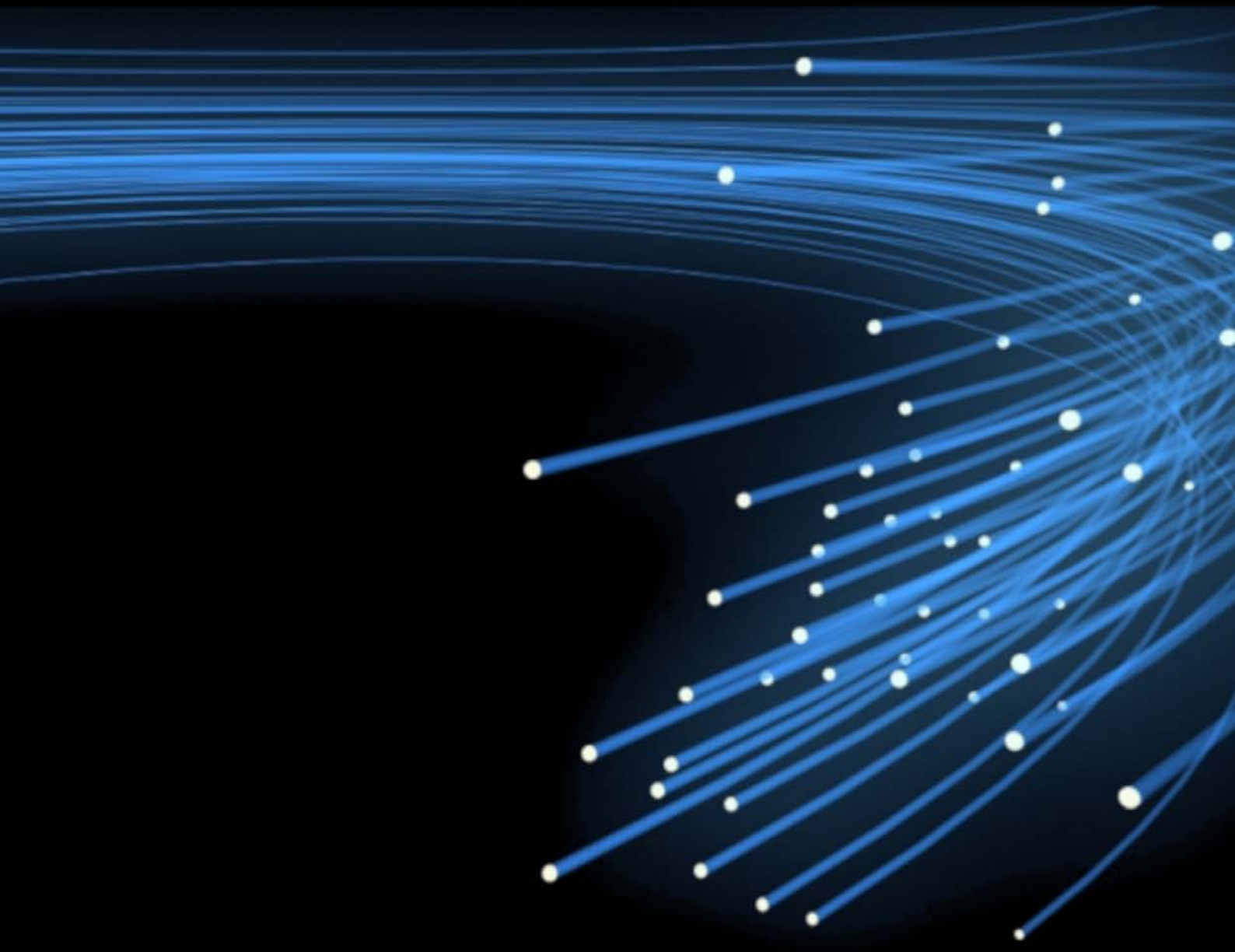
META 2019 Lisbon - Portugal

The 10th International Conference on Metamaterials, Photonic Crystals and Plasmonics



Program

July 23 – 26, 2019
Lisbon - Portugal

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The 10th International Conference on Metamaterials, Photonic Crystals and Plasmonics

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Edited by

Said Zouhdi | Paris-Sud University, France
Antonio Topa | Instituto Superior Técnico, Portugal

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PLENARY SPEAKERS

Jeremy J. Baumberg

University of Cambridge, UK

Extreme nanophotonics : How to confine light below a cubic nanometre

Jeremy J. Baumberg FRS, directs a UK Nano-Photonics Centre at the University of Cambridge and has extensive experience in developing optical materials structured on the nano-scale that can be assembled in large volume. He is also Director of the Cambridge Nano Doctoral Training Centre, a key UK site for training PhD students in interdisciplinary Nano research. Strong experience with Hitachi, IBM, his own spin-offs Mesophotonics and Base4, as well as strong industrial engagement give him a unique position to combine academic insight with industry application in a two-way flow. With over 20000 citations, he is a leading innovator in Nano. This has led to awards of the IoP Faraday gold Medal (2017), Royal Society Rumford Medal (2014), IoP Young Medal (2013), Royal Society Mullard Prize (2005), the IoP Charles Vernon Boys Medal (2000) and the IoP Mott Lectureship (2005). He frequently talks on NanoScience to the media, and is a strategic advisor on NanoTechnology to the UK Research Councils. He is a Fellow of the Royal Society, the Optical Society of America, and the Institute of Physics. His recent popular science book “The Secret Life of Science : How Science Really Works and Why it Matters” is just published by PUP, see np.phy.cam.ac.uk.

Alexandra Boltasseva

Purdue University, USA

Transdimensional Materials for Nanophotonics : From 2D to 3D

Alexandra Boltasseva is a Professor at the School of Electrical & Computer Engineering at Purdue University. She received her PhD in electrical engineering at Technical University of Denmark, DTU in 2004. Boltasseva specializes in nanophotonics, nanofabrication, optical materials, plasmonics and metamaterials. She is 2018 Blavatnik National Award for Young Scientists Finalist and received the 2013 IEEE Photonics Society Young Investigator Award, 2013 Materials Research Society (MRS) Outstanding Young Investigator Award, the MIT Technology Review Top Young Innovator (TR35), the Young Researcher Award in Advanced Optical Technologies from the University of Erlangen-Nuremberg, Germany, and the Young Elite-Researcher Award from the Danish Council for Independent Research. She is a Fellow of the Optical Society of America (OSA) and Fellow of SPIE. She served on MRS Board of Directors and is Editor-in-Chief for OSA’s Optical Materials Express.

Federico Capasso

Harvard University, USA

Metaoptics in the visible

Federico Capasso is the Robert Wallace Professor of Applied Physics at Harvard University, which he joined in 2003 after 27 years at Bell Labs where he was Member of Technical Staff, Department Head and Vice President for Physical Research. He is visiting professor at NTU with both the School of Physical and Mathematical Sciences and Electrical and Electronic Engineering. His research has focused on nanoscale science and technology encompassing a broad range of topics. He pioneered band-structure engineering of semiconductor nanostructures and devices, invented and first demonstrated the quantum cascade laser and investigated QED forces including the first measurement of a repulsive Casimir force. His most recent contributions are new plasmonic devices and flat optics based on metasurfaces. He is a member of the National Academy of Sciences, the National Academy of Engineering, the American Academy of Arts and Sciences. His awards include the King Faisal Prize, the IEEE Edison Medal, the SPIE Gold Medal, the American Physical Society Arthur Schawlow Prize in Laser Science, the Jan Czochralski Award for lifetime achievements in Materials Science, the IEEE Sarnoff Award in Electronics, the Materials Research Society Medal, the Wetherill Medal of the Franklin Institute, the Rank Prize in Optoelectronics, the Optical Society Wood Prize, the Berthold Leibinger Future Prize, the Julius Springer Prize in Applied Physics, the European Physical Society Quantum Electronics Prize.

Nader Engheta

University of Pennsylvania, USA

Analog processing with metastructures

Nader Engheta is the H. Nedwill Ramsey Professor at the University of Pennsylvania in Philadelphia, with affiliations in the Departments of Electrical and Systems Engineering, Materials Science and Engineering, Physics and Astronomy, and Bioengineering. He received his B.S. degree from the University of Tehran, and his M.S and Ph.D. degrees from Caltech. His current research activities span a broad range of areas including nanophotonics, metamaterials, nano-scale optics, graphene optics, optical metatronics, imaging and sensing inspired by eyes of animal species, optical nanoengineering, microwave and optical devices, and physics and engineering of fields and waves He has received several awards for his research including the 2017 William Streifer Scientific Achievement Award from the IEEE Photonics Society, the 2015 Gold Medal from SPIE, the 2015 Fellow of US National Academy of Inventors (NAI), the 2015 National Security Science and Engineering Faculty Fellow (NSSEFF) Award (also known as Vannevar Bush Faculty Fellow Award) from US Department of Defense, the 2015 IEEE Antennas and Propagation Society Distinguished Achievement Award, the 2015 Wheatstone Lecture in King's College London, the 2014 Balthasar van der Pol Gold Medal from the International Union of Radio Science (URSI), the 2013 Inaugural SINA Award in Engineering, the 2012 IEEE Electromagnetics Award, 2006 Scientific American Magazine 50 Leaders in Science and Technology, the Guggenheim Fellowship, and the IEEE Third Millennium Medal. He is a Fellow of seven international scientific and technical societies, i.e., IEEE, URSI, OSA, APS, MRS, SPIE, and American Association for the Advancement of Science (AAAS). He has received the honorary doctoral degrees from the Aalto University in Finland in 2016 and from the University of Stuttgart, Germany in 2016.

Sir John Brian Pendry

Imperial College London, UK

Singular plasmonic surfaces and their properties

Sir John B. Pendry is an English theoretical physicist educated at Downing College, Cambridge, UK, graduating with a Master of Arts degree in Natural Sciences and a PhD in 1969. He is a professor of theoretical solid - state physics at Imperial College London where he was Head of the Department of Physics (1998 – 2001) and Principal of the Faculty of Physical Sciences (2001 – 2002). John Pendry has made seminal contributions to surface science, disordered systems and photonics. His most famous work has introduced a new class of materials, metamaterials, whose electromagnetic properties depend on their internal structure rather than their chemical constitution. He discovered that a perfect lens manufactured from negatively refracting material would circumvent Abbe's diffraction limit to spatial resolution, which has stood for more than a century. His most recent innovation of transformation optics gives the metamaterial specifications required torearrange electromagnetic field configurations at will, by representing the field distortions as a warping of the space in which they exist. In its simplest form the theory shows how we can direct field lines around a given obstacle and thus provide a cloak of invisibility. John Pendry's outstanding contributions have been awarded by many prizes, among which the Dirac Prize(1996), the Knight Bachelor (2004), the Royal Medal (2006), the Isaac Newton Medal (2013) and the Kavli Prize (2014).

Eli Yablonovitch

UC Berkeley, USA

Optical Antenna Physics : Spontaneous Emission Faster than Stimulated Emission

Eli Yablonovitch introduced the idea that strained semiconductor lasers could have superior performance due to reduced valence band (hole) effective mass. With almost every human interaction with the internet, optical telecommunication occurs by strained semiconductor lasers. He is regarded as a Father of the Photonic BandGap concept, and he coined the term "Photonic Crystal". The geometrical structure of the first experimentally realized Photonic bandgap, is sometimes called "Yablonovite".

Prof. Yablonovitch is elected as a Member of the National Academy of Engineering, the National Academy of Sciences, the American Academy of Arts & Sciences, and is a Foreign Member of the Royal Society of London. He has been awarded the Buckley Prize of the American Physical Society, the Isaac Newton Medal of the UK Institute of Physics, the Rank Prize (UK), the Harvey Prize (Israel), the IEEE Photonics Award, the IET Mountbatten Medal (UK), the Julius Springer Prize (Germany), the R.W. Wood Prize, the W. Streifer Scientific Achievement Award, and the Adolf Lomb Medal.

Eli Yablonovitch is the Director of the NSF Center for Energy Efficient Electronics Science (E3S), a multi-University Center headquartered at Berkeley. He received his Ph.D. degree in Applied Physics from Harvard University in 1972. He worked for two years at Bell Telephone Laboratories, and then became a professor of Applied Physics at Harvard. In 1979 he joined Exxon to do research on photovoltaic solar energy. Then in 1984, he joined Bell Communications Research, where he was a Distinguished Member of Staff, and also Director of Solid-State Physics Research. In 1992 he joined the University of California, Los Angeles, where he was the Northrop-Grumman Chair Professor of Electrical Engineering. Then in 2007 he became Professor of Electrical Engineering and Computer Sciences at UC Berkeley, where he holds the James & Katherine Lau Chair in Engineering.

KEYNOTE SPEAKERS

Konstantin Bliokh

Theoretical Quantum Physics Laboratory - Riken, Japan

Topological non-Hermitian origin of surface Maxwell waves

Mark Brongersma

Stanford University, USA

Metasurfaces for Augmented and Virtual Reality

Sven Burger

Zuse Institute Berlin, Germany

Computing resonances in nano-photonic devices using Riesz-projection methods

Giulio Cerullo

Politecnico di Milano, Italy

Tracking ultrafast light-heat conversion in plasmonic nano-assemblies

Manfred Fiebig

ETH Zurich, Switzerland

On the Search for Toroidal Order in Magnetic Materials

Jean-Jacques Greffet

Institut d'Optique Graduate School, France

Electrical generation of surface plasmons with resonant nanoantennas

Thomas Krauss

University of York, UK

Metasurfaces for sensing and imaging

Stefan Maier

LMU Munich, Germany

Plasmonic hot electrons for nanoscale self-assembly and imaging

Sahin K. Ozdemir

The Pennsylvania State University, USA

Non-Hermiticity in Optics and Optomechanics

Nam-gyu Park

Sungkyunkwan University, Korea

Organic-inorganic Lead Halide Perovskite for High Efficiency Energy Conversion

Junsuk Rho

POSTECH, Korea

Artificial chirality evolution in micro-/nano-scale 3D metamaterials

Vladimir Shalaev

Purdue University, USA

Plasmonic Metamaterials Meet Quantum

David R. Smith

Duke University, USA

Optical Field Enhancement in the Nano-Patch Antenna for Lasing, Nonlinear Optics, and Other Nanophotonic Applications

Marin Soljacic

MIT, USA

Neural Networks in Nanophotonics

Jelena Vuckovic

Stanford University, USA

Optimized quantum photonics

Rachel Won

Nature Photonics, UK

Publishing in Nature journals

Nikolay Zheludev

University of Southampton, UK & NTU, Singapore

Optical imaging and metrology with nanoscale resolution

CONFERENCE TUTORIALS

META 2019 features several technical tutorials instructed by world-leading experts on various topics of interest to the META community. Tutorials are intended to provide a high quality learning experience to conference attendees. The tutorials address an audience with a varied range of interests and backgrounds : beginners, students, researchers, lecturers and representatives of companies, governments and funding agencies who wish to learn new concepts and technologies.
The tutorials are part of the conference technical program, and are free of charge for the conference attendees.

ORGANIZER

Prof. Ishwar Aggarwal, UNC Charlotte, USA

Tutorials & Instructors

Prof. Nader Engheta

University of Pennsylvania, USA

Tuesday 23rd July
11:40 - 12:40 — Auditorium I

Near-Zero-Index Metamaterials

In this tutorial, I will present an overview of some of the fundamental principles and unique features of wave interaction with structures with effective refractive index near zero, which include epsilon-near-zero (ENZ), mu-near-zero (MNZ), epsilon-and-mu-near-zero (EMNZ) and Dirac-cone photonic media. I will then discuss some of the applications of near-zero-index metamaterials in photonics and microwave technologies. Possible future directions of research in this field will also be forecasted.

Prof. Federico Capasso

Harvard University, USA

Wednesday 24th July
10:50 - 11:50 — Auditorium I

Flat optics

This tutorial focuses on how metasurfaces enable the redesign of optical components into novel thin and planar diffractive optical elements, that overcome the limitations of Fresnel and refractive optics, promising a major reduction in footprint and system complexity as well as the introduction of new optical functions. The planarity of flat optics will lead to the unification of semiconductor manufacturing and lens making, where the planar technology to manufacture computer chips will be adapted to produce CMOS-compatible metasurface-based optical components, ranging from metalenses to novel multifunctional phase plates.

Prof. Eli Yablonovitch

UC Berkeley, USA

Wednesday 24th July
14:00 - 15:00 — Auditorium II

The Electromagnetic Spectra of Ordinary Objects

There is an aspect of Electromagnetics that has been somewhat overlooked. Common everyday objects can act as electromagnetic resonators. Indeed ordinary objects have a series of resonant frequencies extending from radio waves up to optical frequencies. These resonant modes can be modeled as LC circuits. Thus every object that we encounter is an LC resonator. Since LC circuits support ac currents, and since ac currents imply electron acceleration, they inherently radiate into the far-field. Therefore ordinary objects that we come across, in our daily lives, can act as electromagnetic antennas. This means that ordinary object have a Q-factor and a radiation Q-factor for each resonant mode.The lowest frequency resonance is especially characteristic of the object geometry, but there is an entire spectrum of higher frequencies to work with, a spectral fingerprint for everyday objects. Many of the properties that have been attributed to plasmonic resonances are actually universal, and they arise already in ordinary electromagnetics.In communications technology, the antenna application is the most important. The antennas in cellphones, carried by almost everyone on the planet, are examples of multi-frequency resonant objects, enabling wireless connectivity.

Dr. Rachel Won

Nature Photonics, UK

Thursday 25th July
11:00 - 12:00 — Auditorium II

Writing and submitting your papers : Dos and Don'ts

In this tutorial, Rachel will talk you through the detailed information and guidelines on scientific paper preparation and submission. Guidelines and tips for writing an abstract and a paper will be provided. Submission, editorial and peer-review processes will be discussed. At the end of the tutorial, you will walk away knowing how to write an informative cover letter, an outstanding abstract and a comprehensive scientific paper. You will also get to know where to submit your papers to, what editors seek, how your papers are reviewed and how to make an appeal.

Prof. Michael Fiddy

DARPA, USA

Thursday 25th July
14:00 - 15:00 — Auditorium I

DARPA's interests in metamaterials

Almost twenty years ago, some of the earliest research into metamaterials and their applications was funded by DARPA. The field has grown enormously since, and DARPA still supports fundamental research into improving our understanding and modeling of these engineered materials. This talk will provide the background and context for research of current interests. These include the study of new material properties, including bianisotropy and nonlinearity, advancing flat optics, and developing nonreciprocal and tunable components, all of which may impact imaging and remote sensing capabilities.

META 2019 VENUE

META 2019 will be held at the Congress Center of **Instituto Superior Técnico (IST)**, situated at the Civil Engineering Building. All talks are scheduled for the Congress Centre of IST **except for the Plenary talks** which will be held in **Culturgest**, an independent conference center located 500m away from IST (see map).

Instituto Superior Técnico - Congress Center
Civil Engineering Building (Pavilhão de Civil)
Av. Rovisco Pais 1
1049-001, Lisbon

Website : https ://tecnico.ulisboa.pt/en/

Culturgest
Rua Arco do Cego 77
1000-300
Lisbon

Website : https ://www.culturgest.pt/en/

GETTING TO VENUE

Taxi

The quickest way to get from Lisbon Airport (LIS) to Instituto Superior Técnico is to taxi which costs 7€ - 9€ and takes 10mn.

Metro

Being close to the Lisbon city centre, IST is easily reached by metro (metro station **"Alameda"** - Red and Green lines ; metro sation **"Saldanha"** - Red and Yellow lines), from any location in town, including the airport (metro station **"Aeroporto"**- Red line).

Bus

The bus routes cover all Lisbon and extend to its outskirts. The tickets can be pre-paid, at the counters of Carris, the surface transportation operator for Lisbon, or bought aboard the bus, electric cars or funiculars. For IST hop off on one of the following bus stops :

- ☐ Av. Manuel da Maia
- ☐ Av. Rovisco Pais
- ☐ Arco do Cego

GENERAL INFORMATION

Registration

Registered participants may pick up their conference material at the registration desk which will be located :

• Monday, July 22 (15 :00-18 :00) : IST Civil Engineering Building
• Tuesday, July 23 (08 :00 - 10 :45) : **Culturgest**, in the foyer next to the Main Auditorium

• Tuesday, July 23 (10 :45 - 18 :00) : IST Civil Engineering Building
• Wednesday, July 24 (08 :30-18 :00) : IST Civil Engineering Building
• Thursday, July 25 (08 :30-17 :00) : IST Civil Engineering Building
• Friday, July 26 (08 :30-11 :00) : IST Civil Engineering Building

Plenary Lectures

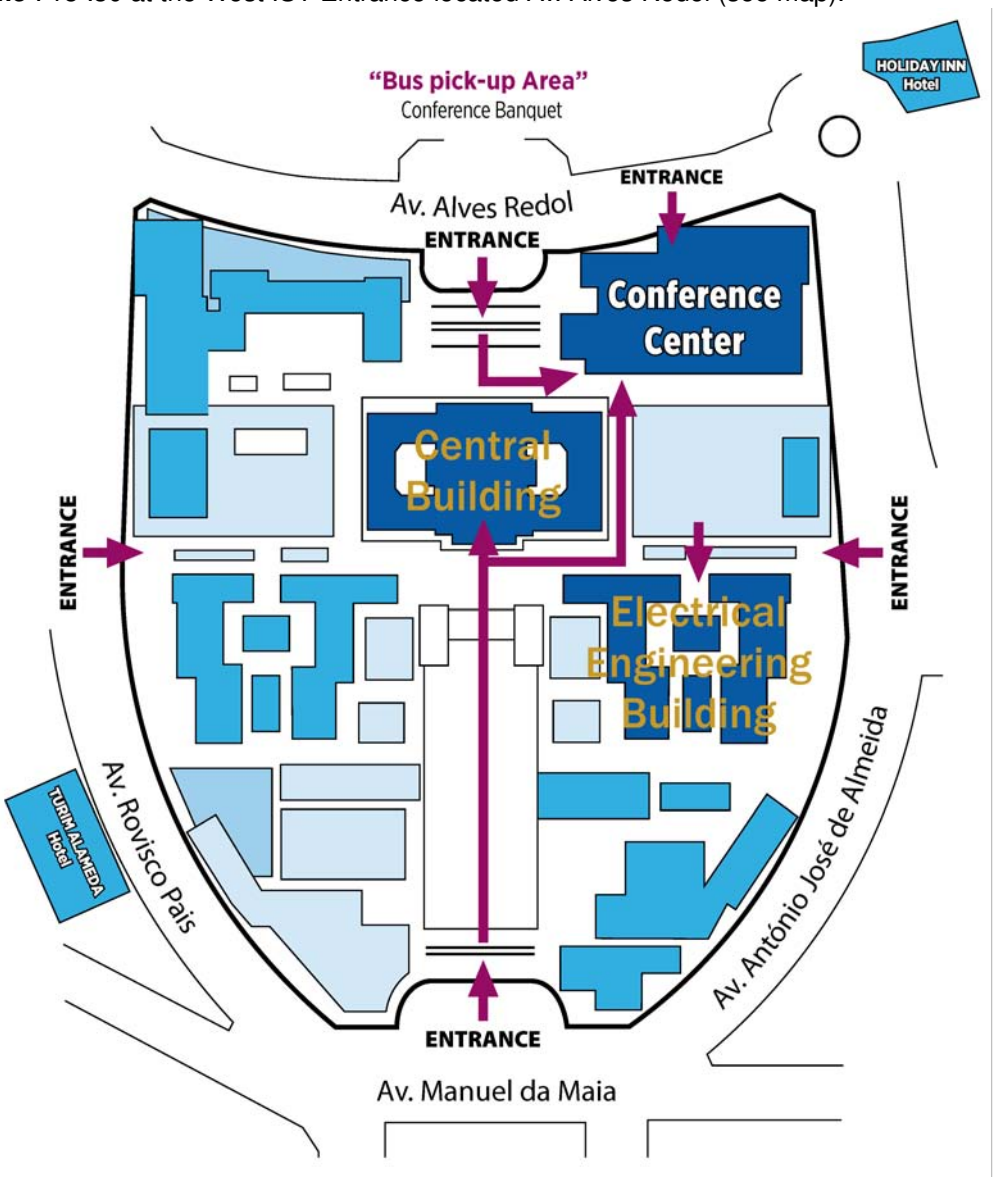
Plenary Lectures will be held at the Main Auditorium of **Culturgest**, located 500m away from Instituto Superior Técnico Congress Center :
• Tuesday, July 23 (08 :45-10 :45)
• Thursday, July 25 (08 :30-10 :15)

Banquet

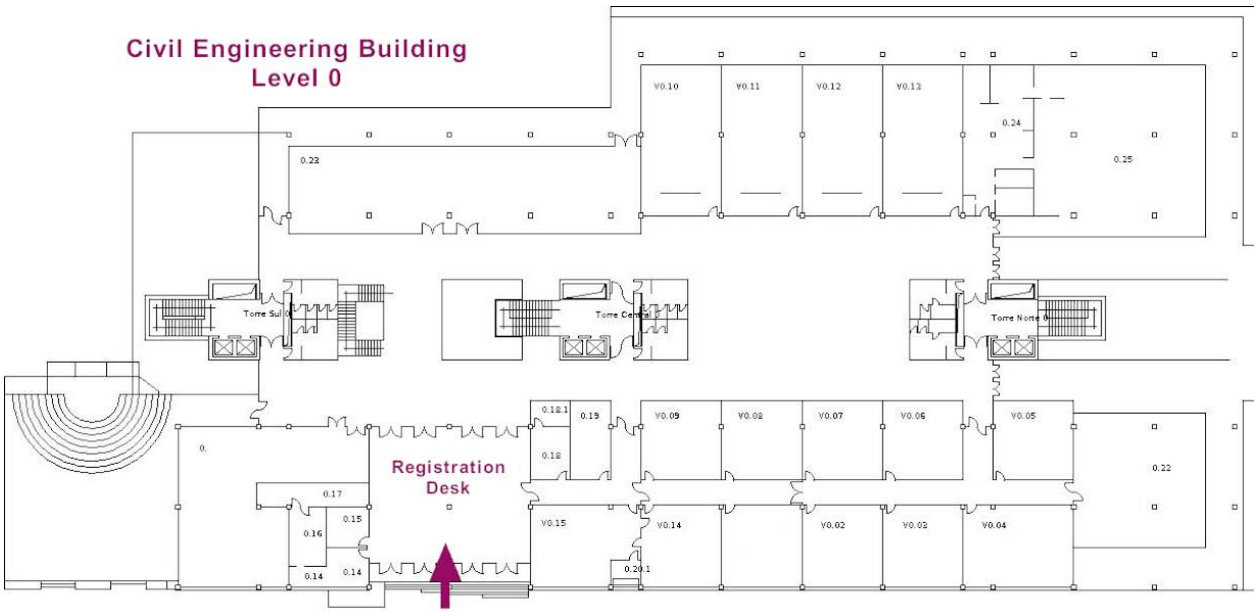
Venue : KAIS Restaurant, Cais da Viscondessa, R. da Cintura – Santos, 1200-109 Lisboa, Portugal.
Schedule : Thursday, July 25 at 20 :00.

Free Shuttle bus service will be provided between the Instituto Superior Técnico Congress Center and the KAIS Restaurant.

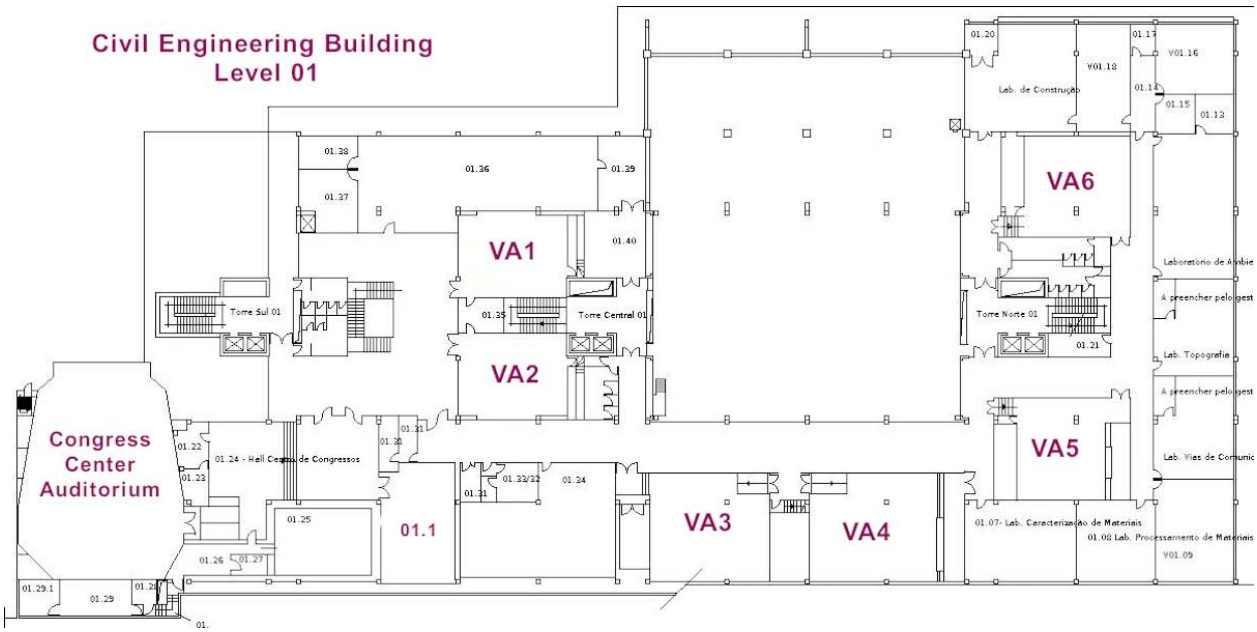
Pick-up time : 18 :30 at the West IST Entrance located Av. Alves Redol (see map).



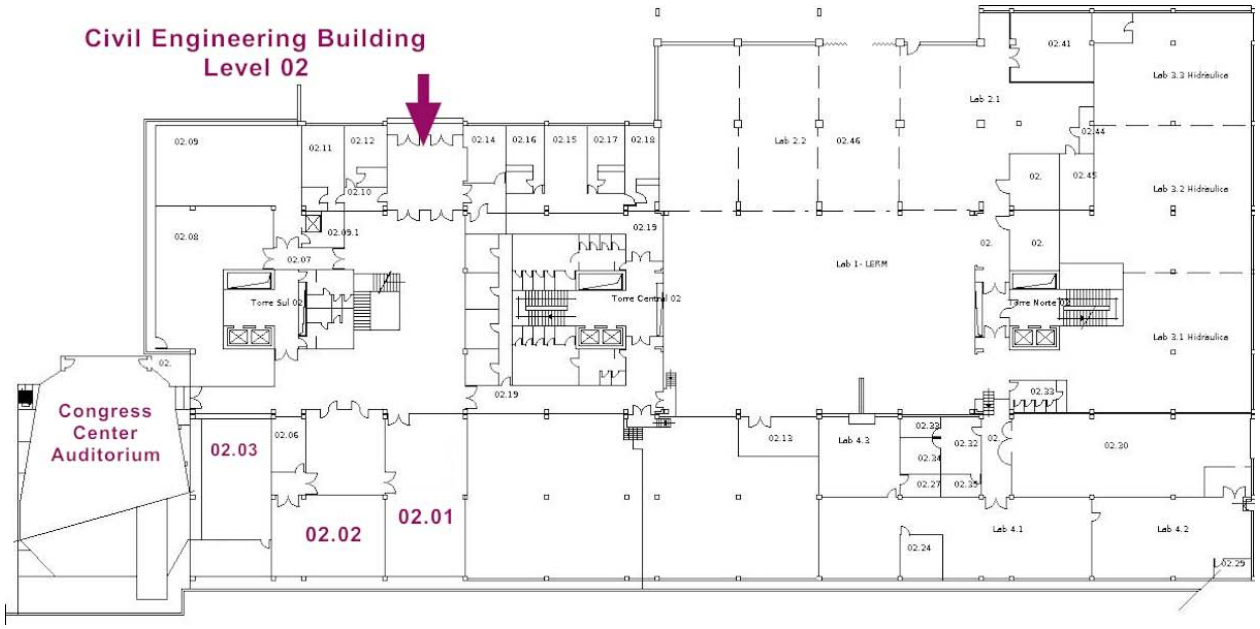
IST CONGRESS CENTER FLOOR PLANS



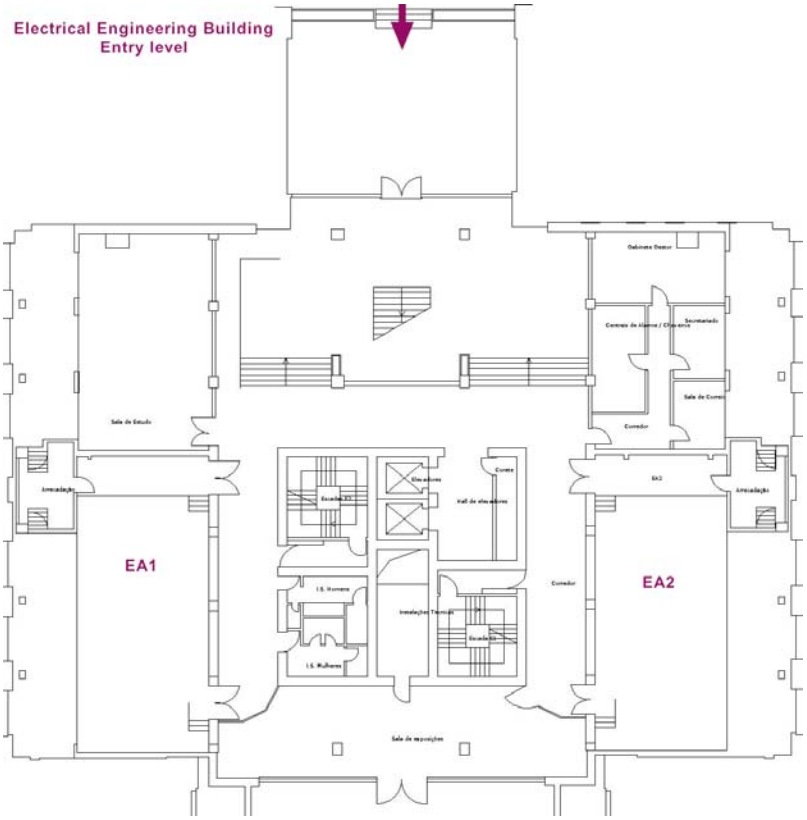
Civil Engineering Building - Level 0



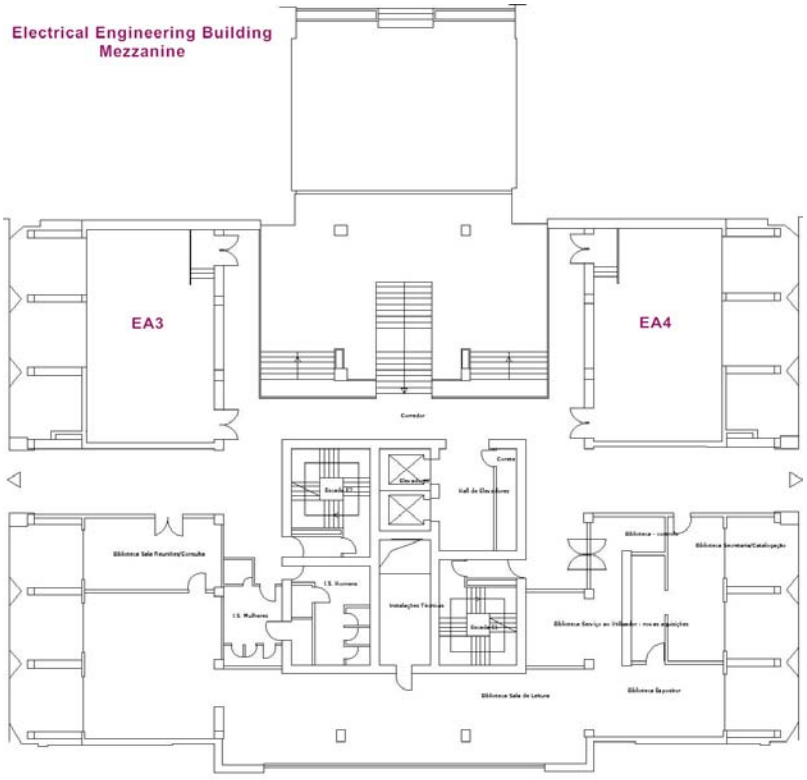
Civil Engineering Building - Level 01



Civil Engineering Building - Level 02



Electrical Engineering Building - Entry level



Electrical Engineering Building - Mezzanine

WI-FI INSTRUCTIONS

Wi-Fi instructions for **META 2019** participants :

1. Browse available wireless networks and select as SSID "tecnico-guest" ;
2. Set IP to automatic (DHCP). This is usually the default setting, so you may probably skip this step ;
3. Open your browser and try to access any external website. You will be automatically redirected to the page **https ://wifi.ist.utl.pt/index_auth.php**. Follow the link 'Web based login' at the top of the page concerning short-time, conference and meetings accounts. Enter the following username/password when requested ;

   Username : **META2019**
   Password : **jwvr2f**

4. After step 3 you may freely browse and access the Internet. You may need to repeat the above steps if you close your browser or if the connection times out.

GUIDELINES FOR PRESENTERS

ORAL PRESENTATIONS

Each session room is equipped with a stationary computer connected to a LCD projector. Presenters must load their presentation files in advance onto the session computer. Technician personnel will be available to assist you.

Scheduled time slots for oral presentations are 15 mn for regular, 20 mn for invited presentations, 30 mn for keynote talks and 35 mn for plenary talks, including questions and discussions. Presenters are required to report to their session room and to their session Chair at least 15 minutes prior to the start of their session.

The session chair must be present in the session room at least 15 minutes before the start of the session and must strictly observe the starting time and time limit of each paper.

POSTER PRESENTATIONS

Presenters are requested to stand by their posters during their session. One poster board, A0 size (118.9 x 84.1 cm), in portrait orientation, will be available for each poster (there are no specific templates for posters). Pins or thumbtacks are provided to mount your posters on the board. All presenters are required to mount their papers 30mn before the session and remove them at the end of their sessions. Posters must prepared using the standard META poster template (available on the conference website).

TECHNICAL PROGRAM

Monday 22nd July, 2019

Registration

IST Civil Engineering Building

15:00 - 18:00

Tuesday 23rd July, 2019

Registration

Culturgest

08:15 - 10:45

Opening Address

Culturgest

08:45 - 09:00

09:00 - 10:45 — Culturgest

Session 1A1

Plenary Session I

Chaired by: John Pendry

09:00 : Plenary talk
Extreme nanophotonics: How to confine light below a cubic nanometre
Jeremy J. Baumberg
University of Cambridge (United Kingdom)

Using DNA origami we couple 1-4 dye molecules together optomechanically, and produce strong-light matter coupling that changes their quantum emission properties. We also watch redox chemistry in real time, watching single electrons shuttle in and out of single molecules, as well as 2D materials confined in the same gap. Prospective applications range from (bio)molecular sensing to fundamental science. I particularly focus on applications to nanomachinery actuation by light.

09:35 : Plenary talk
Analog processing with metastructures
Nader Engheta
University of Pennsylvania (USA)

In my group we have been developing metamaterials that perform analog computation with waves. In particular, we have designed and tested metastructures that solve integral equations as waves go through them. We have been working on two different platforms for such analog processing: (1) Inhomogeneous metamaterials, and (2) Collections of Mach-Zehnder interferometers (MZIs). In this talk, I will present some of our results and will discuss several relevant research directions currently being explored in my group.

10:10 : Plenary talk
Metasurface Polarization Optics
Federico Capasso
Harvard University (USA)

The elements comprising a metasurface may possess tailored structural birefringence, making metasurface based flat optics a fascinating platform for new polarization optics to circumvent the above problems. A new class of phase plates has emerged from our research in this area along with major advances in polarimetry and polarization imaging, with greatly reduced complexity and increased functionality compared to existing technology.

Registration

IST Civil Engineering Building

10:45 - 18:00

Coffee Break and Exhibit Inspection

Session 1P1

Poster session I

10:45 - 11:40

P1: Selectively reconfigurable molecularization of terahertz meta-atoms
Hyunseung Jung, Hyunwoo Jo, Wonwoo Lee, Moon Sung Kang, Hojin Lee
Soongsil University (Korea)

In this study, we propose selectively reconfigurable terahertz meta-molecules by controlling the micro-patterned ion-gel gate structures to change the conductance of graphene bridges between adjacent meta-atoms. Moreover, we experimentally verify that the proposed structures can change the resonance freqeuncy of metamaterial from 1.40, 1.10, to 0.74 THz, by changing the metamaterial unit cell from the individual atom to dimeric and tetrameric molecules, respectively.

P2: Correlated disordered nanostructures embedded in flexible film
Frederic Hamouda, Gil Cardoso, Saber Hammami, Beatrice Dagens
Université Paris-Saclay (France)

Metallic or dielectric nanostructures (NSs) modify the reflectance spectrum of functionalized glass surfaces and allow multiple or localized staining without using complex surface treatments. Here, we present the fabrication of metallic and dielectric NSs embedded in a flexible poly(dimethylsiloxane) (PDMS) film to modify its reflectance spectrum. The NSs are positioned with correlated disordered arrangements to avoid light diffraction and diffusion. PDMS enables fabrication of functionalized flexible and repositionable film which conforms to the shape of rigid transparent supports.

P3: Enhancement of Faraday rotation of iron thin layers on periodic array of Al nanocylinders
Taisuke Atsumi, Shunsuke Murai, Katsuhisa Tanaka
Kyoto University (Japan)

Diffractive plasmonic nanostructures sustain both localized surface plasmon polaritons and optical diffraction in the plane of the array, i.e., lattice plasmon. Although such structure combined with magnetic materials can largely enhance magnetooptical effects, the plasmonic material utilized for MO enhancement is limited to Au. In this study, we fabricated diffractive array composed of Al nanocylinders and succeeded in enhancement of Faraday rotation of Fe layer deposited on the array at spectrally shorter range of visible light.

P4: All dielectric frequency-division multiplexing wave plate metasurface
Shuo Du, Zhe Liu, Junjie Li, Changzhi Gu
Chinese Academy of Sciences (China)

We report an all dielectric frequency-division multiplexing wave plate metasurface, which simultaneously possesses the function of broadband half/quarter-wave plates for transmission spectral in mid/near-infrared. The structure units of our metasurface are silicon cross-nanoblocks, which are easy to be fabricated by planar precesses. Besides, at wavelengths with the function of high working efficiency half-wave plate, the structure units can be used to design variety of wavefront optical devices, such as metalens and holographic imaging.

P5: Nonlocality and singular metasurfaces
Fan Yang, Yao-Ting Wang, Paloma Arroyo Huidobro, John B. Pendry
Imperial College London (United Kingdom)

The far field spectrum of plasmonic metasurface with sharp features is very sensitive to nonlocality in the metal such that the microscopic nonlocal effects can be unveiled from far field measurements.

P6: Antenna-Controlled Photon Antibunching from Individual Carbon Nanotubes as Quasi-1D systems

Lucas Lange, Frank Schafer, Alexander Biewald, Richard Ciesielski, Achim Hartschuh
Ludwig-Maximilians-University (Germany)

We present a combined experimental and numerical study that utilizes optical antennas to convert a carbon nanotube as a model system for 1D emitters into a single photon source by localization and efficient exciton-exciton annihilation (EEA).

P7: Quantum Mechanical Effects on Nanofocusing Limits of Metal-Insulator-Metal Plasmonic Waveguides

Daniel Rimoli Assumpcao[1], **Hyuck Choo**[2]
[1] *California Institute of Technology (USA),* [2] *Samsung Advanced Institute of Technology (Korea)*

We have numerically investigated the degradation of the nano-focusing/confinement performance of plasmonic metal-insulator-metal waveguides due to quantum effects at nanometer gap sizes. We demonstrate that Landau damping is the dominant effect for gaps larger than 0.5 nm but below $\sim$5nm, decreasing the propagation length but not affecting the mode length. Below 0.5 nm, quantum tunneling significantly increases the losses, setting a practical limit of 0.5 nm for the minimum gap size.

P8: Band Structure and Transmission in Multiferroic based Sierpinski Carpet Phononic Crystal

Selami Palaz[1], **Zafer Ozer**[2], **Amirullah M. Mamedov**[3], **Ekmel Ozbay**[3]
[1] *Haran University (Turkey),* [2] *Mersin University (Turkey),* [3] *Bilkent University (Turkey)*

In this study, quasi Sierpinski-carpet phononic crystals (PnCs) were first identified as unit cells and the band structure obtained in the direction of the Γ-X-M-Γ. The Floquet periodicity conditions are applied to the supercells and the band structures are obtained by using the finite element method (FEM). The band gap structure, transmission spectra and displacement fields of eigenmodes of the proposed structures are calculated by using FEM.

P9: Band Gap and Wave Propagation on Liquid Crystal Based Sonic Metamaterials

Selami Palaz
Haran University (Turkey)

The propagation of acoustic waves in 2D sonic crystals (SC) is studied experimentally and theoretically by using plane-wave expansion (PWE) method. 2D SC with square and hexagonal lattices composed of cylindrical rods embedded in the different lyotropic liquid crystals matrices are studied to find the allowed and stop bands for the waves of certain energy. The calculated phonon dispersion results indicate the existence of full acoustic modes in the proposal structure along the high symmetry points.

P10: Picosecond acoustics of vanadium dioxide

Iaroslav Mogunov[1], **Anatolii Fedianin**[2], **Felix Fernandez**[3], **Sergiy Lysenko**[3], **Anthony Kent**[4], **Alexey Scherbakov**[5], **Alexandra Kalashnikova**[1], **Andrey Akimov**[4]
[1] *Ioffe Institute (Russia),* [2] *ITMO University (Russia),* [3] *University of Puerto Rico (USA),* [4] *University of Nottingham (United Kingdom),* [5] *Technische Universitat Dortmund (Germany)*

Picosecond acoustics utilizes short strain pulses generated by pulsed lasers to determine and affect properties of solid media. This represents two challenges in the field - to achieve stronger strain-induced effects and to generate stronger yet shorter strain pulses. Here we examine if a medium with insulator-metal transition, such as vanadium dioxide VO2, may facilitate addressing both challenges.

P11: Dispersive Measurements of flux-Qubit States: Energy-Level Splitting and Beyond

Jeong Ryeol Choi
Kyonggi University (Korea)

The complete quantum solutions of the flux qubit-oscillator in the Fock state have been derived under the condition that the coupling strength is weak. The influence of parameters, such as the tunnel splitting, the coupling strength, the Josephson inductance, and the shunt capacitance, on the system was examined. In particular, upper and lower energy levels and the difference between them were analyzed in detail.

P12: Designer hyperbolic nanostructures for thermo-plasmonic bio-medical applications using finite element and finite difference time domain methods

Nicolo Maccaferri

University of Luxembourg (Luxembourg)

We present a detailed numerical study where, by means of finite element and finite difference time domain methodologies, we design nanostructured meta-antennas which enable a full control of absorption and scattering of light.

P13: Numerical dipoles method for light scattering by disordered metasurfaces

Maxime Bertrand[1], Alexis Devilez[2], Jean-Paul Hugonin[3], Philippe Lalanne[2], Kevin Vynck[2]
[1] *Institut d'Optique Graduate School (France),* [2] *Université de Bordeaux (France),* [3] *Université Paris-Saclay (France)*

We propose a novel numerical method to efficiently and accurately model the optical response of disordered metasurfaces, consisting of large ensembles of non-spherical nanoparticles in a stratified medium, including in cases where the nanoparticles are in the near field of a surface or of each other.

P14: Invariant-Based Dynamics Towards Optimal Adiabatic Qubit-Information Detection with Superconducting Qubit Resonators

Jeong Ryeol Choi
Kyonggi University (Korea)

Time behavior of the Rayleigh-Lorentz invariant for a flux qubit resonator has been investigated in order to achieve better understanding of the resonator in quantum computing systems. We have analyzed the time variation of the Rayleigh-Lorentz invariant of the system and confirmed that such variation is non-negligible especially when the parameters vary significantly. An optimal condition for adiabatic qubit-information detection with the qubit resonator has been obtained from the invariant dynamics.

P15: Phononic Crystals with Archimedean-Like Tiling's: Transmission, Band Structure and Transformation of Sound

Zafer Ozer
Mersin University (Turkey)

In this study we investigate acoustic wave propagation in 3D phononic crystal (PnC) slabs which scatterers having different cross sections by using finite element method (FEM). Compared to traditional square lattice PnC's, it has been observed that the bands obtained in Archimedean-like structures may have some advantages in terms of width and position. It was also shown that the low frequency response of two Archimedean-like structures was similar in with respect to the traditional square lattice.

P16: Design and Manufacturing of Bitmap-type Microwave Absorber Metasurface

Ye-Pil Kwon[1], Eun-Chae Jeon[1], Tae-Jin Je[2], Je-Ryung Lee[2], Seunghwan Moon[2], Myungjoon Kim[3], Joonkyo Jung[3], Jonghwa Shin[3], Doo-Sun Choi[2]
[1] *University of Ulsan (Korea),* [2] *Korea Institute of Machinery and Materials (Korea),* [3] *KAIST (Korea)*

Metasurfaces having a large degree of freedom are highlighted in order to replace absorptive paints for microwave stealth function. We suggested new methods to design and to manufacture bitmap-type microwave absorber metasurfaces based on an inductive and a deductive design approaches and mechanical machining technologies in this study. A manufactured metasurface having 300mm in size showed less than -10dB reflectivity from 9GHz to 12GHz.

P17: Spiral metalens for tight focusing of azimuthally polarized optical vortex

Anton Nalimov[1], Sergey Stafeev[1], Liam O'Faolain[2], Victor Kotlyar[1]
[1] *Russian Academy of Sciences (Russia),* [2] *Cork Institute of Technology (Ireland)*

We investigated a spiral metalens fabricated on a thin film of amorphous silicon. The metalens converts linearly polarized incident light into an azimuthally polarized optical vortex, and focuses it at a distance approximately equal to the wavelength of the incident light 633 nm. Using a scanning near-field optical microscope, it is shown experimentally that the metalens forms an elliptical focal spot with diameters smaller than the diffraction limit: 0.32 and 0.51 of the wavelength.

P18: Coherent perfect absorber and laser for nonlinear waves

Vladimir Konotop[1], Herwig Ott[2], Dmitry Zezyulin[3]
[1] *Universidade de Lisboa (Portugal),* [2] *Technische Universitat Kaiserslautern (Germany),* [3] *ITMO University (Russia)*

Coherent perfect absorber and laser for nonlinear waves are introduced. As an example, we consider an

array of optical waveguides, in which waveguides with gain and absorption are incorporated. The results are generalized to setups with nonlinear active and absorbing waveguides, in particular, characterized by additional nonlinear dissipation or gain. Two-dimensional arrays are also considered.

P19: Perfect absorption using sparse arrays of Helmholtz resonators
Jean-Francois Mercier[1], Agnes Maurel[2], Kim Pham[1]
[1] *ENSTA ParisTech (France),* [2] *ESPCI ParisTech (France)*

We inspect the influence of the spacing on the resonance of an array of Helmholtz resonators. The strength of the resonance is found enhanced when the array becomes sparser, which provides a degree of freedom to control the radiative damping. This is of particular interest since it does not affect the resonance frequency nor the viscous damping and the total thickness of the array. We show that it can be used for the design of a perfect absorbing walls.

P20: High Photoelectrochemical Activity of CuInS2 Quantum Dots/In2S3/ZnO Nanowire Arrays Electrode
Yu-Kuei Hsu, Hao-Hsuan Chang
National Dong Hwa University (Taiwan)

Deposition of CuInS2 QDs on ZnO NWs with interlayer of In2S3 as photoelectrode has been successfully fabricated on FTO via the facile solution routes for photoelectrochemistry. The morphology and structure of CIS QD/In2S3/ZnO NWs are systematically analyzed with SEM, TEM and XRD. In comparison with pristine ZnO, the CIS QD/In2S3/ZnO photoelectrode illustrates efficient charge separation and charge transport path to achieve the highest photocurrent of 2.4 mAcm-2 that is competitive with other Cd- and Pb-free QD-based materials.

P21: Comparison of the negative energy flow in linearly and circularly polarized beams focused with metalens
Victor Kotlyar[1], Anton Nalimov[2], Sergey Stafeev[2]
[1] *IPSI RAS (Russia),* [2] *Samara National Research University (Russia)*

Using the FDTD-aided numerical simulation, we show that uniform linearly or circularly polarized light passing through the proposed optical metasurface with m=2 and then tightly focused with a binary zone plate generates an on-axis near-focus energy backflow comparable in magnitude with the incident energy. Notably, the magnitude of the reverse energy flow is shown to be the same when focusing a circularly polarized optical vortex with topological charge m=2 and a light beam with the second-order polarization singularity.

P22: Coupling of Gap Plasmon and Lattice Plasmon Resonances in Metal-Dielectric-Metal Gratings
Ricky Gibson, Joshua R. Hendrickson, Shivashankar Vangala, Dennis E. Walker
Air Force Research Laboratory (USA)

We investigate, both experimentally and with computational modeling, the coupling of gap plasmon modes and lattice plasmon modes in metal-dielectric-metal structures in the mid-wave infrared. Coupling between these modes is observed due to the asymmetric Fano-like lineshape at the resonant crossings both in finite-difference time-domain simulations and angle dependent spectra.

P23: Sensitivity of layered structures in critical conditions
Agnes Maurel[1], Kim Pham[2], Jean-Francois Mercier[2]
[1] *ESPCI ParisTech (France),* [2] *ENSTA ParisTech (France)*

We conduct two-scale homogenization of multilayered structures composed of nonmagnetic isotropic materials. The resulting effective model involves a relation between the electric field and electric displacement and non intuitive transmission conditions at the interfaces with the surrounding media. In transverse electric polarization, the model reduces to a fully local model and in transverse magnetic polarization, classical non local terms appear. Comparaison with direct numerics show that the model is accurate up to the critical conditions near total reflection.

P24: Ultra-wideband graphene circulators for THz region
Victor Dmitriev, Samara Leandro Matos da Silva, Wagner Castro
Federal University of Para (Brazil)

3-port and 4-port THz circulators are discussed. The circulators are based on graphene placed on a two-layer dielectricsubstrate. The circulation behaviour is defined by application of a DC magnetic field normal to the

graphene plane. We discuss the choice of the physical and geometrical parameters which provide octave frequency band of these components.

P25: Electrically tunable multicolored filter based on plasmonic nanoscale phase retarder and liquid crystals

Luc Driencourt[1], Dimitrios Kazazis[2], Yasin Ekinci[2], Francois Federspiel[3], Richard Frantz[3], Rolando Ferrini[1], Benjamin Gallinet[1]

[1] *Centre Suisse d'Electronique et de Microtechnique (Switzerland),* [2] *Paul Scherrer Institut (Switzerland),* [3] *Rolic Technologies Ltd. (Switzerland)*

An electrically tunable filter based on a nanoimprinted plasmonic phase retarder and liquid crystal cell is reported. A plasmon resonance and its abrupt phase jump yield structural colors between crossed polarizers. A range of 8V is enough to access to more than half of the area covered by standard RGB filters in CIE color coordinates with a single filter. Such approach is foreseen in particular to increase the spatial resolution of display devices.

P26: Titanium nitride nanowires fabricated by oblique deposition for hyperbolic metamaterials

Kenichi Yatsugi, Kazutaka Nishikawa

Toyota Central R-D Labs. (Japan)

We fabricated a nanowire array using titanium nitride, which has a high melting point, by dynamic oblique deposition of titanium and subsequent thermal treatment in ammonia. The opposite signs of in-plane and out-of-plane permittivity indicate that fabricated nanowire array presented here is a promising candidate for hyperbolic metamaterials in high-temperature applications due to the high melting point of titanium nitride.

P27: Optical properties of self-assembled, thin-walled nanotube TiO2 arrays

Christin David

IMDEA Nanoscience (Spain)

Optical properties of twodimensional arrays of hollow TiO2 nanotubes are investigated. Their straightforward fabrication via electrochemical anodization allows precise tailoring of geometry and material properties. We calculate achievable field enhancement, including under additional charge doping occurring during fabrication, and the short circuit current for a range of configurations. For our simulations, we employ the Rigorous Coupled Wave Analysis to perform field enhancement studies of the optical response of arrays of thinwalled nanotubes relative to the bare Ti foil substrate.

P28: Metal-enhanced up-conversion luminescence tuned by optically controlled orientation of dipoles

Maciej Cwierzona[1], Aneta Prymaczek[1], Justyna Grzelak[1], Marcin Nyk[2], Sebastian Mackowski[1], Dawid Piatkowski[1]

[1] *Nicolaus Copernicus University (Poland),* [2] *Wroclaw University of Science and Technology (Poland)*

In this work we present the results regarding interaction between single emitters and silver nanowires. We use Photoluminescence microscopy and fluorescence-Lifetime Imaging Microscopy to investigate radiative emission rates of the nanocrystals localized close to the nanowire. We use polarized laser beam to control orientation of the dipole moments of the nanocrystals to show that radiative rate enhancement strongly depends on orientation of the dipoles with respect to the nanowire, giving new insight into nature of the metal enhanced fluorescence.

P29: Plasmon enhancement of energy transfer from single up-converting nanocrystals to P3HT

Justyna Grzelak[1], Aneta Prymaczek[1], Maciej Cwierzona[1], Marcin Nyk[2], Dawid Piatkowski[1], Sebastian Mackowski[1]

[1] *Nicolaus Copernicus University (Poland),* [2] *Wroclaw University of Technology (Poland)*

We report on the possibility of enhancing the energy transfer from colloidal single up-converting NaYF4 nanocrystals doped with rare-earth ions to poly(3hexylthiophene) (P3HT) polymer by plasmon excitation in a single silver nanowire. Based on such an approach we want to demonstrate how to sensitize organic solar cells to the infrared optical spectrum.

P30: Coding Huygens' Metasurface for Microwave Holography

Chunsheng Guan[1], Xumin Ding[1], Kuang Zhang[1], Badreddine Ratni[2], Shah Nawaz Burokur[2], Ming Jin[1], Qun Wu[1]

[1] *Harbin Institute of Technology (China),* [2] *Univ Paris Nanterre (France)*

In this paper, coding Huygens' metasurface (CHM) is proposed for holographic imaging with enhanced quality. The proof-of-concept experiments show that the quality of holographic imaging can be indeed improved by utilizing digital meta-atoms with several bits. The proposed CHM hologram shows great potential in a variety of application fields, such as programmable high-resolution imaging lenses, microscopy, data storage, information processing and computer-generated holograms.

P31: Acoustic Metamaterial Lenses for 40kHz Ultrasound Fabricated with Consumer 3D-printers
James Hardwick, Jordi Prat-Camps, Sriram Subramanian
University of Sussex (United Kingdom)

With the advent of high resolution 3D printing we can now fabricate complex and intricate structures with relative ease and low cost. In this project we design different acoustic lenses for ultrasonic waves of frequency 40kHz using a set of phase delaying unit cell bricks arranged into specific patterns. We use different consumer 3D-printers to fabricate them and compare the results of these different printing techniques. finally, we test the performance of each in terms of acoustic field control.

P32: Dielectric metamaterials with epsilon-near-zero regime
Ekaterina E. Maslova, Mikhail V. Rybin
ITMO University (Russia)

We consider all-dielectric metamaterials with electric response allowing an epsilon-near zero regime. The metamaterials being a hexagonal lattice of dielectric rods are studied. We construct a photonic phase diagram by analyzing photonic band diagrams. A near-boundary phase with a strong spatial dispersion is found in the structures with a hexagonal lattice, which is not observed in the case of a square lattice.

P33: Control of IR emissivity with metasurface structures
Roxana Tomescu[1], Mihai Kusko[1], Dana Cristea[1], Laura Mihai[2], Ramona Calinoiu[1], Cristian Kusko[1], Catalin Parvulescu[1]
[1] *National Institute for R-D in Microtechnologies (Romania),* [2] *National Institute for Laser Plasma and Radiation Physics (Romania)*

We propose a compact photonic device that presents an improved and controlled emissivity on specific tight infrared wavelengths intervals, consisting in an infrared thermal source and a metasurface absorber. The source is composed of 200nm thick chromium layer in meander configuration, the line width is 100μm and the resistor area is 1mm2. The metasurface is tailored to attain almost perfect absorption on infrared wavelengths intervals specific for gases that may be found in industrial infrastructures like methane or carbon dioxide.

P34: Anti-crossing of counter propagating modes within the Brillouin Zone
Milo Baraclough, William Leslie Barnes, Ian Richard Hooper
University of Exeter (United Kingdom)

Bandgaps resulting from anti-crossings between modes are a common feature of periodic media. Typically they occur at the Brillouin zone boundary, or result from interactions between forward propagating modes of different character. By breaking the symmetry of a metamaterial waveguide that supports both forward and backward propagating modes we demonstrate an anti-crossing within the Brillouin zone that exhibits band edges with zero group velocity.

P35: Hybrid graphene-antenna structure for terahertz detection
KlaasJan Tielrooij[1], Sebastian Castilla[2], Bernat Terrés[2], Marta Autore[3], Leonardo Viti[1], Alexey Nikitin[3], Miriam Vitiello[4], Rainer Hillenbrand[3], Frank Koppens[2]
[1] *Catalan Institute of Nanoscience and Nanotechnology (ICN2) (Spain),* [2] *ICFO (Spain),* [3] *CIC nanoGUNE (Spain),* [4] *NEST- CNR (Italy)*

By combining high-quality graphene with a narrow-gap antenna structure, we demonstrate a very fast and highly sensitive terahertz (THz) detector. The detector is based on the efficient heating of graphene carriers induced by THz absorption and photocurrent generation through the photo-thermoelectric effect, where carrier heat leads to a photoresponse at a junction between two graphene regions with different carrier density, typically a pn-junction. Crucially, the metallic antenna structure leads to strong field enhancement exactly at the location of this junction.

P36: Stealth Acoustic Materials for Scattering Cancellation
V. Romero-Garcia[1], N. Lamothe[1], G. Theocharis[1], O. Richoux[1], L. M. Garcia-Raffi[2]

[1] *Le Mans University (France),* [2] *Universitat Politecnica de Valencia (Spain)*

We report a material that suppresses the acoustic scattering for a given set of incident wave vectors. This stealth acoustic material consists of multiple scatterers, rigid diaphragms, located in an air-filled acoustic waveguide. The experimental results are in good agreement with the theory. The robustness and the generality of the results motivate potential applications in wave physics.

P37: Plasmonic biosensing with silver nanowires
Karolina Sulowska[1], Ewa Rozniecka[2], Joanna Niedziolka-Jonsson[2], Sebastian Mackowski[1]
[1] *Nicolaus Copernicus University (Poland),* [2] *Polish Academy of Sciences (Poland)*

Silver nanowires are applied as a sensor for natural photoactive protein complexes. The surface of silver nanowires is modified in a selective way to detect specific fluorescent protein using wide-field fluorescence imaging, a fast technique, which gives information about sample morphology. In this work we studied and compared three methods of sensor design: mixing in solution, nanowires on glass substrate and in PDMS microchannels. Advantages and limitations of every approach are described and analyzed.

11:40 - 12:40 — IST Congress Center Auditorium

Session 1A2

Conference Tutorials I

Organized by: Ishwar Aggarwal

11:40 : Tutorial
Near-Zero-Index Metamaterials
Nader Engheta
University of Pennsylvania (USA)

In this tutorial, I will present an overview of some of the fundamental principles and unique features of wave interaction with structures with effective refractive index near zero, which include epsilon-near-zero (ENZ), mu-near-zero (MNZ), epsilon-and-mu-near-zero (EMNZ) and Dirac-cone photonic media. I will then discuss some of the applications of near-zero-index metamaterials in photonics and microwave technologies. Possible future directions of research in this field will also be forecasted.

11:40 - 12:40 — Auditorium VA1

Session 1A3

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Jean-Jacques Greffet

11:40 : Invited talk
Plasmonic mode conversion and second harmonic imaging of tilted plasmonic nanocones
Christoph Dreser[1], Dominik A. Gollmer[1], Godofredo Bautista[2], Xiaorun Zang[2], Dieter P. Kern[1], Martti Kauranen[2], Monika Fleischer[1]
[1] *Eberhard Karls Universitat Tubingen (Germany),* [2] *Tampere University (Finland)*

Plasmonic nanocones offer strong, highly localized near-fields at the cone apex that can be utilized for applications in microscopy and sensing. However, the tip mode can only be excited by electric field components parallel to the cone axis. To enable the excitation of the tip mode under vertical illumination, tilted cones are fabricated. Their linear optical properties are investigated and simulated, and their nonlinear optical properties are illustrated by second harmonic imaging.

12:00 : Invited talk

Recovering molecular orientation using single molecule SERS in plasmonic nano-gaps

Jean-Sebastien Bouillard[1], Addison Marshall[1], Francesco Viscomi[1], John Proctor[1], Matthew Roberts[2], Johannes Gierschner[3], Ali Adawi[1]

[1] *University of Hull (United Kingdom),* [2] *Cambridge Display Technology Limited (United Kingdom),* [3] *Madrid Institute for Advanced Studies - IMDEA Nanoscience (Spain)*

Determining the molecular orientation at the single molecule level is of key importance for a wide range of applications from molecular electronic devices to biomedical applications. Plasmonic nano-gaps formed between a silver nanoparticle and a metallic film were optimized for single molecule SERS spectroscopy. The single molecule SERS spectra, which reflect the field enhancement anisotropy in the nanogap, were used in conjunction with DFT calculations to recover the orientation of 2 different analytes, rhodamine6G and F8-PFB, inside the nanogap.

12:20 : Invited talk

Coupled oscillator ensembles with loss and gain: a graph approach of PT symmetry

Henri Benisty, Vincent Brac de la Perriere, Abderrahim Ramdane, Anatole Lupu

University Paris Saclay (France)

We present a approach aimed at generalizing Parity-Time symmetry to mesoscopic ensembles of coupled oscillators with gain and loss, with inspiration from graph-theoretic tools. We globally minimize the imaginary part of the eigenvalues for small gain/loss and describe how couplings adopt some topologies. We also discuss recent results on distributed-feedback laser diodes operating at 1550 nm and having both real and imaginary index modulation. We notably study their resistance to optical feedback.

11:40 - 12:40 — Auditorium VA2

Session 1A4

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

Chaired by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

11:40 : Invited talk

Enantio-separation of chiral molecules adsorbed on a magnetic nanostructure with perpendicular anisotropy

Koyel Banerjee-Ghosh[1], Oren Ben Dor[2], Francesco Tassinari[1], Eyal Capua[1], Shira Yochelis[2], Amir Capua[2], See-Hun Yang[3], Stuart Stephen Papworth Parkin[3], Soumyajit Sarkar[1], Leeor Kronik[1], Ron Naaman[1], Yossi Paltiel[2], Lech Tomasz Baczewski[4]

[1] *Weizmann Institute of Science (Israel),* [2] *Hebrew University (Israel),* [3] *IBM Research Division (USA),* [4] *Polish Academy of Sciences (Poland)*

Recent studies suggested that charge redistribution in chiral molecules manifests an enantiospecific preference in electron spin orientation. It is shown experimentally that the interaction of chiral molecules with a perpendicularly magnetized substrate is enantiospecific as one enantiomer is adsorbed preferentially when the magnetic dipole is pointing up, whereas the other adsorbs faster for the opposite magnetization direction. The interaction between chiral molecules and ferromagnetic layer is not controlled by the magnetic field but by the respective electron spin orientations.

12:00 : Invited talk

Theoretical Design of Two-Dimensional Magnetoelectric Materials

Shuai Dong

Southeast University (China)

Achieving two-dimensional magnetoelectric materials should enable numerous functionalities in nanoscale devices. Until now, however, predicted two-dimensional magnetoelectric materials are very few and with co-

existing yet only loosely coupled ferroelectricity and magnetism. In this talk, I will introduce several recent works on two-dimensional magnetoelectric materials done in my group.

12:20 : Invited talk
Enhancing Circular Dichroism and Chiral Sorting with Chiral Surface Waves
Marco Finazzi, Giovanni Pellegrini, Michele Celebrano, Lamberto Duo, Paolo Biagioni
Politecnico di Milano (Italy)

A platform that combines a one-dimensional photonic crystal with a birefringent surface termination is presented. The platform sustains transverse electric and transverse magnetic surface modes having the same phase velocity, which can be combined to generate chiral surface waves providing homogeneous fields of either handedness over arbitrarily large areas in a wide spectral range. The predicted circular dichroism signals and chiral sorting forces are predicted to be more than two orders of magnitude larger than in any other platform.

11:40 - 12:40 — Auditorium VA3

Session 1A5

Nanophotonic tools for exploring low-energy excitations in nanomaterials

Organized by: Andrea Toma, Luca Razzari and Andrea Perucchi

Chaired by: Andrea Toma, Luca Razzari and Andrea Perucchi

11:40 : Invited talk
Extraordinarily transparent compact metallic metamaterials
Vincenzo Giannini
Consejo Superior de Investigaciones Cientificas (Spain)

Nanostructured bulk metals can be more transparent than glass and for a bigger range of frequencies. We show that the transparency can go from the near infrared to any smaller photon energy. Also, we can easily tune and design the refractive index.

12:00 : Invited talk
Between photonics and electronics: is THz the promised land of graphene technologies?
Alessandro Tredicucci
Universita di Pisa (Italy)

Its peculiar band structure and electron transport characteristics naturally suggest graphene could offer a perfect platform for a new generation of high-performance devices operating in the THz range of the electromagnetic spectrum. This talk will review recent results in the development of high-speed modulators and plasmonic detectors, it will also discuss perspectives towards the implementation of graphene-based deeply sub-wavelength THz emitters and lasers.

12:20 : Invited talk
Probing Plasmons, Phonons, and Phase-Change Materials with Synchrotron Infrared Nanospectroscopy
Hans A. Bechtel[1], Omar Khatib[1], Stephanie N. Gilbert Corder[1], Mengkun Liu[2], Markus B. Raschke[3], Michael C. Martin[1], G. Lawrence Carr[4]
[1]Lawrence Berkeley National Laboratory (USA), [2]Stony Brook University (USA), [3]University of Colorado (USA), [4]Brookhaven National Laboratory (USA)

Synchrotron infrared nanospectroscopy (SINS) combines the broad bandwidth and brightness of synchrotron infrared radiation with scanning near-field optical microscopy (s-SNOM) to enable vibrational spectroscopy spanning the entire mid-infrared region with $<$ 20 nm spatial resolution. By using fast, sensitive custom-modified detectors, we have extended the wavelength range into the far-infrared, enabling direct probing of the tunable plasmon response in a gated graphene device and phonon modes in phase-change materials, such as VO2 and SmS.

11:40 - 12:35 — Auditorium VA4

Session 1A6

Structured and topological photonic fields

Organized by: Jamal Berakdar

Chaired by: Jamal Berakdar

11:40 : Invited talk
Optical spin and orbital angular momentum effects in multiple Laguerre-Gaussian beams
Mohamed Babiker[1], K. Koksal[1], V. E. Lembessis[2], J. Yuan[1]
[1] *University of York (United Kingdom),* [2] *King Saud University (Saudi Arabia)*

The physics arising from the orbital angular momentum as a significant property of twisted light is enhanced considerably when combined with optical spin. The superposition of multiple beams involving twisted light in any geometry can be generated in the laboratory, giving rise to fields that are rich in total amplitude and phase. Their effects on the dynamics of atoms immersed in them as well as the exchange of angular momentum in their interactions with matter are highlighted.

12:00 : Invited talk
Optical helicity gratings
Koen Corstiaan van Kruining[1], Robert Peter Cameron[2], Jorg Bernhard Gotte[3]
[1] *Max Planck Institute for the Physics of Complex Systems (Germany),* [2] *University of Strathclyde (United Kingdom),* [3] *University of Glasgow (United Kingdom)*

We introduce the concept of two- and three-dimensional optical helicity lattices wherein the helicity of light alternates amidst a homogenous electric part of the optical field energy density. Many of our lattices show regions of bright superchirality, where locally the helicity is larger than the modulus square of the electric field. Our helicity gratings create the possibility of trapping ultracold chiral molecules specific to their enantiomer in adjacent lattice sites.

12:20 : Skyrmion structure in vector beams
Sijia Gao, Joerg B. Goette, Fiona Speirits, Neal Radwell, Sonja Franke-Arnold, Stephen M. Barnett
University of Glasgow (United Kingdom)

Associated with Vector beams we find a topological feature, the skyrmion number, that is robust against any deformation during propagation. The simplest way to map out this feature is to use the associated skyrmion field. This is a transverse or divergence-less field and so has neither sources nor sinks. Mapping out the skyrmion field for these beams reveals constraints on the manner in which vector beams can be manipulated.

11:40 - 12:40 — Auditorium VA5

Session 1A7

Nanophononics and nanomechanics

Organized by: Daniel Lanzillotti-Kimura and Pedro David Garcia

Chaired by: Daniel Lanzillotti-Kimura and Pedro David Garcia

11:40 : Invited talk
Controlling the vibrational quality factors of an individual supported nano-object by tuning its morphology
Aurelien Crut[1], Fabio Medeghini[1], Romain Rouxel[1], Marco Gandolfi[2], Francesco Rossella[3], Paolo Maioli[1], Fabrice Vallee[1], Francesco Banfi[1], Natalia Del Fatti[1]
[1] *Univ Lyon (France),* [2] *Universita Cattolica del Sacro Cuore (Italy),* [3] *NEST (Italy)*

Acoustic damping of lithographed gold nanodisk vibrations was investigated using single-particle time-resolved spectroscopy. A strong influence of morphology (diameter/height ratio) on their vibrational quality factors was experimentally demonstrated and confirmed by numerical modeling. These findings thus open new possibilities for engineering the vibrational modes of nano-objects.

12:00 : Invited talk
Following heat transport in 2D materials using ultrafast techniques
KlaasJan Tielrooij[1], Niels Hesp[2], Alexander Block[2], Matz Liebel[2], Aloïs Arrighi[1], Marianna Sledzinska[1], Sergio O. Valenzuela[1], Clivia Sotomayor Torres[1], Frank Koppens[2], Niek van Hulst[2]
[1] *Catalan Institute of Nanoscience and Nanotechnology (ICN2) (Spain),* [2] *ICFO (Spain)*

We have used various ultrafast optical and optoelectronic techniques to study thermal transport phenomena in 2D materials, in particular processes that take place on the femtosecond, picosecond and nanosecond timescale. These processes include the phonon-mediated cooling dynamics of hot electrons in graphene, as well as the thermal diffusion of different heat and charge carriers in graphene and semiconducting layered materials. We will discuss some previous and some ongoing results related to these topics.

12:20 : Invited talk
Anisotropic Thermal Magnetoresistance in Radiative Heat Transfer
Antonio Garcia-Martin
Consejo Superior de Investigaciones Cientificas (Spain)

Here, we predict a huge anisotropic thermal magnetoresistance (ATMR) in the near-field radiative heat transfer between magneto-optical particles when the direction of an external magnetic field is changed with respect to the heat current direction. We illustrate this effect with the case of two InSb particles where we find that the ATMR amplitude can reach values of up to 800 % for a magnetic field of 5 T, which is many orders of magnitude larger than its spintronic analogue.

11:40 - 12:40 — Auditorium VA6

Session 1A8

Metamaterials and Photonic Crystals for THz Science and Technology I

Organized by: Stephen Hanham and Miguel Navarro-Cia

Chaired by: Stephen Hanham and Miguel Navarro-Cia

11:40 : Invited talk
Gate-controlled Optical Properties in Graphene Based Metasurfaces
Teun-Teun Kim[1], Hyeon-Don Kim[2], Hyunjun Kim[3], Sang Soon Oh[4], Bumki Min[3], Shuang Zhang[5]
[1] *Sungkyunkwan University (Korea),* [2] *KIMM (Korea),* [3] *KAIST (Korea),* [4] *Cardiff University (United Kingdom),* [5] *University of Birmingham (United Kingdom)*

We experimentally demonstrate gate-controlled optical properties including an amplitude of anomalously refracted light and group delay of light with graphene integrated metamaterials with different design rules. The graphene based metasurfaces are expected to provide an important applications such as ultrathin lenses, slow light devices and ultrasensitive sensors and switched.

12:00 : Invited talk
Singular graphene metasurfaces for broadband absorption
Paloma Arroyo Huidobro, Emanuele Galffi, J. B. Pendry
Imperial College London (United Kingdom)

Metasurfaces can be formed by structuring a plasmonic surface at the subwavelength scale and yield to richer interactions with external electromagnetic radiation than conventional gratings. In this talk conformal transformations will be discussed to design plasmonic metasurfaces, focusing in the case where these transformations have singular points. This gives rise to singular metasurfaces which have continuous spectra rather than the discrete set of peaks characteristic of conventional gratings.

12:20 : Invited talk
Graphene based terahertz optoelectronics
Coskun Kocabas
University of Manchester (United Kingdom)

Graphene, 2d-crystal of carbon atoms, is a promising candidate for reconfigurable terahertz optoelectronics due to its unique electronic band structure which yields gate-tunable broad-band optical response. In this talk I will present our experimental work on graphene based devices for controlling intensity, phase and polarization of terahertz waves. These new modulation mechanisms could pave the way for developing active THz optoelectronic systems.

11:40 - 12:40 — Auditorium EA1

Session 1A9

Fano resonances in optics and microwaves: Physics and application

Organized by: Eugene Kamenetskii and Almas Sadreev

Chaired by: Eugene Kamenetskii and Almas Sadreev

11:40 : Invited talk
Coupled-wave model of bound states in the continuum in diffraction gratings and integrated diffractive structures
Dmitry A. Bykov, Evgeni A. Bezus, Leonid L. L. Doskolovich
Samara National Research University (Russia)

We study coupled-wave model describing optical properties of diffraction gratings and rectangular ridges located on a slab waveguide. The proposed model enables obtaining simple and accurate formulas for the complex transmission and reflection coefficients of the considered structures. By analyzing these expressions, we analytically show that these structures support bound states in the continuum (BICs). We obtain simple closed-form expressions describing the positions (frequencies and wave numbers) of the BICs emerging in the considered structures.

12:00 : Invited talk
The passive and active controls of Fano resonances in metasurfaces
Shuo Du, Zhe Liu, Junjie Li, Changzhi Gu
Chinese Academy of Sciences (China)

We report the passive and active approaches to manipulate the properties of Fano resonances in metasurfaces. By passively tailoring the height of one arm during fabrication, double Rabi splitting caused by strong coupling of triple Fano resonances are observed in the unique 3D folded metallic resonators. Besides, by introducing the non-volatile chalcogenide phase-change material, the Fano resonances of can be actively controlled. These resonance properties are preservable, and have promising prospects in sensors, switches and modulators.

12:20 : Invited talk
Trapped light states in spatially dispersive plasmonic nanostructures
Solange Vieira da Silva, Tiago André Morgado, Mario Goncalo Goncalo Silveirinha
University of Coimbra (Portugal)

It was shown some time ago that open bi-layered plasmonic nanostructures may support trapped light states with infinite lifetimes. Counterintuitively, here we prove that spatially dispersive effects may relax the material and geometrical conditions required for the formation of embedded eigenstates in plasmonic systems.

11:40 - 12:40 — Auditorium EA2

Session 1A10

Dynamic metamaterials

Organized by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

Chaired by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

11:40 : Invited talk
Bose-Einstein condensation and K-point lasing in a plasmonic lattice
Jani-Petri Martikainen, Antti Moilanen, Rui Guo, Aaro Vakevainen, Marek Necada, Konstantinos S. Daskalakis, Heikki T. Rekola, Aleksi Julku, Paivi Torma
Aalto University (Finland)

We discuss our recent work on condensation phenomena on plasmonic lattices as well as K-point lasing in honeycomb lattices.

12:00 : Invited talk
Functional all-dielectric nanophotonic: from colloidal syntesis to transition metal dichalcogenides nanoantennas
Ruggero Verre, Nils Odebo-Lank, Denis Baranov, Timur Shegai, Mikael Kall
Chalmers University of Technology (Sweden)

We present the first techniques able to fabricate solutions of all-dielectric nanoparticles with predefined shape and demonstrate that multilayer WS2 nanodisks support geometrical Mie resonances and new light-matter regimes not attainable by standard materials.

12:20 : Invited talk
Magnetic field modulation of plasmon properties
Gaspar Armelles[1], Alfonso Cebollada[1], Fernando Garcia[1], Raquel Alvaro[1], Maria Ujue Gonzalez[1], Luca Bergamini[2], Nerea Zabala[2], Javier Aizpurua[2]
[1] *Instituto de Micro y Nanotecnologia (Spain),* [2] *Materials Physics Center, CSIC-UPV/EHU (Spain)*

In this talk we will review a new alternative for magnetic modulation of plasmon porperties in the mid and far IR range by using GMR magnetic multilayers.

11:40 - 12:40 — Auditorium EA3

Session 1A11

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Vladimir Belotelov

11:40 : Invited talk
Vertical Lasing from InP Nanowire with Cat's Eye Antenna
Fangfang Ren[1], Wei-Zong Xu[1], Jiandong Ye[1], Yi Yang[1], Hark Hoe Tan[2], Chennupati Jagadish[2]
[1] *Nanjing University (China),* [2] *The Australian National University (Australia)*

Cat's eye antennas have been designed and fabricated to modify the emission efficiency and profile of InP nanowire lasers. Narrower emission angle, higher polarization degree, increased internal quantum efficiency and lower lasing threshold were achieved from the antenna-coupled system, in comparison to bare nanowire lasers.

12:00 : Invited talk
Bismuth-based Metasurfaces for Nanophotonics from the Ultraviolet to the Far Infrared
Johann Toudert, Rosalia Serna

Instituto de Optica-IO-CSIC (Spain)

Bi-based nanostructures show outstanding optical properties making them ideal building blocks for the fabrication of metasurfaces with tunable response over a broad spectral region, from the ultraviolet to the far infrared. We will report the design, fabrication, and relevant optical properties of Bi-based metasurfaces. We will show how their optical absorption, reflection and phase can be tuned using planar optical cavity designs. The impact of the proposed optical structures for applications in several areas of nanophotonics will be discussed.

12:20 : Invited talk
Design and Experiments of Planar Metamaterial Luneburg Lens on SOI
Hamdam Nikkhah, Trevor J. Hall
University of Ottawa (Canada)

A 2D Luneburg lens may be formed by patterning a planar slab waveguide with a subwavelength grating structure using a silicon photonics integration platform with the advantage of small footprint. Confocal telescopes employing 15 μm diameter lenses were fabricated using a 300 nm silicon on insulator integration platform. The experimentally measured loss of the fabricated structures was found to be 0.726 dB per lens which is close to the value of 0.517 dB predicted by FDTD simulations.

11:40 - 12:40 — Auditorium EA4

Session 1A12

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

11:40 : Invited talk
Anisotropic metal nanostructures
Yurii K. Gun'ko, Valerie Gerard, Daniel K. Kehoe
University of Dublin (Ireland)

The materials have been characterized by various instrumental techniques and their biological behavior and catalytic activities in selected reactions have been tested. We believe that new nanomaterials developed in this work will find various applications in biomedical research, photonics and energy science.

12:00 : Invited talk
Comparison of the optical magnetism of Au dodecahedral clusters and plasmonic raspberries produced by bottom up approach
Laurent Lermusiaux, Veronique Many, Alexandre Baron, Romain Dezert, Etienne Duguet, Virginie Ponsinet, Serge Ravaine, Philippe Richetti, Philippe Barois, Mona Treguer-Delapierre
Université Bordeaux (France)

In this talk, we will compare the optical magnetic response of clusters made of twelve gold or silver patches located at the center of the faces of a dodecahedron and the one of disordered plasmonic clusters ('plasmonic raspberries') of the same size. We will demonstrate that the regular organization of the satellites around the core is more efficient than a random distribution for the generation of a circular current mode.

12:20 : Invited talk
Keeping an eye on the eye through plasmonics
Andrea Lopez-Marino, Ana Sousa-Castillo, Enrique Carbo-Argibay, Francisco Otero-Espinar, Ramon A. Alvarez-Puebla, Moises Perez-Lorenzo, Miguel A. Correa-Duarte
Universidade de Vigo (Spain)

The synthesis of a hydrogel-based soft contact lens featuring laser shielding capabilities is reported. These light-protective properties are accomplished through the integration of gold-based plasmonic nanoresonators

into the lens polymer network, which provides the hydrogel with a high optical density while preserving visible light transmittance. The implementation of these hybrid materials shows great potential in the eye care setting in terms of applications.

11:40 - 12:25 — Room 02.2

Session 1A13

Metamaterial-based devices

Chaired by: Mikhail Rybin

11:40 : Dual-Band Wireless Power Transmission Using Coupled Metamaterial Resonators for Wireless Sensor Networks
Safiullah Khan, Thomas F. Eibert
Technical University of Munich (Germany)

Miniaturized, dual-band microwave energy harvester composed of two distinct types of resonators, a rectangular-split-ring resonator coupled together with T-type resonator is designed to resonate at (7.16,9.25) GHz. The resonance frequencies can be controlled independently with very few parameters. The structure is backed by a metal film. Via on each of the resonating elements is used to divert the current to resistive loads. The power-conversion and the power-harvesting efficiency for the structure at 7.16 GHz(9.25 GHz) are 74.7 %(65.6 %) and 60.5 %(51 %),respectively.

11:55 : Interference phenomena and pulse propagation in a plasmonic wide-ridge metal-dielectric waveguide
Georgiy Yankovskii, Vladimir Kornienko, Alexey Shaimanov Shaimanov, Anton Ignatov, Alexander Merzlikin, Alexander Baryshev
All-Russia Research Institute of Automatics (Russia)

We demonstrate characteristics of plasmonic wide-ridge waveguides made from an Al2O3-Au-Al2O3 sandwich formed on a fused quartz substrate. Interference of travelling waves in the long-range plasmon propagation regime, their damping, throughput and cross-talk were studied when using pulsed laser source.

12:10 : Metasurfaces based coils for MRI
Alena Shchelokova, Alexey Slobozhanyuk, Stanislav Glybovski, Irina Melchakova, Pavel Belov
ITMO University (Russia)

Metasurfaces represent a new paradigm in artificial subwavelength structures due to their potential to overcome many challenges typically associated with bulk metamaterials. The ability to make very thin structures and change their properties dynamically makes metasurfaces an exceptional meta-optics platform for engineering advanced electromagnetic and photonic metadevices. Here, we suggest and demonstrate experimentally several metasurfaces capable of enhancing significantly the local image quality in magnetic resonance imaging (MRI).

11:40 - 12:40 — Room 02.1

Session 1A14

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Takasumi Tanabe

11:40 : Invited talk

Photo-physical properties of intramolecular charge transfer emissions controlled by hyperbolic metamaterials
Kwang Jin Lee[1], **Yeon Ui Lee**[1], **Frederic Fages**[2], **Jean-Charles Ribierre**[3], **Jeong Weon Wu**[1], **Anthony D'Aelo**[2]
[1] *Ewha Womans University (Korea),* [2] *Aix Marseille University (France),* [3] *Kyushu University (Japan)*

Noting that emission in organic molecules is from either pi-pi* or intramolecular charge-transfer (ICT) states, we address here how hyperbolic metamaterial (HMM) modifies ICT emission spectral features by comparing them with a spectral shift depedent on the local polarity of the medium. The 7.0 nm blue shift is observed in ICT emission from DCM dispersed into a polymer matrix prepared on HMM multilayered structure, while no spectral shift is observed in pi-pi* emission from perylene diimide.

12:00 : Invited talk
Multifunctional plasmon-enhanced nanoscopy for nanoscale control of chemical reactions
Taka-aki Yano
Tokyo Institute of Technology (Japan)

We have developed multifunctional plasmon-enhanced nanoscopyfor molecular control and analysis. A plasmonic probe tip is utilized not only to enhance Raman scattering from sample molecules but also to apply pressure and voltage to them, enabling us to locally initiate chemical reactions in the vicinity of the plasmonic tip. Combination of plasmon-enhanced nanoscopy with the local external stimuli has now opened up a new way to control molecular properties and functions on a nanometer scale.

12:20 : Invited talk
Colossal infrared and terahertz magneto-optical activity in graphene/hBN heterostructures
Ievgeniia O. Nedoliuk[1], **Sheng Hu**[2], **Andre K. Geim**[2], **Alexey B. Kuzmenko**[1]
[1] *University of Geneva (Switzerland),* [2] *University of Manchester (United Kingdom)*

The large spacing between the Landau levels (LLs) in graphene is expected to produce a strong optical intensity of the inter-LL transitions. However, so far the reported magneto-infrared spectra revealed only a weak magnetic increase of the absorption, in a complete disagreement with theory. A probable origin of the small intensity of the LL transitions is a high concentration ofdefectsinlarge-area graphene used so far in these experiments.

Lunch

12:40 - 14:00

14:00 - 16:00 — IST Congress Center Auditorium

Session 1A15

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

14:00 : Keynote talk
Neural Networks in Nanophotonics
Marin Soljacic
MIT (USA)

The recent deep-learning revolution offers many exciting opportunities in photonics, both to help with photonics research, but also for photonics to advance deep-learning. Some of our recent work on these topics will be presented.

14:30 : Invited talk
Active Polaritonic Metasurfaces

Clementine Symonds[1], **Kevin Chevrier**[1], **Jean-Michel Benoit**[1], **Semion Saikin**[2], **Joel Yuen-Zhou**[3], **Joel Bellessa**[1]
[1] *Université de Lyon (France),* [2] *Harvard University (USA),* [3] *University of California San Diego (USA)*

We propose a new type of metasurface, which builds on the extended coherent states associated to plasmon/exciton polaritons. For this purpose, periodic stripes of organic dye are deposited on a continuous silver film. With a structuration exceeding the polaritonic wavelength by more than one order of magnitude, we demonstrate anisotropy generation in transition energies and emission patterns. These findings pave the way towards a novel type of artificial materials which require micro- instead of nano-structuration.

14:50 : Invited talk
Intuitive Semi-analytical Model of Channel Plasmon Polaritons in Subwavelength Plasmonic Trench Waveguide
Haitao Liu[1], **Junda Zhu**[1], **Tong Zhu**[1], **Hongwei Jia**[1], **Ying Zhong**[2]
[1] *Nankai University (China),* [2] *Tianjin University (China)*

An intuitive semi-analytical model is proposed to describe the channel plasmon polaritons (CPPs) guided by a subwavelength rectangular groove cut into a metal substrate. The model is built up by considering an intuitive multiple scattering process of gap surface plasmons (GSPs) bouncing between the mouth and the bottom of the groove. The evolution of the CPPs from guided, quasi-guided to evanescent modes with the increase of wavelength is explained with the model.

15:10 : Invited talk
Modulating Propagating Surface Plasmons on Silver Nanowires
Qiang Li[1], **Li Chen**[2], **Hongxing Xu**[3], **Zhaowei Liu**[2], **Hong Wei**[1]
[1] *Chinese Academy of Sciences (China),* [2] *University of California (USA),* [3] *Wuhan University (China)*

Due to the photothermal property of silver nanowire, the local temperature is increased under the excitation of a control laser beam, which results in the increase or decrease of the intensity of the transmitted surface plasmons on the nanowire generated by a probe laser beam. The amplitude of the photothermal modulation depth is found to be strongly dependent on the focal positions, polarizations, and power of the control beam.

15:30 : Keynote talk
Non-Hermiticity in Optics and Optomechanics
Sahin K. Ozdemir
The Pennsylvania State University (USA)

In this talk, after briefly reviewing the related physics and the applications that have been developed in the past few years, I will present the progress in our experimental and theoretical studies towards a better understanding of optical processes and optomechanical interactions at EPs for realizing photonic and phononic devices with novel functionalities. I will also present a brief perspective on the developments and discuss possible future research directions that can benefit from the notion of non-Hermitian engineering.

14:00 - 16:00 — Auditorium VA1

Session 1A16

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Constantinos Valagiannopoulos

14:00 : Invited talk
Photonic phase transitions in dielectric structures
Mikhail V. Rybin
ITMO University (Russia)

Dielectric metamaterials are promising low-loss platform for applications in photonics. In contrast to photonic crystals metamaterials allow a description with effective material parameters. The transition from photonic

crystal to metamaterials is found to be accompanied with an abrupt change in electromagnetic field patterns which is typical behavior of phase transitions. Here we review the recent progress in photonic phase transitions between these two classes of artificial structures.

14:20 : Invited talk
Metasurface Photodetectors for Directional Image Sensing
Leonard Kogos, Yunzhe Li, Jianing Liu, Yuyu Li, Lei Tian, Roberto Paiella
Boston University (USA)

We report the development of photodetectors integrated with plasmonic metasurfaces that only allow for the detection of light incident along a single, geometrically tunable direction (within a small distribution of angles). These devices are promising for the realization of ultrasmall lensless cameras providing the distinctive imaging capabilities of compound eyes.

14:40 : Invited talk
Single hybrid plasmonic structures for efficient photon pair production at the nanoscale
Nicolas Chauvet[1], Maeliss Ethis de Corny[1], Guillaume Laurent[1], Aurélien Drezet[1], Gilles Nogues[1], Géraldine Dantelle[1], Thierry Gacoin[2], Atsushi Uchida[3], Hirokazu Hori[4], Serge Huant[1], Guillaume Bachelier[1], Makoto Naruse[5]
[1] *Université Grenoble Alpes (France),* [2] *Laboratoire Charles Fabry (France),* [3] *Saitama University (Japan),* [4] *University of Yamanashi (Japan),* [5] *University of Tokyo (Japan)*

Efficiency of single hybrid plasmonic nanostructures are discussed for SHG and SPDC. After successful fabrication, results show good agreement between experiments and FEM simulations, indicating field enhancement effect as the main factor for increased efficiency. SPDC simulations at the nanoscale predict measurable pair rate for structures already optimized for SHG. finally, use of entangled photon pairs as a resource for decision-making applications is shown as advantageous over classical photonic states.

15:00 : Invited talk
Topological Photonic Metamaterials with Honeycomb Structure
Xiao Hu
NIMS (Japan)

We propose a generic way to create topological metamaterials. The strategy of our approach is of two steps: (1) create the Dirac-type linear dispersion with the honeycomb lattice, which may be called artificial graphene, and (2) open a band gap and carry out band engineering based on real-space manipulations. Our work shows that fascinating topological functionality can be created using the advanced nanotechnology.

15:20 : Invited talk
Light Scattering from Solid-State Quantum Emitters: Beyond the Atomic Picture
Alistair J. Brash[1], Jake Iles-Smith[1], Catherine L. Phillips[1], Dara P. S. McCutcheon[2], Jesper Mork[3], Maurice S. Skolnick[1], A. Mark Fox[1], Ahsan Nazir[4]
[1] *University of Sheffield (United Kingdom),* [2] *University of Bristol (United Kingdom),* [3] *Technical University of Denmark (Denmark),* [4] *The University of Manchester (United Kingdom)*

The coherent scattering of light by a single quantum emitter is fundamental to quantum optics. Unlike atomic systems, solid-state emitters couple strongly to their host lattice via phonons. Through both theory and experiment we develop an intuitive model of coherent scattering for the case of a solid-state emitter coupled to a nano-cavity. The phonon coupling leads to a sideband that is completely insensitive to excitation conditions, a major deviation from the atomic model of scattering.

15:40 : Invited talk
Ultrafast Light-Induced Magnetism in Plasmonic Nanoparticles
Oscar Hsu-Cheng Cheng, Dong Hee Son, Matthew Sheldon
Texas A-M University (USA)

Here we report the first experimental quantification of optically induced magnetization in plasmonic Au nanoparticles due to the inverse Faraday effect (IFE). The induced magnetic moment in nanoparticles is found to be $\sim$1,000x larger than that observed in bulk Au, and $\sim$20x larger than the magnetic moment from optimized magnetic nanoparticle colloids such as magnetite. Furthermore, the magnetization and demagnetization kinetics are instantaneous within the sub-picosecond time resolution of our study.

14:00 - 16:00 — Auditorium VA2

Session 1A17

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

Chaired by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

14:00 : Invited talk
Magnetoelectric structures and magnetoelectric fields
Eugene Kamenetskii
Ben Gurion University of the Negev (Israel)

The question on relationship between magnetoelectricity and electromagnetism is a subject of a strong interest and numerous discussions in microwave and optical wave physics and material sciences. The definition of the energy and momentum of the electromagnetic (EM) field in a magnetoelectric (ME) medium is not a trivial problem. Visualization of the ME states require a special experimental technique.There should be a probe with a special ME near-field structure.

14:20 : Invited talk
Controlling the plasmon resonance of an Au/Ni hybrid nanostructures using external magnetic field or temperature
Silvere Schuermans[1], Thomas Maurer[1], Alexander Govorov[2], Jerome Plain[1]
[1] *Université de Technologie de Troyes (France),* [2] *Ohio University (USA)*

We report on the fabrication of plasmonic hybrid Ni-Au nanoantennas. The optical properties of such nanostructure depend on the applied magnetic field and/or the temperature. Thus, we tune under control the plasmon resonance using external stimuli.

14:40 : Invited talk
Chirality and Optical Spin-orbit Coupling in Topological Photonic Crystals
Nikhil Parappurath, Filippo Alpeggiani, L.(Kobus) Kuipers, Ewold Verhagen
AMOLF (The Netherlands)

We directly observe the states of topological photonic crystalsat telecom wavelengths. We show that the unidirectional character of the topological edge states is directly linked to the circular polarization of the states' far fields. Using this intrinsic radiation, we measure dispersion, loss, pseudospin, and spin-spin scattering. We image spin-selective unidirectional propagation around sharp corners and junctions and experimentally characterize topological nanocavities.

15:00 : Invited talk
A surface plasmon platform for angle-resolved chiral sensing
Lykourgos Bougas[1], Sotiris Droulias[2]
[1] *Johannes Gutenberg University (Germany),* [2] *FORTH (Greece)*

Chiral sensing is crucial in probing the fundamental symmetries of the universe, study biomolecular structures, and even develop safe drugs. As chiral signals are inherently weak, different techniques have been proposed to overcome the limitations of traditionally used chiral polarimetry. We propose an angle-resolved chiral surface plasmon resonance scheme that can detect the absolute chirality (handedness and magnitude) of a chiral sample and is sensitive to both the real and imaginary part of a chiral sample's refractive index.

15:20 : Invited talk
Terahertz metamaterials: accessing nonlinear spin and phonon dynamics
Stefano Bonetti
Stockholm University (Sweden)

I will describe a few terahertz metamaterials that can be used to drive large amplitude, nonlinear dynamics in condensed matter systems, focusing in particular to the spin and lattice degrees of freedom. I will discuss different designs aimed at enhancing either the electric or the magnetic field component of terahertz radia-

tion. The metamaterial structures have been investigated using three-dimensional finite element simulations. Preliminary results of the observation of the large amplitude dynamics induced by such metamaterials will be shown.

15:40 : Invited talk
Dynamical chiral metasurfaces: mechanical based modulation and polarimetry
Alessandro Pitanti
NEST Lab. (Italy)

We combine the chiral properties of an all-dielectric GaAs metasurfaces operating in the near-infrared range with micro-mechanical motion. We demonstrate polarization modulation and spring-effect based light polarimetry at frequency exceeding 300 kHz.

14:00 - 15:50 — Auditorium VA3

Session 1A18

Nanophotonic tools for exploring low-energy excitations in nanomaterials

Organized by: Andrea Toma, Luca Razzari and Andrea Perucchi

Chaired by: Andrea Toma, Luca Razzari and Andrea Perucchi

14:00 : Invited talk
Nonlinear THz response of graphene plasmonic structures
Stephan Winnerl[1], M. Mehdi Jadidi[2], Matt Chin[2], Angelika Seidl[1], Harald Schneider[1], Manfred Helm[1], H. Dennis Drew[2], Thomas E. Murphey[2], Martin Mittendorff[3]
[1] *Helmholtz-Zentrum Dresden-Rossendorf (Germany),* [2] *University of Maryland (USA),* [3] *Universitat Duisburg-Essen (Germany)*

Ribbons and discs based on doped graphene feature strong tunable plasmonic resonances. We show that excitation with THz radiation results in strong changes of transmission, even at moderate pump fluences. The response is due to a broadening and redshift for the plasmonic absorption line as charge carriers are heated. The response time is determined by the cooling of carriers, which is of the order of 10 ps.

14:20 : Invited talk
Imaging ultrafast dynamics on the nanoscale with terahertz scanning tunneling microscopy
Frank Hegmann
University of Alberta (Canada)

This talk will discuss how ultrafast THz-STM works, recent progress, operation in ambient versus UHV, and how THz-STM can provide new insight into ultrafast dynamics on the atomic scale, which is essential for the development of novel silicon nanoelectronics, nanophotonics, and molecular-scale devices operating at terahertz frequencies.

14:40 : In-plane anisotropic and ultra-low-loss polaritons in a natural van der Waals crystal
Javier Taboada Gutierrez[1], Weiliang Ma[2], Pablo Alonso Gonzalez[1], Shaojuan Li[2], Alexey Nikitin[3], Jian Yuan[2], Javier Martin Sanchez[1], Iban Amenabar[4], Peining Li[4], Saul Velez[4], Christopher Tollan[4], Zhigao Dai[5], Yupeng Zhang[5], Sharath Sriram[6], Kourosh Kalantar-Zadeh[6], Shuit-Tong Lee[2], Rainer Hillenbrand[4], Qiaoliang Bao[2]
[1] *University of Oviedo (Spain),* [2] *Soochow University (China),* [3] *Donostia International Physics Center (DIPC) (Spain),* [4] *CIC nanoGUNE (Spain),* [5] *Monash University (Australia),* [6] *RMIT University (Australia)*

Polaritons -hybrid light-matter excitations- play a crucial role in fundamental and applied sciences, as they enable nanoscale control of light. Polaritons with anisotropic propagation along the surface of vdW materials have been predicted, caused by in-plane anisotropic structural and electronic properties. Here we report anisotropic polariton propagation along the surface of α-MoO3, a natural vdW material using infrared nano-imaging and nano-spectroscopy techniques. In-plane anisotropic polaritons could enable directional and strong light-matter interactions, in applications such as bio-sensing, among others.

14:55 : Highly anisotropic phonon polaritons in natural biaxial hyperbolic van der Waals alpha-MoO3
Zebo Zheng, Huanjun Chen
Sun Yat-sen University (China)

We show that the van der Waals α-MoO3 can support naturally in-plane hyperbolic phonon polariton at mid-infrared frequencies. Because α-MoO3 is a biaxial crystal with three different Reststrahlen bands, where the permittivity is negative due to its lattice vibrations. Interestingly, due to the minimal spectral overlap between these bands, the material is hyperbolic in its natural state. However, unlike previously investigated uniaxial hyperbolic materials, the permittivities along all three axes are different, so in-plane hyperbolic dispersion is also observed.

15:10 : Invited talk
Photonic Crystals for Nano-Light in Twisted Bilayer Graphene
D. N. Basov
Columbia University (USA)

Atomically relaxed twisted bilayer graphene hosts periodic arrays of topological conducting channels that act as a photonic crystal for surface plasmons.

15:30 : Invited talk
Non Linear Single-Particle and Plasmonic Terahertz Properties of 3D Topological Insulators
Paola Di Pietro[1], Federica Piccirilli[2], N. Adhlakha[1], Andrea Perucchi[1], Stefano Lupi[3]
[1] *Elettra Sincrotrone Trieste (Italy),* [2] *CNR-IOM (Italy),* [3] *Sapienza University of Rome (Italy)*

The terahertz properties of Bi2Se3 Topological Insulator have been studied in the 0.2-5 THz spectral range. The linear response is described in terms of a Drude term and plasmon modes mainly related to the surface Dirac conducting states characterizing the low-energy electrodynamics of Bi2Se3. The intrinsic non linearity of Dirac states, when excited by strong THz fields, provide either harmonic generation and strong plasmon softening, opening the use of TIs for photonic devices.

14:00 - 15:40 — Auditorium VA4

Session 1A19

Structured and topological photonic fields

Organized by: Jamal Berakdar

Chaired by: Jamal Berakdar

14:00 : Invited talk
Interaction of an Archimedean spiral structure with twisted light
Richard M. Kerber[1], Jamie M. Fitzgerald[2], Xiaofei Xiao[2], Stefan A. Maier[2], Vincenzo Giannini[2], Doris E. Reiter[1], Sang Soon Oh[3]
[1] *Universitat Munster (Germany),* [2] *Imperial College London (United Kingdom),* [3] *Cardiff University (United Kingdom)*

Light-matter interaction between a structured light and metallic structures allows for interesting plasmonic mode excitation with its unique selections rules. Importantly, the selection rule depends on the size of the structures and the shape of the structured light. Here, we compare two Archimedean spirals consisting of bent gold nanorods with different sizes when illuminated by an orbital angular momentum light. We show the vortex generation and conrol for a micrometer-sized spirals.

14:20 : Invited talk
Visible vector beams using dielectric metasurfaces
Antonio Ambrosio, Yao-Wei Huang, Noah Rubin, Federico Capasso
Harvard University (USA)

Recently, dielectric metasurfaces J-plate [1] allowed themost general conversion from any pair of orthogonalpolarization states to the conjugate states with any value oforbital angular momentum. This is possible

by controllingsimultaneously the propagation phase, the Pancharatman-Berry (PB) phase and the form birefringence of each singleelement of the metasurface.J-plates can be used to generate structured light with bothcomplex intensity as well as optical field distributions.

14:40 : Invited talk
Charge and spin dynamics driven by topological photonic fields
Jonas Watzel, Jamal Berakdar
Martin-Luther University Halle-Wittenberg (Germany)

We consider the spin-dependent charge dynamics in quantum nanostructures in response to radiation fields with a topologically non-trivial wave fronts. We find that optical vortices are well suited as a versatile tool for the ultrafast generation and control of spin accumulations. Vector beams induce rather different types of charge and spin dynamics. For instance, radially polarized vector beams drive radially breathing charge-density oscillations while azimuthally polarized beams trigger a dynamic Aharonov-Bohm effect leading to an oscillating magnetic moment.

15:00 : Invited talk
Controlling Internal Quantum States of Subwavelength Systems with Optical Vortices
Andrei Afanasev, Maria Solyanik-Gorgone
The George Washington University (USA)

Quantized optical vortices, or the twisted photons, may carry pre-set amounts of angular momentum along their direction of propagation, thus allowing for quantum transitions otherwise forbidden for conventional plane-wave light. first, we address the question of the angular momentum transfer to internal degrees of freedom of single atoms excited by the twisted photons. We extend the theory to the case of semi-conductor quantum dots and demonstrate associated spin-orbit effects for spin injection of photoelectrons in bulk GaAs.

15:20 : Invited talk
Microwave magnetoelectric photonics based on magnetic-dipolar-mode resonators
Eugene Kamenetskii, A. Davidov
Ben Gurion University of the Negev (Israel)

Microwave magnetoelectric photonics bridges microwave engineering, optoelectronics and magnetoelectric-coupling effects. Recently, it was shown that with use of quasi-2D ferrite disks with magnetic-dipolar-mode (MDM) oscillations one can observe near-field chirality in microwaves. The fields originated from a MDM ferrite disk, called magnetoelectric (ME) fields, carry both spin and orbital angular momentums. They are characterized by power-flow vortices and non-zero helicity. With use of MDM ferrite resonators we have unique microwave photonics devices.

14:00 - 16:00 — Auditorium VA5

Session 1A20

Nanophononics and nanomechanics

Organized by: Daniel Lanzillotti-Kimura and Pedro David Garcia

Chaired by: Daniel Lanzillotti-Kimura and Pedro David Garcia

14:00 : Invited talk
Surface waves beat phonons in polar ultra-thin films
Sebastian Volz
CNRS (France)

Thermal transport becomes less efficient as structures scale down since phonon-boundary scattering becomes predominant, therefore thermal management becomes more challenging in micro-electronic or optical devices. Here we reveal the predominance of Surface Phonon-Polaritons (SPhPs) in thin film heat conduction.

14:20 : Invited talk

Modulation of the THz Emission by a Quantum Cascade Laser using Coherent Acoustic Phonon Pulses

Anthony J. Kent[1], **Aniela Dunn**[2], **Caroline Poyser**[1], **Andrey Akimov**[1], **Paul Dean**[2], **A. Giles Davies**[2], **Aleksandar Demic**[2], **Dragan Indjin**[2], **Lianhe Li**[2], **Edmund Linfield**[2], **Alexander Valavanis**[2], **John Cunningham**[2]
[1] *University of Nottingham (United Kingdom),* [2] *University of Leeds (United Kingdom)*

We use laser-generated coherent acoustic phonon (strain) pulses to modulate the electronic transport and THz emission of a 2.6 THz Ga(Al)As quantum cascade laser. The modulation amplitude is of the order of a few % and the rise time, limited by the measurement system response, is less than 1 nanosecond.

14:40 : Invited talk

First principles calculation of the real-time dynamics of inter-valley electron-phonon coupling after photoexcitation

Philip Murphy Armando[1], **Eamonn Murray**[1], **Ivana Savic**[1], **Mariano Trigo**[2], **David Reis**[2], **Stephen Fahy**[1]
[1] *University College Cork (Ireland),* [2] *Stanford University (USA)*

We investigate the generation of phonons via inter-valley scattering by calculating the time-dependent relaxation of electrons and phonons on picosecond timescales in photo-excited GaAs, Ge and Bi. We simulate the time evolution of carriers and phonons based on first-principles band structure calculations, including electron-phonon and 3-phonon processes. We compare the simulations with data from time-resolved diffuse x-ray scattering experiments performed at the LCLS free-electron laser facility. We also compare our results in Bi to existing reflectivity experiments

15:00 : Invited talk

Study of the resonant modes of hypersonic acoustic cavities by an ultrafast pump-probe technique

Camille Lagoin, Daniel Garcia-Sanchez, Paola Atkinson, Bernard Perrin
Sorbonne Université (France)

We used an ultrafast pump-probe technique to characterize the acoustic properties of semiconductor micropillars designed for optomechanics experiments. We described the way to measure quality factors as high as 35000 of a 20 GHz cavity mode with subharmonic resonant excitation by a femtosecond laser oscillator which has a repetition rate of 80 MHz. The spatial profile of the modes has also been investigated and discussed.

15:20 : Invited talk

Dynamics of nanomechanical pillar resonators

Juliane Doster[1], **Simon Honl**[1], **Heribert Lorenz**[2], **Philipp Paulitschke**[2], **Eva M. Weig**[1]
[1] *University of Konstanz (Germany),* [2] *Ludwig-Maximilians-Universitat (Germany)*

We investigate inverted conical nanopillars as a mechanicalresonators, considering their flexural modes. Nanopillarsare well suited for dense integration into resonator arrays.Establishing coupling between neighboring nanopillars enablesthen the investigation of coupled resonator networks.

15:40 : Invited talk

Ultrafast microscopy of the acoustic eigenmodes of a single nanoparticle

Yannick Guillet, Allaoua Abbas, Serge Ravaine, Bertrand Audoin
University of Bordeaux (France)

Ultrafast acoustic spectroscopy of single nanoparticles appears as a promising way to probe elasticity of matter at GHz to THz frequencies. To date, ultrafast spectroscopy of the acoustic eigenmodes of nanoparticles are usually performed with single point measurements. For a nanosphere, the acoustic spectrum is then dominated by the purely radial breathing mode. We demonstrate here that ultrafast microscopy allows us to unveil eigenmodes involving a shear component of the particle surface displacement.

14:00 - 16:00 — Auditorium VA6

Session 1A21

Metamaterials and Photonic Crystals for THz Science and Technology II

Organized by: Stephen Hanham and Miguel Navarro-Cia

Chaired by: Stephen Hanham and Miguel Navarro-Cia

14:00 : Invited talk

Photonic Crystal Waveguide Technologies for Terahertz Applications

Masayuki Fujita

Osaka University (Japan)

Terahertz waves, which are located in the region between radio and light waves, have attracted a great deal of interest in the interdisciplinary field of photonics and electronics. This study presents recent progress on photonic-crystal waveguide devices for advanced applications to the terahertz region.

14:20 : Invited talk

Photonic Crystal Resonators as Liquid Sensing Platforms in the Terahertz Band

Stephen M. Hanham[1], Clare Watts[2], Munir M. Ahmad[2], William J. Otter[2], Stepan Lucyszyn[2], Norbert Klein[2]

[1] *University of Birmingham (United Kingdom),* [2] *Imperial College London (United Kingdom)*

We describe the development of high quality (Q) factor photonic crystal resonators (PCRs) integrated with microfluidic systems to form the basis of highly sensitive liquid sensing platforms for the terahertz band. The strong confinement of the terahertz field in combination with the high Q-factor provided by the PCR allows the measurement of the dielectric properties of sub-nanoliter liquid volumes. We demonstrate the utility of this approach by measuring the complex permittivity of several bio-liquids at 100 GHz.

14:40 : Invited talk

Terahertz Spoof Surface Plasmon Polaritons: Modelling, Design, and Experimental Characterization

Mehmet Unlu

TOBB University of Economics and Technology (Turkey)

In this paper, we report the latest progress on the modelling,design, and characterization of the spoof surface plasmonpolariton (sSPP) waveguides (WG) for the terahertz band.We will summarize our approach on the empiricalmodelling of the effective dielectric constant, extraction ofthe lumped-element circuit model, and realization of fixedlengthdelay lines using sSPP WGs. To the best of ourknowledge, this is first extensive characterization that canbe used for advanced sSPP circuit design for the terahertzband.

15:00 : Invited talk

THz Metasurfaces for Spatial Beam Modulation and Chemical Identification

Polina Stefanova, Rhiannon Lees, Andreas K. Klein, Michael D. Cooke, Andrew J. Gallant, Claudio Balocco

Durham University (United Kingdom)

The wavelength of THz radiation enables the use of metasurfaces which are both compact and easy to manufacture using conventional photolithography. This contribution addresses two specific applications: the optical control of an amplitude and phase THz modulator, and the fabrication of large-area disposable split-ring resonators on plastic and paper for chemical identification. All experiments were carried out using a vector network analyser with THz extenders operating in the frequency range 0.75-1.1 THz.

15:20 : Invited talk

High-Performance Metamaterial-Inspired Quasi-Optical Instrumentation for THz Range

Sergei A. Kuznetsov[1], Victor N. Fedorinin[1], Andrey V. Arzhannikov[1], Alexander N. Gentselev[2], Pavel A. Lazorskiy[1], Nazar A. Nikolaev[3]

[1] *Novosibirsk State University (Russia),* [2] *Budker Institute of Nuclear Physics SB RAS (Russia),* [3] *Institute of Automation and Electrometry SB RAS (Russia)*

We review the results of extensive R-D activity focused on elaborating high-performance quasi-optical components of THz instrumentation using plasmonic metamaterials. Practical solutions for frequency filters of different types, non-profiled focusing devices, phase/polarization transformers, ultra-thin metasurface absor-

bers and metasurface-based radiation detectors, thin-film and SEIRA sensors are presented. The issues of design optimization, technological fabrication, and spectral characterization of the developed devices alongside with their practical applications are considered.

15:40 : Invited talk
All-dielectric metasurfaces for terahertz science and technology
Willie J. Padilla, Kebin Fan
Duke University (USA)

All-dielectric metasurfaces are useful for investigation of new devices for terahertz science and technology. Scattering effects ranging from high absorption and Huygens' reflect arrays to bound-states-in-the-continuum (BIC) suggest their use for applications. We experimentally demonstrate several metasurfaces which realize: high transmission Huygens' structures, high absorptive devices for imaging, and dynamic surfaces with optical control. The metasurfaces we explore consists of arrays of high dielectric geometrical shapes, and may support a number of eigenmodes of either odd or even symmetry.

14:00 - 16:00 — Auditorium EA1

Session 1A22

Fano resonances in optics and microwaves: Physics and application

Organized by: Eugene Kamenetskii and Almas Sadreev

Chaired by: Eugene Kamenetskii and Almas Sadreev

14:00 : Invited talk
Superchirality, circular dichroism bands and singular value resonances of a minimal dielectric metasurface
Simone Zanotto
Consiglio Nazionale delle Ricerche (Italy)

We show that a metasurface having the simplest pattern that implements 2d-chirality shows circular dichroism band structure and superchiral near fields. These features occur in correspondence to the resonances of the singular value spectrum. In particular, Fano-like structures in the transmission spectrum are correlated with anomalies of the singular value and of the singular vector polarization states.

14:20 : Invited talk
Hybrid plasmonic-dielectric resonant waveguide grating for diffraction with high color purity
Giorgio Quaranta[1], Olivier J. F. Martin[2], Benjamin Gallinet[1]
[1] *Centre Suisse d'Electronique et de Microtechnique (Switzerland),* [2] *EPFL (Switzerland)*

A hybrid dielectric-plasmonic grating enabling highly color-selective first order diffraction is reported. The effect is achieved by means of waveguide resonances and a Fano-like interference with the continuum formed by grating diffraction orders. This work shows the promising use of plasmonic and dielectrics grating resonances for designing highly integrated optical devices such as spectrometers or optical security features.

14:40 : Invited talk
Acoustic topological Fano resonances
Farzad Zangeneh Nejad, Romain Fleury
EPFL (Switzerland)

We report the observation of acoustic topological Fano resonance, and demonstrate their robustness to imperfections. By going beyond the performance degradations caused by inadvertent flaws occurring during fabrication process, such topologically protected Fano resonances pave the way for a new generation of reliable wave-based devices such as ultrafast switches or modulators , efficient lasers, perfect absorbers, and highly precise interferometers.

15:00 : Invited talk

Fano resonances and exceptional points in waveguides and quantum conductors

Alexander Gorbatsevich, Nikolay Shubin, Vladimir Kapaev, Alexander Friman
P.N. Lebedev Physical Institute (Russia)

We present a unified theory, which makes it possible to study on a unique theoretical platform diverse issues concerning resonances in complex classical as well as quantum systems including Fano resonances and exceptional points, collapse of Fano resonances and bound states in the continuum. We support the main results of our theory by numerical simulations of a real electromagnetic waveguides and discuss the difference between classical and quantum description of Fano resonances.

15:20 : Invited talk

Interaction between dielectric particles enhances the Q-factor

Evgeny Bulgakov, Konstantin Pichugin, Almas Sadreev
Kirensky Institute of Physics (Russia)

We study the behavior of resonant modes under variation of thedistance between two dielectric particles shaped as disks, rods and layers. With decreasing of the distance the interaction is enhanced given rise to strong repulsion of the resonances and avoided crossings with different families of resonances. That in turn results in strong enhancement of the Q-factor of two particles compared to the isolated disks.

15:40 : Invited talk

Multipolar properties of bound states in the continuum supported in all-dielectric metasurfaces

Yi Xu
Jinan University (China)

We study the multipolar properties of bound states in the continuum of all-dielectric metasurfaces which are consisted of periodic silicon nanodisks. Such bound states in the continuum can be regarded as the discrete states (subradiant modes) which involves in forming high-Q Fano resonances. By reconstructed the Fano line shape utilizing the induced multipole moments in one unit cell, we reveal the important roles of multipolar bound states in the continuum play in forming such Fano resonances.

14:00 - 16:05 — Auditorium EA2

Session 1A23

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

14:00 : Invited talk

Metamaterial Absorber-empowered Light-harvesting Devices

Peng Yu[1], Zhiming Wang[1], Alexander Govorov[2]
[1] *University of Electronic Science and Technology (China),* [2] *Ohio University (USA)*

Absorption of light is critical to light-trapping devices such as photovoltaics, biosensors, photodetectors, etc. Naturally occurring materials have weak absorption, while perfect absorbers based on metamaterials are developed to solve the weak light absorption of light-harvesting devices. This presentation will provide an overview of metamaterial absorber enhanced light harvesting devices and our recent research progress on metamaterial absorbers.

14:20 : Invited talk

FRET in Hybrid Nanostructures: General Dimensionality Classes, Assembly Effects and Unique Cases

Pedro Ludwig Hernandez Martinez, Hilmi Volkan Demir
Nanyang Technological University (Singapore)

We present a unified picture for Foerster resonance energy transfer in hybrid nanostructures with mixed dimensionality and in assembly arrays. In addition to general classes of FRET, we will also discuss pecu-

liar examples of FRET processes including the exciton migration from quantum well to an energy gradient structure and near unity energy transfer from Nanoplatelets to a monolayer of MoS2. The general effects of dimensionality and assembly, along with peculiar examples, show the richness of FRET phenomena.

14:40 : Keynote talk
Computing resonances in nano-photonic devices using Riesz-projection-based methods
Sven Burger[1], **Felix Binkowski**[1], **Lin Zschiedrich**[2]
[1] *Zuse Institute Berlin (Germany),* [2] *JCMwave GmbH (Germany)*

Nano-optics and quantum optics setups and devices typically rely on optical structures incorporating resonance effects. Advanced modeling and simulation methods are essential for an effective design of the experimental setupsand for the interpretation of the physical results. In this contribution, we review simulation techniques for computing optical resonances. In particular, we point out Riesz-projection-based methods for computing the interaction of light emitters with resonance modes and for computing eigensolutions in dispersive systems.

15:10 : Invited talk
Entanglement in Hybrid Quantum Dot/Plasmonic Systems
Matthew Otten[1], **Stephen K. Gray**[1], **German Kolmakov**[2]
[1] *Argonne National Laboratory (USA),* [2] *The City University of New York (USA)*

Cavity quantum electrodynamics calculations are used to elucidate how quantum dots can become entangled in hybrid systems composed of quantum dots and plasmonic resonators. By coupling the quantum dots to photonic cavities it is further shown how measurement of the two-photon correlation function can be used to verify the entanglement.

15:30 : Invited talk
Cooperative emission by quantum plasmonic superradiance
Hugo Varguet, Stephane Guerin, Hans Rudolf Jauslin, Gérard Colas des Francs
University Bourgogne Franche-Comté (France)

We investigate the correlated emission from an assembly of emitters coupled to a plasmonic particle, in a quantized model. We observe burst of emission but demonstrate that modal destructive interferences can inhibit the cooperative behaviour.

15:50 : Hot electron generation in plasmonic nanostructures - thermal vs. non-thermal effects
Y. Sivan, Y. Dubi
Ben-Gurion University (Israel)

We present a self-consistent theory of the steady-state electron distribution in metals under continuous-wave illumination which treats both thermal and non-thermal effects. We show that reported faster chemical reactions likely originate from pure heating.

14:00 - 16:00 — Auditorium EA3

Session 1A24

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Manuel Marques

14:00 : Invited talk
Control of Ge(Si) Quantum Dot Emission by Mie Resonances in Silicon Nanodisks
Viktoriia Rutckaia[1], **Dominik Schulze**[1], **Vadim Talalaev**[1], **Frank Heyroth**[1], **Mihail Petrov**[2], **Mikhail Shaleev**[3], **Alexey Novikov**[3], **Joerg Schilling**[1]
[1] *Martin-Luther-University Halle-Wittenberg (Germany),* [2] *ITMO University (Russia),* [3] *Russian Academy of Sciences (Russia)*

We investigate an active photonic system based on Ge(Si) quantum dots embedded into silicon nanodisks.

We show experimentally the enhancement of the photoluminescent signal from quantum dots coupled to Mie-modes of the nanodisks. Using numerical modeling, we identify the coupling mechanism, which allows for engineering the hybridized Mie-modes through the interaction of several nanodisks. We study linear chains consisting of several nanodisks placed next to each other. We demonstrate the resonance-mediated change of spontaneous emission (Purcell-effect) performing time-resolved measurements.

14:20 : Invited talk

Sharp Fano resonance and active response changes in 4D-printed photonic structures

Soo-Chan An[1], Eunsongyi Lee[1], Chang-Hyun Lee[2], Hoon Yeub Jeong[1], Taek-Sun Kwon[2], Jeong-Hae Lee[2], Young Chul Jun[3]

[1] *UNIST (Korea),* [2] *Hongik University (Korea),* [3] *Ulsan National Institute of Science and Technology (UNIST) (Korea)*

Fano-resonant structures that exhibit sharp spectral resonances are demonstrated employing 4D printing of shape memory polymers. When heated above the glass-transition temperature, disordered lattices are transformed into an ordered lattice, resulting in a drastic change in photonic response. This could be useful for long-distance environmental monitoring.

14:40 : Invited talk

Inverse Design and Optimization along Machine Learning for Metasurfaces

Samad Jafar-Zanjani, Hossein Mosallaei

Northeastern University (USA)

Despite many advantages, performance of the conventional optical metasurfaces is not yet satisfactory, in terms of their functionality, frequency and angular response, and efficiency, due to the limitations imposed by their constituent units of canonical shape. In this summary we propose more sophisticated geometries, such as binary-pattern unit-cells, along with adaptive genetic algorithm multi-objective optimization, to overcome the limitations of the conventional metasurfaces and pave the way for efficient inverse design by machine leaning algorithms.

15:00 : Invited talk

Can optical forces be used to measure the polarization state of light inside a birefringent waveguide?

Vincent Ginis[1], Lulu Liu[2], Alan She[2], Federico Capasso[2]

[1] *Vrije Universiteit Brussel (Belgium),* [2] *Harvard University (USA)*

We investigate whether optical forces acting on Mie particles in the vicinity of a birefringent waveguide can be used to reconstruct the polarization state of light inside that waveguide and we identify an interesting parameter regime in which an unambiguous retrieval is possible. This result is utilizing the fact that the lateral Belinfante momentum strongly depends on the helicity of the confined light.

15:20 : Invited talk

Optical switching of the Second Harmonic Generation in AlGaAs nanoantennas

Michele Celebrano[1], Eva A. A. Pogna[1], Lavinia Ghirardini[1], Francesco Rusconi[1], Paolo Biagioni[1], Andrea Mazzanti[1], Giuseppe Della Valle[1], Lamberto Duo[1], Luca Carletti[2], Davide Rocco[2], Carlo Gigli[3], Giuseppe Marino[3], Giuseppe Leo[3], Costantino De Angelis[2], Giulio Cerullo[1], Marco Finazzi[1]

[1] *Politecnico di Milano (Italy),* [2] *University of Brescia (Italy),* [3] *University Paris Diderot (France)*

We demonstrate efficient optical switching of the second harmonic generation (SHG) in AlGaAs nanoantennas. We observe more than 50 $\%$ enhancement/suppression of the SHG excited at telecom wavelength, when simultaneously illuminating with a control beam at an energy above the material bandgap. By means of pump-probe experiments, where the control beam serves as pump, we addressed the temporal evolution of this process revealing ultrafast build-up times ($<$ 300 fs) and slower recovery times above 10 ps.

15:40 : Invited talk

sp3 Defects of Single Walled Carbon Nanotubes: Photonic and Electronic Integration

Han Htoon

Los Alamos National Laboratory (USA)

We will review recent progresses in integration of carbon nanotube defects into plasmonic and photonic cavities for enhancement of light matter interaction and into nano-electronic devices for electrical stimulation.

14:00 - 16:00 — Auditorium EA4

Session 1A25

Dynamic metamaterials

Organized by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

Chaired by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

14:00 : Invited talk

Geometric Frustration in Arrays of Au Nanoelements

Ana Conde-Rubio[1], Arantxa Fraile Rodriguez[1], Francesc Pérez-Murano[2], André Espinha[3], Agustin Mihi[3], Xavier Batlle[1], Amilcar Labarta[1]

[1] *Universitat de Barcelona (Spain),* [2] *Institut de Microelectronica de Barcelona (Spain),* [3] *Institut de Ciencia de Materials de Barcelona (Spain)*

Inspired by frustrated magnetic systems, the effect ofgeometric frustration in the optical response of plasmonicarrays of Au nanoelements is studied. In particular, we showhow the symmetry of the lattice can hamper the excitation ofnear-field dipolar modes among the nanoelements, favoringin turn the excitation of lattice collective modes. Bothsimulations and experimental results demonstrate that thesesystems behave as perfect absorbers in the visible and/or thenear infrared and they exhibit a relatively extended timeresponse.

14:20 : Invited talk

Light modulating and detecting in on-chip plasmonic-graphene hybrid platforms

Sanshui Xiao, Hao Hu, Michael Galili, Asger Mortensen, Leif Katsuo Oxenloewe, Yunhong Ding

Technical University of Denmark (Denmark)

Graphene has offered a new paradigm for extremely fast and active optoelectronic devices. Here we present novle integrated graphene plasmonic devices for on-chip light modulating and detecting. The graphene plasmonic modulator shows high modulation depth and low insertion loss, and the graphene plasmonic waveguide photodetector has the bandwidth beyond 110 GHz and intrinsic responsivity of 360 mA/W.

14:40 : Invited talk

Nanoporous metamaterials as novel electrodes for enhanced in-vitro electrophysiology and toxicology

Michele Dipalo, Giovanni Melle, Laura Lovato, Andrea Jacassi, Francesca Santoro, Valeria Caprettini, Andrea Schirato, Alessandro Alabastri, Denis Garoli, Giulia Bruno, Francesco Tantussi, Francesco De Angelis

Istituto Italiano di Tecnologia (Italy)

In the past decade, the scientific community could obtain the in-vitro recording of intracellular action potentials from networks of electrogenic cells by exploiting 3D nanostructures (nanopillars). However, these techniques were not implemented in commercial products due to difficulties in the production of 3D nanostructures. Here, we show that intracellular signals can be acquired with laser excitation of planar nanoporous metamaterials used as meta-electrodes of multi-electrode arrays. The fabrication of the meta-electrodes is cost-effective and is compatible with large production.

15:00 : Invited talk

Advances in Nanomechanical Metamaterials

Eric Plum, Dimitrios Papas, Jun-Yu Ou, Artemios Karvounis, Kevin F. MacDonald, Nikolay I. Zheludev

University of Southampton (United Kingdom)

We report recent breakthroughs in nanomechanical metamaterials including (i) a giant acousto-optical effect, (ii) on/off switching of metasurfaces, (iii) selective electrical and optical actuation of metamaterials elements with sub-wavelength spatial resolution, (iv) phase-change metasurfaces with bistable optical and mechanical properties and (v) metamaterials tuned by electrostriction.

15:20 : Invited talk

Spiral metamaterials for terahertz magnetic field enhancement

Matteo Pancaldi[1], Debanjan Polley[1], Nanna Zhou Hagstrom[1], Matthias Hudl[1], Paolo Vavassori[2], Sergei

Urazhdin[3], Clemens von Korff Schmising[4], Stefan Eisebitt[4], Stefano Bonetti[1]
[1] *Stockholm University (Sweden),* [2] *CIC nanoGUNE (Spain),* [3] *Emory University (USA),* [4] *MBI Max-Born Institute (Germany)*

We designed a class of spiral thin-film antennas for enhancing, in the near field, the incident terahertz (THz) magnetic field. Indeed, using existing laser-based THz sources, our metamaterial geometry allows generating magnetic fields of the order of 2 T over a time scale of few picoseconds, enabling the investigation of nonlinear ultrafast spin dynamics in table-top experiments.

15:40 : Invited talk
Ultrafast Laser-Induced Control of Interface-Induced Magnetic Anisotropy in Ferromagnetic Thin films
Alexandra Kalashnikova
Ioffe Institute (Russia)

Ultrafast laser-induced changes of magnetic anisotropy is the phenomenon allowing to excite and control dynamics of magnetization in a bulk, thin films, and nanostructures. We present our recent results on studies of ultrafast laser-induced thermal changes of magnetic anisotropy with emphasis put on contributions defining properties of thin and ultrathin films. We consider the laser-induced manipulation of perpendicular magnetic anisotropy in magnetic tunnel junctions, and of magneto-elastic domains in composite strain-mediated multiferroics.

14:00 - 15:20 — Room 02.2

Session 1A26

Novel guided wave configurations with nanostructures for emerging applications

Organized by: Alina Karabchevsky

Chaired by: Alina Karabchevsky

14:00 : Invited talk
Photonic nanojet generated by dielectric multi-material microstructures.
Oksana Shramkova, Laurent Blonde, Valter Drazic, Bobin Varghese, Valerie Allie
Technicolor Research - Innovation (France)

We study high-intensity nanojet (NJ) beams generated at the output of dielectric multi-material elements. The proposed method for generating condensed optical NJ beams relies on the complex electromagnetic phenomenon associated with the light diffraction on the edges of constitutive parts of the studied system embedded in a host medium with lower refractive index. The possibility of NJ shift and deviation in the near zone of such a microstructure illuminated by a plane wave is demonstrated via a double-material microstructure.

14:20 : Invited talk
Light Propagation in Synthetic Photonic Lattices in the Presence of Disorder
Stanislav Derevyanko
Ben Gurion University (Israel)

We discuss recent results for Anderson localization in synthetic photonic lattices. We present the results for the spectra and both dynamic and modal participation number for systems with both phase and coupling static disorder.

14:40 : Invited talk
Towards an integrated quantum photonics platform on GaAs
L. Dusanowksi[1], Christof. P. Dietrich[1], Andrea Fiore[2], Mark Thompson[3], Martin Kamp[1], Sven Hofling[1]
[1] *University of St. Andrews (United Kingdom),* [2] *Eindhoven University of Technology (The Netherlands),* [3] *University of Bristol (United Kingdom)*

We review recent achievements in quantum integrated photonic components and circuits based on the GaAs technology platform. All key functionalities, including single-photon sources and single-photon detectors, integrated auto-correlators and tuneable Mach-Zehnder interferometers have been realized and tested. These

results lay the foundation for a fully-functional and densely integrated quantum photonic technology based on GaAs components.

15:00 : Invited talk
Topological Phase Transitions in Guiding Photonic Systems
Zhaxylyk A. Kudyshev, Vladimir M. Shalaev, Alexandra Boltasseva, Alexander V. Kildishev
Purdue University (USA)

Precise control over the topology of guiding systems is critical for photonic applications, such as topologically protected memory/logic and quantum communication devices. Within this work, we show that by integrating modulator with a photonic waveguide system, it is possible to realize ultrafast control over topologically non-trivial photonic states. We can achieve this task by combining a system of modulators with a silicon resonator array, enabling unparalleled optical/electrical control over the topology of the system with a synthetic magnetic field.

14:00 - 15:20 — Room 02.1

Session 1A27

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Carsten Ronning

14:00 : Invited talk
Chirowaveguides: a balance between circular and linear birefringences
Alban Gassenq, Leo Colliard, Amina Bensalah-Ledoux, Bruno Baguenard, Laure Guy, Stephan Guy
Université Lyon (France)

We have demonstrated that planar chirowaveguides made of chiral hybrid material can propagate circularly polarizedlight. These chirowaveguides require symmetric structure with lowrefractive index mismatch. We show that chiral propagation behavior is theresult from the balance between circular and modal birefringence. Based oncoupled mode theory, we numerically simulate the performance of ribchiro-waveguide in air and show that circular polarization can be obtained bytailoring the dimensions of the waveguide.

14:20 : Invited talk
On-chip fabricated non-transfer plasmonic nanolaser
Ya-Lun Ho, J. Kenji Clark, A. Syazwan Kamal, Jean-Jacques Delaunay
The University of Tokyo (Japan)

We report a non-transfer plasmonic-waveguide nanolaser with a structure size in the sub-wavelength regime. A plasmonic waveguided mode capable of sustaining lasing is carefully designed so that top-down fabrication techniques can be used to simultaneous fabricate the nanolasers together with waveguides for an optical circuit. The design supports a lasing mode with a large effective area and confines the absorption of the pump light to the area in which the plasmonic-waveguide mode is most intense.

14:40 : Invited talk
Spatiotemporal Manipulation of Optical fields enabled by Metasurfaces
Amit Agrawal, Wenqi Zhu, Cheng Zhang, Lu Chen, Shawn Divitt, Henri Lezec
National Institute of Standards and Technology (USA)

We demonstrate the versatility of dielectric metasurfaces to (i) shape the temporal evolution of ultrafast optical pulses, and (ii) discuss their applications towards creating integrated photonic interfaces with quantum systems.

15:00 : Invited talk
Nanophotonic Technology and Applications
Yeshaiahu Fainman

University of California (USA)

Dense photonic integration requires miniaturization of materials, devices and subsystems, including passive components (e.g., engineered composite metamaterials, filters, etc.), active components (e.g., modulators and nonlinear wave mixers) and integrated circuits (Fourier transform spectrometer, programmable phase modulator of free space modes, etc.).

Coffee Break and Exhibit Inspection

Session 1P2

Poster session II

16:00 - 16:40

P1: Finite-difference time-domain (FDTD) simulation for optimization of non-metal based Surface enhanced Raman spectroscopy (SERS)
Eunji Ko[1], Jayeong Kim[1], Heehun Kim[2], Gyu-Chul Yi[2], Seokhyun Yoon[1]
[1] *Ewha Womans University (Korea),* [2] *Seoul National University (Korea)*

We focus on less studied effect in SERS of chemical enhancement responsible for selective enhancement of Raman response of different analyte molcules adsorbed on same substrate materials. We incorporate finite-difference time domain (FDTD) simulations to discuss how the design of models attributes to electric field and absorption of non-metallic SERS system which does not involve surface plasmonic resonance. Comparing to our experimental results, we suggest optimization conditions for chemical enhancement in SERS without involving surface plasmon resonance.

P2: Random interleaved meta-surface for controllable C-Points
Enliang Wang, Jiebin Niu, Lina Shi, Changqing Xie
Chinese Academy of Sciences (China)

In this article, we introduced the random interleavedgeometric meta-surface solution for the reconstruction of thecontrollable C-points in contrast to the kinoform operation.Lemon beams of the C-points are present. The $\pm$1st order ofthe polarization-singular beams has same polarizationsingularity indices with the opposite handedness.Furthermore, spin-induced rotation of the Lemon beams areverified experimentally under different incident linearpolarization states. Our work can be extended into otherpolarization singularity of C-points.

P3: Ultra-Narrowband and Full-Angle Refractive Index Sensor Based on a Planar Multilayer Structure
Linling Qin, Shaolong Wu, Cheng Zhang, Xiaofeng Li
Soochow University (China)

This work reports a design of a ultra-narrowband and wide-angle refractive index sensor based on Tamm plasmon resonance (TPR) by introducing a distributed Bragg reflector (DBR) integrated with a non-adjacent metal layer. The analyte flows into the cavity comprising of the DBR and the non-adjacent metal layer. Simulated results show that the incident light can be strongly confined in the specially designed cavity.

P4: Background-independent thermal camouflage evolved from fin heat sink
Xiayao Peng, Jinlin Song, Run Hu, Xiaobing Luo
Huazhong University of Science and Technology (China)

By drawing inspiration from the fin heat sink, we propose a new kind of thermal camouflage device. The working principle lies in the high thermal conductivity of the folded fins, and the target objects will be concealed inside. Both steady and dynamic simulations were conducted to discuss and evaluate the thermal camouflage performance qualitatively and quantitatively.

P5: Bifurcations of topological edge states in non-linear quantum walks: originating from unique features to Floquet non-linear systems
Ken Mochizuki[1], Norio Kawakami[2], Hideaki Obuse[1]
[1] *Hokkaido University (Japan),* [2] *Kyoto University (Japan)*

Quantum walk, one kind of systems with discrete time-periodicity (Floquet systems), can possess non-trivial

topological phases. Also, recently, quantum walks with non-linear effect have been proposed theoritically. In this study, we study stability of topologically protected edge states in non-linear quantum walks. As a result, we find bifurcations where edge states change from attracter to repeller. The bifurcations we shall show are unique to Floquet non-linear systems, as it originate from the discrete time-periodicity of quantum walks.

P6: Spontaneous Formation of Cold Welded Plasmonic Nanostructures at the Air Water Interface for Intense Raman Scattering

Andrea Marino Lopez, Maria Blanco Formoso, Leonardo N. Furini, Ana Sousa Castillo, Ecem Tiryaki, Moisés Pérez Lorenzo, Martin Testa Anta, Veronica Salgueirino, Miguel A. Correa Duarte
Universidade de Vigo (Spain)

Plasmonic films with concave shapes are known to enhance Raman scattering. Herein, we present monoparticulate films that are formed via self-assembly of gold nanoparticles (NPs) at the air-water interface, upon heating to 80 degrees C a solution containing the NPs. Molecular analytes present in the water can be adsorbed on the metal NPs and be concentrated at the surface, allowing a higher sensitivity for analysis of aliphatic molecules by surface-enhanced Raman Spectroscopy (SERS).

P7: Anisotropic noble metal nanoparticles coated by SiO2 and ZrO2 nanolayer for SHINERS environmental analysis

Jan Krajczewski, Andrzej Kudelski
University of Warsaw (Poland)

In this contribution we report synthesis of some silver and gold nanoparticles having spherical, decahedral and bipyramidal shape which have been covered with various protecting layers. Optical and structural properties of obtained nanomaterials was examined. It was found that the zirconia protecting layer exhibits significantly better durability in corrosive environmental conditions than standard silica nanolayer. Obtained nanoparticles were applied as optical nanoresonators for shell-isolated nanoparticle-enhanced Raman scattering (SHINERS) measurements of various pesticidies.

P8: Wafer-scale gold nanocube arrays for tuneable absorption and refractive-index sensing

Shaolong Wu, Liang Li, Liujing Li, Zhongyuan Zhou, Su Shen, Xiaofeng Li
Soochow University (China)

Here, we have cost-efficiently prepared the large-area Au nanocube arrays (NCAs) only with the help of electrostatic force interacting. This method provides a flexible way for obtaining the controlled Au NCAs with various fill fractions and sizes, leading to a significant and tuneable light absorbance from visible to near-infrared spectrum. Besides, the as-prepared Au NCAs used as a prototype refractive-index (RI) sensor perform excellent stability and a sensitivity over 560 nm per RI unit.

P9: Simulation study of metasurfaces for hemp concrete hydration monitoring

Mehdi Ferhat[1], Badreddine Ratni[2], Fares Bennai[1], Franck Daout[1], Kamilia Abahri[1], Eric Vourc'h[1]
[1] *Université Paris-Saclay (France),* [2] *Université Paris Nanterre (France)*

A metasurface is designed with a view to monitor the hemp concrete hydration. The metasurface is due to be implemented with a hemp concrete sample in an R-band waveguide. By measuring the variations of the resonance frequency of the obtained structure, the dielectric permittivity of the sample can be monitored during the sample hydration (i.e. during the first days or weeks following the material fabrication).

P10: Unidirectional Optical Nanoantenna Design by Bayesian Optimization

F. F. Qin, D. S. Zhang, Jun Jun Xiao
Harbin Institute of Technology (China)

Unidirectional light scattering by a nanoantenna, placed in homogeneous medium or on a substrate is studied in this paper. A fully intelligent method, combining Bayesian optimization algorithm and commercial electromagnetic solver, is utilized to optimize the parameters of the nanoantenna to realize unidirectional scattering. With the aid of the machine learning method, a strong forward or backward scattering by the designed nanoantenna at arbitrary wavelength can be effectively achieved.

P11: Enhanced Magneto-Optical Activity of noble metal nanostructures

Adriano Colombelli[1], Maria Grazia Manera[1], Daniela Lospinoso[2], Antonietta Taurino[1], Roberto Rella[1]
[1] *Institute for Microelectronics and Microsystems IMM-CNR (Italy),* [2] *University of Salento (Italy)*

In this work, the magneto-optical activity of noble metal nanostructures in Kretschmann configuration has

been investigated. The possible effect of an increasing order in their spatial distribution has been theoretically and experimentally investigated, by considering purely disordered, short-range and long-range ordered gold nanostructures. A sizable MO activity can be recognized by using an external magnetic field of low intensity. Modelling tools are used to predict and realize a proper design of the investigated materials tailored on the nanoscale.

P12: Organic materials for plasmonics: nanoscale light-confinement using J-aggregates
Samuel Holder[1], Martin Lopez-Garcia[2], Ruth Oulton[1], Sara Nunez-Sanchez[3]
[1] *University of Bristol (United Kingdom),* [2] *INL-International Iberian Nanotechnology Laboratory (Portugal),* [3] *Universidade de Vigo (Spain)*

In this work we demonstrate that a variety of J-aggregates can be used to make organic materials that confine light on the nanoscale. J-aggregate thin films were prepared by spin-coating a mixture of J-aggregate and polymer matrix. A selection of J-aggregate thin films were chosen with metal-like optical properties from green to red wavelengths. The potential of these films for nanoscale light confinement was then tested by coupling to the surface-exciton-polariton mode of each film, using Fourier imaging spectroscopy.

P13: Tunable SiC Metasurface for Mid-infrared Biochemical Detection
Zhao Huang, Xin Liu, Jianfeng Zang
Huazhong University of Science and Technology (China)

The mid-infrared (MIR) spectral range offers various applications in chemical detection, food safety and biosensing. However, trace detection still remains challenge due to weak light-matter interaction between infrared light and nanoscale molecules. Fortunately, polar dielectrics have ability to achieve optical sub-diffraction confinement and in the MIR spectral range through surface phonon polariton (SPhP) modes. Here, we demonstrate SiC nanoring metasurfaces to achieve high local field enhancement and control the detection frequency by varying structure parameters.

P14: Hiding a QR code in a Vector Light Beam
Chunmei Zhang, Yuttana Intaravanne, Wei Wang, Xianzhong Chen
Heriot-Watt University (United Kingdom)

As one of the important properties of light, polarization profile can be utilized to carry information. Metasurfaces have shown great potentials in manipulating the light propagation. In this paper we experimentally demonstrate a metasurface device which can encode a quick response (QR) code into the space-variant polarization profile of a laser beam. A linear polarizer is used to reveal the hidden QR code. This technology has potential application in anticounterfeiting, security and so on.

P15: Coupling a single carbon-nanotube to a plasmonic 'hotpots-patch' antenna.
Clement Beaufils, Nicolas Izard, Didier Felbacq, Guillaume Cassabois, Emmanuel Rousseau
University Montpellier (France)

We report on the coupling of carbon-nanotubes to plasmonic antennas made by a random collection of metallic scatterers. Preliminarily to lumi- nescence experiments, we have characterized the quench- ing of a single carbon-nanotube due to the metallic plane. We highlight that the experimental results fit well with the power radiated by a dipole parallel to the metallic plane. finally we show that the hotspots lead to luminescence enhancement. Interestingly we report on plasmonic modes with high quality factor.

P16: High-Resolution Quantitative Phase Imaging of Plasmonic Metasurfaces
Petr Bouchal[1], Petr Dvorak[1], Jiri Babocky[1], Zdenek Bouchal[2], Filip Ligmajer[1], Lukas Kejik[1], Martin Hrton[1], Vlastimil Krapek[1], Alexander Fassbender[3], Stefan Linden[3], Radim Chmelik[1], Tomas Sikola[1]
[1] *Brno University of Technology (Czech Republic),* [2] *Palacky University (Czech Republic),* [3] *Universitat Bonn (Germany)*

Optical metasurfaces have emerged as a new generation of building blocks for multifunctional optics. Design and realization of metasurface elements place ever-increasing demands on accurate assessment of phase alterations introduced by complex nanoantenna arrays. Here, we report on a new strategy in incoherent holographic imaging of metasurfaces, in which unprecedented spatial resolution and light sensitivity are achieved by taking full advantage of the polarization selective control of light through the geometric (Pancharatnam-Berry) phase.

P17: Plasmonic Properties of Silver Amalgam Nano- and Microparticles

Lukas Kejik[1], **Filip Ligmajer**[1], **Michal Horak**[1], **Ales Danhel**[2], **Miroslav Fojta**[2], **Tomas Sikola**[1]
[1] *Brno University of Technology (Czech Republic),* [2] *Masaryk University (Czech Republic)*

Silver amalgam represents the most suitable alternative electrode material to metallic mercury in electroanalytical chemistry. Nanostructuring the amalgam promises improved electrochemical performance and brings along the prospect of plasmonic activity. Here, we present a detailed study of plasmonic properties of silver amalgam nano- and microparticles with plasmon resonance wavelengths spanning from ultraviolet to the mid-infrared region depending on the particle size. This combined electrochemical and plasmonic functionality renders the system as a very promising electrode material for spectroelectrochemical studies.

P18: Monolithic high contrast gratings - highly reflective mirrors for VCSELs

Magdalena Marciniak[1], **Artur Broda**[2], **Marcin Gebski**[1], **Jan Muszalski**[2], **Maciej Dems**[1], **Michal Wasiak**[1], **James A. Lott**[3], **Tomasz Czyszanowski**[1]
[1] *Lodz University of Technology (Poland),* [2] *Institute of Electron Technology (Poland),* [3] *Technische Universitat Berlin (Germany)*

High contrast gratings (HCGs) are an attractive alternativeto Distributed Bragg Reflectors (DBRs) as highly reflectivemirrors for Vertical-Cavity Surface-Emitting Lasers (VCSELs).In our group we investigate the use of monolithicHCGs (MHCGs) to reduce the vertical thickness and simplifythe epitaxial structure of VCSELs. In this work wepresent power reflectance measurement for MHCGs and wediscuss properties of these diffraction grating structures.

P19: 'Hybrid plasmonic' to 'plasmonic only' transition and 'photonic only' mode supported by semiconductor near metal

Ning Liu
University of Limerick (Ireland)

Optical modes supported by dielectric-semiconductor-insulator-metal 4-layered structure have gained increasing popularity in recent years due to their applications in nanoscale waveguides and lasers. In this communication, the author is going to discuss different optical modes that co-exist in this configuration, their physical origins and their applications in nanophotonics.

P20: Incidence angle-dependence in image reconstruction crosstalk of broadband birefringent c-Si Metasurfaces

Augusto Martins[1], **Juntao Li**[2], **Achiles Fontana Mota**[1], **Yin Wang**[2], **Luiz Goncalves Neto**[1], **Ben-Hur Viana Borges**[1], **Emiliano Rezende Martins**[1]
[1] *University of Sao Paulo (Brazil),* [2] *Sun Yat-Sen University (China)*

We investigate numerically and experimentally the image reconstruction crosstalk as function of the incidence angle for a broadband stereoscopic hologram metasurface operating in the visible range. To this end, we define a metasurface acceptance cone in which good performance can be achieved with reduced polarization crosstalk. The stereogram consists of a birefringent metasurface with elliptical crystalline silicon (c-Si) nanoposts. The optimum diffraction(transmission) efficiency calculated at normal incidence reach 52.3 % (76.9 %) at the design wavelength of 532 nm.

P21: Optical isolators based on magnetoplasmonic subwavelength gratings

Sevag Abadian, Beatrice Dagens, Vy Yam, Giovanni Magno
Université Paris-Saclay (France)

Our numerical work has shown that when a TE mode magneto-optical Bismuth Iron Garnet waveguide is coupled to a neighboring gold grating, surface plasmon polaritons can enhance the transverse magneto-optical Kerr effect achieving non-reciprocal transmission.

P22: Unidirectional edge states in two dimensional plasmonic arrays

Matthew Proctor, Stefan A. Maier, Richard V. Craster, Paloma Arroyo Huidobro
Imperial College London (United Kingdom)

The combination of topologically protected states with plasmonic systems presents the opportunity to control electromagnetic waves reliably on the nanoscale. Motivated by these effects we investigate arrays of plasmonic nanoparticles with hallmarks of topological effects, including band inversion and unidirectional edge states. These states are a result of particular lattice symmetries. By treating the nanoparticles as point dipoles and applying the coupled dipole method, we model infinite arrays and semi-infinite ribbons.

P23: Design of Meta-reflector by Deep Learning
Wei Xiao, Peter R. Wiecha, Kai Sun, C. H. de Groot, Otto L. Muskens
University of Southampton (United Kingdom)

Meta-surface optical solar reflectors (OSRs) based on metamaterial absorber can provide cost-effective high performance alternative to conventional OSRs in spaceship applications. However, the design and optimization of meta-reflectors unsurprisingly involve numerical simulations with multiple design variables and leads to a low computational efficiency. In this work, we adopted a deep learning technique to speed up the computational efficiency and demonstrated that the prediction of meta-reflectors optical response and inverse design of meta-reflectors structures can be achieved through deep learning.

P24: Correlation between bands structure and quantum magneto-transport in In0.53Ga0.47As/InP type I superlattice for short-infrared detection
Merieme Benaadad, Abdelhakim Nafidi, Samir Melkoud, Nassima Benchtaber, Es-saïd Es-Salhi, Fatiha Chibane, Mustapha Massaq
University Ibn Zohr (Morocco)

We investigated here the band structures and quantum magneto transport properties of InxGa1-xAs.d1 InP.d2 superlattice, based on the envelope function formalism. We studied the effect of d1, the band valence offset and temperature on the cut-off wavelength in the short infrared region. The computed density of states and position of Fermi level, predict that this sample is n type quasi two-dimensional system. We interpreted theoretically the photoluminescence, the Shubnikov de Haas and quantum Hall Effects observed by Pusep et al.

P25: Excitation of near-field resonances in system of two coupled small particles by fast electrons
Daria Sergeeva, A. A. Tishchenko
National Research Nuclear University - MEPhI (Russia)

The first-principles theory of the radiation generated by an electron passing near the system of coupled particles is constructed. Proceeding from microscopic approach and performing the consistent calculations such characteristics as polarizability of the metastructure (the system of many particles) were expressed through the characteristics of a single particle. The obtained results demonstrate essential step towards the further rigorous analysis of the radiation processes in the systems with interaction and collective effects like plasmons, surface plasmon-polaritons, local field effects.

P26: Gain Mediated Surface Plasmon Polariton Propagation in the Near-Infrared
Preksha Tiwari[1], Svenja Mauthe[1], Noelia Vico Trivino[1], Chang-Won Lee[2], Kirsten Moselund[1]
[1] *IBM Research Zurich (Switzerland),* [2] *Hanbat National University (South Korea)*

We demonstrate gain mediated propagation of hybrid plasmonic-photonic modes in near-infrared at temperatures ranging from 95 K to 300 K. Hybrid modes are formed in an oxide layer sandwiched by a gold thin film and an InP substrate. Optical pumping at 750 nm results in photoluminescence from InP which couples to surface plasmon polaritons. In contrast to the photoluminescence efficiency, the plasmonic propagation losses are quasi-temperature-independent. We attribute this non-dependence predominantly to scattering caused by the gold film's polycrystallinity.

P27: Spatial dispersion and local field effects in metamaterials
Alexey Tishchenko
National Research Nuclear University - MEPhI (Russia)

I will discuss correlation between two key phenomena in metamaterials: spatial dispersion and local field effects. I consider 1D, 2D and 3D systems of interacting objects (meta-atoms), and two types of response functions: dielectric function, like the Clausius-Mossotti one, and the response to the field of external sources. The analysis is given for two competing approaches: i) the widely used description via two independent dielectric and magnetic functions, ii) tensor of dielectric function embracing both dielectric and magnetic properties.

P28: Plasmonic TiOxNy based micro-structured films obtained by ammonolysis photopatternable TiO2 sol-gel film
Maria Alejandra Usuga[1], Crespo-Monteiro Nicolas[1], Vocanson Francis[1], Koussi Erika[1], Jamon Damien[1], Verrier Isabelle[1], Langlet Michel[2], Jourlin Yves[1]
[1] *Université de Lyon (France),* [2] *Université Grenoble Alpes (France)*

This paper shows the obtention of thick titania sol-gel films and their technological processing to metallic films of TiOxNy by ammonolysis process. The aim of this process is the realization of subwavelength TiOxNy micro-structured surface for application in resonant plasmonic gratings in the Near - InfraRed range (NIR).

P29: Scattering by Core-Shell Semiconductor Microinclusions for Plasmonically Enhanced Near-IR Applications

Fahime Sadat Seyedheydari, Kevin Conley, Tapio Ala-Nissila
Aalto University (Finland)

We computationally design highly reflective, plasmonically enhanced coatings for more sensitive and versatile radiation detectors in the infrared regime. The large scattering cross-sections of micro-inclusions are exploited to design devices and spectrally sensitive coatings for sensors, insulators, and solar applications. We focus on low-bandgap semiconductor microinclusions which have plasmonic resonances with excellent and tunable scattering properties without suffering from losses at high temperatures. These particles display a rich spectral response dependent on the refractive index of the particles.

P30: Superradiant molecular aggregates on dielectric surfaces interacting with plasmonic structures

Alexander Eisfeld
Max Planck Institute for the Physics of Complex Systems (Germany)

Molecular aggregates formed on dielectric surfaces can show strong collective effects which can result in eigenstates which exhibit super- or sub-radiant emission. Here we discuss how nearby nano-structures influence these eigenstates of the aggregate and the resulting optical properties.

P31: Propagation of Strongly Hybridized Plasmonic Modes: Theory and Applications

Ivan A. Pshenichnyuk[1], Sergey S. Kosolobov[1], Andrei I. Maimistov[2], Vladimir P. Drachev[1]
[1] *Skolkovo Institute of Science and Technology (Russia),* [2] *National Research Nuclear University MEPhI (Russia)*

Propagation of a hybrid mode formed by mixing of a dielectric waveguide mode with several plasmonic modes, is studied numerically in 3D. Edge plasmons are used to maintain coupling between states with different polarisations. Proposed waveguide structures allow to reach a strong light-matter interaction regime and balance plasmonic losses, providing a convenient basis for various compact and efficient photonic devices, including electro-optical modulators and polarisation converters.

P32: Detection of organic molecules using asymmetric plasmonic nanostructures

Ili Farhana Mohamad Ali Nasri, Graham Sharp, Richard De La Rue, Nigel Johnson, Marc Sorel, Caroline Gauchotte-Lindsay
University of Glasgow (United Kingdom)

We demonstrate the fabrication and characterization of an asymmetric split H resonators on a zinc selenide substrate that produce plasmonic resonances matched with the molecular vibrations of estrogenic hormones,17β-Estradiol (E2) and Estrone (E1). The experimental results show there is a good match with the molecular bond resonances of the C-H, C=O and C=C observed in estrogen and we have also shown that it is possible to differentiate the molecular bond resonance spectrum of E2 in a mixture with E1.

P33: Coherent absorption in non-Hermitian multilayers: when the weak controls the strong

Simone Zanotto[1], Giuseppe Carlo La Rocca[2], Alessandro Tredicucci[1]
[1] *Istituto di Nanoscienze - Consiglio Nazionale delle Ricerche (Italy),* [2] *Scuola Normale Superiore and CNISM (Italy)*

Controlling the flow of an intense light beam by means of a much weaker one is a dream whose realization may open the way to potentially disruptive data elaboration techniques. However, since light interacts with itself very weakly and only under precise circumstances, this task has proven elusive for long times. In this abstract we show that a loss-gain thin-film-based or metasurface-based multilayer may implement perfect, asymmetric, full-optical control if non-Hermitian photonics concepts are appropriately exploited.

P34: Coupling regimes in a complex of two rods: from core-shell particle to dimer

Alexey A. Dmitriev, Mikhail V. Rybin
ITMO University (Russia)

We study coupling regimes in a system made of two infinite dielectric rods with the same frequency of dipole Mie resonances. We present simulated scattering spectra in three configurations: a core-shell particle, an

eccentrically coated rod and a dimer. We track the evolution of spectra as the distance between the rods is varied and discuss the coupling regimes.

P35: Metasurface Surface-Wave Dispersion Analysis and Synthesis Technique
Karim Achouri, Olivier J. F. Martin
EPFL (Switzerland)

The proposed technique allows one to efficiently and quickly retrieve the dispersion diagram of a metasurface from its numerically simulated scattering parameters without resorting to a time-consuming numerical eigensolver. It may also be used to find the metasurface structure corresponding to desired surface-wave propagation characteristics.

P36: Complex Band Structure and Dispersion Relation of Acoustic Waves in Piezoelectric Based Topological Phononic Crystals
Selami Palaz[1], Zafer Ozer[2], Sevket Simsek[3], Husnu Koc[4], Amirullah Mamedov[5], Ekmel Ozbay[5]
[1]*Harran University (Turkey),* [2]*Mersin University (Turkey),* [3]*Hakkari University (Turkey),* [4]*Siirt University (Turkey),* [5]*Bilkent University (Turkey)*

In present work, the acoustic band structure of a 2D phononic crystal (PC) containing piezoelectric materials were investigated by the finite element method. 2D PC with triangular and honeycomb lattices. The calculated phonon dispersion results indicate the existence of full acoustic modes in the proposed structure along the high symmetry points. The results show that these acoustic metamaterials with Helmholtz resonators can be used successfully to reduce the Dirac cone frequencies.

16:40 - 19:05 — IST Congress Center Auditorium

Session 1A28

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: David Smith

16:40 : Invited talk
Fabrication of Plasmonic Supercrystals for Microfluidic Sensing
Daniel Garcia-Lojo, Sergio Gomez-Grana, Jorge Perez-Juste, Isabel Pastoriza-Santos
Universidade de Vigo (Spain)

Recently we have demonstrated that PDMS-based microfluidic channels can be used for the fabrication of plasmonic supercrystals through self-assembly of Au octahedrons inside their microchannels through solvent pervaporation. The resulting plasmonic devices could be used for the detection of analytes, even without affinity for gold nanoparticles. The sensing capabilities of the platforms will be analized by investigating the SERS efficiency using different Raman active analytes.

17:00 : Invited talk
Development of a wave machine to model phononic crystals and elastic metamaterials
Motonobu Tomoda, Masahiro Ino, Osamu Matsuda, Oliver B. Wright
Hokkaido University (Japan)

To demonstrate and understand wave motion in phononic crystals (acoustic periodic structures) and elastic metamaterials (structures with local vibrational resonances), we develop an instructive instrument to visualize one-dimensional torsional waves based on a Shive wave machine. Phononic crystals are made by adding extra masses in a spatially periodic fashion, and elastic metamaterials are made by adding blade springs. The frequencies of band gaps agree well with theories based on torsional vibrations, analogous to those based on mass-spring models.

17:20 : Keynote talk
Optimized quantum photonics

Jelena Vuckovic
Stanford University (USA)

We present our recent progress on developing high quality qubits based on color centers in diamond and silicon carbide, combined with powerful optimized photonic structures providing efficient optical interfaces and interconnects. Our inverse design approach offers a powerful tool to implement classical and quantum photonic circuits with superior properties, including robustness to errors in fabrication and temperature, compact footprints, novel functionalities, and high efficiencies.

17:50 : Invited talk
Self-assembled Nano-rings of Plasmonic Nanoparticles
Anna M. Ritcey, Denis Boudreau, Marie-Pier Coté
Université Laval (Canada)

In order to exploit the plasmonic properties of metal nanoparticles in applicationsconvenient methods must be developed for the production of ordered assemblies covering macroscopic surface areas. Our work addresses this goal through the directed assembly of metal nanoparticles within periodic block copolymer templates. This self-assembly method allows for the preparation of unique arrangements, such as nano-rings and hybrid core-satellite structures. The optical properties of these individual nanostructures are characterised combined hyperspectral imaging and scanning electron microscopy.

18:10 : Invited talk
Nanoplasmonics in Embedded CMOS Electronics: Future mm-scale Complex Nano-optical Sensory Systems
Kaushik Sengupta
Princeton University (USA)

Here we demonstrate for the first time massively parallelizable nanoplasmonic structures exploiting the subwavelength lithography of embedded copper-based interconnect layers in an industry standard CMOS process with 65-nm feature size. We show this in the context of a fullyintegrated, fluorescence based CMOS bio-molecular sensor array with integrated angle and scattering insensitive nanoplasmonic filters. The nano-optics and the all the readout analog and digital electronics are all co-designed and co-integrated in a single 2 mm2 CMOS chip.

18:30 : Invited talk
Novel Photonic Architectures by Nanoimprinting Unconventional Materials
Agustin Mihi
Institute of Materials Science of Barcelona ICMAB- CSIC (Spain)

I will show how we use soft nanoimprinting lithography to mold unconventional materials such as polymers, cellulose or metal colloids to produce a variety of novel photonic architectures. By nanostructuring these unconventional materials, we combine the complex optical properties given by the corrugation with the properties of the original materials: biodegradability (cellulose), electrical transport (conductive polymers) and sensing (Au colloids). The final structures exhibit exciting optical properties with tremendous applications as inexpensive disposable photonic components and sensors.

18:50 : Manipulation of nanoparticles using hyperbolic metasurfaces
Nayan Kumar Paul, J. Sebastian Gomez Diaz
University of California (USA)

We explore the possibilities enabled by hyperbolic metasurfaces to manipulate and trap Rayleigh particles located nearby. Our results reveal that hyperbolic surfaces significantly enhance the optical forces induced on the particle, that they present a broadband response, and that they add new knobs to trap and manipulate such particles using Gaussian beams. We envision that this configuration will be useful in the next generation of nano-optical tweezers, with important applications in bioengineering and physics.

16:40 - 19:00 — Auditorium VA1

Session 1A29

Metamaterials/Metasurfaces in Dirac/Kane Plasmons

Organized by: Taiichi Otsuji and Frederic Teppe

Chaired by: Taiichi Otsuji and Frederic Teppe

16:40 : Invited talk

Controlling the THz Dirac plasmon in Bi2Se3 Topological Insulator at the TeraFERMI beamline

Paola Di Pietro[1], Andrea Perucchi[1], Nidhi Adhlakha[1], Federica Piccirilli[2], Seangshik Oh[3], Alessandra Di Gaspare[4], Stefano Lupi[5]

[1] Elettra-Sincrotrone Trieste (Italy), [2] CNR-IOM Trieste c/o Area Science Park (Italy), [3] State University of New Jersey (USA), [4] NEST-Istituto Nanoscienze-CNR (Italy), [5] Univerista di Roma Sapienza (Italy)

Here we show the nonlinear behaviour of the Dirac plasmon in Bi2Se3 Topological Insulator induced by the intense THz electric field provided by the TeraFERMI beamline at the Free Electron Laser Fermi in Trieste (Italy).

17:00 : Invited talk

Ratchet and magneto-ratchet phenomena excited by THz radiation in semiconductor nanostructures and graphene with lateral superlattices

Sergey Ganichev

University of Regensburg (Germany)

The paper overviews experimental and theoretical studies of terahertz radiation induced ratchet effects in graphene and semiconductor nanostructures with a lateral superlattice. We show that the ratchet photocurrents are caused by the combined action of a spatially periodic in-plane potential and the spatially modulated radiation due to the near field effect of light diffraction. We present symmetry arguments allowing a phenomenological analysis of the respective phenomena, then outline the microscopic theory and finally discuss the main experimental findings.

17:20 : Invited talk

Quantum phenomena with collective excitations in confined systems

Angela Vasanelli, S. Huppert, Y. Todorov, D. Gacemi, Carlo Sirtori

Ecole Normale Superieure (France)

We have investigated electronic collective excitations in quantum wells as a platform to probe some fundamental phenomena of quantum electrodynamics. Indeed, each many-body electronic state is a bosonic quasi-particle confined perpendicularly to the plane of the quantum well. These excitations can be regarded as a macro-atom carrying a huge interaction with the electromagnetic field and are ideal quasi-particle for observing superradiance and light matter ultra-strong coupling.

17:40 : Invited talk

Far and Mid IR lasers based on Dirac heterostructures HgTe/CdHgTe

Sergey Morozov

Institute for Physics of Microstructures RAS (Russia)

We report on stimulated emission at wavelengths up to 20μm from HgTe/HgCdTe quantum well heterostructures with wide-gap HgCdTe dielectric waveguide, grown by molecular beam epitaxy on GaAs(013) substrates. The mitigation of Auger processes in structures under study is exemplified, and the promising routes towards the 20-50 μm wavelength range, where HgCdTe lasers may be competitive to the prominent emitters, are discussed.

18:00 : Invited talk

Graphene based field-effect transistors as tunable plasmonic interferometers for terahertz radiation detection

G. E. Fedorov[1], D. Svintsov[1], D. Bandurin[1], I. Gayduchenko[2], G. Goltsman[2]

[1] Moscow Institute of Physics and Technology (Russia), [2] Moscow State University of Education (MSPU) (Russia)

Here we report on plasmon-assisted resonant detection of terahertz radiation by antenna-coupled graphe-

ne transistors that act as both plasmonic Fabry-Perot cavities and rectifying elements. We demonstrate this long-sought resonant regime using field effect transistors (FETs) based on high-quality van der Waals heterostructures.

18:20 : Invited talk
Massless Dirac fermions in III-V semiconductor quantum wells
Sergey S. Krishtopenko[1], Wilfried Desrat[1], Christophe Consejo[1], Sandra Ruffenach[1], Benoit Jouault[1], Wojciech Knap[2], Fernando Gonzalez-Posada[1], Guilhem Boissier[1], Eric Tournié[1], Frédéric Teppe[1]
[1] *Université de Montpellier (France),* [2] *Int'l Research Laboratory CENTERA (Poland)*

We report on massless Dirac fermions in 2D system based on III-V semiconductors. Using a gated Hall bar made on a three-layer InAs/GaSb/InAs quantum well, we restore the Landau levels fan chart by magneto-transport and demonstrate a gapless state in our sample. Measurements of cyclotron resonance at different electron concentrations directly indicate a linear band crossing. Analysis of experimental data allows us not only determing velocity of the massless fermions but also demonstrating significant non-linear dispersion at high energies.

18:40 : Invited talk
Emergent optoelectronic functionality in low dimensional non-centrosymmetric semiconductors
Yijin Zhang[1], Toshiya Ideue[2], Masaru Onga[2], Feng Qin[2], Ryuji Suzuki[2], Alla Zak[3], Reshef Tenne[4], Jurgen Smet[1], Yoshihiro Iwasa[2]
[1] *Max Planck Institute for Solid State Research (Germany),* [2] *University of Tokyo (Japan),* [3] *Holon Institute of Technology (Israel),* [4] *Weizmann Institute of Science (Israel)*

Transition-metal dichalcogenides (TMDs) are exemplary low-dimensional semiconductors. By breaking the inversion symmetry inherent in their bulk crystals, various exotic physical phenomena have been realized. We studied electrical responses under light illumination in such non-centrosymmetric TMDs belonging to a few different point groups, and observed a large photovoltaic effect induced by the reduction of the crystal symmetry.

16:20 - 18:20 — Auditorium VA2

Session 1A30

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

16:20 : Invited talk
First Observation of Optical Activity in Hyper-Rayleigh Scattering
Ventsislav K. Valev
University of Bath (United Kingdom)

We report the first experimental observation of a chiroptical effect that was predicted 40 years ago.

16:40 : Invited talk
Nanoscale Imaging and Control of Chiral Plasmons
Hiromi Okamoto
Institute for Molecular Science (Japan)

Novel near-field optical imaging methods were developed to visualize local optical activity and circularly polarized fields in the vicinities of metal nanostructures. We found not only chiral but also achiral gold nanostructures gave strong optical activity. Based on the result, we propose a method to generate highly circularly polarized local field with controllable handedness using an achiral nanostructure. We also found that chiral plasmon induces highly circularly polarized luminescence from achiral fluorescent molecules that interact with it.

17:00 : Invited talk

Circularly Polarized Luminescence for Handedness Determination in Chiral Lanthanide Phosphate Nanocrystals

Uri Hananel, Eitam Vinegrad, Assaf Ben-Moshe, Ori Cheshnovsky, Gil Markovich
Tel Aviv University (Israel)

The handedness of chiral TbPO4 nanocrystals can be controlled by preparing the nanocrystals in the presence of certain natural chiral acids, such as tartaric acid. We use circularly polarized luminescence measurements to follow the handedness and enantiomeric purity of the produced nanocrystals. Using single particle circularly polarized luminescence microscopy we proved that we obtain enantiomerically pure terbium phosphate nanocrystals when prepared with tartaric acid molecules.

17:20 : Invited talk

Probing optical chirality in the near-field of achiral nanostructures

Andreas Horrer, Yinping Zhang, Thinhinane Aoudjit, Jeremie Beal, Jerome Plain, Renaud Bachelot, Davy Gerard
Université de Technologie de Troyes (France)

We study the optical properties of plasmonic oligomers with trigonal symmetry. Albeit achiral, such structures exhibit a near-field response that depends upon the handedness of the exciting light (i.e., left- or right-circular polarization). This effect stems from near-field interference between the modes sustained by the structure. Then, we experimentally demonstrate this effect by imprinting the local optical chirality into a photosensitive polymer.

17:40 : Invited talk

Optical Circular Dichroism Expressed by Self-Assembled Plasmonic Materials for Molecular Sensing Applications

Alessandro Belardini[1], Grigore Leahu[1], Emilija Petronijevic[1], Marco Centini[1], Roberto Li Voti[1], Tiziana Cesca[2], Giovanni Mattei[2], Teemu Hakkarainen[3], Ventsislav K. Valev[4], Mircea Guina[3], Concita Sibilia[1]
[1] Sapienza Universita di Roma (Italy), [2] Universita di Padova (Italy), [3] Tampere University of Technology (Finland), [4] University of Bath (United Kingdom)

Detection of biomolecules can be boosted by coupling them with field enhancing substrates such as plasmonic nanoantennas or photonics crystals. Many natural occurring molecules are chiral, thus detecting schemes have to discriminate from two opposite enantiomers. This can be obtained by suitable chiral substrate nanopatternig. Among different fabrication methods the selfassembly approach can lead to low cost, large area metasurfaces with desired functionalities. Here we present the optical circular dichroic behavior of some of these structures and possible applications

18:00 : Invited talk

Nonlinear Chiral Response of Planar Plasmonic-Photonics Hybrid Metasurfaces

Feng Wang, Hayk Harutyunyan
Emory University (USA)

Planar structures that can exhibit chiral response are highly desirable because of their facile fabrication, however fundamental challenges arising from the 2-dimensional nature of these systems prevent the generation of strong chiro-optical effects. In this work, giant enhancement of the handedness-dependent optical response in planar metallic nanostructures is shown by exploring the hybridization of plasmonic-photonic modes in a chiral metasurface.

16:40 - 17:40 — Auditorium VA3

Session 1A31

Symposium III: Advanced passive and active metasurfaces

Organized by: Howard Lee and Din Ping Tsai

Chaired by: Howard Lee and Din Ping Tsai

16:40 : Invited talk
Applying computer graphics techniques to optical metasurfaces: Broadband reflective metasurfaces for the visualisation of 3D effects
Diane J. Roth[1], **Alexander E. Minovich**[1], **Guixin Li**[2], **Anatoly V. Zayats**[1]
[1] *King's College London (United Kingdom),* [2] *Southern University of Science and Technology (China)*

We report on the use of optical metasurfaces for the development of the concept of normal mapping to achieve the representation of 3D objects and shading effects. As a proof of principle, a flat diffuse metasurface imitating lighting and shading of a 3D cube was fabricated and characterised under incoherent illumination. The metasurface performs in a broad range of the visible spectrum, including the RGB wavelengths. Applications of these metasurfaces span from 3D security features to efficient optical diffusers.

17:00 : Invited talk
Enhancing Chiral Light-Matter Interactions by Metamaterials
Yongmin Liu
Northeastern University (USA)

In this talk, I will discuss how to design novel metamaterials by symmetry analyses and deep learning to enhance chiral light-matter interactions, which promise important applications in polarimetric imaging and enantioselective sensing.

17:20 : Invited talk
Revealing the Near-field Dynamics in Chiral Metasurfaces: Interactions of Spatially Displaced Surface Plasmon vortices
Chen-Bin Huang
National Tsing Hua University (Taiwan)

The potential to mold user-desired surface plasmon field flow with the existence of two simultaneous surface plasmon vortices with proper spatial offset is studied numerically. In the first case, a squeezed vortex with opposite rotation direction is generated between two co-rotating vortices. In the second case, a linear flow channel is formed in between two counter-rotating vortices.

17:40 - 19:10 — Auditorium VA3

Session 1A32

Acoustic and seismic metamaterials

Chaired by: Romain Fleury

17:40 : Sn2P2X2 (X=S, Se) as novel materials for phononic crystals
Selami Palaz[1], **Zafer Ozer**[2], **Sevket Simsek**[3], **Husnu Koc**[4], **Amirullah Mamedov**[5], **Ekmel Ozbay**[5]
[1] *Harran University (Turkey),* [2] *Mersin University (Turkey),* [3] *Hakkari University (Turkey),* [4] *Siirt University (Turkey),* [5] *Bilkent University (Turkey)*

In this investigation the linear and nonlinear optical properties, band structures and electro-optic effects of Sn2P2X6 (X=S,Se) ferroelectrics are studied by the density functional theory. We present calculations of the frequency-dependent complex dielectric function and the second harmonic generation response coefficient over a large frequency range in different phases.Also, in present work the acoustic band structure and acoustic wave propagations in 2D phononic crystals containing a Sn2P2X6 ferroelectrics were investigated theoretically and numerically by the plane-wave-expansion method.

17:55 : Acoustic antennas based on the topological insulators
Zhiwang Zhang[1], **Ye Tian**[1], **Ying Cheng**[1], **Xiaojun Liu**[1], **Johan Christensen**[2]
[1] *Nanjing University (China),* [2] *Universidad Carlos III de Madrid (Spain)*

Realizing directional acoustic signal transmittance and reception robust against surrounding noise and competing signals is crucial in many areas such as communication and detection for medical and industrial purposes. Here we show how topological acoustic valley transport can be designed to enable a unique beamforming mechanism that renders a super-directive needle-like sound radiation and reception pattern, which

offers new ways to control sound with improved performance and functionalities that are highly desirable for versatile applications.

18:10 : Multiple Weyl and Double-Weyl Points in Elastic Chiral Lattices
Yao-Ting Wang[1], **Ya-Wen Tsai**[2]
[1] *Imperial College London (United Kingdom),* [2] *National Tsing-Hua University (Taiwan)*

We show that multiple Weyl points arise in chiral elastic systems. On the distinct kz plane, the tight-binding band structure exhibits the presence of Weyl points and double Weyl Points. The numerical calculation illustrates several Weyl and double-Weyl points and, to verify the topological feature, the topological charge of degeneracy is calculated. Within these Weyl points, we theoretically prove that the existence of topologically protected surface modes and their robustness against defects is also demonstrated.

18:25 : Asymmetric Wave Transmission in Dissipative Acoustic Metamaterials
Sagr Alamri[1], **Bing Li**[2], **K. T. Tan**[3]
[1] *King Khalid University (Saudi Arabia),* [2] *Northwestern Polytechnical University (China),* [3] *The University of Akron (USA)*

We propose a dissipative triatomic elastic metamaterial to extend the range of the asymmetric elastic wave transmission and to control the elastic wave in two low-frequency bands. A triatomic metamaterial structure consisting of several small-sized unit cells is proposed and verified analytically. The analytical results are verified numerically by analytical lattice and continuum models. We further explore the asymmetric wave transmission experimentally, and the transient wave responses in the time and frequency domains are also investigated.

18:40 : Nonviscous damping effects on the wave dispersion and dissipation of locally resonant acoustic metamaterials
Taufeeq Abbasi, Hui Zheng
Shanghai Jiao Tong University (China)

Periodic structures for various level of wave dispersion and dissipation use material damping, which may contribute to the performance enhancement of locally resonant acoustic metamaterials (AMMs). We investigate the wave dispersion and dissipation performance of AMM by considering the effects of nonviscous damping. It is demonstrated that the effect of nonviscous damping increases the wave dispersion and dissipation performance of AMM by suitable selection of material parameters.

18:55 : Elastic Wave Control in Double-Zero-Index Elastic Metamaterials
Bing Li[1], **Zheng Li**[2], **Johan Christensen**[3], **K. T. Tan**[4]
[1] *Northwestern Polytechnical University (China),* [2] *Peking University (China),* [3] *Universidad Carlos III de Madrid (Spain),* [4] *The University of Akron (USA)*

Double-zero-index properties in electromagnetic and acoustic waveguides have been recently realized, however, limited research has been reported on double-zero-index structural systems of elastic waveguides. Here, we report an elastic metamaterial consisting of non-perforated taper holes with a periodic array of Lieb-like lattice. Based on the proposed elastic medium, two separated elastic-wave Dirac-like cones are simultaneously observed at the Brillouin zone center, and double-zero-index properties at the neighborhood of Dirac-like points are theoretically, numerically and experimentally investigated.

16:40 - 19:00 — Auditorium VA4

Session 1A33

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Mohamed Bakr and Andrey Bogdanov

16:40 : Invited talk

Enhancing Light Absorption with a Complex Environment: What Are the Limits of the Playground?

Emilie Sakat, Leo Wojszvzyk, Jean-Jacques Greffet, Jean-Paul Hugonin, Christophe Sauvan
Institut d'Optique - CNRS (France)

We have derived an upper bound for light absorption by a nanoparticle in a complex environment, which is valid for any environment and any illumination. The upper bound provides a meaningful figure of merit to compare the ability of different systems to enhance absorption. In the scalar approximation, the relevant physical parameters are the field enhancement and the local density of states. We have also applied our theoretical results beyond the scalar approximation and the case of plane-wave illumination.

17:00 : Invited talk

Saturable photoexcited carrier refraction in graphene-covered on-chip waveguides

David Castello-Lurbe[1], Jurgen Van Erps[1], Mulham Khoder[1], Iwona Pasternak[2], Aleksandra Krajewska[2], Tymoteusz Ciuk[2], Wlodek Strupinski[2], JinLuo Cheng[3], Hugo Thienpont[1], Nathalie Vermeulen[1]
[1] *Vrije Universiteit Brussel (Belgium),* [2] *Warsaw University of Technology (Poland),* [3] *Chinese Academy of Sciences (China)*

Based on a novel analysis of pulse spectral broadening experiments in graphene-covered silicon nitride waveguides, we show that, contrarily to a long-standing belief, self-phase modulation in such waveguides does not rely on the Kerr effect. The unconventional spectral broadening behavior observed in our experiments is successfully explained by means of the saturable refraction of free carriers produced by one-photon absorption in graphene.

17:20 : Invited talk

Revealing Light-Matter Interactions at the Nanoscale using Single-Molecule Super-Resolution Microscopy

Nathan Kimmitt, Zachary Hallenbeck, Evan Kalinowsky, Andrew Dibiasio, Esther Wertz
Rensselaer Polytechnic Institute (USA)

We use super-resolution imaging to unravel the coupling of light to a bowtie antenna and investigate single-molecule trapping dynamics.

17:40 : Invited talk

III-V Semiconductor Nanowires for Optoelectronic Applications

Ziyuan Li, Hark Hoe Tan, Chennupati Jagadish, Lan Fu
The Australian National University (Australia)

III-V semiconductor nanowires have been extensively studied for optoelectronic device applications such as lasers, photodetectors, solar cells and light-emitting diodes owing to their small footprint, unique morphology and physical properties, as well as high flexibility to form heterostructures on lattice mismatched substrates such as Si. Here we review our work on the growth and fabrication of III-V semiconductor nanowire materials for solar cell and photodetector applications.

18:00 : Invited talk

On-chip quantum photonic sources based on silicon waveguide

Lantian Feng[1], Ming Zhang[2], Yang Chen[1], Zhiyuan Zhou[1], Hao Wu[2], Ming Li[1], Guoping Guo[1], Guangcan Guo[1], Daoxin Dai[2], Xifeng Ren[1]
[1] *University of Science and Technology of China (China),* [2] *Zhejiang University (China)*

Integrated quantum photonics has attracted intensive attention due to the compactness, scalability, and stability. An on-chip photonic quantum source, especially an on-chip entangled photon source, is a basic device for realizing quantum photonic integrated circuits (QPICs) . Here, I will introduce our recent works on on-chip quantum photonic sources based on silicon waveguide.

18:20 : Invited talk

Silicon Particle Synthesis and 2D Assembly

Glenna L. Drisko[1], Benoit Miller[1], Maria Letizia De Marco[1], Alyxandra N. Thiessen[2], Jonathan G. C. Veinot[2], Alex Baron[3], Philippe Barois[3], Virginie Ponsinet[3]
[1] *ICMCB (France),* [2] *University of Alberta (Canada),* [3] *Centre de Recherche Paul Pascal (France)*

Spherical, crystalline silicon particles, smaller than the wavelength of incident light, demonstrate intense Mie scattering. Our new bottom-up route produces mass quantities of these meta-atoms. Thanks to their large diameter (80-115 nm), high degree of crystallinity, purity and density, both electric and magnetic Mie reso-

nance has been measured using static light scattering. The scattering properties of these particles have been characterized by single particle dark field scattering. The silicon particles were organized on 2D substrates via dip-coating.

18:40 : Invited talk
Integrated single photon sources with colloidal semiconductor nanocrystals
Alberto Bramati
Sorbonne Universite (France)

In this talk I will discuss the different strategies we are pursuing to develop hybrid photonic devices by coupling single nanocrystals with various photonic structures. In particular the deposition of a single emitter on a nanofiber and the observation of single photon statistics through the guided mode of the fiber will be reported. finally I will show how this hybrid system is a very promising playground for novel chiral optics experiments, including a spin-orbit coupling effect for light.

16:40 - 19:00 — Auditorium VA5

Session 1A34

Nanophononics and nanomechanics

Organized by: Daniel Lanzillotti-Kimura and Pedro David Garcia

Chaired by: Daniel Lanzillotti-Kimura and Pedro David Garcia

16:40 : Invited talk
Topological states of acoustic phonons in semiconductor nanocavities
Martin Esmann[1], Fabrice Roland Lamberti[1], Guillermo Arregui[2], Omar Ortiz[1], Clivia M. Sotomayor-Torres[2], Ivan Favero[3], Olivia Mauguin[1], Bernard Perrin[4], Olivier Krebs[1], Loïc Lanco[1], Pascale Senellart[1], Carmen Gomez-Carbonell[1], Pedro David Garcia[2], Aristide Lemaitre[1], Norberto Daniel Lanzillotti-Kimura[1]
[1] *Université Paris-Saclay (France),* [2] *CSIC - BIST (Spain),* [3] *Université Paris-Diderot (France),* [4] *Sorbonne University (France)*

We introduce the concept of topological invariants to nanophononics and implement a nanophononic semiconductor system supporting a robust topological interface state at 300GHz. We optically probe this mode through Brillouin spectroscopy and coherent phonon generation experiments. This type of topological interface states could become part of novel devices requiring resonant nanoacoustic structures such as compact integrated Brillouin light sources operating at ultrahigh frequencies.

17:00 : Invited talk
Magnon-Phonon Coupling in Lateral Ferromagnetic Nanogratings
Alexey V. Scherbakov[1], Felix Godejohann[1], Serhii Kukhtaruk[1], Dmitro Yaremkevych[1], Achim Nadzeyka[2], Andrew Rushforth[3], Dmitri Yakovlev[1], Andrey Akimov[3], Manfred Bayer[1]
[1] *Technische Universitat Dortmund (Germany),* [2] *Raith GmbH (Germany),* [3] *University of Nottingham (United Kingdom)*

The talk gives an overview of the recent experiments with metallic ferromagnetic films, in which a nanoscale periodic pattern results in formation of the localized phonon modes of sub-THz frequencies. In the time-domain experiments, we investigate the effects related to the resonant interaction of the phonon and magnon modes excited by femtosecond laser pulses. A variety of experimental observations includes the phonon driving of the magnetization precession, the magnon driving of coherent phonons and the magnon-phonon strong coupling.

17:20 : Invited talk
Optomechanics with hybrid carbon nanotube resonators
Alexandros Georges Tavernarakis[1], Alexandros Stavrinadis[1], Alex Nowak[1], Ioanis Tsioutsios[1], Adrian Bachtold[2], Pierre Verlot[2]
[1] *ICFO (Spain),* [2] *The University of Nottingham (United Kingdom)*

Here we report what appears the most extreme kind of nanomechanical resonator, consisting of a single-clamped carbon nanotube at the tip of which an efficient nano-optical scatterer has been added. Our system is reported the most sensitive ever demonstrated at room temperature. We also analyze the noise dynamics of our devices and reveal fundamental limitations of nanomechanical sensing.

17:40 : Invited talk
A self-assembled array of microspheres for radiative cooling
Juliana Jaramillo[1], G. L. Whitworth[1], J. A. Pariente[1], P. D. Garcia[2], C. Lopez[2], C. M. Sotomayor-Torres[1]
[1] *Universitat Autonoma de Barcelona (Spain),* [2] *Instituto de Ciencia de Materiales de Madrid (ICMM) (Spain)*

Today, temperature regulation is one of the major contributors to the energy demand of society. Cooling is particularly energy-consuming, accounting for 15 % of the global energy use and 10 % of green-house gas emissions. Here, we propose an array of SiO2 microspheres on a Soda-lime slab as an above-ambient radiative cooler. This structure can improve the thermal performance of devices that undergo critical heating during operation without the need of additional energy or electricity for removing heat from a surface.

18:00 : Invited talk
Mechanical Synchronization of Optomechanical Oscillators
Daniel Navarro Urrios[1], Martin F. Colombano[2], Guillermo Arregui[2], Nestor E. Capuj[3], Alessandro Pitanti[4], Jeremie Maire[2], Simone Zanotto[4], Amadeu Griol[5], Alejandro Martinez[5], Clivia M. Sotomayor-Torres[2]
[1] *University of Barcelona (Spain),* [2] *CSIC (Spain),* [3] *Universidad de La Laguna (Spain),* [4] *NEST (Italy),* [5] *Universitat Politecnica de Valencia (Spain)*

Our work thoroughly addresses the topic of synchronization of nanoscaled optomechanical (OM) oscillators. We demonstrate for the first time synchronization of a pair of mechanically-coupled OM cavities by means of a set of unequivocal experiments. We also show that the collective dynamics can be controlled by externally actuating over a single oscillator. Therefore, these results set a solid basis for realizing reconfigurable networks of OM oscillators displaying collective dynamics dominated by weak mechanical coupling.

18:20 : Invited talk
Ultrafast THz coherent excitation of optical and acoustic phonon modes in topological insulators
Vincent Juvé[1], Artem Levchuk[1], Matteusz Weis[1], Brice Arnaud[1], Gwenaelle Vaudel[1], Bartosz Wilk[2], Jacek Szade[2], Pascal Ruello[1]
[1] *CNRS/Institut des Molécules et Matériaux du Mans (France),* [2] *University of Silesia (Poland)*

Intense picosecond TeraHertz pulses are used to drive coherent phonons dynamics in nanometric films of topological insulators Bi2Te3 measured in time-resolved experiments. The possible coherent phonons excitation mechanisms are discussed.

18:40 : Invited talk
Brillouin scattering in nanofibers
Jean-Charles Beugnot
FEMTO-ST/CNRS (France)

Brillouin light scattering is a fundamental interaction between light waves and small acoustic vibrations which gives rise to inelastic light diffusion with a frequency shift by an amount that corresponds to the acoustic phonon frequency. Due to their strong light confinement capabilities, optical nanofibers have been early recognized as an ideal medium to exploit the Brillouin scattering for applications in e.g., lasers, telecommunications, microwave photonics and optical sensing.

16:40 - 17:35 — Auditorium VA6

Session 1A35

Metamaterials and Photonic Crystals for THz Science and Technology III

Organized by: Stephen Hanham and Miguel Navarro-Cia

Chaired by: Stephen Hanham and Miguel Navarro-Cia

16:40 : Invited talk
Recent progress in the development of efficient semiconductor based THz sources
Edik Rafailov, A. Gorodetsky, T. Gric, N. Bazieva
University Birmingham (United Kingdom)

Quantum-dot semiconductor structures have been used mostly in laser development. However, the unique properties of QD have allowed us to exploit it in the development of THz light source. Here we review our recent progress in generation of CW and pulsed THz radiation from QD based photoconductive antennae. The development of an ultra-compact, efficient, room temperature THz source based on QD structures is possible.

17:00 : Invited talk
High Performance Spintronic Terahertz Emitter Enabled by Metal- Dielectric Photonic Crystal and Metamaterials
Zheng Feng[1], Dacheng Wang[1], Haifeng Ding[2], Jianwang Cai[3], Wei Tan[1]
[1] *China Academy of Engineering Physics (China),* [2] *Nanjing University (China),* [3] *Chinese Academy of Sciences (China)*

Spintronic terahertz (THz) emitter has attracted great interest recently.Here,we introduce two popular optical concepts,photonic crystal and metamaterials,to improve the performance of the emitter.By utilizing the metal-dielectric photonic crystal structure,the conversion efficiency of spintronic THz emitter is improved due to the enhanced absorption of pumped fs laser.By integrating spintronic THz emitter with metamaterials,the THz emission with tunable polarization is demonstrated in a single device.

17:20 : Exploiting the Vacuum State in Materials with Plasmonic-to-Dielectric State Transition in Terahertz Gratings and Metasurfaces
Andriy E. Serebryannikov[1], Akhlesh Lakhtakia[2], Guy A. E. Vandenbosch[1]
[1] *Katholieke Universiteit Leuven (Belgium),* [2] *Pennsylvania State University (USA)*

Certain materials exhibit dynamically controllable transitions from the plasmonic state to the dielectric state, traversing through intermediate states. Components made of such materials disappear electromagnetically in the vacuum state, except for ohmic loss. We have demonstrated the use of two materials, InSb and graphene-dielectric metamaterial in reflection gratings, transmission gratings, and metasurfaces for on-off switching operations that rely on the vacuum state or somehow deviate from it.

17:35 - 18:35 — Auditorium VA6

Session 1A36

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Junichi Takahara

17:35 : Invited talk
Hybrid plasmonic nanostructures based on controlled deposition of MoS2 flakes on plasmonic nanostructures
Dario Mosconi[1], Ermanno Miele[2], Andrea Jacassi[2], Giorgia Giovannini[2], Nicolo Maccaferri[2], Denis Garoli[2]
[1] *Universita degli Studi di Padova (Italy),* [2] *Istituto Italiano di Tecnologia (Italy)*

We report on easy and robust strategies for the versatile integration 2D material flakes on plasmonic nanoholes by means of site selective deposition of MoS2. The methods can be applied both to simple metallic flat nanostructures and to complex 3D metallic structures comprising nanoholes. The deposition methods allow the decoration of large ordered arrays of plasmonic structures with single or few layers of MoS2.

17:55 : Invited talk
Diamond nano-optomechanical devices

Paul Barclay
University of Calgary (Canada)

Using a novel quasi-isotropic etching process we have created a range of diamond optomechanical devices. These include high-Q microdisk resonators operating in the sideband resolved regime that can be used for optical information processing applications such as pulse storage, wavelength conversion, and multi-colour optical interference.

18:15 : Invited talk
Light-Trapping Transparent Electrodes For Photodetection and Photovoltaics
Mengdi Fan, Pieter G. Kik
CREOL, The College of Optics and Photonics (USA)

Shadowing losses by electrical contacts remain a pervasive challenge in a wide range of optical devices. Here we demonstrate that light-trapping electrodes consisting of arrays of metallic nanowires in a dielectric cover layer can practically eliminate all shadowing losses at surprisingly high metal coverage. This is achieved through directional reflection by the electrode surfaces toward angles beyond the critical angle. The approach is shown to allow efficient shadowing mitigation using structure sizes smaller than half the optical wavelength. The optical and electrical performance of these electrodes are shown to rival several current approaches in a compact microstructured surface.

16:40 - 19:20 — Auditorium EA1

Session 1A37

Fano resonances in optics and microwaves: Physics and application

Organized by: Eugene Kamenetskii and Almas Sadreev

Chaired by: Eugene Kamenetskii and Almas Sadreev

16:40 : Invited talk
Light-Matter Interaction in Antenna-based Infrared Nanocavities
Andrea Toma
Istituto Italiano di Tecnologia (Italy)

Antenna-based resonant nanocavities can efficiently couple to other excitations/quasi particles of similar energy, giving rise to strong signal enhancement in the infrared spectral domain. In this framework, Fano-like interferences can be successfully exploited for promoting mid-infrared and THz spectroscopic studies of molecules and/or nanomaterials at extremely low concentrations.

17:00 : Invited talk
Bound states and resonances in lattice models
Ya Yan Lu
City University of Hong Kong (Hong Kong)

In this paper, we develop a general theory for bound states and resonances in locally distorted infinite or semi-infinite tight-binding lattice models. These models can be realized as waveguide arrays. We propose a finite linear matrix eigenvalue problem for computing all bound states and resonant modes. For bound states in the continuum, we establish a necessary and sufficient condition for their existence, and study their robustness with respect to structural perturbations.

17:20 : Invited talk
Reaching dark mode condition in a system of gain-loss assisted coupled resonators
Anatole Lupu[1], Vasily Klimov[2], Henri Benisty[1], Alexander Uskov[2], Abderrahim Ramdane[1]
[1] *Université Paris-Saclay (France),* [2] *Russian Academy of Sciences (Russia)*

A generic model of two antennas type dissimilar resonators coupled both via near-field and far-field coupling with active gain and/or loss media is considered. Conditions required for hitting the dark mode operation are established. It is shown that tuning the material gain level is effective in cancelling the detrimental effect of

deviations from nominal values of resonant elements unavoidably caused by fabrication imperfections. The considered approach can be used for the implementation of high-contrast tunable metasurfaces.

17:40 : Invited talk
Rigorous modal analysis of photonic micro and nanoresonators
Philippe Lalanne[1], **Wei Yan**[2]
[1] *Institut d'Optique (France),* [2] *Westalke University (China)*

We have developed a rigorous modal method of nanoresonators with unprecedented generality and report numerical results for the general case of 3D resonators, made of dispersive materials on substrate with guiding layers.

18:00 : Invited talk
Multiple Fano Feature due to Optical Bound States in the Continuum
Dmitrii N. Maksimov[1], **Evgeny N. Bulgakov**[2]
[1] *Kirensky Institute of Physics, Federal Research Center KSC SB RAS (Russia),* [2] *Reshetnev Siberian State University of Science and Technology (Russia)*

We consider light scattering by 2D arrays of dielectric spheres arranged into the triangular lattice. It is demonstrated that the scattering spectra exhibit a complicated picture of Fano resonances. The Fano features are explained as a signature of bound states in the continuum (BICs). It is found that an in-Gamma BIC induces off-Gamma BICs due to different scaling laws for real and imaginary parts of the resonant eigenfrequency, the latter being parabolic while the former form a Dirac cone.

18:20 : Invited talk
Bound States in the Continuum in Hybrid Photonic-Plasmonic Structures
Shaimaa Azzam, Vladimir Shalaev, Alexandra Boltasseva, Alexander Kildishev
Purdue University (USA)

This work investigates the formation of bound states in the continuum (BICs) in a system of coupled plasmonic grating and a photonic waveguide. Aside from the conventional symmetry-protected BICs that appear at the band edge, the hybrid system also supports Friedrich-Wintgen BICs that are formed in the vicinity of the avoided crossing of strongly-coupled plasmonic and photonic modes. The radiative quality factors of the BIC states diverge to infinity which makes them perfect candidates for many applications.

18:40 : Invited talk
Asymmetric to symmetric line-shape transition of guided-mode resonance enabled by cross-polarization filtering
Jiaxin Lv, Jicheng Jin, Xuefan Yin, Chao Peng
Peking University (China)

The guided-mode resonance in photonic crystal slab, alsoknown as bound state in the continuum (BIC), usuallyexhibits as sharp asymmetric Fano profile owing to theinteraction between the discrete localized state and thecontinuum state. The transition from asymmetric Fanolineshape to symmetric Lorentz lineshape could be achievedby suppressing this non-resonance continuum state. In thiswork, we demonstrate a measurement technique for thispurpose. Nearly symmetric lineshape is observed and weutilize it as thermo-optic phase shifter.

19:00 : Invited talk
Spin-Polarized Directive Coupling of Light and Near-field Amplification at the Bound States in the Continuum of a Transparent Photonic Crystal
Gianluigi Zito[1], **Silvia Romano**[2], **Stefano Managò**[1], **Stefano Cabrini**[3], **Giuseppe Calafiore**[3], **Anna Chiara De Luca**[1], **Erika Penzo**[3], **Vito Mocella**[2]
[1] *National Research Council IBP (Italy),* [2] *National Research Council IMM (Italy),* [3] *Lawrence National Laboratory of Berkeley (USA)*

Spin-polarized directive coupling of light is an intriguing property of topological photonic structures. Associated to the quantum spin Hall effect of light, it results from the transverse spin angular momentum density of inhomogeneous optical fields. We observed a resonantly-enhanced spin-directive coupling of light at bound states in the continuum (BICs) of nanoscale photonic crystal slabs. The application of BICs for achieving a non-plasmonic enhancement of the fluorescence emission and Raman scattering is also discussed.

16:40 - 18:50 — Auditorium EA2

Session 1A38

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

Chaired by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

16:40 : Keynote talk
Artificial Chirality Evloution in Micro-/Nano-scale 3D Plasmonic Metamaterials
Junsuk Rho
Pohang University of Science and Technology (Korea)

I will discuss recent development of hierarchical fabrication techniques for three-dimensional plasmonic metamaterials in optical frequencies based on electron-beam lithography overlay. Also, the recent effort of bottom-up approach using nanoparticles and self-assembled materials for isotropic 3D metamaterials will be discussed. Such unique fabrication techniques will provide the opportunity to achieve true isotropic metamaterials.

17:10 : Invited talk
Magnetic and chemical steering of chiral light at the nanoscale
Alexandre Dmitriev
University of Gothenburg (Sweden)

A major challenge facing nanophotonics is the poor dynamic tunability. We devise an ultra-thin chiroptical surface, built on 2D nanoantennas, where the chiral light transmission is controlled by the externally applied magnetic field with tunability exceeding 100 %. We explore this further by building the dynamic chiroptical surfaces with all-dielectric nanoantennas. Further, we get insight into the plasmon-molecular strong coupling and the associated polaritonic phototransformation chemistry, including the combination of chiral nanoantennas and the enantioselective phototransformations in chiral photoswitches.

17:30 : Invited talk
Skyrmions, Antiskyrmions and Bobbers: Novel particles in chiral magnets
Markus Hoffmann[1], Bernd Zimmermann[1], Gideon Muller[1], Christof Melcher[2], Nikolai Kiselev[1], Filipp Rybakov[3], Aleksandr Borisov[3], Fengshan Zheng[4], Andras Kovacs[4], Rafal E. Dunin-Barkowski[4], Stefan Bluegel[1]
[1] *Peter Gruenberg Institut and Institute for Advanced Simulation (Germany),* [2] *RWTH Aachen University (Germany),* [3] *Russian Academy of Sciences (Russia),* [4] *Ernst Ruska-Centre for Microscopy and Spectroscopy (Germany)*

Chiral magnets are an emerging class of topological matter harbouring localized and topologically protected vortex-like magnetic textures called skyrmions, which are cur-rently under intense scrutiny as a new entity for information storage and processing. Chirality in mag-netism is introduced through the chiral symmetry breaking Dzyaloshinskii-Moriya interaction, which arizes through the spin-orbit interaction in magnets with structural bulk and interface inversion asymmetry.

17:50 : Invited talk
Electromagnetic responses, dynamics, and superconductivity emerging from multipole order
Hikaru Watanabe[1], Atsuo Shitade[2], Akito Daido[1], Jun Ishizuka[1], Youichi Yanase[1]
[1] *Kyoto University (Japan),* [2] *RIKEN (Japan)*

We will discuss electromagnetic responses, dynamics, and superconductivity arising from odd-parity multipole order. Combining group theoretical analysis, numerical calculation of microscopic models, local thermodynamics, we reveal intriguing properties of electromagnetic multipole states with spontaneous inversion symmetry breaking. Candidate materials are proposed by analyzing the existing experimental data.

18:10 : Invited talk
Chiral (excitation of) spin waves in ferromagnetic films and spheres
Tao Yu, Sanchar Sharma, Yaroslav Blanter, Gerrit Bauer

Delft University of Technology (The Netherlands)

Surface waves of ferromagnetic films and spheres propagate only in one direction, with a handedness governed by the vector product of magnetization and surface normal. This chirality gives rise to for example the spin conveyor belt effect.I report our theoretical efforts to understand, control, and find applications for chiral spin waves and chirally excited conventional spin waves in yttrium iron garnet, an insulating ferrimagnet with exceptionally high magnetic quality. We compare our results with available experiments.

18:30 : Invited talk
Spin waves and electromagnetic waves in photonic-magnonic crystals
Jaroslaw W. Klos[1], Igor L. Lyubchanskii[2], Yuliya S. S. Dadoenkova[3], Maciej Krawczyk[1], Nataliya N. Dadoenkova[3]
[1]*Adam Mickiewicz University (Poland),* [2]*Adam Mickiewicz University (Poland),* [3]*Ulyanovsk State University (Russia)*

In the periodic structures combining the ferromagnetic and dielectric elements, both the spin waves and electromagnetic waves can propagate characterized by the dispersion relations with magnonic and photonic band gaps (MBGs and PBGs), respectively. These hybrid structures called photonic-magnonic crystals (PMCs) can be used to enhance the magneto-optical interactions. We calculated the MBG/PBG structures in 1D PMC and discussed the enhancement of Faraday rotation and cross-polarized contribution to Goos-Hanchen shift resulting from the periodicity in the structure under consideration.

16:40 - 18:55 — Auditorium EA3

Session 1A39

Plasmonics and nano-optics

Chaired by: Jean-Jacques Delaunay and Agustín Mihi

16:40 : Near-field phase imaging using phase-shifting digital holography
Petr Dvorak, Michal Kvapil, Petr Bouchal, Zoltan Edes, Tomas Samoril, Michal Horak, Martin Hrton, Filip Ligmajer, Vlastimil Krapek, Tomas Sikola
Brno University of Technology (Czech Republic)

We propose a novel method for the phase distribution measurementof the near electric field based on the principlesof phase-shifting digital holography. The holographic interferenceoccurs already in the near field and the phase distributioncan be determined purely from the scanning nearfieldoptical microscopy measurements. We demonstratethe capabilities of the proposed method by reconstructionof the phase difference between interfering surface plasmonwaves and by imaging the phase of a single surface plasmonwave.

16:55 : Babinet's Principle for Solid and Hollow Plasmonic Antennas
Michal Horak[1], Vlastimil Krapek[1], Martin Hrton[1], Andrea Konecna[2], Filip Ligmajer[1], Michael Stoger-Pollach[3], Tomas Sikola[1]
[1]*Brno University of Technology (Czech Republic),* [2]*Materials Physics Center CSIC-UPV/EHU (Spain),* [3]*USTEM TU Wien (Austria)*

We present an experimental study of Babinet's principle ofcomplementarity in plasmonics which relates the propertiesof solid plasmonic antennas and complemetary apertures inof the same size and shape. It allows, for example, studyingthe magnetic near field by measuring the electric near fieldby EELS in the complementary structure. We have focusedon elementary disc-shaped plasmonic antennas followed bytheoretical and experimental study of plasmonic antennaswith electric and magnetic hot spots based on Babinet'sprinciple.

17:10 : Slender-body theory for localized-surface-plasmon resonance
Matias Ruiz, Ory Schnitzer
Imperial College (United Kingdom)

We propose a slender-body theory for calculating the surface-plasmon eigenvalues and eigenmodes of smooth high-aspect-ratio metallic nanoparticles (of otherwise arbitrary shape) and their resonant excitation by incident electromagnetic radiation. Using matched asymptotic expansions, we develop an equivalent one-

dimensional model which is straightforward to solve numerically and in special cases furnishes closed form solutions.

17:25 : From Classical to Quantum Interactions in Molecular Plasmonics
Giulia Giannone, Fabio Della Sala, Stefania D'Agostino
Center of Biomolecular Nanotechnologies of IIT (Italy)

State-of-the-art fabrication and characterization techniques are to date able to experimentally control light-matter interaction at sub-nanometer scales where computational methods from classical electrodynamics fail. In this work we analyze the effects of the metal-molecule distance on the lower-energy peak appearing in the absorption spectra of hybrid plasmonic nanosystems by underling the importance of a fully quantum mechanical approach to take into account all the phenomena playing a role in such kind of electro-optical interactions.

17:40 : Synthesis and Plasmonic Properties of Au Double Nanorings Supported by Pd Cyclic Nanosheets
Yukie Yokota, Takumi Takatsuki, Tsuyoshi Tokita, Yushi Yabuki, Kazuo Watanabe
Tokyo University of Science (Japan)

Localized surface plasmon resonances (LSPR) of metal nanostructures exhibit peculiar resonance spectra depending on their size, shape and composition. We focus on Au nanorings supported by Pd nanosheets for possible applications in catalysts. In this study, we have prepared Au double nanorings by chemical synthesis in the liquid phase and investigated their optical properties.

17:55 : Efficient Resonance of Double Active Silicon Nanowires
Shengqiong Chen, Lina Shi, Jiebin Niu, Changqing Xie
Chinese Academy of Sciences (China)

The optical properties in active double SiO2-Si wire system have been investigated by using Four-Level Two-Electron model with the finite-Difference Time-Domain(FDTD) solutions. The super resonance occurs with appropriate dimensions of the width of the Si wires and the gap between them. Furthermore, with increasing the separation between two Si wires, the peak value decreases in the beginning and then increases when the optical path difference is exactly equal to the emission wavelength of the gain material.

18:10 : Double-sided, omnidirectional and broadband absorber in visible regime using moth-eye nanostructures covered by non-noble metal
Su Shen, Yun Zhou, Yanhua Liu, Shaolong Wu
Soochow University (China)

Optical obsorber is achieved by employing moth-eye nanostructure covered by a single-layer of non-noble metallic film. The architecture provides uniform, broadband, omnidirectional absorption for both the front- and back-sided incidence by taking advantage of the strong photon manipulation capability of the structure to couple and trap electromagnetic wave.

18:25 : Self-Similar Nanostructured Waveguides for Efficient and Direction Sensitive Plasmon Propagation
Mario Miscuglio[1], **Davide Spirito**[1], **Philip Schaefer**[2], **Roman Krahne**[1]
[1] *Istituto Italiano di Tecnologia (Italy),* [2] *Neaspec GmbH (Germany)*

We design chains of triangular nanostructures and optimize their size, shape, and inter-distance for efficient plasmon propagation. The coupling between neighboring elements is optimized by carefully tuning the distance of the nanostructure elements. We analyze the optical nearfield of such self-similar chains by finite element method simulations. Experimentally, the elements are characterized by scanning electron microscopy, and the optical properties of the self-similar nanostructure chains are investigated by scanning near-field optical microscopy.

18:40 : Angular momentum transfer from a swift electron to a small nanoparticle
Jose A. Castellanos-Reyes, Alejandro Reyes-Coronado
Universidad Nacional Autonoma de Mexico (Mexico)

In this work we present a study of the angular momentum transfer from a fast electron, like those typically used in Transmission Electron Microscopes, to a spherical nanoparticle using a classical electrodynamics approach within the small particle limit. We show preliminar results obtained for an aliminum-like nanoparticle

modelled with a Drude dielectric function.

16:40 - 19:00 — Auditorium EA4

Session 1A40

Dynamic metamaterials

Organized by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

Chaired by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

16:40 : Invited talk
Localization of light in magnetophotonic structures for ultrafast magnetism
Vladimir I. Belotelov[1], Alexander Chernov[1], Mikhail Kozhaev[1], Daria Igantyeva[1], Miguel Levy[2], Alexander Shaposhnikov[3], Vladimir Berzhansky[3]
[1] *Russian Quantum Center (Russia),* [2] *Michigan Technological University (USA),* [3] *Vernadsky Crimean Federal University (Russia)*

Optical control of the magnetization at ultrashort time scales attracts much attention in context of the data processing and spintronic applications. In this work we demonstrate the optical confinement in photonic microcavity that results in the significant increase of the inverse Faraday effect (IFE) within the magnetic layer. Along with that we show the light localization inside the dielectric sub-wavelength gratings in iron-garnet films that gives rise to the enhancement of the photo-magnetic effects.

17:00 : Invited talk
Tunable and nonlinear metamaterials for circular polarization control
Kuniaki Konishi
The University of Tokyo (Japan)

Symmetry of material plays a crucial role in the polarization sensitive optical phenomena, thus it is important to design and control shapes of artificial nanostructures for developing devices for active polarization control. We have been developing methods of circularly polarized light control by using them. In this presentation, I introduce the recent progress of our study for controls of active THz polarization by active chiral metamaterials and second-harmonic generation with nonlinear metasurfaces with rotational symmetries.

17:20 : Invited talk
Exploiting the polarization of nanoparticles near surfaces: position sensing, recoil optical forces, and full angular spectrum engineering
Lei Wei, Jack J. Kingsley-Smith, Michela F. Picardi, Anatoly V. Zayats, Francisco J. Rodriguez-Fortuno
King's College London (United Kingdom)

Small polarized nanoparticles exhibit remarkable electromagnetic properties even in the dipolar regime. The superposition of electric and magnetic dipoles on illuminated nanoparticles may result in far-field destructive interference and in near-field directionality, with applications on ultra-sensitive position sensing, optical forces due to recoil, and polarization control of the amplitude and phase of modal excitation in nearby waveguides. We describe our recent theoretical works on these applications.

17:40 : Invited talk
Ultrafast dynamics at fs-laser-excited magnetic meta-surfaces
Alexandr Alekhin, Vasily Temnov
Le Mans Universite (France)

Interactions of femtosecond laser pulses with magnetic materials result in a large variety of physical phenomena from different fields of physics: nonlinear optics, magnetism, ultrafast spintronics, acoustics, shock waves and/or laser-induced phase transitions. From a metrological perspective different time scales associated with those transient phenomena can be measured with femtosecond temporal resolution in conventional all-optical pump-probe experiments utilizing linear and non-linear magneto-optical techniques.

18:00 : Invited talk
Single-shot all-optical switching in GdFeCo alloys using pulses of varying photon energies and durations
Carl Davies[1], Thom Janssen[1], Johan Mentink[1], Arata Tsukamoto[2], Alexey V. Kimel[1], Lex van der Meer[1], Andrzej Stupakiewicz[3], Andrei Kirilyuk[1]
[1] *Radboud University (The Netherlands),* [2] *Nihon University (Japan),* [3] *University of Bialystok (Poland)*

We experimentally investigate how the process of deterministic all-optical switching in GdFeCo alloys depend on the properties of the optical pulse i.e. photon energy and pulse duration. We reveal that the switching of magnetization can be achieved using photons in the mid-infrared spectral range, and there exists a composition-dependent pulse-duration threshold above (below) which the switching fails (succeeds). To explain our findings, we develop a simple but elegant phenomenological theory of longitudinal magnetization dynamics.

18:20 : Invited talk
Atomically-thin tunable zone plate lens
Jorik van de Groep, Jung-Hwan Song, Umberto Celano, Mark L. Brongersma
Stanford University (USA)

Next-generation flat optics require dynamic control over optical functionalities. We demonstrate actively-tunable and atomically-thin optical lenses by carving them directly out of monolayer WS2. Using ion-liquid gating to dynamically manipulate the material's exciton resonance we show actively modulation of the focal intensity.

18:40 : Invited talk
Beyond plasmonic functional materials: the challenge of magnetoplasmonics towards single molecule detection
Maria Grazia Manera, Adriano Colombelli, Maura Cesaria, Antonietta Taurino, Roberto Rella
Institute for Microelectronics and Microsystems (Italy)

The research activity developed by our group in the ambit of magneto plasmonic metal nanostructures and their functional characterization as chemical sensors with improved performances is here reviewed. Novel insights towards plasmon-molecule interactions studies are opened up.

16:40 - 17:40 — Room 02.2

Session 1A41

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Nika Akopian

16:40 : Invited talk
Plasmonic nanocavities: New understanding on the correlation of near- and far-field spectra and their impact on strong coupling dynamics
Angela Demetriadou, Kalun Bedingfield, Antonios Kotsampaseris
University of Birmingham (United Kingdom)

Plasmonic nano-cavities are the ideal photonic environment to realize light-matter strong-coupling at room temperature. However, they support multiple types of modes, each with a large bandwidth, that can interfere both constructively and destructively. We demonstrate that the interference between such modes leads to a very complex photonic system, with different near-field and far-field spectra, which ultimately change our understanding and interpretation of the strong-coupling dynamics measured experimentally in the far-field.

17:00 : Invited talk
Wideband Absorbing Nonlinear Optical Metamaterials Using Coupled Epsilon-Near-Zero Mode
Jinnan Chen[1], Evan M. Smith[2], Justin Cleary[2], Chandriker Dass[2], Amber Reed[2], Shiva Vangala[2], Jos-

hua R. Hendrickson[2], **Junpeng Guo**[1]
[1] *University of Alabama in Huntsville (USA),* [2] *Air Force Research Laboratory (USA)*

Metamaterials made of epsilon-near-zero indium tin oxide and dielectric multiple layers were investigated for wideband perfect light absorption in the near wavelength range. The enhanced wideband absorption was used for nonlinear optical second harmonic generation applications.

17:20 : Invited talk
Periodic metasurface structures processed with spatially shaped femtosecond laser: Fundamentals and Applications
Xiaowei Li
Beijing Institute of Technology (China)

We propose a mask-free approach of femtosecond laser nonablative processing to fabricate extremely long-range uniform periodic metasurface structures. A cylindrically focused femtosecond laser efficiently produce large-area periodic modified-stripes, then, the modified-stripes act as fine etch stops to generate desirable structures on sample surfaces during the subsequent chemical-etching process. The diffraction efficiency of the incident light could be flexibly tuned. This morphology-controllable periodic surface structures may facilitate application prospects in broad fields, such as optical communications, optical sensors, etc.

17:40 - 19:10 — Room 02.2

Session 1A42

Micro/Nano fabrication and characterization techniques

Chaired by: Changjun Min

17:40 : Nanostructuring of Graphene Membranes with Focused Ion Beams: Towards 2D Metamaterials
Ivan Shorubalko
Empa - Swiss Federal Laboratories for Materials Science and Technology (Switzerland)

Nanostructuring of two-dimensional membranes with focused ion beans is demonstrated to be a promising technique for creating metamaterials. Few-nanometer-small structures with a down to ten nanometer period are demonstrated in graphene. Understanding the interaction between focused ion beams and freestanding 2D materials is crucial for exploiting the method towards novel metamaterials.

17:55 : Large area fabrication of complex periodic nanostructures by 'Double Displacement Talbot Lithography': Fundamentals and applications
Pierre Chausse[1], **Andrei Sarua**[2], **Jon Pugh**[2], **Pierre-Marie Coulon**[1], **Martin Cryan**[2], **Philip Shields**[1]
[1] *University of Bath (United Kingdom),* [2] *University of Bristol (United Kingdom)*

The fabrication of complex periodic metallic nanostructures has been performed at a wafer scale by combining 'Double' Displacement Talbot Lithography (D2TL) and lift-off. Given the high flexibility and efficiency of D2TL, a broad range of periodic configurations can be achieved from one mask, which could facilitate applications in numerous fields, including metamaterials, nanoplasomics or nanophotonics.

18:10 : FiB based Sketch - Peel with various Ion Species for Fast and Precise Patterning of Large Structures
Achim Nadzeyka[1], **Michael Kahl**[1], **Huigao Duan**[2], **Yiqin Chen**[2], **Kaixi Bi**[2]
[1] *Raith GmbH (Germany),* [2] *Hunan University (China)*

FiB nanofabrication has proven unique strengths by numerous applications in R and D prototyping. Moreover the slow patterning speed of direct FIB milling itself (as compared to resist-accelerated lithography) can be overcome by the method of sketch and peel. With the help of a scotch-tape method isolated metallic structures can be created by milling only the outline of the design elements. Here we further investigate sketch and peel as well as its applications employing various ion species.

18:25 : Broadband photoacoustic microscopy based on surface plasmon resonance sensing
Changjun Min

Shenzhen University (China)

The ability to accurately detect pressure transients is critical for photoacoustic (PA) imaging of anatomic and functional information in biological tissues. Here, we propose a surface plasmon resonance (SPR) sensing approach for PA pressure detection, relying on the modulation of PA pressure to refractive index. We realize a broad PA bandwidth more than ∼170 MHz and in vivo imaging of the microvasculature from mouse ears. This SPR sensing method has great potential in PA imaging for biomedical investigations.

18:40 : Direct Electron-Beam Writing of Structural Colors

Soroosh Daqiqeh Rezaei[1], **Jinfa Ho**[2], **Seeram Ramakrishna**[1], **Joel K. W. Yang**[2]
[1] *National University of Singapore (Singapore),* [2] *A*STAR (Singapore)*

Colorimetric size measurements of nano-patterns can lead to a cost-effective fabrication process by removing the need for atomic force microscopy measurements. Here we report on a method that employs electron-beam lithography to directly pattern a surface without the need for additional fabrication steps such as developing and lift-off. A wide range of saturated colors are realized which represent the height of the features. This method can pave the way towards achieving direct patterning along with size measurements feedback.

18:55 : Scattering-type scanning near-field optical microscopy and spectroscopy for real space observation of various polaritons

Philip Schafer, Adrian Cernescu, Sergiu Amarie, Andreas Huber
Neaspec GmbH (Germany)

Scattering-type Scanning Near-field Optical Microscopy and Spectroscopy is the ideal mean for the nanoscale analysis of sub-wavelength excitations in 2D-materials and meta-materials. Confining an incident light beam to the apex of a metallic AFM tip allows the local excitation as well as the local detection of phonon polaritons, exciton polaritons and surface plasmons. This enables a new routine analysis tool for quantum phenomena on the 10-nanometer length scale and sub-picosecond time scale.

16:40 - 19:25 — Room 02.1

Session 1A43

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

16:40 : Invited talk

Understanding Hot Electron Generation in Plasmonic Nanocrystals and Delineating New Research Avenues

Lucas Vazquez Besteiro[1], **Tianji Liu**[1], **Zhiming Wang**[1], **Alexander O. Govorov**[2]
[1] *University of Electronic Science and Technology (China),* [2] *Ohio University (USA)*

Plasmonic hot electrons can carry up to the full energy of the photons impinging in a nanostructure, allowing them to be emitted or injected into adjacent media. They can be used to induce secondary processes relevant in, e.g. photodetection and energy conversion processes. We present work intended to further our fundamental knowledge on hot electron excitation dynamics, provide guidelines to improve their generation efficiency and highlight new research avenues for their study.

17:00 : Invited talk

Generation, thermalization and extraction of hot carriers in metallic nanoparticles

Johannes Lischner
Imperial College London (United Kingdom)

Plasmon-induced hot carriers in metallic nanostructures have attractedsignificant attention as they can be harnessed for applications insensing, photovoltaics and photocatalysis. To study hot carrierproperties, I have developed a material-specific approach thatcombines quantum-mechanical calculations of large nano-

particles witha classical electrodynamic treatment of localized surface plasmonexcitations. I have used this approach to study hot-carrier generationin both mono-metallic nanoparticles and also in bi-metallic core-shellnanoparticles.

17:20 : Invited talk
Polariton chemistry: thinking inside the (photon) box
Joel Yuen-Zhou
University of California San Diego (USA)

In this talk, I will showcase recent theoretical and computational studies that my group has carried out in terms of controlling the physicochemical properties and processes of molecular ensembles that undergo strong light-matter coupling with confined electromagnetic modes in the mid-IR range. Examples include enhancement of thermally-activated ground-state chemical reactions, design of exotic optical nonlinearities, and remote control of chemical reactions.

17:40 : Plasmonic Hot Holes: Fundamentals and Devices
Giulia Tagliabue[1], Joseph S. DuChene[2], Harry A. Atwater[2]
[1] *EPFL (Switzerland),* [2] *Caltech (USA)*

To date, despite the favorable energetics of hot holes predicted by ab-initio calculations, there have been very few realizations of hot-hole based plasmonic devices and the dynamics of hot holes in metal nanostructures have remained largely unknown. Here, we report the construction, optoelectronic and photoelectrochemical characterization of plasmon-driven photodiodes and photocathodes based on a metal/p-type gallium nitride (p-GaN) heterostructure that operate within the visible regime via hot-hole injection.

17:55 : Invited talk
Synthesis of AgCl Nanoparticles and Their Plasmonic Replicas as Photocatalysts and SERS Probes
Han-Hung Ryu, Jang Ho Joo, Jae-Seung Lee
Korea University (Korea)

We reported a rapid one-pot room-temperature aqueous synthesis of highly monodisperse sub-100-nm AgCl nanomaterials with various shapes and sizes. We successfully reduced the size of the AgCl nanomaterials which were replicated into metallic nanomesh structures that were small enough ($\sim$100 nm) to show intense surface-plasmon-absorption bands. The complex comprising semiconducting AgCl/metallic nanomesh replica exhibited excellent plasmonic photocatalysis properties for the complete removal of Cr(IV), and intense surface-enhanced Raman scattering (SERS) properties in a single-particle enhancing the electromagnetic field.

18:15 : Spaser assisted coherent generation of nuclei vibrations in Raman active molecules
Evgeny Andrianov[1], Vladislav Shishkov[1], Alexander Pukhov[1], Alexey Vinogradov[1], Alexander Lisyansky[2]
[1] *Dukhov Research Institute of Automatics (VNIIA) (Russia),* [2] *Queens College of the City University of New York (USA)*

We consider excitation of the plasmonic nanoparticle interacting with Raman active molecules by the external coherent field. We show that there is a threshold value of external field amplitude above which coherent generation both of surface plasmons and nuclei vibrations in the molecules arises. We find that the coherent generation of surface plasmons is always followed by the coherent generation of nuclei vibration in the Raman active molecules.

18:30 : Plasmonics-Nanofluidics Hydrid Metamaterials for Ultrasensitive Infrared Spectroscopy and Studies of Water Confined in Nanospaces
Thu H. H. Le[1], Akihiro Morita[2], Kazuma Mawatari[3], Takehiko Kitamori[3], Takuo Tanaka[1]
[1] *The University of Tokyo (Japan),* [2] *Tohoku University (Japan),* [3] *RIKEN (Japan)*

This study reports a metamaterial consisting of a nanofluidic channel sandwiched between plasmonic resonators and a metal film. This configuration enables a controllable delivery of molecules into the most enhanced field arising from the quadrupole mode, forming a strong plasmon-molecular coupled system. It offers an ultrasensitive IR spectroscopic platform for detection of molecules. Morover, the precise handling of molecules in a well-controlled nanogap allows us to study the molecular structures and physical properties of molecules confined in nanospaces.

18:45 : Invited talk

Plasmonic hot electron nano-emitters by on-chip ablation for femtosecond on-chip electronics

Alexander Holleitner
Technical University Munich (Germany)

Plasmonic nano-emitters are formed from prestructured metal nanogaps on-chip to below 10 nm by femtosecond laser ablation. We explore the plasmonic properties and the nonlinear photocurrent characteristics of such tunnel junctions. The photocurrent is tuned from multiphoton absorption toward the strong-field tunneling regime in the nanogaps. We demonstrate that a unipolar current of hot electrons is achieved by designing the plasmonic enhancement factors in the junctions to be asymmetric, which allows ultrafast electronics on the nanometer scale.

19:05 : Invited talk

Improving the Applicability of Hybrid Plasmonic Nanoparticles by Studying and Tailoring Interfaces

Kholud Dardir, Hao Wang, Ted V. Tsoulos, Supriya Atta, Sakshi Sardar, Laura Fabris
Rutgers University (USA)

Hybrid plasmonic nanoparticles, designed to encompass dielectric or semiconducting coatings, whether of biological nature or not, are fundamental components in sensing platforms or photocatalytic substrates. While the overall properties of the nanomaterial define its performance, we argue that it is in general the interface between the metal and the surrounding medium that plays the most important role.

Wednesday 24th July, 2019

08:30 - 09:55 — IST Congress Center Auditorium

Session 2A1

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

08:30 : Keynote talk
Can plasmonics help outpace quantum decoherence?
Simeon I. Bogdanov, Alexandra Boltasseva, Vladimir M. Shalaev
Purdue University (USA)

Photons are the primary candidates for implementing quantum networks, i.e. systems capable of distributing entanglement and transmit quantum information. Photonic modes must be coupled to matter in order to produce single photons or make them interact. However, naturally the interaction between light and matter is relatively weak, which is one of the reasons why most present photonic quantum technologies suffer from low bit rates. A targeted and strong enhancement of light-matter interaction based on plasmonic nanostructures has a potential to transform the way quantum photonic systems operate. It relies on speeding up processes beyond the rates of dephasing, rather than on achieving long coherence times in matter. We discuss our recent and planned work aimed at outpacing decoherence in quantum optical devices using nanoscale plasmonic metamaterials. We also outline future directions in the development of a platform for high-speed integrated quantum photonics and the application of machine-learning techniques for quantum optical measurements.

09:00 : Invited talk
Materials for Photonics Beyond Noble Metals
Marina S. Leite
University of Maryland (USA)

In this talk I will present how metallic materials beyond coinage metals have enabled us achieve materials with on demand optical responses ranging from the Vis to NIR. first, I will discuss the opportunities for developing optical components using metallic materials beyond noble metals for energy harvesting and superabsorption applications. Second, I will demonstrate a novel platform for transient, dynamic photonics based uniquely on earth-abundant and biocompatible materials: Mg and MgO.

09:20 : Invited talk
Near and far-field optical properties of non-noble metal nanoparticles deposited on nanopatterned dielectric surfaces
Sophie Camelio[1], David Babonneau[1], Frédéric Pailloux[1], Alexandre Fafin[1], Grégory Abadias[1], Panos Patsalas[2]
[1] *Université de Poitiers (France),* [2] *Aristotle University of Thessaloniki (Greece)*

Periodic nanoripple patterns produced by ion-beam sputtering of dielectric surfaces (Si3N4 or Al2O3) are used as templates to elaborate self-aligned nanoparticles and nanowires arrays by deposition at glancing-angle of aluminum and refractory conducting nitrides (TiN, ZrN). From experimental and numerical investigations of their far-field and near-field optical properties, we will show that these alternative materials for plasmonics devices exhibit original dichroic properties.

09:40 : Plasmonics with refractory TiN
Arrigo Calzolari, Alessandra Catellani
CNR-NANO Istituto Nanoscienze (Italy)

Using simulations from first principles we study the optoelectronic and plasmonic properties of Titanium Nitri-

de, a refractory compound that has been proposed as a feasible route to substitute gold in harsh environment applications. The microscopic origin of the plasmon resonances and their dispersions are discussed on the basis of the analysis of the electronic structure and of the interplay between collective and single-particle excitations. The effects of nanostructuring and the formation TiN/dielectric interfaces are also deeply investigated.

08:30 - 10:10 — Auditorium VA1

Session 2A2

Transformation optics concept and applications

Organized by: Shah Nawaz Burokur and Jianjia Yi

Chaired by: Shah Nawaz Burokur and Jianjia Yi

08:30 : Invited talk
Designing devices for sub-wavelength imaging using a transformation-optics approach
Mircea Giloan, Robert Gutt, Gavril Saplacan
Company for Applied Informatics (Romania)

Transformation-optics inspired flat lenses are used to build up optical systems capable to transpose a sub-wavelength sized area surrounding the object focal point of the system into a magnified area surrounding the image focal point of the system. The anisotropic and inhomogeneous media constituting the lenses enable the processing of the high spatial frequencies waves without converting them in evanescent waves. Numerical simulations show the capability of the proposed devices to perform magnified discernible images of the sub-wavelength details.

08:50 : Invited talk
Extended two dimensional transformation optics for reflection suppression
Hossein Eskandari[1], Oscar Quevedo-Teruel[2], Amir Reza Attari[1], Mohammad Saeed Majedi[1]
[1] *Ferdowsi University of Mashhad (Iran),* [2] *KTH Royal Institute of Technology (Sweden)*

Here, we demonstrate that by extending the common two-dimensional (2D) transformation optics (TO) to the third dimension in an engineered fashion, it is possible to eliminate unwanted reflections from the device boundaries in cases where the compression or expansion of the space makes the ideal transmission of the power impossible in the common formulation. The feasibility of the proposed idea is demonstrated by an example simulated in COMSOL.

09:10 : Invited talk
Space Transformation Based Recombinable Lens for Generating Multi-mode OAM Radio Beams
Jianjia Yi[1], Xueqi Cao[1], Zhihao Jiang[2], Rui Feng[1], Badreddine Ratni[3], André de Lustrac[4], Shah Nawaz Burokur[3]
[1] *Xidian University (China),* [2] *Southeast University (China),* [3] *University of Paris Nanterre (France),* [4] *University of Paris-Saclay (France)*

A novel generation method for OAM with different topological charges using the concept of space transformation is presented. The whole device is divided into 8 modules representing the 2pi phase range. Designed modules with different phase values can be judiciously arranged to generate beams carrying OAM with different modes. Three-dimensional simulations validate the spiral-shaped phase fronts of the emitted vortex wave. The proposed method illustrates the practicality of space transformation to achieve a new class of optical devices.

09:30 : Invited talk
Glide Symmetry to Realize broadband Anisotropic Transformation Optics Lenses
Mahsa Ebrahimpouri, Oscar Quevedo-Teruel
KTH Royal Institute of Technology (Sweden)

Here, glide symmetry is proposed to realize two dimensional (2D) broadband anisotropic transformation optics

(TO) designs. We prove that by adding glide symmetry, 2D periodic structures have wider bandwidth, higher level of anisotropy and higher equivalent refractive index. For a specific glide-symmetric configuration on holey plates, a compressed Luneburg lens is designed and simulated. The designed lens operates in wide band from 1 GHz to 13 GHz.

09:50 : Invited talk
Electromagnetic wave shaping, wire media, and transformation optics
Paul Kinsler, Jonathan Gratus, Taylor Boyd
Lancaster University (United Kingdom)

Using the tools of transformation optics, we show how spatially modulated wire media can be treated as if they (instead) had a spatially modulated plasma frequency, in agreement with intensive 3D numerical simulation results.

08:30 - 10:10 — Auditorium VA2

Session 2A3

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

Chaired by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

08:30 : Invited talk
Toroidal Resonances and Reconfigurable Chiral Responses in Kirigami Metamaterials
Liqiao Jing[1], Zuojia Wang[2], Bin Zheng[1], Hongsheng Chen[1]
[1] *Zhejiang University (China),* [2] *Shandong University (China)*

We demonstrate the excitation of multipolar resonances in kirigami metamaterial and the switching of electromagnetic properties among various chiral states. Single-band, dual-band, and broadband circular polarizers with reconfigurable performance are realized by steering the electric, magnetic and toroidal dipolar response. The underlying mechanism is explained and calculated via detailed analysis of the excited multipoles. With the ongoing development of micromanufacturing techniques, our findings may offer an alternate approach to lightweight, reconfigurable, and deployable metadevices.

08:50 : Invited talk
Cavity optomagnonics with magnetic quasi-vortices
Alto Osada
The University of Tokyo (Japan)

We investigate Brillouin scattering of whispering gallery modes, or optical vortices, by various magnetostatic modes, or magnetic quasi-vortices, both being supported inside a ferromagnetic sphere. As a consequence of conservation of angular momenta, Brillouin scattering becomes reciprocal or nonreciprocal, depending on the orbital angular momentum of the magnetic quasi-vortex. Observed experimental results are reasonably explained by the conservation of angular momenta, and the possible enhancement of Brillouin scattering by the use of optical cavity is inferred.

09:10 : Invited talk
Chirality Generation in Discrete Silicon Nanostructures
Xin Zhao, Bjoern Reinhard
Boston University (USA)

Silicon nanostructures provide morphology-dependent resonances that can be tuned across a wide wavelength range, which makes them versatile building blocks for higher order photonic molecules. Electromagnetic interactions between individual building blocks in silicon-based photonic molecules provide additional degrees of freedom for enhancing and controlling light-matter interactions. In this presentation we will review recent studies from our laboratory aimed at generating enhanced optical chirality densities in achiral

structures.

09:30 : Invited talk
Chiral terahertz wave emission from the Weyl semimetal TaAs
Y. Gao[1], Y. Qin[1], Y. P. Liu[1], Y. L. Su[1], S. Kaushik[2], E. J. Philip[2], X. Chen[2], Z. Li[3], H. Weng[4], D. E. Kharzeev[2], M. K. Liu[2], Jingbo Qi[1]
[1] *University of Electronic Science and Technology of China (China),* [2] *Stony Brook University (USA),* [3] *Peking University (China),* [4] *Chinese Academy of Sciences (China)*

We discover strong coherent terahertz emission from the Weyl semimetal TaAs and demonstrate unprecedented manipulation over its polarization and chirality on femtosecond (fs) timescale. Such controllability is achieved via polarization-dependent, colossal ultrafast photocurrents in TaAs generated using the circular and/or linear photogalvanic effect.

09:50 : Invited talk
Magnetoelectricity of Micromagnetic Structures and Chirality
Alexander Pyatakov[1], Daria Kulikova[1], Elena Nikolaeva[1], Tatiana Kosykh[1], Alexey Kaminskiy[1], Wei Ren[2], Athinarayanan Sundaresan[3], Anatoly Zvezdin[4]
[1] *M. V. Lomonosov Moscow State University (Russia),* [2] *Shanghai University (China),* [3] *Jawaharlal Nehru Centre for Advanced Scientific Research (India),* [4] *A.M. Prokhorov General Physics Institute (Russia)*

The electric-field-induced nucleation of magnetic inhomogeneities is discussed. This magnetoelectric effect can develop in accordance to both chirality-dependent and chirality-insensitive scenarios related to two different mechanisms of magnetoelectricity.

08:30 - 10:10 — Auditorium VA3

Session 2A4

Symposium III: Advanced passive and active metasurfaces

Organized by: Howard Lee and Din Ping Tsai

Chaired by: Howard Lee and Din Ping Tsai

08:30 : Invited talk
Light sailing to interstellar space and nearby stars
Artur R. Davoyan
University of California (USA)

In this talk we will overview our recent efforts directed at the design of light sails for interstellar missions. We will highlight our ongoing work on both solar and laser sailing with a particular emphasis on photonic materials, sail design criteria, and light-materials interaction.

08:50 : Invited talk
Dielectric passive metasurface and active tunable nonlinear metasurface
Junxiao Zhou, Haoliang Qian, Zhaowei Liu
Electrical and Computer Engineering University of California (USA)

Metasurface enables a new paradigm to manipulate electromagnetic wave by tailoring subwavelength artificial structures, which provides a promising method for compact, cascadable, and miniaturization elements in integrated optics. Here, we review some of our works on passive dielectric metasurfaces and Kerr nonlinear tunable metasurfaces enabled by metallic quantum wells. The mentioned metasurface may lead important applications in image processing, sensing, switching, and multifunctional photonics devices.

09:10 : Invited talk
Extreme Nonlinear Optics in Epsilon-Near-Zero Meta-films
Yuanmu Yang
Tsinghua University (China)

We demonstrate extreme nonlinear optical properties leveraging epsilon-near-zero (ENZ) effect in plasmonic conductive metal oxide thin films. With the aid of high-mobility indium-doped cadmium oxide (CdO: In) as the gateway plasmonic material, we manage to construct an ultrafast all-optical switch with an absolute change in the p-polarized reflectance from 1.0 to 86.3 % within 800 fs. Furthermore, we utilize the ENZ structure to achieve UV high-harmonic generation up to the 9th-order.

09:30 : Invited talk
Metasurface for artificial neural computing
Zongfu Yu
University of Wisconsin Madison (USA)

We show that optical waves passing through a nanophotonic medium can perform artificial neural computing. Complex information, such as an image, is encoded in the wave front of in-put light. The medium continuously transforms the wave front to realize highly sophisticated computing tasks such as image recognition. To enable these complex neural computing, we use stochastic gradient decent to optimize nonlinear nanophotonic structures with structural gradient computed from adjoint state method.

09:50 : Invited talk
Vortex generation by graphene and near-zero index thin films
Alessandro Ciattoni, Andrea Marini
University of L'Aquila (Italy)

We show that resonant subwavelength media illuminated by a circularly polarized beam produce optical vortices of order two in the opposite circularly polarized components of the reflected and transmitted fields as a consequence of enhanced spin-orbit interaction of light. Our theoretical predictions indicate that graphene and near-zero index media hold great potential as miniaturized active devices for the optical control of light orbital angular momentum.

08:30 - 10:10 — Auditorium VA4

Session 2A5

Non-Hermitian Complex Systems: Photonics, Plasmonics and Metamaterials

Organized by: Konstantinos Makris, Ramy El-Ganainy and Sahin Ozdemir

Chaired by: Konstantinos Makris, Ramy El-Ganainy and Sahin Ozdemir

08:30 : Invited talk
Non-Hermiticity in optical microcavities
Jan Wiersig, Julius Kullig
Otto-von-Guericke-Universitat (Germany)

We discuss two aspects of non-Hermiticity in optical microcavities. first, we theoretically demonstrate third-order exceptional points in whispering-gallery cavities. Second, we reveal the role of mode nonorthogonality in the dynamics of waves propagating in open systems with localized losses.

08:50 : Invited talk
Coherent perfect absorption in disordered media: experimental realization of the random anti-laser
Kevin Pichler[1], Matthias Kuhmayer[1], Julian Bohm[2], Andre Brandstotter[1], Philipp Ambichl[1], Ulrich Kuhl[1], Stefan Rotter[1]
[1] *Vienna University of Technology (Austria),* [2] *Université Côte d'Azur (France)*

We report on the first experimental implementation of coherent perfect absorption in a disordered medium. With this process corresponding to the time-reverse of random lasing at threshold, our microwave experiment constitutes the first 'random anti-laser'. Our approach relies only on the multi-modal scattering matrix of the system based on which we achieve about 99.8 % absorption of the injected intensity. We expect our approach to be suitable for numerous applications where waves need to be perfectly focused, routed or absorbed.

09:10 : Invited talk
Encircling an exceptional point in waveguide structures and electrical circuits
Youngsun Choi[1], Jae Woong Yoon[2], Choloong Hahn[3], Pierre Berini[3], Jong Kyun Hong[1], Yeonghwa Ryu[1], Seok Ho Song[1]
[1] Hanyang University (Korea), [2] Electronics and Telecommunications Research Institute (Korea), [3] University of Ottawa (Canada)

We discuss experimental results on dynamically encircling an exceptional point in coupled waveguides and electrical resonator circuit systems.

09:30 : Invited talk
Photonic topological insulator in synthetic dimensions
Eran Lustig[1], Steffen Weimann[2], Yonatan Plotnik[1], Yaakov Lumer[1], Miguel Bandres[3], Alexander Szameit[2], Mordechai Segev[1]
[1] Technion (Israel), [2] Universitat Rostock (Germany), [3] University of Central florida (USA)

Topological physics enables protected transport along edges of materials. Interestingly, such edge transport can flow not only on edges in real-space, but also on the interface of a synthetic space, such as modal space or spin space. Here, we report the first experimental realization of photonic topological insulators in synthetic dimensions. Our work on these synthetic space concepts leads to combining high-dimensional physics and long-range connectivity with a plethora of optical phenomena such as PT-symmetry, Topological lasers and more.

09:50 : Invited talk
Synthetic Dimensions, PT-Symmetry and Nonlinearity in Photonic Mesh Lattices
Andre Luiz Marques Muniz[1], Martin Wimmer[1], Arstan Bisianov[1], Roberto Morandotti[2], Ulf Peschel[1]
[1] Friedrich Schiller University Jena (Germany), [2] Institut National de la Recherche Scientifique-EMT (Canada)

Using standard telecommunication equipment, we implement parity-time (PT) symmetry in one- and two-dimensional synthetic lattices with tunable gain, loss and phase modulation. By exploiting its non-Hermitian dynamics, we realize different parity time symmetric configurations, observe unidirectional invisibility, PT-Bloch oscillations and solitons in one- and two-dimensional lattices.

08:30 - 09:50 — Auditorium VA5

Session 2A6

Nanophononics and nanomechanics

Organized by: Daniel Lanzillotti-Kimura and Pedro David Garcia

Chaired by: Daniel Lanzillotti-Kimura and Pedro David Garcia

08:30 : Invited talk
Engineering and measuring thermal transport in nanowires
Marta De Luca[1], Milo Y. Swinkels[1], Claudia Fasolato[1], Daniel Vakulov[2], Erik P. A. M. Bakkers[2], Xavier Cartoixa[3], Riccardo Rurali[4], Ilaria Zardo[1]
[1] University of Basel (Switzerland), [2] Eindhoven University of Technology (The Netherlands), [3] Universitat Autonoma de Barcelona (Spain), [4] ICMAB-CSIC (Spain)

The recently growing research field called 'Nanophononics' deals with the investigation and control of vibrations in solids at the nanoscale. Phonon engineering leads to a controlled modification of phonon dispersion, phonon interactions, and transport. Nonetheless, it requires new theoretical and experimental methods, especially when combined with low dimensional physics, which is one of the most promising routes for thermal management.

08:50 : Invited talk
Stochastic and vibrational resonance with a driven electro-mechanical resonator
Guilhem Madiot, Franck Correia, Avishek Chowdhury, Sylvain Barbay, Marcel Clerc, Remy Braive

CNRS-C2N (France)

Stochastic and vibrational resonance are general phenomenon usually observed in one-dimensional, amplitude modulated, bistable systems. We show experimentally the emergence of such resonances in the bidimensional response of a forced nano-electromechanical membrane by evidencing the enhancement of a weak phase modulated signal. Based on a general forced Duffing oscillator model, we demonstrate experimentally and theoretically such resonances. These results may open interesting prospects for phase noise metrology or coherent signal transmission applications in nanomechanical oscillators.

09:10 : Invited talk

Two Level Systems at the surface of crystalline Nano-OptoMechanics

Mehdi Hamoumi[1], Chérif Belacel[1], Pierre Allain[1], William Hease[1], Aristide Lemaitre[2], Giuseppe Leo[1], Ivan Favero[1]

[1] *Université Paris Diderot (France),* [2] *Université Paris-Saclay (France)*

What ultimately limits mechanical dissipation of quantum nanomechanical resonators? The authors report on an experimental and theoretical investigation that consistently answers this question. The work is carried on crystalline semiconductor nano-devices, operated from cryogenic to room temperature, whose coherence properties are shown to be ruled by surface Two Level Systems. These fluctuating entities set the ultimate limit to the frequency-Q product of resonators, a widely used figure of merit for quantum operations.

09:30 : Invited talk

Optomechanical coupling in the Anderson-localization regime

Guillermo Arregui Bravo[1], Norberto D. Lanzillotti Kimura[2], Clivia M. Sotomayor-Torres[3], Pedro D. Garcia[1]

[1] *Institut Catala de Nanociencia i Nanotecnologia (ICN2) (Spain),* [2] *Centre de Nanosciences et de Nanotechnologies (C2N) (Spain),* [3] *Institucio Catalana de Recerca i Estudis Avancats (ICREA) (Spain)*

We study the use of light-matter interaction between Anderson-localized photons and phonons in periodic-on-average nanostructured media to explore Anderson localization of high frequency phonons.

08:30 - 10:10 — Auditorium VA6

Session 2A7

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Dentcho Genov

08:30 : Invited talk

All-optical charging and charge transport in quantum dots

Nika Akopian

Technical University of Denmark (Denmark)

Quantum-dots are one of the best on-demand sources of single and entangled photons, simultaneously merging the highest brightness and indistinguishability of the emitted photons. They are, therefore, among the strongest candidates for practical single-qubit photonic devices. However, to exploit the full advantage of quantum physics, multi-qubit photonic devices are absolutely necessary. Here we propose, for the first time, an experimentally feasible multi-qubit photonic device, and a method for individual charging of multiple quantum-dots and coherent charge transport between them.

08:50 : Invited talk

Optical slot Yagi-Uda antennas

Yeonsang Park[1], Jineun Kim[1], Young-Geun Roh[1], Q-Han Park[2]

[1] *Samsung Advanced Institute of Technology (Korea),* [2] *Korea University (Korea)*

We present the design of optical slot Yagi-Uda antennas and demonstrate the directional radiation from optical slot Yagi-Uda antennas. By calculating the phase between a feed slot and an auxiliary groove, we can find

out parameters where the groove works as a good reflector and fabricate optical slot Yagi-Uda antennas with a good directivity. Through coupling with the optimized optical slot Yagi-Uda antenna, random light from quantum dot light emitting diodes can be directed towards a specific direction well.

09:10 : Invited talk
Thin and Multifunctional Metasurfaces for Display Applications
Jonghwa Shin, Hyowook Kim, Min Sung Heo, Arthur Baucour, Nayeong Kim
Korea Advanced Institute of Science and Technology (Korea)

Modern information display panels are composed of many optical films with different functions. The trend in the industry has been reducing both the number and thickness of these films. While there have been many proposals so far to replace these films with plasmonic structures or metasurfaces, their optical performance is less than ideal, often below that of current technology. Here, design principles of optical metasurfaces for display applications are investigated and examples with promising optical performances are provided.

09:30 : Invited talk
Direct and Inverse Magneto-Optics of Structured All-Dielectric Iron-Garnet films
Andrey Kalish[1], Andrey Voronov[1], Daria Ignatyeva[1], Mikhail Kozhaev[2], Miguel Levy[3], Dolendra Karki[3], Vladimir Belotelov[1]
[1] *Lomonosov Moscow State University (Russia),* [2] *Russian Academy of Sciences (Russia),* [3] *Michigan Technological University (USA)*

The use of all-dielectric materials instead of plasmonic ones to enhance magneto-optical effects allows one to avoid significant energy losses that are present in metals. In this paper, we perform experimental research of the transverse magneto-optical Kerr effect and the inverse Faraday effect in 1D dielectric magnetic structures. Experimental results demonstrate a significant enhancement of magneto-optical effects, as well as high transparency and high Q-factor of the obtained resonances, which opens up broad opportunities for applications.

09:50 : Invited talk
Gold nanorod bending and splitting with light: A new route towards functional plasmonic surfaces
Theobald Lohmuller
Photonics and Optoelektronics Group (Germany)

I will present that gold nanorods can be bent and split into two separate spheres by using a focused laser beam. The optical forces that emerge during this process furthermore allow to deposit the resulting structure with a controlled orientation directly onto a solid support. This approach for optical re-shaping and patterning of plasmonic nanoantennas is applicable on almost any substrate and holds great potential for the fabrication of ultrathin optical components and devices.

08:30 - 10:10 — Auditorium EA1

Session 2A8

Fano resonances in optics and microwaves: Physics and application

Organized by: Eugene Kamenetskii and Almas Sadreev

Chaired by: Eugene Kamenetskii and Almas Sadreev

08:30 : Invited talk
Silent enhancement of SERS signal without increasing the hot spot intensity
Mehmet Emre Tasgin
Hacettepe University (Turkey)

We present a method for enhancing SERS signal thousands times without increasing the intensity at the hot spot.

08:50 : Invited talk

Theory of Fano Resonances in the electromagnetic scattering from two-dimensional bodies.
Carlo Forestiere, Giovanni Gravina, Giovanni Miano, Mariano Pascale, Roberto Tricarico
Universita' degli Studi di Napoli (Italy)

The electromagnetic modes and the resonances of homogeneous, finite size, two-dimensional bodies are examined in the frequency domain by a rigorous full-wave approach. The presence of vortex current modes is demonstrated. The presence of Fano resonances in the scattering from a Si disk of size comparable to the incident wavelength is demonstrated and the interferencing mode behind them are shown.

09:10 : Invited talk
Interference of Multipolar Lattice Resonances in Plasmonic Crystal Excited by Structured Light
Keiji Sasaki, Hiroki Kitajima, Kyosuke Sakai
Hokkaido University (Japan)

We report interference of dipole and quadrupole lattice resonances in plasmonic crystal structures. We theoretically demonstrate that such bright- and dark-mode lattice resonances in finite-sized, square-lattice arrays of metal nanodisks can be excited by both vertically-incident, linearly-polarized Gaussian beam and cylindrical vector beam. The simulation result shows that spatial distributions of the lattice resonances in the plasmonic crystal exhibit characteristic patterns with chirality that conserve chirality of the incident light and the excited plasmonic fields of individual nanodisks.

09:30 : Invited talk
Magnetic interactions and transport properties of parallel coupled magnetic molecules in presence of spin-orbit interactions
Seif Alwan, Jonas Fransson
Uppsala University (Sweden)

Here, we demonstrate that spin-orbit coupling enables an additional control parameter for the Fano resonances. Depending on the phase of the spin-orbit interaction, the asymmetry of the Fano resonance can be shifted from, e.g., dip-peak to peak-dip. This property leads to dramatic variations in the exchange parameters, and the anisotropic interactions are shown to be particularly sensitive to such variations.

09:50 : Invited talk
Disordered metamaterials: Strong interactions, subradiance and field localization
Stewart D. Jenkins, Nikitas Papasimakis, Salvatore Savo, Nikolay I. Zheludev, Janne Ruostekoski
University of Southampton (United Kingdom)

We provide detailed comparisons between experiments and simulations of large cooperatively interacting, spatially disordered metamaterials. Simulations fully incorporate strong field-mediated inter-meta-atom interactions between discrete resonators and statistical properties of disorder, while approximating the resonators' internal structure. We find a qualitative agreement between the simulations and experiments, and characterize the microscopic origins of the observed disorder response. The response with strong field-mediated interactions is inherently linked to their cooperative interactions where the multiple scattering induces strong correlations between individual resonators.

08:30 - 10:20 — Auditorium EA2

Session 2A9

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Monika Fleischer

08:30 : Invited talk
Direct Imaging of Isofrequency Contours of Strongly Localized Guided Modes in Planar Photonic Structures
Anton K. Samusev

ITMO University (Russia)

In this work, we investigate all-dielectric metasurfaces and based on the silicon on insulator platform for manipulating strongly localized evanescent waves in the visible and near-infrared spectral ranges. We implement a back focal plane microscope combined with a high refractive index solid immersion lens to directly image the isofrequency contours of the guided modes (surface waves) in an anisotropic metasurface. Reconstruction of 2D dispersion law unambiguously reveals the transition between different regimes of in-plane propagation of the electromagnetic waves.

08:50 : Invited talk
Use of novel metamaterials for magnetic resonance imaging
Carlo Rizza[1], Marco Fantasia[2], Elia Palange[2], Marcello Alecci[2], Angelo Galante[3]
[1] *CNR-SPIN (Italy),* [2] *University of L'Aquila (Italy),* [3] *MESVA (Italy)*

We propose a novel metamaterial-based device inserted ina magnetic resonance imaging (MRI) setup in order to enhancethe MRI efficiency. More precisely, we show that anegative magnetic permeability metamaterial, coupled to astandard radio-frequency surface coil, allows to boost themagnetic resonance imaging signal to noise ratio with respectto the standard setup. We believe that the proposedsetup holds great potential in MRI applications.

09:10 : Invited talk
Pathways for Ultrafast All-optical Magnetic Recording in Garnets
Andrzej Stupakiewicz
University of Bialystok (Poland)

Nonthermal ultrafast photo-magnetic recording in iron garnet films with femtosecond laser single and multipulses was demonstrated. Mechanism of recording is based on a multiple resonant pumping of localized d-electron transitions in a garnet. The information transferred from light to spins can be encoded not only in polarization state, but also in the wavelength and the intensity of the recording beams.

09:30 : Keynote talk
Electrical generation of surface plasmons with resonant nanoantennas
C. Zhang, J. P. Hugonin, A. L. Coutrot, C. Sauvan, F. Marquier, J. J. Greffet
Université Paris-Saclay (France)

We report the design, fabrication and characterization of antennas to emit surface plasmons by inelastic tunneling. The antenna controls the emission spectrum and enhance the emission efficiency by four orders of magnitude. We measure an emitted optical power of 10pW, four orders of magnitude larger than the power emitted by a scanning tunnelling tip. We introduce a theoretical model of the antenna in good agreement with the results.

10:00 : Invited talk
Balancing the photo-budget in far-field optical imaging for enhanced lateral resolution
Wyatt Adams, Chito Kendrick, Christopher Middlebrook, Durdu Guney
Michigan Technological University (USA)

Owing to the semiclassical process of photodetection, the resolution of optical imaging systems is often limited by shot noise. Here we present a theory to improve the shot noise limit in incoherent imaging and experimentally show its validity with a low numerical aperture system. The same principles can also improve the performance of near-field sub-diffraction-limited imaging via hyperbolic metamaterials.

08:30 - 10:10 — Auditorium EA3

Session 2A10

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Haitao Liu

08:30 : Invited talk
Dielectric-based Hyperbolic Metamaterials and Nano-Optical Cavity
Junichi Takahara, Jun Sagara
Osaka University (Japan)

We study theoretically dielectric-based TiO2/SiO2 Hyperbolic Metamaterial (HMM) at mid-infrared region with high transparency in visible. We report unique resonant properties of a HMM resonator and specific field distribution due to its hyperbolic dispersion relation.

08:50 : Invited talk
Novel Phenomena in Optical Manipulation due to Magnetic-field Induced Resonant States
S. Edelstein[1], R. M. Abraham Ekeroth[1], P. A. Serena[1], J. J. Saenz[2], A. Garcia-Martin[3], Manuel I. Marques[4]
[1] *ICMM-CSIC (Spain),* [2] *DIPC (Spain),* [3] *CSIC (Spain),* [4] *Universidad Autonoma de Madrid (Spain)*

We study the effect of optical forces and torques on a spherical isotropic magneto-optical (MO) nanoparticle. The force on the direction of the applied external magnetic field has two contributions: A first conservative component coming from the 'Zeeman' coupling between the light spin density and the external magnetic field through the imaginary part of the MO polarizability

09:10 : Invited talk
Fully CMOS compatible high-Q photonic crystal nanocavity devices and their applications
Takasumi Tanabe, Nurul Ashikin Binti Daud, Hajime Kumazaki, Shengji Jin
Keio University (Japan)

Although it has been claimed that silicon photonic crystal nanocavity devices are compatible with complementary metal-oxide semiconductors, it remains a challenge to make the structure and the fabrication fully compatible. We demonstrate a photolithographically fabricated photonic crystal nanocavity device that has a high quality factor even when clad with silicon dioxide. These characteristics make it possible to integrate this device with other silicon photonic devices.

09:30 : Invited talk
Polarization Engineering via in-Plane Rotation of Uniaxial Bilayers
Constantinos Valagiannopoulos
Nazarbayev University (Kazakhstan)

Engineering the polarization of the transmitted electromagnetic signals within a small fraction of the operational wavelength is an objective with numerous applications. The necessary anisotropy for this objective can be emulated in various ways but the simplest one is with multiple opaque rods stacked on a transparent background. It is shown that the polarization conversion ratio is small in the presence of realistic losses, however, we propose a pair of identical multilayers suitably tilted in-plane to overcome that bottleneck.

09:50 : Invited talk
Spontaneous emission near photonic Weyl points
Inaki Garcia-Elcano[1], Alejandro Gonzalez-Tudela[2], Jorge Bravo-Abad[1]
[1] *Universidad Autonoma de Madrid (Spain),* [2] *Instituto de fisica Fundamental IFF-CSI (Spain)*

We investigate the quantum electrodynamics of a quantum emitter coupled to a Weyl-point photonic lattice. We find that, despite the smoothness of the density of states near photonic Weyl points, fractional decay is observed when the transition of the quantum emitter is tuned to the frequency of a Weyl point. In addition, we show the emergence in the system of a light-matter bound state exhibiting tunable power-law localization, a feature with no counterpart in any other quantum optical scenario.

08:30 - 10:10 — Auditorium EA4

Session 2A11

Dynamic metamaterials

Organized by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

Chaired by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

08:30 : Invited talk
Designed electron temperature environments for the control of all-optical switching
Luke H. Nicholls[1], Tomasz Stefaniuk[2], Mazhar E. Nasir[1], Francisco J. Rodriguez-Fortuno[1], Gregory A. Wurtz[3], Anatoly V. Zayats[1]
[1] King's College London (United Kingdom), [2] University of Warsaw (Poland), [3] University of North florida (USA)

By designing the electron temperature distribution in hyperbolic metamaterials, induced by control light illumination, we demonstrate the efficient control of the metamaterial's resultant optical dynamics, creating tuneable switching state durations of 200-500 fs. This is shown to be due to the overlap between the signal light mode and the evolving electron temperature distribution.

08:50 : Invited talk
Coupled resonances of Surface Plasmon Polaritons and Localized Surface Plasmons in Ferromagnetic Nanoparticle Arrays
Francisco Freire-Fernandez[1], Mikko Kataja[2], Sebastiaan van Dijken[1]
[1] Aalto University School of Science (Finland), [2] Institut de Ciencia de Materials de Barcelona (ICMAB-CSIC) (Spain)

Surface lattice resonances are coupled resonances in periodic arrays of noble metal nanoparticles that circumvent optical losses and enable surface plasmons resonances with linewidths below 5 nm. However, he excitation of such ultra-narrow modes in magneto-optical systems remains elusive. We investigate coupled resonances in a Ni nanodisk array placed on top of a continuous SiO2/Au bilayer where the near-field of surface plasmon polaritons in Au induces an intense and spectrally narrow localized surface plasmon resonance in the Ni nanodisks.

09:10 : Invited talk
Towards optically adjustable and rewriteable metasurfaces enabled by phase-change materials
Andreas Hessler, Ann-Katrin Michel, Sebastian Meyer, Julian Pries, Yuan Yu, Thomas Kalix, Martin Lewin, Julian Hanss, Angela de Rose, Tobias Mass, Matthias Wuttig, Dmitry N. Chigrin, Thomas Taubner
RWTH Aachen University (Germany)

For arbitrarily programmable metasurfaces, a local change of the optical properties of each individual meta-atom is needed. We employ and compare different non-volatile phase-change materials (PCM) as switchable dielectric environment for meta-atoms. We show the fine-tuning of individual elements of a metasurface covered with a PCM by locally addressing them with laser pulses. Our materials and concepts can be applied to a multitude of already present metasurface designs.

09:30 : Invited talk
Electrochemical plasmonics for dynamic control of optical properties of self-assembling metamaterials
J. B. Edel, Alexei A. Koryshev, A. R. Kucernak, Y. Ma, Y. Montelongo, D. Sikdar, M. Urbakh, L. Velleman, C. Zagar
Imperial College London (United Kingdom)

This talk will overview a new direction of research based on self-assembly of plasmonic nanoparticles at electrochemical liquid-liquid or solid-liquid interfaces. Optical properties of such systems can be varied in real time via voltage-control over the structure and density of the nanoparticle assemblies. Potential applications involve switchable mirror-windows, tunable color mirrors, optical cavities, and pixels.

09:50 : Invited talk
Magnetic Metamaterials
Vassilios Kapaklis
Uppsala University (Sweden)

We will present routes for the fabrication of thermally acive, lithographically defined planar magnetic metamaterials, with sub-micron sized magnetic elements. Recent works have demonstrated that such structures undergo transitions and exhibit dynamics on adjustable length- and energy-scales. We will elaborate on how this can be utilized to create magnetically reconfigurable metasurfaces.

08:30 - 10:10 — Room 02.2

Session 2A12

Thermal-photonics for information and energy applications

Organized by: Qiang Li

Chaired by: Qiang Li

08:30 : Invited talk
Hybrid Plasmonics for Solar Energy Harvesting Through Radiative Heating
Mina Shiran Chaharsoughi, Dan Zhao, Daniel Tordera, Simone Fabiano, Xavier Crispin, Magnus P. Jonsson
Linkoping University (Sweden)

In this presentation, I will present our recent research on thermoplasmonics, with focus on hybrid plasmonic systems enabling radiation sensing and harvesting of energy from random light fluctuations.

08:50 : Invited talk
Resonant laser processing for fabrication of nanobiophotonic devices
Xiaolong Zhu, Airidas Zukauskas, Andreas Raimund Stilling-Andersen, Anders Kristensen
Technical University of Denmark (Denmark)

Nanophotonic devices realized by the state-of-the-art nanofabrication technologies have offered the control of light with nanoscale precision. Most of the functional nanophotonic devices rely on the ability to precisely control its individual meta-elements within the subwavelength scale. The absorption in metallic or dielectric elements provides a new route for photo-to-thermal conversions and processing. Here, we introduce a resonant laser processing technique as a flexible photo-thermal post-writing technology for mass-customization of optical devices.

09:10 : Invited talk
Temperature dependent Mie resonances and spectral characteristics of semiconductor nanoparticles and their composites
Vaibhav Thakore[1], Janika Tang[2], Kevin Conley[2], Tapio Ala-Nissila[2], Mikko Karttunen[1]
[1] *Western University (Canada),* [2] *Aalto University (Finland)*

Thermoplasmonic response of indirect (silicon) and direct (gallium-arsenide) bandgap semiconductor nanoparticles is studied and compared with the results from metallic (gold) nanoparticles. Silicon nanoparticles present high values of quality factors for the resonances while the spectral selectivity of the absorption efficiency in gallium-arsenide nanoparticles is maintained at elevated temperatures in contrast to the gold nanoparticles. Furthermore, results from the multiscale modeling of plasmonically enhanced control of radiation using spherical semiconductor inclusions in a composite will be presented.

09:30 : Invited talk
Thermo-plasmonics on vanadium oxide and silicon-based infrared sensor platforms
Xu Fang
University of Southampton (United Kingdom)

We present recent experimental and numerically simulated results in integrating plasmonic nanostructures with vanadium oxide and silicon thin films for developing infrared sensors with various functionalities. We also present a theoretical model, the modified Maxwell Garnett model, for interpreting hysteresis in vanadium dioxide.

09:50 : Invited talk

Near field based energy applications - thermophotovoltaics and photonic refrigeration by controlling the chemical potential of photons

Linxiao Zhu, Anthony Fiorino, Dakotah Thompson, Rohith Mittapally, Edgar Meyhofer, Pramod Reddy
University of Michigan (USA)

We will talk about our recent experiments of near-field based energy conversion. first, we will show a 40-fold enhancement of thermophotovoltaic electricity generation rates by maintaining a nanoscale gap between a thermal emitter and a photovoltaic cell. Secondly, we will show the realization of photonic refrigeration by controlling the chemical potential of photons. We achieved net cooling on a planar device by suppression of radiation from a reverse-biased photodiode, and enhancement of photon transfer from the planar device.

Coffee Break and Exhibit Inspection

Session 2P1

Poster session III

10:00 - 10:50

P1: A Deep Sub-wavelength Scale Surface Plasmon Polariton Travel Wave Amplifier with Multiple Quantum Wells

Ruijian Rao[1], **Shuwen Chen**[1], **Bing Chen**[2]
[1] *National University of Defense Technology, Information and Communication college (China),* [2] *Xi'an Jiaotong University (China)*

We propose a deep sub-wavelength scale surface plasmon polariton(SPP) travel wave amplifier(TWA) with multiple quantum wells(MQW) working at 1310nm window. The InGaAlAs tensile MQW are adopted for the polarization-independent amplification. We analyze this TWA's electrical and optical characteristics by the finite element method.

P2: Complex epsilon-near-zero materials enhances light absorption in ultra-thin solar cells

Marcella Bonifazi, Valerio Mazzone, Andrea Fratalocchi
PRIMALIGHT - King Abdullah University of Science and Technology (Saudi Arabia)

We engineered an epsilon-near-zero (ENZ) material from suitably disordered metallic nanostructures. We experimentally demonstrate that this nanomaterial increases up to a record value the absorption of ultra-thin light harvesting films at visible and infrared wavelengths with a broadband enhancement of 170 % in the external quantum effciency (EQE). In addition, we developed a cost-effective fabrication process that make these materials suitable to large scale production.

P3: Monolithic Graphene single-mode Vertical-cavity Surface-emitting Lasers

Baolu Guan, Weiling Guo, Yiyang Xie, Chen Xu
Beijing University of Technology (China)

An inter-cavity contact single mode 850nm VCSEL was fabricated with a graphene assisted self-assembly curved dielectric bubble Bragg mirror for the first time. Taking the advantage of graphene's uniform low surface energy, the low cost dielctric bubble DBR (Si3N4/SiO2) was depostited on top of the graphene/half-VCSEL structrure via van der Waals Force (vdWF) without using any additional spacing elements and sacrificial layer release-etch process.

P4: Conception of Circular Microstrip Patch Antenna Based on SINRD Substrate for WI-fi Application

Korchi Narimane, Rachid Oussaid
Houari Boumediene University (Algeria)

This paper demonstrates a study of Circular Patch Antenna using SINRD substrate. The SINRD structure is the air holes used in the substrate. The proposed antenna is designed at an operating resonant frequency of 2.4 GHz to meet Wi-fi 802.11applications. The designed microstrip patch antenna's gain, bandwidth and directivity are analyzed before and after introducing SINRD structure. The numerical results obtained from the comparison of three different configurations of SINRD substrate have been analyzed.

P5: Sound absorbing metafluid inspired by cereal straws
Weichun Huang, Logan Schwan, Vicente Romero-Garcia, Jean-Michel Genevaux, Jean-Philippe Groby
Université du Mans (France)

Used as building biomaterials for centuries, cereal straws are known for their remarkable acoustic performances in sound absorption. Yet, their use as fibrous media disregards their internal structure made of nodes partitioning stems. We show that such nodes can impart negative acoustic bulk modulus to straw balls. Large spectral bandgaps and slow sound regimes are theoretically predicted and experimental results from impedance tube measurements on an idealised 3D-printed sample layer perfectly capture these physical behaviours.

P6: Inverse Design of THz filter based on Self-Complementary Metasurfaces and Deep Neural Network
Celso Martines Leite, Kyung-Bin Lee, Hyo-Jeong Kim, Pyeung-Hwi Choi, Muhammad Tayyab Nouman, Jae-Hyung Jang
Gwangju Institute of Science and Technology (Korea)

We demonstrate the inverse design, where the geometry of the structure is obtained for an on-demand response, of terahertz (THz) filters using Deep Learning. The filter response is achieved by using self-complementary metasurfaces. Our Deep Neural Network is first trained with thousands of synthetic data results obtained from electromagnetic (EM) simulations and tested on its ability to predict the geometry of the metasurface. The presented results allow the on-demand design of THz filters in a rapid and systematic manner.

P7: Energy Transfer in Donor-acceptor Quantum Dots Simultaneous Mediated by Double Plasmon Modes of Gold Nanorod
Hanjie Zhang, Deren Yang, Dongsheng Li
Zhejiang University (China)

In this paper, the gold nano-rod (GNR) with silica shell and quantum dots (QDs) adsorbed on the silica surface, i.e. the GNR@SiO2@QD hybrid structures were constructed to investigate the energy transfer between quantum dots. Two plasmon peaks of gold nano-rod are coupled with the emission peaks of donor and acceptor respectively, in fluorescent resonance energy transfer (FRET). The energy transfer efficiency from donor to acceptor is 35.34 $\%$, and the fluorescence intensity of acceptor is increased by 2 times.

P8: EIT-like Effect Induced by Hybrid State of Tamm and Localized Plasmon-Polaritons in the region of Infrared
Fusheng Deng, Lijuan Dong, Yanhong Liu, Lixiang Liu, Yunlong Shi
Shanxi Datong University (China)

We investigate two kinds of electromagnetically-induced-transparency-like (EIT-like) effect induced by hybrid state of Tamm and localized Plasmon-Polaritons in the region of infrared. The EIT-like effects are corresponding to two mechanism, which induced by near-field coupling and standing-wave-field coupling, respectively.

P9: Reaching the Abbe-Sine condition with curved conformal metasurfaces.
Sandeep Yadav Golla, Patrice Genevet
Université Cote d'Azur (France)

Metasurfaces have a variety of wide applications in the fieldof optics. We exploit the concept of conformal metasurfaceto account for the different types of aberration correctionsanalytically through wave optics approach and support theresults with numerical simulations.

P10: Electrically-injected vertical-cavity surface-emitting lasers incorporating monolithic high contrast gratings
Marcin Gebski[1], James A. Lott[2], Tomasz Czyszanowski[1]
[1] *Lodz University of Technology (Poland),* [2] *Technische Universitat Berlin (Germany)*

We present the experimental realization of the first-of-its-kind vertical-cavity surface-emitting laser (VCSEL) incorporating a monolithic high-contrast grating (MHCG). The incorporation of an MHCG results in a 20 $\%$ reduction of the epitaxial material usage, and enables stable linear polarization of the emitted light and single mode operation for more than a three times larger electrical oxide aperture diameter in comparison to a standard oxide-confinedVCSEL. Our MHCG VCSELs are promising light sources for smartphones, optical communication systems, and sensing systems.

P11: Rock-salt CdZnO for IR plasmonics

Julen Tamayo-Arriola[1], Eduardo Martinez Castellano[1], Adelaida Huerta-Barbera[2], Miguel Montes Bajo[1], Elias Munoz[1], Vicente Munoz-Sanjose[2], Adrian Hierro[1]
[1] *Universidad Politecnica de Madrid (Spain),* [2] *Universitat de Valencia (Spain)*

CdO is an n-type semiconductor with excellent transport properties, gaining attention in recent years for the study of strong light-matter interaction phenomena. Here we show the conductivity of the MOCVD-grown CdO can be improved by alloying it with ZnO, reducing the losses in the mid-IR and enhancing its performance as a plasmonic material. Here we combine infrared reflectance and ultraviolet-visible absorption spectroscopies together with Hall effect, to determine its optical and electrical transport characteristics for increasing Zn contents.

P12: Self-powered humidity sensor using chitosan-based MIM filters

Jaehyuck Jang, Aizhan Ismukhanova, Heonyeong Jeong, Junsuk Rho
Pohang University of Science and Technology (POSTECH) (Korea)

The bioinspired environment-adapting structural coloration offers lots of potential applications, such as health monitoring, various sensing, anti-counterfeiting technology, and colorimetric indicator. Here, we would like to introduce a tunable Fabry-Perot resonator using Metal-Polymer-Metal structures. The chitosan, one of polysaccharide, is stimuli-responsive to external vapor, so it is swollen and deswollen in response to humidity condition. We demonstrated transmissive structural colors of the proposed resonator, then prove its capability toward self-powered humidity sensor application.

P13: Experimental demonstration of topological photonic states based on composite left/right-handed coupled ring resonators

Zhi-Wei Guo, Yong Sun, Haitao Jiang, Hong Chen
Tongji University Shanghai (China)

The array of two-dimensional coupled ring resonators is a typical system to realize the photonic and acoustic topological insulators with robust one-way transportation against defects and impurities. In this work, we theoretically propose and experimentally demonstrate the photonic analogue of quantum spin Hall effect in an improved broadband anomalous Floquet topological insulator in microwave regime, taking advantage of efficient and backward coupling between composite left/right-handed metamaterial rings resonators.

P14: Lighting up magneto-optics to its limit with dark plasmons

Mario Zapata-Herrera[1], Alberto Lopez-Ortega[1], Nicolo Maccaferri[2], Matteo Pancaldi[3], Mikel Mikel Garcia[1], Paolo Vavassori[1]
[1] *CIC nanoGUNE (Spain),* [2] *Université du Luxembourg (Luxembourg),* [3] *Stockholm University (Sweden)*

In this work we present a new strategy to actively enhance the magneto optical activity beyond its current limits by the excitation of a hybrid dark-bright modes in a magnetic-disk/metallic-ring plasmonic nanocavity.

P15: Bloch surface wave based sensor utilizing a multilayer interference filter

Michal Gryga, Dalibor Ciprian, Petr Hlubina
Technical University Ostrava (Czech Republic)

An experimental study of Bloch surface wave (BSW) based sensor which utilizes a one-dimensional photonic crystal (1DPhC) is presented. The 1DPhC is represented by a multilayer interference filter and we measure the response of a BK7 prism/multilayer/analyte system in the Kretschmann configuration. Dip in the reflectance spectrum for s-polarized wave represents the coupling of light to BSW and this is demonstrated for air and water. We also model the response of the system and confirm agreement with the experiment.

P16: Negative In-plane Elastic Moduli of Metallic Lattices: Experimental Investigations

Sondipon Adhikari[1], Alex Shaw[1], Tanmoy Mukhopadhyay[2], Nick Lavery[1]
[1] *Swansea University (United Kingdom),* [2] *University of Oxford (United Kingdom)*

In-plane elastic moduli of lattice mechanical metamaterials are considered. Historically, these moduli were described by positive real values. When dynamic behaviour of lattice metamaterials are considered, it is possible to express elastic moduli as functions of frequency and there exists a critical frequency beyond which the elastic moduli become negative. Theoretical predictions of equivalent elastic moduli and negative frequency values are validated with experimental results.

P17: Emission Pathways for Electrons in Surface Plasmon Enhanced Photoemission

David Janoschka[1], **Pascal Dreher**[1], **Timothy J. Davis**[2], **Frank J. Meyer zu Heringdorf**[1]
[1] *University of Duisburg-Essen (Germany),* [2] *University of Melbourne (Australia)*

In surface plasmon polariton-enhanced nonlinear photoemissionfrom gold surfaces, several pathways can leadto the emission of electrons. In addition to the well established two-photon absorption, emission purely fromthe plasmonic field can occur. More complex emission mechanisms come into play when there are interferences between the surface plasmon polariton and a probing femtosecond laser pulse. Here we use a pump-probe experiment to describe how the different contributions of plasmonand probing laser field can be disentangled.

P18: Off-axis digital holography for cathodoluminescence microscopy
Nick Schilder, Femius Koenderink, Albert Polman
AMOLF (The Netherlands)

We introduce off-axis digital holography for cathodoluminescence microscopy. We perform experiments on nanoholes in aluminium. The incident electron directly excites both surface plasmon polaritons and transition radiation simultaneously. The former scatter from the nanoholes and subsequently interfere in the farfield with (p-polarized) transition radiation, which serves as a reference field. By numerically isolating the interference terms of the farfield intensity, the complex-valued p-polarized electric field can be extracted.

P19: Resonant Lattice Kerker Effect in Metasurfaces of Titanium Dioxide Nanocubes
Longjie Li, Lina Shi, Changqing Xie
Chinese Academy of Sciences (China)

We demonstrate the arrays of titanium dioxide nanocubes, which support electric dipole resonance, magnetic dipole resonance and lattice resonances. By choosing the lattice periods along the x and y directions, we achieve a full overlap between the electric dipole resonance and magnetic dipole resonance and realize the resonant lattice Kerker effect. Meanwhile, we present a new fabrication process to eliminate the influence of the substrate on the electric dipole resonance and magnetic dipole resonance.

P20: Backward groove-regulated light wave resonance inside a subwavelength metallic slit
Jian-Shiung Hong, Kuan-Ren Chen
National Cheng Kung University (Taiwan)

Grooves patterned at the exit side of a subwavelength metallic slit are known to manipulate the transmitted light profile. We study the groove effect and find a backward coupling mechanism. The transmitted light is scattered by the grooves and then re-enters into the slit. This causes a phase delay of the reflected wave and is considered a reduction in the resonant film thickness. The traveling wave in the slit can be more in phase to significantly enhance the transmission.

P21: Much Ado About Nothing: Applying a Metamaterial Model with Negative Energy to Address the Vacuum Catastrophe
Thomas Paul Weldon, Kathryn Leigh Smith
University of North Carolina at Charlotte (USA)

The vacuum catastrophe remains one of the great enigmasof physics, with more than 50 orders of magnitude separatingthe observed nanojoule per cubic meter vacuum energyfrom the theoretical electromagnetic quantum vacuumenergy density. Toward bridging this wide gap, we consideran unconventional model for the vacuum using hypotheticalmetamaterial foam including pockets having negative parametersand negative energy density. The proposed metamaterialproperties are selected to preserve normal vacuumbehavior after homogenization.

P22: Negative phase velocity sound propagation in 1D hyperbolic phononic metamaterials
Yurii Zubov[1], **Arkadii Krokhin**[1], **Bahram Djafari-Rouhani**[2]
[1] *University of North Texas (USA),* [2] *Université de Lille (France)*

Analytical formulas are obtained for the tensor of effec-tive mass densities and for the effective elastic modulus ofa binary superlattice in the long wavelength limit. Theyare valid for high frequencies and oblique propagation.Within the region of frequencies with anomalous disper-sion, the equifrequency curves are hyperbolic and the ef-fective masses exhibit strong anisotropy. It is demonstratedthat hyperbolic dispersion in a 1D periodic system leads tonegative refraction for phase velocity. The group velocityrefraction remains positive.

P23: Solar Thermal Characterisation of Micro Patterned Solar Absorbers

Hanyu Cen[1], **Sara Nunez Sanchez**[2], **Neil Fox**[1], **Martin Cryan**[1]
[1] *University of Bristol (United Kingdom),* [2] *University of Vigo (Spain)*

This paper presents fabrication results showing large area laser patterning of molybdenum for use as a solar thermal absorber. Measured solar absorptance results show good performance and the temperature measurements of the samples show promise for solar thermal applications.

P24: Porous Thermochromic Nano-composite for Smart Window Systems
Man Xu, Charlotte Jansen, Pascal Buskens
Delft University of Technology (The Netherlands)

Nano-porous thermochromic VO2 thin film has been studied as a smart coating in a fenestration system to gain thermal modulation ability depending on the ambient temperature. Both analytical calculation and numerical simulations have been carried out to study the optical performance of the porous thin film. Additionally the functionality of the designed coating on glass has been characterized for the special needs of a smart window.

P25: Photoluminescence Enhancement by Hybrid plasmonic Nanodisks Arrays
Alireza Rahimi Rashed, Mohsin Habib, Nekhel Das, Humeyra Caglayan
Tampere University (Finland)

In this work, we have designed and fabricated an array of plasmonic nanodisks to investigate their interaction with different types of quantum emitters (QEs) in visible wavelength. We consider embedded fluorescent dye molecules in PMMA polymer as a potential QE for our investigation. The interaction between the strong subwavelength localized field at the edges of the gold nanodisks and QEs enhances the Purcell factor towards the modification of spontaneous emission and decay rate of QEs.

P26: Pulsed Two-Dimensional Atomic Crystal Cavity Optomechanics
Yuhao Xu, Wen Chen, Shunping Zhang, Hongxing Xu
Wuhan University (China)

Molecular cavity optomechanics is a new description of surface enhanced Raman scattering, and in return, surface enhanced Raman spectroscopy provides a new method for constructing and studying cavity optomechanics system. Moreover, pulsed excitation with duration time shorter than the phonon decay time, along with two-dimensional atomic crystals with well-defined arrangement and lattice orientation, facilitates the quantitation and simultaneously resolution of the time scale and the space scale. Here we show some results based on such a platform.

P27: Freestanding metallic mesh for transparent electromagnetic interference shielding
YanHua Liu, Su Shen
Soochow University (China)

A unique freestanding Ni metallic mesh based electromagnetic interference shielding film has been fabricated though the direct-writing technique and a subsequent selective metal electrodeposited process. The film demonstrates a series of advantages, including ultrathin thickness and ultralight weight (0.23 mg cm-2), extraordinary optoelectronic performance and outstanding flexibility that it can withstand folded, rolled up and crumpled into various shapes. Experimental results show that the film yields an average electromagnetic interference shielding effectiveness about 40 dB with transparency of 92 $\%$.

P28: Glass microspheres doped with Ag nanoparticles and CdTe quantum dots: towards a plasmonic microlaser
Piotr Piotrowski, Rafal Nowaczynski, Barbara H. Surma, Dorota A. Pawlak
University of Warsaw (Poland)

Plasmonic materials are utilized in plenty of areas like optoelectronics and photonics, due to their unique electromagnetic properties. In this work we develop an efficient glass microlaser co-doped with quantum dots and plasmonic nanoparticles. Response of the system exhibits strong dependence on excitation power and is different within the microsphere, showing whispering gallery modes fine structure on the edge of the microbead. Miniaturization of the laser opens possibilities of new applications in microfluidics, biosensing in vivo or narrow-band lasers.

P29: Invisible metasurfaces based on high-order Kerker and anapole effects
Hadi Shamkhi[1], **Kseniia Baryshnikova**[1], **Andrey Sayanskiy**[1], **Pavel Terekhov**[1], **Egor Gurvitz**[1], **Adria Ca-**

nos Valero[1], Alina Karabchevsky[2], Polina Kapitanova[1], Andrey Evlyukhin[1], Pavel Belov[1], Yuri Kivshar[1], Alexander Shalin[1]
[1] *ITMO University (Russia),* [2] *Ben-Gurion University (Israel)*

Here we briefly review some new results on the induced invisibility regarding fully transparent metasurfaces based on the simultaneous cancellation of the forward and backward scattering via particular optical responses of multipoles (similar to Kerker effect), and invisible objects and structures governed by the novel type of anapoles - hybrid anapole states.

P30: A dual-to-single mode metasurface absorber using phase transition of vanadium dioxide
Ayman Negm[1], Mohamed Bakr[1], Matiar Howlader[1], Shirook Ali[2]
[1] *McMaster University (Canada),* [2] *Sheridan College (Canada)*

A tunable and polarization-insensitive absorber is proposed. The design employs a gold-based metasurface hybridized with vanadium dioxide. The phase-transition property of vanadium dioxide is used to control the operation of the metasurface absorber. In this paper, we study the behavior of the metasurface operating at mid-infrared frequencies in single or dual-band mode based on the operating temperature.

P31: Near Perfect Absorption in Epsilon Near Zero Thin films
Stephen A. O'Brien[1], Frank Bello[1], Lisanne Peters[1], Niall McEvoy[1], David McCloskey[2], John Donegan[1]
[1] *Trinity College Dublin (Ireland),* [2] *University of Warsaw (Poland)*

We report a study of ENZ behavior in thin-film ITO samples by exciting the Ferrell-Berreman mode. We excite this mode in ITO films on glass, and ITO films with a 10 nm Pt metal backing. We demonstrate that the presence of this 10 nm Pt backing significantly enhances the absorption from this mode from 52.6 % without to 89.9 % with the metal.

P32: Phase transition of methylammonium lead halide perovskite (MAPbX3) single crystals studied by Raman scattering spectroscopy
Trang Thi Thu Nguyen[1], Yejin Kim[1], Hye Ri Jung[1], William Jo[1], Won Seok Woo[2], Chang Won Ahn[2], Shinuk Cho[2], Ill Won Kim Kim[2], Maryam Bari[3], Zuo Guang[3], Seokhyun Yoon[1]
[1] *Ewha Womans University (Korea),* [2] *University of Ulsan (Korea),* [3] *Simon Fraser University (Canada)*

For decades, many studies have been conducted to improve the efficiency of photovoltaic devices. In this study, we focused on structural properties, especially phase transition behavior as a results of temperature changes in methylammonium lead halide perovskite (CH3NH3PbX3, X- I, Br, Cl) to understand fundamental properties in these materials. The properties of perovskite materials on halogen elements, and Raman scattering can show that the contribution to the structural phase transition from each atomic/molecular vibration varies from compound to compound.

10:50 - 11:50 — IST Congress Center Auditorium

Session 2A13

Conference Tutorials II

Organized by: Ishwar Aggarwal

10:50 : Tutorial
Flat optics
Federico Capasso
Harvard University (USA)

This tutorial focuses on how metasurfaces enable the redesign of optical components into novel thin and planar diffractive optical elements, that overcome the limitations of Fresnel and refractive optics, promising a major reduction in footprint and system complexity as well as the introduction of new optical functions.

11:50 - 12:40 — IST Congress Center Auditorium

Session 2A14

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

11:50 : Keynote talk
Optical field Enhancement in the Nano-Patch Antenna for Lasing, Nonlinear Optics, and Other Nanophotonic Applications
David R. Smith, Patrick Bowen
Duke University (USA)

The optical nanopatch antenna consists of a metal, planar nanoparticle spaced nanometers from a metal film. For symmetric nanoparticles (e.g., cubes or disks), semi-analytic expressions can be obtained for all relevant optical scattering properties, useful for describing such phenomena as perfect absorption, bistability, enhanced fluorescence and lasing. These analytical expressions enable the nanopatch system to be rapidly optimized for a wide variety of nanophotonic applications. We review the nanopatch antenna and discuss its role as a novel photonic device.

12:20 : Invited talk
Metasurfaces Enabled by Locally Tailoring Disorder in Phase-Change Materials
Martin Hafermann, Philipp Schoppe, Jura Rensberg, Carsten Ronning
Friedrich-Schiller-Universitat Jena (Germany)

Active optical metasurfaces with dynamic switchable, tunable, and reconfigurable optical functionalities are an emerging field in photonics and optoelectronics. Especially, chalcogenide-based phase-change materials, such as Ge2Sb2Te5 (GST), can be fast and repeatedly switched by external stimuli between crystalline and amorphous states, typically accompanied by a tremendous difference of the electronic and photonic properties. Here, we demonstrate that focused ion beam-induced disorder in highly confined regions can transform phase-change materials in active optical metasurfaces by locally adjusting the phase.

10:50 - 12:30 — Auditorium VA1

Session 2A15

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Roberto Paiella

10:50 : Invited talk
Graded metasurface for elastic energy harvesting
Jacopo Maria De Ponti[1], Andrea Colombi[2], Richard Craster[3], Raffaele Ardito[1], Francesco Braghin[1], Alberto Corigliano[1]
[1] *Politecnico di Milano (Italy),* [2] *ETH Zurich (Switzerland),* [3] *Imperial College London (United Kingdom)*

Metamaterial designs combining graded arrays of resonators and elastic wave excitation allows a precise control of the propagation of mechanical waves in solid media. In this study metamaterial's broadband control capacities are used to design an innovative piezoelectric energy harvester.

11:10 : Invited talk
Multipole Decomposition of Bound States in the Continuum in Dielectric Metasurfaces
Zarina Sadrieva, Kristina Frizyuk, Mihail Petrov, Yuri Kivshar, Andrey Bogdanov

ITMO University (Russia)

We suggest a novel approach to explain the physics of bound photonic states embedded into the radiation continuum. We study dielectric metasurfaces composed of planar periodic arrays of Mie-resonant nanoparticles ('meta-atoms) which support both symmetry protected and accidental bound states in the continuum, and employ the multipole decomposition approach to reveal the physical mechanism of the formation of such nonradiating states in terms of multipolar modes generated by isolated meta-atoms.

11:30 : Invited talk
Advances in novel composite materials obtained by crystal growth
D. A. Pawlak[1], P. Paszke[2], R. Nowaczynski[2], K. Szlachetko[2], P. Piotrowski[2], M. Tomczyk[2], K. Sadecka[1], A. Materna[1], B. Surma[1], A. Belardini[3], J. Toudert[4], C. Sibilia[3]
[1] *Institute of Electronic Materials Technology (Poland),* [2] *University of Warsaw (Poland),* [3] *Sapienza Universita di Roma (Italy),* [4] *CSIC (Spain)*

We will demonstrate how to utilize the crystal growth methods for manufacturing of novel composite materials for various applications and especially photonics (metamaterials, plasmonic materials), and energy conversion.

11:50 : Invited talk
Plasmonic near-field probing with sub-nm sensitivity using photoelectrons
Peter Dombi
Wigner Research Centre for Physics (Hungary)

Probing nanooptical near-fields is a major challenge in plasmonics. Photoemission from metal nanostructures induced by femtosecond laser pulses proved to be highly sensitive tools for plasmonic near-field probing. I will show how this technique can provide sub-nm sensitivity. first applications in the investigation of plasmon-plasmon coupling are also demonstrated. In addition, time-resolved measurements of plasmonic near-field dynamics with unprecedented resolution were also performed, the results of which will be presented.

12:10 : Invited talk
Photonic topological edge states in a zig-zag chain composed of split ring resonators
Yuto Moritake
Tokyo Institute of Technology (Japan)

In this study, the zig-zag chains composed of split ring resonators (SRRs) were numerically investigated. The photonic topological edge states (PTESs) in the zig-zag chain was observed at the same resonant wavelength as the single SRR. In the PTESs, Electromagnetic fields concentrate at the edge SRR of the zig-zag chain. Introducing SRRs into the zig-zag chain results in polarization and wavelength selective PTESs due to asymmetry of SRRs. Moreover, PTES of the quadrupole mode was also demonstrated.

10:50 - 12:30 — Auditorium VA2

Session 2A16

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

Chaired by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

10:50 : Invited talk
Chiral electric transport effects in topological solitons
Fabian Lux, Jonathan Kipp, Matthias Redies, Jan-Philipp Hanke, Frank Freimuth, Stefan Blugel, Yuriy Mokrousov
Peter Grunberg Institut and Institute for Advanced Simulation (Germany)

Inspired by our recent work on the orbital magnetism of chiral magnets, we demonstrate how semiclassical gradient expansion in combination with tight-binding modelling of the electronic structure can shed some light

on the classification of Hall effects in chiral magnets. These results may open up new perspectives for the all-electrical detection of non-collinear magnetic structures such as skyrmions, hopfions and chiral bobbers.

11:10 : Invited talk
Structural chirality combined with optical activity (aka magneto-electricity)
Martin McCall
Imperial College London (United Kingdom)

We present a fully analytic solution for axial propagationalong a structurally chiral dielectric medium infiltrated byan optically active medium that is chiral at the molecularlevel.

11:30 : Invited talk
Plasmon assisted improvement of figure of merit of magneto-optical Kerr effect and magnetic anisotropy in Au/Co/Au multilayered nanorectangular array structures
Takuo Tanaka
RIKEN (Japan)

We experimentally demonstrated the significant improvement of the figure of merit (FOM) of the longitudinal magneto-optical Kerr effect and the increase of in-plane magnetic anisotropy in Au/Co/Au multilayered nano rectangular patch array structures. When the local-mode surface plasmons were resonantly excited in the nanostructures, its FOM becomes 3.8 times higher and the in-plane magnetic anisotropy energy density was increased about 24 $\%$ comparing to those of bare Co nano patch array.

11:50 : Invited talk
Microwave-Active Dynamics of Magnetic Skyrmions under Application of a Tilted Magnetic field
Masahito Mochizuki[1], Tatsuya Koide[2], Masahito Ikka[2], Akihito Takeuchi[2]
[1] *Waseda University (Japan),* [2] *Aoyama Gakuin University (Japan)*

We discuss our recent theoretical studies on dynamical phenomena and functionalities of magnetic skyrmions originating from their peculiar microwave-active spin-wave modes. Excitations of the spin-wave modes under application of a tilted magnetic field give rise to microwave-driven translational motion of skyrmions and skyrmion-based microwave-DC-voltage conversions.

12:10 : Invited talk
3D near-field circular dichroism measured by optical force
Masayuki Hoshina, Nobuhiko Yokoshi, Hajime Ishihara
Osaka Prefecture University (Japan)

We theoretically demonstrate an unnoticed role of the three dimensional (3D) superchiral structure in the near-field circulardichroism (NF-CD), and propose a scheme of 3D NFCDmeasurement near plasmonic chiral field by using theoptical force exerted on a tip of the atomic force microscope(AFM), which cannot be performed by aperture-typescanning near-field optical microscope (SNOM) because ofits 2D character of the field measurement.

10:50 - 12:45 — Auditorium VA3

Session 2A17

Symposium III: Advanced passive and active metasurfaces

Organized by: Howard Lee and Din Ping Tsai

Chaired by: Matthew Escarra, Howard Lee and Din Ping Tsai

10:50 : Invited talk
Metasurface and Epsilon-near-zero Resonances on Optical fiber
Jingyi Yang, Indra Ghimire, Khant Minn, Aleksei Anopchenko, Sudip Gurung, Ho Wai Howard Lee
Baylor University (USA)

We report an optical metalens patterned on the facet of a photonic crystal optical fiber. The in-fiber metalenses

with designed focal lengths enables light focusing operating at 1550 nm.We also experimentally show a novel waveguide of side-polished optical fiber nano-coated with ultrathin aluminum-doped zinc oxide epsilon-near-zero film by the atomic layer deposition. With the evanescent field between the core mode and the mode supported by the AZO nano-layer, a highly confined ENZ mode on the fiber could be excited.

11:10 : Invited talk
van der Waals Metasurfaces and Transdimensional Photonic Lattices
Viktoriia Babicheva
University of Arizona (USA)

Transdimensional photonics is an emerging field of science and engineering dealing with the optical properties of nanostructures in the translational regime. We consider optical nanoantennas out of hexagonal boron nitride (hBN) which is a natural material with hyperbolic dispersion in the mid-infrared spectral range. The hBN nanoantennas in the lattice support multipole electric and magnetic resonances, and such lattice possesses 2D/3D translational nature as optical properties are defined by nanoantenna size and shape as well as in-plane lattice arrangement.

11:30 : Invited talk
Optical elements based on engineered subwavelength dielectric structures
Adrei Faraon
California Institute of Technology (USA)

In this talk I give an overview of our recent work on various optical components and systems based on engineered subwavelength dielectric structures.

11:50 : Invited talk
Chalcogenide Glasses: Potential for Passive and Active Dielectric Metasurface Applications
Jesse A. Frantz[1], Robel Y. Bekele[2], Jason D. Myers[1], Anthony Clabeau[2], Vinh Q. Nguyen[1], Yun Xu[3], Jingbo Sun[3], Mikhail Shalaev[3], Wiktor Walasik[3], Apra Pandey[4], Alexander Tsukernik[5], Natalia M. Litchinitser[3], Jasbinder S. Sanghera[1]
[1] *U.S. Naval Research Laboratory (USA),* [2] *University Research Foundation (USA),* [3] *Duke University (USA),* [4] *CST of America (USA),* [5] *University of Toronto (Canada)*

Chalcogenide glasses (ChGs) are of interest for use in dielectric metastructures for several reasons. They typically possess high linear refractive indices, enabling high index contrast devices, they exhibit exceptionally large optical nonlinearities, making them useful for tunable applications, and they have wide transmission windows extending from the visible through the long-wave infrared. We discuss the potential advantages of these materials in the context of dielectric metasurfaces and present recent results for both passive and active devices.

12:10 : Invited talk
Topological protection in spin and valley Hall metasurfaces
Matthias Saba, Stefan Wong, Sang Soon Oh, Ortwin Hess
Imperial College London (United Kingdom)

Topological protection in on-chip optical devices promises strongly improved wave-guiding, insensitive to structural imperfections and environmental fluctuations. Traditional approaches, however, suffer from practicality chalenges at optical wavelengths. Periodic dielectric metasurfaces based on optical analogues of the quantum spin and valley Hall effects have recently emerged as a potential remedy, but the nature and strength of topological protection is poorly understood. We here introduce a group theoretical approach to rigorously characterise topological protection for a broad class of metasurfaces.

12:30 : Optical Metasurfaces for Designing Planar Cassegrain-Schwarzschild Objective
Xuan Liu[1], Junhong Deng[1], King Fai Li[1], Yutao Tang[1], Mingke Jin[1], Jing Zhou[2], Xing Cheng[1], Wei Liu[3], Guixin Li[1]
[1] *Southern University of Science and Technology (China),* [2] *Beijing Normal University (China),* [3] *National University of Defense Technology (China)*

Curved reflective mirrors with inevitably bulky size play an indispensable role in widely-employed Cassegrain-type optical devices. Through substituting geometric phase based flat reflective metasurfaces for curved mirrors, here planar Cassegrain-type Schwarzschild objectives are obtained experimentally, with their achromatic focusing and imaging functionalities. The planar reflective objectives achieved are intrinsically free of

residual light. Our designs can potentially reshape and simplify the core components of many microscope and telescope systems working over broadband spectral regimes.

10:50 - 12:10 — Auditorium VA4

Session 2A18

Non-Hermitian Complex Systems: Photonics, Plasmonics and Metamaterials

Organized by: Konstantinos Makris, Ramy El-Ganainy and Sahin Ozdemir

Chaired by: Konstantinos Makris, Ramy El-Ganainy and Sahin Ozdemir

10:50 : Invited talk
Optical Amplifications at Non-Hermitian singularities
Q. Zhong[1], Sahin Ozdemir[2], Alexander Eisfeld[3], Anja Metelmann[4], Ramy El-Ganainy[1]
[1]Michigan Technological University (USA), [2]Penn State University (USA), [3]Max Planck Institute for the Physics of Complex Systems (Germany), [4]Freie Universitat (Germany)

We propose a new optical amplifier geometry based on exceptional points. Compared to its standard counterpart device, the proposed structure relaxes the limitation imposed by the gain-bandwidth product.

11:10 : Invited talk
Controlling photonic systems via topological anomalies
Henning Schomerus
Lancaster University (United Kingdom)

Anomalies are the term by which we denote that topological states respond in characteristic ways to external probes. Here I show that such anomalies extend naturally to photonic systems, where they take on extra significance in the presence of gain and loss.

11:30 : Invited talk
Quantum criticality and nonequilibrium phases: topology in non-Hermitian physics
Yuto Ashida, Shunsuke Furukawa, Masahito Ueda
The University of Tokyo (Japan)

I will present our recent results on two distinct topological aspects of non-Hermitian physics. first, I discuss the unconventional quantum phase transition and critical phenomena in the parity-time-symmetric sine-Gordon model, which can be realized in ultracold atoms. Second, I talk about the role of topology in nonequilibrium phases of non-Hermitian systems and present a possible topological classification and its relevance to the Hatano-Nelson model.

11:50 : Invited talk
Exceptional-point parity-time symmetry based sensors: limitations due to fluctuations and noise
Christos Tserkezis, Christian Wolff, N. Asger Mortensen
University of Southern Denmark (Denmark)

We theoretically discuss limitations in the operation of sensors based on parity-time symmetric gain-loss resonator pairs initially operating near the exceptional point. In particular, we show how mesoscopic fluctuations in resonator pair ensembles produce a detuning in the frequencies of the constituent resonators, while thermal noise leads to an exponential divergence of the initial states. We therefore show that considerable effort is required in order to exploit the sensitivity of such sensors in its full potential.

10:50 - 11:25 — Auditorium VA5

Session 2A19

Nanophononics and nanomechanics

Organized by: Daniel Lanzillotti-Kimura and Pedro David Garcia

Chaired by: Daniel Lanzillotti-Kimura and Pedro David Garcia

10:50 : Invited talk
Phonon Engineered Detectors and Refrigerators
Mika Prunnila
VTT Technical Research Center of finland Ltd (Finland)

Engineering of electron, photon and phonon thermal fluxes on small length scales is important for different ICT devices ranging from sensors to CMOS circuits. Mastering the different energy/particle channels at the nanoscale enable, especially, high sensitivity detectors and compact refrigerators. In this communication, we discuss on phonon engineering methodologies and physics for thermal radiation detectors and micro-coolers targeting to enhance their performance. Experimental realizations and results will be shown to back up our phonon engineering postulates and theoretical estimates.

11:10 : Synthetic magnetic fields for on-chip phonons through nano-optomechanical interactions
John Mathew, Javier del Pino, Ewold Verhagen
AMOLF (The Netherlands)

We demonstrate synthetic gauge fields for phonon transport in a nano-optomechanical platform. Employing time-modulated radiation pressure forces, we evidence nonreciprocal nanomechanical phase transfer. We show how this enables a new class of on-chip phononic topological insulators.

11:25 - 12:40 — Auditorium VA5

Session 2A20

Photonic crystals

Chaired by: Istvan Kezsmarki

11:25 : Pseudo Jahn Teller effect: Application to Time Crystals
Zafer Ozer[1], Amirullah M. Mamedov[2], Ekmel Ozbay[2]
[1] *Mersin University (Turkey),* [2] *Bilkent University (Turkey)*

In present paper, we proposed the concept of the Photonic Time Crystal (PTC), and simulated electromagnetic wave propagation in 1D, and 2D PTC, the simulated results indicate that the scatter fields in PTC are more intensive than those in conventional PC, and the band gaps in PTC are larger than those in conventional PC.

11:40 : Hybrid External Cavity Laser based on Silicon Nitride 1D Photonic Crystals Cavities for dWDM applications
Simone Iadanza[1], Alessio Tedesco[2], Giuseppe Giannino[2], Marco Grande[2], Liam O'Faolain[1]
[1] *Cork Institute of Technology - Tyndall National Institute (Ireland),* [2] *Politecnico di Bari - DEI (Italy)*

In this paper we show a single-mode silicon nitride external cavity laser based on a 250μm long RSOA coupled to Si3N4 1D photonic crystals that act as wavelength selective resonators, reducing the footprint of the reflector by a factor of 30 compared to conventional gratings. This, combined with the low thermo-optic coefficient of Si3N4, leads to neglectable wavelength drifts with temperature, paving the way to integrated SiN EC lasers in WDM, without the need of active cooling

11:55 : Wavefront manipulation based of the excitation of bound states in dielectric photonic crystals and bilayer metasurfaces
Anna Tasolamprou[1], Maria Kafesaki[1], Thomas Koschny[2], Costas Soukoulis[1]
[1] *IESL - FORTH (Greece),* [2] *Iowa State University (USA)*

We present the study of bound surface modes sustained at the termination of truncated bulk dielectric photonic crystals and isolated metasurfaces of dielectric meta-atoms. We discuss the origins of bound modes in the two systems and their relation. For both systems, we theoretically study and experimentally demonstrate wavefront manipulation, in particular directional emission, frequency splitting and beam collimation achieved by coupling of the bound states to radiation modes through leaky wave radiation mechanism using properly designed scattering gratings.

12:10 : Coalescence-controlled large-scale colloidal films towards robust structural colors
Su Chen, Zhijie Zhu, Xiang-Yun Du, Chang Liu, Qing Li
Nanjing Tech University (China)

Inspired by commonly-seen 'milk skin' phenomena, a general and versatile scheme, namely the polymer colloid ensembles (named 'colloid skin') -regulated assembly route, is demonstrated here for colloidal film deposition, which easily addressed the ubiquitous issues associated with the asymmetrical evaporation processes, implying a new broad-spectrum film-forming strategy.

12:25 : Near-field focusing devices
Yu Chieh Cheng[1], Kestutis Staliunas[2]
[1] *National Taipei University of Technology (Taiwan),* [2] *Universitat Politecnica de Catalunya (Spain)*

The paper shows the recent process towards the design of flat focusing optics in the near field and the far field. An important feature of the near-field flat focusing mirrors - the transverse invariant, i.e. they do not possess any optical axis, very different from the far-field flat optics. The paper also summarizes the near-field and far-field flat optics with a future outlook.

10:50 - 12:30 — Auditorium VA6

Session 2A21

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Xiao Hu

10:50 : Invited talk
Femtosecond laser pulse modification of gold nanorods to provide identical optical response
Guillermo Gonzalez-Rubio[1], Pablo Diaz-Nunez[2], Antonio Rivera[2], Alejandro Prada[2], Gloria Tardajos[1], Jesus Gonzalez-Izquierdo[1], Luis Banares[1], Pablo Llombart[1], Luis G. Macdowell[1], Mauricio Alcolea Palafox[1], Luis M. Liz-Marzan[3], Ovidio Pena-Rodriguez[2], Andres Guerrero Martinez[1]
[1] *Universidad Complutense de Madrid (Spain),* [2] *Universidad Politecnica de Madrid (Spain),* [3] *CICbiomaGUNE (Spain)*

We show how to achieve extreme control over the energy deposited in plasmonic nanorods with femtosecond laser pulses to induce predictable changes in temperature and. There exists a laser fluence window that combined with the appropriate concentration of the organic surfactant (CTAB) leads to a gentle multishot modification of the nanorods to a stable situation at which the nanorod aspect ratio is the same for all the nanorods. The result is an ensemble of optically identical nanorods.

11:10 : Invited talk
Engineering the Refractive Index and Phase of Optical Metamaterials
Zi Jing Wong
Texas A-M University (USA)

Subwavelength structuring of materials can lead to exotic material properties and device functionalities. Using nanostructures, we engineered the real and imaginary part of refractive index and the phase distribution to create optical metamaterials with extraordinary properties and performances.

11:30 : Invited talk

Index-Tunable Terahertz Metadevices Based on Double-Layered Closed-Ring Resonator Arrays

Tatsunosuke Matsui
Mie University (Japan)

We demonstrate index-tunable metamaterials and metadevices working in the terahertz (THz) frequency range based on double-layered closed-ring resonator (CRR) arrays. The double-layered CRR arrays have a narrow-band transmission peak which shows negative refractive index even in normal incidence. We show that the effective refractive index can be widely tuned by slightly shifting relative position of the arrays. We also demonstrate that THz beam steering can be realized by utilizing the double-layered CRR arrays arranged in a wedge-shaped prism.

11:50 : Invited talk

Nano-opto-electro-mechanical systems for optical switching and sensing

Andrea Fiore, Tianran Liu, Francesco Pagliano, Rene van Veldhoven, Vadim Pogoretskii, Yuqing Jiao
Eindhoven University of Technology (The Netherlands)

We report integrated nano-opto-electromechanical systems consisting of coupled InP waveguides on a silicon platform. Due to the tight optical confinement, large phase shifts are obtained over short propagation lengths, enabling efficient switching at low voltages in a small footprint. Due to their large response to nanomechanical displacements, they can also be applied as integrated displacement and force sensors.

12:10 : Invited talk

Nonlinear Light Generation from Si Nanoplasmonic Waveguides

Abdulhakem Elezzabi, Curtis Firby, Shawn Sederberg
University of Alberta (Canada)

Silicon-based nanoplasmonic waveguides are key in integrated chip-scale nanoplasmonic circuitry. In this work, we demonstrate a Si-nanoplasmonic waveguide platform to examine nonlinear light emission processes, such as third harmonic generation, second harmonic generation, white light emission, as well as photogenerated carrier ultrafast streaking and carrier amplification. We envision these structures to be vital components in integrated nanoplasmonic CMOS nanoplasmonic devices.

10:50 - 12:15 — Auditorium EA1

Session 2A22

Fano resonances in optics and microwaves: Physics and application

Organized by: Eugene Kamenetskii and Almas Sadreev

Chaired by: Eugene Kamenetskii and Almas Sadreev

10:50 : Invited talk

Tunable Fano resonances in the radiative decay rate of a dipole emitter near a graphene-coated nanowire

Tiago J. Arruda, Romain Bachelard, John Weiner, Philippe W. Courteille
University of Sao Paulo (Brazil)

We study radiative transition rates for different orientations of a dipole emitter near a graphene-coated nanowire. We show that Fano resonances appear in the Purcell factor as a function of frequency. Furthermore, the Fano lineshape can be tailored and electrically tuned by varying the distance between emitter and cylinder and by modulating the graphene chemical potential. This gate-voltage-tunable Fano resonance leads to a resonant enhancement and suppression of light emission in the far-infrared range of frequencies.

11:10 : Invited talk

Fano Resonances in Dimer Nanoantennas: Switching and Directionality Effects

Angela Inmaculada Barreda[1], Hassan Saleh[2], Amélie Litman[2], Francisco Gonzalez[3], Jean-Michel Geffrin[2], Fernando Moreno[3]
[1] *Universitat Politècnica de València (Spain),* [2] *Aix-Marseille University (France),* [3] *University of Cantabria (Spain)*

Directionality properties of subwavelength High Refractive Index Dielectric particles make them good candidates for controlling the direction of the scattered radiation. Here, we show experimentally, in the microwave range, that a dimer unit made of such materials can optimize the performance of solar cells by redirecting the incident radiation to the photosensitive layer. In addition, we demonstrate its utility for building operational switching devices.

11:30 : Photonic crystal structures treated by the resonant state expansion
Sam Neale, Egor Muljarov
Cardiff University (United Kingdom)

We present a photonic-crystal resonant-state expansion (PC-RSE), a new rigorous approach for accurate calculation of resonant states (RSs) in planar photonic-crystal structures using a homogeneous slab as basis system. Using for illustration a dielectric slab periodically modulated in one direction, we demonstrate the accuracy and efficiency of the PC-RSE for finding the RSs. We further study in these systems bound states in the continuum (BIC), showing how different types of RSs of the homogeneous slab contribute to BIC.

11:45 : Highly-efficient nonlinear image tuning through magnetic dipole quasi-BIC ultra-thin resonators
Lei Xu[1], Khosro Zangeneh Kamali[2], Lujun Huang[1], Mohsen Rahmani[2], Alexander Smirnov[3], Rocio Camacho-Morales[2], Yixuan Ma[4], Guoquan Zhang[4], Matt Wolley[1], Dragomir Neshev[2], Andrey E. Miroshnichenko[1]
[1] *University of New South Wales (Australia),* [2] *The Australian National University (Australia),* [3] *Russian Academy of Science (Russia),* [4] *Nankai University (China)*

We propose an ultra-thin silicon metasurface supporting a high-quality quasi-bound-state-in-the-continuum (BIC) generated by the collective magnetic dipole (MD) resonance excited in the subdiffractive periodic systems. Such quasi-BIC MD state leads to a robust near-field enhancement and a significant boost of the nonlinear process, resulting in measured 500-fold enhancement of third-harmonic emission in comparison to the conventional silicon disk metasurface. We further demonstrate the highly-efficient dynamical switching experimentally over nonlinear images via polarisation and wavelength control.

12:00 : High-Q modes in a single dielectric nonspherical nanocavity
Lujun Huang[1], Lei Xu[1], Mohsen Rahmani[2], Dragomir Neshev[2], Andrey Miroshnichenko[1]
[1] *University of New South Wales (Australia),* [2] *Australia National University (Australia)*

We demonstrate the high-Q factor resonant modes in a single nonspherical dielectric nanocavity (i.e. rectangular nanowire, cuboid, and disk) by exploring quasi bound state in continuum. We find that the high-Q modes only occur at a specific size aspect ratio, around which avoided crossing (or crossing) feature appears for pair modes. Multipole analysis on the high Q eigenmode indicates that radiation is significantly suppressed in the limited eigenchannels. High Q modes are verified experimentally via scattering spectrum.

10:50 - 12:30 — Auditorium EA2

Session 2A23

Dynamic metamaterials

Organized by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

Chaired by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

10:50 : Invited talk
Self-assembled magnetic nanoparticles on plasmonic nanoantennas
G. Petrucci[1], O. Lysenko[2], E. Fantechi[1], C. Sangregorio[3], A. Dmitriev[2], Francesco Pineider[1]
[1] *University of Pisa (Italy),* [2] *Gothenburg University (Sweden),* [3] *CNR-ICCOM (Italy)*

We show that chemically prepared cobalt ferrite nanoparticles can be selectively assembled on plasmonic gold nanodisks, thus forming a hybrid magnetic-plasmonic platform. Spectroscopic and field-dependent magneto-optical studies show an interesting behavior around the plasmon resonance frequency: the magneto-optical response of the gold disks is influenced quantitatively by the local magnetic field induced by the

surrounding nanoparticles. We thus propose the idea of using plasmonic nanoantennas as optical local magnetic field sensors.

11:10 : Invited talk
Control of Hot-Electron Dynamics: From Ballistic Collection to Ultrafast Hot-Hole Removal
Giulia Tagliabue[1], Joseph S. DuChene[2], Ravishankar Sundararaman[3], Harry A. Atwater[2]
[1] *EPFL (Switzerland),* [2] *Caltech (USA),* [3] *Rensselaer Polytechnic Institute (USA)*

Using a combination of solid-state measurements and ultrafast spectroscopy we investigate the dynamics of photoexcited hot-electrons in plasmonic nanostructures. We first study the role of plasmon excitation and metal band-structure on the performance of plasmonic photodiodes and we show that their photoresponse consists primarily of ballistic hot-electrons. Next we show the significant impact of hot-hole removal onto the thermalization of hot-electrons, pointing towards a strategy for the control of their peak temperature.

11:30 : Invited talk
Epsilon-Near-Zero Resonant Tunneling Modes in Metal/Insulator/Metal nanocavities
Vincenzo Caligiuri, Milan Palei, Giulia Biffi, Sergey Artyukhin, Liberato Manna, Roman Krahne
Italian Institute of Technology (Italy)

We demonstrate, theoretically and experimentally, the achievement of customizable Epsilon-Near-Zero response in the visible range by using Metal/Insulator/Metal nano-cavities. The systems are modelled in a quantum framework, elucidating the resonant tunneling nature of the Epsilon-Near-Zero (ENZ) response occurring at the cavity modes. We investigate the hybridization of the ENZ modes in multiple cavity systems, achieving tailorable ENZ bands. The proposed systems can be used as superabsorbers, refractive index sensor and to enhance the photophysical performances of weakly coupled fluorophores.

11:50 : Invited talk
Playing with temperature at the nanoscale
Remo Proietti Zaccaria[1], Tianlong Guo[1], Joao Cunha[1], Alessandro Alabastri[2]
[1] *Cixi Institute of Biomedical Engineering (China),* [2] *Rice University (USA)*

The optical properties of any material are strongly related to the temperature of their surrounding environment as well as by any temperature-carrying-source, such as laser light, impinging on the material. In this regard, it is well known that in bulky metals the reflectivity monotonically decreases upon increase of the temperature.

12:10 : Invited talk
Reprogrammable Nano-Optical Computing Using Metatronic Circuits
Mario Miscuglio, Joseph Crandall, Shuai Sun, Zhizhen Ma, Engin Kayraklioglu, Jeffery Anderson, Yousra Alkabani, Tarek A. El-Ghazawi, Volker J. Sorger
George Washington University (USA)

Here, we demonstrate the realization of a nano-optic co-processor based on air grooves meshes, engraved in an Indium Tin oxide (ITO) substrate at epsilon-near-zero condition, able to instantaneously solve partial differential equation. We show that this platform behaves as a lumped circuit, similarly to a resistive mesh, and can be configured and programmed to map finite difference problems, thus providing an accurate discretized solution to PDEs.

10:50 - 11:30 — Auditorium EA3

Session 2A24

Transformation optics concept and applications

Organized by: Shah Nawaz Burokur and Jianjia Yi

Chaired by: Shah Nawaz Burokur and Jianjia Yi

10:50 : Invited talk
Applications of semiconductor-based and conformal Metasurfaces

P. Ni[1], **A. De Luna Bugallo**[2], **Yi-Yang Xie**[3], **H. Ren**[1], **G. Briere**[1], **S. Chenot**[1], **S. Vezian**[1], **V. Brandli**[1], **B. Damilano**[1], **J. Y. Duboz**[1], **M. Iwanaga**[4], **Patrice Genevet**[1]
[1] *Université Cote d'Azur (France),* [2] *Consejo Nacional de Ciencia y Tecnologia (Mexico),* [3] *Beijing University of Technology (China),* [4] *National Institute for Materials Science (NIMS) (Japan)*

During this presentation, we will review the recent developments realized at CRHEA on the fabrication and design of 2D metasurfaces in the passive and active regime. Passive GaN metasurfaces for beam steering and orbital angular momentum holography will be discussed. We will also present tunable gate-voltage controlled light emission at hybridized MoS2/Metasurface. The concluding remarks will be devoted to the works on conformal metasurfaces.

11:10 : Invited talk
Transformation optics with 'invisible' loss and gain
Yun Lai, Jie Luo
Nanjing University (China)

We introduce balanced loss and gain into a general class of non-Hermitian systems by using transformation optics. We demonstrate that loss and gain turn 'invisible' in such systems, and provide a perfect way of energy transportation in open systems.

11:30 - 12:45 — Auditorium EA3

Session 2A25

Metamaterials and negative index materials

Chaired by: Michael Fiddy

11:30 : Optical properties of planar metal-dieletric layered films: from coupled Fabry-Perot resonators to hyperbolic metamaterials
Manuel Goncalves[1], **Hayk Minassian**[2], **Armen Melikyan**[3], **Othmar Marti**[1]
[1] *Ulm University (Germany),* [2] *Yerevan Institute of Physics (Armenia),* [3] *Russian-Armenian University (Armenia)*

We present a theoretical and experimental study of coupled Fabry-Perot resonators based on layered thin films of silver and a dielectric. Despite the optical losses of the metal we show how these resonators can achieve narrow bandwidths of less than 5 nm at optical wavelengths. By adding several pairs of silver-dielectric layers and reducing the film thickness we reach the regime of hyperbolic metamaterial. We present some advantages of employing these multilayered materials in plasmonic applications.

11:45 : Programmable Electromagnetic Properties of Microwire Metacomposites
Azim Uddin, Faxiang Qin
Zhejiang University (China)

The multifunctional structural composites have gained more attention due to their incorporation of electromagnetic (EM) features into light-weight host materials. In this work, we present a composite medium demonstrating strong microwave dispersion properties enabled by an array of short-cut microwires. They behave as radiative elements with different structural properties into polymer-based composite. The arrangement of wires plays a remarkable role in achieving the controllable EM response.

12:00 : Optical and Nonlinear-Optical Properties of Gold Nanorods' Based Hyperbolic Metamaterials
Irina A. Kolmychek, Aleksander R. Pomozov, Vladimir B. Novikov, Aleksei P. Leontiev, Kirill S. Napolskii, Tatiana V. Murzina
Moscow State University (Russia)

We present the experimental results on optical and nonlinear-optical effects in hyperbolic media based on gold nanorods arrays in porous anodic alumina, demonstrating pronounced effects attributed to epsilon-near-zero and epsilon-near-pole dispersion points. In the spectral vicinity of the epsilon-near-zero, an enhancement of the optical activity and of the second harmonic intensity are observed.

12:15 : Broadband Metamaterial Absorbers: Gold and Tungsten Boride

Ahasanul Haque[1], **Monir Morshed**[1], **Ziyuan Li**[2], **Li Li**[2], **Kaushal Vora**[2], **Lei Xu**[1], **Lan Fu**[2], **Andrey Miroshnichenko**[1], **Haroldo Hattori**[1]
[1] *The University of New South Wales (Australia),* [2] *The Australian National University (Australia)*

In this paper, we experimentally analyze the absorption of two metamaterial perfect absorbers made of different materials: gold (Au) and tungsten boride (WB, a refractory ceramic). We show that WB has wider absorption bandwidth than that of the gold counterpart. Moreover, WB reveals better performance with the absorption of more than 90 % over the spectral range from 950 to 1400 nm.

12:30 : Quantum electronic magneto transport in GaAs/AlxGa1-xAs superlattice at high magnetic fields and low temperature for near infrared detection
Rachid Ben Koujan, Abdelhakim Nafidi, Merieme Benaadad, Samir Melkoud, Driss Barkissy, Nassima Benchtaber, Abderrazak Boutramine
University Ibn Zohr (Morocco)

We report here on electronic bands structures of GaAs/Al0.18Ga0.82As superlattice in the envelope function formalism. We studied the effect of barrier thickness, valence bands offset and temperature on the band gap. The density of states and the Fermi level indicates that this sample is quasi two dimensional with n type conductivity. The cut-off wavelength is located in the near infrared region. We interpreted the Shubnikov de Haas oscillations and the Quantum Hall plateaus observed by Pusep et al.

10:50 - 12:25 — Auditorium EA4

Session 2A26

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

10:50 : Invited talk
Nanoplasmonics for Terahertz Light
Luca Razzari
INRS-EMT (Canada)

I will give a brief overview of our group activities on the use of plasmonic nanostructures to enhance terahertz radiation matter interaction.

11:10 : Invited talk
Plasmon Modulated Silicon Photodetectors based on Photothermoelectric Effect
Weikang Liu, Wenqiang Wang, Zhiqiang Guan, Hongxing Xu
Wuhan University (China)

High integration density, high responsivity, and multifunctional Silicon photodetectors are the long term goals in the field of light detection. The photothermoelectric (PTE) effect provides a promising way towards the requirement above. Here we report a plasmon modulated silicon nanostripe PTE detector with an open-circuit photovoltage responsivity $\sim$82 mV/μW. The gold subwavelength nanogratings provide enhanced optical absorption and polarization and wavelength sensitivity.

11:30 : Invited talk
Plasmonic Aluminum Nanohole Arrays for ITO-Free Ultraviolet Photodetectors with Improved Response Stability and Tunability
Monica Esopi, Qiuming Yu
University of Washington (USA)

Incorporating plasmonic nanostructures into photodetectors provides an avenue for enhancing photoresponse strength, selectivity and tunability. Here, aluminum nanohole arrays (Al-NHAs) were incorporated as transparent electrodes into ultraviolet photodetectors. The optimal gap/pitch were determined to be 175/200 nm by 3-

dimensional finite-difference time-domain (3D-FDTD) simulations. Devices incorporating these Al-NHAs had comparable photoresponse, under reverse biases, compared to ITO-based control devices. Under forward biases, improved, spectrally distinct photoresponse was obtained by the Al-NHA-based devices, enabling a new bias-dependent response tunability.

11:50 : Invited talk
Manipulation of Strong Light-Matter Interactions in Two-Dimensional Transition-Metal Dichagenides Coupled with Nanophotonic Structures
Huanjun Chen, Hao Wang, Jinxiu Wen
Sun Yat-sen University (China)

Strong light-matter interactions in two-dimensional transition-metal dichagenides (TMDCs) coupled with nanophotonic structures can have great potential in future high-performance nanophotonic and quantum devices which operate at room temperature. I will introduce our recent progresses on manipulation of this type of strong interactions using semiconductor as well as plasmonic nanostructures.

12:10 : Folding a 2D material into a W-shape periodic nano-structure: the case of a gold nano-layer and the consequences on its plasmonic and photonic properties
Laurent Arnaud, Shijian Yang, Soukaina Es Saidi, Aurelien Bruyant, serguei Kostcheev, Abdelhamid Hmima, Yassine Hadjar, Sylvain Blaize, Demetrio Macias, Remi Vincent
UTT (France)

Our experiments and simulations show notable effects in the photonic and plasmonic properties when transitioning from a single flat gold layer to a periodically folded layer. In particular the coupling of surface plasmon polaritons to free-space propagating waves becomes possible through the refraction orders, some localized resonances along the segments created by the folding are observed and result in an increased absorption, wedge/corner resonances with a strongly localized enhanced electric field are also observed.

10:50 - 12:30 — Room 02.2

Session 2A27

Thermal-photonics for information and energy applications

Organized by: Qiang Li

Chaired by: Qiang Li

10:50 : Invited talk
Mid-IR emission at high modulation rates with incandescent metasurfaces
Jean Jacques Greffet, Leo Wojszvzyk, Anne-Lise Coutrot, Mondher Besbes, Jean-Paul Hugonin, Benjamin Vest
Institut d'Optique (France)

We report a numerical and experimental study of a metasurface patterned with arrays of nanowires, that reaches an emissivity close to 1 at 4 microns and can be operated at modulation rates up to 50 MHz.

11:10 : Invited talk
Dynamic and spatial multilevel control over emissivity with phase transition material
Qiang Li
Zhejiang University (China)

In this work, phase transition material as a dynamic element is deployed to enable dynamic emissivity modulation. By exploiting the hysteresis of VO2 partial phase transition, successive control of emissivity is partially achieved in this device which has shown spatial resolved multilevel emissivity modulation. The results of this work show potential applications of phase transition material based devices in the field of thermal information management in a feasible way.

11:30 : Invited talk

Narrowband Photothermal Converters for Infrared Sensors

Tadaaki Nagao, Anh Tung Doan, Thang Duy Dao, Satoshi Ishii, Hai Dang Ngo
National Institute for Materials Science (Japan)

We developed uncooled infrared detectors combined with spectroscopic perfect absorbers for wavelength-selective infrared detection. The MIM metamaterial IR sensors exhibit resolutions better than 1um with wide acceptance angles. By adopting Gires-Turnois (asymmetric Fabry-Perot) resonators and similar 1D structures composed of dielectrics and metal reflectors, resolution better than 50 nm was achieved in the mid infrared region. These designs can be adopted also to narrowband thermal emitters when it is fabricated with refractive dielectrics and conductive ceramics.

11:50 : Invited talk

Near-infrared selective thermal emitter for thermo-photovoltaic energy conversion system

Takashi Asano, Masahiro Suemitsu, Susumu Noda
Kyoto University (Japan)

We report a near-infrared selective thermal emitter based on rod-type Si photonic crystals, which can be operated at temperatures above 1300 K. A thermo-photovoltaic energy conversion system using this selective thermal emitter is also discussed.

12:10 : Invited talk

Thermal emission engineering with confined plasmons in semiconductors

Angela Vasanelli, S. Huppert, Y. Todorov, D. Gacemi, Carlo Sirtori
Ecole Normale Superieure (France)

Bulk plasmons are collective excitations of a three dimensional electron gas. Plasma waves undergo size confinement when they lay in a thin film with thickness smaller than their wavelength. The resulting confined plasmon modes are called Berreman or Ferrell - Berreman modes and they are coupled to free space radiation. In this talk we will present how the strong interaction of confined plasmons with the electromagnetic field has been exploited to engineer active and functional mid-infrared thermal emitters

Lunch

12:30 - 14:00

14:00 - 15:00 — IST Congress Center Auditorium

Session 2A28

Conference Tutorials III

Organized by: Ishwar Aggarwal

14:00 : Tutorial

The Electromagnetic Spectra of Ordinary Objects

Eli Yablonovitch
UC Berkeley (USA)

There is an aspect of Electromagnetics that has been somewhat overlooked. Common everyday objects can act as electromagnetic resonators. Indeed ordinary objects have a series of resonant frequencies extending from radio waves up to optical frequencies. These resonant modes can be modeled as LC circuits. Thus every object that we encounter is an LC resonator. Since LC circuits support ac currents, and since ac currents imply electron acceleration, they inherently radiate into the far-field.

15:00 - 16:00 — IST Congress Center Auditorium

Session 2A29

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Alexey Kuzmenko

15:00 : Invited talk
Non-invasive Bio-imager Based on Frequency-tunable Terahertz Plasmonics
Yukio Kawano
Tokyo Institute of Technology (Japan)

We report a frequency-tunable non-circular plasmonic structure for multi-frequency terahertz (THz) analysis on a sub-wavelength scale. Despite much interest in plasmon-based THz technologies, a main shortcoming of conventional devices is that they exhibit poor frequency-tunability in fixed structures. We here demonstrated that the frequency of THz plasmonic resonance is tunable according to the angle of polarization of the incident THz wave, which enhanced the flexibility in near-field THz applications. Biological and medical applications with this method are presented.

15:20 : Invited talk
Comparison of Plasmonic Response of Semiconductor Nanostructures with Spherical Symmetry and Their Prospect for Terahertz Applications
Thomas T. Y. Wong[1], Tao Shen[2], Zhijing Hu[3], Yanlin Li[1], Zi Wang[1]
[1] *Illinois Institute of Technology (USA),* [2] *Kunming University of Science and Technology (China),* [3] *Keysight Technologies, Inc. (USA)*

Electric polarization in three types of semiconductor nanoparticles are compared: bare particle, semiconductor core with dielectric shell, and its dual. Physical insight is drawn from the dipole moments and the equivalent circuits. Their possible role as impetus for development of components in terahertz frequency range is explored.

15:40 : Invited talk
Impact of plasmonic bowtie nanoantennas and nanocavities on the dynamics of nearby nanoemitters
Victor Pacheco-Pena[1], Ruben Alves[2], Miguel Navarro-Cia[2]
[1] *Newcastle University (United Kingdom),* [2] *University of Birmingham (United Kingdom)*

Metallic nanoparticles exert a strong influence on the electrodynamics and mechanical dynamics of nanoemitters in their vicinity. Transformation optics can provide analytical descriptions and physical insight on these scenarios. As a case of study, we discuss the use of conformal transformation to understand the nonradiative Purcell enhancement and the optical forces experienced by nanoemitters nearby bowtie nanocavities and nanoantennas.

14:00 - 16:00 — Auditorium VA1

Session 2A30

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Christophe Sauvan

14:00 : Invited talk
Large-parameter-space optimization of photonic crystal structures
Vincenzo Savona
Ecole Polytechnique Federale de Lausanne (Switzerland)

Using a hybrid stochastic-global optimization strategy, we optimize a silicon-on-air L3 PhC cavity to a quality

factor Q>80M, a buried Si/SiO2 PhC cavity to Q>10M, and a buried Si/SiO2 nanobeam cavity to Q>6M with a nanobeam length much shorter than existing optimized structures. These results open the way to a new class of optimized PhC designs for monolithic structures or low-index-contrast materials, holding promise for enhanced optical nonlinearity, sensing, and solid-state quantum optics.

14:20 : Invited talk
Dielectric nanostructures to enhance the efficiency of solar cells
Braulio Garcia-Camara, Eduardo Lopez-Fraguas, Mahmoud H. Elshorbagy, Ricardo Vergaz
Carlos III University of Madrid (Spain)

The recent results on multilayer solar cells and perovskite solar cells may revolve the photovoltaics field, but they still require light control strategies to optimize their performance. Dielectric nanostructures have the ability to efficiently control light at the nanoscale by directing or confining it. This has an enormous interest in several fields, and in particular in solar cells. This contribution pretends to summarize the latest results in this key topic in the fields of nanophotonic and energy harvesting.

14:40 : Invited talk
Optimal Design of Rectennas for IR Energy Harvesting
Ahmed Elsharabasy, Mohamed Bakr, M. Jamal Deen
McMaster University (Canada)

We present a novel approach to design efficient rectennas for IR energy harvesting. The rectenna is composed of a rectifying element and an antenna. Metal-insulator-metal (MIM) diode is used due to the ultra-fast conduction mechanism of the quantum tunneling. The impedance matching between the antenna and the diode, the diode's nonlinearity, and cutoff frequency represent challenges to achieve an efficient rectenna. An optimization algorithm is carried out to maximize the rectenna's efficiency taking into consideration the aforementioned challenges.

15:00 : Invited talk
A Graphene-Integrated Topological Insulator: Electrical Control of Terahertz Plasmon Polartions
Chihun In, Beom Kim, Hyunyong Choi
Yonsei University (Korea)

Collective oscillations of massless particles in two-dimensional (2D) Dirac materials offer an innovative route toward controlling low-energy quasiparticle resonances. Here, we report the experimental realization of electrically tunable 2D Dirac plasmon polaritons using a topological insulator (TI) in a proximity contact with gate-controlled graphene. In our integrated TI-graphene devices, the 2D Dirac plasmons in micro-patterned TI generate constant plasmon momenta at terahertz (THz) frequency, while the proximity-integrated graphene controls the TI Dirac plasmon polariton resonances.

15:20 : Invited talk
Self-assembled composite metamaterials for hydrogen sensing
Mazhar Ejaz Nasir, Wayne Dickson, Anatoly Zayats
King's College London (United Kingdom)

Hyperbolic metamaterials are playing a key role in the design of integrated deep-subwavelength biochemical sensors, nonlinear nanophotonic devices and magneto-optical applications. Here, we report novel composite metamaterials Au(Core)-Pd(shell) arrays, over large areas using an inexpensive and industrial-friendly self-organization technique. In reflection and transmission typically more than 30 % change has beeen observed with 2 % hydrogen, these changes are visible to the naked eye with conventional illumination of the sensing substrate.

15:40 : Invited talk
Destabilization of polariton condensates due to acousto-optic interactions
Alexey Yulin, Valery K. Kozin, Anton V. Nalitov, Ivan A. Shelykh
ITMO University (Russia)

We analyse the dynamics of the exciton-polaritons interactingwith sound waves propagating in the system. The polaritonsare excited by coherent optical pump. The stationarypolariton states are found and their stability is examinedby solving the corresponding spectral problem and by directnumerical simulations. It is found that the interactionwith the acoustic waves can destabilize the polariton condensates.The nonlinear stage of the instability is studiedby numerical simulations. A simple theory describing thestationary hybrid acousto-

polariton states are developed.

14:00 - 16:05 — Auditorium VA2

Session 2A31

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

Chaired by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

14:00 : Keynote talk
On the Search for Toroidal Order in Magnetic Materials
Manfred Fiebig
ETH Zurich (Switzerland)

Spontaneous long-range order of magnetic vortices is discussed as possible fourth form of primary ferroic order, called ferrotoroidicity. We define the underlying magneto-toroidal moment and discuss manifestations of the hallmark properties of ferroic order in magneto-toroidal materials: domains that are described by the orientation of an associated phase-transition-driving order parameter and that are switchable by a conjugate field. It turns out that 'magneto-toroidal metamaterials' are ideal for elucidating the nature of the ferrotoroidic order and its conjugate toroidal field.

14:30 : Invited talk
Nonlocal effects in piezoelectromagnetic metamaterials
Anatolii Konovalenko, Felipe Perez-Rodriguez
Benemerita Universidad Autonoma de Puebla (Mexico)

A homogenization theory for calculating the nonlocal effective parameters of piezoelectromagnetic crystals with any inclusion form and arbitrary Bravais lattice is proposed. The theory allows to describe the bulk photonic-phononic band structure even beyond the long wavelength limit. Applying the method of expansion into bulk modes, the theory can be used to study the propagation of coupled electromagnetic and sound waves in finite-size piezoelectromagnetic metamaterials.

14:50 : Invited talk
Theory of chiral transport in chiral crystals
Shuichi Murakami
Tokyo Institute of Technology (Japan)

In chiral crystals such as tellurium, we theoretically show that a current induces an orbital magnetization, similarly to solenoids. We can call this effect an orbital Edelstein effect. We show that this effect can be largely enhanced from a classical analogue. Moreover, we propose a similar effect for phonons. We show that a heat current in a chiral crystal induces a nonzero total angular momentum of phonons, and we evaluate this effect for tellurium by ab initio calculation.

15:10 : Invited talk
Chiral Metastructures and Bio-Assemblies: Plasmonic, Thermal and Hot-Electron Effects
Alexander Govorov[1], Larousse Khosravi Khorashad[1], Lucas V. Besteiro[2]
[1] *Ohio University (USA),* [2] *University of Electronic Science and Technology of China (China)*

Metamaterials and bio-assembled colloidal complexes incorporating metal and semiconductor nanocrystals exhibit strong optical absorption associated with exciton and plasmon resonances. When a system includes chiral molecules, Coulomb and electromagnetic interactions between excitons and plasmons are able to alter and enhance natural circular dichroism (CD) of chiral molecular dipoles. Strong CD signals also appear in purely plasmonic systems. In our theoretical approach, we model electromagnetic interactions between chiral and achiral building blocks using both classical and quantum formalisms.

15:30 : Invited talk
Spin waves in thin films and magnonic crystals with Dzyaloshinskii-Moriya interactions
Rodolfo Gallardo[1], David Cortés-Ortuno[2], Roberto Troncoso[3], Pedro Landeros[1]
[1] *Universidad Tecnica Federico Santa Maria (Chile),* [2] *University of Southampton (United Kingdom),* [3] *Norwegian University of Science and Technology (Norway)*

The influence of the Dzyaloshinskii-Moriya interaction (DMI) on the behavior of spin waves in thin ferromagnetic films is reviewed. During the last decade, it has been shown that such interaction produces non-reciprocal features on the spin-wave spectrum. More recently, the concept of a chiral magnonic crystal has been introduced, where the interfacial DMI is periodic. The effect of this periodicity includes flat bands, indirect gaps, and an unusual spin-wave evolution.

15:50 : The roles of 'superchirality', optical chirality dissipation and interference in biomolecular detection with chiral plasmonic structures
Cameron Gilroy[1], Shun Hashiyada[2], Kensaku Endo[3], Affar Shahid Karimullah[1], Laurence Barron[1], Horomi Okamoto[2], Yoshihiko Togawa[3], Malcolm Kadodwala[1]
[1] *University of Glasgow (United Kingdom),* [2] *The Graduate University for Advanced Studies (Japan),* [3] *Osaka Prefecture University (Japan)*

Chiral plasmonic nanostructures enable the sub-pg detection of biomaterials. Sensing capabilities are associated with the chiral asymmetry of near fields which can be greater than circularly polarized light, a property known as superchirality. We show that chiral sensing correlates to the thickness of a nanostructure which we reconcile with a previously unconsidered mechanism for the phenomenon. It involves the 'dissipation' of optical chirality into chiral material currents through the interference of fields generated by two spatially separated chiral modes.

14:00 - 15:55 — Auditorium VA3

Session 2A32

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

14:00 : Invited talk
Nanostructuring of functional polymers for the directed assembly of nano-objects and the integration of hybrid nanosources
Safi Jradi, Ali Issa, Hongshi Chen, Xiaolun Xu, Aurelie Broussier, Dandan Ge, Christophe Couteau, Sylvain Blaize, Renaud Bachelot
Technological University of Troyes (France)

In this work, we show a general strategy of directed assembly of nano-objects. This assembly concerns a wide range of colloidal nanoparticles including Gold, Silver, Iron Oxide, fluorescent polystyrene and CdSe/ZnS Quantum Dots. We show the possibility to integrate nano-emitters into plasmonic nano-antennas (gold nanocubes, nano-wires), optical waveguides and optical fiber tips with a spatially controlled manner.

14:20 : Invited talk
Photochemical properties of organic dye molecules under vibrational strong coupling regimes
Kosei Ueno
Hokkaido University (Japan)

The photochemical properties of dye molecules under vibrational strong coupling regimes have been studied by using plasmonic and microcavity structures which confines infrared light strongly. fluorescence lifetime apparently shortened with increasing of the electromagnetic field intensity of the optical modes, which implies the decreasing of non-radiative rate constant in the energy relaxation process accompanying with the acceleration of vibrational relaxation due to vibrational strong coupling.

14:40 : Invited talk

Revisiting Plasmonic Photocatalysts Based on Titanium Nitride Nanoparticles

Diane Rawach, Peipei Liu, Peikui Wang, Jerome Claverie
Université de Sherbrooke (Canada)

The use of plasmonic nanoparticles has been limited to noble metal NPs such as Au, Ag because they exhibit strong resonances in the visible region but have poor chemical and thermal stability and are costly. An alternative is the use of transition metals such as TiN NPs which exhibit strong resonances in the red, high mechanical strength, durability, thermal and chemical stability. We have combined TiO2 nanobelts coated with TiNx NPs to achieve an enhanced photodegradation photocatalyst.

15:00 : Invited talk

Laser photopatterning of metal oxide functional micro-nano-structures from precursor solutions

C. C. Yeh, S. Y. Yu, P. Y. Chang, B. Leuschel, D. Berling, A. Spangenberg, H. W. Zan, Olivier Soppera
CNRS IS2M Mulhouse France (France)

We present here our latest results on the laser direct writing of metal oxide micro and nanostructures. The key step is to develop photosensitive metal-oxo precursors solutions that can be patterned with high resolution. Stable solution of metal-oxo clusters were prepared by reaction between metal alkoxide precursors (Zn, Ti, Zr) and ligands (mostly carboxylic acids). These solutions were doped to tune the electrical or magnetic properties (In, Al, Co) and thin films were prepared by spin-coating.

15:20 : Invited talk

Two-Photon Excitation of Biomolecules using Mid-infrared Surface-Plasmon Polaritons confined on Metasurfaces

Iram T. Awan, Manoel M. P. Miranda Messias, Otavio Brito Silva, Euclydes Marega Junior
University of Sao Paulo (Brazil)

We explored the potential of using metasurfaces to excite and detect photoluminescence from biomolecules, in particular double-strained DNA (ds-DNA). The excitation of the genetic material placed over a metasurface can be mediated by surface plasmon polaritons (SPPs). In our case, two photon excitation (TPE) at 800nm was used to excited the molecule close by the metasurface generating spectral images recorded in the region of 400nm to 700nm. The plasmonic fields generated by the nanostructures also decreased the emission lifetime.

15:40 : Interface Design for Visible-Light Induced Photochemical Reactions Promoted by Refractory Transition Metal Nitride Nanoparticles Incorporated into TiO2 Matrix

Olga A. Baturina[1], Albert Epshteyn[1], Gregory T. T Forcherio[2], Alexander Govorov[3], Asher C. Leff[2], Andrew Purdy[1], Blake Sympkins[1]
[1] US Naval Research Laboratory (USA), [2] US Army Research Laboratory (USA), [3] Ohio University (USA)

Plasmonic nanoparticle (NP)-semiconductor interface plays crucial role in photocatalysis, in particular for separation of photo-generated carriers. Here, we explore two strategies to improve charge separation at the refractory transition metal nitride NP/TiO2 interface: creating a Schottky barrier between the NP and TiO2 by decorating the TiN core with a gold shell and application of an electric field at a ZrN NP/TiO2 interface. Photoelectrochemical methanol oxidation is used to probe both interfaces under visible excitation. Computational analysis supports experimental observations.

14:00 - 15:55 — Auditorium VA4

Session 2A33

Non-Hermitian Complex Systems: Photonics, Plasmonics and Metamaterials

Organized by: Konstantinos Makris, Ramy El-Ganainy and Sahin Ozdemir

Chaired by: Konstantinos Makris, Ramy El-Ganainy and Sahin Ozdemir

14:00 : Invited talk

Quasi-Normal-Mode Approach for Dissipative Systems - Classical and Quantum Regime
Kurt Busch
Humboldt-Universitat (Germany)

An approach is presented for modeling the response of localized electromagnetic resonators using quasi-normal modes, which represent the natural, dissipative modes of the resonators with complex frequencies. For many problems of interest in optics and nanophotonics, the quasi-normal modes constitute a powerful modeling tool, both in the classical and the quantum regime.

14:20 : Invited talk
Intensity fluctuations and mode correlations in strongly coupled nanolasers
A. M. Yacomotti[1], M. Marconi[1], A. Pan[2], F. Raineri[1], A. El Amili[2], J. A. Levenson[1], Yeshaiahu Fainman[2]
[1] *C2N Center for Nanoscience and Nanotechnology (France),* [2] *University of California San Diego (USA)*

We investigate second order correlations in a bimodal nanolaser and relate them with mode-intensity fluctuations. The modal cross correlation decreases from gi,j(2)=1 in the large photon number limit to gi,j(2)=2/3 in the 'mesoscopic' limit. This is the consequence of flat potential transitions at the origin of large intermode energy fluctuations. We experimentally verify such a limit and confirm the flat potential scenario by means of probability distribution measurements of the mode population imbalance.

14:40 : Invited talk
Port swithing and replication in cyclic non-Hermitian arrays
Blas M. Rodriguez-Lara[1], Benjamin Jaramillo Avila[2]
[1] *Escuela de Ingenieria y Ciencias (Mexico),* [2] *CONACYT-Instituto Nacional (Mexico)*

Abstract symmetries are a powerful framework to study propagation dynamics in photonic devices described by mode-coupling theory. We will show that the cyclic group can help us go beyond the nearest neighbor approximation in periodic multicore photonic devices. In addition, we will show that it is possible to design devices with cyclic composite symmetries that provide us with port replication. We will discuss how the cyclic repetition of a non-Hermitian dimer allows for port switching and replication.

15:00 : Proposal for a New Topological Laser
Xiao-Chen Sun, Xiao Hu
National Institute for Materials Science (NIMS) (Japan)

We propose theoretically to realize a ring laser based on honeycomb-type topological photonic crystals. Using the topological interface states as the cavity modes, we demonstrate a single-mode lasing over a large range of gain value. This lasing phenomenon is available up to frequencies of visible lights and is robust against disorders.

15:15 : Invited talk
PT-symmetric quantum optics
Friederike Ulla Johanna Klauck, Lucas Teuber, Marco Ornigotti, Matthias Heinrich, Stefan Scheel, Alexander Szameit
University of Rostock (Germany)

Photonics has become the primary testbed for Parity-Time-symmetric systems and a wide range of its implications in classical systems. However, the intersection between quantum optics and PT-symmetry remains largely uncharted. Here, we report the first observation of quantum interference achieved by entangled biphotons in lossy directional couplers. We observe the generalized version of the well-known Hong-Ou-Mandel, and find that the underlying non-trivial loss distribution systematically displaces photon bunching with respect to the Hermitian case, as predicted by our theory.

15:35 : Invited talk
Bloch-oscillations in a lattice with passive PT-symmetry
Eva-Maria Graefe, Bradley Longstaff
Imperial College London (United Kingdom)

A tight-binding lattice with losses from every other lattice site is considered. In the absence of losses, if a static tilt is applied to the lattice the continuous dispersion relation is replaced by discrete equidistant egenvalues that lead to periodic dynamics. In particular, an initially broad wave packet will perform the famous Bloch oscillations, effectively mapping out the band structure of the untilted system. The presence of losses leads to a number of intriguing changes explored here.

14:00 - 16:00 — Auditorium VA5

Session 2A34

Plasmonics and nano-optics

Chaired by: Péter Dombi

14:00 : Numerical Design of BioResonator with filtering Effect
Niloufar Raeis-Hosseini, C. Papvassiliou
Imperial College London (United Kingdom)

A bioinspired resonator based on a polysaccharide material for biodegradable nano-optics is designed and simulated. The device has a simple structure with a sandwiched spacer between two metal layers, which represents a resonating effect. Due to the biodegradability of the utilized material and its natural abundance it has potential to be fabricated in the large area. Base on simulation results, the proposed resonant optical device exhibits a narrow bandwidth absorber absorption and filtering effect.

14:15 : Biomechanical sensor based on gold plasmonic nanorods for mechanotransduction investigation
Maria Salbini[1], Tiziana Stomeo[1], Cristian Ciraci[1], Roberto Fiammengo[1], Vincenzo Mangini[1], Marco Leoncini[1], Filippo Pisano[1], Ferruccio Pisanello[1], Tiziano Verri[2], David Smith[3], Massimo De Vittorio[1]
[1] *Istituto Italiano di Tecnologia (Italy),* [2] *Universita del Salento (Italy),* [3] *Duke University (USA)*

We discuss the possibility of implementing a biosensing platform based on SPR for investigating mechanotransduction. The study about optical resonances caused by nanorods adsorbed on films, separated by a polyelectrolyte thin layer is presented. The devices were tested in order to be able to control in a dynamic way the layer thickness swelling. The control of the surface wettability allows adjusting the hydrophilic/hydrophobic character of the surface in order to make use of this effect for future applications.

14:30 : Self-beating during pulsed light transmitting through a plasmonic slit
Kuan-Ren Chen[1], Jian-Shiung Hong[1], Alex E. Chen[2]
[1] *National Cheng Kung University (Taiwan),* [2] *The Pennsylvania State University (USA)*

For explaining the physics puzzle, we discover a new physics of self-beating without nonlinearity, together with plasma effects. While a portion of the light pulse transmits through the slit as a sub-pulse, the rest is reflected at the exit, propagates a round-trip, and then reaches the exit again. These linear processes repeat. The superposition of sub-pulses with a phase delay in-between produces a periodic light that beats its original light frequency. Analytical models proposed agree well with simulations.

14:45 : Multi-polarized Nano-antenna for Surface Enhanced Raman Spectrescopy Application
Monir Morshed, Ahasanul Haque, Lei Xu, Andrey Miroshnichenko, Haroldo Hattori
University of New South Wales Canberra (Australia)

This article proposes a star gap quadrupole nano-antennas that can operate for both linear and circular polarizations. We have achieved the electric field enhancement of 27 and 37 for linear- and circular-polarized pump , respectively. The antenna is characterized using Raman spectroscopy which produce surface enhanced Raman scattering enhancement of 4.18x106 line for methanol.

15:00 : Metamaterials-based probing weak quantum absorber in coupled three-resonator system with guided wave surface plasmons: sensing or all-optical switching?
Alina Karabchevsky, Adir Hazan
Ben-Gurion University (Israel)

Compared to the traditional electronic switches, optical switches are not limited by thermal effects or electromagnetic interferences. Here we show metamaterials-based probing of weak quantum absorber in coupled three-resonator system which reveals the signature of optical switching. The polarization dependent probing of molecular overtones excited in a hybrid system tune the state: when the system is illuminated by transverse magnetic polarized light the switch is on while for the transverse electric polarized light the switch is off.

15:15 : Photon-plasmon coupling in microtubular optoplasmonic cavities
Yin Yin, Jiawei Wang, Libo Ma, Oliver G. Schmidt

Institute for Integrative Nanosciences, IFW Dresden (Germany)

Microtubular cavities, which are self-assembled from prestrained nanomembranes, can support optical whispering-gallery mode (WGM) resonances via light circulating in the tube wall. By coating plasmonic nanosturctures onto the microcavity surfaces, photon-plasmon coupling were investigated relying on the interaction of WGM resonant modes and surface plasmon resonances, which leads to many novel phenomena on optical tuning and potential applications. As a novel platform, our microtubular cavities imply promising applications for enhanced light-matter interactions, optical tuning, photonic integration and quantum optics.

15:30 : Double-interface surface plasmon modes in CdZnO thin films and their hybridization with phonons

Eduardo Martinez Castellano[1], Julen Tamayo-Arriola[1], Miguel Montes Bajo[1], Adelaida Huerta-Barbera[2], Elias Munoz[1], Vicente Munoz-Sanjose[2], Adrian Hierro[1]
[1] *Universidad Politecnica de Madrid (Spain),* [2] *Universitat de Valencia (Spain)*

CdZnO is a promising candidate to substitute metals in future IR plasmonic devices. As an approximation to plasmonic phenomena, we have studied the plasmonic modes present in an air-CdZnO-sapphire system. In thick samples, modes appeared to be asymptotically pinned to the single-interface plasmon frequency. Thinner layers showed an important coupling between both interfaces, with a strongly confined ENZ mode at high energies and a hybrid Surface Plasmon-Phonon mode at lower frequencies.

15:45 : Angle-insensitive mid-IR spectrum filter using slit nanoresonator structure

Evan M. Smith[1], Ivan Avrutsky[2], Shiva Vangala[1], Justin W. Cleary[1], Josh R. Hendrickson[1]
[1] *Air Force Research Laboratory (USA),* [2] *Wayne State University (USA)*

Transmission characteristics of a mid-infrared spectral filter are presented for a device based on metal films with resonant nano-cavities filled with high-index dielectrics. These resonances resemble those in Fabry-Perot resonantors and can yield high transmission with a narrow bandwidth. Importantly, the cavity slit resonance is decoupled from the plasmonic grating resonance, resulting in angular insensitivity for polarized light up to 60 degree incidence.

14:00 - 15:40 — Auditorium VA6

Session 2A35

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Eric Cassan

14:00 : Invited talk

Electrically Tunable Mirror Arrays for Spatial Modulation of Terahertz Radiation over a Wide Frequency Range

Jan Kappa, Dominik Sokoluk, Steffen Klingel, Corey Shemelya, Egbert Oesterschulze, Marco Rahm
Technische Universitat Kaiserslautern (Germany)

We experimentally demonstrated spatial terahertz wave modulation with a modulation contrast exceeding a value of 0.5 over a frequency working range from 0.97 THz to 2.28 THz. Due to its wide working range, the terahertz spatial light modulator is very well suited for spatially resolved terahertz spectroscopy based on the coded aperture imaging method.

14:20 : Invited talk

Quantum control of bosonic modes with superconducting circuits

Liang Jiang
Yale University (USA)

Bosonic modes are widely used for quantum communication and information processing. Recent developments in superconducting circuits enable us to control bosonic microwave cavity modes and implement arbitrary operations allowed by quantum mechanics – in particular, quantum error correction against excitation

losses. We investigate universal control of a single bosonic code with superconducting circuits, including unitary control, driven-dissipative control, holonomic dissipative control and quantum feedback control.

14:40 : Invited talk
Novel deep-learning-based techniques for design and optimization of photonic metastructures
Yashar Kiarashinejad, Sajjad Abdollahramezani, Mohammadreza Zandehshahvar, Omid Hemmatyar, Ali Adibi
Georgia Institute of Technology (USA)

A computationally efficient new approach based on deep-learning techniques for analysis, design, and optimization of electromagnetic nanostructures will be presented. Using the strong correlation among features of an electromagnetic design problem, deep-learning techniques are employed to considerably reduce the dimensionality of the problem and thus, the computation complexity, without imposing considerable error. The application of this technique to designing a series of photonic metastructures, especially a new class of on-demand reconfigurable optical metasurfaces will be discussed.

15:00 : Invited talk
Multiphysics simulations of active meta-surfaces
Dmitry N. Chigrin
RWTH Aachen University (Germany)

Phase-change materials (PCMs) provide excellent opportunities to alter electromagnetic response of artificial materials facilitating design of active and reconfigurable meta-surfaces. Theoretical description and design of PCM based reconfigurable meta-surfaces require a careful analysis of rich multiphysical phenomena associated with the phase transition at nano-scale in inhomogeneous environment. Here some aspects of multiphysics modelling of PCM based meta-surfaces are discussed.

15:20 : Invited talk
Current-Driven Plasmonic Instability in Graphene Metasurfaces for Terahertz Applications
Stephane A. Boubanga-Tombet[1], Deepika Yadav[1], Akira Satou[1], Wojciech Knap[2], Vyacheslav V. Popov[3], Taiichi Otsuji[1]
[1] *Tohoku University (Japan),* [2] *Int'l Research Laboratory CENTERA (Poland),* [3] *Russian Academy of Sciences (Russia)*

We explore current-driven plasmon dynamics including perfect transparency and light amplification in monolayer graphene metasurfaces. Current-induced complete suppression of the graphene absorption is experimentally observed in a broad frequency range followed by a giant amplification (up to $\sim$9 $\%$ gain) of an incoming terahertz radiation at room temperature.

14:00 - 14:45 — Auditorium EA1

Session 2A36

Nonlinear phenomena and topological photonics

Chaired by: Yuriy Mokrousov

14:00 : Long-lived Event Horizon Induced by Topological Phase Transition
Meng Kang[1], Huaqing Huang[2], Shunping Zhang[1], Hongxing Xu[1], Feng Liu[2]
[1] *Wuhan University (China),* [2] *University of Utah (USA)*

As a key to quantum gravity, Hawking radiation has attracted extensive interest in various analogue systems. However there remains debate on its experimental verification in promising analogs. One challenge is that a long-lived event horizon is difficult to achieve experimentally. Here we theoretically show a novel analog of Hawking effect based on topological phase transition from type-II to type-I Dirac cone, where their interface (type-III Dirac cone) acts as a stable event horizon.

14:15 : Nonlinear Optical Bleaching of a Monolayer of Au Plasmonic Coupled Nanoparticles and Percolation-like films with Nanoslits

Vladimir Kaydashev[1], Piero Ferrari[2], Pavel Timoshenko[3], Mikhail Shestakov[2], Ewald Janssens[2], Peter Lievens[2], Evgeni Kaidashev[3]
[1] *Moscow Institute of Physics and Technology (Russia),* [2] *KU Leuven (Belgium),* [3] *Southern Federal University (Russia)*

The optical transmittance of a monolayer of Au plasmonic coupled nanoparticles and percolation-like films with nanoslits is controlled from 54 % to 86 % and from 13 % to 54 %, correspondingly, upon excitation by intense nanosecond laser pulses.

14:30 : Superresolution Stimulated Raman Microscopy
Sergey Kharintsev[1], Anton Kharitonov[1], Aleksander Alekseev[2], Sergei Kazarian[3]
[1] *Kazan Federal University (Russia),* [2] *Nazarbayev University (Kazakhstan),* [3] *Imperial College London (United Kingdom)*

Titanium oxynitride (TiON), being metal-dielectric nano-composite ceramics, near the percolation threshold exhibits a double epsilon-near-zero (2-ENZ) behavior. It favours super-coupling of the incident laser light to surface plasmon resonances. In this work, we experimentally observe stimulated Raman gain emission from continuous and nano-structured TiON thin films exposed to low-power laser light. It is shown that super-resolution of $<\lambda/8$ in the far-field is achieved due to both the enhanced third-order optical nonlinearity and the multiplicative nature of four-wave mixing.

14:45 - 15:40 — Auditorium EA1

Session 2A37

Topology in photonic crystals, metamaterials, and metasurfaces: physics and design

Organized by: Yang Li and Benfeng Bai

Chaired by: Yang Li and Benfeng Bai

14:45 : Invited talk
Topological valley transport on the surface of biaxial hyperbolic metamaterials
Ruo-Yang Zhang, Che Ting Chan
Hong Kong University of Science and Technology (China)

On the iso-frequency surfaces of a homogeneous biaxial hyperbolic metamaterial, there exist four doubly degenerate diabolic points, which are protected by PT and mirror symmetries and can be utilized as valley degrees of freedom. By introducing chiral or gyroelectric material perturbations, we can lift the degeneracy at the diabolic points, and control the existence and chirality of the gapless Fermi arc at each valley. In particular, we can achieve topological valley-dependent helical transport for surface-arc waves.

15:05 : Invited talk
Observations of Polarization Vortices in Momentum Space
Yiwen Zhang[1], Ang Chen[1], Wenzhe Liu[1], Chia Wei Hsu[2], Bo Wang[1], Fang Guan[1], Xiaohan Liu[1], Lei Shi[1], Ling Lu[3], Jian Zi[1]
[1] *Fudan University (China),* [2] *Yale University (USA),* [3] *Chinese Academy of Sciences (China)*

The momentum space vortices were experimentally identified by their winding patterns in the polarization-resolved iso-frequency contours and their diverging radiative quality factors. Such polarization vortices, leading to high Q factor modes so called bound states in the continuum (BIC), can exist robustly on any periodic systems of vector fields, while they are not captured by the existing topological band theory developed for scaler fields.

15:25 : Topological edge modes in dielectric kagome photonic crystals
Stephan Wong[1], Matthias Saba[2], Ortwin Hess[2], Sang Soon Oh[1]
[1] *Cardiff University (United Kingdom),* [2] *Imperial College London (United Kingdom)*

Photonic topological insulators are promising as a new photonic platform due to the unidirectional edge states

insensitive to bendings and fabrication imperfections. A recently prososed all-dielectric perturbed honeycomb photonic crystal, however, intrinsically suffers from back-reflection due to the symmetry breaking at the interface. Here, we propose an all-dielectric photonic topogical insulator based on the kagome lattice geometry in which the topological edge modes do not undergo back reflection for termination along the /Gamma-K direction.

14:00 - 15:30 — Auditorium EA2

Session 2A38

Symposium III: Advanced passive and active metasurfaces

Organized by: Howard Lee and Din Ping Tsai

Chaired by: Howard Lee and Din Ping Tsai

14:00 : Invited talk
Alternative Plasmonic Materials for SERS and Metasurface Applications: Aluminum and Titanium Nitride
Shangjr Gwo
Academia Sinica (Taiwan)

Recently, we have developed epitaxial techniques to grow forming smooth, single-crystalline aluminum (Al) and titanium nitride (TiN) films on transparent sapphire substrates using molecular-beam epitaxy (MBE). In comparison to silver and gold, Al- and TiN-based plasmonics have better material stabilities and spectral responses in the ultraviolet (UV) and visible spectral regions, making them particularly suitable for UV surface-enhanced surface Raman spectroscopy (SERS), optical energy harvesting, and metasurface-based linear and nonlinear optics.

14:20 : Invited talk
Microfluidic Sensing and Dynamic Tuning with Huygens Metasurfaces
Adam J. Ollanik, Isaac O. Oguntoye, George Z. Hartfield, Brittany Simone, Yaping Ji, Matthew D. Escarra
Tulane University (USA)

Huygens metasurfaces have optical performance that is especially sensitive to perturbations in their geometry or constituent material properties. Here we take advantage of this sensitivity for both sensing and dynamic tuning applications. first, we show that silicon metasurfaces embedded in a microfluidic channel provide an affordable, customizable, and highly sensitive platform for refractive index sensing, with experimental transmittance response of 820 % T/RIU. Second, we show that by using VO2 for the antenna elements, we can create dynamically tunable metasurfaces.

14:40 : Invited talk
Ultralow-power thermo-optical switching in graphene metasurfaces
Joel Douglas Cox
University of Southern Denmark (Denmark)

We reveal a strong transient optical nonlinearity associated with plasmons in graphene nanoislands arising from the low graphene electronic heat capacity and manifesting in dramatic spectral shifts when a single plasmon quanta is absorbed. The present phenomenon consists in an ultralow-power all-optical switching mechanism for atomically-thin metasurfaces.

15:00 : Keynote talk
Utilizing plasmonic hot electrons for bridging top-down and bottom-up nanofabrication and for sub-wavelength absorption imaging
Stefan Maier
LMU Munich (Germany)

We demonstrate a novel approach towards the combination of top-down and bottom-up nanofabrication,

based on controlled modification of the surface functionalization of plasmonic nanoantennas facilitated by hot electron bond cleaving.

14:00 - 14:45 — Auditorium EA3

Session 2A39

Metamaterials for high-frequency applications

Chaired by: Pierre-Francois Brevet

14:00 : Synthetic Biological Approaches for the Fabrication of Optical Metamaterials
Simon Butler, Rebecca Seviour
University of Huddersfield (United Kingdom)

Conventional nanofabrication techniques lack the throughput and fidelity to create large scale metamaterial structures capable of operating in the optical regime. Synthetic biological approaches can create nanometer feature size DNA based nanostructures with throughput in the region of over a million individual constructs, per reaction, with high fidelity. We present a pathway for the design of arbitrary, via a modular DNA origami circuit/breadboard, and fabrication, of continuously metalised, 10 nanometer feature size structures by someone unfamiliar with the methodology.

14:15 : Utilization of Cross-Metamaterial Nano-Antenna to Expand the Light Absorption in the Active Layers of Organic Thin films
Yadgar Ibrahim Abdulkarim[1], Lianwen Deng[1], Fahmi F. Muhammad[2], Muharrem Karaaslan[3]
[1] *Central South University (China),* [2] *Koya University (Iraq),* [3] *Iskenderun Technical University (Turkey)*

A new broadband metamaterial absorber based on cross-shaped Nano-antenna was designed in order to improve the light absorption in organic active layers. According to the numerical analysis, the proposed structure has the capability to improve significantly to the light absorption in organic thin films and exhibited a broadband absorption characteristic in the visible and infrared spectrum of light. When cross Nano-antenna are coated on the top of the active layers, an obvious redshift along the optical absorption spectra was noticed.

14:30 : Blueshift in graphene-based hyperbolic metamaterials as a tunable narrowband reflection modulators
Alessandro Pianelli, Rafal Kowerdziej, Marek Olifierczuk, Karol Sielezin, Michal Dudek, Janusz Parka
Military University of Technology (Poland)

Here, we examine numerically the hyperbolic metamaterials based on graphene(1D-GHMM) in mid-IR frequencies. Using the ability to tune the hyperbolic dispersion of graphene-based HMM by varying the chemical potential, we report a tunable narrowband blueshift in reflectance, especially for different incidence angle in TE/TM modes. Furthermore, a type II and type I hyperbolic dispersion and an effective metal behavior are presented.

14:45 - 15:15 — Auditorium EA3

Session 2A40

Thermal metamaterials

Chaired by: Jean-Sebastien Bouillard

14:45 : Generalized Two-Temperature fitting Algorithm for Ultrashort Laser Heating of Metal films.
Paul Bresson[1], Jean-Francois Bryche[2], Julien Moreau[1], Mondher Besbes[1], Paul-Ludovic Karsenti[2], Denis Moreau[2], Paul Charette[2], Michael Canva[2]

[1] *Université Paris-Saclay (France),* [2] *Université de Sherbrooke (Canada)*

We have developed a numerical model and fitting algorithm which combined the classical two-temperature model, the thermal conduction phenomena and a 3D finite-Element-Method to link the spatial and temporal distribution of temperature to the transient optical response of a metallic sample heated by ultrashort laser pulse. Using a pump-probe setup, the spectro-temporal optical response of different thin gold films were quantitatively compared to our model. Study of the dependency and importance of the different model's parameters was also realized.

15:00 : Infrared metasurfaces for polarization control of thermal emission
Sergey A. Dyakov[1], **Nikolay A. Gippius**[1], **Sergei G. G. Tikhodeev**[2]
[1] *Skolkovo Institute of Science and Technology (Russia),* [2] *Lomonosov Moscow State University (Russia)*

The angular emission diagram and polarization of thermal radiation can be controlled by the emitter symmetry. In this work we study a chiral metasurface which has guided resonant modes in the middle infrared range. We demonstrate that due to the absence of a mirror symmetry of such metasurface, the thermally generated electromagnetic waves are circularly polarized.

15:15 - 15:45 — Auditorium EA3

Session 2A41

Laser and cavities

Chaired by: Abdelhakim Nafidi

15:15 : Mode cooperation in plasmonic lasers
Alexander A. Zyablovsky, Nikita Nefedkin, Evgeny Andrianov, Alexander Pukhov, Alexey Vinogravov
Dukhov Research Institute of Automatics (Russia)

We demonstrate that in a two-dimensional plasmonic DFB where the pumping spot is smaller than the laser surface, the nonlinear interaction between the laser modes via the active medium can result in a new effect, namely, mode cooperation. Mode cooperation arises due to non-orthogonality of the laser modes in the pumped area and leads to decrease their laser thresholds. In the plasmonic DFB mode cooperation results in broadening of the radiation pattern, which has been observed in recent experiments.

15:30 : Strong coupling and low, room temperature threshold in nanolasers using optical nanopatch antennas: an analytical and computational study
Patrick Bowen, Xander Deputy, Roberto Zecca, David R. Smith
Duke University (USA)

Despite major advances, nanolasers require either cryogenic temperatures or high thresholds. We demonstrate theoretically that optical nanopatch antenna lasers can yield thresholds orders of magnitude lower by enhancing the atom-cavity interaction into the strong coupling regime. This work presents the first analytic investigation of laser in film-coupled nanoparticles by expanding the optical field into quasi-normal modes. Ohmic, radiative, surface plasmon, and spontaneous decay channels are included analytically, and which allows structures to be optimized to minimize threshold.

14:00 - 14:30 — Auditorium EA4

Session 2A42

Dynamic metamaterials

Organized by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

Chaired by: Nicolo Maccaferri, Paolo Vavassori and Alexandre Dmitriev

14:00 : Thermomechanical behavior of a multistable phase-change/dielectric bimaterial cantilever in response to radiative heat flux
Marta Reina, Riccardo Messina, Philippe Ben-Abdallah
Université Paris-Saclay (France)

We study the thermomechanical behavior of a bimaterial cantilever made of a metal-insulator and a dielectric layer clamped on one of its ends to a wall at a fixed temperature and which interacts radiatively with two further reservoirs at two different temperatures. We show that with an appropriate choice of the three temperatures the cantilver has several stable stationary solutions, between which it can evolve by means of a local thermal excitation.

14:15 : Active Terahertz Superconducting Metamaterial-Based Modulator
Jingbo Wu, Chun Li, Caihong Zhang, Biaobing Jin
Nanjing University (China)

At terahertz (THz) frequencies, superconducting metamaterials offers a promising avenue for low loss and tunable THz functional devices. Using superconducting NbN film, we realized the THz wave modulation by biasing different voltage. The modulation speed is up to 1 MHz and is mainly limited by the slow thermal diffusion in metamaterials. To improve the performance of modulators, we further proposed a type of NbN-Au hybrid metamaterials. The THz modulator shows good prospect in cryogenic THz systems.

14:30 - 16:05 — Auditorium EA4

Session 2A43

Metasurface-based Light Sources, Modulators, and Detectors

Organized by: Yuanmu Yang and Benfeng Bai

Chaired by: Yuanmu Yang and Benfeng Bai

14:30 : Invited talk
Dynamic Formation of Ultra-Small Images via Metasurfaces
Khosro Zangeneh Kamali[1], Lei Xu[2], Jonathan Ward[1], Kai Wang[1], Guixin Li[3], Andrey E. Miroshnichenko[2], Dragomir Neshev[1], Mohsen Rahmani[1]
[1] *The Australian National University (Australia),* [2] *University of New South Wales (Australia),* [3] *Southern University of Science and Technology (China)*

A new technique to achieve image tuning in a reversible fashion by dielectric metasurfaces, composed of subwavelength silicon resonators, is demonstrated. We show that by controlling the temperature of a metasurface we can tune the encoded transmission pattern. To this end, we have designed and fabricated two sets of nanoresonators composed of non-concentric silicon disks with a hole that exhibit spectrally close sharp Fano resonances and forming a Yin-Yang pattern, with a full control on the contrast.

14:50 : Invited talk
Metasurface Based Arbitrary Polarization Control and Its Applications
Xianzhong Chen, Chunmei Zhang, Yuttana Intaravanne
Heriot-Watt University (United Kingdom)

Like amplitude and phase, polarization is a fundamental property of light, whose spatial distribution can be used to record, process and store information. Optical metasurfaces have shown unprecendented capability in the manipulation of the light's polarization profile, providing an unusual approach for image encryption. A novel metasurface platform has been demonstrated to hide an image into the polarization profile of a light beam.

15:10 : Invited talk
Tunable and Reconfigurable Mid-Infrared Metasurfaces
Clayton Fowler[1], Sensong An[1], Mikhail Y. Shalaginov[2], Yifei Zhang[2], Bowen Zheng[1], Hong Tang[1], Hang Li[1], Tian Gu[2], Juejun Hu[2], Hualiang Zhang[1]

[1] *University of Massachusetts Lowell (USA),* [2] *Massachusetts Institute of Technology (USA)*

High-index dielectric Huygens' metasurfaces offer a means to create compact, high-performance infrared optical devices such as lenses, filters, beam-deflectors, waveplates and so on for applications where quality components are difficult to come by. The functionality of such devices could be vastly expanded by creating reconfigurable designs that enable switching and dynamic behavior. We detail how to design reconfigurable Huygens' surfaces, demonstrate some devices operating in the mid-IR, and discuss technical challenges and possible future developments.

15:30 : Invited talk
Dielectric metasurfaces for holography, color printing and crypto-display
Junsuk Rho
Pohang University of Science and Technology (Korea)

In this talk, I will discuss recent progress of metasurfaces-based holography, color printing and cryptographic applications.

15:50 : High-dimensional vectorial metasurface holography
Lingling Huang[1], Ruizhe Zhao[1], Basudeb Sain[1], Qunshuo Wei[1], Chengchun Tang[2], Xiaowei Li[3], Thomas Weiss[4], Yongtian Wang[1], Thomas Zentgraf[1]
[1] *University of Paderborn (Germany),* [2] *Southern University of Science and Technology (China),* [3] *Beijing Institute of Technology (China),* [4] *University of Stuttgart (Germany)*

We demonstrate a novel method for achieving high-dimensional vectorial holography based on birefringent all-dielectric metasurfaces to explore the full capacity of polarization. By considering the anisotropy property and extra design freedom of rotation matrix, together with smart multiplexing algorithms for establishing quantified related phase profiles, high-dimensional multichannel polarization multiplexed holograms have been successfully achieved using the simplest nanofin as the building block. All combinations within twelve polarization channels in total can be obtained.

14:00 - 15:00 — Room 02.2

Session 2A44

Thermal-photonics for information and energy applications

Organized by: Qiang Li

Chaired by: Qiang Li

14:00 : Invited talk
Nanoscale Surface Thermal Hotspots of Vertical Antenna Arrays Activated by Mid-infrared Quantum Cascade Lasers
Andrea Mancini[1], Valeria Giliberti[2], Alessandro Alabastri[3], Eugenio Calandrini[4], Francesco De Angelis[2], Denis Garoli[2], Michele Ortolani[5]
[1] *Ludwig Maximilian University (Germany),* [2] *Istituto Italiano di Tecnologia (IIT) (Italy),* [3] *Rice University (USA),* [4] *Synchrotron SOLEIL (France),* [5] *Sapienza University of Rome (Italy)*

Vertical antenna arrays of few-micron height and pitch, illuminated with a tunable mid-infrared laser, provide intense electric field hotspots far from the solid substrate. These hotspots do not suffer from the high thermal conductivity of the substrate and therefore, if a material with resonant vibrational fingerprint is present, thermal hotspots are generated, with local temperature increase of up to 100 K. Applications in nanoscale thermophoresis, photocatalysis and remote energy transfer are envisaged.

14:20 : Invited talk
Photothermal epoxy curing with plasmonic nanoparticles: From modeling to experiments
Alessandro Alabastri[1], Adam Roberts[2], Jian Yang[1], Matthew Reish[3], Naomi Halas[1], Peter Nordlander[1], Henry Everitt[1]
[1] *Rice University (USA),* [2] *U.S. Army CCDC Aviation - Missile Center (USA),* [3] *Oak Ridge Institute of Science*

and Education (USA)

Epoxy materials are widely used for efficient bonding of composite materials. Plasmonic nanoparticles can be employed as heat source to improve curing of epoxies. We show how the nanoparticle-assisted photothermal curing is a four-stage process: a plasmonic temperature increase, a slow curing initialization, a temperature increase due to cured epoxy light absorption and a final stage that completes the chemical transformation. Experiments confirm predictions and demonstrate how the plasmon-assisted curing forms stronger bonds than conventional thermal curing.

14:40 : Invited talk
Tunable Infrared Perfect Absorption in Bismuth-based Nanostructures for Thermal Photonics
Rosalia Serna, Johann Toudert
Insitituto de Optica-CSIC (Spain)

Bismuth-based nanostructures present unique optical properties related with their giant near-infrared interband transitions. At longer wavelengths in the infrared, their giant refractive index and small extinction coefficient make them efficient light harvesters. In this presentation, we explore the potential of different kinds of bismuth-based nanostructures (nanospheres, nanocylinders and nanolayers) for achieving a spectrally tunable perfect absorption of light in the mid-to-far infrared and discuss the suitability of such nanostructures for thermal photonics.

15:00 - 16:00 — Room 02.2

Session 2A45

Metasurfaces and flat optics, FSS and HIS

Chaired by: Alberto Piqué

15:00 : Touching-dimer metagratings with high asymmetric diffraction in the full visible range
Tan Shi[1], Yujie Wang[1], Zi-Lan Deng[1], Shumin Xiao[2], Xiangping Li[1]
[1]*Jinan University (China),* [2]*State Key Laboratory on Tunable Laser Technology (China)*

We propose a kind of all-dielectric touching-dimer metagratings that can achieve flat-top broadband all-angle high asymmetric diffractions in visible light. High-diffraction light deflection is obtained by proper design of two touching pillars with various cross-section shapes in each unit-cell, without creating a discrete gradient-phase profile as traditional metasurfaces always do. The touching-dimer architecture is superior to many previous multiple scatters metagrating designs that are typically optimized at single wavelength, and is promising for many high-performance angle-controllable wavefront shaping applications.

15:15 : Singular Polaritonic Metasurfaces: Graphene and Beyond
Emanuele Galiffi, Paloma Arroyo Huidobro, John Brian Pendry
Imperial College London (United Kingdom)

We propose a new class of periodically modulated surfaces, which are able to couple light to surface polaritons over a continuum of frequencies by exploiting geometrical singularities in their subwavelength structure. We illuminate how this concept shares its roots with dimensional compactification in high-dimensional field theories, and demonstrate this effect on realistic platforms with plasmons in graphene and phonons in hexagonal boron nitride, paving a novel route towards broadband polaritonics.

15:30 : Computational Spectral Imaging with Metasurface-based, Pixel-scale Color Splitters
Masashi Miyata, Mitsumasa Nakajima, Toshikazu Hashimoto
NTT Device Technology Laboratories (Japan)

We present a single-shot multispectral imaging system using pixel-scale color splitters based on silicon nitride metasurfaces. We demonstrate that the system can computationally create multispectral images without the degradation of the signal levels and spatial resolution achievable in monochrome image sensors. These features are promising for developing high-sensitivity, high-spatial-resolution multispectral imaging system in an integrated device fashion.

15:45 : Hybrid achromats with metasurfaces for IR imaging
Philippe Lalanne
Université Bordeaux (France)

We report on the fabrication of hybrid achromats with metalenses for IR imaging.

Coffee Break and Exhibit Inspection

Session 2P2

Poster session IV

16:00 - 16:40

P1: Metasurface lasers based on resonant dark states
Sotiris Droulias[1], Thomas Koschny[2], Costas M. Soukoulis[2]
[1] *FORTH (Greece),* [2] *Iowa State University (USA)*

Recently our group proposed a metamaterial laser design, which enables the independent control of the stored energy and its outcoupling to radiation. The principle of operation is based on the excitation of a dark mode, i.e. a mode of zero net electric/magnetic moment that does not consequently radiate. With the aid of a small non-resonant scatterer, the dark mode is then coupled to radiation modes. Here we examine the proposed scheme in implementations that represent realistic experiments.

P2: Water-processable cellulose-based sacrificial layers for advanced nanofabrication
Camilla Dore[1], Juan Luis Garcia Pomar[1], Johann Osmond[2], Agustin Mihi[3]
[1] *ICMAB-CSIC (Spain),* [2] *ICFO (Spain),* [3] *ICMAB (Spain)*

In this work, we combine hydroxypropyl cellulose (HPC), a water soluble and biodegradable cellulose derivate, with nanoimprinting lithography (NIL).Using HPC as NIL resist we are able to pattern silicon wafers or fabricate metallic nanoparticle arrays in a straight forward process that requires only water as solvent.Furthermore, HPC sfree standing membranes that can be also suitable as support layer for transfer printing of nanostructured metal electrodes.

P3: Ultrafast response of a plasmonic distributed feedback laser in large-signal modulation regime
Nikita Nefedkin[1], Alexander Zyablovsky[1], Evgeny Andrianov[1], Alexander Pukhov[2], Alexey Vinogradov[2]
[1] *Dukhov Research Institute of Automatics (VNIIA) (Russia),* [2] *Institute for Theoretical and Applied Electromagnetics (Russia)*

The time response to an external signal is the main characteristic of optoelectronic devices which determines their maximum modulation speed. The use of plasmonic structures can significantly reduce the response time. In this paper, we show that the response time of a two-dimensional plasmonic DFB laser in the large-signal modulation regime strongly depends on the size of the pump beam. There is an optimal size of beam for which the modulation speed is a maximum, and can achieve THz.

P4: Optoelectronic Mixers Based on Graphene Photodetectors
Chuantong Cheng, Beiju Huang, Huan Zhang, Hengjie Zhang, Hongda Chen
Chinese Academy of Sciences (China)

We demonstrated a novel optoelectronic mixer based on graphene photodetector in this work. Considering the ultrahigh carrier mobility and the CMOS compatible fabrication routing, graphene material is a potential candidate for the next generation radio frequency applications.

P5: Tunable ferromagnetic resonance in coupled trilayers with crossed perpendicular and in-plane magnetic anisotropies
Daniel Marko[1], Fernando Valdes-Bango Garcia[2], Carlos Quiros Fernandez[2], Aurelio Hierro-Rodriguez[3], Maria Velez Fraga[2], Jose Ignacio Martin Carbajo[2], Jose Maria Maestro Alameda[2], David Schmool[1], Luis Manuel Alvarez-Prado[2]
[1] *Université Paris-Saclay (France),* [2] *Universidad de Oviedo (Spain),* [3] *University of Glasgow (United Kingdom)*

The effect of controllably coupling a hard magnetic NdCox film with perpendicular magnetic anisotropy to a soft magnetic Ni80Fe20 film with in-plane magnetic anisotropy through a non-magnetic Al spacer is investi-

gated. The most striking results of the coupling between both layers can be observed in their ferromagnetic resonance spectra, which, compared to a single Ni80Fe20 film, show a significant increase of the zero-field resonance frequency and, for low bias fields applied along the hard axis, also a frequency hysteresis.

P6: Second harmonic generation in graphene-based hyperbolic metasurface
Olga Kharitonova[1], Igor Bychkov[1], Maksim Usik[1], Vladimir Shavrov[2], Dmitry Kuzmin[1]
[1] *Chelyabinsk State University (Russia),* [2] *Kotelnikov Institute of Radio-engeneering and Electronics of RAS (Russia)*

In this work, the phenomenon of second-harmonic generation in a hyperbolic metasurface based on graphene strips was investigated. Existence of phase matching between surface plasmon-polaritons (SPPs) at fundamental and second harmonic frequencies was shown. The phase matching condition may be satisfied just for certain angles of SPPs propagation. The dependencies of this angle on frequency and filling factor are investigated.

P7: Classification of deformed photonic Dirac cones
Jungmin Kim, Sunkyu Yu, Namkyoo Park
Seoul National University (Korea)

We investigate the classification of photonic band structures in relation to the perturbed effective Hamiltonian for the Gamma-point eigenmodes and their eigenfrequencies. As an example, by top-down engineering the relative spectral distribution of monopole and dipole modes, we classify the modification of the Dirac dispersion. The behavior of wave phenomena inside the designed structure, such as anisotropic Dirac dispersion, will also be discussed.

P8: Efficiency improvement in wireless power transfer system using artificial magnetic conductors
Lijuan Dong, Fusheng Deng, Yanhong Liu, Lixiang Liu, Yunlong Shi
Shanxi Datong University (China)

In this paper, transfer performance improvement in wireless power transfer (WPT) system using a mushroom-type artificial magnetic conductors (AMC) is reported. Numerical simulations confirm that AMC possesses great power for enhancing the WPT efficiency between two nonresonant coils.

P9: Propagation of surface plasmon polaritons in silver nanowires placed on graphene
Aneta Prymaczek[1], Maciej Cwierzona[1], Justyna Grzelak[1], Dorota Kowalska[1], Marcin Nyk[2], Sebastian Mackowski[1], Dawid Piatkowski[1]
[1] *Nicolaus Copernicus University (Poland),* [2] *Wroclaw University of Science and Technology (Poland)*

We investigate a hybrid nanostructure consisting of a single silver nanowire placed on graphene, and with one end being locally decorated by a small amount of colloidal nanocrystals. We show how the propagation length of SPPs can be controlled by a graphene substrate and affects the up-conversion process in nanocrystals coupled with the metallic nanowire. Such structures are of particular interest because they can provide a platform for new applications in photovoltaic devices and various sensor architectures.

P10: Generation of the Robust and Low Loss Diffration-free Bloch Surface Wave
Ruxue Wang, Douguo Zhang, Aimin Wu
Chinese Academy of Sciences (China)

In this report, we present a diffraction-free Bloch Surface Wave in an aqueous environment sustained on all-dielectric multilayers with two crossed gratings or silver nanowires. It can propagate in a straight line for distances longer than 110 μm at a wavelength of 633 nm and could be applied as an in-plane optical virtual probe. Its robustness and long diffraction-free distance to multiple obstacles make this wave ideal for certain applications in bio-photonics and chip-level optical interconnections.

P11: BIC-inspired nonradiating states under structured light illumination
Lei Xu[1], Lujun Huang[1], Mohsen Rahmani[2], Khosro Zangeneh Kamali[2], Rocio Camacho-Morales[2], Matt Wolley[1], Dragomir Neshev[2], Andrey E. Miroshnichenko[1]
[1] *University of New South Wales (Australia),* [2] *The Australian National University (Australia)*

We propose a novel approach to confine light into isolated silicon nanodisk with high-quality (Q) factor electric dipole (ED) or magnetic dipole (MD) states with suppressed scattering inspired by the mechanism of the symmetry-protected bound state in the continuum (BIC). We demonstrate the efficient optical excitation of such states under structured beam illumination. Owing to the strong near-field enhancement, such quasi-BIC

state opens a novel opportunity for boosting nonlinear optical processes.

P12: Quasicrystal Photonic Metasurfaces for Radiation Control of Second Harmonic Generation
Yutao Tang[1], Junhong Deng[1], King Fai Li[1], Mingke Jin[1], Jack Ng[2], Guixin Li[1]
[1] *Southern University of Science and Technology (China),* [2] *Hong Kong Baptist University (Hong Kong)*

Nonlinear optical quasicrystal metasurfaces to control the radiation of the second harmonic generation (SHG) will be presented. The metasurfaces are based on the geometric phase controlled plasmonic meta-atoms with local rotational symmetry, which are ordered quasiperiodically according to two quasicrystalline tilings. We found that the far field radiation of SHG waves are determined by both the tiling schemes and the local symmetry of meta-atoms. The proposed concept may open new avenues for designing nonlinear optical sources with metasurface crystals.

P13: Beam Steering Chip based on VCSEL
Guanzhong Pan[1], Chen Xu[1], Weiling Guo[1], Baolu Guan[1], Beijv Huang[2], Hongda Chen[2]
[1] *Beijing University of Technology (China),* [2] *Chinese Academy of Sciences (China)*

Beam steering devices have wide applications in both military and civil fields. The ultimate goal for such devices is to reduce their size, weight, and power consumption. A novel electrically controlled micro beam-steering chip based on coherently coupled VCSEL array integrated with liquid crystal optical phased array was achieved. One-dimensional beam steering was successfully realized. Such a highly integrated beam steering system has high compactness, small size, simple packaging, which could be transformative for various sensing and imaging applications.

P14: Photonic crystal bead 2D code patterns based on microfluidic 3D printing
Xiang-Yun Du, Zhijie Zhu, Chang Liu, Qing Li, Su Chen
Nanjing Tech University (China)

A novel method for facile preparation of photonic crystal (PCs) bead two-dimensional (2D) code patterns through microfluidic 3D printing technology is developed. Poly(styrene-methyl methacrylate-acrylic acid)-CdTe/ZnS (P(St-MMA-AA)-CdTe/ZnS) hybrid microspheres with structure color and fluorescence are prepared by conjugating P(St-MMA-AA) and CdTe/ZnS quantum dots (QDs) using PAMAM dendrimers as bridges. This work open a promising way for the fabrication of multi-signal 2D code patterns with structural color and fluorescent properties, which has potential application in anti-counterfeiting and optoelectronic field.

P15: Versatile Functionalized Photonic Crystals and Their Self-Assembly Applications through Chip Microfluidic Technology
Chang Liu, Xiang-Yun Du, Zhijie Zhu, Qing Li, Su Chen
Nanjing Tech University (China)

Through microfluidics and chips a variety of particles self-assembled more complex shapes, anisotropic nature, and diverse functionalities. We group develop an available magnetic-directed assembly strategy to construct a series of molecular-analogue photonic crystal cluster particles involving dot, line, triangle, tetrahedron, and triangular bipyramid configurations from solid-liquid Janus building blocks. These versatile multiplex molecular-analogue structural clusters can open a new promising access to a variety of robust hierarchical microstructural particle materials.

P16: Angle-Independent Structural Colors for Personal Thermal Management
Zhijie Zhu, Xiang-Yun Du, Chang Liu, Qing Li, Su Chen
Nanjing Tech University (China)

Recently, bottom-up assembly of colloidal particles into structural colors represent a major research interest of optical devices for coating, sensing, and display. Herein, inspired from membrane separation processes, we develop a membrane separation-assisted assembly (MSAA) strategy for the preparation of angle-independent structural colors. The process is carried out by separating between water and solid particles in colloidal latex, allowing them to facilely form amorphous structures with robust functions.

P17: Super-cell Geometric Phase Metasurface for Multispectral Imaging
Bo Qiang[1], Jie Deng[2], Xiao Siong Tang[2], Soo Seng Ang[2], Jing Hua Teng[2], Qi Jie Deng[1], Qian Wang[2]
[1] *Nanyang Technological University (Singapore),* [2] *A*STAR (Singapore)*

A metasurface is designed to combine the generation of a focused beam and a vortex beam in the same imaging plane which can be used for super-resolution imaging in STED microscopy. It is composed of sub-micron

sized nanobar array to modulate the phase of the multi-spectral incident light locally. With this metasurface, the STED imaging system will be greatly simplified, and there is no need to align the two beams with high precision in the same optical path.

P18: Polarization and diffraction engineering of nonlinear dielectric metasurfaces
C. Gigli[1], G. Marino[1], S. Suffit[1], G. Patriarche[2], G. Beaudoin[2], K. Pantzas[2], I. Sagnes[2], I. Favero[2], G. Leo[1]
[1] *Université Paris Diderot and CNRS (France),* [2] *Université Paris-Sud/Paris-Saclay (France)*

We demonstrate the control of the polarization state in the second harmonic generated by periodic nanostructures. The knowledge of Mie-resonances in single dielectric nanoantennas enables to exploit their scattering features to design the polarization state of the harmonic field. We fabricate AlGaAs-on insulator nonlinear metasurfaces allowing to decouple polarization and diffraction features obtained by single resonators.

P19: Tunable Infrared Energy Transfer through Surface Phonon Polaritons
Mohsen Janipour[1], Matthias Hensen[2], Walter Pfeiffer[1]
[1] *Universitat Bielefeld (Germany),* [2] *Universitat Wurzburg (Germany)*

Realizing and designing switchable cavities in order to establish effective communication between two large distance separated points at the infrared frequencies is crucial for achieving novel integrated photonic circuits. In the infrared and terahertz regime, polar dielectrics can support propagation of surface phonon polaritons with the ability of tuning through carrier concentration. In this context, we investigate a tunable heterojunction elliptical cavity for efficient energy transfer through coupled surface phonon-plasmon polariton modes.

16:40 - 18:50 — IST Congress Center Auditorium

Session 2A46

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Mario Silveirinha

16:40 : Keynote talk
Metasurfaces for sensing and imaging
D. Conteduca[1], I. Barth[1], J. Juan-Colas[1], Steve Johnson[1], E. R Martins[2], Thomas F. Krauss[1]
[1] *University of York (United Kingdom),* [2] *University of Sao Paolo (Brazil)*

Recent developments in metasurfaces, including the phenomenon of bound states in the continuum (BIC) have injected a new dynamics into the paradigm of guided mode resonances for sensing and imaging applications. We will discuss and compare the various geometries, both dielectric and plasmonic, introduce our silicon nanohole approach and demonstrate its superiority in terms of surface sensitivity, which is a key metric for label-free optical sensors yet one that is rarely discussed.

17:10 : Invited talk
Subwavelength polarization optics using helical travelling-wave nanoantennas
Mengjia Wang[1], Roland Salut[1], Huihui Lu[2], Miguel Angel Suarez[1], Nicolas Martin[1], Thierry Grosjean[1]
[1] *University Bourgogne Franche-Comte (France),* [2] *Jinan University (China)*

We present and demonstrate the concept of a helical travelling-wave nanoantenna (HTN) consisting of a tiny gold-coated helix end-fired with a rectangular aperture nanoantenna. The resulting non-resonant nanoantenna produces a background-free directional light beam of tunable polarization and intensity by swirling surface plasmons and taking advantage of optical spin-orbit interaction. Taken as individual or coupled nanostructures, HTNs lead to subwavelength polarization optics which provide new degrees of freedom in light polarization control.

17:30 : Invited talk
Mid IR Dirac-cone dispersion relation materialized in SOI photonic crystal slabs

Yuanzhao Yao, Naoki Ikeda, Takashi Kuroda, Takaaki Mano, Hiromi Koyama, Yoshimasa Sugimoto, Kazuaki Sakoda
National Institute for Materials Science (Japan)

We materialized the isotropic Dirac-cone dispersion relation in the mid infrared range by electron beam lithography of SOI (silicon-on-insulator) wafers. The dispersion relation was examined by the angle-resolved reflection spectra, which showed a good agreement with numerical calculation and the selection rule derived from the symmetry of the Dirac-cone modes.

17:50 : Invited talk
3D Porous Silicon Gradient Refractive Index Micro-Optics and Waveguides
Paul V. Braun
University of Illinois at Urbana-Champaign (USA)

Via electrochemical etching of silicon, various nanophotonic elements, including flat lenses, photonic nanojet generators, Bragg mirrors, polarization sensitive optical splitters and structures with nearly arbitrary refractive index distributions were formed. The conversion from silicon to silica and titania enabled the optics to operate in the visible with minimal loss, something particularly important for visible light applications. A detailed model was developed which enabled tight control over optical properties based only on the electrochemical etch conditions.

18:10 : Invited talk
Local Symmetries in Wave Mechanics: From Fundamentals to first Applications
Peter Schmelcher
Universitat Hamburg (Germany)

The concept of local symmetries which hold only in spatially limited domains is developed. Decomposing space into domains where different local symmetries hold a novel layer of complexity is derived. This way the parity and Bloch theorems are generalized to the case of broken global symmetry [1]. Local inversion or translation symmetries are shown to yield invariant currents that characterize wave propagation. These currents map the wave function from an arbitrary spatial domain to any symmetry-related domain.

18:30 : Invited talk
Long-range FRET-mediated exciton diffusion in cesium lead halide perovskite nanostructures
Monica Lorenzon[1], Anna Loiudice[2], Edward S. Barnard[1], Nicholas J. Borys[1], Matthew J. Jurow[1], Min Ji Hong[1], Yi-Hsien Lu[1], Igor Rajzbaum[1], Edward K. Wong[1], Miquel Salmeron[1], Yi Liu[1], Stefano Cabrini[1], Stephen Whitelam[1], Raffaella Buonsanti[2], Adam M. Schwartzberg[1], Erika Penzo[1], Alexander Weber-Bargioni[1]
[1] Lawrence Berkeley National Laboratory (USA), [2] Ecole Polytechnique Federale de Lausanne (EPFL) (Switzerland)

Colloidal inorganic perovskite nanocrystals (PNCs) are solution-processable functional materials whose emission can be easily tuned via both size and composition.1 Their exciting optical properties such as the large absorption cross-section and high photoluminescence quantum yield (PLQY) make them ideal candidates for a broad range of photonics and optoelectronics applications.2 In this work, we present an overview of the exceptionally efficient exciton transport mediated by Forster Resonant Energy Transfer (FRET) in perovskite systems of increasing dimensionality.

16:40 - 19:00 — Auditorium VA1

Session 2A47

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Matthew Sheldon

16:40 : Invited talk

Photon drag of Bose-Einstein condensates

M. V. Boev[1], A. E. Miroshnichenko[2], V. M. Kovalev[1], I. G. Savenko[3]
[1] *Novosibirsk State Technical University (Russia),* [2] *University of New South Wales (Australia),* [3] *Center for Theoretical Physics of Complex Systems - IBS (Korea)*

We report on the photon drag effect of Bose-Einstein condensates, occurring in systems containing Bose-Einstein-condensed particles, possessing an internal structure of quantum states. We find that the drag results in a flux of particles constituting both the condensate and the excited states. The response of the system acquires step-like behavior as a function of frequency with the elementary step determined by the internal energy structure of the particles.

17:00 : Invited talk

Minimal Designs of Lorentz Non-reciprocal Metasurfaces and 'Diatomic' Resonator Arrays

Wenyan Wang, Wang Tat Yau, K. F. Lee, Jin Wang, Kin Hung Fung
The Hong Kong Polytechnic University (Hong Kong)

In this talk, I will present the recent progress of my group in the design of Lorentz nonreciprocal metasurfaces and related dimer resonator arrays. Anomalous resonance transmission features in these systems will be discussed.

17:20 : Invited talk

Cooperative emission mediated by energy transfer to plasmonic antenna

Tigran V. Shahbazyan
Jackson State University (USA)

We describe a new cooperative mechanism of spontaneous emission by an ensemble of quantum emitters near a plasmonic nanostructure based on cooperative energy transfer to plasmonic antenna from collective states formed due to plasmonic correlations.

17:40 : Invited talk

Advances in Sub-Wavelength Nanophotonic Devices

Jian Wang
Huazhong University of Science and Technology (China)

In this talk, we review recent progress in sub-wavelength nanophotonic deivces and their wide applications. We discuss a variety of sub-wavelength structures on different platforms (silicon, metal, fiber): 1) microring resonator and photonic crystal nanocavity for linear and nonlinear optical signal processing, 2) slot, hybrid plasmonic slot and sub-wavelength slot waveguides for on-chip optical interconnects, 3) surface grating structures, plasmonic and dielectric metasurfaces for spatial light manipulation. The demonstrations show impressive performance in diverse implementations of sub-wavelength nanophotonic devices.

18:00 : Invited talk

Hyperbolic meta-antennas: a new way to manipulate absorption and scattering of light towards biomedical applications

Nicolo Maccaferri[1], Yingqi Zhao[2], Marzia Iarossi[2], Tommi Isoniemi[2], Daniel Darvill[2], Antonietta Parracino[2], Giuseppe Strangi[3], Francesco De Angelis[2]
[1] *University of Luxembourg (Luxembourg),* [2] *Istituto Italiano di Tecnologia (Italy),* [3] *Case Western Reserve University (USA)*

We report about unconventional optical properties of metal-dielectric meta-antennas supporting type II hyperbolic dispersion, which enable almost pure and spectrally separated absorption and scattering channels in the visible/near-infrared spectral range. Our findings open the pathway towards novel routes for exploiting light to energy conversion channels beyond what is offered by current plasmon-based architectures, possibly enabling applications including thermal emission manipulation, thermoplasmonics-based theragnostic nano-devices, novel nano-antenna designs and plasmon-enabled enhanced molecular spectroscopy.

18:20 : Invited talk

Arbitrary Tuning of the Isotopic Hydrogen Evolution Reactions

Hiro Minamimoto, Ryo Osaka, Kei Murakoshi
Hokkaido University (Japan)

The hydrogen evolution reaction in the mixed solution of H2O and D2O has been investigated on the nanostructured electrodes using the electrochemical mass spectroscopy system. Using well-defined nano-structures,

we have demonstrated the precise control of the isotopic selectivity on the hydrogen evolution reactions.

18:40 : Invited talk
Super-Periodic Liquid Crystal Metasurfaces
Maxim V. Gorkunov[1], Alexey V. Kondratov[1], Irina V. Kasyanova[1], Vladimir V. Artemov[1], Alena V. Mamonova[1], Alexander A. Ezhov[2], Serguei P. Palto[1]
[1] *FSRC - Crystallography and Photonics (Russia),* [2] *Lomonosov Moscow State University (Russia)*

We study liquid crystal metasurfaces self-assembling on polymer layers patterned by focused ion beam, which are capable of strong visible light diffraction with millisecond fast electro-optical control. To improve the efficiency of diffraction into a particular channel, we propose super-periodic metasurface designs generated by a multiparametric optimization algorithm.

16:40 - 19:00 — Auditorium VA2

Session 2A48

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

16:40 : Invited talk
Optical properties of plasmonic spiked particles as a function of their size and shape
Ramon A. Alvarez-Puebla
ICREA-Universitat Rovira i Virgili (Spain)

Here we discuss the advantages of using different spiked particles for photonic and sensing applications including distant excitation, direct sensing and bioimaging through the use of encoded particles.

17:00 : Invited talk
Hybrid Plasmonic Nanomaterials for Uranyl Detection
Hoa Phan, Amanda J. Haes
University of Iowa (USA)

Reproducible detection of uranyl, an important biological and environmental contaminant, from complex matrices by surface-enhanced Raman scattering (SERS) is successfully achieved using hybrid plasmonic nanoparticles. Traditionally, non-specific binding of interfering species limits detects of molecules such as uranyl. Herein, this is overcome using materials design and rigorous sample analysis workflow design. Synergistic approaches for uranyl isolation and SERS detection is promising for real-world sample detection and eliminates the need of radioactive tracers and extensive sample pretreatment steps.

17:20 : Invited talk
Multistructured metallic substrate: a promising SERS platform for detecting trace molecules
Mathieu Edely[1], Nicolas Delorme[1], Guy Louarn[2], Ludovic Douillard[3], Jean-Francois Bardeau[1]
[1] *Le Mans Université (France),* [2] *Université de Nantes (France),* [3] *Institut des Molécules et Matériaux du Mans (France)*

An efficient methodology based on scanning probe lithography technique to design complex metallic nanostructures on rigid or flexible substrates will be presented. As the ability to control the 3D arrangement of gold nanostructures is of prior interest for plasmonics and surface-enhanced optical techniques we explored the potential of the substrate for biosensing and in particular for SERS measurements.

17:40 : Invited talk
Super-hydrophobic Surface-enhanced Raman Scattering platform
In Yee Phang
*A*STAR (Singapore)*

In this seminar, I will present our team's effort in fabricating a stable super-hydrophobic surface-enhanced Raman Scattering (SH-SERS) platform for trace molecular sensing. Our protocol is a general method that provides a simple, cost-effective approach to develop a stable and uniform superhydrophobic SERS platform for trace molecular sensing.

18:00 : Invited talk
Surface-enhanced resonant Raman scattering and surface-enhanced fluorescence spectra of a strong coupling system between plasmon and molecular exciton
Tamitake Itoh
National Institute of Advanced Industrial Science and Technology (AIST) (Japan)

Surface-enhanced resonant Raman scattering (SERRS) and surface enhanced fluorescence (SEF) from single silver nanoparticle dimers under strong coupling regimes are investigated. Enhancement and quenching factors are derived from Purcell factors, which are estimated by coupling energies obtained from the spectral changes in plasmon resonance based on a coupling oscillator model. The reproduced SERRS spectra are consistent with the experimental ones. The calculated SEF spectra reproduce the experimental ones by assuming transitions from ultra-fast SEF to conventional SEF.

18:20 : Invited talk
Structural Alteration of Genomic DNA upon Interaction with Silver Nanoparticles
Luca Guerrini
Universitat Rovira I Virgili (Spain)

The cooperative binding of cationic silver nanoparticles and duplex nucleic acids can alter the structural properties of the double-helix leading to strand separation. Still, the exact determinants and underlying mechanisms leading to such perturbation remain unclear. Here, we highlights new fundamental insights in this process by tackling the role of key variables, mainly surface charge and size/geometrical arrangement of DNA/nanoparticle clusters.

18:40 : Invited talk
In Situ Surface-Enhanced Raman Spectroscopic Study of Chemical Reactions on Bifunctional Nanoparticles
Wei Xie
Nankai University (China)

Characterization of reactions catalyzed by nanoparticles (NPs) is challenging because the chemical transformation occurs only at the catalytic interfaces, where the many different components are difficult to separate and purify. Therefore, surface-selective analytical methods are required to monitor the reactions directly on the NP surface. Here, we show the use of surface-enhanced Raman spectroscopy (SERS) for in situ monitoring of catalytic reactions on bifunctional NPs.

16:40 - 18:00 — Auditorium VA3

Session 2A49

Symposium III: Advanced passive and active metasurfaces

Organized by: Howard Lee and Din Ping Tsai

Chaired by: Howard Lee and Din Ping Tsai

16:40 : Invited talk
Recent Advances in Mid-Infrared Graphene Plasmonics: Metasurface for Complex Amplitude Modulation and Compact Waveguide Switch
Sangjun Han[1], Seyoon Kim[1], Sergey Menabde[1], Victor Brar[2], Harry Atwater[3], Min Seok Jang[1]
[1]*Korea Advanced Institute of Science and Technology (KAIST) (Korea),* [2]*University of Wisconsin-Madison (USA),* [3]*California Institute of Technology (USA)*

Tunable plasmonic modes offered by graphene provide new opportunities to create electo-optically active

devices with novel characteristics that have thus far been impossible to be realized by using conventional media. Here we introduce two recent theoretical research results in mid-IR graphene plasmonics: (1) Dynamic complex amplitude modulation in graphene-based metasurfaces and (2) modulated resonant transmission of graphene plasmons across a deep-subwavelength plasmonic waveguide gap.

17:00 : Invited talk
Electrically-pumped Vertical Cavity Metasurface-Emitting Lasers for directional lasing emissions
Yiyang Xie[1], Peinan Ni[2], Gauthier Briere[2], Qiuhua Wang[1], Zhuangzhuang Zhao[1], Chen Xu[1], Qiang Kan[3], Hongda Chen[3], Patrice Genevet[2]
[1] *Beijing University of Technology (China),* [2] *Université Cote d'Azur (France),* [3] *Chinese Academy of Sciences (China)*

Vertical cavity metasurface-emitting lasers (VCMELs) have been proposed and designed into back-emitting configuration. We have demonstrated that the integration with metasurface allow the effective control of the lasing emission wavefront.

17:20 : Invited talk
Highly-Confined Surface Phonon Polaritons in Semiconductor Metamaterial Interfaces
Alexander M. Dubrovkin, Bo Qiang, Nikolay I. Zheludev, Qijie Wang
Nanyang Technological University (Singapore)

We demonstrate that owing to highly-confined surface phonon polaritonic modes, the interfaces between ultra-thin germanium layers and silicon carbide substrate can be used for building diverse mid-IR photonic elements and metamaterials with small on-chip footprints at deeply subwavelength scale. We show that the unique dispersion of the interface phononic modes enables efficient resonant tuning of the optical response by small changes in the layer thickness and composition, as well as in the operation frequency of the device.

17:40 : Invited talk
Plasmonic open systems: theory and applications
Shiyi Xiao[1], Jing Lin[2], Meng Qiu[2], Xiyue Zhang[2], Huijie Guo[2], Lei Zhou[2]
[1] *Shanghai University (China),* [2] *Fudan University (China)*

We present a bottom up coupled-mode-model from first principles (Maxwell's equations) to study the plasmonic open systems, where, all coupling parameters can be calculated by a directly integration of different optical modes. Based on this theory, we establish phase diagrams to systematically study the whole picture of optical response of interested systems. For example, designing meta-surface to realize wide-band optical transparent window (OTW) with diminished transmittance fluctuations.

18:00 - 19:15 — Auditorium VA3

Session 2A50

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Andrei Faraon

18:00 : Invited talk
Photocontrollable dynamic chirality in plasmonic nanoassemblies
Rongyao Wang[1], Wenjing Zhao[1], W. Zhang[1], X. Wu[2], X. D. Zhang[1]
[1] *Beijing Institute of Technology (China),* [2] *National Center for Nanoscience and Technology (China)*

Reversible photocontrol of dynamic chirality in self-assembly systems is of great importance in exploitations of artificial nanomachines for scientific and industrious applications1-4. In this talk, we present a new method to achieve controllable chiral switching and selection in plasmonic nanoassemblies. We show here how light enables the switching between opposite chiral states of plasmonic dimers, and how can the light polarization and frequency be regulated to achieve a selectable chirality amplification in the grown plasmonic nanoassemblies.

18:20 : Invited talk
Flexible control of silicon Bragg grating filters enabled by sub-wavelength and modal engineering
Dorian Oser[1], Xavier Le Roux[1], Florent Mazeas[2], Diego Perez-Galacho[3], Daniel Benedikovic[1], Elena Duran-Valdeiglesias[1], Vladyslav Vakarin[1], Olivier Alibart[2], Pavel Cheben[4], Sebastien Tanzilli[2], Laurent Labonte[2], Delphine Marris-Morini[1], Eric Cassan[1], Laurent Vivien[1], Carlos Alonso-Ramos[1]
[1] University Paris-Saclay (France), [2] University Cote d'Azur (France), [3] Universitat Politecnica de Valencia (Spain), [4] National Research Council (Canada)

Bragg filters stand as a key building blocks of the silicon-on-insulator photonics platform. However, achieving narrowband Bragg filters with large rejection is challenging due to fabrication constraints and imperfections. Here, we present our recent results in de development high-performance Bragg filters based on subwavelength and modal engineering. We experimentally show flexible control over the width and depth of the Bragg resonance. These results pave the way towards high-performance on-chip wavelength filters

18:40 : Manipulating Electric or Magnetic Spontaneous Emission in the Near-field of Silicon Nanoantennas
Mathieu Mivelle[1], Dorian Bouchet[1], Yannick De Wilde[1], Valentina Krachmalnicoff[1], Maria Sanz-Paz[2], Niek F. van Hulst[2], Maria F. Garcia-Parajo[2], Nicolas Bonod[3], Sebastien Bidault[1]
[1] ESPCI Paris (France), [2] ICFO-Institut de Ciencies Fotoniques (Spain), [3] Aix Marseille University (France)

High-index dielectrics such as silicon are an exciting alternative to plasmonic materials for the design of optical nanoantennas with low ohmic losses. We review our recent results on the use of Si-based nanoscale resonators to manipulate magnetic and electric spontaneous emission processes.

18:55 : Invited talk
Dirac-like photonic structures: from pseudospin to topology
Zhigang Chen
Nankai University (China)

Photonic lattices have provided a powerful platform to emulate Dirac physics while discovering new phenomena that would otherwise be inaccessible in natural 2D materials. In this talk, I will present some of our recent work based on Dirac-like photonic structures, including valley vortex states and degeneracy lifting via photonic higher-band excitation, valley Bloch oscillations and Zener tunneling, and unusual flatband localized states protected by real-space topology. I will then focus on discussing pseudospin-orbit angular momentum conversion and universal momentum-to-real-space mapping of topological singularities arising from the interplay of Berry phase, pseudospin, and orbital angular momentum of light.

16:40 - 18:00 — Auditorium VA4

Session 2A51

Non-Hermitian Complex Systems: Photonics, Plasmonics and Metamaterials

Organized by: Konstantinos Makris, Ramy El-Ganainy and Sahin Ozdemir

Chaired by: Konstantinos Makris, Ramy El-Ganainy and Sahin Ozdemir

16:40 : Invited talk
Chiral metamaterials with PT symmetry and beyond
Sotiris Droulias[1], Ioannis Katsantonis[1], Maria Kafesaki[1], Costas M. Soukoulis[2], Eleftherios N. Economou[3]
[1] Foundation for Research and Technology Hellas (FORTH) (Greece), [2] Iowa State University (USA), [3] University of Crete (Greece)

Chiral systems impose circularly polarized waves which do not preserve their handedness under the combined space- and time- reversal operations and, as a result, seem to be incompatible with systems possessing PT symmetry. Here we show that in certain metamaterials, PT symmetric permittivity, permeability and chirality is possible, in addition, real eigenvalues are maintained even if the chirality goes well beyond PT symmetry, thus enabling advanced polarization control of PT symmetric systems.

17:00 : Invited talk
PT symmetry in a Double Quantum Dot circuit-QED set-up
Manas Shreekanth Kulkarni[1], **Archak Purkayastha**[2], **Yogesh Joglekar**[3]
[1] *Tata Institute of Fundamental Research (India),* [2] *The University of Dublin (Ireland),* [3] *Purdue University (USA)*

We show here that state-of-the-art double-quantum-dot circuit-QED (DQD-cQED) system can be controllably tuned to show non-Hermitian quantum dynamics governed by an effective PT -symmetric Hamiltonian. We show this by rigorously deriving the effective dynamics from a microscopic model of the set-up. This also reveals the effect of thermal and quantum fluctuations on the PT symmetric system.

17:20 : Invited talk
Demonstration of a two-dimensional PT-symmetric crystal: Bulk dynamics, topology and edge states
Lukas Maczewsky, Mark Kremer, Tobias Biesenthal, Matthias Heinrich, Ronny Thomale, Alexander Szameit, Lukas Maczewsky
Universitat Rostock (Germany)

We report the first implementation of a two-dimensional PT-symmetric crystalline structure. Using a novel isotropic loss mechanism in a photonic setting, we probe both bulk and edge properties, and study the interplay between PT- symmetry and topology in this system.

17:40 : Invited talk
Nonreciprocity, Chirality and PT-Symmetry in Photonics and Functional Materials
Avadh Saxena
Los Alamos National Lab (USA)

I will discuss the conditions for nonreciprocity of ferro-rotational order in a variety of materials and suggest the use of linear optical gyration and vortex beams as possible ways to detect ferrorotational domains [2]. Next, I will discuss how to generalize the notion of vector order parameters to second- and higher-rank tensor order parameter. I will also elucidate how to achieve high-temperature optical diode effect.

18:00 - 19:00 — Auditorium VA4

Session 2A52

Plasmonics: Fundamentals and Applications

Organized by: Hong Wei

Chaired by: Hong Wei

18:00 : Invited talk
Collective effects on periodic arrays of plasmonic nanostructures
Alejandro Manjavacas
University of New Mexico (USA)

We will discuss some interesting effects arising from the collective interaction in periodic arrays nanostructures.

18:20 : Invited talk
Tuning phase matching conditions in second harmonic generation via the excitation of higher order plasmonic mode in waveguides
Ning Liu[1], **Brian Corbett**[2]
[1] *University of Limerick (Ireland),* [2] *University College Cork (Ireland)*

Plasmonic waveguides, with characteristic strong electric field confinement at the dielectric-metal interface, have found many applications in nonlinear optics. However, the dispersion relationship of fundamental plasmonic mode works against the phase matching condition required for strong second harmonic generation. Here we show that by exciting higher order plasmonic modes, phase matching condition can be satisfied in plasmonic waveguides.

18:40 : Invited talk
Single-molecule sensing mediated by localized plasmon resonances
Peter Zijlstra, Rachel Armstrong, Michael Beuwer, Matej Horacek, Yuyang Wang
Eindhoven University of Technology (The Netherlands)

I will outline recent advances in the plasmon-enhanced detection of single molecules and their application toward single-molecule biosensing and single-molecule biophysical studies.

16:40 - 17:40 — Auditorium VA5

Session 2A53

Plasmonics and nano-optics

Chaired by: Qiuming Yu

16:40 : Plasmon-assisted terahertz detection in graphene transistors
Dmitry Svintsov[1], Denis Bandurin[2], Igor Gayduchenko[1], Maxim Moskotin[3], Andre Geim[2], Georgy Fedorov[1]
[1] *Moscow Institute of Physics and Technology (Russia),* [2] *University of Manchester (United Kingdom),* [3] *Moscow State University of Education (MSPU) (Russia)*

Implementation of resonant plasmonic detectors of terahertz (THz) radiation represents a major challenge due to high requirements on carrier mobility. We demonstrate the resonant plasmon-assisted THz detection in bilayer graphene/boron nitride heterstructures. Due to gate-voltage tuning of plasmon resonance, the reported devices can be used as on-chip THz spectrometers. We show that photovoltage spectroscopy offers a convenient tool to study plasmon spectra and damping in 2d channels, and use it to uncover novel plasmon modes in graphene Moiré superlattices.

16:55 : Characterization of surface plasmon-polariton resonances at solvent-metal interfaces using Fano approximation
Dmitry V. Nesterenko[1], Roman Pavelkin[2], Shinji Hayashi[3], Victor Soifer[2]
[1] *Image Processing Systems Institute RAS (Russia),* [2] *Samara National Research University (Russia),* [3] *Kobe University (Japan)*

Water, ethanol, and isopropyl alcohol are general solvents and dispersing media for different suspensions. We estimate the resonance properties of SPP modes excited at interfaces between silver and these solvents using Fano approximations in the ultraviolet, visible and infrared regions. The obtained results suggest potential applications of planar plasmonic structures in nanotechnology and biosensing in the near- and mid-infrared regions.

17:10 : Nonlocal optical processes mediated by surface plasmon polaritons
Dawid Piatkowski[1], Aneta Prymaczek[1], Maciej Cwierzona[1], Justyna Grzelak[1], Dorota Kowalska[1], Marcin Nyk[2], Sebastian Mackowski[1]
[1] *Nicolaus Copernicus University (Poland),* [2] *Wroclaw University of Science and Technology (Poland)*

In this work we demonstrate that Surface Plasmon Polaritons (SPPs), propagating in a single silver nanowire, can be used for remote (bi-directional) communication with up-converting nanocrystals (UCNPs), which are anti-Stokes emitters. In particular, SPPs activated at one end of the nanowire induce emission of single UCNPs deposited at the opposite end of the nanowire. We show using spectrally- and time-resolved luminescence microscopy that range of this communication depends on light polarization, SPPs mode, and functionalization of the nanocrystals.

17:25 : Wavelength-dependent surface plasmon polariton propagation in long silver nanowire waveguide
Dorota Buczynska[1], Michal Cwik[1], Ewa Rozniecka[1], Sebastian Mackowski[2], Joanna Niedziolka-Jonsson[1]
[1] *Polish Academy of Sciences (Poland),* [2] *Nicolaus Copernicus University (Poland)*

Using our fluorescence microscope setup, with confocal excitation and wide-field fluorescence detection, we were able to excite Surface Plasmon Polaritons (SPP) in a silver nanowire (AgNW) structure, which we demonstrate for several excitation wavelengths. We want to combine the capabilities of our optical setup

and experience in chemical synthesis of long AgNWs [1] to achieve long distance SPP propagation. We intend to first determine experimentally the influence of different dimensions and surface functionality on SPP propagation.

17:40 - 19:15 — Auditorium VA5

Session 2A54

New materials for photonics

Chaired by: Marina Leite

17:40 : Invited talk
Surface plasmon-polaritons in deformed graphene layer
Maksim Usik[1], Igor Bychkov[1], Olga Kharitonova[1], Vladimir Shavrov[2], Dmitry Kuzmin[1]
[1] *Chelyabinsk State University (Russia),* [2] *Kotelnikov Institute of Radio-engeneering and Electronics of RAS (Russia)*

In this work, we theoretically investigated the excitation of surface plasmon-polaritons (SPPs) in deformed graphene by attenuated total reflection method. We considered the Otto geometry for SPPs excitation in graphene. Efficiency of SPPs excitation strongly depends on the SPPs propagation direction. The frequency and the incident angle of the most effective excitation of SPPs strongly depend on the polarization of the incident light. Our results may open up new possibilities for strain-induced molding flow of light at nanoscales.

18:00 : Graphene Plasmonic Slot Photodetector on Silicon-on-insulator with High Responsivity
Zhizhen Ma, Mario Miscuglio, Volker J. Sorger
George Washington University (USA)

Here we demonstrate a plasmonic slot graphene photodetector on silicon-on-insulator platform with high-responsivity given the 5 um-short device length. We observe that the maximum photocurrent scales inversely with the slot width. Using a dual-lithography step, we realize 15 nm narrow slots that show a 15-times higher responsivity per unit device-length compared to photonic graphene photodetectors. This leads to quasi charge neutrality, which explains both the previously-unseen offset between the maximum photovoltaic-based photocurrent relative to graphene's Dirac point.

18:15 : Synthesis and Plasmon Responses of Sodium Tungsten Bronze Nanoparticles
Levi Tegg, Dylan Cuskelly, Vicki J. Keast
University of Newcastle (Australia)

The sodium tungsten bronzes are sub-stoichiometric metal oxides with interesting electrical and optical properties which vary with the sodium content. We have developed a synthesis technique which makes high-purity sodium tungsten bronze nanoparticles across a wide composition range. Results from electron energy-loss spectroscopy reveal that these materials support high-quality localised surface plasmons, with resonance frequencies which are tunable across visible and near-infrared frequencies by varying the sodium content.

18:30 : Near-field nano-imaging of buried microcavity for enhancement of WS2 monolayer exciton photoluminescence
Oliver Mey[1], Franziska Wall[1], Lorenz Maximilian Schneider[1], Darius Gunder[1], Frederik Walla[2], Amin Soltani[2], Hartmut G. Roskos[2], Ni Yao[3], Peng Qing[3], Wei Fang[3], Arash Rahimi-Iman[1]
[1] *Philipps-Universitat Marburg (Germany),* [2] *Johann Wolfgang Goethe-Universitat (Germany),* [3] *Zhejiang University (China)*

Photoluminescence control in suspended 2D TMDC monolayers is explored as a pathway for novel optoelectronic devices. By engineering the dielectric surrounding of TMDC layers one can significantly enhance both light absorption and PL emission. Nanostructured buried microcavities facilitate the enhancement of in- and out-coupled fields in both vertical and horizontal direction. Here, we demonstrate near-field nano-imaging as a tool for characterizing in-coupled light on a WS2 monolayer suspended above a circular Bragg microcavity designed for exciton PL enhancement.

18:45 : Organic excitonic core-shell nanoparticles with plasmon-like response: Towards fully plastic metamaterials
Sara Nunez-Sanchez, C. Estevez-Varela, I. Pastoriza-Santos
Universidade de Vigo (Spain)

In this work we experimentally probed that colloid chemistry routes can be the key to build up organic building blocks at nanoscale showing plasmon-like response with a plastic. Metals have been the driving force for plasmonics and metamaterials applications allowing manipulating light right down to the nanoscale. In this work we show that it is possible to obtain plasmon-like response with Silica-J-aggregate core-shell nanoparticles opening a route for a fully plastic era in metamaterials.

19:00 : Hybrid plasmon-magnon polariton modes in graphene-antiferromagnet heterostructures
Yuliy Bludov[1], Jose Gomes[1], Gil Farias[2], Joaquin Fernandez-Rossier[3], Mikhail Vasilevskiy[1], Nuno Peres[1]
[1] *Universidade do Minho (Portugal),* [2] *Universidade Federal do Ceara (Brazil),* [3] *QuantaLab (Portugal)*

We consider a structure formed by graphene and an insulating antiferromagnet, separated by vacuum. This hybrid structure can host two types of hybrid polariton modes. first, a surface magnon-plasmon polariton whose dispersion is radically changed by the carrier density of the graphene layer, including a change of sign in the group velocity. Second, a surface plasmon-magnon polariton formed as a linear superposition of graphene surface plasmon and the antiferromagnetic bare magnon. This polariton has a dispersion with two branches.

16:40 - 17:40 — Auditorium VA6

Session 2A55

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Oliver Wright

16:40 : Invited talk
Optical Helmholtz resonators
Patrick Bouchon, Paul Chevalier, Riad Haïdar
University Paris Saclay (France)

Optical nanoantennas are studied to manipulate light and enhance light matter interactions. Here, we experimentally demonstrate the optical Hemholtz resonance in a metallic slit-box structure, which is predicted to be harmonic and to enhance the electric field intensity by several orders of magnitude. It is fabricated thanks to a two steps electronbeam lithography, between which the box was filled with benzocyclobutene (BCB).

17:00 : Invited talk
Plasmon-enhancement in nanostructured shells for single particle protein assays and photodynamic therapy
Christophe Silien, Grace Brennan, Daragh Rice, Matthew Gleeson, Rabah Mouras, Tewfik Soulimane, Syed A. M. Tofail
University of Limerick (Ireland)

The ability to grow plasmonic shells on micro- and nanoparticles by electroless plating leads to the creation of easily deployable heterogeneous materials for detection of biomolecules and medical therapy with high sensitivity and low irradiation needs. The overall quality, optical performances, and stability of the shells are important to address and can be controlled by rational design of the shell structures. Here, Ag and Au nanostructured shells are discussed in the context of magneto-plasmonics and attomolar multiplex protein assays.

17:20 : Invited talk
Negative-index metamaterials made by low-cost approaches
Mayte Gomez-Castano[1], Juan Luis Garcia-Pomar[1], Renaud Vallee[2], Agustin Mihi[1], Serge Ravaine[2]

[1] *Institute of Materials Science of Barcelona (Spain),* [2] *University of Bordeaux (France)*

In this communication, we present new low-cost and up-scalable routes for the fabrication of double fishnet metamaterials, based on the combination of colloidal lithography, nanoimprinting lithography and electrodeposition. The proper design of our architectures enables the tuning of the effective refractive index from positive to negative and zero values.

17:40 - 18:55 — Auditorium VA6

Session 2A56

Metasurfaces and flat optics, FSS and HIS

Chaired by: Xianzhong Chen

17:40 : Ultrafast modulation in a THz graphene-based flat absorber through negative photoconductivity

Anna Tasolamprou[1], Anastasios Koulouklidis[1], Christina Daskalaki[1], Charalampos Mavidis[1], George Kananakis[1], George Deligeorgis[1], Zacharias Viskadourakis[1], Polina Kuzhir[2], Stelios Tzortzakis[1], Eleftherios Economou[1], Maria Kafesaki[1], Costas Soukoulis[1]

[1] *IESL - FORTH (Greece),* [2] *Belarusian State University (Belarus)*

We present the experimental and theoretical study of an ultrafast graphene-based thin film absorption modulator for operation in the THz regime. The flat modulator is composed of a graphene-sheet placed on a dielectric layer backed by a metallic back-reflector. A near-IR pulse induces the generation of hot carriers in the graphene sheet reducing effectively its conductivity. The system provides a platform with ultrafast modulation capability for flat optics and graphene-based metasurfaces applications.

17:55 : Reconfigurable coding metamaterial

Eistiak Ahamed, Mohammad Rashed Iqbal Faruque, Mohd Fais Bin Mansor

Universiti Kebangsaan Malaysia (Malaysia)

Reconfigurable coded metasurface is introduced inspired by electric split ring resonator (eSRR) that is working in the terahertz frequency range. The proposed metamaterial structures can be structurally reconfigured to determine its effect on scattering parameters and effective properties by bending its metal strip.

18:10 : Mitigating Chromatic Dispersion with Hybrid Optical Metasurfaces

Rajath Ravindra Sawant[1], Purva Bhumkar[1], Alexander Y. Zhu[2], Peinan Ni[1], Federico Capasso[2], Patrice Genevet[1]

[1] *Université Cote d'Azur (France),* [2] *Harvard University (USA)*

Metasurfaces, arrays of subwavelength spaced nanostructures, control various properties of light. The dispersion of outgoing light can also be controlled using the phase gradient of a metasurface. Exploiting this property, hybrid refractive-metasurface devices is designed to realize nondispersive refraction in the visible. The dispersion of hybrid component, characterized by using a Fourier plane imaging microscopy setup, is essentially achromatic over about 200nm in the visible. Broadband focusing with composite plano-convex metasurface lens is also proposed.

18:25 : Reflective metamirror grating for far field spatial filterin

Pei-Yu Wang[1], Yu-Chieh Cheng[1], Ramon Herrero[2], Muriel Botey[2], Kestutis Staliunas[2]

[1] *National Taipei University of Technology (Taiwan),* [2] *Universitat Politecnica de Catalunya (Spain)*

We successfully demonstrate grating-based reflective spatial filtering devices. Modulation of the refraction index on the sub-micron scale exhibits optical beam shaping with transverse invariance. The paper presents a theoretical model for the proposed metamirrors based on multiple scattering theory. The theoretical results coincide with the numerical ones. The metamirror may serve as a versatile tool for narrowing beam with high efficiency and transverse invariance.

18:40 : Metasurface-based ultra-lightweight high-gain flat parabolic reflectarray for microwave beam collimation/focusing

Sinhara Rishi Malinda Silva, Abdur Rahman, Wilton Kort-Kamp, Diego Dalvit, Hou-Tong Chen, Abul Azad
Los Alamos National Laboratory (USA)

We demonstrate a metasurface-based flat reflectarray antenna with the capability of beam collimation and focusing. The reflectarray is designed to operate at 12GHz in a center-fed configuration. It consist of metallic patches of variable sizes to cover 2π phase range. It exhibits a measured gain of 28dBi and focuses at 50cm with a depth of focusing of 8cm and has a 3dB directionality $\pm 1.6^{\circ}$. The demonstrated reflectarrays may enable low-cost, lightweight, and high-gain deployable transceivers for small-satellite platforms

16:40 - 18:55 — Auditorium EA1

Session 2A57

Topology in photonic crystals, metamaterials, and metasurfaces: physics and design

Organized by: Yang Li and Benfeng Bai

Chaired by: Yang Li and Benfeng Bai

16:40 : Invited talk
Topology Optimization of Photonic Crystals and Large-area Metasurfaces
Zin Lin, Steven G. Johnson
Massachusetts Institute of Technology (USA)

In this talk, we will show that, with careful consideration and reformulation of the design problem, powerful inverse design techniques can be successfully applied to a multitude of interesting problems ranging from designing exotic spectral features in photonic crystals to beam-forming and manipulation through multi-layered metasurfaces.

17:00 : Invited talk
Optimal metasurfaces: Theory and inverse design
Owen Miller
Yale University (USA)

We use two approaches to design best-in-class metasurfaces: 'inverse design', to find optimal configurations of arbitrarily many degrees of freedom, and analytical bounds, to discover fundamental physical limits. For optical superresolution, we derive analytical expressions to maximum intensity for sub-diffraction-limited optical beams, and use inverse design to discover metasurface structures operating near these limits. Conversely, for broadband metasurface lenses, where no such bounds are known, we use inverse design to discover high-numerical-aperture, high-efficiency, broad-bandwidth metalenses.

17:20 : Invited talk
Approaching the fundamental limits of heat transfer at the nanoscale: the surprisingly limited role of inverse design
Prashanth Venkataram, Sean Molesky, Weiliang Jin, Alejandro Rodriguez
Princeton University (USA)

Radiative heat transfer at the nanoscale can surpass blackbody limits on thermal radiation by orders of magnitude due to contributions from evanescent electromagnetic fields. Thus far, large-scale optimization procedures have failed to surpass the performance of ideal planar metals. We present fundamental limits to heat exchange and show that multiple scattering severely limits the utility of nanoscale texturing for the purpose of enhancing heat transfer between extended bodies, beyond shifting the resonant response of materials to selective wavelengths.

17:40 : Invited talk
Design of Photonic Topological Insulators Using Density Based Topology Optimization
Rasmus E. Christiansen, Fengwen Wang, Ole Sigmund, Soren Stobbe

Technical University of Denmark (Denmark)

We provide a novel photonic topological insulator design (PTI) exhibiting the quantum-spin-Hall effect, which, as opposed to previous designs, is conceived using numerical optimization of the transmission through PTI edge states. Specifically, we use topology optimization to maximize the transmission of light through a carefully configured model domain composed of two photonic crystal phases. This leads to a numerically generated PTI, which features larger bandgaps than previously predicted for planar PTIs and excellent suppression of backscattering from sharp bends.

18:00 : Invited talk
Inverse design and demonstration of on-chip ultracompact multimode silicon photonic devices
Weijie Chang, Xinshu Ren, Longhui Lu, Minming Zhang
Huazhong University of Science and Technology (China)

We demonstrate several inverse-designed ultracompact and highly functional silicon devices based on digital subwavelength structures for on-chip optical interconnects, including mode multiplexer, dual mode power splitter, multimode waveguide crossing and multimode bent waveguide. An improved direct-binary-search-based inverse design method is utilized to optimize digital nanophotonic devices. Besides, an efficient inverse design approach based on digitized adjoint method is also discussed. The footprint of the devices we demonstrate is about two order of magnitude smaller than that of conventional ones.

18:20 : Invited talk
Optically Tunable Epsilon-Near-Zero Metamaterials
Surya Ayyagari, Alireza R. Rashed, Humeyra Caglayan
Tampere University (Finland)

In this study, we obtained epsilon-near-zero metamaterial at visible range by designing and fabricating a metal-dielectric multilayer anisotropic hyperbolic metamaterial. Later, we show by optically pumping with fs pulses at a proper wavelength the ENZ point of the structure alters, in comparison to the linear case. The change in the effective permittivity happens in the order of unity, leading to ultrafast light induced refractive index change.

18:40 : Optimal distance above ENZ-materials for fluorescence inhibition: Insight from a perturbative analysis of the surface Green function
Claudio Silvestre Castro[1], Eugenio Rafael Mendez[2], Alexandre Vial[1], Gilles Lerondel[1], Aurelien Bruyant[1], Remi Vincent[1]
[1] *Université de Technologie de Troyes (France),* [2] *Centro de investigacion cientifica y de estudios superiores de Ensenada (Mexico)*

We study the electromagnetic response of a dipole near an epsilon-near-zero (ENZ) planar surface. Analytical expressions are given for the local density of optical states (LDOS). A criterion for evaluating the treshold height above which radiative processes dominate is established. We found results elucidating the origin of LDOS cancellation. By the determination of an optimal spacer thickness between the ENZ substrate and a dipole emitter, the obtained results can be used to strongly augment the lifetime of the emitter.

16:40 - 19:05 — Auditorium EA2

Session 2A58

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

Chaired by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

16:40 : Invited talk
Electromagnetic Responses and Non-reciprocal Phenomena of Metamaterials with Chirality and Magnetism

Kei Sawada[1], **Satoshi Tomita**[2], **Hiroyuki Kurosawa**[3], **Tetsuya Ueda**[4]
[1] *RIKEN (Japan),* [2] *Tohoku University (Japan),* [3] *National Institute of Information and Communication Technology (Japan),* [4] *Kyoto Institute of Technology (Japan)*

Non-reciprocal phenomena of metamaterials are studied in a system containing both chirality and magnetism. Structural chirality and intrinsic magnetism break spatial inversion and time-reversal symmetries, respectively. Such a symmetry breaking gives a magneto-chiral effect, which is a kind of directional birefringence. We experimentally demonstrated and numerically verified that the magneto-chiral effect was enhanced in artificial metamolecules.

17:00 : Invited talk
Generation and Propagation of Surface-Plasmon Polaritons at Lossy Interfaces
Nafiseh Sang-Nourpour[1], **Saeid Asgarnezhad-Zorgabad**[2], **Barry C. Sanders**[1]
[1] *University of Calgary (Canada),* [2] *Sharif University of Technology (Iran)*

We study surface-plasmon polaritons (SPPs) for lossy isotropic media, with the plasmon concept applicable both to metals and to double-negative-index media, and apply this framework to generate, propagate and control linear/nonlinear SPPs. We derive SPP propagation conditions along planar and curved interfaces and study controllable propagation of SPP breathers and creation of polaritonic frequency combs at interfaces between an atomic medium and metamaterials. Our results are important for subwavelength photonic-circuit elements such as SPP phase modulators and frequency-comb generators.

17:20 : Keynote talk
Topological non-Hermitian origin of surface Maxwell and acoustic waves
Konstantin Bliokh
Theoretical Quantum Physics Laboratory - Riken (Japan)

More than 60 years ago it was shown that interfaces between isotropic homogeneous optical media (including dielectrics, metals, negative-index materials) can support surface electromagnetic waves, which now play crucial roles in plasmonics, metamaterials, and nano-photonics. I will show that such surface Maxwell waves have a topological origin explained by the bulk-boundary correspondence.

17:50 : Invited talk
Chirality and Anti-ferromagnetism in Artificial Micro-/Nano-Structures
Kun Huang
University of Science and Technology of China (China)

The light-matter interaction is usually dominated by the coupling between microscopic electromagnetic modes and the geometry of structures. In this talk, the roles of chiral light in enhancing the helical dichroism and exciting anti-ferromagnetic modes will be introduced. Direct detection of chiral microstructures is implemented by using sign-opposite twisted vortices. High-efficiency polarization conversion in dielectric geometric metasurfaces is also interpreted in terms of microscopic antiferromagnetic modes induced by chiral circular-polarized light.

18:10 : Invited talk
Engineering the Optical Magnetoelectric Effect in Crystals on the Sub-Unit-Cell Scale
Istvan Kezsmarki[1], **Sandor Bordacs**[2]
[1] *University of Augsburg (Germany),* [2] *Budapest University of Technology and Economics (Hungary)*

Multiferroics permit magnetic control of the electric polarization and electric control of the magnetization. These static magnetoelectric effects are of enormous interest: The ability to read and write a magnetic state current-free by an electric voltage would provide great technological advantages. Optical magnetoelectric effects are equally interesting, because they give rise to unidirectional light propagation in multiferroic compounds. We show that static and optical magnetoelectric phenomena can be engineered in crystals on the sub-unit-cell scale, similarly to metamaterials.

18:30 : Invited talk
Switchable topological spin textures at a coherent oxide interface
Kathrin Doerr[1], **Martin Koch**[1], **Lukas Bergmann**[1], **Sujit Das**[1], **Stefano Agrestini**[2], **Igor Maznichenko**[1], **Nicolas Gauquelin**[3], **Diana Rata**[1]
[1] *Martin Luther University (Germany),* [2] *ALBA Synchrotron Light Source (Spain),* [3] *University of Antwerp (Belgium)*

Complex conducting oxide ferromagnets, La0.7Sr0.3MnO3 and SrRuO3, are shown to form a Ru exchange spring at their coherent interface when grown on SrTiO3(001) substrates. In low magnetic fields, non-coplanar, topologically non-trivial spin textures arise and can be switched, as is demonstrated based on magnetization and x-ray magnetic circular dichroism data.

18:50 : Manifestation of the spatial Kramers-Kroning relations in plasmonic chiral metasurface
Leeju Singh, Shmuel Sternklar, Yuri Gorodetski
Ariel University (Israel)

Light-matter interactions can exhibit a strong dissymmetry in chiral structure specifically, the phase and amplitude can be strongly affected by altering the chirality strength. The Kramers-Kronig relation between the imaginary and the real part of the index prescribes the connection between the two measurable effects of the optical activity, namely the optical rotation dispersion (ORD) and the circular dichroism (CD). Our results establish a basis for the development of the meta-surface that incorporates structural local chirality for phase modulation.

16:40 - 18:40 — Auditorium EA3

Session 2A59

Photonics for space systems and propulsion

Organized by: Artur Davoyan

Chaired by: Artur Davoyan

16:40 : Invited talk
Metal Oxide Meta-optical Solar Reflector for Space Applications
Kai Sun[1], Wei Xiao[1], Yudong Wang[1], Mirko Simeoni[2], Alessandro Urbani[2], Sandro Mengali[2], Fausto Lucantonio[3], Marco Ivagnes[3], Maksim Zalkovskij[4], Brian Bilenberg[4], C. H. de Groot[1], Otto L. Muskens[1]
[1] University of Southampton (United Kingdom), [2] Consorzio C.R.E.O. (Italy), [3] Thales Alenia Space (Italy), [4] NIL Technology (Denmark)

Optical solar reflectors (OSRs) play a crucial role in the thermal control of a spacecraft. We present novel meta-surface-based OSRs using metal oxides, e.g. Al-doped zinc oxide (AZO) and vanadium dioxide (VO2). Our AZO-based meta-OSRs have been optimized for a high infrared emittance and low solar wavelength absorption. VO2-based meta-OSRs have demonstrated a superior emittance tunability and lower solar absorption than the planar film. Both meta-OSRs have been comprehensively tested for their robustness required by space applications.

17:00 : Invited talk
Passively Actuated Thermal Coating for Radiative Controlled Homeostasis
Philip W. C. Hon, Ahmed Morsy, Virginia D. Wheeler, Michael Barako, Vladan Jankovic, Michelle Povinelli, Luke A. Sweatlock
Northrop Grumman Corporation (USA)

Spacecraft temperature stability and control is achieved using bulky solutions, like thermal heat pipes or technologies that use moving parts like mechanical louvres. Thermal control surfaces are an attractive alternative since they are mechanically compliant and solid-state solutions. We present micro-patterned silicon coated with a phase change material as a passive thermal control surface.

17:20 : Invited talk
Reflectivity control devices for solar sail actuation
Jeremy Munday
University of Maryland (USA)

Radiation pressure from the sun can exert a force on spacecrafts that can either be beneficial, in the case of solar sail propulsion, or harmful, in the case of satellites in predefined orbits. Thus, there is a need for a way to control this radiation pressure. Here we present our latest work on switchable reflectivity materials to actively

control the radiation pressure exerted on a spacecraft to enable real-time attitude control and maneuvering.

17:40 : Invited talk
Relative and Absolute Phase Control of Lasers
Firooz Aflatouni
University of Pennsylvania (USA)

In this paper a review of our work on optical phased arrays and laser stabilization systems is presented. The relative phase between semiconductor lasers are controlled through heterodyne phase locked loops forming a laser phased array. An integrated Pound-Drever-Hall stabilization system is presented that reduced the frequency noise of a commercially available laser by more than 25dB. In another PDH chip, the linewidth of a distributed feedback laser is significantly reduced using an off-chip resonator.

18:00 : Invited talk
Optical rectification and resonant absorption in active nonlinear metasurfaces
Richard Osgood[1], M. Kang[2], K-B. Kim[2], Y. Ait-El-Aoud[1], S. Dinneen[1], S. Kooi[3], G. Fernandes[4], J. M. Xu[4]
[1] US Army CCDC-SC (USA), [2] Seoul National University (Korea), [3] MIT (USA), [4] Brown University (USA)

Rectifying stripe-teeth metasurfaces consisting of nanorectenna arrays with plasmonic near-infrared resonances, coupled to vertical Metal-Insulator-Metal (MIM) diodes with barrier layer, were designed and current-voltage (I-V) curves analyzed, considering barrier heights, thickness, etc. The nanorectenna arrays were illuminated by visible and near-infrared lasers, producing rectified power. An interesting large increase in the forward bias current, greater than predicted by plasmonic field-enhancement, is due to novel optical rectification mechanism: out-of-equilibrium 'hot-electron' energy distribution due to plasmonic resonant Au nanowire antenna absorption.

18:20 : Invited talk
Simulating the Dynamic Structural Stability of Ultrathin Lightsails
Michael D. Kelzenberg, Harry A. Atwater
California Institute of Technology (USA)

Laser-propelled lightsails have been proposed as a technologically viable means of deploying interstellar space probes. Here, we investigate the dynamic structural stability of such light sails, treating the sail as a free membrane rather than a rigid body. Using realistic values for strength and modulus, we show that spin-stabilized paraboloid lightsails can in principle exhibit mechanical stability and beam-riding behavior.

16:40 - 18:45 — Auditorium EA4

Session 2A60

Metasurface-based Light Sources, Modulators, and Detectors

Organized by: Yuanmu Yang and Benfeng Bai

Chaired by: Yuanmu Yang and Benfeng Bai

16:40 : Invited talk
Terahertz Photonic Devices Employing Graphene-based Hybrid Metasurfaces
Peter Qiang Liu
University at Buffalo (USA)

Graphene has recently emerged as a versatile material for photonic devices operating in the infrared to terahertz (THz) spectral region. In particular, this 2D material can support tunable THz surface plasmon polaritons with exceedingly high field enhancement and relatively long lifetime. In this talk, we present several types of THz photonic devices we developed in recent years, including modulators and detectors, which employ graphene-based hybrid structures (e.g. metasurfaces) to achieve enhanced light-matter interactions and hence improved device performances.

17:00 : Transmissive metasurface lens for a mid-wavelength infrared detectors and focal plane arrays
Alexander Soibel[1], Shuyan Zhang[2], Sam Keo[1], Dan Wilson[1], Sir Rafol[1], Alan She[2], David Z. Ting[1], Federico Capasso[2], Sarath D. Gunapala[1]
[1]*JPL-California Institute of Technology (USA),* [2]*Harvard University (USA)*

In this work, we successfully demonstrated flat optical concentrators operating in mid-wavelength infrared (MWIR) spectral range. The optical concentrators are solid immersion polarization-independent transmissive metasurface lens designed to operate in the 3-5 microns band. These 30micron diameter lenses were tested using a JPL-developed MWIR camera showing very good optical characteristics with a small focal spot size and focal length of about 150 micron. This demonstration is the first step in the realization of infrared detectors monolithically integrated with flat lenses.

17:15 : Dielectric Metasurfaces for Ultrathin Half Waveplates
Yuttana Intaravanne, Xianzhong Chen
Heriot-Watt University (United Kingdom)

Traditional half waveplates are not suitable for device miniaturization and system integration due to their large volume. The unprecedented capability of metasurfaces in the manipulation of light's polarization at subwavelength scale has provided an approach to develop ultrathin half waveplates. We developed an ultrathin half waveplate and evaluated its performance in term of conversion efficiency, phase retardation, and polarization rotation. Although our samples cannot be a perfect half waveplate, they can function as a quarter waveplate at some wavelengths.

17:30 : Invited talk
High-efficiency coupling and reshaping of surface plasmon with metasurfaces
Xiaoer Li, Zhuo Wang, Shaohua Dong, Sixiong Yi, Yizhen Chen, Huijie Guo, Fuxin Guan, Qiong He, Lei Zhou, Shulin Sun
Fudan University (China)

Here, we propose a new scheme to simultaneously excite and reshape the SPPs with a single meta-device. Our idea is successfully demonstrated by full wave simulations and near-field experiments. Our work may stimulate many near-field related applications.

17:50 : Nanophotonic Enhancement of Light Out-Coupling for Deep-UV LEDs
Phillip Manley[1], Martin Hammerschmidt[2], Sven Burger[3], Christiane Becker[1]
[1]*Helmholtz-Zentrum Berlin (Germany),* [2]*JCMwave (Germany),* [3]*Zuse Institute Berlin (Germany)*

We present a concept for rapidly evaluating different nanostructures for enhanced out-coupling of light from light emitting diodes in the deep ultra violet wavelength region. The scattering matrix for a given nanostructured interface is calculated by means of rigorous simulations combined with a Brillouin zone sampling technique to minimize the number of required simulations. We then use the scattering matrix to evaluate the out-coupling for a source with an arbitrary angular distribution.

18:05 : Invited talk
Gate-tunable Conducting Oxide Epsilon-near-zero Metasurfaces with Active Nonlinear and Quantum Responses
Aleksei Anopchenko, Subhajit Bej, Sudip Gurung, Khant Minn, Jingyi Yang, Howard (Ho Wai) Lee
Baylor University (USA)

This talk will review our recent development on a gate- tunable conducting oxide epsilon-near-zero metasurfaces. I will present our recent development on the use of gate-tunable materials, transparent conducting oxides, to demonstrate an electrically tunable ultrathin ENZ perfect absorber enabled by the excitation of ENZ modes. In addition, I will present the active control of emissive properties of quantum emitters and enhanced optical nonlinearity in hybrid ENZ-plasmonic heterostructures.

18:25 : Invited talk
Electric-field-Induced Second Harmonic Generation from Organic Polymer
Shumei Chen[1], King Fai Li[2], Guixin Li[2], Kok Wai Cheah[3], Shuang Zhang[1]
[1]*University of Birmingham (United Kingdom),* [2]*Southern University of Science and Technology (China),* [3]*Hong Kong Baptist University (Hong Kong)*

Here, we report giant tuneability of EFISH signal from a subwavelength thick polymer film sandwiched by a transparent electrode and a metallic mirror. By exploiting band-edge enhanced third-order nonlinear sus-

ceptibility from the organic conjugated polymer, we successfully demonstrate a gigantic EFISH effect with modulation ratio up to 422 %/Volt at pumping wavelength of 840 nm. The band-edge enhanced EFISH opens new avenues for modulating the intensity of SHG signals, and for controlling nonlinear electro-optic interaction in nanophotonic devices.

16:40 - 17:40 — Room 02.2

Session 2A61

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Che Ting Chan

16:40 : Invited talk
Photonic Integrated Nanojet
Ali Belarouci, Michele Calvo, Oleksii Hudz, Pedro Rojo Romeo, Regis Orobtchouk
Université de Lyon (France)

We report the direct experimental observation of photonic nanojets created by single SixNy microdisks illuminated by a waveguide. High intensity sub-wavelength spots and low divergence nanojets are observed at a wavelength of 1550nm. Light scattered from the disk is observed by imaging from above. The electromagnetic distributions inside and outside the microdisk are calculated by using finite-difference-time-domain method and compared to the experimental image.

17:00 : Invited talk
Mapping electron emission and multiphoton absorption in plasmonic nanoantenna arrays
Kamonpan Chumpol, Kenan Elibol, Xia Zhang, Richard Hobbs
Trinity College Dublin (Ireland)

Understanding plasmon-driven electron emission and energy transfer on the nanometer length scale is critical to controlling light-matter interactions at nanoscale dimensions. In photoresist and electron-beam resist materials, electron emission and energy transfer lead to chemical transformations. In this work, we use such chemical transformations in two different high-resolution electron-beam lithography resists to map local electron emission and energy transfer with nanometer resolution from plasmonic nanoantennas by exciting both localized surface plasmon resonances and lattice resonances within the antenna arrays.

17:20 : Invited talk
Broadband extraordinary transmission and focusing of sound with flat thin meta-lens
Shanjun Liang[1], Yong Li[2], Qian Cheng[2], Jie Zhu[1]
[1] *The Hong Kong Polytechnic University (China),* [2] *Tongji University (China)*

We report a broadband metalens that can realize wavefront modulation with high energy efficiency. Based on the impedance-matched gradient material, we theoretically and experimentally study a gradient index helical-structured metamaterial that can modulate sound wavefront with near perfect transmission over a broad bandwidth. A thin flat metalens is constructed to demonstrate soundfocusing with the extraordinary transmission for more than 1/3 octave band. It is anticipated that this engineered material may be used in ultrasonography,ultrasound surgery, and DNA fragmentation.

17:40 - 18:55 — Room 02.2

Session 2A62

Plasmonics and nano-optics

Chaired by: Dmitry Chigrin

17:40 : Direct Demonstration of Biexciton Quantum Yield Enhancement in an Individual Quantum Dot Coupled with Gold Nanoparticles in a Thin-film Hybrid Material
Victor Krivenkov[1], Pavel Samokhvalov[1], Ana Sanchez-Iglesias[2], Marek Grzelczak[3], Igor Nabiev[1], Yury Rakovich[3]
[1] *National Research Nuclear University MEPhI (Russia),* [2] *CIC BiomaGUNE (Spain),* [3] *Donostia International Physics Center (Spain)*

Biexcitons, which can be excited in semiconductor quantum dots (QD), cause the multiphoton emission effect. However the photoluminescence quantum yield (QY) of biexcitons is low due to the Auger process. In this study we demonstrate the biexciton QY enhancement in single QDs due to their coupling with gold nanorods (GNRs). Measuring the photoluminescence properties of the same single QD before and after coupling with GNRs, we obtained a confirmation of the biexciton QY increase due to the Purcell effect.

17:55 : Thermal behavior and managament of thermophotovoltaic cells
Etienne Blandre[1], Rodolphe Vaillon[2], Jeremie Drevillon[1]
[1] *Université de Poitiers (France),* [2] *Université Montpellier (France)*

The thermal behavior of a thermophotovoltaic system composed of a metallodielectric spectrally selective radiator at 1500 K and a GaSb photovoltaic cell is investigated. Using a coupled radiative, electrical and thermal model, we highlight that without a large convective heat transfer coefficient applied to the cell, the raise in temperature of the PV cell induces dramatic efficiency losses. We then investigate radiative cooling as a potential passive cooling solution.

18:10 : Designed Au-TiO2 Nanoreactors for Photocatalytic Transformations in Living Cells
Ana Sousa-Castillo, Miguel Comesana-Hermo, Moises Perez-Lorenzo, Miguel A. Correa-Duarte
Universidade de Vigo (Spain)

We describe the fabrication of TiO2-plasmonic hybrid nanocapsules with photocatalytic features These hybrid structures hold a number of outstanding properties that make them valuable photocatalysts in biological media: (i) they can be excited with NIR radiation given the plasmon-induced activation of the semiconductor, (ii) the mesoporous nature of the silica shell surrounding the active species endows them with size selective capabilities and (iii) the production of ROS is limited to the inner space within the capsules.

18:25 : Bridging Classical and Quantum Plasmons via an FDTD-TDDFT Hybrid Model
Jianwei You, Nicolae Coriolan Panoiu
University College London (United Kingdom)

The interaction between classical plasmons of a gold bowtie nanoantenna and quantum plasmons of graphene nanoflakes (GNF) placed in the narrow gap of the nanoantenna is studied by a proposed FDTD-TDDFT hybrid numerical method. Our analysis shows that the quantum plasmon response of a molecular-scale GNF can be enhanced by more than two orders of magnitude in this hybrid system. This finding can be particularly useful for applications to molecular sensors and quantum optics.

18:40 : Controlling the polarization of surface phonon polaritons
Michael A. Meeker[1], Eric M. Jackson[1], Chase T. Ellis[1], Zhizhen Ma[2], Mario Miscuglio[2], Marko J. Tadjer[1], Sarah Brittman[1], Janice E. Boercker[1], Nii-Okaitey Tetteh[1], Volker J. Sorger[2], Joseph G. Tischler[1]
[1] *U.S. Naval Research Laboratory (USA),* [2] *The George Washington University (USA)*

We investigate the evolution of localized surface phonon polariton (SPhP) resonances supported by L-shaped nanoresonators for a range of geometries and incident polarizations. As indicated by polarized reflection spectroscopy, we observe three distinct resonances with in- and out-of-plane polarization selection rules that can be widely varied by changing the length of only a single resonator arm. Such polarization control is expected to play an important role in optimizing light-matter interactions.

Thursday 25th July, 2019

08:30 - 10:15 — Culturgest

Session 3A1

Plenary Session II

Chaired by: Vladimir Shalaev

08:30 : Plenary talk
Transdimensional Materials for Nanophotonics: From 2D to 3D
Alexandra Boltasseva
Purdue University (USA)

In this talk, emerging photonic materials such as transparent conducting oxides, transition metal nitrides (TMNs), transdimensional (ultra-thin) materials (TDMs) and MXenes for photonic devices will be discussed. TDMs and MXenes are promising platforms for achieving actively switchable and tailorable metasurfaces, while TMNs are ideal for robust refractory plasmonic devices.

09:05 : Plenary talk
Singular plasmonic surfaces and their properties
J. B. Pendry
Imperial College London (United Kingdom)

Plasmonic surfaces derive their properties from their structure. This is especially true when a singularity of some sort is present such as two touching spheres, or a sharp edge. Both these instances and many more give rise to intense concentrations of energy near the singularity. Singularities can be removed using transformation optics to relate properties of the singular structure to those of another structure in a higher dimensional space.

09:40 : Plenary talk
Optical Antenna Physics: Spontaneous Emission Faster than Stimulated Emission
Eli Yablonovitch, Ming Wu, Seth Fortuna
University of California (USA)

We will describe the correct optical antenna conditions for making Spontaneous-faster-than-Stimulated emission, and we will review the improvements in our electrically pumped antenna Light Emitting Diodes.

Coffee Break and Exhibit Inspection

Session 3P1

Poster session V

10:15 - 11:00

P1: Effective Decay Coefficient of Low Frequency Sound in Phononic Crystals with Viscous Background
Martin Ibarias[1], Jesus Arriaga[1], Arkadii Krokhin[2]
[1] *Benemerita Universidad Autonoma de Puebla (Mexico),* [2] *University of North Texas (USA)*

The decay coefficient of sound propagating through a phononic crystal of solid rods in a viscous fluid is calculated in the low-frequency limit for arbitrary Bravais lattice and arbitrary cross-section of the rods. The decay coefficient exhibits anisotropy and anomalous frequency dependence. Strong enhancement of losses in a phononic crystal is due to viscous boundary layers formed near each solid scatterer.

P2: Electromagnetically-optomechanically induced transparency in atom-photon-phonon system
He Hao, Juanjuan Ren, Fan Zhang, Ying Gu
Peking University (China)

We propose a scheme of atom-assisted cavity optomechanical system and demonstrate the electromagnetically-optomechanically induced transparency, where a transparent point appears as long as the satisfaction of two sets oftwo-photon resonance. Our work offers new insight for the tripartitle coherent interaction among photon, phonon and atom, giving great exibility for manipulation of light and motivating the development of quantum information process.

P3: Quantification of Resonance Scaling for Open Subwavelength-Resonator Based Structures
Andriy E. Serebryannikov[1], Guy A. E. Vandenbosch[1], Ekmel Ozbay[2]
[1] *Katholieke Universiteit Leuven (Belgium),* [2] *Bilkent University (Turkey)*

Scaling of resonance structures and resonance frequencies therein has always been important for applications. We demonstrate that although the classical scaling rule does not work for open resonance structures, the effect of permittivity of substrate/spacer on resonance frequencies can be quantified. Examples of the scaling are presented for few-layer metasurfaces and miniature microwave antennas.

P4: Frequency Shift of Light in Highly Dispersive Time-Varying Metasurfaces
Jagang Park, Hyukjoon Cho, Hyun Sung Park, Bumki Min
Korea Advanced Institute of Science and Technology (KAIST) (Korea)

This work suggests a new class of time-varying metasurface for efficient frequency shift of light. The proposed metasurface is properly designed to exhibit highly dispersive phase responses, so that a dynamic change in the spectral response gives a rapid phase sweep of transmitted light, which directly corresponds to a frequency shift. The frequency-converted waves through the metasurface are analysed based upon a temporal coupled-mode formalism. Furthermore, we compare our time-varying metasurfaces with the conventionally studied angular Doppler effect.

P5: Chemistry of remotely separated species hybridized by strong light-matter coupling
Matthew Du[1], Raphael F. Ribeiro[1], Luis A. Martinez Martinez[1], Zixuan Hu[2], Vinod M. Menon[3], Joel Yuen-Zhou[1]
[1] *University of California San Diego (USA),* [2] *Purdue University (USA),* [3] *City University of New York (USA)*

Quantum states in different molecules can be hybridized by strong light-matter interaction. Here we present strategies that employ such coupling to enable photochemistry involving remotely separated species. first, we show how polariton-assisted remote energy transfer (PARET) across hundreds of nanometers occurs when surface plasmons strongly interact with both donor and acceptor chromophores. We then propose a remote control of chemistry whereby photoexcitation of molecules in one optical microcavity influences the photoinduced reactivity of molecules in another microcavity.

P6: Effective Approach for Design and Simulation of Metalens Structures
Chenglin Xu[1], Matt Novak[1], Dan Herrmann[1], Li-Ce Hu[2], Evan Heller[1], Mayank Bahl[1]
[1] *Synopsys Optical Solutions Group (USA),* [2] *Cybernet Systems Taiwan (Taiwan)*

An effective simulation approach for metalens design is demonstrated by combining multiple algorithms. finite-Difference Time-Domain (FDTD) or Rigorous Coupled Wave Analysis (RCWA) algorithms are used to calculate the phase delay of various nano-cells, and then efficient beam propagation methods are used to trace the beam through the metalens or its phase mask. The test example shows that this multi-algorithm combined approach is accurate and efficient with reduced demand on computational memory and time.

P7: Pure toroidal dipole excitation in dielectric nanoparticles
Reza Masoudian Saadabad[1], Marcus Cai[2], Lei Xu[1], Andrey E. Miroshnichenko[1]
[1] *University of New South Wales (Australia),* [2] *Australian National University (Australia)*

A tightly focused, radially polarised cylindrical vector beam in conjunction with a plane wave has been applied to launches toroidal dipole moment while suppressing electric dipole moment in a silicon nanodisk. The nanodisk was illuminated in z-axis by the cylindrical vector beam while the plane wave exposed the disk in a 45o direction relative to the beam. In a given configuration we were able to achieve the strongest toroidal dipole moment excitation.

P8: Fundamentals of linear momentum transfer from swift electrons to nanoparticles

Alejandro Reyes-Coronado, Jesus Castrejon-figueroa, Jose angel Castellanos-Reyes
Universidad Nacional Autonoma de Mexico (Mexico)

Following a classical electrodynamics approach, we present an analysis of the linear momentum transfer from swift electrons to nanoparticles as a function of the relevant parameters: particle's radius, speed of the electron and its impact parameter. Since the momentum transfer is given in terms of the Maxwell stress tensor, we split the contribution to the momentum transfer in electric and magnetic components, and discuss their contribution to both attractive and repulsive regimes, previously found.

P9: Experimental observation of topological edge waves in a two-dimensional Su-Schrieffer-Heeger acoustic network

Liyang Zheng, Vassos Achilleos, Olivier Richoux, Georgios Theocharis, Vincent Pagneux
Université du Maine (France)

We propose an acoustic realization of 2D SSH model by constructing a simple network structure for sound waves. We study the network analytically using a tight-binding model. Topological edge waves are predicted on the boundary of the network both from both the analytical model and numerical simulations. We experimentally observe the existence of topological edge waves. The appearance of topological edge waves in the acoustic network provides a flexible platform for the study of topological properties of sound waves.

P10: Broadband flattened parabolic reflector antenna based on metasurface

Vivien Taverny, Badreddine Ratni, Shah Nawaz Burokur
Université Paris Nanterre (France)

A flattened parabolic reflector antenna is designed to operate under right-hand circular polarization (RHCP) by using a reflective metasurface composed of square patches printed on a grounded dielectric substrate. A circularly-polarized patch antenna placed at the focal point of the metasurface reflector is used as the primary feed. Numerical simulations are conducted and far-field simulation results show a highly directive beam with a realized gain of 20 dBic.

P11: Leaky Mode Engineering for Spectral Light Conversion Enhancement on Silicon Photonic Crystal Slabs

Doguscan Ahiboz, Phillip Manley, Christiane Becker
Helmholtz Zentrum Berlin fur Materialien und Energie (Germany)

We designed and produced twodimensional Silicon photonic crystal slabs on glass operating at nearinfrared wavelengths. By tunning the slab thickness, we were able to systematically adjust the spectral position of leaky modes associated with strong near field enhancement effects, over several hundred of nanometers. Near and far field characteristics of the photonic crystal slabs were examined numerically and experimentally. Proper design yields 100fold enhanced near field at 1550nm enabling efficient photon upconversion in future solar energy and telecommunication devices.

P12: An Atomistic Approach for Hybrid Plasmonic Systems

Giulia Giannone, Fabio Della Sala, Stefania D'Agostino
Center for Biomolecular Nanotechnologies-IIT (Italy)

Using Time-Dependent Density Functional Theory, we investigate the interactions between a localized surface plasmon excitable in a silver cluster and a molecular exciton optically active in the same energy range. We show that the optical response of the system, for an ultra-near-field regime of interaction, is marked by the appearance of a two-peak structure. We propose a plasmon-exciton electromagnetic interaction model as explanation of the spectra of such hybrid systems of interest for molecular plasmonics.

P13: Acoustic cloaking and self-cloaking inside ducts using liners

Maaz Farooqui, Yves Auregan, Vincent Pagneux
Le Mans University (France)

Acoustic cloaking for backscattering reduction is proposed inside ductsin the audible range where plane waves are bended around the object using liner surface modes. It is shown that a slowly varying resonant liner forms a dumb zone in which an object of any shape can be rendered acoustically invisible for a wide range of frequencies. For smooth shaped obstacles, there is an ability of the object to help hide itself, which increases the cloaking frequency band (self-cloaking).

P14: Effect of Ballistic Electrons on the Optical Response of Hyperbolic Metamaterials

Guilherme Migliato Marega, Achiles Fontana Mota, Ben-Hur Viana Borges, Euclydes Marega Junior
University of Sao Paulo (Brazil)

This paper presents a theoretical and experimental study of the effect of ballistic electrons on the optical response of a MIM (Metal-Insulator-Metal) like hyperbolic metamaterial structure. The simulated model and the experimental optical transmission show a 20 % peak difference. The higher attenuation attained experimentally may be explained by the existence of ballistic electrons in the silver films.

P15: Haze Removal based on New Estimation of the Atmospheric Light

Ruxi Xiang, Xifang Zhu, Feng Wu, Qingquan Xu, Ye Lu
Changzhou Institute of Technology (China)

In order to obtain the accurate estimation of the atmospheric light, we present a new and effective method for computing the atmospheric light based on the salient region of the input image, which estimates the atmospheric light by combining the statistical characteristics of between the darkness channel and the region of the atmospheric light. Compared with existing methods, our results show that our method can accurately recover the atmospheric light and effectively remove the haze from the bad weather.

P16: Haze removal method based on decomposition

Xifang Zhu, Ruxi Xiang, Feng Wu, Qingquan Xu, Ye Lu
Changzhou Institute of Technology (China)

To obtain a reflected image of haze, a new haze-removing method is proposed based on decomposition, which effectively reconstructs a reflected image from the hazy image. The decomposition problem can be formulated as a constrained quadratic programming optimization problem which can be obtained by combining the Bregman method with the fast Fourier transform method. Compared with existing methods, our results show that our method can effectively remove the haze and improve image qualities such as contrast, sharpness and color.

P17: Photogenerated Excitons of Cesium Lead Bromide Perovskite Quantum dots through ligand Passivation

Sunjoong Park, Hyunjin Cho, Wonseok Choi, Hongjoo Shin, Duk Young Jeon
Korea Advanced Institute of Science and Technology (Korea)

We investigated the mechanism of exciton decay dynamics of cesium lead bromide (CsPbBr3) perovskite quantum dots (QDs) through the X-type ligand passivation process. 1-Dodecanethiol (DDT) ligand passivates the Br vacancy of CsPbBr3 QDs and photoluminescence quantum yield (PLQY) is increased from 76.7 % to 99.76 %. To clarify this phenomenon, we observed exciton decay dynamics by varying the temperature (80k $\sim$ 300k). Our results suggest that Br vacancy of CsPbBr3 QDs affects the increased exciton lifetime.

P18: Rapid and Highly efficient annealing process for photoluminescence efficiency improvement of quantum dots using intence pulse light

Chulhee Lee, Taeyoung Song, Duk Young Jeon
Korea Advanced Institute of Science and Technology (Korea)

Typical quantum dots (QDs) have surface trap sites causing low photoluminescence efficiency. To solve this issue, we have introduced the intense pulse light (IPL) annealing that almost instantaneously supplies heat within very short time and brings enough energy to QDs. The IPL annealing technique is possible to remove the defect by applying optimum amount of heat to QDs using very short pulse, and we have observed considerable improvement from 20 % to 40 % of quantum efficiency of the QDs.

P19: The Software-Defined Metasurfaces Concept and Electromagnetic Aspects

Anna Tasolamprou[1], Alexandros Pitilakis[1], Odysseas Tsilipakos[1], Christos Liaskos[1], Ageliki Tsiolaridou[1], Fu Liu[2], Xuchen Wang[2], Mohammad Mirmoosa[2], Kypros Kossifos[3], Julius Georgiou[3], Andreas Pitsilides[3], Nikolaos Kantartzis[1], Dionysios Manessis[4], Sotiris Ioannidis[1], George Kenanakis[1], George Deligeorgis[1], Eleftherios Economou[1], Sergei Tretyakov[2], Costas Soukoulis[1], Maria Kafesaki[1]
[1] *IESL - FORTH (Greece),* [2] *Aalto University (Finland),* [3] *University of Cyprus (Cyprus),* [4] *Berlin Center of Advanced Packaging (Germany)*

We present the concept and electromagnetic aspects of Hypersurfaces (HFSs), artificial, ultrathin structures with software controlled electromagnetic properties. The HFSs key unit is the metasurface, a plane with designed subwavelength features whose electromagnetic response can be tuned via voltage-controlled continuously-tunable electrical elements that provide local control of the surface impedance and advanced

functionalities, such as tunable perfect absorption or wavefront manipulation. A nanonetwork of controllers enables software defined HFSs control related to the emerging Internet of Things paradigm.

P20: Electrically Controllable Directional Coupler Based on Dielectric Loaded Graphene Plasmon Waveguide

Wei Xu, Hanyu Wang, Chao Li, Jianfa Zhang, Chucai Guo, Ken Liu, Xiaodong Yuan, Zhihong Zhu, Shiqiao Qin

National University of Defense Technology (China)

We propose and numerically analyze a mid-infrared electrically controllable plasmonic waveguide directional coupler that is composed of two parallel identical straight dielectric loaded graphene plasmonic waveguide. By varying the Fermi energy level of the graphene sheet, the maximum power coupled from the input waveguide to the cross-waveguide and the corresponding coupling length could be effectively tuned. This directional coupler could serve as an electrically controlled optical switch or 3-dB splitter around the wavelength of 10.5μm.

P21: Electrically Tunable Graphene Polarization Controlling

Chao Li, Hanyu Wang, Wei Xu, Jianfa Zhang, Chucai Guo, Ken Liu, Xiaodong Yuan, Zhihong Zhu, Shiqiao Qin

National University of Defense Technology (China)

We proposed a tunable terahertz half-wave plate composed of a periodic array of graphene nanodisk dimers supported on a dielectric spacer backed by a planar gold layer. The polarization conversion phenomena are attributed to the hybridization effect caused by coupling interactions between plasmonic resonances in the graphene nanodisk dimers. By varying the distance between graphene nanodisks, the polarization conversion performance can be controlled. Further, the polarization conversion can be dynamically tuned at different frequencies via electrostatic doping of graphene.

P22: Graphene-based Perfect Absorption in the Near Infrared

Hanyu Wang, Wei Xu, Chao Li, Jianfa Zhang, Chucai Guo, Ken Liu, Xiaodong Yuan, Zhihong Zhu, Shiqiao Qin

National University of Defense Technology (China)

In this work, we propose a kind of monolayer graphene based absorption structures which comprise dielectric materials with low refractive index contrast, and we directly verify the complete optical absorption in experiment for monolayer graphene based subwavelength structures in the near-infrared. Peak absorptions over 99 $\%$ at wavelength around 1.5 μm with full-width at half maximum (FWHM) about 20 nm are demonstrated from monolayer graphene coupled with different subwavelength gratings on top of a back gold mirror.

11:00 - 12:40 — IST Congress Center Auditorium

Session 3A2

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

11:00 : Invited talk

Acousto-plasmonics: from acoustic metasurfaces to chirality in coherent phonon generation experiments

Kevin O'Brien[1], Jun Rho[1], Haim Suchowski[1], Xiang Zhang[1], Alba Jimenez[2], Antonio Garcia-Martin[2], Daniel Lanzillotti Kimura[3]

[1] *University of California (USA),* [2] *IMN-Instituto de Micro y Nanotecnologia (CNM-CSIC) (Spain),* [3] *Université Paris-Saclay (France)*

We propose the integration of plasmonics concepts into the field of nanophononics using metallic nanoresonators as coherent phonon generators and detectors. Picosecond ultrasonics tools give direct access to the

study of phonon propagation both in the time and frequency domains, and to the spatial distribution of strain in nanostructures.

11:20 : Invited talk
Using femtosecond laser pulses to control the assembly and welding of plasmonic nanostructures
Ovidio Pena-Rodriguez[1], Guillermo Gonzalez-Rubio[2], Pablo Diaz-Nunez[1], Antonio Rivera[1], Luis Banares[2], Luis M. Liz-Marzan[3], Andres Guerrero-Martinez[1]
[1] *Universidad Politecnica de Madrid (Spain),* [2] *Universidad Complutense de Madrid (Spain),* [3] *CIC biomaGUNE (Spain)*

We describe a light-controlled synthetic procedure to fabricate selected plasmonic oligomers. Directed assembly of gold nanorods using dithiolated molecular linkers allows the controlled tip-to-tip assembly. With the aid of fs laser pulses, this process can be tuned to increase the temperature at the interparticle gaps to either destroy the organic ligands or melt particle tips and weld the particles together, offering a new pathway toward fabrication of novel complex nanoparticles with a plasmonic response not attainable by other methods.

11:40 : Keynote talk
Organic-inorganic Lead Halide Perovskite for High Efficiency Energy Conversion
Nam-Gyu Park
Sungkyunkwan University (Korea)

In this talk, the advent of solid state PSC is briefly introduced, which is followed by progress of PSC in terms of materials and devices. Issues in PSC such as current-voltage hysteresis, control of recombination and stability are also discussed based on doping approach, interface modification using post-treatment and additive engineering.

12:10 : Keynote talk
Optical imaging and metrology with nanoscale resolution
Nikolay I. Zheludev
University of Southampton (United Kingdom)

We introduce a new free space label free imaging paradigm and metrology technique that exploit optical singularities in super-oscillatory optical fields. Imaging resolution beyond $\lambda/100$ and displacement metrology with resolving power of $\lambda/800$ have been demonstrated.

11:00 - 12:40 — Auditorium VA1

Session 3A3

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

11:00 : Invited talk
Adsorption Site Recognition in Single Molecule Junction
Satoshi Kaneko, Manabu Kiguchi
Tokyo Institute of Technology (Japan)

We report on a new methodology for identifiying the connectivity of a single molecule junction through the combination of SERS and current-voltage response.

11:20 : Invited talk
Synthesis of highly brilliant SERS-encoded core-satellite nanostructures
Nicolas Pazos-Perez, Ramon Alvarez Puebla
University Rovira i Virgili (Spain)

A novel method to produce complex SERS encoded nanoparticles (SEPs) is presented. Codified NPs are

first produced and further use as building blocks to produce core-satellite SEPs. This versatile protocol allows SERS codification with a wide variety of Raman codes and the use of different materials and shapes. Moreover, the core-satellites are designed to exhibit minimal interparticle distances (<2-3 nm) with maximum satellite loading, while positioning the encoding agents at the gaps achieving very high optical efficiency

11:40 : Invited talk
Plasmon-enhanced fluorescence of EGFP immobilized on optically thin perforated Al films
Vladimir E. Bochenkov[1], Artyom A. Astafiev[1], Alexander M. Shakhov[2], Vadim A. Timoshenko[1]
[1] *Lomonosov Moscow State University (Russia),* [2] *Semenov Institute of Chemical Physics of RAS (Russia)*

Hybrid bionanomaterial comprised of Enhanced Green fluorescent Protein covalently bound to 20∼nm thick perforated Al film has been created. The short-ordered arrays of nanoholes with diameter in range 65-120 nm have been fabricated using sparse colloidal lithography. By changing the diameter of the nanoholes, the plasmon-polariton frequency has been tuned across the spectrum. The strongest plasmon-enhanced fluorescence has been observed for the systems with 120 nm nanoholes, reaching the 2.75 enhancement factor.

12:00 : Invited talk
Tunable Shape-controlled Plasmonic Nanoparticles Superlattices for Surface-enhanced Raman Scattering Applications
Xing Yi Ling
Nanyang Technological University (Singapore)

A major challenge in nanoparticle self-assembly is tuning one type of anisotropic nanoparticle into distinct superlattices with tunable packing efficiencies. Here, I will discuss how nanoscale surface chemistry is used to direct the self-assembly of shape-controlled silver nanoparticles into three distinct two-dimensional plasmonic superlattices. The structure-to-function characterization reveals that the nanoparticle assembly are highly dependent on their resulting crystal structures.

12:20 : Invited talk
Plasmonics in complex geometries: Modal optical properties and coupling with nanoscale emitters
Pierre-Michel Adam
Université de Technologie de Troyes (France)

Plasmonics deals with the properties and the control of localized and delocalized surface plasmons at the subwavelength scale. Understanding the coupling properties between quantum emitters and surface plasmons resonances and/or nanonantennas is a key step towards realistic applications in the near future. We will present in this paper our latest experimental and theoretical results on the optical properties of different plasmonic systems exhibiting complex resonant modes and applications for the sensitive detection of molecules.

11:00 - 12:40 — Auditorium VA2

Session 3A4

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

Chaired by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

11:00 : Invited talk
Chiral quantum photonics
Nir Rotenberg
University of Copenhagen (Denmark)

We report on recent advances in the field of chiral quantum optics, focusing on experimental implementations using solid-state quantum emitters such as quantum dots. In particular, we discuss how chiral quantum

light-matter interactions can form the basis for deterministic spin-photon interfaces and enable non-reciprocal photonic devices.

11:20 : Invited talk
Photonic Orbital Angular Momentum Transfer and Magnetic Skyrmion Rotation
Wenrui Yang, Huanhuan Yang, Yunshan Cao, Peng Yan
University of Electronic Science and Technology (China)

We predict a photonic orbital angular momentum transfer effect, by studying the dynamics of magnetic skyrmions subject to Laguerre-Gaussian optical vortices, which manifests a rotational motion of the skyrmionic quasiparticle around the beam axis. The topological charge of the optical vortex determines both the magnitude and the handedness of the rotation velocity of skyrmions. The twisted light beam acts as an optical tweezer to displace skyrmion motions.

11:40 : Invited talk
Electromagnetic Sink Based on a Nonreciprocal Metasurface Cavity
Mojtaba Dehmollaian[1], Guillaume Lavigne[2], Christophe Caloz[2]
[1] *University of Tehran (Canada),* [2] *Polytechnique Montreal (Canada)*

This paper proposes a nonreciprocal bianisotropic metasurface cavity to absorb the electromagnetic radiation of a given illumination. Using Generalized Sheet Transition Conditions (GSTCs), it first synthesizes the susceptibility tensors, corresponding to specifications. Next, it employs combined integral equations and GSTCs to compute the scattering by the metasurface cavity. It presents results for a circular cavity illuminated by a plane wave, which reveal that fields inside the cavity are waveguide mode fields and a shadow appears at the cavity backside.

12:00 : Invited talk
Simple Spintronics and Superconducting Spintronics, Based on the Chiral Induced Spin Selectivity (CISS) Effect
Yossi Paltiel
Hebrew University (Israel)

With the increasing demand for miniaturization, nano-structures are likely to become the primary components of future integrated circuits. Different approaches are being pursued towards achieving efficient electronics, among which are spin electronics devices (spintronics). In principle, the application of spintronics should result in reducing the power consumption of electronic devices. A new, promising, effective approach for spintronics has emerged using spin selectivity in electron transport through chiral molecules, termed Chiral-Induced Spin Selectivity (CISS).

12:20 : Invited talk
Topological Magnonic Materials and Devices
Xiangrong Wang
The Hong Kong University of Science and Technology (China)

Several topological magnonic models are presented. The edge spin waves in these magnonic materials are robust against perturbations. An interesting functional magnonic device called beamsplitter and interferometer can be made out of a domain wall in a strip. It is shown that an in-coming spin wave beam along one edge splits into two spin wave beams propagating along two opposite directions on the other edge after passing through a domain wall.

11:00 - 12:50 — Auditorium VA3

Session 3A5

Parity-Time and related symmetries in Photonics, Plasmonics, Acoustics

Organized by: Anatole Lupu and Henri Benisty

Chaired by: Anatole Lupu and Henri Benisty

11:00 : Invited talk
Odd-PT-symmetric couplers
Vladimir Konotop[1], **Dmitry Zezyulin**[2]
[1] *Universidade de Lisboa (Portugal),* [2] *ITMO University (Russia)*

Parity-time-symmetric couplers with odd time reversal are introduced. In such systems the waveguides with gain and losses are coupled by anti-PT-symmetric media. We describe constraints imposed by the symmetry on spectral characteristics of the guided modes. As an application, we propose a coherent switch operating with a superposition of binary states. We also discuss coherent perfect absorption and lasing by non-Hermitian optical potentials embedded in such waveguides.

11:20 : Invited talk
Coupled resonances with dynamic modulation for selective wavelength conversion
Galaad Altares Menendez, Bjorn Maes
University of Mons (Belgium)

We present a method to obtain efficient and selective frequency conversion using a system of two time-modulated cavities. This setup allows to tailor the conversion process by controlling important parameters such as the inter-cavity coupling and the external excitation frequency. We describe the process extensively, with for example an important role for the dynamic modes of the coupled system, the Floquet modes.

11:40 : Invited talk
Non-Hermitian transformations with optical metasurfaces
Andrey A. Sukhorukov
Australian National University (Australia)

We present theoretical and experimental results demonstrating non-Hermitian transformation of classical and quantum states of light with ultra-thin dielectric metasurfaces. We introduce a new conceptual approach for implementing arbitrary complex birefringence with polarization-dependent transmission, based on tailored interference from specially engineered nano-resonators in the metasurface. The fabricated metasurfaces demonstrate new regimes of polarisation control for enhanced measurements and unconventional interference with classical and quantum light, and discuss analogies with Parity-Time symmetric transformations.

12:00 : Electrically injected DFB laser based on the Parity-Time symmetry concept
Vincent Brac de la Perriere, Quentin Gaimard, Henri Benisty, Abderrahim Ramdane, Anatole Lupu
Université Paris-Saclay (France)

The principle of Parity-Time symmetric optics is exploited for realization of electrically injected single frequency DFB lasers based on industry-adopted design and fabrication approaches. Experimental evidence is provided for 'unidirectional' gain discrimination mechanism induced by the complex refractive index Bragg grating. This is expected to enhance lasers' resistance to parasitic optical feedback. The experimental results showing an apparent correlation between the gratings real-to-imaginary phase shift and the laser feedback resistance are corroborating theoretical prediction.

12:15 : Nonreciprocal Passive Acoustic Structures with Broken PT-Symmetry
Arkadii Krokhin[1], **Yurii Zubov**[1], **Jyotsna Dhillon**[1], **Andrey Bozhko**[1], **Ezekiel Walker**[2], **Arup Neogi**[1]
[1] *University of North Texas (USA),* [2] *Echonovus Inc. (USA)*

Nonreciprocal transmission of sound through a phononiccrystal with asymmetric metal rods in viscous background(water) is studied within a wide range of frequencies. Nonreciprocityin transmission is observed if sound wave propagatesalong the directions with broken P-symmetry. Thetransmission remains reciprocal along the P-symmetric direction.Experiments are performed for periodic and disorderedsamples. In the latter case the nonreciprocity isobserved for localized states in the regime of exponentiallyweak transmission.

12:30 : Invited talk
Anisotropic exceptional points of arbitrary order
Yi-Xin Xiao[1], **Zhao-Qing Zhang**[2], **Zhi Hong Hang**[1], **Che Ting Chan**[2]
[1] *Soochow University (China),* [2] *Hong Kong University of Science and Technology (Hong Kong)*

A pair of anisotropic exceptional points (EPs) of arbitrarily high order are found in a class of random non-Hermitian systems carrying non-reciprocal hoppings. Both Eigenvalues and phase rigidity show different asymptotic forms near the anisotropic EPs in two orthogonal directions in the parameter space. Such systems have order-2 EPs forming multiple ellipses that converge to the two high-order EPs in the parameter space

and these ellipses coalesce to form a ring of high-order EPs for some particular configurations.

11:00 - 12:45 — Auditorium VA4

Session 3A6

Plasmonics: Fundamentals and Applications

Organized by: Hong Wei

Chaired by: Hong Wei

11:00 : Invited talk
Plasmon Enhancement of Luminescence Upconversion
Wounjhang Park
University of Colorado Boulder (USA)

This paper presents a comprehensive theoretical framework for plasmon enhancement of luminescence upconversion and also a systematic experimental study demonstrating the enhancement mechanisms. finally, metal-insulator-metal design was used to achieve a record high 1200x enhancement in upconversion.

11:20 : Optical Diversity of Metal Nanoparticles Modified by Stilbene Compounds: Plasmon Coupling, Raman Resonance Enhancement and fluorescence Quenching
Elena Solovyeva, Alexey Smirnov, Olga Odintsova, Vlad Deev
Saint-Petersburg State University (Russia)

In this work, we investigated the optical properties and surface chemistry of noble metal nanoparticles modified by mono- and 4,4'-bifunctional stilbene compounds. Based on SERS spectra, UV-vis and TEM data, the linking of nanoparticles accompanied by plasmon coupling was revealed for 4,4'-diaminostilbene but remains under question for 4,4'-dimercaptostilbene. Ligand to metal charge transfer, occurring exclusively in the regions of plasmon coupling, was established. Analytical enhancement factors were calculated. Optical activity of modified nanoparticles was also investigated by fluorescent spectroscopy.

11:35 : Continuously tuning the coupling strength of bow-tie nanoantennas by strain variation
Florian Laible, Dominik A. Gollmer, Simon Dickreuter, Dieter P. Kern, Monika Fleischer
Eberhard Karls Universitat Tubingen (Germany)

Plasmonic coupling effects show a strong distance dependence for few nanometer gaps. The coupling of individual nano-bowties is reversibly tuned by fabricating antennas on flexible polymers, enabling their use as plasmon rulers or strain sensors.

11:50 : Invited talk
Optical and spectroscopic properties of large scale and flexible plasmonic metasurfaces by colloidal self-asssembly
Tobias A. F. Konig
Technical University Dresden (Germany)

For the next generation of optical computing, a novel and cost efficient approach is needed. This future development requires both tailored control over nanometer-sized building blocks on large area and a fundamental understanding of the strong as well as coherent coupling mechanisms. Currently, practical demonstrations are scarce, and are limited in terms of how many devices may be fabricated in parallel. To realize fabrication on a larger scale, a synergy between optical metasurfaces and colloidal self-assembly will be leveraged.

12:10 : Invited talk
Extraordinary Transmission and Polarization Control of Cavity Modes in Thue-Morse Gold Nanocavities
Antonio De Luca[1], Rakesh Dhama[2], Vincenzo Caligiuri[3], Lucia Petti[4], Alireza R. Rashed[5], Massimo Rippa[4], Raffaella Lento[6], Roberto Termine[6], Humeyra Caglayan[5]
[1]*University of Calabria (Italy),* [2]*Bangor University (United Kingdom),* [3]*Istituto Italiano di Tecnologia (Italy),*

[4]*CNR (Italy),* [5]*Tampere University of Technology (Finland),* [6]*CNR Nanotec (Italy)*

Plasmonic quasi-periodic structures are well-known to exhibit several surprising phenomena with respect to their periodic counterparts, due to their long-range order and higher rotational symmetry. Thanks to their specific geometrical arrangement, plasmonic quasi-crystals offer unique possibilities in tailoring the coupling and propagation of surface plasmons through their lattice, unabling a plethora of fascinating phenomena. In this work we investigate the extraordinary transmission phenomenon occurring in specifically patterned Thue-Morse gold nanocavities and the polarization dependence of their cavity modes.

12:30 : The role of the thermo-optic nonlinearity of metals in plasmonic-assisted photocatalysis
Ieng Wai Un, Yonatan Dubi, Y. Sivan
Ben-Gurion University (Israel)

We show that a failure to account for the thermo-optic nonlinear response of the metals leads to significant overestimates of the temperature developing in illuminated metal-dielectric composites used for photocatalysis. This error is then frequently interpreted incorrectly as non-thermal (i.e., 'hot') electrons action. As an alternative, we provide a purely thermal self-consistent model that explains the observed experimental data.

11:00 - 12:40 — Auditorium VA5

Session 3A7

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Marco Rahm

11:00 : Invited talk
Nanocrystal Optoelectronics
Hilmi Volkan Demir
Bilkent University (Turkey)

In this talk, we will introduce the emergent field of nanocrystal optoelectronics using solution-processed quantum dots and wells. In particular, we will present a new concept of all-colloidal lasers developed by incorporating nanocrystal emitters as the optical gain media, intimately integrated into fully colloidal cavities [3]. In the talk, we will then focus on our most recent work on the latest rising star of tightly-confined atomically flat nanocrystals, the quasi-2D colloidal quantum wells (CQWs), also popularly nick-named 'nanoplatelets'.

11:20 : Invited talk
Quantum Plasmons and Plasmon-Emitter Interactions at the Nanoscale
Paulo André Dias Goncalves[1], Thomas Christensen[2], Nicholas Rivera[2], Antti-Pekka Jauho[1], Marin Soljacic[2], N. Asger Mortensen[3]
[1]*Technical University of Denmark (Denmark),* [2]*Massachusetts Institute of Technology (USA),* [3]*University of Southern Denmark (Denmark)*

We present a theory for quantum nanoplasmonics that incorporates nonlocality and quantum effects like electronic spill-out and surface-enabled Landau damping, while also including retardation. We derive analytical expressions for the nonclassical scattering coefficients, from which the optical response of the systems can be unambiguously determined. We compute the systems' plasmonic excitations and investigate the role of quantum surface corrections to plasmon-emitter interactions, e.g., Purcell enhancement, dipole-forbidden transitions rates, and plasmon-mediated energy transfer.

11:40 : Invited talk
Surface plasmon-driven ultrafast dynamics of hot electrons
Ilya Razdolski[1], Alexander L. Chekhov[2], Alexander I. Stognij[3], Andrzej Stupakiewicz[4]
[1]*Fritz Haber Institute of the Max Planck Society (Germany),* [2]*Moscow State University (Russia),* [3]*Scientific-Practical Materials Research Center of the NASB (Belarus),* [4]*University of Bialystok (Poland)*

We analyze ultrafast hot electron dynamics in the time domain upon optical excitation of propagating surface

plasmon-polaritons in metal-dielectric heterostructures. Considering both local and non-local hot electron relaxationon equal footing, we develop a kinetic model elucidating the role of surface plasmon-polaritons in an apparent slowdown of electron transport. We show how the timetransmissivity data can be employed for the direct measurement of surface plasmon lifetimes at arbitrary corrugated interfaces with unknown losses.

12:00 : Invited talk
Mid Infrared Metasurfaces
Yoshiaki Nishijima, Naoki To, Takuhiro Kumagai
Yokohama National University (Japan)

Mid infrared wavelength is unique to detect the molecular vibration mode.Especially absorption type of frequency selective meta surface can be used for thermal light source, detector and sensing material.Here we demonstrate the recent advances of plasmonic meta surfaces in mid infrared wavelength region. The experimentally measured optical properties were compared with simulations by finite-difference time-domain calculations. Also, we demonstrate applications of these structures for the plasmonic IR-light sources and detectors.

12:20 : Invited talk
Translational invariant structured mirrors for beam-shaping
Ramon Herrero Simon[1], Pei-Yu Wang[2], Yu-Chieh Cheng[2], Muriel Botey[1], Kestutis Staliunas[1]
[1] *Universtitat Politecnica de Catalunya (Spain),* [2] *University Taipei (Taiwan)*

We propose beam-shaping and light filtering in reflection based on translational invariant structured mirrors. These meta-mirrors are composed by a thin structured layer with a transverse modulation of the refractive index in the micron scale and positioned in front of a metallic flat mirror. The strong transverse spectrum modification allows spatial filtering and beam-shaping of the reflected beam. The study points toward new possible type of filtering devices without alignment needs due to its translational invariance.

11:00 - 12:40 — Auditorium VA6

Session 3A8

Silicon Photonic Integrated Circuits

Organized by: Jian Wang

Chaired by: Jian Wang

11:00 : Invited talk
Hybrid on silicon photonics for light amplification and Fano-enhanced electro-optical modulation at telecom wavelengths
Jianhao Zhang[1], John Ronn[2], Xavier Le Roux[1], Carlos Alonso-Ramos[1], Mathias Berciano[1], Delphine Marris-Morini[1], Sailing He[3], Zhipei Sun[2], Laurent Vivien[1], Eric Cassan[1]
[1] *University Paris-Saclay (France),* [2] *Aalto University (Finland),* [3] *Zhejiang University (China)*

Our presentation will summarize recent contributions on two key functions in in silicon photonics for on-chip amplification and Fano-enhanced nanocavities devoted to electro-optical modulation at telecom wavelengths.

11:20 : Invited talk
Scaling of monolayer 2D photonic crystal surface emitting lasers for 3D integrated photonics
Weidong Zhou, Xiaochen Ge
University of Texas at Arlington (USA)

In this talk, I will report recent progresses related to hybrid integrated photonic crystal surface-emitting membrane lasers on silicon substrate, based on QW gain material and transition metal dichalcogenide monolayers. Issues to be discussed related to thermal performance, charge injection, and scaling towards energy efficient optical interconnects.

11:40 : Invited talk

Plasmonics in Silicon Photonics for Microwave Photonics

Yannick Salamin[1], Wolfgang Heni[1], Ping Ma[1], Yuriy Fedoryshyn[1], Benedikt Baeuerle[1], Arne Josten[1], Christian Haffner[1], Michael Baumann[1], Bojun Cheng[1], Tatsuhiko Watanabe[1], Maurizio Burla[1], Alexandros Emboras[1], Delwin L. Elder[2], Larry R. Dalton[2], Juerg Leuthold[1]
[1] *ETH Zurich (Switzerland),* [2] *University of Washington (USA)*

We show how plasmonics can be integrated with the silicon photonics platform to enable new electro-optic devices. Different active materials are integrated with a plasmonic slot waveguide technology to achieve highest speed modulators and photodetectors on a lowest footprint. It is discussed how the unique properties offered by plasmonics enables new opportunities for the field of microwave photonics.

12:00 : Invited talk

Heterogeneously integrated membrane III-V/Si photonic devices

Tatsurou Hiraki, Takuma Aihara, Koji Takeda, Takuro Fujii, Hidetaka Nishi, Takaaki Kakitsuka, Tai Tsuchizawa, Hiroshi Fukuda, Shinji Matsuo
NTT Device Technology Labs (Japan)

We reveiw our recent work on heterogeneously integrated III-V/Si MOS capacitor Mach-Zehnder modulators and lateral current injection lasers with a membrane III-V semiconductor structure, which provides a high optical confinement factor for low power consumption and easy integration with Si waveguide circuits.

12:20 : Invited talk

Lithium Niobate Michelson Interferometer Modulator on Silicon-On-Insulator Platform

Xinlun Cai
Sun Yat-sun University (China)

We demonstrate a lithium niobate Michelson interferometer (MI) modulator on silicon-on-insulator platform with half the voltage-length product (Vpi.L) compare to silicon based Mach-Zehnder interferometer (MZI). A single MI modulator shows the electro-optic modulation efficiency of 1.2V·cm and insertion loss of 3dB. The -3dB electro-optic bandwidth is approximately 16 GHz, and the optical eye diagrams, operating at 30 Gbit/s and 40 Gbit/s, with dynamic extinction ratios are measured at 10 dB and 6.8 dB respectively.

11:00 - 12:55 — Auditorium EA1

Session 3A9

Modelling, simulation and optimization of metasurfaces

Organized by: Patrice Genevet and Stéphane Lanteri

Chaired by: Patrice Genevet and Stéphane Lanteri

11:00 : Invited talk

Generalized Brewster conditions and bound states in the continuum in metal and all-dielectric metasurfaces through a coupled electric/magnetic dipole model

Diego R. Abujetas[1], Juan J. Saenz[2], Jose A. J. Sanchez-Gil[1]
[1] *Instituto de Estructura de la Materia (IEM-CSIC) (Spain),* [2] *Donostia International Physics Center (Spain)*

We derive a coupled electric and magnetic dipole theoretical formulation to describe the optical properties of a periodic array consisting of one/several electric/magnetic dipoles per unit cell. This formulation is exploited to show that a generalized Brewster effect can be achieved in all-dielectric-nanorod-based metasurfaces. Also, we investigate symmetry-protected bound states in the continuum (BICs) in arrays of detuned resonant dipoles. We also propose a scheme to engineer angularly-selective BICs with single magnetic-dipole resonance meta-atoms, called Brewster-like quasi BICs.

11:20 : Invited talk

Optimized 3D metasurface for maximum light deflection at visible range

Mahmoud M. R. Elsawy[1], Stephane Lanteri[1], Regis Duvigneau[1], Peinan Ni[2], Gauthier Briere[2], Patrice Genevet[2]

[1] *INRIA (France),* [2] *Université Cote d'Azur (France)*

In this contribution, we use two different efficient global optimization techniques in order to optimize 3D real life gradient metasurface based on GaN semiconductor. Ourresults show that we can achieve more than 87 % of diffraction efficiency at the visible regime using only 150 solver calls for optimizing 12 parameters. Our methods seem to be more efficient than other optimization techniques that requirecostly simulations, especially for 3D structures. The optimized structure will be fabricated and characterized experimentally.

11:40 : Invited talk
Modelling of Nonlinear Metasurfaces: Second-Harmonic Generation and Kerr Effect
Karim Achouri, Olivier J. F. Martin
EPFL (Switzerland)

We present a nonlinear metasurface modelling framework based on the generalized sheet transition conditions (GSTC). It may be used to synthesize or analyse the scattering behavior of second- and third-order metasurfaces. We specifically study second-harmonic generation (SHG) and the Kerr effect. This framework is formulated in the frequency-domain and provides the relationships between the metasurface linear and nonlinear susceptibilities and the fields interacting with it.

12:00 : Invited talk
Perfect Penetrable Cloaking Using Arbitrary-Shape Bianisotropic Metasurfaces
Mojtaba Dehmollaian[1], Christophe Caloz[2]
[1] *University of Tehran (Iran),* [2] *Polytechnique Montreal (Canada)*

This paper combines Integral Equations (IEs) and GeneralizedSheet Transition Conditions (GSTCs) with bianisotropicsusceptibility tensors, to compute the wave scatteringby cylindrical metasurfaces of arbitrary cross sections.It applies this technique to a newly introduced formof cloaking, penetrable cloaking, which is more realisticthan transformation-electromagnetics cloaking. It showsthat for a given object, properly synthesized gain-less andloss-less susceptibilities can perfectly cloak the object.

12:20 : Invited talk
Biosensor chip based on VCSELs and gold grating
YiYang Xie[1], Chen Xu[2], Qiang Kan[2], Beijv Huang[2], Hongda Chen[2]
[1] *Beijing University of Technology (China),* [2] *Chinese Academy of Sciences (China)*

We combine gold grating with vertical cavity surface emitting lasers to realize a prototype of miniaturized chemical/biosensor. The advantage of such chips include compact size, low cost and low power consumption, long life time, stable performance, easy to make array and multi-flux test, and label-free sensing. The finite difference time domain method is employed to model the transmission signal from the chips. It is believed that the biosensor chip has potential applications in health care and environmental monitoring.

12:40 : Effective transmission conditions for an array of locally resonant inclusions
Kim Pham[1], Agnes Maurel[2], Jean-Jacques Marigo[3]
[1] *IMSIA/ENSTA ParisTech (France),* [2] *Institut Langevin / ESPCI (France),* [3] *LMS / Ecole Polytechnique (France)*

We study the scattering of waves by a single row of resonant inclusions, of the Mie type. An effective model based on matched asymptotic analyzed is used to account for the small thickness of the array. Hence, instead of the effective bulk parameters, we end up with interface parameters entering in jump conditions for the electromagnetic fields. Our effective model is validated by comparison with results of full wave calculations.

11:00 - 12:00 — Auditorium EA2

Session 3A10

Conference Tutorials IV

Organized by: Ishwar Aggarwal

11:00 : Tutorial
Writing and submitting your papers: Dos and Don'ts

Rachel Won
Nature Photonics (UK)

In this tutorial, Rachel will talk you through the detailed information and guidelines on scientific paper preparation and submission. Guidelines and tips for writing an abstract and a paper will be provided. Submission, editorial and peer-review processes will be discussed. At the end of the tutorial, you will walk away knowing how to write an informative cover letter, an outstanding abstract and a comprehensive scientific paper.

12:00 - 12:40 — Auditorium EA2

Session 3A11

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Zi Jing Wong

12:00 : Invited talk
Control of Emission Photon Statistics from a Single Colloidal Quantum Dot Using Plasmonic Nanostructures
Sadahiro Masuo
Kwansei Gakuin University (Japan)

One of the important emission behavior of semiconductor nanocrystal quantum dots (QDs) is the emission photon statistics, i.e., single-photon and multiphoton emission. Generally, the emission photon statistics of the QDs are governed by the multiexciton dynamics based on the quantum confinement depending on the size, shape, and atomic composition of QDs themselves. In this work, we demonstrated that the emission photon statistics from a single QD could be controlled by the interaction with the plasmonic nanostructures.

12:20 : Invited talk
Plasmonic Monitoring of Lithium Metal Evolution in Nanobatteries
Yan Jin, Jia Zhu, Lin Zhou
Nanjing University (China)

The development of plasmonics has led to significant advancement in sensitive chemical and biological sensing and surface enhanced spectroscopies, which is urgent for real-time electrochemical detection in batteries. Alkali metals featured by ideal free electron gas models, have long been regarded as promising plasmonic materials but seldom been explored due to their high chemical reactivity. Here, we demonstrate our recent progresses in lithium metal plasmonics and in operando monitoring of lithium metal evolution during battery cycling.

11:00 - 11:40 — Auditorium EA3

Session 3A12

Metasurface-based Light Sources, Modulators, and Detectors

Organized by: Yuanmu Yang and Benfeng Bai

Chaired by: Yuanmu Yang and Benfeng Bai

11:00 : Invited talk
Metasurface Light Sources and Modulators Based on Kerker Effects
Austin Howes[1], Zhihua Zhu[1], Wenyi Wang[1], Joshua R. Nolen[1], Ivan I. Kravchenko[2], Richard Haglund[1], Joshua Caldell[1], Jason Valentine[1]

[1] *Vanderbilt University (USA),* [2] *Oak Ridge National Laboratory (USA)*

The first Kerker condition states that spectrally overlapped, and equal strength, electric and magnetic dipole modes will result in cancellation of the backscattered field. In this talk, I will outline how this effect, and related Kerker effects, can be harnessed in all-dielectric modulators and light sources. In the case of modulators this allows for high on-state transmission and large modulation depth. In absorbing metasurfaces this effect can be used to realize near-unity absorption leading to efficient thermal emitters.

11:20 : Invited talk

High-performance, All-dielectric Metasurfaces in the Ultraviolet Regime

Cheng Zhang[1], Shawn Divitt[1], Qingbin Fan[2], Wenqi Zhu[1], Amit Agrawal[1], Ting Xu[2], Henri J. Lezec[1]
[1] *National Institute of Standards and Technology (USA),* [2] *Nanjing University (China)*

I will present our recent efforts of achieving an assortment of low-loss all-dielectric metasurfaces operating down to a record-short deep-UV wavelength of 266 nm, with efficiencies up to 72 %.

11:40 - 12:40 — Auditorium EA3

Session 3A13

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Thomas Krauss

11:40 : Invited talk

Enabling Plasmonic Metasurfaces by Laser Processing

Alberto Pique, Ray C.Y. Auyeung, Heungsoo Kim, Kristin M. Charipar, Jake Fontana, Nicholas A. Charipar
U.S. Naval Research Laboratory (USA)

This work aims to study the influence of material growth and laser processing conditions on the plasmonic behavior of various types of laser-patterned thin films, from metal-oxides such as ITO and vanadium dioxide (VO2) to monolayers of hexagonally packed ligand capped gold nano-spheres. Here, direct laser interference patterning or DLIP enables the patterning of these films into plasmonic metasurfaces suitable for flat optics. The plasmonic assisted ultrafast optically induced nonlinear switching of VO2 patterned structures is also discussed.

12:00 : Invited talk

Integrated frequency combs for the on-chip generation of optical quantum states

Stefania Sciara[1], Michael Kues[2], Christian Reimer[1], Piotr Roztocki[1], Benjamin Wetzel[1], Brent E. Little[3], Sai T. Chu[4], David J. Moss[5], Lucia Caspani[6], Roberto Morandotti[1]
[1] *Institut National de la Recherche Scientifique (Canada),* [2] *University of Glasgow (Scotland),* [3] *Chinese Academy of Science (China),* [4] *City University of Hong Kong (China),* [5] *Swinburne University of Technology (Australia),* [6] *University of Strathclyde (Scotland)*

We make use of integrated frequency combs to generate on-chip heralded single photons, cross-polarized photon pairs, as well as two- and multiphoton time-bin entangled states and high-dimensional frequency entangled states.

12:20 : Invited talk

Optical Pump - Terahertz Probe Spectroscopy of Semiconductor Nanostructures

Hynek Nemec, Petr Kuzel
Czech Academy of Sciences (Czech Republic)

Charge transport in semiconductor nanostructures can be studied in non-contact way and with sub-picosecond time resolution using optical pump - terahertz probe spectroscopy. Interpretation of the measurements requires a careful description of photonic effects governing the propagation of the optical excitation beam, modelling of the terahertz conductivity of confined charges and consideration of the depolarization field effects. All

these issues will be addressed in this paper.

11:00 - 12:45 — Auditorium EA4

Session 3A14

Structural Color for Displays and Imaging

Organized by: Debashis Chanda

Chaired by: Debashis Chanda

11:00 : Invited talk
Hybrid Plasmonic and Electrochromic Displays
Magnus Jonsson
Linkoping University (Sweden)

I will here present our recent results on reflective displays, with focus on developing and understanding hybrid plasmonic and electrochromic systems for electronic paper in color.

11:20 : Invited talk
Optimizing electrochromism for plasmonic electronic paper: Inorganic vs organic
Marika Gugole[1], Oliver Olsson[1], Jose Montero Amenedo[2], Kunli Xiong[1], Gunnar A. Niklasson[2], Andreas Dahlin[1]
[1] *Chalmers University of Technology (Sweden),* [2] *Uppsala University (Sweden)*

The combination of plasmonic nanostructures and electrochromic materials for dynamic color generation has been of interest in recent years due to the possibility to make reflective displays in full color with extremely low power consumption compared to emissive displays. We show a comparison between two electrochromic materials, tungsten trioxide (inorganic) and PProDOT-Me2 (organic), for electrical modulation of the resonantly reflected light from plasmonic nanostructures. The comparison focuses on achievable contrast, switching speed, coloration memory and power consumption.

11:40 : Invited talk
High purity reflective structural colors using bilayer hybrid absorbers and investigation of solution process via electrodeposition of thin-films
L. Jay Guo, Saurabh Acharya, Zhengmei Yang, Chengang Ji
University of Michigan (USA)

We present a general design strategy to create high-purity RGB reflective colors based on a dielectric-absorber-dielectric-metal multilayered configuration. Guided by the derived refractive index for an ideal absorber, an effective medium consisting of two ultrathin absorber films is used to improve the color purity by suppressing the reflection in the undesired color range. We also describe a simple, inexpensive, and non-toxic bench-top electrodeposition process for the fabrication of structural color based on multilayer films at ambient conditions.

12:00 : Tunable All-dielectric Metasurface for Color Printing
Jianfeng Zang, Xin Liu, Zhao Huang
Huazhong University of Science and Technology (China)

Color printing has drawn tremendous attention as a promising candidate in display and security technology. Plasmonics nanostructures has been intensively investigated and opened up a way to achieve color printing at deepsubwavelength scales. However, plasmonics suffers from intrinsic loss and heating effect. Dielectric materials with low loss and strong mie resonance become a promising candidate to fabricate metasurface for color printing. Here, we demonstrate all-dielectric Si nanoring metasurfaces (SRMs) for generating high saturation colors by tuning structure parameters.

12:15 : Light manipulation by natural photonic structures in diatom microalgae
Johannes Goessling, Martin Lopez Garcia

Natural and Artificial Photonic Structures Group (Portugal)

In this work we communicate an experimental investigation of the photonic properties of nano-porous silicate exoskeletons of diatom microalgae. We demonstrate that such natural structures can function as a wavelength selective light coupler and waveguide. The brilliant colors produced under certain illumination conditions could be the visual side-effects of an important underlying biological principle, i.e. manipulation of the photonic environment inside the cell to optimize light capture and photosynthesis.

12:30 : Tunable spherical colloidal photonic pigments with non-iridescent structural color
Laurinda R. P. Areias, José Paulo S. Farinha
Universidade de Lisboa (Portugal)

Colloidal photonic crystals exhibit shining structural coloration that arises from the modulation of electromagnetic waves by means of Bragg reflection from photonic stop bands, originated from the periodical arrangement of nanoparticles.We develop uniformly sized spherical colloidal photonic pigments that exhibit structural coloration throughout the visible spectrum light range, from differently sized colloidal building blocks synthesized by emulsion polymerization.Spherical photonic pigments were obtained upon self-assembly of colloidal nanoparticles inside monodispersed emulsion droplets generated by soft-lithography microfluidics.

Lunch

12:40 - 14:00

14:00 - 15:00 — IST Congress Center Auditorium

Session 3A15

Conference Tutorials V

Organized by: Ishwar Aggarwal

14:00 : Tutorial
DARPA's interests in metamaterials
Michael Fiddy
DARPA (USA)

Almost twenty years ago, some of the earliest research into metamaterials and their applications was funded by DARPA. The field has grown enormously since, and DARPA still supports fundamental research into improving our understanding and modeling of these engineered materials. This talk will provide the background and context for research of current interests.

15:00 - 16:00 — IST Congress Center Auditorium

Session 3A16

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Ali Adibi

15:00 : Invited talk
Fast Optoelectronic Modulation of Surface Plasmons Polaritons at Degenerate Semiconductor Inteфaces
Dentcho A. Genov
Louisiana Tech University (USA)

In this talk we present an optoelectronic switch for functional plasmonic circuits based on active control of Surface Plasmon Polaritons (SPPs) at degenerate pn++ junction interfaces. Self-consistent multi-physics simulations and experimental validation of the device electromagnetic, thermal and IV characteristics have been performed. Our data shows signal modulation surpassing -100dB and switching rates of up to 50GHz, with the device thus providing a new pathway toward bridging the gap between electronic and photonic devices.

15:20 : Invited talk
(Chiro)-optical properties of chiral inorganic-plasmonic nanocomposites
Thierry Verbiest, Ward Brullot, Tom Swusten
University of Leuven (Belgium)

We will discuss the chiro-optical properties of chiral self-assembled nanostructures that are composed of superparamagnetic iron oxide and plasmonic nanoparticles.

15:40 : Invited talk
Block copolymer based self-assembled metamaterials and metasurfaces at optical frequencies
Alberto Alvarez-Fernandez[1], Cian Cummins[1], Guillaume Fleury[1], Xuan Wang[1], Morten Kildemo[2], Alexandre Baron[1], Virginie Ponsinet[1]
[1] *University of Bordeaux (France),* [2] *NTNU (Norway)*

Self-assembled diblock copolymers were used as templates to produce well-defined gold nanostructures in 3D or 2D, with so degree of order. Resulting structures were shown to present specific and tunable optical resonant properties, and include hyperbolic metamaterials and high-index metasurfaces.

14:00 - 16:00 — Auditorium VA1

Session 3A17

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Didier Felbacq and Takashige Omatsu

14:00 : Invited talk
Demonstration of Active and non-reciprocal Willis coupling
Choonlae Cho[1], Jensen Li[2], Xinhua Wen[2], Namkyoo Park[1]
[1] *Seoul National University (Korea),* [2] *The Hong Kong University of Science and Technology (Hong Kong)*

The tuning of metamaterials depends very much on modifying the physical structures, posing a fundamental challenge to the degree of tunability. As well, it is difficult to control the resonance strength, bandwidth, and phase lag separately. Here, we propose present the concept of virtualized metamaterials by focusing on the acoustic platform. As an application, we also challenge on the active and non-reciprocal Willis coupling, in manipulating acoustic waves. We demonstrate experimentally that the maximum bound of bianisotropy given by passivity can be surpassed by our virtualized metamaterial. Such an active and non-reciprocal implementation of bianisotropy can be useful to control both efficiency and wavefront in applications including amplified sensing and non-reciprocal communication.

14:20 : Invited talk
Optomechanical Kerker effect for trembling resonant particles
Alexander V. Poshakinskiy, Alexander N. Poddubny
Ioffe Institute (Russia)

We propose an optomechanical Kerker effect, where the tunable directional inelastic scattering is achieved for a small particle that trembles in space. We show that the motion of the electric dipole leads to appearance of a magnetic dipole. The interference of the electric and magnetic dipole radiation patterns is governed by the frequency dependence of the particle permittivity. For a resonant particle, the light is scattered preferably forward at resonance and backward away from it.

14:40 : Invited talk
Flexible metasurfaces in the visible range for imaging and biophotonic applications
Andrea Di Falco
University of St Andrews (United Kingdom)

We present our recent results on biophotonic applications of flexible photonic metasurfaces in the visible range, including sensing and imaging in microfluidic environments.

15:00 : Invited talk
Propagation and spectral sorting of single photons in high-index dielectric nanowires
Melodie Humbert[1], Peter R. Wiecha[1], Gerard Colas des Francs[2], Aurelie Lecestre[1], Guilhem Larrieu[1], Christian Girard[1], Vincent Paillard[1], Aurelien Cuche[1]
[1] *Université de Toulouse (France),* [2] *Université Bourgogne-Franche Comte (France)*

We show experimentally and theoretically that dielectric nanowires (Si-NW) are an efficient platform to transfer visible light from quantum emitters. We first study the effect of Si-NW on the spontaneous emission of the emitters positioned in their vicinity. Then, we demonstrate that the 1D propagation of light can be efficiently controlled by the geometry of the wire. These emitter-nanowire structures might be good candidates as building blocks for the design of optical nanodevices working in the single photon regime.

15:20 : Invited talk
Magnon Kerr Effect in a Cavity QED System
Tiefu Li
Tsinghua University (China)

We experimentally demonstrate magnon Kerr effect in a cavity quantum electrodynamics (QED) system, where magnons in a small yttrium iron garnet (YIG) sphere are strongly but dispersively coupled to the photons in a three-dimensional cavity. The nonlinear properties may be utilized in the hybrid quantum information processing system.

15:40 : Invited talk
Generation of on-chip D-dimensional entangled cluster states and their characterization via optimal entanglement witnesses
Lucia Caspani[1], Stefania Sciara[2], Christian Reimer[2], Piotr Roztocki[2], Mehedi Islam[2], Luis Romero Cortés[2], Yanbing Zhang[2], Bennet Fischer[2], Sébastien Loranger[3], Raman Kashyap[3], Alfonso Cino[4], Sai T. Chu[5], Brent E. Little[6], David J. Moss[7], William J. Munro[8], José Azaña[2], Michael Kues[2], Roberto Morandotti[2]
[1] *University of Strathclyde (United Kingdom),* [2] *Institut National de la Recherche Scientifique (Canada),* [3] *Polytechnique Montreal (Canada),* [4] *University of Palermo (Italy),* [5] *City University of Hong Kong (China),* [6] *Chinese Academy of Science (China),* [7] *Swinburne University of Technology (Australia),* [8] *NTT Corporation (Japan)*

We report the on-chip generation of hyper-entangled states in the time-frequency domain and their transformation in high-dimensional cluster states via deterministic controlled phase gates. We characterized these states developing a universal technique for deriving 'experimentally friendly' entanglement witness operators.

14:00 - 16:00 — Auditorium VA2

Session 3A18

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

Chaired by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

14:00 : Invited talk
Generalization of the Optical Chirality to Arbitrary Media
J. Enrique Vazquez-Lozano, Alejandro Martinez

Universitat Politecnica de Valencia (Spain)

Motivated by recent theoretical results concerning energy, momentum, angular momentum, and optical helicity of electromagnetic waves in dispersive and lossless media, here we address a parallel derivation for the optical chirality, extending it so as to include dissipative effects as well. Looking into the mathematical structure of the continuity equation, we find a new general expression for optical chirality density in lossless and lossy dispersive media, which may be applied to any medium, including dielectrics, plasmonic nanostructures, and metamaterials.

14:20 : Invited talk
Tailoring the Chiral Response of Achiral Nanostructures Using Structured Light
Peter Banzer
Max Planck Institute for the Science of Light (Germany)

By utilizing engineered highly confined light for excitation, we show that an achiral nanosphere can scatter like a chiral dipole. While the input beam carries neither spin nor orbital angular momentum, we take advantage of the complex polarizabilities of an achiral spherical silicon particle.

14:40 : Invited talk
Stability and dynamics of skyrmions in multiferroic transition metal halides
Maxim Mostovoy, Alessio Pozzi
University of Groningen (The Netherlands)

We study non-collinear magnetic orders in a transition metal dihalide with competing exchange interactions. We find an unusual defect with the skyrmion topology carrying both magnetic and electric dipole moments, which is stable in uniform and modulated magnetic phases of this material. We study dynamics of these skyrmions induced by spin-orbit torques and by the magnetoelectric coupling to an applied electric field.

15:00 : Invited talk
Circular Dichroism and Spontaneous Chiral Symmetry Breaking in Rotational Particles
Deng Pan[1], Hongxing Xu[2], Javier Garcia de Abajo[1]
[1] *ICFO-Institut de Ciencies Fotoniques (Spain),* [2] *Wuhan University (China)*

We predict that rotating nano-rings and solid nanoparticles show different optical circular dichroisms, and when optically trapped by an unpolarized blue-detuned laser above a certain intensity the void particle starts rotating spontaneously.

15:20 : Invited talk
Spin-Polarized Plasmonics
Vladimir Drachev[1], Hari Bhatta[2], Ali Aliev[3]
[1] *Skolkovo Institute of Science and Technology (Russia),* [2] *University of North Texas (USA),* [3] *University of Texas at Dallas (USA)*

Magnetic nanoparticles with a single-domain crystal structure support a plasmon resonance in the deep UV range with the quality better than gold nanoparticle plasmons. The exchange interaction of electrons splits the energy bands between spin-up electrons and spin-down electrons. These two group of electrons have very different relaxation constants providing high and low plasmon quality for two independent plasmons. The scattering without spin flip is required to keep these two plasmons independent.

15:40 : Invited talk
Collective polarization-dependent plasmon routing by means of spin-locking metasurface
Matan Revah, Andre Yaroshevsky, Yuri Gorodetski
Ariel University (Israel)

We propose a spin-locking metasurface incorporating a transverse spin of the SP wave to selectively route the near-field beams.Owing to the combination of the oblique incidence of circularly polarized light with the accurately designed momentum matching of the grating we achieve a precise directional control over the plasmonic distributions. The experimental verification of the directional launching is performed by a time-resolved leakage radiation measurements allowing one to visualize the shape and the dynamics of the excited beam.

14:00 - 15:50 — Auditorium VA3

Session 3A19

Parity-Time and related symmetries in Photonics, Plasmonics, Acoustics

Organized by: Anatole Lupu and Henri Benisty

Chaired by: Anatole Lupu and Henri Benisty

14:00 : Invited talk
Active parity-time symmetric and exceptional point structures
Choloong Hahn[1], Youngsun Choi[2], Jae Woong Yoon[3], Seok Ho Song[2], Pierre Berini[1]
[1] *University of Ottawa (Canada),* [2] *Hanyang University (Korea),* [3] *Electronics and Telecommunications Research Institute (ETRI) (Korea)*

We discuss recent progress on active parity-time symmetric plasmonic systems. We discuss interactions based on encircling-an-exceptional-point, which are reciprocal in the linear regime, but become nonreciprocal in the nonlinear regime over a very broad optical bandwidth. We present an implementation based on plasmonic waveguides incorporating an IR140-doped PMMA gain medium.

14:20 : Topological protection and quantum noise in nonlinear photonic systems
Henning Schomerus
Lancaster University (United Kingdom)

Many prospective applications of topological photonics involve intrinsically nonlinear media, such as in lasers, plasmonic structures, or excitonic condensates. As I show here, one of the main underlying symmetries know from the linear context extends seamlessly to these situations. This allows us to precisely define topologically protected dynamically stable states, which either may be stationary states replicating zero modes, or power-oscillating states.

14:35 : Short Pulse Propagation in Quasi-PT-Symmetric Structure
Dmitri Tsvetkov[1], Vladimir Bushuev[1], Vladimir Konotop[2], Boris Mantsyzov[1]
[1] *Lomonosov Moscow State University (Russia),* [2] *Universidade de Lisboa (Portugal)*

It is shown that inhomogeneous broadening of the spectral line of active impurities may sustain simultaneously parity and time symmetries of a medium, in finite range of field frequencies, what is forbidden by the causality principle in media without broadening. If spectral width of a propagating pulse is less than the inhomogeneous broadening, the medium for such pulse becomes quasi-PT-symmetric. The effect of the broadband quasi-PT symmetry is illustrated by examples of unidirectional diffraction of pulses in photonic crystals.

14:50 : Invited talk
Active Electroacoustic Resonators and their Application to Non-Hermitian Acoustics
Romain Fleury
EPFL (Switzerland)

We will discuss our recent experimental progress on developing active acoustic resonators that provide independently tunable acoustic properties, namely the possibility to control at will their resonance frequency, absorption losses, and radiative losses.

15:10 : Invited talk
Nonlinear scattering by PT-symmetric layered periodic structures with gain and loss saturation effects
Oksana Shramkova[1], Giorgos Tsironis[2]
[1] *Technicolor Research - Innovation (France),* [2] *University of Crete (Greece)*

We investigate the effect of gain saturation on scattering characteristics of PT-symmetric periodic stacks of the layers with balanced loss and gain. The closed form solutions for calculating the transmission and reflection of nonlinear system have been. It is shown that the non-reciprocal response of the nonlinear medium depends on parameters of the stack, angles of wave incidence and saturation intensity. The effects of nonlinearity on the exceptional points and symmetry breaking are systematically examined.

15:30 : Invited talk

Chiral symmetry in non-Hermitian systems: product rule and Clifford algebra
Li Ge
City University of New York (USA)

Chiral symmetry provides the symmetry protection for a large class of topological edge states. Here we show two general approaches to construct chiral symmetry in non-Hermitian systems, with an emphasis on lattices with detuned on-site potentials that can vary in both their real and imaginary parts. One approach relies on the simultaneous satisfaction of both non-Hermitian particle-hole symmetry and a non-Hermitian bosonic anti-linear symmetry, while the other utilizes Clifford algebra satisfied by the Dirac matrices.

14:00 - 15:50 — Auditorium VA4

Session 3A20

Plasmonics: Fundamentals and Applications

Organized by: Hong Wei

Chaired by: Hong Wei

14:00 : Invited talk
Plasmoemission: Nonlinear Electron Emission from Surface Plasmon Polaritons
Frank J. Meyer zu Heringdorf, Daniel Podbiel, Philip Kahl, Pascal Dreher, David Janoschka
University of Duisburg Essen (Germany)

The time-resolved investigation of surface plasmon polaritons by means of photoelectron imaging after femtosecond laser pulse excitation has developed into a mature technique over the last years. By using a normal-incidence geometry in a photoemission electron microscope it has become possible to record slow-motion movies of surface plasmon propagation and to spatio-temporally resolve standing plasmon waves. Analyzing the energy distribution of emitted electrons shows that above threshold ionization and strong-field emission from plasmonic foci is possible.

14:20 : Invited talk
Optically Thin Plasmonic Nanohole Metasurfaces: Fano Interferences and Strong Coupling
Evan S. H. Kang, Magnus P. Jonsson
Linkoping University (Sweden)

In this presentation, I will present our recent research on optically thin plasmonic nanohole metasurfaces.

14:40 : Confining plasmon-exciton interaction in individual nanocavity
Jiawei Sun, Huatian Hu, Di Zheng, Daxiao Zhang, Shunping Zhang, Hongxing Xu
Wuhan University (China)

The highly-confined nanogap plasmons in nanocube-over-mirror (NCOM) system possess huge enhancement of electric field and local density of states, and these fascinating properties make NCOM to be an idea platform to study the light-matter interaction. Here, we demonstrate the coupling between neutral excitons in monolayer TMDs and magnetic plasmons in NCOM. In this geometry, we found that huge PL enhancement and Rabi splitting are achieved simultaneously, whereas the circular emission of PL can be manipulated by the nanogap plasmons.

14:55 : Invited talk
Emission spectra of plasmon-exciton hybrid systems: A simple model
Xiaoguang Li
Shenzhen University (China)

Absorption spectra of a plasmon-exciton hybrid system can be qualitatively or even quantitatively studied by using the classical or quantum model with coupled oscillators. However, the emission spectra of plasmon-exciton hybrid systems are still largely unexplored, which presumably is due to the relatively slow emission process frequently interfered by other faster transition channels. Here, we describe a simple phenomenological model, which can evaluate both the absorption and emission spectra by selectively excluding some

transitions during the emission process.

15:15 : Out-of-equilibrium dynamics of silver: saturated nonlinear response
Andrea Marini[1], **Alessandro Ciattoni**[2], **Claudio Conti**[3]
[1] *University of L'Aquila (Italy),* [2] *Consiglio Nazionale delle Ricerche (Italy),* [3] *University Sapienza (Italy)*

Starting from the Fokker-Planck-Landau theory of electron collisions, we derive a novel set of hydrodynamical equations accounting for the ultrafast dynamics of silver, demonstrating that absorption saturates owing to the quenching of electron collisions. Our results hold great potential for mitigating absorption of plasmonic materials, thus opening novel avenues for the development of low-loss plasmonic circuits and solid-state attosecond pulse sources along with ultra-efficient nonlinear control at the nanoscale by near-zero index media.

15:30 : Invited talk
Energy of plasmonic photocatalytic sites
Emiliano Cortes
Ludwig-Maximilians-Universitat Munchen (Germany)

Plasmonic photocatalysts hold the potential of transforming visible light into chemical energy [1]. Here we performed a spectral screening study on the energy of the extracted hot-holes in a 80 nm Au nanoparticle that photocatalyze an electro-polimerization reaction. We demonstrate that Landau damping is the absorption channel that leads to the most energetic carriers for plasmonic photocatalysis [2].

14:00 - 16:15 — Auditorium VA5

Session 3A21

Acoustic Metamaterials in the audible frequency range

Organized by: Jean-Philippe Groby and Vicente Romero Garcia

Chaired by: Jean-Philippe Groby and Vicente Romero Garcia

14:00 : Invited talk
Sound Transmission Loss through a Phononic Crystal Panel: Prediction and Validation
Bart Van Damme[1], **Armin Zemp**[1], **Sepide Ahsani**[2], **Lucas Van Belle**[2], **Claus Claeys**[2], **Elke Deckers**[2]
[1] *Empa - Materials Science and Technology (Switzerland),* [2] *KU Leuven (Belgium)*

Acoustic metamaterials are often presented as improved solutions for acoustic isolation. However, structural band gaps in a metamaterial do not necessarily lead to high sound transmission losses, since acoustic transmission is not only governed by wave processes. In this paper, the case of a sandwich panel with a core consisting of periodic stiffeners is considered. A suitable geometry is defined using structural bandgap analysis. The STL under diffuse excitation is predicted, and compared to measurements of a realistic sample.

14:20 : Invited talk
Unidirectional zero sonic reflection in passive Partity-Time symmetric Willis media
Aurelien Merkel[1], **Vicent Romero-Garcia**[2], **Jean-Philippe Groby**[2], **Jensen Li**[3], **Johan Christensen**[1]
[1] *Universidad Carlos III de Madrid (Spain),* [2] *Université du Mans (France),* [3] *The Hong Kong University of Science and Technology (China)*

In an effective medium description of acoustic metamaterials, the Willis coupling plays the same role as the bianisotropy in electromagnetism. Willis coupling have not only emerged to obtain physically meaningful effective parameters, but also to describe media presenting asymmetry in reflection. Asymmetries in reflection have also been made possible by considering the Parity-Time symmetry. In this work, we theoretically, in accordance with experimental results, show that a passive Willis media can be mapped onto Parity-Time symmetric systems.

14:40 : Deep Sub-wavelength Materials for Controlling Sound Diffusion: Experimental Validation of Metadiffusers

E. Ballestero[1], **N. Jimenez**[2], **J.-P. Groby**[2], **S. Dance**[1], **V. Romero-Garcia**[3]
[1] *London South Bank University (United Kingdom),* [2] *CSIC (Spain),* [3] *Le Mans Universite (Fance)*

This work reports the experimental validation of metadiffusers. Metadiffusers are rigidly backed slotted panels, each slit being loaded by an array of Helmholtz resonators introducing strong dispersion and slow sound conditions. Therefore, the effective thickness of the panel is dramatically reduced down-shifting its quarter wavelength resonance in the deep-subwavelength regime. By tuning the geometry, the reflection coefficient profile can be tailored to obtain custom reflection phase. In this work we validate a metadiffuser based on a quadratic residue sequence.

14:55 : On the use of plate-type metamaterial to experimentally highlight a hiding zone in Density Near Zero acoustic metamaterial

Matthieu Mallejac[1], **Aurelien Merkel**[2], **Jose Sanchez Dehesa**[3], **Johan Christensen**[2], **Vincent Tournat**[1], **Vicent Romero-Garcia**[1], **Jean-Philippe Groby**[1]
[1] *Le Mans University (France),* [2] *Universidad Carlos III de Madrid (Spain),* [3] *Universitat Politecnica de Valencia (Spain)*

Acoustic metamaterials composed of a periodic arrangement of plates or membranes in the air are of growing practical interest because of their peculiar properties such as the possibility to obtain zero dynamic mass density. The aim of this work is to experimentally, numerically and theoretically report and characterize the anomalous propagation of sound waves in a one-dimensional periodic system of thin elastic clamped plates emphasizing a hiding zone due to the near zero density regime.

15:10 : Acoustic demultiplexers based on Fano and induced transparency resonances in slender tubes

Abdelkader Mouadili[1], **El Houssaine El Boudouti**[2], **Bahram Djafari-Rouhani**[3]
[1] *Université Hassan II (Morocco),* [2] *University Mohammed I (Morocco),* [3] *Université de Lille (France)*

We give an analytical demonstration of the possibility to realize a phononic demultiplexer based on Fano and acoustic induced transparency resonances. The demultiplexer consists of a Y-shaped waveguide with an input line and two output lines. Each output line contains two stubs grafted either at a given position or at two positions far from the input line. We derive the analytical expressions for a selective transfer of a single propagating mode through one line keeping the other line unaffected.

15:25 : Invited talk
Using mean flow to make a broadband acoustic diode

Vassos Achilleos, Yves Aurégan, Vincent Pagneux
Laboratoire d'Acoustique de l'Université du Man (France)

A flow in a waveguide caused significant changes in wave propagation. Among the effects of flow, it can used as a vectorial field that break reciprocity. We demonstrate theoretically and experimentally that an acoustic diode can be manufactured by slowing down the acoustic wave and the effective sound velocity can be so low that no waves can propagate against the flow. This phenomenon occurs over a wide range of frequencies that can be extended to very low frequencies.

15:45 : Effective transmission conditions across a resonant bubbly metascreen

Kim Pham[1], **Jean-Francois Mercier**[1], **Daniel Fuster**[2], **Agnes Maurel**[3], **Jean-Jacques Marigo**[4]
[1] *ENSTA ParisTech (France),* [2] *University Paris 6 (France),* [3] *ESPCI ParisTech (France),* [4] *Ecole Polytechnique (France)*

We study the propagation of acoustic waves through a thin bubbly screen. The analysis is conducted in the time domain and preserves the nonlinear response of the bubbles, it provides an effective model involving a jump of the normal velocity coupled to an equation of the Rayleigh-Plesset's type for the bubble radius. Numerical implementation of the effective model allows us to discuss the influence of the distance between bubbles within the screen and that of the nonlinearities.

16:00 : Scattering by arrays of open ended resonators

Agnes Maurel[1], **Jean-Francois Mercier**[2], **Kim Pham**[2]
[1] *Institut Langevin/ESPCI (France),* [2] *ENSTA ParisTech (France)*

We study the interaction of acoustic waves with arrays of cavities open at both ends. This is done owing to an ef- fective model which provides explicit expressions of the re- flection and transmission coefficients. Here, this is used to provide the relations required to produce zero reflection situation which are known to be

surrounded by rapid vari- ations of the scattering coefficients. The influence of the symmetry or asymmetry of the array is discussed.

14:00 - 15:40 — Auditorium VA6

Session 3A22

Silicon Photonic Integrated Circuits

Organized by: Jian Wang

Chaired by: Jian Wang

14:00 : Invited talk

Power Efficient Thermal Optical Tunable Grating Coupler Based on Silicon Photonic Platform

Lifeng Chen
Sun Yat-sun University (China)

We demonstrate a tunable grating coupler with low power consumption, fabricated via a standard complementary metal-oxide-semiconductor process. The grating coupler locates on a freestanding silicon-on-insulator strip waveguides. The air gap between the grating structure and the silicon substrate enhances the heating efficiency. We achieve a central wavelength thermal shift of 55 nm with 19.5 mW input power, a tuning efficiency of 2.82 nm/mW. The dynamic response with rise time and fall time are 0.16 ms and 0.74 ms, respectively.

14:20 : Invited talk

Silicon Integrated Quantum Photonics

Yunhong Ding[1], Davide Bacco[1], Karsten Rottwitt[1], Mark Thompson[2], Jianwei Wang[3], Leif Katsuo Oxenlowe[1]
[1] *Technical University of Denmark (Denmark),* [2] *University of Bristol (United Kingdom),* [3] *Peking University (China)*

Quantum photonics opens a new era of technology revolution deeply embedded in quantum mechanism. Silicon integrated quantum photonics is of particular interest able to integrate mass of quantum photonic components on a single silicon chip. Here we present our recent work on silicon photonics for advanced quantum applications, including high-dimensional quantum quantum key distribution, high-dimensional quantum entanglement, and Hong-Ou-Mandel interference of two independent lasers on silicon for quantum communication.

14:40 : Invited talk

Application opportunities for field-Programmable Photonic Integrated Circuits

Daniel Perez Lopez, Prometheus DasMahapatra, Jose Capmany
Universitat Politecnica de Valencia (Spain)

The advent of a new generation of programmable photonic integrated circuits (PICs) has paved the path for costeffective solutions for a wide variety of applications which employ at least one photonic-based subsystem. Here, we review the main characteristics of programmable PICs and analyze their trade-offs and performance in the different fields of application: telecommunications, datacentres, radio-over-fiber, microwave photonics processing, high-performance computing and sensing.

15:00 : Invited talk

Laser Processing of Amorphous Semiconductors on Planar Substrates for Photonic and Optoelectronic Applications

Ozan Aktas[1], Yohann Franz[1], Antoine Runge[2], Stuart MacFarquhar[1], Swe Zin Oo[1], Vinita Mittal[1], Antulio Tarazona[1], Harold Chong[1], Sakellaris Mailis[3], Anna Peacock[1]
[1] *University of Southampton (United Kingdom),* [2] *University of Sydney (Australia),* [3] *Skolkovo Institute of Science and Technology (Russia)*

We report results of laser processing on amorphous silicon and silicon-germanium films deposited on planar substrates. Pre-patterned a-Si waveguides were recrystallized to enhance their material and optical proper-

ties. Formation of millimeter long crystal grains and surface roughness of 0.52 nm enable optical losses to become as low as 5.3 dB/cm. Laser-driven phase separation in the binary alloy of a-SiGe allows fabrication of composition graded microstructures with Si-rich and Ge-rich regions. A composition tuning capability of 40 % was demonstrated.

15:20 : Invited talk
Microresonator Soliton frequency combs
Tobias J. Kippenberg
EPFL (Switzerland)

Recent work moreover has shown that DKS can be extended to the biological imaging window at 1 micron, relevant for e.g. Raman spectral imaging or OCT. Soliton microcombs have the potential to advance time-keeping, metrology or telecommunication by providing a technology amenable to full photonic integration, low power consumption and large comb bandwidth and repetition rate.

14:00 - 15:15 — Auditorium EA1

Session 3A23

Modelling, simulation and optimization of metasurfaces

Organized by: Patrice Genevet and Stéphane Lanteri

Chaired by: Patrice Genevet and Stéphane Lanteri

14:00 : Invited talk
Designing nanophotonic structures using conditional-deep convolutional generative adversarial network
Sunae So, Junsuk Rho
Pohang University of Science and Technology (Korea)

A data-driven design approach based on deep-learning is introduced in nanophotonics to reduce time-consuming iterative simulations. We report the first use of conditional deep convolutional generative adversarial network to design nanophotonic antennae that are not constrained to a predefined shape. For given input reflection spectra, the network provides desirable designs in the form of images. Numerical simulation results obtained from the generated designs agree well with the input reflection spectrum. The results provide a noteworthy contribution in nanophotonics.

14:20 : Invited talk
Multiple scattering by complex objects: revisiting the methods of fictitious sources
Anthony Gourdin[1], Patrice Genevet[2], Didier Felbacq[3]
[1] *Safran Electronics - Defense (France),* [2] *Université Cote d'Azur (France),* [3] *University of Montpellier (France)*

We present a numerical method allowing to solve efficiently the Maxwell system in the presence of many obstacles. Each obstacle is characterized by a scattering matrix written in an adapted basis. The scattered field is then represented by fictitious sources. This approach is mixed with a fast multiple algorithm in order to deal with several different obstacles.

14:40 : Invited talk
Global Topology Optimization Networks (GLOnets) for Metasurface Design
Jonathan A. Fan
Stanford University (USA)

I will introduce a new method for designing ultra-high efficiency metamaterials using global topology optimization networks (GLOnets). These networks combine deep generative neural networks with adjoint-based topology optimization to perform a global search and topology optimization within the design space. Importantly, these concepts utilize a population-based approach to optimize a distribution of device instances, which ensures that the full design space is properly sampled and vetted during network training. These hybrid algorithms that combine machine learning with physical calculations will set the stage for big data approaches to

assist in defining the next generation of nano-based optical devices.

15:00 : Different Photonic Structures via Inverse-Design Algorithm
Done Yilmaz, Mediha Tutgun, Ahmet M. Alpkilic, Yusuf A. Yilmaz, Hamza Kurt
TOBB University of Economics and Technology (Turkey)

In this work, we present various photonic structures generated by the inverse design algorithm. The computational method is used to obtain various photonic phenomena such as negative refraction, optical filtering and wavelength selectivity. The high performances of the designed structures reveal that the objective-first inverse-design algorithm is an effective and successful computational design approach for the realization of the photonic devices.

15:15 - 16:15 — Auditorium EA1

Session 3A24

Optical antennas and plasmonics-based devices

Chaired by: Pierre Berini

15:15 : Multiband Antennas for Si-based Terahertz Detectors
Ke Wang, Fangfang Ren, Yi Yang, Ping Han, Xiaoli Ji
Nanjing University (China)

The authors demonstrate a Si-based multiband terahertz antenna which can be fully integrated with MOSFET-based terahertz detectors in standard Si technologies. It consists of semicircular nesting rings and slots. For an optimized antenna structure with a size of 160 um x 160 um, four separated bands can be achieved in the range of 0.1∼1.2 THz with the central one located at 0.5 THz with a bandwidth of 30 GHz.

15:30 : Self-Assembled Plasmonic DNA Origami Nanoantennas for Diagnostic Applications
Florian Steiner[1], Carolin Vietz[2], Sarah Ochmann[1], Kateryna Trofymchuk[1], Viktorija Glembockyte[1], Cindy Close[1], Hakan Inan[1], Lennart Grabenhorst[1], Florian Selbach[1], Guillermo Acuna[3], Birka Lalkens[4], Philip Tinnefeld[1]
[1] *Ludwig-Maximilians-Universitat Munchen (Germany),* [2] *Technische Universitat Braunschweig (Germany),* [3] *University of Fribourg (Switzerland),* [4] *LENA - Institute of Semiconductor Technology (Germany)*

By using DNA nanotechnology it is now possible to build complex nanostructures and hybrid materials. We used DNA origami structures to design plasmonic nanoantennas containing fluorescent dyes or molecular assays placed in a controlled way into the hotspot of two metallic nanoparticles which are connected to the DNA origami. With these nanoantennas, we were able to optically detect Zika-virus nucleic acids. The fluorescence enhancement enables detection of fluorescence signals of single dyes on low-tech devices such as smartphones.

15:45 : Hexagonal Arrays of Gold Nanodot Dipole Nanoantennas Fabricated by Displacement Talbot Lithography
Jon Pugh[1], Pierre Chausse[2], Andrei Sarua[1], Philip Shields[2], Martin James Cryan[1]
[1] *University of Bristol (United Kingdom),* [2] *University of Bath (United Kingdom)*

This paper presents simulated fluorescence enhancement results for large area gold dipole nanoantenna arrays. Each array element consists of two circular gold nanodots with a small gap between their outer-edges. The hexagonal arrays can be formed by 'Double' Displacement Talbot Lithography via a lift-off process to pattern large area substrates. Intensity enhancement of 2249 at λ=1371nm is simulated when an analyte of n=1.333 flows over the nanoantenna array.

16:00 : High Q-factor coupled Fabry-Perot plasmonic nanoresonator
Baptiste Fix, Julien Jaeck, Patrick Bouchon, Nathalie Bardou, Sebastien Heron, Benjamin Vest, Riad Haïdar
Université Paris Saclay (France)

Fabry-Perot (FP) nanoantennas combined in the same periodic motif have been to behave independently.

However, we evidence the interferences between two under-coupled FP absorbing nanoantennas with a strong impact on the optical behavior: the level of absorption reaches 100 % and the quality factor increases up to factor 7. We first demonstrate by an analytical model that this resonance can be ascribed to the coupling of the two FP-cavities. Then, we experimentally illustrate the existence of this high Q-factor resonance.

14:00 - 16:10 — Auditorium EA2

Session 3A25

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

14:00 : Invited talk
Quantum dot-cavity QED: Acoustic phonon-induced dephasing of polaritons
Egor Muljarov, Amy Morreau
Cardiff University (United Kingdom)

We present a semi-analytic exact solution to the problem of the phonon-induced dephasing in a quantum dot-microcavity system. Central to our approach is a Trotter decomposition of the full system Hamiltonian into two exactly solvable parts: a phonon-free Jaynes-Cummings model and a cavity-free independent boson model. Our approach is valid in a wide range of the exciton-phonon and exciton-cavity coupling parameters, covering regimes of weak, intermediate and strong coupling.

14:20 : Invited talk
From nonlinear plasmonics to entangled photon pair generation in hybrid nanostructures
Nicolas Chauvet[1], Maeliss Ethis de Corny[1], Guillaume Laurent[1], Eric Dujardin[2], Aurélien Drezet[1], Serge Huant[1], Gilles Nogues[1], Guillaume Bachelier[1]
[1] *Université Grenoble Alpes (France),* [2] *CEMES (France)*

Nanoscale second harmonic generation (SHG) and photon pair generation is quantitatively investigated in hybrid nonlinear/plasmonic antennas by coupling quantum and numerical approaches. We demonstrate that the origin of SHG in plasmonic nanostructures are often not coming from the usually invoked local surface nonlinearity and that measurable photon pair production are reachable at the single nanostructure level.

14:40 : Keynote talk
Publishing in Nature journals
Rachel Won
Nature Photonics (United Kingdom)

This talk introduces you to all the existing and new journals in the family of Nature, and covers the detailed information and guidelines on scientific manuscript preparation and submission.

15:10 : Invited talk
Opto-mechanical control of the plasmonic heat generation towards the realization of smart biochips
Roberto Caputo, Giovanna Palermo, Giuseppe Emanuele Lio, Antonio De Luca
University of Calabria (Italy)

In this contribution, we show how it is possible to rigorously predict strain-related phenomena in case of plasmonic systems made of arrangements of metallic nanoparticles immobilized on a flexible elastomeric tape. This insight allows the study of the thermal response of the system and of the heat photogenerated at the nanoscale. Results evidence how the opto-mechanical control of the system depends on external parameters like incident light polarization, nanoparticle inter-distance, and distribution arrangement.

15:30 : Invited talk
Plasmonic Hot-Carrier-Mediated Solar Energy Conversion and Tunable Photochemical Reactions

Yu Zhang[1], **Tammie Nelson**[1], **Sergei Tretiak**[1], **Hua Guo**[2], **ChiYung Yam**[3], **George Schatz**[4]
[1] *Los Alamos National Laboratory (USA),* [2] *University of New-Mexico (USA),* [3] *Beijing Computational Science Research Center (China),* [4] *Northwestern University (USA)*

A new design for hot-carrier solar cells is discussed in which a conventional semiconductor heterojunction is attached to a plasmonic medium. Our theoretical model indicates the opportunities and limitations of employing plamsonic hot-carriers for solar energy conversion. In addition, applications of plasmonic hot-carriers in photochemistry will also be introduced.The atomistic-scale mechanisms of tunable photochemistry via plasmonic hot-carriers will be discussed.

15:50 : Invited talk
Complex materials created by warped spaces for energy harvesting, bio-imaging, and broadband light control at the nanoscale
Andrea Fratalocchi
King Abdullah University of Science and Technology (Saudi Arabia)

In this invited talk, I will review our recent results on complex photonics materials created by warped spaces with application in energy harvesting, structural coloration, bio-imaging and broadband light control in nanoscale structures.

14:00 - 15:00 — Auditorium EA3

Session 3A26

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Junpen Guo

14:00 : Invited talk
Recent advances in phase-change materials for high-speed optoelectronics
Imad Agha
University of Dayton (USA)

By doping Ge2Sb2Te5 phase change material with differentmetals, we produce material with improved electrical properties while simultaneously maintaining the opticalcontrast necessary for light modulation and switching. On the other hand, by nanopatterning the material into nanorodmetamaterials, we can change its thermal response byorders of magntidude, paving the way towards ultra high speed materials for reconfigurable photonic applications.

14:20 : Invited talk
Superconducting thin films and nanowires for mid-infrared single photon detection
Dmitry Morozov[1], **Gregor Taylor**[1], **Archan Banerjee**[1], **Kleanthis Erotokritou**[1], **Umberto Nasti**[1], **Shigehito Miki**[2], **Hirotaka Terai**[2], **Robert H. Hadfield**[1]
[1] *University of Glasgow (United Kingdom),* [2] *National Institute of Information and Communications Technology (Japan)*

Superconducting nanowire single-photon detectors are free running photon counters. At telecom wavelengths they are capable of high quantum efficiency, ultra-low rate of dark counts and a few picosecond timing jitter. Extension of SNSPDs operation into mid-infrared opens new avenues in photonics and quantum communication. Here we report on comprehensive study of superconducting materials (TiN, NbTiN, MoSi) and SNSPDs for mid-infrared photon counting.

14:40 : Invited talk
Plasmonic transition metal nitride and carbide for photocatalytic and photothermal applications
Satish L. Shinde, Satoshi Ishii, Manpreet Kaur, Thang Duy Dao, Tadaaki Nagao
National Institute for Materials Science (Japan)

Optical excitation of hot carriers in metals can be injected into adjacent semiconductors to collect sub-

bandgap photons. In the present work, we experimentally demonstrate that transition metal nitrides and carbides can act as metals and generate hot electrons by optical illumination similar to metals. Since transition metal nitrides and carbides have broad absorption in the visible spectrum with tunable plasmon resonances, they have the potential to be used for photocatalytic, photovoltaic, and photothermal applications to harvest solar energy.

15:00 - 16:00 — Auditorium EA3

Session 3A27

Magneto-plasmonics

Organized by: Ilya Razdolski, Vasily Temnov and David Schmool

Chaired by: Ilya Razdolski, Vasily Temnov and David Schmool

15:00 : Invited talk

Plasmon-induced inverse Faraday Effect and switchable routers and modulators in magneto-plasmonic structures

Joachim Herrmann[1], **Song-Jin Im**[2], **Ji-Song Pae**[2], **Kum-Song Ho**[2], **Yong-Ha Han**[2]

[1] *Max-Born-Institute for Nonlinear Optics and Short Pulse Spectroscopy (Germany),* [2] *Kim Il Sung University (Democratic People's Republic of Korea)*

Recently, the inverse Faraday Effect (IFE) has attracted much attention because of its potential impact for ultrafast all-optical switching of magnetization in thin magnetic films induced by ultrafast pulses [1] which opens the possibility for magnetic data storage with unprecedented speed. In order to enable sub-wavelength spatial resolution for magnetic recording we study a modified version- the plasmon-induced IFE- in which instead of free space circular polarized optical pulses free running surface-plasmon-polaritions (SPP) generated by incident linearly polarized input pulses induce a quasi-static magnetic field.

15:20 : Invited talk

Nanoscale Localization of sub-Terahertz Spin Dynamics in Au/Garnet Magnetoplasmonic Crystals

Alexander L. Chekhov[1], **Alexander I. Stognij**[2], **Takuya Satoh**[3], **Tatiana V. Murzina**[4], **Ilya Razdolski**[5], **Andrzej Stupakiewicz**[6]

[1] *Free University Berlin (Germany),* [2] *Scientific-Practical Materials Research Centre of the NASB (Belarus),* [3] *Kyushu University (Japan),* [4] *Moscow State University (Russia),* [5] *Radboud University (The Netherlands),* [6] *University of Bialystok (Poland)*

We present results on ultrafast magnetization dynamics induced by the surface plasmon-polariton electric field in Au/iron-garnet magnetoplasmonic crystals. The spin precession excited through the inverse Faraday effect demonstrates strong localization and efficiency enhancement by two orders of magnitude at the surface plasmon resonance. The mechanisms of the observed effect are discussed both analytically and numerically.

15:40 : Invited talk

Revealing the Coupling Mechanism of Plasmonic and Magneto-Optically Induced Near-fields in Bi:YIG/Au nanostructures

Spiridon D. Pappas, Philipp Lang, Evangelos Papaioannou

TU Kaiserslautern (Germany)

We demonstrate the anomalous enhancement of the longitudinal magneto-optic Kerr effect of bismuth-substituted yttrium iron garnet films, induced by localized surface plasmons in embedded gold nanoparticles. We reveal the underlying mesoscopic near-field mechanism by quantifying the result of the mixing of the two localized plasmonic resonant modes on the magneto-optic response in the far-field. Our results pave the way to the design on demand of the magneto-optic response of similar hybrid structures.

14:00 - 15:15 — Auditorium EA4

Session 3A28

Structural Color for Displays and Imaging

Organized by: Debashis Chanda

Chaired by: Jay Guo

14:00 : Invited talk
Skin-like Full-Color Angle Independent Plasmonic Reflective Displays
Pablo Manuel Cencillo Abad, Debashis Chanda
University of Central florida (USA)

Tuning plasmonic light absorption with liquid crystal (LC), the color reflected from a nanostructured surface can be changed as a function of voltage. The engineered plasmonic surface allows complete LC reorientation and maximum overlap between plasmonic fields and LC, enabling large tunability across the entire visible spectrum.

14:20 : Invited talk
Nano-structured optical surfaces based on ultrathin materials for displays and sensing
Bruno Paulillo, Rinu Maniyara, Juan Rombaut, Kavitha Kalavoor Gopalan, Nestor Bareza, Valerio Pruneri
ICFO-Institut de Ciencies Fotoniques (Spain)

Optical structures based on nano-structured ultrathin materials offer unprecedented flexibility in molding light propagation for a variety of applications from the visible to the infrared range. In this talk we will discuss our recent work on optical surfaces that combine large-area graphene and/or ultra-thin ($<$10 nm) metal films with scalable nano-patterning techniques (dewetting, nano-imprint). Their applications include transparent electrodes, glass functional nano-structures for displays, and plasmonic metasurfaces for surface-enhanced sensing.

14:40 : Invited talk
Dual-color plasmonic filters
E. Heydari, J. Sperling, S. Neale, Alasdair W. Clark
University of Glasgow (United Kingdom)

We demonstrate a plasmonic approach to high-density optical data storage. We employ dual-color plasmonic nano-pixels to encode two information sets into a single arrays of metal nano-apertures.

15:00 : High-Density Data Storage with Plasmonic Color Metapixels
Alexander V. Kildishev[1], Maowen Song[1], Di Wang[1], Zhaxylyk A. Kudyshev[1], Honglin Yu[2], Alexandra Boltasseva[1], Vladimir M. Shalaev[1]
[1] *Purdue University (USA),* [2] *Chongqing University (China)*

The plasmonic color metapixels have attracted increasing interest in high-density data storage. We experimentally demonstrate plasmonic nanostructructures that significantly expand the number of degrees of freedom for tuning the output colors and encoding more information states. A set of the plasmonic antennas orientation angles inside each metapixel is mapped onto a unique color code and then translated into a corresponding state. Such information-multiplexing holds a great promise for high-density data storage, already exceeding the capacity of conventional optical disks.

15:15 - 15:45 — Auditorium EA4

Session 3A29

Modeling and computational techniques

Chaired by: Teun-Teun Kim

15:15 : Multiobjective Optimization-aided Metamaterial Synthesis
Ronald Paul Jenkins, Sawyer Duane Campbell, Pingjuan L. Werner, Douglas H. Werner
Penn State University (USA)

Metamaterial design, from RF to optical frequencies, can present a significant challenge to engineers. In this paper, several recent tools that can aid in the process of metamaterial synthesis are presented, and their relative advantages are discussed for various kinds of design goals.

15:30 : A Circuit Model for the Spoof Surface Plasmon Polariton Waveguides for the Terahertz Band
Gulay Ozsahin[1], Muhammed Abdullah Unutmaz[1], Mehmet Unlu[2]
[1] *Ankara Yildirim Beyazit University (Turkey),* [2] *TOBB University of Economics and Technology (Turkey)*

We present a circuit model for the spoof Surface Plasmon Polaritons (sSPP) waveguides for the terahertz band. The circuit model uses the theorical calculation and optimization of the circuit elements in terms of the groove parameters. Here, we first simulate the sSPP waveguide by changing the groove dimensions that are the depth, aperture, and periodicity and extract the values of the circuit model parameters. finally, we present the comparison of the proposed circuit model with the measurements.

14:00 - 15:50 — Room 02.2

Session 3A30

Nonreciprocal and Topological Photonics

Organized by: Tiago A. Morgado and Sylvain Lannebère

Chaired by: Tiago A. Morgado and Sylvain Lannebère

14:00 : First Principles Calculation of Topological Invariants by Means of the Photonic Green's Function
Filipa Prudencio, Mario Silveirinha
University of Lisbon (Portugal)

The Chern topological numbers of a material platform are usually written in terms of the Berry curvature which depends on the normal modes of the system. Here, we use a gauge invariant Green's function method to determine from 'first principles' the topological invariants of photonic crystals. The proposed formalism does not require the calculation of the photonic band-structure, and can be easily implemented using the operators obtained with a standard plane-wave expansion.

14:15 : Photonic analogues of the Haldane and Kane-Mele Models
Sylvain Lannebere, Mario G. Silveirinha
University of Coimbra (Portugal)

We propose strict electromagnetic analogues of the Haldane and Kane-Mele models in photonic crystals made of dielectric cylinders with honeycomb symmetry embedded in a metallic background with a nonreciprocal spatially variable pseudo-Tellegen response. In addition, it is shown using a duality transformation that the Kane-Mele model can be implemented in a reciprocal system made of matched anisotropic dielectrics with identical permittivity and permeability.

14:30 : Invited talk
Protected Edge Modes in Metasurface Junctions
Enrica Martini[1], Mario G. Silveirinha[2], Stefano Maci[1]
[1] *University of Siena (Italy),* [2] *University of Lisbon (Portugal)*

This paper presents a new type of waveguide supporting robust propagation of an edge mode thanks to the property of parity, time-reversal and duality (PTD) symmetry. It consists of the combination of two dual parallel-plate waveguides with artificial impedance surfaces as sidewalls. In the particular case of PEC/PMC boundaries, a closed form solution is found for the supported mode through a mode matching procedure. Artificial impedance implementation through mushroom type metasurface is also discussed

14:50 : Invited talk

Synthetic gauge fields and tilted Dirac cones in photonic honeycomb lattices

Omar Jamadi[1], Marijana Milicevic[2], Elena Rozas[3], Grazia Salerno[4], Tomoki Ozawa[5], Iacopo Carusotto[6], Gilles Montambaux[2], Luc Le Gratiet[2], Abdelmounaim Harouri[2], Isabelle Sagnes[2], Aristide Lemaitre[2], Jacqueline Bloch[2], Alberto Amo[1]

[1] *Université de Lille (France),* [2] *Université Paris-Saclay (France),* [3] *Universidad Autonoma de Madrid (Spain),* [4] *Université Libre de Bruxelles (Belgium),* [5] *RIKEN (Japan),* [6] *Universita di Trento (Italy)*

Strain engineering is a powerful tool to shape the dispersion of Dirac materials. Here we use a honeycomb lattice of coupled polariton micropillars to implement tilted photonic Dirac cones, including type-III cones. To do so, we introduce a spatial asymmetry in the hopping of photons in the x and y directions of the lattice. When the hopping presents a spatial gradient, an artificial gauge field for photons is engineered, and photonic Landau levels are observed.

15:10 : Invited talk

Theory of Chiral Edge State Lasing in a 2D Topological System

Matteo Secli[1], Massimo Capone[1], Iacopo Carusotto[2]

[1] *International School for Advanced Studies (SISSA) (Italy),* [2] *Universita di Trento (Italy)*

We numerically simulate a Harper-Hofstadter model equipped with broadband optical gain, with the goal of extracting those general features of the lasing regime resulting from the chirality of the edge modes. We find ultraslow relaxation times well above threshold and, depending on the shape of the amplifying region, the opening of a convective instability region in which the competition between the two chiral edge modes emerges more clearly.

15:30 : Invited talk

Experimental realization of valley-Hall photonic topological insulators with dual-band kink states

Qiaolu Chen[1], Li Zhang[1], Mengjia He[1], Yihao Yang[1], Huaping Wang[2], Hongsheng Chen[1]

[1] *Zhejiang University (China),* [2] *Nanyang Technological University (Singapore)*

We experimentally realize a valley-Hall photonic topological insulators in a substrate-integrated microwave circuitry, where the kink states exist at two separated frequency bands. Both the simulated and experimental results verify the existence of topological dual-band kink states. Moreover, the kink states are robust against the sharp bends of the internal domain wall with negligible inter-valley scattering.

Coffee Break and Exhibit Inspection

Session 3P2

Poster session VI

16:00 - 16:40

P1: The Transverse Magneto-Optical Kerr Effect in Two-Dimensional Magnetoplasmonic Periodic and Quasicrystalline structures

Andrey Kalish[1], Roman Komarov[1], Mikhail Kozhaev[2], Achanta Venu Gopal[3], Aman Agrawal[3], Vladimir Belotelov[1]

[1] *Lomonosov Moscow State University (Russia),* [2] *Russian Quantum Center (Russia),* [3] *Tata Institute of Fundamental Research (India)*

We report on the transverse magneto-optical Kerr effect in a two-dimensional magnetoplasmonic quasicrystal and compare it to the case of magnetoplasmonic crystals with different basic angles. The quasicrystalline structure provides resonant response with increased bandwidth.

P2: Spatio-temporal simulation of defect mode laser in 2D groove metal array inside MIM Structure

Seong-Han Kim, Chul-Sik Kee

Advanced Photonics Research Institute - GIST (Korea)

We numerically investigate the spatio-temporal dynamics of lasing action in a metallic resonant cavity with four-level gain media, based on defect modes on 2D groove metal array. By performing semiclassical time-domain simulations based on the finite-element method, we obtain dynamical distributions of populations and

fields in gain medium and threshold behavior of the laser.

P3: Miniature Spectroscopes with Metasurfaced Transmitted Color filters Integrated on a Photodiode Array
Yoshiaki Kanamori, Daisuke Ema, Kazuhiro Hane
Tohoku University (Japan)

As applications of metamaterial, we fabricated metasurfaced transmitted color filters integrated on a photodiode array for miniature spectroscopes. The color filters consisted of two-dimensional guided-mode resonant metal grating filters. Characteristics of the fabricated color filters and miniature spectroscopes were evaluated. Transmittance characteristics of the fabricated color filters showed that the peak wavelengths were proportional to grating periods as designed. From measurement of the fabricated spectroscopes using monochromatic lights, obtained spectra agreed with the center wavelengths of the monochromatic lights.

P4: Engineered Lab-On-fiber SERS Optrodes based on Nanosphere Lithography
Giuseppe Quero[1], Gianluigi Zito[2], Stefano Manago[2], Francesco Galeotti[2], Marco Pisco[1], Anna Chiara De Luca[2], Andrea Cusano[1]
[1] *University of Sannio (Italy),* [2] *National Research Council (Italy)*

We report on reproducible surface enhanced Raman scattering (SERS) probes fabricated onto optical fiber tips (OFTs) through nanosphere lithography. We first evaluated the SERS performances pertaining to different patterns with different nanosphere diameters and gold thicknesses, then the SERS-OFT performance. The most promising SERS platform with an Enhancement Factor of 4x105 and signal fluctuation $< 10\,\%$ was identified. Current activities are devoted to realize Lab-on-fiber SERS probes for human Thyroglobulin, a protein marker of differentiated thyroid cancer.

P5: VIS-UV resonance Raman scattering study of chemical enhancement mechanism in surface enhanced Raman spectroscopy (SERS)
Jayeong Kim[1], Tomke Glier[2], Benjamin Grimm-Lebsanft[2], Soren Buchenau[2], Melissa Teubner[2], Florian Biebl[2], Nam-Jung Kim[3], Heehun Kim[3], Gyu-Chul Yi[3], Michael Rubhausen[2], Seokhyun Yoon[1]
[1] *Ewha Womans University (Korea),* [2] *Universitat Hamburg (Germany),* [3] *Seoul National University (Korea)*

Surface enhanced Raman scattering (SERS) has been studied for several decades. However, chemical enhancement, one of the mechanisms of SERS, is not yet known. In this study, the chemical contribution of the SERS effect of 4-Mpy deposited on ZnO nanostructures was investigated by resonance Raman scattering with incident photon energy ranging from 1.7 eV to 5.7 eV. Through this study, we provide a theoretical and an experimental means to study chemical enhancement mechanism for SERS more in depth.

P6: Dynamics of entanglement for quantum emitters near MoS2 nanodisks
Nikolaos Iliopoulos, Vasilios Karanikolas, Dionisios Stefanatos, Emmanuel Paspalakis
University of Patras (Greece)

We study the dynamics of entanglement for a composite system that consists of a pair of two-level quantum emitters, with picosecond free-space decay time, each one close to a MoS2 nanodisk. We take into consideration the counter-rotating terms and present the time evolution of the concurrence, our entanglement measure, for different initial states of this hybrid system, under strong coupling conditions.

P7: Metamaterial flat lens with properties independent of light polarization
Alexander Agashkov, Nadezhda Ivanova, Nikolay Kazak, Vladimir Agabekov
National Academy of Sciences of Belarus (Belarus)

Experimental and theoretical investigations of promising metamaterial flat lens have been carried out. Unique optical properties are detected of the polymer film PVA/PVP with nanoparticles of gold displaying independence of polarization of incident radiation and low losses in absorption.

P8: Split Ring Resonator Loaded Double Opposite E-shaped Left-Handed Metamaterial for Modern Electronic Communications
Ahmed Mahfuz Tamim, Mohammad Rashed Iqbal Faruque, Mohammad Tariqul Islam
Universiti Kebangsaan Malaysia (Malaysia)

A compact double opposite E-structured metamaterial emerged on split ring resonator (SRR) is introduced and discussed for quad-frequency applications. The unit cell is formed by etching copper on FR4 and its size is 11.12x11.12 mm2. The unit cell shows both the characteristics of negative refractive index and double-

negative characteristics.

P9: Ultimate Material Selection Methodology for Ultra-Broadband M-I-M Metamaterial Absorber
Imre Ozbay
Middle East Technical University (Turkey)

We demonstrate an ultra-broadband metal-insulator-metal (MIM) metamaterial absorber of unrivaled bandwidth within the near-infrared (NIR) regime.

P10: High-efficiency anomalous refraction in terahertz metamaterial
Chunying Guan, Ruiqiang Zhao, Rongyu Liu, Zheng Zhu, Yuxiang Li, Jinhui Shi
Harbin Engineering University (China)

In this work, a transmission type Huygens' metasurfaces with a two-layer metal structure is studied, which achieves reflectless phase modulation at a specific frequency for linear polarization. We design a beam deflector to realize a high-efficient anomalous refraction angle with 19.8°.

P11: High-efficiency asymmetric transmisson in terahertz metamaterials
J. H. Shi, Tingting Lv, Guohua Dong, Zheng Zhu, Yuxiang Li, Chunying Guan
Harbin Engineering University (China)

A chiral metamaterial with crossed-S resonators is proposed and demonstrated experimentally based on the broken symmetry along the propagation direction, which enables a high efficient, broadband and mutually independent dual-band asymmetric transmission (AT) in both x and y polarized directions.

P12: Polarization-sensitive coherent absorption in metamaterials
Yuxiang Li, Bowen Li, Jintong Shi, Wenjin Lv, Chunying Guan, Jinhui Shi
Harbin Engineering University (China)

We reported multi-band absorption in bilayered asymmetrically split ring metamaterials.The absorption can be coherently modulated by a second conterpropagating wave.The spectrally overlapped electric and magenetic resonances can be selectively observed based on the interaction of light with light on metamaterials.In particular, the scheme for realizing multi-band coherent perfect absorption operates from microwave to optical frequency.

P13: Focusing and Ultra-high Resolution by Integrated Metalens
Juntao Li, Qian Sun, Yuhao Ren, Haowen Liang
Sun Yat-sen University (China)

We present a metalens composed of double layer crystalline silicon metasurfaces to achieve an optical needle focusing with ultra-high resolution of $\lambda/5$. This metalens is promising for non-intrusive, far-field super-resolution optical imaging.

16:40 - 18:00 — IST Congress Center Auditorium

Session 3A31

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Hou-Tong Chen

16:40 : Invited talk
Synthetic Weyl points in plasmonic-dielectric crystals
Z. Z. Liu, Q. Zhang, Jun Jun Xiao
Harbin Institute of Technology (China)

Weyl points, where three-dimensional linearly dispersive bands cross, give rise to many intriguing phenomena including topologically protected surface states and chiral anomaly. We show that a geometrical dimension

can also induce a phase transition in 1D plasmonic-dielectric crystals, where a Dirac point emerges. The surface states can be engineered by such synthetic Weyl point concept and observed in lower dimensional systems. We expect similar results be found in 2D as well.

17:00 : Invited talk
Field-Resolved Detection of the Temporal Response of a Mid-Infrared Plasmonic Antenna
Marco P. Fischer[1], Kevin Gallacher[2], Jacopo Frigerio[3], Giovanni Pellegrini[4], Niccolo Maccaferri[5], Giovanni Isella[3], Alfred Leitenstorfer[1], Douglas J. Paul[6], Paolo Biagioni[4], Daniele Brida[5]
[1] *University of Konstanz (Germany),* [2] *University of Glasgow (United kingdom),* [3] *L-NESS (Italy),* [4] *Politecnico di Milano (Italy),* [5] *University of Luxembourg (Luxembourg),* [6] *University of Glasgow (United Kingdom)*

We performed electro-optic sampling of the pulses re-emitted by a heavily-doped germanium antenna resonant in the mid-infrared. This field-resolved measurement allows observing the time domain response of a single plasmonic structure in amplitude and phase.

17:20 : Invited talk
Correlated Photon pairs at 2 microns: Generation, Characterisation, and Detection
Shashi Prabhakar[1], Taylor Shields[1], Gregor G. Taylor[1], Dmitry Morozov[1], Michael Kues[1], Corin Gawith[2], Lucia Caspani[3], Robert H. Hadfield[1], Matteo Clerici[1]
[1] *University of Glasgow (United Kingdom),* [2] *University of Southampton (United Kingdom),* [3] *University of Strathclyde (United Kingdom)*

We report the generation and characterization of non- classical photon states in the 2-micron spectral region, paving the way to low-loss free-space and guided wave quantum communication in the 2-micron window.

17:40 : Invited talk
All-optical signal processing with hybrid III-V-on-silicon chip
Léa Constans[1], Dorian Sanchez[2], Sylvain Combrié[1], Fabrice Raineri[2], Alfredo De Rossi[1]
[1] *Thales Research and Technology (France),* [2] *Université Paris-Saclay (France)*

We discuss the properties of ultrafast nonlinear hybrid devices on a silicon-photonic platform. Nanoscale resonators made of III-V alloys are used as all-optical gates. As an example we have considered this technology for on-chip optical sampling of signals up to 40 GHz. Due to their ultrafast dynamics, high non-linearity and low footprint, these nanoswitches can easily be combined to build complex photonic circuits, e.g. for advanced photonic computing.

16:40 - 18:00 — Auditorium VA1

Session 3A32

A bottom-up approach towards metamaterials and plasmonics

Organized by: Dorota Pawlak and Virginie Ponsinet

Chaired by: Dorota Pawlak and Virginie Ponsinet

16:40 : Invited talk
Metasurfaces atop Self-Assembled Metamaterials
Ullrich Steiner
Adolphe Merkle Institute (Switzerland)

The triply periodic morphology of self-assembled copolymers into plasmonic metals has been used for the manufacture of optical metamaterials. While the chiral morphology of the single gyroid holds promise for negative refraction, several aspects of this metamaterial are not well understood. Using simulations and experiments we show that the termination of the gyroid surface breaks the symmetry of the bulk morphology, inducing linear dichroism.This presentation discusses the interplay of surface and bulk modes in polymer self-assembled metamaterials.

17:00 : Invited talk

Spherically Confined Self-Assembly of Molecular Bottlebrushes - A Facile Route to Hierarchical Photonic Pigments

Richard Mark Parker[1], **Dong-Po Song**[2], **Tianheng H. H Zhao**[1], **Giulia Guidetti**[1], **Silvia Vignolini**[1]
[1] *University of Cambridge (United Kingdom),* [2] *Tianjin University (China)*

Structurally-coloured materials offer a wide variety of visual effects that cannot be achieved with standard pigments. However, their fabrication requires simultaneous control over multiple length-scales. Here we present a robust strategy for the fabrication of hierarchical photonic pigments via the confined self-assembly of molecular bottlebrushes within emulsified microdroplets. The resultant highly-ordered concentric lamellar structure gives rise to a near perfect photonic multilayer in the solid-state, with reflectivity up to 100 %.

17:20 : Invited talk

Ligand-free synthesis of gold nanoparticles incorporated within oriented cylindrical block copolymer films : towards optical metamaterials

Florian Aubrit[1], **Fabienne Testard**[1], **Aurelie Paquirissamy**[1], **Frederic Gobeaux**[1], **Xuan Wang**[2], **Frederic Nallet**[2], **Philippe Fontaine**[3], **Virginie Ponsinet**[2], **Patrick Guenoun**[1]
[1] *Université Paris Saclay (France),* [2] *Université de Bordeaux (France),* [3] *Synchrotron SOLEIL (France)*

We report a method to incorporate gold nanoparticles (AuNPs) in oriented cylindrical phases of a block copolymer, perpendicular to a substrate. AuNPs are produced by ultra-sound reduction of a gold salt in the copolymer solution. The AuNPs are found to be located within the PVP cylinders which keep their orientation. The seeded-growth of these pre-formed AuNPs produced plasmonic AuNPs. Ellipsometric optical properties of these nanocomposites show an extinction in reflectivity at a precise energy and incidence angle.

17:40 : Invited talk

Photonic crystal phosphors: materials meet structures for efficient color conversion

Tae-Yun Lee[1], **Jongho Lee**[1], **Yeonsang Park**[2], **Kyung-Sang Cho**[2], **Kyungtaek Min**[3], **Heonsu Jeon**[1]
[1] *Seoul National University (Korea),* [2] *Samsung Advanced Institute of Technology (Korea),* [3] *Korea Polytechnic University (Korea)*

Phosphor material is reconfigured into a lateral photonic crystal structure such that the light-matter interaction can be enhanced, resulting in an improved color conversion efficiency. Following conceptual demonstrations, red and green photonic crystal phosphor plates are stacked in multiplicity on top of a blue light-emitting diode to generate white light of high quality and efficiency.

16:40 - 17:40 — Auditorium VA2

Session 3A33

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

Chaired by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

16:40 : Invited talk

Ultrafast Magnetic Recording with Terahertz Light

I. Radu[1], **M. Shalaby**[2], **M. Hennecke**[1], **D. Engel**[1], **C. von Korff Schmising**[1], **A. Tsukamoto**[3], **C. P. Hauri**[4], **S. Eisebitt**[1]
[1] *Max Born Institute Berlin (Germany),* [2] *Advanced Innovation Center for Imaging Technology CNU (China),* [3] *Nihon University (Japan),* [4] *Paul Scherrer Institute (Switzerland)*

We report on the first demonstration of THz-driven ultrafast magnetization switching of a magnetically ordered material using intense, single-cycle THz pulses. The magnetization switching process evolves on a few picoseconds timescale as probed by time-resolved magneto-optics in visible spectral range. Our findings reveal a fully deterministic switching event occurring upon each single-shot THz excitation of the ferrimagnetic GdFe alloy.

17:00 : Invited talk
Optical response of magnetoelectric materials with spin-induced chirality and polarity
Youtarou Takahashi
University of Tokyo (Japan)

Optical effects induced by the spin-driven chirality and polarity are investigated by using the time-domain terahertz polarimetry. The resonantly enhanced nonreciprocal optical effects are observed on the electromagnon excitation, which is an electrically active collective spin excitation. The observed nonreciprocal directional dichroism, gyrotropic birefringence and natural optical activity can be viewed as the dynamical counterpart of the magnetoelectric coupling.

17:20 : Invited talk
Spatio-Temporal Conductivity Modulation: A Pathway Towards CMOS Compatible, Low Loss, Magnetic-Free Non-Reciprocity
Aravind Nagulu, Negar Reiskarimian, Tolga Dinc, Harish Krishnaswamy
Columbia University (USA)

Magnetic-free non-reciprocity using spatio-temporal modulation has gained a lot of attention in the recent years. Some approaches use permittivity modulation, but feature a large form-factor or high loss due to small modulation contrasts. More recent approaches leverage much larger conductivity modulation contrasts available in CMOS to achieve drastically smaller form-factors and low-loss non-reciprocity. Here we review recent progress on spatio-temporal conductivity-modulation, which enabled non-reciprocal components operating from radio frequencies to millimeter-waves in a CMOS platform.

16:40 - 17:40 — Auditorium VA3

Session 3A34

Parity-Time and related symmetries in Photonics, Plasmonics, Acoustics

Organized by: Anatole Lupu and Henri Benisty

Chaired by: Anatole Lupu and Henri Benisty

16:40 : Invited talk
Discovery of parity-time symmetry in optical-electrical hybrid oscillators
Yanzhong Liu[1], Tengfei Hao[1], Wei Li[1], Jose Capmany[2], Ninghua Zhu[1], Ming Li[1]
[1] *Chinese Academy of Sciences (China),* [2] *Universitat Politecnica de Valencia (Spain)*

The advance of parity-time (PT) symmetry attracts considerable attention in optics. This phenomenon provides a new tool for manipulating oscillation modes which leads to a potential field of application in microwave photonics. Stable single mode oscillation is theoretically analyzed and experimentally observed in a mutually coupled PT symmetric optoelectronic oscillator (OEO) without any high-Q filter. This observation offers a new method for signal generation and processing in microwave photonics.

17:00 : Invited talk
Regularization of broad-area lasers by non-Hermitian potentials
Muriel Botey[1], Waqas Wasser Ahmed[2], Judith Medina[1], Ramon Herrero[1], Ying Wu[2], Kestutis Staliunas[1]
[1] *Universitat Politecnica de Catalunya (UPC) (Spain),* [2] *King Abdullah University of Science and Technology (KAUST) (Saudi Arabia)*

It was recently shown that arbitrary non-Hermitian optical potentials based on local Parity-Time (PT-) symmetry may control the flow of light, due to the asymmetric mode coupling. We propose periodic non-Hermitian potentials to efficiently regularize the complex spatial dynamics of broad-area semiconductor (BAS) lasers and Vertical-Cavity Surface-Emitting Lasers (VCSELs). Light generated from the entire active layer is concentrated on the structure axis, confined in an intense central narrow beam opening the path to design compact, bright broad-area lasers.

17:20 : Invited talk

Chiral-reversing vortex radiation at the exceptional point of a plasmonic nanocavity

Renmin Ma[1], **Xing-Yuan Wang**[1], **Hua-Zhou Chen**[1], **Suo Wang**[1], **Li Ge**[2], **Shuang Zhang**[3]
[1] *Peking University (China),* [2] *College of Staten Island (USA),* [3] *University of Birmingham (United Kingdom)*

We report a counterintuitive phenomenon where the radiation field of a dipole in a parity-time symmetric ring resonator displays the opposite handedness to the coalesced eigenstate of the system. This finding, to the best of our knowledge, is the first time the wave function of a Jordan vector is revealed in a physical system.

16:40 - 17:40 — Auditorium VA4

Session 3A35

Plasmonics: Fundamentals and Applications

Organized by: Hong Wei

Chaired by: Hong Wei

16:40 : Invited talk

Chiral Weak and Strong Photon-Emitter Coupling in Coupled Photonic Structures

Fan Zhang[1], **Juanjuan Ren**[2], **Lingxiao Shan**[1], **Xueke Duan**[1], **Yan Li**[1], **Tiancai Zhang**[3], **Qihuang Gong**[1], **Ying Gu**[1]
[1] *Peking University (China),* [2] *Beijing Academy of Quantum Information Sciences (China),* [3] *Shanxi University (China)*

To bridge the gap between the cavity quantum electrodynamics and chiral photon-emitter coupling, we propose the coupled photonic crystal and metallic nanoparticle structure, where through strong local field with high helicity, both weak and strong couplings between the circularly polarized emitter and photons are obtained with almost the unidirectional photons propagating, which can be utilized in directional quantum light sources.

17:00 : Invited talk

Strong coupling between plasmonic meta-atoms and plasmonic surface bloch waves

Chun-Yuan Wang[1], **Yungang Sang**[2], **Xinyue Yang**[2], **Soniya S. Raja**[1], **Haozhi Li**[2], **Yufeng Ding**[2], **Shuoyan Sun**[2], **Chang-Wei Cheng**[1], **Hyeyoung Ahn**[3], **Chih-Kang Shih**[4], **Shangjr Gwo**[1], **Jinwei Shi**[2]
[1] *National Tsing-Hua University (Taiwan),* [2] *Beijing Normal University (China),* [3] *National Chiao-Tung University (Taiwan),* [4] *The University of Texas at Austin (USA)*

A strong coupling system is realized by using silver nanogrooves as meta-atoms and surface Bloch waves launched by periodic nanogroove arrays. This system is found to be analogous to electronic band structure in solids. Due to directly sharing the free electrons in the metallic medium, the plasmonic gap modes coherently couple with surface Bloch waves when they overlap with each other in real- and momentum-space. A giant Rabi splitting on the order of 400-500 meV can be experimentally achieved.

17:20 : Invited talk

Tailoring Induced Plasmonic Circular Dichroism in Hybrid Nanostructures with Different Geometric Configurations

Wei Zhang
Institute of Applied Physics and Computational Mathematics (China)

We investigate various ways of tailoring the induced circular dichroism in nanostructures with different geometric configurations (end-to-end, side-by-side assembly nanorod configurations or nanorod with core-shell structure) and explore the key factors affecting the chiroptical responses. It is revealed that the interplay between the local field enhancement and backaction, and the morphology of the nanorod with core-shell structure play important roles in the chiral properties of the hybrid nanostructures.

16:40 - 18:00 — Auditorium VA5

Session 3A36

Exotic Meta-media – Spatial, Non-local and Other Novel Responses

Organized by: Martin McCall, Jonathan Gratus and Paul Kinsler

Chaired by: Martin McCall, Jonathan Gratus and Paul Kinsler

16:40 : Invited talk

Omnidirectional impedance match and its applications based on effective nonlocal media

Jie Luo[1], **Yun Lai**[2]
[1] *Soochow University (China),* [2] *Nanjing University (China)*

In this work, we demonstrate that pure dielectric photonic crystals can be used to realize effective nonlocal media with omnidirectional impedance matching effect, which allow near 100 % transmission of light for all incident angles. We also show that designed with shifted elliptical equal frequency contours, such effective nonlocal media not only provide a low-loss and feasible platform for transformation optics and illusion optics devices, but also provide new ways to realize omnidirectional light absorption.

17:00 : Invited talk

Exotic symmetry-induced effects in photonic and phononic systems

Mehul Makwana[1], **Richard Craster**[1], **Sébastien Guenneau**[2], **Kun Tang**[3], **Patrick Sebbah**[3], **Gregory Chaplain**[1], **Kin Ian Lo**[1]
[1] *Imperial College London (United Kingdom),* [2] *Aix Marseille University (France),* [3] *Bar-Ilan University (Israel)*

Predictive theory to geometrically engineer materials in continuum systems to have desired symmetry-induced effects is developed here by bridging the gap between quantum and continuum descriptions. We emphasise a predictive approach, the strength of which is demonstrated by the ability to design well-defined broadband edge states, valley-Hall networks and anisotropic quasicrystalline effects. We solely use semi-analytical models,this means we can concentrate cleanly upon issues such as group theory, and its influence upon the effects we see, without numerical distractions.

17:20 : Invited talk

Modeling large scale metamaterials for elastic waves control

Bogdan Ungureanu[1], **Stéphane Brulé**[2], **Younes Achaoui**[2], **Stefan Enoch**[2], **Richard Craster**[1], **Sébastien Guenneau**[2]
[1] *Imperial College London (United Kingdom),* [2] *Aix Marseille University (France)*

We've studied and proposed to apply the large scale metamaterials properties, which are based on the negative values of the Bulk modules K and G, the Young modulus, of longitudinal elasticity, as well as on the negative mass density, in order to obtain elastic waves control. These negative values are obtained with the help of the local resonance of the elementary cells that lead to very dispersive properties of the metamaterials.

17:40 : Invited talk

Electromagnetic Wave generation and Amplification mediated via Artificial Materials.

Rebecca Seviour, Simon Foulkes
University of Huddersfield (United Kingdom)

In this paper we examine the use of artificial electromagnetic media to mediate interactions between electromagnetic waves and charged particle beams. Where we consider the physics and application of interaction between artificial media and electron beams, and how this interaction can be used to create novel sources and amplifiers of EM waves.

16:40 - 18:00 — Auditorium VA6

Session 3A37

Synthesis and characterization of plasmonic nanostructures

Organized by: Mohamed Boutinguiza Larosi

Chaired by: Juan M. Pou Saracho

16:40 : Invited talk

Liquid Crystalline Metasurfaces for Spin Control of Light

Yanjun Liu, Zhen Yin, Yue Shi, Ruiheng Peng, Guixin Li, Dan Luo
University of Science and Technology (China)

We demonstrate a facile and low-cost fabrication of silver nanoparticle metasurface with a holographic technique. Mimicking the liquid crystal molecules, the silver nanoparticles show a well-observed polarization-directed shape-dependent nanoparticle growth and large-area interference-patterned nanoparticle assembly. The silver nanoparticle metasurface possesses excellent chiroptical properties that can be further used for spin control of light.

17:00 : Invited talk

Recent advances in the bottom-up approach to artificial optical magnetism

Philippe Barois, Alexandre Baron, Romain Dezert, Etienne Duguet, Rajam Elancheliyan, Veronique Many, Olivier Mondain-Monval, Virginie Ponsinet, Serge Ravaine, Philippe Richetti, Mona Treguer-Delapierre
Université de Bordeaux (France)

We present several routes towards the generation of artificial magnetism in visible light. Our bottom-up strategies combine nano-chemistry for the fabrication of optically resonant elements and colloidal self-assembly for the fabrication of macroscopic materials. Two types of optical resonators are investigated, namely plasmonic and Mie resonators. In the first type, the magnetic response is optimized by a proper design of plasmonic nano-clusters. In the second type, the challenge is to produce nanoparticles of high refractive index.

17:20 : Invited talk

Laser implantation of plasmonic nanoparticles into glass

Jurgen Ihlemann[1], Jorg Meinertz[1], Maximilian Heinz[2], Manfred Dubiel[2]
[1] *Laser-Laboratorium Gottingen e.V. (Germany),* [2] *Martin-Luther-Universitat Halle-Wittenberg (Germany)*

UV-laser irradiation of gold-coated glass leads to gold nanoparticle formation and, at sufficiently high laser fluence, to incorporation or implantation of these particles into the glass. A characteristic plasmon absorption peak around 550 nm is observed. Gold particles in SiO2-glass are obtained by implanting gold into SiOx that is subsequently oxidized to SiO2 Spatially defined particle implantation is achieved by structured irradiation.

17:40 : Invited talk

Plasmonic nanoparticles for molecular detection

David Zopf, Angelina Pittner, Cornelia Arnold, Stephan Kastner, Andre Dathe, Matthias Thiele, Jacqueline Jatschka, Thomas Schneider, Ondrej Stranik, Andrea Csaki, Wolfgang Fritzsche
Leibniz Institute of Photonic Technology (IPHT)Jena (Germany)

A reliable, sensitive and cost-efficient molecular detection could have a broad field of bioanalytical applications in fields ranging from clinical diagnostics over food safety to environmental applications. We describe here the use of localized surface plasmon resonance (LSPR), an effect based on collective oscillations of conduction electrons in gold nanoparticles under visible light irradiation, in order to realize a label free and multiplexed molecular detection.

16:40 - 17:55 — Auditorium EA1

Session 3A38

Light ma ement in solar cells

Organized by: Braulio Garcia-Camara and Ricardo Vergaz

Chaired by: Braulio Garcia-Camara and Ricardo Vergaz

16:40 : Invited talk
Correlation between Light Absorption and External Quantum Efficiency of Metamaterial Perfect Absorber Solar Cell
Wakana Kubo
Tokyo University of Agriculture and Technology (Japan)

We examined the light absorption properties and device performance of the metamaterial perfect absorber (MPA) solar cell in order to clarify the contribution of plasmonic light confinement effect on the solar cell device performance. The metamaterial perfect absorber solar cell exhibited the enhanced external quantum efficiency (EQE) at the wavelength where the MPA can confine light into the active layer. This result is an evidence the enhancement in EQE is strongly correlated to the light confinement acquired by MPA.

17:00 : Ultrathin Semiconductor Superabsorbers from the Visible to the Near Infrared
Pau Molet Bachs, Juan Luis Garcia Pomar, Cristiano Matricardi, Miquel Garriga, Maria Isabel Alonso, Agustin Mihi
ICMAB (Spain)

In this work, we present a strategy that achieves broadband optimal absorption in arbitrarily thin semiconductor materials for all energies above their bandgap. Our strategy follows an easy and scalable fabrication route enabled by soft nanoimprinting lithography with seamless integration in many optoelectronic fabrication procedures.

17:15 : Invited talk
Subwavelength High Refractive Index Dielectric structures for photovoltaic applications
Angela Inmaculada Barreda[1], Amélie Litman[2], Francisco Gonzalez[1], Pablo Albella[1], Jean-Michel Geffrin[2], Fernando Moreno[1]
[1] *University of Cantabria (Spain),* [2] *Aix-Marseille University (France)*

High Refractive Index Dielectric (HRID) nanostructureshave become an alternative to metallic in the VIS-NIRdue to their low-losses and magnetic response. In addition,they can be basic units in applications where directionalitycontrol of the scattered radiation is required. Here, we showthat aggregates of subwavelength HRID particles, understrong electromagnetic interaction, can be efficientscattering units for redirecting the incident radiationtowards a photosensitive substrate. Applications foroptimizing the efficiency of photovoltaic devices (solarcells) are envisaged.

17:35 : Invited talk
Next generation solar cells and photodetectors with III-V nanowires
Anna Fontcuberta i Morral
EPFL (Switzerland)

Nanowires are filamentary crystals with a tailored diameter ranging from few to $\sim$100 nm. The special geometry and tailored dimensions result in photonic properties providing great potential in applications requiring enhanced light absorption. We will review how these properties can be used in different configurations for both photo-detection and energy harvesting applications.

16:40 - 17:50 — Auditorium EA2

Session 3A39

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

16:40 : Keynote talk

Tracking ultrafast light-heat conversion in plasmonic nanoassemblies

Andrea Mazzanti[1], Zhijie Yang[2], Marie-Paule Pileni[3], Giuseppe Della Valle[1], Giulio Cerullo[1]
[1] *Politecnico di Milano (Italy),* [2] *Université Paris Diderot (France),* [3] *CEA/IRAMIS (France)*

We investigate the photothermal properties of water-soluble hybrid organic-inorganic Au nanocrystal assemblies, comprising plasmonic nanocrystals embedded in a matrix of organic ligands, via a combination of ultrafast optical spectroscopy and semi-classical numerical modeling. We observe a complex transient optical response, with picosecond electron-phonon equilibration followed by heat release to the matrix on the 100-ps timescale.

17:10 : Invited talk

Refractory plasmonic nanocavities for chemistry at high temperatures

Alberto Naldoni[1], Zhaxylyk A. Kudyshev[2], Luca Mascaretti[1], Stepan Kment[1], Alexandra Boltasseva[2], Vladimir M. Shalaev[2], Patrik Schmuki[3], Radek Zboril[1]
[1] *Palacky University (Czech Republic),* [2] *Purdue University (USA),* [3] *University of Erlangen-Nuremberg (Germany)*

Plasmonic metamaterials provide sub-wavelength light concentration and consequent localized heating, which holds great potential in the development of solar-thermal technologies. Here, I will present our recent efforts to fabricate large-scale refractory metamaterial films made by cylindrical plasmonic cavities of titanium nitride (TiN) and their use in various thermoplasmonic applications such as decomposition of molecules, synthesis of metal nanoparticles, conformal deposition of inorganic thin films, and steam generation.

17:30 : Invited talk

Shaping and measuring temperature at the microscale for biological applications

Chang Liu[1], Pascal Berto[1], Clémence Gentner[1], Minh-Chau Nguyen[1], Ivan Flores[2], Robert Kuszelewicz[1], Marc Guillon[2], Gilles Tessier[1]
[1] *Sorbonne Université (France),* [2] *Université Paris Descartes (France)*

Using a spatial light modulator, a pre-calculated heat source distribution is projected on a plasmonic nanoparticle carpet to produce a fast, reconfigurable and accurate temperature distribution in an arbitrarily-shaped 2D region. The temperature maps induced by the thermoplasmonic effect are deduced from images obtained using two types of wavefront sensors, a shearing interferometer and a thin-diffuser-based imaging approach.

16:40 - 18:00 — Auditorium EA3

Session 3A40

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Nathalie Destouches

16:40 : Invited talk

Recent advances in subwavelength metamaterial silicon photonics

Pavel Cheben[1], Carlos Alonso-Ramos[2], Robert Halir[3], Jens Schmid[1], Jiri Ctyroky[4], Daniel Benedikovic[2], Alejandro Ortega-Monux[3], Alejandro Sanchez-Postigo[3], David Gonzalez-Andrade[5], Gonzalo Wangüemert-

Perez[3], Inigo Molina-Fernandez[3], Aitor Velasco[5], Alaine Herrero-Bermello[5], Jose Manuel Luque-Gonzalez[3], Daniel Pereira-Martin[3], Jean Lapointe[1], Siegfried Janz[1], Dan Xia Xu[1], Daniele Melati[1], Yuri Grinberg[1], Shurui Wang[1], Martin Vachon[1], Mohsen KamandarDezfouli[1], Ross Cheriton[1], Vladyslav Vakarin[2], Milan Dado[6], Dorian Oser[2], Florent Mazeas[7]
[1] *National Research Council (Canada),* [2] *Université Paris-Saclay (France),* [3] *Universidad de Malaga (Spain),* [4] *Institute of Photonics and Electronics, CAS (Czech Republic),* [5] *CSIC (Spain),* [6] *University of Zilina (Slovakia),* [7] *Université Cote d'Azur (France)*

Subwavelength grating metamaterial waveguide structures are becoming established as important building blocks for silicon photonic integrated circuits. The novel optical properties found in these structures and ability to control their optical responses with unprecedented accuracy are opening new prospects for controlling flow of light in nanophotonic waveguides circuits. In this invited talk we will present an overview of our recent advances in this exciting field, including efficient fiber-chip couplers, ultra-broadband waveguide devices and Bragg filters with high spectral sensitivity.

17:00 : Invited talk
Surface Acoustic Wave generation of guided Modes in Phononic Nanobeams
Alexander Korovin[1], Yan Pennec[1], Matteo Stocchi[2], Davide Mencarelli[3], Luca Pierantoni[2], Tapani Makkonen[4], Jouni Ahopelto[4], Bahram Djafari Rouhani[1]
[1] *University of Lille (France),* [2] *Marche Polytechnic University (Italy),* [3] *Marche polytechnic University (Italy),* [4] *VTT Technical Research Centre (Finland)*

We investigate theoretically the conversion of surface acoustic waves generated on a substrate to the guided modes of a phononic nanobeam. An efficiency of -23 dB is demonstrated. We study the interaction of these converted modes with a structured phononic crystal nanobeam containing a cavity and evaluate the transmission through localized cavity modes. We also discuss the optomechanic interaction of the phononic cavity with an external optical waveguide and the emission of phonons into the nanobeam.

17:20 : Invited talk
Heterogeneous Integrated Nanomaterials for Attojoule Optoelectronics and Neuromorphic Information Processing
Jonathan K. George, Mario Miscuglio, Rubab Amin, Zhizhen Ma, Volker J. Sorger
George Washington University (USA)

Here we will discuss our recent devices demonstrating 100aJ/bit modulators, graphene photodetectors, and epsilon-near-zero modes. Using those, we further show that underlying mathematical function of a multiply-accumulate (MAC) can be realized photonically, here the nonlinear activation function can be achieved with electro-optic modulators. We will share our photonic neural network (NN) processors to include a feed-forward fully-connected NN and a convolutional NN processor where convolutions are expressed as multiplications in the Fourier domain at nanosecond-short delays for real-time processing.

17:40 : Invited talk
Direct Integration of Scalable Quantum Sources into Pre-Fabricated Integrated Optics
Khaled Mnaymneh, Dan Dalacu, David B. Northeast, Joseph McKee, John Weber, Sofiane Haffouz, Jean Lapointe, Philip P. Poole, Geof C. Aers, Robin L. Williams
National Research Council (Canada)

We present a monolithic integration technique for the direct integration of single quantum sources into pre-fabricated photonic circuitry. Using a SEM-based nanomanipulator, we preselect, transfer and place epitaxially grown tapered InP nanowires embedded with a single InAs quantum dot on top of or beside pre-fabricated optical waveguides.

16:40 - 18:00 — Auditorium EA4

Session 3A41

Magneto-plasmonics

Organized by: Ilya Razdolski, Vasily Temnov and David Schmool

Chaired by: Ilya Razdolski, Vasily Temnov and David Schmool

16:40 : Invited talk
Nonreciprocal magnetoplasmonic gratings
Rafael Cichelero, Mikko Kataja, Gervasi Herranz
Institute for Materials Science of Barcelona ICMAB-CSIC (Spain)

Grating offer a solution towards integrated optical isolation by coupling optic fibers to on-chip waveguides. In this context, we study the interplay between diffraction and plasmons in magnetoplasmonic gratings, where broken time-reversal symmetry induces frequency shifts in energy and angular spectra of plasmon resonances. As a result, exceptionally large magneto-optic responses are seen in diffracted modes. Our results can be generalized to complex diffractive elements, such as metasurfaces, where they could find use in designing tunable nonreciprocal devices.

17:00 : Invited talk
Faraday Rotation Enhancement in Graphene Metasurfaces
Jean-Marie Poumirol[1], M. Tamagnone[2], T. M. Slipchenko[3], L. Martin-Moreno[4], J. R. Mosig[1], Alexey B. Kuzmenko[1]
[1] *University of Geneva (Switzerland),* [2] *Harvard John A. Paulson School of Engineering and Applied Sciences (USA),* [3] *CSIC-Universidad de Zaragoza (Spain),* [4] *EPFL de Lausanne (Switzerland)*

In this work we studied both theoretically and experimentally the possibilities that graphene based metasurfaces offer for the control of the Faraday rotation and MCD.

17:20 : Invited talk
Magnetoplasmonic Modulators for Integrated Optics
Curtis Firby, Abdulhakem Elezzabi
University of Alberta (Canada)

Incorporating magnetic materials into plasmonic devices facilitates unique nonreciprocal phenomenon and highly nonlinear temporal dynamics in integrated nanoplasmonic circuitry. In this work, we review some of our recent advances in the development of magnetoplasmonic waveguide devices. Specifically, we demonstrate that integrating magnetic garnets as the core of plasmonic waveguide platforms allows for the development of unique optical phase and intensity modulators which are vital for integrated plasmonic networks.

17:40 : Invited talk
Nonlinear and parametric magneto-elastic dynamics in ferromagnetic nanostructures
Vladimir Vlasov[1], Anton Golov[1], Alexandr Alekhin[2], Alexey Lomonosov[2], Leonid Kotov[1], Dmitry Kuzmin[3], Igor Bychkov[3], Vasily Temnov[2]
[1] *Syktyvkar State University (Russia),* [2] *Le Mans Universite (France),* [3] *Chelyabinsk State University (Russia)*

This work investigates theoretically nonlinear and parametric magneto-elastic interactions between surface acoustic waves and magnetization in ferromagnetic thin films and nanoparticles. Excitation of magnetic oscillations by elastic waves is calculated within the framework of a theoretical model based on the Landau-Lifshitz-Gilbert (LLG) equations dynamically driven via magneto-elastic interactions. In particular, we report on a theoretical investigation of magnetization switching in polycrystalline Ni nanoparticles induced by ultrashort pulses of surface acoustic waves.

16:40 - 17:35 — Room 02.2

Session 3A42

Nonreciprocal and Topological Photonics

Organized by: Tiago A. Morgado and Sylvain Lannebère

Chaired by: Tiago A. Morgado and Sylvain Lannebère

16:40 : Invited talk

Experimental Discovery of Photonic Nodal Chains

Rongjuan Liu[1], Qinghui Yan[1], Zhongbo Yan[2], Boyuan Liu[1], Hongsheng Chen[3], Zhong Wang[2], Ling Lu[1]
[1] *Chinese Academy of Sciences (China),* [2] *Tsinghua University (China),* [3] *Zhejiang University (China)*

We theoretically predict and experimentally observe nodal chains in a metallic-mesh photonic crystal across the entire Brillouin zone. These nodal chains are protected by mirror symmetry and have a frequency variation of less than 1 %. We use angle-resovled transmission measurements to probe the projected bulk dispersion and perform Fourier-transformed field scans to map out the dispersion of the drumhead surface state. Our results establish an ideal nodal-line material for further study of topological line degeneracies with non-trivial connectivity.

17:00 : Invited talk

Nonreciprocity, Isolation and Time-reversal Symmetry in Nonlinear Devices

David E. Fernandes[1], Mario G. Silveirinha[2]
[1] *Universidade de Coimbra (Portugal),* [2] *University of Lisbon (Portugal)*

Here we highlight that nonlinear devices that operate as 'electromagnetic diodes' for individual port excitations, cannot possibly provide a robust optical isolation under a simultaneous port excitation. Moreover, in the lossless case, typical nonlinear structures, despite being nonreciprocal, are time-reversal invariant, and thereby are inherently bidirectional.

17:20 : One-way surface plasmons in drift-current biased graphene

Tiago Morgado, Mario Silveirinha
Universidade de Coimbra (Portugal)

We propose an innovative solution to break reciprocity and obtain one-way subwavelength light propagation. We theoretically demonstrate that the biasing of a graphene sheet by an electric drift current leads to the emergence of one-way surface plasmons. Our findings open interesting perspectives in nonreciprocal photonics and offer new opportunities to control the flow of light at the nanoscale.

BANQUET

Departure by bus from Instituto Superior Técnico at 18:30

18:30 - 22:00

Friday 26th July, 2019

08:30 - 10:50 — IST Congress Center Auditorium

Session 4A1

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Mario Miscuglio

08:30 : Invited talk
DNA Self-Assembled Plasmonic Nanoantennas
Mauricio Pilo-Pais
University of Fribourg (Switzerland)

DNA can be used as a tool to rationally assemble metallic nanoparticles (NPs) and single photon emitters (e.g. organic fluorophores and QDs) with a defined arrangement, nanometer spacing, and tunable plasmon resonance. These structures can be tailored to have unique optical properties. In this talk, I will discuss our assembly strategies to use DNA as a self-assembly tool to fabricate optical antennas that include a variety of hybrid nanocomponents such as a single QD positioned between two metallic NPs.

08:50 : Invited talk
Invisible Dielectric Cylinders at Optical Frequency
Kotaro Kajikawa, Yusuke Kobayashi
Tokyo Institute of Technology (Japan)

Reported here is invisible circular cylinders at optical frequency, with no coating, on the basis of analytical and numerical calculations . We can realize this, using a dielectric cylinder with its refractive index ranging from 2.7 to 3.8. According to our FDTD calculations, the invisibility stems from cancellation of the dipoles generated in the cylinder.

09:10 : Invited talk
Metasurfaces for Optical Antireflection and Bandpass filters
Hou-Tong Chen, Chun-Chieh Chang, Beibei Zeng, Li Huang
Los Alamos National Laboratory (USA)

We experimentally demonstrate bilayer metasurfaces for optical antireflection. The metasurfaces consist of a square array of silicon pillars with self-aligned top gold resonators and complementary bottom gold slots, enabling near-zero reflection and simultaneously close-to-unity transmission at designed operational frequencies in the terahertz and mid-infrared spectral regions. We further demonstrate THz bandpass filters based on stacked bilayer metasurfaces, allowing fairly narrow, fast roll-off, and high-transmission bandpass performance, with an extremely clean background outside the passband.

09:30 : Invited talk
Hybridization between Parallel and Orthogonal Surface Lattice Resonances
Shao-Ding Liu[1], Peng Yue[1], Shi Zhang[2], Mingshan Wang[3], Hongwei Dai[3], Yiqin Chen[2], Zhong-Quan Nie[1], Yanxia Cui[1], Jun-Bo Han[3], Huigao Duan[2]
[1] Taiyuan University of Technology (China), [2] Hunan University (China), [3] Huazhong University of Science and Technology (China)

Multiple surface lattice resonances generated under normal incidence suppress radiative losses effectively around several spectral positions. In this work, we propose an approach to excite multiple surface lattice resonances with rationally designed plasmonic molecule arrays. It is demonstrated that owning to the formation of various hybridized localized surface plasmon resonances (LSPRs) with a plasmonic trimer, multiple surface lattice resonances can be excited with plasmonic trimer arrays caused by the hybridization between parallel and orthogonal surface lattice resonances.

09:50 : Invited talk
Strong Light-Matter Interaction in Lithography-free Metamaterial Perfect Absorbers: Energy conversion, color filtering, and sensing applications
Ekmel Ozbay, Amir Ghobadi, Hodjat Hajian, Bayram Butun
Bilkent University (Turkey)

The efficient harvesting of electromagnetic (EM) waves by sub-wavelength nanostructures can result in perfect light absorption in the narrow or broad frequency range. In this talk, we will review the material and architecture requirements for the realization of light perfect absorption using these multilayer metamaterial designs from ultraviolet (UV) to far-infrared (fiR) wavelength regimes. We will also discuss the progress, challenges, and outlook of this field to outline its future direction.

10:10 : Invited talk
Bifacial metasurfaces and their applications
Byoungho Lee, Jangwoon Sung, Gun-Yeal Lee
Seoul National University (Korea)

Metasurfaces, which are periodic or semi-periodicarrangement of artificially made nanostructures, haveattracted enormous attention thanks to its unprecedentedability to control the electromagnetic properties of light. Inthis invited talk, general introduction of metasurface will bepresented with their principles and applications.Furthermore, a full-space control, which indicatessimultaneous phase modulation of transmission andreflection space, will be discussed with its theoretical andexperimental demonstration.

10:30 : Invited talk
Angular momentum of light induces chiral mass transport
Takashige Omatsu
Chiba University (Japan)

We discovered that irradiation with light possessing orbital angular momentum owing to its phase singularity, i.e. an optical vortex, twists a variety of materials, including metal, silicon, polymer, and even liquid-phase resin to form various helically structured materials. In this presentation, we report on the unique helical structures created via the interaction between the orbital angular momentum of light and matter.

08:30 - 10:10 — Auditorium VA1

Session 4A2

Exotic Meta-media – Spatial, Non-local and Other Novel Responses

Organized by: Martin McCall, Jonathan Gratus and Paul Kinsler

Chaired by: Martin McCall, Jonathan Gratus and Paul Kinsler

08:30 : Invited talk
Nonlocal homogenisation of centro-symmetric optical metamaterials
Karim Mnasri, Fatima Z. Goffi, Michael Plum, Carsten Rockstuhl
Karlsruhe Institute of Technology (Germany)

Homogenizing metamaterials with local constitutive relations frequently fail when the characteristic length scale of the metamaterial is no longer much smaller than the wavelength. To improve the situation, we consider nonlocal constitutive relations and demonstrate an improvement in the effective description of metamaterials. We discuss the dispersion relations, the additional interface conditions, and study the emerging reflection and transmission coefficients. We validate our model by testing it on selected metamaterials of interest by comparing the response from a slab.

08:50 : Invited talk
Challenging the foundations of electromagnetism: the excitation fields D and H
Jonathan Gratus[1], **Paul Kinsler**[1], **Martin W. McCall**[2]
[1] *Lancaster University (United Kingdom),* [2] *Imperial College London. (United Kingdom)*

Maxwell's equations contain two auxiliary 'excitation' fields, namely (D,H). These not only contain a gauge freedom, but have no way of being directly measured, as can be demonstrated by considering H inside a permanent magnet. This (D,H) freedom even allows us to defy global charge conservation in topologically non-trivial spacetimes (e.g. if a black hole forms and evaporates). We can also better understand the constitutive axion terms, and explore the possibility of a new treatment of electromagnetic current.

09:10 : Invited talk
Electron Spill-Out Effects on Strong Light-Matter Coupling in Plasmonic Systems
Radoslaw Jurga, Khalid Muhammad, Fabio Della Sala, Cristian Ciraci
Istituto Italiano di Tecnologia (Italy)

At sub-nanometer length-scale, nonlocal and quantum effects are expected to influence the interaction between emitters and plasmonic systems, which unavoidably requires to go beyond classical models. Here, we apply state-of-the-art quantum hydrodynamic theory to investigate the quantum effects on strong coupling of a point-dipole emitter placed nearby metallic particles. In order to understand the effects of the quantum hydrodynamic model on the plasmon-emitter coupling, we compare our results with the conventional local response approximation and Thomas-Fermi hydrodynamic theory.

09:30 : Invited talk
Electromagnetic clocks at the rim of metamaterial black holes
Sophie Viaene[1], Vincent Ginis[2], Jan Danckaert[2], Ortwin Hess[1], Philippe Tassin[3]
[1] *Imperial College London (United Kingdom),* [2] *Vrije Universiteit Brussel (Belgium),* [3] *Chalmers University of Technology (Sweden)*

It is notoriously difficult to emulate black hole physics with experiments on earth. This is especially true when emulating the event horizon, which requires controlling materials or experimental settings in time. In contrast, here, we show that hallmark phenomena such as a gravitational red shift can be imposed by a static metamaterial black hole. To this end, we solve for the spontaneous emission rate of a two-level emitter inside a metamaterial black hole, which serves as an electromagnetic clock.

09:50 : Invited talk
Simultaneous amplification and attenuation of plane waves and surface waves possible using nanoengineered materials
Tom Mackay[1], Akhlesh Lakhtakia[2]
[1] *University of Edinburgh (United Kingdom),* [2] *Pennsylvania State University (USA)*

Electromagnetic plane waves are attenuated by dissipative materials and amplified by active materials. However, by virtue of judicious design, certain nanoengineered materials may be neither wholly dissipative nor wholly active. In such materials, whether plane waves are amplified or attenuated can depend upon the direction of propagation or on the polarization state. The prospects of achieving simultaneous amplification and attenuation of plane waves and surface waves have been established theoretically and numerically using a variety of nanoengineered materials.

08:30 - 09:50 — Auditorium VA2

Session 4A3

Symposium IV: Chirality, magnetism, and magnetoelectricity: Separate phenomena and joint effects in metamaterial structures

Organized by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

Chaired by: Eugene Kamenetskii, Tetsuya Ueda and Andrey Miroshnichenko

08:30 : Invited talk
Photonic properties of multiferroic layered metasurfaces
Ramaz Khomeriki[1], Levan Chotorlishvili[2], Jamal Berakdar[2]
[1] *Tbilisi State University (Georgia),* [2] *Martin-Luther Universitat (Germany)*

We discuss the electromagnetic wave propagationin a multiferroic, insulating oxide-based metastructureconsisting of alternating coupled layers of ferroelectric(SrTiO3) and ferromagnetic (Y3Fe2(FeO4)3,YIG) layers. The dynamic magnetic and electric polarization responses are explicitly accounted for by self-consistent, discretized, coupled equations for the Maxwell/ferroelectric/ferromagnetic dynamics. We find for particular GHz frequencies that waves with different polarizations are characterized by different signs of the refractive index, implying new phenomena such as a positive-negative birefringent effect, and magnetically controlled light trapping and accelerations.

08:50 : Invited talk
Biomacromolecular Charge Chirality Detected Using Chiral Plasmonic Nanostructures
Marion Rodier, Maryam Hajji, Malcolm Kadodwala
University of Glasgow (United Kingdom)

We demonstrate that chiral plasmonic nanostructures can be used to detect the chirality of the surface charge distribution of a biomacromolecule. A property which is invisible to conventional spectroscopy. This phemonon is utilised to discriminate between an enzyme which has been obtained from two sources, with identical structures but with differing primary sequences.

09:10 : Invited talk
Chiral Optomagnonics with Polarized Light in Magnetic Insulators
Igor Proskurin[1], Alexander S. Ovchinnikov[2], Jun-Ichiro Kishine[3], Robert L. Stamps[1]
[1] *University of Manitoba (Canada),* [2] *Ural Federal University (Russia),* [3] *The Open University of Japan (Japan)*

Several questions related to the interaction of magnetic excitations with polarized electromagnetic fields will be considered. We are going to discuss how chirality of spin waves can be introduced in analogy to the optical zilch, how chiral electromagnetic fields can be used to generate magnon spin currents, and couple to the collective degrees of freedom via the magneto-optical interactions.

09:30 : Invited talk
Theory for Ultrafast Control of Spin Current and Spin Textures with AC fields
Masahiro Sato
Ibaraki University (Japan)

The development of THz-laser science has accelerated the study of controlling magnetism with THz laser. Motivated by this, we have explored ultrafast ways of controlling magnetism. We propose new Floquet-engineering methods in magnetic insulators, and numerically show that a class of magnetic defects can be created by applying topological light-waves to chiral magnets. Moreover, we show a new mechanism of spin-current rectification with THz laser in non-centrosymmetric magnets. I would like to report some of these results.

09:50 - 10:40 — Auditorium VA2

Session 4A4

Plasmonics-based devices

Chaired by: Gary Wiederrecht

09:50 : Invited talk
Holey metal films for sensing applications - Impact of nonlocality on extraordinary optical transmission
Christin David[1], Johan Christensen[2]
[1] *IMDEA Nanoscience (Spain),* [2] *Universidad Carlos III de Madrid (Spain)*

Electron interactions in metals are neglected in classical electrodynamics. Short-ranged, they can have a remarkable impact on the optical response of metals. The excitation of additional pressure waves and anomalous diffraction lead to a substantial change in the bandstructure and electromagnetic fields supported by a nonlocal holey metal film with respect to the classical local response approximation even at large geometrical parameters. In contrast to homogeneous nonlocal metal films, spatial dispersion is found to emerge also at

normal incidence.

10:10 : Real-Time In-Situ Optical Tracking of Oxygen Vacancy Migration in Memristors
Giuliana Di Martino[1], Dean Kos[1], Weiwei Li[1], Bonan Zhu[1], Xuejing Wang[2], Haiyan Wang[2], Angela Demetriadou[3], Judith Driscoll[1], Jeremy Baumberg[1]
[1] *University of Cambridge (United Kingdom),* [2] *Purdue University (USA),* [3] *University of Birmingham (United Kingdom)*

The switching mechanism of valence change memories involves the migration, accumulation and rearrangement of oxygen vacancies within a dielectric medium to change the electrical conductivity, and is triggered by an external applied potential. Here, resistive switches are constructed to exploit the high sensitivity to morphology at tightly-confined plasmonic hotspots within the switching material. This gives a non-destructive technique to detect oxygen vacancy motion with nm-scale sensitivity using visible light.

10:25 : A 10 um x 10 um Longwave Infrared Imaging Pixel Based on Split Ring Resonators
Mohammed R. AlShareef, Mohamed Ramy Abdel-Rahman
King Abdulaziz City for Science and Technology (Saudi Arabia)

In this work, a 10μm x 10μm infrared imaging pixel is proposed based on electrically small resonators. The novel pixel configuration is composed of eight split ring resonators electromagnetically coupled to two tapered transmission lines that are purposed to deliver the coupled electromagnetic power to a resistive sheet, representing a microbolometer. The proposed structure is simulated and the power absorption efficiency in the longwave infrared (8-12 μm) band is analyzed.

08:30 - 10:30 — Auditorium VA3

Session 4A5

Symposium II: New trends in nanophotonics and advanced materials

Organized by: Junsuk Rho, Hakjoo Lee and Namkyoo Park

Chaired by: Bahram Djafari-Rouhani

08:30 : Invited talk
Laser induced nanostructuring of plasmonic composite films for color image multiplexing
Nipun Sharma[1], Marie Vangheluwe[2], Matthieu Bugnet[1], Alice Vermeulin[2], Nathalie Destouches[1]
[1] *Lyon University (France),* [2] *HID Global CID (France)*

Plasmonic and interferometric colors are of great interest for their vibrancy, stability over time and their potential dichroic properties. Here, we present a laser-based technology that allows controlling the colors of plasmonic nanocomposite films and to print multiplexed images observable under white light independently in reflection, transmission or diffraction. Two approaches lead either to hide diffractive images in a homogeneous reflective area or to encode three different images selectively displayed in reflection or polarized transmission on the same area.

08:50 : Invited talk
Far-field sub-diffraction imaging with wire array metamaterials
Alessio Stefani, Simon Fleming, Boris Kuhlmey
The University of Sydney (Australia)

Fiber drawing is used to realize extended and scalable metamaterials. Such metamaterials are used for light guidance and sub-resolution imaging. In this paper, the application of fiber drawn wire array metamaterials for far field imaging is reported. The scalability of the process allows fabrication of structures sized for frequencies between the THz and the IR.

09:10 : Invited talk
Deciphering, Characterization and Nanocontrol of Single Quantum Dots for Single Photon Emission and Near-field Imaging

Xuewen Chen
Huazhong University of Science and Technology (China)

We show in-situ deciphering the charging status, and precisely assessing the absorption cross section, and determining the absolute emission quantum yields for neutral, positively-charged, and negatively-charged single QD. We uncover very different photon statistics of the three charge states in single QD. We report on nano-controlled coupling of one colloidal quantum dot to a dielectric nanotip for single-mode outcoupling of the single photons. We demonstrate three-dimensional manipulation of the QD towards precise integration of nanophotonic structures and near-field imaging.

09:30 : Invited talk
Key Issues in the Rational Design of Plasmonic Nanoparticles for Second Harmonic Generation
Pierre-Francois Brevet
Université de Lyon (France)

Second Harmonic Generation from plasmonic nanoparticles requires a delicate balance between material size, shape or morphology for the best performances according to the laser excitation conditions. We investigate all these issues in a first step using available experimental data and then present further avenues to explore using hybrid dielectric - metallic nanoparticles.

09:50 : Invited talk
Aggregation Enhanced Two-photon Photoluminescence of Plasmonic Metal Nanoparticles and Their Biomedical Applications
Peiyan Yuan, Zhenping Guan, Cuifeng Jiang, Monalisa Garai, Qing-Hua Xu
National University of Singapore (Singapore)

Noble metal nanoparticles were found to display significantly enhanced two-photon photoluminescence upon aggregate formation, which has been studied in the colloid solutions and on the single particle level. This phenomenon has been utilized to develop various schemes for two-photon excitation based biomedical applications.

10:10 : Invited talk
Optical manipulation of exciton polaritons in semiconductor microcavity structures: from transitional to rotational motion
Yong-Hoon Cho
Korea Advanced Institute of Science and Technology (KAIST) (Korea)

We present the intriguing physical phenomena including generation of quantum vortex and ballistic transport via the optical manipulation of exciton polariton condensate. Exciton polaritons generated in two-dimensional microcavity based on arsenide semiconductor system are exploited for the generation of quantum vortex via directly transferring orbital angular momentum of optical pump to polariton quantum fluid. Nitride semiconductor based one-dimensional exciton polariton shows ballistic transport of exciton polariton condensate at room temperature through the gradient control of exciton reservoir.

08:30 - 10:25 — Auditorium VA4

Session 4A6

Metasurfaces and 2D Metamaterials in microwave region

Organized by: Badreddine Ratni and Kuang Zhang

Chaired by: Badreddine Ratni and Kuang Zhang

08:30 : Invited talk
Dynamically controlling focal point position with reconfigurable metasurface
Badreddine Ratni[1], Zhuochao Wang[2], Kuang Zhang[2], Xumin Ding[2], Andre de Lustrac[3], Shah Nawaz Burokur[1]
[1] Université Paris Nanterre (France), [2] Harbin Institute of Technology (China), [3] Université Paris-Saclay (Fran-

ce)

The phase distribution required along a metasurface in order to converge the energy to any desired spatial position is calculated. In order to dynamically control this convergence point, a planar reconfigurable metasurface has been developed. This structure is composed of meta-atoms that incorporate voltage-controlled varactor diodes. The dispersion responses of each unit cell are individually tailored for the reconfigurability mechanism. Experimental verifications performed on an active metasurface agree with theoretical calculations and validate the proposed concept.

08:50 : Invited talk

Size influence of checkerboard-like wideband metamaterial absorbers

Andre Barka[1], Xavier Begaud[2], Anne-Claire Lepage[2], Stefan Varault[2], Michel Soiron[3], Olivier Rance[2]
[1] *Université de Toulouse (France),* [2] *Télécom ParisTech (France),* [3] *SART (France)*

Recently the performances of radar absorbing materials have been extended by designing new thin structures with wideband properties and large angles of incidence [1]. In this paper, the design and performances of such ultra-wideband microwave absorber of low thickness material developed within the framework of the SAFAS project (self-complementary surface with low signature) are confirmed with complementary quasi monostatic measurements and finite array simulations using finite Element Tearing and Interconnecting domain decomposition methods (FETI).

09:10 : Invited talk

Holographically-modulated metasurface leaky-wave antennas for multiple near-field focused spots manipulation

José Luis Gomez-Tornero, Miguel Poveda Garcia
Technical University of Cartagena (Spain)

This works describes a synthesis technique to generate multiple near-field focused beams in the microwave regime, using single-fed thin metasurface antennas. Using spatially-modulated leaky-wave theory and holographic principles, it is demonstrated how one can tailor the equivalent amplitude and phase aperture distributions of the waves emerging from the metasurface, so to precisely locate several independent near-field focused spots in the Fresnel region.

09:30 : Abnormal Refractions with Independent-Polarizations Enabled by Transmissive-Type Metasurface in Microwave Region

Kuang Zhang[1], Yueyi Yuan[1], Xumin Ding[1], Badreddine Ratni[2], Shah Nawaz Burokur[2], Qun Wu[1]
[1] *Harbin Institute of Technology (China),* [2] *University Paris Nanterre (France)*

In this paper, transmissive-type metasurfaces is proposed to independently refract the orthogonal circularly polarized wave in microwave region. Based on the combination of propagation phase and geometry phase principles, the opposite circularly polarized transmitted wave can be deflected into independent and arbitrary directions. Experimental measurement are conducted and effectively verified the feasibility of the proposed theory for artificial manipulation of circular polarization manipulation in microwave region.

09:45 : Invited talk

Experimental Realization of Tunable Microwave Coherent Perfect Absorber in Graphene-based Sandwich Structure

Jin Zhang, Weiren Zhu
Shanghai Jiao Tong University (China)

We exploit experimentally a graphene-based sandwich structure for the realization of tunable microwave coherent absorption. It is demonstrated that the coherent absorption can be tuned from 65 % to 100 % via changing the Fermi energy of graphene, in good accordance with numerical simulations and equivalent circuit model analysis.

10:05 : Invited talk

Active Metasurfaces and Waveguiding with Photoexcited Graphene

Yuancheng Fan[1], Fuli Zhang[1], C. T. Chan[2]
[1] *Northwestern Polytechnical University (China),* [2] *Hong Kong University of Science and Technology (China)*

The high intrinsic loss of graphene severely obstructs us from achieving high-quality resonance in various graphene metasurfaces. Here, we demonstrate that the photoexcited graphene can boost the originally extremely weak plasmonic resonances in a graphene metasurface, showing remarkable modulations in the trans-

mission. And it is also found the loss compensation in graphene is helpful in realizing long-range plasmonic waveguiding. Our work pioneers the possibilities of optically pumped graphene metasurfaces for significant enhancement of light-graphene interactions for various active metadevices.

08:30 - 10:25 — Auditorium VA5

Session 4A7

A bottom-up approach towards metamaterials and plasmonics

Organized by: Dorota Pawlak and Virginie Ponsinet

Chaired by: Dorota Pawlak and Virginie Ponsinet

08:30 : Invited talk
DNA-Based Self-Assembly of Plasmonic Nanoantennas
Sebastien Bidault
ESPCI Paris (France)

DNA nanotechnology provides numerous degrees of freedom to create hybrid plasmonic nanostructures for surface enhanced fluorescence and optical biosensing. We review some of our recent results.

08:50 : Invited talk
Nanoparticle clusters as building blocks for bottom-up metasurfaces
Alexandre Baron[1], Romain Dezert[2], Rajam Elancheliyan[2], Olivier Mondain-Monval[2], Philippe Barois[2], Philippe Richetti[2]
[1] *University of Bordeaux (France),* [2] *Université de Bordeaux (France)*

We present spherical clusters, composed of dielectric or metallic inclusions, as a new kind of efficient and isotropic Huygens sources. We demonstrate that this design overlapping electric and magnetic resonances excited at visible frequencies. They may serve as building blocks for metasurfaces. We investigate their possible uses in high transmittance devices requiring a local phase control, and in thin absorber metalattices. They are particularly suited to bottom-up fabrication and self-assembly, offering an alternative to the classical lithographically fabricated metasurfaces.

09:10 : Silicon Particles with Optical Magnetic and Electric Mie Scattering: from the Synthesis to the Assembly of a Metamaterial
Maria L. De Marco[1], Taizhi Jiang[2], Jie Fang[2], Benoit Miller[1], Brian Korgel[2], Yuebing Zheng[2], Philippe Barois[3], Glenna L. Drisko[1], Cyril Aymonier[1]
[1] *Institut de Chimie de la Matiere Condensee de Bordeaux-CNRS (France),* [2] *University of Texas at Austin (USA),* [3] *Centre de Recherche Paul Pascal-CNRS (France)*

Silicon particles with sub-wavelength dimensions support intense electric and magnetic dipole scattering in the visible spectrum. They are among the best candidates for the assembly of optical metamaterials. We propose a high through-put synthesis for the production silicon particles with Mie scattering in the visible spectrum. particles have been assembled into a thin film by dip-coating. The optical properties of individual particles and of thin films have been characterized by single particle scattering, static light scattering and ellipsometry.

09:25 : Invited talk
Self-Assembled Plasmon-Upconversion Nanoclusters for Cancer Theranostics
Wounjhang Park
University of Colorado Boulder (USA)

Nanoclusters of upconversion nanoparticle and gold nanorod are synthesized by a modified PEGylation process and further conjugated with antibody to epidermal growth factor receptor to target bladder cancer. They are then used to simultaneous imaging and optoporation aided chemotherapy of bladder cancer with high selectivity.

09:45 : Invited talk
Second-harmonic generation from metal oxide metasurfaces and photonic crystals
Flavia Timpu, Viola Valentina Vogler-Neuling, Rachel Grange
ETH Zurich (Switzerland)

We fabricate barium titanate metasurfaces from thin films and woodpile photonic crystals from nanoparticles to exploit the bulk optical nonlinearities of this non-centrosymmetric metal oxide. We demonstrate efficient second-harmonic generation in both devices, which shows the potential of top-up and bottom-up fabrication for nonlinear versatile flat photonics.

10:05 : Invited talk
Cooperative Energy Transfer Controls the Spontaneous Emission Rate Beyond field Enhancement Limits
Mohamed ElKabbash[1], Tigran V. Shahbazyan[2], Jesse Berezovsky[1], Francesco De Angelis[3], Giuseppe Strangi[1]
[1] *Case Western Reserve University (USA),* [2] *Jackson State University (USA),* [3] *IIT - Istituto Italiano di Tecnologia (Italy)*

Quantum emitters located in proximity to a metal nanostructure individually transfer their energy via near-field excitation of surface plasmons. The energy transfer process increases the spontaneous emission (SE) rate due to plasmon-enhanced local field. Here, we demonstrate significant acceleration of quantum emitter SE rate in a plasmonic nano-cavity due to cooperative energy transfer (CET) from plasmon-correlated emitters. The accelerated SE rate exceeds the rate acceleration experienced by individual emitters due to local field enhancement.

08:30 - 10:00 — Auditorium VA6

Session 4A8

Synthesis and characterization of plasmonic nanostructures

Organized by: Mohamed Boutinguiza Larosi

Chaired by: Mohamed Boutinguiza Larosi

08:30 : Synthesis, characterization and application of novel bifunctional magneto - plasmonic nanocomposites
Jan Krajczewski, Karol Kolataj, Andrzej Kudelski
University of Warsaw (Poland)

Herein we describe synthesis of some magneto - plasmonic nanocomposites consisting of Fe2O3 and various plasmonic nanoparticles. Optical and structural properties of obtained materials are carefully examined. TEM micrographs and XRD measurements confirmed formation of magneto - plasmonic nanocomposites. Application of external magnetic field allows to obtained highly organized substrate for repetitive SERS measurements, which allows to eliminate the so-called 'coffee - ring effect', involving peripheral accumulation of nanoparticles.

08:45 : Invited talk
Plasmonic nanoparticles synthesized by laser ablation and their antibacterial activity
M. Fernandez-Arias, M. Boutinguiza, J. del Val, A. Riveiro, R. Comesana, F. Lusquinos, Juan Pou
University of Vigo (Spain)

Plasmonic nanoparticles have been of great interest as a subject of investigation due to their unique property of absorbing and scattering strongly certain frequency of light. This capacity of interacting with light makes plasmonic nanoparticles profusely used in many applications and produced following different methods and strategies. In this work we present the results of producing silver and copper nanoparticles by laser ablation in liquid and their capacity as antimicrobial agents.

09:05 : Invited talk

Bottom-up fabrication for ultradense, ultraclean plasmonic ensembles

Francesco Bisio[1], **Michele Magnozzi**[2], **Marzia Ferrera**[2], **Remo Proietti Zaccaria**[3], **Alessandro Alabastri**[4], **Maurizio Canepa**[2]
[1] *CNR-SPIN (Italy),* [2] *Universita di Genova (Italy),* [3] *Chinese Academy of Sciences (China),* [4] *Rice University (USA)*

Bottom-up fabrication methods surely represent a niche within the broad field of nanofabrication of plasmonic structures, yet what they lack in terms of structure complexity is more than compensated by the ability to affordably produce ultradense, highly-packed and ultraclean structures over large areas. In this contribution we will review some of the most intriguing physics of spontaneously-arranged plasmonic nanostructures.

09:25 : Invited talk

Plasmonic Horizon in Noble Metal Nanosponges

Thomas A. Klar
Johannes Kepler University (Austria)

Local electron-hole recombination in gold nanosponges can coherently excite plasmonic hot-spots only within a horizon given by the lifetime of localized plasmons and the finite speed carrying the information that a plasmon has been created.

09:45 : Au nanorods based core@shell SERS tags with incorporated Raman reporters

Vitaly Khanadeev[1], **Boris Khlebtsov**[1], **Snezhana Kushneruk**[2], **Nikolai Khlebtsov**[1]
[1] *IBPPM RAS (Russia),* [2] *Saratov National Research State University (Russia)*

In this work, we investigated the effect of synthetic parameters on the formation of a detectable gap inside SERS tags consisting of gold nanorods coated by 4-nitrobenzenethiol (NBT) and gold or silver shell. We found that the presence of a detectable intermetallic gap inside AuNR@NBT@Au nanoparticles can be tuned by synthetic parameters. For AuNR@NBT@Ag nanoparticles the intermetallic gap is indistinguishable. However, indirect experiments confirm that NBT molecules are inside the particles.

10:00 - 10:30 — Auditorium VA6

Session 4A9

Metamaterial-based devices

Chaired by: Kotaro Kajikawa

10:00 : Wave Propagation in Mechanical Metamaterial Configurations with Piezoelectric Vibration Energy Harvestors

Jatin Patrick, Sondipon Adhikari
Swansea University (United Kingdom)

The research work carried out sheds light on wave propagation in different configurations of mechanical metamaterialswith vibration energy harvesters.

10:15 : Tunable high-birefringence metamaterial nanoparticles dispersed in water

Ying Tang[1], **Seungkyu Ha**[1], **Thomas Begou**[2], **Julien Lumeau**[2], **Nynke Dekker**[1], **Aurele Joseph Louis Adam**[1], **Paul Urbach**[1]
[1] *Delft University of Technology (The Netherlands),* [2] *Aix Marseille University (France)*

We present the design, fabrication, and characterization of birefringent multilayer metamaterial particles (MMP) at nanoscale, dispersed in aqueous solutions. We have designed MMP using the effective medium theory (EMT) and the finite element method (FEM). Our top-down fabricated MMP feature optical properties that are tunable through changes in the composite material filling ratio. The MMP are also chemically stable, highly uniform, and ready for volume production and wide range of applications such as optical torque wrench (OTW).

08:30 - 10:05 — Auditorium EA1

Session 4A10

Light management in solar cells

Organized by: Braulio Garcia-Camara and Ricardo Vergaz

Chaired by: Braulio Garcia-Camara and Ricardo Vergaz

08:30 : Total internal reflection using nano-gratings for enhancing the optical response of perovskite solar cells
Eduardo Lopez-Fraguas, Braulio Garcia-Camara, Ricardo Vergaz
Carlos III University of Madrid (Spain)

In this work, we propose the use of a simple transmission diffraction nano-grating to improve the optical absorption of a perovskite solar cell through the Total Internal Reflection (TIR) phenomenon in the active layer, enlarging the optical path and the photon absorption rate. We design the structure close to the active layer to avoid further optical losses. Although we considered perovskite solar cells, this can be also extended to other types like silicon or organic solar cells.

08:45 : Invited talk
Novel perforated all-dielectric metamaterials
Alexey A. Basharin
National University of Science and Technology - MISIS (Russia)

In this report we discuss a novel type of perforated silicon metamaterials, possessing toroidal and anapole mode in visible spectral range due to destructive interference between electric and toroidal dipole moments. This type of metamaterial is simple fabrication process without complicated 3D toroidal geometry and exhibits a desirable physical effects like multipolar interactions. We shown how does it possible to split toroidal and electric dipoles excitation by changing geometry of metamolecules.

09:05 : Invited talk
Nanophotonic enhanced perovskite-silicon solar cell devices
Christiane Becker[1], Phillip Manley[1], Klaus Jager[1], David Eisenhauer[1], Johannes Sutter[1], Steve Albrecht[1], Kaibo Zheng[2], Tonu Pullerits[2], Sven Burger[3]
[1]Helmholtz-Zentrum Berlin fur Materialien und Energie (Germany), [2]Lund University and NanoLund (Germany), [3]Zuse Institute Berlin (Germany)

Perovskite-silicon tandem solar cells are a promising concept for overcoming the limits of conventional silicon single-junction technology. Light management is doubtless a key issue for further boosting efficiency. We discuss the impact of photonic nanostructures on the optical performance of perovskite-silicon devices. We experimentally and numerically demonstrate shallow antireflective nanotextures, which are compatible with perovskite solution processing. We further showcase enhanced photon up-conversion using perovskite nanoparticles interacting with photonic nanostructures and discuss the applicability for spectral conversion of sunlight.

09:25 : Invited talk
Nanostructuring photovoltaic cells: How to push some limits.
Mahmoud Elshorbagy, Alexander Cuadrado, Javier Alda
University Complutense of Madrid (Spain)

The quest for higher efficiency in solar cellis pursued using complex arrangements of materials. We have tailored the geometry and structures of auxiliary layers terminating thephotovoltaic cell. This approach needs the full understanding of the interaction of light with nanostructures on ultra-thin films. The involved physical mechanisms are funneling and guiding effects. We apply this strategy to amorphous Si hydrogenated cells. This contribution shows how a proper dimensional and material set-up increases short circuit current more than 50 %.

09:45 : Invited talk
Some insights on the light management in halide perovskite solar cells and optoelectronic devices

Ivan Mora-Sero
Universitat Jaume I (Spain)

In this presentation some insights about light management in halide perovskite optoelectronic devices is provided. The introduction of light scattering nanoparticles can enhance the perovskite solar cell photocurrent by the improvement of performance by the incorporation of Au nanoparticles cannot be always assigned to plasmonic effects but to interface modification. The outstanding properties of halide perovskites can also be used to develop other optoelectronic devices as light amplifiers and photodetectors.

10:05 - 10:35 — Auditorium EA1

Session 4A11

Laser and cavities

Chaired by: Alexey Basharin

10:05 : Rabi splitting of broadband emission of strongly coupled organic dye excitons in tunable optical microcavity
Dmitriy Dovzhenko[1], Konstantin Mochalov[2], Ivan Vaskan[1], Irina Kryukova[1], Yury Rakovich[3], Igor Nabiev[4]
[1] *National Research Nuclear University MEPhI (Russia),* [2] *Russian Academy of Sciences (Russia),* [3] *Donostia International Physics Center (Spain),* [4] *Université de Reims Champagne-Ardenne (France)*

Resonance interaction between molecular excited states and localized electromagnetic field allows to control fundamental properties of a matter. In this study we have measured the emission spectra of Rhodamine 6G organic dye being placed in a precisely tunable Fabry-Perot microcavity. We have demonstrated emission from both upper and lower polaritonic states of strongly coupled organic dye excitons with relatively low and unoriented dipole moments. Rabi splitting estimated from emission spectra was as large as 225 meV.

10:20 : Optimal design of Quantum-Cascade Vertical-Cavity Surface-Emitting Laser
Sandra K. Grzempa, Wlodzimierz Nakwaski, Tomasz Czyszanowski
Lodz University of Technology (Poland)

Quantum-Cascade Vertical-Cavity Surface-Emitting Lasers (QC VCSELs) are anticipated to exhibit advantages of both the vertical-cavity surface-emitting lasers (VCSELs) and the unipolar quantum-cascade lasers (QCLs). In QC VCSELs vertical resonance and stimulated emission occurs due to positioning of QCs in the stripes of the monolithic high (refractive-index) contrast grating (MHCG).The performance of QC VCSELs relies on sophisticated design of MHCG and the active regions which takes into account distributions of the QC VCSEL modes.

08:30 - 10:35 — Auditorium EA2

Session 4A12

Magneto-plasmonics

Organized by: Ilya Razdolski, Vasily Temnov and David Schmool

Chaired by: Ilya Razdolski, Vasily Temnov and David Schmool

08:30 : THz graphene four-port circulators with elliptic resonators
Victor Dmitriev, Gabriel Barros, Thiago Oliveira, Wagner Castro
Federal University of Para (Brazil)

We investigate four-port circulators for THz region which present two parallel graphene waveguides with SPP modes and a magnetized resonator of elliptic form. The waveguides and the resonator are placed on a two-layer dielectric substrate. The working principle of the device is based on the rotating dipole resonance of the

magnetized graphene resonator. Numerical simulations demonstrate good parameters of the circulators.

08:45 : Versatile Tb18Co72 magnetoplasmonic nanooptical antennas
Richard Matthew Rowan-Robinson[1], Jerome Hurst[1], Agne Ciuciulkaite[1], Ioan-Augustin Chioar[1], Matteo Pancaldi[2], Paolo Vavassori[2], Peter M. Oppeneer[1], Alexander Dmitriev[3], Vassilios Kapaklis[1]
[1] *Uppsala University (Sweden),* [2] *CIC nanoGUNE (Spain),* [3] *University of Gothenburg (Sweden)*

We demonstrate the fabrication and measurement of hybrid magnetoplasmonic Au/Tb18Co72 nanoantennas. TbxCo1-x alloys have been shown to exhibit all-optical switching and the merging with plasmonics could yield routes to optical switching of single nanomagnetic elements. The structures exhibit a dramatic enhancement of the Faraday effect when localized surface plasmons (LSPs) are excited. An angular dependence is observed, whereby the sign and magnitude of the Faraday effect can by tuned through the mutual combination of incidence wavelength and incidence angle.

09:00 : Transverse magnetic routing of light emission in hybrid plasmonic semiconductor structures
Lars Klompmaker[1], Felix Spitzer[1], Alexander N. Poddubny[2], Ilya A. Akimov[1], Leonid V. Litvin[3], Ralf Jede[3], Grzegorz Karczewski[4], Maciej Wiater[4], Tomasz Wojtowicz[4], Dmitri R. Yakovlev[1], Manfred Bayer[1]
[1] *Technische Universitat Dortmund (Germany),* [2] *Russian Academy of Sciences (Russia),* [3] *Raith GmbH (Germany),* [4] *Polish Academy of Sciences (Poland)*

We report on transverse magnetic routing of light emission (TMRLE) from excitons in a diluted-magnetic semiconductor quantum well. The strongest directionality is achieved for a quantum well located several tens of nm apart from a metal-semiconductor interface. At such distance the quantum well is coupled to surface plasmon polaritons that carry large transverse spin and are efficiently controlled by the magnetic field direction. We observe directionality of up to 60 % for the emission detected from the grating side.

09:15 : Invited talk
Layer-selective All-Optical Magnetization Switching in Plasmonic Magnetic Heterostructure
Daria Ignatyeva[1], Carl Davies[2], Daria Sylgacheva[1], Arata Tsukamoto[3], Hiroki Yoshikawa[3], Pavel Kapralov[4], Andrey Kirilyuk[2], Vladimir Belotelov[1], Alexei Kimel[2]
[1] *M.V. Lomonosov Moscow State University (Russia),* [2] *Radboud University (The Netherlands),* [3] *Nihon University (Japan),* [4] *Russian Quantum Center (Russia)*

We propose and experimentally demonstrate a novel approach for all-optical control and switching of magnetization states of individual layers in the multilayered GdFeCo structures utilizing the excitation of the surface plasmon polaritons. Surface plasmon polaritons provide us an efficient tool to tailor light energy distribution inside the multilayered structure with GdFeCo layers, and thus for addressed magnetization reversal in the particular layer of the whole structure without any impact on the other layers.

09:35 : Invited talk
Naturally Hyperbolic and Chirality Too: The Optics of Antiferromagnets
Robert Stamps[1], Rair Macedo[2], Igor Proskurin[1]
[1] *University of Manitoba (Canada),* [2] *University of Glasgow (United Kingdom)*

The optical properties of antiferromagnets and cavity magnonics of ferromagnets are discussed. The antiferromagentic system displays phenomena analogous to non-ferroic hyperbolic materials and meta-materials, with interesting possibilities for optical spintronics. The ferromagnet cavity system shows mode attraction and may also support an analogy to opto-mechanical cavity response.

09:55 : Invited talk
Second Harmonic Generation in Hyperbolic Magneto-Plasmonic Metasurfaces
Dmitry Kuzmin[1], Igor Bychkov[1], Vladimir Shavrov[2], Vasily Temnov[3]
[1] *Chelyabinsk State University (Russia),* [2] *Kotelnikov Institute of Radio-engeneering and Electronics of RAS (Russia),* [3] *Université du Maine (France)*

In this work we propose a new class of hyperbolic magneto-plasmonic metasurface for second harmonic generation (SHG). We discuss three possible realizations of such a metasurfaces, which based on non-linear magneto-plasmonic multilayers. Theoretical models for investigation of SHG in abovementioned realizations are performed.

10:15 : Invited talk
Ultrafast Magnetization Dynamics of CoFeB-based multilayer thin films with perpendicular anisotropy

Ana S. Silva[1], **Simao P. Sa**[1], **Sergiy Bunyayev**[1], **Gleb Kakazei**[1], **Miguel Canhota**[1], **Miguel Miranda**[1], **Carlos Garcia**[2], **Inigo J. Sola**[3], **Helder Crespo**[1], **David Navas**[1]
[1] *Universidade do Porto (Portugal),* [2] *Technical University Federico Santa Maria (Chile),* [3] *University of Salamanca (Spain)*

In this work, we studied [CoFeB/Pd] multilayer thin films as well as [CoFeB/Pd]/Co exchange spring structures by comparing time-resolved magneto-optical Kerr effect (TRMOKE) measurements with ferromagnetic resonance analysis (VNA-FMR).

08:30 - 10:25 — Auditorium EA4

Session 4A13

Symposium I: Hybrid Photonic and Plasmonic Materials for Sensing, Energy conversion and Imaging Applications

Organized by: Xing Yi Ling, Jerome Plain and Alexander Govorov

Chaired by: Xing Yi Ling, Jerome Plain and Alexander Govorov

08:30 : Invited talk
Electrochemical Tuning of Plasmoinc Surface Lattice Resonance
Hiro Minamimoto, Kei Murakoshi
Hokkaido University (Japan)

Plasmonic properties of the surface lattice resonance (SLR) mode of the Au lattice structure were controlled by electrochemical potential. The structural factors were optimized through metal dissolution. The present method successfully controlled the structure by controlled surface dissolution of the Au lattice structure at a rate of a few nanometers per minute to prepare the lattice structures showing a spectral width of 0.145 eV with a resonance maximum of 1.74 eV (714 nm).

08:50 : Invited talk
Ultrafast Nanophotonics and Quantum Optics in Nano-bio Assemblies, Colloidal Nanostructures, and Metamaterials
Gary Wiederrecht
Argonne National Laboratory (USA)

We describe the ultrafast dynamics and quantum optic behavior of three different light-activated hybrid nanostructures. These include colloidal semiconductor nanoplatelets, chromophore-doped peptide bio-assemblies, and plasmonic gap-mode metamaterials. Ultrafast transient absorption and photoluminescence studies, as well as single photon correlation studies, are described. Insight into the design considerations for cooperative nanoassemblies for efficient light-activated structures is given.

09:10 : Invited talk
Plasmonic Metamaterials for Sensing Applications
Pan Wang, Alexey Krasavin, Mazhar Nasir, Wayne Dickson, Anatoly Zayats
King's College London (United Kingdom)

In this talk, we will overview the sensing applications of plasmonic metamaterials including Au nanorod arrays and metal-dielectric multishells.

09:30 : Invited talk
Tailoring electric and magnetic dipole emissions by high-refractive index dielectric nanostructures
Peter R. Wiecha[1], **Clement Majorel**[1], **Christian Girard**[1], **Arnaud Arbouet**[2], **Bruno Masenelli**[2], **Olivier Boisron**[2], **Aurelie Lecestre**[1], **Guilhem Larrieu**[1], **Aurelien Cuche**[1], **Vincent Paillard**[1]
[1] *University of Toulouse (France),* [2] *University of Lyon (France)*

Silicon nanostructures, providing well-separated electric and magnetic hot spots, are covered by thin films doped by Europium ions supporting both electric and magnetic dipole transitions. Photoluminescence mappings, obtained by raster scanning a laser beam at saturation over the sample, exhibit very distinct features

corresponding either to the electric or magnetic dipole transition. They are interestingly comparable to the corresponding radiative electric or magnetic local density of optical states, calculated using the Green dyadic method.

09:50 : Photoluminescence from emitters on periodic diffractive arrays of plasmonic and non-plasmonic nanocylinders
Shunsuke Murai, Kazuki Noguchi, Katsuhisa Tanaka
Kyoto University (Japan)

We fabricated periodic diffractive arrays of Al, Ag and Si nanocylinders with the identical design and compared their photoluminescence outcouplings. We deposited polymer layers containing rhodamine 6G and examined enhanced PLs from the layers. The optical transmission with varied incident angle revealed the excitation the hybrid modes of diffraction with localized surface plasmon resonance in Al and Ag arrays and with Mie resonance in the Si array. The PL enhancements were explainable by the profiles of the hybrid modes.

10:05 : Invited talk
Broadband Mid-Infrared Absorber Using Gosper Curve
Jihua Zou, Peng Yu, Alexander Govorov, Jiang Wu, Zhiming Wang
University of Electronic Science and Technology of China (China)

We designed an ultra-broadband metamaterial absorber by using space filling Gosper curve. The optimized design shows an average absorption up to 95.78 % from 2.64 to 9.79 μm across the entire mid-infrared region. Meanwhile, the absorber shows a great insensitivity to polarization and the angle of light incidence. The broadband perfect absorption can be attributed to the defined Gosper curve with different segments that support electric resonances at different wavelengths.

08:30 - 10:30 — Room 02.2

Session 4A14

Towards High Efficiency Detectors and Sources for Field-Ready Quantum Nanophotonics

Organized by: Dondu Sahin and Khaled Mnaymneh

Chaired by: Dondu Sahin and Khaled Mnaymneh

08:30 : Invited talk
Impact of ultrasmall capacitance for OE/EO conversions using photonic crystals
Masaya Notomi
NTT Basic Research Laboratories (Japan)

We have realized sub-femtofarad photodetectors by using photonic crystal platform, enabling amplifier-free and bias-free photoreceivers without consuming any electric power. We have also realized sub-femtofarad electro-optic modulators with record-low consumption energy (42aJ/bit). Furthermore, we have integrated fF photodetectors with fF electro-optic modulators via load resistor, presenting three-terminal optical nonlinear (transistor-like) functionalities, such as switching with signal gain. These achievements pave the way to novel optoelectronic processing having OE/EO conversions with very fine granularity.

08:50 : Invited talk
Generating and routing single photons in GaAs nanophotonic circuits
Leonardo Midolo
University of Copenhagen (Denmark)

We report the latest advances in controlling single-photon emission and routing using photonic integrated circuits with embedded quantum dots. These include methods for performing on-chip resonance fluorescence, actively routing photons within a chip, and efficiently couple them into optical fibers. These results constitute key steps to develop scalable emitter-photon interfaces with high efficiency and coherence.

09:10 : Invited talk

Limits to the fidelity of on-demand single photon sources using quantum dot-cavity systems

Stephen Hughes
Queen's University (Canada)

A quantum dot coupled to an optical cavity has recently proven to be an excellent source of on demand single photons. We investigate the factors associated with pulsed excitation that can limit simultaneous efficiency and indistinguishability, including excitation of multiple excitons, multiphotons, and pump-induced dephasing, and find for realistic single photon sources that these effects cause degradation of the source figures-of-merit comparable to that of phonon scattering. We also compare and contrast semiconductor cavity systems with metallic resonator systems.

09:30 : Invited talk

Metrology for single-photon detectors and sources

Angela Gamouras
National Research Council (Canada)

National metrology institutes around the world have been working to provide characterization techniques and reference standards for few-photon technologies including single-photon detectors and sources. As advances are made towards on-chip integration of single-photon sources, detectors, and other optical components, methodologies for effectively characterizing these quantum integrated circuits will need to be developed. This presentation will discuss ongoing efforts in this area, including the need for consistency in the measurement of performance metrics for deterministic and probabilistic single-photon sources.

09:50 : Invited talk

Engineering Photon-pair Sources for Integrated Quantum Technologies

Gary Sinclair, Will McCutcheon, Imad Faruque, Imad Faruque, John G. Rarity
University of Bristol (United Kingdom)

The on-chip generation of quantum states of light is afundamental requirement for integrated photonic quantumtechnologies. Many photonic integrated chip platforms exhibitan intrinsic material nonlinearity which can be usedfor quantum state generation. We focus on engineeringphoton-pair sources in silicon photonics. This platform offersthe ability to construct photonic circuits of unparalleledsize and complexity. Nonetheless, careful engineering ofthe classical and quantum source physics is needed to constructhigh-performance sources for next-generation quantumtechnology applications.

10:10 : Invited talk

High efficiency entangled photon sources and single photon detectors based-on semiconductor nanowires

Michael E. Reimer[1], Arash Ahmadi[1], Mohd Zeeshan[1], Simon Daley[1], Nachiket Sherlekar[1], Bradley van Kasteren[1], Burak Tekcan[1], Sandra J. Gibson[1], Andreas Fognini[2], Klaus Jons[3], Val Zwiller[3], Dan Dalacu[4], Philip J. Poole[4]
[1] *University of Waterloo (Canada),* [2] *Delft University of Technology (The Netherlands),* [3] *Royal Institute of Technology (KTH) (Sweden),* [4] *National Research Council of Canada (Canada)*

Semiconductor nanowires offer a powerful platform for engineering light at the nanoscale by controlling their size and shape in order to guide light efficiently and minimize undesired reflections. In this work we have shaped the nanowires with a unique tapering to realize bright quantum dot based entangled photon sources and high efficiency single photon detectors with high speed and timing resolution over an unprecedented bandwidth.

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