HL 5: Symposium Nanostructured Photonic Materials

Time: Monday 15:00–18:15 Location: ER 270

Invited Talk HL 5.1 Mon 15:00 ER 270
FDTD method in nanophotonics: 2D and 3D photonic crystals and lasing — •Andrei Lavrinenko — Building 345V, Oersted Plads

2D photonic crystals are treated in verious regimes: transmission bands, TE-TM conversion and slow light regime. The Si inverted-opals based 3D photonic crystals are explored as hosts for effective air-channel waveguides served as parts of photonic circuits. The influence of imperfections on the existence of photonic band gaps as the principle mechanism for waveguiding in such channels is studied. High appropriateness and precision of employed numerical method * 3D FDTD * is validated in the direct comparison with forward scattering experiments in thin opal films. A process of the seeding two coupled defects in photonic crystals filled by gain medium with a symmetric or antisymmetric pulse is shown to act as an ultrafast switchable mechanism for lasing. The generic idea is valid for different photonic applications.

Invited Talk HL 5.2 Mon 15:30 ER 270
Efficient Coupling into Photonic-Crystal Cavities and Waveguides — •Solomon Assefa, William Green, Fengnian Xia, and Yurii Vlasov — IBM Research Center, Yorktown Heights, NY 10589, USA

Photonic-crystals (PhC) provide a compact platform attractive for potential applications such as delay lines, all-optical buffers, highly nonlinear devices, and light-matter interaction. To this end, extensive studies are currently in progress to achieve low group-velocity in PhC waveguides while maintaining low chromatic dispersion. Additionally, on-going research on the confinement and enhancement of quantum-dot emission has increased interest in high-Q PhC cavities.

The W1 waveguide and the microcavity designs both require efficient coupling in order to explore the frequency regimes of interest. We will present experimental results focusing on efficient coupling to W1 waveguides and microcavities fabricated in SOI membrane. Coupling schemes such as group-index tapering and surface-state optimization are explored by making reliable phase information measurements in order to study coupling coefficients and high-order dispersion. We investigate strategies for efficient coupling into a suspended PhC microcavity that is side-coupled to a suspended photonic wire via PhC surface state engineering.

Invited Talk HL 5.3 Mon 16:00 ER 270
Optical Super Lens: From Near-Field to Far Field — •Xiang Zhang — University of California, Berkeley, USA

Recent theory predicted a new class of meta structures made of engineered sub wavelength entities - meta atoms and molecules which enable the unprecedented electromagnetic properties that do not exist in the nature. For example, artificial plasma and artificial magnetism, and super lens that focuses far below the diffraction limit. The metamaterials may have profound impact in wide range of applications such as nano-scale imaging, nanolithography, and integrated nano photonics.

I will discuss a few recent experiments that demonstrated these intriguing phenomena. We showed, for the first time, the high frequency magnetic activity at THz generated by artificially structured meta molecule resonance, as well as the artificial plasma. Our experiment also confirmed the key proposition of super lens theory by using surface plasmon. We indeed observed optical superlensing which breaks down so called diffraction limit. I will also discuss nano plasmonics for imaging and bio-sensing. The surface plasmon indeed promises an exciting engineering paradigm of x-ray wavelength at optical frequency.

15 min. break

Invited Talk HL 5.4 Mon 16:45 ER 270
Nanoplasmonics for field enhancement and subwavelength guiding — •Sergey I. Bozhevolnyi — Department of Physics and Nanotechnology, Aalborg University, Skjernvej 4A, Aalborg, Denmark

The explosive progress in nanoscience has led to uncovering and exploring numerous physical phenomena occurring at nanoscale. One of the main research directions in nano-optics is the search for configurations that efficiently interconvert propagating and strongly localized (nm-sized) optical fields resulting in strongly enhanced local fields indispensable for optical characterization, sensing and manipulation at nanoscale. After briefly reviewing various configurations used for creating enhanced optical fields, a novel route exploiting retardation-based resonances involving (slow) surface plasmon polaritons (SPPs) supported by metal nanostructures is considered in detail.

Photonic components are superior to electronic ones in terms of operational bandwidth but suffer from the diffraction limit that constitutes a major problem on the way towards miniaturization and high density integration of optical circuits. The main approach to circumvent this problem is to take advantage of hybrid nature of SPPs whose subwavelength confinement is achieved due to very short (nm-long) penetration of light in metals. After briefly reviewing various SPP guiding configuration, the results of our investigations of subwavelength photonic components utilizing SPP modes propagating along channels cut into gold films are overviewed demonstrating first examples of ultracompact plasmonic components.

Invited Talk HL 5.5 Mon 17:15 ER 270
Scaling left-handed materials towards optical frequencies — •Maria Kafesaki[1], Raluca Penciu[1], Thomas Koschny[1,2], Eleftherios Economou[1], and Costas Soukoulis[1,2] — [1]Foundation for Research and Technology Hellas (FORTH), Institute of Electronic Structure and Laser (IESL), P.O. Box 1527, 71110 Heraklion, Crete, Greece, and University of Crete, Greece — [2]Ames Laboratory, and Dept. of Physics and Astronomy, Iowa State University, Ames, Iowa

Left-handed materials (LHMs), i.e. materials with electrical permittivity and magnetic permeability both negative over a common frequency band, have been a subject of increasing interest in the last seven years. This is mainly due to their novel and unique properties (like backwards propagation, negative refraction, superlensing, etc) which entail new capabilities in the manipulation of electromagnetic waves.

A large part of the current efforts in the LHMs research is to achieve left-handed behavior beyond the microwave regime (where this behavior was initially demonstrated), and mainly in the optical regime, exploiting the unique capabilities of LHMs in applications like telecommunications and imaging. A common approach to obtain optical LHMs is the scaling down of well established microwave designs. In this talk we discuss the behavior of specific, well-established in microwaves left-handed designs as they are scaled down into the nanoscale, targeting optical frequencies. Particular attention will be given in the understanding of the scaling behavior of the effective permeability and permittivity, the magnetic resonance frequency and the losses in those designs.

Invited Talk HL 5.6 Mon 17:45 ER 270
Engineering optical space with metamaterials — •Vladimir Shalaev — Purdue University, West Lafayette, IN, USA

Metamaterials are expected to open a gateway to unprecedented electromagnetic properties and functionality unattainable from naturally occurring materials, thus enabling a family of new *meta-devices*. We review this new emerging field and significant progress in developing metamaterials for the optical part of the spectrum. Specifically, we describe recently demonstrated artificial magnetism across the whole visible, negative-index in the optical range, and challenges along with promising approaches for accomplishing optical cloaking. The new paradigm of engineering space for light with transformation optics will be also discussed.