Monday Afternoon, October 19, 2015

IPF on Mesoscale Science and Technology of Materials and Metamaterials
Room: 210F - Session IPF+MS-MoA

Mesoscale Phenomena in the Biosciences II (2:20-3:40) & Metamaterials (3:40-5:40)
Moderator: Carolyn Larabell, University of California, San Francisco, Mark Brongersma, Stanford University

2:20pm **IPF+MS-MoA1 Mesoscale Imaging in Cell Biology**, ***Gerry McDermott***, *M. Do, J.-H. Chen, A. Walter, M.A. Le Gros, C.A. Larabell*, University of California, San Francisco **INVITED**

Soft X-ray tomography (SXT) is ideally suited to imaging the sub-cellular architecture of biological cells. In SXT, specimens are illuminated with 'water window' photons. X-rays within this energy range (284 – 543eV) are absorbed an order of magnitude more strongly by carbon- and nitrogen-containing organic materials than by water. Consequently, the variation in biomolecule composition and concentration within the specimen gives rise to quantitative, high-contrast images of intact, fully hydrated cells, without the need to use contrast-enhancing agents. The utility of SXT has recently been enhanced by the development of high numerical aperture cryogenic fluorescence tomography (CFT) for correlated imaging studies. This multi-modal approach allows labelled molecules to be localized in the context of a high-resolution 3-D tomographic reconstruction of the cell. This talk will describe correlated CFT-SXT and the application of this technique to long-standing questions in cell biology.

3:00pm **IPF+MS-MoA3 Biomimetic Material Approaches to Tissue Engineering, Regenerative Medicine, and Wound Healing**, ***Elizabeth Loboa***, UNC-Chapel Hill & NC State University **INVITED**

There is growing clinical need in wound healing, tissue engineering, and regenerative medicine for controlled release systems that encapsulate therapeutic compounds and provide sustained release in a site-specific manner. Biocompatible, biodegradable nanofibrous scaffolds with their morphological similarities to the natural extracellular matrix (ECM) in vivo, high surface area to volume ratio, and small interfibrous pore sizes hold great potential for this application. Loading dopants within an electrospun polymeric matrix allows for consistent entrapment throughout the nanofibers. Further, the high surface area to volume ratio of these matrices maximizes the interaction of the carrier with a surrounding medium. A critical parameter for achieving success in controlled release is controlled diffusion of molecules out of the electrospun scaffolds. The drug release characteristics of nanofibrous scaffolds rely on how well the drug is encapsulated inside the nanofibers. These characteristics are critically affected by fiber morphology.

In this presentation, Dr. Loboa will discuss approaches in her lab to elucidate and optimize biomimetic fibrous systems for wound healing, tissue engineering, and regenerative medicine applications. Focus will be placed on regeneration of skin and musculoskeletal tissues and approaches to wound care and tissue regeneration while combating multi-drug resistant bacteria.

3:40pm **IPF+MS-MoA5 Structured Light and Structured Surface Waves from Metasurfaces**, ***Federico Capasso***, Harvard University **INVITED**

Patterning surfaces with subwavelength spaced metallo-dielectric features (metasurfaces) allows one to locally control the amplitude, phase and polarization of the scattered light, allowing one to generate complex wavefronts such as optical vortices of different topological charge and dislocated wavefronts. 1,2 Recent results on achromatic metasurfaces will be presented including lenses and collimators. Metasurfaces have also become a powerful tool to shape surface plasmon polaritons (SPPs) and more generally surface waves. I will present new experiments on imaging SPP that have revealed the formation of Cherenkov SPP wakes and demonstrated polarization sensitive light couplers that control the directionality of SPP and lenses which demultiplex focused SPP beams depending on their wavelength and polarization.

1. N. Yu and F. Capasso Nature Materials 13, 139 (2014)

2. P. Genevet and F. Capasso Reports on Progress in Physics 78, 24401 (2015)

4:20pm **IPF+MS-MoA7 Quest for Extreme Photonics**, ***Nader Engheta***, University of Pennsylvania **INVITED**

Waves can be tailored, manipulated and sculpted by materials. Recent development in condensed matter physics, nanoscience, and materials science and technology has made it possible to construct materials and structures with unusual “extreme” characteristics. These “extreme” scenarios in light-matter interaction may come in several forms: It may be due to extreme in dimensionality such as metasurfaces and one-atom-thick materials, extreme near field such as subwavelength nonreciprocal vortexes in near zones of plasmonic structures, extreme anisotropy in design of superlattices with anisotropic effective mass of charged carriers, giant nonlinearity in phase-change dynamics, extreme information processing as in optical metatronics and "informatic" metastructures, and extreme material parameters such as epsilon- and/or mu-near-zero (ENZ, MNZ, and EMNZ) features leading to phenomena of “static optics”. Such “extreme photonics” may provide us with exciting functionalities in both wave physics and quantum optics and engineering. In this talk, some of our ongoing work in these areas will be discussed along with some of the opportunities and challenges in this area.

5:00pm **IPF+MS-MoA9 2D Materials: Graphene and Beyond**, ***Tony Heinz***, Stanford University **INVITED**

The past few years have witnessed a surge of activity in the study of graphene and, more recently, in other atomically thin two-dimensional materials. We will describe some the reasons for the intense interest in these new material systems, highlighting their unusual electronic properties. We will show how we can use light to probe the distinctive properties electrons in model 2-D materials such as graphene and transition metal dichalcogenides. We will discuss the basics of light-matter interactions in these 2-D materials, as well as signatures of electron-electron and electron-phonon interactions, describing both the fascinating physics of these material systems and emerging applications in photonics.

Authors Index

Bold page numbers indicate the presenter