

SINAM NANO SEMINAR

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Various Approaches to Loss Mitigation in Nanoplasmonics and their Limitations

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3110 Etcheverry Hall

Abstract

Recent years have seen staggering growth of interest in using nanostructured metals in optical range with the goal of enhancing linear and nonlinear optical properties or even engineering entirely novel optical materials unknown in Nature. After the initial heady years of excitement the community is recognizing that loss in the metal is an important factor that might impede practical application of plasmonic devices, be it in signal processing, sensing, imaging or more esoteric applications like cloaking. Attempts are being made to “design away” the loss, compensate it by gain, or find new lossless materials. In this talk we examine these concepts one by one and find that they all have their limitations. First we demonstrate that in truly sub-wavelength in all three dimensions metal structures the loss is inherent and cannot be engineered away by clever changes in shape for as long as one operate in visible and IR region of the spectrum, while in THz frequency this approach actually works and explain the reasons behind it. We then consider the idea of compensating loss using semiconductor gain medium and demonstrate that required gain is difficult to achieve and maintain due to increase in recombination rates caused by Purcell’s effect. We also consider a fresh idea for loss reduction by using plasmonic structures combining metals with strongly dispersive dielectrics (as in slow light media) to store the energy in atomic polarization rather than in kinetic energy of electrons and thus achieve orders of magnitude reduction of loss at the cost of reduction in field enhancement. After that we consider the physics of losses in metals at optical frequencies and show that the nature of these losses is quite different from the losses in RF domain. We then show that negative dielectric constant at optical frequencies does not have to inevitably lead to large absorption, and with guarded optimism point to the tentative way in which new materials with negative dielectric constant and very low loss might be synthesized.

Biography

Jacob B. Khurgin graduated with MS in Optics from the Institute of Fine Mechanics and Optics in St Petersburg, Russia. He worked at the Philips Laboratories of NV Philips for 8 years. Simultaneously he pursued his graduate studies at Polytechnic Institute of NY (nowadays NYU School of Engineering) where he received PhD in Electro-physics. Prompted by a promotion to a Department Manager, he joined the Electrical Engineering department of Johns Hopkins University, where he is currently a Professor. Currently he is working in the areas of mid-infrared lasers and detectors, phonon engineering for high frequency transistors, disorder in condensed matter physics, plasmonics, coherent secure optical communications, phased array antennae, and slow light propagation. His publications include 4 book chapters, one book edited, 240 papers in refereed journals and 28 patents. He has held positions of a Visiting Professor in an array of institutions of variable degrees of repute. He is a Fellow of American Physical Society and Optical Society of America and other less distinguished organizations.

Refreshments Provided

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