MRSEC SEMINAR SERIES

Designing Optical Materials from Plasmonic Nanocrystal Building Blocks

Plasmonic nanocrystals are known for their size- and shape-dependent localized surface plasmon resonances. In this talk, I will describe the use of plasmonic nanocrystals as building blocks of mesoscale, nanocrystal-based superstructures for optical metamaterials. We show that chemical exchange of the long ligands used in nanocrystal synthesis with more compact ligand chemistries brings neighboring nanocrystals into proximity and gives rise to a dielectric-to-metal transition. This transition is seen by a 10^{10} range in DC conductivity and a dielectric permittivity ranging from everywhere positive to everywhere negative across the whole range of optical frequencies. The compact ligand exchange allows us to realize a "diluted metal" with optical properties not found in the bulk metal analog, presenting a new axis in plasmonic material design and the realization of optical properties akin to next-generation metamaterials. We harness the properties of metal NCs by using nanoimprint lithography to print large-area metamaterials on glass and plastics with widely tailorable optical properties that are used to realize near-infrared devices. Time-permitting, I will also describe the use of plasmonic nanostructures to enhance the emission efficiency of nanoscale phosphors that upconvert near-infrared light into the visible and are of interest for applications in photovoltaics, bioimaging and lighting and display technologies.

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