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Shape-dependent oriented scaffolding of plasmonic nanoparticles by topological defects for colloidal dimer self-assembly in liquid crystals

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Plasmonic metal nanoparticles are of great interest for applications in nanophotonics, solar cells, photothermal therapies, and imaging. Nonspherical particles can exhibit surface plasmon resonance (SPR) tunable throughout the visible and near-infrared spectral regions and their plasmonic properties can be further enhanced by the collective behavior when the inter-particle separation becomes comparable to their size. For example, multipole SPRs and well-defined assemblies of nanoparticles give simple ways of obtaining a non-trivial magnetic response, making plasmonic colloidal systems useful for the preparation of metamaterials. Near-field proximity of plasmonic nanoparticles can also alter the fluorescent behavior of semiconductor and dielectric particles as well as molecular dyes. Precise arrangement of metal nanoparticles can yield highly desirable functionality for applications such as nanoantennas. Non-contact manipulation and trapping techniques would allow for precise positioning of plasmonic and other particles with respect to each other in fluid host media. This lecture will demonstrate scaffolding of plasmonic nanoparticles by topological defects induced by colloidal microspheres to match their surface boundary conditions with a uniform far-field alignment in a liquid crystal host. Displacing energetically costly liquid crystal regions of reduced order, anisotropic nanoparticles with concave or convex shapes not only stably localize in defects but also self-orient with respect to the microsphere surface. Using laser tweezers, we manipulate the ensuing nanoparticle-microsphere colloidal dimers, probing the strength of elastic binding and demonstrating self-assembly of hierarchical colloidal superstructures such as chains and arrays. The lecture will conclude with a discussion of potential applications of our findings.

Biography

Ivan I. Smalyukh is an Asst. Professor at the Department of Physics and the Liquid Crystal Materials Research Center at the University of Colorado at Boulder. He holds a PhD in Chemical Physics from Kent State University. Prof. Smalyukh leads an interdisciplinary research group which utilizes and develops powerful optical imaging and laser manipulation techniques to study physics phenomena in soft condensed matter and biological systems. His scientific interests encompass molecular and colloidal self-assembly, fundamental properties of liquid crystals, Coherent anti-Stokes Raman scattering (CARS) polarized microscopy, confocal and two-photon fluorescence imaging, laser trapping and manipulation, electro-optic and photonic phenomena in liquid crystals, polymers, nano-structured and other functional materials, as well as their applications.

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