Condensed Matter and Nanotechnology Division

XVI NANOTECH CONGRESS

May 28-31, 2024, GUADALAJARA, MEXICO

Characteristics of Polymer Microgel-Colloids and Pastes Analyzed through Light Scattering and Superresolution Microscopy

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ABSTRACT

Microgels are among the most studied colloidal and polymeric systems of the past decades [1,2]. Swelling thermosensitive poly(N-isopropylacrylamide) microgels by lowering the temperature provides a unique mechanism for controlling the porosity and size of colloidal particles on the nanoscale. Consequently, these smart microgel particles are being considered for applications ranging from viscosity modifiers and sensing to drug delivery and as models for the glass and the jamming transition of soft colloids.

Here, we present results from light scattering, rheology and in-situ two-color superresolution microscopy of dye-labeled submicron-sized pNiPAM microgels. We use static (SLS) and dynamic light scattering (DLS) to study the swollen microgel's density profile and hydrodynamic size over a large range of temperatures. We show that the q-dependent scattered intensity I(q) can be used to quantitatively model the microgel suspensions' absorbance, unraveling a recently found scaling behavior of the absorbance temperature dependence from UV-VIS spectroscopy data [3]. Moreover, we study the de-swelling of microgels by applying an extra osmotic pressure, suspending the microgels in a high molecular weight dextran solution at different concentrations and we utilize optical tweezers to investigate the interaction potential of microgel particles exhibiting weak interactions [4].

In addition to light scattering, we use direct Stochastic Optical Reconstruction Microscopy (dSTORM) to image single microgels in two and three dimensions, at different stages of the volume phase transition, with a lateral optical resolution of 30nm [2]. Utilizing superresolution fluorescent microscopy enables the examination of individual colloids within a densely packed microgel paste, leveraging the specificity afforded by multi-color dye labelingAs we increase the packing density, we map out the different contributions that allow the dense packing of the soft microgels due to deformation, interpenetration, and compression. Based on a detailed understanding of the local structure and morphology, we can describe the macroscopic elastic properties of dense suspensions over a broad range of densities [5,6].

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