QUANTIFYING COLLOIDAL NANOPARTICLE INTERACTIONS IN LIQUID ENVIRONMENT BY CRYOGENIC ELECTRON MICROSCOPY

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The self-assembly process of nanoparticles in liquid environment depends crucially on the colloidal interactions between the nanoparticles.[1] Whereas most research has examined the physical properties of the eventually obtained colloidal assembly structures, we focus in our experiments on the interactions between nanoparticles while dispersed in the liquid. An approach that we have introduced to study the interactions between magnetic and semiconducting nanoparticles is cryogenic electron microscopy.[2-6] The presentation will visualize in which ways dispersive, magnetic dipolar, electric dipolar, and coulombic interactions affect the nanoparticle positions, leading to different local structures in the liquid. For example, magnetic nanoparticles self-assemble into living polymer structures that grow in an external magnetic field. In zero field, quantum dots exhibit similar linear structures, which we ascribe to the presence of a permanent electric dipole moment. Currently, we are investigating the effects of coulombic screening on dipolar structure formation. In all cases, not only do the interactions lead to a rich variety of nanostructures in the liquid dispersion, but conversely, quantitative analysis of the visualized structures constitutes a powerful characterization of the colloidal interactions between the nanoparticles. These are the same interactions that affect self-assembly into novel nanostructured meta-materials of interest for applications.

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