TCI SEMINAR

Kinetic Arrest, Mechanical Response and Massively Reconfigurable Assembly in Rod-Sphere Nanoparticle Mixtures

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Colloidal suspensions offer the level of control necessary to assemble and form novel equilibrium, and non-equilibrium soft solids. On the non-equilibrium side, we will explore nonspherical particles that form glasses and gels. We develop and apply a microscopic statistical dynamical approach for dense isotropic mixtures of spheres and rods as a function of attraction strength, aspect ratio, and composition. Using on the pair structure as input, up to seven transiently localized phases are predicted corresponding to fluid, repulsive glass, attractive glass, gel, a mixed coexisting glass-gel state, and several partially localized states. Dynamical complexity increases with aspect ratio, and reflects a competition between caging, bonding and rod interpenetration. The elastic shear modulus and absolute yield stress are also studied, and dramatic changes are predicted. On the equilibrium side, we explore the possibility of using of a quench disordered large mesh gel composed of long rigid rod polymers, to provide a tool to mediate the structure and thermodynamics of colloidal/nanoparticle suspensions. We employ the Replicated Reference Interaction Site Model approach to study a model quenched fiber gel immersed in a spherical colloid fluid. The theory predicts a sharp wetting-like transition with increasing colloid-fiber attractions accompanied by strong thermodynamic and colloid packing changes. By increasing the colloid-colloid attractions at constant colloid-fiber interactions, a surprising state of maximum adsorption is predicted. This phenomenon suggests a strategy for avoiding macrophase separation and achieving a new state characterized by large, but controlled, density fluctuations. The possibility of exploiting these phenomena to create assemblies that can be switched between electrically conductive and non-conductive states is explored.

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