Structure and Dynamics of Core-Shell Colloids

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Abstract

Soluble polymer is a widely used additive in colloidal systems. It can be used to regulate colloidal interactions, to tailor structures and properties. Aqueous dispersions of colloids bearing surface-grafted poly(ethylene glycol) (PEG) have been synthesized and extensively characterized. The particles obtain a core-shell morphology, a structure ubiquitous to colloidal systems. Solvent quality controls the colloidal interactions, such that they can be tuned from repulsive under good solvent conditions to attractive under marginal/poor solvent conditions, in a fully reversible fashion.

Small-angle neutron scattering (SANS), 3D cross-correlation dynamic light scattering (DLS), and rheology, have been used to study the structure and dynamics close to the glass transition under good solvent conditions and close to macroscopic aggregation in marginal/poor solvents. The low-shear and small-amplitude oscillatory rheology are found to be governed by the glassy dynamics, in qualitative accord with observations on hard-sphere dispersions. In marginally stable dispersions it is necessary to distinguish between dynamic gelation and flocculation.

Non-adsorbing polymer dissolved in the solvent can be used to aggregate solid-particle colloids or emulsion drops through the depletion mechanism. It is shown here that depletion also provides a faithful description of interactions in oil-in-water droplet microemulsions.

Soluble polymer not only influences colloidal interactions, it may also change single-particle properties. Models that take some explicit but simple account of the polymer modification are suggested, derived, and tested against experiments.

Keywords: core-shell, colloids, poly(ethylene glycol) (PEG), small-angle neutron scattering (SANS), dynamic light scattering (DLS), rheology, glass transition, flocculation, aggregation, depletion

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