

MAR13-2012-020184

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Gels from soft hairy nanoparticles in polymeric matrices

DIMITRIS VLASSOPOULOS, FORTH and University of Crete, Department of Materials Science and Technology, Heraklion

Hairy particles represent a huge class of soft colloids with tunable interactions and properties. Advances in synthetic chemistry have enabled obtaining well-characterized such systems for specific needs. In this talk we present two model hairy soft particles with diameters of the order of tens of nanometers, star polymers and polymerically grafted spherical particles. In particular, we discuss design strategies for dispersing them in polymeric matrices and eventually creating and breaking gels. Control parameters are the matrix molar mass, the grafting density (or functionality) and the size of the grafts (or arms). The linear viscoelastic properties and slow time evolution of the gels are examined in view of the existing knowledge from colloidal gels consisting of micron-sized particles, and compared. In the case of stars we start from a concentrated glassy suspension in molecular solvent and add homopolymer at increasing concentration, and as a result of the induced osmotic pressure the stars shrink and a depletion gel is formed. For the grafted colloidal particles, they are added at low concentration to a polymer matrix, and it has been shown that under certain conditions the anisotropy of interactions gives rise to network formation. We then focus on the nonlinear rheological response and in particular the effect of shear flow in inducing a solid to liquid transition. Our studies show that the yielding process is gradual and shares many common features with that of flocculated colloidal suspensions, irrespectively of the shape of the building block of the gel. Whereas shear can melt such a gel, it cannot break it into its constituent blocks and hence fully disperse the hairy nanoparticles. On the other hand, the hairy particles are intrinsically hybrid. We show how this important feature is reflected on the heating of the gels. In that case, the mismatch of thermal expansion coefficients of core and shell appears to play a role on the particle response as it imposes and internal strain on the particle, which in turn changes the shell conformation and under some conditions can lead to thermal melting of the gel. These alternative avenues for manipulating the gel-to-liquid transition have potential implications in directing the properties of hairy nanoparticles and their assemblies in viscoelastic matrices. Parts of this work reflect collaboration with D. Truzzolillo (FORTH), J. F. Moll and S. K.Kumar (Columbia). R. H. Colby (Penn State), M. Gauthier (Waterloo) and B. C. Benicewicz (Univ. South Carolina).