Colloidal Thermoresponsive Gel Forming Hybrids

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Colloidal hybrids comprise organic and inorganic components and are attracting considerable attention in the literature. Recently, we reported hybrid anisotropic microsheets that formed thermoresponsive gels in polymer solutions[1]. Here, we investigate the composition and properties of these hybrid colloids themselves in detail for the first time. Three different cationic PNIPAm (N-isopropylacrylamide) graft copolymers and two inorganic nanoparticle types (laponite and Ludox silica) were used to prepare a range of hybrids. Anisotropic microsheets only formed when laponite particles were added to the copolymer implying directed self-assembly. Aqueous dispersions of the microsheets spontaneously formed gels at room temperature and these gels were thermoresponsive. They represent a new class of gel forming colloid and are termed thermoresponsive gel forming hybrids. The compositions of the hybrids were determined from thermogravimetric analysis and those that gave gel forming behaviour identified. Variable-temperature rheology experiments showed that the elasticity of the gels increased linearly with temperature. The reversibility of the thermally-triggered changes in gel elasticity was investigated. The concentration dependence of the rheology data was well described by elastic percolation scaling theory and the data could be collapsed onto a master curve. The concentration exponent for the elastic modulus was 2.5. The majority of the concentration-dependent and temperature-dependent rheology data could also be modelled using a single equation. The strong attractive interactions that exist between the dispersed gel forming hybrids was demonstrated by the formation of stable thermoresponsive hybrid hydrogels through casting of hybrid dispersions.

Figure 1. Preparation of colloidal hybrids with self-associating behavior.