17b Mechanics of Thermal Gels

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Gels of colloidal particles are widely used in industrial applications. In many of these applications, control of the mechanical properties is critical in processing of the gels and in their end use. An approach that is used to tailor the mechanical properties is to first develop a microscopic model which can predict the flow properties from interaction energies. Once the predictive capability is developed, the flow properties can then be tuned by changing the interaction energy parameters.

A theory which has been successful in predicting the flow properties of dense depletion gels (gels formed from colloidal particles due to addition of nondadsorbing polymer) is the Naive Mode Coupling Theory (NMCT). The only input to NMCT is the equilibrium particle structure factor - thus relating interaction energies to macroscopic flow properties. In this work, we test the universality of NMCT - how successful is it in predicting the flow properties of gels in which particles are interacting with interaction energies other than the depletion system.

Colloidal silica particles coated with octadecanol and suspended in decalin gels when the suspension temperature is reduced. The interaction energy between the colloidal particles can be represented by the Yukawa potential in this thermal gel system. The different parameters of interest are the particle volume fraction φ, strength of attraction ε/kT and range of attraction κD (D is the particle diameter). Calculations of elastic modulus (G') using NMCT and Yukawa potential for different potential parameters yields a correlation for G'. The correlation is then used to back out interaction potential parameters which best represent experimental measurements of the elastic modulus. Parameters calculated from the correlation are then used to predict measured G' over a wide range of temperature and φ. There is excellent agreement between experiment and theory thus demonstrating the success of NMCT.