Elastic properties of soft particle pastes

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Synopsis

Soft microgel pastes are modeled as a three-dimensional system of randomly packed elastic spheres. Simulations are performed wherein the packing is subject to isochoric uniaxial extension to compute the high- and low-frequency shear moduli for various packing fractions. The simulation results agree well with the data from experiments on crosslinked polymer microgels. The low-frequency shear modulus is found to follow the osmotic pressure (the mean normal stress) closely, especially at high packing fractions. In addition, expressions involving the radial distribution function and the pair-wise Hertzian potential have been used to reproduce the high-frequency shear modulus and the osmotic pressure. The radial distribution functions for varying packing fractions are self-similar and after suitable coordinate transformations, all the first peaks collapse onto a single curve. The shift in the first peak and the peak width are related to the packing fraction through semiempirical scaling relations. Shearing introduces systematic changes in the paste microstructure and the final pair correlation function has an additional dependence on the angle from the extended axis. [DOI: 10.1122/1.2186982]