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Yielding of colloidal gels under steady and oscillatory shear

GEORGE PETEKIDIS, ESMAEEL MOGHIMI, NICK KOUMAKIS, IESL-FORTH, FORTH TEAM — The structural and rheological properties of intermediate volume fraction colloid polymer gels are examined during and after steady and oscillatory shear flow using rheometry, confocal microscopy, light scattering and Brownian Dynamics simulations. Our main objective is to rationalize the microscopic mechanisms through which one can tune the mechanical properties of such metastable colloidal gels by imposing different types of external shear and flow. Experimentally, the gels consist of model hard sphere particle dispersions of φ =0.44 with the addition of non-adsorbing linear chains, while BD simulations are conducted for hard spheres with the superposition of an AO potential for depletion attractions. Structural analysis shows that variation of the applied shear rate produces strong changes in the structure of the gels both when under shear and during gel reformation at cessation. Larger rates are characterized by disperse particles and the total breakage of structures at rest, which after cessation evolve with time into strong solids with relatively homogeneous structures. However, smaller rates show large inhomogeneous structures under flow, which do not evolve after cessation and additionally exhibit reduced elasticity and as such are weaker solids. Furthermore oscillatory shear is far more efficient than steady shear creating gels with stronger differences in their elastic modulus. Thus by tuning the way a gel is sheared, one may vary the final strength and structure of the resulting gel. Work in collaboration with R. Besseling, W. C. K. Poon and J. F. Brady

George Petekidis
IESL-FORTH

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