Colloids in Electric Fields and Shear Flow

Jan K.G. Dhont
Forschungszentrum Juelich

After a general introduction to colloids, the response of suspensions of long and thin colloidal rods to external electric fields will be discussed, as well as the response of glasses of spherical colloids to shear flow.

For concentrations of rod-like particles within the two-phase isotropic-nematic coexistence region, various phases and dynamical states can be induced by means of an oscillating external electric field, depending on the field amplitude and frequency. A non-chiral nematic, a chiral nematic and a homeotropically aligned homogeneous phase are observed, and a dynamical state where non-chiral nematic domains melt and form. The phase/state diagram in the field-amplitude versus frequency is determined by means of polarization microscopy, and the nature of the various transition lines is characterized with birefringence, dynamic light scattering and image-correlation spectroscopy. The microscopic origin for the existence of these various phases and dynamical states will be discussed.

Experiments on hard-sphere glasses revealed a shear-induced instability at low shear rates. An initially uniformly sheared state is unstable, which transforms to a stationary banded state where two regions are in coexistence: a flowing and a non-flowing region. This instability is attributed to a shear-induced mass flux together with a strong coupling of the stress to concentration. The origin of the shear-induced mass flux resulting from direct interactions between the colloids, and the resulting instability is discussed. Numerical results are shown for the stationary banded flow profiles and concentration profiles, which will be compared to experiments.