Composites of Lyotropic Lamellar Systems and Micro-Particles

Shahram Shafaei

Department Chemie, Universität Paderborn

The lamellar phase of the pseudo-ternary system formed by lecithin, D_2O, and n-decane was investigated. The phase behaviour as a function of temperature and the influence of spherical micro-particles on the shear-induced orientation states of the lamellar phase were analyzed in a narrow range of compositions. By using polarizing microscopy, small-angle X-ray scattering, deuterium NMR spectroscopy, and rheology on samples containing 50 % (w/w) lecithin and 5.5 water molecules per lecithin molecule a nematic phase coexisting with the lamellar phase was discovered at elevated temperatures. Spherical particles of different sizes, for example, SiO_2 and PMMA particles with diameters of a few hundred nanometers and melamine-formaldehyde condensates with diameters of ca. 2 μm, were synthesized. The shear-induced orientation states of the lamellar phase formed by the pure lecithin/D_2O/n-decane system and by its mixtures with up to 5 % (w/w) of PMMA particles with a diameter of 2 μm were investigated using deuterium rheo-NMR spectroscopy, rheo-microscopy, and rheological measurements. Different orientation states of the lamellar phase were observed under shear: a parallel orientation, multi-lamellar vesicles (MLVs) and a perpendicular orientation were found upon increasing temperature. When micro-particles were added the sequence of orientation states stayed approximately the same, but the temperature range of MLVs was extended, indicating a stabilization of MLVs. Time-dependent NMR measurements at shear rates from 1 to 50 s^{-1} showed that the shear-induced formation of MLVs is accelerated in the composite of lamellar phase and micro-particles.