OP-Carreau-605

Wednsday, May 11, 2011, 05:40-06:00 pm
Room: Karam 4

A COMPARATIVE STUDY ON ORIENTATION AND VISCOUS AND ELASTIC PROPERTIES OF NANO-SIZED PLATELETS IN NEWTONIAN AND VISCOELASTIC FLUIDS

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The shear response of model polymer-clay suspensions was measured using rotational rheometry. A recently developed mesoscopic model is used to investigate nonlinear rheological properties of model nanoparticles filled systems. The influence of several model parameters as well as flow conditions on the nanoparticles orientation, shear and elongational viscosities are investigated. Our simulation results prove that depending on the applied flow conditions (i.e. shear and elongation rates), the model nanocomposites microstructure can vary from isotropic at low shear rates to partially aligned at the intermediate rates to nearly anisotropic at high shear rates. As the flow disrupts the randomly dispersed structure of the suspension, coupling between components and shear stress leads to the formation of a new microstructure where the nano-platelets orient with their surface normal parallel to the direction of gradient. At the very high shear rates $(1000 \leq \dot{\gamma}\ s^{-1}), t$he nano-platelets lie in the shear and vorticity plane with the surface normal aligned with the velocity gradient direction. However, the axis of nano-platelets is moderately aligned with the velocity gradient direction at the intermediate shear rates $(10 \leq \dot{\gamma} \leq 100\ s^{-1})$. At low rates of deformation ($\dot{\gamma} < 10\ s^{-1}$), the orientation of platelets is insignificant and the model predictions show a nearly unbounded viscosity at the very low shear rates. As the particles are aligned with the flow, the suspensions exhibit strong shear-thinning behaviour. Similar behaviour was observed in the measured steady state viscosities of the nanocomposites.