Abstract

This work is in two parts The first is an experimental study of the steady shear and dynamic properties of a polymer solution and the effect of particulate additives The second is an experimental study of the rheology of a lamellar lyotropic liquid crystal and the effect of particulate additives

Particle-loaded polymeric fluids find widespread industrial applications such as polymer processing, paper coating, paint manufacture etc , but the understanding of their rheological properties is inadequate The significance of the present work on particle-filled polymer solutions is two-fold First, there is only limited understanding of the rheology of particle-filled polymeric fluids Secondly, among these studies, most are focussed on polymer melts In the present work, the steady shear and dynamic properties of a non-Newtonian polymer solution, with and without particulate additives, are measured experimentally The effect of particles in the polymer solution is compared with that in Newtonian fluids as well as polymer melts The density of the polymer solution and that of the particles are matched to eliminate sedimentation effects The viscosity, the first normal stress difference and the dynamic properties of the polymer solution are found to be increasing with increase in concentration of particles Addition of particles is found to enhance the non-Newtonian characteristics of the polymer solution. The effect of particles in the dynamic properties of the polymer solution is found to be greater than that reported in the case of polymer melts The Cox-Merz rule is found to be not applicable for volume fraction of particles $\phi \geq 30\%$, which is in agreement with the studies conducted on polymer melts

The second part of the present work deals with the rheology of a lamellar lyotropic liquid crystal with and without particulate additives The present work is motivated by the industrial handling of lamellar phases in the processing of detergents, cosmetics, foodstuffs etc In the present work, the transient behaviour of the viscosity of a lamellar lyotropic liquid crystal is studied when it is sheared for a long time, and the effect of rigid particles in the transient behaviour is investigated When a constant shear stress is applied on a lamellar lyotropic liquid crystalline

phase, using the parallel plate geometry, the shear rate is found to show an oscillating behaviour with time The amplitude of the shear rate oscillation increases with the applied shear stress as well as the thickness of sample between the parallel plates When rigid particles are added to the system, it is found that the baseline and the amplitude of oscillation decrease with increase in concentration of particles An instability due to undulation of the layers of the lamellar phase, can be held responsible for the oscillating viscosity, as a result of which defects are formed and healed The oscillating behaviour of shear rate remains for the entire duration of the experiment, which is about one hour, indicating that the suspected phenomenon of undulation instability prevails as long as the shearing is continued