Flows of CTAB/NaSal surfactant solutions through a capillary

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It is well known that surfactant solutions exhibit highly viscoelasticity as well as polymeric fluids especially when salt concentration C_S is higher than surfactant concentration C_D. Until now, rheological properties for various surfactant solutions have been measured using various rheometers. We also have examined rheological properties for CTAB/NaSal systems as surfactant solutions using a capillary rheometer. In Fig. 1 open circles show the data obtained using a capillary rheometer made of stainless steel for C_D=0.03M and C_S=0.06M. The capillary diameter and length are 2.8mm and 495mm, respectively. The flow curve exhibits complex shape: the shear rate jump, shear-thickening, and shear-thinning are observed. It is thought that these phenomena are related to the structural change of micellar network that occurs in the capillary pipe. Therefore, it is very interesting to investigate the flow in the capillary pipe. In the present study, we examined velocity distribution using the technique of particle tracking velocimetry in a glass capillary and observed the occurrence of white turbidity.

In Fig 1, filled circles show the flow curve using a glass capillary rheometer for C_D=0.03M and C_S=0.06M. The diameter and length of the glass capillary are 3.0mm and 500mm, respectively. In the flow curve for the glass pipe the shear rate jump or shear thickening are not observed. The difference between two flow curves may result from the difference in surface roughness or molecular adsorption.

Figure 2 shows the dependence of velocity profile on shear rate. At low shear rates the velocity profile is similar to that in a Poiseuille flow of Newtonian fluid. At high shear rates the velocity profile changes to that for polymeric fluids with shear-thinning viscosity.

Figure 3 shows photographs indicating the structural change in micellar network with increasing the shear rate. At higher shear rates than 30s^{-1}, the white turbidity is generated near the pipe wall, while it is not able to be observed in the core region. This white turbidity becomes clearer with increasing the shear rate and the layer of the white turbidity oscillates like a wave. The white turbidity is supposed to be the scattered light from the micellar network structure induced by the pipe flow.

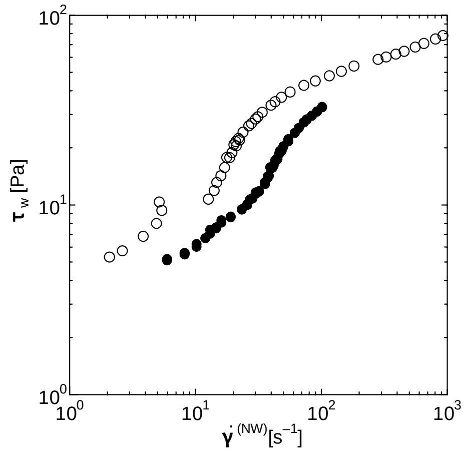

Fig. 1 Flow curves for a stainless steel capillary (open circles) and a glass capillary (filled circles)

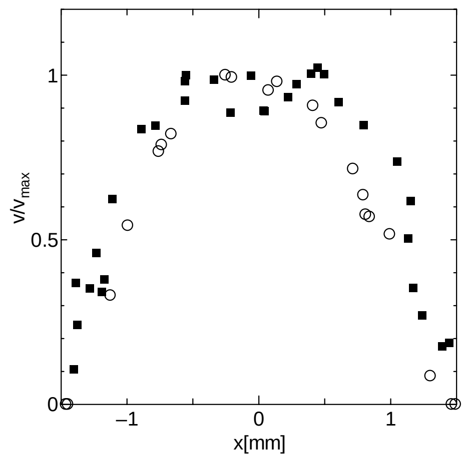

Fig. 2 Velocity profiles at $\dot{\gamma}^{(NW)}$ = 6.0s^{-1} (open circles) and 41s^{-1} (filled squares)

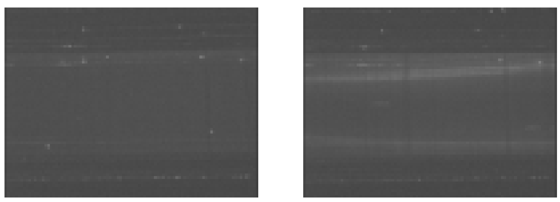

Fig. 3 Photographs indicating the occurrence of white turbidity at $\dot{\gamma}^{(NW)}$ = 6.0s^{-1} (left) and 41s^{-1} (right).