Electrorheology of Polymer Blends Suspended in Silicon Oil

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Introduction The electrorheological (ER) effect is the change of viscoelastic properties on the application or removal of electric fields. The ER fluids recently have gained much more attention because of their potential applications in many industrial areas.

Typical ER fluids are suspensions of polarizable particles dispersed in insulating oils. Particles polarize and align into chains in the presence of electric fields. But sometimes ER effect cannot be shown because the electrophoresis, DC conduction, or gravitational sedimentation occurs.

To prevent these interferences, several composite particles were developed and they show significant ER effects[1]. On the other hand, there are many examples to create interesting properties by blending polymers. In this study, we made several polymer blends containing samples which does not show the ER effect and studied ER properties of suspensions. We show the result of poly(lactic acid) (PLA) /poly(ethylene glycol) (PEG) and poly(vinyl acetate) (PVAc)/PEG blends suspended in silicon oil. In particular, PVAc/PEG blend is known as a miscible blend.

Experimental PLA (racemic compound, M.W. = 2.0 × 10^4), PVAc (n = 1,400 - 1,600) and PEG (M.W. = 3,000) were obtained from Wako Pure Chemical Industries, Ltd. To prepare polymer blends, samples were dissolved in 1,4-dioxane and freeze-dried. To make suspensions, samples were crushed by a mortar and sifted out by a sieve (75 μm). Rheological proper-ties were measured by Haake Rheostress RS-100 altered to apply electric fields.

Result and Discussion Figure 1 shows the shear stress of suspensions of PLA/PEG blend (PLA 25wt%) and neat PEG. In this study, all suspensions contain 20 wt% particles. Suspensions of neat PLA and PLA/PEG blend (PLA 50wt%) does not show the ER due to electrophoresis. However, the suspension of the blend containing 25wt% PLA shows higher yield stress than that of neat PEG.

Shear stress of the suspension of PVAc/PEG (PVAc 25wt%) blend is shown in Figure 2. Suspensions of neat PVAc does not show the ER due to electrophoresis. The yield stress is much stronger than that of the suspension of neat PEG (~ 30 Pa in 1.5kV/mm)

It can be thought that ER effect requires the interparticle interaction, but when the interaction is strong, electrophoresis occurs. In other words, polymer blend can be controlled the interparticle interaction and shows stronger ER effect than the component polymer.

We also measure the shear stress of suspensions of PVAc obtained by Acros Organics (M.W. = 1.7 × 10^5)/PEG (PVAc 25wt%) blend but shear stress is ~40 Pa at 1.5kV/mm. The current density of this suspension (0.60 μA/cm^2 at 1.5kV/mm) was larger than that of Fig.2(0.20 μA/cm^2 at 1.5kV/mm). This differen-ce is caused by ionic conduction.

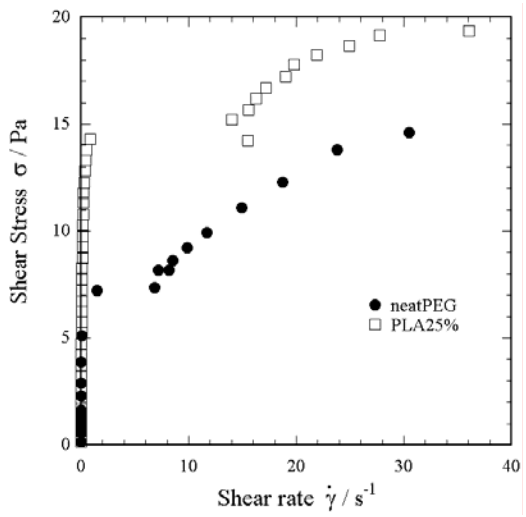

Fig. 1 Shear rate dependence of shear stress under 0.5kV/mm for PLA/PEG=25/75 blend (20 wt%) suspensions at 25℃.

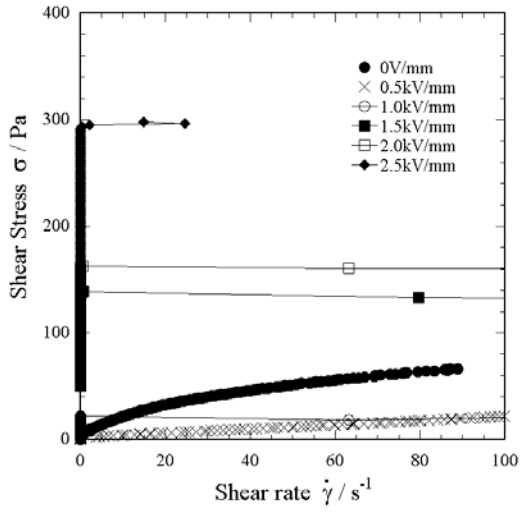

Fig.2 Shear rate dependence of shear stress for PVAc/PEG=25/75 blend (20 wt%) suspensions at 25℃.

References

[1] Y. Otsubo; K. Edamura, J. Colloid Interface Sci. **168** (1994) 230.