Interfacial Slip between Polypropylene and Polystyrene Melts in Capillary Flow.

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Abstract:

When two or more polymers are coextruded, it is important to produce smooth interface between the layers, because an irregular interface significantly reduces the quality of the product in term of mechanical and optical properties. Immiscible polymers have low entanglement densities and weak interactions at the interface and therefore the interface cannot sustain high stress transferred from one component to the others when they are under shear. Interfacial slip is believed to occur under this situation. In this study, we investigated interfacial slip phenomena of polypropylene (PP) / polystyrene (PS) concentric flow in capillary extrusion.

In this study, we used three types of PP (PP1-3) and one type of PS that have different viscoelastic property (Fig. 1). Fig. 2 shows the cross-section of PS coated with PP, where the thickness of PS is *δ*, and the radius of the die is *R*. We can obtain the flow rate of the melt by using the following equation:

$$Q = Q_A + Q_B = \int_0^{R-\delta} 2\pi r v_B dr + \int_{R-\delta}^{R} 2\pi r v_A dr \qquad (1)$$

eq. (1) can be written as

$$Q = \pi\left[(R-\delta)^2 v_s + \frac{R^3}{\sigma_w^3}\int_0^{R-\delta}\sigma^2\left(-\frac{dv_B}{dr}\right)d\sigma + \frac{R^3}{\sigma_w^3}\int_{R-\delta}^{R}\sigma^2\left(-\frac{dv_A}{dr}\right)d\sigma\right] \qquad (2)$$

where, v_s is interfacial slippage speed of PP on PS. We estimated v_s from eq. (2)

Fig.3 shows the interfacial slip velocity between PP3 and PS as a function of shear stress at 230°C. From this result, the critical interfacial slip stress of PP3/PS at 230°C is nearly 8.0×10^3 Pa. Furthermore, the extrudates of PP3/PS is unstable, though each extrudate of neat PP3 and PS is stable at similar condition. We consider that this results from interfacial slip between PP3 and PS.

In our presentation, we discuss it in more detail.

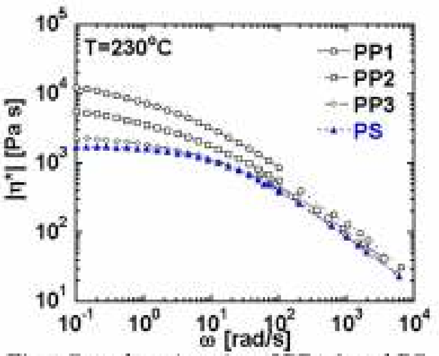

Fig.1 Complex viscosity of PP1-3 and PS as a function of frequency of oscillatory shear at 230°C.

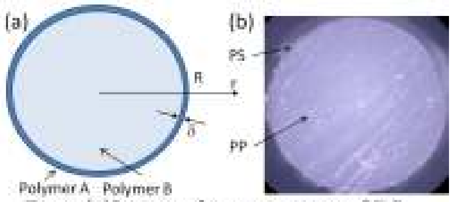

Fig.2 (a)Image of cross-section of PS coated with PP flowing through. (b)Cross-section of experimental sample.

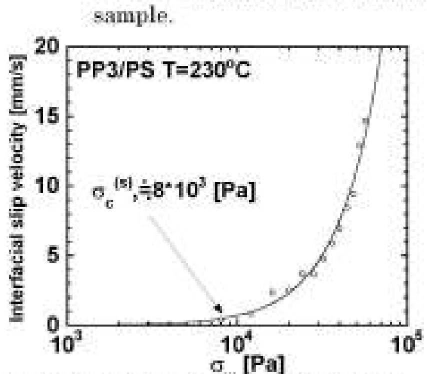

Fig.3 Interfacial slip velocity between PP3 and PS as a function of shear stress at 230°C.