PREDICTION OF THE POLYMER BLEND MORPHOLOGY USING CONCEPT OF EFFECTIVE SHEAR FLOW

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One of the most successful routes of modification of polymer materials is blending polymers with complementary properties, e.g. high-modulus thermoplastics with rubbers. Because most polymer pairs are immiscible, morphology of their blends is formed during their mixing and processing. For achievement of materials with required properties, the morphology of polymer blends must be controlled. It is well known that the size of dispersed droplet of the minor phase in the matrix of the major phase in flowing blends is determined by the competition between the droplet breakup and coalescence. This effect is described quite satisfactorily for steady shear flow but not for complex flow fields in mixing and processing devices. Therefore, the important question is whether a complex flow field in mixers can be substituted by shear flow with an effective shear rate. With the aim to answer this question, we studied dependence the size of ethylene-propylene rubber particles form at steady mixing on the composition of polypropylene/ethylene-propylene rubber (PP/EPR) blends. Rheological properties of PP and EPR at mixing conditions can be found in Table 1. The results were compared with prediction of the theory for shear flow with effective shear rate, determined by common method[1] for mixing conditions.

Table 1. Storage modulus, G', loss modulus, G'', and complex viscosity, $|\eta^*|$, of the blend components measured at angular frequency, ω, related to $\dot{\gamma}_{eff}$.

Material	ω (rad/s)	G'x10^{-3} (Pa)	G''x10^{-3} (Pa)	$\|\eta^*\|$x10^{-2} (Pas)
EPR	18.5	17.4	44.9	25.1
EPR	185	159	203	9.85
PP	18.5	26.1	27.1	18.9
PP	185	126	88.2	4.2

The effective shear rate, $\dot{\gamma}_{eff}$, in B 50 EHT chamber of a Brabender Plasticorder determined according to Bousmina et al.[1] was 185 s^{-1}. Besides it, also $\dot{\gamma}_{eff}$ = 18.5 s^{-1}, related to lower limit of $\dot{\gamma}_{eff}$ determined by other methods[2], was considered. Dependence of average Equivalent Diameter of EPR particles, determined by scanning electron microscopy, on weight fraction of EPR is plotted in Fig. 1. Average droplet diameter at zero EPR concentration and slope of the dependence was compared with prediction of the theory assuming dynamic equilibrium between the droplet breakup and coalescence in the shear flow[2,3]. It was found that *linear increase of the particle size with EPR concentration matches theory very well* but *calculated and experimentally determined particle sizes differ by order of magnitude.*

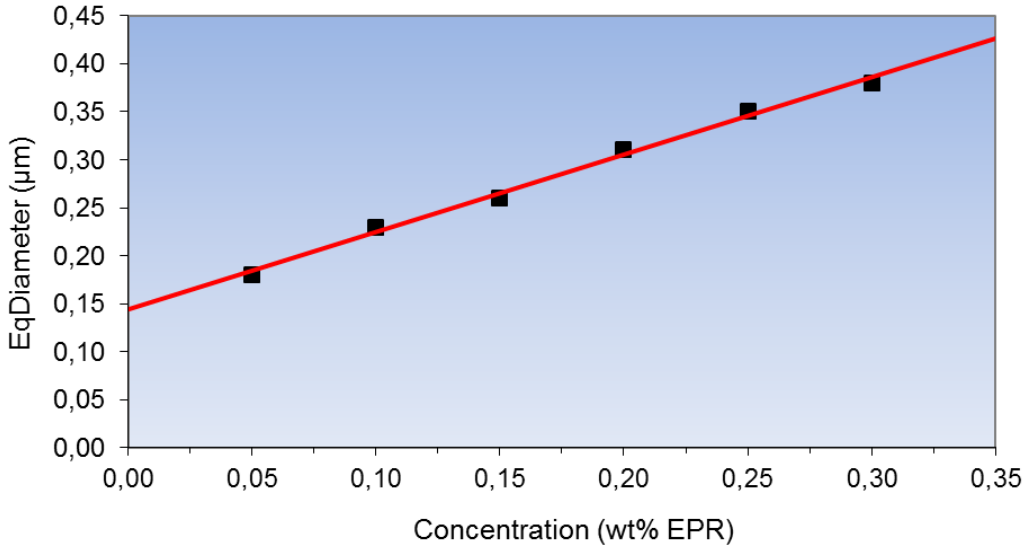

Figure 1. Dependence of number average equivalent diameter, ED, of EPR particles on their weight fraction in PP/EPR blends.

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References

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