

Title	低分子量成分を含んだ相溶系/非相溶系ポリマーブレンドの特異的なレオロジー特性と構造形成
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Abstract

Anomalous rheological response and structure development for miscible/immiscible polymer blends having a low molecular weight component

Blending of two different polymers is a common and simple method for enhancing polymer characteristics. The final morphology of mixtures is the most essential aspect in determining its qualities. Miscible polymer blends and immiscible polymer blends are the two main types of polymer mixtures. Molecular weight is one of the key factors to decide the miscibility and the structure. Moreover, molecular weight and its distribution affect the properties of polymers. In this study, a role of a low-molecular-weight polymer in polymer blends including both miscible and immiscible systems is focused.

Some systems are miscible because of the influence of the mixing entropy. Recently, it was revealed that a miscible polymer blend exhibited a flow-induced segregation behavior without phase separation. In specifically, surface of an injection-molded product was enriched with a low-molecular-weight fraction. This phenomenon was revealed using binary blends of PC and PMMA, in which one of them has low molecular weight. In the study, miscible blends of PC and low-molecular-weight PMMA were used to investigate the effect of processing variables such as shear rate, residence time, and temperature on segregation behavior. A capillary rheometer with a rectangular die was utilized for extrusion, and ATR-IR was used to measure the PMMA content at surface. It was found that the PMMA segregation occurred during flow, resulting in a PMMA-rich surface. The PMMA content at surface increased at high shear rates and high temperatures. In contrast, the residence time in a die barely affected the segregation. The effect of PMMA molecular weight on separation was also investigated. The experimental results indicated that lower molecular weight PMMA was segregated significantly. Furthermore, there was no segregation seen in the extrudate of PC/PC-L ("L" in the sample code denotes that the molecular weight is low), i.e. the blend system consisting of the same polymer species with low molecular weight. These results suggest that segregation phenomena occurs in a miscible blend with a positive Flory-Huggins parameter. Furthermore, the PC/PMMA blends of high and low molecular weights with a blend ratio of 90/10 were used to study the segregation phenomena at injection-molding. It was found that products obtained by injection molding from PMMA-H/PC-L (90/10) had more PC-L content on the surface than films produced via compression molding from the same blend. Furthermore, the injection-molded products obtained from PC-H/PMMA-L (90/10) had a higher concentration of PMMA-L on the surface than the compression-molded films prepared from the same blend. Moreover, the segregation was pronounced near the gate, i.e., the region with a high shear rate.

In the case of immiscible mixtures containing a low-molecular-weight component, the influence on shear viscosity was studied. High and low molecular weights of polypropylene (PP) and polystyrene (PS) including with low molecular weight polyethylene (PE) were used in the experiment. A low viscosity dispersion deformed significantly into a fibrous shape, which increased the interface area between immiscible polymers. Because of a high interfacial tension, interfacial slippage occurred, resulting in low shear viscosity. Decrease in the shear viscosity is desired significantly at injection molding.

For a miscible blend, a low-molecular weight polymer has a high potential on segregation to the surface under pressure-driven shear flow. In an immiscible blend, it plays an important role on viscosity drop due to an enlarge interfacial area with a high interfacial tension. Although this thesis effectively defined the rheological behaviors under shear flow for polymer blends incorporating a low-molecular-weight polymer, the mechanical characteristics of these samples should be validated in future.

Keywords: low-molecular-weight, miscible/immiscible blend, surface segregation, viscosity decrease, interfacial tension