607d Polymer Blends Processed by Solid-State Shear Pulverization: Compatibilization by Block Copolymer Addition and Basic Studies of Dispersed-Phase Morphology

Ying Tao, Andrew Lebovitz, and John Torkelson

Compatibilization of immiscible polymer blends by the addition of block copolymer during melt mixing has been heavily studied. While compatibilization has been achieved in small scale academic studies, this method is not commercially viable due to thermodynamic and kinetic limitations. After addition during melt mixing, block copolymers are mostly wasted in micelles instead of going to the blend interface. Here we introduce a new strategy using a continuous, industrially scalable process called solid-state shear pulverization (SSSP) to compatibilize polystyrene (PS) / high-density polyethylene (HDPE) immiscible blends by the addition of a commercially available styrene / ethylene-butylene / styrene (SEBS) triblock copolymer. The results show that SSSP can yield compatibilization by substantially reducing coarsening during subsequent melt processing. Compared to the 90/10 PS/HDPE blend without SEBS addition by twin screw melt extrusion, the coarsening constant of the same blend with 5% addition of SEBS by SSSP is reduced by a factor of 30. In the case of a 80/20 PS/HDPE blend with 10% SEBS addition by SSSP, the HDPE particle size is stable after 2hrs annealing. The implications of these results for developing a new, technologically attractive method for achieving compatibilization of immiscible polymer blends are discussed. Intimate mixing ability of SSSP is also shown in PS / poly (n-butyl methacrylate) (PnBMA) and PS / poly (methyl methacrylate) (PMMA) blends because of repeated fragmentation and fusion steps during SSSP. In the first blend, PnBMA dispersed phase in PS matrix is as small as hundreds of nms. In the second blend, PMMA dispersed phase is even smaller, less than 100 nms. During SSSP, both dispersed phases show three dimensional irregular structures instead of spherical structure generally observed during melt mixing.