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341 Words

Abstract

Cocontinuous morphologies are distinguished by the mutual interpenetration of two polymer phases and allow for enhanced mechanical properties, static charge dissipation, and barrier properties. Cocontinuous morphologies form over a range of compositions, depending largely on mixing history and the relative polymer viscosities, elasticities, and interfacial tension. Because cocontinuous morphologies are thermodynamically unstable, they will coarsen when held above their glass or melt transition temperature. Since the unique properties of these blends depend directly on the continuous nature of the microstructure and its phase size, stabilization of the cocontinuous morphology is extremely important. To address this challenge, compatibilizers, e.g. block copolymers (bcp), are often added to hinder phase coarsening in blends of immiscible polymers and can improve bonding at interfaces.

The effects of bcp on the cocontinuous morphology of polystyrene (PS)/polyethylene (PE) and PS/poly(methyl methacrylate) (PMMA) blends were studied using scanning electron microscopy (SEM) with image analysis, 3D imaging, mercury porosimetry, solvent extraction, and rheology. It was shown that diblock copolymers were able to suppress coarsening during annealing in cocontinuous PS/PE and PS/PMMA blends. Bcp effectiveness was dependent on molecular weight, concentration, and

architecture. Self consistent mean field theory and bending elasticity theory were used to estimate the proper bcp architecture for maximum reduction in interfacial tension; experimental results agreed well with the theory. In addition to slowing coarsening, bcp was shown to widen the range of cocontinuity for both the PS/PE and PS/PMMA systems.

To aid determination of the range of cocontinuity, a new technique for analyzing SEM micrographs was developed. The new technique classifies blend morphology according to the normalized fraction of drops present in the 2D microstructure. It was found that a blend becomes cocontinuous when the normalized fraction of drops < 50%. Another imaging technique employed for blend characterization was synchrotron X-ray microtomography. This technique gave both 3D images and quantitative analysis of the blend morphology during annealing. Measurements of pore size during annealing were compared to results obtained from SEM and mercury porosimetry, and it was shown that SEM techniques can become inaccurate at large pore sizes.