

Melt Processing and Mechanical Properties of Polyolefin Block Copolymers

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Abstract

This thesis addresses the mechanical properties and melt processing behavior of lamellae-forming polyolefin based block copolymers composed of poly(cyclohexylethylene) (C) and polyethylene (E). These materials display a variety of desirable physical properties, most notably, a significantly higher upper use temperature than polystyrene based block copolymers used in traditional thermoplastic elastomers and plastics.

A comprehensive framework was developed to describe the toughness of C/E block copolymers having a wide range of chain architectures. Uniaxial tensile testing experiments revealed that the weight fraction of E chains confined between C domains (ψ_E) critically controls the elongation-to-break. A design parameter was thus identified to potentially predict the toughness of any hard-soft block copolymer system. CEC and CECEC block copolymers, and their blends were extruded through a capillary rheometer, and the resulting lamellar alignment was studied. Extrudates were found to possess mixed or perpendicular alignment of lamellae, in agreement with the previously established phenomenology from oscillatory shear experiments. CEC and CECEC extrudates displayed dramatically different surface properties. CECEC extrudates exhibited undesirable surface roughness, which was eliminated by adding just 20% CEC. Thus, an "optimum" CEC/CECEC blend composition window was identified that provides high toughness, without undesirable surface instabilities during extrusion. In the final part of the thesis, an experimental apparatus was designed and built to produce melt blown fibers on a laboratory scale. A number of polymers, including a CEC triblock, were extruded using a capillary rheometer and hot air streams were used to successfully attenuate the extrudate into sub-micron fibers. These results prove the potential of the melt blowing process to compete with electrospinning, which is currently the only continuous process to produce polymeric nanofibers.