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Modification of Aliphatic-Aromatic Copolyesters with Polyether Block for Segmented Copolymers with Elastothemoplastic Properties

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Abstract : Due to the number of advantages such as high tensile strength, sensitivity to hydrolytic degradation, and biocompatibility poly(lactic acid) (PLA) is one of the most common polyesters for biomedical and pharmaceutical applications. However, PLA is a rigid, brittle polymer with low heat distortion temperature and slow crystallization rate. In order to broaden the range of PLA applications, it is necessary to improve these properties. In recent years a number of new strategies have been evolved to obtain PLA-based materials with improved characteristics, including manipulation of crystallinity, plasticization, blending, and incorporation into block copolymers. Among the other methods, synthesis of aliphatic-aromatic copolyesters has been attracting considerable attention as they may combine the mechanical performance of aromatic polyesters with biodegradability known from aliphatic ones. Given the need for highly flexible biodegradable polymers, in this contribution, a series of aromatic-aliphatic based on poly(butylene terephthalate) and poly(lactic acid) (PBT-b-PLA) copolyesters exhibiting superior mechanical properties were copolymerized with an additional poly(tetramethylene oxide) (PTMO) soft block. The structure and properties of both series were characterized by means of attenuated total reflectance – Fourier transform infrared spectroscopy (ATR-FTIR), nuclear magnetic resonance spectroscopy (^{1}H NMR), differential scanning calorimetry (DSC), wide-angle X-ray scattering (WAXS) and dynamic mechanical, thermal analysis (DMTA). Moreover, the related changes in tensile properties have been evaluated and discussed. Lastly, the viscoelastic properties of synthesized poly(ester-ether) copolymers were investigated in detail by step cycle tensile tests. The block lengths decreased with the advance of treatment, and the block-random diblock terpolymers of (PBT-ran-PLA)-b-PTMO were obtained. DSC and DMTA analysis confirmed unambiguously that synthesized poly(ester-ether) copolymers are microphase-separated systems. The introduction of polyether co-units resulted in a decrease in crystallinity degree and melting temperature. X-ray diffraction patterns revealed that only PBT blocks are able to crystallize. The mechanical properties of (PBT-ran-PLA)-b-PTMO copolymers are a result of a unique arrangement of immiscible hard and soft blocks, providing both strength and elasticity.

Keywords : aliphatic-aromatic copolymers, multiblock copolymers, phase behavior, thermoplastic elastomers
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