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Relationship between Functional Properties and Supramolecular Structure of the Poly(Trimethylene 2,5-Furanoate) Based Multiblock Copolymers with Aliphatic Polyethers or Aliphatic Polyesters

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Abstract : Over the last century, the world has become increasingly dependent on oil as its main source of chemicals and energy. Driven largely by the strong economic growth of India and China, demand for oil is expected to increase significantly in the coming years. This growth in demand, combined with diminishing reserves, will require the development of new, sustainable sources for fuels and bulk chemicals. Biomass is an attractive alternative feedstock, as it is widely available carbon source apart from oil and coal. Nowadays, academic and industrial research in the field of polymer materials is strongly oriented towards bio-based alternatives to petroleum-derived plastics with enhanced properties for advanced applications. In this context, 2,5-furandicarboxylic acid (FDCA), a biomass-based chemical product derived from lignocellulose, is one of the most high-potential biobased building blocks for polymers and the first candidate to replace the petro-derived terephthalic acid. FDCA has been identified as one of the top 12 chemicals in the future, which may be used as a platform chemical for the synthesis of biomass-based polyester. The aim of this study is to synthesize and characterize the multiblock copolymers containing rigid segments of poly(trimethylene 2,5-furanoate) (PTF) and soft segments of poly(tetramethylene oxide) (PTMO) with excellent elastic properties or aliphatic polyesters of polycaprolactone (PCL). Two series of PTF based copolymers, i.e., PTF-block-PTMO-T and PTF-block-PCL-T, with different content of flexible segments were synthesized by means of a two-step melt polycondensation process and characterized by various methods. The rigid segments of PTF, as well as the flexible PTMO/or PCL ones, were randomly distributed along the chain. On the basis of 1H NMR, SAXS and WAXS, DSC an DMTA results, one can conclude that both phases were thermodynamically immiscible and the values of phase transition temperatures varied with the composition of the copolymer. The copolymers containing 25, 35 and 45wt.% of flexible segments (PTMO) exhibited elastomeric property characteristics. Moreover, with respect to the flexible segments content, the temperatures corresponding to 5%, 25%, 50% and 90% mass loss as well as the values of tensile modulus decrease with the increasing content of aliphatic polyether or aliphatic polyester in the composition.

Keywords : furan based polymers, multiblock copolymers, supramolecular structure, functional properties
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