Doctoral Dissertations 1911-2013

Toughening Semicrystalline Poly(Lactic Acid) By Morphology Alteration

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Date of Award
9-2013

Document Type
Campus Access

Degree Name
Doctor of Philosophy

Degree Program
Polymer Science and Engineering

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Keywords
Pure sciences, Applied sciences, Hydrolytic stability, Morphology, Poly(lactic acid), Rubbery, Stereocomplex, Toughening

Subject Categories
Materials Chemistry | Other Chemistry | Polymer Chemistry

Abstract
For the first time, a physical method based on polymer crystallization is employed, to overcome the inherent brittleness of poly (L-lactic acid) (PLLA) by kinetically trapping a low Tg continuous amorphous phase. The decrease in mobility as a result of polymer crystallization is used to arrest the remaining polymer in the amorphous phase. This is achieved by melt blending and co-crystallizing a triblock copolymer with a configuration of the form PDLA-soft block-PDLA with PLLA. When crystallized from a

temperature Tb, such that TmPLLA < Tb < Tm stereocomplex, the slow quiescent crystallization of PLLA and the preferential crystallization of the PLA stereocomplex results in formation of a morphology that can be described as stereocomplex crystals dispersed in a soft continuous amorphous phase containing the amorphous PLLA and the non-crystallized triblock copolymer. A systematic investigation of the effect of various parameters on the stereocomplex crystallization, morphology and properties of the PDLA-softblock-PDLA triblock copolymer/ PLLA blends is performed. These parameters include the chemical nature of the midblock, the triblock composition and the triblock architecture. The effect of addition of a molecular plasticizer as a third component to the blend to modify the properties of the amorphous phase is also investigated. Finally, varying functionality epoxy oligomers are investigated as additives to improve the hydrolytic stability and durability of the poly(lactic acid) based blends developed. Based on these studies, poly(lactic acid) based flexible, rubbery, semicrystalline materials containing a physically cross-linked network with the stereocomplex crystals acting as physical cross-links and the amorphous PLLA, triblock and plasticizer acting as mobile amorphous chains between the cross-links has been developed.