

Super toughened biodegradable polylactide blends with non-linear copolymer interfacial architecture obtained via facile in-situ reactive compatibilization

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Abstract

Polylactide (PLA) has inherent shortcomings that limit its widespread application: brittleness, slow crystallization rates, low melt strength and thermal instability during melt processing. In this paper, these problems are addressed through a facile melt blending of PLA with a soft and biodegradable polymer, poly[(butylene succinate)-co-adipate] (PBSA). In-situ compatibilization of these immiscible blends was achieved via melt mixing the blends with a multifunctional reactive oligomer that led to the formation of non-linear copolymer architecture at the interface. Scanning electron microscopy showed a drastic reduction of the dispersed phase size upon compatibilization, even at very low quantities of the chain extender. Rheological probing of the structures revealed gel-like behavior in oscillatory experiments and enhanced viscosities for the compatibilized blends, and long-chain branched (LCB) topology for the components. The impact strength of PLA improved from 4.6 to 38.4 kJ/m² for the blend with 40wt% PBSA and 0.6wt% chain extender. Likewise, the elongation-at-break increased from 6% for PLA to 179% for the blend containing 40wt% PBSA and 0.6wt% chain extender. Importantly, these super-tough blends lost little of their tensile strength while simultaneously exhibiting improved thermal stability and better crystallizability. The toughening is attributed to improved interfacial adhesion and the resultant morphology, while the formation of LCBs enhanced the melt strength, strain hardening and crystal nucleation of the components. The thermal stability is ascribed to the chain extension and hence improved the molecular weight.