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A new insight into morphological, thermal, and mechanical properties of melt-processed polylactide/poly(ε-caprolactone) blends

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ABSTRACT:

Biodegradable polylactide (PLA)/poly (ε-caprolactone) (PCL) blend is a well-studied immiscible polymer blend system; however, there is no fundamental understanding of how the dispersed phase morphology controls the thermal stability, and the thermal and mechanical properties of the blend systems. Addressing this research question, a series of PLA/PCL blends were processed using melt-blending technique. The results show that the unique thermal stability of the dispersed PCL domains prolonged the complete degradation process of PLA. Furthermore, altering the activation energies (E_a) of PLA/PCL blends revealed that thermal stability depends not only on the governing mechanism change during degradation process but also on the behavior of phase-separated morphology characteristics. The presence of evenly dispersed PCL particles within PLA matrix enhanced the crystallization rate coefficient of PLA and tailored the spherulite morphologies by acting as a nucleating agent, thus promoting the crystallization ability of PLA chains. Consequently, remarkable increase in elongation at break was achieved for 60PLA/40PCL blend, with well-balance tensile modulus and tensile strength characteristics. Despite the significant storage modulus increase of the blends at low temperatures, significant storage modulus decrease is noted with increasing temperature, due to packing density, chain mobility phenomenon, and unfrozen PCL molecules. The enhanced processability of PLA by ductile PCL, with improved and balanced properties, enables the technological advancement of bio-based PLA for a wide range of applications.