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Abstract

Poly(lactic acid) (PLA) is one of the most popular biobased polymer. Although the ultimate tensile strength of PLA is comparable to poly(ethylene terephthalate), slow crystallization of PLA limits its wide spreading of applications. In this study, a biobased filler, silk fibroin nanodisc (SFN), was included in the PLA matrix with the aim of accelerating the crystallization process of PLA. This dissertation consists of three chapters. In chapter 1, the detailed investigation of the effect of SFN inclusion on the crystallizability of PLLA was performed by the polarizing optical microscope observation and the differential scanning calorimetry (DSC) measurement. For the isothermal crystallization studies by DSC, extremely quick cooling (~300˚C/min) from the melt to the crystallization temperature has been conducted. The experimental results show that the small amount of SFN (only 1%) can significantly enhance the crystallizability of PLLA. It was found that the SFN works as a nucleation agent by increasing the number of nuclei about 4 times while it doesn't change the growth rate of the spherulites. In chapter 2, the time-resolved synchrotron wide-angle X-ray scattering (WAXS) and small-angle X-ray scattering (SAXS) techniques were employed to study the effect of SFN on the evolution of the structure and the kinetics of the crystallization of PLLA. The results showed that the loading SFN shortens the induction period and increases the ultimate degree of crystallinity. The crystallization half-time was reduced which suggests that the overall crystallization process was accelerated. The SAXS results suggested that the lamellar thickening process was accelerated, and the thickness of the initial lamella was decreased by loading 1% SFN in PLLA. In chapter 3, the effect of SFN on the stereo-complex (SC) formation in the blend of PLLA/PDLA(50/50) was studied by using the DSC and time-resolved WAXS techniques. It was found that the SFN favors the formation of SC crystallites than the homo-crystallites (HC). However, the induction period for the HC was unchanged.