Preparation and characterization of biodegradable PLA polymeric blends

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摘要.

Abstract

The purpose of this study was to fine-tune the mechanical properties of high molecular-weight poly-L-lactic acid (PLLA), especially to increase its toughness without sacrificing too much of its original strength. Besides of its long degradation time, PLLA is usually hard and brittle, which hinders its usage in medical applications, i.e., orthopedic and dental surgery. Some modifications, such as the addition of plasticizers or surfactants/compatibilizers, are usually required to improve its original properties. PDLLA can degrade quickly due to its amorphous structure, thus shortening the degradation time of PLLA/PDLLA blends. Blends of biodegradable poly-L-lactic acid (PLLA) and poly-DL-lactic acid (PDLLA) or polycaprolactone (PCL), in addition to a third component, the surfactant-a copolymer of ethylene oxide and propylene oxide, were prepared by blending these three polymers at various ratios using dichloromethane as a solvent. The weight percentages of PLLA/PDLLA (or PCL) blends were 100%/0%, 80%/ 20%, 60%/40%, 50%/50%, 40%/60%, 20%/80% and 0%/100%, respectively. Physical properties such as the crystalline melting point, glass transition point (Tg), phase behavior, degradation behavior, and other mechanical properties were characterized by thermogravimetric analysis, differential scanning calorimetry (DSC), infrared spectroscopy, gel permeation chromatography, and dynamic mechanical analysis (DMA). DSC data indicate that PLLA/PDLLA blends without the surfactant had two Tg's. With the addition of the surfactant, there was a linear shift of the single Tg as a function of composition, with lower percentages of PLLA producing lower glass transition temperatures indicating that better miscibility had been achieved. DMA data show that the 40/60 PLLA/PDLLA blends without the surfactant had high elastic modulus and elongation, and similar results were observed after adding 2% surfactant into the blends. The 50/50 PLLA/PDLLA/2% surfactant blend had the highest elastic modulus, yield strength, and break strength compared with other ratios of PLLA/PDLLA/2% surfactant blends. The elongation at break of 50/50 PLLA/PDLLA was similar to that of PLLA. Again, the elongation at break of 50/50 PLLA/PDLLA/2% surfactant was almost 1.2-1.9 times higher than that of 50/50 PLLA/PDLLA and PLLA. Elongation of PLLA increased with the addition of PCL, but

the strength decreased at the same time. In conclusions, adding PDLLA and surfactant to PLLA via solution-blending may be an effective way to make PLLA tougher and more suitable to use in orthopedic or dental applications.