IOWA STATE UNIVERSITY

Materials Science & Engineering Department

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"Novel bio-based and biodegradable polymer blends"

Most plastic materials, including high performance thermoplastics and thermosets are produced entirely from petroleum-based products. The volatility of the natural oil markets and the increasing cost of petroleum have led to a push to reduce the dependence on petroleum products. Together with an increase in environmental awareness, this has promoted the use of alternative, biorenewable, environmentally-friendly products, such as biomass. The growing interest in replacing petroleum-based products by inexpensive, renewable, natural materials is important for sustainable development into the future and will have a significant impact on the polymer industry and the environment. This thesis involved characterization and development of two series of novel bio-based polymer blends, namely polyhydroxyalkanoate (PHA)/polyamide (PA) and poly(lactic acid) (PLA)/soy protein. Blends with different concentrations and compatible microstructures were prepared using twin-screw extruder. For PHA/PA blends, the poor mechanical properties of PHA improved significantly with an excellent combination of strength, stiffness and toughness by adding PA. Furthermore, the effect of blending on the viscoelastic properties has been investigated using small-amplitude oscillatory shear flow experiments as a function of blend composition and angular frequency. The elastic shear modulus (G') and complex viscosity of the blends increased significantly with increasing the concentration of PHA. Blending PLA with soy protein aims at reducing production cost, as well as accelerating the biodegradation rate in soil medium. In this work, the mechanical, thermal and morphological properties of the blends were investigated using dynamic mechanical analysis (DMA), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), scanning electron microscopy (SEM), and tensile tests.