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Mechanical and Morphology Behaviours of Polybutylene (succinate)/Thermoplastic Polyurethaneblend

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Abstract

Today, massive increase in the usage of plastic products leads to environmental pollution. To worsen the situation, biodegradable materials alone will not satisfy some properties required by the industries. Therefore, in this research, blends of biodegradable polybutylene(succinate)(PBS)/thermoplastic polyurethane(TPU) polymer blend were developed, with the aim of getting a biodegradable material with improved properties. The idea of selecting TPU as the second component is mainly to improve the toughness.It is also motivated by the advantages it offers such as good abrasion resistance, good mechanical properties with rubber-like elasticity as well as good tear resistance.The aims of the present study are to show the effect of blend ratios on the mechanical and morphology properties and identify the optimum weight ratio for PBS/TPU. Effect of various weight ratios (30wt%, 50wt% and 70 wt%) TPU addition into PBS were studied. Tensile test were examined in order to determine the best weight ratio PBS/TPU blend. Scanning electron microscope (SEM) and differential scanning calorimetry (DSC) were used to examine compatibility and miscibility of the blends. The results from this work show that high weight ratio of PBS will influence high mechanical properties of the blend. PBS/TPU (70:30) have highest tensile modulus and strength compare to lower PBS concentration. SEM and DSC results were shown to support the tensile modulus and strength.

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*Keywords:*Polymer blend;Biodegradable materials;Weight ratio

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1. Introduction

Poly(butylene succinate) (PBS) is one of the most promising biodegradable polyesters, which is chemically synthesized by the polycondensation of 1,4-butanediol with succinic acid as shown in Fig. 1[1,2]. PBS exhibits many desirable properties including biodegradability, melt processability, as well as thermal and chemical resistance[3,4]. Consequently, it is a potential candidate various applications such as packaging film, foamed sheet, blown bottles, or highly expanded foam. Fujimaki compared the properties between the biodegradable PBS and the conventional plastic packaging materials, such as polypropylene (PP) and low-density polyethylene (LDPE)[5]. He reported that the yield strength of PBS (Bionelle#1020) was 10.3% higher than that of PP, and was 264% higher than that of LDPE. However, other properties such as softness, gas-barrier properties, melt viscosity for further processing, and so forth, are frequently insufficient for various end-use applications. Thus, PBS is often blended with other compounds, such as fillers and copolymers, in order to make it useful in various applications[6].

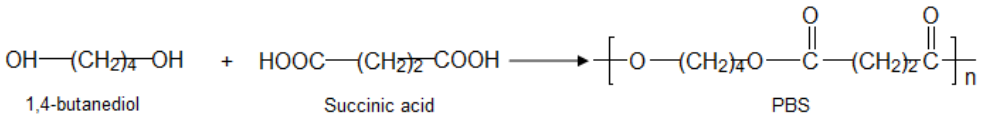

Fig.1. Synthesis of PBS.

Thermoplastic polyurethanes are randomly segmented copolymers[7] composed of hard and soft segments forming a two-phase microstructure (Fig. 2). Generally, phase separation occurs in most TPUs due to the intrinsic incompatibility between the hard segments and soft segments: the hard segments, composed of polar materials, can form carbonyl to amino hydrogen bonds and thus tend to cluster or aggregate into ordered hard domains, whereas the soft segments form amorphous domains. The presence of hard domains in segmented polyurethanes is very important to the mechanical properties. In segmented polyurethanes, hard domains act as physical crosslinks. Since hard domains also occupy significant volume and are stiffer than soft domains, they also function as effective nano-scale fillers and render a material behavior similar to that of a composite[8].

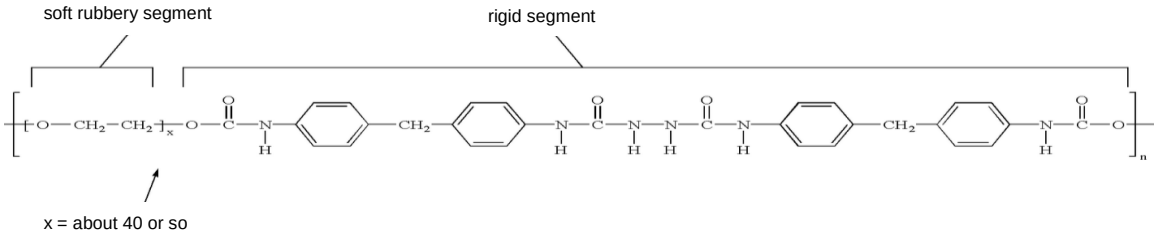

Fig.2. Hard and soft segments of TPU.

In this research, TPU was blended into PBS. PBS which is naturally rigid is expected to increase its elongation properties after the blending process. Polymer blends are physical mixtures of two or more polymers with or without any chemical bonding between them. The objective of polymer blending is a practical one of achieving commercially viable products through either unique properties or lower cost than some other means might provide. Property of polymer blends is superior to homopolymers. When two or more polymers are mixed, the phase structure of the material can be either miscible or immiscible. Due to their high molar mass, the entropy of mixing of polymers is relatively low and consequently specific interactions are needed to obtain blends, which are miscible or homogenous on a molecular scale[9]. In the case of immiscible systems the overall physicomechanical behaviour depends critically on two demanding structural parameters which are; a proper interfacial tension leading to a phase size small enough to allow the material to be considered as macroscopically homogenous, and an interphase adhesion strong enough to assimilate stresses and strains without disruption of the established morphology.