MECHANICAL PROPERTIES OF A POLYAMIDE
6-REINFORCED PTFE COMPOSITE

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Polytetrafluoroethylene (PTFE) blends with polyamide 6 (PA6) in various ratios were prepared in a corotating twin-screw extruder, where PTFE acted as a polymer matrix and PA6 as a disperse phase, and the morphology and mechanical properties of the blends were investigated by using SEM. With increasing content of PA6 in the blends, their flexural properties improved. The interfacial adhesion promoted the creation of an interphase between the PTFE and PA6 and led to improved mechanical properties of the material. The mechanical properties of the blends were optimum at 30 vol.% PA6.

1. Introduction

It has been widely reported that the incorporation of particulate fillers into thermoplastic matrices induces considerable changes in their physicochemical and mechanical properties [1]. At present, different types of fillers are being used to enhance such their mechanical properties as the stiffness and strength [2, 3]. Another obvious aim of introducing fillers into polymer matrices is to reduce their cost. The majority of polymer blends are thermodynamically immiscible in nature due to the low entropy of mixing. Binary blends of two immiscible components form a coarse and unstable phase morphology, with high interfacial tension and low interfacial adhesion [4-6]. As a result, the mechanical properties of immiscible polymer blends are rather poor. The microstructure of the composites, such as the degree of filler dispersion in the polymer matrix and the interfacial filler–matrix bonding, is known to play a significant role in determining the mechanical properties of filled composites. Also, the compatibility of the blends is greatly affected by their composition.

PA6-reinforced polymeric composites are being widely used as structural materials in many engineering applications. Because they offer several advantages, such as the ease of processing, the possibility of obtaining complex shapes and recycling, and high strength/density ratios, PA6-reinforced thermoplastics are of great commercial and scientific interest. It is also known that some properties of plastics can be improved through incorporation of PA6 by using economical processing methods, such as extrusion and injection molding [7].

In this study, we aimed to prepare PA6/PTFE blends with different content of PA6 by twin-screw extrusion and to characterize their mechanical properties. Effects of the compositions on the interfacial adhesion between the fibers and the polymer matrix were also established.

2. Experimental

2.1. Materials and test specimens

The reinforcement was polyamide 6 supplied by the YueYang Juli Engineering Plastic Co. Hunan, whose tensile strength was 85 MPa, flexural strength 115 MPa, and density 1150 kg/m³. A PTFE powder with a grit size of about 30.0 μm was used as a matrix resin of the composites prepared.

2.2. Preparation process

Blends containing 0, 10, 20, 30, and 40 vol.% PA6 were prepared by using a twin-screw extruder. The extrudate was chopped into small pellets, which were vacuum-dried at 80°C for 12 h. The specimens for mechanical experiments were prepared by using an injection-molding machine at a barrel temperature of 230°C and mold temperature of 80°C.

2.3. Mechanical tests

Tensile and flexural tests were carried out on a computer-controlled Universal Testing Machine (China Shenzhen Sans Materials Detection Systems Inc.) at room temperature. For flexural tests, the PA6/PTFE composite was cut into narrow-waist dumbbell-shape beam specimens in accordance with the Chinese standard GB/T1040-1992. The bending load was applied perpendicularly to the specimen at its center at a crosshead speed of 0.01 mm/min, keeping the distance between supports equal to 40 mm. This speed was chosen so that to allow the maximum time for slow crack growth to take place in the specimen. The PA6/PTFE composite used for tensile tests was cut into narrow-waist dumbbell-shape specimens in accordance with the Chinese standard GB/T1040-1992. The deformation rate was 5 mm/min.

Specimens of size measuring up to the GB/T16420-1996 standard were prepared from a molded board for impact tests. The bottom surface of impacted specimens was ground and polished. The tests were conducted on a type ZBC-4B impact machine (made in China) at room temperature. The fracture was brittle and occurred at the midpoint of the specimens.

The measurements were made at five magnitudes of a constant load for five specimens. The results obtained were then averaged and used to calculate the impact strength of the composite. To observe the morphological structure of the fracture surface of the specimens, a scanning electron microscope (SEM) was employed.