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Preparation and Mechanical Properties of Carbon Fiber reinforced Polybutylene Terephthalate Composites ⋆

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Abstract

This paper studied the mechanical properties of carbon fiber reinforced polybutylene terephthalate (PBT) composites, selected the different sizing agent to improve the interface binding capacity of carbon fibers (CFs) and PBT. Some CFs were modified with polyvinyl acetate (PVAc), and they were named p-C. Some other CFs were modified by ethylene acrylic acid (EAA), and they were named e-C. After modification, the groups of carboxyl were introduced into the surface of p-C. For e-C, the groups of C=C were introduced. For PBT/p-C composites, the maximum of tensile strength reached 68.22 MPa and elastic modulus reached 3263.18MPa, while the content of CFs is 15 wt.%. For PBT/e-C composites, with addition of the same content of CFs, the tensile strength and elastic modulus could reach 90.76 MPa and 4334.76 MPa respectively. Compared with pure PBT, the mechanical properties of the composites were improved significantly, and the reinforcement effect was more obvious in PBT/e-C composites, because of the better binding capacity between CFs and PBT. The decomposition temperature of the composites was between 378 °C and 417 °C, and they presented better heat resistance property.

Keywords: PBT; Carbon Fibers; Composites; Mechanical Properties

1 Introduction

Carbon fibers (CFs) with high tensile strength, high temperature, friction and other advantages, are used to improve the mechanical properties of polymer materials [1-4]. They are mixed with thermoplastic resin and present high strength, good rigidity, light quality, and recyclable [5-7]. These kinds of composites have excellent abrasion resistance, self-lubricity, anti-electrostatic, electromagnetic interference, small thermal expansion, coefficient fatigue resistance and creep resistance properties and were used in aerospace equipment, aircraft parts, electronic instrument, weaponry and automobile [8-11].

Polybutylene terephthalate (PBT) is a kind of semi-crystalline thermoplastic polymer. It is one of the top five engineering plastics. Because of good mechanical properties, especially excellent

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tensile property, electrical performance, abrasion and chemical resistance, It is widely used in automotive, electrical and electronic industries [12-13].

In the case of that CFs without any surface treatment, the interfacial adhesion is poor in composites and it is difficult to make full use of advantages of CFs [14]. Thus, the surface modification of carbon fibers is very important to improve the interfacial adhesion between carbon fibers and resin matrix [15-17].

There are some surface treatments, such as gas phase oxidation, acid oxidation treatment, plasma treatment and so on [18, 19]. This article select surface sizing.The carbon fiber filament is immersed in the slurry tank by the guide roller and the immersion roller, and then pressed by rollers, it is simple and effective [20].

2 Experimental Section

2.1 Materials

CFs (T700) were purchased from TORAY Company in Japan. PBT pellets were purchased from Xin jiang Blue Mountain station River Polyester Co. Ltd.

2.2 Preparation of Samples

Before melt blending, PBT pellets and CFs were dried at 80 °C for 24 h in a vacuum oven. Composites with varying CFs contents were prepared by melt blending in a Haake mixer (RheoDrive 7) at 230 °C for 5 min with 30 rpm.

Plate specimens were prepared by compression molding at 235 °C for 10 min. The drawing dumbbell specimens were cut to 1.2 mm thickness, 5 mm width, and 55 mm length.

Table 1: Mass fraction of CFs in PBT

Carbon fiber contents	5%	10%	15%	20%	30%	40%
CFs (g)	3	6	9	12	18	24
PBT (g)	57	54	51	48	42	36

2.3 Characterization

Fourier Transform infrared spectroscopy (FTIR, TENSOR-27) was used to characterize the functional groups on CFs. The spectra were measured between 400 and 4000 cm^{-1}, and the resolution was set at 4 cm^{-1}.

Thermogravimetric Analysis (TGA, TG-209F1) was employed to characterize the stability of composites under argon atmosphere. TGA curves were obtained at temperatures ranging from 50 °C to 600 °C at 10 °C/min heating rate.