

# Preparation and properties of single-walled carbon nanotubes/poly(butylene terephthalate) nanocomposites

Khalid Saeed · Ibrahim Khan

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**Abstract** A neat poly(butylene terephthalate) (PBT) polymer and functionalized single-walled carbon nanotubes (F-SWNTs)/PBT nanocomposite films were prepared by solution casting technique. The SWNTs were functionalized by acid treatment, which introduced carboxylic groups onto the SWNTs. The morphological studies showed that the F-SWNTs were embedded and dispersed well within the PBT polymer matrix. The POM study illustrated that a neat PBT showed Maltese-type spherulites. It was also observed that the size of neat PBT spherulites was larger than F-SWNTs/PBT nanocomposite spherulites, which might be due to the nucleation effect of F-SWNTs in the case of nanocomposites. The thermal stabilities and mechanical properties such as stress yield and moduli of F-SWNTs/PBT nanocomposites were enhanced as compared to neat PBT. The DSC study showed that the melting temperature ( $T_m$ ) of PBT was slightly increased by addition of F-SWNTs. This increase in  $T_m$  might be due to the formation of compact structure, which was formed through different types of molecular interactions with addition of F-SWNTs. It was also found that initially the solvent (distilled water, kerosene, 2 M HNO<sub>3</sub> solution) uptake by neat PBT polymer and its nanocomposites increased gradually, which became steady after specific intervals for each sample. The results also exhibited that the solvent uptake of F-SWNTs/PBT nanocomposites was less than neat PBT.

**Keywords** Single-walled carbon nanotubes · Spherulites · Nanocomposites · PBT

K. Saeed (✉) · I. Khan  
Department of Chemistry, University of Malakand, Chakdara,  
Dir (Lower), Khyber Pakhtunkhwa, Pakistan  
e-mail: khalidkhalil2002@yahoo.com

## Introduction

Carbon nanotubes (CNTs) are important form of fullerenes, which are also known as tubular fullerenes. CNTs are cylindrical graphene sheets of sp<sup>2</sup> bonded carbon atoms. It was synthesized by Iijima in 1991 by using arc-evaporation method [1]. CNTs have two types, single-walled carbon nanotubes (SWNTs) and multi-walled carbon nanotubes (MWNTs). SWNTs consist of a single graphene sheet rolled upon itself with diameter of 1–2 nm while MWNTs consist of multi-layers of graphene sheets rolled upon itself with diameter ranging from 2 to 50 nm, which depend on the number of graphene tubes. The interlayer distance between these tubes is approximately 0.34 nm [2]. CNTs can be prepared by several ways, but widely used methods are electric arc discharge, laser evaporation and chemical vapor deposition [3–5]. Electrically CNTs may be metallic or semiconductor that depends on graphene sheet rolling pattern and geometry [6]. CNTs exhibit variety of unique mechanical, optical, electrical properties and are also very stable chemically, which asserts its importance in nanotechnology [7, 8]. Also these characteristics make CNTs an important contender in many applications, i.e., as reinforcing material in composites, hydrogen storage, actuators, sensors etc. [9–11].

PBT is an important engineering polymer having high melting point (223 °C). It is a semi-crystalline polymer and has high resistance to solvents like water, methanol, chloroform, etc. PBT is relatively a new comer into polymer industry, but due to their characteristic properties it shows a wide range of applications. It is mechanically very strong and can resist heat up to 150–200 °C, thus it can be used as flame retardant. PBT is also used as an insulator in the electrical and electronics industries due to its unique insulating nature. It is mainly used for housings in