NON-ISOTHERMAL CRYSTALLIZATION KINETICS OF POLYMER NANOCOMPOSITE USING DIFFERENTIAL SCANNING CALORIMETRY

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ABSTRACT

Nanocomposite of **p**oly(**b**utylenes**t**erephthalate) (PBT) with **m**ulti **w**alled **c**arbon **n**ano**t**ubes (MWCNT) was successfully obtained. Non-isothermal crystallization of this nanocomposite was investigated by **D**ifferential **S**canning **C**alorimetry (DSC) technique. Behaviour nanocomposite when they are heated and cooled at the rate of 2, 5, 10 and 20^{O}C per minute is discussed in this paper. It was found that the peak crystallization temperature nanocomposite is dependent on the heating and cooling rate of the sample.

Theme: *Applied Science, Technology and Applications*

1. Introduction:

The behavior of thermoplastic semicrystalline polymers during non-isothermal crystallization from the molten state is of increasing theoretical importance, because these conditions are important from industrial applications point of view. The modeling of isothetmal crystallization of polymers can be done satisfactorily by Arvami equations[1]. However, the non-isothermal crystallization of polymers is not easy to model and various approaches have been tried like Ozawa analysis[2]. In this paper, the non-isothermal crystallization behavior of nanocomposite of poly(butylene terephthalate) (PBT) with multi walled carbon nano-tubes (MWCNT) is discussed.

2. Experimental:

2.1 Materials:

Poly(butylenesteraphthalate)is a semicrystalline polyester. Figure 1 shows the chemical structure of PBT. It is known for its good mechanical and thermal properties and its processability. It is stable till temperature 250^{O}C[3]. The PBT shows crystalline behavior[4]. The properties of any matrix can be modified by introducing filers[5].

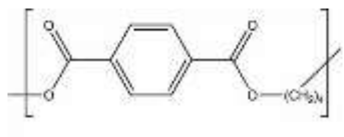

Figure 1: Chemical structure of PBT

Multi walled carbon nanotubes (MWCNT) are very strong. These are very god conductor of heat. These are strong and light weight material. In the present study, MWCNTs are selected as fillers in PBT matrix.

2.2 Synthesis of nanocomposites:

PBT and MWCNTs were dried in oven at a temperature $100^{O}C$ for 12 hours to remove moisture before processing. The concentration of MWCNT incorporated was 0.2% . The nanocomposite was synthesized with internal mixture of HaakeRheomix 600 Batch Intensive mixture with Rheocord 9000 control system, by continuously monitoring temperature, torque and rpm of mixer. The palletized strands were then dried at a temperature $100^{O}C$ for 12 hours.

2.3 Crystallization study:

Non-isothermal crystallization kinetics was determined with Perkin Elmer model Pyris manager Differential Scanning Calorimeter (DSC). The samples were heated to $230^{O}C$ with different heating rates 2, 5, 10 and $20^{O}C$. Then the melt was rapidly cooled to $180^{O}C$ at different cooling rates 2,5,10 and $20^{o}C$ per minute for non-isothermal crystallization process. The flow of heat as a function of time were recorded and investigated for both heating and cooling.

3 Results and Discussion:

The figure clearly shows that the peak crystallization temperature decreases with increasing cooling rate. Figure 2 and 3 show peak crystallization temperature of neat PBT and its nanocomposite as a function of heating and cooling rate respectively of PBT/MWCNT nanocomposites. Figures 2 and 3 clearly show that the crystallization temperature and the melting temperature shift to lower ends.

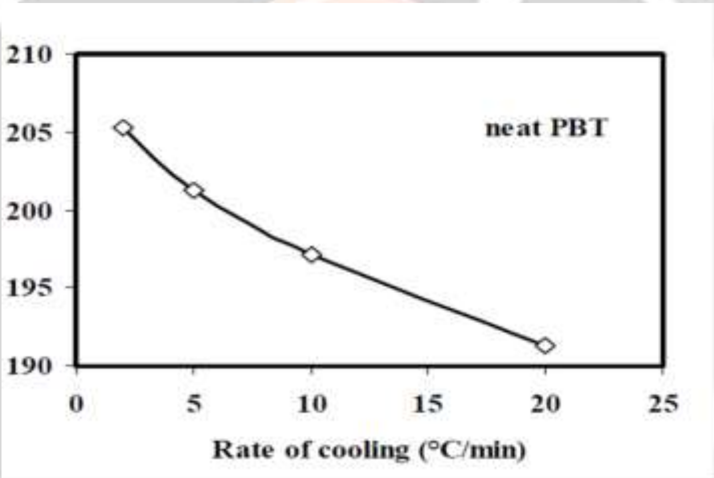

Figure 2: Peak crystallization temperature of neat PBT as a function of cooling rate

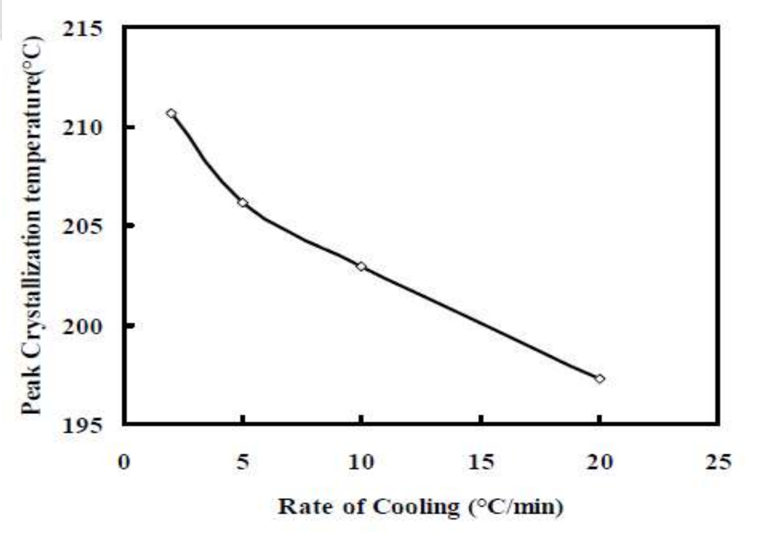

Figure 3: Peak crystallization temperature of PBT nanocomposite as a function of cooling rate

Addition of nanoparticles to a polymer melt can cause processing difficulties due to increase in viscosity. The test that can directly be connected to the flow of polymer melt in the process is the shear rate or the shear stress sweeping viscometry.

4 Conclusions:

PBT nanocomposites with MWCNT reinforcement have been successfully fabricated through melt compounding. The MWCNTs are dispersed uniformly in the polymer matrix with no obvious segregation. The nanocomposites have increased thermal stability and decreased peak crystalline temperature. The nanocomposites also show steady shear viscosity and shear thinning behaviour.

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