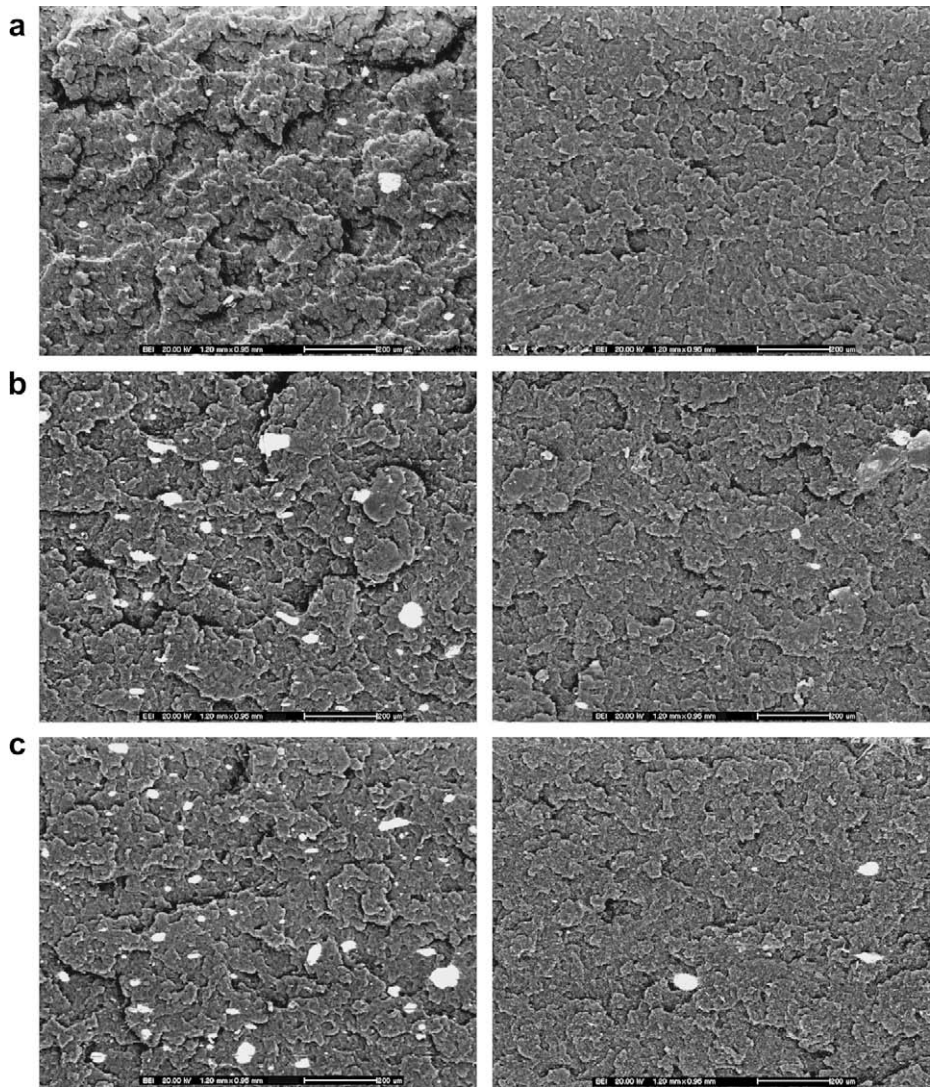

Fig. 10. SEM micrographs comparing the impact fractured surfaces of between POM/ZnO71 nanocomposites and POM/ZnO250 nanocomposites at (a) 2.0 wt% (b) 4.0 wt% and (c) 8.0 wt%.

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PP 29

Effect of Particle Sizes of Titanium Dioxide on Mechanical Properties of Polypropylene/Titanium Dioxide Nanocomposites

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Abstract

The paper studies the effect of particle sizes of titanium dioxide (TiO_2) on mechanical properties of polypropylene(PP)/TiO_2 nanocomposites. PP/TiO_2 nanocomposites were prepared by melt mixing technique in a twin screw extruder. The results found that the tensile strength of PP nanocomposites after adding TiO_2 130 nm (TD130) and TiO_2 42.3 nm (TD42.3) decreased with increasing TiO_2 content and stress at break increased after adding TD130 and TD43.2. Moreover, the addition of TD130 beyond 3.0 wt% increased the impact strength. The effect of particle sizes showed that TD130 improved mechanical properties of PP more than TD42.3.

1. Introduction

The purpose of adding inorganic mineral fillers are used to fulfill a functional rule, such as increasing the stiffness, dimension stability, heat distortion temperature, hardness and toughening of the polymers [1-4]. The properties of particulate filled polymer composites depend on the particle size, shape, loading, dispersion, interfacial bonding and surface treatment of the fillers [5-8]. PP as one of the most important commodity polymers is widely used in technical applications. Because of its good processability, relatively high mechanical properties, great recyclability, and low cost. PP has found a wide range of applications in the household goods, packaging, and automobiles [9].

Starkova et al. [10] studied the long-term tensile creep of polyamide 66 and its nanocomposites filled with 1 vol.% TiO_2 nanoparticles 21 and 300 nm in diameter. The creep isochrones obtained show that the materials exhibit a nonlinear viscoelastic behaviour and the degree of nonlinearity is reduced significantly by incorporation of the nanoparticles. Džunuzović et al. [11] prepared poly (methyl methacrylate) (PMMA)/TiO_2 nanocomposites by in situ radical polymerization of methyl methacrylate (MMA) in a toluene solution of TiO_2/6-palmitate ascorbic acid (6-PAA). The influence of the TiO_2 nanoparticles on the thermal properties of the PMMA matrix was investigated using thermo-gravimetric analysis and differential scanning calorimetry. The glass transition temperature of the polymer was not influenced by the presence of the nanoparticles while the thermal stability was significantly improved.

This work studies the effect of particle sizes of TiO_2 on mechanical properties of polypropylene (PP)/TiO_2 nanocomposites.

2. Experimental

2.1 Materials

Pure PP (Mophen HP400K) was supplied by HMC Polymers Co, Ltd. The melt flow rate of PP is 4 dg/min. TiO_2 with an average particle size 42.3 nm (TD42.3) and 130 nm (TD130) purchased from Aldrich and S.R.LAB Co., Ltd, respectively. TiO_2 is in form of a white powder.

2.2 Polymer Nanocomposites Preparation

Pure PP pellets and TiO_2 nanoparticles were dried in an oven at 100 °C for 3 hrs before melt extrusion. The PP pellets and TiO_2 nanoparticles were melt-compounding in desired compositions in a twin screw extruder at temperatures in a range of 160-220 °C and a screw speed of 50 rpm. The extrudates were pelletized at the die exit. After compounding, the blends were compression molded into standard dumb-bell tensile bars and rectangular bars. The mold temperature was kept at 190 °C.

2.3 Polymer Nanocomposites Characterization

Tensile tests were conducted according to ASTM D 638 with a universal tensile testing machine LR 50k from Lloyd instruments. The tensile tests were performed at crosshead speed of 50 mm/min. Each value obtained represented the average of five samples. Charpy impact strength tests were performed according to D 6110-06 standard at room temperature. Each value obtained represented the average of five samples.

3. Results and discussion

In consideration of the effect of particle sizes of TiO_2 on mechanical properties in Figures 1-4, it can be seen that the values of tensile strength of PP/TD130 and PP/TD42.3 nanocomposites were not quite different and small decreased with increasing TiO_2 content. The PP/TD130 nanocomposites exhibited higher Young's modulus and stress at break than PP/TD42.3 nanocomposites. This may be due to difference in a polarity miss match of fillers and polymer matrix, because TD42.3 has higher surface area than that of TD130. This may induce agglomeration as shown in Figure 5 and poor adhesion between TD42.3 and polymer matrix and subsequently decrease the Young's modulus and impact strength. Moreover, it can be seen that impact strength of PP/TD130 was higher than PP/TD42.3 nanocomposites.

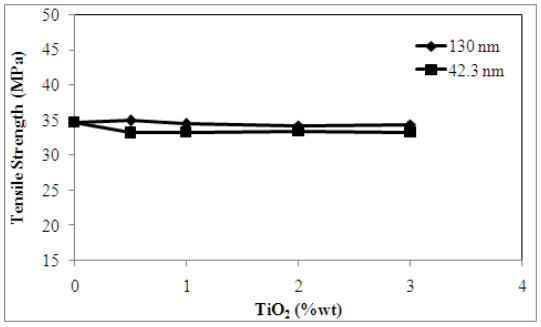

Figure 1. Tensile strength of neat PP and PP after adding TD42.3 and TD130.

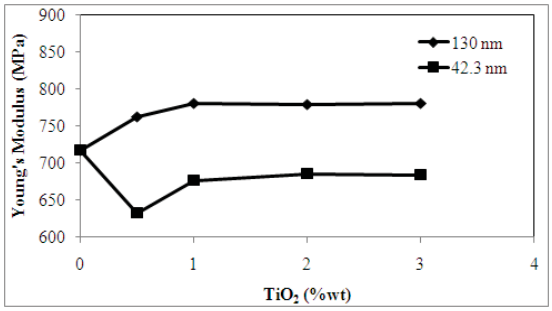

Figure 2. Young's modulus of neat PP and PP after adding TD42.3 and TD130.

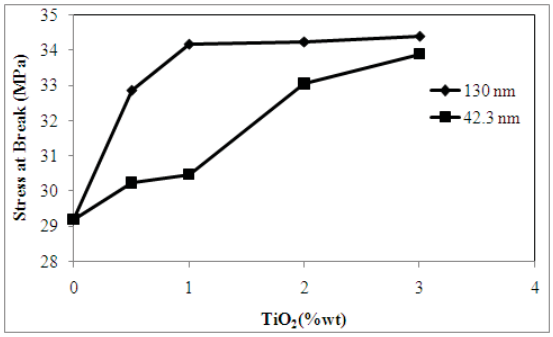

Figure 3. Stress at break of neat PP and PP after adding TD42.3 and TD130.

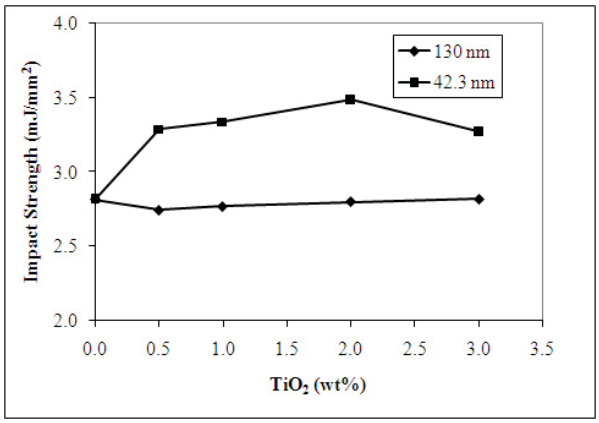

Figure 4. Impact strength of neat PP and PP after adding TD42.3 and TD130.

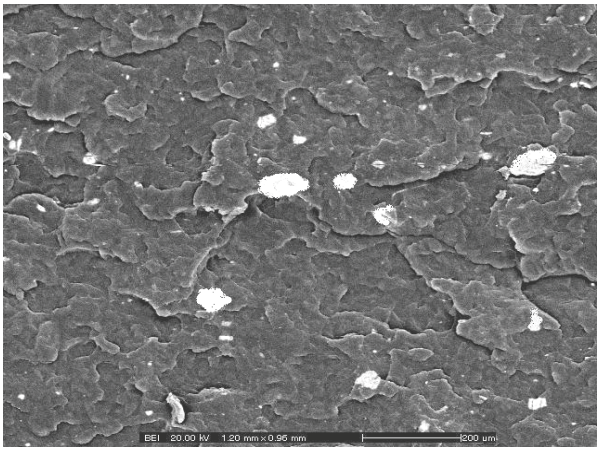

Figure 5. SEM micrograph of PP after adding 2.0 wt% of TD42.3.

4. Conclusions

The pure PP, PP/TD130 nanocomposites with increasing TD130 contents showed small change tensile strength. Young's modulus, the stress at break and impact strength of PP/TD130 nanocomposites increased with increasing TD130 contents. The PP/TD130 nanocomposites exhibited higher Young's modulus and stress at break than PP/TD42.3 nanocomposites.

5. Acknowledgements

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