Effect of Titanate Coupling Agent on the Mechanical Properties of Talc Filled Polypropylene

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ABSTRACT

Composites of polypropylene filled with untreated and treated talc have been prepared. The surface modification of talc was done by using titanate coupling agent (TCA). The effect of this treatment on the interfacial adhesion of filler particles in the polymeric matrix was evaluated by mechanical analysis. The results obtained indicate that incorporation of non treated talc generally decreased the mechanical properties of the composites except the modulus. However, the use of treated talc increased the amount of filler that was incorporated in the polymeric matrix. Therefore the Mechanical properties such as tensile strength, flexural strength, elongation at break and impact strength are also improved.

Keywords: Titanate coupling agent, Mechanical properties, Talc, Polypropylene, Composites, Filler, Particle Sizes

INTRODUCTION

One of the areas of development is the combination of mineral fillers with thermoplastic such as polyethylene, polypropylene, polyvinyl chloride and polystyrene (Mittal, et al. 2006). Several studies were conducted to manufacture polymer composites using mineral fillers in powdered form including Calcium Carbonate (Gue et al. 2005, Wang et al. 2006, Zhuo et al. 2006).

Composites are made from combination of two or more materials present as separate phases and combined to form desired structures so as to take advantage of certain desirable properties of each components (Ashton et al., 1998). The constituents can be on organic or inorganic in form of particle, rods, fibres, plates. This additional variable often provides greater latitude in optimization for a given application, such as physically uncorrelated parameters like strength density, electrical and cost. Furthermore, a composite may be only effective vehicle for exploiting the unique properties of certain special material example the high strength of graphite, boron or aramid fibres, all of which have high strength (Broutman et al., 2000).

The use of coupling agents for polyolefin reinforced composites is well known and widely practiced. In composites, weak adhesion may result from the lack of stress transfer from the polymer matrix to the load bearing filler (Mohanty et al., 2002).Numerous studies have used coupling agents for thermoplastic composites (Kazayawoko, 1999 and Maldas, 1994). In order to improve the similarity and adhesion between wood flour and thermoplastic matrices, coupling agents were added (Mengeloglu et, al. 2007 and Xie et al. 2005) discovered that there was an enhancement in tensile, impact and flexural strength of mixed polypropylene with short glass fibre and silane was used for compatibilization and adhesion. It is important to note that the work reported on the utilization of only talc powder to fill polypropylene was exploratory and omitted in scope (Igwe and Onuegbu 2012).

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MATERIALS AND METHODS

Materials

The polypropylene used in this study was bought from CEEPLAST Industry Limited, Osisioma Ngwa, Aba, Nigeria. It has a melt flow index of 2.5 to 3.5g/min and density 0.926g/cm^3. The talc and titanate coupling agents were purchased from a local store at Owerri, Imo State Nigeria.

Preparation of Polypropylene

The polypropylene composites of talc were prepared at 0.20µm filler particle size, 0 to 5 wt % filler contents, and 1 wt % of titanate coupling agent.

Testings

Testings on the mechanical and end-use properties of polypropylene composites were carried out as described previously

RESULTS AND DISCUSSION

Tensile Strength

The effect of talc powder contents and titanate coupling agent on the tensile strength of polypropylene are illustrated in figure 1. From figure 1, it is observed that the tensile strength of polypropylene composites decreased with increase in talc powder contents but increased with increase in titanate coupling agents. Similar observation on the variation of composite strength with filler and coupling agents contents have been reported (Doufnoune et al. 2003).

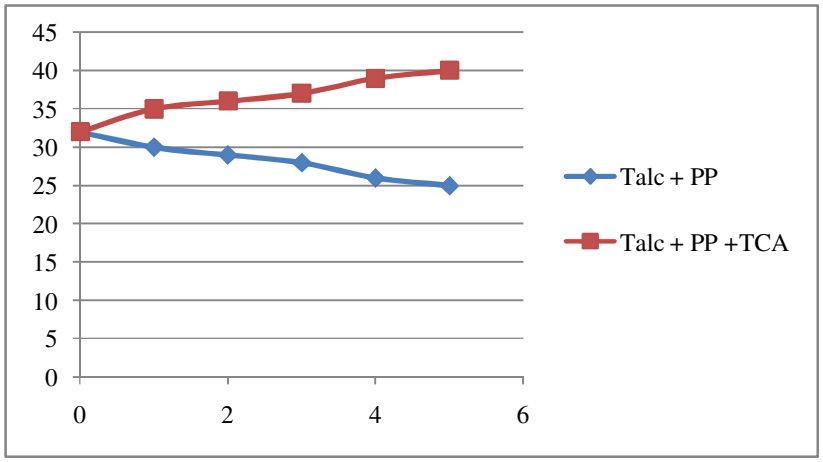

Figure 1

Elongation at Break

The data on elongation at break obtained for talc filled polypropylene at different filler and titanate coupling contents are illustrated graphically in figure 2. The figure shows that the elongation at break of polypropylene composites decreased with increase in the filler content at 1 and 2 wt. % of fillers but increased further from 3 to 5 wt. %. The reason is that the polymer matrix at the concentrations might not be high enough to significantly restrain the polypropylene molecules.

The figure also show s increased in elongation with increase in coupling agent contents such reduction in elongation at break was reported (Fuad et al.)

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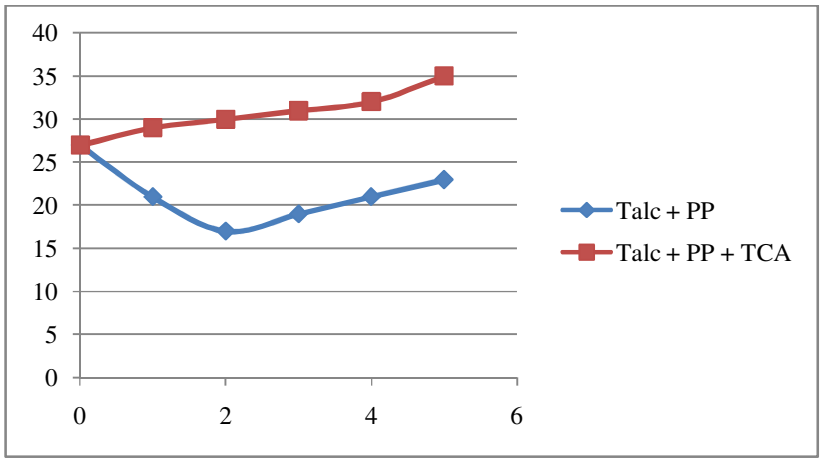

Figure 2

Modulus

The tensile modulus of filled and unfilled polypropylene is illustrated in figure 3. Figure 3 shows that the modulus of polypropylene/talc composites was lower than the modulus of unfilled polypropylene, and decreased with increase in filler and titanate coupling agent contents. This observation high lights the fact that the incorporation of fillers into polymer matrix reduces the stiffness of the latter. The result obtained in this study is contrary with the findings of (Rozman et al., 1999) that working on oil palm empty fruit bunch powder. Polypropylene system found that the tensile modulus of the composites increased with increase oil palm empty fruit bunch powder content.

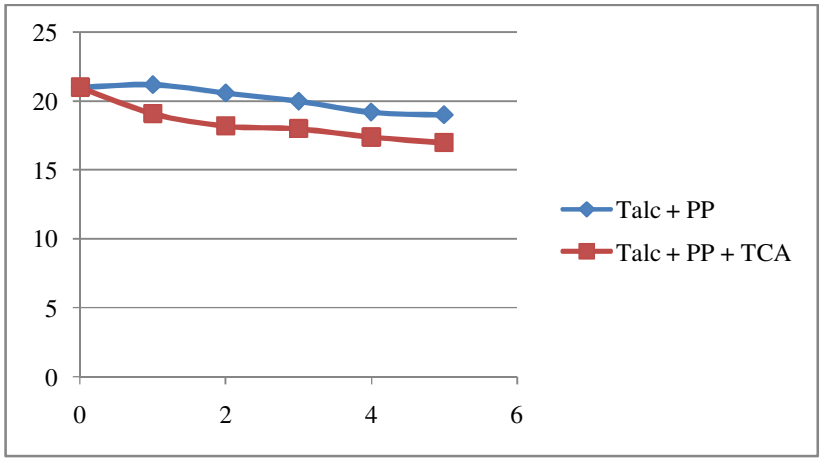

Figure 3

Impact Strength

The data on impact strength of the polypropylene composites are illustrated graphically in figure 4. The figure shows that the impact strength of polypropylene composites increased with decrease in filler contents.

Thus, increasing the talc contents probably increased the level of stress concentration in the composites with the resultant decrease in impact strength. (Guo et al. 2005) who investigated polypropylene filled with carbonate system found that the impact strength of the composites increased at first with increase in filler content and later decreased with further addition of filler.

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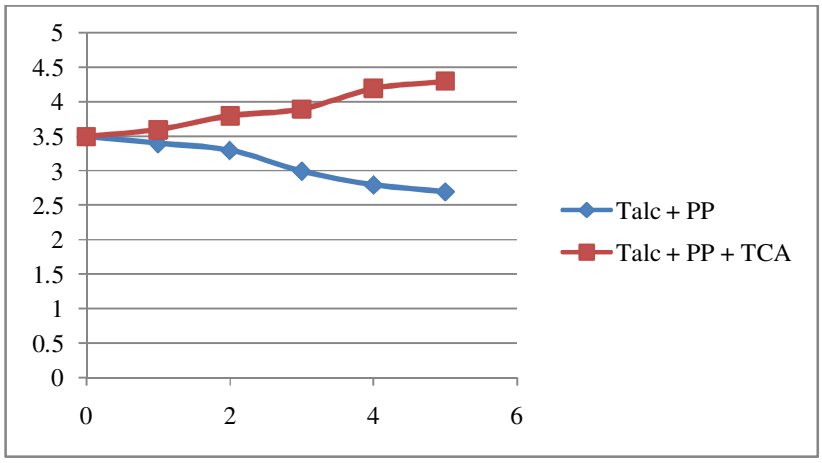

Figure 4

Flexural Strength

The experimental data on the flexural strength of polypropylene composites are illustrated graphically in figure 4. It is evident that flexural of the composites decreased with increase in filler content. However, there was increased in the flexural strength with increase in the titanate coupling agent contents. This is attributed to improved interaction and adhesion between the polymer matrix and filler (talc). Similar results were also reported in the flexural strength of wood flour filled thermoplastic composites, Backiel (1995).

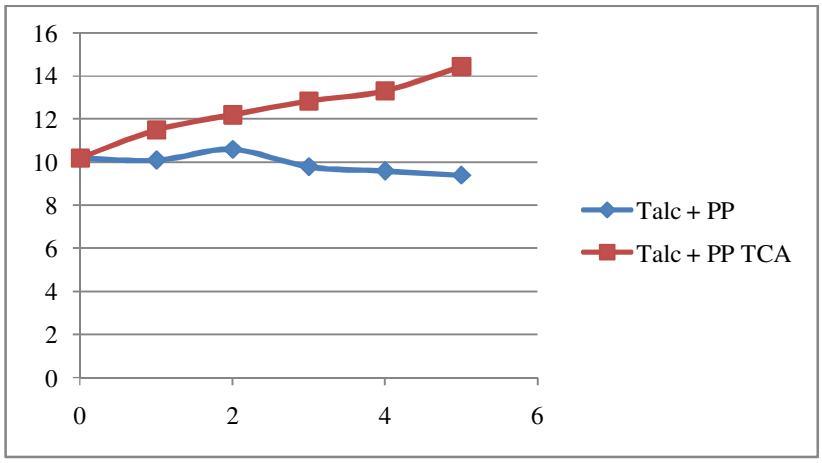

Figure 5

CONCLUSION

Talc powder and titanate coupling agents have been utilized successfully in preparing polypropylene composite. The tensile, elongation at break, modulus, flexural strength of the polypropylene composite were found to decrease with increase in filler(talc) contents but increased with increase in titanate coupling agent. However, modulus decreased with increase in talc contents and decreased the more with addition of titanate coupling agent. Generally, coupling agents significantly used in producing composite due to their high matrix filler interaction.

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