MECHANICAL, PHYSICAL, AND WEAR PROPERTIES OF POLYPROPYLENE REINFORCED SHORT CARBON FIBER COMPOSITES WITH DIFFERENT FIBER LENGTH

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Keywords: Composite, Short carbon fiber, Mechanical properties, Physical properties, Wear

ABSTRACT

Thermoplastic polymers have in general low mechanical and physical properties. However, they have the advantage of having light weight and easier to process. Due to of these properties, thermoplastic materials are widely used in automotive industry. In order to use thermoplastic polymers in load bearing applications, most of thermoplastic materials are used in the form of thermoplastic composites.

The objective of this research is to study the effect of short carbon fibers with different fiber length on the mechanical, physical and wear properties of polypropylene reinforced short carbon fiber composites. Polypropylene reinforced short carbon fiber (SCF) composites with different weight% were fabricated using twin-screw extruder followed by injection molding to produce testing samples. Fiber diameter of 7-9 μm with two different length, 90 and 150μm, were used in this study. Five different composition were used, 5, 10, 15, 20, and 35 wt%.

Using Scanning Electron Microscopy, the morphology of the composites was investigated. The composite showed nicely dispersed fibers. For low percentage of filler loading, up to 20wt%, fiber orientation tends to be directed on the direction of the injection. Low percentage of fibers were oriented on the transverse direction of injection. However, at 35wt% loading, the fibers were oriented randomly and more percentage of fibers were oriented in the transverse direction.

Mechanical properties were evaluated using tensile test. Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) evaluated the physical properties of the composites. Tribology properties were studied by ball-on-disk for wear resistance property. Scanning Electron Microscope (SEM) was used to observe the orientation and distribution of the SCF fillers.

Tensile testing results showed that the tensile modulus and ultimate tensile strength increased by the increase of SCF weight%. On the other hand, ductility decreased drastically by the increase of SCF weight%. SCF of 150mic length tends to have higher tensile modulus and strength but lower ductility. PP-35wt%SCF composite (150mic length) gave the highest tensile modulus which is 8.7 times that of pure PP and also gave the lowest ductility which is 2% strain compared to 662% of strain for pure PP (for cross head speed of 5mm/min).

From DSC Results, melting point did not show much variation for the composites compared to the pure PP. SCF wt% in the composite was verified using TGA> Once the polymeric materials degrade, we were able to measure the exact weight percent of the filler materials in the composites.

Wear resistance of the composites dropped significantly with the increase of SCFwt% up to 20wt%SCF. At 34wt%SCF the wear resistance increase sharply. The effect of SCF on the wear properties still need further investigations

REFERENCES

[1] Margolis JM. Engineering Thermoplastics: Properties and Applications Marcel Dekker Inc.; 1985.

[2] Hou M, Friedrich K. Stamp forming of continuous carbon fibre/polypropylene composites. Composites Manufacturing. 1991;2:3-9.

[3] Thomason JL. The influence of fibre length and concentration on the properties of glass fibre reinforced polypropylene: 5. Injection moulded long and short fibre PP. Composites Part A: Applied Science and Manufacturing. 2002;33:1641-52.

[4] Karger-Kocsis J, Friedrich K. Fracture Behavior of Injection-Molded Short and Long Glass Fiber-Polyamide 6.6 Composites. Composites Science and Technology. 1988;32:293-325.

[5] Zhang, H., Z. Zhang, and K. Friedrich, Effect of fiber length on the wear resistance of short carbon fiber reinforced epoxy composites. Composites Science and Technology, 2007. 67(2): p. 222-230.