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THERMAL CONDUCTIVITY OF POLYPROPYLENE REINFORCED ALUMINA PARTICLES

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ABSTRACT

Effect of addition alumina particles on thermal conducting of polypropylene was investigated in this study. 0.1 micron Alumina particles were added to polypropylene with (1, 2, 3) wt.% Fourier equation was used to calculate the changing in thermal conductivity coefficient (k) for polypropylene. The results that have been obtained from the thermal conductivity test that the thermal conductivity of polypropylene increased when adding alumina and conductivity increases with increasing proportion of alumina added.

Keywords: Thermal conductivity, polypropylene, alumina particles

INTRODUCTION

Thermal conductivity of polymers is an important thermal property for both polymer applications and processing. Polymers typically have intrinsic thermal conductivity much lower than those for metals or ceramic materials, and therefore are good thermal insulators (Agari et al, 1997). In other applications which require higher thermal conductivity, such as in electronic packaging and encapsulations, satellite devices, and in areas where good heat dissipation, low thermal expansion and light weight are needed, polymers reinforced with fillers, organic or inorganic, are becoming more and more common in producing advanced polymer composites for these applications (Liu & Mather, 2004).

For one-dimensional and rectilinear heat flow, the steady-state heat transfer in polymeric materials can be described by the Fourier's law of heat conduction:

$$Q = -k \times A \times \left(\frac{dT}{dX} \right)$$

Where Q is the heat flux (i.e., the heat transfer rate per unit area normal to the direction of flow), the proportionality constant k is known as the thermal conductivity (W/m.ºC), A is area (m^2) and dT/dx is the temperature gradient per unit length(ºC/m).

Heat transfer involves the transport of energy from one place to another by energy carriers. In a gas phase, gas molecules carry energy either by random molecular motion (diffusion) or by an overall drift of the molecules in a certain direction (advection). In liquids, energy can be transported by diffusion and advection of molecules. In solids, phonons, electrons, or photons transport energy. Phonons, quantized modes of vibration occurring in a rigid crystal lattice, are the primary mechanism of heat conduction in most polymers since free movement of electrons is not possible (Majumdar, 1998).

Polypropylene is used in nursery pots and containers, row covers, yogurt cups, weed barriers, tree netting, and battery cases. Polypropylene is light weight, durable, moderately inexpensive, and chemical resistant. It can be found in either film or rigid form. Many of these properties make PP popular to use for food packaging such as screw-on caps, juice containers, and straws (Ali et al., 2011).

MATERIALS AND METHOD

Polypropylene resin supplied by MRC Polymers Inc. company. Alumina particles with 0.1 micron from Good fellow supplies. Samples have a disc shape with (25 mm) diameter and (3 mm) thickness .Heat Conduction Unit Manufactured P.A. Hilton Ltd England was used in this test, and Fourier equation applied to calculate thermal conductivity coefficient (k).

RESULTS & DISCUSSION

Figure 1 represents the thermal conductivity of polypropylene resin before and after reinforcing with alumina, where generally resins have poor heat conduction which is what we observe through the first curve, which represents the thermal conductivity of pure polypropylene resin (Al-Khazraji, Al-Mosawi, 2004). But as seen in the second curved that, after the addition of 1% of alumina to improve resin thermal conductivity of resin with high of 0.14 W/m.℃ at 25 °C to 0.25 W/m.℃ at the same temperature. Thermal conductivity continues to rise when you add 2% of alumina to the resin where increasing to 0.28 at 25 °C as in the third curved, and rising to 0.321 W/m.℃ at the same temperature when you add 3% of alumina, as is evident from the fourth curved (Nurul, Mariatti, 2013).

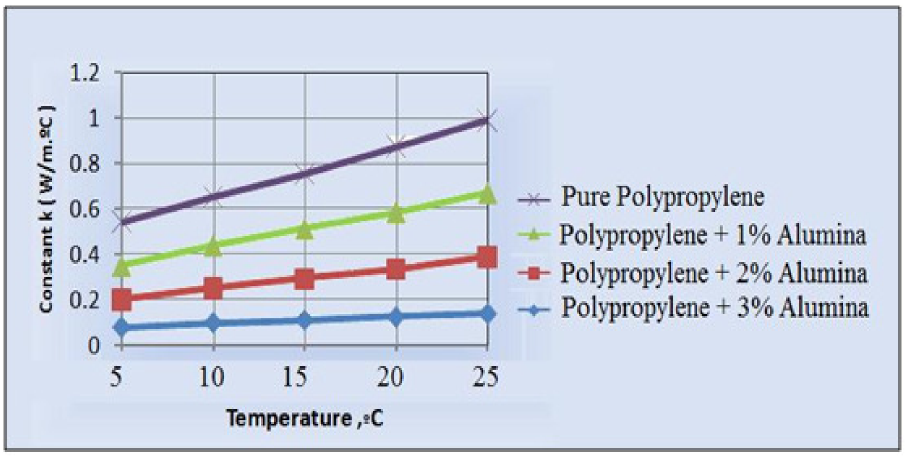

Figure 1. Thermal conductivity of polypropylene reinforced with alumina particles

CONCLUSIONS

From the obtained results we get: Improvement of thermal coefficient when reinforcing by alumina particles. Increasing thermal coefficient values with increased reinforcing percentage, where increased from 0.14 W/m.℃ at 25 °C to 0.25 , 0.28 ,0.321 W/m.℃ with 1% ,2% and 3% from alumina particles respectively at the same temperature.

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