World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:8, No:10, 2014

Investigation of Heat Conduction through Particulate Filled Polymer Composite

Authors : Alok Agrawal, Alok Satapathy

Abstract : In this paper, an attempt to determine the effective thermal conductivity (keff) of particulate filled polymer composites using finite element method (FEM) a powerful computational technique is made. A commercially available finite element package ANSYS is used for this numerical analysis. Three-dimensional spheres-in-cube lattice array models are constructed to simulate the microstructures of micro-sized particulate filled polymer composites with filler content ranging from 2.35 to 26.8 vol %. Based on the temperature profiles across the composite body, the keff of each composition is estimated theoretically by FEM. Composites with similar filler contents are than fabricated using compression molding technique by reinforcing micro-sized aluminium oxide (Al2O3) in polypropylene (PP) resin. Thermal conductivities of these composite samples are measured according to the ASTM standard E-1530 by using the Unitherm™ Model 2022 tester, which operates on the double guarded heat flow principle. The experimentally measured conductivity values are compared with the numerical values and also with those obtained from existing empirical models. This comparison reveals that the FEM simulated values are found to be in reasonable good agreement with the experimental data. Values obtained from the theoretical model proposed by the authors are also found to be in even closer approximation with the measured values within percolation limit. Further, this study shows that there is gradual enhancement in the conductivity of PP resin with increase in filler percentage and thereby its heat conduction capability is improved. It is noticed that with addition of 26.8 vol % of filler, the keff of composite increases to around 6.3 times that of neat PP. This study validates the proposed model for PP-Al2O3 composite system and proves that finite element analysis can be an excellent methodology for such investigations. With such improved heat conduction ability, these composites can find potential applications in micro-electronics, printed circuit boards, encapsulations etc.

Keywords : analytical modelling, effective thermal conductivity, finite element method, polymer matrix composite
Conference Title : ICMAME 2014 : International Conference on Mechanical, Aeronautical and Manufacturing Engineering
Conference Location : Bali, Indonesia
Conference Dates : October 09-10, 2014

Open Science Index, Aerospace and Mechanical Engineering Vol:8, No:10, 2014 publications.waset.org/abstracts/8125.pdf