Methods of Measuring Thermal Conductivity of Small Samples

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Two methods of measuring thermal conductivity (k) of small samples were tested: (1) Differential Scanning Calorimetry (DSC) method developed by Hu and Wey (2007), using cylinders of 6 mm diameter and (2) 2-8 mm length and a radial method using cylinders of 5-10 mm diameter and 10-20 mm length.

The DSC method utilises the DSC instrument for measuring k of small samples. The method does not require any use of temperature sensors. In contrast to the existing DSC methods wherein thermal contact resistance usually leads to great deviation in thermal conductivity measurement of samples, this method minimises the effect of thermal contact resistance. Thermal conductivities have been obtained from Polyethylene samples using this method and the results showed good agreement with the literature values. The thermal resistance (R) is given by the ratio of difference in temperature to difference in heat flow ($H_2 - H_1$) shown in Figure 1. The thermal conductivity was calculated from the gradient of the graph shown in Figure 2 (Thermal conductivity = 1/gradient).

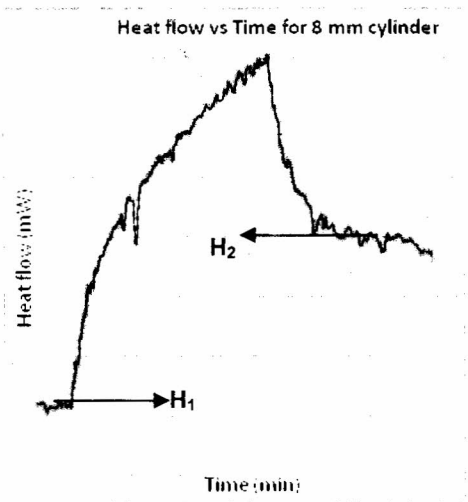

Figure 1. Heat flow vs Time

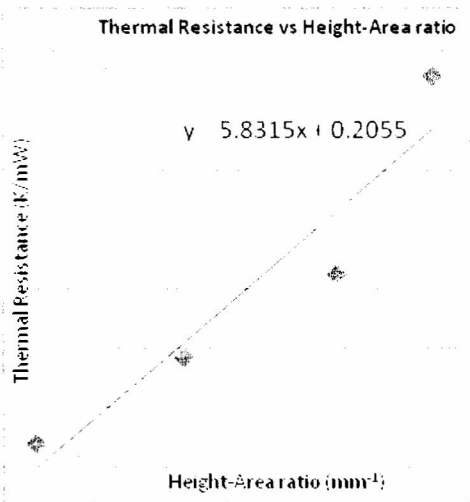

Figure 2. R vs Height/Area

In the radial method, a nichrome heating element was used to heat the sample from the centre and the temperature measurements were measured in a radial direction at two separate points. Two separate theoretical equations were used to calculate the thermal conductivity. Samples of Ebonite, Wood, Teflon, Rubber, and Polyethylene were tested and yielded thermal conductivity values that were in good agreement with the standard values. The method was tested against the Lee's disc method for comparison of several materials.