The Applicability and Accuracy of Thermal Conductivity Measurement Techniques for the Characterization of Nanofluids

Jessica Townsend [C, S] and Rebecca Christianson
Olin College, Needham, MA, U.S.A.

In the search for new, more effective coolants, suspensions of nanoparticles (also known as nanofluids) have generated a lot of promise. The Maxwell model predicts enhancement of nanofluid thermal conductivity over the base fluid (the media that the nanoparticles are suspended in). However, there have been widely varying results of the thermal conductivity increase in the literature. Some studies report anomalous enhancements well above those predicted by the Maxwell theory while others show good agreement with the theory. There are a number of explanations for the degree to which the reported results vary, including the preparation and handling of the nanofluids, the additives that may be present, the amount of aggregation and agglomeration of the nanoparticles, and the applicability and accuracy of the measurement technique. Some of the common techniques include the transient hot wire technique (both custom-built and off the shelf models), the steady-state parallel plate method, and forced Rayleigh scattering. Each method requires a thorough understanding of the theory, a proper application of the theory to the design and fabrication of the device, and a measurement protocol that minimizes experimental uncertainty in the measurements. A review of these techniques related to the thermal conductivity measurement of nanofluids will be presented and will include the accuracy, limits, and practical challenges associated with building and operating each device. Thermal conductivity measurements made with each type of the measurement will be presented, and the common errors associated with each measurement technique will be described.