Uncertainty Assessment of Thermal Conductivity Measurement at High Temperatures Using Guarded Hot Plate Apparatus

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The uncertainty of measurement of thermal conductivity using a guarded hot plate (GHP) apparatus built at Korea Research Institute of Standards and Science was assessed at high temperature range up to 700 °C. The thermocouples installed for the temperature measurements at various parts of heater plates in the GHP have been calibrated before the installation in such a way to maximize the correlation of calibration uncertainty between a pair of thermocouples that measure the gap imbalance. Therefore, the temperature difference across the gap between the hot and guard plates could be measured with low uncertainty. Also, a method to minimize the lateral heat flow was employed. For the measurement of thermal conductivity at the mean specimen temperature T_m, the temperature difference δT_0 between the hot and guard plates was measured while no electrical power was applied to the hot plate, and the guard plates and cold plates were kept at T_m. Then δT_0 was applied as an offset to compensate for the lateral heat flow at given measurement temperature. Extrapolation of the measured thermal conductivity to the limit of large temperature difference between hot and cold plates ($1/\Delta T \rightarrow 0$) confirmed validity of this correction. After including the uncertainties in power measurement, dimensional measurements and the temperature difference measurements, the expanded uncertainty ($k = 2$) of the thermal conductivity measurement between 200 °C and 700 °C was assessed to be 4.6 % to 6.7 %.