Development of an Apparatus for Measurements of Thermal Expansion Coefficients of Solid Materials Around Room Temperature

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Low thermal expansion materials are important functional materials in the precision machinery industry, semiconductor industry, and space industry, etc. For instance, low thermal expansion glass has a typical coefficient of thermal expansion value of several 10^{-8} K^{-1} around room temperature. It is necessary to evaluate the coefficient of thermal expansion with high sensitivity and high accuracy for applications. However, the value is too small to measure by convenient measurement methods like a push-rod dilatometer. Therefore, we have developed a precise measurement technique of the thermal expansion for solids around room temperature.

The developed measurement apparatus consists of a thermal bath and a laser interferometer. The thermal bath has a sample stage in a vacuum chamber. The temperature of the sample stage is controlled using a Peltier device. The controllable temperature range is from -60 to 80 ºC, with a temperature stability of about 10 mK. The change in sample length is measured by the laser interferometer utilizing an optical-heterodyne method. A measurement feature is that the laser interferometer is able to detect the change in sample length without an additional reflector. In this presentation, we are going to report the structure and performance of our measurement apparatus and the measurement results of single crystal silicon and several kinds of typical optical glass.