

R&D of Standard Samples of Thermal Expansion at the D.I.Mendeleev Institute for Metrology

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Thermal expansion is a general property of condensed materials. Investigation of thermal expansion can give detailed information about the structure of crystals and glasses; the coefficient of thermal expansion is related to other thermal properties, such as heat capacity. Thermal expansion should be taken into account in most areas of engineering R&D – from cryogenics up to semiconductor technology; in any type of activity that deals with devices and construction, operating in a wide temperature range. Coefficients of thermal expansion for natural and artificial materials can vary over a wide range between $0.01 \cdot 10^{-6} \text{ K}^{-1}$ and $50 \cdot 10^{-6} \text{ K}^{-1}$. A specific kind of dilatometer should be used for TEC measurement, depending of the material and temperature. In order to obtain correct and reliable data, the measurement devices should be calibrated by carrying out tests with standard samples. The D.I.Mendeleev Institute for metrology has been developing and certifying standard samples of TEC for a long period of time. The set of samples cover the temperature interval from 90 K up to 3000 K, and the interval of TEC from $1 \cdot 10^{-8} \text{ K}^{-1}$ up to $30 \cdot 10^{-6} \text{ K}^{-1}$. Additionally, there are samples from materials with various thermal conductivities and other physical properties, because the accuracy of the measurement depends on the parameters of the material. For instance, there are the certified samples of aluminum, polycrystalline copper, fused silica, molybdenum, tungsten, graphite, single crystal Al_2O_3 with different axis orientations, and others. Nowadays the samples in highest demand are from single crystal Al_2O_3 with orientation 59° to c-axis. Those samples have the same TEC as the corundum ceramic has, and are suitable for calibration of high temperature dilatometers. The results of materials research and the methods used for investigation are described in this report.