Characterizing the Temperature Measuring Capabilities at the PTB-Sphere Interferometer II

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Abstract

The PTB, within an international corporation, aims at reaching a relative uncertainty of less than $2x10^{-8}$ for the determination of the Avogadro Constant by using the X-Ray-Crystal-Density-Method on a silicon single crystal. In the equation for the calculation of the Avogadro Constant the ratio of the lattice constant of the single crystal and the volume of the sphere made of nearly 1 kilogram of the silicon is involved. Since both – lattice constant and volume – show the same underlying temperature dependency it is extremely important to achieve optimal repeatability of temperature measurements in addition to the necessary absolute temperature determination. With this the uncertainty contribution from the temperature measurement will be reduced below a significant level.

In the volume measurements with the PTB-sphere interferometers the temperature of the sphere is determined by measuring the temperature of a copper-block with a Pt25-Platinum Resistance Thermometer (PRT) and the temperature difference between the sphere and the block with a pair of Cu/CuNi-thermocouples.

In this contribution the properties of the PRT-part of the temperature calibration and measurement system has been investigated in detail. For this characterization three different Pt25-sensors were calibrated in a triple point of water cell and a Gallium melting point cell and compared at the measurement temperature of 20°C in a PTB-made 20°C-reference point. A RMS-value of slightly more than 0.1 mK was reached for three measurement campaigns within four months showing maximum deviations of less than 0.2 mK.