

Interferometric determination of thermal expansion on material measures

The realisation and dissemination of the SI base unit metre is part of the legal assignment of a national metrology institute like PTB. Therefore the length of material measures (usually in the form of gauge blocks) is determined with high precision by special imaging interferometers which have been developed for this purpose. The focus of the research activities is on the reduction of the measurement uncertainty in order to meet the demands of industry with regard to decreasing production tolerances. Consequently the temperature as an important parameter has to be monitored precisely when the absolute length of a sample body is measured. The measurement of the absolute length of a material depending on the temperature (or time) allows the determination of its thermal expansion (or stability over time). Instead of measuring differential length changes the absolute length as a function of temperature in the interval from 7 K up to 330 K can be investigated with a resulting uncertainty on the order of $10^{-9}/\text{K}$. Such high-accuracy knowledge of the temperature-dependent thermal expansion is required for the development and characterisation of ultra-stable materials, for instance in the semiconductor industry, precision optics, or aerospace applications. The capabilities – and limitations – of the available interferometers will be presented.