International Comparison

Final Report

Field

Length

Subject

Thermal expansion measurement of gauge blocks

Participants

CH (OFMET), NL (NMi/VSL), UK (NPL), IT (IMGC), DE (2 × PTB Braunschweig, PTB Berlin)

Organizing body

EUROMET

Results

An international comparison of measurements of the thermal expansion coefficient was carried out between October 1993 and June 1994. Four 100 mm gauge blocks of different material (steel, tungsten carbide, ceramic based on zirconium oxide, zerodur) were circulated in one loop. The pilot laboratory carried out its measurements before and after circulation.

The quantity to be measured was the linear coefficient of thermal expansion, defined by $\alpha_T = (1/L)\mathrm{d}L/\mathrm{d}T$, at $T = 20$ °C, and possibly higher-order terms. Various types of instrument were used for the measurements. Common to all but one instrument was interferometric length measurement. Some laboratories carried out measurements on their usual absolute gauge block interferometer (NMi/VSL, PTB1, IMGC), changing the temperature of the gauge blocks using a thermostatic cooler/heater or by changing the laboratory temperature. Others have developed dedicated instruments for thermal expansion measurement, exclusively for gauge blocks (NPL, OFMET) or for more general, larger specimens (PTB3). The PTB2 used a mechanical comparator and thermal expansion standards calibrated by the PTB1.

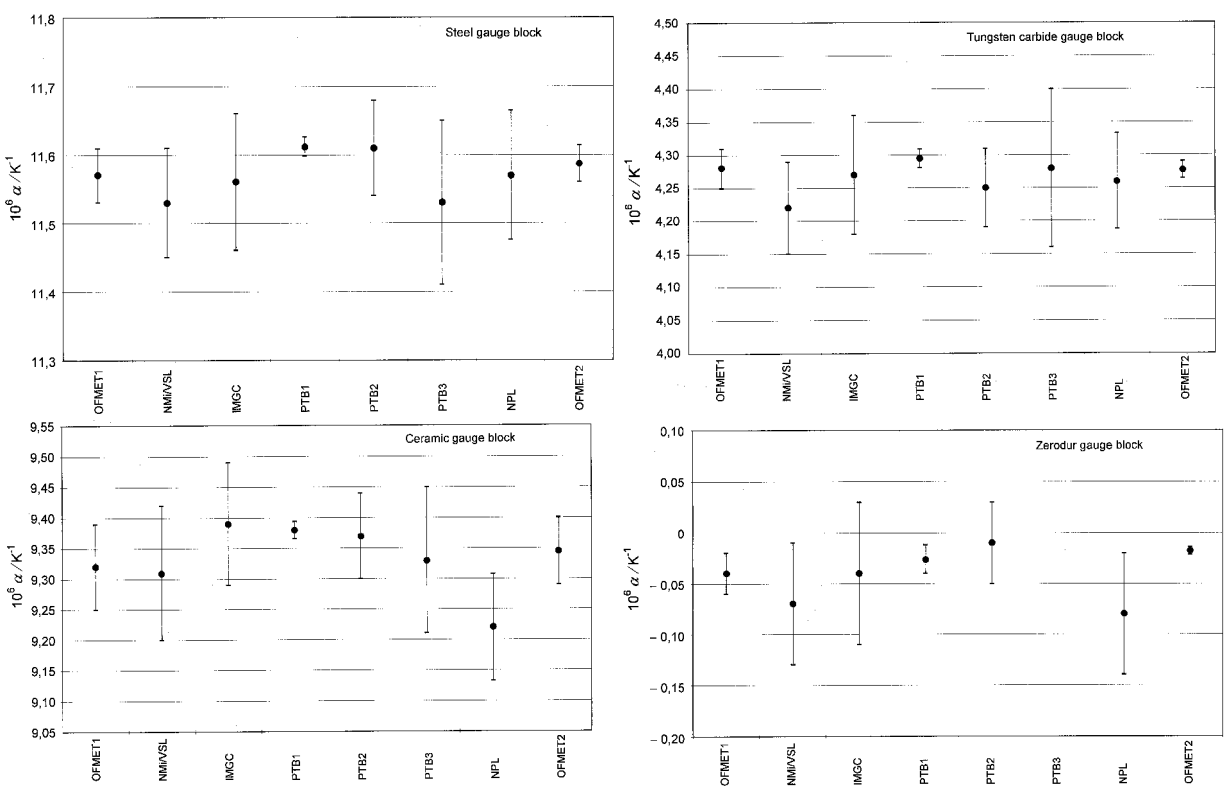

Figure 1.

The measurement results, together with the associated uncertainties, are shown in Figure 1. The comparison shows satisfactory agreement. The agreement expressed as the difference between the largest and the smallest value is $0{,}08 \times 10^{-6}$ K^{-1} for steel, $0{,}075 \times 10^{-6}$ K^{-1} for tungsten carbide, $0{,}17 \times 10^{-6}$ K^{-1} for ceramic, and $0{,}07 \times 10^{-6}$ K^{-1} for zerodur.

Some laboratories also contributed results for the quadratic expansion coefficient. For those where the numerical determination of this second-order coefficient was statistically significant, the agreement was within a few parts in 10^8 K^{-2}.

A detailed final report has recently been prepared. The standards remain available to the participating and other laboratories for further measurements and comparisons.

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