Dielectric-Constant Gas Thermometry –
Measurements of Thermophysical Properties of Capacitor Materials and Measuring Gases

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Dielectric-constant gas thermometry (DCGT) performed by PTB is now a well-established method of primary thermometry and a tool for investigating the thermophysical properties (particle interaction, polarizability) of gases. The basic idea of DCGT is to replace the density in the equation of state by the dielectric constant and to measure this constant by the capacitance changes of a capacitor filled with gas at different pressures and constant temperature (measurement of isotherms). Until now the main application of DCGT was the determination of thermodynamic temperature below the triple point of water (TPW, 273.16 K) [1] or, in recent times, the determination of the Boltzmann constant at the TPW for the new definition of the base unit kelvin of the International System of Units [2]. The extreme demands concerning the uncertainty of pressure, capacitance and temperature measurements led to unique experimental capabilities at PTB. This was recently demonstrated by the determination of the virial coefficients of helium [3]. New measurements with argon, neon and helium have been performed. As experimental basis, the thermophysical properties of the capacitor materials (thermal expansion, heat capacity and elastic constants) have been investigated in dependence on temperature, which now allows covering the complete temperature range from 2 K to 300 K. A comparison with literature data verifies the potential of DCGT in gas metrology.

References

[1] C. Gaiser *et al.*, *Int. J Thermophys* **2010**, 31, 1428..
[2] C. Gaiser *et al.*, *Metrologia* **2013,** 50, L7.
[3] C. Gaiser *et al.*, *Int. J. Thermophys.* **2014,** 35, 395.