High Temperature Acoustic and Microwave Transducers for Primary Acoustic Thermometry

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Relative acoustic gas thermometry leads us a better understanding of the difference between the thermodynamic temperature (T) and the International Temperature Scale of 1990 (T90). By measuring the ratio of the speed of sound along the reference temperature isotherm and the unknown temperature isotherm, the thermodynamic temperature can be determined with an uncertainty several times lower than present temperature scale. There are limited thermodynamic temperature measurements at temperature higher than 500 K. The measurements of a prototype cylindrical microwave cavity using Nickel-Chromium alloy confirmed the possibility of developing high temperature acoustic thermometry up to the copper point. NIM (National Institute of Metrology, China) is now in the progress of investigating primary acoustic gas thermometry at temperature higher than 800 K with the collaboration with NIST. The cylindrical acoustic and microwave resonator was used because of the stable mechanic structure and the convenience of machining and assembling. The room temperature acoustic transducers with high temperature alloy acoustic ducts were used to measure the acoustic resonant frequencies in argon. The thermal expansion of the cavity was measured by the homemade microwave transducers. The signal to noise ratios and quality factors of acoustic and microwave responses were measured at different temperatures. The ratios of the acoustic and microwave resonant frequencies between high temperature and room temperature were compared between different modes. Those acoustic and microwave techniques can also be used to measure the speed of sound and refractive index of working fluids at temperature high up to 1360 K.