

Measurement of the Dielectric Constant of Water Vapor and Humid Mixtures with a Quasi-Spherical Resonator

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We have developed an apparatus suitable for accurate measurements of the dielectric constant of gases in the temperatures range from ambient up to 500 K. The experiment is based on the determination of the microwave resonance frequencies of a gold-plated quasi-spherical cavity carefully thermostatted in an electric oven. The thermal expansion of the cavity and the temperature dependence of the electrical conductivity of its inner surface were characterized by measurements in vacuum. The deformation of the cavity under pressure and the overall performance of the experiment were checked by measurements with high purity helium and comparison of the results with those predicted by theory, using *ab-initio* calculated values of the thermodynamic and electric properties of He. With the aim of reducing the uncertainty currently associated to the literature values of the constants in the Debye equation, we have measured the dielectric constant of pure water vapor in the temperature range from 320 K to 470 K at pressures up to 1.7 MPa. To test the performance of the resonator as an hygrometer, we have measured the dielectric constant of the mixtures of CO₂-free air/H₂O and N₂/H₂O prepared with INRiM humidity generator at ambient pressure.