Study of Graphite Reflectance for the Evaluation of Fixed-Point Blackbody Emissivity

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We report measurement results of the reflectance properties of graphite at 405 nm and 658 nm at elevated temperatures, which were obtained using a new vacuum high temperature reflectometer (HTR) facility. This facility is designed to perform measurements of emittance and bi-directional reflectance of materials at temperatures up to 2100 K in vacuum. This study is part of an effort to accurately determine the emissivity of high temperature fixed point cavities of the eutectics Co-C, Pt-C and Re-C, with eutectic temperatures of 1597 K, 2011 K, and 2747 K, respectively, which are being evaluated for inclusion as high temperature reference points in a new practical temperature scale. The primary available approach to obtaining the cavity emissivity is through modeling that employs measured optical properties of the cavity wall material — graphite. Two interchangeable experimental setups are used in the HTR facility for the measurements. For sample temperatures up to 1200 K, a miniature sodium heat pipe sample heater and an integrating sphere reflectometer is used to obtain the near-normal hemispherical-directional reflectance factor (HDRF) of the graphite sample, from which the emittance is directly obtained. The input sources used are diode lasers operating at 405 nm and 658 nm, which represent typical wavelengths of filter radiometers that would be used for radiant temperature measurements of the fixed-point blackbody sources. For all temperatures up to 2100 K, a goniometer setup, employing the same diode lasers, is used to measure the bidirectional reflectance distribution function (BRDF) of the heated samples. Using all measurement results, we obtain the graphite emittance, as well as the effective cavity emissivity for an example geometry. We describe the overall approach, the developed hardware and the HDRF and BRDF measurement results at high temperatures, as well as their significance for cavity effective emissivity modeling.