Experimental Measurement on Spectral Emissivity of Ceramic Samples at Elevated Temperatures

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Ceramic materials are usually applied to the modern industry, especially in high temperature conditions, such as space shuttle, thermal barrier coating, and selective emitter for thermophotovoltaic systems. Understanding and controlling the spectral emissivity of the ceramic materials at high temperatures is indispensable in thermal design related with these applications. The spectral emissivity measurement method is presented on the base of the definition of the emissivity. An experimental setup for the measurements of the normal spectral emissivity of solid material at elevated temperatures is developed. The experimental setup covers the temperature range from 800°C and 1600°C and wavelengths from 1μm to 25μm. Sample is heated by a torch flame, and the sample surface temperature is determined by the Christiansen wavelength method. Two different temperature-tunable blackbody sources are used as the standard references and the radiance is measured by a FTIR spectrometer. Firstly, the validation of the Christiansen wavelength method is verified experimentally below 400°C with the comparison of the temperature results between a K-type thermocouple and Christiansen wavelength method, and the relative deviation is less than 2%. Next, the spectral emissivity of MgO at ambient temperature is measured to determine the Christiansen wavelength, and the measurement results of the normal spectral emissivity of MgO between 832°C and 1508°C are also presented. The results show that the Christiansen wavelength of MgO is found to be 12.5μm at room temperature and about 12.8μm at elevated temperatures. The spectral emissivity is influenced slightly by the sample temperature, and the absorption peaks around 3μm and 7μm at room temperature, which is caused by water, disappear at high temperatures. Finally, a thorough analysis of the uncertainty components of the emissivity measurement is carried out and the combined relative uncertainty of MgO sample at 1323°C is less than 4%.