

A Multiple Interface Method for Measuring Spectral Properties of a Semitransparent Medium with Low Absorption at High Temperatures

Shun-De Zhang

School of Energy Science and Engineering, Harbin Institute of Technology, Harbin, Heilongjiang, China

Feng-xian Sun

School of Power and Energy Engineering, Harbin Engineering University, Harbin, Heilongjiang, China

Xin-Lin Xia^{C, S} and Chuang Sun

School of Energy Science and Engineering, Harbin Institute of Technology, Harbin, Heilongjiang, China

xiaxl@hit.edu.cn

In order to retrieve radiative properties of a semitransparent medium, such as refractive index and absorptive coefficient, multiple samples with different thicknesses are usually used to measure their transmittances. However, within the spectral band of very low absorption, the transmittances of specimens with different thicknesses are hard to distinguish. To resolve this problem, a multiple Interface method was developed to acquire a series of distinct transmittances of a low absorption material. By arranging several thin sheets to construct a combined specimen with multiple interfaces, the apparent transmittance obviously varies as the number of the optical-interfaces increases due to the interface effect causing optical reflection/refraction. For a given sum of thicknesses, multiple combined specimens with different numbers of optical interfaces/layers can be measured at an elevated temperature. In this methodology, bare influence would occur on the precise knowledge of the sample temperature because the heating condition and the detector access are identical in the measurements. In this paper, C-cut sapphire was measured for the high-transparent wavelengths ranging from 0.35 to 0.85 μm at several high temperatures to verify this method. And then a genetic-algorithm-based least-square method was adopted to extract the spectral refractive index and absorptive index by minimizing the difference between the experimental transmittance and relevant theoretic values calculated by a Monte-Carlo ray-tracing (MCRT) method. Finally, the temperature and frequency dependence of transmission properties of the C-cut sapphire up to 1800 K were obtained.