Apparent Emissivity Measurement of Semitransparent Materials

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Scientific and commercial application of semitransparent materials calls for precise infrared-optical characterization. For instance, accurate emissivity data enables prediction of temperature response by components made from fiber reinforced plastics, thereby enabling non-destructive testing by active or passive thermography. Used as reflective and transmissive optics components in the infrared wavelength range, as they are typically used for remote sensing, not only their emissivity, but also transmissivity and reflectivity become important. Here, it is only possible to reach low uncertainties by carefully correcting the emitted background radiation of optical components, which in turn requires knowledge of their respective emissivities, transmissivities and reflectivities.

Unfortunately, spectral emissivity between 5 µm and 25 µm and between 20 °C and 90 °C is difficult to measure because of low signals and large thermal background radiation. Additionally, for semitransparent samples the evaluation of measurement data is further complicated by the fact, that the apparent emissivity, reflectivity, and transmissivity are intertwined in the optical signals.

To tackle these challenges a sample holder and evaluation scheme based on PTB's established method for emissivity measurement of opaque samples have been developed. Here, emissivity is indirectly measured by identifying transmissivity and reflectivity simultaneously from a series of independent measurements and considering emission explicitly during evaluation. This enables the spectral emissivity measurement of semitransparent samples in the spectral range from 5 µm to 25 µm as well as at temperatures between 20 °C and 90 °C at PTB's established emissivity facilities under air and vacuum.

The apparent emissivity, reflectivity and transmissivity of an optically polished silicon sample with a thickness of 5 mm have been measured. These measurements were successfully validated by two independent setups comparing spectral reflectivity and transmissivity.