Accurate Measurement of Infrared Emissivity at Room Temperature

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Master of Science in Mechanical Engineering

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The surface property of emissivity is of high interest in applications such as non-contact temperature measurement. The measurement of emitted radiation, however, is affected by reflected ambient light. When the surface temperature is close to the ambient temperature, this effect can be significant and can lead to significant error in the emissivity value. An additional source of error is directional effects. These are usually not considered, and the assumption is of a diffuse sample surface or a diffuse background radiation. However, this is usually untrue and can also lead to significant error. This work proposes a new measurement method that deals with the background reflected radiation and the directional effects by using an integrating sphere, variable background radiation, and simultaneous measurement of the sample and a reference surface.

A measurement system was built and tested. The sample and reference surfaces are placed opposite a thermal camera (mid infrared 8—14 mm) inside an integrating sphere. The variable background conditions are achieved by connecting alternately to the main sphere an auxiliary sphere where a thermal emitter generates the high background radiation. The sample can rotate in two axes to measure the directional variation of the emissivity. Measurements of the normal emissivity of various surfaces are reported, and detailed error analysis of the measurements and the analysis leading to the emissivity are given. Also, an analysis of error sources and their influence on the measurement accuracy is presented for the new method and compared to previous methods. The measured samples emissivity values: Gold − 0.1±0.01, Stainless Steel − 0.037±0.009, White Paper − 0.90±0.01, Leaf − 0.948±0.007. With reference to previous measurement methods results, this method results are more accurate or at the same order of accuracy, while the objective of this work was to measure the emissivity with an accuracy value of 0.5%.