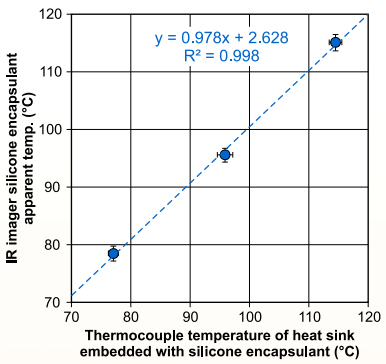
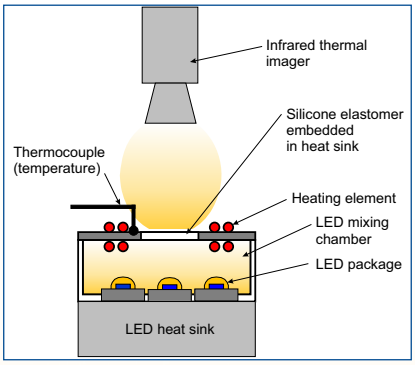
Measuring LED Lens Surface Temperature with Infrared Thermography

Measuring the surface temperature of an LED lens accurately in the presence of high-luminous exitance is quite challenging. LRC researchers investigated the use of an infrared (IR)imager to measure LED lens surface temperature. The analysis focused on factors such as emissivity of the lens surface, aiming angle of the IR imager, distance between the lens surface and the IR imager, and the background temperature and how they affect the accuracy of the measured temperature value.



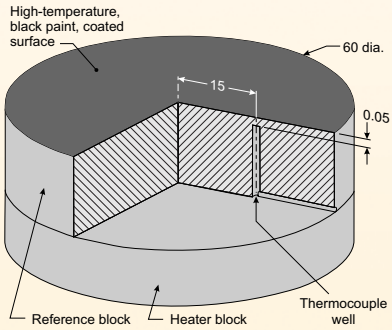
LED light engine luminous exitance surface temperature measurement from IR imager apparent temperature compared to thermocouple heat sink temperature



Schematic of the LED light engine with heated silicone layer experiment setup

Experiment

Surface emissivity is a critical parameter that is needed to make surface temperature measurements using IR imagers. First, a black paint-coated surface was characterized using a heater block. Calibrated thermocouples were embedded in the heater block for comparison of apparent temperature from the IR imager for surface emissivity characterization. Next, the characterized black paint was coated on one-half of a silicone encapsulant surface. These paint-coated and uncoated halves were used in characterizing the surface emissivity of the encapsulant surface. Finally, the characterized silicone encapsulant was embedded in a perforated aluminum heat sink, with external heaters to change silicone operating temperature and mounted to an LED light engine. The geometric configuration of this perforated heat sink with embedded encapsulant maintained a uniform constant temperature distribution on the encapsulant and heat sink surface. A thermocouple mounted on the heat sink surface was used to compare the IR imager apparent temperature of the luminous surface.



High-temperature black paint characterization experimental setup

Results

- Surface emissivity and angular effect were the two main sources of error in the estimated temperatures when using the IR imager.
- Measurement accuracy of the LED silicone encapsulant temperature was within 2% after correcting for surface emissivity and angle.

Application

The IR imager can be used to measure LED primary lens temperature.

Citation

Perera, I.U., and N. Narendran. 2016. Measuring the temperature of high-luminous exitance surfaces with infrared thermography in LED applications. *Proceedings of SPIE 9954, Fifteenth International Conference on Solid State Lighting and LED-based Illumination Systems,* 99540K (September 7, 2016); doi: 10.1117/12.2240650.

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