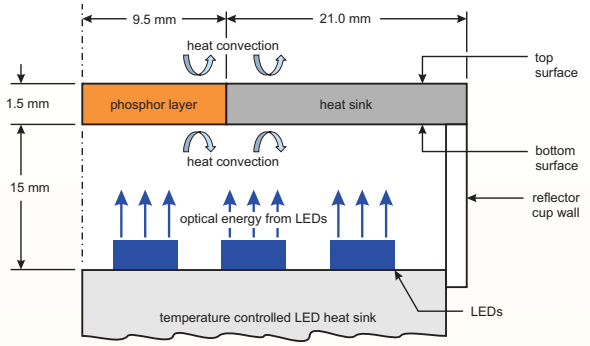
Heat Transfer Analysis of a Remote Phosphor Layer

The heat generated in a white LED can be broadly categorized into two parts: the heat generated in the LED chip and the heat generated in the phosphor layer. Smaller package size and increased luminous flux from LEDs are raising reliability concerns because of high heat density within the phosphor layer. The LED industry has made significant strides to manage the heat generated from the LED chip to improve package reliability, but very little effort has gone into managing the heat generated within the phosphor layer. Therefore, knowing the temperature and the temperature distribution across the phosphor layer is important for the design and manufacture of reliable LED packages.

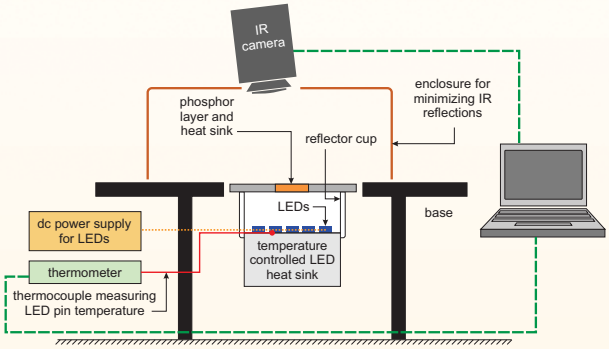
Due to practical limitations, measuring the temperature distribution within the phosphor layer has been difficult. The objective of this study was to develop a mathematical model to predict the phosphor layer temperature profile.

Mathematical Model and Experiment Validation

The mathematical model developed in this study considered light propagation, heat generation, and heat transfer. The light propagation model was built on previous research. The predictions made for light output and temperature by the developed model was compared and validated with results from past research studies. Next, this model was utilized to simulate a particular experimental setup with a remote phosphor package configuration (see configuration figure). An IR thermal imaging system was used to measure the temperature values and the distribution

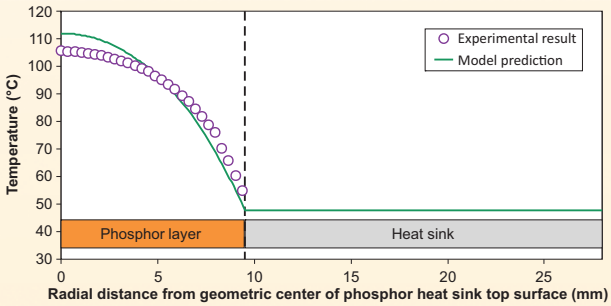


Remote phosphor configuration.



Experimental setup.

across the top surface of the phosphor layer (see experimental setup figure). The experimental result and model prediction are illustrated in the temperature graph showing good agreement. The published paper describes some of the refinements to the model that further improved the match between the experiment and the model prediction.



Comparison of experimantal and modeled results for temperature profile of the phosphor layer.

For More Information

Perera IU and Narendran N. 2014. Mathematical model to analyze phosphor layer heat transfer of an LED system. *Proceedings of SPIE 9190: 91900R*. Available: http://www.lrc.rpi.edu/programs/solidstate/pdf/Perera-SPIE2014.pdf.

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