Measuring the Junction Temperature of White LEDs

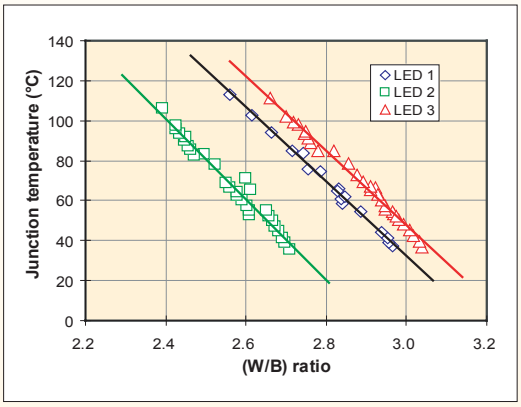
Light-emitting diodes (LEDs) are rapidly evolving for use in general illumination applications. With this growing popularity comes the question of how long white LEDs will operate effectively in a system, considering that packaging, drive current, and environmental conditions all affect LED performance. Estimating the life of an LED system through long-term testing is too time-consuming.

Heat at the p-n junction is the primary cause of degradation in white LEDs. Furthermore, heat affects the emission spectra. LRC researchers chose to measure junction temperature non-invasively by measuring and analyzing the spectral power distribution. Although there are other methods to measure junction temperature, they all require access to the lead wires of the LEDs. This means disassembling the system and possibly affecting its performance. Therefore, the non-invasive method developed here is attractive for predicting LED system life.

Experiment

Based on past studies, LRC researchers hypothesized that the junction temperature of GaN-based, phosphor-converted white LEDs could be predicted from the W/B ratio, where W and B are the radiant energies of the entire emission and the blue emission, respectively.

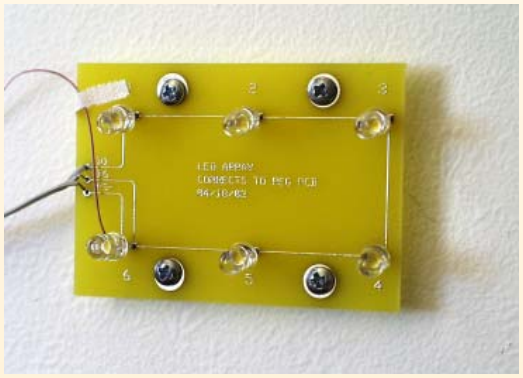
Commercial 5 mm white LEDs were assembled into arrays and operated at various drive currents and ambient temperatures. All LEDs in an array had the same peak wavelength for the blue emission. Altogether, three arrays with different peak wavelengths were tested. During the experiment, the spectral power distributions and the lead wire temperatures were recorded simultaneously. The junction temperatures were estimated from the lead wire temperatures using the thermal resistance coefficient of these white LEDs.



Effect of junction temperature on W/B ratio for three LED samples

Conclusions

- Results show that W/B ratio is linearly proportional to junction temperature. This linear relationship holds true even when the spectral characteristics of the LEDs are not identical.
- By measuring the initial ambient temperature and the spectra at onset and at final operating conditions, the junction temperature of the LEDs can be estimated.
- Application of this method, combined with forthcoming LED degradation rates, would mean that an LED's life in a system could be estimated without long-term testing.



Sponsors

U.S. Department of Energy

University of California at Santa Barbara

Rensselaer

Lighting Research Center

Lighting Research Center, Rensselaer Polytechnic Institute • 21 Union Street • Troy, NY 12180 • (518) 687-7100 • www.lrc.rpi.edu