Effects of Dimming on High-power LEDs

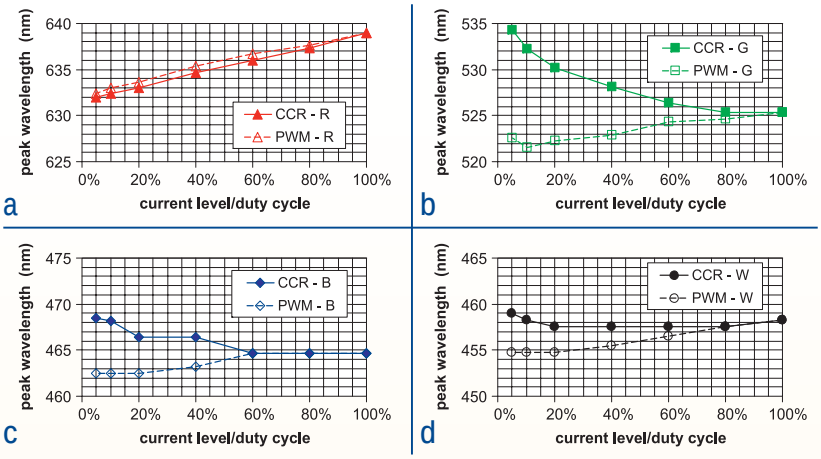
Dimming is an important feature for light sources used in general lighting applications, especially for energy conservation. When light sources are dimmed, they must maintain luminous efficacy and have no perceivable chromaticity change.

Commercial LED drivers with dimming capabilities commonly use either continuous current reduction (CCR) or pulse-width modulation (PWM) dimming methods.

This study set out to characterize different types of high-power LEDs to understand how luminous efficacy and spectrum change when high-power LEDs are dimmed using both dimming techniques.

Experiment

The LRC tested commercial high-power red, green, blue, and pc-white LEDs from three LED manufacturers. Spectral and luminous efficacy changes of individual LEDs were monitored under wide ranges of dimming levels and ambient temperatures.



Peak wavelength shift as a function of current level or duty cycle for (a) red, (b) green, (c) blue, and (d) white LEDs for a given product manufacturer.

Results

For InGaN-based blue, green and pc-white LEDs, the peak wavelength shifts are in opposite directions for the two dimming schemes:

- Blue shift with increased current (CCR) dominated by band filling.
- Red shift with increased duty cycle (PWM) due to junction heat.
- Green LEDs always exhibit a greater spectrum shift than corresponding blue packages because of higher indium composition.

For AlInGaP red LEDs, the peak wavelength shifts to red with increased current or duty cycle caused by junction heat.

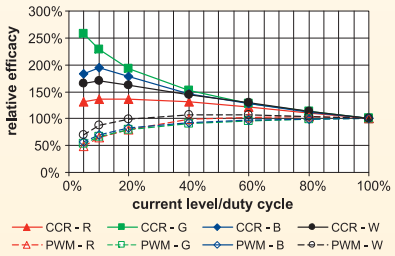
At dimmed levels, the luminous efficacy is always higher using CCR for the tested LEDs.

Further Information

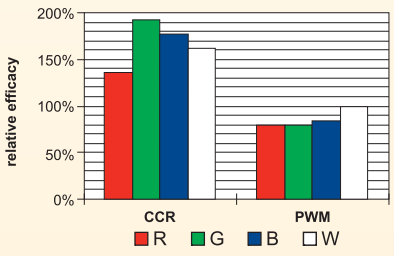
Gu et al. “Spectral and luminous efficacy change...” *SPIE* 2006.

Dyble et al. “Impact of dimming white LEDs...” *SPIE* 2005.

Available at: www.lrc.rpi.edu/programs/solidstate/SSLLRCAuthored.htm



Relative luminous efficacy as a function of current level or duty cycle for red, green, blue, and white LEDs for a given product manufacturer.



Relative luminous efficacy for red, green, blue, and white LEDs at 20% current level or duty cycle for a given product manufacturer.

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