Spectral Method for Measuring White OLED Junction Temperature

Organic light-emitting-diode (OLED) technology has the potential to provide novel solutions in certain lighting applications with low power demand. As with inorganic LEDs, junction temperature is an important parameter for determining OLED performance. But unlike traditional LEDs, the OLED is a large area source, so its multiple p–n junctions are spatially distributed; therefore, an average temperature across the panel can be used to estimate performance. However, presently there is no standardized method to measure the junction temperature of OLED devices. The LRC investigated a method for estimating the average junction temperature of white OLEDs based on changes in spectrum caused by temperature sensitivity differences in the radiant power emitted by individual emitter materials.

Experiment

The spectral radiance distributions of six white OLED panels from five manufacturers were characterized as a function of panel temperature when ambient temperatures varied from 25°C to 65°C at each panel's rated current. These panels were made up of all phosphorescent or a combination of phosphorescent and fluorescent red, green and blue materials. Each white OLED panel was mounted vertically inside a temperature-controlled enclosure. During each measurement, first the ambient temperature was set to a target value, and then spectral measurements were taken after each OLED panel reached thermal and optical stability.

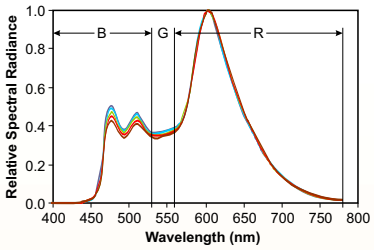

Figure 1. Relative spectral radiance distributions at the center of OLED Panel A at varying panel temperatures

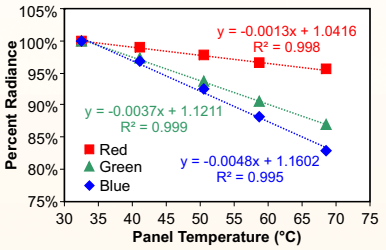

Figure 2. Relative radiance for spectral bands "blue," "green," and "red" as a function of panel temperature for OLED Panel A

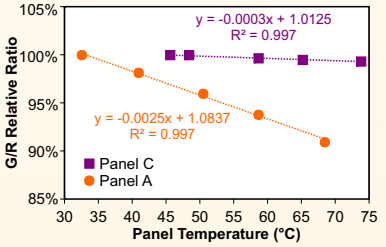

Figure 3. Relative radiance ratios for G/R as a function of panel temperature for OLED Panel A

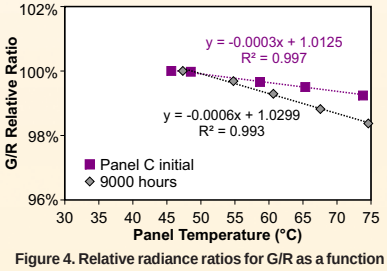

Figure 4. Relative radiance ratios for G/R as a function of panel temperature for OLED Panel C at 0 hour ("initial") and after continuously operating for 9000 hours at an ambient temperature of 55°C

Results

For each spectral band, the relative radiance was calculated by taking the ratio of the radiance at each elevated ambient temperature over the radiance at an ambient temperature of 25°C. The relative radiance ratios of blue over red (B/R), green over red (G/R), and blue over green (B/G) as a function of panel temperature were then used to find correlations between spectral change and panel temperature.

For most panels, the G/R ratio showed high linear correlation with panel temperature in the short term (see Figure 3); therefore, the G/R ratio method has the potential for estimating the OLED panel temperature and the average junction temperature. However, a long-term test showed that the G/R ratio changes with time (see Figure 4), and the temperature sensitivity of G/R also changes. Therefore, this G/R ratio may only be used for determining the average junction temperature of OLED panels immediately after characterization or within the short term. A new calibration will be needed for OLED devices that have operated for a long period.

Citation

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