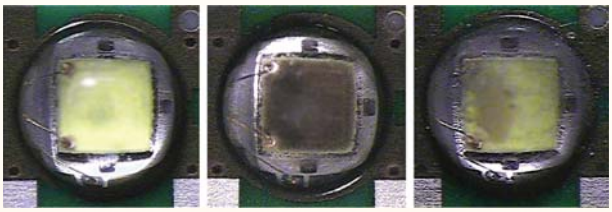
Effects of VOCs on LED Lighting Packages

Volatile organic compounds (VOCs) are common chemical structures that occur in countless chemical compositions. Recent reports have suggested a negative effect of VOCs on LED light output, with the outgassing of VOCs inside hermetically sealed environments causing rapid lumen depreciation. Outdoor and wet location-rated fixtures are likely to be vulnerable to the effects of VOCs due to their tight seal. This depreciation is not necessarily permanent. Removing the seal can often lead to a recovery in lumen output. However, existing literature has not discussed the causes underlying these interactions.



Exposing a pcWhite LED sample to VOCs: before exposure (left), after exposure (center), and after outgassing (right).

Experiment

LRC researchers developed experiments examining the effects of a VOC on silicone-encapsulated, phosphor-converted white (pcWhite) LEDs due to environment temperature and visible radiation exposure in a hermetically sealed environment. The experiments hypothesized that increasing levels of each variable would increase the rate of lumen depreciation of the LED samples.

Trials were also conducted on blue and red LEDs (non-phosphor-converted) to understand the effects of VOC exposure without intermediate materials. These trials kept the environment temperature, forward current, and VOC concentration constant so that the LED emitters could be compared.

Sponsor

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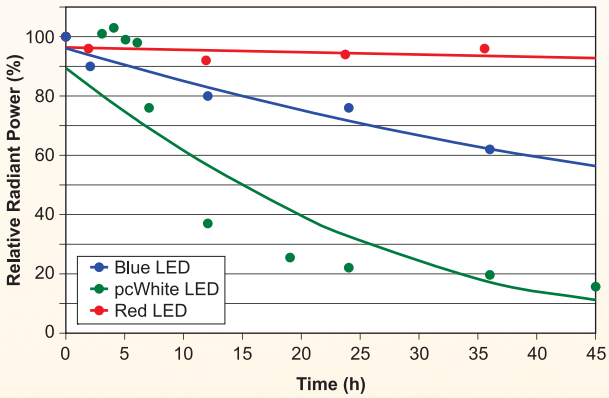
Results

Results from experiments and conclusions drawn from literature suggest that LED lumen depreciation is initiated by thermal oxidation and/or photooxidation. The results from silicone-encapsulated blue, red, and pcWhite LEDs suggest that an energy level greater than the activation energy for chemical reaction is required to initiate this reaction. While a statistically significant degradation occurred in the blue LEDs, the red LED samples did not degrade at all for the same period of time, at the same temperature and radiant power emission. These data suggest that the red LED did not offer enough energy to initiate a chemical reaction, since longer wavelength (red) LEDs have lower energy compared with shorter wavelength (blue) LEDs.



Relative radiant power as a function of time for encapsulated blue, red and pcWhite LEDs.

Further research is ongoing to determine the effects of VOCs on different components of pcWhite LEDs, specifically the LED die, phosphor, and encapsulant, as well as investigations into the quantification of the activation energy required at different wavelengths to initiate chemical reactions.

Publication

Marcus HD. 2012. *Optical impact of volatile organic compounds on LEDs* (Master's thesis). Rensselaer Polytechnic Institute, Troy, NY.

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