SSL Postings
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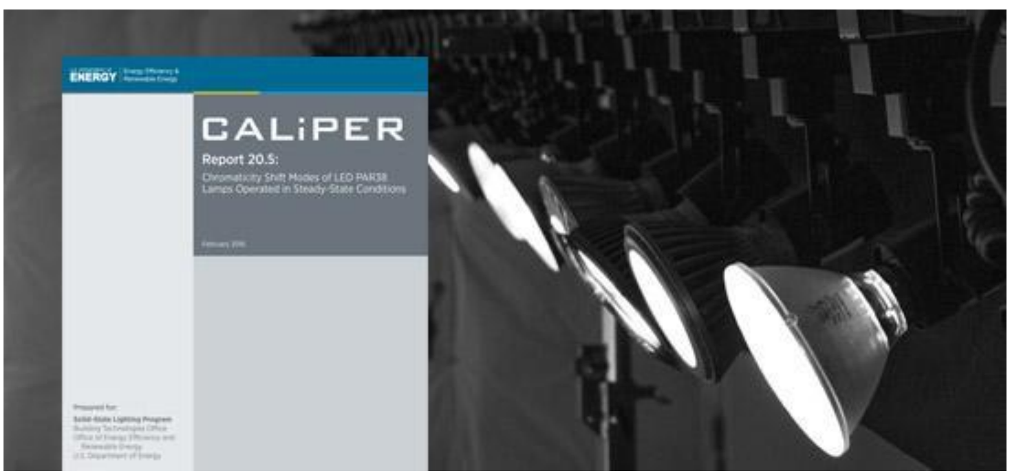
A New CALiPER Report on Chromaticity Shift Modes in LED PAR38 Lamps

The PAR (parabolic aluminized reflector) lamp is a common type of reflector lamp that's often used in retail display lighting and other demanding applications where color quality and visual appearance are important considerations. Although the directionality of LEDs makes them well-suited for use in PAR lamps, the effectiveness and utility of conventional halogen PAR lamps present a challenge to SSL. DOE's CALiPER program has just released the latest report in a series of investigations on LED PAR38 lamps. CALiPER Report 20.5 examines the same LED lamp models that were covered in CALiPER Report 20.4 but focuses more on the chromaticity maintenance of individual samples rather than on the lamp model averages that were emphasized in 20.4. This new approach was taken to facilitate a classification of the chromaticity shift modes (CSM) for each sample, and a comparison of CSMs across all samples of a particular lamp model and between lamp models with similar characteristics.



The new report builds on Report 20.4 by providing a tear-down analysis of its 32 LED PAR38 lamp models and also performing additional analyses on the spectroradiometric data obtained using a specially developed automated long-term test apparatus. The goal of the new report is to investigate causes of color shift and parametric failures within these lamps.

In general, samples of the same PAR38 lamp model usually exhibited the same chromaticity shift behavior, and there were similarities in chromaticity shift trends between lamp models with similar LED packages. However, the timing of different chromaticity shifts varied somewhat between lamp models and appears to depend upon lamp design, characteristics of the LED packages used in the lamp model, and lamp operational conditions.

The PAR38 lamp models examined in this study exhibited a systematic chronology in the chromaticity shift that depended on LED package type and operational conditions such as LED board temperature and drive current. Nearly all samples were found to initially shift in the blue direction. Subsequent shifts tended to be first in the green direction, followed by a shift in the yellow direction.

After the initial blue color shift, four primary CSMs were identified that appeared in a sequential fashion, depending on design and operational conditions:

- *CSM-1* involves a continuation of the chromaticity shift in the blue direction and closely follows the blue-yellow line. This CSM is favored by low-operational-stress conditions, such as low LED board temperatures and low drive currents. It's speculated that longer test times or more-aggressive test conditions would result in the appearance of additional CSMs in these samples.
- *CSM-2* involves a shift off of the blue-yellow line and in the green direction. This CSM is also favored by low-operational-stress conditions and appears to be caused by small shifts in the emission maxima of the phosphor that may signify phosphor oxidation.
- *CSM-3* involves an initial shift in the blue direction, followed by a shift in the yellow direction. This CSM produces a characteristic hook pattern in the time-based profile of chromaticity coordinates. The primary cause of CSM-3 behavior is believed to be degradation of the binder in the phosphor-binder composite, resulting in delamination and cracking between the phosphor/binder layer and the LED die. CSM-3 behavior was prevalent in high-power LEDs and occurred during the test period in 72% of the samples using this LED package, and in most of the parametric failures for excessive chromaticity shift.
- *CSM-4* involves a short initial shift in the blue direction, followed by a shift in the yellow direction, followed by a second blue shift. It produces a characteristic double-hook pattern in the time-based profile of chromaticity coordinates. CSM-4 behavior was only found in samples containing plastic leaded chip carrier (PLCC) LED packages, suggesting that the primary cause of this color-shift mode is oxidation of the molding resin used in PLCC devices. All of the parametric failures for excessive chromaticity shift in samples with PLCC LEDs occurred through a CSM-4 behavior, indicating that this type of chromaticity shift can produce parametric failure in PLCC devices.

These four CSMs provide a means to understand the chronology of chromaticity shifts in relatively simple LED lighting devices such as PAR38 lamps, and may provide a convenient starting point for analyzing chromaticity shifts in more complex LED products. For full details on this informative study, see the report.

Best regards,
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As always, if you have questions or comments, you can reach us at
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