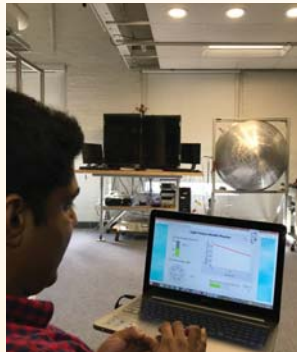


Real-time Remote Monitoring of LED System Performance

Connected LED lighting systems are beginning to target mainstream lighting applications as the Internet of Things takes shape. Remote monitoring of a lighting system's performance is a welcome feature for building managers looking to optimize energy usage and to better facilitate maintenance scheduling and timely replacement of fixtures ahead of failure. A remote monitoring system that can estimate remaining life, however, requires life prediction capabilities.

Experiment

Past LRC studies have shown that when LEDs age, the forward voltage of an LED package increases. Other researchers have investigated a distance-based, data-driven method (Euclidean distance [ED]) to estimate the remaining useful life of high-power LEDs with in-situ



Lighting system performance monitoring dashboard

monitoring of operating parameters. ED is a measure of deviation of the operating parameters from their nominal operating conditions. ED converts multi-dimensional data to a single parameter. As a first step, LRC researchers focused on studying the ED method and its applicability to LED systems. The measured forward voltage and LED pin temperature were used as the monitoring parameters along with the measured catastrophic failure time during aging tests of four samples of LED arrays. The ED method was used for predicting time to failure.

$$ED_i = \sqrt{(V_i - \bar{V})^2 + (T_i - \bar{T})^2}$$

V_i, T_i = instantaneous value of forward voltage and LED pin temperature

\bar{V}, \bar{T} = mean values of forward voltage and LED pin temperature under normal operating conditions

Results

The experiment showed that the samples exhibited similar forward voltage and LED pin temperature increases of 7.75 V for forward voltage and 12°C for LED pin temperature at the failure point during the aging tests. These values were used as the failure criteria for the arrays aged at different temperature conditions. The time to failure at each temperature condition was estimated (Figure 1).

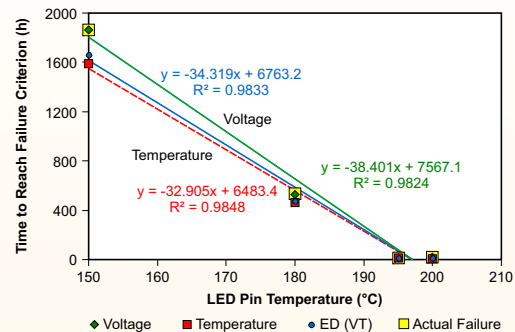


Figure 1. Time to reach failure criteria for voltage and temperature.

A summary of the predicted time to failure results for the sample aged at 180°C is presented in Figure 2. These findings show that all three parameters—V, T, and ED—can predict failure time (within 10%) sufficiently early, at around 60% of the operating life. Ongoing research at the LRC will conduct additional investigations to further this assessment.

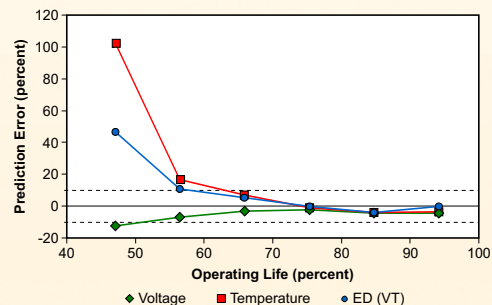


Figure 2. Prediction error at 180°C.

Citation

Thotagamuwa, D.R., I.U. Perera, and N. Narendran. 2016. Remote monitoring of LED lighting system performance. *Proceedings of SPIE 9954, Fifteenth International Conference on Solid State Lighting and LED-based Illumination Systems, 99540I* (September 7, 2016); doi: 10.1117/12.2240463.