# Using Phosphor Luminescence to Reduce Ac LED Flicker

White alternating current (ac) LEDs operate directly off ac electrical mains rather than using an external driver to direct current (dc) as with traditional dc LEDs. With the elimination of the driver, ac LEDs have the potential advantages of greater efficiency, lower cost, and better reliability, as well as a smaller system footprint. However, ac LEDs suffer from more frequent and perceptible flicker than their dc counterparts, which could lead to undesirable light qualities. Some traditional light sources exhibit perceptible light flicker, and one method employed to counteract it is to add an external electronic circuit; however, such solutions often negate the ac LED's advantages. Recent studies have reported that the luminescence emitted from slow-decay phosphors, when applied to an ac LED, can reduce the appearance of flicker, but their mechanism and luminescence property requirements have remained unknown.

## Experiments

In this study, LRC researchers investigated the luminescence of slow-decay phosphors under flickering excitation from an ac LED. A mathematical model was then developed to predict the behavior of slow-decay phosphors, which considered the following factors that affect the ac LED's properties:

- the 80% decay constant of the luminescence ($\tau_{80}$)
- the extraction efficiency of excitation light in the phosphor layer ($\eta_{ex}$)
- the extraction efficiency of emission light in the phosphor layer ($\eta_{em}$)

## Results

The experimental results showed that when $\tau_{80}$ increases, the flicker index of the resultant white light decreases, with flicker index extrapolated to reach 0.1 at $\tau_{80}$ equal to 0.4 ms (see Figure 1). Based on the experiment and human factors results, LRC researchers developed a set of luminescence properties for slow-decay phosphors that can create a white ac LED with minimal flicker. This study showed that the mathematical model developed can reliably predict the behavior of a slow-decay phosphor, which can be useful for scientists developing new phosphors. The study showed that with suitable characteristics, slow decay phosphors can reduce flicker from ac LEDs and create white light with good quality. The human factors experiments verified the potential of slow-decay phosphors to improve the acceptability of white ac LED light output. For values greater than 0.22, $\tau_{80}$ is acceptable.

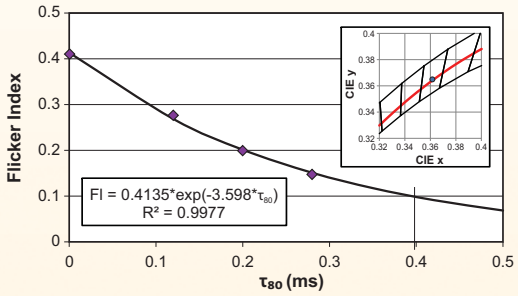


**Figure 1. Experiment results: flicker index with chromaticity fixed on the blackbody locus, as in the inset.**

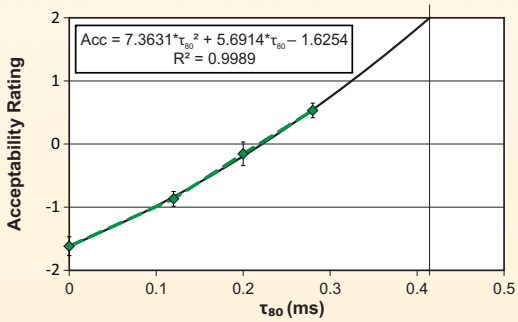


**Figure 2. Acceptability ratings of stroboscopic effects under white lighting conditions with different $\tau_{80}$ values (+2: very acceptable; -2: very unacceptable).**

## More Information


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