LED Replacement for Linear Fluorescent Lamps

Linear fluorescent lamps (LFLs) are the dominant technology for lighting commercial buildings. However, as building practices move toward minimizing hazardous waste, the mercury in fluorescent lamps could become a significant concern. LED lighting, which maintains high efficiency and long useful life without known toxic waste, becomes an ideal replacement. However, commercial LED replacements for LFLs have yet to achieve the necessary lumen output at similar luminous efficacy, beam distribution, and cost. When the study began in 2011, commercially available 4-foot LED replacement lamps could rarely achieve more than 1600 lumens with a system efficacy of approximately 75 lumens per watt (lm/W).

Objectives

The LRC investigated solutions for creating a 4-foot LED replacement for LFLs with a system efficacy of 110 lm/W, having similar color properties and distribution, and which would result in energy savings over current LFL technology. In order to achieve this goal, LRC researchers employed a patented remote-phosphor technology called SPE™ (scattered photon extraction) that increases the number of backscattered photons extracted from the LED package. SPE is a concept where the phosphor layer is placed remotely from the LED die, and a specific shaped optic is used to extract the backward emitted and scattered light. The remote phosphor package has a blue LED and optics covered with a phosphor layer on the top surface. Backward emitted and scattered light has a more significant chance to be extracted out from the side of the optics than to be sent back to the LED die and potentially lost.

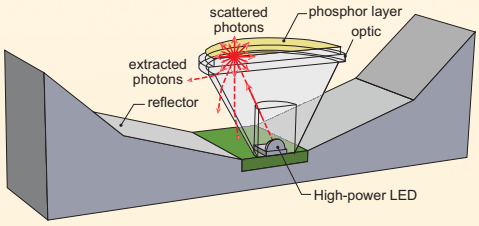

Diagram of an SPE optical assembly used in this study

SPE remote phosphor packages

Outcomes

The luminous efficacy of the SPE package used in the prototype was 143 lm/W. The prototype LED T8 replacement lamp's luminous efficacy was 110 lm/W. Comparing a two-lamp T8 fluorescent recessed prismatic troffer (typically 56 W) with the LRC's prototype lamp (40 W), shows a 28% power reduction with similar light output (~4000 lm).

The LRC's prototype met the targeted efficacy and luminous output, but with a CRI of 65. The lower CRI is mostly attributed to the limited availability of a red phosphor at the right peak wavelength, full width half maximum and conversion efficiency. Ongoing investigations are focusing on the development of phosphor formulas for the SPE technology that maintain a high efficacy while improving overall CRI.

Final prototype LED linear lamp

Sponsor

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