Snap-in LED Module for Outdoor Luminaires

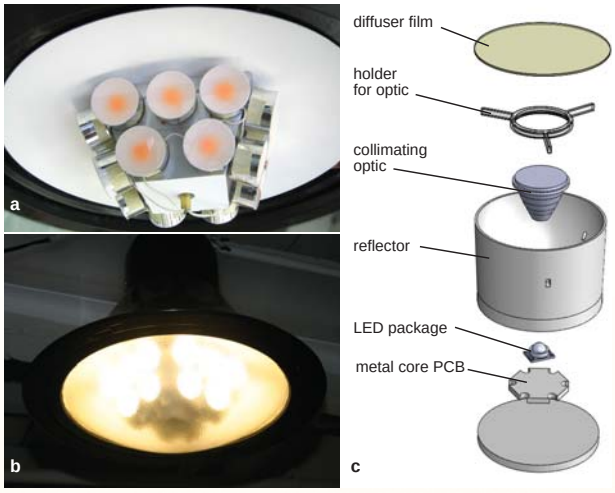
The growing interest in photovoltaic (solar) energy and the rapid development of LED technology have triggered significant interest for PV-powered outdoor LED lighting systems. Although LEDs are considered long-life light sources, in practice one or two LEDs could fail. Presently, it is almost impossible to replace the failed LED without taking down the luminaire and disassembling everything. Alternatively, if a snap-in module design with a simple mechanical connection were considered in advance, when encountering the same problem, only the failed LED module would need replacing. Each individual module could be easily fixed or disassembled from the luminaire as needed.

In this study, LRC researchers developed an energy-efficient, snap-in LED module for lighting systems using the LRC's patented scattered photon extraction (SPE) technology. SPE has been shown to generate 30% more light output and luminous efficacy than similar white LEDs. For PV-powered LED systems, implementing SPE technology could increase the time of use or light level and open new applications.

Prototype Development

Several tasks were conducted:

- Selection of a short-wavelength LED, SPE optics and down-conversion materials, and optical ray-tracing analysis for high efficacy and good color properties.
- Optical ray-tracing analysis and creation of a high performance reflector.
- Characterization of thermal interface materials to identify low thermal resistance and longevity.
- Optical ray-tracing analysis to create a Type V beam distribution from the outdoor luminaire.
- Investigation of discomfort glare and ways to reduce the perception of glare from LED lighting.



(a) The snap-in SPE LED modules in the luminaire housing; (b) the final prototype outdoor luminaire; (c) the snap-in module components.

Performance Results

A prototype with a snap-in mechanical module design was built with 20 blue LEDs capped by SPE lenses and customized reflectors. The modules were tested in a commercial Type V outdoor luminaire housing at a 10-foot mounting height, which achieved the following performance:

- System efficacy: 63 lm/W
- Total luminous flux: 1563 lumens
- Input power: 24.4 W
- Correlated color temperature: 2981 K
- CRI: 65

A non-SPE reference prototype also was built for comparison. Using a similar design with the best commercially available warm-white LEDs, the highest measured efficacy for the reference prototype was 44 lm/W. Compared with the reference prototype, the SPE prototype provides 44% greater system efficacy and used 20% fewer LEDs. The two prototype luminaires met IES illuminance distribution criteria.

Sponsors & Collaborators

Sponsor: New York State Energy Research and Development Authority
Equipment Donor: Philips Hadco
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Lighting Research Center, Rensselaer Polytechnic Institute • 21 Union Street • Troy, NY 12180 • (518) 687-7100 • www.lrc.rpi.edu

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