High-flux focusable color-tunable and efficient white-light-emitting diode light engine for stage lighting

A color mixing light-emitting diode (LED) light engine that can replace 2-kW halogen–Fresnel spotlight with high-luminous flux in excess of 20,000 lm is reported for applications in professional stage and studio lighting. The light engine focuses and mixes the light from 210 LEDs of five different colors through a microlens array (MA) at the gate of ∅50 mm. Hence, it produces homogeneous color-mixed tunable white light from 3000 to 6000 K that can be adjustable from flood to spot position providing 10% translational loss, whereas the corresponding loss from the halogen–Fresnel spotlight is 37%. The design, simulation, and optimization of the light engine is described and compared to the experimental characterization of a prototype. The light engine is optimized through the simulated design of reflector, total internal reflection lens, and MA, as well as the number of LEDs. An optical efficiency of 59% and a luminous efficacy of 33 lm/W are achieved, which is three times higher than the 2-kW halogen–Fresnel spotlight. In addition to having color rendering of color rendering index Ra > 85 and television lighting consistency index 12 > 70, the dimmable and tunable white light can be color controlled during the operational time.
Scopus rating (2011): CiteScore 0.91 SJR 0.471 SNIP 0.966
Web of Science (2011): Impact factor 0.959
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.442 SNIP 0.931
Web of Science (2010): Impact factor 0.822
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.47 SNIP 0.88
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.472 SNIP 0.888
Scopus rating (2007): SJR 0.559 SNIP 0.897
Scopus rating (2006): SJR 0.542 SNIP 1.115
Scopus rating (2005): SJR 0.624 SNIP 1.398
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.632 SNIP 1.284
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.748 SNIP 1.364
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.61 SNIP 1.51
Scopus rating (2001): SJR 0.821 SNIP 1.701
Scopus rating (2000): SJR 1.546 SNIP 0.917
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.296 SNIP 0.81
Original language: English
Keywords: Optoelectronics, Geometric optical design, Illumination design, Microstructure fabrication, Light-emitting diodes, Optical engineering
Electronic versions: OE_55_8_085101.pdf
DOIs: 10.1117/1.OE.55.8.085101

Bibliographical note
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Research output: Research - peer-review › Journal article – Annual report year: 2016