

Technical University of Denmark



Saturation effects of phosphor converted laser diodes

Krasnoshchoka, Anastasiia; Jensen, Ole Bjarlin; Thorseth, Anders; Dam-Hansen, Carsten; Petersen, Paul Michael

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Krasnoshchoka, A., Jensen, O. B., Thorseth, A., Dam-Hansen, C., & Petersen, P. M. (2016). Saturation effects of phosphor converted laser diodes. Poster session presented at DOPS annual conference 2016, Kgs. Lyngby, Denmark.

DTU Library

Technical Information Center of Denmark

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

SATURATION EFFECTS OF PHOSPHOR CONVERTED LASER DIODES

A. Krasnoshchoka, O. B. Jensen, A. Thorseth, C. Dam Hansen, P. M. Petersen

Department of Photonics Engineering, Technical University of Denmark, Roskilde, Denmark

The golden standard for the solid-state lighting (SSL), light emitting diodes (LED), has been rapidly developing during the last decade and continue improving in terms of efficiency and variety of applications [1, 2]. It has lately become competitive with conventional light sources, such as incandescent, halogen, fluorescent and others in the marketplace. Reducing heat generation and lowering energy dissipation LEDs can create more energy conversion efficient visible light for general lighting application as well as for specific applications [3]. Extremely long lifetime, low energy consumption are also some of the factors forcing the growth of the SSL technology.

One of the widely known contemporary architectures of high-brightness white LED is the phosphor converted white light-emitting diode (PC-LED), where blue LED and one or more wavelength-downconverting phosphors are used (fig.1). Due to location of blue at short-wavelength part of the visible spectrum, it makes achievable downconverting blue light into green, yellow and red parts of the spectrum together with phosphorescent and fluorescent materials. Despite great commercial success of PC-LED, they have one remarkable limitation: «nonthermal drop» in efficiency with increasing input power density [4, 5]; thus LED chips need to be operated at low current densities (fig.2). Consequently, to ensure a high efficiency, increasing the number of LED chips is needed to reach a desired high lumen output. A good alternative to achieve high-brightness white light sources is to investigate phosphor converted blue laser diodes (PC-LD) [6-9]. Replacing LDs with LED as a solid-state lighting source could become a solution for “efficiency droop” at high input power densities.

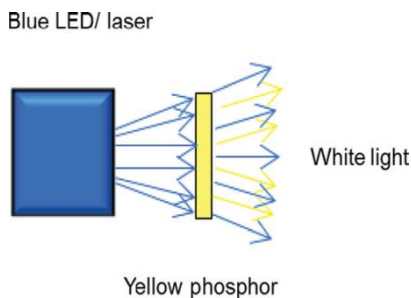


Figure 1 Schematics of a blue LED/LD and phosphor based white light source [10]

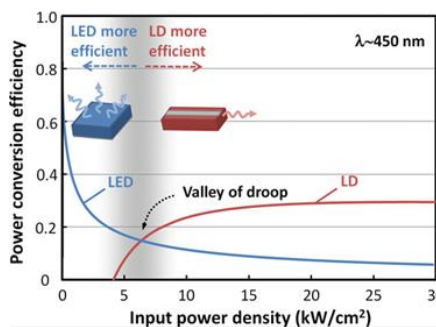


Figure 2 Power-conversion efficiencies versus input power density of high-efficiency blue LED and a high-efficiency blue LD [6]

In our project we are working on improvement of light quality of the PC-LD, both for general lighting and specific applications. Laser generated white light has recently been demonstrated for high beams in top-line cars [11] and introduced in projectors, where the use of ceramic phosphor materials have proven to perform better in terms of resistance to high power densities compared to standard silicone or epoxy based matrices [12]. We assume that investigation of the saturation effects of the ceramic phosphors is the key to empower highly efficient white laser lighting.

References:

- [1] R. Haitz, J. Y. Tsao, *Physica Status Solidi (A) Applications and Materials Science* 208, 17-29 (2011).
- [2] J. Y. Tsao et al., *Advanced Optical Materials* 2, 809-836 (2014).
- [3] C. Basu, M. Meinhardt-Wollweber, B. Roth, *Advanced Optical Technologies* 2, 313-321 (2013).
- [4] Y. C. Shen et al., *Applied Physics Letters* 91 (2007).
- [5] M. H. Crawford, *IEEE Journal on Selected Topics in Quantum Electronics* 15, 1028-1040 (2009).
- [6] J. J. Wierer, J. Y. Tsao, D. S. Sizov, *Laser and Photonics Reviews* 7, 963-993 (2013).
- [7] K. A. Denault et al., *AIP Adv.* 3, 072107 (2013).
- [8] A. Lenef et al., in *Proc. SPIE 9190, Thirteenth International Conference on Solid State Lighting*, M. H. Kane, J. Jiao, N. Dietz, Eds. (Dow Corning, 2014), vol. 9190, p. 11.
- [9] J.-J. Huang, Eds. (Dow Corning, 2014), vol. 9190, p. 11.
- [10] W. W. Chow, M. H. Crawford, *Applied Physics Letters* 107 (2015).
- [11] C. Basu, M. Meinhardt-Wollweber, B. Roth, *Advanced Optical Technologies* 2, 313-321 (2013).
- [12] L. Ulrich, *IEEE Spectrum*, 50, 36 - 56, (2013).