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SATURATION EFFECTS OF PHOSPHOR CONVERTED LASER DIODES

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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.

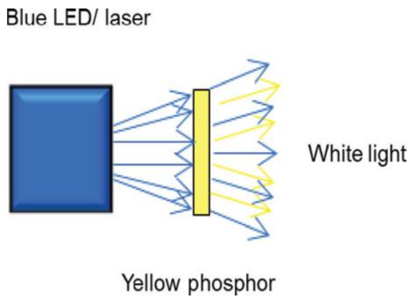

Figure 1 Schematics of a blue LED/LD and phosphor based white light source [10]

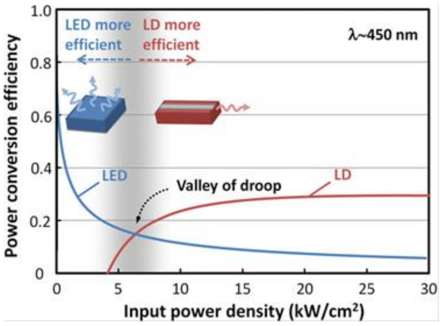

Figure 2 Power-conversion efficiencies versus input power density of high-efficiency blue LED and a high-efficiency blue LD [6]

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.

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