Phosphor converted laser diode light source for endoscopic diagnostics

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PHOSPHOR CONVERTED LASER DIODE LIGHT SOURCE FOR ENDOSCOPIC DIAGNOSTICS

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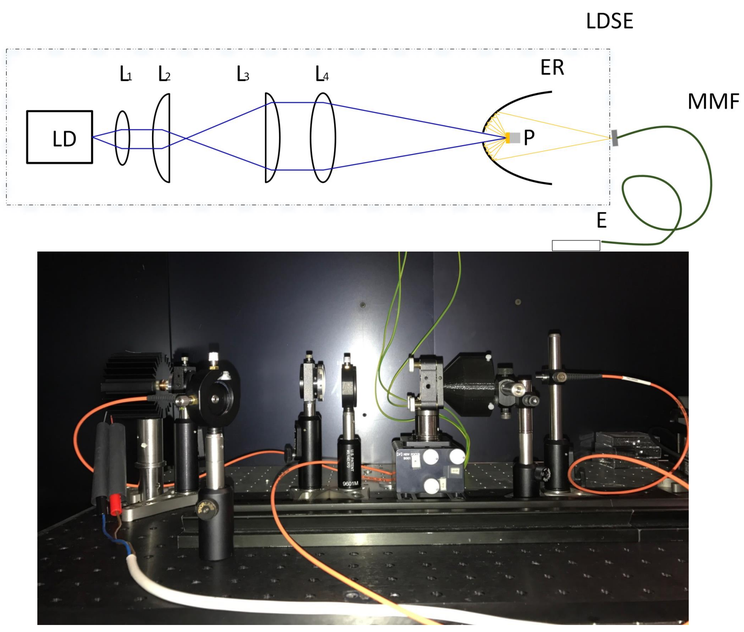
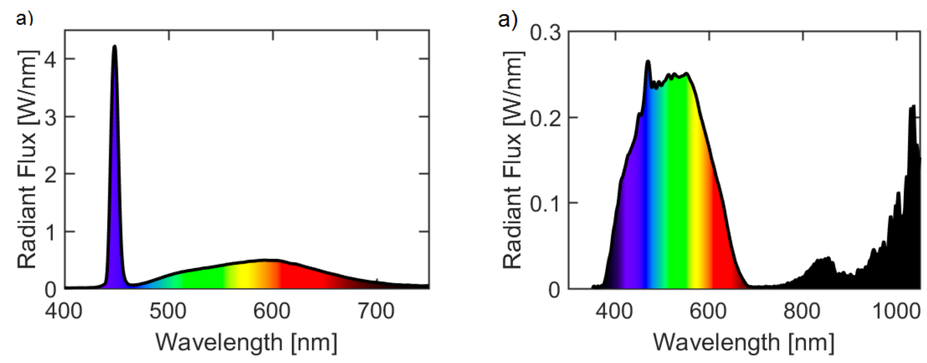
Highly efficient endoscopic white light sources may be enabled by use of phosphor converted blue laser diodes. This light source offers the advantages of a more compact and ergonomic design, lower cost, possibility of tailoring the spectral content and more uniform illumination in comparison with current technology, as well as providing the possibility of shadow formation within the operative field.

Phosphor converted laser diode light source for endoscopy set-up

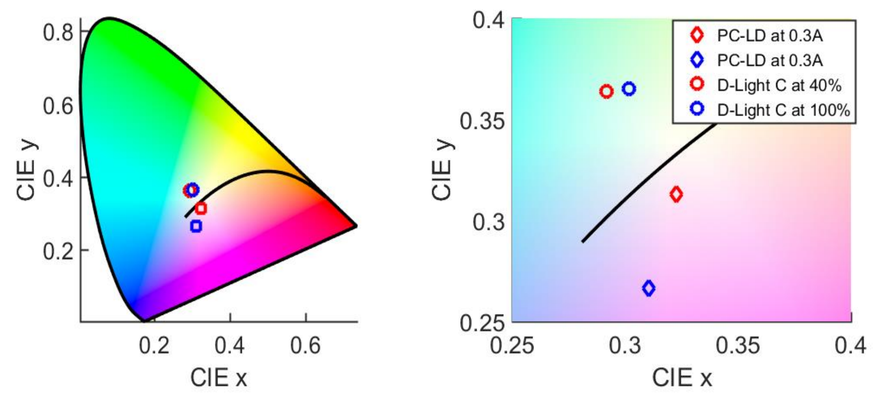


LD – laser diode ($\lambda = 455\ nm$)
L1 – LD lens
L2, L3 – Telescopic system of 2 cylindrical lenses
L4 – Focusing lens
P – Phosphor plate
ER – Elliptical reflector
LDSE – Laser diode system for endoscopy
E – Endoscope
MMF – multimode fiber

Spectral characteristics endoscopic light sources at 4 cm distance



	PC-LD light source at 0.3 A	PC-LD light source at 0.4 A	Karl Storz D Light C, 40% power level	Karl Storz D Light C, 100% power level
Illuminance, lx	18677	28592	6324	15613
CRI	83.3	85.3	77.7	75.4
CCT, K	5976	7972	6772	7256
D_{uv}	-0.0123	-0.0432	+0.0321	+0.0366



Spectral characteristics of fiber coupled generated white light from PC-LD

Power, W	Illuminance, lx			
	PC-LD light source before fiber coupling	PC-LD light source coupled into 400 μm fiber	PC-LD light source coupled into 600 μm fiber	PC-LD light source coupled into 1000 μm fiber
0.011	4749	320	940	1716
0.022	8195	968	2378	4489
0.055	19300	2307	5272	10030

Maximal coupling efficiency of generated white light achieved – 55 %

We present a novel endoscopic illumination source, based on the use of a blue LD and a mixture of the down-converting materials Ce:LuAG and Eu-doped nitride yellow phosphor for the production of white light. We have been investigating general behavior of the ceramic phosphors and their tendency to saturate under certain intensity of illumination.

Among the main advantages are higher efficiency, much better coupling efficiency into thin fibers and possibility of tailoring the spectral content. It is also worth mentioning that in our prototype, the phosphor material is not situated at the distal end of the endoscope and light is being converted before coupling into a fiber, thus it is not toxic for the patient.

With our PC-LD light source we achieved comparable illuminance as a commercially available D-Light C xenon lamp. We were also able to couple generated white light from PC-LD into thin optical fibers (400 μm, 600 μm, 1000 μm) with a maximal coupling efficiency of 55%.