Ce:$(Y_{1-x}Gd_x)_3Al_5O_{12}$ single-crystal phosphors for high brightness white LEDs/LDs

○**Stelian Arjoca[1,2*], Encarnación G. Víllora[2], Daisuke Inomata[3,4], Kazuo Aoki[4], and Kiyoshi Shimamura[1,2]**

[1] *Department of Nanoscience and Nanoengineering, Waseda University, 3-4-1 Okubo, Shinjuku, Tokyo 169-8555, Japan.*

[2] *National Institute for Materials Science (NIMS), 1-1 Namiki, Tsukuba, Ibaraki 305-0044, Japan.*

[3] *Tamura Co., Ltd., Sayama, Saitama 350-1328, Japan.*

[4] *Koha Co., Ltd., Nerima, Tokyo 176-0022, Japan.*

*E-mail address: arjoca.stelian@nims.go.jp

Highly efficient and stable phosphors are required to realize high-brightness (HB) white light-emitting diodes (wLEDs). Recently, we have proposed the use of single-crystal phosphors (SCPs) based on Ce:$Y_3Al_5O_{12}$ (Ce:YAG) instead of conventional ceramic powder phosphors [1,2]. Compared to these, SCPs possess a higher quantum efficiency, a higher thermal stability, and an outstanding higher thermal conductivity, which prevents from device overheating. Therefore, high conversion efficiencies are achieved even under high irradiances. The pure Ce:YAG SPCs in conjunction with blue LEDs and laser diodes (LDs) produce white light with a color temperature *Tc* in the range of 6000-7000 K [1]. There are many applications, however, which require a lower *Tc*. The simplest approach is to broaden the emission of the yellow phosphor towards the red region. For this purpose, in this study the optical properties of Ce:$(Y_{1-x}Gd_x)_3Al_5O_{12}$ (Ce:YGdAG) SCPs are investigated as a function of Gd concentration and temperature.

Ce:YGdAG single-crystals were grown by the Czochralski technique with Gd concentrations varying between 0 and 18 at.%. Powder X-ray diffraction measurements indicate, on the one hand, that the lattice expansion follows the Vegard's law approximately and on the other hand, that the thermal expansion is practically independent of Gd in the considered content range. Photoluminescence measurements show that with the increase in Gd concentration the Ce^{3+} emission is redshifted, while the quenching temperature of the SCP decreases. Figure 1 illustrates, as an example, the *Tc* that can be obtained with Ce:YGdAG SCPs at different temperatures in conjunction with a blue-LED/LD emitting at 450 nm. As can be seen, the incorporation of a small amount of Gd is efficient to lower the *Tc*, achieving neutral *Tc* in the range 5000-6000 K. Therefore, Ce:YGdAG SCPs are promising for neutral white HB wLEDs/LDs.

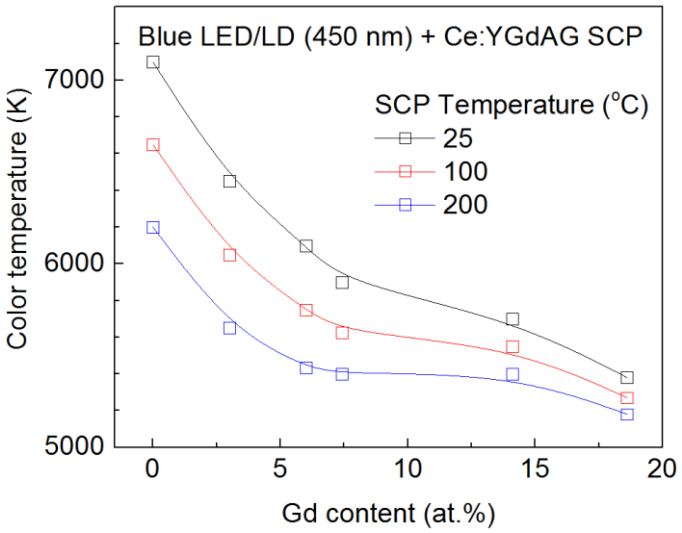

Figure 1 Estimated color temperature as a function of Gd concentration in Ce:YGdAG plus a 450 nm LED.

Acknowledgement

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References:

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