Wavelength conversion material "Phosphor-glass composites" for high power solid-state lighting

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Phosphor converted-Light Emitting Diodes / Laser Diodes (pc-LEDs/LDs) have been attracting much attention as solid-state lighting devices. Most of the common pc-LEDs/LDs consist of Ce doped YAG phosphor sealed in resin matrix and a blue-LED/LD for exciting light source. However, the resin matrix tends to be deteriorated by heat arising from the high power of blue LED/LD. [1,2] This deterioration results in undesirable color changes and deformations of it, therefore lifetime of pc-LEDs/LDs might become short. To solve these problems, we have developed a wavelength conversion material 'Phosphor-Glass Composites' in which phosphors are dispersed homogeneously.

The phosphor-glass composites were obtained by vitrifying mixtures of B_2O_3-SiO_2 system glass powder and commercial phosphors such as YAG, $La_3Si_6N_{11}$:Ce (LSN) and α-SiAlON. In the result of highly accelerated stress test (Fig. 1.), the phosphor-glass composite shows higher weather resistance than conventional phosphor-resin composite. The relative luminous flux didn't change at all even if the sample was exposed under a condition of 121°C, 95% RH and 2atm for 300h. The phosphor-glass composites provide another feature that the variation in emission color is extremely small because of homogeneous dispersion of the phosphor in glass matrix and precise dimensional control in process. These phosphor-glass composites show high fluorescence intensity more than double, when appropriate blue band-pass filter is coated on the incident surface of the exciting blue light source (Fig. 2.). The band pass filter consists of dielectric multi-layer.

As outputs of pc-LEDs/LDs increase, high weather resistance and heat resistance are required in wavelength conversion materials. Phosphor-glass composites, which have high weather resistance and heat resistance, are expected as a wavelength conversion material for high power solid-state lighting. Moreover, a small variation in emission color would help to precise optical designs of solid-state lighting devices

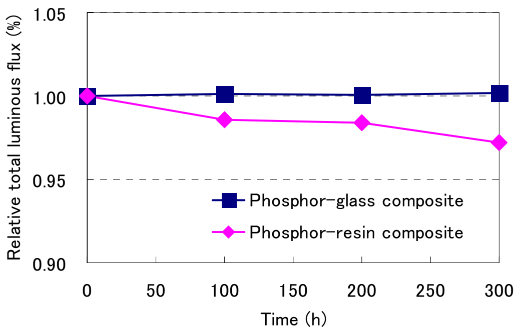

Fig. 1. The change of total luminous flux during the highly accelerated stress test under the conditions of 121°C, 95% RH and 2 atm. (Phosphor: LSN)

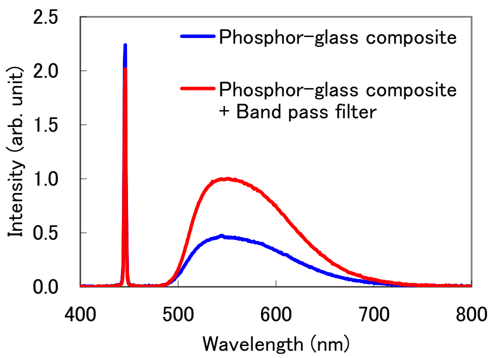

Fig. 2. Emission intensity of each sample.

References

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[2] S. I. Chan, W. S. Hong, K. T. Kim, Y. G. Yoon, J. H. Han and J. S. Jang, "Accelerated life test of high power white light emitting diodes based on package failure mechanisms", Microelectronics Reliability 51, 1806 (2011).