Alumina coating on Eu^{2+}-doped Sr_3SiO_5 phosphor powder by atomic layer deposition and its encapsulation into phosphate glass

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The light emitting diode (LED) is practically assembled by the encapsulation of InGaN-based diode and phosphor into the polymer resins (*e.g.*, silicone resin). However, the increase in heat generated by the LED, due to the power increase, brings about the problem regarding the degradation of not only phosphors but also polymer resin. Therefore, we paid attention to glass materials for encapsulation, instead of polymer resin, and enhanced thermal stability of phosphor powder. In this research, we examined the utilization of $30Na_2O$-$10Al_2O_3$-$60P_2O_5$ glass, instead of polymer resign, and coating of europium-doped strontium silicate (Sr_3SiO_5:Eu^{2+}) phosphor particles by alumina (Al_2O_3), both for the enhancement of thermal stability. An atomic layer deposition (ALD) in a fluidized bed reactor was conducted for the coating of Sr_3SiO_5:Eu^{2+} phosphor particles by Al_2O_3, using trimethyl aluminum ($Al(CH_3)_3$: TMA)/water (H_2O) as reaction precursors, and N_2 gas as a purge gas. The emission intensity in air, as well as thermal stability, increased with number of cycles to 200. The resulting Al_2O_3-coated Sr_3SiO_5:Eu^{2+} phosphor particles (200 ALD cycles, the estimated film thickness being 24.1 nm; **Fig. 1**) were encapsulated into $30Na_2O$-$10Al_2O_3$-$60P_2O_5$ glass by the firing at 450°C for 15 min in air. The emission peak appeared at the same value as that of original Sr_3SiO_5Ëu^{2+} phosphor (588 nm) and the phosphor-in-glass showed bright yellowish-orange light emission without thermal degradation. No peak shift, as well as no marked changes in peak intensity of emission spectra, were found in the case of Al_2O_3-coated Sr_3SiO_5:Eu^{2+} particles, which proved that the Al_2O_3 film is effective for the enhancement of thermal stability.

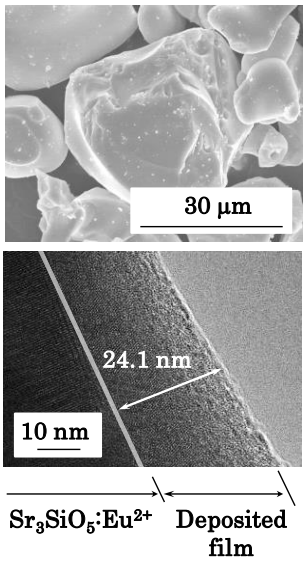

Fig. 1 SEM micrograph (above) and TEM micrograph (below) of Al_2O_3-coated Sr_3SiO_5:Eu^{2+} particles after 200 ALD cycles of TMA-N_2-H_2O-N_2 in the glass reactor tube at 120°C.