펄스레이저법으로 증착한 $Y_{2-x}Gd_xO_3:Eu^{3+}$ 형광체 박막의 형광 특성

Photoluminescence characteristics of pulsed laser deposited $Y_{2-x}Gd_xO_3:Eu^{3+}$ thin film phosphors

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Significant research interest in the growth and characterization of $Y_2O_3:Eu^{3+}$ thin films has been shown over the last few years because of the promise for applications of display devices.(1) Although an Eu-doped oxysulfide (Eu: Y_2O_2S) which has an efficiency of 13% has been used for a traditional cathode ray tube (CRT) red phosphor,(2) the sulfide system is known to degrade rapidly under the high current densities needed for field-emission display (FED) technology.(3) On the other hand, the oxide-based phosphors have been found to be more stable under these conditions. Therefore, oxide-based phosphors are likely to emerge as the potential choice for the FED red phosphor.

In this work, we have deposited $Y_{2-x}Gd_xO_3:Eu^{3+}$ thin films on single crystal Al_2O_3 (0001) and Si (100) substrates using a pulsed-laser deposition technique. Y_2O_3 and Gd_2O_3 could have the same cubic structure and a very small difference in lattice constant. By substituting Y_2O_3 with Gd_2O_3, we could improve the luminescent characteristics under optimized conditions. Also, we report structural characterization and measurements of luminescence properties of $Y_{2-x}Gd_xO_3:Eu^{3+}$ thin films.

The films were grown by PLD using an ArF excimer laser with a wavelength of 193 nm. The distance between target and substrate was kept at 35 mm. The laser fluence was approximately 4.0 J/cm^2 and repetition rate was 5 Hz. The thin films were deposited on Si (100) and Al_2O_3 (0001) substrates at substrate temperature of 600 °C with the oxygen pressures of 200 mTorr. The surface morphology of the films were measured by a atomic force microscope (AFM). The structural characteristics of the films were analyzed by using X-ray diffraction (XRD). The PL spectra were measured at room temperature using a luminescence spectrometer broadband incoherent ultraviolet light source with a dominant excitation wavelength of 254 nm.

Shown in Fig. 1 is the XRD patterns of the $Y_{1.35}Gd_{0.6}O_3:Eu^{3+}$ thin films deposited on Al_2O_3 (0001) and Si (100) substrates at the substrate temperature 600 °C with the oxygen pressure of 200 mTorr. Si (100) substrate has a cubic (a = 0.543 nm) structure and Al_2O_3 (0001) substrate has a hexagonal structure (lattice constants a = 0.476 nm, c = 1.299 nm). Y_2O_3 and Gd_2O_3 have a cubic structure

(a_{Y2O3} = 1.0604 nm and a_{Gd2O3} = 1.0813 nm) and Y_2O_3 has the lattice mismatches with Si (100) and Al_2O_3 (0001) substrates are (7.4 % and 2.9 %), respectively. The diffraction data suggest that the (222) surface is preferred orientation for films grown on both Si (100) and Al_2O_3 (0001) substrate. The full width at half maximum (FWHM) of the diffraction peaks is narrower for the film grown on Al_2O_3 (0001) substrate than for the film grown on Si (100) substrate, indicating the better crystallinity of the former than of the latter due to the lower lattice mismatch.

The AFM measurements from both thin films grown on (a) Al_2O_3 (0001) and (b) Si (100) substrates have shown in Fig. 2. It is clear from AFM images that the grains of $Y_{1.35}Gd_{0.6}O_3:Eu^{3+}$ film grown on Al_2O_3 (0001) substrate are larger as well as well-defined ones with octahedral shape compared with those of the film grown on Si (100) substrate. The average grain sizes (~290 nm) in the $Y_{1.35}Gd_{0.6}O_3:Eu^{3+}$ films grown on Al_2O_3 (0001) substrate is larger than the grain size (~210 nm) grown on Si (100) substrate.

Figure 3 shows the PL behaviors of the $Y_{1.35}Gd_{0.6}O_3:Eu^{3+}$ films grown on Al_2O_3 (0001) and Si (100) substrates at temperature of 600 °C with oxygen pressure of 200 mTorr. The PL of films were dominated by a red emission peak at 612 nm. Due to the shielding effect of 4f electrons by 5s and 5p electrons in the outer shells of the europium ion, narrow emission peaks are expected, consistent with the sharp peak in Fig. 3. It is clear from Fig. 3 that the PL brightness of the $Y_{1.35}Gd_{0.6}O_3:Eu^{3+}$ films on Al_2O_3 (0001) are higher than that of films on Si (100) substrates.

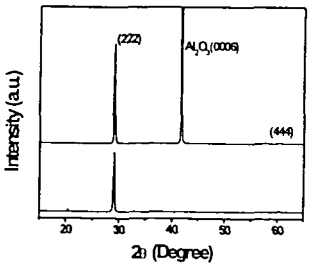

Figure 1. XRD patterns of the $Y_{1.35}Gd_{0.6}O_3:Eu^{3+}$ thin films deposited on Al_2O_3 (0001) and Si (100) substrates

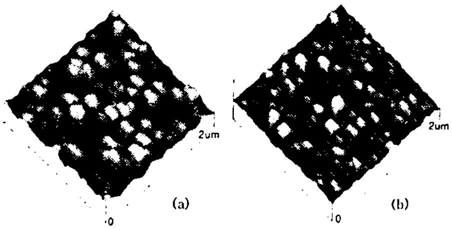

Figure 2. AFM images of the $Y_{1.35}Gd_{0.6}O_3:Eu^{3+}$ thin films deposited on Al_2O_3 (0001) and Si (100) substrates

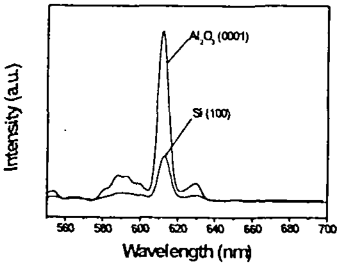

Figure 3. PL intensity of the $Y_{1.35}Gd_{0.6}O_3:Eu^{3+}$ thin films deposited on Al_2O_3 (0001) and Si (100) substrates

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