Li 첨가에 의한 $Gd_2O_3:Eu^{3+}$ 박막 형광체의 형광 특성

Luminescence characteristics of $Gd_2O_3:Eu^{3+}$ thin film phosphors by Li-doping

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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. Among those oxide-based phosphors, $Gd_2O_3:Eu^{3+}$ thin film was proposed as one of the most promising oxide-based red phosphor systems.(4)

It is well known that even in very small quantities, the Li^+ coactivators frequently play an important role in the enhancement of the luminescent efficiency of phosphors.(5) In this work, we report the comprehensive study of PLD, structural characterization, and measurement of luminescence properties of $Gd_2O_3:Eu^{3+}$ and Li-doped $Gd_2O_3:Eu^{3+}$ 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 $Al_2O_3(0001)$ substrates at substrate temperature 600 °C under 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.

Figure 1 shows the XRD patterns of the $Gd_2O_3:Eu^{3+}$ and Li-doped $Gd_2O_3:Eu^{3+}$ films deposited on Al_2O_3 (0001) substrate at 600 °C and oxygen pressure of 200 mTorr. The diffraction data suggest that the films grown with Li-doping exhibited a complete cubic structure but the mixed structure of cubic and monoclinic phases is detected in the film grown without Li doping. These diffraction patterns illustrate that the (222) surface is preferred orientation and the full width at half maximum (FWHM) of the diffraction peaks is narrower (~20%) for the film grown with Li doping than for the film grown without Li doping.

As shown in Fig. 2, the AFM measurements have shown that the grain size (~190 nm) in the Li-doped $Gd_2O_3:Eu^{3+}$ film is larger than the grain size (~140 nm) in $Gd_2O_3:Eu^{3+}$ film. The root mean square (rms) roughness of these films, measured by AFM, was found to increase from 8.4 to 16.1 nm by doping Li contents. The increase in the value of rms roughness with Li doping is attributed to the enhanced grain size.

Figure 3 shows the comparison of the room temperature PL spectra of $Gd_2O_3:Eu^{3+}$ and Li-doped $Gd_2O_3:Eu^{3+}$ films grown at the same conditions. The film was ~1.0 m thick and the radiation was dominated by the red emission peak at 612 nm. Due to the shielding effect of *4f* electrons by *5s* and *5p* electrons in outer shells in the europium ion, narrow emission peaks are expected, consistent with the sharp peak in Fig. 3. As shown in Fig. 3, the brightness of Li-doped $Gd_2O_3:Eu^{3+}$ films was increased by a factor of 2.3 in comparison with that of $Gd_2O_3:Eu^{3+}$ films.

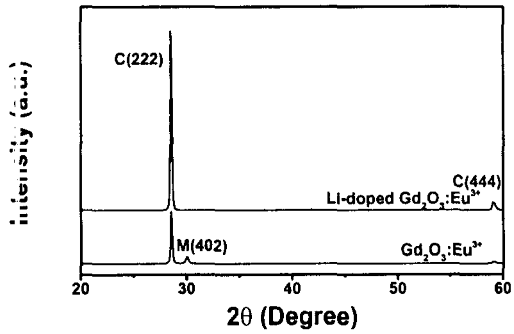

Fig. 1 XRD patterns of $Gd_2O_3:Eu^{3+}$ and Li-doped $Gd_2O_3:Eu^{3+}$ films deposited on Al_2O_3 (0001) substrate

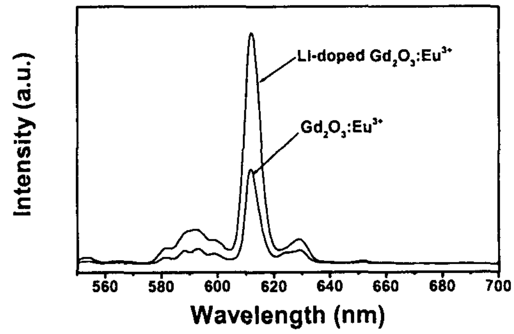

Fig. 3 A comparison of PL spectra of $Gd_2O_3:Eu^{3+}$ and Li-doped $Gd_2O_3:Eu^{3+}$ thin films.

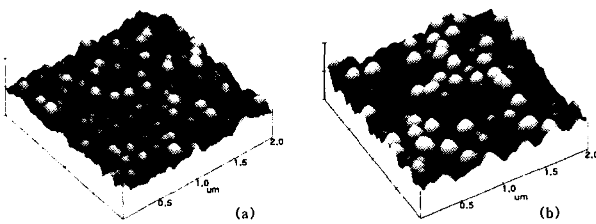

Fig. 2 AFM images of $Gd_2O_3:Eu^{3+}$ and Li-doped $Gd_2O_3:Eu^{3+}$ films deposited on Al_2O_3 (0001) substrate

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