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EXAFS analysis of local structures around Tb ions implanted in SiO_2 by detecting x-ray-excited visible luminescence

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Introduction

Rare-earth doped semiconductors have been attracting much interest for possible applications in light-emitting devices and for their unique optical properties. Intra-4f-shell luminescence of rare-earth ions doped in semiconductor is sharp and temperature-stable. For example, it is reported that Tb ions implanted in SiO_2:Tb thin film on Si showed strong visible luminescence at room temperature [1]. However, the luminescence intensity in the SiO_2:Tb thin film has been found to depend strongly on growth conditions. In this work, local structures around optically active Tb ions implanted in SiO_2 on Si, which exhibited strong green luminescence (540 nm) at room temperature, were investigated site-selectively by using x-ray-excited visible luminescence EXAFS analysis.

Experimental

SiO_2 films of 200 nm thickness, which were formed by dry thermal oxidation, were grown on p-Si(001). Tb ion was introduced into the oxide layer by ion implantation. The implantation was performed at 300keV. Dose density of Tb implanted in SiO_2 was 1×10^{15} Tb ions/cm^2. Annealing of the SiO_2:Tb film was performed in vacuum (~10^{-5} Torr) at 900 ºC for 30min. The EXAFS measurements were performed at the beam line BL9A at KEK-PF. X-ray-excited visible luminescence was detected by CCD detector or photomultiplier.

Results and discussion

Figure 1 shows the photoluminescence spectra for SiO_2:Tb excited by synchrotron radiation (SR) and Ar^+ laser. By X-rat-excited visible luminescence due to Tb intra-4f transition was observed clearly. Figure 2 shows visible luminescence intensity excited by SR and fluorescence x-ray intensity. By detecting visible luminescence due to Tb intra-4*f* transition, oscillatory spectrum was clearly observed, suggesting that there is a possibility of EXAFS analysis for SiO_2:Tb by detecting x-ray-excited visible luminescence.

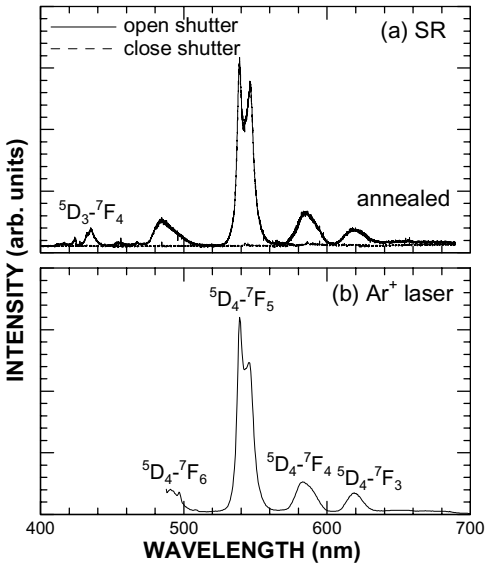

Fig.1 Photoluminescence spectra for SiO_2:Tb excited by (a) synchrotron radiation (SR) and (b) Ar^+ laser. Photoluminescence was detected by CCD.

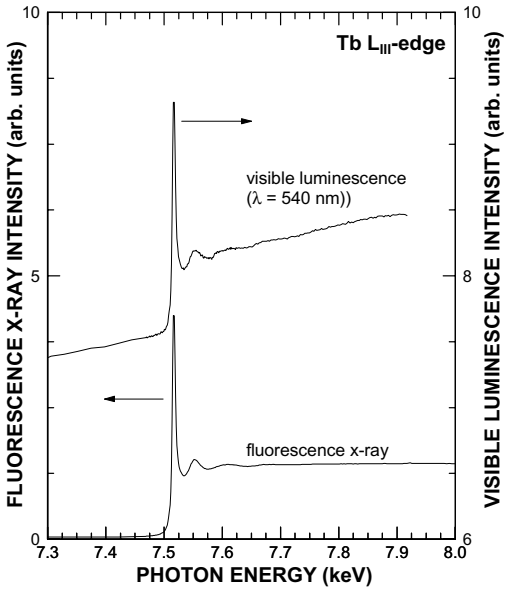

Fig. 2: Visible luminescence intensity excited by SR and fluorescence x-ray intensity.

References

[1] H. Amekura et al., J. Appl. Phys. 84 (1998) 3867.

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