EXAFS analysis of local structures around Tb ions implanted in SiO$_2$
by detecting x-ray-excited visible luminescence

Hironori OFUCHI*1, Yoshiaki IMAIZUMI2, Hiroharu SUGAWARA3, Masao TABUCHI1 and Yoshikazu TAKEDA1
1 Nagoya University, Furo-Cho, Chikusa-Ku, Nagoya 464-8603, Japan
2 IMR, Tohoku University, Aoba-Ku, Katahira, Sendai 980-8577, Japan
3 TMIT, 6-6, Asahigaoka, Hino City, Tokyo 191-0065, Japan

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 $1 \times 10^{15}$ Tb ions/cm$^2$. Annealing of the SiO$_2$:Tb film was performed in vacuum (~10$^{-5}$ Torr) at 900 $^\circ$C 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-4f 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.

References

* ofuchi@numse.nagoya-u.ac.jp

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.