Design of a transmission mode detector by using a Tl doped scintillator for Si K-edge XANES

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BL-10 in the SR Center is a XAFS beam line in the soft X-ray region from 1000 eV to 4000 eV. We have developed a multimode simultaneous detection system with the Total Electron Yield (TEY) and Partial Fluorescence Yield (PFY) modes. [1] This system simultaneously provides surface sensitive and bulk sensitive signals, and enables us to monitor the depth profile of a sample in detail. However, the XAFS spectra using the Fluorescence Yield mode are sometimes distorted by the self-absorption effect for thick and/or highly concentrated samples. To overcome this problem, we installed a Si photo diode detector and examined whether the transmission mode is usable or not in the soft X-ray region. Consequently, we proved the transmission mode is available for a particular sample, suitably adjusted in the soft X-ray region. We have tested two kinds of detector systems; Si photo diode detector (SPD) and SPD with scintillator made of Tl doped CsI crystal, as shown in Fig. 1(left).

A scintillator emits visible radiation when it receives X-rays, as shown in Fig.1 (right). Our new transmission mode has an advantage of detecting not direct X-rays, but the secondary light at Si K-edge. Figure 2 exhibits Si K edge spectra of quartz powder buried in resin by

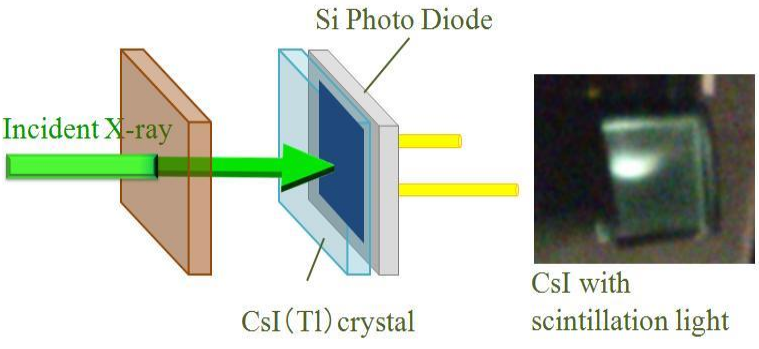

Fig.1 The new transmission beam detector at Si K-edge. The CsI crystal form is an 10mm square and a thickness of 3mm.

two kinds of detection systems. The red line spectrum was taken by using only Si photo diode, which is distorted around Si absorption edge, while the other was taken by the new transmission detector, which avoids the self-absorption effect.

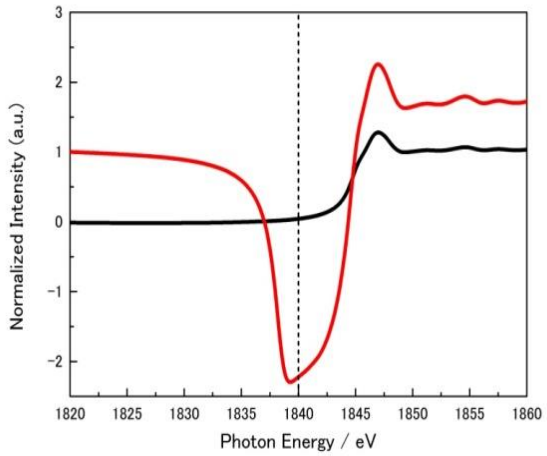

Fig.2 Si K-edge XANES spectra of quartz powder buried in resin. Red line is the spectrum obtained by the SPD itself. Black line is obtained by the new detector. Vertical dot line indicates around Silicon K absorption edge.

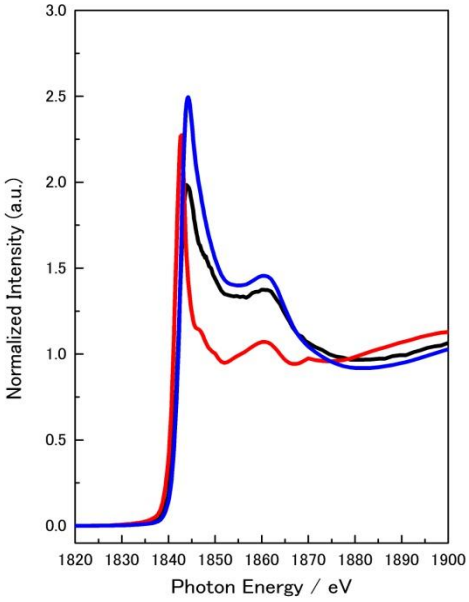

Fig.3 SiN XAFS spectra taken by the different detection modes. Black and red lines are the spectra by the PFY and TEY modes, respectively, while blue line is that by the new transmission mode.

Note that the CsI scintillation detector provided undistorted spectra. Figure 3 shows Si K-edge XANES spectra of a SiN film obtained by the multimode simultaneous detection system with PFY, TEY and Transmission method. Silicon nitride thin film (SiN) was made by Silson Ltd. These three modes provide us the spectra with different probing depth.

It should be noted that the TEY spectrum does not look like the transmission one, indicating that the surface is not SiN, but closer to SiH_4.

We constructed an unprecedented and original soft-XAFS detection system.

Reference

(1) Koji Nakanishi and Toshiaki Ohta, *Surf. Interface Anal*., **44** (2012) 784 - 788.