Development of a Partial Electron Yield Detector in the Tender X-ray Region for Surface Sensitive Analysis

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In the soft X-ray region , X-ray absorption fine structure (XAFS) spectra are usually taken with the total and partial electron yield (TEY and PEY) modes, as well as the fluorescence yield (FY) mode due to the low transmittance of soft X-rays. Since these three modes have different probing depths, combined use of them provides depth profiling XAFS spectra. The PEY mode is generally performed by the set of a retarding grid and a micro-channel plate. It works successfully in the low energy soft X-ray region below 1000 eV, but it does not provide a surface sensitive PEY spectrum above 1000 eV (tender X-ray region) due to mixing of FY spectra. In this report, a new setup of PEY detector has been developed, which almost completely suppresses the mixing of FY spectra in the tender X-ray region.

Fig. 1 shows the experimental setup for the PEY detection. The new PEY detector consists of a Chevron-type MCP, an electron collector, retarding grid, electron deflecting plate and shielding plate that blocks electrons and X-rays emitted directly toward the MCP. To reduce electrical noise, a specially designed battery box was also fabricated as a high voltage power supply for the electronic collector of MCP. By applying a proper set of voltages on the retarding grid and deflecting plate, we can collect only high energy electrons emitted from the sample, which provides more surface sensitive XAFS than TEY. Fig. 2 shows the Si K-edge XAFS spectra for SiO_2 / Si (111) measured by PEY mode. Two peaks are easily identified. The features observed around 1840 eV are attributable to Si^0 and those around 1847 eV are associated with Si^{4+} (referred to as SiO_2).

As the thickness of SiO_2 film is increased, the intensity of Si^0 component decreases and that of Si^{4+} component increases. For SiO_2 film thicknesses exceeding 8.1 nm, the Si^0 signal can no longer be observed. These results suggest that the maximum sampling depth for PEY is found to be ~10 nm for the Si K-edge regions while for TEY are ~70nm[1].

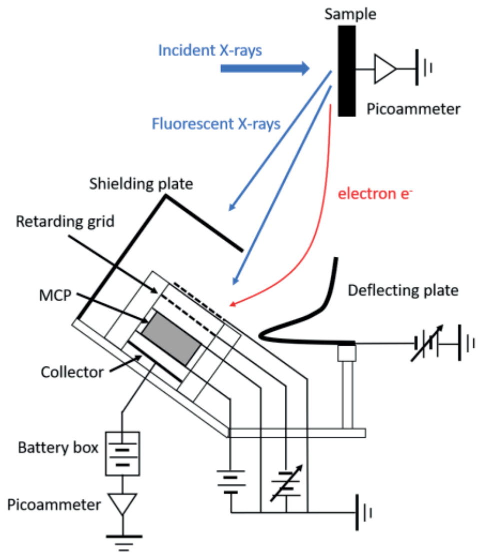

Fig. 1 Schematic of the PEY detection system with trajectories of electrons and X-rays.

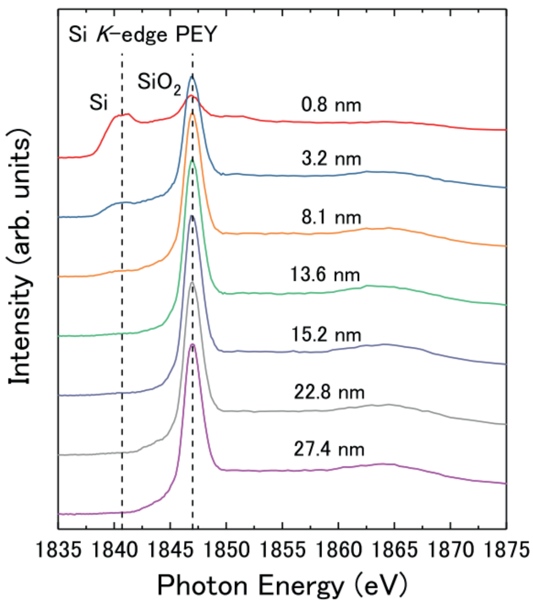

Fig. 2 S Si K-edge XAFS spectra of SiO_2/Si(111) as a function of SiO_2 film thickness by PEY mode.

References

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