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Study on the behavior of the photoelectrons with lower energies in the ultra thin film of silicon oxide

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1 Introduction

X-ray photoelectron spectroscopy (XPS) has been used for the quantitative and qualitative analysis method in the development of functional material because of its high surface sensitivity. To determine the thickness of the thin film using XPS, the attenuation length (AL) of the photoelectron is an important parameter. For a long time, inelastic mean free path (IMFP) has been used as an alternative of AL because the values of IMFP can be calculate using the equation TPP-2M [1]. However the effect of the elastic scattering is not considered in the evaluation of IMFPs.

Recently effective attenuation length (EAL) is proposed [2]. I have been studied the EAL of the photoelectron in the SiO_2 thin films with the energy range of 100–1000 eV [3] at old BL-13C station [4,5]. In this P-type proposal, the preliminary experiments for the measurements of EALs of the photoelectrons in the silicon oxide thin film with lower energy.

2 Experiment

The measurements of XPS spectra were carried at BL-3B using the apparatus for the angle-resolved x-ray photoemission spectroscopy (ARPES II). In this apparatus, the hemispherical electron analyzers with a 50 mm mean radius (VSW HA54) are fixed on the goniometer can be rotate in the vacuum chamber. The energy step was 0.05 eV. The pass energy was set as 10 eV. The acceptance angle was ±1°. The angle between the incident x-ray and the surface normal of the sample was fixed as 55°. The emission angle of the photoelectrons from the surface normal was changed as 0°, 15°, 30°, 45°, 60°, and 75° rotating the electron analyzer. The energy of the incident x-ray was selected as 130 eV, 150 eV, 200 eV, 250 eV.

The SiO_2 thin film was fabricated by a thermal process on Si(100) substrate with a thickness of 2.2 nm. The thickness of the SiO_2 was certified using grazing incident x-ray reflectivity.

3 Results and Discussion

Fig. 1 shows the Si 2p spectra of SiO_2 thin film measured with the emission angle of surface normal excited by x-ray with the energy of 150 eV. Si oxide peak from the thin film appears at 43 eV and Si metal peak from the substrate at 47 eV. The peak intensity from the substrate at 47 eV is weaker than that from the thin film because of the very small value of EAL. To estimate the value of EALs correctly, the enough time to measure the peak from the substrate clearly. From the results of the measurements with several different condition, the necessary beam time for the succeeding G-type proposal was estimated.

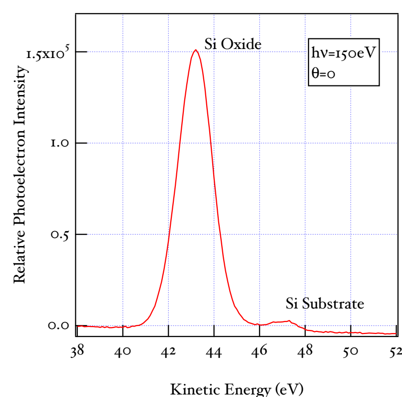

Fig. 1: XPS Spectrum of SiO_2 thin film.

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References

[1] S. Tanuma *et al.*, *Surf. Interface Anal.*, **17** (1991) 927; **20** (1993) 77; **21** (1993) 165.
[2] ISO 18115:2001-surface chemical analysis - vocabulary.
[3] M. Imamura *et al.*, *Meas. Sci. Technol.* **22** (2011) 024007.
[4] N. Matsubayashi *et al.*, *Rev. Sci. Instrum.* **63** (1992) 1363.
[5] H. Shimada *et al.*, *Rev. Sci. Instrum.*] **66** (1995) 1780.

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