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Total Reflection Compton Profile

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It is interesting to understand electronic structure of surface nano-structured materials. As the penetration depth under the X-ray total reflection (XTR) is about 2nm, Compton scattering under the XTR will give information on the wave function of surface states of the nano-structured materials. In this study we try a Compton scattering measurement under the XTR to get the surface sensitive Compton profile.

The incident monochromatized X-ray energy was 41.8keV. The scattering angle was 160 degrees. A beam size was 0.05×2mm^2. Au buffer layer (200nm) was evaporated on a polished quartz substrate (20×90×20mm^3) and the topmost Fe layer with 20nm was evaporated on the buffer layer. The Fe plate (20×90×1mm^3) was measured as a reference sample with an incident angle of 10 degrees. The measurement was carried out in the air at R. T

Figure 1 shows an experimental reflection curve of the sample. Critical angles of Fe: θ_{Fe} =0.07degree (the calculated value is 0.079 degree.) and Au: θ_{Au} =0.105 degree (the calculated value is 0.115 degree.) are observed in Fig. 1.

Figures 2 show Compton profiles under the XTR ((a), θ = 0.05 degree), just on the Fe critical angle ((b), θ=0.07 degree), and just below the Au critical angle ((c), 0.11 degree). The Fe Kα fluorescence shows the maximum at the θ=0.07 degrees. This suggests that Compton scattered photons just come from the Fe layer. Compton scattered photons are dominated by the Au layer in Fig. 1(c) because the Au Lα fluorescence increases.

The scattering from air (30%) and Au buffer layer (25%) were removed from the spectra in Fig. 2 to get contributions from Fe layer. Figures 3 show estimated Compton profiles of the topmost Fe layer. The Compton profile at θ=0.07degree is similar to that of the reference Fe sample (the Fe plate). However, the Compton profile under the XTR is narrower than the Compton profile of the reference Fe sample. This is because Compton scattered photons come from surface oxide layer.

In conclusion, we succeed to measure surface sensitive Compton profile under the X-ray total reflection condition. We will move to measuring magnetic Compton profile under the X-ray total reflection condition as a next step.

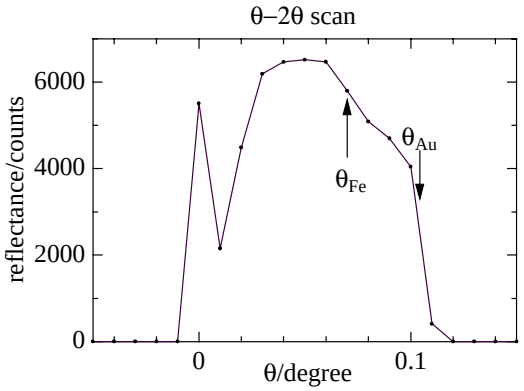

Figure 1

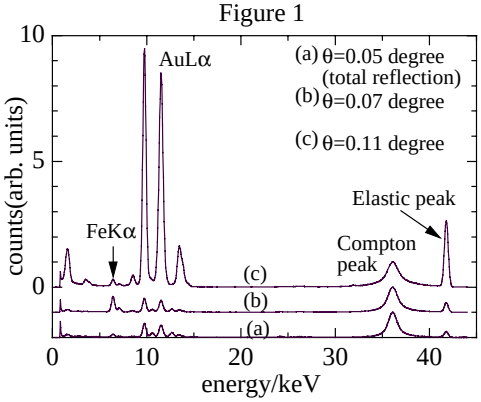

Figure 2
Compton profiles

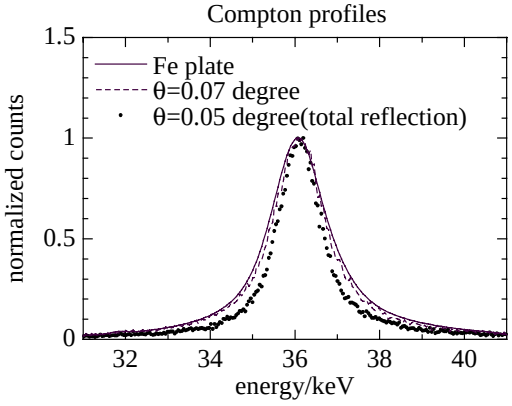

Figure 3

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