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X-ray Characterization of Cu/Fe/Cu(001) Interface

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Introduction

The magnetic property of Fe thin film grown on the Cu(001) surface is very attractive subject because it changes drastically depending on the thickness and crystal structure of the film[1]. Although it had been believed that the Fe crystal growth starts from the fcc type according to the crystal structure of the Cu(001) substrate[2], the present situation is somewhat confused because the recent STM study observed bcc Fe islands in the early stage of the growth[3]. Since the perfect determination of the structure of the Fe film is the key to understand its magnetic property, we made X-ray characterization experiment.

Experimental and results

Our sample was prepared in an ultrahigh vacuum chamber whose base pressure is $1x10^{-10}$ Torr. The Cu(001) substrate was cleaned by the cycle of 10-minute annealing at 800K and 30-minute Ar sputtering of 2keV, which was repeated until the clean 1x1 LEED pattern appeared and no contamination was observed by Auger electron spectroscopy. After the cleaning, about 4ML of Fe atoms were deposited by a Knudsen cell on the Cu(001) surface kept at the room temperature.

Figure 1 is the LEED pattern of the Fe/Cu(001) surface. The satellite spots beside the 01 spots show a distinct profile of the 4ML Fe film on the Cu(001)[4].

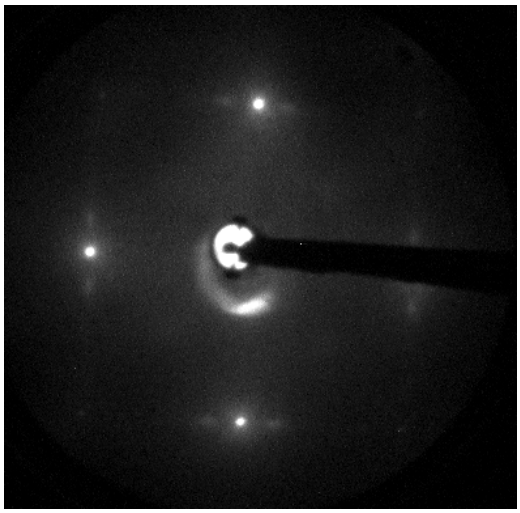

Fig.1. LEED pattern of the Fe/Cu(001) taken at 135eV.

Finally several ML of Cu atoms were deposited as a capping layer before the sample was taken out from the chamber.

The X-ray measurement was performed at BL-9C using the 6-circle diffractometer controlled by SPEC[5].

We could not find the fractional order reflections that correspond to the satellite spots in Fig.1 provably because the sample was not perfect enough for X-ray diffraction, which is suitable for determination of long-range order structures. However, the result of another measurement using the anomalous scattering of Fe would be a clue to analyze the sort-range order structure. Figure 2 shows the scattering intensity at the reciprocal lattice point (0 0 0.07) as a function of the energy of the incident X-rays.

A subtle oscillation that appears above the absorption edge corresponds to the XAFS pattern. Therefore, interatomic distances of Fe-Fe and Fe-Cu might be estimated by the Fourier analysis. Further data analysis is proceeding. Also we will perform the same measurements on different lattice points in the next machine time.

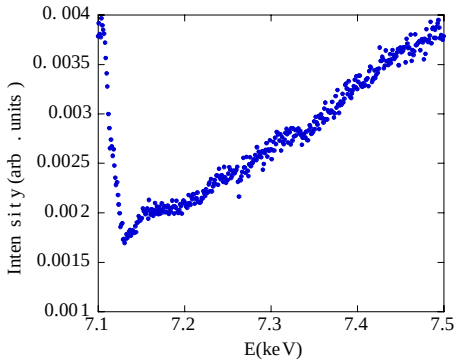

Fig.2. Scattering intensity measured at the (0 0 0.07) point as a function of the energy of the X-rays.

References

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