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Preparation of a-Si/Fe/Si(111) interface and its characterization

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Introduction

Thin iron films deposited on Si(111)7x7 surfaces form various structures depending on the film thickness and annealing temperature: 1x1, 2x2, 7x7 and √3x√3 structures[1,2]. Although those structures are supposed to be caused by iron silicides[3,4], the atomic arrangements of the silicides are not clear. Therefore the iron thin film on Si(111) is an attractive subject from the viewpoint of structure analysis.

Experimental

We prepared two samples using the ultrahigh vacuum chamber of our laboratory. First sample was prepared in the following way. About 1 monolayer of Fe was deposited onto a Si(111)7x7 substrate by an effusion cell at room temperature and the substrate was annealed at 770K. After the annealing, the 2x2 RHEED pattern was observed. Finally an a-Si cap layer of 90Å was deposited to keep the 2x2 structure intact. In the case of the second sample, the process was almost the same besides the slightly lower annealing temperature, namely 750K. In this case, not only the 2x2 structure but also the √3x√3 structure, which is difficult to observe since the allowance of the temperature range is very narrow[2], were obtained.

In this work the first sample was used for the measurement because the prior examination by the conventional X-ray source showed that the damage of the first sample caused by annealing was much lighter than that of the second one and negligible for the experiment of synchrotron radiation.

We performed the X-ray standing wave (XSW) measurement at BL-14B. The geometry of the measurement is the (+,-) parallel setting of the 111 reflection. The X-rays of wavelength 1.2Å were selected by the double-crystal monochromator. The X-rays were reflected by a Si(111) fore crystal and the Si(111) substrate of the sample subsequently in the experimental hutch. The beam size of the X-rays was 0.5mm(H) x0.7mm(V).

The intensity curve of the X-rays reflected from the sample (rocking curve) and the yield curve of fluorescent X-rays of FeKα were measured around the 111 Bragg point by a PIN detector and an SSD, respectively. The typical counting rates of the PIN and the SSD were 8000cps and 5cps, respectively.

Results and discussions

The rocking curve and the yield of FeKα fluorescence are shown in Fig.1. The fluorescence yield curve, which indicates the interaction between the XSW field and Fe atoms, shows an almost symmetrical form. This means that Fe atoms diffuse at the interface and do not stay on any particular sites in this sample. This result suggests that there is much room to improve the capping process to maintain the surface structure suitable for the XSW experiment. The effort to obtain the Fe/Si(111) surface of the better quality is continued

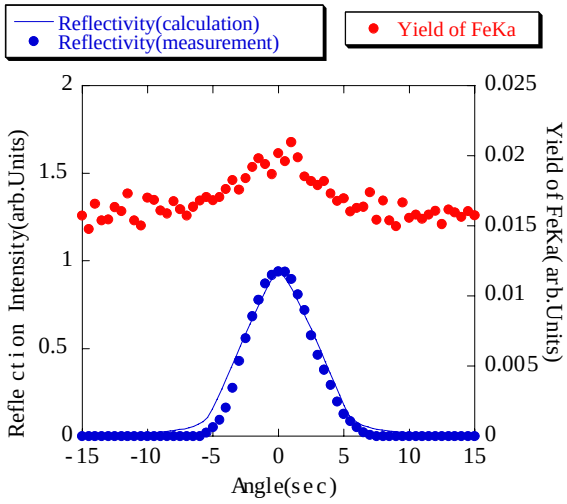

Fig.1. Rocking curve of the 111 reflection and yield of FeKα fluorescence.

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