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X-RAY FLOURESCENCE HOLOGRAPHY OF FePt THIN FILM

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Introduction

X-ray fluorescence holography (XFH) is a new technique for providing an atomic configuration around atoms emitting fluorescence in a single crystal. The x-ray fluorescence hologram includes the phase information of scattered x-rays, which is not obtained by the standard x-ray diffraction technique. The atomic structure is, therefore, directly determined by a modified Fourier transformation of the experimentally observed hologram without assuming any structural model. This is also a great advantage over the other methods to study local atomic structures, such as EXAFS.

Recently, Shima *et al.* has reported the $L1_0$ ordered FePt films, which are prepared at low temperatures below 503 K[1]. In this study, holograms of a Fe(1 ML)/Pt(1 ML) (ML: monoatomic layer) multiplayer film are measured and atomic images around Fe atoms are reconstructed.

Experiment

The measurement of multiple energy x-ray holograms was performed at BL3A. The four incident energies were selected form 9.0 to 11.25 keV with a 0.75 keV step between Fe-K (7.11 keV) and Pt-L_3 (11.56 keV) absorption edges. Figure 1 shows a schematic illustration of the experimental setup. The Fe fluorescence and elastically scattered x-rays from the sample were separately observed by the silicon drift detector with the digital signal processor. The sample was set on two θ- and ϕ- axis rotation stages. Intensities of Fe fluorescence were measured as a function of $\phi(0°\leq\phi\leq360°)$ and $\theta(0°\leq\theta_1\leq360°)$.

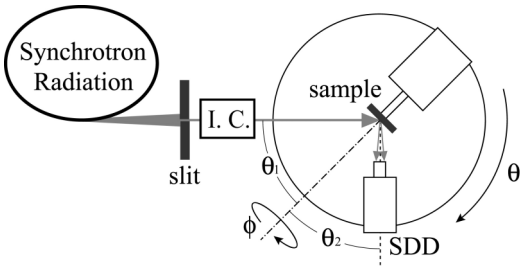

Fig. 1 Experiment setup.

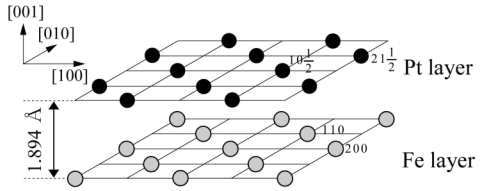

Fig. 2 Schematicdrawing of atomic arrangements around Fe atoms in the FePt film.

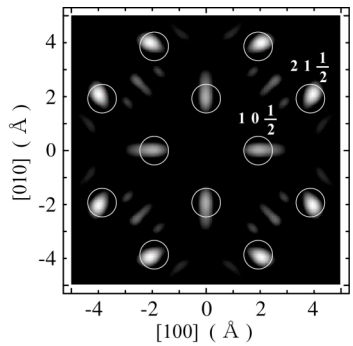

Fig. 3 Atomic images of Pt layer in the FePt film.

Results and discussion[2)]

The atomic environment around Fe was reconstructed from four measured hologram patterns using a numerical algorithm. Figure 2 shows the model of the local environment around the Fe atoms in the FePt $L1_0$ ordered film. The crystal structure of this FePt film is known to be $L1_0$ ordered structure with a=b=3.861 Å and c=3.788 Å. Figure 3 shows the atomic image at Z= 1.894 Å (=c/2) above the Fe layer. The atomic image at 1 0 1/2 and 2 1 1/2 in Fig. 3 are the second and fourth neighbors of Fe atoms, respectively, and expected to be Pt atoms. The reconstructed intensity of the atomic image at 1 0 1/2 is weaker than that at 2 1 1/2. This is due to the consequence of the high frequency-pass filter and/or the effect of the real-twin interference. The deviation of the intensity maxima from the Pt positions expected from the FePt bulk was the order of 0.1 Å in the FePt(002) plane of Fig. 2. Although the FePt(001) plane was also reconstructed, the Fe atomic images at 110 and 200 could not be observed. This may be explained by the fact that the atomic scattering factor of Fe is about one-third smaller than that of Pt. Thus, in order to image the Fe atoms, we must collect at least 10^6 photons in each pixel. In the present measurement, the statistical accuracy of the holographic signal may not be sufficient.

References

1) T. Shima et al., Appl. Phys. Lett. 80, 288 (2002).
2) Y. Takahashi et al., Scr. Mater. 48, 975 (2003).