16A1/2010G689

In Situ Evaluation of Ion-Beam Irradiation Induced Ferromagnetism at Ultra-Surface of FeRh Thin Films by XMCD

K. Aikoh[1], A. Tohki[1], M. Sakamaki[2], K. Amemiya[2], A. Iwase*[1] and T. Matsui[1]

[1] Osaka Prefecture University, Sakai, Osaka 599-8531, Japan
[2] High Energy Accelerator Research Organization (KEK), Tsukuba, Ibaraki 305-0801, Japan.

1 Introduction

FeRh alloys have several potential technological advantages for device applications, such as thermally assisted magnetic recording media, mainly due to their first order antiferromagnetic (AF) - ferromagnetic (FM) phase transition. Our previous studies have shown that energetic ion beam irradiation induces FM spin order in Fe-50at.%Rh even in low temperature regions at which they are originally AF state. [1-3] In the present studies, we tried to modify the magnetic state at the ultra-surface of the FeRh thin films by 1 keV Ar ion-beam irradiation. According to its small penetration depth less than 5 nm, the modified magnetic state was evaluated by means of soft x-ray Magnetic Circular Dichroism (XMCD)

2 Experiment

FeRh thin films 30 nm thick were prepared by ion-beam sputtering of $Fe_{50}Rh_{50}$ target at 700 ºC on MgO(100) single crystal. The crystal structure of the samples was characterized by X-ray diffraction. Irradiations with 1 keV Ar ions and XMCD measurements near Fe $L_{2,3}$-edge were carried out without exposing ambient atmosphere at the BL-16A of KEK-PF. First, the Fe $L_{2,3}$-edge XMCD spectrum for the unirradiated sample was measured under the magnetic field of 0.6 T. Then, the sample was irradiated with 1 keV Ar ions for 5 minutes and we measured again the XMCD spectrum at the same condition. The same experiments were performed also at the total irradiation time of 7.5, 12.5, 17.5 and 122.5 minutes.

3 Results and Discussion

Fig. 1 shows the dependence of XMCD spectrum on the Ar ion irradiation time. The intensity of the spectrum increases with increasing the irradiation time, reaches the maximum value at the irradiation time of 7.5 min., and then the intensity decreases. This fact indicates that the magnetic moment of Fe atoms increases by the small fluence of 1 keV Ar ion-beam irradiation. However, it also reveals that the irradiation with higher Ar ion fluences decreases the spin ordering. This trend of the change in magnetic properties is similar to our previous result for FeRh irradiated with several MeV ions..

The present XMCD result shows that the keV ion-beam irradiation systematically changes the magnetic moments of Fe atom at the ultra-surface of the FeRh thin film. The combination of the magnetic modification by keV ion beam with the original magnetic nature of the FeRh has some potential to make new magnetic devices.

To evaluate the present result more quantitatively, the analysis by using the well-established XMCD sum rule for the L edge is now in progress.

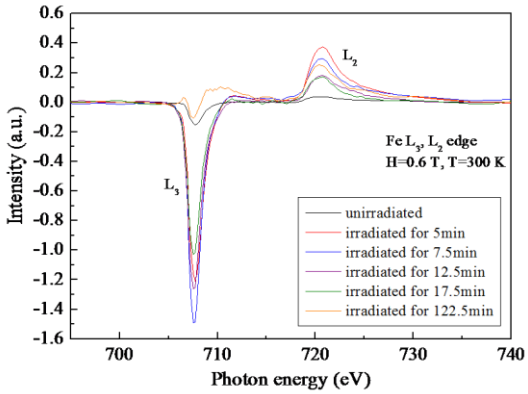

Fig. 1 The Fe $L_{2,3}$-edge XMCD spectra at 300 K for unirradiated sample and those irradiated with 1 keV Ar ion with various irradiation times.

References

[1]M. Fukuzumi et al., Nucl. Instr. and Meth. B **245**, 161 (2006).
[2]A. Iwase et al., Nucl. Instr. and Meth. B **256**, 429 (2007).
[3]Y. Zushi et al., Nucl. Instr. and Meth. B **256**, 434 (2007).

*iwase@mtr.osakafu-u.ac.jp