BL-16A/2016S2-005, 2014G677

Irradiation Effect on Magnetic Properties of FeRh Thin Films with Energetic C60 Cluster Ion Beam

Toshiyuki Matsui[1*], Ryunosuke Soma[2], Yuichi Saitoh[3], Masako Sakamaki[4], Kenta Amemiya[4], AkihiroIwase[2]

[1]Faculty of Arts and Sciences, Osaka Prefecture University, Sakai, Osaka, Japan
[2]Department of Materials Science, Osaka Prefecture University, Sakai, Osaka, Japan
[3]National Institutes for Quantum and Radiological Science and Technology, Takasaki, Gunma, Japan
[4]High Energy Accelerator Research Organization, Tsukuba, Ibaraki, Japan

The abstract is optional; if your report is long and an abstract is necessary, please include it here. If an abstract is not necessary, please delete this sentence.

1 Introduction

Iron rhodium is known to exhibit a first order magnetic phase transition from anti-ferromagnetic to ferromagnetic near room temperature. We have ever revealed that energetic ion beam irradiation induces FM state below room temperature. [1] In addition, the change in magnetization of ion irradiated FeRh was considered to be mainly dominated by the deposition energy through elastic collisions between the ions and the sample species. [2] In the recent studies, however, the saturation magnetization of the sample irradiated with the Au3 cluster ion has known to exhibit larger magnetization than that of the sample irradiated with the Au single ion, even when the same number of Au ions are irradiated. Here, in order to clarify such effect, we examined this cluster effect in the case of C60 cluster ion.

2 Experiment

Thin film samples of FeRh with 50 nm thick were deposited on MgO substrates by ion beam sputtering. The samples were irradiated with 83 keV C1 ion beam in the fluence of 6.75×10^{12}/cm^2, 1.35×10^{13}/cm^2, 1.35×10^{14}/ cm^2, as well as with 5 MeV C60 ion beam in the corresponding fluence. The magnetic properties were characterized by X-ray magnetic circular dichroism (XMCD), as well as a SQUID magnetometer

3 Results and Discussion

Figure 1 shows the XMCD spectra at the Fe L2 and L3-edges for the unirradiated and irradiated samples. As seen in the figure, XMCD signal for the C60 samples shows larger XMCD signal than that of the C1 samples. In contrast, the samples irradiated with considerably large amount C1 and C60 ions, the opposite tendency can be observed in Fig. 2 for the same ion fluence. On the other hand, with larger ion fluence, the spectrum for the sample irradiated with C1 ion shows larger XMCD signal than that for the sample irradiated with C60 cluster ion.

Figure 3 shows that the magnetic moment per Fe atom as a function of ion fluence, which was obtained by analyzing XMCD spectra. As can be seen in the figure, for the sample irradiated with C60 cluster ion, the magnetic moment significantly increases with relatively

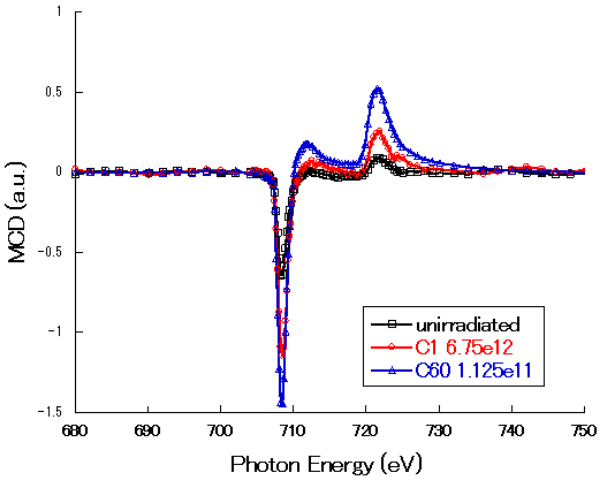

Fig. 1: XMCD spectra for the irradiated samples with the C1 and C60 cluster ion.

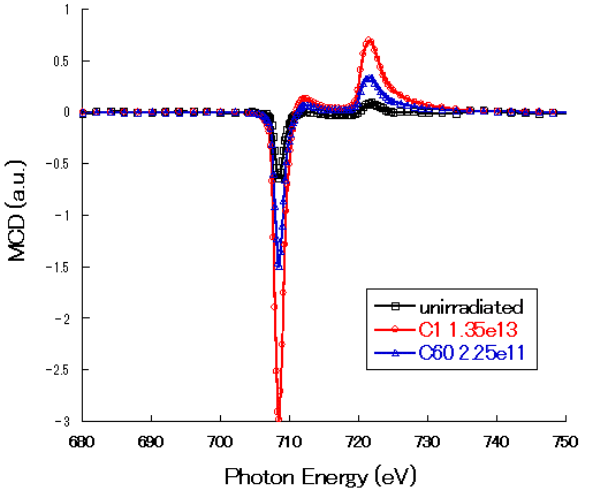

Fig. 2: XMCD spectra for the irradiated samples with the C1 and C60 cluster ion.

small ion fluence and then starts to decreases with increase in the ion fluence. In contrast, as for the sample irradiated with C1 ions, it monotonically increases with increasing ion fluence.

These results show that C60 cluster ion irradiation can effectively induced the ferromagnetic order in the ultra-surface region of the sample rather than C1 single ion irradiation. This is also qualitatively in agreement with the result in the case of Au cluster ion irradiation. We will discuss the effect of ion clustering for irradiation induced ferromagnetic ordering in FeRh.

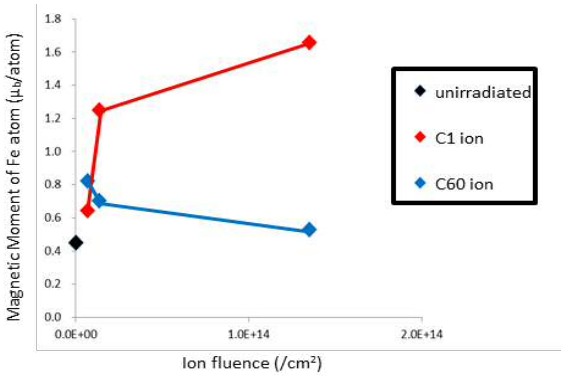

Fig. 3: Ion fluence dependence of magnetic moment per Fe atom for the samples irradiated samples with C1 and C60 cluster ions. The magnetic moment was calculated by using sum rule analysis for the XMCD spectra of the samples.

References

[1] M. Fukuzumi et al, Nucl. Instr. and Meth.B, **230**, 269 (2005).
[2] N. Fujita et al., J. Appl. Phys. *107*, 09E302 (2010).

* matsui@las.osakafu-u.ac.jp