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Study on Ion Beam Induced Non Thermal-Equilibrium Lattice Structures in FeRh Alloy by EXAFS Measurement

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1 Introduction

Fe-Rh intermetallic compound shows the B2 (CsCl type) lattice structure at room temperature. Above 1300K, its lattice structure changes from B2 to A1 structure (the FCC structure with randomly distributed Fe and Rh atoms). Recently, we have found from the EXAFS and x ray diffraction (XRD) measurements that energetic ion irradiation induces A1 structure in FeRh alloy even at room temperature. In this report, we show the EXAFS spectrum for ion-irradiated FeRh, which clearly shows the A1 structure.

2 Experiment

Specimens used in the experiment were bulk Fe-50%Rh alloy specimens and thin films of Fe-53%Rh. The former specimens were cut into sheets of 5x5x0.2mm^3 from an ingot and the latter ones were synthesized by using an ion sputtering method. The thickness of the thin films was about 100 nm. These specimens were irradiated with 10 MeV iodine ions at Japan Atomic Energy Agency-Takasaki. Before and after the irradiation, the lattice structure of the specimens was estimated by means of XRD. The local atomic arrangement around Fe ions were studied by means of the extended x-ray absorption fine structure (EXAFS) at BL27B of KEK synchrotron radiation facility.

3 Results and Discussion

Figure 1 shows the FT-EXAFS spectra for unirradiated and irradiated FeRh thin films. The x-ray energy was near 7.1 keV (Fe K-absorption edge). Before the irradiation, a large peak is observed, which corresponds to nearest Rh atoms around Fe atom. The spectrum fitting by the computer code, FEFF shows that the lattice structure of the FeRh specimen is definitely the B2 structure, which is the thermal-equilibrium state at room temperature. After the irradiation with 10MeV iodine ions to the fluence of 1x10^{14}/cm^2, the main peak splits into two peaks. This result suggests that Fe and Rh atoms are randomly located around Fe atoms. The FEFF simulation shows that this FT-EXAFS spectrum corresponds to the A1 lattice structure. Under the thermal equilibrium condition, the A1 structure appears only above 1300C. The present experimental result shows that non thermal-equilibrium lattice structure is induced by energetic ion irradiation. Such a structure can hardly be realized by a conventional rapid–quenching procedure. We have also shown that the ion irradiation induced structural change is accompanied by the change in magnetic properties. The details have been published elsewhere[1,2].

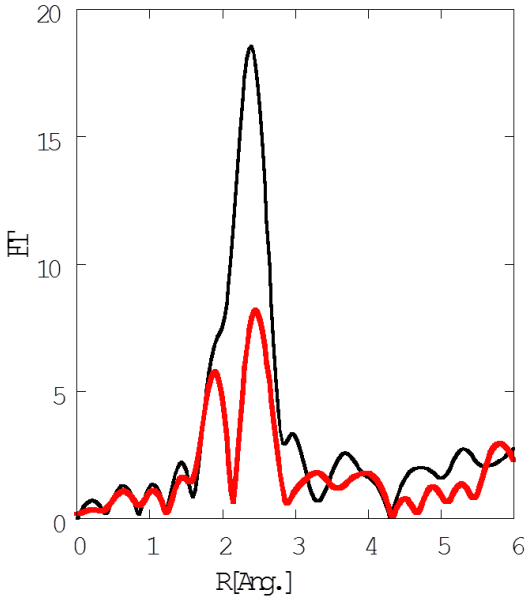

Fig. 1: EXAFS –FT spectra for unirradiated FeRh film (black) and that for FeRh film irradiated with 10 MeV iodine ions(red).

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References

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