ESRF	**Experiment title:** XMCD study of a valence-fluctuating state in $EuNi_2(Si_{1-x}Ge_x)_2$	**Experiment number:** HC-3785
Beamline: ID24	**Date of experiment:** from: 11/04/2018 to: 17/04/2018	**Date of report:** 11/06/2018
Shifts: 18	**Local contact(s):** Dr. Olivier Mathon	*Received at ESRF:*

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Motivation

3*d*-4*f* intermetallic compounds show hard magnetic properties originated from the itinerant and localized nature of the transition metal and the rare-earth metal sublattice, respectively. Especially, RFe5Al7, where R expresses a rare-earth metal, is expected to show a first-order magnetic transition at the magnetic field of the order of tens of tesla as a result of competition between magnetocrystalline anisotropy and exchange interaction between the two sublattices. This magnetic transition is believed that both sublattice magnetization rotate together with increasing the magnetic field. However, direct measurements on these material groups have not been well investigated so far. In the current beamtime, we focused on a strongly anisotropic ferrimagnet, $ErFe_5Al_7$. Before the beamtime, we observed two metamagnetic transitions in a single-crystal $ErFe_5Al_7$ through bulk magnetization measurements using pulsed magnetic fields parallel to [110] direction up to 30 T in the temperature range of 30-40 K. Figure 1 shows the magnetization curve at 33.4 K. The goal of the experiment was to reveal the evolution of the sublattice magnetization with respect to the external field near the magnetic phase transition points.

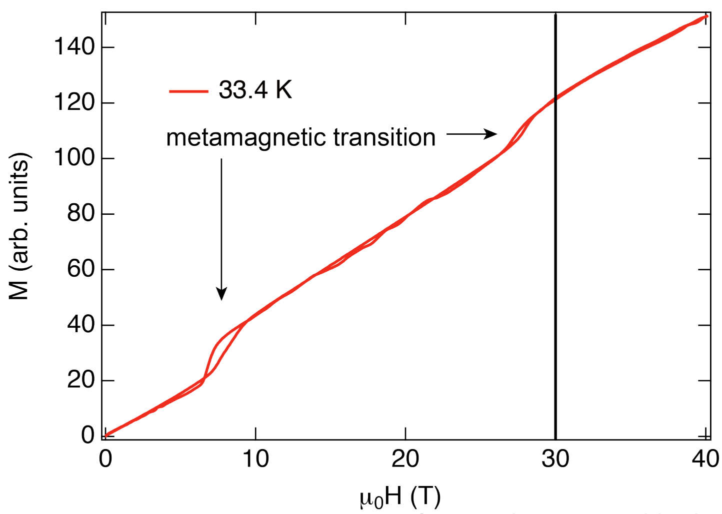

Fig. 1 Metamagnetic transitions of $ErFe_5Al_7$ measured by bulk magnetization measurements in pulsed magnetic fields. The external field is applied parallel with [110] direction.

Methods

Er L_3-edge X-ray magnetic circular magnetism (XMCD) measurements with a transmission mode were performed on a single-crystal $ErFe_5Al_7$ in the temperature range from 5-51 K at the energy-dispersive beamline, ID24. Pulsed magnetic fields up to 30 T were applied in the direction of [110] crystallographic axis. In order to avoid artificial backgrounds in XMCD spectra, transmission measurements near Er L_3 edge were carried out for both polarization helicities and magnetic field directions. The sample dimension is assumed to be 200 μm × 200 μm × 16 μm (thickness). The sample was sandwiched by two nanopolycrystalline diamond windows for preventing the sample from jumping out during high magnetic field pulses.

Results

Figure 2 shows the field-dpendence of XMCD spectra up to 30 T at 25, 30 and 41 K. Each spectrum was measured at the external field shown in the rightmost figure. These measurements were proceeded from bottom to top in the figure. At 25 K, the XMCD signal reversed at the beginning of the magnetic field pulse. At 30 K, the XMCD signal appears only near the maximum of the magnetic field pulse. At 41 K, the XMCD signal shows complex behavior when compared with the data at 25 or 30 K. The field-dependence of XMCD signals were measured from 5 K to 51 K. Their dependence can be categorized into the three groups: the behavior observed at 25 K, 30 K or 41 K.

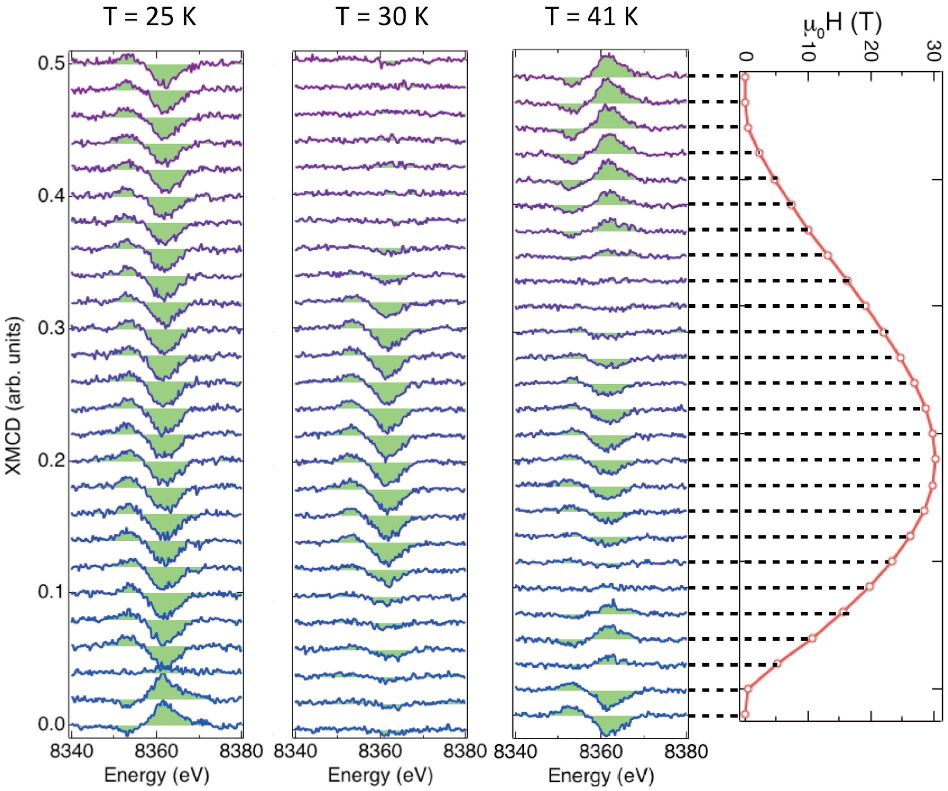

Fig. 2 Magnetic-field dependence of Er L_3-edge XMCD spectra in pulsed fields up to 30 T. The magnetic field that is shown in the rightmost figure is applied in each XMCD measurement at 25, 30 and 41 K shown in the left three columns.

Summary and future prospects

Er L_3 edge XMCD measurements were carried out on the $ErFe_5Al_7$ single crystal in the transmission mode at ID24. The XMCD spectra show complex the evolution with increasing the magnetic field depending on temperature. We observed that there were three types of field dependences that were hidden in the bulk magnetization measurements. Therefore the coherent rotation of Er sublattice magnetization was directly observed. Fe *K*-edge or *L*-edge XMCD measurements should give the whole picture of the sublattice-magnetization rotation under high magnetic fields which cause metamagnetic transition. Furthermore, XMCD measurements in higher magnetic fields are required for reaching to the forced-ferromagnetic phase because the system does not saturate at 30 T yet.