	Experiment title: Element-specific temperature dependent magnetization study of $ErFeMnO_5$ with X-ray Magnetic Circular Dichroism	**Experiment number**: HE-2249
Beamline: ID12	**Date of experiment**: from: 6 December 2006 to: 12 December 2006	**Date of report**:
Shifts: 18	**Local contact(s)**: Fabrice Wilhelm	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

*A. Muñoz, Universidad Carlos III de Madrid

J.A. Alonso, Instituto de Ciencia de los Materiales de Madrid, CSIC

M.J. Martínez-Lope, Instituto de Ciencia de los Materiales de Madrid, CSIC

Report:

Introduction

$ErFeMnO_5$ is a ferrimagnetic oxide derived from $ErMn_2O_5$ by replacing Mn^{3+} by Fe^{3+}. For the sample preparation, high oxygen pressure conditions have been required to stabilize the Mn^{4+} cations. The study of the crystallographic structure from neutron powder diffraction [1] has shown that $ErFeMnO_5$ is orthorhombic as the parent material (space group Pbam); the structure is formed by chains of edge-linked $Mn^{4+}O_6$ octahedra connected via dimer groups of square pyramids $Fe^{3+}O_5$. Magnetization measurements together with neutron diffraction experiments have revealed that $ErFeMnO_5$ orders at a higher temperature ($T_C \approx 165K$) and with a simple ferrimagnetic. Below T_C the magnetic order only concerns the Mn^{4+} and Fe^{3+} ions which are antiferromagnetically coupled; below 75 K the Er^{3+} sublattice starts to participate in the order with a ferromagnetic coupling with the Fe^{3+} ions.

The aim of this experiment has been to study the thermal evolution of the magnetic coupling between moments carried by Er, Fe and Mn atoms in $ErFeMnO_5$ ferrimagnetic oxide. Similar measurements have been done on $YFeMnO_5$, another member of the family, ferrimagnetic with $T_C \approx 165K$ [2]. By comparing the results of both compound it is expected to obtain the influence of the magnetic moment of the Er sublattice into the magnetic moments of the Fe and Mn sublattices.

Experimental measurements and discussion

For $ErMn_2O_5$, they have been measured the XMCD signals at the L_3,L_2-edges of Er and K-edges of Mn and Fe at 7 K and 115 K under a magnetic field of 6 Tesla. Hysteresis curves were also collected at T=7 K for a magnetic field ranging from -6 to 6 Tesla and from the K-edges of Mn and Fe and the L_3-edges of Er. For this last ion, it was also measured a hysteresis curve at T=112 K from the L_3,L_2-edges. The XMCD signals at the L_3,L_2-edges of Er has also been measured in the 15-220 K temperature interval under a zero and

a 6 Tesla magnetic field. Finally for YMn_2O_5, they have also been mesured the XMCD signals at the L_3,L_2-edges of Y and K-edges of Mn and Fe at 7 K and under a 6 Tesla magnetic field.

The absorption Mn K-edge and the corresponding XMCD signal measured at different temperatures for $RMnFeO_5$ (R=Er,Y) are presented in Fig. 1. The XANES spectra shows a pre-edge formed by two peaks which correspond to a 1s-3d dipole transition weakly allowed because of the hybridization of the Mn 4p states with the 3d states of neighboring Mn atoms. In $YMnFeO_5$, the peaks of the pre-edge are sligtly shifted to higher energies. As it can be seen in Fig. 1, an important XMCD signal is obtained in $ErMnFeO_5$ and in $YMnFeO_5$. For $ErMnFeO_5$, a positive XMCD signal is obtained at around 6557 eV; as it is expected, the intensity is smaller at T=115 K than at T=7 K, since the magnetic moment inccreases on decresing the temperature. The absorption Fe K-edge and the corresponding XMCD signal for $RMnFeO_5$ (R=Er,Y) are presented in Fig. 2. In the XANES pattern, below the mean absoption Fe K-edge a small pre-edge is observed. It is associated with the 1s-3d transition, which is dipole forbidden; however, it can be interpreted as being due to the mixing of p orbitals of both the ligand and the 4p state of the cation allowing the transition to take place. Near the mean Fe K-edge, an important negative XMCD signal is observed at around 7126 eV. The intensity decreases on increasing the temperature, as it is expected for a decreasing of the magnetic moment. On the other hand, the fact that the XMCD signals have a different sign for Mn and Fe, implies that their moments are orientated antiparallel, what is in good agreement with the ferrimagnetic structure.

The XANES patterns for the Er L_2 and L_3 edges are presented in Fig. 3. As it is shown in Fig. 3, the XMCD signal is only important at 7 K; at 115 K and under a zero magnetic field, the XMCD signal is negligible, what implies that the Er^{3+} cations do not present a long range magnetic order.

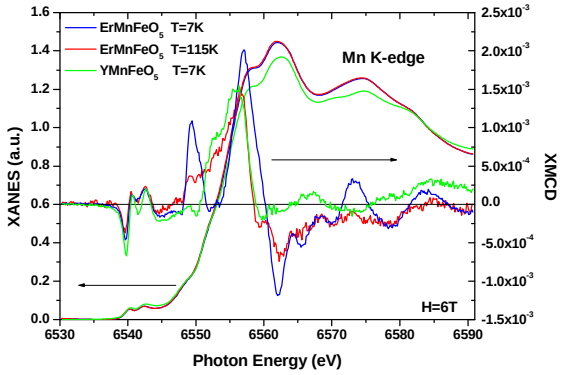

Figure 1

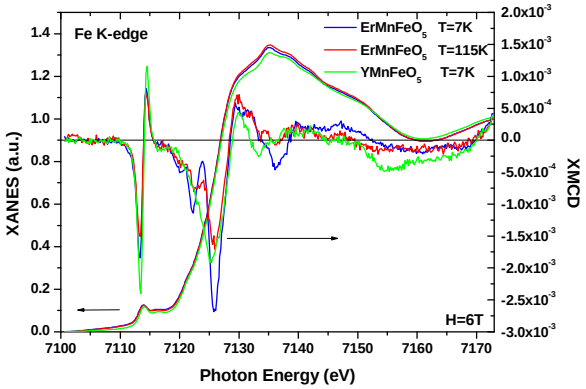

Figure 2

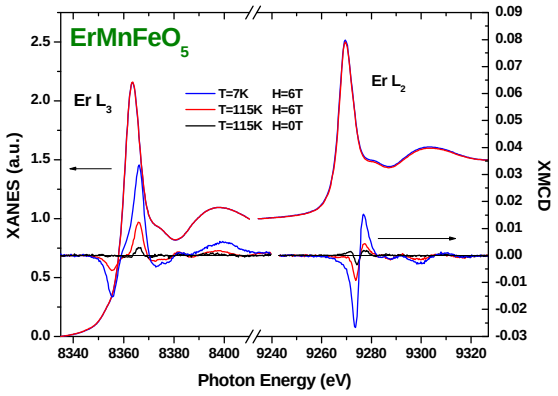

Figure 3

References

[1] A. Muñoz, J. A. Alonso, M.J. Martínez-Lope and J. L. Martínez, Phys. Rev. B**72**, 184402 (2005).

[2] A. Muñoz, J. A. Alonso, M.J. Martínez-Lope and J. L. Martínez, Chem. Mater. 16, 4087 (2004).