ESRF	**Experiment title:** Revisiting the magnetic moment of rhenium in magnetoresistive double perovskites using valence band RIXS-MCD	**Experiment number**: HE-3503
Beamline: ID26	**Date of experiment**: from: 24/11/2010 to: 1/12/2010	**Date of report**: 23/08/2012
Shifts: 18	**Local contact(s)**: Pieter Glatzel	*Received at ESRF:*

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Report:

The experiment reported was devoted to element selective probing of magnetic moments in A_2FeReO_6 double perovskites. The measurements were performed in helium cryostat (at approx. 8 K) using a permanent Nd-Fe-B magnet that delivered magnetic field of the order of 2.5 kOe at the surface of either of the three polycrystalline samples studied, namely $BaSrFeReO_6$, Sr_2FeReO_6, and Ca_2FeReO_6. Althought, in the original proposal only Re $L_{2,3}$-edge RIXS-MCD study of the valence band was planned, the experiment started with measurements of the 1*s*2*p* RIXS-MCD of iron because the beamline was already setup for these contitions. As such, it was possible to test, whether the sample enviroment available is capable to promote a substantial magnetic ordering in the samples studied. It appeared that the considerable effect Has only been observed from the Sr_2FeReO_6 sample. Acquired spectrum is shown in Figure 1.

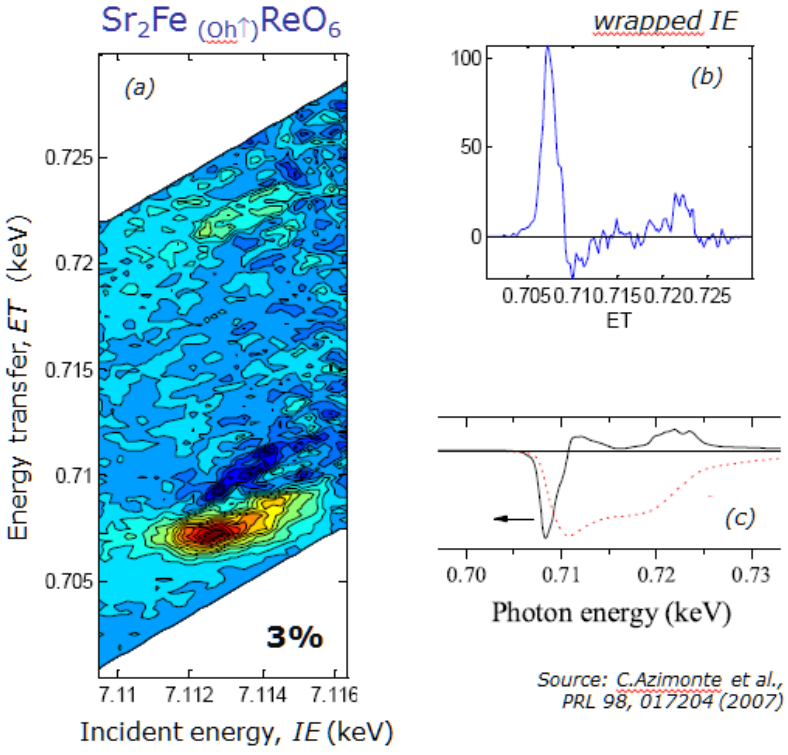

Figure 1. (a) 1s2p RIXS-MCD detected at Fe K-edge of Sr_2FeReO_6. (b) XMCD plotted along energy transfer (obtained by integration along incident energy, IE) reveal simillar spectral shape as $L_{2,3}$-edge spectrum (c) of simillar compound, namely Ba_2FeReO_6, but with positive sign of $K\alpha_1$ RIXS-MCD feature, oposite to that of L_3-edge SXMCD.

The 1*s*2*p* RIXS-MCD effect is of the order of 3% of the pre-edge intensity and reveals a simillar shape to that of SXMCD spectra of Fe^{3+} oxides, however, the sign of the $K\alpha_1$ RIXS-XMCD feature is opposite to that of L_3-edge SXMCD reported in simillar compound [1]. Theoretical analysis of the spectrum, considering both intermediate state effects and minority band coupling in double perovskites, is on going.

Considering possible scenarios for the continuation of the experiment, especially taking into account that only one sample reveal magnetic effects and estimating the time necessary for realignment of the beamline and preparation of the RIXS-MCD setup for Re L_3 & L_2 edges, a decision was made to make additional measurements at Fe *K*-edge in order to verify the linearity of the 1s2p RIXS-MCD effect with respect to net magnetization. Tests were performed on a set of thin magnetite layers showing excelent agreement between hysteresis loops measured by means of bulk (VSM) and element/site-specific (RIXS-MCD) magnetometry. Results were presented during 56th MMM conference and published in Journal of Applied Physics [2].

Finally, the 2*p*5*d* RIXS-MCD measurements were performed at the L_3-edge of Re on Sr_2FeReO_6. Unfortunately, due to low intensity of the X-ray emission from the valence band spectral features of the sample kept in cryostat and (likely) due to low circular polarisation ratio of the QWP used, it was impossible to detect a full RIXS-MCD plane with resonable statistics. We were, however, able to acquire RXES-MCD line profile (figure 2), that confirm a feasibility of such a direct magnetic polarisation probe using element and symmetry sensitive valence band spectroscopy [3]. Hopefully, within next few years, it will be possible to repeat the experiment, provided a stronger magnetic filed source compatible with the large solid angle X-ray emission spectrometer will be available.

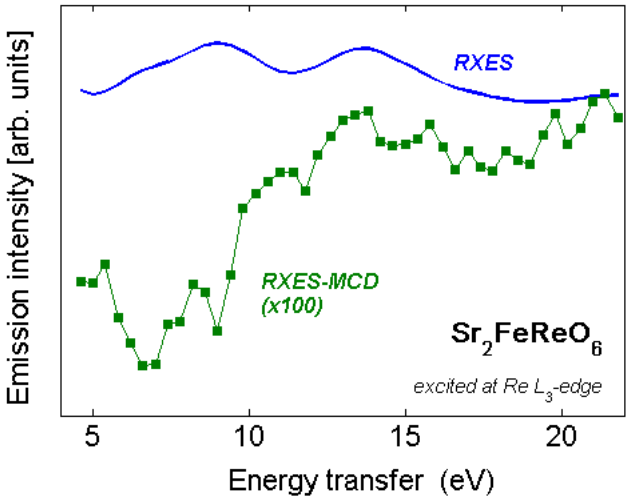

Figure 2.
(a) 2p5d VB RXES & RXES-MCD spectra excited at the maximum of Re L_3 'white line' of Sr_2FeReO_6.
A significant magnetic polarisation is revealed especially at the low energy transfer range of the spectra, namely close to the Fermi edge. The spectra were calibrated with respect to elastic scattering peak (removed for clarity).

Report is partly based on the oral presentation given during the *ESRF Users Meeting 2011*.

References

[1] C.Azimonte et al., Phys. Rev. Lett. **98**, 017204 (2007).
[2] M. Sikora et al., Journal of Applied Physics **111**, 07E301 (2012).
[3] N. Smolentsev et al., Phys. Rev. B **84**, 235113 (2011).