STUDY OF MAGNETISM WITH XMCD AND XES

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X-ray absorption and emission spectroscopy techniques give an element and symmetry sensitive insight into the electronic structure of condensed matter. Using intensive hard X-rays produced by modern synchrotron sources bulk and surface properties of solid and liquid phases may be studied *in-situ* in a demanding sample environments, *e.g.* extreme temperatures, high pressure, high magnetic field, etc.

In this contribution the experimental and theoretical aspects of X-ray Magnetic Circular Dichroism (XMCD) and high resolution $K\beta$ X-ray emission spectroscopy (XES) in the element selective investigation of magnetic moments will be presented and illustrated with examples of spotlight publications found in literature accompanied with a specific application example for each of the techniques to be discussed in details.

The first example will focus on the evolution of spin and orbital moment of rhenium in Ca_2FeReO_6 double perovskite upon application of strong magnetic field. Using an energy dispersive XMCD setup combined with a pulsed magnetic field installation, magnetic moment of Re was observed in a wide temperature (10-250 K) and magnetic field (up to 30 T) range, Fig. 1. The results reveal a spatial separation between two phases characterised by the different magnetostructural coupling and the distinct transport properties. A strong external magnetic field controls the relative abundance of the phases, thus having a strong influence on the average structural and electronic properties and being responsible for colossal magnetoresistance phenomena observed in this compound.

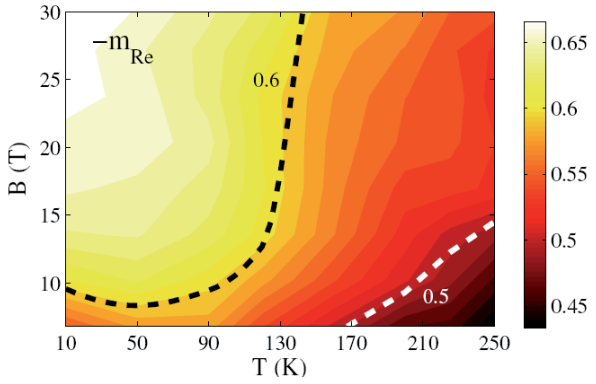

Figure 1. Low temperature, high field magnetisation dependence of the rhenium magnetic moment in Ca_2FeReO_6 double perovskite as derived from the Re $L_{2,3}$-edge XMCD spectra acquired using pulsed magnetic field generation.

In the second example the application of X-ray emission and absorption spectroscopy to study the electronic and magnetic properties of $LaMn_{1-x}Co_xO_3$ solid solution will be shown. Combined analysis of the *K*-edge absorption edges and $K\beta$ emission lines is applied to determine the average charge and spin of the transition metal ions. Quantitative analysis of the spectral shape reveal electron transfer from Mn to Co site with a tendency to creation of Co^{2+}/Mn^{4+} ordered phase. Comparison of the charge and spin evolution revealed that $Mn^{3+/4+}$ and Co^{2+} ions are in their high spin configurations. The Co^{3+} ions are at room temperature in their low spin configuration up to $x \leq 0.6$, while at higher doping level an increase of the average Co^{3+} spin state is observed, which plausibly explains the magnetization anomalies observed in the bulk magnetization measurements.

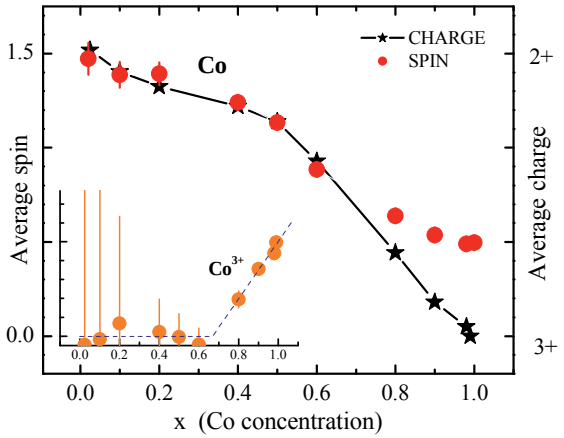

Figure 2. Comparison of the average Co charge and spin evolution in $LaMn_{1-x}Co_xO_3$ perovskite series as derived from the *K*-edge energy shift (stars) and shape of the $K\beta$ emission spectra (circles), respectively. Inset shows evolution of the average Co^{3+} spin state.

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