



	<b>Experiment title:</b> RIXS-MCD study of mixed valence perovskites	<b>Experiment number:</b> HC-752
<b>Beamline:</b> ID26	<b>Date of experiment:</b> from: 4/06/2013 to: 11/06/2013	<b>Date of report:</b> 28/06/2018  <i>Received at ESRF:</i>
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## Report:

Main results of the experiment, namely 1s2p and 1s3p RIXS-MCD planes of 3d transition metals in Co and Sr doped manganese perovskites have not been published yet due to inconsistency between the data measured at Co and Mn K edge. However, some of the results obtained, namely Mn Kb XES of binary Mn oxide references and Sr doped series of perovskites as well as 1s2p RIXS-MCD of reference MnZn ferrite powder have been published in three papers. These are listed along with their abstracts:

D. Rybicki, M. Sikora, J. Przewoznik, C. Kapusta, and J. F. Mitchell, *Interplay of local structure, charge, and spin in bilayered manganese perovskites*, Phys. Rev. B **97**, 115158 (2018).

*Chemical doping is a reliable method of modification of the electronic properties of transition metal compounds. In manganese perovskites, it leads to charge transfer and peculiar ordering phenomena. However, depending on the interplay of the local crystal structure and electronic properties, synthesis of stable compounds in the entire doping range is often impossible. Here, we show results of high-energy resolution x-ray absorption and emission spectroscopies on a  $\text{La}_{2-2x}\text{Sr}_{1+2x}\text{Mn}_2\text{O}_7$  family of bilayered manganites in a broad doping range ( $0.5 \leq x \leq 1$ ). We established a relation between local Mn charge and Mn-O distances as a function of doping. Based on a comparison of such relation with other manganites, we suggest why stable structures cannot be realized for certain doping levels of bilayered compounds.*

J. Stępień, M. Sikora, C. Kapusta, D. Pomykalska, and M. M. Bućko, *Determination of oxygen vacancy limit in Mn substituted yttria stabilized zirconia*, Journal of Applied Physics **123**, 185108 (2018).

*A series of  $\text{Mn}_x(\text{Y}_{0.148}\text{Zr}_{0.852})_{1-x}\text{O}_{2-\delta}$  ceramics was systematically studied by means of X-ray absorption spectroscopy (XAS) and X-ray emission spectroscopy (XES) and DC magnetic susceptibility. The XAS and XES results show the changes in manganese oxidation state and a*

*gradual evolution of the local atomic environment around Mn ions upon increasing dopant contents, which is due to structural relaxation caused by the growing amount of oxygen vacancies. Magnetic susceptibility measurements reveal that Mn<sub>3</sub>O<sub>4</sub> precipitates are formed for  $x \geq 0.1$  and enable independent determination of the actual quantity of Mn ions dissolved in Yttria Stabilized Zirconia (YSZ) solid solution. We show that the amount of oxygen vacancies generated by manganese doping into YSZ is limited to  $\sim 0.17$  per formula unit.*

A. Juhin, A. López-Ortega, M. Sikora, C. Carvallo, M. Estrader, S. Estradé, F. Peiró, M. D. Baró, P. Sainctavit, P. Glatzel, and J. Nogués, *Direct evidence for an interdiffused intermediate layer in bi-magnetic core–shell nanoparticles*, *Nanoscale* **6**, 11911 (2014).

*Core–shell nanoparticles attract continuously growing interest due to their numerous applications, which are driven by the possibility of tuning their functionalities by adjusting structural and morphological parameters. However, despite the critical role interdiffused interfaces may have in the properties, these are usually only estimated in indirect ways. Here we directly evidence the existence of a 1.1 nm thick (Fe,Mn)<sub>3</sub>O<sub>4</sub> interdiffused intermediate shell in nominally  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub>–Mn<sub>3</sub>O<sub>4</sub> core–shell nanoparticles using resonant inelastic X-ray scattering spectroscopy combined with magnetic circular dichroism (RIXS-MCD). This recently developed magneto-spectroscopic probe exploits the unique advantages of hard X-rays (i.e., chemical selectivity, bulk sensitivity, and low self-absorption at the K pre-edge) and can be advantageously combined with transmission electron microscopy and electron energy loss spectroscopy to quantitatively elucidate the buried internal structure of complex objects. The detailed information on the structure of the nanoparticles allows understanding the influence of the interface quality on the magnetic properties.*