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$LuFe_2O_4$: a potential multiferroic studied by synchrotron radiation techniques

Abstract

Multiferroic oxides that bring together ferroelectric and ferromagnetic orderings with added strong magnetoelectric coupling have drawn enormous attention in the last decades owing to the promising technological applications. The mixed-valence oxide $LuFe_2O_4$ is among the most studied multiferroic candidates since a new type of ferroelectricity based on charge ordering (CO) of Fe^{2+} and Fe^{3+} was postulated in this compound below $T_{CO} \approx 320$ K [1]. Regarding the magnetic properties, $LuFe_2O_4$ shows ferrimagnetic ordering below $T_N \approx 240$ K and therefore both the electric and magnetic orderings would interestingly occur at high transition temperatures. With the aim at validating the proposed bimodal Fe^{2+}/Fe^{3+} CO model we have carried out a complete structural and electronic microscopic characterization of $LuFe_2O_4$ by means of various synchrotron radiation based techniques: high resolution powder diffraction (HRPD), x-ray absorption spectroscopy (XAS) and x-ray magnetic circular dichroism (XMCD). All in all, our results discard a bimodal CO below T_{CO} and agree with the presence of a $Fe^{2.5\pm\delta}$ ($\delta \leq 0.25$) distribution incompatible with the occurrence of ferroelectricity. The so-called CO transition is originated by the ordering of local distortions as it is revealed by the temperature evolution of the XAS spectra. Finally, results of XMCD on $LuFe_2O_4$ will be also discussed within this new framework for the CO transition.

[1] Ikeda N, Ohsumi H, Ohwada K, Ishii K, Inami T, Kakurai K, Murakami Y, Yoshii K, Mori S, Horibe Y and Kitô H 2005 *Nature* **436** 1136