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Electronic Structure Studies of Mn Doped $La_{0.8}Bi_{0.2}FeO_3$ Multiferroic Thin Film Using Near-Edge X-Ray Absorption Fine Structure

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Abstract : Multiferroic materials are vital for new application and memory devices, not only because of the presence of multiple types of domains but also as a result of cross correlation between coexisting forms of magnetic and electrical orders. In spite of wide studies done on multiferroic bulk ceramic materials their realization in thin film form is yet limited due to some crucial problems. During the last few years, special attention has been devoted to synthesis of thin films like of $BiFeO_3$. As they allow direct integration of the material into the device technology. Therefore owing to the process of exploration of new multiferroic thin films, preparation, and characterization of $La_{0.8}Bi_{0.2}Fe_{0.7}Mn_{0.3}O_3$ (LBFMO3) thin film on $LaAlO_3$ (LAO) substrate with $LaNiO_3$ (LNO) being the buffer layer has been done. The fact that all the electrical and magnetic properties are closely related to the electronic structure makes it inevitable to study the electronic structure of system under study. Without the knowledge of this, one may never be sure about the mechanism responsible for different properties exhibited by the thin film. Literature review reveals that studies on change in atomic and the hybridization state in multiferroic samples are still insufficient except few. The technique of x-ray absorption (XAS) has made great strides towards the goal of providing such information. It turns out to be a unique signature to a given material. In this milieu, it is time honoured to have the electronic structure study of the elements present in the $LBFMO_3$ multiferroic thin film on LAO substrate with buffer layer of LNO synthesized by RF sputtering technique. We report the electronic structure studies of well characterized LBFMO3 multiferroic thin film on LAO substrate with LNO as buffer layer using near-edge X-ray absorption fine structure (NEXAFS). Present exploration has been performed to find out the valence state and crystal field symmetry of ions present in the system. NEXAFS data of O K- edge spectra reveals a slight shift in peak position along with growth in intensities of low energy feature. Studies of Mn $L_{3,2}$- edge spectra indicates the presence of Mn^{3+}/Mn^{4+} network apart from very small contribution from Mn^{2+} ions in the system that substantiates the magnetic properties exhibited by the thin film. Fe $L_{3,2}$- edge spectra along with spectra of reference compound reveals that Fe ions are present in +3 state. Electronic structure and valence state are found to be in accordance with the magnetic properties exhibited by LBFMO/LNO/LAO thin film.

Keywords : magnetic, multiferroic, NEXAFS, x-ray absorption fine structure, XMCD, x-ray magnetic circular dichroism
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