Abstract

Doctoral Thesis

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This thesis consists of three parts. The first section is about $CoFe_2O_4$-$BiFeO_3$ core shell multiferroic nanocomposite synthesized via a two-step wet chemical process. The presence of both spinel and the perovskite structure was confirmed by the X-ray Diffraction (XRD) and Transmission Electron Microscopy (TEM). The low temperature (5K) field cooled hysteresis loop exhibited a significant exchange bias (H_{EX}=1750 Oe) in the core shell nano composite which confirms a promising connectivity of the constituents in the interface. Since this nanocomposite has gained considerable interest due to the presence of a possible magnetoelectric effect (ME), magnetic field dependent of the dielectric constant has been measured. The obtained result revealed a significant enhancement (1.2 %) in MD of the core shell nano composite. A study on the magneto-loss (ML) demonstrated the contribution of the magneto-electric (ME) effect and Maxwell-Wagner (M-W) effect in MD of the core shell nanocomposite.

In the second part of this thesis, $SrFe_{(12-2x)}Co_xRu_xO_{19}$ where (x=0, 0.1, 0.2, 0.3, 0.4), has been synthesized through the solid-state reaction method. DC and AC Susceptibility measurements exhibited a reduction in the Curie temperature as the concentration of dopants increased which was due to the perturbation of the exchange interaction between Fe^{3+} by doping. It was also seen that the magnetic anisotropy transformed from uniaxial to conical in a certain level of dopants that leads to a significant reduction in the coercive field.

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In the last part of the present work, thin films of $SrFe_{(12-2x)}Co_xRu_xO_{19}$ (x=0, 0.1, 0.2, 0.3, 0.4) on (111) $SrTiO_3$ fabricated by the pulsed laser deposition (PLD) technique. The high-resolution parallel beam x-ray diffraction (HR-XRD) results showed a single orientation for all thin films except one. The thickness of the deposited films has been evaluated by X-Ray Reflectivity (XRR) measurements. The presence of a certain level of mosaicity in the heteroepitaxial films has been detected using the Rocking Curve measurement technique. This result was confirmed by the Reciprocal Space mapping (RSM) measurement, as well. RSM results also revealed that all the deposited films are epitaxially strained. Finally, In-Plane Pole Figure measurements have shown highly textured thin films with a 6-fold hexagonal symmetry. The DC magnetization measurement, at room temperature, indicated the presence of an out of plane anisotropy for all thin films. It is observed that the distribution of dopants in different interstitial spaces, the thickness of thin films, and the change in the magneto anisotropy state, have a significant effect on the magnetic characteristic of thin films. Therefore, an appropriate application of these films can be determined based on these characteristics.

Although in this thesis I am discussing the three different topics mentioned above, my aim has been to work diligently to show the use of these materials in the possible application in the field of multiferroic technology, specifically, data storage devices.