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Enhanced Exchange Bias in Poly-crystalline Compounds through Oxygen Vacancy and B-site Disorder

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Abstract : In recent times, perovskite and double perovskite (DP) systems attracts lot of interest as they provide a rich material platform for studying emergent functionalities like near-room-temperature ferromagnetic (FM) insulators, exchange bias (EB), magnetocaloric effects, colossal magnetoresistance, anisotropy, etc. These interesting phenomena emerge because of complex couplings between spin, charge, orbital, and lattice degrees of freedom in these systems. Various magnetic phenomena such as exchange bias, spin glass, memory effect, colossal magneto-resistance, etc. can be modified and controlled through antisite (B-site) disorder or controlling oxygen concentration of the material. By controlling oxygen concentration in $SrFe_{0.5}Co_{0.5}O_3 - \delta$ (SFCO) ($\delta \sim 0.3$), we achieve intrinsic exchange bias effect with a large exchange bias field (~1.482 Tesla) and giant coercive field (~1.454 Tesla). Now we modified the B-site by introducing 10% iridium in the system. This modification give rise to the exchange bias field as high as 1.865 tesla and coercive field 1.863 tesla. Our work aims to investigate the effect of oxygen deficiency and B-site effect on exchange bias in oxide materials for potential technological applications. Structural characterization techniques including X-ray diffraction, scanning tunneling microscopy, and transmission electron microscopy were utilized to determine crystal structure and particle size. X-ray photoelectron spectroscopy was used to identify valence states of the ions. Magnetic analysis revealed that oxygen deficiency resulted in a large exchange bias due to a significant number of ionic mixtures. Iridium doping was found to break interaction paths, resulting in various antiferromagnetic and ferromagnetic surfaces that enhance exchange bias.

Keywords : coercive field, disorder, exchange bias, spin glass
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