Effect of Yttrium Substitution on the Structural and Magnetic Properties of $SmFeO_3$.

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ABSTRACT- Polycrystalline samples of $SmFeO_3$ (SFO) and $Y_{0.5}Sm_{0.5}FeO_3$ (YSFO 50/50) are prepared by conventional solid state reaction method. Crystal structure refinement shows the decrease in the lattice parameter ‘a’ of the orthorhombic cell in SFO relative to that of (YSFO 50/50), which has been ascribed to the increasing FeO6 octahedral distortions and vast deviation from their non-rigidity. The Magnetic measurements on both the samples in the temperature range of 2-350K shows thermomagnetic irreversibility between the ZFC-FC curves for both the samples, which can be ascribed to the formation of the nearly collinear magnetic state in the parent and the doped samples. These results indicate the pronounced effects of Sm^{3+} ions in determining the structural and magnetic properties of these materials.

Sample Preparation

$Sm_2O_3+Fe_2O_3+Y_2O_3$. In stoichiometric quantities.

Grinded

Heat Treatment, 1300°C, 16Hrs

Regrinded

Heat Treatment, 1300°C, 16Hrs

Regrinded, palletising

Heat Treatment, 1300°C, 16Hrs

Brown coloured pellets Of $Sm_{(1-x)}Y_xFeO_3$ obtained (x=0, 0.5)

Introduction

I. Recent interest in magnetoelectric multiferroics for its potential applications [1,2], has led to the discovery of multiferroism and magneto-dielectricity in several classes of the magnetic materials. These includes perovskite manganites [3], $Ni_3V_2O_8$ [4], double perovskites [5], Haldane chain antiferromagnets [6] and so on. In such materials, the coupling between the electric and magnetic order parameters are needed to be very strong for the greater control of one order parameter by another conjugate field.

II. In this aspects perovskite RMO_3 (M=Mn. Cr, V, Fe, Ni, Co etc.) have been studied widely.

III. RFeO3 systems exhibits high magnetic order disorder phase transition (640-740K) .

IV. Below TN the members of the RFeO3 family crystalizes with an orthorhombic structure exhibiting canted G-type antiferromagnetic spin structure with irreducible representations $\Gamma_4(G_aF_bA_c)$ (Pnma setting). Here ‘G_a’ is the basic antiferromagnetic component directed along the a-axis, ‘F_b’ is the weak ferromagnetic component directed along the b-axis and ‘A_c’ is a weak antiferromagnetic component directed along the c axis.

V. The weak ferromagnetism arises because of the Dzyaloshinsky-Moriya (DM) antisymmetric exchange interaction, between the nearest neighbor cations (Fe^{3+}).

VI. Possibility of having ferroelectricity through exchange striction mechanism.

Structural studies

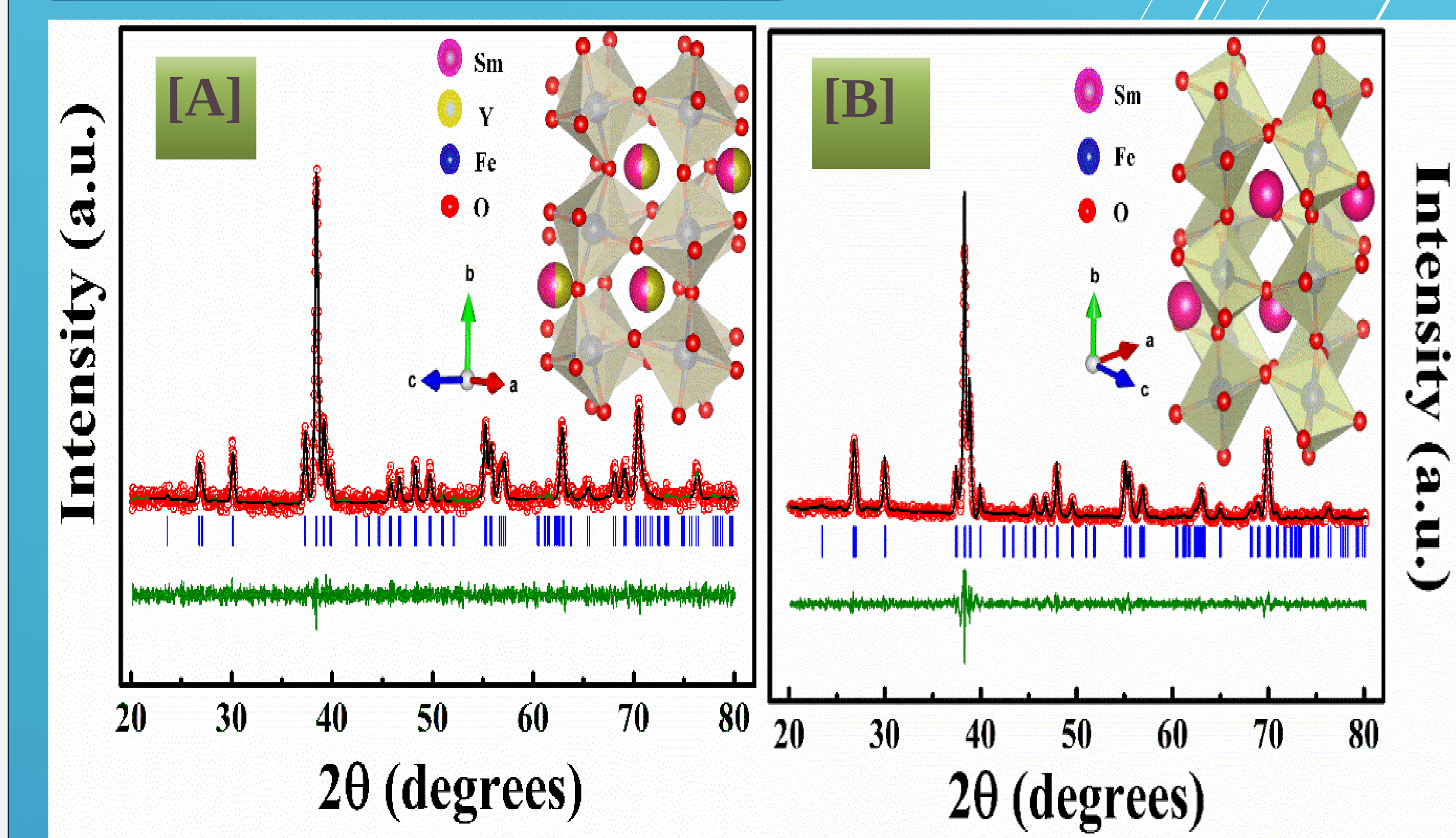
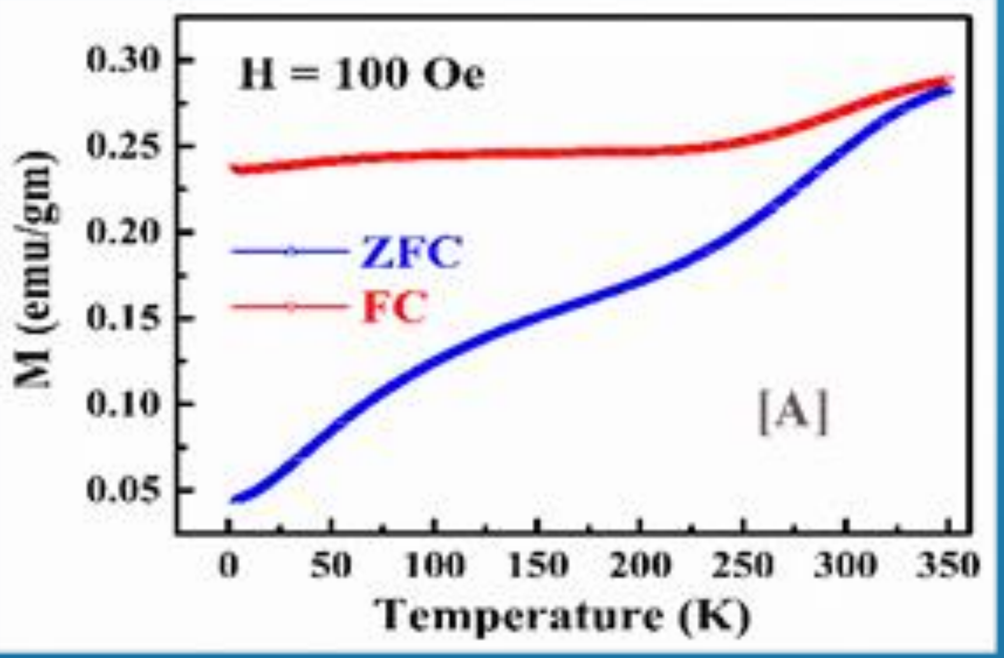


FIGURE 1. Rietveld refined plots of (a)$Y_{0.5}Sm_{0.5}FeO_3$, (b) $SmFeO_3$. Black (solid lines) represents the calculated points, open circles (red) represents the experimental data points, vertical bars (blue) represents the Bragg’s reflections and solid lines (olive) represents the error. The Insets shows the schematic representations of their respective unit cells.

Table-I

Compositions	Residuals			χ^2	Lattice parameters (Å)			Cell Volume (Å^3)	Density (gm/cm^3)
	R_p	R_{wp}	R_{exp}		a	b	c		
$SmFeO_3$	21.9	17.8	16.5	1.164	5.5773(3)	7.6841(3)	5.3822(2)	230.661(19)	7.329
$Y_{0.5}Sm_{0.5}FeO_3$	37.1	26.4	23.64	1.25	5.5933(3)	7.6517(4)	5.3368(3)	228.40(2)	6.517

Magnetic studies



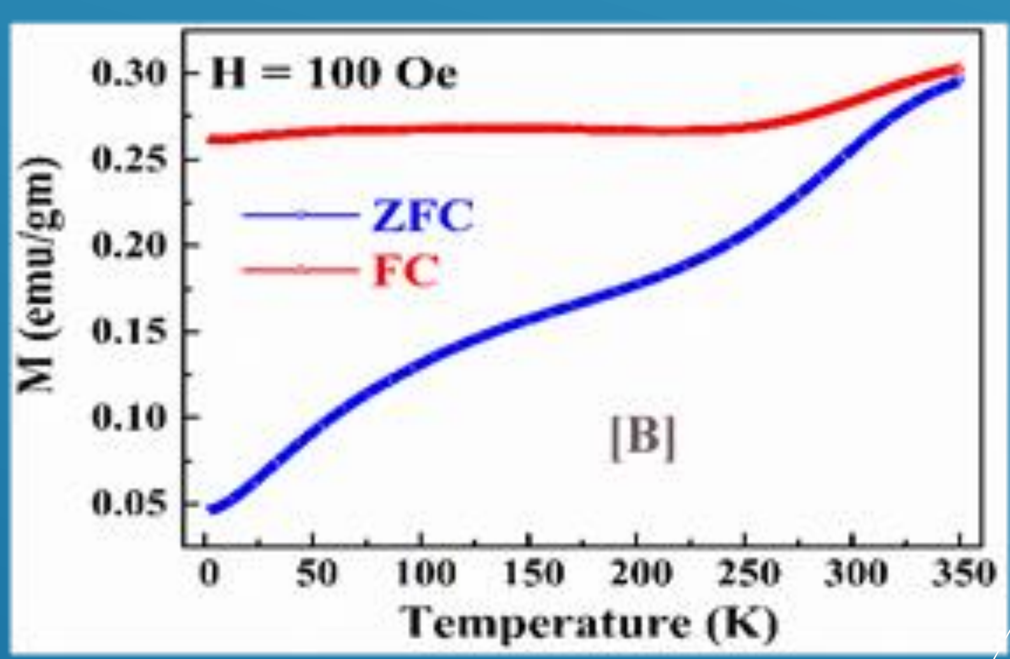


FIGURE 3. Magnetic Susceptibility versus T- plots in ZFC and FC protocols (a)$SmFeO_3$, (b) $Y_{0.5}Sm_{0.5}FeO_3$.

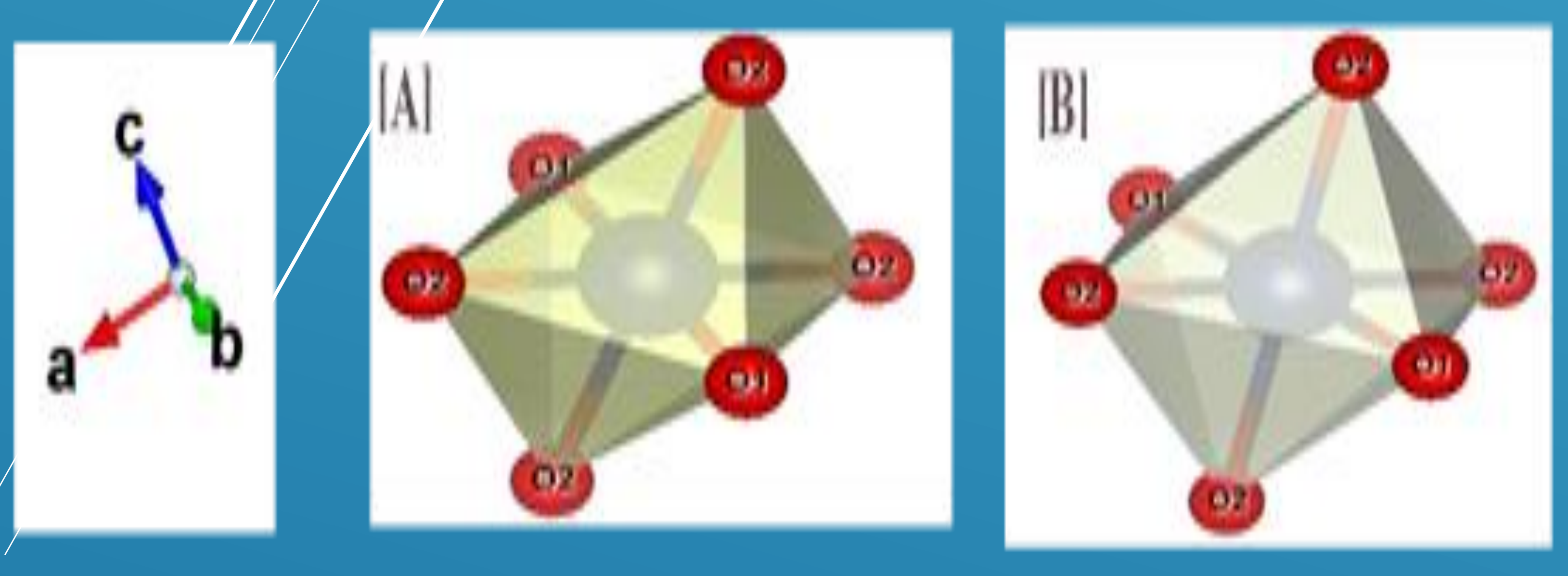


FIGURE 1. Distorted octahedrons of [A] $SmFeO_3$ and [B] $Y_{0.5}Sm_{0.5}FeO_3$. Distortion in FeO6 octahedra in SFO is clearly more than that of the YSFO (50/50) samples.

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