

## Doping induced modification in magnetism and magnetoelectric coupling at room temperature in $\text{Fe}_2\text{Te}_{(1-x)}\text{Nb}_x\text{O}_6$

P. Pal<sup>1</sup>, Md. F. Abdullah<sup>1</sup>, A. Sahoo<sup>2</sup>, S. D. Kaushik<sup>3</sup>, A. K. Singh<sup>1</sup>

<sup>1</sup>Dept. of Physics and Astronomy, NIT Rourkela, Odisha, 769008, India, <sup>2</sup>CSIR-Central Glass and Ceramic Research Institute, Kolkata-700032, India, <sup>3</sup>UGC-DAE-CSR Mumbai Centre, R-5 Shed, BARC, Mumbai-400085, India, Email:

**Abstract:** The polycrystalline  $\text{Fe}_2\text{Te}_{(1-x)}\text{Nb}_x\text{O}_6$  (0.0, 0.05, 0.10) is synthesized following solid state reaction route. The phase purity and the structural study are done by the Reitveld refinement of the X-ray diffraction data. The improved magnetic property of the materials is confirmed by temperature and magnetic field dependent magnetization measurement. We observe a Griffith phase like transition and increased irreversibility in MH hysteresis loop in case of 10% Nb doping. The presence of room temperature ferroelectricity and magnetoelectricity is confirmed through remanent polarisation measurement under 0T and 1.2T magnetic field. The increasing trend in magnetoelectric coupling is observed with increasing doping concentration.

### 1. INTRODUCTION

Manipulating the interaction pathways in complex oxide materials by several external perturbations like pressure, chemical doping, magnetic/electric field is very popular to obtain exotic properties for various applications. The magnetic and electrical properties of complex oxides can be control by tuning the different magnetic interactions by nonisovalent and isovalent substitutions at nonmagnetic lattice sites [1].  $\text{Fe}_2\text{TeO}_6$  ( $P4_2/mnm$  space group) is an antiferromagnetic magnetoelectric (ME) material which possess tetragonal trirutile structure [2]. In this work, we intend to present the modification in structural, magnetic, dielectric and ME properties in  $\text{Fe}_2\text{TeO}_6$  (FTO) as a consequence of the Nb doping at Te site.

### 2. PRELIMINARY RESULTS

#### 2.1. Magnetization study

Temperature dependent magnetization (Fig. 1) shows a broad antiferromagnetic transition prior to the sharp antiferromagnetic fall at 210 K. This broad antiferromagnetic transition ( $T_N$ ) signifies the presence of mixed magnetic ordering at room temperature. In case of  $\text{Fe}_2\text{Te}_{0.90}\text{Nb}_{0.10}\text{O}_6$  (FTON10), Griffith like transition is observed. This is the indication of coexistence of more than one magnetic phase before  $T_N$ . The MH loop shown in the Fig. 2 (i) at room temperature shows an onset ferromagnetic induction due to 10% Nb doping at Te position.

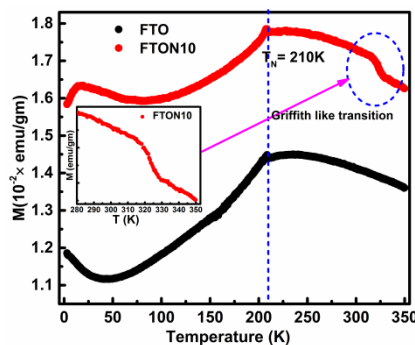


Fig.1. Temperature dependent zero field cooled magnetization of FTO and FTON10.

This type of mixed magnetic ordering and the Griffith like phase arises due to the change in the exchange interaction pathways in the system consequence of Nb doping. The unoccupied  $d$  orbital of the Nb overlaps with the  $p$  orbital of the O can change the magnetic exchange interaction and consequently results a ferromagnetic bilayer interaction [1]. This type of magnetic interaction favors the coexistence of mixed magnetic phase or Griffith like phase.

#### 2.2. Polarization and ME coupling study:

Figure 2(ii) shows the polarization hysteresis loop measured using special remanent polarization in both FTO ( $4.84\text{nC/cm}^2$ ) and FTON10 ( $1.94\text{nC/cm}^2$ ) at room temperature (RT). These polarization values changes  $\sim 50\%$  for FTO and  $\sim 70\%$  FTON10 under application on 1.2T magnetic field.

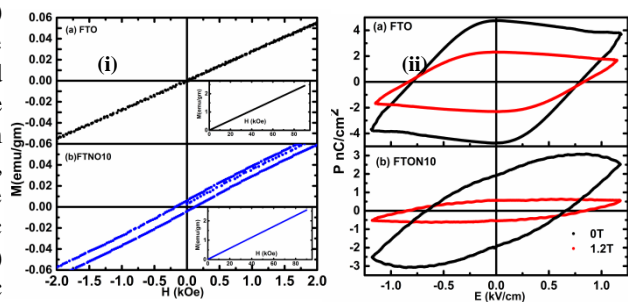


Fig. 2. (i) MH hysteresis loop for FTO and FTON10. The inset of the figures shows the MH hysteresis in between magnetic field 0kOe to 90kOe magnetic field; (ii) The PE hysteresis loop at RT of (a) FTO and (b) FTON10 under 0T and 1.2T magnetic field.

The PE loop study confirms the presence of strong ME coupling at RT in both the studied material.

All these results will be correlated further with structural, magnetic, dielectric and ME properties of all Nb doping concentrations.

### REFERENCES

- [1]. M. Zhu et al, Phys. Rev. Lett. 113 (2014), 076406
- [2]. J. Wang et al, J. Phys. Condens. Matter 26 (2014), 05514