Structural and Dielectric properties of Pb substituted $NdFeO_3$

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Abstract: $Pb_xNd_{1-x}FeO_3$ (x = 0.1 and 0.2) sample synthesised via solid state reaction route. XRD confirms the orthorhombic phase. The dielectric measurements show that with substituting Pb at A- site in $NdFeO_3$, dielectric constant as well as Dielectric loss increases.

I. INTRODUCTION

Perovskite based materials are most widely used in the modern industrial applications due to their interesting dielectric, magnetic , optical and transport properties in area of solid state chemistry and physics. Currently, these materials are most widely used in the field of solid oxide fuel cell, magneto-optic devices etc. The general formula of perovskite is ABO_3 where A is rare earth ion, B is transition ion. The larger sizes of A-site ion affect the physical properties whereas B-site ion plays an important role in electronic as well as magnetic properties of the material[1-2]. $NdFeO_3$ is rare earth ortho-ferrites having orthorhombic crystal structure with space group P b n m (62). It shows the G-type antiferromagnetic ordering with Neel Temperature T_N ~ 760K. In rare earth ortho-ferrites, magnetic interactions are either due to Fe-Fe with canted antiferromagnetic structure [3].

II. EXPERIMENTAL

The (Pb_xNd_{1-x}) FeO_3 where x = 0.1 and 0.2 solid solution was synthesized using conventional solid state reaction route. The raw materials Nd_2O_3, PbO, and Fe_2O_3 (99.99% purity) from Sigma Aldrich were weighed in stoichiometric proportions and mixed using pestle and mortar for one hour. This powder was then transferred to a bottle containing propanol and zirconia balls and ball milled successively for 12 hours in a simple and planetary ball mill respectively. The mixed powder was then calcined at 1000 °C for 12 hours. The calcined powder was then mixed with PVA binder (2 wt %). The binder mixed powder was then pressed in form of pellets of 10 mm diameter and thickness ~1 mm. The pellets were then sintered at 1200 °C for 2 hours in the lead environment to reduce the weight loss due to lead volatility in closed crucible type arrangement. The XRD data over the sintered samples was collected from 20º to 80º at a step size of 0.02º and at a scan speed of 2º/min using Shimadzu (Maxima) diffractometer equipped with Cu Kα (λ = 1.54 Aº) anode. The dielectric studies were done using impedance analyzer (KEYSIGHT E4990A).

III. RESULT AND DISCUSSION

Structural Analysis

X-ray diffractrograms of Pb doped $NdFeO_3$samples are shown in figure 1. The data clearly reveals the crystalline nature of the samples. No extra peak present shows the pure phase formation. All the peaks are indexed according to the orthorhombic phase (Space Group P n m a No. 62). There are some peaks in sample (x = 0.2) marked may be impurity peaks but in sample for x = 0.1, there is no impurity peaks present reveals the pure orthorhombic phase.

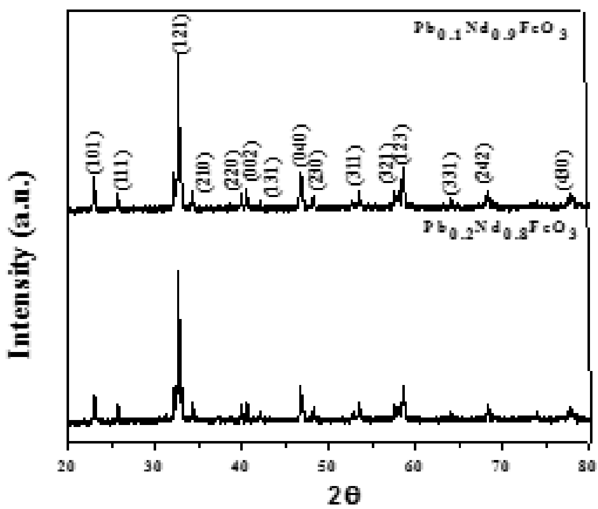

Fig.1: X-Ray Diffractograms of Pb doped $NdFeO_3$

Dielectric Study

The figure 2 shows the variation of dielectric constant and dielectric loss with frequency at room temperature for $Pb_xNd_{1-x}FeO_3$ where x = 0.1 and 0.2. It is clearly seen that with increasing Pb content, at lower frequencies, dielectric constant increases with increasing frequency, dielectric constant decreases because at lower frequencies, all type of polarization (Space Charge, Dipolar, Ionic and electronic) may contribute to dielectric constant. The dielectric loss also shows the same behaviour. At lower frequency, dielectric loss for x = 0.2 is more than x = 0.1. From graphs it is clear that with increasing Pb content, dielectric constant increases which may be due to Hopping Conduction phenomenon.

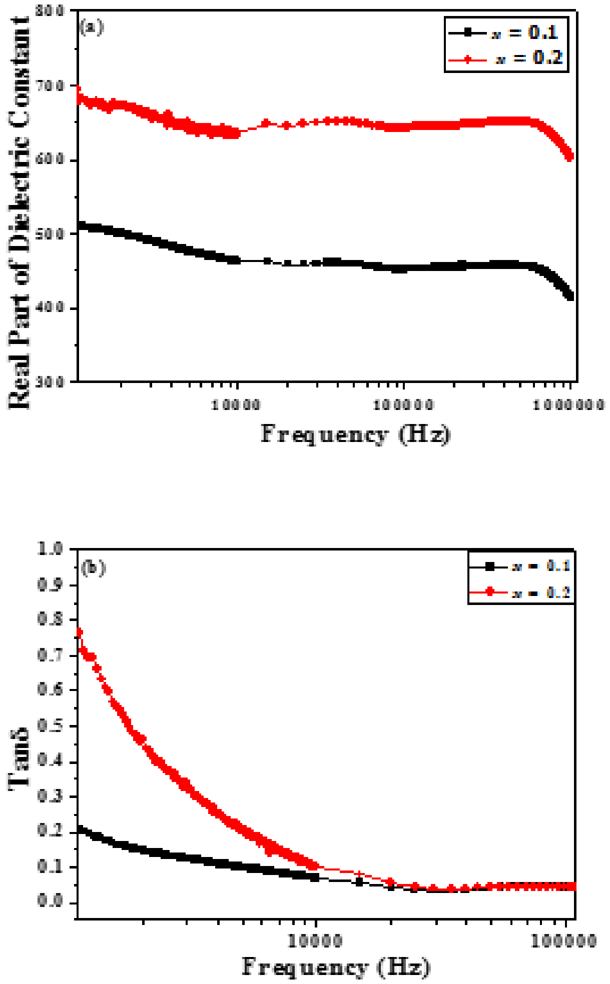

Fig.2**:** (a): Variation of Dielectric Constant with frequency at room temperature. (b) Variation of Dielectric loss with frequency at room temperature.

IV. CONCLUSION

Pb doped $NdFeO_3$ samples prepared by solid state reaction route shows orthorhombic phase. It is clear from dielectric study that with increasing Pb content, Dielectric constant and Dielectric loss increases.

V. REFERENCES

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