Structural Morphological, Elemental Analysis and Magnetic properties of $Pb_{0.5}Nd_{0.5}FeO_3$

Jaswinder Pal, Amandeep Kaur , Jyoti Bala , Rupinder Kaur and Anupinder Singh
Multifunctional Material Laboratory, Department of Physics, Guru Nanak Dev University, Amritsar.

Abstract: $Pb_{0.5}Nd_{0.5}FeO_3$ sample synthesised via solid state reaction route. XRD confirms the orthorhombic phase along with pyrochlore phase. SEM micrographs show increase in grain size with Pb content and EDX confirms elemental composition. It is clear from magnetic hysteresis that with Pb content, $NdFeO_3$ shows some magnetic ordering.

I. INTRODUCTION

Perovskite materials are used for a number of applications such as actuators, transducers and sensors etc. Rare earths are currently with general formula $RFeO_3$ where R = La, Nd has distorted perovskite structure. These materials are most widely used in modern technological applications due their excellent magneto optical, magneto electrical properties.

$NdFeO_3$ exhibits orthorhombic crystal structure with canted antiferromagnetic ordering (G type, T_N-760K) along with weak ferromagnetic component.[1-2]

II. EXPERIMENTAL

The $Pb_{0.5}Nd_{0.5}FeO_3$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 ball mill. The 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. 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 microstructural and Elemental analysis was done using FeSEM (Field Emission Scanning Electron Microsope) from Carl Zeiss and EDX from Oxford Instruments. The room temperature magnetic measurement was done using VSM (Vibrating Sample Magnetometer) from Microsence E 40.

III. RESULTS AND DISCUSSION

The phase formation was confirmed using X ray diffractograms. The high intensity peaks shows the crystalline nature of the prepared samples. All the peaks are indexed according to the orthorhombic space group P b n m No. 62. There are some extra peaks (marked) due to the pyrochlore phase. The xrd pattern of the sample is given in Figure 1.

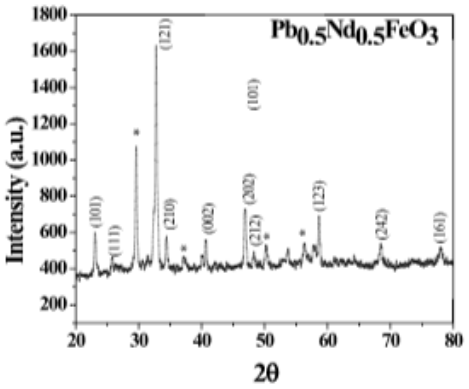

Fig.1**:** XRD pattern of$Pb_{0.5}Nd_{0.5}FeO_3$

The Scanning electron micrographs of $NdFeO_3$ and $Pb_{0.5}Nd_{0.5}FeO_3$were taken using FESEM from Carl Zeiss Supra 55. All images are taken at same magnification for the comparison of grain growth. It is clear from the figure that with substitution of Pb at A-site in $NdFeO_3$, grain size increases. The micrographs also show the compactness of grain which reveals the densification.

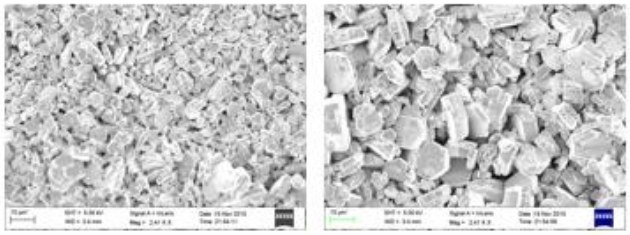

Fig.2**:** FESEM micrographs of $NdFeO_3$ and $Pb_{0.5}Nd_{0.5}FeO_3$.

The elemental analysis of sample $Pb_{0.5}Nd_{0.5}FeO_3$ to confirm the substitution of Pb was done using EDX. The elements present in the samples were given in the form of spectrum as well as in the form of table below.

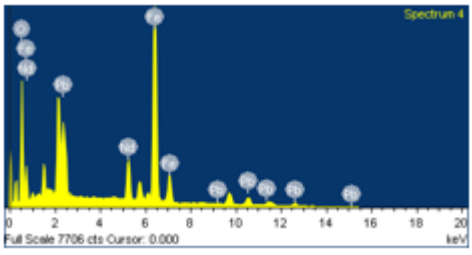

Fig.3: EDX analysis of $Pb_{0.5}Nd_{0.5}FeO_3$

The room temperature magnetic measurements of $NdFeO_3$ and $Pb_{0.5}Nd_{0.5}FeO_3$ are shown in figure 3. Since $NdFeO_3$ is antiferromagnetic at room temperature but when we introduce Pb at A- site, sample shows hysteresis curve which reveals the ferromagnetic ordering. The magnetic hysteresis of $Pb_{0.5}Nd_{0.5}FeO_3$ shows mixed ferromagnetic and antiferromagnetic ordering.

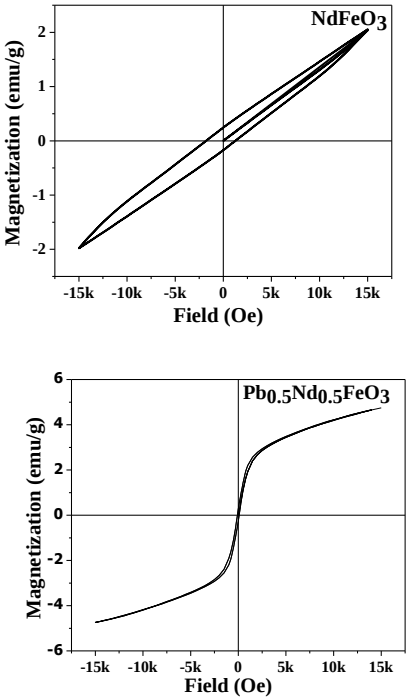

Fig.4: Magnetization vs. Magnetic Field hysteresis of $NdFeO_3$ and $Pb_{0.5}Nd_{0.5}FeO_3$

Sample	$Pb_{0.5}Nd_{0.5}FeO_3$
Elements	**Weight %**
O	**19.07**
Fe	**48.57**
Nd	**16.40**
Pb	**15.96**

IV. CONCLUSION

$Pb_{0.5}Nd_{0.5}FeO_3$ sample prepared by solid state reaction route shows orthorhombic phase along with pyrochlore phase. SEM micrographs shows that with Pb substitution, grain size increases and EDX confirms elemental composition. It is clear from magnetic hysteresis that with Pb content, $NdFeO_3$ shows some magnetic ordering.

V. REFERENCES

[1]. C. Du , H. Qin , S. Ren , L. Zhao , M. Zhao and W. Su, Electric field control of magnetization in $Nd_{1-x}Sm_xFeO_3$ (x = 0, 0.2 and 0.4) at room temperature. Appl. Phys. Lett. 104, 082415 (2014).

[2]. W. Slawinski , R. Przenioslo , I. Sosnowska and E. Suard. Spin reorientation and structural changes in $NdFeO_3$. J. Phys: Condens. Matter. 17. 4605-4614 (2005).

Jaswinder Pal Completed his Graduation in Non- Medical from Panjab University Chandigarh and Post Graduation in field of Applied Physics from Punjabi University Patiala. Now Author pursuing his Ph. D in the field of Multiferroic Materials.