Structural and magnetic properties of biphasic La_2NiMnO_6

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ABSTRACT:- **The magnetoelectric multiferroic La_2NiMnO_6 (LNM) compound mostly come across in controversy based on its crystal structure and oxidation states of Ni and Mn. So in order to investigate its existence of single phase and mixed phase, structural and magnetic properties in double perovskites LNM were studied using X-ray diffraction (XRD), neutron diffraction and magnetisation measurements. LNM is synthesised by sol-gel auto combustion method using Pechini's technique, by varying sintering time at 1200°C, i.e. 4 hours (4H), 8 hours (8H), 12 hours (12H) and 24 hours (24H). The Rietveld analysis of XRD data showed the biphasic (monoclinic + orthorhombic) nature of all the samples. The volume fraction of both the phases varies with varying sintering time. This observation is also confirmed by neutron diffraction data. 12H sample shows the highest magnetisation as compared to other samples.**

INTRODUCTION

- The manipulation of magnetic/elecric properties by an electric/magnetic field in magnetoelectric multiferroic materials like La_2NiMnO_6(LNM) has driven significant research interest, with the aim of realizing their transformative technological potential.
- La_2NiMnO_6 systems drew attention due to its multiphasic nature. Some people have reported this material as a mixed phase system of Pbnm + R-3c, whereas some researchers have reported it as a single-phase material ordered in P21/n symmetry. In addition to this, there are also reports of Pbnm + P21/n and P21/n + R-3c symmetries present in it.
- Double perovskite La_2NiMnO_6 has provided both challenges and opportunity due to its rich magnetoresistance, magnetocapacitance, and dielectric properties. In particular, the near room temperature magnetic properties have opened up a wealth of promising applications in spintronics and magnetoelectronics.
- It thus seems worthy to investigate this compound for the possession of magnetoelectricity.

SAMPLE SYNTHESIS

The Polycrystalline LNM nanoparticles are prepared by sol–gel method, adopting Pechini technique.

$La(NO_3)_3.6H_2O$ + $Ni(NO_3)_2.6H_2O$ + $(CH_3COO)_2Mn.4H_2O$ + $C_6H_8O_7$

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Heating with continuous stirring

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LNM Xerogel powder

↓

Grinding

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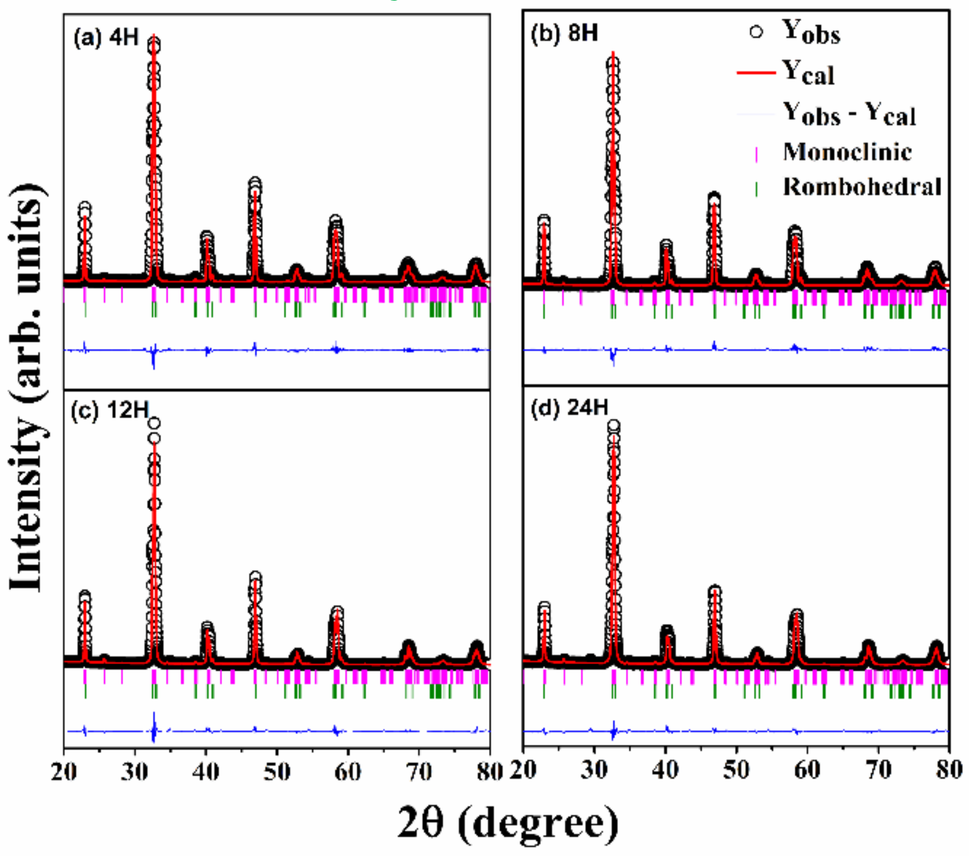
Pelletisation

↓

Sintered at 1200 ^{0}C for 4H, 6H, 8 H, 12H and 24 H.

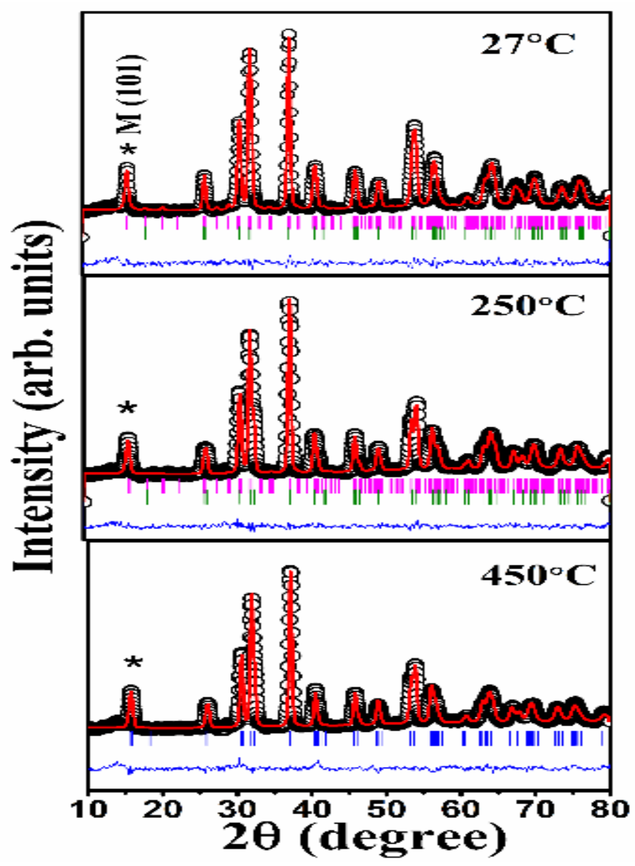
RESULTS AND DISCUSSIONS

X-Ray Diffraction



- The samples are found to be biphasic with the two perovskites phases being easily fitted with rhombohedral and monoclinic phase having space group P21/n and R-3c, as shown in the well-fitting XRD-data.
- With increase in sintering time the volume fraction of P21/n phase is increasing, which becomes maximum in 1200°C.

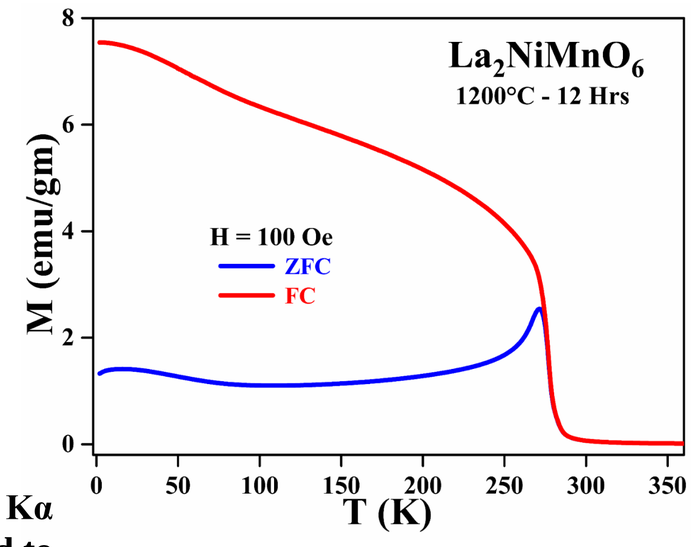
Neutron Diffraction



- As Ni and Mn are indistinguishable to Cu Kα radiation, neutron diffraction data were used to determine the distribution of Ni and Mn in the unit cell.
- The neutron diffraction data shows the same trends as XRD.
- At 450°C, monoclinic + Rhombohedral → Rhombohedral transition is observed

Magnetization

- For the 24H samples, the temperature dependence of dc magnetization under the field cooled (FC) mode at an applied field of 100 Oe is shown.
- The samples display a very clear ferromagnetic transition having Curie temperature 275 K.
- Below 50K a spin glass like dynamics is observed



- The magnetic moment of this sample is maximum as compared to the others samples.

CONCLUSION

- LNM nanoparticles are prepared by sol–gel method.
- Rietveld refinement confirms its mixed phase existence i.e. P21/n and R-3c.
- The volume fraction of both the phases changes with sintering time.
- The monoclinic phase becomes 73% in 24H sample.
- A very clear ferromagnetic transition is observed in magnetization measurement ~ 275K
- Neutron diffraction study indicates a very clear transition at 450°C.

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