

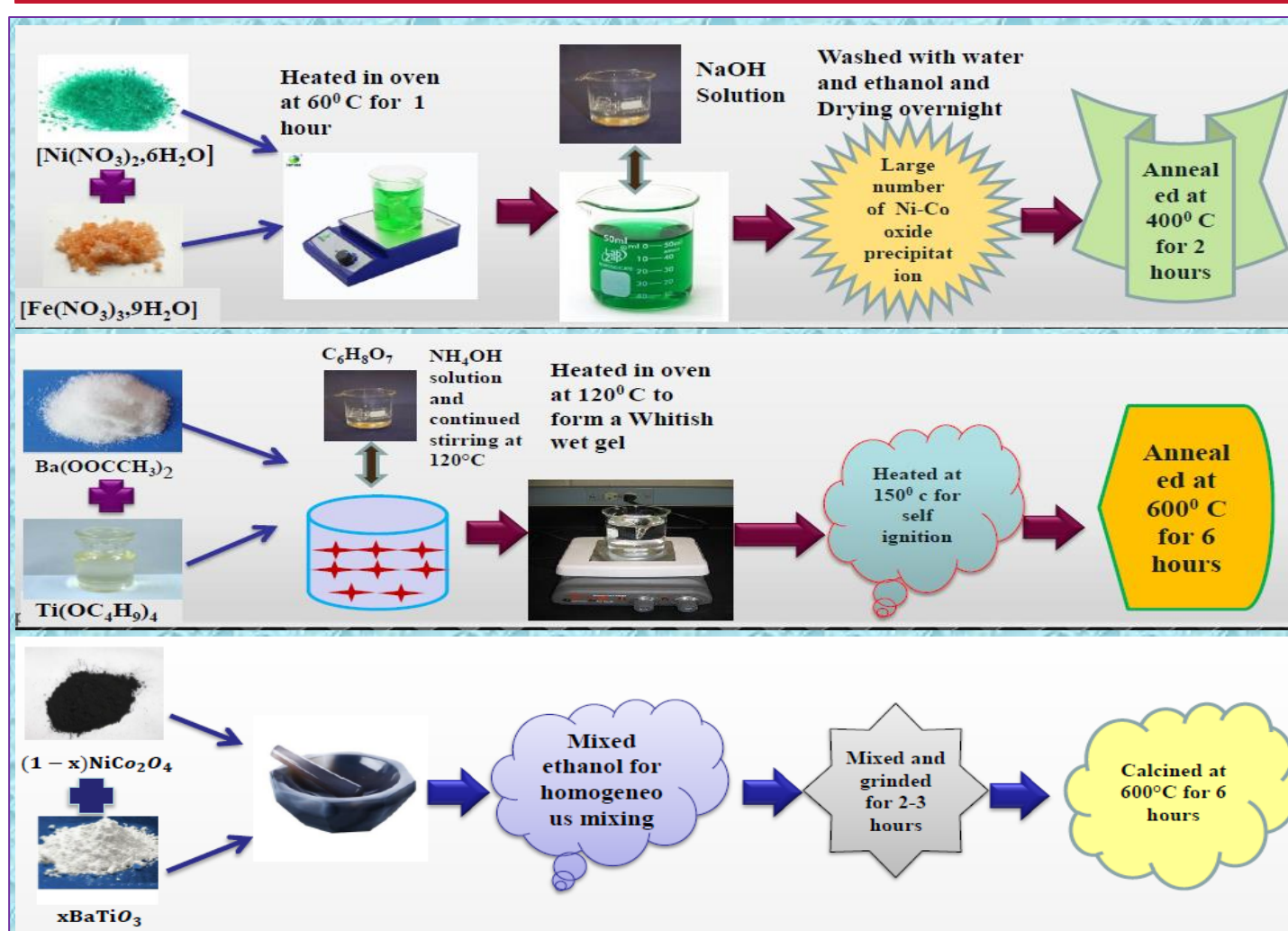
Abstract

The single phase NiCo_2O_4 and BaTiO_3 were synthesized via Coprecipitation and solgel auto-combustion route separately and polycrystalline novel Nanocomposites $(1-x)\text{NiCo}_2\text{O}_4 - x\text{BaTiO}_3$ [$x=0.1, 0.3, 0.5$] were prepared by ultra-sonication respectively with a prospect to understand the correlation between room temperature magnetic and ferroelectric performance. The structural information, pure phase formation and surface morphology with elemental composition were confirmed by XRD, FTIR and FESEM analysis. Various Raman peaks (F_{2g} , E_g , A_{1g}) were observed corresponding to NiCo_2O_4 and $E(\text{TO})$, $E(\text{LO}+\text{TO})$ and $E(\text{LO})$ are assigned to BaTiO_3 nanoparticles. The M-H hysteresis loop exhibits the curtailment of saturation magnetization and coercive field of NiCo_2O_4 from 5.07 emu/gm. to 2.8 emu/gm. and 448 Oe to 61 Oe with the incorporation of 50% BaTiO_3 . Furthermore, the P-E response enhances in NiCo_2O_4 with the evolution of BaTiO_3 percentages.

Introduction & Objectives

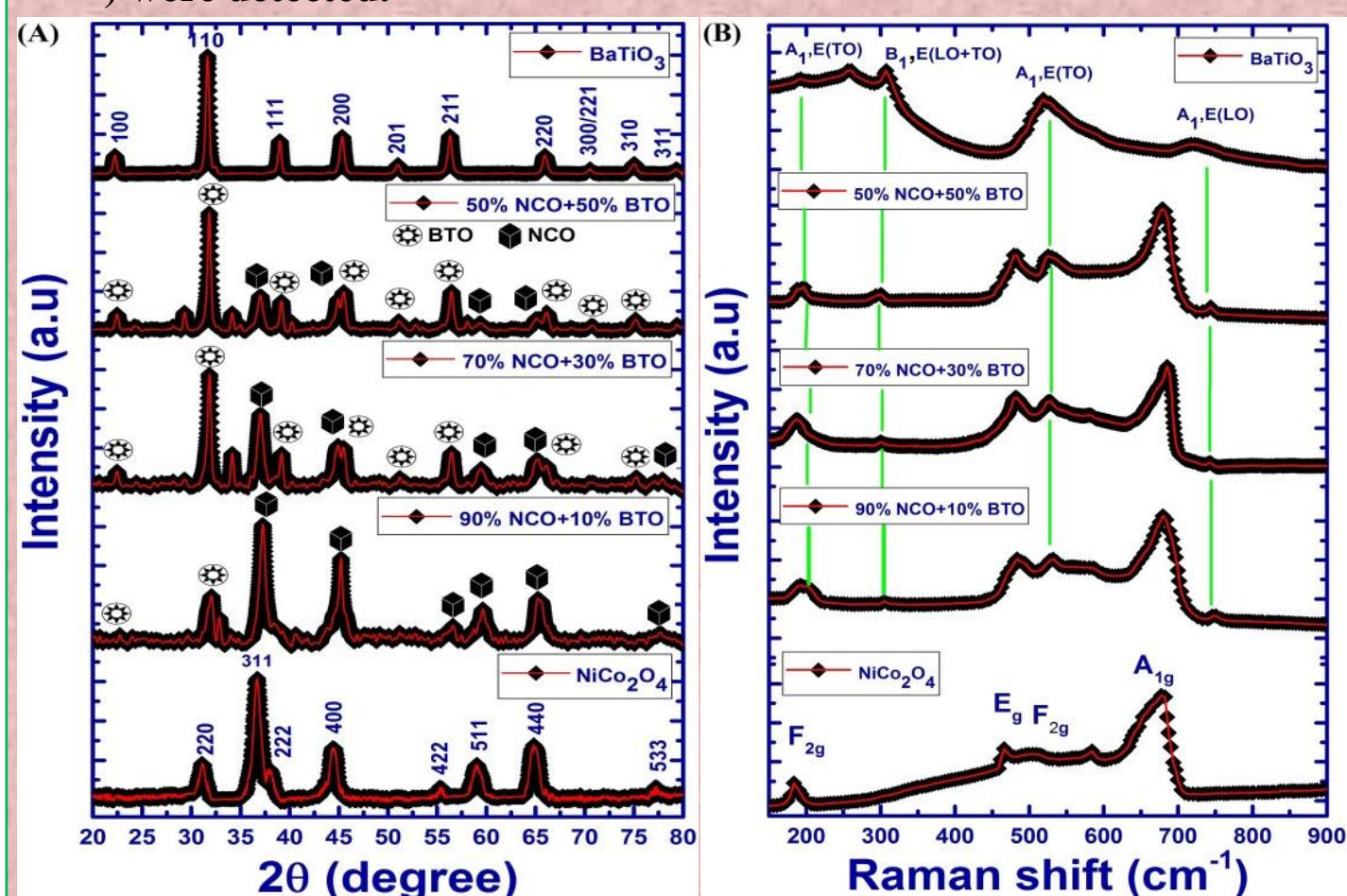
- ❖ Tuning the magnetic and ferroelectric properties is a huge demand of several technologies to integrate future magnetic and nanodevices.
- ❖ The combination of ferrimagnetic NiCo_2O_4 and ferroelectric BaTiO_3 (BTO) composites are one of the unique examples of multiferroic materials and they would exhibit exceptional magnetic and electric properties than individual component.
- ❖ The motivation of our works arises from the additional degrees of freedom of application of both NiCo_2O_4 and BaTiO_3 composites in the design of actuators, transducers, and energy storage devices by tuning their magnetic and ferroelectric properties.

Methods

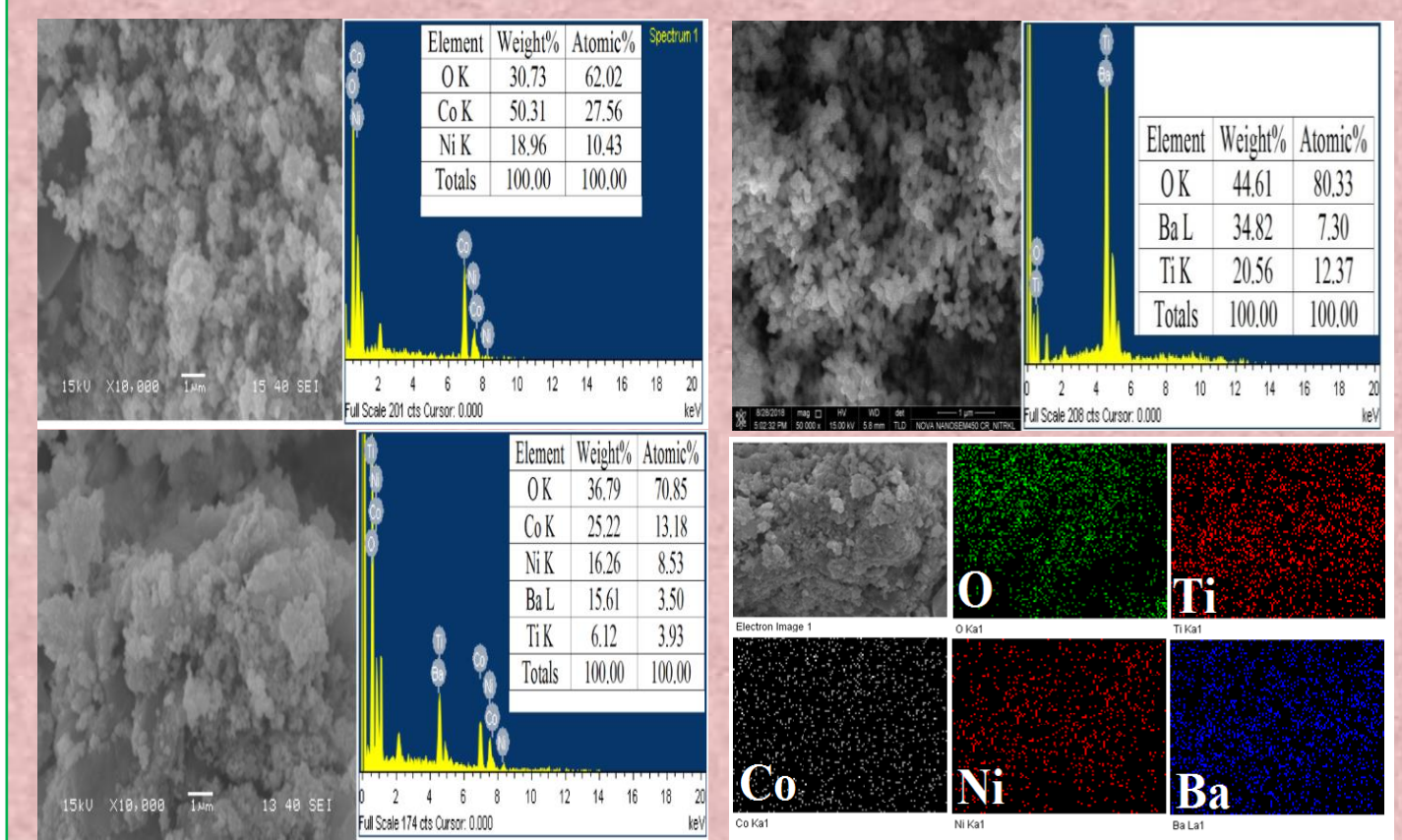


Results & Discussion

- ❑ All major peaks of NiCo_2O_4 (space group- $Fd3m$) and BaTiO_3 (space group- $P4mm$) are assigned to their corresponding hkl planes of JCPDS card No.73-1702 and 81-2205.
- ❑ The broad peak (A_{1g}) for NiCo_2O_4 around 685 cm^{-1} is associated with the vibration of O^{2-} ions in octahedral sites combined with Co^{3+} ions.
- ❑ The additional peaks E_g (481 cm^{-1}) and F_{2g} (519 cm^{-1}) are assigned to combined vibrations of O atoms in tetrahedral and octahedral position.
- ❑ In BaTiO_3 , various phonon vibration modes $A_1, E(\text{TO})$ (172 cm^{-1}), $B_1, E(\text{TO}+\text{LO})$ (305 cm^{-1}), $A_1, E(\text{TO})$ (518 cm^{-1}) and $A_1, E(\text{LO})$ (720 cm^{-1}) were detected.

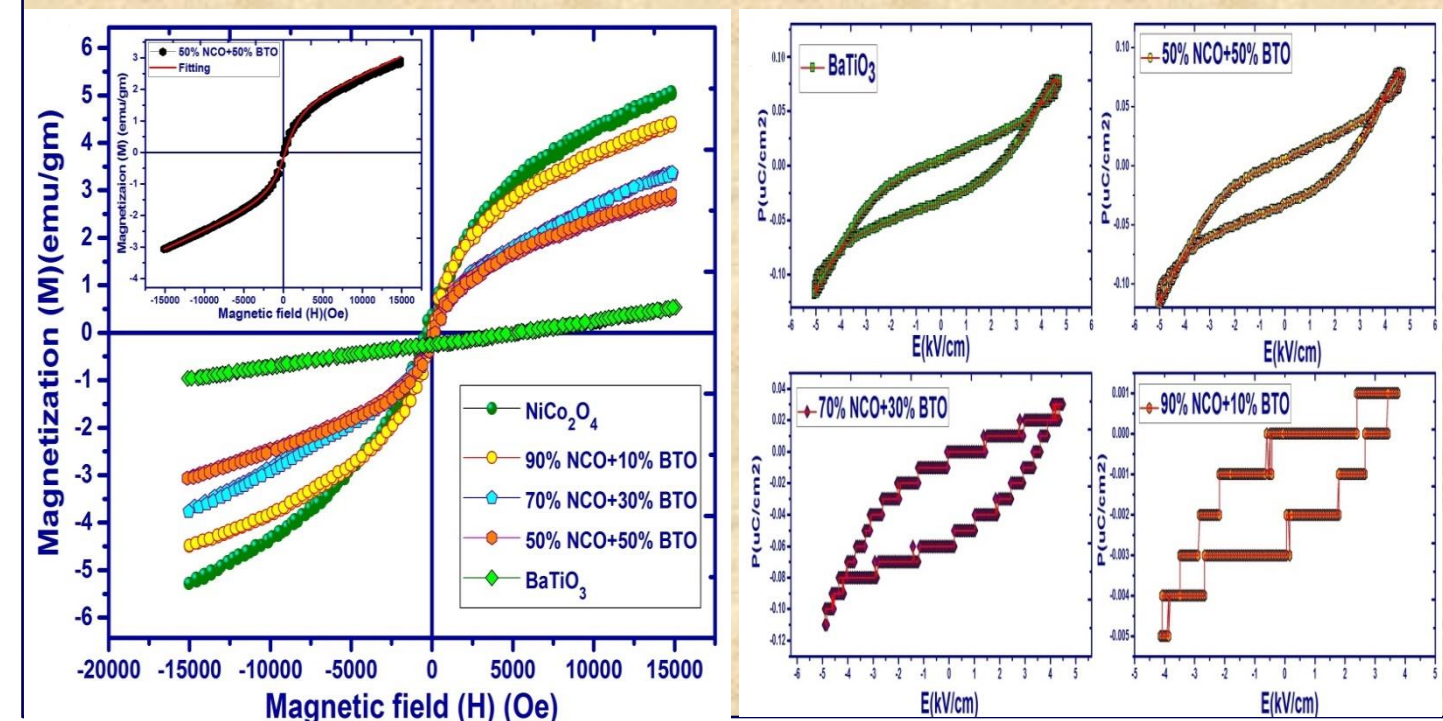


- ❑ The HRSEM micrographs that both NiCo_2O_4 and BaTiO_3 are agglomerated in nature and their grain growth in nm range with average grain sizes 60 nm.
- ❑ The EDX spectra confirm the presence of fundamental particle Ni, Co, Ba, Ti, and O with their true stoichiometrical ratios.



Result & Discussion

- ❑ The NiCo_2O_4 nanoparticles exposed the ferrimagnetic nature at room temperature with saturation magnetization (M_s) 5.07 emu/gm. and coercive field 448 Oe.
 - ❑ The M-H loops are fitted with
- $$M(H) = \left[2 \frac{M_{FM}^S}{\pi} \tan^{-1} \left\{ \left(\frac{H \pm H_{ci}}{H_{ci}} \right) \tan \left(\frac{\pi M_{FM}^R}{2 M_{FM}^S} \right) \right\} \right] + \chi H$$
- ❑ The maximum polarization (P_{max}) and coercive field (V_c) of ferroelectric BaTiO_3 nanoparticles curtailed gradually from $0.05\text{ }\mu\text{C}/\text{cm}^2$ to $0.0009\text{ }\mu\text{C}/\text{cm}^2$ and $1.65\text{ kV}/\text{cm}$. to $0.25\text{ kV}/\text{cm}$. due to the incorporation of non-ferroelectric NiCo_2O_4 .



Conclusion

- ❑ The ferrimagnetic nature of NiCo_2O_4 diminished gradually with the inclusion of BaTiO_3 nanoparticle.
- ❑ The ferroelectric nature BaTiO_3 curtailed with the evolution of NiCo_2O_4 percentages and $0.5\text{NiCo}_2\text{O}_4 - 0.5\text{BaTiO}_3$ composites exhibits ferrimagnetic and ferroelectric nature simultaneously at room temperature.

Acknowledgement

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