

# Title: Design, Synthesis and Characterization of Quantum Paraelectric Modified Multiferroic Materials

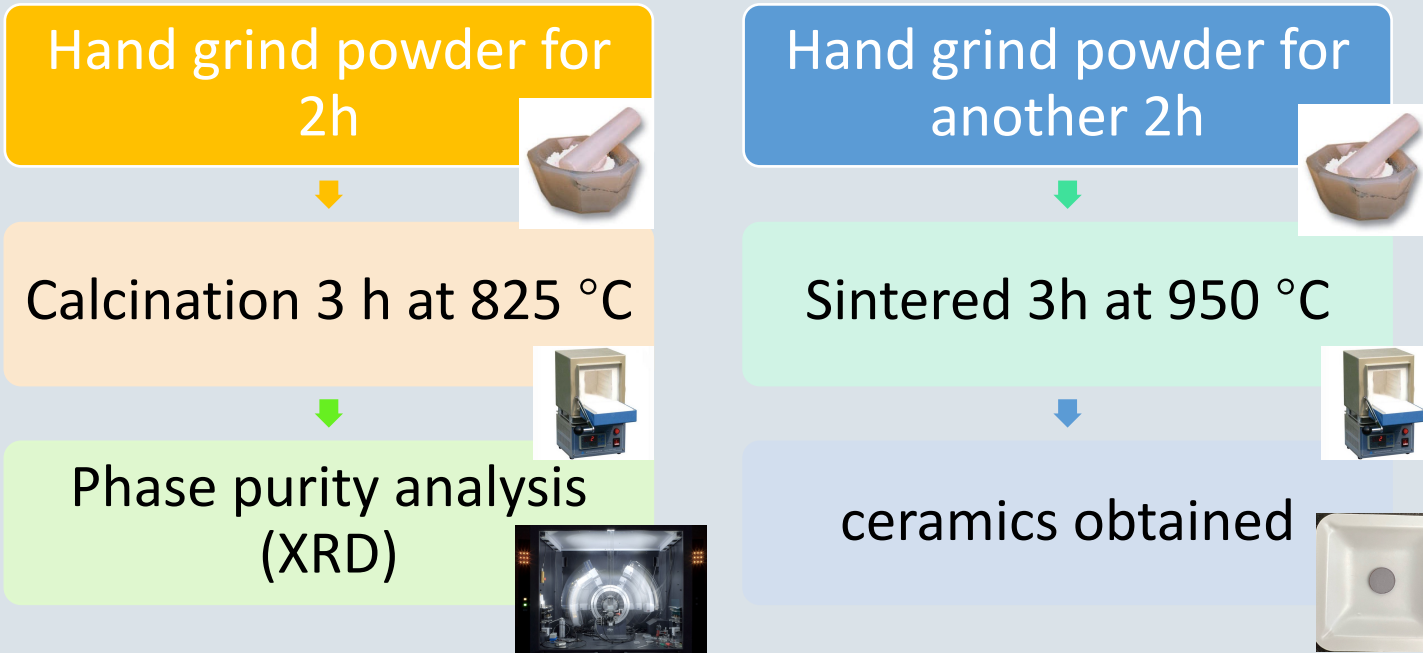
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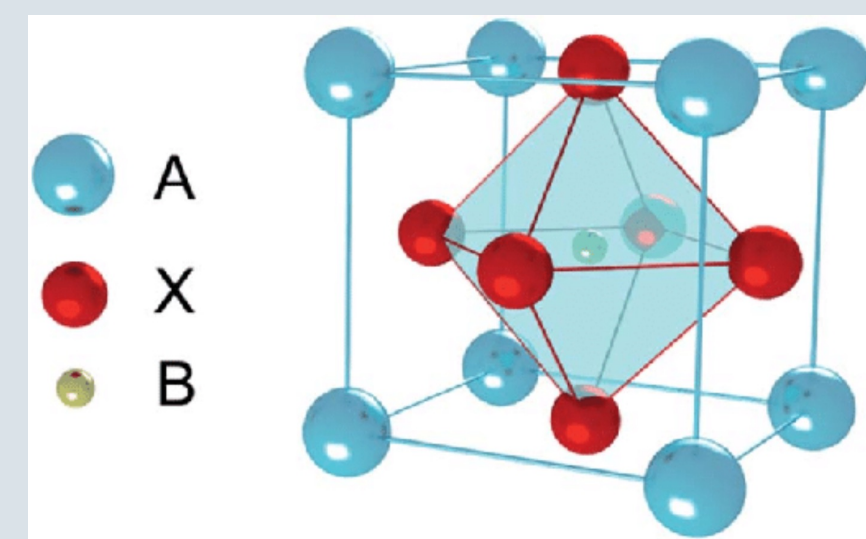
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**BACKGROUND:** Among multiferroic materials, bismuth ferrite (BiFeO<sub>3</sub>) has been high-profile because it is perhaps the only compound that has both magnetic and strong ferroelectric properties at room temperature. This presentation will explore quantum paraelectric (EuTiO<sub>3</sub>) modified multiferroic (BiFeO<sub>3</sub>) materials, focusing on ways to modify different structures and achieve enhanced physical properties can be used in manufacturing.

## METHODS :



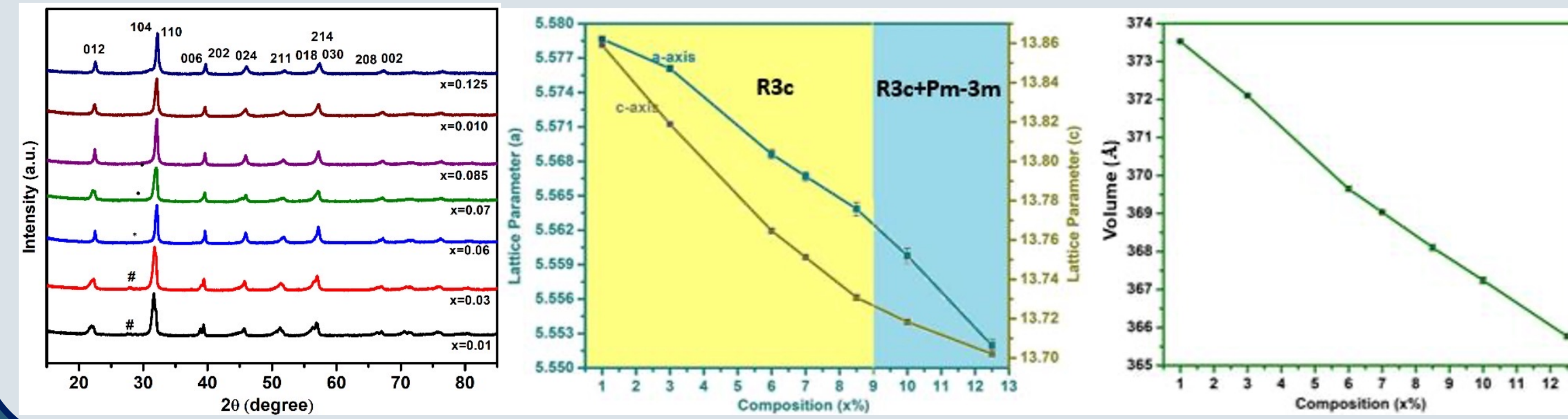
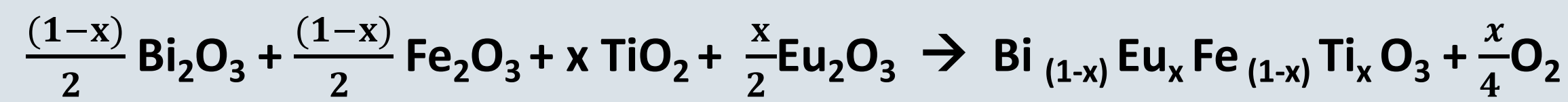
## PEROVSKITE STRUCTURE:



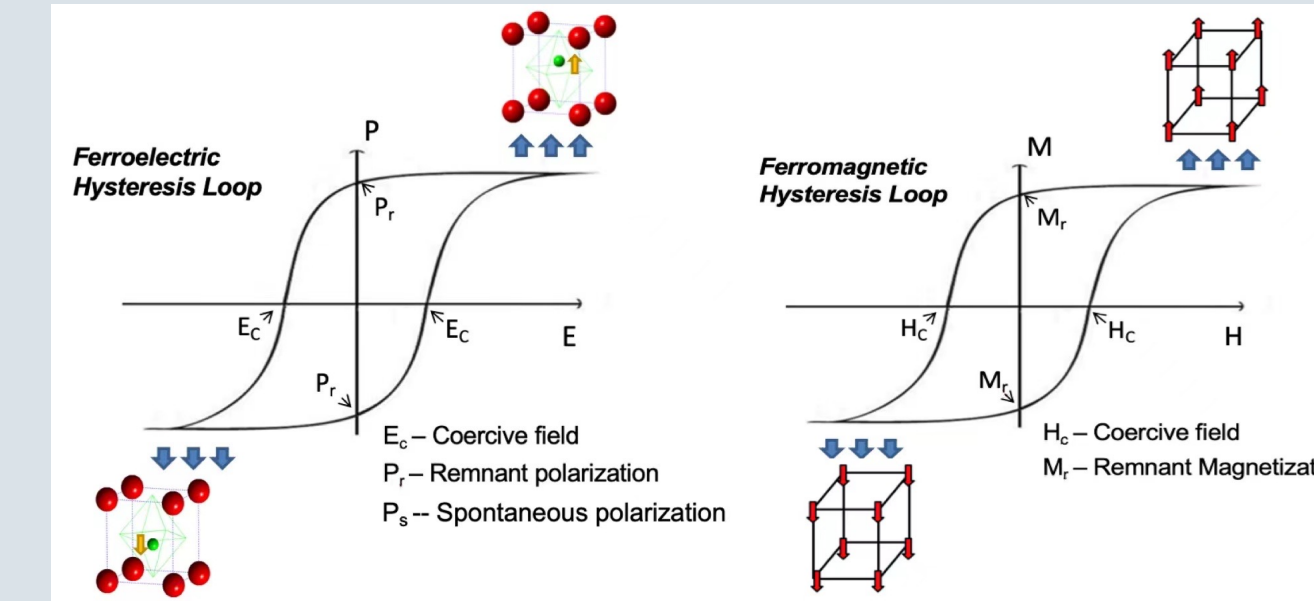
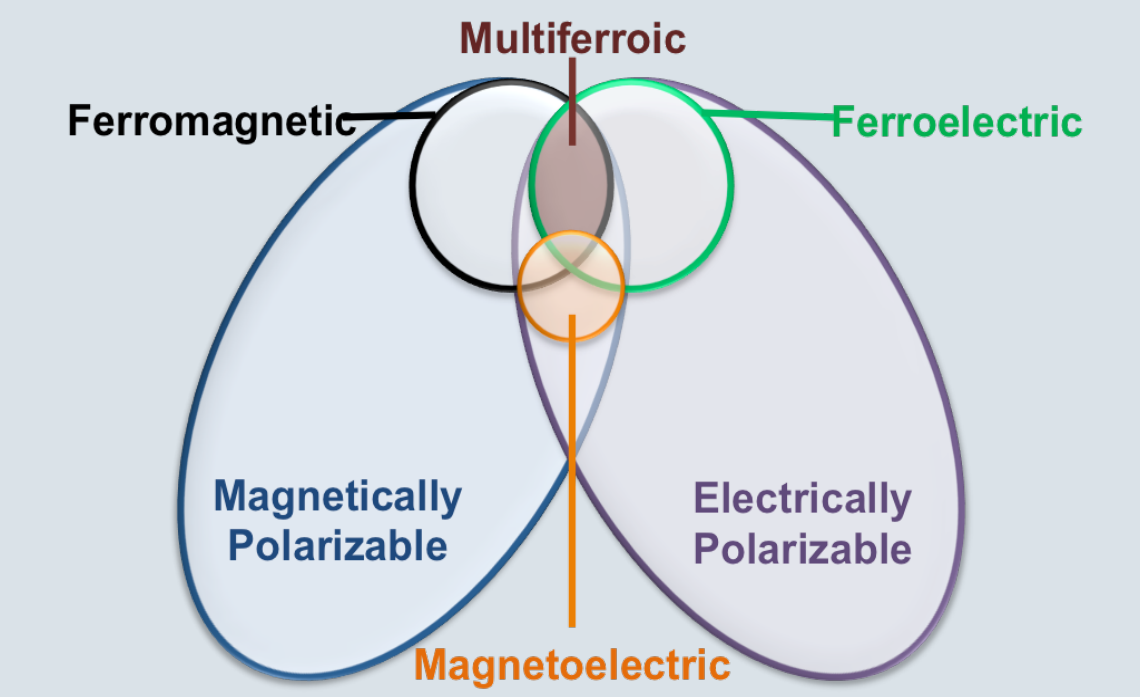
A Ionic Radii (Å)	B Ionic Radii (Å)	X Ionic Radii=1.42 (Å)	Electrical Properties (ABO <sub>3</sub> )
Bi 1.40 Bismuth	Fe 0.645 Iron	O	BiFeO <sub>3</sub> Multiferroic
Eu 1.46 Europium	Ti 0.605 Titanium	O	EuTiO <sub>3</sub> Quantum Paraelectric

# Results & Discussion

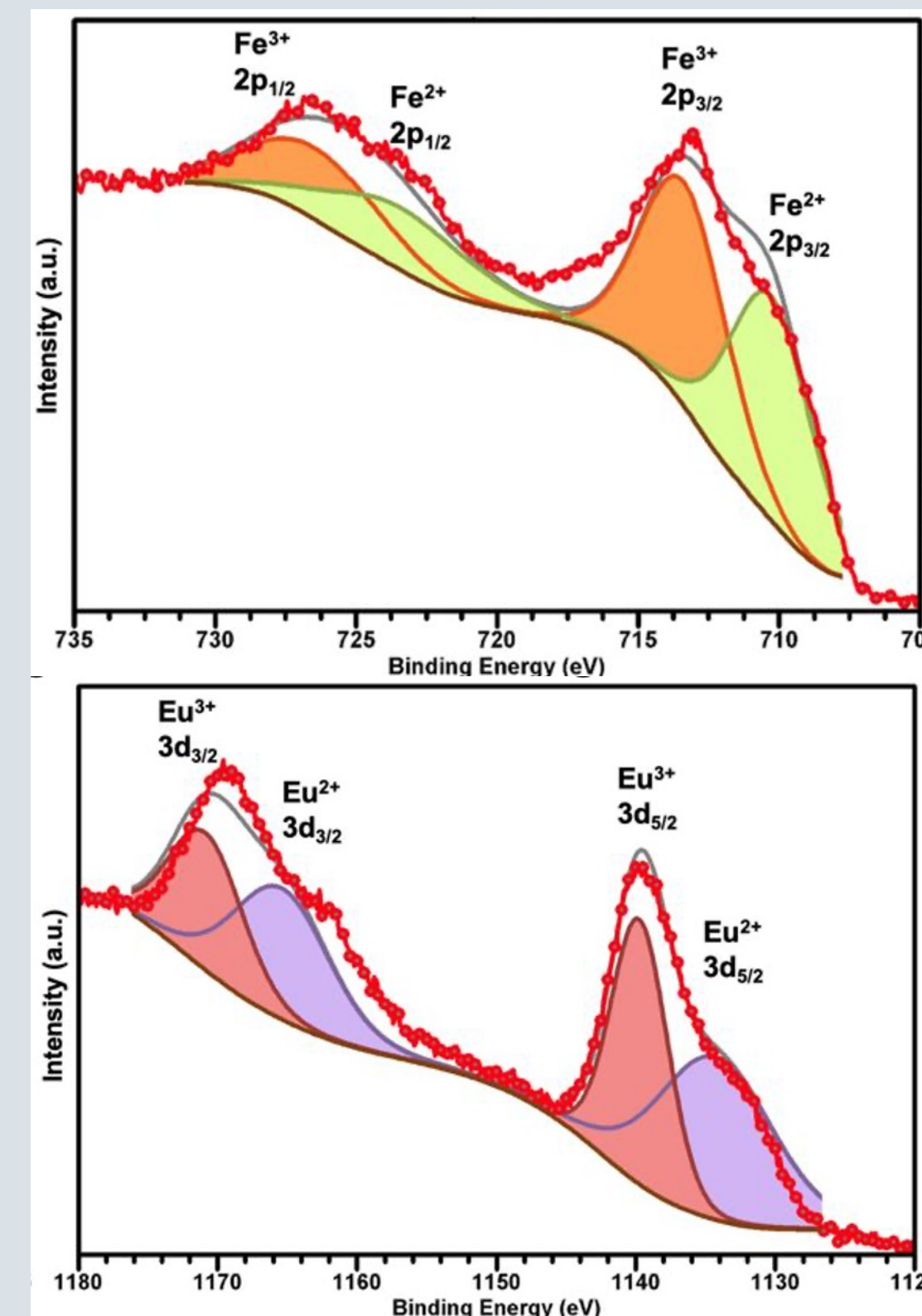
## Synthesis and Structural Analysis



- XRD patterns shows that with the increase of EuTiO<sub>3</sub> content, evolution from the rhombohedral (R3c) to MPB (R3c +Pm-3m) phase was detected.
- Both the hexagonal lattice parameters, a and c decrease with increasing x, leading to shrinkage of unit cell.



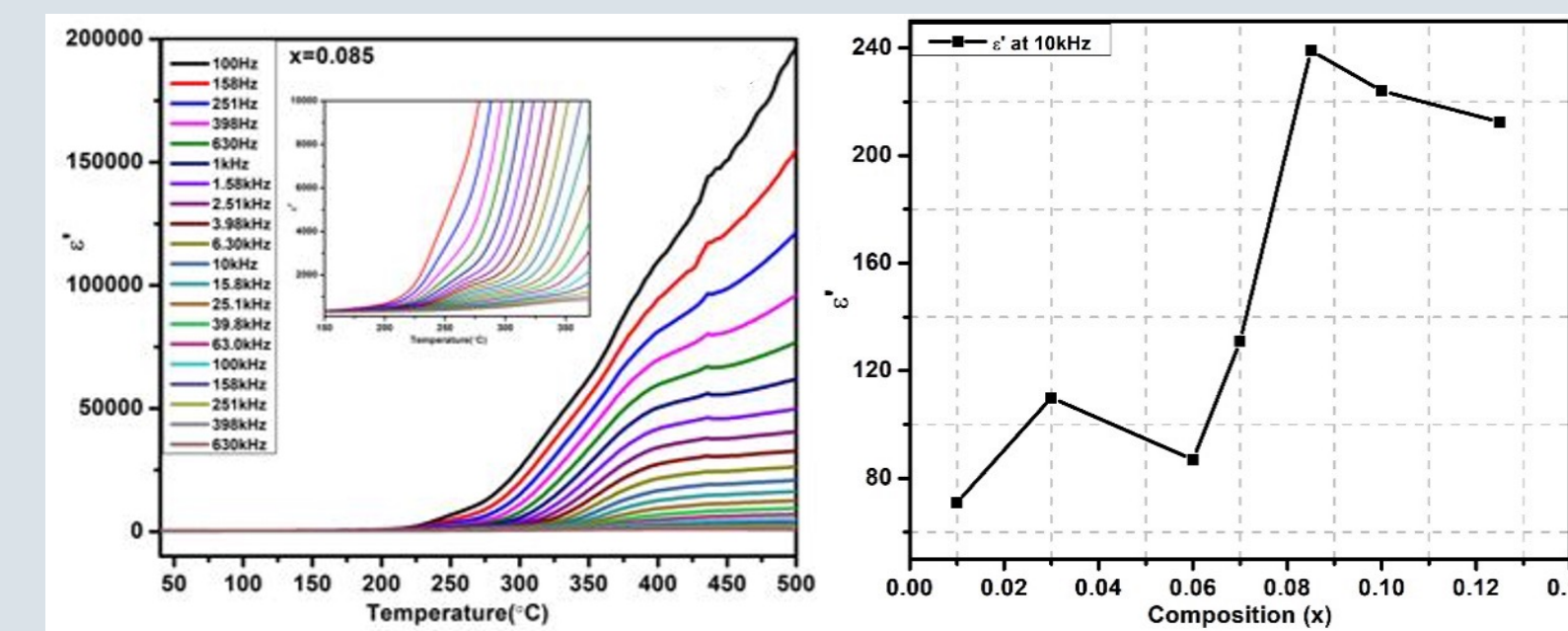
## X-Ray Photoelectron Spectroscopy (XPS) Analysis



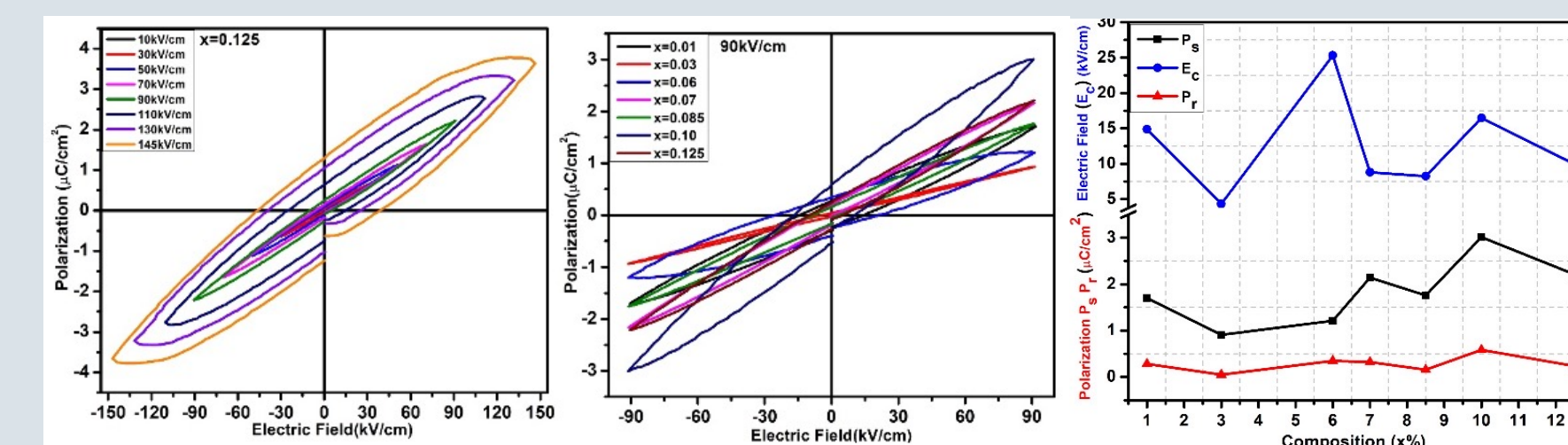
- Two oxidation states of iron: Fe<sup>2+</sup> and Fe<sup>3+</sup>.
- Two oxidation states of europium: Eu<sup>3+</sup> and Eu<sup>2+</sup>.
- The Fe 2p and Eu 3d peaks were studied to verify the oxidation states of the cations.

- Mixture of oxidation states for Fe and Eu are found in the as prepared sample which could influence the properties of (1-x) BiFeO<sub>3</sub>-xEuTiO<sub>3</sub>, thereby changing their electrical and magnetic characteristics.

## Dielectric & Ferroelectric properties

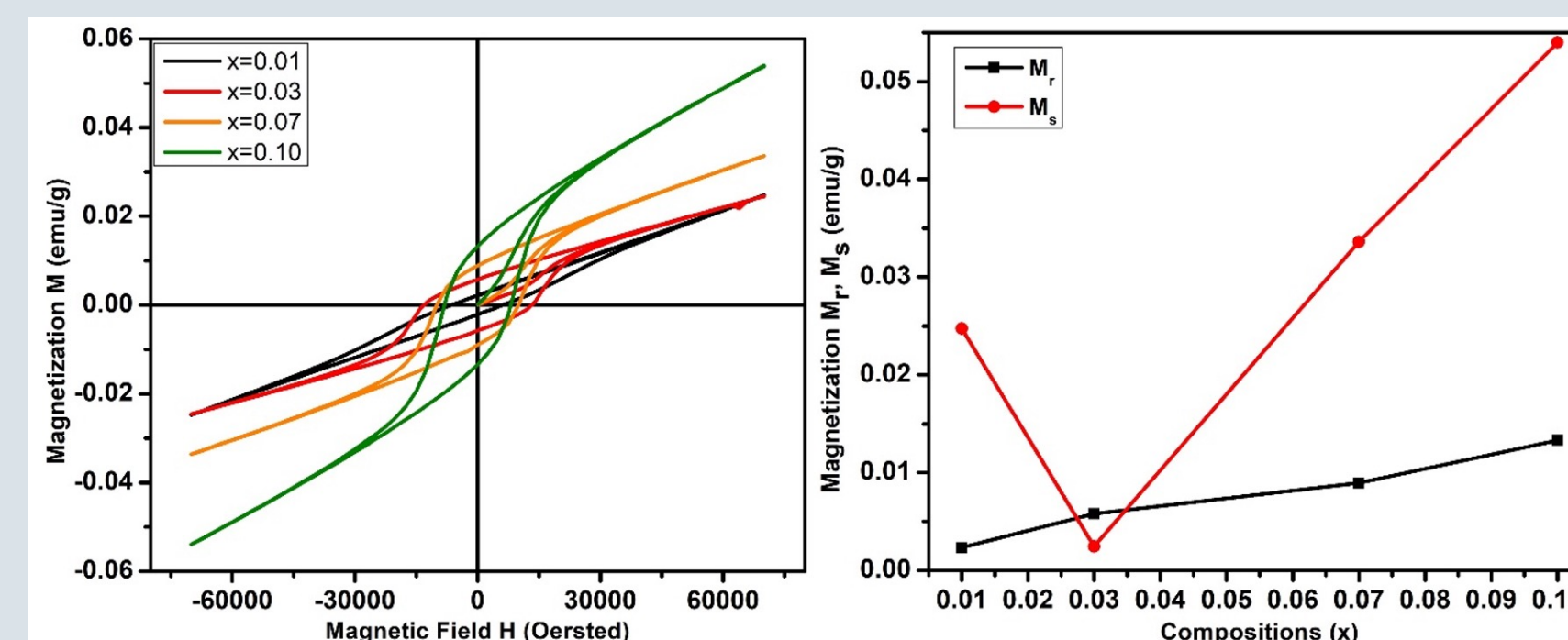


A step-like decrease in the permittivity (ε') value between successive relaxation processes is the characteristic of giant dielectric constant materials.



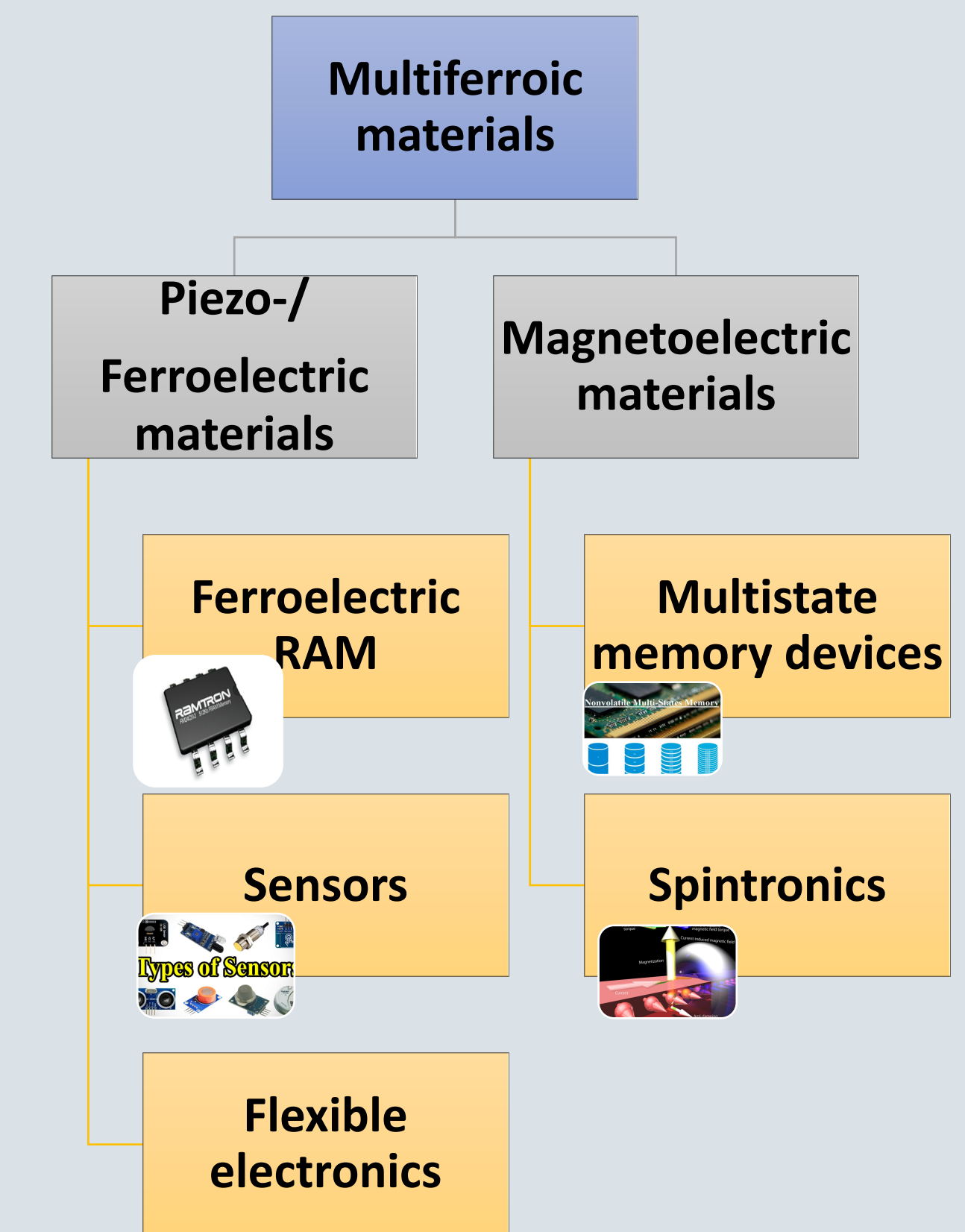
- The highest spontaneous polarization reached 3.78 μC/cm<sup>2</sup> at 140kV/cm in the composition of x=0.125.
- The prepared solution shows an increase in spontaneous polarization (P<sub>s</sub>) and remnant polarization (P<sub>r</sub>) with increasing EuTiO<sub>3</sub>.

## Magnetic properties



- Substitution of EuTiO<sub>3</sub> induces ferromagnetic order at room temperature.
- Prepared new solid solution (1-x) BiFeO<sub>3</sub>-xEuTiO<sub>3</sub> is truly multiferroic material with the coexistence of ferroelectric and ferromagnetic properties.

## APPLICATIONS:



## REFERENCES:

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- Palneedi, H et al. Advanced Functional Materials, 28 (42),1803665, (2018)
- Gao, W.; Zhu, Y.; Wang, Y. et al, *Journal of Materiomics*, 6 (1), 1–16, (2020).
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