

Track (AM/SM/AF/AI/BD/DM/HR/ID/MT/PR/SD/SE/EG/TD/TL/RD): AM

## **Improvement in Multifunctional Features of BFO solid solution due to Addition of $\text{MgTiO}_3$**

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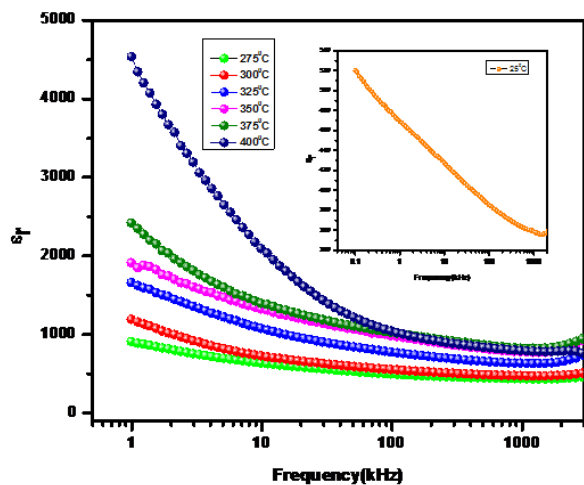
Modifications in the perovskite structure by another perovskite structure having alkaline earth elements at the A site significantly affect its physiochemical properties such as dielectric, electric and magnetic behaviors. Following this motivation, here we report our findings from the magnetic, dielectric, optical, Impedance and modulus studies on the solid solution method synthesized sample  $(\text{BiFeO}_3)_{0.80}(\text{MgTiO}_3)_{0.20}$ . The structural investigation was carried out to delineate the lattice formation, space groups etc. A structural transition from spin cycloid rhombohedral phase to orthorhombic phase was noticed due to the doping by alkaline earth ion based  $\text{MgTiO}_3$  structure. The X-Ray Photoelectron Spectroscopy (XPS) proved the existence of multiple valence states in the ceramic which in turn validates the phenomena of hopping conduction and short-range double-exchange interactions [1-4], thereby improving the magnetic property. The Fourier Transform Infrared spectroscopy (FTIR) and Raman analysis give an insight into the various vibrational states that are present in the sample. The modification of BFO reduced the optical bandgap to 1.87 eV from 2.2-2.5 eV for pure  $\text{BiFeO}_3$ , as divulged from the tauc plot of the absorbance curve. The value of the dielectric permittivity at ambient temperature and low frequency is also significantly high. The impedance and modulus analysis divulge the negative resistance in the studied sample, which enables it to be applied for semiconducting devices fabrication. The involvement of different charge carriers in conduction and relaxation mechanisms was evidenced from the DC conductivity plots.

The results from the experimental characterizations revealed that

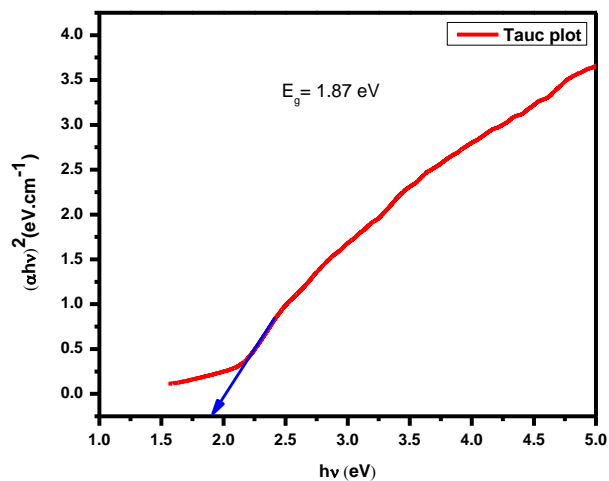
- a) The room temperature dielectric permittivity value is very high at low frequency, which is a pre-requisite for electrical energy storage applications
- b) The Tauc plot of the UV absorbance spectra reveals very narrow tapered energy band gap as compared to the pure BFO.
- c) The impedance analysis reveals good semiconducting nature of the composite.
- d) Modulus spectroscopy ensures non-existence of electrode polarizing effects.
- e) The XPS analysis proves the existence of multiple valence states of Fe and Ti along with the existence of oxygen defects which in turn validates the phenomenon of short range hopping conduction and possible ferromagnetic interactions.
- f) Existence of weak ferromagnetic ordering in lieu of AFM ordering due to canted spin cycloid ordering of magnetic moments is visible from room temperature magnetic study.

## References

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**Figure 1:** Variations of Dielectric permittivity with frequency



**Figure 2:** Tauc plot for estimation of  $E_g$