Evidence of Magneto-Dielectric Coupling at Room Temperature in Polycrystalline $KBiFe_2O_5$

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Abstract

The phase pure polycrystalline $KBiFe_2O_5$ with space group P2/c is synthesized following solid state reaction route. The temperature dependent real and imaginary part of dielectric constant is studied over wide temperature (26˚C to 580˚C) and frequency range (100 Hz ≤ f ≤1 MHz). Two distinct anomalies at around 110˚C and 510˚C is observed in both real (ε) an imaginary (tanδ) part of dielectric constant which can be attributed to Maxwell-Wagner effect. Our DC susceptibility measurement up to room temperature does not show any transition even up to room temperature, giving an indication that its transition temperature is above room temperature. This aspect is further confirmed from M-H hysteresis loop which shows a weak ferromagnetic hysteresis loop at room temperature. The evidence of magnetodielectric (MD) coupling at room temperature is confirmed from magnetic field dependent dielectric measurement in the form of inverted butterfly shaped ε-H loop .

Introduction

- **The novels behaviour of showing coupling between magnetic and electric order in materials usually known as multiferroicity[1,2].**
- **The simultaneous existence of magnetism and ferroelectricity in magnetoelectric multiferroic is rare [3]. Moreover, the number of single phase materials with substantial ME coupling are very few.**
- **Among all the existing materials most of the materials show their ME coupling below liquid nitrogen temperature.**
- **KBFO to reported to be a multiferroic at RT with Curie temperature (Tc ≈ 780 K) and Néel temperature (T_N ≈ 560 K) [6].**
- **We have investigated the structural, magnetic and dielectric properties of KBFO.**

Solid State Reaction Route

K_2CO_3+Fe_2O_3+ Bi_2O_3

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Mixing and Grinding

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Calcined at 650˚C for 4 h

↓

Sintered at 700˚C For 2 h

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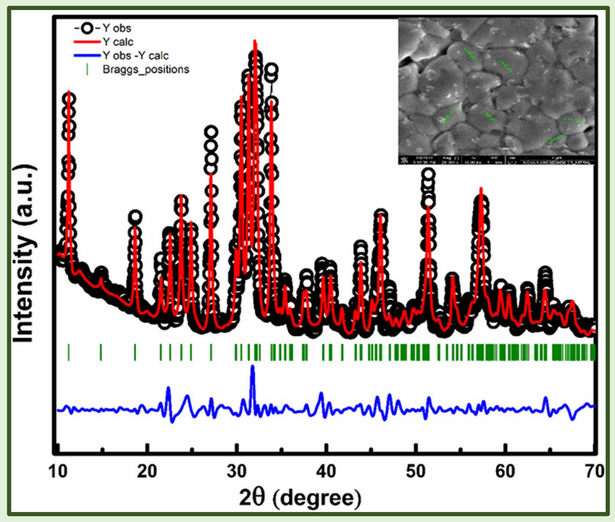
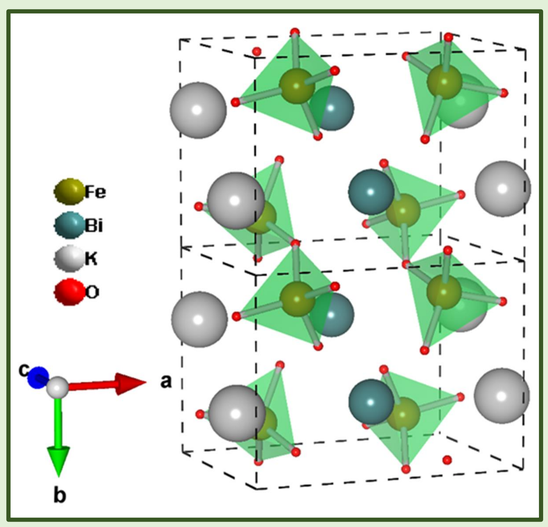
$KBiFe_2O_5$

Results

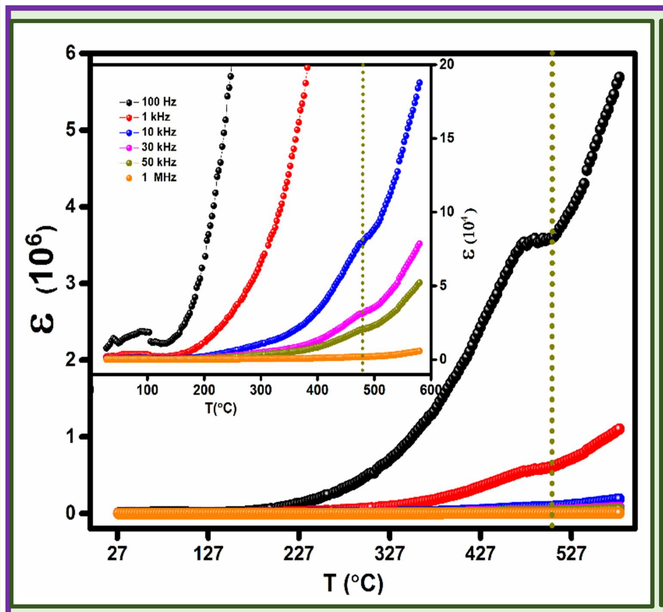


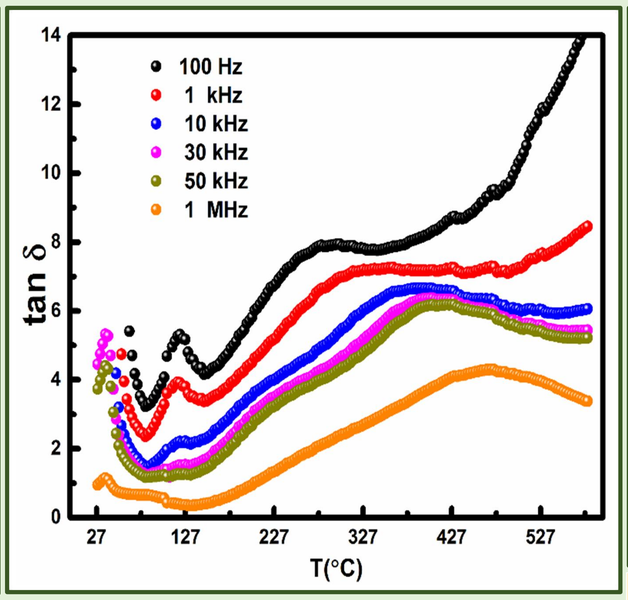
- KBFO having P2/c space group with inset shows FESM of grain size in (2-3)μm range.

- Schematic monoclinic structure of the KBFO.

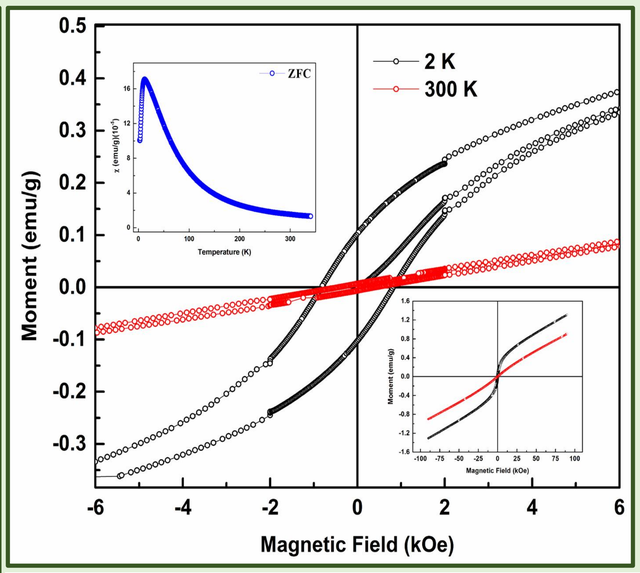


Dielectric and Magnetic Characterization

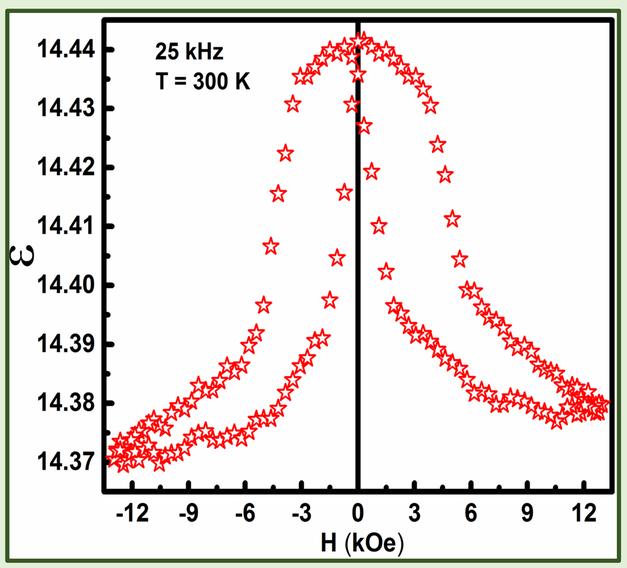




- **In both dielectric constant and loss a broad hump observed at 110˚C and 510˚C.**
- **The broad shoulder in temperature dependent dielectric loss termed as a relaxation peak.**
- **The high value of step like increase of dielectric constant and peak in the dielectric loss plot indicates that dielectric constant may be of non-intrinsic in nature at high temperature.**



- **The M-H data at 2K signifies the presence of enhanced hysteresis with respect to 300K due to ferromagnetic ordering of Fe^{3+} ions .**
- **The small amount of hysteresis at 300K attributed to the magnetic ordered state even at room temperature**
- **ZFC shows a spin cluster like behaviour of Fe^{3+} at 13K.**



- **An inverted butterfly loop in dielectric constant was observed as a function of magnetic field signifying the presence of Magnetodielectric (MD) effect at room temperature.**

References

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Conclusion

- **The temperature dependent real and imaginary part of dielectric constant shows two distinct anomalies at around 110˚C and 510˚C which can be attributed to Maxwell-Wagner effect.**
- **DC susceptibility measurement confirms the presence of magnetic ordering even up to room temperature which is confirmed from presence of weak hysteresis loop (M versus H)at 300K.**
- **The evidence of magnetodielectric (MD) coupling at room temperature is confirmed from magnetic field dependent dielectric measurement (ε versus H) in the form of inverted butterfly shaped ε-H loop.**

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