Magnetic and Dielectric Study of $KBiFe_2O_5/CoFe_2O_4$ Composite

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Abstract: In this work, (90)$KBiFe_2O_5$-(10)$CoFe_2O_4$ [KBFO(90)-CFO(10)] composite is synthesized in polycrystalline form following the sol-gel technique. The magnetic, dielectric, and signature of the magnetodielectric (MD) effect in the prepared composite is verified over a wide temperature range. The phase purity of the prepared KBFO-CFO composite is confirmed by the room temperature (RT) X-Ray diffraction technique. The RT magnetization study reveals the weak ferromagnetic nature of the composite. The dielectric study reveals an anomaly near 500 °C, expected to be a structural phase transition. The magnetic anomaly near the dielectric transition suggests the signature of the MD coupling of the composite. The composite's indirect band-gap of 1.01 eV made it suitable for technological applications. Finally, the prepared composite shows the signature of the MD effect, and the low band gap suggests it is ideal for photovoltaic applications

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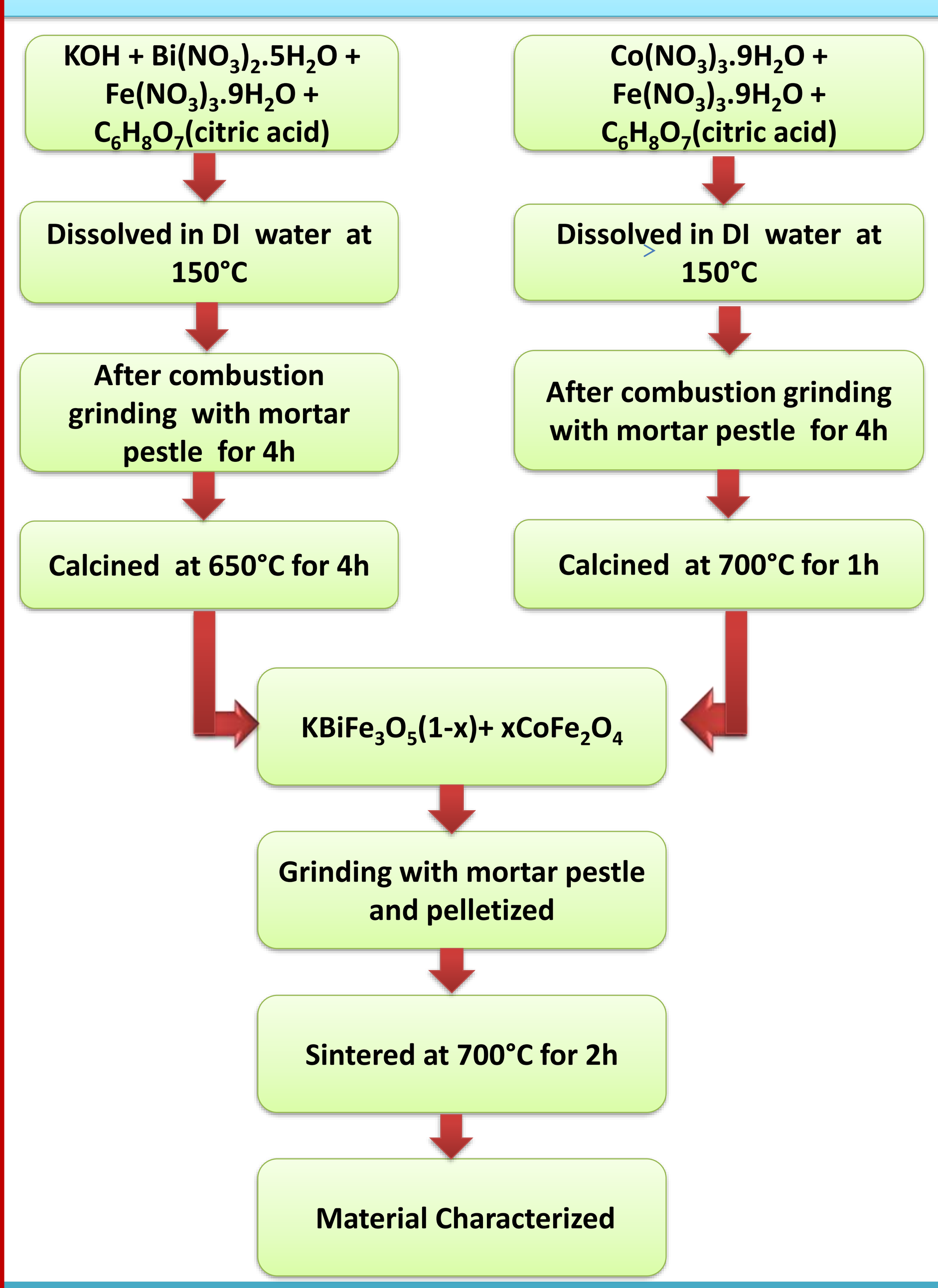
ABSTRACT

In this work, $(90)KBiFe_2O_5$-$(10)CoFe_2O_4$ [KBFO(90)-CFO(10)] composite is synthesized in polycrystalline form following the sol-gel technique. The magnetic, dielectric, and signature of the magnetodielectric (MD) effect in the prepared composite is verified over a wide temperature range. The phase purity of the prepared KBFO-CFO composite is confirmed by the room temperature (RT) X-Ray diffraction technique. The RT magnetization study reveals the weak ferromagnetic nature of the composite. The dielectric study reveals an anomaly near 500 °C, expected to be a structural phase transition. The magnetic anomaly near the dielectric transition suggests the signature of the MD coupling of the composite. The composite's indirect band-gap of 1.01 eV made it suitable for technological applications. Finally, the prepared composite shows the signature of the MD effect, and the low band gap suggests it is ideal for photovoltaic applications.

INTRODUCTION

- Electric property is due to the charge of an electron. Material that has unpaired electrons commonly shows magnetic behavior.[1]
- The coupling between the magnetic and electric order parameters in the same phase is known as the magnetoelectric (ME) effect [2]
- Electric and magnetic properties are indirectly coupled via the magnetodielectric (MD) effect [3]
- The difficulty in this research area is obtaining a high MD coupling strength at room temperature (RT) [4]
- The composite materials are preferable candidates to satisfy the above requirements [5].

SOL-GEL SYNTHESIS ROUTE



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2. N. A. Spaldin, Proc. R. Soc. A 476, 17 (2020).
3. M. D. Rather, R. Samad, N. Hassan, B. Want, J. Alloy. Compd.794, 416 (2019).
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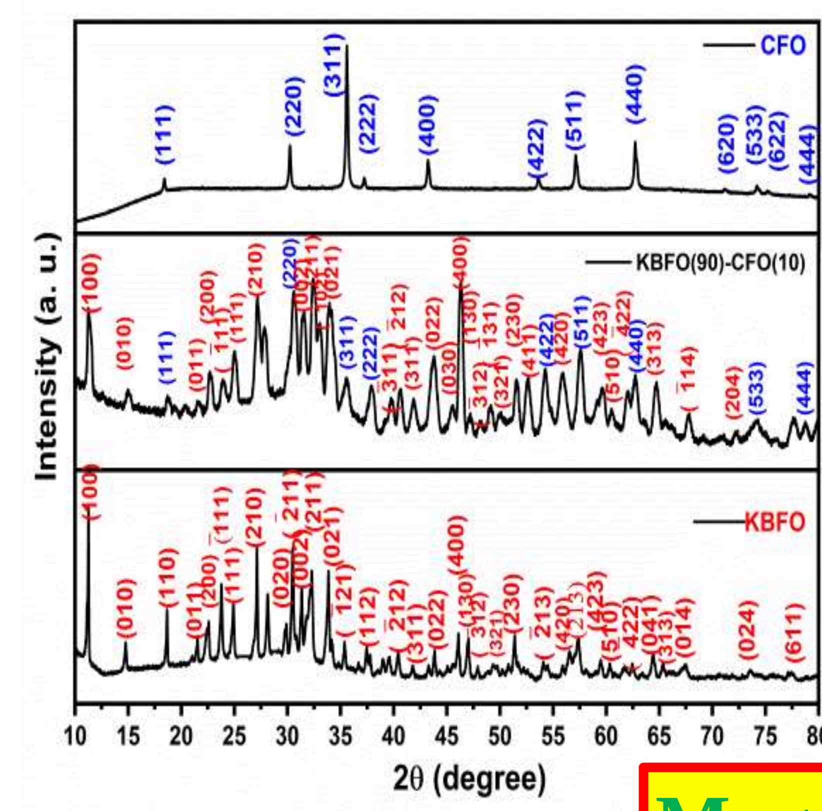
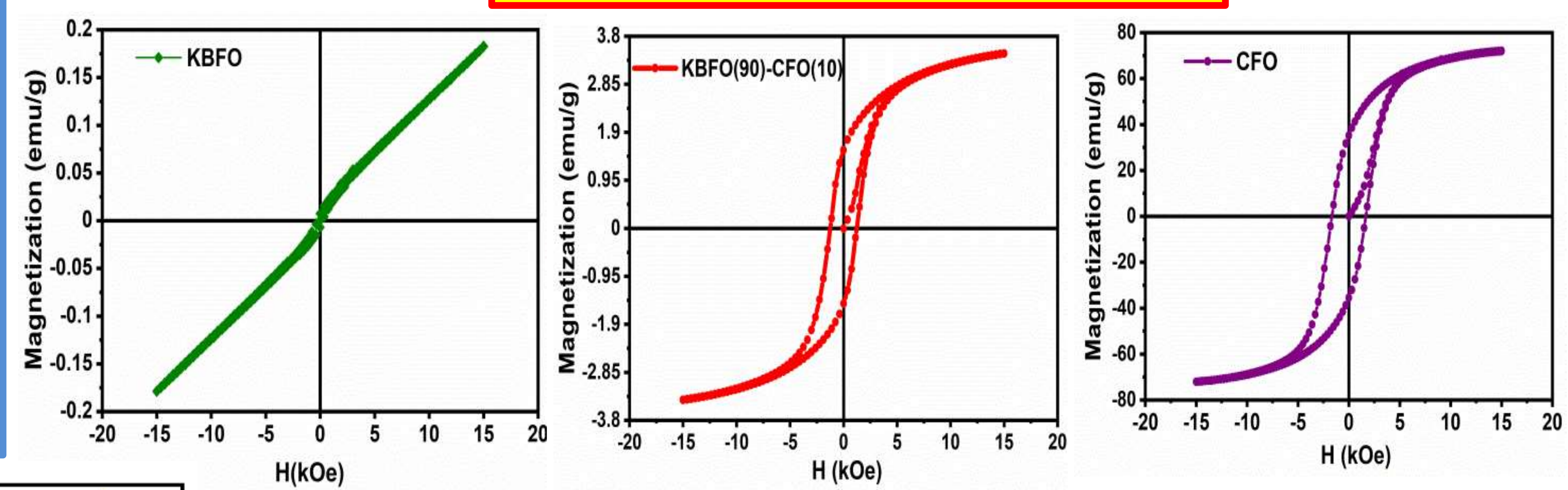
EXPERIMENTAL RESULTS

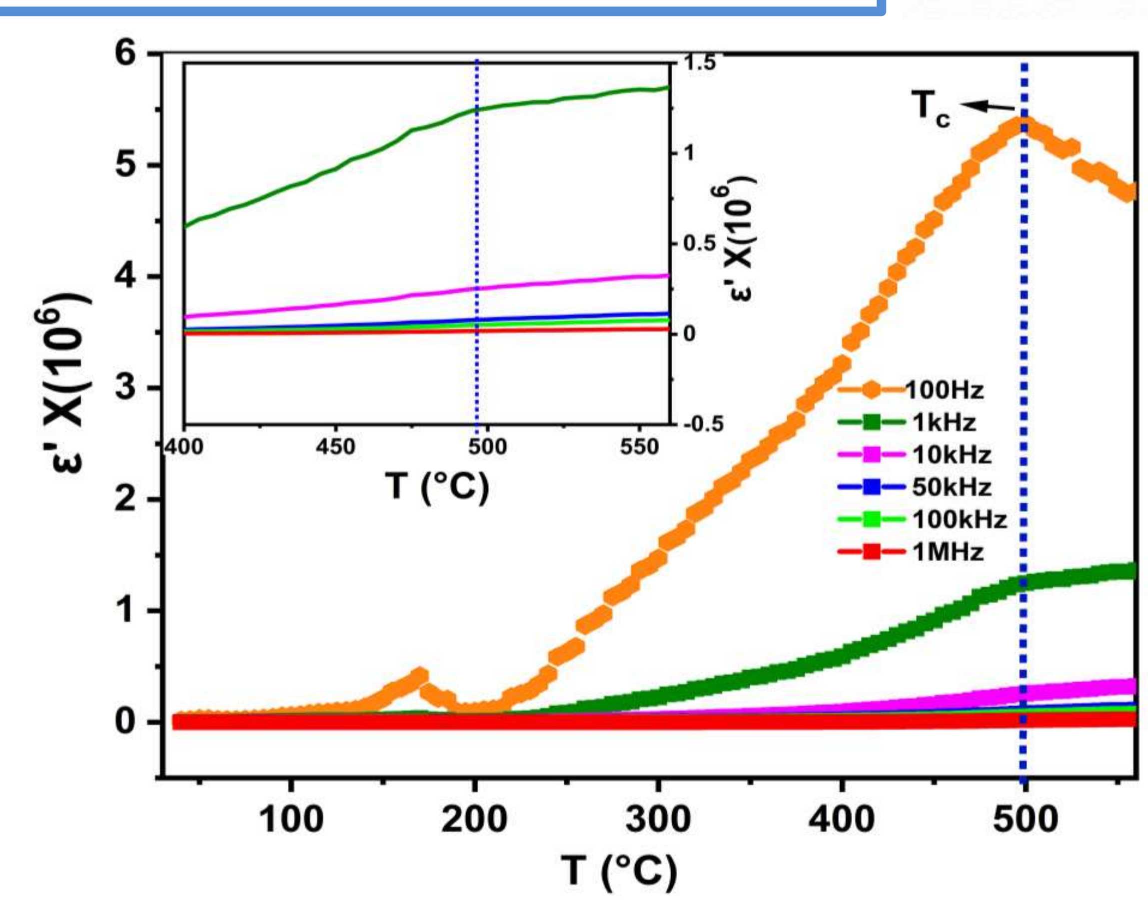
X-Ray Diffraction Analysis



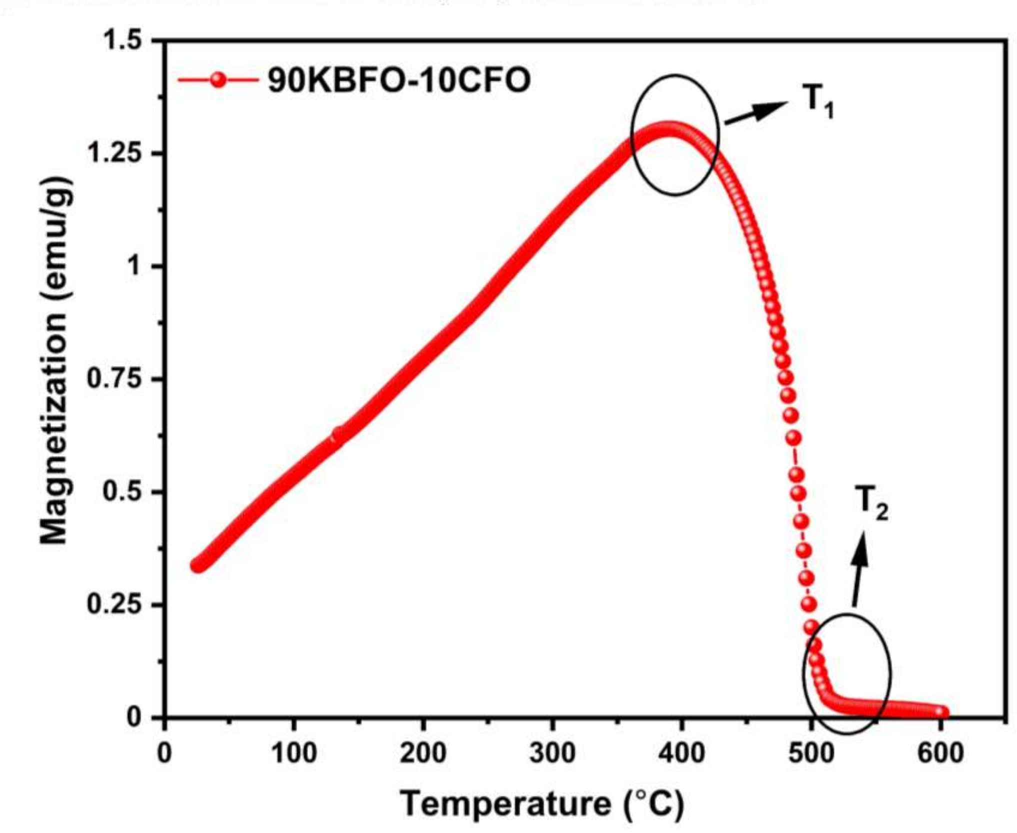
Material	H_c (Oe)	M_r (emu/g)
KBFO	253.65	0.0075
KBFO(90) +CFO(10)	1245.01	1.5488
CFO	1660.13	35.24

Magnetic and dielectric study



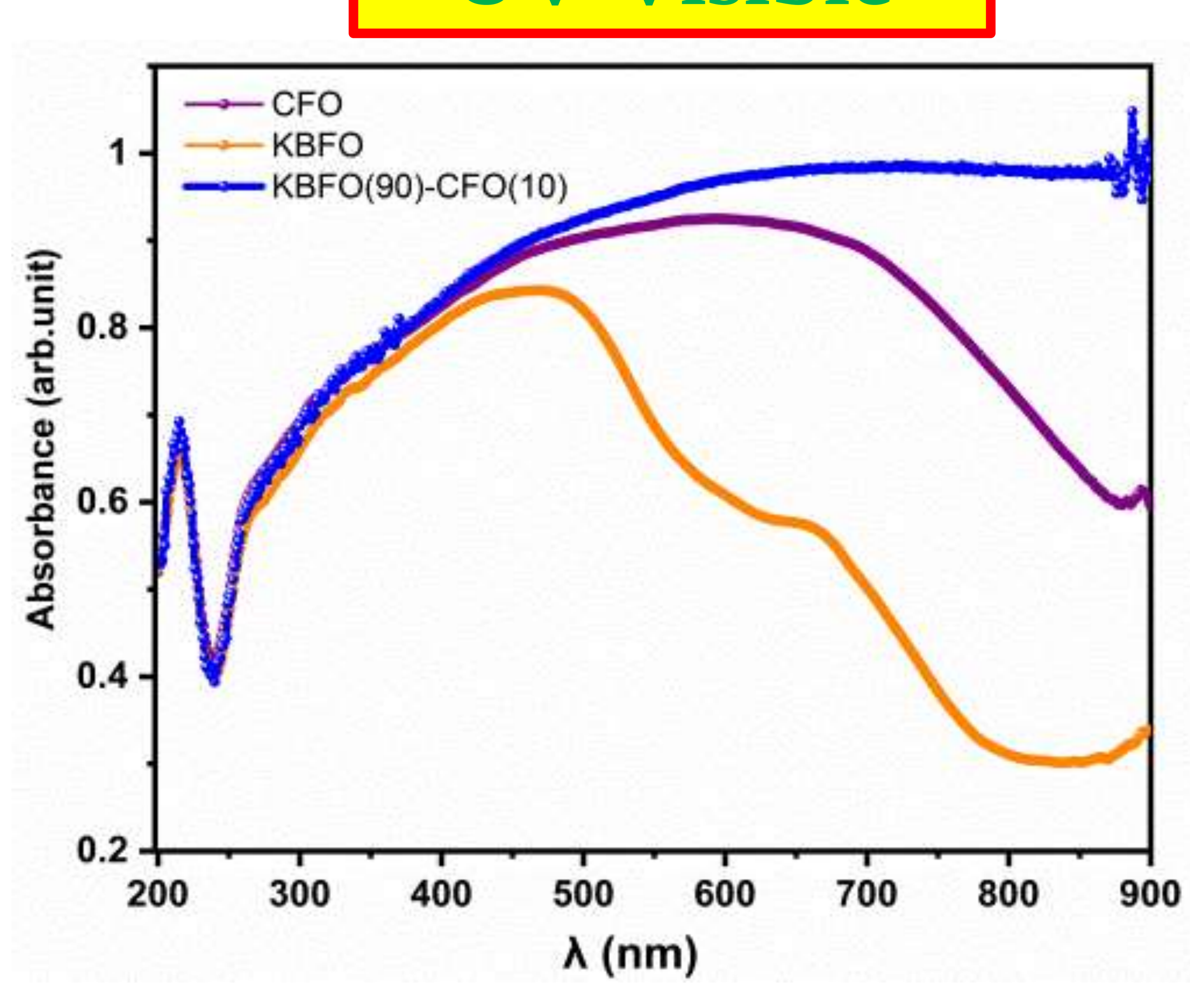


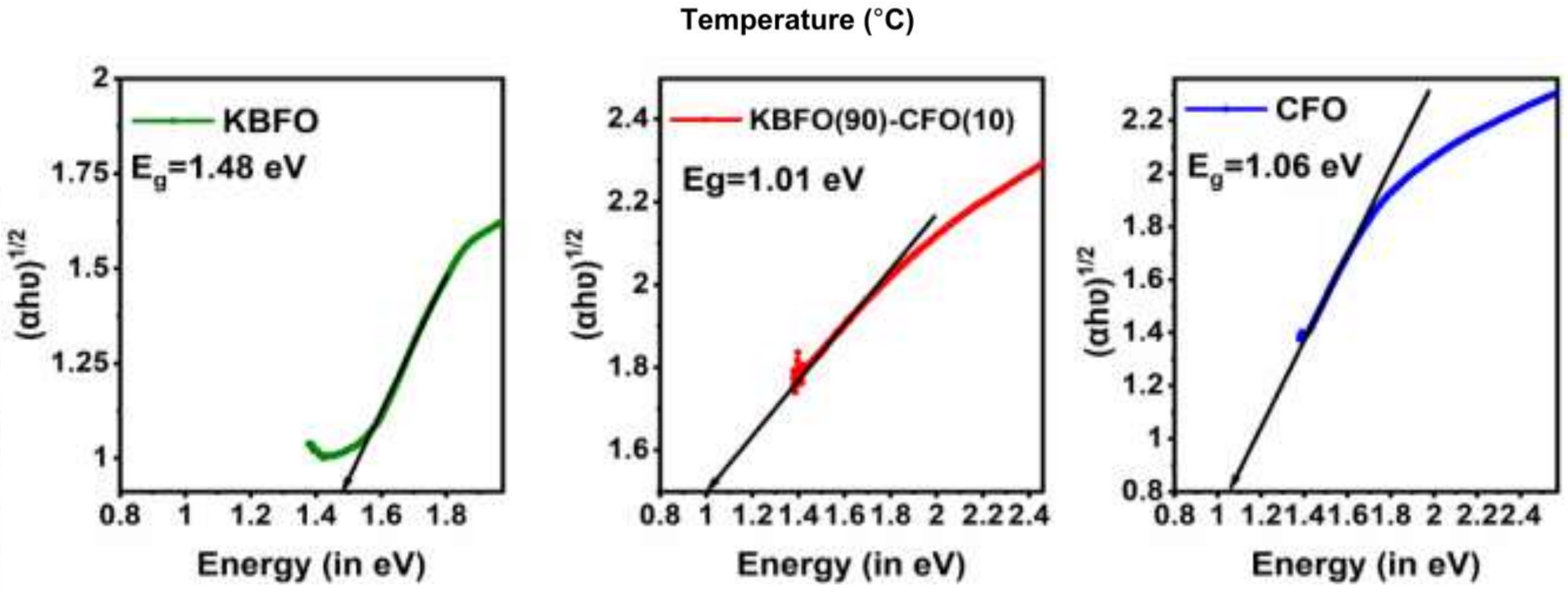
Frequency:
100 to 1M Hz
Dielectric
T_c: ~ 500 °C



M-T data
T_1: 390 °C
T_2: 500 °C

UV-Visible





CFO	KBFO	KBFO(90) +CFO(10)
1.06 eV	1.48 eV	1.01 eV

CONCLUSIONS

- The magnetic properties of the composite reveal the presence of weak ferromagnetism.
- Magnetic transition in composite is observed near 390 °C.
- Temperatures-dependent magnetic and dielectric data shows transition around 500 °C, indicating the existence of magnetodielectric coupling.
- The UV-visible spectroscopy study reveals the band-gap of composite is found at ~ 1.01 eV The low band-gap with MD coupling in the KBFO(90)–CFO(10) composite is suitable for technological applications.