Magnetic study and magnetoelectric measurement on $CoFe_2O_4$-$BiFeO_3$ nanocomposite

S. Kuila, S. Tiwary, M. R. Sahoo, A. Barik and P. N. Vishwakarma

National Institute of Technology Roukela, Department of Physics & Astronomy, Rourkela 769008, Odisha, INDIA

This document provide Composite multiferroics, shows relatively larger coupling between ferroelectric and magnetic spin orders than single phase multiferroics. This magnetoelectric (ME) coupling can be exploited for novel spintronic and memory devices, as well as for ME sensors. Nanocomposite based multiferroic are another area of interest which has emerged in the recent years.

Here we are presenting the study of $CoFe_2O_4$/$BiFeO_3$ nanocomposite, synthesized via sol-gel method. The phase analysis via powder x-ray diffraction confirms the $BiFeO_3$ (BFO) and $CoFe_2O_4$ (CFO) crystal reflections only, without any secondary phases.

Isothermal magnetic field (H) dependent (+1T to -1T) magnetoelectric (ME) measurement is carried out in the temperature range 125K – 375K. First order ME coefficient (α) is extracted from the zero magnetic field ME voltage and found to increase steadily with decrease in temperature. Plot of ΔV (= V(H) – V(0); V(H) and V(0) are the ME voltage at non-zero and zero field H) for different temperatures shows sharp slope change at ~±5kOe and 125K. Such behaviour is usually found in piezoelectric and magnetostrictive composites. As temperature rises, slope change position shifts to lower fields, depicting the weakening of magnetostriction strength. Almost negligible variation of ΔV has been found with H at room temperature and above.

The magnetization versus field, M-H plot, when the sample is zero field cooled (ZFC) from T_C, shows ferromagnetic loops at room temperature. No saturation in M-H curve is observed. The area under the loop and highest field magnetization (say M_H) decreases with increase in temperature. A sharp ferromagnetic to paramagnetic transition has been observed in temperature dependent magnetization (M-T) plot at ~840K, corresponding to T_C of CoFe2O4. Interestingly, the transition temperature of BFO (which is 643K for bulk) is shifted to slightly higher temperature ~700K. Such shift in transition temperature generally happens due to magnetic proximity effect. In the data measured under field cooled (FC) mode, this peak gets diffused.