Accepted Manuscript

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PII: S0925-8388(17)33371-6

DOI: 10.1016/j.jallcom.2017.09.309

Reference: JALCOM 43365

To appear in: *Journal of Alloys and Compounds*

Received Date: 13 June 2017

Revised Date: 28 August 2017

Accepted Date: 27 September 2017

Please cite this article as: R.M. Thankachan, B. Raneesh, A. Mayeen, S. Karthika, S. Vivek, S.S. Nair, S. Thomas, N. Kalarikkal, Room temperature magnetoelectric coupling effect in $CuFe_2O_4/BaTiO_3$ core-shell and mixed nanocomposites, *Journal of Alloys and Compounds* (2017), doi: 10.1016/j.jallcom.2017.09.309.

Room temperature magnetoelectric coupling effect in $CuFe_2O_4/BaTiO_3$ core-shell and mixed nanocomposites

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Abstract

Novel magnetoelectric (ME) $CuFe_2O_4$@$BaTiO_3$ core-shell and (1-*x*)$BaTiO_3$-*x*$CuFe_2O_4$ (*x*=0.1, 0.3, 0.5, 0.7 and 0.9) mixed composites were prepared by two step sol-gel and a sol-gel followed by a solid state reaction respectively. Crystal structure and microstructure of the samples were examined using X-ray diffraction (XRD) and transmission electron microscopic (TEM) techniques. The ferroelectric and magnetic properties of the materials were confirmed by polarization versus electric field (P-E) and magnetization versus magnetic field (M-H) measurements respectively. To determine the coupling between ferroelectric and magnetic orderings, ME coupling studies were performed using a lock-in amplifier setup. The highest value of the ME coupling coefficient (α) was noticed for the $CuFe_2O_4$@$BaTiO_3$ core-shell (α = 22.5 mV cm^{-1} Oe^{-1}) sample. Superior ME coupling behavior in the core-shell material is due to better connectivity between the ferroelectric and magnetic phases. The optical measurements indicate the possibility of easy manipulation of the band gap over a range of energies by mere control of the molar ratio of the phases. The smart architecture enables $CuFe_2O_4$@$BaTiO_3$ sample to be a highly promising material for the design of devices based on ME multiferroics.

Keywords: Multiferroic; core-shell; mixed nanocomposite; magnetoelectric coupling