Magnetic ground state and multiferroic nature of hexagonal $LuFeO_3$ nanoparticles

Pittala Suresh
Indian Institute of Science, India

Multiferroic materials with coupling between electric and magnetic orders are of great interest in recent times due to their technological importance. Rare earth manganites, $RMnO_3$ (R = Ho ... Lu, Y or Sc) are one of the most studied multiferroic systems. In these systems, the magnetic ordering lies in low temperatures whereas the ferroelectric ordering lies much above room temperature (~ 1000 K). $RMnO_3$ compounds can have favorable crystallization in both orthorhombic and hexagonal phases depending on the choice of rare earth element. The magnetic ordering is expected to be higher in the isostructural hexagonal ferrites (h-$RFeO_3$, R = Sc, Y, and Ho–Lu), due to the strong exchange coupling between Fe^{3+} ions in the lattice compared with Mn^{3+} ions and high localized magnetic moment of Fe. The preparation of hexagonal $LuFeO_3$ (h-LFO) is tedious in the bulk form due to its metastable nature. However it is possible to stabilize it in thin film form. In this study, h-LFO nanoparticles were synthesized by optimizing the preparation conditions. XRD analysis reveals its structure in $P6_3cm$ space group, which has polar symmetry. Microstructure shows the homogeneous particles with an average grain size of 50 nm. Raman spectra show 13 active phonon modes corresponding to the $P6_3cm$ symmetry. XPS establishes the Fe^{3+} oxidation state and sample quality. These samples order antiferromagnetically with Néel temperature, T_N~130K. Neutron measurements reveal the magnetic structure to be either in Γ1 or Γ1+Γ2 configurations. The ordered site moment of Fe ions is found to be m=2.84 μB/Fe^{3+}at 6 K. The hexagonal nature of the samples leads to the room temperature ferroelectric loops with remnant polarization Pr ~ 0.18 μC/cm^2. A clear anomaly in the heat capacity and the dielectric data is observed at the magnetic transition temperature as an indirect evidence of the magneto electric effect.

Biography

Pittala Suresh has completed his PhD at the age of 28 years from University of Hyderabad and currently a postdoctoral student at department of physics, Indian Institute of Science, Bengaluru. He has published more than 25 papers in reputed journals and has been working on multiferroic materials.

spittala.phy@gmail.com

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