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Study of some optical and electrical properties of Mn doped nanocrystalline lanthamum ferrite

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Research interest in multiferroic has increased in recent days because of their potential application in multifunctional devices like transducers, spintronics, sensors, actuators. Multiferroics are the combination of more than one ferroic characteristics (ferroelectric, ferromagnetic/antiferromagnetic and often ferroelastic) in the same phase. There is a coupling between ferroelectric and ferromagnetic orders. Lanthanum ferrite ($LaFeO_3$) is a very well-known canted antiferromagnetic material with high value of Neel temperature (T_N~740°C).

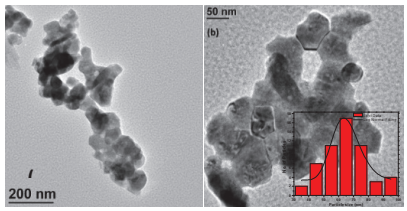

Figure 1: (a) HRTEM image of Pure $LaFeO_3$ and (b) 10% Mn doped $LaFeO_3$; inset shows log-normal fitting

Pure and Mn doped $LaFeO_3$ (LAFO) with distorted orthorhombic perovskite structure was synthesized by auto combustion method. Phase formation of the LAFO was confirmed by XRD (JCPDS card No. 37-1493). Average particle size was calculated 68nm for pure LAFO from HRTEM image (Figure 1). Interestingly in 10% Mn doped LAFO, the average particle size was calculated 63nm. Existence of Mn has been confirmed by the Energy-dispersive X-ray spectroscopy (EDX) analysis. Optical properties of the samples were studied by using UV-Vis spectroscopy and photoluminance spectroscopy.

Band gap (E_g) was calculated from UV-Vis spectroscopy. The values of E_g have been estimated by taking the intercept of the extrapolation of the zero absorption with photon energy (hν) axis of $(\alpha h\nu)^2$ verses hν graph. E_g was calculated of pure LAFO is 3.70 eV. But for 10% Mn doped LAFO, it increased up to 3.91eV.

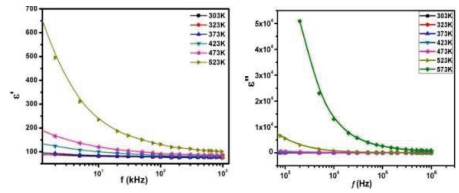

Figure 2: (a) Variation of $\varepsilon'(f)$ with frequency at different temperature (b) Variation of $\varepsilon''(f)$ with frequency for pure at different temperature for pure LAFO sample

Effect of Mn doping on electrical transport properties of nanocrystalline LAFO was investigated. The frequency variation of real and imaginary parts of dielectric permittivity is shown in Figure 2a and 2b respectively within frequency window $20Hz \leq f \leq 1MHz$. It is very clear that at low frequency the dispersion curves are more steepens than at high frequency. In the lower frequency region, the hopping electrons are trapped by the inhomogeneity. Due to the decrease in the resistance of the samples with increasing temperature, ε' increases with temperature at constant frequency. Electron hopping increase for low resistance and hence results in larger $\varepsilon'(f)$.The value of dielectric constant decreases with increase in frequency, since at low frequency the electrical dipoles can follow the applied field whereas at high frequency the dipoles cannot follow the applied field. Different types of thermal analysis like differential thermal analysis (DTA) and Thermogravimetric analysis (TGA) are also studied.

Keywords: Lanthanum ferrite, Optical properties, Electrical property, Nanomaterials.

References

1. J. Wang, J.B. Neaton, H. Zheng, V. Nagarajan, S.B. Ogale, B. Liu, *Science*, 299 (2003), 1719.
2. A. Mukherjee, S. Basu, G. Chakraborty, and M. Pal, *J. Appl. Phys.*, 112 (2012), 014321.
3. K. K. Bhargav, S. Ram, and S. B. Majumder, *J. Appl. Phys.*, 115 (2014), 204109.