Room temperature magnetic memory effect in cluster-glassy Fe-doped NiO nanoparticles

Ashish Chhaganlal Gandhi,[1] Tai-Yue Li,[1] B. Vijaya Kumar,[2] P. Muralidhar Reddy [2] Jen-Chih Peng,[3] Chun-Ming Wu,[3] and Sheng Yun Wu[*1]

[1]Department of Physics, National Dong Hwa University, Hualien 97401, Taiwan.

[2]Department of Chemistry, Nizam College, Osmania University, Hyderabad-500001, India.

[3]National Synchrotron Radiation Research Center, Hsinchu 30076, Taiwan

ABSTRACT: The effect of Fe-doping in NiO nanoparticle (NP) leads to a transition from spin-glassy to cluster-glassy state and the appearance of low-temperature magnetic memory effect [1]. Such type of nanoscale system can be used as a "thermal assistant memory cell" in digital information storage[2]. However, the magnetic effect is mostly observed in the low-temperature region far below the room temperature due to the lower blocking temperature (T_B), and this is the major obstruct precluding its application in nanotechnology. In the past, the above obstacle has been foiled through introducing exchange-coupling and particle size distribution.[3-5] In this study, a co-precipitation method followed by annealing in an ambient atmosphere is used for the synthesis of pure, 0.5, and 1% Fe-doped NiO NPs. The synchrotron radiation X-ray powder diffraction measurement confirmed 0.5 and 1% samples are of single phase having the same crystal structure as that of NiO and characterized with enhanced lattice expansion. The neutron powder diffraction experiment revealed an enhanced magnetic moment about ~5.6% (1.305(17) μ_B) and 6.5% (1.318(18) μ_B) from 0.5 and 1% Fe-NiO samples with respect to pure NiO NPs. The field, temperature, and time-dependent magnetization measurements show that the effect of Fe-doping in NiO leads to a transition from SG to CG state and enhanced RT FM properties. The intrinsic intraparticle interaction dominating at higher temperature is proposed to provide additional anisotropic energy, leading to enhancement of the memory effect up to RT. Based on the memory effect measured from different Fe-concentration, the magnitude of memory effect is revealed to be tunable simply by controlling the Fe-dopant concentration. The outcome of this is technologically attractive for the future development of RT ferromagnetism to facilitate the integration of spintronic devices.

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***Corresponding Author:** sywu@mail.ndhu.edu.tw (SYW)

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