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Modulating magnetic behavior of ultrafine ferrite nanoparticles by surface coating thickness

Abstract:

This talk will focus on the description of surface functionalized ultrafine CoFe_2O_4 nanoparticles (NPs), with mean diameter ~ 5 nm. The investigated properties include DC magnetization and AC susceptibility measurements over the temperature range of 4 – 400 K. All evaluated NPs present the same CoFe_2O_4 core, with different molecular surface coatings, increasing gradually the number of carbon atoms in the coating layer, in the following list: glycine ($\text{C}_2\text{H}_5\text{NO}_2$), alanine ($\text{C}_3\text{H}_7\text{NO}_2$), aminobutanoic acid ($\text{C}_4\text{H}_9\text{NO}_2$), aminohexanoic acid ($\text{C}_6\text{H}_{13}\text{NO}_2$), and aminododecanoic acid ($\text{C}_{12}\text{H}_{25}\text{NO}_2$). Importantly, samples were intentionally fabricated in order to modulate the core–core magnetic dipolar interaction, as the thickness of the coating layer increases with the number of carbon atoms in the coating molecule. The magnetic data of the uncoated CoFe_2O_4 NPs it is also presented for comparison. All investigated CoFe_2O_4 NPs (coated and uncoated) are in magnetically blocked state at room temperature as evidenced by ZFC/FC measurements and the presence of hysteresis with ~ 700 Oe coercivity. Low temperature magnetization scans show slightly constricted hysteresis loops with coercivity decreasing systematically while the number of carbon atoms in the coating molecule decreases, possibly resulting from differences in magnetic dipole coupling between NPs. Large thermomagnetic irreversibility, slow monotonic increase in the FC magnetization and non-saturation of the magnetization give evidence for the cluster glass (CG) nature in the CoFe_2O_4 NPs. The out of phase part (χ_c) of AC susceptibility for all samples shows a clear frequency dependent hump which is analyzed to distinguish superparamagnetic (SPM), cluster glass (CG) and spin glass (SG) behavior by using Néel–Arrhenius, Vogel–Fulcher, and power law fittings.

Biography

Paulo Cesar De Moraes, PhD, was full Professor of Physics at the University of Brasilia (UnB) – Brazil up to 2013. Appointed as UnB's (Brazil) Emeritus Professor (2014); Visiting Professor at the Huazhong University of Science and Technology (HUST) – China (2012–2015); Distinguished Professor at the Anhui University (AHU) – China (2016–2019); Full Professor at the Catholic University of Brasília (CUB) – Brazil (2018); CNPq-1A Research Fellow since 2010; 2007 Master Research Prize from UnB. He held two-years (1987–1988) post-doc position with Bell Communications Research, New Jersey – USA and received his Doctoral degree in Solid State Physics (1986) from the Federal University of Minas Gerais (UFMG) – Brazil. With more than 12,000 citations, He has published about 500 papers (Web of Science) and more than 15 patents.