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High frequency study of core-shell $CoFe_2O_4$-ZnO nanospheres

Bijoy K. Kuanr[1], Alka V. Kuanr[2], S. R. Mishra[3] and Z. Celinski[1]
[1]University of Colorado, USA
[2]University of Delhi, India
[3]University of Memphis, USA

Currently incurable disorders like brain cancer, Alzheimer's, and Parkinson's drastically reduce quality of life of millions of people worldwide. Magnetic nano-sized hollow spheres filled with proper drugs have great potential for use in various biomedical applications; including drug-delivery, magnetic resonance imaging (MRI), hyperthermia, transfections, *in vivo* cell tracking, and tissue repair. Recently, coated nanoshells combined with magnetic nanoparticles and cancer-cell-specific antibodies, have been used to develop a multifunctional platform for simultaneously diagnosing and treating cancer, via MRI and photothermal therapy. For this application, core-shell nano-spheres with a low resonance frequency (low GHz range) are required.

The ferromagnetic resonance experiment (FMR) is an important tool for determining the dynamic properties of nano-materials. Our earlier study shows that the complex dynamics of the magnetic nanoparticles results in FMR spectra. Using a vector network analyzer we have investigated the dynamic properties of ZnO coated and uncoated magnetic CoFe2O4 nano-sized hollow spheres in a non-magnetic matrix. The shell thickness of ZnO was varied by varying the initial concentration of Zn precursor at 0.1834 (sample-A), 0.3668 (B), and 0.5502 (C) g.

Magnetic field dependence of resonance frequency (fr) and linewidth (Δf and ΔH) for both the ZnO coated and uncoated CoFe2O4 hollow spheres are studied. In order to evaluate possible capabilities as a contrast agent for MRI, T1 (spin-lattice) and T2 (spin-spin) relaxation times are derived from the line widths. We observe the following: (1) fr increases with the increase in the applied magnetic field for all samples (2) at a given applied magnetic field, the uncoated hollow spheres resonate at higher frequency compared to the ZnO-coated ones and (3) the increase in shell thickness of ZnO reduces fr (4) ZnO coated hollow spheres show larger Δf compared to uncoated ones, (4) only the ZnO-coated hollow spheres show additional peaks. (5) gyromagnetic ratio and effective fields decreased by ZnO coating. (5)Saturation magnetization (4MS) of 2.4 kOe for CoFe2O4 hollow spheres and 2.1, 1.92, and 1.7 kOe for samples A, B, and C observed.

Biography

Bijoy K. Kuanr received the Ph.D. degree in Electronic Sciences from the University of Delhi, India in 1993. From 1994-96, he joined the Microwave Laboratory of Professor Dr. Güther Nimtz at University of Koeln, Germany as a Post-Doctoral Researcher. From 1999-2001 he worked with Professor Dr. Peter Grünberg - (Nobel Laureate - Physics 2007) as a guest scientist in Ultra-thin Magnetic Multilayer Structures & GMR-Sensor project. In 2002 he joined University of Colorado at Colorado Springs as a senior Research Associate. He is also a permanent faculty in the Electronics Department of Zakir Husain Delhi College at Delhi University. His main research deals with the development of microwave and millimeter-wave devices based on nanoscaled materials for telecommunication applications.

bkuanr@uccs.edu

Effect of mercaptoethanol and Na_2S dropwise addition rate on the zinc sulfide semiconductor nanocrystals: Synthesis and characterization

Abbas Rahdar
Department of Physics, University of Zabol, Iran

Zinc Sulfide (ZnS) semiconductor nanocrystals with mercaptoethanol (ME) as a stabilizer (capping agent) were synthesized by co-precipitation method in room temperature using the solution of zinc chloride ($ZnCl_2$), sodium sulfide (Na_2S) as starting material. The effect of ME and Na_2S dropwise addition rate on the preparation of these samples was measured using UV-Vis absorption and XRD. The UV-Vis absorption and XRD of the prepared ZnS nanoparticles shows increase of band gap and decrease of particle size with decrease in ME and Na_2S dropwise addition rate to the reaction medium. This behavior is related to the size quantization effect due to small size of particles. The photoluminescence (PL) emission peak positions exhibit obvious blue shift, from 510 to 455 nm. The particle sizes were obtained from transmission electron microscopy (TEM) images.

a.rahdar@uoz.ac.ir