Poster

Magnetic Characterization of Nanocrystalline Ferrite Films Obtained by Soft Solution Processing Methods

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With the burst of miniaturization of electronic components, the development of new synthetic strategies for the selective deposition of transition metal ferrites MFe_2O_4 films is critical for the future of microelectronic circuitry. Consequently, a myriad of synthetic strategies which differ in the manufacturability, cost, complexity and environmental hazard have been developed in the last decade [1-5]. We report here on the synthesis and characterization of nickel ferrite films with different chemical compositions obtained by the soft solution processing methods. As an example, the spin-spray deposition consists of the simultaneous spraying of a reaction solution containing the metal salts and an oxidizing solution buffered to a pH of 8 onto a substrate (glass, silicon, plastics, etc). The substrate is mounted onto a rotating table, maintained at a constant temperature [6]. Consequently, a low temperature ($T<100^oC$), single step deposition of solutions of transition metal salts leads to uniform, well adherent ferrite films with thicknesses which can be easily controlled by varying the reaction parameters, such as concentration of the reagents, temperature and deposition time.

Experimental results have shown a linear increase of the metal content of the deposited films with the cationic ratio in the treatment solution. In all cases, films are found to be single-phase and highly crystalline (Fig. 1), with a cubic unit cell (space group *Fd3m*) in close agreement with data reported in literature. Correspondingly, the calculated crystallite size is close to 20nm, as deduced from the broadening of the diffraction peaks. SEM investigation of the morphology of the films has shown that nickel ferrite films obtained by spin-spray deposition present a granular morphology being constructed by grains with a size of ≈200-400nm. SEM observations were confirmed by AFM data, which also indicate a roughness of the films less than 100nm, corresponding to a high uniformity of the films (Fig. 2).

Magnetic properties of the resulted films were investigated with a Vibrating Sample Magnetometer (VSM). The saturation and the remanent magnetization are found to decrease with the increase of the nickel content in the films, whereas the coercivity follows an opposite trend. In all cases, films present a hysteretic behavior at room temperature with the hysteresis loops having different shapes for parallel and perpendicular orientations of the film with respect to the external magnetic field. Regardless the chemical composition of the nickel ferrite films, the data corroborate well the experimental results obtained from FMR spectroscopy indicating the existence of an in-plane uniaxial randomly oriented anisotropy. Additionally, the saturation magnetizations deduced from the single FMR absorption peaks are in good agreement with the values reported in literature for similar nickel ferrite films. The existence of very well-defined absorption peaks in the FMR spectra also indicates that the ferrite films are magnetically homogeneous. The magnetic properties of nickel ferrite films can be interpreted in terms of the cationic distribution of Ni^{2+}/Fe^{2+} and Fe^{3+} ions over the two crystallographic sites of the spinel structure.

References:

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Figures:

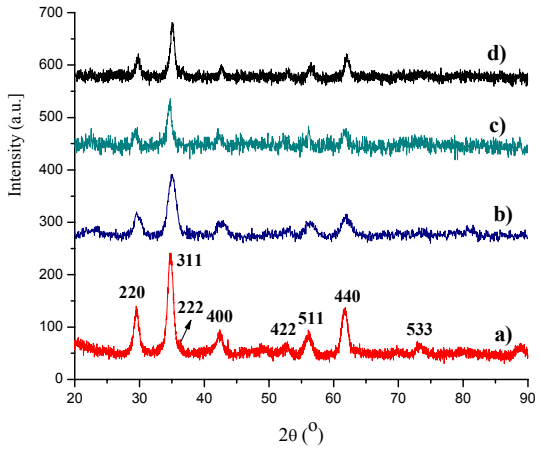

Fig. 1 Typical X-Ray diffraction patterns of $Zn_xFe_{3-x}O_4$ films (0.17<x<0.55)

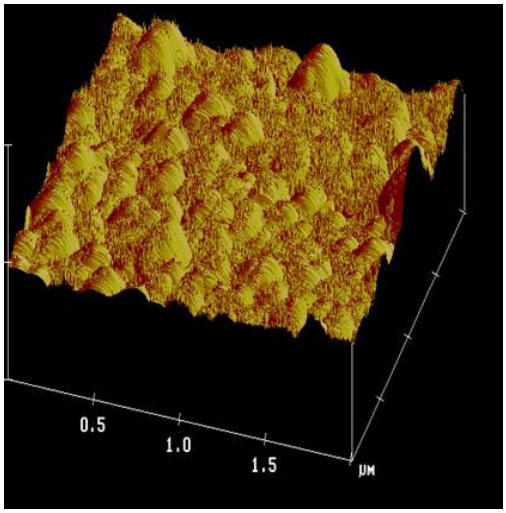

Fig. 2 AFM profile s of a 450nm-thick $Ni_{0.28}Fe_{2.72}O_4$ film

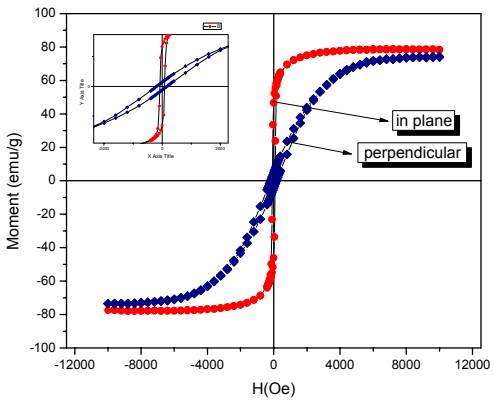

Fig. 3 RT hysteresis loop of $Ni_{0.28}Fe_{2.72}O_4$ film

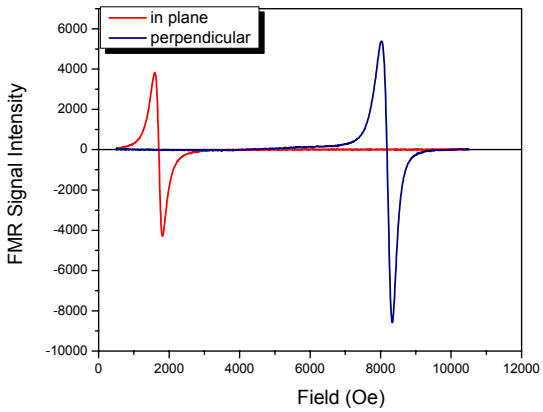

Fig. 4 Ferromagnetic resonance absorption peaks for the $Ni_{0.28}Fe_{2.72}O_4$ film with parallel and perpendicular orientations