JOURNAL OF APPLIED PHYSICS VOLUME 91, NUMBER 10 15 MAY 2002

Magnetic properties of Zn^{2+} substituted ultrafine Co-ferrite grown by a sol-gel method

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Ultrafine $Co_{1-x}Zn_xFe_2O_4$ $(0 \leqslant x \leqslant 1.0)$ particles are fabricated by a sol-gel method. The magnetic and structural properties of powders were investigated with x-ray diffraction, vibrating samples magnetometer and Mössbauer spectroscopy. The lattice parameter (a_0) increases linearly with increasing Zn concentration (x) and follows Vegard's law approximately. $Co_{0.9}Zn_{0.1}Fe_2O_4$ powders that were annealed at and above 673 K have only a single phase spinel structure and behave ferrimagnetically. Powders annealed at 523 K and 573 K have a typical spinel structure and are simultaneously paramagnetic and ferrimagnetic in nature. The magnetic behavior of $Co_{0.9}Zn_{0.1}Fe_2O_4$ powders annealed at and above 573 K shows that an increase of the annealing temperature yields a decrease of the coercivity and an increase of the saturation magnetization. The maximum coercivity and the saturation magnetization of $Co_{0.9}Zn_{0.1}Fe_2O_4$ ferrite powders are 1328 Oe and 81.1 emu/g, respectively. Mössbauer spectra of Co–Zn ferrite have been taken at various temperatures from 20 to 800 K. The isomer shifts indicate that the iron ions were ferric at the tetrahedral $[A]$ and the octahedral $[B]$. The Néel temperature of $Co_{0.9}Zn_{0.1}Fe_2O_4$ was determined to be $T_N = 790$ K and It is found that Debye temperature for the A and B sites of the sample annealed at 1123 K is found to be $\Theta_A = 756 \pm 5$ K and $\Theta_B = 199 \pm 5$ K, respectively. The Néel temperature dramatically decreased with increasing x from about $T_N = 870$ K for $x = 0.0$ to $T_N = 35$ K for $x = 1.0$. [DOI: 10.1063/1.1452215]