Microstructural and Magnetic Behavior of (111)-preferentially Oriented Cobalt Ferrite Thin Films

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Due to Its large magnetocrystalline anisotropy (K_1=+2×10^6 erg/cm^3), high coercivity (5400 Oe), moderate saturation magnetization (about 80 emu/g), remarkable chemical stability, and mechanical hardness [1-4], the cobalt ferrites ($CoFe_2O_4$) have been utilized for biological and device applications. The cobalt ferrite is an inverse spinel, in which the divalent Co^{2+} ions occupy the octahedral (B) site, while half of the Fe^{3+} ions occupy the tetrahedral (A) site, and the other half fill the octahedral (B) site. In this work, we have synthesized nanocrystalline$CoFe_2O_4$ thin films which have (111)-preferred orientation. The stable sol solution for $CoFe_2O_4$ thin films were prepared from the aqueous solution of $Co(NO_3)_2.6H_2O$ and $Fe(NO_3)_2.9H_2O$, then deposited on Pt(111)/TiO_2/SiO_2/Si substrates by spin-coating technique with three stages of heating: drying (170^0C, 10 min), pre-annealing (400^0C, 10 min), and post-annealing (700^0C, 1 h). The thickness of the films was adjusted by controlling the concentration of the solutions as 0.1, 0.2, and 0.3 M, and the number of coatings as 5, 8, and 10 layers. X-ray diffraction spectra showed that when the precursor concentration was higher than 0.1 M, the films were preferentially oriented in <111> direction. The $CoFe_2O_4$ thin films prepared with 0.2 M solution and 5-layers had the smoothest surface as revealed by Scanning electron microscopy, and magnetic anisotropy as evidenced from the vibrating sample magnetometer measurement. Interestingly, the sol-gel $CoFe_2O_4$ films showed stable and repeatable unipolar resistive switching behavior, indicating that $CoFe_2O_4$can be used as a promising oxide material with both magnetic and resistance switching properties.

Keywords: $CoFe_2O_4$, sol-gel, preferred orientation, magnetic anisotropy

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