B6

한국과학기술연구원, 이재광, 오영제
국민대학교, 박승일, 김철성

Fabrication of $CoFe_2O_4$ thin films by a sol-gel method

KIST, Jae-Gwang Lee*, Young-Jei Oh
Kookmin Univ., Seung Iel Park, Chul Sung Kim

1. Introduction.

Thin films of ferrite have become attractive for high-density recording media because of high coercivity, mechanical hardness and chemical stability. These magnetic and physical properties of the ferrite films enable the development of contact recording media that will ultimately be required in the near future[1]. Cobalt ferrite, a cubic ferrimagnetic oxide, is also one of the candidates for high-density recording media that is a well-known hard magnetic material. $CoFe_2O_4$ has a high coercivity (5400 Oe) and a moderate saturation magnetization (about 80 emu/g) as well as a remarkable chemical stability and a mechanical hardness for recording media[2]. For the practical applications of Co-ferrite thin films such as magnetic recording and magneto-optic recording media, a sol-gel pyrolysis method is introduced as an attractive alternative to some of the other deposition techniques that have been used to grow Co-ferrite thin films.

In this study, the growth of the Co-ferrite thin films on thermally oxidized silicon substrates is introduced by a sol-gel method and the films are characterized as a function of annealing temperatures Magnetic and structural properties of $CoFe_2O_4$ thin films will be presented in this paper

2. Experiment

Powders and thin films of $CoFe_2O_4$ were prepared by using a sol-gel pyrolysis method. Appropriate portions of $Co(CH_3CO_2)_2 \cdot 4H_2O$ and $Fe(NO_3)_3 \cdot 9H_2O$ were dissolved in 2-methoxy-ethanol and water with an ultrasonic cleaner. The solution was refluxed for 12 hours at 70 °C and some of the solution was dried for 24 hours at 100 °C for Co-ferrite powders. Films were spin-coated onto thermally oxidized Si wafers (700 Å). Detailed process will be explained elsewhere[3]. The crystalline structures and magnetic properties of the Co-ferrite powers and thin films were investigated by a x-ray diffractometer, a Mossbauer spectroscopy and a vibrating sample magneto-meter after powders were annealed at different temperatures. An atomic force microscope was used for characterizing the surface roughness of thin Co-ferrite films.

3. Result and discussion

The x-ray patterns of $CoFe_2O_4$ thin films annealed at different temperatures (650 and 750 °C) are shown in Fig. 1. All peaks of $CoFe_2O_4$ thin films are consistent with ones of typical $CoFe_2O_4$ powders prepared by a conventional solid state reaction. The x-ray measurement reveals that the Co ferrite films grown successfully on the thermally oxidized Si wafers are polycrystalline with a single phase spinel structure and that they exhibit no preferred crystallite orientation. The surface morphologies of the films are characterized using an atomic force microscope. The root-mean-square (rms) surface roughness is 1~2 nm and the estimated grain size of the Co-ferrite is about 20.0 nm that is too large to be useful in the high density recording media.

Magnetic properties are determined at room temperature by applying the magnetic field parallel or perpendicular to the planes of the films grown on SiO_2 with a1400 Å thickness. Fig. 2 shows the typical hystersis loops of the film annealed at 650 °C are measured normal and parallel to the plane with an external magnetic field up to 15 kOe. In this figure, the perpendicular magnetization is not corrected for the demagnetization effect. The result of the magnetic measurement shows the in-plane and perpendicular coercivity of the Co-ferrite film takes the same value of 1900 Oe and there is no significant difference of the magnetic properties for the field-applied directions.

4. Conclusion

Co-ferrite films are fabricated on thermally oxidized Si substrates by using the sol-gel method and their crystallite and magnetic characteristics were investigated. The films are polycrystalline with a single phase of the spinel structure and exhibit no preferred crystalline orientation. The film surfaces are smooth enough to apply ferrite films for a high density magnetic recording media and the films exhibit the surface roughness of less than 3 nm. Magnetic measurements show that coercivity and saturation magnetization do not depend on the field-applied directions, that is, there is no significant difference of the magnetic properties for the field-applied directions. The maximum value of the coercivity is about 2700 Oe for Co-ferrite films fired at 850 °C.

Reference

1. E.S. Murdock, IEEE Trans. Mag., **28**, 3078(1992).
2. T. Kodama, Y. Kitayama, M. Tsuji and Y. Tamaura, J. Mag. Soc. Jpn **20**, 305(1996).
3. J.-G. Lee, C.S. Kim and Y.-J. Oh, to be published

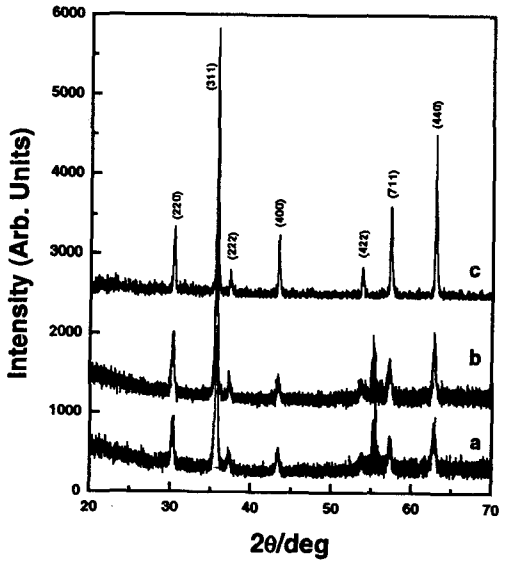

Fig. 1 X-ray patterns of Co-ferrite thin films fired at (a) 650, (b) 750 °C and (c) Co-ferrite powder annealed at 800 °C.

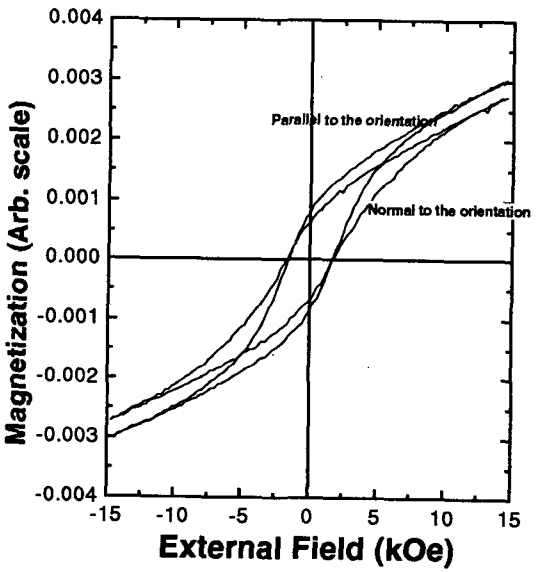

Fig. 2. Hystersis loops of the Co-ferrite thin film fired at 650 °C.