KMS-2-T5

$CoNbZr-Sm_2O_3$계 granular 박막의 전기적, 자기적 특성과 구조
(Electircal resistivity, magnetic properties and structure of $CoNbZr-Sm_2O_3$ granular films.)

정원정[1*], 이찬규[1], 구본흔[1], Y.Shimada[2]

[1] 창원대학교 나노・신소재공학부, [2] 日本 東北大學校 多元科學物質研究所

1. Introduction

Since all these physical properties strongly depend on the precipitation states of the magnetic granules, accurate control for the phase separation in indispensable. Although the details of the phase separation still remain unclear, it is proposed that the difference in the formation energies between a FM-X (FM: ferromagneticelement, X: oxygen, nitrogen, etc.) and M-X compounds (M: nonmagnetic element) plays a dominant role in the phase separation process of a FM-M-X system.

Granular metallicmagnetic thin film materials, however, have limitation in the range of electrical resistivity of about $10^3 \mu\Omega$cm. When FM particles are placed in a certain distance, granular thin film shows soft-magnetism, which is causing by exchange-coupling. It has limitation in resistivity increment when reducing the volumetric ratio to achieve high resistivity, because itbecame super-paramagnetic resulting from disappearing in exchange-coupling. For that reason, it is required to develop soft-magnetic thin film materials where electrically insulated nano-particles can be act soft magnetically without exchange-coupling.

In this study, we prepared granular thin films with CoNbZr and Sm_2O_3. We then characterized its magnetic properties and analyzed its structure.

2. Experiment

Granular films were prepared by reactive RF magnetron sputtering, with a base pressure less than 2×10^{-6}Torr, and Ar gas pressure of 8mTorr during sputtering. The film was deposited on Si(100) substrates from a CoNbZr target with Sm_2O_3 chips on it. The film thickness is about 300nm. The amount of chips on the target was varied so that the packing density p(volume ratio of CoNbZr to the total deposited volume) becomes 1~0.2. The magnetic properties were measured by a vibrating sample magnetometer (VSM). The electrical resistivity (ρ) of the thin film was determined by means of a four-point probe method. The film structures were investigated by X-ray diffractometry (XRD) with Cu Kα lineand JEM-2100F transmission electron microscopy (TEM).

3. Results and discussion

Fig. shows coercivity and electrical resistivity of the $CoNbZr-Sm_2O_3$ films with packing density. As the packing density decreased, the coercivity decreased but electrical resistivity increased. At p=1.0 of CoNbZr film, a soft magnetic characteristic of CoNbZr was appeared. At p=0.29 of $CoNbZr-Sm_2O_3$ film, coercivity was 2.8Oe and electrical resistivity was $4.74\times10^5 \mu\Omega$cm. $CoNbZr-Sm_2O_3$ film is expected to be a granular film of the structure which the oxides matrix are randomly distributed around metal particle because of high resistivity and low coercivity.

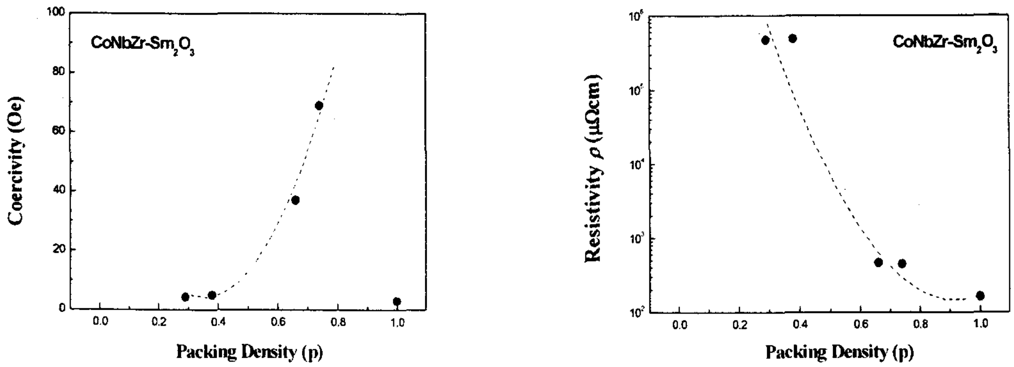

Fig. Variation of coercivity and electircal resistivity with packing density for $CoNbZr-Sm_2O_3$ films

Reference
(1) H. Karamon, T. Masumoto, Y. Makino, J. Appl. Phys.,vol.57, pp.3527–3532, 1985.
(2) G. Xiao, C.L. Chien, Appl. Phys. Lett., vol.51, pp.1280–1282, 1987.
(3) G. Herzer, IEEE Trans. Magn., vol.25, pp.3327–3329, 1989.
(4) C. Chen, O. Kitakami, Y. Shimada, J. Appl. Phys., vol.84 pp,2184–2188, 1998.
(5) T. Ito, O. Kitakami, Y. Shimada, Y. Kamo, S. Kukuchi, J. Magn. Magn. Mater., vol.235 pp.165–168, 2001.