

Magnetic Properties of Electroplated CoNiFe Thin Films

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전기도금법으로 제조된 CoNiFe 박막의 자기적 특성

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1. Introduction

Electroplating method, which is suitable for fabricating a high aspect ratio structure, has been used for depositing $\text{Ni}_{80}\text{Fe}_{20}$ films (permalloy) as a core material of write head in magnetic recording. Recently, as the areal recording density of hard disk drive (HDD) has increased at the annual growth rate of above 100 %, new soft magnetic materials with high saturation magnetization (B_s) to be able to meet with the high coercivity media at high frequencies has been strongly required. Electroplated CoNiFe thin films were reported as one of excellent soft magnetic thin films with high B_s as a core material of write head[1]. CoNiFe films electroplated in no SCA (sulfur containing additive) bath have high B_s of 20~21 kG and the coercivity (H_c) of below 2 Oe[2]. But, in case of no additive, some limitations occur on its use because of the difficulty in the fabricating thick films due to the internal stress. By previous studies, CoNiFe films electroplated with saccharin additive have B_s of 16~17 kG and H_c of below 2 Oe[2][3]. In this study, by investigating optimum condition in case of electroplating with saccharin additive, we found out the possibility of CoNiFe soft magnetic films with high B_s , and of thick films by reducing internal stress in films, which would expand their applications in micro magnetic devices such as thin film inductors.

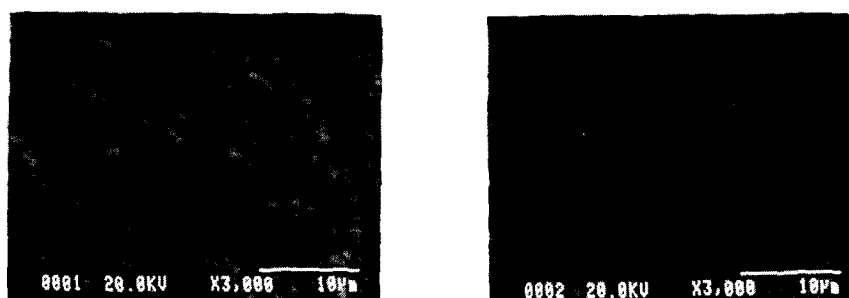
2. Experiment

Plating bath was essentially same as permalloy (Ni-Fe) plating bath except for the addition of CoSO_4 . Constituents of bath were CoSO_4 , NiSO_4 , NiCl_2 , FeSO_4 as metal sources, boric acid as pH buffer, NaCl , NH_4Cl as supporting electrolytes, Na saccharin as additive, and ascorbic acid as a reductant preventing the oxidation of Fe^{++} to Fe^{+++} . pH was adjusted to 2.0 by addition of sulfuric acid, and the plating temperature was 45°C. All

CoNiFe films were electroplated on glass substrates evaporated Cu using a paddle cell. Magnetic properties of CoNiFe films were measured by VSM and permeability measuring system.

3. Results and Discussion

It is already known that B_s is largely dependent on film composition but H_c is influenced by plating condition[2]. Optimum electroplating condition could be set by finding proper range of each variable. As the number of variable is increased, the overall window range is reduced. In case of electroplating with saccharin additive, we found out the optimum plating condition by Hull cell method. Magnetic properties of CoNiFe films fabricated by this process showed high B_s of 18~19 kG and low H_c of below 2 Oe. The reason was attributed to the high content of S inclusion as high as 0.6 at % which is nearly double of the value in films electroplated with saccharin[4]. Addition of S is known to induce a decrease in grain size and coercivity[4]. Figure 1 shows SEM images of electroplated CoNiFe films. CoNiFe film with low H_c had bright and smooth surface, whereas film with high H_c was rough.



H_c of 20~40 Oe

H_c of 0.5~2 Oe

Figure 1. SEM images of electroplated CoNiFe films

4. References

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