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Determination of anion site distribution in spin-sprayed ferrite films by XAFS

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Introduction

By spin-spray ferrite plating with optimizing conditions in the oxidizing and reaction solutions, we can easily synthesize polycrystalline film of spinel type ferrites in low temperatures (<100°C) [1]. These films exhibit high permeability, exceeding the Sneok's limit for bulk ferrites by one order of magnitude, in the frequency range from MHz to GHz. Site distribution of cations strongly influences magnetization of the ferrimagnetic spinel ferrites. Site distribution of cations in the ferrites changes depending on the preparation methods. Thus, it is important to estimate site distribution of cations in the ferrite films for controlling magnetic properties of the film. In this work we report the site distribution of cations in the Zn-Co-Fe ferrite films, which were prepared by spin-sprayed ferrite plating, by XAFS analysis.

Experimental

$Zn_xCo_yFe_{3-x-y}O_4$ ($0 \leq x \leq 1.08$, y = 0, 0.1, 0.15) with film thickness of 3 μm were prepared onto the ployimide matrix at 90°C by spin-sprayed ferrite plating. The compositions of the films were determined by ICP. The magnetizations of the films of the direction in plane were measured by VSM. Complex permeabilities of the films were measured by shielded-loop coil permeameter. X-ray fine structure spectra of the films at Fe-*K*, Zn-*K* and Co-*K* edges were measured at BL9C and 12C. Ifeffit 1.2.9 was used for EXAFS analysis.

Results and discussion

From the EXAFS analysis, about 90 % of Zn occupied A site in spite of the composition. When Co content keep constant, A site occupation ratio of Fe and Co decrease with increasing Zn content. Figure 1 shows site distribution of Zn, Fe and Co ions in $Zn_xCo_{0.15}Fe_{2.85-x}O_4$ films.

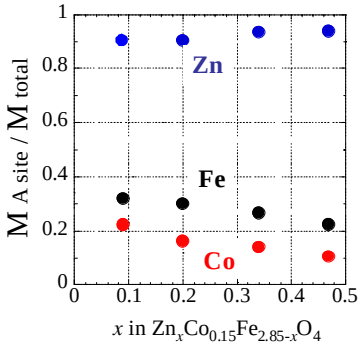

Fig. 1 Site distribution of Zn, Fe and Co ions in $Zn_xCo_{0.15}Fe_{2.85-x}O_4$ films determined by EXAFS analysis.

The relation between coercivity H_c and Co content in A site of $Zn_xCo_yFe_{3-x-y}O_4$ is given in Fig. 2. Coercivity Hc is in proportion to Co content in A site. Resonace frequency fR of the film also seems to be proportional to the Co content in A site (Fig. 3).

These results indicate that the magnetic anisotropic of $Zn_xCo_yFe_{3-x-y}O_4$ films is strongly affected from cobalt ions occupying A site.

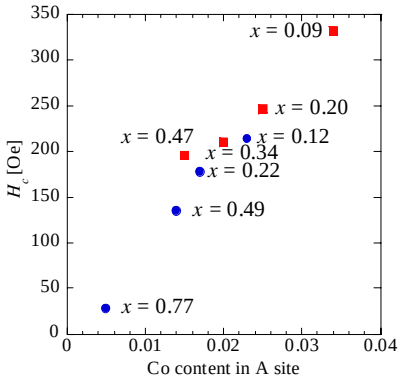

Fig. 2 Relation between coercivity H_c and Co content in A site. ○ the samples with y = 0.1 and □ the samples with y = 0.15

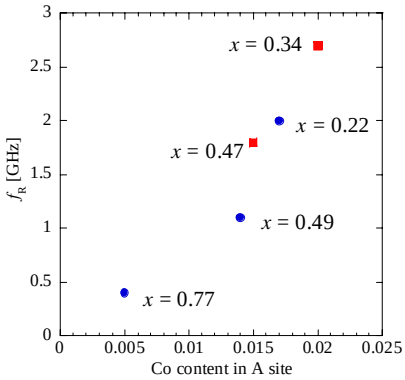

Fig. 3 Relation between resonance frequency f_R and Co content in A site. ○ the samples with y = 0.1 and □ the samples with y = 0.15

References

[1] K. Konde et al., J. Appl. Phys 93, 7130 (2003).

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