Formability and Stability of α′ and α″ Phase in $(Fe_{1-y}Co_y)$-(B,C,N) Films

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α′ and α″ phase of Fe have attracted much attention of researcher with the interest in their intrinsic magnetism; the giant magnetic moment problem of α″-$Fe_{16}N_2$ [1], for example. The authors have succeeded in synthesis of (α″+α′)-$Fe_{16}N_2$ films but also α′-$(Fe_{1-y}Co_y)$-N, α′-$(Fe_{1-y}Co_y)$-C, α′-Fe-C, α′-Fe-B films [2], and found that the compositional range where the α′ phase could be formed is quite different against the substituents/interstituents to α-Fe. In the present study, in order to illuminate a way to obtain stable α′ and α″ phase, the formability and thermal stability of α′-$(Fe_{1-y}Co_y)$-(B,C,N) film is systematically discussed.

3000 Å thick $(Fe_{1-y}Co_y)$-(B,C,N) films were fabricated on MgO {100} single-crystal substrates using a facing-targets type dc sputtering method with Fe buffer layer. Structural analysis of the films was performed by X-ray diffractometry. M_s was measured with VSM as a function of temperature up to 400 °C. Heating and cooling rates were 1 °C/min.

α′-Fe-C and α′-Fe-N phase with a C or N content up to about 12 at.% could be synthesized. On the other hand, α′-Fe-B phase could be synthesized up to only 4 at.%B, meaning lower formability of α′-Fe-B than α′-Fe-C and α′-Fe-N. Based on the rigid sphere model, such the difference of formability is explained by the larger atomic radius of B than those of C and N.

Fig. 1 shows the change of the decomposition temperature of the α′-$(Fe_{1-y}Co_y)$-X (X=B,C,N) phase against X content. The decomposition temperature of α′-$(Fe_{1-x}Co_x)$-N phase slightly decreases with increasing the interstituent N content, and drastically degrades with increasing the substituent Co content. Comparing to the decomposition temperature of 250°C in α′-Fe-C phase, and 230°C in α′-Fe-B phase, the α′-Fe-N phase is concluded to have less stability. It might be due to its peculiar decomposition process of α′-Fe-N phase to γ′-Fe_4N phase, only with the N diffusion in bone structured Fe lattice.

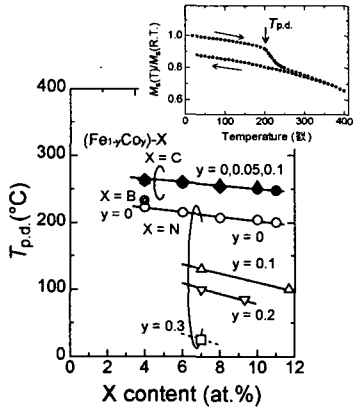

Fig.1. Change of the phase decomposition temperature for α′-$(Fe_{1-y}Co_y)$-X (X = B, C, N) films.

References

[1] M. Takahashi *et al.*, J. Magn. Magn. Mat., **208**, 145 (2000).