R-2

Phase relations and magnetic properties of HDDR-treated $Sm_3(Fe,Co,V)_{29}$ alloy

Pukyong National University, Y.S. Han*, S.W. Shon[a], and H.W. Kwon
[a] present address: R+D Centre, Pacific Metals Co.

HDDR 처리한 $Sm_3(Fe,Co,V)_{29}$ 합금의 상관계 및 자기적 성질

부경대학교, 한영신*, 손성우[a], 권해웅
[a] 현재근무처: 태평양금속㈜, 기술연구소

1. INTRODUCTION

The $Sm_3(Fe,M)_{29}$ compound (M = V, Ti, Cr, Mn)[1] with lattice symmetry of monoclinic (space group: $P2_1/c$) is attracting much attention in technical point of view. Its nitride, $Sm_3(Fe,M)_{29}N_x$[2], has been reported to have good hard magnetic properties with high Curie temperature and strong uniaxial anisotropy, which make this material a promising candidate for high performance permanent magnets. More interestingly, the $Sm_3(Fe,M)_{29}$ compound attracts much attention due to its unique HDDR (hydrogenation, disproportionation, desorption and recombination) feature. Unlike the other rare-earth-transition metal magnetic alloys, such as Nd-Fe-B-type and Sm_2Fe_{17} alloys, the HDDR-treated $Sm_3(Fe,M)_{29}$-type alloy does not recombine into the initial 3:29 phase, but rather, recombines into a mixture of Sm-(Fe,M) phase with different stoichiometry from the parent 3:29 and α-Fe(M) phase[3]. Principal aim of the present work includes examination of the effect of recombination condition on the phase relations and magnetic properties of the HDDR-treated $Sm_3(Fe,Co,V)_{29}$ alloy.

2. EXPERIMENTAL WORK

The $Sm_9Fe_{65}Co_{20}V_6$ alloy used in the present study was prepared by an induction melting of high purity constituent metals. The prepared alloy ingot was homogenised by annealing it at 1150 °C for 20 hrs and then quenching under argon gas. The material was then pulverised into a powder with particle size of 40–60 μm, which was subjected to an HDDR-treatment. The hydrogenation and disproportionation of the alloy was undertaken by heating it to 750 °C and holding it at this temperature for 1 hr under hydrogen gas. The desorption and recombination was performed by holding the disproportionated material at various temperatures (600 – 900 °C) under vacuum. Phase analysis of the recombined material was performed by TMA and XRD. Magnetic characterisation of the HDDR-treated material was undertaken by means of VSM (maximum field of 1.5 T).

3. RESULTS AND DISCUSSION

The $Sm_3(Fe,M)_{29}$-type alloy with composition of $Sm_9Fe_{65}Co_{20}V_6$ showed unique HDDR characteristics. The $Sm_3(Fe,M)_{29}$-type alloy was not recombined into the initial 3:29 phase after HDDR, but rather, recombined into a mixture of Sm-(Fe,M) phase with different stoichiometry from the parent 3:29 and α-Fe(M) phase. Stoichiometry of the Sm-(Fe,M) phase in the mixture was dependent upon the recombination condition. Full phase diagram showing phase variation in the HDDR-treated $Sm_9Fe_{65}Co_{20}V_6$ alloy according to the recombination temperature and time has been established. The alloy recombined at higher temperature above 900 °C (high temperature range) consisted of a mixture of Sm-(Fe,M) phase with stoichiometry of 2:17 and α-Fe(M). Recombination at temperature range from 700 °C to 900 °C (medium temperature range) led to a mixture of Sm-(Fe,M) phase with stoichiometry of 1:7 and α-Fe(M). Recombination at lower temperature below 650 °C (low temperature range) resulted in a mixture of Sm-(Fe,M) phase with stoichiometry of 1:3 and α-Fe(M). It was found that at the boundary temperature between the high and medium temperature range both the 1:7 and 2:17 phases existed together with α-Fe(M). At the boundary temperature between the medium and low temperature range both the 1:3 and 1:7 phases were found together with α-Fe(M). At lower recombination temperature the stoichiometry of Sm-(Fe,M) phase in the HDDR-treated alloy tends to change from 1:3 to 1:7 on prolonged recombination, and at higher temperature it changes from 1:7 to 2:17. This indicates that the most stable Sm-(Fe,M) phase in the HDDR-treated $Sm_9Fe_{65}Co_{20}V_6$ alloy may be 2:17 phase and both the 1:7 and 1:3 phases are probably metastable phases. Correlation between magnetic properties and phase constitution of the HDDR-treated alloy with different recombination condition will be discussed in this article.

4. REFERENCES

[1] J. M. Cadogan, H. S. Li, A. Margarian, J. B. Dunlop, D. H. Ryan, S. J. Collocott, and R. Davies, J. Appl., Phys. **76**, 6138(1994).

[2] D. Courtois, H. S. Li, and J. M. Cadogan, Solid State Commun. **98**, 565(1996).

[3] D. Book, H. Nakamura, S. Sugimoto, T. Kagotani, M. Okada, and M. Homma, Materials Transactions, JIM, **37**, 1228(1996).