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Phases and Magnetic Properties of $Sm_{10}Fe_{90-x}Ga_x$ (x=2, 4, 6) and Their Nitrides

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Introduction

Sm-contained compounds is attractive because of the high anisotropy originated from the Sm sublattice in $Sm_2Fe_{17}N_y$, $SmFe_7N_y$[1], and $Sm_3Fe_{29}N_y$[2] compounds. And their structure is still obscure and can be stabilized by the third element. In this work, we report the phases and magnetic properties of $Sm(Fe,Ga)_9$ and Their Nitrides.

Experimental

The nominal compositions of $Sm_{10}Fe_{90-x}Ga_x$(x=2, 4 ,6) were induction-melted and annealed at 950 °C - 1050 °C for 3 days. Nitrides were prepared by heating fine powders of ingots and melt-spun ribbons at 440 °C - 460 °C for 3-10 hours in N_2 atmosphere. The crystal structure and phase were examined by X-ray diffractometer using Cu-K_α radiation with a graphite monochrometer. And, the melt-spun ribbons were made by single-roller method with the wheel velocity of 35 m/s, and subsequently annealed at the temperature of 700 °C for 0.5 h. In order to measure magnetic properties, the fine particles were imbedded to epoxy-resin and solidified to form the isotropic magnets with the cylindrical shape of about 2 mm-diameter and 20 mm-length. The Magnetization and anisotropy constants(K_1, K_2) were determined using SQUID magnetometer in fields up to 10 T, by the $M\text{-}H^{-1}$ plots and the magnetization-fitting methods. The Curie temperature, Tc was deduced from the *M-H* Curves.

Results and Discussion

The results of XRD (Fig.1) show that the $Sm_{10}Fe_{88}Ga_2$ has a main phase of 3:29-type, but $Sm_{10}Fe_{86}Ga_4$ and $Sm_{10}Fe_{84}Ga_6$ have the 2:17-type one. And in the $Sm_{10}Fe_{88}Ga_2$ annealed at 950 °C, it is found to be 2:17-type, meaning that 3:29-type structure is a high temperature equilibrium phase. By SQUID (Fig. 2), it has been found that saturation magnetization (Table 1) was decreased with increasing the Ga, resulting from the substitution of a non-magnetic element. And with increasing the Ga content, the anisotropy constants (K_1, K_2) were decreased, but the Curie temperature, deduced from *M-H* curves(Fig. 3), was increased due to the expansion of the lattice resulting from the Ga substitution for Fe element.

Table 1. The values of anisotropy constants (K_1, K_2), the magnetization(Ms), the Curie Temperature(T_c) $\triangle T_c$, the coercivity(iHc), and the maximum energy product ((BH)max) for $Sm_{10}Fe_{90-x}Ga_x$(x=2, 4, 6) and their nitrides.

Compositions	K_1, (erg/g)	K_2 (erg/g)	M_s, (KG)	T_c, (K)	$\triangle T_c$,	$_iH_c$, (KOe)	$(BH)_{max}$ (MGOe)
$Sm_{10}Fe_{88}Ga_2$				450			
$Sm_{10}Fe_{88}Ga_2N_y$	9.3 x 10^6	10.0 x 10^6	15.23	775	325	2.21	1.71
$Sm_{10}Fe_{86}Ga_4$				505			
$Sm_{10}Fe_{86}Ga_4N_y$	3.4 x 10^6	9.0 x 10^6	14.38	740	235	1 .65	1.09
$Sm_{10}Fe_{84}Ga_6$				520			
$Sm_{10}Fe_{84}Ga_6N_y$	1.3 x 10^6	2.5 x 10^6	13.25	530	10	0.60	0.20

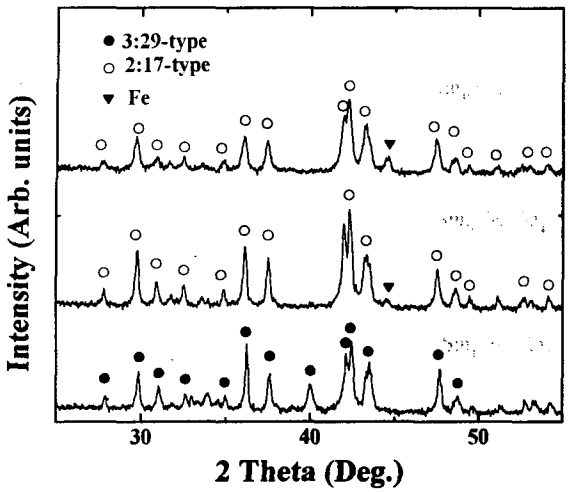
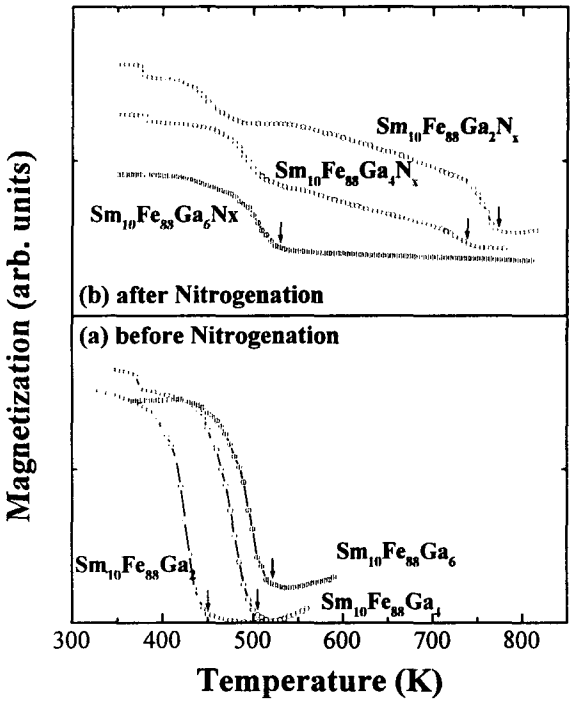


Fig. 1. X-ray diffraction patterns for $Sm_{10}Fe_{90-x}Ga_x$ (x=2, 4, 6) annealed at 1050 °C for 3 days.

Fig. 2. Magnetization of magnetically aligned for $Sm_{10}Fe_{90-x}Ga_xN_y$ (x=2, 4, 6 powders measured parallel(●) and perpendicular(▲) to the alignment direction.



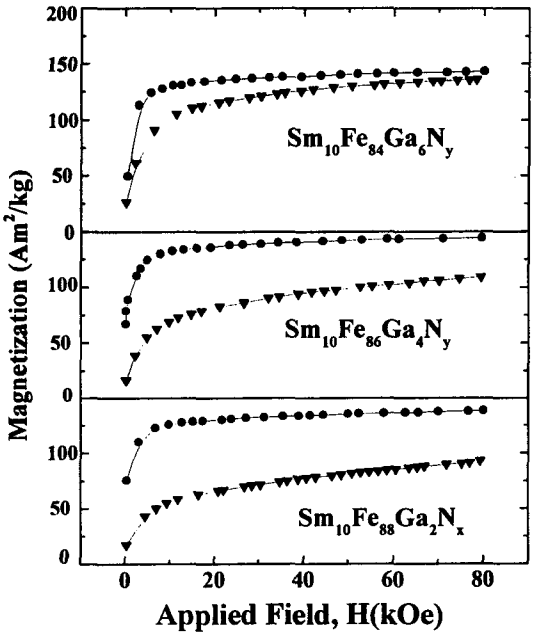


Fig. 3. Temperature dependence of magnetization of $Sm_{10}Fe_{90-x}Ga_x$ (x=2, 4, 6) and their nitrides.

References

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