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Hot Isostatic Pressing in Oxygen of Ferrite Magnet


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Abstract. The effect of hot isostatic pressing in 5%O2-95%Ar on the magnetic properties of Sr ferrite magnet was studied. It was found that the size of voids at grain boundaries are decreased by hot isostatic pressing without substantial grain growth and the density of isostatically hot-pressed body is about 5.03x10^3 kg/m^3. Magnetic measurement revealed that the hot isostatic pressing does not significantly decrease coercive force and keeps the good squareness of B-H curve of pre-sintered body unchanged. The typical value of residual flux density Br of the isostatically hot-pressed magnet is 0.43T at Hr = 5180 A/m.

1. Introduction

Recently, it is intensively demanded to improve the magnetic properties of Sr ferrite magnet in order to decrease the weight of motors used in automobiles and to increase the efficiency of motors used in electric appliance such as air conditioner. There are four ways as listed below to increase residual flux density and the coercive force of anisotropic ferrite magnet.

1) To increase the degree of crystallographic alignment[1].
2) To increase the density of sintered body
3) To control the size distribution of ferrite particles and to make the average grain size as equal as to the critical size for single domain possible[1].
4) To increase the intrinsic magnetization or anisotropic constant of ferrite material[2].

This report is concerned with 2) shown above. The density of commercial ferrite magnet is around 4.9x10^3 kg/m^3 which is 96% of X-ray density. It is thought that there is a possibility to improve magnetic properties of ferrite magnet by increasing the density of sintered body. The purpose of this investigation is to show how the increase of the density influences the magnetic properties of ferrite magnet using hot isostatic pressing (HIP) technique.

2. Experimental Procedure

FeO and SrCO3 were mixed in water, then dried and calcined in air. The calcined ferrite powder was wet-milled with additives(CaCO3, SiO2, SrCO3, Cr2O3) using a ball-mill. The finely milled slurry was pressed into disk shaped compacts in a magnetic field of 800kA/m which was parallel to the pressing direction. The compacts were pre-sintered in air at 1453 ~ 1493K. Each pre-sintered specimen was cut into two pieces. One was used for the reference and the other was successively hot-pressed isostatically in 5%O2-95%Ar and 100%Ar atmosphere. The pressure and the temperature were 101.3MPa and 1353 ~ 1373K respectively. The change of density, magnetic properties and microstructure were investigated.

3. Results and Discussion

Fig.1 shows the dependence of the density of isostatically hot-pressed body on the density of pre-sintered body in the case of 5%O2-95%Ar. 101.3MPa and 1353K condition. It is found that the density of sintered body can be increased by 0.05 ~ 0.1x10^3 kg/m^3 in hot isostatic pressing process if the density of pre-sintered body is higher than 4.7x10^3 kg/m^3. Typical value of the density of isostatically hot-pressed body in this experiment is around 5.03x10^3 kg/m^3 which is 96.8% of theoretical density assuming that the theoretical density of Sr ferrite is 5.1 x10^3 kg/m^3. Almost the same result was obtained in the case of 100%Ar atmosphere. Fig.2 shows the change of magnetic properties of Sr ferrite magnet by hot isostatic pressing in the case of 5%O2-95%Ar. 101.3MPa, 1353K. It is found that the isostatic pressing process increases the residual flux density by 0.005 ~ 0.007 T. Little change of coercive force was observed which indicates that there was no significant grain growth in the

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The density increase without substantial grain growth by hot isostatic pressing was found to improve the magnetic properties of Sr ferrite magnet. The typical value of Br obtained in this investigation is 0.438T at Hc=318 kA/m, which is 0.005 - 0.007T higher compared with that of pre-sintered body.

References