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MICROSTRUCTURES AND MAGNETIC PROPERTIES OF HIGH COERCIVITY $SmFe_{11}Ti$ MELT-SPUN RIBBON

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I. INTRODUCTION

RE(Fe,M)$_{12}$-type compounds with $ThMn_{12}$ structure are promising materials as permanent magnets(1). Among the reported, $SmFe_{11}Ti$ is one of the most suitable candidate for permanent magnetic material because of its high magnetocrystalline anisotropy, relatively high magnetization and Curie temperature(2). It has been known that the appropriate surface etching is very effective for the increment of coercivity in a $SmFe_{11}Ti$ melt-spun ribbon(3).

The purpose of this work is to clarify the relation between the characteristics of ribbon surface and the coercivity of $SmFe_{11}Ti$ melt-spun ribbon.

II. EXPERIMENTAL PROCEDURES

$SmFe_{11}Ti$ melt-spun ribbon was prepared by single wheel technique under Ar atmosphere. The surface velocity of Cu wheel was 40 m/s. The as-quenched ribbons were annealed at 600-900 ^{o}C for 15-60 minutes. The magnetic properties of annealed ribbons were measured by vibrating sample magnetometer. The crystal structures and microstructures of melt-spun ribbons were investigated by X-ray diffractometer and SEM, respectively. The compositions of the surface of melt-spun ribbons were analyzed by SEM-EDX.

III. RESULTS AND DISCUSSION

It was reported that much of α-Fe exists on the surface than the inside of $SmFe_{11}Ti$ melt-spun ribbon which was annealed in vacuum(3). We could obtain the same results for the melt-spun ribbons which have the compositions around $SmFe_{11}Ti$. A possible explanation for the formation of α-Fe on the surface was the off-stochiometry from $SmFe_{11}Ti$ due to the evaporation of Sm atoms during the high temperature annealing(4).

Fig.1 shows the morphology of free-side surface of $SmFe_{11}Ti$ melt-spun ribbon which was annealed at 850 ^{o}C for 45 minutes in vacuum. The surface of ribbon is composed of (A) grey and (B) bright regions. The results of SEM-EDX revealed that the atomic ratios of the surface and the inside of ribbon were $SmFe_{21.3}Ti_{2.3}$ and $SmFe_{11.7}Ti_{0.9}$, respectively.

In order to decrease the volume of α-Fe which exists in the $SmFe_{11}Ti$ melt-spun ribbon, the surface layer of about one-third of the ribbon thickness was removed by chemical etching. After the surface etching, a considerable increment(about 35 %) in coercivity was achieved. We also measured the coercivity of $SmFe_{11}Ti$ melt-spun ribbon that half of the ribbon thickness was removed. The shape of demagnetization curve and the coercivity of the ribbon was almost the same to those of one-third of ribbon thickness was removed. The results mean that much of α-Fe exists only on the thin layer near the surfaces. The coercivity of $SmFe_{11}Ti$ melt-spun ribbon after removing the surface was 565 kA/m(about 7.1 kOe). This is the highest value among the reported earlier on the $SmFe_{11}Ti$.

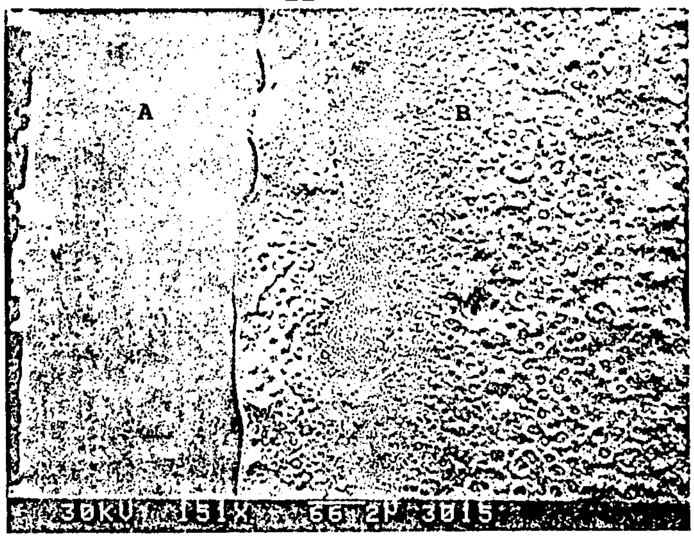

Fig.1 The morphology of the free-side surface of $SmFe_{11}Ti$ melt-spun ribbon annealed at 850°C for 45 minutes in vacuum.

IV. CONCLUSION

α-Fe is formed on the surface of $SmFe_{11}Ti$ melt-spun ribbon due to the evaporation of Sm atoms during the high temperature annealing in vacuum. The coercivity of $SmFe_{11}Ti$ melt-spun ribbon increases considerably by removing the surface of ribbon.

References

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