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## The effect of hydrogen treatment on the nitride formation of a $Sm_2Fe_{17}$-type alloy

Department of Material Science and Engineering,
The National Fisheries University of Pusan

H.W.Kwon*

## $Sm_2Fe_{17}$ 계 합금의 질화반응에 미치는 수소처리의 영향

부산수산대학교 재료공학과

권 해 웅*

### 1. Introduction

The $Sm_2Fe_{17}$ nitride material has been considered to be a potential candidate for the permanent magnetic application because of the high Curie temperature, the improved uniaxial magnetocrystalline anisotropy, and the high saturation magnetisation. It is apparent, however, that there are some practical difficulties in the preparation of the $Sm_2Fe_{17}$ nitride material. The cast $Sm_2Fe_{17}$ alloys have a severe structural inhomogeneity featured with a presence of considerable amount of free iron which reduces dramatically the intrinsic coercivity of the nitride unless removed by a proper treatment prior to the nitriding process. In addition to the structural inhomogeneity, the poor kinetics of the nitride formation is also a limiting factor for the application of the material as a permanent magnetic material. In the present study, the $Sm_2Fe_{17}$ alloy has been modified by a substitution of Nb for Fe in order to overcome the difficulty associated with the structural inhomogeneity, and a hydrogen treatment has been employed in order to find an effective way of production of the $Sm_2Fe_{17}N_x$ type material.

### 2. Experimentals

A $Sm_2Fe_{17}$ alloy containing 4at% Nb was prepared using an induction melting at 1400C. The as-cast alloy was subjected to a hydrogen treatment consisting of hydrogenation and degassing prior to nitriding process. The hydrogenation was carried out at room temperature or elevated temperature(300°C), and the degassing was performed at 450°C under vacuum better than 0.05mbar. The hydrogenation and degassing was repeated four times. The hydrogen treated alloy was pulverised for 1 hr in a glove box filled with high purity nitrogen gas(oxygen content in the glove box: less than 150ppm). The pulverised alloy was then moved to the nitrogenation at the temperature range of 450° - 525°C for 4 - 15 hrs under nitrogen gas(nitrogen pressure: 1 bar). The nitrogenation behaviour of the hydrogenated or the as-cast alloys was investigated by means of TPA(Thermopiezic Analysis). The magnetic properties of the nitride material were characterised by means of VSM or TMA.

### 3.Results and discussion

The microstructure of the as-cast $Sm_2Fe_{17}$(4at%Nb) alloy has been found to consist of a mixture of $Sm_2Fe_{17}$ matrix phase and eutectic phase region. The eutectic region has been found to be a mixture of $Sm_2Fe_{17}$ and $NbFe_2$ laves phase. No obvious evidence for the presence of the free iron has been observed in the as-cast alloy, the as-cast alloy, therefore, was able to be used straightaway for the production of nitride without any homogenising treatment. The hydrogen treated material has been found to pick up the nitrogen at considerably lower temperature with respect to the alloy without hydrogen treatment, indicating that the nitride formation of $Sm_2Fe_{17}$ -type alloy can be facilitated significantly by employing the previous hydrogen treatment.

## 4. Conclusion

The hydrogen treatment prior to the nitrogenation has been found to facilitate significantly the formation of $Sm_2Fe_{17}N_x$-type nitride, and this may be due to the hydrogen decrepitation which results in a clean surface and a finer particle size of the powder. It has been found that the combination of the alloy modification with Nb addition and the hydrogen treatment can be utilised effectively for the production of $Sm_2Fe_{17}$ nitride. The nitride produced in the present study showed a reasonably high intrinsic coercivity(over 7 kOe) after milling.

## Figure captions

Fig.1 TMA results for the nitrided materials nitrogenated for 4hrs at various temperatures using the as-cast alloy

Fig.2 TMA results for the nitrided materials nitrogenated for 4hrs at various temperatures using the hydrogen treated alloy

Fig.1

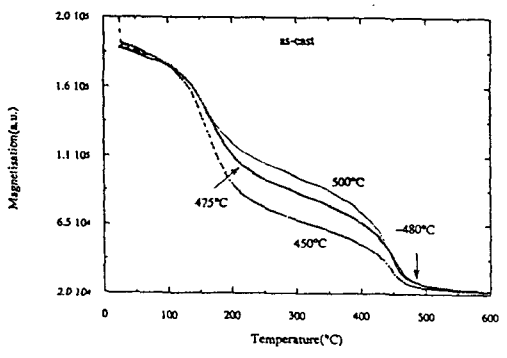


Fig.2