EB05

Studies on the Time Stability of the Magnetic Performance of Nd-Fe-B Magnets

Zhu Ming-Gang, Liu Xing-Min, Li Zheng-bang, Li Wei*

Division of Functional Materials, Central Iron & Steel Research Institute, Beijing 100081,China

*Corresponding author: Supervisor. E-mail: weili@public3.bta.net.cn

Nd-Fe-B sintered permanent magnets as a high performance material have been extensively used in many fields such as spaceflight, navigation, communication, computer and high precision instruments [1]. In this paper, the irreversible flux loss(FL) of sintered Nd-Fe-B magnets, Exposed at room temperature (RT), have been investigated after aging about 920 days. The values of FL are about 1.4%. However, after a pre-aging treatment, the FL of experimental magnets are reduced to about 6‰. Therefore, the stability of flux has been obviously improved by the pre-aging treatment. A theoretical formula, based on the Boltzmann statistics, has been used to discuss the effect of microstructure on flux loss (FL). It is found that the experimental results can be well explained by this formula (see fig. 1 and fig. 2). Relaxation of magnetism theory has been used to study the dependence of magnetic properties on time and describe this formula.

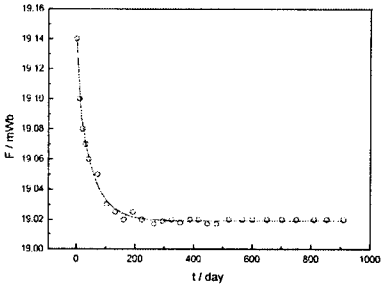

Fig. 1. The experiment data and theory curve of the time dependence of irreversible flux loss at 293K

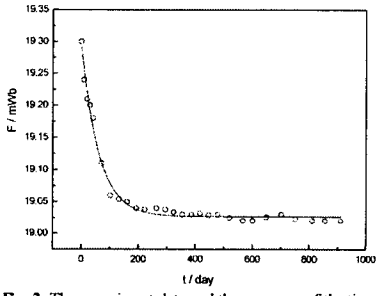

Fig. 2. The experiment data and theory curve of the time dependence of irreversible flux loss at 293K

REFERENCES

[1] J. Bernardi, J. Fidler, M. Sagawa, Y. Hirose, J. Appl. Phys. 83 (1998) 6396.

This word was Supported by the National High Technology Development Program of China, and the National Natural Science Foundation of China, and Program of Beijing Municipal Science & Technology Commission

EB06

Epitaxial Growth of Nd-Fe-B Films with Perpendicular Magnetic Anisotropy on bcc Metals with (110) Orientation

A. Morisako*, and Xiaoxi Liu

[1]Department of Information Engineering, Shinshu University, 4-17-1 Wakasato, Nagano, 380-8553, Japan

*Corresponding author: Morisako@cs.shinshu-u.ac.jp, Phone: +81 26 269 5481, Fax: +81 26 269 5481

$Nd_2Fe_{14}B$ is a well known material for permanent magnet because of its high saturation magnetization and large magnetic anisotropy, K_u. $Nd_2Fe_{14}B$ thin films with perpendicular anisotropy are promising for the applications of MEMS and perpendicular magnetic recording media. Ta, W, Mo underlayers have been reported to be suitable for $Nd_2Fe_{14}B$ thin films with perpendicular anisotropy. However, the mechanism is still unclear.

In this experiment, bcc metals, such as Ta, W, Mo, as well as FeCo have been used as underlayers to grow $Nd_2Fe_{14}B$ thin films. The films were prepared by a facing targets sputtering system. It is a well known technique for the high sputtering rate of magnetic materials. Most important, this kind of sputtering process can minimize the inter-diffusion between the underlayer and Nd-Fe-B layer. The magnetic properties of the films were determined by a vibrating sample magnetometer. The crystallographic properties of the films were observed by an x-ray diffractometer. The underlayers were prepared at different substrate temperature and different sputtering conditions to achieve different crystal orientations. XRD diagrams show that $Nd_2Fe_{14}B$ thin films with c-axis perpendicular to the films plane can be successfully prepared onto all the four underlayers with (110) orientation. C-axis orientation is clearly deteriorated for films prepared onto underlayers with (001) orientation. VSM measurement confirmed the XRD results. Films with perpendicular anisotropy have coercivities as large as 18 kOe in the perpendicular direction. Almost zero coercivity was observed in the in-plane direction for those films with perpendicular anisotropy.

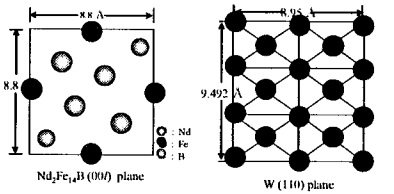

Fig. 1. Epitaxial relation between $Nd_2Fe_{14}B$ (00*l*) plane and W (110) plane.

Fig. 1 shows the (110) plane of bcc metals and (001) plane of tetragonal $Nd_2Fe_{14}B$. It is clearly that the two planes could have epitaxial relation although the (110) plane of bcc metals have rectangular shape and the (001) plane of tetragonal $Nd_2Fe_{14}B$ have squared shape. The misfit ratio between (110) plane of Ta, Mo, W, FeCo and (001) plane of tetragonal $Nd_2Fe_{14}B$ is no more that 9%, according to fig. 1.

In conclusion, we have found the epitaxial relation between bcc (110) plane and tetragonal (001) plane. $Nd_2Fe_{14}B$ thin films is successfully prepared with perpendicular magnetic anisotropy onto bcc metals with (110) orientation. This new technique not only provide a simple process to prepare $Nd_2Fe_{14}B$ thin films with perpendicular anisotropy, most importantly, an laminate of magnetically hard $Nd_2Fe_{14}B$ and magnetically soft FeCo can provided spring magnet with perpendicular orientation.