UB04

Study on the Microstructure of Single Stage Hot Deformed Anisotropic Nd-Fe-B Magnets

Hao Tian[1], Ying Li*[1], Mingyuan Zhu[1], Hongming Jin[1], and Dongzhe Jin[2]
[1] School of Materials Science and Engineering, Shanghai University, Shanghai 200072 P.R. China
[2] College of Science and Technology, Yanbian University, Yanji City, 133000, China
*Corresponding author: liying62@shu.edu.cn, Phone: +86 21 5633 8874, Fax: +86 21 5633 7364

Anisotropic Nd-Fe-B magnets were fabricated by the single stage hot deformation *(SSHD) method which is a more effective method that simplifies the traditional* hot-pressing and die-upsetting process as one step hot press and replaces the sample die with copper tube. In previous work [1, 2], we have researched much about the magnetic properties affected by raw materials, the fabrication process, etc. This study will focus on the microstructure of the single stage hot deformed NdFeB magnets in order to understand the origin of anisotropy in SSHD magnets.

Fig. 1-3 are the SEM imagesof SSHD magnet fabricated at 650°C,700°C and 750°C, respectively.

In Fig. 1, it is observedthat randomly oriented grains with the diameter of 40-60nm at 650°C without Nd-rich liquid phase.

Fig. 2 shows the platelet-shaped $Nd_2Fe_{14}B$ grains formed at 700°C. They are about 0.8 μm long and 0.2 μm wide on the average. At the boundary of the flake, the grain size is much bigger than the typical platelet-shaped $Nd_2Fe_{14}B$ grains. While the temperature of hot deformation was increasing up to 750°C, the coarse grains grown larger, shown in Fig. 3.

EDS analysis results shows that the ratio of Fe to Nd in the coarse grain zone is lower than that in platelet-shaped $Nd_2Fe_{14}B$ grains zones, and also lower than that in raw material, MQPA powder. It means Nd is enriched and the large amount of Nd-rich liquid phase formed between the powder flakes, which is good for hot deformation, but at the same time promotes the formation of coarse grains leading to low coercivity. The reason for coercivity decreasing may relate with coarse grain. And the intergranular Nd-rich liquid phase plays key role in the alignment growing of the NdFeB grainsand improving magnetic anisotropy.

Fig. 1. SS hot deformed at 650°C

Fig. 2. SShot deformed at 700°C

Fig. 3. SS hot deformed at 750°C

REFERENCES

[1] Ying Li, Y. B. Kim, T. S. Yoon, C. O. Kim, Journal of Magnetism and Magnetic Materials, **263**, 11(2003).
[2] Ying Li, Y. B. Kim, T. S. Yoon, D. Z. Jin, C. O. Kim, Journal of Applied Physics, **91**(10), 7887(2002).

UB05

Magnetic Properties of Melt-spun $(Nd_{62.5}Ni_{37.5})_{85}Al_{15}$ Aloy

Feng Xu*[1], Shandong Li[2], Jianzhong Jiang[3], Youwei Du[4], Guang Chen[1]
[1] Department of Materials Science and Engineering, Nanjing Universityof Science and Technology, Nanjing 210094, China
[2] Physics Department, Fujian Normal University, Fuzhou 350007, China
[3] Department of Materials Science and Engineering, ZhejiangUniversity, Hangzhou 310027, China
[4] Physics Department, NanjingUniversity, Nanjing 210093, China
*Corresponding author: xufeng_njust@yahoo.com.cn, Phone: +886-3-5715131-35343, Fax: +886-3-5722366

Since the bulk amorphous Nd-Fe-Al alloy with hard magnetic properties was reported by Inoue, Nd-based bulk amorphous alloys have gradually attracted the interest of researches [1]. In the previous work, Ni and Cu were selected to substitute Fe and form $(Nd_{62.5}Ni_{17.5-x}Cu_x)_{85}Al_{15}$ metallic glasses, which have a certain glass-forming ability [2].

In the present work, the magnetic properties of $(Nd_{62.5}Ni_{37.5})_{85}Al_{15}$ are further studied. The ribbon samples were prepared by melt-spinning method. XRD pattern shows that the as-quenched sample isamorphous. The magnetic properties were characterized with SQUID. The hysteresis loopsmeasured at 5K *show that for the as-quenched sample, the sample annealed to* T_g (glass-transition temperature, 240°C) and the sample annealed to T_x (onset temperature of crystallization, 275°C), the magnetic coercivities are 290±10Oe, 334±5Oe, 570±10Oe, respectively. The magnetization of the sample didn't reach saturation even at 70 kOe. This indicated that the sample has a complicated magnetic structure, a kind of speromagnetism, which possibly originates from the RE-TM alloy [3]. The thermomagnetic relations indicate Curie temperature is as low as about 15K, and it is also increased by annealing, especially when annealed to T_x.

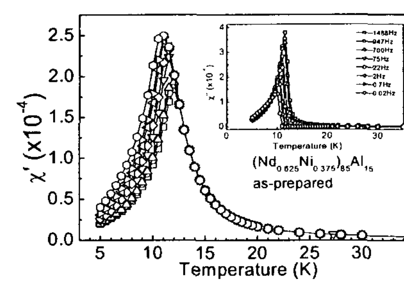

Fig. 1. AC susceptibility spectra at different frequencies under 100 Oe.

The ZFC-FC thermomagnetic relations under 100Oe show the typical bifurcations of spin-glasses. The spin-glass behavior is further supported by AC susceptibility spectra. The AC susceptibility spectra measured at different frequencies (from 0.02 Hz to 1488 Hz) are shown in Fig. 1. The freezing peak moves to higher temperature with increasing frequency. In order to estimate the dynamical parameters characterizing the SG state the obtained T_f data are fitted to the standard expression $\tau_{max} = \tau_0[(T_f - T_s)/T_s]^{-z\nu}$ (the critical slowing down). $f_0=1.2\times10^{14}$ was kept fixed, the fit yields the static freezing temperature T_s=10.2384K and the critical dynamical exponent $z\nu$ =12.9. When the temperature is higher than the freezing temperature, the spectra follow the Curie-Weiss Law. This is a very typical character of spin glass.

REFERENCES

[1] A. Inoue, T. Zhang, W. Zhang, A. Takeuchi, Mater. Trans. JIM 37 (1996) 99.
[2] F. Xu, Z.M. *Wang*, Z.R. *Yuan, G. Chen, J.Z. Jiang, submitted to* J. *Alloys Compd.*
[3] K. Moorjani, J.M.D. Coey, (ed.) Chapter 6 and Chapter 7 of Magnetic Glasses, published by Elsevier Science Publishers B. V. (1984).