Thermal activation analysis on Nd-Fe-B hot-deformed magnets with Pr-Cu grain boundary diffusion process

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Since the discovery of $Nd_2Fe_{14}B$ magnets[1, 2], numerous and extensive efforts to increase the coercive field H_c have been made. Nevertheless, the value of H_c remains as small as 1/3 of the anisotropy field H_k. Moreover, H_c rapidly decreases with the temperature T above the ambient temperature. The low H_c and its large temperature dependence are well known as the coercivity problem of Nd-Fe-B magnets. To solve this problem, it is essential to understand the magnetization reversal mechanism of Nd-Fe-B magnet. In this study, thermal activation analyses based on the magnetic viscosity measurement were performed to discuss the magnetization reversal process of the Nd-Fe-B hot-deformed magnets.

Nd-Fe-B hot-deformed magnet with the Pr-Cu eutectic alloy grain boundary diffusion (GBD) process was used in this study[3]. Under finite temperature, the magnetization reversal takes place through the thermal activation process against the energy barrier $E_b(H)$. $E_b(H)$ is usually expressed as $E_b(H) = E_0(1 - H/H_0)^n$, where H is the magnetic field, E_0 is the energy barrier height at H = 0, n is the constant depending on the magnetization reversal mode: n = 1 for domain wall pinning and n = 1.5 ~ 2 for nucleation or coherent rotation. Since E_b strongly depends on the magnetization reversal process, it is expected that detailed information about the reversal process in a Nd-Fe-B magnet can be obtained if E_b is accurately evaluated. Recently we proposed the method to determine these energy barrier parameters based on the magnetic viscosity measurements [4]. Fig.1 (a) shows the hysteresis loop of Pr-Cu GBD sample measured at 100℃. Fig.1 (b), (c), (d) shows the viscosity curves of Pr-Cu GBD sample at H_c(M/M_s = 0), nucleation field H_n (M/M_s = 0.9) and saturation field H_s (M/M_s = -0.9) measured at 100℃, respectively. The values of n are about 1 at H_c and H_s. These facts indicate that the domain wall pinning is the major magnetization reversal process at H = H_c and H_s. While for H = H_n, the values of n are about 1.4, indicating that the nucleation is the dominant magnetization reversal process.

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Reference

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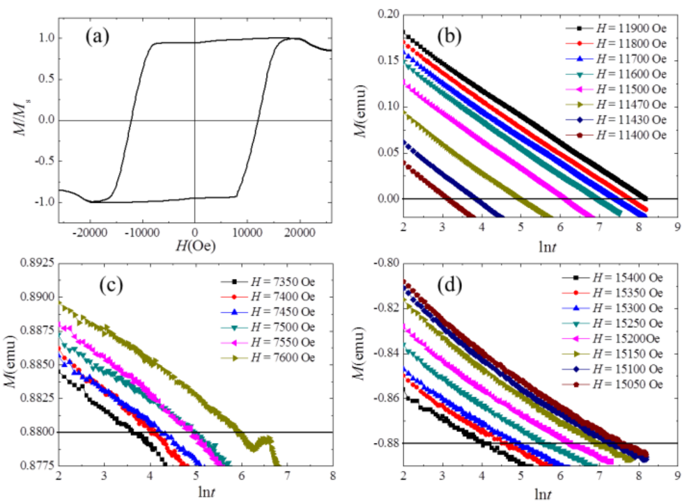

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