Angular Dependence of Coercivity Derived from Alignment Dependence of Coercivity in Sintered Nd-Fe-B Magnets

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The coercivity of Nd-Fe-B sintered magnets and ferrite magnets decreases as the alignment (α=Br/Js) improves. It was found that their coercivity reaches 70% of that of istropically oriented magnets at the perfect alignment (α=1). 1) These results could not be explained by the coherent rotation model, but they were qualitatively explained by the magnetic domain wall motion model. The angular dependence of coercivity is usually used to verify which model is suitable for the coercivity mechanism. But, it is difficult to decide.

Magnets of several different compositions were made by the powder metallurgical method that is described in our previous papers. 2) To investigate the alignment dependence of coercivity, we used $Nd_{13.48}Co_{0.55}B_{5.76}Fe_{bal.}$ with α=0.95 and $Nd_{12.75}Dy_{0.84}B_{5.81}Co_{0.55}Fe_{bal.}$ for anisotropically aligned magnets. For the angular dependence of coercivity of anisotropically aligned magnets, we used $Nd_{14.2}B_{6.2}Co_{1.0}Fe_{bal.}$ and $Nd_{14.2}Dy_{0.3}B_{6.2}Co_{1.0}Fe_{bal.}$, which have similar compositions to analyze the alignment dependence of coercivity. Coercivity was measured by permeameter. Samples and the measurement method used for the angular dependence of coercivity are mentioned in our previous papers. 2)

Figure 1 shows the observed alignment dependence of the coercivity change rate obtained from that of isotropically oriented magnets, and the calculation results that were obtained using the statistical method based on the Gaussian distribution, which served as the alignment distribution. In the calculation results, we used the postulation that every grain follows the 1/cos θ law. It was found that the calculated curve differed from the observed curve. Figure 2 shows the magnetization reversed area. The solid curve is the calculation result obtained from the same method as Fig. 1. The magnetization reversed areas of $Nd_{12.75}Dy_{0.84}B_{5.81}Co_{0.55}Fe_{bal.}$ and $Nd_{14.2}Dy_{0.3}B_{6.2}Co_{1.0}Fe_{bal}$ are 30^{o} and 36^{o}, which was wider than the expected values for their alignment distributions. We used 30^{o} and 36^{o} along the solid line in Fig. 2, which have 31^{o} and 44^{o} for as the standard deviations of the Gaussian distribution, and applied them to the calculation of the angular dependence of coercivity.

Figure 3 shows the observed angular dependence of $Nd_{14.2}B_{6.2}Co_{1.0}Fe_{bal.}$ and $Nd_{14.2}Dy_{0.3}B_{6.2}Co_{1.0}Fe_{bal.}$, and the calculation results. It was found that the calculation results qualitatively explain the observed angular dependence of coercivity. These results reinforce our conclusion that the magnetic domain wall is pinned at grain tilted away from the easy magnetization direction, and when the magnetic domain wall de-pinned from the pinning sites, the magnetic domain wall jump through several grains, which means that the crust of the grain reverse because of the magnetic domain wall jump.

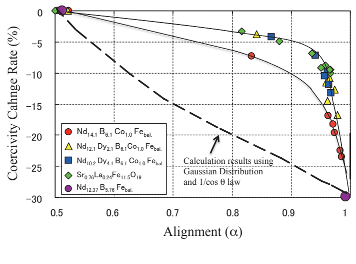

Fig.1 Alignment dependence of coercivity change rate

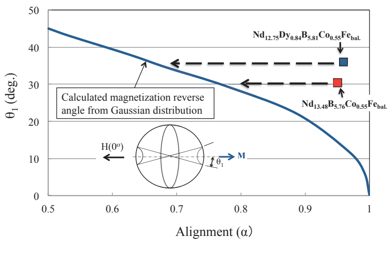

Fig.2 Alignment dependence of magnetization reverse area

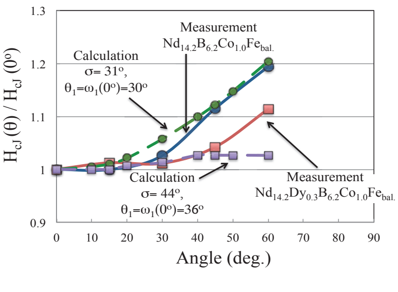

Fig. 3 Angular dependence of coercivity

References

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