Observations of Coercivity in RE-Fe-B Magnets in Pulsed Fields up to 30T

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The measurements of the coercivity (*Hc*) of magnets are very important to obtain the stored energies in magnets. However it is difficult to determine *Hc* as a function of the effective fields in samples with arbitrary shapes in pulsed fields. We tried to obtain the exact coercive force and the *M-H* curve in high pulsed magnetic fields up to 30T with long pulsed fields (e.g. half width of 80ms in $20T_{max}$) by using an induction method with a triple-fold pick-up coil [1]. In this experiment, the values of *Hc* were found much smaller than *10-20*% in the Nd-Fe-B and in Sm-Fe-B magnets which were supplied and announced ratings by a company. These errors might be caused by the sample insertion gap in between the sample and probe. These magnetic field configurations of samples with some insertion gaps of the pick-up coil were well simulated using JMAG and were well coincide with the experimental results. Fig. 1 shows the experimental results of H_{eff} vs. $\mu_0 H$ for two samples of Nd-Fe-B. Table1 shows the discrepancies of the several parameters between the announced values and those in this study. Here it must be noted that we obtained the same samples with a sample maker and we prepared two types of samples which were cut along easy and hard axis, respectively. Therefore, to avoid errors, we prepared samples with the largest diameter up to the allowance to insert samples into the inner diameter of the pick -up coil (*10*mm$^{\Phi}$). The physical origin of this discrepancy is very plausible to consider the magnetic flux density at $B=\mu_0 H_{eff}+M$. In other words, at the coercive field (*Hc, M=0*), the effective fields as a function of the positions are uniform as described by $B= \mu_0 H_{eff} (=\mu_0 Hc)$. Therefore the voltages in the pick-up coil with its cross section are always larger than those of the samples by the insertion gap.

References

[1] K. Nakahata,B. Borkovsky, K. Yamada,T. Todaka, M. Enokizono, J. AEM,Vol.19,No2,pp207-212, ,2011

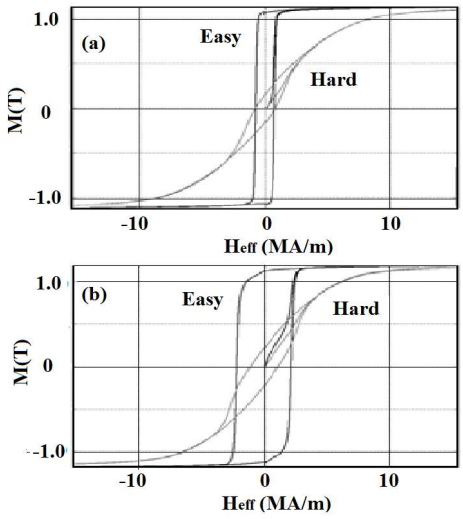

Fig.1 Experimental results of M-H curves of Nd-Fe-B magnets measured along Easy and Hard axes in pulsed fields

Table 1. Experimental results of typical samples

Nd-Fe-B(1)	Easy	Hard	Easy(Catalog)
Mr (T)	1.48	0.168	1.48
H_{cB}(kA/m)	867	91.1	1046
H_{cJ}(kA/m)	1024	607	875
$(BH)_{Max}$	314	3.90	421

Nd-Fe-B(2)	Easy	Hard	Easy(Catalog)
Mr (T)	1.12	0.16	1.13
H_{cB}(kA/m)	697.2	92.3	835 - 915
H_{cJ}(kA/m)	2499	1051	2387
$(BH)_{Max}$	197	3.76	240

Sm-Fe-B(c)	Easy	Hard	Easy(Catalog)
Mr (T)	1.07	0.16	1.08
H_{cB}(kA/m)	579	88.9	557
H_{cJ}(kA/m)	753	767	598
$(BH)_{Max}$	174.8	3.48	215