Magnetic imaging by nano-focused synchrotron light and a perspective of its application to analysis of the local magnetism

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To clarify the coercivity (H_c) mechanism of high-performance permanent magnets, we have developed a scanning soft X-ray magnetic circular dichroism spectromicroscope with the ability to observe magnetic domains under high fields up to 8 T [1]. In permanent magnets, the demagnetization process is spatially inhomogeneous; the bulk magnetization is determined by the integral of the local magnetization over the whole system. In this context, it is important to understand how the demagnetization process occurs locally. Previous studies have shown that the fractured surface is representative of the bulk magnetic state [2]. Therefore, the domains in the fractured surface of a Nd-Fe-B sintered magnet were observed, and local M-H loops for (150 nm)^2 areas were determined from 66 images taken under various applied fields. From these, the local H_c were extracted for the descending (Fig. 1(a)) and ascending (Fig. 1(b)) branches. For the two regions bound by broken lines in Fig. 1(a) and (b), H_c differed by ≥ 0.4 T between the ascending and descending branches. To demonstrate this, single-pixel M-H loops from those regions are shown in Fig. 1(c), where the loops are horizontally-shifted in opposite directions. The difference arises because: 1) the order of reversals varies stochastically due to thermal agitations and 2) once one grain reverses, the other is stabilized via the magneto-static coupling between them. The former effect has a microscopic origin, whilst the latter interaction is long-range. Thus, a statistical analysis of the magnetic images is required to properly understand the reversal process and to optimize the microstructure for high H_c magnets.

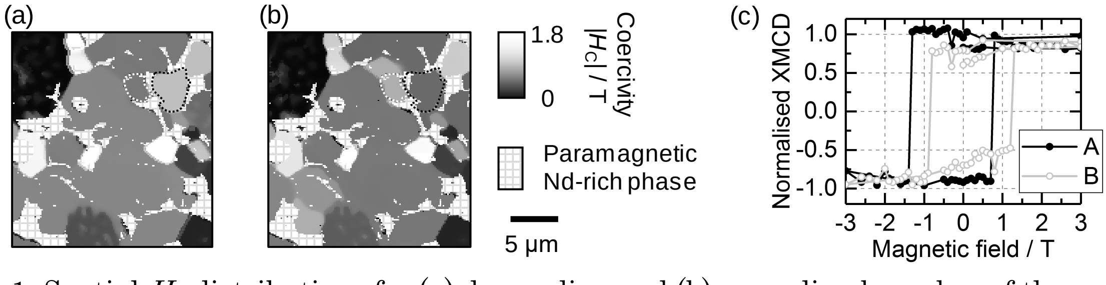

Fig. 1. Spatial H_C distributions for (a) descending and (b) ascending branches of the fractured surface of a Nd-Fe-B magnet. (c) M-H loops for 1 pixel in the regions bounded by black (A) and white (B) broken lines in both (a) and (b).

Bibliography

[1] Y. Kotani *et al.*; *in preparation.*
[2] T. Nakamura *et al.*; Appl. Phys. Lett., **105**, 202404 (2014).

External links

http://www.spring8.or.jp/wkg/BL25SU/instrument/lang/INS-0000000489