Application of XMCD-PEEM to the magnetic domain structural analysis of Nd-Fe-B sintered magnets

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Nd-Fe-B sintered magnets have been widely applied for various motors, e.g., hybrid electric vehicles, which need higher coersivities. The coersivity mechanism of Nd magnets is interpreted based on the nucleation of reverse domains. According to this theory, the morphologies of the minor phases and magnetic domain structures are important, because such phases become the nucleation sites or inhibiters of reverse domains. In this study, we applied the XMCD-PEEM to the domain structural analysis in order to develop a new method of research on coersivity mechanism. The raw alloys of Nd-Fe-B were synthesized by the induction melting and made into the sintered magnets by means of powder metallurgical processing. The magnetic powders were mostly pulverized into single crystal particles, and then their easy axes (c-axis of tetragonal structure) were accumulated into the magnetic field direction during pressing. The magnets in thermal demagnetized state were cut out so that the easy axes of grains were oriented into one direction in the surface plane. Figure shows Fe L3-edge PEEM (a) and MCD (b) image, respectively. The projection of SR was parallel to the direction of easy axes orientation. Prior to these measurements, the minor phases had been already identified as Nd-oxide and Nd-rich region by the pre-exam of FE-SEM/EDS. The tendency of secondary photoelectron intensities of Fe and Nd-edge from each region agrees with the results of the pre-exam. Dark gray regions in Fig.(a) are the minor phases, which were distinguished from matrix by contrasts in the PEEM image. The dark and light gray contrasts in Fig.(b) show the domain structures. In order to know the effects of external field on domain structures, the field-demagnetized samples were also investigated. As a result, almost all surface grains were changed into single domains form multi-domain structures. We consider that XMCD-PEEM is a promising method for research of coersivity mechanism, because of its high contrasts and resolution.

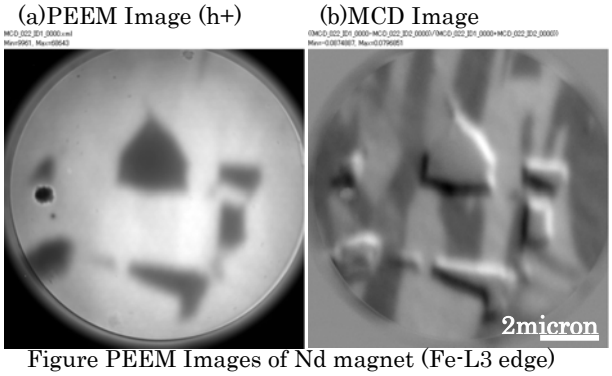

Figure PEEM Images of Nd magnet (Fe-L3 edge)