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Coercive force mechanism in Nd-Fe-B nanocrystalline magnet investigated by SANS

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Permanent magnet material with high maximum energy product is demanded for industrial applications such as high-efficiency motors for hybrid and electric vehicles. Maximum energy product depends on the coercive force and the saturation magnetization. In order to achieve the high maximum energy product, current Nd-Fe-B magnets are doped with heavy rare-earth element Dy to enhance the coercive force at the expense of reducing the saturation magnetization. Viewed from another side, a supply of Dy is highly concerned because of the inequitable distribution of rare-earth resources on the Earth. Therefore, development of a Dy-free Nd-Fe-B magnet is desired. In this context, we have fabricated the Dy-free Nd-Fe-B nanocrystalline magnet and performed the small-angle neutron scattering (SANS) experiment to reveal the mechanism of its coercive force. Hot-deformed Nd-Fe-B nanocrystalline magnets with and without the diffusion process of Pr-Cu eutectic alloy were prepared [1]. Coercive forces were 1.46 T and 2.64 T for as-deformed and Pr-Cu infiltrated sample, respectively. Magnetic field dependent SANS experiment was performed to observe the magnetization reversal process. The reversal magnetic field was swept from 0 T to 5 T. SANS intensities exhibit maxima around the coercive force for both as-deformed and infiltrated sample, which indicates the evolution of the magnetic domain structure. In addition, suppressed intensity variation in infiltrated sample compared to that in as-deformed sample indicates the magnetic isolation of Nd2Fe14B grains, which is responsible for the high coercive force. We will compare the results for Pr-Cu infiltrated sample with Nd-Cu infiltrated one [1]. This work was supported by the Elements Strategy Initiative Center for Magnetic Materials under the outsourcing project of the MEXT, Japan. We thank HZB for the allocation of neutron beamtime (Proposal No. MAT-04-2110). The sample preparation was performed under the MagHEM project.

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