Characterization of rare-earth permanent magnets using quantum beams

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Reducing fossil fuel consumption is essential to stop global warming and realize a sustainable society. In the transportation sector, the rapid shift to electric vehicles is in progress on a global scale. In hybrid vehicles and electric vehicles, the driving motor is the most important factor together with the battery, the power control device, and a high-performance permanent magnet material is indispensable. From the viewpoint of resource problems, critical elements such as rare-earth metals used for high-performance permanent magnet materials are essential elements for clean energy technologies such as wind turbines, electric vehicles, batteries, solar cells, etc. Under such circumstances, it is urgent to develop high-performance magnetic materials that replace critical elements.

To realize a high-performance magnetic material, substituting a critical element, it is necessary to clarify high magnetic anisotropy and coercive force mechanism, with the high-throughput synthesis of new magnetic materials, and precise characterization. Therefore, the use of quantum beams such as synchrotron radiation and neutrons is indispensable. We comprehensively use synchrotron radiation and neutrons to investigate the mechanism of magnetic anisotropy required for high-performance magnetic materials, elucidate the coercive force mechanism, and even elucidate the problems in the manufacturing process, we are studying to contribute to the development of high-performance magnetic materials substituting critical elements. [1]
In the talk, we introduce current status of research and research results on the following themes.

1. Coercive force analysis of neodymium magnets by high-resolution magnetic imaging using X-ray microscope [2-5]
2. Elucidation of rare earth site selectivity of Dy-substituted neodymium magnets by neutron diffraction [6]
3. Bulk structure / magnetic structure analysis and coercive force mechanism using small-angle neutron scattering [7-10]

Bibliography

[1] K. Ono; まてりあ, **56**, 199 (2017)
[2] K. Ono et al.; IEEE Trans. Magn. **47**, 2672 (2011).
[3] H. Ohtori et al.; J. Appl. Phys. **115**, 17A717 (2014).
[4] H. Ohtori et al.; J. Appl. Phys. **117**, 17B312 (2015).
[5] T. Ueno et al.; AIP Advances **7**, 056804 (2016).
[6] K. Saito et al.; J. Alloys. Compounds **721**, 476 (2017).
[7] M. Yano et al.; J. Appl. Phys. **115**, 17A730 (2014).
[8] T. Ueno et al.; IEEE Trans. Magn. **50**, 2103104 (2014).
[9] K. Saito et al.; J. Appl. Phys. **117**, 17B302 (2015).
[10] T. Ueno et al.; Scientific Reports **6**, 28167 (2016)