Poster | Material, processing, and characterization

Tue. Jul 29, 2025 4:35 PM - 6:00 PM JST | Tue. Jul 29, 2025 7:35 AM - 9:00 AM UTC Blue zone, Conference rooms 101 and 102(1F)

[P2] Sm-based Magnets & Nitrides

Session Chair: Mr. Johann Fischbacher (University for Continuing Education Krems, Austria), Dr. Yusuke Hirayama (AIST, Japan)

[P2-56] Rapid Preparation of $Sm_2Fe_{17}N_3$ Fine Powder by Cryo-milling

*Qiang Gao[1], Dong Liang[1], Hui-Dong Qian[1], Tao Zhu[1], Jingzhi Han[1,2], Changsheng Wang[1,2], Wenyun Yang[1,2], Jinbo Yang[1,2,3,4] (1. Institute of Condensed Matter and Material Physics, School of Physics, Peking University (China), 2. Beijing Key Laboratory for Magnetoelectric Materials and Devices (China), 3. State Key Laboratory for Mesoscopic Physics and School of Physics, Peking University (China), 4. Peking University Yangtze Delta Institute of Optoelectronics (China))

Keywords：Sm2Fe17N3、cryo-milling、coercivity

Samarium iron nitride ($Sm_2Fe_{17}N_3$) permanent magnetic materials possess excellent intrinsic magnetic properties, including a saturation magnetization of 1.54 T [1]. To reach the full potential, the key is to increase the coercivity of the powder. Since the coercivity mechanism of $Sm_2Fe_{17}N_3$ is nucleation-controlled, reducing the grain size through grinding is a necessary step in preparing highperformance powders for $Sm_2Fe_{17}N_3$ magnets [2-4].

In this study, by using the equipment named Freezer/Mill, the $Sm_2Fe_{17}N_3$ coarse powder was ground by cryo-milling method at liquid nitrogen temperature. After 1 minute of grinding, the coercivity of the $Sm_2Fe_{17}N_3$ powder went up from 1.5 kOe to 7.0 kOe, while after 4 minutes, the coercivity reached 13.4 kOe. However, as the grinding time increased further, the coercivity began to decrease. X-ray diffraction (XRD) results indicated that no α-Fe phase was generated during the grinding process, and the $Sm_2Fe_{17}N_3$ diffraction peaks broadened continuously with increasing grinding time, showing that the liquid nitrogen conditions inhibit oxidation and thermal decomposition during the milling process of $Sm_2Fe_{17}N_3$, and as the grinding time increases, the grain size of the $Sm_2Fe_{17}N_3$ powder continuously decreases.

Meanwhile, scanning electron microscope (SEM) results showed that the sample ground for 4 minutes by cryo-milling had a similar particle size to that of the sample ground for 120 minutes by

conventional ball milling. This indicates that the material becomes more brittle at low temperatures,
making it easier to break. Compared to jet milling and ball milling methods, cryo-milling does not
require the use of conventional solvents, is more efficient, and effectively avoids heat and oxidation
issues during the grinding process. The cryo-milling method thus provides a promising approach to
fabricate high-performance $Sm_2Fe_{17}N_3$ powder.

References

[1] Coey, J. M. D., et al. (2019). Journal of Magnetism and Magnetic Materials 480: 186-192.
[2] Liang, D., et al. (2023). AIP Advances 13(2): 025104.
[3] Ye, L., et al. (2024). Journal of Materials Research and Technology 30: 451-460.
[4] Fang, Q., et al. (2016). Journal of Magnetism and Magnetic Materials 410: 116-122.