KYUSHU UNIVERSITY

Public Relations Office, Kyushu University
744 Motooka Nishi-ku Fukuoka, 819-0395
TEL: +81-92-802-2443 FAX: +81-92-802-2139
E-MAIL: koho@jimu.kyushu-u.ac.jp
URL: https://www.kyushu-u.ac.jp

PRESS RELEASE (2025/10/10)

A new method to build more energy efficient information devices for a sustainable data future

Kyushu University researchers succeed in developing a method to build memory devices that can provide high-speed, low-power information rewriting at room temperature

Fukuoka, Japan—Publishing in *npj Spintronics*, a research team led by Kyushu University have developed a new fabrication method for energy-efficient magnetic random-access memory (MRAM) using a new material called thulium iron garnet (TmIG) that has been attracting global attention for its ability to enable high-speed, low-power information rewriting at room temperature. The team hopes their findings will lead to significant improvements in the speed and power efficiency of high-computing hardware, such as those used to power generative AI.

The rapid spread of generative AI has made the power demand from data centers a global issue, creating an urgent need to improve the energy efficiency of the hardware that runs the technology.

"Spin-orbit torque, or SOT, is an important technology that can potentially help with this problem. It is a method of memory storage that uses electricity, as opposed to magnets, to control the orientation of microscopic magnets on a thin film of material in a device, allowing us to produce faster MRAM," explains Associate Professor Naoto Yamashita of Kyushu University's Faculty of Information Science and Electrical Engineering, the corresponding author of the study. "A promising SOT material is thulium iron garnet (TmIG). It was originally developed in Japan in 2012 and can produce SOT when a film of platinum is placed on it and a current is applied. It is quite a groundbreaking material."

However, TmIG requires a high-quality thin film to be a viable memory device. Previous methods of coating have shown to be costly and technically difficult. In their new findings Yamashita and his team succeeded in producing these films using an established mass production method called 'on-axis sputtering.' In this process, atoms are 'knocked-out' of the film material and then deposited on the substrate layer by layer.

"We utilized this method to deposit a very thin three nanometer layer of platinum on the TmIG. Follow up tests showed that we could alter its memory data (magnetic orientation) by simply passing a small current through it," continues Yamashita. "The data writing efficiency was 0.7×10^{11} A/m^2 and is comparable to films fabricated using conventional methods."

The team's new findings mark an important step in bridging the gap between basic and applied research on high-performance memory technology.

"We are already developing functional devices that take advantage of our new findings," concludes Yamashita. "We hope to leverage our work to build a more sustainable information society."

###

For more information about this research, see "Deterministic spin-orbit torque switching of

epitaxial ferrimagnetic insulator with perpendicular magnetic anisotropy fabricated by on-axis magnetron sputtering," Roselle Ngaloy, Naoto Yamashita, Bing Zhao, Soojung Kim, Kohei Yamashita, Ivo P. C. Cools, Marlis N. Agusutrisno, Soobeom Lee, Yuichiro Kurokawa, Chun-Yeol You, Hiromi Yuasa, Saroj P. Dash *npj Spintronics*, https://doi.org/10.1038/s44306-025-00105-z

About Kyushu University

Founded in 1911, Kyushu University is one of Japan's leading research-oriented institutes of higher education, consistently ranking as one of the top ten Japanese universities in the Times Higher Education World University Rankings and the QS World Rankings. The university is one of the seven national universities in Japan, located in Fukuoka, on the island of Kyushu—the most southwestern of Japan's four main islands with a population and land size slightly larger than Belgium. Kyushu U's multiple campuses—home to around 19,000 students and 8000 faculty and staff—are located around Fukuoka City, a coastal metropolis that is frequently ranked among the world's most livable cities and historically known as Japan's gateway to Asia. Through its VISION 2030, Kyushu U will "drive social change with integrative knowledge." By fusing the spectrum of knowledge, from the humanities and arts to engineering and medical sciences, Kyushu U will strengthen its research in the key areas of decarbonization, medicine and health, and environment and food, to tackle society's most pressing issues.

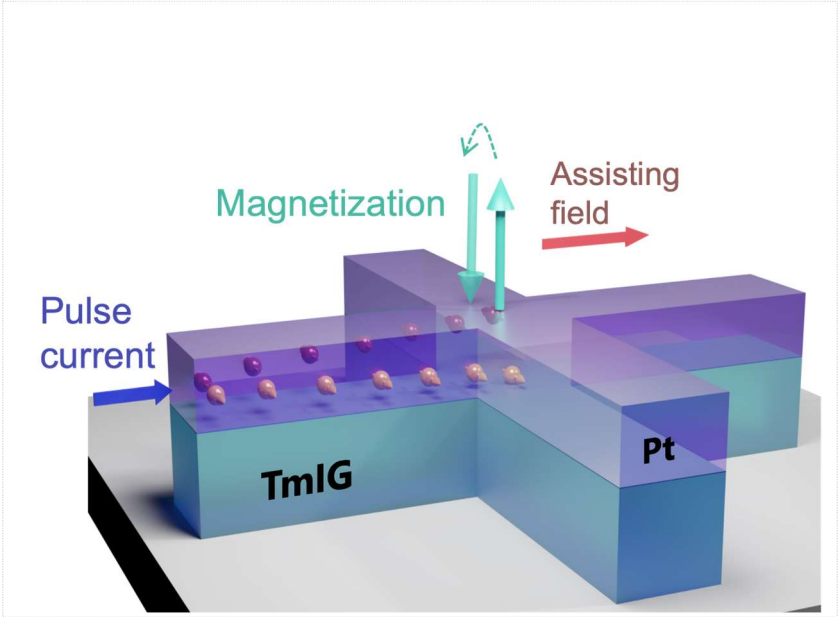

Fig. 1. Illustration of magnetization reversal by a current. A diagram of the material developed using on-axis magnetron sputtering. By applying a current through the platinum material on top of the TmIG, researchers were able to reverse the magnetization insulator validating its use as a magnetic random-access memory material. (Kyushu University/Naoto Yamashita)

[Contact]
Naoto Yamashita, Associate Professor
Faculty of Information Science and Electrical Engineering Department of I&E Visionaries
Tel: +81 92-802-3764
E-mail: yamashita.naoto.952@m.kyushu-u.ac.jp