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 (2026/01/20)

Toward energy-efficient information technology with magnetic skyrmions

Researchers from Japan explore a new strategy for harnessing nanoscale magnetic spins to overcome the limits of conventional electronics

Fukuoka, Japan—Researchers at Kyushu University have recently shown that careful engineering of materials interfaces can unlock new applications for nanoscale magnetic spins, overcoming the limits of conventional electronics. Their findings, published in *APL Materials*, open up a promising path for tackling a key challenge in the field and ushering in a new era of next-generation information devices.

The study centers around magnetic skyrmions—swirling, nanoscale magnetic structures that behave like particles. Skyrmions possess three key features that make them useful as data carriers in information devices: nanoscale size for high capacity, compatibility with high-speed operations in the GHz range, and the ability to be moved around with very low electrical currents. A skyrmion-based device could, in theory, surpass modern electronics in applications such as large-scale AI computing, Internet of Things (IoT), and other big data applications.

Despite their potential, however, skyrmions research faces a "trilemma"—a three-way trade-off between size, speed, and power. Put simply, shrinking a skyrmion to increase storage capacity slows it down. To speed it up, however, a stronger electric current has to be applied, which cancels out the benefits of low-power consumption. Solving this trilemma requires finding a way to move smaller skyrmions faster without using more energy.

In the present study, a team of researchers led by Professor Hiromi Yuasa and PhD student Lin Zhang, in collaboration with Assistant Professor Yuichiro Kurokawa, from Kyushu University's Faculty of Information Science and Electrical Engineering, and Assistant Professor Yuto Tomita, Professor Yasukazu Murakami from Kyushu University's Faculty of Engineering, explored whether the insertion of an extremely thin interlayer in a platinum/cobalt/nickel (Pt/Co/Ni) stack, a reference system, could help overcoming the three-way trade-off.

"In our field, the rare earth element gadolinium (Gd) is well known for its unique characteristics. Because Gd and Co have spins oriented in opposite directions, GdCo shows perpendicular magnetic anisotropy," notes Yuasa. "We found that these properties are useful for enhancing spin–orbit torque."

To this end, the researchers added a 0.3 nm thick layer Gd—roughly the size of a few atoms—between the platinum and cobalt layers, creating a Pt/Gd/Co/Ni multilayered structure. They then employed advanced transmission electron microscopy to directly observe magnetic skyrmions in both materials and compared the spin–orbit torque (SOT) required for high-speed motion in each. SOT, which drives the movement of the skyrmions, is produced by applying an electrical current to the heavy metal layer; a material with higher SOT efficiency achieves faster skyrmion motion under the same applied current.

A key finding was that adding the Gd interlayer altered the balance between the different types of magnetic skyrmions while maintaining their stability. This suggests that it should be possible, with careful interface design, to create materials with tailored properties for skyrmion-based technology.

"Our results demonstrate both the stability of these nanoscale magnetic structures and the possibility of fast, low-current operation enabled by high spin–orbit torque," highlights Yuasa. "This could help us overcome the conventional limitations in magnetic skyrmion applications, and greatly expand their potential uses in new information devices."

Explosive global data growth from AI and IoT demands energy-efficient processing for sustainability. This study offers a promising materials-based route toward next-generation devices with drastically reduced power consumption.

"We are only witnessing the beginning of full-scale research and development in this field," remarks Yuasa. "We will continue to develop advanced materials so that magnetic skyrmions could effectively bolster an 'information society,'" she concludes.

###

For more information about this research, see "Direct observation of skyrmions by Lorentz TEM and evaluation of SOT efficiency in Pt/Gd/Co/Ni laminated systems," Lin Zhang, Kazuhiko Tokunaga, Yuichiro Kurokawa, Takehiro Tamaoka, Yuto Tomita, Yasukazu Murakami, and Hiromi Yuasa, *APL Materials*, https://doi.org/10.1063/5.0294523

About Kyushu University
Founded in 1911, Kyushu University is one of Japan's leading research-oriented institutions 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. Located in Fukuoka, on the island of Kyushu—the most southwestern of Japan's four main islands—Kyushu U sits in a coastal metropolis frequently ranked among the world's most livable cities and historically known as Japan's gateway to Asia. Its multiple campuses are home to around 19,000 students and 8,000 faculty and staff. 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.

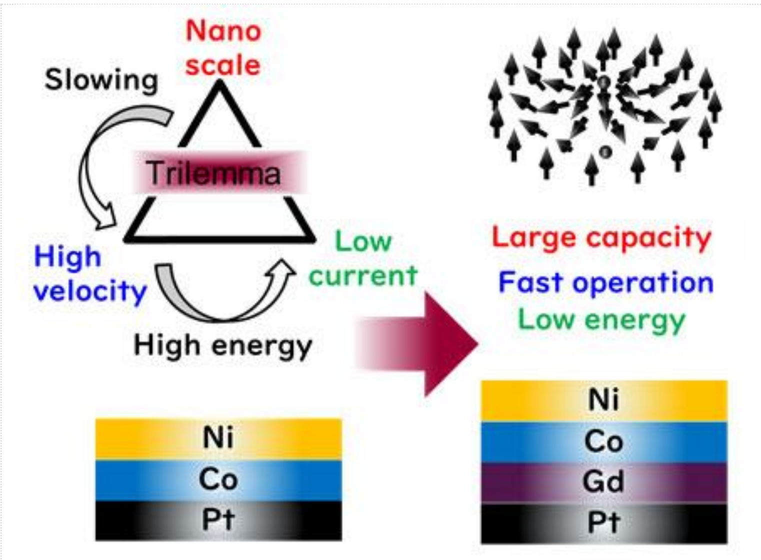

Fig. 1. Toward energy-efficient information technology with magnetic skyrmions
Researchers from Kyushu University added an atomic-scale gadolinium layer (0.3 nm) to a Pt/Co/Ni structure. The rare earth interlayer altered the balance of skyrmion types while preserving stability, demonstrating that careful interface design can tailor material properties for skyrmion-based devices.

[Contact]
Hiromi Yuasa, Professor
Faculty of Information Science and Electrical Engineering
Tel: +81 92 802 3706
E-mail: hiromi.yuasa@ed.kyushu-u.ac.jp