Associate Professor S. Mizukami and Professor T. Miyazaki -- Observation of ultrafast electron spin precession in magnetic alloys --

- Contributions to the development of materials for gigabits Magnetoresisitive Random Access Memory-

A research group led by Associate Professor Shigemi Mizukami and Professor Terunobu Miyazaki at WPI Advanced Institute for Materials Research, Tohoku University, through a collaborative research with a research group led by Professor Akimasa Sakuma and Professor Yasuo Ando, has developed a thin-film material with a large perpendicular magnetic anisotropy and a low magnetic friction. This achievement is a significant step toward the development of materials for gigabit Magnetoresistive Random Access Memory (MRAM).

In a MRAM, known to be a nonvolatile RAM, tunnel Magneto-Resistance elements are used as memory elements. Since the element size of a gigabit MRAM is several tens of nanometers, perpendicular magnetized films with a high magnetic anisotropy are utilized to reduce the thermal spin fluctuations. Using these films, however, a magnetic friction tends to be larger during the fast spin switching (reversal), and the electric power required for recording of information become larger. Therefore, it has been expected to explore for the magnetic material with a large magnetic anisotropy and a low magnetic friction, and to reveal its physical mechanism.

The present study has focused on a film of manganese gallium alloys with a large magnetic anisotropy, combined manganese and gallium, which are the non-magnetic elements. Using an ultrashort pulsed-laser, the research group has successfully observed the spin oscillation at a maximum of approximately 280 gigahertz in real-time, and has proved its low magnetic friction. This result has been supported by theoretical calculations. From experimental and theoretical aspects, this study has demonstrated that manganese gallium alloys, which are rare earth-free and noble metal-free, have both of the large magnetic anisotropy and low magnetic friction, and they can be Green Materials for gigabits MRAM.

This study has been conducted in collaboration with University of Göttingen. The research result was published in Physical Review Letters on March 18, 2011. The paper’s title is "Long-lived Ultrafast Spin Precession in Manganese Alloys Films with a Large Perpendicular Magnetic Anisotropy".

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