Division of Materials Chemistry
– Nanospintronics –

http://www.scl.kyoto-u.ac.jp/~ono/onolab/public_html/english/index_e.html

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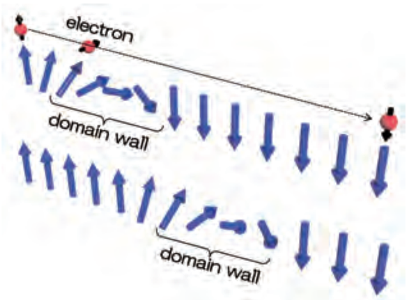
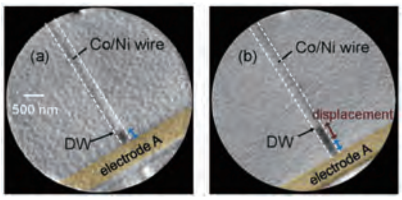
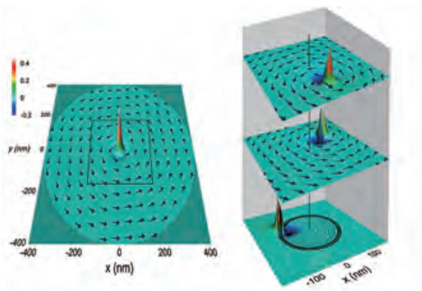
Scope of Research

KEYWORDS
Spintronics
Quantum Transport
Nano-fabrication
Artificial Materials

The conventional electronics utilizes only the “charge” of electrons, while the traditional magnetic devices use only “spin” degree of freedom of electrons. Aiming at the complete control of both charge and spin in single solid-state devices, an emerging field called *spintronics* is rapidly developing and impacting on information technologies. By combining the atomic-layer deposition with nanofabrication, we focus on the development of spin properties of various materials and the control of quantum effects in mesoscopic systems for novel spintronics devices.







Selected Publications

Delmo, M. P.; Yamamoto, S.; Kasai, S.; Ono, T.; Kobayashi, K., Large Positive Magnetoresistive Effect in Silicon Induced by the Space-Charge Effect, *Nature*, **457,** 1112-1115 (2009).

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Chiba, D.; Fukami, S.; Shimamura, K.; Ishiwata, N.; Kobayashi, K.; Ono, T., Electrical Control of the Ferromagnetic Phase Transition in Cobalt at Room Temperature, *Nature Materials*, **10,** 853-856 (2011).

Tanabe, K.; Chiba, D.; Ohe, J.; Kasai, S.; Kohno, H.; Barnes, S. E.; Maekawa, S.; Kobayashi, K.; Ono, T., Spin-motive Force Due to a Gyrating Magnetic Vortex, *Nature Communications*, **3,** 845 (2012).

Koyama, T.; Ueda, K.; Kim, K.-J.; Yoshimura, Y.; Chiba, D.; Yamada, K.; Jamet, J.-P.; Mougin, A.; Thiaville, A.; Mizukami, S.; Fukami, S.; Ishiwata, N.; Nakatani, Y.; Kohno, H.; Kobayashi, K.; Ono, T., Current-induced Magnetic Domain Wall Motion Below Intrinsic Threshold Triggered by Walker Breakdown, *Nature Nanotechnology*, **7,** 635 (2012).

Kim, K.-J.; Hiramatsu, R.; Koyama, T.; Ueda, K.; Yoshimura, Y.; Chiba, D.; Kobayashi, K.; Nakatani, Y.; Fukami, S.; Yamanouchi, M.; Ohno, H.; Kohno, H.; Tatara, G.,; Ono, T., Two-barrier Stability that Allows Low-power Operation in Current-induced Domain-wall Motion, *Nature Communications*, **4,** 2011 (2013).

Two-barrier Stability that Allows Low Power Operation in Current-induced Domain Wall Motion

Energy barriers appear in diverse systems and its determination has long been a debatable issue because it determines the thermal stability of devices as well as the threshold force triggering their dynamics. In general, there is a severe dilemma between the thermal stability of bit data and the operation power of devices, because larger energy barrier for higher thermal stability inevitably leads to larger magnetic field (or current) for operation. Here we show that this is not the case for the current-induced magnetic domain wall motion induced by the adiabatic spin transfer torque. By quantifying domain wall depinning energy barriers by magnetic field and current, we have found that there exist two different pinning barriers, extrinsic and intrinsic energy barriers, which govern the thermal stability and threshold current, respectively. This unique two-barrier system allows the low power operation with high thermal stability, which is impossible in conventional single-barrier systems.

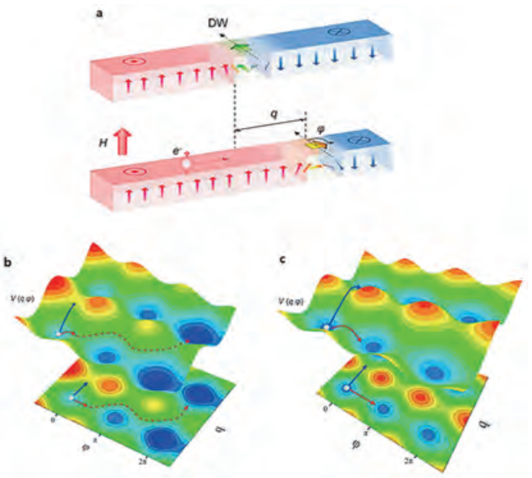

Figure 1. Schematic illustration of DW motion and energy landscape. (a) A magnetic DW in a nanowire and its collective coordinates, the position q and the tilting angle φ. (b,c) Energy landscape for the DW motion in the presence (b) and absence (c) of d.c. current.

Spin-motive Force Due to a Gyrating Magnetic Vortex

A change of magnetic flux through a circuit induces an electromotive force. By analogy, a recently predicted force that results from the motion of non-uniform spin structures has been termed the spin-motive force. Although recent experiments seem to confirm its presence, a direct signature of the spin-motive force has remained elusive. We report the observation of a real-time spin-motive force produced by the gyration of a magnetic vortex core (Figure 2). We find a good agreement between the experimental results, theory and micromagnetic simulations, which taken as a whole provide strong evidence in favour of a spin-motive force.

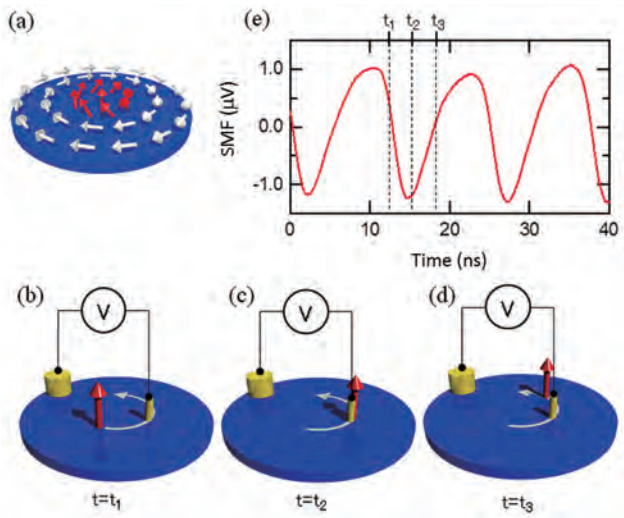

Figure 2. (a) A vortex state in a micron-size magnetic disk. (b)-(d) Illustrations of the time domain measurements in a gyrating vortex core at a time t. The vortex core is indicated by the red arrow. (e) Experimentally observed spin motive force (SMF) as a function of time.