Highly-efficient voltage control of magnetic anisotropy

Development of a fundamental technology for voltage-driven spintronic devices

We have developed a highly-efficient voltage control of magnetic anisotropy in an ultrathin 3*d* transition ferromagnetic metal layer. In spintronics, current-induced magnetic field or spin-polarized current have been used to manipulate the magnetization. However, these current-based manipulations have a fundamental problem of Ohmic dissipation, which causes the high power consumption of devices. Voltage control of magnetic anisotropy in an ultrathin ferromagnetic metal layer is currently of high interest as the ultimate technology for the ultralow-power spin manipulation. In this study, three times larger effect of magnetic anisotropy energy change was achieved in a newly developed MgO double barrier structure compared with a conventional single barrier structure. Our findings will lead to the realization of voltage-driven spintronic devices with ultralow stand-by and operating power.

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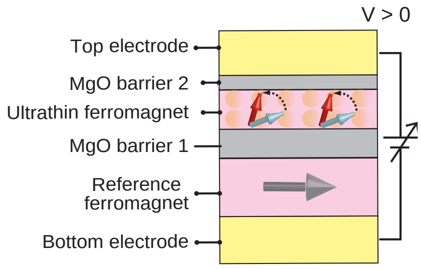
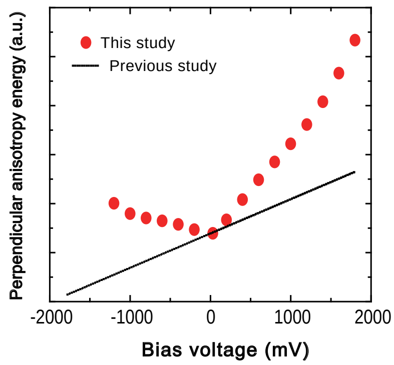


Schematic of the voltage-driven spintronic device with double barrier structure
Arrows represent magnetization directions.



Experimetal results of the voltage-induced perpendicular magnetic anisotropy change

Information Technology and Electronics

Simulation technology for microdroplet shapes on substrates

Rapid, precise, and easy simulation of microdroplet shapes on hydrophilic/hydrophobic patterned surfaces

We have developed efficient software, named "HyDro," for simulating equilibrium shapes of microdroplets placed on flat substrates that have fine, discontinuous, and arbitrarily shaped hydrophilic/hydrophobic patterned surfaces. HyDro uses a hybrid energy-minimization technique that combines a direct search method to determine the droplet shape around solid/liquid contact lines with a gradient descent method for the other parts of the droplet surface. The software provides high-convergence at a low computational cost with sufficient mesh resolution. We demonstrated that the simulation using HyDro can accurately reproduce observed equilibrium microdroplet shapes on hydrophilic/hydrophobic patterned surfaces deposited by an inkjet printing technique. HyDro provides a useful tool for the optimal design of printed electronic devices. It is also possible to evaluate the surface-energy distribution within the hydrophilic region based on the comparison between observation and simulation. The program can be executed on a commercial personal computer, and is now available for free via a web page.

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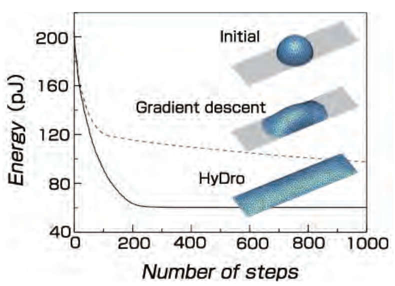
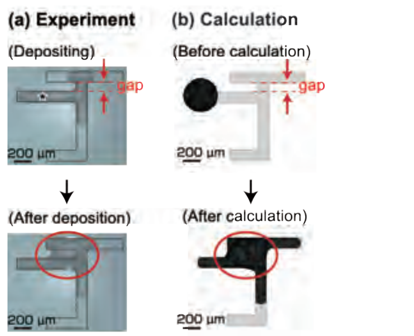


Solution convergence of HyDro and a conventional method for simulating the microdroplet shape placed on a hydrophilic/hydrophobic patterned surface



Observed microdroplet on a wiring pattern deposited by an inkjet printing technique (left) and a simulated result (right)