Fast Magnetic Domain-Wall Motion in a Ring-Shaped Nanowire Driven by a Voltage

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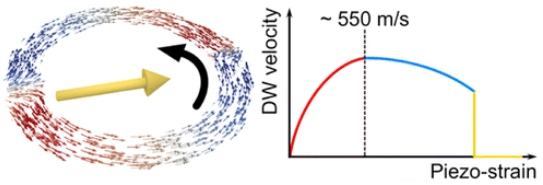

Magnetic domain-wall motion driven by a voltage dissipates much less heat than by a current, but none of the existing reports have achieved speeds exceeding 100 m/s. Here phase-field and finite-element simulations were combined to study the dynamics of strain-mediated voltage-driven magnetic domain-wall motion in curved nanowires. Using a ring-shaped, rough-edged magnetic nanowire on top of a piezoelectric disk, we demonstrate a fast voltage-driven magnetic domain-wall motion with average velocity up to 550 m/s, which is comparable to current-driven wall velocity. An analytical theory is derived to describe the strain dependence of average magnetic domain-wall velocity. Moreover, one 180° domain-wall cycle around the ring dissipates an ultrasmall amount of heat, as small as 0.2 fJ, approximately 3 orders of magnitude smaller than those in current-driven cases. These findings suggest a new route toward developing high-speed, low-power-dissipation domain-wall spintronics.