Investigation on the current induced domain-wall motion in Pt/GdFe wires for thinner GdFe region

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Electric-current-induced movements of domain walls in magnetic wires are paid attention because of the curiosity from their potential as new spintronics devices, such as racetrack memories. It is possible to achieve speed-up and low power consumption for these memories with increase of the domain-wall velocity. Recently, a domain-wall velocity greater than 1000 m/s was observed for perpendicularly magnetized ferrimagnetic GdFe wires [1]. In this study, we investigated the dependence of the domain-wall velocity on the GdFe thickness for a thinner region in order to realize high velocity of the domain wall movement.

Pt (3 nm)/GdFe (t) wires with 10 μm in width were fabricated on thermally oxidized Si substrates with SiN (3 nm) buffer layers using electron-beam lithography, sputtering, and a lift-off method. Wires with GdFe thicknesses t of 8, 10, 15, and 20 nm were prepared. Note that the Gd compositions are set to 29% for the wire with t = 8 nm and 26% for the wire with t = 10, 15, and 20 nm because the optimum Gd compositions for stabilizing the perpendicular magnetic anisotropy vary depending on the film thickness. The coercive forces of the wires with t = 8, 10, and 15 nm were almost the same. The velocities of the domain walls were measured by Kerr microscopy with applying periodic current pulses.

Figure 1 shows the current-dependence of domain-wall velocity for these wires. The domain-wall velocity increases with an increase in the current, and the increase rate increases with a decrease in the GdFe film thickness. For wires with t = 10, 15, and 20 nm, the rate of increase as a function of the current slows down, and the velocity does not increase above 1500 m/s. In contrast, for the wire with t = 8 nm, the velocity increased smoothly with increasing current, and a high velocity of more than 5000 m/s was observed. These findings demonstrate that ultrathin GdFe films with the thicknesses below 10 nm enable high-speed domain-wall movement.

[1] S. Ranjbar *et al*., Adv. Mater. **3**, 7028 (2022).

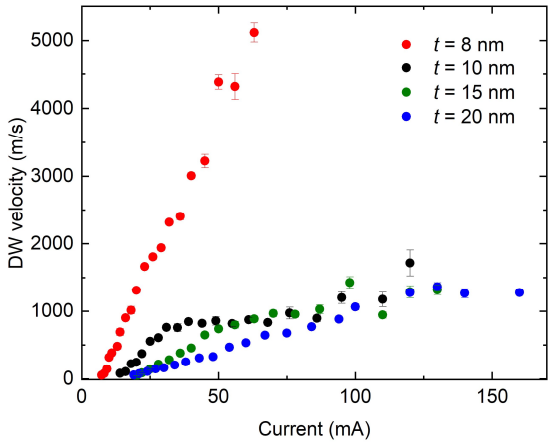

Fig.1 Current- and GdFe-thickness-dependence of domain-wall velocity.