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Domain wall based spin-Hall nano-oscillators

Magnons are the fundamental excitations in magnetic materials, and they can transport angular momentum without actual charge currents. Therefore, they are attractive for applications in energy efficient information technology, offering high operating frequencies up to the THz range. Here we present a novel scheme for magnon generation using spin currents and domain walls.
When a charge current is applied to a bilayer consisting of a heavy metal and a ferromagnetic metal, the spin currents originating from the spin Hall effect in the heavy metal apply a spin transfer torque on the magnetization of the ferromagnetic layer. This allows driving efficiently auto-oscillations of magnetization [1]. We focused on domain walls as local nano magnon channels [2]. Since it is possible to move domain walls by electrical currents [3], domain walls are attractive for nano-sized reprogrammable circuits.
A 370 nm wide boomerang structure was fabricated from a Pt/CoFeB bilayer. The sample was magnetized by applying a large external magnetic field. After the saturation, the external magnetic field was set to 0 Oe, and a domain wall was introduced at the apex of the boomerang structure. The magnon intensity at the apex was measured by Brillouin light scattering microscopy [4] with applying a dc current. The magnons were detected for the positive dc current, while there was no magnon for the negative dc current. This current direction dependency indicates the spin transfer torque drives magnons. We succeeded to excite magnons in the domain wall due to the auto-oscillation of the magnetization by spin transfer torque.

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