Excitation and control of propagating spin waves by pure spin current.

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Recently it was demonstrated that pure spin currents can be utilized to excite coherent magnetization dynamics [1], which enables development of novel magnetic nano-oscillators. Such oscillators do not require electric current flow through the active magnetic layer, which can help to reduce the Joule power dissipation and electromigration. In addition, this allows one to use insulating magnetic materials and provides an unprecedented geometric flexibility.

The pure spin currents can be produced by using the spin-Hall effect (SHE). However, SHE devices have a number of shortcomings. In particular, efficient spin Hall materials exhibit a high resistivity, resulting in the shunting of the driving current through the active magnetic layer and a significant Joule heating. These shortcomings can be eliminated in devices that utilize spin current generated by the nonlocal spin-injection (NLSI) mechanism. Here we review our recent studies of excitation of magnetization dynamics and propagating spin waves by using NLSI [2,3,4]. We show that NLSI devices exhibit highly-coherent dynamics resulting in the oscillation linewidth of a few MHz at room temperature. Thanks to the geometrical flexibility of the NLSI oscillators, one can utilize dipolar fields in magnetic nano-patterns to convert current-induced localized oscillations into propagating spin waves. The demonstrated systems exhibit efficient and controllable excitation and directional propagation of coherent spin waves characterized by a large decay length [5].

The obtained results open new perspectives for the future-generation electronics using electron spin degree of freedom for transmission and processing of information on the nanoscale.

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