Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Fast reversal of magnetic vortex chirality by electric current[1]
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We demonstrate reversal of magnetic vortex in a microscopic Pt/Permalloy bilayer disk by a nonuniform electric current in the plane of the disk. The switching is detected electronically by measuring the response to a small ac magnetic field, and confirmed by direct imaging with x-ray magnetic dichroism microscopy (XMCD). The magnetic contrasts obtained from time-resolved x-ray imaging indicate a fast and robust switching of magnetic vortex driven by electric current. The time-resolved XMCD measurements show that the characteristic switching time is less than 3 ns. Analysis from micromagnetic simulation shows that the reversal of the magnetic vortex is driven by a combination of the Oersted field due to the charge current and the spin transfer due to spin current generated by the spin Hall effect in Pt. The simulation reveals that the magnetization switching process of the magnetic vortex involves two distinct stages. The switching first proceeds with a fast dynamics and then evolves at a slower dynamics before reaching the final magnetic vortex state with opposite chirality, in agreement with the experimental result. The simulation also shows that the spin transfer torque (STT) accelerates the reversal of magnetic vortex in comparison to the case without STT.

[1]Funded by National Science Foundation (Grant no. ECCS-1305586).

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Date submitted: 14 Nov 2013 Electronic form version 1.4