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Thermal spin transfer torque driven by ultrafast heat current in metallic spin-valve structures GYUNG-MIN CHOI, University of Illinois, BYOUNG-CHUL MIN, Korea Institute of Science and Technology, KYUNG-JIN LEE, Korea University, DAVID CAHILL, University of Illinois — Spin transfer torque (STT), coupling of the angular momentum of the spin of electrons and the magnetization of a ferromagnet, enables the manipulation of nanomagnets with spin currents rather than magnetic fields. STT has been most often realized by passing electrical currents through magnetic layers. Generation of STT by passing a heat current through magnetic layers has been theoretically predicted. This so-called "thermal STT" relies on the transport of thermal energy, as opposed to the transport of electrical charge, and provides new functionality for device applications. Here, we provide direct evidence of thermal STT generated by ps time-scale heat currents on the order of 100 GW m^{-2}. In metallic spin valve structures, the physical mechanism for thermal STT is the spin-dependent Seebeck effect (SDSE). We create ultrafast heat currents using ps duration pulses of laser light in the NM1/FM1/NM2/FM2 structure: FM1 acts as a spin generation layer by SDSE and FM2 acts as a spin detection layer by STT; NM1 acts as a heat absorbing layer and NM2 acts as a heat sink layer. The magnetization dynamics of FM2 are probed by time-resolved magneto-optic Kerr effect with a time resolution of 1 ps. By incorporating different ferromagnetic layers, which have different signs for SDSE, and varying the thickness of the heat sink layer, we are able to control the sign and magnitude of thermal spin torque.

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