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Spin Hall Control of Magnetization in a Perpendicularly-Magnetized Magnetic Insulator CHI-FENG PAI, ANDY QUINDEAU, ASTERA TANG, MEHMET ONBASLI, MAXWELL MANN, LUCAS CARETTA, CAROLINE ROSS, GEOFFREY BEACH, Massachusetts Institute of Technology — Spin Hall effect (SHE)-induced spin-orbit torque (SOT) has been shown to be an efficient mechanism to control the magnetization in magnetic heterostructures. Although numerous works have demonstrated the efficacy of SOT in manipulating the magnetization of ferromagnetic metals (FM), SOT-controlled switching of ferromagnetic insulators (FMIs) has not yet been observed. In this work we show that spin Hall currents in Pt and Ta can generate SOTs strong enough to control the magnetization direction in an adjacent thulium iron garnet FMI film with perpendicular magnetic anisotropy. We find that dc current in the heavy metal (HM) generates an out-of-plane effective field in the FMI consistent with an antidamping torque whose magnitude is comparable to that observed in all-metallic systems. Spin Hall magnetoresistance (SMR) measurements reveal a large spin-mixing conductance, which implies considerable spin transparency at the metal/insulator interface and explains the observed strong current-induced torque. Our results show that charge currents flowing in a HM can be used to both control and detect the magnetization direction in a FMI electrically.

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