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The spin Hall effect and spin-orbit torques in SH-metal/normal metal/ferromagnetic trilayers MINH-HAI NGUYEN, CHI-FENG PAI, DANIEL C. RALPH, ROBERT A. BUHRMAN, Cornell Univ — The spin Hall effect (SHE) in ferromagnet/transition metal bilayer structures has been demonstrated to be a powerful means for producing pure spin currents and for exerting spin-orbit damping-like and field-like torques on the ferromagnetic layer. Large spin Hall angles have been reported for Pt, β-Ta and β-W films and have been utilized to achieve magnetic switching of in-plane and out-of-plane magnetized nanomagnets, spin torque auto-oscillators, and the control of high velocity domain wall motion. In general the spin orbit torques and the effective damping are predicted to depend directly on the spin-mixing conductance of the SHE/ferromagnet interface. This opens up the possibility of tuning these properties with the insertion of a very thin layer of another metal between the SH metal and the ferromagnet. Here we will report on experiments with such trilayer structures where we have studied the variation of the effective spin Hall angle and the effective damping constant with the choice and thickness of the insertion layer. Our results indicate that there is considerable opportunity to optimize the effectiveness and energy efficiency of the damping-like torque through engineering of such trilayer structures.

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