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Magnetization dynamics enabling reliable nanosecond-timescale switching through the spin Hall effect SRIHARSHA ARADHYA, GRAHAM ROWLANDS, SHENGJIE SHI, ERIN YANDEL, Cornell University, DANIEL RALPH, Cornell University and Kavli Institute at Cornell for Nanoscale Science, ROBERT BUHRMAN, Cornell University — We have recently reported that spin Hall torque can drive magnetic switching that is simultaneously fast and reliable ($<10^{-5}$ write error rates with 2 ns pulses) in 3-terminal magnetic tunnel junctions (3T-MTJs) with in-plane magnetization [1]. This is in contrast to switching of in-plane 2-terminal MTJs by conventional spin transfer torque (STT), where there are 10's of ns latency times. Here we present a comprehensive elucidation of the switching dynamics in 3T-MTJs obtained through fast-pulse measurements in a variety of material stacks and detailed micromagnetic simulations. We demonstrate that the interaction between the self-generated Oersted field in 3T-MTJs and the micromagnetics of the free layer can lead to reliable sub-nanosecond reversal. We further show through simulations that an artificially reversed Oersted field, which corresponds to the field-like component of spin torque in 2-terminal STT-switched MTJs, leads to undesirable pre-switching dynamics that are highly reminiscent of the latency times in literature. These results establish the in-plane 3T-MTJ as an attractive memory element for applications that do not require ultra-high density, due to its high magnetoresistance read signal, low impedance write path, and fast reliable switching. [1] S. V. Aradhya et al., Nano Lett., 2016, 16 (10), 5987.

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