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Few-nanosecond pulse switching with low write error for in-plane nanomagnets using the spin-Hall effect SRIHARSHA ARADHYA, GRAHAM ROWLANDS, SHENGJIE SHI, JUNSEOK OH, D. C. RALPH, ROBERT BUHRMAN, Cornell University — Magnetic random access memory (MRAM) using spin transfer torques (STT) holds great promise for replacing existing best-in-class memory technologies in several application domains. Research on conventional two-terminal STT-MRAM thus far has revealed the existence of limitations that constrain switching reliability and speed for both in-plane and perpendicularly magnetized devices. Recently, spin torque arising from the giant spin-Hall effect in Ta, W and Pt has been shown to be an efficient mechanism to switch magnetic bits in a three-terminal geometry [1-3]. Here we report highly reliable, nanosecond timescale pulse switching of three-terminal devices with in-plane magnetized magnetic tunnel junctions. We obtain write error rates (WER) down to ˜10^{-5} using pulses as short as 2 ns, in contrast to conventional in-plane STT-MRAM devices where write speeds were limited to a few tens of nanoseconds for comparable WER. Utilizing micro-magnetic simulations, we discuss the differences from conventional MRAM that allow for this unanticipated and significant performance improvement. Finally, we highlight the path towards practical application enabled by the ability to separately optimize the read and write pathways in three-terminal devices. [1] L. Liu et al., Science, 336, 2012; [2] C-F. Pai et al., APL, 101, 2012; [3] M-H. Nguyen et al., APL, 106, 2015.

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