Colloquium

Department of Physics, Temple University

Physics and applications of spin torque magnetic random access memories

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As information technology enters new era, with Internet of Things soon expected to connect over 30 billion devices generating vast amount of data that need to be processed and stored, there is a rapidly growing demand for faster, denser and more power efficient memories that could be organized in alternative hierarchies offering better system performance and greater functionality, all at preferably lower cost. Spin torque magnetic random access memory (MRAM) is uniquely positioned to address this challenge as it is the only emerging memory technology that could combine high speed and endurance of SRAM, high density of DRAM and non-volatility of Flash [1]. In this colloquium I will describe basic physics of spin transfer torque (STT) MRAM cell operation and highlight specific physical cell requirements from the applications perspective. I will review progress in the field [2] and discuss the remaining challenges and research opportunities for continuous development of STT-MRAM technology. I will then introduce spin orbit torque (SOT), which utilizes the spin Hall effect [3] in non-magnetic materials to generate pure spin current, as an alternative mechanism to STT for writing bits in MRAM cells. I will present results of our experimental studies of direct SOT induced switching in Pt(or Ta)/CoFeB/ MgO structures, where CoFeB is patterned into a nanoscale pillar and is magnetized in plane [4]. These results encourage further development of SOT-MRAM technology as a promising candidate for low power, fast, high endurance and low-error rate applications such as cache memories.

[1] D. Apalkov et al., Proceedings of IEEE 104, 1796 (2016)
[2] S. -W. Chung et al., IEDM Proceedings 16 - 659 (2016)
[3] J. Sinova et al., Rev. Mod. Phys. 87, 1213 (2015)
[4] G. Mihajlović et al., Appl. Phys. Lett. 109, 192404 (2016)

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Refreshments served at 2:45pm