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Spin-Torque Switching with the Giant Spin Hall Effect

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Magnetic devices are a leading contender for the implementation of memory and logic technologies that are non-volatile, that can scale to high density and high speed, and that do not wear out. However, widespread application of magnetic memory and logic devices will require the development of efficient mechanisms for reorienting their magnetization using the least possible current and power. I will discuss recent progress that has resulted from using the spin Hall effect in certain heavy metals to drive efficient magnetic switching. The spin Hall effect can provide spin-transfer torques that are more than an order of magnitude stronger per unit current than conventional spin torque in magnetic tunnel junctions. These torques can switch magnetic devices with either in-plane or perpendicular anisotropy, and can also drive very rapid domain wall motion in perpendicularly-magnetized samples. I will describe our efforts to identify the materials and device geometries that can provide the strongest spin Hall effects for applications, and to understand the physical mechanisms at work. This work was performed in collaboration with the research groups of Bob Buhrman at Cornell and Nitin Samarth at Penn State.