Room temperature perpendicular magnetization switching through giant spin-orbit torque from sputtered Bi$_x$Se$_{1-x}$ film

M. DC$^1$, R. Grassi$^2$, JY Chen$^2$, M. Jamali$^2$, D. Hickey$^3$, D. Zhang$^2$, Z. Zhao$^2$, H. Li$^3$, P. Quarterman$^2$, Y. Lv$^2$, M. Li$^2$, K. Mkhoyan$^3$, T. Low$^2$, and JP Wang$^{2,1,3,*}$

$^1$School of Physics and Astronomy, University of Minnesota, MN 55455
$^2$Department of Electrical and Computer Engineering, University of Minnesota, MN 55455
$^3$Department of Chemical Engineering and Material Science, University of Minnesota, MN 55455

The spin-orbit torque (SOT) arising from materials with large spin-orbit coupling promises a path for ultra-low power and fast magnetic-based storage and computational devices. We investigated the SOT from magnetron-sputtered Bi$_x$Se$_{1-x}$ thin films in Bi$_x$Se$_{1-x}$/CoFeB heterostructures by using dc planar Hall and spin-torque ferromagnetic resonance (ST-FMR) methods. Remarkably, the spin Hall angle (SHA) was determined to be as large as $18.62 \pm 0.13$ and $8.67 \pm 1.08$ using dc planar Hall and ST-FMR methods, respectively. Moreover, switching of perpendicular CoFeB multilayer using SOT from the Bi$_x$Se$_{1-x}$ has been observed at room temperature (RT) with the lowest-ever switching current density reported in a bilayer system $4.3 \times 10^5$ A/cm$^2$. The demonstrated giant SHA, ease of growth of the films on silicon substrate, successful growth and switching of a perpendicular CoFeB multilayer on Bi$_x$Se$_{1-x}$ film opens a path for use of Bi$_x$Se$_{1-x}$ topological insulator (TI) as a spin-current generator in SOT-based memory and logic devices.

- IEEE Member Number:
- Year Expected Graduation: 2018
- Advisor Name: Jian-Ping Wang
- Advisor Institution: University of Minnesota