Interplay between Spin-Orbit Torque and Unidirectional Magnetoresistance in Modulation-Doped Topological Insulators

YABIN FAN, QIMING SHAO, LEI PAN, XIAOYU CHE, QINGLIN HE, GEN YIN, KANG L. WANG, Electrical Engineering Department, University of California, Los Angeles, DEVICE RESEARCH LABORATORY TEAM — We study the current-induced spin-orbit torque (SOT) and unidirectional magnetoresistance (UMR) in modulation-doped topological insulators (TIs). In the bilayer structures composed of TI and Cr-doped TI (Cr-TI, for short), both the SOT and UMR are very large with the values orders of magnitudes greater than those reported in traditional materials, such as the heavy metal-based magnetic structures or the doped diluted magnetic semiconductors. Furthermore, both the SOT and UMR are consistent with the current-induced spin polarization on the TI surface arising from the spin-momentum locking feature of the topological surface states. On the other hand, in the TI/Cr-TI/TI trilayer structures where the Cr-TI layer is in the middle, both the SOT and UMR values become significantly smaller. Through modulation doping and structure engineering, we reveal that the giant SOT and UMR in TI/Cr-TI bilayers originate in the topological spin-momentum locked Dirac Fermions on the TI surface, and they exhibit a strong correlation to each other.

1We acknowledge the support from the FAME center, the SHINES program and the Army Research Office (ARO).

Yabin Fan
Electrical Engineering Department, University of California, Los Angeles

Date submitted: 10 Nov 2016
Electronic form version 1.4