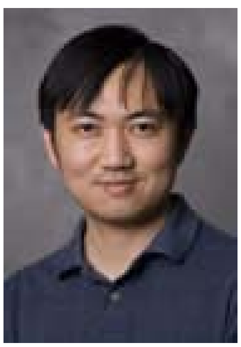
Electrically Controlled Spin Polarization in Topologically Insulators

Yong Chen, *Purdue University*

One of the most important properties of topological insulators (TI) is the helical spin-momentum locking of the topological surface states (TSS), giving rise to a current induced helical spin polarization (CISP). Various recent experiments including ours have measured a CISP in TIs and demonstrated the promise of TIs as electrically-controlled spin injectors and source of spin polarization for spintronics applications. On the other hand, CISP is not unique to TIs, and has been measured previously in other spin-orbit coupled (SOC) systems such as heavy metals with spin Hall effects (SHE) and 2D electron gases (2DEG) with Rashba SOC in InSb or InAs based semiconductor structures. Since many commonly studied TI materials often possess conducting bulk and/or band-bending-induced (topologically trivial) surface 2DEG with Rashba SOC, it is important to ask whether such channels and mechanisms (bulk SHE, surface Rashba 2DEG) may also give rise to a CISP measurable in experiments. I will discuss our spin-sensitive transport measurements (such as spin potentiometry) using ferromagnetic electrodes to detect spin polarization, where we have found different types and behaviors of CISP in various different TI materials. For example, the CISP measured in our exfoliated Bi_2Te_2Se has the spin helicity consistent with that of TSS, while in Bi_2Se_3 we have measured the opposite spin helicity that is consistent with the Rashba surface 2DEG. I will also discuss possible effects of hyperfine coupling to nuclear spins that has been revealed in NMR but largely neglected in transport measurements so far. Our studies reveal a rich variety of entities in real TI materials that may play important roles in potential applications of TIs in spintronics.



BIO: Yong P. Chen is Associate Professor of Physics and Astronomy and Associate Professor of Electrical & Computer Engineering at Purdue University. He leads an interdisciplinary research group that works on quantum matter and devices involving such systems as graphene & 2D materials, topological insulators, and cold atoms & molecules, and explores their applications in electronics, sensors, energy and quantum information. He has published over 140 papers and delivered over 100 invited talks and seminars on these topics. He was a recipient of NSF CAREER Award, DOD DTRA Young Investigator Award, IBM Faculty Award and Purdue University's Miller Family Professorship in Nanoscience and University Faculty Scholar Award. He received an MSc degree in mathematics from MIT, a PhD in Electrical Engineering from Princeton University and did a postdoc in physics and nanotechnology at Rice University.