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Molecular beam epitaxy growth and novel properties of topological insulator films of Bi2Te3 and Bi2Se3

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In this talk, we summarize our recent activity in state-of-art molecular beam epitaxy (MBE) growth and characterization of nontrivial surface states of topological insulator films of Bi2Te3 and Bi2Se3 on Si(111) and 6H-SiC(0001) substrates. We studied the growth dynamics and epitaxial relationship under different flux ratios and substrate temperatures, and identified the optimized conditions for stoichiometric and layer-by-layer MBE deposition of both Bi2Te3 and Bi2Se3 films by real time reflection high energy electron diffraction (RHEED). We demonstrate the atomically flat morphology and intrinsic topological property of the resulted films by angle resolved photoemission spectroscopy (ARPES) and scanning tunneling microscopy/spectroscopy (STM/STS). By direct imaging standing waves associated with magnetic and nonmagnetic impurities and steps on Bi2Te3 and Bi2Se3 (111) surfaces, we show that the topological states have a surface nature and are protected by the time reversal symmetry. We also studied the growth of conventional superconductor and magnetic thin films on Bi2Te3 and Bi2Se3. Implication on probing Majorana states and topological magneto-electric effect will be discussed. Work done in collaboration with Xi Chen, Jinfeng Jia, Xucun Ma, Ke He, Lili Wang, Yayu Wang, Xi Dai, Zhong Fang, Xincheng Xie, Shunqing Shen, Qian Niu, Ying Liu, Xiao-Liang Qi, and Shou-Cheng Zhang.