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Topological limit of ultrathin quasi-freestanding Bi_2Te_3 films grown on Si(111) YANG LIU, Advanced Photon Source, Argonne National Lab, HUAN-HUA WANG, GUANG BIAN, University of Illinois, Urbana-Champaign, MARK BISSEN, Synchrotron Radiation Center, ZHAN ZHANG, Advanced Photon Source, Argonne National Lab, TOM MILLER, University of Illinois, Urbana-Champaign, HAWOONG HONG, Advanced Photon Source, Argonne National Lab, TAI-CHANG CHIANG, University of Illinois, Urbana-Champaign — A fundamental issue for ultrathin topological films is the thickness limit below which the topological surface states become impacted by interfacial interactions. We show that for Bi_2Te_3 grown on Si(111) this limit is four quintuple layers (QLs) based on angle-resolved photoemission measurements, using optimized photon energies and polarizations, of the Dirac cone warping and interaction-induced gap as a function of film thickness. The results are close to theoretical predictions for free-standing films, despite the expected strong bonding of the film with the reactive Si(111) substrate. In-situ surface X-ray scattering (SXS) study shows that a buffer layer exist on the Si(111) surface, which effectively saturates all the Si(111) dangling bonds. These interfacial properties, revealed only by diffractions from deeply penetrating X-rays, are critical in understanding the topological surface states in ultrathin films, where electronic coupling is strongly enhanced. Our SXS measurement also yields new information regarding the internal structures of these topological thin films, including layer stacking, QL-by-QL growth, relaxations, etc.

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