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Experimental demonstration of the topological surface states protected by the time-reversal symmetry XI CHEN, TONG ZHANG, PENG CHENG, JIN-FENG JIA, Tsinghua University, XUCUN MA, KE HE, LILI WANG, HAIJUN ZHANG, XI DAI, ZHONG FANG, XINCHENG XIE, Institute of physics, Chinese academy of sciences, QI-KUN XUE, Tsinghua University — In this work, we use a low temperature scanning tunneling microscope (STM) to observe the standing waves formed by the nontrivial surface states of topological insulator Bi_2Te_3 . Molecular beam epitaxy was used to grow $\text{Bi}_2\text{Te}_3(111)$ film on $\text{Si}(111)$ substrate. The interference fringes are caused by the scattering of the topological states off Ag impurities and step edges on the $\text{Bi}_2\text{Te}_3(111)$ surface. By studying the voltage-dependent standing wave patterns, we determine the energy dispersion $E(k)$, which confirms the Dirac cone structure of the topological states. We show that the backscattering of the topological states by nonmagnetic impurities is completely suppressed, which is very different from the conventional surface states. The absence of backscattering is a spectacular manifestation of the time-reversal symmetry, which offers a direct proof of the topological nature of the surface states.

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