Scanning Tunneling Spectroscopy Studies of Layered Topological Materials

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Topological materials have become promising materials for next generation devices though utilizing their exotic states. Such exotic states intrinsically caused by spin-orbital coupling (SOC) usually localized on the surfaces or at the edges. Scanning tunneling spectroscopy (STS) is a powerful tool to reveal the local electronic structure for condensed matters. Therefore, STS provides us an almost perfect method to access the exotic states of topological materials. We report the current investigations by several methods based on STS technique for layered topological material from transition metal dichalcogenide (TMD) Weyl semimetals [1, 2] to two dimensional (2D) topological insulators (TI) [3-5] (including layered bismuth and silicene). The characteristics of these layered topological materials are experimentally identified.

A new class of layered topological materials, TMD Weyl semimetals (WTe_2 and $MoTe_2$) is recently proposed by theoretical calculations. Soon after, the quasiparticle inference (QPI) studies clearly show the most important character of Weyl semimetals, Weyl points and its connection with Fermi arc topological states for both WTe_2 [1] and $MoTe_2$ [2]. A difference in the topologies of Fermi arcs topological states between two TMD Weyl semimetals is also observed.

Layered Bi and silicene are strong candidates of two-dimensional topological insulators (2DTI). STS spectra acquired on the edges of layered Bi thin film grown on Si(111) manifest a significant difference on neighboring edges [3]. Further studies of this one-dimensional edge states by QPI give the same dispersion as that found on the edges of bulk Bi, which is claimed to be topological. On the other hand, silicene, a honeycomb sheet consisting of Si has also been theoretically predicted to be a 2DTI in freestanding form. The presence of topological properties in silicene fabricated on real surfaces is one of the central issues. Landau level studies of monolayer silicene on Ag(111) clearly show that Dirac fermions are quenched due to substrate induced symmetry breaking [4]. The strong coupling in between Si and Ag atoms also destroys the possibility to be a 2DTI. Meanwhile the surface state of multilayer silicene studied by QPI also shows a parabolic band with the effective mass close to Si-Ag reconstruction [5], lowing its prospect of topological properties.

Reference:

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