Low-Dimensional Topological Insulator Nanodevices

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Abstract

In pursue of the long sought Majorana fermion, hybrid systems of topologically insulating materials (TI) and superconducting metals (SC) are investigated. Due to the proximity coupling of the SC to the spinless TI surface states Majorana zero modes (MZMs) emerge, which are the condensed matter equivalent to the Majorana fermion. In experiment, the dimensionality of the TI has to be reduced for the investigation and manipulation of only a single pair of MZMs. We discuss two possibilities (see fig. 1) to define nanodevices of three-dimensional TIs of reduced dimensionality using molecular beam epitaxy. The first is to define TI nanoribbons using selective area growth [1]. In combination with in situ shadow evaporation techniques for electrode deposition this allows for great scalability and high quality devices. The drawback is that large magnetic fields need to be applied, parallel to the nanoribbon main axis, for the system to be in its topological phase [2]. The second approach is based on the hybridization of top and bottom surface of a three-dimensional TI in ultra-thin films [3], that gives rise to quantum spin Hall edge states. We introduce both systems, present recent experimental findings and discuss the versatility of both approaches.

References

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Figures

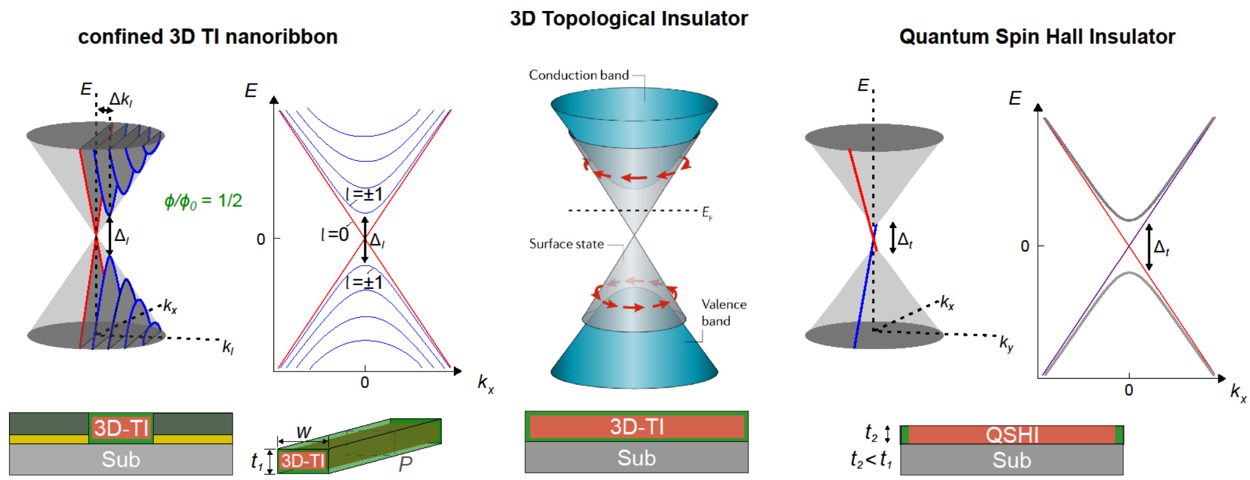

Figure 1: Pathway from MBE grown 3D TI thin films (center, scheme taken from [4]) to 1D confined nanoribbons [5] (left) or the hybridization evoked quantum spin Hall insulator (right).