Introduction to topological insulators and their connection to ferromagnetism, ferroelectricity and strong electron correlation

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Abstract

Basic properties of topological isulators are introduced. Their use in information technology requires their functionalization. Here, examples are shown for the connection to ferromagnetic and ferroelectric properties. In addition, the question is considered where strong electron correlation, as in oxides, can help improve the properties of topological insulators.

1. Introduction

Topological matter is of high current interest as the bestowal of the Nobel prizes 2016 shows. Generally, a topological insulator features a metallic surface protected by time-reversal symmetry and an isulating bulk. We start from the first prediction of spin-orbit coupled topological systems for the example of graphene and discuss the properties of three-dimensional topological insulators through their signatures in spin- and angle-resolved photoelectron spectroscopy. We discuss the magnetic functionalization of topological insulators and the conditions for the creation of magnetic band gaps by impurities as they are a necessary condition for the quantum anomalous Hall effect.

So-called topological crystalline insulators are more vulnerable systems where surface states are protected by mirror symmetries only instead of time-reversal symmetry. We show that the system $Pb_{1-x}Sn_xSe$ can be driven by doping into a topological quantum phase transition from mirror- to time-reversal symmetry protection

Topological insulators are a pure band structure effect, however, electron correlation would add interesting aspects and enhance the operating temperature of devices. The search for the first strongly correlated topological insulator is reviewed.

2. References

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Fig.1: Schematic electronic band structure of a topological insulator. The Dirac cone of a topological surface state is shown at momentum k_1.

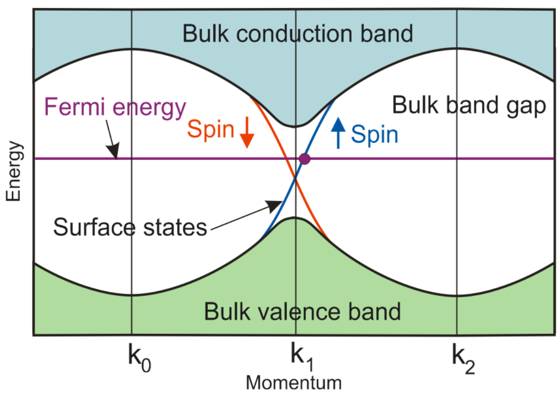

Fig.2: Schematic of a topological quantum phase transition introduced by 2% Bi doping in $Pb_{72}Sn_{28}Se$. A lattice distortion leads to a modifcation of the bulk band inversions and a change in the topological class [1].