Abstract

Topological insulators have been among the most intensively studied group of materials in condensed matter physics over the past twenty years. They contain theoretically predicted new quantum states of matter, characterized by unique properties that lead to the formation of metallic surface states, a key feature of these materials. The exceptional electronic structure of these materials and their potential applications in various fields have attracted the attention of numerous research groups.

The aim of this doctoral dissertation was to determine the impact of an ultra-thin layer of transition metals, iron, and cobalt, on the electronic structure of the surface states of Bi_2Te_3. The study also explains changes in the core states of this material during the formation of an interface with the deposited transition metals. Using research techniques such as angle-resolved photoemission spectroscopy (ARPES), photoelectron spectroscopy (PES), X-ray absorption spectroscopy (XAS), and circular dichroism-ARPES (CD-ARPES) that utilize synchrotron radiation, the physicochemical structure of the created transition metal-topological insulator interface/junction was determined. ARPES and CD-ARPES studies were also conducted to illustrate the dispersion dependence of the surface states and the top of the valence band before and after the deposition of the iron and cobalt layers, as well as to determine the impact of the deposited structures on the possibility of opening an energy gap (band gap).

The results obtained through angle-resolved photoemission spectroscopy revealed band bending phenomena and the lifting of the degeneracy of the states at the top of the valence band and the bottom of the conduction band. Additionally, photoelectron spectroscopy provided information about the formation of additional phases, such as metallic Bi and compounds like FeTe and CoTe during the deposition of transition metals. Using X-ray absorption spectroscopy and circular dichroism techniques, the magnetic properties at the transition metal-topological insulator boundary were determined.

The dissertation also provides a detailed discussion of the technique of synchrotron radiation generation.