DESCRIPTION FOR THE GENERAL PUBLIC

Our projects concerns topological insulators – a quite new class of materials which has very specific properties making them exciting for physicists and also for engineers designing elements for future electronics. These materials called three dimensional topological insulators (3D TI) conduct very well electricity only on their surface, while the bulk remains insulating, in fact it is semiconducting. Moreover, the surface electronic states are protected against scattering and the electrical current formed from the surface Dirac fermions has a specific spin polarization. It means that surface fermions are the perfect current carriers and the current is spin polarized. Direction of polarization depends on the direction of movement.

Topological insulators have been intensively studied since a couple of years but many questions related to their properties remain unsolved. One of the important problems is the stability of the chemical and electronic structure when a junction is formed between TI and other material. In our project we are going to study junction between 3D TI such as bismuth telluride and bismuth seleno-telluride and metals including ferromagnetic ones like iron or cobalt.

Such junctions are inevitable when a device is planned which will use the specific electronic surface states and its spin polarization. Knowledge about possible chemical reactions between TI layer and layer of metal is crucial because a potential chemical instability would kill or modify the surface states. On the other hand there are first reports about quite new phenomena which can be expected at the area of junctions between IT and semiconductors or between different TIs like Sb_2Te_3 and Bi_2Te_3

Our project is focused on studies of the junctions between TI and other metal formed as heterostructures of thin films with the use molecular beam epitaxy. The problem we are going to solve requires advanced research methods and a group of experienced researchers. Both requirements are fulfilled. Most experiments including thin film deposition will be performed in our laboratories . We have the unique multitechnique ultra-high vacuum cluster which enables thin film deposition and their detailed characterization *in-situ* without a contact of the films with atmosphere. We will test atomic and chemical structure of the regions in the proximity of junctions by using such techniques as electron diffraction, photoelectron spectroscopy, scanning Auger electron spectroscopy or atomic force microscopy. Additionally, scanning tunneling spectroscopy will be applied which is a kind of spectromicroscopy used for detection of the surface states. Additional techniques will be applied for selected samples to gain knowledge about the behavior of the electronic system when excited with the ultrashort laser pulses or to get information about the energy dispersion of the electronic states. The last one will be studied in Polish synchrotron SOLARIS with the use of angle resolved photoelectron spectroscopy and synchrotron radiation with variable polarization.