Surface electronic structure of magnetically doped topological insulators studied by means of STM and STS

K. Nowak,[1,2] M. Jurczyszyn,[2] M. Chrobak,[1,2] K. Maćkosz,[1,2] M. Sikora,[2] and M. Przybylski[1,2]

[1] *Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, 30-059 Krakow, Poland*
[2] *Academic Centre for Materials and Nanotechnology, AGH University of Science and Technology, 30-059 Krakow, Poland*

Topological insulators represent a quantum state of matter characterised by simultaneous occurrence of bulk energy gap and peculiar topological surface states, which form Dirac cones with linear dispersion relation. Topological states occur among others in three-dimensional single crystalline Bi_2Se_3. Doping can be used to shift the Fermi level into the linear region and thus realize the quantum topological transport. However, dopants may also influence the topological states, and in the special case of magnetic dopant, the topological states can be destroyed [1]. On the other hand, the recent literature reports that magnetic topological insulators exist [2]. The goal of our work is to determine how small amounts of both magnetic and non-magnetic dopants influence the electronic structure and what are the consequences for the surface topological states.

We present scanning tunnelling microscopy (STM) and scanning tunnelling spectroscopy (STS) study of single crystals of pristine Bi_2Se_3, non-magnetically doped $Bi_{1.96}Mg_{0.04}Se_3$ and magnetically doped $Bi_{1.98}Fe_{0.02}Se_3$. STM images of all investigated crystals exhibit a variety of surface defects. Due to well confined probing region STS offers an unique possibility to find out how the single structural defect or dopant modify the local density of states (LDOS) at the surface. We observe clear differences in LDOS structure depending on whether the measurement was carried out at the defect or far from the defect. Small amounts of both magnetic and non-magnetic dopants introduce subtle changes in the LDOS of the surface. However, they do not destroy the topological surface states of studied material.

References:

[1] Chrobak, M., et al., New J. Phys, 22, 063020 (2020)
[2] Tokura, Y., et al., Nat Rev Phys 1, 126–143 (2019)

Kamil Nowak has been partly supported by the EU Project POWR.03.02.00-00-I004/16