

The project is related to currently intensively studied, but still not fully understood topic of the two dimensional topological insulators. In these exotic systems the interior of the sample is insulating - and doesn't conduct any current - but the edges are one dimensional conducting channels. It has to be noted that this is a result of specific properties of the material and does not depend on impurities and defects. Due to theoretical predictions, direction of motion of the edge electrons is coupled to their spin. The spin could be described in simplified way as a internal magnet of the electron. If there is no external magnetic field and magnetic impurities, the time reversion symmetry is conserved and thus the backscattering is forbidden. Because of this topological protection, electrons can propagate without any scattering which could reverse the trajectory of their motion. In this way, on each edge one should observe two channels guiding electrons with opposite spins. Like on the road - electrons on two different channels propagate in the opposite directions. Theory predicts electrical resistance for topological insulator state should be invariant, precisely defined and be equal  $12.9k\Omega$ .

The system which we are considered is the HgTe/HgCdTe quantum well, which is a thin (6.3-8nm) layer of mercury telluride sandwiched between mercury cadmium telluride alloy. In 2007 group of scientist from Wurzburg had published results of their research, which had confirmed the existence the edge conduction and its approximate quantization. Unfortunately, only for few smaller structures values of the resistance was close to the predicted one. Because of that very important question occurred: what is a reason of discrepancy with the theory? What is a mechanism breaking the topological protection? For those few years scientists had been trying to answer for these questions. Unfortunately, without any remarkable results. There was few different possible reasons of that situations, and one of them was quality of initial samples.

Our group is trying to answer for the question, whether those problems are caused by the method of preparation of the samples. One should take into account that the materials containing mercury are highly sensitive for the increasing of temperature. In the higher temperatures mercury atoms starts to move inside the material, which may cause in our case mixing of the subsequent layers and damage the thin layer of pure mercury telluride. The problem is that the most of the microstructurization techniques, like soldering, heating, exposition on the electron beam, requires high temperatures.

One of the goals of our project is to improve the sample fabrication procedures by developing low-temperature technology, important for mercury telluride quantum wells. Thanks to that we will be able to fabricate samples of high quality and unchanged properties in comparison to the initial samples. The second, and main goal of the project is to determine the basic properties of the topological edge states in this system by performing electrical measurements in low, cryogenic temperatures.