DESCRIPTION OF THE PROJECT FOR THE GENERAL PUBLIC

This project focus on a new class of materials called topological insulators. These interesting materials are insulators in the bulk, surprisingly however, despite insulating bulk the surface of these materials is characterized by metallic properties. This means that they have completely different properties inside and at the edges. A special case of topological insulators are two-dimensional (2D) topological insulators based on 2D materials. Shortly, 2D materials can be characterized as those which have well-defined (macroscopic) length and width but their thickness is on the order of one to several atoms. One can imagine such a material as a kind of paper sheet but a thousand times thinner. The general property of 2D topological insulators is the same - the interior of such material (sheet) is an insulator but its edge is metallic i.e. the edges are completely different if compared to the interior. Even more importantly these metallic edge states are protected i.e. not so easy do destroy! To understand this better imagine a knife whose edge is sharp and one can easily hurt himself but the remaining part of the knife is completely harmless. Moreover, think about such knife as forever sharp independently what you will do with it - you can smash it with hammer, hit with stone or even shut it using laser blaster and none of these affect sharpness!

Recently, it was shown that many different 2D materials can be synthesized. It also turned out that some of these materials can be classified as 2D topological insulators. In this project, we will deal with a group of materials located in the 15^{th} group of the periodic table i.e. bismuth and antimony. It has been shown that these materials can grow in a 2D fashion and are called bismuthene and antimonene and that some of them are 2D topological insulators. Unfortunately, these 2D materials are unstable in air where undergo quick oxidation which severely influences their properties. Unfortunately, some of the measurements on pristine materials should be conducted in air which currently is not possible. Using the allegory to the knife - we would like to check if our knives are sharp by slicing a bread but because we are doing this experiment in air our knife corrodes and quickly is loosing its wonderful sharpness becoming completely useless. In this project our aim is not related to slicing the bread but we want to build simple electronic devices basing on bismuthene and antimonene. Unfortunately, however, also in this case, exposure to air causes corrosion and in consequence properties change, in particular metallic edge state vanish. Therefore, as part of this project, we will search for an effective method of protecting grown 2D materials against corrosion so that they can be used in the air. Unfortunately, no effective anti-corrosion method has been provided so far. Our idea will be to cover the grown 2D materials with a capping layer and to examine whether it is effective anti-oxidation method. Moreover we will check if this protective layer affects topologically protected edge state. In other words, if we cover the knife with a layer of paint, will it still be a sharp knife?

If we succeed by protecting 2D topological insulator and preserving its edge state we will attempt to build a simple electronic device and examine its electrical properties. Using an allegory to a knife - we will check whether it is suitable for cutting bread or maybe butter spreading or if it is suitable only for decoration purposes.