DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

Production of novel semiconductor devices is a very important element for development of civilization and information society. Almost each person on the World uses a smartphone and other devices containing transistors. So far most transistors are fabricated using silicon technology which is close to the limits resulting from physical properties of this material. Therefore scientists devote a lot of effort for studies of new materials, which could replace the silicon-based devices. In this project we are going to focus on van der Waals semiconductors. They are crystals similar to graphite, from which a single layer (i.e. a layer of graphene) can be fabricated by an exfoliation process. Due to very interesting properties of graphene (e.g. high carrier mobility) this material is very interesting for electronics. In case of van der Waals crystals a similar situation takes place but these crystals have an open energy gap. It gives perspectives of applications of these materials in optoelectronics, i.e., the field which combine optical and electrical properties of semiconductors where the basic semiconductor devices are detectors, LED diodes, and lasers. Currently physical properties of van der Waals crystals composed of single layers are not well understood since these materials are at the beginning of synthesis/development. In the framework of this project electromodulation (EM) spectroscopy (i.e., photoreflectance and contactless electroreflectance) will be applied to study these materials. It is a technique which measures changes in reflectance spectrum. Due to phase-sensitive detection of EM signal this method allows measurements of changes in reflectance spectrum even on the level of $\Delta R/R = 10^{-6}$, i.e., at the sixth significant digit. Because of high sensitivity we expected that this method will be an excellent tool to study optical transitions in van der Waals semiconductors composed of single layers. So far EM spectroscopy was not applied to study two dimensional van der Waals crystals. Our preliminary studies show that this technique works very well for this kind of materials. Therefore in the framework of this project this method will be applied to study the electronic band structure of van der Waals semiconductors and changes in the electronic band structure, which are caused by reduction of crystal sizes from a few layers to a single layer and application of external hydrostatic pressure.