DESCRIPTION FOR THE GENERAL PUBLIC

PREPARATION AND THERMAL PROPERTIES INVESTIGATION OF TWO DIMENSIONAL LAYERED MATERIALS THIN FILMS

The development of two dimensional layered materials research was initiated by isolation of monolayer graphene – the electronic vicious hope. With time the next unique properties of graphene were discovered, the undesirable properties were also revealed. That undesirable properties make the implement of this material on the market truly difficult. The solution of this problem could be the others layered materials, which include, inter alia, Transition Metal Dichacogenides (TMDC) with general formula MX_2, where M stands by metal atom and X stands by selenide, tellurium or sulphide or narrow-band-gap IV-VI chalcogenides. This materials also reveals as intriguing as graphene electronic, optoelectronic and thermoelectric properties. Nowadays one observes a return to the research to the materials, which were for the first time described in the sixties and eighties of XX century. Recently the first articles concerning both properties and first applications of $ReSe_2$ and GeSe as a mono- and few- layers were published. These materials are supposed to become an important part of modern electronic soon. To make it possible, we have to get to know their properties, especially the thermal properties, which are exceptionally significant issues in the operating electronic devices. The heat conduction and the heat removal due to the power dissipation, which limits electronic devices performance are one of these crucial issues. What is more a current saturation in devices based on low dimensional materials strongly depends on the interfacial thermal transport between the material and the substrate. So the knowledge and understating of the phenomena occurring in the materials upon heating is essential for making the progress both in the two dimensional materials science and electronic industry.

The proposed project is aimed to produce thin films of the materials: $ReSe_2$, $SnSe_2$, GeSe, GeS, black phosphorus (BP) and hexagonal boron nitride (hBN) and thermal properties investigation. The process of production of these materials include two simple and well-known methods: mechanical exfoliation – the Noble Prize method for graphene production and vacuum filtration, which are successfully applied in the carbon materials thin film production. In the context of the new two dimensional materials both methods need to be improved. The mechanical exfoliation allows to produce the high quality flakes, but the yield of produced mono- and few- layers flakes are significantly lower in comparison to graphene. In case of vacuum filtration method, no one has produced to this time a homogenous, stabile with full control of size and thickness a thin film of one of mentioned in the project material. One observes also the absence of the reports in the literature concerning the thermal properties investigation of selected materials. Those which are published are incomplete and need to be clarified. The next goals of the project are to determine the temperature-dependence of phonon energy, thermal conductivity and interfacial thermal conductance. The research will be performed using the Raman Spectroscopy based on the Raman effect.

It is worth to mention that all selected in the project materials are perspective for further application not only in the electronic industry, but also as photodetectors, solar cell, anode materials for ion-lithium batteries or thermoelectric materials.

The research, which are embraced in the project, are mentioned in *National Framework Programme: VI. New Materials and Technologies: 6.1 Nanomaterial and multifunctional nanodevices and 6.2 Advanced materials and electronic and optoelectronic devices.*