

## 1 Objective of the project

The 2010 Nobel Prize awarded to A. Geim and K. Novoselov for a groundbreaking experiment on graphene - a single layer of carbon atoms - initiated a new trend in science focusing on two-dimensional structures of well-known bulk materials. In addition, rapid advances in mechanical exfoliation techniques have contributed to increased interest in layered materials, including transition metal dichalcogenides (TMD).

Part of the compounds crystallizing in the hexagonal structure due to the partially filled d shell of transition metals is characterized by semiconductor properties. The size of the energy gap is additionally conditioned by the atomic number of the selected chalcogen. The variety of chemical-physical properties distinguishes these materials with an extremely wide range of possible applications in the fields of electronics, optoelectronics, photovoltaics, and can be used in photovoltaics, medicine and biological sensors.

## 2 Research description

Research conducted as part of the proposed project will be based on measurements of Raman spectroscopy, a technique widely used in studies of transition metal dichalcogens as well as other two-dimensional materials (eg graphene, hexagonal boron nitride, ...). The technique focuses on phonon research, providing information on crystal lattice dynamics, heat propagation and mechanical strength of crystals. Raman scattering spectra primarily remain an important source of information on the thickness of the examined flakes. This technique is less invasive than standard measurements of atomic force microscopy (AFM) and its sensitivity to possible atmospheric pollution of thin layers caused by water deposition or fine impurities on the flakes causing possible errors of the measured thickness is much lower. An important part of the project will be the study of inter layer movements. They have a strong influence on the shape of the scatter Raman spectra.

The assumption of the proposed project is to a large extent based on efforts to understand the impact of the environment on two-dimensional flakes of layered materials. Another important issue will be an attempt to better understand the nature of resonance effects by using different energies of stimulation and conducting measurements in a wide range of temperatures on layers of different thickness.

The final results are to summarize the systematic measurements carried out for layers with different thickness of selenide and molybdenum telluride, energized with different energies under variable temperature conditions. This work aims to better understand the processes of crystal lattice excitation and resonant effects in two-dimensional structures of materials from the transition metal dichalcogenide family.

## 3 Reasons for choosing the research topic

Due to the growing interest in layered materials and the diversity of optical or electrical properties, there is a strong motivation to conduct measurements of two-dimensional materials from the transition metal dichalcogenide family. The basic research planned under this project will be an excellent source of knowledge about the dynamics of the crystal lattice of thin layers of two-dimensional materials. The results are expected to help understand a number of physical processes such as carrier scattering, surface stresses, heat propagation and mechanical strength of crystals.