

The beginning of this century brought an important scientific discovery regarding a new class of materials: atomically thin (two-dimensional) crystals. The discovery of a mechanical exfoliation technique made it possible to easily produce high-quality layers with a thickness of individual atoms. The first material obtained in this way was graphene. Soon after, other classes of two-dimensional materials were introduced. One of the most promising types of two-dimensional materials is the transition metal dichalcogenides. Unlike graphene, transition metal dichalcogenides exhibit a bandgap, allowing the creation of various electronic devices such as transistors or optoelectronic devices. Many difficulties are still to be overcome before silicon-based devices will replace their transition metal dichalcogenide counterparts. However, there are areas in which the specific properties of structures based on atomically thin layers of transition metal dichalcogenides may constitute a significant advantage.

One of such systems is the single photon emitters in the transition metal dichalcogenides. Such objects are created by carrier trapping in a specific spot in the atomically thin layer of material. This mechanism involves trapping a single exciton (an electron-hole pair) either in a strained region of the flake or at a defect in the crystal lattice. A highly localized exciton, upon recombination, emits a single photon of light with a well-defined wavelength. Single photon emitters are an important tool in studying quantum phenomena, including quantum cryptography and other research fields.

The proposed project aims to develop a thorough understanding of the types and properties of single-photon emitters formed in transition metal dichalcogenides. The main tool in our approach will be the ability to control the electric charge accumulated in the monolayer. The control of the sign of the changes introduced into the sample will determine the type of defect responsible for each of the single photon emitters. This possibility will allow comparing the properties of the emitters based on different defect types.

For this purpose, special structures will be prepared. The structures will form a flat capacitor with a thickness of about 100 nm, with one of the plates being a layer of a transition metal dichalcogenide. It will be possible to control the sign and amount of electric charge in the studied layer by applying voltage to the sample.

We expect that the gained understanding of the phenomena responsible for carrier trapping in the single photon emitters and understanding of the differences in the properties between various types of such objects will significantly contribute to the further development of this field and that it will bring closer the perspective of practical applications of such objects.