

SUMMARY

„Electrical and mechanical investigations of the membranes based on transition metal dichalcogenides”

The doctoral dissertation entitled: "Electrical and mechanical investigations of the membranes based on transition metal dichalcogenides" was carried out in the Laboratory of Nanometrology of Electronic Instruments and Materials in the Department of Nanometrology at Wrocław University of Science and Technology under the supervision of dr. Jarosław Serafińczuk, associate professor.

The aim of the dissertation was to determine the electrical and mechanical properties of membranes based on selected van der Waals crystals suspended over a microcavity using scanning probe microscopy methods.

The dissertation was divided into three parts. The first two chapters focus on theoretical aspects of fabrication and research methods used to characterize the properties of two-dimensional materials. The first chapter describes the structure and basic properties of transition metal dichalcogenides. Then the methods of fabrication of two-dimensional structures are presented. Most attention was paid to the method of mechanical exfoliation and transfer, which were used to prepare the samples that are the subject of the following dissertation. The second chapter is dedicated to methods for studying the properties of structures from single layers of transition metal dichalcogenides. The following methods and measurement techniques are discussed: optical microscopy, differential transmission and reflection spectroscopy, photoluminescence, optical and Raman spectroscopy, and atomic force microscopy. The description of the equipment is enriched with examples of their use in the characterization of two-dimensional materials. The chapters also describe the constructing of workstations for the fabrication and characterization of 2D materials created in the course of the work.

The third (research) part contains the description of experiments and discussion of the results of research on thin films of TMD materials produced at the Wrocław University of Technology. This chapter is divided into two parts: the first, concerning the study of the electrical properties of the materials, and the second, containing a description of the experiments leading to the determination of the mechanical properties of the analyzed structures using an atomic force microscope.

In summary, as part of the work conducted in the course of the dissertation, methods for fabricating membranes with thicknesses of several atomic layers based on transition metal dichalcogenides were developed. Transfer stations were built to enable precise placement of the material to specialized substrates with holes and electrodes. The electrical and mechanical properties of the fabricated membranes made with MoS₂ and WS₂ were investigated. The research results presented as part of the dissertation can be used in the design of new devices like sensors and transistors. In addition, the fabrication and transfer techniques developed as part of the thesis, as well as the research methodology, are used in the characterization of new two-dimensional materials (Janus-TMD, monochalcogenides) and heterostructures, and are the basis for obtaining further research projects.

Magdalena Tamburini-Szopka
.....
PhD student signature