Abstract of the PhD thesis “Epitaxy of 2D layered materials from the group of transition metal dichalcogenides: $MoTe_2$, $MoSe_2$, $NiTe_2$” by Bartłomiej Seredyński

Layered materials are intensively investigated crystals nowadays. One of the pronounced group in this class are transition metal dichalcogenides. Their interesting properties comes with the reduction of dimensionality which leads to the observation of physical phenomena not available in the bulk form e.g. high oscillator strength of excitons. Such behaviour brings variety of potential application in various fields such as nanophotovoltaics or nanodetection.

For many years now the epitaxial techniques provides high quality three-dimensional crystals and heterostructures. State of the art carrier mobility or super narrow exciton lines are just a few to be mentioned. From the other hand, the growth of two-dimensional layered materials by such methods still leaves a lot of space for improvements. The results presented so far still fail to compete with other production methods of thin layered materials.

The aim of this work was to produce high quality two-dimensional thin films of transition metal dichalcogenides using molecular beam epitaxy method. Presented results concerns the growth of molybdenum ditelluride, molybdenum diselenide and nickel ditelluride. From above $MoSe_2$ is a semiconductor, $NiTe_2$ is a semimetal and $MoTe_2$ belongs to the two groups depending on its crystal phase. The above three are a illustrative representatives of materials with various electrical properties. The heterostructures of these crystals were produced with molecular beam epitaxy and are also presented. Numerous techniques were used to characterise created crystals. Two models are proposed to qualitatively analyse growth outcomes.

Results presented in this work prove truly epitaxial character of produced two-dimensional structures. First, the symmetry of a chosen substrate is critical. Second, crystal axes of the grown layers reflects the crystal axes of the substrate. Third, lattice constant of the grown thin layers are strained with respect to the substrate.