Thin films of transition metal dichalcogenides. The influence of the substrate on the $MoTe_2$ structure, morphology and magneto-transport properties.

Molybdenum telluride ($MoTe_2$) is a layered material and similarly to the graphene, can be easily exfoliated into single layers. It exists in several crystallographic phases and each of them has different optical and electrical properties: from semiconducting to metallic. Although multiphase can be problematic in the context of selective growth, the richness of magnetic and optoelectronic properties makes this material potentially applicable in electronics, optoelectronics, spintronics and sensing devices. Many chemical and physical methods have been used for the growth of high-quality $MoTe_2$ layers, but still the process of $MoTe_2$ nucleation is not fully understood and the process of selective-phase growth is a challenge. It turns out that despite its layered structure, the $MoTe_2$ growth is strongly correlated with the substrate used in the growth process, and some substrates appear to be better to others. Such a process has not been explored yet in the context of the growth using molecular beam epitaxy technique - a method that allows a precise deposition of a large-scale thin films and heterostructures. In our research, we have shown that the growth of the semiconducting phase is promoted by the gallium-arsenide (GaAs) substrate. Although the images of the samples, taken by a transmission electron microscope, showed that the grown layers were of high quality, the type of electron transport was dominated by hopping. This type of conductivity, which can be pictured as movements of scattered electrons between different states, is typically observed in materials with a disorder. There are several basic models that explain the hopping transport, but none of them can be applied to our samples. Our results showed an anomalous dependence of the resistivity on temperature, which can be only described by the parameters which are far from well known textbook models. Although similar resistivity dependencies were seen in the nineties in thin, granulated metallic films, this type of resistivity dependence was seen for the $MoTe_2$ for the first time and until today no clear explanation of this phenomenon has appeared. Knowing that the substrates have a high impact on the growth of $MoTe_2$ layers, the influence of the substrate on the structure, morphology and magneto-transport properties of $MoTe_2$ is crucial to investigate. This is especially important for ultra-thin samples where the interactions between the substrate and the layers can be much greater. In order to investigate the influence of the substrate on the type of the crystallographic phase, $MoTe_2$ layers will be grown on substrates with different structural properties: GaAs, InAs or GaN. In order to understand the origin of the hopping transport in the $MoTe_2$, a series of samples of various thicknesses will be prepared. By increasing the number of the layers, the interactions between the substrate and the layers should weaken. If the type of transport also changes with the thickness of the layers to the band transport typical for semiconductors (through electrons excited from the valence band to the conduction band), the assumed hypothesis of the substrate influence on $MoTe_2$ growth would be appropriate. An adequate series of exfoliated $MoTe_2$ samples will be used for the reference. The $MoTe_2$ layers will be exfoliated from the bulk and will be separated from the substrate by a non-interacting insulating layer.