Molecular beam epitaxy of crystalline tellurium thin layers grown on semi insulating substrate

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Crystalline tellurium is a well-known narrow band gap p-type semiconductor with the energy gap of 0.35eV. Its trigonal crystalline structure is highly anisotropic and consists of one dimensional helical nearest neighbors chains which are parallel arranged and bound to each other via van der Waals forces. Recently, thin layers of tellurium have attracted an interest due to theoretical prediction of topological phase transition under strain [1] and thickness induced tuning of the energy gap [2] as well as excellent parameters of field effect transistors made of tellurium [3]. However, to the best of our knowledge, there is so far only one report of epitaxial growth of thin layers of tellurium on graphene, [2].

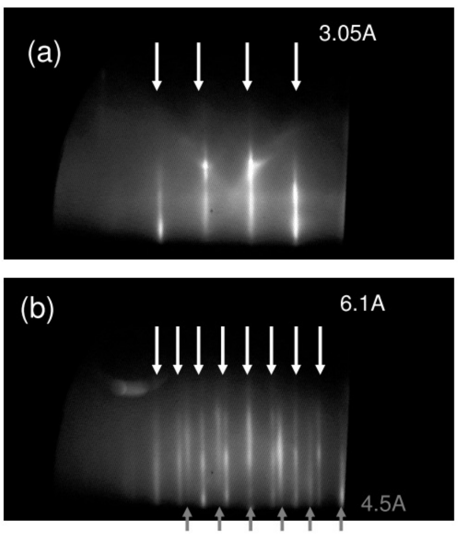

Figure 1. RHEED pattern from (a) ZnTe buffer layer grown on (001)-GaAs and (b) crystalline Te-layer grown on top of it. The arrows indicate the position of reflection pattern. The corresponding lattice constants are given.

In this work, the epitaxial growth of crystalline tellurium on semi-insulating (001) ZnTe layers is reported. It takes place at relatively low temperatures being in the range 70 -100ºC. Further lowering of the growth temperature induces the growth of amorphous tellurium, whereas its increase induces formation of three dimensional islands on the surface.

The growth is monitored by the Reflection High Energy Electron Diffraction (RHEED). RHEED images before and after tellurium deposition are shown in Figure 1a and Figure 1b, respectively. The images reveal streaky character typical for 2D epitaxial growth. Moreover, two different crystalline structures can be distinguish after Te deposition, which can be explained by the fact that the anisotropy axis of crystalline tellurium can be either in (0,1,0) or in (1,0,0) direction of ZnTe. Raman spectroscopy and X-ray diffraction measurements confirm the crystalline character of epitaxial tellurium. Low temperature magneto-transport measurements show weak antilocalization effect, which is characteristic for semiconductors with a strong spin-orbit coupling.

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