Abstract of doctoral dissertation

“Crystallographic and electronic structure of antimonene on the W(110) surface”

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Antimonene, the monolayer of antimony, is relatively novel analogy of graphene. The advantage of antimonene over graphene is the natural presence of considerable band gap which allows to regulate flow of current making this material useful in electronic devices. Among different allotropes of antimonene, α-type and β-type are stable. The α-phase has a puckered atomic-scale structure with two sublayers, and β-antimonene has a buckled honeycomb-like structure. These two forms reveal completely different physical properties important for potential applications in electronics and optoelectronics. The α-phase of antimonene, contrary to the β-phase, reveals direct and smaller band gap, higher carrier mobility as well as anisotropic electronic and thermal properties due to its lower symmetry. From these reasons α-phase is currently attracting much interest. However, the experimental realization of α-antimonene, especially investigations of electronic properties of pristine as well as modifieed structure, still remain challenging.

The main aim of this dissertation is determination of crystallographic and electronic structure of clean antimonene obtained on the tungsten surface and antimonene modified by adsorption of submonolayer amount of lead. The investigations include single and multiple layers of this material. The study has been performed using following experimental techniques: low-energy electron diffraction (LEED), reflection high-energy electron diffraction (RHEED) and angle-resolved photoelectron spectroscopy (ARPES). Electronic structure has been compared with band structure obtained as a result of density functional theory (DFT) calculations of freestanding antimonene.

The results of diffraction measurements indicate rectangular lattice of Sb atoms in material which suggests the existence of α-antimonene. The linear bands revealed in electronic structure confirm this assumption. Their arrangement is in agreement with theoretical results of freestanding antimonene. The small modifications of electronic band positions are observed during increasing number of layers. The diffraction patterns of antimonene after adsorption of small coverage of lead indicate a mixed system of both α and β phases of antimonene. Additional domains of α-antimonene are also observed.

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