STM study of $PtSe_2$ surface morphology before and after modification with Pb clusters

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Platinum diselenide ($PtSe_2$) belongs to the transition metal dichalcogenides (TMDs), which are a group of layered materials gaining significant interest among scientists and engineers due to their exceptional characteristics, such as strong thickness-dependence of their electronic band structure. Its transition from 2D layer to 3D bulk material leads to modification of its' properties, e.g. increase in the in-plane lattice constant and decrease in the bandgap. In addition, it is possible to tune the band structure and resistivity of $PtSe_2$ by introducing mechanical strain [1]. This property makes $PtSe_2$ an attractive candidate for future application in microelectronics, as well as valleytronics. Its strain-dependent resistivity has already been utilised in nanoscale pressure sensors [2]. Another advantage of $PtSe_2$ is the fact that it can be manufactured using both methods common in nanotechnology, such as chemical vapour deposition (CVD) and chemical vapour transport (CVT), as well as a newly developed method, namely direct selenization of the platinum substrate [3].

In this work CVD-grown $PtSe_2$ monocrystals were analyzed. Preliminary characterization of their surface morphology was carried out using scanning tunnelling microscopy (STM), and scanning electron microscopy (SEM). Both qualitative and quantitative data on the samples' surface structure was obtained, i.e. the height of monolayer terraces, the refraction angles of their edges and the in-plane lattice constant. Furthermore, the influence of various surface preparation methods on the quality of the samples' surface was investigated. After achieving an atomically clean sample surface, a subatomically thin layer of lead (Pb) was deposited on the monocrystals. Pb clusters exhibit quantum size effect and have been proven to self-organize on crystal surfaces, which could be utilised in nanoelectronics [4]. Hence, the influence of $PtSe_2$ surface morphology on Pb clusters' growth and distribution was also analysed.

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References

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