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Antimonene on silicon substrate – synthesis and characterization by low energy electron microscopy

Antimonene is a two-dimensional (2D) material composed of antimony atoms with a thickness not exceeding several layers. Sb monolayers can be produced in two stable phases - α with a rectangular crystallographic structure and β with a honeycomb lattice. The uniqueness of this material is based on properties that distinguish it from graphene and other 2D materials. Unlike graphene, antimonene exhibits semiconducting properties. On the other hand, unlike transition metal dichalcogenides, the narrower width of energy gap allows the potential use of antimonene in optoelectronic devices. Other unique features of antimonene include its high stability in the air and water, extremely low thermal conductivity, predicted properties of a topological insulator at a certain thickness, to name a few. However, there are also disadvantages which strongly limit further research and future application of this 2D material. These include small sizes (in the range of nano- or micrometers) of antimonene samples and interaction with a substrate affecting its properties.

During my PhD work, I synthesized antimonene on different substrates: W(110), W(001), Co/W(110), Au/Fe/Au/W(110), Si(111)-(6x6)Au, Si(111)-(√3x√3)Au. The main goal was to obtain continuous Sb monolayer with macroscopic dimensions and to investigate its properties. For the characterization of 2D material low energy electron diffraction (LEED) and microscope (LEEM), including spin-polarized LEEM, techniques were used.

In this talk, I will present a part of my results - the preparation and characterization of antimonene on Si(111)-(6x6)Au substrate. The obtained results indicate that the growth of antimonene proceeds in three stages: I) formation of a single antimonene layer; II) formation of an amorphous layer; III) formation of Sb multilayers. In the first stage the antimonene monolayer forms a continuous film covering entire silicon substrate. It appears that very weak interaction between antimonene and the substrate promotes formation of free-standing-like 2D layer. The amorphous phase is problematic to investigate by electron microscopy due to the lack of atomic order. Antimonene multilayers form bulk-like structures which grow in a form of triangular islands on the Si(111)-(6x6)Au surface.

Uprzejmie zapraszam wszystkich pracowników, doktorantów i studentów Instytutu Fizyki.

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