

Epitaxial growth of α -antimonene on ferromagnetic Co film – LEEM studies

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Antimonene is a two-dimensional material that occurs in nature in two phases - alpha and beta. In the former, antimonene atoms create a rectangular crystallographic lattice, while the latter takes the form of a honeycomb structure. This material is a semiconductor and exhibits properties typical of 2D materials (e. g. the presence of Dirac cones and high carrier mobility). One of the ways to obtain this material is molecular-beam epitaxy (MBE). To date, antimonene has been obtained on substrates such as SiO₂, PbTe₂, Ge(111), Ag(111), Cu(111) and Cu(110) by this method [1]. In this presentation, we report the synthesis of α -antimonene on a ferromagnetic cobalt film. The resulting heterostructure was characterized using a SPLEEM microscope.

This device uses elastically backscattered low-energy electrons to image the sample surface in three modes: Low Energy Electron Microscopy (LEEM), Low Energy Electron Diffraction (LEED) and Spin Polarized Low Energy Electron Microscopy (SPLEEM). They enable: real-time observation of the sample surface (LEEM); creation of diffraction images (LEED); and observation of magnetic domains on the sample surface (SPLEEM).

A ferromagnetic cobalt film (5 monolayers (ML)) was prepared using MBE on a monocrystalline W(110) substrate. In the next step antimonene layer was grown on a top of Co. The LEEM mode provided information on the mechanism of growth and enabled optimization of the preparation process. Using the LEED mode, the formation of alpha phase antimonene was confirmed. The size of its rectangular unit cell was determined as 4.43 (± 0.05) Å and 4.36 (± 0.05) Å. These values are consistent with literature data (4.48 Å and 4.31 Å [2]). Unlike the literature data, in this case the unit cell is almost square. SPLEEM studies revealed that after creation of antimonene, the heterostructure retains its ferromagnetic properties.

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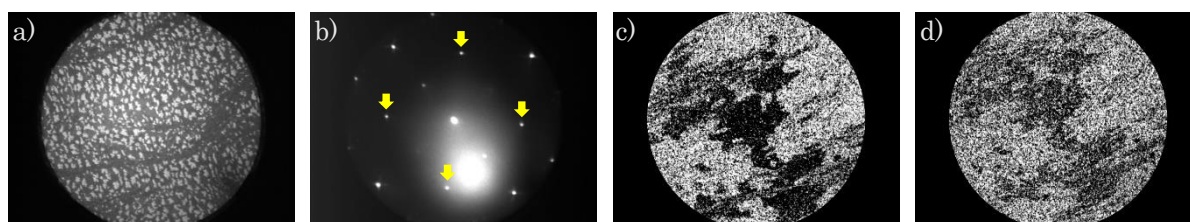


Fig. 1. a) LEEM image of 5 ML Co/W(110) with antimonene islands (white areas). FoV = 5 μ m, E = 5.8 eV; b) LEED image of antimonene on 5 ML Co (antimonenes spots marked by yellow arrows). E = 43 eV; c) SPLEEM image of 5 ML Co/ W(110). FoV = 15 μ m. E = 2 eV; d) SPLEEM image of Sb/5 ML Co/ W(110). FoV = 15 μ m. E = 1.7 eV.

[1] D. Zhou, H. Li *et al.*, *Advanced Functional Materials* **31**, 2006997 (2021)

[2] G. Wang, R. Pandey, S. P. Karna, *ACS Appl. Mater. Interfaces* **7**, 11490 (2015)