Low dimensional systems

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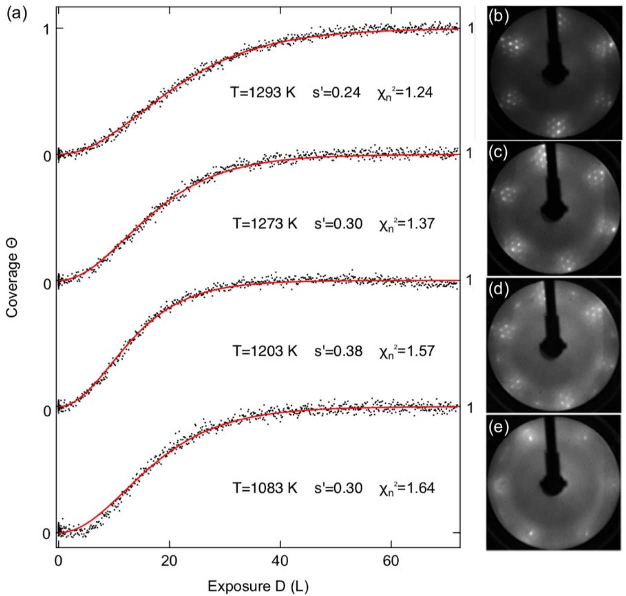
We study objects like **zero dimensional endofullerene** molecules and **two dimensional (2D) boron nitride** layers in view of their functionality as nano-materials. Single molecule magnetism is the focus in the fullerene research, where we apply x-ray absorption and a sub-Kelvin superconducting quantum interference device. In the 2D materials activity we grow highest quality boron nitride on substrates up to the four inch wafer scale with chemical vapour deposition and subsequent exfoliation and device implementation. For these purposes we use a dedicated clean room, optical microscopy, ink jet printing and surface science tools such as low energy electron diffraction, photoemission and scanning tunnelling microscopy. At the Swiss Light Source we perform photoemission and x-ray absorption spectroscopy.

https://www.physik.uzh.ch/g/osterwalder

Wafer scale single layer *h*-BN on Pt(111)

Hexagonal boron nitride is considered as key material for the exploration and exploitation of two dimensional materials. Large scale single layer material may be grown by chemical vapour deposition of precursor molecules on hot transition metal surfaces like platinum. These surfaces act as catalysts for the decomposition of the precursors and their incorporation into the two-dimensional skin that forms. The growth process starts from *h*-BN nuclei and their merging into macroscopic sheets of material. The product is used as electrochemical electrode, template for supramolecular structures, as an ultimately thin membrane on a metal. The single layers can be exfoliated and transferred on arbitrary substrates. On insulators they may be used as single photon emitters. Furthermore, the *h*-BN/Pt(111) substrates serve as templates for the growth of insulating multilayer boron nitride with a low dielectric constant as it is needed for fast electronics and spintronics in next generation integrated circuits.



Growth kinetics and correlation to LEED patterns: (a) h-BN coverage on Pt(111) vs. borazine exposure. Black dots, data, red lines, $\tanh^2$ fits with effective sticking parameters s'. A value χ_n^2 of 1 indicates a perfect fit of the model. (b-e) LEED patterns (Electron energy E=100 eV). (b) T=1293 K, (c) T=1273 K, (d) T=1203 K; note the minority phase 30 degrees away from the high symmetry direction, (e) T=1083 K growth temperature.

We optimised the growth of low-defect monolayer h-BN on 2 inch Pt(111)/sapphire wafers. The growth kinetics were monitored in situ with photoelectron yield measurements. They follow a $\tanh^2$ law. The quality of h-BN/Pt(111) is studied with scanning low energy electron diffraction (LEED). The data indicate a strong dependence of the epitaxy on the growth temperature. [1].

The project is a collaboration with the Interuniversity Microelectronics Centre (IMEC) in Leuven where the Pt thin film substrates were produced. This activity is supported by the European Future and Emerging Technology flagship graphene.

Highlighted Publications:

1. Wafer-scale, epitaxial growth of single layer hexagonal boron nitride on Pt(111),
   A. Hemmi *et al.*, J. Phys. Mater. **4**, 044012 (2021)
2. Precise measurement of angles between two magnetic moments and their configurational stability in single-molecule magnets,
   R. Westerström *et al.*, Phys. Rev. B **104**, 224401 (2021)
3. Ferromagnetic insulating epitaxially strained La2NiMnO6 thin films grown by sputter deposition,
   G. De Luca *et al.*, APL Materials **9**, 081111 (2021)