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 bulk sensitive x-ray absorption and a sub-Kelvin superconducting quantum interference device for the investigation of the materials that are obtained from collaborations with synthesis groups.
In the 2D materials activity we aim to grow highest quality boron nitride on substrates with chemical vapour deposition methods and subsequent exfoliation. For this purposes we use a clean room, optical microscopy, transmission electron microscopy and surface science methods such as low energy electron diffraction, photoemission and scanning tunneling microscopy for our investigations.

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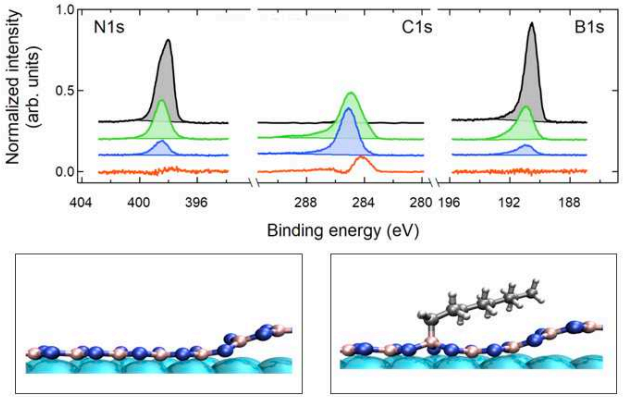
Catalyst Proximity-Induced Functionalization of $h-$BN

A single layer boron nitride realises a membrane that separates two regions. Still, such membranes allow chemical interaction across the layer. As we showed this year [1] one layer of $h-$BN on rhodium does not suppress the catalytic action of the rhodium substrate, which is reminiscent to proximity effects as they are observed in magnetic interfaces or in superconductors. We investigated with high resolution x-ray photoelectron spectroscopy (XPS) the interaction tetraoctylammonium (TOA) ions with $h-$BN/Rh(111). While the electrochemical process enables the large scale exfoliation of single layer $h-$BN, the underlying mechanism was not understood. XPS before and after TOA treatment in the liquid phase and density functional theory detailed a picture where the proximity of the substrate on which $h-$BN was grown is essential for the processes at work. The results as summarised in the Figure indicate that TOA may dissociate and that part of the resulting octyl radicals bind on the top face of $h-$BN but do not intercalate between the interface of $h-$BN and



Experimental XPS spectra of nitrogen, carbon and boron on h-BN/Rh(111) before (black) and after TOA treatment at normal emission (green), and at 84° grazing emission (blue). The differences between green and blue are depicted in orange. The photon energy is 850 eV, and all signals are normalised with their corresponding photoemission cross sections. The grazing angle data are scaled with a factor of 5.7 such that the carbon peak heights coincide. Bottom panels: Cross-sectional views of structures from XPS calculations before and after TOA treatment. The octyl radicals bind to a boron atom (pink) in the h−BN nanomesh pores.

rhodium. This functionalization scheme realises $h-$BN Janus membranes with two distinct faces which may become of use for biasing the transport direction of ions across such membranes.

Due to the required kinetic energy and resolution of the photoelectrons the XPS experiments were performed at the photoemission and atomic resolution laboratory (PEARL) beamline at the Swiss Light Source of the Paul Scherrer Institut.

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Highlighted Publications:

1. Catalyst Proximity-Induced Functionalization of $h-$BN with Quat Derivatives
   A. Hemmi *et al.*, Nano Letters **19**, 5998 (2019)
2. Circular dichroism and angular deviation in x-ray absorption spectra of $Dy_2ScN@C_{80}$ single-molecule magnets on *h*-BN/Rh(111)
   T. Greber *et al.*, Phys. Rev. Mat., **3**, 014409 (2019)
3. Production and processing of graphene and related materials
   C. Backes *et al.*, 2D Mater., **7**, 022001 (2020)