Quantum Physics at the Edge

The Solid State Physics group
Experimental Physics
Chalmers University of Technology and Göteborg University
Sweden

Films, Islands and Wires

Lars Walldén, Stig-Åke Lindgren, Håkan Ohlin, Marcus Breitholtz and Theresa Kihlgren investigate low dimensional systems where quantum effects are prominent. An example of low dimensional systems is thin films of alkali metals in which quantum well states are formed. The electron structure in these states are investigated by scanning tunnelling spectroscopy and photoelectron spectroscopy.

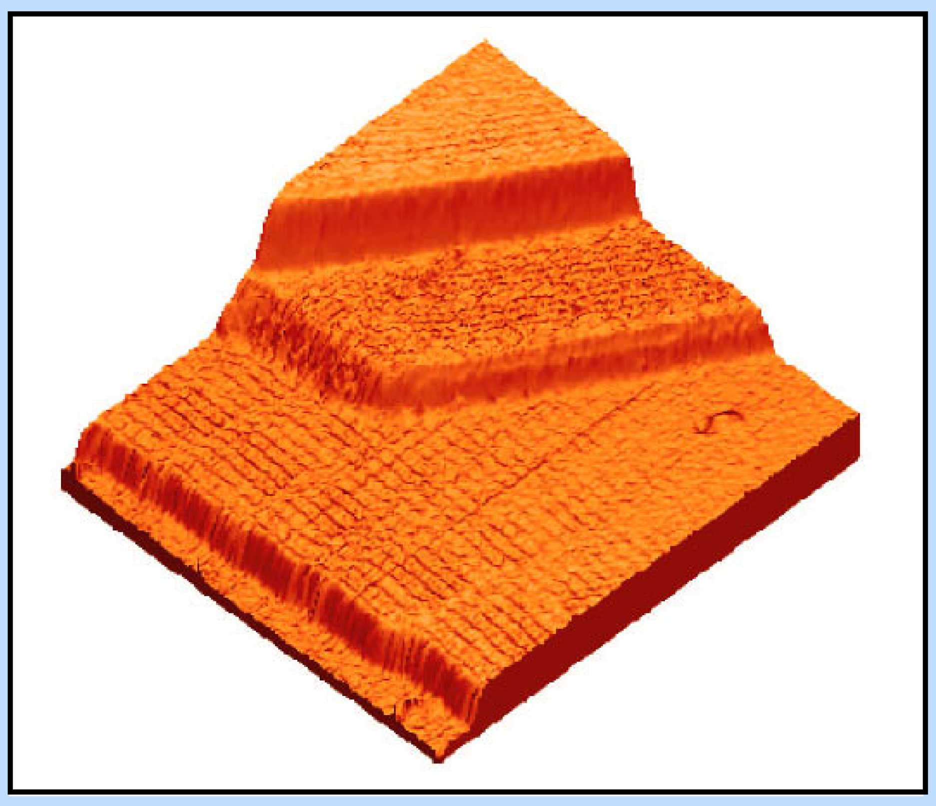

Figure 1. A STM image showing a 2-5 ML thick sodium island grown on graphite. Standing waves appear due to the quantum wells within the layers in the island. The scan size is 20 nm x 20 nm.

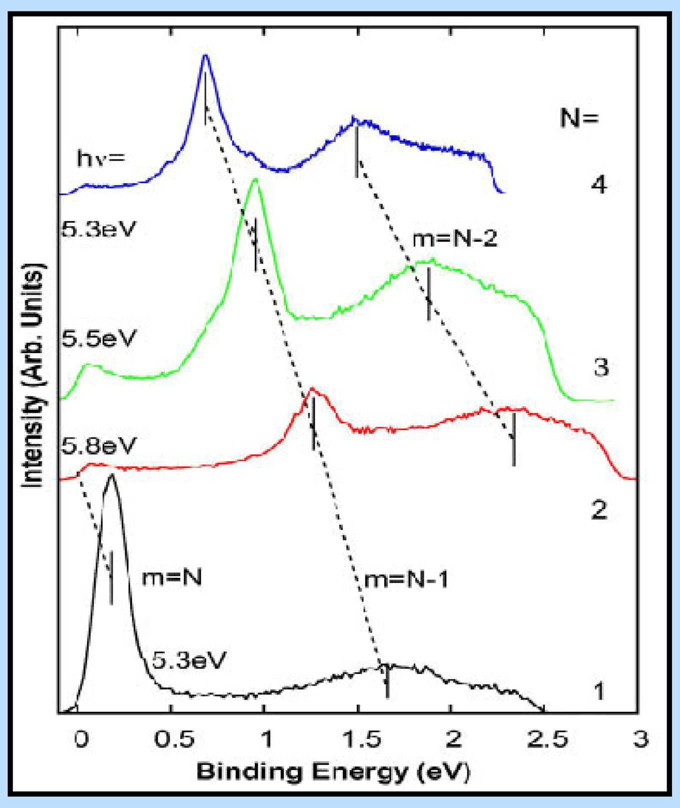

Figure 2. Normal photoemission spectra showing 1-4 ML Na films on graphite. Given in the figure are the photon energies (hv), the number of atomic layers (N) and the number of nodes in the films (m).

Infrared spectroscopy of molecules on surfaces

Kristian Gustafsson uses Fourier transformed infrared spectroscopy to study the vibrational modes of atoms and molecules adsorbed on surfaces.

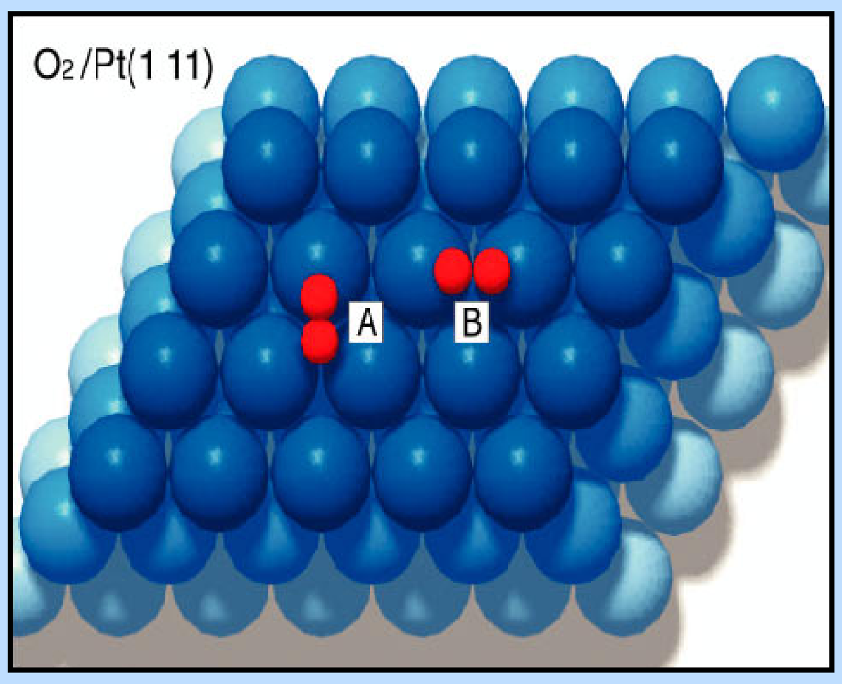

Figure 3. Oxygen molecules adsorbed at fcc (A) and bridged (B) sites on a Pt(111) surface.

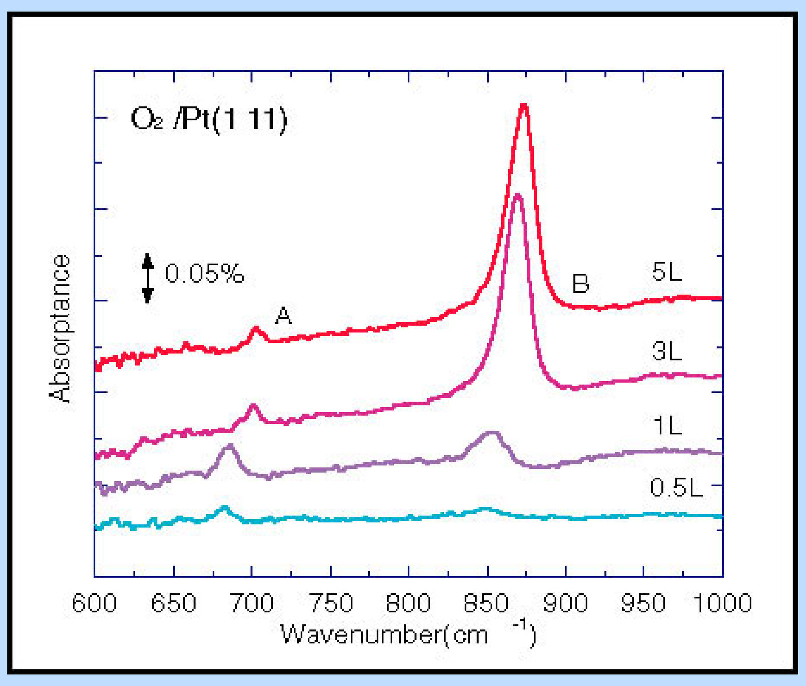

Figure 4. Infrared absorption spectra of a Pt(111) crystal exposed to several different doses of oxygen at 90 K, as indicated in the figure ($1L=10^{-6}$ Torr s). A and B refer to molecular oxygen positions shown in figure 3.

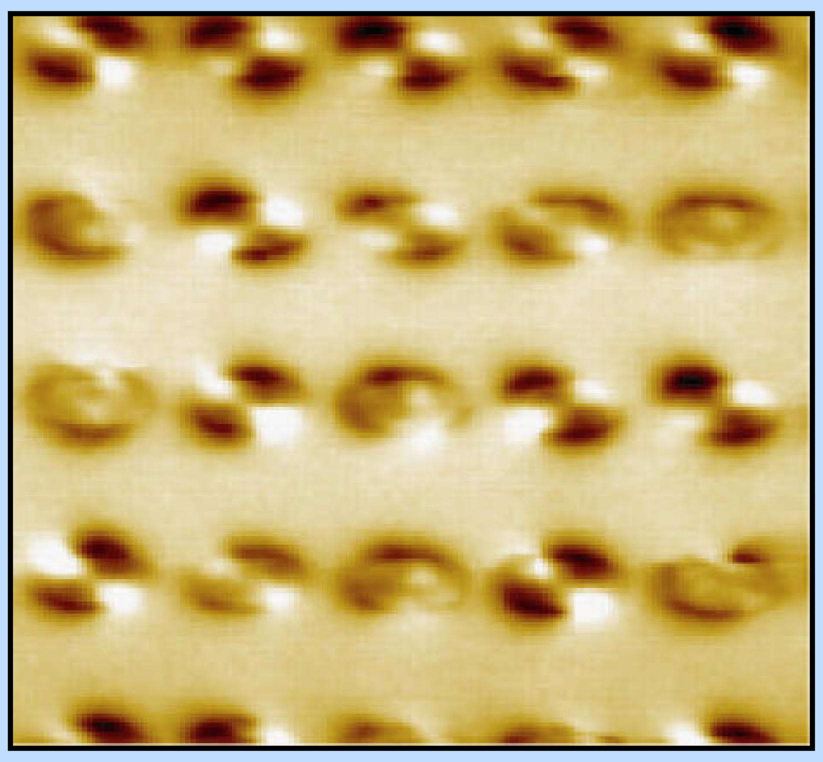

Figure 5. Non-interacting particles, comprising at least two magnetic domains. The shortest distance between the particles is 450 nm and the scan size is 5 µm x 5 µm.

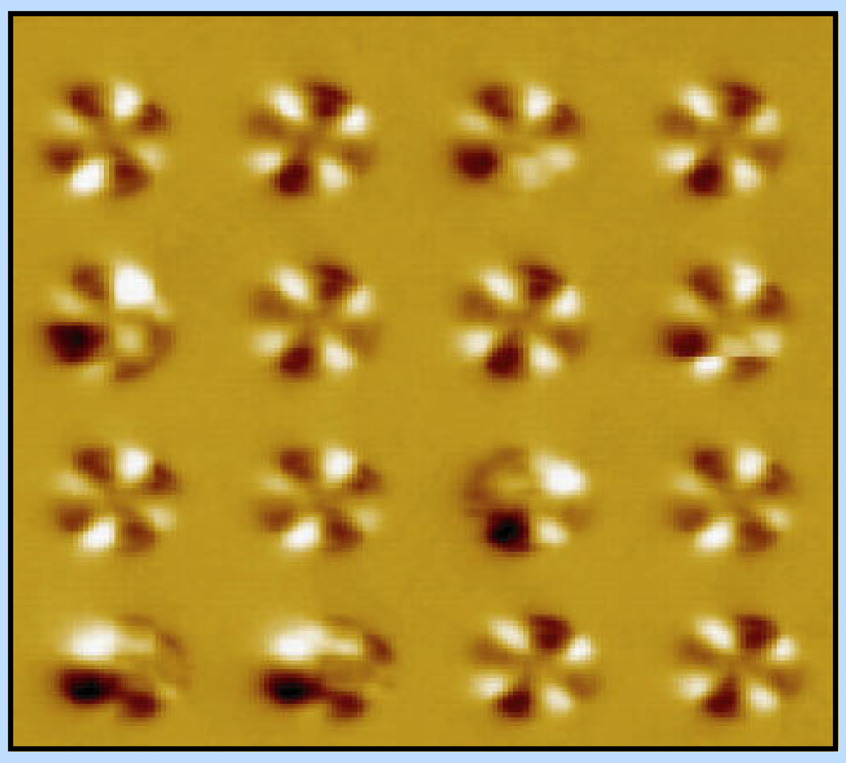

Figure 6. Groups of four interacting ellipses positioned in a square with a minimum distance of 100 nm. As can be seen, a single-domain state is stabilized in these particles and their individual moments align forming a closed magnetic structure. The scan size is 7 µm x 7 µm.

Nano-magnets

Maj Hanson and Olga Kazakova investigate how the magnetic properties of films and multi-layers are affected when their lateral dimensions are decreased to the range below 1 µm. An example is given in figures 5 and 6 showing MFM images of elliptical particles, with axes 150 and 450 nm and thickness 35 nm, prepared by electron lithography from Fe2ML/Co6ML multilayers.

Interface Modeling

Bo Hellsing, Johan Carlsson and Vanja Lindberg perform ab initio electron structure calculations on grain boundaries in doped ZnO and metallic overlayers shown in figure 7. They also investigate phonon induced lifetimes of surface and quantum well states. In another project, total energy calculations are performed for molecule adsorption on metallic quantum dots (see figure 8) with applications in nano catalysis.

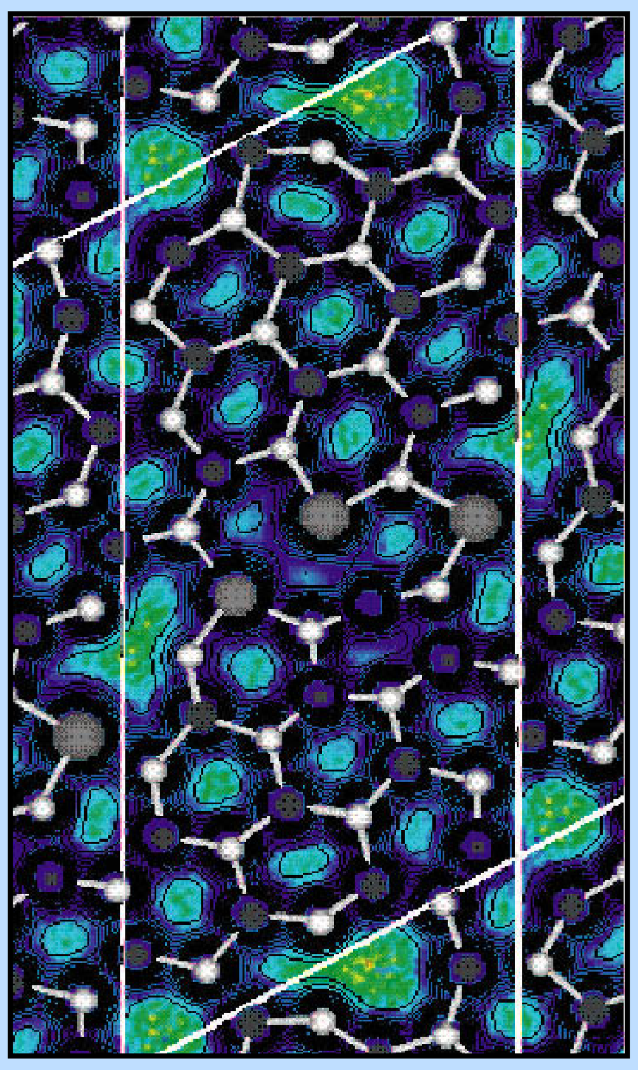

Figure 7. Electronic structure of a Bi-doped Σ=13 tilt grain boundary in ZnO. The colour coding represents the effective potential, blue means attractive and green means repulsive potential. The black lines represents the charge density.

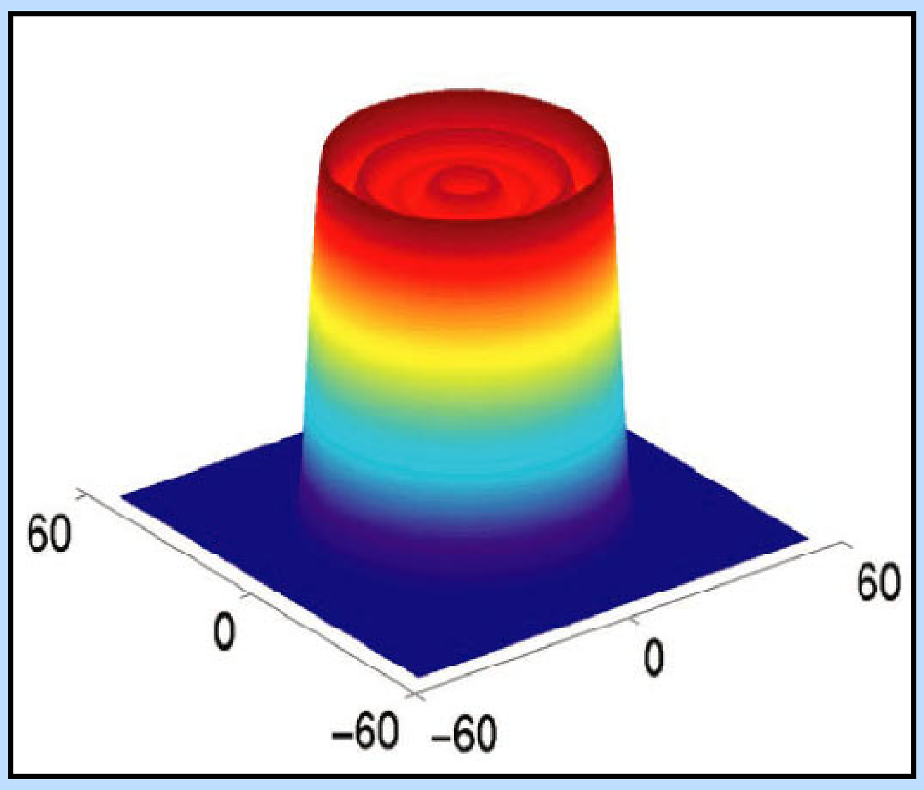

Figure 8. Total valence electron density of a cylindrical Na Quantum Dot with a radius of 36.4 a.u. corresponding to 100 electrons.