Goal: Fabrication of 1D nanoscale structures (quantum wires) on Si
- Self-organized adsorbate induced faceting
- Step arrangement control
- One-dimensional mesoscopic system
- Growth of nanowires

Au-induced giant faceting of vicinal Si(001): a template for the growth of nanowires.

S. Heun¹, Th. Schmidt¹, B. Ressel¹, E. Bauer², F.-J. Meyer zu Heringdorf³, P. Zahl³, R. Hild¹, and M. Horn-von Hoegen³.
¹Sincrotrone Trieste, 34012 Basovizza (TS), Italy.
²Arizona State University, Department of Physics and Astronomy, Tempe, AZ, USA.
³Institut für Festkörperphysik, Universität Hannover, Appelstr. 2, 30167 Hannover, Germany.

References:

Au-induced faceting of vicinal Si(001):
(a) Starting surface: ordered double steps, terrace width 4 nm. Gold deposition at 850°C: gold adsorbs as lattice gas.
(b) At critical coverage of ≈0.3 ML: Formation of flat and elongated (001) terraces, stabilized by (5x3.2) reconstruction.
(c) Upon further gold deposition: Terraces grow, step bunches become steeper.
(d) When inclination angle reaches 16°: Step bands transform into (119) facets. Faceting process is completed.
Typical structure length: several millimeters, (001) terrace width: 300nm - 1µm, (119) facet width: 50 nm - 300 nm.
(e) Further gold deposition: Formation of 3d clusters on the surface.

Nanospectroscopy with the SPELEEM at ELETTRA:
Integral photoelectron spectrum of clean Si.
Inset: XPEEM at the Si 2p core level (E_bulk = 28 eV). Field of view: 12 µm. hν = 128 eV.

Integral photoelectron spectrum of completely faceted sample. Si 2p core level line shape and position unchanged.
Inset: XPEEM at the Si 2p core level (E_bulk = 28 eV). Field of view: 12 µm. hν = 128 eV.
XPEEM on a partly faceted sample. Field of view: 12 µm.
Left: Image at the Si 2p core level.
Right: Image at the Au 4f core level. Contrast inversion. hν = 128 eV.
Laterally resolved photoelectron spectra from a stack of XPEEM images across the Au 4f core level. Green: (001) terrace. Blue: Step band. No chemical shift observed. Therefore: peak intensity ∝ local gold coverage. hν = 128 eV.

Fabrication of long metallic nanowires
How to grow in-situ metallic nanowires?
- Metal deposition under grazing incidence (already done, see SEM image).
- Step decoration with a suitable metal?
- Use of surfactant?
This work is in progress.

Figure captions:
- LEEM/XPEEM: LEEM/XPEEM:
- Nanospectroscopy with the SPELEEM at ELETTRA:
- XPEEM movie at the energy of the Au 4f core level. Field of view for each image: 12 µm. Photoelectron yield ∝ local gold coverage.
- Slice from each image displayed versus time:
  - Average gold coverage increases with time.
  - Terrace: When a terrace nucleates, the gold coverage increases instantaneously.
  - At the same time, the gold coverage on the neighboring step bands decreases.

SEM image of first Au-nanowires, ex-situ grown on a Au-faceted Si(001) surface. Nanowires are bright.