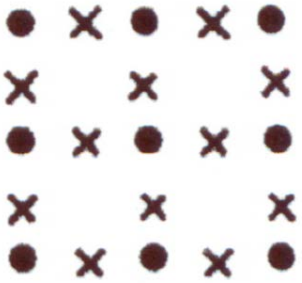
Übungen zur Oberflächenphysik

Blatt 5 – 30.04/1.05.2014

1) LEED – a 2nd attempt

Let's do the "LEED exercise" the other way around: assume that you obtain the following LEED pattern (dots = substrate; crosses = adsorbate). Reconstruct the real space situation.



2) RHEED

a) Please explain, why only surfaces with low index (Miller indices) occur and why Miller indices are used to describe lattice planes.
b) Why one finds spots in diffraction for all electron energies but only for selected X-ray photon energies?
c) What are the important characteristics of a diffraction system such as LEED and RHEED?
d) How one can discriminate between surface and bulk contributions to RHEED pattern?
e) What information we can extract from electron diffraction pattern of surfaces?

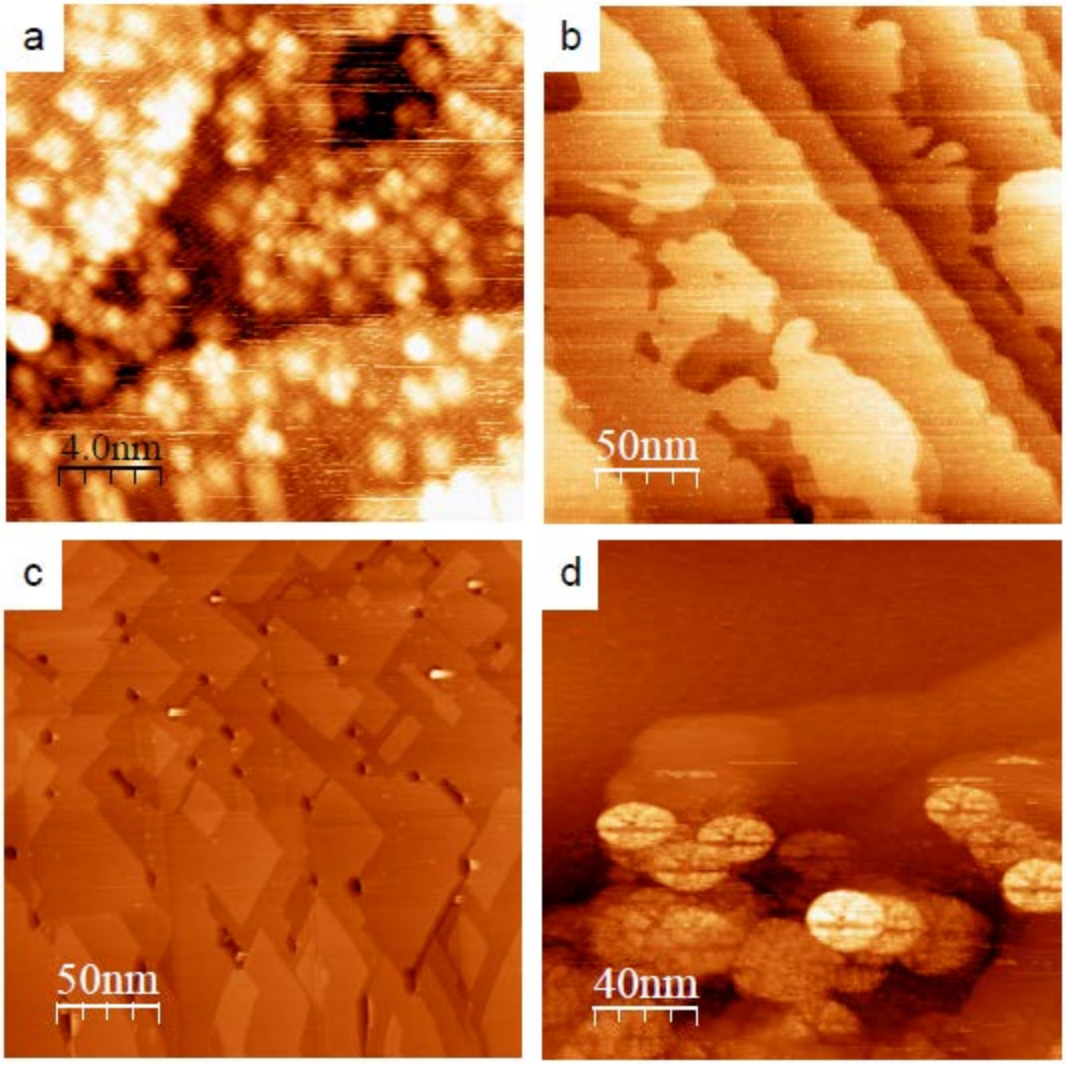
3) STM

a) Name the two different STM operation modes that are commonly used. For each mode, indicate which quantity corresponds to the recorded signal and briefly discuss the advantages and disadvantages.

b) Estimate the factor by which the tunneling current changes when decreasing the tip-sample distance by 0.2 nm (a typical mono-atomic step height). Assume a work function of 4 eV which is typical for a metal.

c) The crystalline structure of the surface of highly oriented pyrolytic graphite (HOPG) is such that one would expect to image the hexagons of a graphite layer. However, STM images show a triangular structure. Explain this phenomenon.

d) The following STM images all have an artefact. For each image, briefly discuss the reason of the artefact and how to avoid it.



4) STS

Describe qualitatively the I-V spectra for the following situations:

a) Tip and sample are metallic.
b) Tip is metallic and the sample is a semiconductor with a gap of ΔE1
c) The sample is a semiconductor with a gap of ΔE1 and the tip is also a semiconductor having a gap of ΔE2.
d) How does the temperature influence the I-V spectra?
e) Why are I-V spectra normally given in dI/dV?