AFM
ATOMIC FORCE MICROSCOPY

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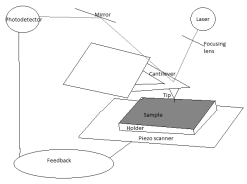
Scanning tunneling microscope
Řádkovací tunelový mikroskop

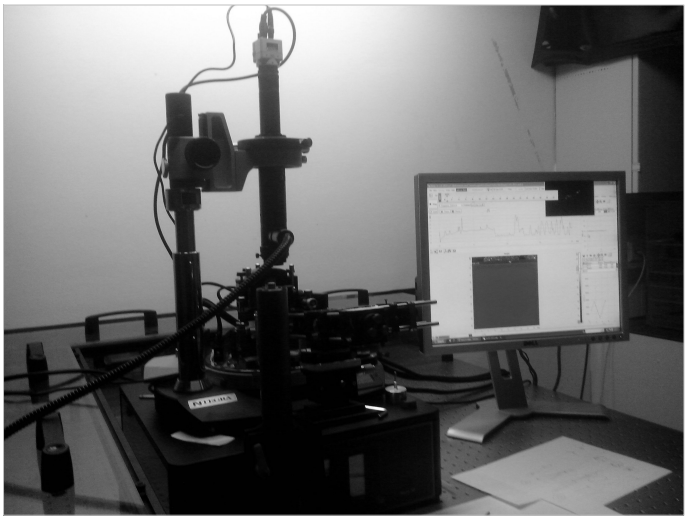
- 1981 G. Binning, H. Rohrer
- 1986 NP physics
- Tunneling current – electrons in small vicinity over sample surface – when approached by tip ended by single atom.
- Current changes with distance of tip from sample.
- With combination of XY piezoscanner we can obtain topographic image
- Conducting and SC surfaces
- Charles university, Doc. Peksa: “rejpání hřebíkem do kusu plechu”

http://krystal.karlov.mff.cuni.cz/FPL145/stm-afm.pdf

Atomic force microscopy/ scannig force microscopy/ mikroskopie atomárních sil

- 1986 further improvement of STM
- Suitable also for insulants, biological samples (very popular in live cell imaging)
- Various modes
- Non-contact
- Tip oscillating in small height over sample, influences from forces (VDW, TC) – change of amplitude
- Piezo – changing the oscillation magnitude via voltage change
- Laser as optical leverage (500x feedback gain)
- University of Vienna, prof. Kautek – „Blind man with stick“





Why to use AFM and not SEM?

- We do not need vacuum (biological samples)
- 3D profile
- No charging artifacts – no coatings
- Samples in liquid enviroment measurable

Why is then SEM more common?

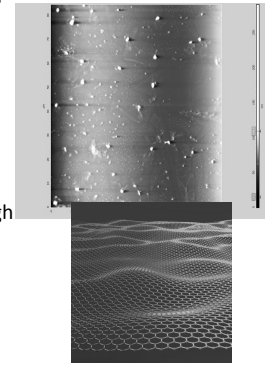
- Very low scannig speed – 10-15 min. scan with good resolution – 0,5 Hz scanning speed – 1 line 2s, hundreds of lines
- Image artifacts from tip, sample
- Single scan image size (SEM – mm; AFM – ≈100 µm)
- Cannot measure steeps walls, overhangs

Experimental problems

- Fragility of tip (carbon nanotubes)
- Aiming the laser PD to tip (diffraction pattern visible on paper sheet put behind, greatest intensity)
- Landing the tip fast steps/ slow continuos landing
- Finding clean (relatively) surface on sample

Graphene

- Single sheet of Csp2
- Monolayer of graphite
- 1962 H.P. Boehm
- Exquisite properties –
- Zero band gap SC
- Optically transparent – yet high opaqueness for ML
- Great strenght and elasticity
- Extreme electron mobility
- Some other quantum effects anomalous (Hall, Kerr)

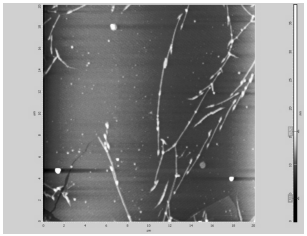


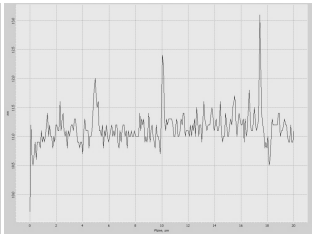
http://www.britishcarbon.org/images.shtml

Graphene

20x20 µm Scan of Graphene surface

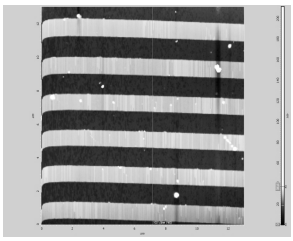
X-crosssection



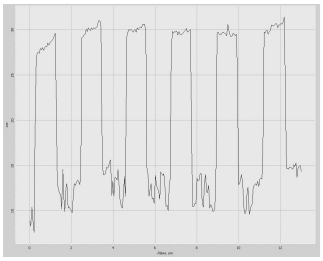


Crating

Crating Scan 15x15 µm

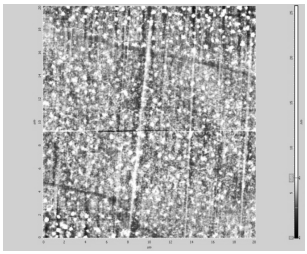


Cross-section in Y direction of Crating



Polycarbonate

20x20 µm Scan



X-crossection