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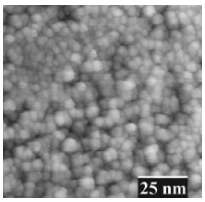
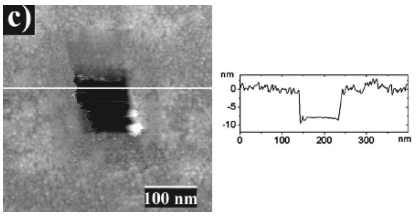
Production and Nanolithography on Silicon Nanoparticle-Films

Mag. rer.nat. Stefan Jaksch

The idea

- We want to produce stable and homogeneous films of silicon nanoparticles
- Investigate and manipulate (nanolithography) these films with the STM
- Tests showed very strong dependence of sputtering parameters

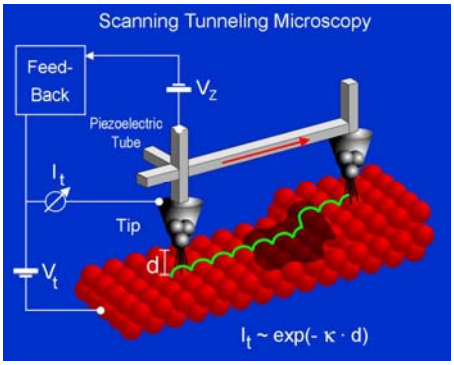




P. Scheier, B. Marsen, and K. Sattler J. Appl. Phys., Vol. **94**, No. 9, 6069 (2003)

Principle of STM

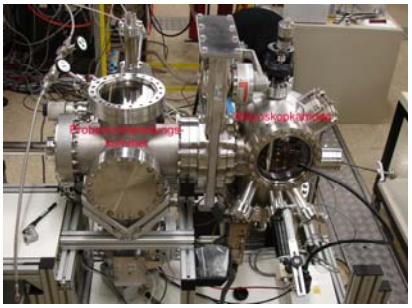
- Quantum mechanical effect of tunneling
- Voltage between surface and tip
- Measurement of tunneling current
- Tip rasters over the sample driven by a piezoelectric tube



http://dpmc.unige.ch/gr_fischer/localprobe.html

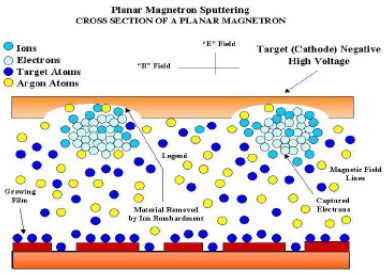
Experimental setup and specifications

- Transfer- and sample preparation chamber with magnetically coupled manipulator
- Valve for separating the 2 parts of the setup
- ‘Vibration-free’ system
- STM and Needeling possible
- Temperature range 25K to 1300K



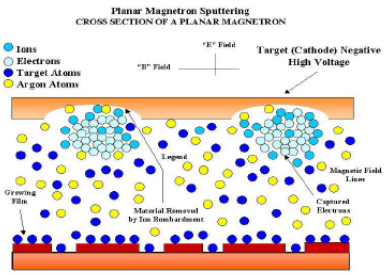
Principle of the sputter source

- Argon is used as sputter gas
- Cathode (Target material) is set to a negative voltage of some 100V
- Rest of the chamber acts as anode on gnd
- Ar is ionised and hits the target



Principle of the sputter source

- Silicon atoms are emitted from the target and follow the field lines
- During their fly the silicon atoms form clusters and leave the field lines
- Silicon clusters land on the HOPG surface



MAK Manual Sputter Source

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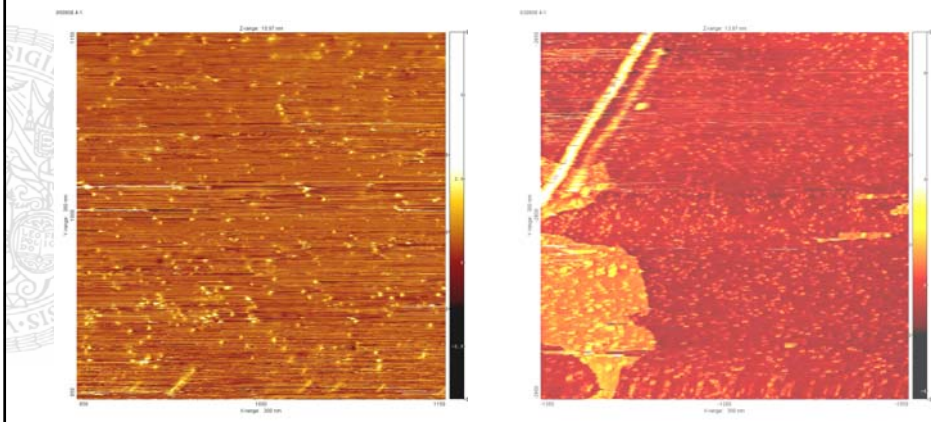
Characterization of the source

- Different parameters
  - distance / geometry
  - pressure
  - current
- Distance has the largest influence
- Pressure takes effect in the amount and the sticking coefficient of the clusters
- Current affects the amount of sputtered silicon

Growth of Silicon films

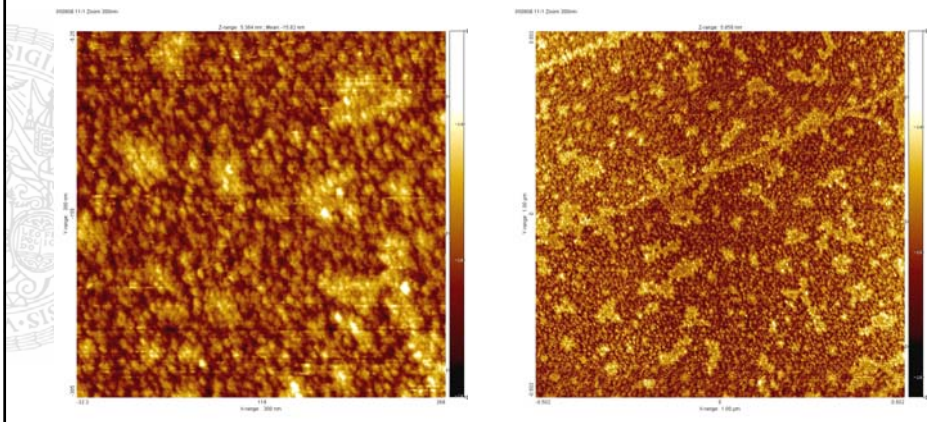
Time of Sputtering: 15s (l), 30s (r)



300nm 300nm

Growth of Silicon films

Time of sputtering: 60s



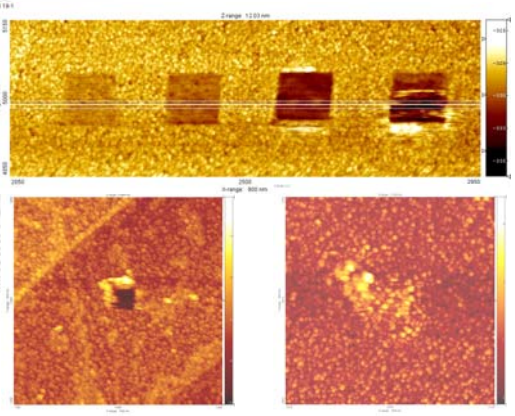
300nm 1000nm

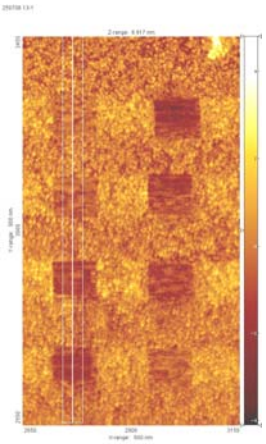
Conclusions for growth of Si films

- Clusters stick poorly on the HOPG and have a high mobility
- Clusters are well sticking on edges or defects of the HOPG
- Clusters form little islands and grow layer by layer
- Films are very homogeneous over huge area
- Cluster size approx. 7nm
- Growth rate differs for different current and pressure

Manipulation of the films

- Vaporization of clusters with a high current
- Wiping away the clusters with the tip
- Fusion of clusters with a high voltage





Conclusions and Outlook

- A greyscale could be done by vaporization and fusion of siliconclusters
- The different effects wiping, vaporization and fusion will be investigated further on by different parameter sets and spectroscopy
- With a very thin film (15s), the properties of single clusters could be investigated
- Characterization of the magnetron sputtering (ionic clusters, variation of cluster speed, biasing the sample, …) is just in progress
- Deposition of single molecules on HOPG and manipulating them with tunneling electrons

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Thanks for your attention!

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