Some Basic Principles of AFM Sample Preparation

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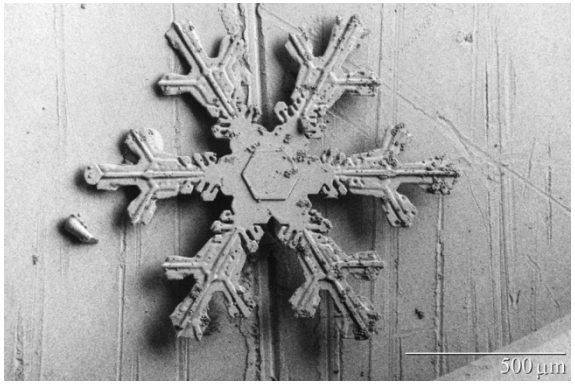
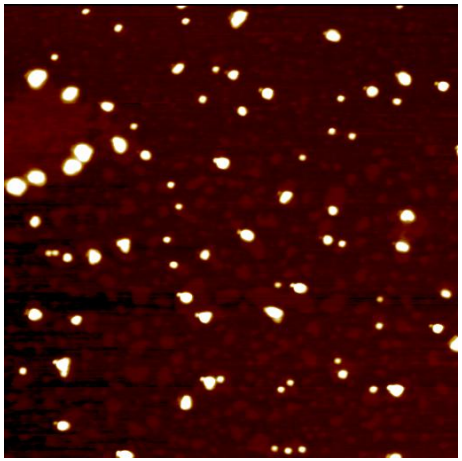
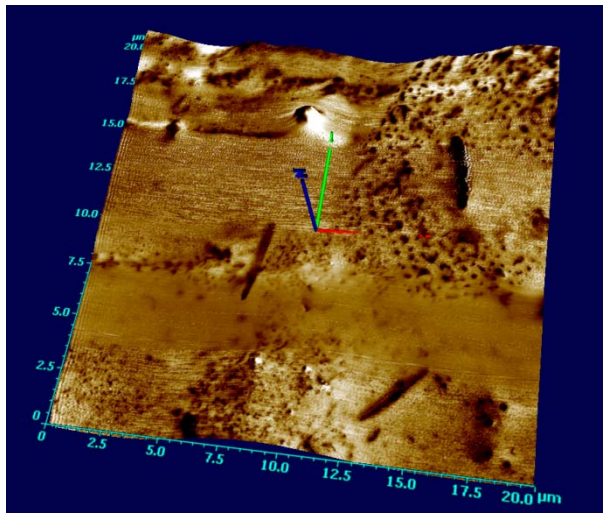
Basic principle of sample preparation I: separation



Snow flak and packed snow



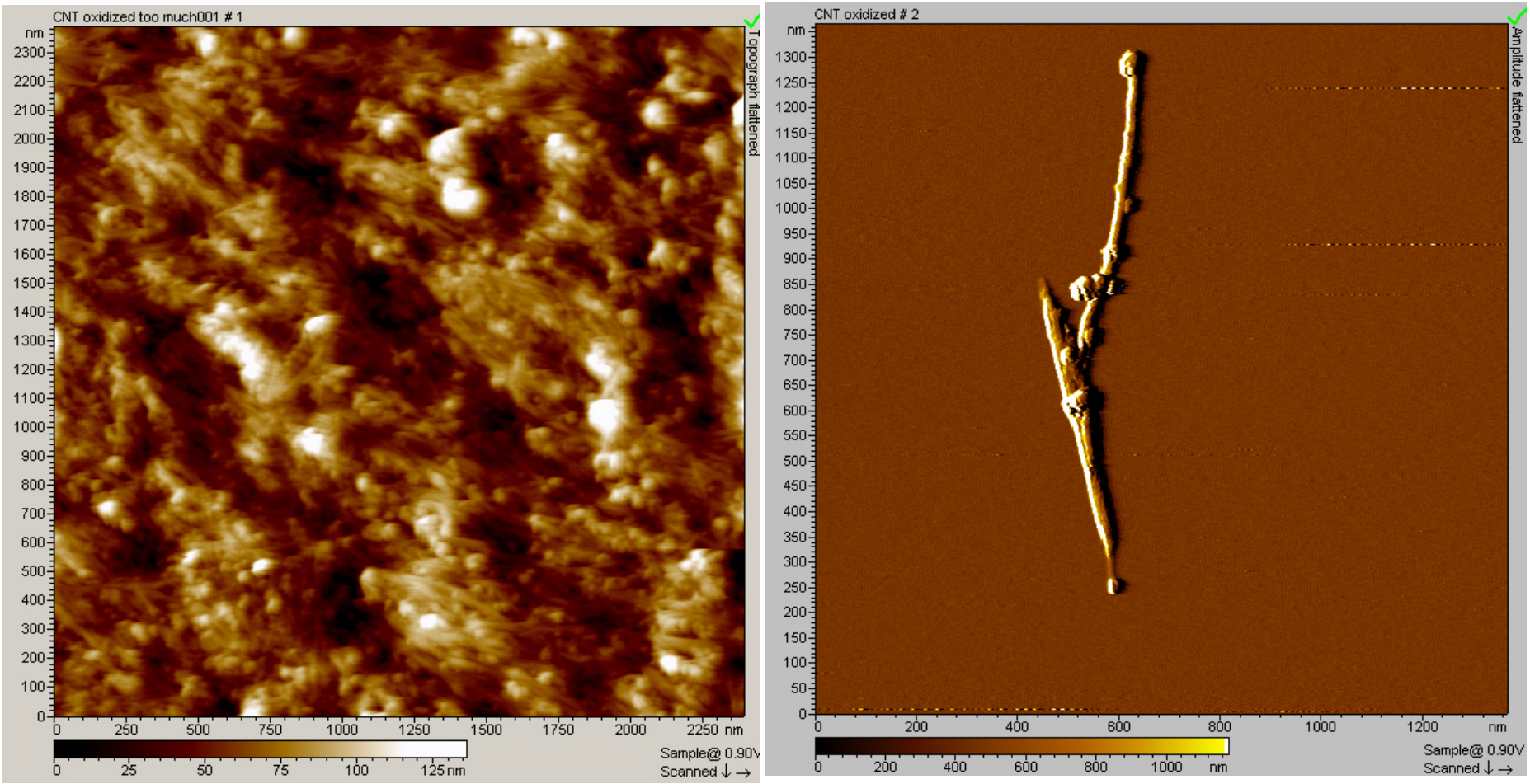
5nm and 10nm gold nanoparticle on glass slide



Techniques of separation

- Lower concentration
- Charge based separation: a molecular level separation.
- Solvent dispersion: for nanoparticles, colloidal, nanotubes.
- Sonication: extra energy to help.
- Use of dry air jet stream.

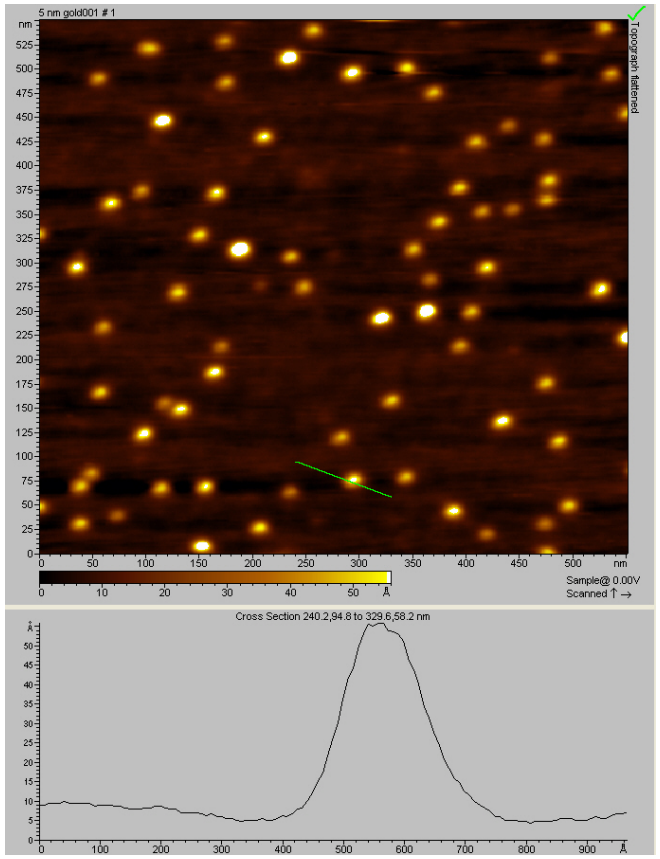
Concentration: the math of monolayer coverage

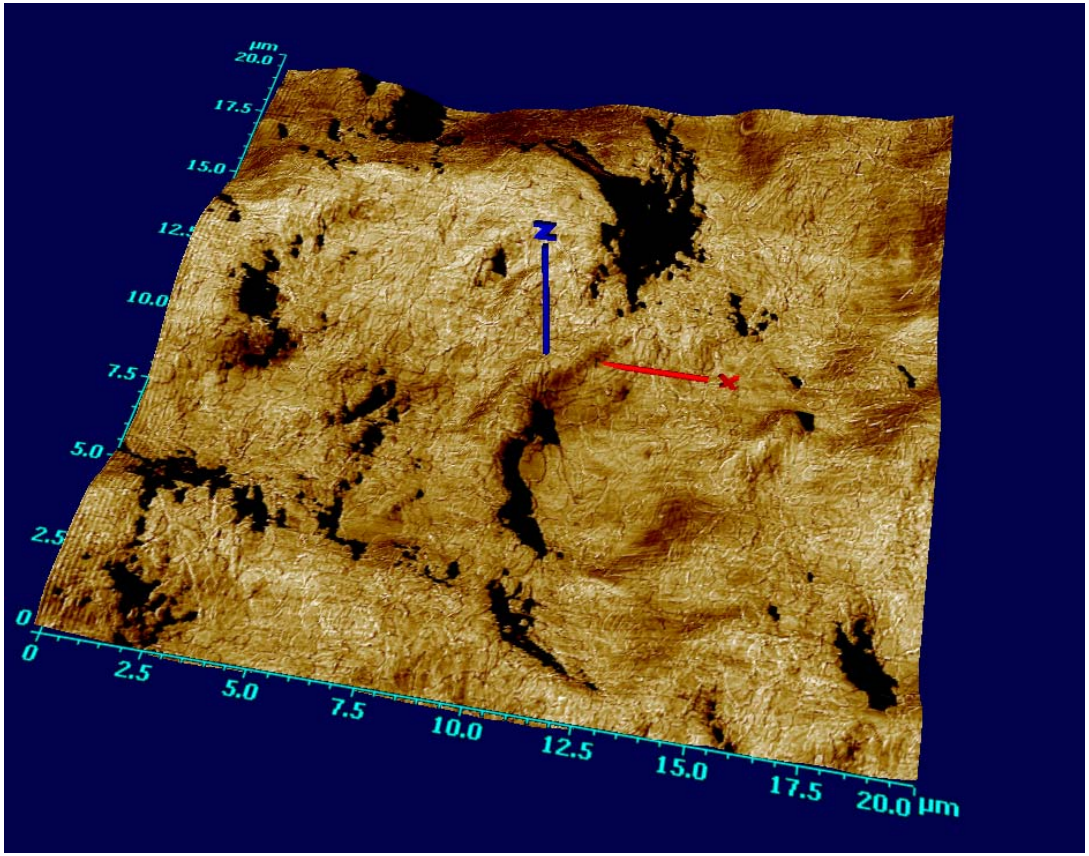


Oxidized nanotubes on mica

Basic principle of sample preparation II: choose a clean and flat substrate

Gold nanoparticles on mica vs. Platinum nanoparticle on fuel cell membrane





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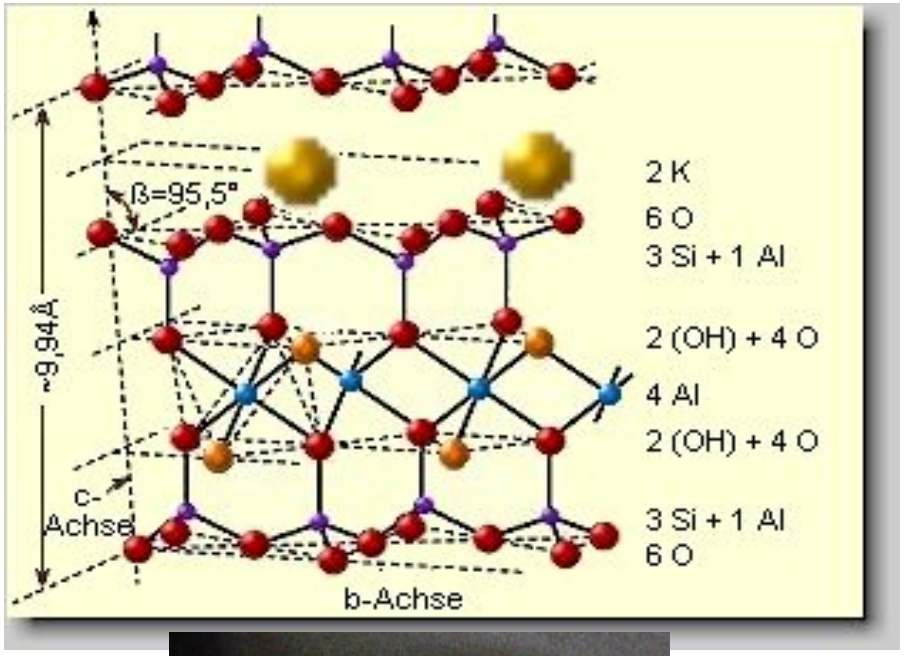
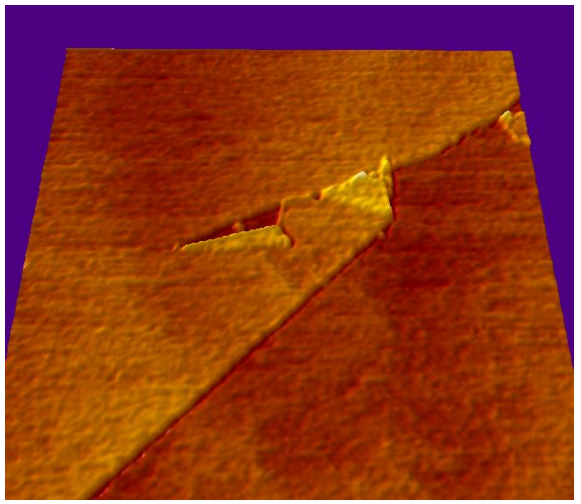
An atomically flat substrate: Muscovite Mica



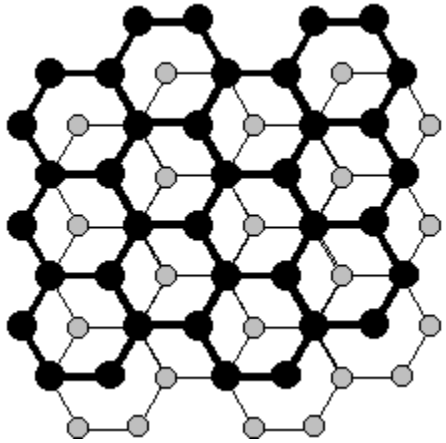
$[KAl_2(OH)_2(AlSi_3O_{10})]$

- Layered structure of Al, Si, O, & K
- Mechanically cleaved to produce clean, atomically flat surfaces
- Negative surface charge in pure water – strong electrostatic interactions
- Model substrate for adsorption studies

HOPG: Atomically flat surface with conductivity

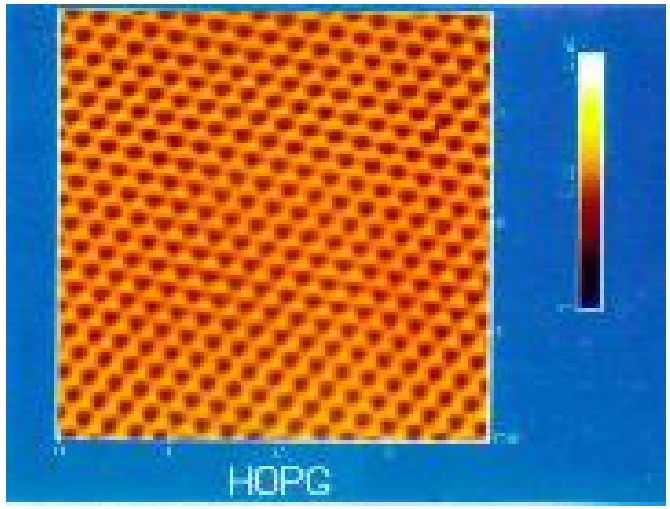


HOPG 500 x 500nm



Upper layer (A)

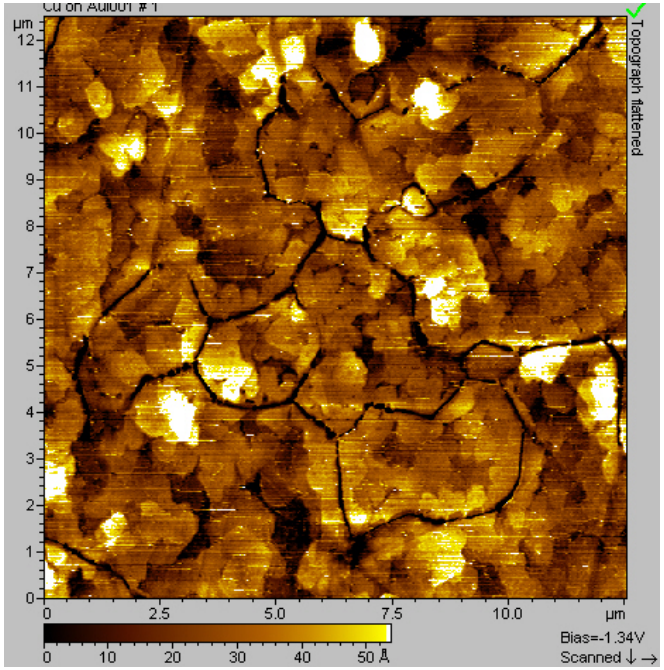
Lower layer (B)

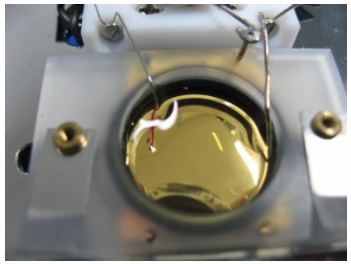


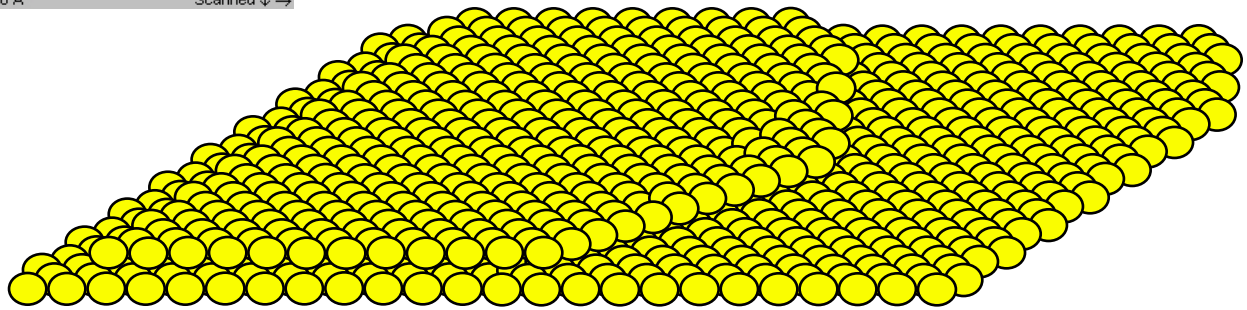
HOPG atomic resolution

A versatile substrate: Au(111)

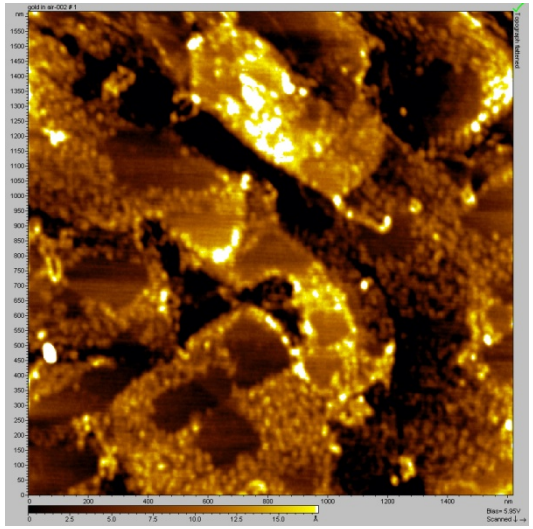
Thermo evaporated gold on mica



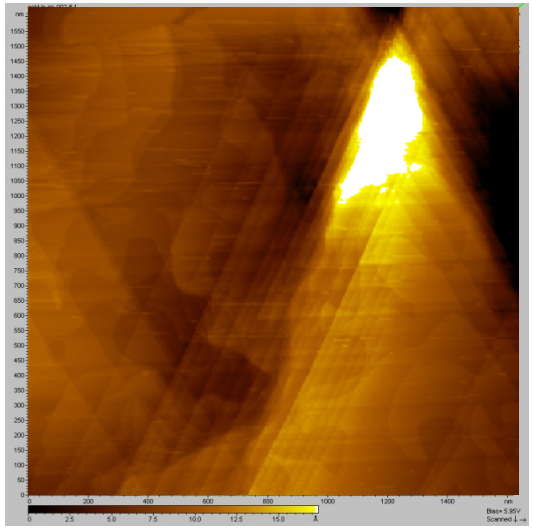




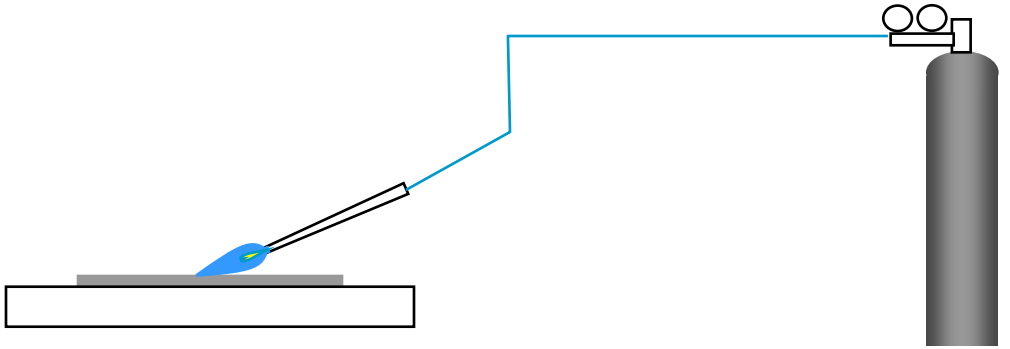
Cleanness of substrate



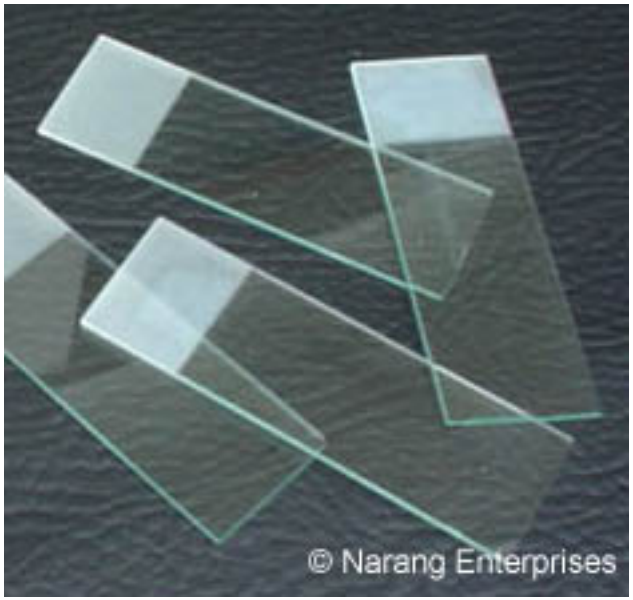
Au(111) after exposed in air for

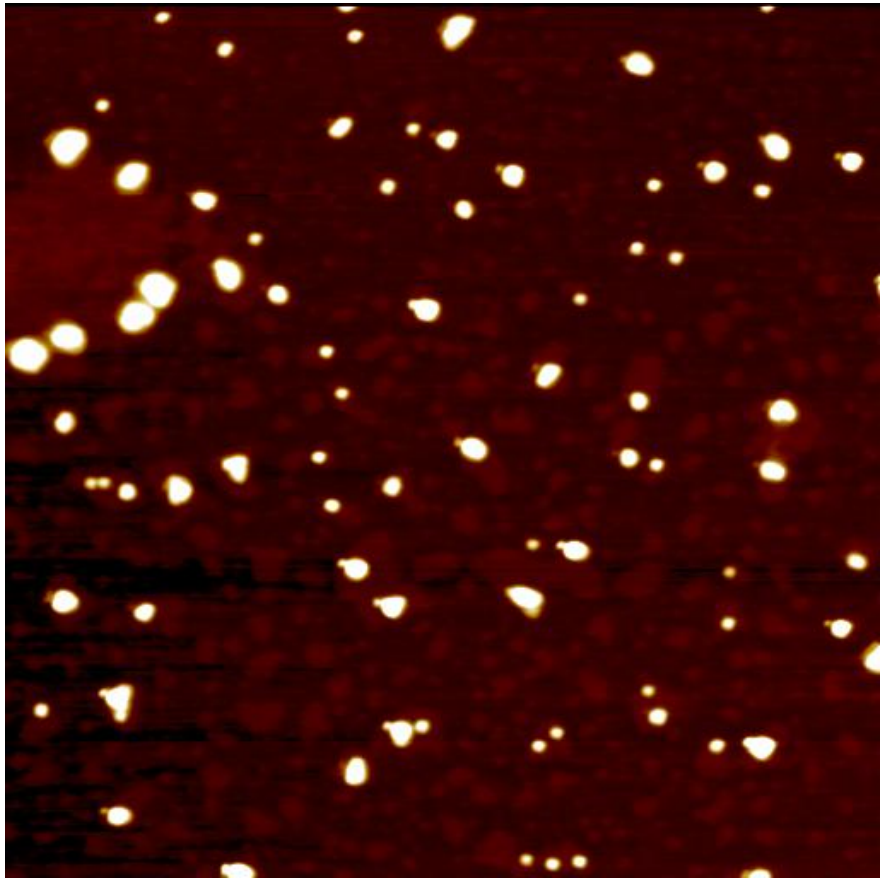


After hydrogen flaming



Glass slides

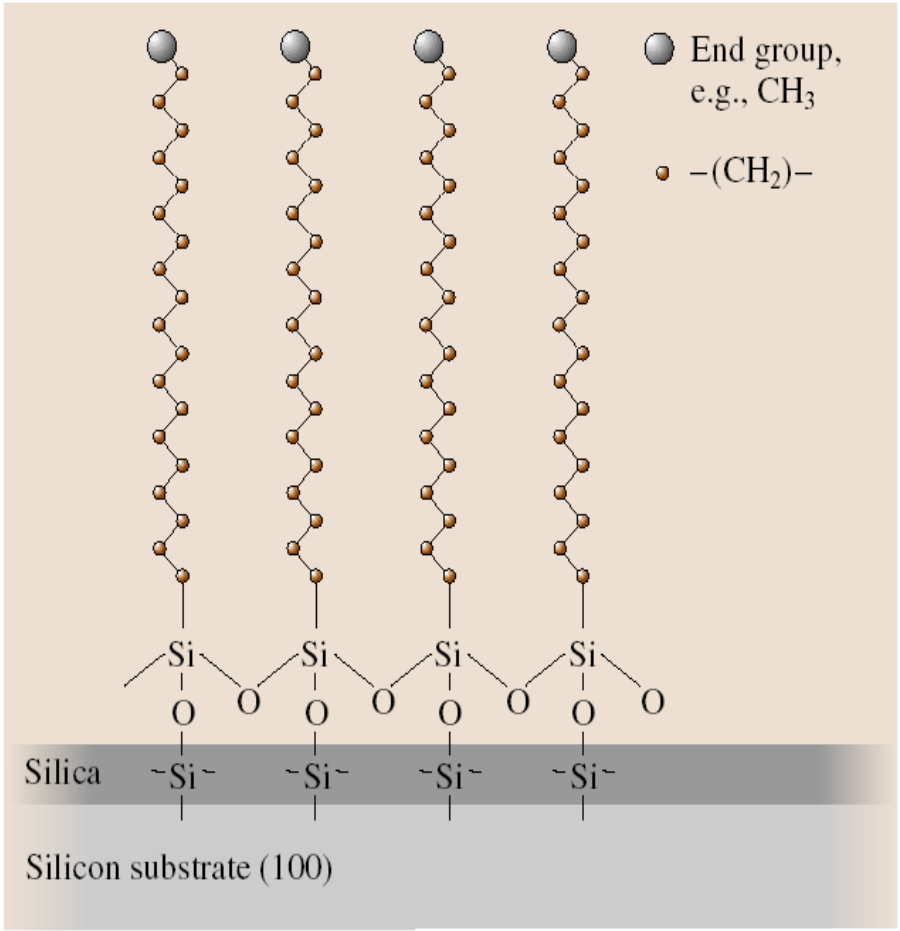




5 nm and 10 nm gold on glass slides

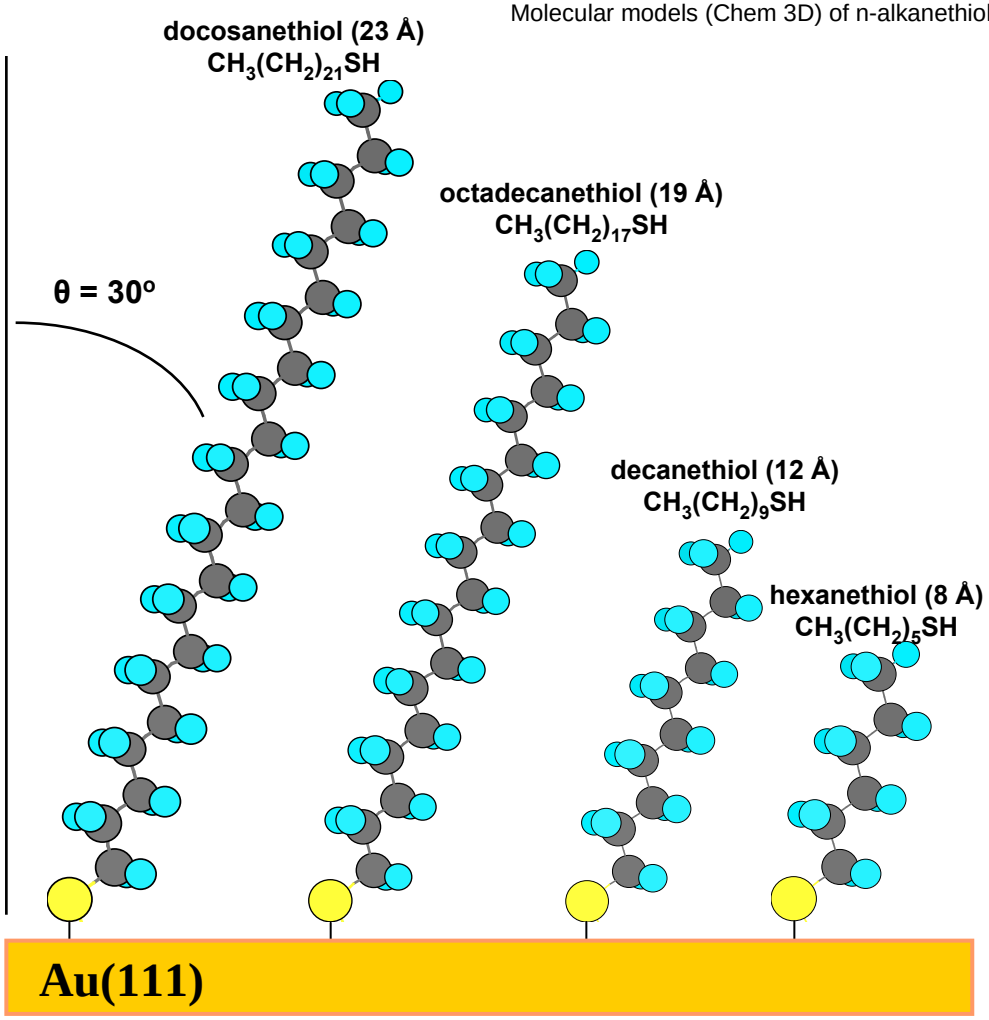
Sample Preparation Principle III: immobilization

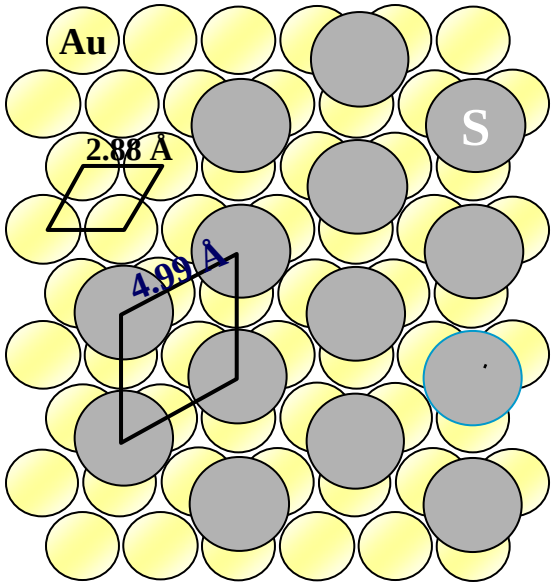
Functional Modification on Silica surface



Functional modification on Au(111):
n-alkanethiols/Au(111) self-assembled monolayer

Molecular models (Chem 3D) of n-alkanethiols/Au(111).

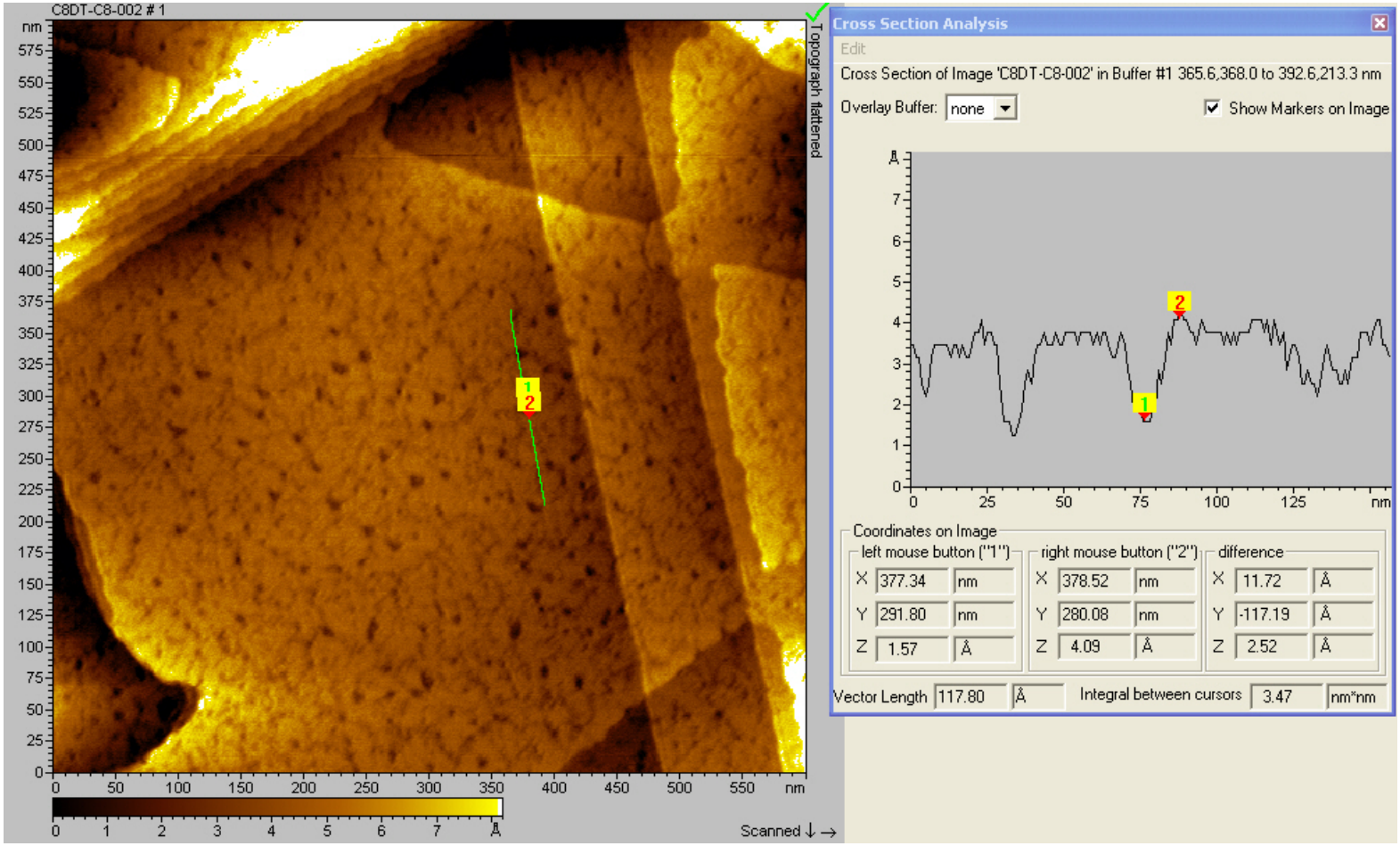




$(\sqrt{3} \times \sqrt{3})R30^o$

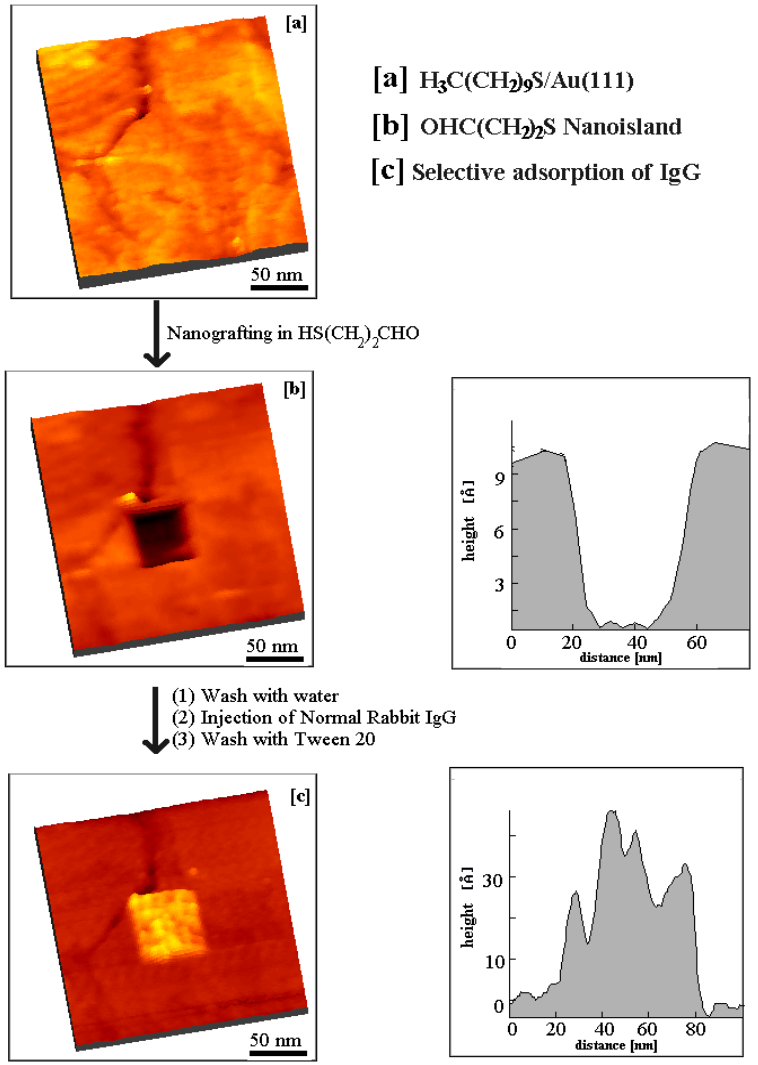
Surface structure of alkanethiols/Au(111). Sulfur (gray circles) binds at the triple hollow sites of Au(111).

Thiol self-assembled monolayer on Au(111) Highly ordered functional surface with internal height reference

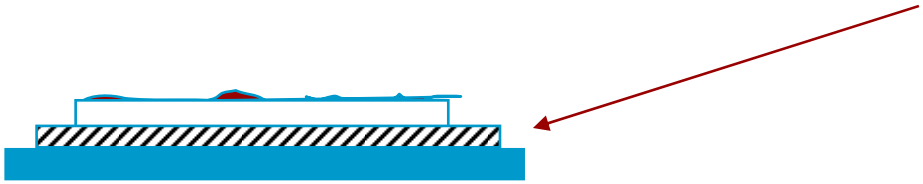


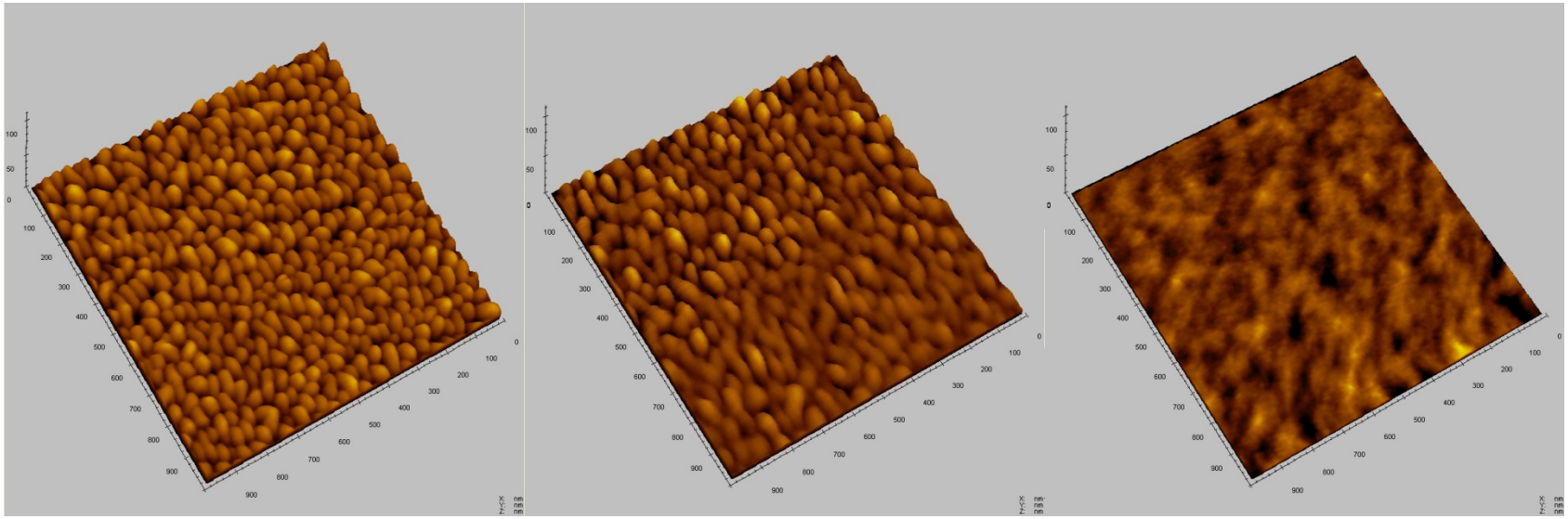
Surface functional group selected immobilization

Formation of Protein Nanosensors via Covalent Binding



Sample Preparation Principle IV: avoid use fixing material that cause drifting, creeping, contamination and peeling



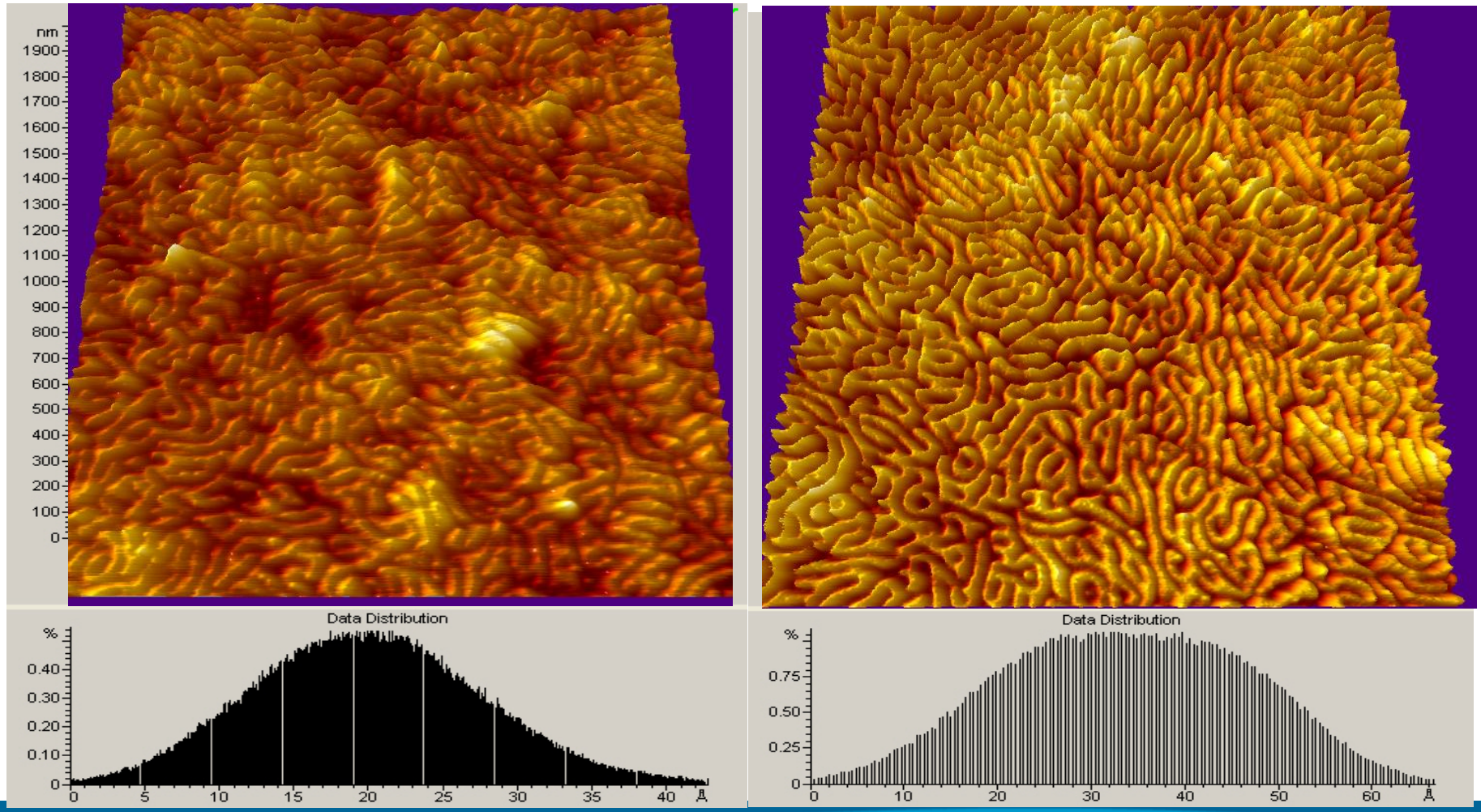


Room temperature 212 ~ 215 C 215 ~218C

BCP Toluene exposure

Before

after



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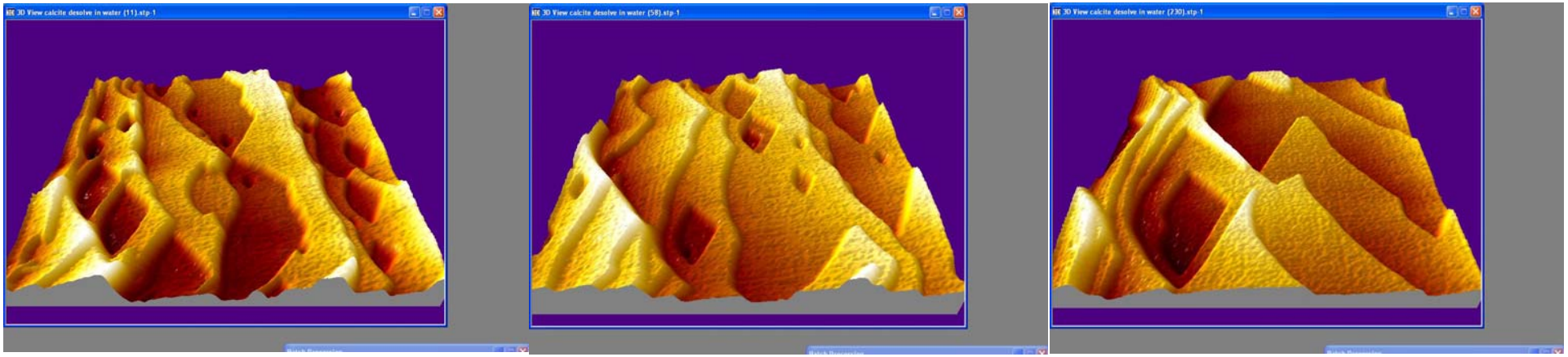
Example of Sample with unusual shape

Cleaved calcite dissolve in water



Conclusion

- Principle I: separate individual species and features from each other
- Principle II: choose a flat and clean substrate
- Principle III: immobilize the sample onto the substrate
- Principle IV: avoid any source of drifting, creeping and peeling.