Contra Costa College

Nanosphere Lithography via Continuous Convective Assembly

Simranbir (Simi) Hundal

Chemical Engineering

Contra Costa Community College, San Pablo, CA

Mentor: Erin Orazem Faculty Advisor: Dr. Steven K. Buratto

BURATTO GROUP

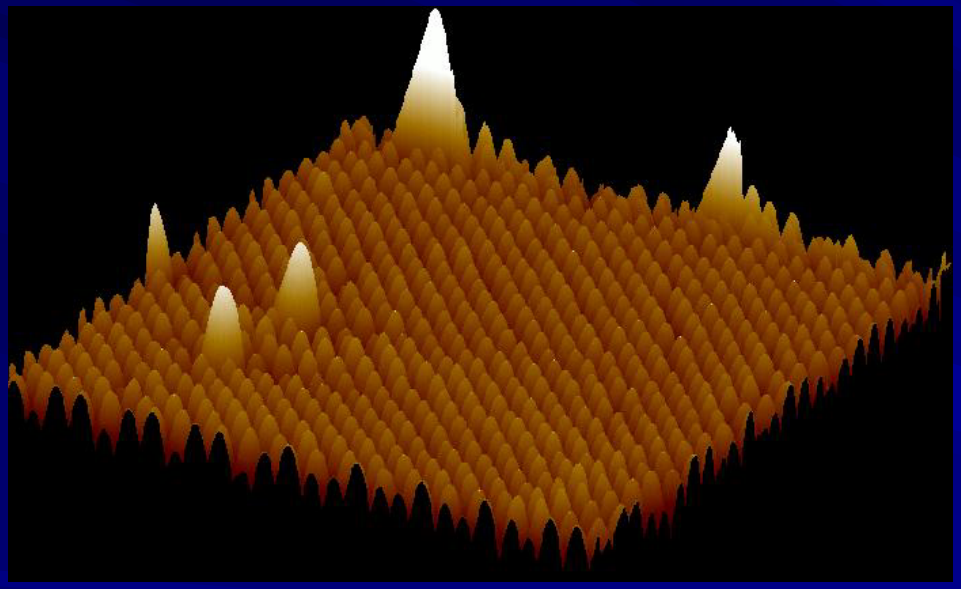
UNIVERSITY OF CALIFORNIA - SANTA BARBARA

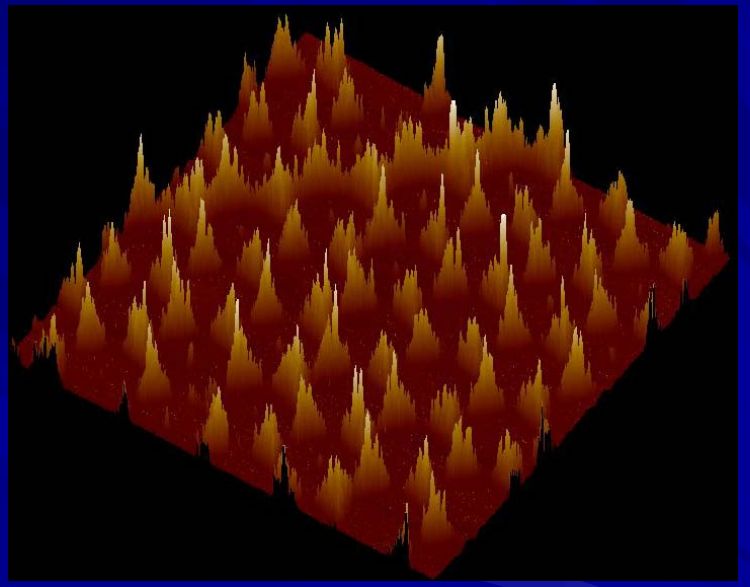
INSET

UCSB

The “Big Picture”

- Using nanosphere lithography to produce the largest possible coverage of silver triangles

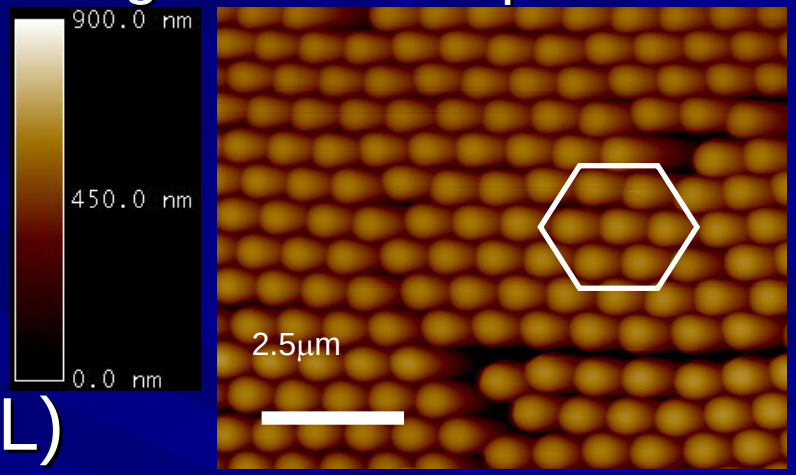




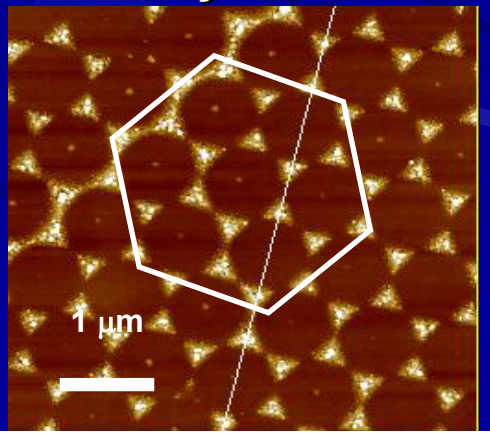
- Considered variables: cleaning solutions, nanosphere solution concentration, slide type, sphere size, and withdrawal rate

Methods

- Continuous Convective Assembly (CCA)
  - To create monolayer arrays of hexagonal closed packed nanospheres

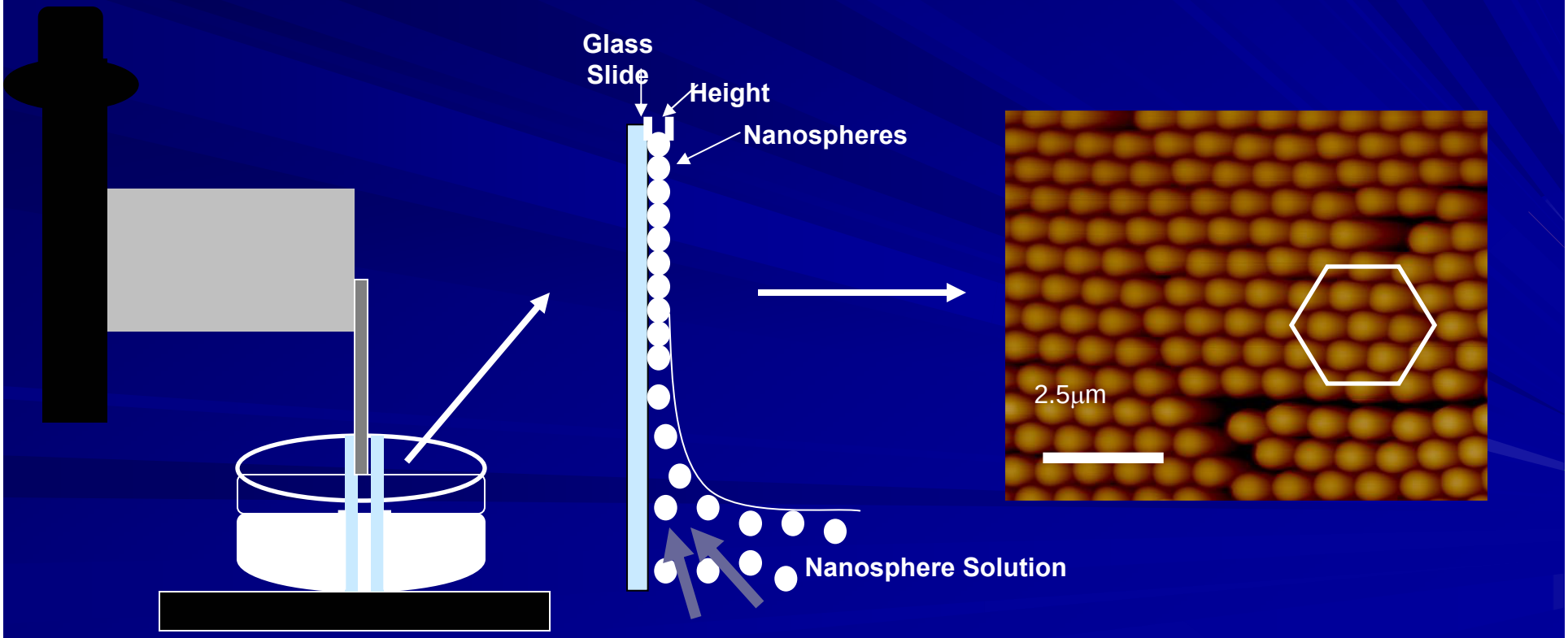


- Nanosphere Lithography (NSL)
  - Monolayers of nanospheres used as “masks” when evaporating with silver to generate ordered arrays of triangles.



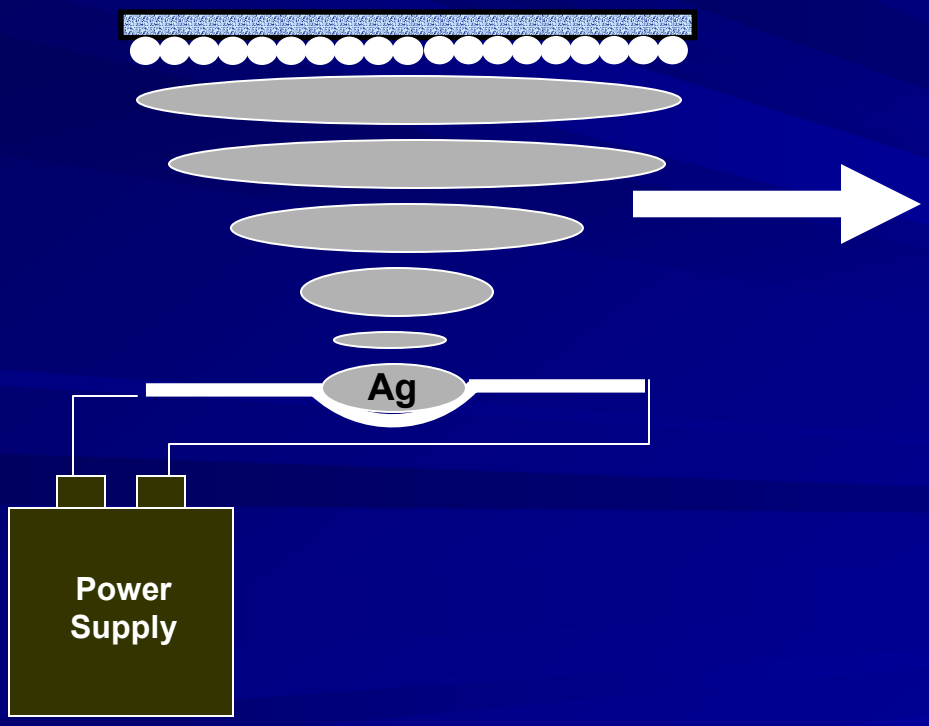
Continuous Convective Assembly using the Stepper Motor (Dippy)

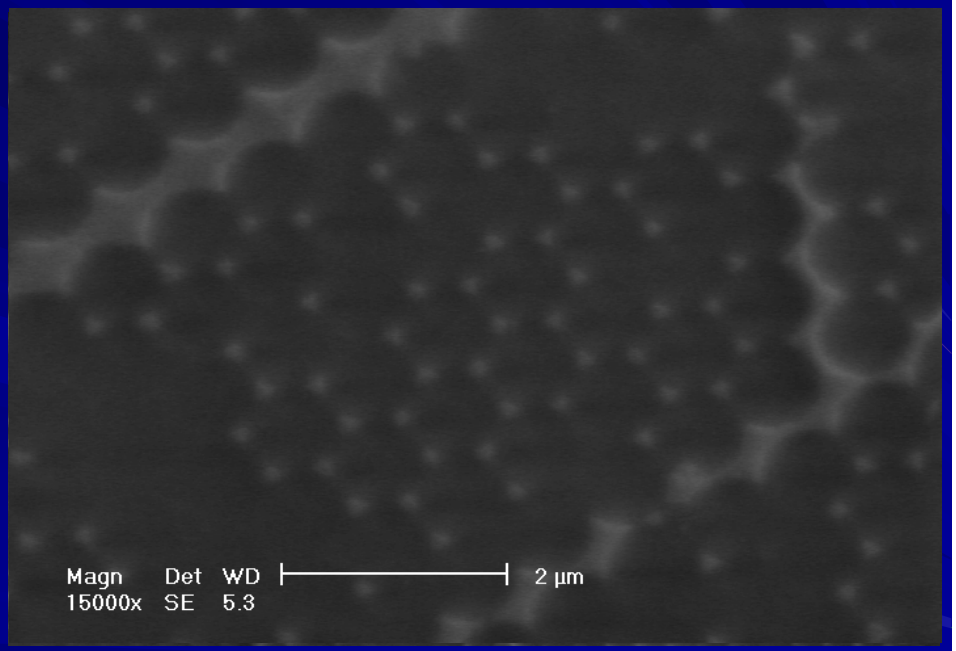
- Convective Assembly of the nanospheres on the slide
- Slide is withdrawn out of the solution at a particular rate (slow: ~60μm/min; fast: 180μm/min)



Nanosphere Lithography

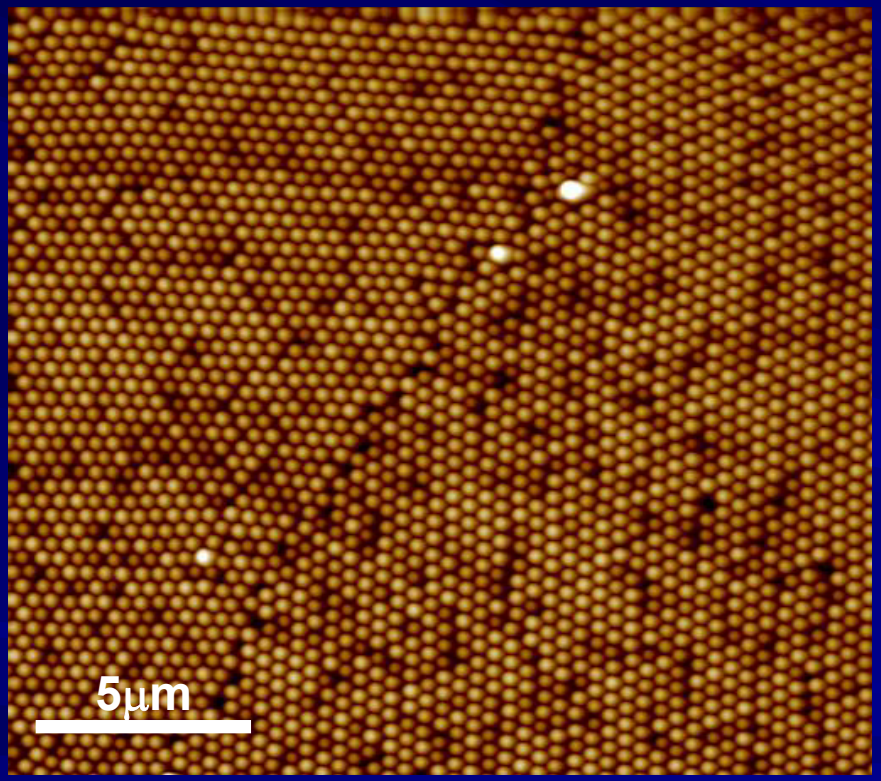
- Used to generate ordered arrays of triangles by using the monolayers of nanospheres as a “mask” for the evaporation of silver.





Cleaning Solution: Piranha/RCA vs. Chromic/Sulfuric Acid Bath

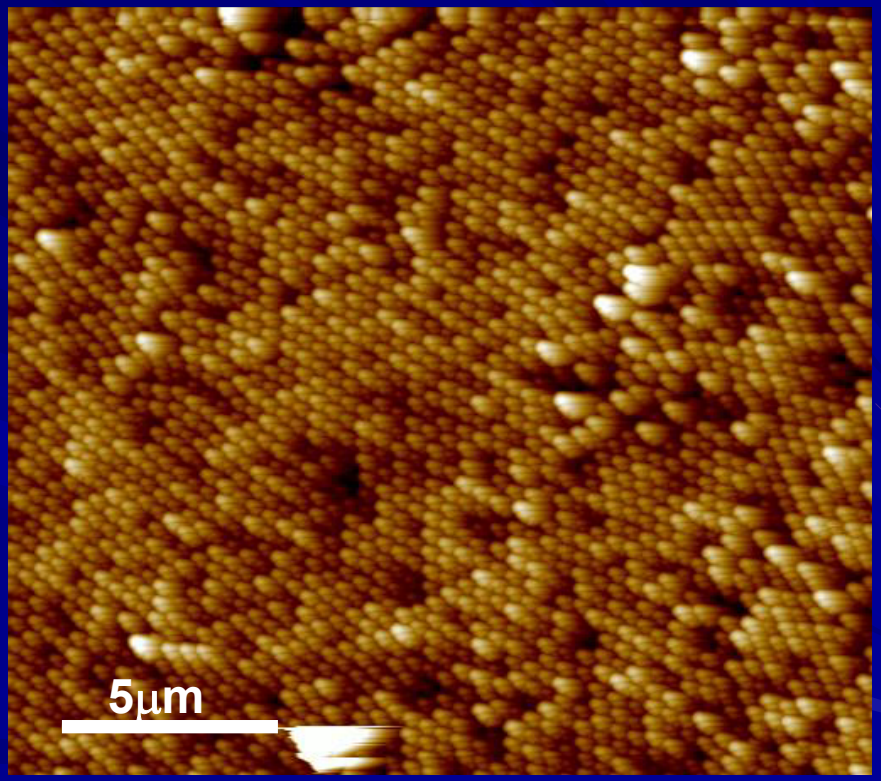
900nm spheres



Piranha/RCA

Piranha: Concentrated Sulfuric Acid and 30% Hydrogen Peroxide

RCA: Nanopure water, Ammonium hydroxide, and 30% Hydrogen Peroxide

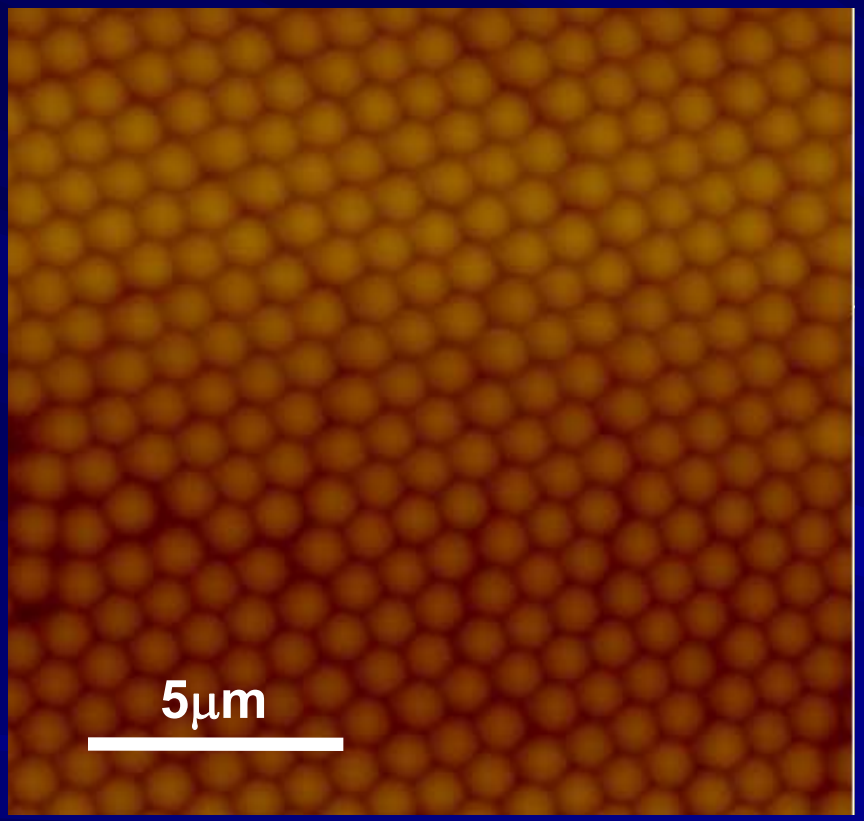


Chromic/Sulfuric Acid Bath

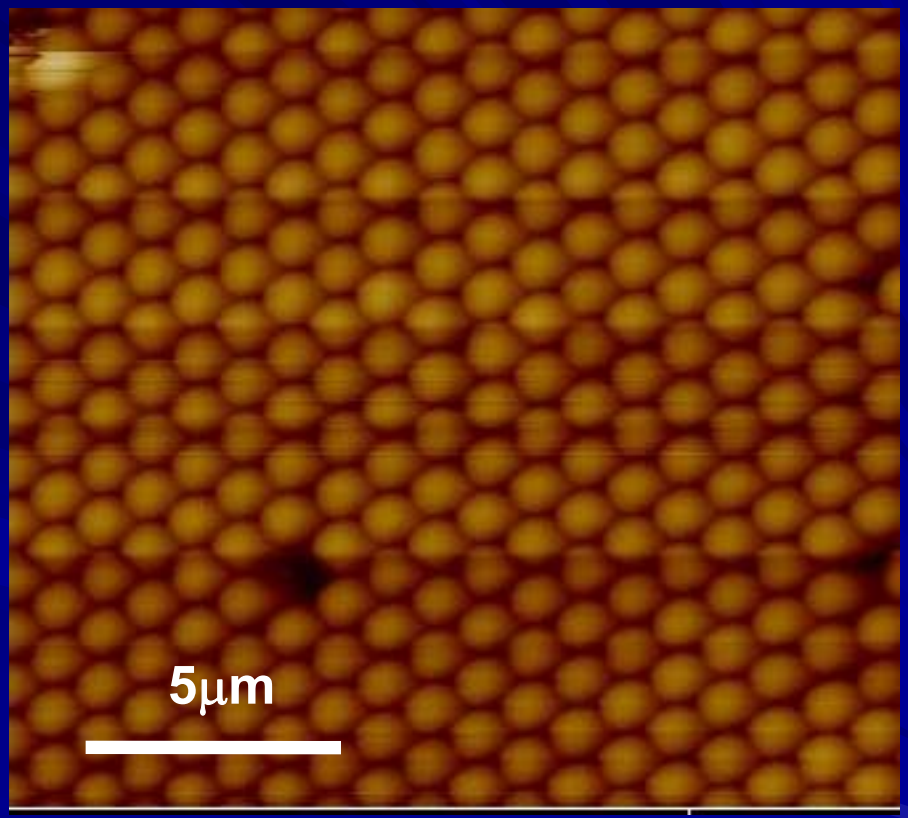
Chromium Trioxide in concentrated Sulfuric Acid

Glass vs. Mica

900nm spheres



Glass



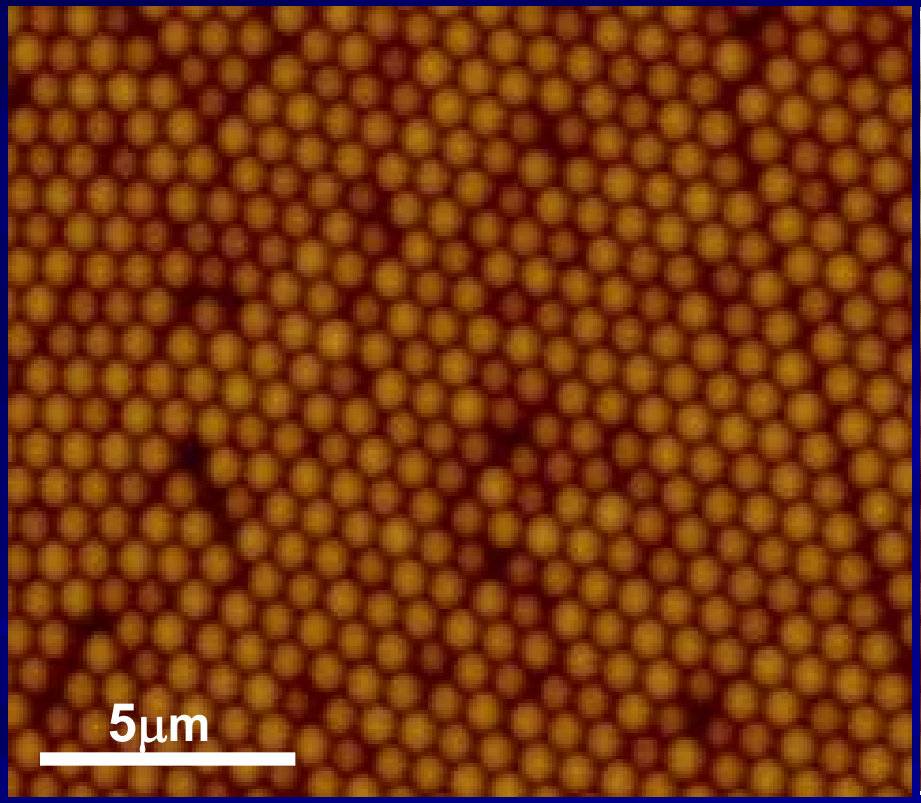
Mica

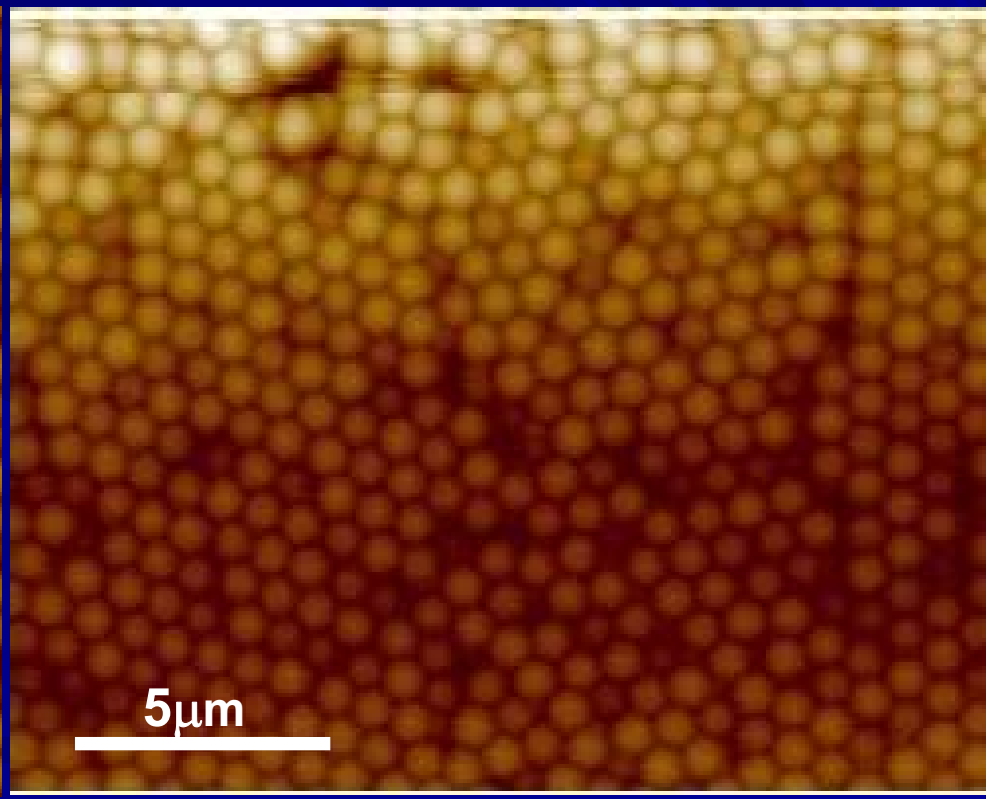
- **In consideration of the variables, the slide type did not have a major affect of the formation of hexagonal close packing.**

Withdrawal Rate

400nm spheres

- **Fast rate: ~180μm/min**
- **Slow rate: ~60μm/min**





- At the fast rate there was much more of a closed packed surface

Future Plans

- Optimizing evaporation conditions
- Optimizing variables: volume concentration, sphere size
- Optimizing for smaller sphere diameters, i.e. 20nm

Applications

- **The triangular arrays are used as substrates for surface-enhanced Raman spectroscopy (SERS).**
  - Prepare optical units, electronic Read Only Memory (ROM) devices
  - Fabrication of periodic particle array (PPA) surfaces.
  - Chemical and biological sensors

So What Did I Learn?

- **Instruments**
  - Atomic Force Microscope (AFM): Operation and theory
  - Stepper Motor: Operation and using Lab View program
  - Thermal Evaporator: Operation
- **Research**
  - Basics of Nanosphere Lithography and characterization using different instruments
  - 8 weeks is not enough for research

Acknowledgements

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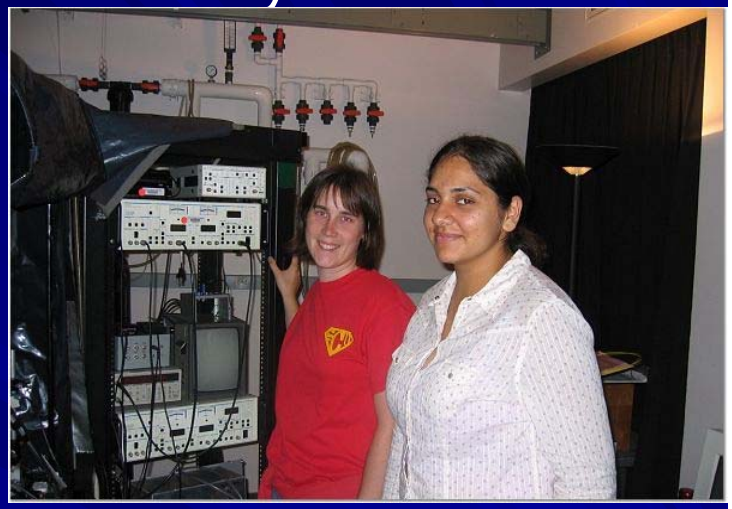
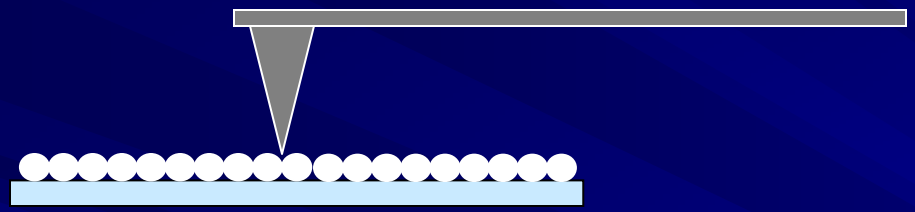
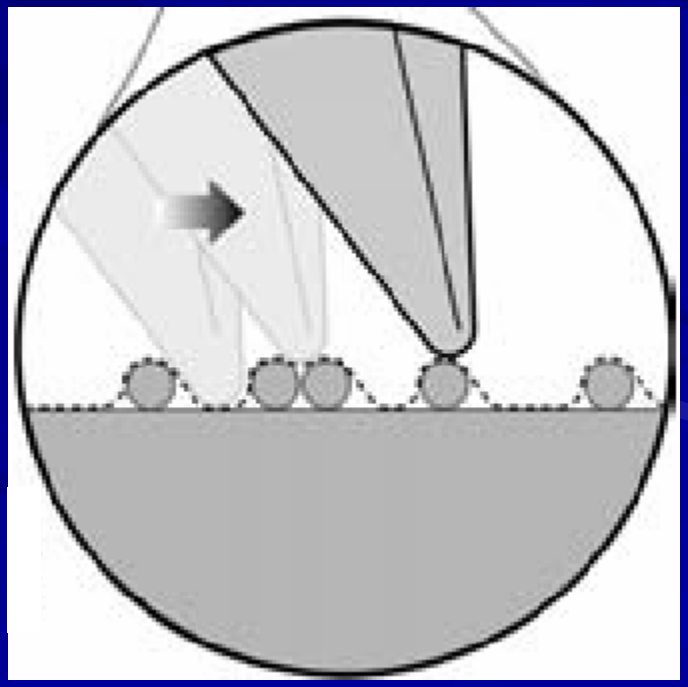
- Martin Vandenbroek: Engineering I Teaching Clean Room



Atomic Force Microscope (AFM)



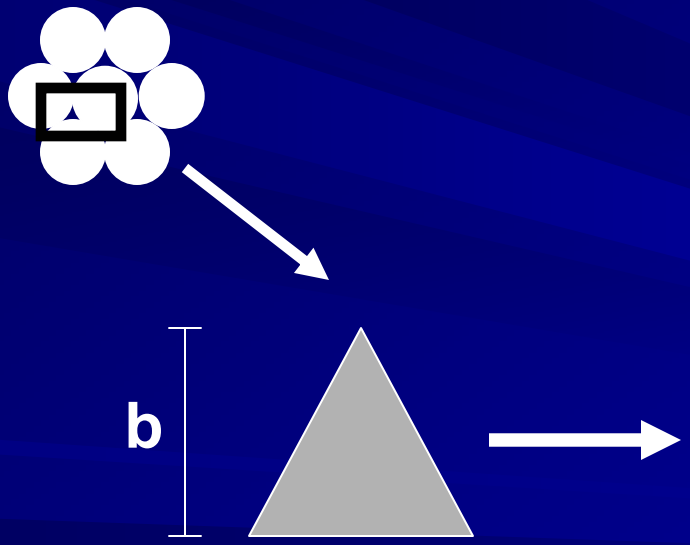
Tapping Mode



Determining the height of the Triangle

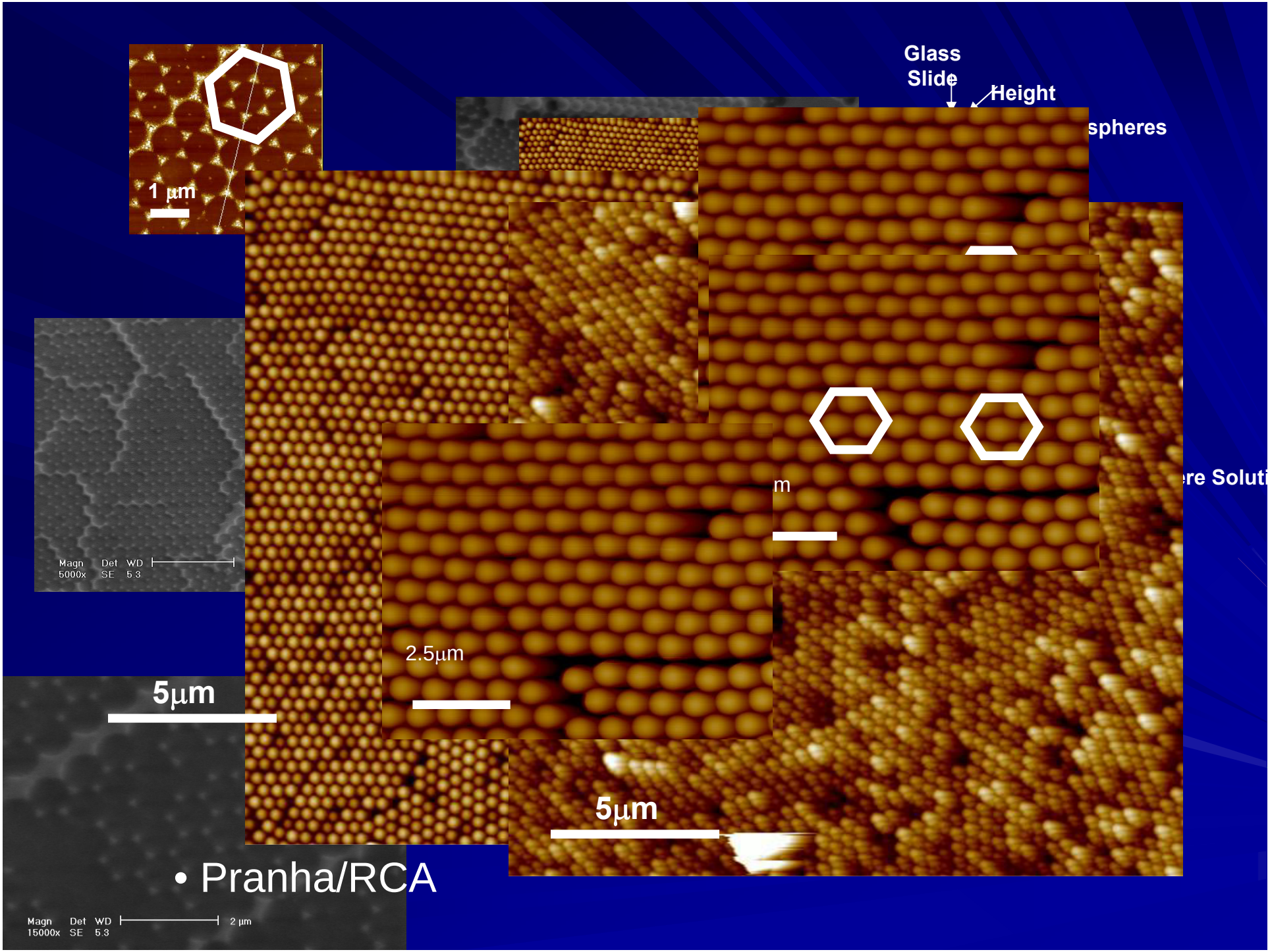
$$b = 3/2(\sqrt{3}-1-(1/\sqrt{3}))D$$

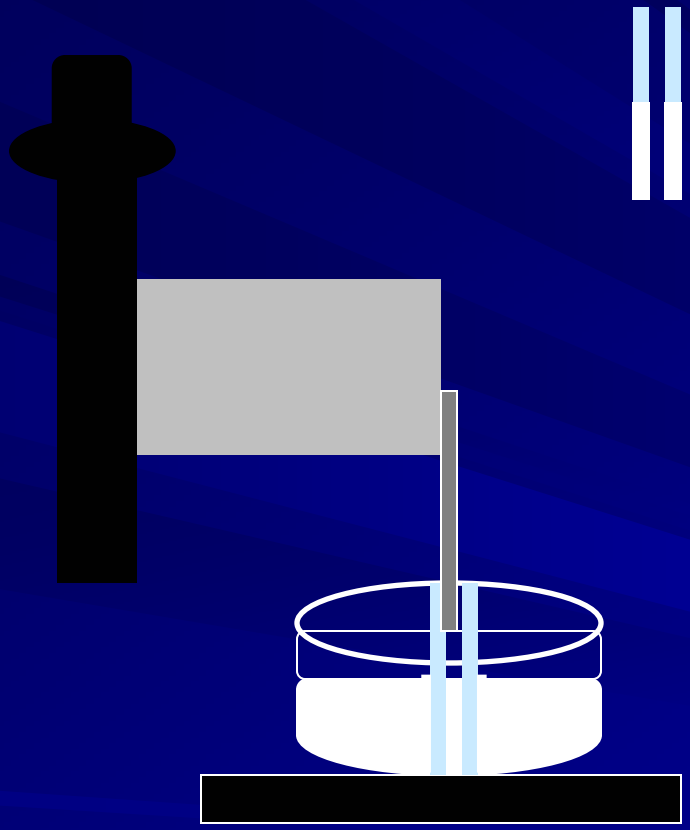
$$= 0.232D$$

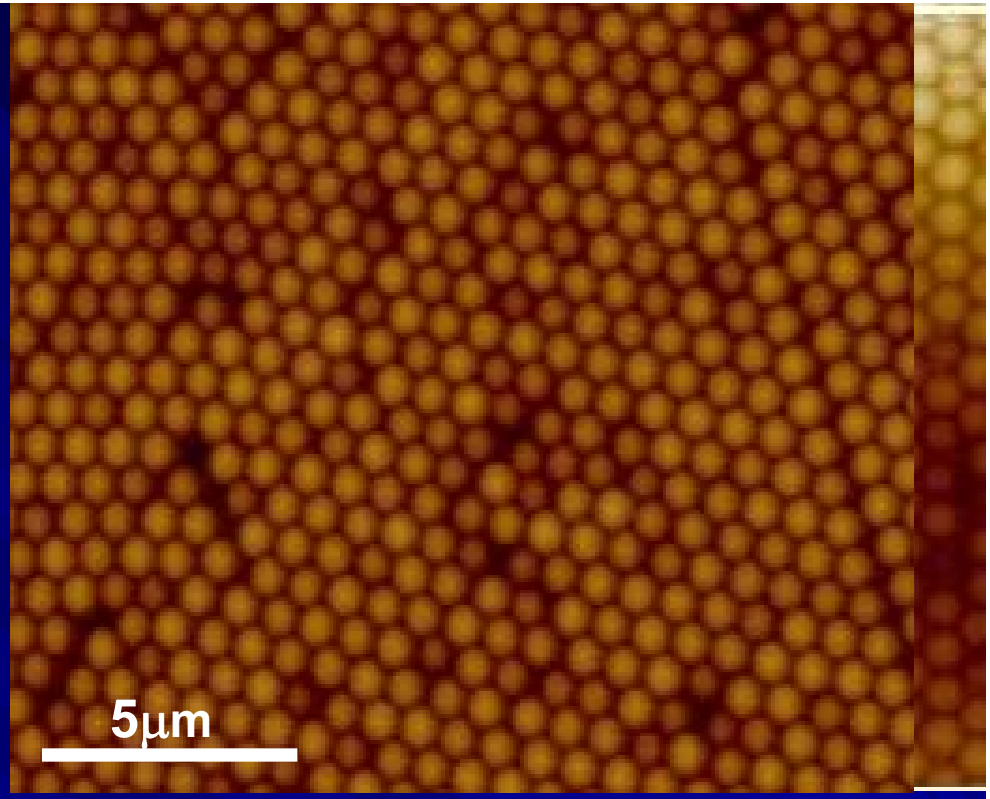


b= D*0.232

- 900nm→ b~ 209nm
- 400nm→ b~ 93nm


Glass
Slide
Height
spheres
1 µm
Magn Det WD
5000x SE 5.3
2.5µm
5µm
5µm
• Pranha/RCA
Magn Det WD
15000x SE 5.3
2 µm





Power
Supply