Lung Surfactant Collapse and Recovery

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Overview

- Purpose
- Background
- Methods
- Results/ Discussion
- Conclusion
- Future Work

Purpose

General Goal:

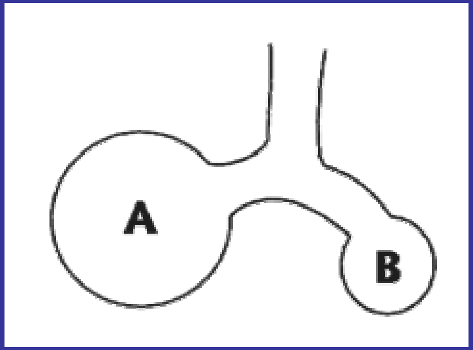
- To develop a lung surfactant that can be artificially produced and work with greater efficiency than natural surfactant.

Specific Goal:

- To study the properties of three clinically used lung surfactants:
  - Survanta (bovine)
  - Curosurf (porcine)
  - Infasurf (calf)

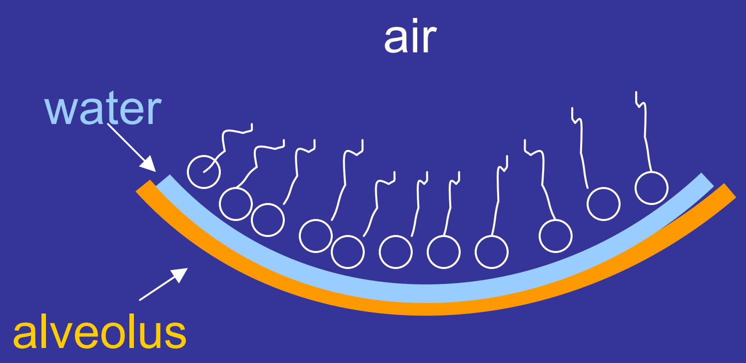
Background

- Lung Surfactant coats the inner lining of the alveoli
- It reduces the surface tension of the alveoli so that the lungs may expand and compress without collapsing.



LaPlace's Law:
$P = 2\gamma/R$

- Premature infants do not synthesize surfactant and may suffer from Respiratory Distress Syndrome (RDS)—
  - poor lung expansion, inadequate gas exchange, and a gradual collapse of the lungs.



Surface tension of water in the lungs in the absence of surfactant is

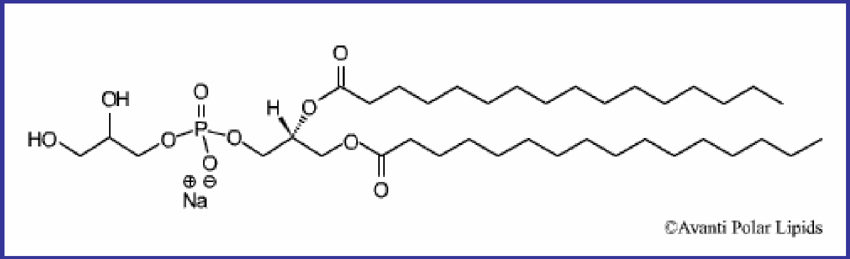
~72 mN/m

Surfactant reduces water's surface tension.

Thus, the lungs require less energy to breathe.

Lung Surfactant Composition

- Lung Surfactant consists of :
  - 93% Phospholipids (molecules with a hydrophilic head and hydrophobic tail)

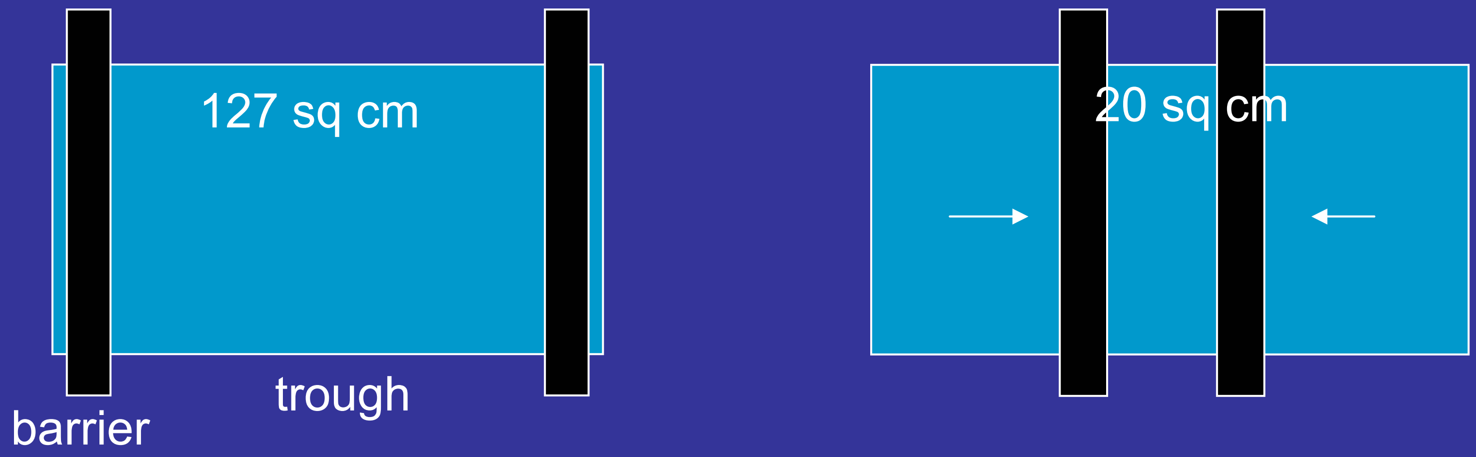


DPPG (1,2-Dipalmitoyl-*sn*-Glycero-3-[Phospho-rac-(1-glycerol)]

  - 5% Cholesterol (fluidizes the surfactant)
  - 1.5% Proteins (transport of molecules, catalysts?)

Langmuir-Blodgett Trough

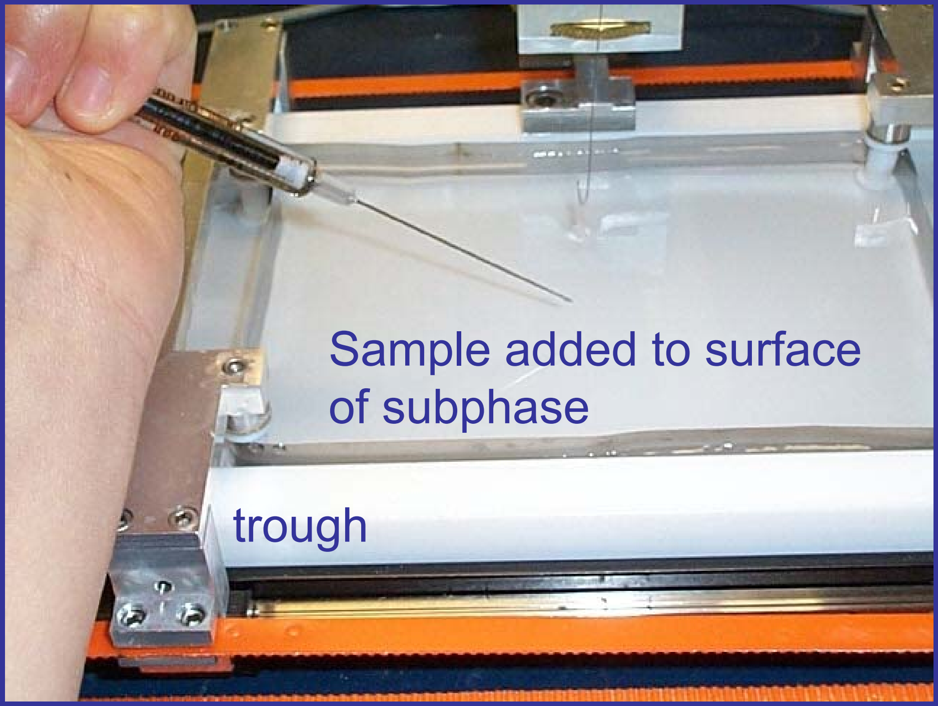
- The trough expands and compresses to simulate alveolar expansion and compression.
- Its trough area ranges from 127 sq.cm to 20 sq.cm.

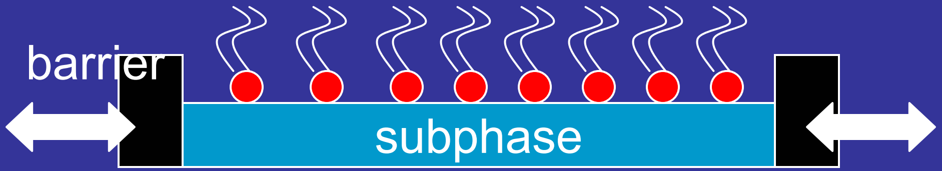


100% trough area **18 % trough area**

Methods

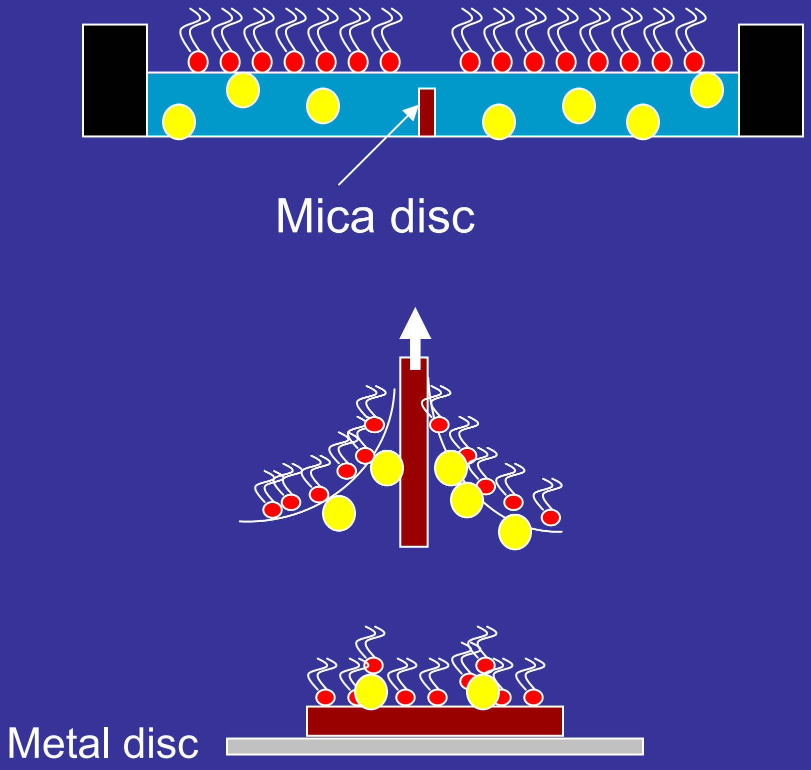
- Fill trough with subphase.
  Subphase typically consists of:
  - 150 mM NaCl
  - 2 mM $CaCl_2$
  - 0.2 mM $NaHCO_3$
- Add LS as a film to the surface of the subphase with a syringe
- Compress and expand sample to study changes in surface pressure





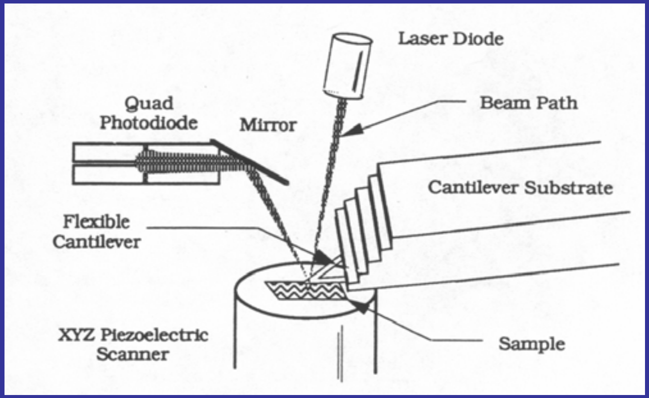
Depositions

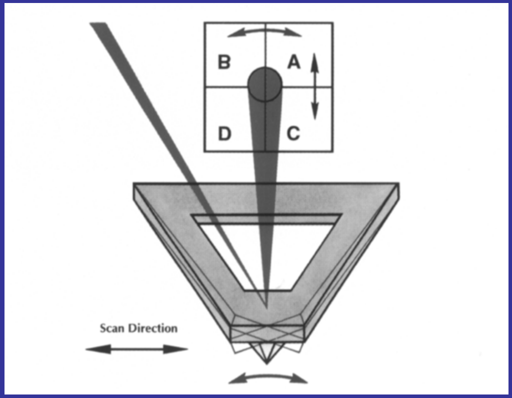
- "Deposition" is the term used for affixing LS to a mica disc in order to observe it under the AFM.
- Mica is organized into thin sheets. Each sheet is composed of one molecular layer. We use mica because it is even and smooth.



AFM Imaging

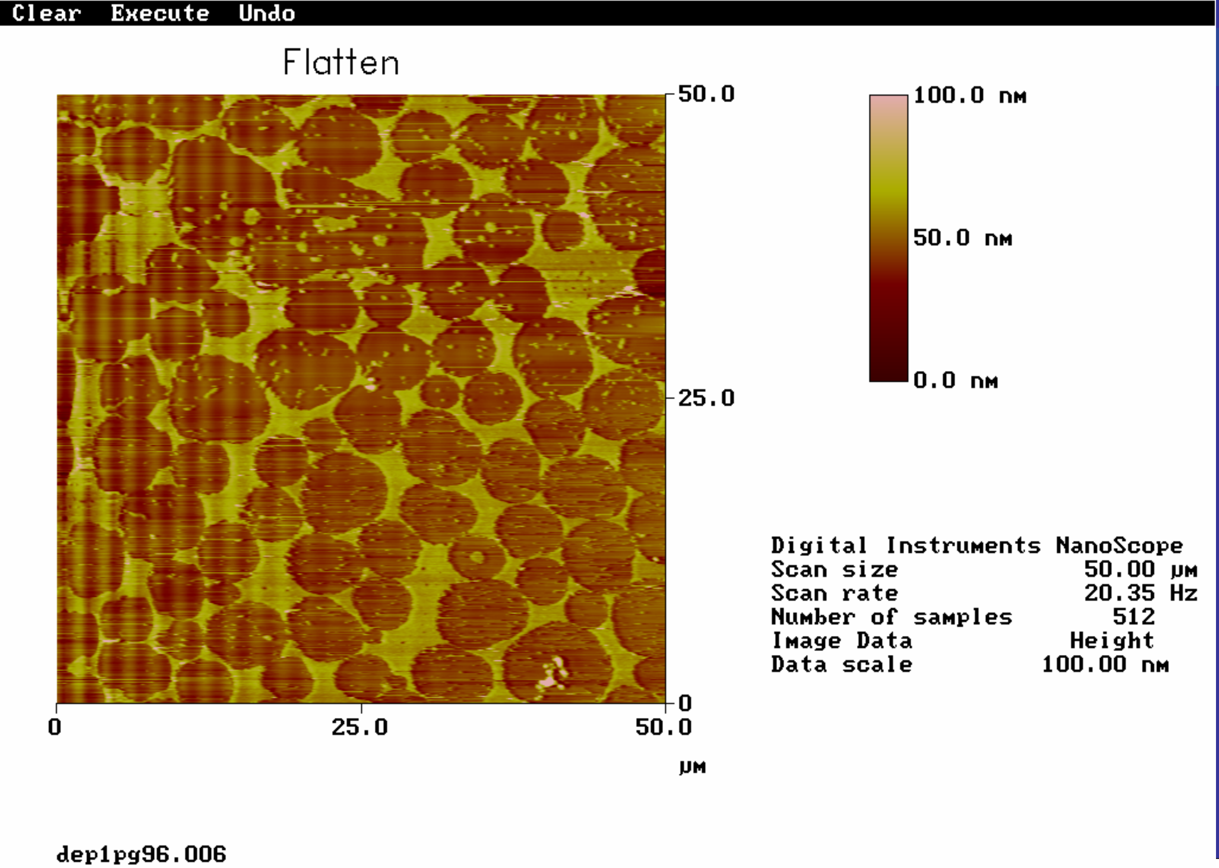
- Now that we have depositions on mica discs, we can see what they look like using an Atomic Force Microscope (AFM)



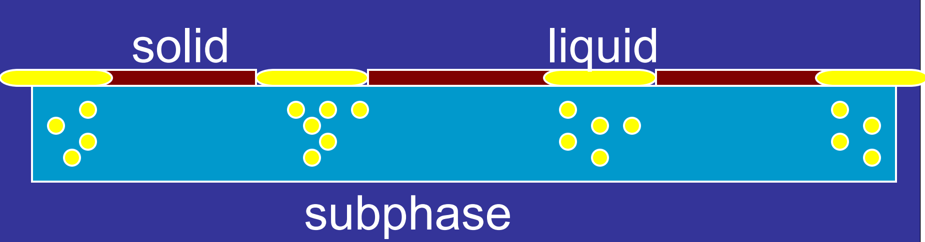


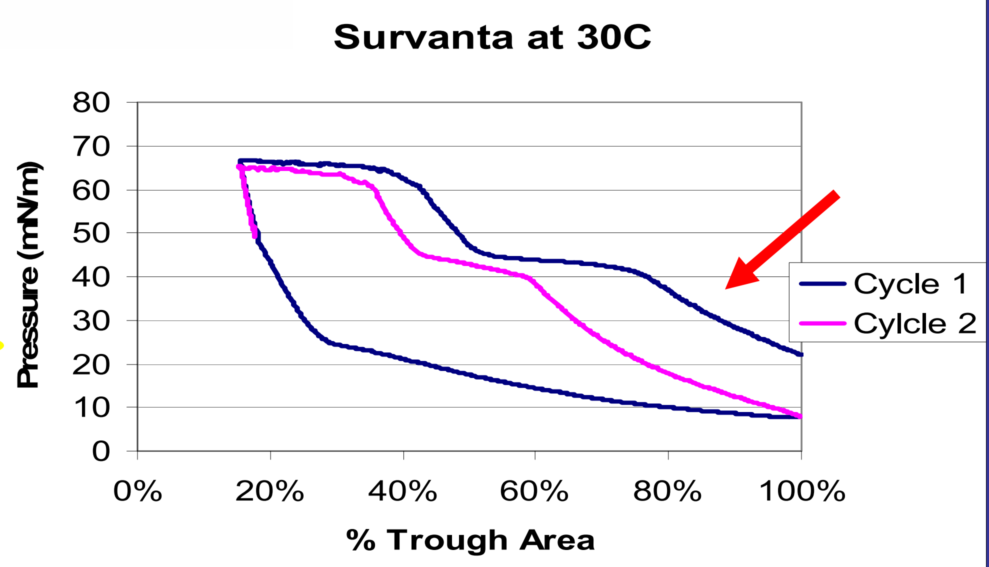
Data

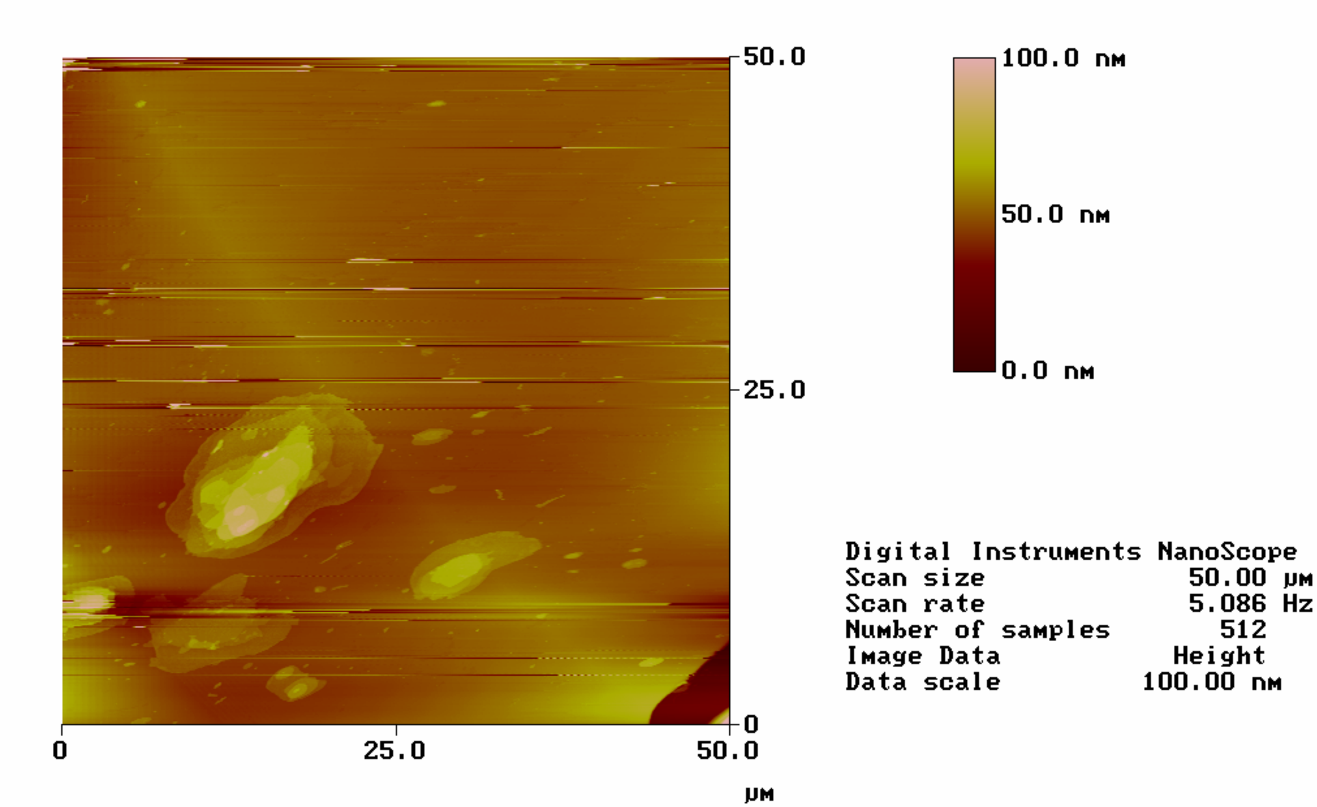
AFM Images



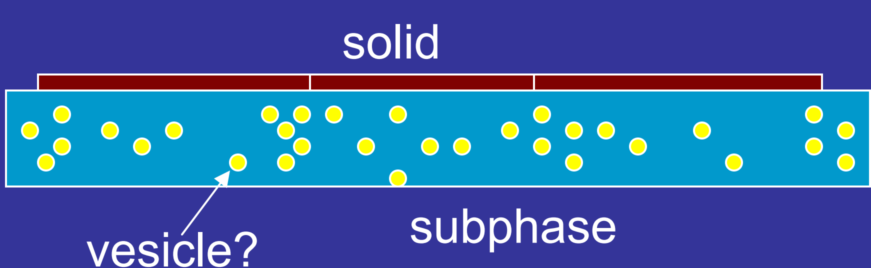
At 85 % Trough Area

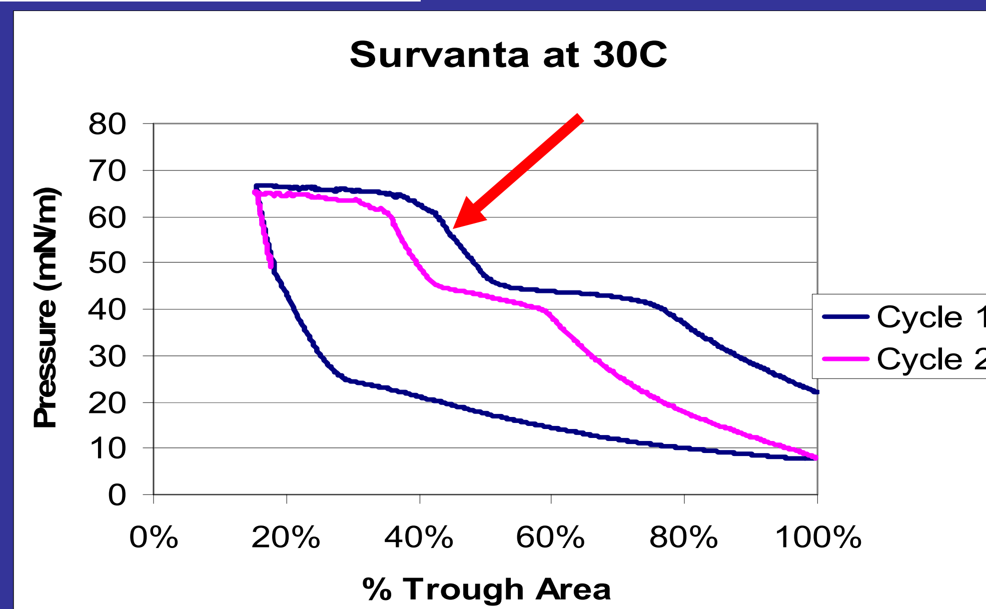


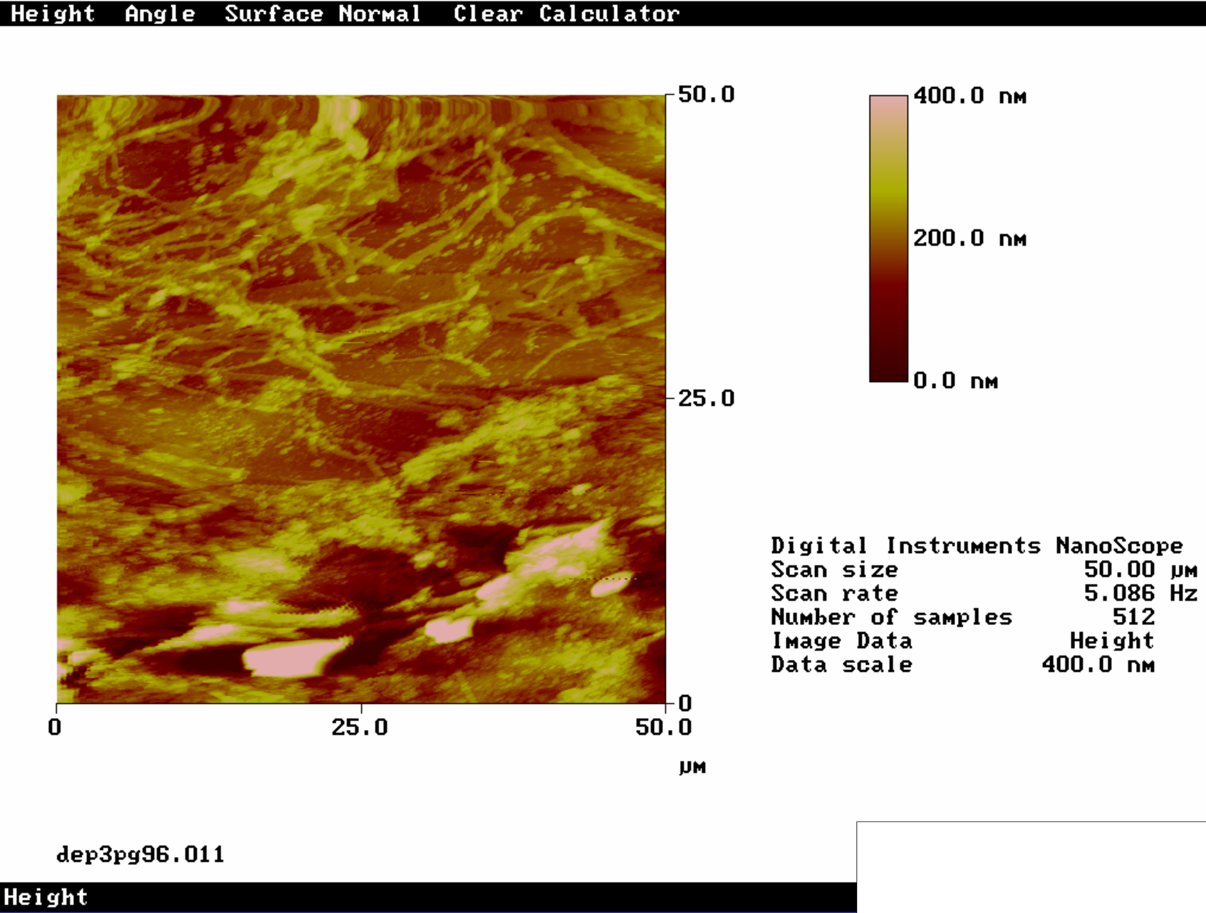




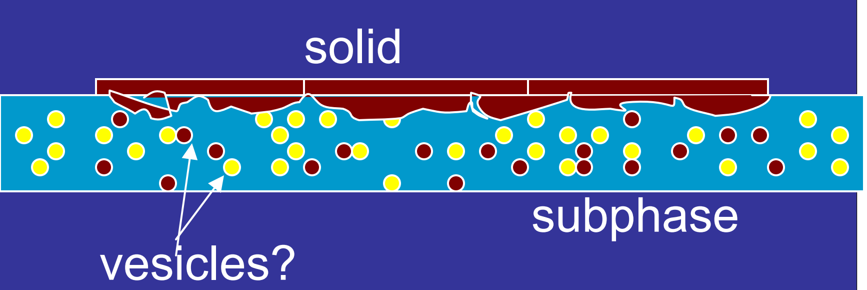
At 45 % Trough Area

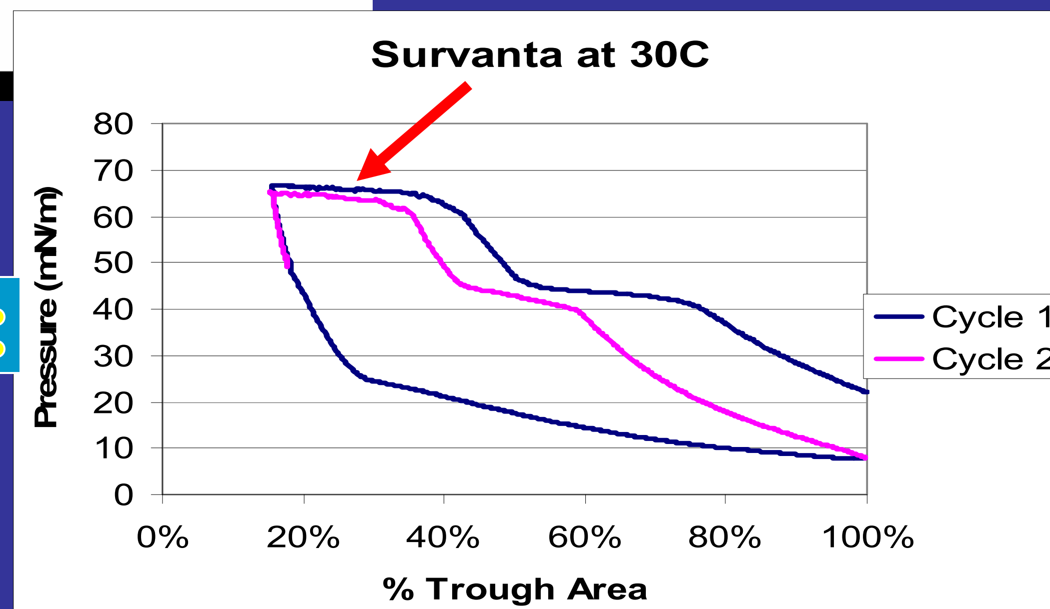


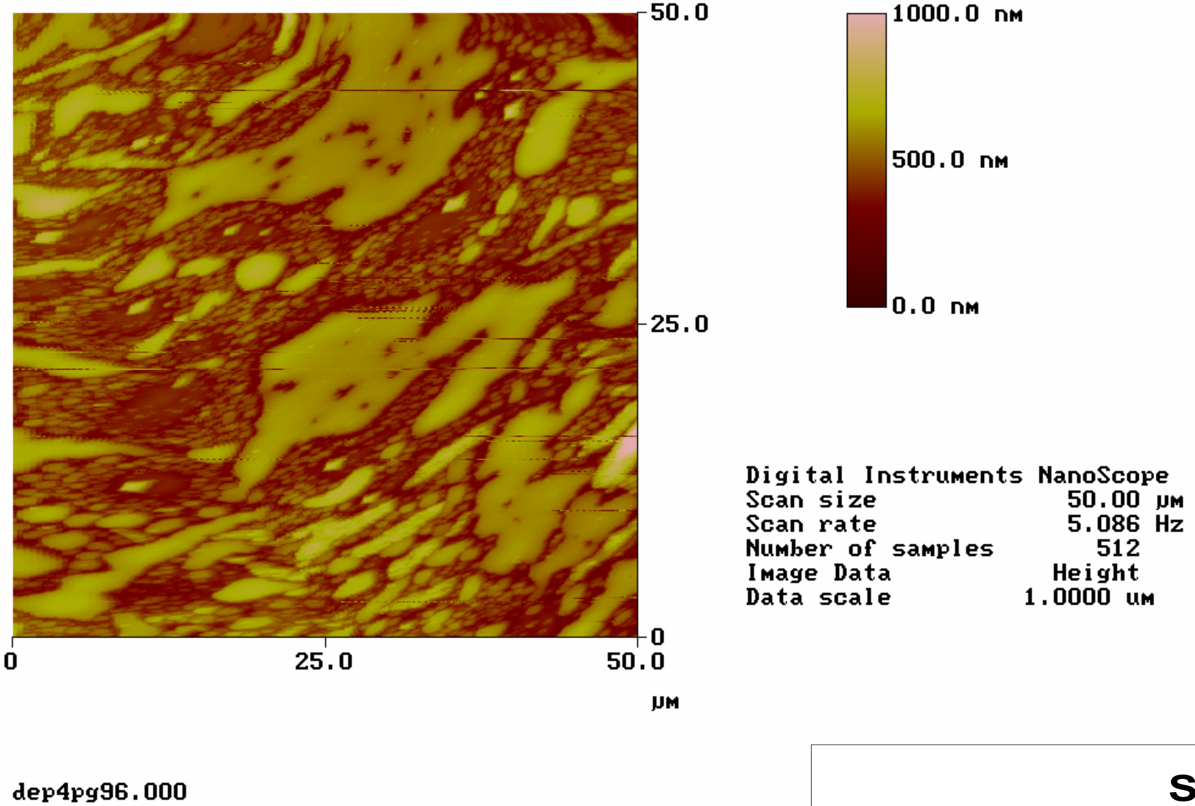




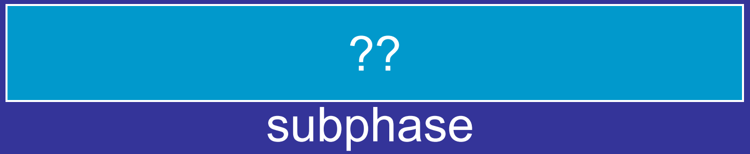
At 23 % Trough Area

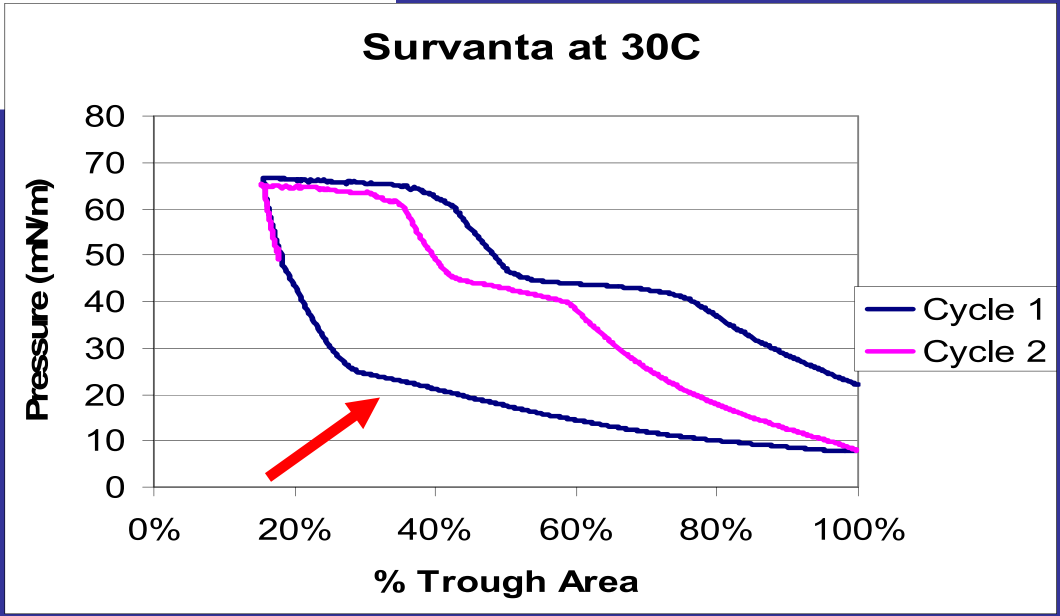


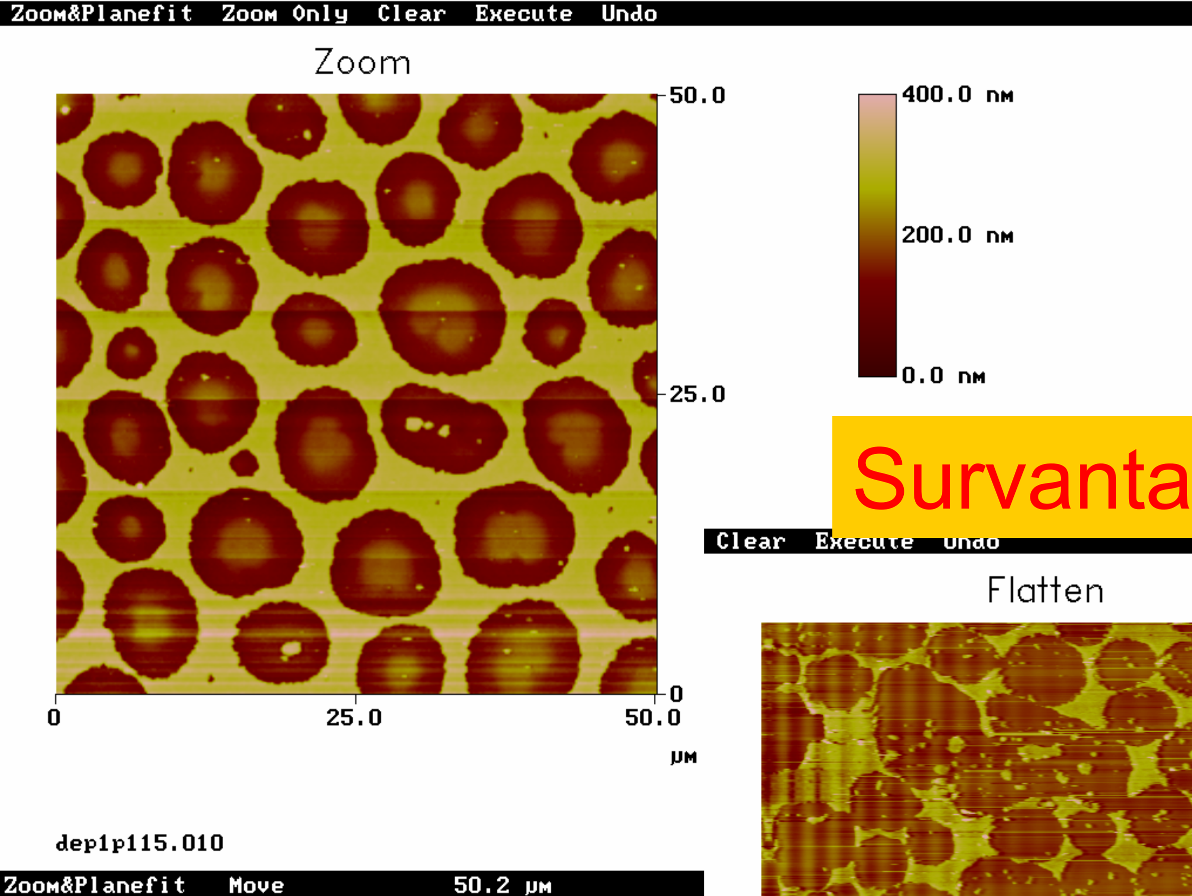




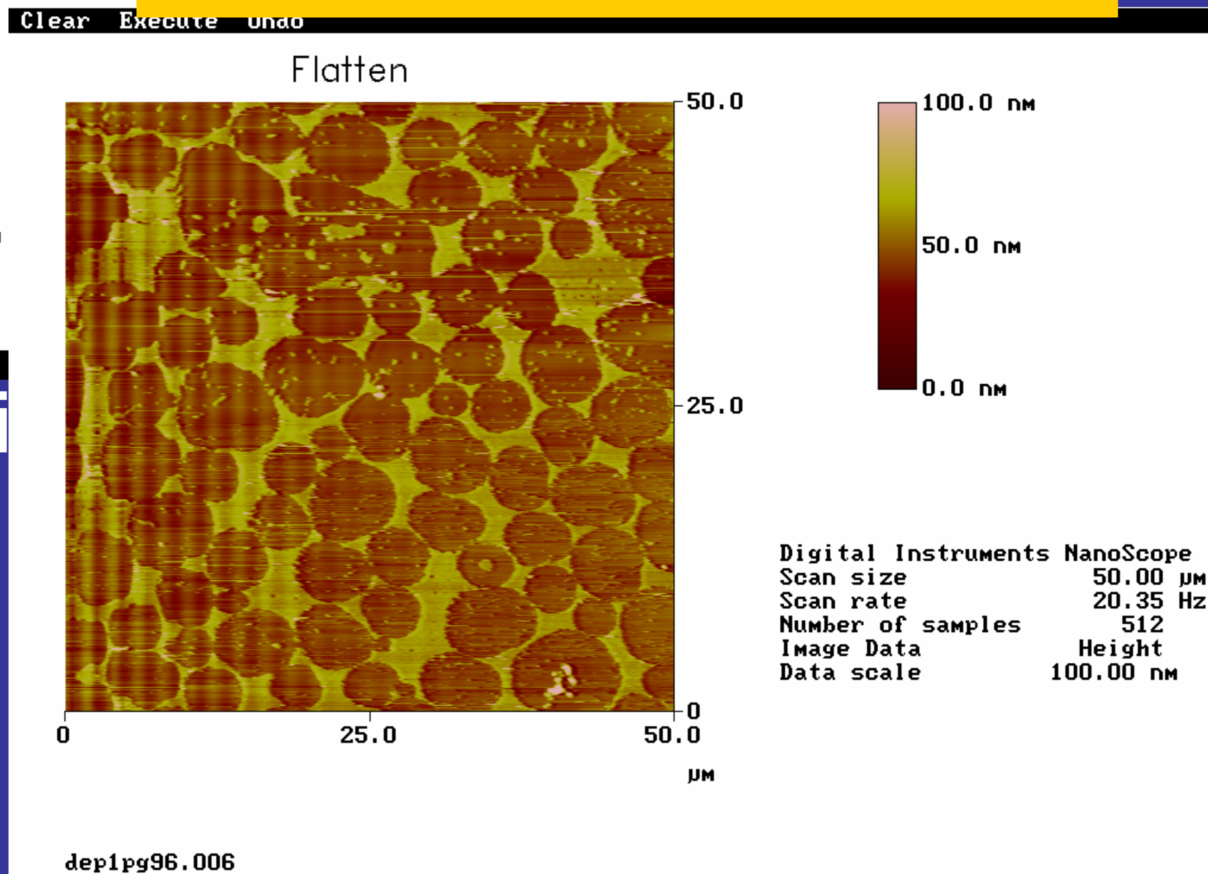
At 33 % Trough Area



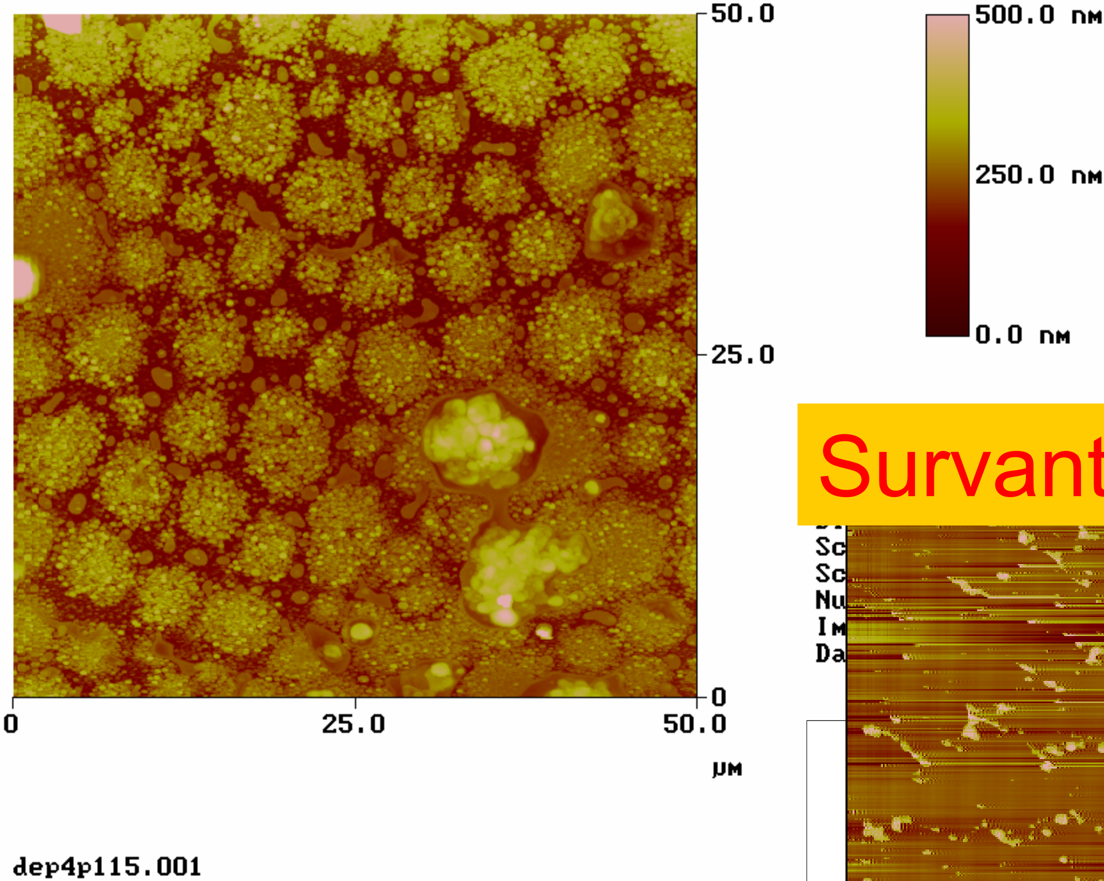




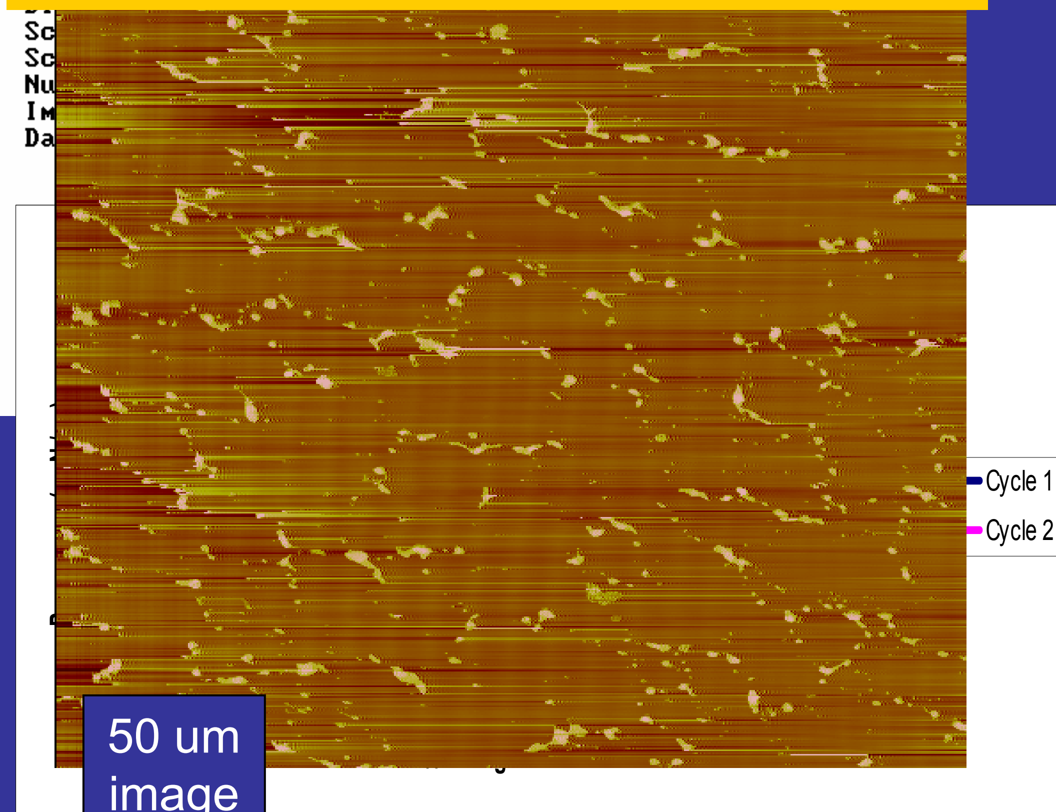
Survanta in Saline Buffer



- Survanta in hi salt buffer (1M NaCl)



Survanta in Saline Buffer



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Survanta in high salt buffer (1M NaCl)

Conclusion

- An increase in the concentration of NaCl in the subphase led to an increase of surfactant recovery.
- The Na+ and Cl- ions may minimize the repulsive forces between the surfactant molecules.

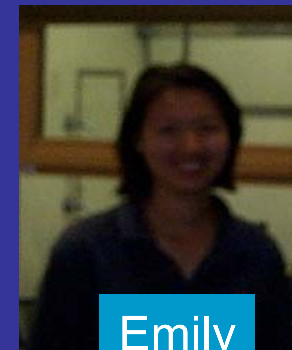
Further Study

- Make depositions of LS from chloroform to study monolayer dynamics on the surface of the subphase.
- Cycle pressure within one area of the isotherm to measure hysteresis
- Fluoresce mini-B to investigate the role of proteins in surfactant.

Joe Zasadzinski's Molecular Engineering Lab Group Members working on Lung Surfactants

Coralie – Viscosity of LS

Tim – my mentor



Emily

Joonsung – LS study using Fluorescence

Derek – Coralie's summer intern

Joe's Lab Group members working on vesicles