TWO-DIMENSIONAL SHEAR VISCOSITY OF MODEL LUNG SURFACTANT

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Funding: National Institute of Health and the State of California

Abstract

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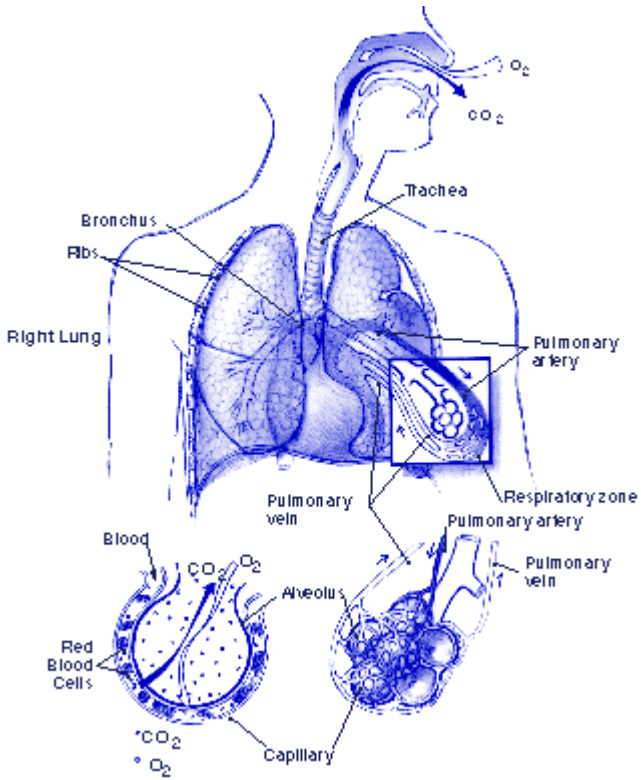
The lung surfactant (LS) is a film (monolayer) that lines the lung alveoli, which is necessary for normal lung compliance and ease of breathing. The unique mixture of lipids and proteins reduces the surface tension at the air-alveoli interface, thus reducing the work of breathing and preventing the collapse of alveoli upon exhalation. A lack or dysfunction of LS induces respiratory problems such as Neonatal Respiratory Stress Disorder (NRDS) in infants. The current treatment for NRDS lies in replacement LS extracted from animals but quantities available are rather small and there is a risk of viral contamination.

A synthetic LS should present the same physical properties as the natural LS, particularly it should present a rigid phase at high surface pressure. Our project focuses on the effect of the protein SP-B on the monolayer viscosity. Using a Magnetic Needle Viscometer, isotherm and viscosity measurements can be taken. Isotherms show the pressure of SP-B, as the molecular area increases with SP-B concentration. Viscosity measurements show an increase in the maximum viscosity with an increase in SP-B concentration. The results agree with the fact that SP-B interacts specifically with the lipid POPG by helping this relatively fluid lipid to build 3-D structures upon compression.

Lung Surfactant

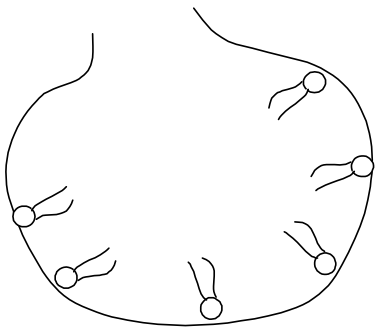


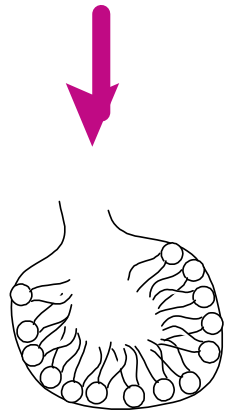
Babies born premature presenting respiratory disease can be treated with natural surfactant, but the amount of lung surfactant depends on the weight of a person. Then the synthetic formula is needed to treat adults.

Role of Lung Surfactant

rigid enough to prevent alveoli collapse

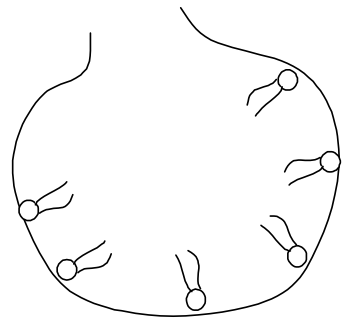
Inspiration





Exhalation

Inspiration



reduce the work of breathing by reducing surface tension

Composition of Lung Surfactant

The lung surfactant is made up of a unique mixture of proteins and lipids. Each play an important role in the model lung surfactant. The main components are:

Lipids: DPPC - reduces surface tension and increases viscosity

POPG - re-spreading agent and lowers viscosity

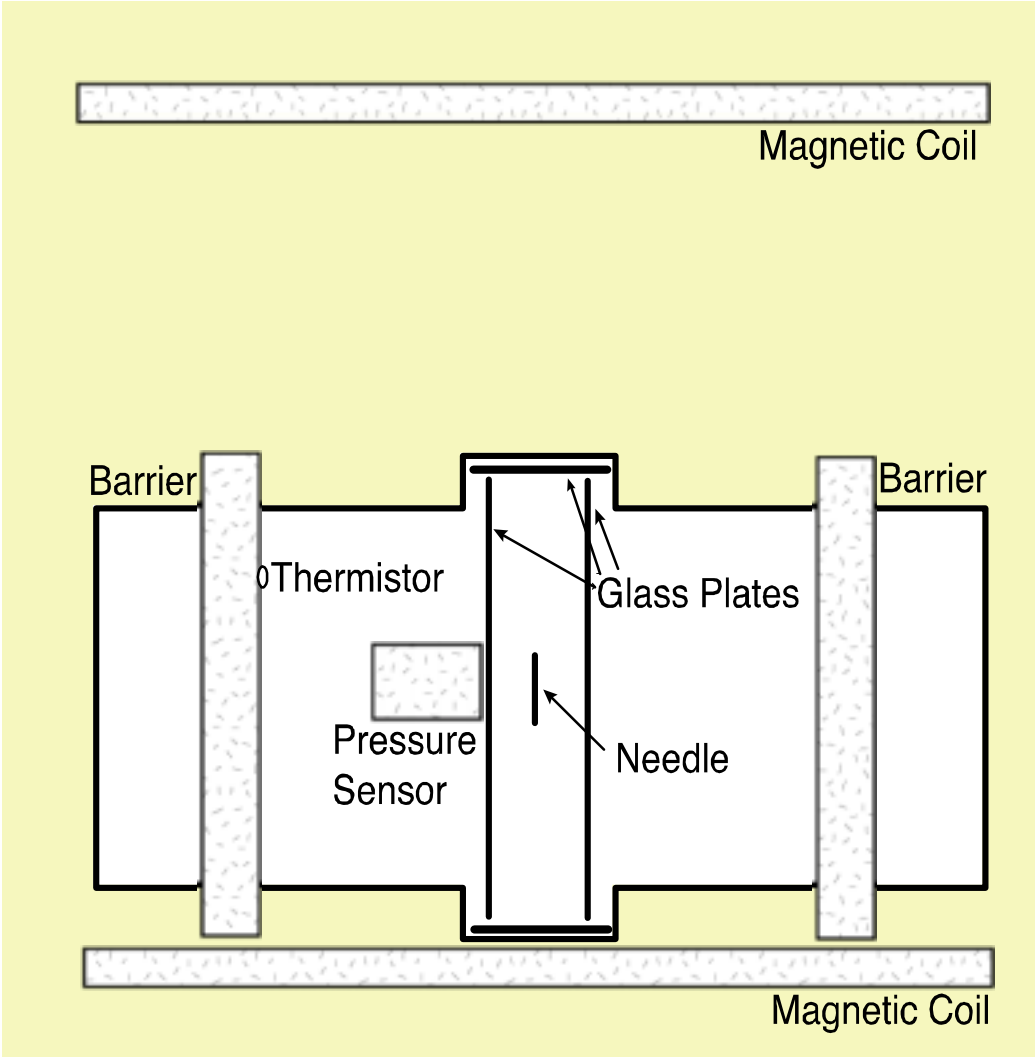
PA - aids in DPPC molecule alignment

Protein: SP-B ????

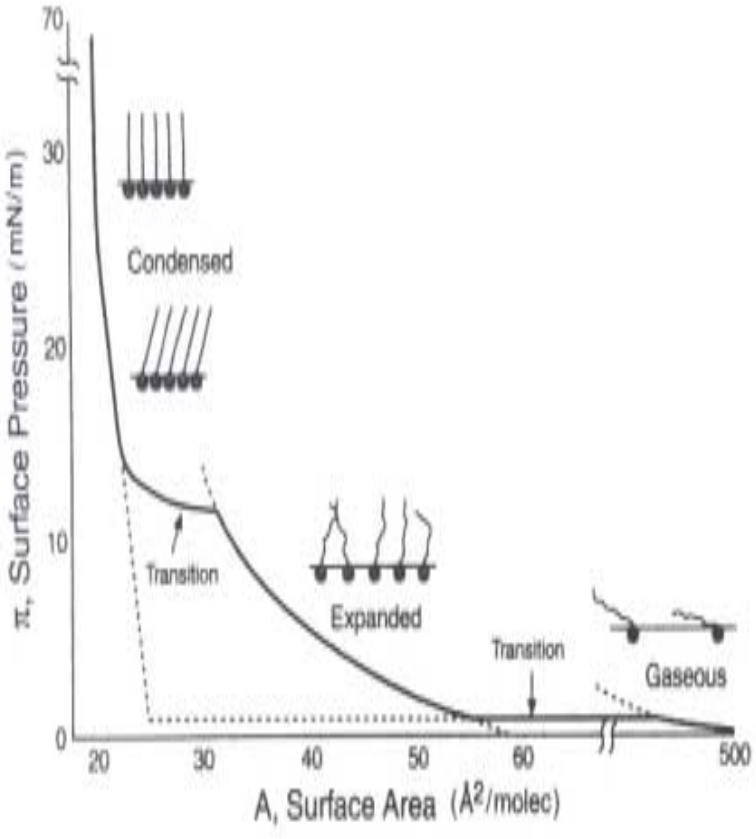
SP-C ????

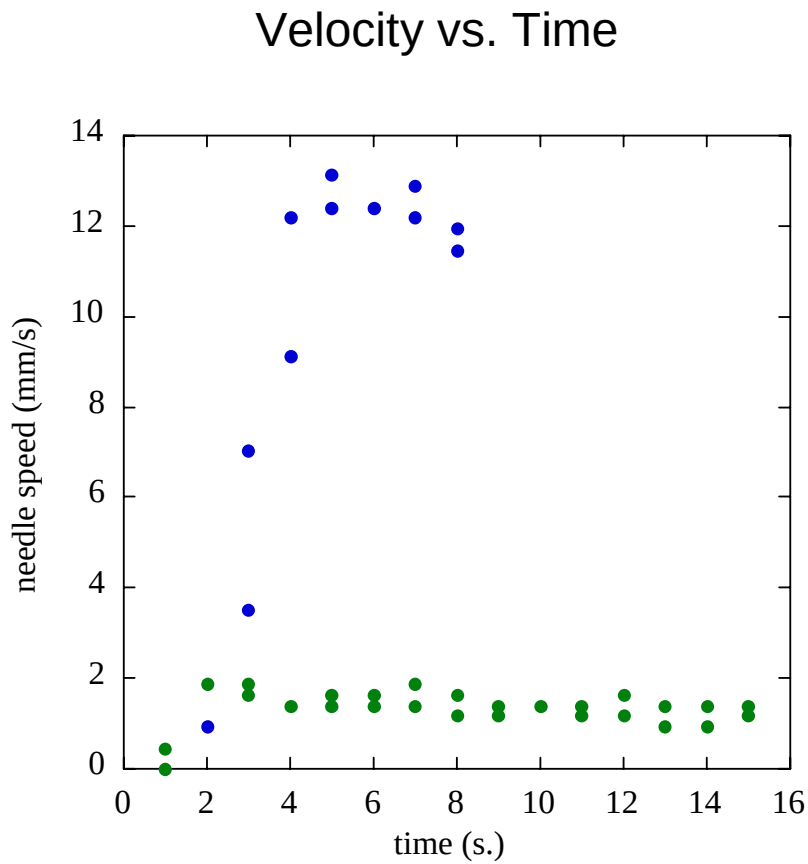
Set-up:

Magnetic Needle Viscometer

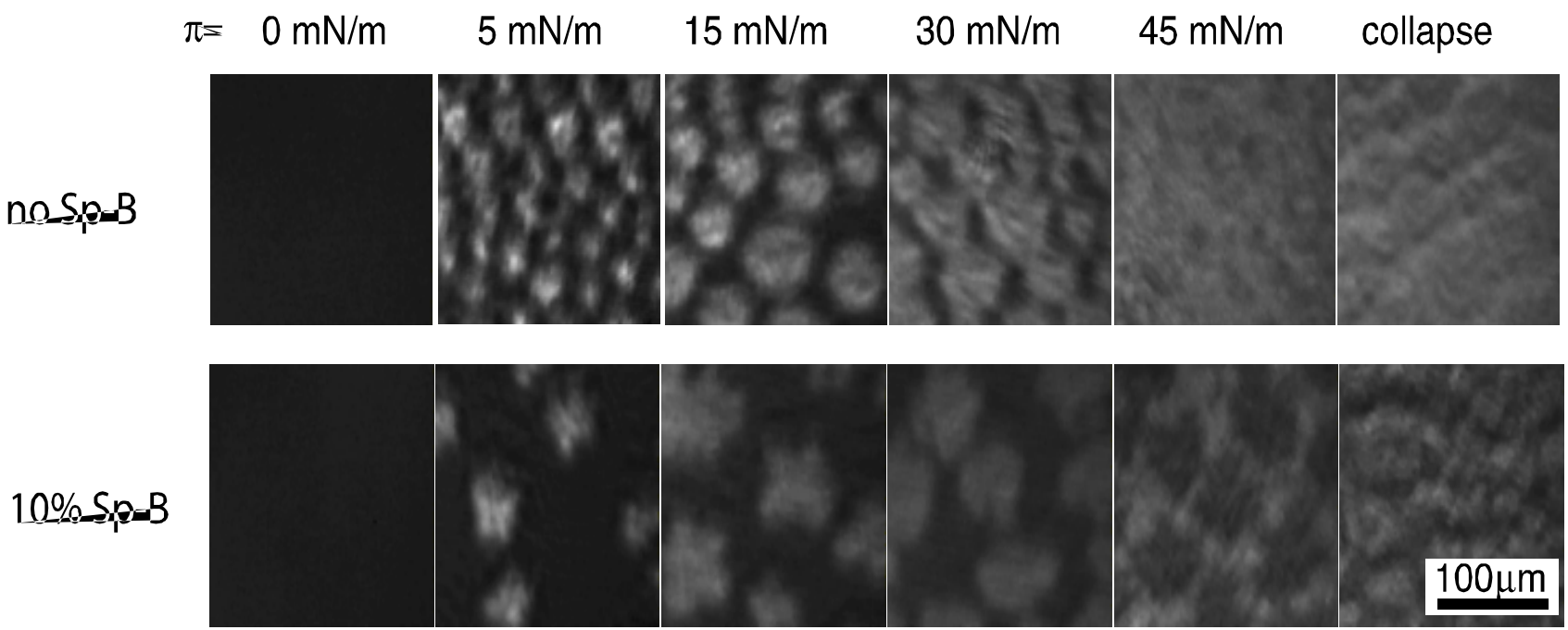


Isotherm and viscosity measurements of DPPC





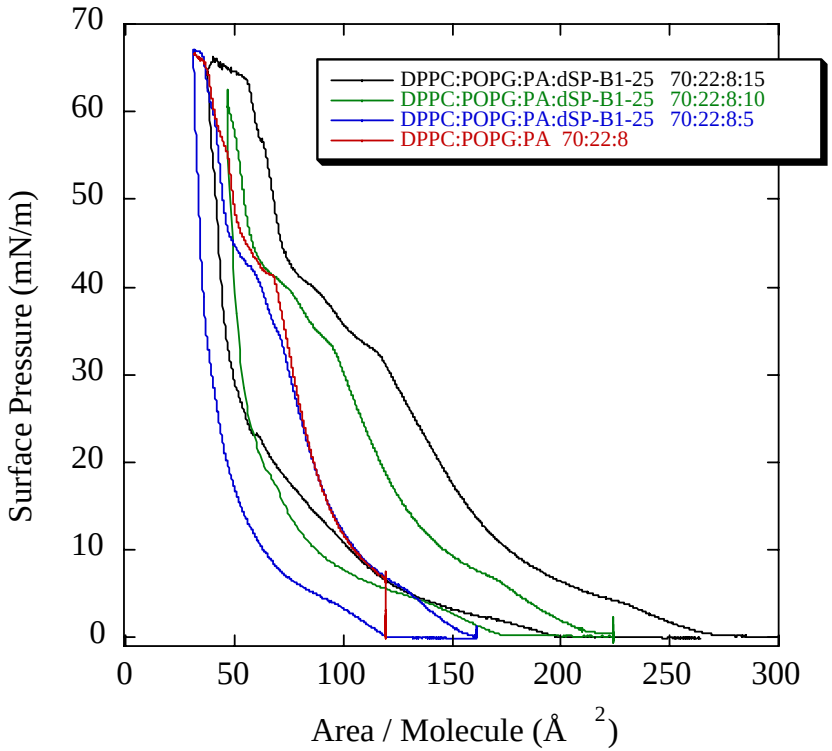
Brewster Angle Microscopy Images

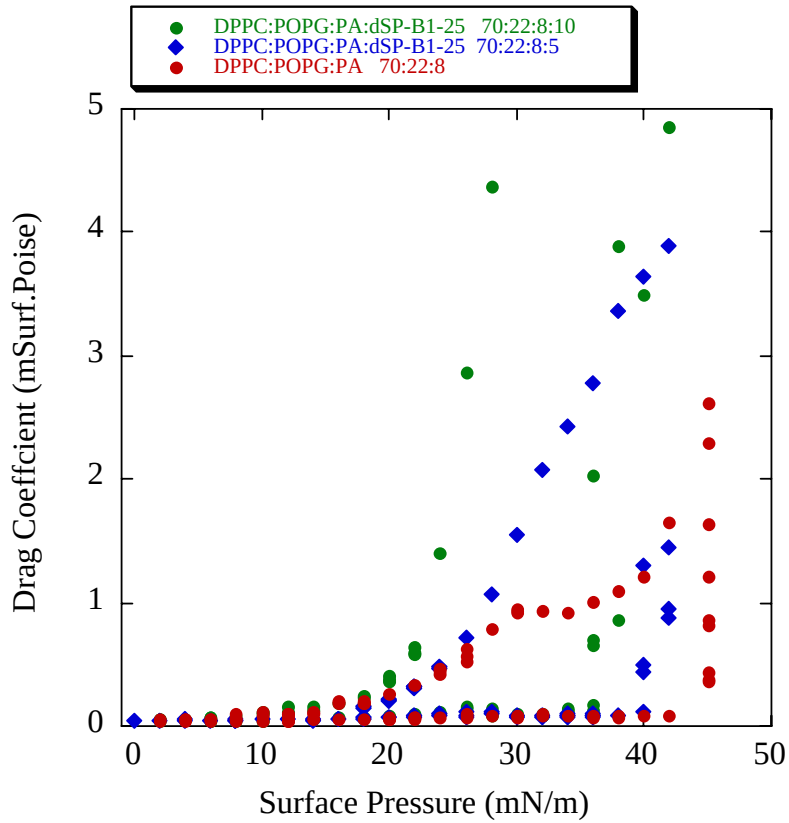


Pictures courtesy of Junqi Ding's thesis, UCSB

With SP-B the domains are less numerous, but larger.

Results: Interaction of SP-B and lipid mixture

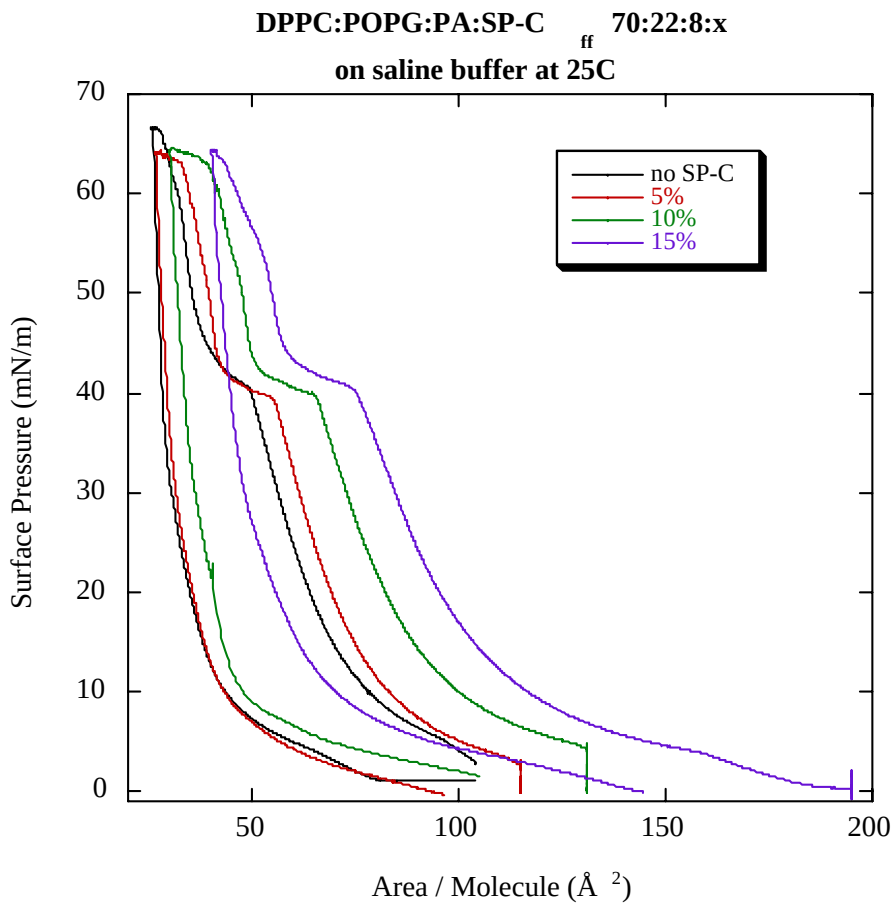




The viscosity increases sharply at the plateau and increases with SP-B concentration.

What's next?

- Investigate the effect of the protein SP-C on the viscosity of the lipid mixture.
- Take pictures of the domains.



Acknowledgements:

•Materials Research Laboratory, University of California at Santa Barbara

•National Science Foundation (NSF)

•Funding Source: National Institute of Health and State of California

•INSET Program, University of California at Santa Barbara

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