Assessment of Motion for Initially Stagnant Thin films

Neil Morley

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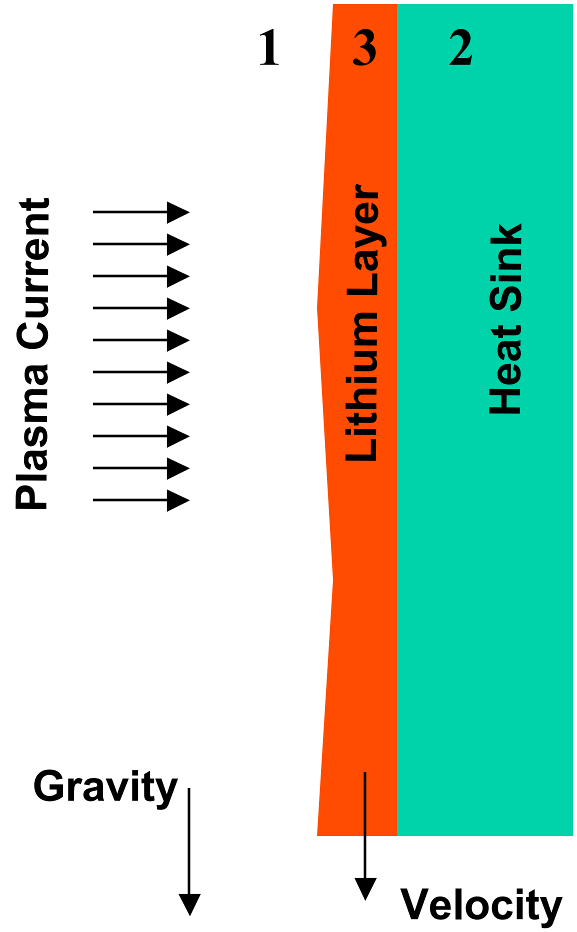
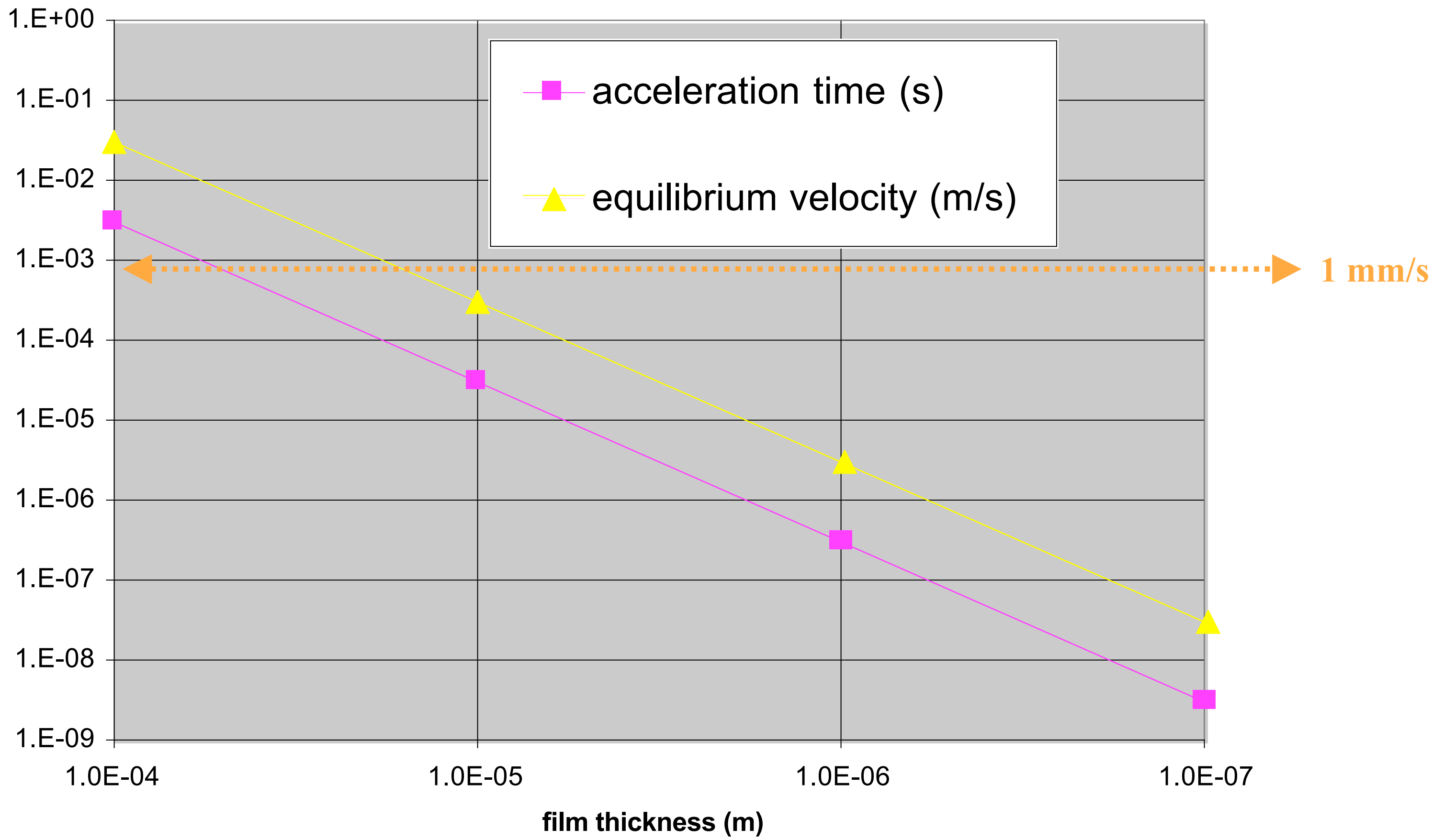
Geometry Assumptions

- Uniform liquid films from 0.1 to 100 microns considered
- Heat sink plate is vertically oriented and is 1 m x 1 m in size
- Any plasma current penetrates the thin film into heat sink
- Lithium properties at 250C used



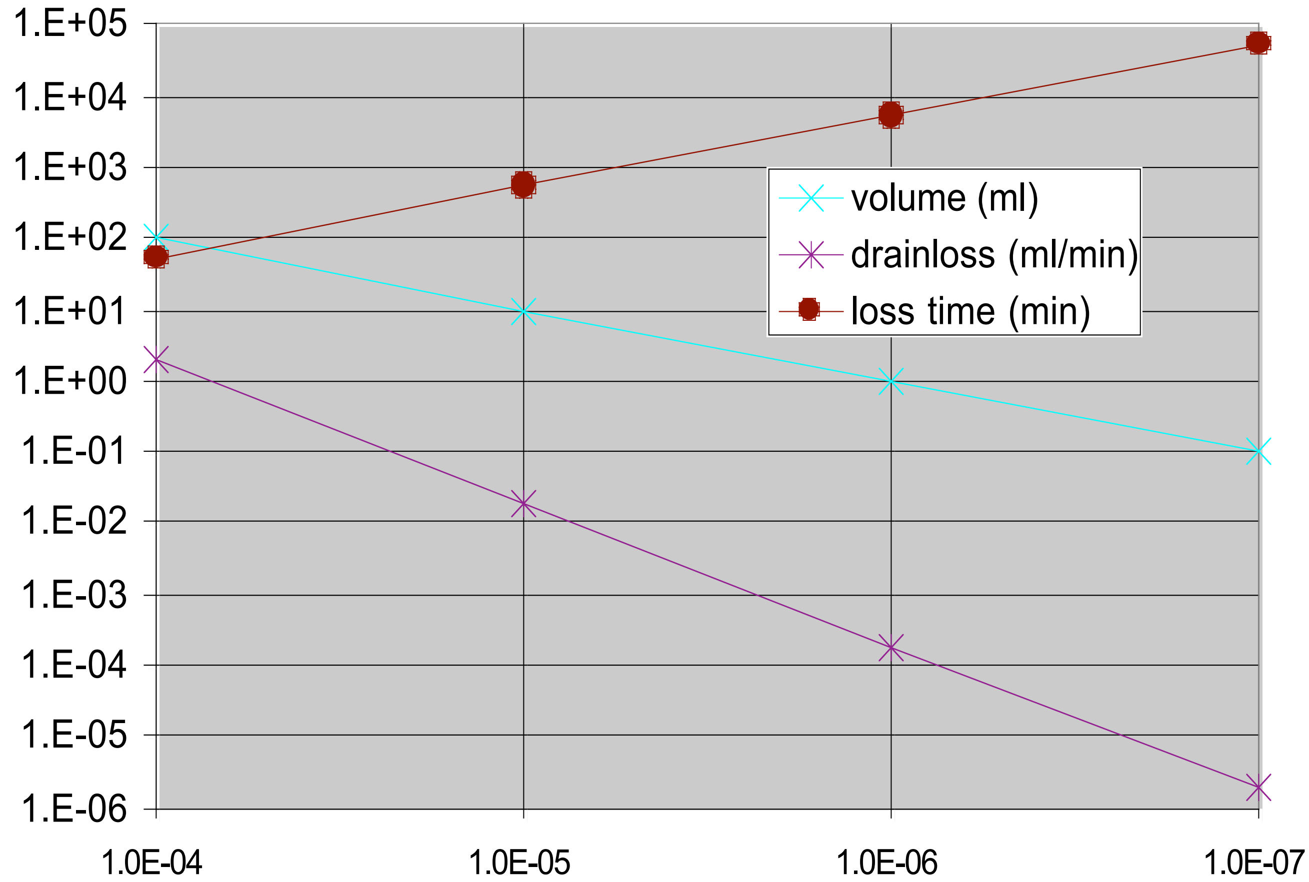
Gravity will almost instantly accelerate thin film to equilibrium velocity



Liquid drainage to bottom of the plate gets relatively large above film thickness 100 microns

- Plate could be designed to catch cumulative drainage at bottom

- Drainage could be inhibited by waffling plate surface.



Surface tension forces dominate if the film tries to deform

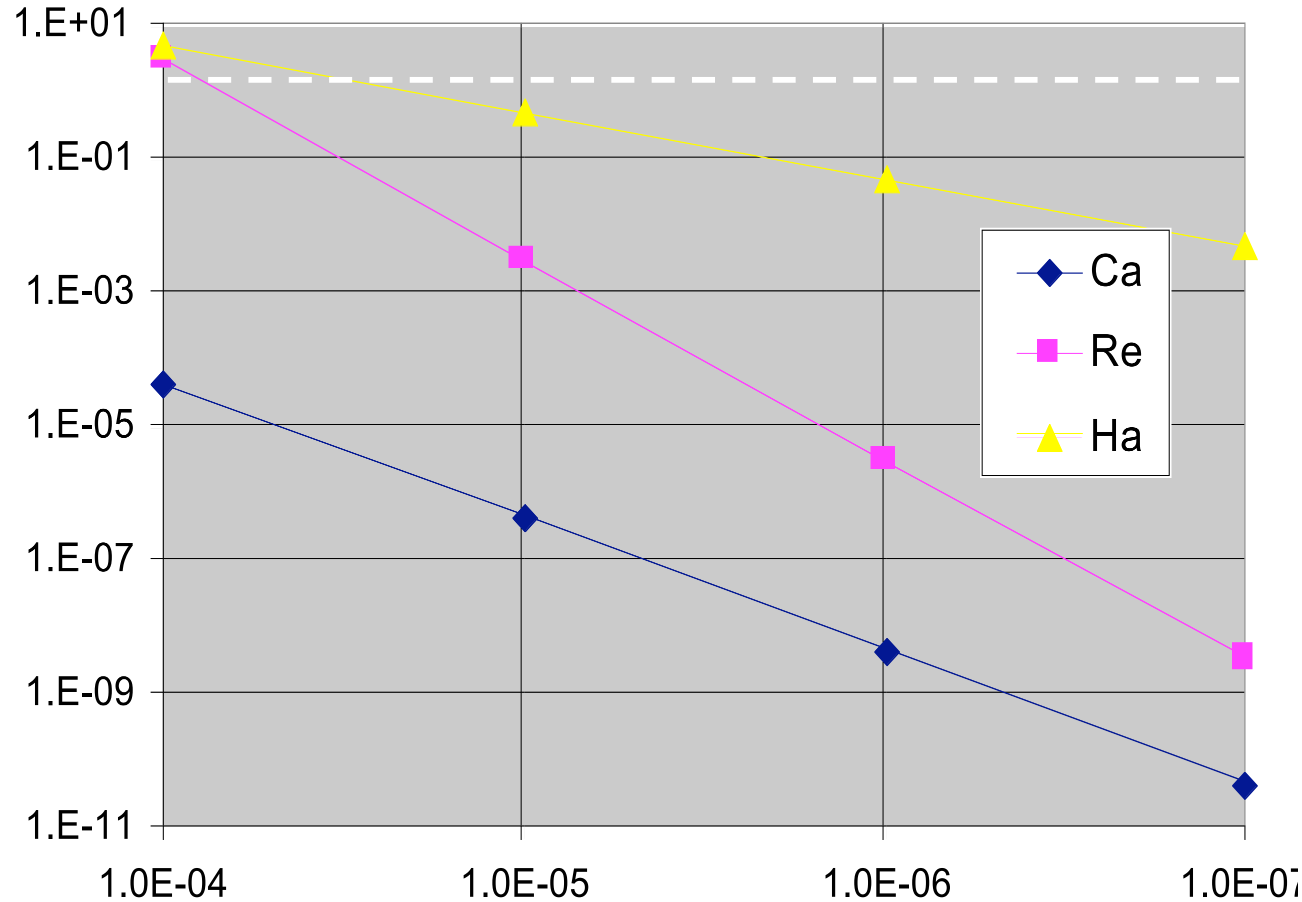
Capillary No. Ca = $\mu V/\sigma_s$ Ratio viscous to surface tension

Reynolds No. Re = $\rho V h/\mu$ Ratio inertial to viscous

Hartmann No. Ha = $Bh(\sigma/\mu)^{1/2}$ Ratio magnetic to viscous

At large h, MHD forces may affect drain rate, but surface tension forces should prevent atomization

Long wavelength less stabilized



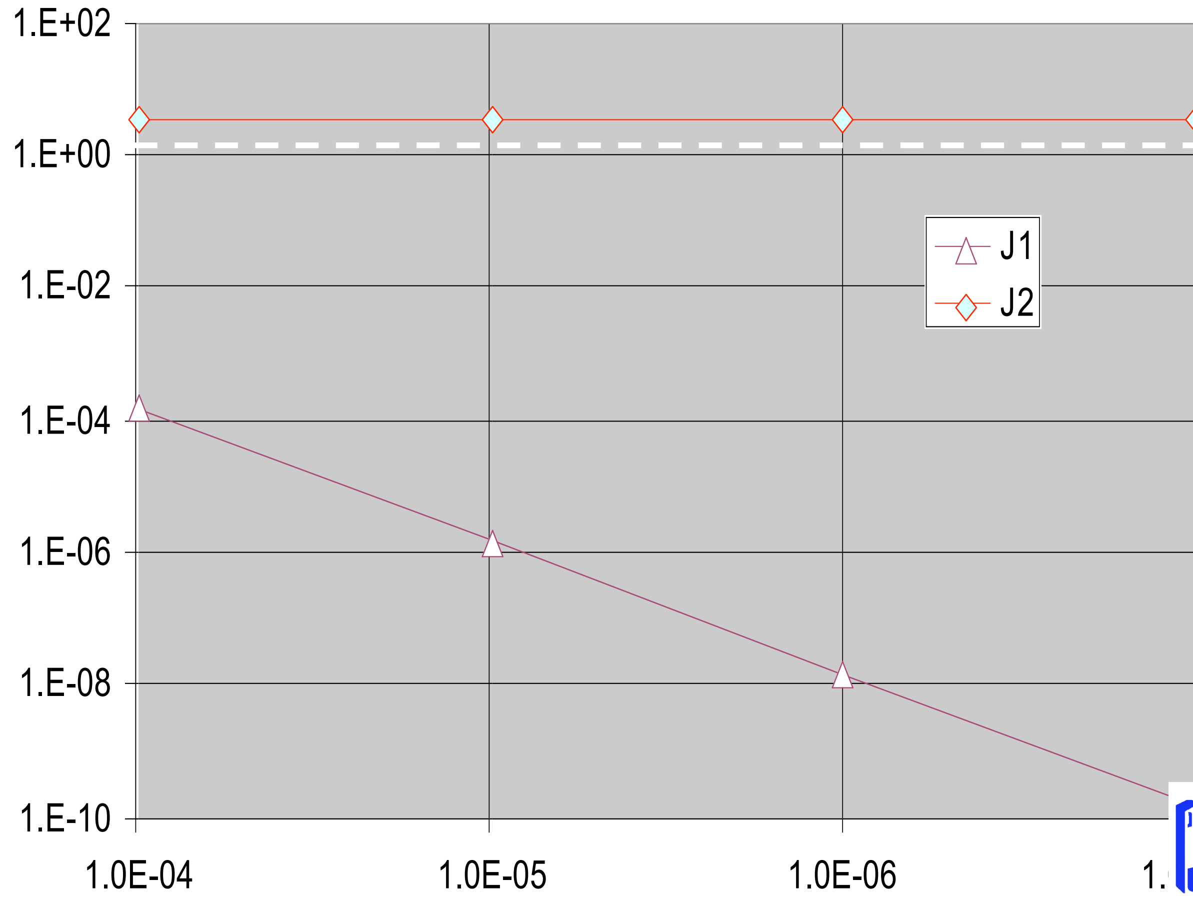
J_p x B forces will probably affect the flow velocity on the plate, but can not overcome surface tension of wetted film

$J_1 = J_p Bh^2/\sigma_s$ ratio plasma current MHD to surface tension

$J_2 = J_p Bh^2/u\mu$ ratio plasma current MHD to viscous

Again - Long wavelengths less stabilized

Disturbance size of 1 cm needed for J2 = 1



van der Waals effects on thin film stability

(taken from Reiter, Langmuir, 15, 1999)

- Competition between wetting and van der waals forces can act to cause films to bunch up into beaded structures with local dewetted regions.
- Good adhesion does not necessarily mean that the particular ultra thin film/substrate is stable from dewetting
- dispersion forces can not always be neglected at distances of greater than 100 nm

Different stability modes exist depending on sign of short and long range molecular forces

$$\nabla G = -A_{123}/12\pi h^2 + S^p\exp(-h/l)$$

$$A_{123} = (\sqrt{A_{11}} - \sqrt{A_{33}})(\sqrt{A_{22}} - \sqrt{A_{33}})$$

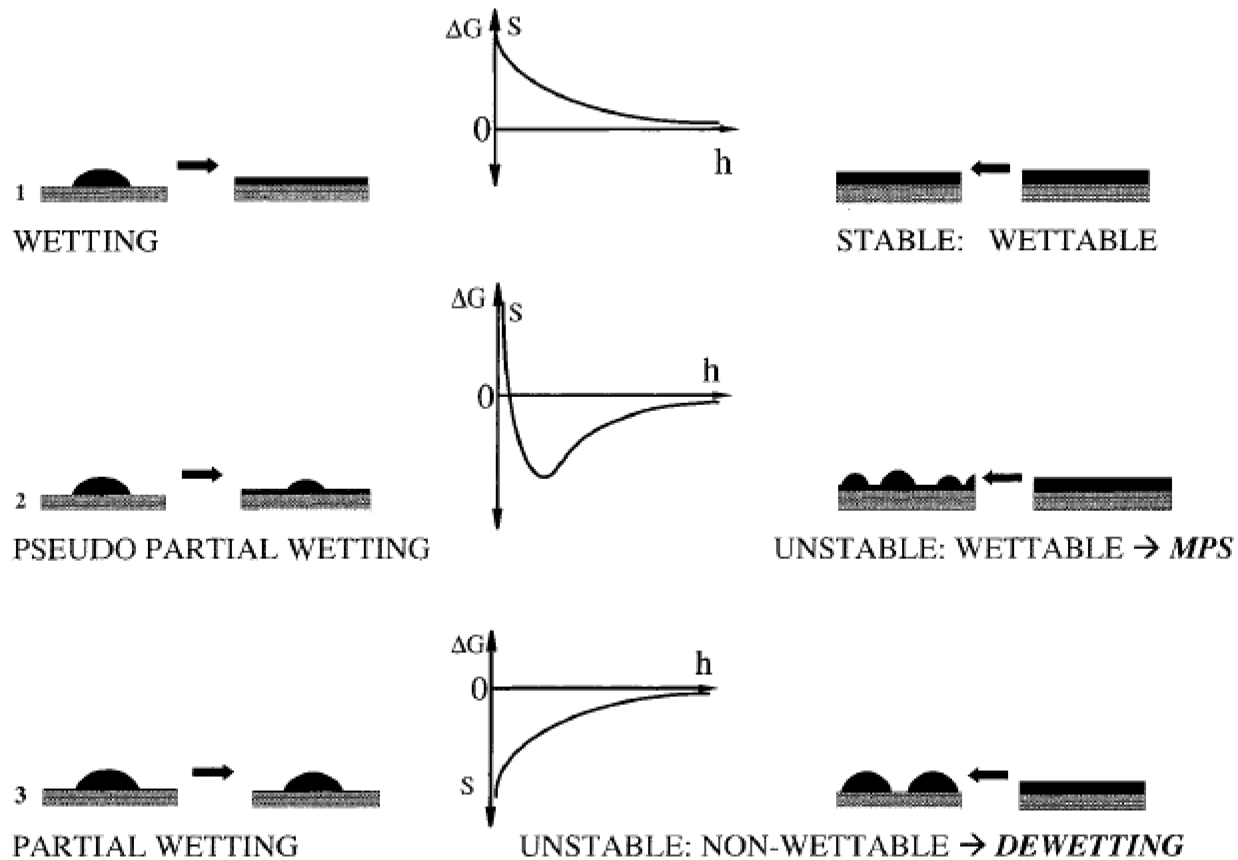
A_{123} is Hamaker coefficient for "long" range van der Waals forces for the system

A_{11}=0 J

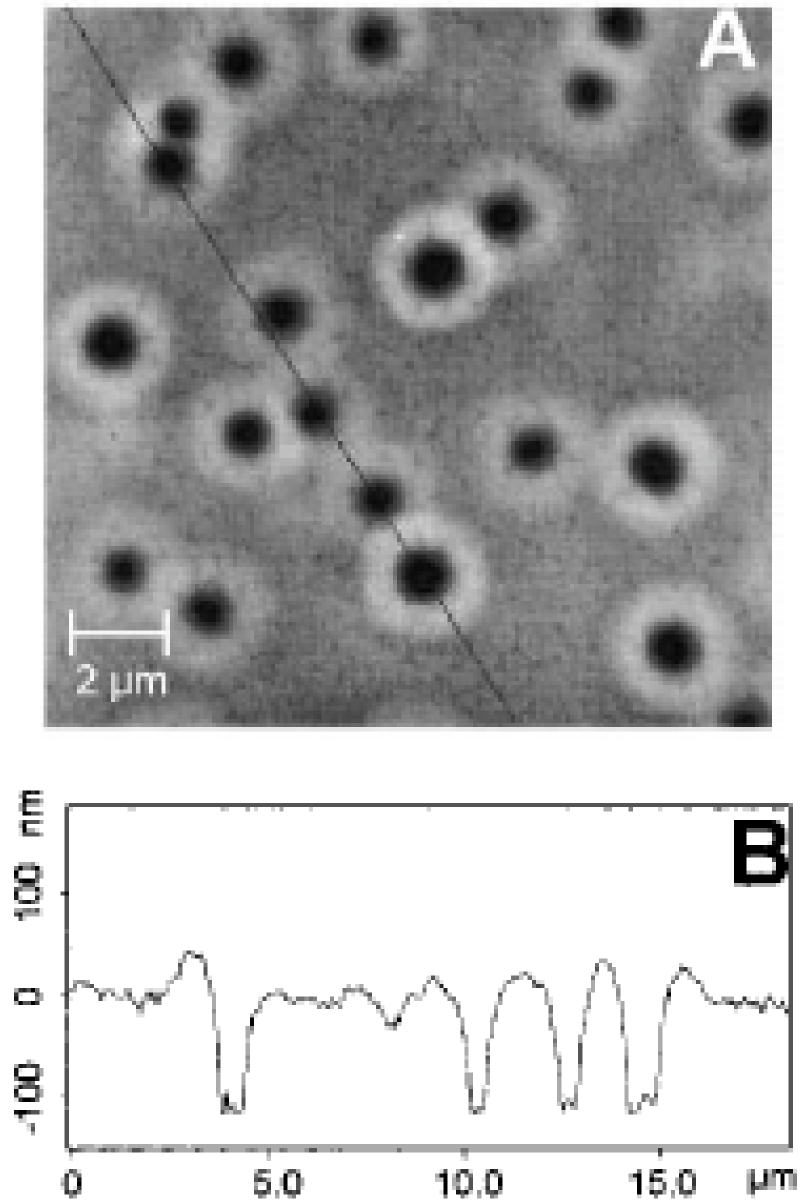
A_{Au}=3.6x10^{-19} J

A_{Al}=4.4x10^{-19} J

S^p is the short range polar forces



Dewetting of 100 nm gold film on fused silica



Partial instability not necessarily bad thing from fluid perspective but may reduce the volume of Lithium available for pumping

I would like to see the results of initial film deposition tests before considering any further modeling