

03.03.2022

3322

Lecture 21

\*  $G_{\text{Film}}^{\text{LW}} = C - \frac{A_{11}}{12\pi h^2}$  \* Interfacial VDW Interaction.

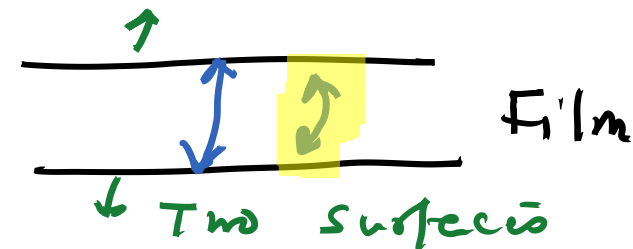
If  $h \rightarrow \infty$  (Large), Then  $G_{\text{Film}}^{\text{LW}} = \text{Constant}$

(  $h > 100 \text{ nm}$  )

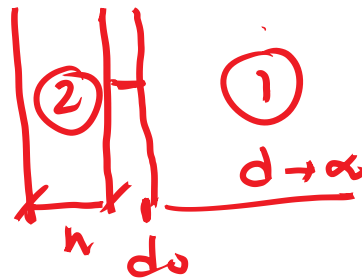
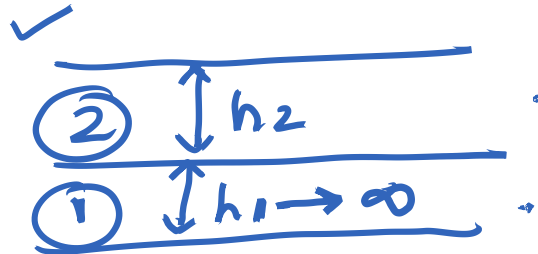
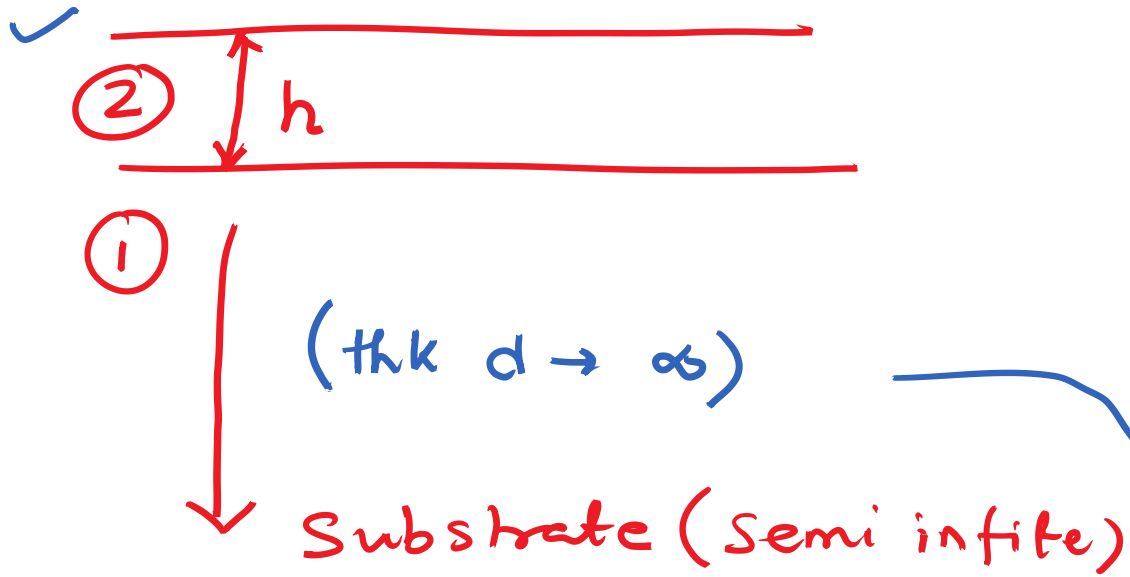
→ If  $h$  is low, (small) then  $G_{\text{Film}}^{\text{LW}} = f(h)$ .

What is a Thin Film? →

A film in our context is THIN as long as  $G$  of the Film is a function of  $h$ . → If there is active (non zero) VDW interaction between its two interfaces.



# Supported Thin Film



$G_{System}^{Lw}$

$$= G_{Film}^{Lw} + G_{Substrate}^{Lw} + G_{1-2\ Interface}^{Lw}$$

$$= \left( \check{C}_1 - \frac{A_{22}}{12\pi h^2} \right) + \left( \check{C}_2 - \frac{A_{11}}{12\pi d^2} \right) - \frac{A_{12}}{12\pi} \left[ \frac{1}{d_0^2} + \frac{1}{(d+h+d_0)^2} - \frac{1}{(d+d_0)^2} - \frac{1}{(h+d_0)^2} \right]$$

Annotations for the equation above:

- $\check{C}_1$  and  $\check{C}_2$  are marked with green checkmarks.
- $A_{22}$  is highlighted in yellow.
- $\frac{A_{11}}{12\pi d^2}$  has a red arrow pointing to 0, with  $\infty\ d \rightarrow \infty$  written above it.
- $\frac{1}{d_0^2}$  has a green checkmark.
- $\frac{1}{(d+h+d_0)^2}$  has a red arrow pointing to 0, with  $\infty\ d \rightarrow \infty$  written above it.
- $\frac{1}{(d+d_0)^2}$  has a red arrow pointing to 0, with  $d \rightarrow \infty$  written below it.
- $\frac{1}{(h+d_0)^2}$  has a green checkmark, a red arrow pointing to 0, and  $h+d_0 \approx h$  written below it.

$$G_{\text{System}}^{LW} = (C_1 + C_2) - \frac{A_{22}}{12 \pi h^2} - \frac{A_{12}}{12 \pi d_0^2} + \frac{A_{12}}{12 \pi h^2}$$

$$= C - \frac{(A_{22} - A_{12})}{12 \pi h^2}$$

C = Combined Constant

$$G_{\text{System}}^{LW} = C - \frac{AE}{12 \pi h^2}$$

AE = Effective Hamaker  
Const =  $A_{22} - A_{12}$

For a supported thin film  $G^{LW} = f(h)$ , if the film  
thk is less.

If h is thick  $G^{LW} = \text{constant}$   
=  $(\gamma_1, \gamma_2, \gamma_{12} \text{ etc})$ .

$$\boxed{G_{\text{Film}}^{LW}} = C - \frac{AE}{12\pi h^2} = G_{\text{System}}^{LW} \rightarrow \text{Supported Thin Film}$$

$$\boxed{\pi} = - \frac{\partial (\Delta G^{LW})}{\partial h} = \frac{AE}{6\pi h^3}$$

Disjoining Pressure



How the Excess free Energy of the System varies with  $h$ .

$$\boxed{\Delta G_{\text{System}}^{LW}} = G_{\text{Film}}^{LW} \Big|_h - G_{\text{Film}}^{LW} \Big|_{h \rightarrow \infty} = - \frac{AE}{12\pi h^2}$$

(Finite) Thick

Excess free Energy  
due to its thinness.

