Electronic Supplementary Material (ESI) for Soft Matter

Supplementary Material

S4 Order of Magnitude Analysis

As a quantitative comparison, the scaling analysis between these three works, we can compare the capillary pressures and disjoining pressure in these works. The total pressure in the film can be expressed as

$$P = P_a - \gamma \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial h}{\partial r}\right) + \varepsilon {V_o}^2 \frac{1}{h^2} \qquad (1)$$

Considering the following dimensionless parameters:

$$\bar{r} = \frac{r}{r^*} \quad , \qquad \bar{h} = \frac{h}{h^*} \qquad (2)$$

Substituting (2) in (1), we have the pressure based on dimensionless parameters as

$$P = 1 - \frac{\gamma h^*}{{r^*}^2}\frac{1}{\bar{r}}\frac{\partial}{\partial \bar{r}}\left(\bar{r}\frac{\partial \bar{h}}{\partial \bar{r}}\right) + \frac{\varepsilon {V_o}^2}{{h^*}^2}\frac{1}{\bar{h}} \qquad (3)$$

(3) includes two parameters:

$$\frac{\gamma h^*}{{r^*}^2} \ , \frac{\varepsilon {V_o}^2}{{h^*}^2}$$

$\frac{\gamma h^*}{{r^*}^2}$, gives the strength of capillary and $\frac{\varepsilon {V_o}^2}{{h^*}^2}$ estimates the strength of electrostatic disjoining pressure.

In the present work, the capillary force $\frac{\gamma h^*}{{r^*}^2} \sim \frac{20\frac{mN}{m}\times 10^{-8} m}{10^{-4} m}$. The capillary force is in the order of $\frac{\gamma h^*}{{r^*}^2} \sim O(10^{-6}\,\frac{N}{m^2})$. The electrostatic pressure, $\frac{\varepsilon {V_o}^2}{{h^*}^2} \sim \frac{8.85\times 2.7\times 10^{-12}\times 10^{-2}}{10^{-16}}$, is in the order of $O(10^3\,\frac{N}{m^2})$. The capillary force can be ignored here.