

Ions binding to model lipid membranes: obtaining the adsorption value from indirect measurements

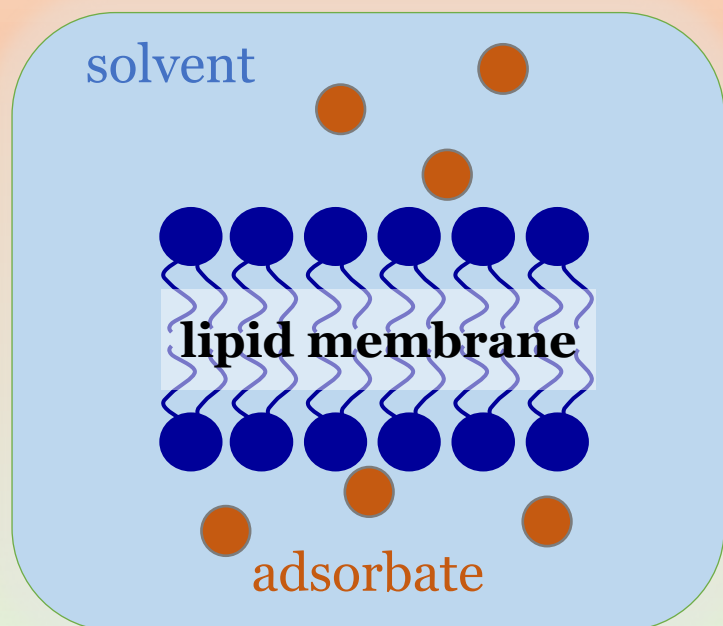
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Background



Binding of ions (or other adsorbates) to lipid membranes shifts their melting temperature T , which is a one-to-one related parameter of the adsorption value s . $\Delta T = \gamma s$ — the T shift. The value of s is a key parameter of membrane-ion interactions, though it is difficult to be determined directly.

Can we determine s from ΔT ? We need γ !

Freundlich isotherm: $s = kc^\beta \Rightarrow \Delta T = \gamma kc^\beta$

Problem: γ is only in a combination with another constant k

Idea

Effects of finite amount of solution

$$c = \frac{V_0 - V_{ads}}{V_a - V_{al}}$$

adsorbate uptake (orange box)
solvent uptake (blue box)

Explicit accounting of these effects allows to separate the constants γ and k

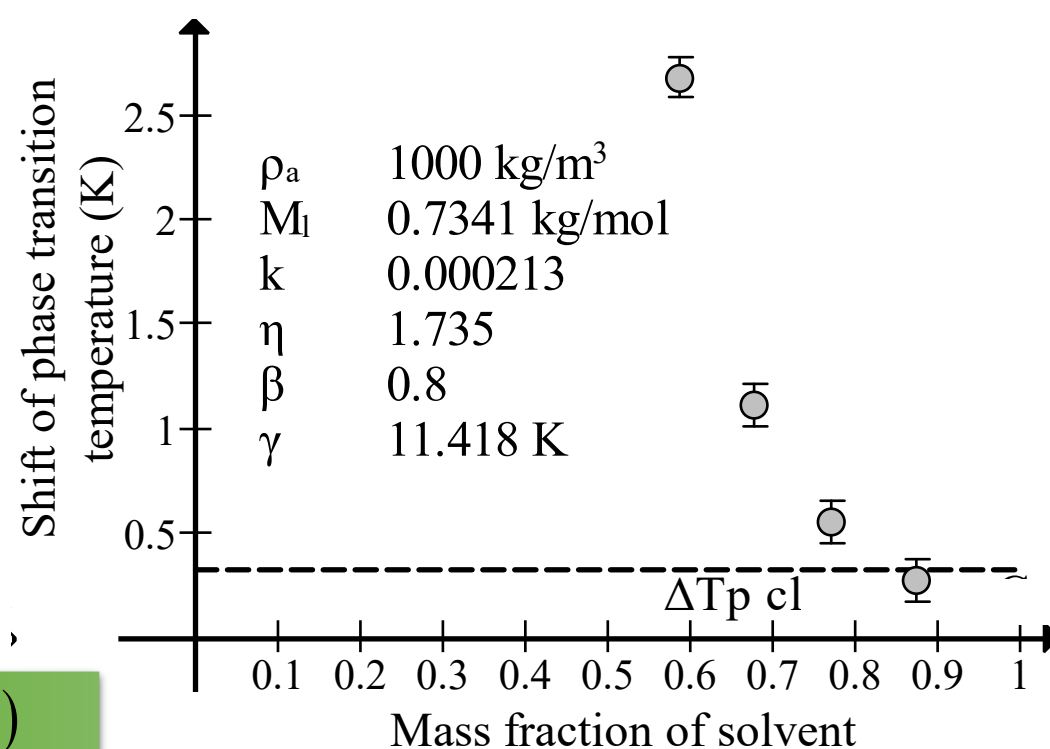
Method

$$\begin{cases} \Delta T_1 = f(k, \gamma | \kappa_{a1}, \Delta T_1) \\ \Delta T_2 = f(k, \gamma | \kappa_{a2}, \Delta T_2) \end{cases} \leftarrow f(k, \gamma | \kappa_a(C_a), \Delta T)$$

$$f = \gamma kc_0^\beta \left(\frac{\kappa_a - \alpha / c_0 \cdot (\Delta T / \gamma)}{\kappa_a - \eta} \right)^\beta$$

γ

the adsorption value s can be determined from ΔT



s

lipid : ion ratio 10 : 1 $\leftarrow (C_a, \Delta T)$

Dipalmitoylphosphatidylcholine (DPPC) membrane and 0,45 M KCl water solution

Conclusions

- Explicit accounting of the effects of finite amount of solution allows obtaining the adsorption value from indirect, one-to-one related parameters.
- Applying this method to our experimental data, we determined the lipid : ion ratio at DPPC membrane surface as $\sim 10 : 1$ at $C_a \approx 0,9$.
- The method seems quite applicable to various adsorption processes on liquid-solid, gas-solid and gas-liquid interfaces.