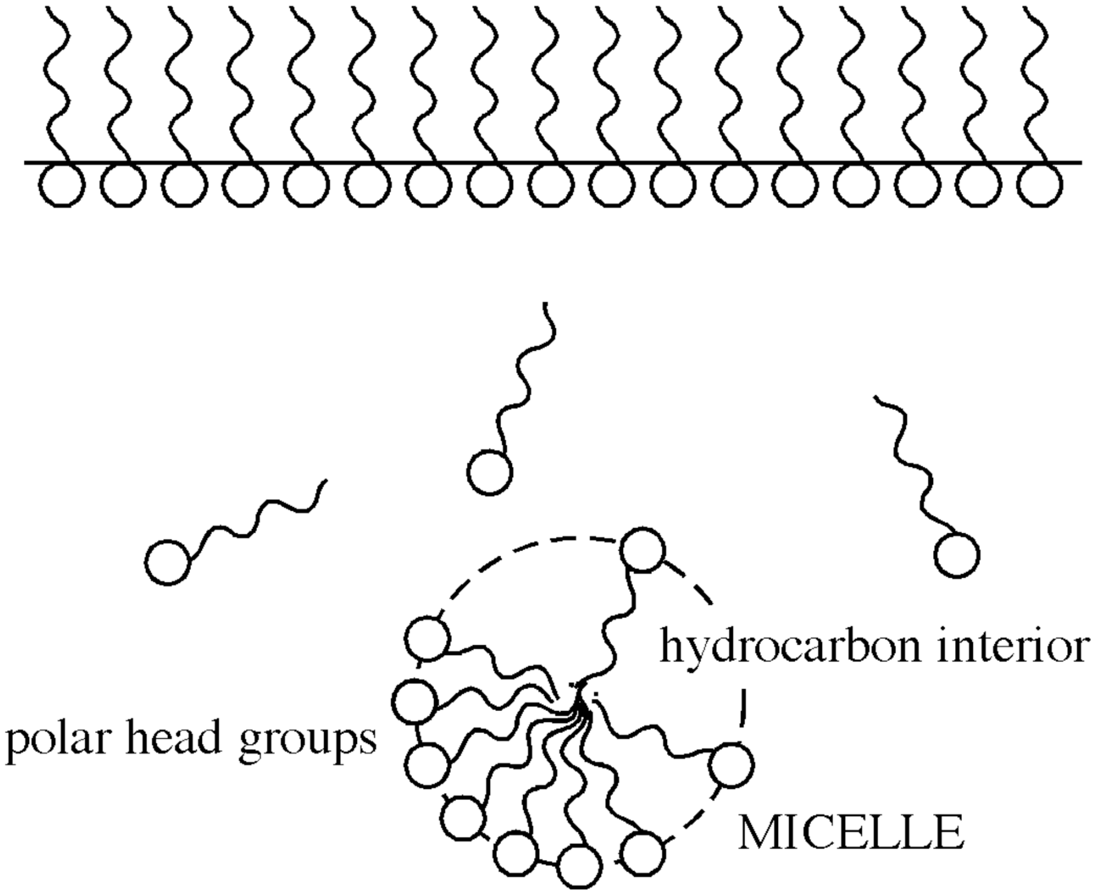
Determination of Critical Micelle Concentration by Conductivity

Teng-Jui Lin
Department of Chemical Engineering, University of Washington

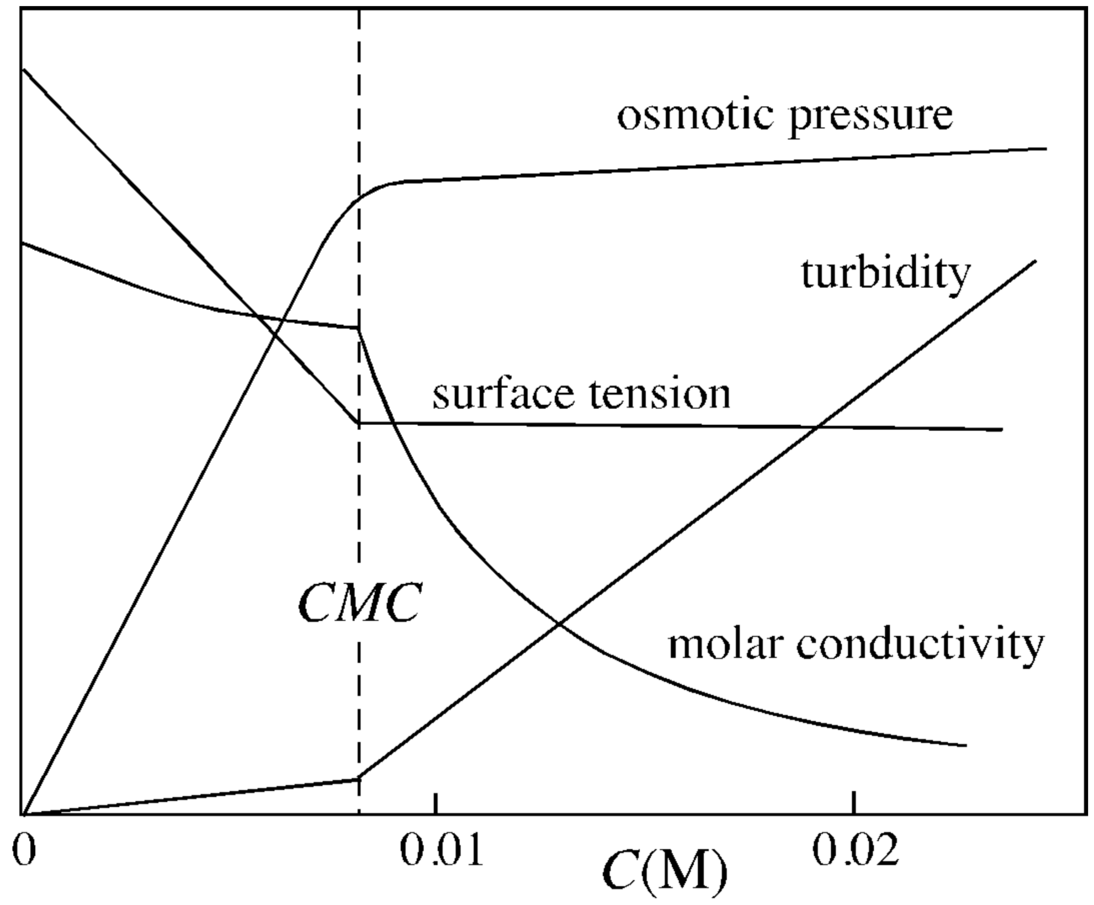
Surface and Colloid Science

Micelle formation changes physical properties

- Micelle formation



- Physical property of SDS at 25 °C



- CMC = critical micelle concentration

CMC can be determined using conductivity measurements

- Conductivity $\kappa[\mu\mathrm{S/cm}]$ increases linearly with concentration $C[\mathrm{M}]$

$$\kappa = \kappa_0 + k_\kappa C$$

- Equivalent conductivity $\Lambda[\mathrm{S\ cm^2/mol}]$

$$\Lambda = \frac{\kappa}{C}$$

- Equivalent conductivity decreases linearly with square root of concentration

$$\Lambda = \Lambda_0 - k_\Lambda \sqrt{C}$$

CMC decreases with alkyl chain length: Klevens equation

- Klevens equation: increasing alykl chain length n decreases CMC

$$\log \mathrm{CMC} = A - Bn$$

Surfactants of interest

Surfactant	Chemical Formula	Number of alkyl chains n	Surfactant classification	Ionic classification
SDS	$CH_3(CH_2)_{11}OSO_3Na^+$	12	Sodium alkyl sulfates	Anionic
DTAB	$CH_3(CH_2)_{11}N^+(CH_3)_3Br^-$	12	Alkyl trimethyl ammonium bromides	Cationic
HTAB	$CH_3(CH_2)_{15}N^+(CH_3)_3Br^-$	16	Alkyl trimethyl ammonium bromides	Cationic
OTAB	$CH_3(CH_2)_{17}N^+(CH_3)_3Br^-$	18	Alkyl trimethyl ammonium bromides	Cationic

Experimental procedure

- Calibrate conductivity meter
- Wait 2 min for the *system* to equilibrate before recording the conductivity measurement
  - The equipment reading may have stabilized, but the system might not have reached equilibrium