Determination of Critical Micelle Concentration of Aerosol-OT in a Two-Solvent System by Fluorescence Spectroscopy

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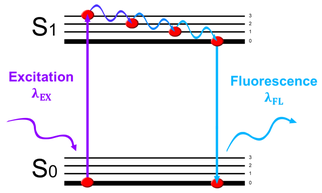
Introduction

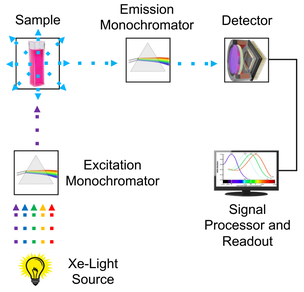
Fluorescence

- Three-step process:
  1) Excitation by absorbing radiation (λ_{EX})
  2) Vibrational relaxation and internal conversion to lowest vibrational level of the excited state
  3) Emission of a photon of lower energy (λ_{FL})



Fluorescence Spectroscopy

- Polychromatic light is wavelength-selected by a monochromator and used to excite the fluorophore
- Fluorescence emission is collected at 90° relative to the excitation and directed towards an emission monochromator and a detector



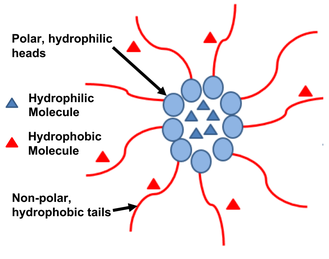
Coumarin-120 (C-120) Fluorescent Probe

- Hydrophilic molecule
- Intensity depends on environmental conditions including pH, solvent polarity, and viscosity
- Useful in cell tracking applications

Coumarin-120

Reverse Micelles

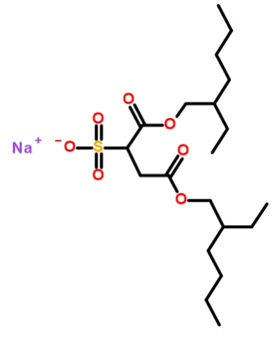
- Surfactants are composed of a hydrophilic head and hydrophobic tail(s)
- Aggregate into ordered structures, such as micelles, due to entropic processes
- Critical Micelle Concentration (CMC) - lowest concentration of surfactant required for aggregation
- Reverse micelles are composed of hydrophilic heads with hydrophobic tails extending outwards
- Applications include targeted drug delivery, and protein isolation and refolding
- Hydrophilic fluorophores may be encapsulated in the core and used to determine the CMC by measuring fluorescence intensity



Reverse Micelle

Aerosol-OT (AOT)

- Most widely studied surfactant molecule
- Capable of forming microemulsions
- Excellent in encapsulating hydrophilic molecules



Aerosol-OT

Experimental

Determination of CMC

- AOT sample solutions (0.20 – 2.50 mM) were prepared in hexane
- Each sample contained 0.15 nM C-120 in THF
- Concentration of C-120 previously optimized for limit of detection

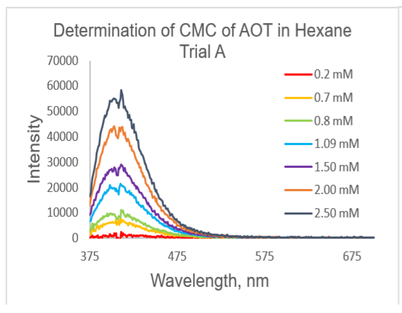
Spectrofluorometer Parameters

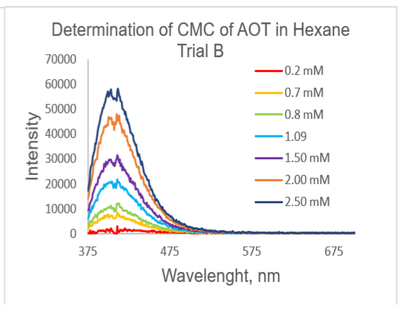
- λ increments: 1 nm
- Excitation bandpass: 3 nm
- Emission bandpass: 3 nm

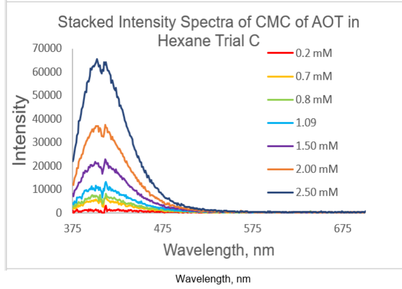
Results and Discussion

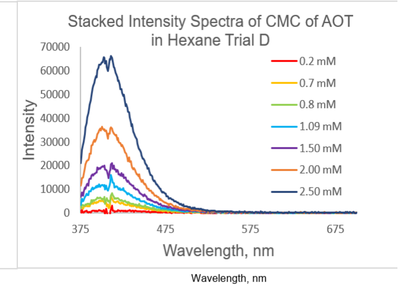
Salvatochromic Shift and Resolution of C-120 Intensity

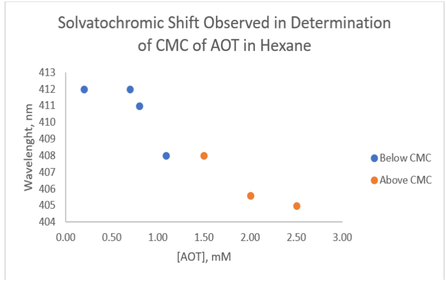
- Blue shift occurred as intensity increased
- Range of solvatochromic shift was 7 nm
- Indicated C-120 was encapsulated in the core of the micelle
- Low resolution observed in stacked C-120 intensity spectra
- Inconsistent maximum intensities





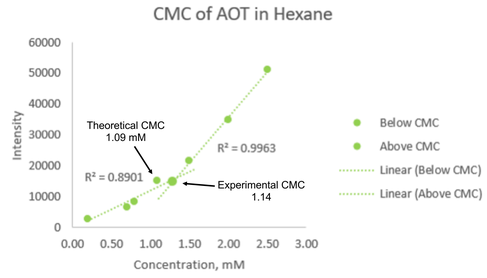






Determination of CMC

- Literature CMC of 1.09 mM was used as a center point for CMC study
- Experimental CMC was determined to be 1.14 mM (±0.35mM)



Conclusions & Future Work

- Concentration of C-120 should be reoptimized to improve resolution of spectra
- Deposition method using THF was successful in encapsulating the fluorophore, should be optimized to lower standard deviation
- Another fluorophore, soluble in a nonpolar environment, such as dansyl chloride, can be used to determine CMC

References

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