Effects of Light Wavelength on Aggregate Structures of Photoresponsive Surfactants

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Background & Procedures

This summer we worked with photoresponsive surfactant particles – that is, particles with a hydrophilic end and a hydrophobic end that change structure depending on the wavelength of light (visible vs UV). In this project, a cationic (positive) surfactant (azoTAB) was synthesized and mixed with an anionic (negative) surfactant (SHS), causing it to aggregate into 3-dimensional structures such as vesicles and micelles when dissolving in water.

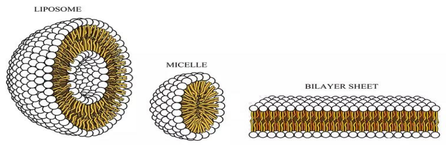


Figure 1: Three different types of aggregate structures formed by azoTAB and SHS. PC: LipoLife.co.uk

We created solutions at a ratio of 93/7 azoTAB/SHS, then diluted the substance to various concentrations ranging from 0.5% weight to 0.03% weight. We exposed one of these samples only to visible light, causing it to aggregate in the *trans* form, while the other sample was exposed only to UV light, causing aggregation in the *cis* form.

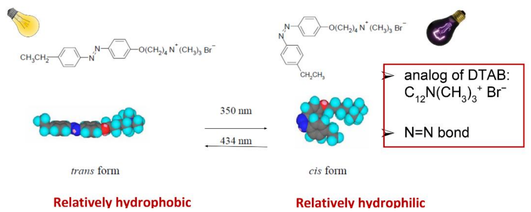
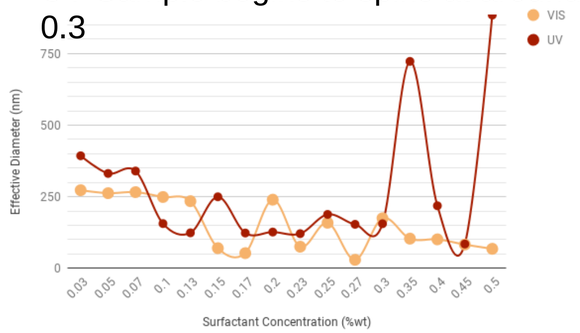


Figure 2: A molecular diagram of the cis and trans form of azoTAB and a brief explanation of its properties. PC: Zumra Peksaglam

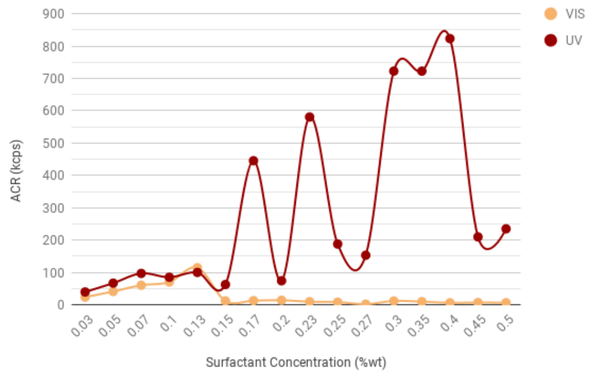
We observed these aggregate structures at various concentrations using Dynamic Light Scattering (DLS), which uses a laser to observe Brownian motion to determine size and count. We experienced significant interference, especially in the visible-light solution at higher concentrations, which we reduced by heating the samples and reducing the time of exposure to the laser.

Data and Conclusions

- UV sample has larger particle size
  - Both have initial decrease in diameter
  - UV Sample begins to spike at around 0.3



- UV Sample has higher count rate
  - Both have initial increase in count rate
  - UV sample has high spikes starting at 0.15
  - Visible sample drops at 0.15, possibly increase in concentration results in crystallization, which would reduce ACR and denote a lower solubility



Evidently, there are larger and more aggregate structures in the cis (UV) sample than the trans (visible) sample, so exposure to UV light could be used to dissociate aggregate structures.

Knowledge & Skills Obtained

- Research techniques
  - Using the micropipette and balance
  - Being accurate and meticulous
- Equipment Use
  - Dynamic Light Scattering Laser and Software
  - Vortex
  - Centrifuge
  - Incubator
  - Water filter
  - Fume hood
- Course Content
  - Amphipathic particles-Chemistry
  - Properties of cellular membranes/structures-Biology
  - Interactions of different wavelengths of electromagnetic spectrum (Physics)
- Outside of the Lab
  - Writing a college essay
  - Reading and understanding academic literature
  - Creating an annotated bibliography
  - Introduction to other engineering fields
  - Civil engineering – Arduino programming and soldering
  - Biomedical engineering introduction
  - Aerospace engineering introduction
  - Electrical engineering – basics of quantum computing

Impact of Professor's Research

Upon discovery that the aggregate structures dissociate under visible light, these structures can be associated and disassociated at will. So, given that the surfactant is membrane-permeable, it can serve as a drug delivery mechanism, delivering DNA, RNA, chemotherapy particles, or other medicinal particles.

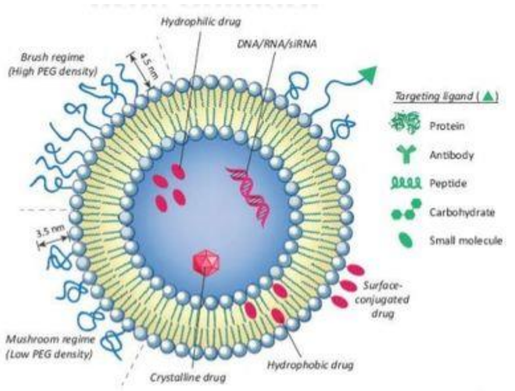


Figure 5: A diagram of a vesicle serving as a drug delivery mechanism. PC: intechopen.com

The structures could transport them through the membrane and a change in light wavelength could dissociate the structures, releasing the drugs inside of the cell.

Acknowledgements

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