Characterization and Analysis of SDS Micelles for The Preparation of Nanotemplated Hydrogels

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Introduction

Hydrogels are porous water-filled networks of polymer chains that are currently being investigated for a wide range of applications in biotechnology. Many studies have been done in last forty years that propose methods for tailoring the properties of hydrogels to fit specific applications. One possibility is to modify the gel porosity through a templating process. The specific focus of this project will be on the characterization of particles called micelles and the subsequent evaluation of their potential success as templating agents. Micelles are aggregates of amphiphilic molecules that form in aqueous solution. They are particles formed by monomer molecules which arrange themselves so that their nonpolar tails are oriented in toward each other and their hydrophilic polar heads point outward.

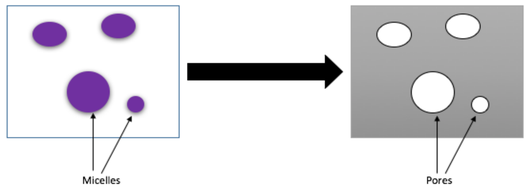


Figure 1: Sketch indicating a potential path to synthesize nano-template gels.

Project Goals

- Determine optimal experimental conditions for the production of SDS micelles
- Establish a set of reliable procedures for the characterization of detergent micelle
- Evaluate the precision of experimental methods used to obtain measurements of particle size at the nano-scale.
- Gather and analyze data to construct an empirical equation for the calculation of micelle aggregation number

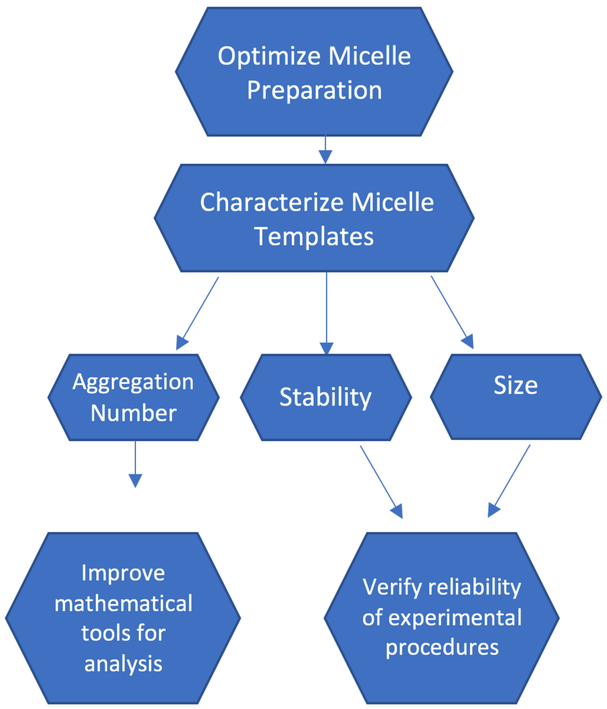


Figure 2: Visual representation of project steps

Methods

Micelle Preparation

Micelles are aggregates of amphiphilic molecules that form in aqueous solution at equilibrium. The procedures for preparing micelles in a laboratory setting are simple and inexpensive, but the exact experimental conditions are rarely reported. Generally, the procedure is completed by mixing the SDS in water until it is dissolved. The objectives of this research rely heavily on a strict adherence to precision with a focus on experimental phenomena that may have been previously neglected. Therefore, the preparation step will need to be performed under optimal conditions (temperature, mixing speed, mixing method).

Micelle Characterization

This project will include a characterization of the prepared micelles by their size, stability, and aggregation number. Table 1 provides information on the experimental techniques and calculations that will be employed for each characteristic.

Property	Measurement	Technique	Description	Instrumentation
Size	Hydrodynamic radius	Dynamic Light Scattering	Measure light scattering intensity fluctuations due to Brownian Motion as a function of time	Zetasizer Nano
Colloidal Stability	Electrostatic stability	Zeta Potential	Measure	Zetasizer Nano
Aggregation Number	Intensity vs. wavelength of emission spectra	Steady-state fluorescent quenching	A fluorophore binds to a micelle at a 1:1 ratio and a quencher is introduced. Light intensities before and after quenching are applied to an equation to calculate aggregation number.	Spectrofluorometer

Table 1: Summary of micelle characterization techniques

Figure 4: Hardware setup for Zetasizer Nano[2]

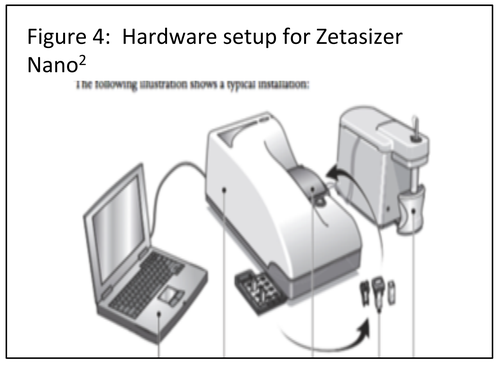
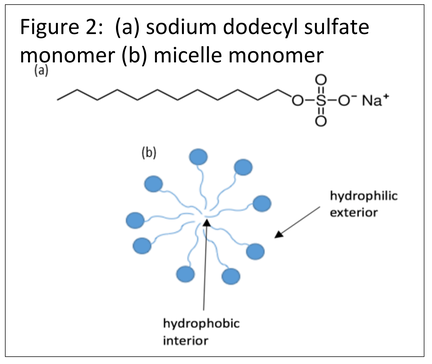


Figure 2: (a) sodium dodecyl sulfate monomer (b) micelle monomer



Experimental Design

A 2k factorial design will be used to determine the number of runs necessary for each characterization. The number of runs for an experiment will be determined based on two levels (high or low) for each of several factors. An example using two (A and B) is shown in Figure 5.

Figure 5: 2k factorial design

Trial	A	B
1	+	+
2	+	-
3	-	-
4	-	+

References

1. Alex Sherrill, Masters Thesis: Characterization of Sodium Dodecyl Sulfate Micelles Used as a Templating Agent in Polyacrylamide Nanostructured Hydrogels
2. Manual, Z. N. S. U. (2004). Malvern instruments ltd. *United Kingdom, Man0317, 2*, 5-5.
3. Turro, N. J., & Yekta, A. (1978). Luminescent probes for detergent solutions. A simple procedure for determination of the mean aggregation number of micelles. *Journal of the American Chemical Society*, *100*(18), 5951-5952.

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