Optical Fiber: A Potential Method for Critical Micelle Concentration Measurement

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Introduction

This study is concerned with measuring the Critical Micelle Concentration (CMC) of surfactants using optical fiber in which the spectrum width center was measured.

To verify the results, the conventional method called drop profile analysis tensiometry (PAT) technique was also used. Therefore, the surface tension of the solutions at different concentrations of the surfactant were obtained.

Based on the preliminary results, the main considerations for the future studies, using optical fiber, were suggested.

Materials and Methods

The cationic and anionic surfactants were CTAB and SDS, respectively. Their concentrations in DI water were 1e-1, 1e-2, 5e-3, 2.5e-3, 1e-3, 5e-4, 1e-4, 5e-5, 1e-5, 5e-6, and 1e-6 M.

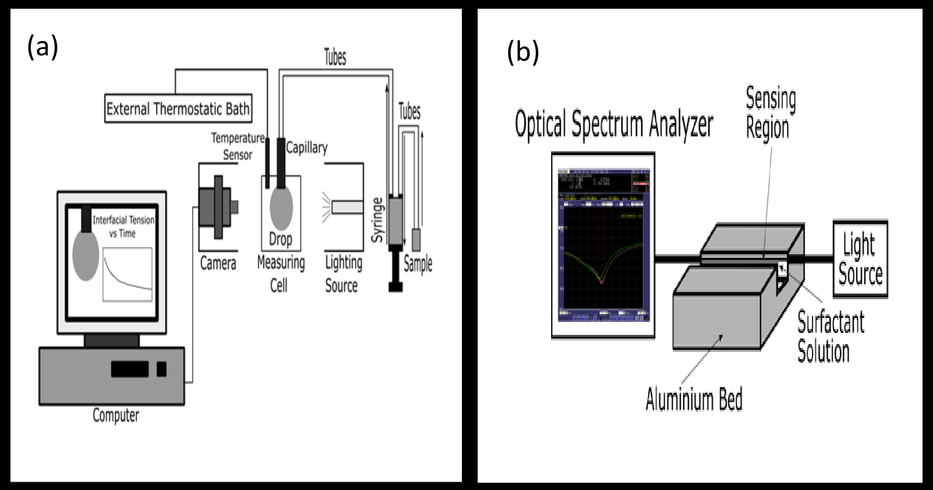

Fig.1 Set-up for (a) profile analysis tensiometer (PAT) and (b) Optical fiber.

Results and Discussion

The trend in the behavior of λc is suddenly altered in the vicinity of the CMC for both CTAB and SDS. At the concentrations less than CMC, there is a linear trend while it changes to logarithmic relationship at the concentrations higher than CMC.
Despite this similarity, a difference was observed. At the concentrations below CMC, λc is increasing for CTAB while it is decreasing for SDS.

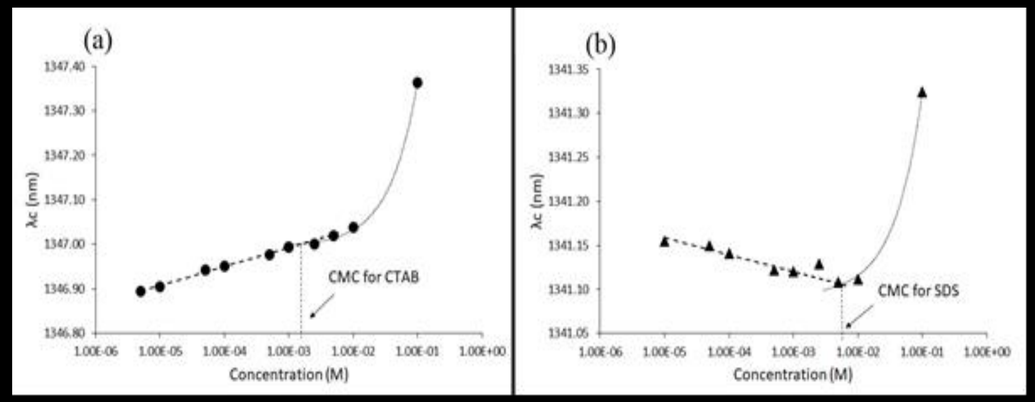

Fig. 2 Spectrum width center versus surfactant concentration for (a) CTAB, and (b) SDS.

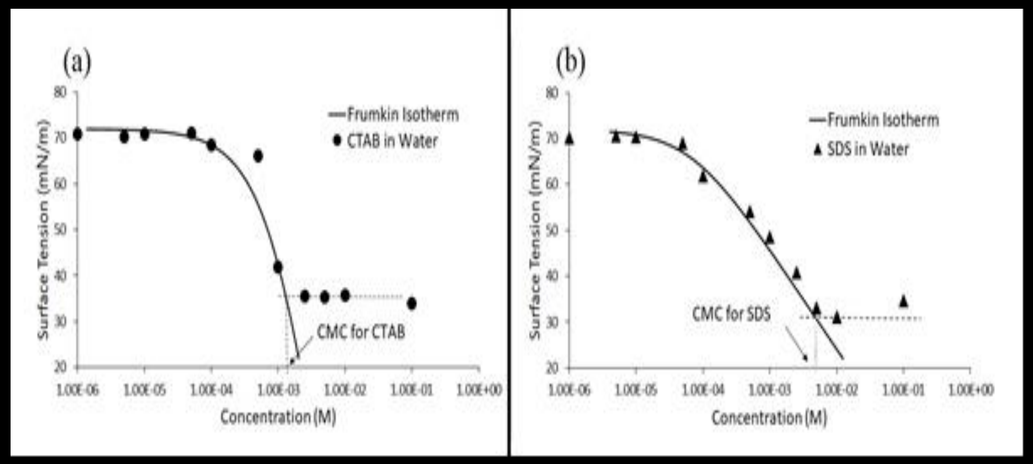

Fig. 3 Surface tension against concentration of the surfactant for (a) CTAB and (b) SDS.

Using PAT, the plot of surface tension versus concentration, i.e. adsorption isotherm, for each surfactant was obtained. Frumkin model was used for fitting the data.

Table 1. CMC obtained from two methods.

Method / Surfactant	PAT	Optical fiber
CTAB	1.30e-3M	1.60e-3 M
SDS	4.23e-3 M	6.50e-3 M

Conclusion

The preliminary results for measuring CMC showed the consistency between optical fiber and PAT methods. Based on the presence of the surface of fiber in the system, the factors which should be considered in the future are: (a) interactions between the surfactant molecules and fiber surface, (b) eliminating the air-liquid interface, and (c) using fiber sensors with higher sensitivity.

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Can optical fiber compete with profile analysis tensiometry in critical micelle concentration measurement?

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