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Surface and aggregation properties of heterogemini surfactants containing quaternary ammonium and guanidine moiety

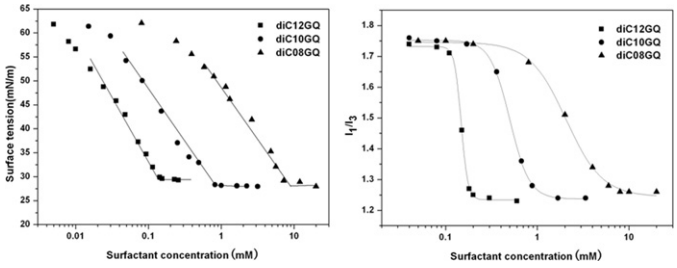
Yongbo Song[a,b], Qiuxiao Li[b,*], Yunling Li[b], Lifei Zhi[b]

[a] College of Chemistry and Chemical Engineering, Shanxi University, Taiyuan, Shanxi Province 030006, PR China
[b] China Research Institute of Daily Chemical Industry, 34# Wenyuan Street, Taiyuan, Shanxi Province 030001, PR China

HIGHLIGHTS

- Heterogemini surfactants containing guanidine group were synthesized.
- Higher surface activity than monomeric surfactants and their equimolar mixture.
- The adsorption, aggregation and thermodynamic parameters evaluated.

GRAPHICAL ABSTRACT



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ABSTRACT

A novel gemini surfactant with nonidentical hydrophilic groups containing guanidine group and quaternary salt, N,N-dimethyl-N-[3-(N′,N′-dimethyl-N″-alkylguanidiumhydrochloride)propyl]-1-alkyl ammonium chloride (diC*n*GQ, where *n* represents hydrocarbon chain lengths of 8, 10, and 12) was successfully synthesized. The adsorption and aggregation properties of diC*n*GQ in aqueous solution have been investigated through surface tension, conductivity, steady-state fluorescence. The critical aggregation concentration (cac) obtained from different techniques showed fairly good agreement. Surface tension measurements have been used to derive surface adsorption properties such as adsorption efficiency and effectiveness (pC_{20} and cac/C_{20}), the maximum surface excess concentration (Γ_{max}) and minimum surface area permolecule (A_{min}) at the air–water interface. Temperature dependent conductivity measurements have been used to obtain the degree of counterion binding (β), and the thermodynamic parameters such as standard free energy (ΔG_{agg}), enthalpy (ΔH_{agg}), and entropy (ΔS_{agg}) of aggregation. The aggregation number (N_{agg}) for diC*n*GQ has been derived by using the fluorescence quenching technique. As a comparison, the heterogemini surfactants showed a lower cac and higher efficiency in lowering the surface tension than the corresponding monomeric surfactants and their equimolar mixture.

1. Introduction

Gemini surfactants contain two hydrophilic head groups and two hydrophobic chains linked by a spacer in a molecule which have been regarded as the next generation surfactants [1,2]. Of the gemini surfactants, cationic types of alkanediyl-α,ω-bis(alkyldimethylammonium)dibromide were first synthesized by Bunton et al. in 1971, and by far the most investigated surfactants [3]. The quaternary ammonium type gemini surfactants show much lower critical aggregate concentration (cac) values, greater efficiency in lowering the surface tension of water, and interfacial tension at the oil/water interface, and stronger adsorption at the solid/solution interface than the conventional monomeric surfactants [4–8].

Researches have been carried out on gemini surfactants in which the headgroups or hydrocarbon chain lengths are chemically nonidentical which referred to them as "heterogemini" surfactants [9]. Later on several heterogemini surfactants with different head

* Corresponding author. Tel.: +86 351 4046718; fax: +86 351 4040802.
E-mail address: liqiuxiao@sina.com (Q. Li).

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