
Supporting Information

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$^{13}$C spectra of 1-(1H-imidazol-1-yl)dodecan-2-ol (3).
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2D COSY ($^1$H-$^1$H) spectra of 1-(1H-imidazol-1-yl)dodecan-2-ol (3).
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$^1$H spectra of 3,3'-(butane-1,4-diyl)bis(1-(2-hydroxydodecyl)-1H-imidazol-3-ium) bromide (10).
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2D HETCOR ($^1$H-$^{13}$C) spectra of 3,3’-(butane-1,4-diyl)bis(1-(2-hydroxydodecyl)-1H-imidazol-3-ium) bromide (10).
Mass Spectra

1-(1H-imidazol-1-yl)dodecan-2-ol (3).

3,3'-(Propane-1,3-diyl)bis(1-(2-hydroxydodecyl)-1H-imidazol-3-ium) bromide (9).
3,3’-(Butane-1,4-diyl)bis(1-(2-hydroxydodecyl)-1H-imidazol-3-ium) bromide (10).

3,3’-(Pentane-1,5-diyl)bis(1-(2-hydroxydodecyl)-1H-imidazol-3-ium) bromide (11).
3,3’-(Hexane-1,6-diyl)bis(1-(2-hydroxydodecyl)-1H-imidazol-3-ium) bromide (12).

3,3’-(Octane-1,8-diyl)bis(1-(2-hydroxydodecyl)-1H-imidazol-3-ium) bromide (13).
Analysis data of gemini surfactant (13).

Γ is surface excess concentration at the air/water interface and its unit is mol/m$^2$. It has been determined by equation 1.

$$\Gamma_{\text{max}} = -\frac{1}{2.30nRT} \left( \frac{d\gamma}{d \log C} \right)_T$$

Here $n$ is number of counterion for gemini imidazolium surfactant.

$n = 2$ or $3$

$R = 8.314$ JK$^{-1}$mol$^{-1}$

$T = 298$ K

In equation 1, $\left( \frac{d\gamma}{d \log C} \right)_T$ is slope of surfactant and has been determined from surface tension versus log of concentration plot (b).

Here we are taking one example of gemini imidazolium surfactant (13) and from its surface tension plot we find out all the surface parameter given in Table 1.

From plot (a), cmc of gemini surfactant (13) = 1.14 mM

Slope $\left( \frac{d\gamma}{d \log C} \right)_T = -21.766$

$C_{20}$, the surfactant concentration required to reduce the surface tension by 20 mN/m have also been calculated from the surface tension versus log of concentration plot.

Here $C_{20} = 2.63 \times 10^{-4}$
Graph **a** show the surface tension vs log of concentration plot and plot **b** determined the slope of *gemini imidazolium surfactant* (13).

For \( n = 2 \), \[
\Gamma_{\text{max}} = \frac{-21.766}{2.303 \times 2 \times 8.314 \times 298 \times 1000}
\]

\( \Gamma_{\text{max}} = 1.90 \times 10^{-6} \)

\( 10^6 \Gamma_{\text{max}} = 1.90 \text{ mol/m}^2 \)

For \( n = 3 \), \[
\Gamma_{\text{max}} = \frac{-21.766}{2.303 \times 3 \times 8.314 \times 298 \times 1000}
\]

\( \Gamma_{\text{max}} = 1.27 \times 10^{-6} \)

\( 10^6 \Gamma_{\text{max}} = 1.27 \text{ mol/m}^2 \)

The area occupied per surfactant molecule \( (A_{\text{min}}) \) at the air-water interface has been obtained by using the equation-2.

\[
A_{\text{min}} = \frac{1}{N} \Gamma_{\text{max}}
\]

In equation 2, \( N = 6.022 \times 10^{23} \)

For \( n = 2 \), \[
A_{\text{min}} = \frac{1}{(6.022 \times 10^{23} \times 1.90 \times 10^{-6})}
\]

\( A_{\text{min}} = 0.87 \text{ nm}^2 \)
For \( n = 3 \), \( A_{\text{min}} = \frac{1}{6.022 \times 10^{23} \times 1.27 \times 10^{-6}} \)

\[ A_{\text{min}} = 1.30 \text{ nm}^2 \]

The Gibbs free energy of micellization (\( \Delta G^\circ_{\text{mic}} \)) has been calculated with the following equation-3.

\[ \Delta G^\circ_{\text{mic}} = RT (0.5 + \beta) \ln X_{\text{cmc}} \]  \hspace{1cm} (Equation 3)

Where \( X_{\text{cmc}} \) is the molar fraction of the cmc and \( X_{\text{cmc}} = \text{cmc}/55.4 \), where cmc is in mols/L and 55.4 comes from 1 L of water corresponding to 55.4 mols of water at 25 °C. \( \beta \) is the degree of counterion binding to micelles and calculated by conductivity plot.

For gemini surfactant (13), \( \beta = 0.70 \)

cmc determined by conductivity method for gemini surfactant (13) = 1.59 mM

\[ \Delta G^\circ_{\text{mic}} = 8.314 \times 298(0.5+0.70) \ln \frac{1.59}{1000 \times 55.4} \]

\[ \Delta G^\circ_{\text{mic}} = -31.14 \text{ KJ/mol} \]

The Gibbs free energy of adsorption (\( \Delta G^\circ_{\text{ads}} \)) has been calculated with the following equation.

\[ \Delta G^\circ_{\text{ads}} = \Delta G^\circ_{\text{mic}} - \pi_{\text{cmc}} \]  \hspace{1cm} (Equation 4)

Here, \( \pi_{\text{cmc}} \) denotes the surface pressure at the cmc (\( \pi_{\text{cmc}} = \gamma_0 - \gamma_{\text{cmc}} \)), where \( \gamma_0 \) and \( \gamma_{\text{cmc}} \) are the surface tensions of water and the surfactant solution at the cmc, respectively).

\[ \gamma_0 = 72.4 \quad \gamma_{\text{cmc}} = 37.60 \]

\[ \Delta G^\circ_{\text{ads}} = -31.14 - [(72.4-37.60)/1.90] \]

\[ \Delta G^\circ_{\text{ads}} = -31.14 - 18.31 \]

\[ \Delta G^\circ_{\text{ads}} = -49.45 \text{ KJ/mol} \]
Krafft Temperature plot of gemini surfactant (13).

The Krafft temperature of gemini surfactant (13) were determined using surfactant solutions of concentration close to 1 wt% (i.e., well above the cmc of the investigated gemini surfactants) using electrical conductivity method (Nishikido et al. J. Phys. Chem. 1982, 86, 3170-3172) as well as visual observation of the clarification of the system. The surfactant first dissolved in water and then left in a refrigerator at a temperature 1.5 °C until precipitation occurred. The precipitated solution was introduced in the conductivity cell and measured the conductance with progressively increased temperature until well above the clarification. The krafft temperature was taken as the temperature where the conductance versus plot T plot showed a break (Figure S1). Break usually coincided with the full clarification of the solution.

**Figure S1.** Plot of conductivity (κ) versus temperature (T) for gemini surfactant (13). The arrow indicates the krafft temperature taken from the plot.
Error estimate surface tension plot for gemini surfactant (9)

Figure S2. An error estimate plot for gemini surfactant (9).

Figure S2 showing upper and lower limits of error estimates of surface tension experiment. The slope value for extreme ends have been determined by applying linear fit and the mean value is considered as actual data and extreme values are considered as error estimate. The reading on the repetition of surface tension experiment lies within these two error extreme and this has been shown in Table 1 (± error estimate).

Figure S3. Surface tension vs log C plot for gemini imidazolium surfactants(11-13)