Wormlike micellar solutions formed by an anionic surfactant and a cationic surfactant with two head groups

Hongye Li[a], Zhengrong Lin[a], Zhao Chen[a], Zhenggang Cui[a], Lan Lei[b] and Binglei Song [a]*

a. The Key Laboratory of Synthetic and Biological Colloids, Ministry of Education, School of Chemical and Material Engineering, Jiangnan University, Wuxi, Jiangsu 214122, P.R. China.

b. School of chemistry and chemical engineering, University of Jinan.

1. Synthesis of C18-DQA

The detailed synthetic process, which is shown in **Figure 1**, is described as follows.

(1) Synthesis of **methyl stearate**. Octadecanoic acid (250.0 g, 0.88 mol) and anhydrous methanol (168.7 g, 5.27 mol) were added into a 1000 mL three-necked flask. The concentrated sulfuric acid was added as a catalyst. And the reaction was carried out at 85 °C for 24 h. After the reaction was stopped, the raw product was washed three times with deionized water. After drying, the purified methyl stearate was obtained by vacuum distillation. Yield: 72.6 %.

(2) Synthesis of **N-3-(dimethylamino)propyloctadecanamide**. The methyl stearate (189.3 g, 0.63 mol) and 3-dimethylaminopropylamine (194.3 g, 1.90 mol) were added to a 1000 mL single-necked flask. KOH was added as a catalyst. The reaction was carried out at 100°C for 48 h. The mixture was recrystallized three times in a mixed solvent of acetone and ethanol. N-3-(dimethylamino)propyloctadecanamide was obtained after drying under vacuum at 60 °C. Yield: 87.4 %.

(3) Synthesis of **C18-DQA**. N-3-(dimethylamino)propyloctadecanamide (89.0 g, 0.24 mol) and (3-bromopropyl)trimethylnitrogen bromide (56.9 g, 0.22 mol) were placed in a 500 mL single-necked flask. An appropriate amount of ethanol was added as a solvent, and the reaction was carried out at

* Corresponding author. E-mail address: ccfsbl@jiangnan.edu.cn

90 °C for 48 h. After the reaction, the solvent was removed under reduced pressure. The residue was washed three times with a mixed solvent of ethyl acetate and ethanol (ethyl acetate: ethanol = 50:1). The final product C18-DQA was obtained as a white power after dried under vacuum at 60 °C. Yield: 86.3 %.

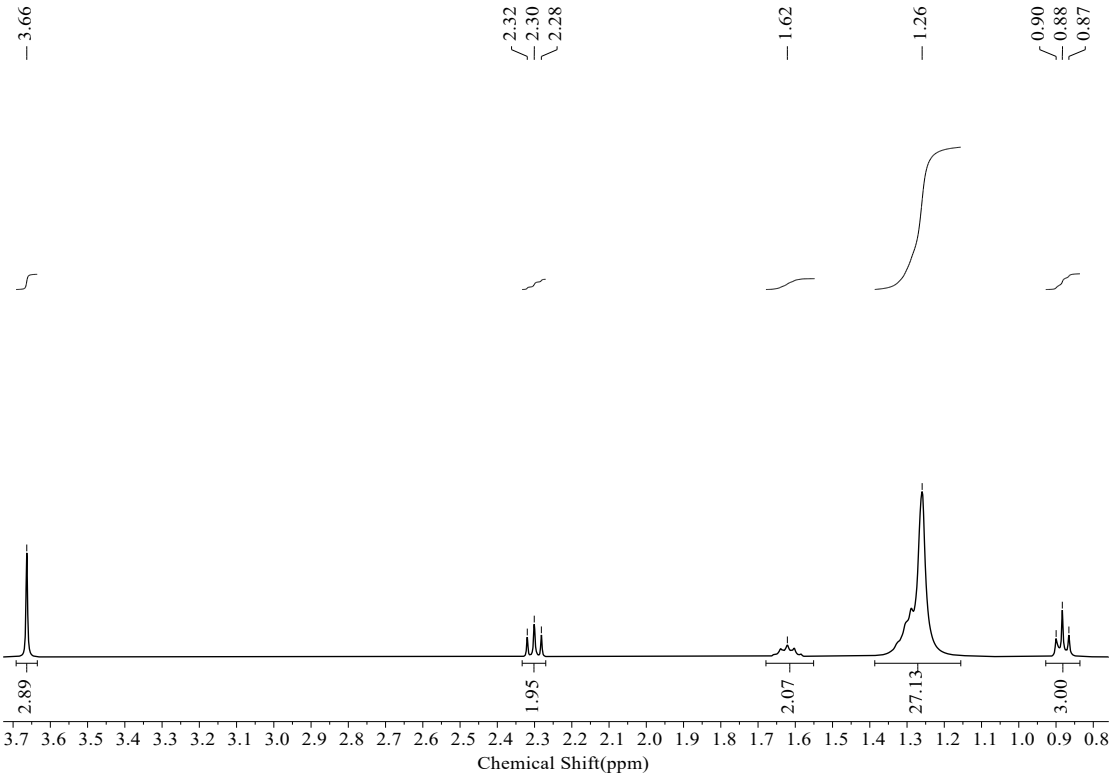
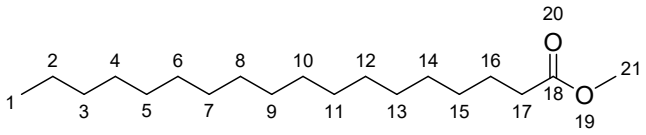


Fig S1 ^{1}H NMR spectrum of methyl stearate (25℃)



^{1}H NMR (400 MHz, $CDCl_3$) δ 3.66 (s, 3H), 2.30 (t, 2H), 1.62 (m, 2H), 1.26 (m, 28H), 0.88 (t, 3H).

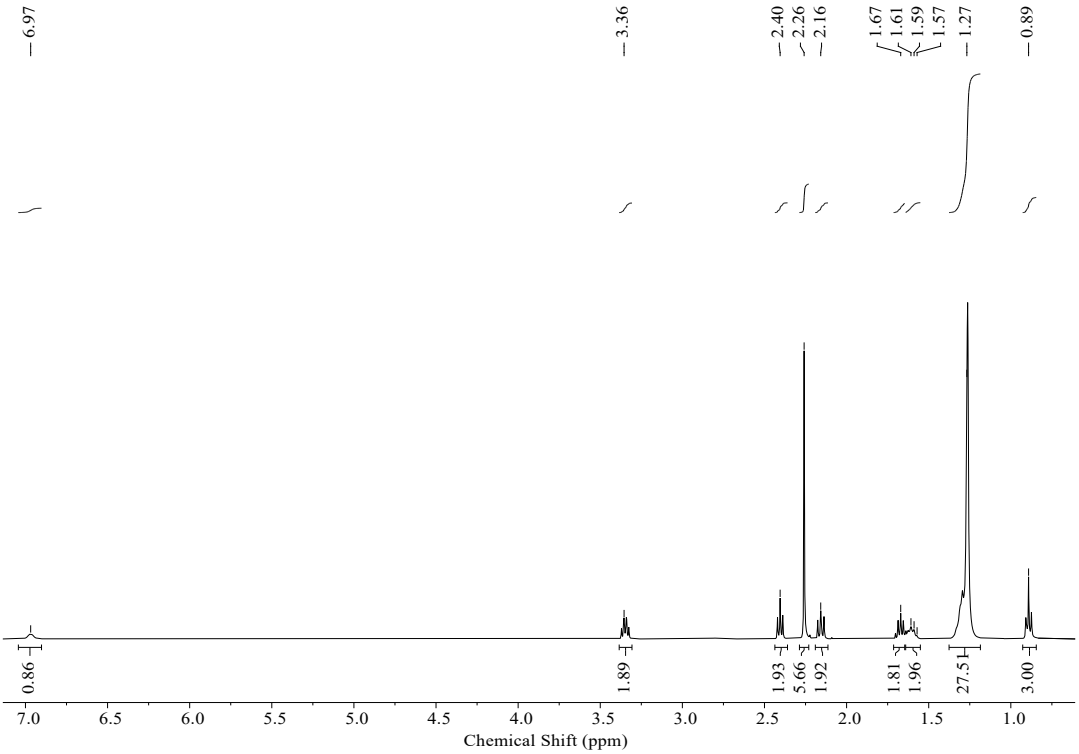
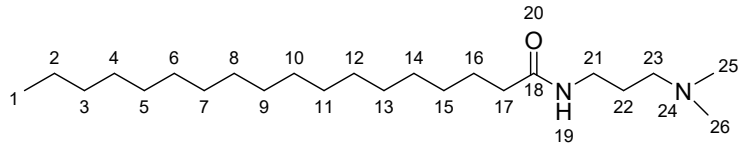


Fig S2 ^{1}H NMR spectrum of N-3-(dimethylamino)propyloctadecanamide (25℃)



^{1}H NMR (400 MHz, $CDCl_3$) δ 6.97 (s, 1H), 3.36 (m, 2H), 2.40 (t, 2H), 2.26 (m, 6H), 2.16 (t, 2H), 1.67 (m, 2H), 1.59 (m, 2H),1.27 (m, 28H), 0.89 (t, 3H).

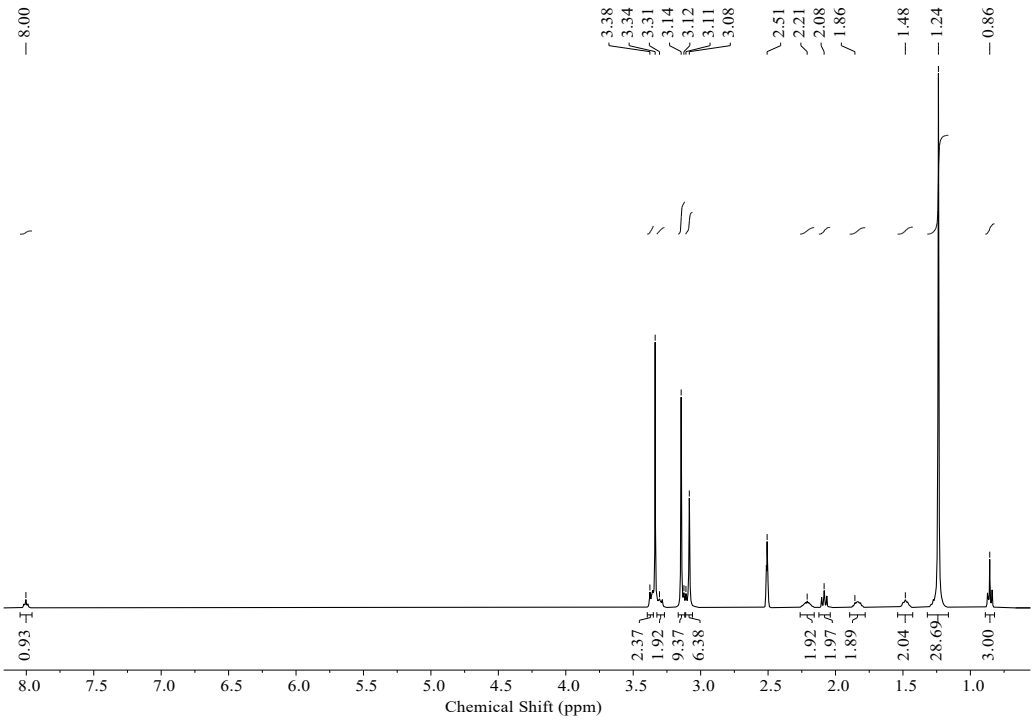
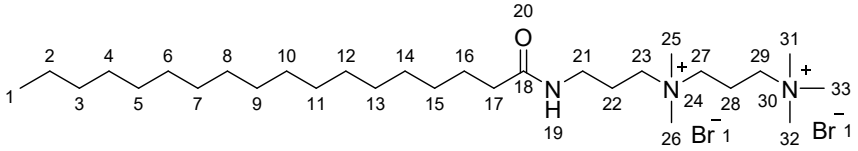


Fig S3 [1]H NMR spectrum of C18-DQA (25℃)



[1]H NMR（400 MHz, DMSO-d6）δ 8.00 (t, 1H), 3.39 – 3.31 (m, 8H), 3.14 (s, 9H), 3.08 (s, 6H), 2.21 (m, 2H), 2.08 (t, 2H), 1.86 (m, 2H), 1.48 (m, 2H), 1.24 (m, 28H), 0.86 (t, 3H).

2. Physical appearances of C18-DQA solutions with different concentrations

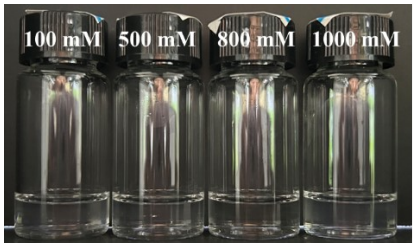


Fig S4 Digital photos of aqueous solutions of C18-DQA with different concentrations

3. Fluorescence measurement

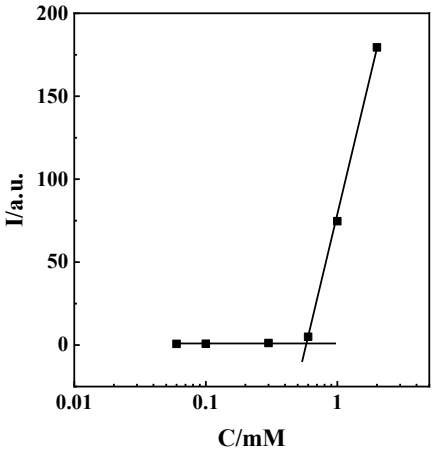


Fig S5. Variation of Nile red fluorescence intensity with concentrations of C18-DQA solutions.(25 ℃)

4. Surface tension measurement

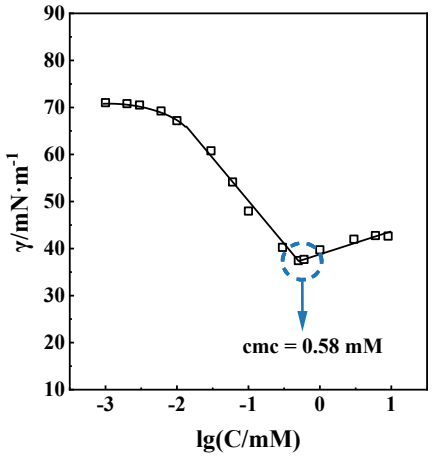


Fig S6. The equilibrium surface tension with concentrations of C18-DQA aqueous solutions. (25 ℃)

5. Steady rheology of C18-DQA solutions

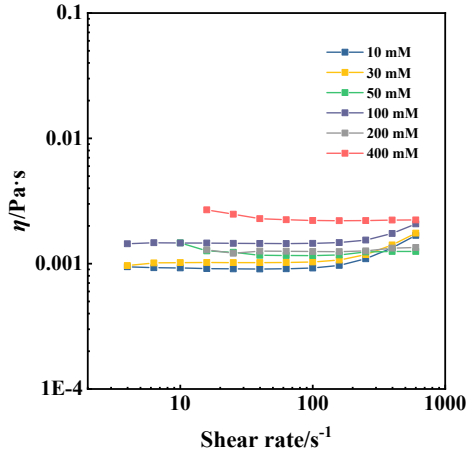
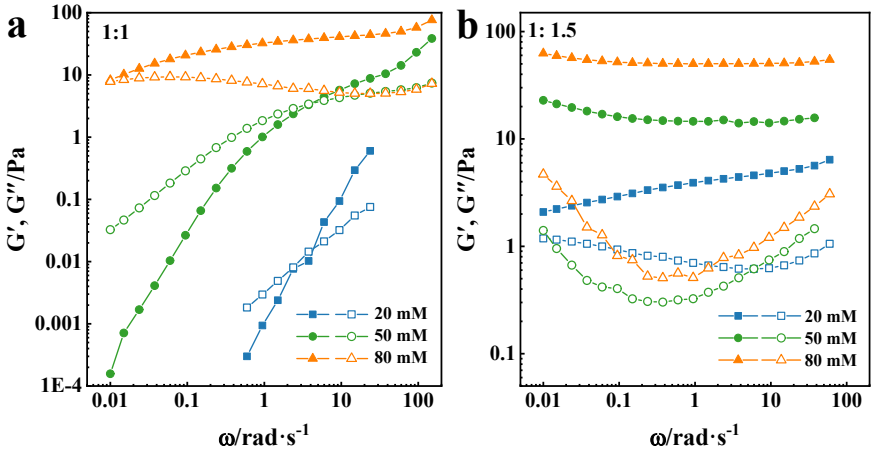


Fig S7 Viscosity (η) of C18-DQA solutions of different concentrations as a function of shear rate at 25 ℃.

6. Physical appearance of C18-DQA and sodium laurate at different ratios

Fig S8 Digital photos of mixed solutions of C18-DQA and sodium laurate at different ratios (denoted with the concentration of C18-DQA)

7. Oscillatory rheological measurement of C18-DQA/SL mixed solutions



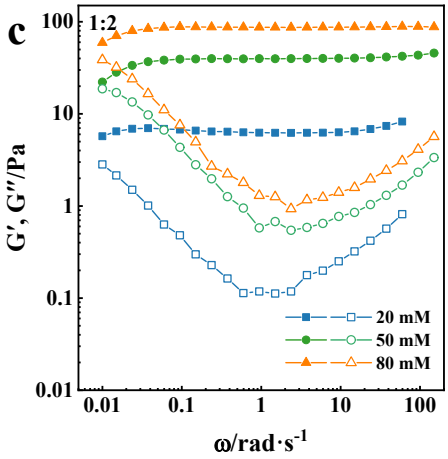


Fig S9 Storage modulus, G', (black blocks) and loss modulus, G'', (white blocks) as a function of the oscillatory frequency of C18-DQA/SL mixed solutions at molar ratio of (a) 1:1, (b) 1:1.5 and (c) 1:2 at 25 °C, the concentration of C18-DQA is shown in the figure.