

# Supporting Information

## **Responsive, Switchable Wormlike Micelles for CO<sub>2</sub>/N<sub>2</sub> and Redox Dual Stimuli Based on Selenium-Containing Surfactants**

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### **1 EXPERIMENTAL SECTION**

#### **1.1 Synthesis of Double-11-alkyl carboxylic acid sodium selenide**

Sodium borohydride (purity  $\geq 96\%$ , 1.7047 g) in 15 mL of deionized water was added with magnetic stirring into Se (purity  $\geq 99\%$ , 1.4836 g) suspension in deionized water (25 mL) under N<sub>2</sub> flow. The Se powder was disappeared with the generation of H<sub>2</sub> and a colorless Na<sub>2</sub>Se solution was obtained within 10 min. The mixture was continuous stirred for 20 min at 50 °C. Then 11-Bromoundecanoic (purity 97.5%, 10 g) dissolved in DMSO (purity  $\geq 99\%$ , 75 mL) was injected into it and the mixture was stirred for 18 h at 50 °C. The yellow mixture was extracted three times with dichloromethane (purity  $\geq 99\%$ ). The dichloromethane layer was washed three times by water, dried with anhydrous Na<sub>2</sub>SO<sub>4</sub> (purity  $\geq 99\%$ ), and evaporated. The residue double-11-alkyl carboxylic acid selenide dissolved in ethanol was added with magnetic stirring to

saturated NaOH ethanol/water (9:1) solution. After this the solution was filtered. The yellow crystal, Double-11-alkyl carboxylic acid sodium selenide was obtained by recrystallization with ethanol-water (4:1) (5.86 g, purity  $\geq$  99% , yield 63 %).  $^1\text{H}$  NMR (400 MHz,  $\text{D}_2\text{O}$ )  $\delta$  2.57 - 2.45 (m, 4H), 2.07 (dd,  $J = 9.2, 5.8$  Hz, 4H), 1.67 - 1.50 (m, 4H), 1.44 (t,  $J = 6.8$  Hz, 4H), 1.25 - 1.19 (s, 28H).

### **1.2 Measurement of the critical micellar concentration (cmc)**

The cmc of  $\text{C}_{11}\text{-Se-C}_{11}$  before and after oxidation was measured using a Varian Cary Eclipse spectrometer (Varian Inc. USA). The fluorescence emission spectra were recorded from 550 to 750 nm. The excitation wavelength was set at 540 nm, and the excitation and emission slit widths were 5 nm, and the scan speed was set at 250  $\text{nm}\cdot\text{min}^{-1}$ . First, the Nile red (NR) methanol solution (10 mL, 0.1 mM ) was prepared, and then transfer the NR methanol solution (20  $\mu\text{L}$ ) into series 25 mL glass bottle. Next, a series of  $\text{C}_{11}\text{-Se-C}_{11}$  solutions were transferred into glass bottle after remove of methanol by blow  $\text{N}_2$ , and then ultrasonic dispersion 2 h and oscillation 24 h. All the measurements were performed at 45  $^\circ\text{C}$ .

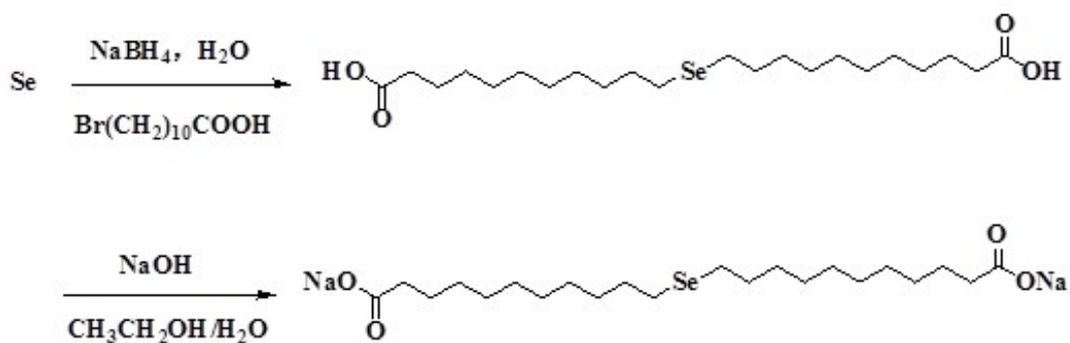
### **1.3 Determination of the Krafft point ( $T_k$ )**

The  $T_k$  of the  $\text{D}_{11}\text{-Se-COONa}$  solutions before and after oxidation was measured using a UV-vis spectrophotometer (Beijing purkinje general instrument co., Ltd, China). The wavelength was set at 500 nm.

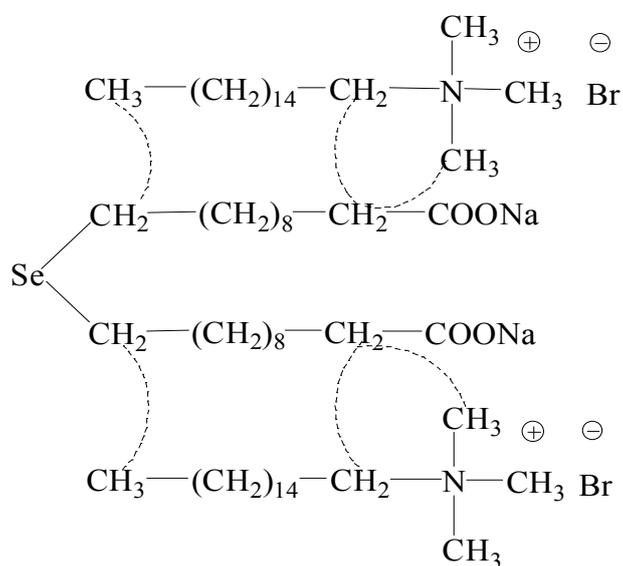
### **1.4 Dynamic light scattering (DLS) measurements**

DLS measurements were measured by using a Laser Light Scattering System (ALV/DLS/SLS-5022F, HOSIC LIMITED, Germany). Samples were filtered with a

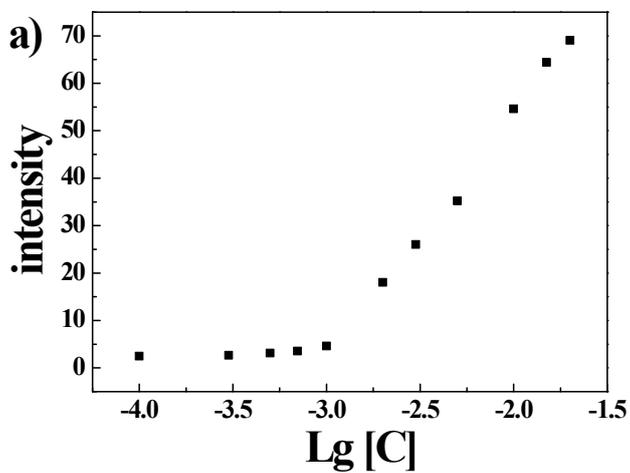
syringe filter to remove dust particles. To obtain the apparent hydrodynamic radius ( $R_h$ ), the intensity autocorrelation functions were analyzed using CONTIN.

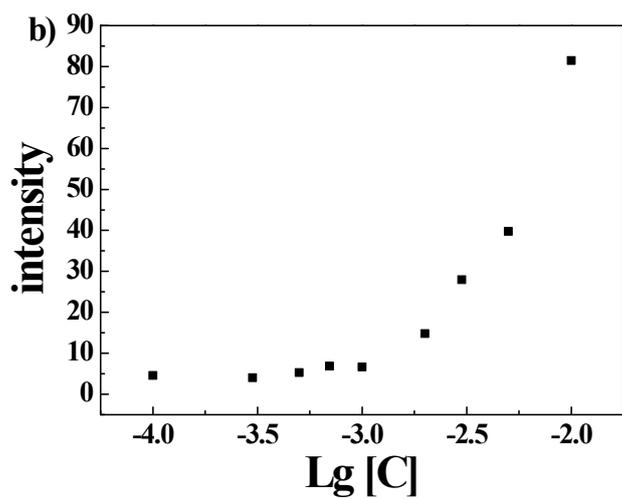


**Scheme S1.** Synthesis route for C<sub>11</sub>-Se-C<sub>11</sub>.

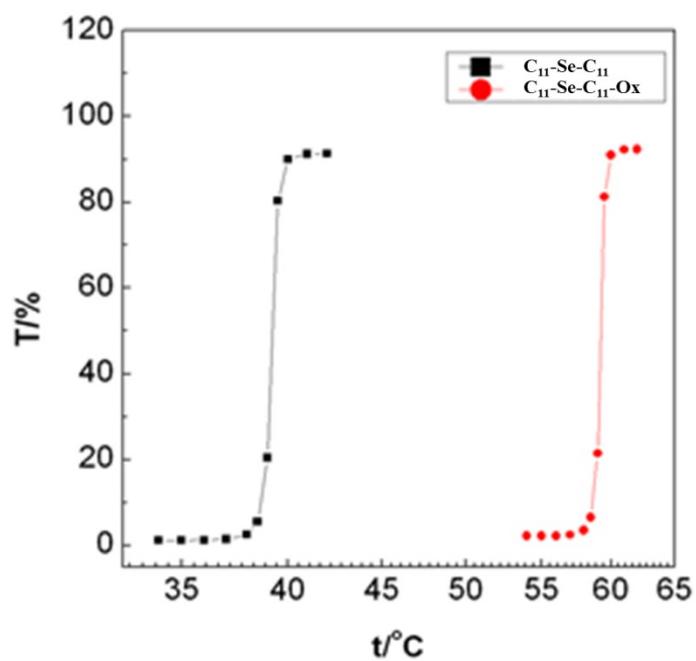


**Scheme S2.** Interaction of protons between CTAB and C<sub>11</sub>-Se-C<sub>11</sub> molecules.

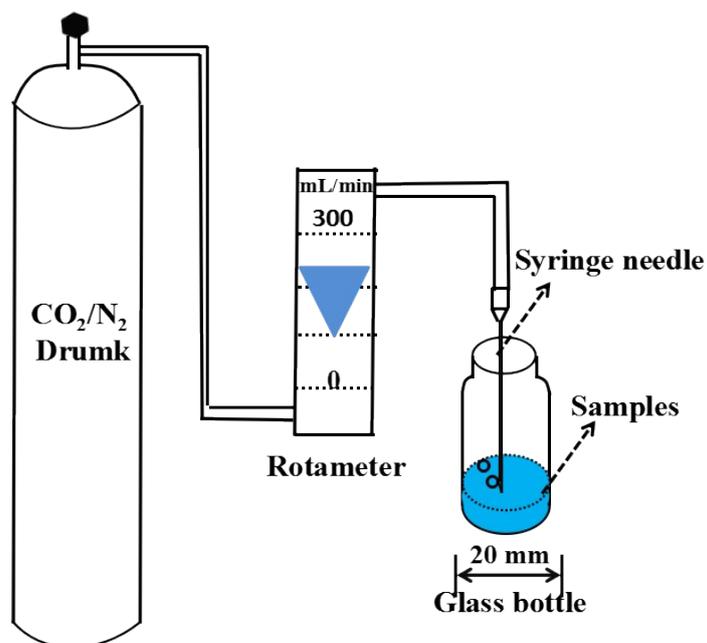




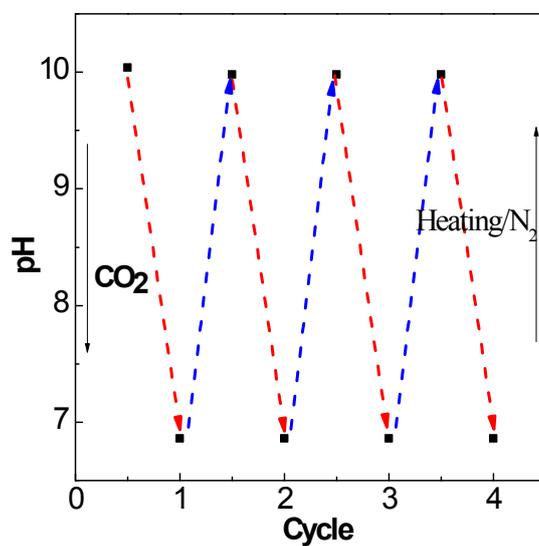
**Figure S1.** Critical micelles concentration of  $C_{11}$ -Se- $C_{11}$ . a) before oxidation, b) after oxidation.



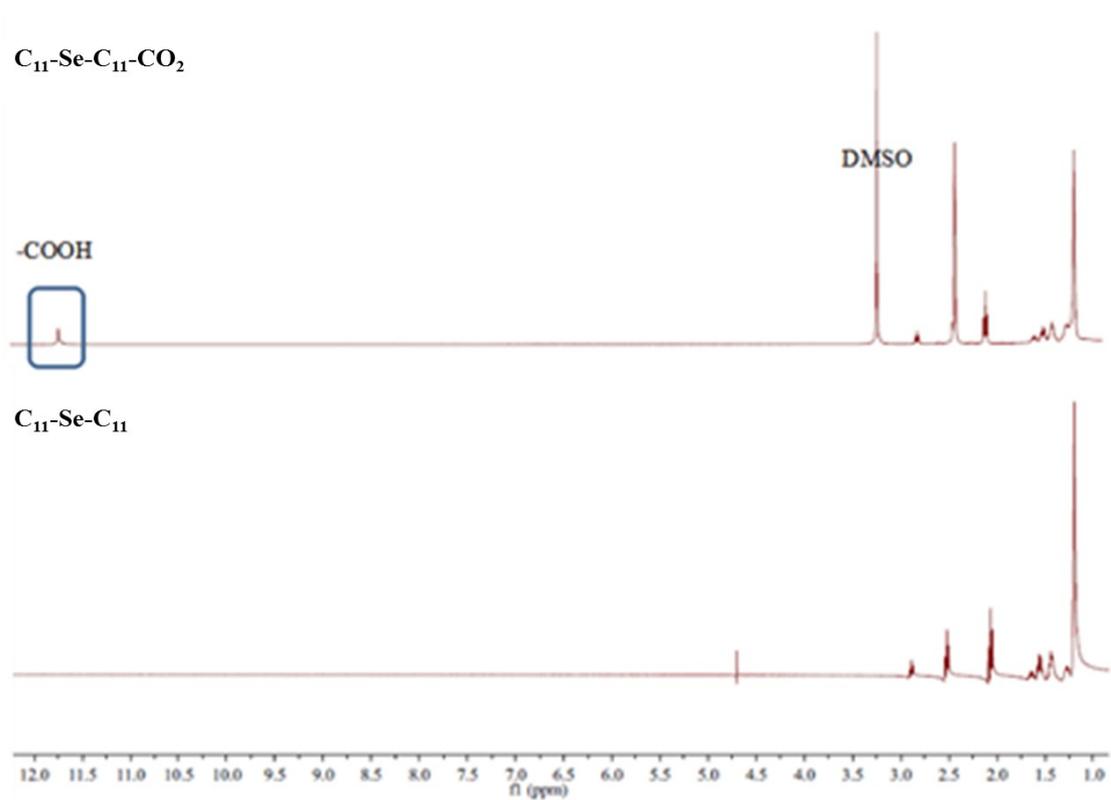
**Figure S2.** Krafft point of  $C_{11}$ -Se- $C_{11}$  before and after oxidation.



**Figure S3.** Illustration of the experimental set-up for bubbling  $\text{CO}_2$  and  $\text{N}_2$  into samples at a glass bottle (diameter = 2 cm, height = 5 cm).



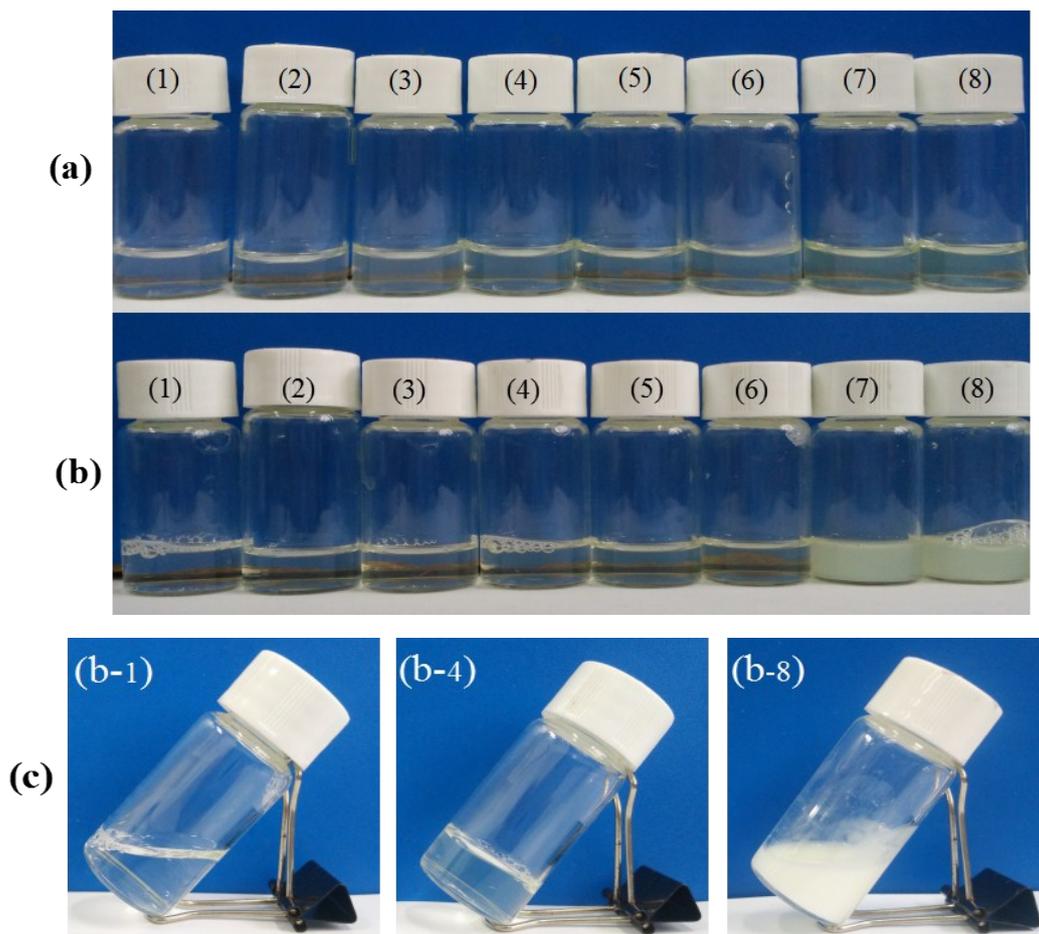
**Figure S4.** pH value of  $\text{C}_{11}\text{-Se-C}_{11}$  solution after bubbling  $\text{CO}_2$  2 min (30 mL/min) followed by heating 2 min at 60 °C then budding  $\text{N}_2$  5 min (four cycles).



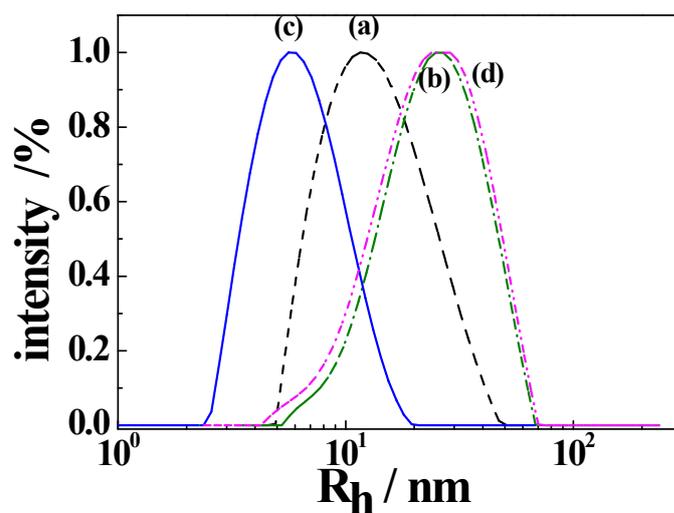
**Figure S5.**  $^1\text{H}$  NMR spectrum of  $\text{D}_{11}\text{-Se-COONa}$  before ( $\text{D}_2\text{O}$ ) and after bubbling  $\text{CO}_2$  ( $\text{DMSO-D}_6$ ).



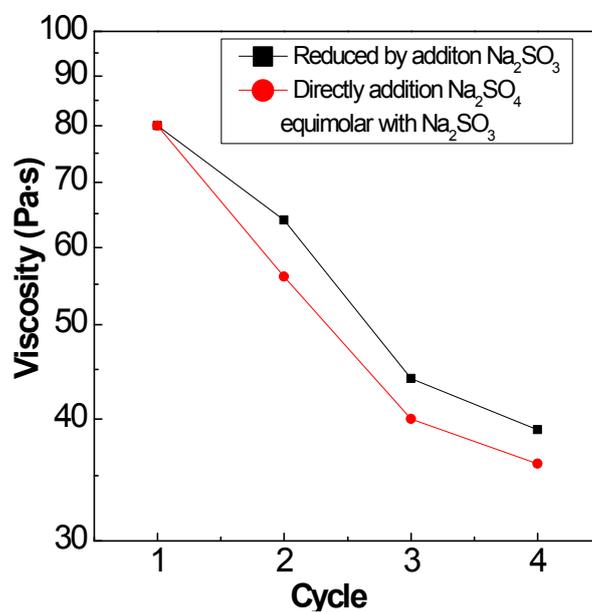
**Figure S6.** a) Photograph of  $\text{C}_{11}\text{-Se-C}_{11}$  solution (20 mM), b) after bubbling  $\text{CO}_2$  (30 mL/min) for 2 min, c) after addition  $\text{H}_2\text{O}_2$  (20 mM).



**Figure S7.** (a) Photographs of  $C_{11}$ -Se- $C_{11}$  solutions at different concentration after preparation 10 min at 40 °C without add CTAB, (b) add CTAB(145 mM), (c) after preparation 24 h at 25 °C. Concentration of  $C_{11}$ -Se- $C_{11}$  in the aqueous phase from (1) to (8) is 0.005, 0.01, 0.015, 0.020, 0.025, 0.04, 0.05 and 0.06 M, respectively.



**Figure S8** Size distribution of (a) CTAB (0.145 M ), (b) CTAB- C<sub>11</sub>-Se-C<sub>11</sub> (145 mM and 25 mM ), (c) CTAB- C<sub>11</sub>-Se-C<sub>11</sub>-Ox (145 and 25 mM ), (d) Re-CTAB- C<sub>11</sub>-Se-C<sub>11</sub> (145 and 25 mM ).



**Figure S9.** The zero-shear viscosity changes of the CTAB-C<sub>11</sub>-Se-C<sub>11</sub> (25 mM) binary system after three cycles by adding Na<sub>2</sub>SO<sub>3</sub> and directly adding Na<sub>2</sub>SO<sub>4</sub> equimolar with Na<sub>2</sub>SO<sub>3</sub>.