Electronic Supplementary Material for

High efficiency of biosurfactant in stabilizing oil micro-droplets with millisecond aging time: a microfluidic study

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This electronic supplementary material includes:

1. The images captured by the high-speed camera in the coalescence chamber of the microfluidic chip are edited into three movies (Movie S1-S3).

2. Results of ESI-MS for biosurfactant $C_{15}$-SFT and chemically synthetic surfactant 8-SCBS (Fig. S1)

3. Three kinds of microfluidic chip designs with different narrow channels to create three aging times used in this work (Fig. S2), volume shared by the micro-droplets in different radii (Fig. S3), micro-droplet radius distribution at different positions of the coalescence chamber (Fig. S4).

4. The calculation of the average coalescence time, $\bar{t}_v$. 
Description of movies

**Movie S1:** Micro-droplets stabilized by $1 \times 10^{-4}$ mol/L $\text{C}_{15}$-SFT at the outlet of the coalescence chamber with 600 ms aging time. Shooting speed: 30 fps; Playing speed: 10 fps.

**Movie S2:** Micro-droplets stabilized by $1 \times 10^{-4}$ mol/L 8-SCBS at the outlet of the coalescence chamber with 600 ms aging time. Shooting speed: 30 fps; Playing speed: 10 fps.

**Movie S3:** Coalescence event of micro-droplets stabilized by $1 \times 10^{-6}$ mol/L $\text{C}_{15}$-SFT at the inlet of the coalescence chamber with 600 ms aging time. Shooting speed: 13600 fps; Playing speed: 60 fps.
Fig. S1. ESI-MS for biosurfactant C\textsubscript{15}-SFT and chemically synthetic surfactant 8-SCBS
**Fig. S2.** Schematic diagrams of microfluidic chips that have three aging times. (The lengths of the narrow channels in blue, orange, and green are 23.3mm, 46.7mm, and 93.3mm, respectively)

**Fig. S3.** Volumes shared by the micro-droplets in different radii (concentrations of C_{15}-SFT (right panel) and 8-SCBS (left panel) are $1 \times 10^{-6}$ mol/L). Size1 represents the
micro-droplets in original size, size $n$ represents the droplets formed by the coalescence of $n$ original micro-droplets, and size 7+ represents the droplets formed by the coalescence of seven or more original micro-droplets.
Fig. S4. Radius distributions of micro-droplets stabilized by (a) $1 \times 10^{-6}$ mol/L 8-SCBS, (b) $1 \times 10^{-4}$ mol/L 8-SCBS, and (c) $1 \times 10^{-6}$ mol/L $C_{15}$-SFT at different positions in coalescence chamber after 600 ms aging time.

**Averaged coalescence time, $\bar{t}_v$**

In a coalescence event, one approach velocity corresponds to one coalescence time. All the coalescence events were sorted by approaching velocity, and the averaged coalescence time, $\bar{t}_v$, were calculated by the number-average coalescence time of the coalescence events in which the approaching velocities were below $v$.

$$\bar{t}_v = \frac{\sum_{0}^{v} t_{coal}}{\sum_{0}^{v} N}$$