

Supplementary Materials

Surface Adsorption Properties and Layer Structures of Homogeneous Polyoxyethylene-Type Nonionic Surfactants in Quaternary-Ammonium-Salt-Type Amphiphilic Gemini Ionic Liquids with Oxygen- or Nitrogen-Containing Spacers

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Details of Measurements

Wide-angle X-ray scattering (WAXS)

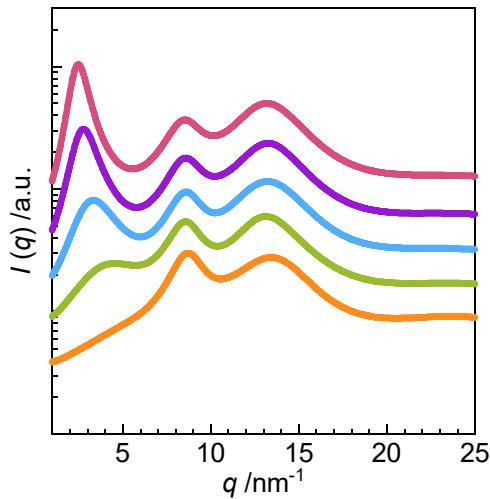


Figure S1. WAXS profiles for amphiphilic monomeric ionic liquids $C_n \text{NTf}_2$ at 25 °C: $n = 4$ (orange ●), $n = 6$ (50 °C, yellow green ○), $n = 8$ (blue ○), $n = 10$ (purple ●), and $n = 12$ (50 °C, red ●).

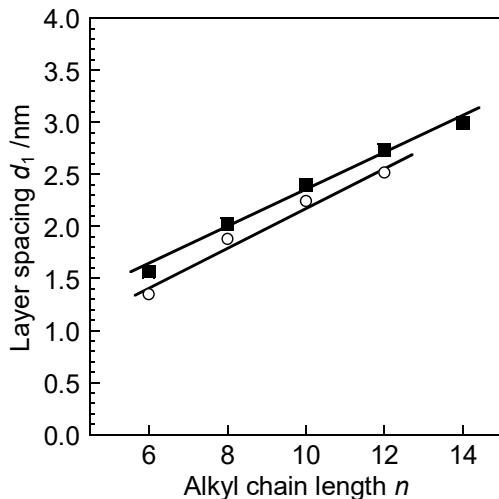


Figure S2. Relationship between layer spacing d_1 and alkyl chain length n for amphiphilic gemini and monomeric ionic liquids at 25 °C: $2C_{12}(2\text{-O-}2)\text{ NTf}_2$ (black ■) and $C_n \text{NTf}_2$ (black ○, 50 °C for $n = 6, 10$).

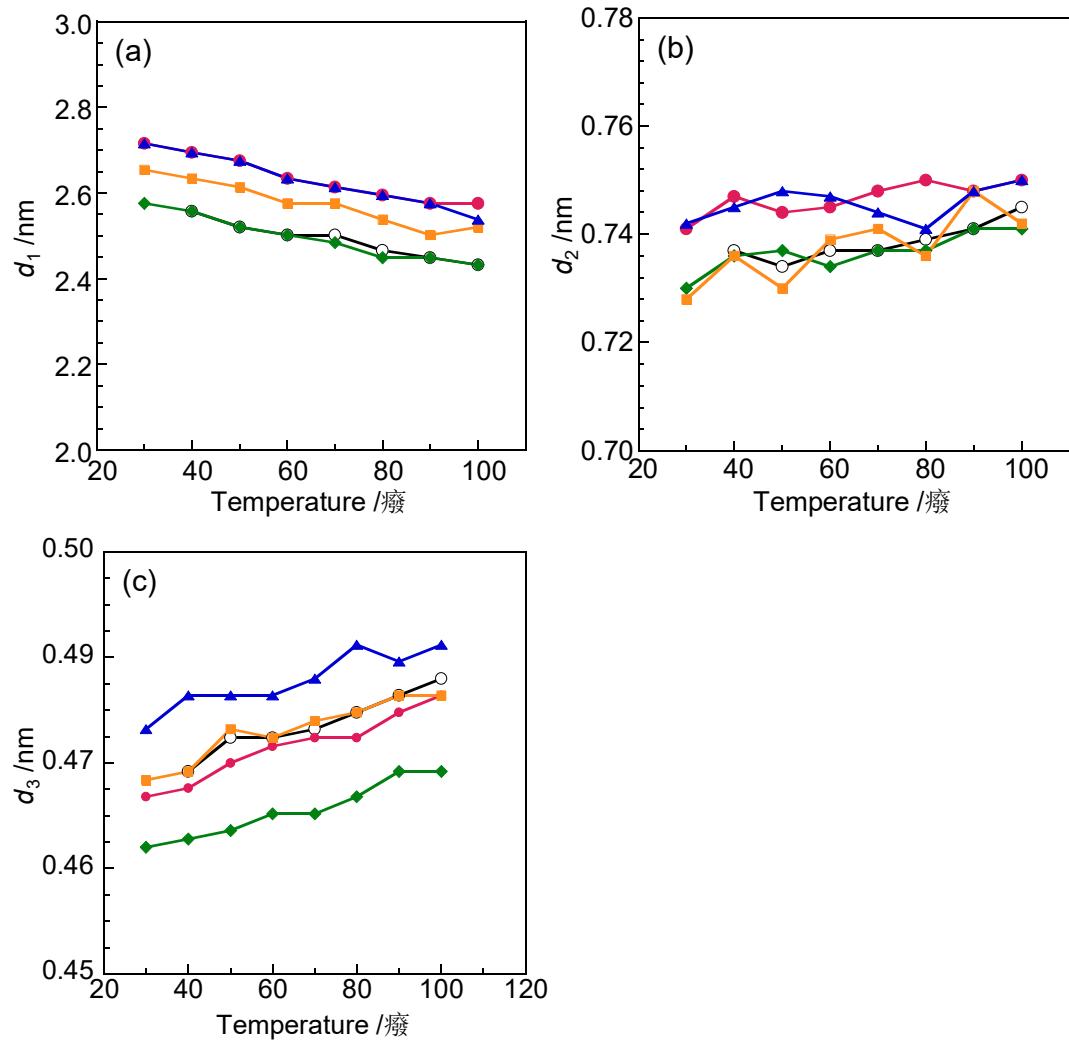


Figure S3. Variation in (a) d_1 , (b) d_2 , and (c) d_3 with temperature for amphiphilic ionic liquids: C_{12} NTf₂ (black ○), 2C₁₂(2-O-2) NTf₂ (red ●), 2C₁₂(2-O-2-O-2) NTf₂ (orange ■), 2C₁₂(2-N-2) NTf₂ (blue ▲), 2C₁₂-3 NTf₂ (green ♦).

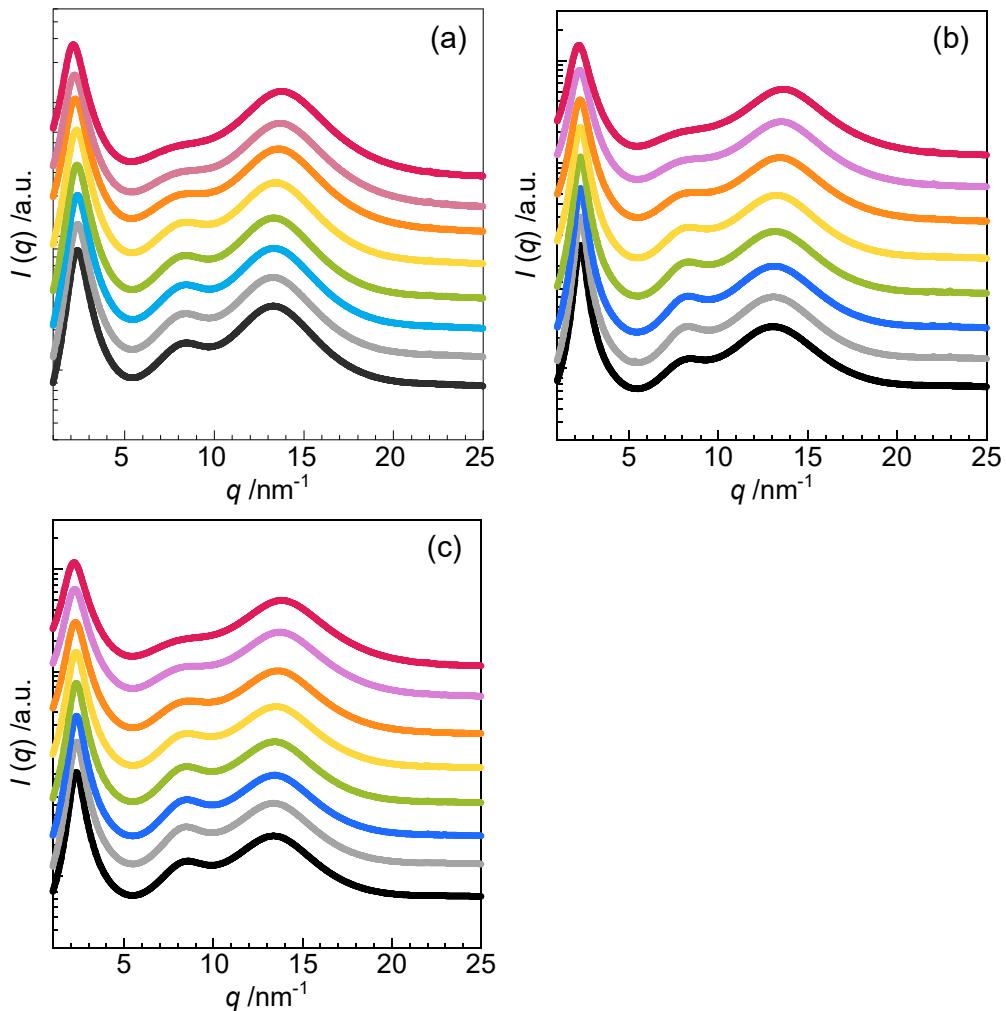


Figure S4. WAXS profiles for nonionic surfactant C_{12}EO_6 in amphiphilic gemini ionic liquids at 25 °C: (a) $2\text{C}_{12}(2\text{-O-2-O-2}) \text{NTf}_2$, (b) $2\text{C}_{12}(2\text{-N-2}) \text{NTf}_2$ and (c) $2\text{C}_{12}(2/2\text{-N-2}) \text{NTf}_2$ (30 °C): 0 (black ●), 10 (gray ●), 50 (blue ●), 100 (yellow green ●), 250 (yellow ●), 500 (orange ●), 750 (pink ●), and 1000 mmol dm⁻³ (red ●).

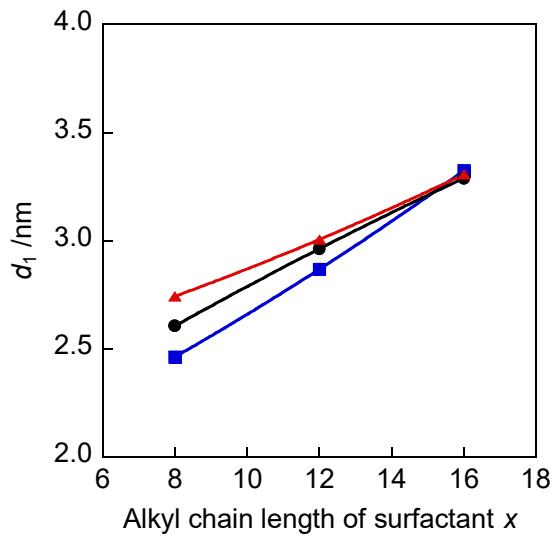


Figure S5. Relationship between d_l and alkyl chain length of nonionic surfactants C_xEO_6 at 1000 mmol dm^{-3} in amphiphilic gemini ionic liquids: $2C_{10}(2-O-2)$ NTf₂ (blue ■), $2C_{12}(2-O-2)$ NTf₂ (black ●), and $2C_{14}(2-O-2)$ NTf₂ (red ▲).

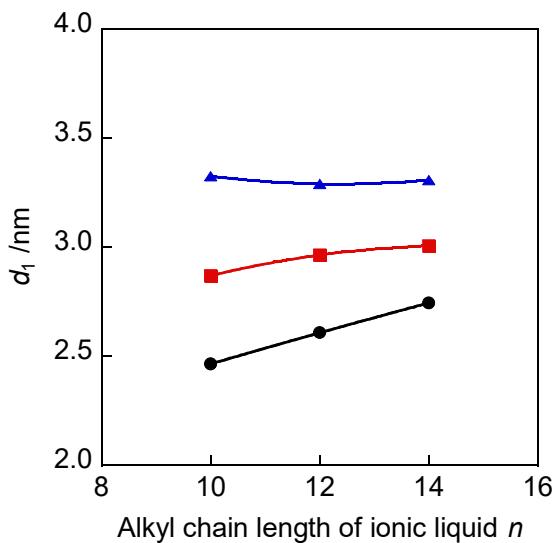


Figure S6. Relationship between d_l and alkyl chain length n of amphiphilic ionic liquid $2C_n(2-O-2)$ NTf₂ containing nonionic surfactants C_xEO_6 at 1000 mmol dm^{-3} : C_8EO_6 (black ●), $C_{12}EO_6$ (red ■), and $C_{16}EO_6$ (blue ▲).

Cryogenic transmission electron microscopy (cryo-TEM)

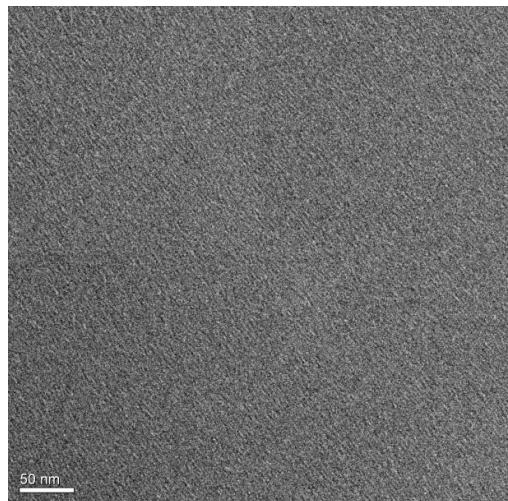


Figure S7. Cryo-TEM image of 750 mmol dm⁻³ C₁₂EO₆ in 2C₁₂(2-O-2) NTf₂.