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Effect of Spacer Length of Ionic Liquid-Type Imidazolium Gemini Surfactant Based Water-in-Oil Microemulsion for Extraction of Gold from Hydrochloric Acid Medium

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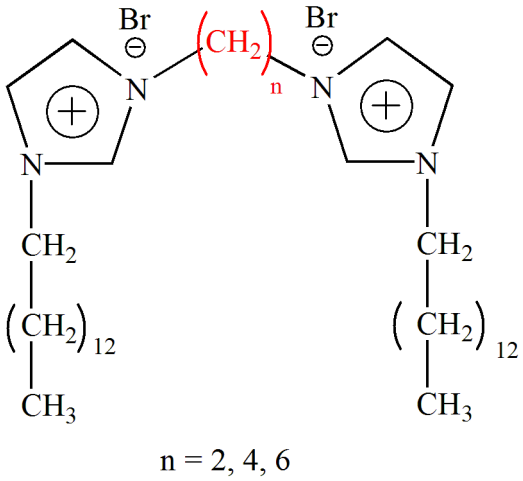


Fig. S1. The chemical structures of ionic liquid-type gemini imidazolium surfactants with different spacer lengths

Synthesis of ionic liquid-type imidazolium gemini surfactants

This class of ionic liquid-type imidazolium gemini surfactants were synthesized by mixing 0.05 mol of imidazolium and 0.052 mol of sodium hydroxide in 35 mL of dimethyl sulfoxide with stirring for 2 h at room temperature. After that, 0.04 mol of 1-bromotetradecan was added drop wise and the mixture was stirred at room temperature for 8-10 h. The resulting mixture was then dissolved in 35 mL of chloroform. The solution was washed several times with deionized water. Residual solvent was removed under vacuum for 1 h at 40 ℃. Then, 0.01 mol, 1,2-dibromoethane, 1,4-dibromobutae, or 1,6-dibromohexane was added drop wise with absolute ethyl alcohol and the mixture was refluxed

at 80 ℃ with stirring for 48 h under nitrogen atmosphere. The obtained products were purified twice by recrystallization in ethyl acetate and then dried under vacuum for 2 day.[1]

The schematic diagram of synthesis route is presented in Figure S2. The ^{1}H-NMR spectra of [C_{14}-n-C_{14}im]Br_2 (n = 2, 4, 6) in $CDCl_3$ is presented in Figure S3, S6, S8, respectively. All the products are characterized through ^{1}H-NMR spectrum (AV300, Bruker) in $CDCl_3$ and the result are shown below.

(1) 1,2-bis(3-myristylimidazolium-1-yl) ethane bromide [C_{14}-2-C_{14}im]Br_2

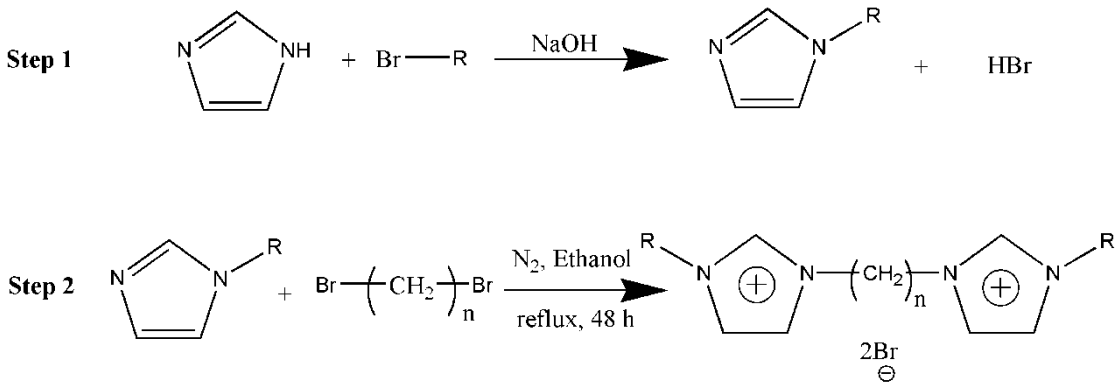
^{1}H-NMR (300MHz, $CDCl_3$): δ (ppm) 10.37 (s, 2H), 8.86 (s, 2H), 7.13 (s, 2H), 5.33 (s, 4H), 4.15 (s, 4H), 1.92 (s, 4H), 1.30 (d, 44H), 0.88 (t, 6H)

(2) 1,4-bis(3-myristylimidazolium-1-yl) butane bromide [C_{14}-4-C_{14}im]Br_2

^{1}H-NMR (300MHz, CDCl3): δ (ppm) 10.35 (s, 2H), 8.01 (s, 2H), 7.17 (s, 2H), 4.60 (s, 4H), 4.25 (t, 4H), 2.24 (s, 4H), 1.91 (s, 4H), 1.28 (m, 44H), 0.88 (t, 6H).

(3) 1,6-bis(3-myristylimidazolium-1-yl) hexane bromide [C_{14}-6-C_{14}im]Br_2

^{1}H-NMR (300MHz, $CDCl_3$): δ (ppm) 10.75 (s, 2H), 8.03 (s, 2H), 7.38 (s, 2H), 4.66 (t, 4H), 4.49 (t, 4H), 2.25 (d, 4H), 2.11 (s, 4H), 1.73 (s, 4H), 1.48 (d, 44H), 0.88 (t, 6H).



$R = C_{14}H_{29}$, n = 2, 4, 6

Fig. S2. The synthesis route of ionic liquid-type gemini imidazolium surfactants

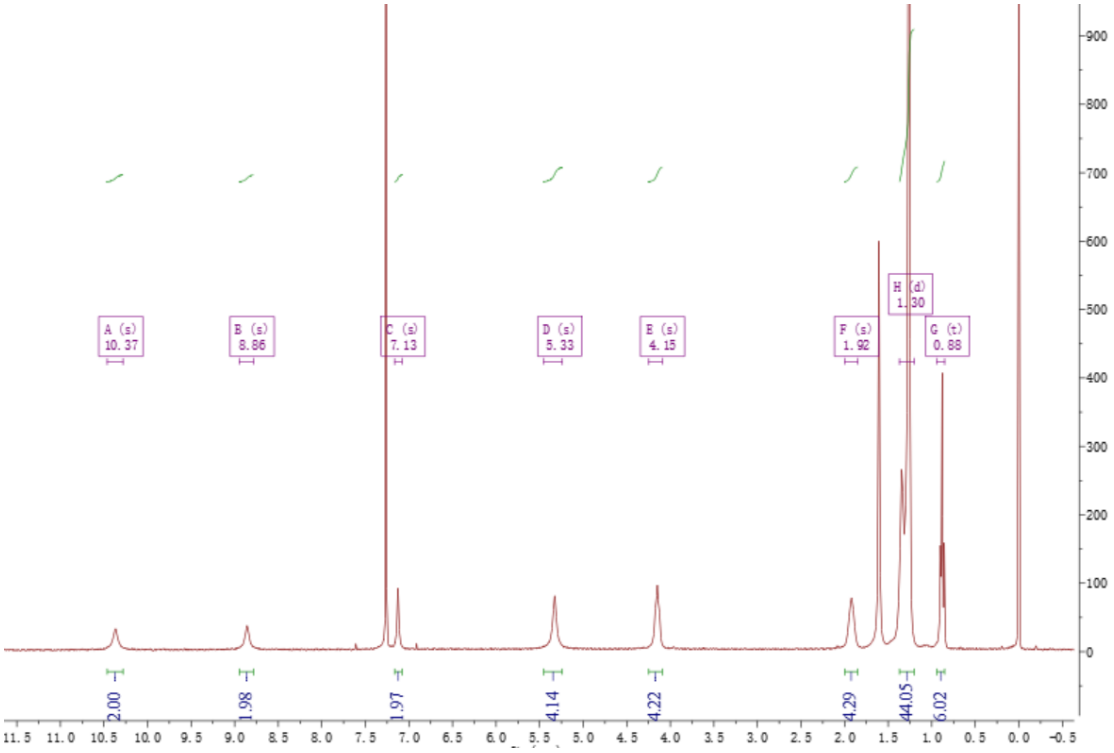


Fig. S3. The ^{1}H-NMR spectra of $[C_{14}\text{-}2\text{-}C_{14}im]Br_2$ in $CDCl_3$

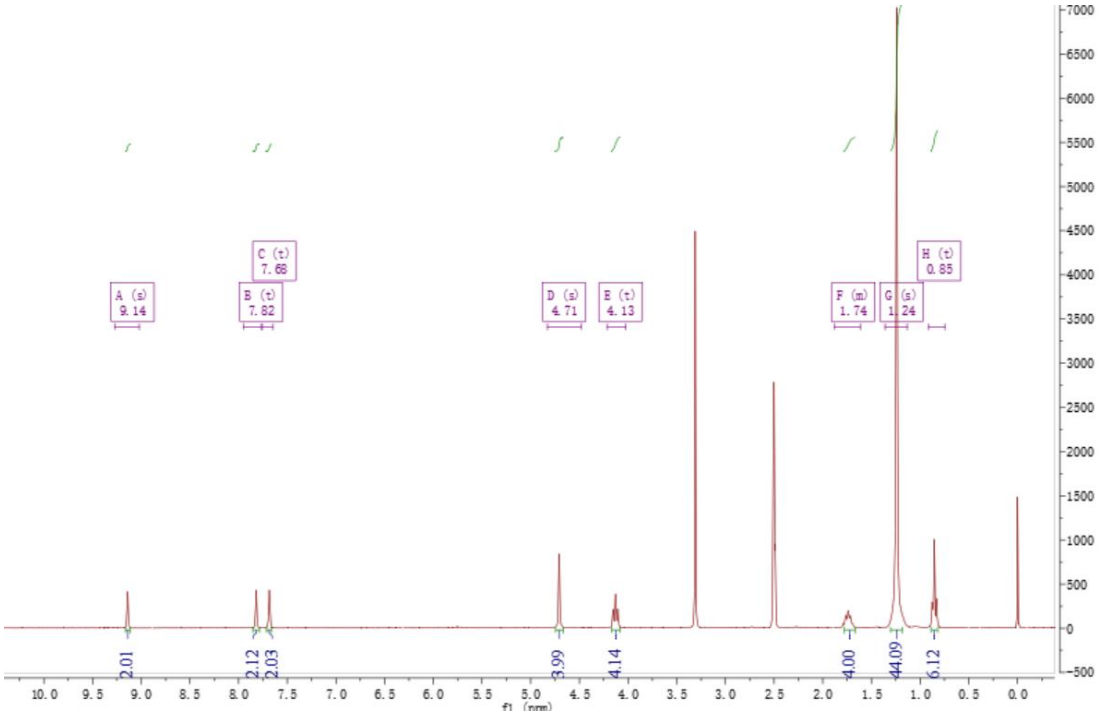


Fig. S4. The ^{1}H-NMR spectra of [C_{14}-2-C_{14}im]Br_2 in DMSO

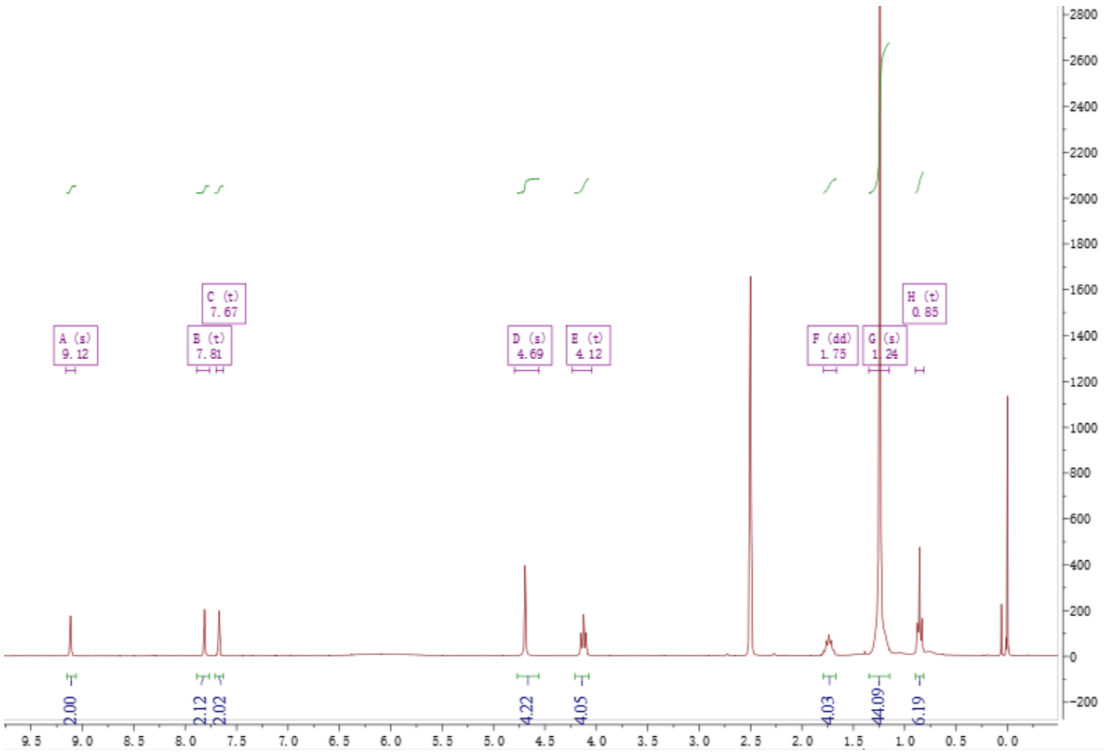


Fig. S5. The ^{1}H-NMR spectra of [C_{14}-2-C_{14}im]-Au (III) in DMSO

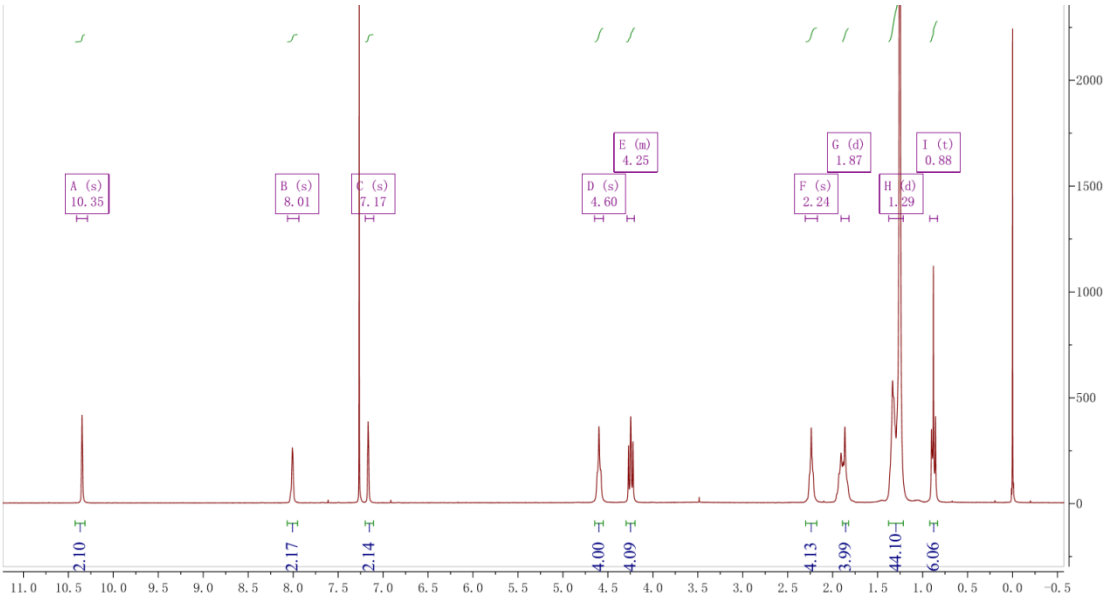


Fig. S6. The ^{1}H-NMR spectra of [C_{14}-4-C_{14}im]Br_2 $CDCl_3$

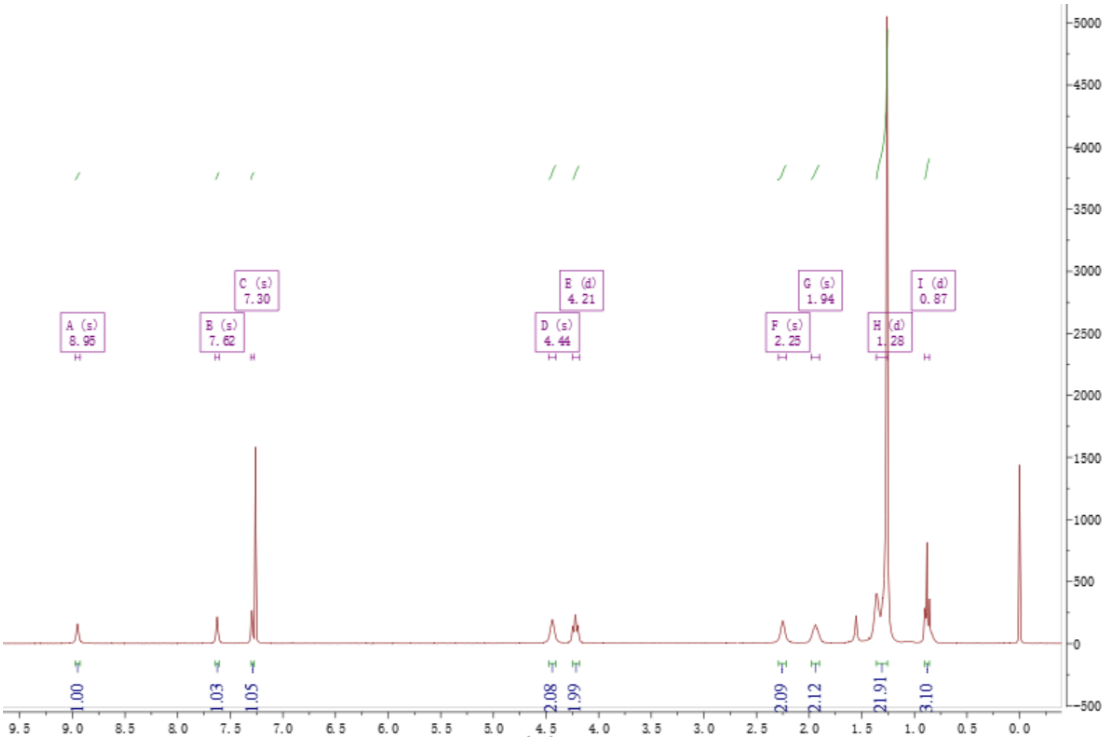


Fig. S7. The ^{1}H-NMR spectra of [C_{14}-4-C_{14}im]-Au (III) in $CDCl_3$

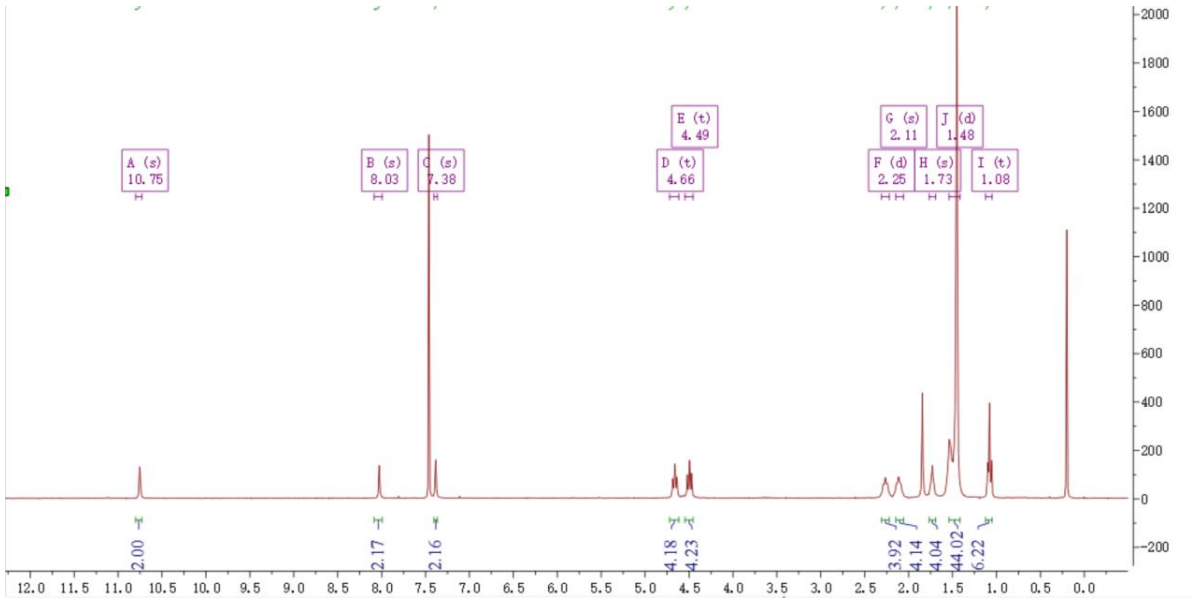


Fig. S8. The ^{1}H-NMR spectra of [C_{14}-6-C_{14}im]Br_2 in $CDCl_3$

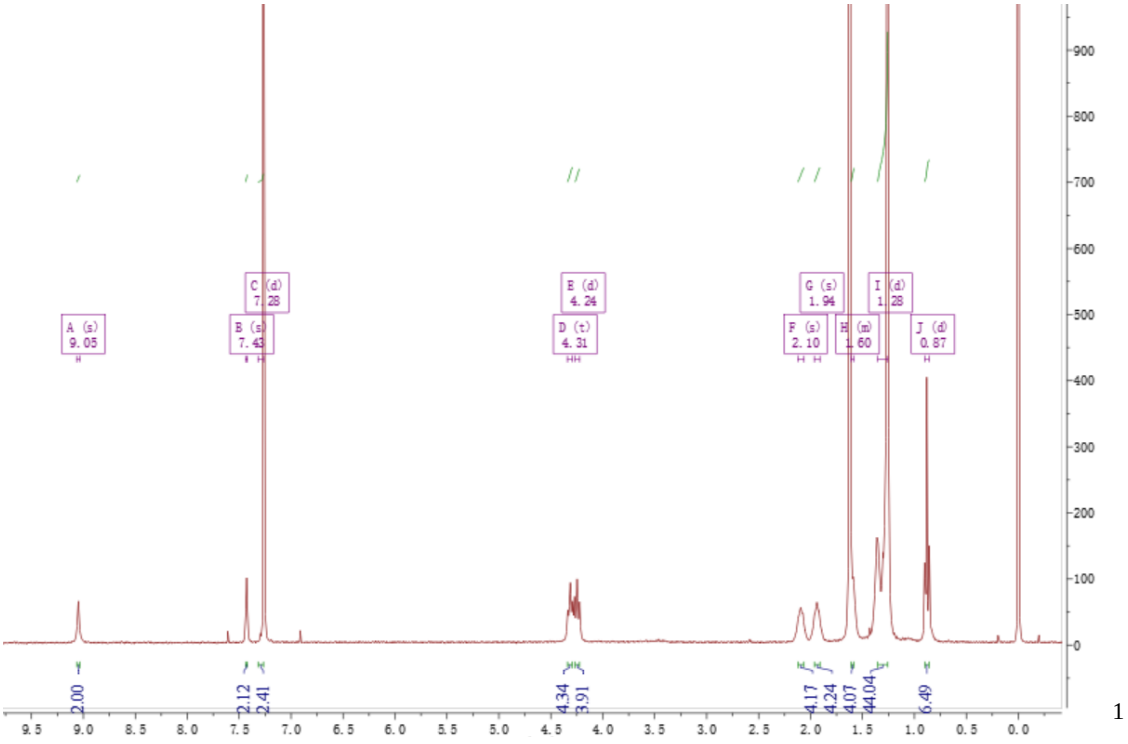


Fig. S9. The ^{1}H-NMR spectra of [C_{14}-6-C_{14}im]-Au (III) in $CDCl_3$

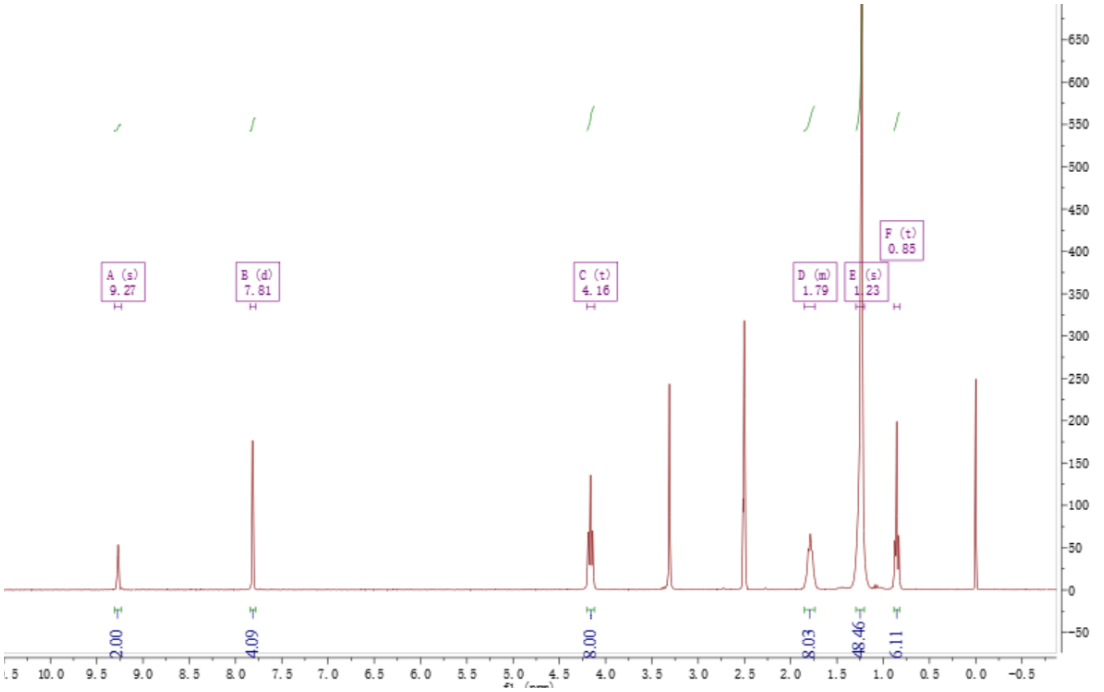


Fig. S10. The ^{1}H-NMR spectra of [C_{14}-6-C_{14}im]Br_2 in DMSO

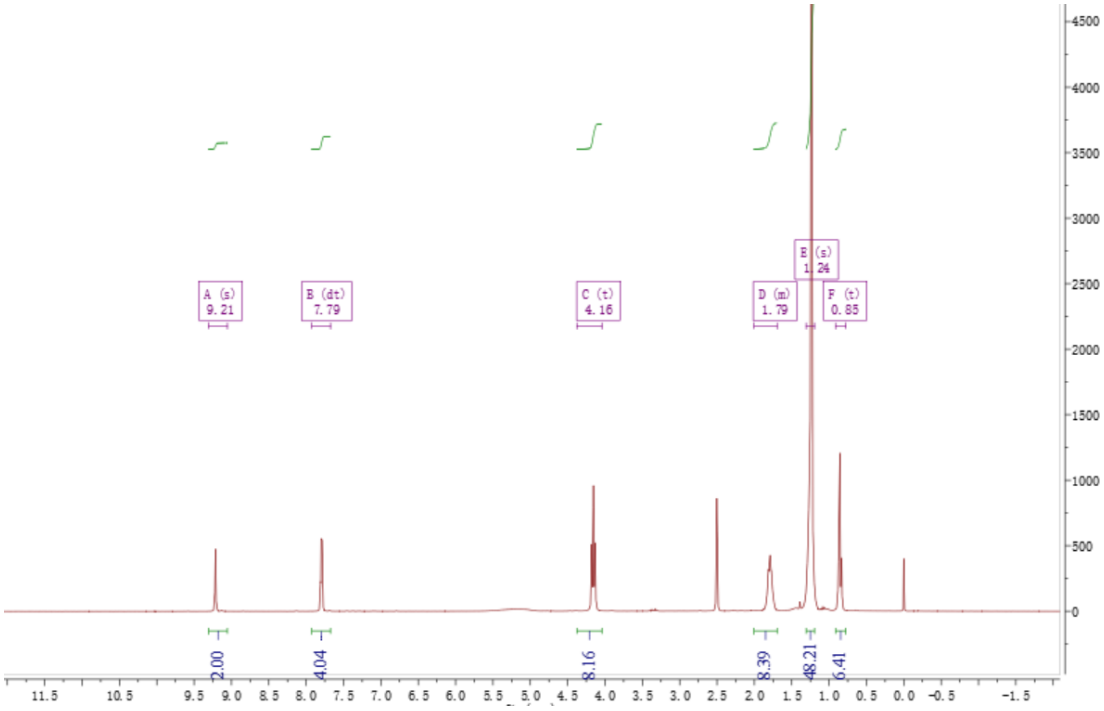


Fig. S11. The ^{1}H-NMR spectra of [C_{14}-6-C_{14}im]-Au (III) in DMSO

Reference

1 M. Ao, P. Huang, G. Xu, X. Yang, Y. Wang, *Colloid. Polym. Sci*, 2008, **287**, 395.