



Supporting Information

for

HFIP as a versatile solvent in resorcin[*n*]arene synthesis

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Experimental procedures for reactions, and relevant spectra of all new compounds

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Experimental section

General considerations. All reactions were performed in 20 mL scintillation vials. The vials were fitted with a Teflon magnetic stirring bar and the respective caps on the vials. Gram scale reactions were performed in 100 mL round-bottomed flasks equipped with a magnetic stirring bar. Reactions were not performed under inert conditions unless otherwise noted. Hexafluoro-2-propanol was purchased from Synquest Laboratories Inc.

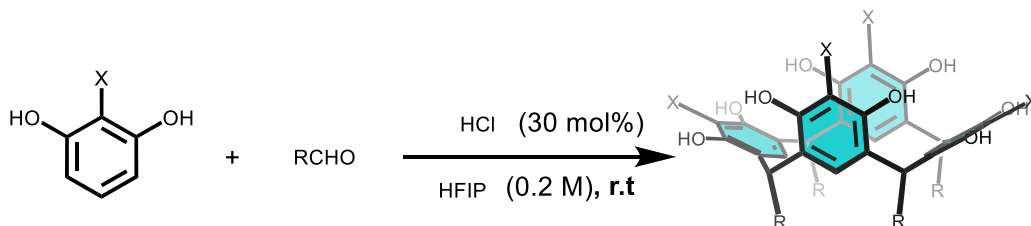
^1H and ^{13}C NMR spectra were recorded on Bruker Avance III and Bruker Avance NEO 600MHz. Chemical shifts for protons are reported in parts per million (ppm) downfield from tetramethylsilane (TMS) and are reference to residual protium in the NMR solvent (acetone: δ 2.05; MeOH: δ 3.31; $(\text{CH}_3)_2\text{SO}$: δ 2.50). Chemical shifts for carbon are reported in ppm downfield from TMS and are referenced to the carbon resonances of the solvent (acetone: δ 29.84; MeOH: δ 49.0; $(\text{CH}_3)_2\text{SO}$: δ 39.51). Data is presented as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, m = multiplet, br = broad), coupling constants in hertz, and integration. Resonances corresponding to the numerous aromatic and/or aliphatic carbon atoms in the reported compounds sometimes overlap, thereby reducing the number of observed resonances.

Flow injection accurate mass analysis was conducted using an Agilent Infinity II Ultra-High Performance Liquid Chromatography (UHPLC) system interfaced to an Agilent 6545XT Quadrupole Time-of-Flight (qToF) mass spectrometer through an Agilent Jet Spray (AJS) electrospray ionization (ESI) source. The source was operated in the positive ion mode. The mobile phase composition was 30:70 0.1% formic acid in water/0.1% formic acid in acetonitrile. Injection volume for each sample was 0.5 μL .

Single crystal data for **1h**, **1i**, and **1s** were collected on a Rigaku Synergy-S diffractometer equipped with dual-beam microfocus Cu $K\alpha$ and Mo $K\alpha$ X-ray radiation sources paired with a Rigaku's HyPix-Arc150 detector. Temperature was maintained using an Oxford Cryosystem nitrogen flow apparatus. Single crystals suitable for X-ray structure analysis were coated with Paratone N-oil and mounted on MiTeGen Kapton loops (polyimide). Data from Rigaku's diffractometer was integrated and corrected using CrysAlisPro V42. Space group assignments were determined by examination of systematic absences, E-statistics, and successive refinement

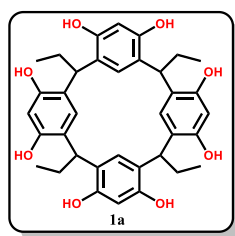
of the structures. The program PLATON [1,2] was employed to confirm the absence of higher symmetry for any of the crystals. The positions of the heavy atoms were determined using intrinsic phasing methods using the program SHELXT[3] and SHELXL[4] with Olex2[5] interface. Successive cycles of least-square refinement followed by difference Fourier syntheses revealed the positions of the remaining non-hydrogen atoms. Non-hydrogen atoms were refined with anisotropic displacement parameters, and hydrogen atoms were added in idealized positions. Crystallographic data for **1h**, **1i**, and **1s** is given in Table S1.

Synthetic details. General procedure for the synthesis of resorcin[*n*]arenes. Compounds **1a–s** were obtained following this general reaction sequence:



Resorcinol (1 mmol) was added to a 20 mL scintillation vial equipped with a Teflon stirring bar. Next, 5 mL of hexafluoro-2-propanol were added to the flask to create a solution. The resorcinol was left to completely dissolve for 20 minutes. Once dissolved, 1 mmol of the aldehyde was added to the solution. Subsequently, using a 9" long glass Pasteur pipette, a singular drop of 37 wt % HCl was added to the solution. A precipitate formed immediately. The reaction was stirred at room temperature for 40 minutes. Afterwards, the reaction was poured onto a filter paper in a funnel, vacuum was not applied. The filter paper was washed with 5 mL of H₂O. The precipitate was dried under high vacuum to afford a pale colored powder. ****Note:** For resorcinols containing electron-withdrawing groups, the reaction must be stirred for: a) 24 h when containing halogens or b) 48 h and 50 °C when having a carboxylic acid.

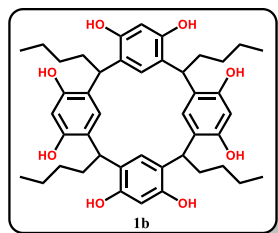
1a



Spectroscopic signatures match literature reports.[6]

¹H NMR (600 MHz, Acetone-*d*₆): δ_H = 8.33 (s, 8H), 7.42 (s, 4H), 6.11 (s, 4H), 4.05 (t, J = 7.9 Hz, 4H), 2.19 (p, J = 7.4 Hz, 8H), and 0.77 (t, J = 7.2 Hz, 12H) ppm.

1b

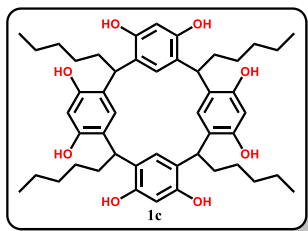


Spectroscopic signatures match literature reports.[7]

Pale beige-yellow colored solid, 179.0 mg (92% yield).

¹H NMR (600 MHz, Acetone-*d*₆): δ_H = 8.43 (s, 8H), 7.56 (s, 4H), 6.24 (s, 4H), 4.30 (td, J = 7.9, 1.8 Hz, 4H), 2.30 (q, J = 7.7 Hz, 8H), 1.42 – 1.35 (m, 8H), 1.31 – 1.25 (m, 8H), and 0.89 (t, J = 7.3 Hz, 12H) ppm.

1c

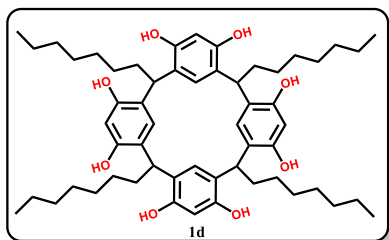


Spectroscopic signatures match literature reports.[8]

Pale yellow solid, 201.4 mg (98% yield).

¹H NMR (500 MHz, Acetone-*d*₆): $\delta_{\text{H}} = 8.45$ (s, 8H), 7.56 (s, 4H), 6.24 (s, 4H), 4.31 (t, *J* = 7.9 Hz, 4H), 2.30 (q, *J* = 7.6 Hz, 8H), 1.37 – 1.31 (m, 24H), and 0.90 (d, *J* = 7.0 Hz, 12H) ppm.

1d

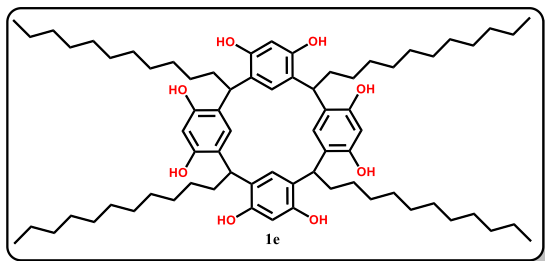


Spectroscopic signatures match literature reports.[9]

Pale yellow solid, 210.0 mg (66% yield).

¹H NMR (600 MHz, Methanol-*d*₄): $\delta_{\text{H}} = 7.10$ (s, 4H), 6.13 (s, 4H), 4.18 (t, *J* = 7.9 Hz, 4H), 2.08 (q, *J* = 7.8 Hz, 8H), 1.26 – 1.20 (m, 40H), and 0.84 (t, *J* = 7.0 Hz, 12H) ppm.

1e



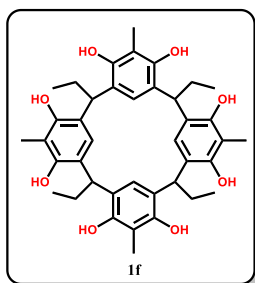
Spectroscopic signatures match literature reports.[6]

Pale yellow solid, 170.1 mg (62% yield).

¹H NMR (500 MHz, Acetone-*d*₆): $\delta_{\text{H}} = 8.44$ (s, 8H), 7.55 (s, 4H), 6.24 (s, 4H), 4.31 (t, *J* = 7.9 Hz, 4H), 2.30 (q, *J* = 7.7 Hz, 8H), 1.39 (s, 72H), and 0.89 (s,

12H) ppm.

1f

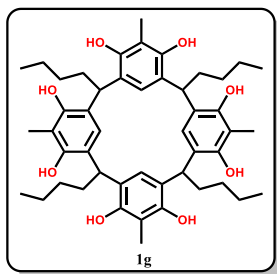


Spectroscopic signatures match literature reports.[10]

To obtain the pure compound, the solid that was initially collected through gravity filtration was slightly dissolved in acetone. A dropwise addition of hexanes was added to precipitate out the pure compound. The precipitate that occurs after the addition of hexanes is then collected via gravity filtration. Brown solid, 139.7 mg (84% yield).

¹H NMR (600 MHz, Methanol-*d*₄): $\delta_{\text{H}} = 7.09$ (s, 4H), 4.25 (t, *J* = 7.9 Hz, 4H), 2.20 (p, *J* = 7.3 Hz, 8H), 2.03 (s, 12H), and 0.91 (t, *J* = 7.2 Hz, 12H) ppm.

1g

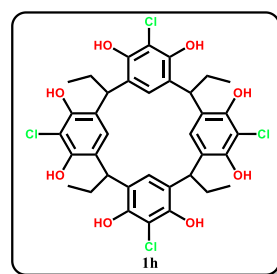


Spectroscopic signatures match literature reports.[10]

Light beige-yellow solid, 159.0 mg (81% yield).

^1H NMR (600 MHz, Acetone- d_6): $\delta_{\text{H}} = 7.92$ (s, 8H), 7.41 (s, 4H), 4.38 – 4.34 (m, 4H), 2.27 (q, $J = 7.7$ Hz, 8H), 2.03 (s, 12H), 1.37 (q, $J = 7.2$ Hz, 8H), 1.27 – 1.23 (m, 8H), and 0.87 (t, $J = 7.3$ Hz, 12H) ppm.

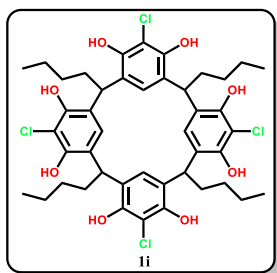
1h



To obtain the pure compound, the solid that was collected through gravity filtration was slightly dissolved in acetone. A dropwise addition of hexanes was added to precipitate out the pure compound. The precipitate that occurs after the addition of hexanes is then collected via gravity filtration. White solid, 89.1 mg (48% yield).

^1H NMR (500 MHz, DMSO- d_6): $\delta_{\text{H}} = 8.95$ (s, 8H), 7.18 (s, 4H), 4.30 (t, $J = 7.9$ Hz, 4H), 2.09 (d, $J = 2.9$ Hz, 8H), and 0.81 (t, $J = 7.2$ Hz, 12H) ppm; **^{13}C NMR (126 MHz, DMSO- d_6):** $\delta_{\text{C}} = 147.9, 124.5, 123.1, 109.1, 36.9, 27.0,$ and 12.4 ppm; **HRMS-ESI (m/z):** calculated for $\text{C}_{36}\text{H}_{36}\text{Cl}_4\text{O}_8$ $[\text{M}+\text{H}]^+$ 737.1237 found 737.1240.

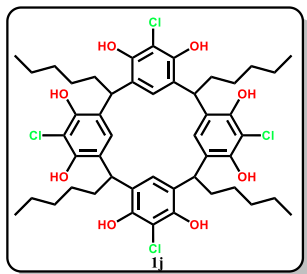
1i



To obtain the pure compound, the solid that was initially collected through gravity filtration was slightly dissolved in acetone. It was then stored in the freezer for 10 minutes. A dropwise addition of hexanes was added to precipitate out the pure compound. The precipitate that occurs after the addition of hexanes is then collected via gravity filtration. White solid, 148.5 mg (69% yield).

^1H NMR (500 MHz, DMSO- d_6): $\delta_{\text{H}} = 8.85$ (s, 8H), 7.07 (s, 4H), 4.43 (t, $J = 7.8$ Hz, 4H), 1.99 (q, $J = 7.7$ Hz, 8H), 1.30 (p, $J = 7.5$ Hz, 8H), 1.16 (ddt, $J = 15.2, 9.8, 6.1$ Hz, 8H), and 0.84 (t, $J = 7.3$ Hz, 12H) ppm; **^{13}C NMR (126 MHz, DMSO- d_6):** $\delta_{\text{C}} = 147.9, 124.4, 123.2, 109.2, 35.0, 34.0,$ 29.9, 22.2, and 14.1 ppm; **HRMS-ESI (m/z):** calculated for $\text{C}_{44}\text{H}_{52}\text{Cl}_4\text{O}_8$ $[\text{M}+\text{H}]^+$ 849.2489 found 849.2492.

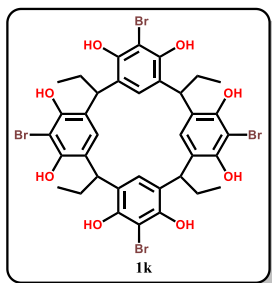
1j



To obtain the pure compound, the solid that was collected through gravity filtration was slightly dissolved in acetone. It was then stored in the freezer for 10 minutes. A dropwise addition of MeOH/H₂O (1:1) was added to precipitate out the pure compound. The precipitate that occurs after the addition of MeOH/H₂O is then collected via gravity filtration. White solid, 122.2 mg (52% yield).

¹H NMR (500 MHz, DMSO-*d*₆): δ_{H} = 8.85 (s, 8H), 7.06 (s, 4H), 4.43 (t, *J* = 7.7 Hz, 4H), 1.97 (q, *J* = 7.7 Hz, 8H), 1.24 (ddd, *J* = 26.3, 15.6, 10.7 Hz, 24H), and 0.82 (t, *J* = 6.9 Hz, 12H) ppm; **¹³C NMR (151 MHz, DMSO-*d*₆)**: δ_{C} = 148.3, 124.9, 123.6, 109.6, 35.5, 34.7, 31.9, 27.8, 22.7, and 14.4 ppm; **HRMS-ESI (m/z)**: calculated for C₄₈H₆₀Cl₄O₈ [M+H]⁺ 905.3115 found 905.3114.

1k

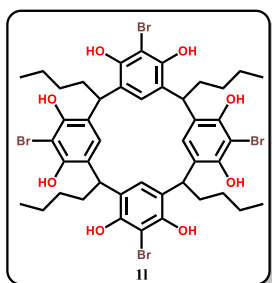


Spectroscopic signatures match literature reports.[11]

To obtain the pure compound, the solid that was initially collected through gravity filtration was boiled in acetone. It was then stored in the freezer for 10 min. A dropwise addition of hexanes was added to precipitate out the pure compound. The precipitate that occurs after the addition of hexanes is then collected via gravity filtration. White solid, 73.5 mg (31% yield).

¹H NMR (500 MHz, DMSO-*d*₆): δ_{H} = 9.15 (s, 8H), 7.43 (s, 4H), 4.23 (t, *J* = 7.9 Hz, 4H), 2.25 (p, *J* = 7.3 Hz, 8H), and 0.83 (t, *J* = 7.2 Hz, 12H) ppm.

1l

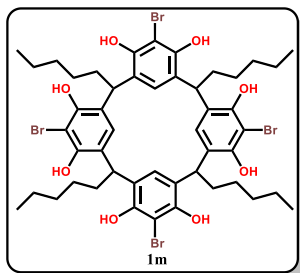


Spectroscopic signatures match literature reports.[12]

To obtain the pure compound, the solid that was initially collected through gravity filtration was boiled in acetone. It was then stored in the freezer for 10 min. A dropwise addition of hexanes was added to precipitate out the pure compound. The precipitate that occurs after the addition of hexanes is then collected via gravity filtration. White solid, 168.9 mg (61% yield).

¹H NMR (600 MHz, DMSO-*d*₆): δ_{H} = 9.09 (s, 8H), 7.36 (s, 4H), 4.34 (t, *J* = 7.9 Hz, 4H), 2.18 (q, *J* = 7.7 Hz, 8H), 1.34 (h, *J* = 7.4 Hz, 8H), 1.21 – 1.13 (m, 8H), and 0.85 (t, *J* = 7.3 Hz, 12H) ppm.

1m

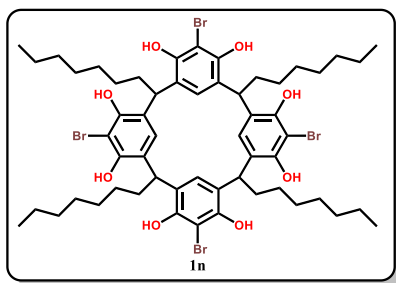


Spectroscopic signatures match literature reports.[13]

To obtain the pure compound, the solid that was initially collected through gravity filtration was boiled in acetone. It was then stored in the freezer for 10 minutes. A dropwise addition of a (1:1:1) mixture of hexanes, MeOH, water was added. The precipitate that occurs after the addition of the previous solvent mixture is then collected via gravity filtration. Light brown solid, 263.7 mg (94% yield).

¹H NMR (600 MHz, DMSO-*d*₆): $\delta_{\text{H}} = 9.14$ (s, 8H), 7.40 (s, 4H), 4.41 (t, $J = 7.8$ Hz, 4H), 2.22 (q, $J = 7.7$ Hz, 8H), 1.39 – 1.35 (m, 8H), 1.33 – 1.29 (m, 8H), 1.26 – 1.22 (m, 8H), and 0.90 (t, $J = 7.1$ Hz, 12H) ppm.

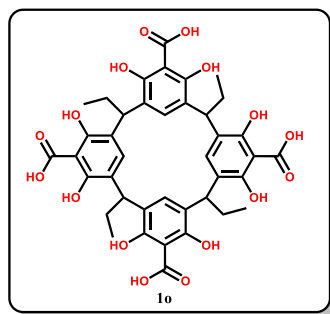
1n



To obtain the pure compound, the solid that was initially collected through gravity filtration was boiled in acetone. It was then stored in the freezer for 10 minutes. A dropwise addition of hexanes, water, and MeOH (1:1:1) was added to precipitate out the pure compound. The precipitate that occurs after the addition of the previous solvent mixture is then collected via gravity filtration. Brown solid, 129.8 mg (42% yield).

¹H NMR (600 MHz, DMSO-*d*₆): $\delta_{\text{H}} = 9.06$ (s, 8H), 7.32 (s, 4H), 4.35 (t, $J = 7.8$ Hz, 4H), 2.14 (q, $J = 7.7$ Hz, 8H), 1.31 (q, $J = 7.2$ Hz, 8H), 1.23 (dt, $J = 10.2, 5.3$ Hz, 24H), 1.18 – 1.16 (m, 8H), and 0.84 (t, $J = 7.1$ Hz, 12H) ppm; **¹³C NMR (151 MHz, DMSO-*d*₆):** $\delta_{\text{C}} = 148.7, 125.5, 123.8, 101.4, 35.5, 33.7, 31.4, 29.2, 29.0, 27.8, 22.2,$ and 14.0 ppm; **HRMS-ESI (m/z):** calculated for C₅₆H₇₆Br₄O₈ [M+H]⁺ 1193.2346 found 1193.2346.

1o

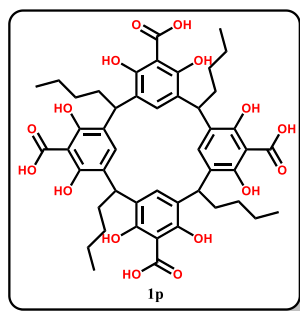


To obtain the pure compound, the solvent was evacuated from the scintillation vial. Next, water is added to the solid and allowed to stir for 1 hour. The precipitate is then collected through gravity filtration. Beige solid, 226.7 mg (69% yield).

¹H NMR (600 MHz, DMSO-*d*₆): $\delta_{\text{H}} = 9.55$ (s, 12H), 7.11 (s, 4H), 4.51 (t, *J* = 7.7 Hz, 4H), 1.89 (p, *J* = 7.3 Hz, 8H), and 0.86 (t, *J* = 7.2

Hz, 12H) ppm; **¹³C NMR (151 MHz, DMSO-*d*₆):** $\delta_{\text{C}} = 173.7, 156.7, 131.8, 121.4, 100.3, 35.8, 28.1,$ and 13.1 ppm; **HRMS-ESI (m/z):** calc. for C₄₀H₄₀O₁₆ [M+H]⁺ 777.2389 found 777.2383.

1p

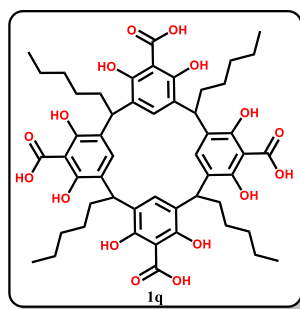


To obtain the pure compound, the solvent was evacuated from the scintillation vial. Next, water is added to the solid and allowed to stir for 1 hour. The precipitate is then collected through gravity filtration. Beige solid, 134.2 mg (60% yield).

¹H NMR (600 MHz, Acetone-*d*₆): $\delta_{\text{H}} = 10.36$ (s, 12H), 7.22 (s, 4H), 4.67 (t, *J* = 7.6 Hz, 4H), 1.95 (q, *J* = 7.4 Hz, 8H), 1.41 – 1.34 (m, 8H),

1.33 – 1.27 (m, 8H), and 0.88 (t, *J* = 7.2 Hz, 12H) ppm; **¹³C NMR (151 MHz, Acetone-*d*₆):** $\delta_{\text{C}} = 172.7, 157.6, 133.8, 123.3, 100.2, 35.6, 35.1, 31.4, 23.7,$ and 14.7 ppm; **HRMS-ESI (m/z):** calculated for C₄₈H₅₆O₁₆ [M+H]⁺ 889.3641 found 889.3621.

1q

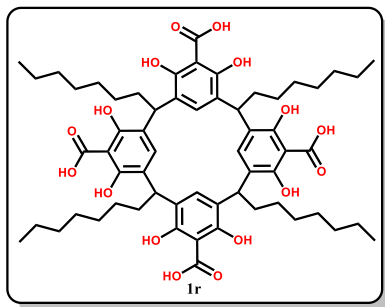


To obtain the pure compound, the solvent was evacuated from the scintillation vial. Next, water is added to the solid and allowed to stir for 1 hour. The precipitate is then collected through gravity filtration. Beige solid, 223.0 mg (92% yield).

¹H NMR (600 MHz, DMSO-*d*₆): $\delta_{\text{H}} = 10.13$ (s, 12H), 7.04 (s, 4H), 4.58 (t, *J* = 7.6 Hz, 4H), 1.82 (q, *J* = 7.6 Hz, 8H), 1.31 – 1.21 (m, 24H), and

0.89 – 0.84 (m, 12H) ppm; **¹³C NMR (151 MHz, DMSO-*d*₆):** $\delta_{\text{C}} = 173.7, 156.6, 131.7, 121.3, 100.4, 35.1, 34.1, 32.0, 27.9, 22.6,$ and 14.4 ppm; **HRMS-ESI (m/z):** calculated for C₅₂H₆₄O₁₆ [M+H]⁺ 945.4267 found 945.4275.

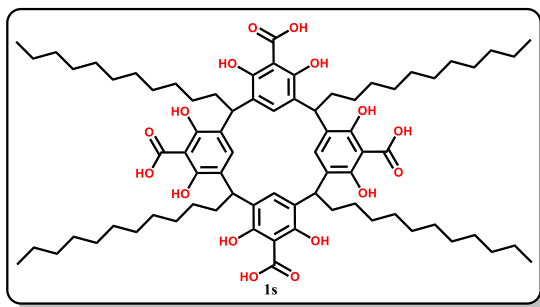
1r



To obtain the pure compound, the solvent was evacuated from the scintillation vial. Next, water is added to the solid and allowed to stir for 1 hour. The precipitate is then collected through gravity filtration. Beige solid, 264.8 mg (64% yield).

^1H NMR (500 MHz, DMSO-*d*₆): δ_{H} = 10.79 (s, 12H), 6.91 (s, 4H), 4.47 (t, *J* = 7.6 Hz, 4H), 1.68 (q, *J* = 7.5 Hz, 8H), 1.13 (dt, *J* = 23.5, 8.9 Hz, 40H), and 0.74 (t, *J* = 6.9 Hz, 12H) ppm; **^{13}C NMR (126 MHz, DMSO-*d*₆):** δ_{C} = 173.6, 156.6, 131.6, 121.4, 100.3, 35.2, 34.1, 31.8, 29.7, 29.2, 28.2, 22.5, and 14.3 ppm; **HRMS-ESI (m/z):** calculated for C₆₀H₈₀O₁₆ [M+H]⁺ 1057.5520 found 1057.5526.

1s



To obtain the pure compound, the solvent was evacuated from the scintillation vial. Next, water is added to the solid and allowed to stir for 1 hour. The precipitate is then collected through gravity filtration. Beige solid, 320.6 mg (95% yield).

^1H NMR (600 MHz, Acetone-*d*₆): δ_{H} = 10.55 (s, 12H), 7.09 (s, 4H), 4.55 (t, *J* = 7.6 Hz, 4H), 1.82 (q, *J* = 7.3 Hz, 8H), 1.18 (d, *J* = 45.3 Hz, 72H), and 0.74 (t, *J* = 6.9 Hz, 12H) ppm; **^{13}C NMR (151 MHz, Acetone-*d*₆):** δ_{C} = 171.7, 156.5, 132.5, 122.2, 99.2, 34.5, 34.3, 31.8, 29.7, 29.7, 29.6, 29.6, 29.6, 29.3, 28.0, 22.5, and 13.5 ppm; **HRMS-ESI (m/z):** calculated for C₇₆H₁₁₂O₁₆ [M-H]⁻ 1279.7874 found 1279.7859.

Table S1. Crystallographic data for **1h** and **1i**.

	1h	1i	1s
CCDC Number	2365251	2365250	2380394
Chemical formula	C ₃₆ H ₃₆ Cl ₄ O ₈ ·4(C ₂ H ₆ OS)	C ₄₄ H ₅₂ Cl ₄ O ₈ ·4(C ₂ H ₆ OS)	2(C ₇₆ H ₁₁₂ O ₁₆) ·15(CH ₄ O)
Formula weight	1050.96	1163.16	3043.93
Space group	<i>P2₁/c</i>	<i>P-1</i>	<i>P-1</i>
<i>a</i> (Å)	13.9271 (3)	13.0540 (4)	13.8306 (1)
<i>b</i> (Å)	13.6605 (3)	13.1859 (4)	25.2831 (2)
<i>c</i> (Å)	25.9533 (5)	17.8437 (7)	27.2500 (4)
<i>α</i> (deg)	90	83.153 (3)	103.911 (1)
<i>β</i> (deg)	96.411 (2)	85.142 (3)	91.044 (1)
<i>γ</i> (deg)	90	72.146 (2)	99.080 (1)
<i>V</i> (Å³)	4906.77 (18)	2898.88 (17)	9117.72 (17)
<i>Z</i>	4	2	2
<i>μ</i> (mm⁻¹)	4.28	3.67	0.65
<i>T</i> (K)	100	100	100
<i>R1^a</i> (<i>wR2^b</i>)	0.099 (0.279)	0.199 (0.594)	0.166 (0.518)
Reflections	10143	10640	34316
Radiation type	Cu <i>Kα</i>	Cu <i>Kα</i>	Cu <i>Kα</i>

$${}^aR1 = [\Sigma w(F_o - F_c)^2 / \Sigma wF_o^2]^{1/2}; {}^b wR2 = [\Sigma [w(F_o^2 - F_c^2)^2] / \Sigma w(F_o^2)^2]^{1/2}, w = 1/[\sigma^2(F_o^2) + (aP)^2 + bP], \text{ where } P = [\max(F_o^2, 0) + 2(F_c^2)]/3$$

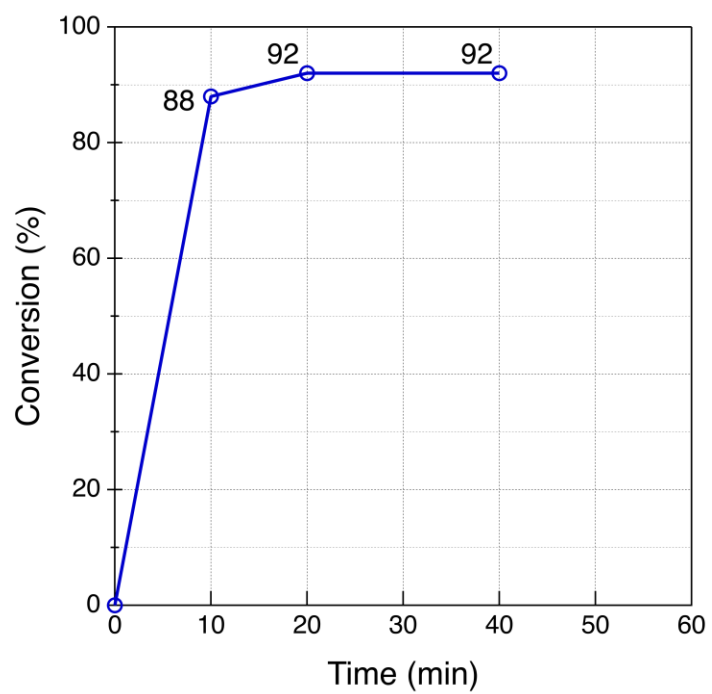


Figure S1. Conversion versus time for **1a** following conditions of Table 1, entry 2.

1a

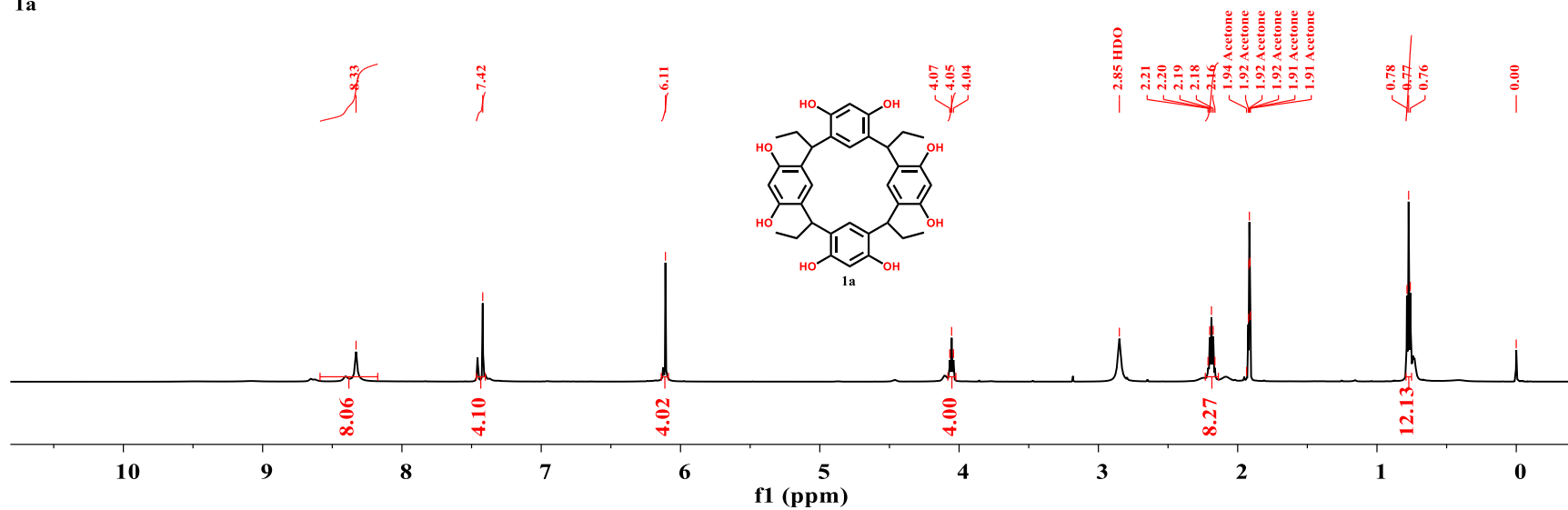


Figure S2. ¹H NMR spectrum (600 MHz) of compound 1a. Data collected in acetone-*d*₆ at 20 °C.

1b

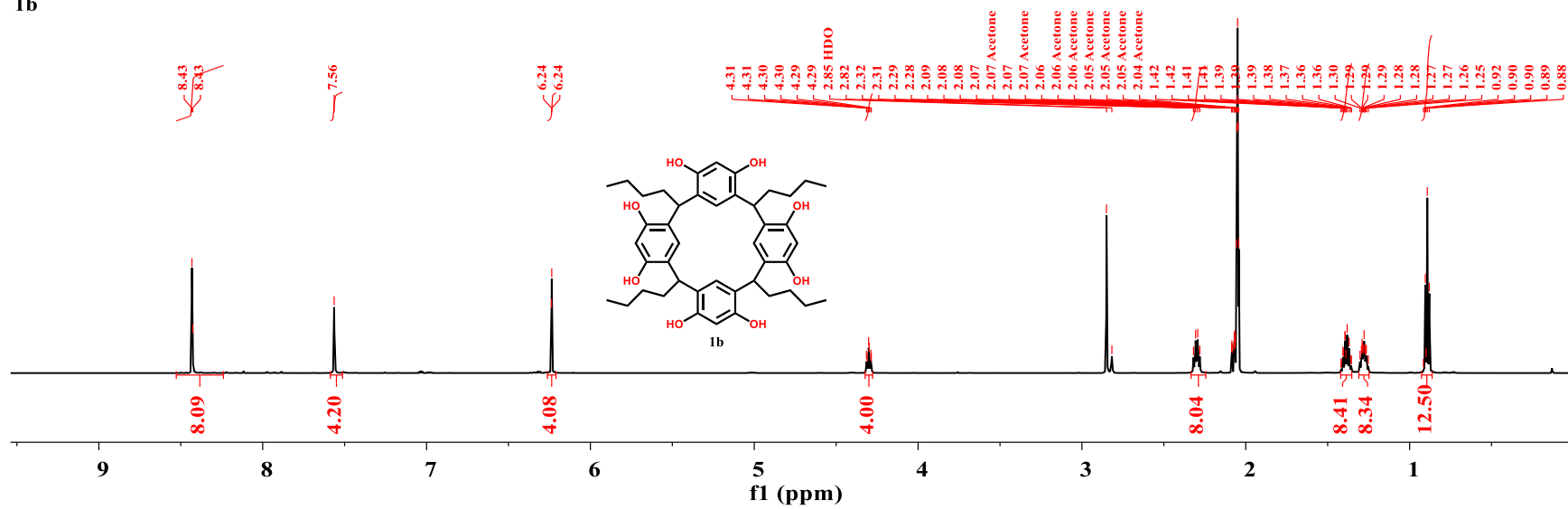


Figure S3. ¹H NMR spectrum (600 MHz) of compound 1b. Data collected in acetone-*d*₆ at 20 °C.

1c

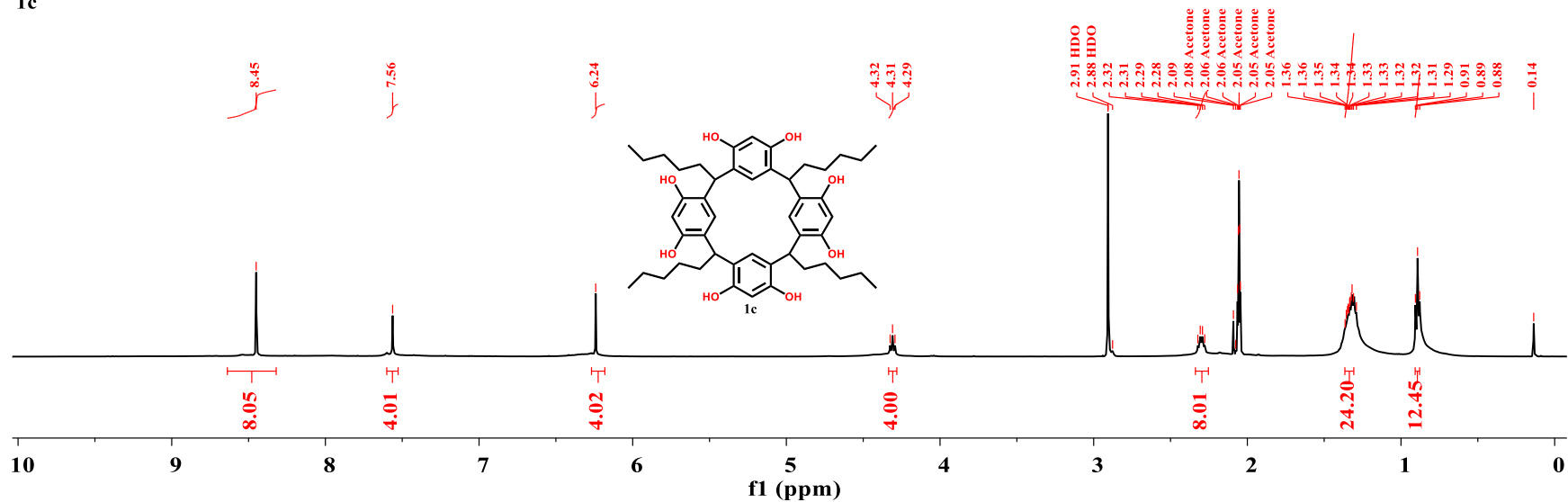


Figure S4. ¹H NMR spectrum (600 MHz) of compound **1c**. Data collected in acetone-*d*₆ at 20 °C.

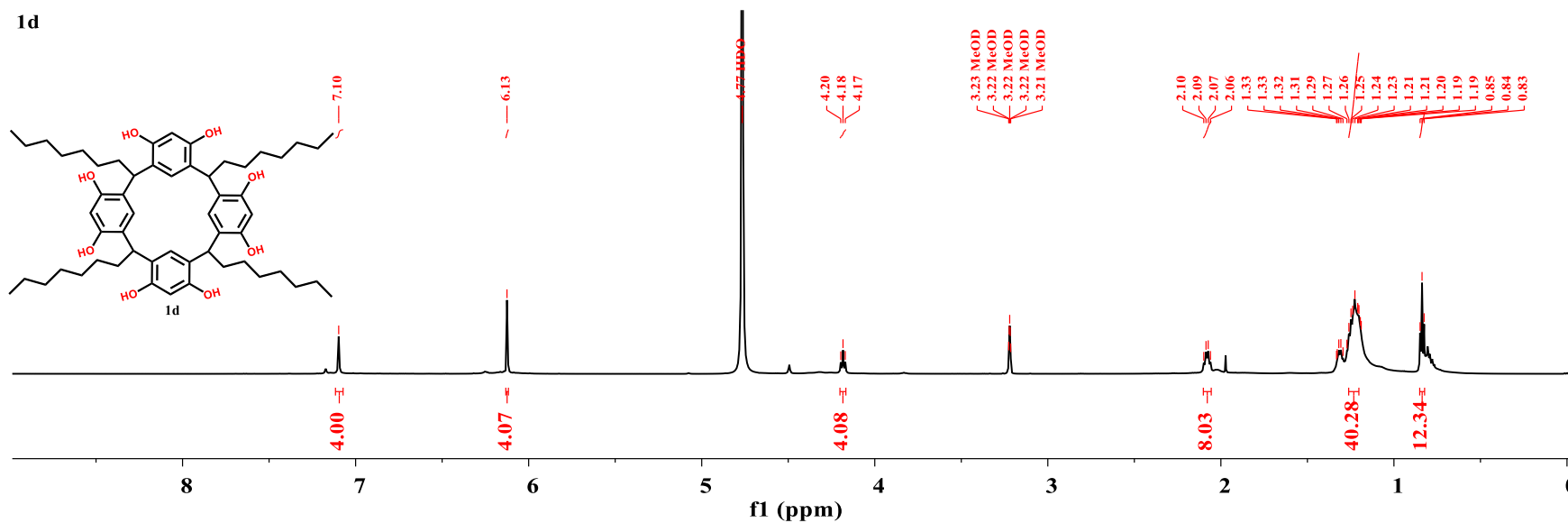


Figure S5. ^1H NMR spectrum (600 MHz) of compound **1d**. Data collected in methanol- d_4 at 20 °C.

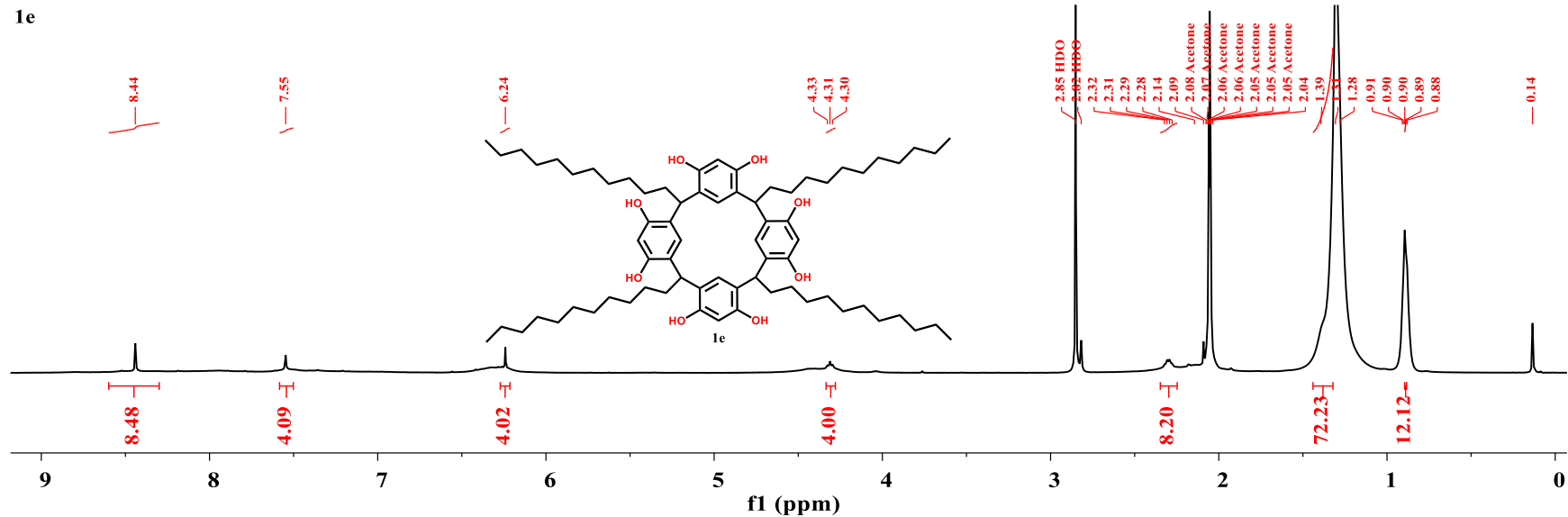


Figure S6. ^1H NMR spectrum (500 MHz) of compound **1e**. Data collected in acetone- d_6 at 20 °C.

1f

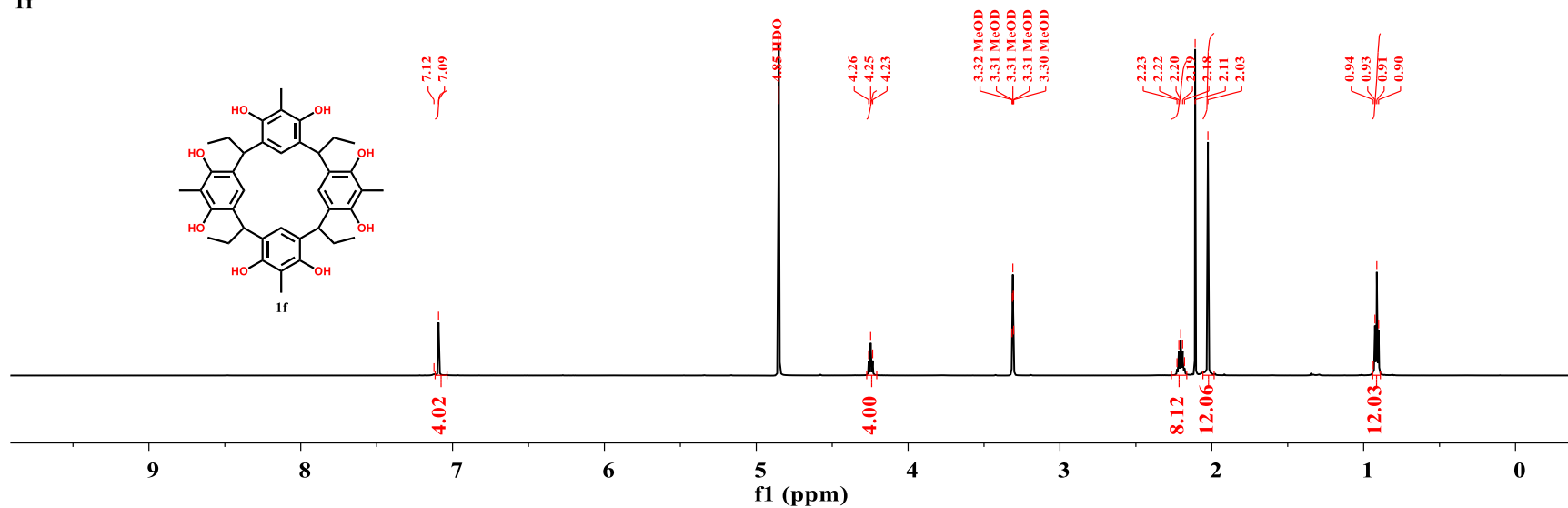


Figure S7. ¹H NMR spectrum (600 MHz) of compound **1f**. Data collected in methanol-*d*₄ at 20 °C.

1g

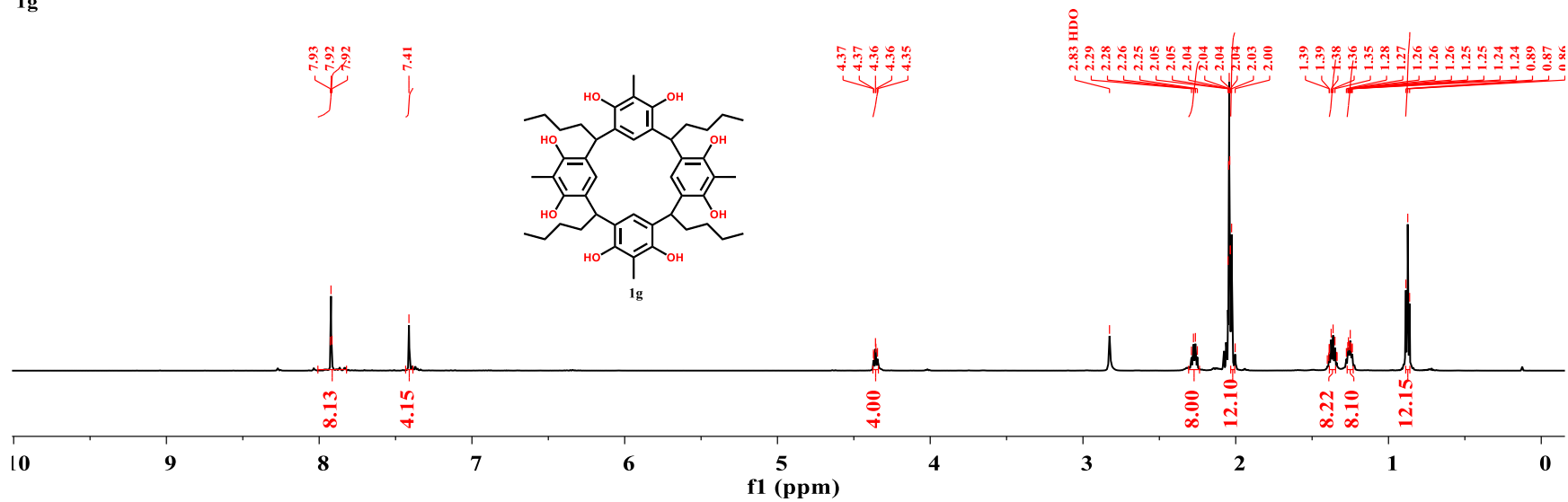


Figure S8. ¹H NMR spectrum (600 MHz) of compound **1g**. Data collected in acetone-*d*₆ at 20 °C.

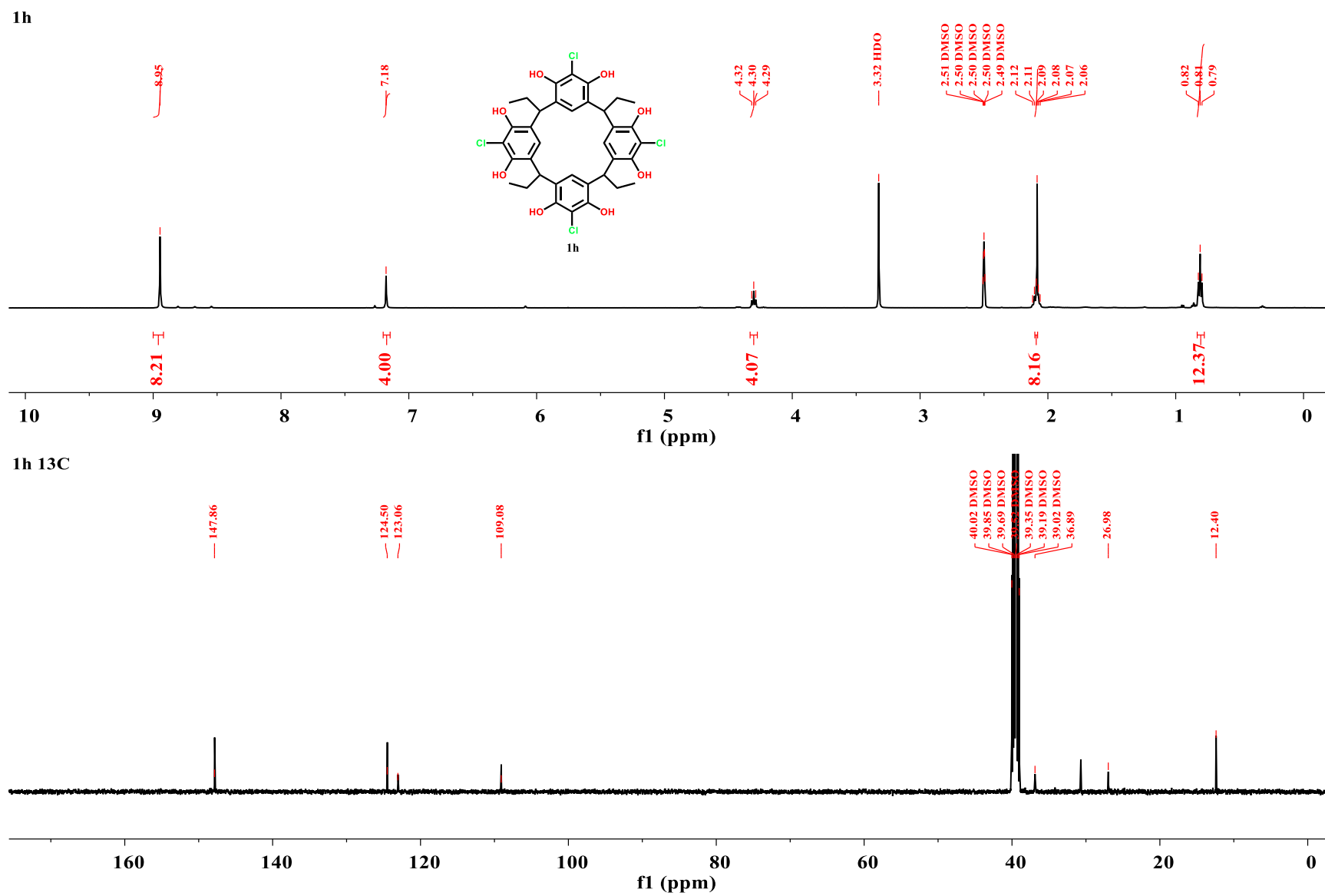


Figure S9. ^1H and ^{13}C NMR spectra of compound **1h**. Data collected in $\text{DMSO-}d_6$ at $20\text{ }^\circ\text{C}$.

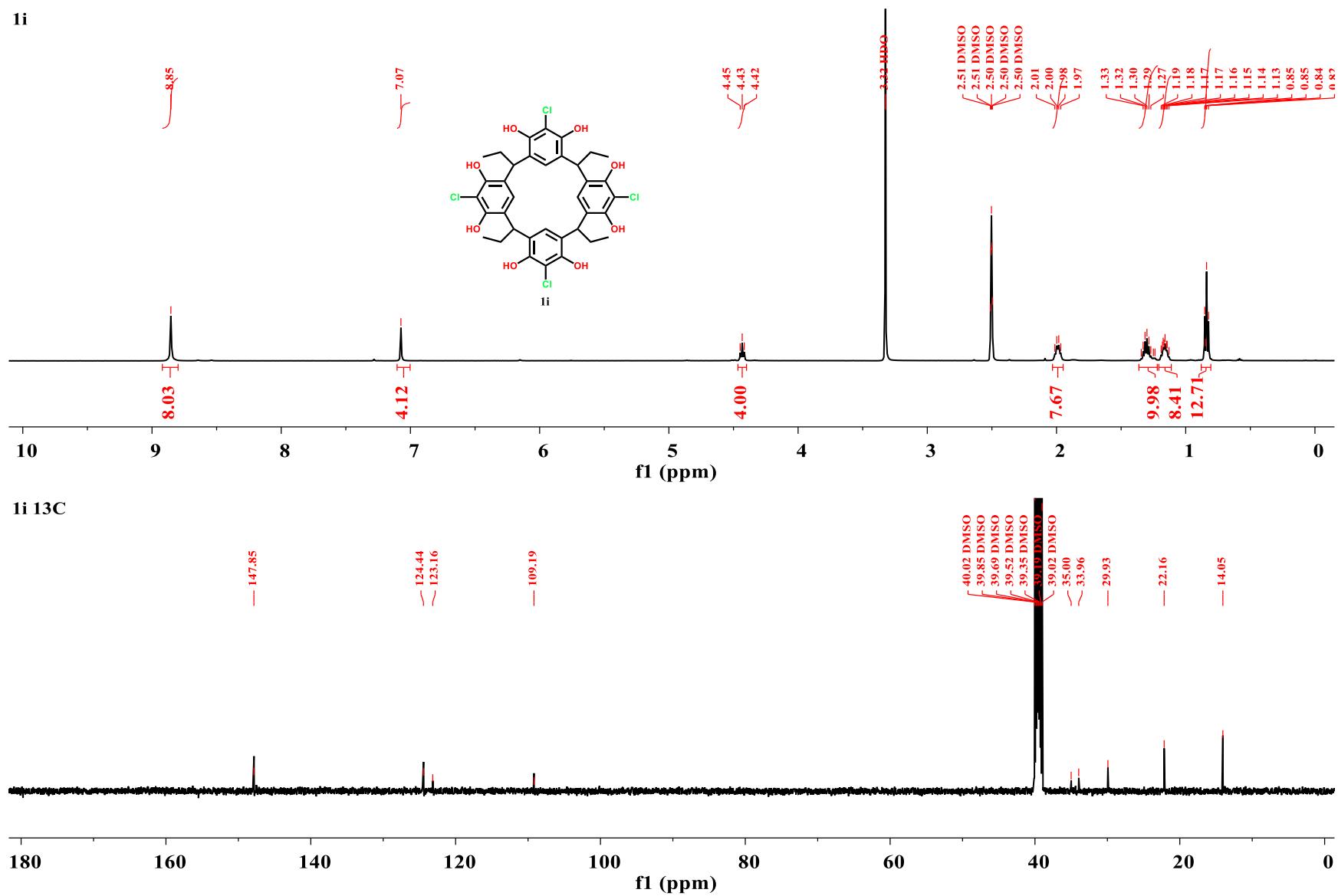


Figure S10. ¹H and ¹³C NMR spectra of compound **1i**. Data collected in DMSO-*d*₆ at 20 °C.

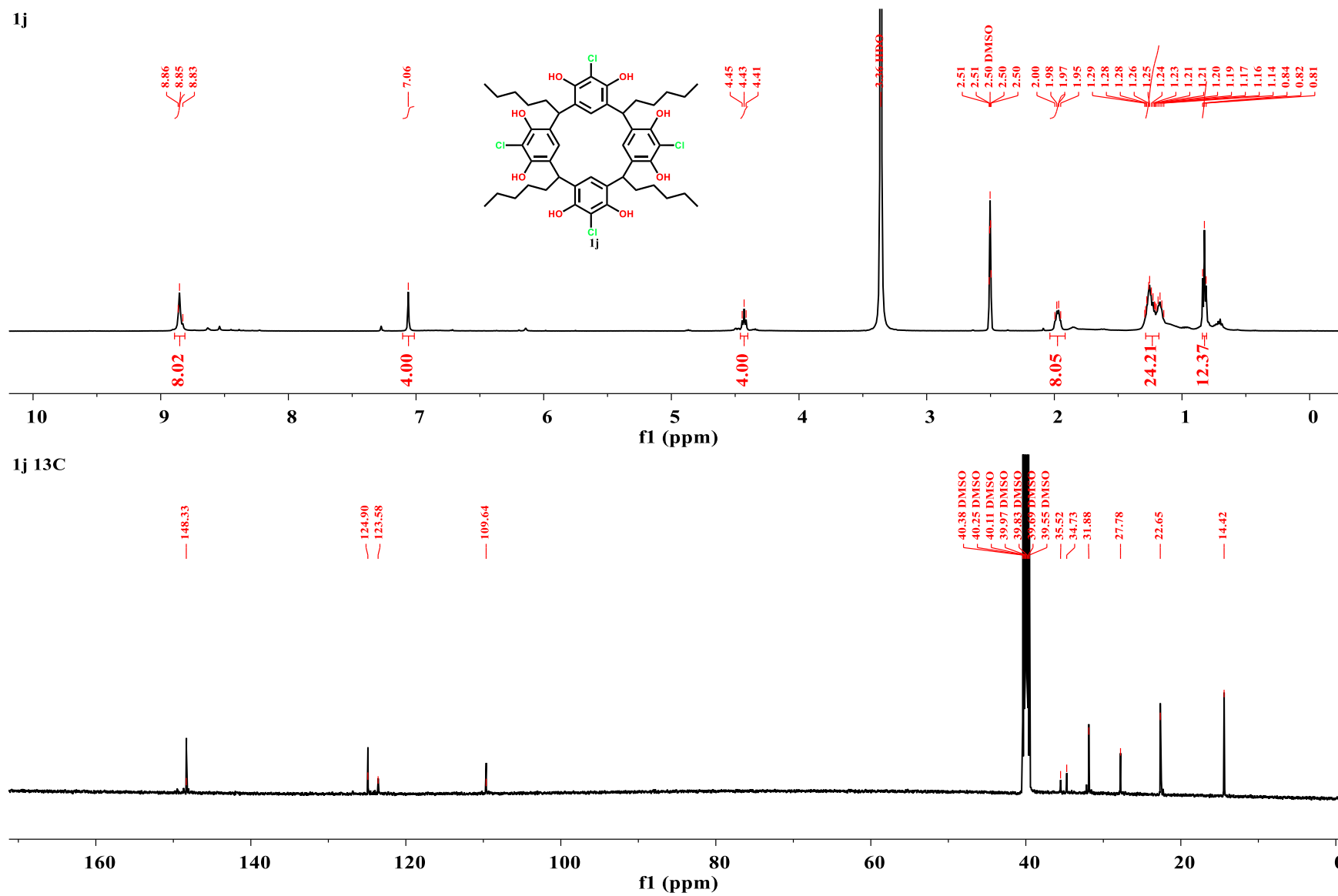


Figure S11. ^1H and ^{13}C NMR spectra of compound **1j**. Data collected in $\text{DMSO-}d_6$ at 20 °C.

1k

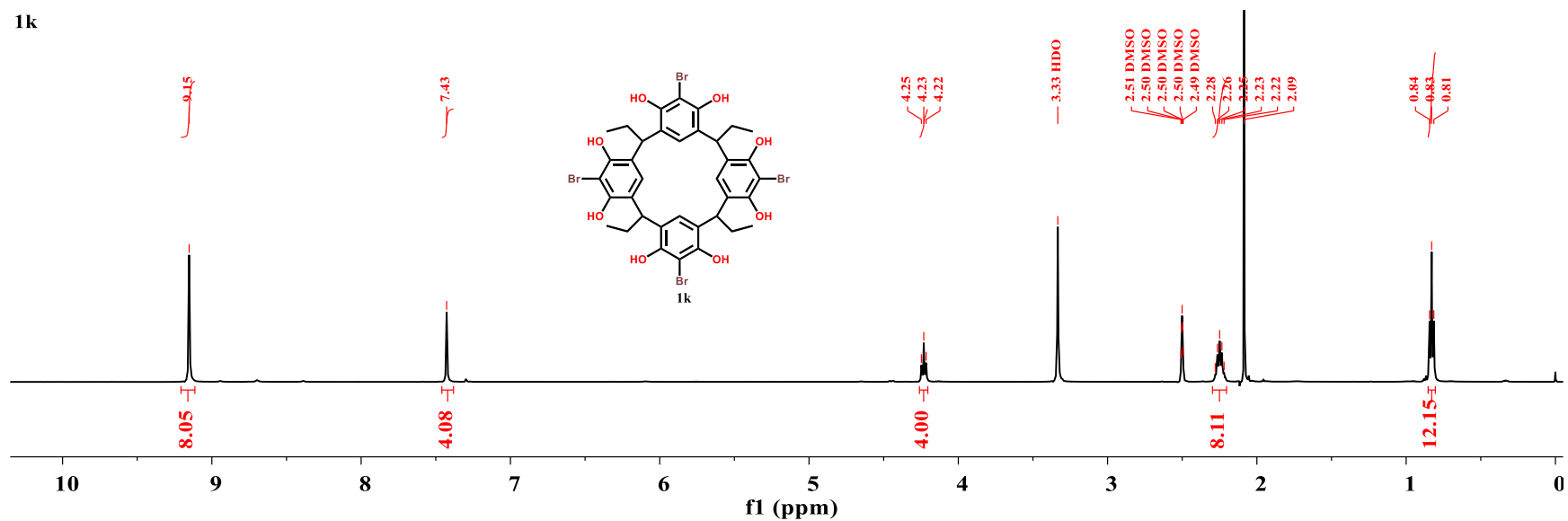


Figure S12. ¹H NMR spectrum (500 MHz) of compound **1k**. Data collected in DMSO-*d*₆ at 20 °C.

11

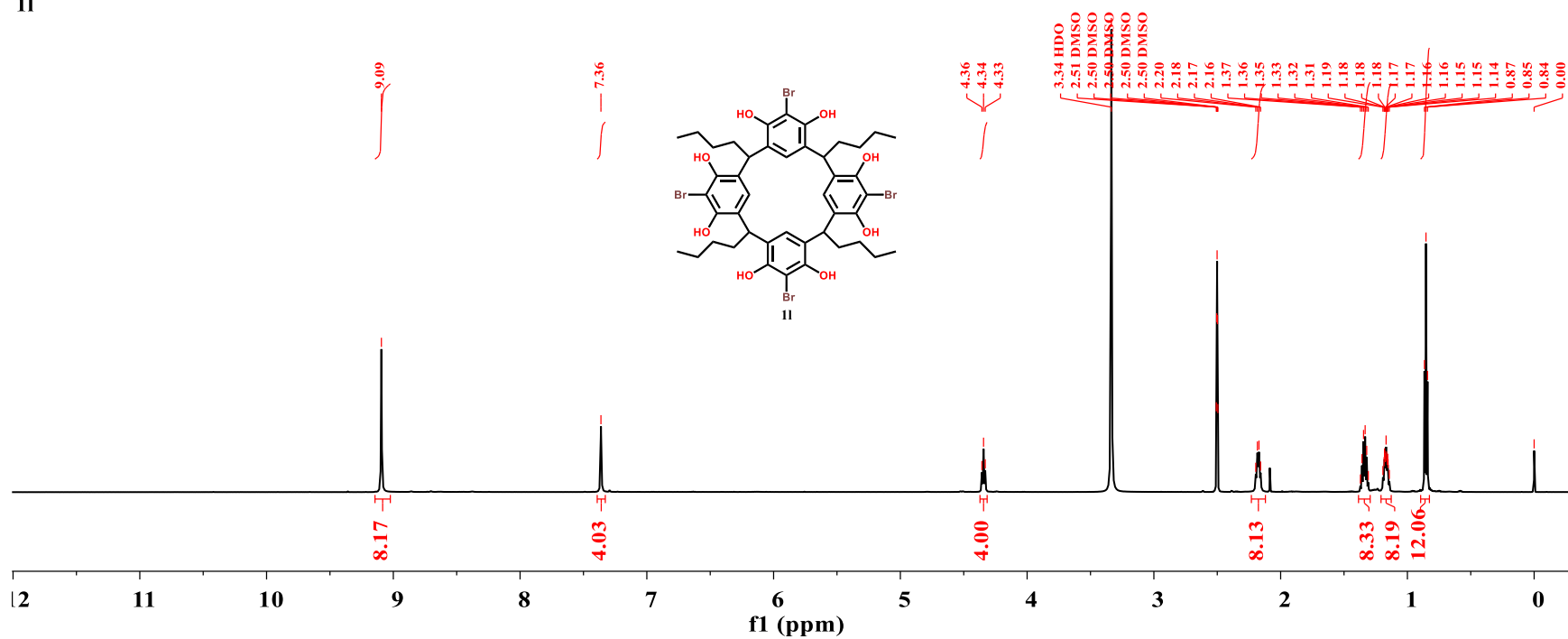


Figure S13. ¹H NMR spectrum (600 MHz) of compound **11**. Data collected in DMSO-*d*₆ at 20 °C.

1m

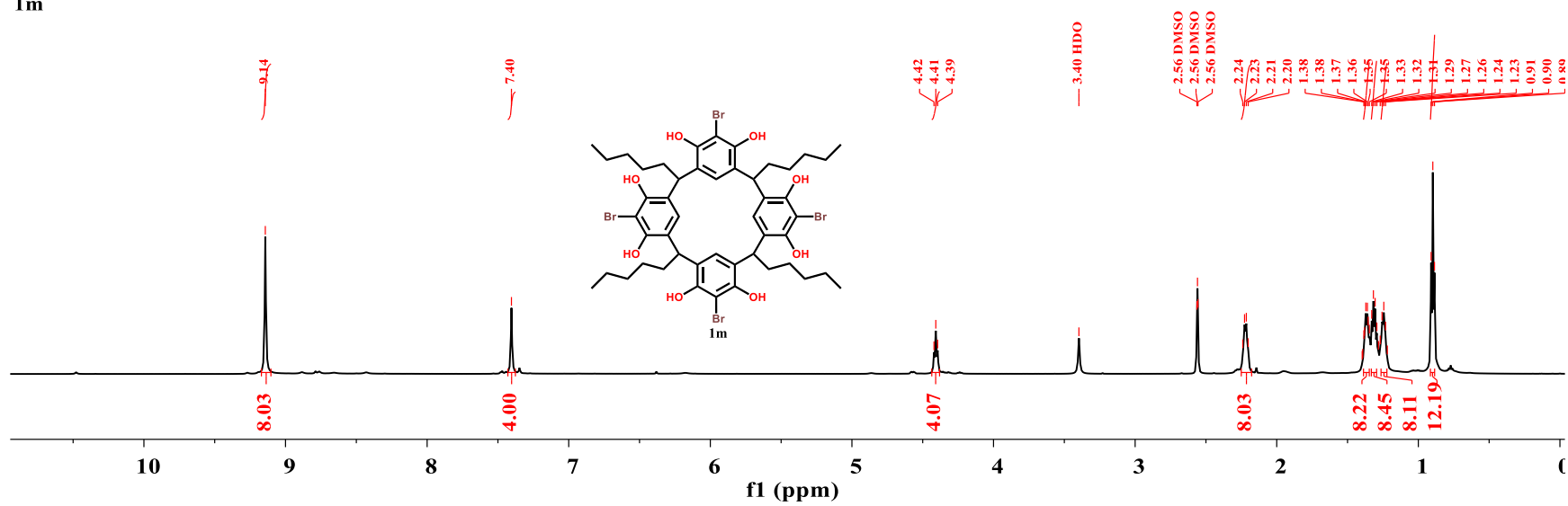


Figure S14. ¹H NMR spectrum (600 MHz) of compound **1m**. Data collected in DMSO-*d*₆ at 20 °C.

1n

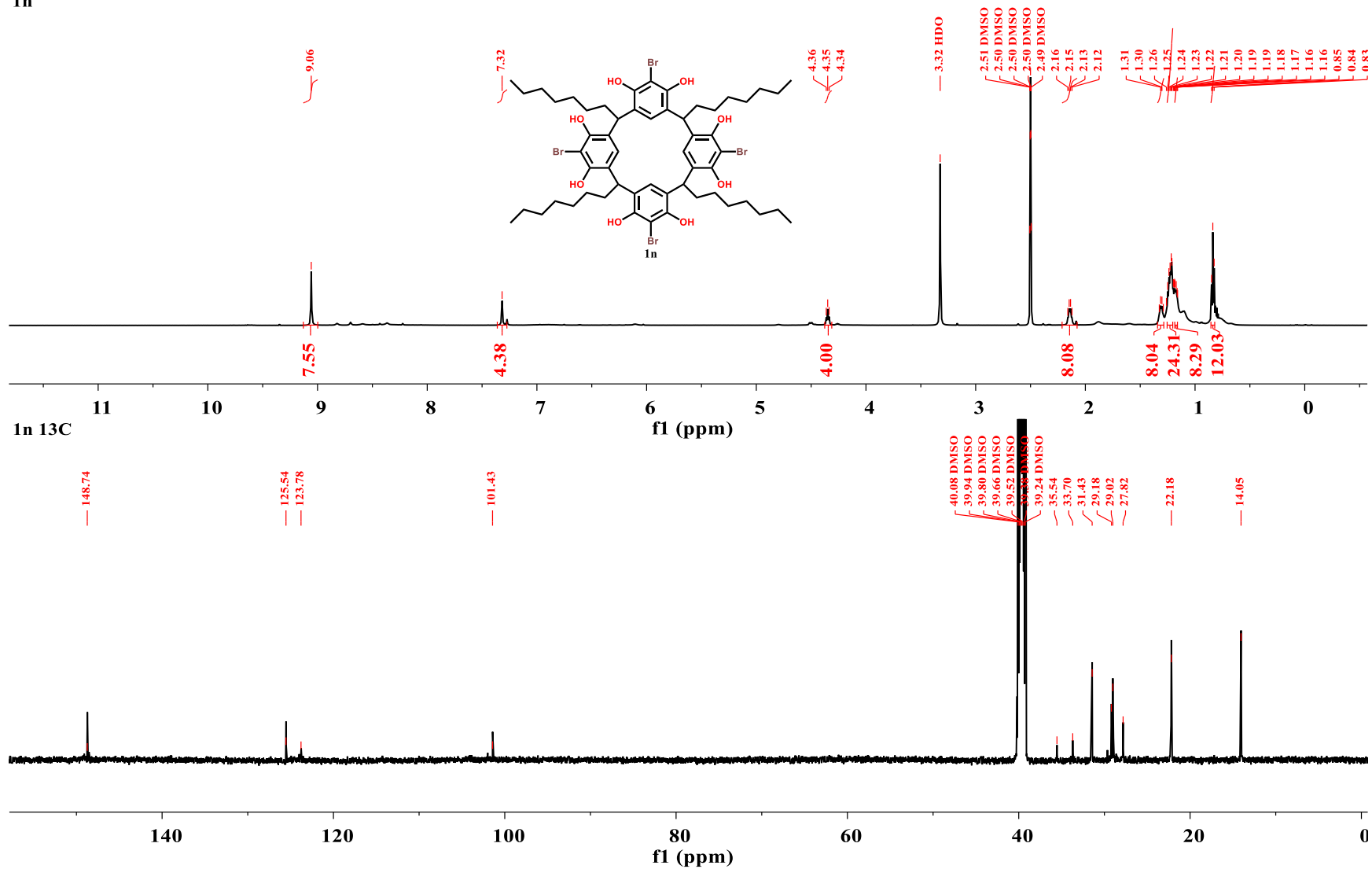
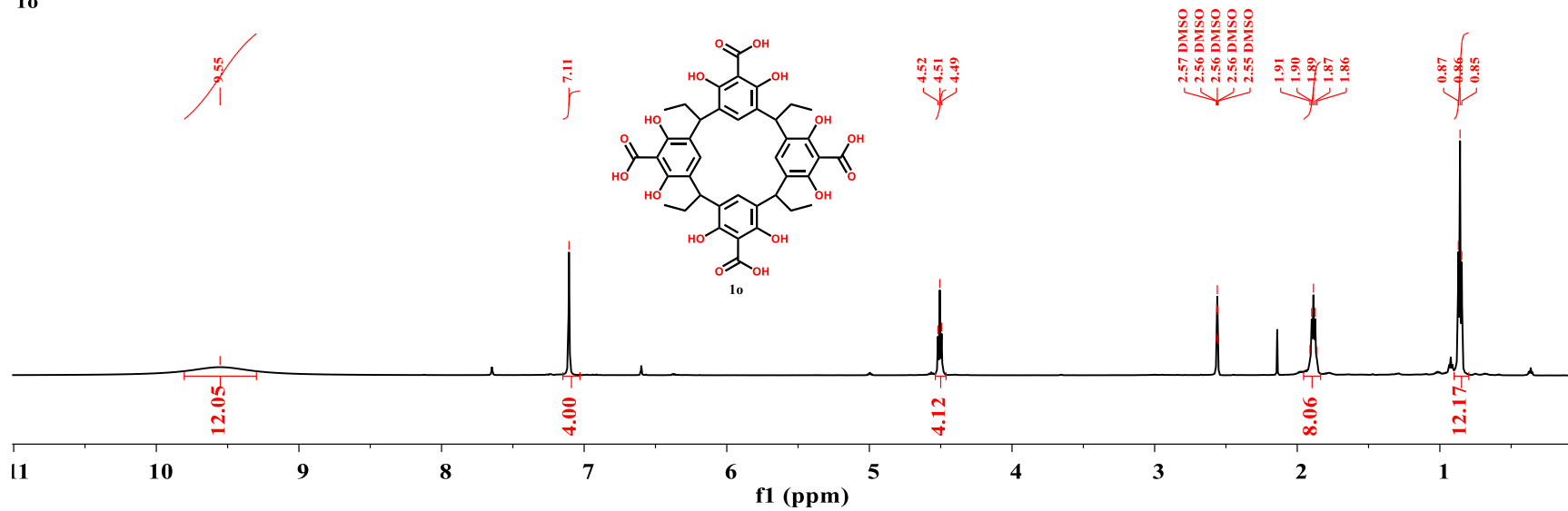


Figure S15. ^1H and ^{13}C NMR spectra of compound **1n**. Data collected in $\text{DMSO}-d_6$ at 20 °C.

1o



1o 13C

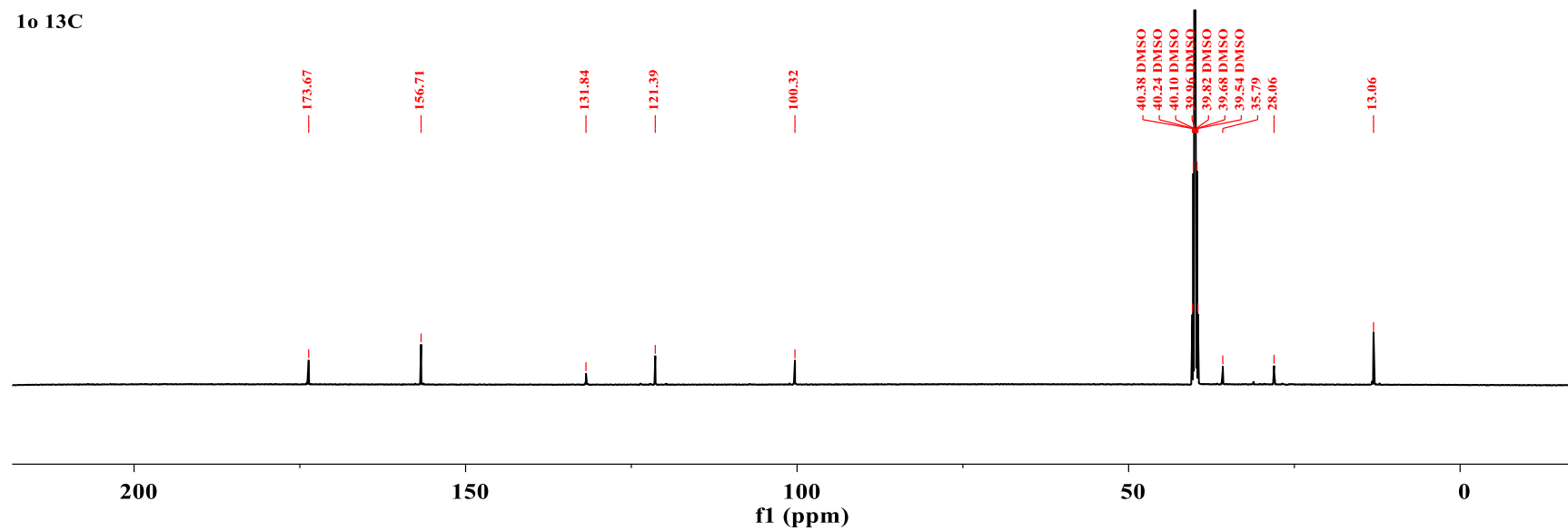


Figure S16. ¹H and ¹³C NMR spectra of compound **1o**. Data collected in DMSO-*d*₆ at 20 °C.

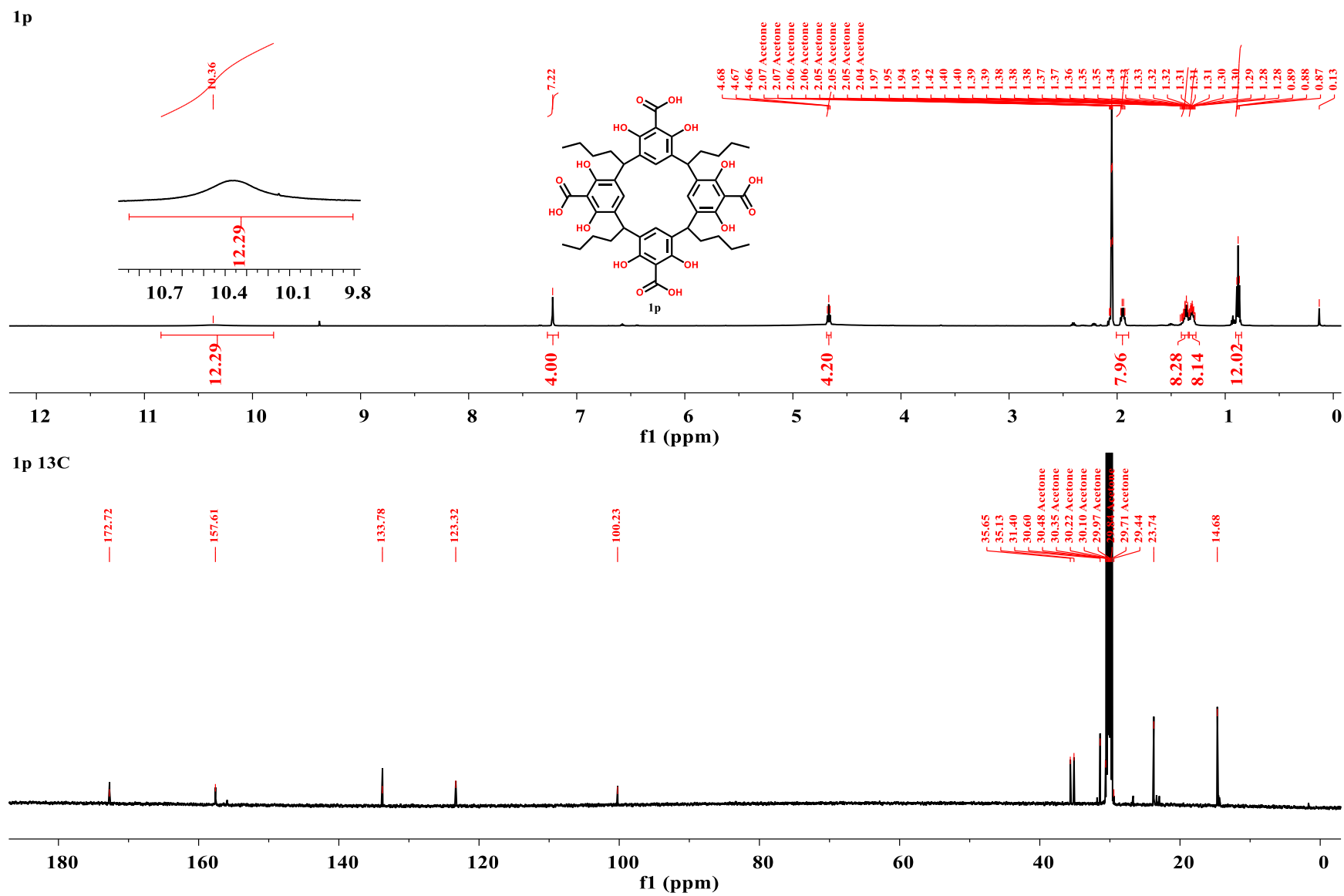
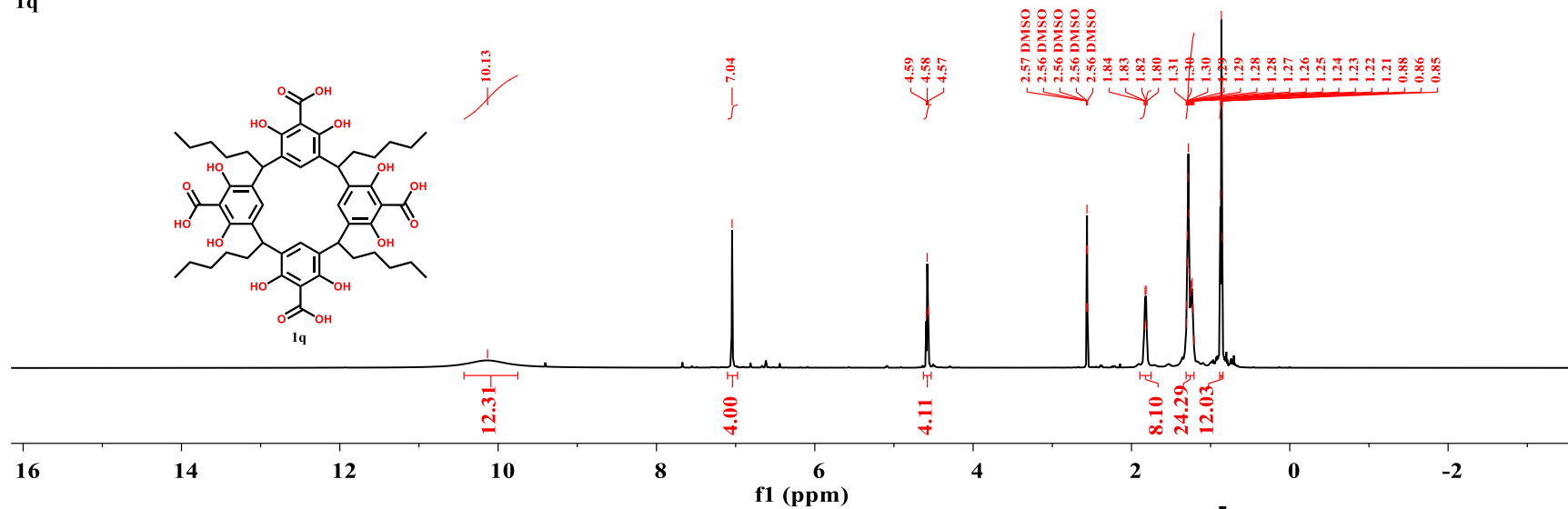


Figure S17. ¹H and ¹³C NMR spectra of compound **1p**. Data collected in acetone-*d*₆ at 20 °C.

1q



1q 13C

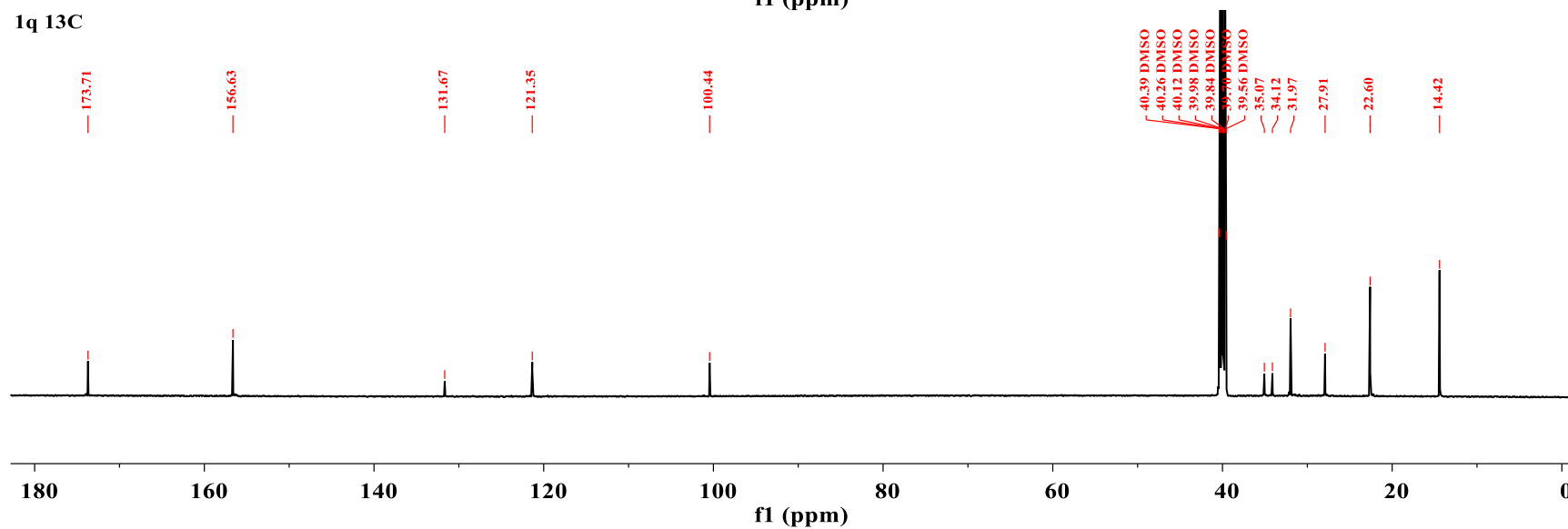


Figure S18. ¹H and ¹³C NMR spectra of compound **1q**. Data collected in DMSO-*d*₆ at 20 °C.

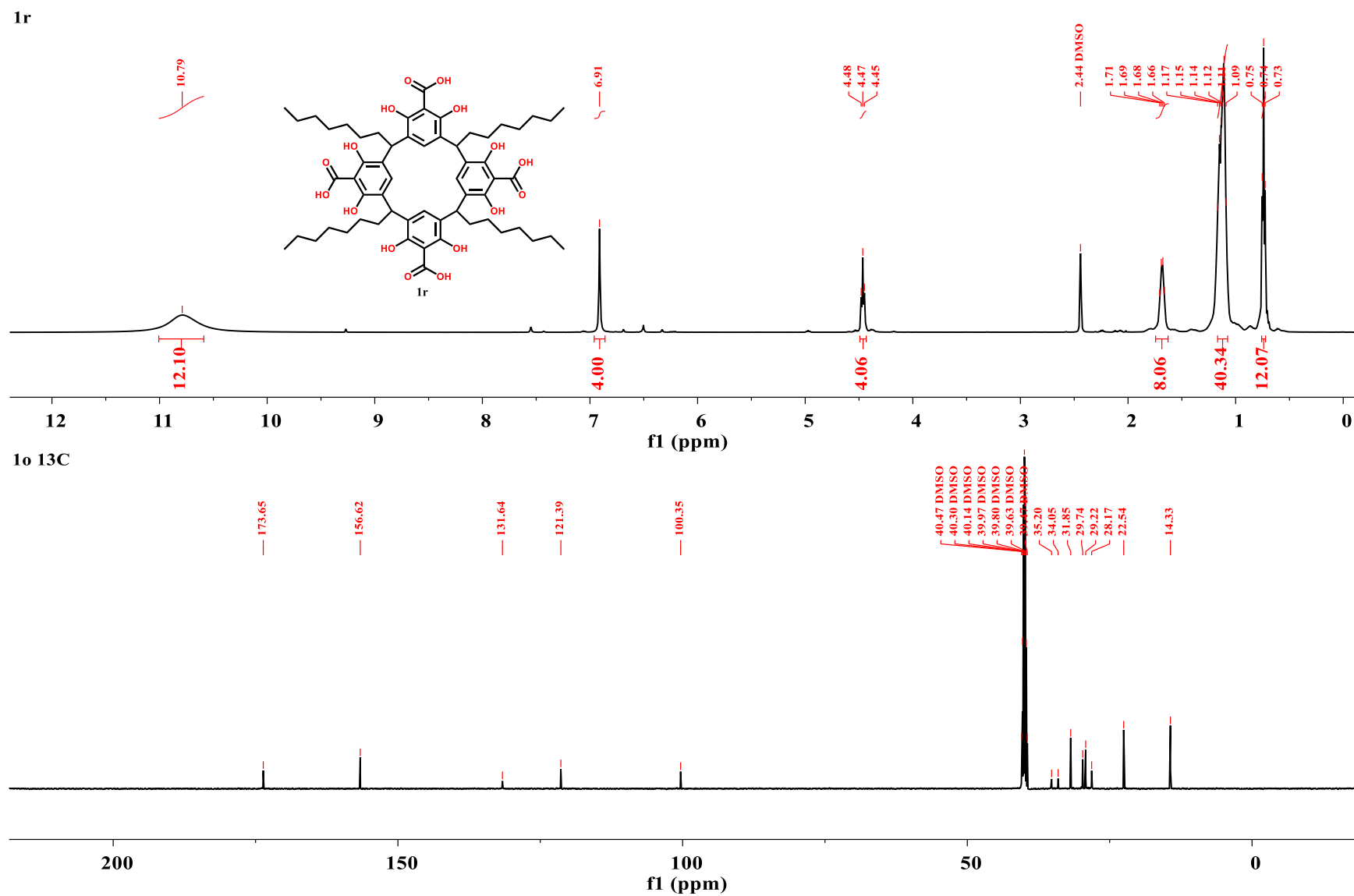


Figure S19. ¹H and ¹³C NMR spectra of compound **1r**. Data collected in DMSO-*d*₆ at 20 °C.

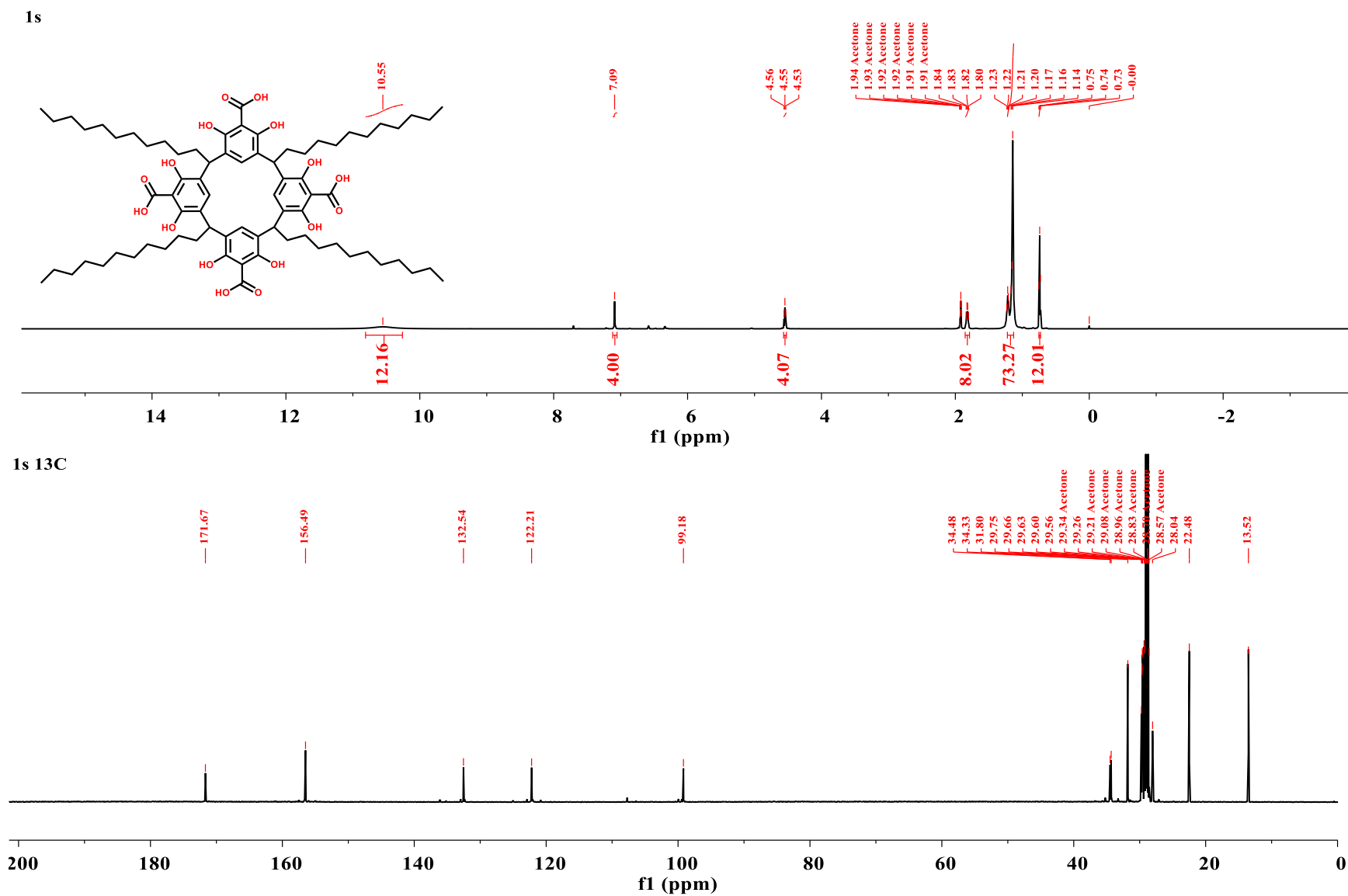


Figure S20. ¹H and ¹³C NMR spectra of compound **1s**. Data collected in acetone-*d*₆ at 20 °C.

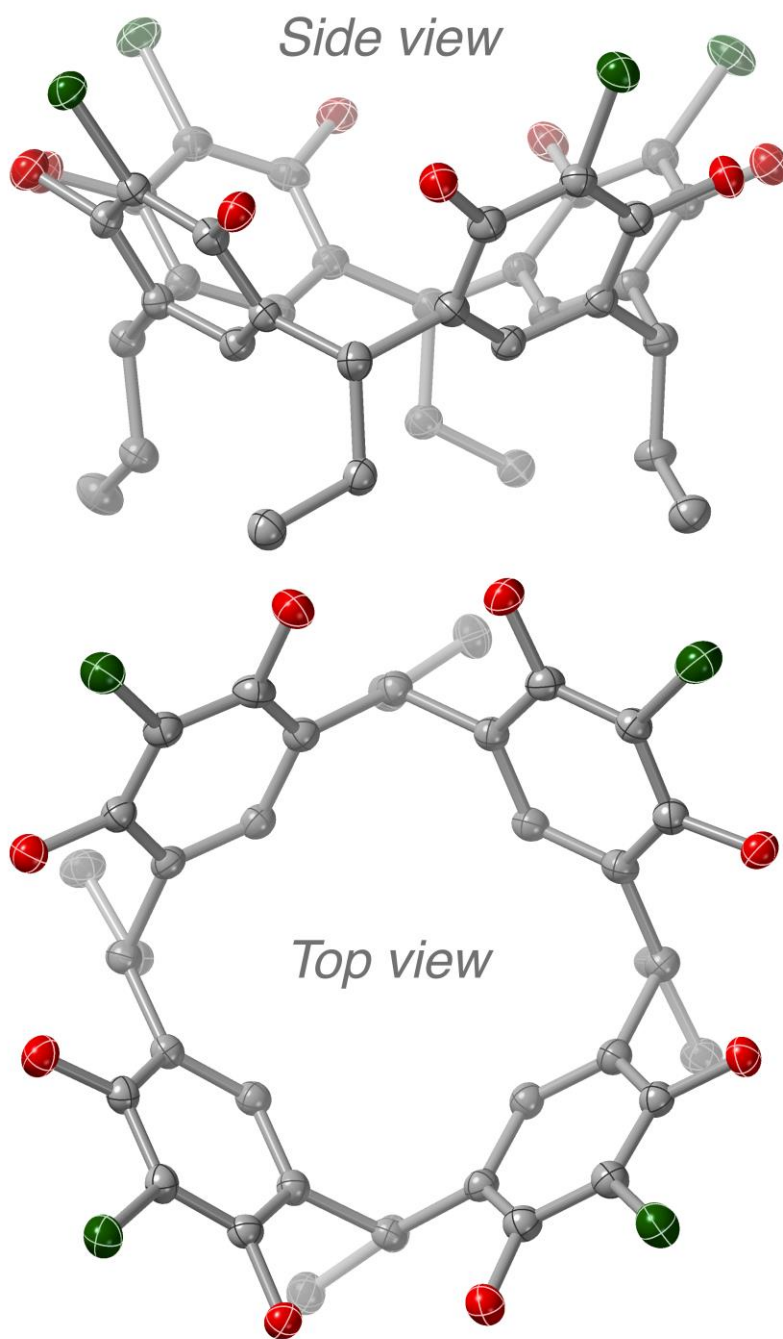


Figure S21. Molecular crystal structure of **1h** obtained at 100 K. Thermal ellipsoids are set at 50% probability level. Hydrogen atoms are omitted for clarity. The C, Cl, and O atoms are colored grey, green, and red, respectively.

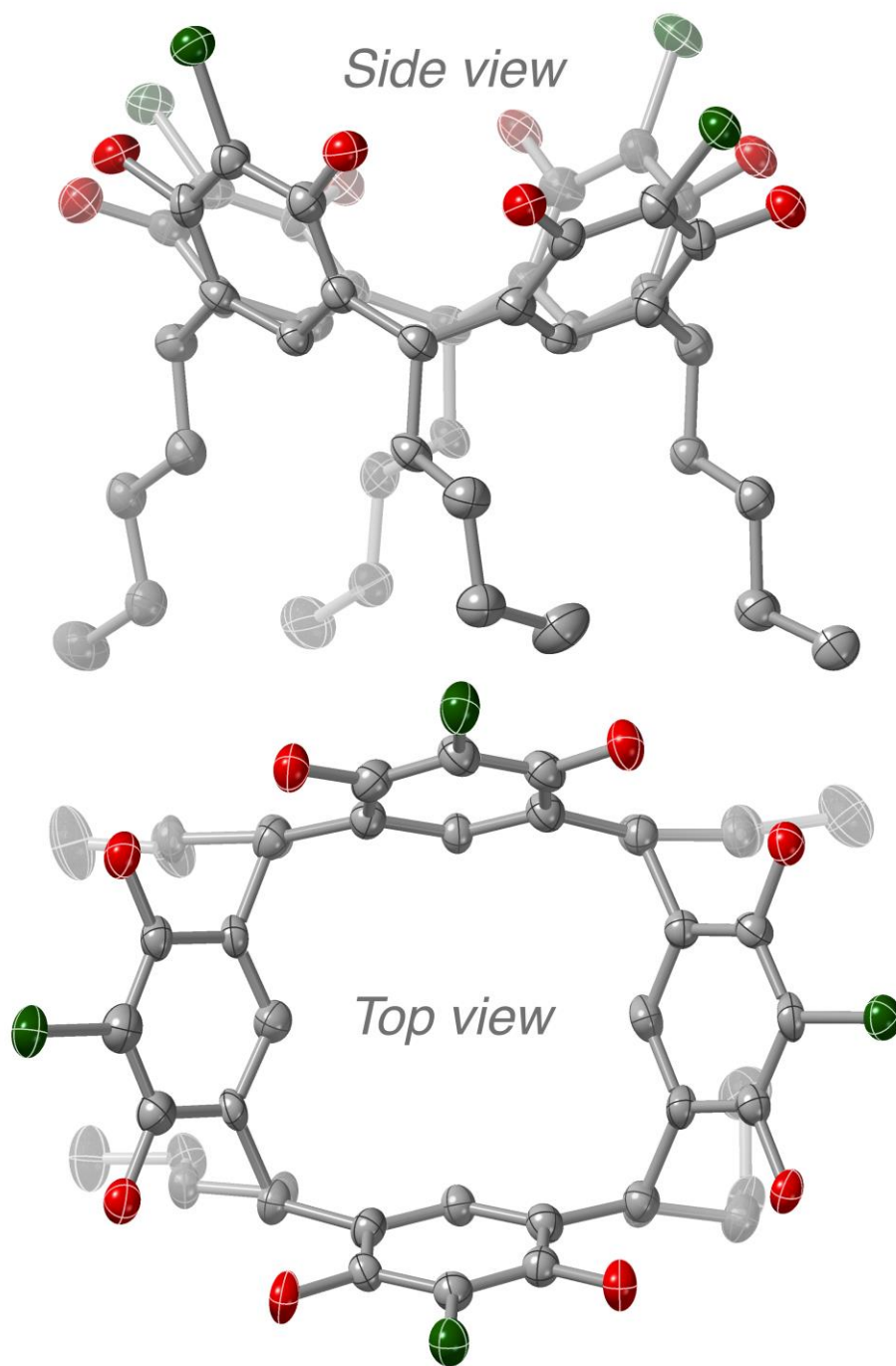


Figure S22. Molecular crystal structure of **1i** obtained at 100 K. Thermal ellipsoids are set at 50% probability level. Hydrogen atoms are omitted for clarity. The C, Cl, and O atoms are colored grey, green, and red, respectively.

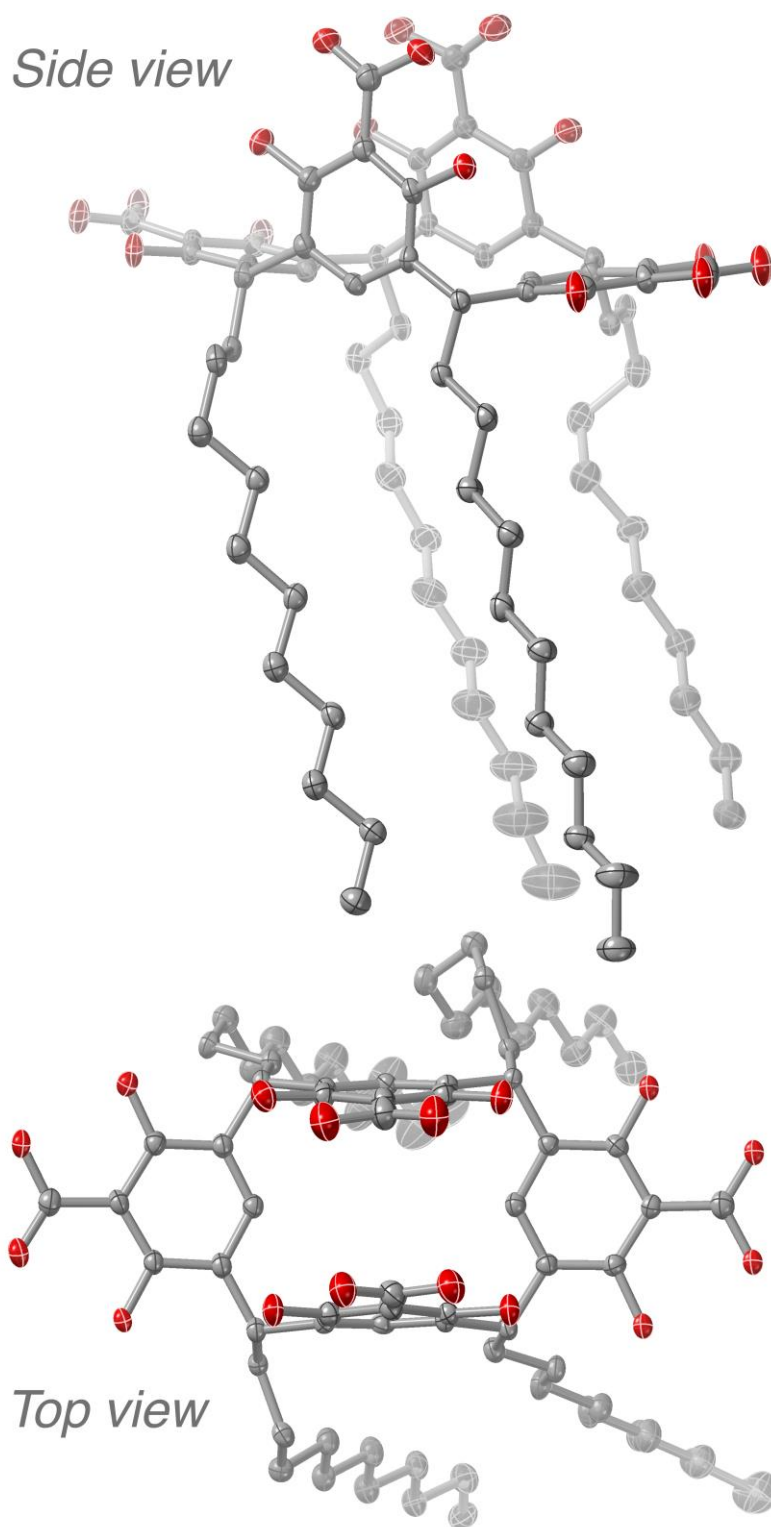


Figure S23. Molecular crystal structure of **1s** obtained at 100 K. Thermal ellipsoids are set at 50% probability level. Hydrogen atoms are omitted for clarity. The C and O atoms are colored grey and red, respectively.

References

1. Spek, A. *J. Appl. Cryst.* **2003**, *36*, 7-13.
2. Spek, A. *Acta Cryst. D* **2009**, *65*, 148-155.
3. Sheldrick, G. M. *Acta Cryst. A* **2015**, *71*, 3-8.
4. *Acta Cryst. C* **2015**, *71*, 3-8.
5. Dolomanov, O. V.; Bourhis, L. J.; Gildea, R. J.; Howard, J. A. K.; Puschmann, H. *J. Appl. Cryst.* **2009**, *42*, 339-341.
6. Tunstad, L. M.; Tucker, J. A.; Dalcanale, E.; Weiser, J.; Bryant, J. A.; Sherman, J. C.; Helgeson, R. C.; Knobler, C. B.; Cram, D. J. *J. Org. Chem.* **1989**, *54*, 1305-1312.
7. Salas, S. D.; Baumgartner, M. T.; Veglia, A. V. *J. Mol. Liq.* **2019**, *277*, 769-775.
8. Adhikari, B. B.; Fujii, A.; Schramm, M. P. *Eur. J. Org. Chem.* **2014**, *2014*, 2972-2979.
9. Fransen, J. R.; Dutton, P. J. *Can. J. Chem.* **1995**, *73*, 2217-2223.
10. Hussain, H.; Du, Y.; Tikhonova, E.; Mortensen, J. S.; Ribeiro, O.; Santillan, C.; Das, M.; Ehsan, M.; Loland, C. J.; Guan, L.; Kobilka, B. K.; Byrne, B.; Chae, P. S. *Chem. Eur. J.* **2017**, *23*, 6724-6729.
11. Tan, S.-D.; Chen, W.-H.; Satake, A.; Wang, B.; Xu, Z.-L.; Kobuke, Y. *Org. Biomol. Chem.* **2004**, *2*, 2719-2721.
12. Ananthnag, G. S.; Mondal, D.; Mague, J. T.; Balakrishna, M. S. *Dalton Trans.* **2019**, *48*, 14632-14641.
13. Bryant, J. A.; Blanda, M. T.; Vincenti, M.; Cram, D. J. *J. Am. Chem. Soc.* **1991**, *113*, 2167-2172.