Supporting Information

Divergent Electrolysis for the Controllable Coupling of Thiols with 1,2-Dichloroethane: a Mild Approach to Sulfide and Sulfoxide

Fei Ling,* Tao Liu, Chao Xu, Jiaying He, Wangqin Zhang, Changwu Ling, Lei Liu and Weihui Zhong

*lingfei@zjut.edu.cn

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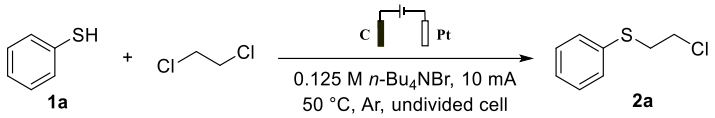
1. General information

NMR spectra were recorded with tetramethylsilane (TMS) as the internal standard. 1H NMR spectra were recorded at 600 MHz or 400 MHz, and 13C NMR spectra were recorded at 150 MHz or 100 MHz (Bruker Avance). 1H NMR chemical shifts (δ) are reported in ppm relative to tetramethylsilane (TMS) with the solvent signal as the internal standard ($CDCl_3$ at 7.26 ppm). 13C NMR chemical shifts are reported in ppm from tetramethylsilane (TMS) with the solvent resonance as the internal standard ($CDCl_3$ at 77.0 ppm). Data are given as: s (singlet), d (doublet), t (triplet), q (quartet), dd (double of doublet) or m (multiplets), coupling constants (Hz) and integration. Flash column chromatography was carried out using silica gel eluting with ethyl acetate, petroleum ether, dichloromethane and methanol. High resolution mass spectra were obtained with the Q-TOF-Premier mass spectrometer. Reactions were monitored by TLC and visualized with ultraviolet light. Cyclic voltammetry experiments were carried out in an equipment of CHI761E. CV curves were recorded using a three-electrode scheme. The working electrode was a glassy carbon electrode, A platinum electrode served as counter electrode. Ag/AgCl (KCl sat'd) was used as the reference electrode. The working electrode was polished before recording each CV curve.

2. Optimization of reaction condition

Table S1 Optimization of condition for sulfidation [a]



1a **2a**

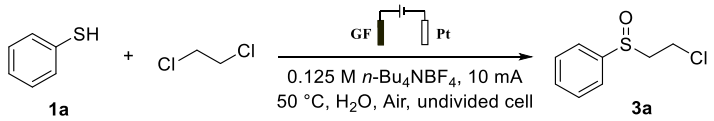
Entry	Variation from the standard conditions	Yield
1	None	47%
2	Graphite felt as an anode	39%
3	Pt as an anode	31%
4	*n*-Bu_4NBF_4 instead of *n*-Bu_4NBr	33%
5	*n*-Bu_4NPF_6 instead of *n*-Bu_4NBr	trace
6	*n*-Bu_4NI instead of *n*-Bu_4NBr	18%
7	*n*-$(C_8H_{17})_4NBr$ instead of *n*-Bu_4NBr	41%
8	2 mA instead of 10 mA	40%
9	4 mA instead of 10 mA	60%
10	6 mA instead of 10 mA	51%
11	dry DCE instead of DCE	68% [b]
12	Adding 3Å MS	77% [c]
13	30 °C instead of 50 °C	56% [d]
14	**60 °C instead of 50 °C**	**85% [d]**
15	increase *n*-Bu_4NBr to 1 mmol	84% [e]
16	No electric current	0

[a] Reaction conditions: Undivided cell, Graphite rod anode, Pt cathode (1 cm x 2 cm), **1a** (0.5 mmol), DCE (4.0 mL), *n*-Bu_4NBr (0.5 mmol), constant current = 10 mA, 30 h, 60 °C. Isolated yields. [b] Constant current = 4 mA. [c] Constant current = 4 mA, 4 mL dry DCE as solvent. [d] Constant current = 4 mA, 4 mL dry DCE as solvent, adding 3Å MS (20 mg) into the reaction mixture. [e] Constant current = 4 mA, 4 mL dry DCE as solvent, adding 3Å MS (20 mg)

into the reaction mixture, 60 °C.

At the outset of this study, thiophenol (**1a**) and DCE (4 mL) were chosen as the starting materials (Table S1). The initial reaction was performed in an undivided cell with graphite rod as anode and Pt (1 cm × 2 cm) as cathode, under 10 mA constant current at 50 °C using *n*-Bu_4NBr (0.5 mmol, 1.0 equiv.) as the electrolyte, the whole reaction mixture was exposed to Argon atmosphere. The desired product **2a** was obtained in 47% isolated yield (Table S1, entry 1). The electrode effect was then studied (Table S1, entries 2 and 3). Graphite felt or Platinum cannot replace graphite rod as an anode to provide more than 47% yield. Subsequently, a series of supporting electrolytes such as *n*-Bu_4NBF_4, *n*-Bu_4NPF_6, *n*-Bu_4NI, *n*-$(C_8H_{17})_4NBr$ were investigated (Table 1, entries 4-7), indicating that changing electrolyte did not promote the reaction: using *n*-Bu_4NBF_4 and *n*-$(C_8H_{17})_4NBr$ as electrolyte resulted lower yields, affording the desired product in 33% and 41% yield, respectively, while a much poorer yield was gotten when using *n*-Bu_4NPF_6 or *n*-Bu_4NI. Furthermore, the constant current affected the reaction significantly (Table S1, entries 8-10). To our delight, the desired product was formed in 60% yield (Table S1, entry 9) by decreasing the constant current to 4 mA. In addition, using dry DCE as material and solvent resulted in a higher yield (Table S1, entry 11) based on entry 9. Then, we further controlled the content of water by adding 3Å MS (20 mg) into the system, which was relied on the previous condition (Table S1, entry 11). As expected, the yield of **2a** was further increased up to 77% (Table S1, entry 12). These experiment dates told us that the presence of water will hinder the formation of target product **2a**, on the contrary, water will promote the formation of sulfoxide **3a**. Notably, changing the reaction temperature would affect the reaction yield (Table S1, entries 13 and 14). In particular, when the temperature increased to 60 °C, we obtained the target molecular in the optimal 85% yield (Table S1, entry 14). What's more, the equivalent of *n*-Bu_4NBr was investigated, increasing electrolyte to 1 mmol didn't obviously change the yield (Table S1, entry 15). Finally, no desired product was obtained without an electric current (Table S1, entry 16).

Table S2 Optimization of condition for sulfoxidation [a]



1a **3a**

Entry	Variation from the standard conditions	Yield
1	None	78%
2	*n*-Bu_4NBr instead of *n*-Bu_4NBF_4	41%
3	*n*-Bu_4NPF_6 instead of *n*-Bu_4NBF_4	63%
4	Graphite rod as an anode	48%
5	Pt as an anode	39%
6	5 mA instead of 10 mA	57%
7	**20 mA instead of 10 mA**	**83%**
8	40 mA instead of 10 mA	47%
9	40 °C	55%
10	70 °C	73%
11	Acetonitrile : DCE = 4 : 1	34%

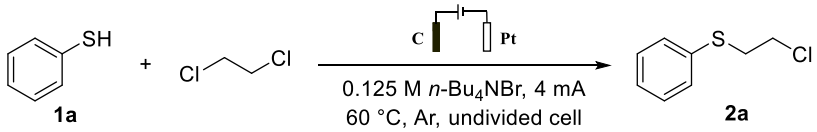
12	N_2 instead of Air	73%
13	O_2 instead of Air	75%
14	No electric current	0

[a] Reaction conditions: Undivided cell, Graphite felt anode, Pt cathode (1 cm x 2 cm), **1a** (0.5 mmol), DCE (4.0 mL), *n*-Bu_4NBF_4 (0.5 mmol), constant current = 10 mA, H_2O (5 equiv.), 12 h, 60 °C. Isolated yields.

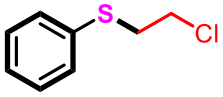
This study began our investigation with optimizing the reaction conditions for the electrosynthesis of chloroethyl sulfoxide. In the initial reaction thiophenol (**1a**) and 1,2-dichloroethane were chosen as the starting materials (Table S2), which was performed in an undivided cell with Graphite felt (GF) as anode and platinum as cathode under 10 mA constant current at 60 °C using *n*-Bu_4NBF_4 as the electrolyte and DCE as the solvent. Fortunately, the desired product **3a** was obtained in 78% yield (Table S2, entry 1). Then, a series of electrolyte were investigated, and replacement of *n*-Bu_4NBF_4 with *n*-Bu_4NBr or *n*-Bu_4NPF_6 gave an obviously decreased yield. (Table S2, entries 2 and 3). Next, various supporting electrodes were explored, such as using graphite rod and platinum as an anode electrode resulted in a much poorer yield. (Table S2, entries 4 and 5). In addition, the constant current affected the reaction dramatically; increasing the current to 20 mA could slightly increase the yield but too high or too low current led to a lower yield (Table S2, entries 6-8). Notably, changing the reaction temperatures did not improve the product yield and low reaction temperatures evidently decreased the product yield (Table S2, entries 9 and 10). Furthermore, reducing the concentration of DCE by adding acetonitrile led the lower yield. (Table S2, entry 11). It was noteworthy that the reaction with N_2 and O_2 instead of Air under the standard conditions also afforded the desired product **3a** in similar yield (Table S2, entries 12 and 13). In contrast, no desired product was obtained without an electric current (Table S2, entry 14).

3. General procedure for the synthesis of 2 and 3

General procedure for the synthesis of 2



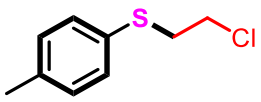
To a dry schlenk tube was added dry stir bar, TBAB (161 mg, 0.5 mmol, 1.0 equiv.), thiol **1** (0.5 mmol, 1.0 equiv.) and 3Å MS (20 mg). The schlenk was equipped with a carbon rod anode and a platinum plate (1 cm × 1 cm) cathode, and flushed with argon for 3 times, 4 mL dry DCE (1,2-dichloropropane or DBE) was injected into the schlenk tube. The resulting reaction mixture was stirred at 60 °C without current for 1 h, and then stirred at 60 °C under the constant current of 4 mA for 18-30 hours. The reaction mixture was then concentrated. The residue was purified by silica gel chromatography (petroleum ether or petroleum ether/EtOAc= 50:1) to give desired product **2**.



(2-Chloroethyl)(phenyl)sulfide (2a):

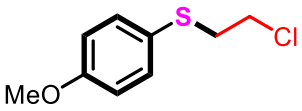
The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, colorless oil liquid (71.4 mg, 85% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.38

(d, *J* = 7.5 Hz, 2H), 7.31 (m, 2H), 7.23 (m, 1H), 3.60 (t, *J* = 8.0 Hz, 2H), 3.21 (t, *J* = 8.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 134.1, 130.4, 129.2, 127.0, 42.4, 36.0. HRMS (ESI): calcd for $C_8H_{10}ClS$ $[M+H]^+$ 173.0186, found 173.0183.



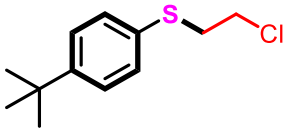
(2-Chloroethyl)(p-tolyl)sulfide (2b):

The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, colorless yellow oil liquid (44.6 mg, 48% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (d, *J* = 8.0 Hz, 2H), 7.13 (d, *J* = 8.0 Hz, 2H), 3.59 (t, *J* = 8.0 Hz, 2H), 3.16 (t, *J* = 8.0 Hz, 2H), 2.34 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.4, 131.4, 130.3, 129.9, 42.4, 36.8, 21.1. HRMS (ESI): calcd for $C_9H_{12}ClS$ $[M+H]^+$ 187.0343, found 187.0339.



(2-Chloroethyl)(4-methoxyphenyl)sulfide (2c):

The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, light yellow oil liquid (50.6 mg, 55%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.39 (d, *J* = 8.8 Hz, 2H), 6.86 (d, *J* = 8.8 Hz, 2H), 3.80 (s, 3H), 3.57 (t, *J* = 7.8 Hz 2H), 3.10 (t, *J* = 7.8 Hz 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 159.6, 134.4, 124.2, 114.7, 55.3, 42.4, 38.0. HRMS (ESI): calcd for $C_9H_{11}OClNaS$ $[M+Na]^+$ 225.0111, found 225.0103.

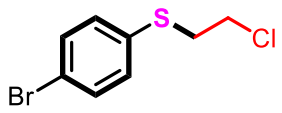


(4-(tert-Butyl)phenyl)(2-chloroethyl)sulfide (2d):

The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, light yellow oil liquid (95.8 mg, 84%).^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (s, 4H), 3.63 (t, *J* = 8.0 Hz, 2H), 3.20 (t, *J* = 8.0 Hz, 2H), 1.36 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.4, 130.8, 130.5, 126.2, 42.4, 36.5, 34.5 , 31.2. HRMS (ESI): calcd for $C_{12}H_{18}ClS$ $[M+H]^+$ 229.0812, found 229.0803.

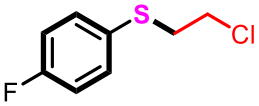
4-((2-Chloroethyl)thio)aniline (2e):

The title compound was prepared via general procedure, reaction time: 18 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 50:1, light yellow oil liquid (43.9 mg, 47%). ^{1}H NMR (600 MHz, DMSO) δ 7.14 (d, *J* = 7.8 Hz, 2H), 6.55-6.53 (m, 2H), 5.38 (s, 2H), 3.60 (t, *J* = 7.8 Hz, 2H), 3.01 (t, *J* = 7.8 Hz, 2H). ^{13}C NMR (150 MHz, DMSO) δ 149.0, 134.5, 117.0, 114.5, 43.0, 38.1. HRMS (ESI): calcd for $C_8H_{11}ClNS$ $[M+H]^+$ 188.0295, found 188.0290.



(4-Bromophenyl)(2-chloroethyl)sulfide (2f):

The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, light yellow oil liquid (78.7 mg, 83%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.43 (d, J = 8.4 Hz, 2H), 7.24 (d, J = 8.4 Hz, 2H), 3.59 (t, J = 7.8 Hz, 2H), 3.20 (t, J = 7.8 Hz, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 133.4, 132.3, 131.8, 121.0, 42.0, 36.1. HRMS (ESI): calcd for $C_8H_8BrClNaS$ $[M+Na]^+$ 272.9111, found 272.9105.

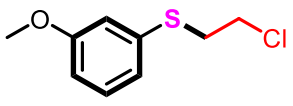


(2-Chloroethyl)(4-fluorophenyl)sulfide (2g):

The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, yellow oil liquid (51.7 mg, 66%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 (dd, J = 8.4, 5.2 Hz, 2H), 7.02 (t, J = 8.4 Hz, 2H), 3.58 (t, J = 8.0 Hz, 2H), 3.15 (t, J = 8.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.3(d, $^{1}J_{C\text{-}F}$ = 240 Hz), 133.8 (d, $^{3}J_{C\text{-}F}$ = 8 Hz), 129.0 (d, $^{4}J_{C\text{-}F}$ = 6 Hz), 116.3 (d, $^{2}J_{C\text{-}F}$ = 22 Hz), 42.2, 37.3. ^{19}F NMR (376 MHz, $CDCl_3$) δ -113.8. HRMS (ESI): calcd for $C_8H_8ClFNaS$ $[M+Na]^+$ 212.9911, found 212.9903.

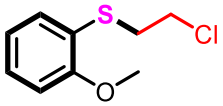
(2-Chloroethyl)(4-(trifluoromethyl)phenyl)sulfide (2h):

The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, light yellow oil liquid (73.2 mg, 61%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (d, J = 8.0 Hz, 2H), 7.42 (d, J = 8.0 Hz, 2H), 3.65 (t, J = 8.0 Hz, 2H), 3.31 (t, J = 8.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.8, 128.4 (q, $^{2}J_{C\text{-}F}$ = 33 Hz), 128.4, 125.9 (q, $^{3}J_{C\text{-}F}$ = 4 Hz), 123.9 (q, $^{1}J_{C\text{-}F}$ = 270 Hz), 41.8, 34.8. ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.5. HRMS (ESI): calcd for $C_9H_8ClF_3NaS$ $[M+Na]^+$ 262.9880, found 262.9870.



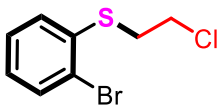
(2-Chloroethyl)(3-methoxyphenyl)sulfide (2i):

The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, light yellow oil liquid (44.2mg, 48%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23 (t, J = 8.0 Hz, 1H), 6.96 (d, J = 8.0 Hz, 1H), 6.92 (d, J = 2.0 Hz, 1H), 6.78 (dd, J = 8.0, 2.4 Hz, 1H), 3.80 (s, 3H), 3.62 (t, J = 8.0 Hz, 2H), 3.22 (t, J = 8.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.9, 135.4, 130.0, 122.1, 115.5, 112.5, 55.3, 42.2, 35.8. HRMS (ESI): calcd for $C_9H_{11}OClNaS$ $[M+Na]^+$ 225.0111, found 225.0103.



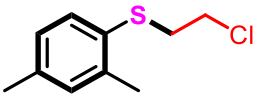
(2-Chloroethyl)(2-methoxyphenyl)sulfide (2j):

The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, light yellow oilt liquid (51.6mg, 56%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.26 – 7.22 (m, 1H), 6.93-6.85 (m, 2H), 3.87 (s, 3H), 3.58 (t, *J* = 8.0 Hz, 2H), 3.18 (t, *J* = 8.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.9, 131.5, 128.5, 121.4, 120.8, 110.6, 55.6, 42.4, 34.2. HRMS (ESI): calcd for $C_9H_{11}OClNaS$ $[M+Na]^+$ 225.0111, found 225.0104.



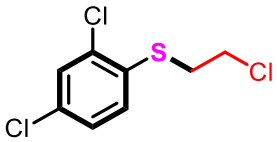
(2-Bromophenyl)(2-chloroethyl)sulfide (2k):

The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, light yellow liquid (88.7 mg, 71%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (dd, *J* = 8.0, 1.1 Hz, 1H), 7.33-7.25 (m, 2H), 7.09-7.05 (m, 1H), 3.64 (t, *J* = 8.0 Hz, 2H), 3.26 (t, *J* = 8.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 135.7, 133.5, 129.5, 128.1, 127.8, 125.0, 41.9, 35.1. HRMS (ESI): calcd for $C_8H_8BrClNaS$ $[M+Na]^+$ 272.9111, found 272.9106.



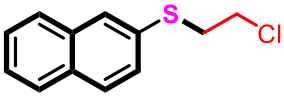
(2-Chloroethyl)(2,4-dimethylphenyl)sulfide (2l):

The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, light yellow oil liquid (41.0mg, 41%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 (d, *J* = 8.1 Hz, 1H), 7.05 (s, 1H), 6.99 (d, *J* = 8.1 Hz, 1H), 3.58(t, *J* = 8.0 Hz, 2H), 3.13 (t, *J* = 8.0 Hz, 2H), 2.40 (s, 3H), 2.31 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.5, 137.4, 131.4, 131.3, 129.5, 127.4, 42.3, 36.0, 20.9, 20.5. HRMS (ESI): calcd for $C_{10}H_{14}ClS$ $[M+H]^+$ 201.0499, found 201.0493.



(2-Chloroethyl)(2,4-dichlorophenyl)sulfide (2m):

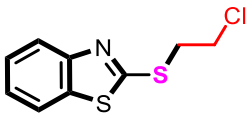
The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, yellow oil liquid (54.0 mg, 45%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 (d, *J* = 2.4 Hz, 1H), 7.31 (d, *J* = 8.4 Hz, 1H), 7.23 (dd, *J* = 8.4, 2.4 Hz, 1H), 3.62 (t, *J* = 8.0 Hz, 2H), 3.25 (t, *J* = 8.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 135.8, 133.3, 132.1, 131.2, 129.9, 127.6, 41.8, 35.0. HRMS (ESI): calcd for $C_8H_8Cl_3S$ $[M+H]^+$ 240.9407, found 240.9400.



(2-Chloroethyl)(naphthalen-2-yl)sulfide (2n):

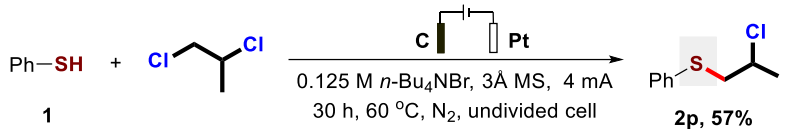
The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, light yellow oil liquid (81.0 mg, 73%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 –

7.78 (m, 4H), 7.55 – 7.47 (m, 3H), 3.68 (t, J = 8.0 Hz, 2H), 3.34 (t, J = 8.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 133.5, 132.0, 131.4, 128.8, 128.6, 127.8, 127.6, 127.1, 126.7, 126.1, 42.2, 35.9. HRMS (ESI): calcd for $C_{12}H_{12}ClS$ $[M+H]^+$ 233.0343, found 233.0329.



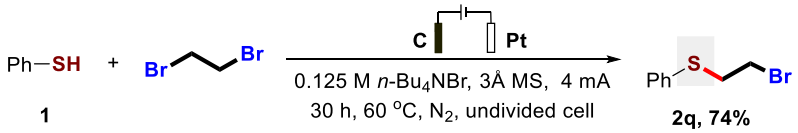
2-((2-Chloroethyl)thio)benzothiazole (2o):

The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 200/1, colorless oil liquid (43.9 mg, 57%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.88 (d, J = 7.8 Hz, 1H), 7.76 (d, J = 7.8 Hz, 1H), 7.43 (t, J = 7.8 Hz, 1H), 7.31 (t, J = 7.8 Hz, 1H), 3.92 (t, J = 7.5 Hz, 2H), 3.70 (t, J = 7.5 Hz, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 164.8, 152.9, 135.3, 126.1, 124.5, 121.6, 121.0, 42.4, 34.9. HRMS (ESI): calcd for $C_9H_8ClNNaS_2$ $[M+Na]^+$ 252.9752, found 252.9748.



(2-chloropropyl)(phenyl))sulfane (2p):

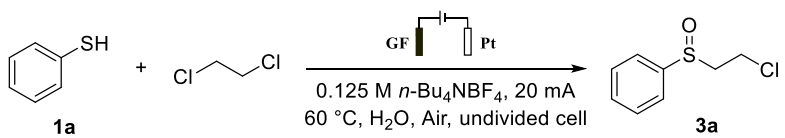
The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, colorless oil liquid (53.0mg, 57%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.38 (d, J = 7.2 Hz, 2H), 7.30 (t, J = 7.8 Hz, 2H), 7.23 (t, J = 7.5 Hz, 1H), 4.09 – 4.04 (m, 1H), 3.40 (dd, J = 13.8, 4.8 Hz, 1H), 3.08 (dd, J = 13.8, 8.4 Hz, 1H), 1.61 (d, J = 6.6 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 135.1, 130.2, 129.2, 126.8, 55.9, 43.6, 23.8. HRMS (ESI): calcd for $C_9H_{12}ClS$ $[M+H]^+$ 187.0343, found 187.0338.



(2-bromoethyl)(phenyl)sulfane (2q):

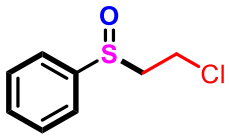
The title compound was prepared via general procedure, reaction time: 30 h, purified by flash chromatography on silica gel eluting with petroleum ether, yellow oil liquid (80.4mg, 74%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.41 (d, J = 7.8 Hz, 2H), 7.34 (t, J = 7.5 Hz, 2H), 7.28 (d, J = 7.2 Hz, 1H), 3.49 (t, J = 8.1 Hz, 2H), 3.32 (t, J = 8.1 Hz, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 134.0, 130.5, 129.2, 127.1, 36.0, 29.8. HRMS (ESI): calcd for $C_8H_{10}BrS$ $[M+H]^+$ 216.9681, found 187.0338.

General procedure for the synthesis of 3



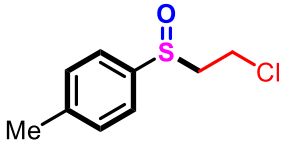
To a shlenk tube was added stir bar, n-Bu_4NBF_4 (165 mg, 0.5 mmol, 1.0 equiv.), thiol **1** (0.5 mmol, 1.0 equiv.), DCE

or 1,2-dichloropropane (4 mL) and H_2O (45 mg, 5 equiv.). The flask was equipped with a graphite felt anode (1 cm × 1 cm × 0.5 cm) and a platinum plate (1 cm × 1 cm) cathode. The resulting reaction mixture was stirred at 60 °C under the constant current of 20 mA for 12 hours. The reaction mixture was then concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc= 5:1-4:1) to give the desired product **3**.



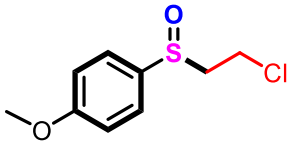
((2-Chloroethyl)sulfinyl)benzene (3a):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, colorless oil liquid (78.0 mg, 83%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (dd, *J* = 7.6, 2.0 Hz, 2H), 7.54 – 7.49 (m, 3H), 4.97 – 3.90 (m, 1H), 3.65 – 3.59 (m, 1H), 3.16 – 3.12 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.6, 131.3, 129.4, 123.7, 59.2, 36.6. HRMS (ESI): calcd for $C_8H_{10}ClOS$ $[M+H]^+$ 189.0135, found 189.0126.



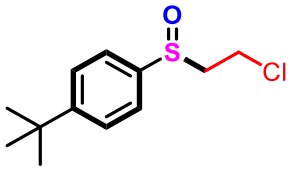
((2-Chloroethyl)sulfinyl)-4-methylbenzene (3b):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, colorless oil liquid (57.6 mg, 57%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, *J* = 8.0 Hz, 2H), 7.34 (d, *J* = 8.0 Hz, 2H), 3.97 – 3.91 (m, 1H), 3.67 – 3.61 (m, 1H), 3.14 (t, *J* = 6.8 Hz, 2H), 2.42 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.0, 139.3, 130.2, 123.9, 59.3, 36.7, 21.4. HRMS (ESI): calcd for $C_9H_{12}ClOS$ $[M+H]^+$ 203.0292, found 203.0281.



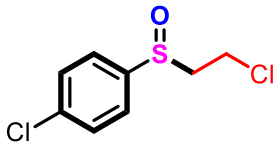
((2-Chloroethyl)sulfinyl)-4-methoxybenzene (3c):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 4:1, light yellow oil liquid (68.7 mg, 63%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 8.8 Hz, 2H), 7.01 (d, *J* = 8.8 Hz, 2H), 3.92 – 3.86 (m, 1H), 3.82 (s, 3H), 3.64 – 3.58 (m, 1H), 3.17 – 3.04 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.1, 133.3, 125.8, 114.9, 59.3, 55.4, 36.7. HRMS (ESI): calcd for $C_9H_{11}ClNaO_2S$ $[M+Na]^+$ 241.0060, found 241.0052.



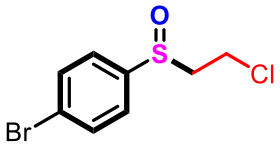
(tert-Butyl)-4-((2-chloroethyl)sulfinyl)benzene (3d):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, light yellow oil liquid (67.1 mg, 55%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (s, 4H), 3.97-3.90 (m, 1H), 3.65-3.60 (m, 1H), 3.14 (t, J = 8.0 Hz, 2H), 1.32 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.1, 139.4, 126.4 123.7, 59.2, 36.7, 34.9, 31.1. HRMS (ESI): calcd for $C_{12}H_{18}ClOS$ $[M+H]^+$ 245.0761, found 245.0755.



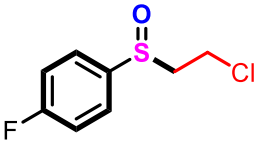
1-Chloro-4-((2-chloroethyl)sulfinyl)benzene (3e):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, yellow oil liquid (68.8 mg, 62%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (d, J = 8.8 Hz, 2H), 7.50 (d, J = 8.8 Hz, 2H), 4.96 – 3.89 (m, 1H), 3.67 – 3.61 (m, 1H), 3.14 – 3.10 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.2, 137.6, 129.7, 125.2, 59.3, 36.4. HRMS (ESI): calcd for $C_8H_9Cl_2OS$ $[M+H]^+$ 222.9746, found 222.9740.



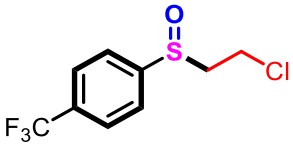
1-Bromo-4-((2-chloroethyl)sulfinyl)benzene (3f):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, light yellow oil liquid (105.0 mg, 79%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, J = 8.4 Hz, 2H), 7.52 (d, J = 8.4 Hz, 2H), 4.00 – 3.93 (m, 1H), 3.70 – 3.64 (m, 1H), 3.17 – 3.13 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.0, 132.8, 126.0, 125.5, 59.5, 36.5. HRMS (ESI): calcd for $C_8H_8BrClNaOS$ $[M+Na]^+$ 288.9060, found 288.9054.



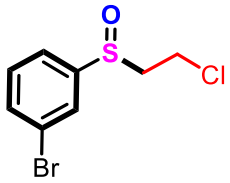
((2-Chloroethyl)sulfinyl)-4-fluorobenzene (3g):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, yellow oil liquid (69.3 mg, 67%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (dd, J = 8.7, 5.0 Hz, 2H), 7.33 – 7.22 (m, 2H), 4.0-3.93 (m, 1H), 3.71-3.65 (m, 1H), 3.16 (t, J = 6.8 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.4 (d, $^1J_{C\text{-}F}$ = 250 Hz), 138.0 (d, $^4J_{C\text{-}F}$ = 3.0 Hz), 126.2 (d, $^3J_{C\text{-}F}$ = 9.0 Hz), 116.8 (d, $^2J_{C\text{-}F}$ = 23 Hz), 59.4, 36.5. ^{19}F NMR (565 MHz, $CDCl_3$) δ -107.8. HRMS (ESI): calcd for $C_8H_9Cl_2OS$ $[M+H]^+$ 207.0041, found 207.0036.



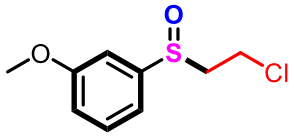
((2-Chloroethyl)sulfinyl)-4-(trifluoromethyl)benzene (3h):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, light yellow oil liquid (113.4 mg, 87%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 (q, *J* = 8.4 Hz, 4H), 4.01 – 3.94 (m, 1H), 3.71 – 3.65 (m, 1H), 3.24 – 3.11 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.3, 133.3 (q, $^{2}J_{C\text{-}F}$ = 33 Hz), 126.4 (q, $^{3}J_{C\text{-}F}$ = 4 Hz), 124.5, 123.3 (q, $^{1}J_{C\text{-}F}$ = 270 Hz), 59.4, 36.3. ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.9. HRMS (ESI): calcd for $C_9H_8ClF_3NaOS$ $[M+Na]^+$ 278.9829, found 278.9819.



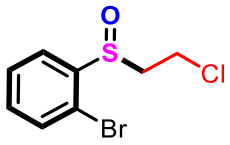
1-Bromo-3-((2-chloroethyl)sulfinyl)benzene (3i) :

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, light yellow oil liquid (107.7 mg, 81%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (t, *J* = 2.0 Hz, 1H), 7.64 – 7.62 (m, 1H), 7.54 – 7.52 (m, 1H), 7.40 (t, *J* = 8.0 Hz, 1H), 3.99 – 3.92 (m, 1H), 3.70 – 3.64 (m, 1H), 3.21 – 3.11 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.1, 134.5, 130.9, 126.7, 123.8, 122.4, 59.5, 36.5. HRMS (ESI): calcd for $C_8H_8BrClNaOS$ $[M+Na]^+$ 288.9060, found 288.9055.



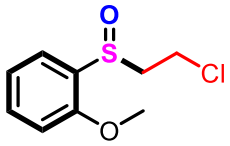
((2-Chloroethyl)sulfinyl)-3-methoxybenzene (3j):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 4:1, light yellow oil liquid (70.9 mg, 65%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 (t, *J* = 8.0 Hz, 1H), 7.21 (t, *J* = 2.0 Hz, 1H), 7.13 (d, *J* = 7.6 Hz, 1H), 7.02 (dd, *J* = 8.0, 2.4 Hz, 1H), 3.98 – 3.91 (dt, *J* = 11.6, 7.5 Hz, 1H), 3.86 (s, 3H), 3.68 – 3.62 (m, 1H), 3.17 – 3.14 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 106.6, 144.1, 130.4, 117.7, 115.8, 108.3, 59.3, 55.6, 36.6. HRMS (ESI): calcd for $C_9H_{11}ClNaO_2S$ $[M+Na]^+$ 241.0060, found 241.0053.



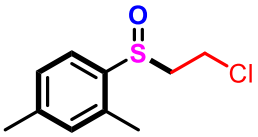
1-Bromo-2-((2-chloroethyl)sulfinyl)benzene (3k) :

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, yellow oil liquid (77.1 mg, 58%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.60 – 7.56 (m, 2H), 7.42 – 7.36 (m, 1H), 4.04 – 3.99 (m, 1H), 3.75 – 3.70 (m, 1H), 3.57 – 3.50 (m, 1H), 3.16 – 3.10 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.4, 133.2, 132.6, 128.6, 126.5, 118.6, 56.3, 36.6. HRMS (ESI): calcd for $C_8H_8BrClNaOS$ $[M+Na]^+$ 288.9060, found 288.9055.



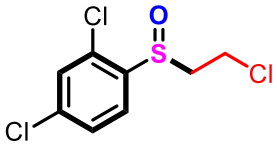
((2-Chloroethyl)sulfinyl)-2-methoxybenzene (3l):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 4:1, yellow oil liquid (63.3 mg, 58%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.47 – 7.43 (m, 1H), 7.16 (t, *J* = 8.0 Hz, 1H), 6.92 (d, *J* = 8.0 Hz, 1H), 3.99 – 3.88 (m, 1H), 3.88 (s, 3H), 3.65 – 3.59 (m, 1H), 3.47 – 3.40 (m, 1H), 3.16 – 3.10 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.8, 132.3, 129.6, 125.2, 121.6, 110.8, 55.7, 54.8, 36.6. HRMS (ESI): calcd for $C_9H_{11}ClNaO_2S$ $[M+Na]^+$ 241.0060, found 241.0051.



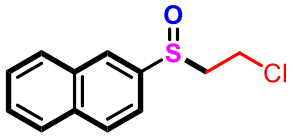
((2-Chloroethyl)sulfinyl)-2,4-dimethylbenzene (3m):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, light yellow liquid (57.5 mg, 53%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (d, J = 8.0 Hz, 1H), 7.24 (d, J = 8.0 Hz, 1H), 7.04 (s, 1H), 4.04-3.97 (m, 1H), 3.73-3.69 (m, 1H), 3.20 – 3.12 (m, 1H), 3.07-3.01 (m, 1H), 2.37 (s, 3H), 2.36 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.6, 137.7, 134.3, 131.7, 128.1, 123.8, 57.8, 37.1, 21.2, 18.0. HRMS (ESI): calcd for $C_9H_{14}ClOS$ $[M+H]^+$ 217.0448, found 217.0439.



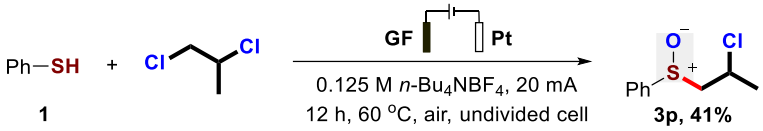
2,4-Dichloro-1-((2-chloroethyl)sulfinyl)benzene (3n):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, yellow oil liquid (80.6 mg, 63%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.4 Hz, 1H), 7.50 (d, *J* = 8.4 Hz, 1H), 7.43 (d, *J* = 1.2 Hz, 1H), 4.01 – 3.95 (m, 1H), 3.75 – 3.70 (m, 1H), 3.51 – 3.44 (m, 1H), 3.14 – 3.08 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.4, 138.1, 130.6, 129.8, 128.5, 127.2, 56.0, 36.2. HRMS (ESI): calcd for $C_8H_8Cl_3OS$ $[M+H]^+$ 256.9356, found 256.9356.



2-((2-Chloroethyl)sulfinyl)naphthalene (3o):

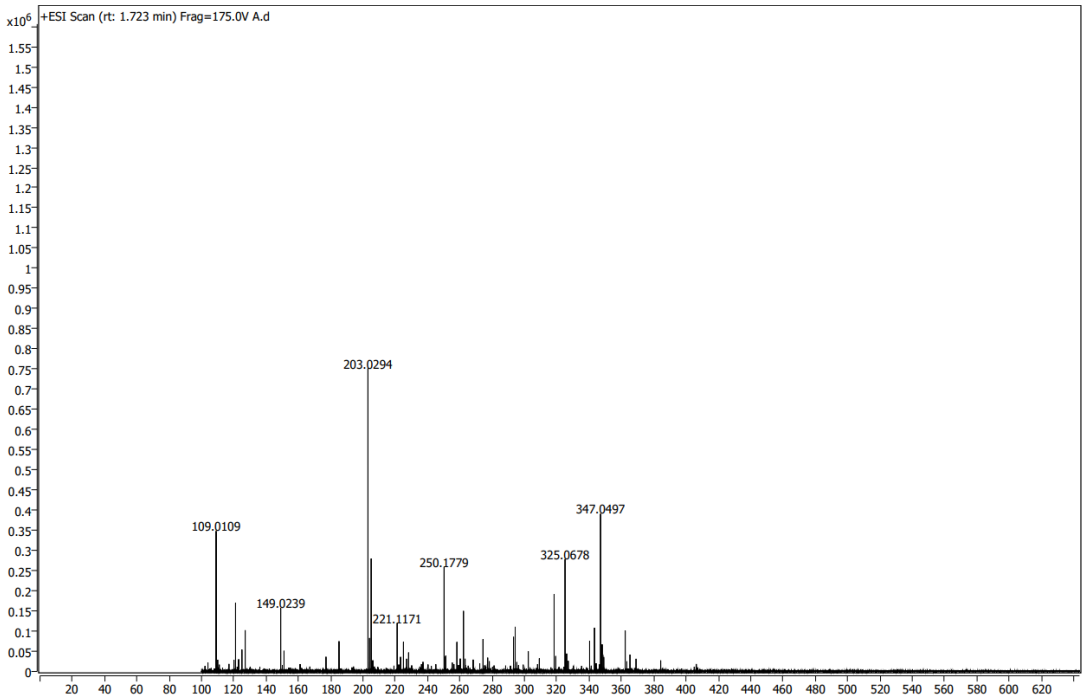
The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, yellow oil liquid (58.3 mg, 49%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 (s, 1H), 8.01 (d, *J* = 8.4 Hz, 1H), 7.96 – 7.91 (m, 2H), 7.64 – 7.58 (m, 3H), 4.04 – 3.97 (m, 1H), 3.70 – 3.64 (m, 1H), 3.31 – 3.19 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.7, 134.6, 132.9, 129.8, 128.5, 128.1, 128.0, 127.5, 124.7, 119.5, 59.0, 36.7. HRMS (ESI): calcd for $C_{12}H_{12}ClOS$ $[M+H]^+$ 239.0292, found 239.0288.



(2-chloropropyl)sulfinyl)benzene (3p):

The title compound was prepared via general procedure, reaction time: 12 h, purified by flash chromatography on silica gel eluting with petroleum ether/EtOAc = 5:1, colorless oil liquid (41.6 mg, 41%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.38 (m, 2H), 7.31 – 7.27 (m, 2H), 7.23 – 7.19 (m, 1H), 3.89 – 3.82 (m, 1H), 3.11 (dd, J = 13.6, 3.6 Hz, 1H), 2.85 (dd, J = 13.6, 8.8 Hz, 1H), 1.27 (d, J = 6.0 Hz, 3H). HRMS (ESI): calcd for $C_9H_{12}ClOS$ $[M+H]^+$ 203.0292, found 203.0294.

The product **3p** was not pure enough, we had tried our best to separate the pure **3p** by column chromatography, but failed. In order to confirm the structure of **3p**, we carried out a confirmatory analysis by high resolution mass spectrometry (HRMS). Fortunately, the result showed that **3p** was indeed generated.



In 2021, Lei and coworkers found that weak hydrogen bonding between sulfide and hydrochloric acid could accelerate the single electron transfer process from sulfide at the anode[1]. This discovery may explain why 1,2-dichloropropane could react with thiophenol to afford **3p** but 1,2-dibromoethane (DBE) couldn't finish it. The really reason needs to be further explored.

[1] H. Wang, M. Yu, P. Zhang, H. Wan, H. Cong and A. Lei, Electrochemical dual-oxidation strategy enables access to α-chlorosulfoxides from sulfides. *Science Bulletin*, 2021, DOI: 10.1016/j.scib.2021.07.004.

4. Cyclic voltammetry (CV) studies

The cyclic voltammograms were recorded on a CHI 600E instrument using a glassy-carbon working electrode (diameter, 3 mm), a Pt wire auxiliary electrode, an Ag/AgCl reference electrode, and a scan rate of 100 mV/s.

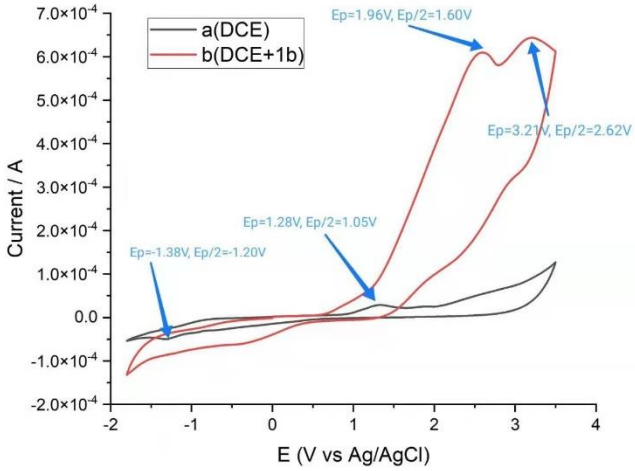


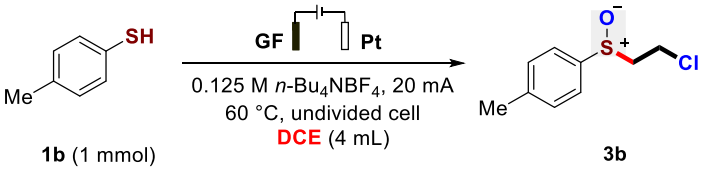
Figure S1. Cyclic voltammograms measured in an electrolyte solution of *n*-Bu_4NBF_4 (0.1 M) in DCE. a) background. b) 4-methylbenzenethiol (**1b**, 30 mM) + background.

Based on the initial measurement results, we chose -1.8V to 3.5V as a potential window measured by a cyclic voltammetry curve (Figure S1). One oxidation wave appeared on the forward potential sweep (1.28 V) and one reduction wave (-1.38 V) occurred on the backward potential sweep at a Pt wire electrode at 100 mVs^{-1} in 0.1 m *n*-Bu_4NBF_4 in DCE (Figure S1, curve a). This redox couple is probably due to the oxidation of Cl^- by the forward sweep and the reduction of DCE to DCE^- by the backward sweep (Figure S1, curve a). Subsequently, two oxidation waves (1.96 V and 3.21 V) of thiol **1b** in DCE were observed, which might correspond to the oxidation of thiol to thiol radicals or disuflide and further to sulfoxide species, respectively (Figure S1, curve b).

5. Control experiments

Table S3

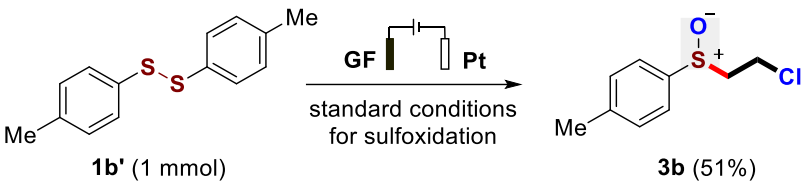
Control experiments for researching the source of oxygen



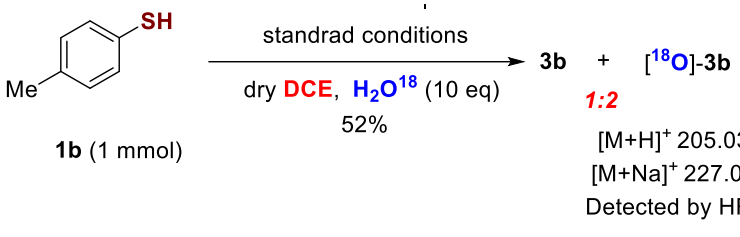
1b (1 mmol) **3b** **(1) – (4)**

Entry	Variation from the standard conditions	Yield [a]
1	With 10 equiv of H_2O	57%
2	Dry DCE instead of DCE	15%
3	Dry DCE and Ar instead of DCE and air	trace
4	Dry DCE and O_2 instead of DCE and air	trace

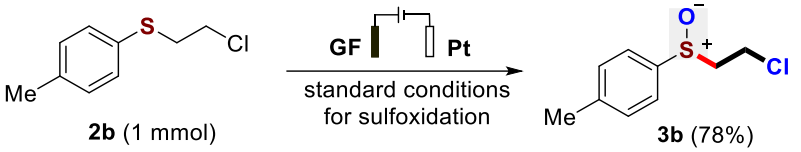
[a] Reaction conditions: Undivided cell, Graphite felt anode, Pt cathode (1 cm x 2 cm), **1a** (0.5 mmol), DCE (4.0 mL), *n*-Bu_4NBF_4 (0.5 mmol), constant current = 20 mA, 12 h, 60 °C. Isolated yields.



(5)



(6)



(7)

To gain mechanistic insight into this transformation, some control experiments were performed. Using the commercial available DCE with addition of 10 equiv of water as gave the target product **3b** in 57% yield (Table S3, eq 1). In addition, we observed that the yield of desired product **3b** decreased dramatically from 57% to 15%when using dry DCE instead without water (Table S3, eq 2). Then, we continued to eliminate the interfering factor of water in the air by exchanging air with Ar (Table S3, eq 3), as expected, the yield of **3b** was further decreased. So, we guessed that the source of oxygen might come from water in the reaction mixture. Moreover, only a trace amount of product was observed when replacing DCE and air with dry DCE and oxygen atmosphere (Table 3, eq 4). The experimental results strongly suggested that water, the source of oxygen, may act as oxidants to oxidize the S(II) to S(IV) species. Furthermore, the disulfide **1b'** also reacted with DCE smoothly to give **3b** in 51% yield under the standard conditions (eq 5), indicating that **1b'** might be involved in this transformation. More importantly, an isotopic labelling reaction was carried out by the treatment of **2b** and dry DCE in the presence of $H_2{}^{18}O$ (eq 6) under the standard conditions, leading to a mixture of **3b** and [^{18}O]-**3b** (1:2) in 52% combined yield. The isotopic labelling experimental results further confirmed that oxygen in *β*-chloroethyl sulfoxide came from water. Finally, treating **2b** in the standard conditions for **3b** resulted in a high conversion of **2b** to **3b**, suggesting **2b** might be an intermediate in the formation of **3b**.

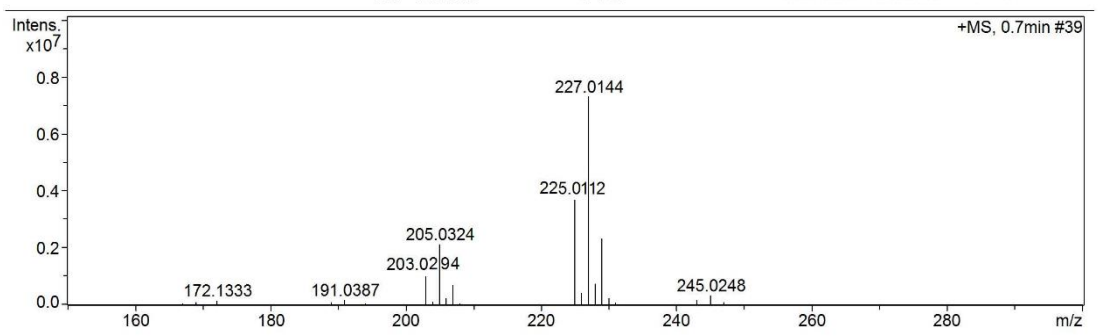


Figure S2. The HRMS spectrum of the mixture of **3b** and [^{18}O]-**3b**.

Table S4

Different electrolytes in sulfidation reaction for 30 h

Electrolyte	4 mA + dry DCE (30 h)		pH value
	Yield of **2a**	Yield of **3a**	

n-Bu_4NBF_4	trace	trace	6~7
TBAB	85%	trace	1~2

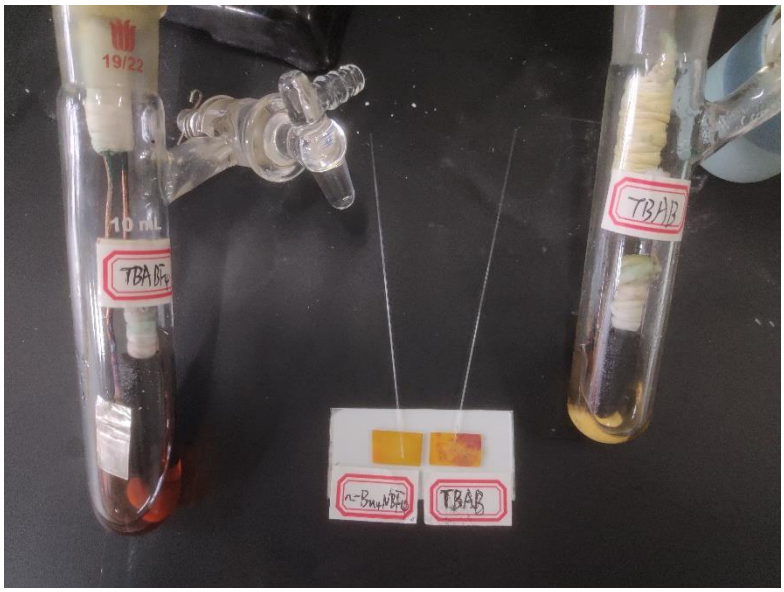


Figure S3 pH value of different systems

In order to understand the diverse behaviors of *n*-Bu_4NBF_4 and *n*-Bu_4NBr (TBAB), serval control experiments were conducted. For sulfidation reaction, we compared these two electrolytes, the results showed that 85% yield of **2a** was obtained when using TBAB, while *n*-Bu_4NBF_4 turned to be ineffective (Table S4). We also found that these two reaction mixtures had dramatically different pH value. The reaction with *n*-Bu_4NBF_4 had a pH of 6~7, while pH of that with TBAB raised to 1~2 (Figure S3). These phenomena disclosed that the DCE was electrolyzed into vinyl chloride and HCl only when TBAB was used, might owing to the assistance of Br anion. By contrast, *n*-Bu_4NBF_4 was unable to generate vinyl chloride to furnish the sulfidation reaction.

Table S5

Different electrolytes in sulfoxidation reaction for 12 h

Electrolyte	20 mA + DCE + H_2O（12 h）	
	Yield of **2a**	Yield of **3a**
n-Bu_4NBF_4	/	83%
TBAB	51%	33%

Table S6

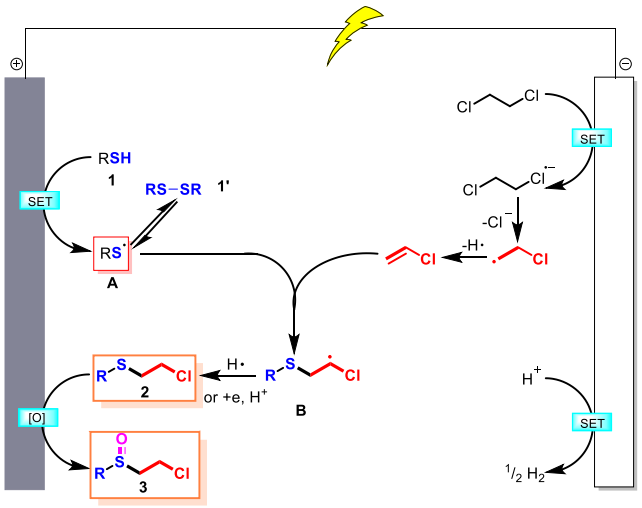
TBAB as electrolyte in sulfoxidation reaction for 21 h

Electrolyte	20 mA + DCE + H_2O（21 h）	
	Yield of **2a**	Yield of **3a**
TBAB	/	75%

On the other hand, for sulfoxidation reaction, we compared these two electrolytes. the results showed that 83% yield of **3a** was obtained when using *n*-Bu_4NBF_4, while TBAB resulted in lower yield (33%). As the reaction continued, the yield of **3a** in TBAB group increased to 75% after 21 hours. These data showed that high voltage may be beneficial to generating vinyl chloride and HCl, and sulfide can be quickly oxidized to sulfoxide when *n*-Bu_4NBF_4 was used as electrolyte. By contrast, TBAB was low effective than *n*-Bu_4NBF_4. The reason needs to be further explored.

6. Proposed mechanism

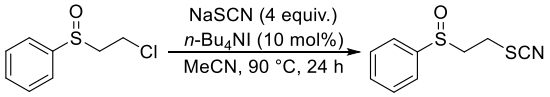
On the basis of the control experiments and literature reports,[11–15] a plausible mechanism is depicted in Scheme S1. the cathode anode reduction of DCE happened to form DCE^{-*}, an excited state of high energy level for DCE, which further degraded into vinyl chloride and hydrochloride. Meanwhile, the hydrogen ion was reduced to dihydrogen gas in the cathode. On the anode, thiol **1** was oxidazed to thiol radical **A**, which could give disulfide **1'** via radical coupling. Next, the thiol radical **A** coupled with vinyl chloride to offer, followed by H radical absorbtion or cathode redcution to provide sulfide **2**. Finially, sulfide **2** underwent selective anode oxidation to generate sulfoxide **3** in the presence of water.



Scheme 1. The proposed mechanism.

7. Procedure for diverse transformations of (2-chloroethyl)sulfoxide 3

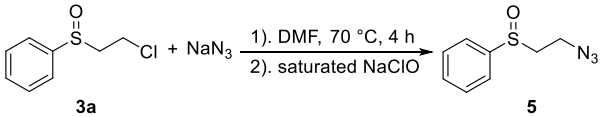
Procedure for the synthesis of 4 and analytical data.



3a **4**

To a 25 mL flask were added *n*-Bu_4NI (36.9 mg, 10 mol %), **3a** (188.7 mg, 1.0 mmol, 1.0 equiv.), NaSCN (324.0 mg, 4.0 mmol, 4.0 equiv.) and MeCN (6 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 90 ºC in an oil bath and stirred for 24 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 4/1) to give product **4** (170.9 mg, 81% yield) as light purple solid. m.p.: 57-60 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (dd, *J* = 8.0, 1.6 Hz, 2H), 7.56 – 7.52 (m, 3H), 3.36 – 3.28 (m, 2H), 3.15 – 3.05 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.6, 131.5, 129.5, 123.7, 110.9, 55.1, 25.8. HRMS (ESI): calcd for $C_9H_9NNaOS_2$ $[M+Na]^+$ 234.0018, found 234.0006.

Procedure for the synthesis of 5 and analytical data.

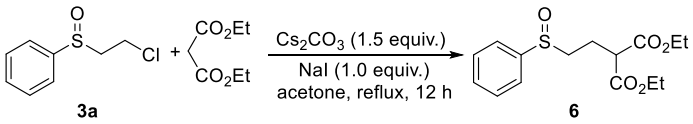


3a **5**

To a 25 mL flask were added **3a** (188.7 mg, 1.0 mmol, 1.0 equiv.), sodium azide (130.2 mg, 2.0 equiv.) and DMF

(4 mL). The tube was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 70 °C in an oil bath and stirred for 4 h followed by adding saturated NaClO to the reaction mixture, then 20 mL water and 15 mL EA was added. Organic layer was combined and dried by anhydrous sodium sulfate. The reaction mixture was filtered and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 3/1) to give product **5** (169.7 mg, 87% yield) as yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (dd, *J* = 7.6, 1.6 Hz, 2H), 7.54 – 7.49 (m, 3H), 3.83 – 3.76 (m, 1H), 3.59 – 3.53 (m, 1H), 3.00 – 2.87 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.8, 131.2, 129.3, 123.7, 55.8, 44.2. HRMS (ESI): calcd for $C_8H_{10}N_3OS$ $[M+H]^+$ 196.0539, found 196.0531.

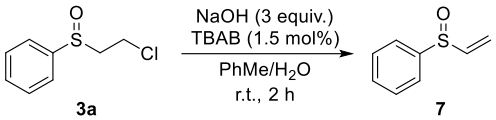
Procedure for the synthesis of 6 and analytical data.



3a **6**

To a 25 mL flask were added **3a** (188.7 mg, 1.0 mmol, 1.0 equiv.), diethyl malonate (192.0 mg, 1.2 mmol, 1.2 equiv.), cesium carbonateand (203.9 mg, 1.5 mmol, 1.5 equiv.), NaI (149.9 mg, 1.0 mmol, 1.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 3/1) to give product **6** (209.1 mg, 67% yield) as colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 – 7.58 (m, 2H), 7.53 – 7.48 (m, 3H), 4.19 – 4.13 (m, 4H), 3.44 (t, *J* = 7.2 Hz, 1H), 2.96 – 2.89 (m, 1H), 2.85 – 2.78 (m, 1H), 2.36 – 2.27 (m, 1H), 2.20 – 2.11 (m, 1H), 1.25 – 1.20 (m, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.4, 143.0, 131.1, 129.2, 123.9, 61.6, 53.8, 50.4, 21.2, 13.9. HRMS (ESI): calcd for $C_{15}H_{21}O_5S$ $[M+H]^+$ 313.1104, found 313.1097.

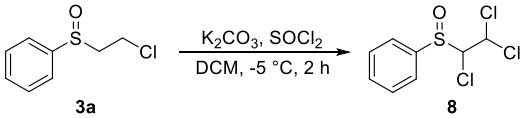
Procedure for the synthesis of 7 and analytical data.



3a **7**

To a 50 mL flask were added **3a** (188.7 mg, 1.0 mmol, 1.0 equiv.), NaOH (120.0 mg, 3.0 mmol, 3.0 equiv.), TBAB (4.8 mg, 1.5 mol %) and mixed solvent (toluene 4 mL and water 2 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was stirred at room temperature for 2 h. The reaction mixture concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 5/1) to give product **7** (88.2 mg, 58% yield) as colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 – 7.57 (m, 2H), 7.48 – 7.44 (m, 3H), 6.56 (dd, *J* = 16.8, 9.6 Hz, 1H), 6.16 (d, *J* = 16.8 Hz, 1H), 5.85 (d, *J* = 9.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.1, 142.8, 131.1, 129.3, 124.5, 120.6. HRMS (ESI): calcd for C_8H_9OS $[M+H]^+$ 153.0369, found 153.0360.

Procedure for the synthesis of 8 and analytical data.



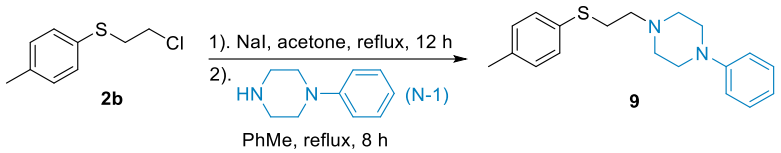
3a **8**

To a stirred solution of the **3a** (188.7 mg, 1.0 mmol, 1.0 equiv.) in dichloromethane (4 mL) containing potassium carbonate (152.0 mg, 1.1 mmol, 1.1 equiv.) was added dropwise sulfury chloride (142.8 mg, 1.2 mmol, 1.2 equiv.) at -5 °C. The progress of the reaction was followed by the TLC (hextane/ethyl acetate = 1:1). When the starting material had disappeared (about 2 h), the reaction mixture was poured on ice. The organic layer was separated and

the aqueous layer was extracted with dichlormethane (2 × 5 mL). The conbined organic layer was dried over sodium sulfate and after evaporation of the solvent, he residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 1/1) to give product 8 (158.7 mg, 62% yield) as yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (dd, *J* = 8.4, 1.2 Hz, 2H), 7.67 – 7.63 (m, 1H), 7.59 – 7.55 (m, 2H), 4.42 (d, *J* = 12.4 Hz, 1H), 4.13 (d, *J* = 12.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.1, 133.2, 128.6, 127.9, 99.3, 50.3. HRMS (ESI): calcd for $C_8H_7Cl_3NaOS$ $[M+Na]^+$ 278.9175, found 278.9168.

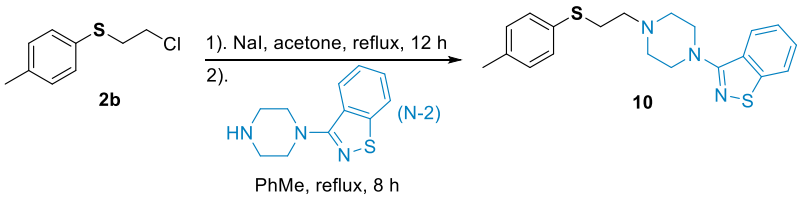
8. Procedure for late stage diversifications

Procedure for the synthesis of 9 and analytical data.



To a 25 mL flask were added **2b** (186.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. The reaction mixture was cooled and concentrated. Then, **N-1** (1-phenylpiperazine, 324.2 mg, 2.0 mmol, 2.0 equiv.) and PhMe (4 mL) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 110 °C for 8 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 10/1) to give product **9** (209.2 mg, 67% yield) as white solid. m.p.: 173-175 °C. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.32 (d, *J* = 7.8 Hz, 2H), 7.32 (t, *J* = 7.8 Hz, 2H), 7.16 (d, *J* = 7.8 Hz, 2H), 6.97 (d, *J* = 8.4 Hz, 2H), 6.91 (t, *J* = 7.2 Hz, 1H), 3.24 (t, *J* = 4.8 Hz, 4H), 3.10 (t, *J* = 7.8 Hz, 2H), 2.72 (t, *J* = 7.8 Hz, 2H), 2.67 (t, *J* = 4.8 Hz, 4H), 2.40 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 151.0, 135.9, 132.3, 127.7, 129.5, 128.9, 119.5, 115.8, 57.6, 53.9, 49.8, 31.2, 20.8. HRMS (ESI): calcd for $C_{19}H_{24}N_2NaOS$ $[M+Na]^+$ 335.1552, found 335.1544.

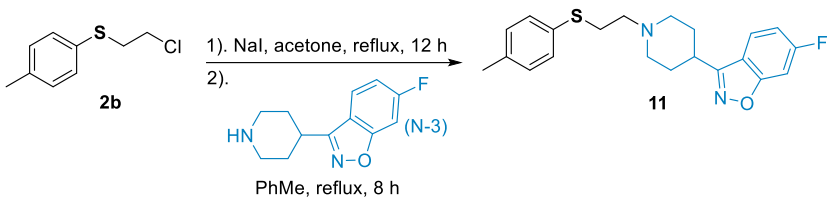
Procedure for the synthesis of 10 and analytical data.



To a 25 mL flask were added **2b** (186.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. The reaction mixture was cooled and concentrated. Then, **N-2** (3-(piperazin-1-yl)benzoisothiazole, 438.2 mg, 2.0 mmol, 2.0 equiv.) and PhMe (4 mL) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 110 °C for 8 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 5/1) to give product **10** (199.3 mg, 54% yield) as yellow viscous oil. ^{1}H NMR (600 MHz, DMSO) δ 8.02 (t, *J* = 9.4 Hz, 2H), 7.54 (t, *J* = 7.6 Hz, 1H), 7.41 (t, *J* = 7.6 Hz, 1H), 7.26 (d, *J* = 7.8 Hz, 2H), 7.12 (d, *J* = 7.8 Hz, 2H), 3.42 (t, *J* = 4.2 Hz, 4H), 3.07 (t, *J* = 7.3 Hz, 2H), 2.60 (t, *J* = 4.2 Hz, 4H), 2.58 (t, *J* = 7.3 Hz, 2H), 2.25 (s, 3H). ^{13}C NMR (150 MHz, DMSO) δ 163.5, 152.1, 135.2, 132.6, 129.7, 128.8, 127.8, 127.4, 124.4, 124.1, 121.0, 57.2, 52.3, 49.6, 30.2, 20.6.

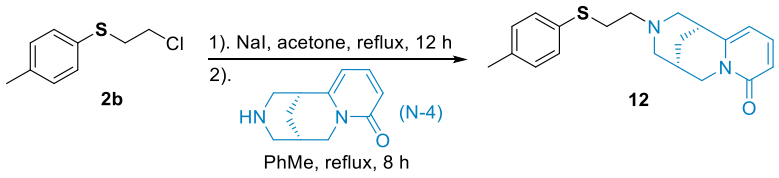
HRMS (ESI): calcd for $C_{20}H_{23}N_3NaS_2$ $[M+Na]^+$ 392.1226, found 392.1219.

Procedure for the synthesis of 11 and analytical data.



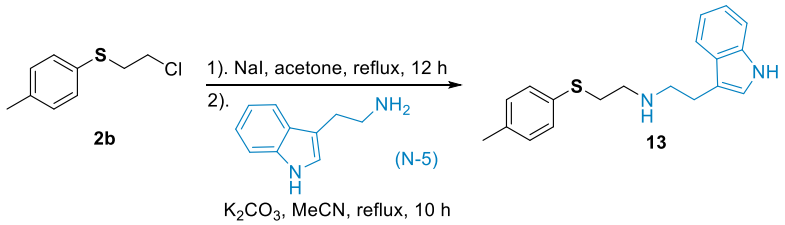
To a 25 mL flask were added **2b** (186.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. The reaction mixture was cooled and concentrated. Then, **N-3** (6-fluoro-3-(piperidin-4-yl)benzoisoxazole, 440.40 mg, 2.0 mmol, 2.0 equiv.) and PhMe (4 mL) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 110 °C for 8 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 5/1) to give product **10** (144.7 mg, 39% yield) as white oil. ^{1}H NMR (400 MHz, DMSO) δ 7.99 (dd, J = 8.4, 5.2 Hz, 1H), 7.68 (dd, J = 9.2, 2.0 Hz, 1H), 7.29 (d, J = 2 Hz, 1H), 7.26 (d, J = 8.0 Hz, 2H), 7.14 (d, J = 8.0 Hz, 2H), 3.13 (m, 1H), 3.07 (t, J = 7.4 Hz, 2H), 2.98 (d, J = 11.2 Hz, 2H), 2.57 (m, 2H), 2.27 (s, 3H), 2.16 (t, J = 11.2 Hz, 2H), 2.00 (d, J = 11.6 Hz, 2H), 1.81 (m, 2H). ^{13}C NMR (100 MHz, DMSO) δ 164.1 (d, $^1J_{C\text{-}F}$ = 247 Hz), 163.4 (d, $^3J_{C\text{-}F}$ = 14 Hz), 161.8, 135.6, 133.1, 130.1, 129.1, 124.2 (d, $^3J_{C\text{-}F}$ = 11 Hz), 117.7, 112.9 (d, $^2J_{C\text{-}F}$ = 27 Hz), 97.8 (d, $^2J_{C\text{-}F}$ = 27 Hz), 57.9, 53.2, 33.82, 30.6, 30.5, 21.0. ^{19}F NMR (376 MHz, DMSO) δ -109.9. HRMS (ESI): calcd for $C_{20}H_{23}FN_3OS$ $[M+H]^+$ 371.1588, found 371.1577.

Procedure for the synthesis of 12 and analytical data.



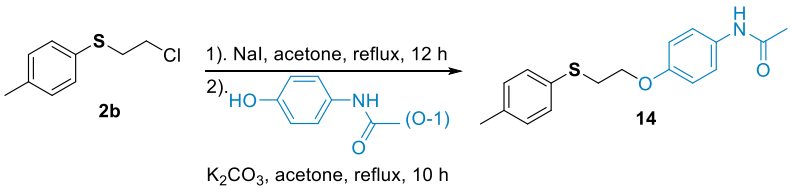
To a 25 mL flask were added **2b** (186.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. The reaction mixture was cooled and concentrated. Then, **N-4** (cytisine, 380.5 mg, 2.0 mmol, 2.0 equiv.) and PhMe (4 mL) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 110 °C for 8 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 1/1) to give product **12** (217.7 mg, 64% yield) as yellow viscous oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 – 7.17 (m, 1H), 7.09 – 7.05 (m, 2H), 6.99 (d, J = 5.6 Hz, 2H), 6.40 – 6.35 (m, 1H), 5.92 – 5.88 (m, 1H), 4.01 – 3.94 (m, 1H), 3.84 – 3.75 (m, 1H), 2.86 (d, J = 4.8 Hz, 2H) 2.81 – 2.73 (m, 3H), 2.41 – 2.29 (m, 4H), 2.24 – 2.21 (m, 4H), 1.79 (s, 1H), 1.69 (d, J = 9.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.4, 151.1, 138.4, 135.8, 132.0, 129.9, 129.4, 116.3, 104.4, 60.0, 59.4, 56.4, 49.7, 35.2, 31.1, 27.7, 25.6, 20.8. HRMS (ESI): calcd for $C_{20}H_{24}FN_2OS$ $[M+H]^+$ 340.1609, found 340.11603.

Procedure for the synthesis of 13 and analytical data.



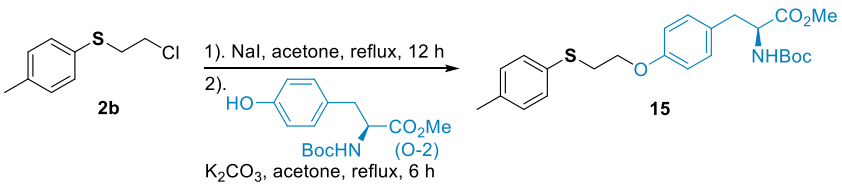
To a 25 mL flask were added **2b** (186.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. The reaction mixture was cooled and concentrated. Then, **N-5** (tryptamine, 320.4 mg, 2.0 mmol, 2.0 equiv.), K_2CO_3 (276 mg, 2.0 mmol, 2.0 equiv.) and MeCN (4 mL) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 80 °C for 10 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc/Et_3N = 75/25/1) to give product **13** (161.3 mg, 52% yield) as light yellow solid. m.p.: 96-99 °C. ^{1}H NMR (400 MHz, DMSO) δ 10.82 (s, 1H), 7.51 (d, *J* = 8.0 Hz, 1H), 7.35 (d, *J* = 8.0 Hz, 1H), 7.20 (d, *J* = 8.0 Hz, 2H), 7.13 (d, *J* = 2.0 Hz, 1H), 7.08 (m, 3H), 6.97 (t, *J* = 7.2 Hz, 1H), 2.99 (t, *J* = 6.8 Hz, 2H), 2.81 (s, 4H), 2.73 (t, *J* = 6.8 Hz, 2H), 2.51 (), 2.25 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ 136.7, 135.7, 132.7, 130.1, 129.5, 127.7, 123.1, 121.3, 118.8, 118.6, 112.9, 111.8, 50.1, 48.6, 33.7, 26.0, 21.0. HRMS (ESI): calcd for $C_{19}H_{22}N_2NaS$ $[M+Na]^+$ 333.1396, found 333.1380.

Procedure for the synthesis of 14 and analytical data.



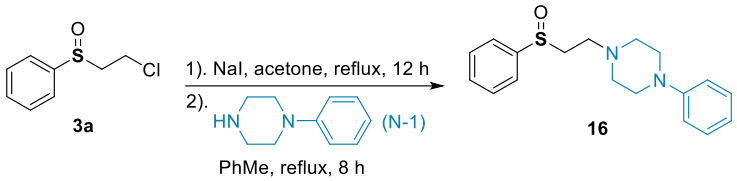
To a 25 mL flask were added **2b** (186.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. Then, **O-1** (paracetamol, 302.3 mg, 2.0 mmol, 2.0 equiv.) and K_2CO_3 (276 mg, 2.0 mmol, 2.0 equiv.) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 65 °C for 10 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 3/1) to give product **14** (147.5 mg, 49% yield) as white solide. m.p.: 133-135 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (d, *J* = 9.2 Hz, 2H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.12 (d, *J* = 8.0 Hz, 2H), 6.79 (d, *J* = 8.8 Hz, 2H), 4.08 (t, *J* = 7.0 Hz, 2H), 3.22 (t, *J* = 7.0 Hz, 2H), 2.33 (s, 3H), 2.14 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.3, 155.1, 136.8, 131.3, 131.1, 130.7, 129.8, 121.8, 114.8, 66.8, 33.4, 24.3, 21.0. HRMS (ESI): calcd for $C_{17}H_{20}NO_2S$ $[M+H]^+$ 302.1209, found 302.1201.

Procedure for the synthesis of 15 and analytical data.



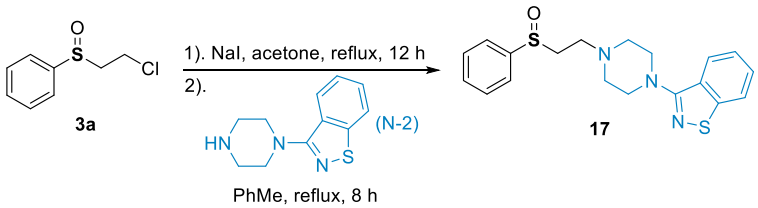
To a 25 mL flask were added **2b** (186.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. Then, **O-2** (paracetamol, 442.7 mg, 1.5 mmol, 1.5 equiv.) and K_2CO_3 (207.0 mg, 1.5 mmol, 1.5 equiv.) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 65 °C for 6 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 6/1) to give product **15** (200.3 mg, 45% yield) as light yellow viscous oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (d, *J* = 8.0 Hz, 2H), 7.12 (d, *J* = 8.0 Hz, 2H), 7.00 (d, *J* = 8.0 Hz, 2H), 6.77 (d, *J* = 8.0 Hz, 2H), 4.96 (d, *J* = 8.0 Hz, 1H), 4.53 (q, *J* = 6.0 Hz, 1H), 4.08 (t, *J* = 7.2 Hz, 2H), 3.70 (s, 3H), 3.22 (t, *J* = 7.2 Hz, 2H), 3.07 – 2.96 (m, 2H), 2.32 (s, 3H), 1.42 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.3, 157.4, 155.0, 136.8, 130.6, 130.2, 129.8, 128.2, 114.5, 79.8, 66.5, 54.4, 52.2, 37.42, 33.4, 28.2, 27.6, 21.0. HRMS (ESI): calcd for $C_{24}H_{32}NO_5S$ $[M+H]^+$ 446.1996, found 446.1982.

Procedure for the synthesis of and analytical data.



To a 25 mL flask were added **3a** (188.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. The reaction mixture was cooled and concentrated. Then, **N-1** (1-phenylpiperazine, 324.2 mg, 2.0 mmol, 2.0 equiv.) and PhMe (4 mL) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 110 °C for 8 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: DCM/MeOH/Et_3N = 400:1:2) to give product **16** (172.8 mg, 55% yield) as white solid. m.p.: 89-92 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (dd, *J* = 6.8, 1.2 Hz, 2H), 7.57 – 7.51 (m, 3H), 7.28 (t, *J* = 7.6 Hz, 2H), 6.94 (d, *J* = 8.8 Hz, 2H), 6.88 (td, *J* = 7.2, 0.8 Hz, 1H), 3.20 (t, *J* = 4.6 Hz, 4H), 3.07 – 3.00 (m, 2H), 2.97 – 2.90 (m, 1H), 2.68 – 2.62 (m, 5H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.1, 143.8, 131.0, 129.2, 129.0, 124.0, 119.8, 116.0, 54.7, 52.9, 50.8, 49.0. HRMS (ESI): calcd for $C_{18}H_{22}N_2NaOS$ $[M+Na]^+$ 337.1345, found 337.1339.

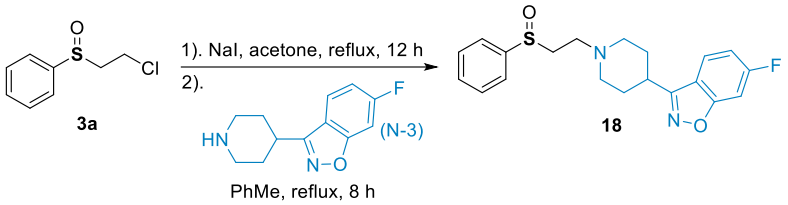
Procedure for the synthesis of 17 and analytical data.



To a 25 mL flask were added **3a** (188.7 mg mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. The reaction mixture was cooled and concentrated. Then, **N-2** (3-(piperazin-1-yl)benzoisothiazole, 438.2 mg, 2.0 mmol, 2.0 equiv.) and PhMe (4 mL) was added into the resulted mixture. The flask was evacuated and

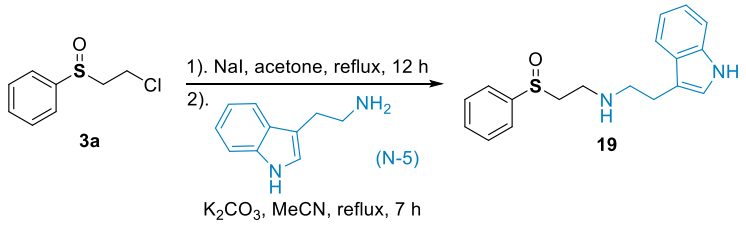
backfilled with Ar for 3 times. The reaction mixture was stirred at 110 °C for 8 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: DCM/MeOH/Et_3N = 400:1:4) to give product **17** (170.7 mg, 46% yield) as yellow viscous oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 8.0 Hz, 1H), 7.78 (d, *J* = 8.0 Hz, 1H), 7.67 (d, *J* = 2.0 Hz, 1H), 7.65 (s, 1H), 7.53 – 7.48 (m, 3H), 7.44 (t, *J* = 7.6 Hz, 1H), 7.33 (t, *J* = 7.6 Hz, 1H), 3.52 (t, *J* = 4.6 Hz, 4H), 3.03 – 2.99 (m, 2H), 2.97 – 2.90 (m, 1H), 2.72 – 2.63 (m, 5H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.6, 152.6, 143.7, 131.0, 129.2, 127.8, 127.5, 124.0, 123.8, 123.7, 120.5, 54.6, 52.6, 50.9, 49.8. HRMS (ESI): calcd for $C_{19}H_{22}N_3OS_2$ $[M+H]^+$ 372.1199, found 372.1190.

Procedure for the synthesis of 18 and analytical data.



To a 25 mL flask were added **3a** (188.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. The reaction mixture was cooled and concentrated. Then, **N-3** (6-fluoro-3-(piperidin-4-yl)benzoisoxazole, 440.40 mg, 2.0 mmol, 2.0 equiv.) and PhMe (4 mL) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 110 °C for 8 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc/Et_3N =25/75/2) to give product **18** (122.8 mg, 33% yield) as white viscous oil. ^{1}H NMR (400 MHz, DMSO) δ 7.94 (dd, *J* = 8.6, 5.4 Hz, 1H), 7.69 (d, *J* = 7.2 Hz, 2H), 7.64 – 7.62 (m, 1H), 7.59 – 7.50 (m, 3H), 7.27 – 7.22 (m, 1H), 3.17 – 3.05 (m, 2H), 2.98 – 2.92(m, 3H), 2.80 – 2.73 (m, 1H), 2.47 – 2.42 (m, 1H), 2.16 (t, *J* = 10.8 Hz, 1H), 2.07 (t, *J* = 10.8 Hz, 1H), 1.97 (d, *J* = 12.0 Hz, 2H), 1.82 – 1.73 (m, 2H). ^{13}C NMR (100 MHz, DMSO) δ 163.7 (d, $^1J_{C\text{-}F}$ = 246 Hz), 163.1 (d, $^3J_{C\text{-}F}$ = 14 Hz), 161.3, 144.6, 130.7, 129.2, 124.1, 123.8 (d, $^3J_{C\text{-}F}$ = 11 Hz), 117.3, 112.5 (d, $^2J_{C\text{-}F}$ = 25 Hz), 97.4 (d, $^2J_{C\text{-}F}$ = 27 Hz), 53.5, 53.0, 52.5, 50.5, 33.3, 30.1, 30.0. ^{19}F NMR (376 MHz, DMSO) δ -109.9. HRMS (ESI): calcd for $C_{20}H_{22}FN_2O_2S$ $[M+H]^+$ 373.1381, found 373.1377.

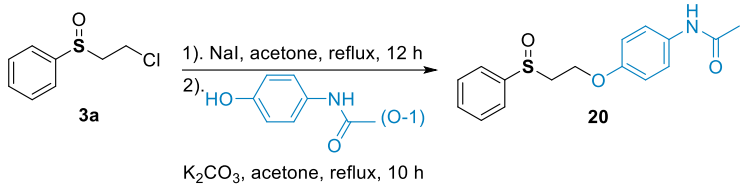
Procedure for the synthesis of 19 and analytical data.



To a 25 mL flask were added **3a** (188.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. The reaction mixture was cooled and concentrated. Then, **N-5** (tryptamine, 320.4 mg, 2.0 mmol, 2.0 equiv.), K_2CO_3 (276 mg, 2.0 mmol, 2.0 equiv.) and MeCN (4 mL) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 50 °C for 7 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: DCM/MeOH/Et_3N = 100:1:1) to give product **19** (237.1 mg, 76% yield) as orange viscous oil. ^{1}H NMR (400 MHz, DMSO) δ 10.88 (s,

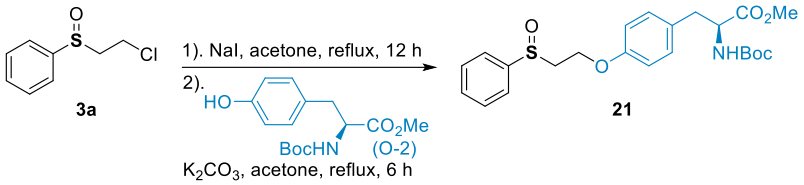
1H), 7.63 (d, J = 6.8 Hz, 2H), 7.53 (dd, J = 15.4, 7.4 Hz, 4H), 7.36 (d, J = 8.0 Hz, 1H), 7.15 (s, 1H), 7.07 (t, J = 7.4 Hz, 1H), 6.98 (t, J = 7.2 Hz, 1H), 3.36 – 3.30 (m, 1H), 3.05 – 2.92 (m, 3H), 2.90 – 2.85 (m, 1H), 2.81 – 2.74 (m, 4H). ^{13}C NMR (100 MHz, DMSO) δ 144.7, 136.4, 130.7, 129.3, 127.4, 124.0, 122.8, 120.9, 118. 4, 118.3, 112.5, 111.5, 56.7, 49.9, 42.5, 25.5. HRMS (ESI): calcd for $C_{18}H_{20}N_2NaOS$ $[M+Na]^+$ 335.1189, found 335.1175.

Procedure for the synthesis of 20 and analytical data.



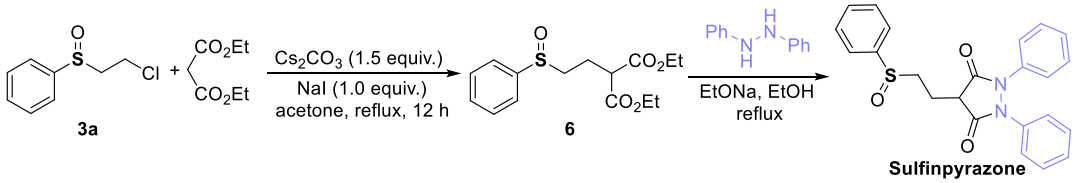
To a 25 mL flask were added **3a** (188.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. Then, **O-1** (paracetamol, 302.3 mg, 2.0 mmol, 2.0 equiv.) and K_2CO_3 (276 mg, 2.0 mmol, 2.0 equiv.) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 65 °C for 10 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: EtOAc) to give product **20** (124.3 mg, 41% yield) as white solid. m.p.: 162-165 °C. ^{1}H NMR (400 MHz, DMSO) δ 9.85 (s, 1H), 7.70 (d, J = 6.4 Hz, 2H), 7.61 – 7.55 (m, 3H), 7.48 (d, J = 8.8 Hz, 2H), 6.84 (d, J = 8.8 Hz, 2H), 4.32 – 4.26 (m, 1H), 4.21 – 4.16 (m, 1H), 3.42 – 3.36 (m, 1H), 3.14 (dt, J = 13.4, 4.2 Hz, 1H), 2.00 (s, 3H). ^{13}C NMR (100 MHz, DMSO) δ 167.8, 153.6, 144.3, 133.1, 130.9, 129.3, 124.0, 120.4, 114.5, 60.7, 55.6, 23.9. HRMS (ESI): calcd for $C_{16}H_{17}NNaO_3S$ $[M+Na]^+$ 326.3652, found 326.3643.

Procedure for the synthesis of 21 and analytical data.



To a 25 mL flask were added **3a** (188.7 mg, 1.0 mmol, 1.0 equiv.), NaI (449.7 mg, 3.0 mmol, 3.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. During the reaction, the solution turned brown and solid was formed in the solution. Then, **O-2** (paracetamol, 442.7 mg, 1.5 mmol, 1.5 equiv.) and K_2CO_3 (207.0 mg, 1.5 mmol, 1.5 equiv.) was added into the resulted mixture. The flask was evacuated and backfilled with Ar for 3 times. The reaction mixture was stirred at 65 °C for 6 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 1/3) to give product **21** (134.2 mg, 30% yield) as light yellow viscous oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (dd, J = 7.6, 1.8 Hz, 2H), 7.54 – 7.50 (m, 3H), 7.02 (d, J = 8.4 Hz, 2H), 6.79 (d, J = 8.4 Hz, 2H), 4.98 (d, J = 8.0 Hz, 1H), 4.55 – 4.50 (m, 1H), 4.46 – 4.41 (m, 1H), 4.20 – 4.15 (m, 1H), 3.70 (s, 3H), 3.24 – 3.12 (m, 2H), 3.07 – 2.96 (m, 2H), 1.41 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.3, 157.0, 155.0, 143.5, 131.2, 130.3, 129.3, 128.7, 123.9, 114.6, 79.9, 60.6, 57.1, 54.4, 52.2, 37.4, 28.2.
HRMS (ESI): calcd for $C_{23}H_{30}NO_6S$ $[M+H]^+$ 448.1788, found 448.1781.

9. Procedure for total synthesis of Sulfinpyrazone



Step 1:

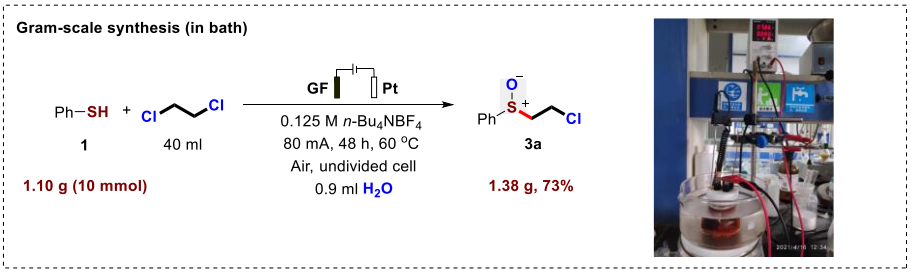
To a 25 mL flask were added **3a** (188.7 mg, 1.0 mmol, 1.0 equiv.), which was synthesized from electrochemical sulfoxidation reaction (83% yield), diethyl malonate (192.0 mg, 1.2 mmol, 1.2 equiv.), cesium carbonateand (203.9 mg, 1.5 mmol, 1.5 equiv.), NaI (149.9 mg, 1.0 mmol, 1.0 equiv.) and acetone (4 mL). The flask was evacuated and backfilled with Ar for 3 times. The resulting mixture was heated to 65 °C in an oil bath and stirred for 12 h. The reaction mixture was cooled and concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc = 3/1) to give product **6** (209.1 mg, 67% yield) as colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 – 7.58 (m, 2H), 7.53 – 7.48 (m, 3H), 4.19 – 4.13 (m, 4H), 3.44 (t, *J* = 7.2 Hz, 1H), 2.96 – 2.89 (m, 1H), 2.85 – 2.78 (m, 1H), 2.36 – 2.27 (m, 1H), 2.20 – 2.11 (m, 1H), 1.25 – 1.20 (m, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.4, 143.0, 131.1, 129.2, 123.9, 61.6, 53.8, 50.4, 21.2, 13.9. HRMS (ESI): calcd for $C_{15}H_{21}O_5S$ $[M+H]^+$ 313.1104, found 313.1097.

Step 2:

0.26 mL of sodium ethoxide solution 21 wt. % in ethanol (0.69 mmol of sodium ethoxide, 1.15 equiv.) was added to a 50 mL three-necked flask charged with Ar, followed by 4 mL of additional absolute EtOH. Product **6** (187.3 mg, 0.6 mmol) was added and stirred until it is fully dissolved at room temperature, followed by hydrazobenzene (110.5 mg, 0.6 mmol). The mixture was refluxed while being stirred for 24 h. The solvent was removed under reduced pressure. Then 4 mL water was added, followed by 4 mL of diethylether. A slight precipitate may be observed and should be filtered off. The layers are separated and the aqueous layer washed with 2 x 4 mL ether. The sulfopridone was precipitated from the aqueous layer as a white solid by addition of 3 mL of 2 N HCl and collected via filtration. The solid was washed with water (3 x 5 mL). Drying afforded 140.6 mg (58% yield) of a white solid. m.p.: 130-132 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (dd, *J* = 7.6, 1.6 Hz, 2H), 7.52 – 7.47 (m, 3H), 7.31 – 7.24 (m, 9H), 7.16 (t, *J* = 6.8 Hz, 2H), 3.52 (t, *J* = 7.4 Hz, 1H), 3.33 – 3.26 (m, 1H), 3.09 – 3.02 (m, 1H), 2.55 – 2.45 (m, 1H), 2.23 – 2.20 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.8, 142.7, 135.2, 131.1, 129.3, 129.0, 127.0, 124.0, 122.6, 52.2, 44.1, 20.7.

10. Procedure for gram-scale experiments

Gram-scale experiment in batch:

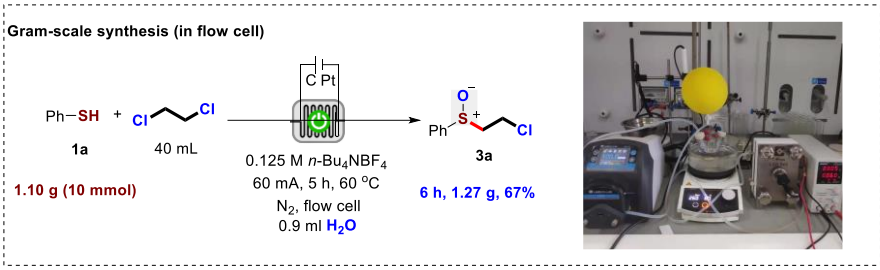


Conditions for sulfoxidation in batch: Undivided cell, graphite felt anode (2 cm* 3 cm), Pt plate cathode (2 cm* 3 cm), **1a** (10 mmol), **DCE** (40 mL), *n*-Bu_4NBF_4 (5 mmol), 48 h, H_2O (5.0 equiv.), 60 °C, N_2, *j* = 13.3 mA/cm^2,

constant current: 80 mA, isolated yield.

To a 100 mL pore cylindrical glass instrument was added stir bar, *n*-Bu_4NBF_4 (1.65 g, 5 mmol, 0.5 equiv.), thiol **1** (1.10g, 10 mmol, 1.0 equiv.), DCE (40 mL) and H_2O (900 mg, 5.0 equiv.), then, pore cylindrical glass instrument was covered with the graphite felt (2 cm x 3 cm) as anode and Pt (2 cm x 3 cm) as cathode. The resulting reaction mixture was stirred at 60 °C under the constant current of 80 mA for 48 hours. The reaction mixture was then concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc= 5:1) to give desired product **3a** (1.38 g, 73% yield).

Gram-scale experiment in flow



Conditions for sulfoxidation in flow cell: Undivided fellow cell, graphite felt anode (5 cm* 5 cm), Pt plate cathode (5 cm* 5 cm), **1a** (10 mmol), **DCE** (40 mL), *n*-Bu_4NBF_4 (5 mmol), 5 h, H_2O (5.0 equiv.), 60 °C, N_2, j = 2.4 mA/cm^2, t_R = 50 min (retention time), constant current : 60 mA, isolated yields.

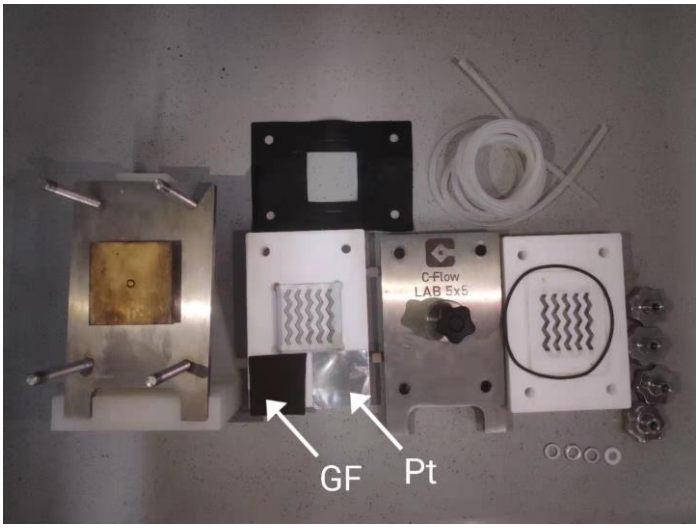
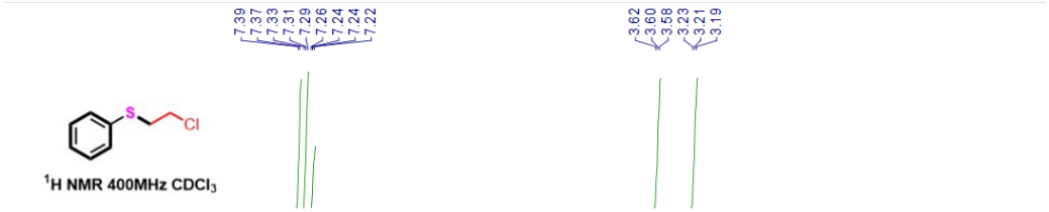


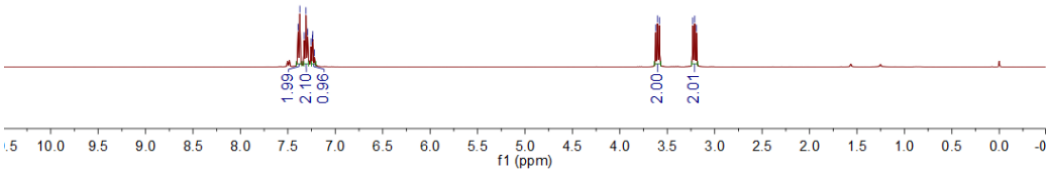
Figure S4. Picture of C-Flow instrument

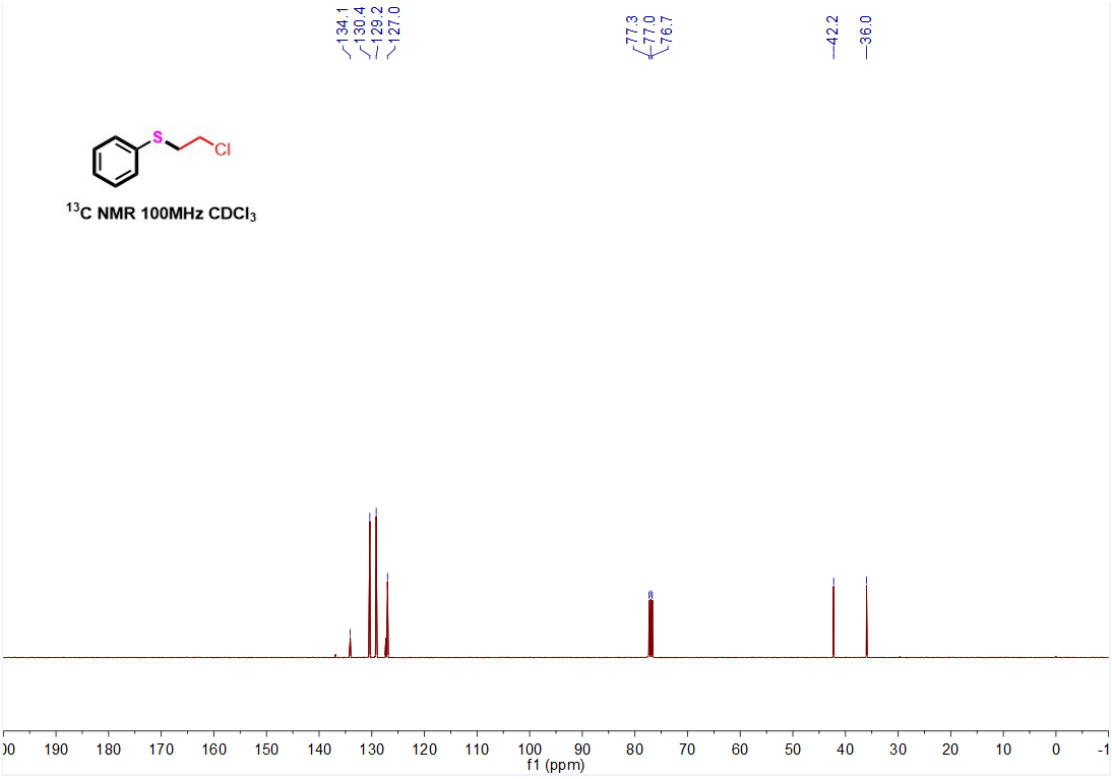
To a 50 mL three neck flask was added stir bar, n-Bu_4NBF_4 (1.65 g, 5 mmol, 1.0 equiv.), thiol **1** (10 mmol, 2.0 equiv.), DCE (40 mL) and H_2O (0.9 mL, 10 equiv.). Then, stirring the solution until it was transparent followed by starting the peristaltic pump (current speed: 100 uL/min) which fill the pipe and flow cell with solution. The flask was evacuated and backfilled with N_2 for 3 times. The resulting mixture was heated to 60 °C in an oil bath and circulated in the flow system for 5 h. The reaction mixture was then concentrated. The residue was purified by silica gel chromatography (eluent: petroleum ether/EtOAc= 5:1) to give desired product **3a** (1.27 g, 67% yield).

11. ^{1}H NMR, ^{13}C NMR and ^{19}F NMR of compounds

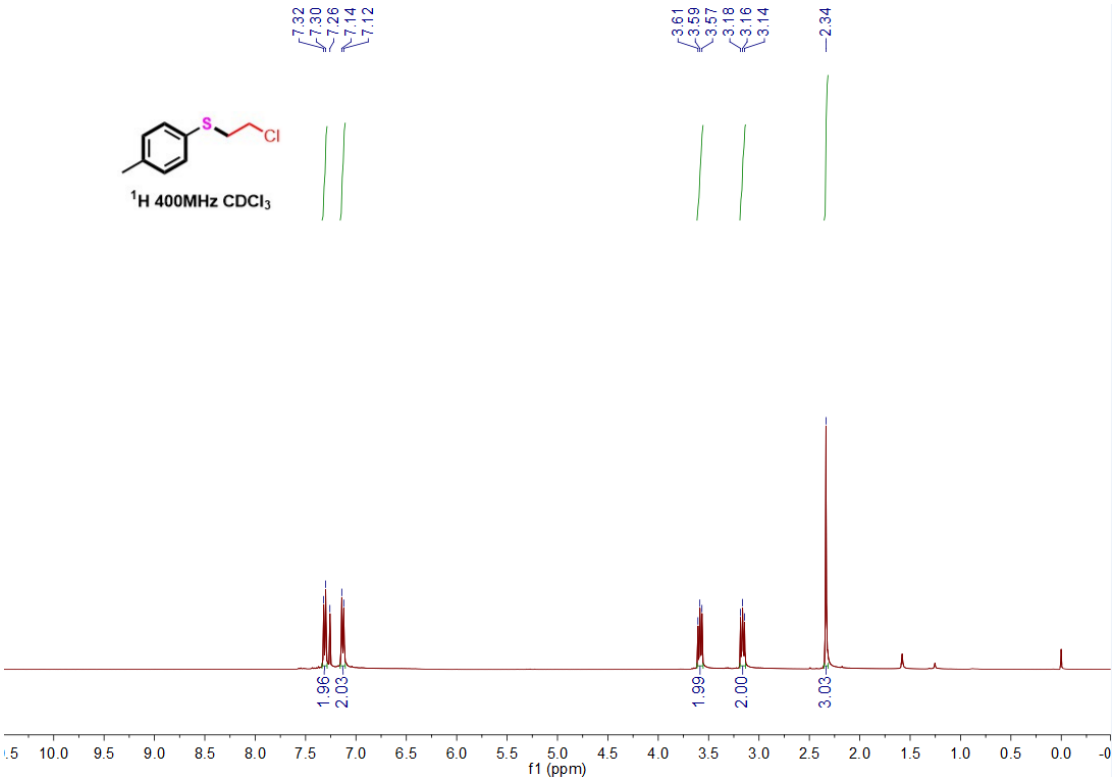
(2-Chloroethyl)(phenyl)sulfide (2a)

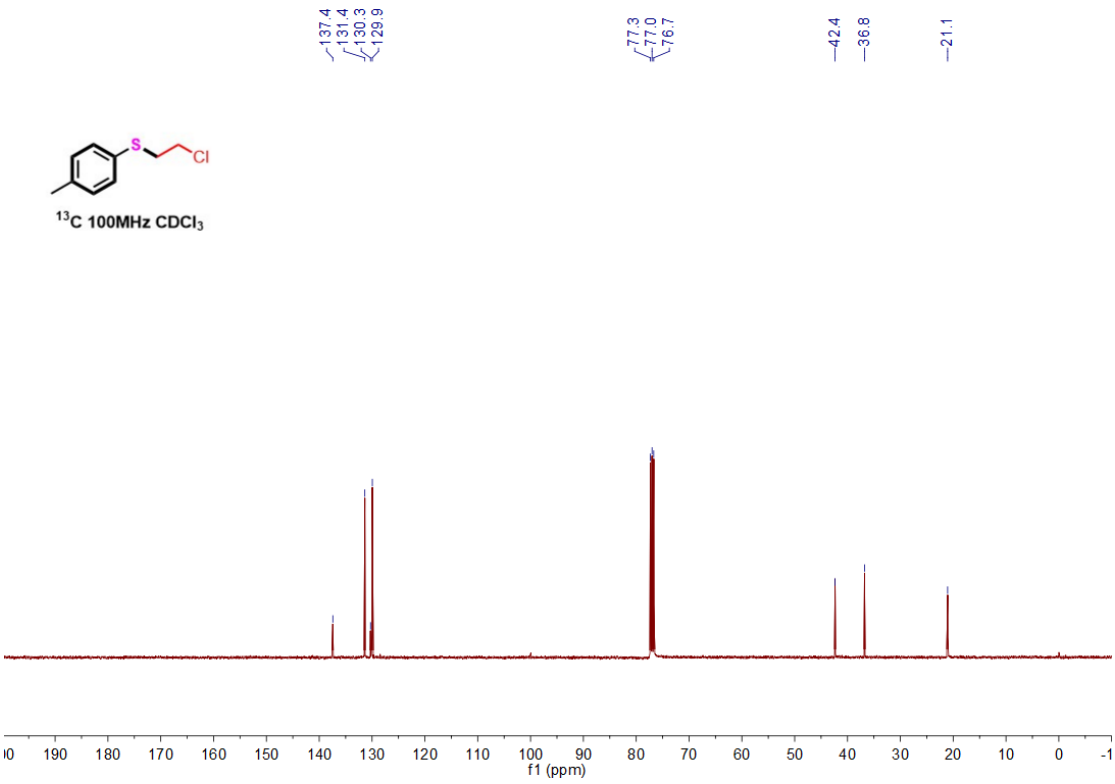




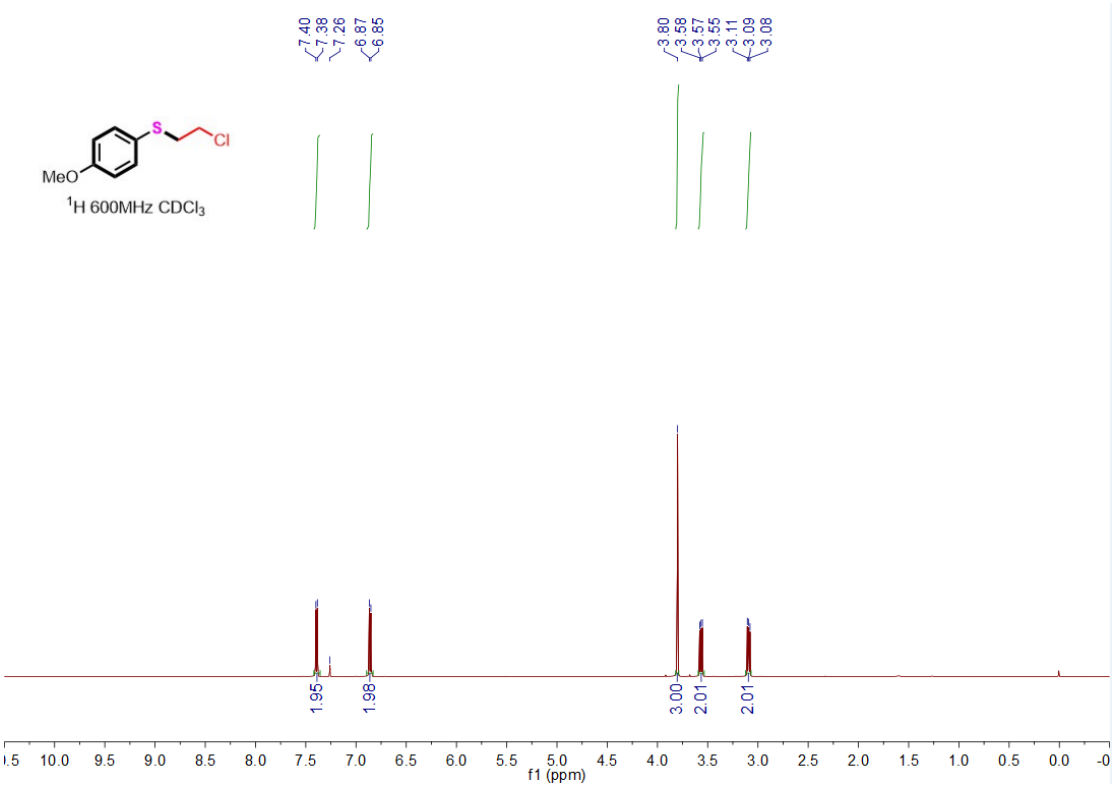


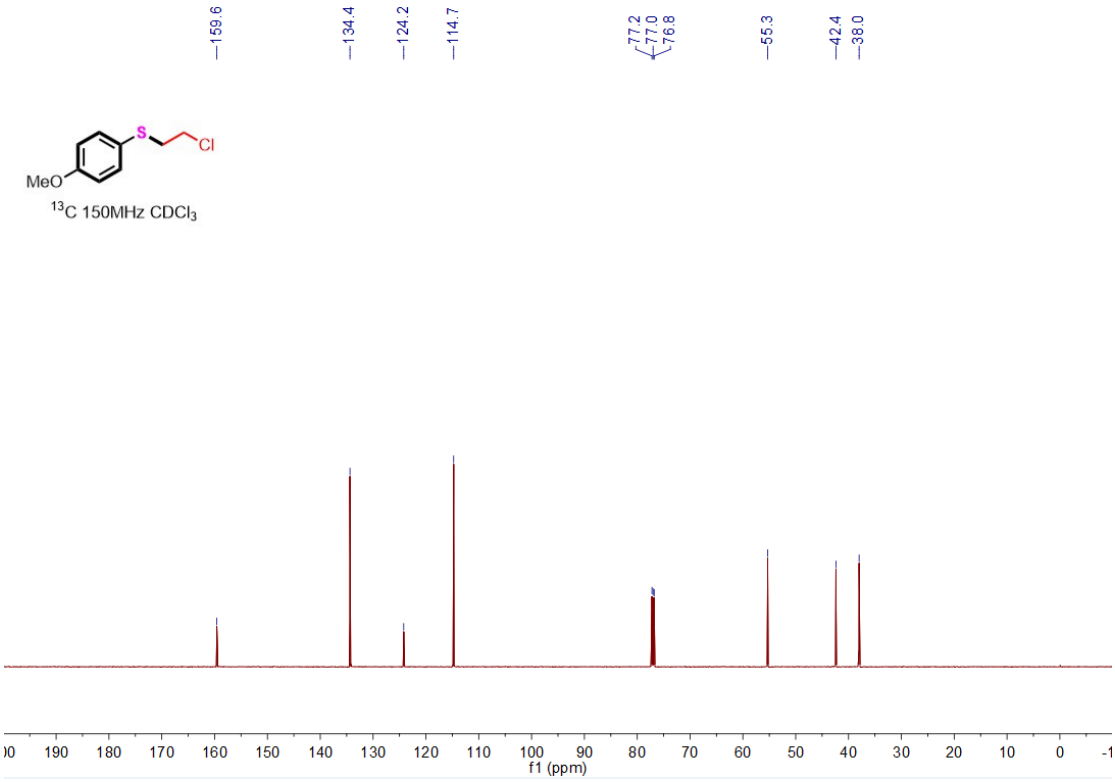
(2-Chloroethyl)(p-tolyl)sulfide (2b)



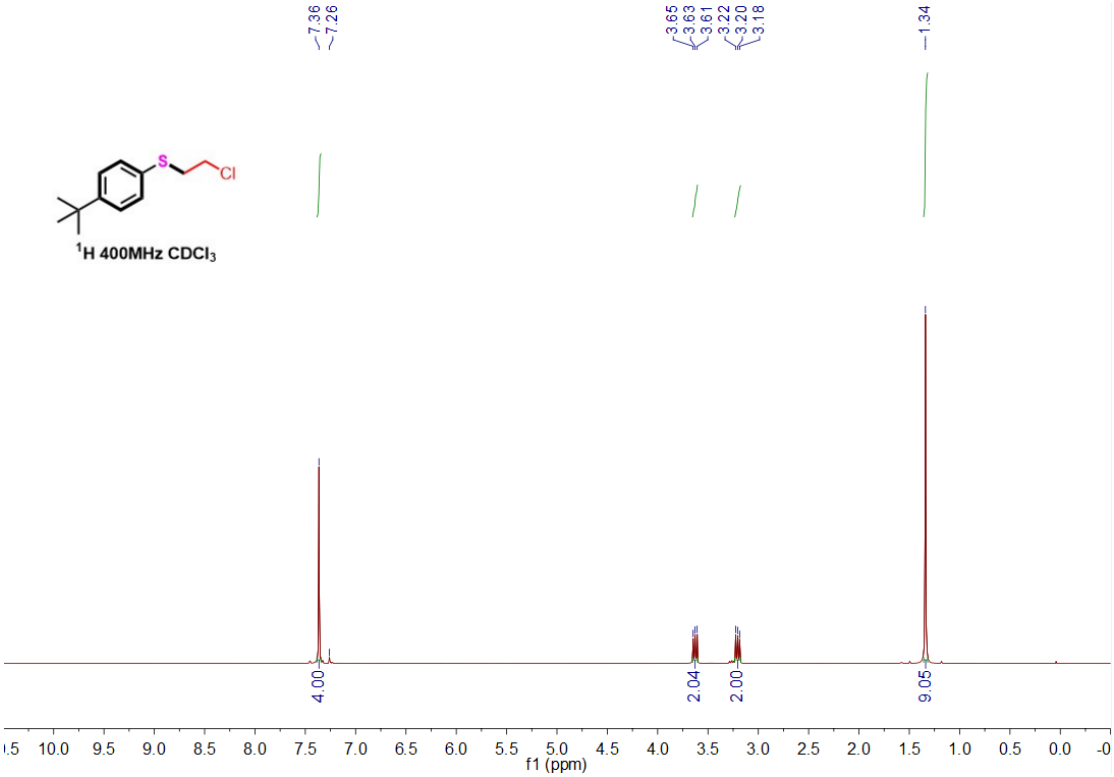


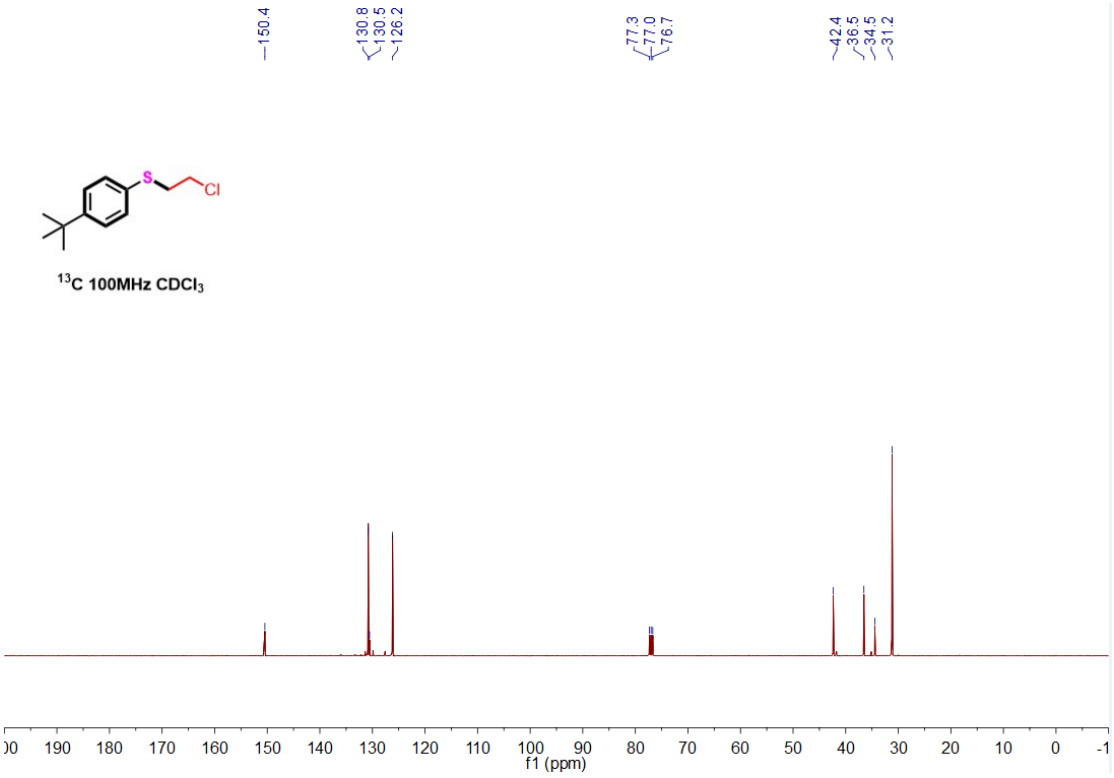
(2-Chloroethyl)(4-methoxyphenyl)sulfide (2c)



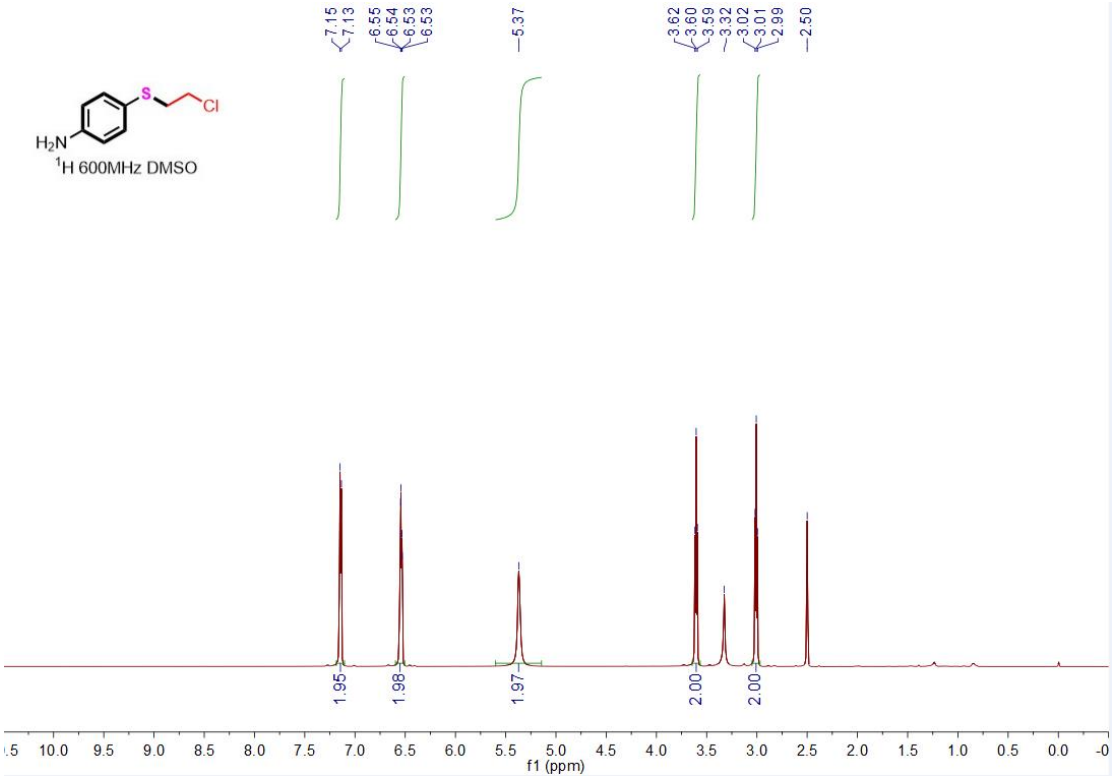


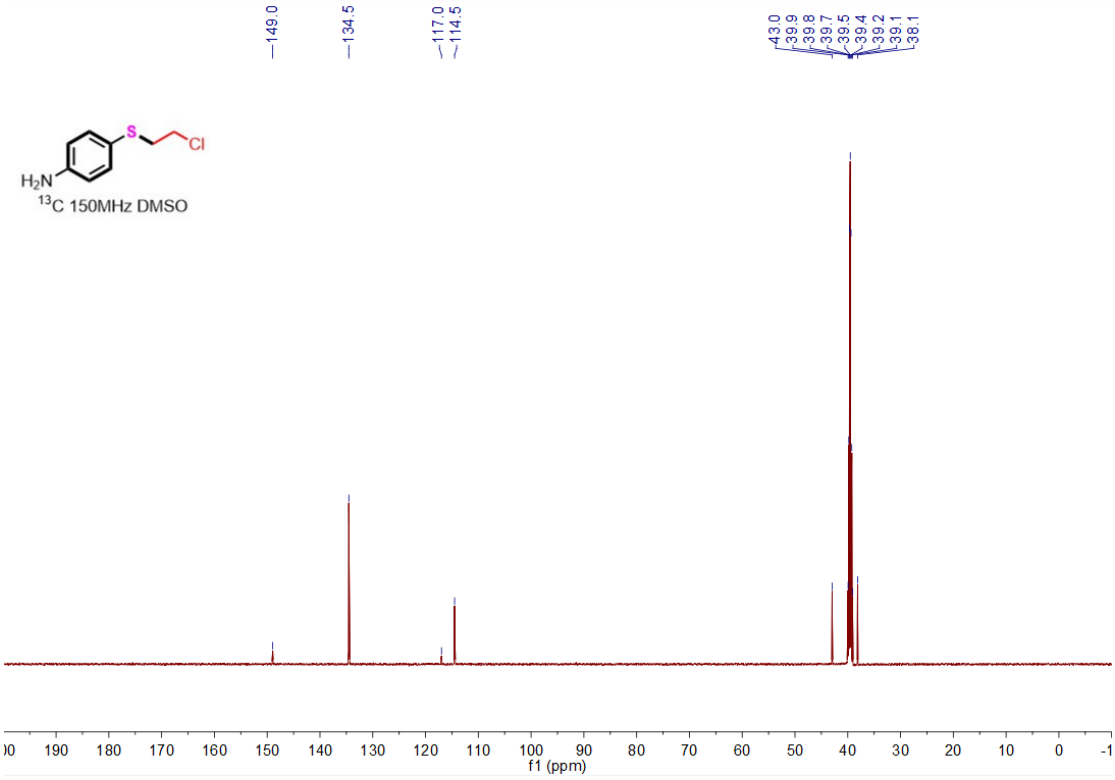
(4-(tert-Butyl)phenyl)(2-chloroethyl)sulfide (2d)



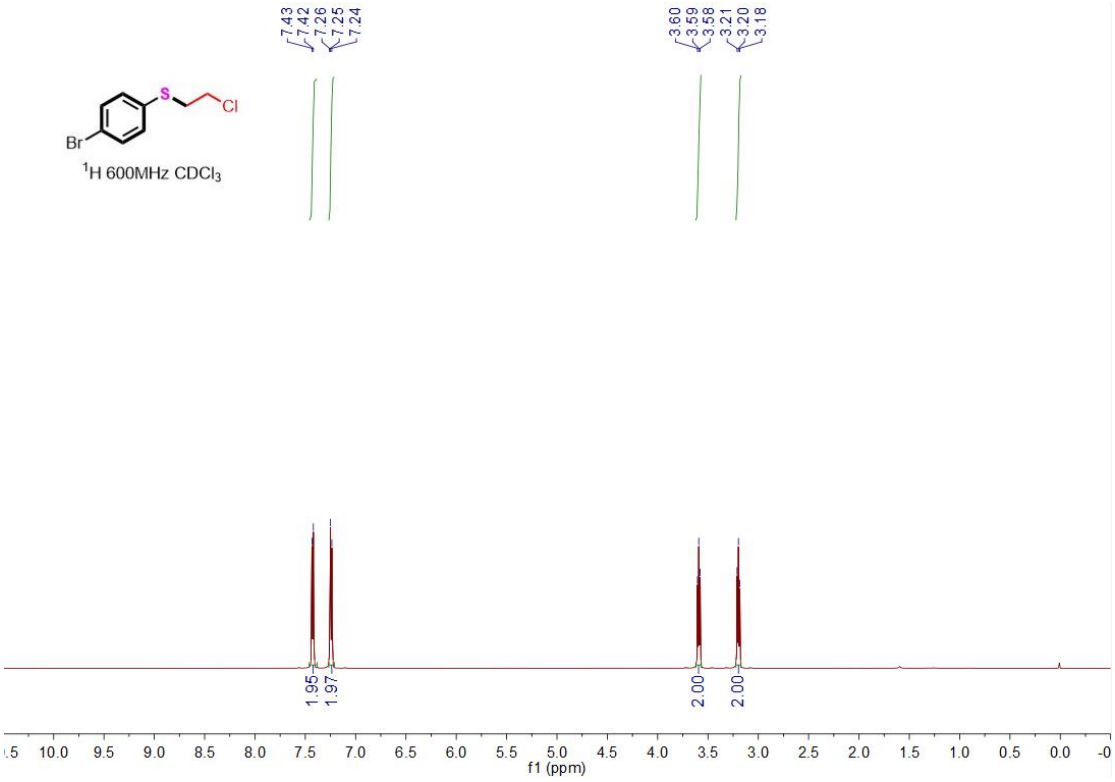


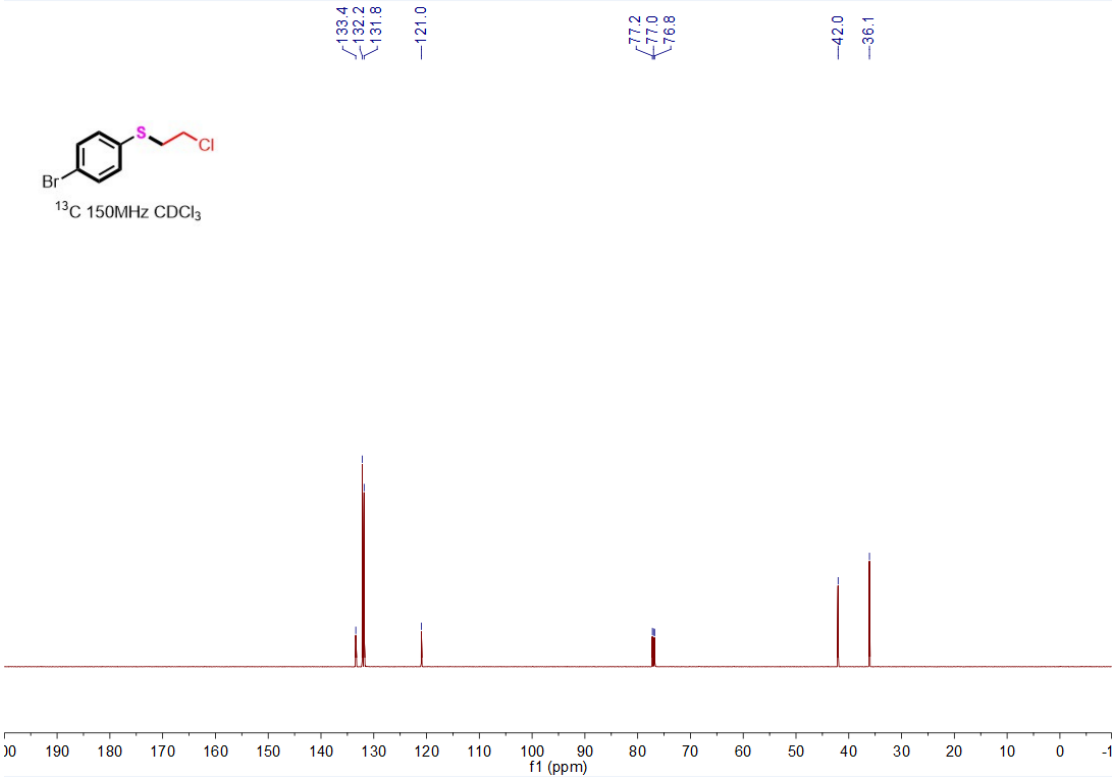
4-((2-Chloroethyl)thio)aniline (2e)



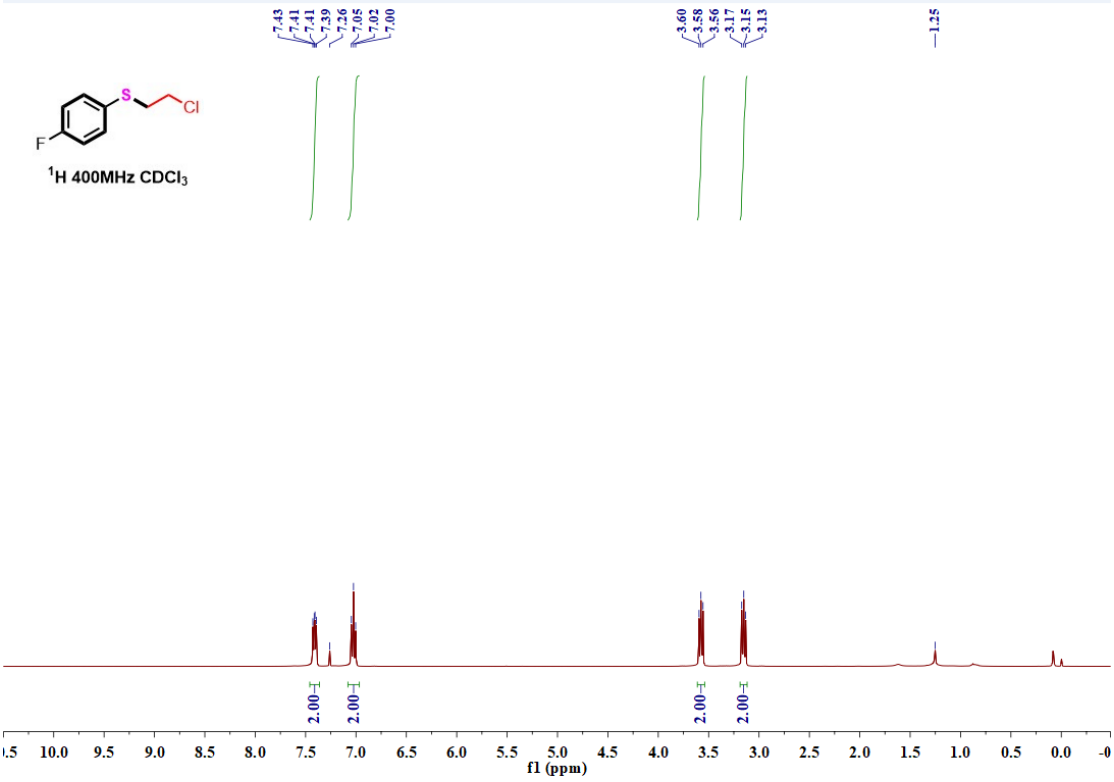


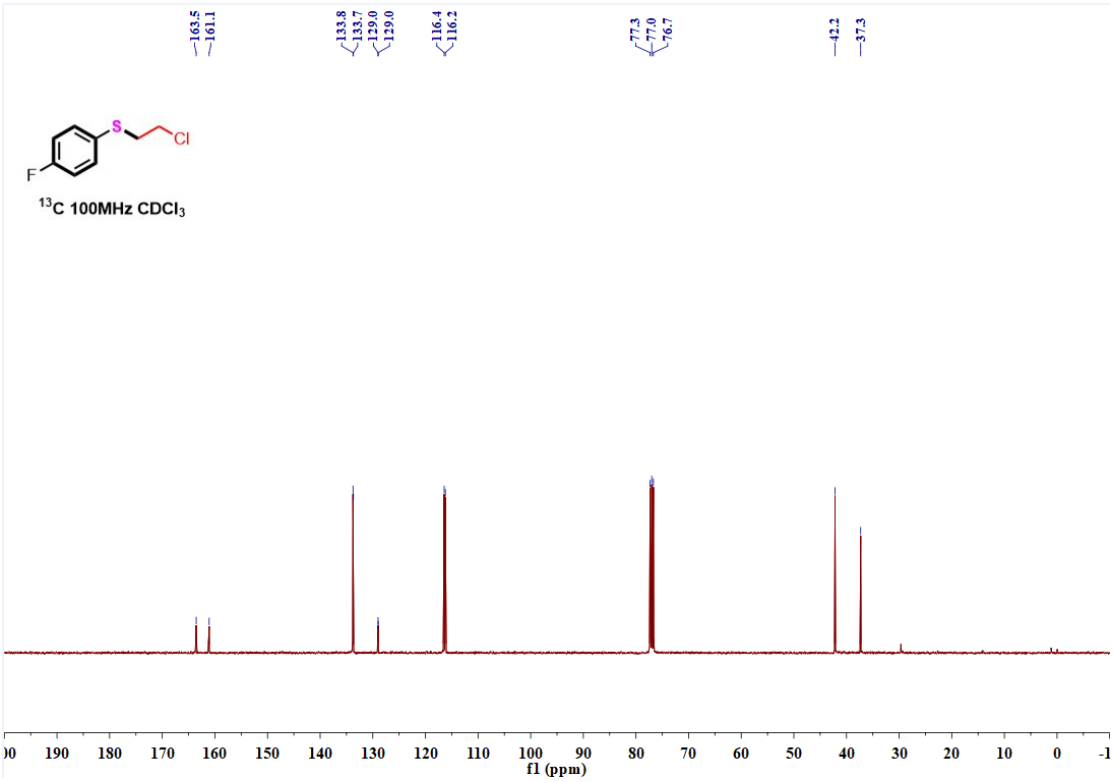
(4-Bromophenyl)(2-chloroethyl)sulfide (2f)

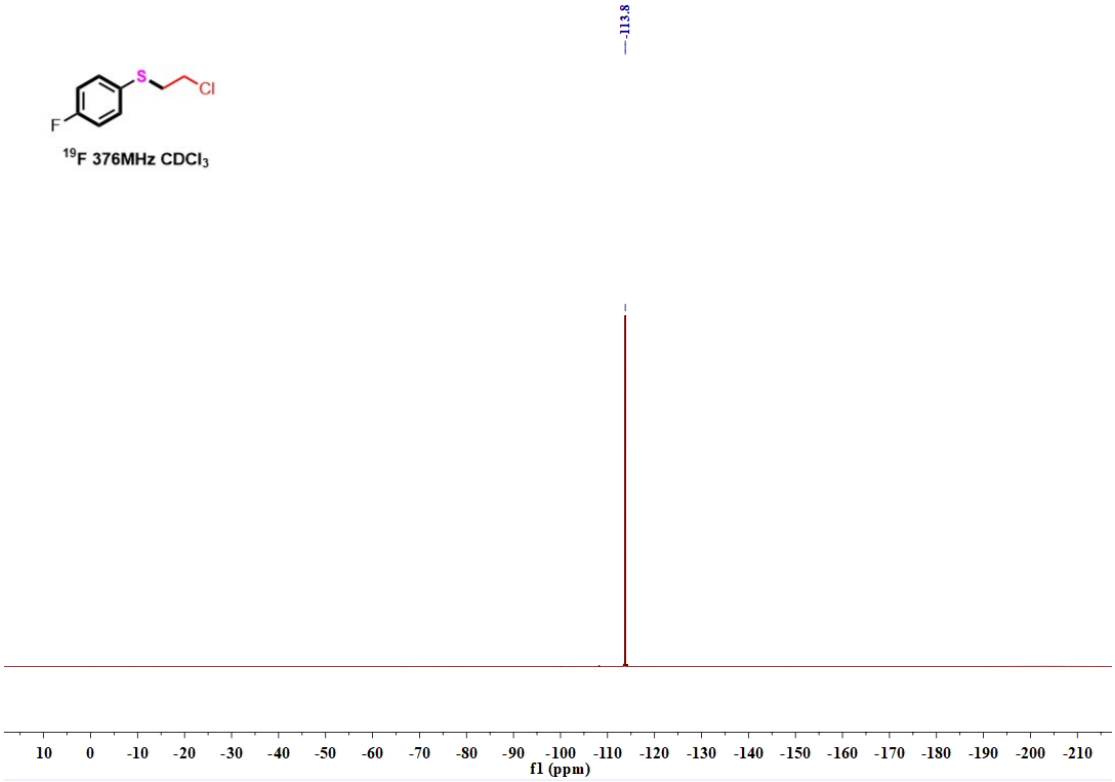




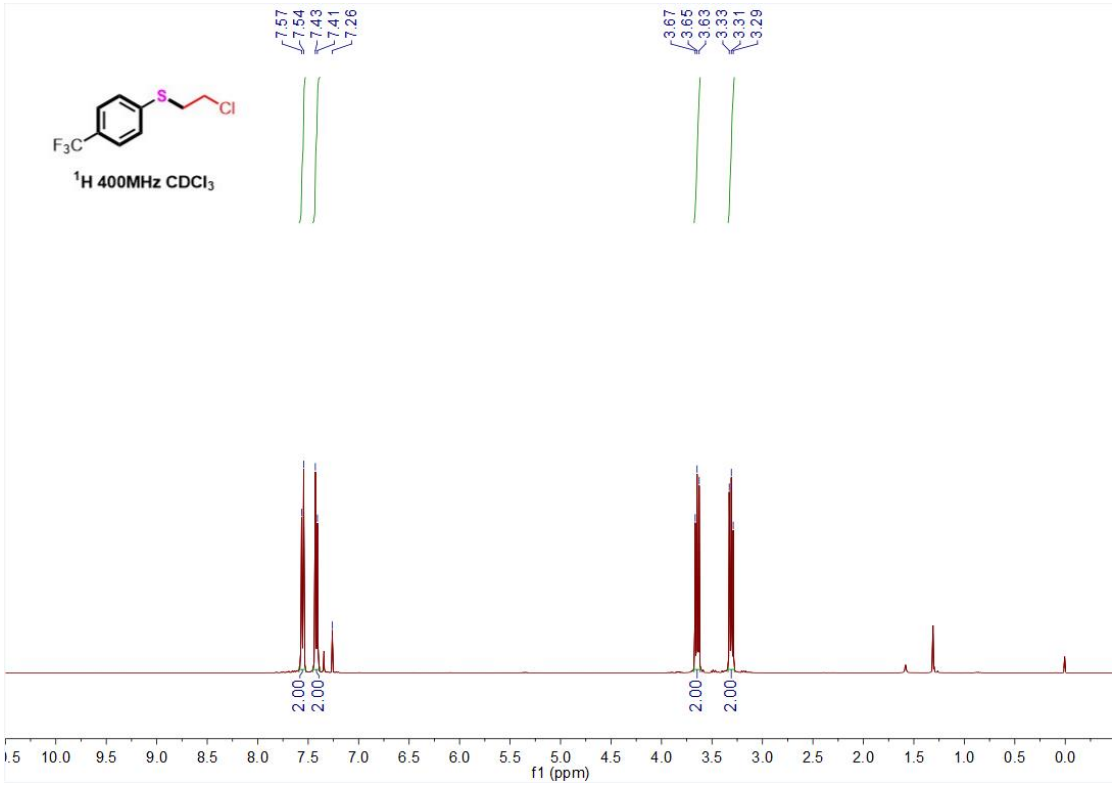
(2-Chloroethyl)(4-fluorophenyl)sulfide (2g)

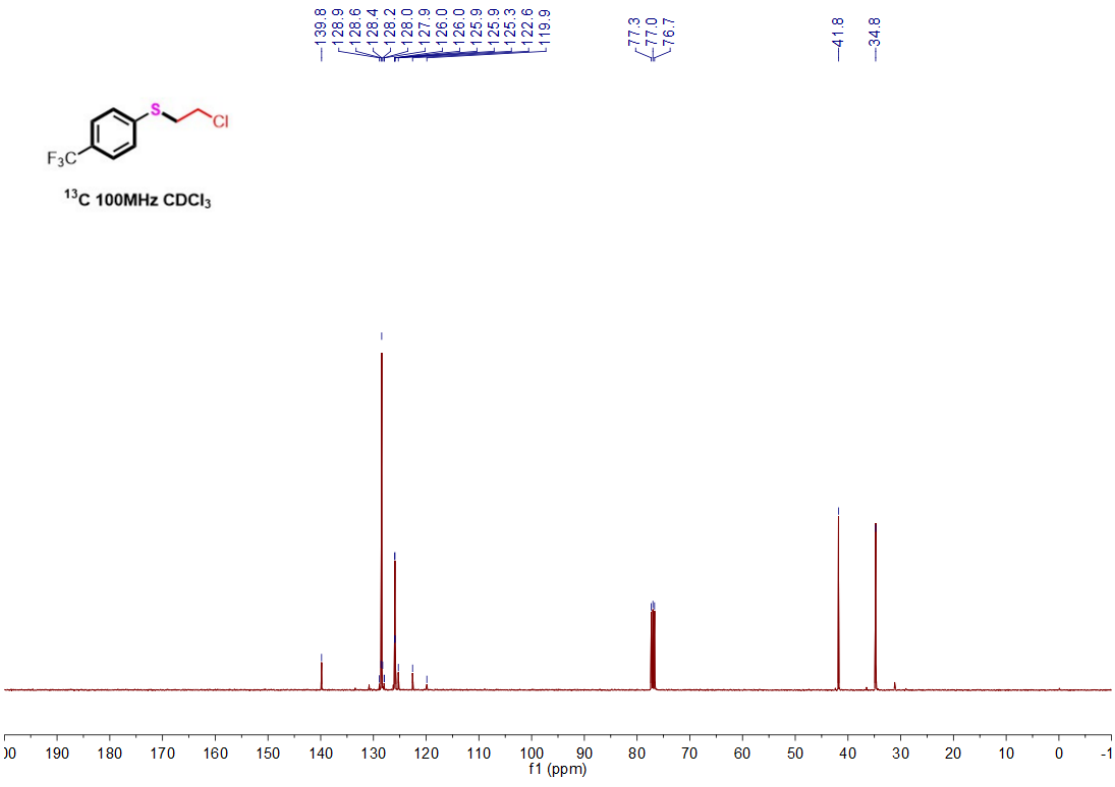






(2-Chloroethyl)(4-(trifluoromethyl)phenyl)sulfide (2h)

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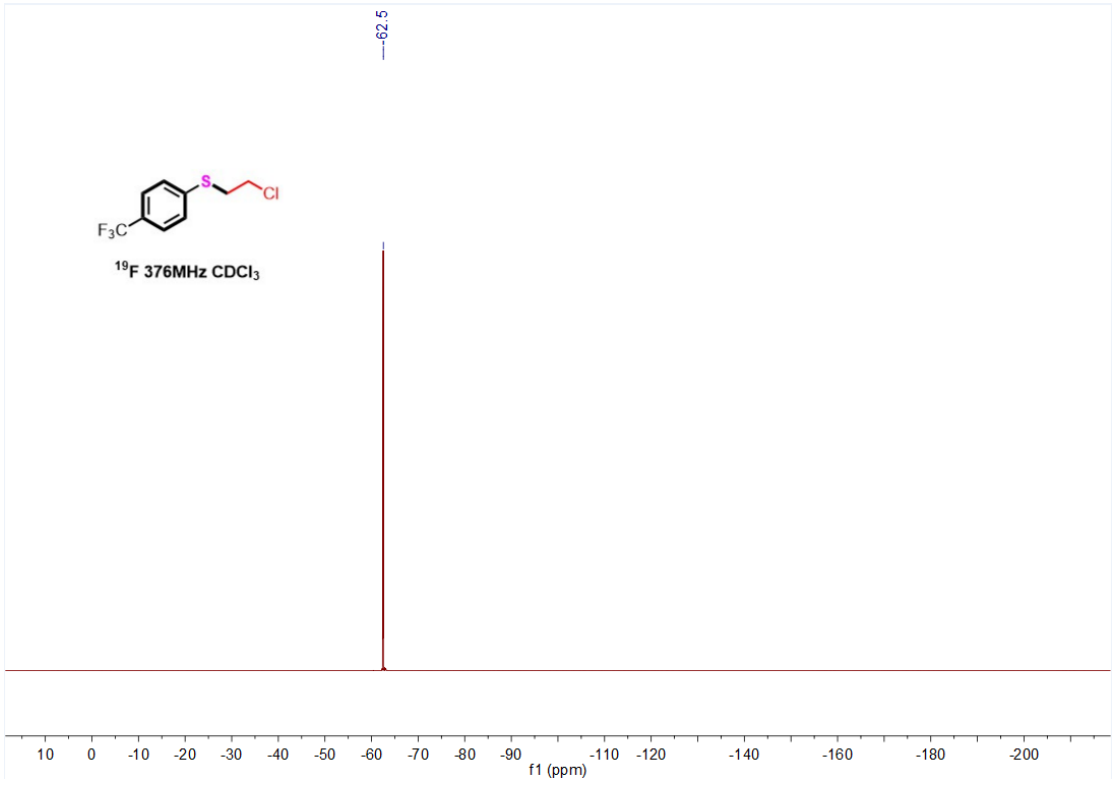
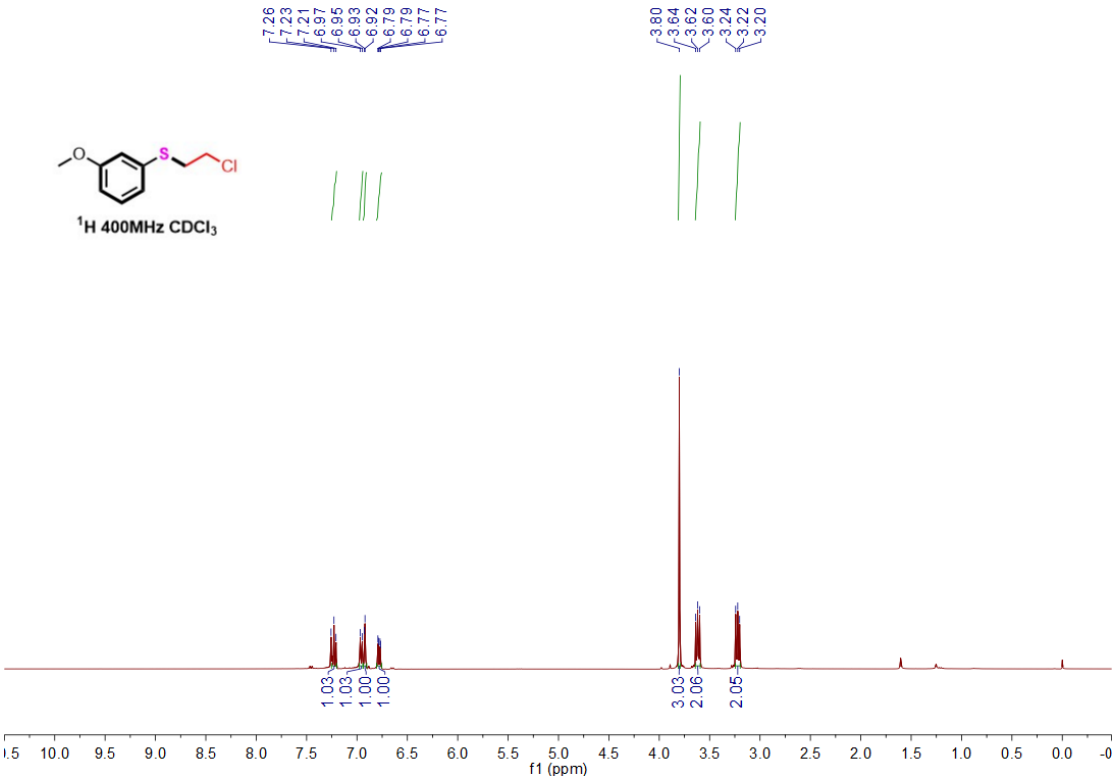
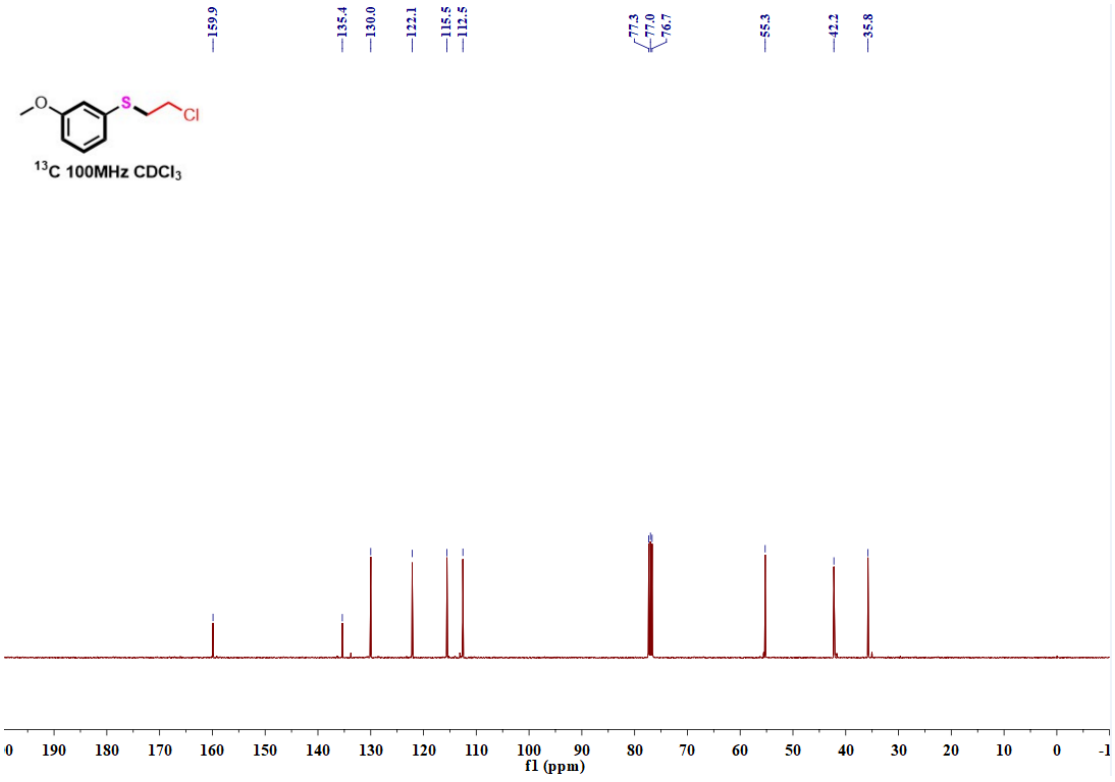
128.6
128.4
128.2
128.0
127.9
126.0
126.0
125.9
125.9
125.3
122.6
119.9
77.3
77.0
76.7
41.8
34.8
S
Cl
F3C
13C 100MHz CDCl3
f1 (ppm)

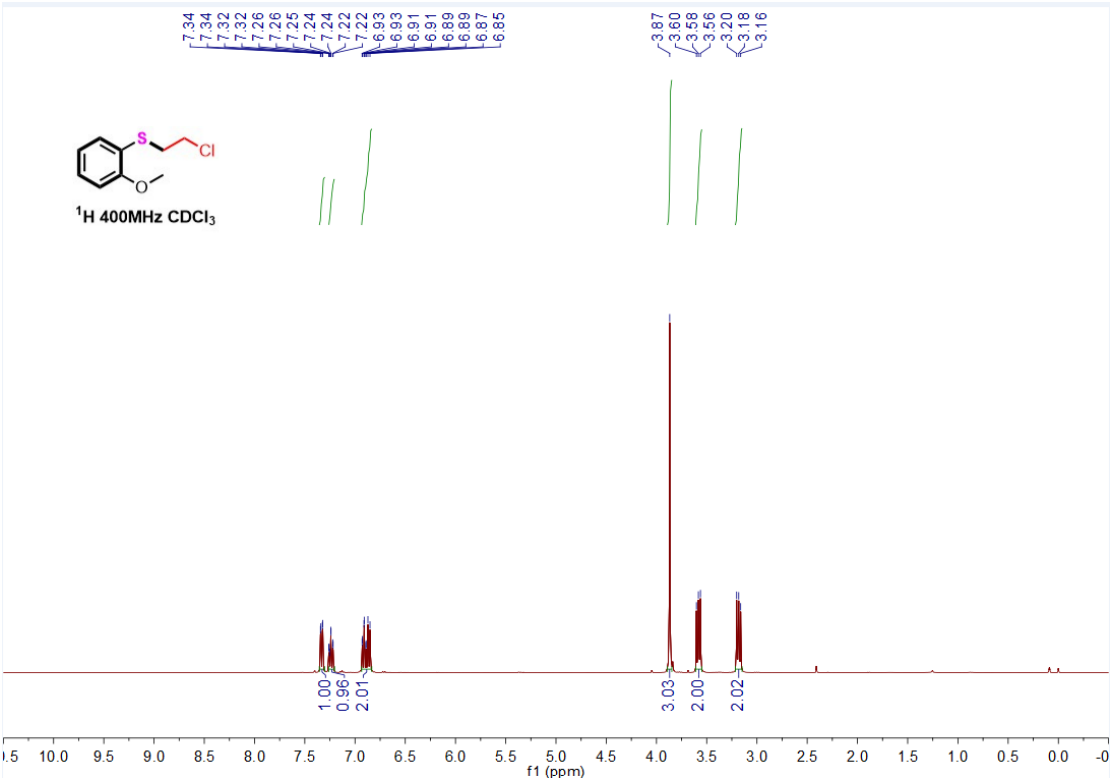

62.5
S
Cl
F3C
19F 376MHz CDCl3
f1 (ppm)

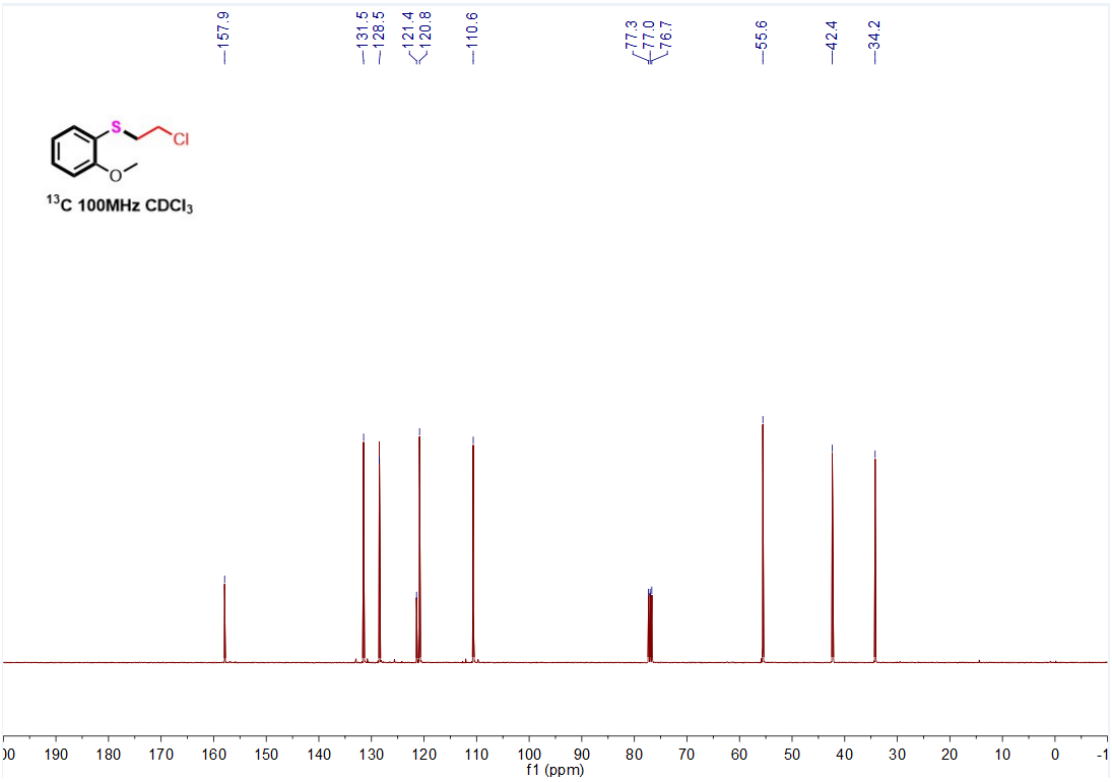
(2-Chloroethyl)(3-methoxyphenyl)sulfide (2i)



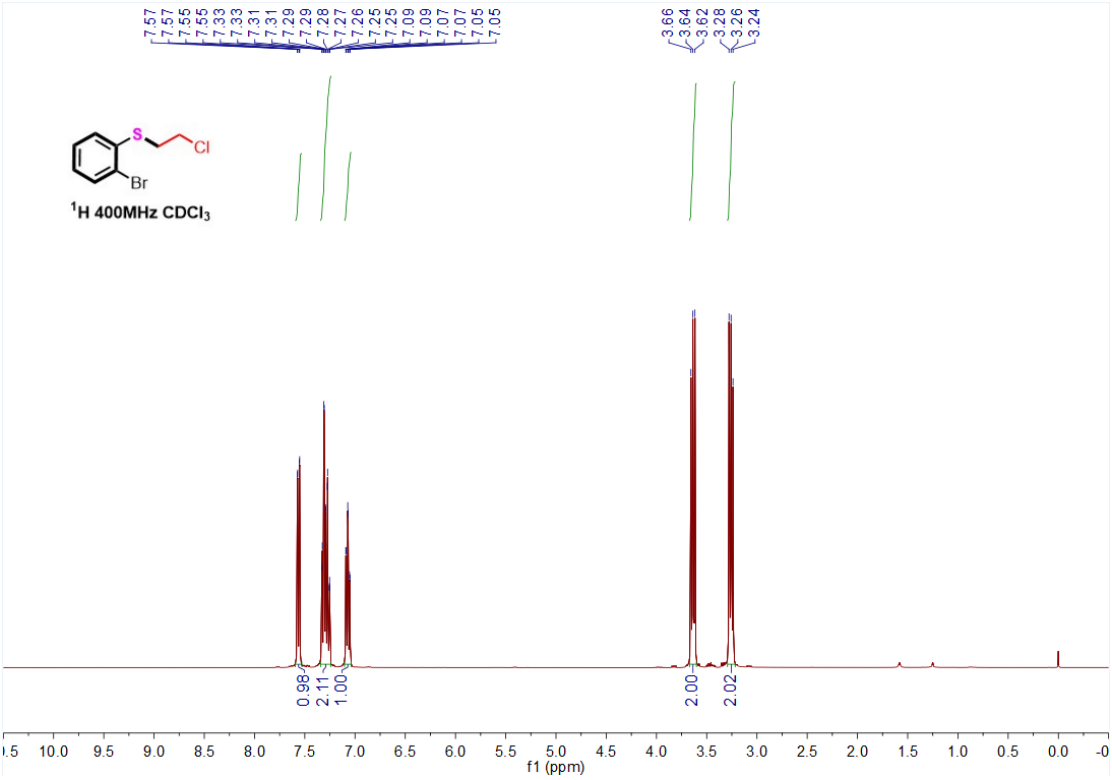


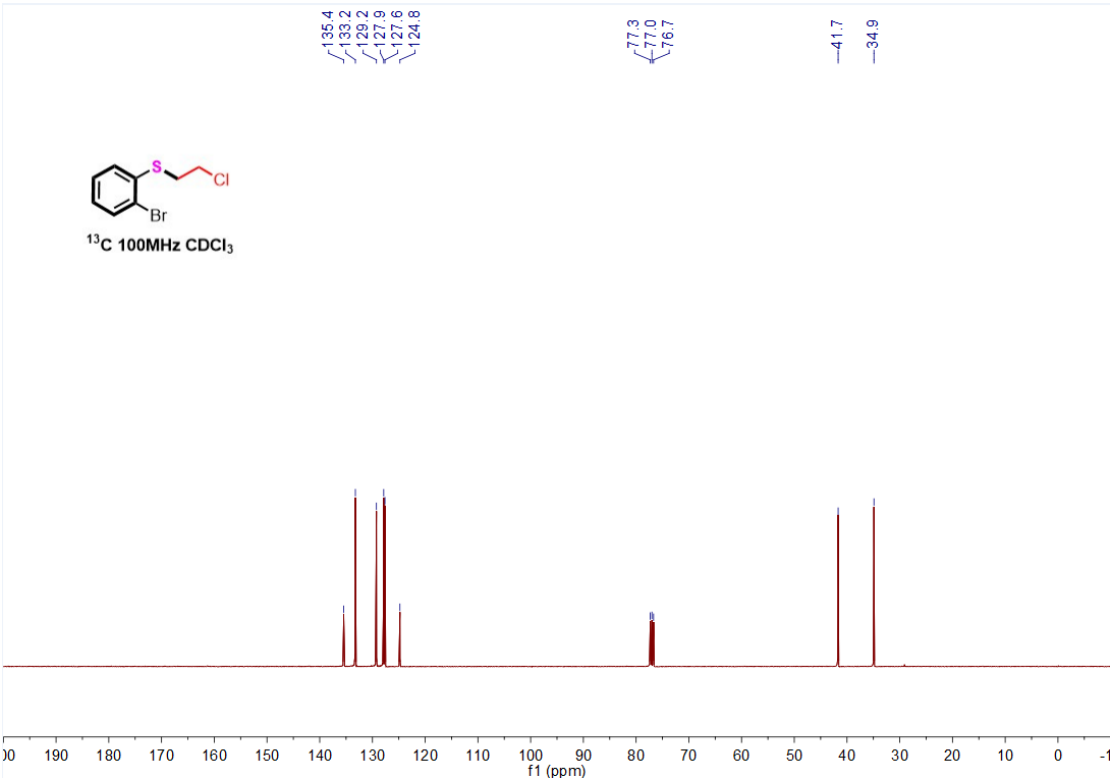
(2-Chloroethyl)(2-methoxyphenyl)sulfide (2j)



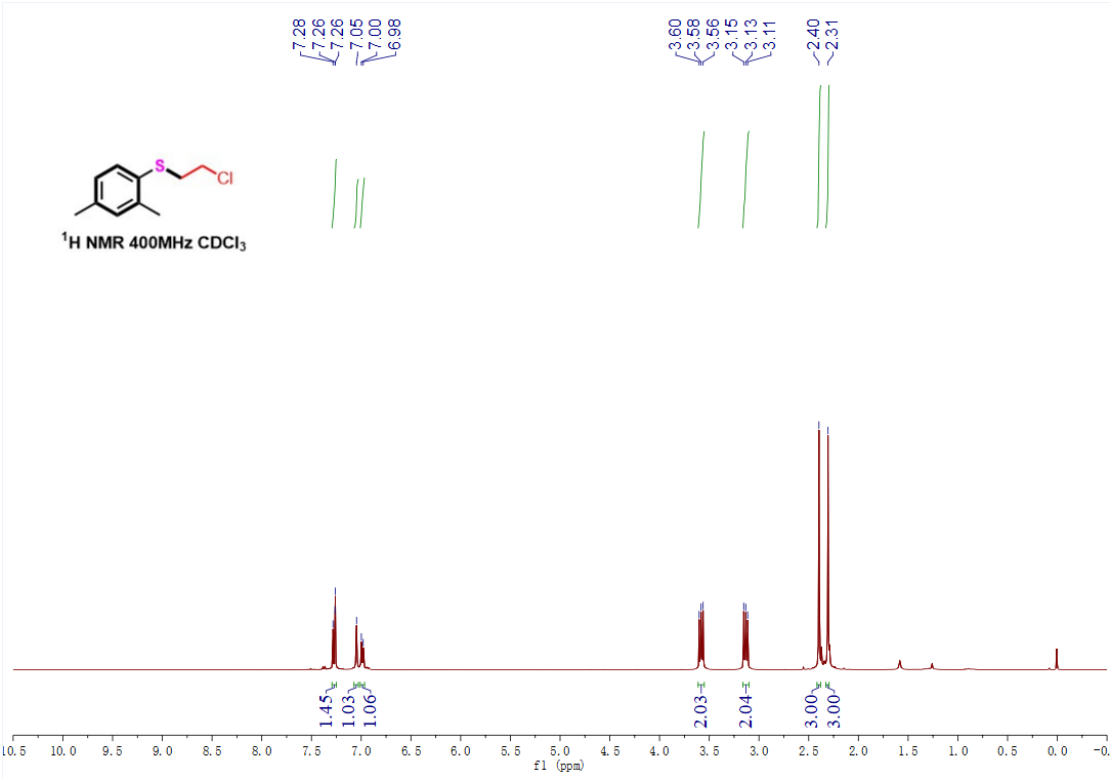


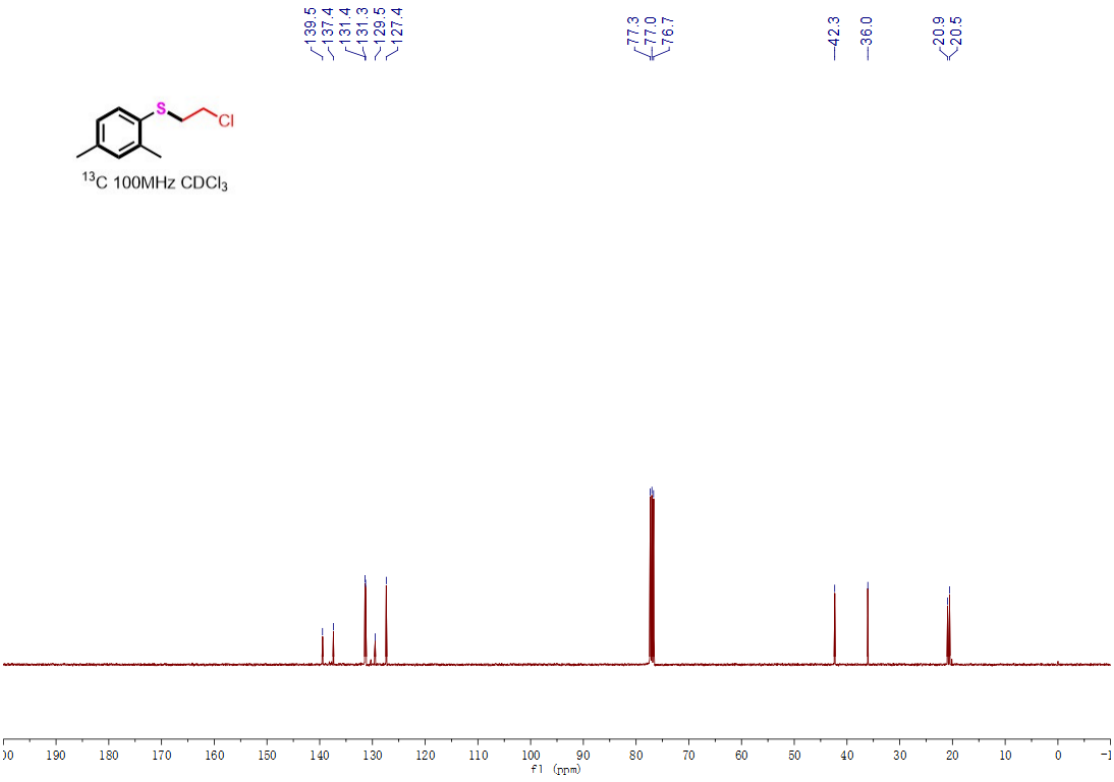
(2-Bromophenyl)(2-chloroethyl)sulfide (2k)



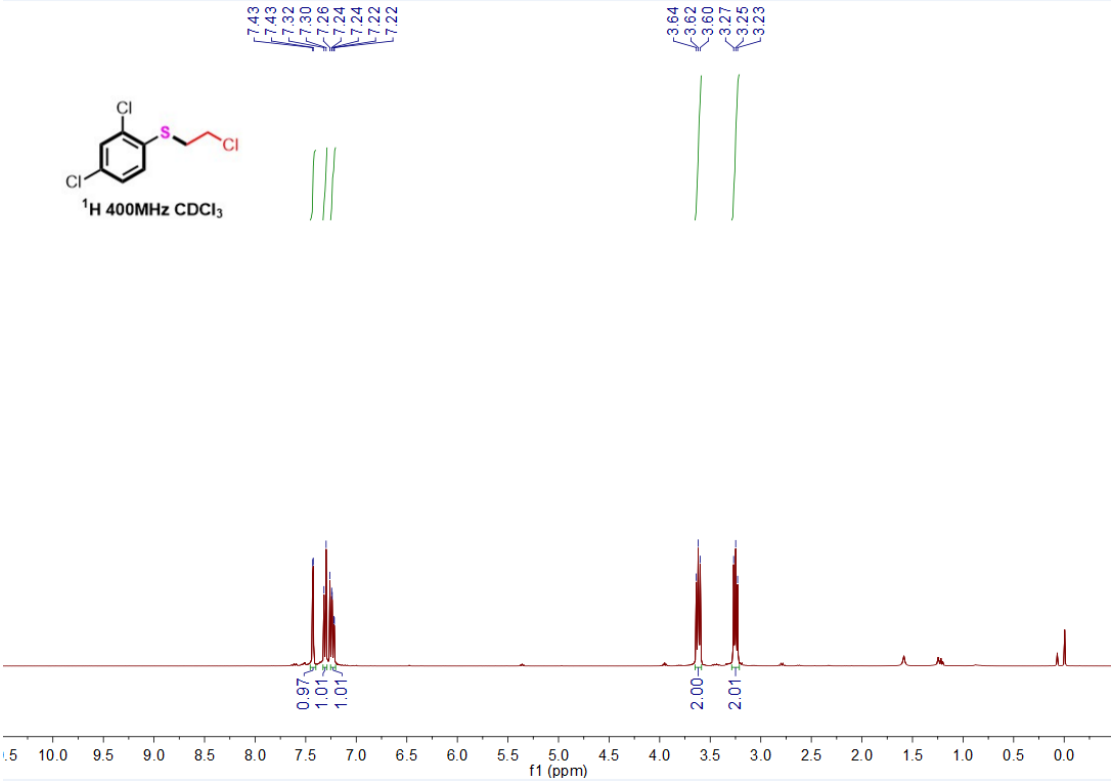


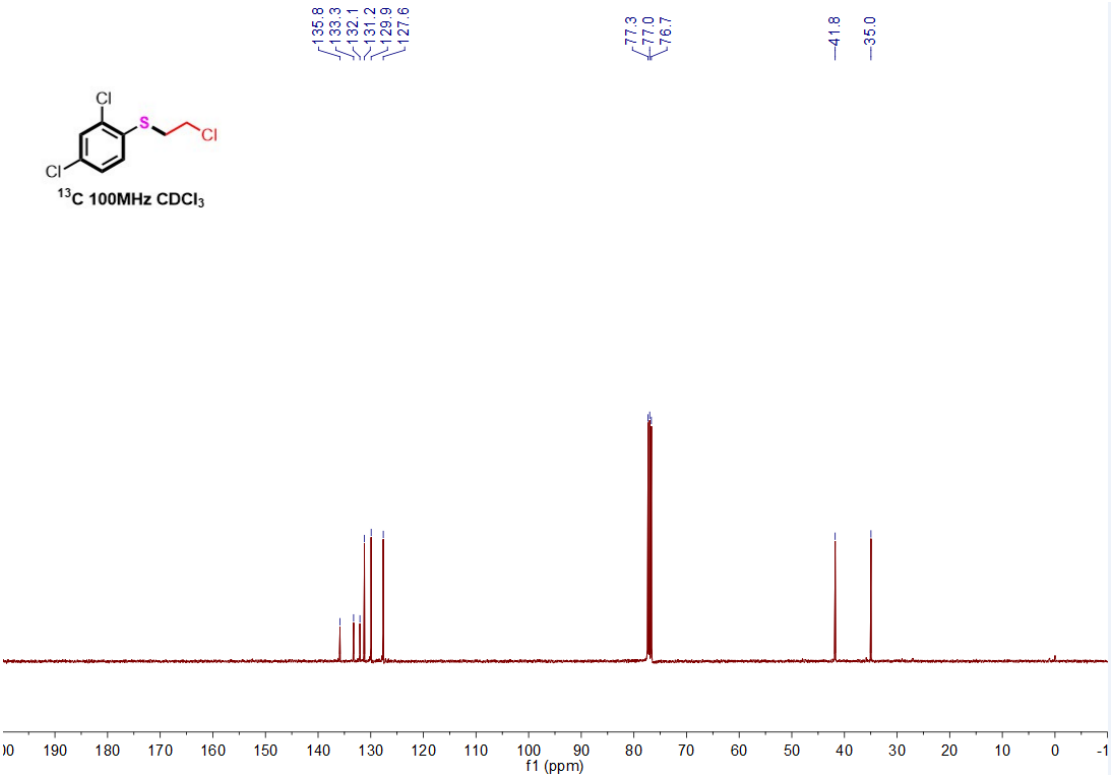
(2-Chloroethyl)(2,4-dimethylphenyl)sulfide (2l)



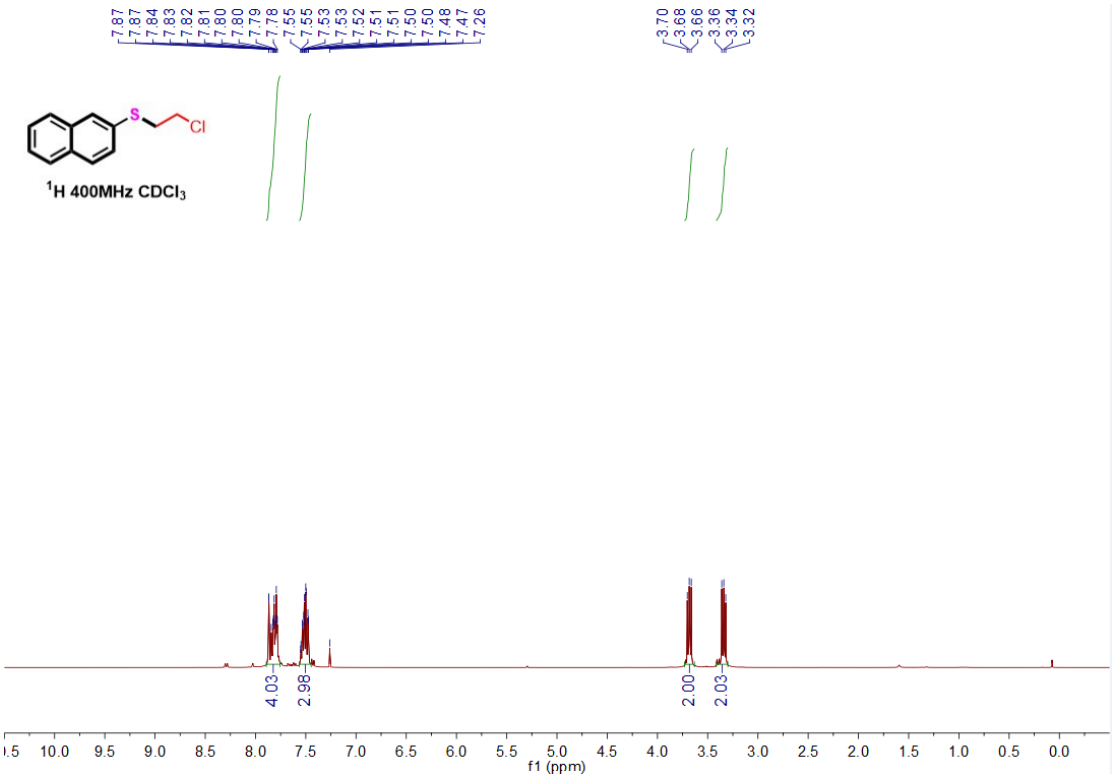


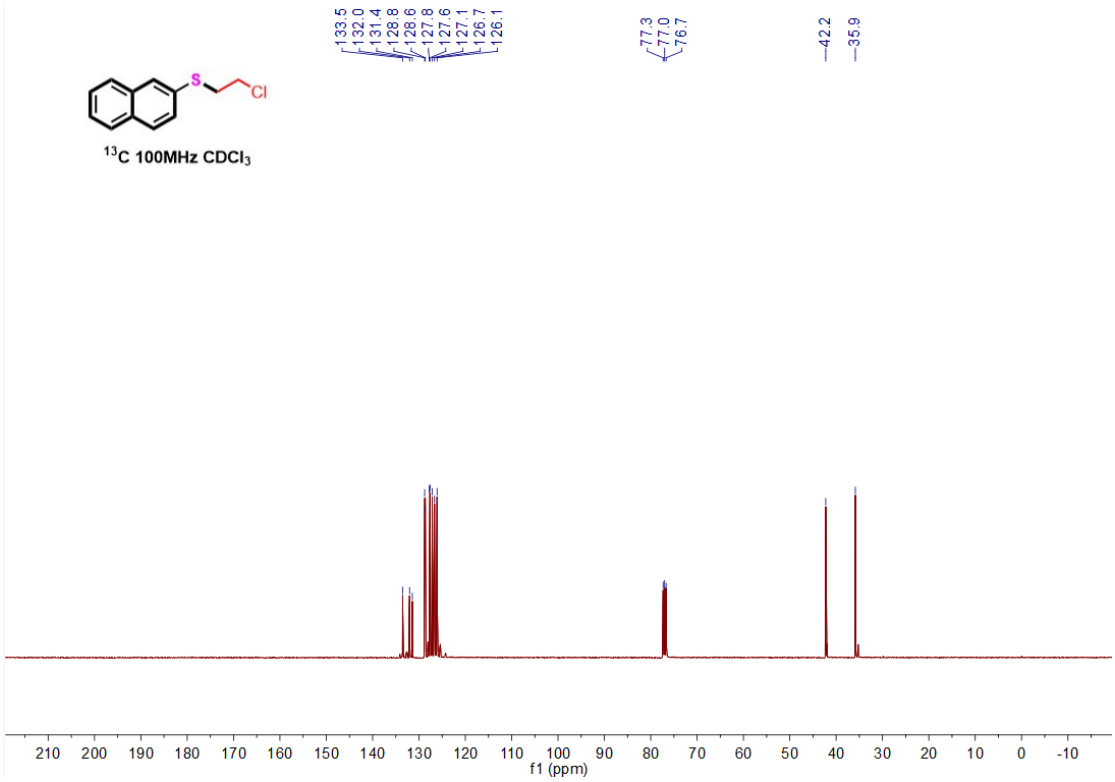
(2-Chloroethyl)(2,4-dichlorophenyl)sulfide (2m)



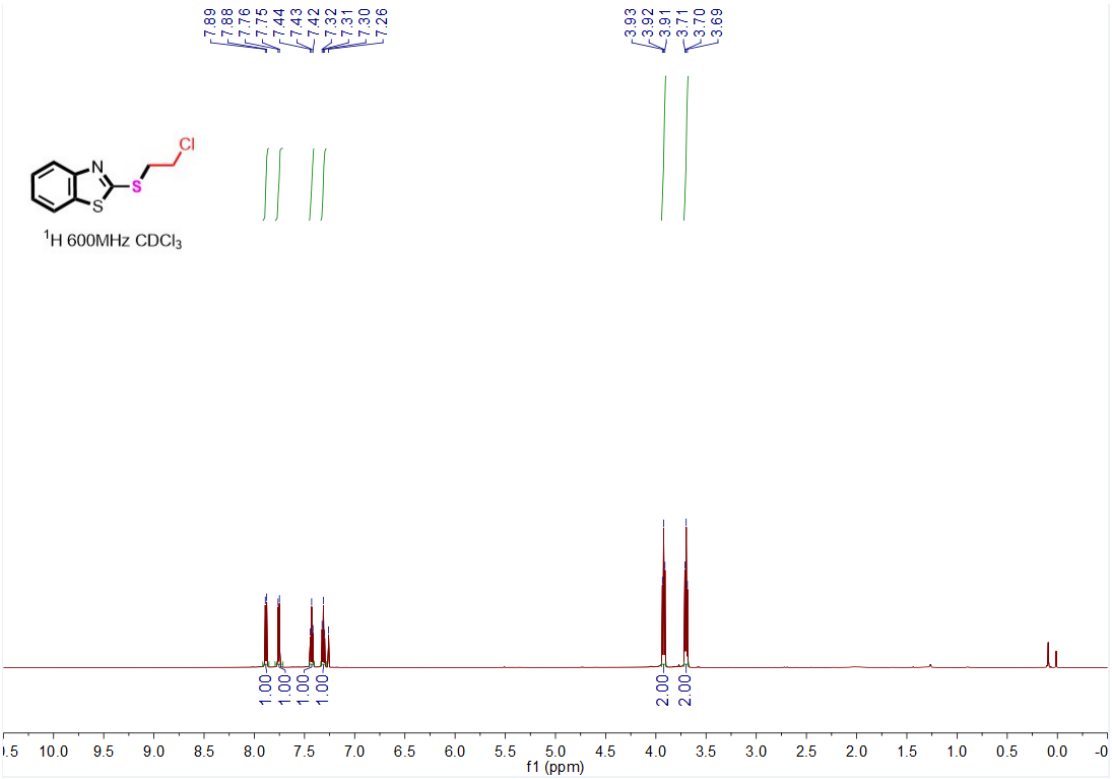


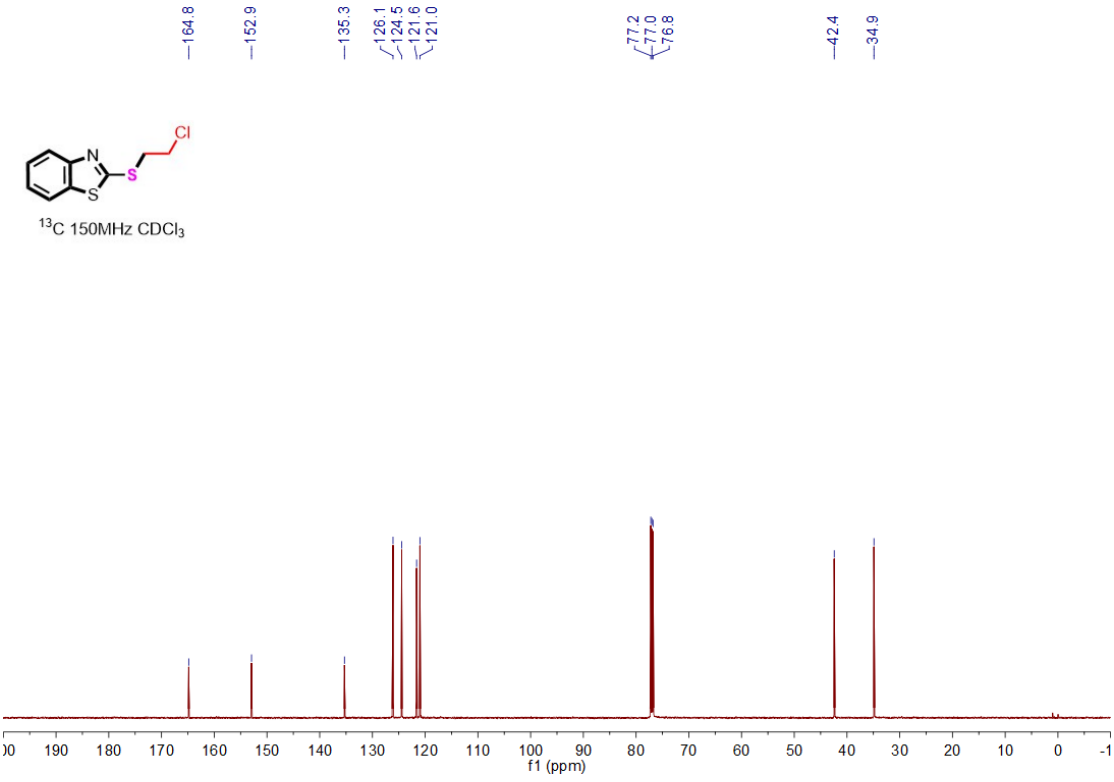
(2-Chloroethyl)(naphthalen-2-yl)sulfide (2n)



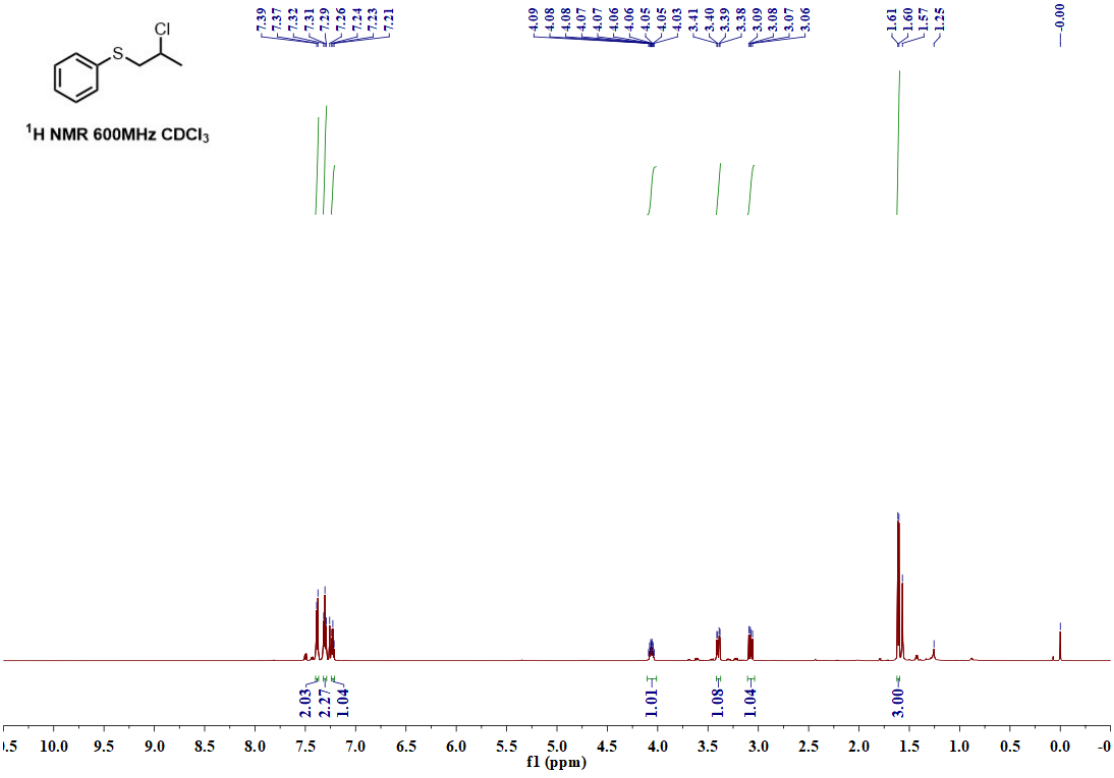


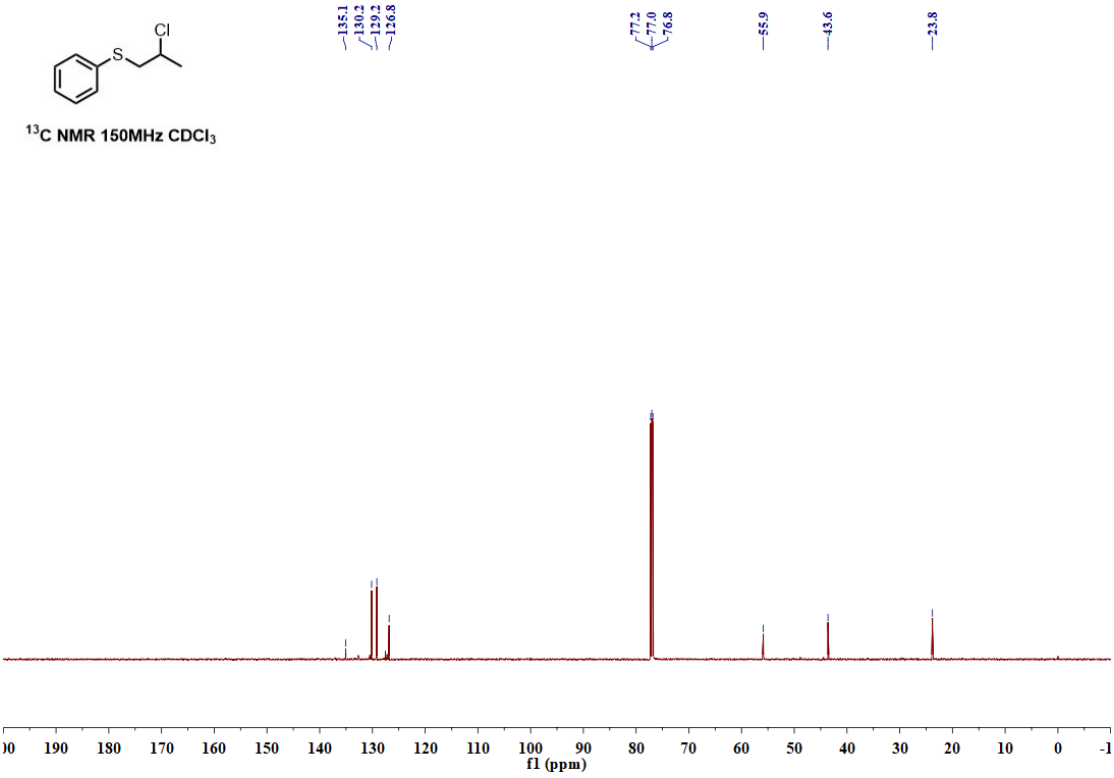
2-((2-Chloroethyl)thio)benzothiazole (2o)



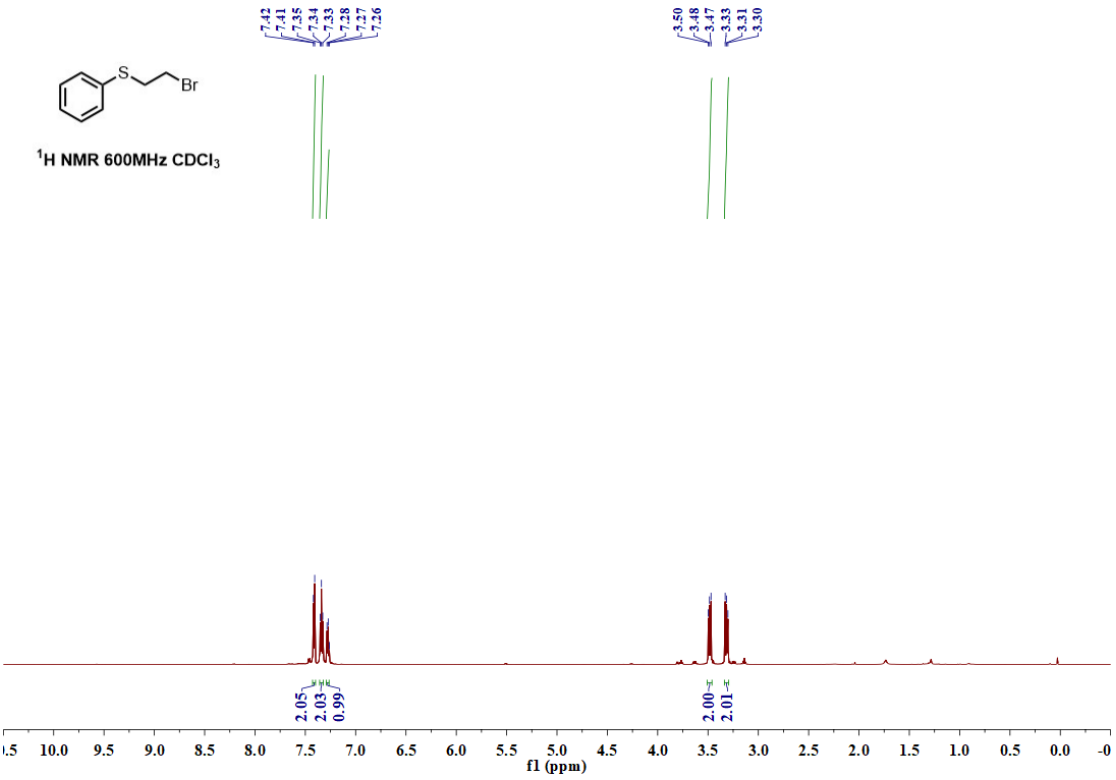


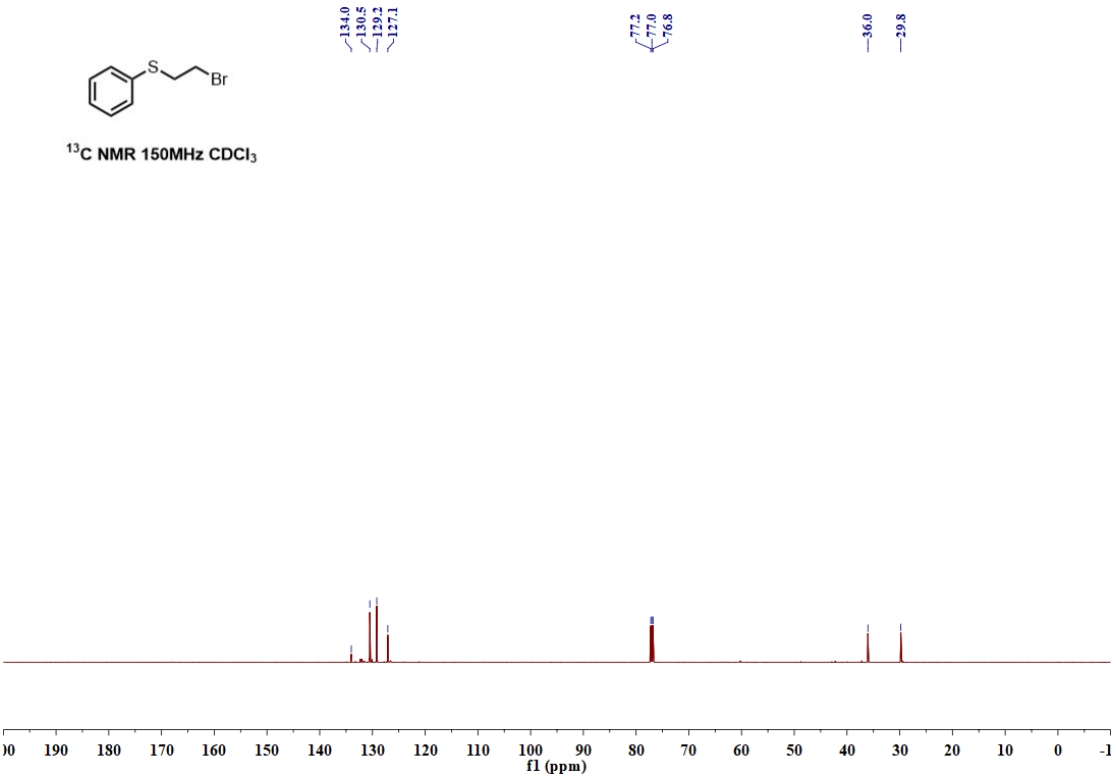
(2-chloropropyl)(phenyl))sulfane (2p)



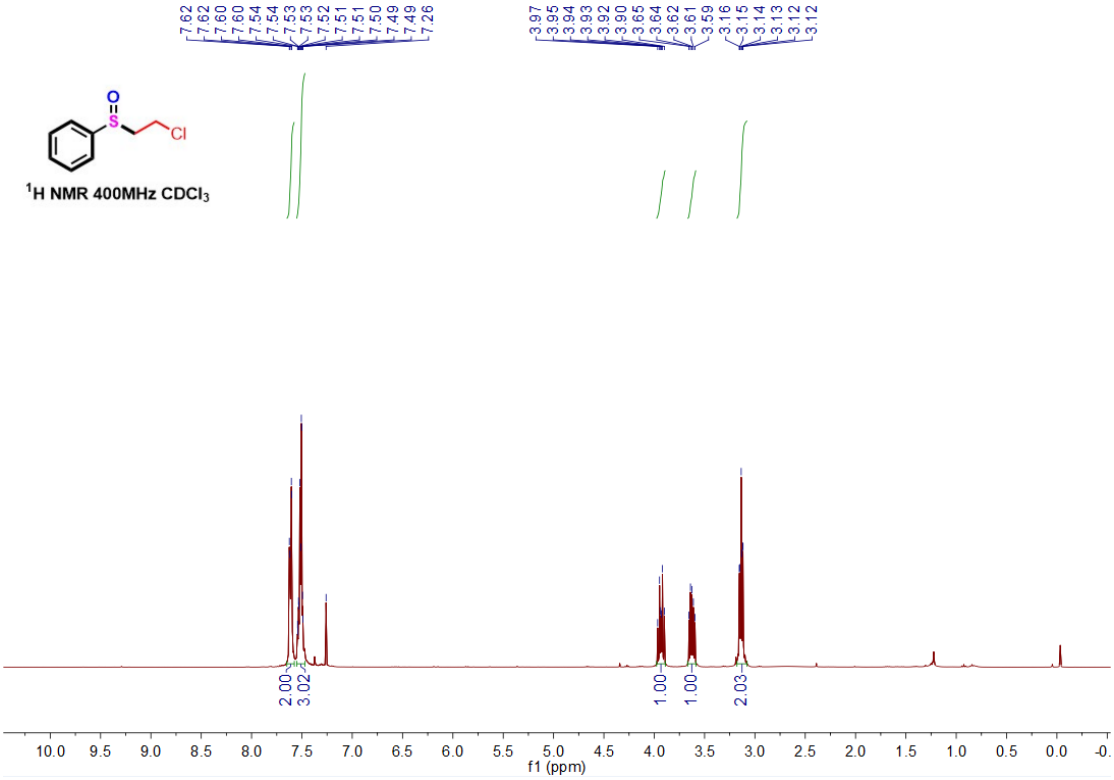


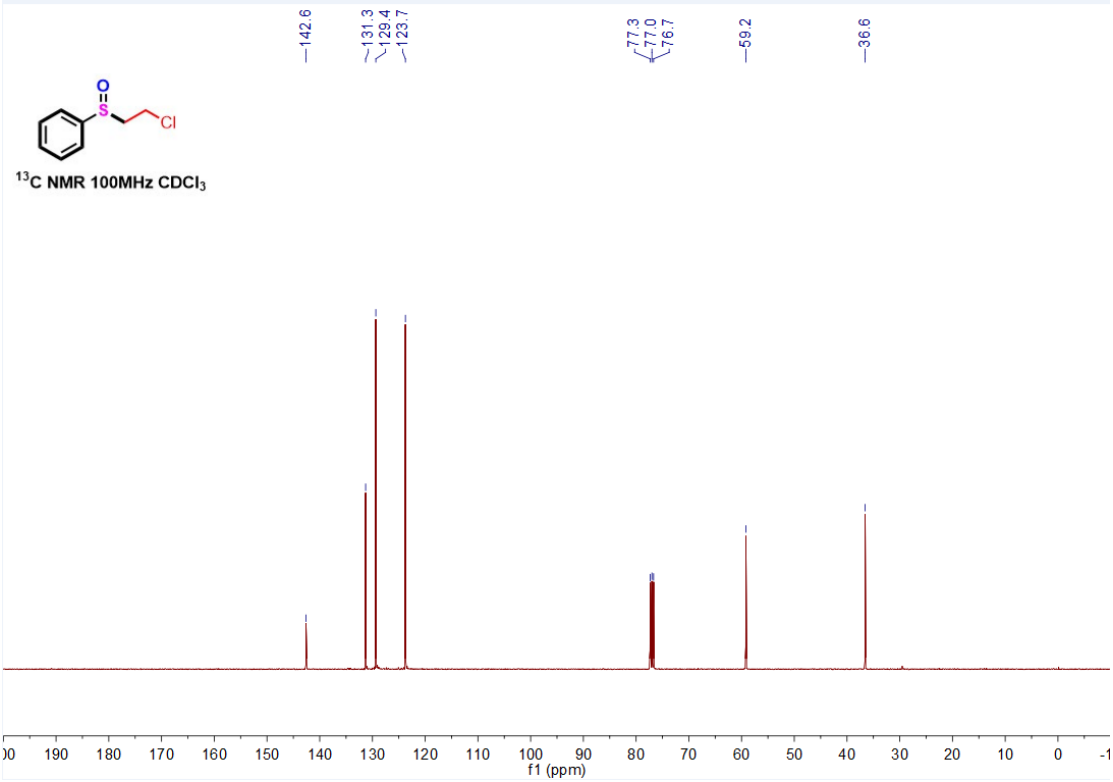
(2-chloropropyl)sulfinyl)benzene (3p)



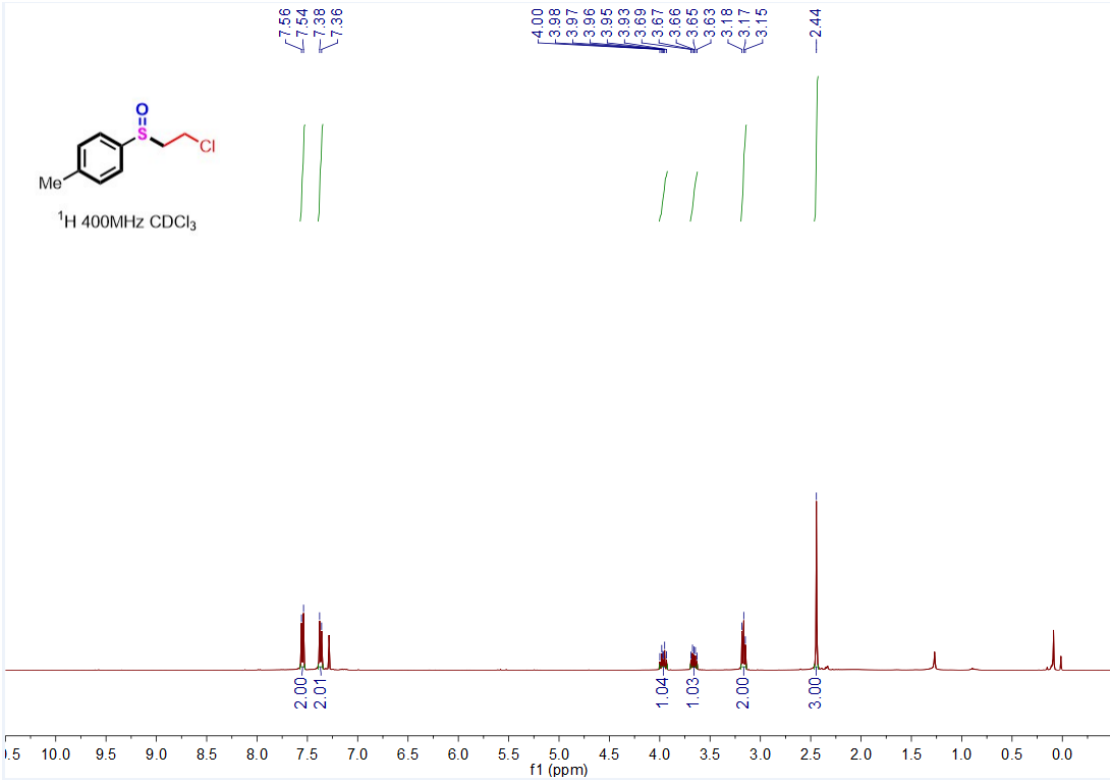


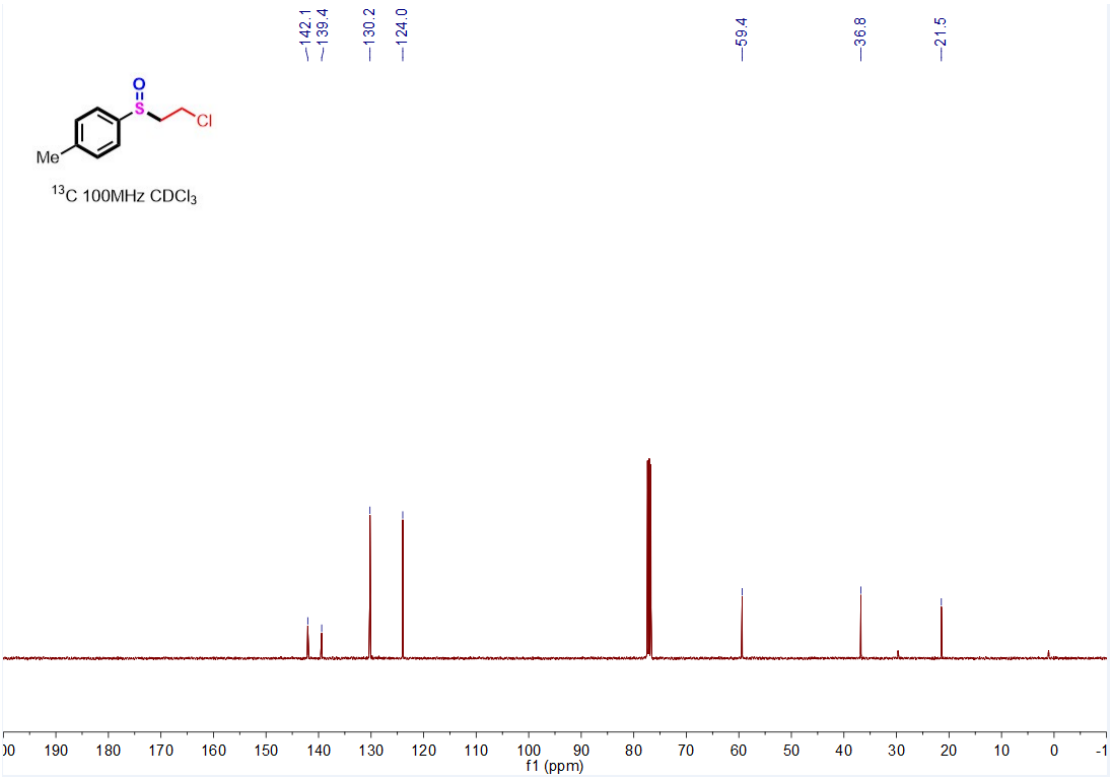
((2-Chloroethyl)sulfinyl)benzene (3a)



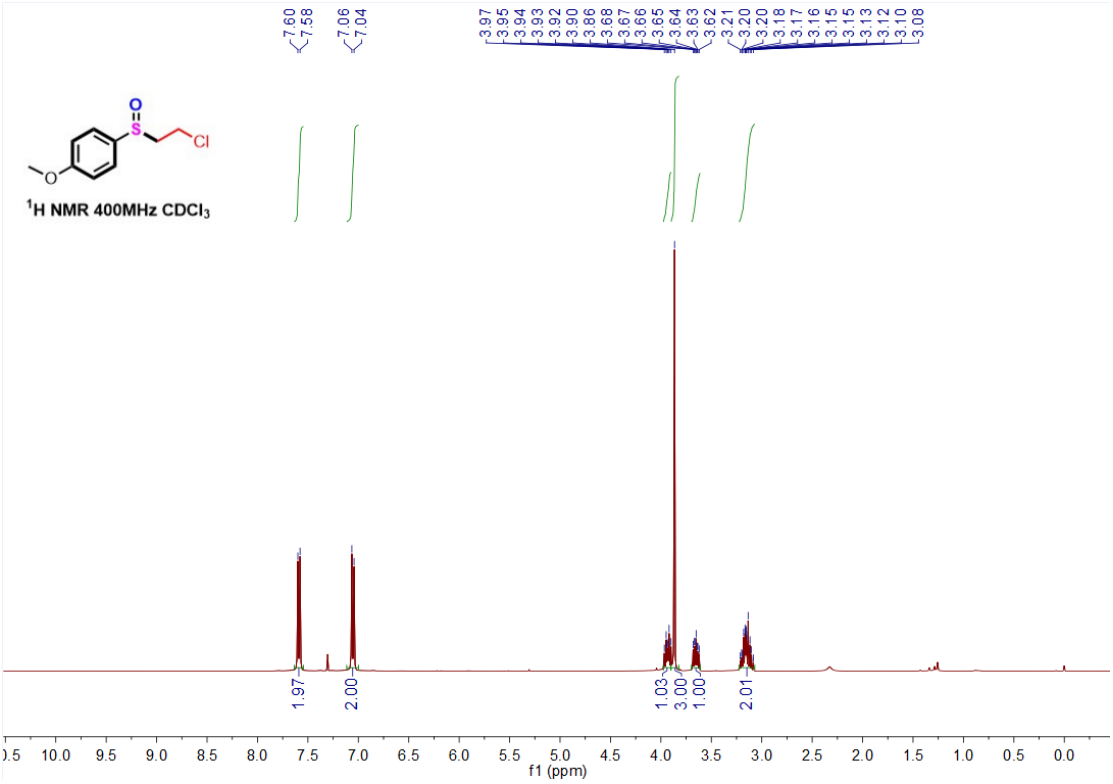


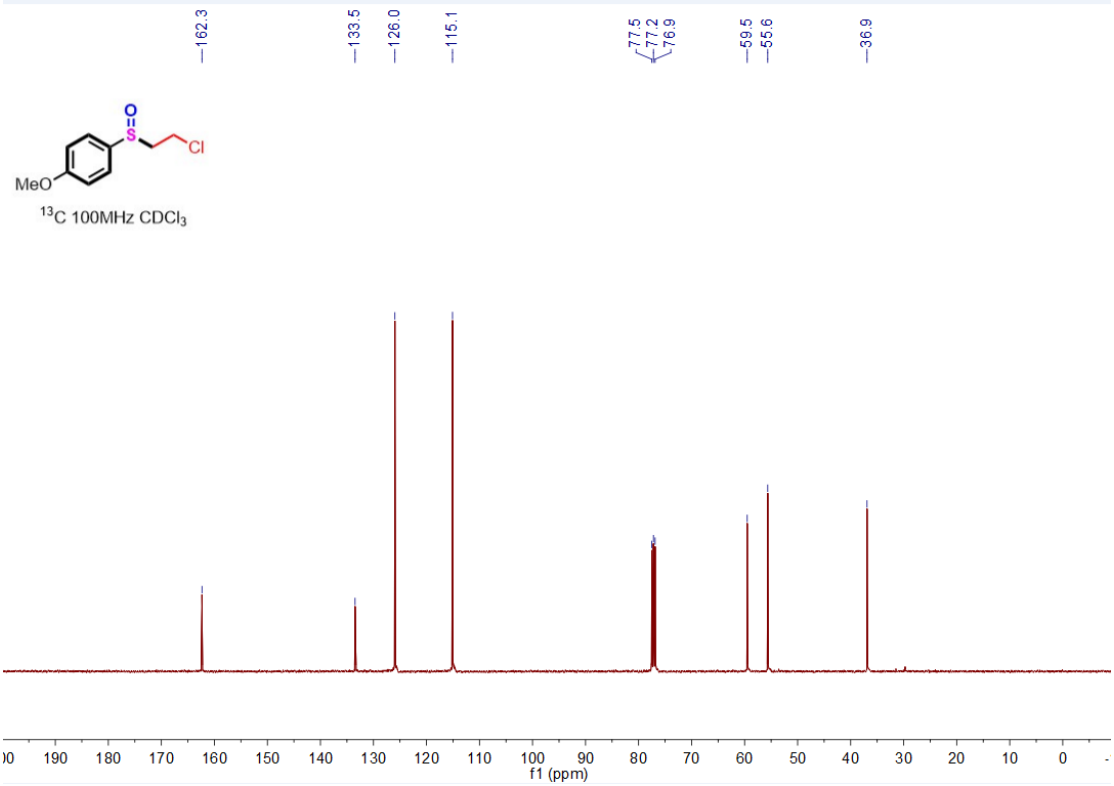
((2-Chloroethyl)sulfinyl)-4-methylbenzene (3b)



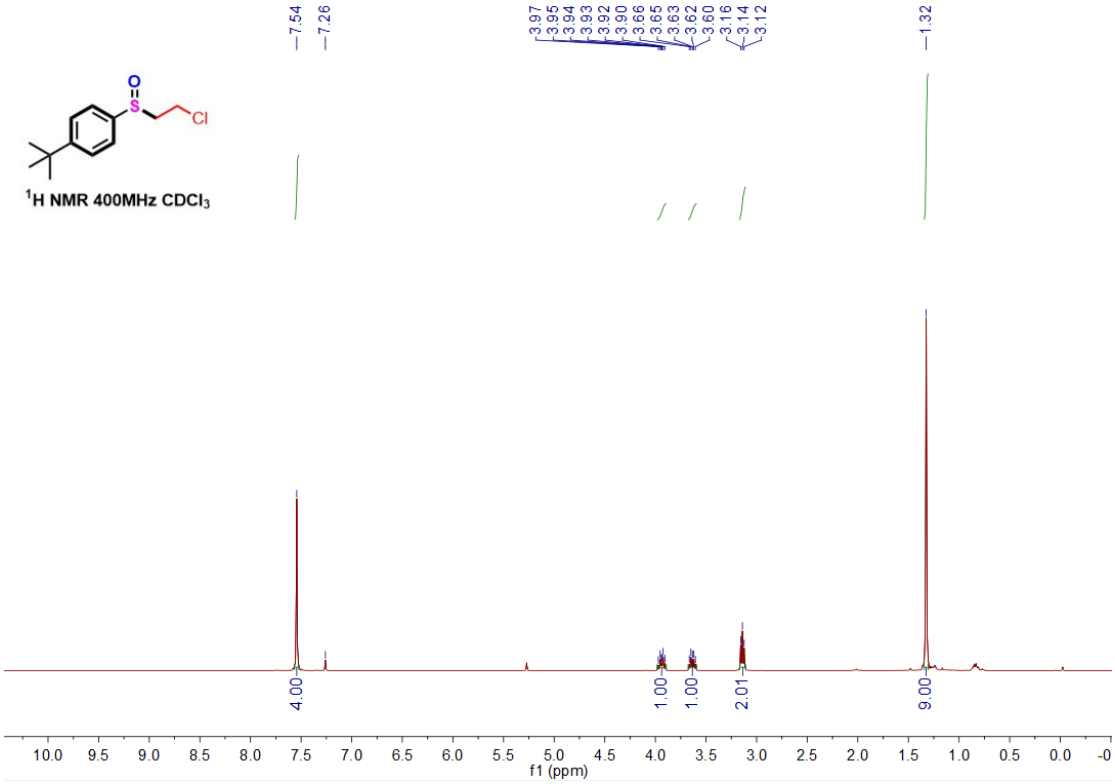


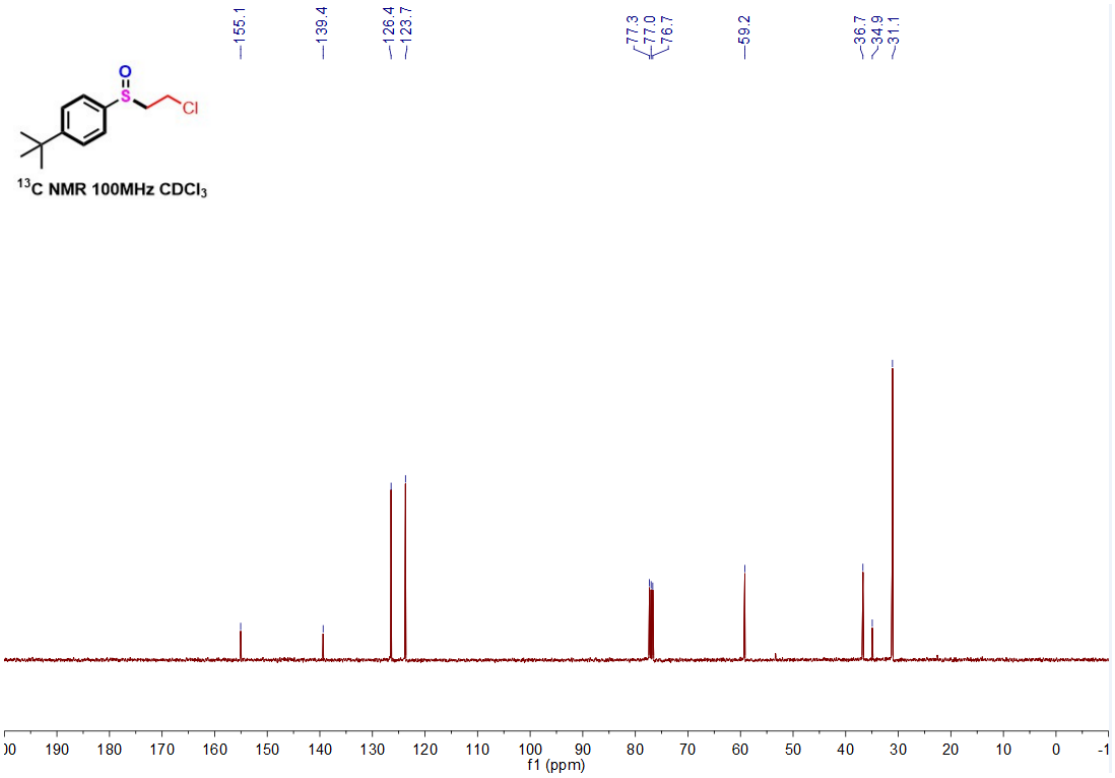
((2-Chloroethyl)sulfinyl)-4-methoxybenzene (3c)



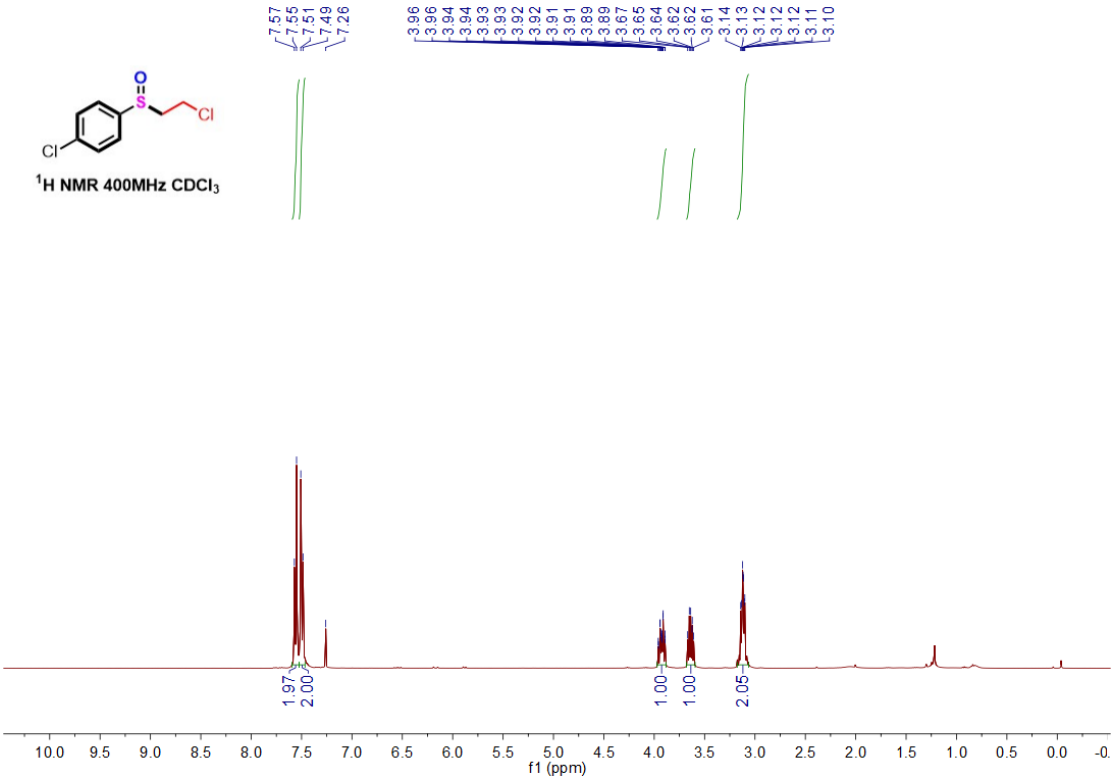


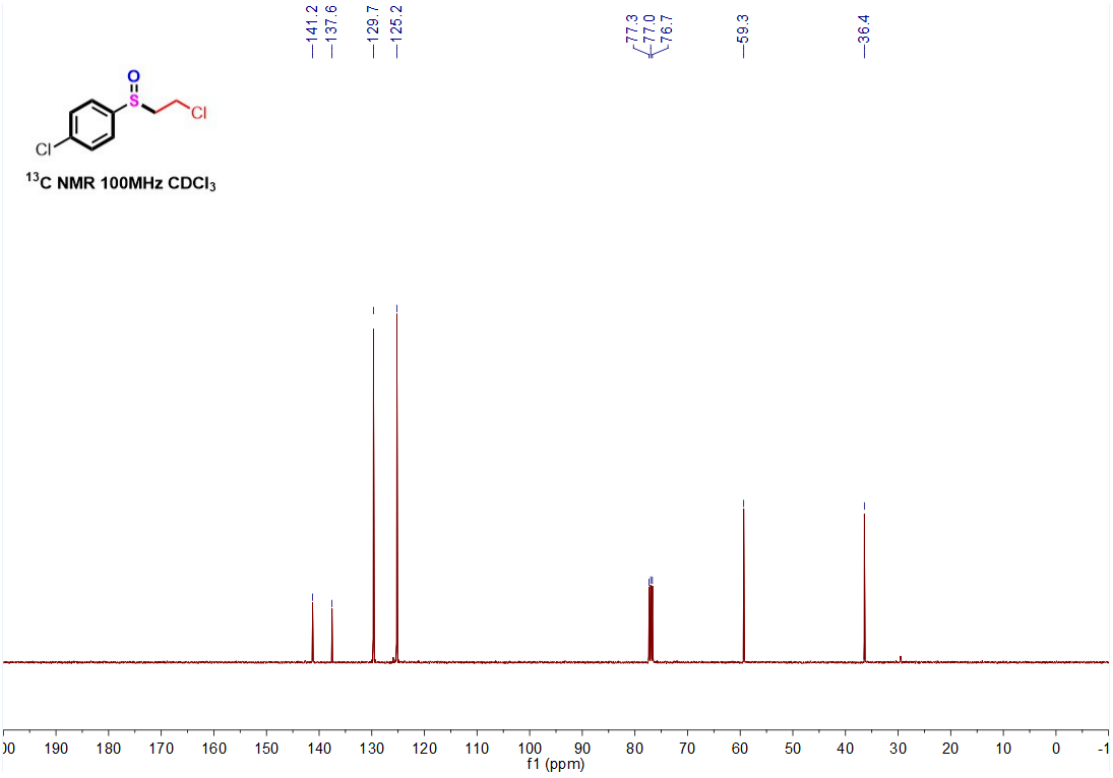
(tert-Butyl)-4-((2-chloroethyl)sulfinyl)benzene (3d)



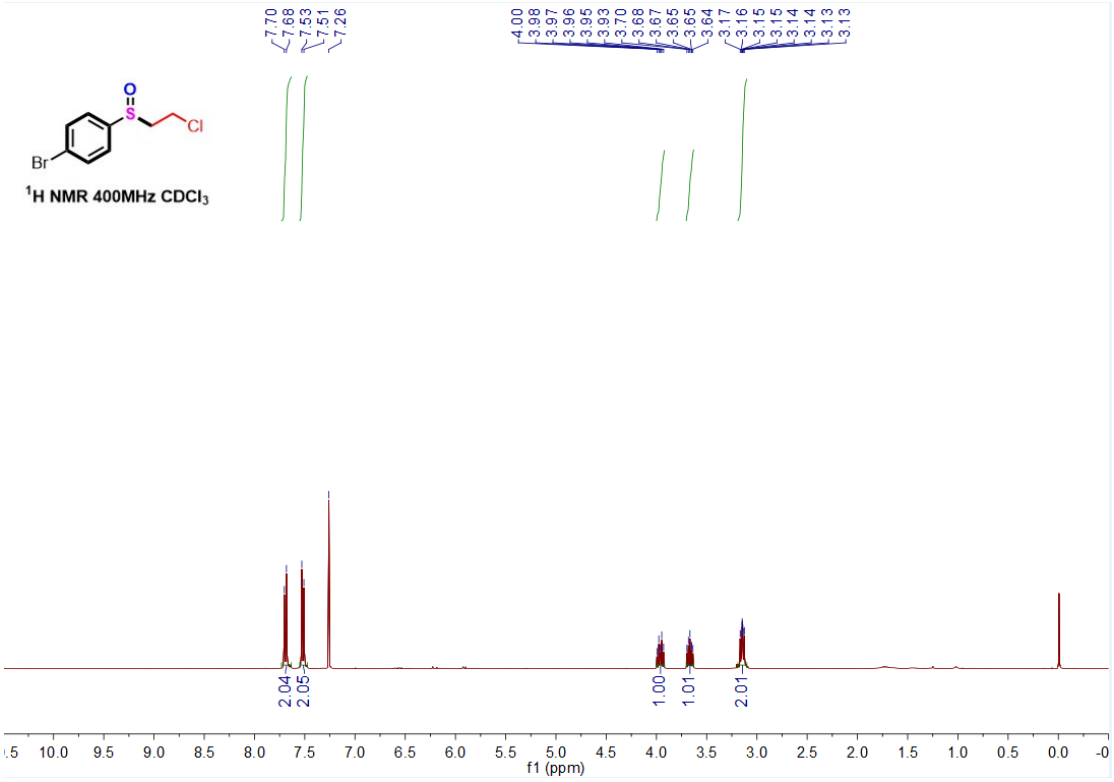


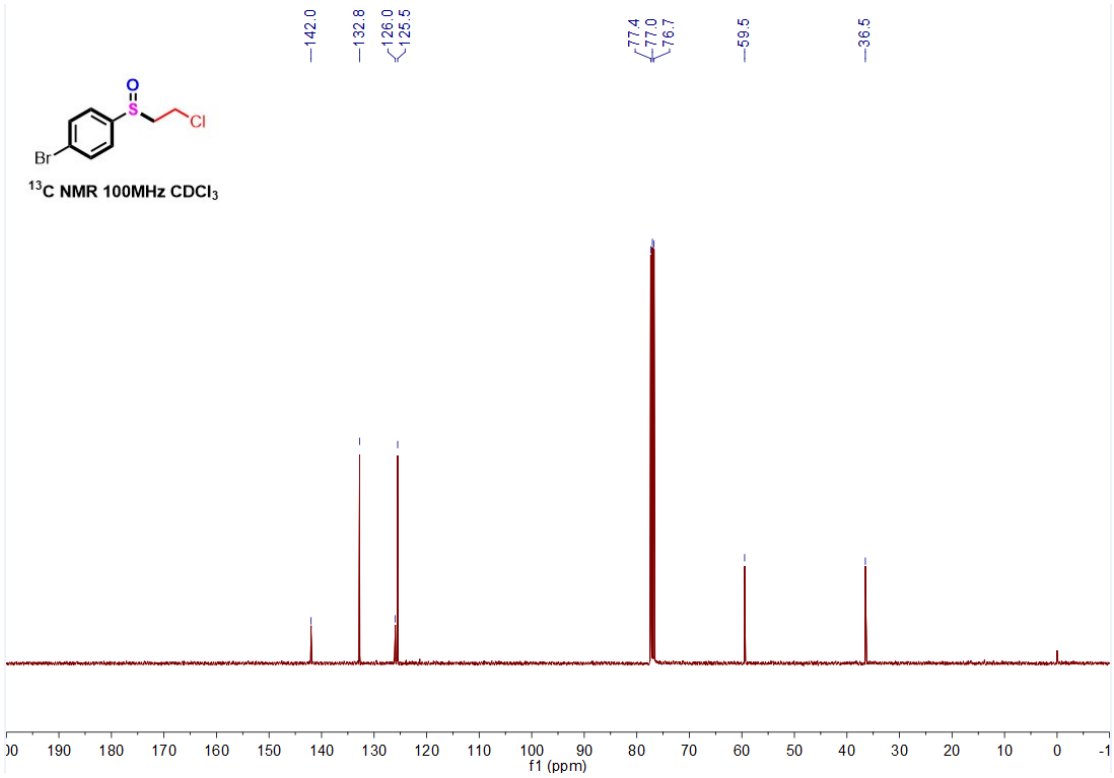
1-Chloro-4-((2-chloroethyl)sulfinyl)benzene (3e)



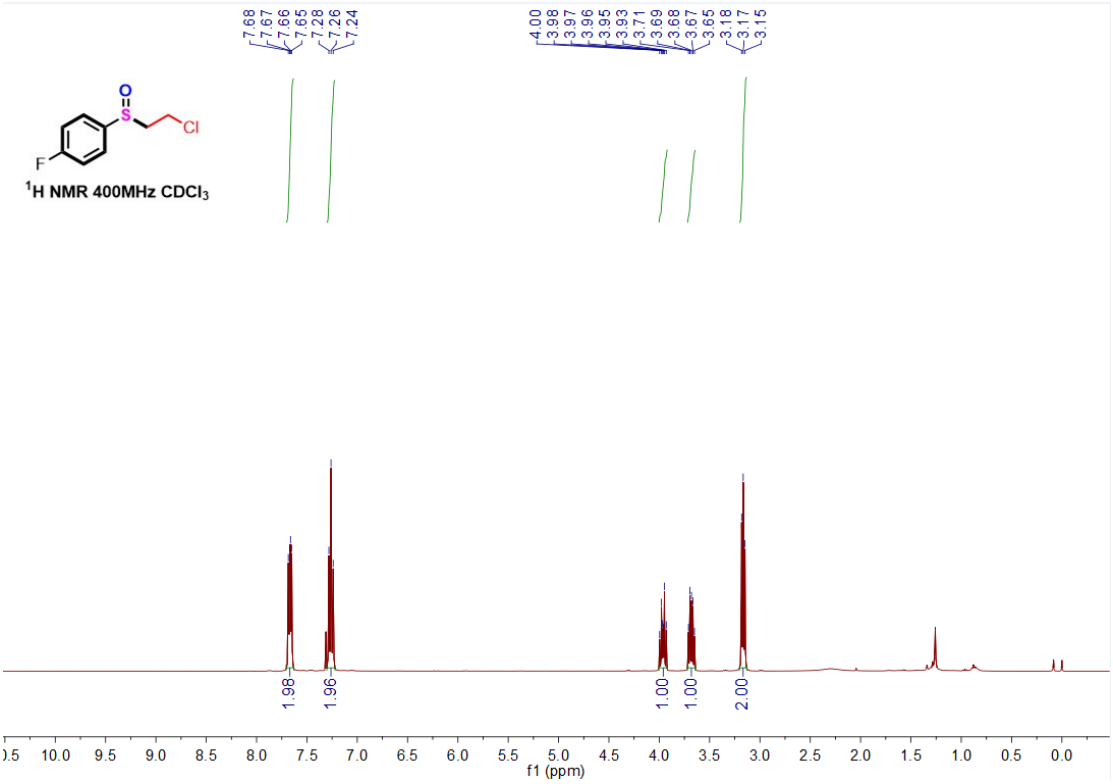


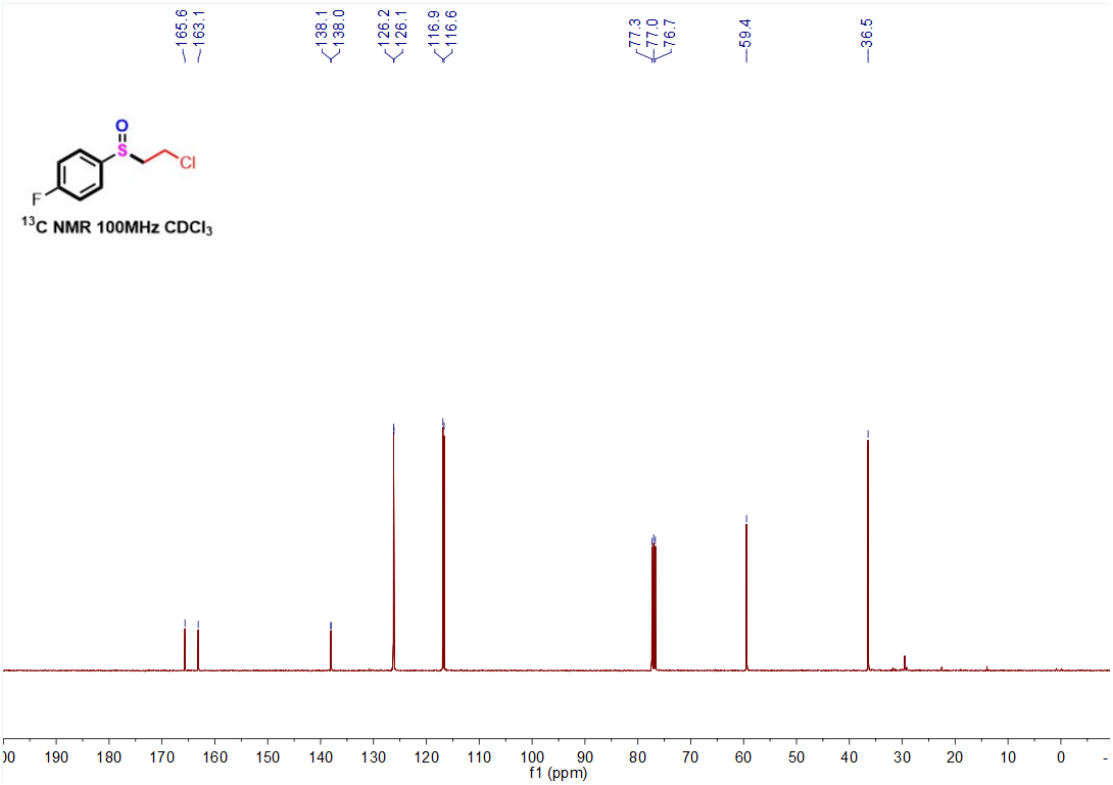
1-Bromo-4-((2-chloroethyl)sulfinyl)benzene (3f)

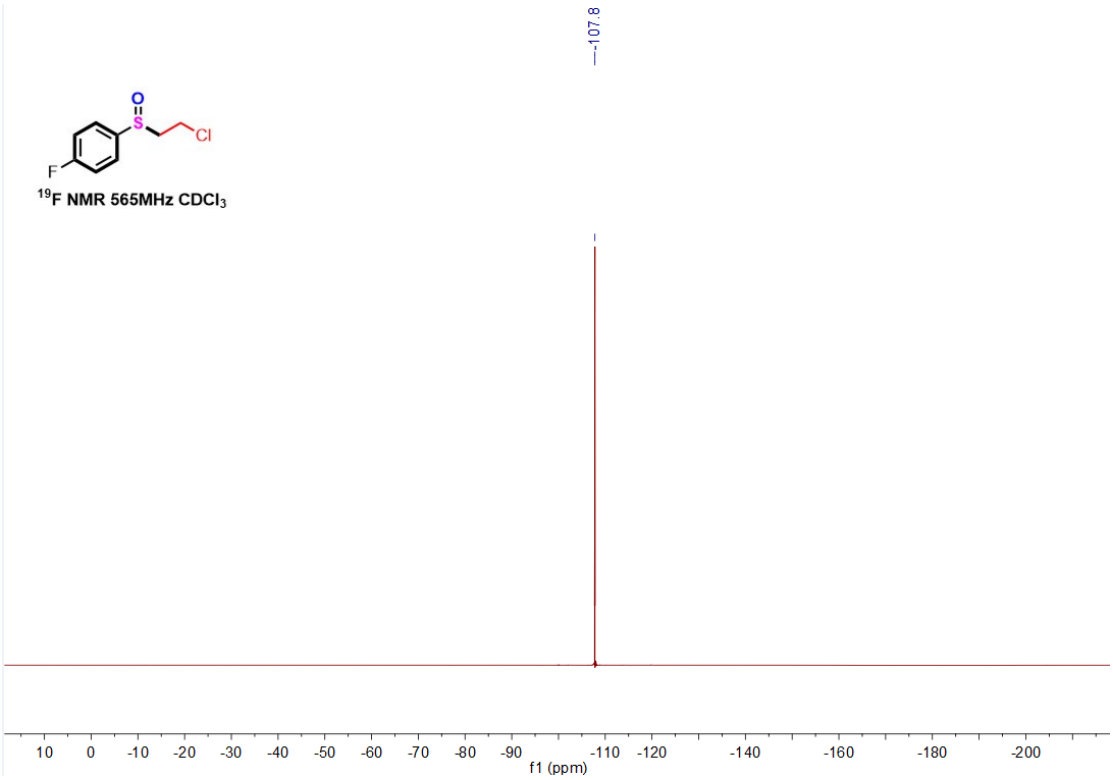




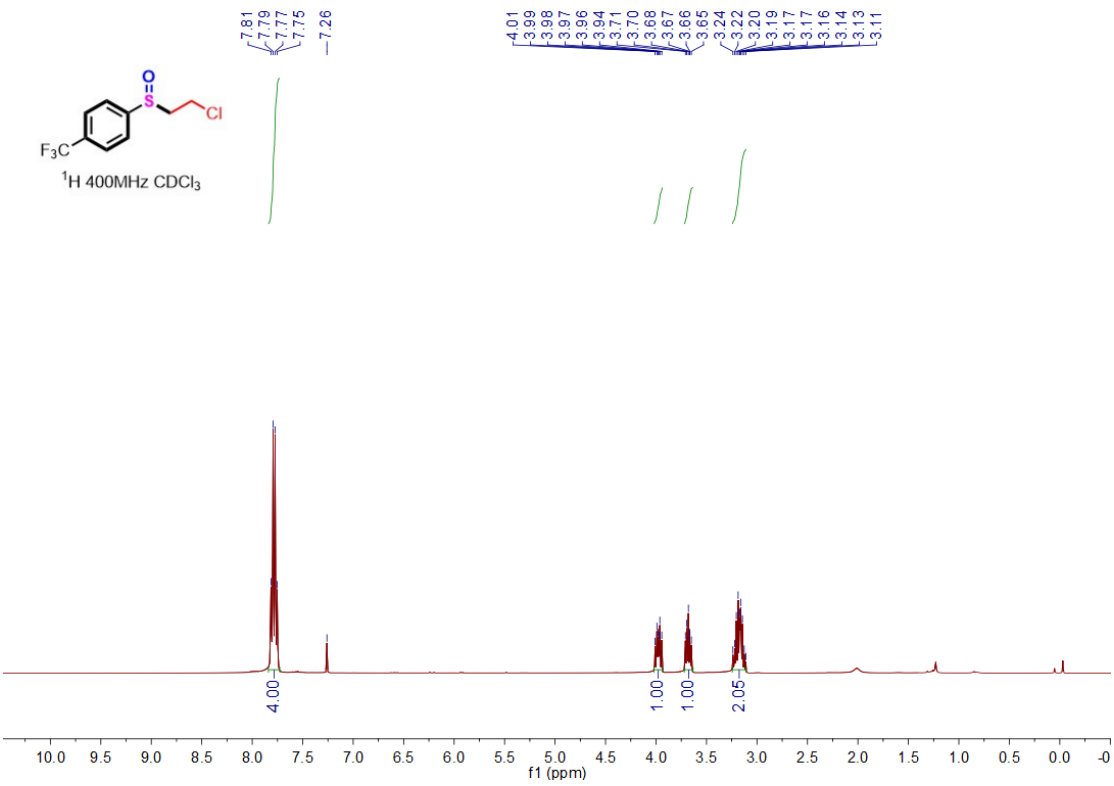
((2-Chloroethyl)sulfinyl)-4-fluorobenzene (3g)

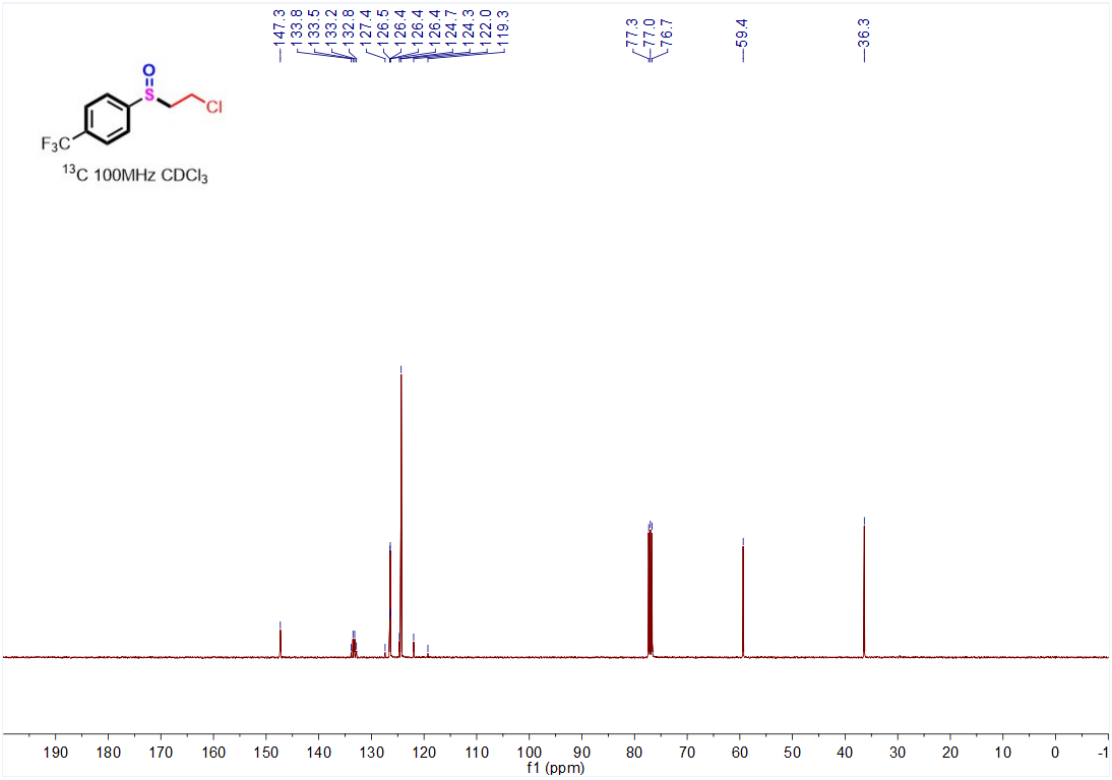






((2-Chloroethyl)sulfinyl)-4-(trifluoromethyl)benzene (3h)

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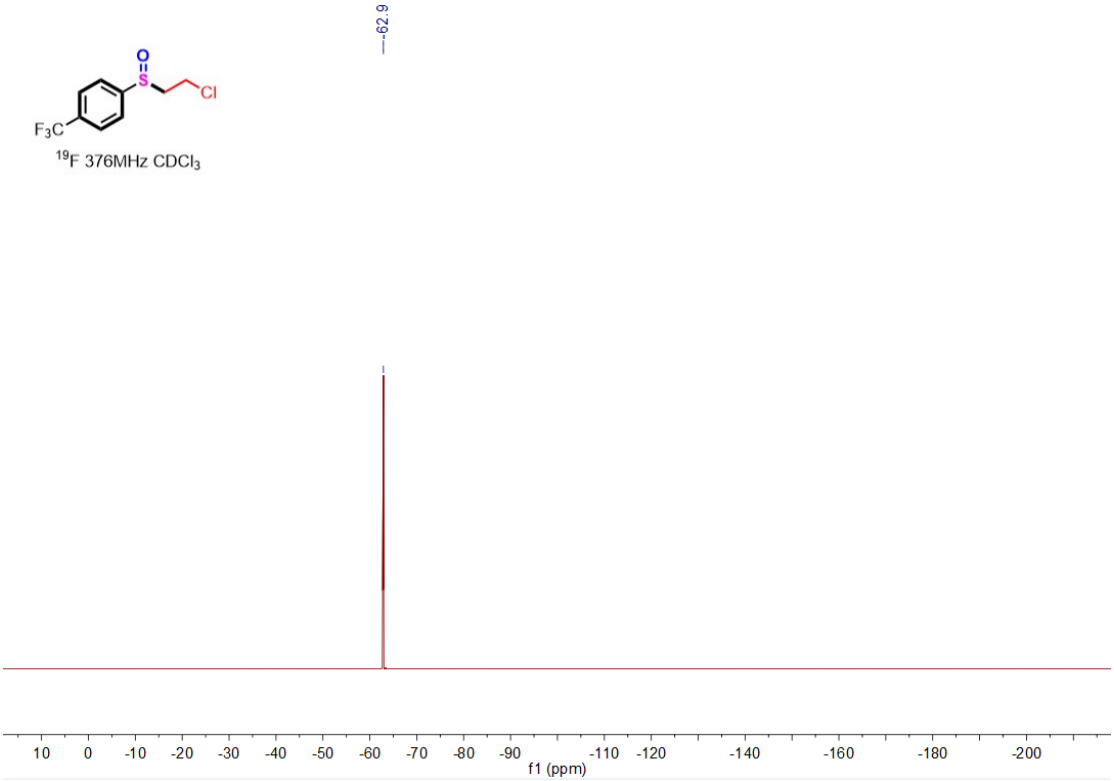
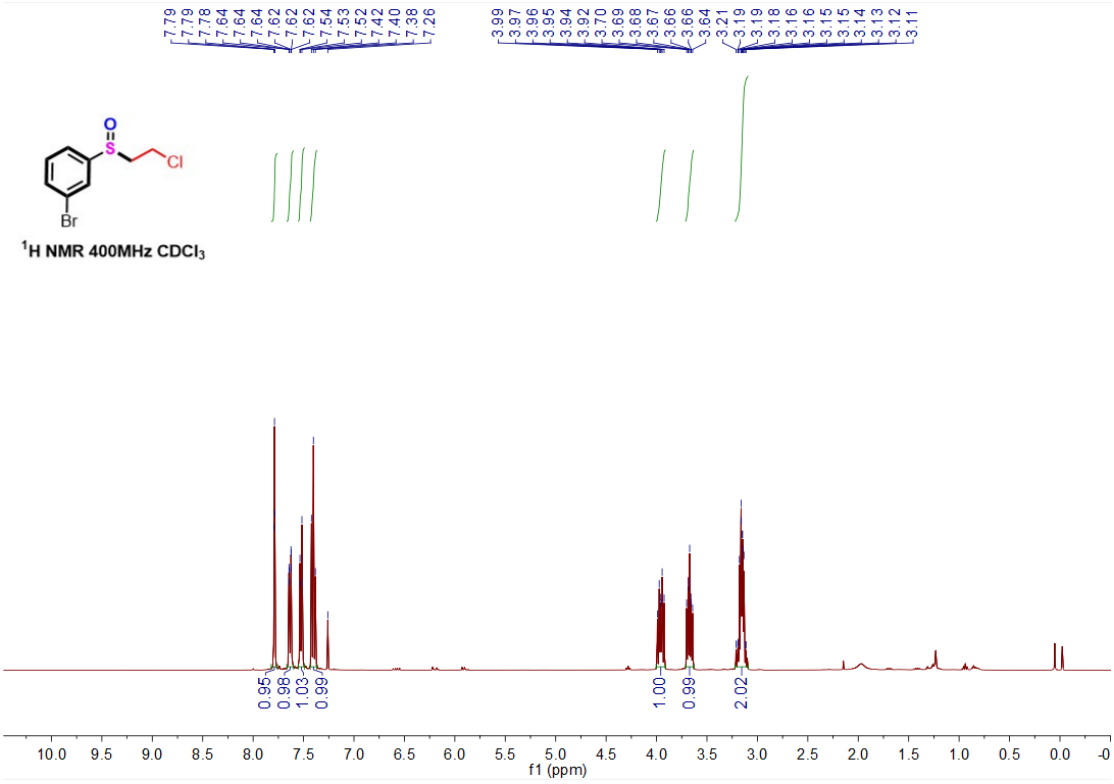
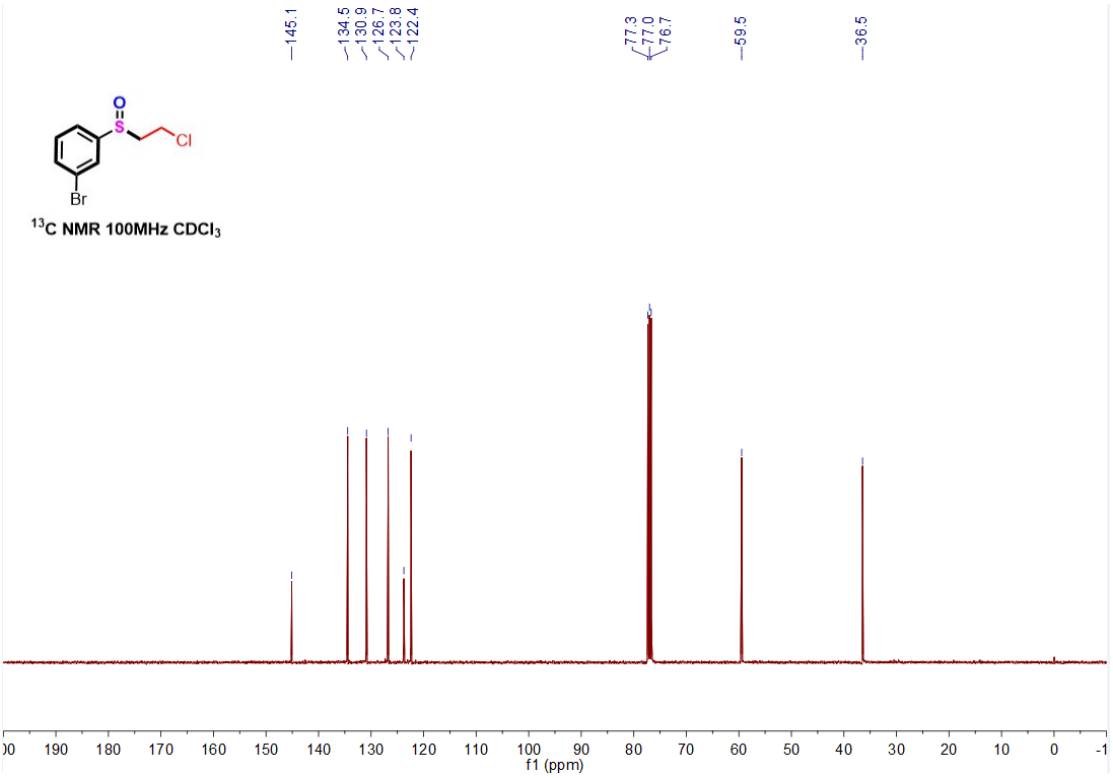
133.8
133.5
133.2
132.8
127.4
126.5
126.4
126.4
126.4
124.7
124.3
122.0
119.3
77.3
77.0
76.7
59.4
36.3
O
S
Cl
F3C
13C 100MHz CDCl3
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

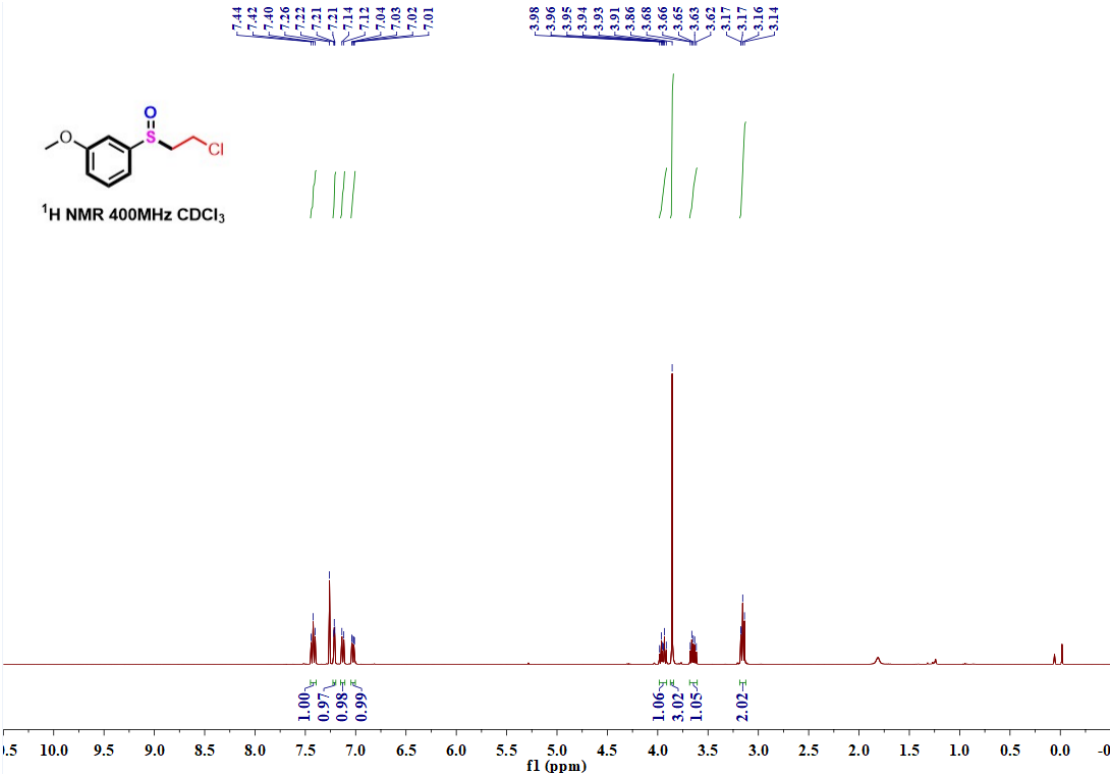

-62.9
O
S
Cl
F3C
19F 376MHz CDCl3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -120 -140 -160 -180 -200
f1 (ppm)

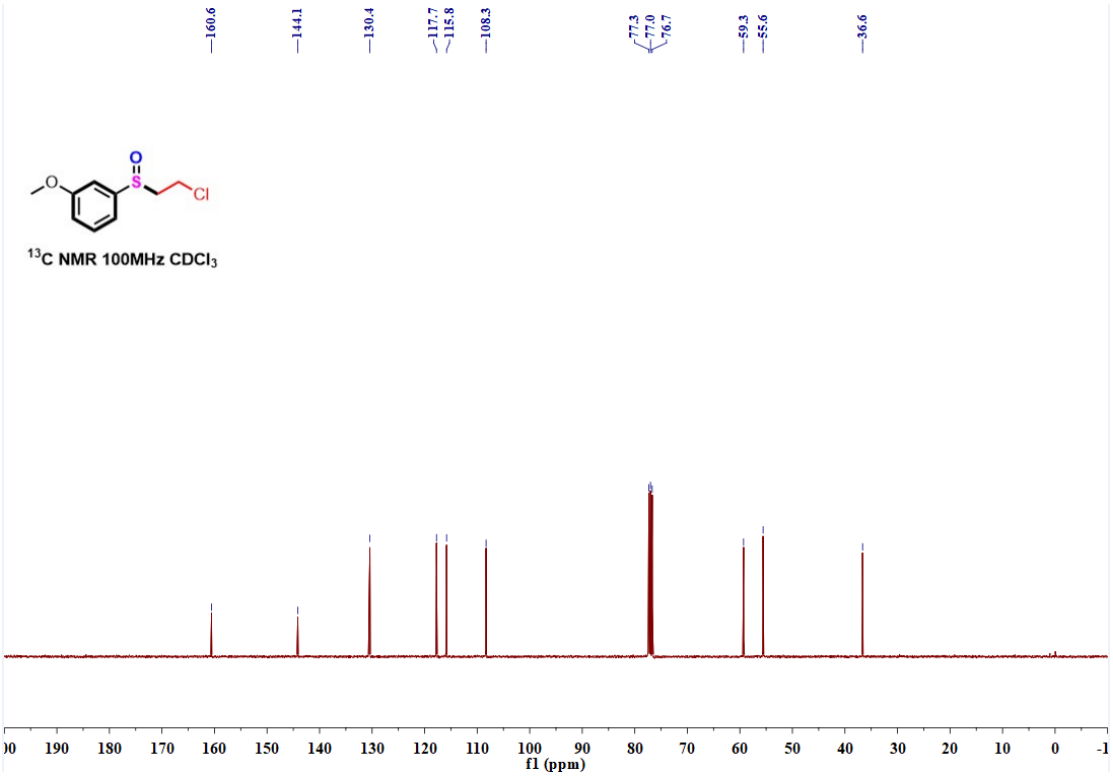
1-Bromo-3-((2-chloroethyl)sulfinyl)benzene (3i)



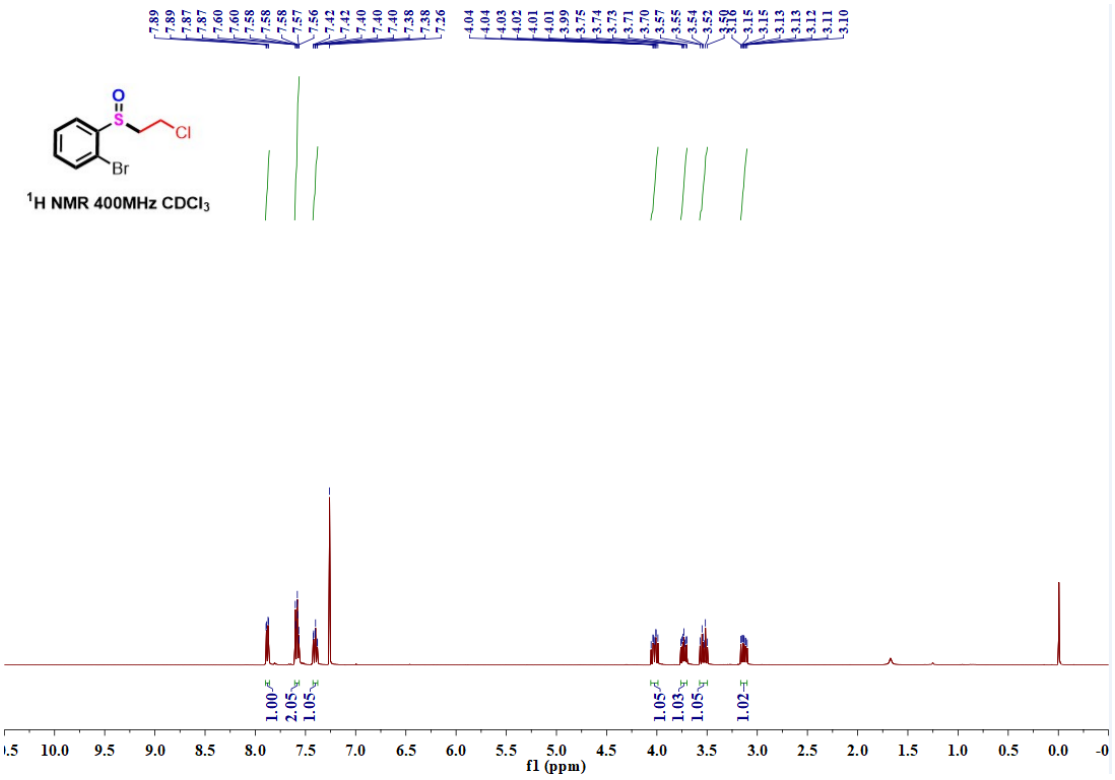


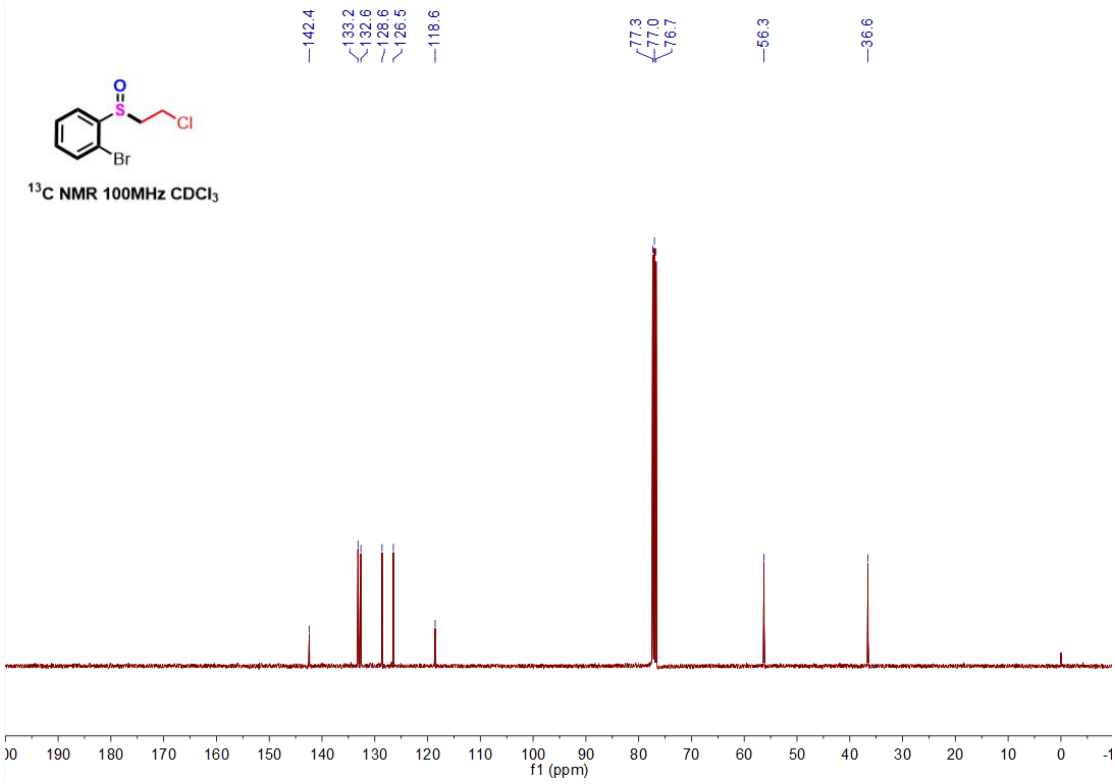
((2-Chloroethyl)sulfinyl)-3-methoxybenzene (3j)



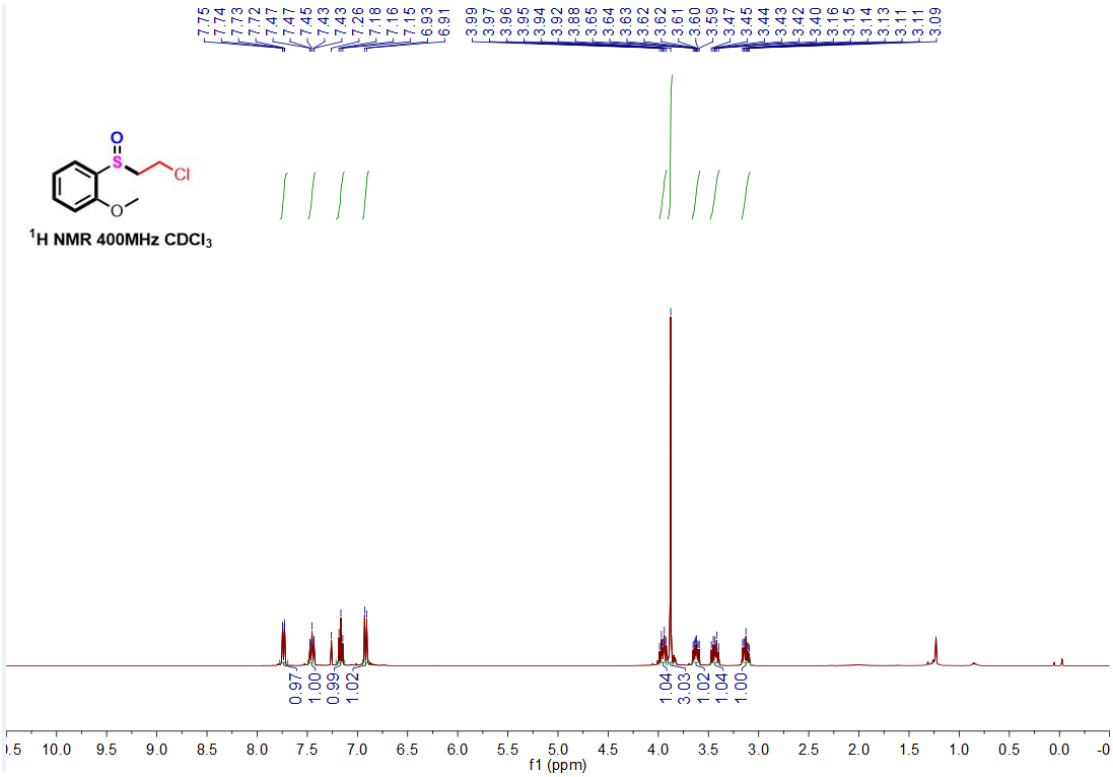


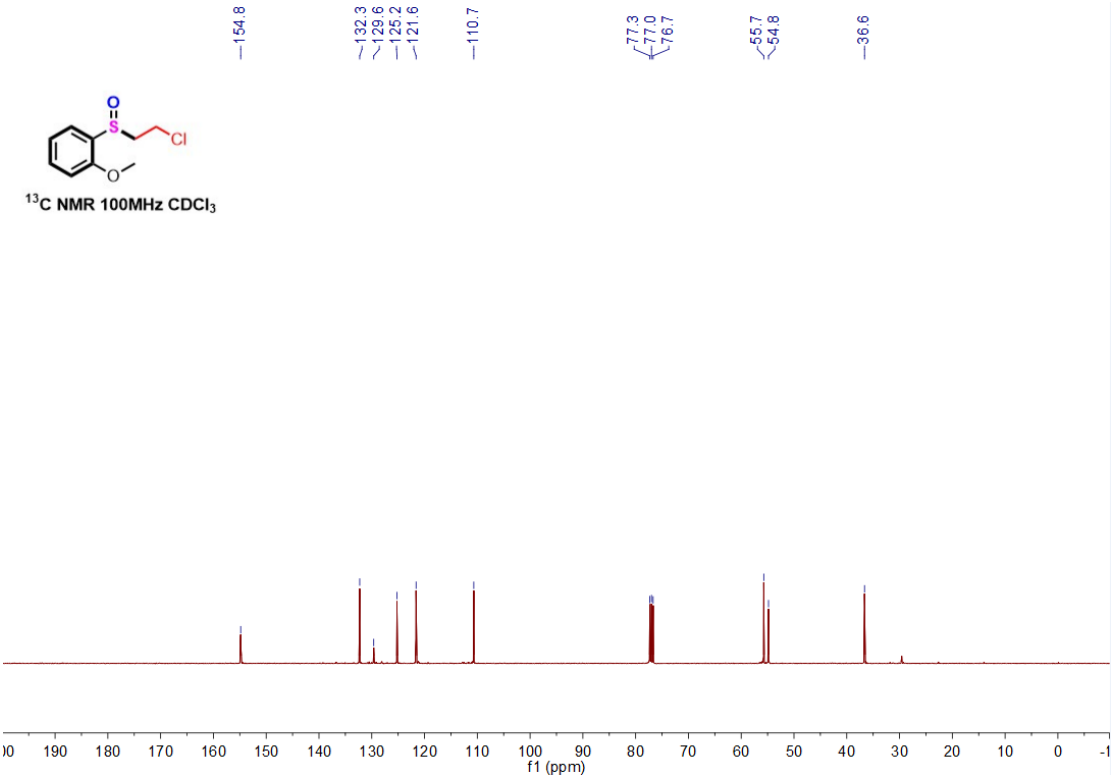
1-Bromo-2-((2-chloroethyl)sulfinyl)benzene (3k)



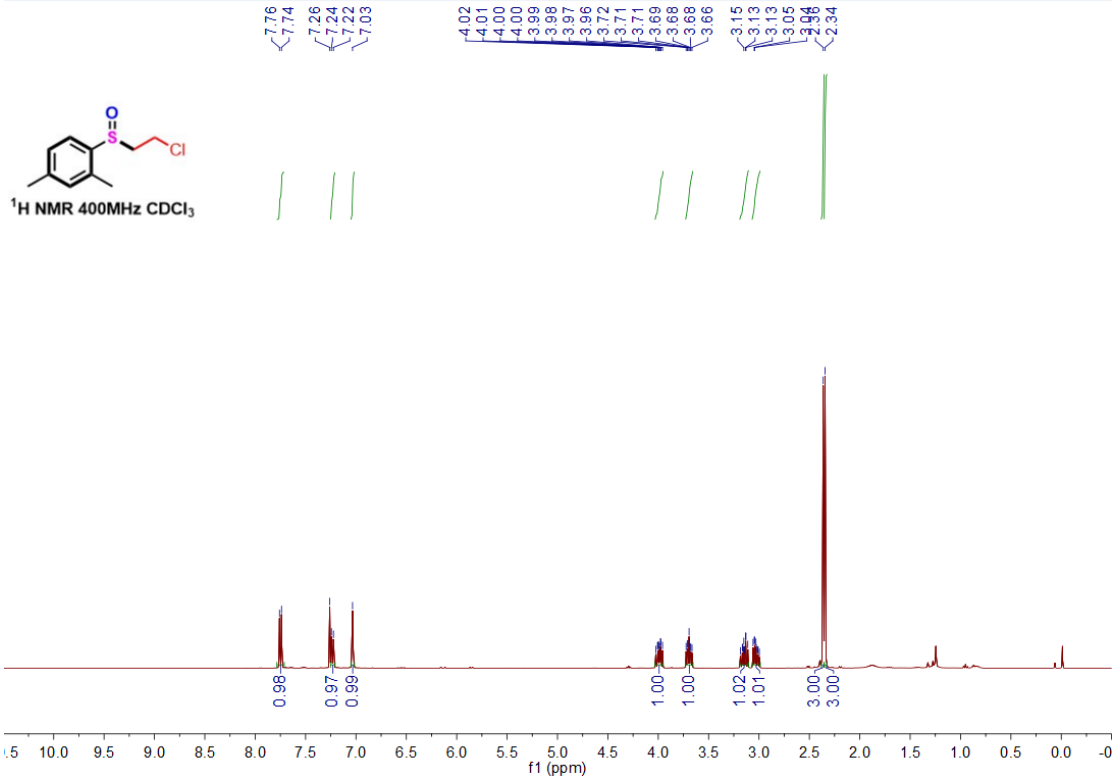


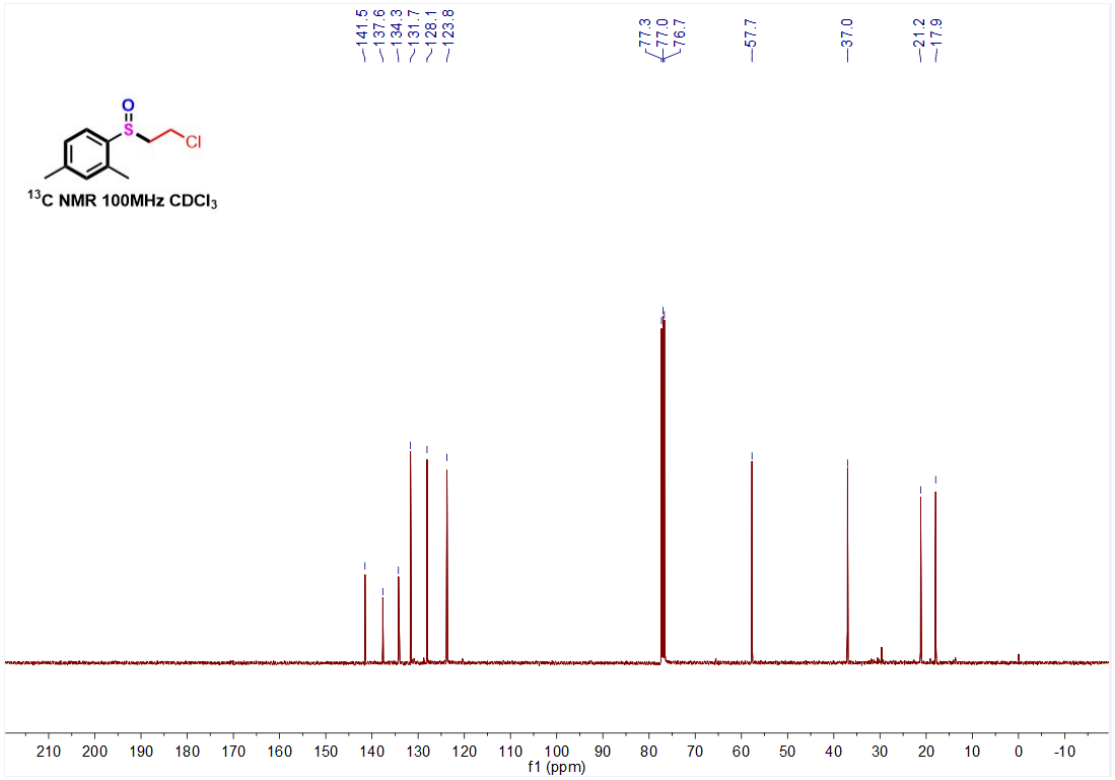
((2-Chloroethyl)sulfinyl)-2-methoxybenzene (3l)



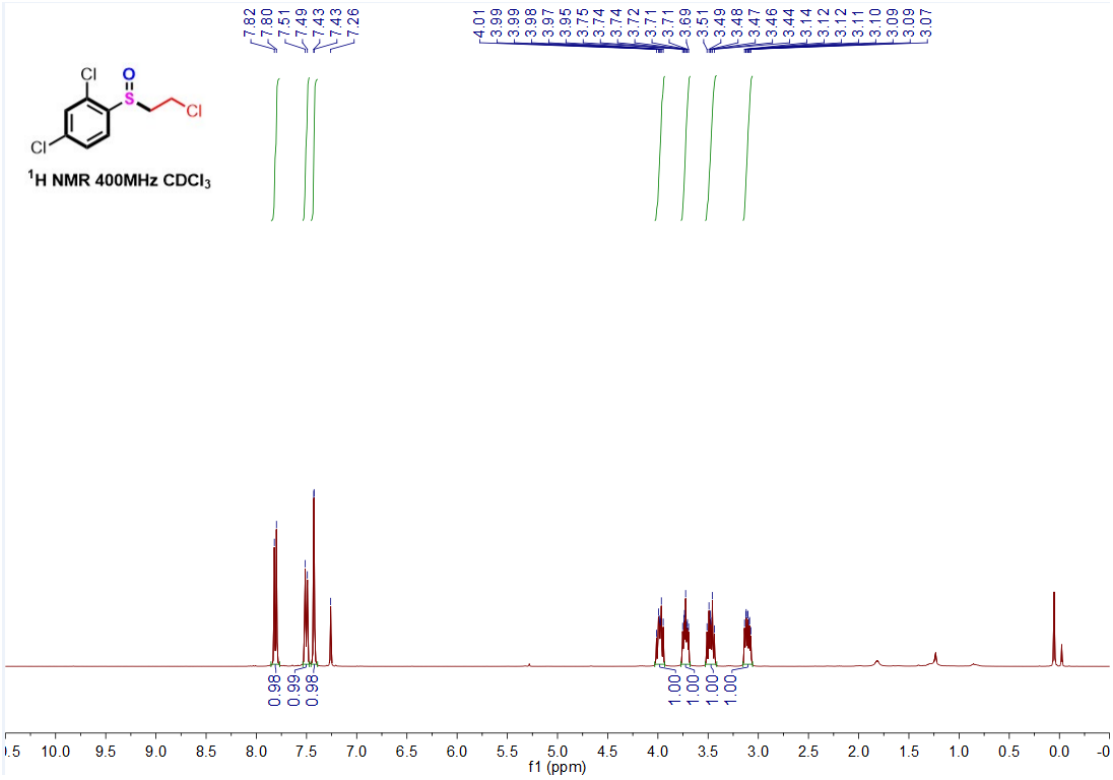


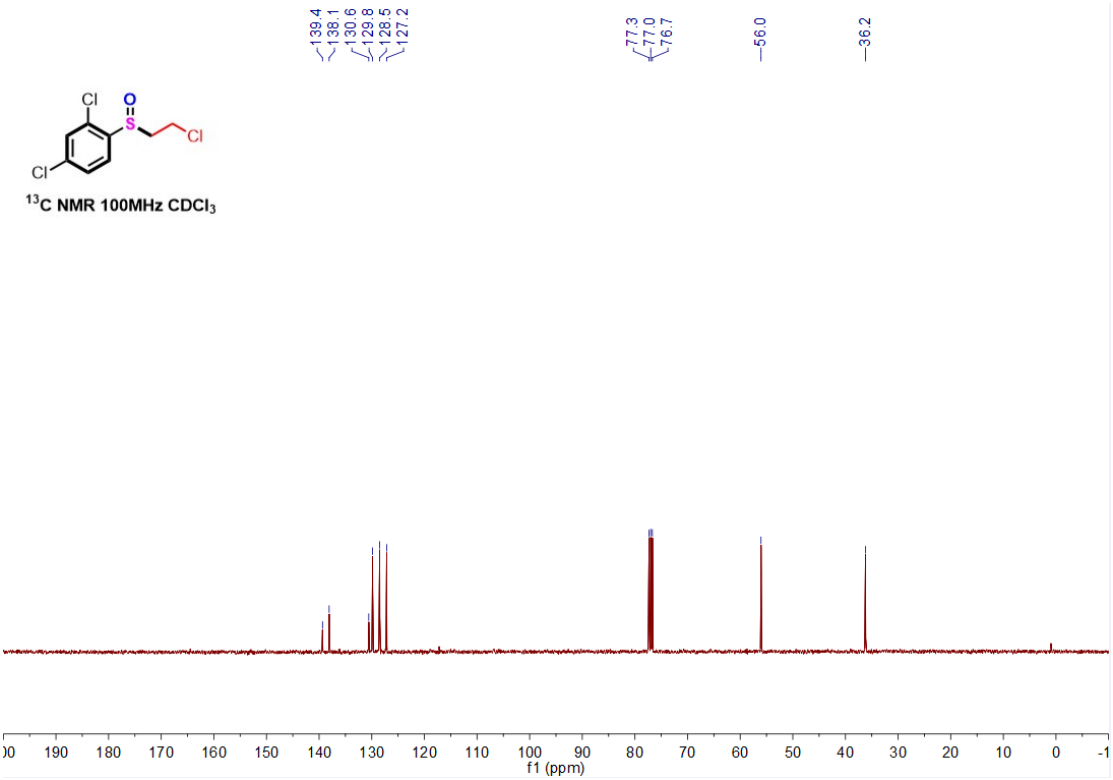
((2-Chloroethyl)sulfinyl)-2,4-dimethylbenzene (3m)



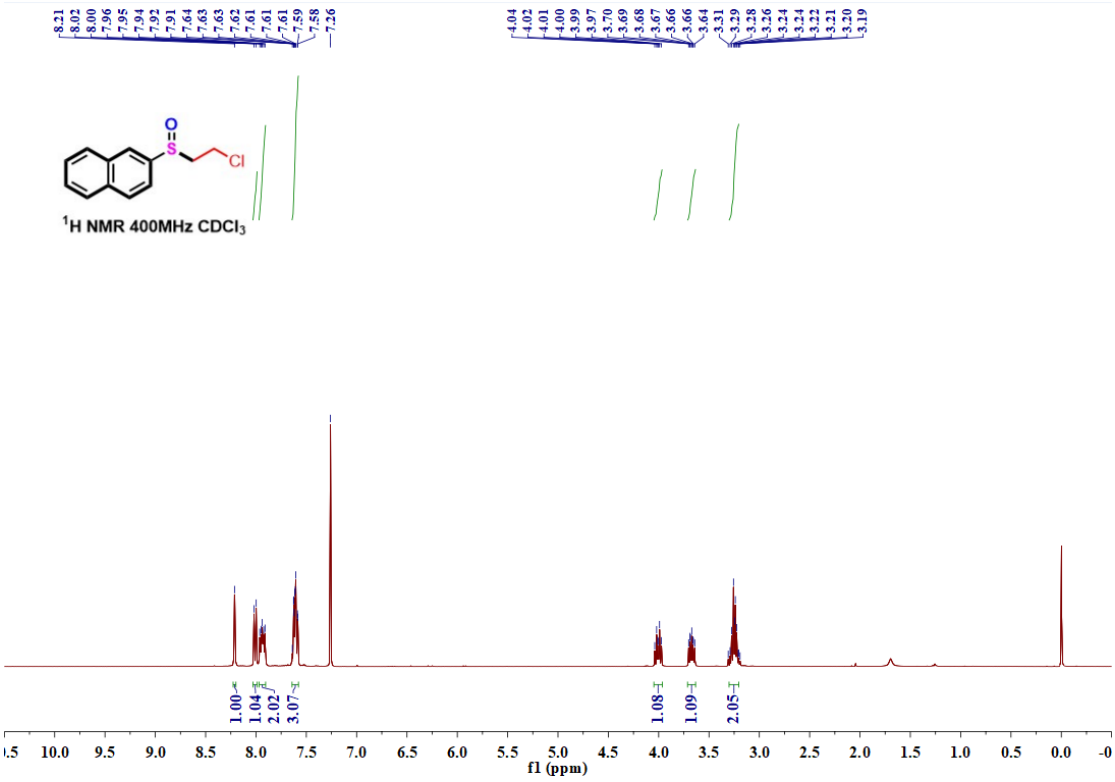


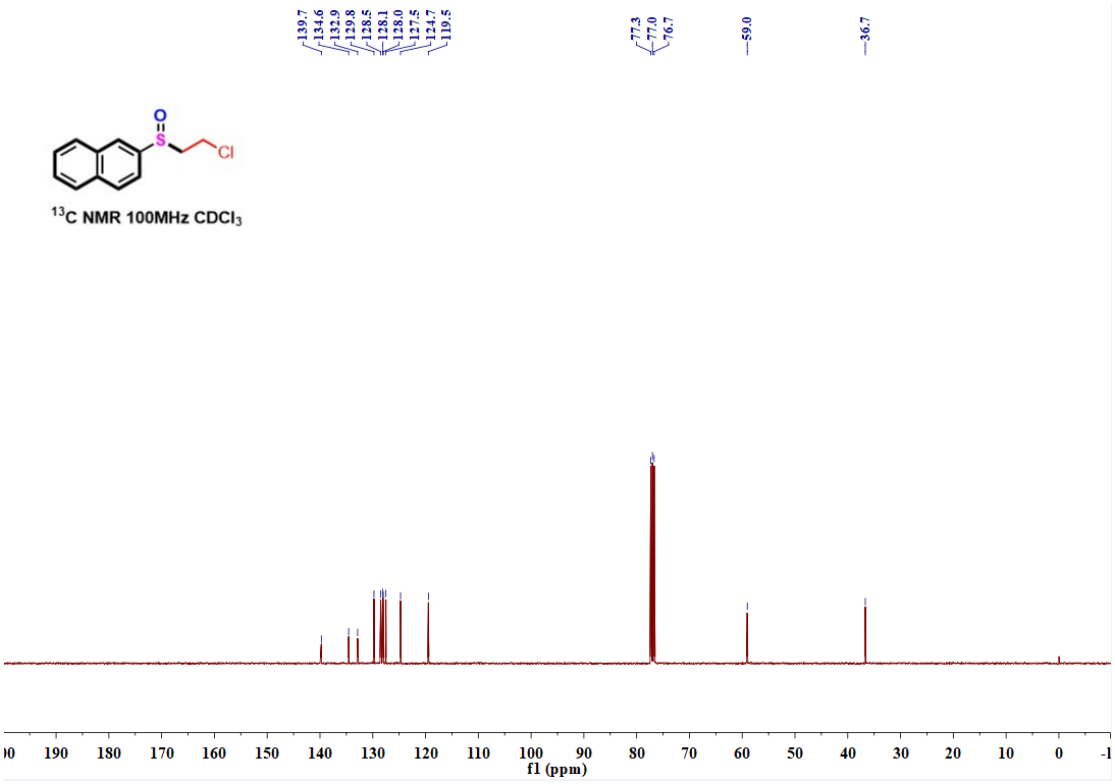
2,4-Dichloro-1-((2-chloroethyl)sulfinyl)benzene (3n)



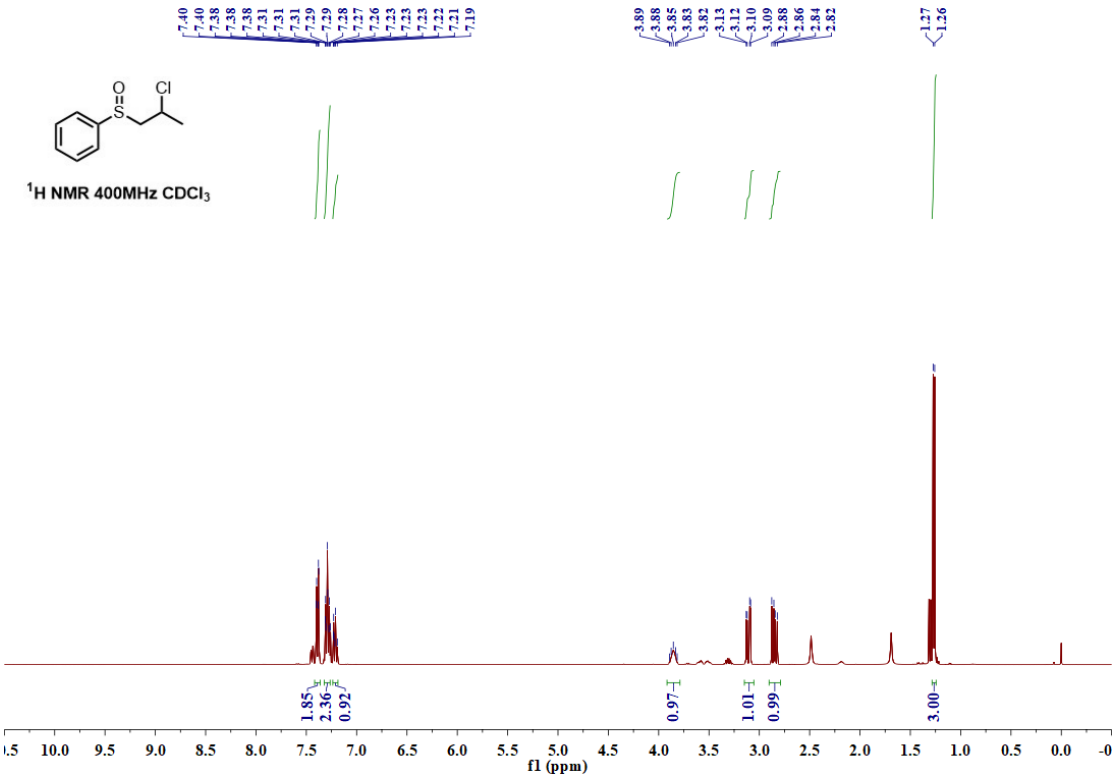


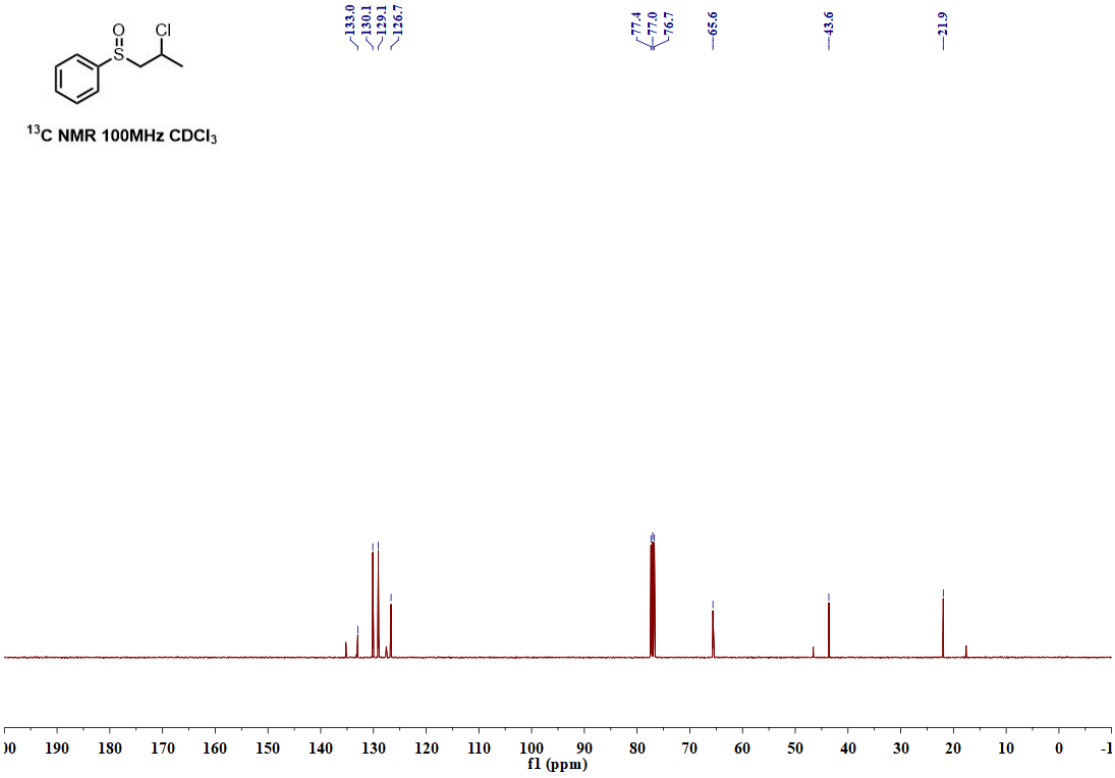
2-((2-Chloroethyl)sulfinyl)naphthalene (3o)



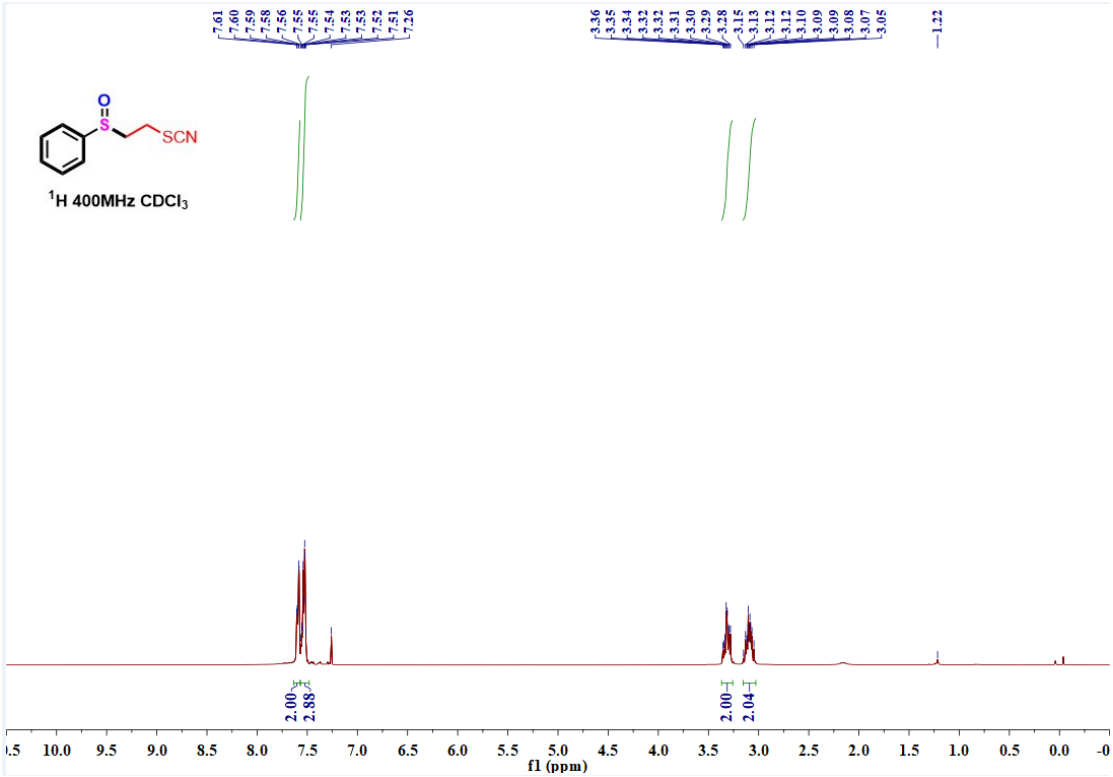


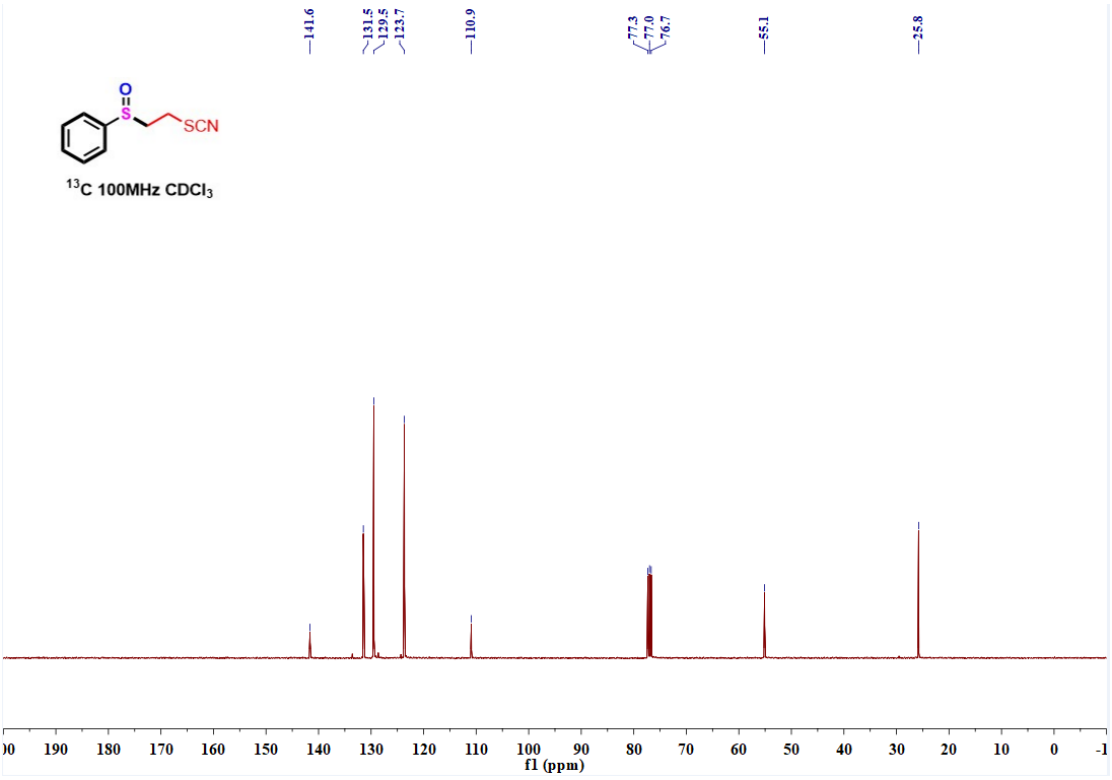
(2-chloropropyl)sulfinyl)benzene (3p)



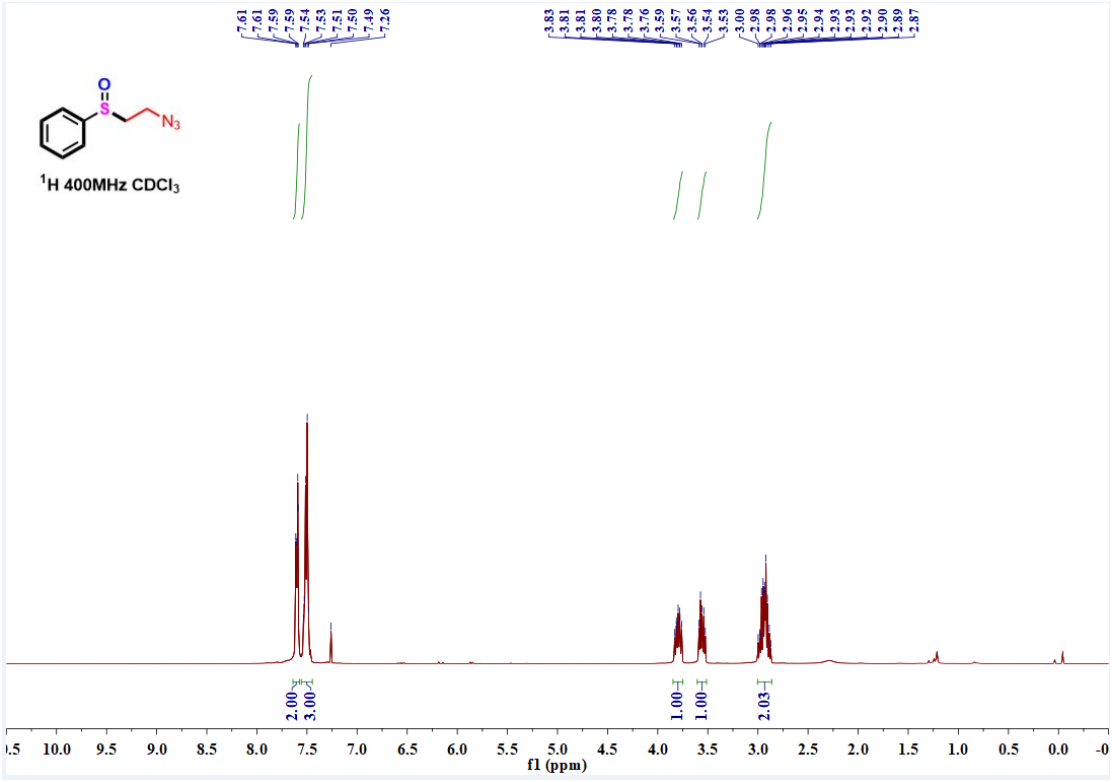


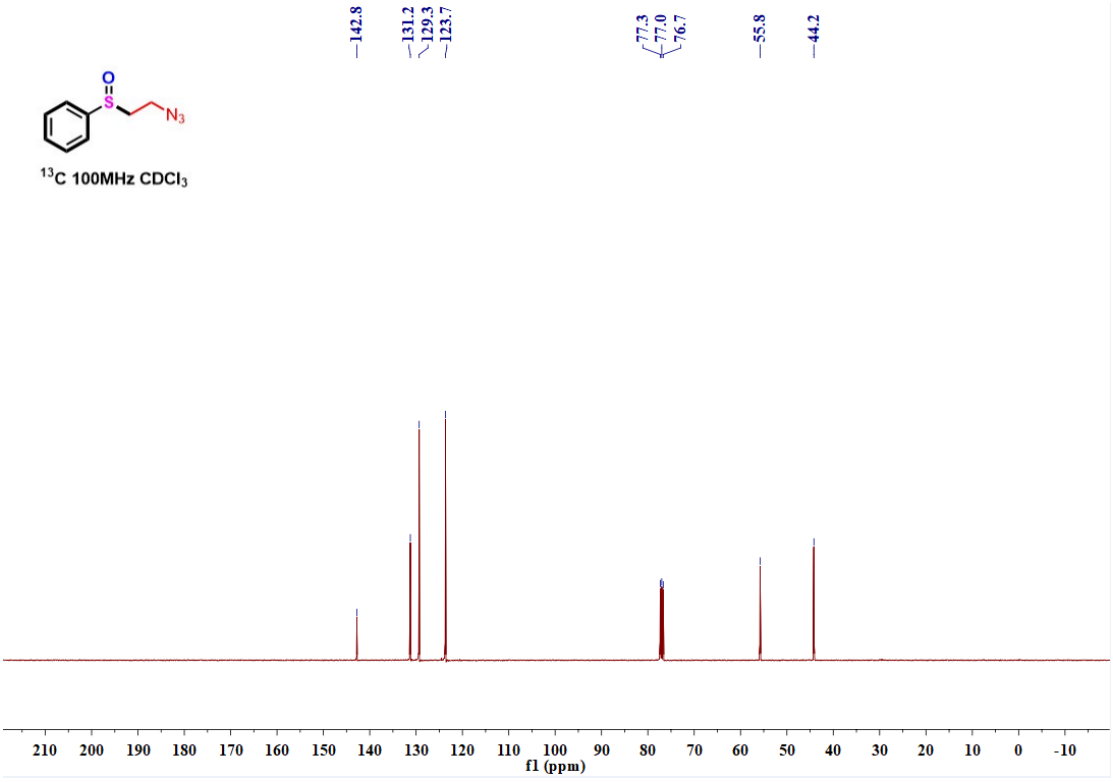
4


7.61
7.60
7.59
7.58
7.56
7.55
7.55
7.54
7.53
7.53
7.52
7.51
7.26
3.36
3.35
3.34
3.32
3.32
3.31
3.30
3.29
3.28
3.15
3.13
3.12
3.12
3.10
3.09
3.09
3.08
3.07
3.05
1.22
O
S
SCN
^{1}H 400MHz CDCl$_3$
2.00
2.88
2.00
2.04
f1 (ppm)

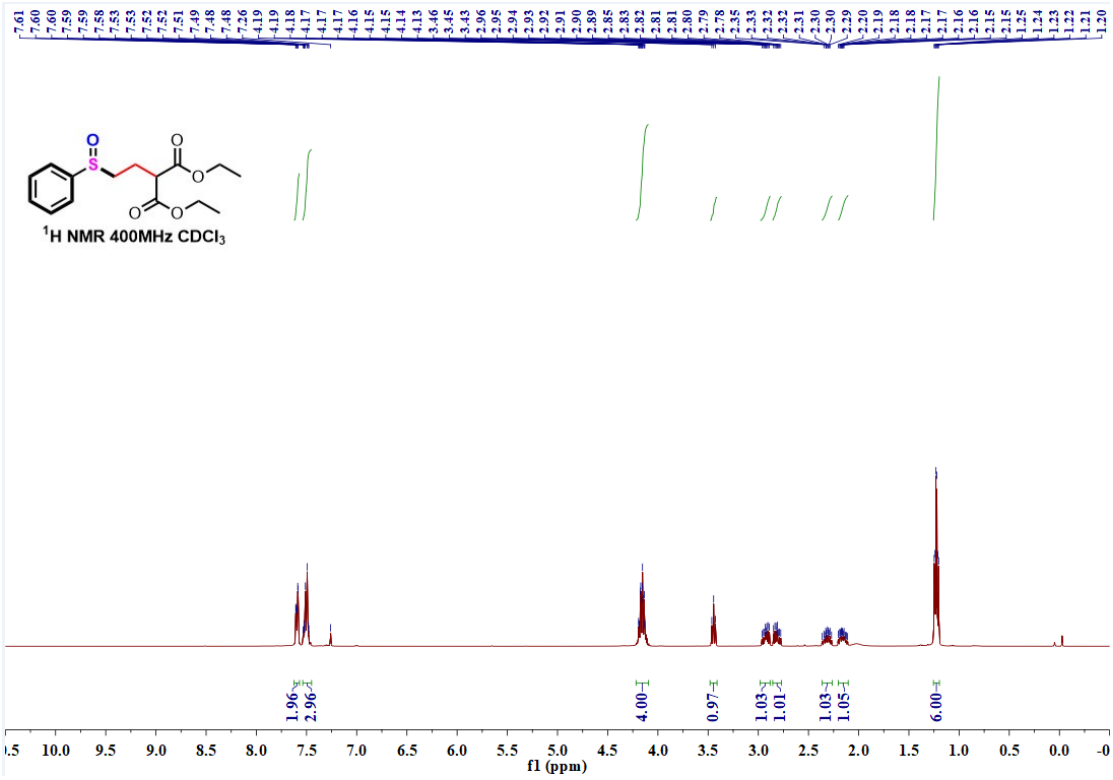

141.6
131.5
129.5
123.7
110.9
77.3
77.0
76.7
55.1
25.8
O
S
SCN
^{13}C 100MHz CDCl$_3$
f1 (ppm)

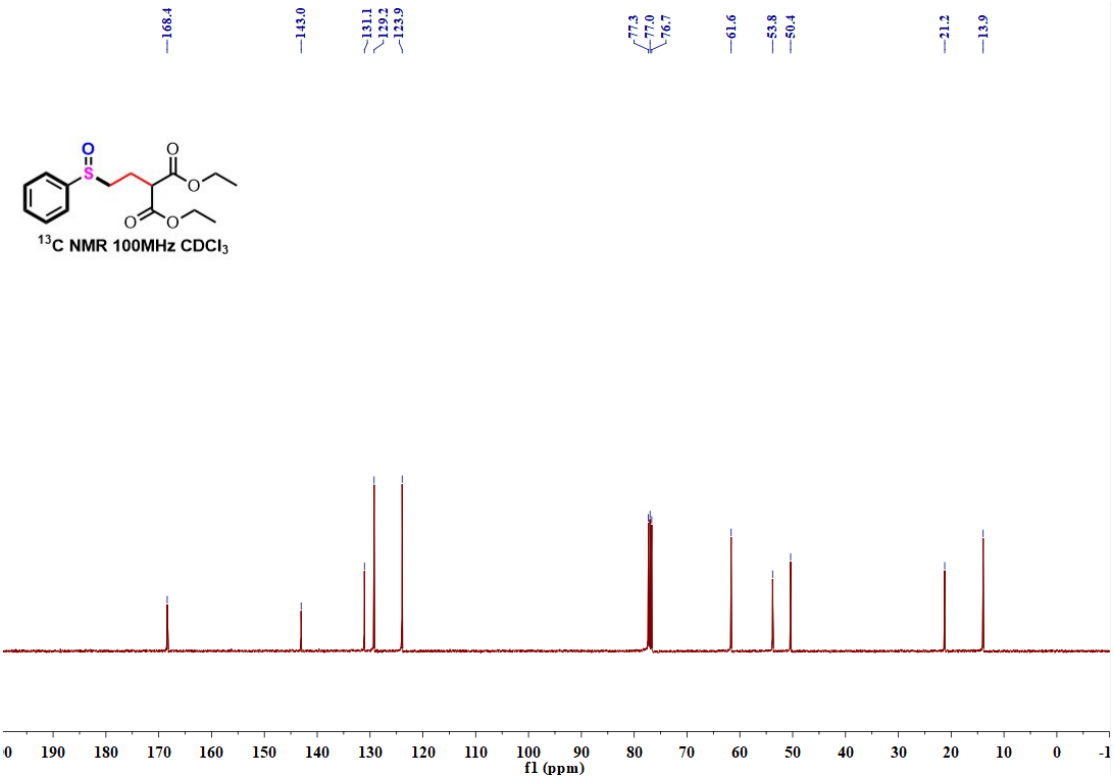
5


7.61
7.61
7.59
7.59
7.54
7.53
7.51
7.50
7.49
7.26
3.83
3.81
3.81
3.80
3.78
3.78
3.76
3.59
3.57
3.56
3.54
3.53
3.00
2.98
2.98
2.96
2.95
2.94
2.93
2.93
2.92
2.90
2.89
2.87
O
S
N3
1H 400MHz CDCl3
2.00
3.00
1.00
1.00
2.03
f1 (ppm)

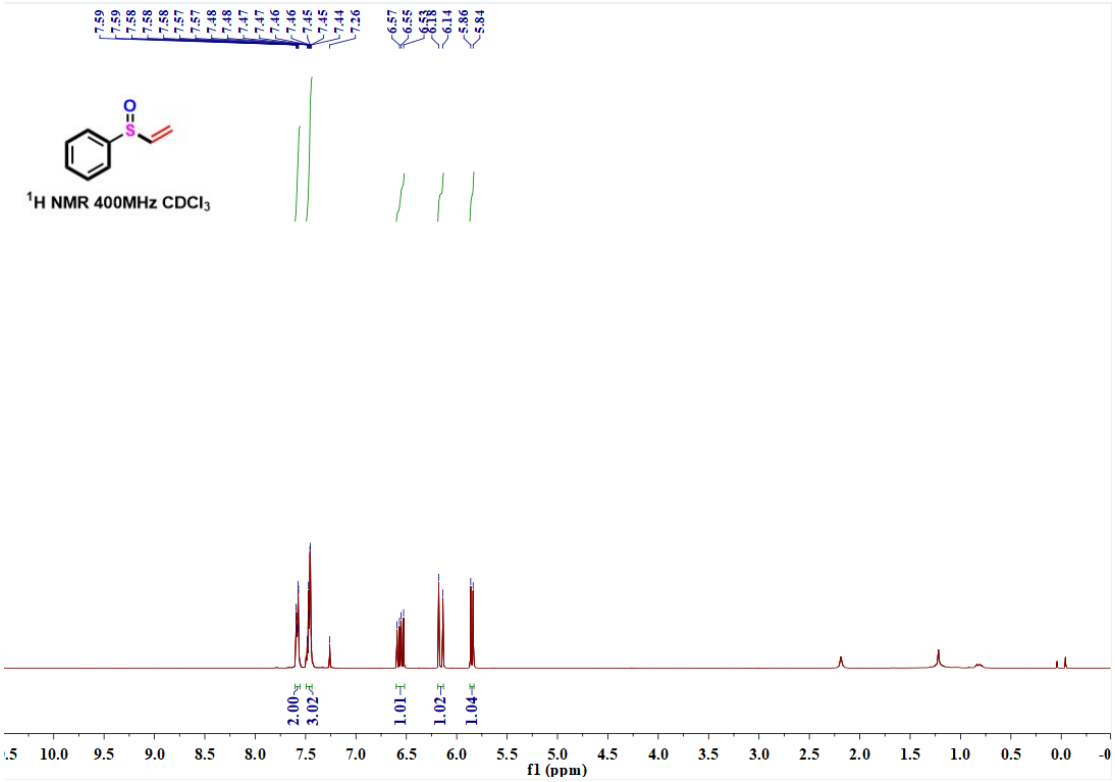

142.8
131.2
129.3
123.7
77.3
77.0
76.7
55.8
44.2
O
S
N3
13C 100MHz CDCl3
f1 (ppm)

6


^{1}H NMR 400MHz CDCl$_3$
1.96
2.96
4.00
0.97
1.03
1.01
1.03
1.05
6.00
f1 (ppm)


168.4
143.0
131.1
129.2
123.9
77.3
77.0
76.7
61.6
53.8
50.4
21.2
13.9
^{13}C NMR 100MHz CDCl$_3$
f1 (ppm)

7


7.59
7.59
7.58
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7.58
7.57
7.57
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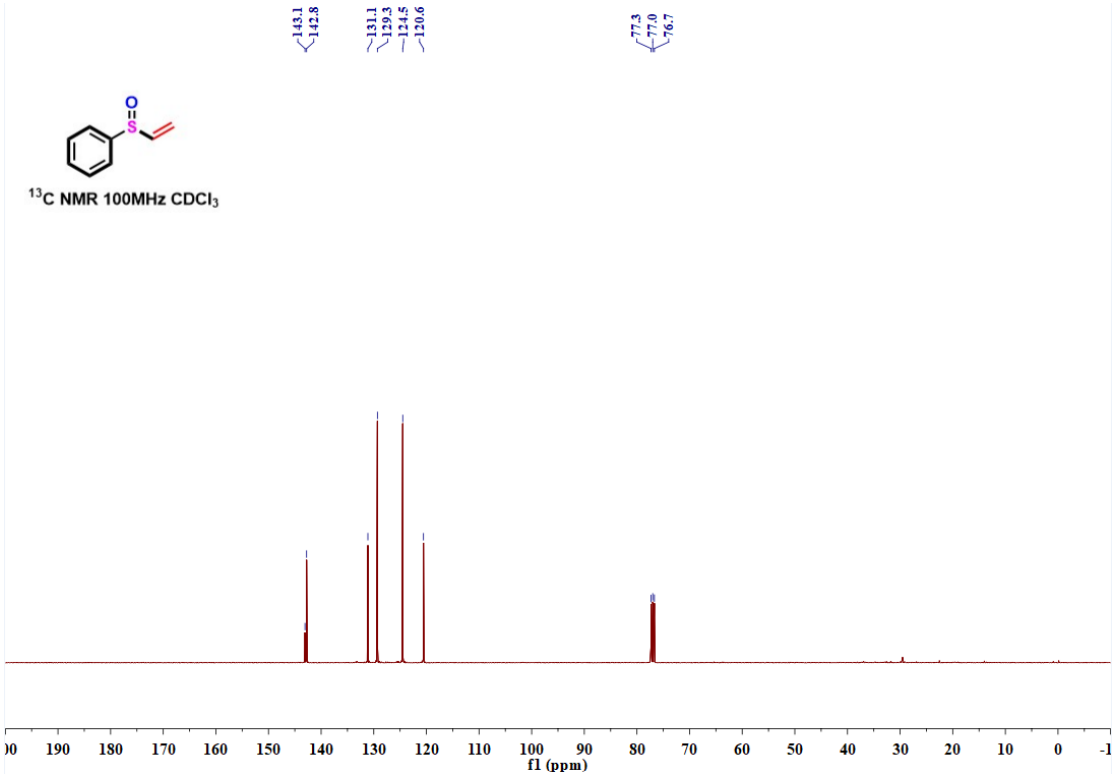
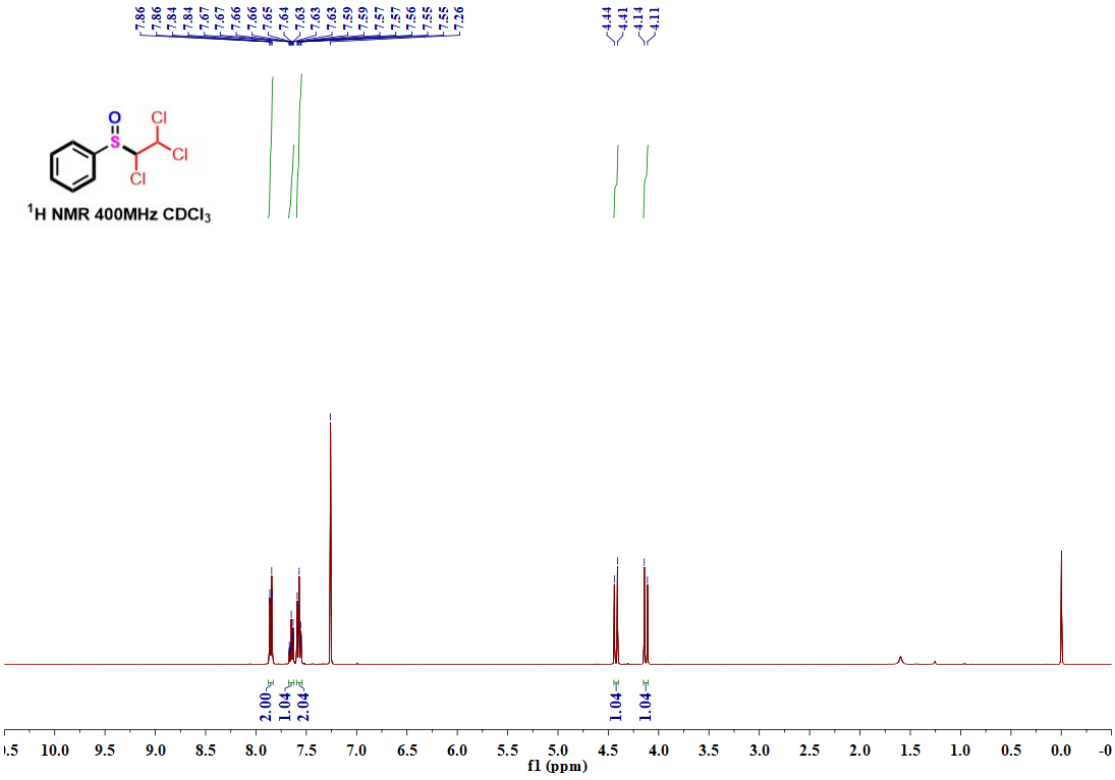
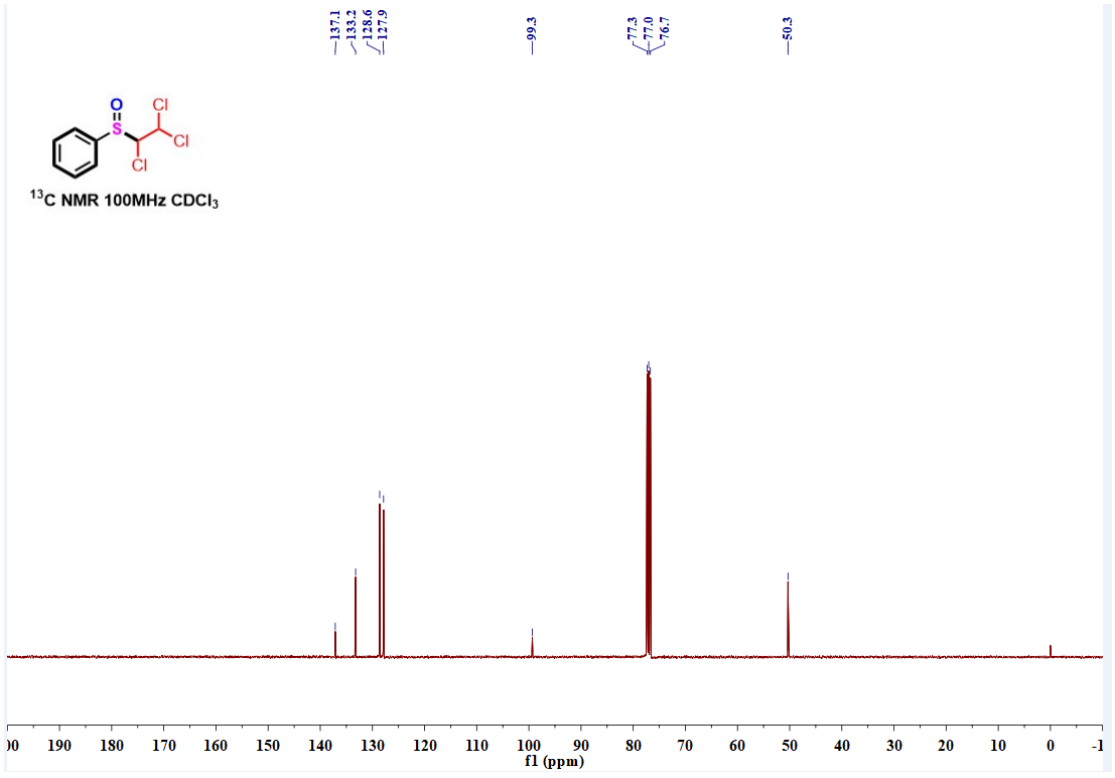
7.47
7.47
7.47
7.46
7.46
7.45
7.45
7.44
7.26
6.57
6.55
6.38
6.14
5.86
5.84
O
S
^{1}H NMR 400MHz CDCl$_3$
2.00
3.02
1.01
1.02
1.04
f1 (ppm)

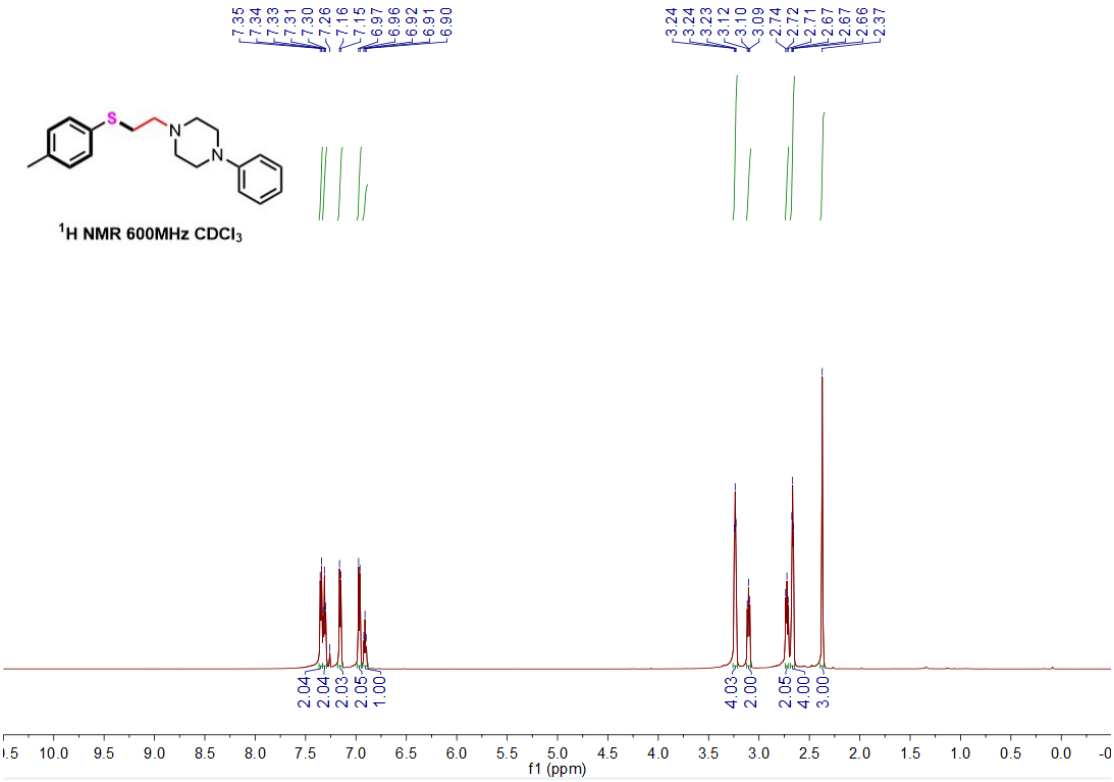

143.1
142.8
131.1
129.3
124.5
120.6
77.3
77.0
76.7
O
S
^{13}C NMR 100MHz CDCl$_3$
f1 (ppm)

8

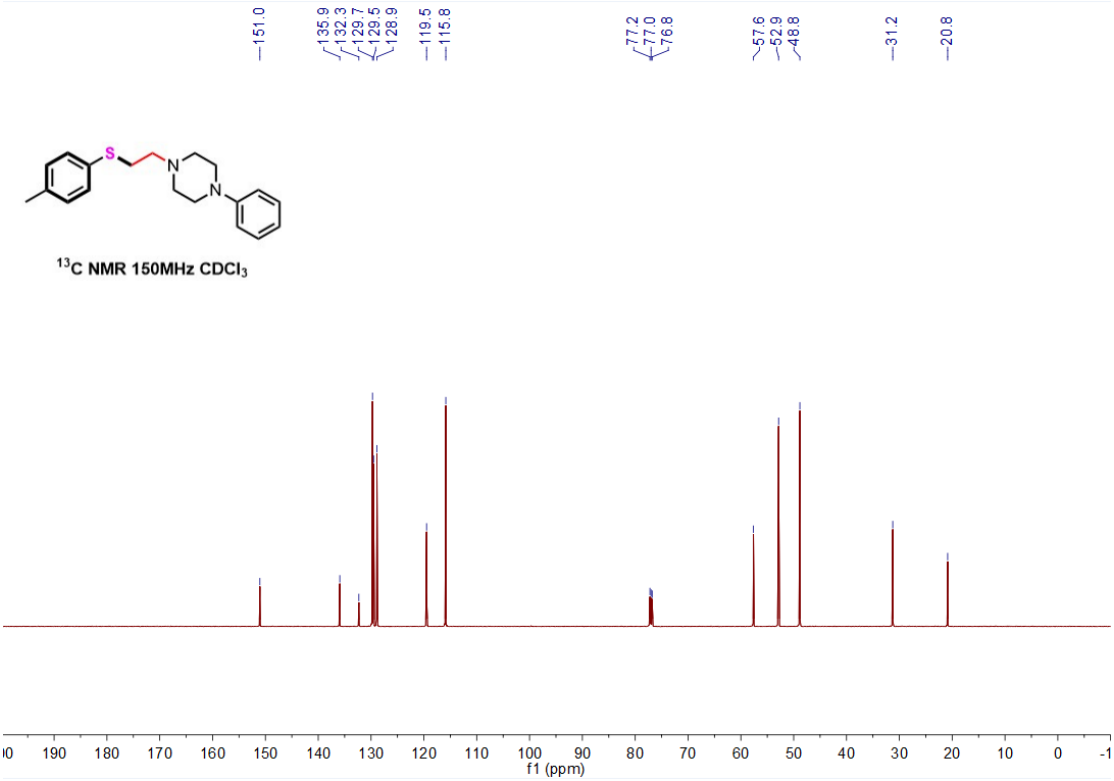

7.86
7.86
7.84
7.84
7.67
7.67
7.66
7.66
7.65
7.64
7.63
7.63
7.59
7.59
7.57
7.57
7.56
7.55
7.55
7.26
4.44
4.41
4.14
4.11
O
S
Cl
Cl
Cl
^{1}H NMR 400MHz CDCl$_3$
2.00
1.04
2.04
1.04
1.04
f1 (ppm)


137.1
133.2
128.6
127.9
99.3
77.3
77.0
76.7
50.3
O
S
Cl
Cl
Cl
^{13}C NMR 100MHz CDCl$_3$
f1 (ppm)

9

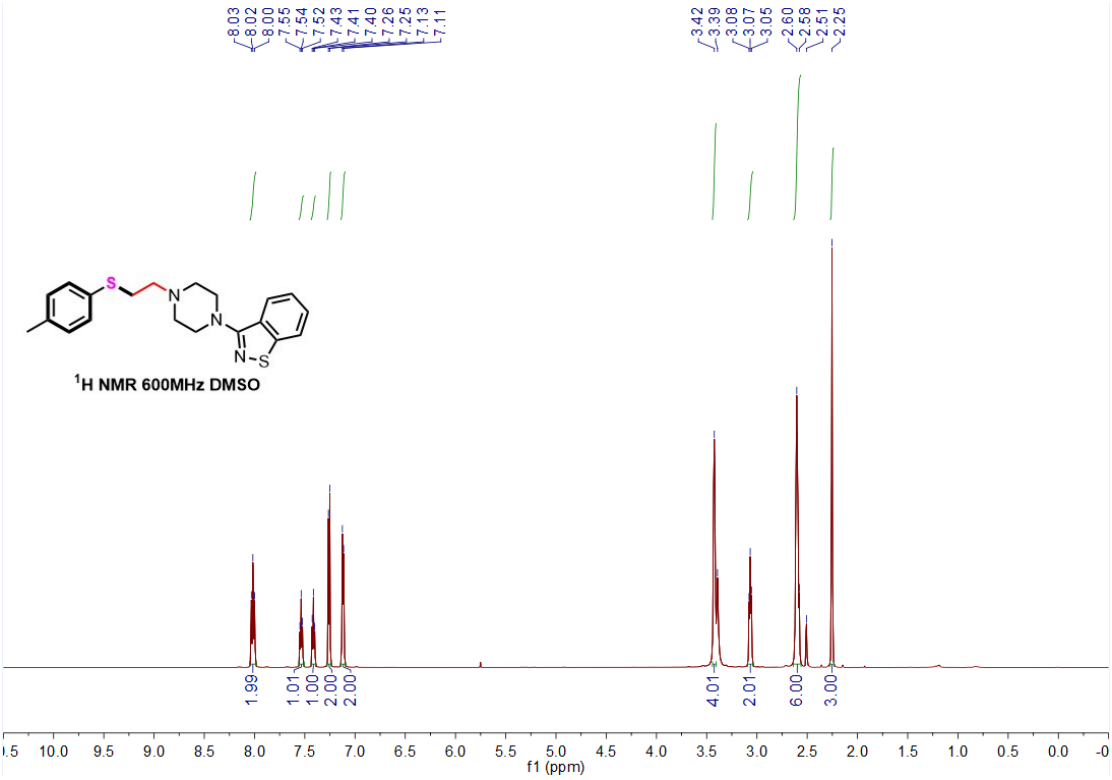


^{1}H NMR 600MHz $CDCl_3$

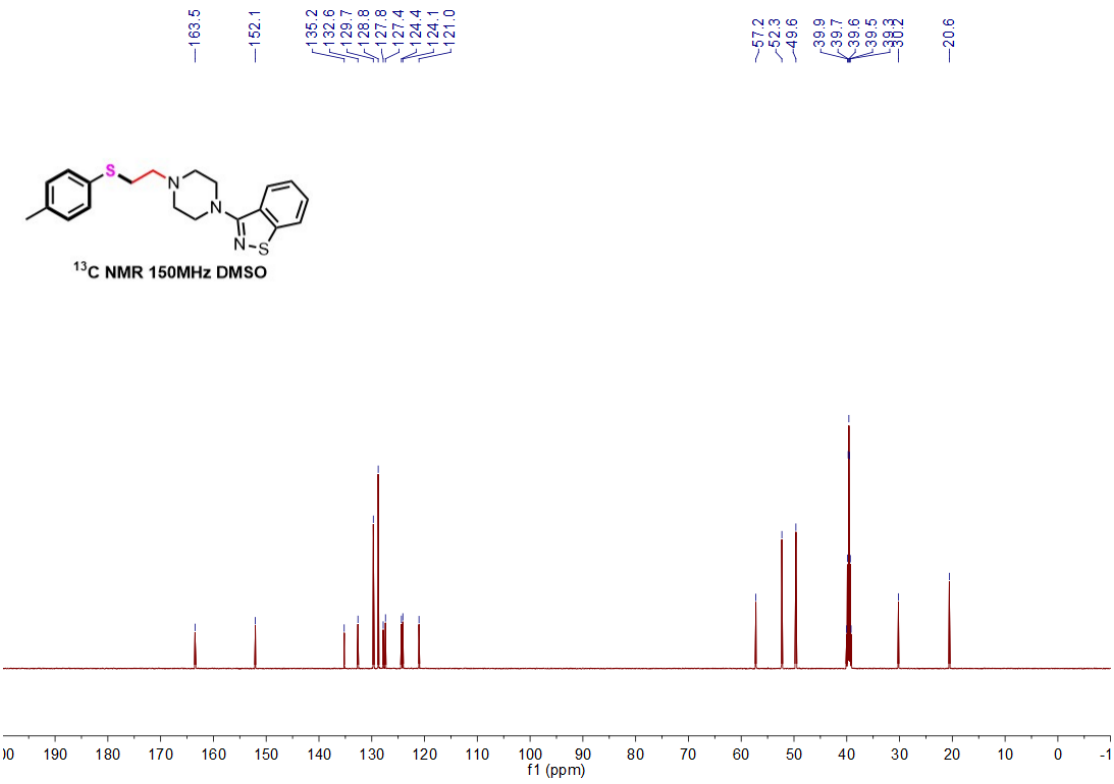


^{13}C NMR 150MHz $CDCl_3$

10

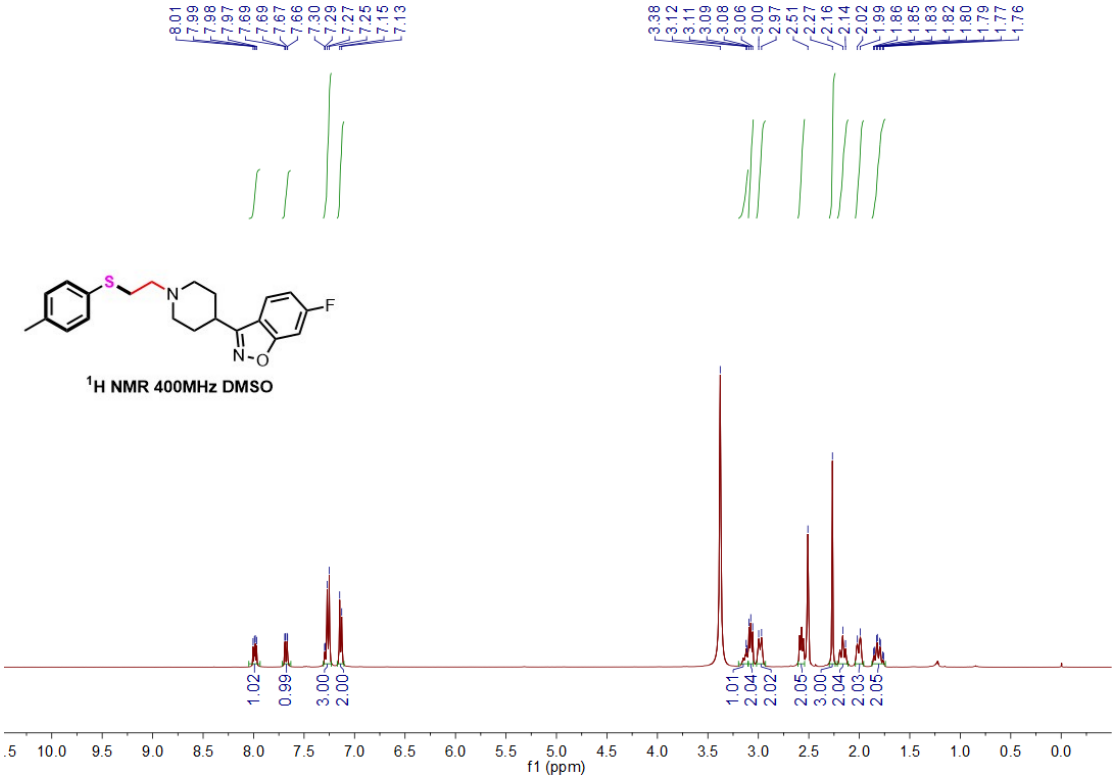


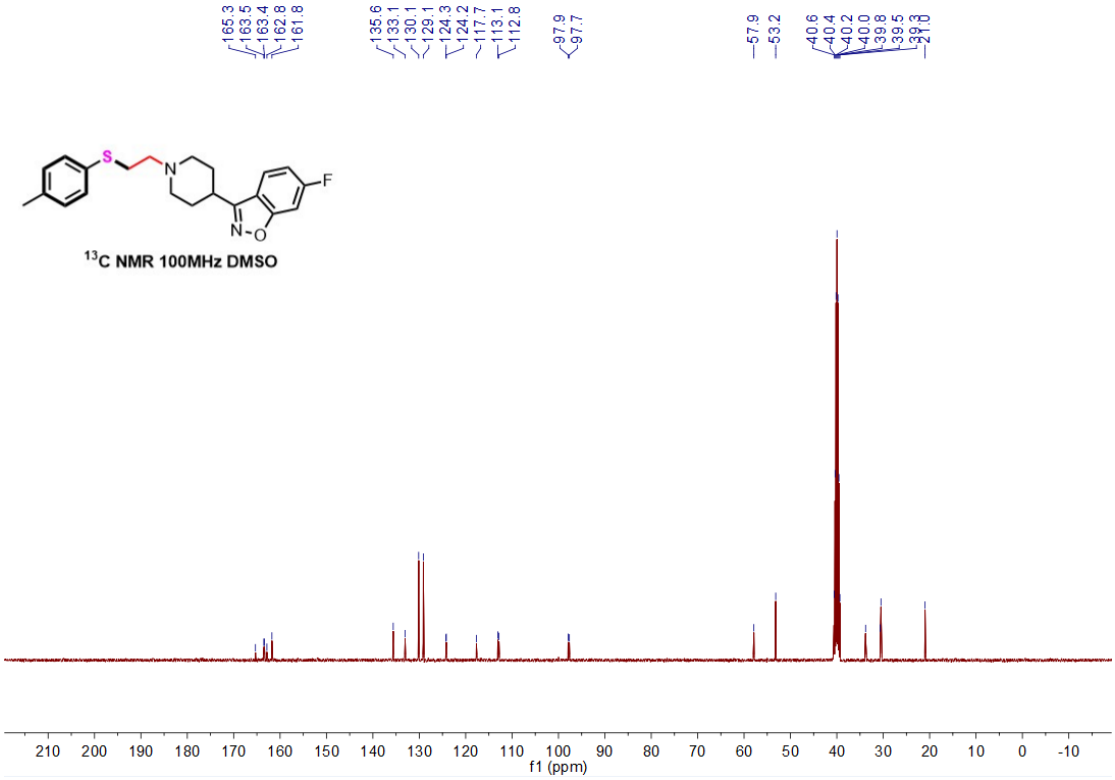
^{1}H NMR 600MHz DMSO



^{13}C NMR 150MHz DMSO

11


8.01
7.99
7.98
7.97
7.69
7.69
7.67
7.66
7.30
7.29
7.27
7.25
7.15
7.13
3.38
3.12
3.11
3.09
3.08
3.06
3.00
2.97
2.51
2.27
2.16
2.14
2.02
1.99
1.86
1.85
1.83
1.82
1.80
1.79
1.77
1.76
S
N
F
N
O
1H NMR 400MHz DMSO
1.02
0.99
3.00
2.00
1.01
2.04
2.02
2.05
3.00
2.04
2.03
2.05
f1 (ppm)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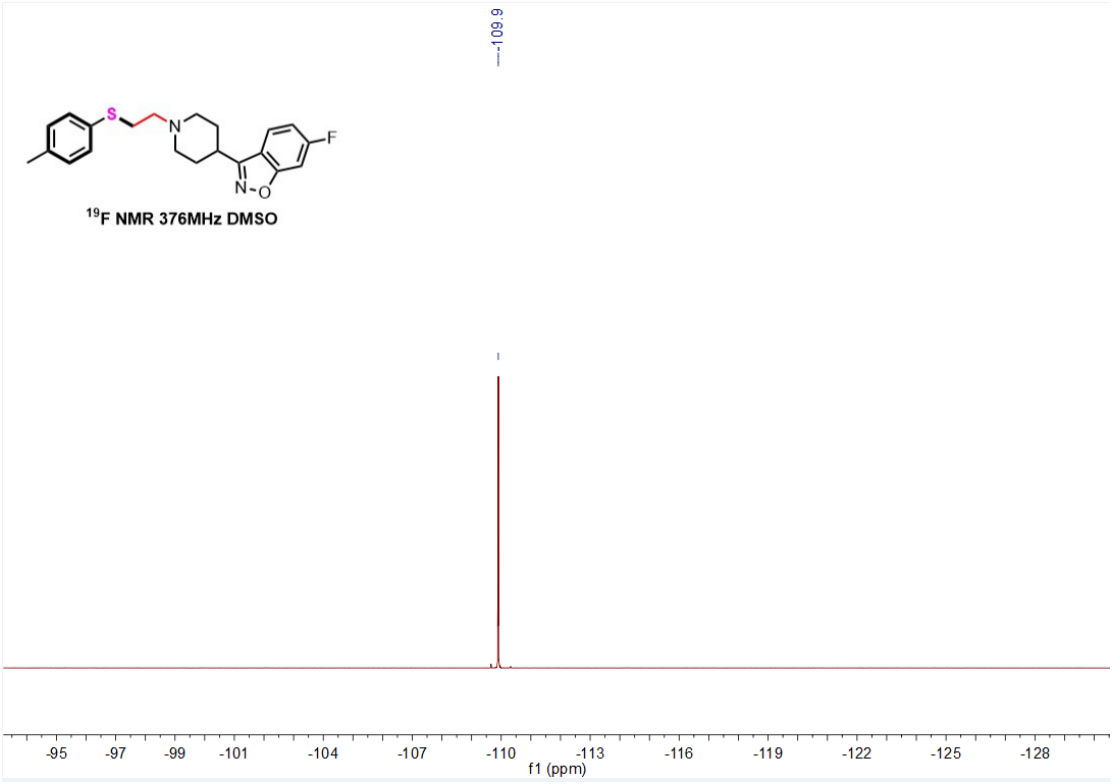
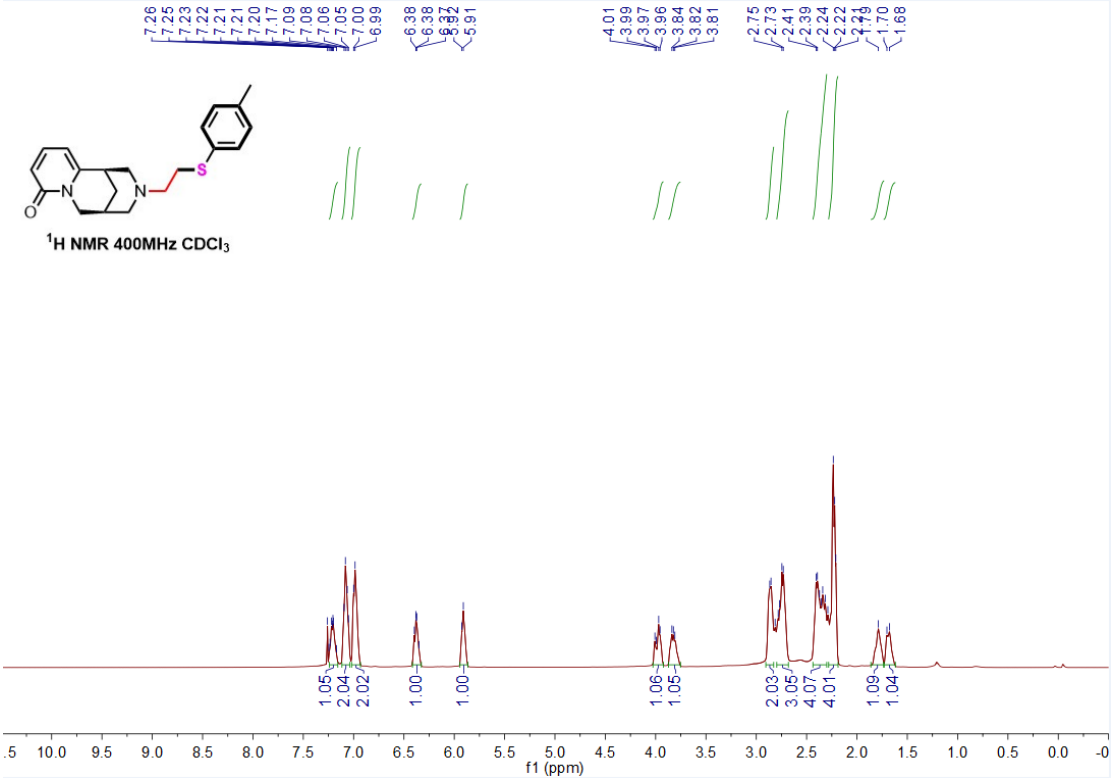
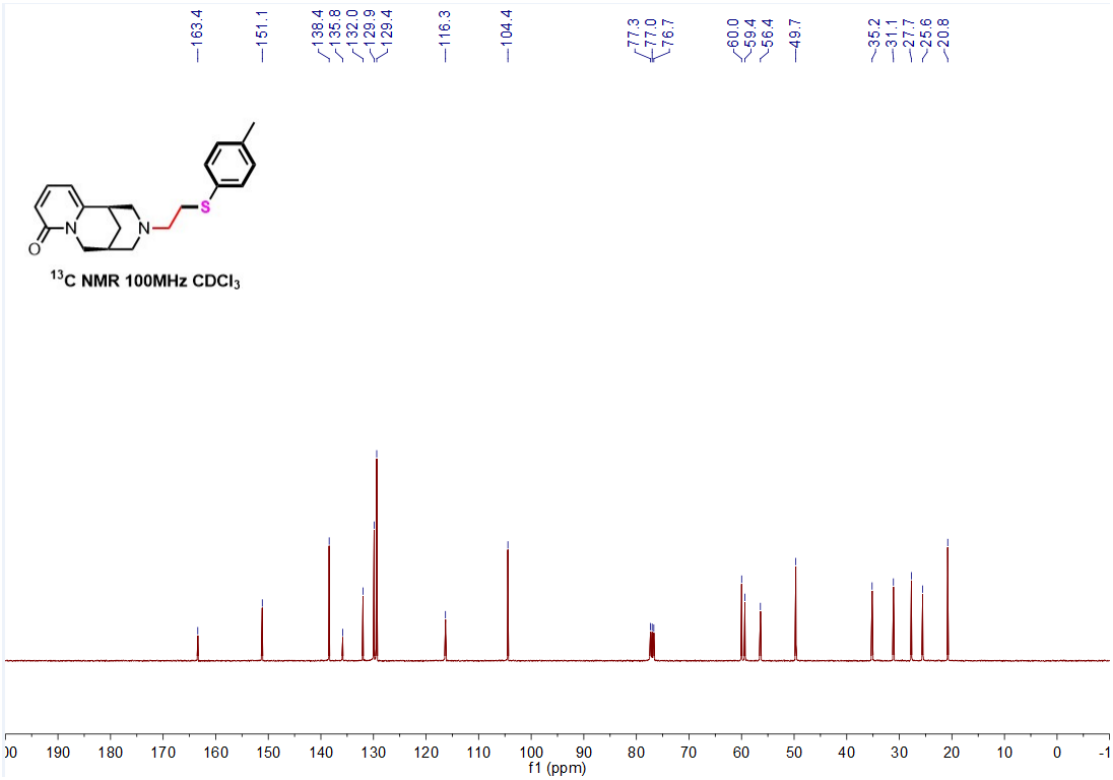
163.5
163.4
162.8
161.8
135.6
133.1
130.1
129.1
124.3
124.2
117.7
113.1
112.8
97.9
97.7
57.9
53.2
40.6
40.4
40.2
40.0
39.8
39.5
21.8
S
N
F
N
O
13C NMR 100MHz DMSO
f1 (ppm)


-109.9
S
N
F
N
O
^{19}F NMR 376MHz DMSO
-95 -97 -99 -101 -104 -107 -110 -113 -116 -119 -122 -125 -128
f1 (ppm)

12


7.26 7.25 7.23 7.22 7.21 7.21 7.20 7.17 7.09 7.08 7.06 7.05 7.00 6.99
6.38 6.38 6.37 5.92 5.91
4.01 3.99 3.97 3.96 3.84 3.82 3.81
2.75 2.73 2.41 2.39 2.24 2.22 1.70 1.68
N
N
S
O
^{1}H NMR 400MHz $CDCl_3$
1.05 2.04 2.02 1.00 1.00 1.06 1.05 2.03 3.05 4.07 4.01 1.09 1.04
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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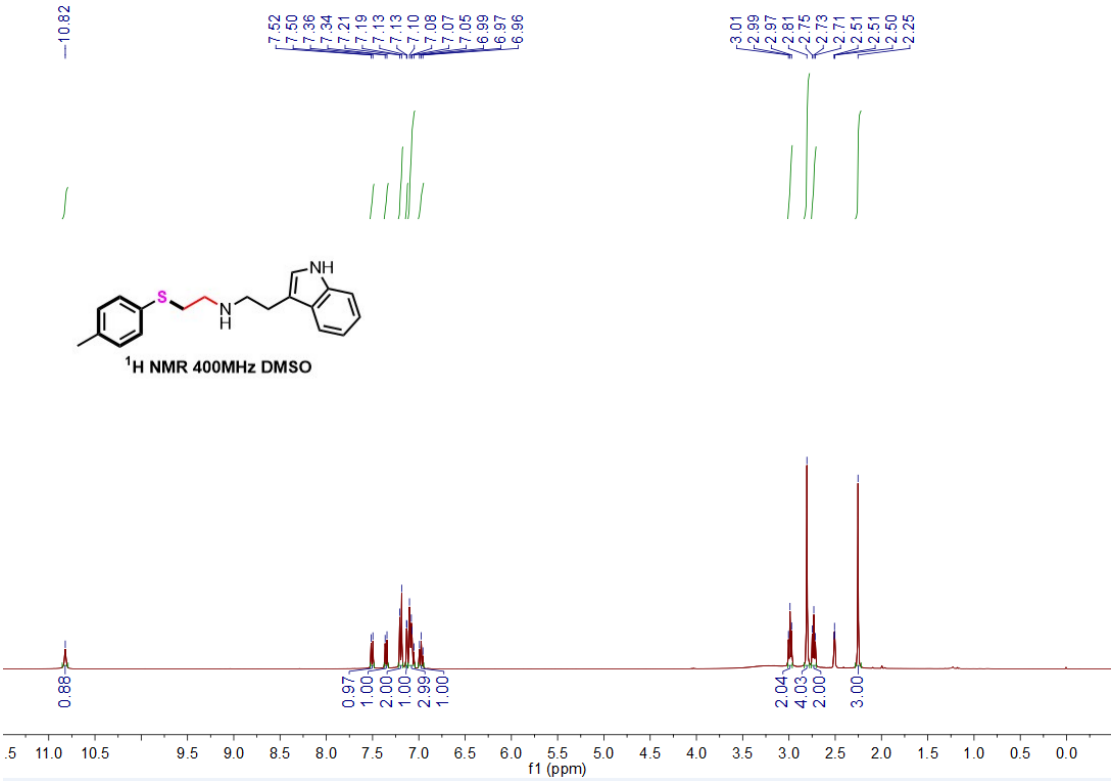
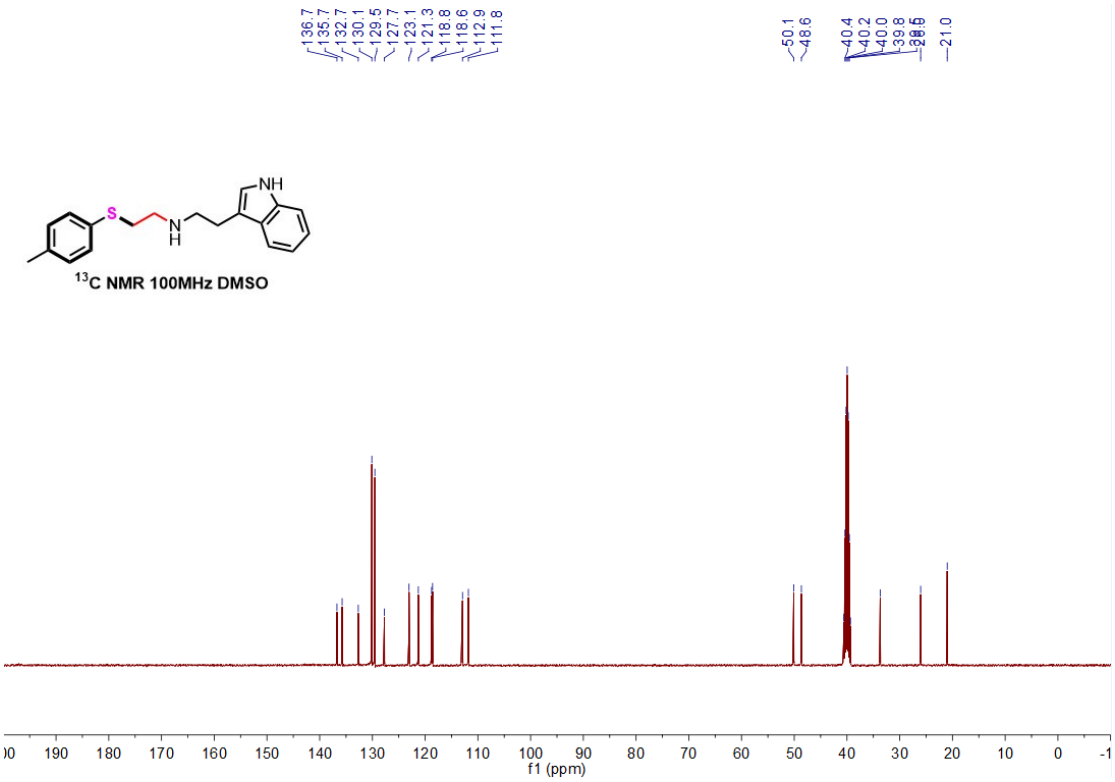
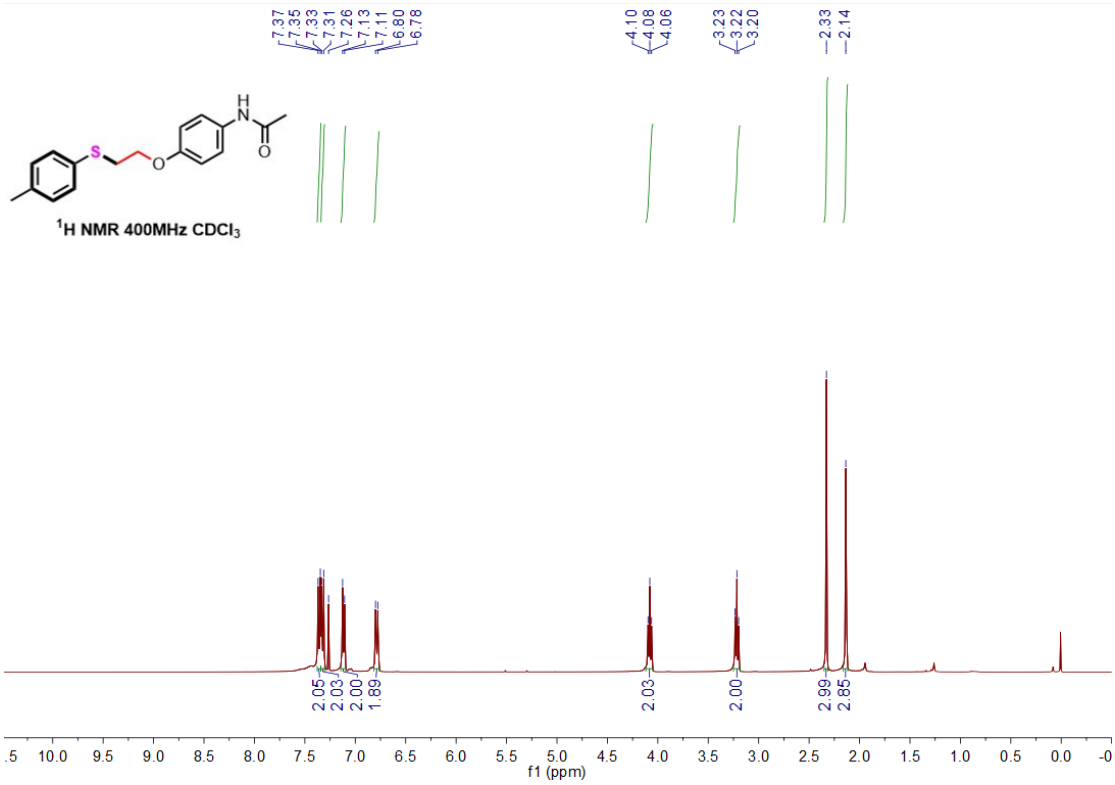
151.1
138.4
135.8
132.0
129.9
129.4
116.3
104.4
77.3
77.0
76.7
60.0
59.4
56.4
49.7
35.2
31.1
27.7
25.6
20.8
13C NMR 100MHz CDCl3
f1 (ppm)

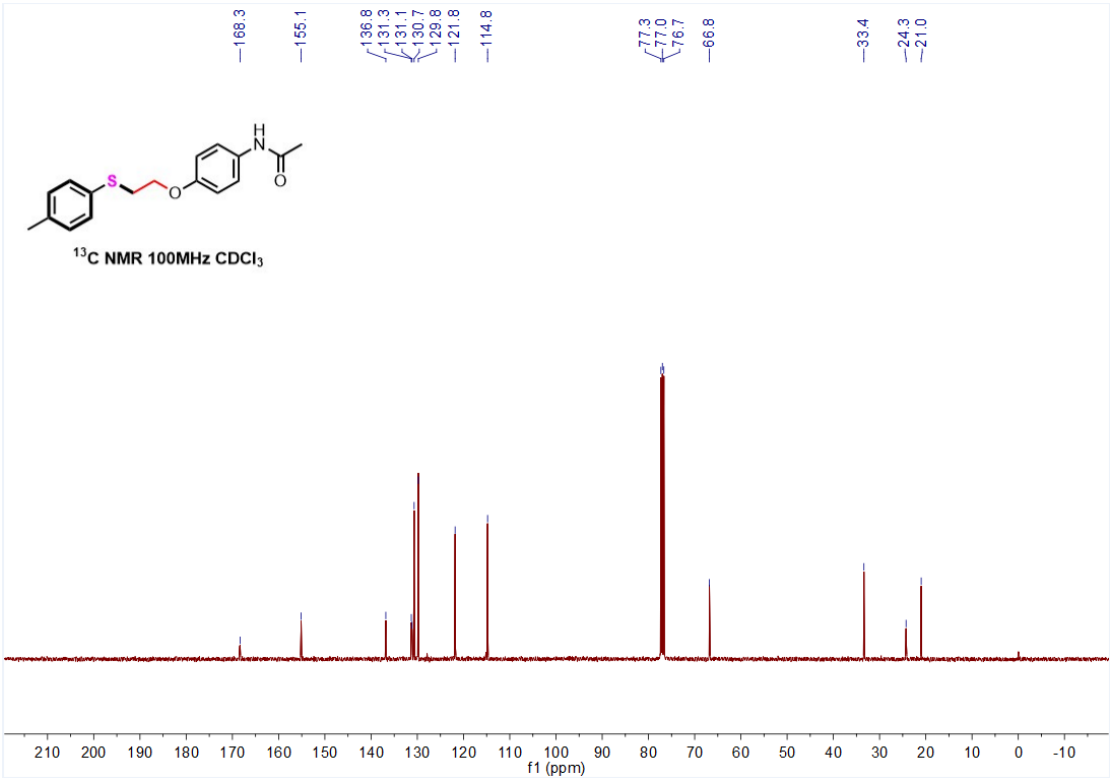
13


10.82
7.52
7.50
7.36
7.34
7.21
7.19
7.13
7.13
7.10
7.08
7.07
7.05
6.99
6.97
6.96
3.01
2.99
2.97
2.81
2.75
2.73
2.71
2.51
2.51
2.50
2.25
1H NMR 400MHz DMSO
0.88
0.97
1.00
2.00
1.00
2.99
1.00
2.04
4.03
2.00
3.00
f1 (ppm)


136.7
135.7
132.7
130.1
129.5
127.7
123.1
121.3
118.8
118.6
112.9
111.8
50.1
48.6
40.4
40.2
40.0
39.8
21.0
NH
S
N
H
13C NMR 100MHz DMSO
f1 (ppm)

14


7.37
7.35
7.33
7.31
7.26
7.13
7.11
6.80
6.78
4.10
4.08
4.06
3.23
3.22
3.20
2.33
2.14
H
N
O
S
O
1H NMR 400MHz CDCl3
2.05
2.03
2.00
1.89
2.03
2.00
2.99
2.85
f1 (ppm)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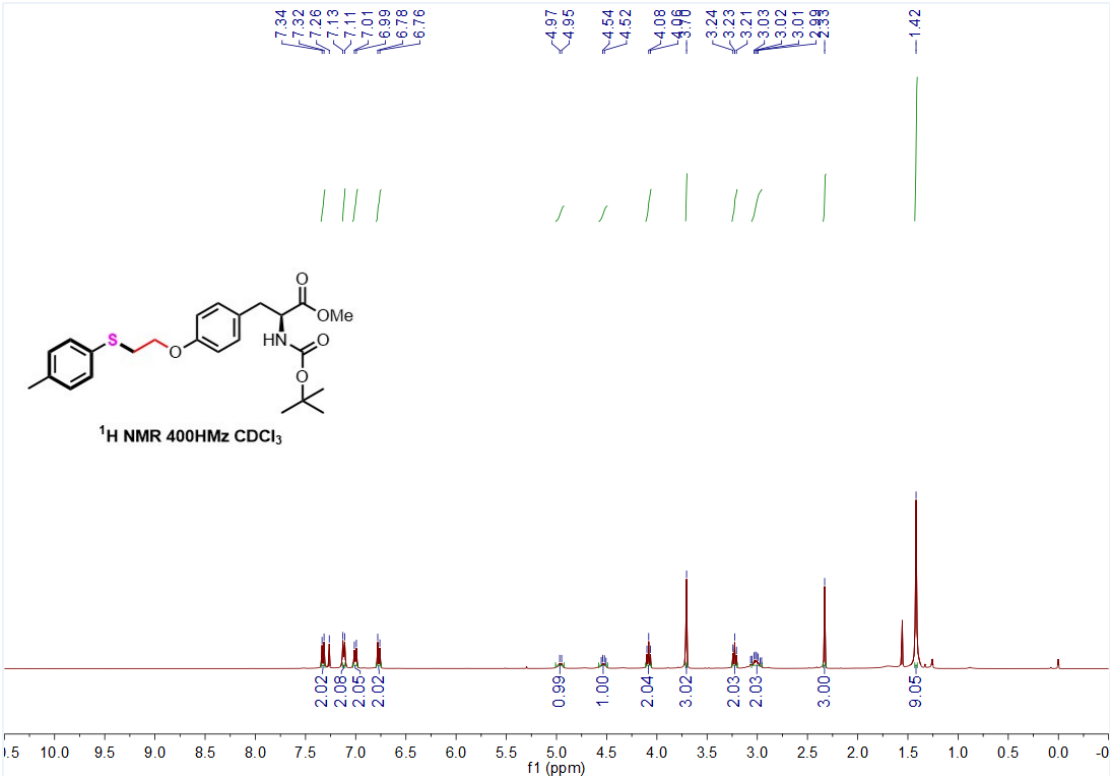
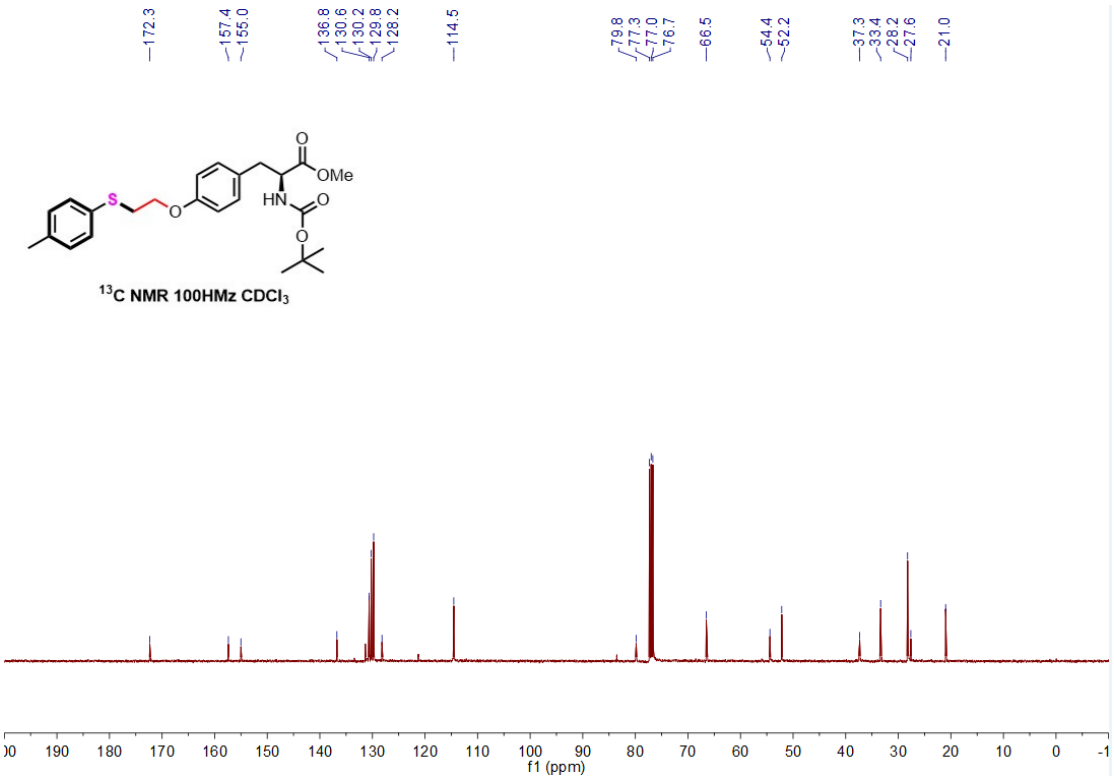
155.1
136.8
131.3
131.1
130.7
129.8
121.8
114.8
77.3
77.0
76.7
66.8
33.4
24.3
21.0
^{13}C NMR 100MHz CDCl$_3$
f1 (ppm)

15


7.34
7.32
7.26
7.13
7.11
7.01
6.99
6.78
6.76
4.97
4.95
4.54
4.52
4.08
3.24
3.23
3.21
3.03
3.02
3.01
1.42
OMe
^{1}H NMR 400HMz CDCl$_3$
2.02
2.08
2.05
2.02
0.99
1.00
2.04
3.02
2.03
2.03
3.00
9.05
f1 (ppm)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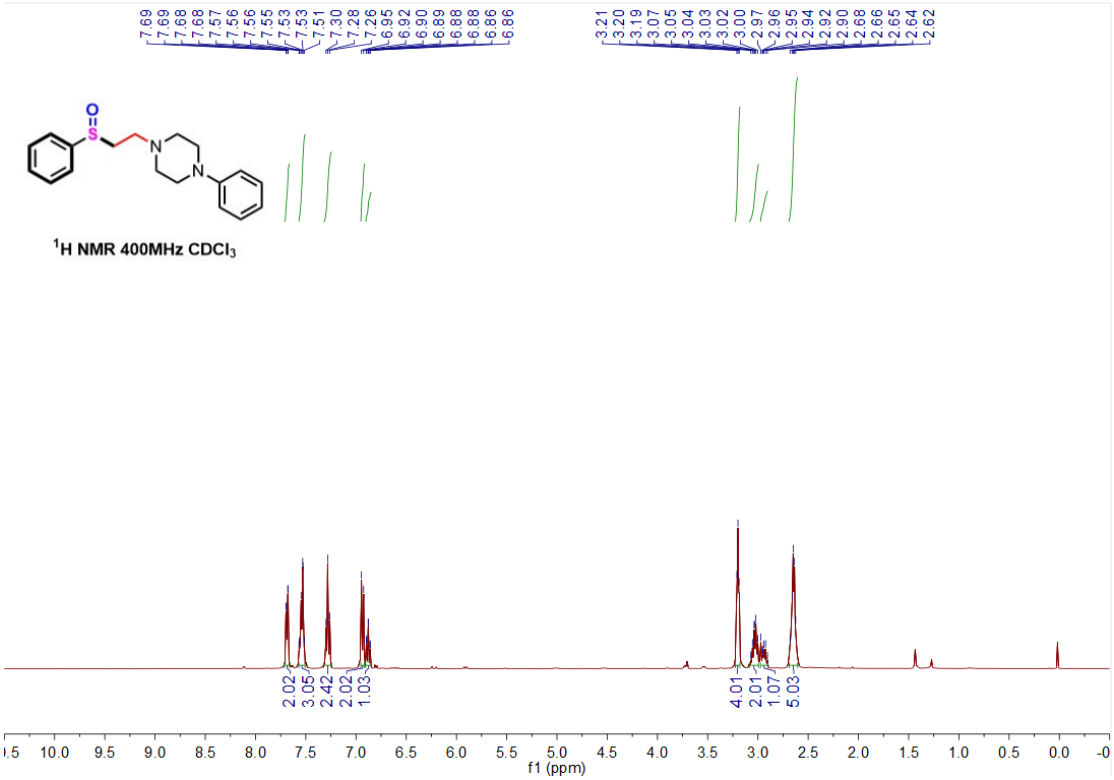
136.8
130.6
130.2
129.8
128.2
114.5
79.8
77.3
77.0
76.7
66.5
54.4
52.2
37.3
33.4
28.2
27.6
21.0
OMe
HN
O
S
O
^{13}C NMR 100HMz CDCl$_3$
f1 (ppm)

16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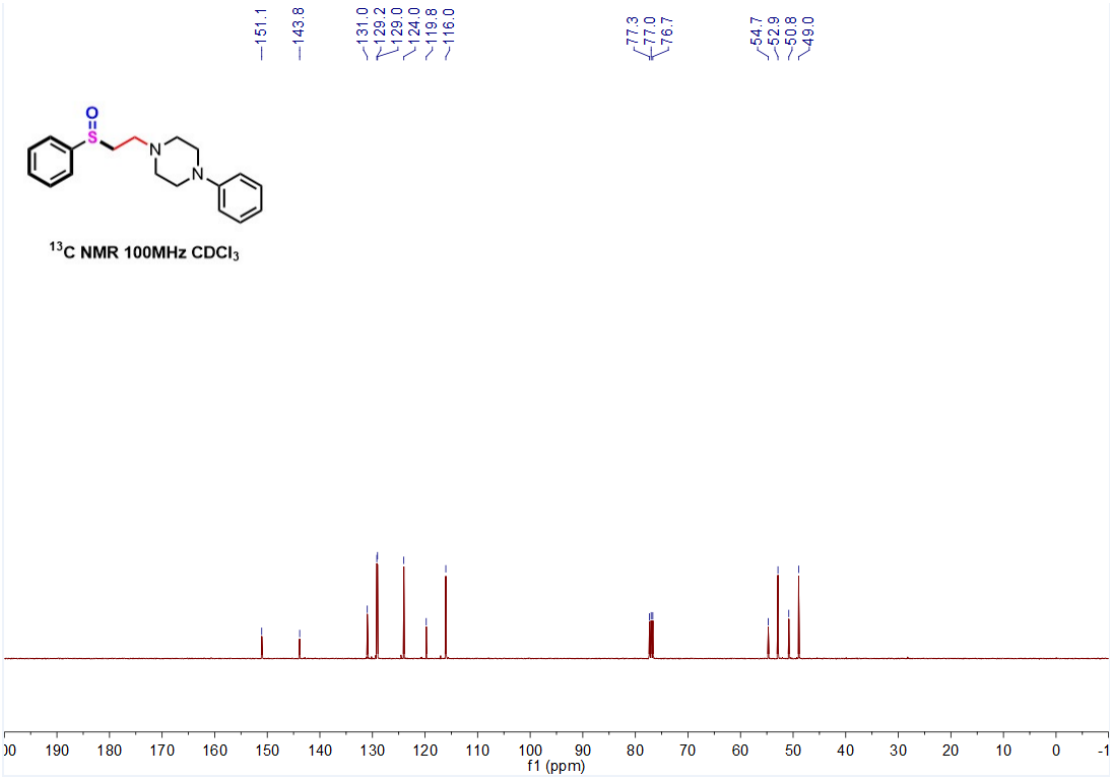
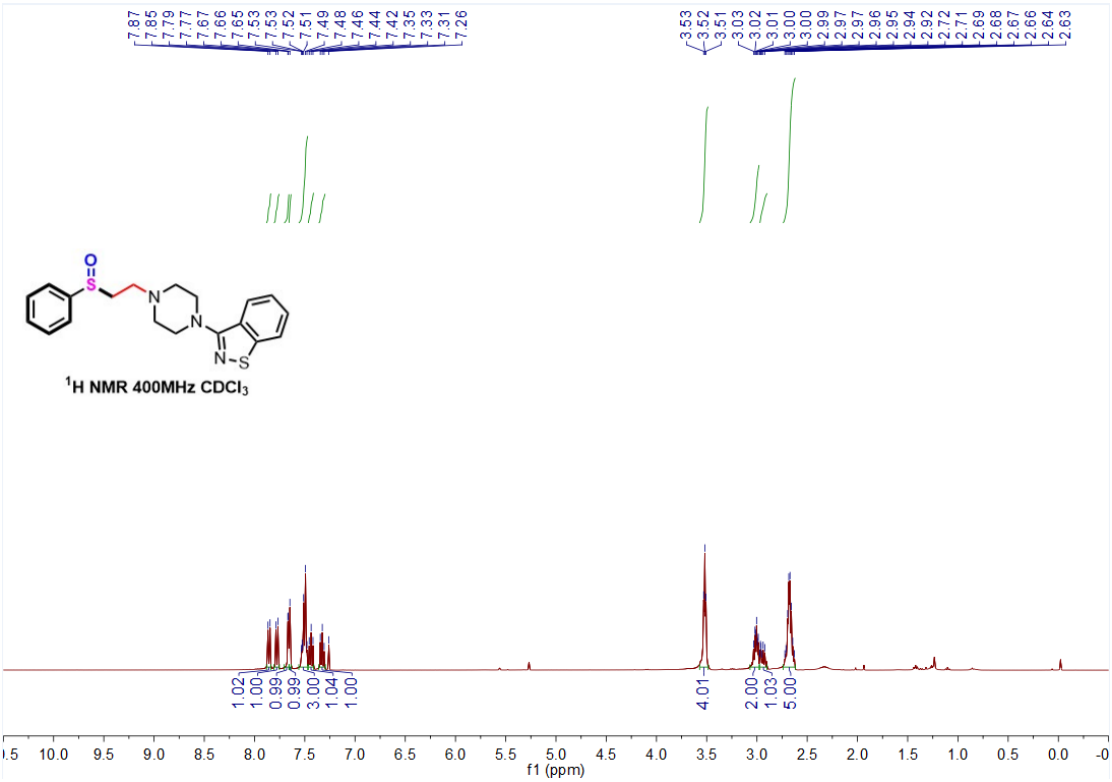
7.51
7.30
7.28
7.26
6.95
6.92
6.90
6.89
6.88
6.86
3.21
3.20
3.19
3.07
3.05
3.04
3.03
3.02
3.00
2.97
2.96
2.95
2.94
2.92
2.90
2.68
2.66
2.65
2.64
2.62
O
S
N
N
^{1}H NMR 400MHz CDCl$_3$
2.02
3.05
2.42
2.02
1.03
4.01
2.01
1.07
5.03
f1 (ppm)


151.1
143.8
131.0
129.2
129.0
124.0
119.8
116.0
77.3
77.0
76.7
54.7
52.9
50.8
49.0
O
S
N
N
13C NMR 100MHz CDCl3
f1 (ppm)

17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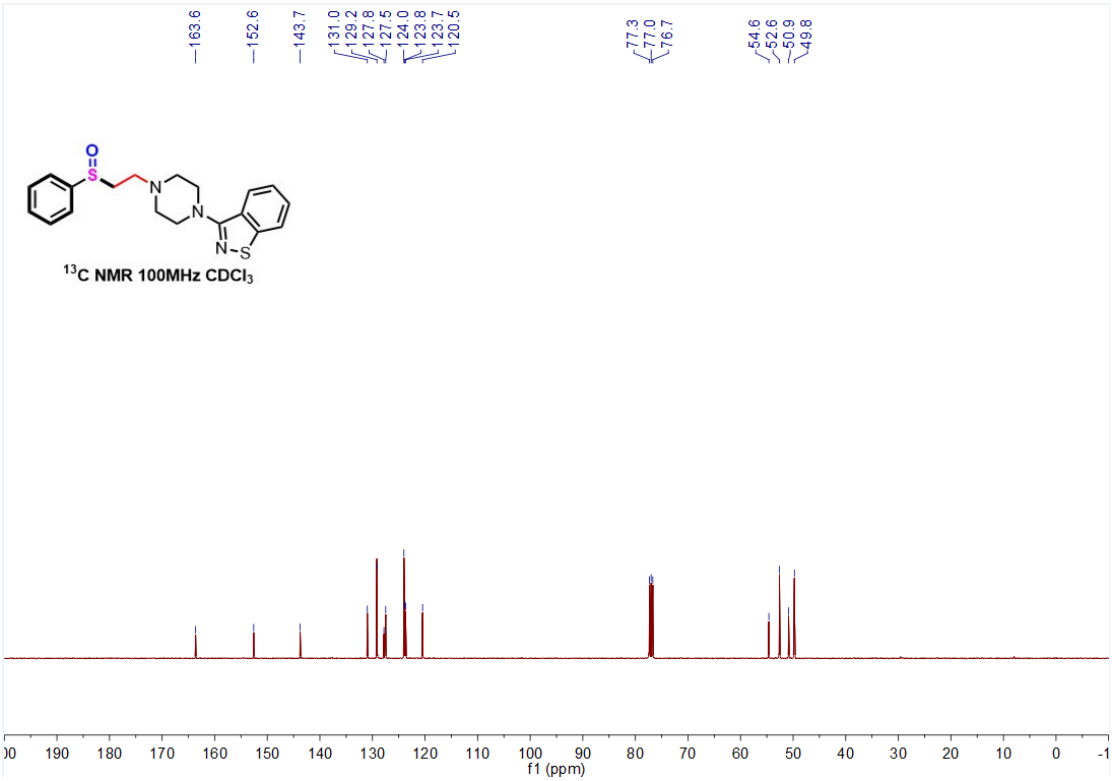
7.65
7.53
7.52
7.51
7.49
7.48
7.46
7.44
7.42
7.35
7.33
7.31
7.26
3.53
3.52
3.51
3.03
3.02
3.01
3.00
3.00
2.99
2.97
2.96
2.95
2.94
2.92
2.72
2.71
2.69
2.68
2.67
2.66
2.64
2.63
O
S
N
N
N
S
1H NMR 400MHz CDCl3
1.02
1.00
0.99
0.99
3.00
1.04
1.00
4.01
2.00
1.03
5.00
f1 (ppm)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143.7
131.0
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127.8
127.5
124.0
123.8
123.7
120.5
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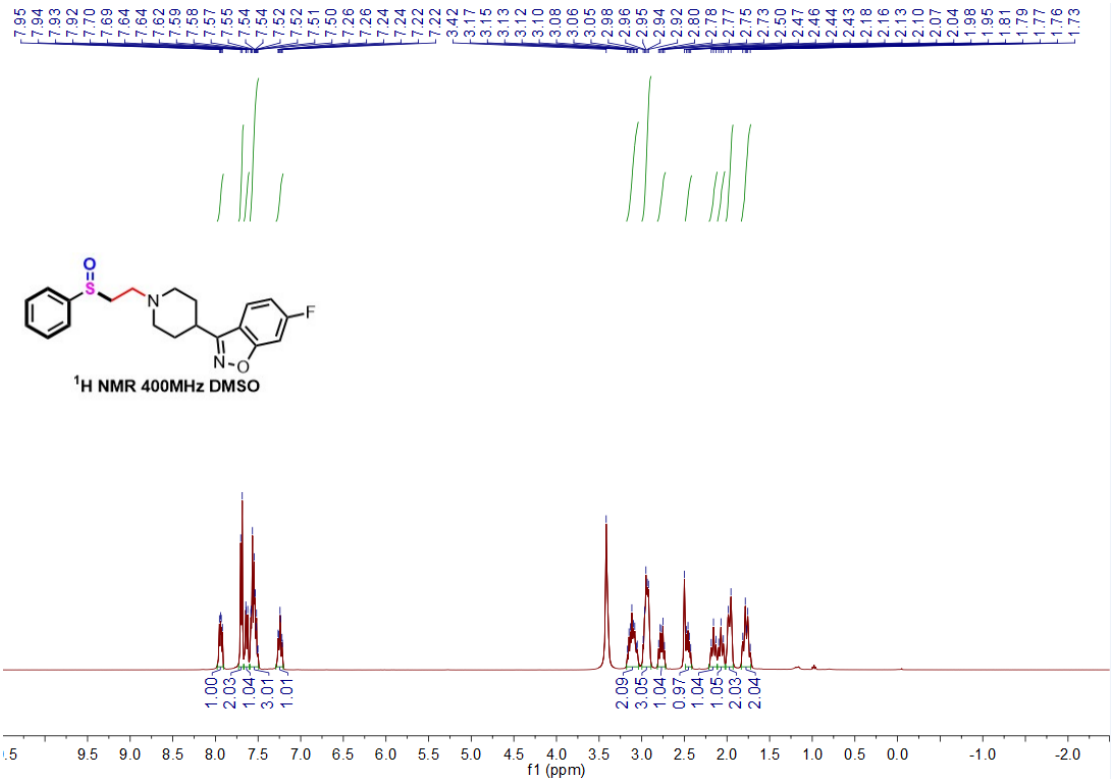
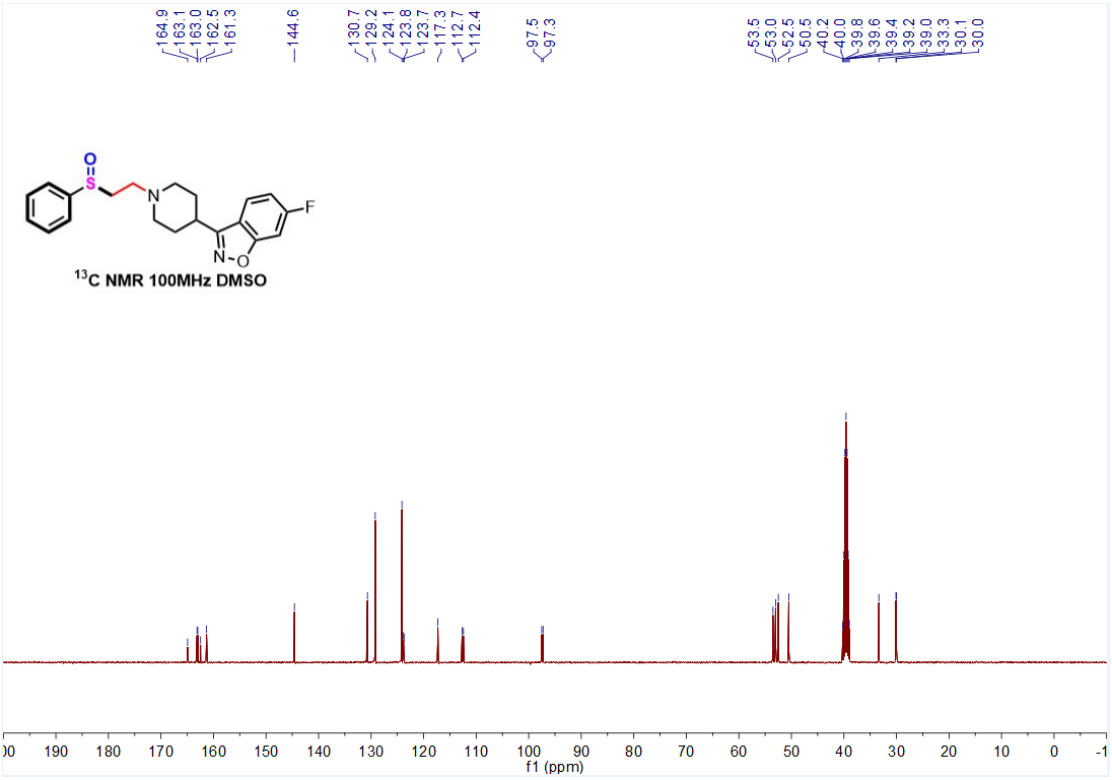
77.0
76.7
54.6
52.6
50.9
49.8
^{13}C NMR 100MHz CDCl$_3$
f1 (ppm)

18


^{1}H NMR 400MHz DMSO
f1 (ppm)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144.6
130.7
129.2
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123.7
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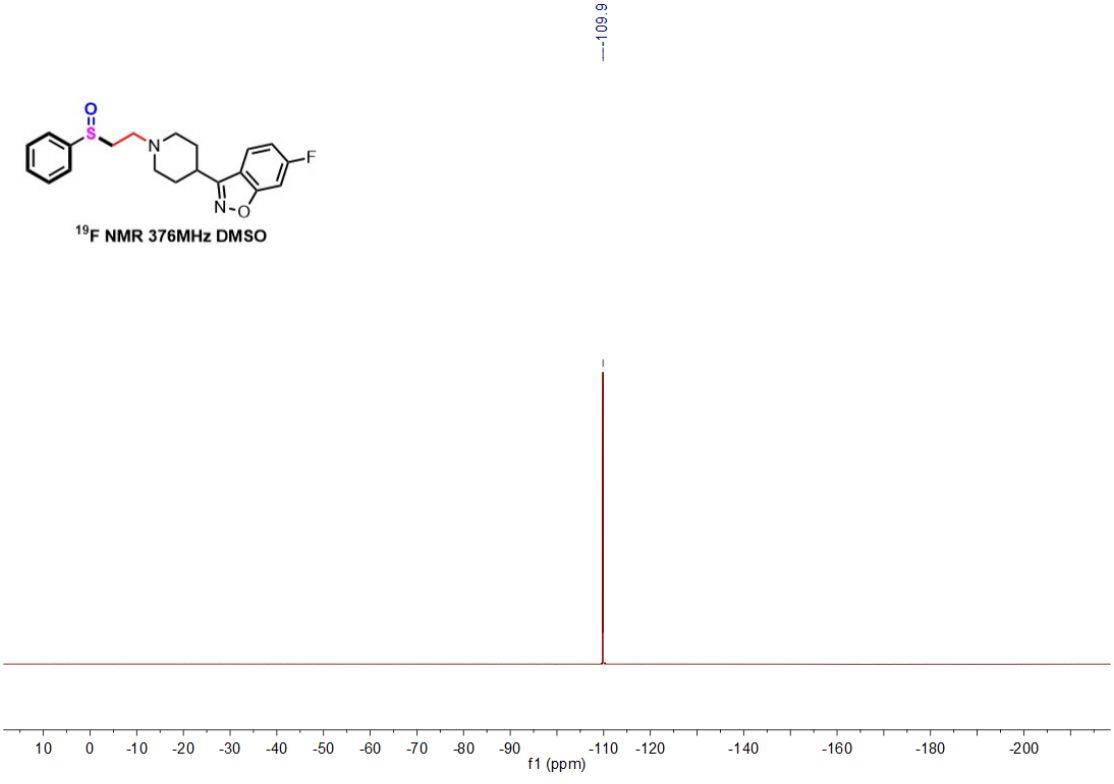
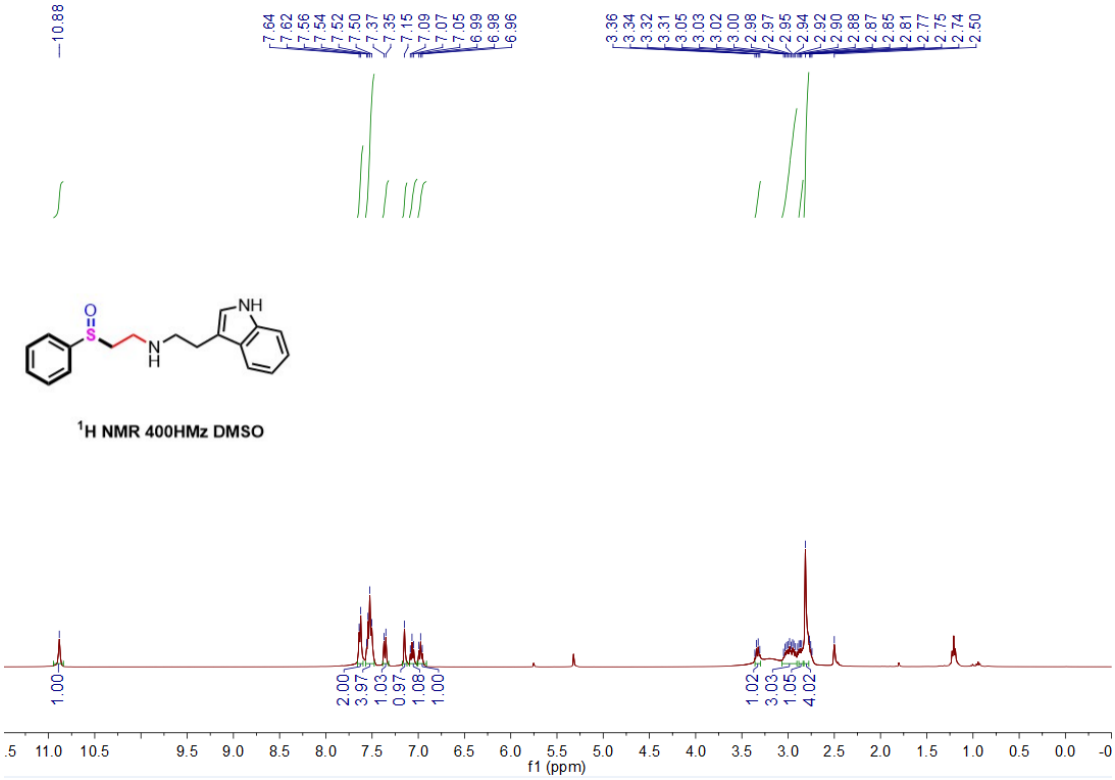
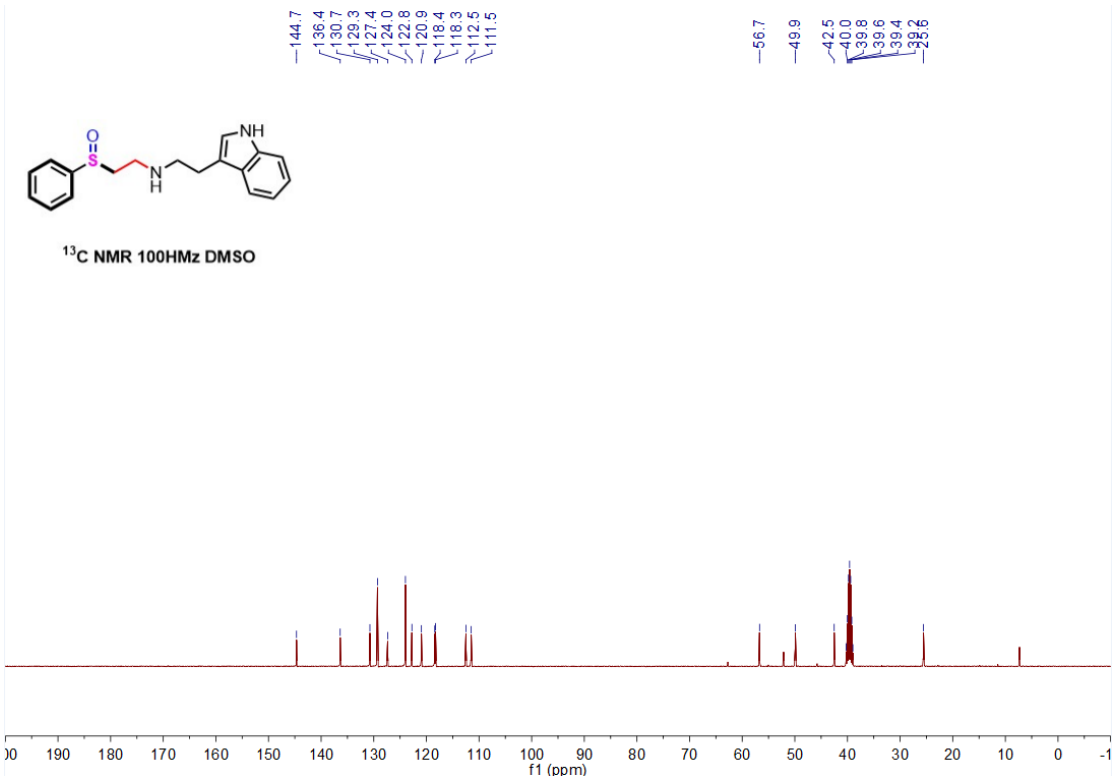
112.7
112.4
97.5
97.3
53.5
53.0
52.5
50.5
40.2
40.0
39.8
39.6
39.4
39.2
39.0
33.3
30.1
30.0
O
S
N
F
N
O
13C NMR 100MHz DMSO
f1 (ppm)


-109.9
O
S
N
F
N
O
19F NMR 376MHz DMSO
f1 (ppm)

19

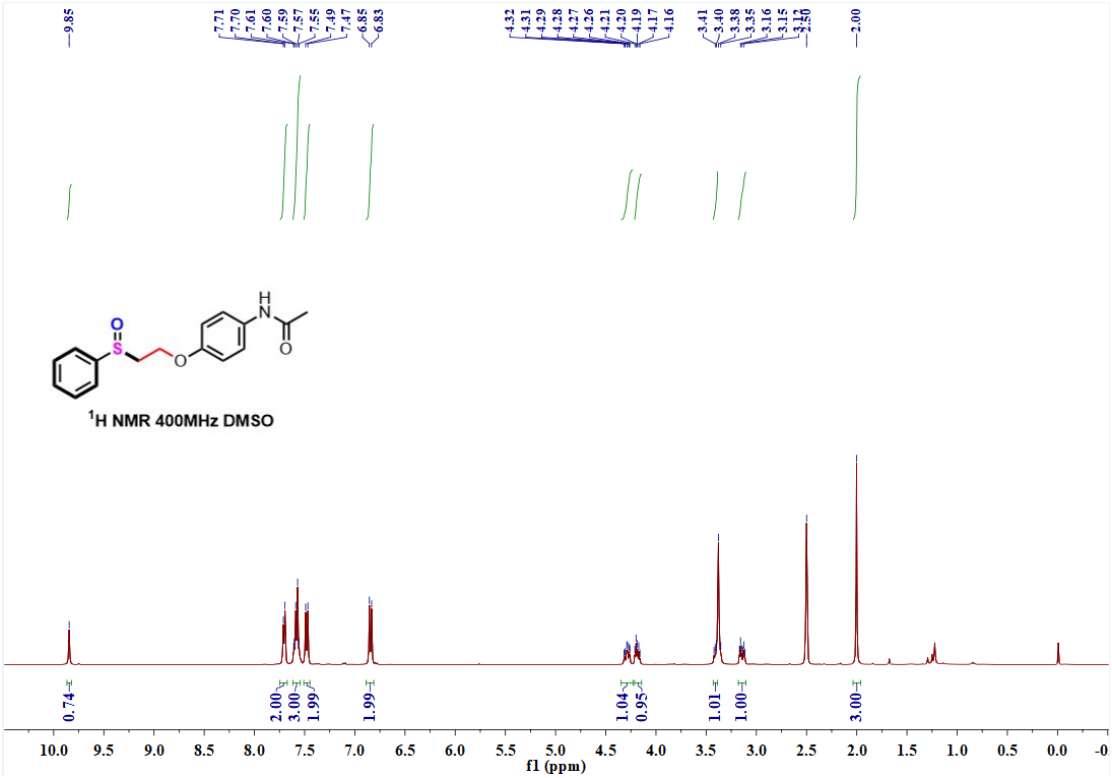


^{1}H NMR 400HMz DMSO



^{13}C NMR 100HMz DMSO

20



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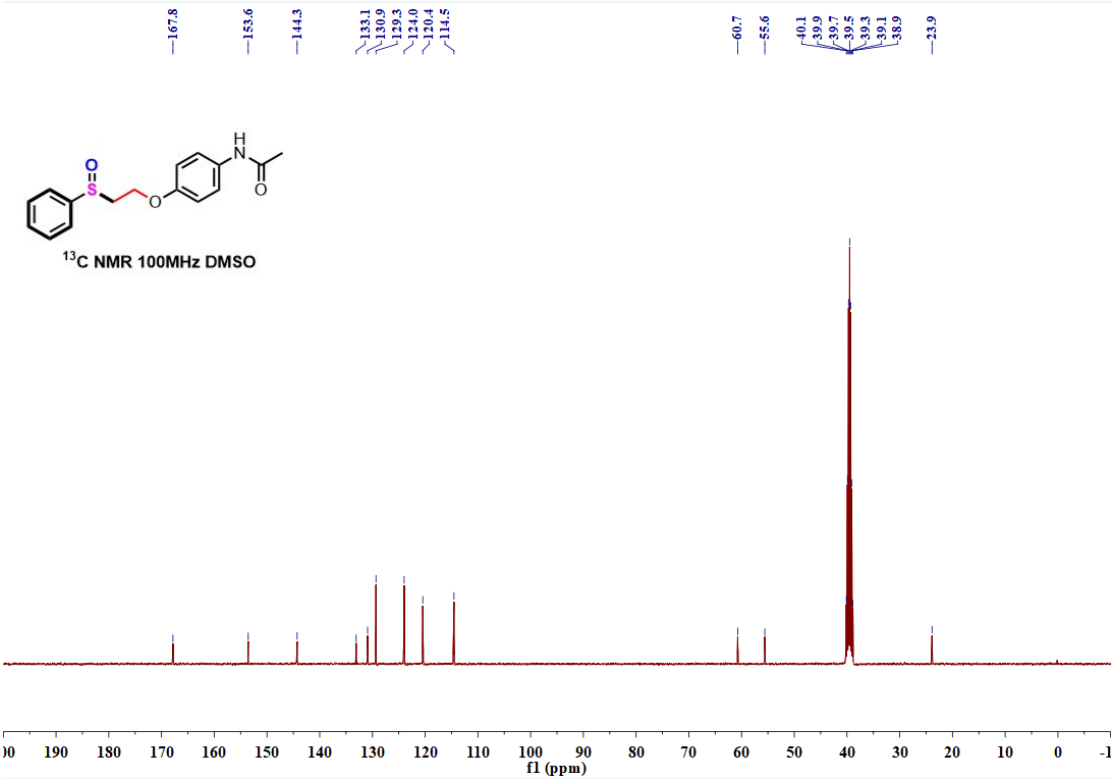
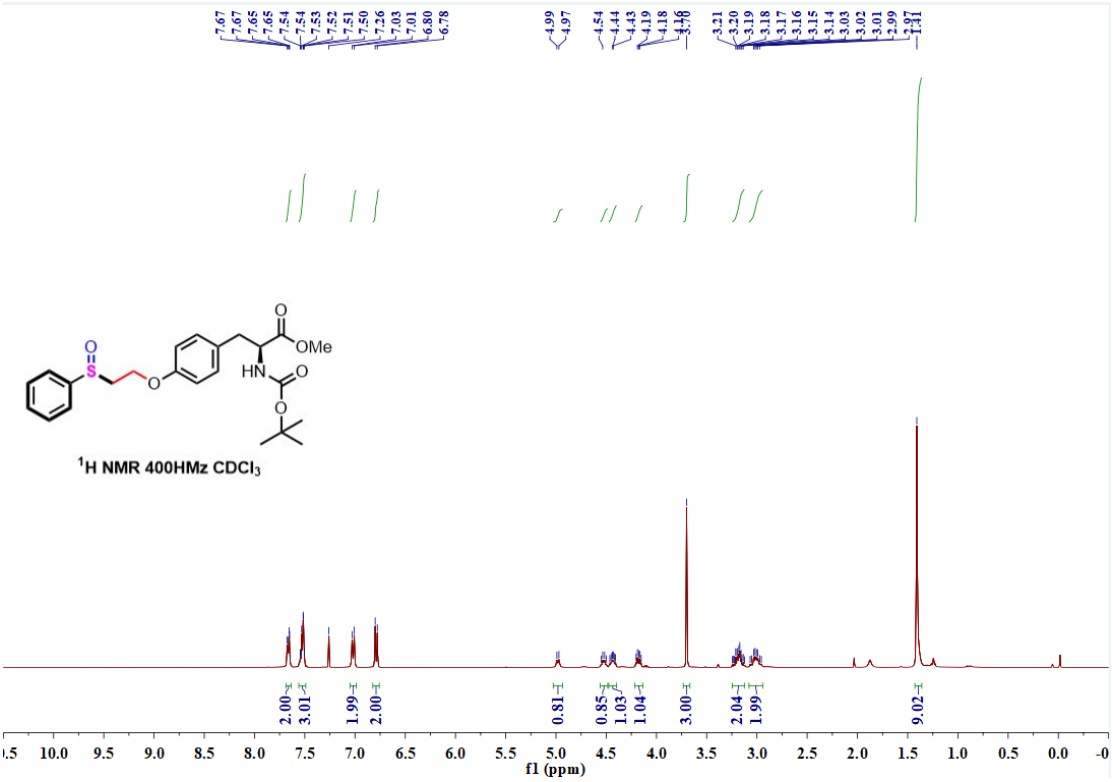


^{13}C NMR 100MHz DMSO

21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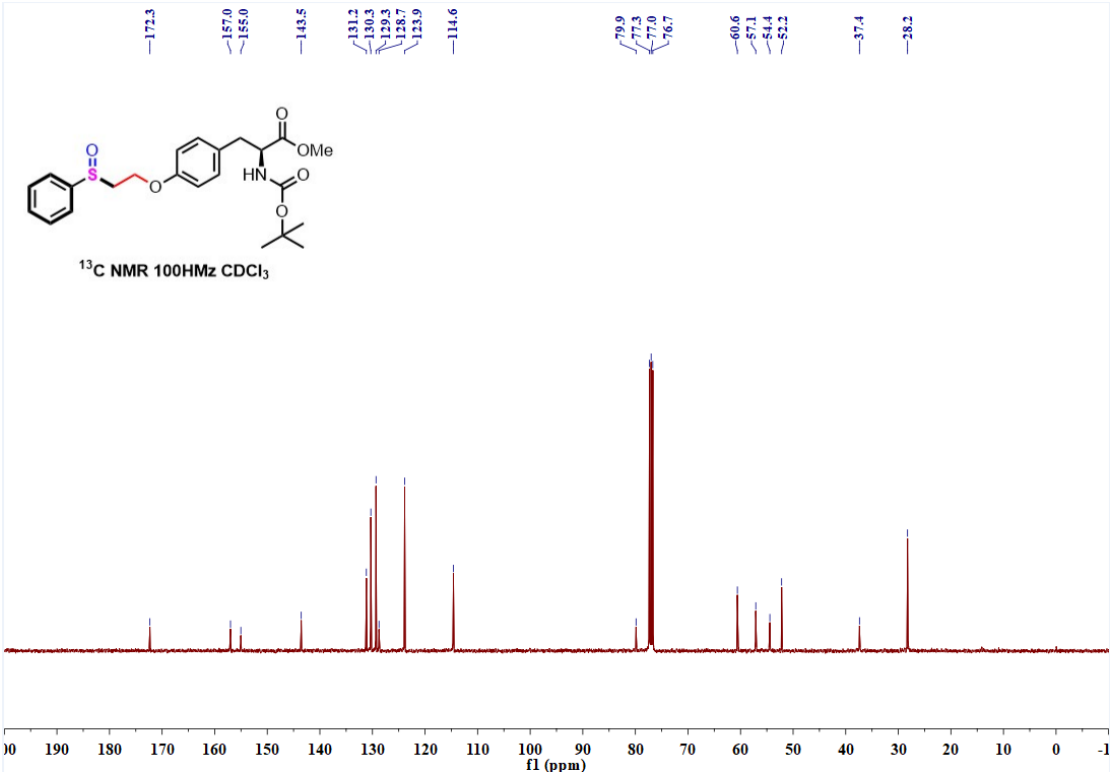
7.01
6.80
6.78
4.99
4.97
4.54
4.44
4.43
4.19
4.18
4.16
3.76
3.21
3.20
3.19
3.18
3.17
3.16
3.15
3.14
3.03
3.02
3.01
2.99
2.97
1.41
OMe
HN
O
O
O
O
S
^{1}H NMR 400HMz CDCl$_3$
2.00
3.01
1.99
2.00
0.81
0.85
1.03
1.04
3.00
2.04
1.99
9.02
f1 (ppm)


172.3
157.0
155.0
143.5
131.2
130.3
129.3
128.7
123.9
114.6
79.9
77.3
77.0
76.7
60.6
57.1
54.4
52.2
37.4
28.2
OMe
HN
O
O
O
O
S
^{13}C NMR 100HMz CDCl$_3$
f1 (ppm)

Sulfinpyrazone