Supporting Information

Catalyst-free Electrochemical Sulfonylation of Amines with Sulfonyl Hydrazide in Aqueous Medium

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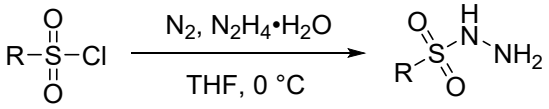
1. General methods

Unless otherwise noted, materials were obtained from commercial suppliers and used without further Purified. Reactions were monitored by thin layer chromatography (TLC). Yields refer to products isolated after Purified by column chromatography. ^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra were recorded on a Bruker AV 400 MHz spectrometer using $CDCl_3$ or DMSO-d_6 as the solvent with TMS as the internal standard. Chemical shifts are reported in parts per million. Multiplicity was indicated as follows: s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet. Coupling constants (*J*) were reported in Hz. Electrolysis experiments were performed using MESTEK DC power supply. Cyclic voltammetry was obtained from CHI 660E (Shanghai Chenhua Instrument Factory, Shanghai, China).

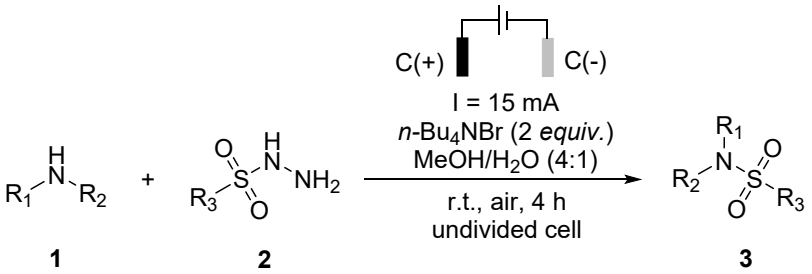
2. General procedure

General procedure for the synthesis of 2



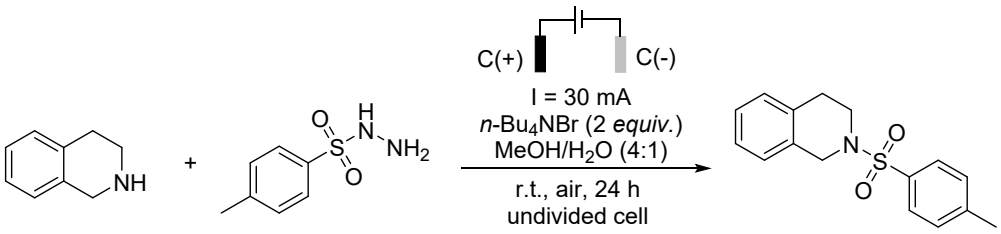
The hydrazine monohydrate (6 mmol) was added dropwise to the solution of sulfonyl chloride (2 mmol) in THF (10 mL) at 0 °C. Subsequently, the mixture was further stirred at 0 °C for 1 h. After the solvent was removed by evaporation. The pure products **2** were obtained by silica gel column chromatography with petroleum ether/ethyl acetate as eluent.

General procedure for the synthesis of 3



In an oven-dried undivided three-necked bottle (25 mL) equipped with a stir bar, amines **1** (0.3 mmol, 1 *equiv.*), sulfonyl hydrazides **2** (0.3 mmol, 1 *equiv.*), *n*-Bu_4NBr (0.6 mmol, 2 *equiv.*), MeOH (8 mL) and H_2O (2 mL) were combined and added. Two graphite rod (ϕ 5 mm) were used as anode and cathode respectively (the electrodes were immersed 1 cm in the reaction solution). The reaction mixture was stirred and electrolyzed at a constant current of 15 mA under room temperature for 4 h. After reaction completion, the solvents were removed in vacuum, the products **3** were obtained by silica gel column chromatography.

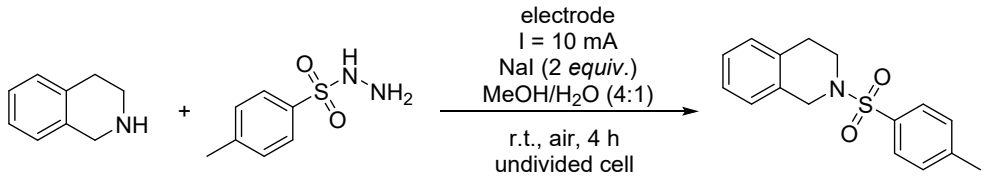
Procedure for gram scale synthesis of 3aa



In an oven-dried undivided three-necked bottle (50 mL) equipped with a stir bar, 1,2,3,4-tetrahydroisoquinoline **1a** (5 mmol, 1 *equiv.*), *p*-toluenesulfonyl hydrazide **2a** (5 mmol, 1 *equiv.*), *n*-Bu_4NBr (10 mmol, 2 *equiv.*), MeOH (16 mL) and H_2O (4 mL) were added. Two graphite rods (ϕ 10 mm) were used as anode and cathode, respectively (the electrodes were immersed 3 cm in the reaction solution). The reaction mixture was stirred and electrolyzed at a constant current of 30 mA under room temperature for 24 h. After reaction completion, the reaction mixture was diluted with water, and extracted with ethyl acetate. The organic layers were combined, washed with brine, dried over Na_2SO_4 and concentrated under reduced pressure. The crude was purified by silica gel column (petroleum ether/ethyl acetate = 8:1) to obtain the product **3aa** (1.14g, 80%).

3. Optimization of reaction conditions

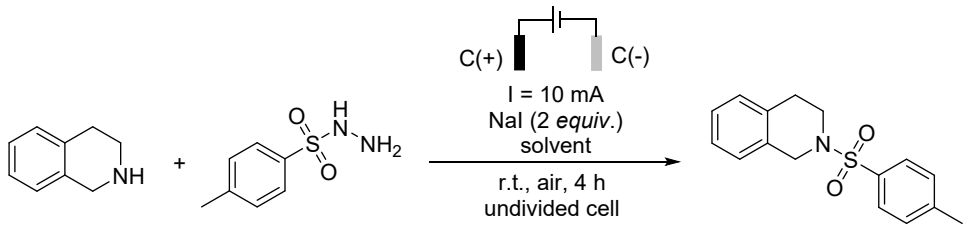
Table S1 Optimization of electrode materials[a]



Entry	Electrode material	Yield (%)[b]
1	Pt(+) || Pt(-)	75
2	C(+) || C(-)	80
3	C(+) || Pt(-)	64
4	Pt(+) || C(-)	57
5	Pt(+) || Ni(-)	72
6	C(+) || Ni(-)	73

[a]Reaction conditions: **1a** (0.3 mmol, 1 *equiv.*), **2a** (0.3 mmol, 1 *equiv.*), NaI (0.6 mmol, 2 *equiv.*), MeOH/H_2O (v/v = 4:1, 10.0 mL), constant current (10.0 mA), air, room temperature, 4 h, undivided cell. [b]Isolated yields.

Table S2 Optimization of solvents[a]

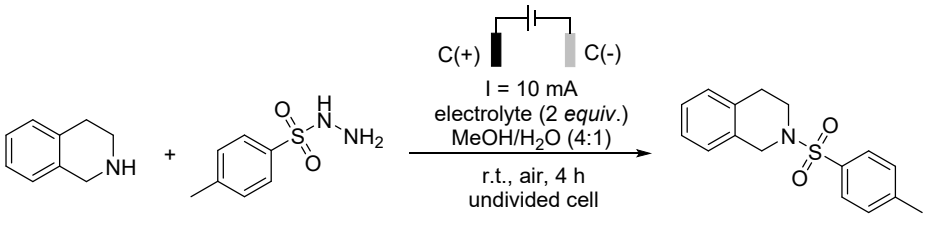


1a **2a** **3aa**

Entry	Solvent	Yield (%)[b]
1	MeOH	36
2	DMF	53
3	MeOH/H_2O (4:1)	80
4	MeOH/H_2O (2:1)	66
5	MeOH/H_2O (1:1,)	46
6	MeOH/H_2O (1:2)	22
7	MeCN/H_2O (4:1)	69
8	EtOH/H_2O (4:1)	57
9	THF/H_2O (4:1)	32
10	DMSO/H_2O (4:1)	38
11	DMF/H_2O (4:1)	61

[a]Reaction conditions: **1a** (0.3 mmol, 1 *equiv*.), **2a** (0.3 mmol, 1 *equiv*.), NaI (0.6 mmol, 2 *equiv*.), solvent (10.0 mL), constant current (10.0 mA), air, room temperature, 4 h, undivided cell. Anode: graphite rod, cathode: graphite rod. [b]Isolated yields.

Table S3 Optimization of electrolytes[a]

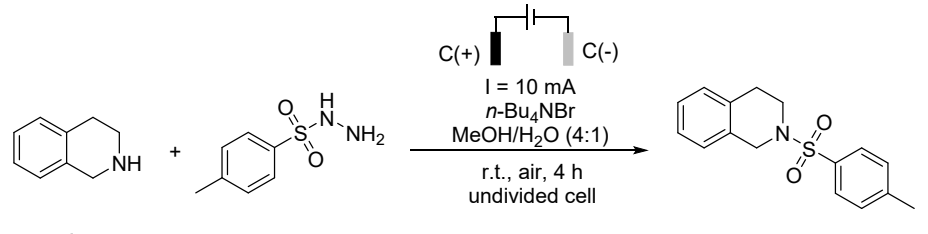


1a **2a** **3aa**

Entry	Electrolyte	Yield (%)[b]
1	*n*-Bu_4NBF_4	N.d.
2	*n*-Bu_4NPF_6	N.d.
3	*n*-Bu_4NI	42
4	*n*-Bu_4NBr	82
5	NaBr	37
6	KBr	35
7	NaI	80
8	KI	49
9	NH_4I	36
10	DMMI	43

[a]Reaction conditions: **1a** (0.3 mmol, 1 *equiv.*), **2a** (0.3 mmol, 1 *equiv.*), Electrolyte (0.6 mmol, 2 *equiv*.), MeOH/H_2O (v/v = 4:1, 10.0 mL), constant current (10.0 mA), air, room temperature, 4 h, undivided cell. Anode: graphite rod, cathode: graphite rod. Isolated yields. [c]N.d. = no detected. DMMI = 1,3-dimethylimidazolium iodide.

Table S4 Optimization of the amount of *n*-Bu_4NBr[a]

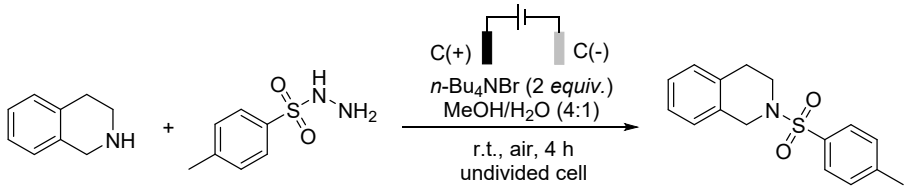


1a **2a** **3aa**

Entry	Amount of *n*-Bu_4NBr (*equiv*.)	Yield (%)[b]
1	1	57
2	2	82
3	3	30

[a]Reaction conditions: **1a** (0.3 mmol, 1 *equiv*.), **2a** (0.3 mmol, 1 *equiv*.), *n*-Bu_4NBr, MeOH/H_2O (v/v = 4:1, 10.0 mL), constant current (10.0 mA), air, room temperature, 4 h, undivided cell. Anode: graphite rod, cathode: graphite rod. [b]Isolated yields.

Table S5 Optimization of current[a]

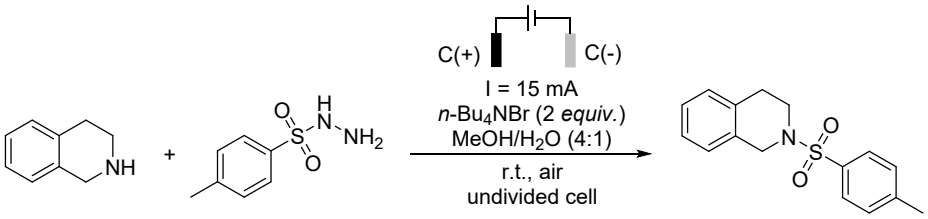


1a **2a** **3aa**

Entry	Current (mA)	Yield (%)[b]
1	0	N.d.
2	8	13
3	10	82
4	12	85
5	15	89
6	20	83

[a]Reaction conditions: **1a** (0.3 mmol, 1 *equiv*.), 2a (0.3 mmol, 1 *equiv*.), *n*-Bu_4NBr (0.6 mmol, 2 *equiv*.), H_2O/MeOH (v/v = 4:1, 10.0 mL), constant current electrolysis, air, room temperature, 4 h, undivided cell. Anode: graphite rod, cathode: graphite rod. [b]Isolated yields. [c] N.d. = no detected.

Table S6 Optimization of reaction time[a]

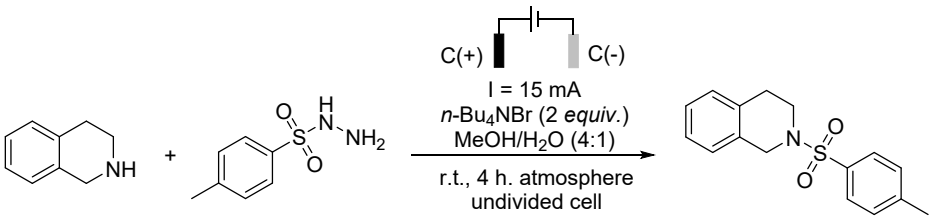


1a **2a** **3aa**

Entry	Time (h)	Yield (%)[b]
1	2	56
2	3	82
3	4	89
4	6	78

[a]Reaction conditions: **1a** (0.3 mmol, 1 *equiv*.), 2a (0.3 mmol, 1 *equiv*.), *n*-Bu_4NBr (0.6 mmol, 2 *equiv*.), H_2O/MeOH (v/v = 4:1, 10.0 mL), constant current (10.0 mA), air, room temperature, undivided cell. Anode: graphite rod, cathode: graphite rod. [b]Isolated yields.

Table S7 Optimization of atmosphere[a]



Entry	Atmosphere	Yield (%)[b]
1	Air	89
2	N_2	88

[a]Reaction conditions: **1a** (0.3 mmol, 1 *equiv.*), 2a (0.3 mmol, 1 *equiv.*), *n*-Bu_4NBr (0.6 mmol, 2 *equiv.*), H_2O/MeOH (v/v = 4:1, 10.0 mL), constant current (10.0 mA), room temperature, 4 h, undivided cell. Anode: graphite rod, cathode: graphite rod. [b]Isolated yields.

4. Mechanistic investigation

Cyclic voltammetry experiments

Cyclic voltammetry was performed in a 25 mL three-electrode cell under air at room temperature. The working electrode was a steady glassy carbon disk electrode, the counter electrode a platinum wire. The reference was an Ag/AgCl electrode submerged in saturated aqueous KCl solution. 8 mL of methanol and 2 mL of water containing 0.1 M *n*-Bu_4NBF_4 were poured into the electrochemical cell in all experiments. The scan rate is 0.1 V/s, ranging from 0 V to 3.0 V. Background (*n*Bu_4NBF_4, 0.1 M in the mixed solvent); 1,2,3,4-tetrahydroisoquinoline (**1a**, 0.1 M in the mixed solvent); *p*-toluenesulfonyl hydrazide (**2a**, 0.1 M in the mixed solvent); *n*-Bu_4NBr (0.1 M in the mixed solvent) and the mixture of **1a**, **2a** and *n*-Bu_4NBr (0.1 M in the mixed solvent).

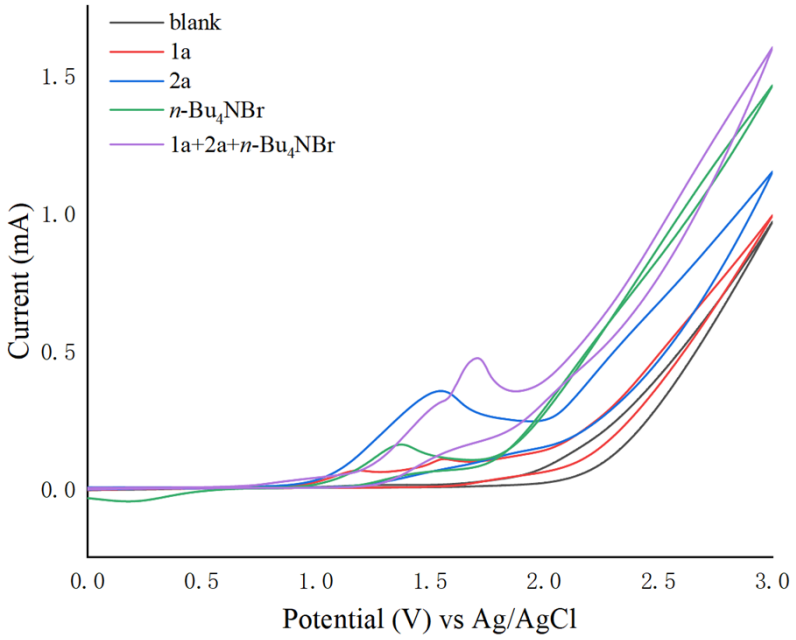
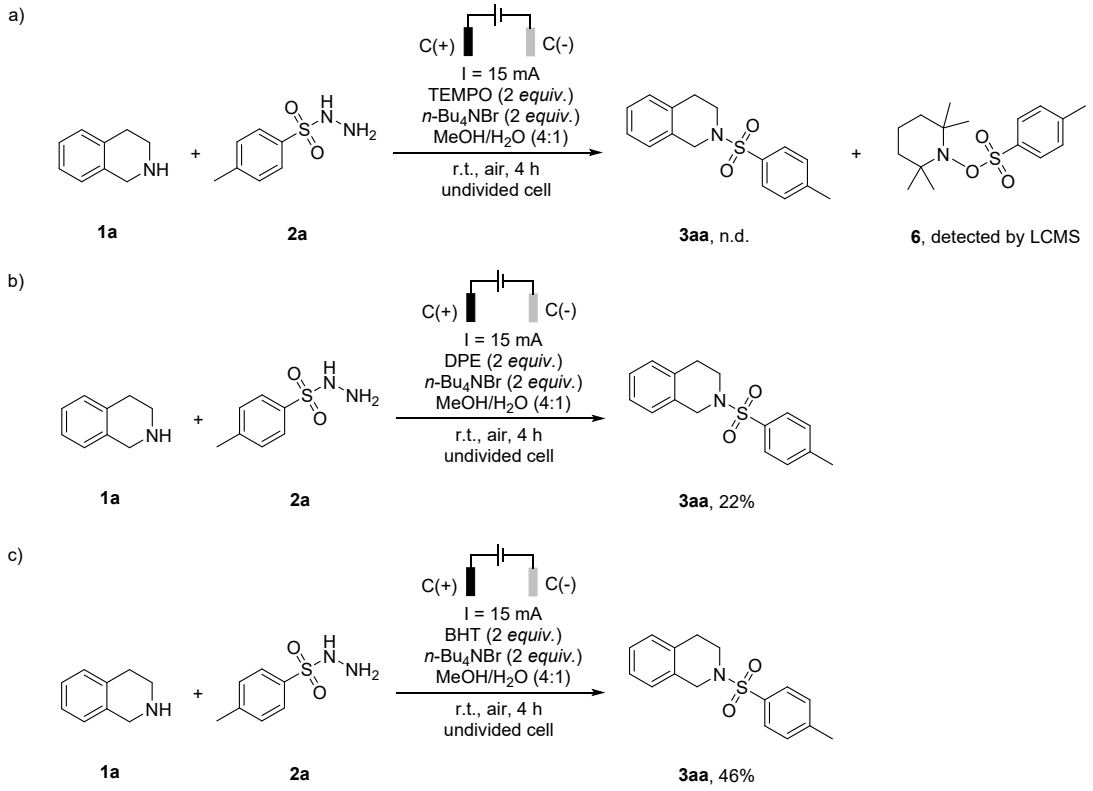


Figure S1 CV measurements. *n*-Bu_4NBF_4 was used as the electrolyte for the CV measurements.

Radical trapping experiment



In order to confirm whether the reaction undergoes a radical mechanism, commonly used radical scavengers such as 2,2,6,6-tetramethylpiperidinooxy (TEMPO), 1,1-diphenylethylene (DPE) and butylated hydroxytoluene (BHT) was used respectively in radical capture and suppression experiments. Under the standard conditions, the radical scavenger (2.0 *equiv*. to **2a**) was added to the model reaction system at the beginning of the reaction. Additionally, after 4 h, a small amount of the reaction mixture added with TEMPO was used to measurement. The radical trapping product **6** can be observed by LCMS.

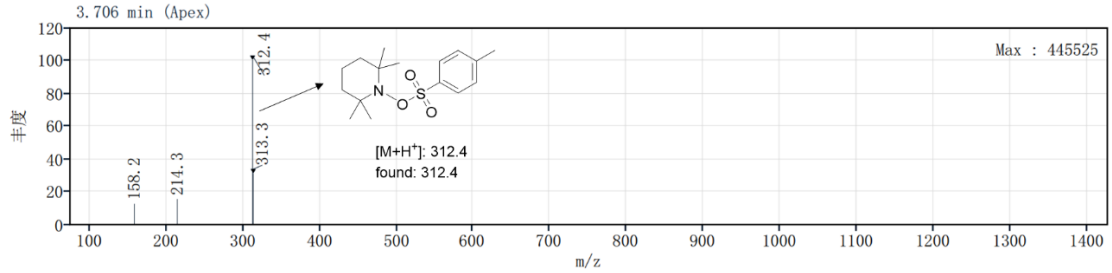
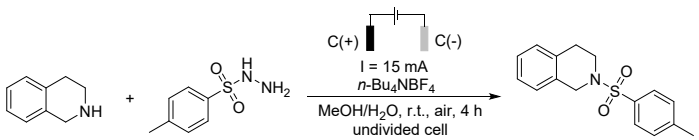


Figure S2. Mass spectrometry (LCMS) data of possible intermediate (with TEMPO).

Control experiments

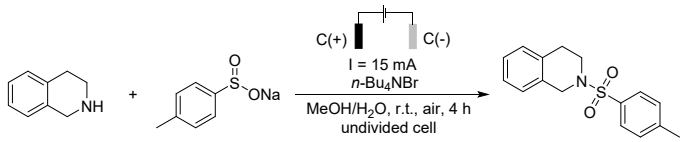
To investigate the possible mechanism of this electrochemical sulfonation, a series of control experiments were conducted.

(a)



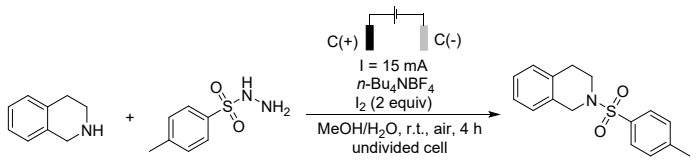
1a **2a** **3aa**, n.d.

(b)



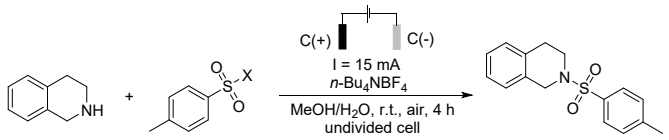
1a **7a** **3aa,** 39%

(c)



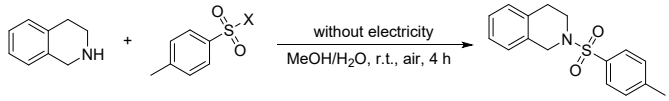
1a **2a** **3aa**, n.d.

(d)



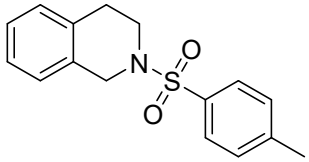
1a X = Br, **8a** Cl, **8b** **3aa** X = Br, 40% Cl, 13%

(e)

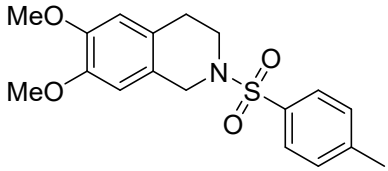


1a X = Br, **8a** Cl, **8b** **3aa** X = Br, 68% Cl, 42%

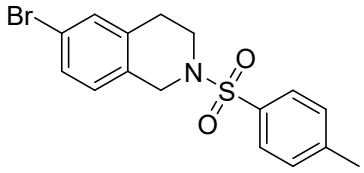
5. Characterization data of the products



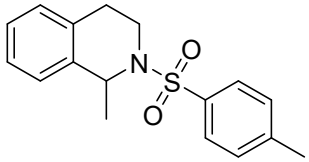
2-Tosyl-1,2,3,4-tetrahydroisoquinoline (**3aa**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3aa** as a white solid (76.7 mg, 89% yield). m.p. 138~140 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.73 (d, J = 8.2 Hz, 2H), 7.32 (d, J = 8.0 Hz, 2H), 7.17 – 7.11 (m, 2H), 7.10 – 7.05 (m, 1H), 7.05 – 6.99 (m, 1H), 4.24 (s, 2H), 3.35 (t, J = 6.0 Hz, 2H), 2.93 (t, J = 5.8 Hz, 2H), 2.42 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 143.8, 133.3, 133.2, 131.7, 129.8, 128.9, 127.9, 126.8, 126.5, 126.4, 47.6, 43.8, 29.0, 21.6. HRMS (ESI) calc for $C_{16}H_{18}NO_2S$ ([M+H]$^+$): 288.1058, Found: 288.1066.



6,7-Dimethoxy-2-tosyl-1,2,3,4-tetrahydroisoquinoline (**3ba**)[1]: Purified by column chromatography on silica gel (4:1 petroleum ether/ethyl acetate) afforded **3ba** as a white solid. m.p. 134~136 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.71 (d, J = 8.2 Hz, 2H), 7.31 (d, J = 8.0 Hz, 2H), 6.54 (s, 1H), 6.50 (s, 1H), 4.16 (s, 2H), 3.81 (s, 3H), 3.80 (s, 3H), 3.32 (t, J = 6.0 Hz, 2H), 2.83 (t, J = 5.8 Hz, 2H), 2.41 (s, 3H). HRMS (ESI) calc. for $C_{18}H_{22}NO_4S$ ([M+H]$^+$): 348.1270, Found: 348.1250.

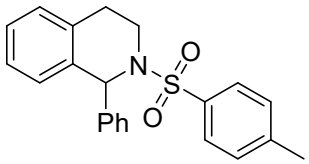


6-Bromo-2-tosyl-1,2,3,4-tetrahydroisoquinoline (**3ca**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ca** as a white solid (68.6 mg, 63% yield). m.p. 154~156 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.71 (d, J = 8.2 Hz, 2H), 7.32 (d, J = 8.0 Hz, 2H), 7.28 – 7.21 (m, 2H), 6.90 (d, J = 8.2 Hz, 1H), 4.18 (s, 2H), 3.33 (t, J = 6.0 Hz, 2H), 2.89 (t, J = 5.8 Hz, 2H), 2.42 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 144.0, 135.5, 133.4, 131.7, 130.9, 129.9, 129.6, 128.1, 127.8, 120.5, 47.3, 43.5, 28.8, 21.6. HRMS (ESI) calc. for $C_{16}H_{17}BrNO_2S$ ([M+H]$^+$): 366.0163, Found: 366.0171.

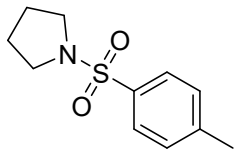


1-Methyl-2-tosyl-1,2,3,4-tetrahydroisoquinoline (**3da**): Purified by column chromatography on silica gel (10:1 petroleum ether/ethyl acetate) afforded **3da** as a

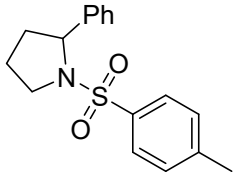
colorless liquid (60.4 mg, 67% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.67 (d, J = 8.3 Hz, 2H), 7.19 (d, J = 8.0 Hz, 2H), 7.16 – 7.02 (m, 3H), 6.98 (d, J = 7.4 Hz, 1H), 5.14 (q, J = 6.8 Hz, 1H), 3.90 – 3.82 (m, 1H), 3.49 – 3.37 (m, 1H), 2.78 – 2.58 (m, 2H), 2.36 (s, 3H), 1.47 (d, J = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 143.2, 138.1, 137.9, 132.9, 129.7, 129.1, 127.1, 126.8, 126.7, 126.4, 52.2, 38.7, 28.0, 23.6, 21.5. HRMS (ESI) calc. for $C_{17}H_{20}NO_2S$ ([M+H]$^+$): 302.1215, Found: 302.1222.



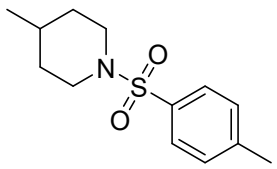
1-Phenyl-2-tosyl-1,2,3,4-tetrahydroisoquinoline (**3ea**)[2]: Purified by column chromatography on silica gel (10:1 petroleum ether/ethyl acetate) afforded **3ea** as a white solid (68.5 mg, 63% yield). m.p. 154~156 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.55 (d, J = 8.2 Hz, 2H), 7.29 – 7.22 (m, 3H), 7.21 – 7.17 (m, 2H), 7.16 – 7.10 (m, 2H), 7.08 (d, J = 8.2 Hz, 2H), 7.01 – 6.96 (m, 2H), 6.23 (s, 1H), 3.80 – 3.72 (m, 1H), 3.36 – 3.27 (m, 1H), 2.73 – 2.62 (m, 1H), 2.60 – 2.53 (m, 1H), 2.32 (s, 3H). HRMS (ESI) calc. for $C_{22}H_{22}NO_2S$ ([M+H]$^+$): 364.1371, Found: 364.1380.



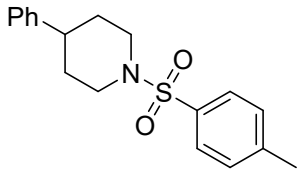
1-Tosylpyrrolidine (**3fa**)[3]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3fa** as a white solid (59.1 mg, 88% yield). m.p. 132~134 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.71 (d, J = 8.0 Hz, 2H), 7.31 (d, J = 8.0 Hz, 2H), 3.22 (t, J = 6.6 Hz, 4H), 2.42 (s, 3H), 1.74 (t, J = 6.8 Hz, 4H). HRMS (ESI) calc. for $C_{11}H_{16}NO_2S$ ([M+H]$^+$): 226.0902, Found: 226.0897.



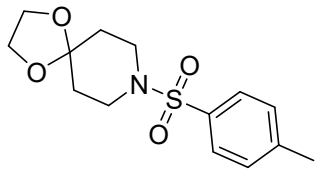
2-Phenyl-1-tosylpyrrolidine (**3ga**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ga** as a white solid (73.1 mg, 81% yield). m.p. 110~112 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.66 (d, J = 8.0 Hz, 2H), 7.33 – 7.25 (m, 6H), 7.24 – 7.18 (m, 1H), 4.78 (dd, J = 8.0, 3.6 Hz, 1H), 3.65 – 3.57 (m, 1H), 3.47 – 3.38 (m, 1H), 2.41 (s, 3H), 2.05 – 1.93 (m, 1H), 1.90 – 1.76 (m, 2H), 1.71 – 1.61 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.4, 143.2, 135.3, 129.7, 128.4, 127.6, 127.1, 126.3, 63.4, 49.5, 35.9, 24.1, 21.6. HRMS (ESI) calc. for $C_{17}H_{20}NO_2S$ ([M+H]$^+$): 302.1215, Found: 302.1222.



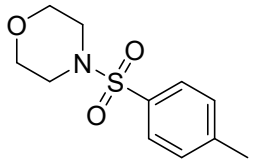
4-Methyl-1-tosylpiperidine (**3ha**)[4]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ha** as a white solid (62.0 mg, 82% yield). m.p. 164~166 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.63 (d, J = 8.2 Hz, 2H), 7.30 (d, J = 8.0 Hz, 2H), 3.75 – 3.68 (m, 2H), 2.42 (s, 3H), 2.27 – 2.17 (m, 2H), 1.68 – 1.61 (m, 2H), 1.31 – 1.23 (m, 3H), 0.89 (d, J = 5.6 Hz, 3H). HRMS (ESI) calc. for $C_{13}H_{20}NO_2S$ ([M+H]$^+$): 254.1215, Found: 254.1187.



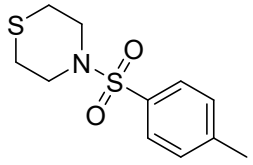
4-Phenyl-1-tosylpiperidine (**3ia**)[4]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ia** as a white solid (72.3 mg, 77% yield). m.p. 150~152 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.69 (d, J = 8.2 Hz, 2H), 7.35 (d, J = 8.0 Hz, 2H), 7.34 – 7.25 (m, 2H), 7.25 – 7.16 (m, 1H), 7.18 – 7.11 (m, 2H), 3.97 – 3.90 (m, 2H), 2.45 (s, 3H), 2.43 – 2.39 (m, 1H), 2.39 – 2.31 (m, 2H), 1.91 – 1.81 (m, 4H). HRMS (ESI) calc. for $C_{18}H_{22}NO_2S$ ([M+H]$^+$): 316.1371, Found: 316.1383.



8-Tosyl-1,4-dioxa-8-azaspiro[4.5]decane (**3ja**): Purified by column chromatography on silica gel (2:1 petroleum ether/ethyl acetate) afforded **3ja** as a white solid (69.7 mg, 79% yield). m.p. 114~116 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.64 (d, J = 8.2 Hz, 2H), 7.31 (d, J = 8.0 Hz, 2H), 3.89 (s, 4H), 3.14 (t, J = 5.8 Hz, 4H), 2.42 (s, 3H), 1.77 (t, J = 5.8 Hz, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 133.7, 129.8, 127.7, 106.2, 64.5, 44.6, 34.6, 21.6. HRMS (ESI) calc. for $C_{14}H_{20}NO_4S$ ([M+H]$^+$): 298.1113, Found: 298.1104.

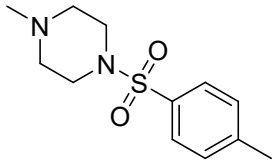


4-Tosylmorpholine (**3ka**)[5]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ka** as a white solid (67.9 mg, 94% yield). m.p. 144~146 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.63 (d, J = 8.2 Hz, 2H), 7.34 (d, J = 8.0 Hz, 2H), 3.73 (t, J = 4.8 Hz, 4H), 2.98 (t, J = 4.8 Hz, 4H), 2.44 (s, 3H). HRMS (ESI) calc. for $C_{11}H_{16}NO_3S$ ([M+H]$^+$): 242.0851, Found: 242.0844.

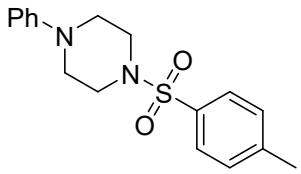


4-Tosylthiomorpholine (**3la**)[5]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3la** as a white solid (40.7 mg, 53% yield). m.p.

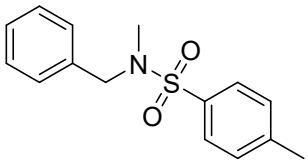
126~128 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.61 (d, J = 8.2 Hz, 2H), 7.32 (d, J = 8.0 Hz, 2H), 3.32 (t, J = 5.0 Hz, 4H), 2.69 (t, J = 5.0 Hz, 4H), 2.43 (s, 3H). HRMS (ESI) calc. for $C_{11}H_{16}NO_2S_2$ ([M+H]$^+$): 258.0622, Found: 258.0618.



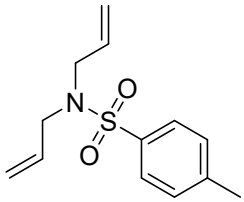
1-Methyl-4-tosylpiperazine (**3ma**)[5]: Purified by column chromatography on silica gel (2:1 petroleum ether/ethyl acetate) afforded **3ma** as a white solid (62.8 mg, 83% yield). m.p. 140~142 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.62 (d, J = 8.2 Hz, 2H), 7.31 (d, J = 8.0 Hz, 2H), 3.01 (t, J = 5.0 Hz, 4H), 2.46 (t, J = 5.0 Hz, 4H), 2.41 (s, 3H), 2.25 (s, 3H). HRMS (ESI) calc. for $C_{13}H_{20}NO_2S$ ([M+H]$^+$): 255.1167, Found: 255.1151.



1-Phenyl-4-tosylpiperazine (**3na**): Purified by column chromatography on silica gel (4:1 petroleum ether/ethyl acetate) afforded **3na** as a white solid (72.8 mg, 77% yield). m.p. 198~200 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.71 (d, J = 8.2 Hz, 2H), 7.37 (d, J = 8.0 Hz, 2H), 7.31 – 7.26 (m, 2H), 6.96 – 6.86 (m, 3H), 3.32 – 3.23 (m, 4H), 3.22 – 3.14 (m, 4H), 2.47 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 150.8, 144.0, 129.9, 129.4, 128.0, 120.9, 117.0, 49.3, 46.2, 21.7. HRMS (ESI) calc. for $C_{17}H_{21}N_2O_2S$ ([M+H]$^+$): 317.1324, Found: 317.1313.

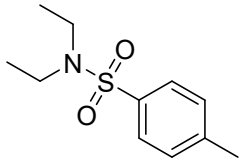


N-Benzyl-N,4-dimethylbenzenesulfonamide (**3oa**)[1]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3oa** as a white solid (68.2 mg, 83% yield). m.p. 90~92 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.73 (d, J = 8.2 Hz, 2H), 7.36 (d, J = 8.0 Hz, 2H), 7.34 – 7.28 (m, 5H), 4.13 (s, 2H), 2.58 (s, 3H), 2.46 (s, 3H). HRMS (ESI) calc. for $C_{15}H_{18}NO_2S$ ([M+H]$^+$): 276.1058, Found: 276.1060.

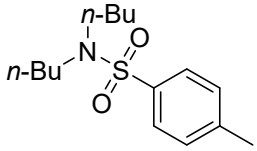


N, N-Diallyl-p-toluenesulfonamide (**3pa**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3pa** as a colorless oil (46.7 mg, 62% yield). ^{1}H NMR (400 MHz, DMSO-d_6): δ 7.62 (d, J = 8.0 Hz, 2H), 7.21 (d, J = 7.9 Hz, 2H), 5.59 – 5.43 (m, 2H), 5.14 – 4.95 (m, 4H), 3.72 (d, J = 6.2 Hz, 4H), 2.34 (s, 3H).

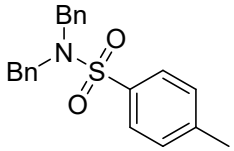
^{13}C NMR (100 MHz, $CDCl_3$): δ 143.3, 137.4, 132.7, 129.8, 127.2, 119.1, 49.4, 21.6. HRMS (ESI) calc. for $C_{13}H_{18}NO_2S$ ($[M+H]^+$): 252.1058, Found: 252.1061.



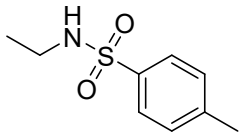
N, N-Diethyl-4-methylbenzenesulfonamide (**3qa**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3qa** as a white solid (33.9 mg, 50% yield). m.p. 58~60 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.68 (d, J = 8.2 Hz, 2H), 7.27 (d, J = 8.0 Hz, 2H), 3.21 (q, J = 7.2 Hz, 4H), 2.41 (s, 3H), 1.11 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 143.0, 137.6, 129.7, 127.2, 42.1, 21.6, 14.3. HRMS (ESI) calc. for $C_{11}H_{18}NO_2S$ ($[M+H]^+$): 228.1058, Found: 228.1068.



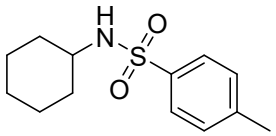
N, N-Dibutyl-4-methylbenzenesulfonamide (**3ra**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ra** as a white solid (48.2 mg, 57% yield). m.p. 166~168 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.68 (d, J = 8.2 Hz, 2H), 7.28 (d, J = 8.0 Hz, 2H), 3.08 (t, J = 7.6 Hz, 4H), 2.41 (s, 3H), 1.49 (p, J = 7.6 Hz, 4H), 1.28 (h, J = 7.6 Hz, 5H), 0.89 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 142.9, 137.2, 129.6, 127.2, 48.1, 30.9, 21.6, 20.0, 13.8. HRMS (ESI) calc. for $C_{15}H_{26}NO_2S$ ($[M+H]^+$): 284.1684, Found: 284.1692.



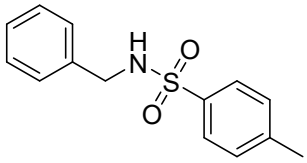
N, N-Dibenzyl-4-methylbenzenesulfonamide (**3sa**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded 3sa as a white solid (69.3 mg, 66% yield). m.p. 138~140 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.74 (d, J = 8.2 Hz, 2H), 7.31 (d, J = 8.0 Hz, 2H), 7.23 – 7.20 (m, 6H), 7.07 – 7.03 (m, 4H), 4.31 (s, 4H), 2.45 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 143.4, 137.8, 135.8, 129.8, 128.7, 128.5, 127.8, 127.4, 50.6, 21.7. HRMS (ESI) calc. for $C_{21}H_{22}NO_2S$ ($[M+H]^+$): 352.1371, Found: 352.1370.



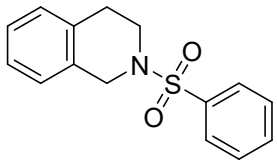
N-Ethyl-4-methylbenzenesulfonamide (**3ta**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ta** as a white solid (69.5 mg, 70% yield). m.p. 58~60 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.78 (d, J = 8.2 Hz, 2H), 7.30 (d, J = 8.0 Hz, 2H), 5.15 (s, 1H), 2.97 (p, J = 7.0 Hz, 2H), 2.42 (s, 3H), 1.08 (t, J = 7.2 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 143.4, 137.1, 129.7, 127.2, 38.3, 21.5, 15.0. HRMS (ESI) calc. for $C_9H_{14}NO_2S$ ($[M+H]^+$): 200.0745, Found: 200.0758.



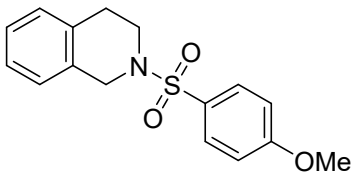
N-Cyclohexyl-4-methylbenzenesulfonamide (**3ua**)[1]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ua** as a white solid (47.4 mg, 60% yield). m.p. 84~86 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.77 (d, J = 8.4 Hz, 2H), 7.28 (d, J = 8.0 Hz, 2H), 4.71 (br, 1H), 3.16 – 3.06 (m, 1H), 2.42 (s, 3H), 1.78 – 1.70 (m, 2H), 1.68 – 1.58 (m, 2H), 1.53 – 1.45 (m, 1H), 1.27 – 1.03 (m, 5H). HRMS (ESI) calc. for $C_{13}H_{20}NO_2S$ ($[M+H]^+$): 254.1215, Found: 254.1201



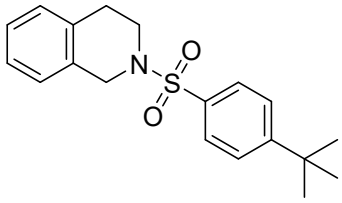
N-Benzyl-4-methylbenzenesulfonamide (**3va**)[1]: Purified by column chromatography on silica gel (4:1 petroleum ether/ethyl acetate) afforded **3va** as a white solid (61.4 mg, 79% yield). m.p. 108~110 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.77 (d, J = 8.2 Hz, 2H), 7.32 (d, J = 8.0 Hz, 2H), 7.30 – 7.18 (m, 5H), 4.67 (br, 1H), 4.13 (d, J = 6.2 Hz, 2H), 2.45 (s, 3H). HRMS (ESI) calc. for $C_9H_{14}NO_2S$ ($[M+H]^+$): 200.0745, Found: 200.0758.



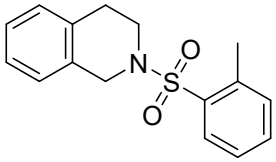
2-(Phenylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3ab**)[6]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ab** as a white solid (72.4 mg, 89% yield). m.p. 152~154 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.87 – 7.83 (m, 2H), 7.62 – 7.51 (m, 3H), 7.16 – 7.11 (m, 2H), 7.10 – 7.06 (m, 1H), 7.05 – 7.01 (m, 1H), 4.28 (s, 2H), 3.39 (t, J = 6.0 Hz, 2H), 2.93 (t, J = 6.0 Hz, 2H). HRMS (ESI) calc. for $C_{15}H_{16}NO_2S$ ($[M+H]^+$): 274. 0902, Found: 274. 0908.



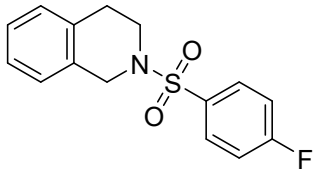
2-((4-Methoxyphenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3ac**)[7]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ac** as a white solid (69.5 mg, 77% yield). m.p. 122~124 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.81 – 7.75 (m, 2H), 7.17 – 7.11 (m, 2H), 7.10 – 7.06 (m, 1H), 7.04 – 7.01 (m, 1H), 7.01 – 6.96 (m, 2H), 4.25 (s, 2H), 3.86 (s, 3H), 3.35 (t, J = 6.0 Hz, 2H), 2.93 (t, J = 6.0 Hz, 2H). HRMS (ESI) calc. for $C_{16}H_{18}NO_3S$ ($[M+H]^+$): 304.1007, Found: 304.0996.



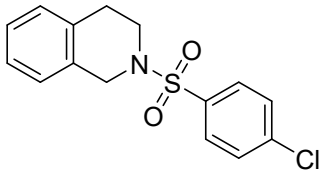
2-((4-(tert-Butyl)phenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3ad**)[7]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ad** as a white solid (72.4 mg, 74% yield). m.p. 150~152 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.79 – 7.74 (m, 2H), 7.56 – 7.51 (m, 2H), 7.17 – 7.10 (m, 2H), 7.10 – 7.00 (m, 2H), 4.27 (s, 2H), 3.38 (t, J = 6.0 Hz, 2H), 2.94 (t, J = 6.0 Hz, 2H), 1.33 (s, 9H). HRMS (ESI) calc. for $C_{19}H_{24}NO_2S$ ([M+H]$^+$): 330.1528, Found: 330.1537.



2-(o-Tolylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3ae**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ae** as a white solid (65.5 mg, 76% yield). m.p. 138~140 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.99 (d, J = 7.8 Hz, 1H), 7.49 – 7.43 (m, 1H), 7.36 – 7.28 (m, 2H), 7.20 – 7.14 (m, 2H), 7.13 – 7.02 (m, 2H), 4.40 (s, 2H), 3.53 (t, J = 6.0 Hz, 2H), 2.90 (t, J = 5.8 Hz, 2H), 2.63 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 138.2, 136.4, 133.4, 133.0, 132.9, 132.0, 130.3, 129.1, 126.9, 126.5, 126.2, 46.7, 42.9, 29.0, 20.7. HRMS (ESI) calc. for $C_{16}H_{18}NO_2S$ ([M+H]$^+$): 288.1058, Found: 288.1031.

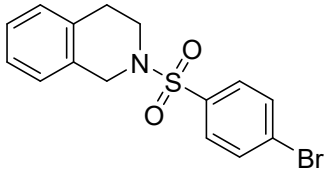


2-((4-Fluorophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3af**)[7]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3af** as a white solid (65.6 mg, 75% yield). m.p. 152~154 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.89 – 7.82 (m, 2H), 7.24 – 7.17 (m, 2H), 7.17 – 7.12 (m, 2H), 7.10 – 7.01 (m, 2H), 4.28 (s, 2H), 3.39 (t, J = 6.0 Hz, 2H), 2.92 (t, J = 6.0 Hz, 2H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -105.00. HRMS (ESI) calc. for $C_{15}H_{15}FNO_2S$ ([M+H]$^+$): 292.0808, Found: 292.0825.

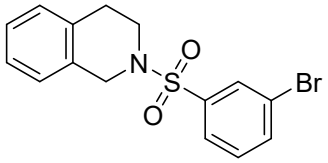


2-((4-Chlorophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3ag**)[7]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ag** as a white solid (80.5 mg, 88% yield). m.p. 150~152 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.81 – 7.74 (m, 2H), 7.52 – 7.46 (m, 2H), 7.18 – 7.13 (m, 2H), 7.10 – 7.06 (m, 1H),

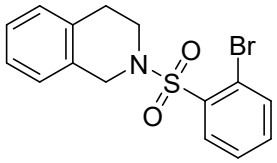
7.05 – 6.99 (m, 1H), 4.28 (s, 2H), 3.39 (t, J = 6.0 Hz, 2H), 2.92 (t, J = 6.0 Hz, 2H). HRMS (ESI) calc. for $C_{15}H_{15}ClNO_2S$ ([M+H]$^+$): 308.0512, Found: 308.0535.



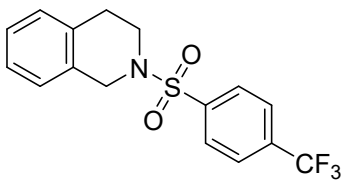
2-((4-Bromophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3ah**)[7]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ah** as a white solid (79.5 mg, 76% yield). m.p. 148~150 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.74 – 7.62 (m, 4H), 7.18 – 7.12 (m, 2H), 7.10 – 7.06 (m, 1H), 7.05 – 6.99 (m, 1H), 4.28 (s, 2H), 3.38 (t, J = 6.0 Hz, 2H), 2.92 (t, J = 6.0 Hz, 2H). HRMS (ESI) calc. for $C_{15}H_{15}BrNO_2S$ ([M+H]$^+$): 352.0007, Found: 352.0006.



2-((3-Bromophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3ai**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ai** as a white solid (73.2 mg, 70% yield). m.p. 136~138 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.00 – 7.97 (m, 1H), 7.79 – 7.75 (m, 1H), 7.73 – 7.69 (m, 1H), 7.43 – 7.38 (m, 1H), 7.19 – 7.12 (m, 2H), 7.11 – 7.02 (m, 2H), 4.30 (s, 2H), 3.41 (t, J = 6.0 Hz, 2H), 2.93 (t, J = 6.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 138.9, 136.0, 133.1, 131.4, 130.7, 130.6, 129.0, 127.1, 126.6, 126.5, 126.3, 123.3, 47.6, 43.9, 28.9. HRMS (ESI) calc. for $C_{15}H_{15}BrNO_2S$ ([M+H]$^+$): 352.0007, Found: 352.0014.

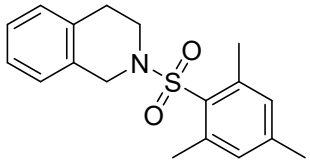


2-((2-Bromophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3aj**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3aj** as a white solid (64.0 mg, 61% yield). m.p. 144~146 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.18 (dd, J = 7.9, 1.8 Hz, 1H), 7.72 (dt, J = 7.9, 1.3 Hz, 1H), 7.46 (td, J = 7.7, 1.3 Hz, 1H), 7.39 (td, J = 7.6, 1.8 Hz, 1H), 7.20 – 7.14 (m, 2H), 7.14 – 7.08 (m, 1H), 7.08 – 7.02 (m, 1H), 4.52 (s, 2H), 3.63 (t, J = 5.9 Hz, 2H), 2.92 (t, J = 5.9 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 138.3, 135.8, 133.7, 133.5, 132.4, 132.1, 129.1, 127.6, 126.9, 126.5, 126.3, 120.6, 46.9, 43.3, 29.0. $C_{15}H_{15}BrNO_2S$ ([M+H]$^+$): 352.0007, Found: 352.0017.

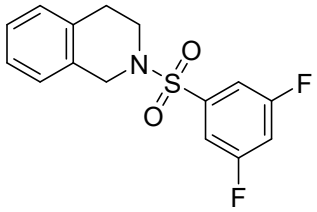


2-((4-(Trifluoromethyl)phenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3ak**)[7]: Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate)

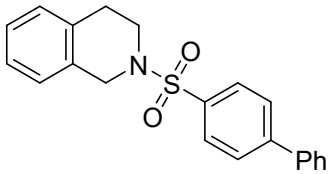
afforded **3ak** as a white solid (62.2 mg, 61% yield). m.p. 152~154 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.97 (d, J = 8.2 Hz, 2H), 7.79 (d, J = 8.2 Hz, 2H), 7.18 – 7.12 (m, 2H), 7.10 – 7.01 (m, 2H), 4.32 (s, 2H), 3.43 (t, J = 6.0 Hz, 2H), 2.93 (t, J = 6.0 Hz, 2H). ^{19}F NMR (376 MHz, $CDCl_3$): δ -63.13. HRMS (ESI) calc. for $C_{16}H_{15}F_3NO_2S$ ($[M+H]^+$): 342.0776, Found: 342.0801.



2-(Mesitylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3al**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3al** as a white solid (68.9 mg, 73% yield). m.p. 120~122 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.19 – 7.14 (m, 2H), 7.13 – 7.08 (m, 1H), 7.08 – 7.03 (m, 1H), 6.96 (s, 2H), 4.36 (s, 2H), 3.47 (t, J = 6.0 Hz, 2H), 2.87 (t, J = 5.8 Hz, 2H), 2.64 (s, 6H), 2.30 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 142.8, 140.7, 133.5, 132.2, 132.1, 131.9, 129.1, 126.8, 126.6, 126.4, 45.9, 42.1, 28.8, 23.0, 21.1. HRMS (ESI) calc. for $C_{18}H_{22}NO_2S$ ($[M+H]^+$): 316.1371, Found: 316.1362.

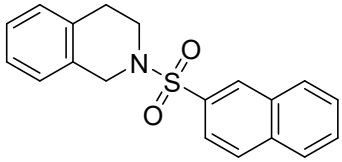


2-((3,5-Difluorophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3am**): Purified by column chromatography on silica gel (10:1 petroleum ether/ethyl acetate) afforded **3am** as a white solid (72.4 mg, 79% yield). m.p. 158~160 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.40 – 7.35 (m, 2H), 7.20 – 7.14 (m, 2H), 7.12 – 7.01 (m, 3H), 4.32 (s, 2H), 3.43 (t, J = 6.0 Hz, 2H), 2.95 (t, J = 5.8 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 163.0 (d, $^1J_{CF}$ = 255.1Hz), 140.3 (t, $^3J_{CF}$ = 7.9 Hz), 132.9, 131.2, 129.0, 127.2, 126.7, 126.4, 111.2 (d, $^2J_{CF}$ = 11.4 Hz), 111.2 (d, $^2J_{CF}$ = 28.0 Hz), 108.6 (t, $^2J_{CF}$ = 25.0 Hz), 47.6, 43.9, 28.8. ^{19}F NMR (376 MHz, $CDCl_3$): δ -105.44. HRMS (ESI) calc. for $C_{15}H_{14}F_2NO_2S$ ($[M+H]^+$): 310.0713, Found: 310.0738.

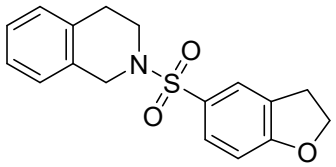


2-([1,1'-Biphenyl]-4-ylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3an**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3an** as a white solid (83.6 mg, 80% yield). m.p. 126~128 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.92 (d, J = 8.4 Hz, 2H), 7.74 (d, J = 8.4 Hz, 2H), 7.62 – 7.57 (m, 2H), 7.52 – 7.46 (m, 2H), 7.45 – 7.39 (m, 1H), 7.19 – 7.12 (m, 2H), 7.12 – 7.02 (m, 2H), 4.33 (s, 2H), 3.44 (t, J = 6.0 Hz, 2H), 2.95 (t, J = 6.0 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$): δ 145.8,

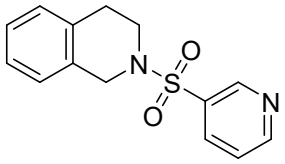
139.3, 135.2, 133.2, 131.7, 129.2, 128.9, 128.6, 128.3, 127.8, 127.4, 126.9, 126.5, 47.7, 43.9, 28.9. HRMS (ESI) calc. for $C_{21}H_{20}NO_2S$ ([M+H]$^+$): 350.1215, Found: 350.1244.



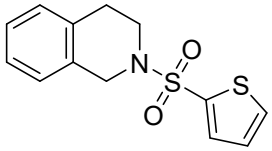
2-(Naphthalen-2-ylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3ao**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ao** as a white solid (71.0 mg, 74% yield). m.p. 150~152 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.43 (s, 1H), 8.01 – 7.95 (m, 2H), 7.91 (d, J = 8.2 Hz, 1H), 7.85 – 7.80 (m, 1H), 7.67 – 7.59 (m, 2H), 7.16 – 7.09 (m, 2H), 7.09 – 7.00 (m, 2H), 4.34 (s, 2H), 3.45 (t, J = 6.0 Hz, 2H), 2.93 (t, J = 6.0 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$): δ 134.9, 133.5, 133.1, 132.2, 131.6, 129.4, 129.3, 129.1, 128.9, 128.9, 128.0, 127.7, 126.8, 126.4, 122.9, 47.6, 43.9, 28.9. HRMS (ESI) calc. for $C_{19}H_{18}NO_2S$ ([M+H]$^+$): 324.1058, Found: 324.1031.



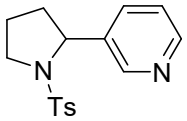
2-((2,3-Dihydrobenzofuran-5-yl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3ap**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ap** as a white solid (75.5 mg, 80% yield). m.p. 132~134 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.64 (d, J = 9.0 Hz, 2H), 7.18 – 7.00 (m, 4H), 6.85 (d, J = 8.2 Hz, 1H), 4.66 (t, J = 8.8 Hz, 2H), 4.25 (s, 2H), 3.35 (t, J = 5.9 Hz, 2H), 3.26 (t, J = 8.8 Hz, 2H), 2.93 (t, J = 5.9 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$): δ 164.1, 133.3, 131.9, 129.4, 128.9, 128.5, 128.1, 126.8, 126.5, 126.4, 125.1, 109.6, 72.4, 47.7, 43.9, 29.2, 29.0. HRMS (ESI) calc. for $C_{17}H_{18}NO_3S$ ([M+H]$^+$): 316.1007, Found: 316.1001.



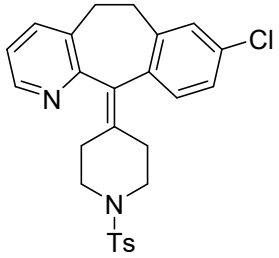
2-(Pyridin-3-ylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3aq**): Purified by column chromatography on silica gel (2:1 petroleum ether/ethyl acetate) afforded **3aq** as a white solid (64.1 mg, 78% yield). m.p. 144~146 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.06 (d, J = 2.2 Hz, 1H), 8.80 (dd, J = 4.8, 1.6 Hz, 1H), 8.11 (dt, J = 8.0, 2.0 Hz, 1H), 7.46 (dd, J = 7.8, 4.8 Hz, 1H), 7.17 – 7.13 (m, 2H), 7.09 – 7.02 (m, 2H), 4.34 (s, 2H), 3.45 (t, J = 6.0 Hz, 2H), 2.93 (t, J = 6.0 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$): δ 153.5, 148.5, 135.3, 133.8, 133.0, 131.2, 129.0, 127.1, 126.7, 126.4, 123.8, 47.5, 43.8, 28.7. HRMS (ESI) calc. for $C_{14}H_{15}N_2O_2S$ ([M+H]$^+$): 275.0854, Found: 275.0844.



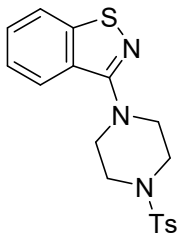
2-(Thiophen-2-ylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (**3ar**): Purified by column chromatography on silica gel (8:1 petroleum ether/ethyl acetate) afforded **3ar** as a white solid (62.4 mg, 75% yield). m.p. 118~120 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.65 – 7.57 (m, 2H), 7.20 – 7.12 (m, 3H), 7.12 – 7.03 (m, 2H), 4.33 (s, 2H), 3.41 (t, J = 6.0 Hz, 2H), 2.97 (t, J = 5.8 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 133.2, 132.6, 132.2, 131.6, 128.9, 127.7, 127.0, 126.6, 126.6, 47.7, 44.0, 29.0. HRMS (ESI) calc. for $C_{14}H_{15}N_2O_2S$ ([M+H]$^+$): 280.0466, Found: 280.0452.



3-(1-Tosylpyrrolidin-2-yl)pyridine (**5a**): Purified by column chromatography on silica gel (80:1 dichloromethane/methanol) afforded **5a** as a white solid (78.8 mg, 87% yield). m.p. 104~106 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.54 (s, 1H), 8.49 (d, J = 4.4 Hz, 1H), 7.75 – 7.64 (m, 3H), 7.34 – 7.22 (m, 3H), 4.76 (t, J = 6.2 Hz, 1H), 3.67 – 3.59 (m, 1H), 3.47 – 3.38 (m, 1H), 2.43 (s, 3H), 2.11 – 1.99 (m, 1H), 1.92 – 1.76 (m, 2H), 1.74 – 1.62 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 148.6, 148.0, 143.8, 138.6, 134.7, 134.1, 129.8, 127.6, 123.4, 61.2, 49.5, 35.8, 24.1, 21.6. HRMS (ESI) calc. for $C_{16}H_{19}N_2O_2S$ ([M+H]$^+$): 303.1167, Found: 303.1173.

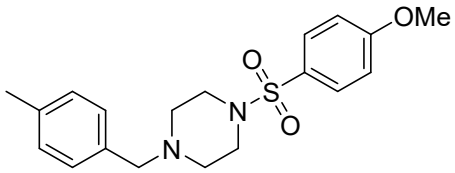


8-Chloro-11-(1-tosylpiperidin-4-ylidene)-6,11-dihydro-5H-benzo[5,6]cyclohepta[1,2-b]pyridine (**5b**): Purified by column chromatography on silica gel (4:1 petroleum ether/ethyl acetate) afforded **5b** as a white solid (103.1 mg, 74% yield). m.p. 198~200 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.35 (d, J = 4.6 Hz, 1H), 7.63 (d, J = 8.2 Hz, 2H), 7.40 (d, J = 7.6 Hz, 1H), 7.31 (d, J = 8.0 Hz, 2H), 7.14 – 7.05 (m, 3H), 7.00 (d, J = 8.0 Hz, 1H), 3.32 – 3.16 (m, 4H), 3.00 – 2.90 (m, 2H), 2.83 – 2.68 (m, 2H), 2.64 – 2.55 (m, 1H), 2.52 – 2.45 (m, 1H), 2.43 (s, 3H), 2.38 – 2.28 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 156.8, 146.8, 143.7, 139.6, 137.7, 137.4, 135.9, 134.8, 133.5, 133.4, 133.1, 130.5, 129.8, 129.1, 127.7, 126.3, 122.5, 47.4, 30.3, 30.0, 21.6. HRMS (ESI) calc. for $C_{26}H_{26}ClN_2O_2S$ ([M+H]$^+$): 465.1404, Found: 465.1415.

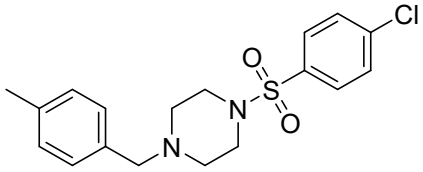


3-(4-Tosylpiperazin-1-yl)benzo[d]isothiazole (**5c**): Purified by column chromatography on silica gel (4:1 petroleum ether/ethyl acetate) afforded **5c** as a white solid (46.8 mg, 42% yield). m.p. 130~132 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.82 –

7.73 (m, 2H), 7.69 (d, J = 8.0 Hz, 2H), 7.49 – 7.41 (m, 1H), 7.40 – 7.28 (m, 3H), 3.61 (t, J = 4.8 Hz, 4H), 3.24 (t, J = 5.2 Hz, 4H), 2.44 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 163.1, 153.0, 144.0, 132.7, 129.9, 128.0, 127.8, 127.8, 124.2, 123.5, 120.8, 49.5, 45.9, 21.7. HRMS (ESI) calc. for $C_{18}H_{20}N_3O_2S_2$ ([M+H]$^+$): 374.0997, Found: 374.0991.



1-((4-Methoxyphenyl)sulfonyl)-4-(4-methylbenzyl)piperazine (**5d**): Purified by column chromatography on silica gel (2:1 petroleum ether/ethyl acetate) afforded **5d** as a white solid (72.8 mg, 68% yield). m.p. 88~90 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.68 (d, J = 9.0 Hz, 2H), 7.14 – 7.06 (m, 4H), 6.98 (d, J = 8.9 Hz, 2H), 3.87 (d, J = 1.2 Hz, 3H), 3.44 (s, 2H), 3.00 (t, J = 4.9 Hz, 4H), 2.50 (t, J = 5.0 Hz, 4H), 2.31 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 163.2, 137.1, 134.5, 130.1, 129.2, 129.1, 127.3, 114.3, 62.5, 55.7, 52.2, 46.2, 21.2. HRMS (ESI) calc. for $C19H_{25}N_2O_3S$ ([M+H]$^+$): 361.1586, Found: 361.1592.



1-((4-Chlorophenyl)sulfonyl)-4-(4-methylbenzyl)piperazine (**5e**): Purified by column chromatography on silica gel (2:1 petroleum ether/ethyl acetate) afforded 5e as a white solid (57.8 mg, 53% yield). m.p. 84~86 °C. ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.72 – 7.64 (m, 2H), 7.54 – 7.46 (m, 2H), 7.15 – 7.05 (m, 4H), 3.45 (s, 2H), 3.02 (t, J = 5.0 Hz, 4H), 2.51 (t, J = 5.0 Hz, 4H), 2.32 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 139.52, 137.11, 134.37, 134.25, 129.46, 129.33, 129.15, 129.14, 62.39, 52.07, 46.20, 21.20. HRMS (ESI) calc. for $C_{18}H_{22}ClN_2O_2S$ ([M+H]$^+$): 365.1091, Found: 365.1079.

references

1. Y.-y. Jiang, Q.-Q. Wang, S. Liang, L.-M. Hu, R. D. Little and C.-C. Zeng, *The Journal of Organic Chemistry*, 2016, **81**, 4713-4719.
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3. X. Pan, J. Gao, J. Liu, J. Lai, H. Jiang and G. Yuan, *Green Chemistry*, 2015, **17**, 1400-1403.
4. F. Toriyama, J. Cornella, L. Wimmer, T.-G. Chen, D. D. Dixon, G. Creech and P. S. Baran, *Journal of the American Chemical Society*, 2016, **138**, 11132-11135.
5. S. Yotphan, L. Sumunnee, D. Beukeaw, C. Buathongjan and V. Reutrakul, *Organic & Biomolecular Chemistry*, 2016, **14**, 590-597.
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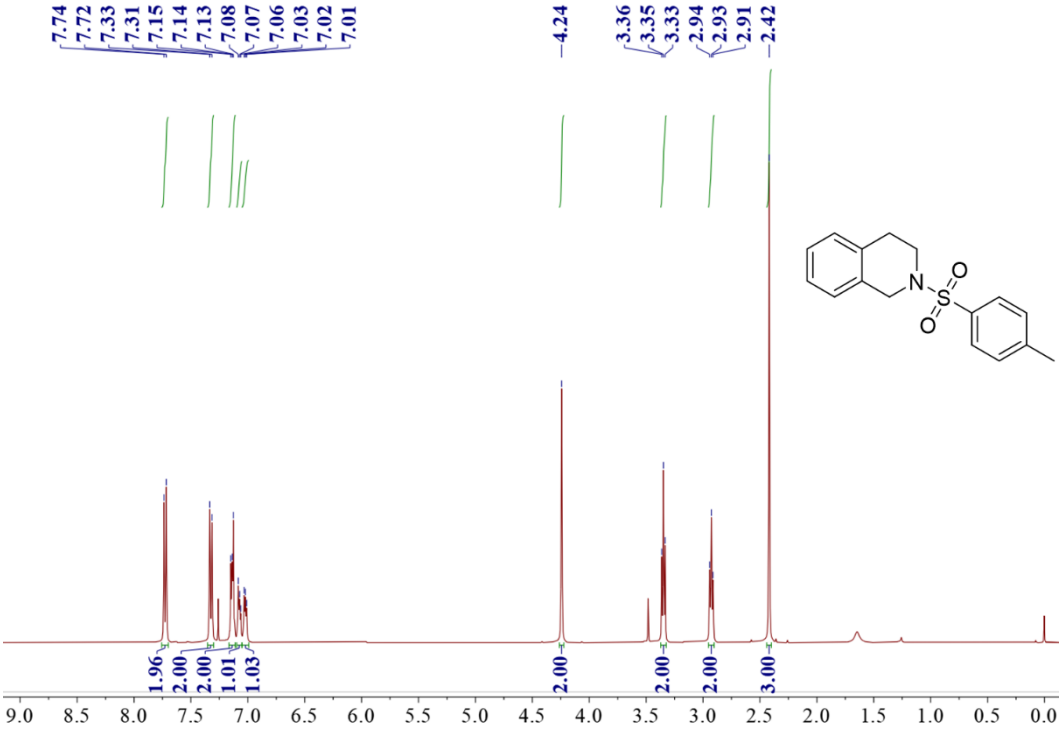
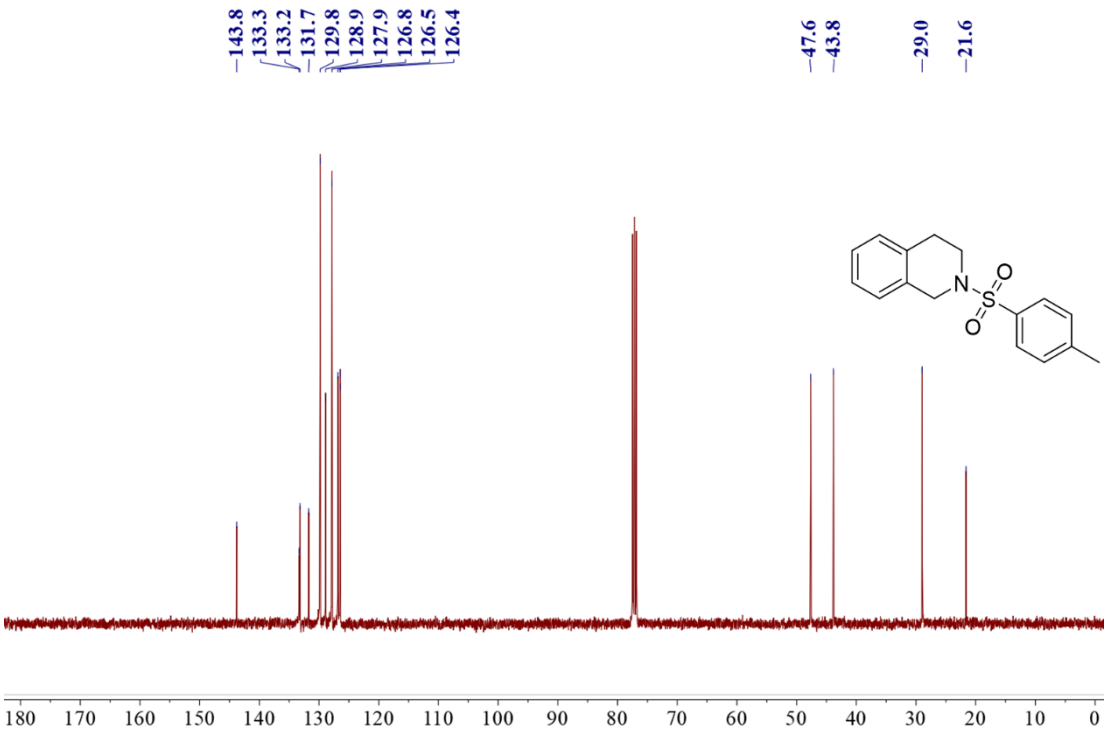
6. NMR of Products

2-tosyl-1,2,3,4-tetrahydroisoquinoline (3aa)

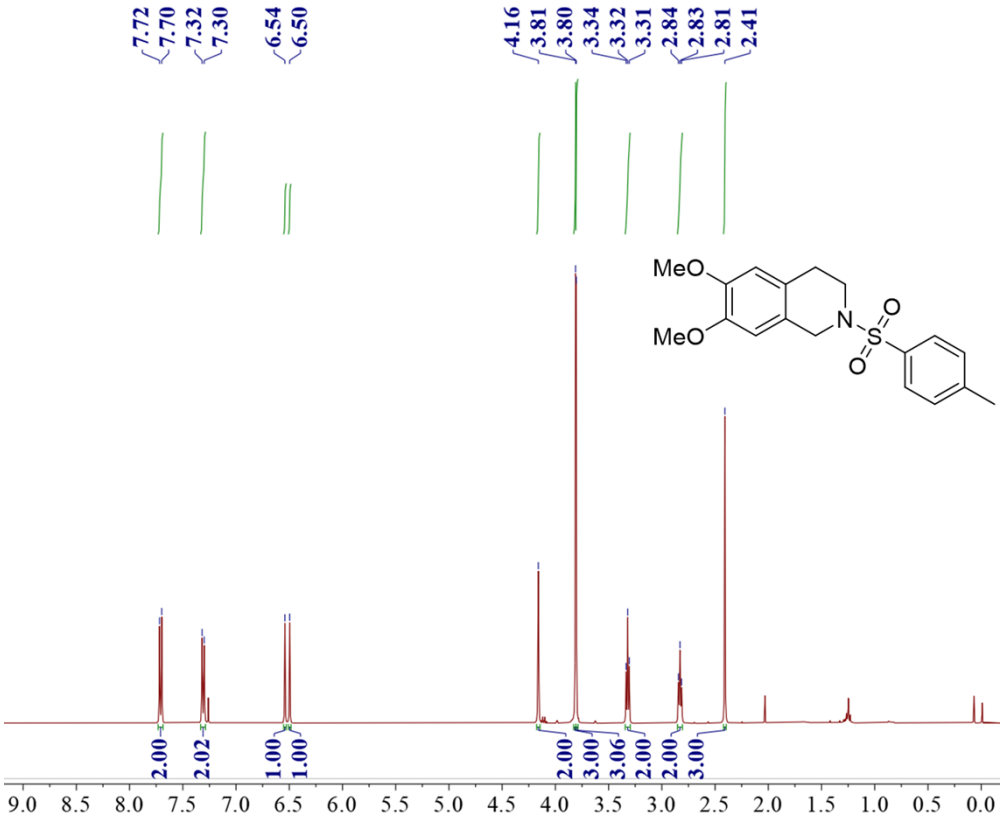


^{1}H NMR spectrum of 3aa



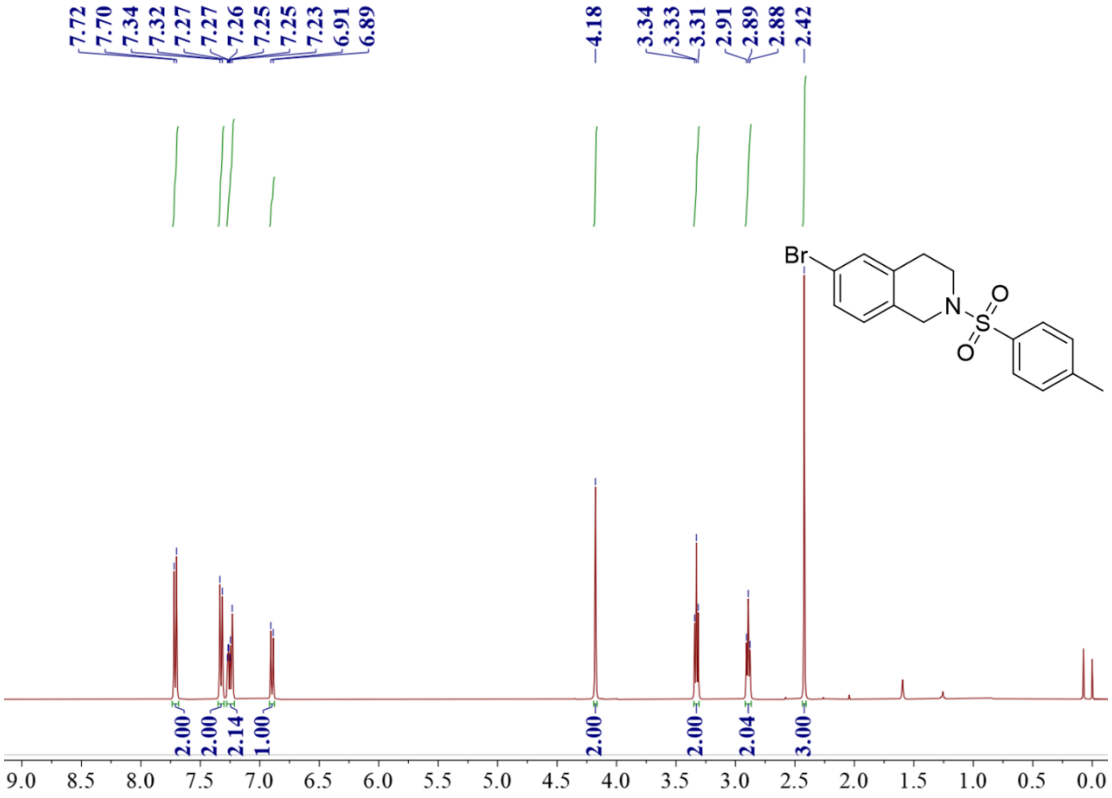
^{13}C NMR spectrum of 3aa

6,7-dimethoxy-2-tosyl-1,2,3,4-tetrahydroisoquinoline (3ba)

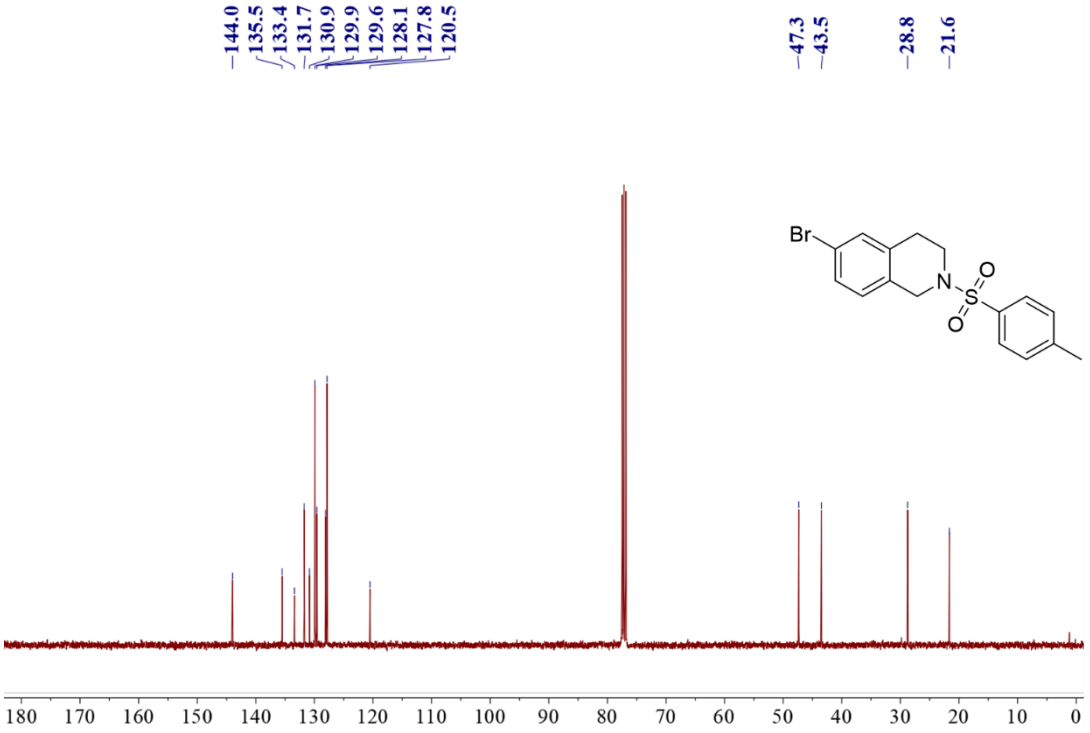


^{1}H NMR spectrum of 3ba

6-bromo-2-tosyl-1,2,3,4-tetrahydroisoquinoline (3ca)

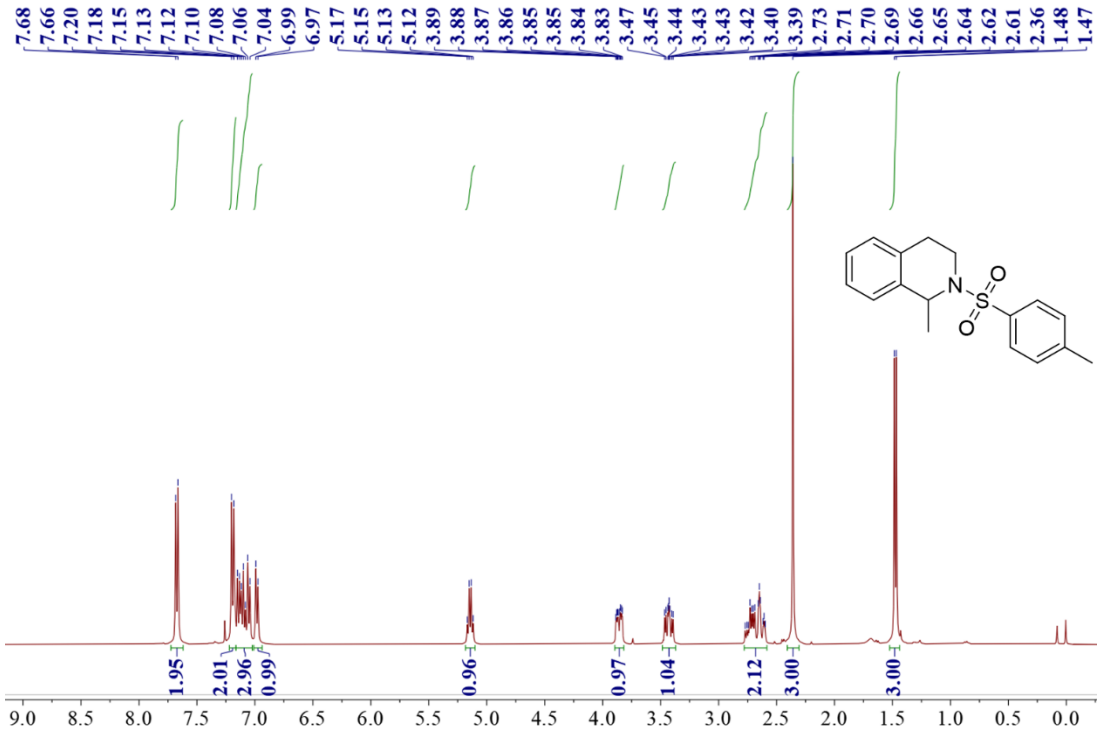


^{1}H NMR spectrum of 3ca

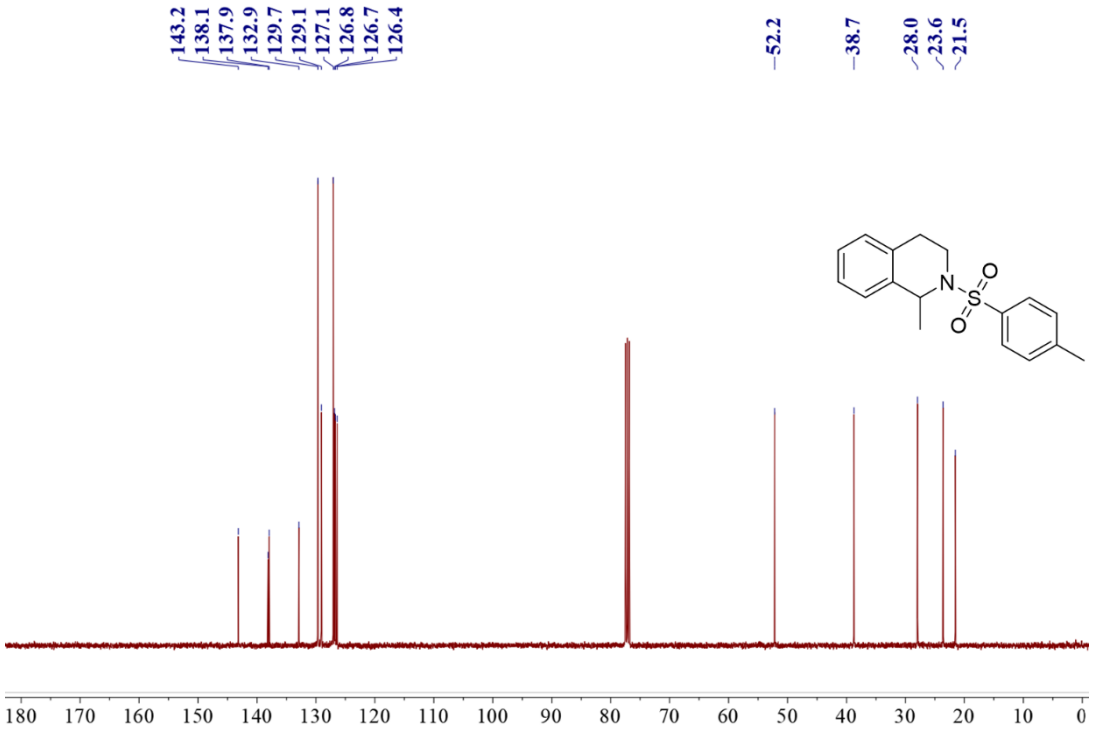


^{13}C NMR spectrum of 3ca

1-methyl-2-tosyl-1,2,3,4-tetrahydroisoquinoline (3da)

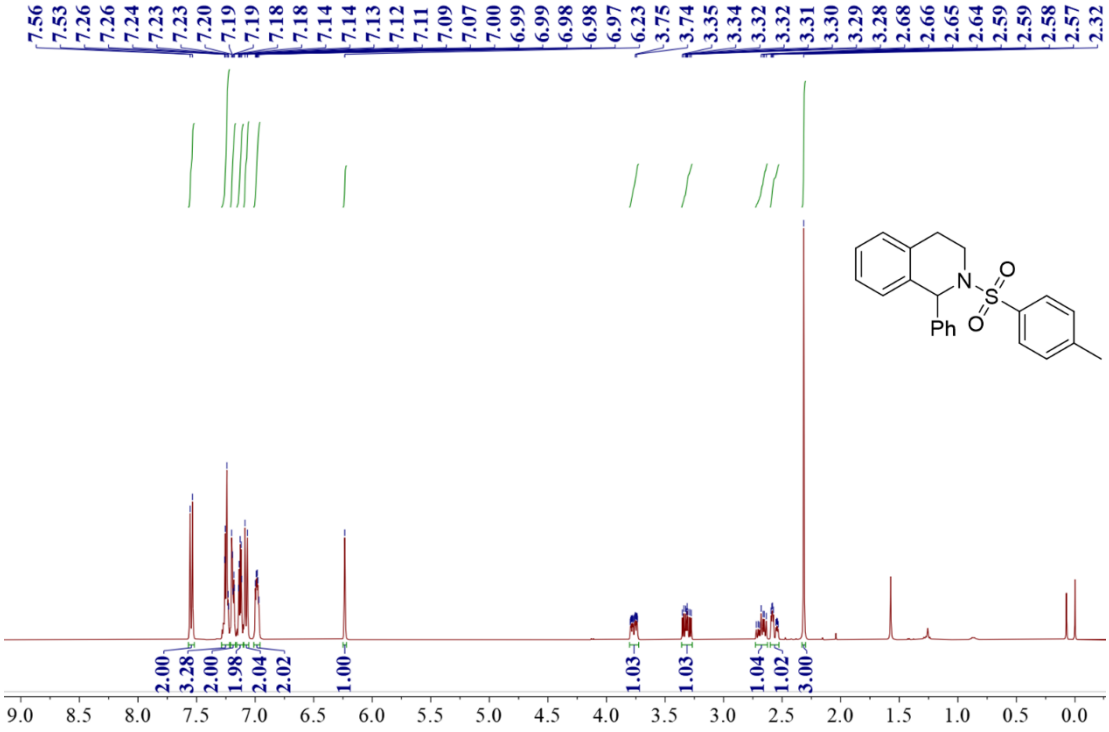


^{1}H NMR spectrum of 3da



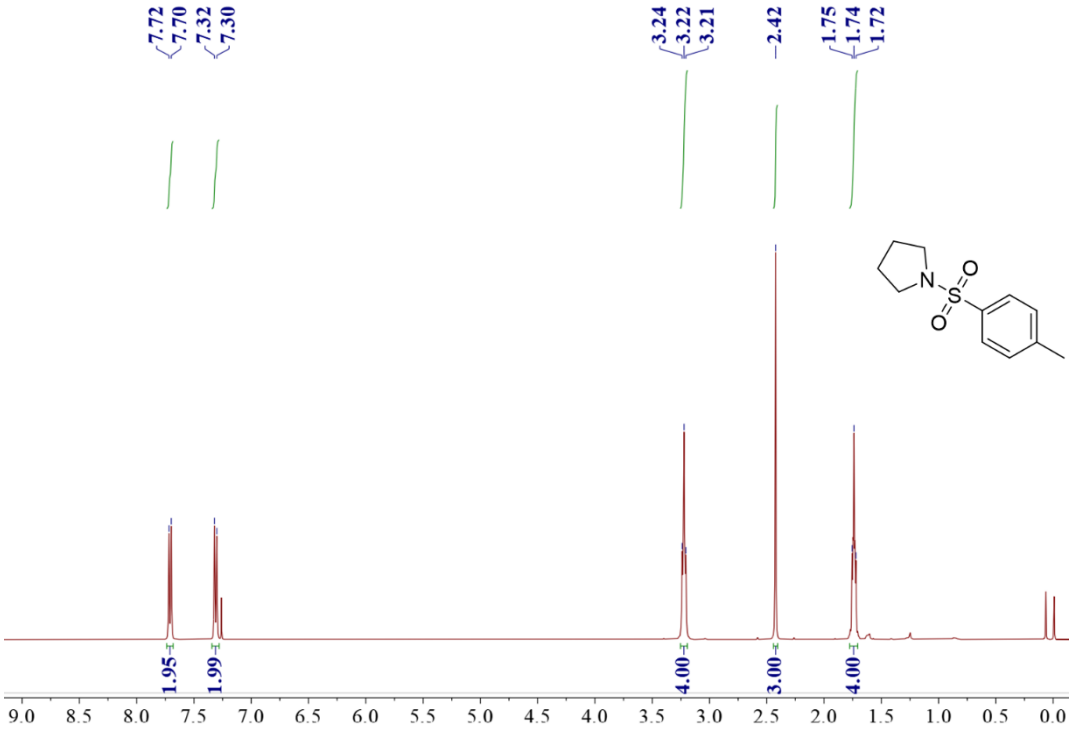
^{13}C NMR spectrum of 3da

1-phenyl-2-tosyl-1,2,3,4-tetrahydroisoquinoline (3ea)



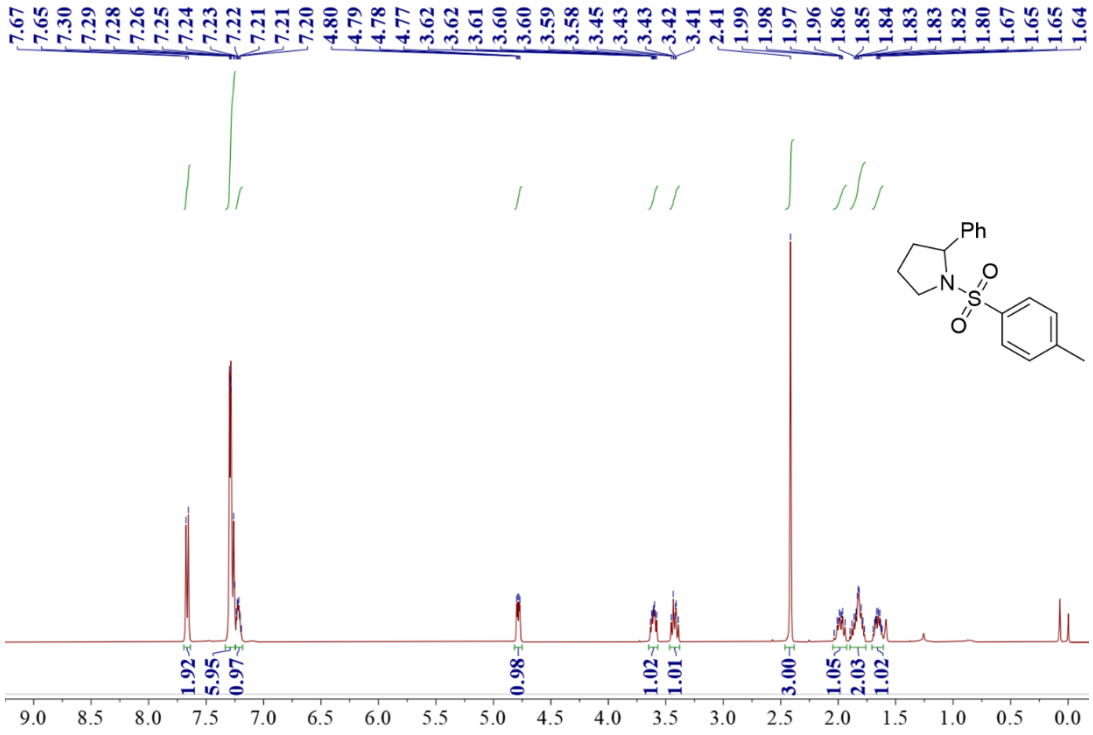
^{1}H NMR spectrum of 3ea

1-tosylpyrrolidine (3fa)

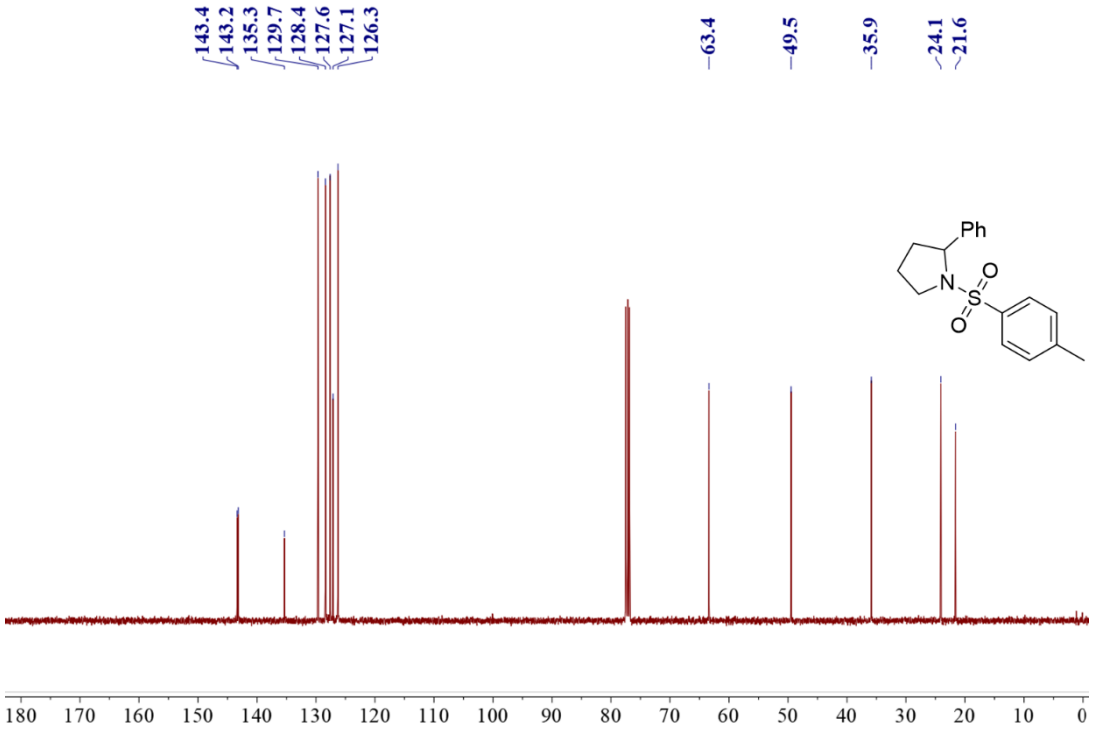


^{1}H NMR spectrum of 3fa

2-phenyl-1-tosylpyrrolidine (3ga)

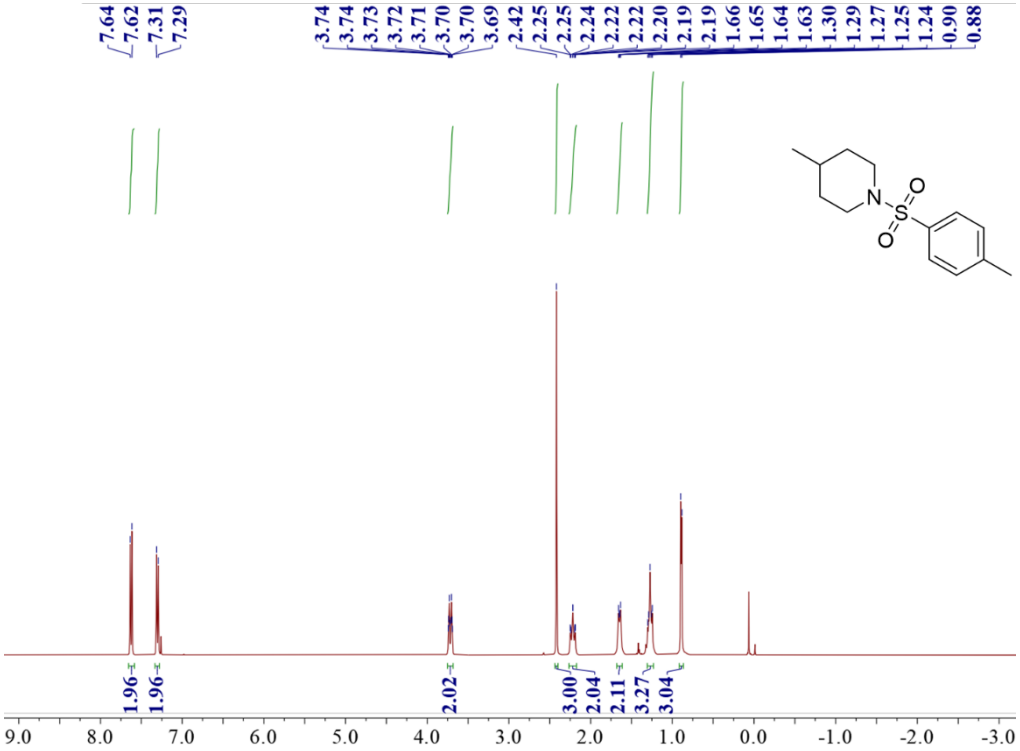


^{1}H NMR spectrum of 3ga



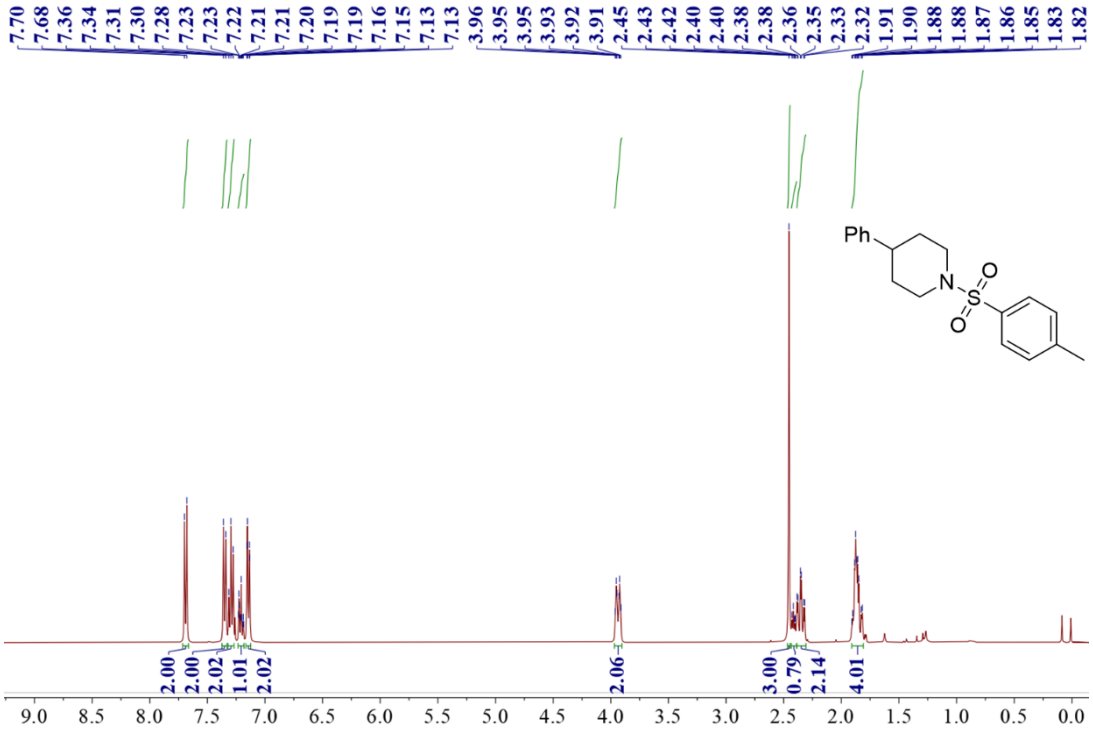
^{13}C NMR spectrum of 3ga

4-methyl-1-tosylpiperidine (3ha)



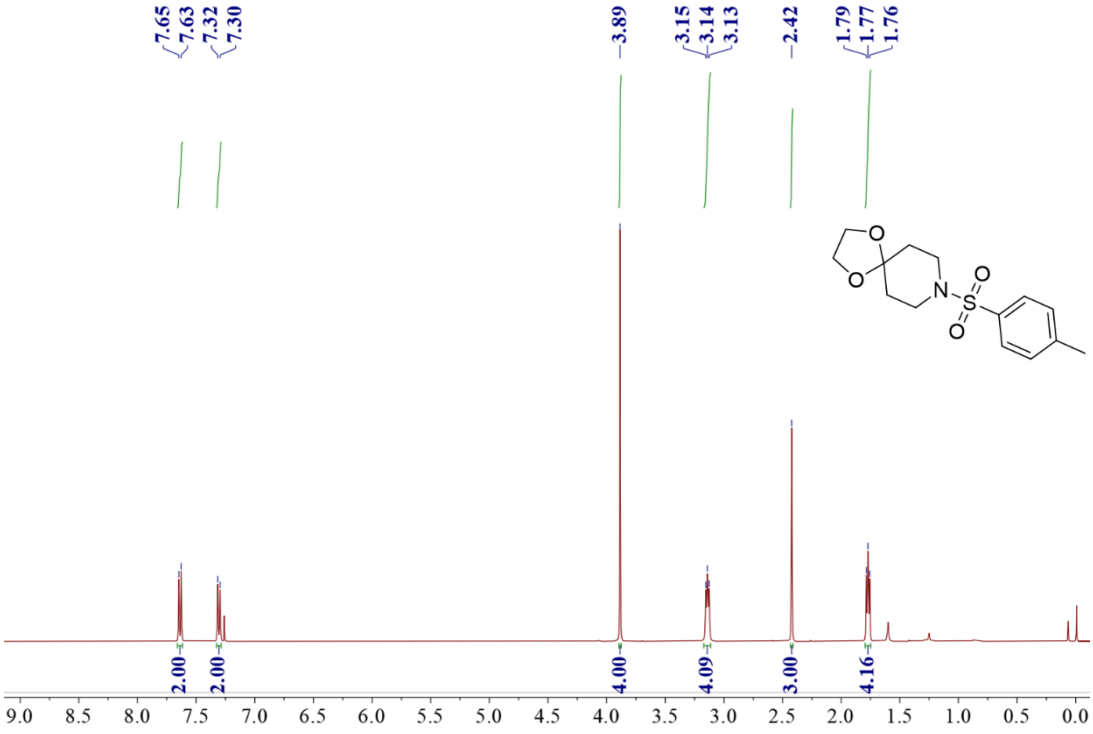
^{1}H NMR spectrum of 3ha

4-phenyl-1-tosylpiperidine (3ia)

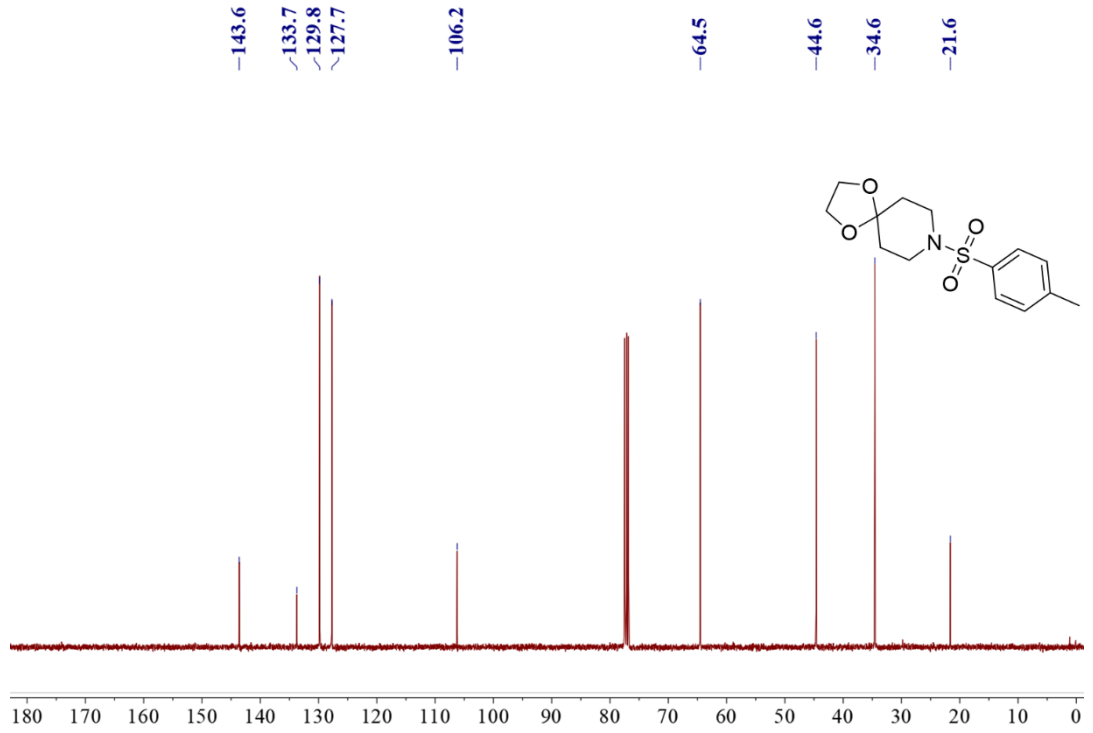


^{1}H NMR spectrum of 3ia

8-tosyl-1,4-dioxa-8-azaspiro[4.5]decane (3ja)

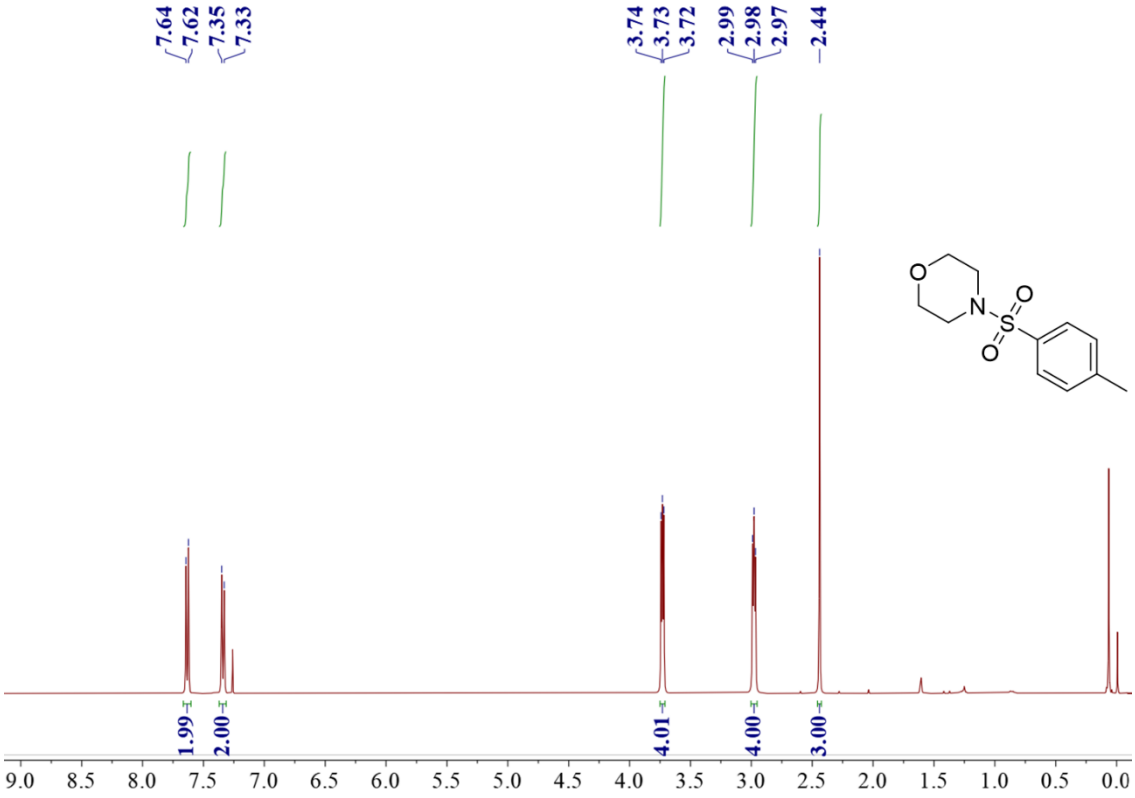


^{1}H NMR spectrum of 3ja



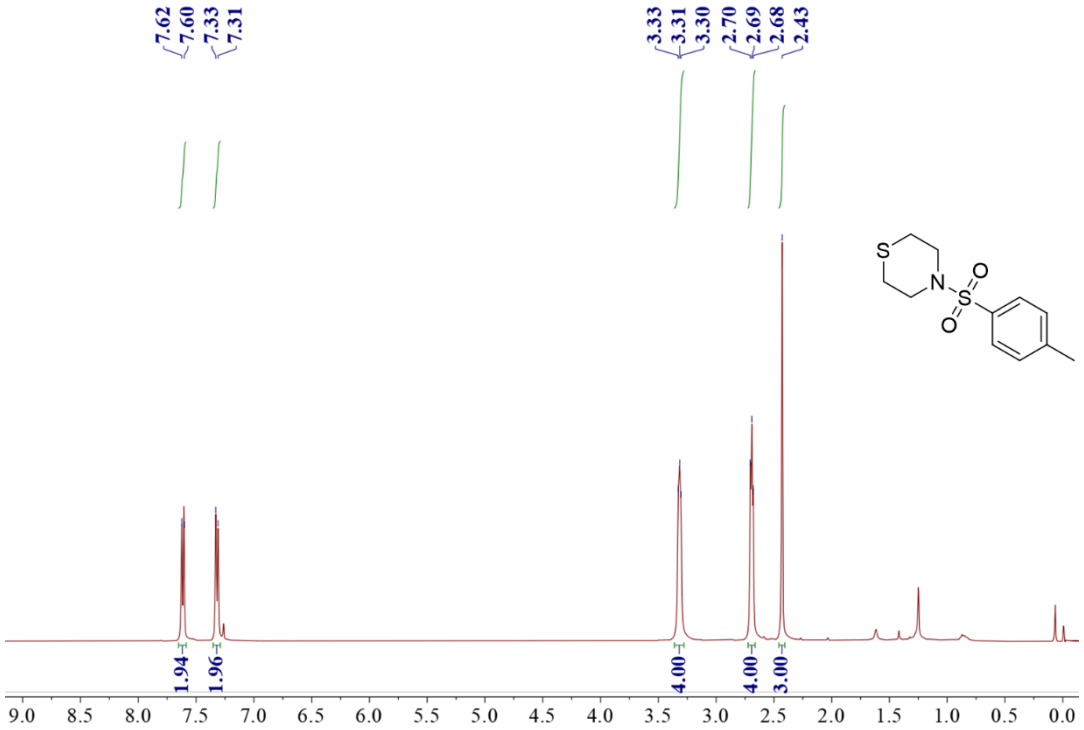
^{13}C NMR spectrum of 3ja

4-tosylmorpholine (3ka)



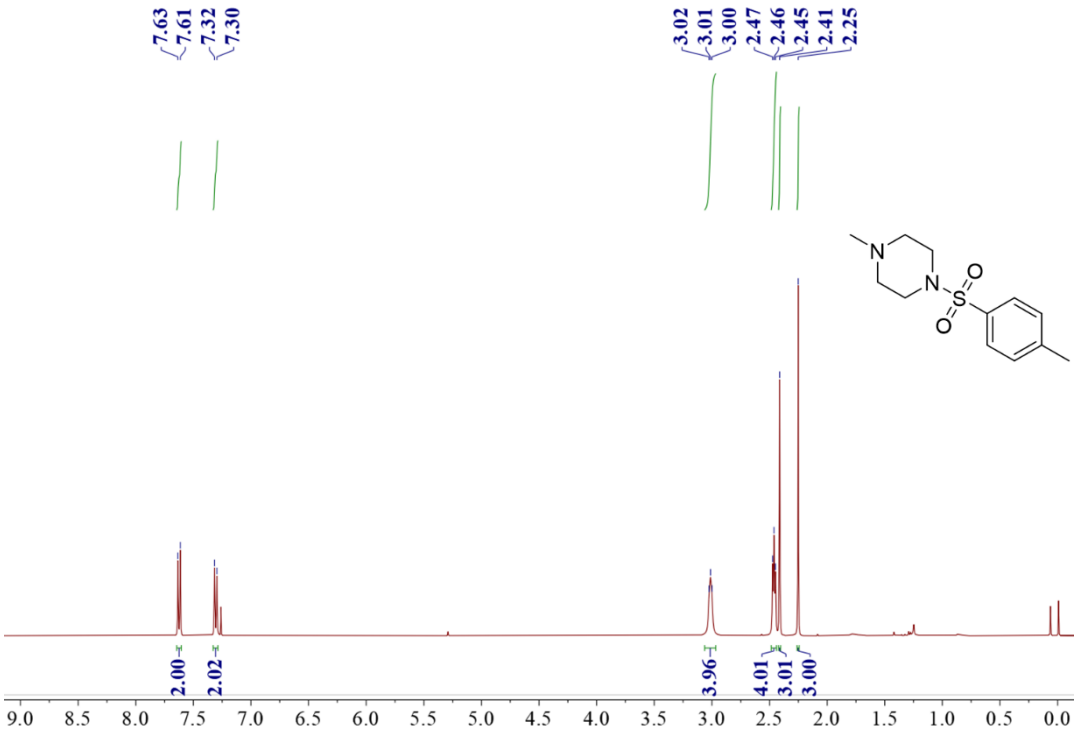
^{1}H NMR spectrum of 3ka

4-tosylthiomorpholine (3la)



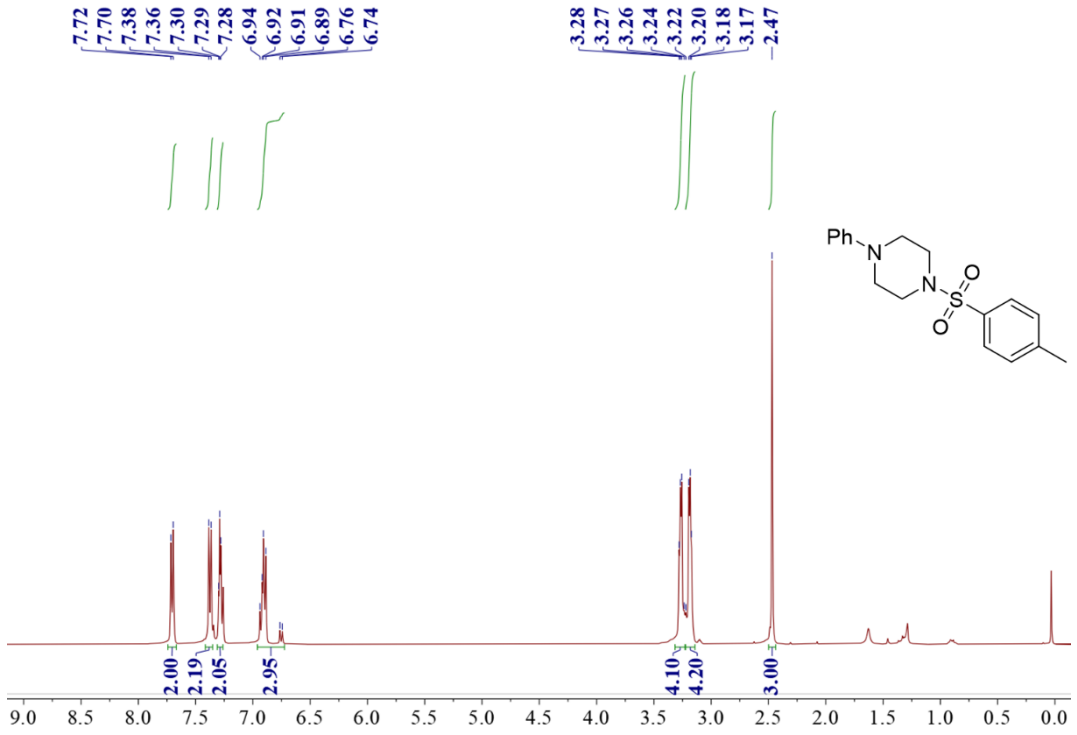
^{1}H NMR spectrum of 3la

1-methyl-4-tosylpiperazine (3ma)

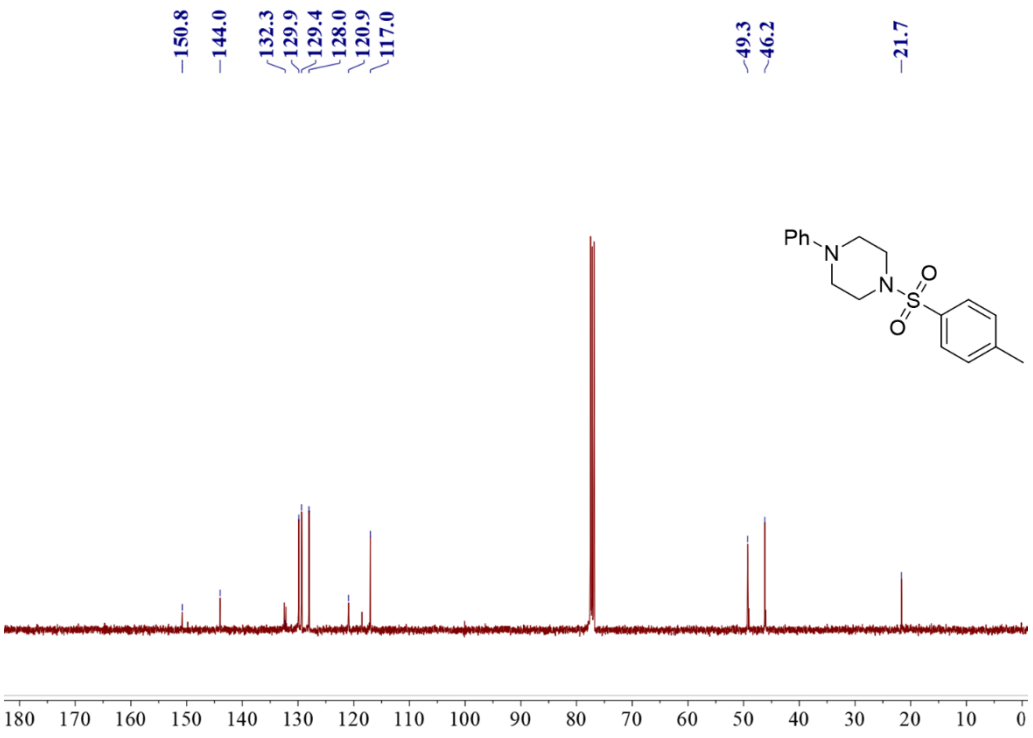


^{1}H NMR spectrum of 3ma

1-phenyl-4-tosylpiperazine (3na)

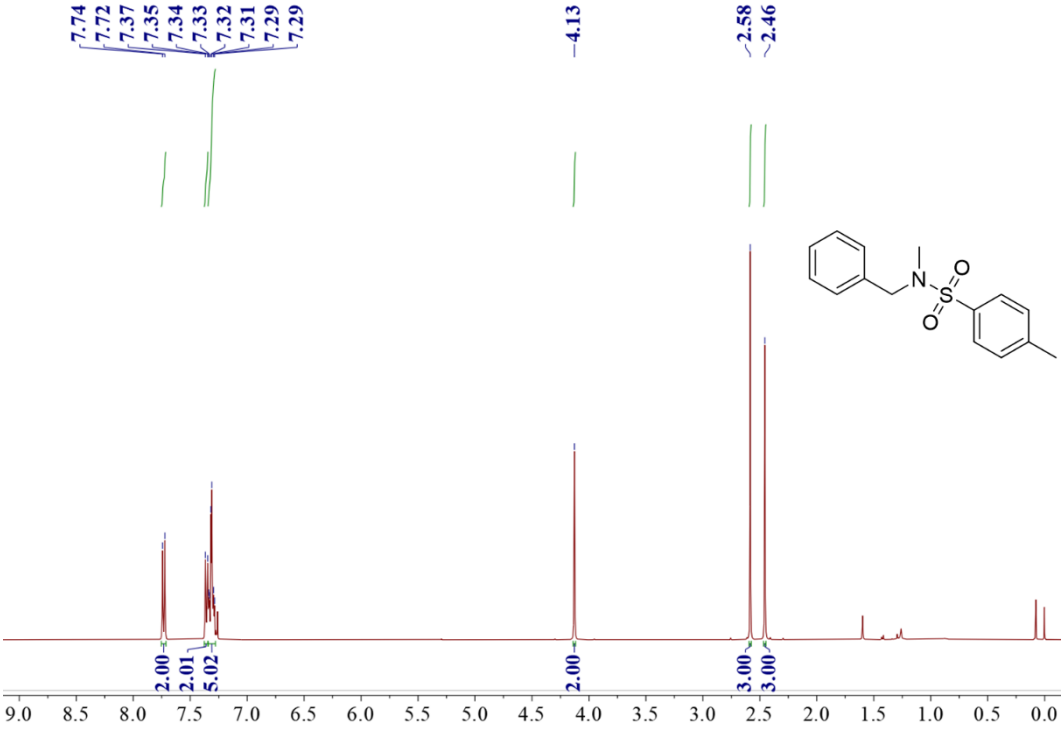


^{1}H NMR spectrum of 3na



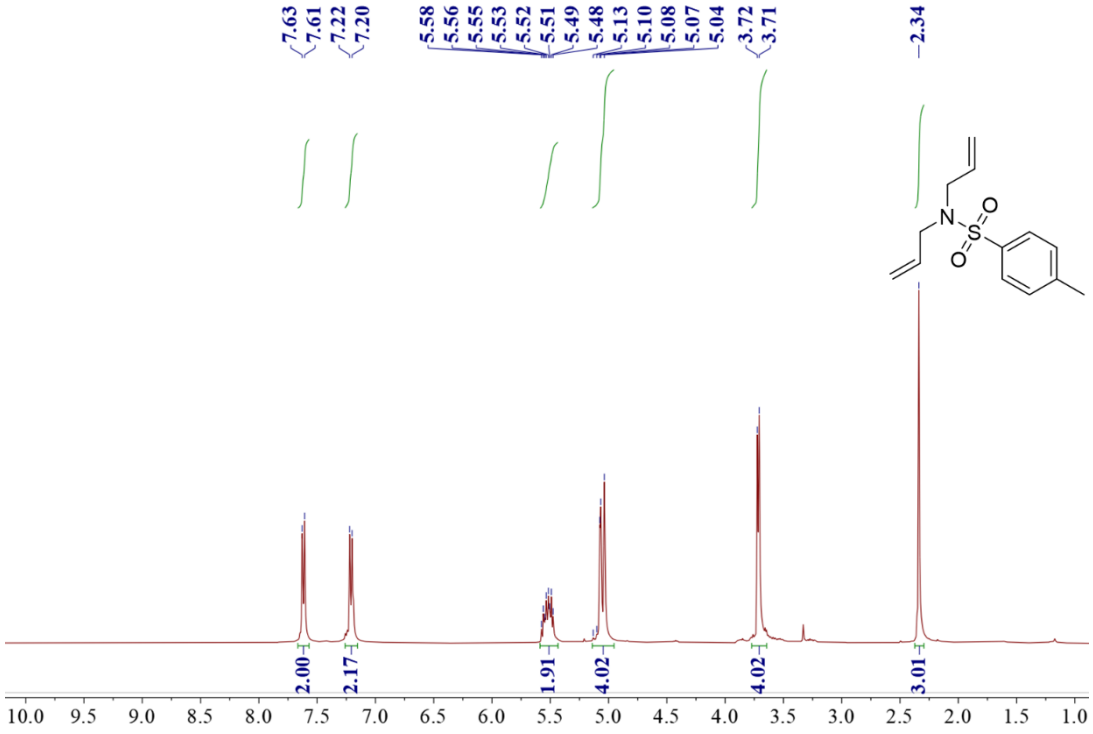
^{13}C NMR spectrum of 3na

N-benzyl-N,4-dimethylbenzenesulfonamide (3oa)

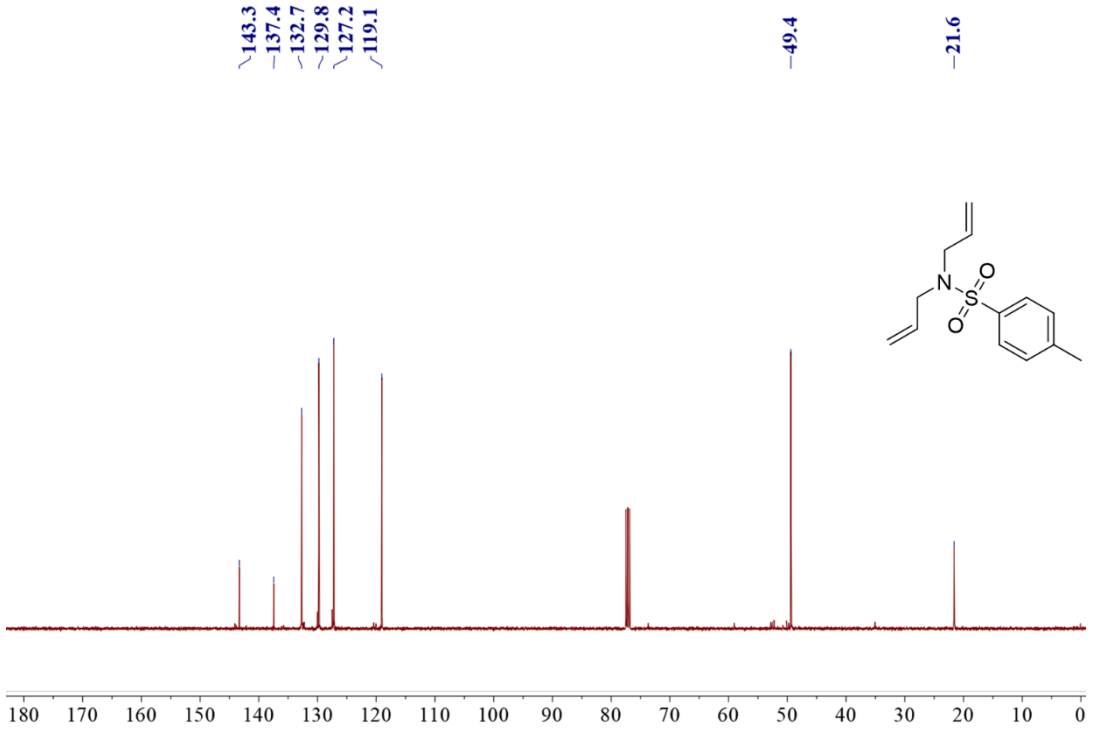


^{1}H NMR spectrum of 3oa

N,N-Diallyl-*p*-toluenesulfonamide (3pa)

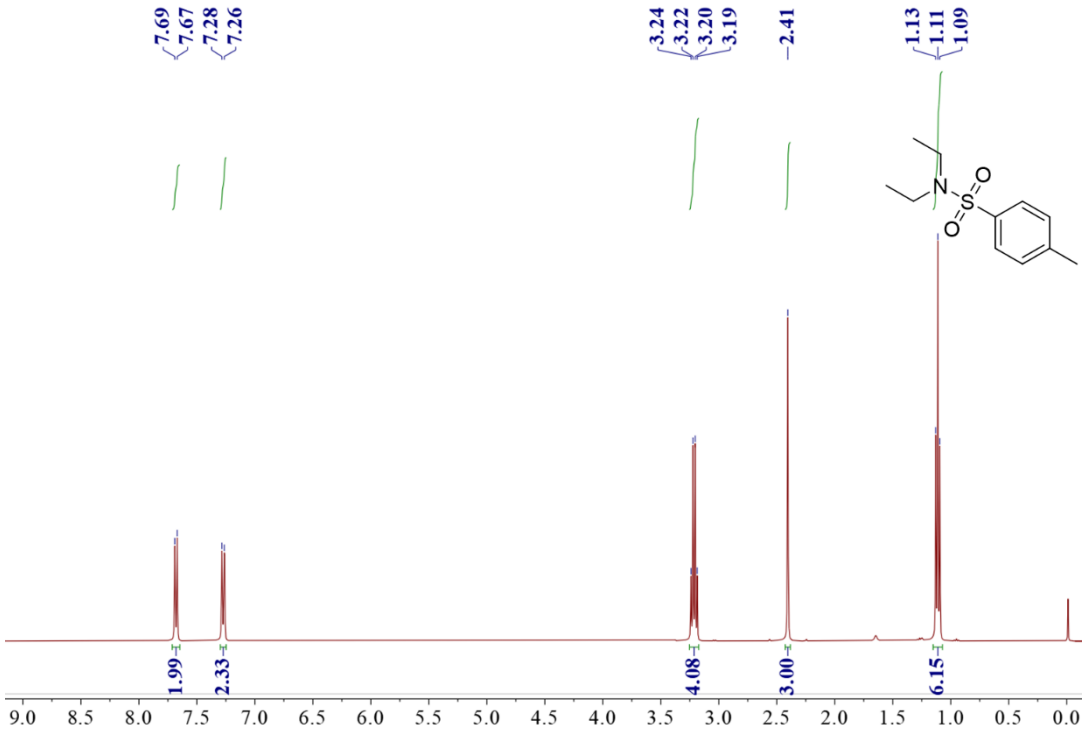


^{1}H NMR spectrum of 3pa

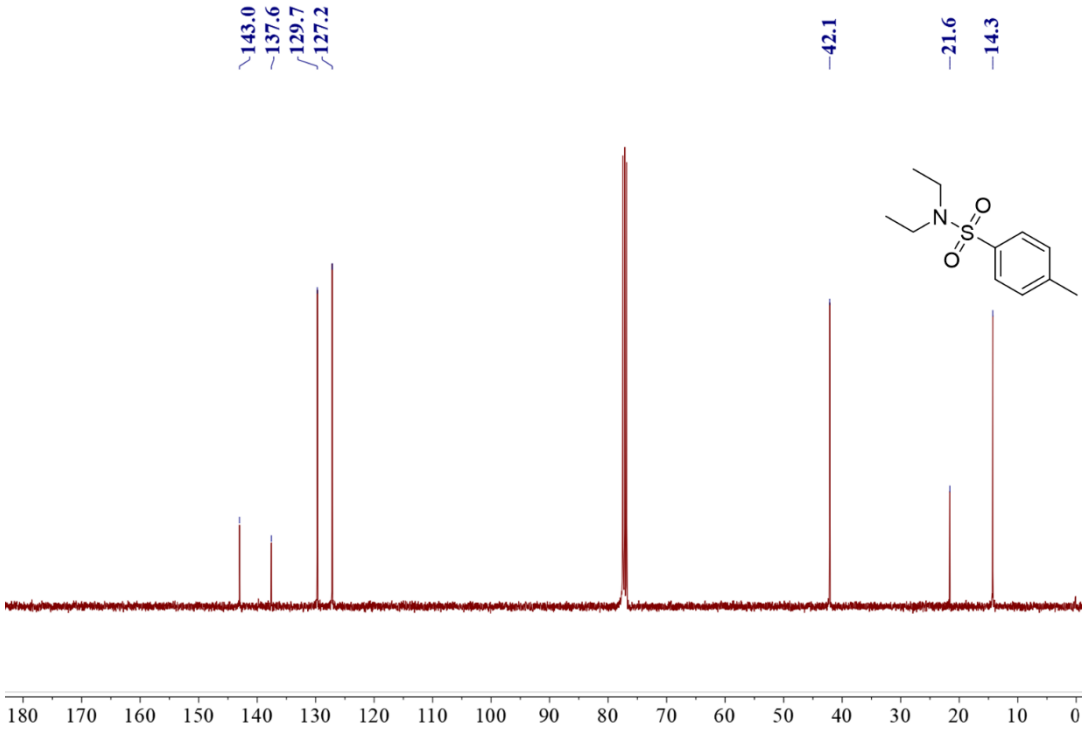


^{13}C NMR spectrum of 3pa

N,N-diethyl-4-methylbenzenesulfonamide (3qa)

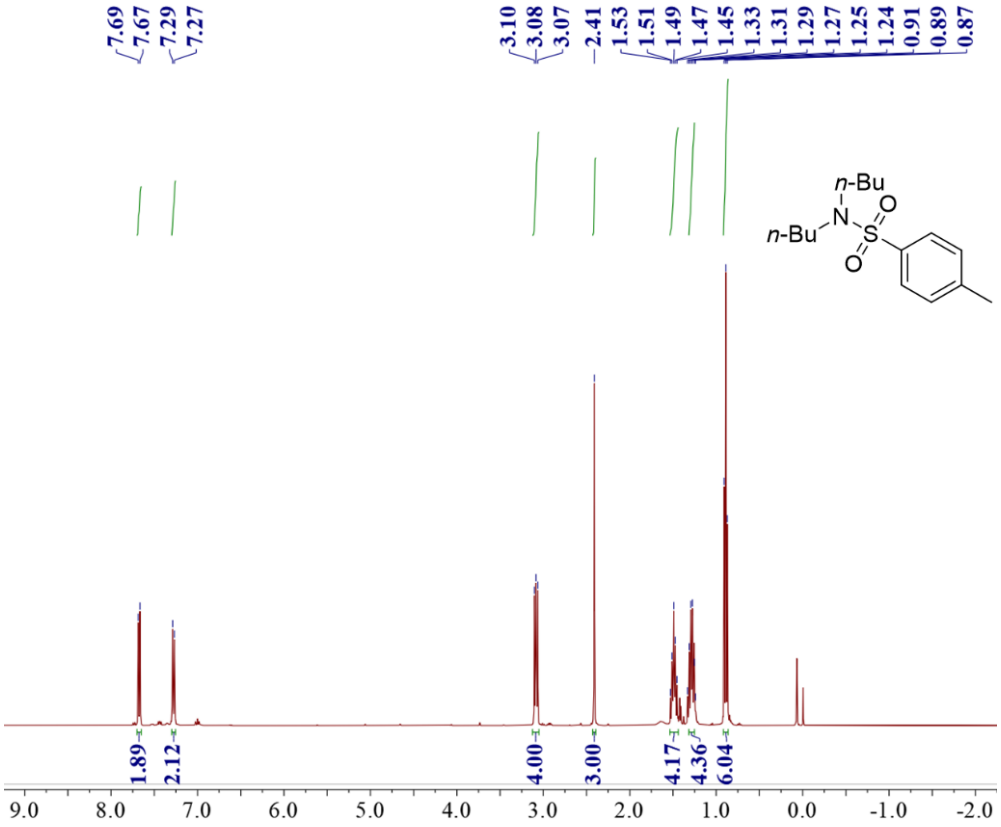


^{1}H NMR spectrum of 3qa

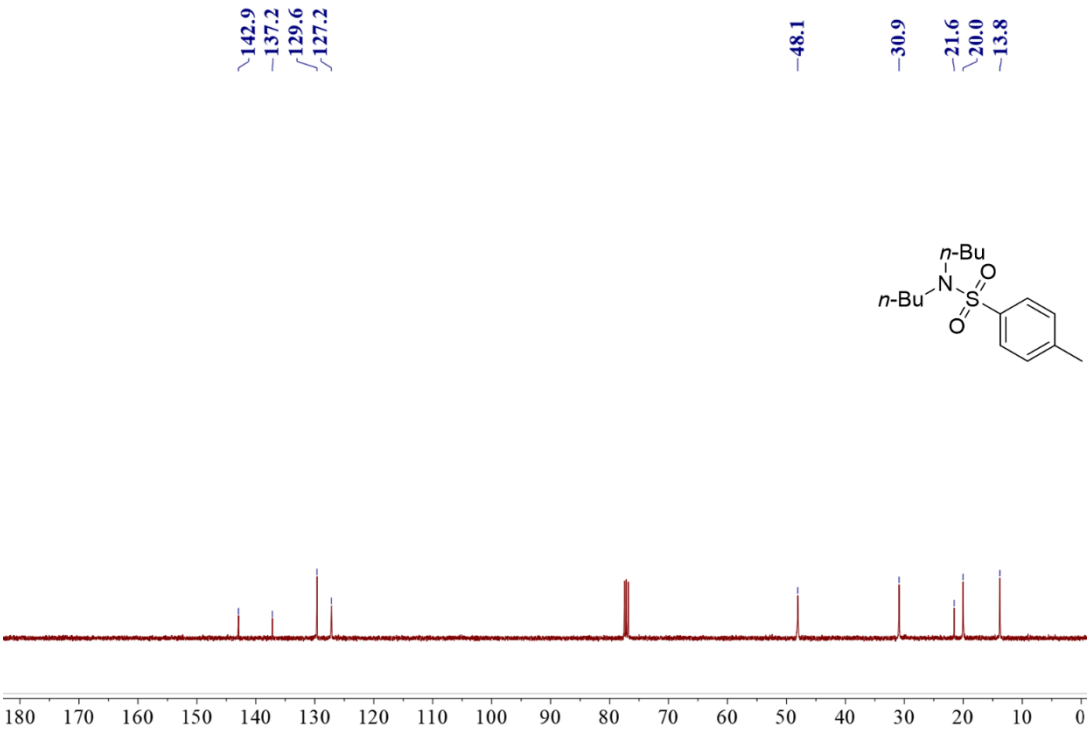


^{13}C NMR spectrum of 3qa

N,N-dibutyl-4-methylbenzenesulfonamide (3ra)

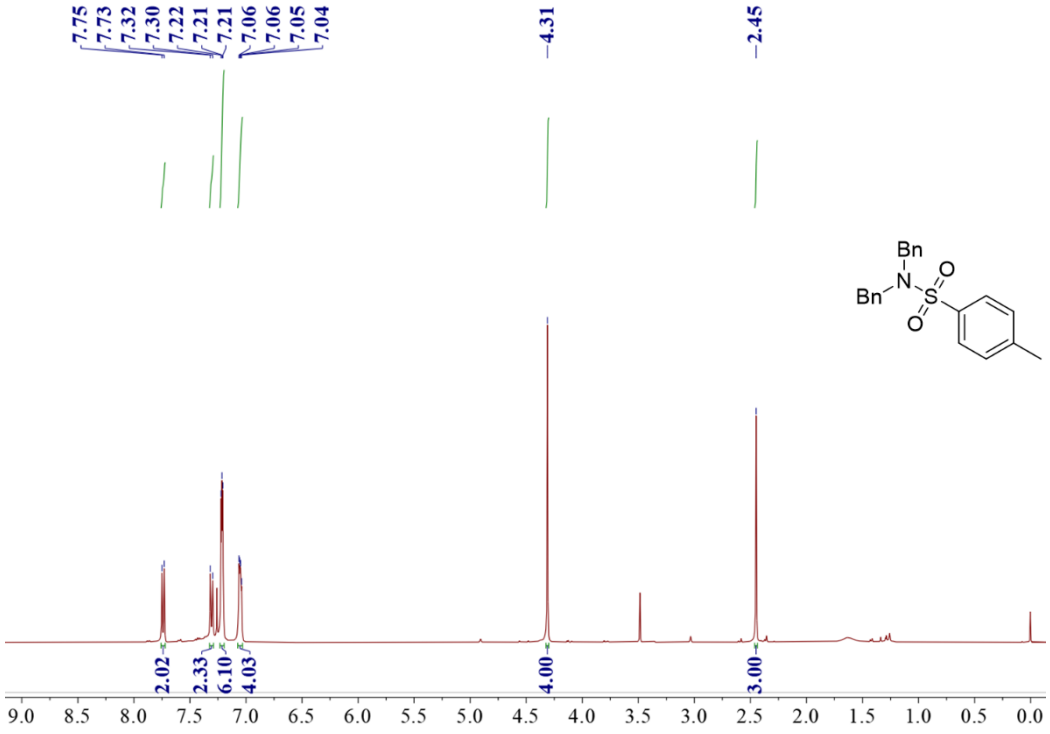


^{1}H NMR spectrum of 3ra

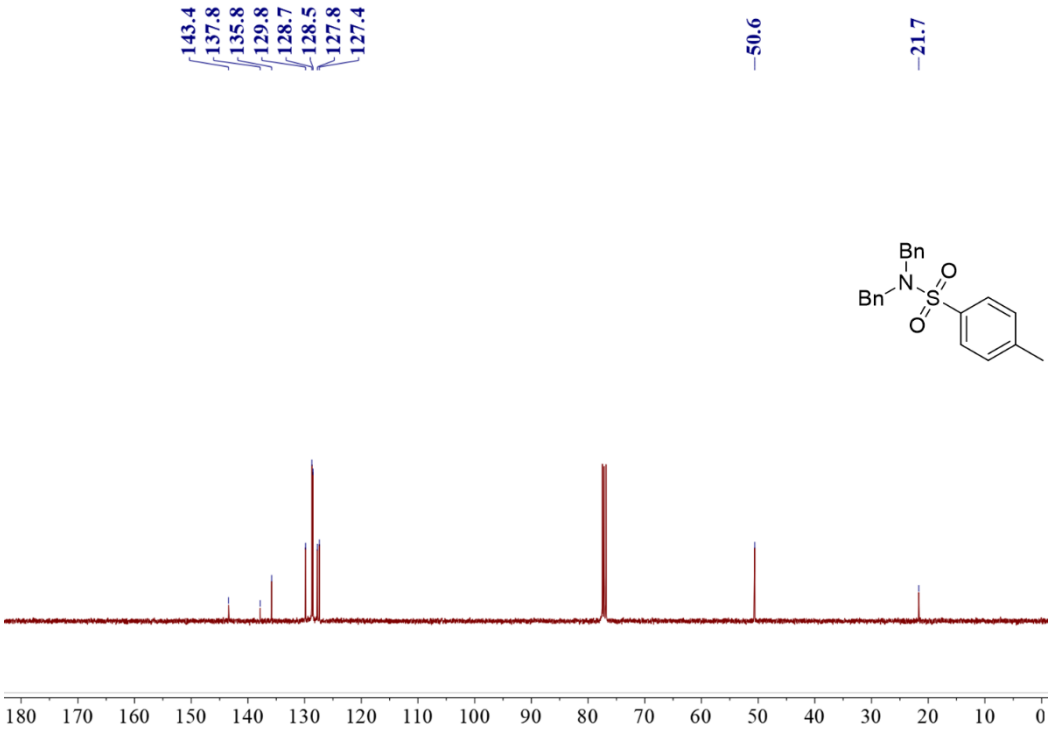


^{13}C NMR spectrum of 3ra

4-Methyl-N,N-bis(phenylmethyl)benzenesulfonamide (3sa)

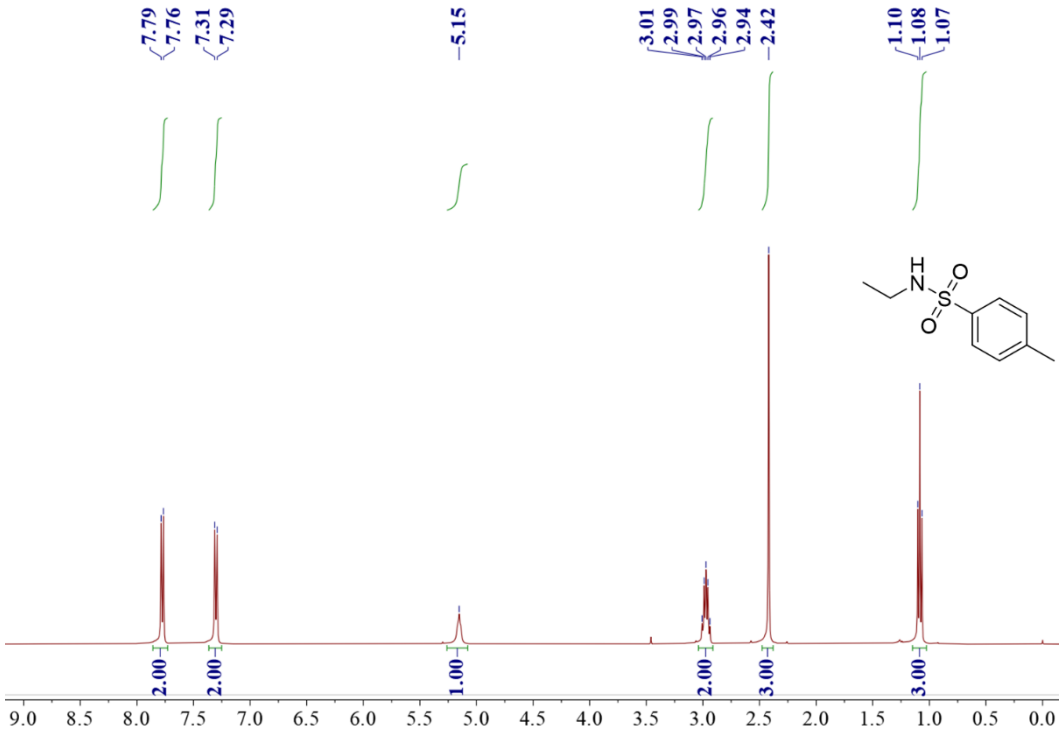


^{1}H NMR spectrum of 3sa

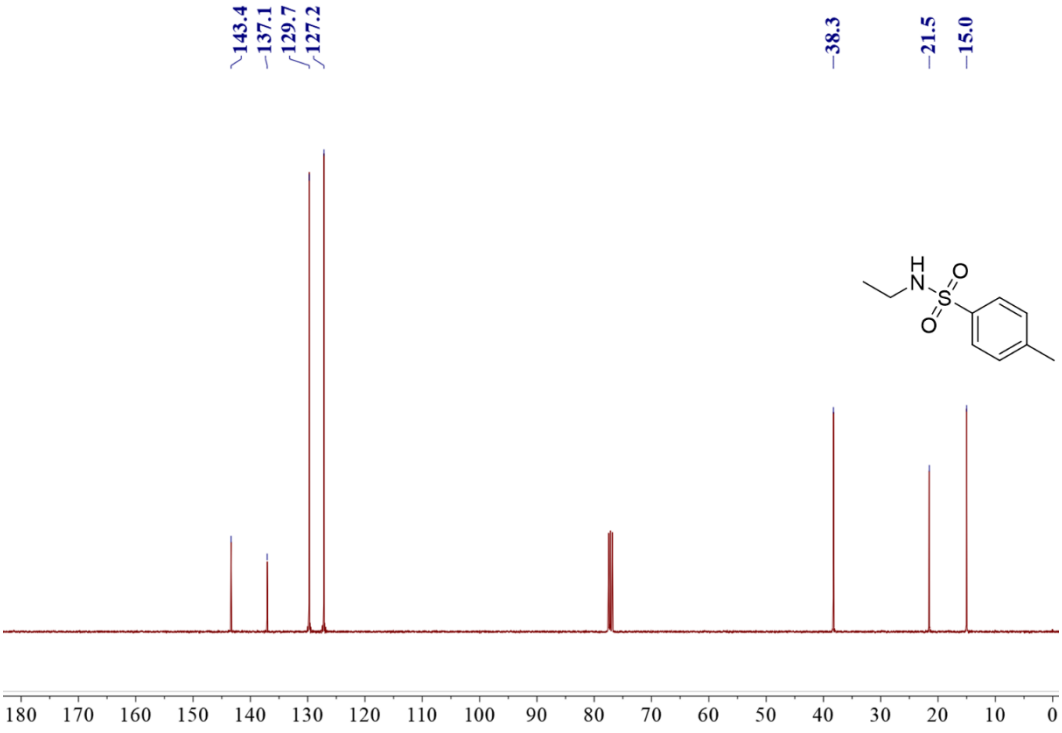


^{13}C NMR spectrum of 3sa

N-ethyl-4-methylbenzenesulfonamide (3ta)

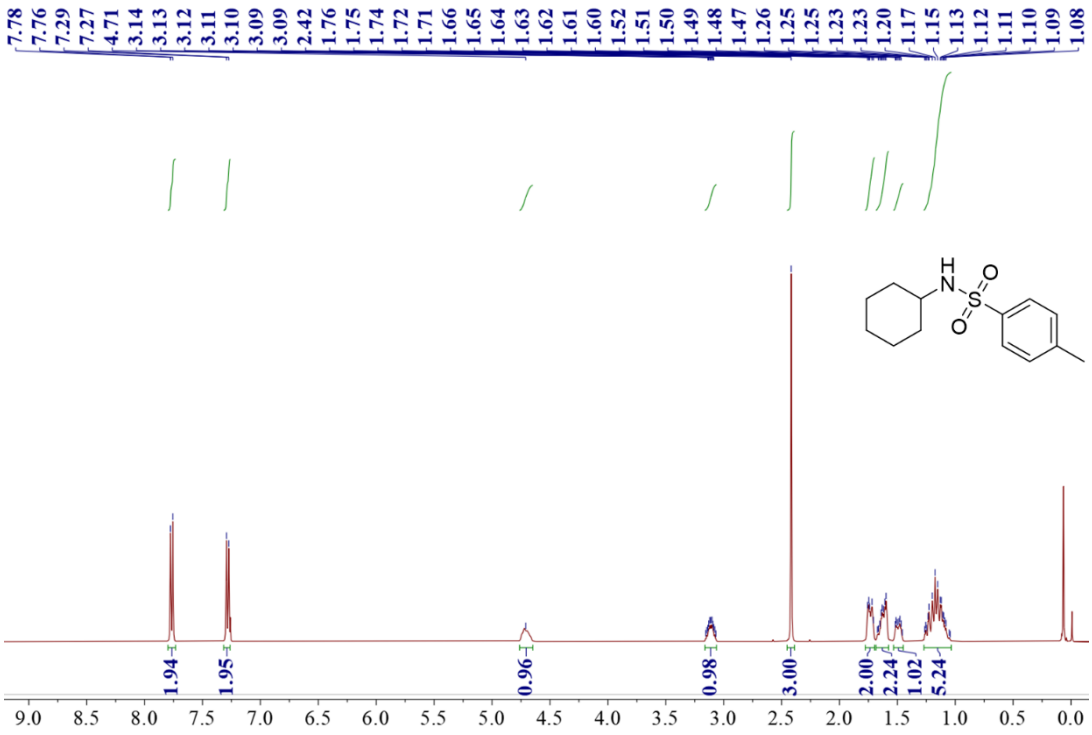


^{1}H NMR spectrum of 3ta



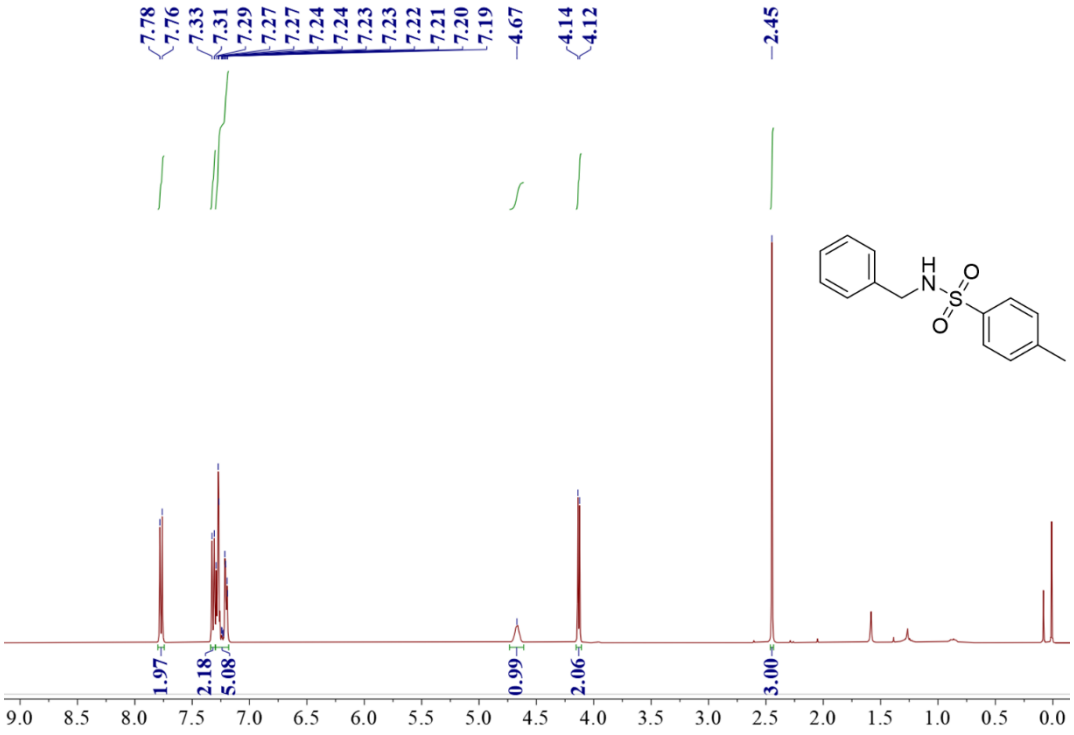
^{13}C NMR spectrum of 3ta

N-cyclohexyl-4-methylbenzenesulfonamide (3ua)



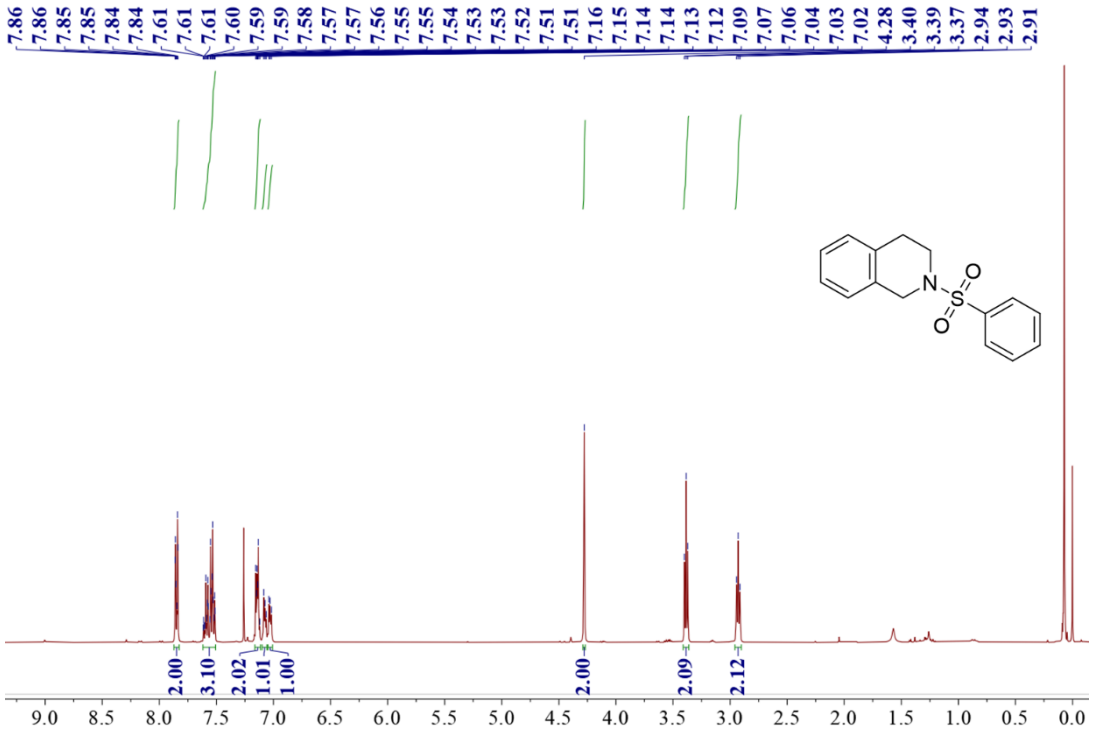
^{1}H NMR spectrum of 3ua

N-benzyl-4-methylbenzenesulfonamide (3va)



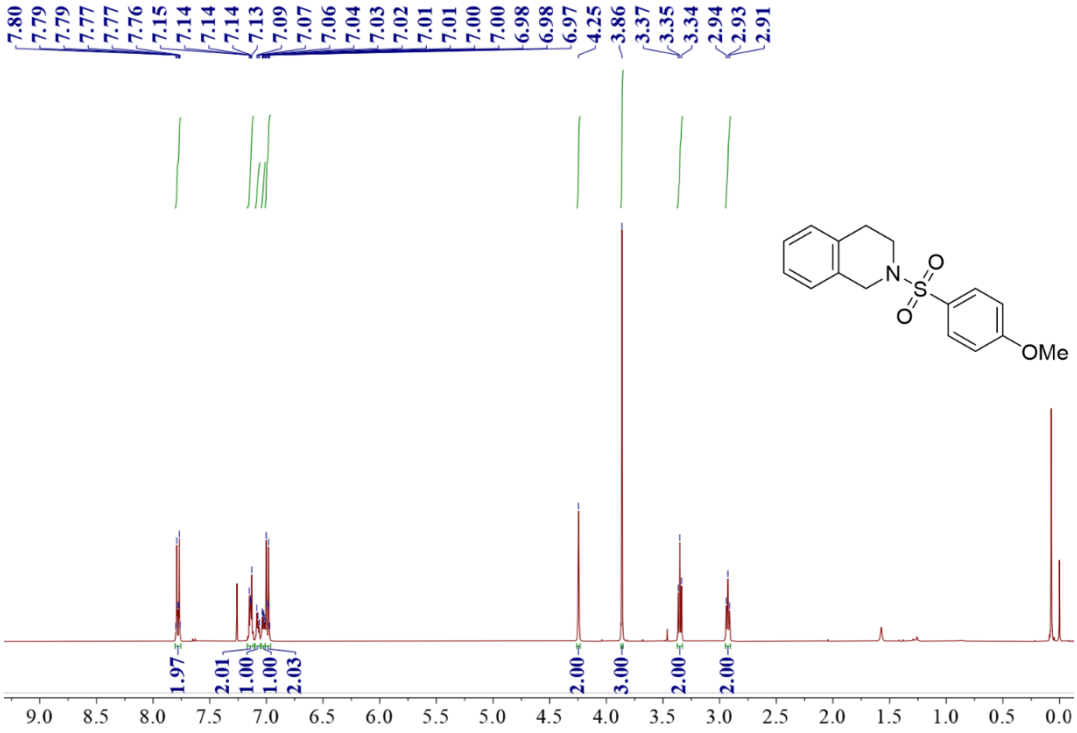
^{1}H NMR spectrum of 3va

2-(phenylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (3ab)



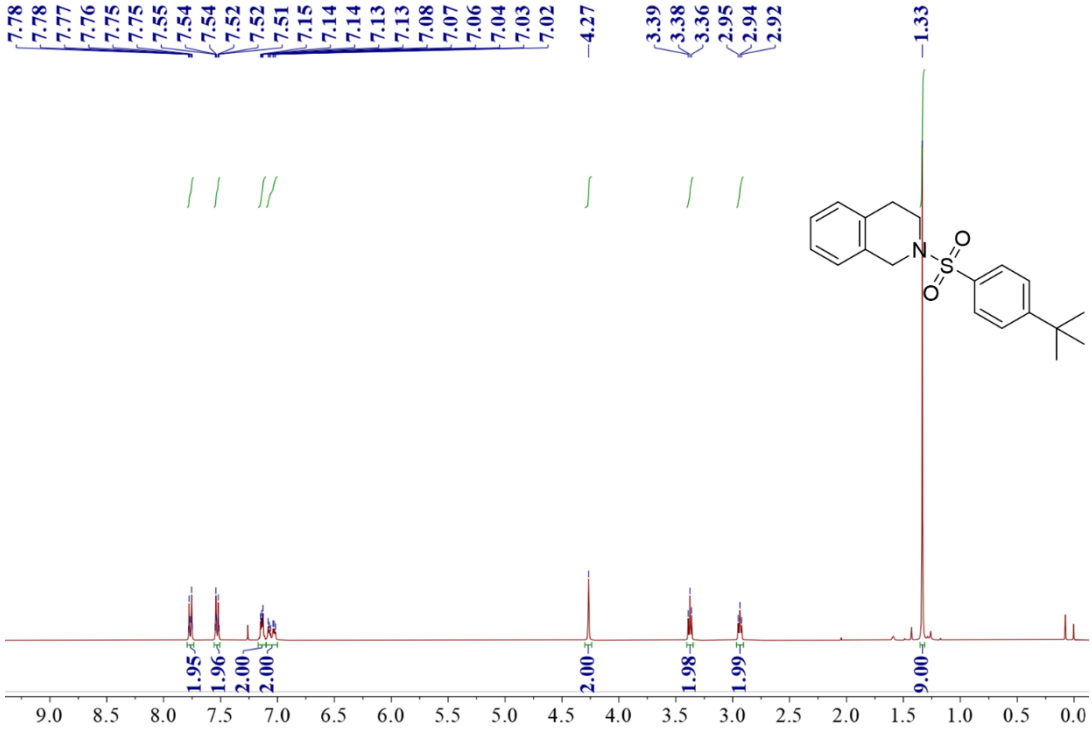
^{1}H NMR spectrum of 3ab

2-((4-methoxyphenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (3ac)



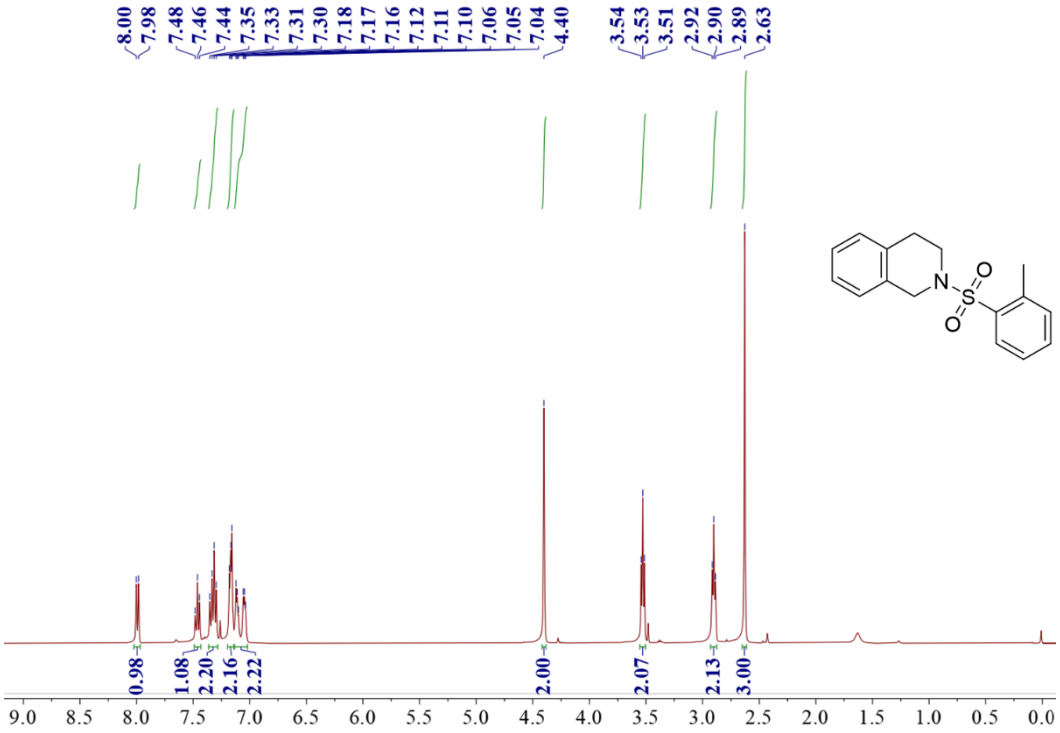
^{1}H NMR spectrum of 3ac

2-((4-(tert-butyl)phenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (3ad)

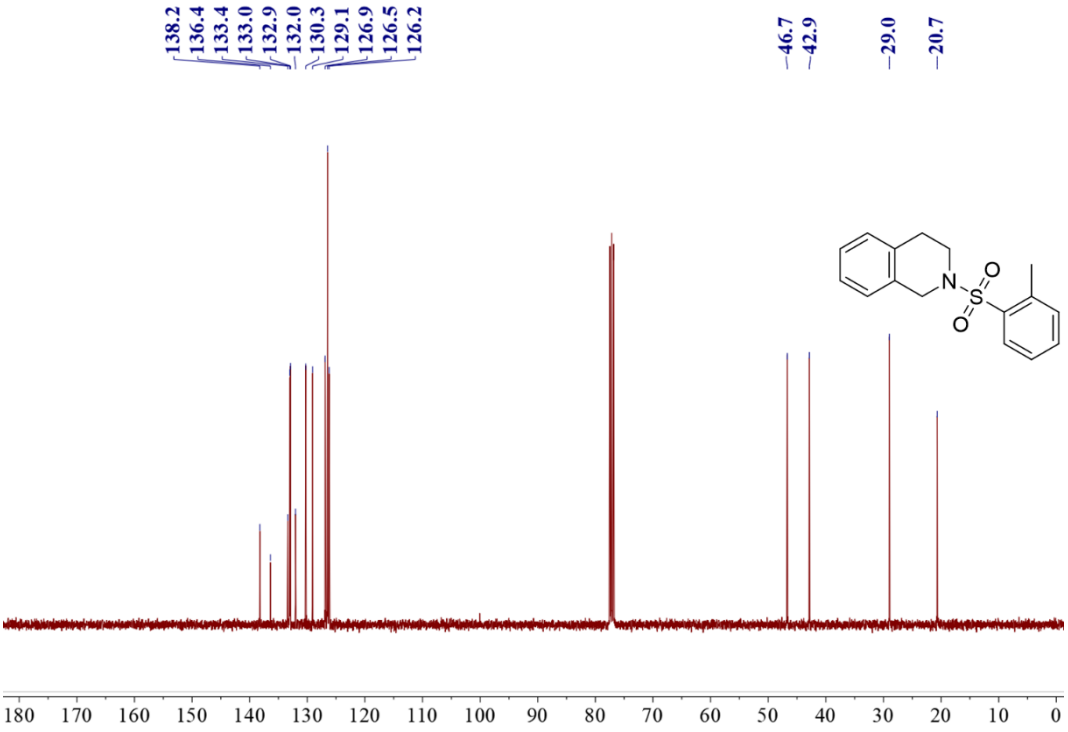


^{1}H NMR spectrum of 3ad

2-(o-tolylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (3ae)

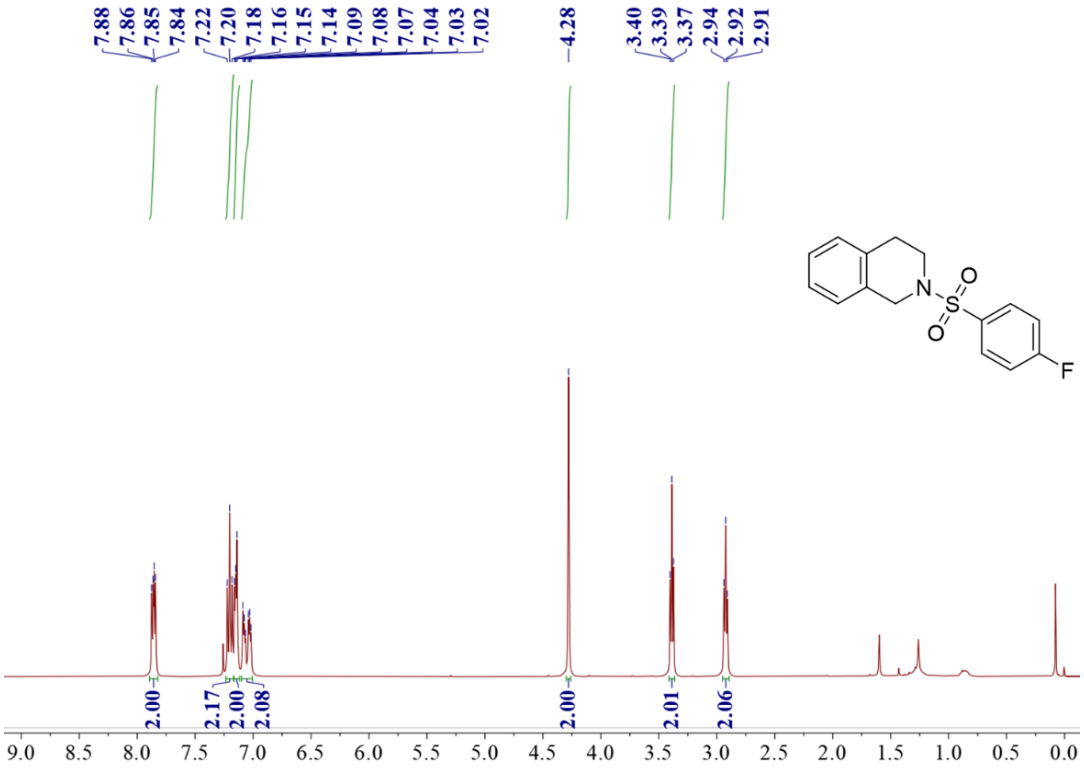


^{1}H NMR spectrum of 3ae

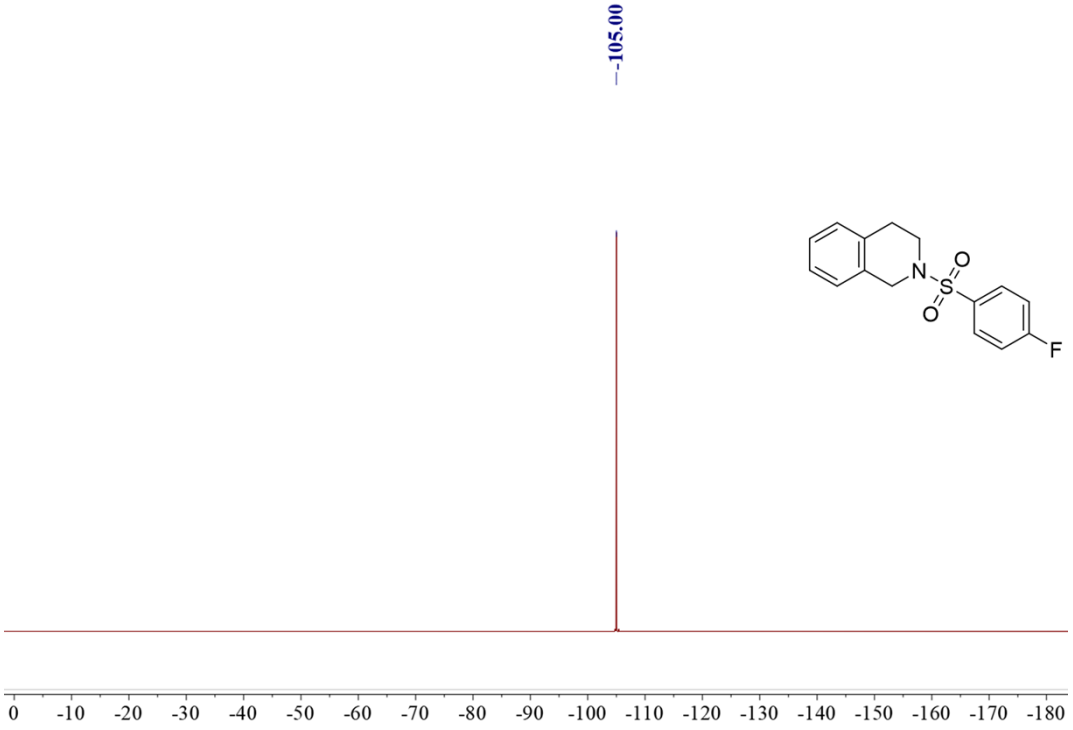


^{13}C NMR spectrum of 3ae

2-((4-fluorophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (3af)

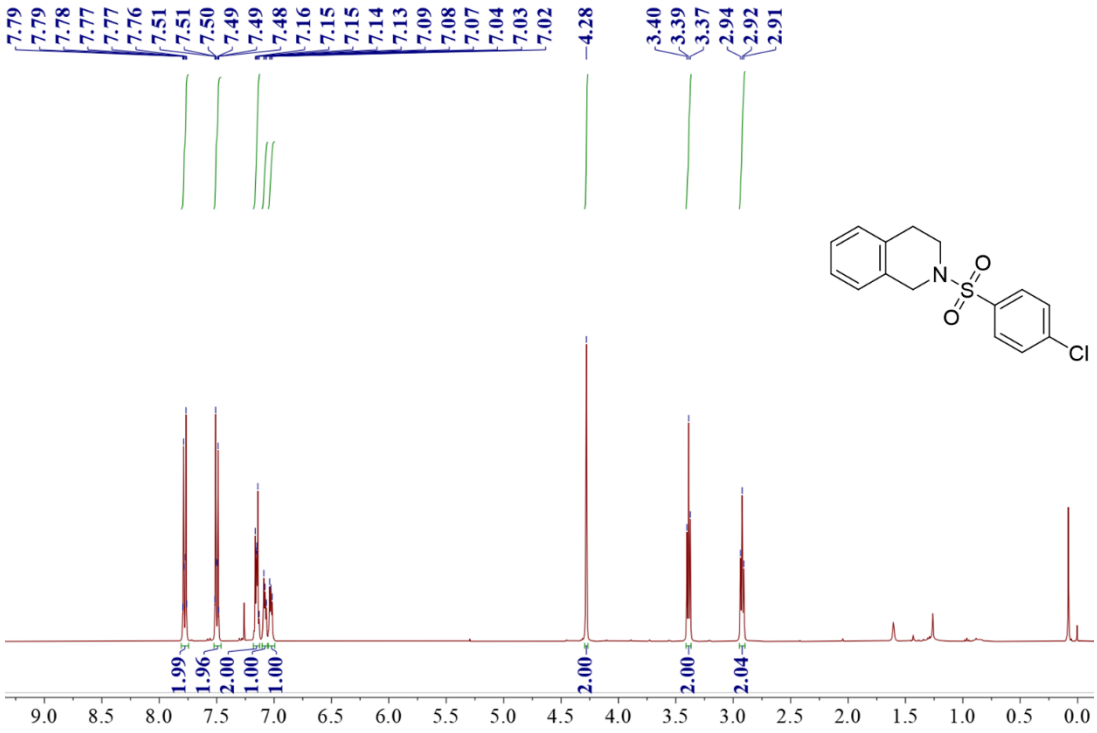


^{1}H NMR spectrum of 3af



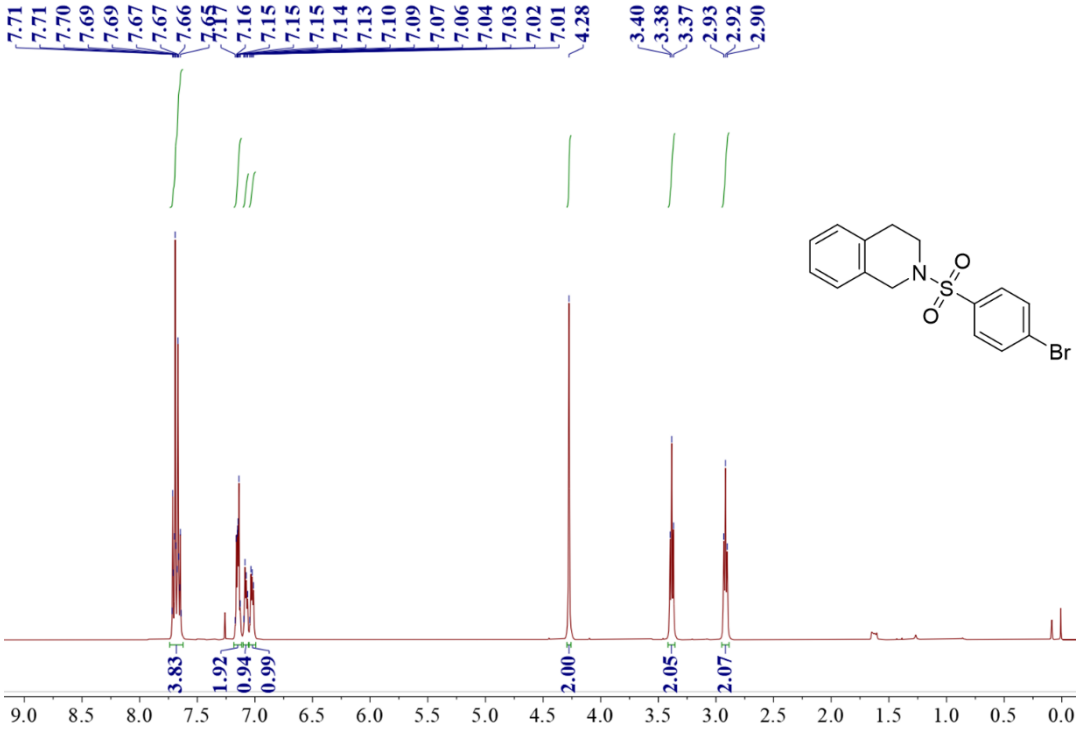
^{19}F NMR spectrum of 3af

2-((4-chlorophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (3ag)



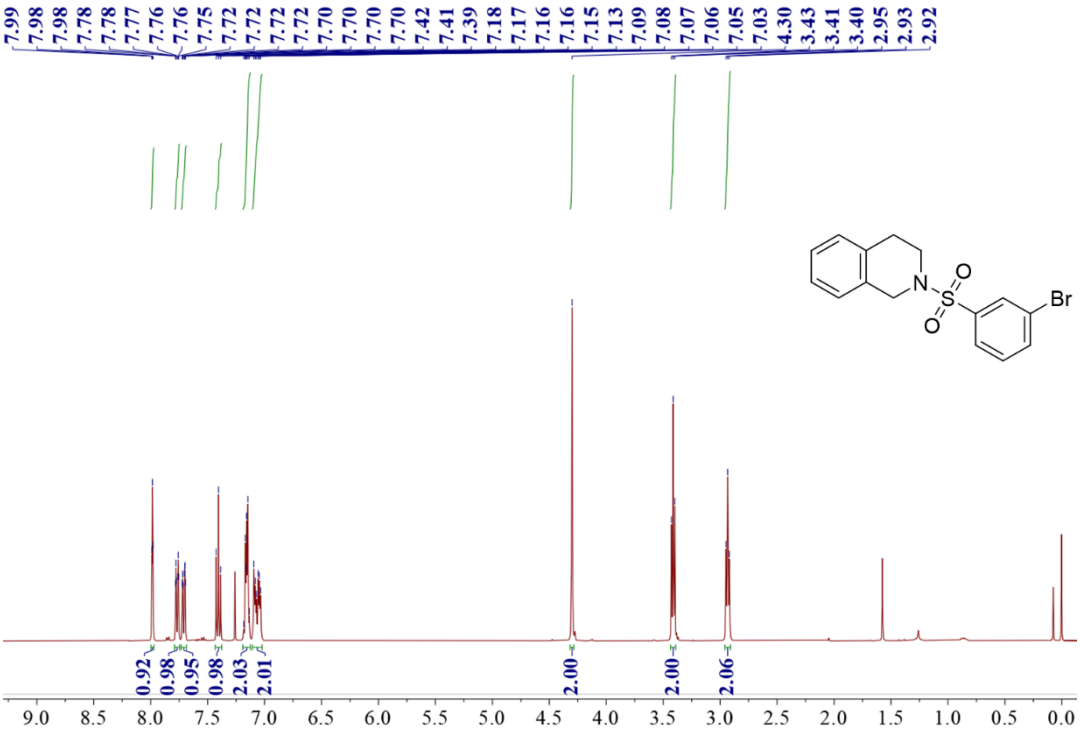
^{1}H NMR spectrum of 3ag

2-((4-bromophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (3ah)

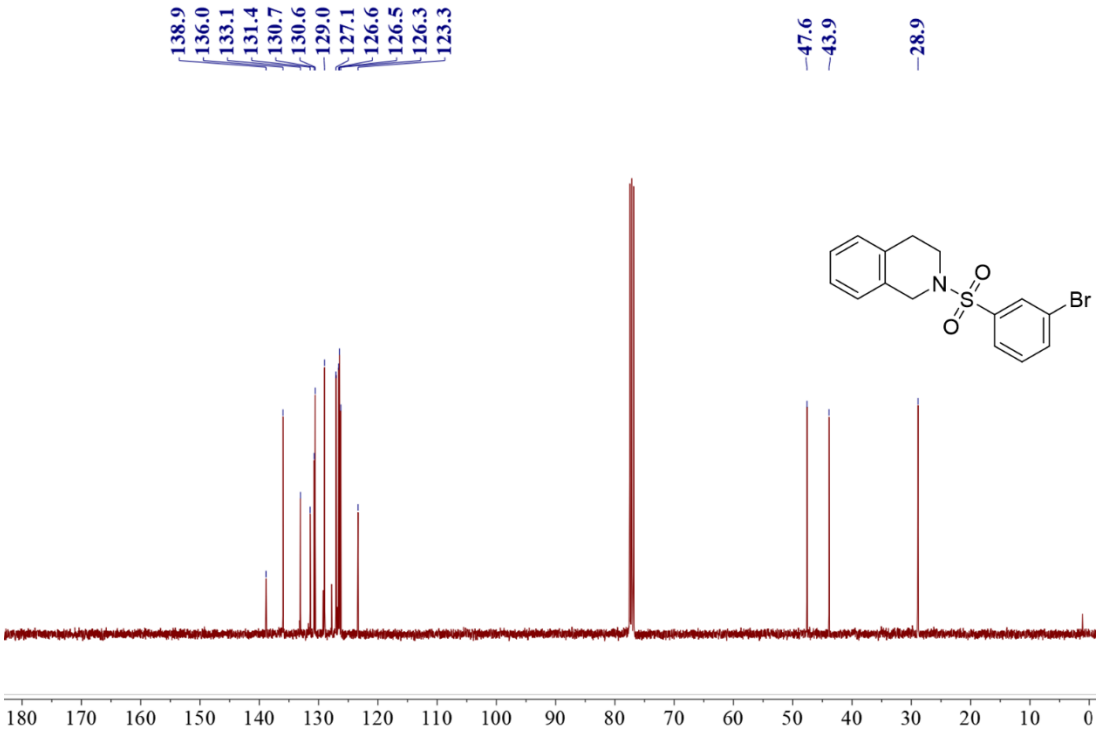


^{1}H NMR spectrum of 3ah

2-((3-bromophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (3ai)

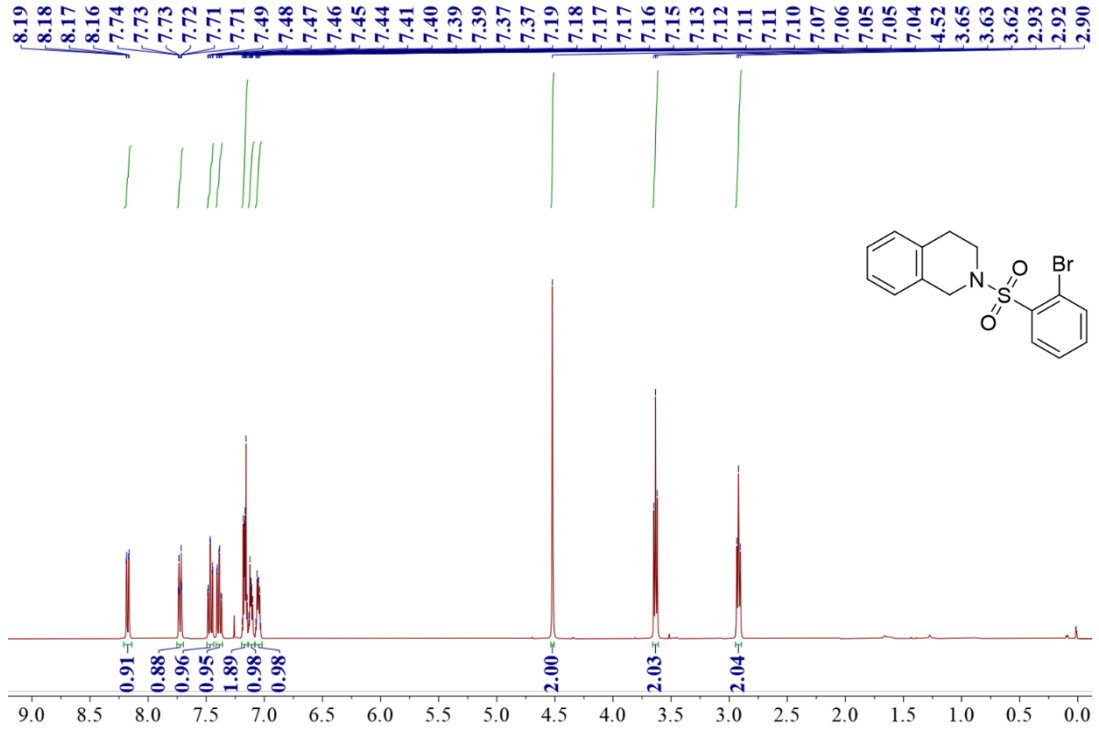


^{1}H NMR spectrum of 3ai

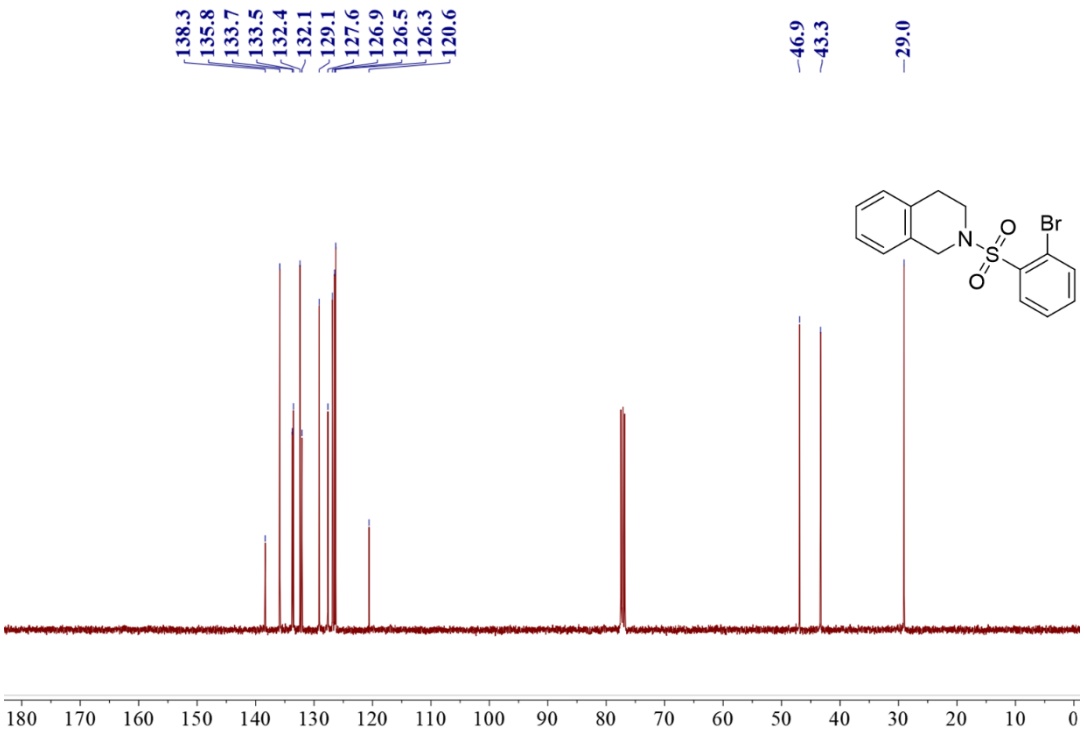


^{13}C NMR spectrum of 3ai

2-((2-bromophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (3aj)

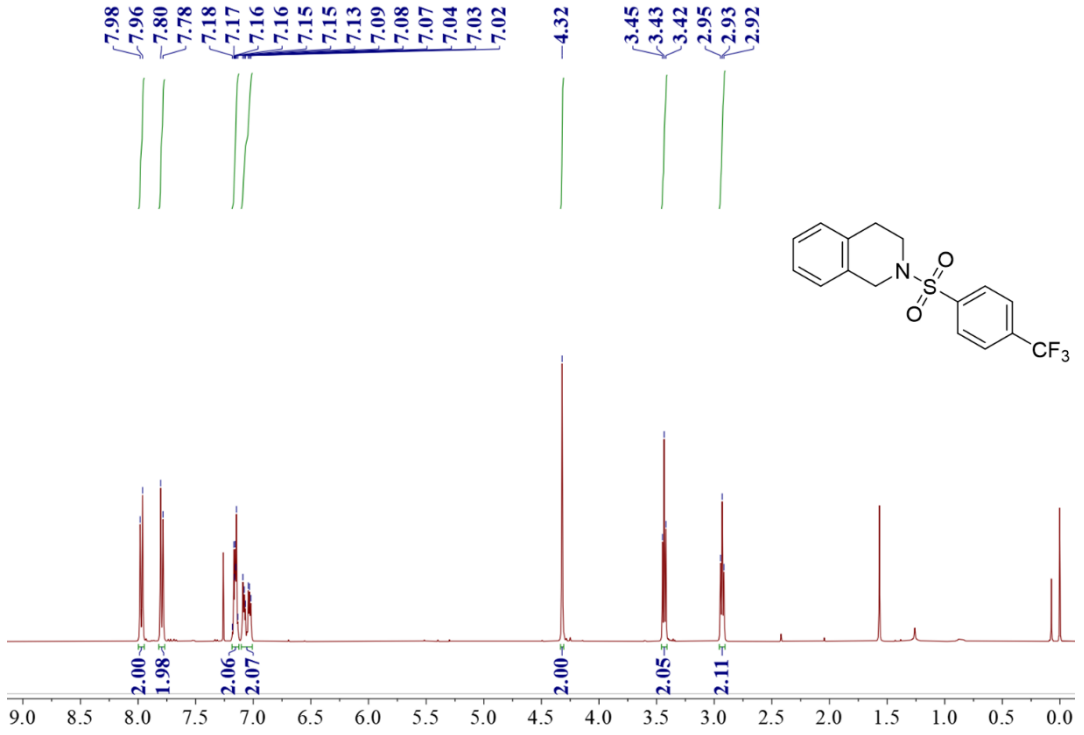


^{1}H NMR spectrum of 3aj

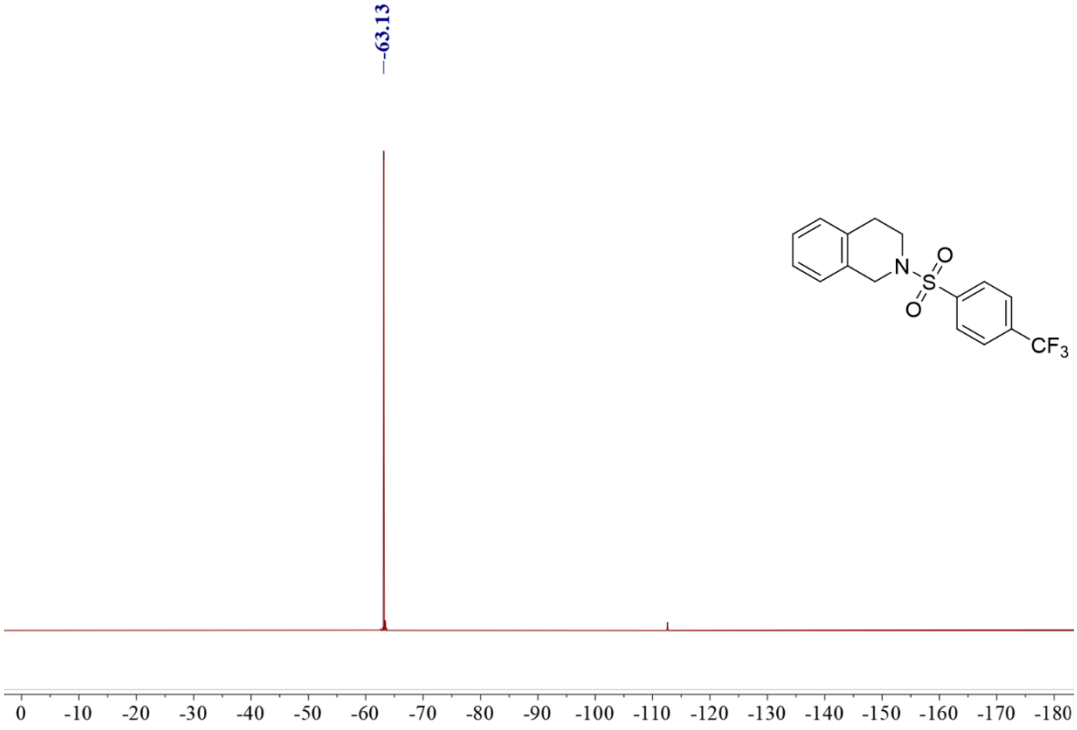


^{13}C NMR spectrum of 3aj

2-((4-(trifluoromethyl)phenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (3ak)

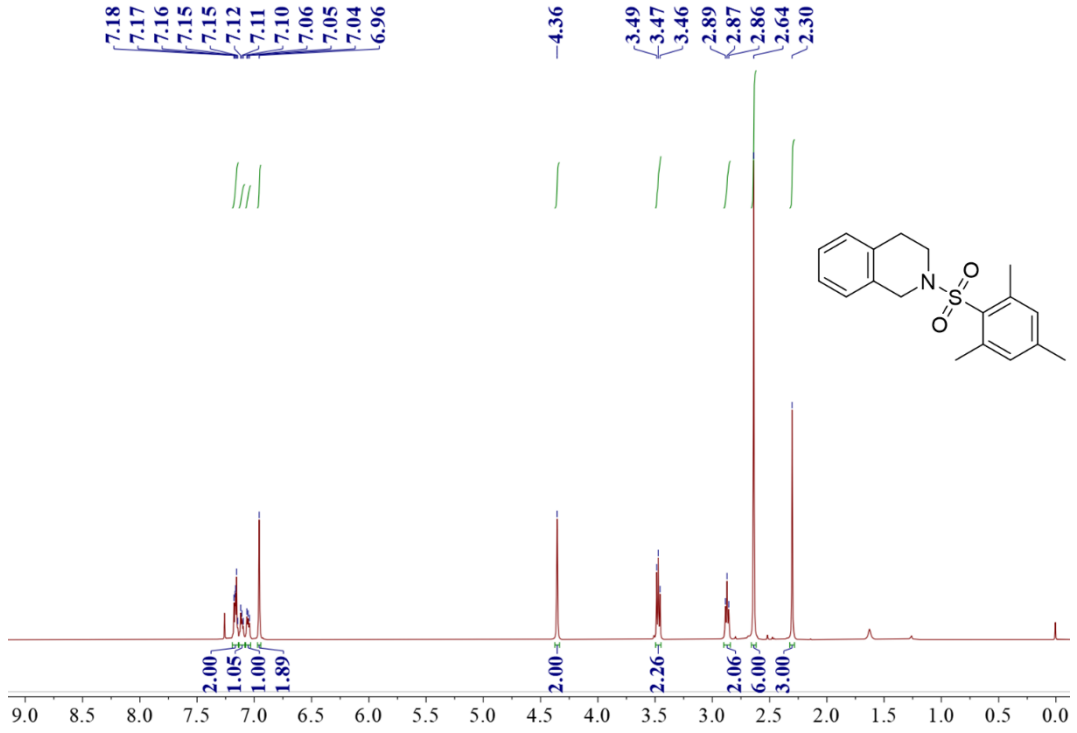


^{1}H NMR spectrum of 3ak

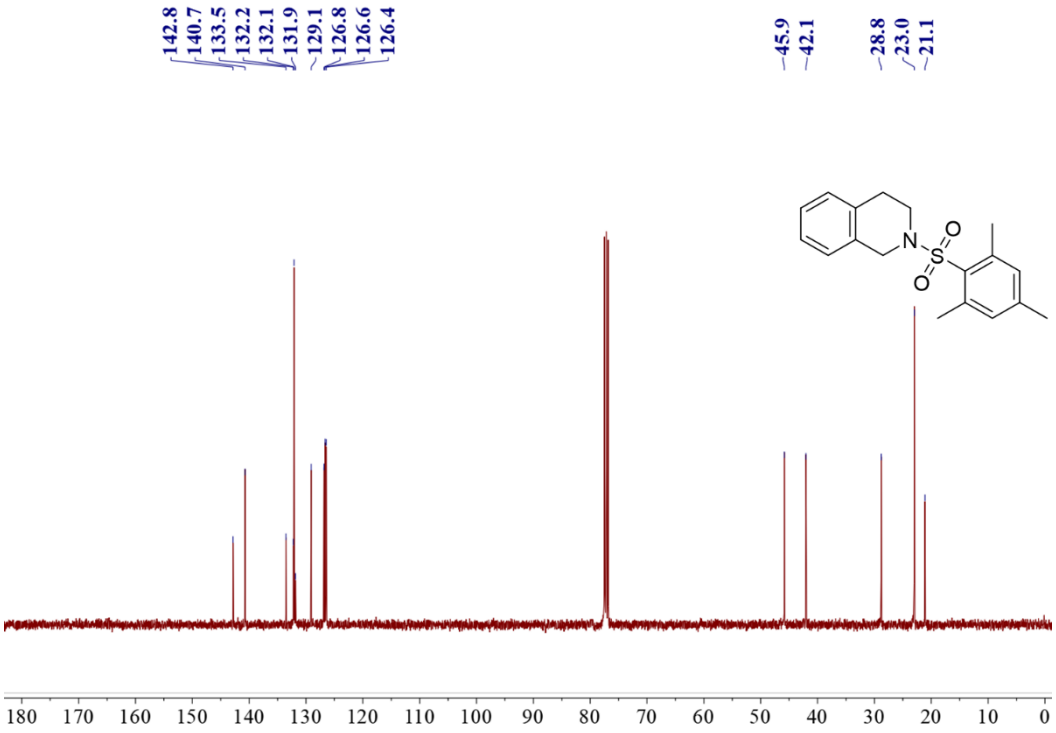


^{19}F NMR spectrum of 3ak

2-(mesitylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (3al)

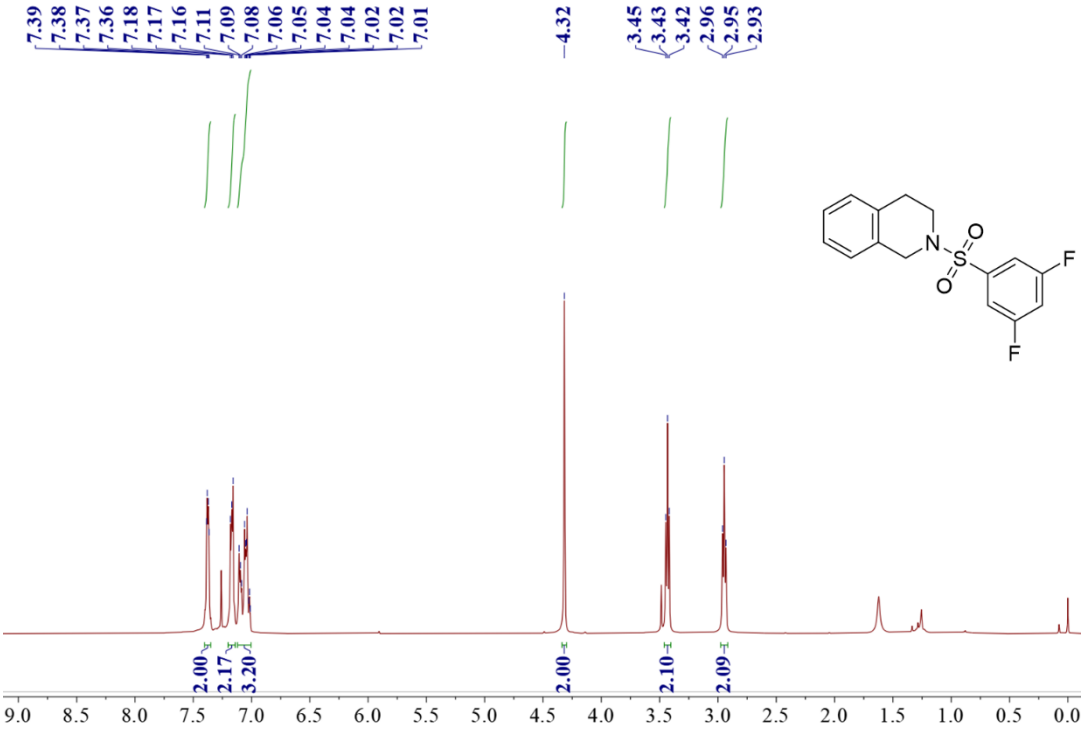


^{1}H NMR spectrum of 3al

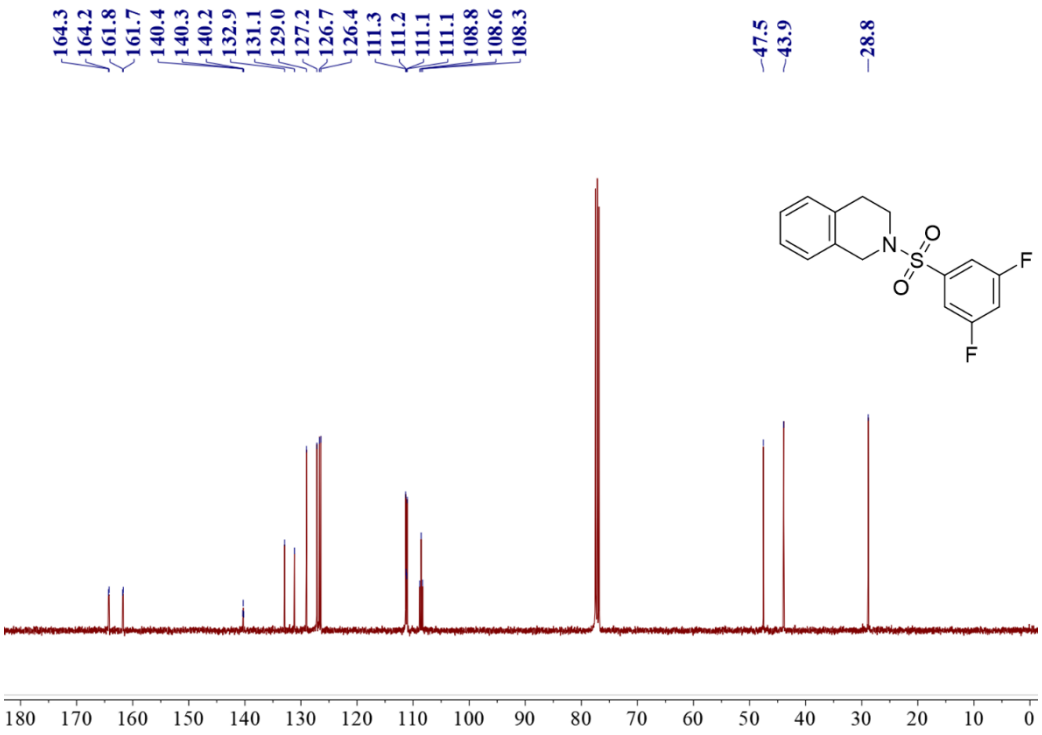


^{13}C NMR spectrum of 3al

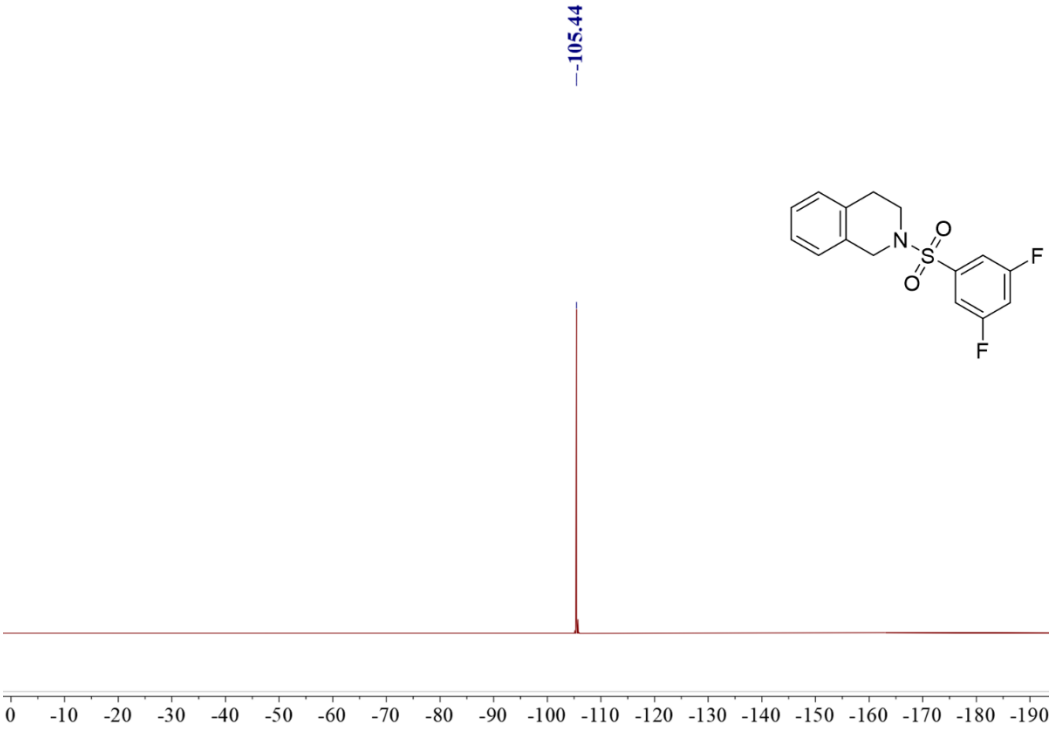
2-((3,5-difluorophenyl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (3am)



^{1}H NMR spectrum of 3am

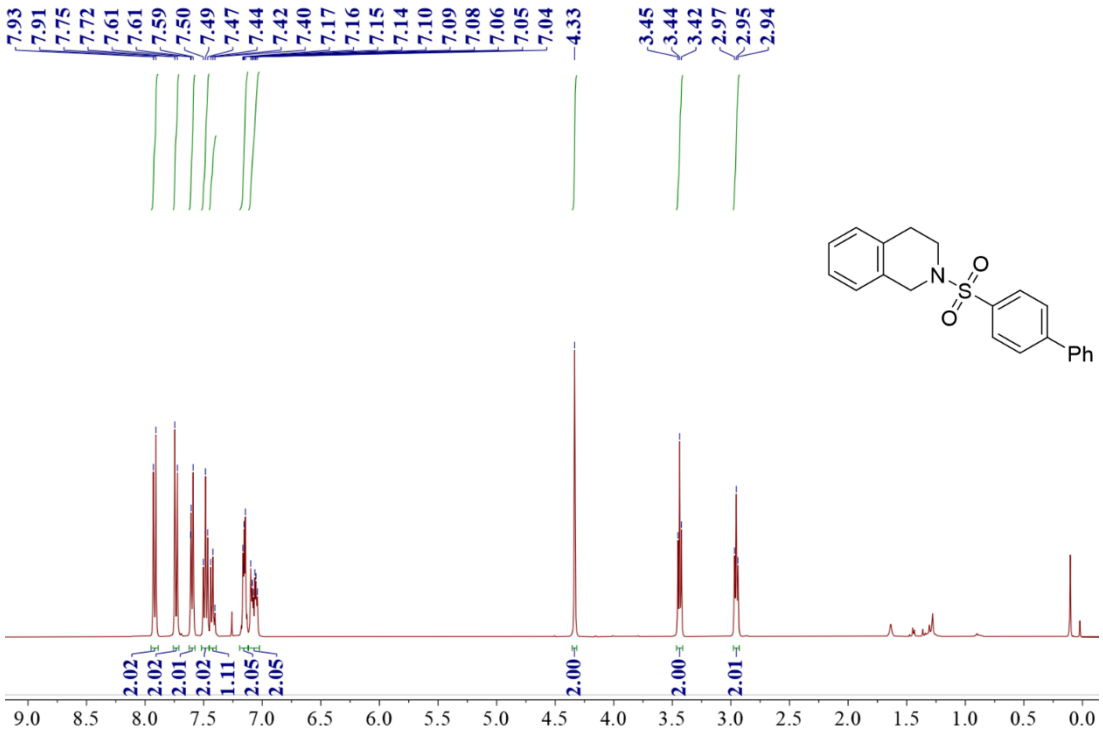


^{13}C NMR spectrum of 3am

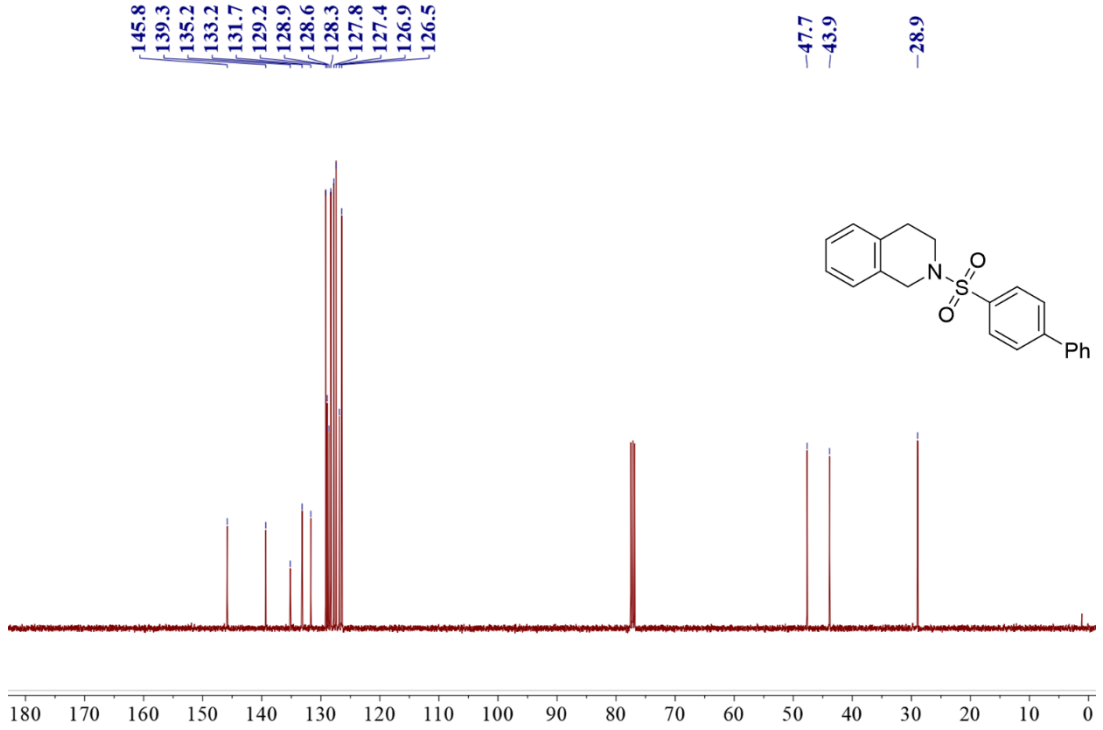


^{19}F NMR spectrum of 3am

2-([1,1'-biphenyl]-4-ylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (3an)

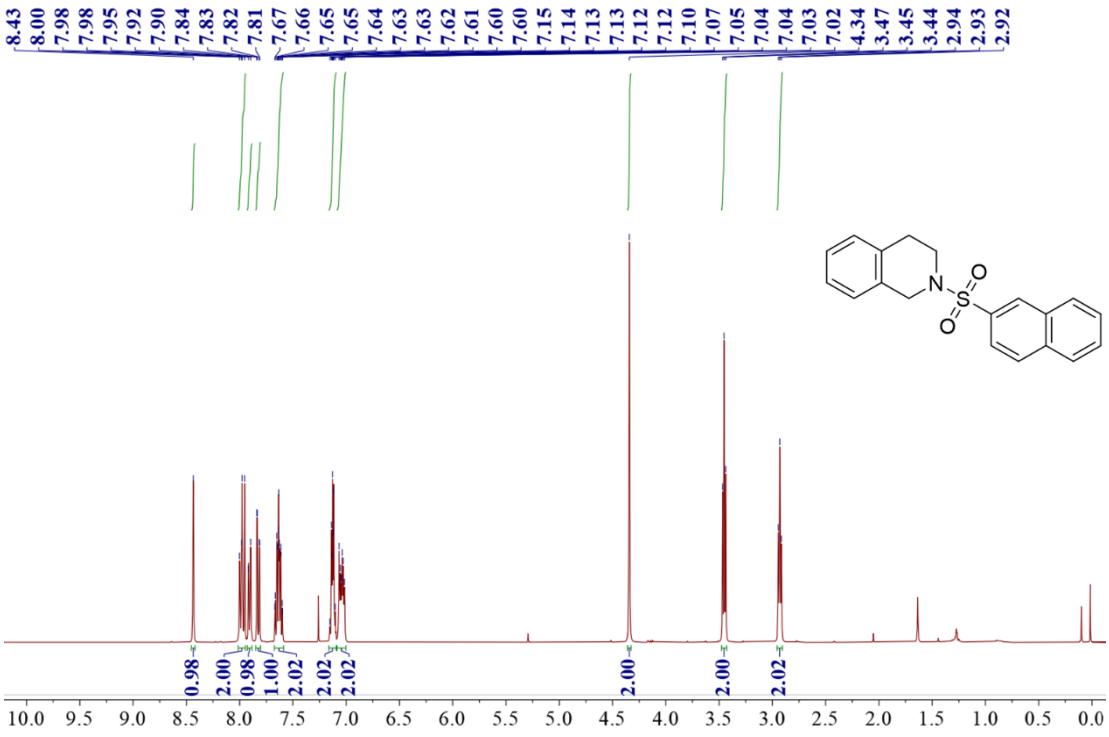


^{1}H NMR spectrum of 3an

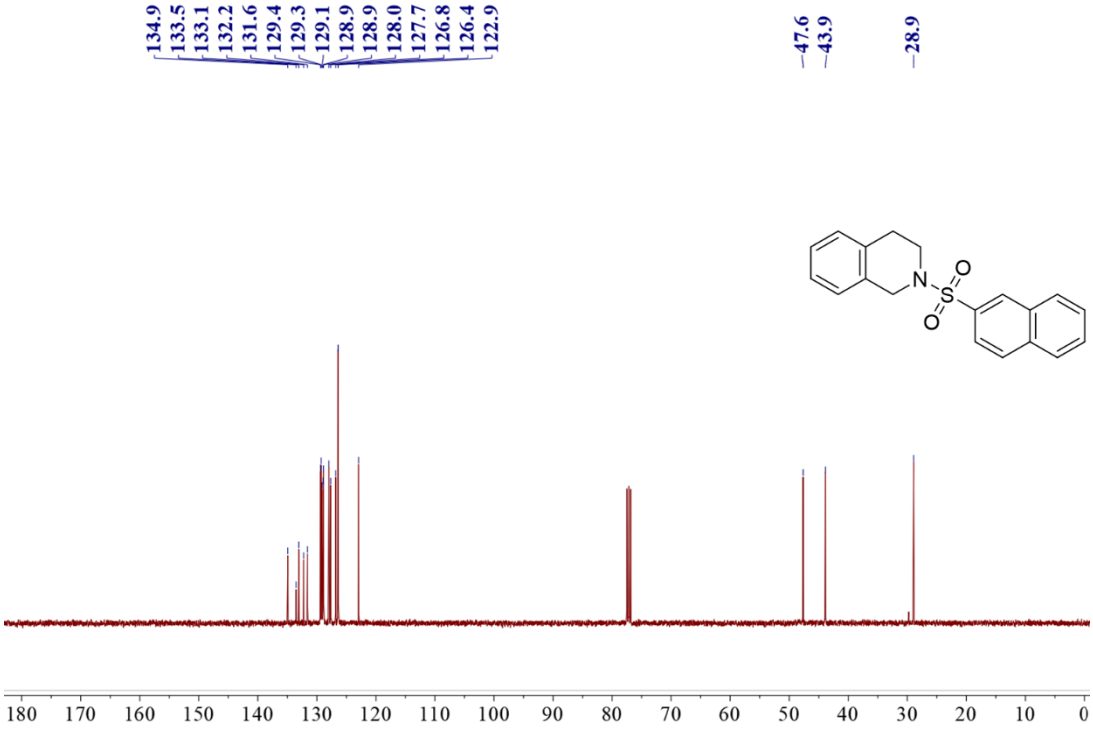


^{13}C NMR spectrum of 3an

2-(naphthalen-2-ylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (3ao)

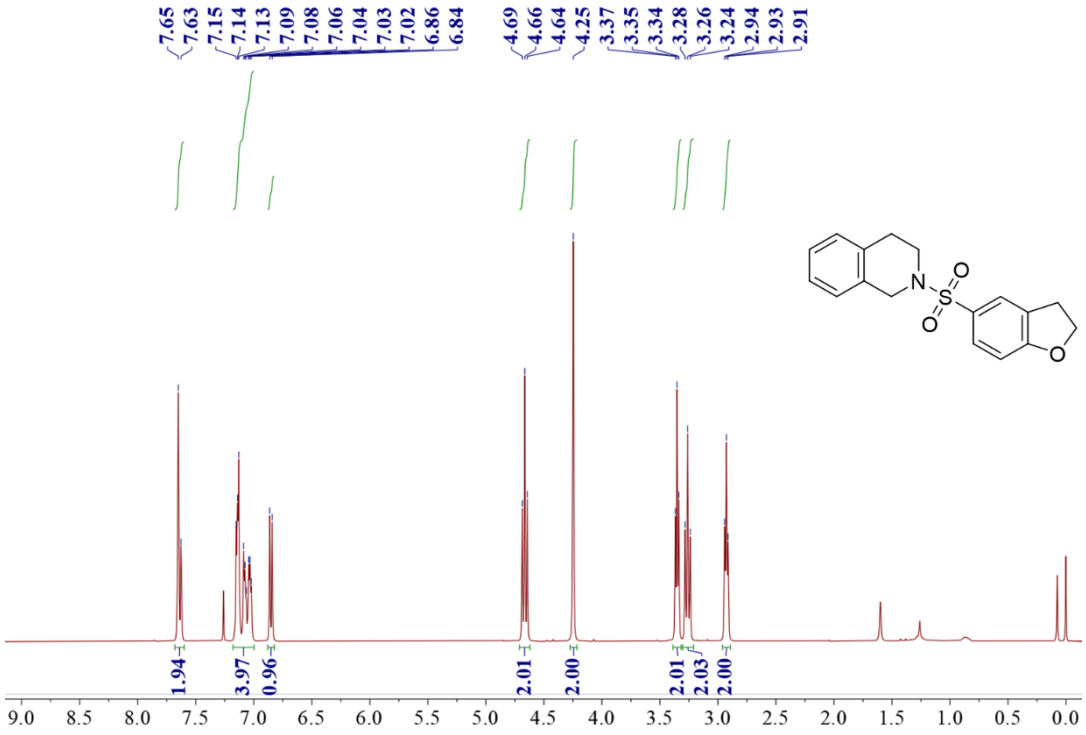


^{1}H NMR spectrum of 3ao

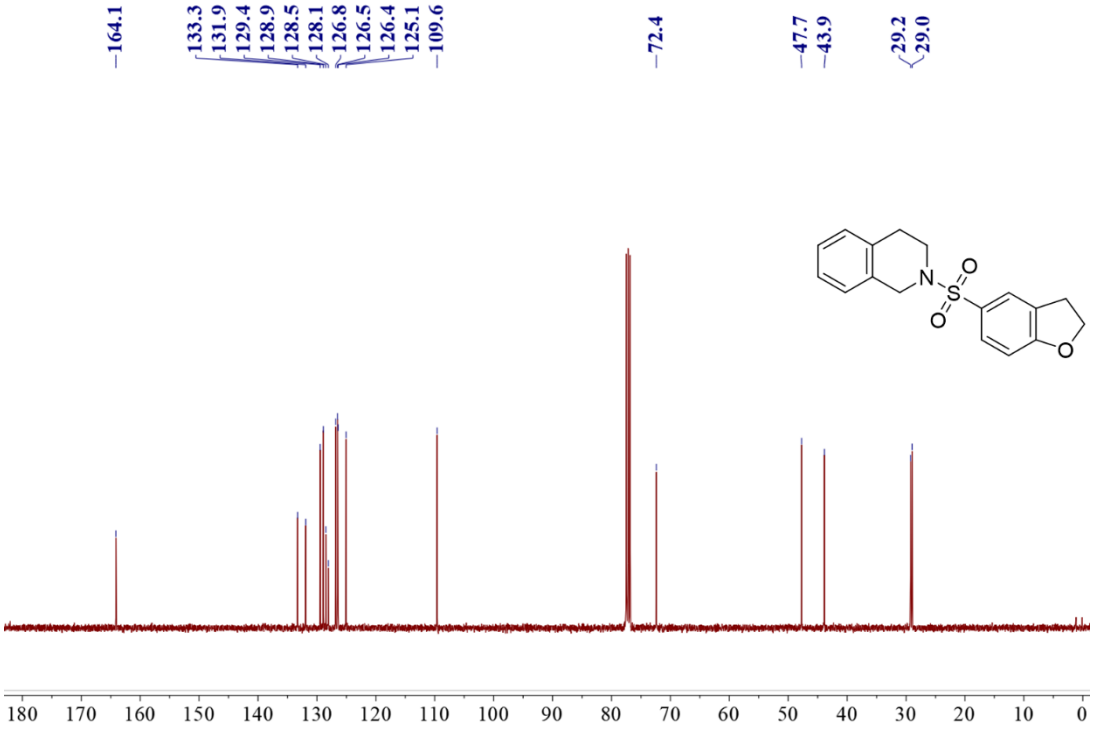


^{13}C NMR spectrum of 3ao

2-((2,3-dihydrobenzofuran-5-yl)sulfonyl)-1,2,3,4-tetrahydroisoquinoline (3ap)

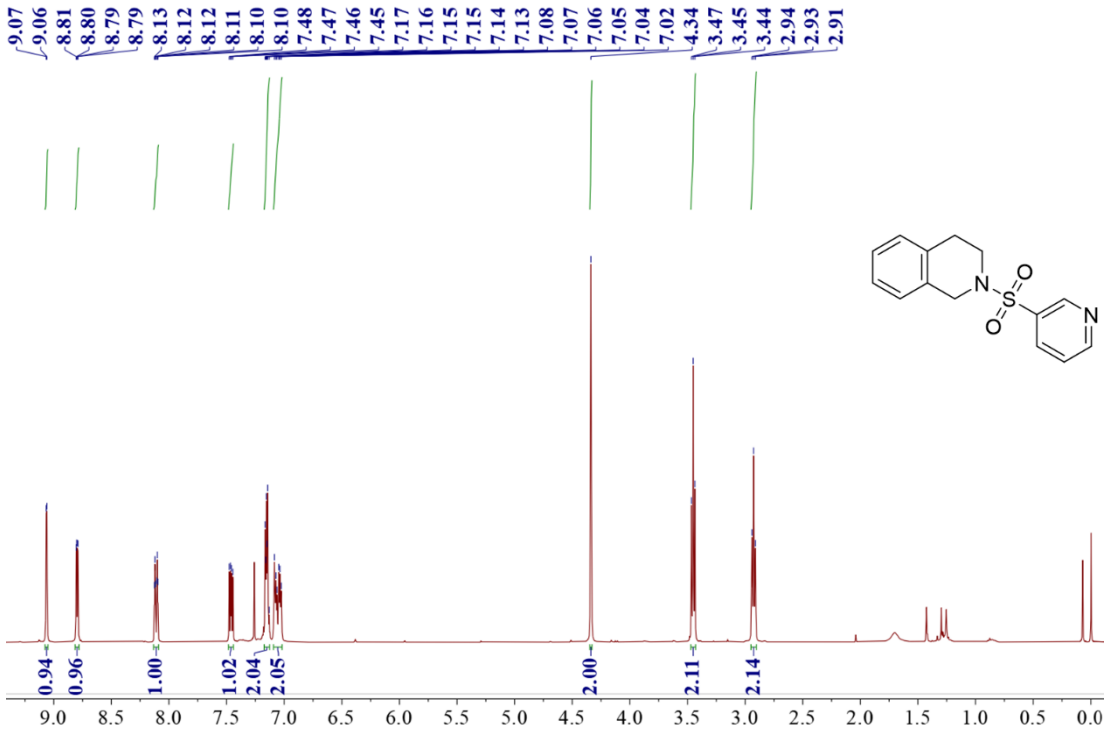


^{1}H NMR spectrum of 3ap

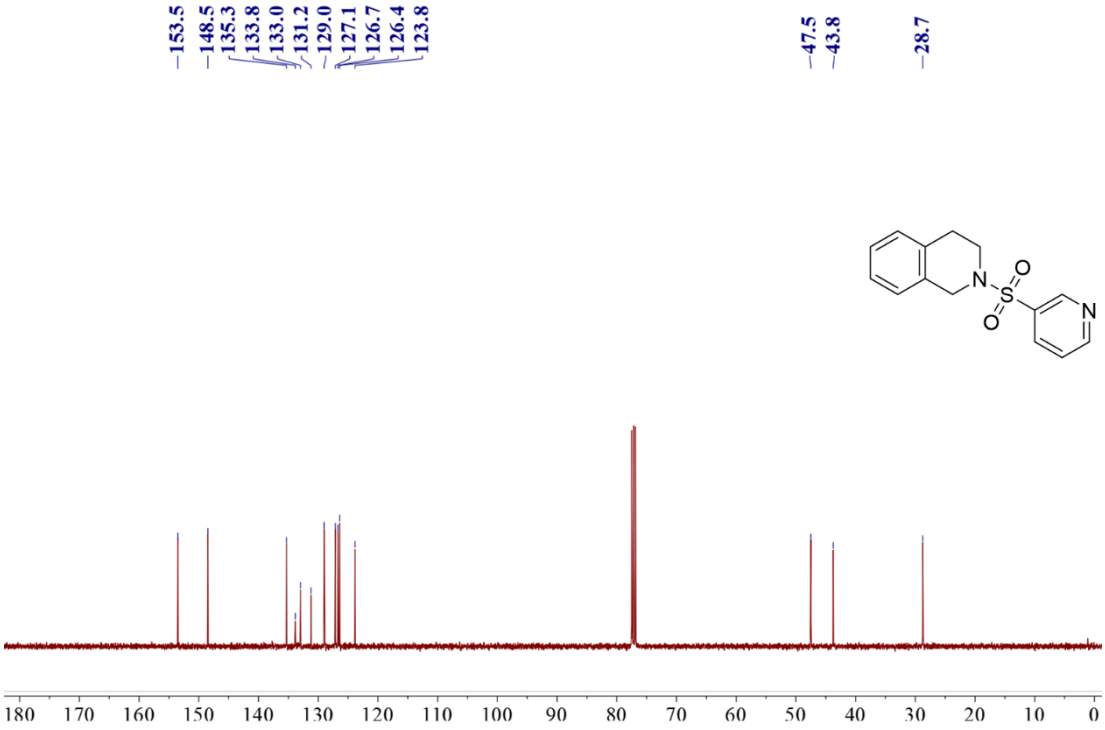


^{13}C NMR spectrum of 3ap

2-(pyridin-3-ylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (3aq)

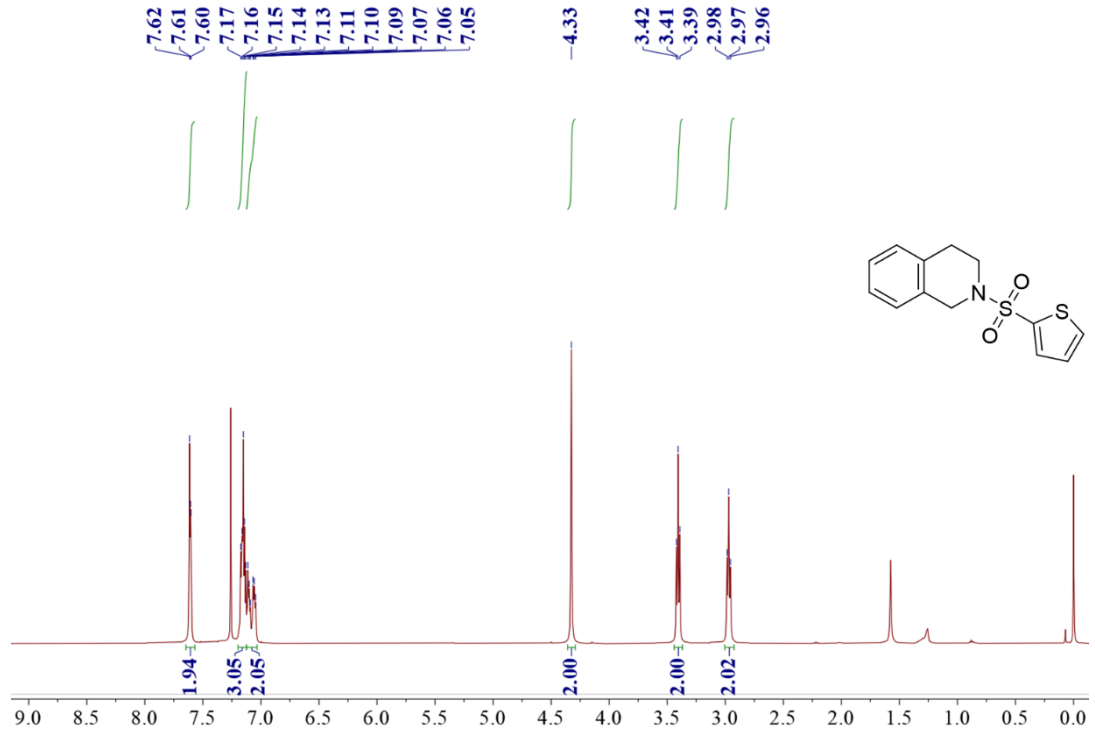


^{1}H NMR spectrum of 3aq

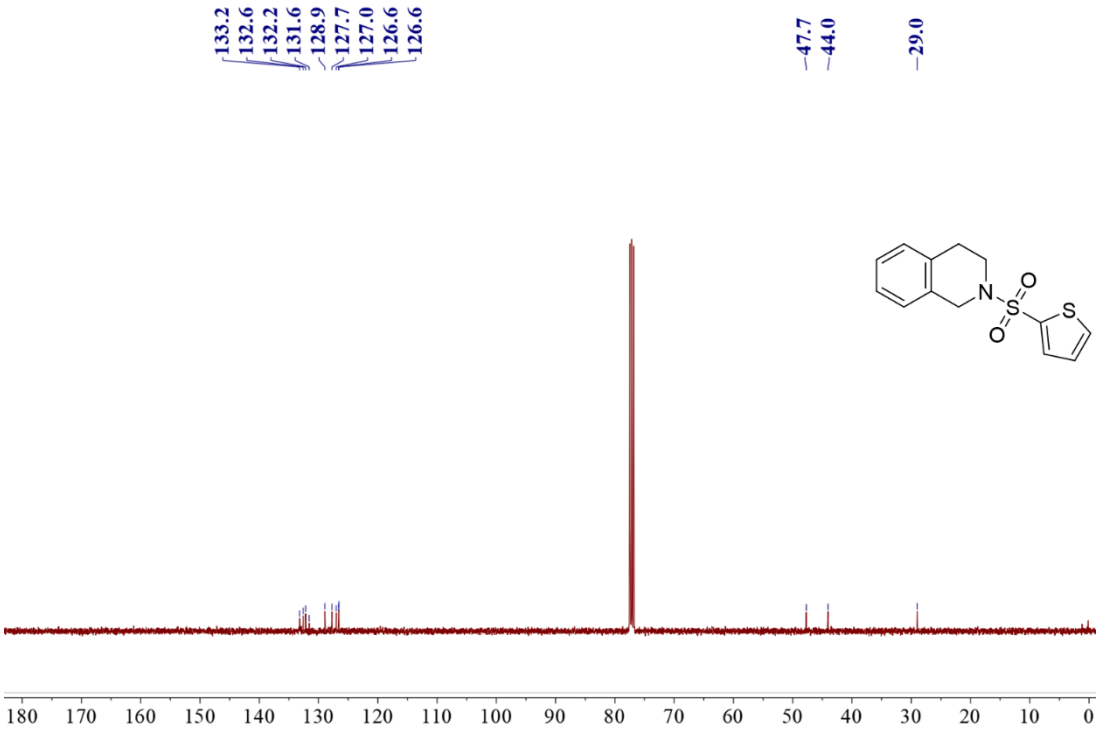


^{13}C NMR spectrum of 3aq

2-(thiophen-2-ylsulfonyl)-1,2,3,4-tetrahydroisoquinoline (3ar)

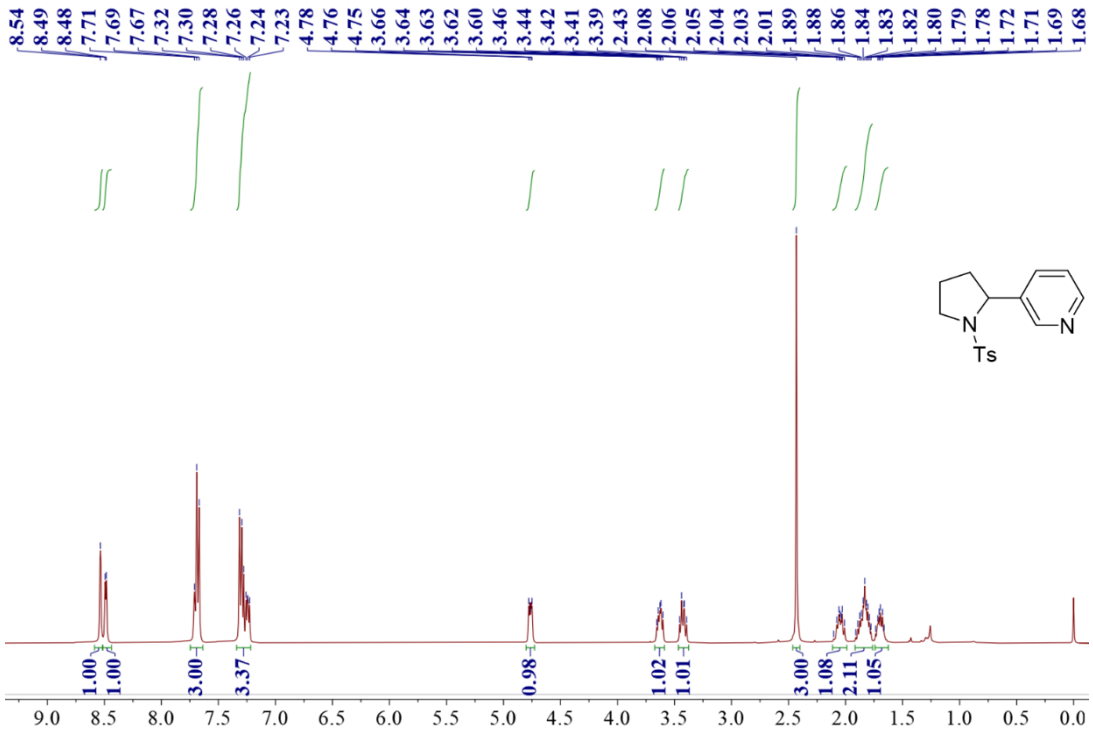


^{1}H NMR spectrum of 3ar

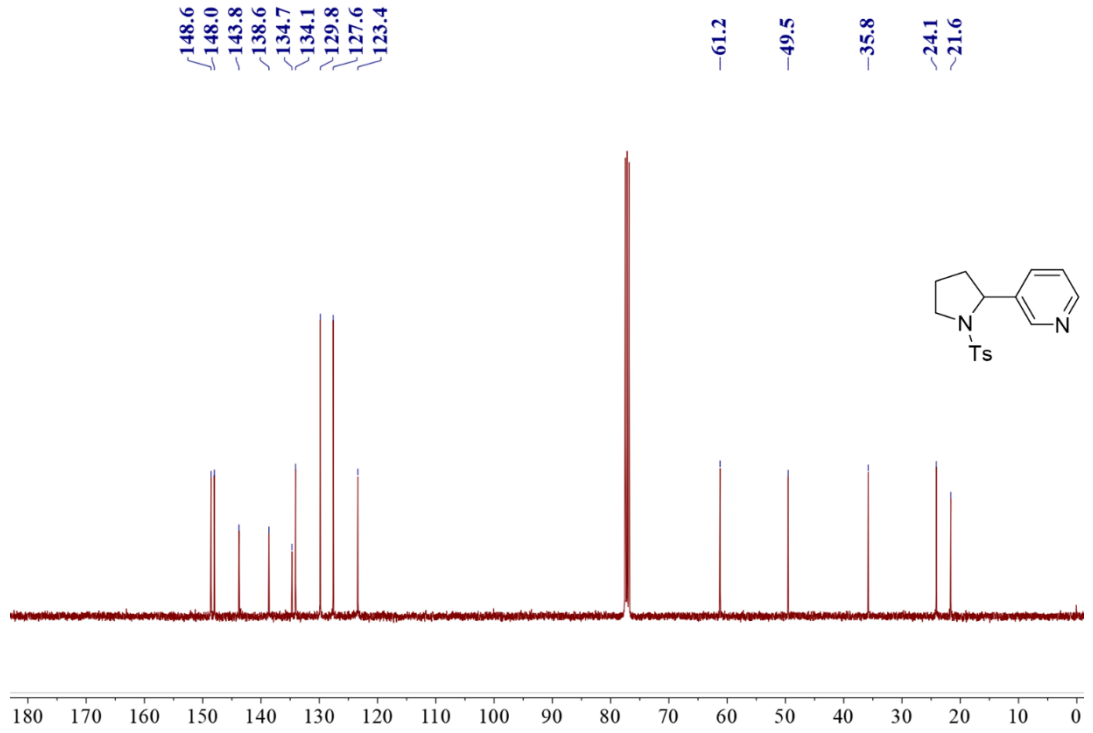


^{13}C NMR spectrum of 3ar

3-(1-tosylpyrrolidin-2-yl)pyridine (5a)

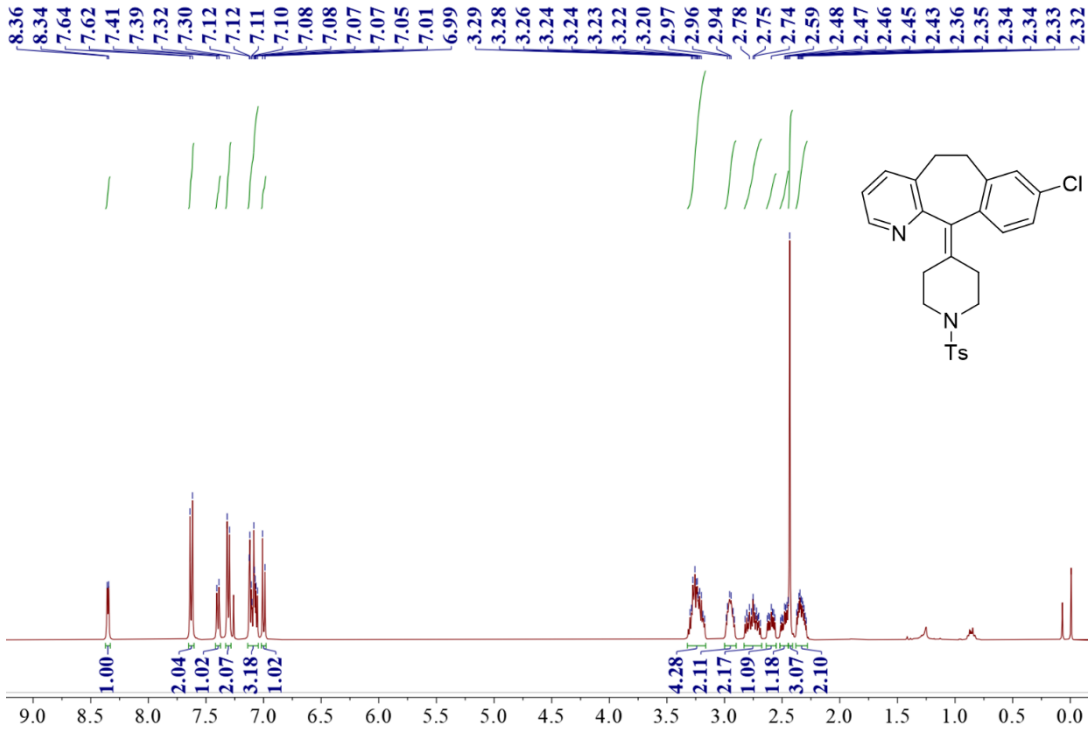


^{1}H NMR spectrum of 5a

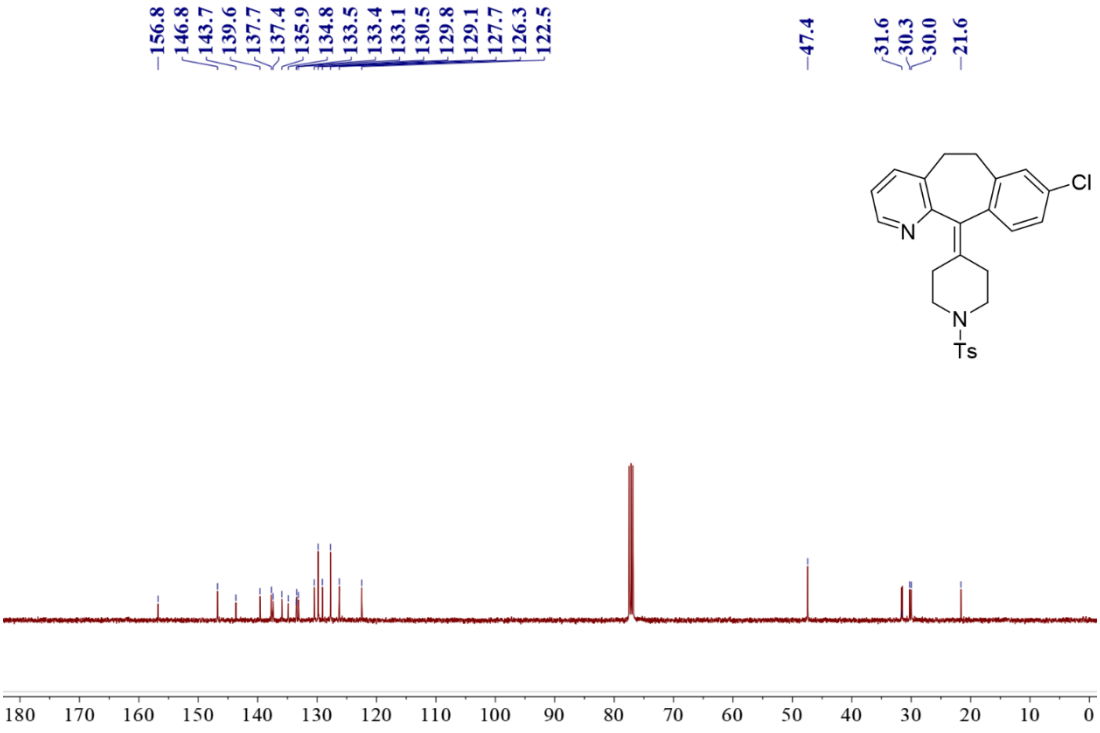


^{13}C NMR spectrum of 5a

8-chloro-11-(1-tosylpiperidin-4-ylidene)-6,11-dihydro-5H-benzo[5,6]cyclohepta[1,2-b]pyridine (5b)

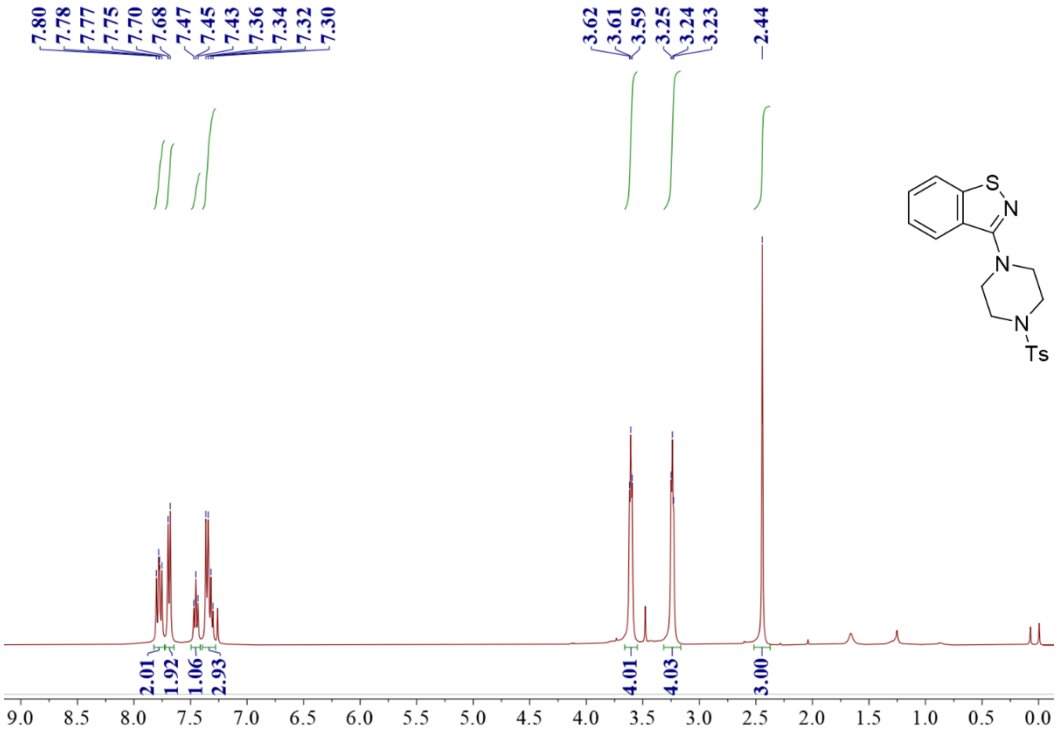


^{1}H NMR spectrum of 5b

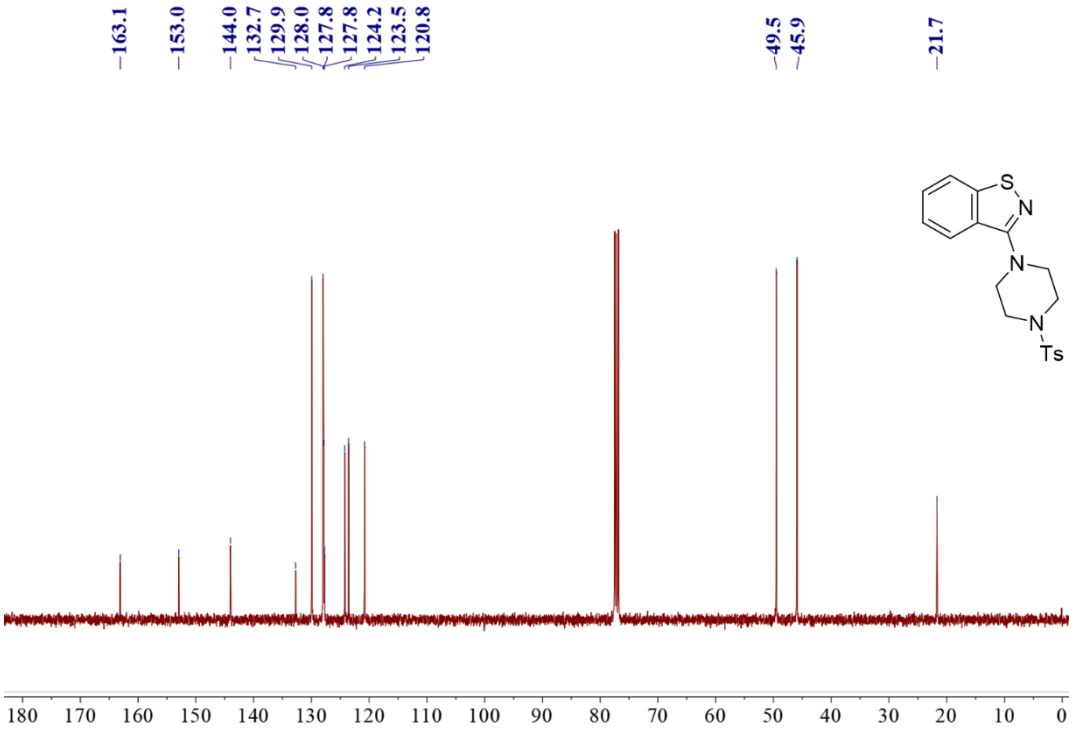


^{13}C NMR spectrum of 5b

3-(4-tosylpiperazin-1-yl)benzo[d]isothiazole (5c)

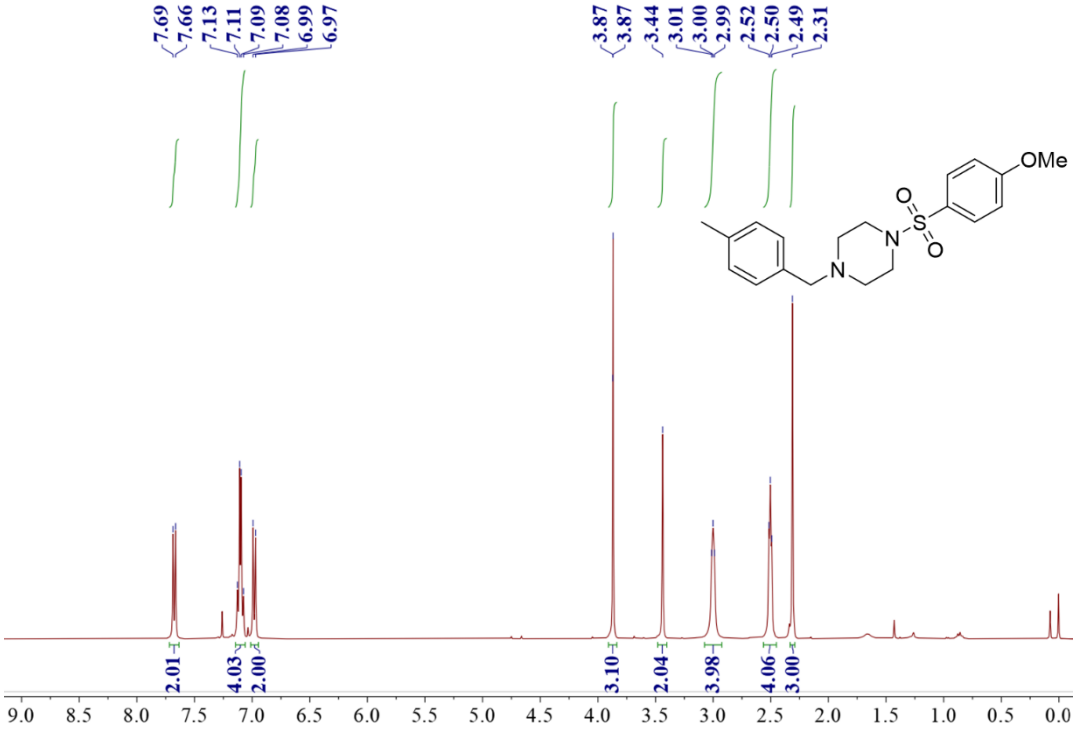


^{1}H NMR spectrum of 5c

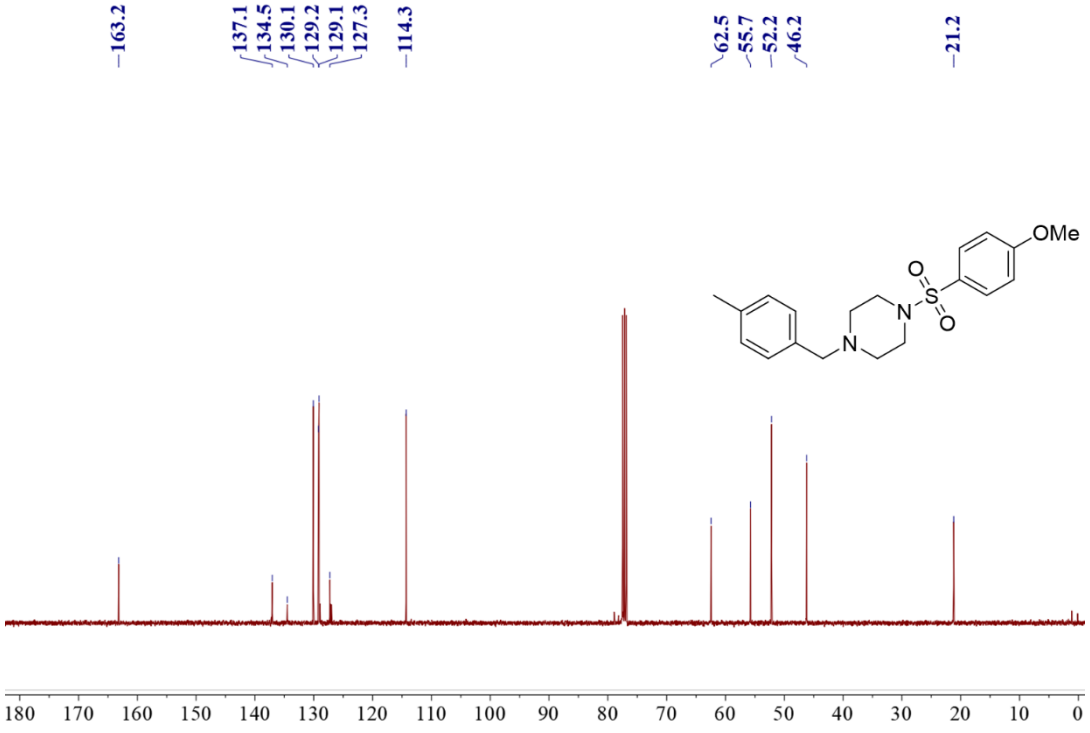


^{13}C NMR spectrum of 5c

1-((4-methoxyphenyl)sulfonyl)-4-(4-methylbenzyl)piperazine (5d)

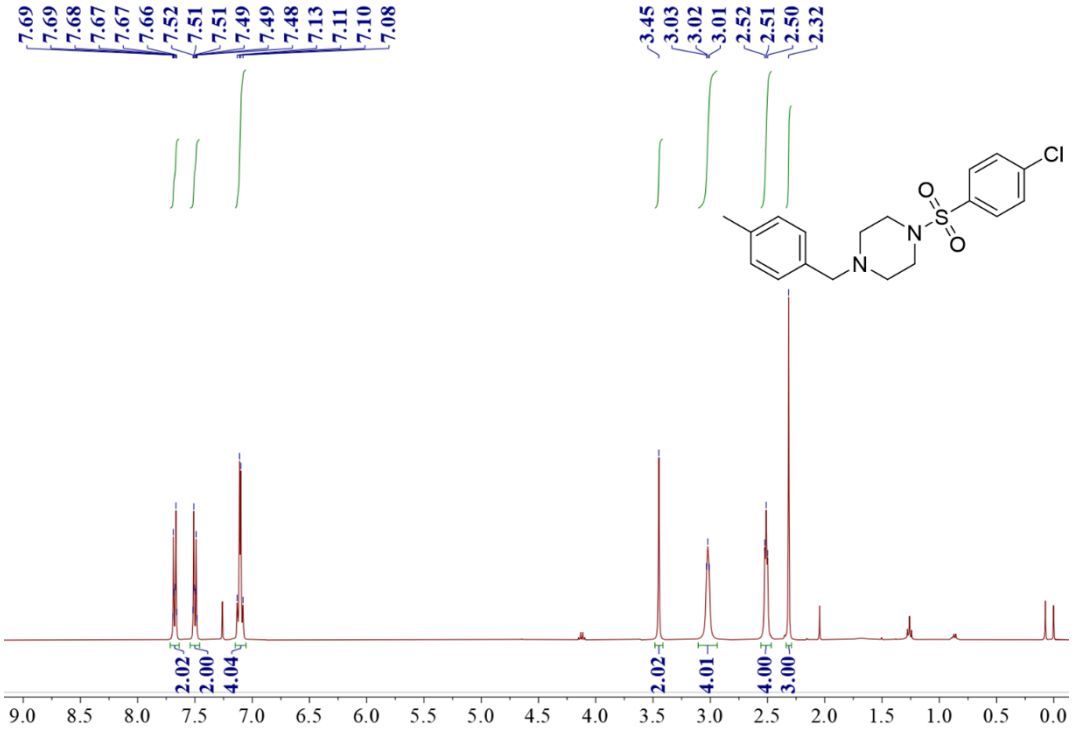


^{1}H NMR spectrum of 5d

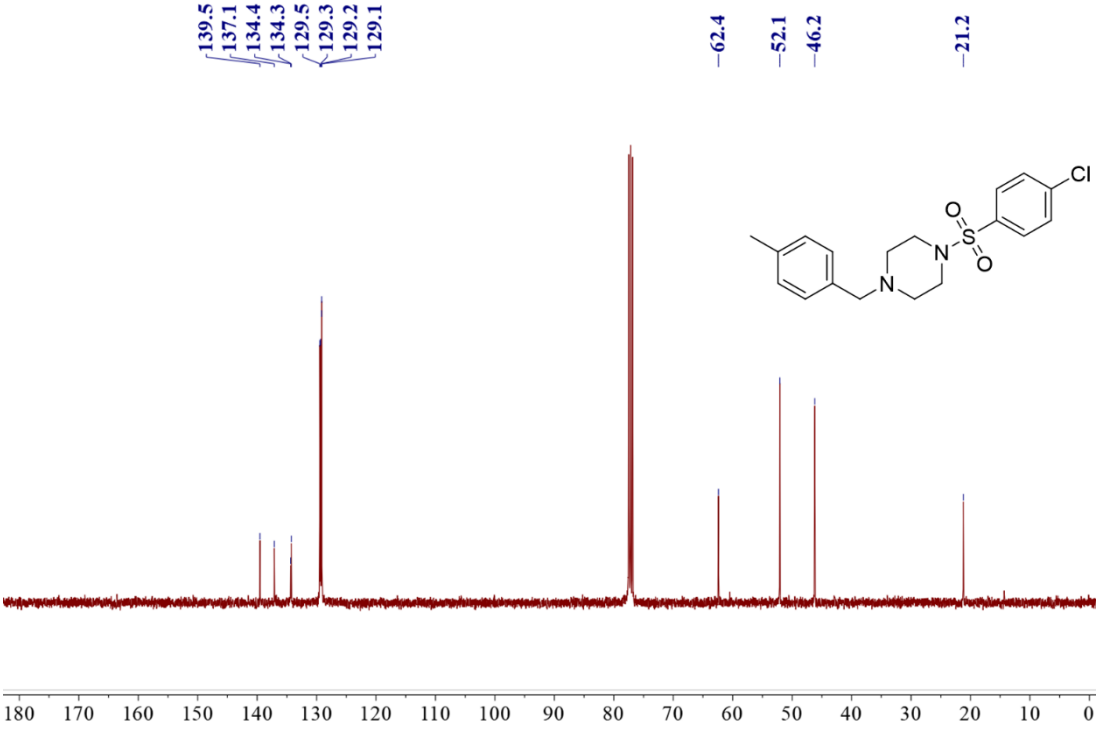


^{13}C NMR spectrum of 5d

1-((4-chlorophenyl)sulfonyl)-4-(4-methylbenzyl)piperazine (5e)



^{1}H NMR spectrum of 5e



^{13}C NMR spectrum of 5e