Supporting Information

Selective synthesis of alkyl amines and *N*-vinylazoles from vinyl sulfonium salts with *N*-nucleophiles

Lianghua Zou[#], Biao Liu[#], Cheng Wang, Zeyu Shao, Junqi Zhou, Andong Shao and Jian Wen*

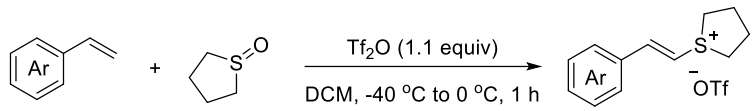
School of Life Science and Health Engineering, Jiangnan University, Wuxi, Jiangsu, 214122, People's Republic of China.

Table of contents

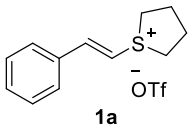
1. General Information

All solvents were dried over molecular sieves. Unless otherwise noted, materials obtained from commercial suppliers were used without further purification. The products were isolated by column chromatography on silica gel (200-300 mesh) by using petroleum ether (PE, 30-60 °C) and ethyl acetate (EA) as eluents. Silica gel for column chromatography was purchased from AnhuiLiangchen Chemical Co, Lt. All yields described herein are the isolated yields after column chromatography. Reaction progress and product mixtures were routinely monitored by TLC using TLC SiO_2 sheets, and compounds were visualized under ultraviolet light. ^{1}H, ^{13}C and ^{19}F NMR spectra were recorded on a Bruker AVANCE III 400 spectrometer. Chemical shifts are reported in ppm with the residual solvent signal as the internal standard. For ^{1}H NMR: $CDCl_3$, δ 7.26; CD_3OD, δ 3.31. For ^{13}C NMR: $CDCl_3$, δ 77.00; CD_3OD, δ 49.15. Abbreviations are as follows: s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), brs (broad singlet). High–Resolution Mass Spectra (HRMS) were recorded on Agilent 1290UPLC-QTOF-MS (6546). Melting points were measured with a melting point instrument (Shanghai Yidian Physical Optical Instrument Co., Ltd., SGW, and X-4A) and were uncorrected.

2. Synthesis of vinyl sulfonium salts



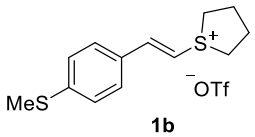
General experimental procedures for the synthesis of vinyl sulfonium salts: Under an argon atmosphere, tetramethylene sulfoxide (0.49 mL, 5.5 mmol) and anhydrous DCM (25 mL) were added to a 100 mL round bottom flask at -40 °C. The Tf_2O (0.93 mL, 5.5 mmol) was added dropwise under argon, then styrene derivative (5.0 mmol) was added gradually. The reaction mixture was stirred at -40 °C for 15 min before warming to 0 °C. Upon completion monitored by the TLC, the solvent was removed under reduced pressure. The resulted crude product was dissolved in a small amount of anhydrous DCM, which was slowly dropped into anhydrous ether (100 mL) to precipitate out the vinyl sulfonium salts solid. The solid was collected by recrystallisation (DCM/Et_2O) to afford the sulfonium salts **1.**



1a

(*E*)-1-styryltetrahydro-1*H*-thiopheN-1-ium trifluoromethanesulfonate [1]

1a was synthesized following the general procedure on 10.0 mmol scale. Sulfonium salt **1a** was obtained as a white solid in 90% yield (3.15 g). **^{1}H NMR** (400 MHz, CD_3OD) δ 7.75–7.64 (m, 3H), 7.52–7.42 (m, 3H), 7.08 (d, J = 15.2 Hz, 1H), 3.83–3.76 (m, 2H), 3.60–3.50 (m, 2H), 2.58–2.45 (m, 2H), 2.38–2.27 (m, 2H).

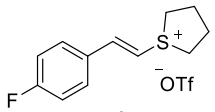


1b

(*E*)-1-(4-(methylthio)styryl)tetrahydro-1*H*-thiopheN-1-ium trifluoromethanesulfonate

1b was synthesized following the general procedure on 2.0 mmol scale. Sulfonium salt **1b** was obtained as a yellow solid in 80% yield (926.5 mg). M.p. = 94-96 °C. **^{1}H NMR** (400 MHz, CD_3OD) δ 7.62–7.57 (m, 3H), 7.31–7.28 (m, 2H), 6.99 (d, J = 15.2 Hz, 1H), 3.81–3.74 (m, 2H), 3.54–3.48 (m, 2H), 2.54–2.46 (m, 5H), 2.34–2.28 (m, 2H). **^{13}C NMR** (101 MHz, CD_3OD) δ 150.04, 145.90, 130.59, 130.18, 126.90, 121.97(d, J = 320.2 Hz), 112.75, 49.01, 29.95, 14.87. HRMS *m/z* (ESI)

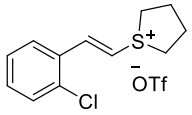
calcd for $C_{13}H_{17}S_2$ $(M–OTf)^+$ 237.0766, found 237.0766.



1c

(*E*)-1-(4-Fluorostyryl)tetrahydro-1*H*-thiopheN-1-ium trifluoromethanesulfonate[1]

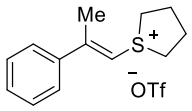
1c was synthesized following the general procedure on 2.0 mmol scale. Sulfonium salt **1c** was obtained as a white solid in 95% yield (680.5 mg). **^{1}H NMR** (400 MHz, CD_3OD) δ 7.75–7.71 (m, 2H), 7.67 (d, J = 15.2 Hz, 1H), 7.22–7.17 (m, 2H), 7.04 (d, J = 15.2 Hz, 1H), 3.83–3.76 (m, 2H), 3.57–3.51 (m, 2H), 2.56–2.47 (m, 2H), 2.36–2.27 (m, 2H).



1d

(*E*)-1-(2-Chlorostyryl)tetrahydro-1*H*-thiophen-1-ium trifluoromethanesulfonate[1]

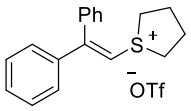
1d was synthesized following the general procedure on 2.0 mmol scale. Sulfonium salt **1d** was obtained as a white solid in 82% yield (613.4 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.02–7.81 (m, 2H), 7.43–7.27 (m, 3H), 7.19 (d, J = 15.3 Hz, 1H), 3.94–3.84 (m, 2H), 3.62–3.50 (m, 2H), 2.66–2.51 (m, 2H), 2.41–2.28 (m, 2H).



1e

(*E*)-1-(2-phenylprop-1-en-1-yl)tetrahydro-1*H*-thiophen-1-ium trifluoromethanesulfonate

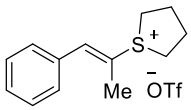
1e was synthesized following the general procedure on 2.0 mmol scale. Sulfonium salt **1e** was obtained as a white solid in 83% yield (690.5 mg). M.p. = 128-130 °C. **^{1}H NMR** (400 MHz, CD_3OD) δ 7.64–7.61 (m, 2H), 7.47–7.43 (m, 3H), 6.60 (d, J = 1.2 Hz, 1H), 3.84–3.77 (m, 2H), 3.56–3.50 (m, 2H), 2.55 (d, J = 1.2 Hz, 3H), 2.53–2.44 (m, 2H), 2.36–2.27 (m, 2H). **^{13}C NMR** (101 MHz, CD_3OD) δ 159.49, 139.84, 131.76, 130.10, 127.72, 121.96 (d, J = 320.2Hz), 113.11, 49.00, 30.08, 19.56. HRMS *m/z* (ESI) calcd for $C_{13}H_{17}S$ $(M–OTf)^+$ 205.1045, found 205.1045.



1f

1-(2,2-diphenylvinyl)tetrahydro-1*H*-thiophen-1-ium trifluoromethanesulfonate[2]

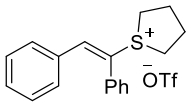
1f was synthesized following the general procedure on 2.0 mmol scale. Sulfonium salt **1f** was obtained as a white solid in 93% yield (772.0 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.52–7.47 (m, 3H), 7.44–7.32 (m, 5H), 7.24–7.20 (m, 1H), 6.92 (s, 1H), 3.75–3.68 (m, 2H), 3.63–3.56 (m, 2H), 2.61–2.54 (m, 2H), 2.32–2.24 (m, 2H).



1g

(*E*)-1-(1-phenylprop-1-en2-yl)tetrahydro-1*H*-thiophen-1-ium trifluoromethanesulfonate

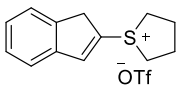
1g was synthesized following the general procedure on 2.0 mmol scale. Sulfonium salt **1g** was obtained as a white solid in 61% yield (431.9 mg). M.p. = 95-97 °C. **^{1}H NMR** (400 MHz, CD_3OD) δ 7.62–7.60 (m, 1H), 7.52–7.40 (m, 5H), 3.84–3.68 (m, 4H), 2.49–2.41 (m, 2H), 2.35 (s, 3H), 2.33–2.27 (m, 2H). **^{13}C NMR** (101 MHz, CD_3OD) δ 147.12, 134.94, 131.23, 130.84, 130.08, 125.18, 121.95 (d, J = 319.2Hz), 44.88, 30.57, 13.96. HRMS *m/z* (ESI) calcd for $C_{13}H_{17}S$ $(M–OTf)^+$ 205.1045, found 205.1045.



1h

(*E*)-1-(1, 2-diphenylvinyl)tetrahydro-1*H*-thiophen-1-ium trifluoromethanesulfonate[2]

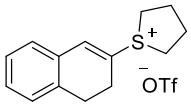
1h was synthesized following the general procedure on 1 mmol scale. Sulfonium salt **1h** was obtained as a white solid in 60% yield (249.6 mg). **^{1}H NMR** (400 MHz, CD_3OD) δ 7.77 (s, 1H), 7.69–7.62 (m, 3H), 7.51–7.48 (m, 2H), 7.35–7.31 (m, 1H), 7.22 (t, J = 7.8 Hz, 2H), 7.11 (d, J = 7.8 Hz, 2H), 3.85–3.78 (m, 2H), 3.65–3.58 (m, 2H), 2.11–2.01 (m, 2H), 1.76–1.66 (m, 2H).



1i

1-(1*H*-inden-2-yl)tetrahydro-1*H*-thiophen-1-ium trifluoromethanesulfonate (1i)

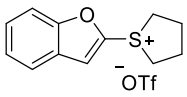
1i was synthesized following the general procedure on 2 mmol scale. Sulfonium salt **1i** was obtained as a white solid in 65% yield (423.0 mg). M.p. = 117-119 °C. **^{1}H NMR** (400 MHz, CD_3OD) δ 7.95–7.94 (s, 1H), 7.64–7.59 (m, 2H), 7.47–7.38 (m, 2H), 3.95 (s, 2H), 3.91–3.82 (m, 2H), 3.79–3.71 (m, 2H), 2.58–2.47 (m, 2H), 2.43–2.32 (m, 2H). **^{13}C NMR** (101 MHz, CD_3OD) δ 148.24, 148.16, 146.11, 142.27, 129.96, 128.75, 128.58, 125.55, 124.76, 120.35 (d, J = 320.2 Hz), 48.58, 39.38, 30.52. HRMS *m/z* (ESI) calcd for $C_{13}H_{15}S$ $(M–OTf)^+$ 203.0889, found 203.0889.



1j

1-(3,4-dihydronaphthalen-2-yl)tetrahydro-1*H*-thiophen-1-ium trifluoromethanesulfonate

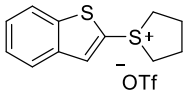
1j was synthesized following the general procedure on 2 mmol scale. Sulfonium salt **1j** was obtained as a white solid in 81% yield (591.8 mg). M.p. = 110-112 °C; **^{1}H NMR** (400 MHz, CD_3OD) δ 7.54 (s, 1H), 7.40–7.24 (m, 4H), 3.83–3.67 (m, 4H), 3.09 (t, J = 8.2 Hz, 2H), 2.75–2.69 (m, 2H), 2.51–2.39 (m, 2H), 2.37–2.25 (m, 2H). **^{13}C NMR** (101 MHz, CD_3OD) δ 143.87, 136.99, 132.53, 132.30, 130.05, 129.13, 128.51, 124.33, 121.96 (d, J = 320.2 Hz), 45.49, 30.64, 28.70, 23.74. HRMS *m/z* (ESI) calcd for $C_{14}H_{17}S$ $(M–OTf)^+$ 217.1405, found 217.1406.



1k

1-(benzofuran-2-yl)tetrahydro-1*H*-thiophen-1-ium trifluoromethanesulfonate

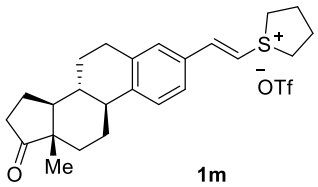
1k was synthesized following the general procedure on 2.0 mmol scale. Sulfonium salt **1k** was obtained as a white solid in 56% yield (395.5 mg). M.p. = 102-104 °C. **^{1}H NMR** (400 MHz, CD_3OD) δ 7.92 (d, J = 0.9 Hz, 1H), 7.83–7.79 (m, 1H), 7.72–7.69 (m, 1H), 7.62–7.57 (m, 1H), 7.46–7.42 (m, 1H), 4.00–3.93 (m, 4H), 2.77–2.68 (m, 2H), 2.50–2.41 (m, 2H). **^{13}C NMR** (101 MHz, CD_3OD) δ 159.27, 137.75, 130.14, 127.85, 126.21, 124.27, 121.56, 113.29, 49.94, 31.07. HRMS *m/z* (ESI) calcd for $C_{12}H_{13}OS$ $(M–OTf)^+$ 205.0682, found 205.0682.



1l

1-(benzo[b]thiophen-2-yl)tetrahydro-1*H*-thiophen-1-ium trifluoromethanesulfonate

1l was synthesized following the general procedure on 2.0 mmol scale. Sulfonium salt **1l** was obtained as a white solid in 55% yield (406.1 mg). M.p. = 101-102 °C; **^{1}H NMR** (400 MHz, CD_3OD) δ 8.67 (s, 1H), 8.13–8.09 (m, 2H), 7.68–7.57 (m, 2H), 4.09–4.00 (m, 2H), 3.94–3.85 (m, 2H), 2.64–2.54 (m, 2H), 2.52–2.42 (m, 2H). **^{13}C NMR** (101 MHz, CD_3OD) δ 141.53, 137.08, 135.50, 127.90, 127.58, 124.93, 122.25, 121.94 (d, J = 319.2 Hz), 116.94, 49.36, 30.01. HRMS *m/z* (ESI) calcd for $C_{12}H_{13}S_2$ $(M–OTf)^+$ 221.0453, found 221.0453.



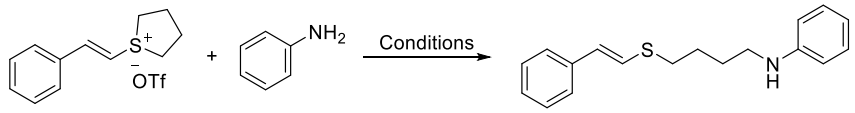
1m

1-((E)-2-((8*R*,9*S*,13*S*,14*S*)-13-methyl-17-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6*H*-cyclopenta[*a*]phenanthren-3-yl)vinyl)tetrahydro-1*H*-thiophen-1-ium trifluoromethanesulfonate

1m was synthesized following the general procedure on 3 mmol scale. Sulfonium salt **1m** was obtained as a white solid in 45% yield (687.0 mg). M.p. = 211-214 °C. **^{1}H NMR** (400 MHz, CD_3OD) δ 7.61 (d, J = 15.2 Hz, 1H), 7.44–7.39 (m, 3H), 7.01 (d, J = 15.2 Hz, 1H), 3.81–3.76 (m, 2H), 3.55–3.50 (m, 2H), 2.96–2.93 (m, 2H), 2.53–2.47 (m, 4H), 2.35–2.28 (m, 3H), 2.18–2.13 (m, 1H), 2.11–2.05 (m, 2H), 1.93–1.89 (m, 1H), 1.70–1.45 (m, 6H), 0.92 (s, 3H). **^{13}C NMR** (101 MHz, CD_3OD) δ 223.51, 150.71, 145.66, 139.09, 131.88, 130.38, 127.43, 127.17, 113.12, 51.81, 48.98, 46.06, 39.42, 36.82, 32.89, 30.36, 29.98, 27.49, 26.81, 22.62, 14.37. **HRMS *m/z*** (ESI) calcd for $C_{24}H_{31}OS$ $(M–OTf)^+$ 367.2090, found 367.2091.

3. Experimental Optimization

Table S1: Optimization of the Reaction Conditions for the Synthesis of 3aa

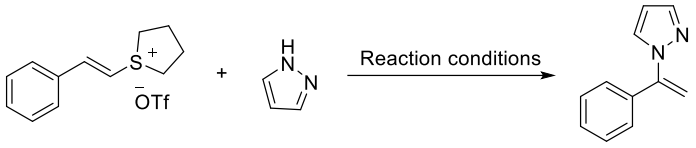


1a **2a** **3aa**

Entry	2a (equiv)	Base (equiv)	Solvent	T (°C)	Yield of 3aa[b]
1	1.5	t-BuOK (2.0)	THF	rt	20%
2	1.5	t-BuONa (2.0)	THF	rt	18%
3	1.5	t-BuOLi (2.0)	THF	rt	30%
4	1.5	K_3PO_4 (2.0)	THF	rt	25%
5	1.5	KOH (2.0)	THF	rt	28%
6	1.5	Cs_2CO_3 (2.0)	THF	rt	30%
7	1.5	$NaCO_3$ (2.0)	THF	rt	35%
8	1.5	NaOH (2.0)	THF	rt	35%
9	1.5	NaH (2.0)	THF	rt	32%
10	1.5	Na_3PO_4 (2.0)	THF	rt	38%
11	1.5	Et_3N (2.0)	THF	rt	40%
12	1.5	-	THF	rt	32%
13	2.0	-	THF	rt	35%
14	3	-	THF	rt	46%
15	4.0	-	THF	rt	48%
16	3	-	THF	40	50%
17	3	-	THF	60	72%
18	3	-	THF	80	89%
19	3	-	THF	100	86%
20[c]	2.0	-	THF	80	88%

[a] Reaction conditions: **1** (0.3 mmol), amines **2a** (3.0 equiv), THF (2.0 mL), 80 ^{0}C, 6 h, under an air atmosphere; [b] Isolated yield after chromatography; [c] Under an argon atmosphere.

Table S2: Optimization of the Reaction Conditions for the Synthesis of 4aa'

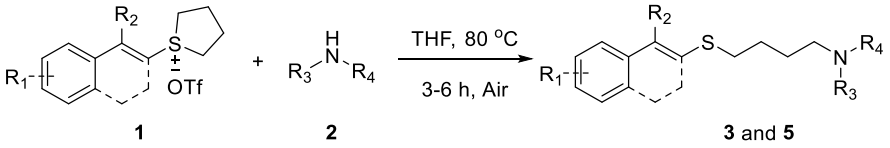


1a **2a'** **4aa'**

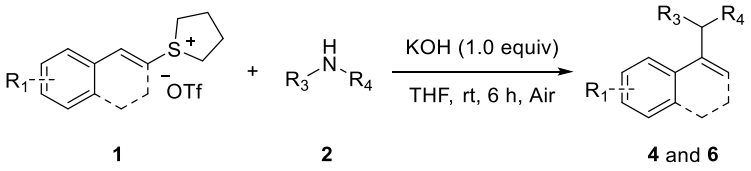
Entry	2a' (equiv)	Base (equiv)	Solvent	T (°C)	Yield of 4aa'[b]
1	3.0	-	THF	80	15%
2	3.0	-	THF	rt	18%
3	1.5	-	THF	rt	14%
4	1.5	t-BuOK (1.0)	THF	rt	78%
5	1.5	Cs_2CO_3 (1.0)	THF	rt	82%
6	1.5	KOH (1.0)	THF	rt	86%
7	1.5	K_3PO_4 (1.0)	THF	rt	60%
8	1.5	NaH (1.0)	THF	rt	80%
9	1.5	Et_3N (1.0)	THF	rt	20%
10	1.5	DBU (1.0)	THF	rt	66%
11	1.5	KOH (2.0)	THF	rt	86%
12	1.5	KOH (3.0)	THF	rt	86%

[a] Reaction conditions: **1a** (0.3 mmol), amines **2a'** (1.5 equiv), KOH (1.0 equiv), THF (2.0 mL), rt, 6 h, under an air atmosphere; [b] Isolated yield after chromatography.

4. General procedures for the products

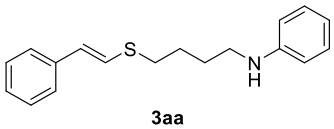


General procedure A for the synthesis of alkylamines: A 10.0 mL schlenk tube with a stirring bar was added vinyl sulfonium salts **1** (0.3 mmol, 1.0 equiv), **2** (0.9 mmol, 3.0 equiv) and THF (2.0 mL). The reaction mixture was stirred at 80 °C for 3-6 h. After complete consumption of the vinyl sulfonium salts (monitored by the TLC), the resulting solution was concentrated under reduced pressure and purified by column chromatography on silica gel to afford desired product (**3 and 5**).



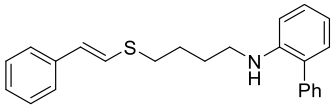
General procedure B for the synthesis of *N*-vinylazoles: A 10.0 mL schlenk tube with a stirring bar was added vinyl sulfonium salts **1a** (102 mg, 0.3 mmol, 1.0 equiv), **2** (0.45 mmol, 1.5 equiv), KOH (16.8 mg, 0.3 mmol, 1.0 equiv) or KOH (50.4 mg, 0.3 mmol, 3.0 equiv) and THF (2.0 mL). The reaction mixture was stirred at room temperature for 3-6 h. After complete consumption of the vinyl sulfonium salts (monitored by the TLC), the resulting solution was concentrated under reduced pressure and purified by column chromatography on silica gel to afford desired product (**4 and 6**).

5. Characterization data of products



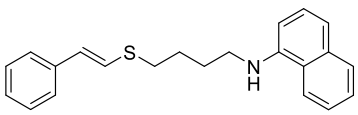
3aa

(*E*)-*N*-(4-(styrylthio)butyl)aniline (3aa). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3aa** was obtained as a colorless oil in 89% yield (75.5 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.33–7.29 (m, 4H), 7.22–7.16 (m, 3H), 6.72 (d, J = 15.6 Hz, 1H), 6.71 (t, J = 7.3 Hz, 1H), 6.61 (d, J = 7.8 Hz, 2H), 6.49 (d, J = 15.6 Hz, 1H), 3.60 (brs, 1H), 3.17 (t, J = 6.6 Hz, 2H), 2.86 (t, J = 6.8 Hz, 2H), 1.87–1.74 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 148.21, 136.99, 129.24, 128.62, 127.29, 126.88, 125.49, 124.82, 117.31, 112.73, 43.44, 32.39, 28.57, 27.01. **HRMS *m/z*** (ESI) calcd for $C_{18}H_{21}NS$ $(M+H)^+$ 284.1764, found 284.1764.



3ab

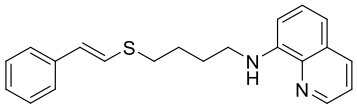
(*E*)-*N*-(4-(styrylthio)butyl)-[1,1'-biphenyl]-2-amine (3ab). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3ab** was obtained as a white solid in 88% yield (94.8 mg). M.p. = 39-40 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.42–7.37 (m, 4H), 7.33–7.18 (m, 7H), 7.08 (d, J = 7.2 Hz, 1H), 6.76 (t, J = 7.4 Hz, 1H), 6.70–6.65 (m, 2H), 6.44 (d, J = 15.5 Hz, 1H), 3.89 (brs, 1H), 3.12 (t, J = 6.4 Hz, 2H), 2.78 (t, J = 6.6 Hz, 2H), 1.74–1.64 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.92, 139.36, 136.93, 130.19, 129.26, 128.85, 128.67, 128.59, 127.52, 127.15, 127.11, 126.84, 125.44, 124.74, 116.79, 110.23, 43.38, 32.26, 28.34, 26.97. **HRMS *m/z*** (ESI) calcd for $C_{24}H_{25}NS$ $(M+H)^+$ 360.1780, found 360.1782.



3ac

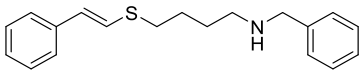
(*E*)-*N*-(4-(styrylthio)butyl)naphthalen-1-amine (3ac). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3ac** was obtained as a colorless

oil in 85% yield (84.9 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.79–7.76 (m, 2H), 7.43 (t, J = 7.0 Hz, 1H), 7.41–7.36 (m, 1H), 7.34 (t, J = 7.8 Hz, 1H), 7.30–7.27 (m, 4H), 7.23 (d, J = 8.3 Hz, 1H), 7.21–7.17 (m, 1H), 6.72 (d, J = 15.6 Hz, 1H), 6.60 (d, J = 7.5 Hz, 1H), 6.50 (d, J = 15.6 Hz, 1H), 4.32 (brs, 1H), 3.32 (t, J = 6.4 Hz, 2H), 2.89 (t, J = 6.7 Hz, 2H), 1.96–1.89 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 143.31, 136.97, 134.28, 128.65, 128.62, 127.40, 126.89, 126.58, 125.68, 125.50, 124.74, 124.68, 123.35, 119.74, 117.34, 104.29, 43.67, 32.42, 28.32, 27.13. **HRMS *m/z*** (ESI) calcd for $C_{22}H_{23}NS$ $(M+H)^+$ 334.1624, found 334.1626.



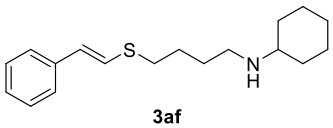
3ad

(*E*)-*N*-(4-(styrylthio)butyl)quinolin-8-amine (3ad). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3ad** was obtained as a yellow solid in 95% yield (95.2 mg). M.p. = 40-42 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.68 (d, J = 3.6 Hz, 1H), 8.03 (d, J = 8.1 Hz, 1H), 7.39–7.32 (m, 2H), 7.29–7.23 (m, 4H), 7.21–7.15 (m, 1H), 7.03 (d, J = 8.2 Hz, 1H), 6.73–6.65 (m, 2H), 6.47 (d, J = 15.6 Hz, 1H), 6.15 (brs, 1H), 3.37–3.33 (m, 2H), 2.86 (t, J = 6.6 Hz, 2H), 1.94–1.87 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.76, 144.70, 138.13, 137.01, 135.94, 128.63, 128.57, 127.75, 127.15, 126.79, 125.46, 124.89, 121.33, 113.69, 104.46, 42.84, 32.39, 28.29, 27.12. **HRMS *m/z*** (ESI) calcd for $C_{21}H_{22}N_2S$ $(M+H)^+$ 335.1576, found 335.1581.



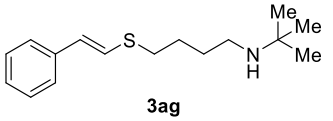
3ae

(*E*)-*N*-benzyl-4-(styrylthio)butan-1-amine (3ae). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3ae** was obtained as a colorless oil in 66% yield (58.9 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.34–7.15 (m, 10H), 6.70 (d, J = 15.6 Hz, 1H), 6.46 (d, J = 15.6 Hz, 1H), 3.78 (s, 2H), 2.80 (t, J = 7.1 Hz, 2H), 2.66 (t, J = 6.9 Hz, 2H), 1.78–1.71 (m, 2H), 1.68–1.61 (m, 2H), 1.41 (brs, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 140.34, 137.04, 128.57, 128.35, 128.06, 126.90, 126.88, 126.76, 125.42, 125.06, 53.96, 48.76, 32.48, 29.13, 27.21. **HRMS *m/z*** (ESI) calcd for $C_{19}H_{23}NS$ $(M+H)^+$ 298.1624, found 298.1625.



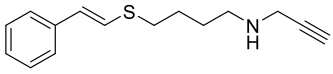
3af

(*E*)-*N*-(4-(styrylthio)butyl)cyclohexanamine (3af). Prepared following the general procedure A, after purification by column chromatography using PE/EA (5:1), **3af** was obtained as a colorless oil in 64% yield (55.5 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.27 (m, 4H), 7.21–7.16 (m, 1H), 6.71 (d, J = 15.6 Hz, 1H), 6.47 (d, J = 15.6 Hz, 1H), 2.81 (t, J = 7.3 Hz, 2H), 2.66 (t, J = 7.3 Hz, 2H), 2.45–2.39 (m, 1H), 1.90–1.85 (m, 2H), 1.76–1.71 (m, 4H), 1.66–1.60 (m, 3H), 1.26–1.21 (m, 2H), 1.18–1.14 (m, 1H), 1.09–1.02 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.06, 128.58, 126.91, 126.77, 125.43, 125.10, 56.84, 46.41, 33.62, 32.53, 29.64, 27.39, 26.14, 25.06. **HRMS *m/z*** (ESI) calcd for $C_{18}H_{27}NS$ $(M+H)^+$ 290.1937, found 290.1937.



3ag

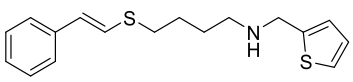
(*E*)-*N*-(tert-butyl)-4-(styrylthio)butan-1-amine (3ag). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3ag** was obtained as a colorless oil in 74% yield (58.4 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.30–7.27 (m, 4H), 7.21–7.16 (m, 1H), 6.71 (d, J = 15.6 Hz, 1H), 6.47 (d, J = 15.6 Hz, 1H), 2.81 (t, J = 7.3 Hz, 2H), 2.58 (t, J = 7.2 Hz, 2H), 1.78–1.71 (m, 2H), 1.64–1.56 (m, 2H), 1.10 (s, 9H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.08, 128.59, 126.91, 126.78, 125.44, 125.15, 50.29, 42.07, 32.56, 30.27, 29.01, 27.55. **HRMS *m/z*** (ESI) calcd for $C_{16}H_{25}NS$ $(M+H)^+$ 264.1780, found 264.1780.



3ah

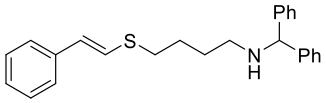
(*E*)-*N*-(prop-2-yn-1-yl)-4-(styrylthio)butan-1-amine (3ah). Prepared following the general procedure A under argon atmosphere, after purification by column chromatography using PE/EA (10:1), **3ah** was obtained as a colorless oil in 71% yield (52.2 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.26 (m, 4H), 7.21–7.17 (m, 1H), 6.71 (d, J = 15.6 Hz, 1H), 6.47 (d, J = 15.6 Hz, 1H), 3.43 (s, 2H), 2.82 (t, J = 7.1 Hz, 2H), 2.73 (t, J = 6.9 Hz, 2H), 2.22 (s, 1H), 1.80–1.72 (m, 2H), 1.68–1.60 (m, 2H), 1.37 (brs, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.00, 128.57, 126.91, 126.78, 125.41, 124.98, 82.10, 71.31, 47.98, 38.07, 32.39, 28.82, 27.13. **HRMS *m/z*** (ESI) calcd for $C_{15}H_{19}NS$

$(M+H)^+$ 246.1311, found 246.1312.



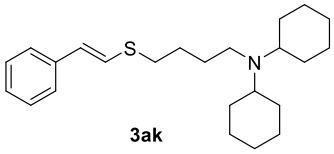
3ai

(*E*)-4-(styrylthio)-*N*-(thiophen-2-ylmethyl)butan-1-amine (3ai). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3ai** was obtained as a colorless oil in 77% yield (70.0 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.27 (m, 4H), 7.21–7.18 (m, 2H), 6.96–6.91 (m, 2H), 6.71 (d, J = 15.5 Hz, 1H), 6.47 (d, J = 15.6 Hz, 1H), 3.99 (s, 2H), 2.82 (t, J = 7.1 Hz, 2H), 2.70 (t, J = 6.9 Hz, 2H), 1.80–1.72 (m, 2H), 1.69–1.62 (m, 2H), 1.49 (brs, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.20, 137.07, 128.59, 126.99, 126.79, 126.58, 125.46, 125.07, 124.77, 124.28, 48.48, 48.37, 32.49, 29.04, 27.19. **HRMS *m/z*** (ESI) calcd for $C_{17}H_{21}NS_2$ $(M+H)^+$ 304.1188, found 304.1190.



3aj

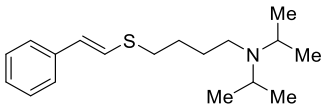
(*E*)-*N*-benzhydryl-4-(styrylthio)butan-1-amine (3aj). Prepared following the general procedure A**,** after purification by column chromatography using PE/EA (10:1), **3aj** was obtained as a colorless oil in 95% yield (106.3 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.41 (d, J = 7.5 Hz, 4H), 7.34–7.27 (m, 8H), 7.22 (t, J = 7.3 Hz, 3H), 6.73 (d, J = 15.5 Hz, 1H), 6.48 (d, J = 15.5 Hz, 1H), 4.83 (s, 1H), 2.81 (t, J = 7.2 Hz, 2H), 2.63 (t, J = 6.9 Hz, 2H), 1.82–1.75 (m, 2H), 1.71–1.64 (m, 2H), 1.53 (brs, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.17, 137.07, 128.58, 128.43, 127.21, 126.94, 126.77, 125.44, 125.12, 67.54, 47.56, 32.50, 29.27, 27.19. **HRMS *m/z*** (ESI) calcd for $C_{25}H_{27}NS$ $(M+H)^+$ 374.1937, found 374.1937.



3ak

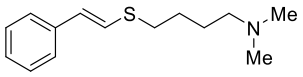
(*E*)-*N*-cyclohexyl-*N*-(4-(styrylthio)butyl)cyclohexanamine(3ak). Prepared following the general procedure A**,** after purification by column chromatography using PE/EA (10:1), **3ak** was obtained as a colorless oil in 70% yield (77.9 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.27 (m, 4H), 7.20–

7.16 (m, 1H), 6.73 (d, *J* = 15.6 Hz, 1H), 6.46 (d, *J* = 15.6 Hz, 1H), 2.81 (t, *J* = 7.4 Hz, 2H), 2.52 (t, *J* = 7.4 Hz, 4H), 1.78–1.64 (m, 10H), 1.61–1.48 (m, 4H), 1.26–1.18 (m, 8H), 1.10–1.02 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.14, 128.56, 126.68, 126.60, 125.39, 125.38, 57.87, 45.65, 32.67, 31.68, 30.44, 27.25, 26.43, 26.28. **HRMS *m/z*** (ESI) calcd for $C_{24}H_{37}NS$ $(M+H)^+$ 372.2719, found 372.2719.



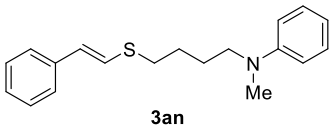
3al

(*E*)-*N*,*N*-diisopropyl-4-(styrylthio)butan-1-amine (3al). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3al** was obtained as a colorless oil in 79% yield (70.0 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.27(m, 4H), 7.21–7.16 (m, 1H), 6.73 (d, *J* = 15.6 Hz, 1H), 6.46 (d, *J* = 15.6 Hz, 1H), 3.04–2.97 (m, 2H), 2.82 (t, *J* = 7.4 Hz, 2H), 2.42 (t, *J* = 7.5 Hz, 2H), 1.73–1.65 (m, 2H), 1.57–1.49 (m, 2H), 1.00 (d, *J* = 6.5 Hz, 12H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.13, 128.58, 126.70, 126.64, 125.40, 125.31, 48.25, 44.60, 32.62, 30.29, 27.28, 20.65. **HRMS *m/z*** (ESI) calcd for $C_{18}H_{29}NS$ $(M+H)^+$ 292.2093, found 292.2095.



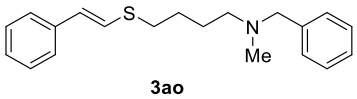
3am

(*E*)-*N*,*N*-dimethyl-4-(styrylthio)butan-1-amine (3am). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3am** was obtained s a colorless oil in 46% yield (32.5 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.25 (m, 4H), 7.20–7.17 (m, 1H), 6.72 (d, *J* = 15.5 Hz, 1H), 6.47 (d, *J* = 15.5 Hz, 1H), 2.82 (t, *J* = 7.0 Hz, 2H), 2.29 (t, *J* = 7.2 Hz, 2H), 2.22 (s, 6H), 1.76–1.69 (m, 2H), 1.65–1.58 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.06, 128.58, 126.82, 126.75, 125.41, 125.07, 59.13, 45.42, 32.47, 27.24, 26.75. **HRMS *m/z*** (ESI) calcd for $C_{14}H_{21}NS$ $(M+H)^+$ 236.1467, found 236.1468



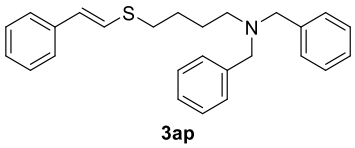
3an

(*E*)-*N*-methyl-*N*-(4-(styrylthio)butyl)aniline (3an). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3an** was obtained as a colorless oil in 58% yield (51.6 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.29–7.18 (m, 7H), 6.69 (d, J = 8.2 Hz, 4H), 6.47 (d, J = 15.6 Hz, 1H), 3.36–3.29 (m, 2H), 2.91 (s, 3H), 2.83–2.77 (m, 2H), 1.75–1.68 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 149.14, 136.95, 129.14, 128.58, 127.07, 126.82, 125.44, 124.89, 116.06, 112.14, 52.22, 38.30, 32.47, 27.04, 25.92. **HRMS *m/z*** (ESI) calcd for $C_{19}H_{23}NS$ $(M+H)^+$ 298.1624, found 298.1624.



3ao

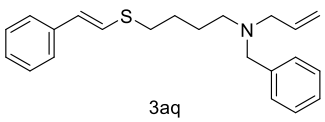
(*E*)-*N*-benzyl-*N*-methyl-4-(styrylthio)butan-1-amine (3ao). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3ao** was obtained as a colorless oil in 91% yield (83.0 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.32–7.16 (m, 10H), 6.71 (d, J = 15.2 Hz, 1H), 6.46 (d, J = 15.0 Hz, 1H), 3.47 (s, 2H), 2.79 (t, J = 6.3 Hz, 2H), 2.39 (t, J = 6.3 Hz, 2H), 2.19 (s, 3H), 1.77–1.61 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.14, 137.09, 128.97, 128.58, 128.16, 126.87, 126.77, 126.73, 125.42, 125.16, 62.30, 56.61, 42.18, 32.44, 27.12, 26.39. **HRMS *m/z*** (ESI) calcd for $C_{20}H_{25}NS$ $(M+H)^+$ 312.1780, found 312.1780.



3ap

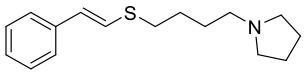
(*E*)-*N*,*N*-dibenzyl-4-(styrylthio)butan-1-amine (3ap). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3ap** was obtained as a colorless oil in 89% yield (103.4 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.35 (d, J = 7.1 Hz, 4H), 7.30–7.27 (m, 8H), 7.22–7.16 (m, 3H), 6.67 (d, J = 15.6 Hz, 1H), 6.41 (d, J = 15.6 Hz, 1H), 3.53 (s, 4H), 2.65 (t, J = 6.9 Hz, 2H), 2.43 (t, J = 6.5 Hz, 2H), 1.73–1.60 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.75, 137.09, 128.76, 128.57, 128.14, 126.78, 126.71, 126.68, 125.40, 125.17, 58.28, 52.33,

32.20, 26.74, 25.94. **HRMS *m/z*** (ESI) calcd for $C_{26}H_{29}NS$ $(M+H)^+$ 388.2093, found 388.2095.



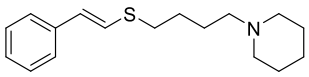
3aq

(*E*)-*N*-allyl-*N*-benzyl-4-(styrylthio)butan-1-amine (3aq). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3aq** was obtained as a colorless oil in 82% yield (83.0 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.33–7.17 (m, 10H), 6.70 (d, J = 15.4 Hz, 1H), 6.44 (d, J = 15.7 Hz, 1H), 5.92–5.82 (m, 1H), 5.20–5.11 (m, 2H), 3.55 (s, 2H), 3.06 (d, J = 6.3 Hz, 2H), 2.75 (t, J = 7.1 Hz, 2H), 2.45 (t, J = 6.9 Hz, 2H), 1.74–1.58 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.65, 137.12, 135.99, 128.83, 128.58, 128.14, 126.77, 126.74, 125.43, 125.20, 117.22, 58.11, 56.77, 52.51, 32.41, 27.03, 26.06. **HRMS *m/z*** (ESI) calcd for $C_{22}H_{27}NS$ $(M+H)^+$ 338.1937, found 338.1938.



3ar

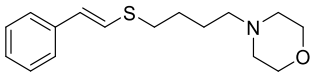
(*E*)-1-(4-(styrylthio)butyl)pyrrolidine (3ar). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3ar** was obtained as a colorless oil in 71% yield (55.6 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.32–7.25 (m, 4H), 7.20–7.16 (m, 1H), 6.72 (d, J = 15.6 Hz, 1H), 6.46 (d, J = 15.6 Hz, 1H), 2.82 (t, J = 7.1 Hz, 2H), 2.51–2.44 (m, 6H), 1.79–1.64 (m, 8H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.06, 128.57, 126.76, 126.73, 125.40, 125.09, 55.93, 54.17, 32.48, 28.16, 27.50, 23.35. **HRMS *m/z*** (ESI) calcd for $C_{16}H_{23}NS$ $(M+H)^+$ 262.1624, found 262.1624.



3as

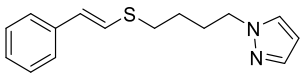
(*E*)-1-(4-(styrylthio)butyl)piperidine (3as). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3as** was obtained as a colorless oil in 93% yield (76.8 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.27 (m, 4H), 7.21–7.16 (m, 1H), 6.71 (d, J = 15.6 Hz, 1H), 6.46 (d, J = 15.6 Hz, 1H), 2.82 (t, J = 7.0 Hz, 2H), 2.37–2.30 (m, 6H), 1.74–1.62 (m, 4H), 1.61–1.55 (m, 4H), 1.45–1.40 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.08, 128.56,

126.79, 126.73, 125.41, 125.13, 58.83, 54.58, 32.52, 27.57, 26.08, 25.96, 24.44. **HRMS *m/z*** (ESI) calcd for $C_{17}H_{25}NS$ $(M+H)^+$ 276.1780, found 276.1780.



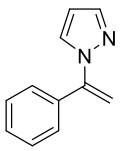
3at

(*E*)-4-(4-(styrylthio)butyl)morpholine (3at). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **3at** was obtained as a colorless oil in 88% yield (73.1 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.27 (m, 4H), 7.22–7.16 (m, 1H), 6.71 (d, J = 15.6 Hz, 1H), 6.47 (d, J = 15.5 Hz, 1H), 3.71 (t, J = 4.4 Hz, 4H), 2.83 (t, J = 7.1 Hz, 2H), 2.46–2.41 (m, 4H), 2.36 (t, J = 7.3 Hz, 2H), 1.77–1.70 (m, 2H), 1.68–1.60 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.06, 128.61, 127.03, 126.83, 125.44, 125.01, 66.98, 58.38, 53.72, 32.51, 27.27, 25.57. **HRMS *m/z*** (ESI) calcd for $C_{16}H_{23}NOS$ $(M+H)^+$ 278.1573, found 278.1573.



3aa'

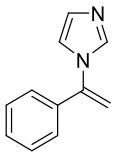
(*E*)-1-(4-(styrylthio)butyl)-1*H*-pyrazole (3aa'). Prepared following the general procedure A, after purification by column chromatography using PE/EA (5:1), **3aa'** was obtained as a colorless oil in 55% yield (42.6 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.50 (s, 1H), 7.37 (s, 1H), 7.31–7.25 (m, 4H), 7.19 (s, 1H), 6.66 (d, J = 15.9 Hz, 1H), 6.45 (d, J = 16.2 Hz, 1H), 6.23 (s, 1H), 4.16 (t, J = 6.4 Hz, 2H), 2.78 (t, J = 6.4 Hz, 2H), 2.06–1.98 (m, 2H), 1.72–1.64 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.21, 136.92, 128.86, 128.58, 127.32, 126.87, 125.45, 124.61, 105.35, 51.45, 32.00, 29.36, 26.39. **HRMS *m/z*** (ESI) calcd for $C_{15}H_{18}N_2S$ $(M+H)^+$ 259.1263, found 259.1264.



4aa'

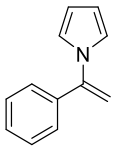
1-(1-phenylvinyl)-1*H*-pyrazole.[3] **(4aa').** Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **4aa'** was obtained as a colorless oil in 86% yield (43.9 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.72–7.66 (m, 1H), 7.51–7.49 (m, 1H), 7.43–7.37 (m, 5H), 6.36 (t, J = 2.1 Hz, 1H), 5.60 (s, 1H), 5.20 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ

145.80, 140.87, 135.86, 129.64, 129.24, 128.45, 128.02, 106.48, 104.97.



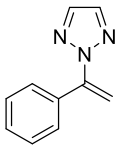
4ab'

1-(1-phenylvinyl)-1*H*-imidazole [3] **(4ab').** Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **4aa'** was obtained as a colorless oil in 80% yield (40.8 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.64 (s, 1H), 7.43–7.35 (m, 3H), 7.34–7.31 (m, 2H), 7.13 (s, 1H), 7.02 (s, 1H), 5.32 (s, 1H), 5.29 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 143.19, 137.12, 135.59, 129.66, 129.60, 128.69, 127.20, 119.25, 106.36.



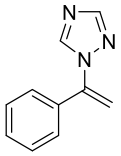
4ac'

1-(1-phenylvinyl)-1*H*-pyrrole [3] **(4ac').** Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **4ac'** was obtained as a colorless oil in 79% yield (39.6 mg) when KOH (3.0 equiv) was used in reaction. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.38 (s, 5H), 6.83–6.80 (m, 2H), 6.27–6.25 (m, 2H), 5.18 (s, 1H), 5.09 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.36, 136.97, 129.09, 128.34, 127.86, 121.07, 109.32, 103.24.



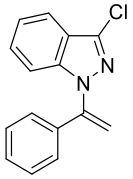
4ad'

2-(1-phenylvinyl)-2*H*-1,2,3-triazole (4ad'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **4ac'** was obtained as a colorless oil in 46% yield (23.5 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.78 (s, 2H), 7.41 (s, 5H), 5.91 (s, 1H), 5.40 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.05, 135.31, 134.75, 129.31, 128.30, 128.16, 107.51. **HRMS *m/z*** (ESI) calcd for $C_{10}H_9N_3$ $(M+H)^+$ 172.0869, found 172.0869.



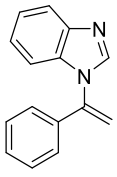
4ae'

1-(1-phenylvinyl)-1*H*-1,2,4-triazole[3] (4ae'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **4ae'** was obtained as a colorless oil in 83% yield (42.5 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.15 (s, 1H), 8.06 (s, 1H), 7.46–7.30 (m, 5H), 5.69 (s, 1H), 5.36 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 152.33, 143.19, 142.73, 134.31, 129.85, 128.80, 127.62, 107.62.



4af'

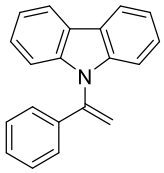
3-chloro-1-(1-phenylvinyl)-1*H*-indazole (4af'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **4ae'** was obtained as a white solid in 91% yield (69.3 mg). M.p. = 41-42 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.71 (d, J = 8.1 Hz, 1H), 7.43–7.27 (m, 6H), 7.26–7.19 (m, 1H), 7.00 (d, J = 8.5 Hz, 1H), 5.57 (s, 1H), 5.56 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.73, 141.01, 135.83, 135.72, 129.39, 128.63, 127.84, 127.23, 122.15, 121.99, 119.79, 111.84, 108.74. **HRMS *m/z*** (ESI) calcd for $C_{15}H_{11}ClN_2$ $(M+H)^+$ 255.0684, found 255.0684.



4ag'

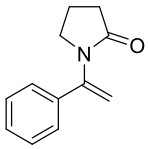
1-(1-phenylvinyl)-1*H*-benzo[*d*]imidazole[3] (**4ag'**). Prepared following the general procedure B, after purification by column chromatography using PE/EA (3:1), **4ag'** was obtained as a colorless oil in 78% yield (51.5 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.03 (s, 1H), 7.85 (d, J = 8.1 Hz, 1H), 7.43–7.35 (m, 3H), 7.34–7.25 (m, 3H), 7.20 (t, J = 7.7 Hz, 1H), 7.07 (d, J = 8.2 Hz, 1H), 5.69 (s, 1H), 5.47 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 143.89, 143.04, 142.15, 135.26, 133.75, 129.74,

128.84, 126.71, 123.38, 122.62, 120.44, 111.71, 109.43.



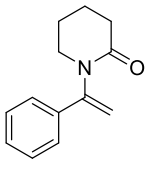
4ah'

9-(1-phenylvinyl)-9*H*-carbazole[3] (**4ah'**). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **4ah'** was obtained as a colorless oil in 76% yield (61.3 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.19 (d, J = 7.7 Hz, 2H), 7.44–7.29 (m, 11H), 6.12 (s, 1H), 5.64 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 142.67, 140.78, 136.32, 129.03, 128.70, 126.20, 125.81, 123.38, 120.15, 119.77, 112.87, 110.84.



4ai'

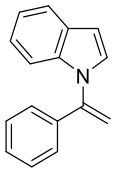
1-(1-phenylvinyl) pyrrolidin-2-one (4ai'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (2:1), **4ai'** was obtained as a colorless oil in 85% yield (47.7 mg) when KOH (3.0 equiv) was used in reaction. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.33 (s, 5H), 5.39 (s, 1H), 5.28 (s, 1H), 3.53 (t, J = 7.1 Hz, 2H), 2.55 (t, J = 8.1 Hz, 2H), 2.14–2.06 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 174.62, 143.42, 136.07, 128.44, 128.37, 126.27, 109.34, 49.47, 31.86, 18.49. **HRMS *m/z*** (ESI) calcd for $C_{12}H_{13}NO$ $(M+H)^+$ 188.1070, found 188.1070.



4aj'

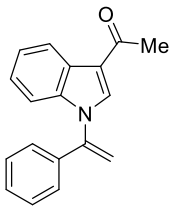
1-(1-phenylvinyl)piperidin-2-one[3] **(4aj')**. Prepared following the general procedure B, after purification by column chromatography using PE/EA (2:1), **4aj'** was obtained as a colorless oil in 60% yield (36.1 mg) when KOH (3.0 equiv) was used in reaction. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.43–7.23 (m, 5H), 5.71 (s, 1H), 5.25 (s, 1H), 3.48 (t, J = 5.4 Hz, 2H), 2.55 (t, J = 6.0 Hz, 2H), 1.99–1.86 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 169.79, 147.85, 135.44, 128.54, 128.41, 125.30,

111.88, 50.57, 32.60, 23.31, 21.40.



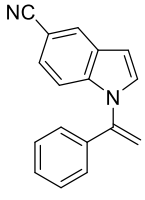
4ak'

1-(1-phenylvinyl)-1*H*-indole[3] **(4ak').** Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **4ak'** was obtained as a white solid in 86% yield (56.5 mg) when KOH (3.0 equiv) was used in reaction. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.73–7.65 (m, 1H), 7.46–7.31 (m, 5H), 7.21 (d, J = 3.3 Hz, 1H), 7.18–7.10 (m, 3H), 6.66 (d, J = 3.4 Hz, 1H), 5.62 (s, 1H), 5.41 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.92, 136.99, 136.37, 129.24, 129.13, 128.68, 128.56, 126.92, 121.95, 120.90, 120.15, 111.86, 108.10, 103.05.



4al'

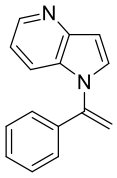
1-(1-phenylvinyl)-1*H*-indole-5-carbonitrile (4al'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (3:1), **4al'** was obtained as a white solid in 86% yield (67.3 mg). M.p. = 123-124 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.45 (d, J = 7.9 Hz, 1H), 7.84 (s, 1H), 7.43–7.35 (m, 3H), 7.33–7.28 (m, 3H), 7.19 (t, J = 7.6 Hz, 1H), 7.12 (d, J = 8.3 Hz, 1H), 5.79 (s, 1H), 5.50 (s, 1H), 2.55 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.33, 144.13, 137.24, 135.69, 135.12, 129.64, 128.84, 126.51, 126.38, 123.65, 122.89, 122.57, 118.23, 111.90, 110.67, 27.66. **HRMS *m/z*** (ESI) calcd for $C_{18}H_{15}NO$ $(M+H)^+$ 262.1226, found 262.1227.



4am'

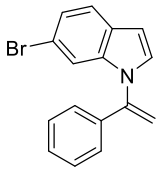
1-(1-phenylvinyl)-1*H*-indole-5-carbonitrile (4am'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **4am'** was obtained as a colorless

oil in 85% yield (62.2 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.99 (s, 1H), 7.43–7.28 (m, 5H), 7.24 (d, J = 7.6 Hz, 2H), 7.14 (d, J = 8.6 Hz, 1H), 6.69 (d, J = 3.4 Hz, 1H), 5.71 (s, 1H), 5.41 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.19, 137.84, 136.01, 130.94, 129.57, 128.84, 128.79, 126.59, 126.42, 124.92, 120.49, 112.54, 109.77, 103.70, 103.30. **HRMS *m/z*** (ESI) calcd for $C_{17}H_{12}N_2$ $(M+H)^+$ 245.1073, found 245.1073.



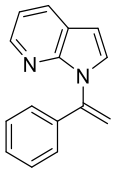
4an'

1-(1-phenylvinyl)-1*H*-pyrrolo[3,2-*b*]pyridine (4an'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (2:1), **4an'** was obtained as a colorless oil in 80% yield (52.8 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.46 (d, J = 4.0 Hz, 1H), 7.44 (d, J = 2.7 Hz, 1H), 7.42–7.32 (m, 4H), 7.30–7.26 (m, 2H), 7.02–6.98 (m, 1H), 6.83 (s, 1H), 5.58 (s, 1H), 5.35 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 147.50, 144.49, 143.75, 136.26, 131.67, 129.47, 129.37, 128.69, 126.92, 118.97, 116.75, 108.15, 104.11. **HRMS *m/z*** (ESI) calcd for $C_{15}H_{12}N_2$ $(M+H)^+$ 221.1073, found 221.1073.



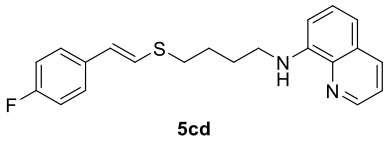
4ao'

6-bromo-1-(1-phenylvinyl)-1*H*-indole (4ao'). Prepared following the general procedure B. after purification by column chromatography using PE/EA (5:1), **4ao'** was obtained as a white solid in 86% yield (76.6 mg). M.p. = 58-59 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.50 (d, J = 8.4 Hz, 1H), 7.40–7.31 (m, 4H), 7.28–7.20 (m, 3H), 7.11 (d, J = 3.3 Hz, 1H), 6.57 (s, 1H), 5.64 (s, 1H), 5.37 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.37, 136.48, 129.38, 129.22, 128.68, 127.92, 126.74, 123.50, 122.10, 115.65, 114.59, 108.94, 103.12. **HRMS *m/z*** (ESI) calcd for $C_{12}H_{12}BrN$ $(M+H)^+$ 298.0226, found 298.0227.



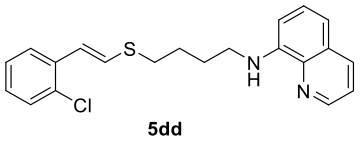
4ap'

1-(1-phenylvinyl)-1*H*-pyrrolo[2,3-*b*]pyridine[3] (4ap'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **4ap'** was obtained as a colorless oil in 91% yield (60.0 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.34 (d, J = 3.7 Hz, 1H), 7.96 (d, J = 7.8 Hz, 1H), 7.40-7.27 (m, 5H), 7.18 (d, J = 3.2 Hz, 1H), 7.11 (m, 1H), 6.54 (d, J = 3.2 Hz, 1H), 5.77 (d, J = 12.8 Hz, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 148.28, 143.50, 142.78, 137.26, 128.93, 128.92, 128.84, 128.43, 126.72, 121.27, 116.49, 110.08, 100.71.



5cd

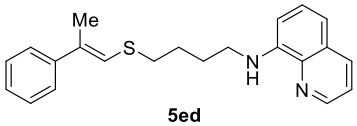
(*E*)-*N*-(4-((4-fluorostyryl)thio)butyl)quinolin-8-amine (5cd). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **5cd** was obtained as a yellow oil in 95% yield (100.3 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.67 (s, 1H), 8.03 (d, J = 8.1 Hz, 1H), 7.39–7.32 (m, 2H), 7.23–7.17 (m, 2H), 7.03 (d, J = 8.0 Hz, 1H), 6.95 (t, J = 8.0 Hz, 2H), 6.66–6.59 (m, 2H), 6.42 (d, J = 15.6 Hz, 1H), 6.14 (brs, 1H), 3.38–3.31 (m, 2H), 2.90–2.81 (m, 2H), 1.95–1.86 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 161.76 (d, J = 246.2 Hz), 146.74, 144.67, 138.09, 135.94, 133.22 (d, J = 3.1 Hz), 128.61, 127.73, 126.87 (d, J = 7.8 Hz), 126.03, 124.56 (d, J = 2.3 Hz), 121.33, 115.42 (d, J = 21.7 Hz), 113.69, 104.44, 42.78, 32.38, 28.23, 27.09. **^{19}F NMR** (376 MHz, $CDCl_3$) δ –115.40. **HRMS *m/z*** (ESI) calcd for $C_{21}H_{21}FN_2S$ $(M+H)^+$ 353.1482, found 353.1483.



5dd

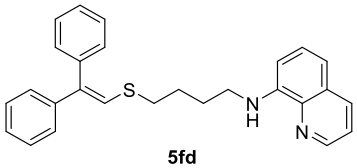
(*E*)–*N*–(4–((2–chlorostyryl)thio)butyl)quinolin–8–amine (5dd). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **5dd** was obtained

as a yellow oil in 96% yield (106.0 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.71 (s, 1H), 8.05 (d, J = 8.1 Hz, 1H), 7.44–7.34 (m, 4H), 7.19 (t, J = 7.3 Hz, 1H), 7.12 (t, J = 7.3 Hz, 1H), 7.06 (d, J = 8.1 Hz, 1H), 6.85–6.75 (m, 2H), 6.68 (d, J = 7.5 Hz, 1H), 6.18 (brs, 1H), 3.41–3.35 (m, 2H), 2.96–2.89 (m, 2H), 1.99–1.89 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.72, 144.63, 138.06, 135.92, 134.98, 131.83, 129.64, 128.58, 128.07, 127.72, 127.62, 126.77, 125.86, 122.05, 121.31, 113.67, 104.44, 42.80, 32.06, 28.31, 26.85. **HRMS *m/z*** (ESI) calcd for $C_{21}H_{21}ClN_2S$ $(M+H)^+$ 369.1187, found 369.1187.



5ed

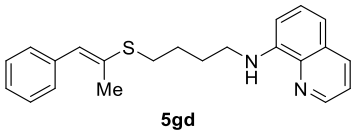
(*E*)-*N*-(4-((2-phenylprop-1-en-1-yl)thio)butyl)quinolin-8-amine (5ed). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **5ed** was obtained as a yellow oil in 96% yield (100.2 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.66 (s, 1H), 8.02 (d, J = 8.0 Hz, 1H), 7.38–7.26 (m, 6H), 7.21–7.18 (m, 1H), 7.02 (d, J = 8.0 Hz, 1H), 6.64 (d, J = 7.8 Hz, 1H), 6.29 (s, 1H), 6.14 (brs, 1H), 3.36-3.30 (m, 2H), 2.85–2.81 (m, 2H), 2.12 (s, 3H), 1.92–1.84 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.73, 144.69, 141.96, 138.09, 135.92, 133.68, 128.60, 128.25, 127.73, 126.56, 125.06, 123.42, 121.31, 113.63, 104.43, 42.85, 33.94, 28.09, 17.59. **HRMS *m/z*** (ESI) calcd for $C_{22}H_{24}N_2S$ $(M+H)^+$ 349.1733, found 349.1736.



5fd

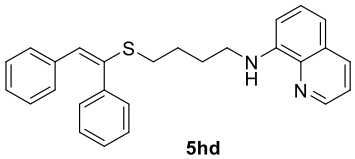
***N*-(4-((2,2-diphenylvinyl)thio)butyl)quinolin-8-amine (5fd).** Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **5fd** was obtained as a yellow oil in 98% yield (120.5 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.66 (s, 1H), 8.01 (d, J = 8.2 Hz, 1H), 7.39–7.29 (m, 7H), 7.26–7.17 (m, 5H), 7.01 (d, J = 8.1 Hz, 1H), 6.63 (d, J = 7.3 Hz, 1H), 6.57 (s, 1H), 6.13 (brs, 1H), 3.36–3.29 (m, 2H), 2.84–2.78 (m, 2H), 1.91–1.83 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.73, 144.67, 141.84, 139.51, 138.69, 138.09, 135.91, 129.66, 128.59, 128.24, 128.17, 127.73, 127.42, 126.96, 126.77, 125.85, 121.31, 113.64, 104.43, 42.80, 34.57, 28.08,

27.93. **HRMS *m/z*** (ESI) calcd for $C_{27}H_{26}N_2S$ $(M+H)^+$ 411.1889, found 411.1889.



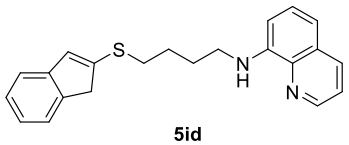
5gd

(*E*)-*N*-(4-((1-phenylprop-1-en-2-yl)thio)butyl)quinolin-8-amine (5gd). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **5gd** was obtained as a yellow oil in 75% yield (78.3 mg). **^{1}H NMR** (400 MHz, CDCl3) δ 8.68 (s, 1H), 8.03 (d, *J* = 8.0 Hz, 1H), 7.39–7.28 (m, 4H), 7.24–7.16 (m, 3H), 7.03 (d, *J* = 8.0 Hz, 1H), 6.66 (d, *J* = 7.4 Hz, 1H), 6.35 (s, 1H), 6.15 (brs, 1H), 3.38–3.31 (m, 2H), 2.88 (t, *J* = 6.9 Hz, 2H), 2.12 (s, 3H), 1.96–1.84 (m, 4H). **^{13}C NMR** (101 MHz, CDCl3) δ 146.74, 144.67, 138.08, 137.47, 135.94, 134.10, 128.60, 128.51, 128.14, 127.74, 126.05, 123.52, 121.33, 113.65, 104.44, 42.84, 31.09, 28.46, 26.25, 19.59. **HRMS *m/z*** (ESI) calcd for $C_{22}H_{24}N_2S$ $(M+H)^+$ 349.1733, found 349.1736.



5hd

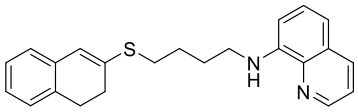
(*E*)-*N*-(4-((1,2-diphenylvinyl)thio)butyl)quinolin-8-amine (5hd). Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **5hd** was obtained as a yellow oil in 90% yield (110.7 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) *δ* 8.69 (s, 1H), 8.05 (d, *J* = 7.9 Hz, 1H), 7.41–7.29 (m, 7H), 7.11–7.04 (m, 4H), 6.97–6.92 (m, 2H), 6.81 (s, 1H), 6.64 (d, *J* = 7.5 Hz, 1H), 6.13 (brs, 1H), 3.31–3.26 (m, 2H), 2.59 (t, *J* = 6.8 Hz, 2H), 1.89–1.74 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) *δ* 146.71, 144.66, 138.06, 137.85, 137.83, 136.65, 135.92, 129.57, 128.87, 128.60, 127.98, 127.90, 127.72, 127.32, 126.43, 121.31, 113.58, 104.42, 42.75, 31.43, 28.13, 26.88. **HRMS *m/z*** (ESI) calcd for $C_{27}H_{26}N_2S$ $(M+H)^+$ 411.1889, found 411.1889.



5id

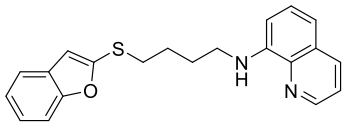
***N*-(4-((1*H*-inden-2-yl)thio)butyl)quinolin-8-amine (5id).** Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **5id** was obtained

as a yellow solid in 82% yield (85.1 mg). M.p. = 79-81 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.67 (s, 1H), 8.02 (d, J = 8.0 Hz, 1H), 7.39–7.29 (m, 3H), 7.22–7.15 (m, 2H), 7.07–7.02 (m, 2H), 6.65 (d, J = 7.6 Hz, 1H), 6.48 (s, 1H), 6.15 (brs, 1H), 3.45 (s, 2H), 3.38–3.32 (m, 2H), 3.00–2.95 (m, 2H), 1.96–1.89 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.74, 145.01, 144.66, 143.52, 142.12, 138.10, 135.93, 128.60, 127.73, 126.48, 124.62, 123.38, 123.05, 121.32, 118.99, 113.69, 104.45, 42.79, 42.05, 32.28, 28.43, 26.53. **HRMS *m/z*** (ESI) calcd for $C_{22}H_{22}N_2S$ $(M+H)^+$ 347.1576, found 347.1576.



5jd

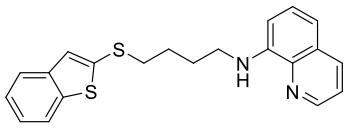
N*-(4-((3,4-dihydronaphthalen-2-yl)thio)butyl)quinolin-8-amine (5jd).** Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **5jd** was obtained as a yellow oil in 94% yield (101.5 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.72 (s, 1H), 8.06 (d, J = 8.0 Hz, 1H), 7.43–7.35 (m, 2H), 7.17–7.06 (m, 4H), 6.96 (d, J = 7.1 Hz, 1H), 6.70 (d, J = 7.5 Hz, 1H), 6.25 (s, 1H), 6.19 (brs, 1H), 3.41–3.35 (m, 2H), 2.94 (t, J = 6.8 Hz, 2H), 2.86 (t, J = 8.0 Hz, 2H), 2.43 (t, J = 8.0 Hz, 2H), 1.99–1.88 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.72, 144.64, 138.06, 136.89, 135.92, 134.42, 133.52, 128.58, 127.72, 127.16, 126.54, 125.92, 124.78, 121.31, 119.47, 113.66, 104.44, 42.78, 30.56, 29.05, 28.43, 28.31, 26.13. **HRMS *m/z (ESI) calcd for $C_{23}H_{24}N_2S$ $(M+H)^+$ 361.1733, found 361.1736.



5kd

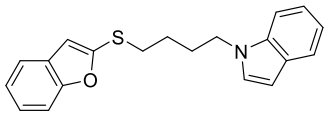
***N*-(4-(benzofuran-2-ylthio)butyl)quinolin-8-amine (5kd).** Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **5kd** was obtained as a yellow solid in 94% yield (98.1 mg). M.p. = 64-66 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.67 (s, 1H), 8.02 (d, J = 8.2 Hz, 1H), 7.46–7.40 (m, 2H), 7.37–7.31 (m, 2H), 7.26–7.16 (m, 2H), 7.02 (d, J = 8.2 Hz, 1H), 6.77 (s, 1H), 6.62 (d, J = 7.6 Hz, 1H), 6.12 (brs, 1H), 3.34–3.28 (m, 2H), 2.99 (t, J = 6.9 Hz, 2H), 1.94–1.80 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 156.26, 150.29, 146.71, 144.66, 138.10, 135.92, 128.60, 128.56, 127.73, 124.27, 122.80, 121.31, 120.31, 113.65, 111.07, 110.88,

104.44, 42.77, 34.38, 27.95, 27.38. **HRMS *m/z*** (ESI) calcd for $C_{21}H_{20}N_2OS$ $(M+H)^+$ 349.1369, found 349.1370.



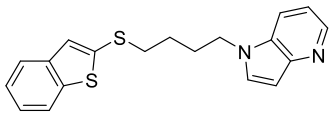
5ld

N*-(4-(benzo[*b*]thiophen-2-ylthio)butyl)quinolin-8-amine (5ld).** Prepared following the general procedure A, after purification by column chromatography using PE/EA (10:1), **5ld** was obtained as a yellow oil in 97% yield (105.9 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.72 (s, 1H), 8.06 (d, J = 8.2 Hz, 1H), 7.96 (d, J = 7.9 Hz, 1H), 7.87 (d, J = 7.9 Hz, 1H), 7.46–7.35 (m, 5H), 7.05 (d, J = 8.2 Hz, 1H), 6.65 (d, J = 7.7 Hz, 1H), 6.15 (brs, 1H), 3.36–3.29 (m, 2H), 2.95 (t, J = 7.1 Hz, 2H), 1.97–1.90 (m, 2H), 1.85–1.78 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.73, 144.67, 139.83, 139.09, 138.11, 135.93, 128.62, 127.74, 126.95, 126.78, 124.73, 124.40, 122.85, 122.54, 121.32, 113.64, 104.44, 42.80, 34.52, 28.06, 27.08. **HRMS *m/z (ESI) calcd for $C_{21}H_{20}N_2S_2$ $(M+H)^+$ 365.1141, found 365.1143.



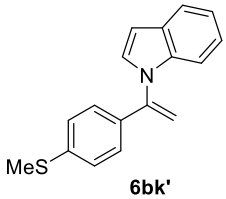
5kp'

1-(4-(benzofuran-2-ylthio)butyl)-1*H*-indole (5kp'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (10:1), **5kp'** was obtained as a colorless oil in 74% yield (71.3 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.62 (d, J = 7.9 Hz, 1H), 7.47 (d, J = 7.6 Hz, 1H), 7.41 (d, J = 8.2 Hz, 1H), 7.32–7.17 (m, 4H), 7.09 (t, J = 7.5 Hz, 1H), 7.02 (s, 1H), 6.67 (s, 1H), 6.44 (s, 1H), 4.11 (t, J = 7.0 Hz, 2H), 2.89 (t, J = 7.2 Hz, 2H), 2.01–1.94 (m, 2H), 1.68–1.60 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 156.25, 135.76, 128.55, 128.48, 127.67, 124.41, 122.87, 121.39, 120.97, 120.42, 119.24, 111.46, 110.90, 109.25, 101.08, 45.77, 34.10, 28.77, 26.98. **HRMS *m/z*** (ESI) calcd for $C_{20}H_{19}NOS$ $(M+H)^+$ 322.1260, found 322.1260.



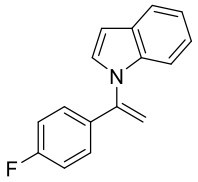
5lp'

1-(4-(benzo[*b*]thiophen-2-ylthio)butyl)-1*H*-pyrrolo[3,2-*b*]pyridine (5lp'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (10:1), **5lp'** was obtained as a colorless oil in 85% yield (86.2 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.30 (s, 1H), 7.90 (d, J = 7.8 Hz, 2H), 7.85 (d, J = 7.7 Hz, 1H), 7.44–7.36 (m, 2H), 7.29 (s, 1H), 7.14 (s, 1H), 7.06–7.03 (m, 1H), 6.43 (s, 1H), 4.29 (t, J = 7.2 Hz, 2H), 2.86 (t, J = 7.3 Hz, 2H), 2.05–1.98 (m, 2H), 1.65–1.57 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 147.34, 142.69, 139.80, 139.04, 128.72, 127.73, 127.27, 126.46, 124.74, 124.40, 122.87, 122.50, 120.49, 115.58, 99.44, 43.91, 34.21, 29.22, 26.64. **HRMS *m/z*** (ESI) calcd for $C_{19}H_{18}N_2S_2$ $(M+H)^+$ 339.0984, found 339.0985.



6bk'

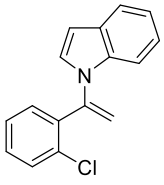
1-(1-(4-(methylthio)phenyl)vinyl)-1*H*-indole (6bk'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **6bk'** was obtained as a white solid in 88% yield (70.0 mg) when KOH (3.0 equiv) was used in reaction. M.p. = 89-90 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.64 (d, J = 7.1 Hz, 1H), 7.22–7.18 (m, 5H), 7.16–7.07 (m, 3H), 6.63–6.59 (m, 1H), 5.53 (s, 1H), 5.31 (s, 1H), 2.47 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.42, 140.04, 136.30, 133.51, 129.22, 128.64, 127.24, 125.98, 121.96, 120.90, 120.17, 111.88, 107.47, 103.06, 15.33. **HRMS *m/z*** (ESI) calcd for $C_{17}H_{15}NS$ $(M+H)^+$ 266.0998, found 266.0999.



6ck'

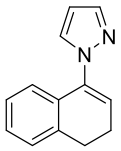
1-(1-(4-fluorophenyl)vinyl)-1*H*-indole[4] (6ck'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **6ck'** was obtained as a white solid in 96% yield (68.3 mg) when KOH (3.0 equiv) was used in reaction. **^{1}H NMR** (400 MHz, $CDCl_3$) δ

7.69 (d, J = 6.3 Hz, 1H), 7.34-7.29 (m, 2H), 7.20-7.14 (m, 4H), 7.06 (t, J = 8.5 Hz, 2H), 6.66 (d, J = 2.8 Hz, 1H), 5.55 (s, 1H), 5.38 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 163.25 (d, J = 249.0 Hz), 143.98, 136.25, 133.11 (d, J = 3.3 Hz), 129.30, 128.76 (d, J = 8.3 Hz), 128.56, 122.06, 120.99, 120.28, 115.59 (d, J = 21.8 Hz), 111.81, 107.83, 103.27. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -112.00.



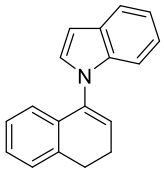
6dk'

1-(1-(2-chlorophenyl)vinyl)-1*H*-indole (6dk'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **6dk'** was obtained as a white solid in 95% yield (72.1 mg) when KOH (3.0 equiv) was used in reaction. M.p. = 55-57 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.62–7.59 (m, 1H), 7.46–7.43 (m, 1H), 7.39–7.28 (m, 3H), 7.23–7.20 (m, 1H), 7.12–7.09 (m, 2H), 7.05–7.02 (m, 1H), 6.57 (d, J = 2.5 Hz, 1H), 5.58 (s, 1H), 5.33 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 142.72, 136.37, 135.77, 133.48, 131.40, 130.28, 130.18, 129.59, 127.63, 126.94, 122.23, 121.00, 120.36, 111.56, 108.84, 103.63. **HRMS *m/z*** (ESI) calcd for $C_{16}H_{12}ClN$ $(M+H)^+$ 254.0731, found 254.0731.



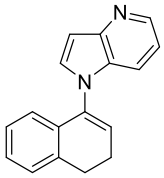
6ja'

1-(3,4-dihydronaphthalen-1-yl)-1*H*-pyrazole (6ja'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **6ja'** was obtained as a colorless oil in 79% yield (46.5 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.71 (s, 1H), 7.62 (s, 1H), 7.22–7.12 (m, 3H), 6.86 (d, J = 7.6 Hz, 1H), 6.41 (s, 1H), 6.20 (t, J = 4.8 Hz, 1H), 2.90 (t, J = 8.0 Hz, 2H), 2.52–2.47 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 140.23, 138.27, 136.31, 131.25, 130.15, 128.06, 127.57, 126.55, 123.19, 122.89, 105.85, 27.43, 22.44. **HRMS *m/z*** (ESI) calcd for $C_{13}H_{12}N_2$ $(M+H)^+$ 197.1073, found 197.1073.



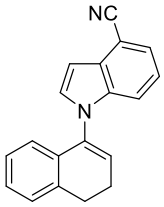
6jk'

1-(3,4-dihydronaphthalen-1-yl)-1*H*-indole[4] (6jk'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **6jk'** was obtained as a colorless oil in 56% yield (41.1 mg) when KOH (3.0 equiv) was used in reaction. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.70–7.65 (m, 1H), 7.23–7.16 (m, 4H), 7.14–7.09 (m, 2H), 7.02 (t, J = 7.6 Hz, 1H), 6.66–6.61 (m, 1H), 6.54 (d, J = 7.7 Hz, 1H), 6.19 (t, J = 4.9 Hz, 1H), 2.96 (t, J = 7.9 Hz, 2H), 2.61–2.50 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 136.70, 136.35, 136.23, 132.11, 128.64, 128.50, 128.01, 127.63, 126.63, 125.14, 123.11, 121.76, 120.78, 119.83, 111.13, 102.33, 27.56, 22.78.



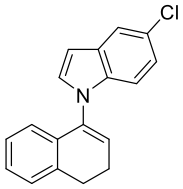
6jn'

1-(3,4-dihydronaphthalen-1-yl)-1*H*-pyrrolo[3,2-*b*]pyridine (6jn'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **6jn'** was obtained as a green oil in 70% yield (51.7 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.49-8.47 (m, 1H), 7.45 (d, J = 8.3 Hz, 1H), 7.43 (d, J = 3.3 Hz, 1H), 7.25–7.18 (m, 2H), 7.06–7.02 (m, 2H), 6.84 (d, J = 3.8 Hz, 1H), 6.52 (d, J = 7.7 Hz, 1H), 6.19 (t, J = 4.7 Hz, 1H), 2.97 (t, J = 8.1 Hz, 2H), 2.59–2.55 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.86, 143.59, 136.22, 135.85, 131.76, 131.52, 129.67, 128.31, 127.80, 126.69, 125.35, 122.77, 118.21, 116.61, 103.39, 27.42, 22.69. **HRMS *m/z*** (ESI) calcd for $C_{17}H_{14}N_2$ $(M+H)^+$ 247.1230, found 247.1230.



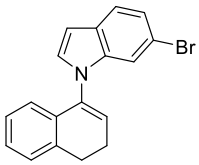
6jq'

1-(3,4-dihydronaphthalen-1-yl)-1*H*-indole-4-carbonitrile (6jq'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **6jq'** was obtained as a colorless oil in 52% yield (42.1 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.49 (d, J = 7.4 Hz, 1H), 7.40–7.36 (m, 2H), 7.26–7.19 (m, 2H), 7.15 (t, J = 8.0 Hz, 1H), 7.04 (t, J = 7.6 Hz, 1H), 6.87–6.83 (m, 1H), 6.42 (d, J = 7.7 Hz, 1H), 6.24–6.20 (m, 1H), 2.99 (t, J = 8.1 Hz, 2H), 2.62–2.57 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 136.32, 136.10, 135.59, 131.47, 131.25, 129.69, 128.42, 127.85, 126.74, 126.28, 125.36, 122.57, 121.46, 118.67, 115.84, 103.11, 101.29, 27.33, 22.72. **HRMS *m/z*** (ESI) calcd for $C_{19}H_{14}N_2$ $(M+H)^+$ 271.1230, found 271.1230.



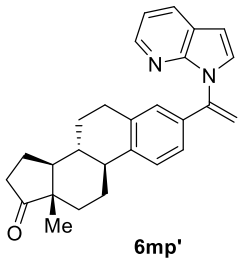
6f

5-chloro-1-(3,4-dihydronaphthalen-1-yl)-1*H*-indole (6jr'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **6jr'** was obtained as a green oil in 60% yield (50.2 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.62 (s, 1H), 7.23–7.17 (m, 3H), 7.09–7.01 (m, 3H), 6.59 (d, J = 3.2 Hz, 1H), 6.51 (d, J = 7.8 Hz, 1H), 6.20 (t, J = 4.7 Hz, 1H), 2.98 (t, J = 8.1 Hz, 2H), 2.58–2.53 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 136.19, 136.06, 135.06, 131.76, 129.94, 129.46, 128.19, 127.74, 126.67, 125.53, 125.48, 122.87, 122.07, 120.13, 112.14, 101.96, 27.45, 22.73. **HRMS *m/z*** (ESI) calcd for $C_{18}H_{14}ClN$ $(M+H)^+$ 280.0888, found 280.0888.



6jo'

6-bromo-1-(3,4-dihydronaphthalen-1-yl)-1*H*-indole (6jo'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **6jo'** was obtained as a green oil in 45% yield (43.6 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.52 (d, J = 8.4 Hz, 1H), 7.34 (s, 1H), 7.24–7.17 (m, 3H), 7.14 (d, J = 2.8 Hz, 1H), 7.04 (t, J = 7.1 Hz, 1H), 6.63–6.59 (m, 1H), 6.48 (d, J = 7.7 Hz, 1H), 6.19 (t, J = 4.6 Hz, 1H), 2.97 (t, J = 8.2 Hz, 2H), 2.61–2.53 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.52, 136.16, 135.82, 131.79, 129.30, 128.25, 127.76, 127.24, 126.74, 125.90, 123.15, 122.74, 122.01, 115.44, 113.84, 102.48, 27.41, 22.76. **HRMS *m/z*** (ESI) calcd for $C_{18}H_{14}BrN$ $(M+H)^+$ 324.0382, found 324.0382.

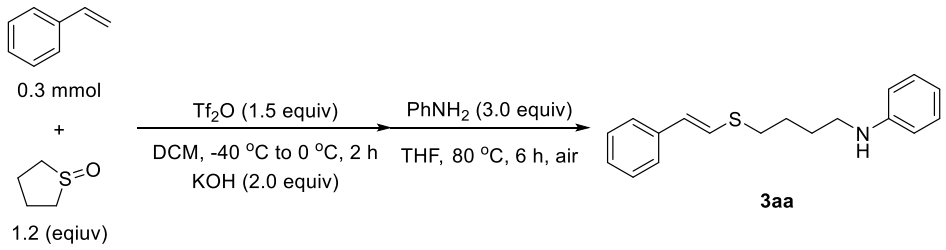


6mp'

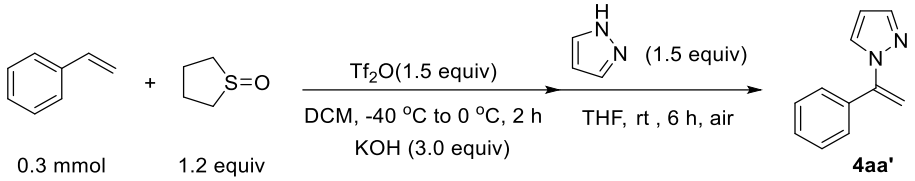
(8*R*,9*S*,13*S*,14*S*)-3-(1-(1*H*-pyrrolo[2,3-*b*]pyridin-1-yl)vinyl)-13-methyl-6,7,8,9,11,12,13,14,15,16-decahydro-17*H*-cyclopenta[*a*]phenanthren-17-one (6mp'). Prepared following the general procedure B, after purification by column chromatography using PE/EA (5:1), **6mp'** was obtained as a white solid in 65% yield (75.9 mg). M.p. = 206-208 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.36–8.32 (m, 1H), 7.95 (d, J = 7.6 Hz, 1H), 7.24 (d, J = 8.0 Hz, 1H), 7.19 (s, 1H), 7.13–7.08 (m, 1H), 7.07–7.01 (m, 2H), 6.53 (s, 1H), 5.71 (d, J = 22.1 Hz, 2H), 2.90–2.82 (m, 2H), 2.56–2.46 (m, 1H), 2.44–2.37 (m, 1H), 2.35–2.25 (m, 1H), 2.21–1.93 (m, 4H), 1.68–1.38 (m, 6H), 0.91 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 220.80, 143.47, 142.68, 140.63, 136.58, 134.73, 129.08, 128.89, 127.18, 125.45, 124.16, 121.29, 116.43, 109.43, 100.55, 50.44, 47.91, 44.40, 37.95, 35.80, 31.51, 29.34, 26.37, 25.58, 21.54, 13.80. **HRMS *m/z*** (ESI) calcd for $C_{27}H_{28}N_2O$ $(M+H)^+$ 397.2274, found 397.2275.

6. Synthetic Application

5.1 One-pot synthesis of 3aa and 4aa'

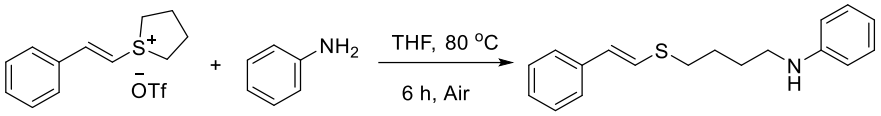


General procedure: Under an argon atmosphere, sulfoxide (32.0 μL, 0.36 mmol, 1.2 equiv) and anhydrous DCM (2.0 mL) were added to a 10 mL schlenk tube at -40 °C. The Tf_2O (76.0 μL, 0.45 mmol, 1.5 equiv) was added dropwise under argon, then styrene (34.5 μL, 0.3 mmol, 1.0 equiv) was added gradually. The reaction mixture was stirred at -40 °C for 15 min before warming to 0 °C. After stirring for 2 h, the solvent was removed under reduced pressure. Then KOH (33.6 mg, 0.9 mmol, 2.0 equiv), aniline (82.5 μL 0.9 mmol, 3.0 equiv) and THF (2 mL) were added. The reaction mixture was stirred at 80 °C for 6 h. The crude product was purified by column chromatography on silica gel (PE/EA=10/1) to afford product **3aa** (79%, 67.0 mg).



General procedure: Under an argon atmosphere, sulfoxide (32.0 μL, 0.36 mmol, 1.2 equiv) and anhydrous DCM (2.0 mL) were added to a 10 mL schlenk tube at -40 °C. The Tf_2O (76.0 μL, 0.45 mmol, 1.5 equiv) was added dropwise under argon, then styrene (34.5 μL, 0.3 mmol, 1.0 equiv) was added gradually. The reaction mixture was stirred at -40 °C for 15 min before warming to room temprature. After stirring for 2 h, the solvent was removed under reduced pressure. Then KOH (50.4 mg, 0.9 mmol, 3.0 equiv), pyrazole (30.6 mg, 0.45 mmol, 1.5 equiv) and THF (2.0 mL) were added. The reaction mixture was stirred at room temperature for 6 h. The crude product was purified by column chromatography on silica gel (PE/EA=5/1) to afford product **4aa'** (73%, 37.2 mg).

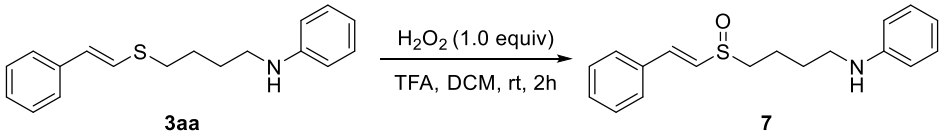
5.2 Scale-up reaction



1a (5.0 mmol) **2a** **3aa,** yield = 86%

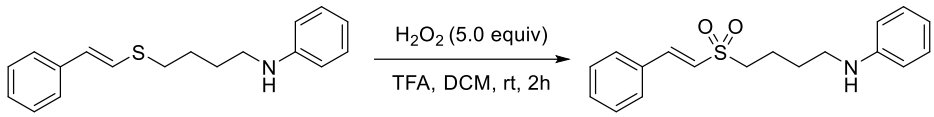
General procedure: To a solution of aniline (1.37 mL, 15.0 mmol, 3.0 equiv) in THF (50.0 mL) was added styrene sulfonium salts (1.7 g, 5.0 mmol, 1.0 equiv). The reaction mixture was stirred at 80 °C for 6 h (under reflux). The crude product was concentrated under reduced pressure and purified by column chromatography on silica gel (PE/EA=10/1) to afford product **3aa** (86%, 1.21 g).

5.3 Product derivatization



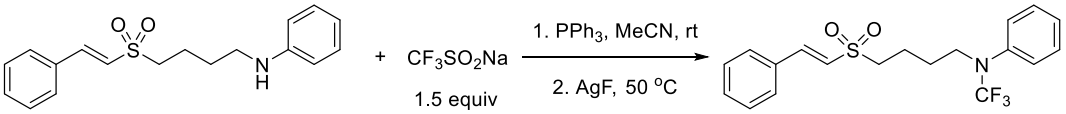
3aa **7**

Following the relative literature[5]: A 10 mL schlenk tube with a stirring bar was added **3aa** (56.6 mg, 0.2mmol, 1.0 equiv), TFA (1.0 mL), DCM (1.0 mL) and H_2O_2 (30% aq., 20.4 μL, 0.2 mmol, 1.0 equiv) under argon. The reaction mixture was stirred at room temperature for 2 h. The reaction was then quenched with saturated aqueous $NaHCO_3$ at 0 °C and the aqueous phase extracted with DCM. The combined organic layers were dried with Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography on silica gel (PE/EA=3/1) to afford product **7** (colorless liquid, 89%, 53.2 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.48–7.44 (m, 2H), 7.41–7.34 (m, 3H), 7.24 (d, J = 15.4 Hz, 1H), 7.19–7.14 (m, 2H), 6.81 (d, J = 15.5 Hz, 1H), 6.69 (t, J = 7.3 Hz, 1H), 6.61–6.56 (m, 2H), 3.70 (brs, 1H), 3.17 (t, J = 6.8 Hz, 2H), 2.91–2.76 (m, 2H), 1.98–1.74 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 148.00, 136.96, 133.72, 130.16, 129.65, 129.21, 128.89, 127.56, 117.32, 112.66, 53.50, 43.27, 28.53, 19.68. HRMS *m/z* (ESI) calcd for $C_{18}H_{21}NOS$ $(M+H)^+$ 300.1417, found 300.1416.



3aa **8**

Following the relative literature[5]: A 10 mL schlenk tube with a stirring bar was added **3aa** (56.6 mg, 0.2mmol, 1.0 equiv), TFA (1.0 mL), DCM (1.0 mL) and H_2O_2 (30% aq., 102 μL, 1.0 mmol, 5.0 equiv) under argon. The reaction mixture was stirred at room temperature for 2 h. The reaction was then quenched with saturated aqueous $NaHCO_3$ at 0 °C and the aqueous phase extracted with DCM. The combined organic layers were dried with Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography on silica gel (PE/EA=5/1) to afford product **8** (colorless liquid, 90 %, 56.7 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.61 (d, J = 15.4 Hz, 1H), 7.53–7.50 (m, 2H), 7.48–7.41 (m, 3H), 7.20–7.13 (m, 2H), 6.83 (d, J = 15.5 Hz, 1H), 6.70 (t, J = 7.3 Hz, 1H), 6.59 (d, J = 7.7 Hz, 2H), 3.68 (brs, 1H), 3.17 (t, J = 6.8 Hz, 2H), 3.14–3.09 (m, 2H), 2.00–1.93 (m, 2H), 1.81–1.74 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 147.92, 144.98, 132.09, 131.37, 129.23, 129.11, 128.56, 124.50, 117.41, 112.67, 54.74, 43.15, 28.12, 20.35. HRMS *m/z* (ESI) calcd for $C_{18}H_{21}NO_2S$ $(M+H)^+$ 316.1366, found 316.1367.



8 (0.5 mmol) **9**

Following the relative literature [6]: A 10 mL schlenk tube with a stirring bar was added CF_3SO_2Na (117 mg, 0.75 mmol, 1.5 equiv) and PPh_3 (393.4 mg, 1.5 mmol, 3.0 equiv), compound **8** (157.5 mg, 0.5 mmol) was dissolved in MeCN (2.5 mL), and the solution was added under argon. The resulting mixture was stirred at room temperature for 1 h. After that, AgF (2.25 mmol, 286 mg, 4.5 equiv) was added. Then the reaction mixture was stirred at 50 °C for 5 h. The resulting mixture was concentrated and purified by column chromatography on silica gel (PE/EA=10/1) to afford product **9** (colorless liquid, 70 %, 134.0 mg). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.60 (d, J = 15.5 Hz, 1H), 7.56–7.51 (m, 2H), 7.50–7.42 (m, 3H), 7.39–7.32 (m, 2H), 7.32–7.23 (m, 3H), 6.82 (d, J = 15.4 Hz, 1H), 3.40 (t, J = 7.0 Hz, 2H), 3.08–3.01 (m, 2H), 1.94–1.84 (m, 2H), 1.68–1.59 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 145.05, 140.28, 132.10, 131.40, 129.27, 129.12, 128.54, 127.26, 127.19, 124.44, 123.30 (d, J = 255.2 Hz), 54.48, 48.04, 26.72, 19.74. **^{19}F NMR** (376 MHz, $CDCl_3$) δ -58.23. **HRMS *m/z*** (ESI) calcd for $C_{19}H_{20}F_3NO_2S$ $(M+Na)^+$ 406.1059, found 406.1059.

7. References

[1] Y. L. Zhang, L. Yang, J. Wu, C. Y. Zhu, P. Wang. *Org. Lett.* **2020**, *22*, 7768-7772.

[2] M. H. Aukland, F. J. T. Talbot, J. A. F. Salas, M. Ball, A. P. Pulis, D. J. Procter. *Angew. Chem. Int. Ed.* **2018**, *57*, 9785-9789.

[3] Z. W. Nie, H. F. Lv, M. D. Su, T. L. Yang, W. P. Lou, Q. liu, C. C. Guo. *Adv. Synth. Catal.* **2021**, *363*, 1-7.

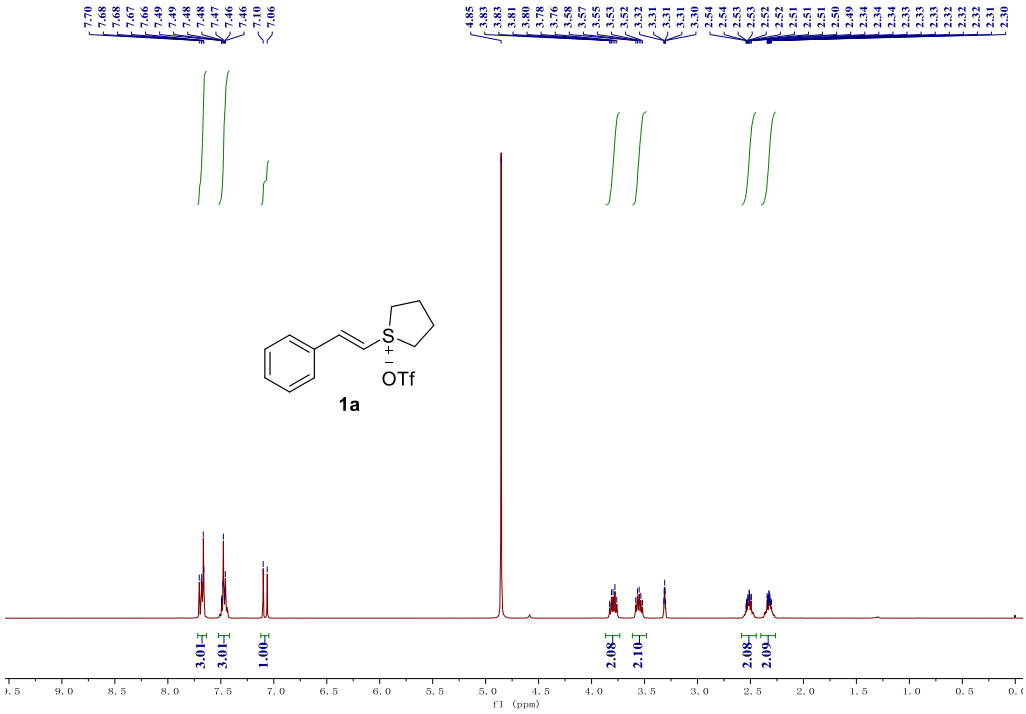
[4] X. B. Zeng, G. L. Cheng, J. H. Shen, X. L. Cui. *Org. Lett.* **2013**, *15*, 3022-3025.

[5] Z. He, A. P. Pulis, D. J. Procter. *Angew. Chem. Int. Ed.* **2019**, *58*, 7813-7817.

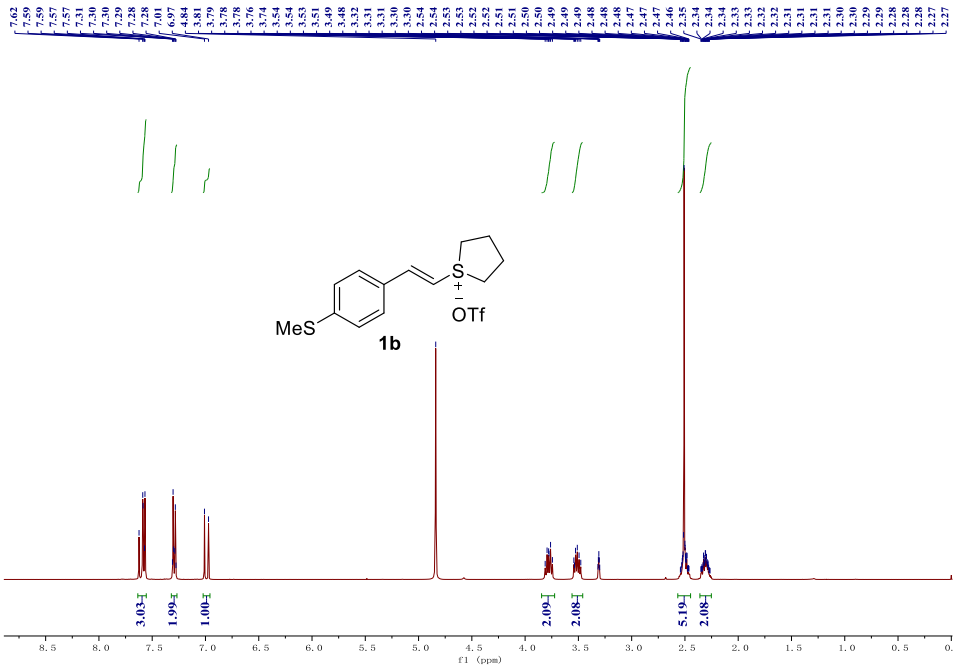
[6] S. S. Liang, J. J. Wei, L. Q. Jiang, J. Liu, Y. Mumtaz, W. B. Yi. *Chem. Commun.*, **2019**, 55, 8536-8539

8. ^{1}H, ^{13}C, and ^{19}F NMR spectra

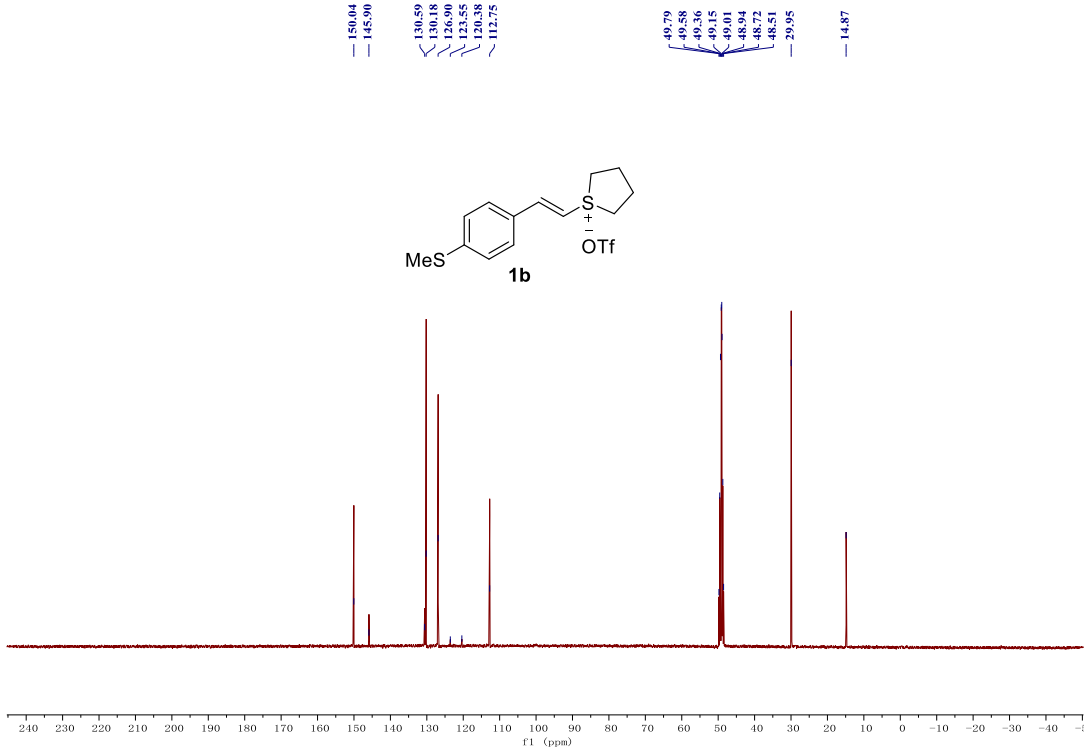
^{1}H NMR of 1a



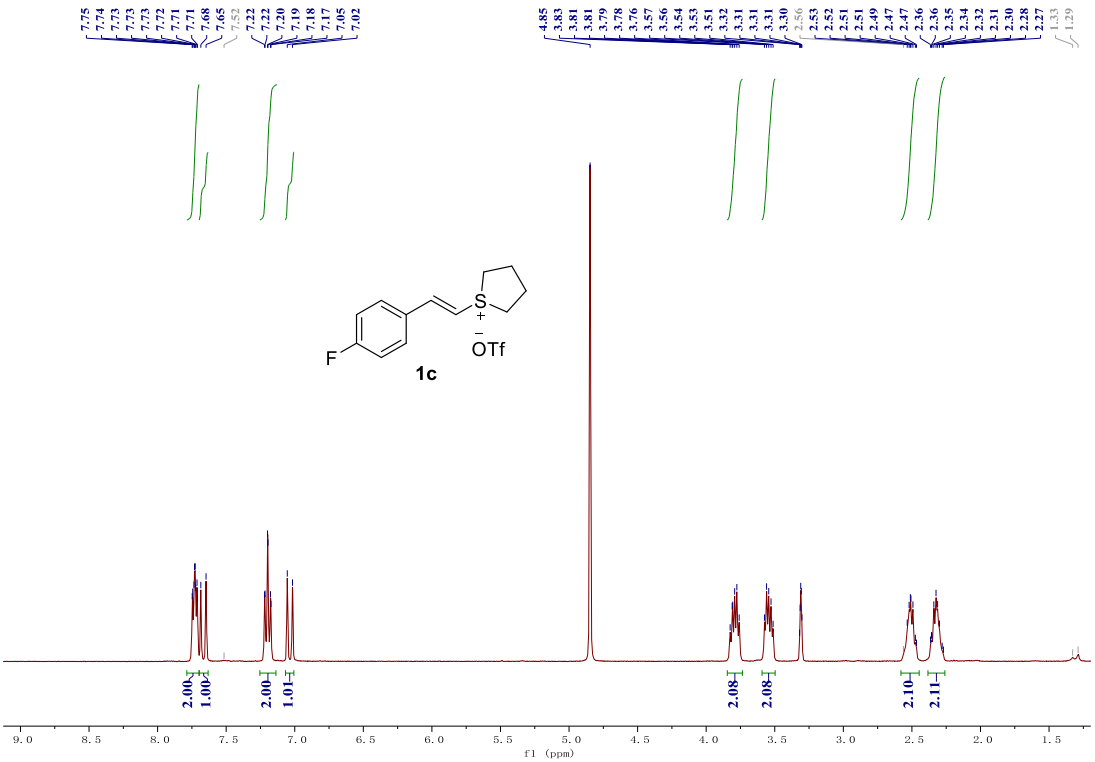
^{1}H NMR of 1b



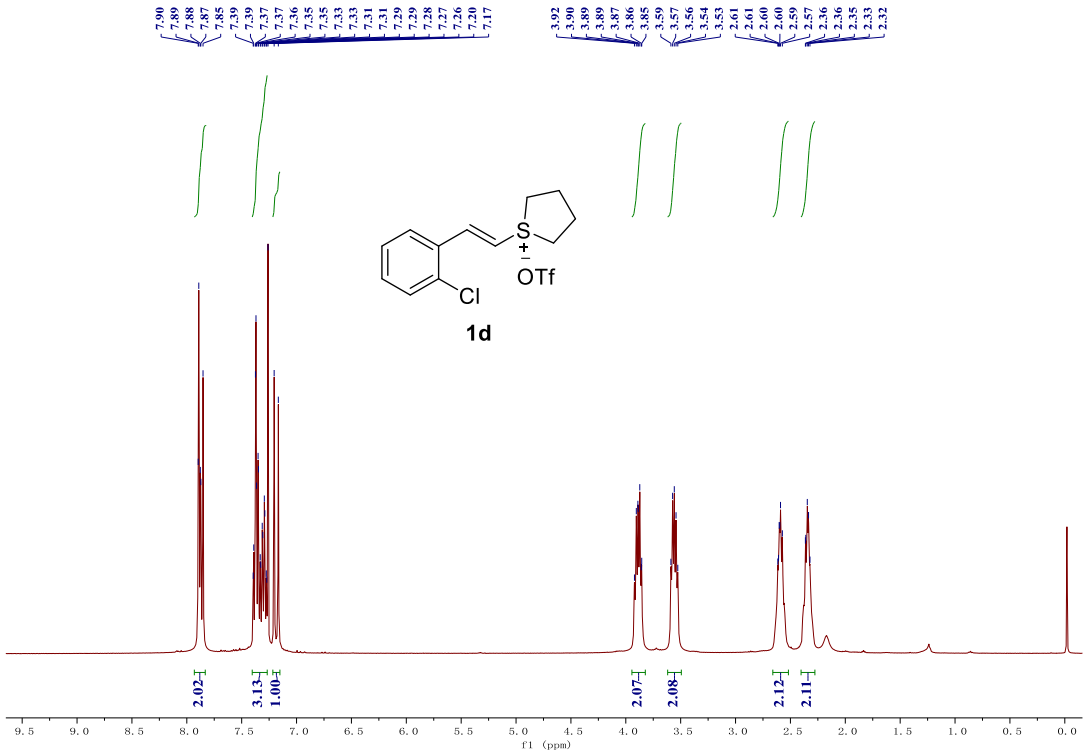
^{13}C NMR of 1b



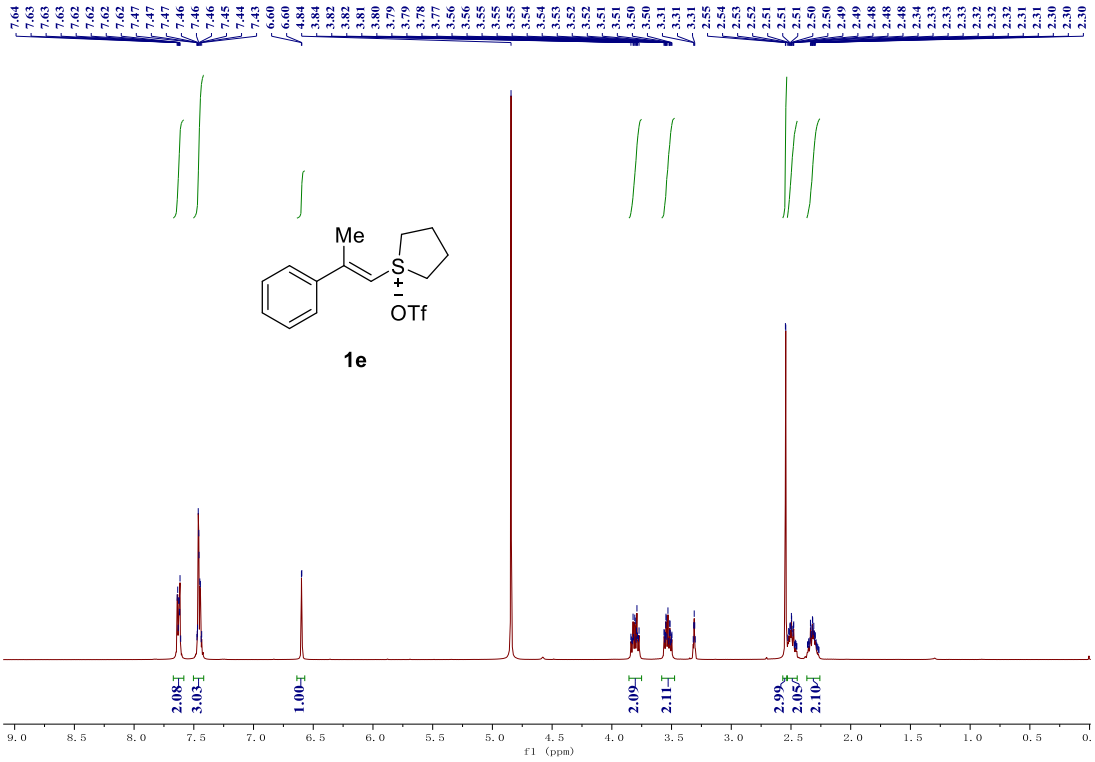
^{1}H NMR of 1c



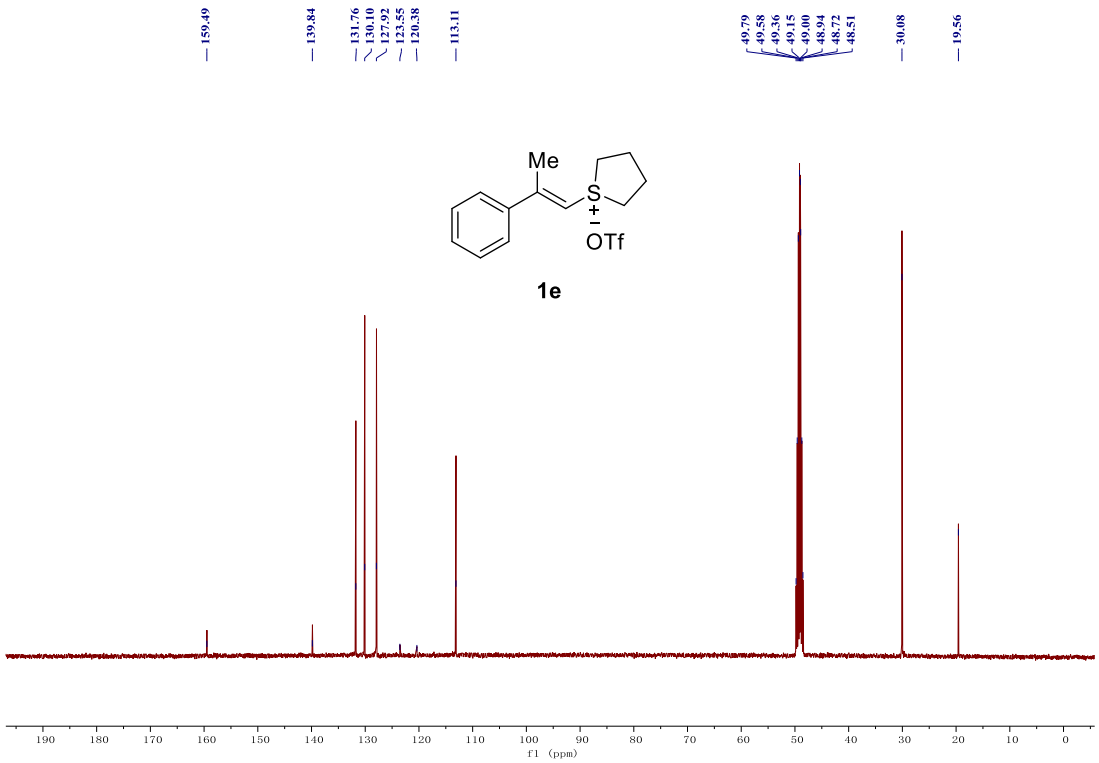
^{1}H NMR of 1d



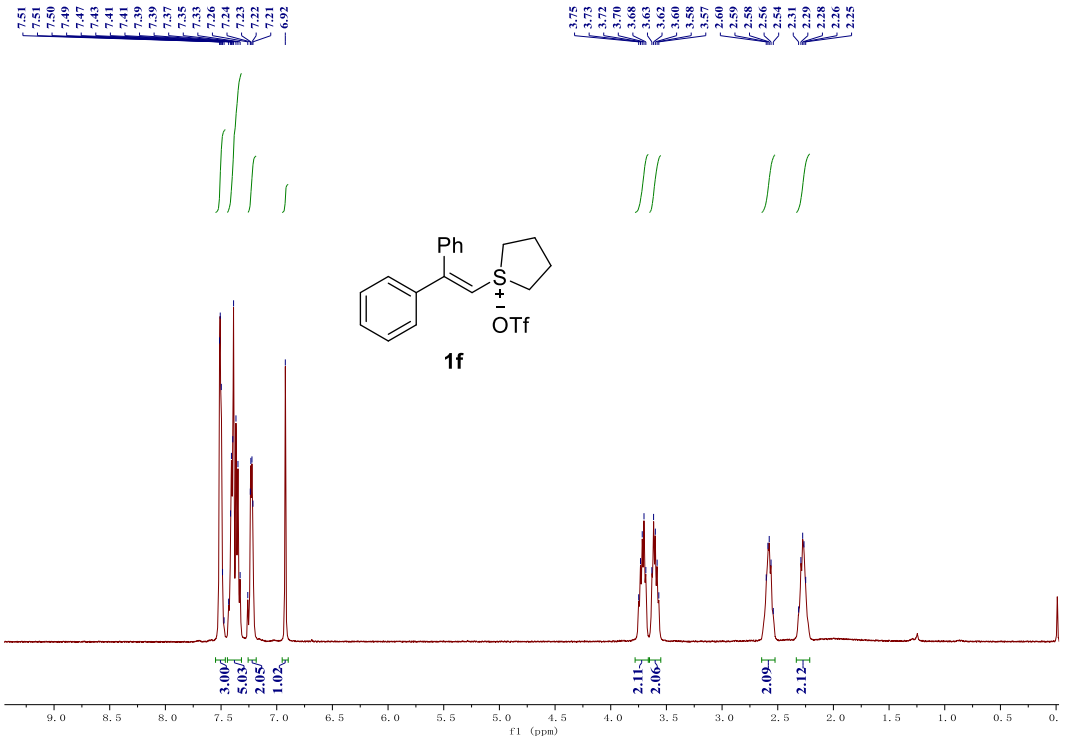
^{1}H NMR of 1e



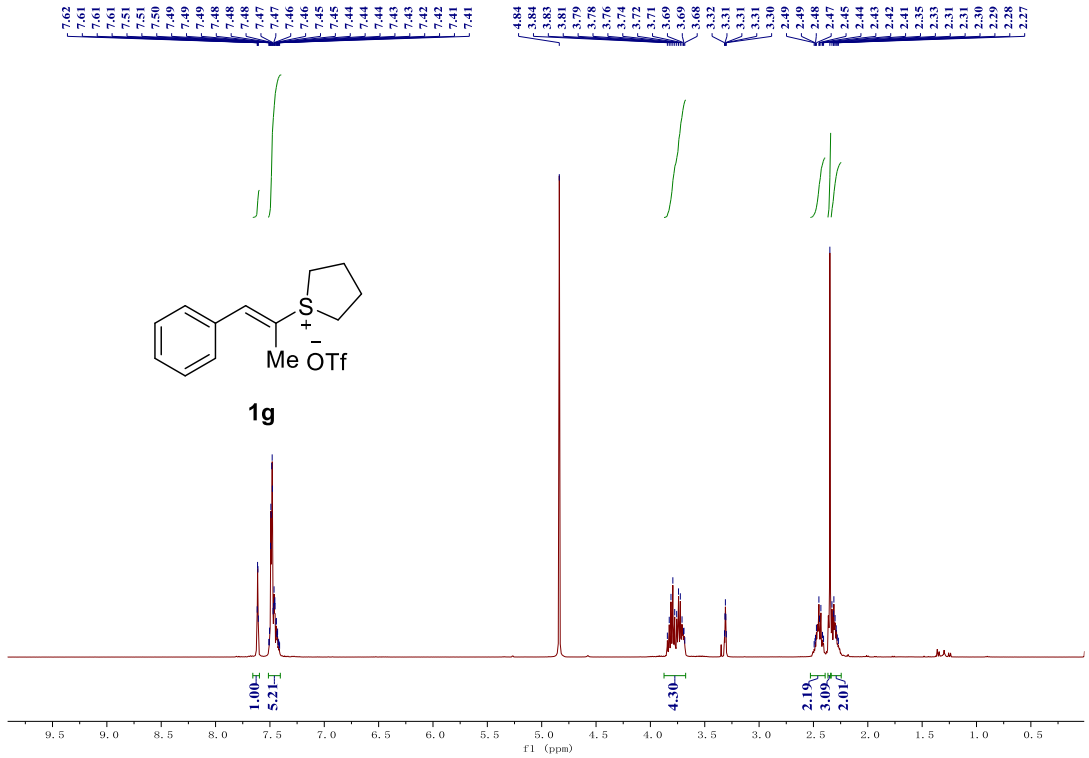
^{13}C NMR of 1e



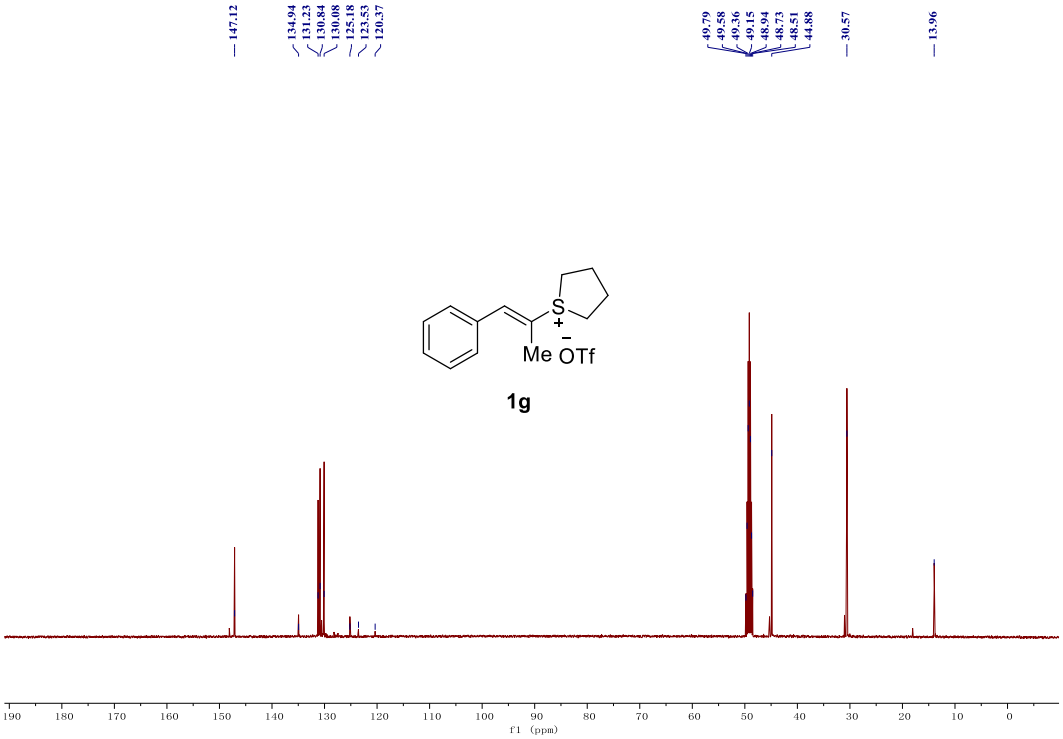
^{1}H NMR of 1f



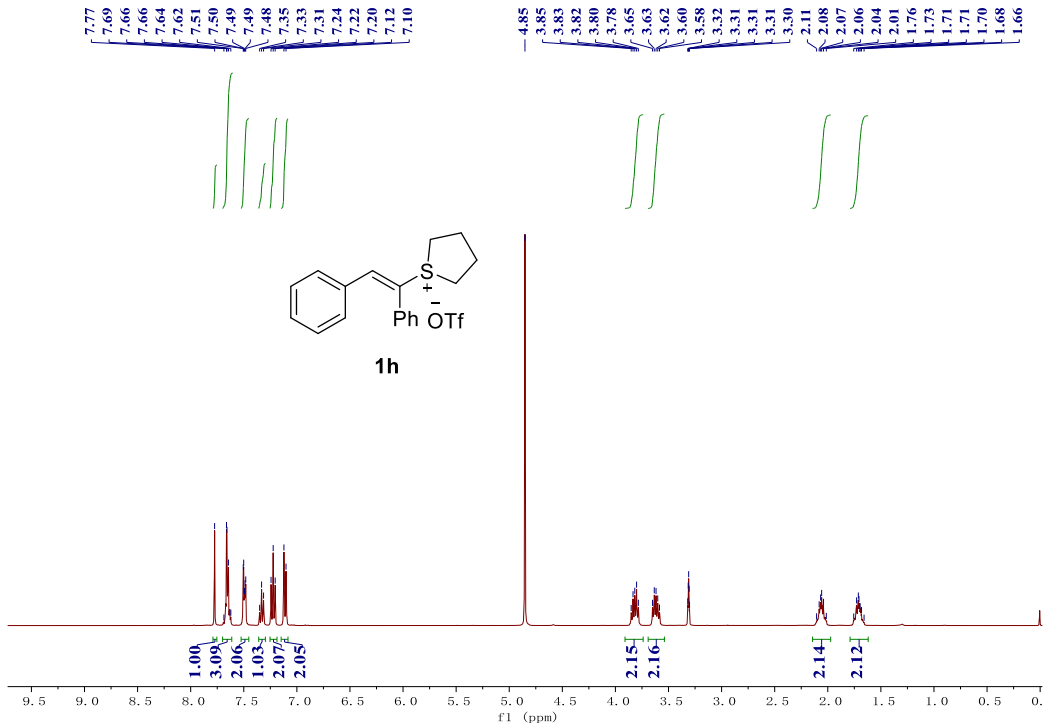
^{1}H NMR of 1g



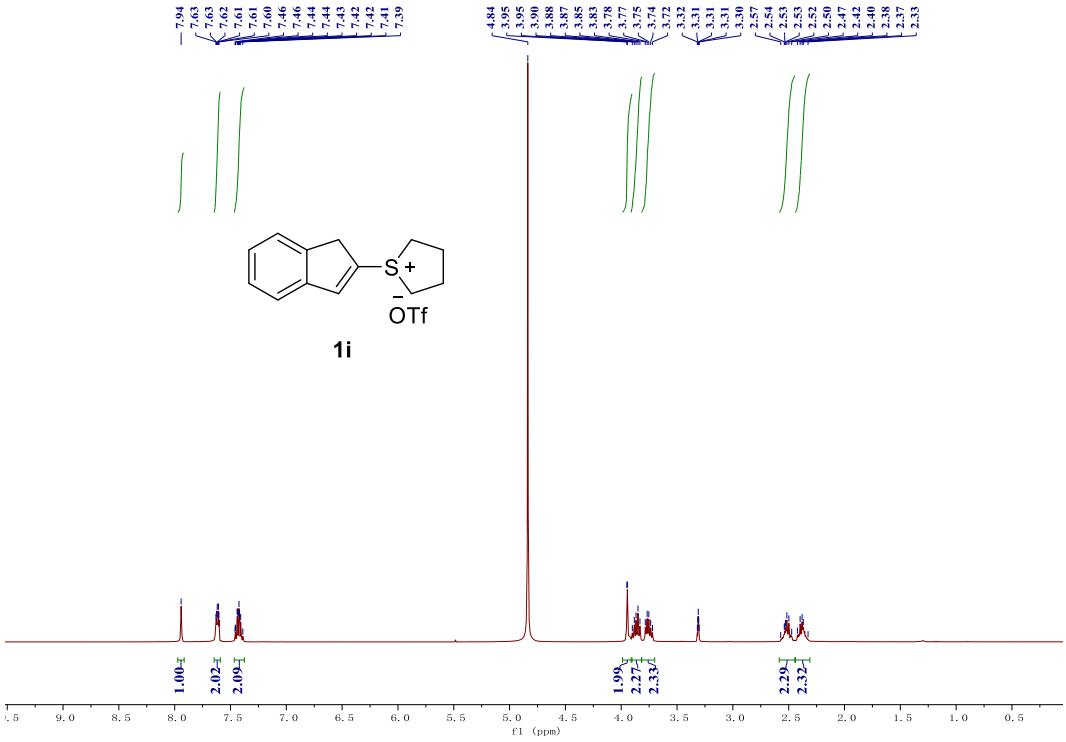
^{13}C NMR of 1g



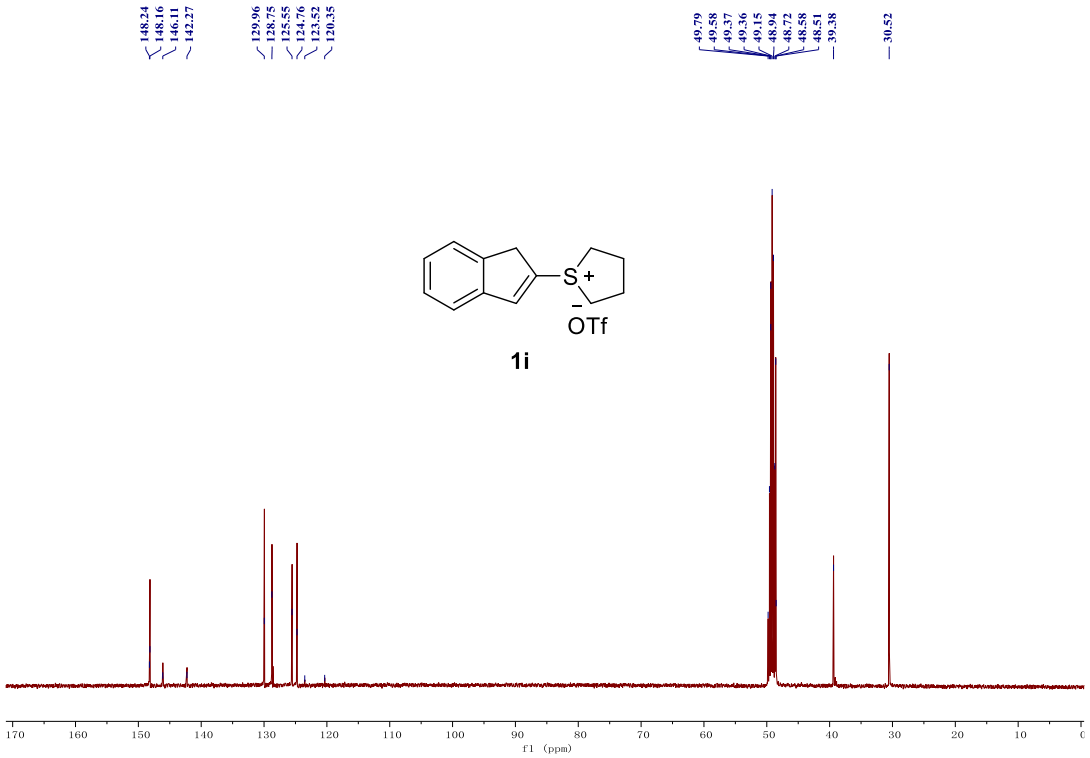
^{1}H NMR of 1h



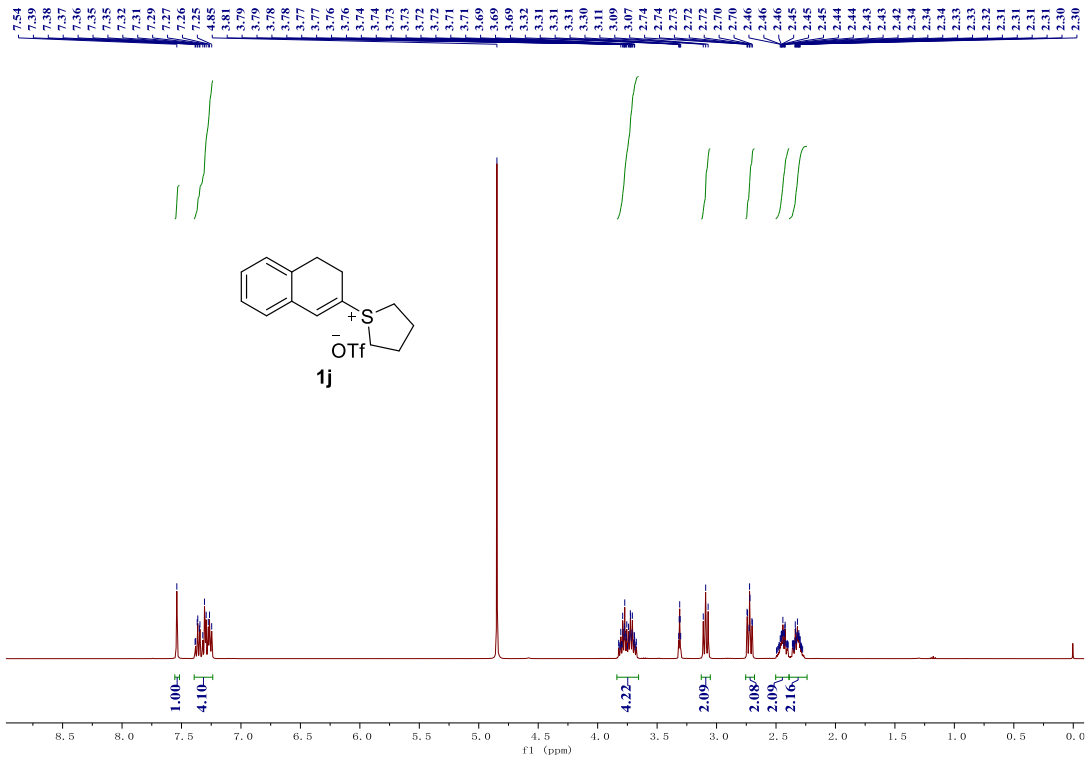
^{1}H NMR of 1i



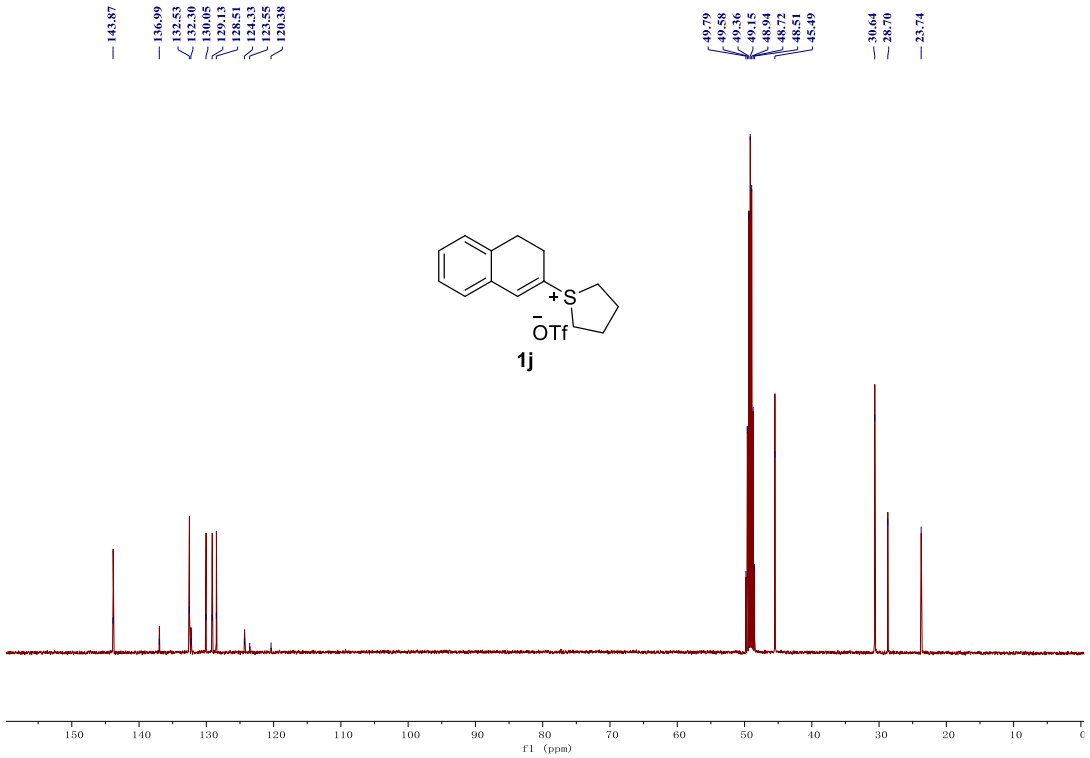
^{13}C NMR of 1i



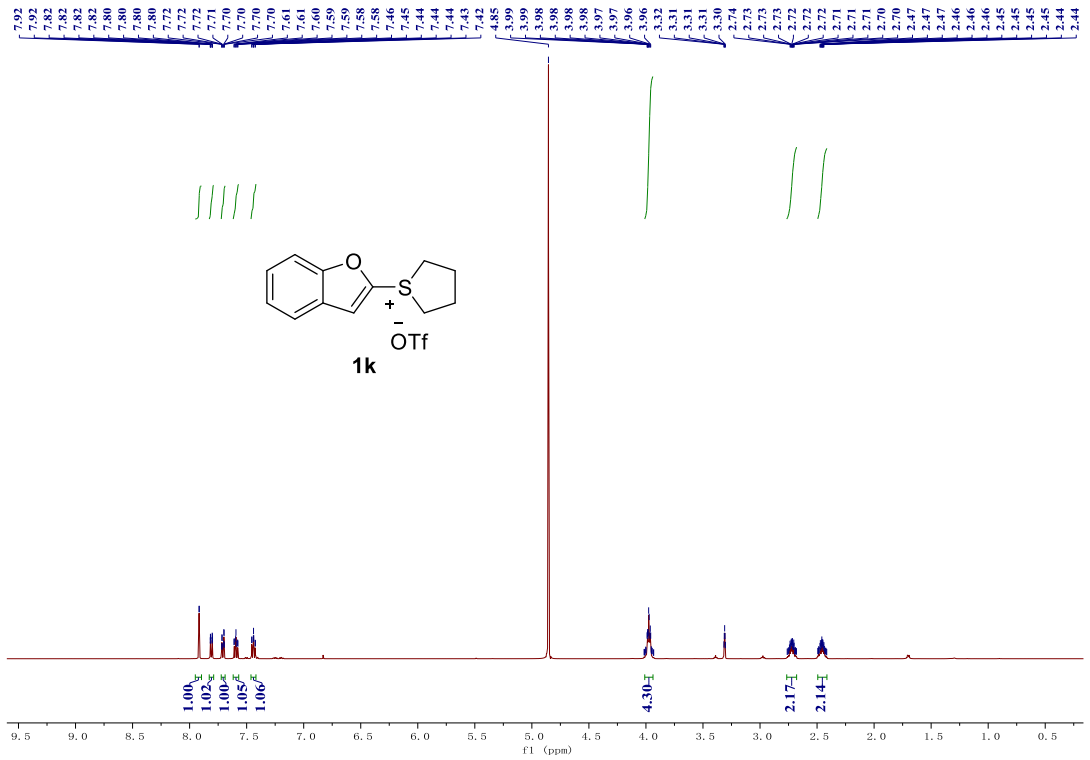
^{1}H NMR of 1j



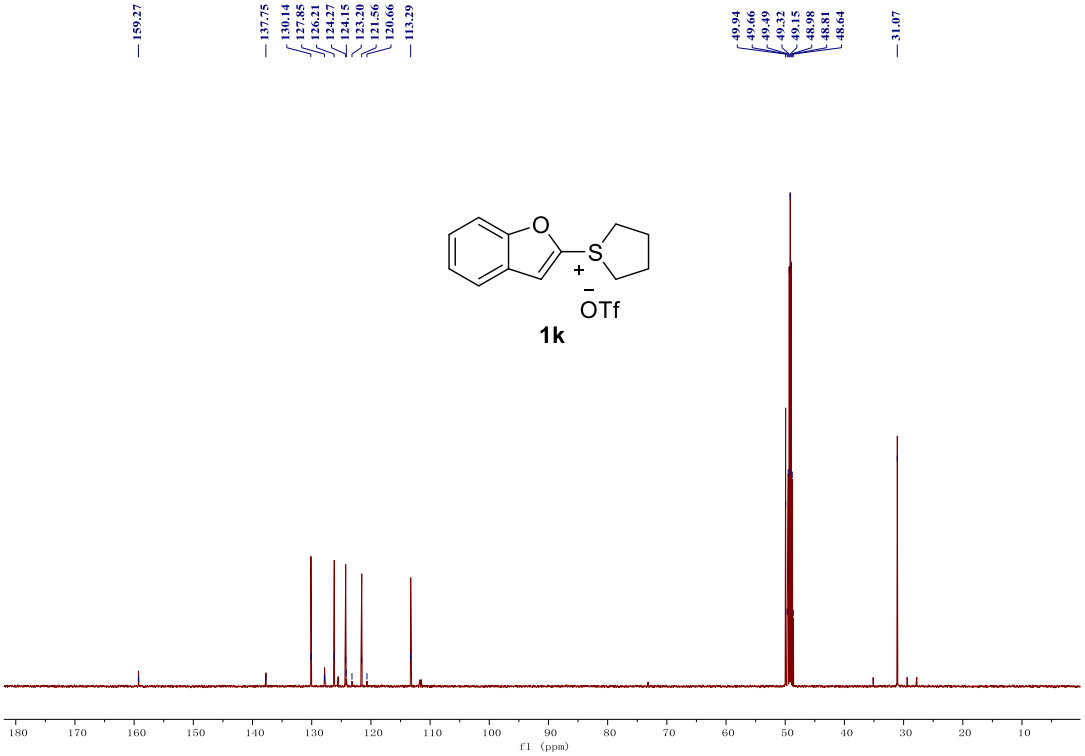
^{13}C NMR of 1j



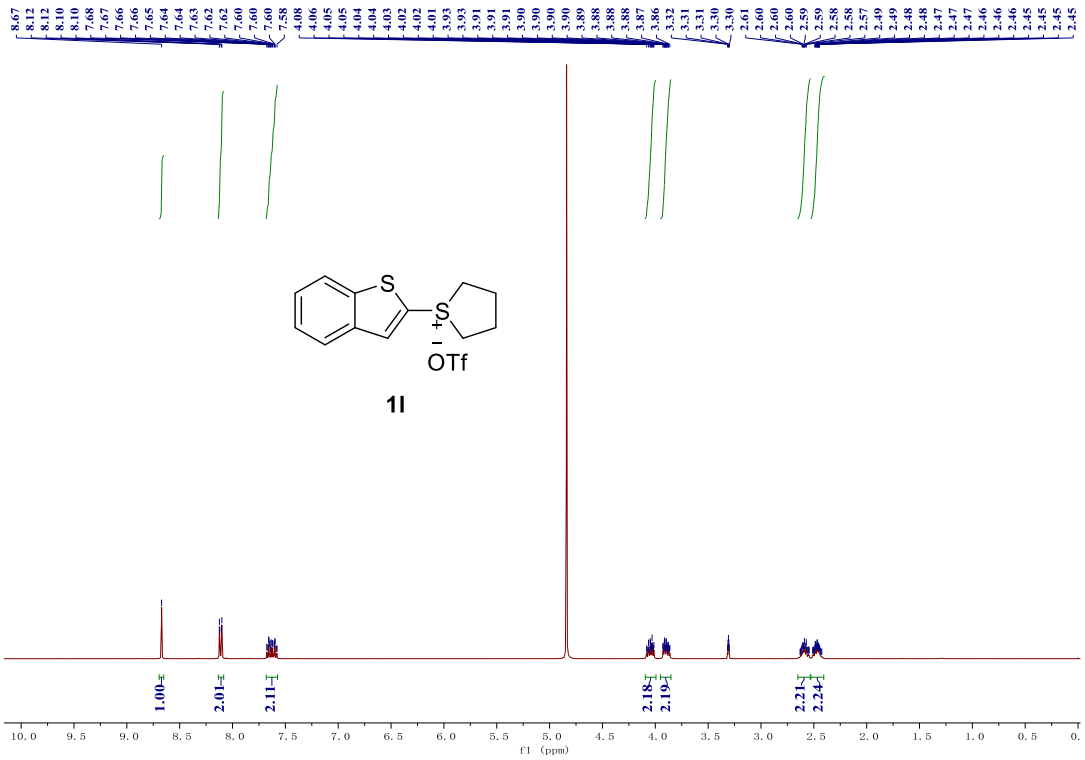
^{1}H NMR of 1k



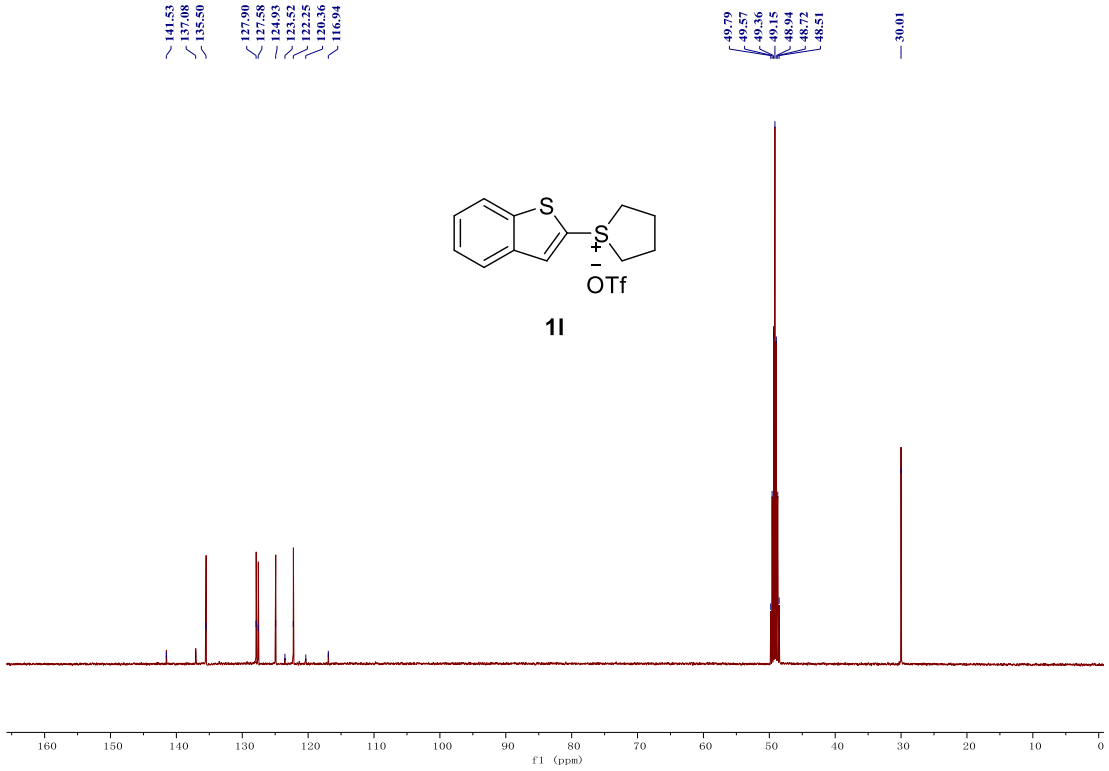
^{13}C NMR of 1k



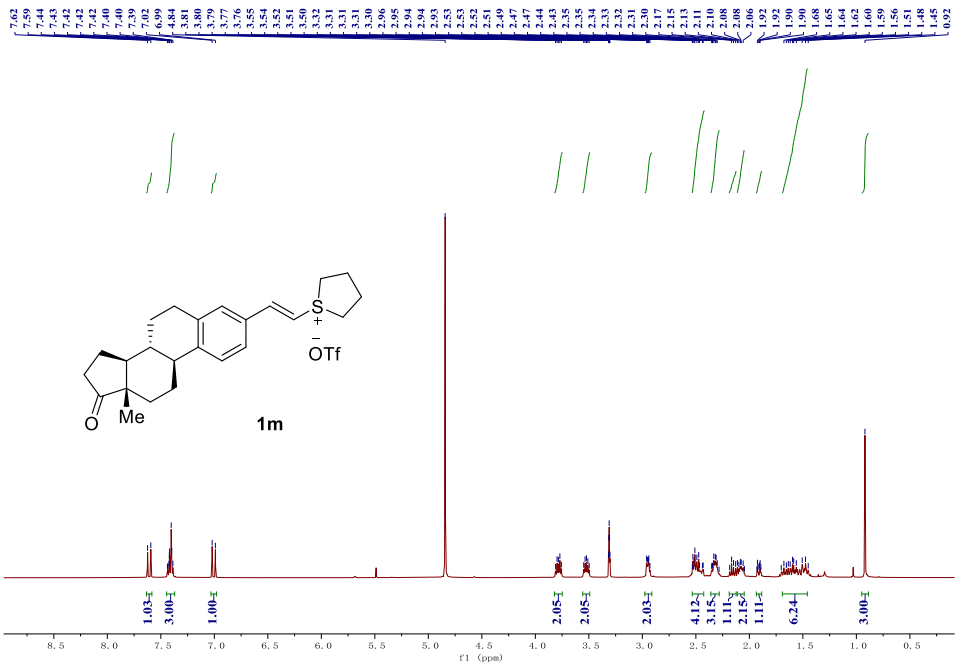
^{1}H NMR of 1l



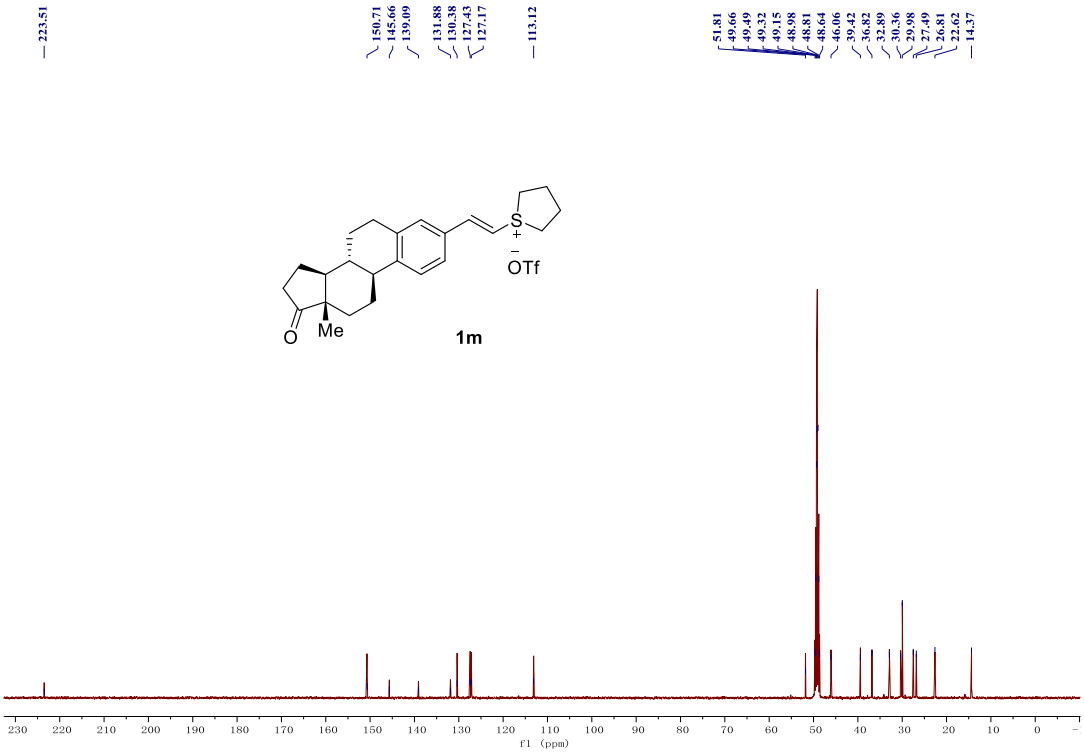
^{13}C NMR of 1l



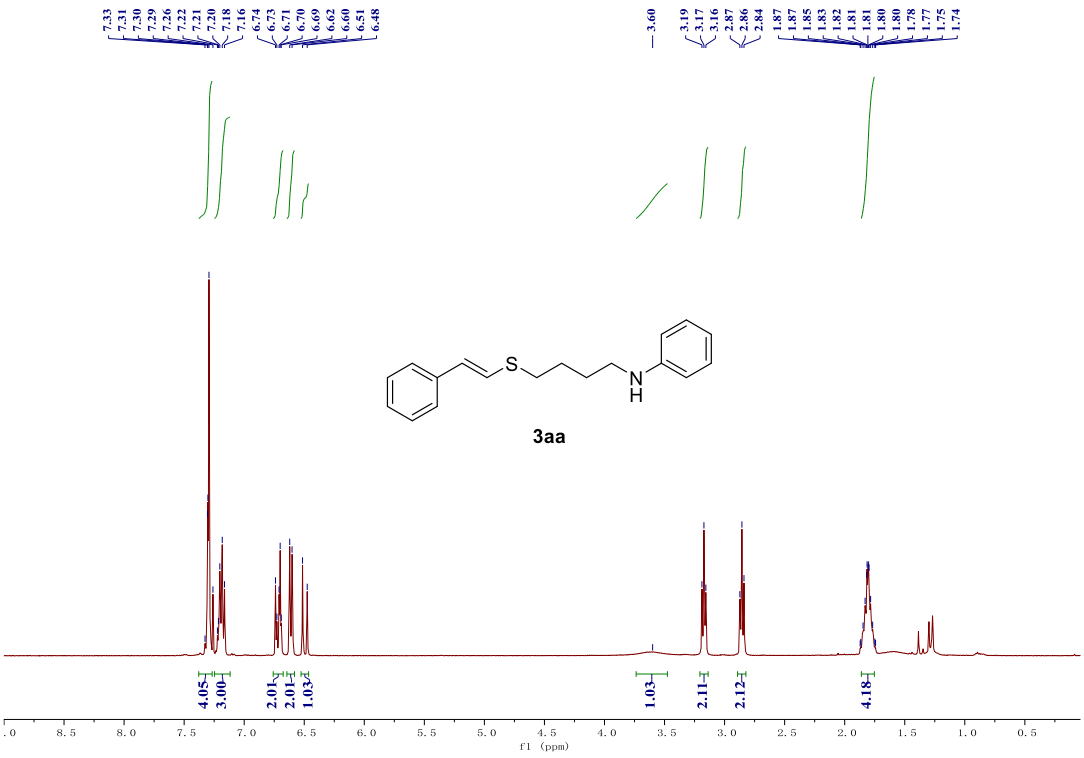
^{1}H NMR of 1m



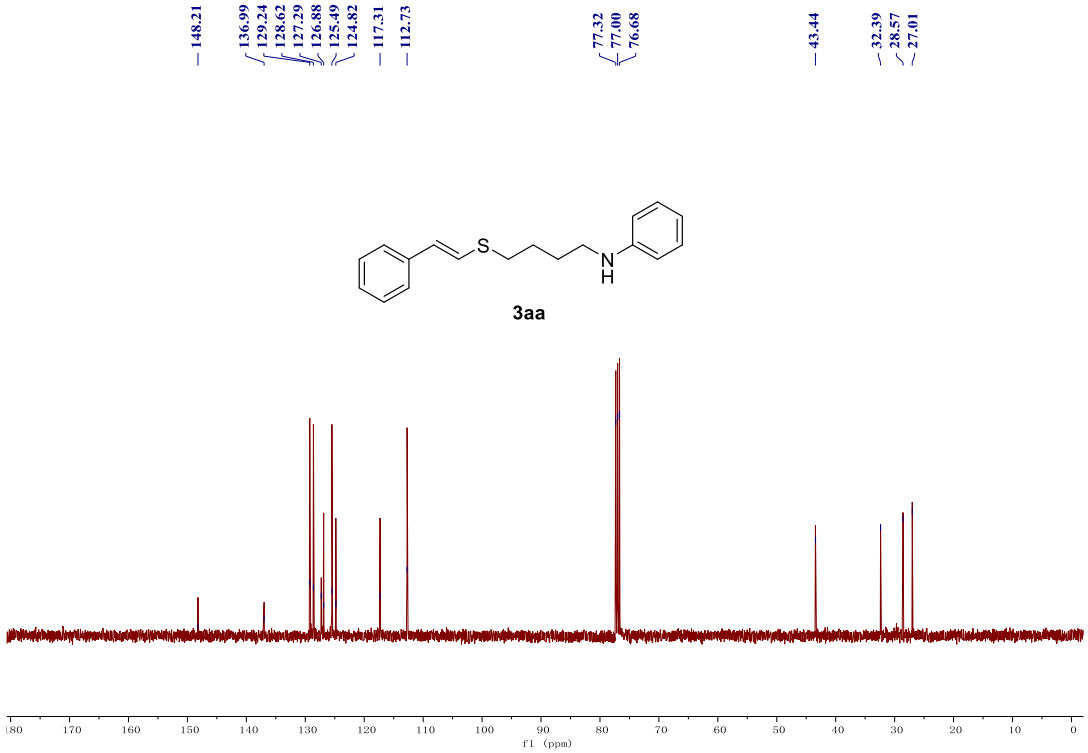
^{13}C NMR of 1m



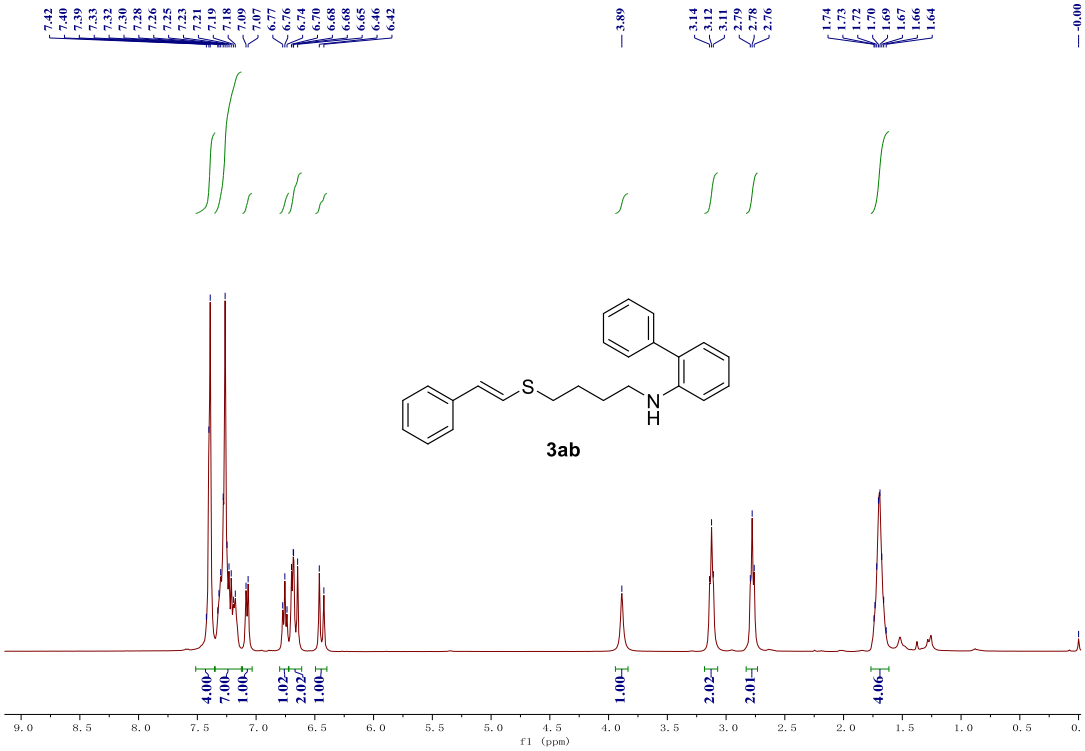
^{1}H NMR of 3aa



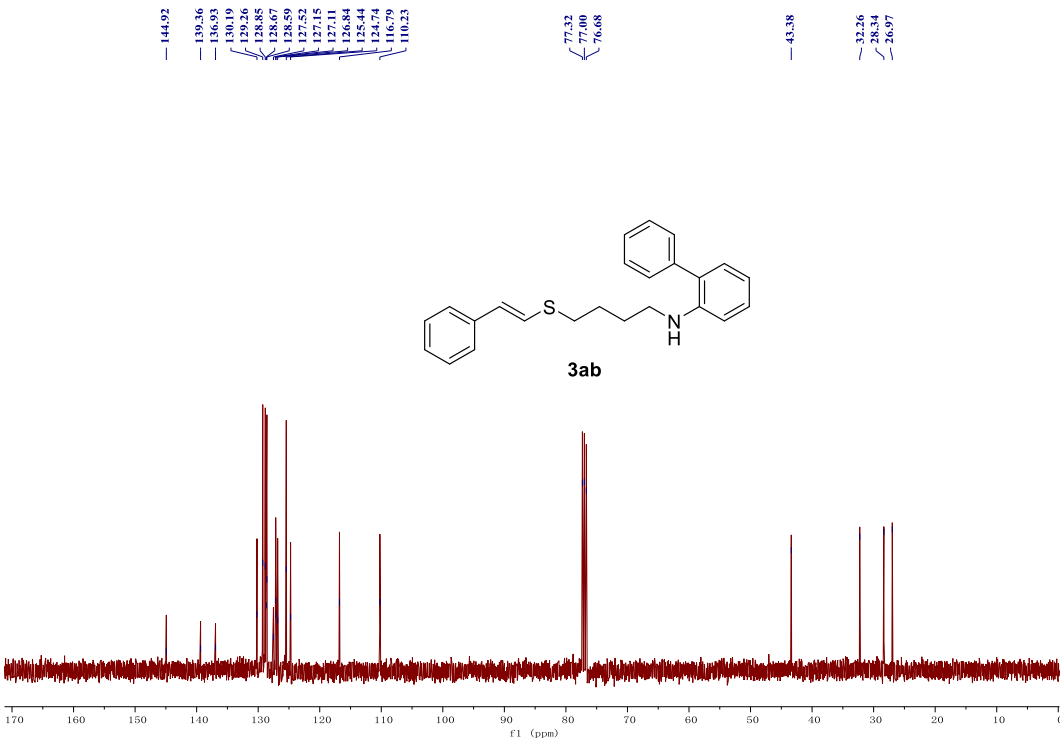
^{13}C NMR of 3aa



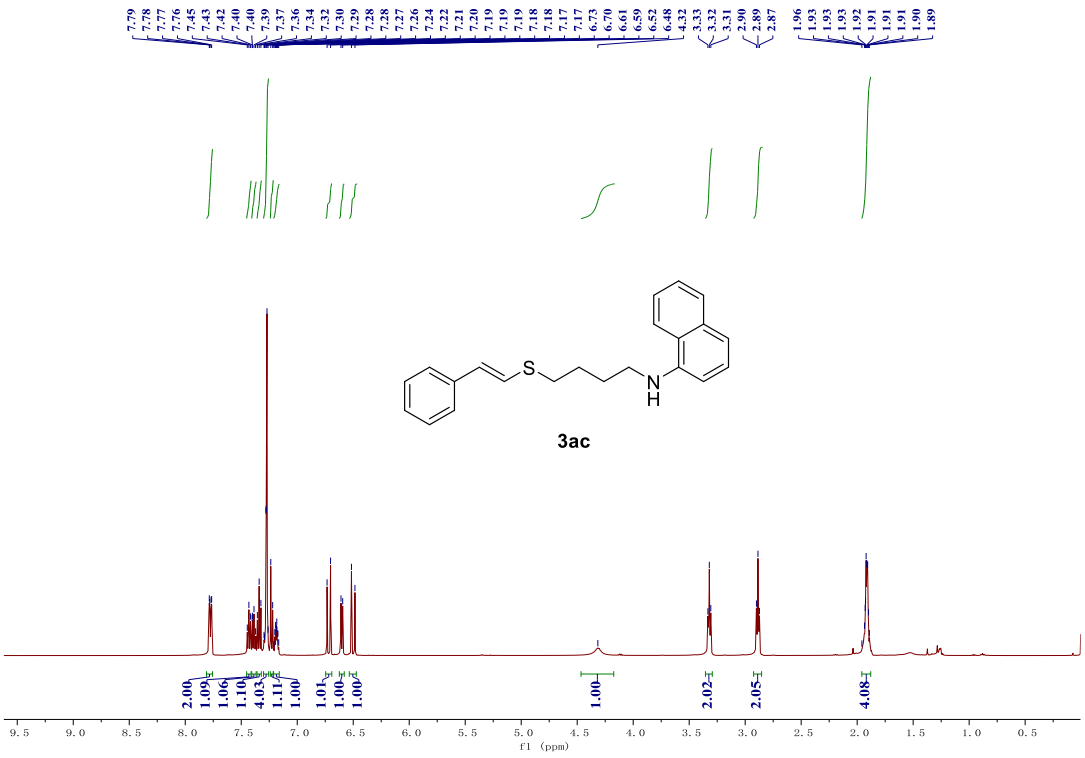
^{1}H NMR of 3ab



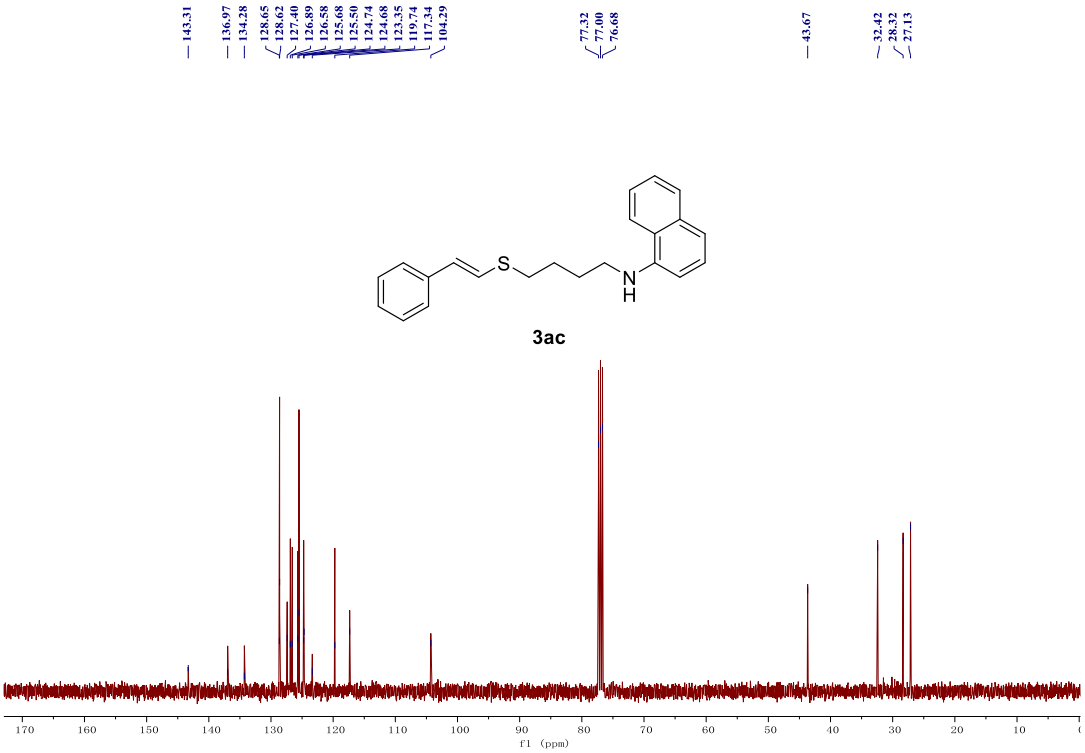
^{13}C NMR of 3ab



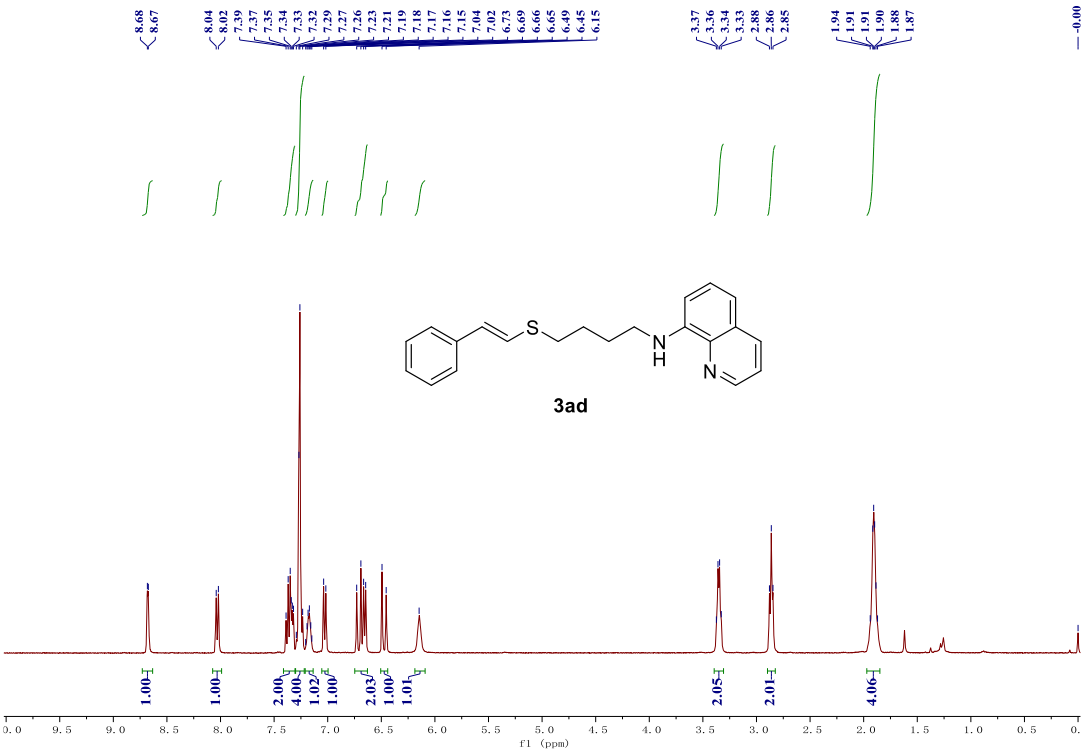
^{1}H NMR of 3ac



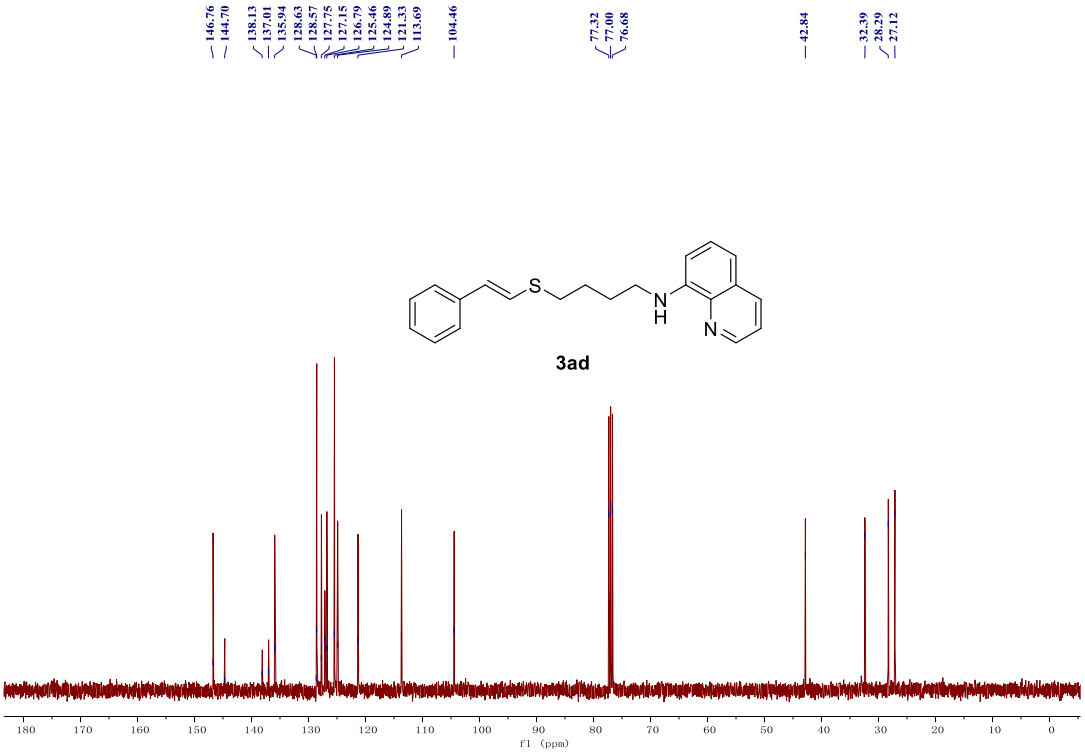
^{13}C NMR of 3ac



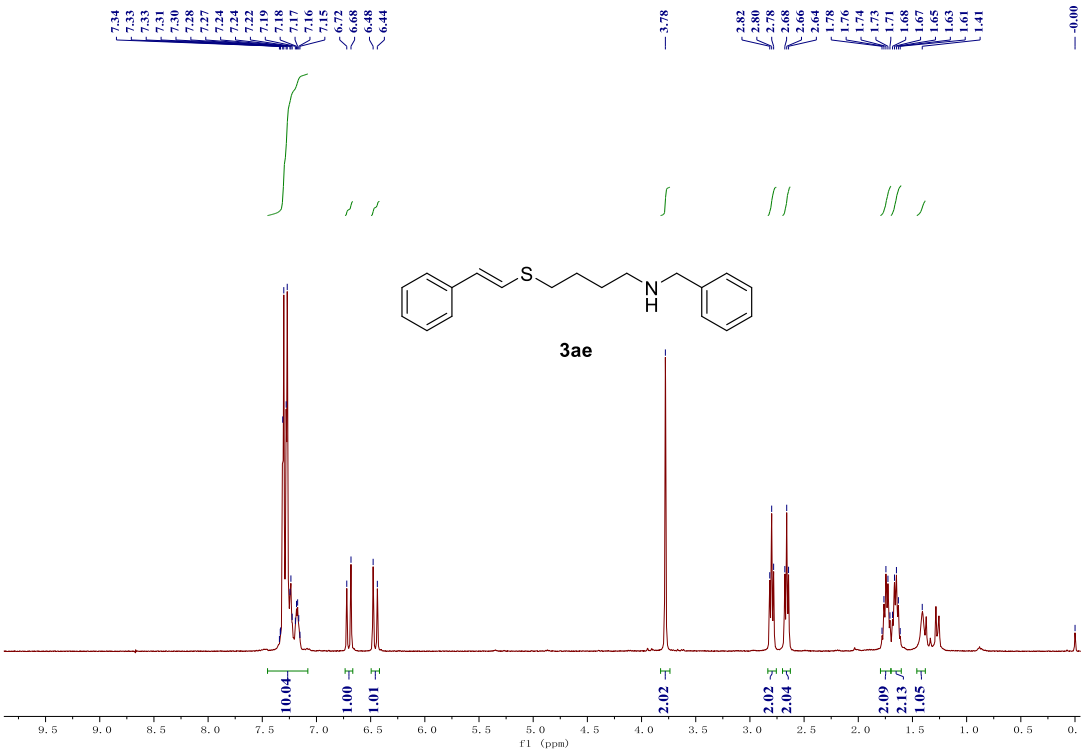
^{1}H NMR of 3ad



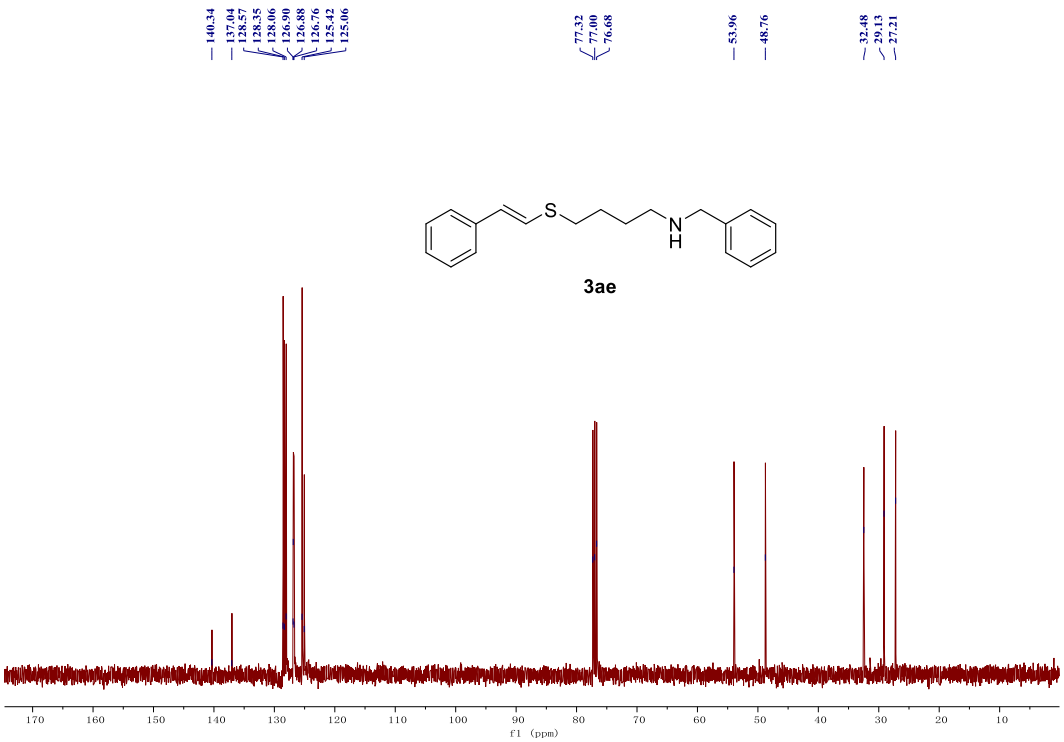
^{13}C NMR of 3ad



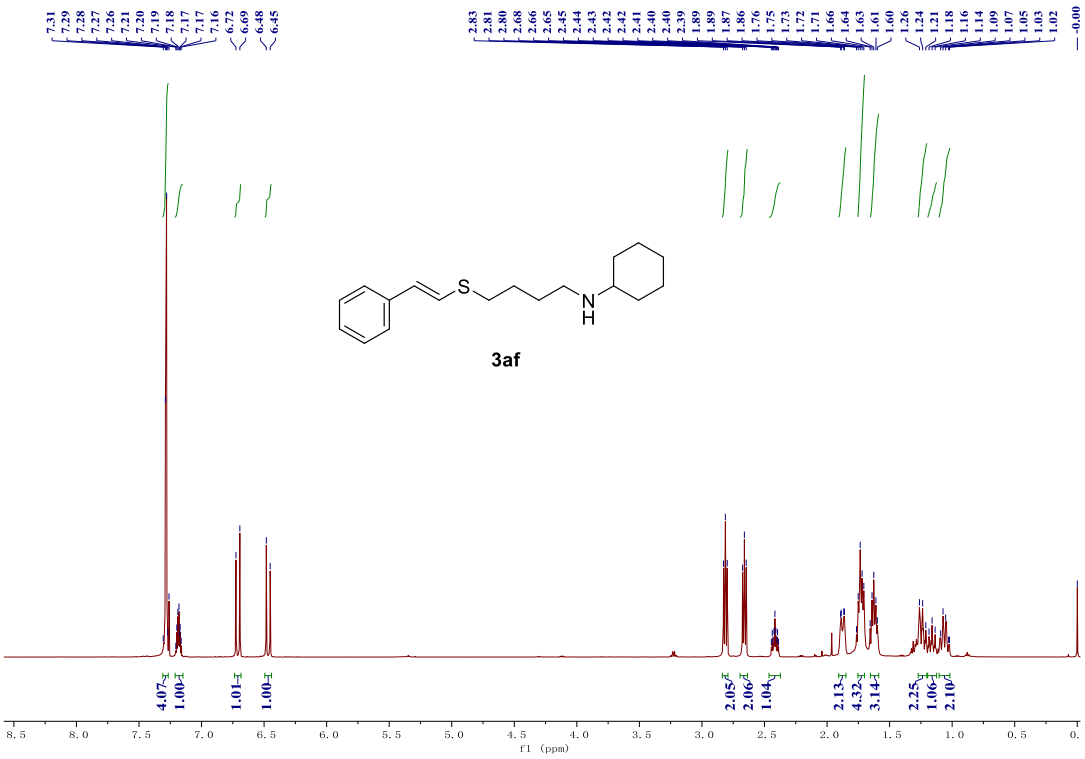
^{1}H NMR of 3ae



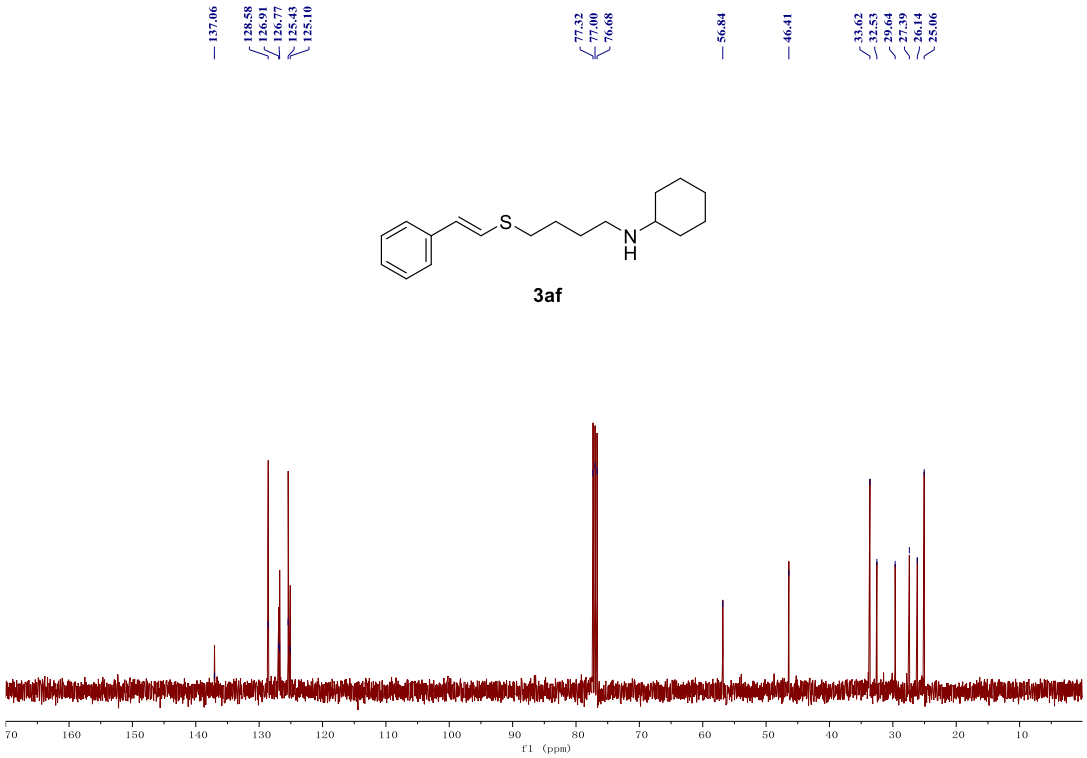
^{13}C NMR of 3ae



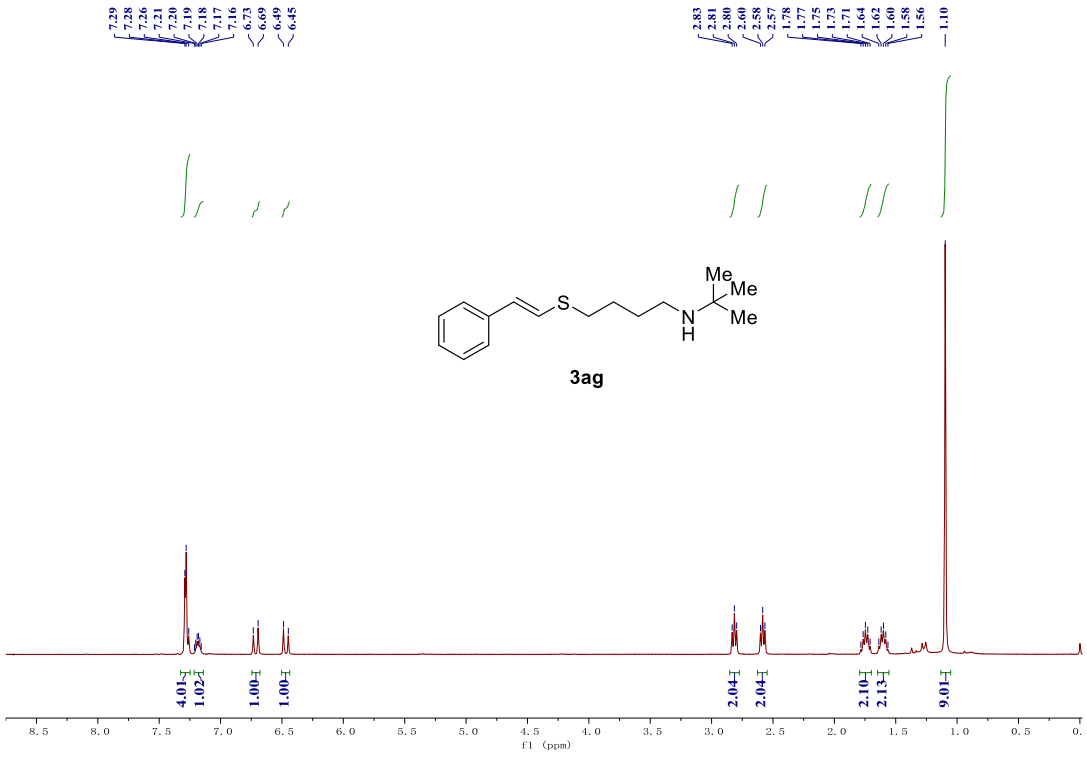
^{1}H NMR of 3af



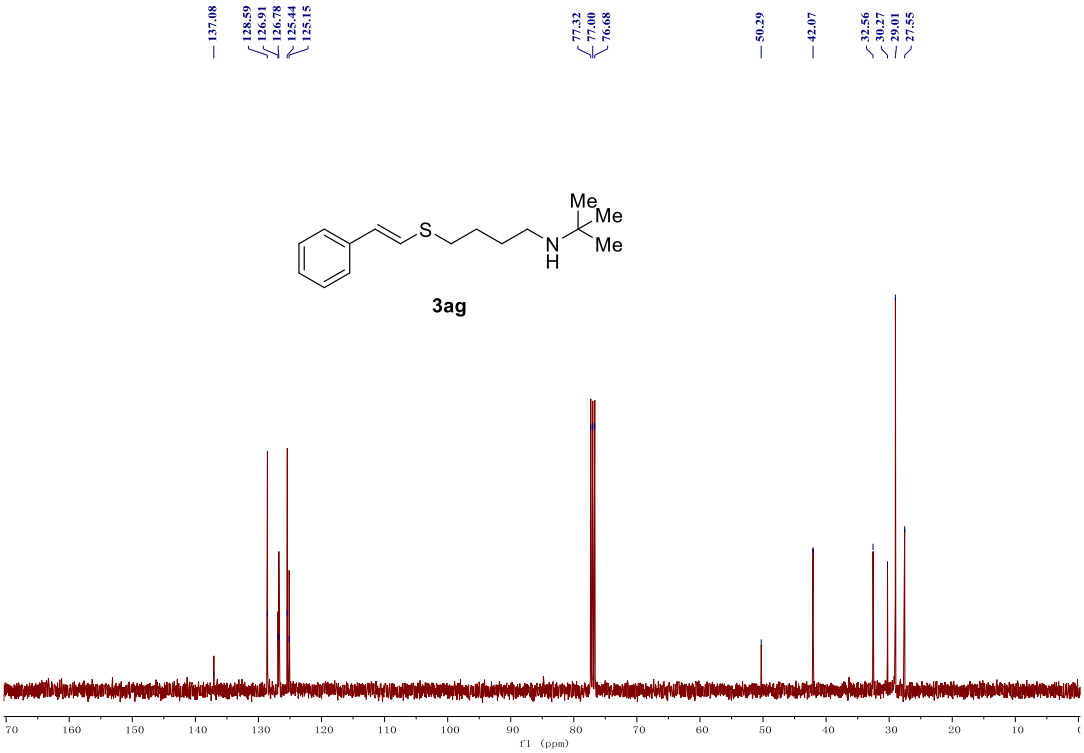
^{13}C NMR of 3af



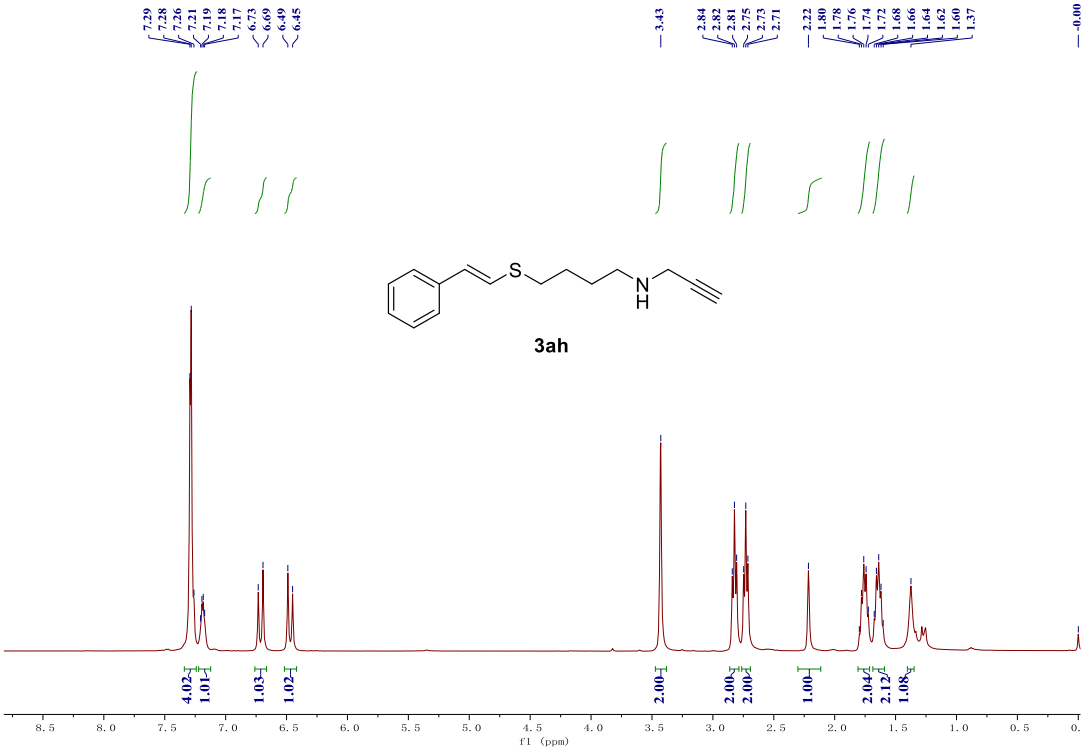
^{1}H NMR of 3ag



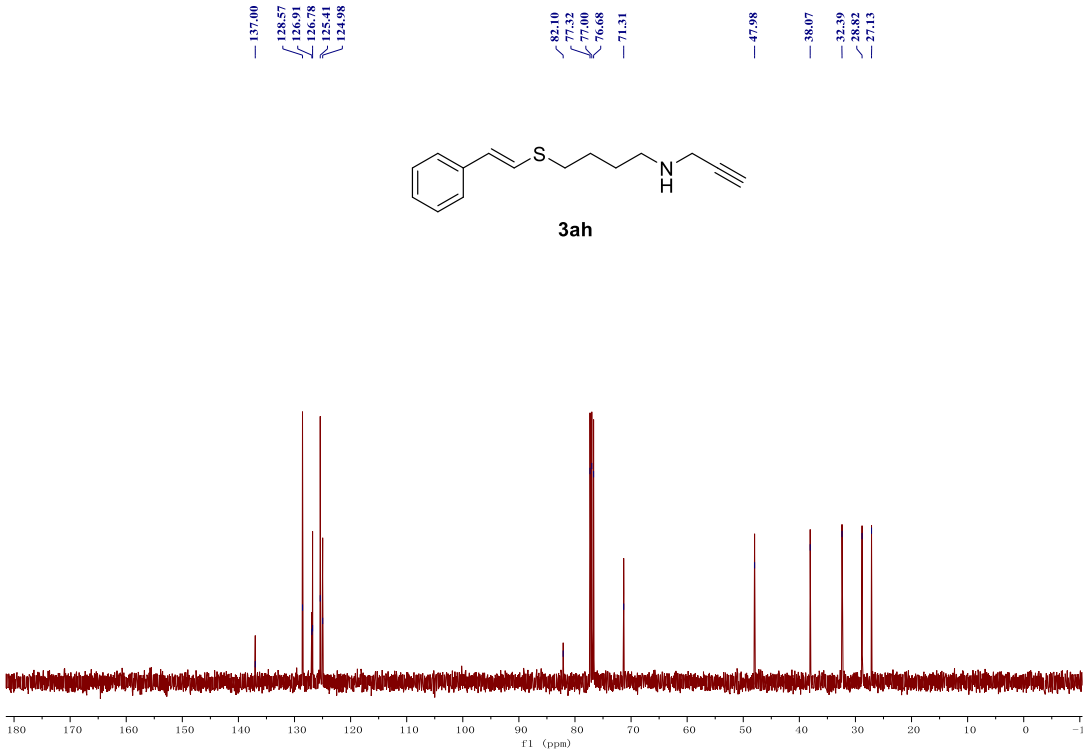
^{13}C NMR of 3ag



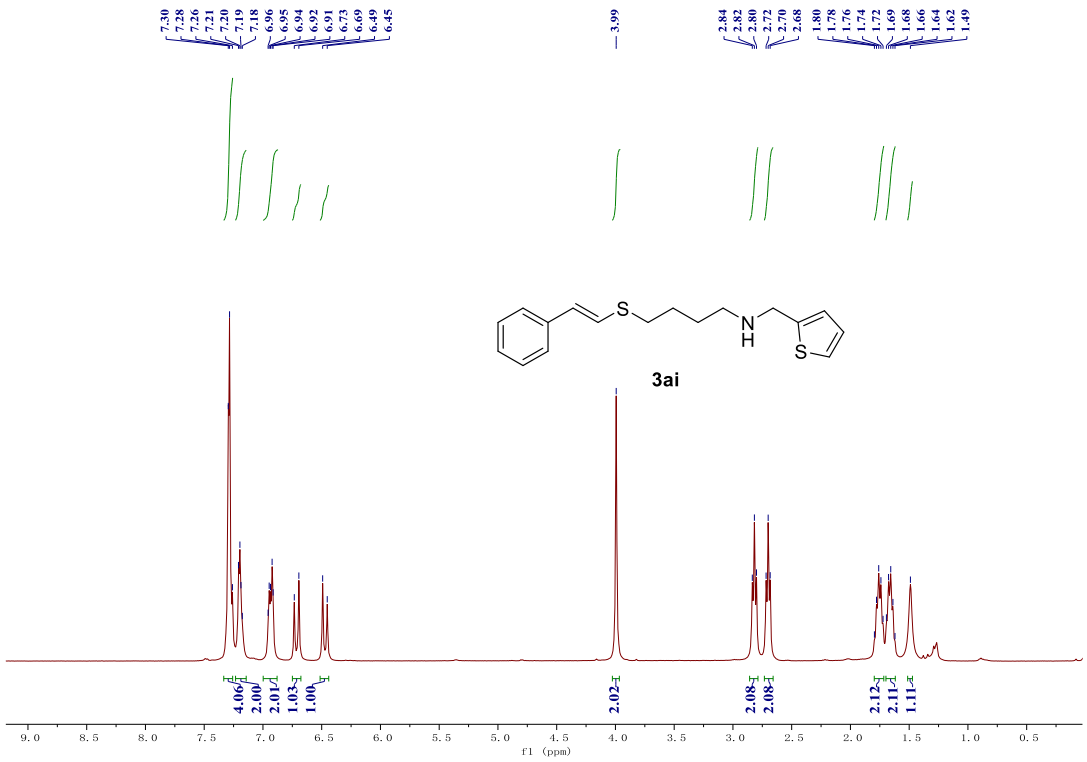
^{1}H NMR of 3ah



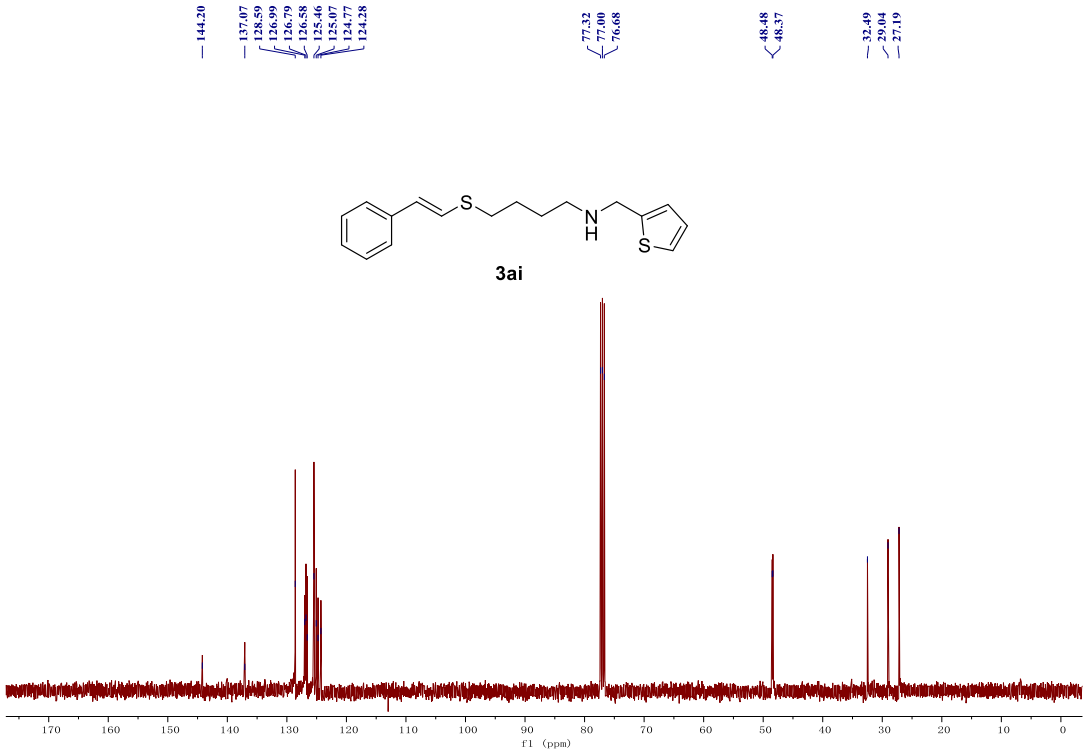
^{13}C NMR of 3ah



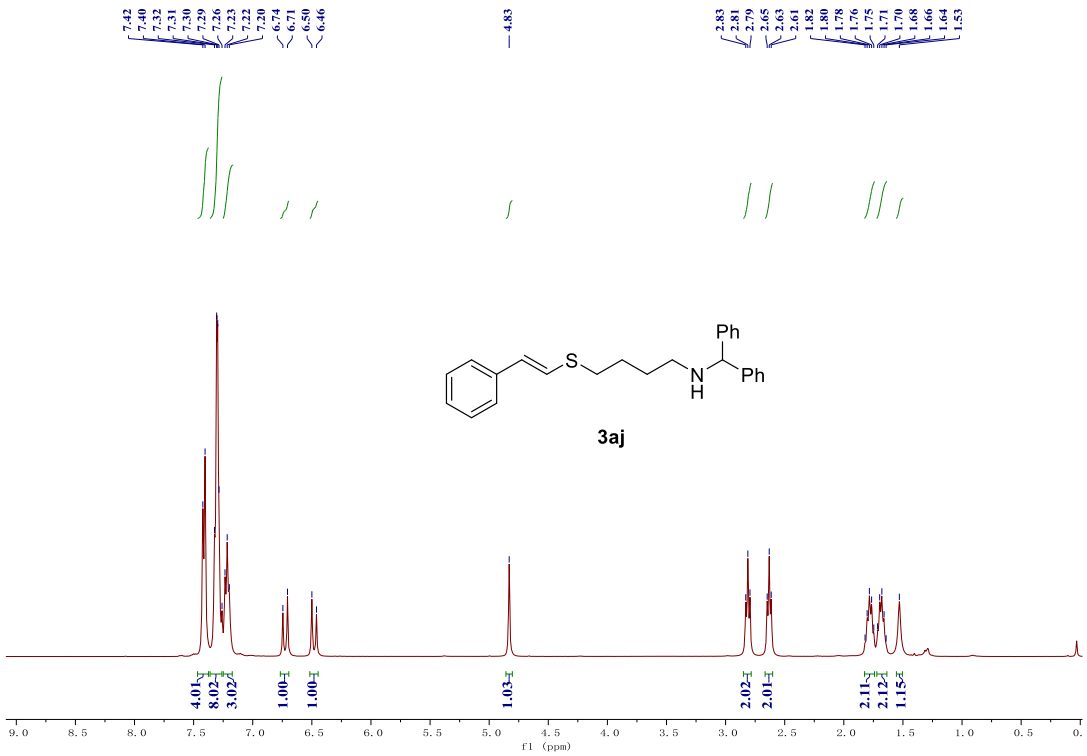
^{1}H NMR of 3ai



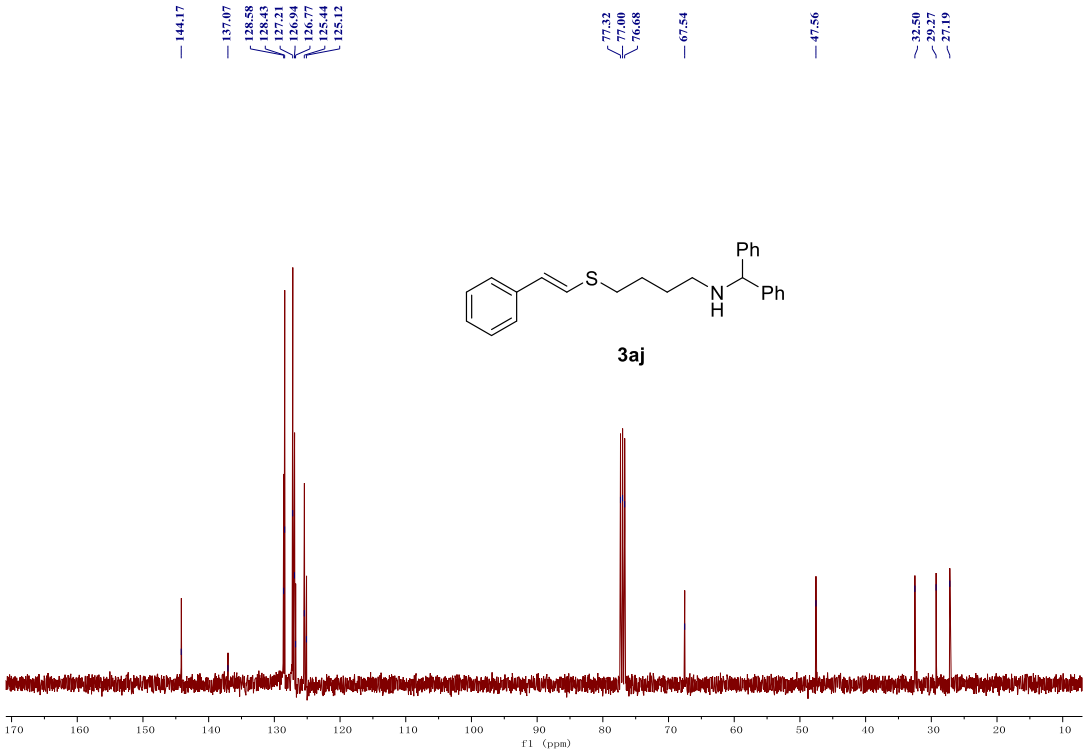
^{13}C NMR of 3ai



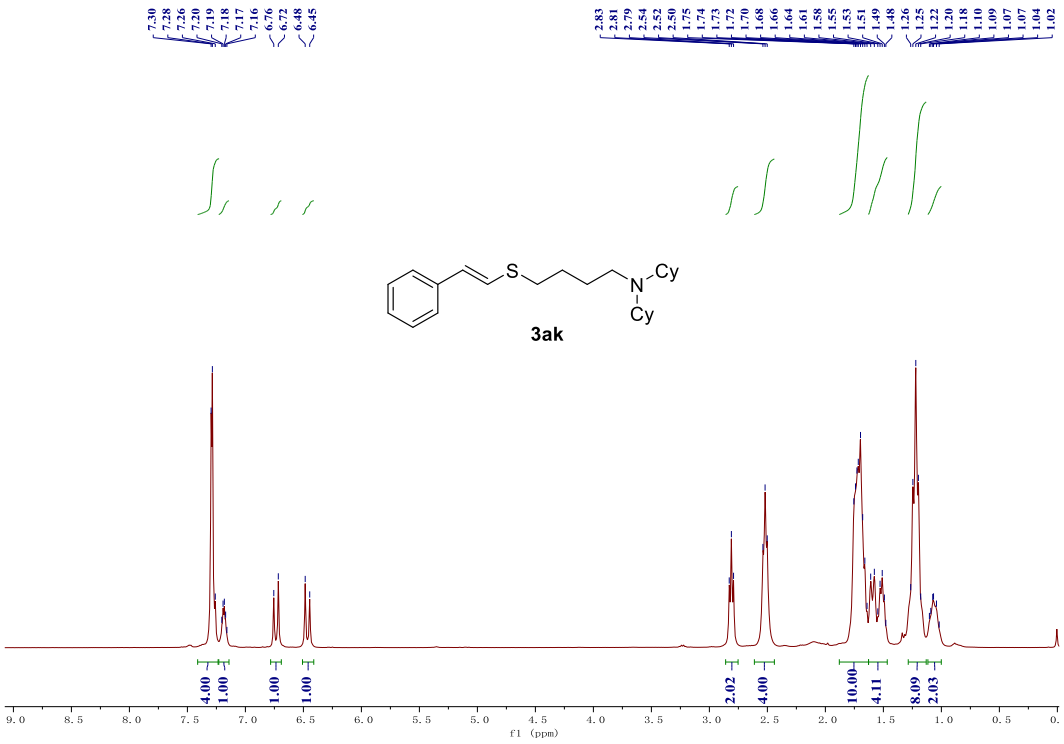
^{1}H NMR of 3aj



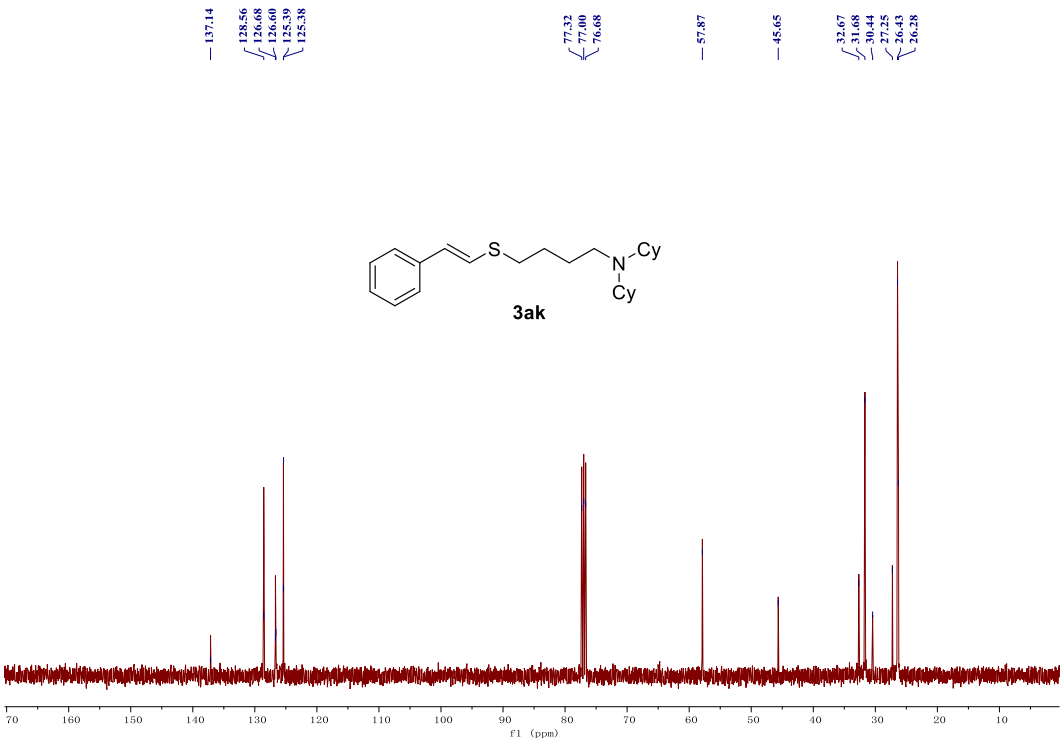
^{13}C NMR of 3aj



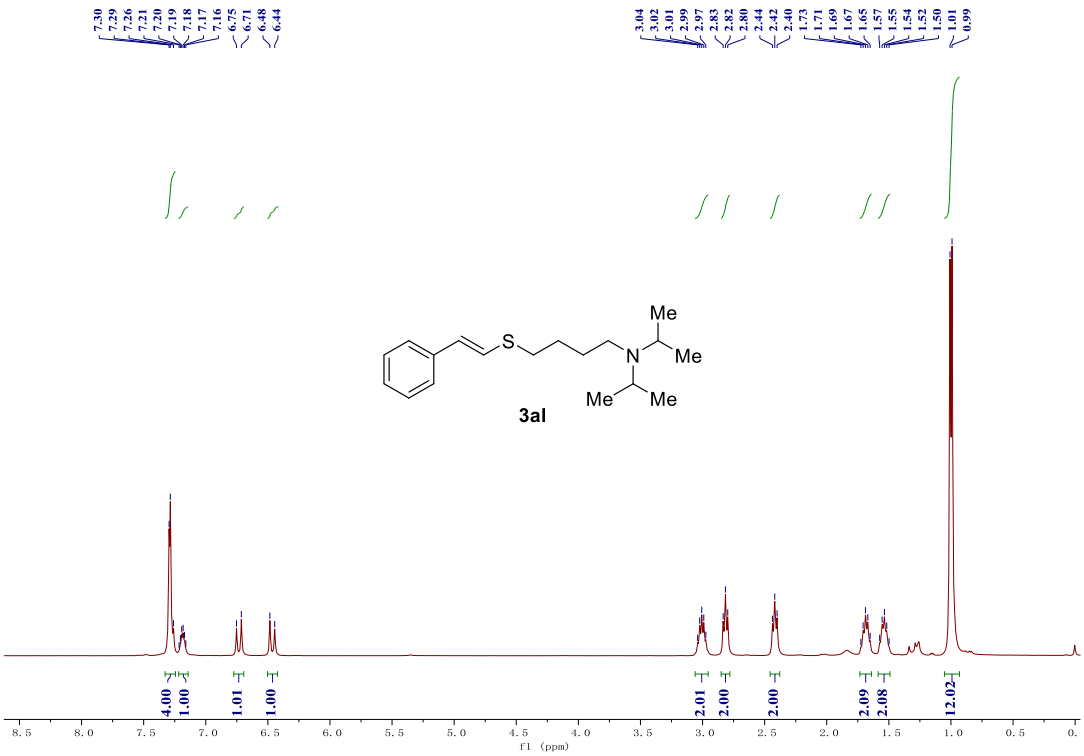
^{1}H NMR of 3ak



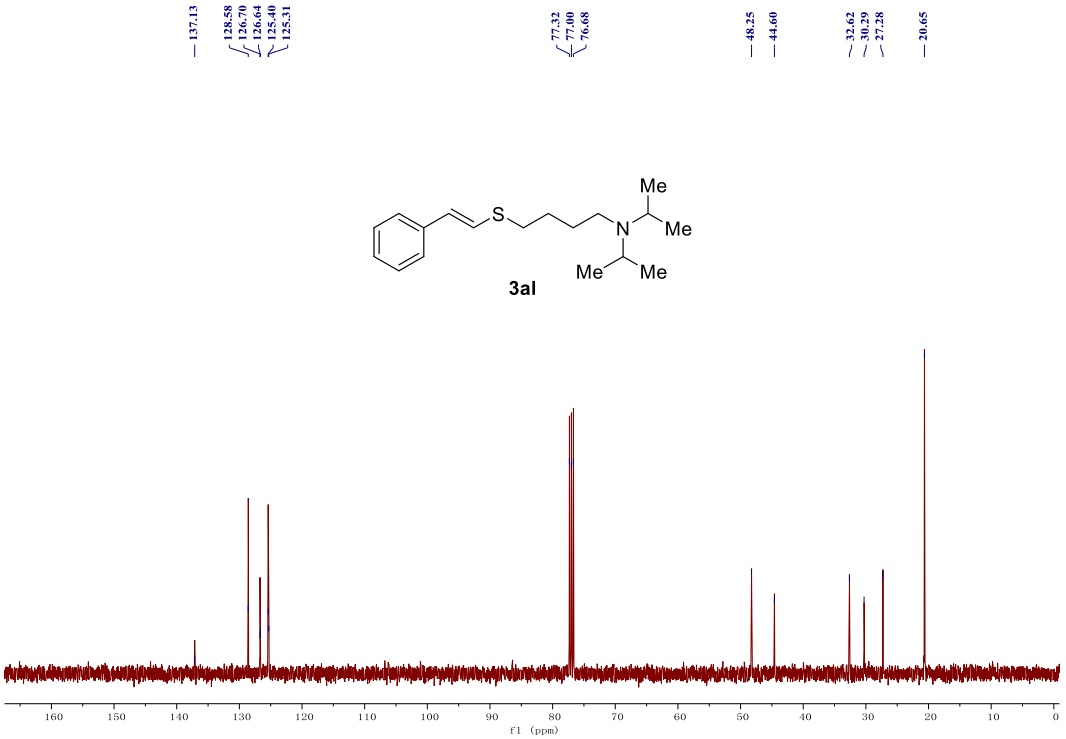
^{13}C NMR of 3ak



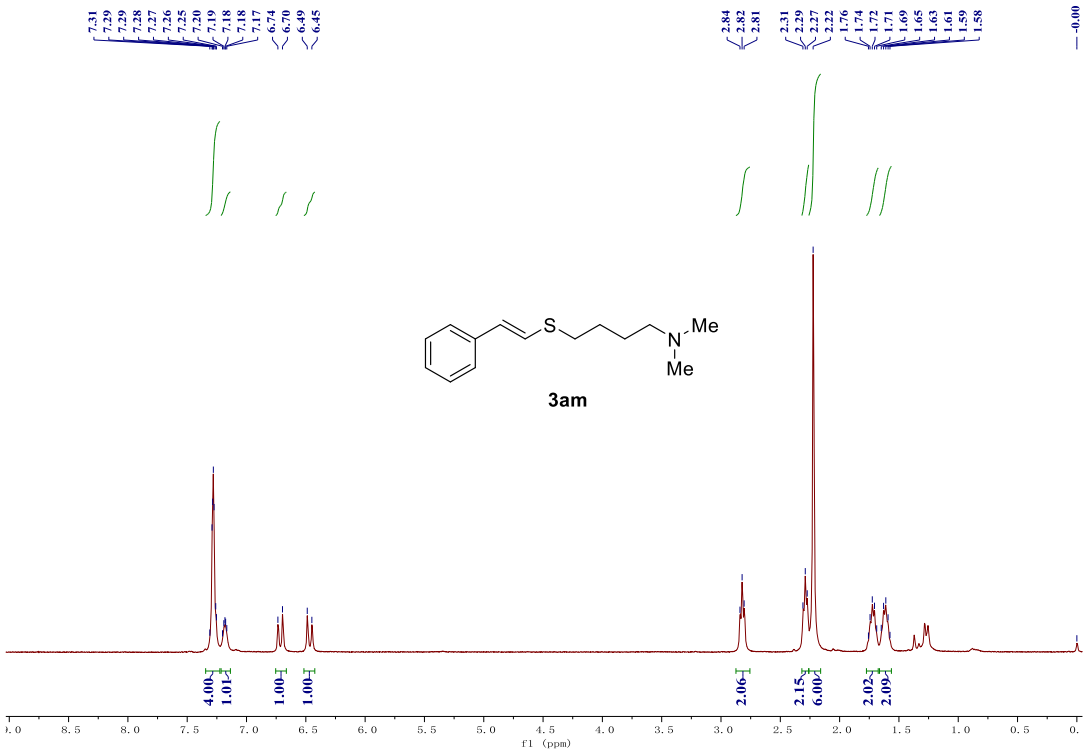
^{1}H NMR of 3al



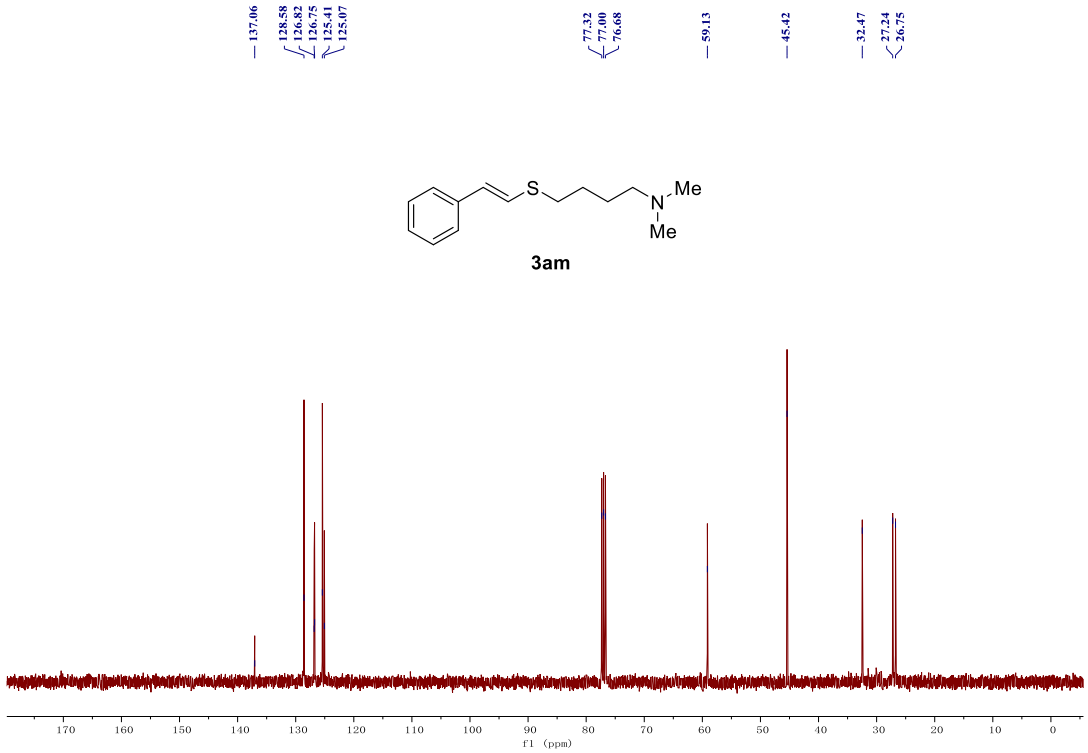
^{13}C NMR of 3al



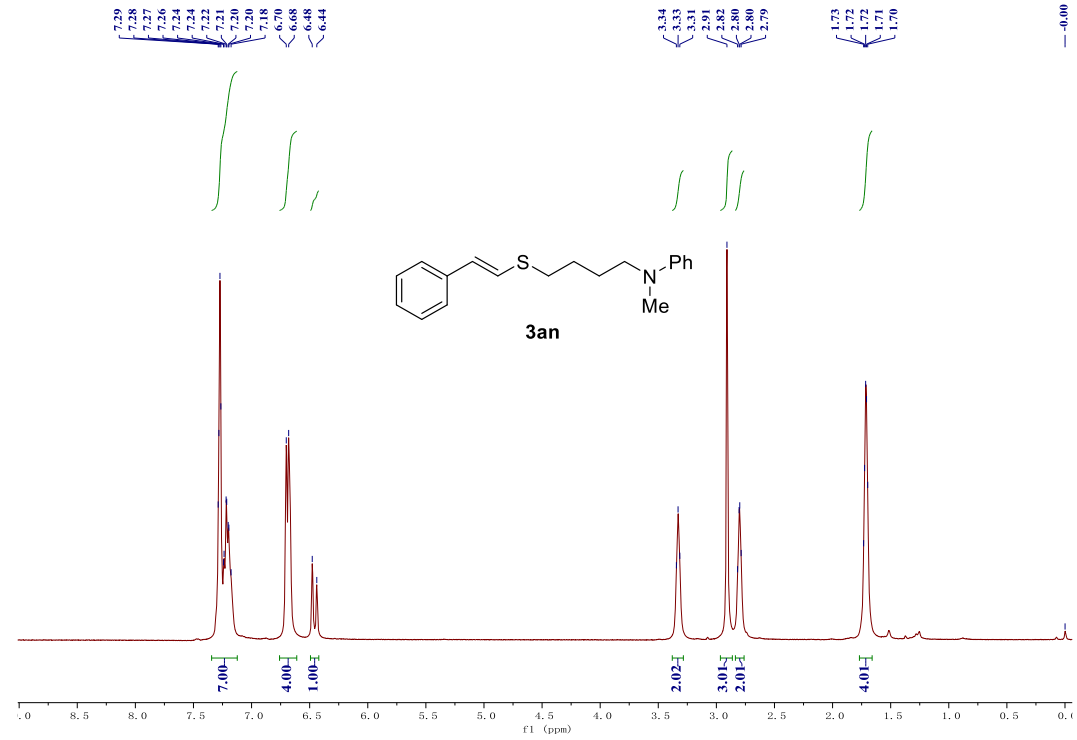
^{1}H NMR of 3am



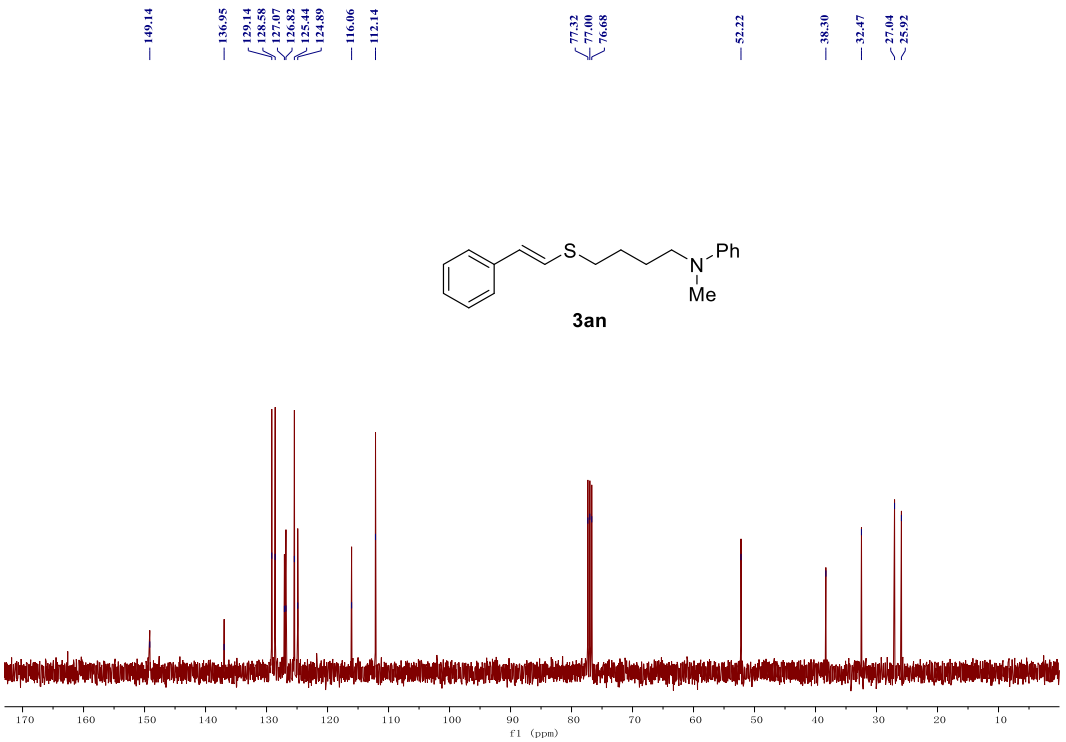
^{13}C NMR of 3am



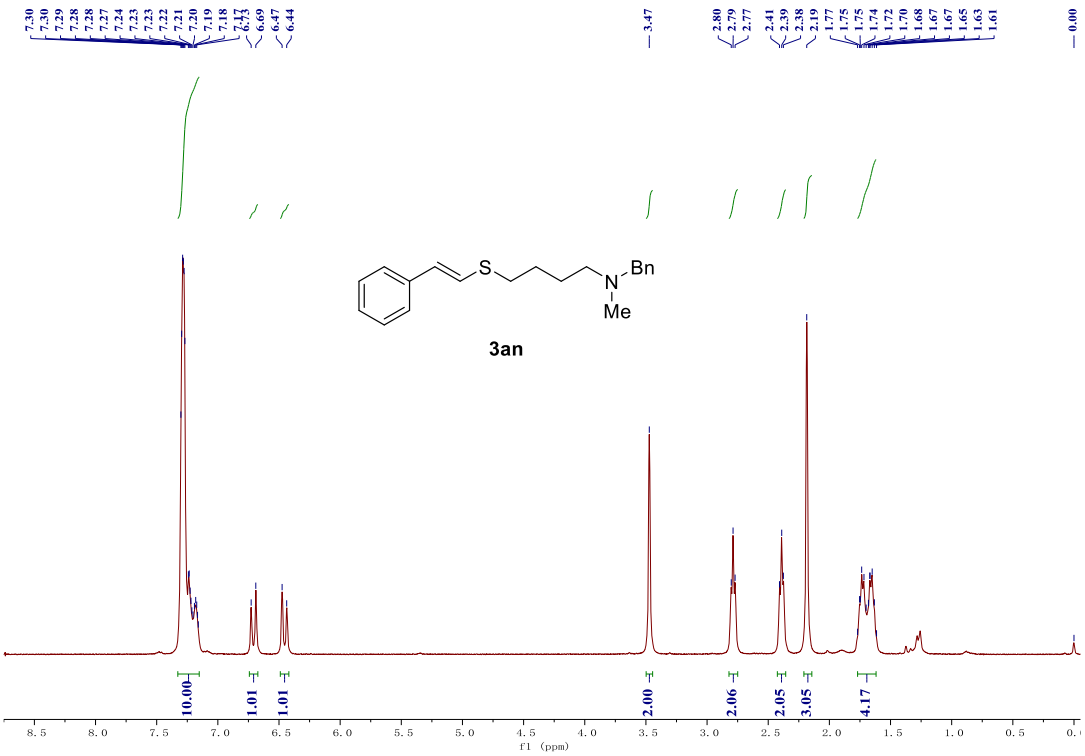
^{1}H NMR of 3an



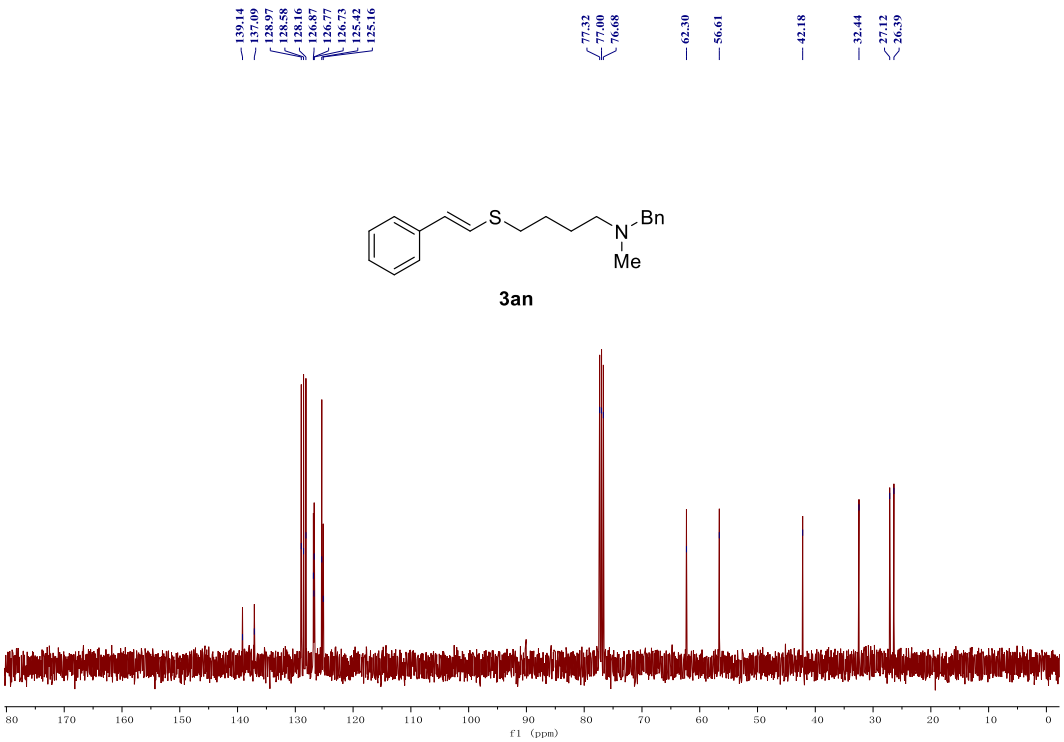
^{13}C NMR of 3an



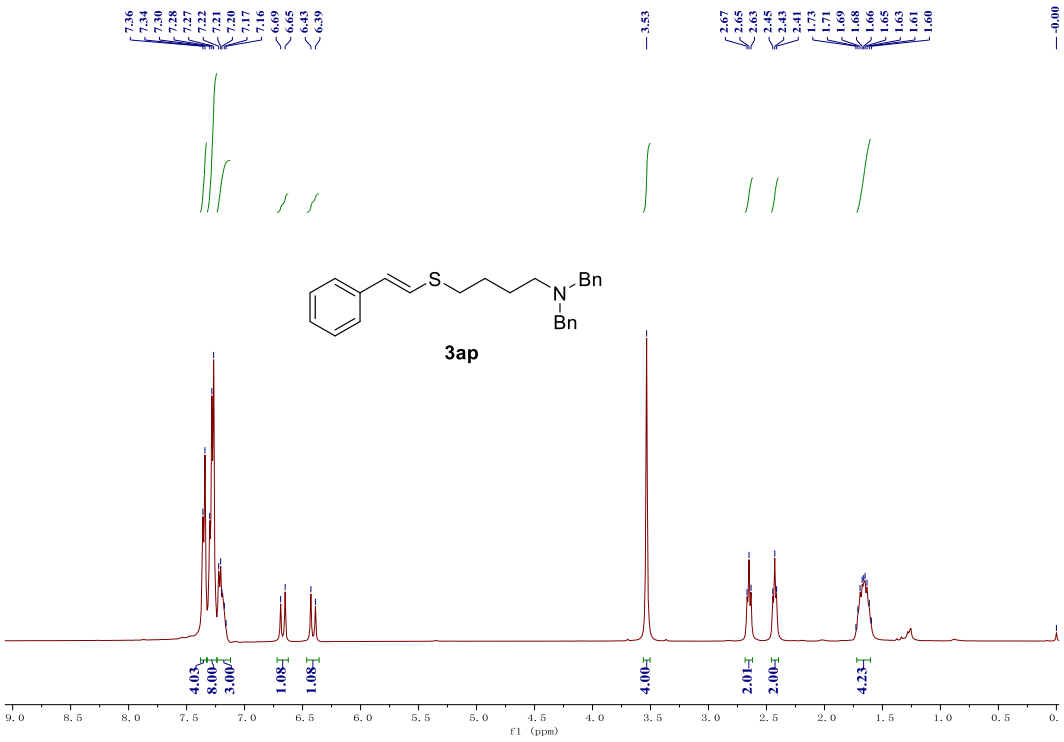
^{1}H NMR of 3ao



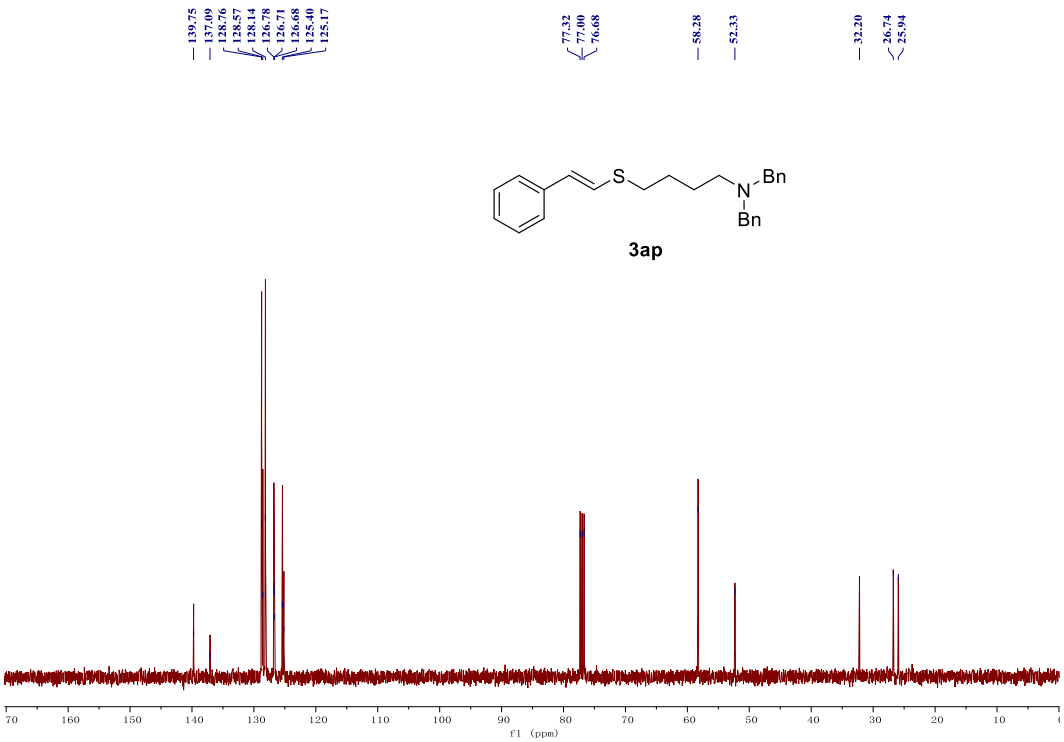
^{13}C NMR of 3ao



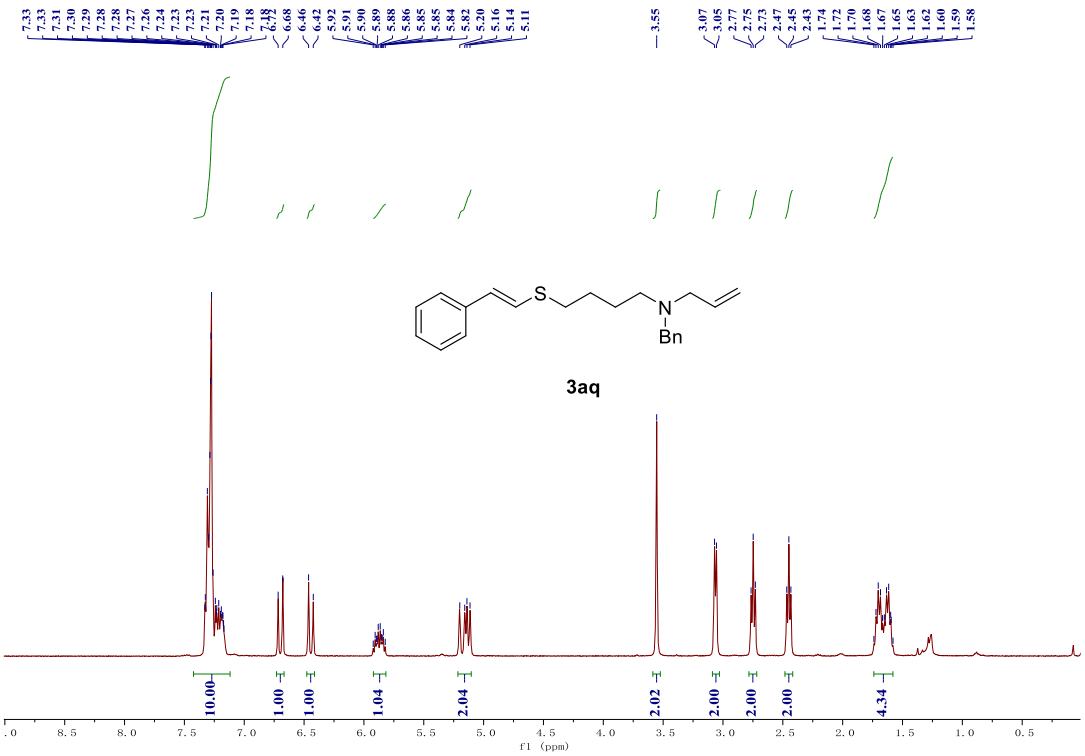
^{1}H NMR of 3ap



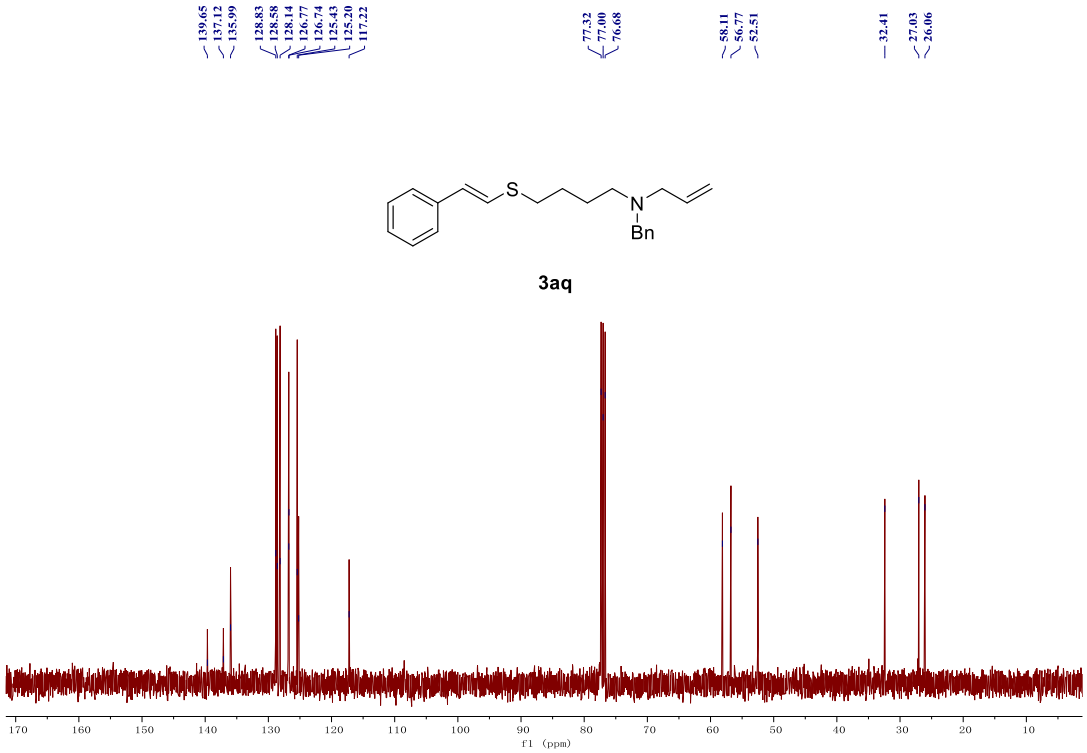
^{13}C NMR of 3ap



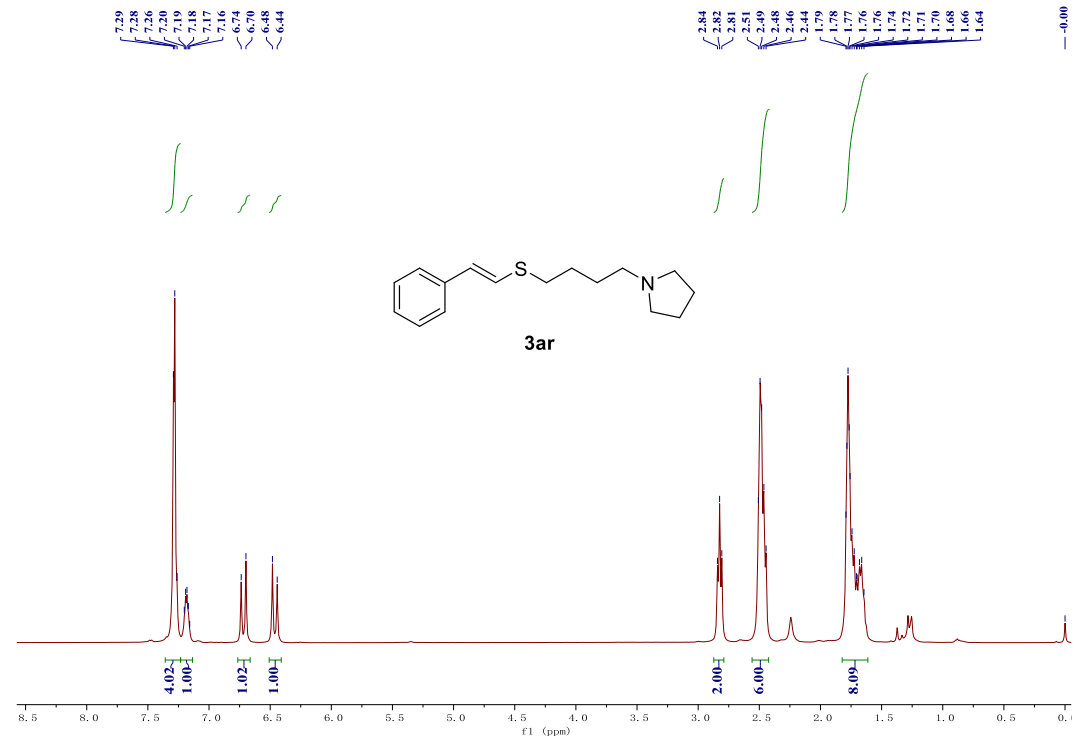
^{1}H NMR of 3aq



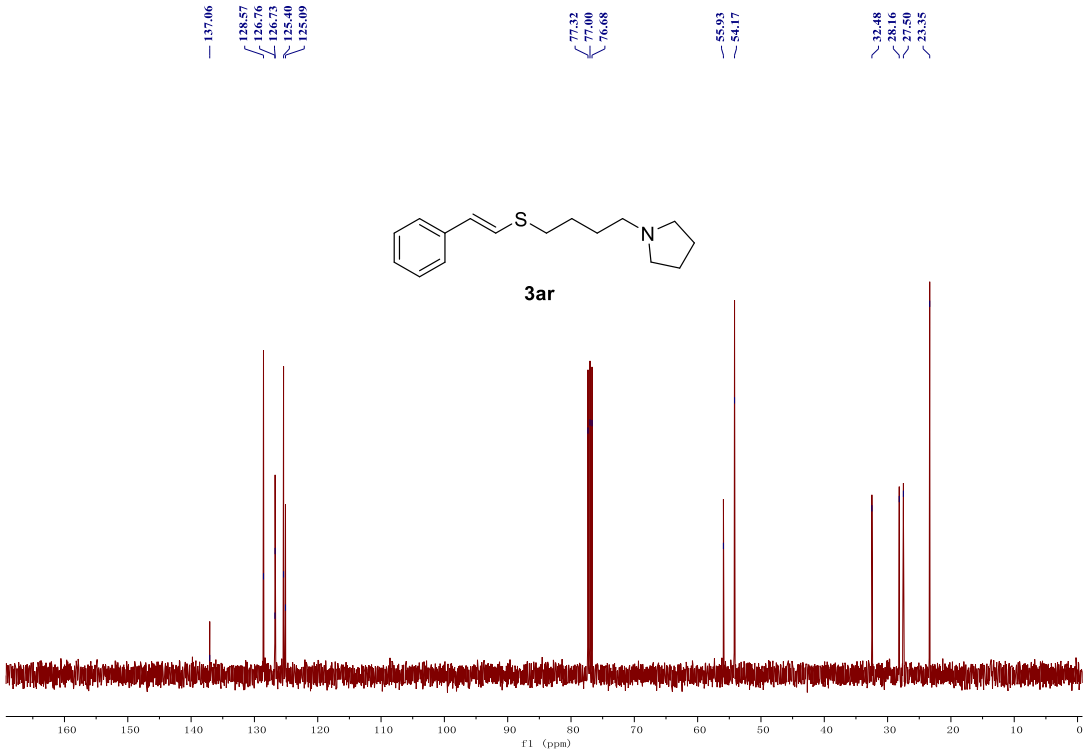
^{13}C NMR of 3aq



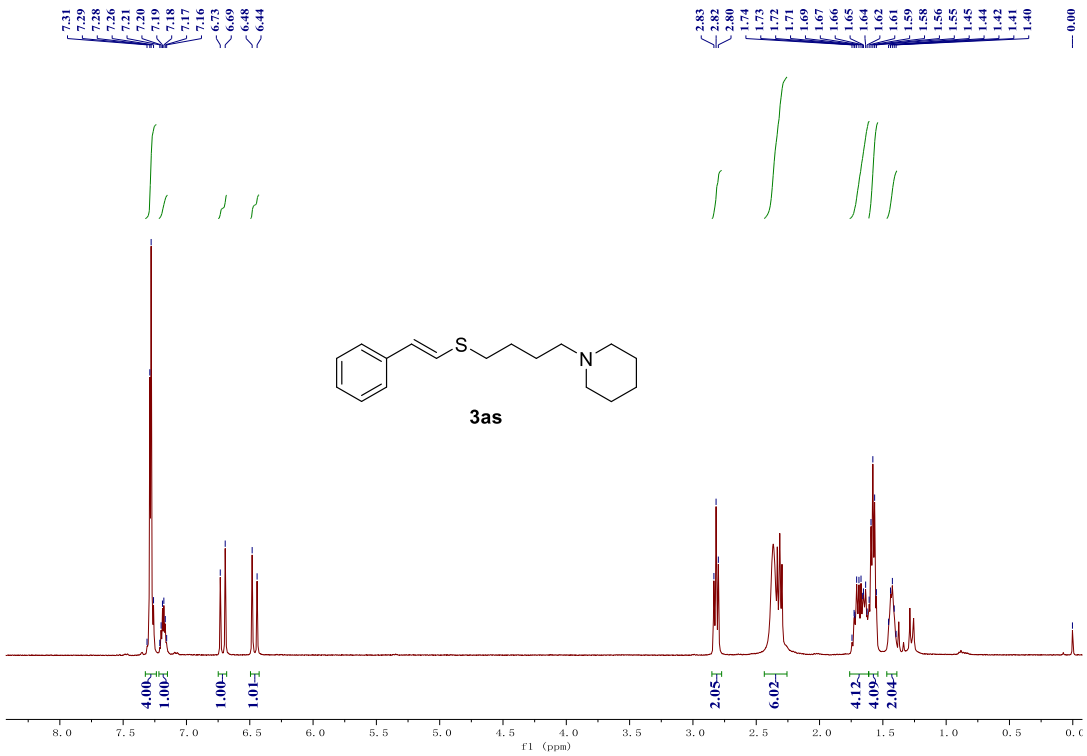
^{1}H NMR of 3ar



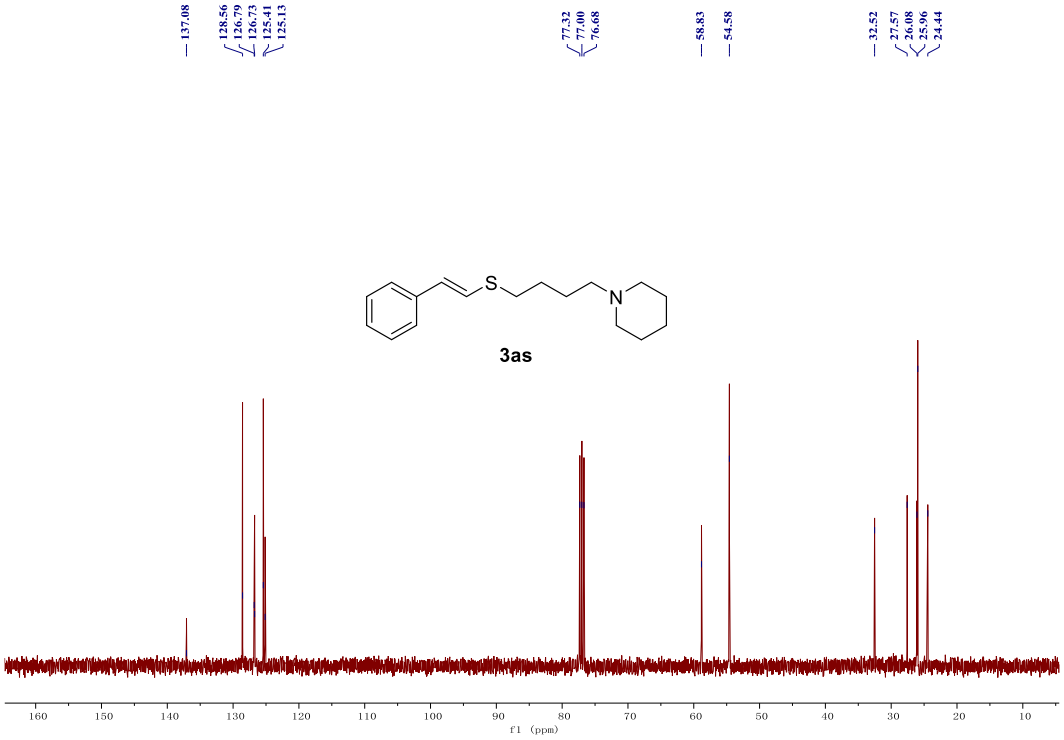
^{13}C NMR of 3ar



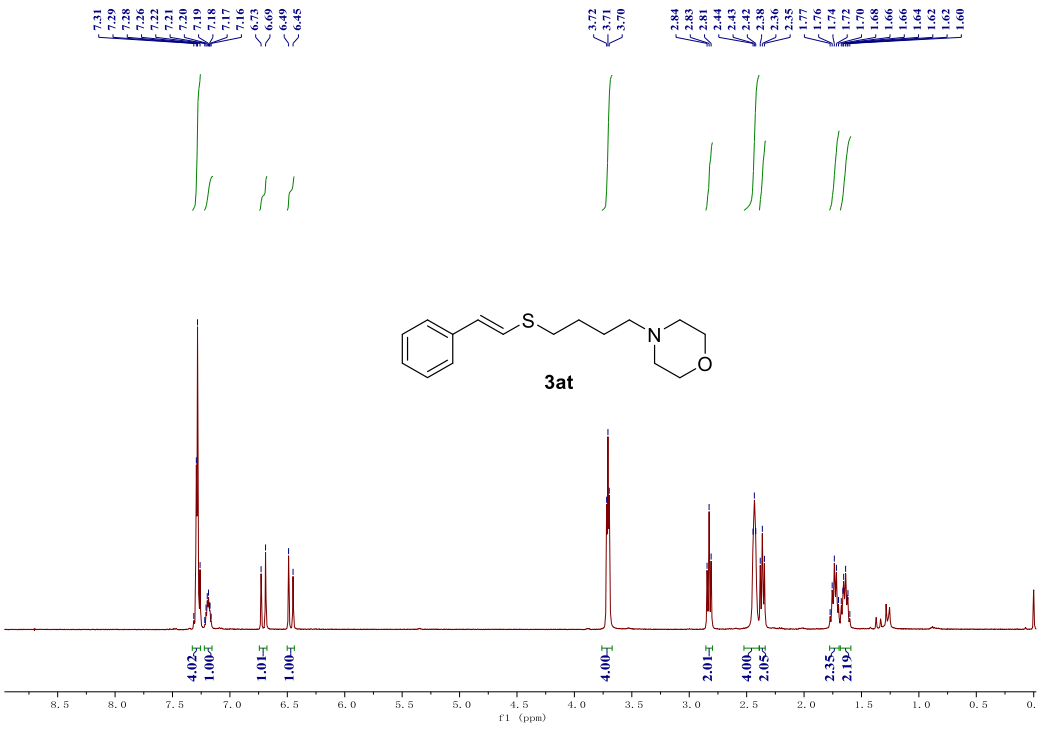
^{1}H NMR of 3as



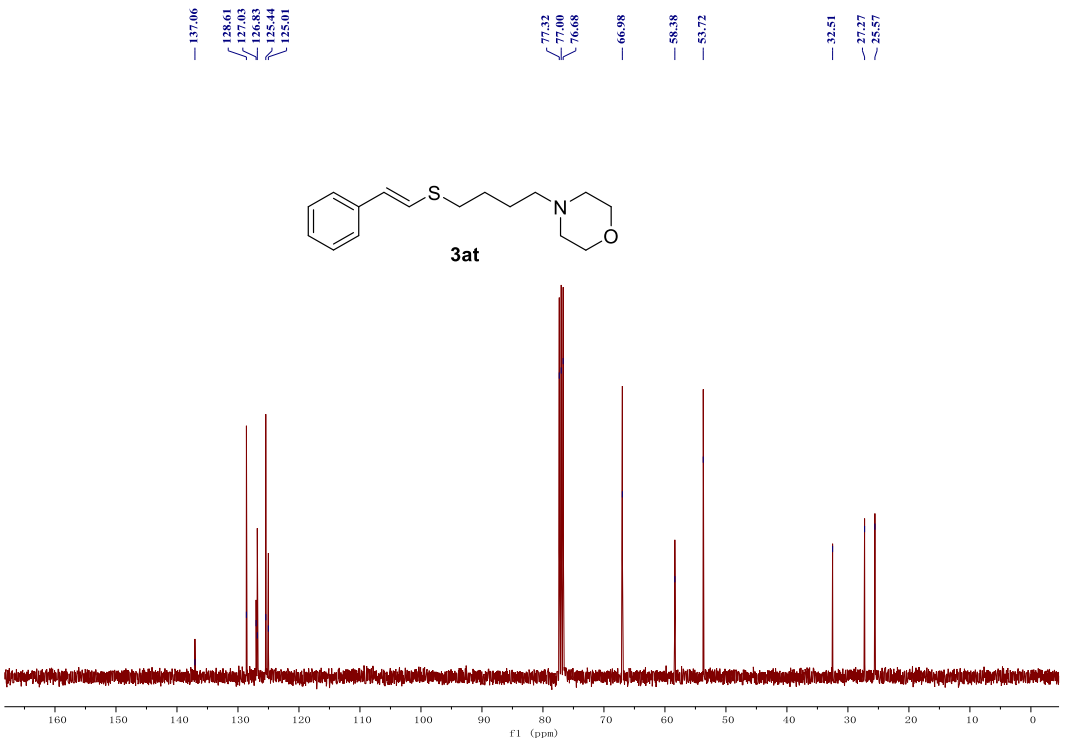
^{13}C NMR of 3as



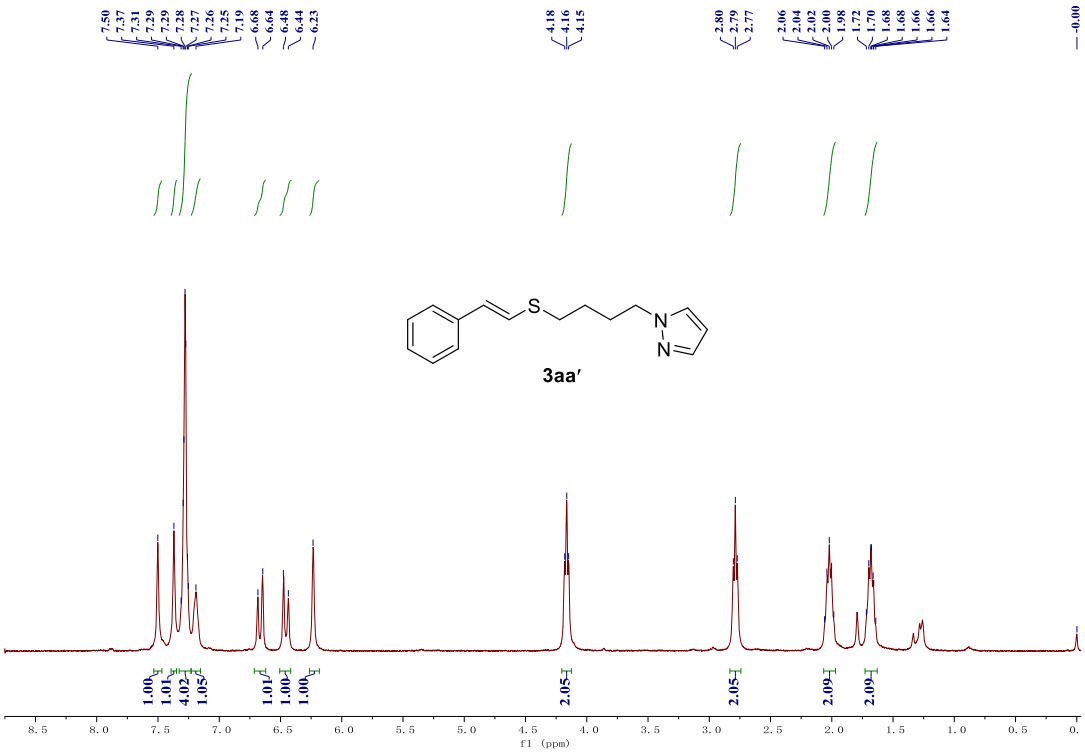
^{1}H NMR of 3at



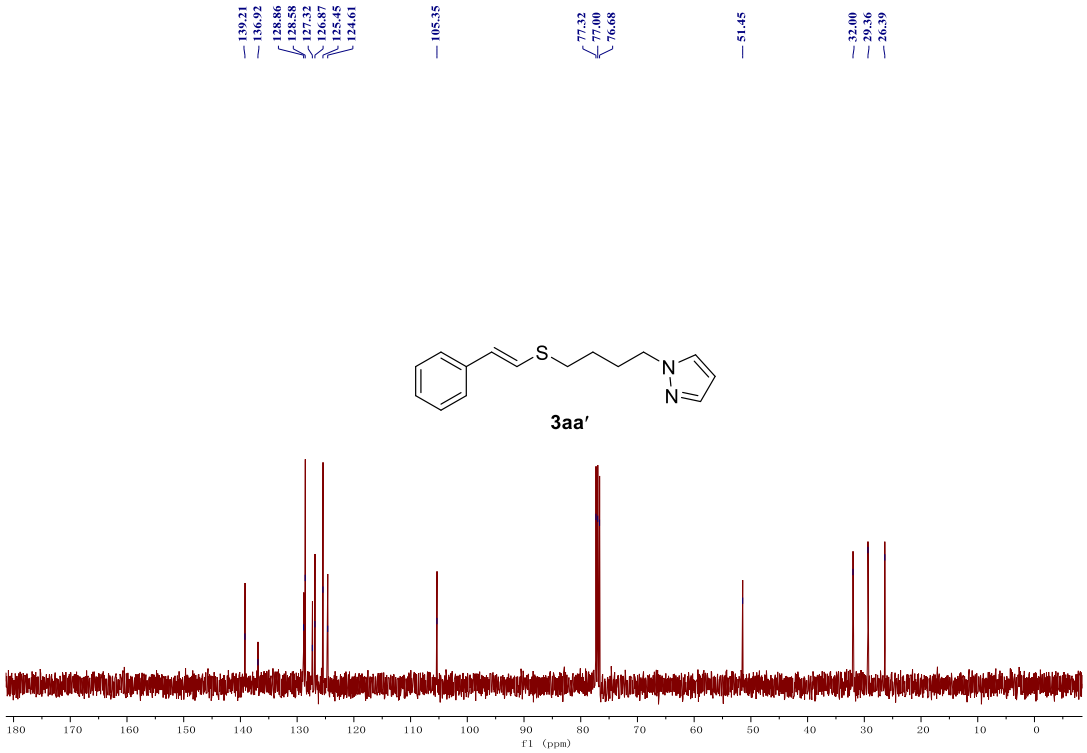
^{13}C NMR of 3at



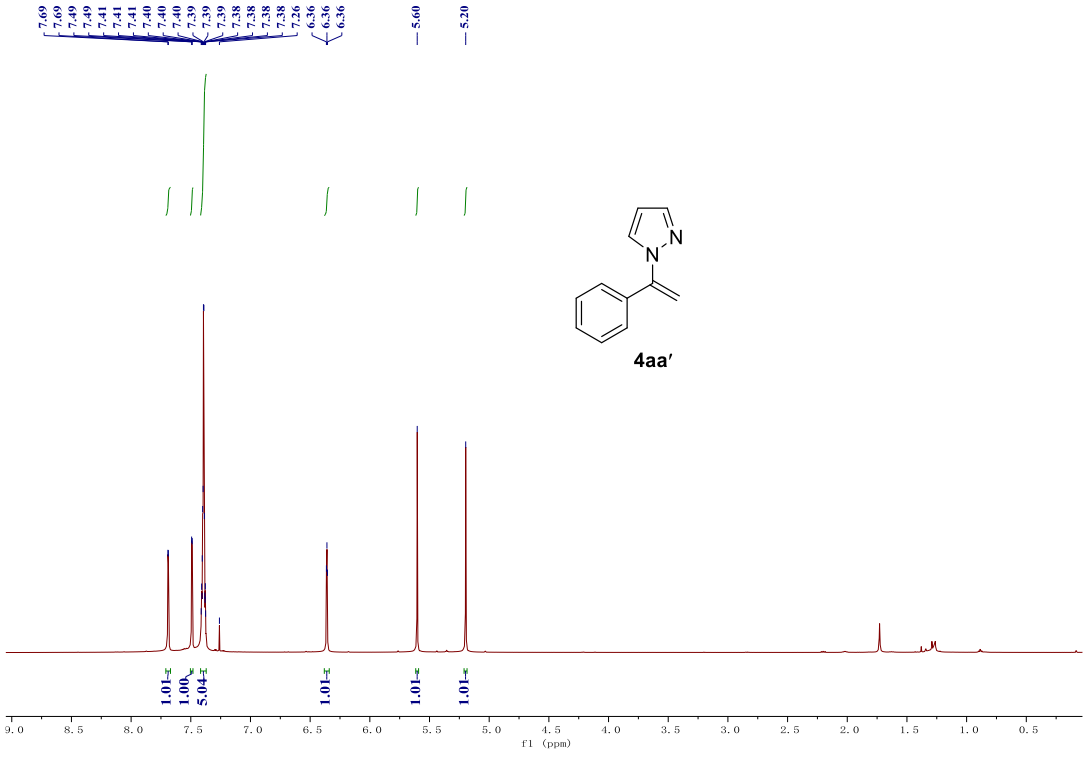
^{1}H NMR of 3aa'



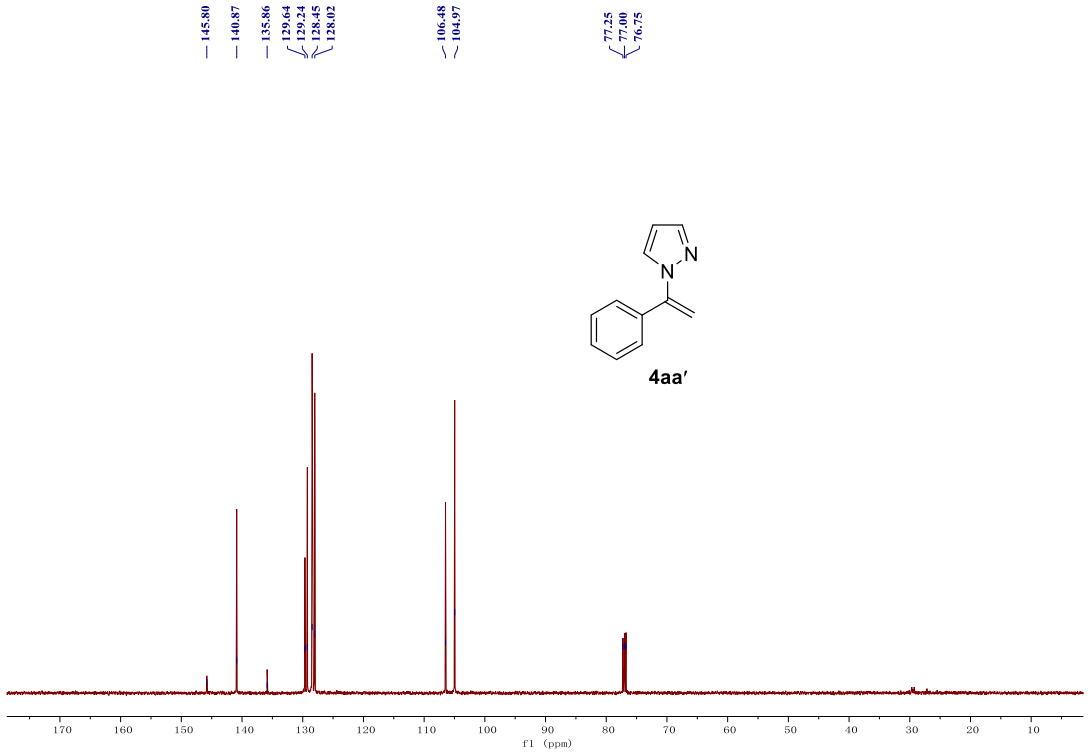
^{13}C NMR of 3aa'



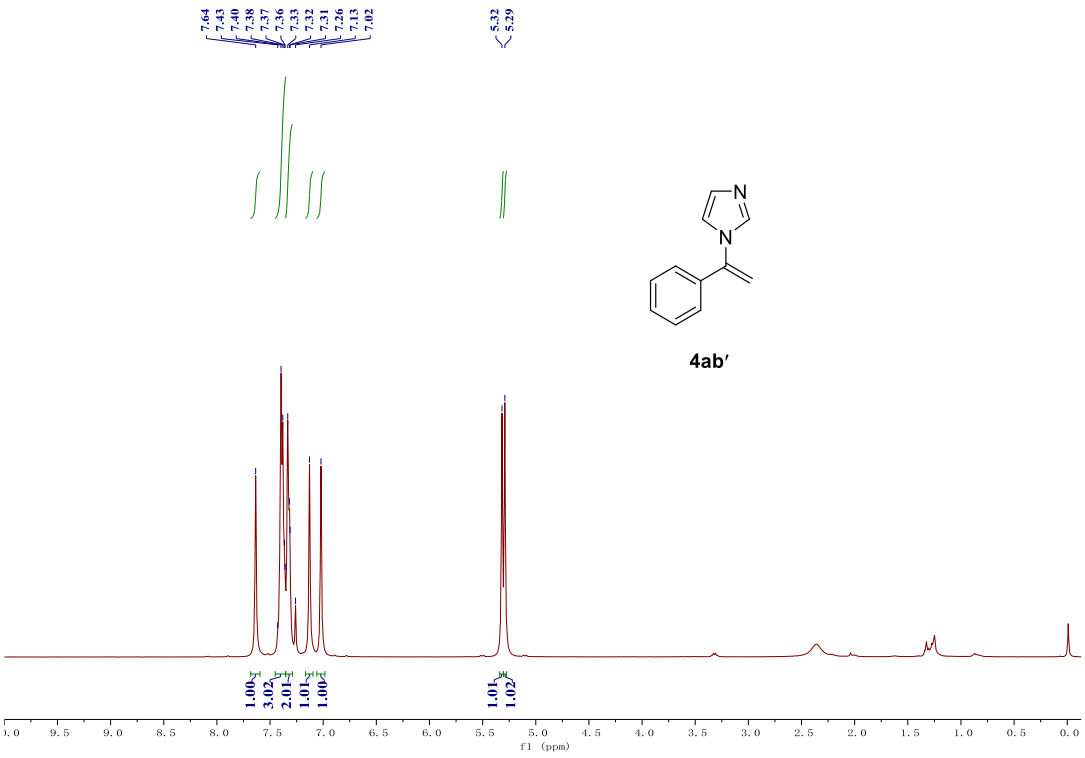
^{1}H NMR of 4aa'



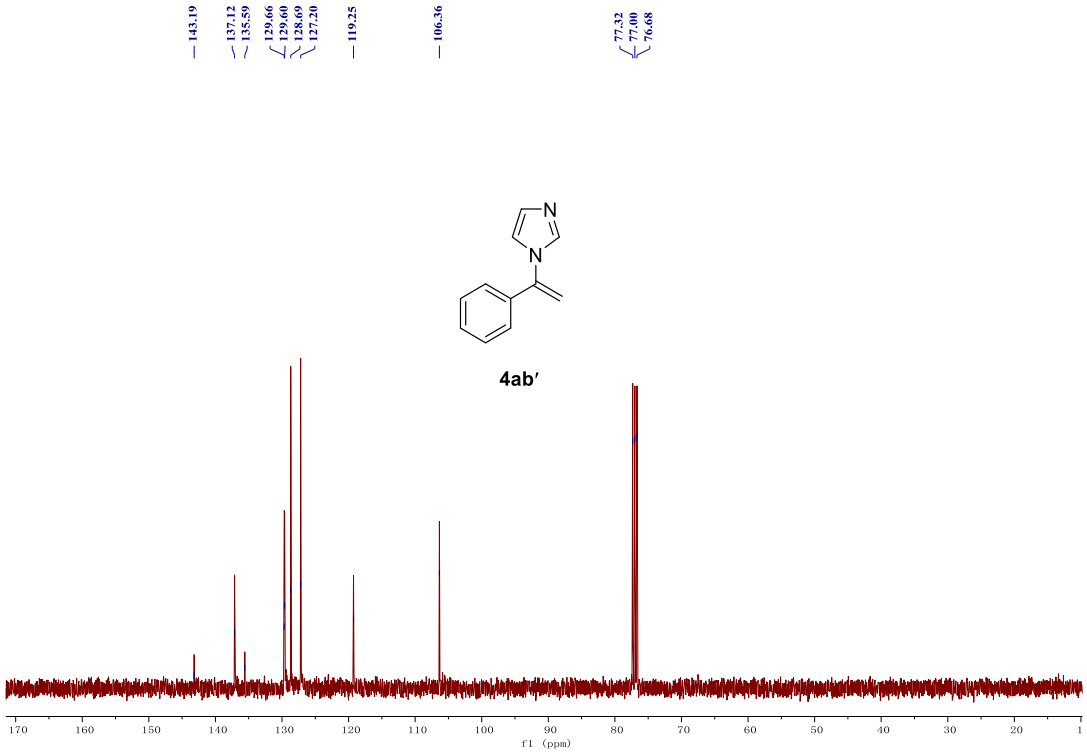
^{13}C NMR of 4aa'



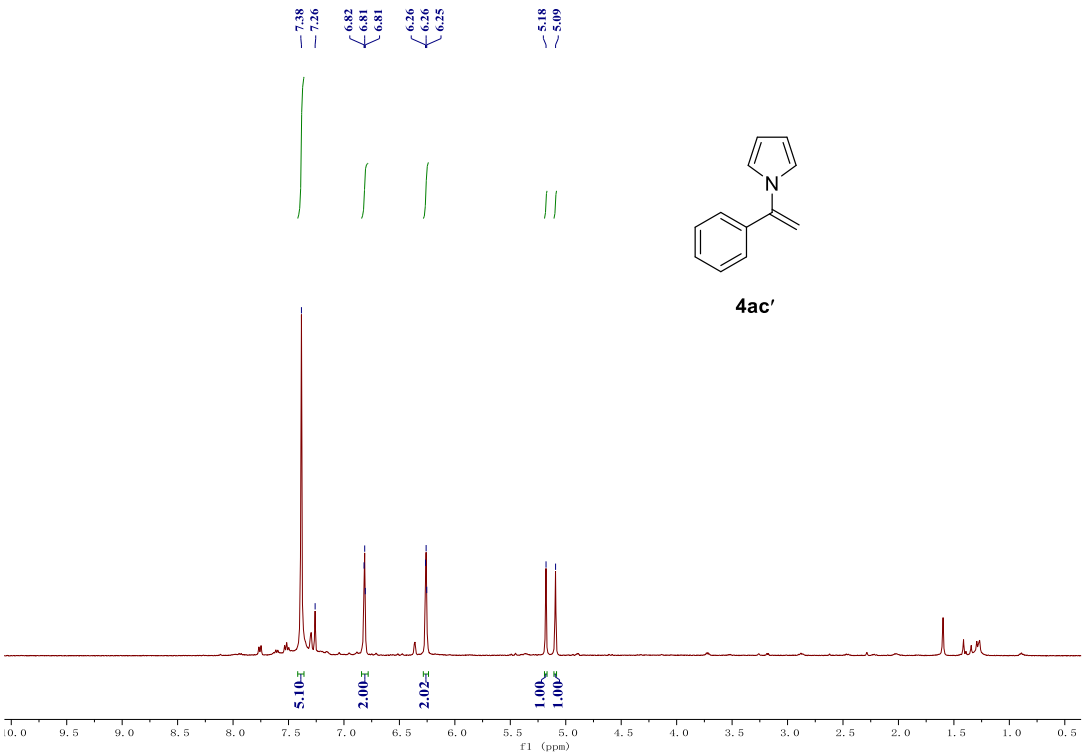
^{1}H NMR of 4ab'



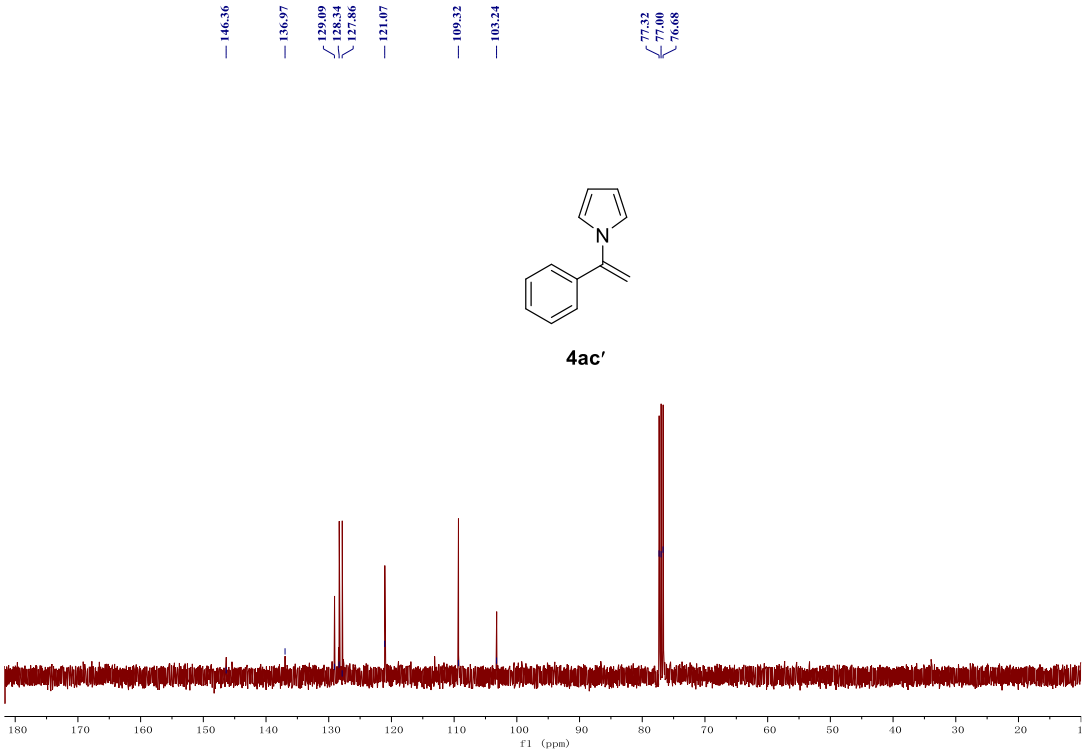
^{13}C NMR of 4ab'



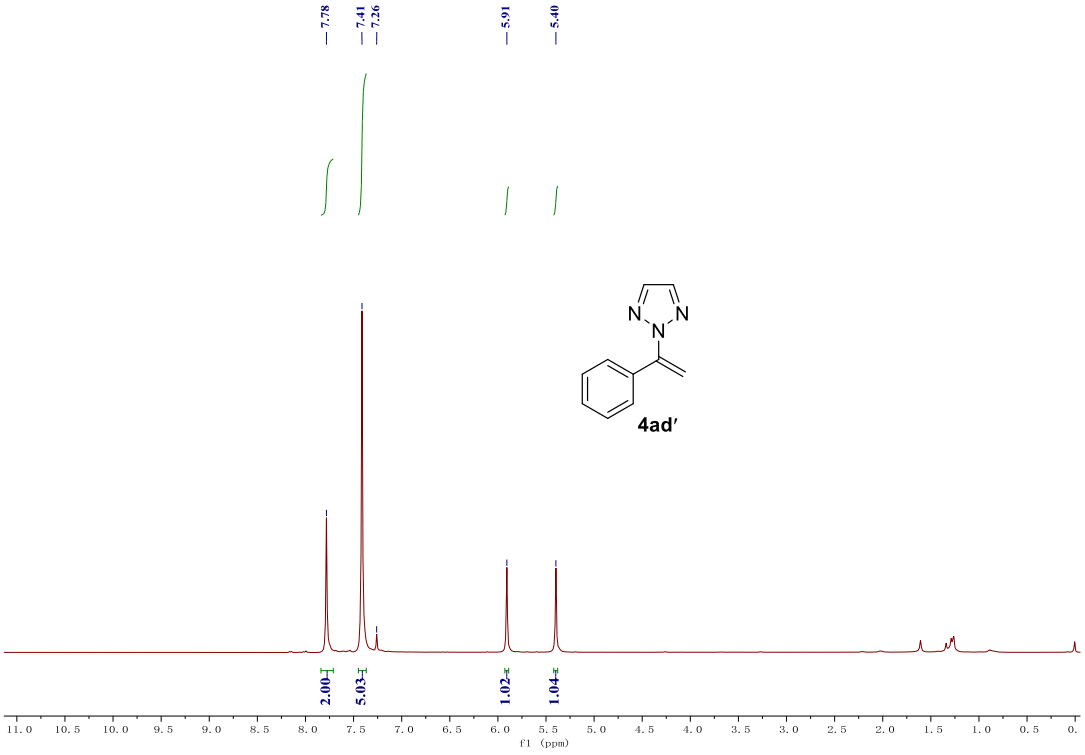
^{1}H NMR of 4ac'



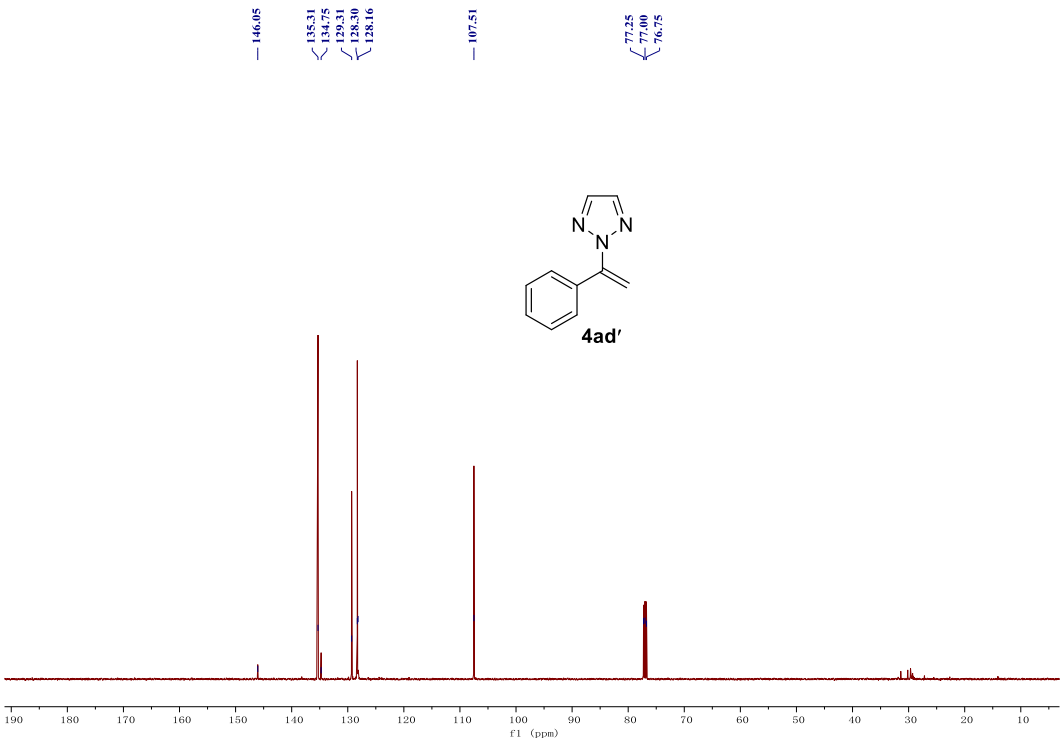
^{13}C NMR of 4ac'



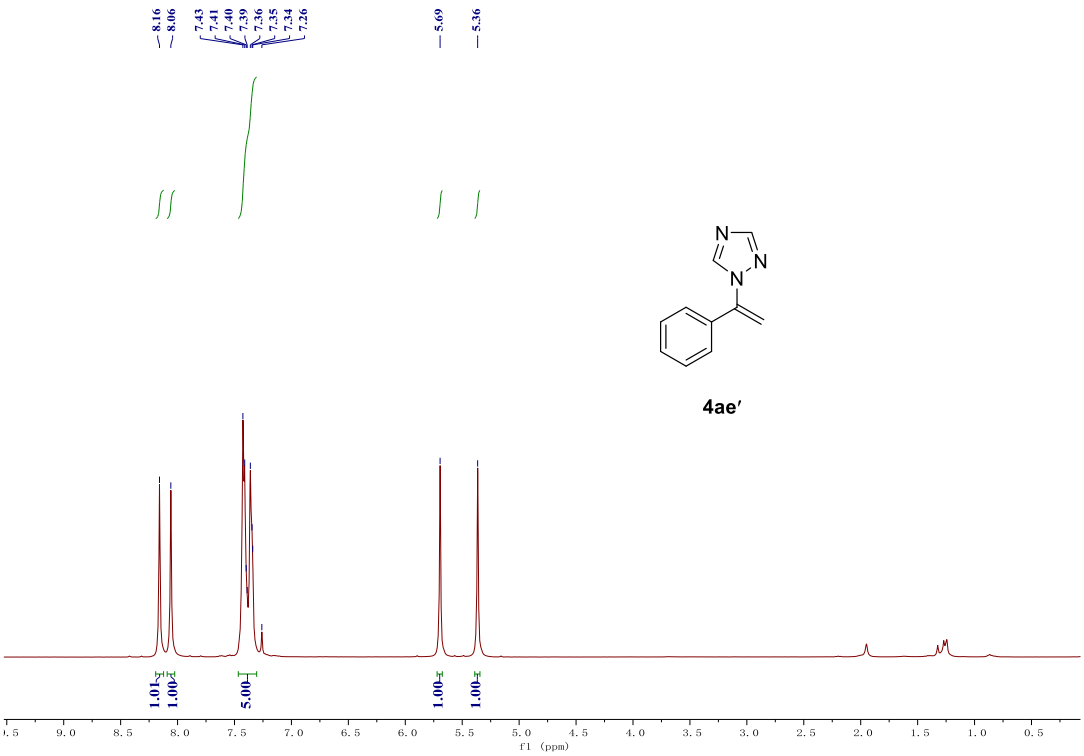
^{1}H NMR of 4ad'



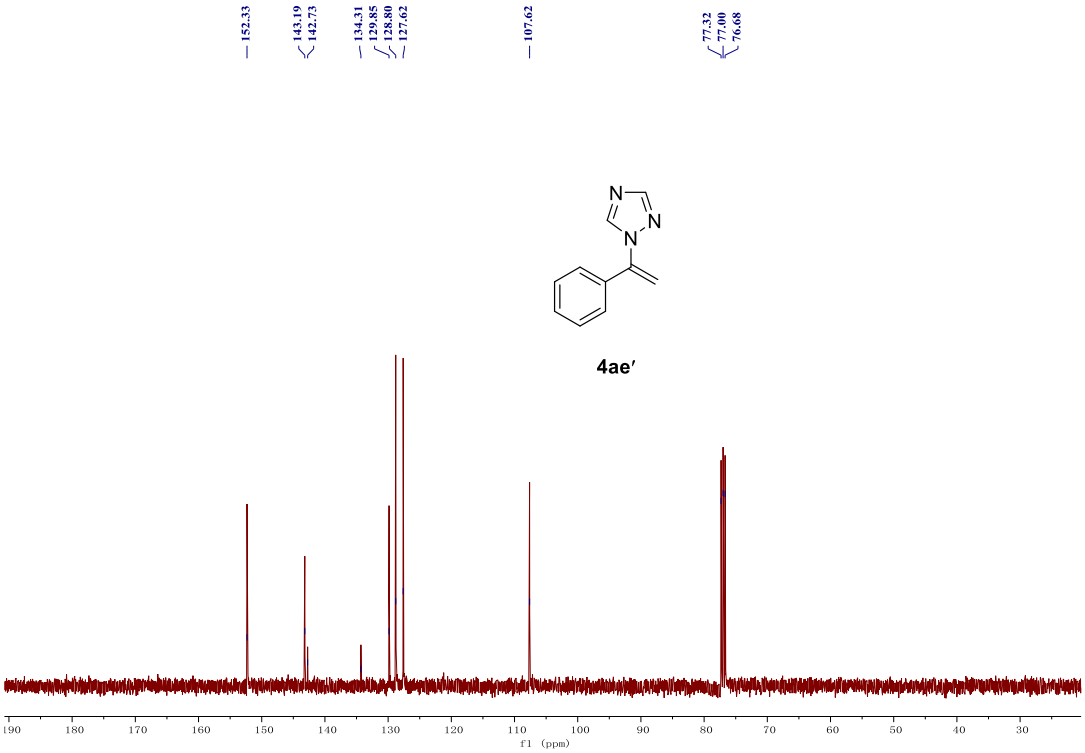
^{13}C NMR of 4ad'



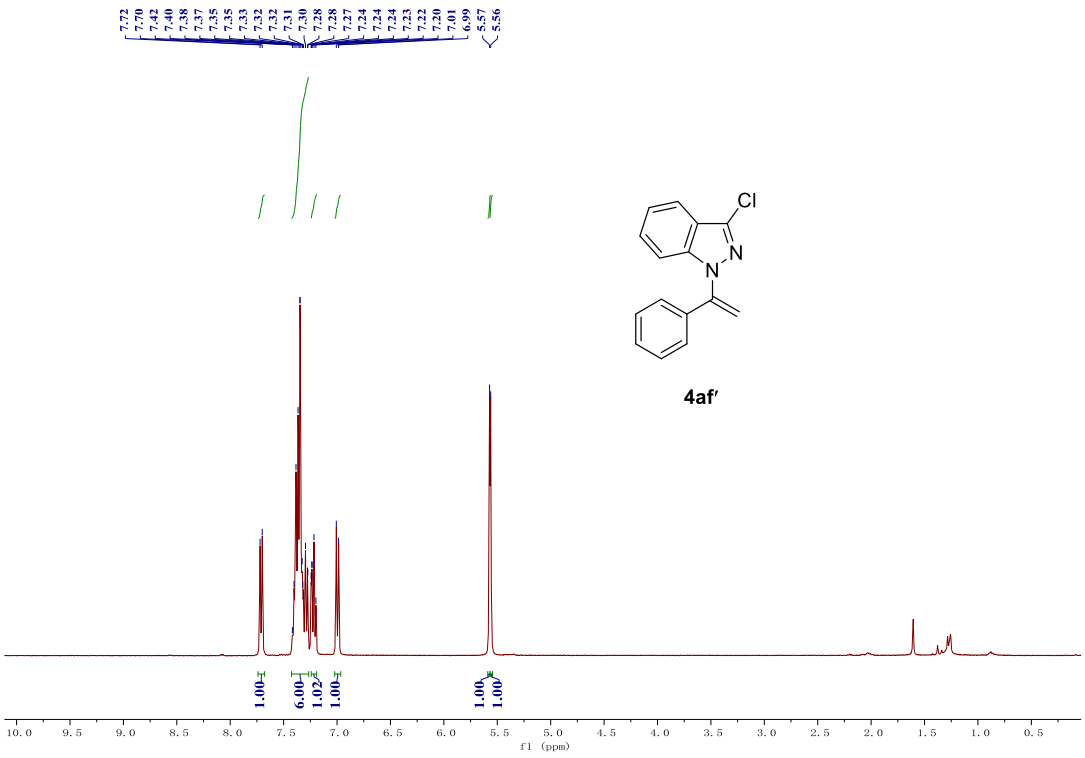
^{1}H NMR of 4ae'



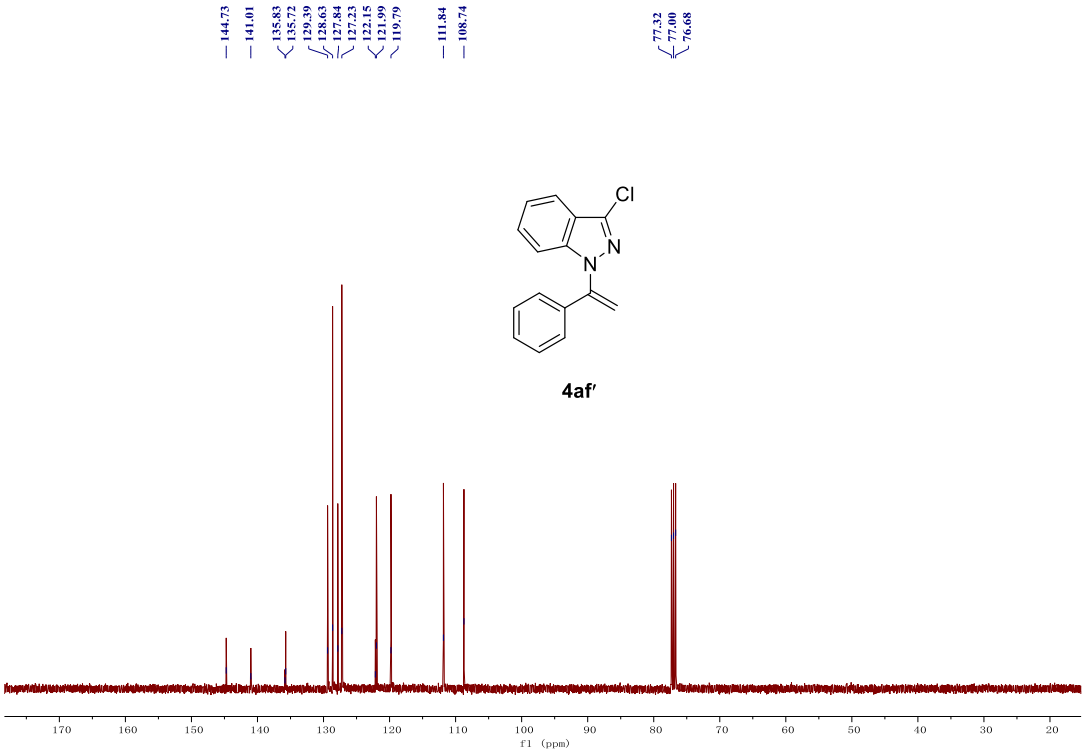
^{13}C NMR of 4ae'



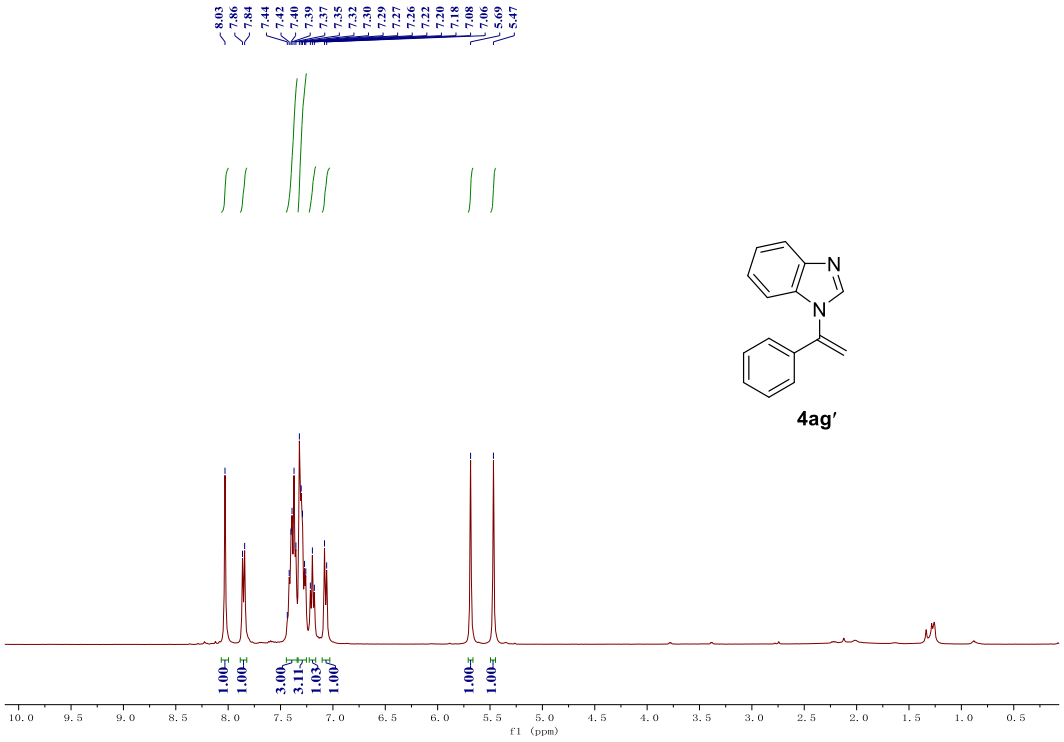
^{1}H NMR of 4af'



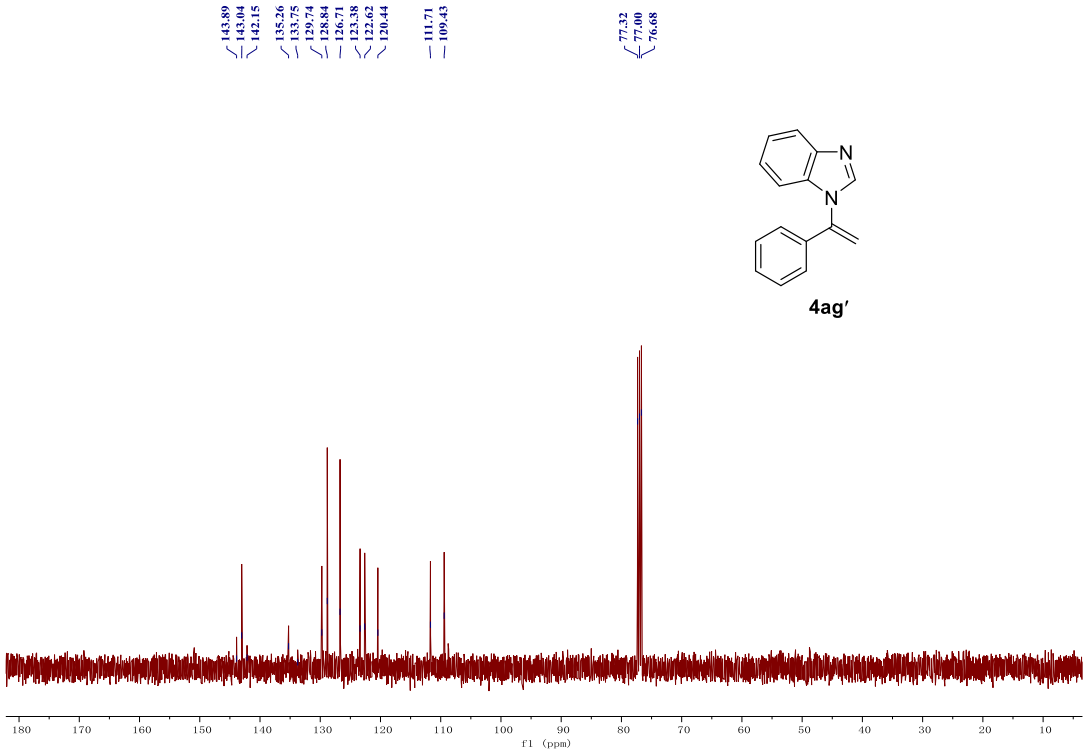
^{13}C NMR of 4af'



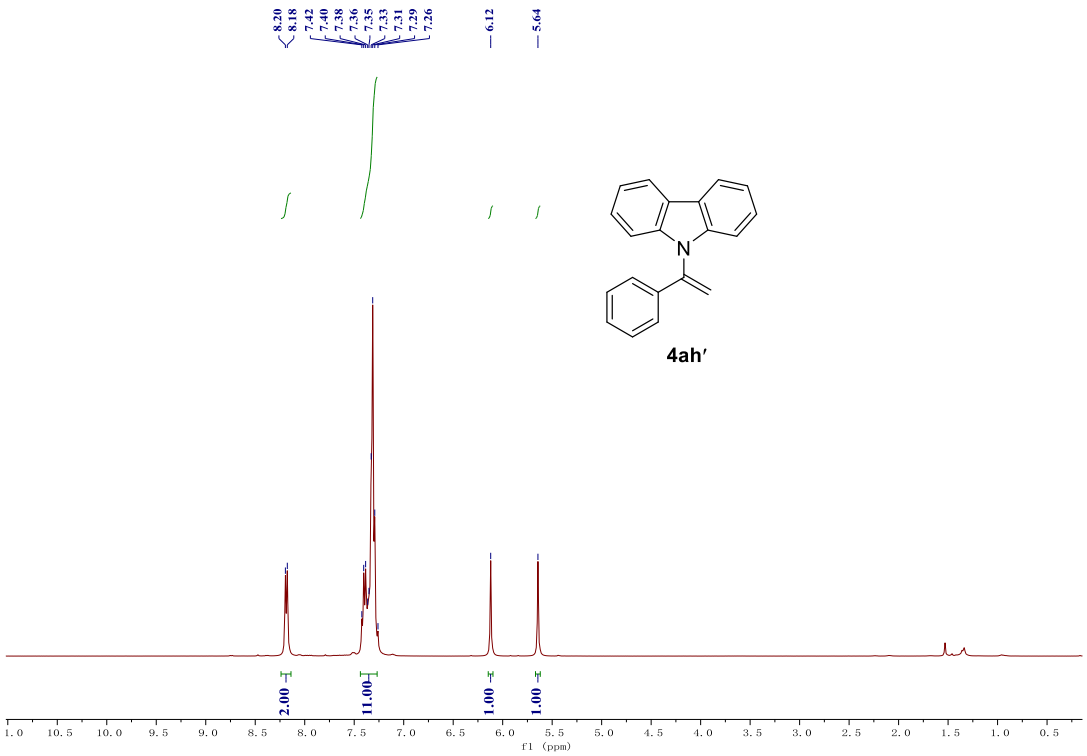
^{1}H NMR of 4ag'



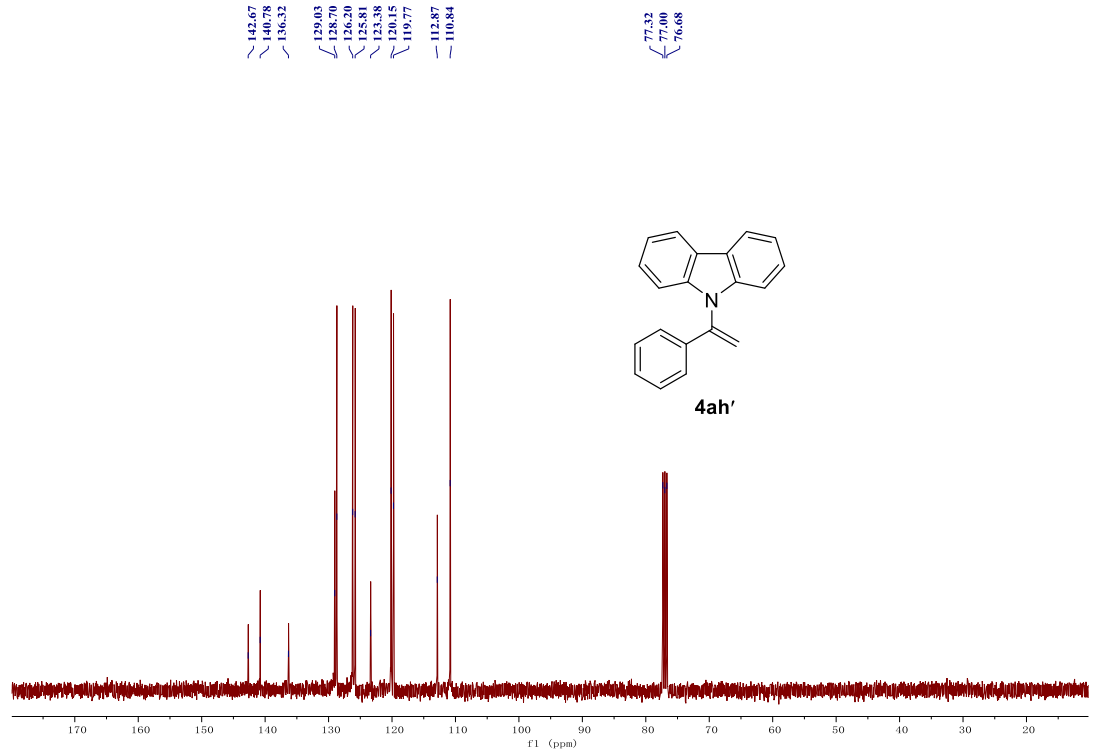
^{13}C NMR of 4ag'



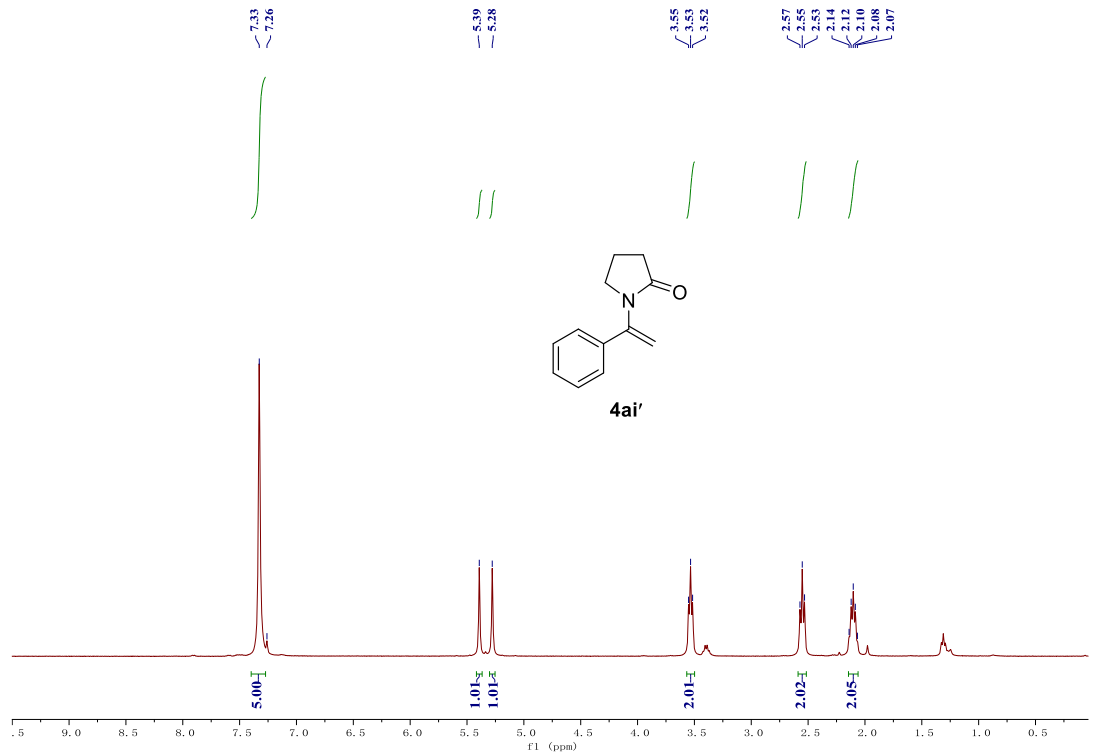
^{1}H NMR of 4ah'



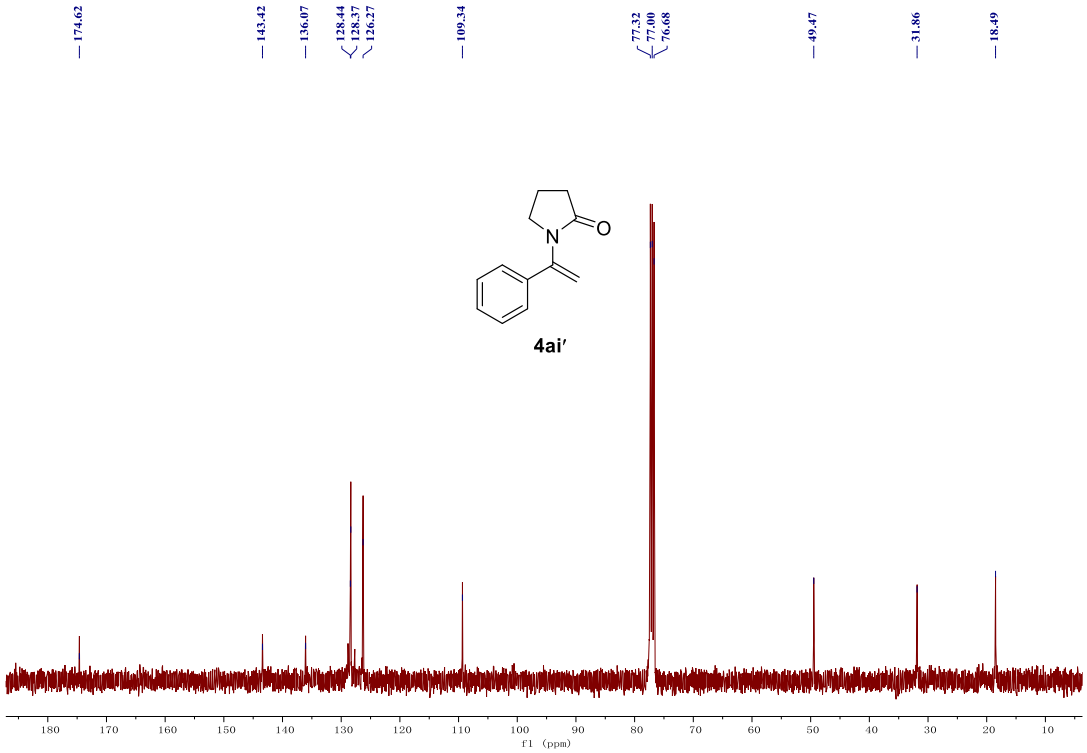
^{13}C NMR of 4ah'



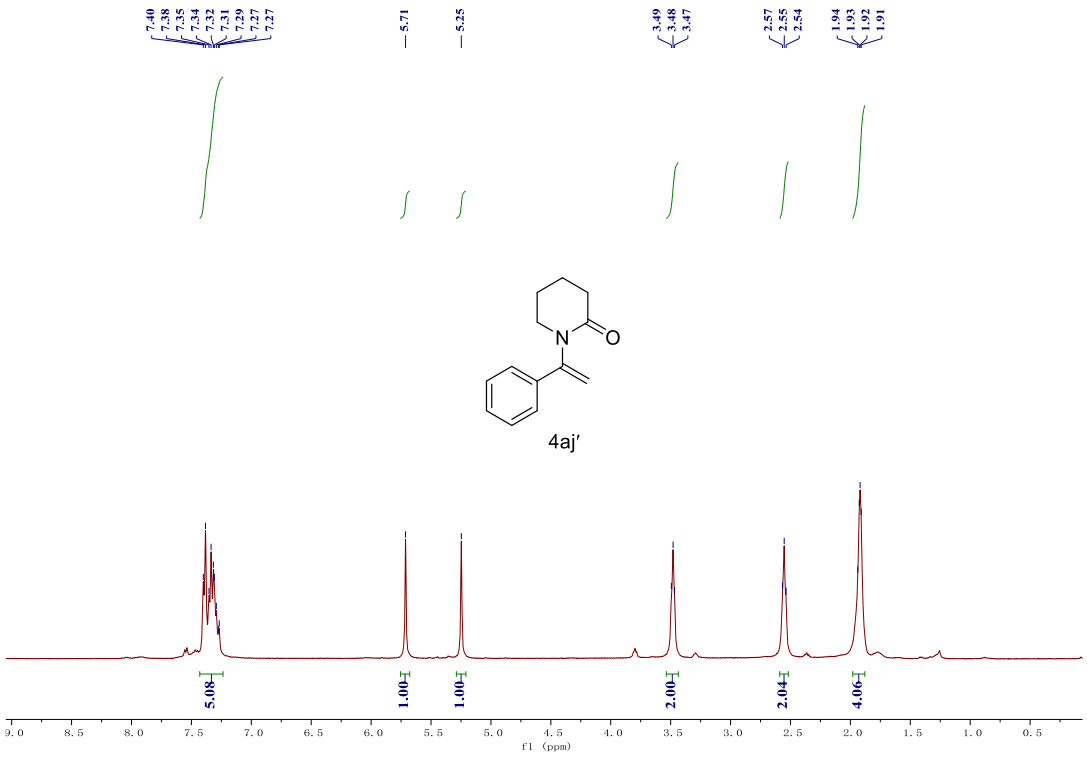
^{1}H NMR of 4ai'



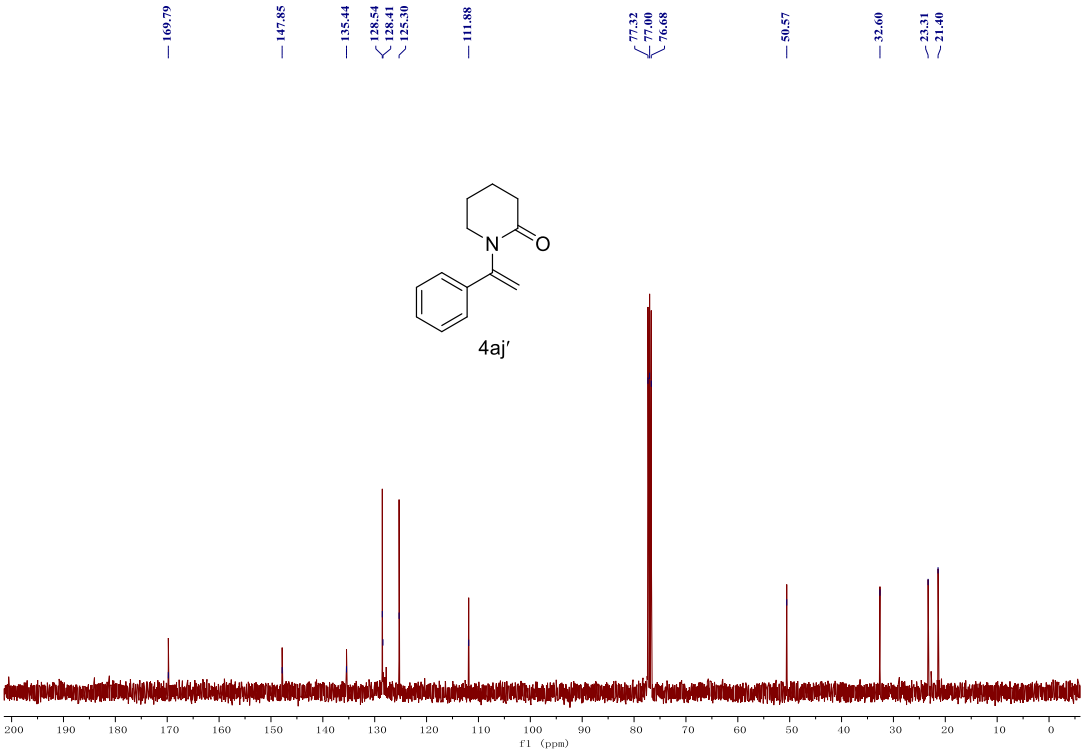
^{13}C NMR of 4ai'



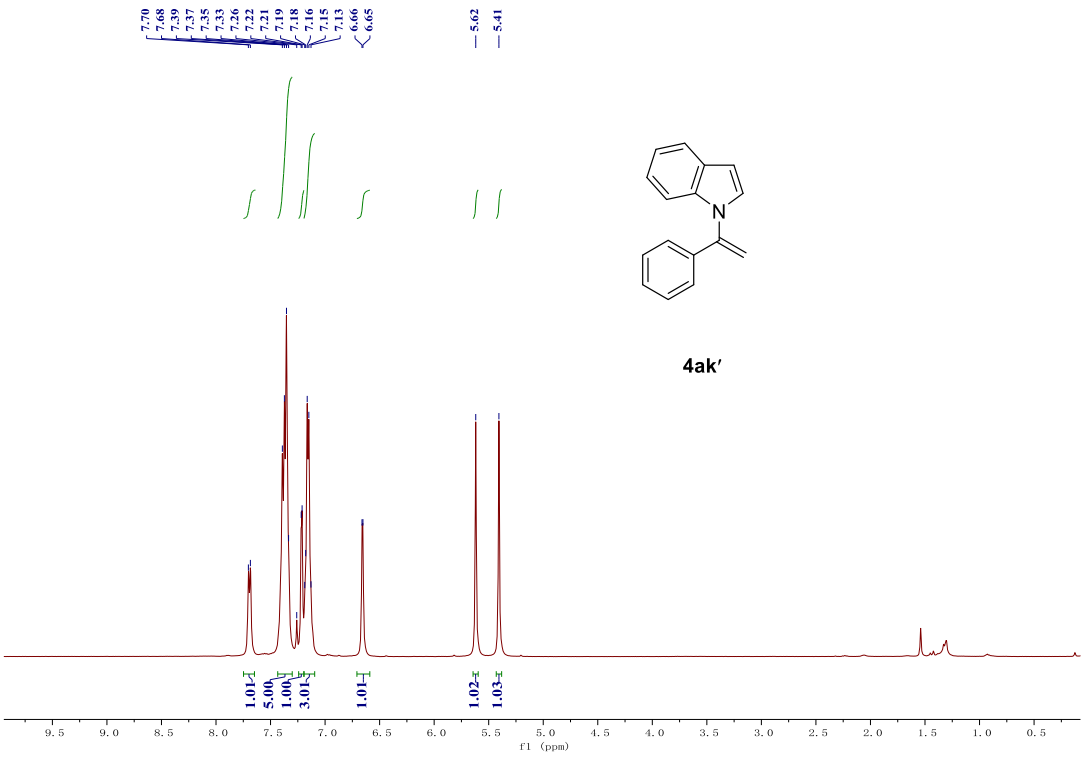
^{1}H NMR of 4aj'



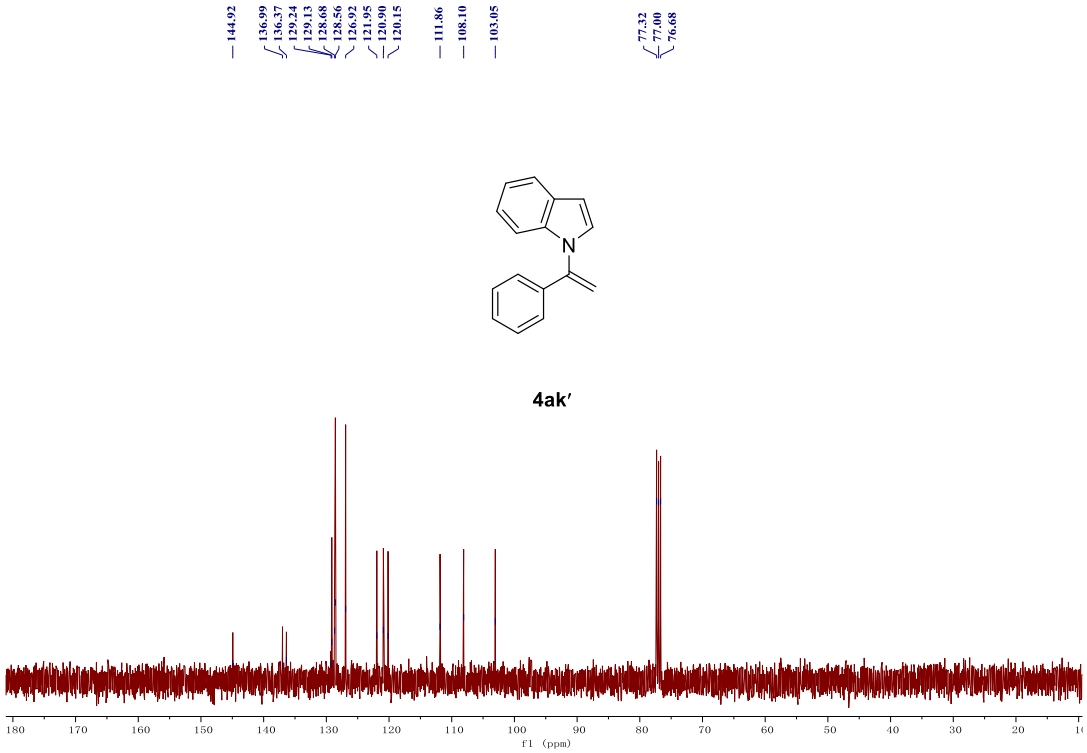
^{13}C NMR of 4aj'



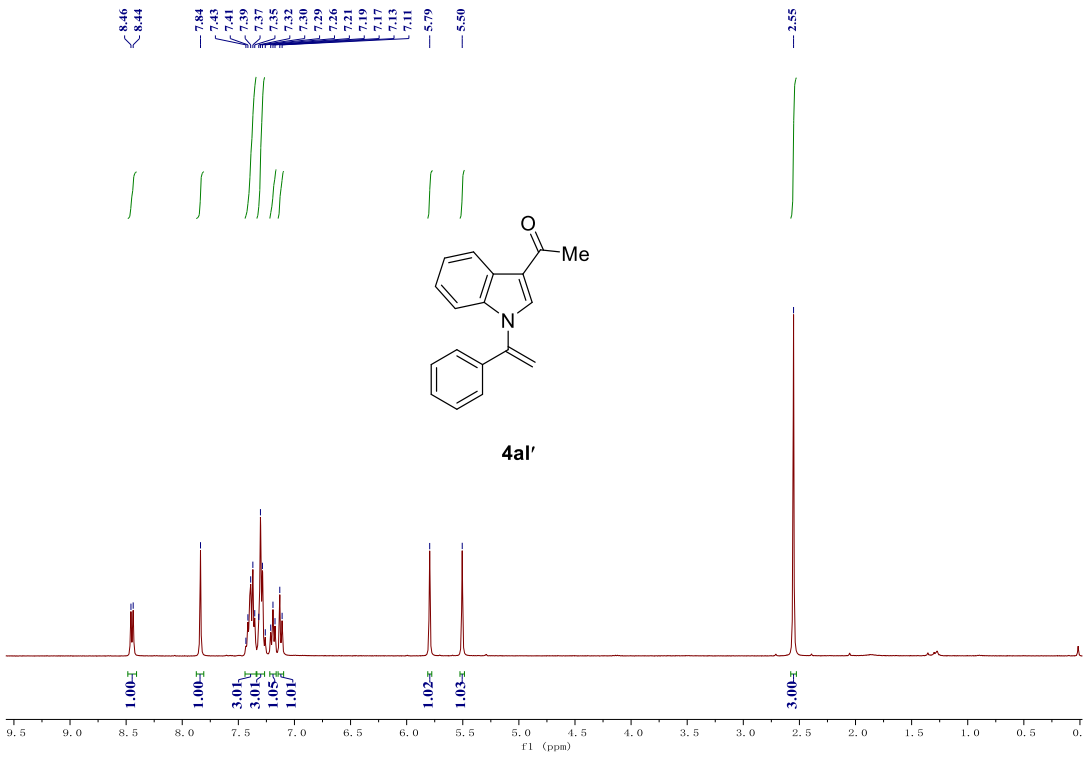
^{1}H NMR of 4ak'



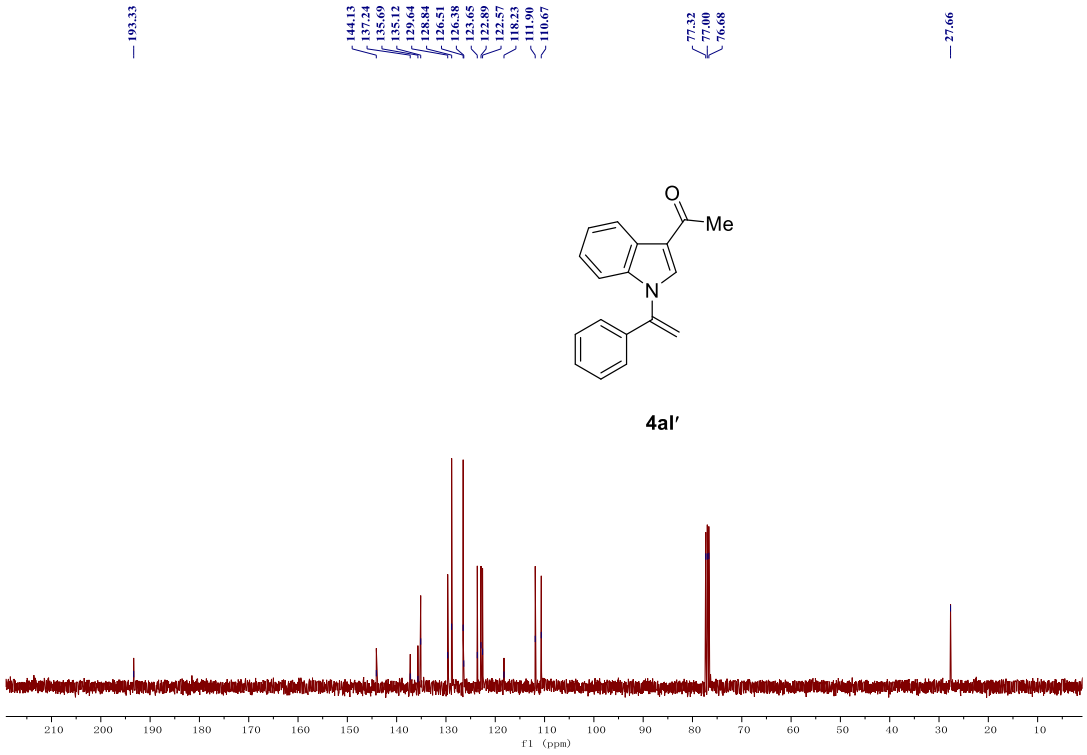
^{13}C NMR of 4ak'



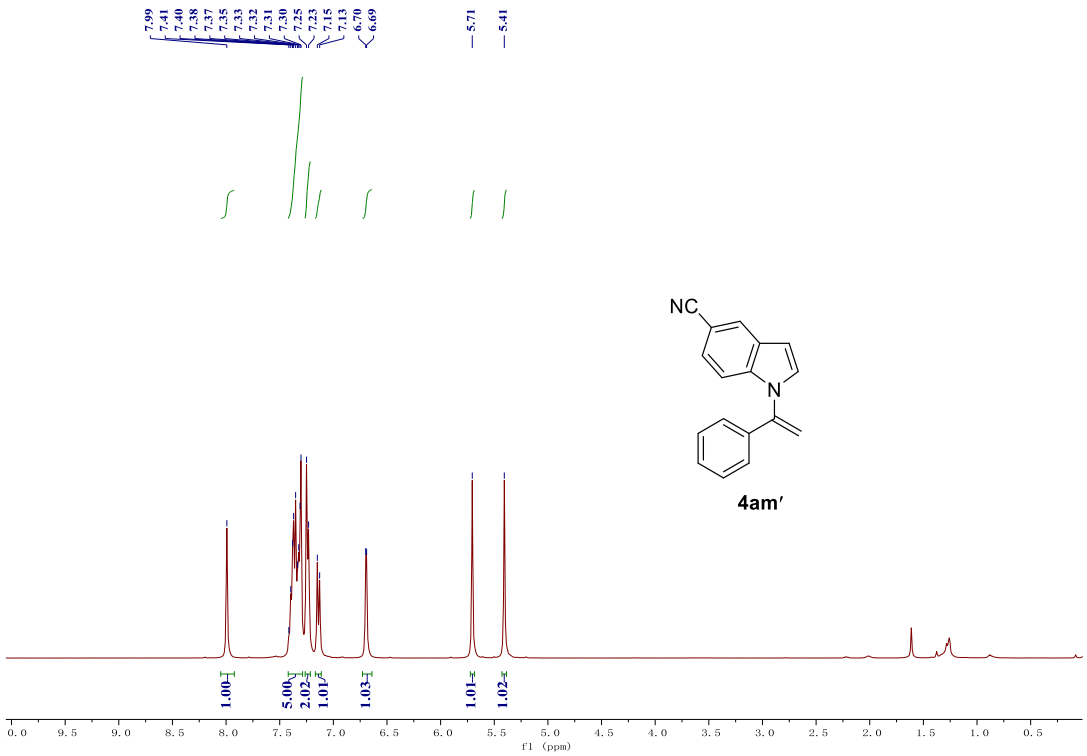
^{1}H NMR of 4al'



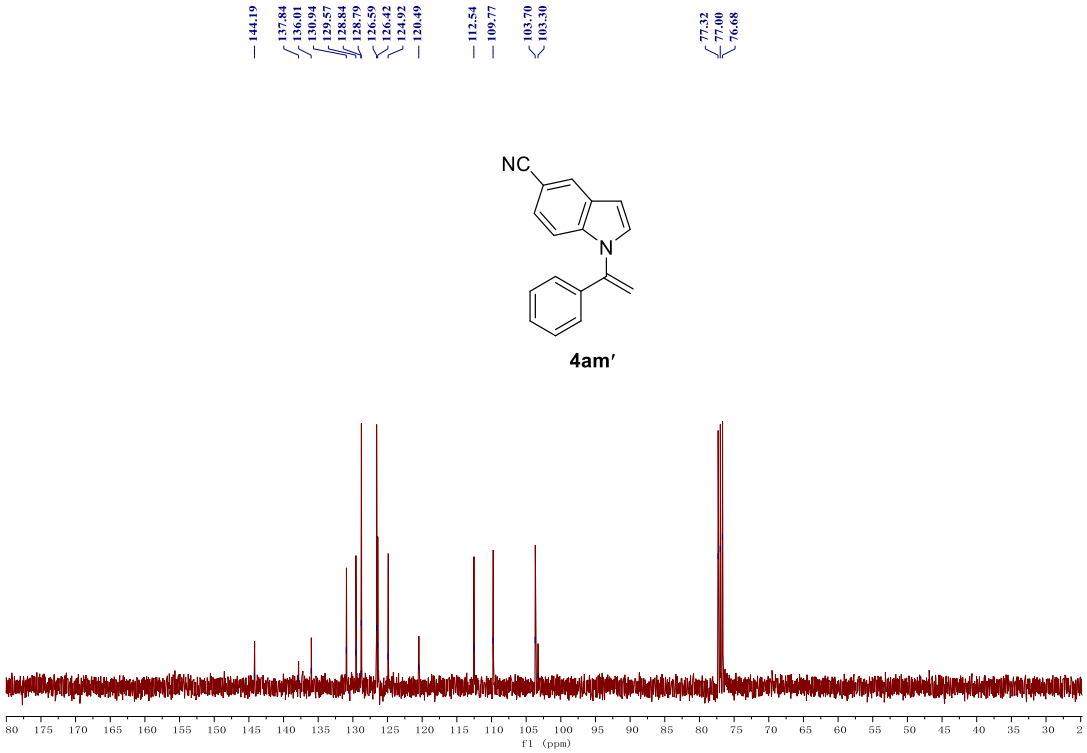
^{13}C NMR of 4al'



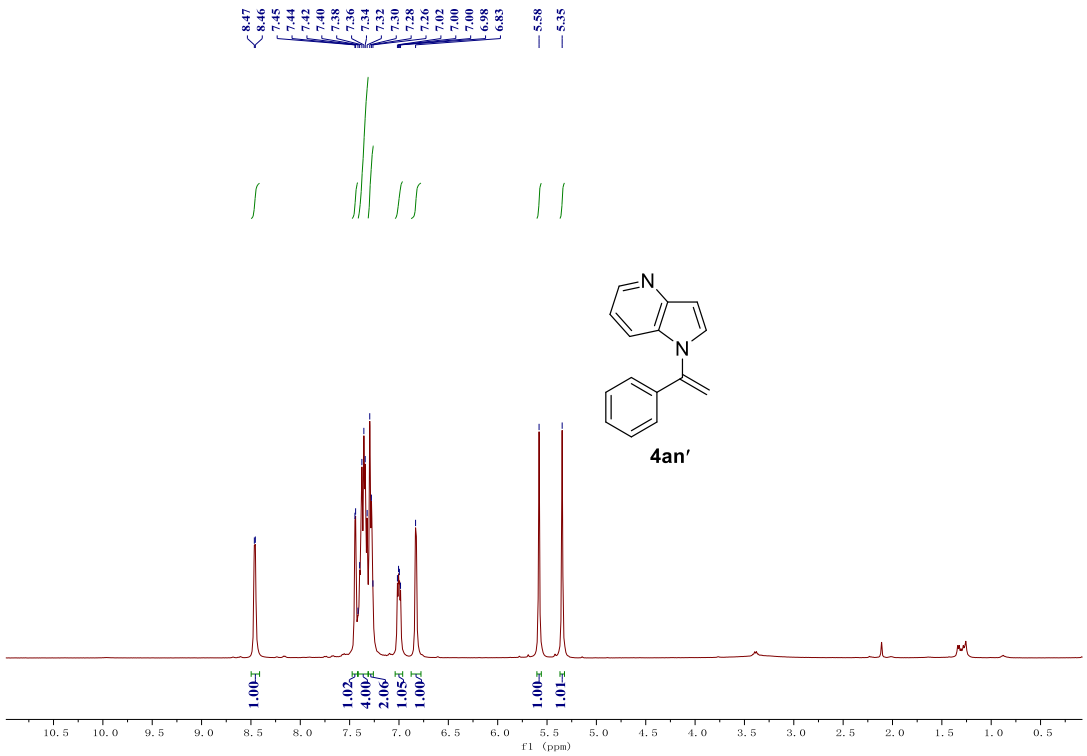
^{1}H NMR of 4am'



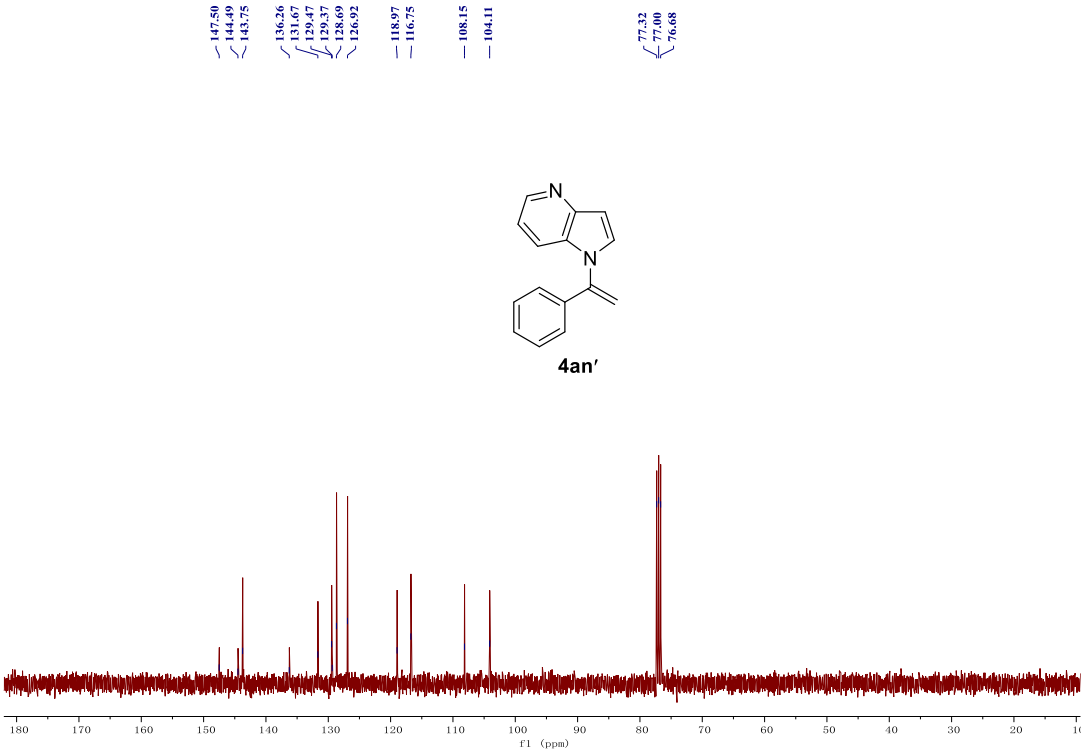
^{13}C NMR of 4am'



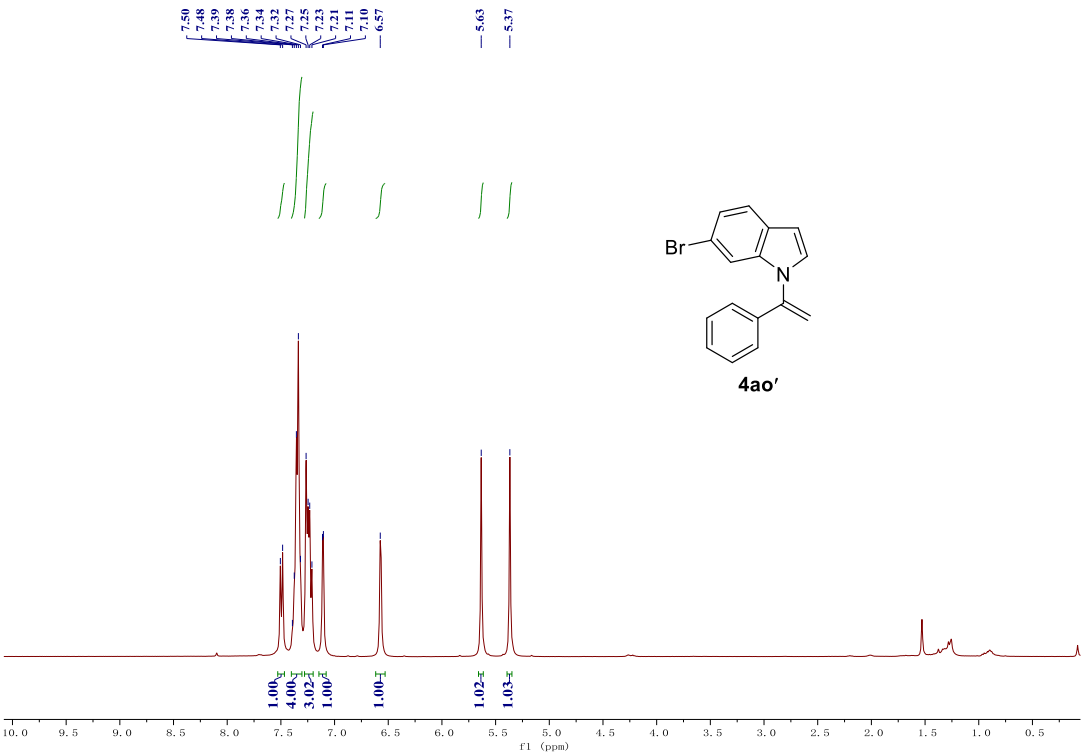
^{1}H NMR of 4an'



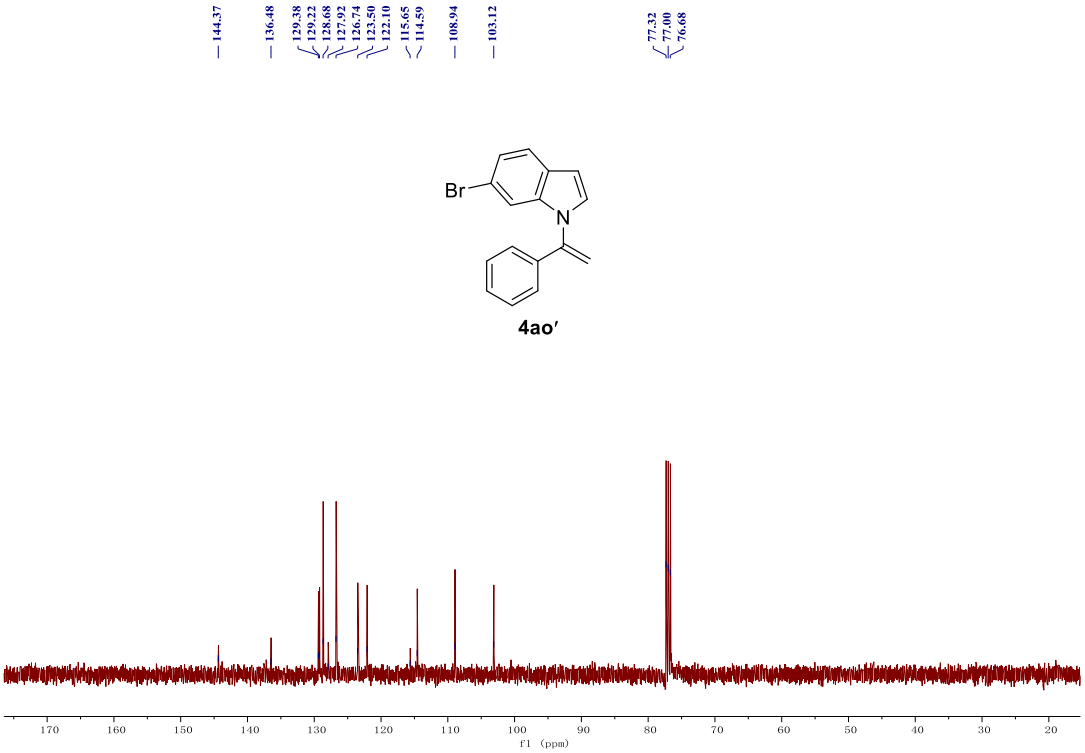
^{13}C NMR of 4an'



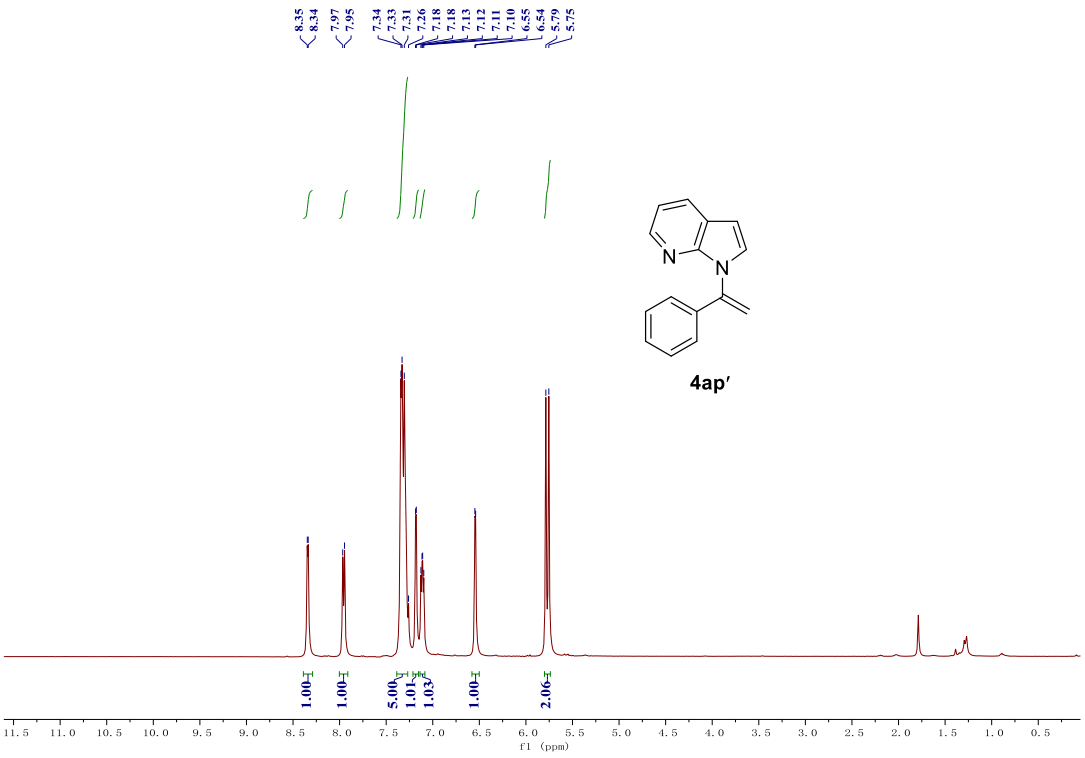
^{1}H NMR of 4ao'



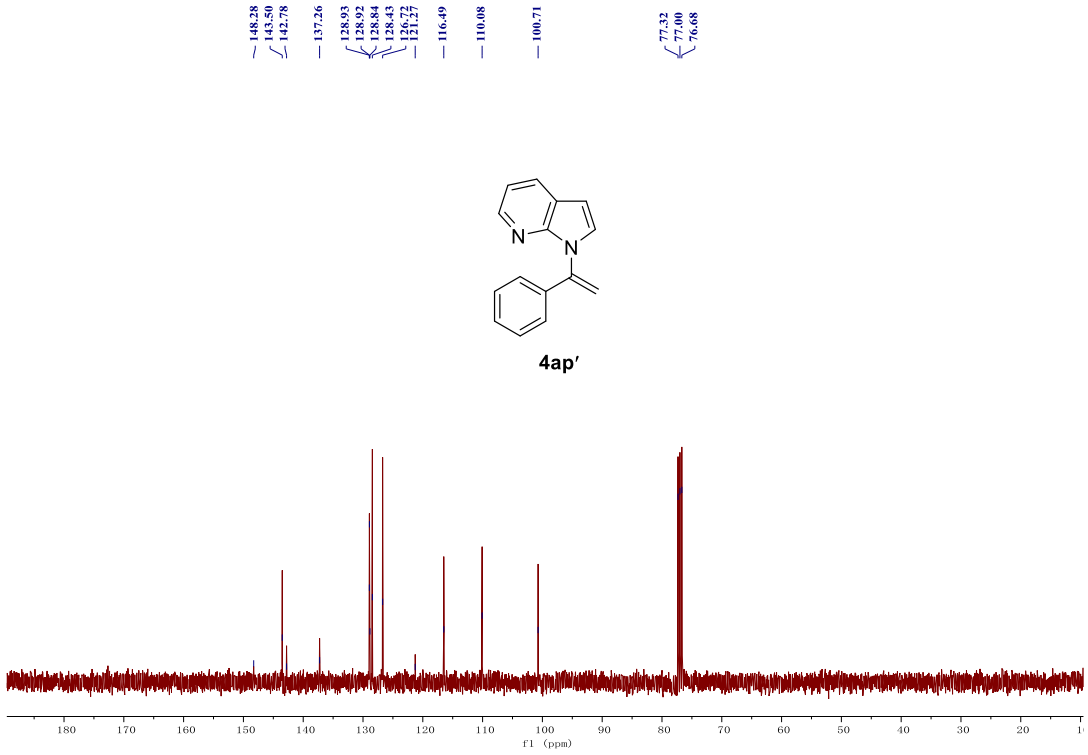
^{13}C NMR of 4ao'



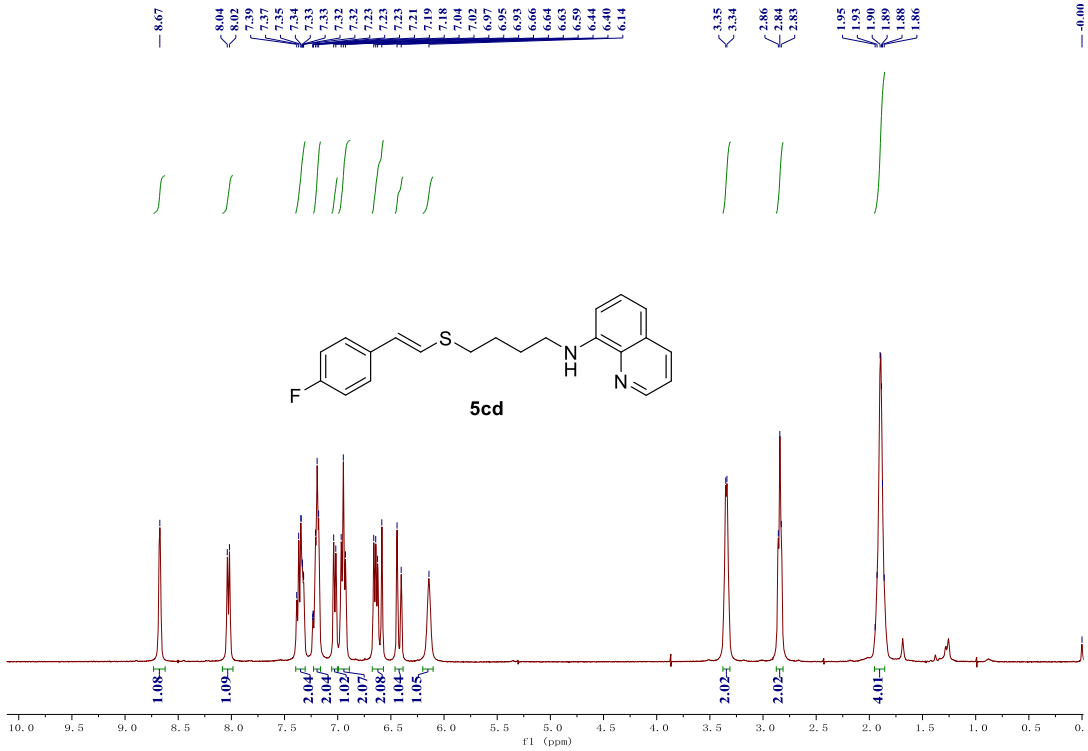
^{1}H NMR of 4ap'



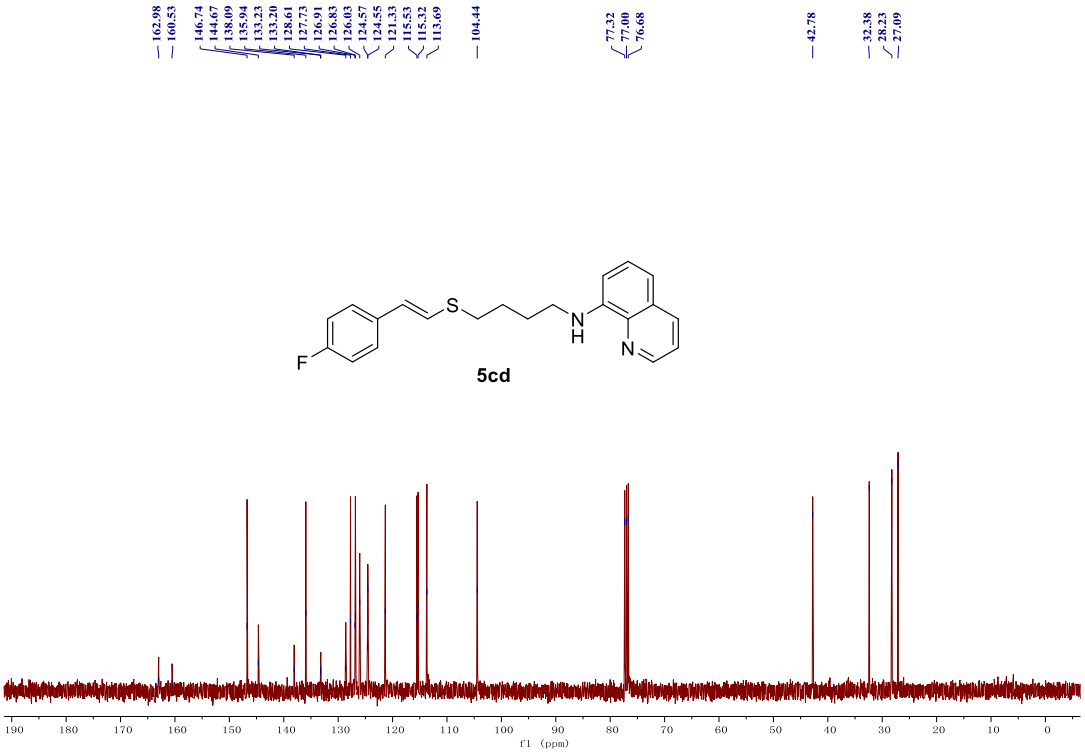
^{13}C NMR of 4ap'



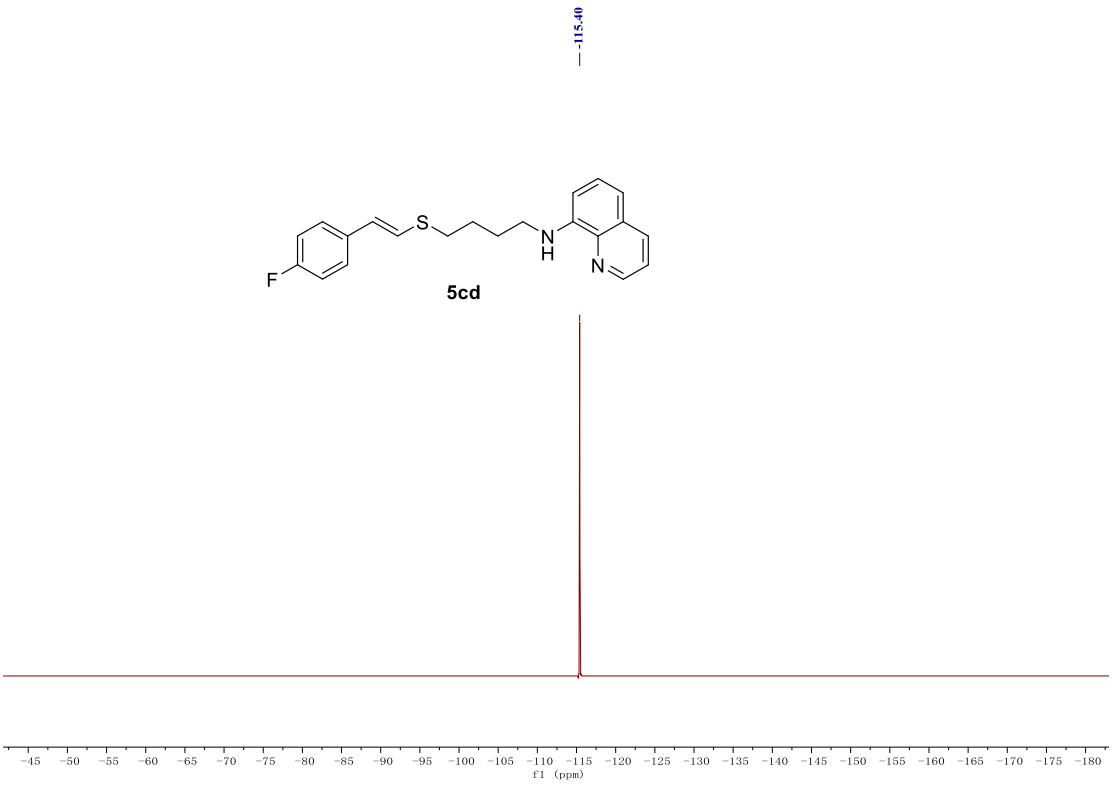
^{1}H NMR of 5cd



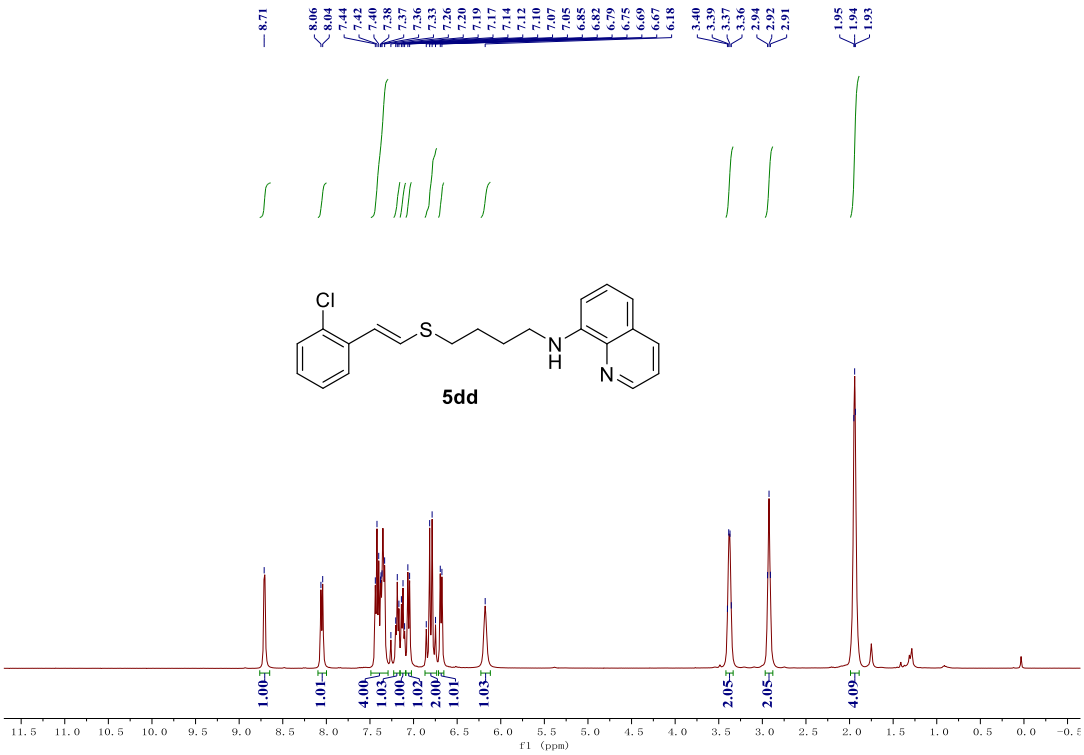
^{13}C NMR of 5cd



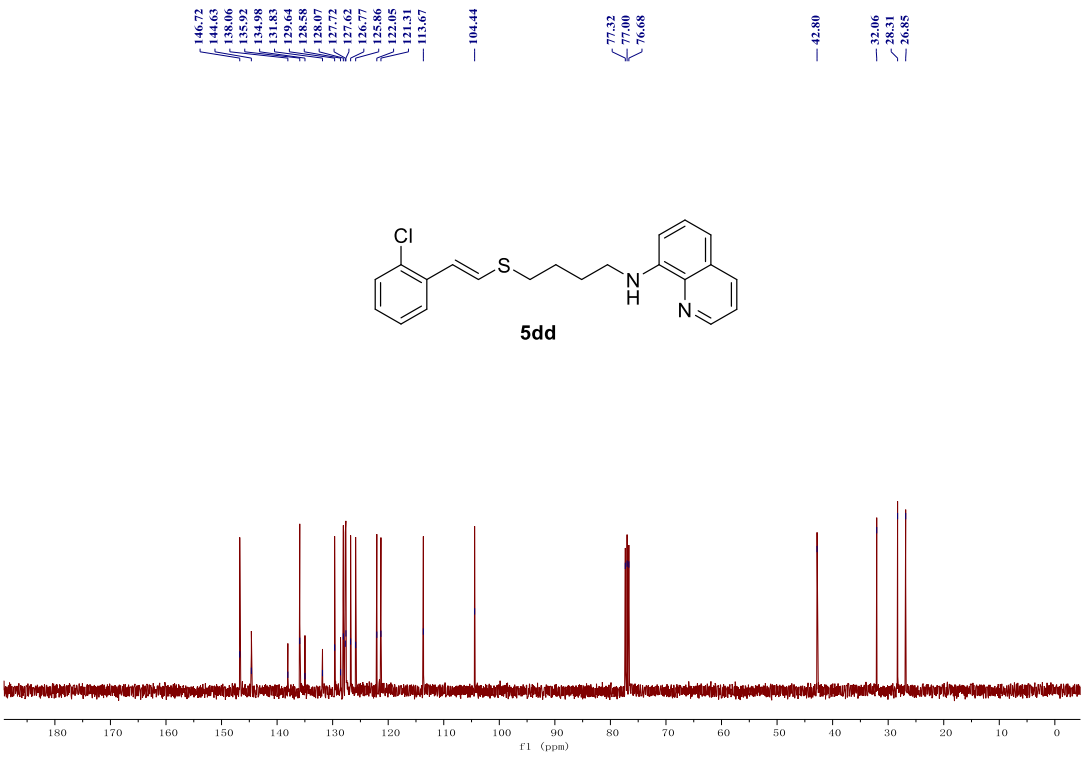
^{19}F NMR of 5cd



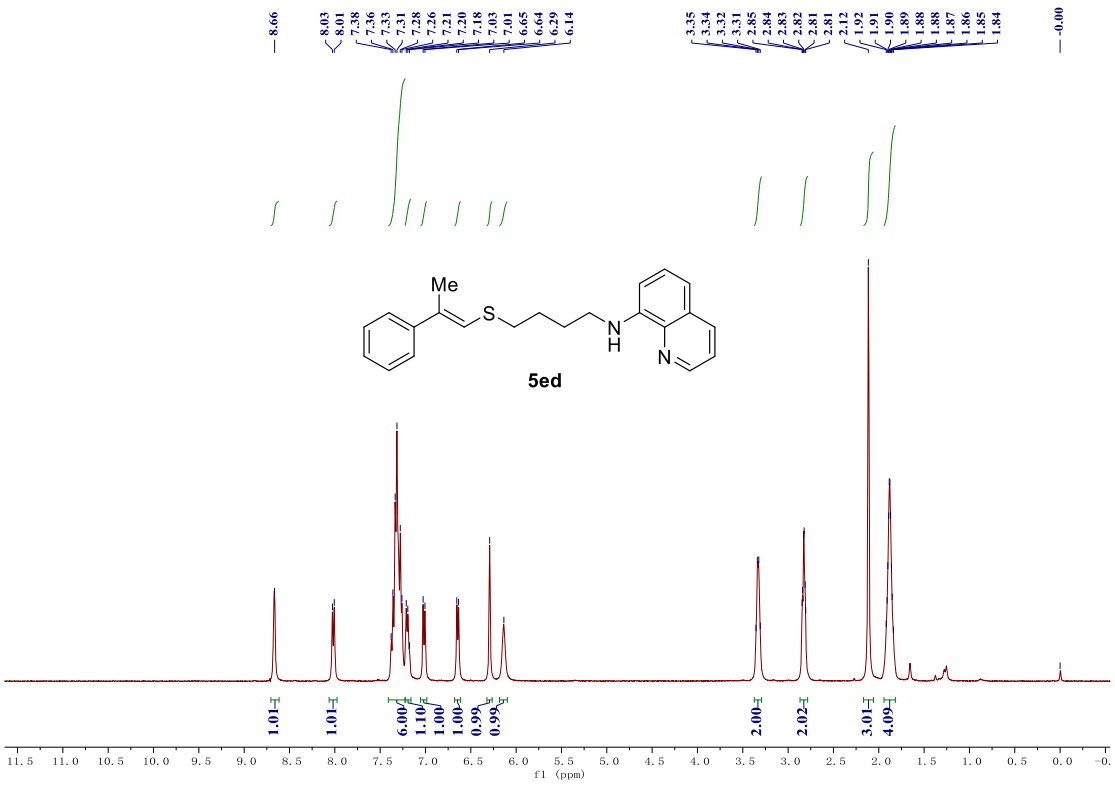
^{1}H NMR of 5dd



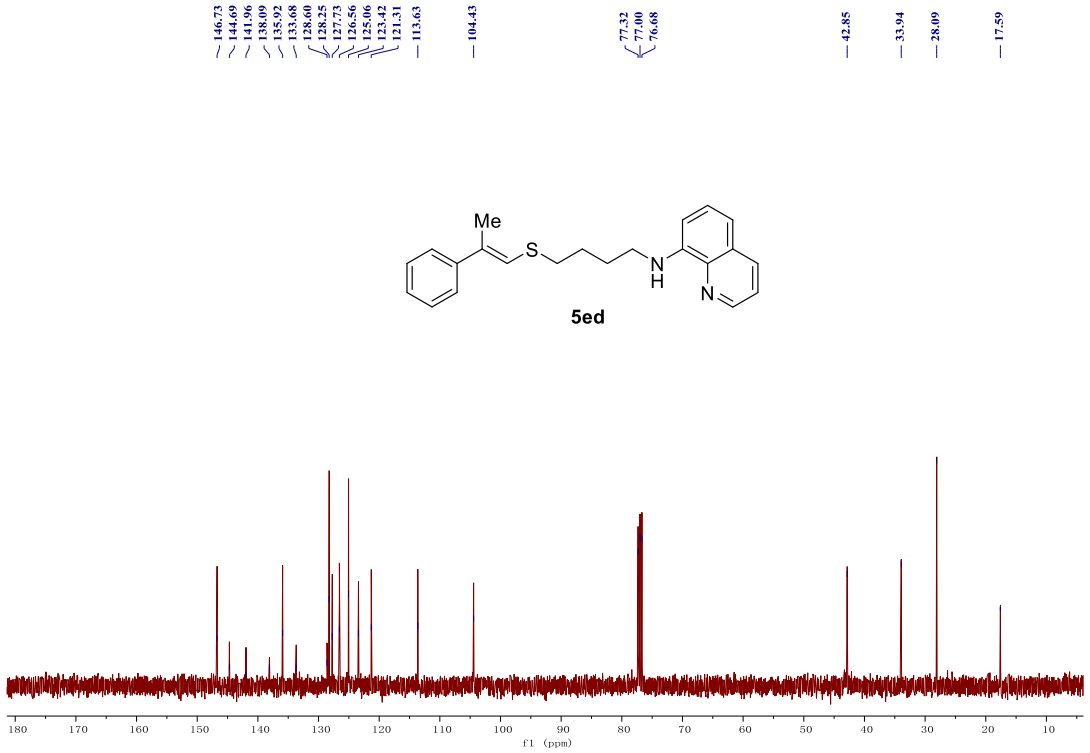
^{13}C NMR of 5dd



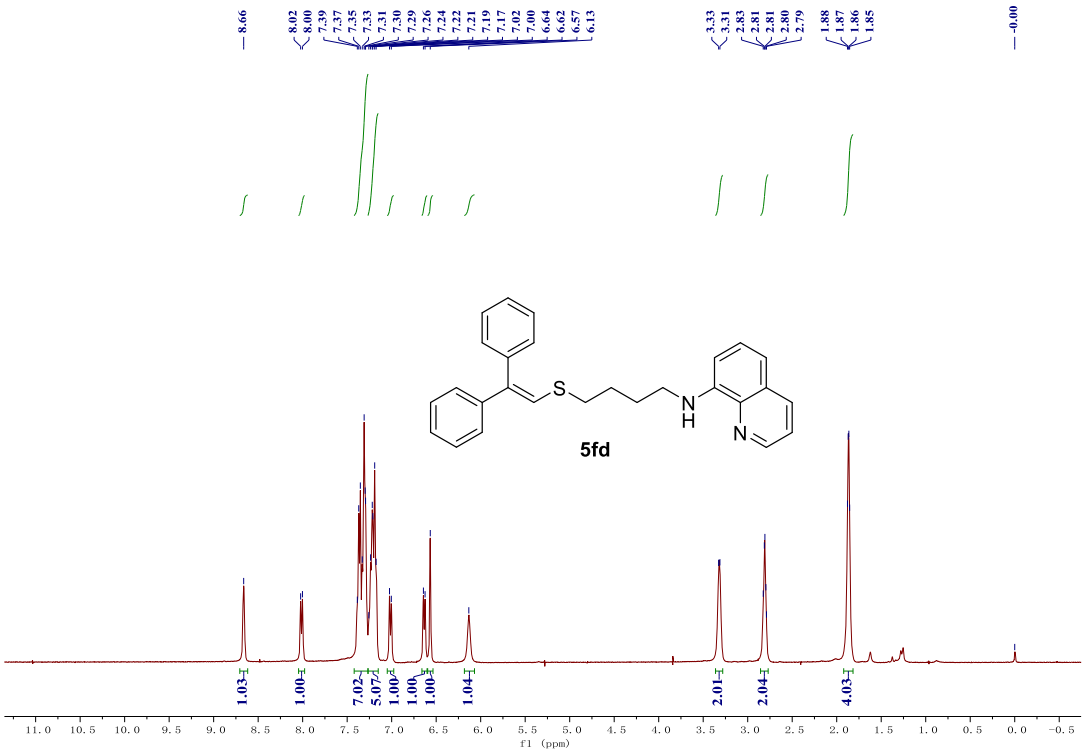
^{1}H NMR of 5ed



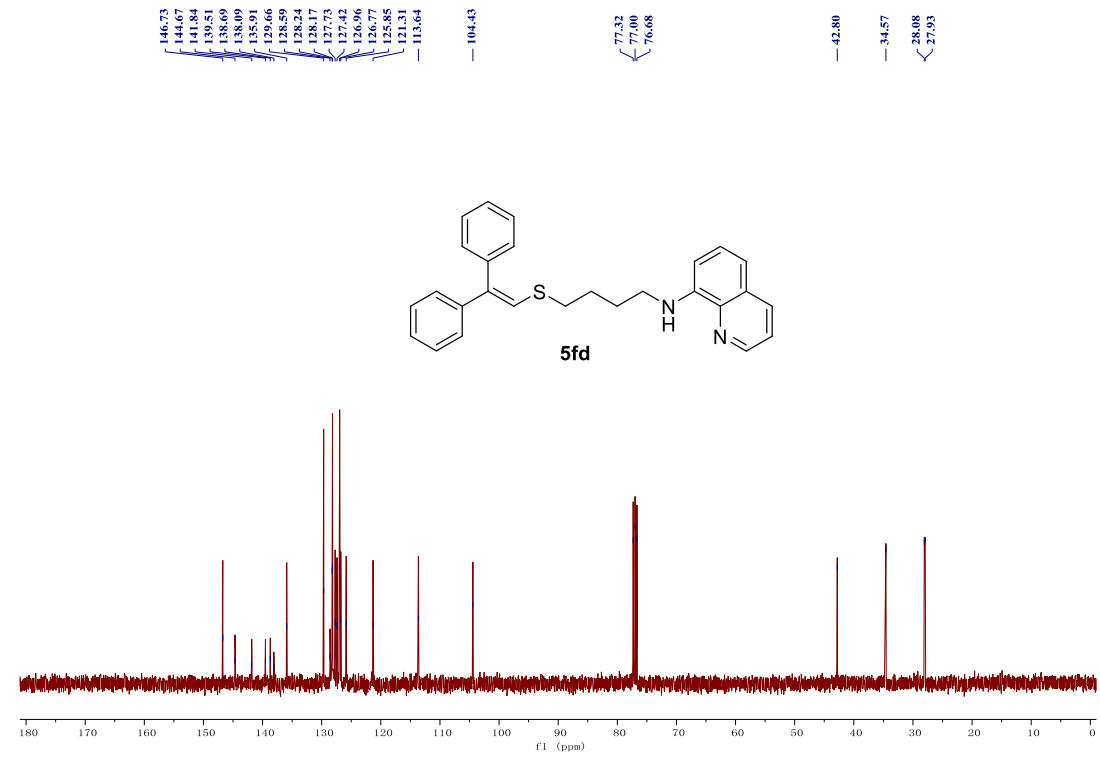
^{13}C NMR of 5ed



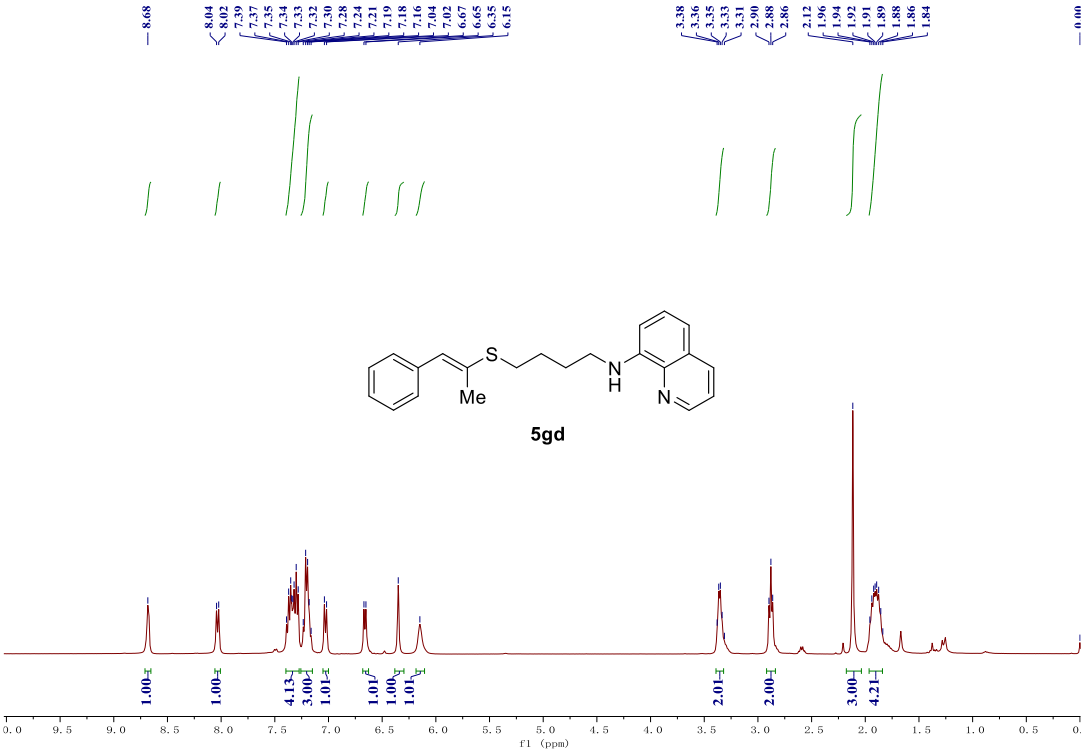
^{1}H NMR of 5fd



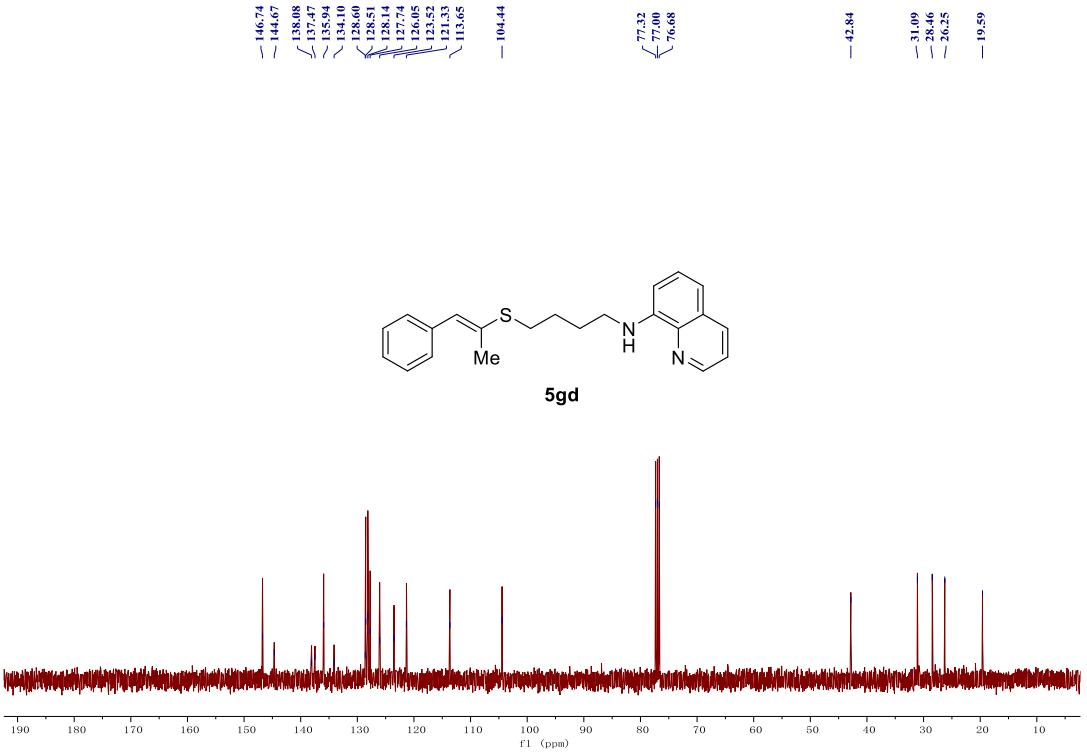
^{13}C NMR of 5fd



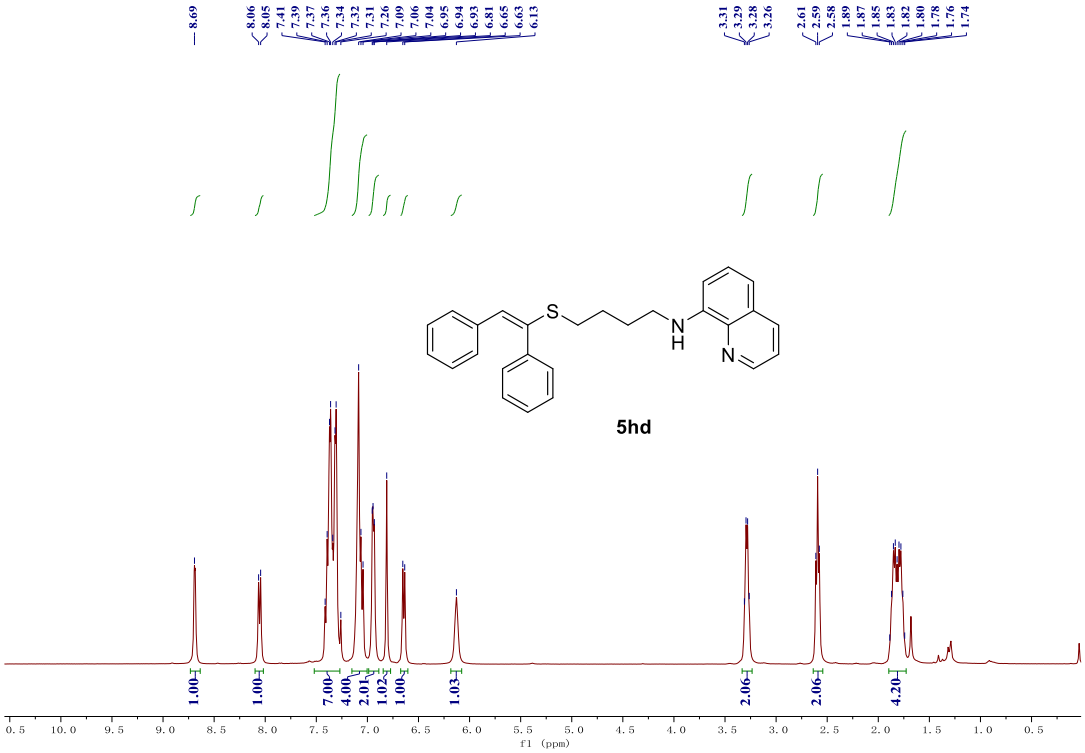
^{1}H NMR of 5gd



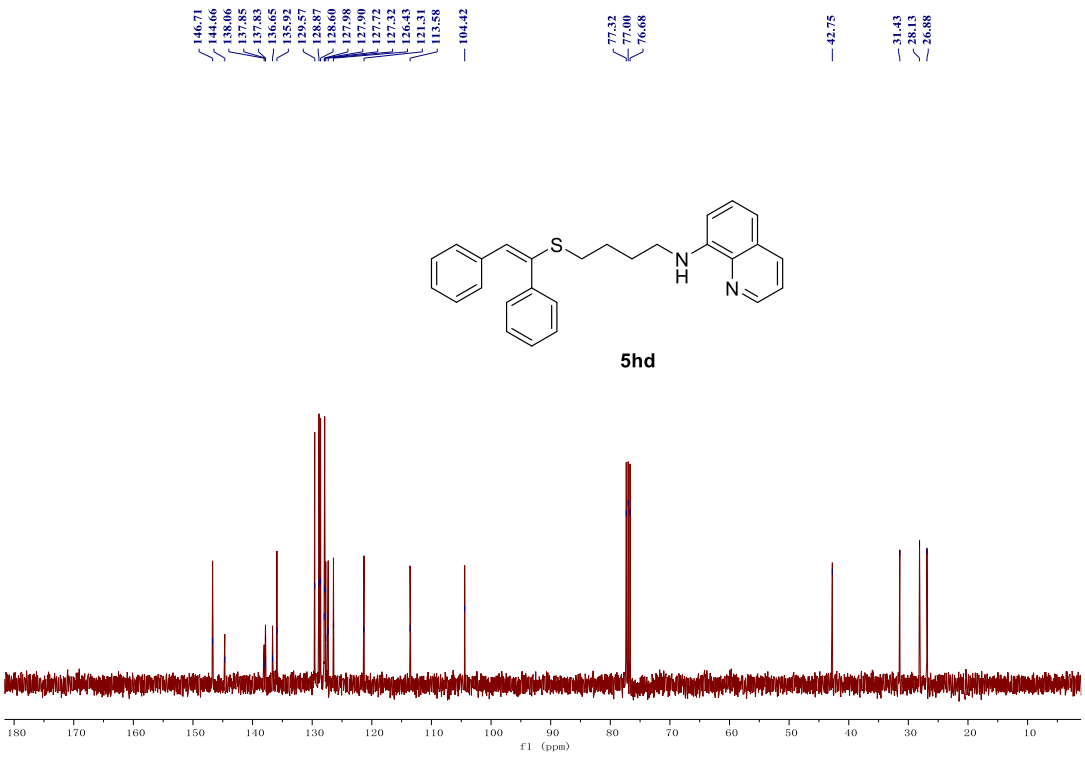
^{13}C NMR of 5gd



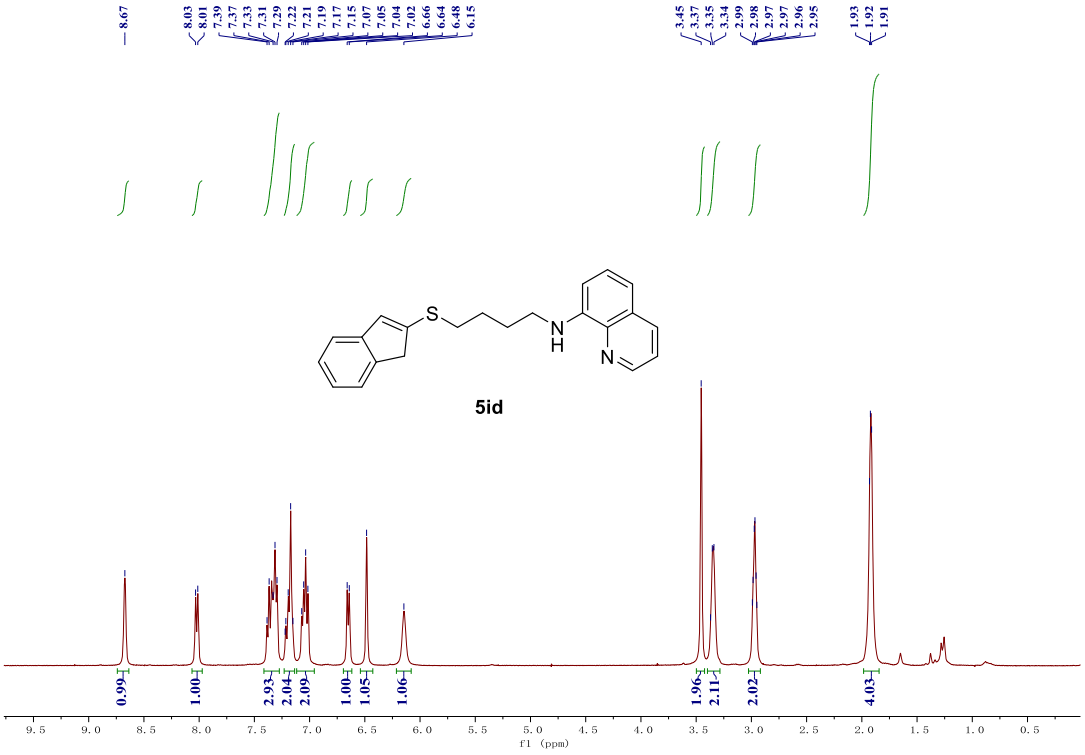
^{1}H NMR of 5hd



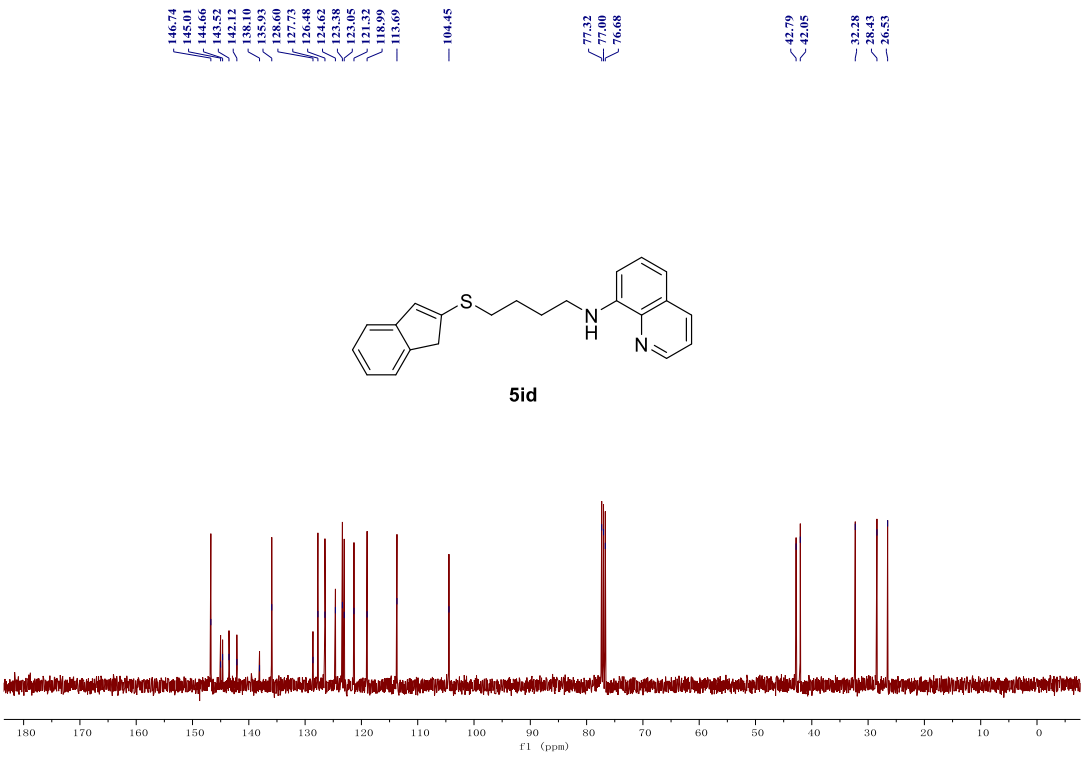
^{13}C NMR of 5hd



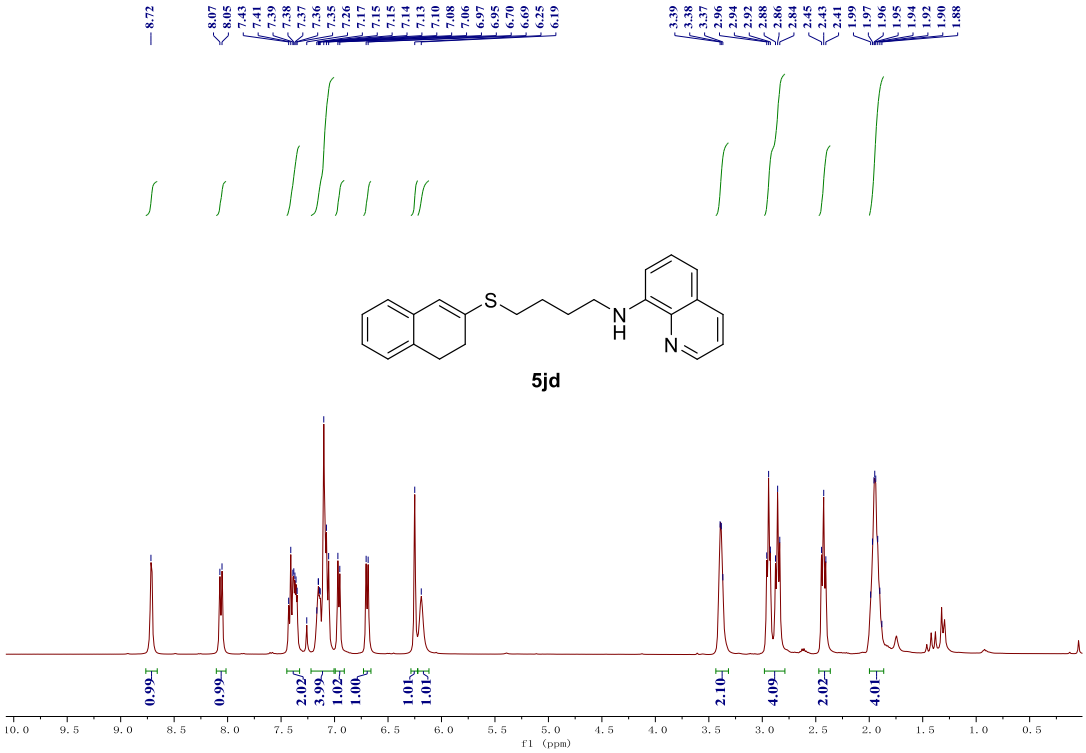
^{1}H NMR of 5id



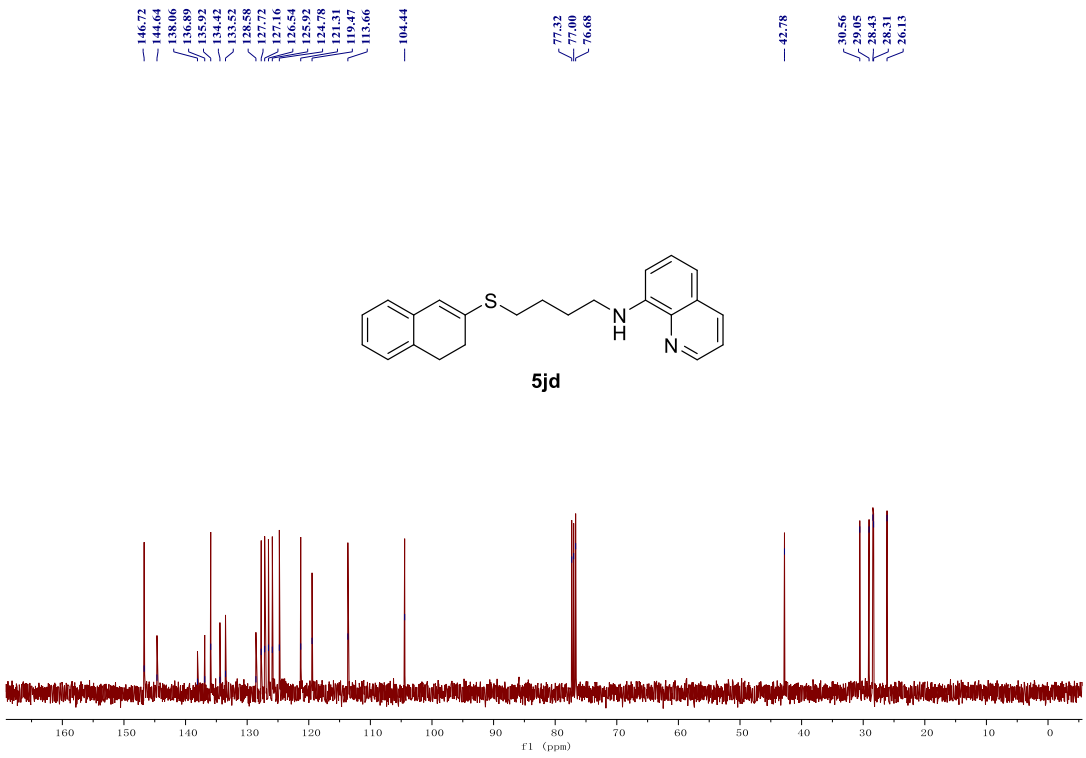
^{13}C NMR of 5id



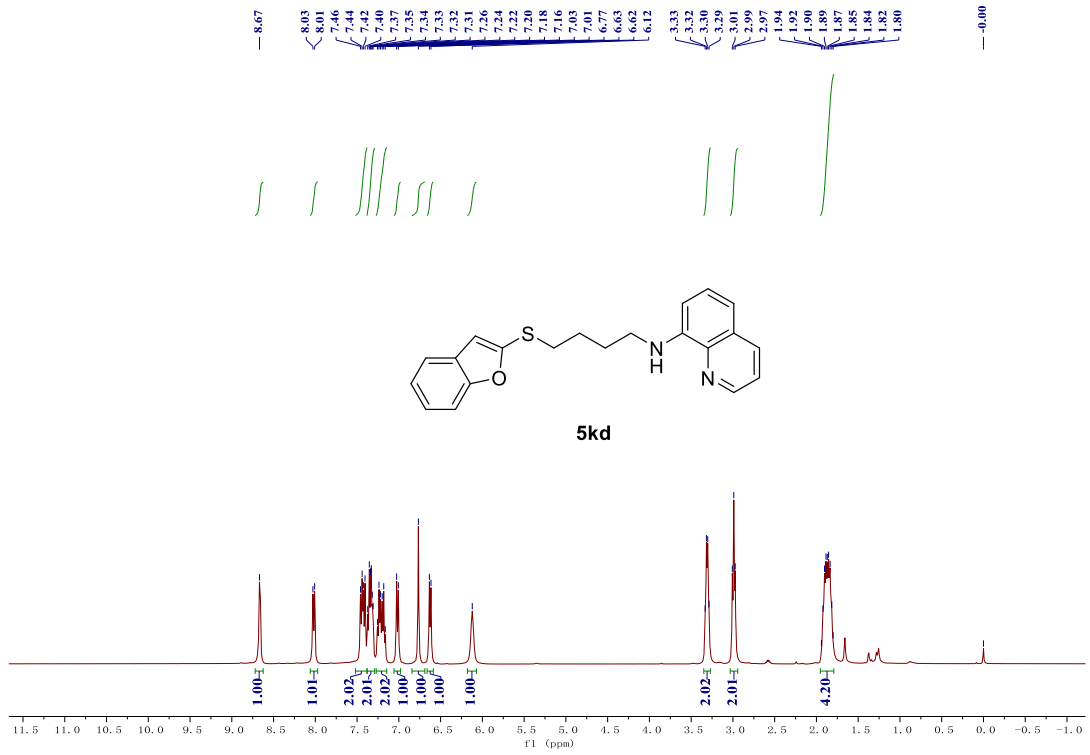
^{1}H NMR of 5jd



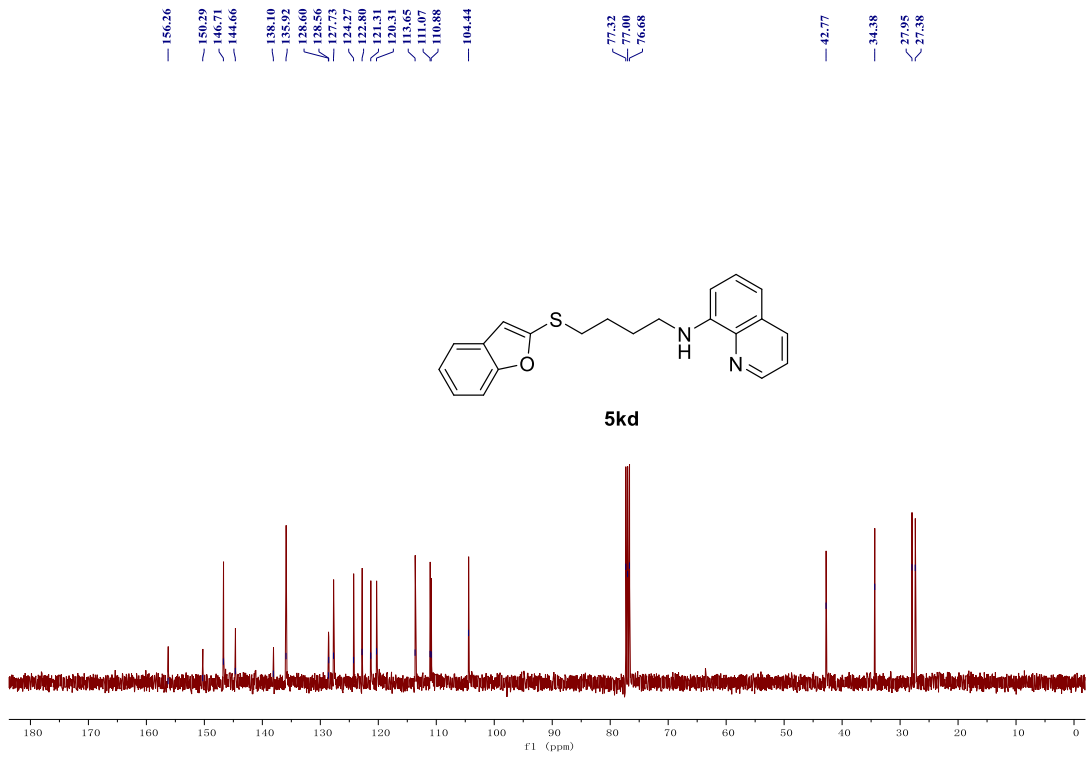
^{13}C NMR of 5jd



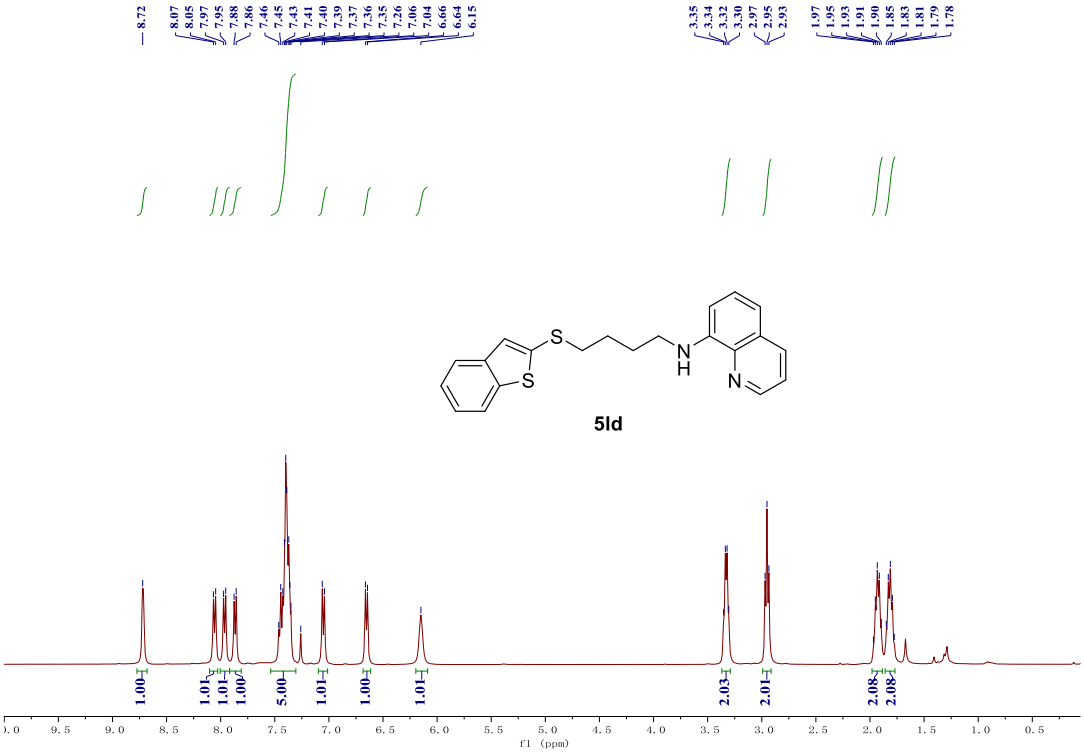
^{1}H NMR of 5kd



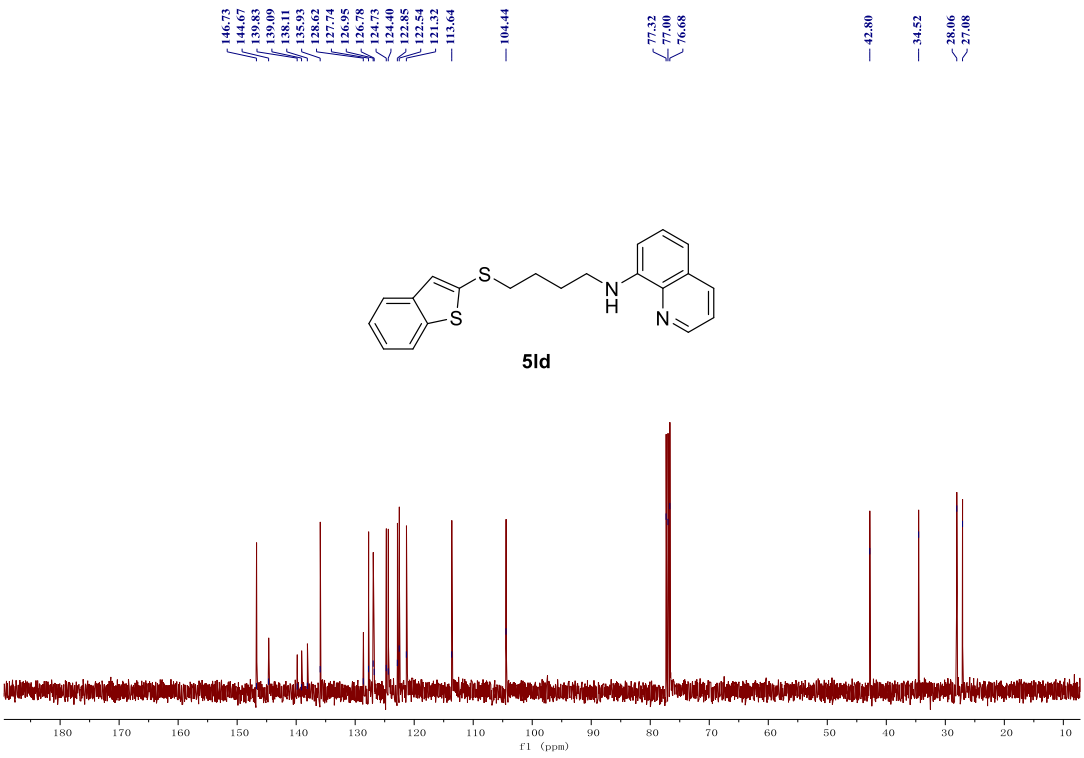
^{13}C NMR of 5kd



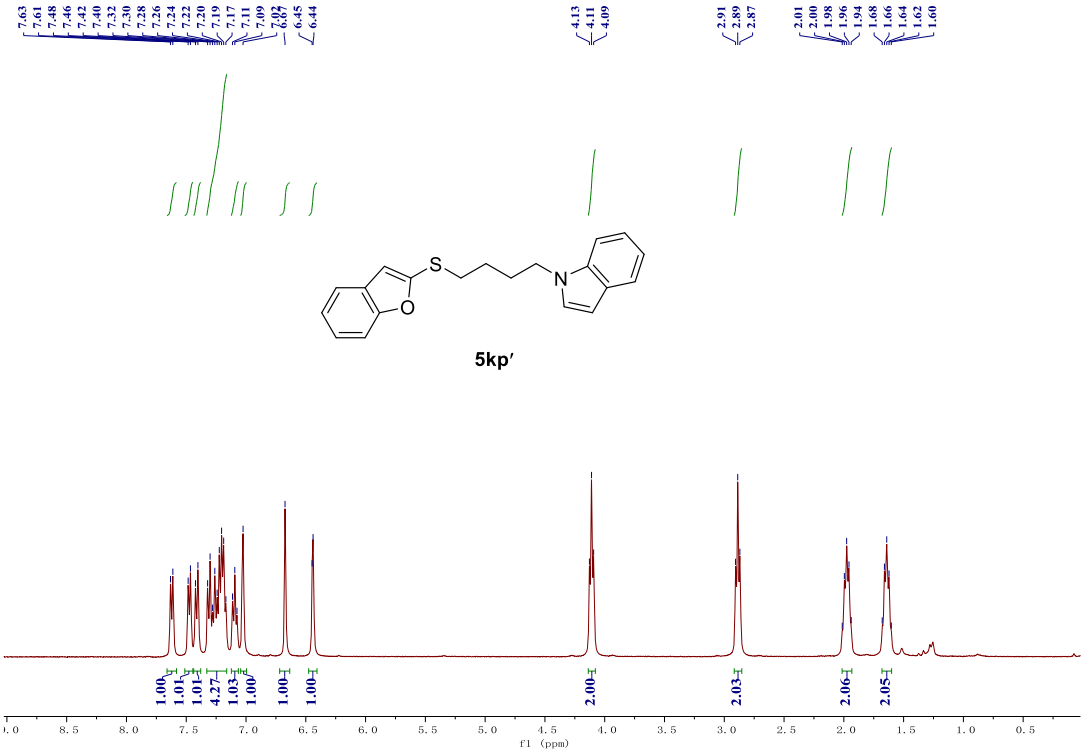
^{1}H NMR of 5ld



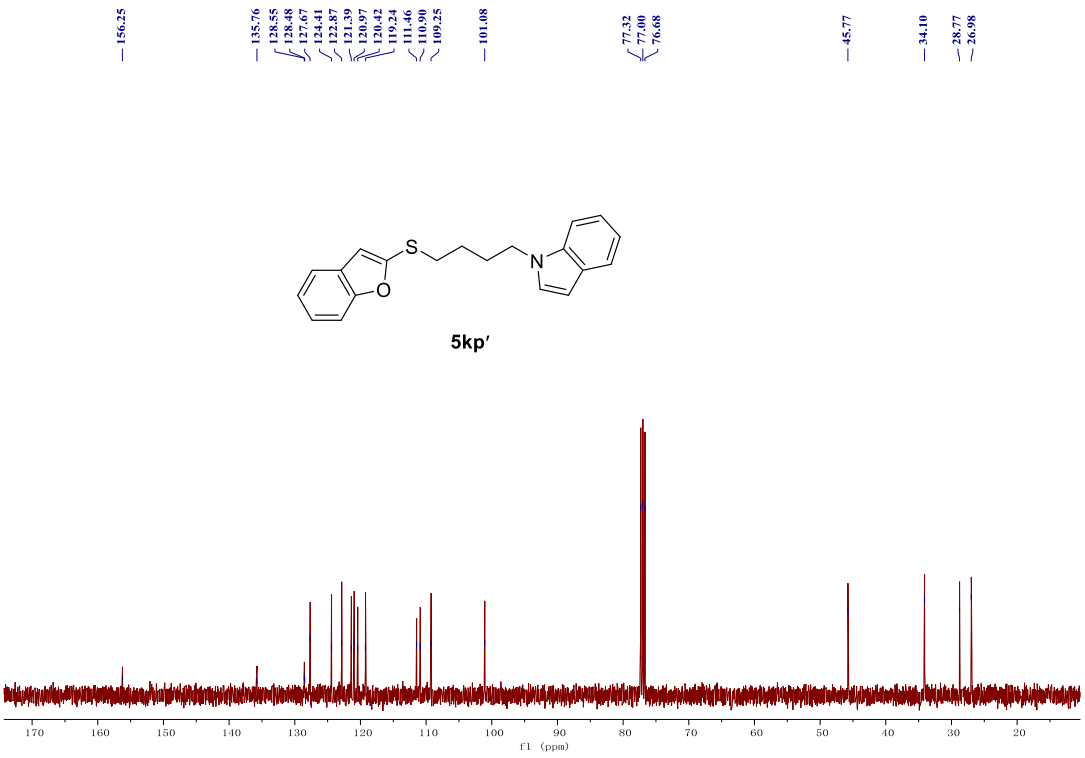
^{13}C NMR of 5ld



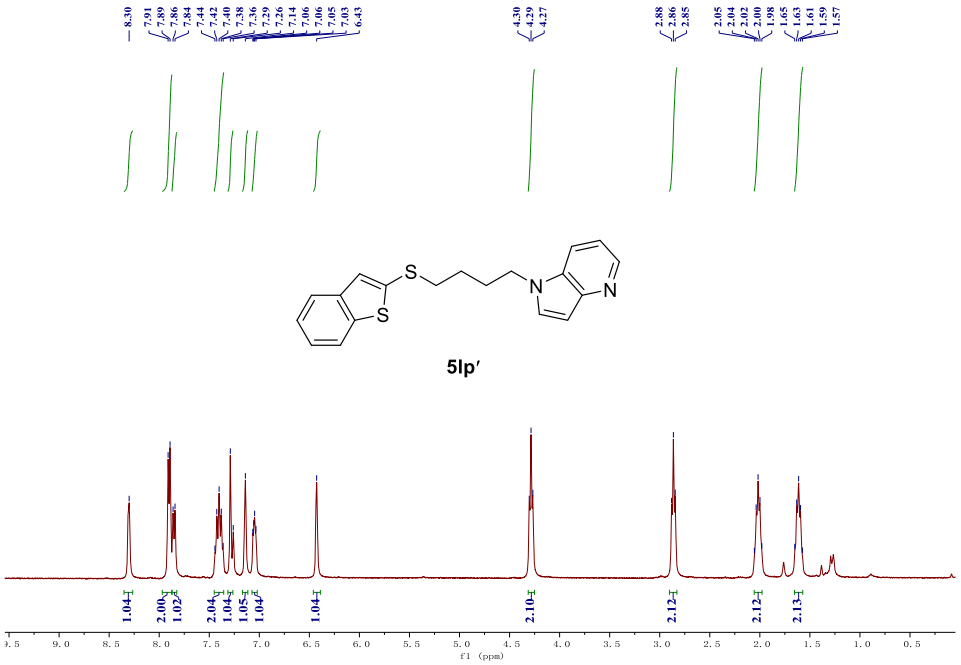
^{1}H NMR of 5kp'



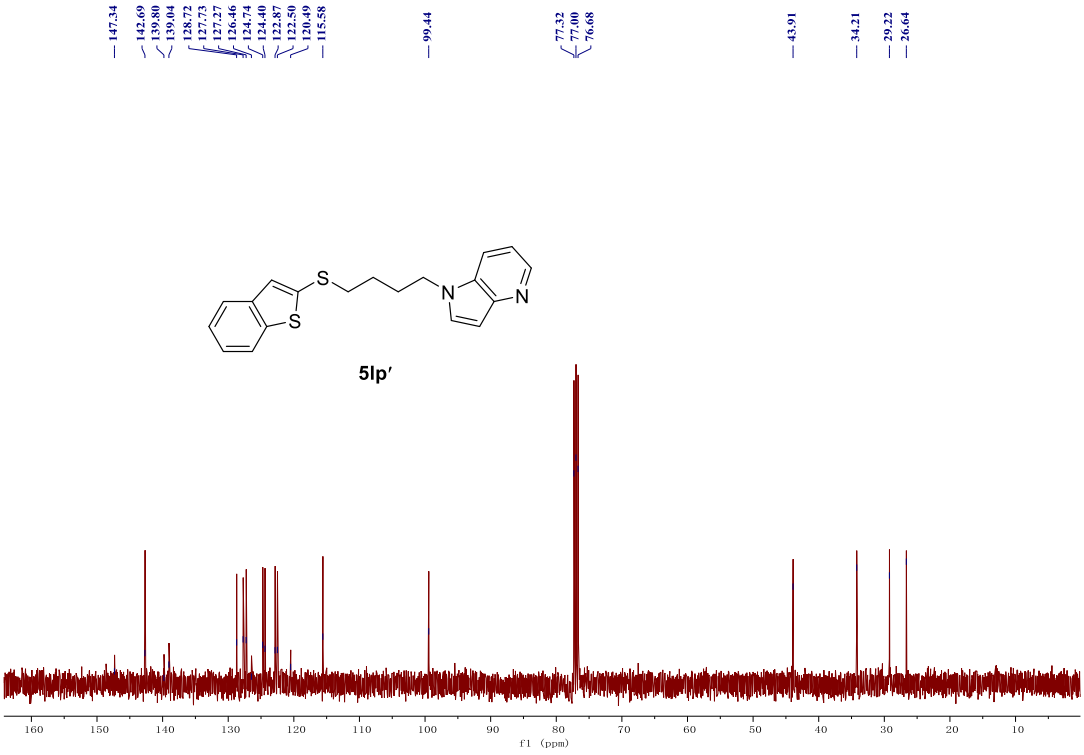
^{13}C NMR of 5kp'



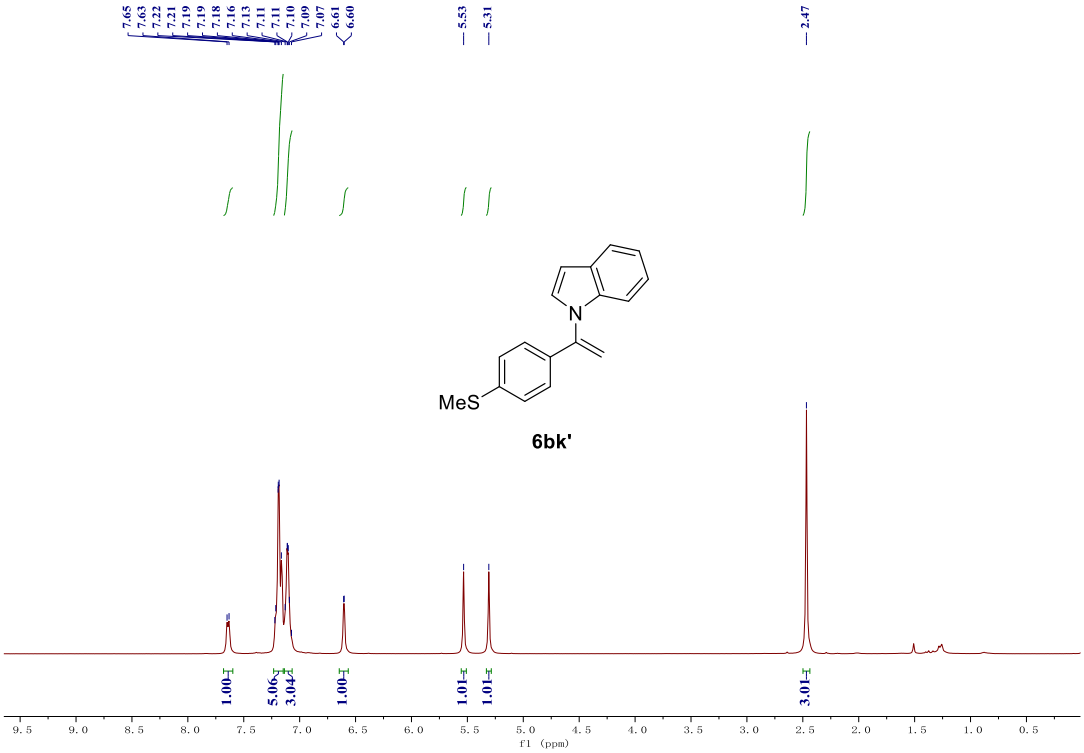
^{1}H NMR of 5lp'



^{13}C NMR of 5lp'

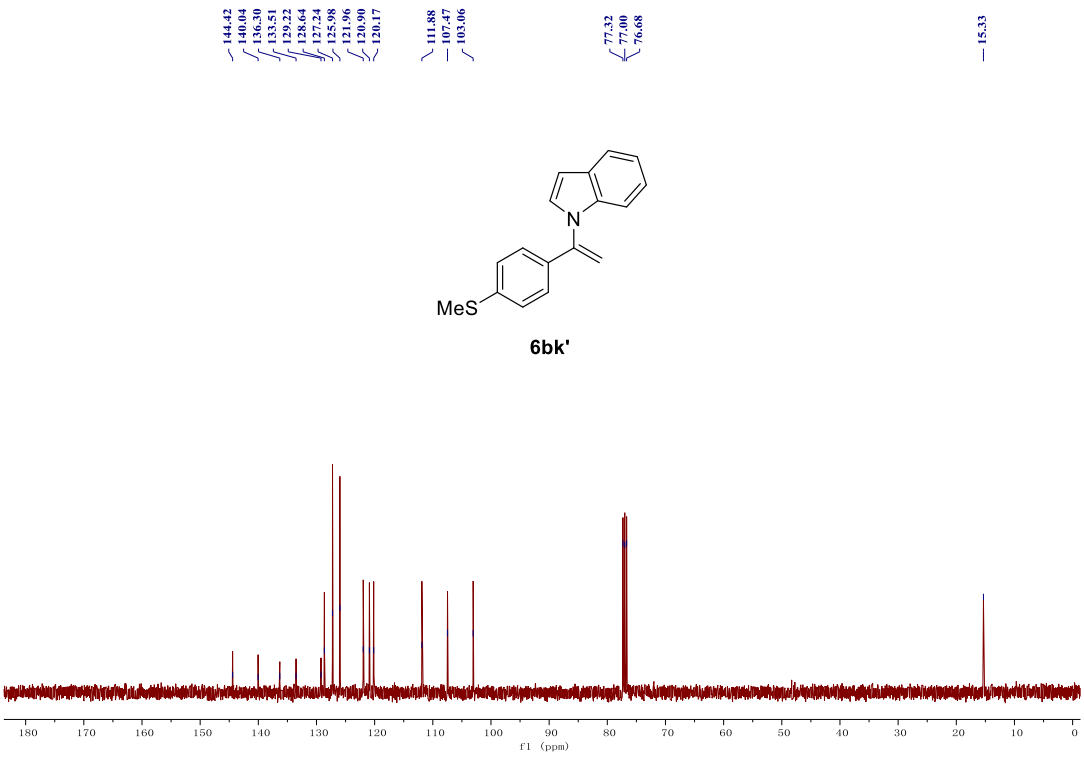


^{1}H NMR of 6bk'



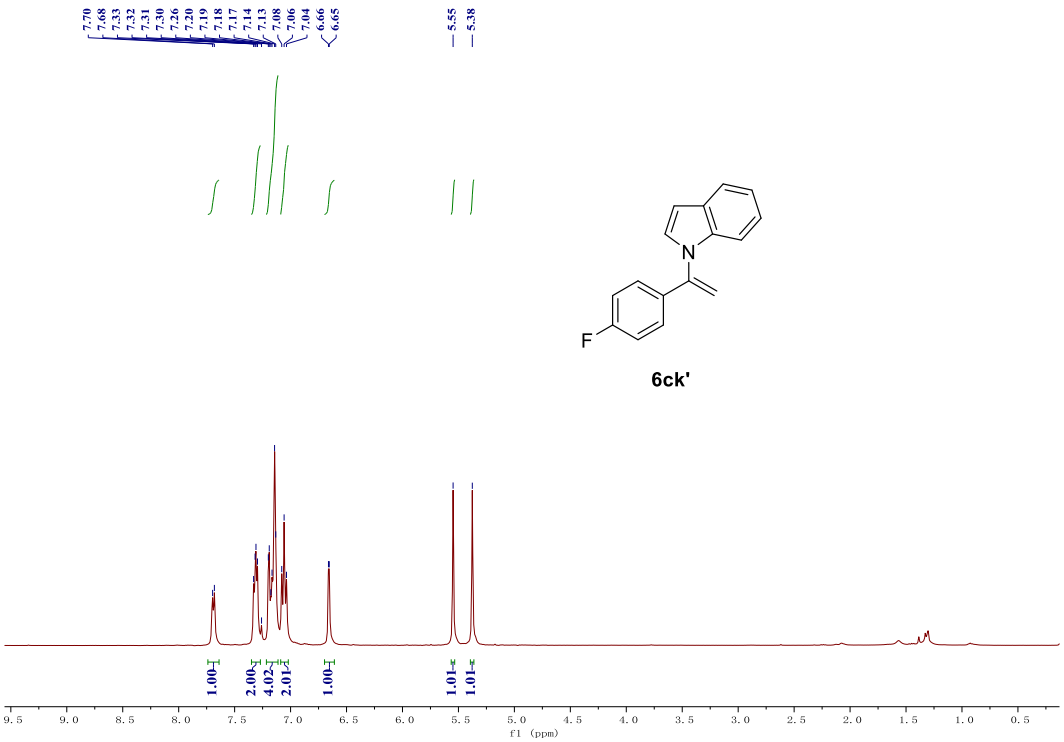
6bk'

^{13}C NMR of 6bk'

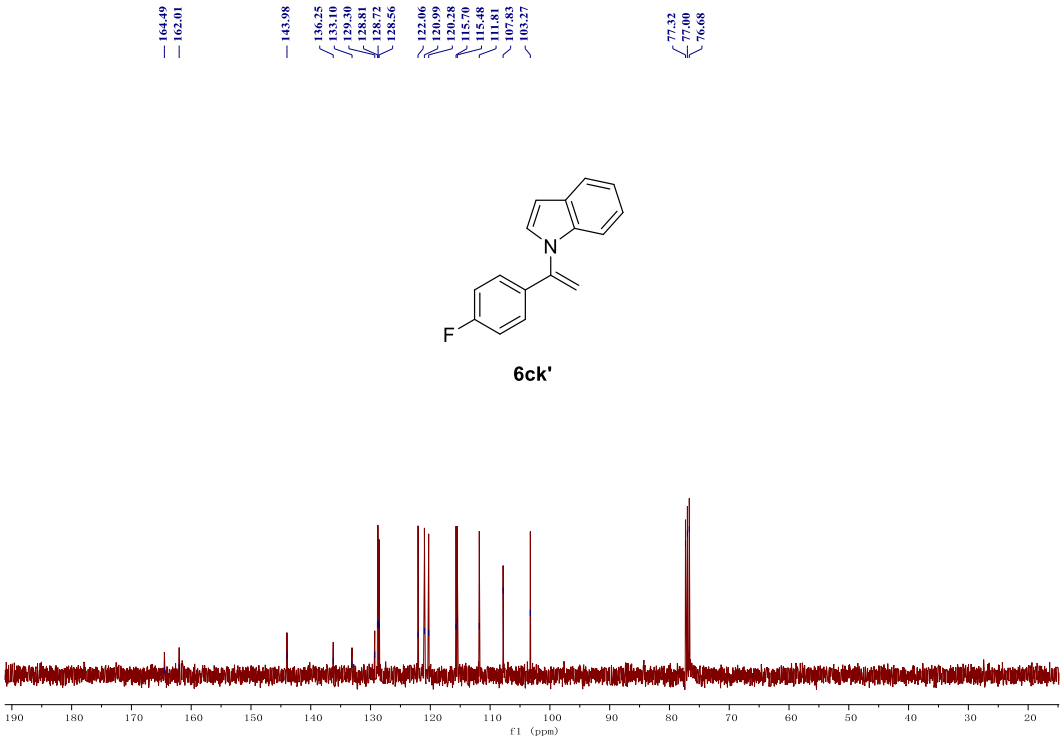


6bk'

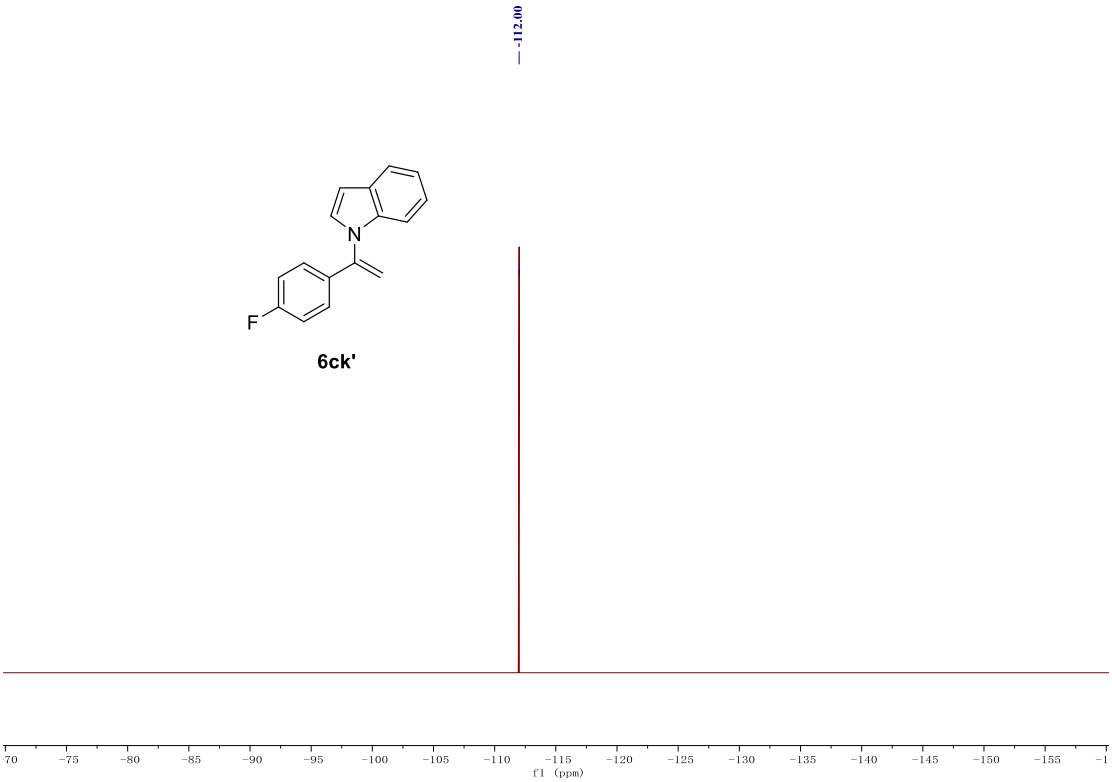
^{1}H NMR of 6ck'



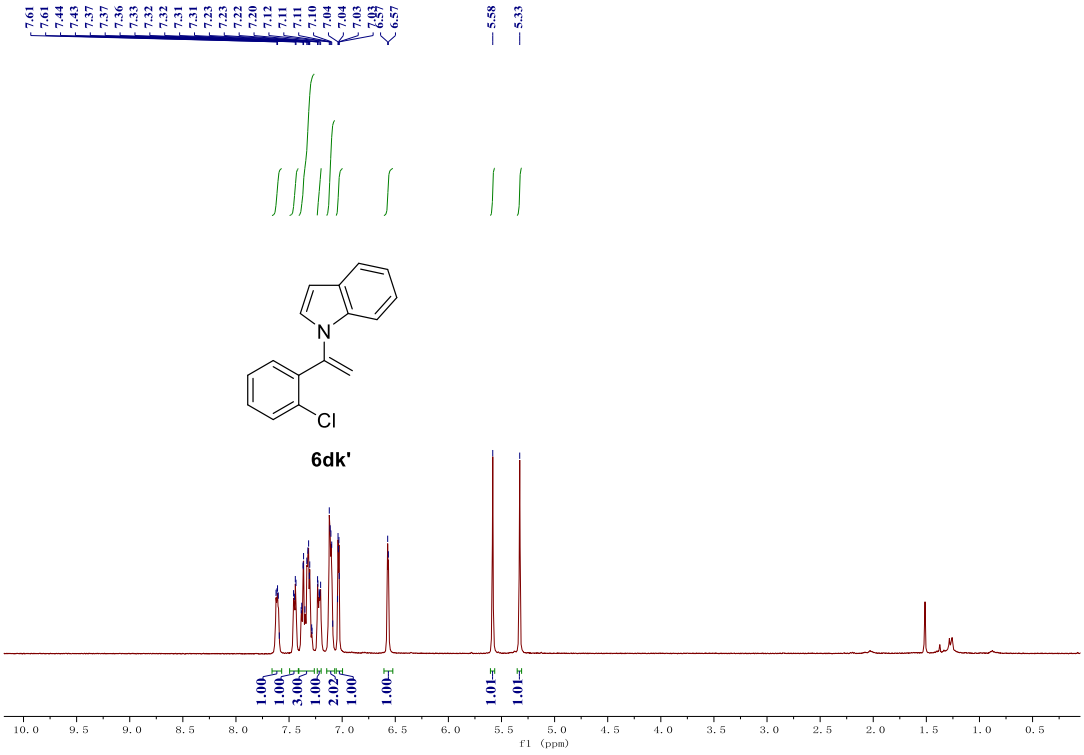
^{13}C NMR of 6ck'



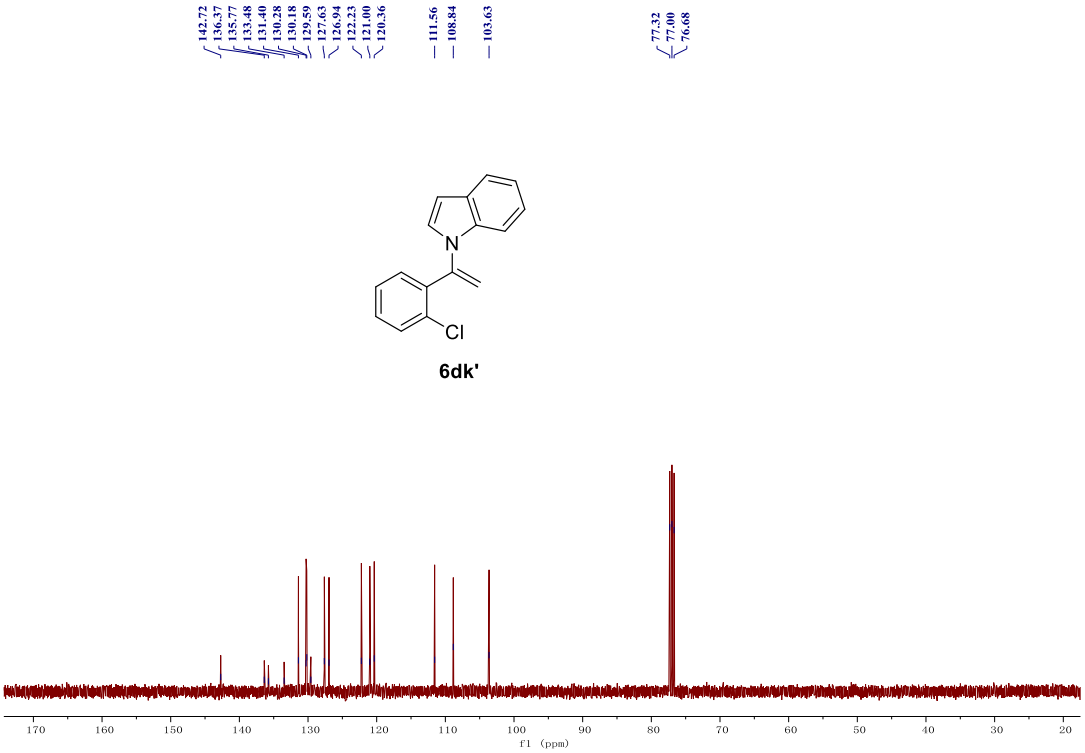
^{19}F NMR of 6ck'



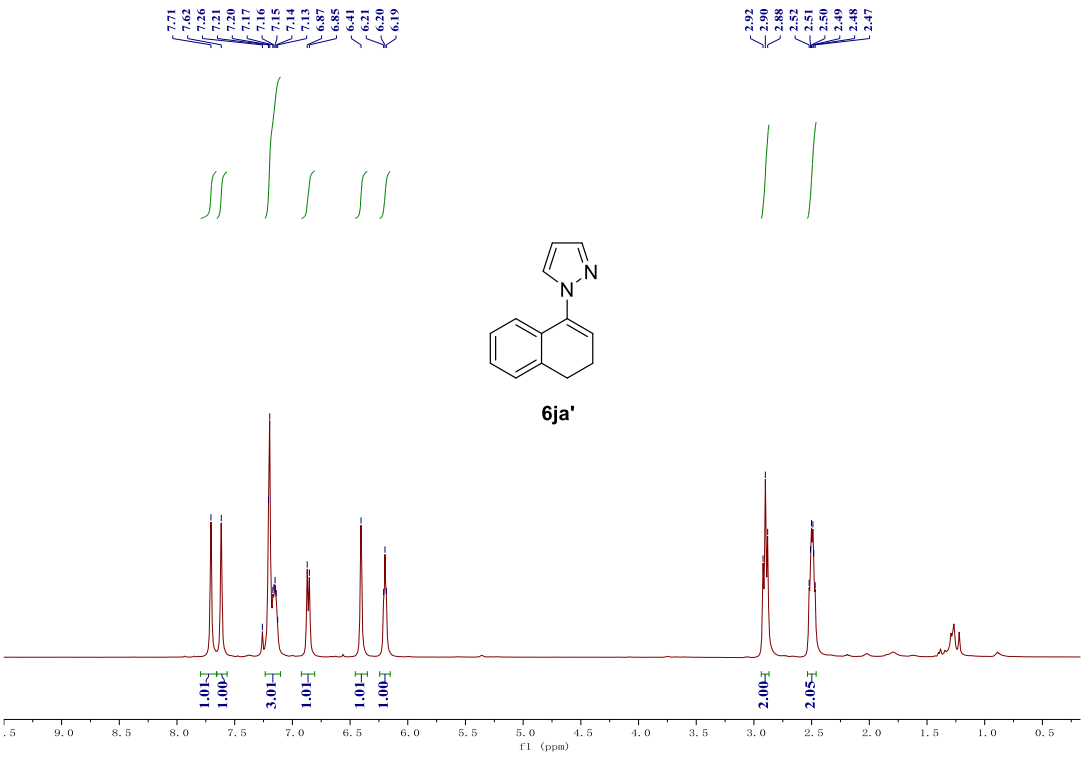
^{1}H NMR of 6dk'



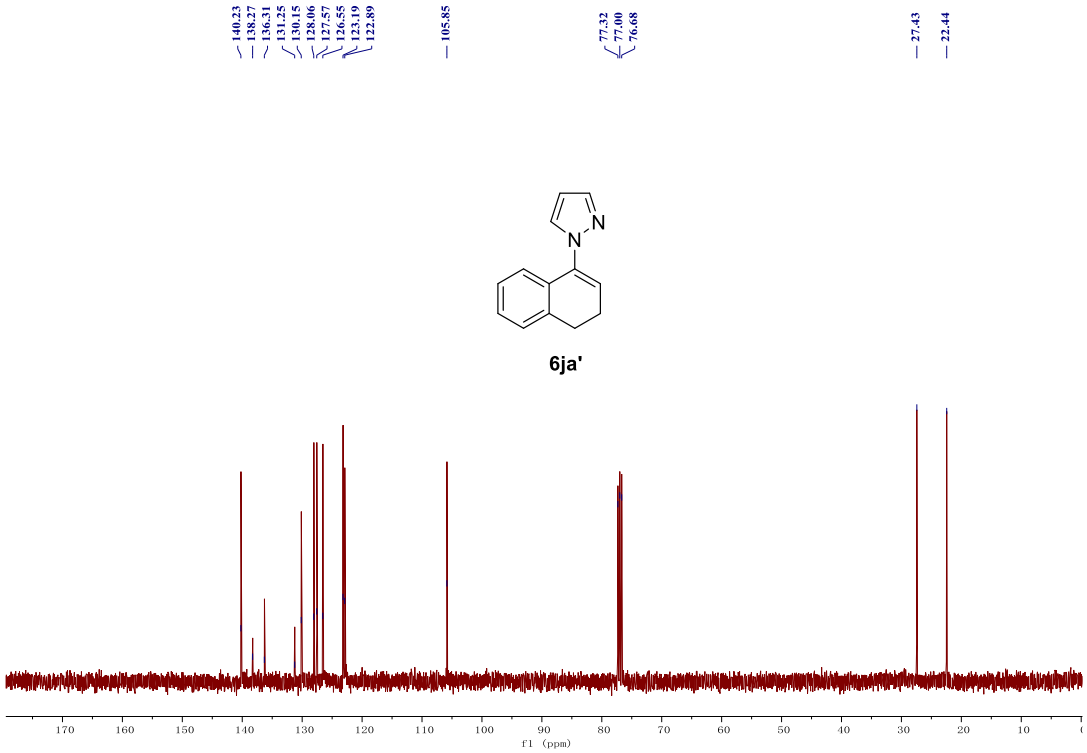
^{13}C NMR of 6dk'



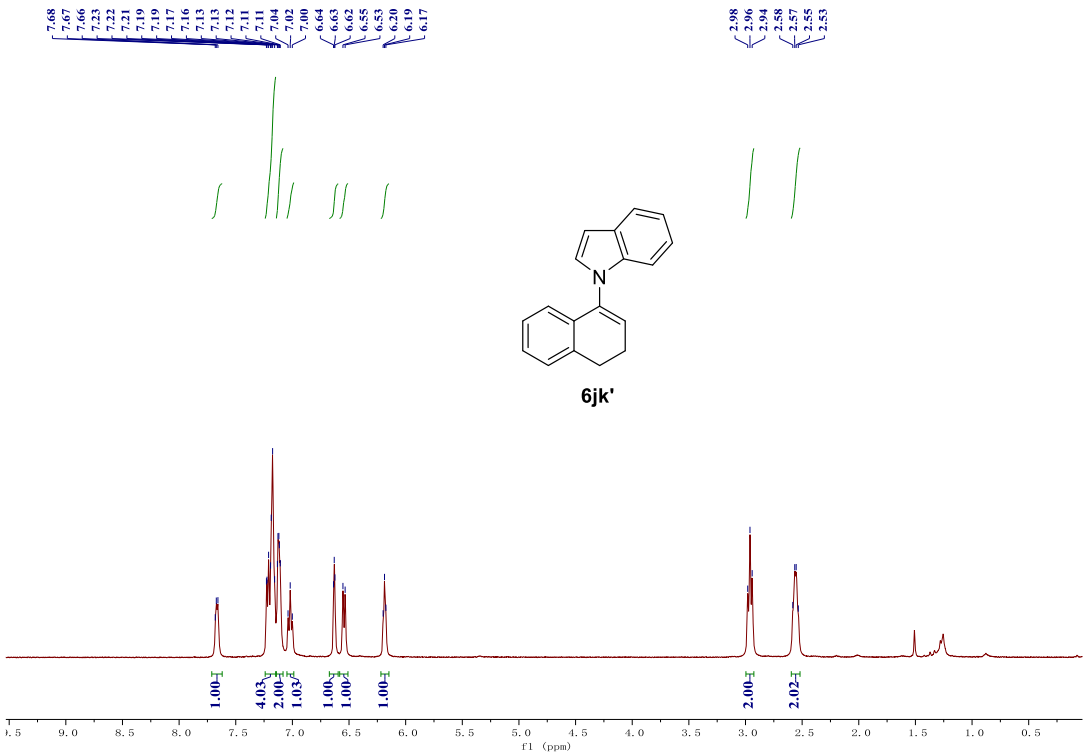
^{1}H NMR of 6ja'



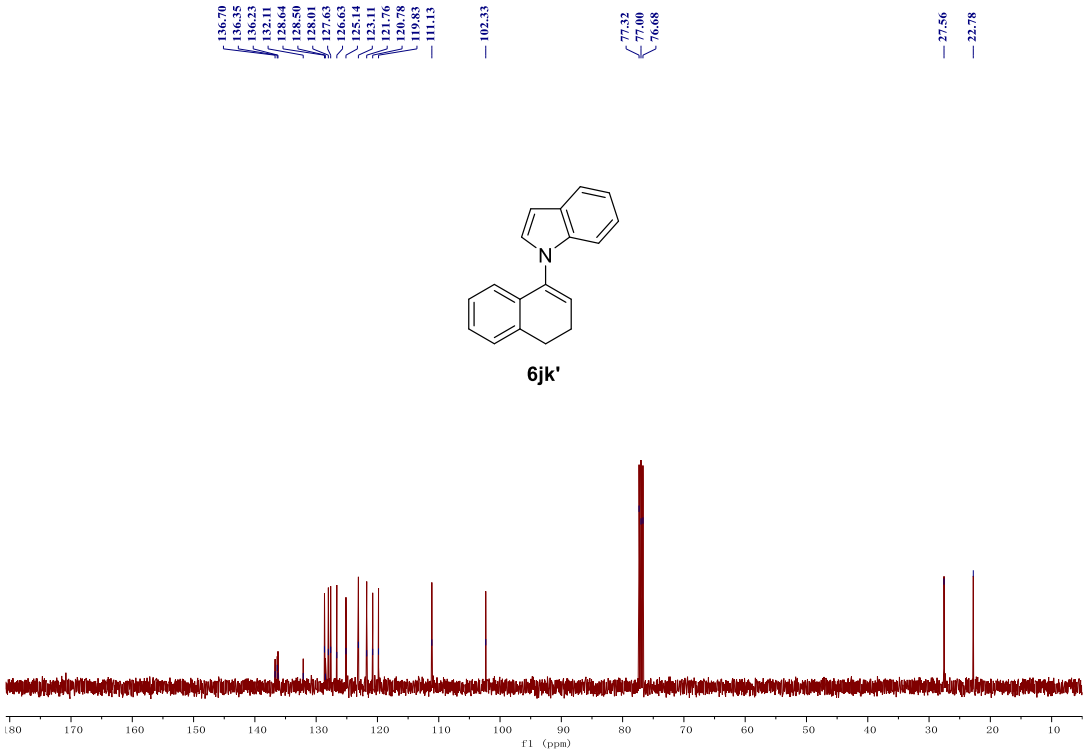
^{13}C NMR of 6ja'



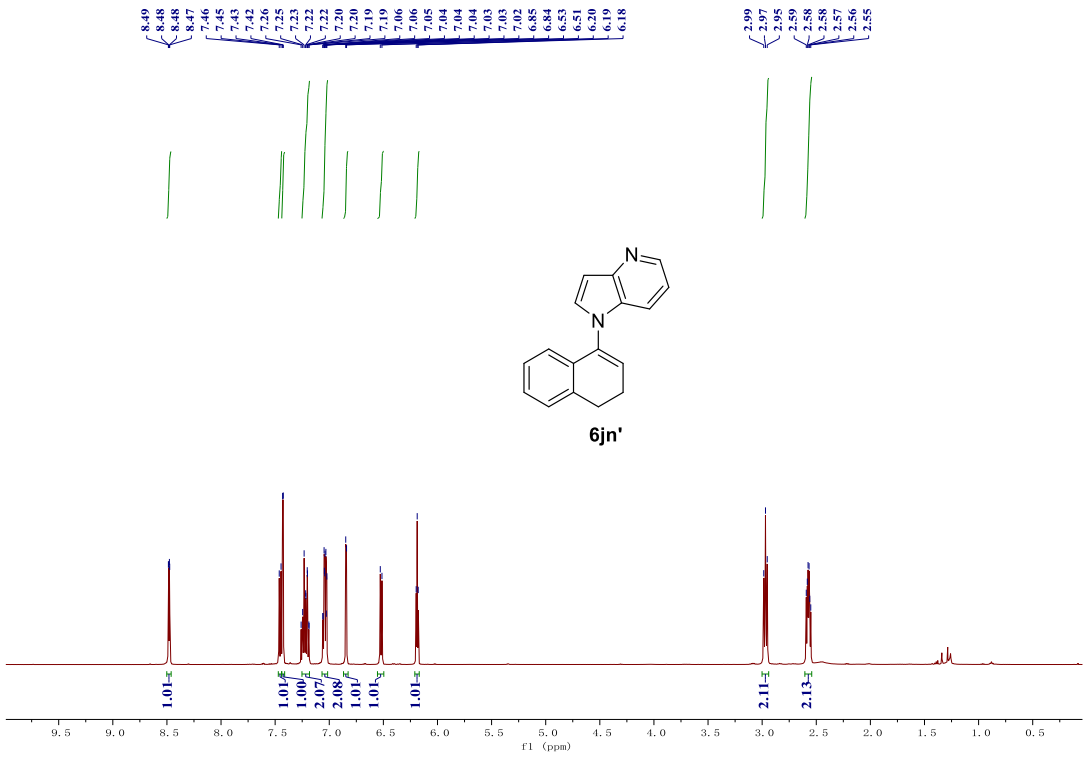
^{1}H NMR of 6jk'



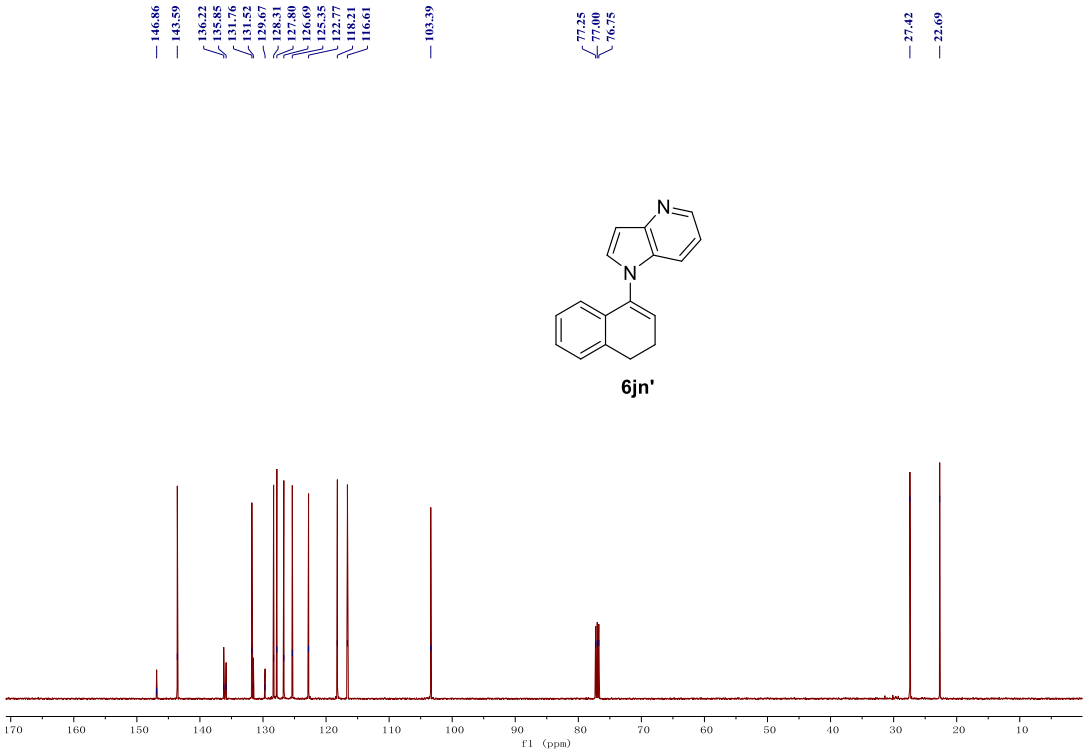
^{13}C NMR of 6jk'



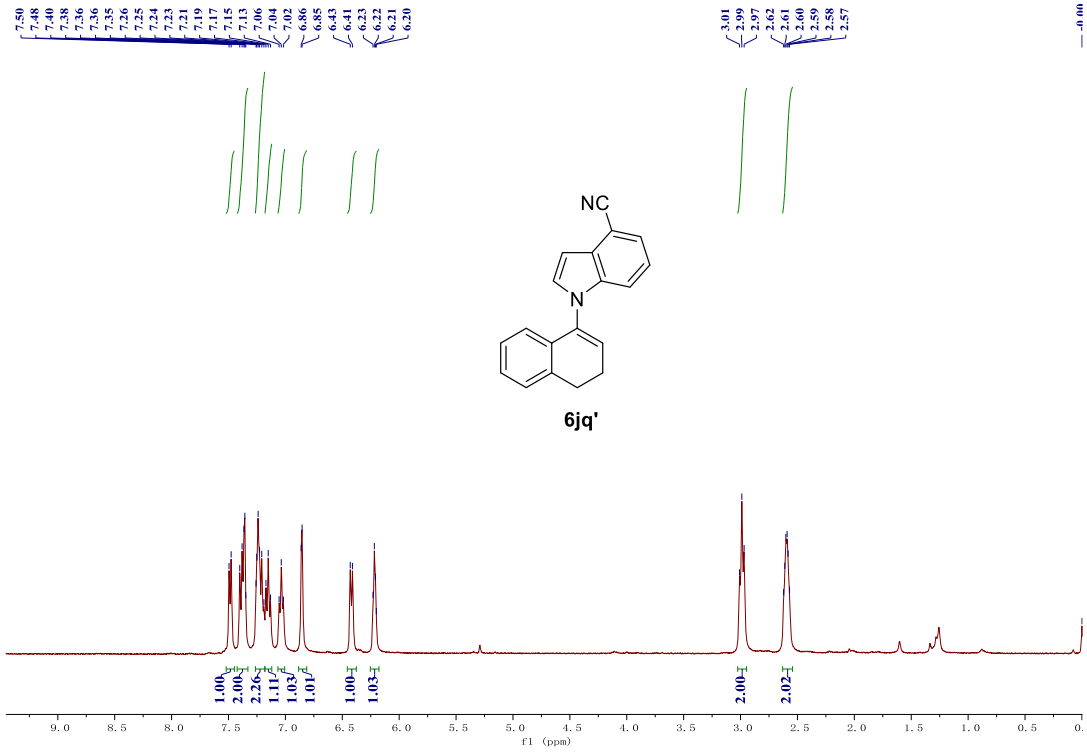
^{1}H NMR of 6jn'



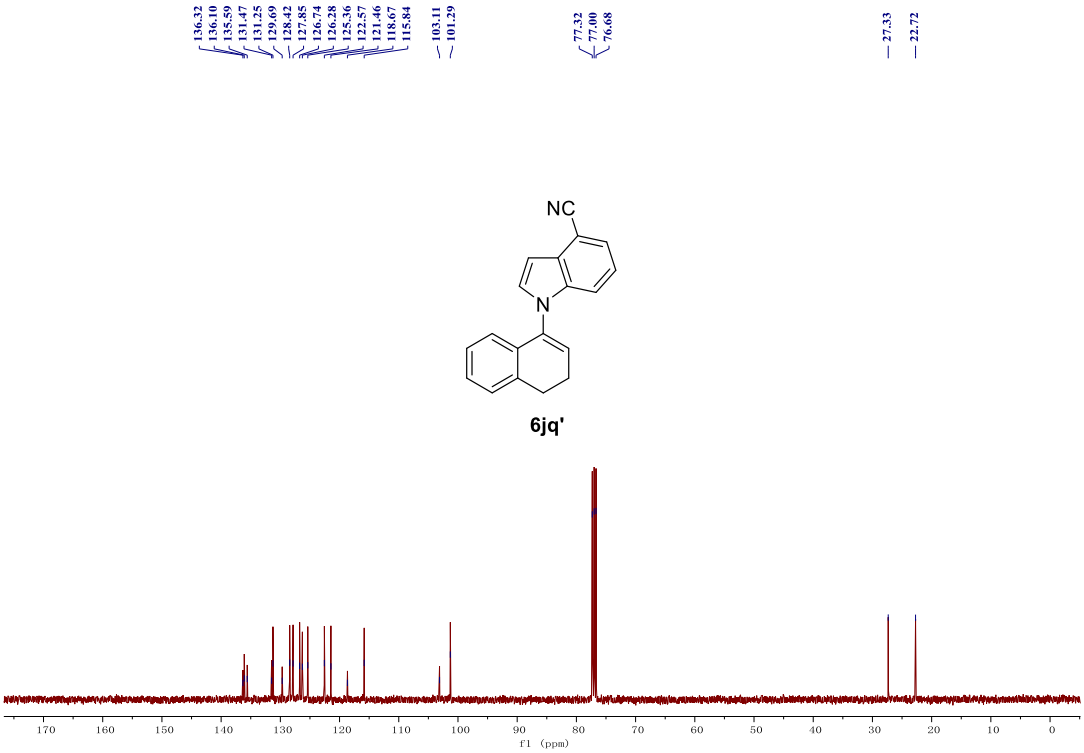
^{1}H NMR of 6jn'



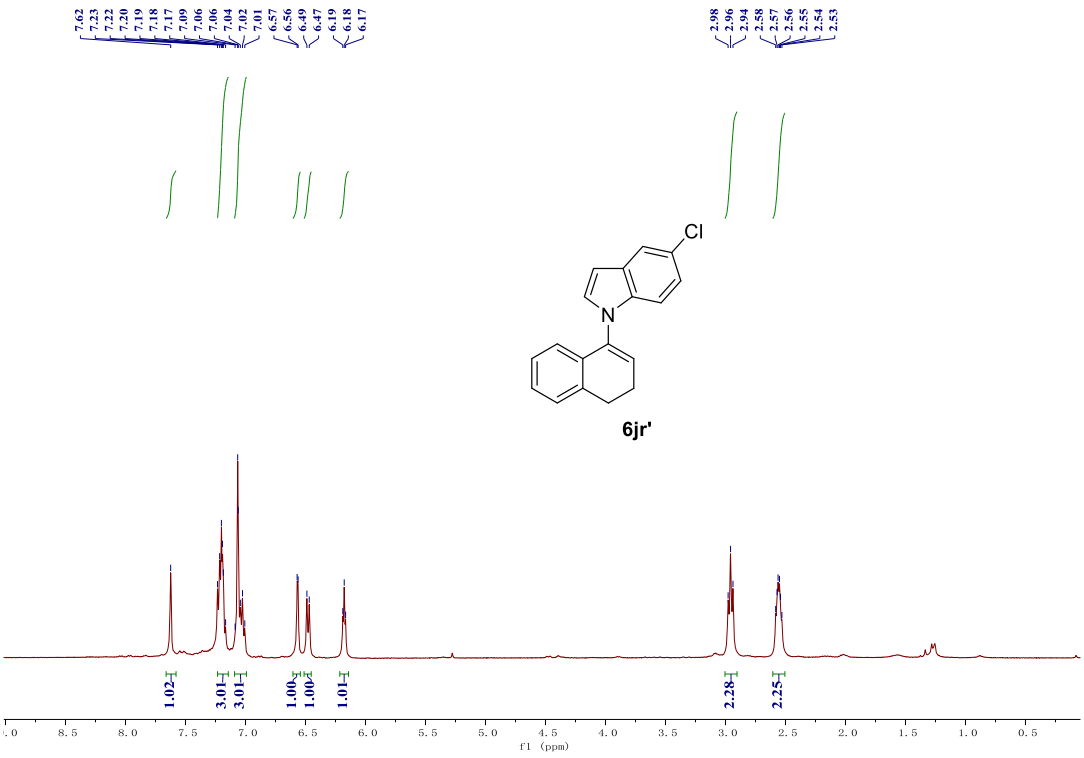
^{1}H NMR of 6jq'



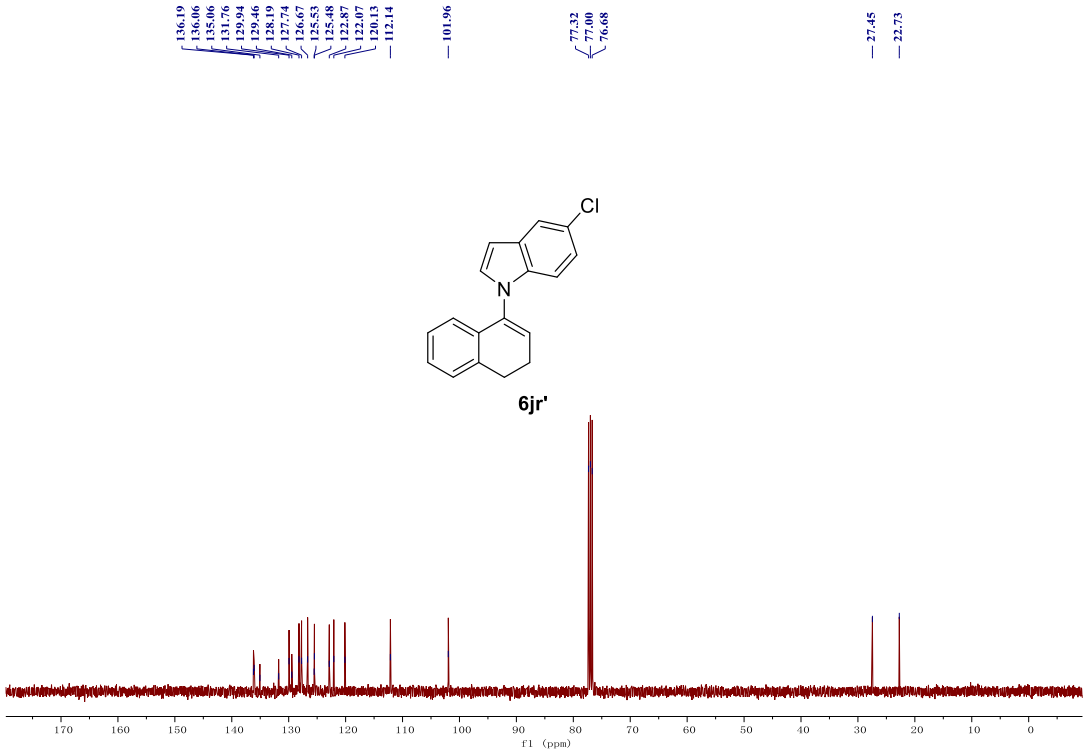
^{13}C NMR of 6jq'



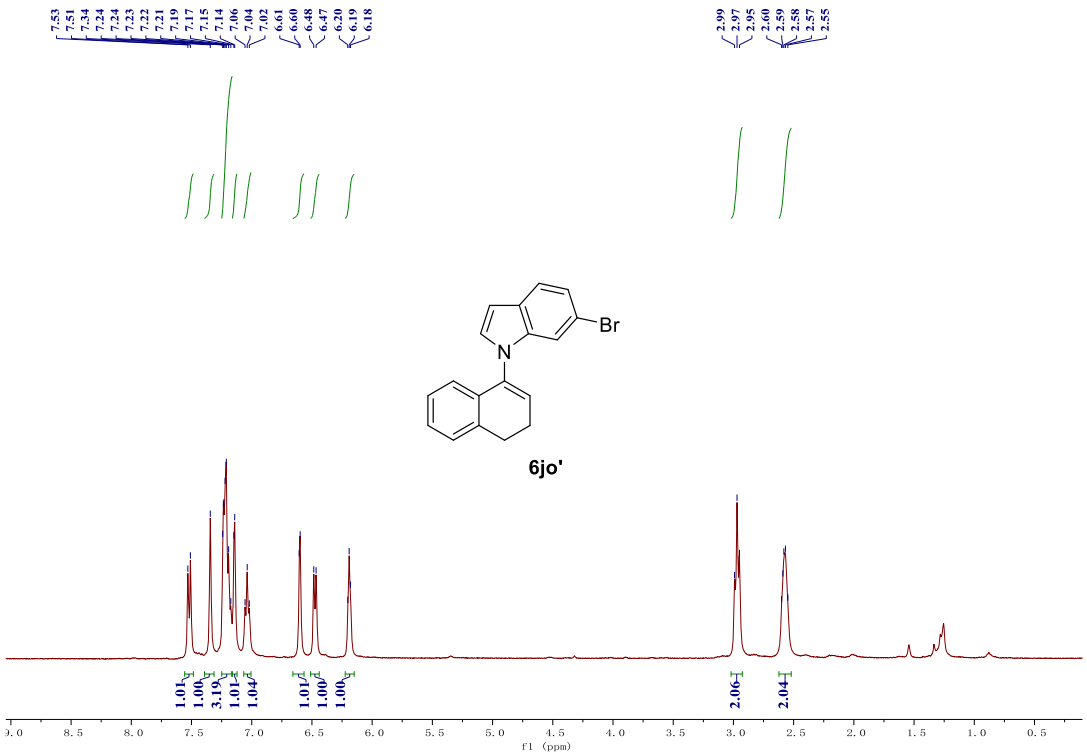
^{1}H NMR of 6jr'



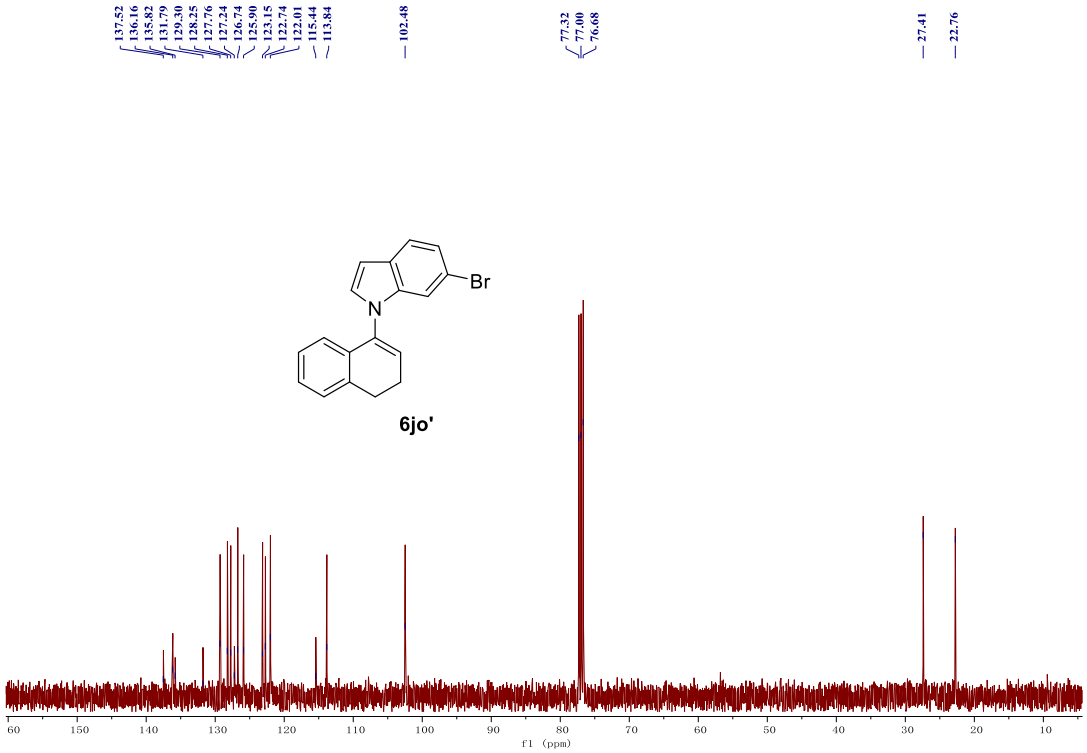
^{13}C NMR of 6jr'



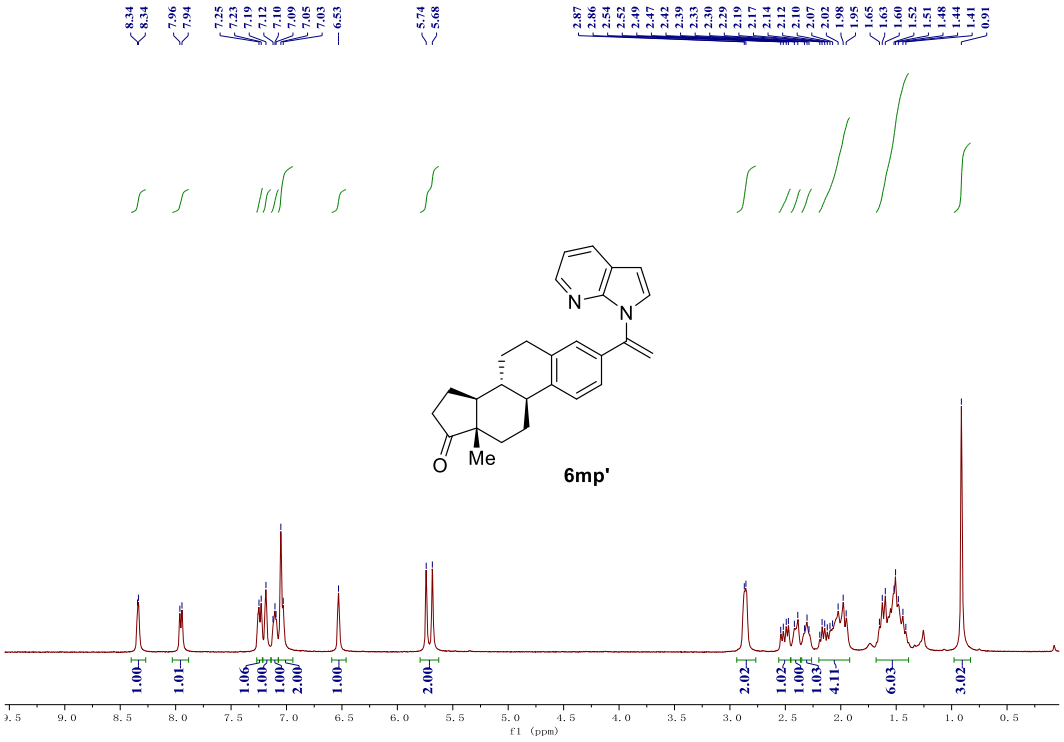
^{1}H NMR of 6jo'



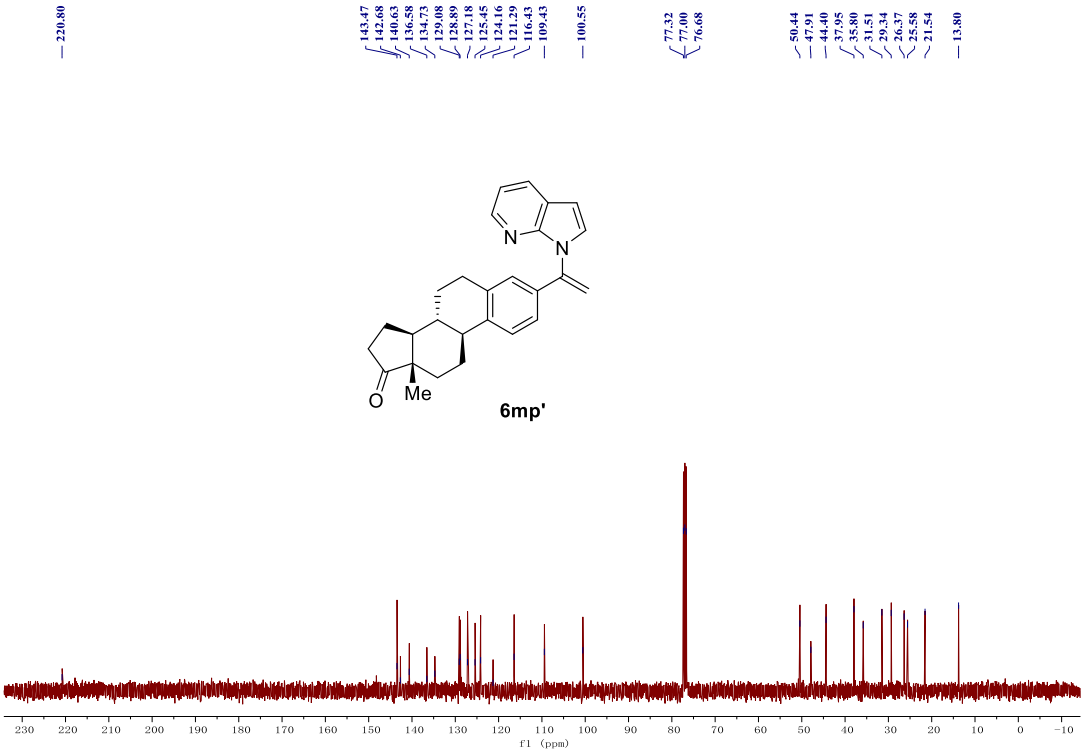
^{13}C NMR of 6jo'



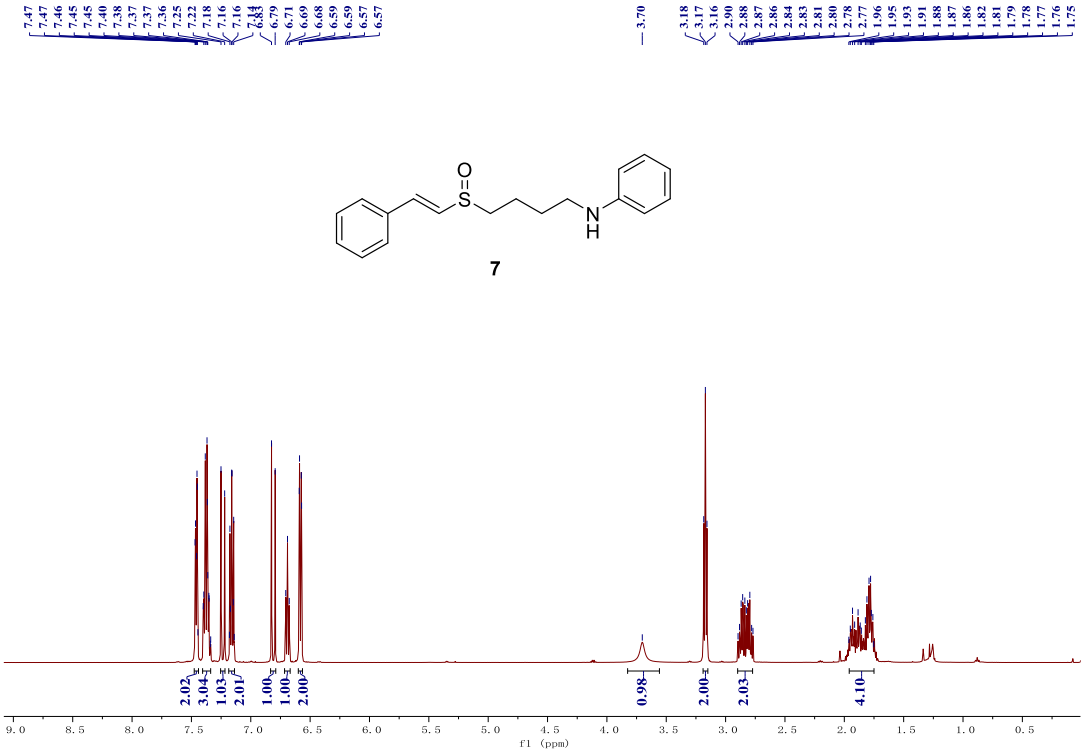
^{1}H NMR of 6mp'



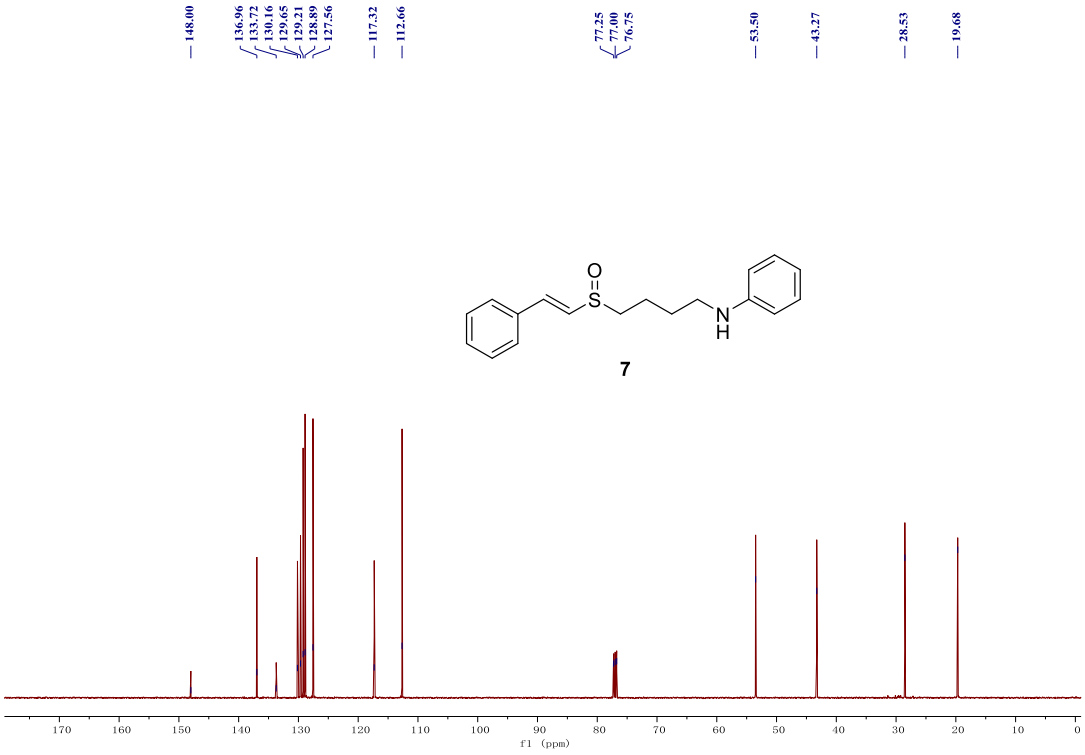
^{13}C NMR of 6mp'



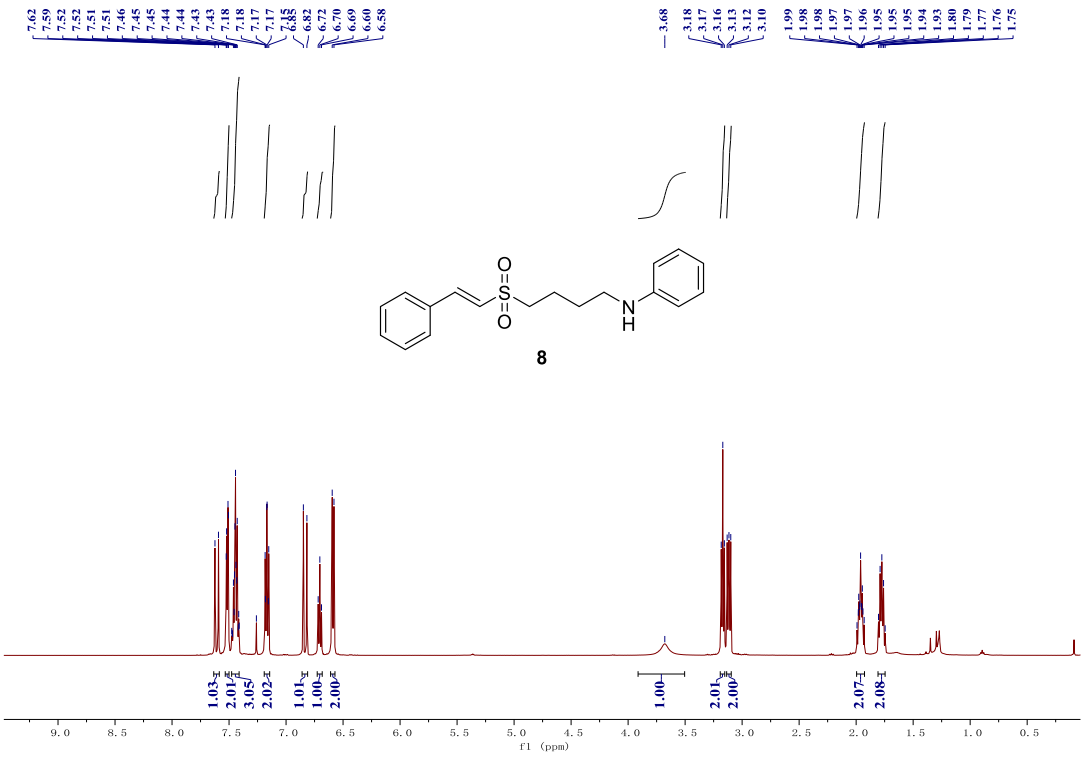
^{1}H NMR of 7



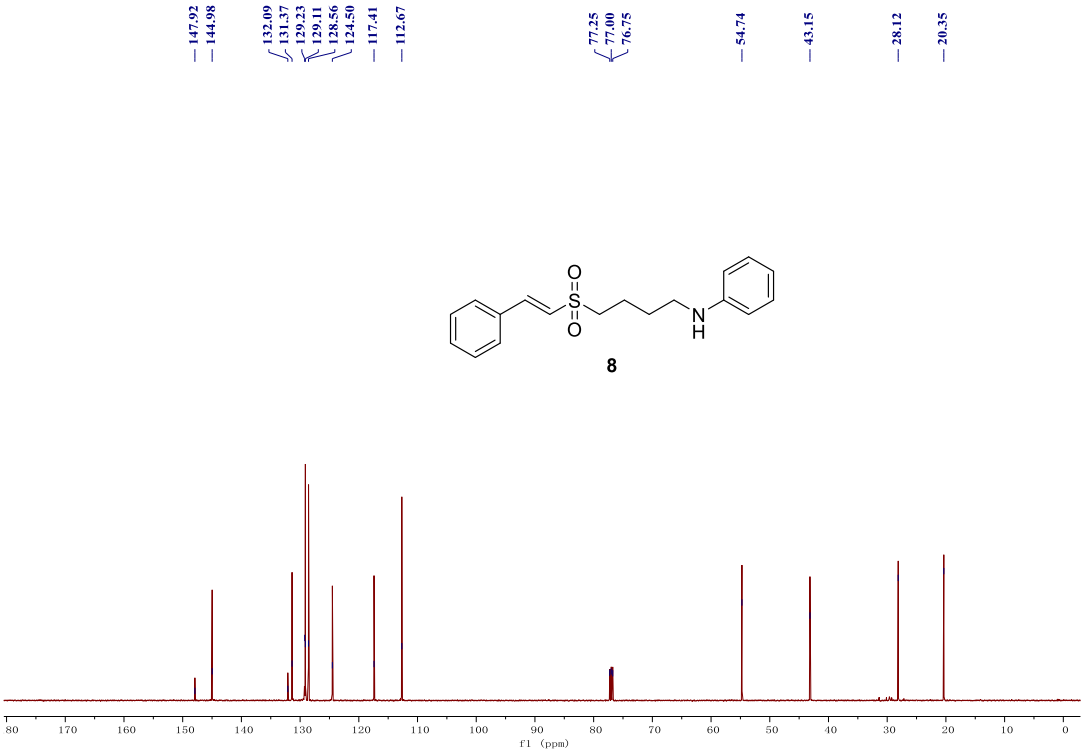
^{13}C NMR of 7



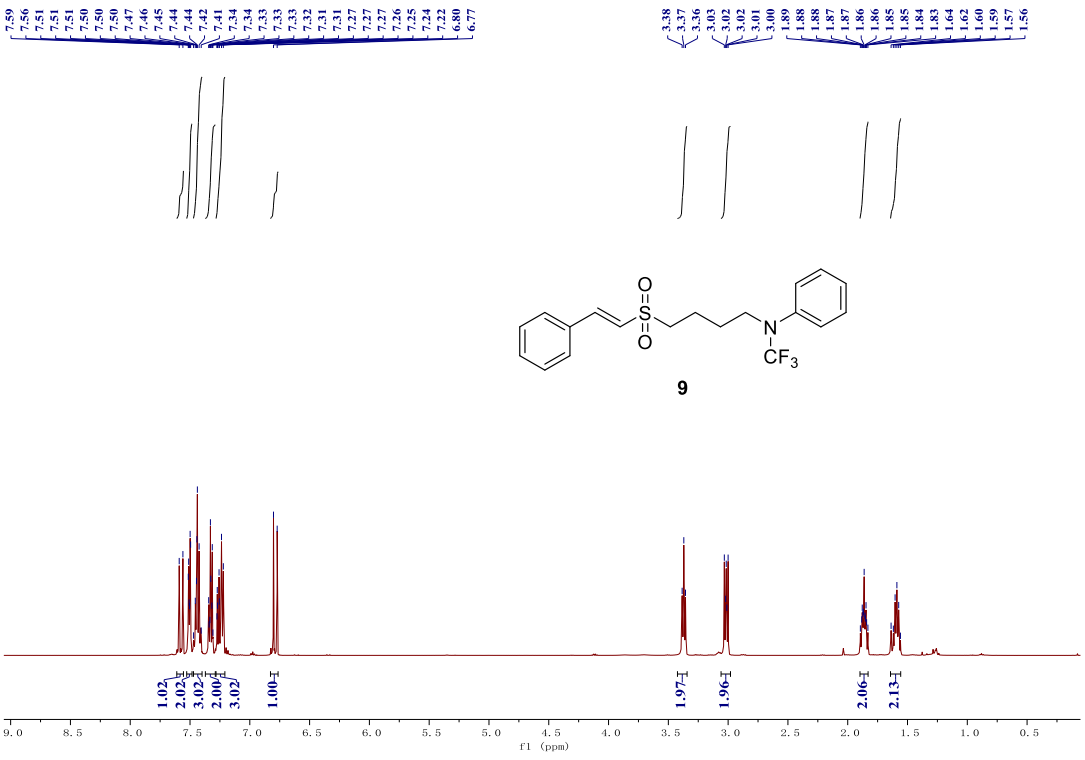
^{1}H NMR of 8



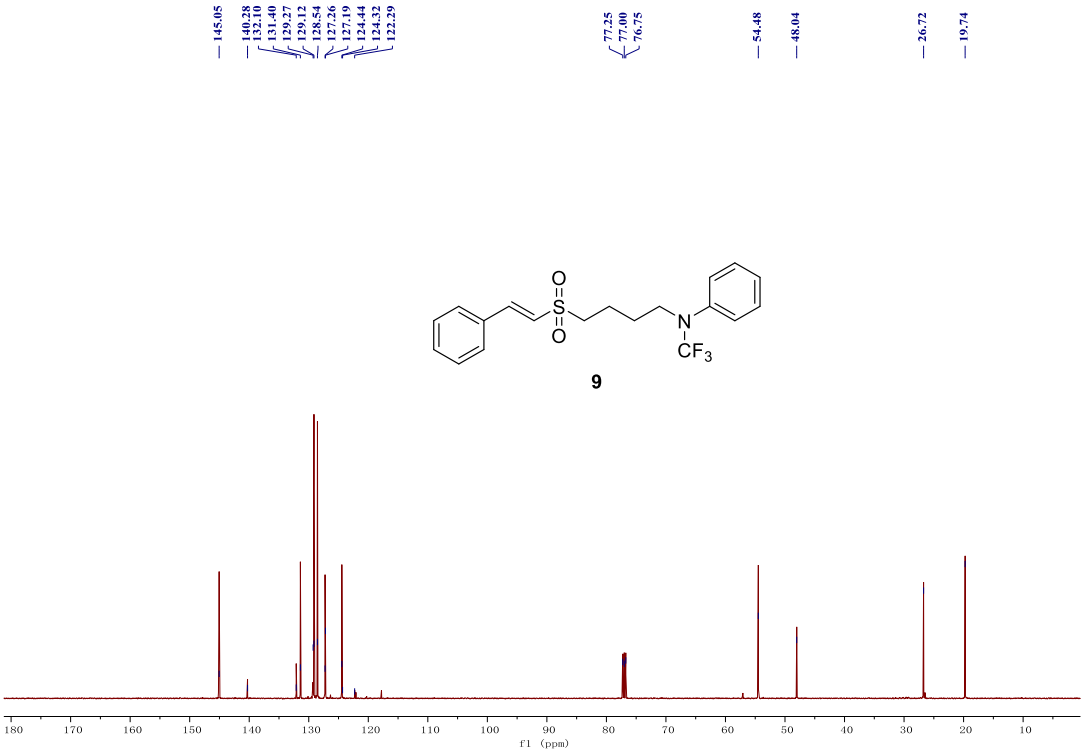
^{13}C NMR of 8



^{1}H NMR of 9



^{13}C NMR of 9



^{19}F NMR of 9