Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Photocatalyzed Sulfoximination/Amidation of (Het)Arylethenes Tethered *N*-Tosyl Amide: A Versatile Entry to Sulfoximidoyl *β*- And *γ*-Lactams

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General Procedures and New Compounds Characterization

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1.General Information

All commercially available compounds were purchased from Energy Chemical, Tansoole or Bide Pharmatech Ltd, and used without further purification, unless otherwise noted. The reactions were monitored by thin layer chromatography (TLC) with aluminium sheets silica gel GF254 from Energy Chemical. Flash column chromatography was performed on silica gel (particle size 300-400 mesh). NMR spectra were recorded on Bruker 400 (400 MHz for ^{1}H; 376 MHz for ^{19}F; 101 MHz for ^{13}C) spectrometer. The chemical shifts (δ) are given in parts per million relative to $CDCl_3$ (7.26 ppm for ^{1}H), TMS (0 ppm for ^{1}H) and $CDCl_3$ (77.0 ppm for ^{13}C), DMSO-d_6 (2.50 ppm for ^{1}H), DMSO-d_6 (40.0 ppm for ^{13}C). ^{1}H, ^{13}C and ^{19}F multiplicities are reported as following: singlet (s), doublet (d), doublet of doublets (dd), quartet (q), multiplet (m). High resolution mass spectra (HRMS) were recorded on a Shimadzu LCMS-IT-TOF. DCM (99.9%, Super Dry) was purchased from Admas-beta and was used without further purification, but degassing is required before use. The irradiation source was purchased from Taobao (30 W blue LED, 2.3.2 Optimized procedure for details). Low-temperature Stirring Reaction Bath (DHJF-8005) equipment purchased from Zhengzhou Greatwall Scientific Industrial and Trade Co., Ltd.

2. Experimental Section

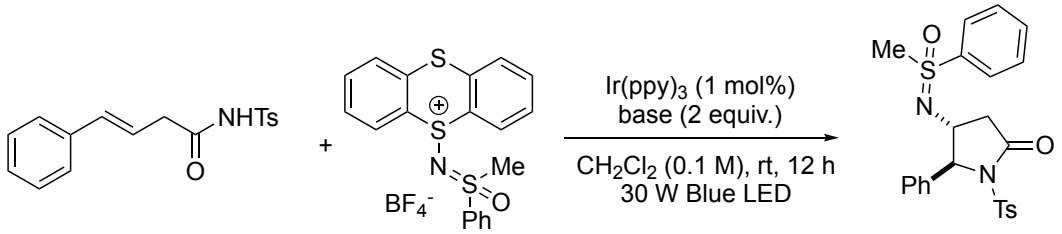
2.1 Optimization of the reaction conditions Optimized procedure

2.1.1 Optimization of the Reaction Conditions

Sulfoximidoyl thianthrene salts **1a** (0.15 mmol), **2a** (0.1 mmol), photocatalysis (1 mol%) and base (0.2 mmol) in a Penicillin vial was evacuated and backfilled with argon via Schlenk line three times. Subsequently, DCM (anhydrous, 1.0 mL) were added and irradiated by 30 W blue LED strip light for various time. After completion of the reaction. Yields were determined by ^{1}H NMR with CH_2Br_2 as an internal standard. The

results were listed in Table S1-S4

Table S1. Base optimization [a]

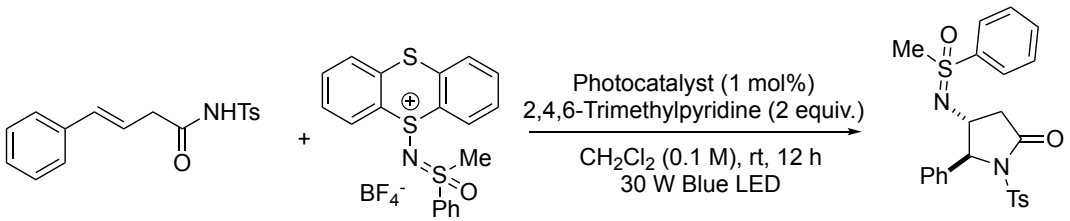


1a **2a** **3aa**

Entry	Base	Yield (%) [b]
1	KOAc	trace
2	K_2CO_3	trace
3	K_3PO_4	20
4	NaOH	22
5	*t*-BuOK	25
6	Et_3N	27
7	DBU	26
8	DIPEA	17
9	DABCO	25
10	TMEDA	7
11	Ph_3N	7
12	N-Methylpiperidine	27
13	N-Methyl-2-pyrrolidone	trace
14	Pyridine	32
15	2,4,6-Trimethylpyridine	42
16	Piperidine	trace
17	2,6-Dichloropyridine	trace
18	2-Phenylpyridine	15
19	2,6-Dimethoxypyridine	trace
20	2,6-Lutidine	36
21	DMAP	25
22	N, N-Dimethylaniline	0
23	Pyrazine	0
24	Pyrimidine	0

[a] Reaction condition: 0.1 mmol **2a**, 0.2 mmol base, 0.15 mmol **1a**, 30W blue LED, 12 hours. [b]Yield were determined by ^1H NMR with CH_2Br_2 as an internal standard.

Table S2. photocatalysis optimization [a]

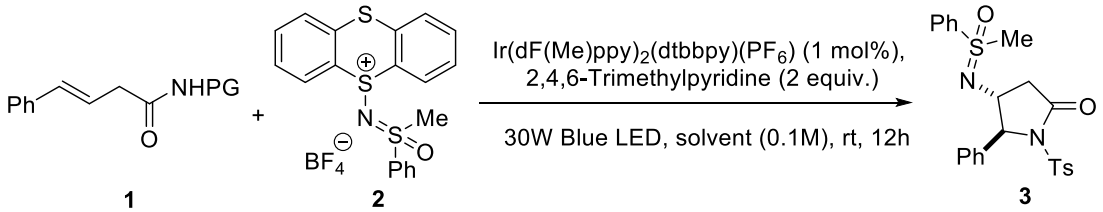


1a **2a** **3aa**

Entry	Photocatalyst	Yield (%) [b]
1	$Ru(bpy)_2Cl_2$	20
2	$Ir(ppy)_3$	42
3	$Ir(dF(Me)ppy)_2(dtbbpy)[PF_6]$	55
4	$[Ir(dtbbpy)(ppy)_2][PF_6]$	23
5	$Ir(ppy)_2(dtbbpy)[PF_6]$	30
6	$Ir(dF\text{-}mppy)_2(dtppy)[PF_6]$	32
7	$Ir(dF(CF_3)ppy)_2(dtbby)[PF_6]$	52
8	$Ir(dF\text{-}ppy)_2(dtbbpy)[PF_6]$	50
9	9H-Thioxanthen-9-one, 4a,9a-dihydro-	trace
10	Solvent Red	11
11	Fluorescein Sodium	trace
12	Eosin Y-Na_2	trace
13	none	0

[a] Reaction condition: 0.1 mmol **2a**, 0.2 mmol 2,4,6-Trimethylpyridine, 0.15 mmol **1a**, 30 W blue LED, 12 hours. [b]Yields were determined by ^1H NMR with CH_2Br_2 as an internal standard.

Table S3. Solvents optimization [a]

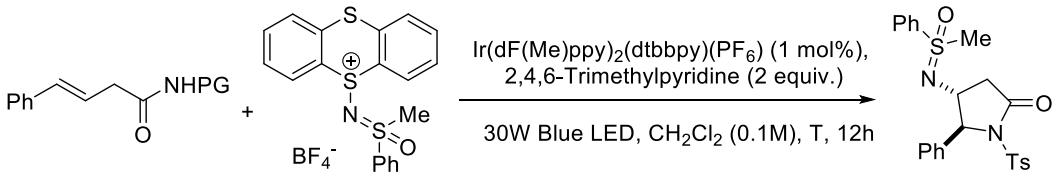


1 **2** **3**

Entry	Solvents	Yield (%) [b]
1	DCM	55
2	DCE	18
3	DMSO	5
4	CH_3CN	17
5	EtOAc	0

[a] Reaction condition: 0.1mmol **2a**, 0.2 mmol 2,4,6-Trimethylpyridine, 0.15 mmol **1a**, 30 W blue LED, 12 hours. [b]Yields were determined by ^1H NMR with CH_2Br_2 as an internal standard.

Table S4. Temperature optimization [a]



Entry	Temperature (°C)	Protecting group (PG)	Yield (%) [b]
1	rt	Ts	55
2	-20	Ts	72
3	-20	H	trace
4	-20	Bn	trace
5	-20	OBn	trace

[a] Reaction condition: 0.1 mmol **2a**, 0.2 mmol 2,4,6-Trimethylpyridine, 0.15 mmol **1a**, 30 W blue LED, 12 hours. [b]Yields were determined by ^{1}H NMR with CH_2Br_2 as an internal standard.

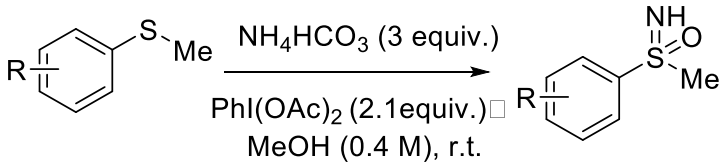
2.1.2 Optimized procedure

Reagent **2** (1 equiv), Ir(dF(Me) ppy)$_2$(dtbbpy)[PF_6] (1 mol%) and **1** (1.5 equiv) in a Penicillin vial was evacuated and backfilled with argon via Schlenk line three times. Subsequently, DCM (anhydrous, 1 M) and 2,4,6-Trimethylpyridine (2 equiv), were added, cooled to -20 °C and irradiated by 30 W blue LED strip light for 12 hours. The reaction mixture was concentrated in vacuo and purified by column chromatography to afford the desired product.

Figure S1. Reaction Equipment

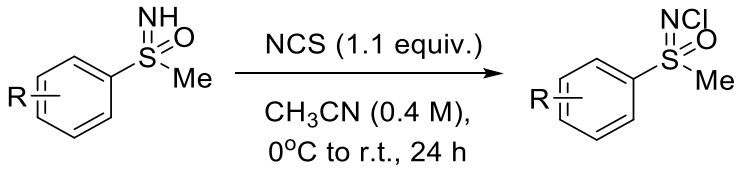
2.2 Synthesis of sulfoximidoyl thianthrene salts[1-2]

2.2.1 Synthesis of *NH*-sulfoximines



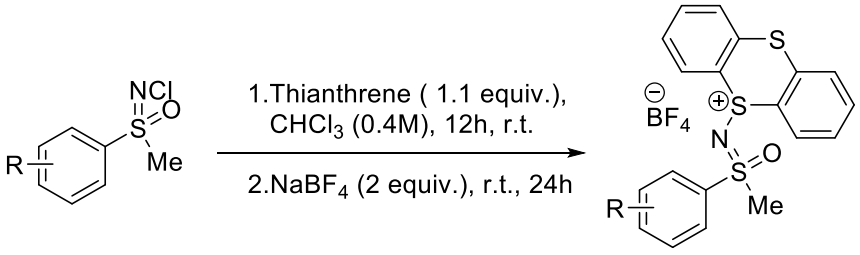
The sulfide (10 mmol), (diacetoxyiodo) benzene (21 mmol, 2.1 equiv.) and ammonium bicarbonate (3.0 equiv) were added to a flask containing a stirrer bar. MeOH (25 mL, 0.4 M) was added and the reaction was stirred at room temperture for 3 hours. Removal of the solvent under reduced pressure and subsequent flash column chromatography of the obtained residue on silica gel with pure petroleum ether/ethyl acetate (1:1) or ethyl acetate as eluent afforded the desired products (light yellow oil) (yield 90-100%).

2.2.2 Synthesis of *N*-chlorosulfoximine.



The acetonitrile solution (0.4 M) of sulfoximine (10 mmol, 1.0 equiv.) was stirred in an ice bath, *N*-chlorosuccinimide (1.1 equiv.) was added after 30 minutes. After 24 hours, removal of the solvent under reduced pressure and subsequent flash column chromatography of the obtained residue on silica gel with pure petroleum ether/ethyl acetate (2:1) as eluent afforded the desired products (yield 70-80%).

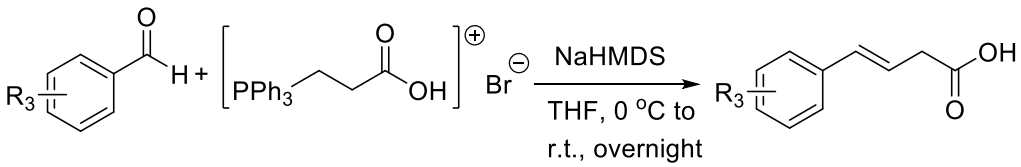
2.2.3 Synthesis of sulfoximidoyl disulfides salts[3]



To a stirred chloroform solution (0.4 M) of *N*-chlorosulfoximine (8 mmol, 1.0 equiv.), thianthrene (1.1 equiv.) was added at room temperature and the solution was stirred overnight. To the solution, $NaBF_4$ (2.0 equiv.), was added and the solution was continued to stir for 24 hours. The chloroform solution was diluted with dichloromethane and washed with water, dried over $MgSO_4$, and evaporated under vacuum. Crystals obtained were recrystallized from ethanol-hexane (yield 70-80%). The spectral data were fully consistent with those previously reported.

2.3 Synthesis of (*E*)-4-aryl-*N*-tosylbut-3-enamide (1a-1o, 6) [4]

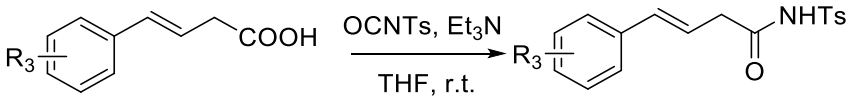
2.3.1 Synthesis of (*E*)-4-arylbut-3-enoic acid



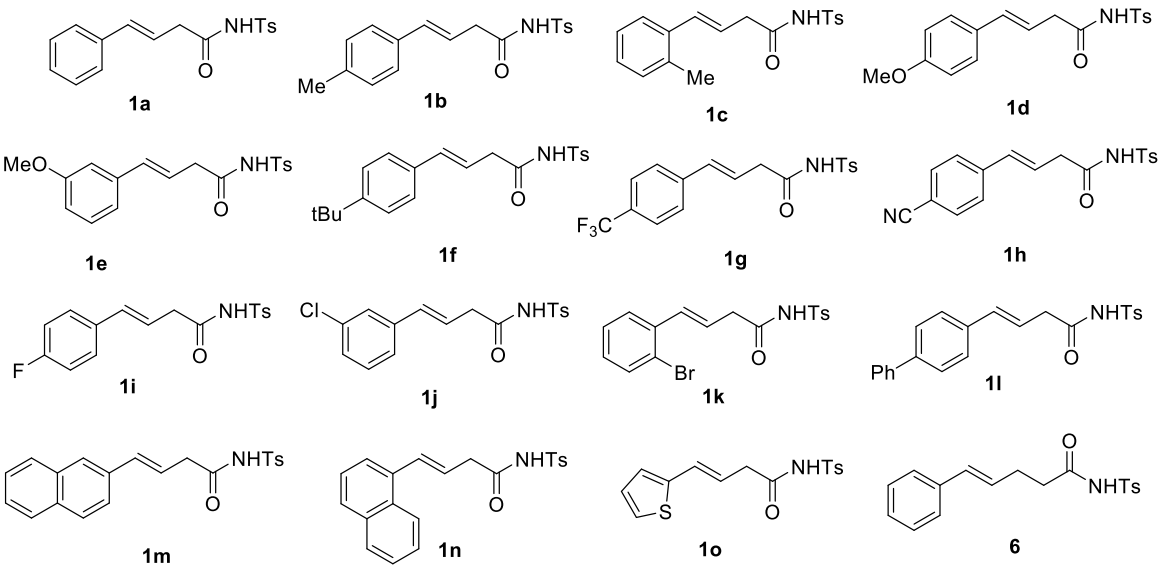
A flame-dried, 100-mL, Schlenk flask equipped with stir bar, argoninlet, septum, glass stopper, magnetic stir bar, and digital thermocouple was charged with (2-carboxyethyl)triphenylphosphonium bromide (4.568 g, 11 mmol, 1.1 equiv). The flask was evacuated and back-filled with argon. THF (20 mL) was added by syringe through a septum and the solution was cooled to –20 °C. To the white suspension was added sodium bis(trimethylsilyl)amide (NaHMDS) (4.401g, 24.0 mL, 24.00 mmol, 2.4 equiv) dropwise via syringe over 5 min. The resulting orange solution was stirred for 30 min and became homogenous gradually. A solution of aldehyde (10.00 mmol) in 2-5 mL THF was added by syringe at -20 °C. The resulting mixture was allowed to warm to room temperature (23 °C) slowly while stirring overnight. The heterogeneous reaction mixture was quenched with water (50 mL) and washed with ether (2 x 50 mL), then the aqueous layer was acidified to pH 1 by dropwise addition of HCl (2 M) and then was extracted with EtOAc (3 x 50 mL). The combined organic extracts were dried over $MgSO_4$, filtered and concentrated by rotary evaporation. Most carboxylic acids were taken forward as crude products into the next step. The acids determined to be too

impure were subjected to silica gel flash chromatography.

2.3.2 Synthesis of (*E*)-4-aryl-*N*-tosylbut-3-enamide

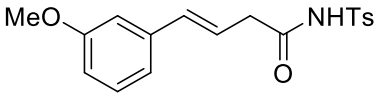


A flame-dried, 100-mL, Schlenk flask equipped with a magnetic stir bar and argon inlet was added carboxylic acid (1 equiv, 5-10 mmol) and then was dissolved in THF (0.2 M). To the stirred solution was added 4-methylbenzenesulfonyl isocyanate (1 equiv.) and the solution was stirred at room temperature (25 ˚C) for 10 minutes. Triethylamine (1 equiv) was added dropwise to the reaction mixture by syringe and the mixture was stirred for 3 hours at room temperature (25˚C). The reaction solution was diluted with ether and washed with 1 M HCl (1 x 15 mL). The aqueous layer was extracted with ethyl acetate (3 x 20 mL), and the combined organic layers were washed with brine, dried over magnesium sulfate, filtered then concentrated by rotary evaporation. The crude product was purified by silica gel flash chromatography (60-90%).



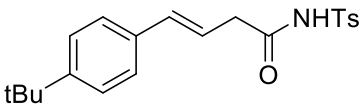
1a, **1b**, **1c, 1d**, **1g**,**1m**, The spectral data were fully consistent with those previously reported [4]. **6** The spectral data were fully consistent with those previously reported.[6]

(*E*)-4-(3-methoxyphenyl)-*N*-tosylbut-3-enamide(1e)



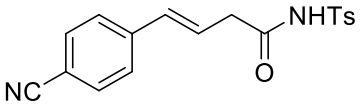
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.05 (s, 1H), 7.94 (d, *J* = 8.4 Hz, 2H), 7.30 (d, *J* = 8.2 Hz, 2H), 7.18 (t, *J* = 7.9 Hz, 1H), 6.87 (d, *J* = 7.7 Hz, 1H), 6.82 (s, 1H), 6.78 (ddd, *J* = 8.2, 2.6, 0.9 Hz, 1H), 6.41 (d, *J* = 15.9 Hz, 1H), 6.15 (dt, *J* = 15.8, 7.1 Hz, 1H), 3.77 (s, 3H), 3.19 (dd, *J* = 7.1, 1.4 Hz, 2H), 2.41 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 168.7, 159.7, 145.2, 137.6, 135.4, 135.3, 129.6, 129.5, 128.4, 120.0, 119.1, 113.7, 111.6, 55.2, 40.4, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{18}H_{19}NO_4SNa^+$:368.0927; Found: 368.0927.

(*E*)-4-(4-(tert-butyl)phenyl)-*N*-tosylbut-3-enamide (1f)



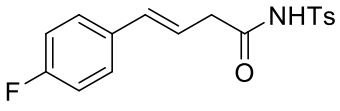
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.01 (s, 1H), 7.96 (d, *J* = 8.4 Hz, 2H), 7.33 – 7.29 (m, 4H), 7.24 (d, *J* = 8.4 Hz, 2H), 6.44 (d, *J* = 15.9 Hz, 1H), 6.12 (dt, *J* = 15.8, 7.2 Hz, 1H), 3.20 (dd, *J* = 7.2, 1.4 Hz, 2H), 2.42 (s, 3H), 1.31 (s, 9H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 169.0, 151.1, 145.2, 135.4, 135.3, 133.4, 129.6, 128.4, 126.1, 125.4, 118.8, 40.6, 34.5, 31.2, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{21}H_{25}NO_3SNa^+$:394.1448; Found: 394.1448.

(*E*)-4-(4-cyanophenyl)-*N*-tosylbut-3-enamide (1h)



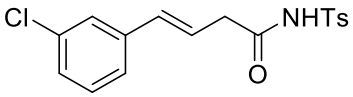
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.03 (s, 1H), 7.92 (d, *J* = 8.3 Hz, 2H), 7.54 (d, *J* = 8.3 Hz, 2H), 7.34 (dd, *J* = 14.0, 8.2 Hz, 4H), 6.45 (d, *J* = 16.0 Hz, 1H), 6.30 (dt, *J* = 15.9, 6.9 Hz, 1H), 3.23 (dd, *J* = 7.0, 1.3 Hz, 2H), 2.43 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 168.2, 145.5, 140.6, 135.2, 133.6, 132.4, 129.7, 128.4, 126.8, 124.0, 118.8, 111.1, 40.1, 21.7. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{18}H_{16}N_2O_3S\ Na^+$:363.0774; Found: 363.0774.

(*E*)-4-(4-fluorophenyl)-*N*-tosylbut-3-enamide (1i)



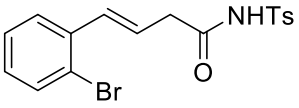
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.41 (s, 1H), 7.97 (d, *J* = 8.0 Hz, 2H), 7.31 (d, *J* = 8.1 Hz, 2H), 7.23 (dd, *J* = 8.5, 5.4 Hz, 2H), 6.94 (t, *J* = 8.5 Hz, 2H), 6.40 (d, *J* = 15.9 Hz, 1H), 6.09 (dt, *J* = 15.8, 7.1 Hz, 1H), 3.39 – 3.01 (m, 2H), 2.42 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 169.2, 162.3 (d, *J* = 247.3 Hz), 145.2, 135.2, 134.0, 132.4 (d, *J* = 3.3 Hz), 129.6, 128.3, 127.8 (d, *J* = 8.0 Hz), 119.4 (d, *J* = 2.4 Hz), 115.3 (d, *J* = 21.6 Hz), 40.2, 21.5. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -113.89. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{17}H_{16}FNO_3S\ Na^+$:356.0728; Found: 356.0728.

(*E*)-4-(3-chlorophenyl)-*N*-tosylbut-3-enamide (1j)



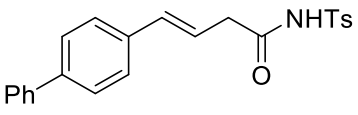
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.28 (s, 1H), 7.94 (d, *J* = 8.4 Hz, 2H), 7.30 (d, *J* = 8.1 Hz, 2H), 7.21 (s, 1H), 7.17 (d, *J* = 5.4 Hz, 2H), 7.15 (d, *J* = 1.7 Hz, 1H), 7.13 (tt, *J* = 4.4, 2.1 Hz, 1H), 6.35 (d, *J* = 15.8 Hz, 1H), 6.16 (dt, *J* = 15.9, 7.0 Hz, 1H), 3.21 (dd, *J* = 7.0, 1.4 Hz, 2H), 2.41 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 168.9, 145.3, 138.0, 135.2, 134.4, 133.8, 129.7, 129.6, 128.3, 127.7, 126.3, 124.5, 121.4, 40.2, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{17}H_{16}ClNO_3SNa^+$:372.0432, 374.0403; Found: 372.0434, 374.0404.

(*E*)-4-(2-bromophenyl)-*N*-tosylbut-3-enamide (1k)



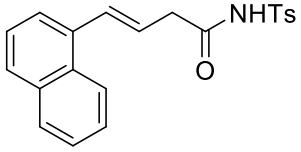
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.20 (s, 1H), 7.98 (d, *J* = 8.4 Hz, 2H), 7.51 (d, *J* = 8.0 Hz, 1H), 7.45 (dd, *J* = 7.8, 1.7 Hz, 1H), 7.33 (d, *J* = 8.2 Hz, 2H), 7.22 (ddd, *J* = 7.6, 6.3, 1.4 Hz, 1H), 7.15 – 6.99 (m, 1H), 6.95 – 6.60 (m, 1H), 6.16 (dt, *J* = 15.8, 7.1 Hz, 1H), 3.29 (dd, *J* = 7.1, 1.5 Hz, 2H), 2.43 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 168.8, 147.1, 145.3, 136.2, 135.4, 133.9, 132.9, 129.7, 129.2, 128.4, 127.5, 127.2, 123.1, 40.3, 21.7. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{17}H_{16}BrNO_3SNa^+$:415.9927, 417.9906; Found: 415.9925, 417.9904.

(*E*)-4-([1,1'-biphenyl]-4-yl)-*N*-tosylbut-3-enamide (1l)



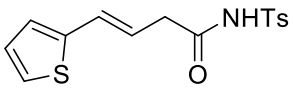
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (s, 1H), 7.96 (d, *J* = 8.3 Hz, 2H), 7.58 (d, *J* = 7.6 Hz, 2H), 7.54 (d, *J* = 8.2 Hz, 2H), 7.44 (t, *J* = 7.6 Hz, 2H), 7.38 (d, *J* = 8.5 Hz, 2H), 7.36 – 7.29 (m, 3H), 6.51 (d, *J* = 15.8 Hz, 1H), 6.19 (dt, *J* = 15.8, 7.2 Hz, 1H), 3.22 (dd, *J* = 7.2, 1.3 Hz, 2H), 2.43 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 168.4, 145.3, 140.9, 140.5, 135.5, 135.4, 135.0, 129.7, 128.8, 128.5, 127.4, 127.3, 126.9, 126.9, 119.5, 40.7, 21.7. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{23}H_{21}NO_3SNa^+$:414.1135; Found: 414.1134.

(*E*)-4-(naphthalen-1-yl)-*N*-tosylbut-3-enamide (1n)



^{1}H NMR (400 MHz, $CDCl_3$) δ 9.17 (s, 1H), 7.97 (dd, *J* = 8.8, 6.6 Hz, 3H), 7.86 – 7.79 (m, 1H), 7.76 (d, *J* = 8.2 Hz, 1H), 7.50 (d, *J* = 7.1 Hz, 1H), 7.48 – 7.42 (m, 2H), 7.38 (t, *J* = 7.7 Hz, 1H), 7.24 (d, *J* = 8.2 Hz, 2H), 7.20 (d, *J* = 15.4 Hz, 1H), 6.19 (dt, *J* = 15.6, 7.1 Hz, 1H), 3.33 (dd, *J* = 7.1, 1.5 Hz, 2H), 2.36 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 168.9, 145.2, 135.3, 133.8, 133.5, 132.6, 130.9, 129.6, 128.4, 128.3, 128.2, 126.1, 125.8, 125.5, 123.9, 123.5, 122.8, 40.7, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{21}H_{19}NO_3S\ Na^+$:388.0977; Found: 388.0977.

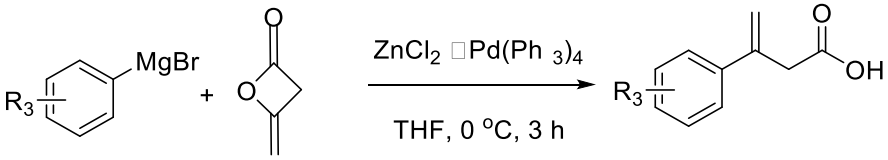
(*E*)-4-(thiophen-2-yl)-*N*-tosylbut-3-enamide(1o)



^{1}H NMR (400 MHz, $CDCl_3$) δ 8.89 (s, 1H), 7.95 (d, *J* = 8.4 Hz, 2H), 7.32 (d, *J* = 8.1 Hz, 2H), 7.14 (d, *J* = 4.9 Hz, 1H), 6.92 (dd, *J* = 5.1, 3.5 Hz, 1H), 6.89 (d, *J* = 3.6 Hz, 1H), 6.57 (d, *J* = 15.7 Hz, 1H), 5.96 (dt, *J* = 15.6, 7.2 Hz, 1H), 3.16 (dd, *J* = 7.1, 1.5 Hz, 2H), 2.43 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 168.5, 145.3, 141.0, 135.3, 129.7, 128.7, 128.4, 127.3, 126.1, 124.7, 119.0, 40.2, 21.7. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{15}H_{15}NO_3S_2Na^+$:344.0386; Found: 344.0385.

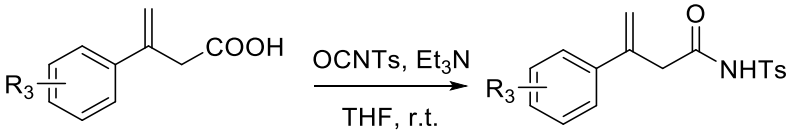
2.4 Synthesis of 3-aryl-*N*-tosylbut-3-enamide (4a-4i)

2.4.1 Synthesis of 3-aryl-3-butenoic acids [5]



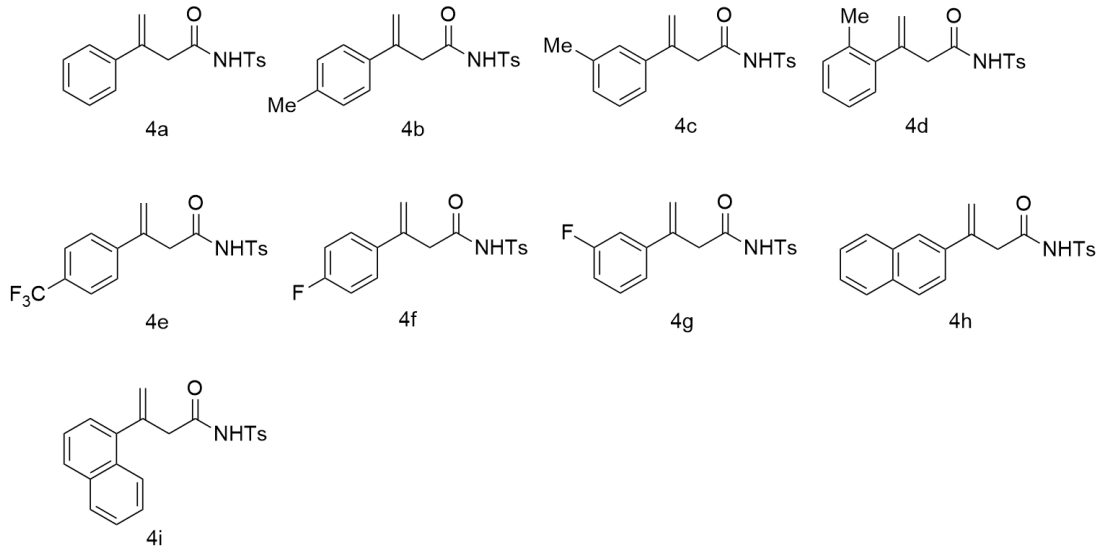
According to literatures, with a slight modification, the Grignard reagent was prepared from Mg turning (0.40g, 16.5 mmol) and aryl bromide (15.0 mmol) in 20 mL THF. Diketene (1.05g, 12.5 mmol) and Pd (PPh_3)$_4$ (0.375 mmol, 3 mol%) in dry THF 20 mL under nitrogen were added dropwise to a suspension of arylzinc chloride, prepared by adding anhydrous $ZnCl_2$ (2.3 g, 16.8 mmol) in THF 15 mL to aryl magnesium bromide with ice-water cooling and the resulting mixture was stirred for additional 3 h at 0 °C. The reaction mixture was poured into a cold 2 equiv. HCl aq and extracted with ether. The separated organic layer was extracted with 3 equiv. NaOH aq. The alkaline extracts was acidified with 6 equiv HCl aq, and then extracted with ether (40 mL × 3). The ether extracts were combined, washed with brine and dried over anhydrous Na_2SO_4. After removal of the solvent, most of the acids can be purified by recrystallization in hexane to give the corresponding 3-aryl-3-butenoic acids (60-85% isolated yields), which were used directly.

2.4.2 Synthesis of 3-aryl-*N*-tosylbut-3-enamide

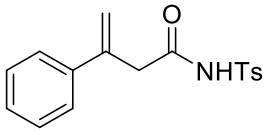


A flame-dried, 100-mL, Schlenk flask equipped with a magnetic stir bar and argon inlet was added 3-aryl-3-butenoic Acids (1 equiv, 5-10 mmol) and then was dissolved in THF (0.2 M). To the stirred solution was added 4-methylbenzenesulfonyl isocyanate (1 equiv.) and the solution was stirred at room temperature (25 ˚C) for 10 minutes. Triethylamine (1 equiv.) was added dropwise to the reaction mixture by syringe and the mixture was stirred for 3 hours at room temperature (25˚C). The reaction solution was diluted with ether and washed with 1 M HCl (1 x 15 mL). The aqueous layer was

extracted with ethyl acetate (3 x 20 mL), and the combined organic layers were washed with brine, dried over magnesium sulfate, filtered then concentrated by rotary evaporation. The crude product was purified by silica gel flash chromatography (60-90%).

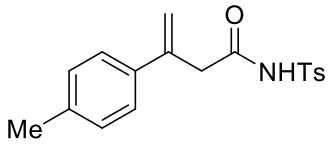


3-phenyl-*N*-tosylbut-3-enamide (4a)



^{1}H NMR (400 MHz, $CDCl_3$) δ 8.34 (s, 1H), 7.73 (d, *J* = 8.4 Hz, 2H), 7.42 – 7.30 (m, 5H), 7.24 (d, *J* = 8.2 Hz, 2H), 5.70 (s, 1H), 5.29 (s, 1H), 3.48 (s, 2H), 2.44 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.9, 144.9, 140.1, 137.8, 135.0, 129.4, 128.8, 128.5, 128.2, 125.5, 118.3, 44.2, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{17}H_{17}NO_3SNa^+$:338.0822; Found: 338.0821.

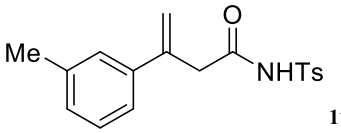
3-(p-tolyl)-*N*-tosylbut-3-enamide (4b)



^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (s, 1H), 7.71 (d, *J* = 8.4 Hz, 2H), 7.21 (d, *J* = 8.1 Hz, 2H), 7.16 (d, *J* = 8.3 Hz, 2H), 7.05 (d, *J* = 8.0 Hz, 2H), 5.63 (s, 1H), 5.20 (s, 1H), 3.43 (s, 2H), 2.42 (s, 3H), 2.34 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 168.1, 144.8, 139.9, 138.4, 129.7, 129.4, 129.4, 128.3, 126.4, 125.4, 117.4, 44.2, 21.6, 21.1. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{18}H_{19}NO_3SNa^+$:352.0978;

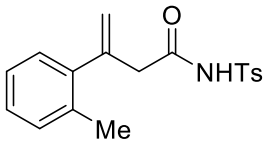
Found: 352.0978.

3-(m-tolyl)-*N*-tosylbut-3-enamide (4c)



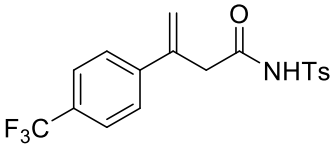
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (s, 1H), 7.71 (d, *J* = 8.4 Hz, 2H), 7.21 (d, *J* = 8.0 Hz, 2H), 7.15 (t, *J* = 7.5 Hz, 1H), 7.08 (t, *J* = 7.8 Hz, 2H), 7.04 (s, 1H), 5.63 (s, 1H), 5.23 (s, 1H), 3.44 (d, *J* = 1.1 Hz, 2H), 2.41 (s, 3H), 2.25 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 168.2, 144.8, 140.1, 138.3, 137.9, 135.0, 129.4, 129.2, 128.6, 128.2, 126.2, 122.7, 118.1, 44.1, 21.6, 21.3. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{18}H_{19}NO_3SNa^+$:352.0978; Found: 352.0977.

3-(o-tolyl)-*N*-tosylbut-3-enamide (4d)



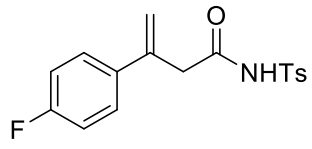
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.57 (s, 1H), 7.82 (d, *J* = 8.4 Hz, 2H), 7.29 (d, *J* = 8.1 Hz, 2H), 7.19 – 7.10 (m, 2H), 7.04 (td, *J* = 7.2, 1.8 Hz, 1H), 6.94 (d, *J* = 1.4 Hz, 1H), 5.36 (d, *J* = 1.2 Hz, 1H), 5.11 (d, *J* = 1.2 Hz, 1H), 3.29 (d, *J* = 1.2 Hz, 2H), 2.44 (s, 3H), 2.19 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.6, 145.0, 141.2, 140.0, 135.2, 134.8, 130.6, 129.5, 128.3, 128.0, 127.7, 125.8, 120.2, 45.9, 21.6, 19.7. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{18}H_{19}NO_3SNa^+$:352.0978; Found: 352.0978.

***N*-tosyl-3-(4-(trifluoromethyl)phenyl)but-3-enamide (4e)**



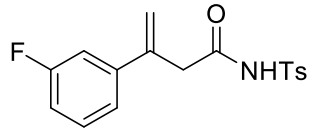
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.70 (s, 1H), 7.72 (d, *J* = 8.4 Hz, 2H), 7.44 (d, *J* = 8.3 Hz, 2H), 7.34 (d, *J* = 8.2 Hz, 2H), 7.21 (d, *J* = 8.1 Hz, 2H), 5.66 (s, 1H), 5.33 (s, 1H), 3.48 (d, *J* = 1.1 Hz, 2H), 2.40 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 168.00, 145.2, 141.7, 138.9, 134.9, 130.0 (q, *J* = 32.5 Hz), 129.5, 128.1, 125.9, 125.5 (q, *J* = 3.9 Hz), 123.9 (q, *J* = 272.1 Hz), 120.1, 43.6, 21.5. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -62.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{18}H_{16}F_3NO_3SNa^+$:406.0696; Found: 406.0695.

3-(4-fluorophenyl)-*N*-tosylbut-3-enamide(4f)



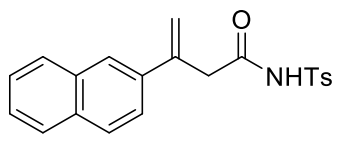
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.41 (s, 1H), 7.71 (d, *J* = 8.4 Hz, 2H), 7.22 (dd, *J* = 8.6, 5.5 Hz, 4H), 6.90 (t, *J* = 8.7 Hz, 2H), 5.58 (s, 1H), 5.23 (s, 1H), 3.43 (d, *J* = 1.1 Hz, 2H), 2.43 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.9, 162.7 (d, *J* = 248.4 Hz), 145.1, 139.1, 134.9, 129.4, 128.2, 127.3 (d, *J* = 8.2 Hz), 118.1, 115.7, 115.5, 44.3, 21.6. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -113.2. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{17}H_{16}FNO_3SNa^+$:356.0728; Found: 356.0729.

3-(3-fluorophenyl)-*N*-tosylbut-3-enamide(4g)



^{1}H NMR (400 MHz, $CDCl_3$) δ 8.66 (s, 1H), 7.75 (d, *J* = 8.3 Hz, 2H), 7.24 (d, *J* = 8.2 Hz, 2H), 7.19 (dd, *J* = 8.0, 6.0 Hz, 1H), 7.08 – 7.00 (m, 1H), 6.99 – 6.79 (m, 2H), 5.63 (s, 1H), 5.27 (s, 1H), 3.43 (s, 2H), 2.42 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.9, 162.8 (d, *J* = 246.3 Hz), 145.2, 140.4 (d, *J* = 7.4 Hz), 139.0 (d, *J* = 2.4 Hz), 134.9, 130.2 (d, *J* = 8.4 Hz), 129.5, 128.1, 121.3 (d, *J* = 2.8 Hz), 119.2, 115.1 (d, *J* = 21.2 Hz), 112.6 (d, *J* = 22.4 Hz), 43.7, 21.6. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -112.4. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{17}H_{16}FNO_3SNa^+$:356.0728; Found: 356.0727.

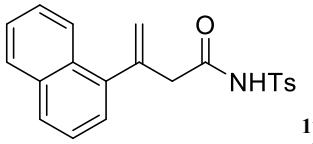
3-(naphthalen-2-yl)-*N*-tosylbut-3-enamide(4h)



^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (s, 1H), 7.95 – 7.80 (m, 1H), 7.77 (d, *J* = 8.8 Hz, 1H), 7.64 – 7.54 (m, 1H), 7.53 (d, *J* = 5.3 Hz, 6H), 6.89 (t, *J* = 5.7 Hz, 2H), 6.01 – 5.76 (m, 1H), 5.55 – 5.32 (m, 1H), 3.60 (d, *J* = 4.3 Hz, 2H), 2.24 (s, 3H).**^{13}C NMR (101 MHz, $CDCl_3$)** δ 168.0, 144.7, 140.0, 134.8, 134.6, 133.1, 129.2,

128.5, 128.5, 128.0, 127.5, 126.6, 126.4, 124.7, 123.3, 118.8, 44.4, 21.5. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{21}H_{19}NO_3SNa^+$:388.0978; Found: 388.0978.

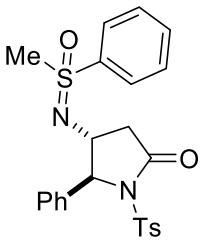
3-(naphthalen-1-yl)-*N*-tosylbut-3-enamide(4i)



^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (s, 1H), 7.89 (d, *J* = 8.2 Hz, 1H), 7.83 (d, *J* = 8.4 Hz, 1H), 7.75 (d, *J* = 8.2 Hz, 1H), 7.69 (d, *J* = 8.4 Hz, 2H), 7.51 – 7.40 (m, 2H), 7.30 (dd, *J* = 8.3, 7.0 Hz, 1H), 7.18 (d, *J* = 8.1 Hz, 2H), 7.14 (dd, *J* = 7.0, 1.2 Hz, 1H), 5.57 (d, *J* = 1.4 Hz, 1H), 5.33 (d, *J* = 1.2 Hz, 1H), 3.46 (s, 2H), 2.40 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.5, 144.9, 139.9, 138.1, 135.0, 133.7, 130.5, 129.4, 128.5, 128.2, 128.2, 126.4, 125.9, 125.2, 125.2, 124.8, 121.6, 46.3, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{21}H_{19}NO_3SNa^+$:388.0978; Found: 388.0979.

3 New Compounds Characterization

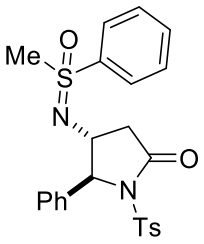
***trans*-4-((methyl(oxo)(phenyl)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3aa-1)**



General procedure A: Unsaturated N-tosyl amide **1a** (0.6 mmol), Sulfoximidoyl thianthrene salts **2a** (0.4 mmol) and $Ir(dF(Me)ppy)_2(dtbbpy)[PF_6]$ (1 mol%) in a Penicillin vial was evacuated and backfilled with argon via Schlenk line three times. Subsequently, DCM (anhydrous, 4.0 mL) and 2,4,6-Trimethylpyridine (0.8 mmol) were added, cooled to -20 ºC and irradiated by 30 W blue LED strip light for 12 hours. Then the reaction mixture was concentrated in vacuo and purified by column chromatography to afford the desired product as colorless oil 75 mg (40%). (PE/EA=1:1, R_f = 0.6). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.74 (dd, *J* = 7.8, 4.3 Hz, 4H), 7.60 (t, *J* = 7.4 Hz, 1H), 7.50 (t, *J* = 7.7 Hz,

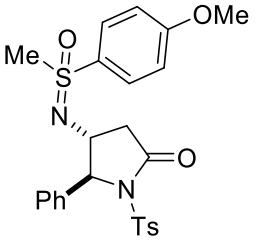
2H), 7.25 – 7.12 (m, 4H), 7.05 – 6.91 (m, 2H), 5.17 (d, *J* = 2.5 Hz, 1H), 3.52 (dt, *J* = 6.0, 2.8 Hz, 1H), 3.05 (s, 3H), 2.76 (dd, *J* = 17.2, 6.3 Hz, 1H), 2.48 (dd, *J* = 17.2, 3.1 Hz, 1H), 2.39 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.9, 144.6, 139.1, 138.5, 135.7, 133.2, 129.5, 129.1, 128.6, 128.5, 128.3, 127.9, 126.1, 72.4, 56.7, 45.2, 41.0, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{24}H_{24}N_2O_4S_2Na^+$:491.1070; Found: 491.1069.

***trans*-4-((methyl(oxo)(phenyl)- λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3aa-2)**



Isolated colorless oil 60 mg (32%). (PE/EA=1:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.89 (d, *J* = 8.1 Hz, 2H), 7.84 – 7.76 (m, 2H), 7.60 (t, *J* = 7.3 Hz, 1H), 7.54 (d, *J* = 7.7 Hz, 2H), 7.28 (m, 5H),7.19 (d, *J* = 6.4 Hz, 2H), 5.49 (s, 1H), 3.44 (d, *J* = 5.9 Hz, 1H), 3.01 (s, 3H), 2.69 (dd, *J* = 16.9, 6.0 Hz, 1H), 2.43 (s, 3H), 2.19 (d, *J* = 17.0 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.0, 144.6, 139.3, 138.6, 135.8, 133.3, 129.7, 129.1, 128.7, 128.4, 127.8, 125.8, 73.7, 57.0, 45.4, 39.8, 21.7. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{24}H_{24}N_2O_4S_2Na^+$:491.1070; Found: 491.1069.

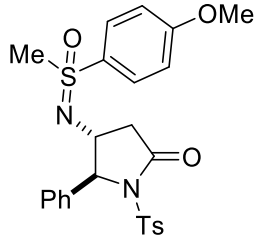
***trans*-4-(((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ab-1)**



Following General Procedure A, isolated colorless oil 86 mg (43%). (PE/EA=1:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.73 (d, *J* = 8.4 Hz, 2H), 7.62 (d, *J* = 8.8 Hz, 2H), 7.29 – 7.23 (m, 3H), 7.20 (d, *J* = 8.1 Hz, 2H), 7.00 (dd, *J* = 7.5, 2.0 Hz, 2H), 6.93 (d, *J* = 8.9 Hz, 2H), 5.17 (d, *J* = 2.6 Hz, 1H), 3.87 (s, 3H), 3.51 (dt, *J* = 6.2, 3.1 Hz, 1H), 3.02 (s, 3H), 2.75 (dd, *J* = 17.2, 6.3 Hz, 1H), 2.47 (dd, *J* =

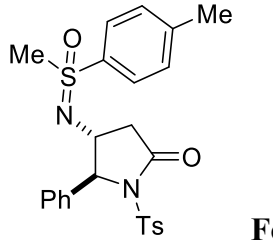
17.2, 3.4 Hz, 1H), 2.39 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.0, 163.4, 144.6, 138.6, 135.8, 130.5, 130.1, 129.1, 128.6, 128.5, 127.9, 126.1, 114.7, 72.47, 56.7, 55.7, 45.6, 41.1, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{26}N_2O_5S_2Na^+$:521.1176; Found: 521.1175.

***trans*-4-(((4-methoxyphenyl)(methyl)(oxo)- λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ab-2)**



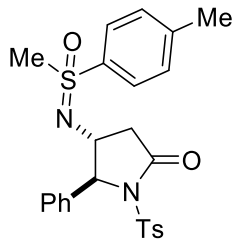
Isolated colorless oil 62 mg (31%). (PE/EA=1:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.90 (d, *J* = 8.4 Hz, 2H), 7.71 (d, *J* = 8.9 Hz, 2H), 7.32 – 7.23 (m, 5H), 7.22 – 7.16 (m, 2H), 6.98 (d, *J* = 8.9 Hz, 2H), 5.48 (s, 1H), 3.85 (s, 3H), 3.43 (d, *J* = 6.0 Hz, 1H), 2.99 (s, 3H), 2.69 (dd, *J* = 16.9, 6.0 Hz, 1H), 2.43 (s, 3H), 2.18 (d, *J* = 16.9 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.1, 163.5, 144.6, 138.8, 135.8, 130.5, 130.3, 129.1, 128.7, 127.8, 125.7, 114.9, 73.7, 57.0, 55.7, 45.7, 39.8, 21.7. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{25}H_{27}N_2O_5S_2^+$:499.1356; Found: 499.1355.

***trans*-4-((methyl(oxo)(p-tolyl)- λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ac-1)**



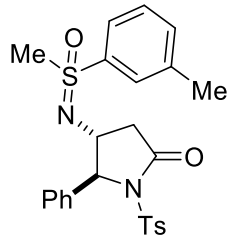
Following General Procedure A, isolated colorless oil 81 mg (42%). (PE/EA=1:1, R_f = 0.6). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.74 (d, *J* = 8.4 Hz, 2H), 7.61 (d, *J* = 8.3 Hz, 2H), 7.28 (d, *J* = 8.1 Hz, 2H), 7.26 – 7.16 (m, 5H), 6.97 (dd, *J* = 7.7, 1.9 Hz, 2H), 5.18 (d, *J* = 2.4 Hz, 1H), 3.51 (dt, *J* = 6.0, 2.8 Hz, 1H), 3.03 (s, 3H), 2.75 (dd, *J* = 17.2, 6.3 Hz, 1H), 2.47 (dd, *J* = 17.2, 3.2 Hz, 1H), 2.43 (s, 3H), 2.39 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.9, 144.6, 144.1, 138.5, 135.9, 135.7, 130.1, 129.0, 128.6, 128.5, 128.4, 127.9, 126.0, 72.5, 56.7, 45.3, 41.0, 21.6, 21.5. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{26}N_2O_4S_2Na^+$:505.1227; Found: 505.1228.

***trans*-4-((methyl(oxo)(p-tolyl)- λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ac-2)**



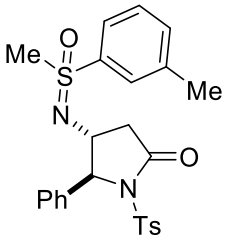
Isolated colorless oil 64 mg (33%). (PE/EA=1:1, R_f = 0.5). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.89 (d, *J* = 8.4 Hz, 2H), 7.67 (d, *J* = 8.3 Hz, 2H), 7.34 – 7.26 (m, 5H), 7.26 – 7.22 (m, 2H), 7.21 – 7.16 (m, 2H), 5.49 (s, 1H), 3.42 (d, *J* = 6.0 Hz, 1H), 2.99 (s, 3H), 2.68 (dd, *J* = 16.9, 6.0 Hz, 1H), 2.43 (s, 3H), 2.41 (s, 3H), 2.18 (d, *J* = 16.9 Hz, 1H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 173.0, 144.6, 144.3, 138.7, 136.1, 135.8, 130.3, 129.1, 128.7, 128.4, 127.8, 125.7, 73.7, 57.0, 45.4, 39.8, 21.6, 21.4. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{26}N_2O_4S_2Na^+$:505.1227; Found: 505.1226.

***trans*-4-((methyl(oxo)(m-tolyl)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ad-1)**



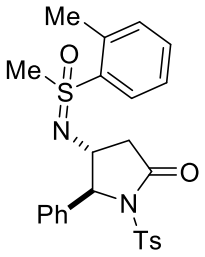
Following General Procedure A, isolated colorless oil 79 mg (41%). (PE/EA=1:1, R_f = 0.6). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.73 (d, *J* = 8.2 Hz, 2H), 7.59 (s, 1H), 7.57 – 7.51 (m, 1H), 7.39 (d, *J* = 7.1 Hz, 2H), 7.21 (dd, *J* = 9.5, 7.5 Hz, 5H), 7.04 – 6.87 (m, 2H), 5.18 (d, *J* = 2.4 Hz, 1H), 3.52 (dt, *J* = 5.9, 2.8 Hz, 1H), 3.05 (s, 3H), 2.76 (dd, *J* = 17.2, 6.3 Hz, 1H), 2.48 (dd, *J* = 17.2, 3.0 Hz, 1H), 2.41 (s, 3H), 2.39 (s, 3H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 173.0, 144.7, 140.0, 139.0, 138.6, 135.80, 134.1, 129.5, 129.1, 128.8, 128.7, 128.6, 128.0, 126.1, 125.5, 72.4, 56.7, 45.3, 41.1, 21.6, 21.4. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{26}N_2O_4S_2Na^+$:505.1227; Found: 505.1228.

***trans*-4-((methyl(oxo)(m-tolyl)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ad-2)**



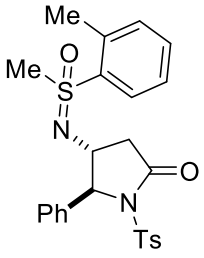
Isolated colorless oil 73 mg (38%). (PE/EA=1:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.89 (d, *J* = 8.1 Hz, 2H), 7.61 (s, 1H), 7.59 – 7.54 (m, 1H), 7.39 (d, *J* = 6.2 Hz, 2H), 7.31 – 7.24 (m, 5H), 7.22 – 7.18 (m, 2H), 5.49 (s, 1H), 3.45 (d, *J* = 5.9 Hz, 1H), 3.00 (s, 3H), 2.69 (dd, *J* = 16.9, 6.0 Hz, 1H), 2.43 (s, 3H), 2.41 (s, 3H), 2.19 (d, *J* = 17.0 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.0, 144.6, 140.0, 139.2, 138.7, 135.8, 134.1, 129.5, 129.1, 128.8, 127.8, 125.8, 125.4, 73.7, 57.0, 45.4, 39.8, 21.7, 21.4. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{26}N_2O_4S_2Na^+$:505.1227; Found: 505.1227.

***trans*-4-((methyl(oxo)(o-tolyl)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ae-1)**



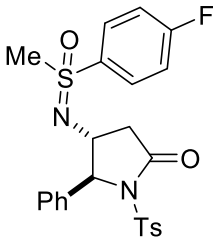
Following General Procedure A, isolated colorless oil 42 mg (22%). (PE/EA=1:1, R_f = 0.6). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.95 (d, *J* = 8.0 Hz, 1H), 7.69 (d, *J* = 8.2 Hz, 2H), 7.58 – 7.44 (m, 1H), 7.35 (d, *J* = 7.2 Hz, 2H), 7.18 (dd, *J* = 8.5, 1.9 Hz, 5H), 6.91 – 6.76 (m, 2H), 5.14 (d, *J* = 1.9 Hz, 1H), 3.55 (d, *J* = 6.1 Hz, 1H), 3.12 (s, 3H), 2.79 (dd, *J* = 17.3, 6.2 Hz, 1H), 2.68 (s, 3H), 2.51 (dd, *J* = 17.3, 2.5 Hz, 1H), 2.39 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.0 144.7, 138.4, 137.7, 135.7, 133.3, 133.2, 130.5, 129.1, 128.7, 128.6, 128.0, 126.9, 126.1, 72.0, 56.6, 44.2, 41.0, 21.6, 20.2. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{26}N_2O_4S_2Na^+$:505.1227; Found: 505.1228.

***trans*-4-((methyl(oxo)(o-tolyl)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ae-2)**



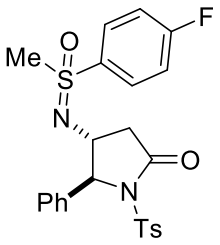
Isolated colorless oil 37 mg (19%). (PE/EA=1:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.02 (d, *J* = 7.8 Hz, 1H), 7.90 (d, *J* = 8.1 Hz, 2H), 7.48 (t, *J* = 7.4 Hz, 1H), 7.37 (t, *J* = 7.5 Hz, 1H), 7.33 – 7.23 (m, 6H), 7.20 – 7.13 (m, 2H), 5.54 (s, 1H), 3.41 (d, *J* = 5.6 Hz, 1H), 3.09 (s, 3H), 2.69 (dd, *J* = 16.9, 6.0 Hz, 1H), 2.57 (s, 3H), 2.43 (s, 3H), 2.19 (d, *J* = 16.8 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.0, 144.6, 138.7, 137.6, 137.2, 135.8, 133.3, 133.1, 130.9, 129.1, 128.8, 128.7, 127.8, 127.0, 125.7, 73.6, 57.4, 44.3, 39.5, 21.7, 20.0. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{26}N_2O_4S_2Na^+$:505.1227; Found: 505.1226.

***trans*-4-(((4-fluorophenyl)(methyl)(oxo)- λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3af-1)**



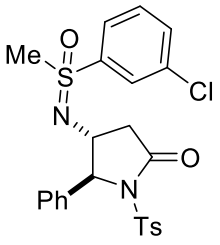
Following General Procedure A, isolated colorless oil 66 mg (34%). (PE/EA=1:1, R_f = 0.7). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.70 (dt, *J* = 8.9, 2.6 Hz, 2H), 7.31 – 7.22 (m, 1H), 7.19 (d, *J* = 8.1 Hz, 1H), 7.13 (t, *J* = 8.5 Hz, 1H), 7.03 – 6.95 (m, 1H), 5.15 (d, *J* = 2.9 Hz, 1H), 3.50 (dt, *J* = 6.5, 3.4 Hz, 1H), 3.05 (s, 3H), 2.76 (dd, *J* = 17.2, 6.5 Hz, 1H), 2.49 (dd, *J* = 17.8, 3.0 Hz, 1H), 2.39 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.7, 165.5 (d, *J* = 256.0 Hz), 144.7, 138.5, 135.7, 134.9 (d, *J* = 3.1 Hz), 131.1 (d, *J* = 9.5 Hz), 129.1, 128.7, 128.5, 128.0, 126.2, 116.7 (d, *J* = 22.5 Hz), 72.3, 56.8, 45.4, 41.0, 21.6. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -104.4. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{24}H_{23}FN_2O_4S_2Na^+$:509.0976; Found: 509.09765.

***trans*-4-(((4-fluorophenyl)(methyl)(oxo)- λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3af-2)**



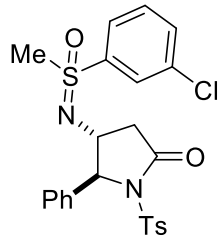
Isolated colorless oil 47 mg (24%). (PE/EA=1:1, R_f = 0.6). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.87 (d, *J* = 8.4 Hz, 2H), 7.81 (dd, *J* = 8.8, 5.1 Hz, 2H), 7.32 – 7.22 (m, 5H), 7.23 – 7.11 (m, 4H), 5.47 (s, 1H), 3.43 (d, *J* = 6.0 Hz, 1H), 3.01 (s, 3H), 2.70 (dd, *J* = 17.0, 6.0 Hz, 1H), 2.42 (s, 3H), 2.18 (d, *J* = 16.9 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.8, 165.6 (d, *J* = 256.1 Hz), 144.7, 138.5, 135.7, 135.2, 131.1 (d, *J* = 9.5 Hz), 129.1, 128.8, 128.7, 127.9, 125.7, 116.9 (d, *J* = 22.6 Hz), 73.6, 56.9, 45.6, 39.7, 21.6. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -104.3. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{24}H_{23}FN_2O_4S_2Na^+$:509.0976; Found: 509.0976.

***trans*-4-(((3-chlorophenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ag-1)**



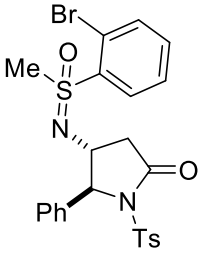
Following General Procedure A, isolated colorless oil 76 mg (38%). (PE/EA=1:1, R_f = 0.6). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.81 (s, 1H), 7.74 (d, *J* = 8.2 Hz, 2H), 7.66 – 7.55 (m, 2H), 7.45 (t, *J* = 7.9 Hz, 1H), 7.30 – 7.24 (m, 3H), 7.22 (d, *J* = 8.1 Hz, 2H), 7.09 – 6.93 (m, 2H), 5.20 (d, *J* = 2.4 Hz, 1H), 3.52 (dt, *J* = 5.9, 2.8 Hz, 1H), 3.09 (s, 3H), 2.80 (dd, *J* = 17.3, 6.3 Hz, 1H), 2.51 (dd, *J* = 17.3, 3.1 Hz, 1H), 2.42 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.7, 144.7, 141.1, 138.3, 135.8, 135.7, 133.4, 130.8, 129.1, 128.7, 128.5, 128.5, 128.1, 126.4, 126.0, 72.4, 56.7, 45.1, 40.9, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{24}H_{23}ClN_2O_4S_2Na^+$:525.0680, 527.0651; Found: 525.0680, 527.0649.

***trans*-4-(((3-chlorophenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ag-2)**



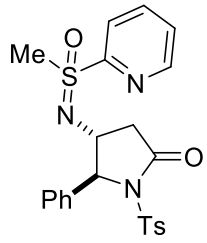
Isolated colorless oil 58 mg (29%). (PE/EA=1:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.89 (d, *J* = 8.4 Hz, 2H), 7.82 (t, *J* = 2.0 Hz, 1H), 7.72 – 7.66 (m, 1H), 7.61 – 7.55 (m, 1H), 7.49 (t, *J* = 7.9 Hz, 1H), 7.36 – 7.26 (m, 5H), 7.21 (dd, *J* = 7.7, 1.8 Hz, 2H), 5.49 (s, 1H), 3.46 (d, *J* = 6.0 Hz, 1H), 3.05 (s, 3H), 2.74 (dd, *J* = 16.9, 6.0 Hz, 1H), 2.45 (s, 3H), 2.22 (d, *J* = 16.9 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.7, 144.7, 141.4, 138.4, 135.9, 135.7, 133.5, 130.9, 129.1, 128.8, 128.7, 128.5, 127.9, 126.3, 125.8, 73.5, 56.9, 45.3, 39.7, 21.7. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{24}H_{23}ClN_2O_4S_2Na^+$:525.0680, 527.0651; Found: 525.0680, 527.0652.

***trans*-4-(((2-bromophenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ah)**



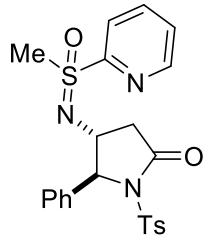
Following General Procedure A, isolated colorless oil 145 mg (66%). dr = 1.27:1. (PE/EA=1:1, R_f = 0.6) **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.21 (dd, *J* = 7.9, 1.8 Hz, 0.45H), 8.14 (dd, *J* = 7.3, 2.3 Hz, 0.55H), 7.89 (d, *J* = 8.3 Hz, 1H), 7.82 (dd, *J* = 7.2, 1.9 Hz, 0.55H), 7.78 (d, *J* = 8.3 Hz, 1H), 7.70 (d, *J* = 7.8 Hz, 0.45H), 7.55 – 7.45 (m, 1.39H), 7.45 – 7.39 (m, 0.7H), 7.30 – 7.12 (m, 6H), 6.94 (dd, *J* = 6.4, 2.8 Hz, 1H), 5.48 (s, 0.45H), 5.36 (s, 0.55H), 3.42 – 3.28 (m, 2.74H), 3.24 (s, 1.28H), 2.71 (ddd, *J* = 39.6, 17.1, 6.0 Hz, 1H), 2.53 – 2.25 (m, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.0, 172.9, 144.6, 138.7, 138.4, 138.3, 137.7, 135.8, 134.5, 133.4, 133.4, 129.1, 129.1, 128.8, 128.7, 128.7, 128.7, 128.5, 128.4, 127.9, 127.8, 125.9, 125.7, 120.7, 120.6, 73.4, 72.0, 57.6, 56.9, 43.0, 42.9, 40.6, 39.2, 29.7, 21.7, 21.7. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{24}H_{23}BrN_2O_4S_2Na^+$:569.0175, 571.0155; Found: 569.0174, 571.0154.

***trans*-4-((methyl(oxo)(pyridin-2-yl)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ai-1)**



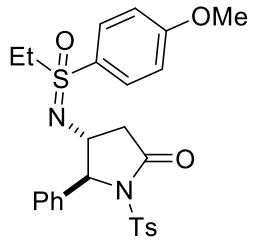
Following General Procedure A, isolated colorless oil 60 mg (32%). (PE/EA=1:1, R_f = 0.3). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.95 – 8.69 (m, 1H), 8.02 (d, *J* = 7.8 Hz, 1H), 7.92 (td, *J* = 7.7, 1.7 Hz, 1H), 7.83 (d, *J* = 8.3 Hz, 2H), 7.55 (ddd, *J* = 7.7, 4.7, 1.2 Hz, 1H), 7.24 (d, *J* = 8.1 Hz, 2H), 7.18 (dd, *J* = 5.1, 1.9 Hz, 3H), 6.98 – 6.73 (m, 2H), 5.14 (s, 1H), 3.61 (d, *J* = 6.1 Hz, 1H), 3.19 (s, 3H), 2.79 (dd, *J* = 17.1, 6.1 Hz, 1H), 2.49 – 2.29 (m, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.9, 157.8, 150.6, 144.6, 138.5, 138.2, 135.8, 129.1, 128.7, 127.8, 127.0, 125.7, 123.4, 77.3, 72.5, 56.3, 41.5, 40.7, 21.7. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{23}H_{24}N_3O_4S_2^+$:470.1203; Found: 470.1203.

***trans*-4-((methyl(oxo)(pyridin-2-yl)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ai-2)**



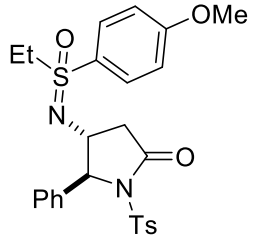
Isolated colorless oil 56 mg (30%). (PE/EA=1:1, R_f = 0.2). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.69 (ddd, *J* = 4.7, 1.8, 0.9 Hz, 1H), 8.03 (d, *J* = 7.9 Hz, 1H), 7.90 (td, *J* = 7.7, 1.7 Hz, 1H), 7.84 (d, *J* = 8.4 Hz, 2H), 7.47 (ddd, *J* = 7.6, 4.7, 1.2 Hz, 1H), 7.34 – 7.24 (m, 5H), 7.21 (dd, *J* = 7.6, 1.8 Hz, 2H), 5.47 (s, 1H), 3.47 (d, *J* = 6.1 Hz, 1H), 3.17 (s, 3H), 2.60 (dd, *J* = 17.1, 6.2 Hz, 1H), 2.42 (s, 3H), 2.18 (dd, *J* = 16.9, 1.6 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.9, 157.4 150.6, 144.6, 138.8, 138.1, 135.8, 129.1, 128.8, 128.7, 127.9, 126.9, 125.9, 123.3, 73.4, 56.8, 41.6, 39.8, 21.7. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{23}H_{24}N_3O_4S_2^+$:470.1203; Found: 470.1202.

***trans*-4-((ethyl(4-methoxyphenyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3aj-1)**



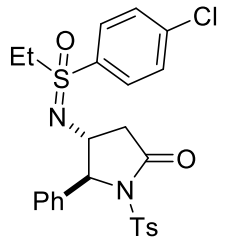
Following General Procedure A, isolated colorless oil 92 mg (45%). (PE/EA=1:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.78 (d, *J* = 8.1 Hz, 2H), 7.60 (d, *J* = 8.8 Hz, 2H), 7.30 – 7.26 (m, 3H), 7.23 (d, *J* = 8.1 Hz, 2H), 7.06 (dd, *J* = 6.6, 2.7 Hz, 2H), 6.96 (d, *J* = 8.9 Hz, 2H), 5.22 (d, *J* = 2.6 Hz, 1H), 3.89 (s, 3H), 3.58 (dt, *J* = 6.2, 3.0 Hz, 1H), 3.11 (qd, *J* = 7.2, 3.7 Hz, 2H), 2.78 (dd, *J* = 17.2, 6.3 Hz, 1H), 2.49 (dd, *J* = 17.2, 3.3 Hz, 1H), 2.42 (s, 3H), 1.19 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.2, 163.4, 144.7, 138.8, 135.8, 131.3, 129.1, 128.7, 128.5, 128.2, 127.9, 126.2, 114.7, 72.7, 56.7, 55.7, 51.4, 41.3, 21.7, 7.4. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{26}H_{29}N_2O_5S_2^+$:513.1513; Found: 513.1512.

***trans*-4-((ethyl(4-methoxyphenyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3aj-2)**



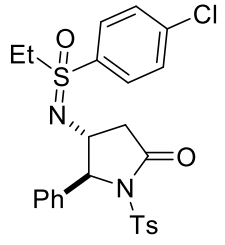
Isolated colorless oil 82 mg (40%). (PE/EA=1:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.90 (d, *J* = 8.2 Hz, 2H), 7.66 (d, *J* = 8.8 Hz, 2H), 7.31 – 7.25 (m, 4H), 7.21 (d, *J* = 7.8 Hz, 3H), 6.97 (d, *J* = 8.8 Hz, 2H), 5.47 (s, 1H), 3.84 (s, 3H), 3.48 (d, *J* = 5.8 Hz, 1H), 3.04 (dq, *J* = 9.5, 7.1 Hz, 2H), 2.71 (dd, *J* = 16.9, 6.0 Hz, 1H), 2.42 (s, 3H), 2.18 (d, *J* = 16.9 Hz, 1H), 1.19 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.2, 163.5, 144.6, 138.8, 135.8, 131.2, 129.1, 128.7, 128.6, 127.7, 125.7, 114.8, 74.0, 56.9, 55.6, 51.4, 39.8, 21.6, 7.0. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{26}H_{29}N_2O_5S_2^+$:513.1513; Found: 513.1513.

***trans*-4-(((4-chlorophenyl)(ethyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ak-1)**



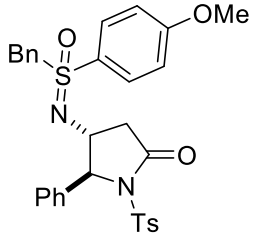
Following General Procedure A, isolated colorless oil 81 mg (39%). (PE/EA=1:1, R_f = 0.6). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.75 (d, *J* = 8.1 Hz, 2H), 7.60 (d, *J* = 8.4 Hz, 2H), 7.45 (d, *J* = 8.2 Hz, 2H), 7.29 (t, *J* = 3.8 Hz, 3H), 7.22 (d, *J* = 8.0 Hz, 2H), 7.04 (d, *J* = 7.1 Hz, 2H), 5.18 (d, *J* = 2.8 Hz, 1H), 3.56 (dt, *J* = 6.5, 3.3 Hz, 1H), 3.14 (p, *J* = 7.2 Hz, 2H), 2.79 (dd, *J* = 17.2, 6.3 Hz, 1H), 2.52 (dd, *J* = 17.1, 3.8 Hz, 1H), 2.42 (s, 3H), 1.21 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.8, 144.7, 139.9, 138.5, 135.8, 135.7, 130.5, 129.7, 129.1, 128.7, 128.5, 128.1, 126.2, 72.4, 56.7, 51.1, 41.2, 21.6, 7.2. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{25}ClN_2O_4S_2Na^+$:539.0837, 541.0807; Found: 539.0839, 541.0809.

***trans*-4-(((4-chlorophenyl)(ethyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ak-2)**



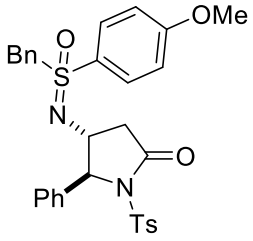
Isolated colorless oil 58 mg (28%). (PE/EA=1:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.90 (d, *J* = 8.4 Hz, 2H), 7.71 (d, *J* = 8.6 Hz, 2H), 7.51 (d, *J* = 8.5 Hz, 2H), 7.32 – 7.24 (m, 5H), 7.24 – 7.18 (m, 2H), 5.48 (s, 1H), 3.48 (d, *J* = 6.0 Hz, 1H), 3.19 – 2.98 (m, 2H), 2.74 (dd, *J* = 16.9, 6.0 Hz, 1H), 2.45 (s, 3H), 2.20 (d, *J* = 17.0 Hz, 1H), 1.23 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.9, 144.6, 140.1, 138.6, 136.4, 135.8, 130.5, 129.9, 129.1, 128.8, 128.7, 127.9, 125.7, 73.8, 56.8, 51.3, 39.8, 21.6, 6.9. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{25}H_{26}ClN_2O_4S_2^+$:517.1018, 519.0988; Found: 517.1017, 519.0988.

***trans*-4-((benzyl(4-methoxyphenyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3al-1)**



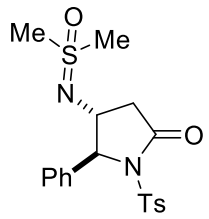
Following General Procedure A, isolated colorless oil 62 mg (27%). (PE/EA=1:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.79 (d, *J* = 8.2 Hz, 2H), 7.42 – 7.14 (m, 10H), 7.05 (dd, *J* = 6.7, 2.7 Hz, 2H), 6.98 (d, *J* = 7.1 Hz, 2H), 6.79 (d, *J* = 8.8 Hz, 2H), 5.22 (d, *J* = 2.6 Hz, 1H), 4.40 – 4.17 (m, 2H), 3.84 (s, 3H), 3.58 (dt, *J* = 6.2, 3.1 Hz, 1H), 2.75 (dd, *J* = 17.1, 6.2 Hz, 1H), 2.55 – 2.41 (m, 1H), 2.39 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.2, 163.4, 144.7, 138.8, 135.8, 131.7, 131.2, 129.1, 128.8, 128.7, 128.6, 128.4, 128.3, 127.9, 127.6, 126.1, 114.2, 72.8, 63.5, 57.0, 55.7, 41.2, 21.7. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{31}H_{31}N_2O_5S_2^+$:575.1669; Found: 575.1668.

***trans*-4-((benzyl(4-methoxyphenyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3al-2)**



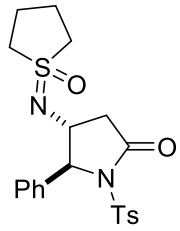
Isolated colorless oil 48 mg (21%). (PE/EA=1:1, R_f = 0.4) **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.91 (d, *J* = 8.4 Hz, 2H), 7.37 (d, *J* = 8.5 Hz, 2H), 7.30 (d, *J* = 7.9 Hz, 3H), 7.26 – 7.20 (m, 5H), 7.17 (dd, *J* = 7.7, 1.8 Hz, 2H), 6.97 (d, *J* = 7.2 Hz, 2H), 6.84 (d, *J* = 8.5 Hz, 2H), 5.52 (s, 1H), 4.47 – 4.19 (m, 1H), 3.82 (s, 3H), 3.53 (d, *J* = 5.7 Hz, 1H), 2.73 (dd, *J* = 16.9, 6.0 Hz, 1H), 2.42 (s, 3H), 2.32 (d, *J* = 16.9 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.9, 163.7, 144.7, 138.5, 135.7, 131.7, 131.2, 129.2, 129.0, 128.7, 128.4, 127.9, 125.7, 114.5, 73.5, 63.3, 56.9, 55.7, 39.5, 21.7. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{31}H_{31}N_2O_5S_2^+$:575.1669; Found: 575.1670.

***trans*-4-((dimethyl(oxo)-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3am)**



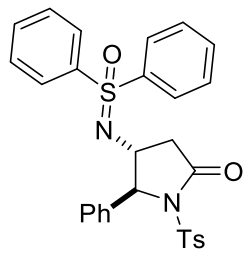
Following General Procedure A, isolated colorless oil 72 mg (44%). (EA, R_f = 0.6). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.76 (d, *J* = 8.2 Hz, 2H), 7.40 – 7.27 (m, 3H), 7.23 (d, *J* = 7.8 Hz, 4H), 5.25 (d, *J* = 1.9 Hz, 1H), 3.77 (d, *J* = 6.3 Hz, 1H), 2.94 (s, 3H), 2.85-2.80 (m,4H), 2.41 (s, 3H), 2.30 (dd, *J* = 17.1, 2.4 Hz, 1H). ^{13}C NMR (101 MHz, **CDCl$_3$**) δ 172.8, 144.7, 138.7, 135.7, 129.1, 128.9, 128.6, 128.1, 126.1, 73.3, 56.4, 42.9, 42.3, 40.6, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{19}H_{22}N_2O_4S_2Na^+$:429.0914; Found: 429.0913.

***trans*-4-((1-oxidotetrahydro-1λ^6-thiophen-1-ylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3an)**



Following General Procedure A, Isolated colorless oil 106 mg (61%). (PE/EA=1:1, R_f = 0.3). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.76 (d, *J* = 8.2 Hz, 2H), 7.36 – 7.28 (m, 3H), 7.25 – 7.19 (m, 4H), 5.27 (d, *J* = 2.1 Hz, 1H), 4.42 – 3.47 (m, 1H), 3.46 – 2.89 (m, 4H), 2.87 – 2.74 (m, 1H), 2.40 (s, 3H), 2.32 (dd, *J* = 17.1, 2.6 Hz, 1H), 2.25 – 1.96 (m, 4H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 172.8, 144.7, 138.7, 135.6, 129.1, 128.8, 128.5, 128.1, 126., 73.1, 57.7, 53.0, 52.6, 40.6, 23.5, 23.3, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{21}H_{25}N_2O_4S_2^+$:433.1251; Found: 433.1251.

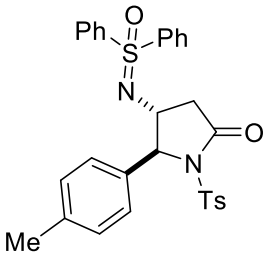
***trans*-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-5-phenyl-1-tosylpyrrolidin-2-one (3ao)**



Following General Procedure A, isolated colorless oil 176 mg (83%). (PE/EA=2:1, R_f = 0.6). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.96 – 7.82 (m, 4H),

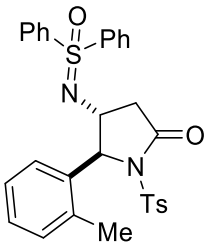
7.80 (d, *J* = 7.2 Hz, 2H), 7.53 (q, *J* = 7.3 Hz, 2H), 7.45 (q, *J* = 7.5 Hz, 4H), 7.35 – 7.22 (m, 4H), 7.16 (t, *J* = 7.3 Hz, 3H), 5.45 (d, *J* = 1.7 Hz, 1H), 3.66 (d, *J* = 5.8 Hz, 1H), 2.79 (dd, *J* = 16.9, 5.9 Hz, 1H), 2.39 (dd, *J* = 16.9, 2.0 Hz, 1H), 2.35 (s, 3H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 173.2, 144.5, 140.3, 140.2, 138.6, 135.7, 132.8, 132.7, 129.3, 129.2, 129.1, 128.8, 128.5, 128.3, 128.3 127.9, 125.9, 73.4, 56.9, 40.5, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{29}H_{27}N_2O_4S_2^+$:531.1407; Found: 531.1408.

***trans*-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-5-(p-tolyl)-1-tosylpyrrolidin-2-one (3bo)**



Following General Procedure A, isolated colorless solid 163 mg (75%). (PE/EA=2:1, R_f = 0.7). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.86 (t, *J* = 8.1 Hz, 4H), 7.80 (dd, *J* = 8.4, 1.3 Hz, 2H), 7.58 – 7.49 (m, 2H), 7.49 – 7.40 (m, 4H), 7.15 (d, *J* = 7.8 Hz, 2H), 7.08 (q, *J* = 8.2 Hz, 4H), 5.42 (s, 1H), 3.63 (d, *J* = 5.7 Hz, 1H), 2.79 (dd, *J* = 16.9, 5.9 Hz, 1H), 2.39-2.35 (m, 4H), 2.32 (s, 3H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 173.2, 144.5, 140.4, 140.3, 137.7, 135.8, 135.7, 132.8, 132.7, 129.4, 129.3, 129.2, 129.1, 128.5, 128.4, 128.3, 125.7, 73.3, 57.0, 40.5, 21.6, 21.1. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{30}H_{28}N_2O_4S_2Na^+$:567.1383; Found: 567.1383.

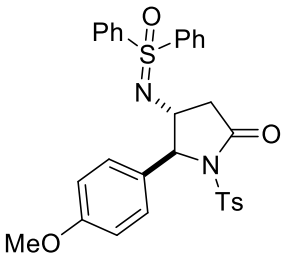
***trans*-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-5-(o-tolyl)-1-tosylpyrrolidin-2-one (3co)**



Following General Procedure A, isolated colorless oil 128 mg (59%). (PE/EA=2:1, R_f = 0.6). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.88 (d, *J* = 8.3 Hz, 2H), 7.82 (d, *J* = 7.2 Hz, 4H), 7.57 – 7.48 (m, 2H), 7.43 (q, *J* = 7.8 Hz, 4H), 7.19 – 7.04 (m, 6H), 5.65 (d, *J* = 1.4 Hz, 1H), 3.94 – 3.20 (m, 1H), 2.78 (dd, *J* = 16.6, 5.4 Hz, 1H), 2.40 (s,

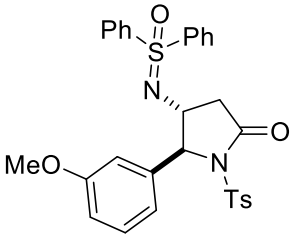
3H), 2.37-2.33 (m, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.5, 144.4, 140.5, 140.5, 136.3, 135.7, 135.4, 132.8, 132.7, 130.9, 129.3, 129.1, 129.0, 128.6, 128.3, 128.2, 127.8, 126.2, 124.9, 70.6, 55.3, 40.6, 21.6, 19.5. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{30}H_{29}N_2O_4S_2^+$:545.1564; Found: : 545.1564.

***trans*-5-(4-methoxyphenyl)-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-1-tosylpyrrolidin-2-one (3do)**



Following General Procedure A, isolated colorless oil 135 mg (60%). (PE/EA=2:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.85 (d, *J* = 8.5 Hz, 4H), 7.80 (d, *J* = 7.9 Hz, 2H), 7.53 (q, *J* = 7.2 Hz, 2H), 7.46 (dd, *J* = 7.8, 6.0 Hz, 4H), 7.15 (d, *J* = 8.0 Hz, 2H), 7.08 (d, *J* = 8.4 Hz, 2H), 6.81 (d, *J* = 8.6 Hz, 2H), 5.39 (s, 1H), 3.79 (s, 3H), 3.62 (d, *J* = 5.5 Hz, 1H), 2.79 (dd, *J* = 16.9, 5.9 Hz, 1H), 2.39 (dd, *J* = 16.9, 2.2 Hz, 1H), 2.35 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.1, 159.3, 144.5, 140.4, 140.3, 135.8, 132.8, 132.7, 130.7, 129.3, 129.2, 129.1, 128.5, 128.3, 128.3, 127.1, 114.2, 73.0, 56.9, 55.3, 40.5, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{30}H_{29}N_2O_4S_2^+$:561.1513; Found: 561.1512.

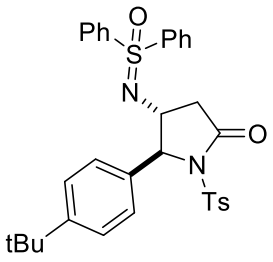
***trans*-5-(3-methoxyphenyl)-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-1-tosylpyrrolidin-2-one (3eo)**



Following General Procedure A, isolated colorless oil 121 mg (54%). (PE/EA=2:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.87 (dd, *J* = 8.3, 1.8 Hz, 4H), 7.81 (d, *J* = 7.1 Hz, 2H), 7.58 – 7.50 (m, 2H), 7.46 (td, *J* = 7.6, 5.6 Hz, 4H), 7.20 (t, *J* = 7.9 Hz, 1H), 7.18 – 7.12 (m, 2H), 6.82 – 6.74 (m, 2H), 6.65 (s, 1H), 5.45 – 5.41 (m, 1H), 3.70 (s, 3H), 3.66 (dt, *J* = 5.9, 1.9 Hz, 1H), 2.79 (dd, *J* = 16.9, 5.9 Hz,

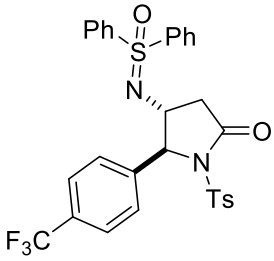
1H), 2.39 (dd, *J* = 16.9, 2.1 Hz, 1H), 2.35 (s, 3H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 173.2, 159.9, 144.6, 140.1, 140.1, 140.1, 135.6, 132.9, 132.8, 129.9, 129.3, 129.2, 129.1, 128.5, 128.3, 128.3, 118.1, 113.8, 111.0, 73.2, 56.8, 55.1, 40.5, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{30}H_{29}N_2O_4S_2^+$:561.1513; Found: 561.1513.

***trans*-5-(4-(tert-butyl)phenyl)-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-1-tosylpyrrolidin-2-one (3fo)**



Following General Procedure A, isolated colorless oil 190 mg (81%). (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.88 – 7.83 (m, 5H), 7.81 (d, *J* = 1.5 Hz, 1H), 7.59 – 7.49 (m, 2H), 7.49 – 7.41 (m, 4H), 7.28 (d, *J* = 8.4 Hz, 2H), 7.12 (d, *J* = 8.1 Hz, 2H), 7.07 (d, *J* = 8.4 Hz, 2H), 5.44 (d, *J* = 1.4 Hz, 1H), 4.06 – 3.39 (m, 1H), 2.81 (dd, *J* = 16.9, 5.8 Hz, 1H), 2.37 (dd, *J* = 17.2, 2.0 Hz, 1H), 2.34 (s, 3H), 1.29 (s, 9H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 173.2, 150.9, 144.4, 140.5, 140.4, 135.9, 135.4, 132.8, 132.7, 129.3, 129.2, 129.1, 128.5, 128.4, 128.3, 125.7, 125.6, 73.3, 56.8, 40.6, 34.5, 31.3, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{33}H_{35}N_2O_4S_2^+$:587.2033; Found: 587.2033.

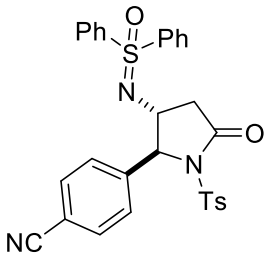
***trans*-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-1-tosyl-5-(4-(trifluoromethyl)phenyl)pyrrolidin-2-one (3go)**



Following General Procedure A, isolated colorless oil 177 mg (74%). (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.87 (d, *J* = 8.4 Hz, 2H), 7.84 (d, *J* = 7.1 Hz, 2H), 7.78 (d, *J* = 7.1 Hz, 2H), 7.59 – 7.50 (m, 4H), 7.45 (ddd, *J* = 13.1, 8.3, 6.8 Hz, 4H), 7.33 (d, *J* = 8.1 Hz, 2H), 7.16 (d, *J* = 8.1 Hz, 2H), 5.48 (s, 1H), 3.63 (dt, *J* = 6.0, 2.2 Hz, 1H), 2.75 (dd, *J* = 16.9, 6.0 Hz, 1H), 2.42 (dd, *J* = 16.9, 2.3

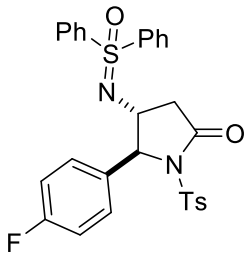
Hz, 1H), 2.35 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.8, 144.9, 142.8, 140.1, 139.9, 135.4, 133.0, 132.9, 130.2 (q, *J* = 32.6 Hz), 129.40, 129.2, 129.2, 128.4, 128.3, 128.1, 126.3, 125.8 (q, *J* = 3.9 Hz), 123.9 (q, *J* = 272.1 Hz), 72.8, 56.8, 40.3, 21.6. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -62.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{30}H_{25}F_3N_2O_4S_2Na^+$:621.1101; Found: 621.1101.

***trans*-5-oxo-3-((oxodiphenyl-λ^6-sulfaneylidene)amino)-1-tosylpyrrolidin-2-yl)benzonitrile (3ho)**



Following General Procedure A, isolated colorless oil 113 mg (51%). (PE/EA=2:1, R_f = 0.3). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.88 (d, *J* = 8.3 Hz, 2H), 7.84 – 7.75 (m, 4H), 7.60 (d, *J* = 8.1 Hz, 2H), 7.54 (dd, *J* = 10.0, 7.3 Hz, 2H), 7.46 (q, *J* = 7.4 Hz, 4H), 7.34 (d, *J* = 8.0 Hz, 2H), 7.17 (d, *J* = 8.1 Hz, 2H), 5.47 (d, *J* = 1.8 Hz, 1H), 3.60 (dd, *J* = 5.2, 2.7 Hz, 1H), 2.72 (dd, *J* = 17.0, 6.0 Hz, 1H), 2.40 (dd, *J* = 16.9, 2.3 Hz, 1H), 2.35 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.6, 145.0, 144.2, 140.0, 139.9, 135.3, 133.0, 132.9, 132.6, 129.5, 129.3, 129.2, 128.5, 128.3, 128.0, 126.7, 118.4, 111.9, 72.9, 56.7, 40.3, 21.7. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{30}H_{26}N_3O_4S_2^+$:556.1360; Found: 556.1359.

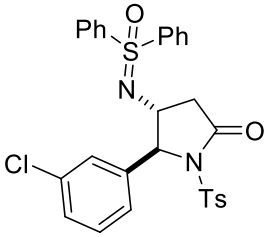
***trans*-5-(4-fluorophenyl)-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-1-tosylpyrrolidin-2-one (3io)**



Following General Procedure A, isolated colorless oil 151 mg (69%). (PE/EA=2:1, R_f = 0.6). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.84 (dd, *J* = 7.8, 2.8 Hz, 4H), 7.79 (d, *J* = 7.4 Hz, 2H), 7.54 (q, *J* = 7.2 Hz, 2H), 7.46 (q, *J* = 7.7 Hz, 4H), 7.15 (t, *J* = 7.9 Hz, 4H), 6.98 (t, *J* = 8.6 Hz, 2H), 5.41 (d, *J* = 1.9 Hz, 1H), 3.61 (d, *J* =

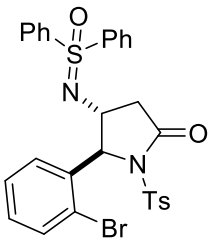
6.0 Hz, 1H), 2.76 (dd, *J* = 17.0, 6.0 Hz, 1H), 2.40 (dd, *J* = 17.0, 2.3 Hz, 1H), 2.35 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.9, 144.7, 140.2 (d, *J* = 2.6 Hz), 135.7, 134.6 (d, *J* = 3.3 Hz), 132.9, 132.8, 129.4, 129.2, 128.5, 128.3, 128.2, 127.7, 127.6, 115.8, 115.6, 72.7, 56.9, 40.4, 21.6. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -114.3. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{29}H_{25}FN_2O_4S_2Na^+$:571.1132; Found: 571.1133.

***trans*-5-(3-chlorophenyl)-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-1-tosylpyrrolidin-2-one (3jo)**



Following General Procedure A, isolated colorless oil 124 mg (55%). (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.90 – 7.82 (m, 4H), 7.79 (d, *J* = 7.4 Hz, 2H), 7.54 (q, *J* = 7.3 Hz, 2H), 7.46 (q, *J* = 7.6 Hz, 4H), 7.25 – 7.22 (m, 2H), 7.17 (d, *J* = 8.1 Hz, 2H), 7.14 – 7.04 (m, 1H), 6.99 (s, 1H), 5.38 (d, *J* = 1.9 Hz, 1H), 3.61 (d, *J* = 6.0 Hz, 1H), 2.77 (dd, *J* = 17.0, 6.1 Hz, 1H), 2.42 (dd, *J* = 17.0, 2.4 Hz, 1H), 2.36 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.8, 144.8, 140.7, 140.1, 140.0, 135.5, 134.7, 132.9, 132.8, 130.1, 129.3, 129.2, 129.2, 128.4, 128.3, 128.2, 128.1, 126.0, 124.2, 72.6, 56.7, 40.4, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{29}H_{26}ClN_2O_4S_2^+$:565.1018, 567.0988; Found: : 565.1020, 567.0986.

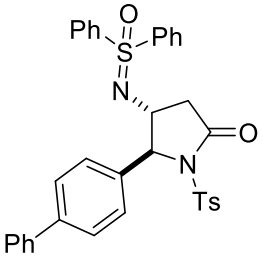
***trans*-5-(2-bromophenyl)-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-1-tosylpyrrolidin-2-one (3ko)**



Following General Procedure A, isolated colorless oil 117 mg (48%). (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.97 (d, *J* = 8.4 Hz, 2H), 7.91 – 7.83 (m, 2H), 7.80 (dd, *J* = 8.4, 1.3 Hz, 2H), 7.57 – 7.46 (m, 3H), 7.50 – 7.44 (m, 2H), 7.41 (dt, *J* = 7.7, 6.5 Hz, 2H), 7.31 (ddd, *J* = 15.7, 7.5, 1.6 Hz, 2H), 7.15 (td,

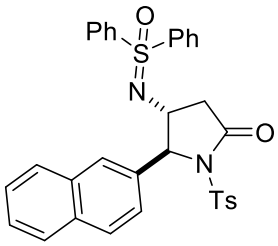
J = 7.5, 1.6 Hz, 3H), 5.74 (d, *J* = 1.6 Hz, 1H), 3.79 (dt, *J* = 5.2, 1.8 Hz, 1H), 2.69 (dd, *J* = 16.6, 5.2 Hz, 1H), 2.41 (dd, *J* = 16.6, 1.9 Hz, 1H), 2.32 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.4, 144.6, 140.7, 140.4, 137.4, 135.5, 133.4, 132.7, 132.6, 129.5, 129.2, 129.1, 129.0, 128.6, 128.6, 128.2, 127.8, 122.5, 72.4, 55.5, 40.7, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{29}H_{26}BrN_2O_4S_2^+$:609.0512, 611.0492; Found: : 609.0511, 611.0490.

***trans*-5-([1,1'-biphenyl]-4-yl)-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-1-tosylpyrrolidin-2-one (3lo)**



Following General Procedure A, isolated colorless oil 170 mg (70%). (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.88 (t, *J* = 7.2 Hz, 4H), 7.81 (d, *J* = 7.3 Hz, 2H), 7.58 – 7.50 (m, 6H), 7.48 (d, *J* = 7.8 Hz, 2H), 7.46 – 7.41 (m, 4H), 7.35 (t, *J* = 7.3 Hz, 1H), 7.24 (d, *J* = 8.3 Hz, 2H), 7.16 (d, *J* = 8.1 Hz, 2H), 5.49 (s, 1H), 3.70 (d, *J* = 5.9 Hz, 1H), 2.83 (dd, *J* = 16.9, 5.9 Hz, 1H), 2.42 (dd, *J* = 16.9, 2.2 Hz, 1H), 2.35 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.1, 144.6, 141.0, 140.5, 140.3, 140.3, 137.7, 135.8, 132.8, 132.7, 129.3, 129.2, 129.2, 128.8, 128.6, 128.4, 128.3, 127.5, 127.4, 127.1, 126.3, 73.2, 56.9, 40.6, 21.7. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{35}H_{30}N_2O_4S_2Na^+$:629.1540; Found: 629.1541.

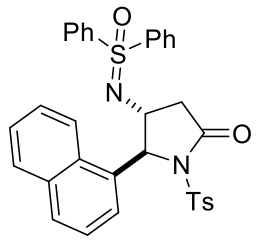
***trans*-5-(naphthalen-2-yl)-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-1-tosylpyrrolidin-2-one (3mo)**



Following General Procedure A, isolated colorless oil 173 mg (76%). (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.91 – 7.85 (m, 4H), 7.80 (d, *J* = 7.5 Hz, 3H), 7.75 (d, *J* = 8.5 Hz, 1H), 7.71 – 7.65 (m, 1H), 7.57 (s, 1H),

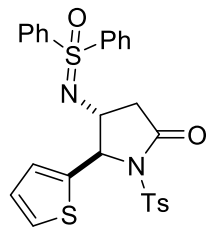
7.52 (t, J = 7.3 Hz, 2H), 7.47 (d, J = 7.3 Hz, 4H), 7.39 (t, J = 7.7 Hz, 2H), 7.21 (dd, J = 8.4, 1.8 Hz, 1H), 7.12 (d, J = 8.0 Hz, 2H), 5.60 (s, 1H), 3.74 (d, J = 6.0 Hz, 1H), 2.84 (dd, J = 17.0, 6.0 Hz, 1H), 2.45 (dd, J = 16.9, 2.2 Hz, 1H), 2.34 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.2, 144.6, 140.2, 140.2, 135.9, 135.8, 133.1, 132.9, 132.8, 132.7, 129.3, 129.1, 128.7, 128.5, 128.3, 128.3, 128.0, 127.6, 126.4, 126.2, 124.6, 123.9, 73.4, 56.7, 40.6, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{33}H_{29}N_2O_4S_2^+$:581.1564; Found:581.1565.

***trans*-5-(naphthalen-1-yl)-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-1-tosylpyrrolidin-2-one (3no)**



Following General Procedure A, isolated colorless oil 148 mg (64%). (PE/EA=2:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.22 (d, J = 7.8 Hz, 1H), 8.02 (d, J = 8.0 Hz, 2H), 7.88 (d, J = 7.8 Hz, 2H), 7.85 (d, J = 7.3 Hz, 3H), 7.77 (d, J = 8.2 Hz, 1H), 7.59 – 7.36 (m, 10H), 7.13 (d, J = 7.9 Hz, 2H), 6.23 (s, 1H), 3.83 (d, J = 4.8 Hz, 1H), 2.71 (dd, J = 16.4, 5.0 Hz, 1H), 2.32-2.27 (m, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.8, 144.4, 140.6, 140.5, 135.7, 133.9, 133.8, 132.8, 132.7, 130.2, 129.3, 129.1, 129.0, 128.8, 128.7, 128.6, 128.4, 128.2, 126.5, 125.9, 125.4, 123.6, 71.4, 55.7, 40.8, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{33}H_{29}N_2O_4S_2^+$:581.1564; Found:581.1565.

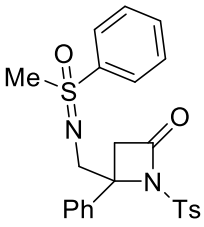
***trans*-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-5-(thiophen-2-yl)-1-tosylpyrrolidin-2-one (3oo)**



Following General Procedure A, isolated colorless oil 97 mg (45%). (PE/EA=2:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.86 (dd, J = 10.0, 7.7 Hz, 4H), 7.81 (d, J = 8.2 Hz, 2H), 7.54 (t, J = 6.6 Hz, 2H), 7.47 (t, J = 7.6 Hz, 4H), 7.18 (dd, J =

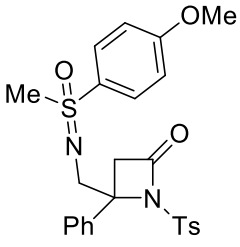
5.0, 1.2 Hz, 1H), 7.13 (d, *J* = 8.1 Hz, 2H), 6.96 (d, *J* = 3.5 Hz, 1H), 6.92 (dd, *J* = 5.0, 3.6 Hz, 1H), 5.64 (s, 1H), 3.96 – 3.54 (m, 1H), 2.93 (dd, *J* = 17.0, 5.8 Hz, 1H), 2.44 (dd, *J* = 17.0, 1.6 Hz, 1H), 2.33 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.4, 144.5, 141.8, 140.2, 140.2, 135.7, 132.8, 132.8, 129.3, 129.2, 129.1, 128.4, 128.3, 128.3, 126.9, 125.7, 125.1, 69.2, 56.8, 40.9, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{27}H_{24}N_2O_4S_2Na^+$:559.0791; Found: : 559.0792.

4-(((methyl(oxo)(phenyl)-λ^6-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5aa)



Following General Procedure A, isolated colorless oil 152 mg (81%). dr = 1.02:1. (PE/EA=2:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.05 – 7.91 (m, 2H), 7.81 (t, *J* = 8.5 Hz, 2H), 7.70 – 7.50 (m, 3H), 7.39 (dd, *J* = 6.8, 2.9 Hz, 1H), 7.33 – 7.27 (m, 3H), 7.24 (dd, *J* = 5.4, 3.3 Hz, 3H), 4.11 (d, *J* = 12.8 Hz, 0.5H), 3.88 – 3.76 (m, 1.5H), 3.69 (dd, *J* = 34.5, 13.2 Hz, 1H), 3.05 (s, 1.57H), 3.05 – 2.92 (m, 2.60H), 2.42 (s, 1.60H), 2.40 (s, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.8, 164.7, 144.5, 144.4, 139.78, 139.1, 138.8, 138.8, 137.0, 136.7, 133.1, 133.0, 129.5, 129.4, 129.3, 129.2, 128.7, 128.5, 128.4, 1282, 128.1, 128.0, 127.7, 127.7, 126.2, 126.0, 71.1, 70.9, 48.3, 48.2, 47.5, 47.0, 45.5, 43.2, 21.6, 21.5. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{24}H_{25}N_2O_4S_2^+$:469.1251; Found: 469.1251.

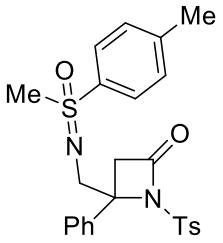
4-((((4-methoxyphenyl)(methyl)(oxo)- λ^6-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5ab)



Following General Procedure A, isolated colorless oil 183 mg (92%). dr = 1.11:1. (PE/EA=2:1, R_f = 0.3). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.89 (dd, *J* = 9.0, 7.6 Hz, 2H), 7.80 (dd, *J* = 10.1, 8.3 Hz, 2H), 7.39 (dd, *J* = 6.7, 3.1 Hz, 1H), 7.31

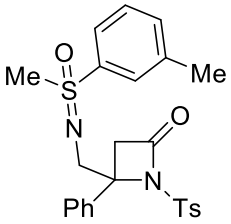
– 7.27 (m, 3H), 7.25 – 7.22 (m, 3H), 7.03 (dd, *J* = 8.9, 3.8 Hz, 2H), 4.08 (d, *J* = 12.8 Hz, 0.51H), 3.88 (s, 1.36H), 3.87 (s, 1.68H), 3.84 – 3.76 (m, 1.47H), 3.68 (dd, *J* = 42.7, 12.9 Hz, 1H), 3.04 (s, 1.68H), 3.02 – 2.90 (m, 2.42H), 2.42 (s, 1.42H), 2.40 (s, 1.58H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.8, 164.8, 163.4, 163.3, 144.5, 144.4, 139.0, 138.9, 137.1, 136.9, 131.3, 130.9, 130.4, 130.2, 129.4, 129.2, 128.5, 128.4, 128.2, 128.1, 127.8, 127.7, 126.2, 126.0, 114.7, 114.5, 71.2, 71.1, 55.6, 55.6, 48.4, 48.3, 47.6, 47.1, 45.9, 43.4, 21.6, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{25}H_{27}N_2O_5S_2^+$:499.1356; Found: 499.1356.

4-(((methyl(oxo)(p-tolyl)-λ^6-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5ac)



Following General Procedure A, isolated colorless oil 174 mg (90%). dr = 1.15:1. (PE/EA=2:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.92 – 7.72 (m, 4H), 7.45 – 7.33 (m, 3H), 7.32 – 7.27 (m, 3H), 7.24 (dd, *J* = 5.4, 3.4 Hz, 3H), 4.08 (d, *J* = 12.8 Hz, 0.5H), 3.89 – 3.75 (m, 1.5H), 3.68 (dd, *J* = 36.3, 12.9 Hz, 1H), 3.10 – 2.87 (m, 4H), 2.45 (s, 1.66H), 2.44 (s, 1.43H), 2.42 (s, 1.66H), 2.40 (s, 1.34H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.8, 164.7, 144.5, 144.4, 144.0, 143.9, 139.0, 138.9, 137.1, 136.9, 136.9, 136.1, 130.2, 130.0, 129.4, 129.2, 128.8, 128.5, 128.5, 128.2, 128.1, 127.8, 127.8, 126.3, 126.1, 71.2, 71.0, 48.4, 48.3, 47.6, 47.1, 45.7, 43.4, 21.6, 21.6, 21.5. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{26}N_2O_4S_2Na^+$:505.1227; Found: 505.1228.

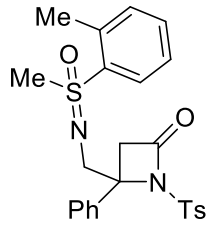
4-(((methyl(oxo)(m-tolyl)-λ^6-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5ad)



Following General Procedure A, isolated colorless oil 141 mg (73%). dr = 1.14:1. (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.98 – 7.63

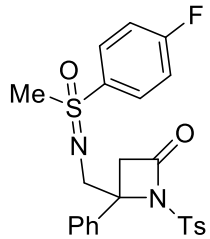
(m, 4H), 7.50 – 7.40 (m, 2H), 7.39 (dd, *J* = 6.9, 2.9 Hz, 1H), 7.32 – 7.26 (m, 3H), 7.27 – 7.20 (m, 3H), 4.09 (d, *J* = 12.8 Hz, 0.49H), 3.91 – 3.74 (m, 1.51H), 3.77 – 3.58 (m, 1H), 3.16 – 2.81 (m, 4H), 2.46 (s, 1.44H), 2.45 (s, 1.62H), 2.41 (s, 1.40H), 2.40 (s, 1.60H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.8, 164.7, 144.5, 144.4, 139.9, 139.8, 139.6, 138.9, 138.9, 137.1, 136.9, 133.9, 133.8, 129.4, 129.4, 129.2, 129.2, 129.2, 128.5, 128.5, 128.5, 128.2, 128.1, 127.8, 127.8, 126.3, 126.1, 125.8, 125.1, 71.2, 70.9, 48.4, 48.3, 47.6, 47.1, 45.6, 43.3, 21.6, 21.4, 21.3. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{25}H_{27}N_2O_4S_2^+$:483.1407; Found: 483.1406.

4-(((methyl(oxo)(o-tolyl)-λ^6-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5ae)



Following General Procedure A, isolated colorless oil 73 mg (38%). dr = 1.36:1. (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.04 (d, *J* = 7.9 Hz, 1H), 7.83 (d, *J* = 8.4 Hz, 1H), 7.73 (d, *J* = 8.4 Hz, 1H), 7.56 – 7.44 (m, 1H), 7.42 – 7.37 (m, 2H), 7.37 – 7.30 (m, 2H), 7.28 – 7.24 (m, 3H), 7.21 (d, *J* = 8.4 Hz, 2H), 4.05 (d, *J* = 12.9 Hz, 0.51H), 3.89 – 3.73 (m, 1.49H), 3.72 – 3.60 (m, 1H), 3.12 – 2.93 (m, 4H), 2.73 (s, 1.29H), 2.71 (s, 1.69H), 2.40 (s, 1.73H), 2.39 (s, 1.28H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.7, 164.6, 144.5, 144.4, 139.0, 138.6, 138.2, 138.0, 138.0, 137.6, 137.0, 136.7, 133.1, 133.1, 133.0, 133.0, 130.6, 130.1, 129.3, 129.1, 128.5, 128.2, 128.1, 128.0, 127.8, 126.8, 126.8, 126.4, 126.1, 48.4, 48.3, 47.5, 47.0, 44.3, 43.0, 21.6, 20.4, 20.3. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{25}H_{27}N_2O_4S_2^+$:483.1407; Found: 483.1408.

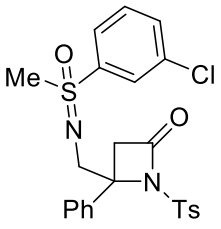
4-((((4-fluorophenyl)(methyl)(oxo)- λ^6-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5af)



Following General Procedure A, isolated colorless oil 138 mg (71%).

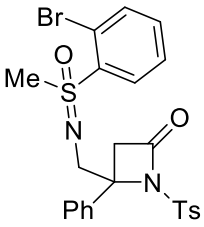
dr = 1.29:1. (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 8.02 (dt, *J* = 9.2, 4.8 Hz, 2H), 7.78 (dd, *J* = 8.4, 3.2 Hz, 2H), 7.49 – 7.33 (m, 1H), 7.30 (dd, *J* = 5.2, 2.0 Hz, 3H), 7.23 (dq, *J* = 5.1, 3.2, 2.7 Hz, 5H), 4.15 (d, *J* = 12.8 Hz, 0.52H), 3.88 – 3.77 (m, 1.52H), 3.76 – 3.61 (m, 1H), 3.10 (s, 1.62H), 3.09 (s, 1.32H), 3.01 (dd, *J* = 15.3, 10.0 Hz, 1H), 2.43 (s, 1.68H), 2.41 (s, 1.32H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 166.9, 166.8, 164.8, 164.7, 164.3, 164.3, 144.7, 144.5, 138.8, 137.1, 136.9, 136.0 (d, *J* = 3.0 Hz), 134.9 (d, *J* = 2.9 Hz), 131.7 (d, *J* = 9.5 Hz), 130.9 (d, *J* = 9.4 Hz), 129.5, 129.3, 128.6 128.5, 128.3, 128.2, 127.6, 126.2, 126.0, 116.9, 116.6, 116.6, 116.4, 71.1, 71.0, 48.3, 48.3, 47.7, 47.1, 45.8, 43.1, 21.6, 21.6. **^{19}F NMR (376 MHz, CDCl$_3$)** δ -105.1, -105.1. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{24}H_{24}FN_2O_4S_2^+$:487.1157; Found: 487.1156.

4-((((3-chlorophenyl)(methyl)(oxo)- λ^6-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5ag)



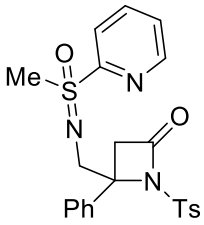
Following General Procedure A, isolated colorless oil 115 mg (57%). dr = 1.08:1. (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.99 (dt, *J* = 6.8, 1.9 Hz, 1H), 7.90 (ddt, *J* = 17.3, 7.7, 1.5 Hz, 1H), 7.82 (dd, *J* = 8.2, 5.7 Hz, 2H), 7.61 (ddt, *J* = 6.0, 4.7, 1.6 Hz, 1H), 7.54 (td, *J* = 7.9, 3.2 Hz, 1H), 7.44 – 7.37 (m, 1H), 7.35 – 7.31 (m, 2H), 7.28 (td, *J* = 5.6, 1.9 Hz, 4H), 4.13 (d, *J* = 12.8 Hz, 0.48H), 3.87 – 3.76 (m, 1.52H), 3.76 – 3.65 (m, 1H), 3.17 – 2.86 (m, 4H), 2.44 (s, 1.56H), 2.43 (s, 1.44H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 164.7, 164.5, 144.6, 144.5, 141.8, 141.1, 138.7, 138.7, 137.1, 136.8, 135.7, 135.5, 133.3, 133.2, 130.8, 130.7, 129.5, 129.3, 128.9, 128.5, 128.5, 128.29, 128.2, 128.1, 127.7, 126.9, 126.3, 126.2, 126.0, 71.0, 70.8, 48.4, 48.3, 47.6, 47.1, 45.5, 43.3, 21.6, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{24}H_{24}ClN_2O_4S_2^+$:503.0861, 505.0832; Found: 503.0863, 505.0833.

4-((((2-bromophenyl)(methyl)(oxo)- λ^6-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5ah)



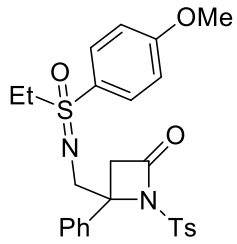
Following General Procedure A, isolated colorless oil 114 mg (52%). dr = 1.14:1. (PE/EA=2:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.45 – 8.13 (m, 1H), 7.85 (dd, *J* = 13.6, 8.4 Hz, 2H), 7.80 (td, *J* = 8.0, 1.2 Hz, 1H), 7.60 – 7.52 (m, 1H), 7.48 (td, *J* = 7.7, 1.7 Hz, 1H), 7.44 (dd, *J* = 6.7, 2.8 Hz, 1H), 7.40 (dd, *J* = 6.7, 3.0 Hz, 1H), 7.32 – 7.25 (m, 4H), 7.23 (d, *J* = 8.1 Hz, 1H), 3.96 (d, *J* = 12.9 Hz, 0.50H), 3.90 – 3.74 (m, 1.50H), 3.52 – 3.32 (m, 1H), 3.18 (s, 1.63H), 3.15 (s, 1.38H), 3.05 (dd, *J* = 15.4, 9.5 Hz, 1H), 2.44 (s, 1.45H), 2.42 (s, 1.55H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.6, 164.5, 144.4, 144.4, 137.0, 138.9, 138.6, 138.4, 136.7, 136.6, 135.8, 135.6, 134.2, 134.2, 133.2, 132.8, 129.3, 129.1, 128.5, 128.3, 128.3, 128.2, 128.1, 128.1, 126.3, 126.3, 120.8, 120.3, 70.6, 70.5, 48.5, 48.4, 47.4, 47.3, 42.9, 42.4, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{24}H_{24}BrN_2O_4S_2^+$:547.0356, 549.0335; Found: 547.0354, 549.0336.

4-(((methyl(oxo)(pyridin-2-yl)-λ^6-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5ai)



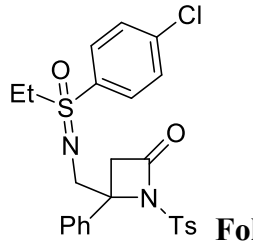
Following General Procedure A, isolated colorless oil 109 mg (58%). dr = 1.54:1. (EA, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.78 (d, *J* = 4.6 Hz, 0.40H), 8.72 (d, *J* = 4.6 Hz, 0.60H), 8.15 (d, *J* = 7.9 Hz, 0.60H), 8.07 (d, *J* = 7.8 Hz, 0.40H), 8.00 – 7.92 (m, 1H), 7.84 (d, *J* = 8.2 Hz, 2H), 7.61 – 7.46 (m, 1H), 7.45 – 7.34 (m, 2H), 7.33 – 7.12 (m, 5H), 4.10 (d, *J* = 13.0 Hz, 0.68H), 3.89 – 3.73 (m, 1.32H), 3.73 – 3.52 (m, 1H), 3.12 (s, 3H), 2.98 (dd, *J* = 15.4, 12.0 Hz, 1H), 2.40 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.8, 164.4, 157.6, 157.4, 150.4, 150.0, 144.5, 144.4, 139.0, 138.2, 138.0, 136.7, 136.4, 129.3, 129.1, 128.5, 128.5, 128.5, 128.2, 128.1, 126.8, 126.7, 126.2, 126.1, 123.5, 123.0, 71.0, 70.9, 48.4, 48.3, 47.2, 47.1, 41.3, 40.3, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{23}H_{24}N_3O_4S_2^+$:470.1203; Found: 470.1202.

4-(((ethyl(4-methoxyphenyl)(oxo)- λ⁶-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5aj)



Following General Procedure A, isolated colorless oil 84 mg (82%). dr = 3.73:1. (PE/EA=2:1, R_f = 0.4)**^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.94 – 7.83 (m, 0.79H), 7.78 (dd, *J* = 18.0, 8.6 Hz, 3.19H), 7.52 – 7.37 (m, 1.66H), 7.33 – 7.20 (m, 5.34H), 7.01 (d, *J* = 8.9 Hz, 2H), 4.05 – 3.81 (m, 4H), 3.79 – 3.66 (m, 2H), 3.25 – 2.85 (m, 3H), 2.42 (s, 3H), 1.23 (t, *J* = 7.4 Hz, 0.64H), 1.13 (t, *J* = 7.4 Hz, 2.41H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.9, 164.7, 163.4, 163.3, 144.5, 139.1, 139.0, 137.2, 136.9, 131.6, 131.0, 129.4, 129.7, 129.0, 128.7, 128.4, 128.1, 128.1, 127.8, 127.8, 126.4, 126.0, 71.5, 71.1, 55.6, 55.6, 52.0, 50.2, 48.5, 48.3, 47.3, 46.8, 21.6, 8.0, 7.2. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{26}H_{29}N_2O_5S_2^+$:513.1513; Found: 513.1513.

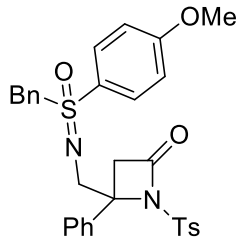
4-((((4-chlorophenyl)(ethyl)(oxo)- λ⁶-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5ak)



Following General Procedure A, isolated colorless oil 128 mg (62%). dr = 1.54:1. (PE/EA=2:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.92 (d, *J* = 8.7 Hz, 1H), 7.80 (dd, *J* = 8.4, 3.1 Hz, 3H), 7.53 (dd, *J* = 10.5, 8.5 Hz, 2H), 7.39 (dd, *J* = 6.8, 2.9 Hz, 1H), 7.30 (d, *J* = 2.6 Hz, 2H), 7.28 – 7.17 (m, 4H), 4.06 (d, *J* = 12.7 Hz, 0.50H), 3.90 – 3.75 (m, 1.51H), 3.74 – 3.58 (m, 1H), 3.25 – 3.07 (m, 2H), 3.01 (dd, *J* = 18.6, 15.2 Hz, 1H), 2.42 (s, 1.42H), 2.41 (s, 1.62H), 1.27 (t, *J* = 7.4 Hz, 1.63H), 1.16 (t, *J* = 7.4 Hz, 1.34H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.8, 164.6, 144.6, 144.6, 139.8, 139.8, 138.8, 137.1, 136.8, 136.1, 136.1, 131.1, 130.4, 129.8, 129.6, 129.4, 129.4, 128.5, 128.2, 128.2, 127.7, 127.6, 126.3, 125.9, 71.3, 70.9, 51.8, 49.9, 48.4, 48.3, 47.3, 46.8, 21.6, 8.0, 7.1. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{25}H_{26}ClN_2O_4S_2^+$:517.1018,

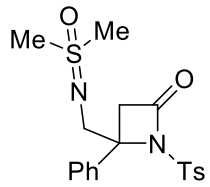
519.0988; Found: 517.1018, 519.0989.

4-(((benzyl(4-methoxyphenyl)(oxo)- λ⁶-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5al)



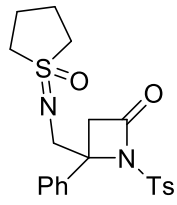
Following General Procedure A, isolated colorless oil 117 mg (51%). dr = 1.20:1. (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.90 (d, *J* = 8.4 Hz, 1H), 7.83 (d, *J* = 8.4 Hz, 1H), 7.72 (d, *J* = 8.9 Hz, 1H), 7.47 – 7.40 (m, 1H), 7.37 (d, *J* = 8.9 Hz, 1H), 7.32 – 7.26 (m, 4H), 7.25 – 7.09 (m, 6H), 6.95 (d, *J* = 8.9 Hz, 1H), 6.90 – 6.80 (m, 2H), 4.36 (d, *J* = 13.4 Hz, 1.75H), 4.30 – 4.20 (m, 0.70H), 4.16 – 4.04 (m, 1H), 3.85 (d, *J* = 2.6 Hz, 3.34H), 3.76 – 3.35 (m, 2H), 2.93 (dd, *J* = 22.4, 15.2 Hz, 1H), 2.43 (s, 1.38H) , 2.39 (s, 1.63H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.9, 164.6, 163.4, 163.3 144.5, 144.5, 139.2, 139.0, 137.2, 136.8, 131.8, 131.5, 131.4, 131.1, 129.4, 129.4, 129.3, 129.0, 128.6, 128.5, 128.4, 128.4, 128.2, 128.2, 128.1, 128.1, 128.1, 127.9, 127.7, 126.2, 126.0, 114.4, 114.1, 71.5, 71.4, 63.8, 62.7, 55.6, 48.3, 48.26, 47.1, 46.8, 21.7, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{31}H_{31}N_2O_5S_2^+$:575.1669; Found: 575.1669.

4-(((dimethyl(oxo)- λ⁶-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5am)



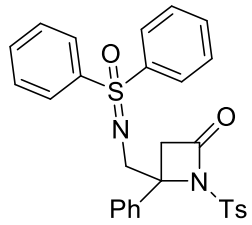
Following General Procedure A, isolated colorless oil 84 mg (56%). (EA, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.80 (d, *J* = 8.1 Hz, 2H), 7.52 – 6.67 (m, 7H), 4.10 (d, *J* = 12.7 Hz, 1H), 3.90 – 3.73 (m, 2H), 3.12 (s, 3H), 3.05 (s, 3H), 2.98 (d, *J* = 15.2 Hz, 1H), 2.45 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.8, 144.6, 139.0, 137.1, 129.5, 128.6, 128.3, 127.5, 126.0, 71.4, 48.1, 47.7, 43.7, 39.9, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{19}H_{23}N_2O_4S_2^+$:407.1094; Found: 407.1095.

4-(((1-oxidotetrahydro-1λ^6-thiophen-1-ylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5j)



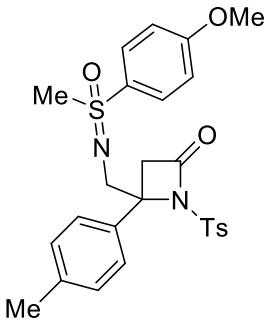
Following General Procedure A, isolated colorless oil 111 mg (64%). (EA, R_f = 0.4). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.73 (d, *J* = 8.4 Hz, 2H), 7.34 – 7.26 (m, 5H), 7.24 (d, *J* = 8.2 Hz, 2H), 4.05 (d, *J* = 12.8 Hz, 1H), 3.90 – 3.74 (m, 2H), 3.50 (dt, *J* = 13.0, 6.9 Hz, 1H), 3.23 (dt, *J* = 12.8, 7.5 Hz, 1H), 3.15 – 3.01 (m, 1H), 2.97 (d, *J* = 15.2 Hz, 1H), 2.89 (dt, *J* = 12.6, 7.5 Hz, 1H), 2.42 (s, 3H), 2.35 – 2.22 (m, 3H), 2.22 – 2.10 (m, 1H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 164.8, 144.5, 138.8, 137.1, 129.4, 128.6, 128.2, 127.4, 126.0, 71.1, 54.4, 49.5, 48.8, 48.1, 24.3, 23.1, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{21}H_{25}N_2O_4S_2^+$:433.1251; Found: 433.1250.

4-(((oxodiphenyl-λ^6-sulfaneylidene)amino)methyl)-4-phenyl-1-tosylazetidin-2-one (5ao)



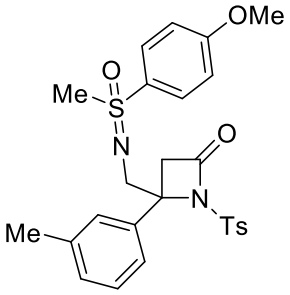
Following General Procedure A, isolated colorless oil 176 mg (83%). (PE/EA=2:1, R_f = 0.6). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 8.02 (dd, *J* = 8.2, 1.6 Hz, 2H), 7.94 (dd, *J* = 8.1, 1.6 Hz, 2H), 7.86 (d, *J* = 8.4 Hz, 2H), 7.49 (ddd, *J* = 10.0, 7.0, 5.0 Hz, 6H), 7.40 – 7.31 (m, 2H), 7.30 – 7.23 (m, 3H), 7.20 (d, *J* = 8.2 Hz, 2H), 4.00 (d, *J* = 12.9 Hz, 1H), 3.88 – 3.63 (m, 2H), 3.03 (d, *J* = 15.2 Hz, 1H), 2.34 (s, 3H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 164.7, 144.5, 140.8, 140.1, 139.1, 136.8, 132.5, 132.5, 129.3, 129.2, 129.1, 128.8, 128.5, 128.2, 128.1, 127.8, 126.0, 71.4, 48.5, 46.8, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{29}H_{27}N_2O_4S_2^+$:531.1407; Found: 531.1408.

4-((((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)methyl)-4-(p-tolyl)-1-tosylazetidin-2-one (5bb)



Following General Procedure A, isolated colorless oil 176 mg (86%). dr = 1.56:1. (PE/EA=2:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.90 (dd, *J* = 8.9, 3.6 Hz, 2H), 7.80 (t, *J* = 8.7 Hz, 2H), 7.26 (td, *J* = 4.7, 4.3, 2.0 Hz, 3H), 7.23 – 7.14 (m, 1H), 7.09 (d, *J* = 8.0 Hz, 1H), 7.03 (dd, *J* = 9.1, 2.7 Hz, 3H), 4.08 (d, *J* = 12.7 Hz, 0.50H), 3.88 (s, 1.63H), 3.87 (s, 1.37H), 3.85 – 3.74 (m, 1.50H), 3.67 (dd, *J* = 43.3, 12.7 Hz, 1H), 3.12 – 2.80 (m, 4H), 2.42 (s, 1.90H), 2.40 (s, 1.21H), 2.34 (s, 1.80H), 2.29 (s, 1.20H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 165.1, 165.0, 163.3, 163.3, 144.5, 144.4, 138.1, 137.9, 137.1, 136.9, 135.9, 135.8, 131.3, 131.0, 130.3, 130.2, 129.4, 129.2, 129.2, 129.1, 127.8, 127.7, 126.4, 126.1, 125.9, 114.7, 114.5, 71.1, 70.9, 55.6, 48.3, 48.2, 47.6, 47.1, 46.0, 43.3, 21.6, 21.6, 21.0, 21.0. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{26}H_{29}N_2O_5S_2^+$:513,1513; Found: 513,1514.

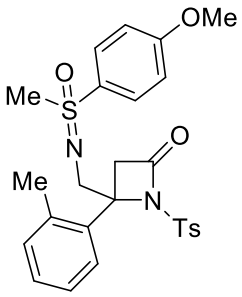
4-((((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)methyl)-4-(m-tolyl)-1-tosylazetidin-2-one (5cb)



Following General Procedure A, isolated colorless oil 148 mg (72%). dr = 1.40:1. (PE/EA=2:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.92 (d, *J* = 9.0 Hz, 2H), 7.79 (dd, *J* = 9.8, 8.3 Hz, 2H), 7.27 – 7.22 (m, 2H), 7.18 (d, *J* = 1.3 Hz, 1H), 7.14 – 7.07 (m, 2H), 7.03 (dd, *J* = 8.9, 2.1 Hz, 3H), 4.10 (d, *J* = 12.7 Hz, 0.48H), 3.88 (s, 1.51H), 3.86 (s, 1.50H), 3.84 – 3.76 (m, 1.51H), 3.76 – 3.61 (m, 1H), 3.06 (s, 1.55H), 3.04 (s, 1.42H), 2.97 (dd, *J* = 15.3, 13.8 Hz, 1H), 2.42 (s, 1.54H), 2.40 (s, 1.42H), 2.23 (s, 1.60H), 2.18 (s, 1.40H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 165.0, 164.9, 163.4, 163.3, 144.5, 144.4, 138.8, 138.7, 138.1, 138.1, 137.2 137.0, 131.5, 131.0, 130.4,

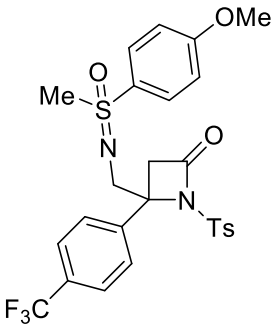
130.2, 129.4, 129.2, 128.9, 128.8, 128.4, 128.3, 127.7, 127.6, 126.9, 126.7, 123.2, 123.1, 114.7, 114.5, 71.0, 70.9, 55.6, 55.6, 48.5, 48.5, 47.5, 47.0, 46.0, 43.2, 21.6, 21.6, 21.3, 21.3. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{26}H_{29}N_2O_5S_2^+$:513.1513; Found: 513.1512.

4-((((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)methyl)-4-(o-tolyl)-1-tosylazetidin-2-one (5db)



Following General Procedure A, isolated colorless oil 84 mg (41%). dr = 1.50:1. (PE/EA=2:1, R_f = 0.4) **^{1}H NMR (400 MHz, CDCl$_3$)** δ 8.18 (d, *J* = 8.4 Hz, 1H), 8.15 (d, *J* = 8.4 Hz, 1H), 7.89 (d, *J* = 8.9 Hz, 1H), 7.85 (d, *J* = 8.9 Hz, 1H), 7.71 (dd, *J* = 7.3, 2.0 Hz, 1H), 7.40 – 7.36 (m, 1H), 7.34 (d, *J* = 8.2 Hz, 1H), 7.21 – 7.07 (m, 3H), 7.01 (dd, *J* = 8.9, 3.9 Hz, 1H), 4.12 – 3.78 (m, 4.58H), 3.72 (d, *J* = 13.9 Hz, 0.45H), 3.49 (dd, *J* = 45.0, 13.8 Hz, 1H), 3.09 – 2.79 (m, 4H), 2.45 (s, 1.80H), 2.42 (s, 1.20H), 2.15 (s, 1.17H), 2.13 (s, 1.80H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 165.3, 165.3, 163.3, 163.2, 144.6, 144.5, 138.0, 138.0, 137.1, 136.9, 133.6, 131.7, 131.6, 131.2, 130.7, 130.1, 129.4, 129.1, 128.4, 128.3, 128.1, 127.9, 127.5, 127.5, 125.9, 125.9, 114.7, 114.4, 76.7, 76.6, 76.5, 55.6, 46.6, 46.4, 46.4, 46.4, 45.6, 43.2, 21.6, 21.6, 20.4, 20.3. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{26}H_{29}N_2O_5S_2^+$:513.1513; Found: 513.1514.

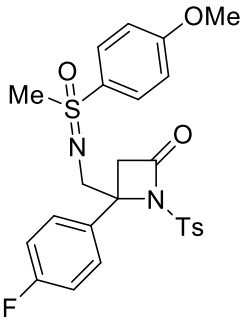
4-((((4-methoxyphenyl)(methyl)(oxo)- λ^6-sulfaneylidene)amino)methyl)-1-tosyl-4-(4-(trifluoromethyl)phenyl)azetidin-2-one (5eb)



Following General Procedure A, isolated colorless oil 84 mg (77%). dr = 1.30:1. (PE/EA=2:1, R_f = 0.6). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.99 – 7.72

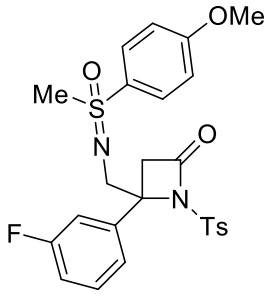
(m, 4H), 7.53 (s, 2H), 7.51 – 7.37 (m, 2H), 7.31 – 7.18 (m, 2H), 7.03 (dd, *J* = 8.8, 5.8 Hz, 2H), 3.98 (d, *J* = 12.8 Hz, 0.50H), 3.91 – 3.77 (m, 14.55H), 3.75 – 3.58 (m, 1H), 3.18 – 2.86 (m, 4H), 2.42 (s, 1.70H), 2.40 (s, 1.30H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 164.2, 164.2, 163.5, 163.4, 144.9, 144.8, 142.9, 142.8, 136.7, 136.5, 130.8, 130.4 (q, *J* = 29.4 Hz), 130.3 (q, *J* = 31.4 Hz), 130.2, 130.1, 129.6, 129.5, 129.3, 127.7, 127.6, 126.8, 126.6, 126.4, 125.4 (dd, *J* = 5.1, 3.3 Hz), 123.8 (q, *J* = 273.0 Hz), 123.7 (q, *J* = 273.2 Hz), 114.8, 114.6, 70.4, 70.1, 55.7, 48.7, 48.5, 47.6, 46.9, 45.8, 43.8, 21.6, 21.6. **^{19}F NMR (376 MHz, CDCl$_3$)** δ -62.7, -62.8. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{26}H_{25}F_3N_2O_5S_2Na^+$:589.1050; Found: 589.1050.

4-(4-fluorophenyl)-4-((((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)methyl)-1-tosylazetidin-2-one (5fb)



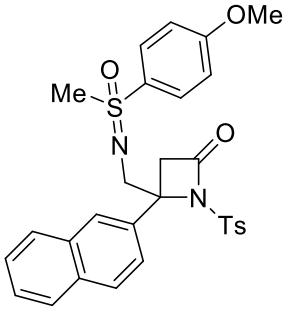
Following General Procedure A, isolated colorless oil 157 mg (76%). dr = 1.01:1. (PE/EA=2:1, R_f = 0.4). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.89 (dd, *J* = 12.9, 8.9 Hz, 2H), 7.81 (t, *J* = 8.4 Hz, 2H), 7.40 (dd, *J* = 8.9, 5.1 Hz, 1H), 7.33 – 7.21 (m, 3H), 7.05 (dd, *J* = 8.9, 5.5 Hz, 2H), 7.00 (t, *J* = 8.6 Hz, 1H), 6.94 (t, *J* = 8.6 Hz, 1H), 4.03 (d, *J* = 12.7 Hz, 0.51H), 3.91 (s, 1.50H), 3.90 (s, 1.50H), 3.87 – 3.76 (m, 1.49H), 3.74 – 3.58 (m, 1H), 3.11 – 2.80 (m, 4H), 2.45 (s, 1.50H), 2.43 (s, 1.50H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 164.6 (d, *J* = 8.6 Hz), 163.5 (d, *J* = 7.9 Hz), 163.4 (d, *J* = 9.1 Hz), 161.1 (d, *J* = 7.6 Hz), 144.7, 144.6, 136.9, 136.7, 131.0, 130.8, 130.2, 130.2, 129.6, 129.5, 129.3, 128.2 (d, *J* = 8.2 Hz), 128.0 (d, *J* = 8.2 Hz), 127.7, 127.6, 126.4, 125.4, 115.5, 115.4, 115.2, 115.2, 114.8, 114.6, 70.4, 70.2, 55.6, 55.6, 48.5, 48.4, 47.7, 47.1, 45.9, 43.6, 21.6, 21.6. ^{19}F NMR (**376 MHz, CDCl$_3$**) δ -113.6, -113.7. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{25}FN_2O_5S_2Na^+$:539.1082; Found: 539.1081.

4-(3-fluorophenyl)-4-((((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)methyl)-1-tosylazetidin-2-one (5gb)



Following General Procedure A, isolated colorless oil 118 mg (57%). dr = 1.00:1. (PE/EA=2:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.88 (dd, *J* = 10.3, 8.9 Hz, 2H), 7.82 (dd, *J* = 11.4, 8.4 Hz, 2H), 7.34 – 7.22 (m, 3H), 7.22 – 7.15 (m, 1H), 7.10 – 7.06 (m, 1H), 7.03 (dd, *J* = 8.9, 4.2 Hz, 2H), 7.00 – 6.93 (m, 1H), 4.01 (d, *J* = 12.8 Hz, 0.50H), 3.88 (s, 1.46H), 3.87 (s, 1.57H), 3.86 – 3.74 (m, 1.55H), 3.74 – 3.58 (m, 1H), 3.10 – 2.83 (m, 4H), 2.42 (s, 1.50H), 2.40 (s, 1.49H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.4 (d, *J* = 9.1 Hz), 163.8 (d, *J* = 4.3 Hz), 163.4 (d, *J* = 8.8 Hz), 161.4 (d, *J* = 4.2 Hz), 144.8, 144.7, 136.8, 136.6, 131.0, 130.8, 130.2, 130.1, 130.0 (d, *J* = 3.6 Hz), 129.6, 129.5, 129.4, 129.3, 128.2 (d, *J* = 8.8 Hz), 127.7, 127.6, 126.3, 121.9 (d, *J* = 2.9 Hz), 121.7 (d, *J* = 2.9 Hz), 115.2 (d, *J* = 9.6 Hz), 115.0 (d, *J* = 9.6 Hz), 114.7, 114.6, 113.7 (d, *J* = 23.1 Hz), 113.5 (d, *J* = 23.2 Hz), 70.5 (d, *J* = 2.1 Hz), 70.3 (d, *J* = 2.1 Hz), 55.6, 55.6, 48.5, 48.4, 47.5, 46.9, 45.8, 43.5, 21.6, 21.6. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -112.0, -112.0. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{25}H_{26}FN_2O_5S_2^+$:517.1262; Found: 517.1263.

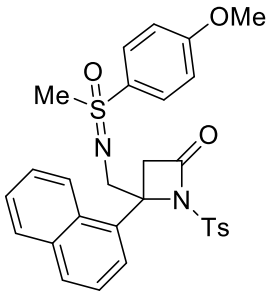
4-((((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)methyl)-4-(naphthalen-2-yl)-1-tosylazetidin-2-one (5hb)



Following General Procedure A, isolated colorless oil 177 mg (81%). dr = 1.19:1. (PE/EA=2:1, R_f = 0.3).**^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.94 (dd, *J* = 8.9, 6.6 Hz, 2H), 7.85 – 7.72 (m, 3H), 7.75 – 7.60 (m, 3H), 7.52 – 7.48 (m, 1H), 7.48 – 7.44 (m, 1H), 7.36 (ddd, *J* = 40.5, 8.6, 2.0 Hz, 1H), 7.17 (t, *J* = 8.2 Hz, 2H), 7.04 (dd, *J* = 8.9, 6.7 Hz, 2H), 4.20 (d, *J* = 12.7 Hz, 0.45H), 4.02 – 3.86 (m, 4.56H), 3.86 – 3.77

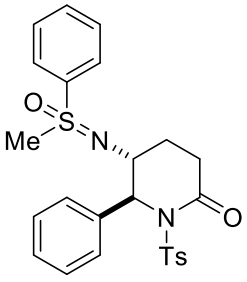
(m, 1H), 3.31 – 2.92 (m, 4H), 2.39 (s, 1.63H), 2.37 (s, 1.38H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.9, 164.8, 163.4, 163.4, 144.6, 144.5, 137.1, 136.9, 136.0, 136.0, 132.9, 132.9, 132.8, 132.8, 131.0, 130.3, 129.4, 129.3, 128.4, 128.3, 128.3, 128.2, 127.7, 127.6, 127.5, 127.4 126.6, 126.5, 126.5, 126.4, 125.7, 125.5, 123.7, 123.5, 114.8, 114.6, 70.9, 70.9, 55.7, 55.6, 48.6, 48.6, 47.6, 46.9, 46.1, 43.4, 21.6. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{29}H_{29}N_2O_5S_2^+$:549.1513; Found: 549.1512.

4-((((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)methyl)-4-(naphthalen-1-yl)-1-tosylazetidin-2-one (5ib)



Following General Procedure A, isolated colorless solid 110 mg (50%). (PE/EA=2:1, R_f = 0.4) **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.21 (d, *J* = 8.4 Hz, 2H), 7.92 (dd, *J* = 8.1, 3.4 Hz, 2H), 7.89 – 7.83 (m, 1H), 7.80 (d, *J* = 8.2 Hz, 1H), 7.52 – 7.36 (m, 5H), 7.39 – 7.33 (m, 1H), 7.04 (d, *J* = 8.9 Hz, 2H), 4.20 (dd, *J* = 14.5, 10.3 Hz, 2H), 3.91 (d, *J* = 12.6 Hz, 4H), 3.12 (d, *J* = 14.9 Hz, 1H), 3.00 (s, 3H), 2.47 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 165.4, 163.3, 144.7, 136.8, 135.5, 134.1, 131.2, 130.1, 129.4, 129.1, 129.1, 128.5, 126.1, 125.7, 125.5, 125.1, 123.8, 114.5, 76.6, 55.7, 47.2, 47.1, 43.2, 21.7. **HRMS (IT-TOF)**: $[M+H]^+$ Calcd for $C_{29}H_{29}N_2O_5S_2^+$:549.1513; Found: 549.1514.

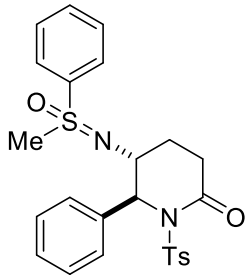
(5R,6S)-5-((methyl(oxo)(phenyl)-λ^6-sulfaneylidene)amino)-6-phenyl-1-tosylpiperidin-2-one (7-1)



Following General Procedure A, isolated colorless oil 37 mg (19%). (PE/EA=1:1, R_f = 0.5). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.00 (d, *J* = 7.0 Hz, 2H), 7.79 (d, *J* = 8.1 Hz, 2H), 7.68 (dd, *J* = 12.8, 7.2 Hz, 3H), 7.25 – 7.21 (m, 3H), 7.16 (d,

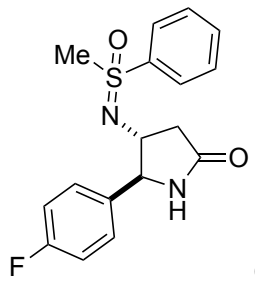
J = 8.1 Hz, 2H), 6.98 – 6.87 (m, 2H), 5.64 – 5.21 (m, 1H), 3.54 (d, *J* = 3.3 Hz, 1H), 3.13 (s, 3H), 2.97 (ddd, *J* = 18.8, 11.2, 8.0 Hz, 1H), 2.54 – 2.23 (m, 5H), 1.73 (dt, *J* = 11.2, 4.0 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 171.0, 144.2, 139.6, 139.4, 136.5, 133.3, 129.7, 129.2, 128.7, 128.6, 128.5, 127.6, 126.3, 67.9, 54.2, 45.6, 29.4, 23.9, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{26}N_2O_4S_2Na^+$:505.1227; Found: 505.1227.

***trans*-5-((methyl(oxo)(phenyl)-λ^6-sulfaneylidene)amino)-6-phenyl-1-tosylpiperidin-2-one (7-2)**



Isolated colorless oil 33 mg (17%). (PE/EA=1:1, R_f = 0.4). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.99 (d, *J* = 8.1 Hz, 2H), 7.96 – 7.85 (m, 2H), 7.68 – 7.60 (m, 1H), 7.57 (t, *J* = 7.5 Hz, 2H), 7.32 – 7.24 (m, 4H), 7.21 (t, *J* = 9.1 Hz, 3H), 5.75 (t, *J* = 2.1 Hz, 1H), 3.57 (d, *J* = 3.2 Hz, 1H), 3.03 (s, 3H), 2.81 (ddd, *J* = 19.0, 11.4, 8.0 Hz, 1H), 2.51 – 2.35 (m, 5H), 1.35 (ddd, *J* = 11.9, 7.5, 3.6 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 170.8, 144.2, 140.3, 140.1, 136.6, 133.2, 129.6, 128.7, 128.6, 128.2, 127.5, 126.1, 69.3, 54.2, 45.5, 29.2, 22.7, 21.6. **HRMS (IT-TOF)**: $[M+Na]^+$ Calcd for $C_{25}H_{26}N_2O_4S_2Na^+$:505.1227; Found: 505.1228.

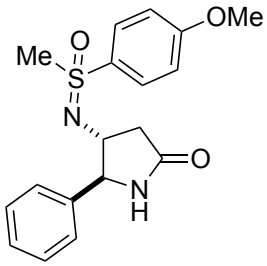
(4R,5S)-5-(4-fluorophenyl)-4-((methyl(oxo)(phenyl)-λ^6-sulfaneylidene)amino)pyrrolidin-2-one (8a)



General procedure B: Under argon atmosphere, to a solution of lactams **3** (0.1 mmol) in dry THF (1 mL) at 0 °C was added a solution of SmI_2 (0.1 M in THF, 2 mL, 0.2 mmol). The reaction mixture was stirred at 0 °C for 6 h. Then the reaction mixture was quenched with saturated sodium thiosulfate (2 mL), extracted with ethyl acetate (3 ×10 mL), the organic layer was dried over $MgSO_4$, filtered and

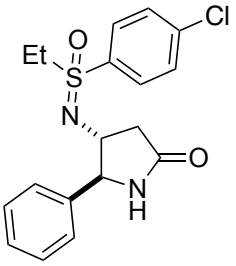
evaporated to afford a crude product. Then the crude product was concentrated in vacuo and purified by column chromatography to afford the desired product as colorless oil 28 mg (85 %). (DCM/Acetone=1:3, R_f = 0.5). **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.42 – 7.22 (m, 7H), 6.87 (dd, *J* = 12.5, 4.9 Hz, 2H), 5.73 (s, 1H), 4.51 (d, *J* = 7.2 Hz, 1H), 3.42 (q, *J* = 8.1 Hz, 1H), 3.04 (s, 3H), 2.74 – 2.50 (m, 2H). **^{13}C NMR (126 MHz, $CDCl_3$)** δ 175.6, 165.3 (d, *J* = 255.6 Hz), 140.0, 131.3(d, *J* = 10.1 Hz), 128.8, 128.4, 126.9, 116.4, 116.3, 66.4, 60.8, 45.4, 41.1. **^{19}F NMR (471 MHz, $CDCl_3$)** δ -105.0. **HRMS (Quadrupole-Orbitrap):** $[M+H]^+$ Calcd for $C_{17}H_{18}FN_2O_2S^+$: 333.1073; Found: 333.1057.

(4R,5S)-4-(((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenylpyrrolidin-2-one (8b)



Following General Procedure B, Isolated colorless oil 32 mg (92%) (DCM/Acetone=1:3, R_f = 0.3) **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.35 (dd, *J* = 5.1, 2.2 Hz, 3H), 7.29 – 7.26 (m, 2H), 7.26 – 7.20 (m, 2H), 6.66 (d, *J* = 8.9 Hz, 2H), 5.72 (s, 1H), 4.52 (d, *J* = 7.1 Hz, 1H), 3.81 (s, 3H), 3.45 (dt, *J* = 9.0, 7.4 Hz, 1H), 3.02 (s, 3H), 2.70 – 2.49 (m, 2H). **^{13}C NMR (126 MHz, $CDCl_3$)** δ 175.9, 163.1, 140.2, 130.7, 128.7, 128.2, 126.9, 114.4, 66.5, 60.7, 55.6, 45.6, 41.2, 29.3. **HRMS (Quadrupole-Orbitrap)**: $[M+H]^+$ Calcd for $C_{18}H_{21}N_2O_3S^+$: 345.1273; Found: 345.1254.

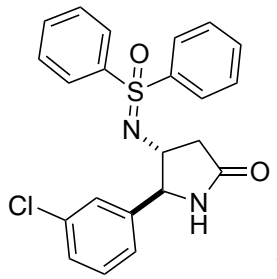
(4R,5S)-4-(((4-chlorophenyl)(ethyl)(oxo)-λ^6-sulfaneylidene)amino)-5-phenylpyrrolidi-2-one(8c)



Following General Procedure B, Isolated colorless oil 30 mg (82%) (DCM/Acetone=1:3, R_f = 0.3) **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.42 – 7.33 (m, 3H), 7.28 (dd, *J* = 6.7, 4.9 Hz, 2H), 7.15 (s, 4H), 5.84 (s, 1H), 4.51 (d, *J* = 7.3 Hz, 1H),

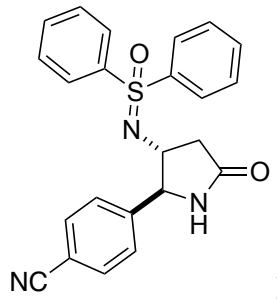
3.45 (dt, *J* = 9.6, 7.5 Hz, 1H), 3.22 – 3.03 (m, 2H), 2.59 (ddd, *J* = 26.1, 16.7, 8.5 Hz, 2H), 1.17 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR (126 MHz, $CDCl_3$)** δ 175.8, 140.0, 139.6, 130.7, 129.3, 128.8, 128.3, 126.9, 60.7, 50.1, 41.3, 7.4. **HRMS (Quadrupole-Orbitrap)**: $[M+H]^+$ Calcd for $C_{18}H_{20}ClN_2O_2S^+$: 363.0934; Found: 363.0919.

(4R,5S)-5-(3-chlorophenyl)-4-((oxodiphenyl-λ^6-sulfaneylidene)amino)pyrrolidin-2-one(8d)



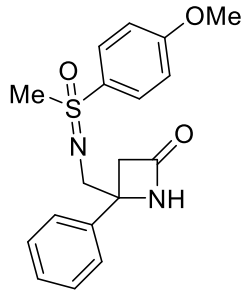
Following General Procedure B, Isolated colorless oil 37 mg (89%) (PE/EA=1:3, R_f= 0.3) **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.89 (d, *J* = 7.7 Hz, 2H), 7.58 – 7.42 (m, 6H), 7.34 – 7.21 (m, 6H), 6.10 (s, 1H), 4.69 (d, *J* = 6.3 Hz, 1H), 3.59 (q, *J* = 7.5 Hz, 1H), 2.71 – 2.53 (m, 2H). **^{13}C NMR (126 MHz, $CDCl_3$)** δ 176.0, 142.4, 140.2, 139.4, 134.7, 132.8, 132.6, 130.0, 129.3, 129.1, 128.5, 128.3, 128.2, 126.8, 124.9, 66.5, 60.3, 40.6, 29.3. **HRMS (Quadrupole-Orbitrap)**: $[M+H]^+$ Calcd for $C_{22}H_{19}ClN_2O_2S^+$: 411.0934; Found: 411.0919.

4-((2S,3R)-5-oxo-3-((oxodiphenyl-λ^6-sulfaneylidene)amino)pyrrolidin-2-yl)benzonitrile(8e)



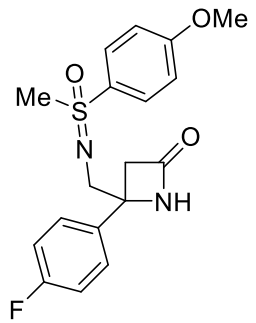
Following General Procedure B, Isolated colorless oil 36 mg (89%) (PE/EA=1:3, R_f = 0.3) **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.83 (d, *J* = 7.9 Hz, 2H), 7.64 (d, *J* = 8.0 Hz, 4H), 7.54 – 7.50 (m, 1H), 7.47 (dd, *J* = 8.2, 1.6 Hz, 5H), 7.33 (t, *J* = 7.3 Hz, 2H), 6.25 (s, 1H), 4.77 (d, *J* = 5.9 Hz, 1H), 3.58 (q, *J* = 6.8 Hz, 1H), 2.74 – 2.44 (m, 2H). **^{13}C NMR (126 MHz, $CDCl_3$)** δ 176.1, 145.7, 140.1, 132.9, 132.8, 132.5, 129.3, 129.2, 128.3, 128.2, 127.3, 118.5, 112.1, 66.7, 60.1, 40.4. **HRMS (Quadrupole-Orbitrap)**: $[M+H]^+$ Calcd for $C_{23}H_{20}N_3O_2S^+$: 402.1276; Found: 402.1258.

4-((((4-methoxyphenyl)(methyl)(oxo)- λ⁶-sulfaneylidene)amino)methyl)-4-phenylazetidin-2-one(9a)



General procedure C: Under argon atmosphere, to a solution of **5** (0.1 mmol) in dry THF (2 mL) at 0 °C was added a solution of SmI2 (0.1 M in THF, 4 mL, 0.4 mmol). After 5 minutes, the reaction mixture was warm to room temperature and stirred for 6 h. Then the reaction mixture was quenched with saturated sodium thiosulfate (2 mL), extracted with ethyl acetate (3 ×10 mL), the organic layer was dried over $MgSO_4$, filtered and evaporated to afford a crude product. Then the crude product was concentrated in vacuo and purified by column chromatography to afford the desired product as colorless oil 28 mg (80%). dr = 1.26:1 (PE/EA=1:3, R_f = 0.3). **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.71 (d, *J* = 8.8 Hz，0.83H), 7.60 (m，1.16H), 7.41 – 7.32 (m, 2H), 7.31 – 7.26 (m, 3H), 7.14 (s, 0.58H), 6.99-6.95 (m, 2H), 6.86 (s, 0.46H)， 3.86 (m, 3H), 3.41-3.15(m, 3H), 3.02 (s, 3H), 2.98-2.91 (m, 1H). **^{13}C NMR (126 MHz, $CDCl_3$)** δ 168.0, 167.4, 163.4, 163.4, 142.4, 130.8, 130.7, 130.5, 130.4, 128.2, 128.2, 127.1, 127.0, 126.0, 125.8, 114.8, 114.7, 59.7, 59.6, 55.6, 53.5, 53.5, 51.8, 48.1, 48.0, 45.6, 45.1, 29.3. **HRMS (Quadrupole-Orbitrap)**: $[M+H]^+$ Calcd for $C_{18}H_{21}N_2O_3S^+$: 345.1273; Found: 345.1256.

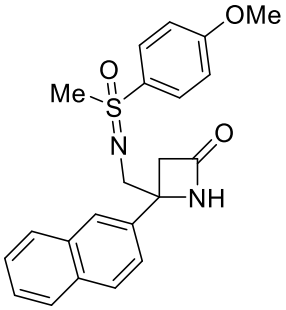
4-(4-fluorophenyl)-4-((((4-methoxyphenyl)(methyl)(oxo)-λ⁶-sulfaneylidene)amino)methyl)azetidin-2-one(9b)



Following General Procedure C, Isolated colorless oil 30 mg (82%) dr = 1.17:1 (PE/EA=1:3, R_f = 0.3) **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.71 (d, *J* =

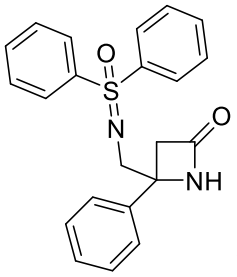
9.2 Hz, 0.87H), 7.61 (d, *J* = 9.2 Hz, 1.02H), 7.27-7.25 (m, 2H), 7.13 (s, 0.54H), 7.05-6.96 (m, 4H), 6.88 (s, 0.46H), 3.85 (m, 3H), 3.41-3.29 (m, 1.44H), 3.25-3.19 (m, 0.87H), 3.11-3.08 (m, 0.68H), 3.01 (s, 3H), 2.93 -2.87 (m, 1H). **^{13}C NMR (126 MHz, $CDCl_3$)** δ 167.9, 167.2, 163.5, 163.4, 162.0 (d, *J* = 243.8 Hz), 162.0 (d, *J* = 243.8 Hz), 138.2, 130.7, 130.4, 127.7 (d, *J* = 8.0 Hz), 127.6 (d, *J* = 8.0 Hz), 115.1, 115.1, 115.0, 114.9, 114.8,114.8, 59.3, 59.1, 55.7, 53.7, 51.8, 48.3, 48.3, 45.7, 45.1, 29.3. **^{19}F NMR (471 MHz, $CDCl_3$)** δ -115.4, -115.7. **HRMS (Quadrupole-Orbitrap)**: $[M+H]^+$ Calcd for $C_{18}H_{20}FN_2O_3S^+$: 363.1179; Found: 363.1164.

4-((((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)methyl)-4-(naphthalen-2-yl)azetidin-2-one(9c)



Following General Procedure C, Isolated colorless oil 31 mg (78%). dr = 1.17:1 (PE/EA=1:3, R_f = 0.3) **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.83-7.69 (m, 5.19H), 7.54-7.39 (m, 4.21H), 7.18(s, 0.46H), 6.93 (d, *J* = 8.6 Hz, 0.98H), 6.85-6.82 (m, 1.21H), 3.83 (m, 3H), 3.56-3.17(m, 3.22H), 3.06-2.98 (m, 0.47H), 3.02 (m, 3H). **^{13}C NMR (126 MHz, $CDCl_3$)** δ 168.0, 167.2, 163.4, 139.7, 133.1, 133.0, 132.4, 130.8, 130.7, 130.5, 128.1, 128.0, 127.9, 127.6, 126.4, 126.3, 126.1, 126.0, 124.8, 124.6,124.0, 123.9, 114.7, 59.9, 59.7, 55.6, 53.6, 51.7, 48.3, 48.2, 45.6, 45.1, 29.7. **HRMS (Quadrupole-Orbitrap)**: $[M+H]^+$ Calcd for $C_{22}H_{23}N_2O_3S^+$: 395.1429; Found: 395.1412.

4-(((oxodiphenyl-λ^6-sulfaneylidene)amino)methyl)-4-phenylazetid in-2-one(9d)



Following General Procedure C, Isolated colorless oil 29 mg (76%) (PE/EA=1:2, R_f = 0.4) **^{1}H NMR (500 MHz, $CDCl_3$)** δ 7.94 (d, *J* = 7.8 Hz, 2H), 7.48 (ddd, *J* = 32.8, 20.1, 7.7 Hz, 6H), 7.34 – 7.23 (m, 7H), 5.97 (s, 1H), 4.81 (d, *J* = 5.6 Hz, 1H), 3.65 (dd, *J* = 15.4, 8.2 Hz, 1H), 2.89 (dd, *J* = 17.0, 9.0 Hz, 1H), 2.50 (dd, *J* = 17.0, 8.9 Hz, 1H). **^{13}C NMR (126 MHz, $CDCl_3$)** δ 175.3, 140.8, 140.3, 132.9, 132.7, 129.3, 129.2, 128.7, 128.6, 127.9, 127.6, 127.1, 72.9, 51.6, 37.4, 29.3. **HRMS (Quadrupole-Orbitrap)**: $[M+Na]^+$ Calcd for $C_{22}H_{20}N_2O_2SNa^+$: 399.1143; Found: 399.1124.

4 Mechanistic investigations

4.1 Cyclic voltammograms of thiophene sulfoxide imine

Cyclic voltammograms were recorded using an CS150H potentiostat and a Pt working electrode, a silver wire reference electrode and a Pt sheet auxiliary electrode, referenced to $Fc^{0/+}$couple. The voltammograms were recorded at room temperature in 0.1 M tetrabutylammonium hexafluorophosphate in DCM (5 mL) containing sulfoximidoyl thianthrenium tetrafluoroborate salts **2a** (0.01 mmol) or 2,4,6 - Trimethylpyridine (0.02 mmol). The scan rate was 100 mV s^{-1}.

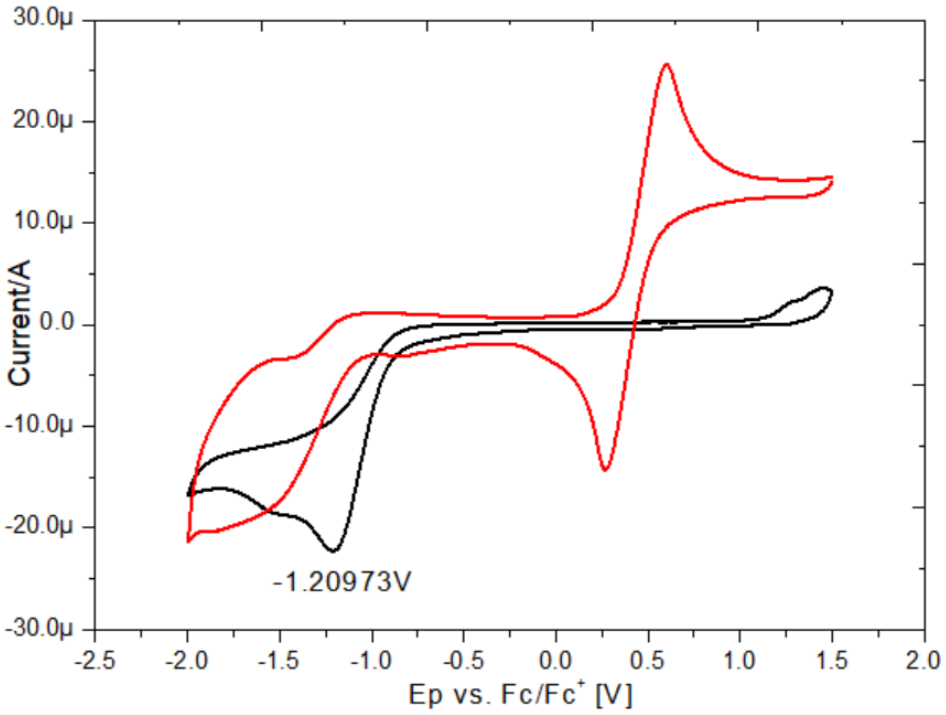


Figure S2. Cyclic voltammetry studies with **2a** (black) referenced to $Fc^{0/+}$couple (red)

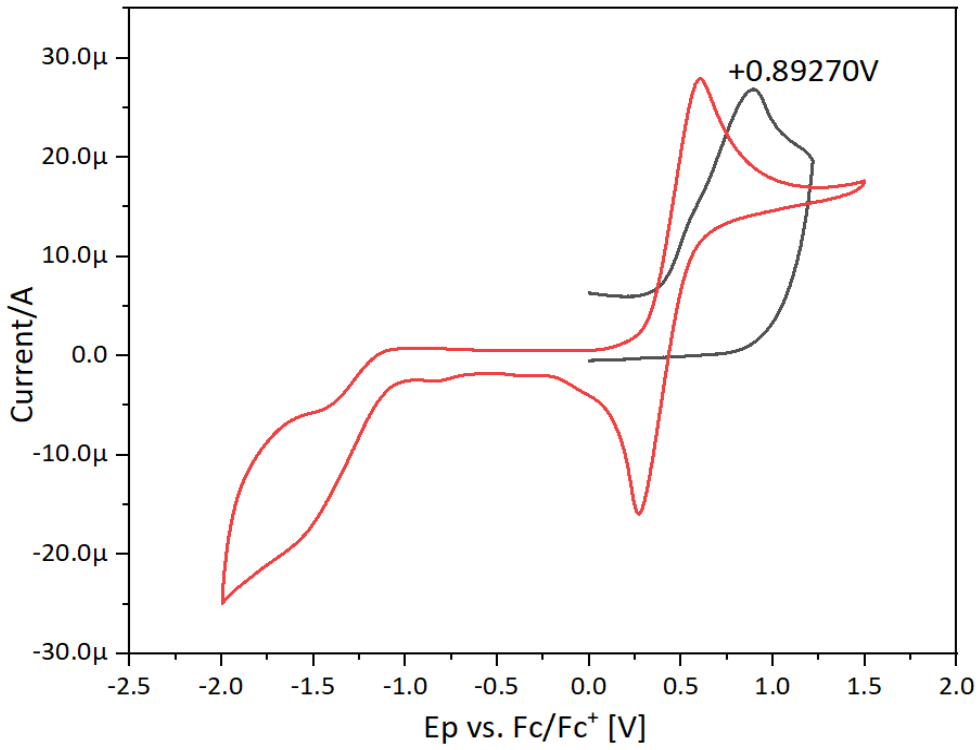


Figure S3. Cyclic voltammetry studies with 2,4,6-Trimethylpyridine (black) referenced to $Fc^{0/+}$couple (red)

4.2 Stern-Volmer Luminescence Quenching Studies

Visible light luminescence intensities were recorded using a PerkinElmer LS 55 spectrofluorometer. All luminescence measurements were recorded using a quartz cuvette (Shufu fluorescence quartz cuvette, 12.5 x 12.5 x 4.5 mm, 3.5 mL). All solutions of Ir(dF-mppy)$_2$(dtbbpy)[PF$_6$] (10 mM), reagents sulfoximidoyl thianthrenium tetrafluoroborate salts **2a** (45.7 mg, 0.1 mmol), 2,4,6-Trimethylpyridine (24.2 mg, 0.200 mmol) were prepared in DCM（mL）. In a typical procedure, Ir(dF-mppy)$_2$(dtbbpy)[PF$_6$] (50 uL, 10 mM) and Quencher (**2a**, 2,4,6-Trimethylpyridine) were added fluorescence quartz cuvette and diluted to a final volume of 3.5 mL. All solutions were excited at 400 nm and the emission was measured from 450 to 700 nm. Quenching was analyzed by plotting I_0/I according to the Stern-Volmer relationship:

$$I_0/I = kq\tau_0[Q]+1$$

where I_0 represents the integral of the luminescence over the range of 450 to 700 nm in the absence of a quencher, I is the integral of luminescence over the range of 450 to 700 nm in the presence of a quencher, kq represents the quenching rate constant, [Q] is the concentration of a given quencher, and τ_0 is the excited state lifetime of the emissive photocatalyst in the absence of quencher.

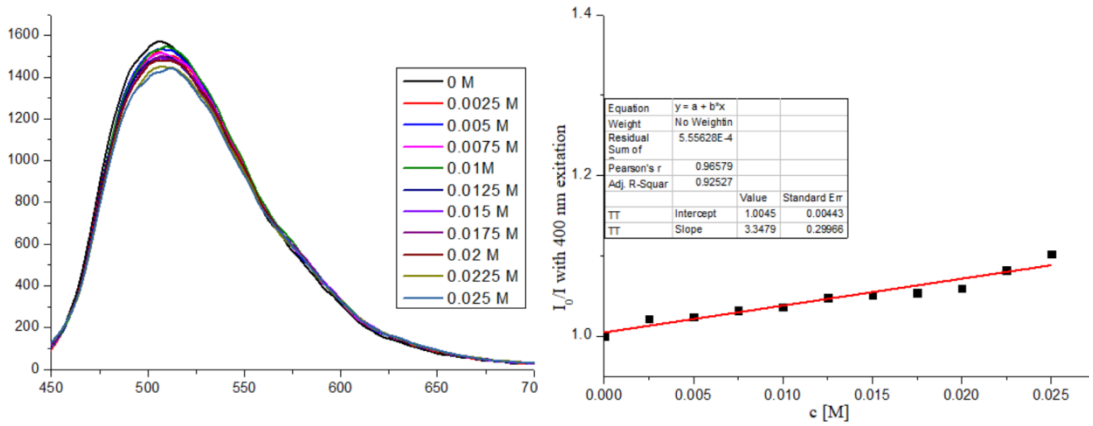


Figure S4. Emission spectra for Ir(dF-mppy)$_2$(dtbbpy)[PF$_6$] luminescence quenching by **2a** as additive (left) and Stern-Volmer plot (right)

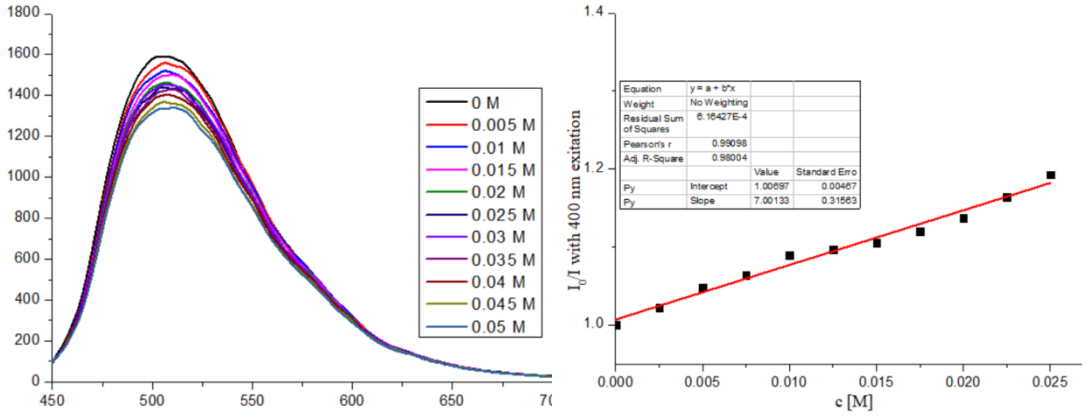


Figure S5. Emission spectra for Ir(dF-mppy)$_2$(dtbbpy)[PF$_6$] luminescence quenching by 2,4,6-Trimethylpyridine (left) and Stern-Volmer plot (right).

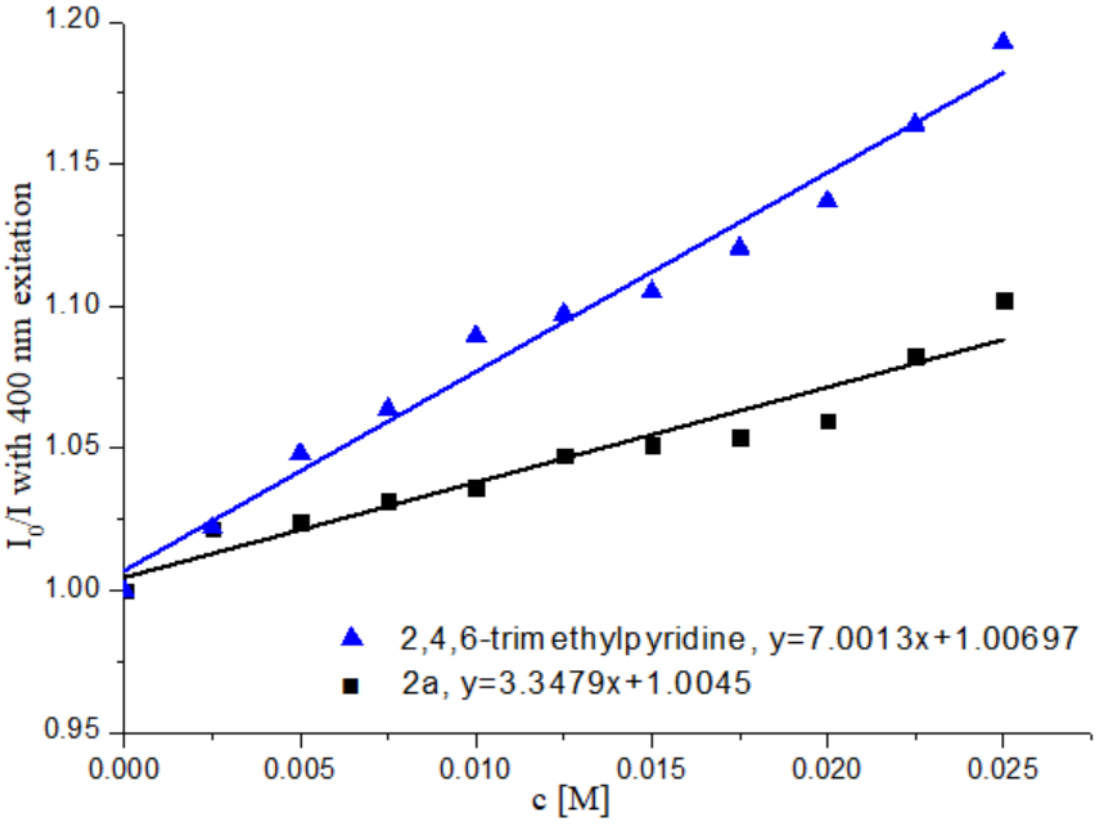
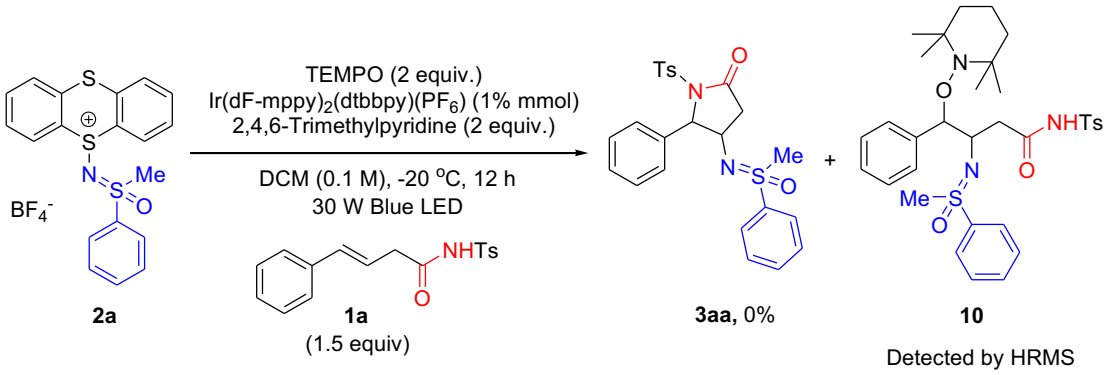


Figure S6. Stern-Volmer quenching experiments.

4.3 TEMPO trap

Reagent **1a** (0.1 mmol), **2a** (0.15 mmol), Ir(dF-mppy)$_2$(dtbbpy)[PF$_6$] (1% mmol), TEMPO (0.2 mmol) in a Penicillin vial was evacuated and backfilled with argon via

Schlenk line three times. Subsequently, DCM (anhydrous, 1.0 mL) and 2,4,6-Trimethylpyridine (0.2 mmol) were added, cooled to -20 ºC and irradiated by 30 W blue LED strip light for 12 hours. After the reaction is complete, dichloromethane is removed, and acetonitrile as solvent were added to detect TEMPO capture products **10** by mass spectrometry.



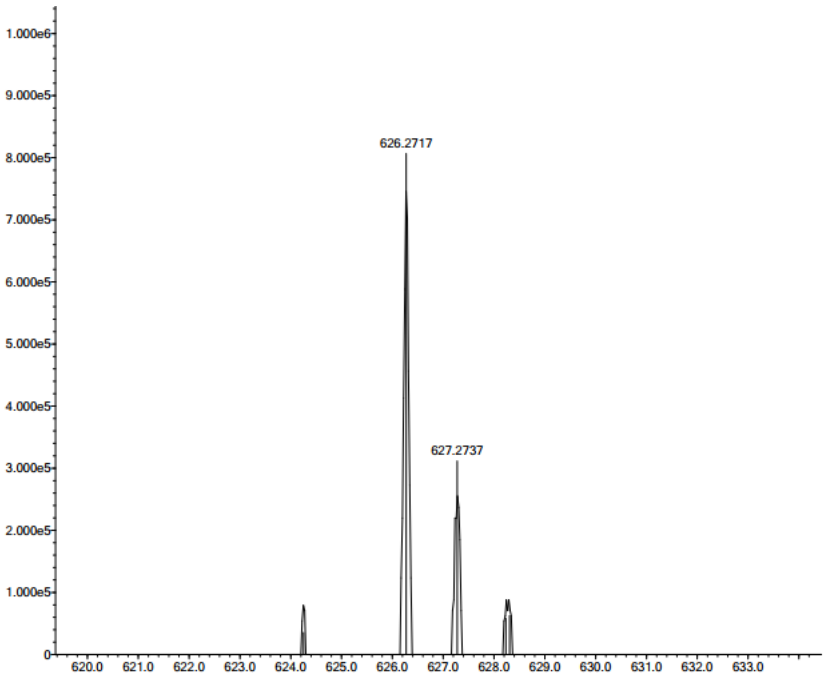


Figure S7. HRMS analysis of TEMPO trap reaction.

5. X-Ray crystallographic analysis

X-Ray Chrystallographic Data **3bo**, **5ib**

Experimental 1

4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-5-(p-tolyl)-1-tosylpyrrolidin-2-one (3bo)[7] was crystallized from a dichloromethane/petroleum ether mixture (1/1, v/v). The crystallographic data are summarized in the following table.

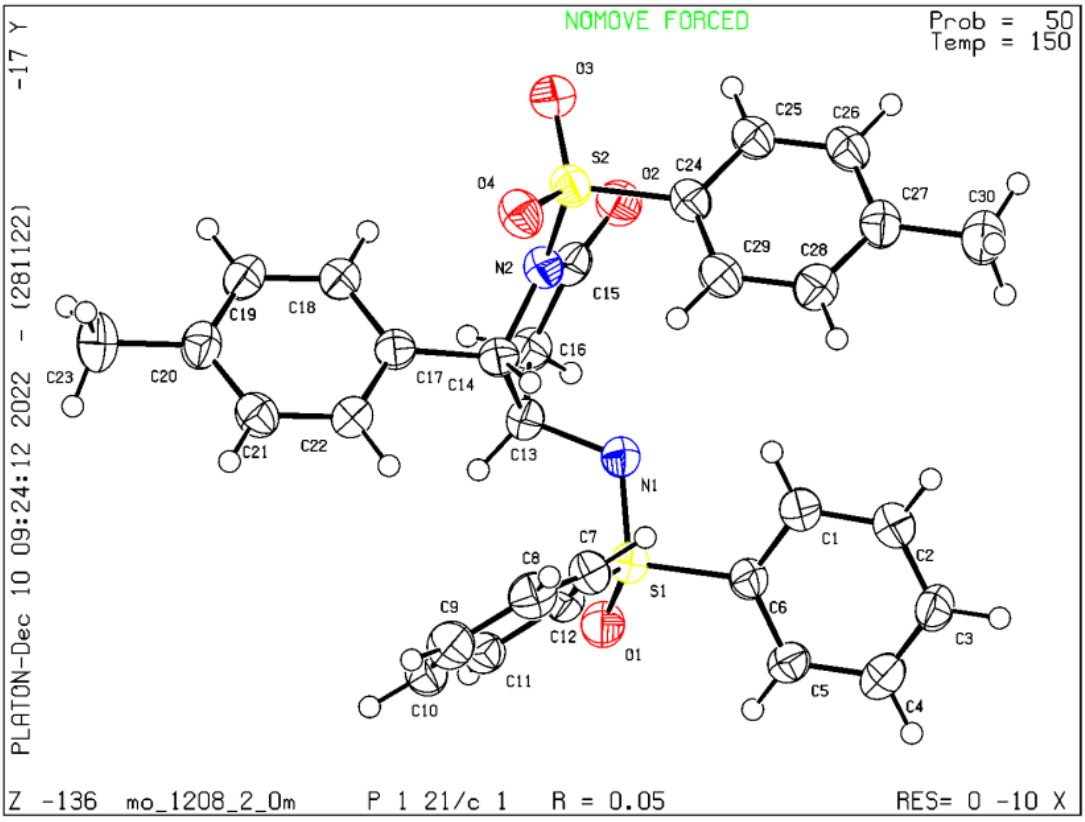


Figure S8. X-ray structure of 4-((oxodiphenyl-λ^6-sulfaneylidene)amino)-5-(p-tolyl)-1-tosylpyrrolidin-2-one (**3bo**).

.

Experimental 2

3-((((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)methyl)-4-(naphthalen-1-yl)-1-tosylazetidin-2-one (5ib)[8] was crystallized from a dichloromethane/petroleum ether mixture (1/1, v/v). The crystallographic data are summarized in the following table.

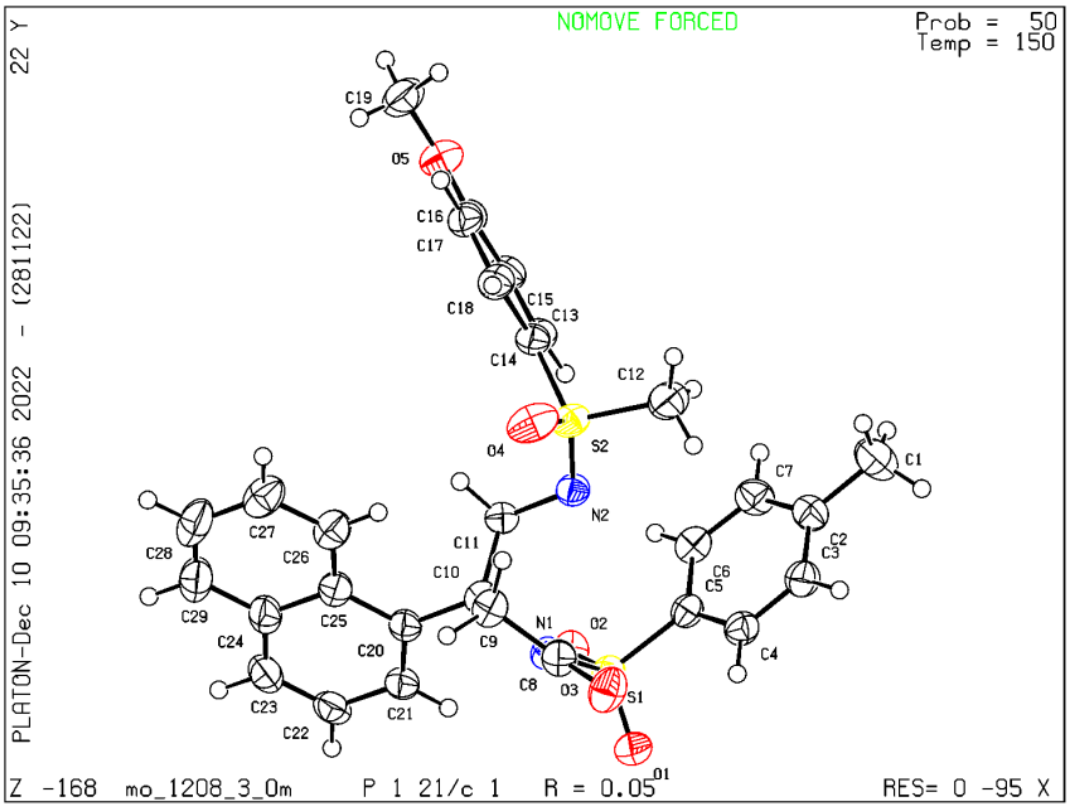


Figure S9. X-ray structure of 3-((((4-methoxyphenyl)(methyl)(oxo)-λ^6-sulfaneylidene)amino)methyl)-4-(naphthalen-1-yl)-1-tosylazetidin-2-one (**5ib**).

6. Reference

[1] J. M. Miao, N. Richards, H.-B. Ge. *Chem. Commun*. **2014**, *50*, 9687.

[2] K. Kikuchi, N. Furukawa. *Phosphorur and Sulfur,* **1985**, *24*, 291.

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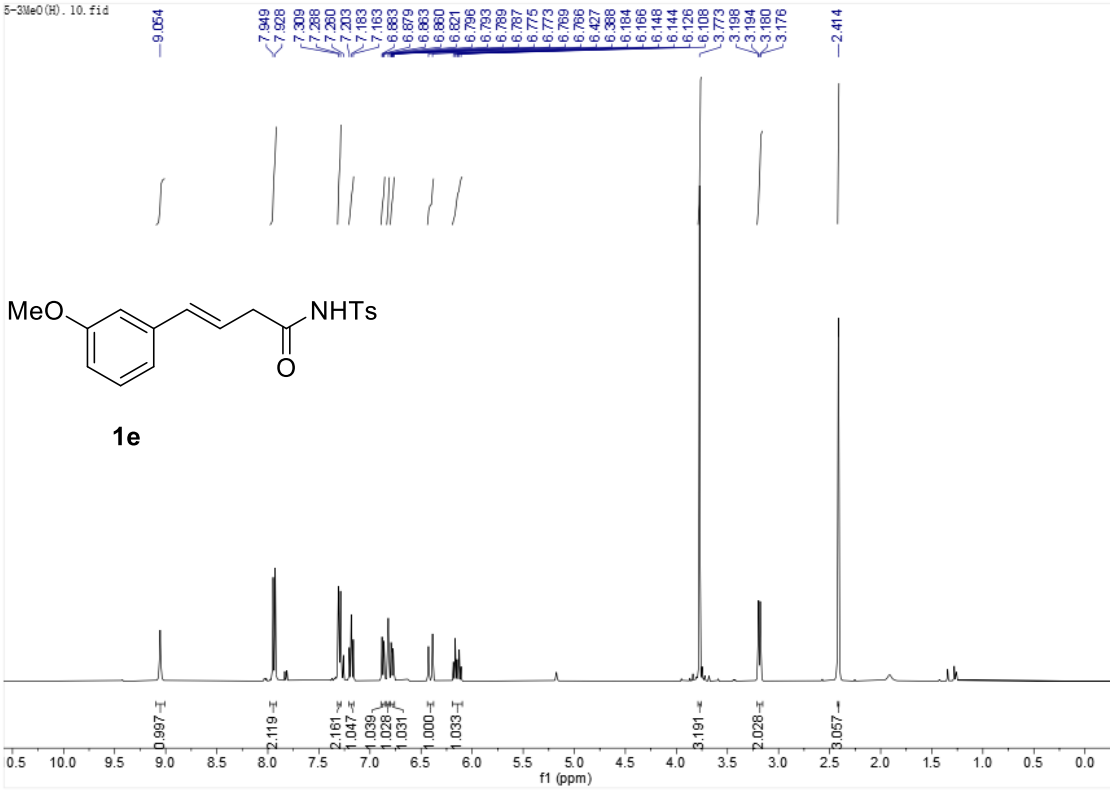
[7] Crystal data for **3bo** : $C_{30}H_{28}N_2O_4S_2$, MW = 544.66, monoclinic, space group P21/c, final R indices [I > 2σ(I)]: R1 = 0.0487, wR2 = 0.1266; R indices (all data): R1 = 0.0954, wR2 = 0.1549; a = 10.8535(5), b = 19.1389(10), c = 13.1871(8) Å, α = 90.00, β = 102.0857(17), γ = 90, *V*= 2678.6(2) Å^3, T= 150 K, Z=4, reflections collected/unique : 52763 / 5499 [R(int) = 0.1058] number of observations [> 2s(I)]: 5499, parameters : 345. CCDC 2261877 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www. ccdc.cam.ac.uk/data_request/cif.

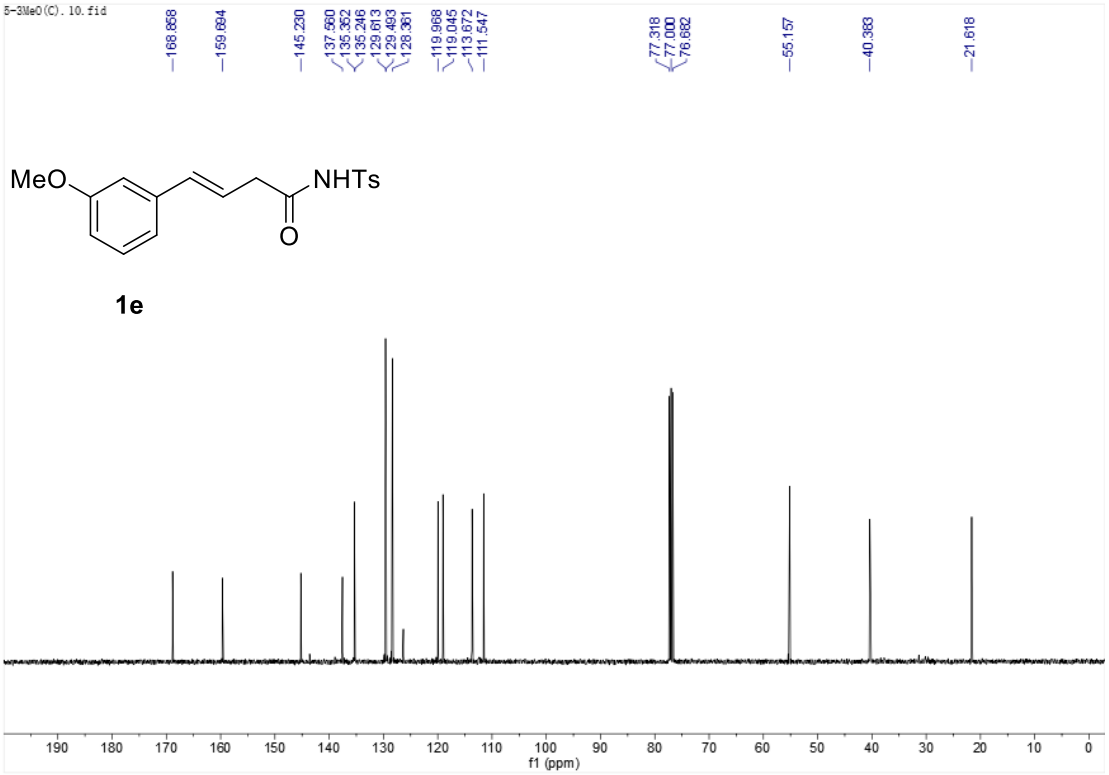
[8] Crystal data for **5ib**: $C_{29}H_{28}N_2O_5S_2$, MW = 548.65, monoclinic, space group P21/c, final R indices [I > 2σ(I)]: R1 = 0.0491, wR2 = 0.1251; R indices (all data): R1 = 0.0608, wR2 = 0.1352; a = 12.4216(3), b = 12.3863(3), c = 18.4643(6) Å, α = 90.00, β = 103.3797(10), γ = 90, *V*= 2763.77(13) Å^3, T= 150 K, Z=4, reflections collected/unique : 62147 / 5643 [R(int) = 0.0628]; number of observations [> 2s(I)]: 5643, parameters : 346. CCDC 2261890 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www. ccdc.cam.ac.uk/data_request/cif.

7. NMR Spectroscopes of New Compounds

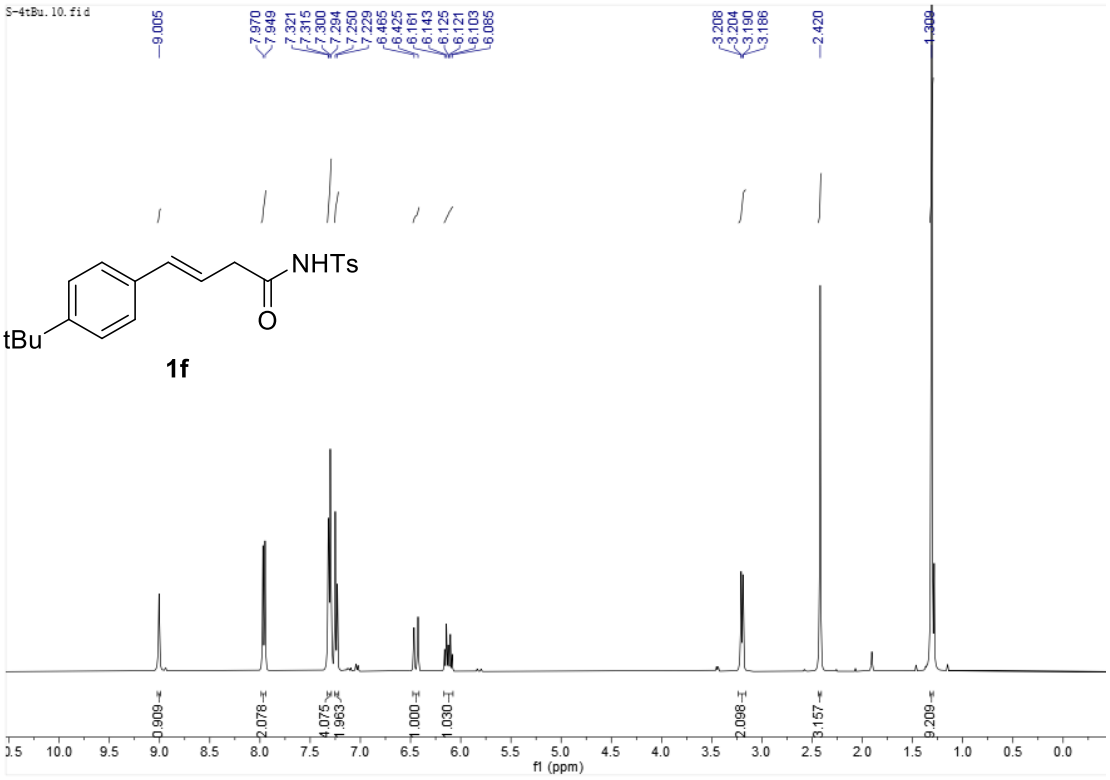
^{1}H NMR (400 MHz, $CDCl_3$) of **1e**



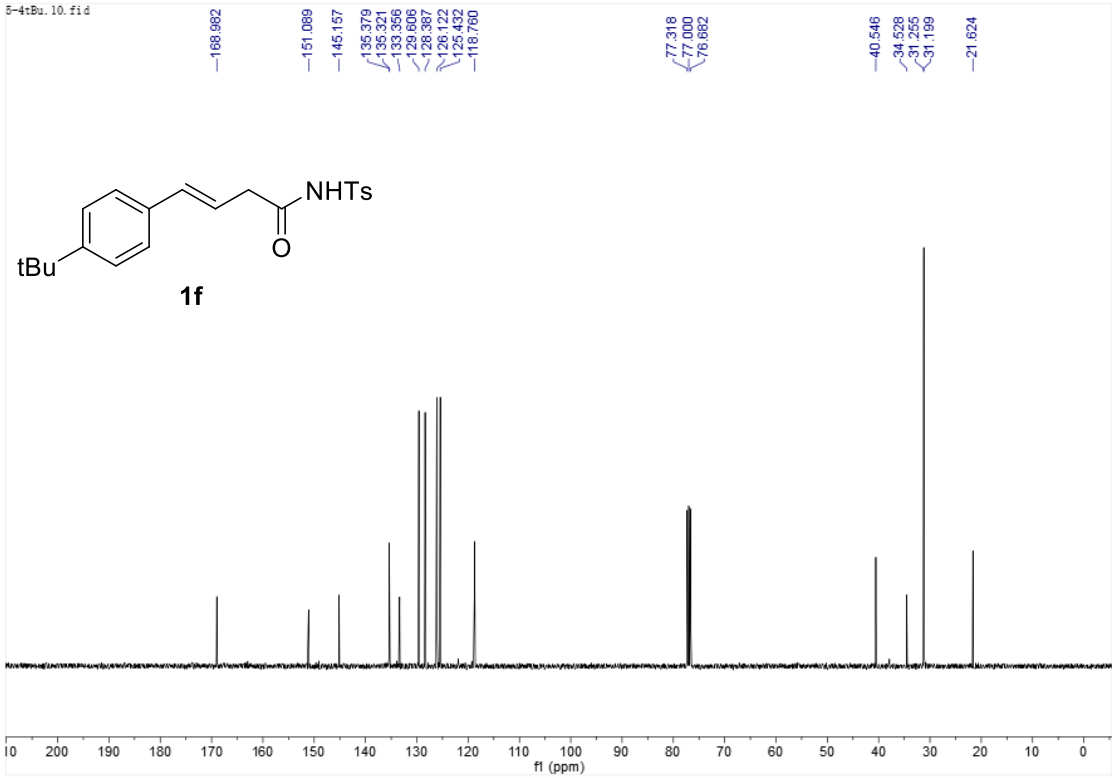
^{13}C NMR (101 MHz, $CDCl_3$) of **1e**



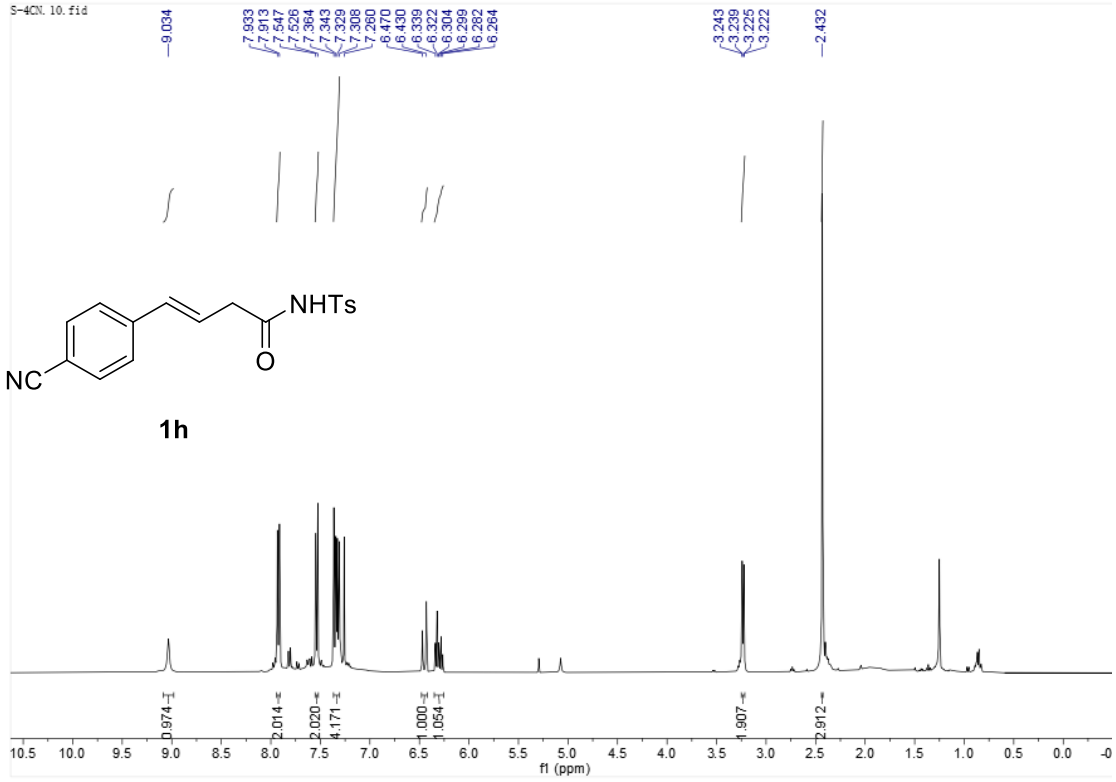
^{1}H NMR (400 MHz, $CDCl_3$) of **1f**



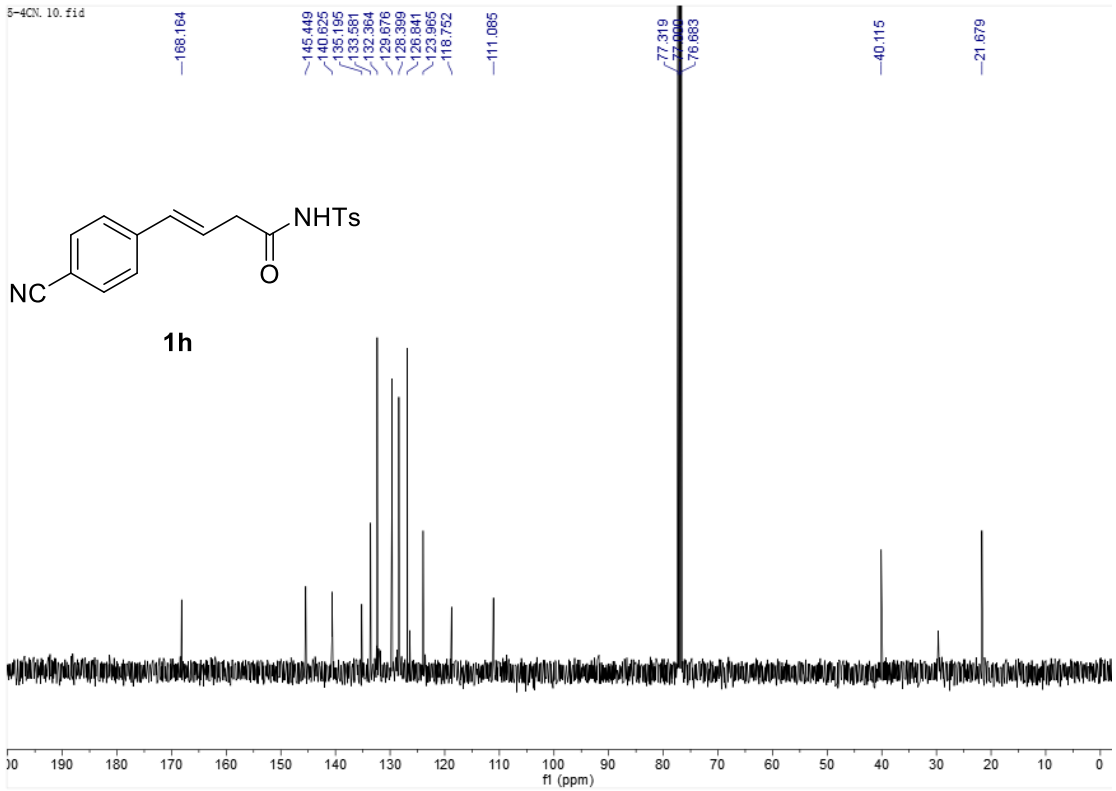
^{13}C NMR (101 MHz, $CDCl_3$) of **1f**



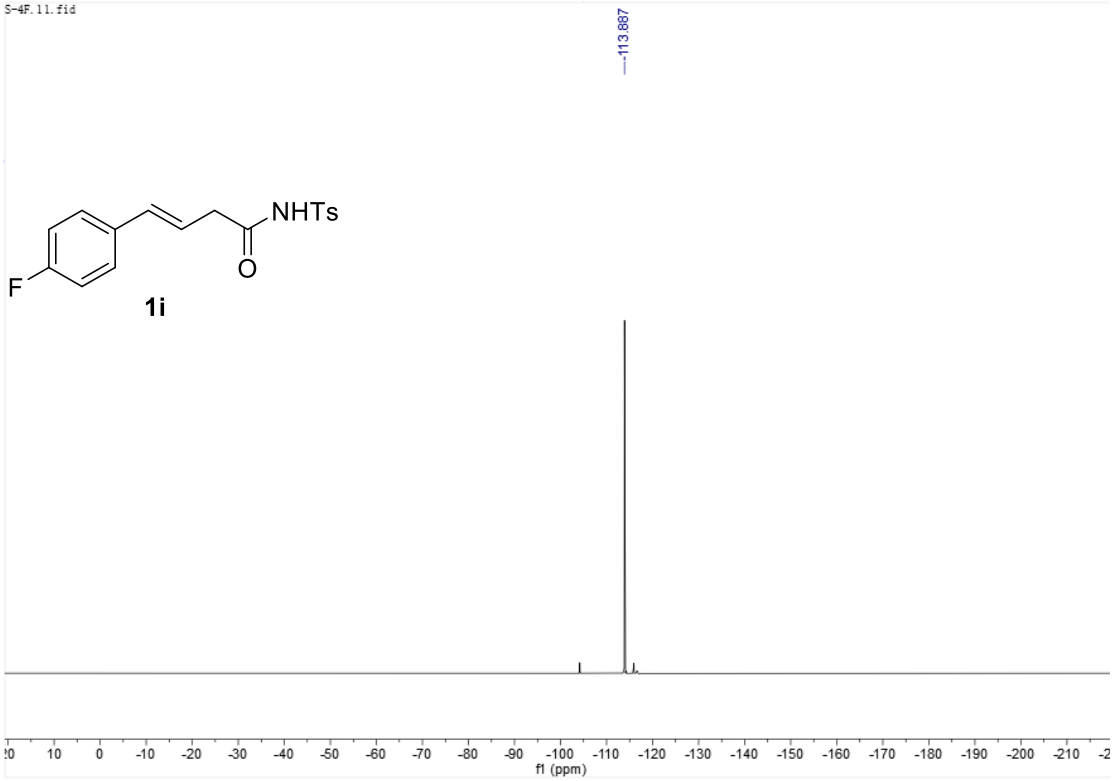
^{1}H NMR (400 MHz, $CDCl_3$) of **1h**



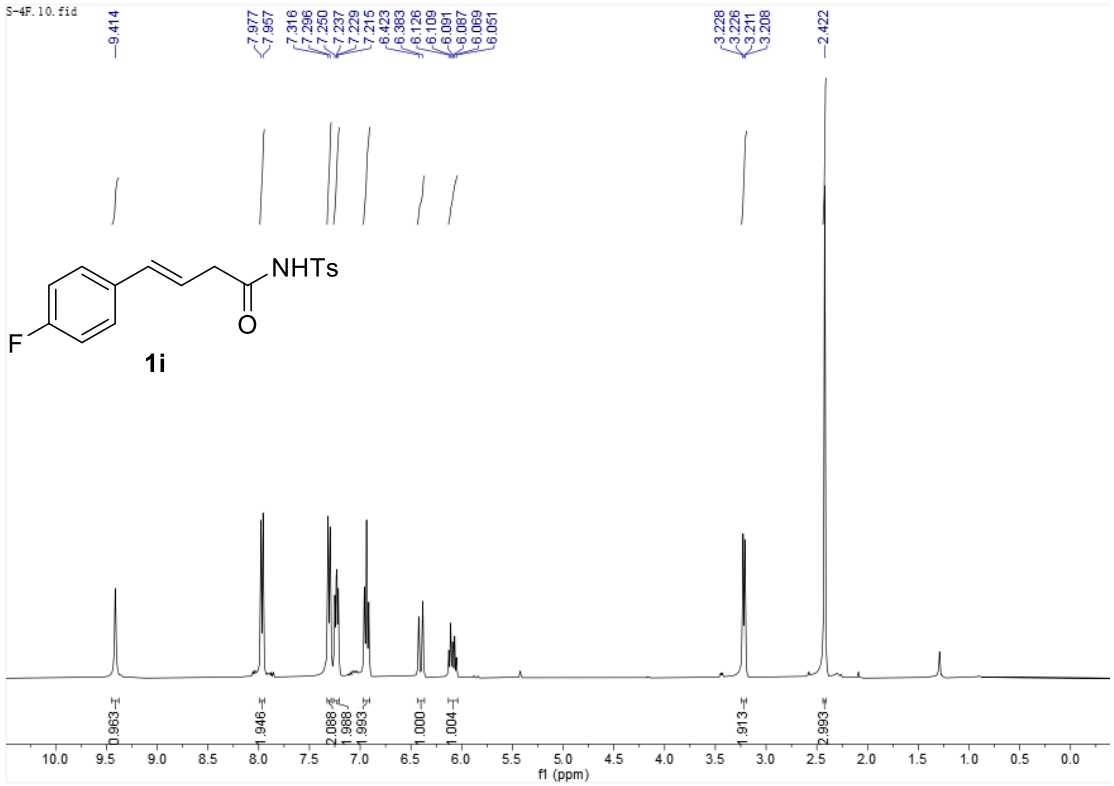
^{13}C NMR (101 MHz, $CDCl_3$) of **1h**



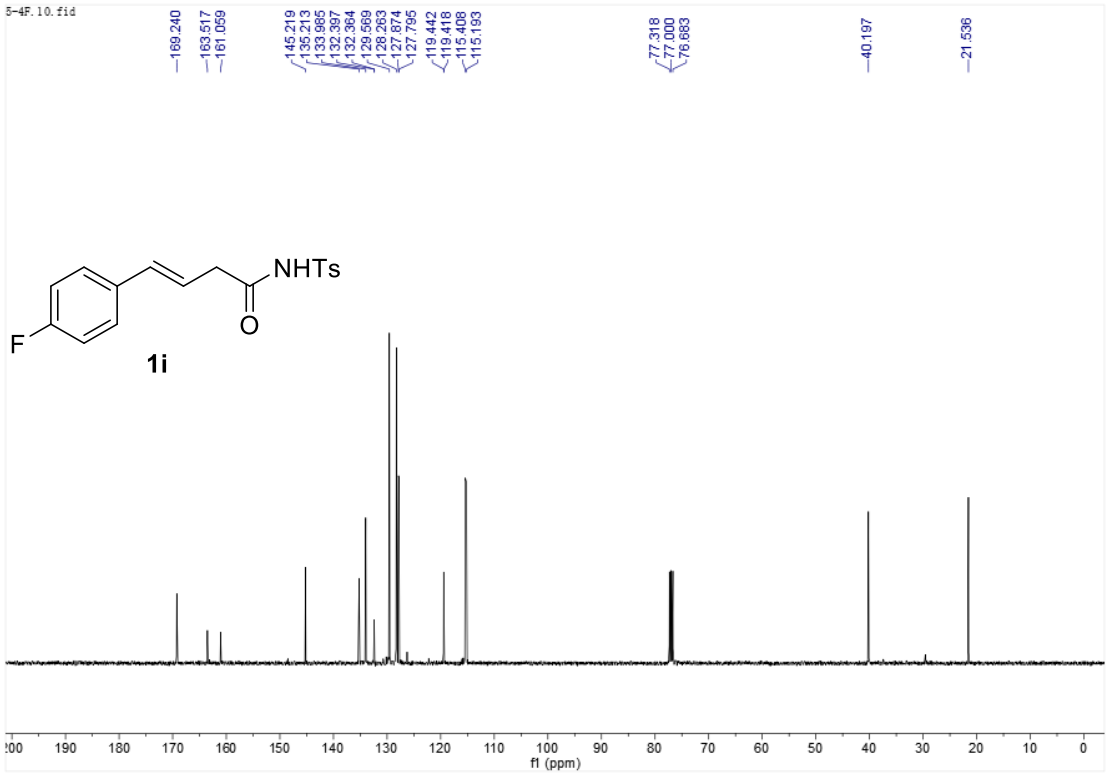
^{19}F NMR (376 MHz, $CDCl_3$) of **1i**



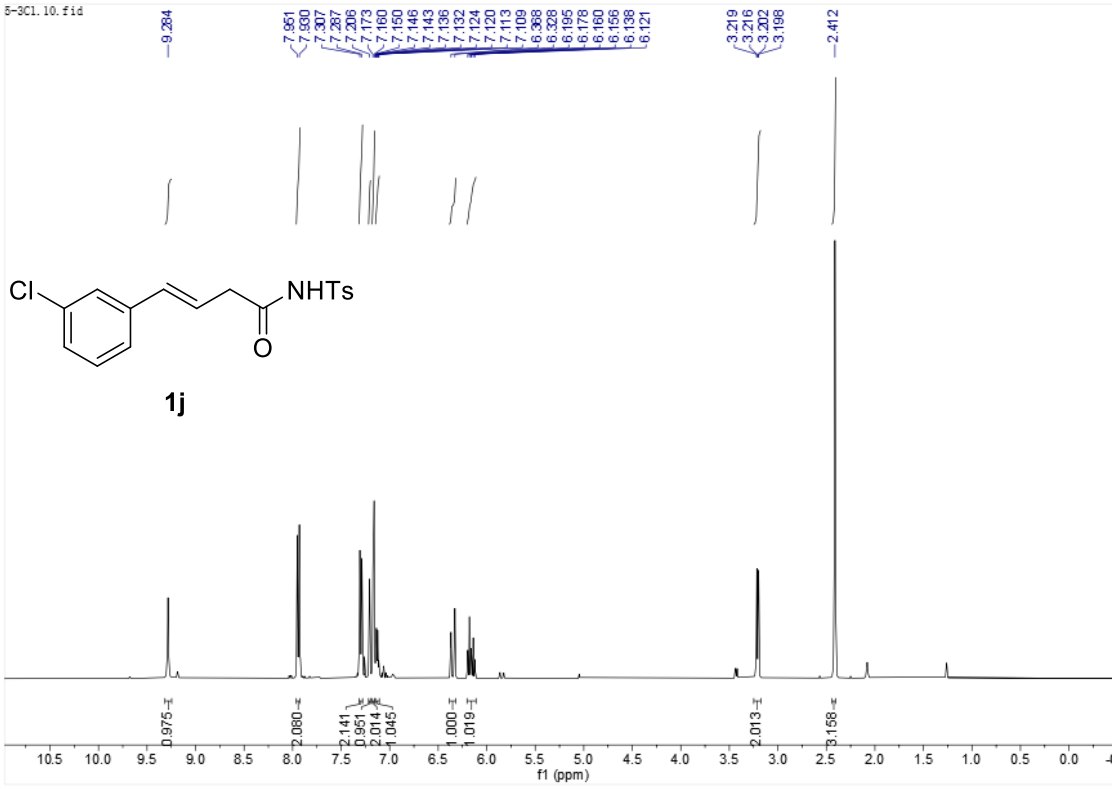
^{1}H NMR (400 MHz, $CDCl_3$) of **1i**



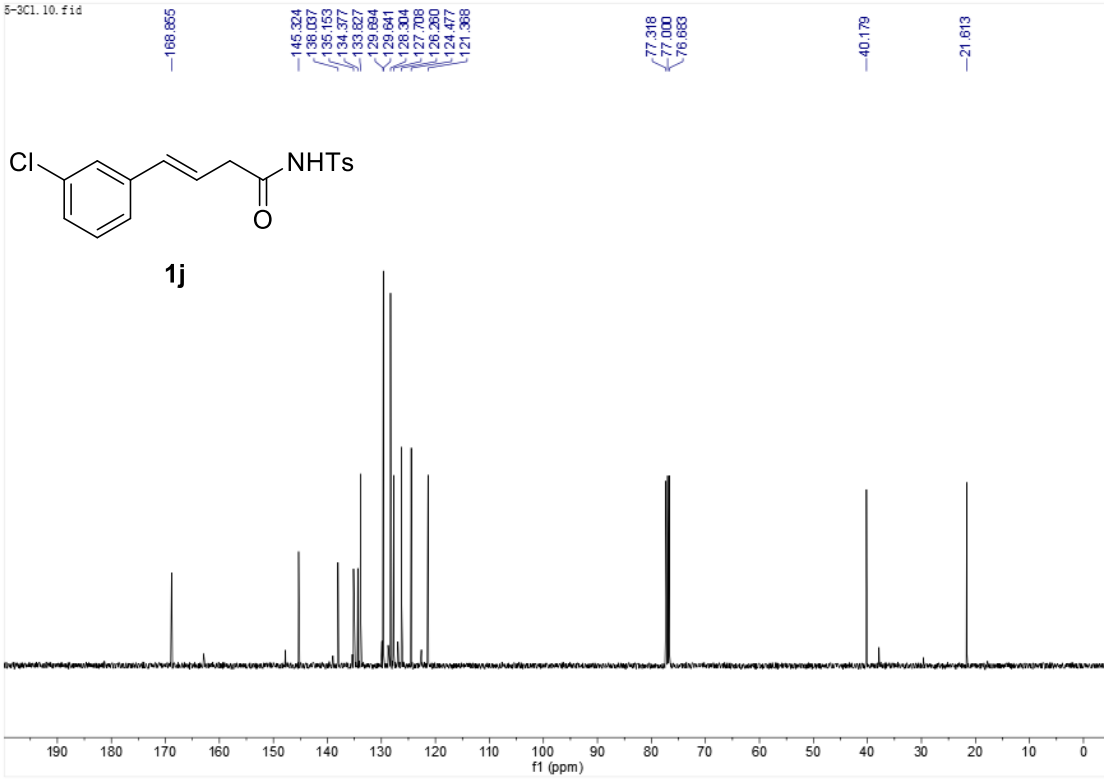
^{13}C NMR (101 MHz, $CDCl_3$) of **1i**



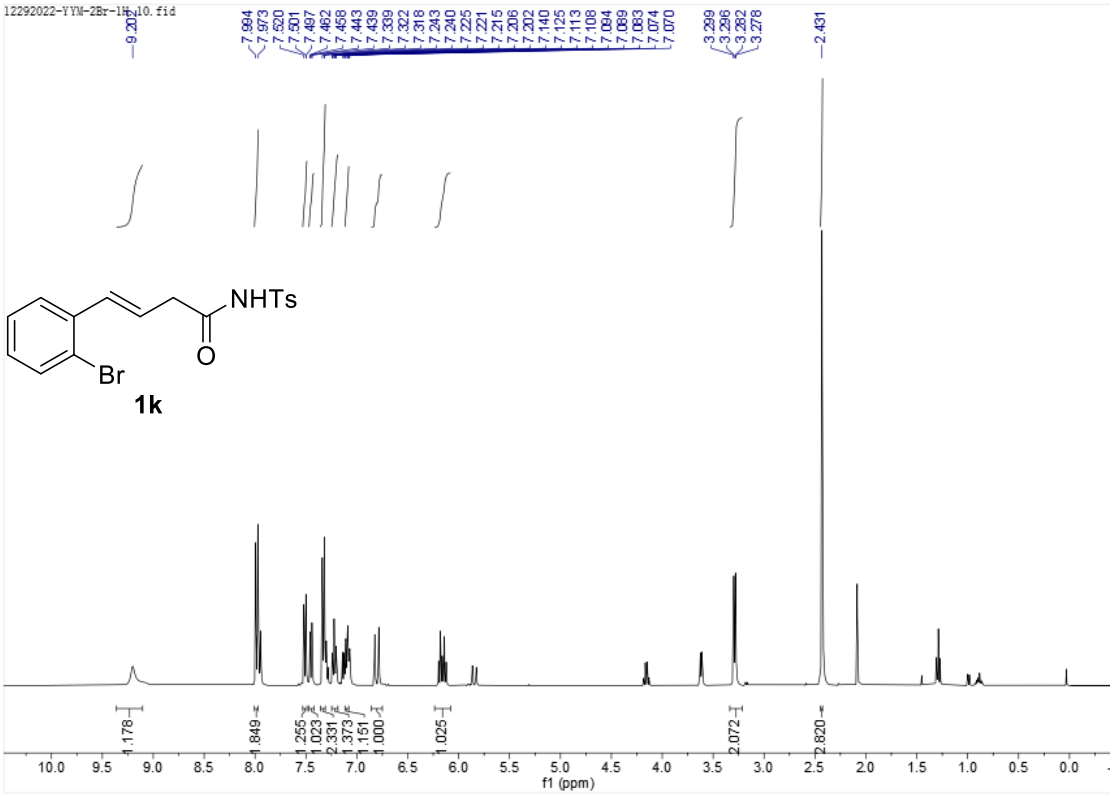
^{1}H NMR (400 MHz, $CDCl_3$) of **1j**



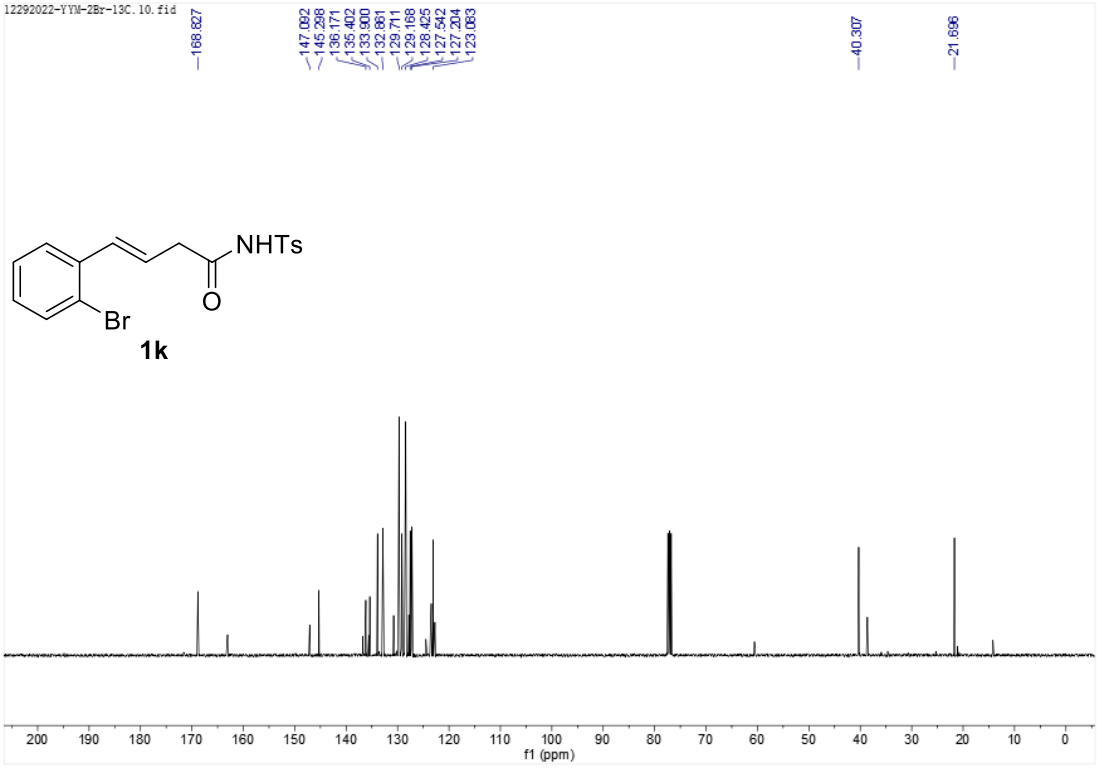
^{13}C NMR (101 MHz, $CDCl_3$) of **1j**



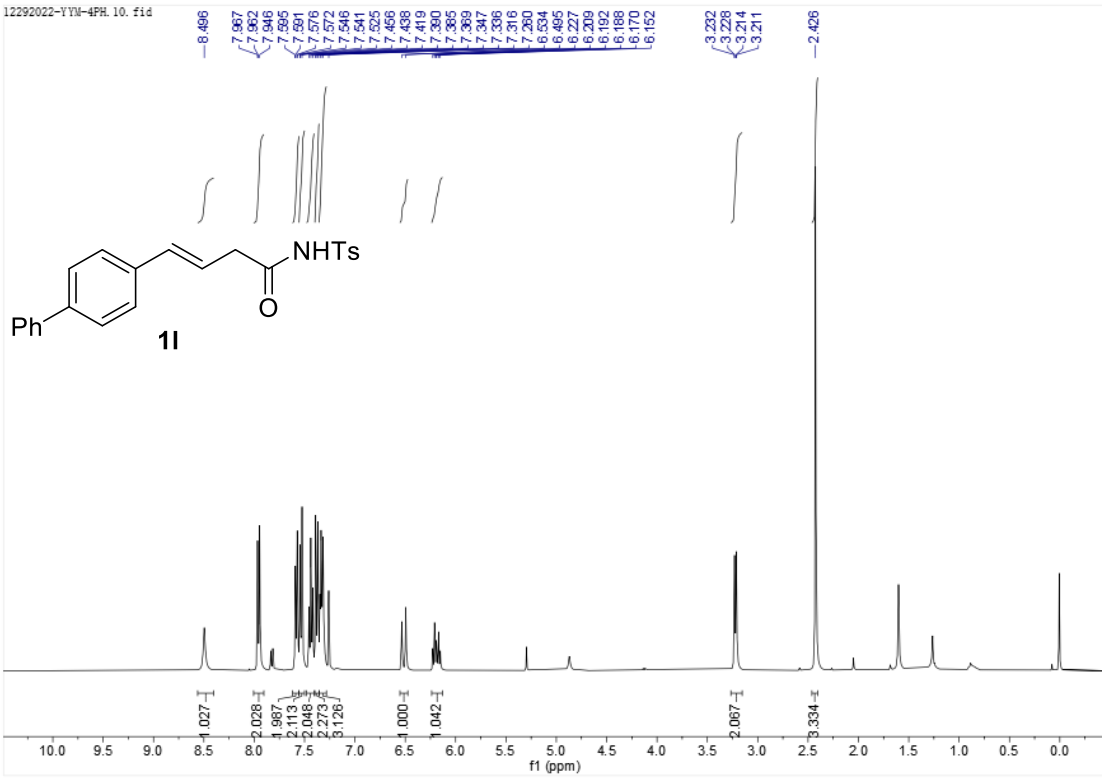
^{1}H NMR (400 MHz, $CDCl_3$) of **1k**



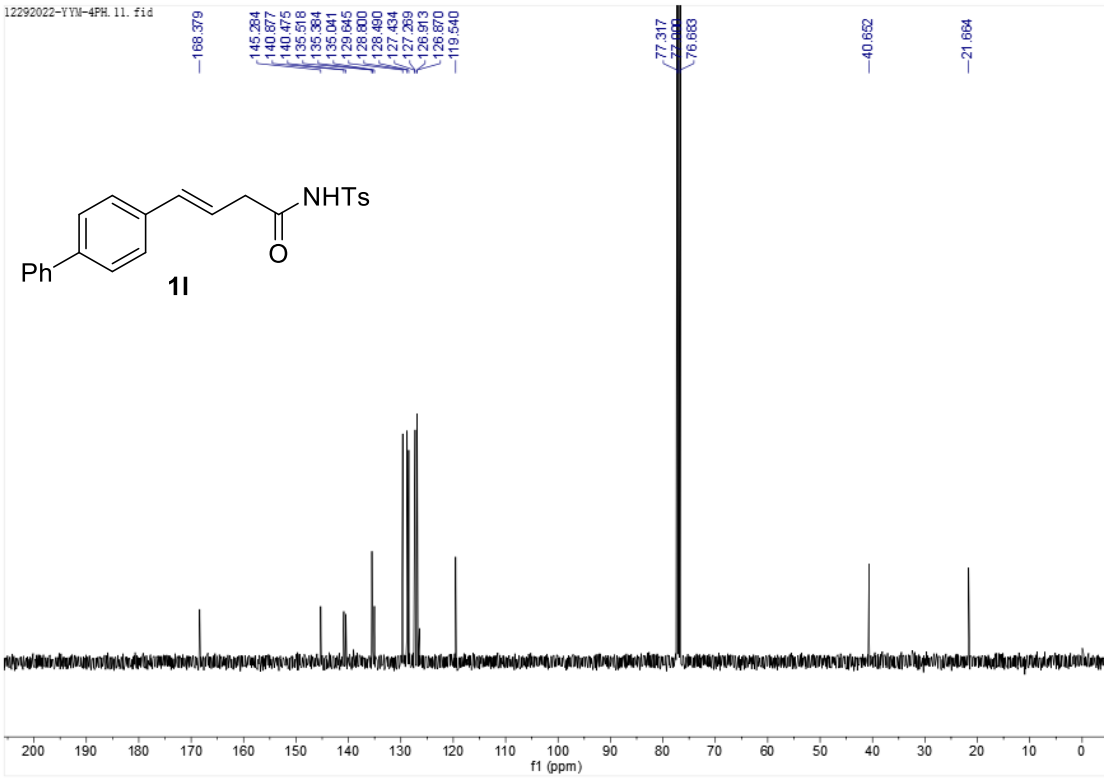
^{13}C NMR (101 MHz, $CDCl_3$) of **1k**



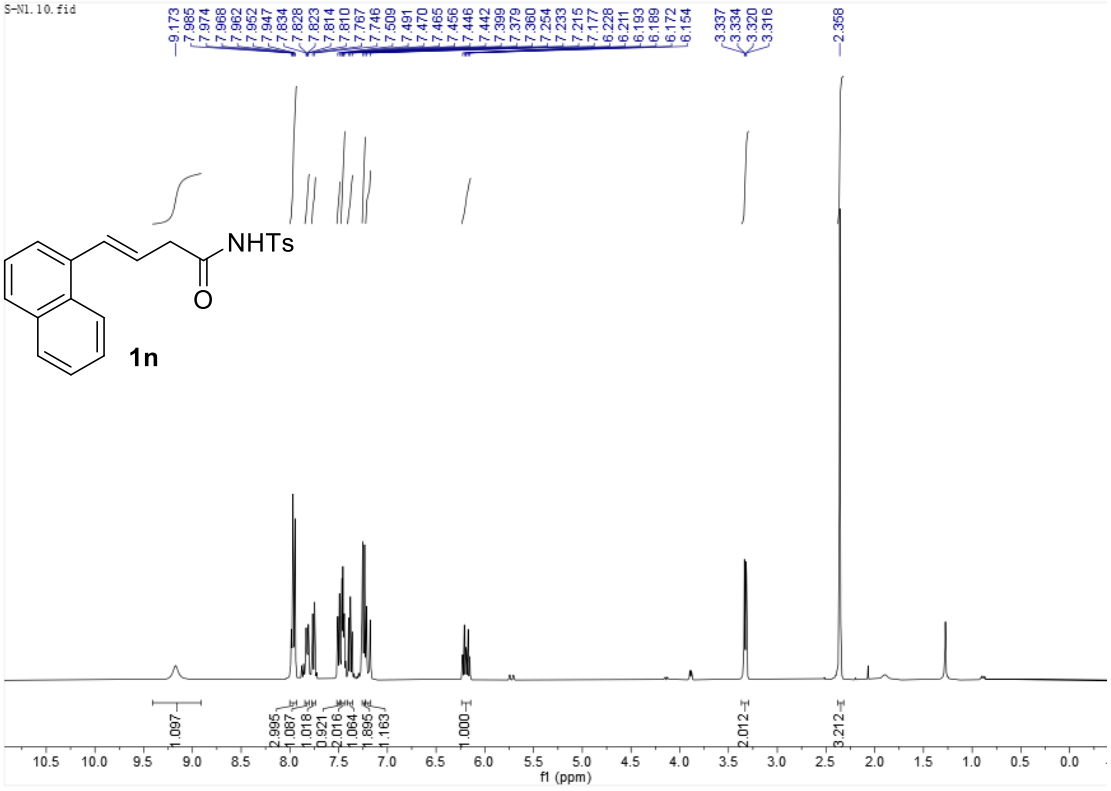
^{1}H NMR (400 MHz, $CDCl_3$) of **1l**



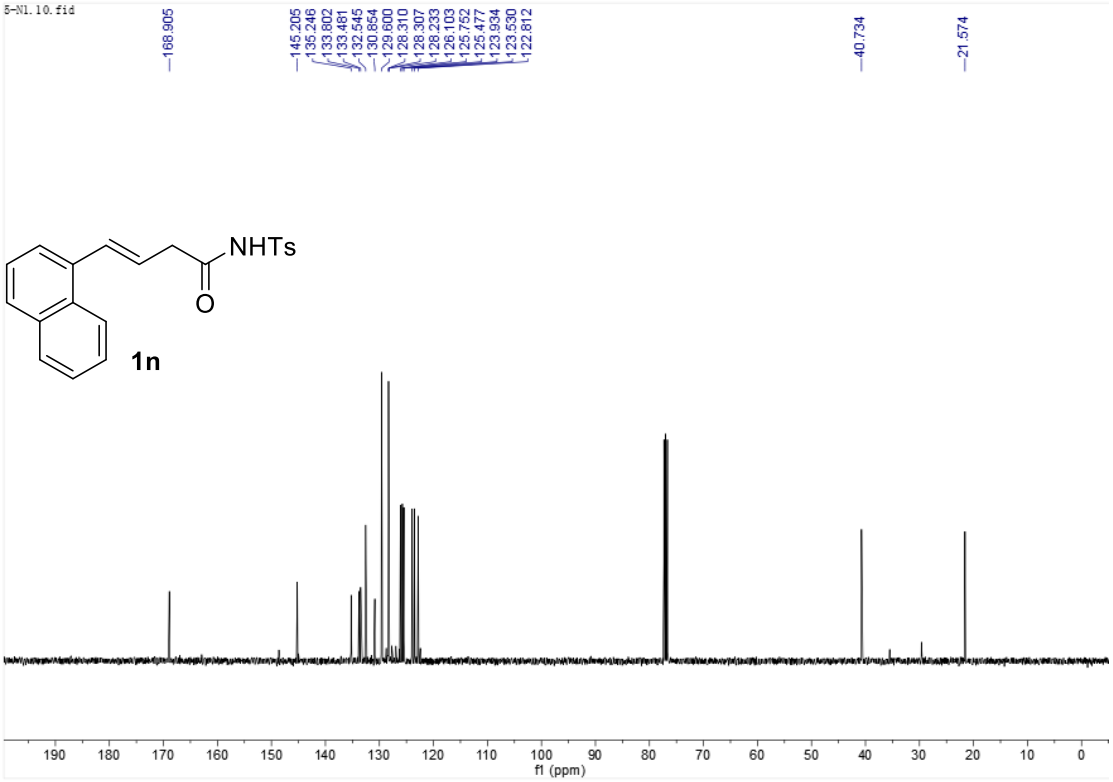
^{13}C NMR (101 MHz, $CDCl_3$) of **1l**



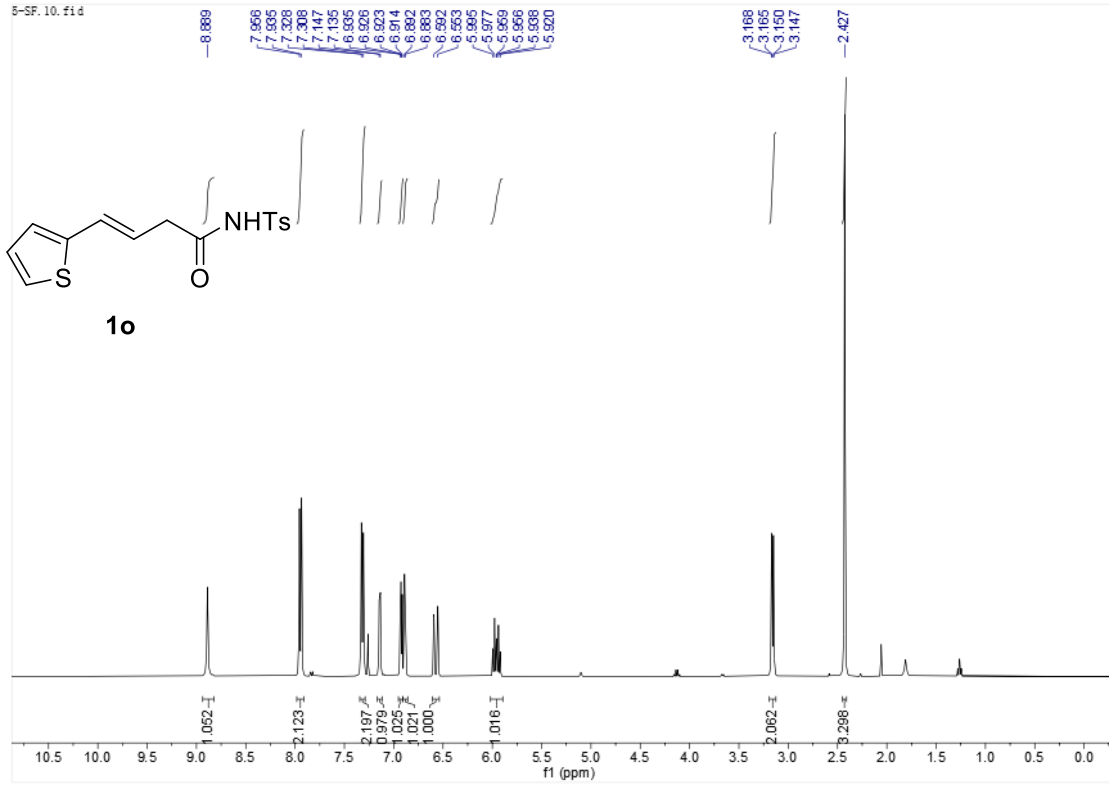
^{1}H NMR (400 MHz, $CDCl_3$) of **1n**



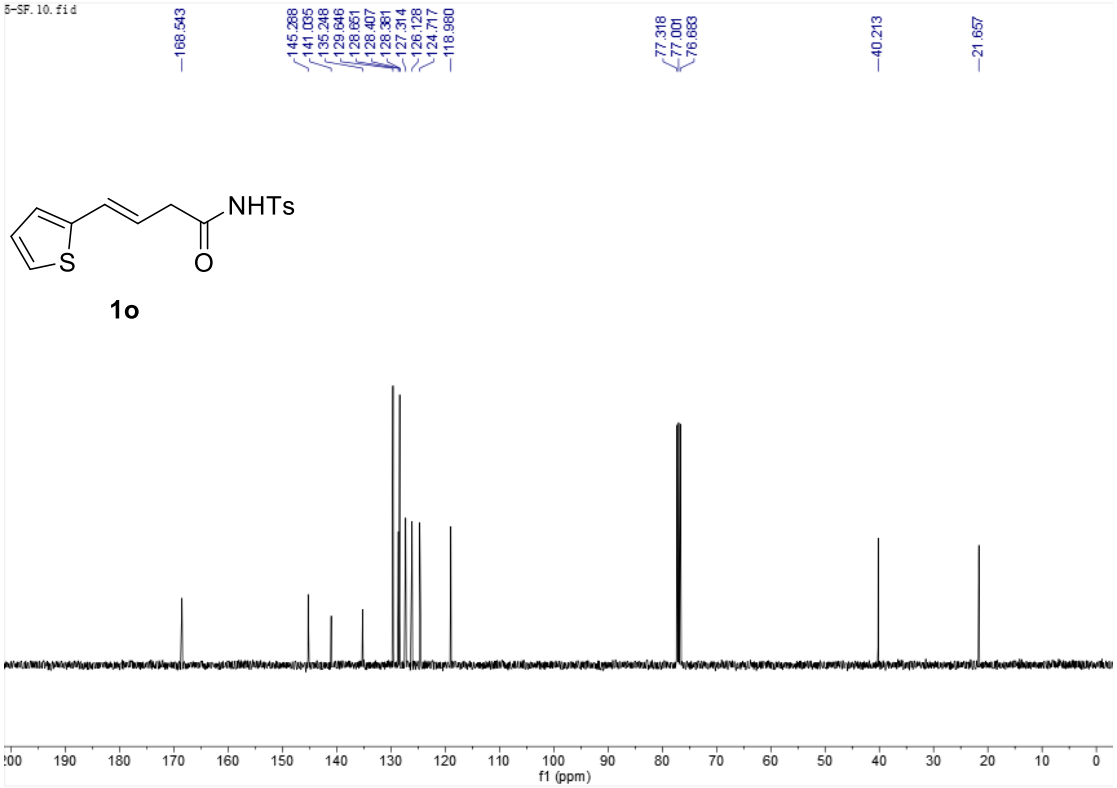
^{13}C NMR (101 MHz, $CDCl_3$) of **1n**



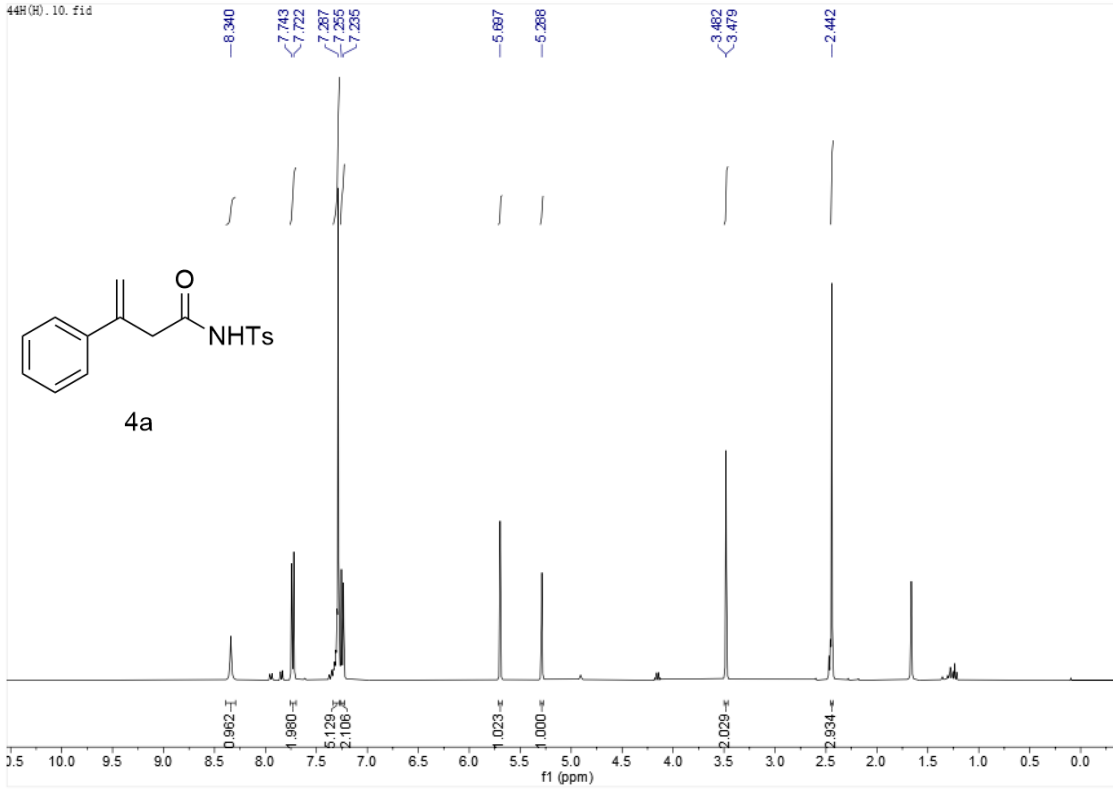
^{1}H NMR (400 MHz, $CDCl_3$) of **1o**



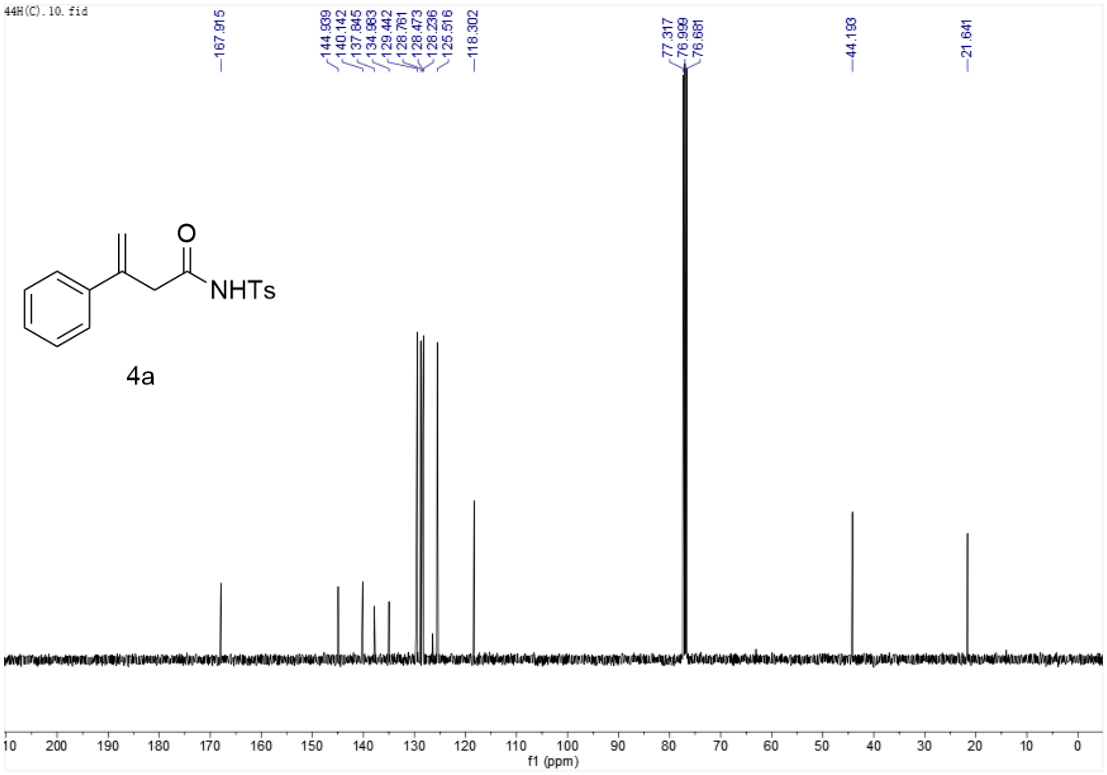
^{13}C NMR (101 MHz, $CDCl_3$) of **1o**



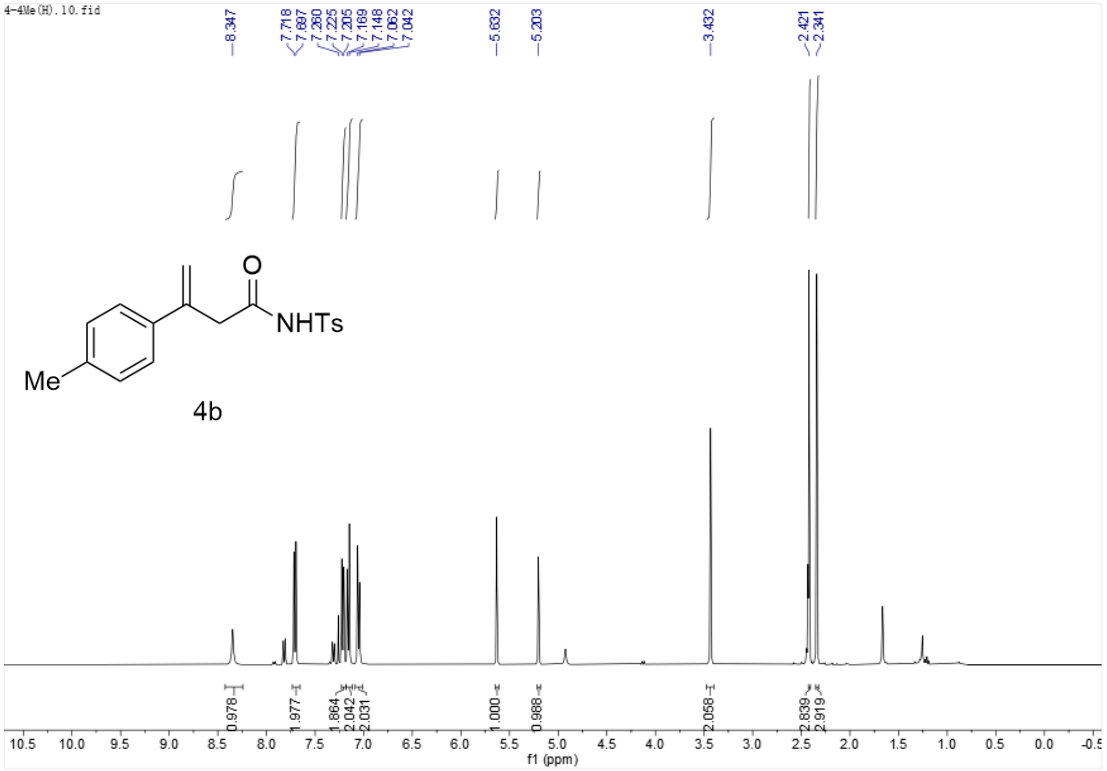
^{1}H NMR (400 MHz, $CDCl_3$) of **4a**



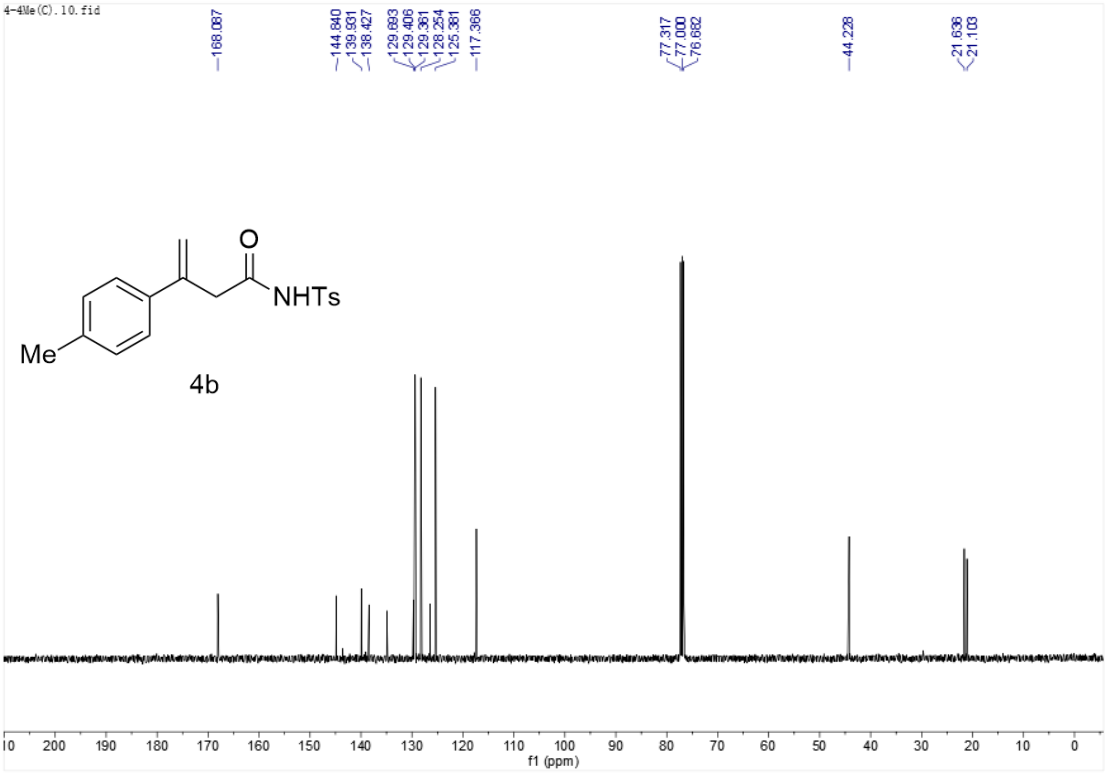
^{13}C NMR (101 MHz, $CDCl_3$) of **4a**



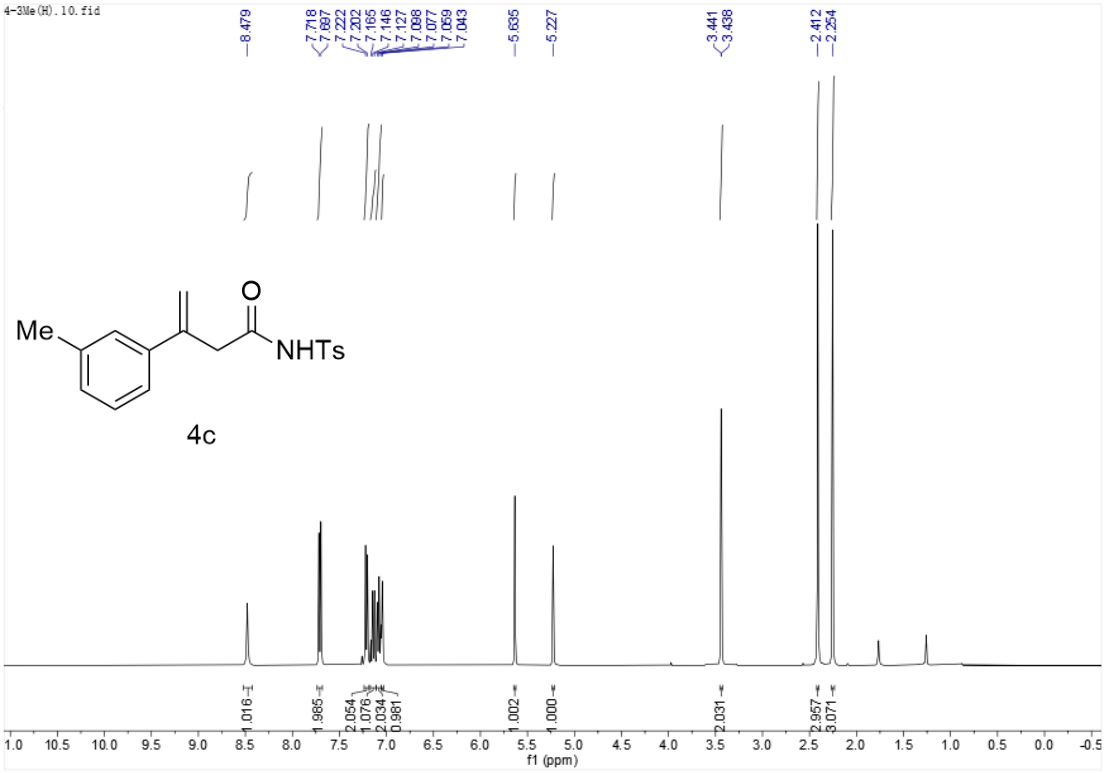
^{1}H NMR (400 MHz, $CDCl_3$) of **4b**



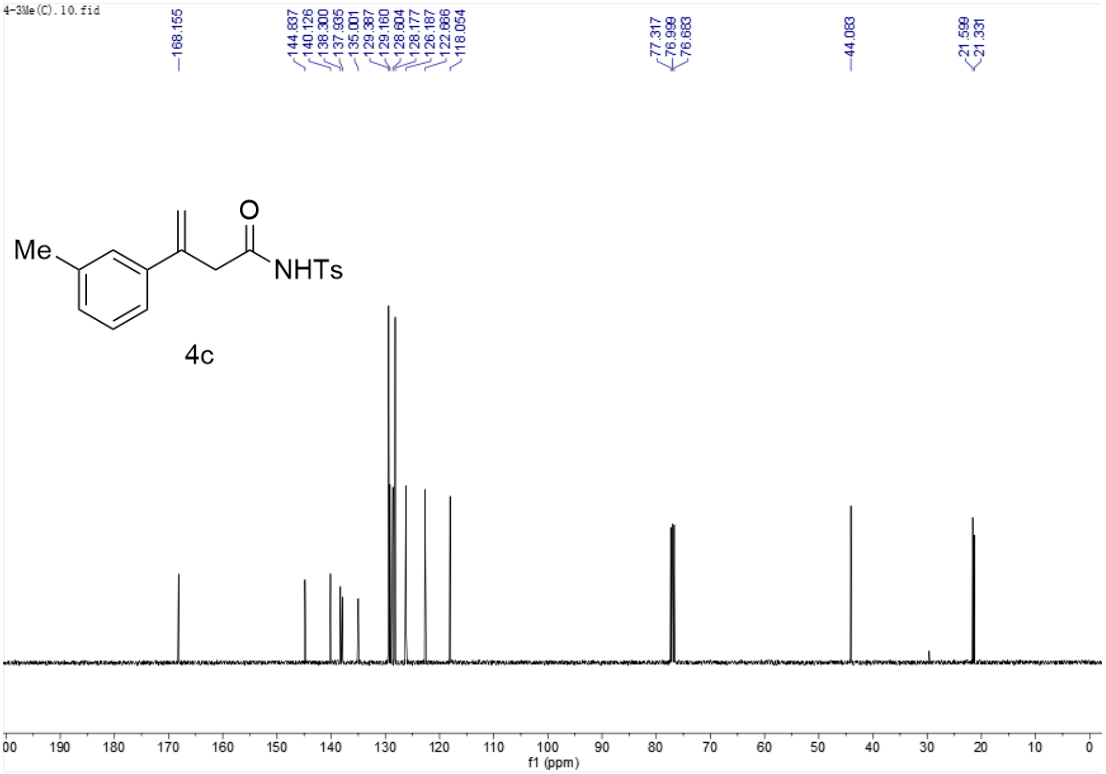
^{13}C NMR (101 MHz, $CDCl_3$) of **4b**



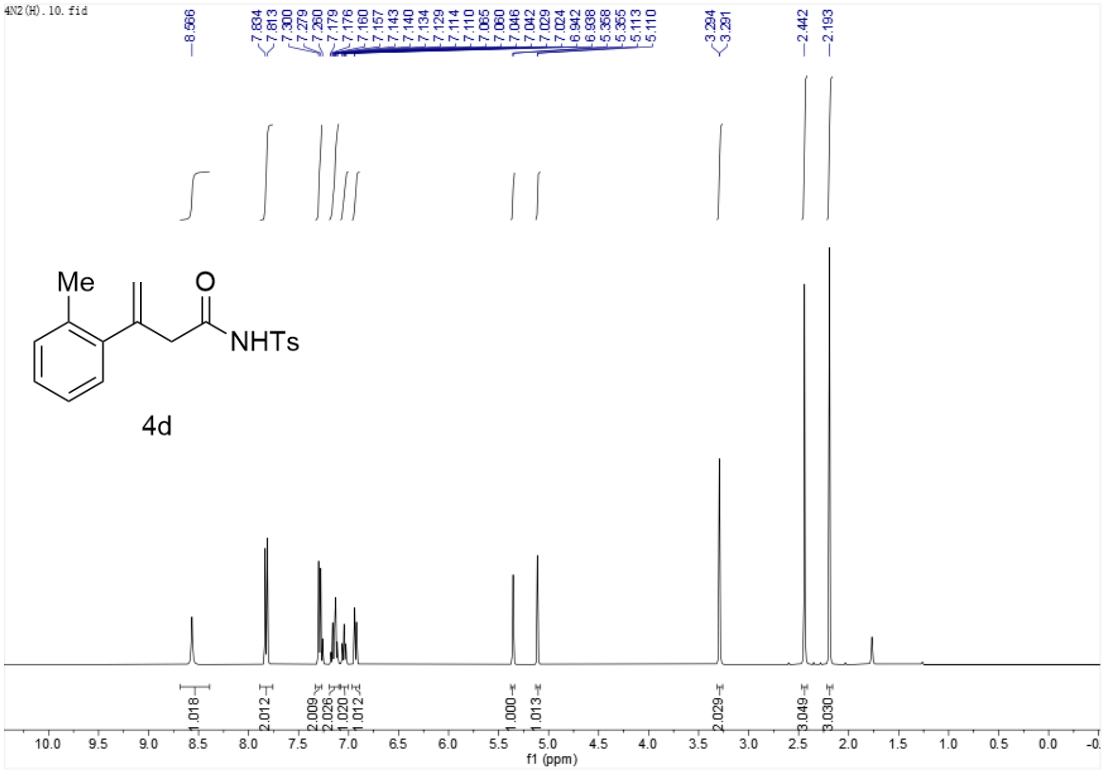
^{1}H NMR (400 MHz, $CDCl_3$) of **4c**



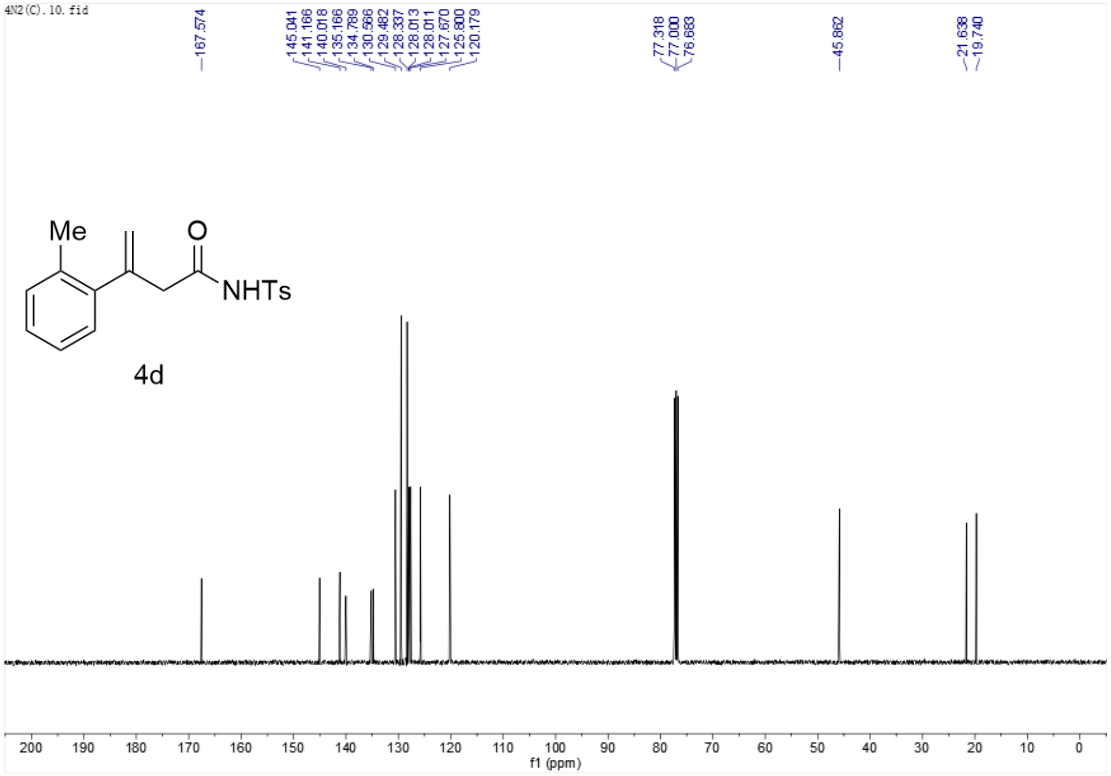
^{13}C NMR (101 MHz, $CDCl_3$) of **4c**



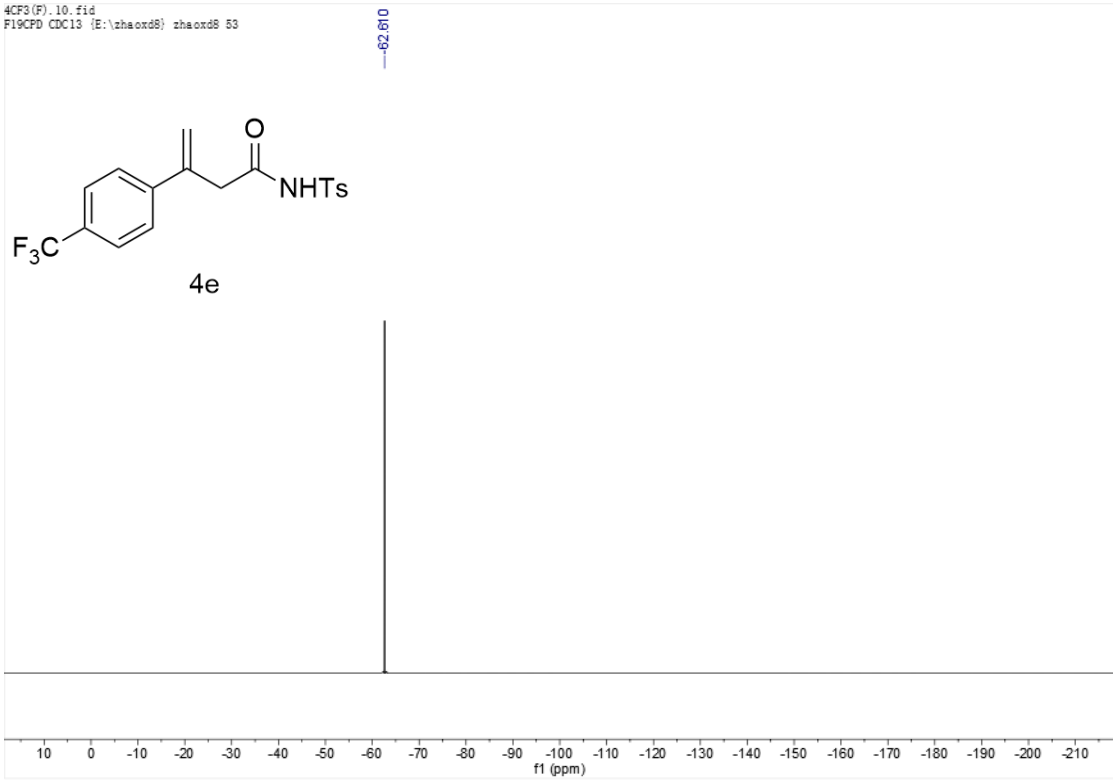
^{1}H NMR (400 MHz, $CDCl_3$) of **4d**



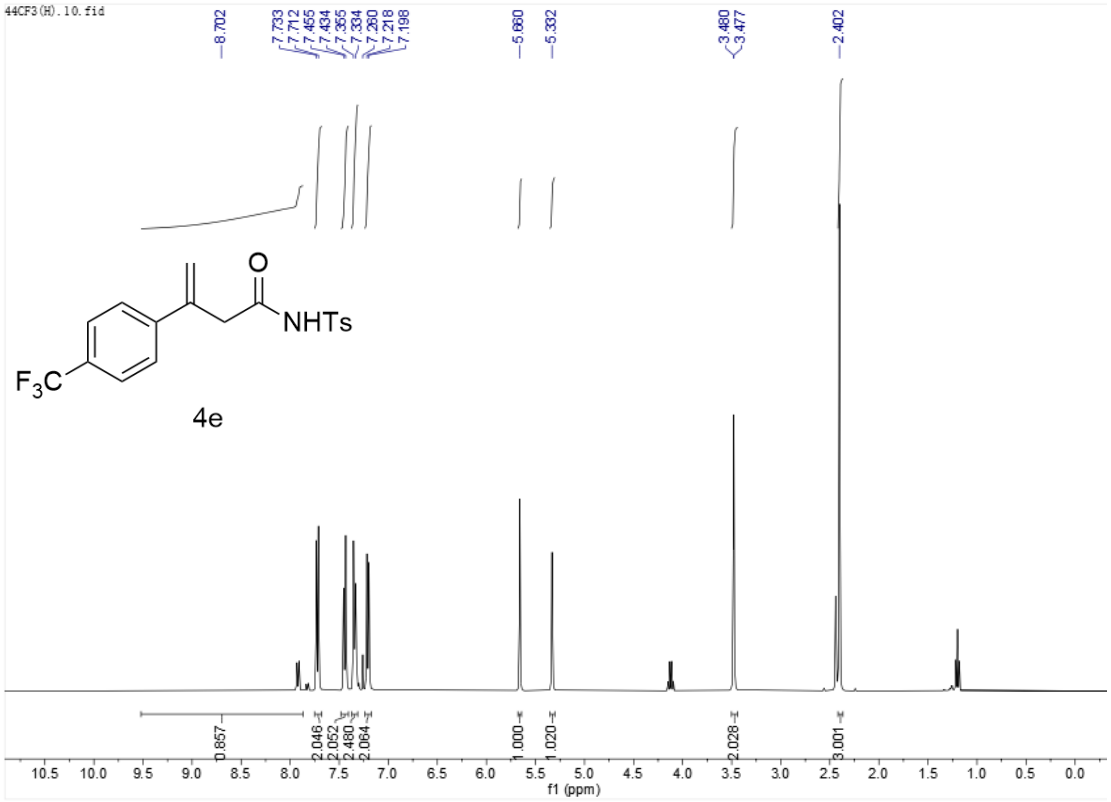
^{13}C NMR (101 MHz, $CDCl_3$) of **4d**



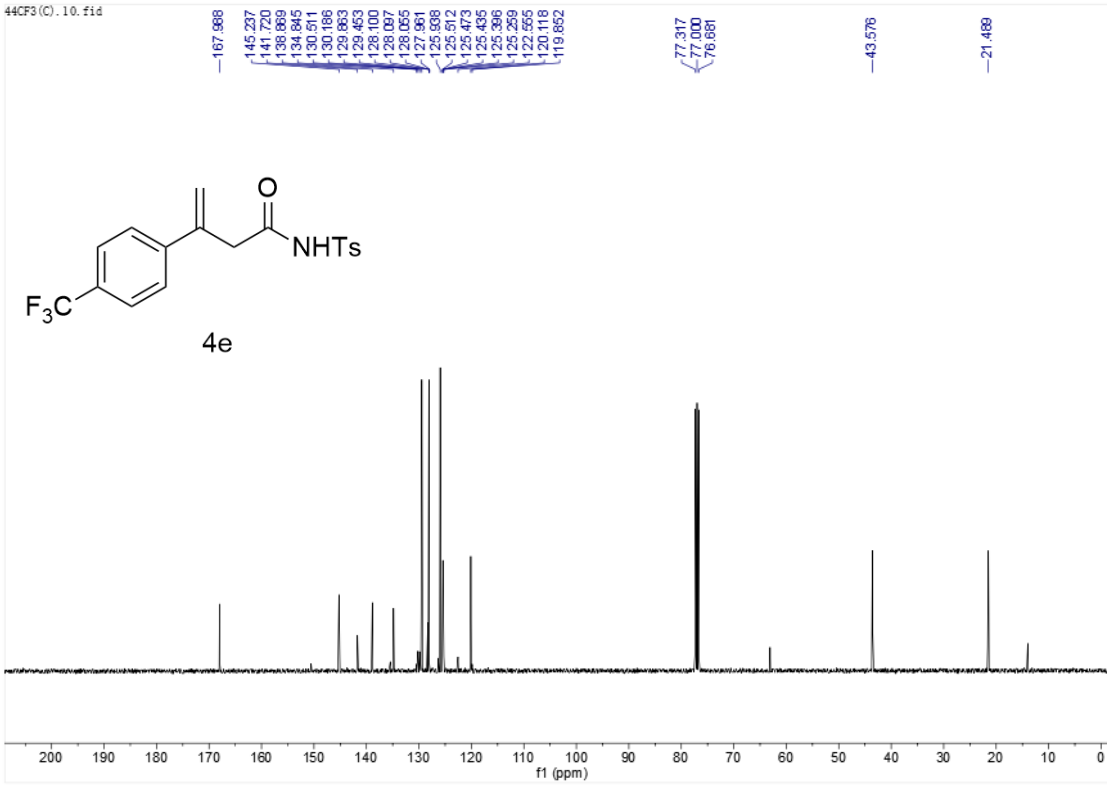
^{19}F NMR (376 MHz, $CDCl_3$) of **4e**



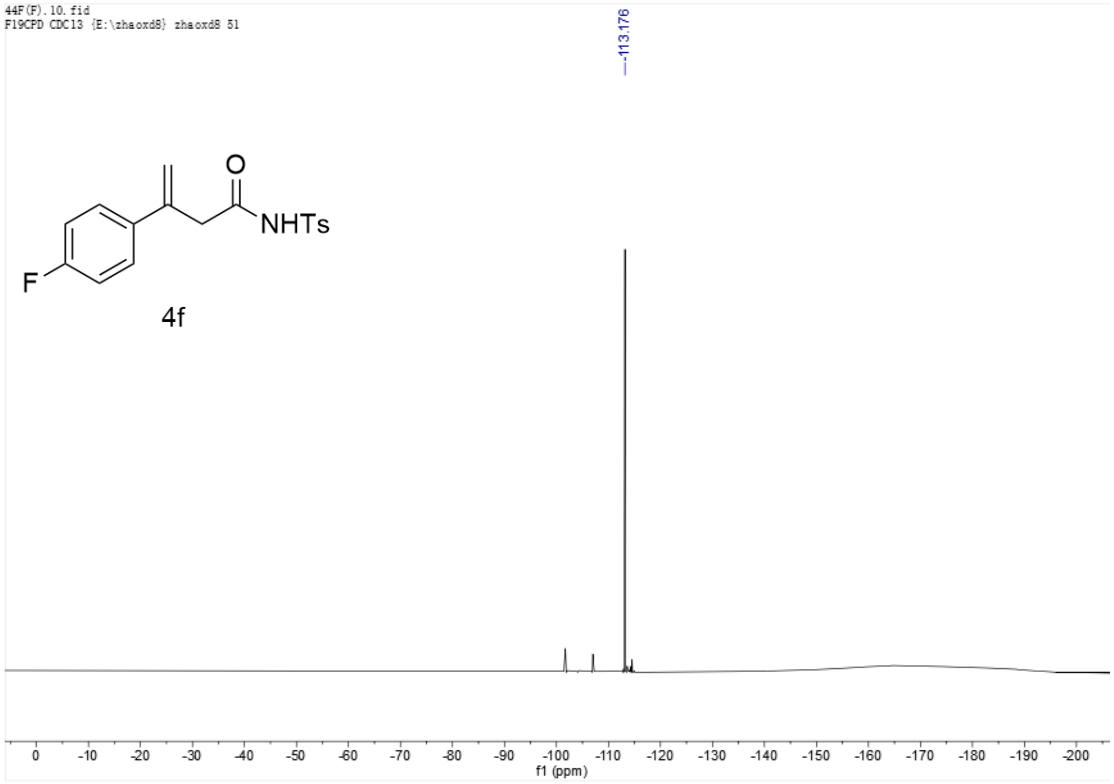
^{1}H NMR (400 MHz, $CDCl_3$) of **4e**



^{13}C NMR (101 MHz, $CDCl_3$) of **4e**



^{19}F NMR (376 MHz, $CDCl_3$) of **4f**



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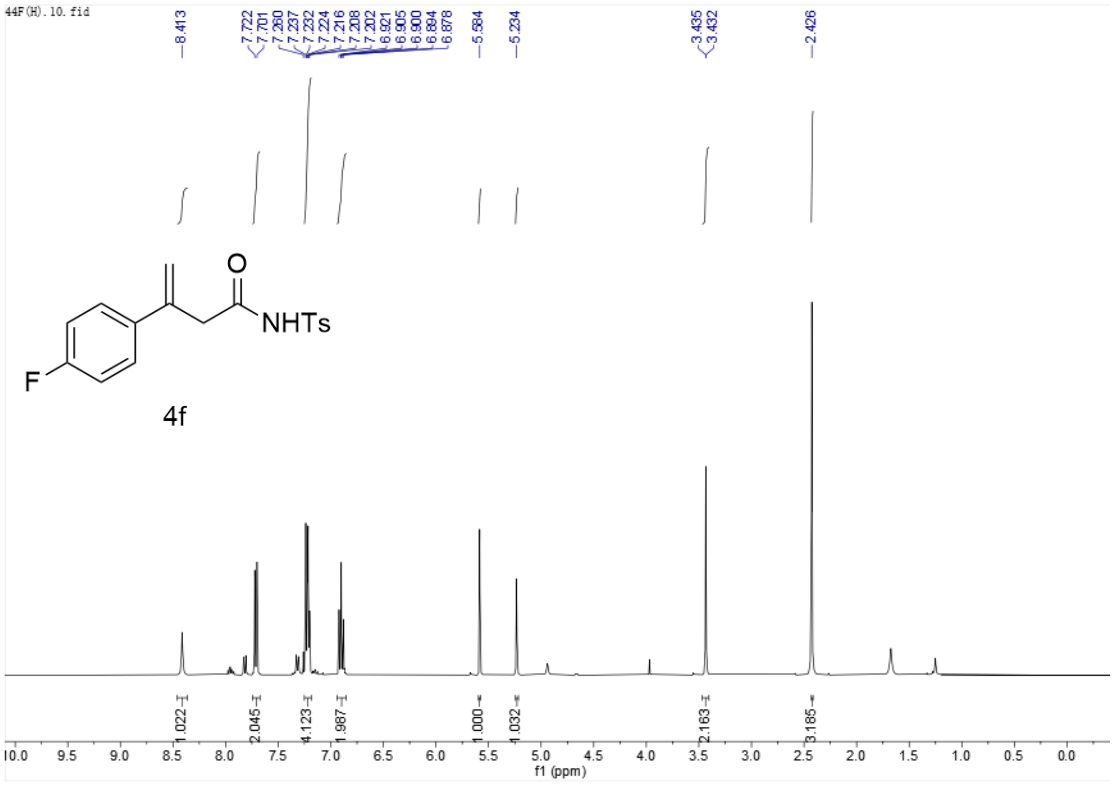
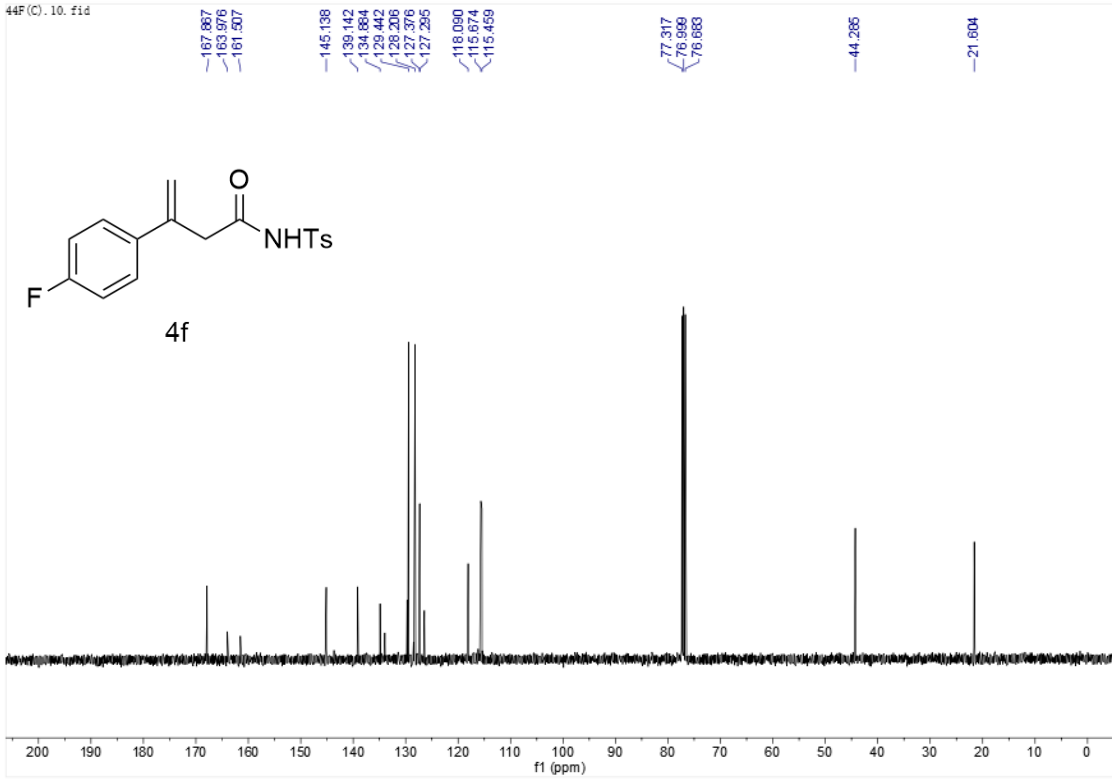
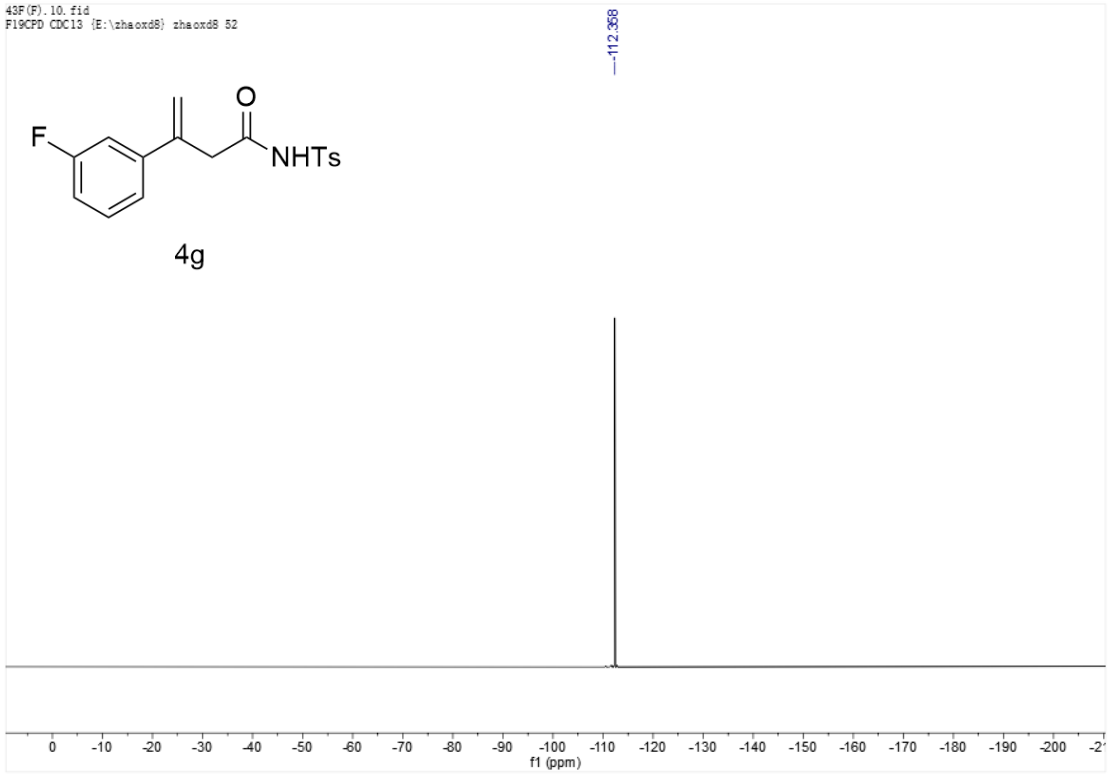


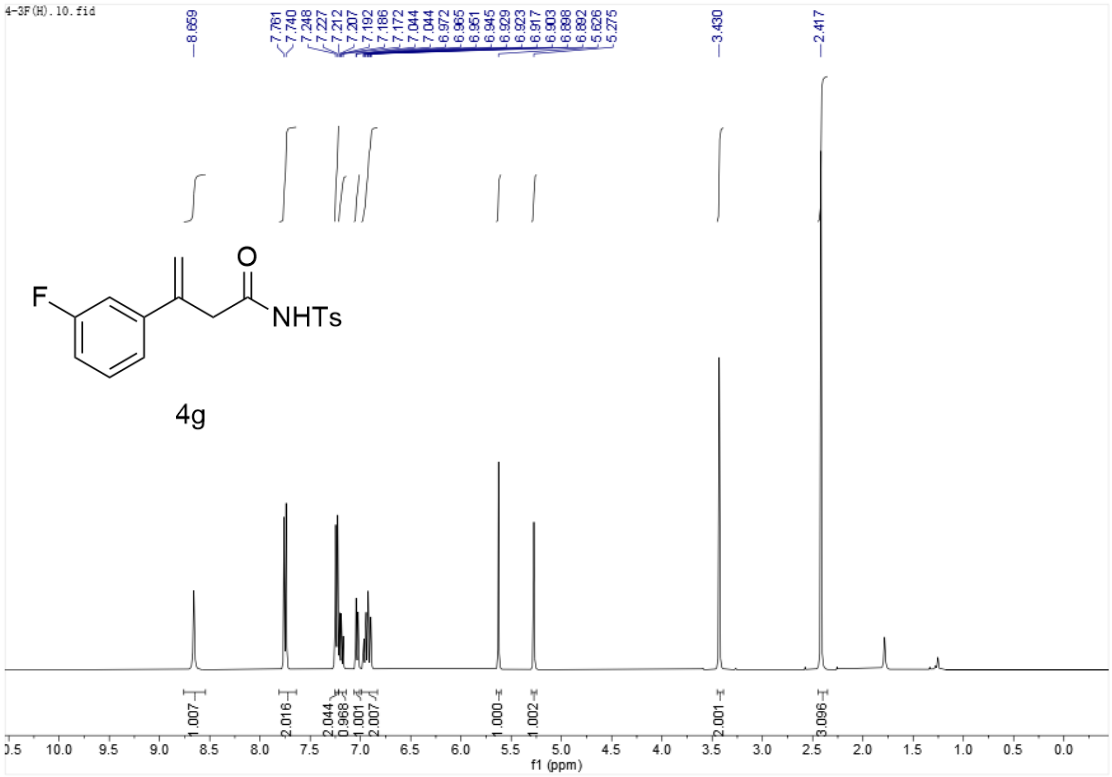
^{13}C NMR (101 MHz, $CDCl_3$) of **4f**



^{19}F NMR (376 MHz, $CDCl_3$) of **4g**



^{13}C NMR (101 MHz, $CDCl_3$) of **4g**



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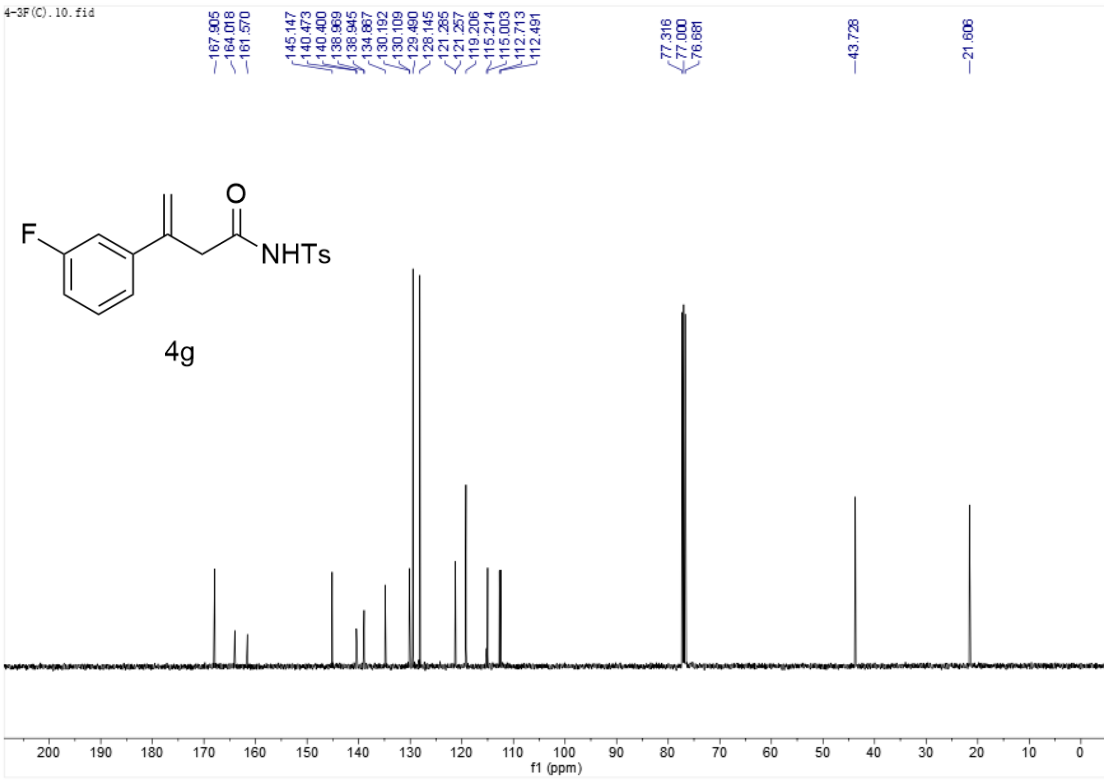
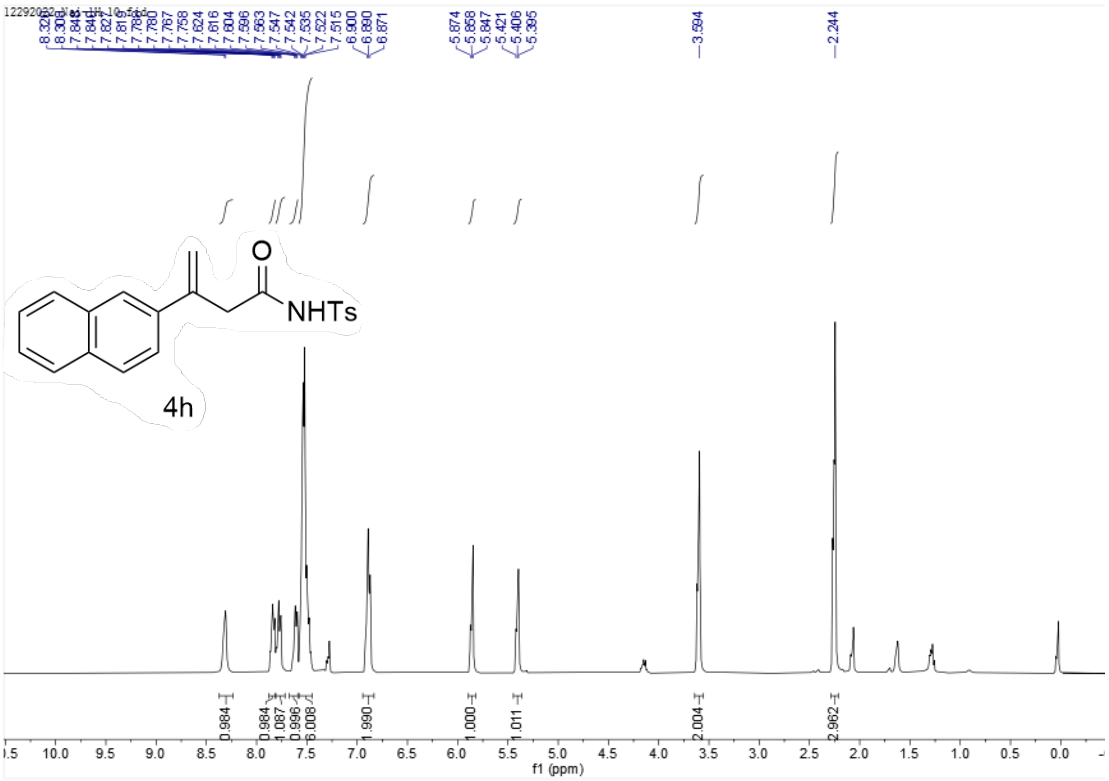


^{1}H NMR (400 MHz, $CDCl_3$) of **4h**



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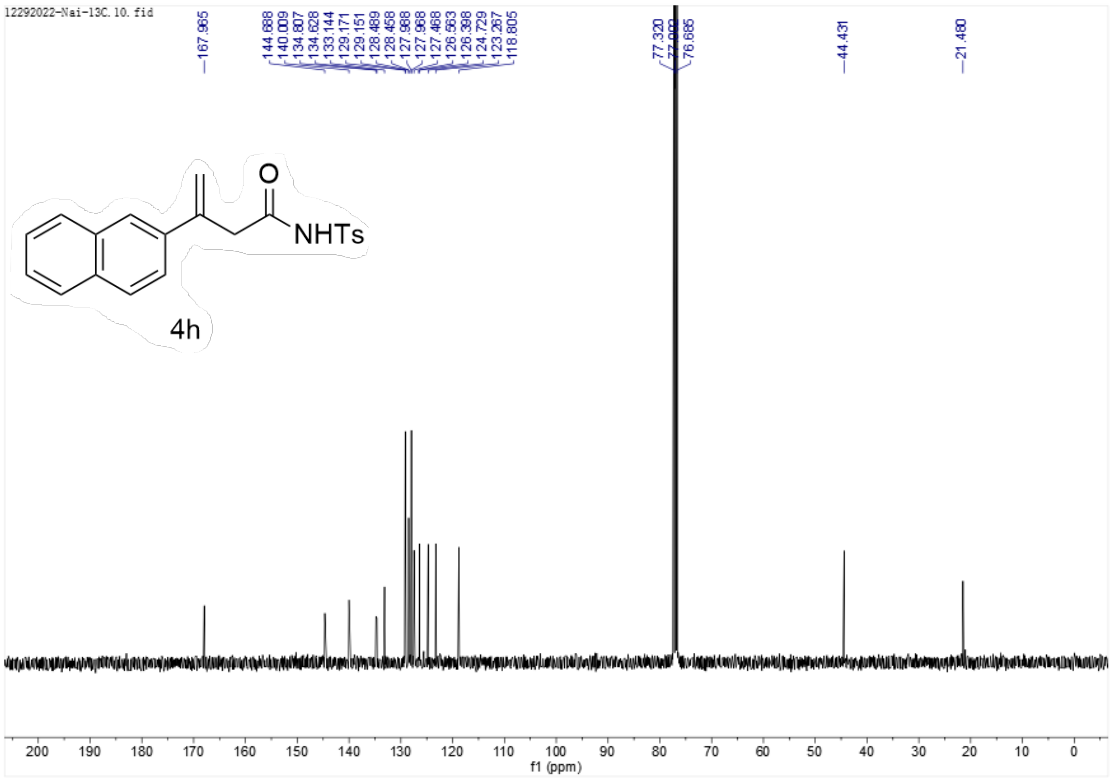
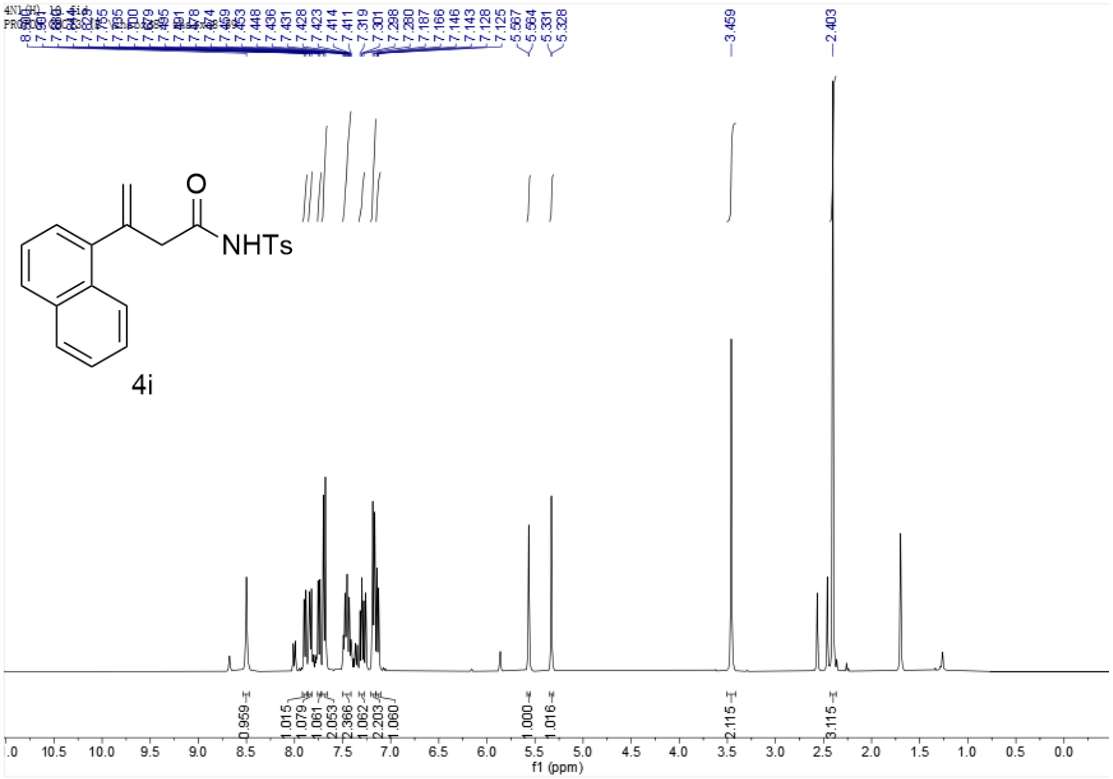


^{1}H NMR (400 MHz, $CDCl_3$) of **4i**



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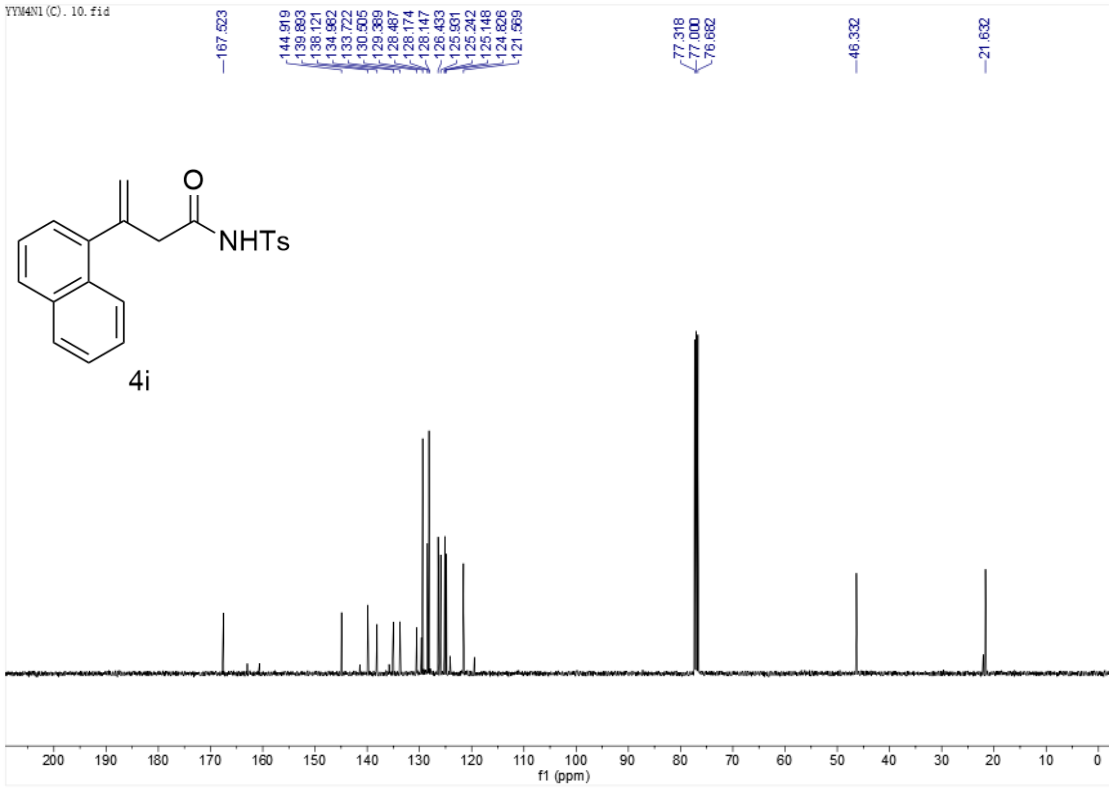
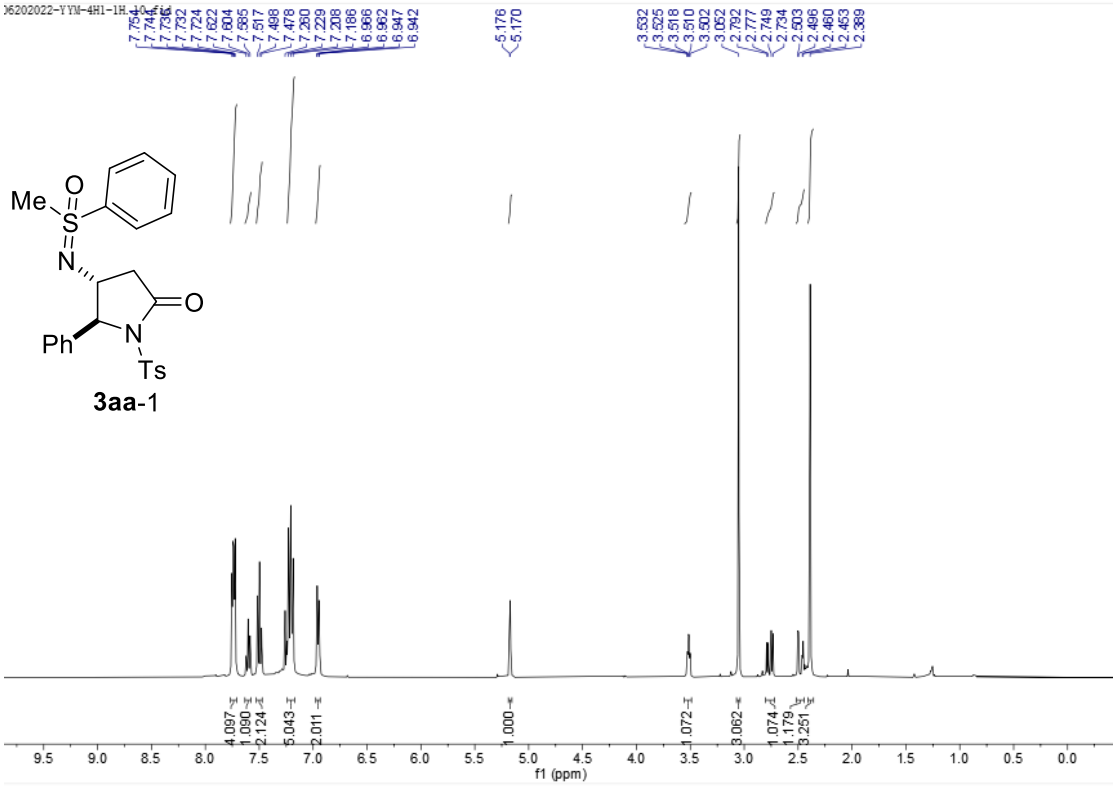
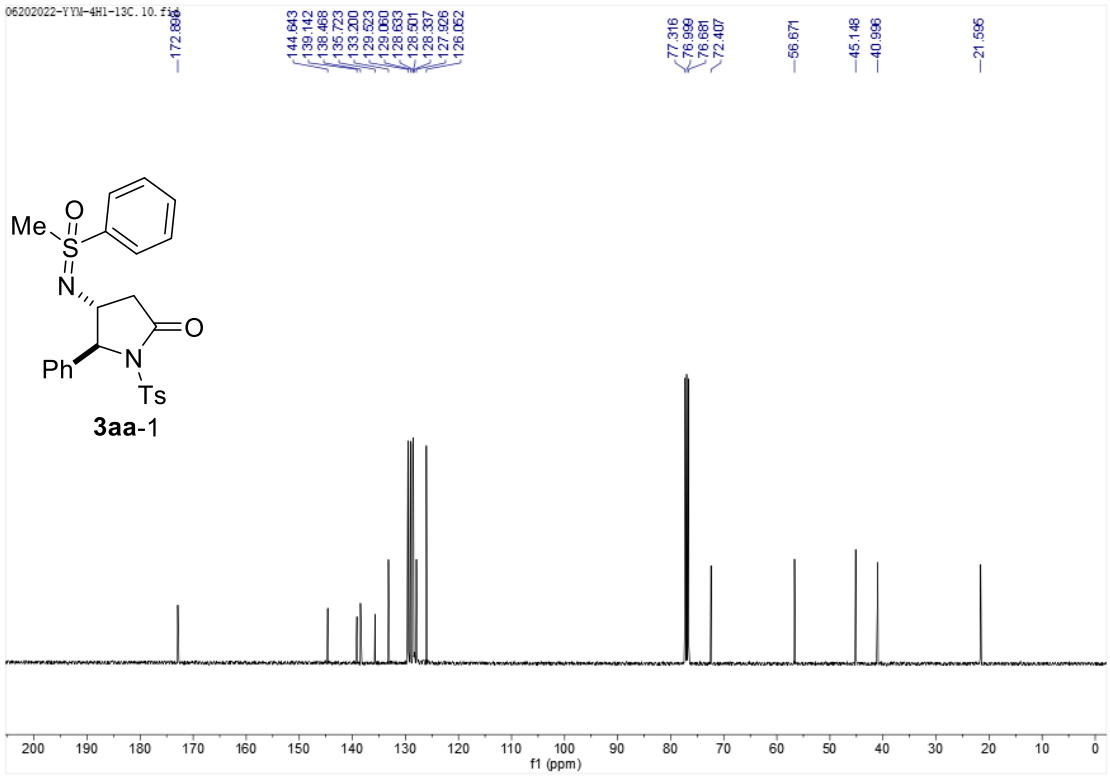


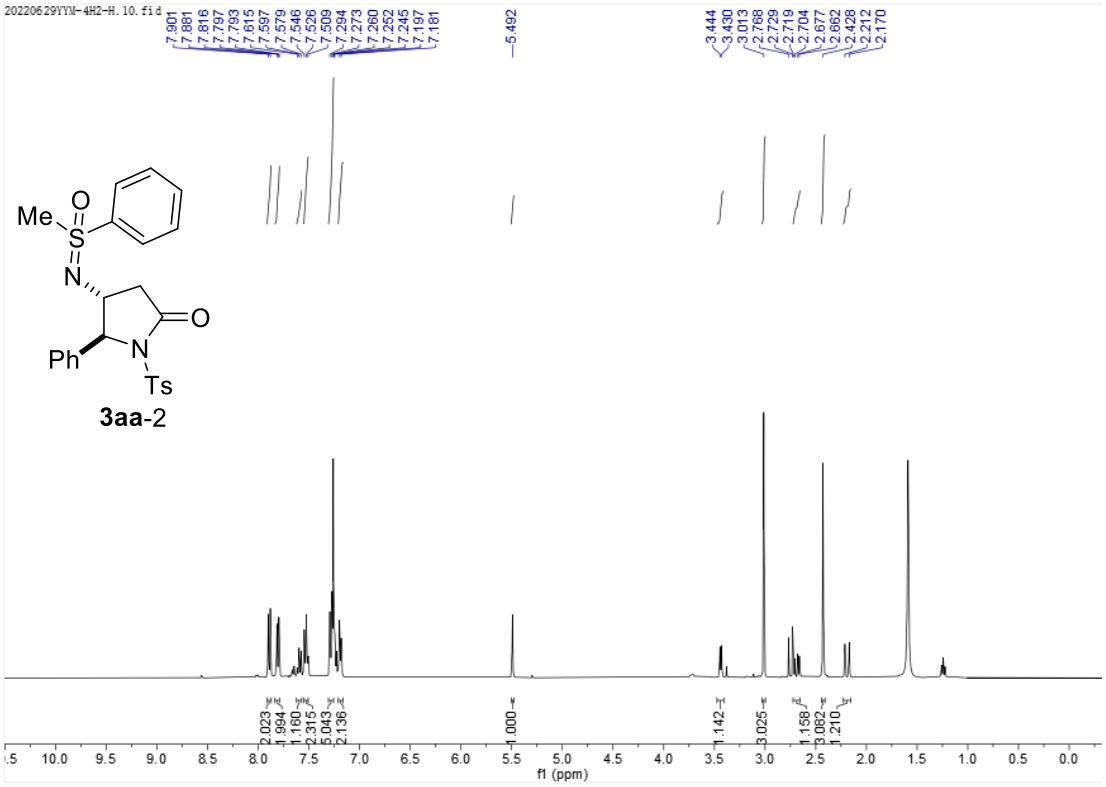
^{1}H NMR (400 MHz, $CDCl_3$) of **3aa-1**



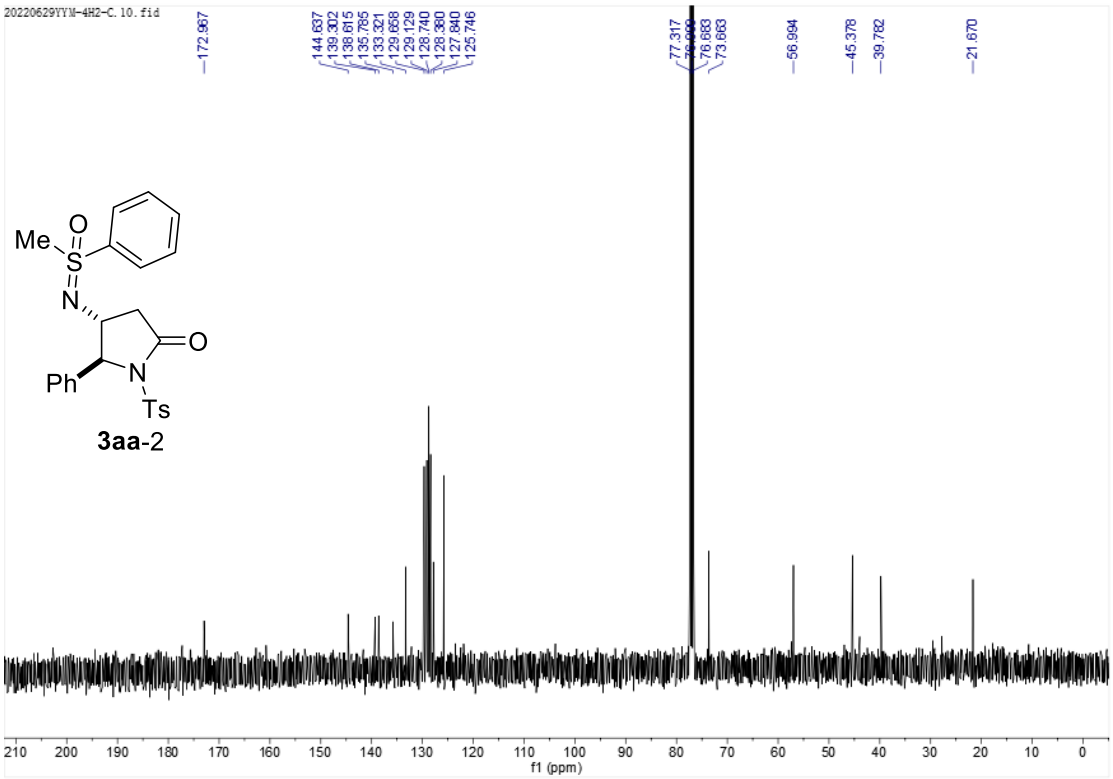
^{13}C NMR (101 MHz, $CDCl_3$) of **3aa-1**



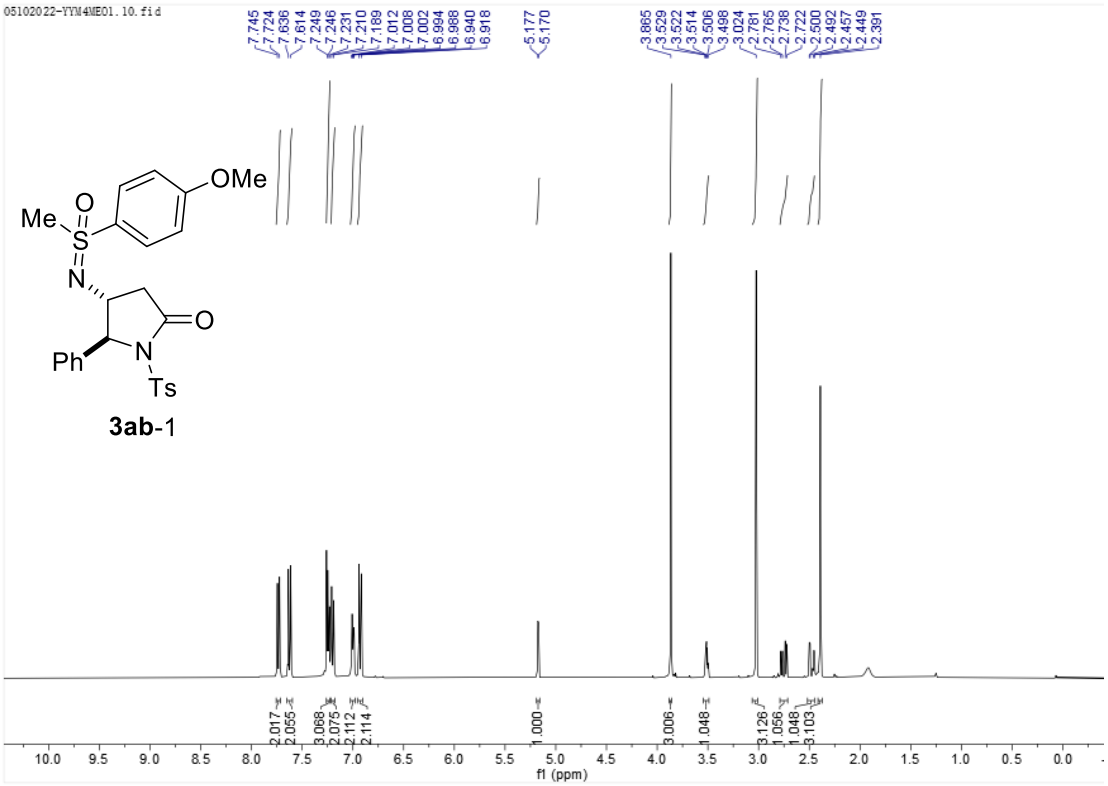
^{1}H NMR (400 MHz, $CDCl_3$) of **3aa-2**



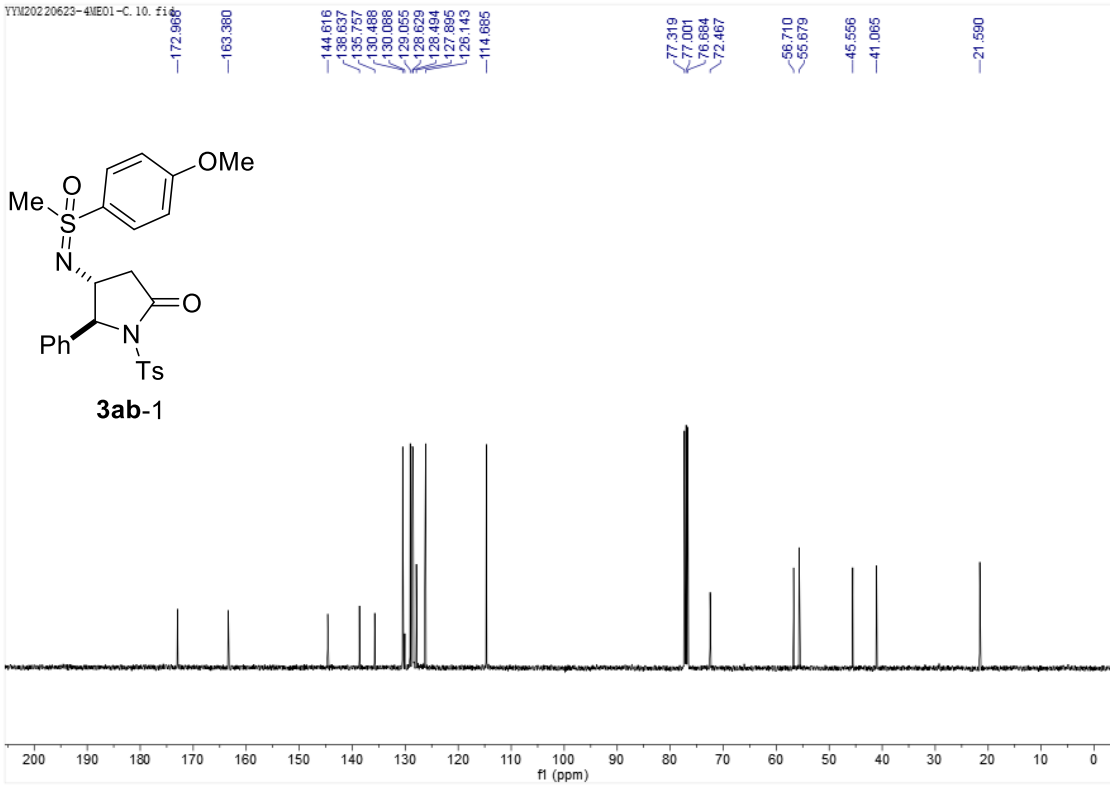
^{13}C NMR (101 MHz, $CDCl_3$) of **3aa-2**



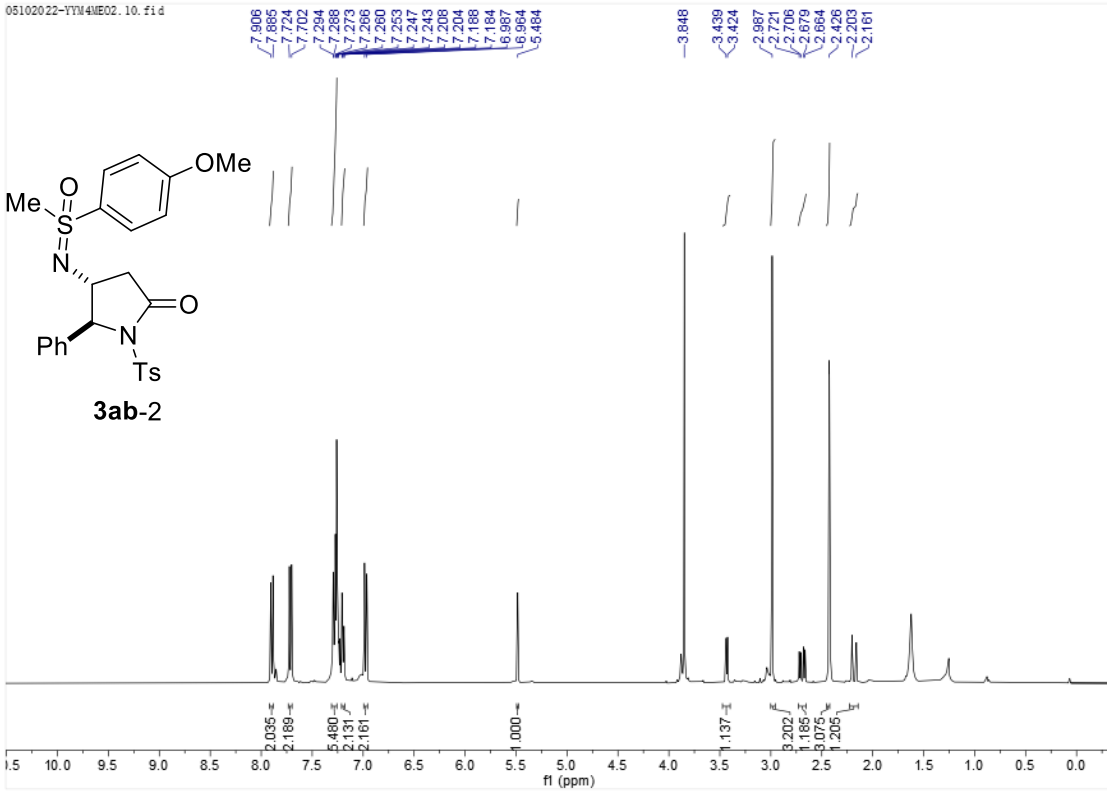
^{1}H NMR (400 MHz, $CDCl_3$) of **3ab-1**



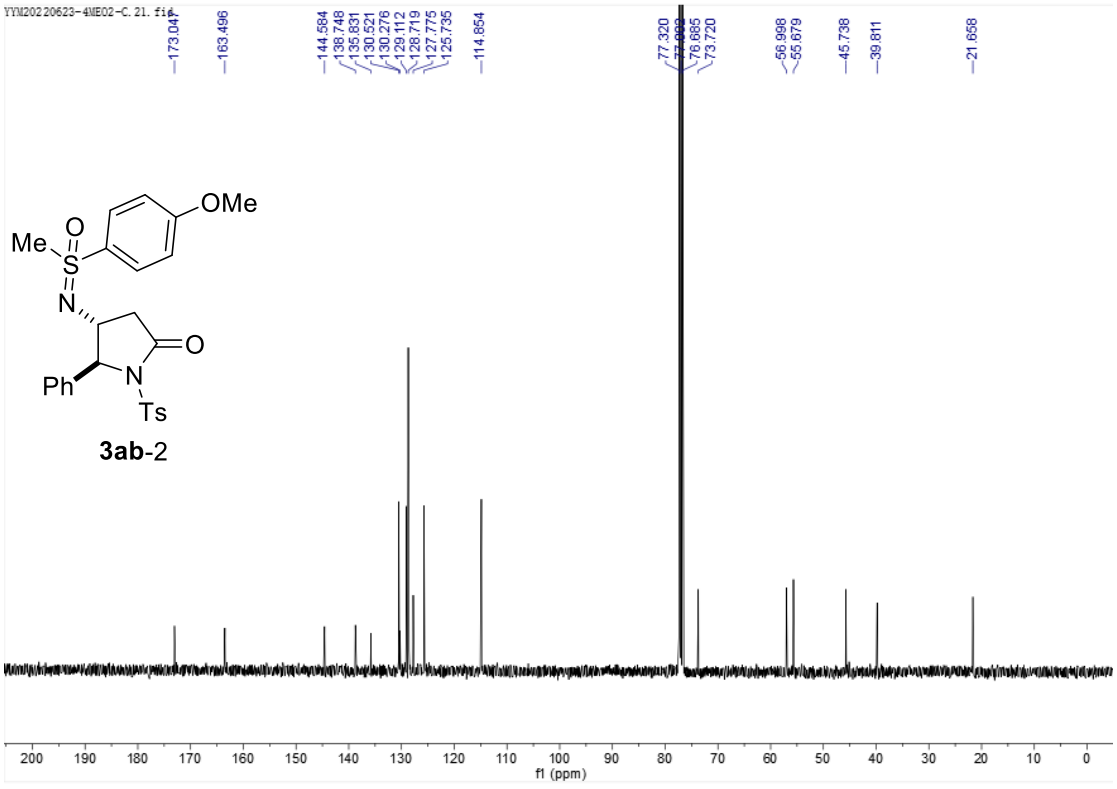
^{13}C NMR (101 MHz, $CDCl_3$) of **3ab-1**



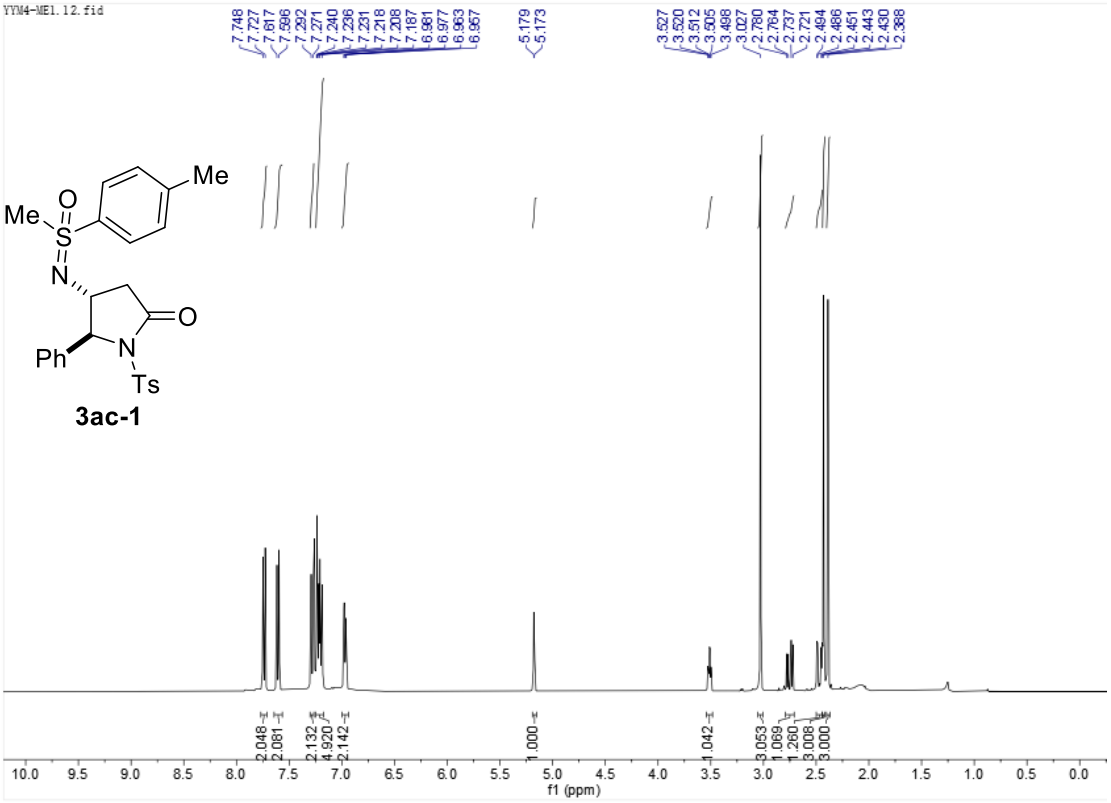
^{1}H NMR (400 MHz, $CDCl_3$) of **3ab-2**



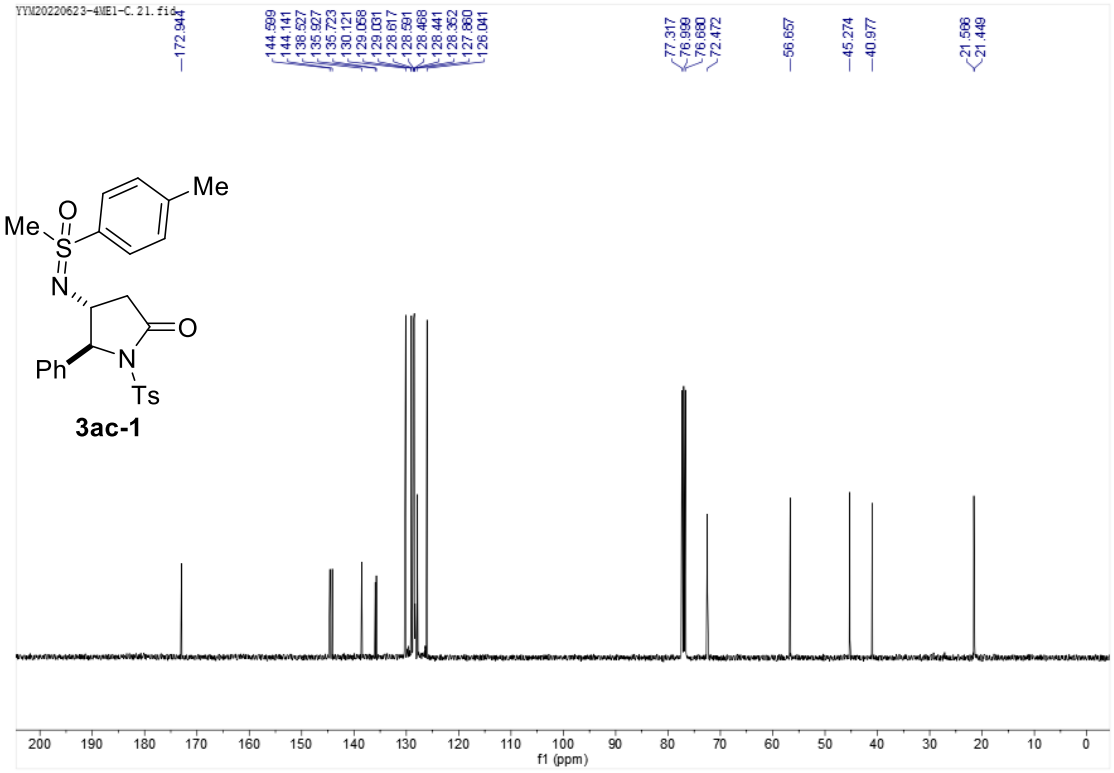
^{13}C NMR (101 MHz, $CDCl_3$) of **3ab-2**



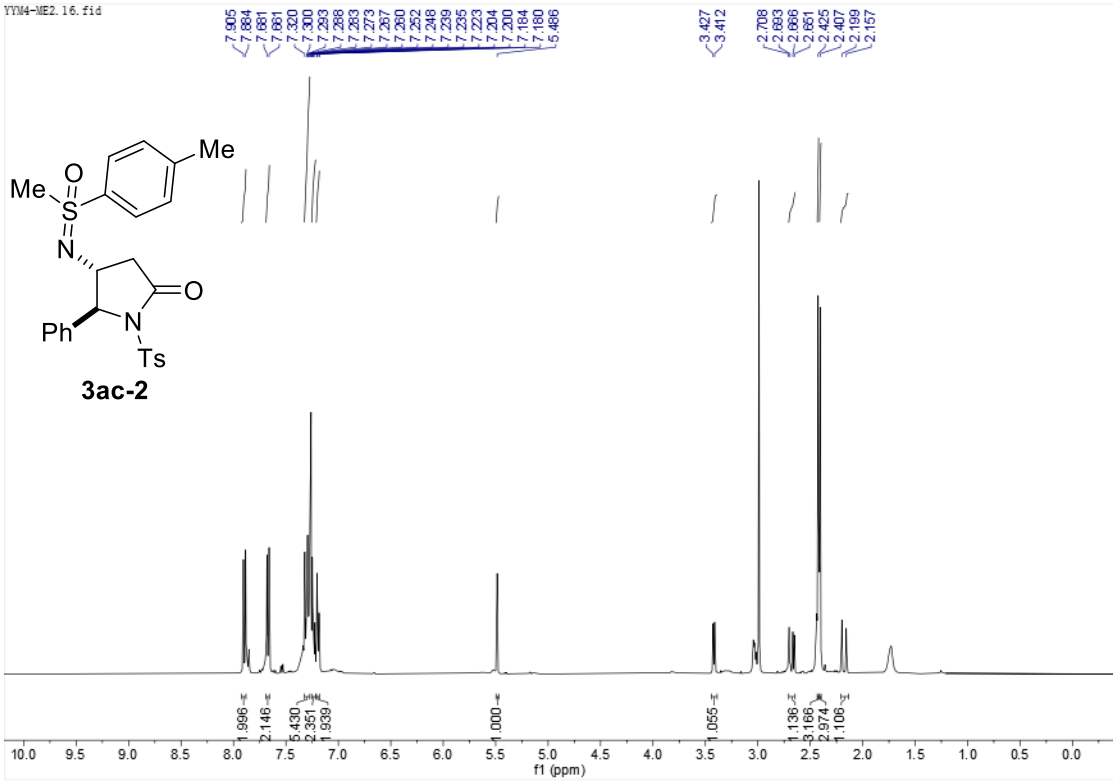
^{1}H NMR (400 MHz, $CDCl_3$) of **3ac-1**



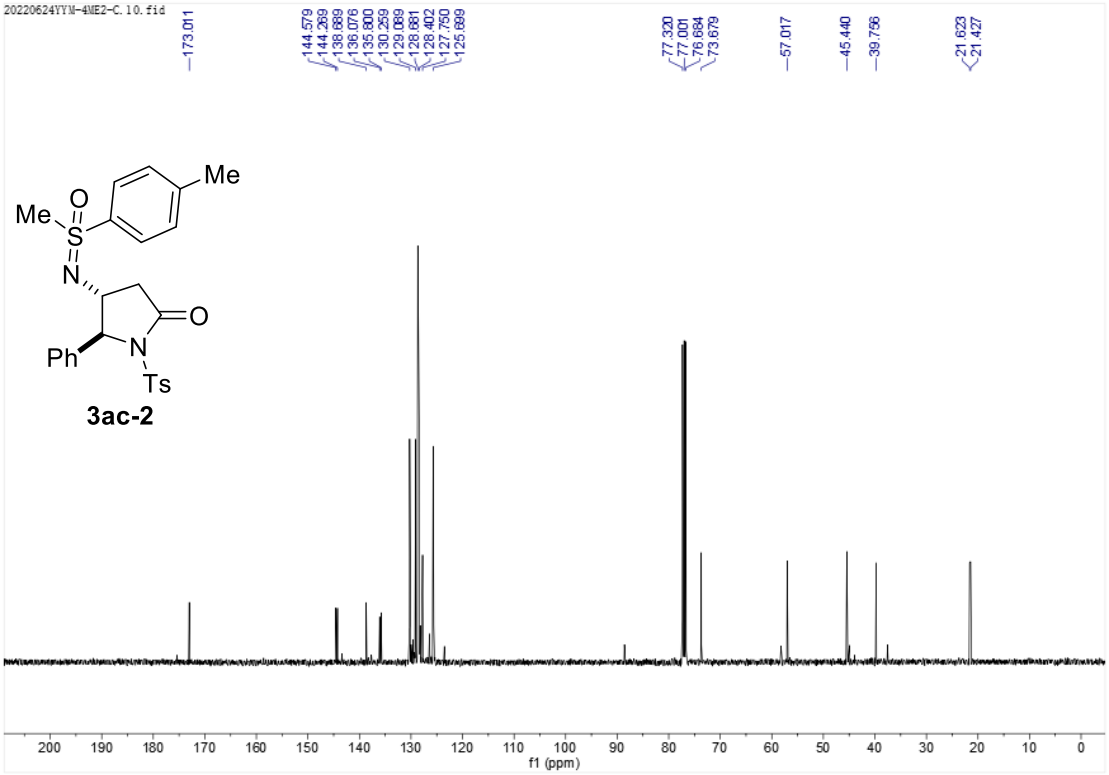
^{13}C NMR (101 MHz, $CDCl_3$) of **3ac-1**



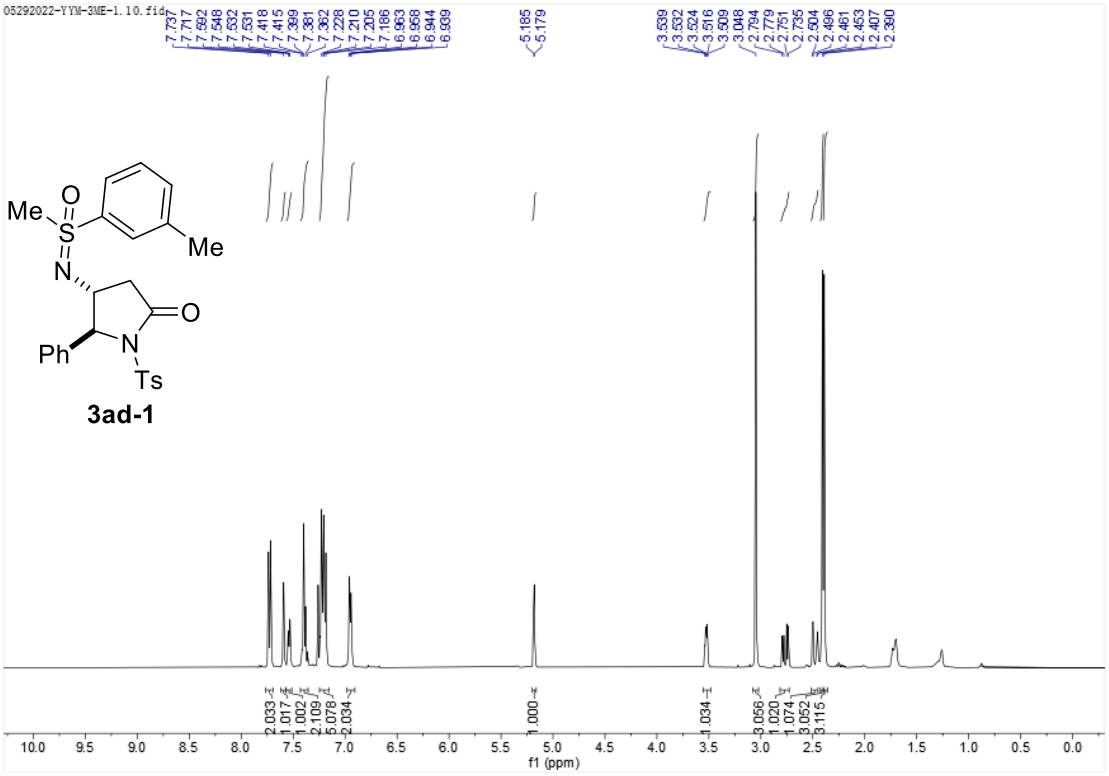
^{1}H NMR (400 MHz, $CDCl_3$) of **3ac-2**



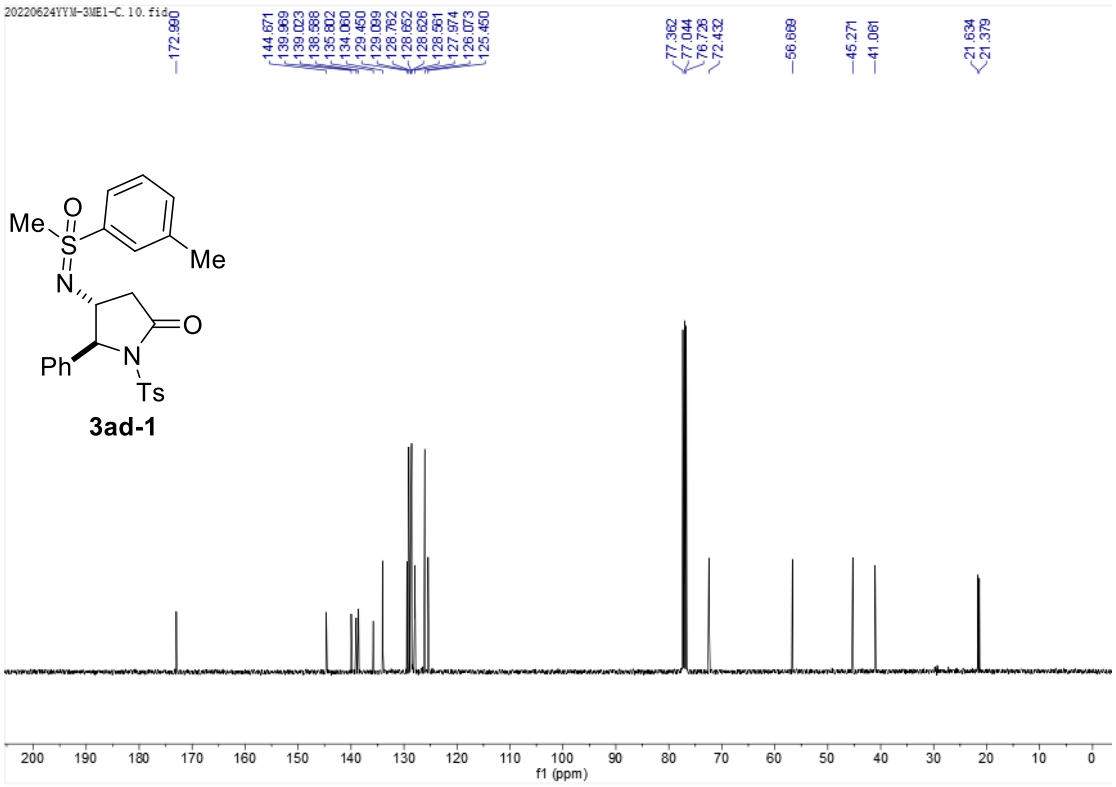
^{13}C NMR (101 MHz, $CDCl_3$) of **3b-2**



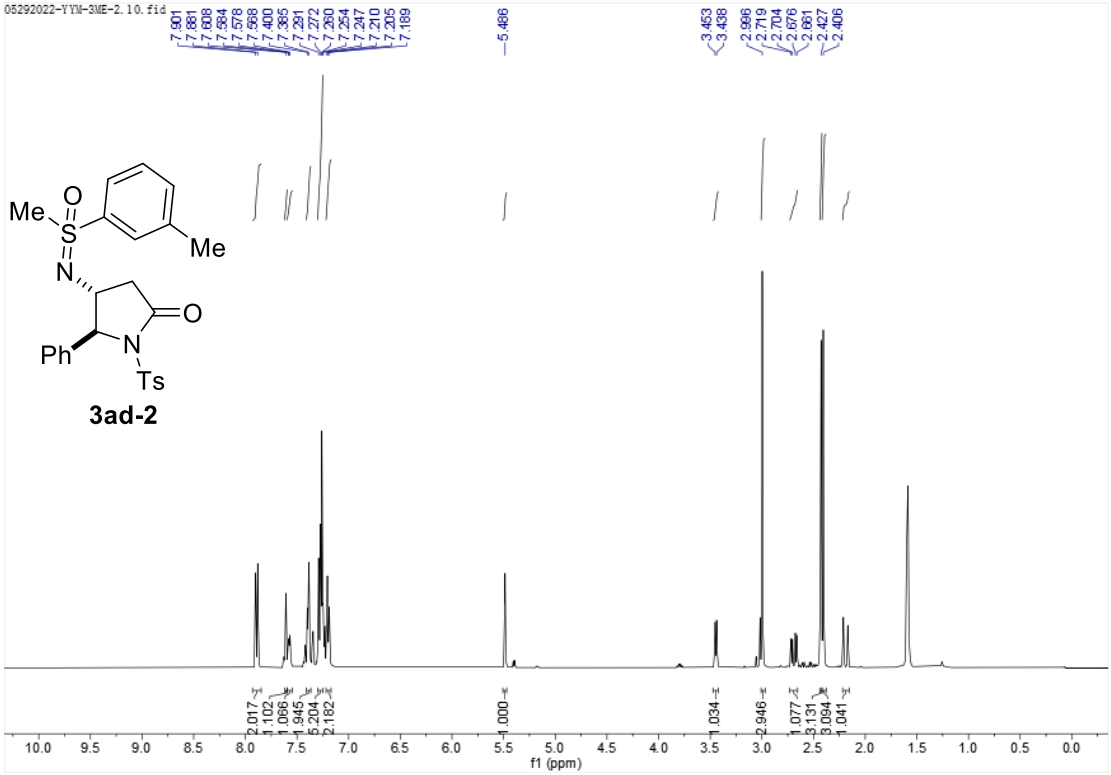
^{1}H NMR (400 MHz, $CDCl_3$) of **3ad-1**



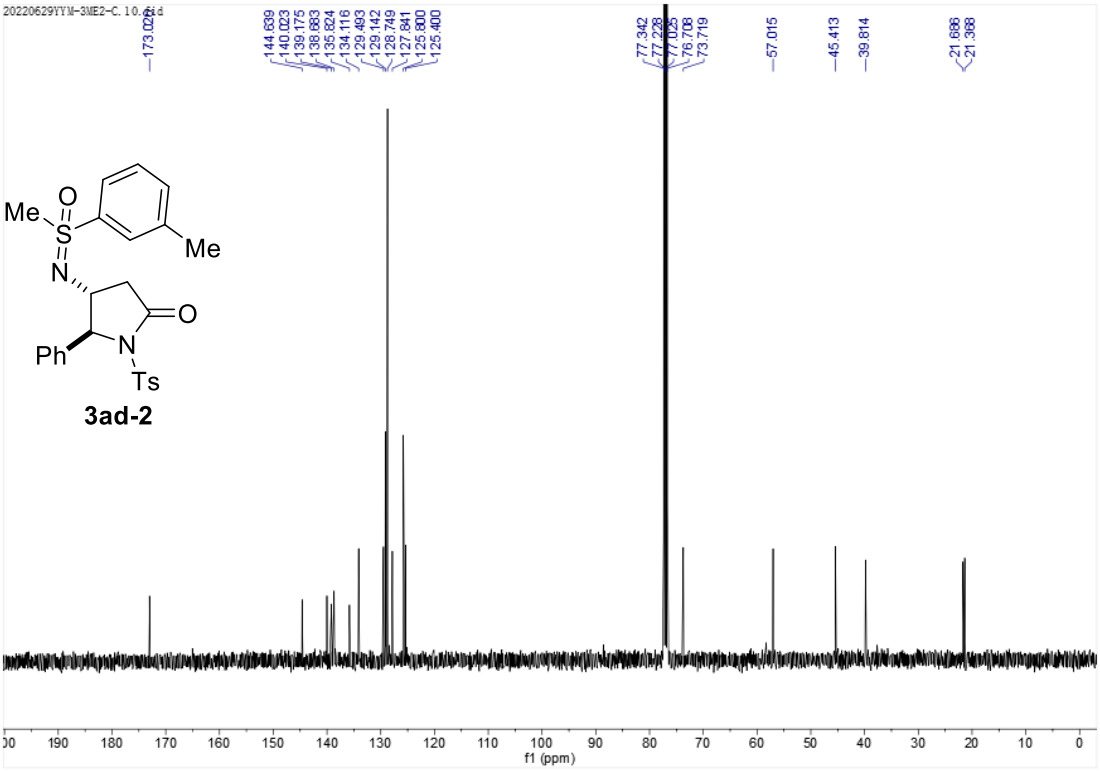
^{13}C NMR (101 MHz, $CDCl_3$) of **3ad-1**



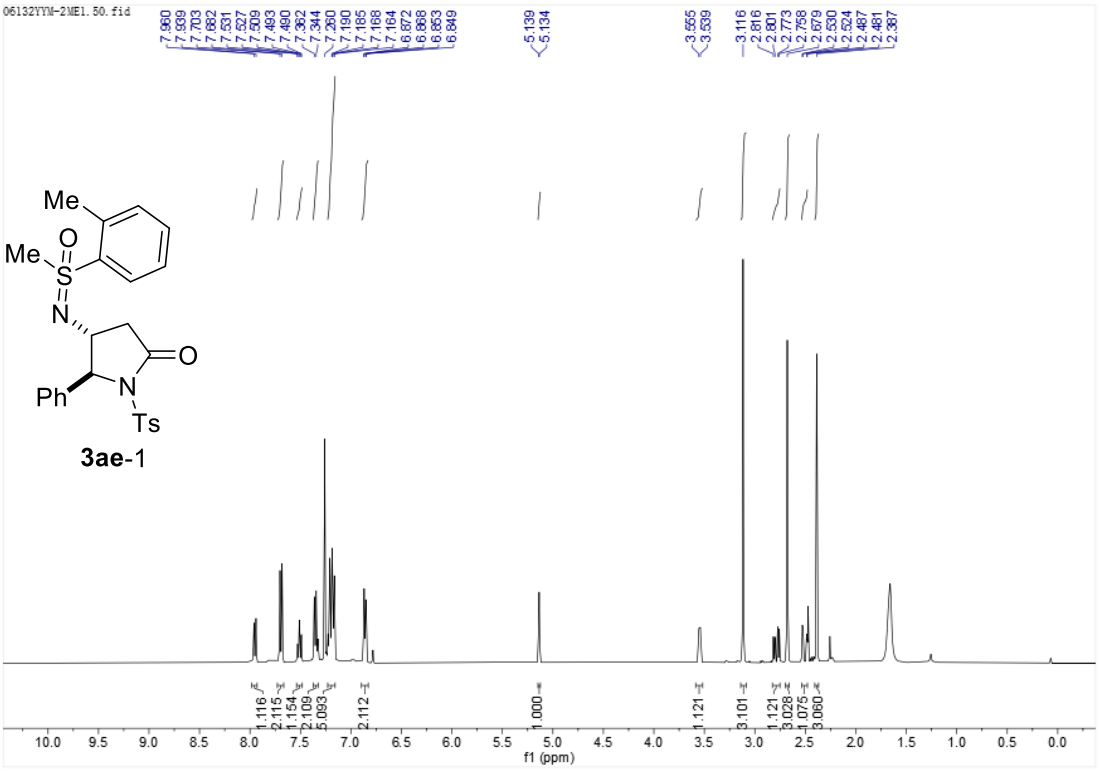
^{1}H NMR (400 MHz, $CDCl_3$) of **3ad-2**



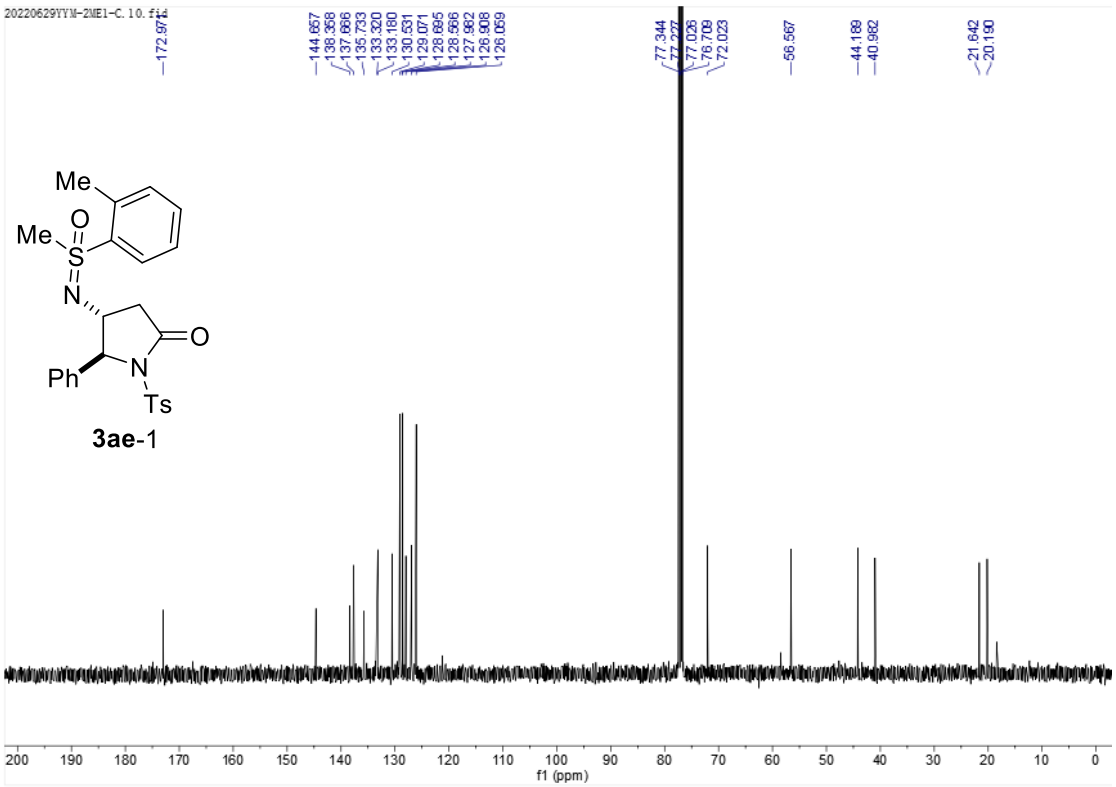
^{13}C NMR (101 MHz, $CDCl_3$) of **3ad-2**



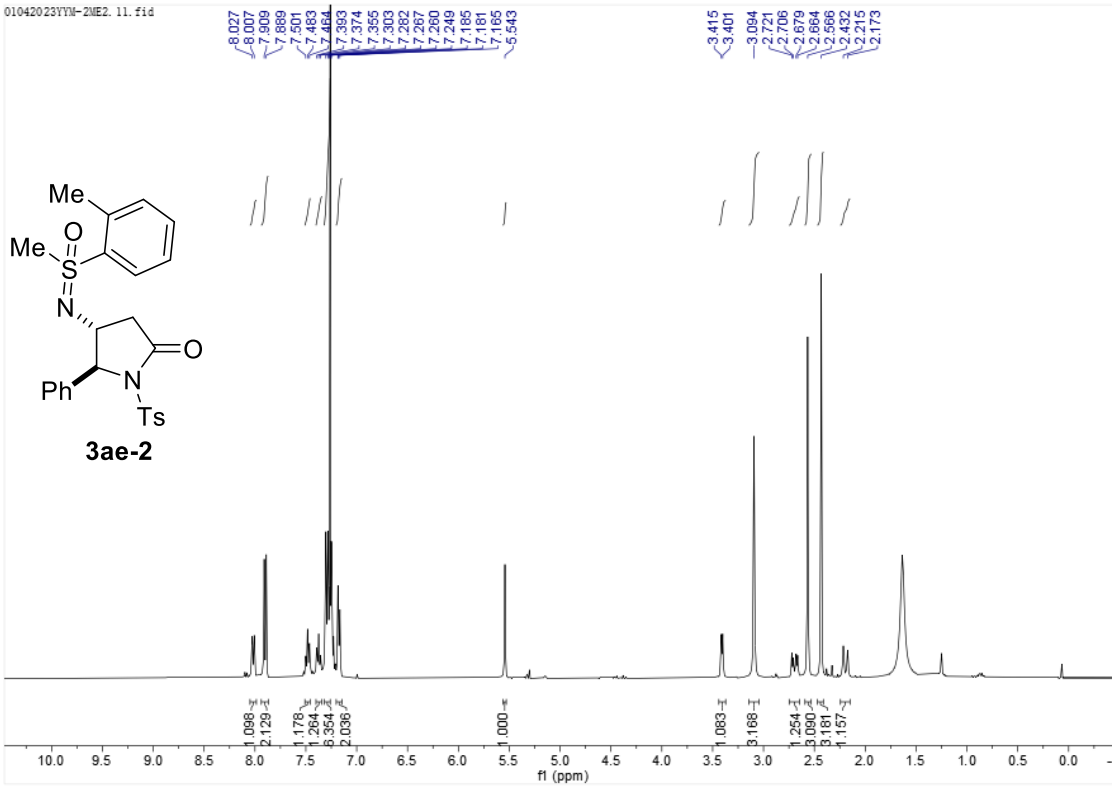
^{1}H NMR (400 MHz, $CDCl_3$) of **3ae-1**



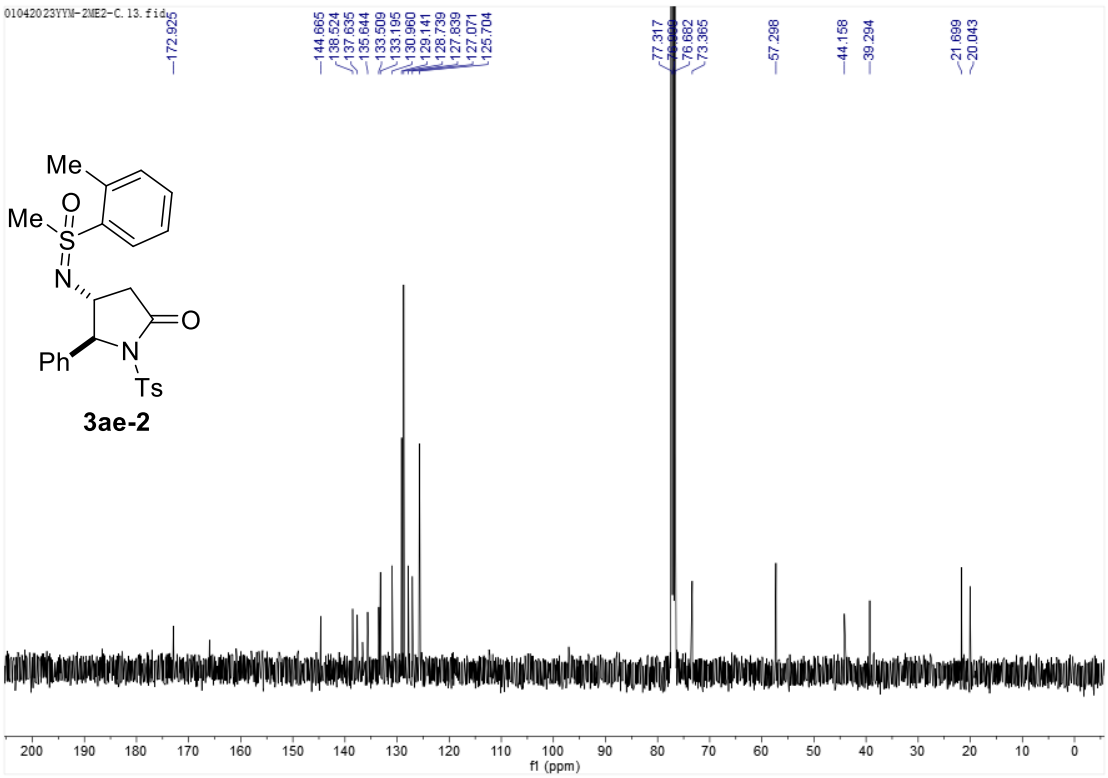
^{13}C NMR (101 MHz, $CDCl_3$) of **3ae-1**



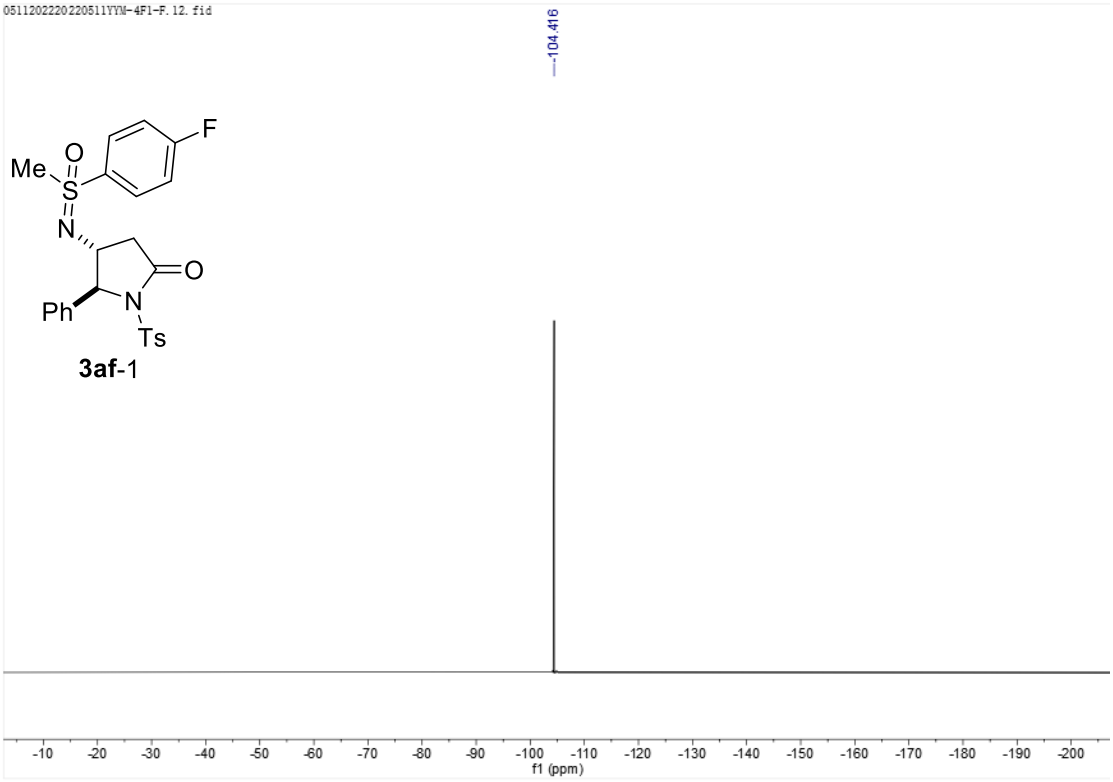
^{1}H NMR (400 MHz, $CDCl_3$) of **3ae-2**



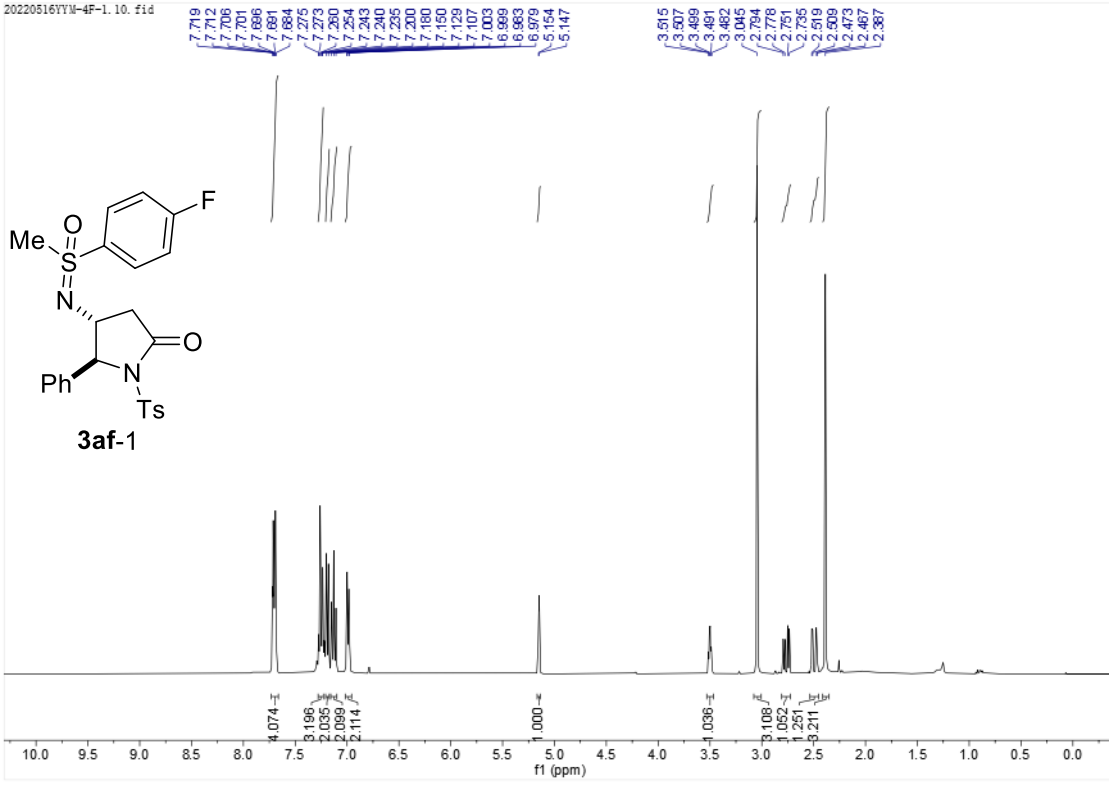
^{13}C NMR (101 MHz, $CDCl_3$) of **3ae-2**



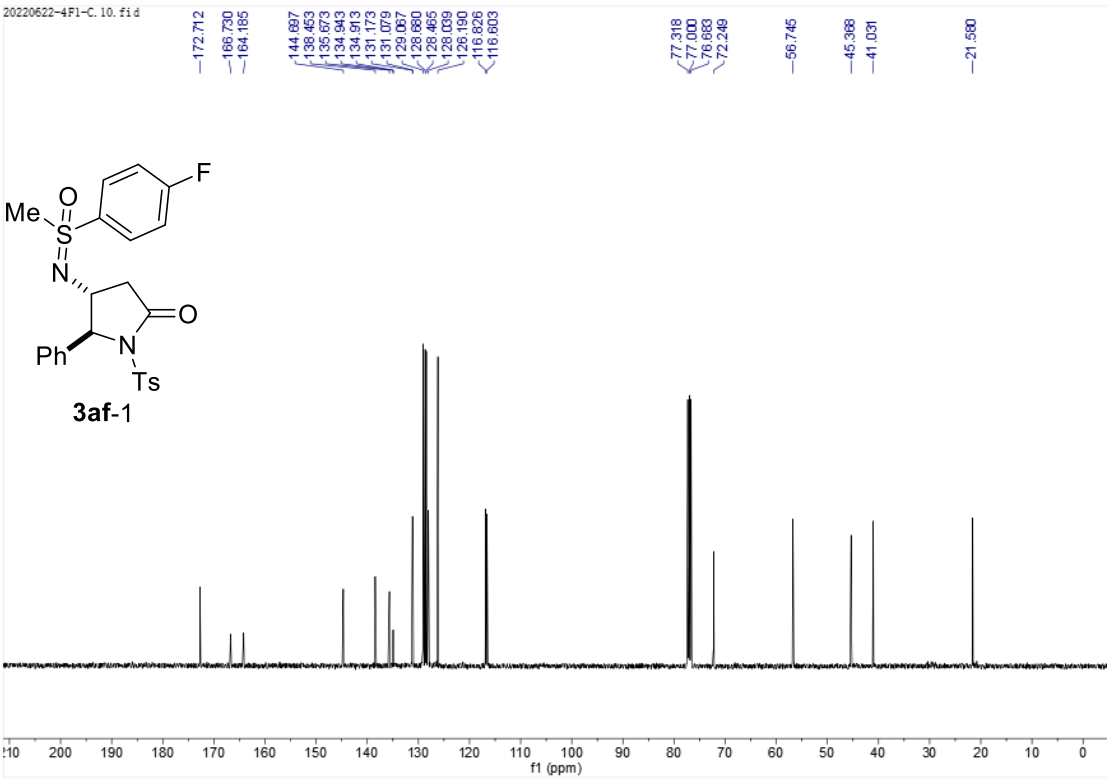
^{19}F NMR (376 MHz, $CDCl_3$) of **3af-1**



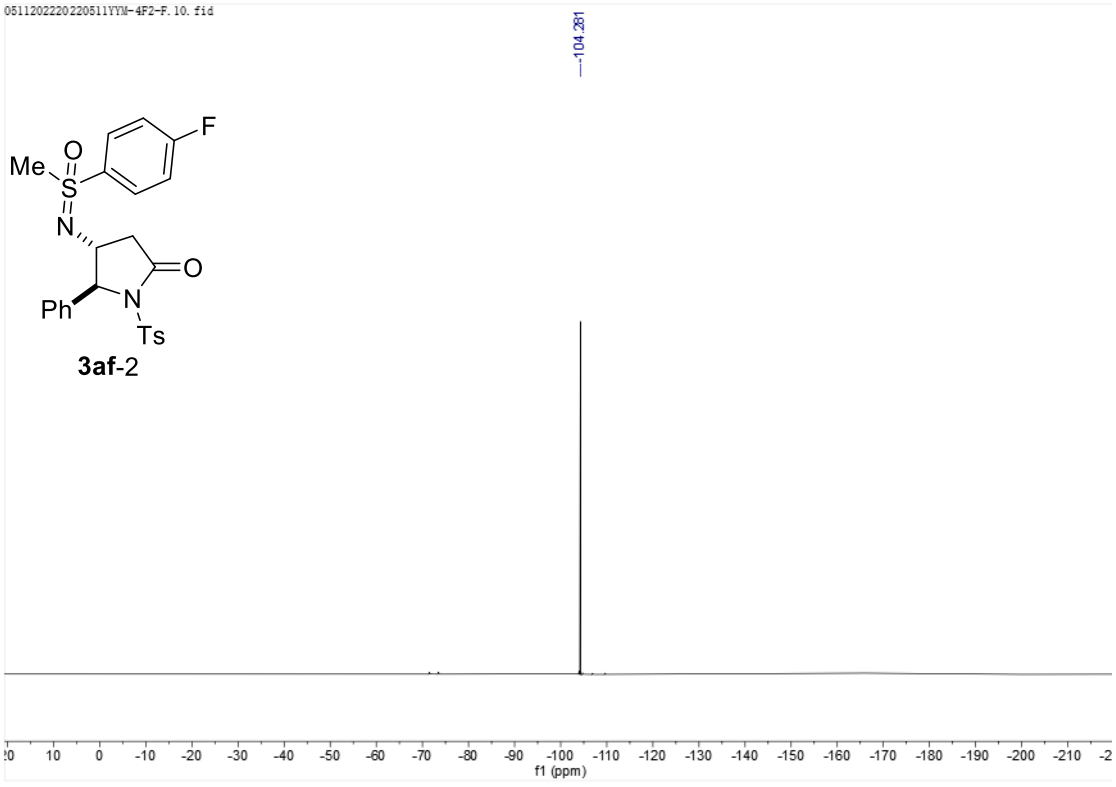
^{1}H NMR (400 MHz, $CDCl_3$) of **3af-1**



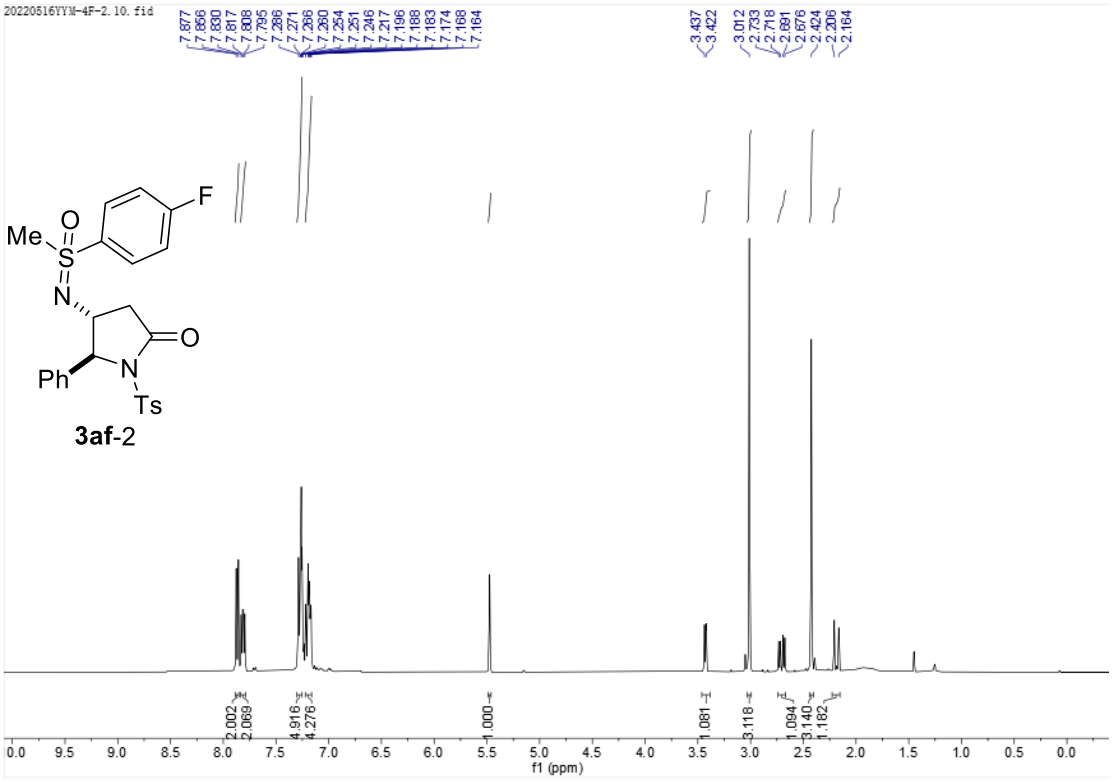
^{13}C NMR (101 MHz, $CDCl_3$) of **3af-1**



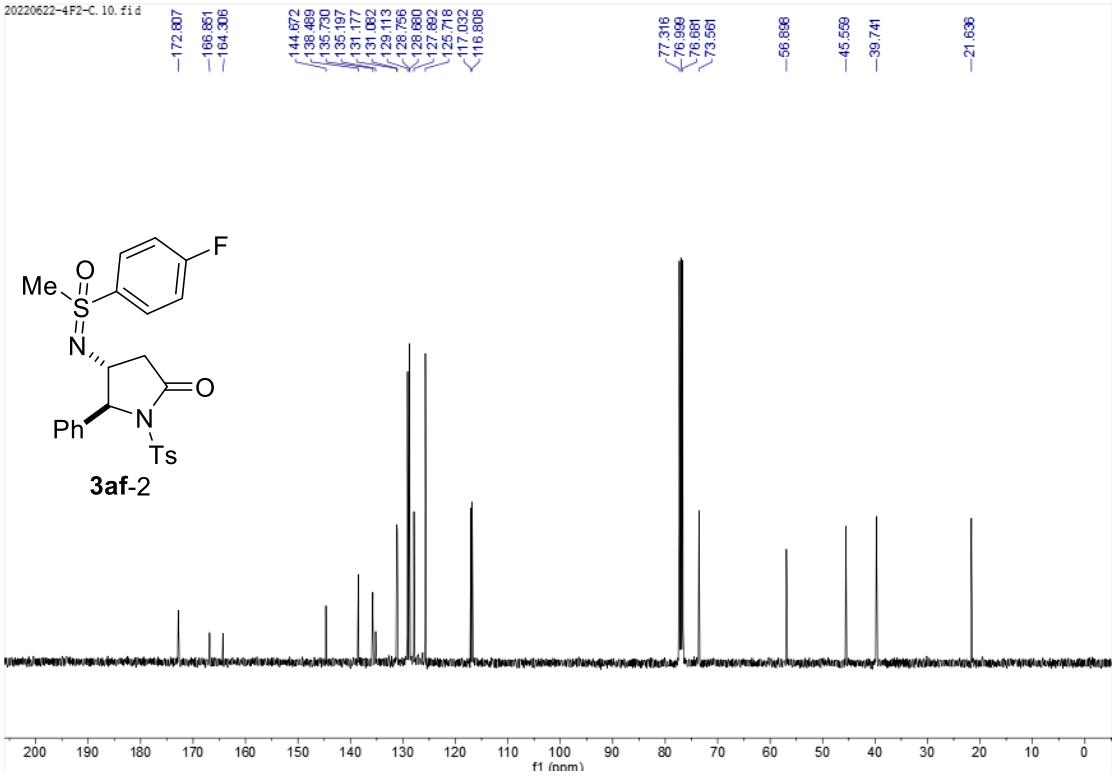
^{19}F NMR (376 MHz, $CDCl_3$) of **3af-2**



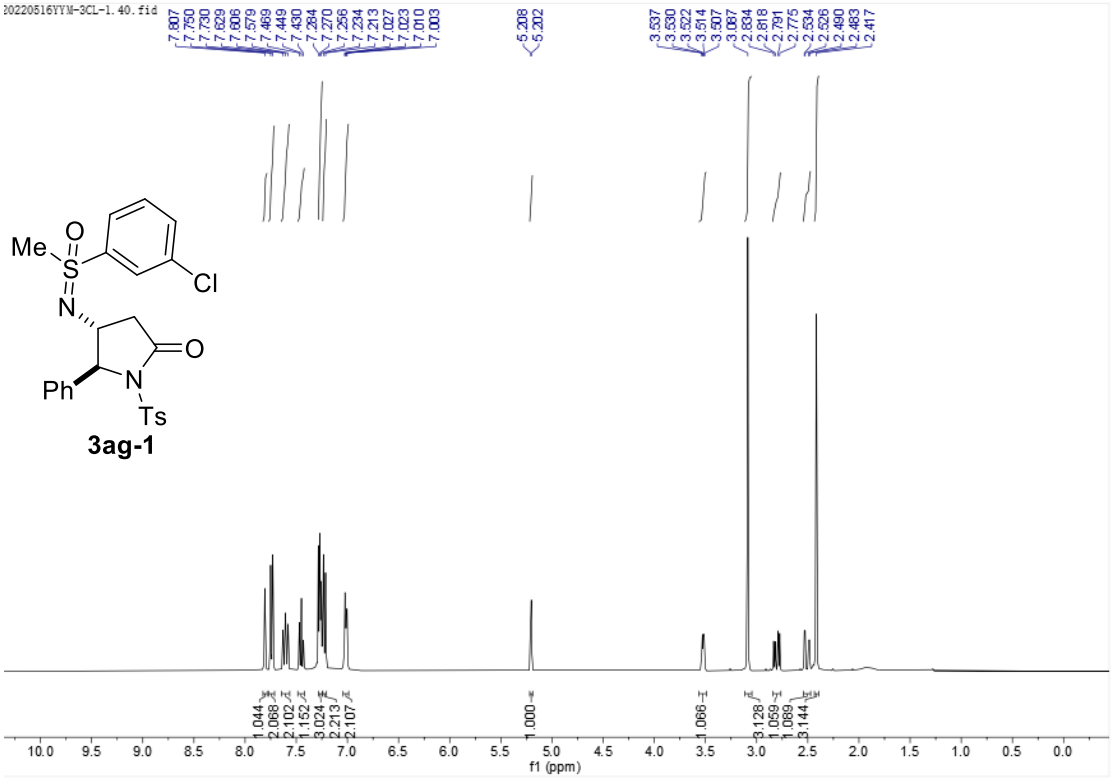
^{1}H NMR (400 MHz, $CDCl_3$) of **3af-2**



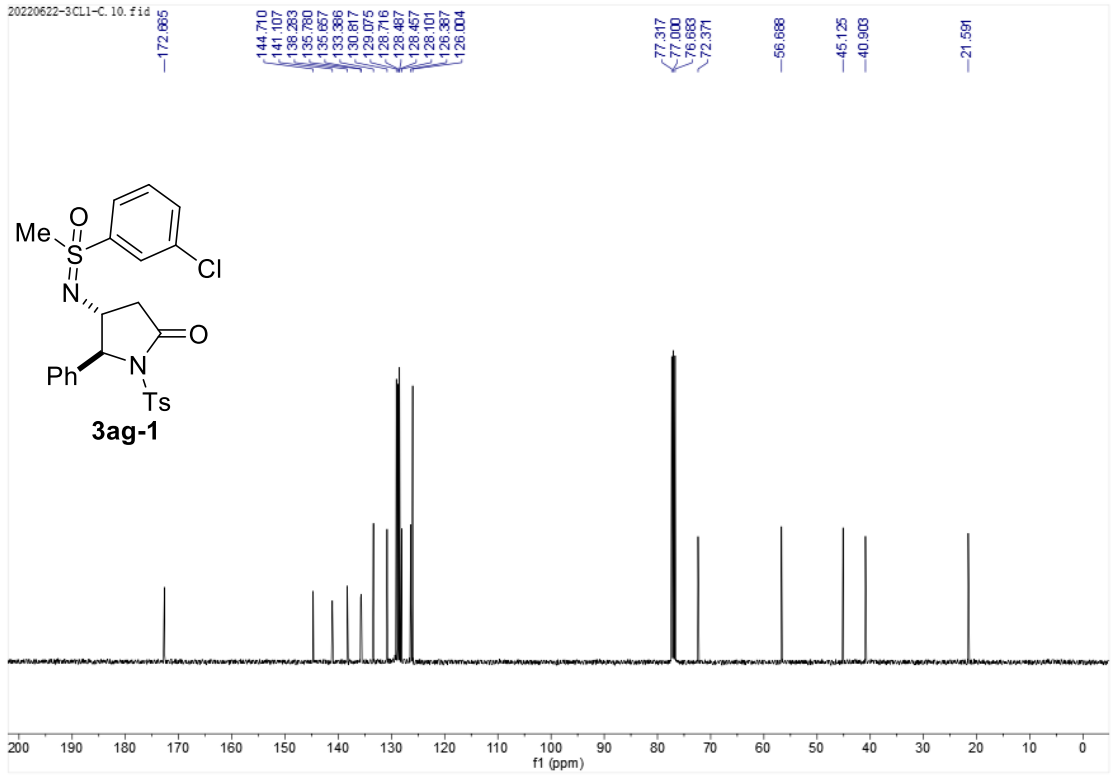
^{13}C NMR (101 MHz, $CDCl_3$) of **3af-2**



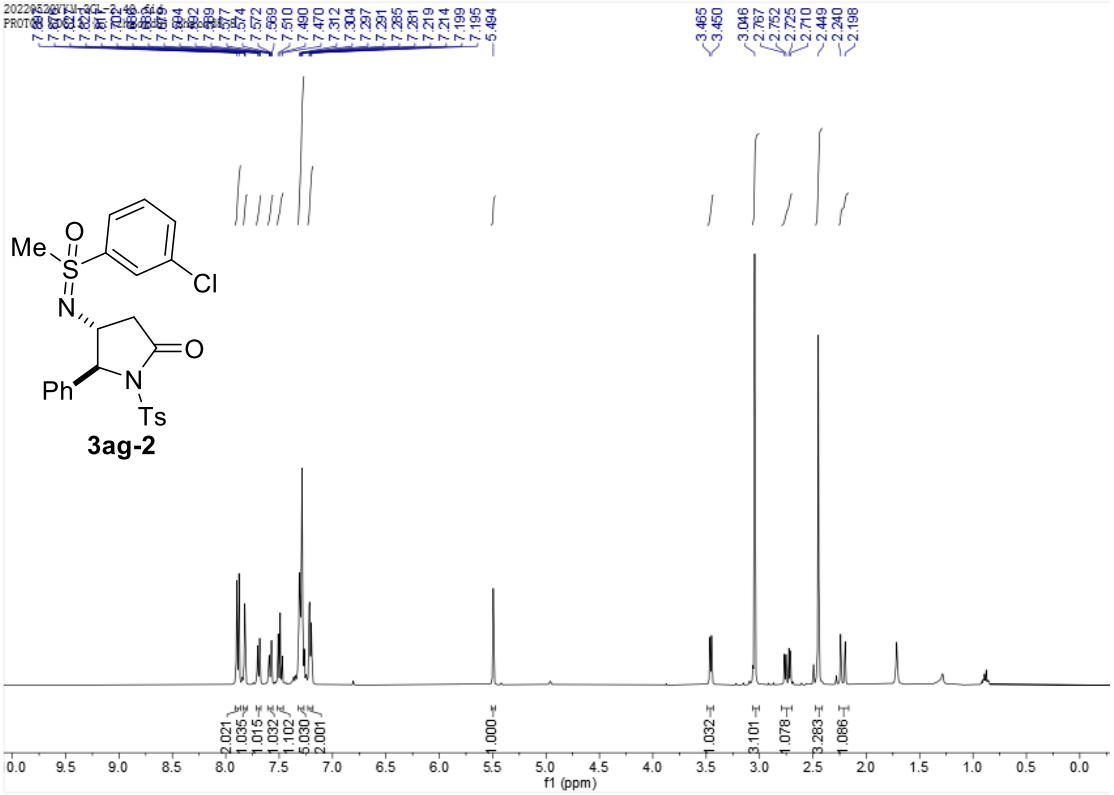
^{1}H NMR (400 MHz, $CDCl_3$) of **3ag-1**



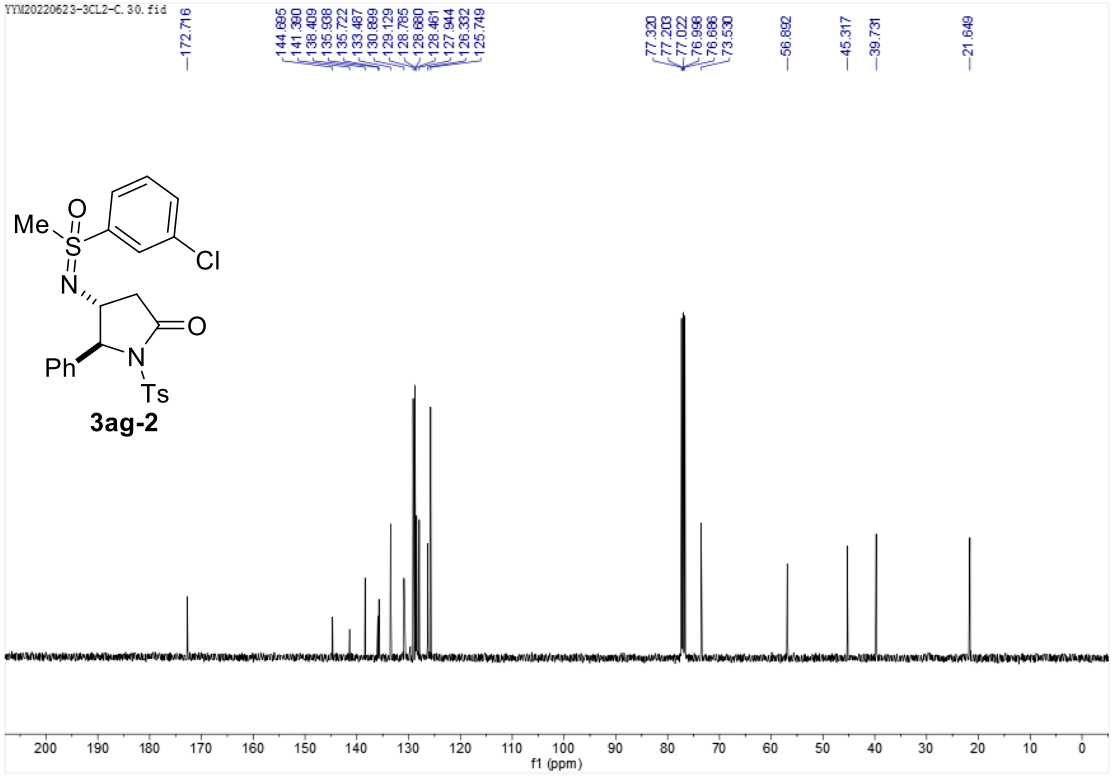
^{13}C NMR (101 MHz, $CDCl_3$) of **3ag-1**



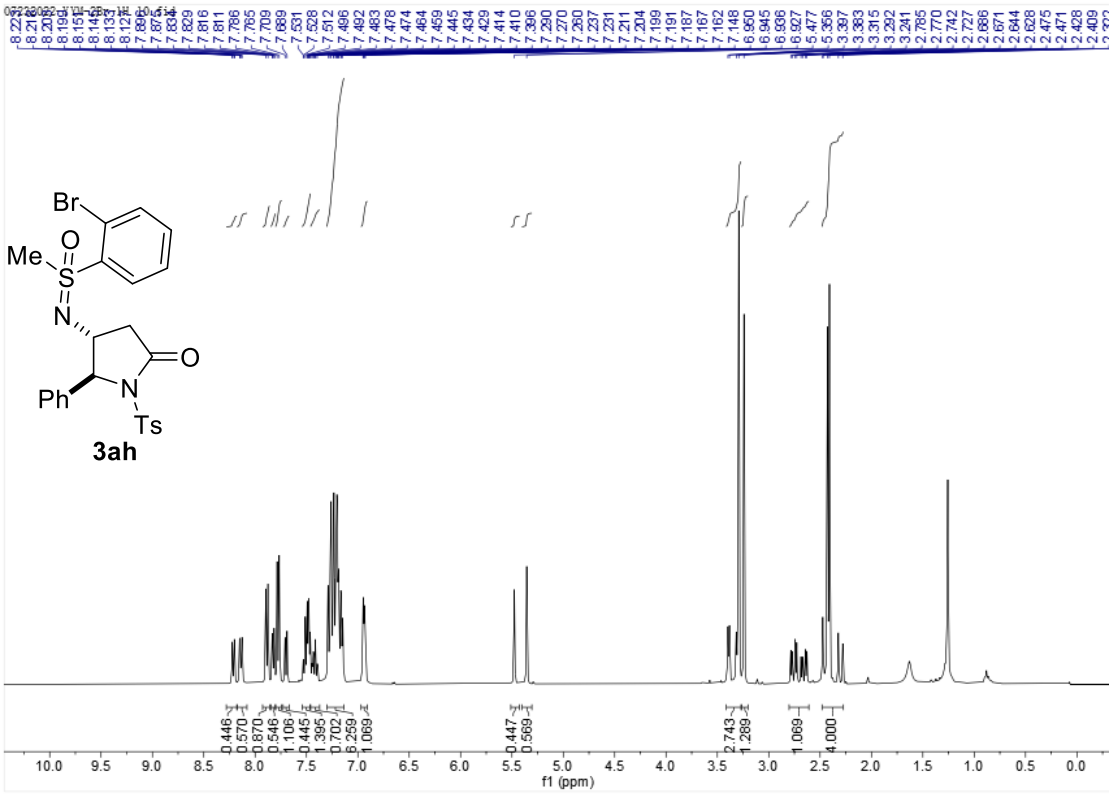
^{1}H NMR (400 MHz, $CDCl_3$) of **3ag-2**



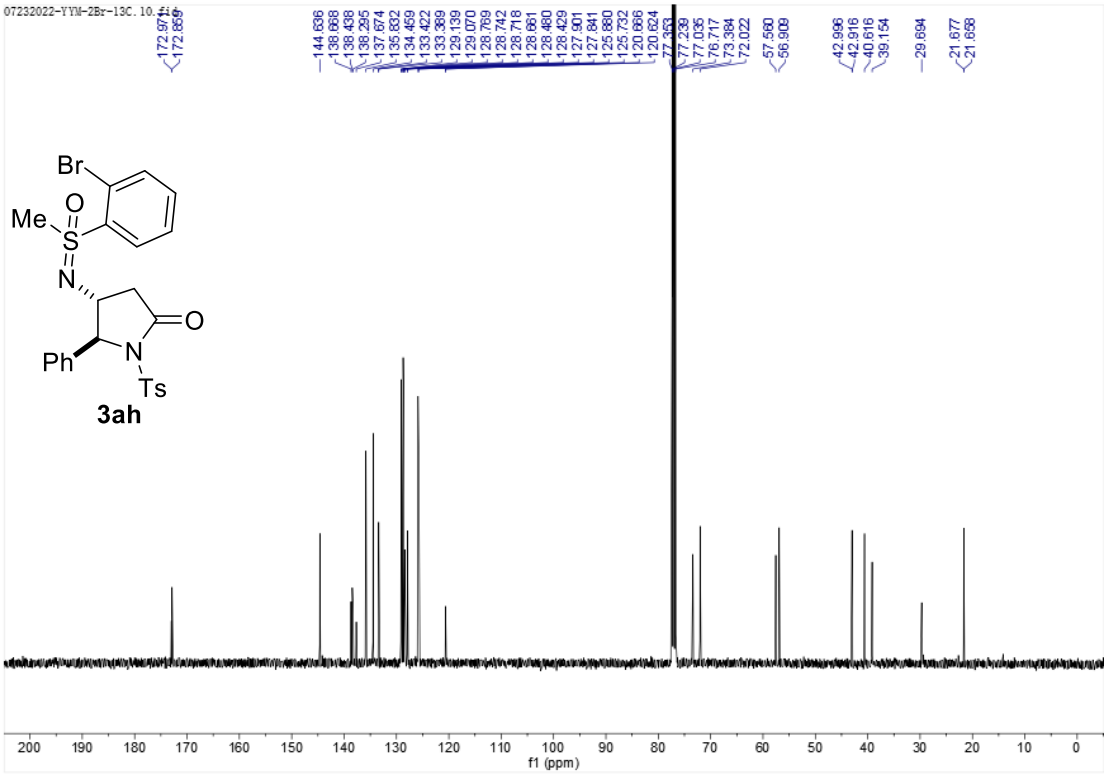
^{13}C NMR (101 MHz, $CDCl_3$) of **3ag-2**



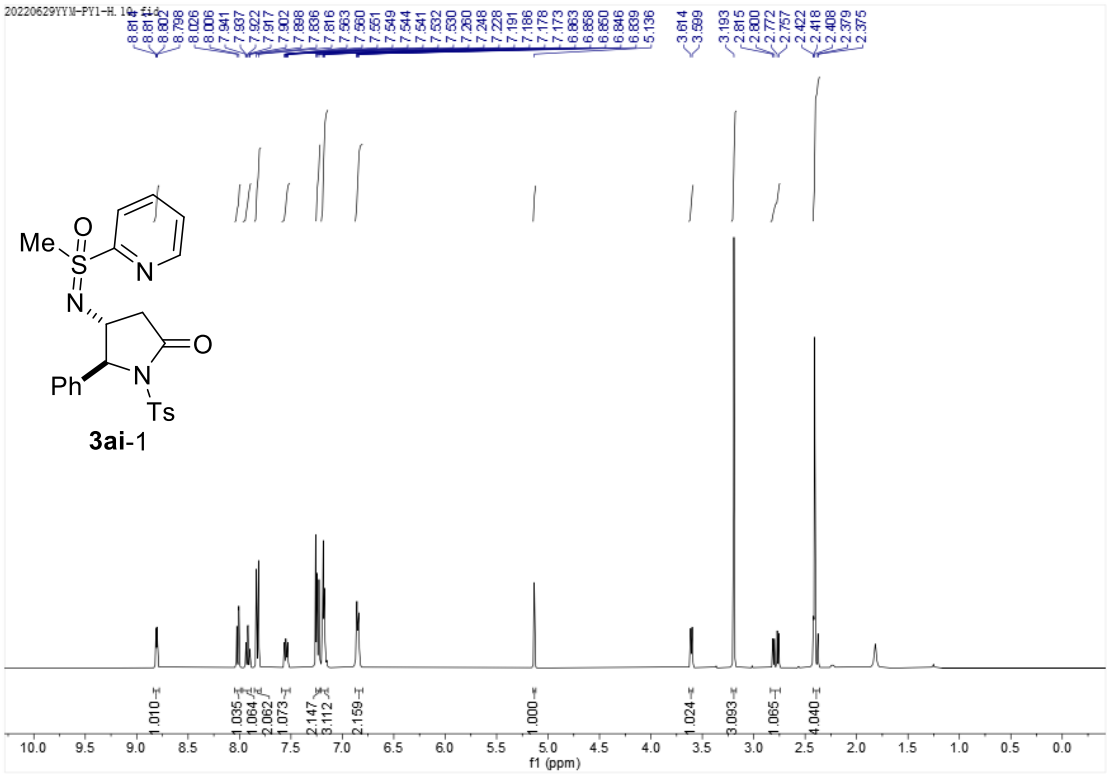
^{1}H NMR (400 MHz, $CDCl_3$) of **3ah**



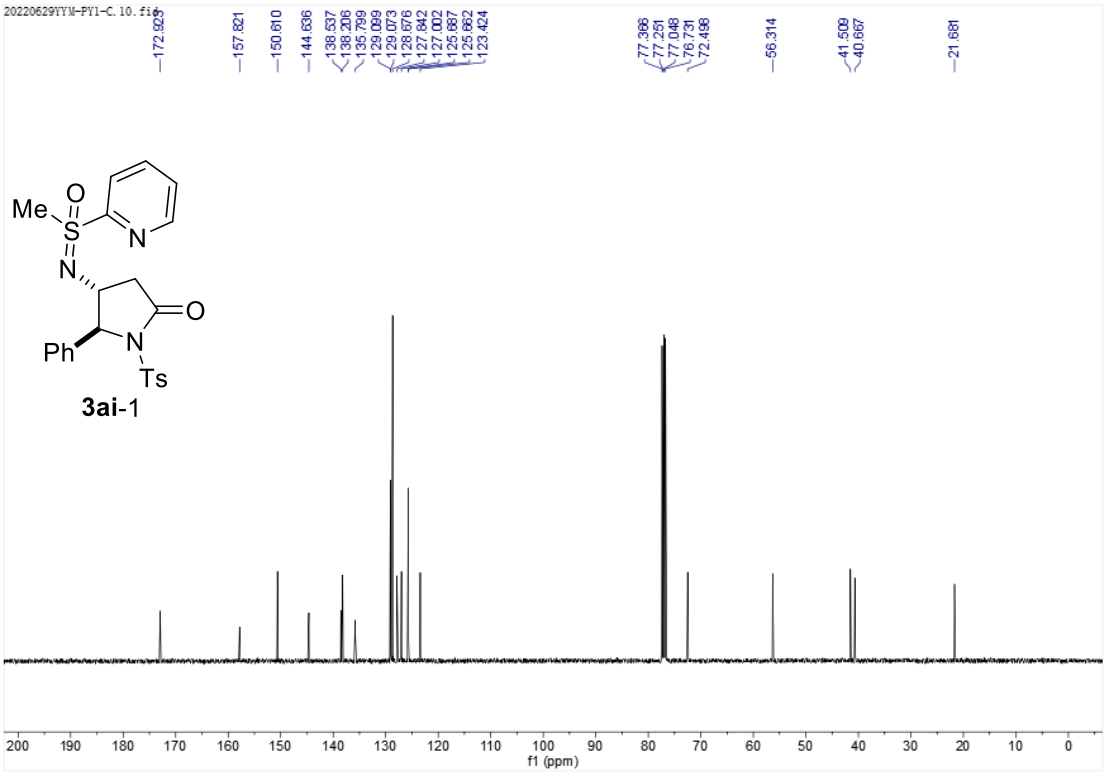
^{13}C NMR (101 MHz, $CDCl_3$) of **3ah**



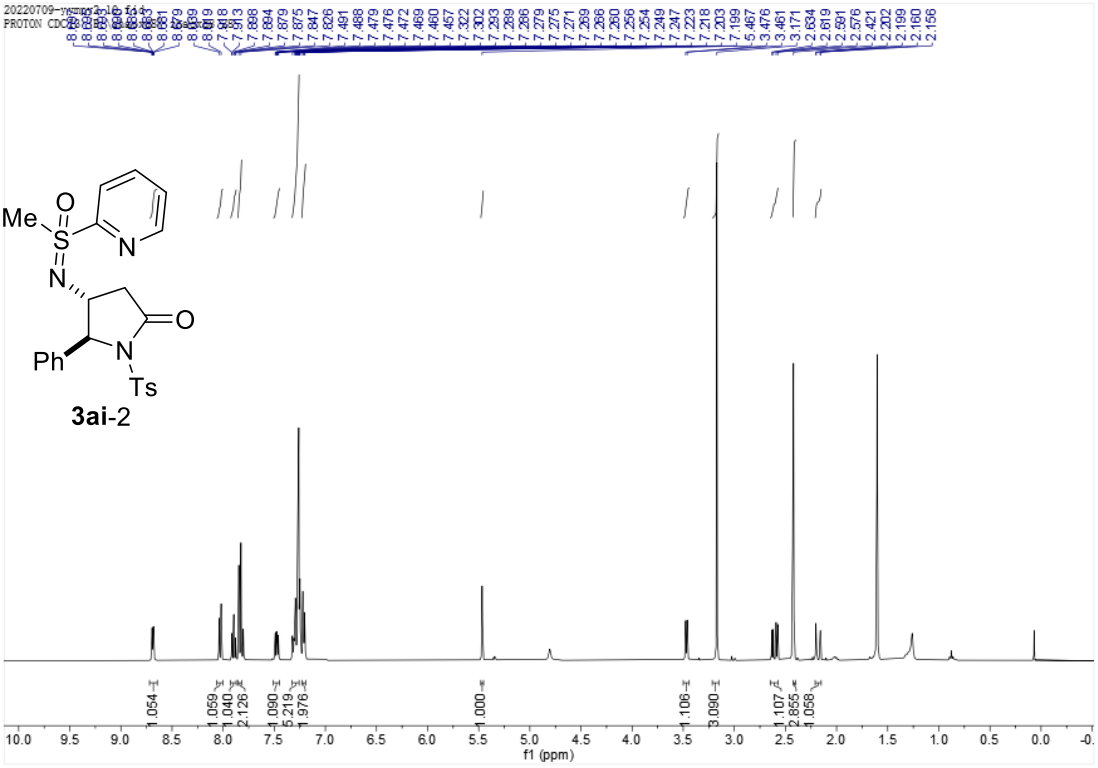
^{1}H NMR (400 MHz, $CDCl_3$) of **3ai-1**



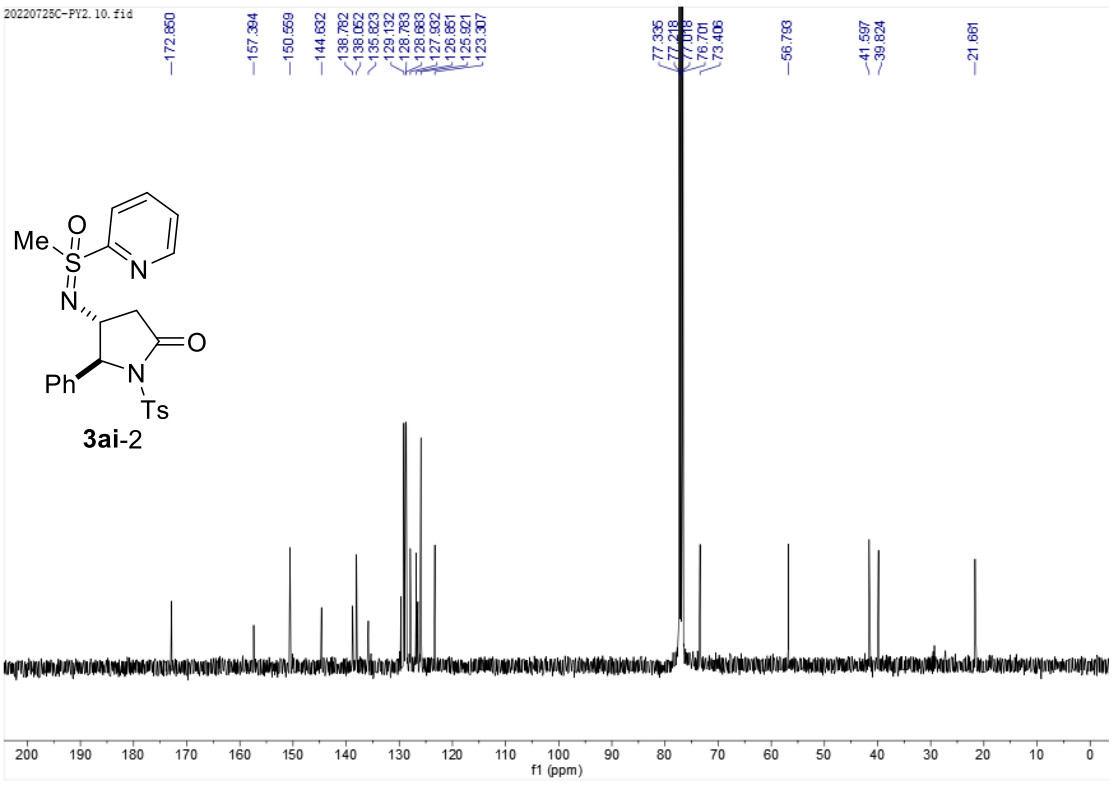
^{13}C NMR (101 MHz, $CDCl_3$) of **3ai-1**



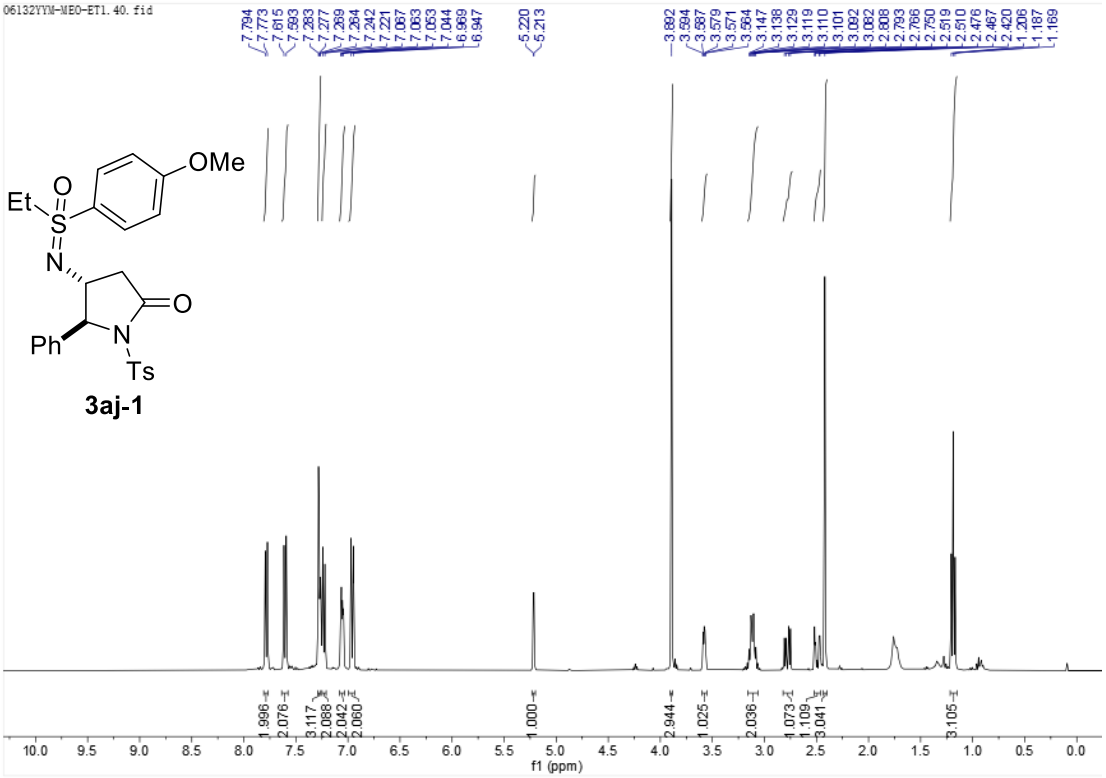
^{1}H NMR (400 MHz, $CDCl_3$) of **3ai-2**



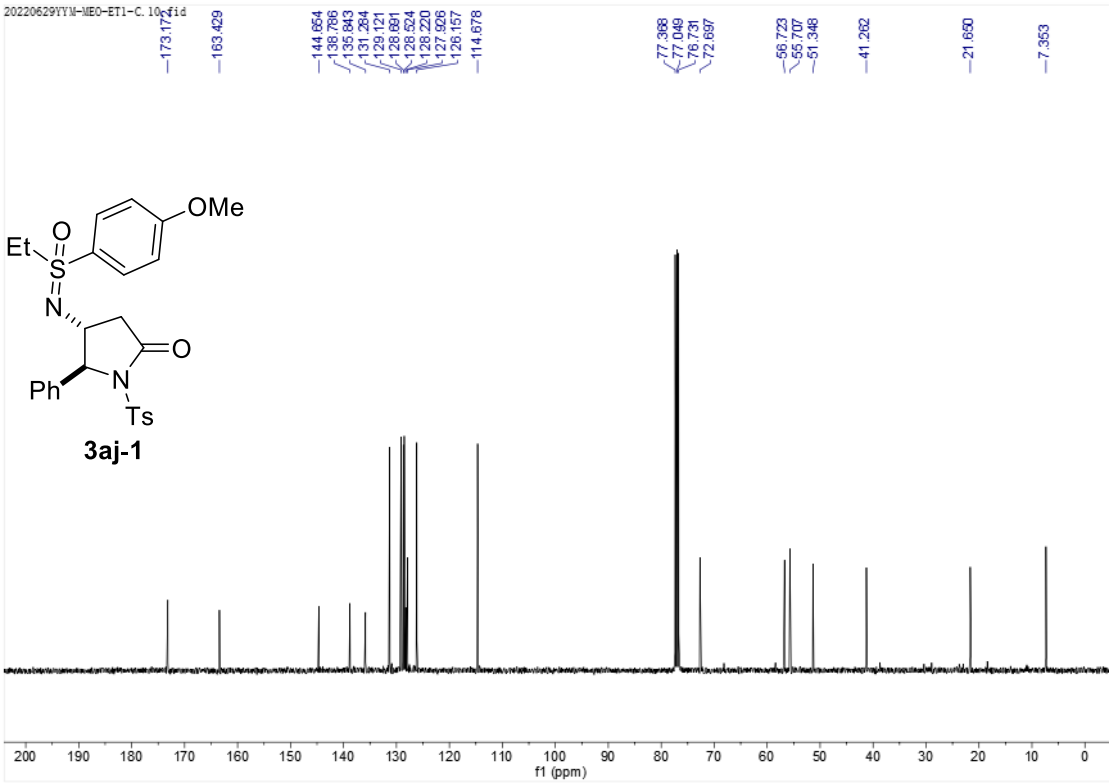
^{13}C NMR (101 MHz, $CDCl_3$) of **3ai-2**



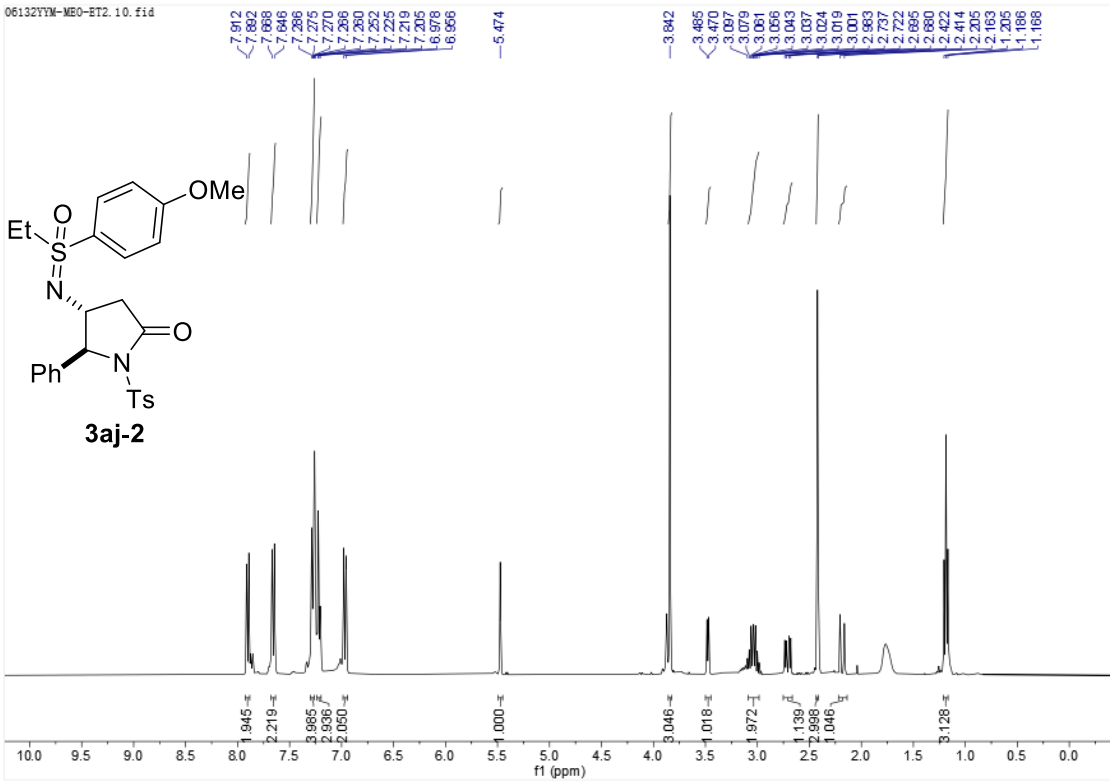
^{1}H NMR (400 MHz, $CDCl_3$) of **3aj-1**



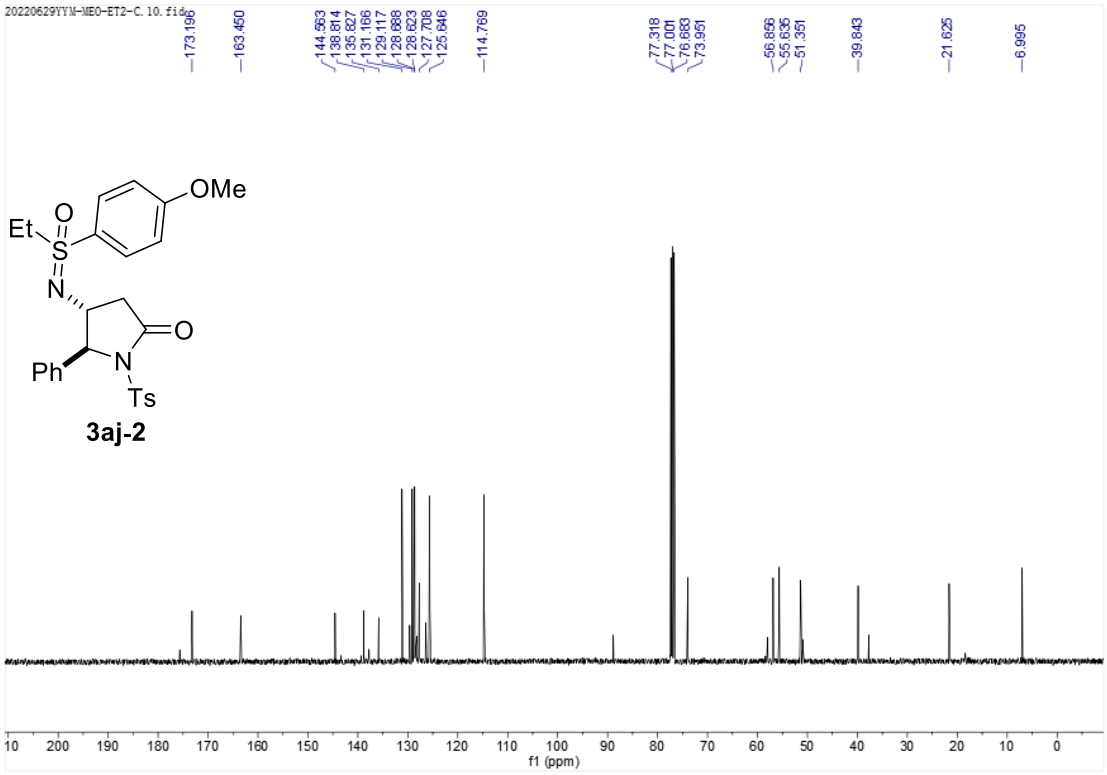
^{13}C NMR (101 MHz, $CDCl_3$) of **3aj-1**



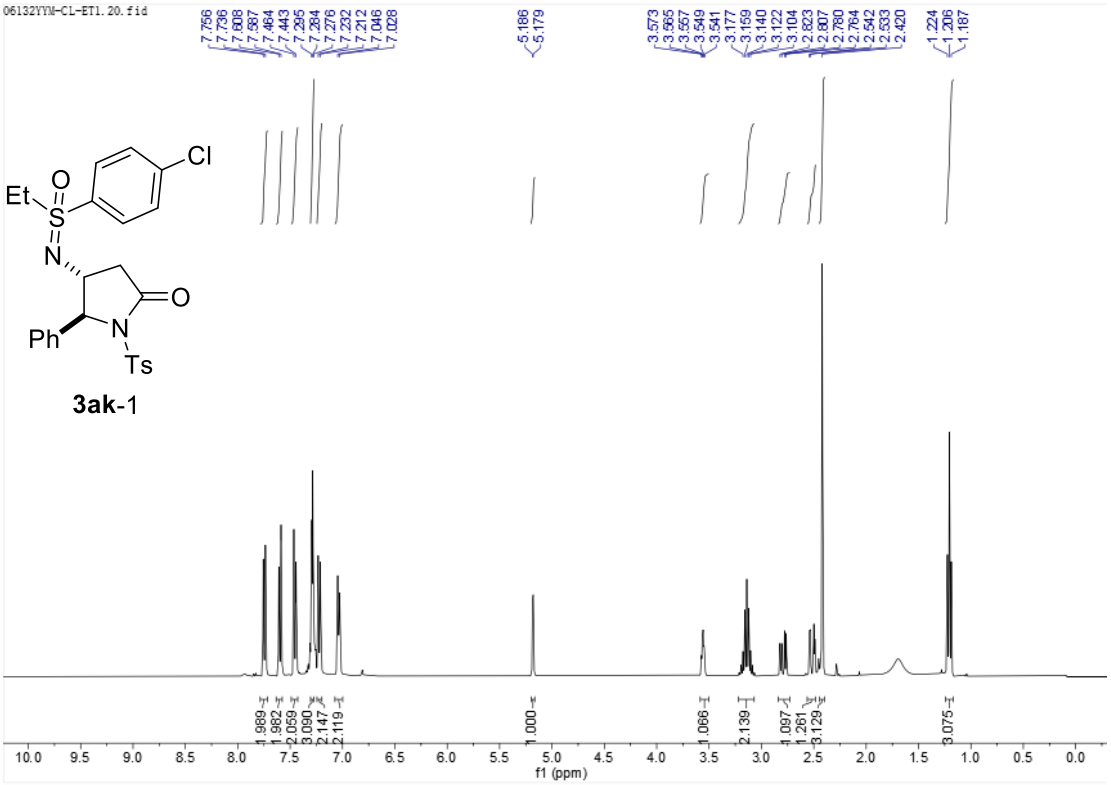
^{1}H NMR (400 MHz, $CDCl_3$) of **3aj-2**



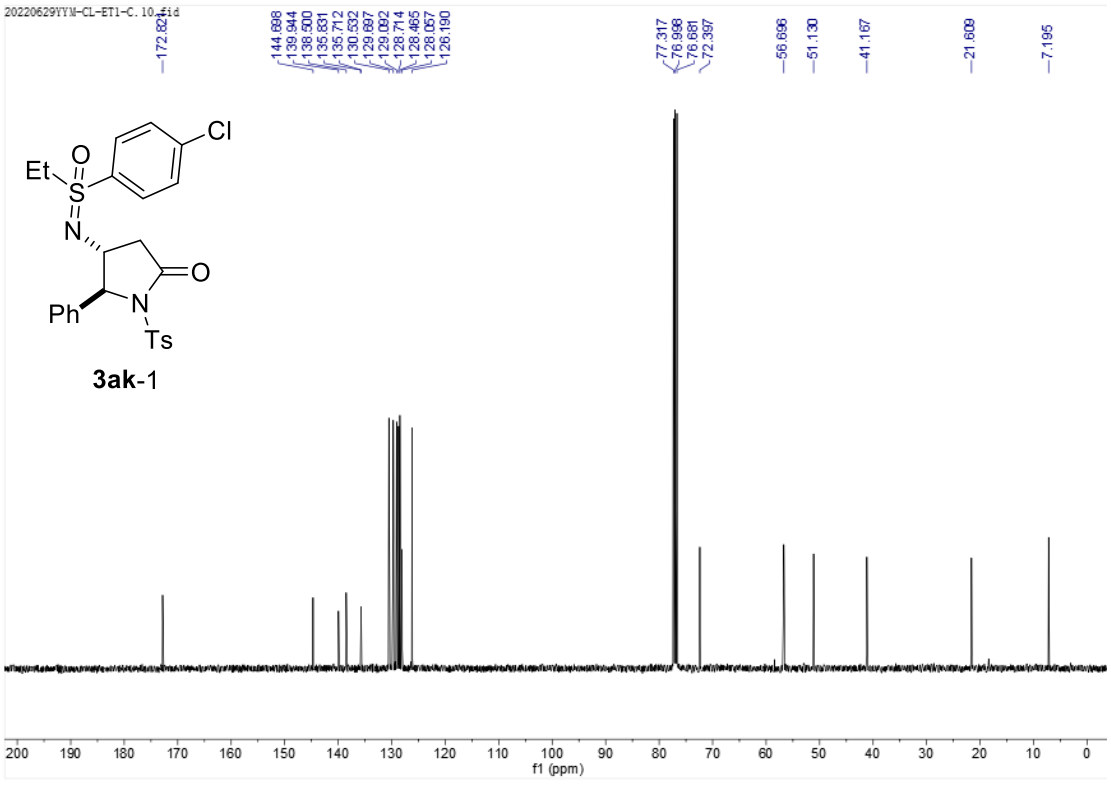
^{13}C NMR (101 MHz, $CDCl_3$) of **3aj-2**



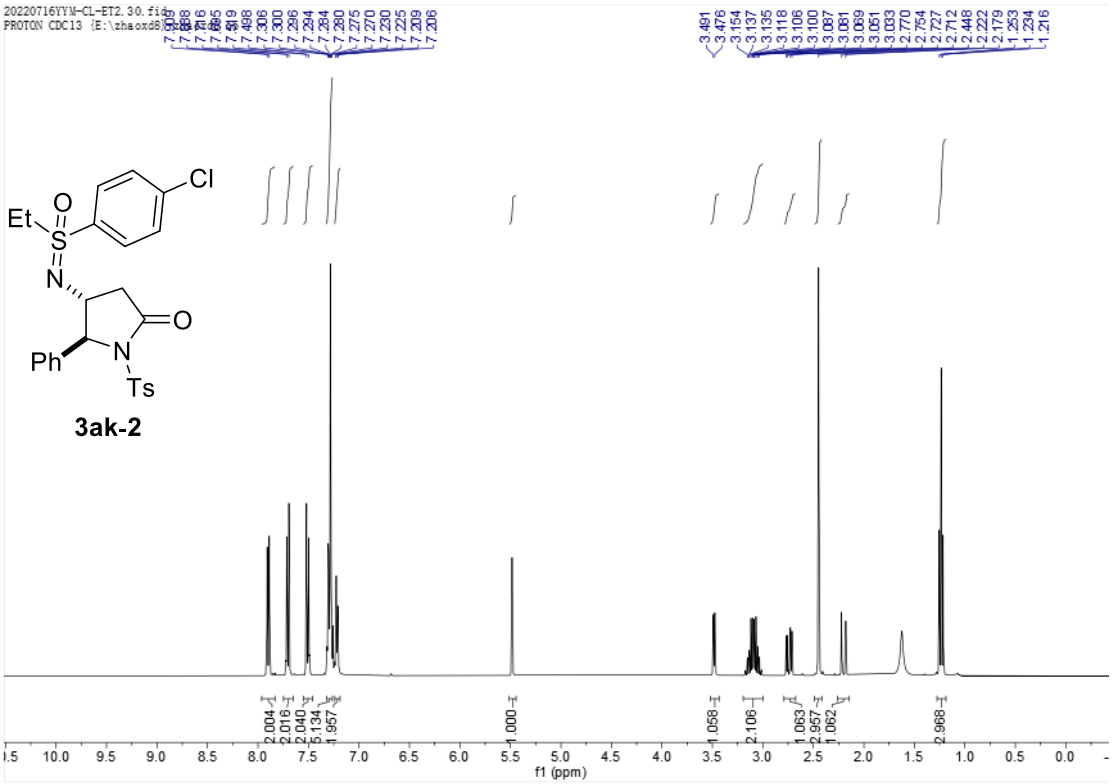
^{1}H NMR (400 MHz, $CDCl_3$) of **3ak-1**



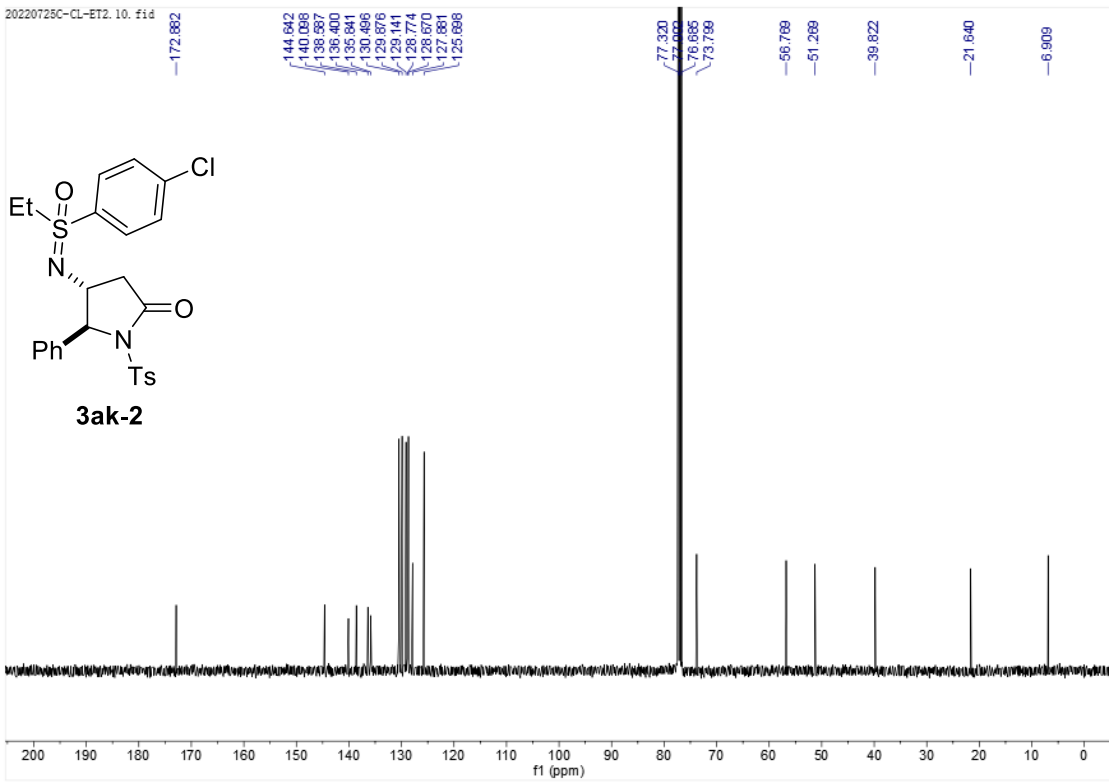
^{13}C NMR (101 MHz, $CDCl_3$) of **3ak-1**



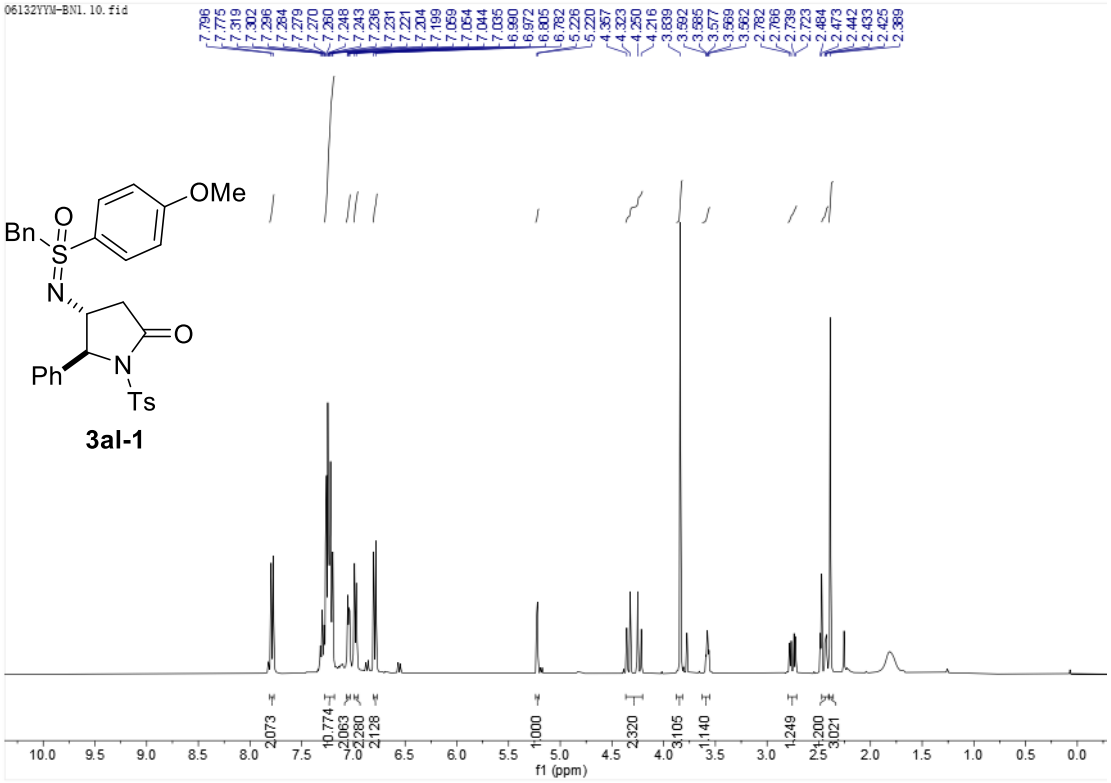
^{1}H NMR (400 MHz, $CDCl_3$) of **3ak-2**



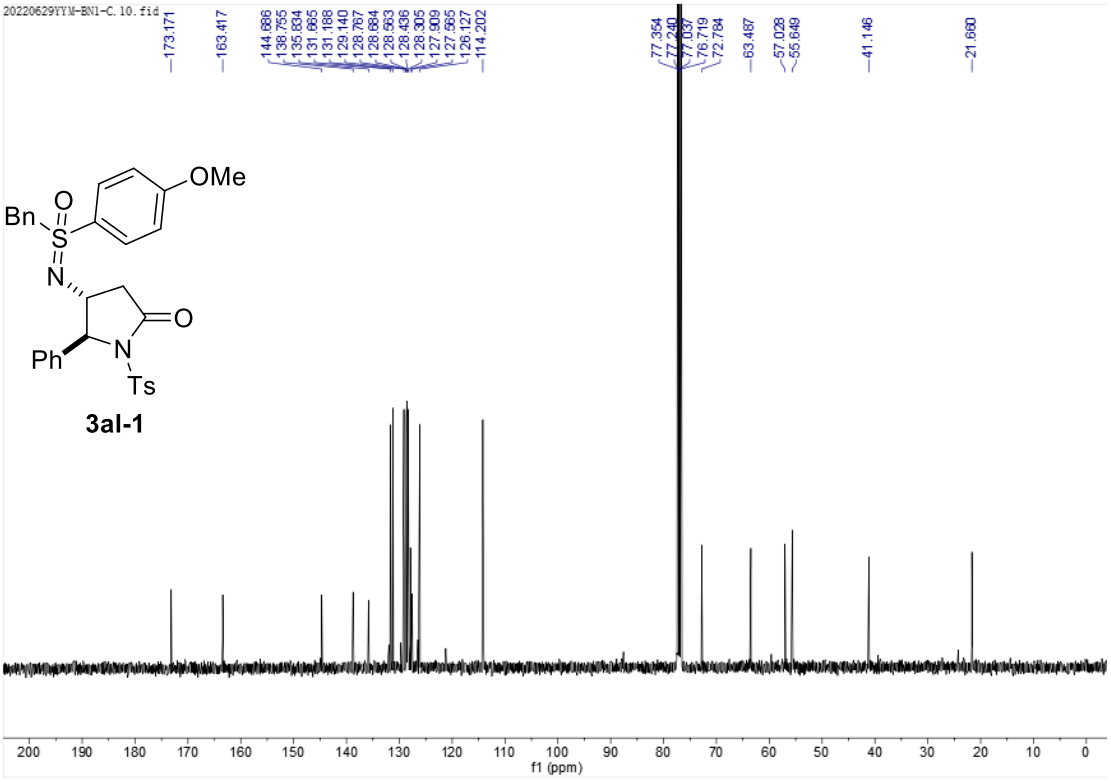
^{13}C NMR (101 MHz, $CDCl_3$) of **3ak-2**



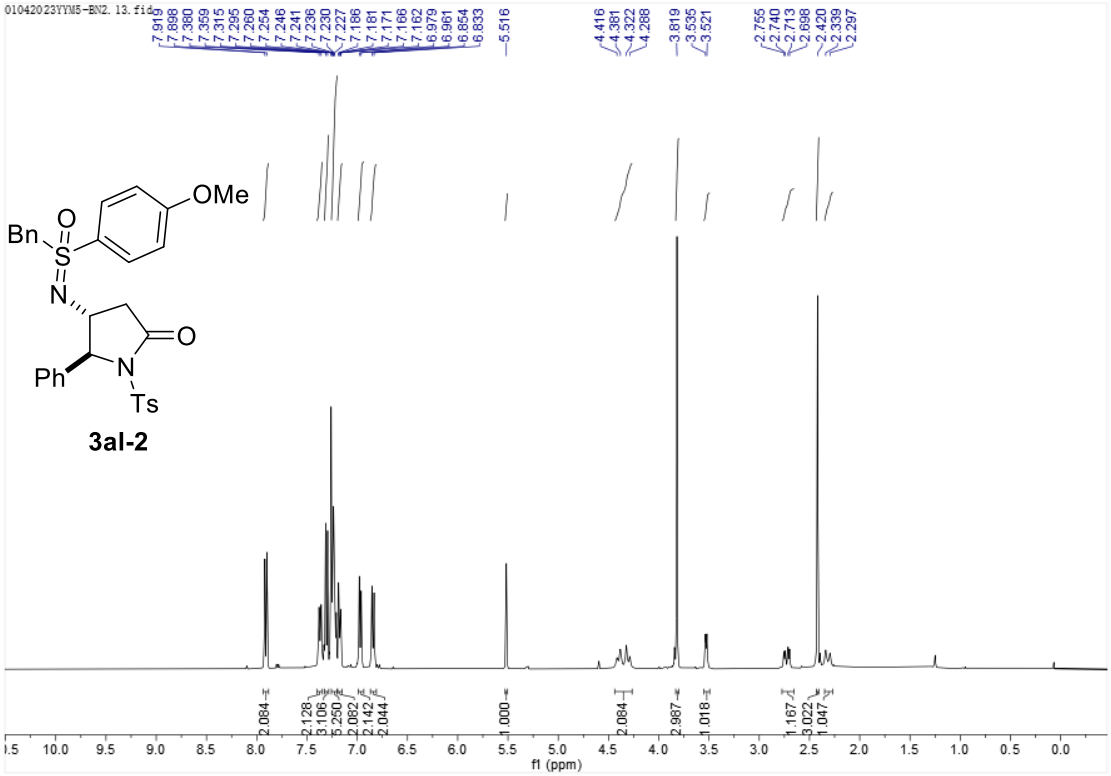
^{1}H NMR (400 MHz, $CDCl_3$) of **3al-1**



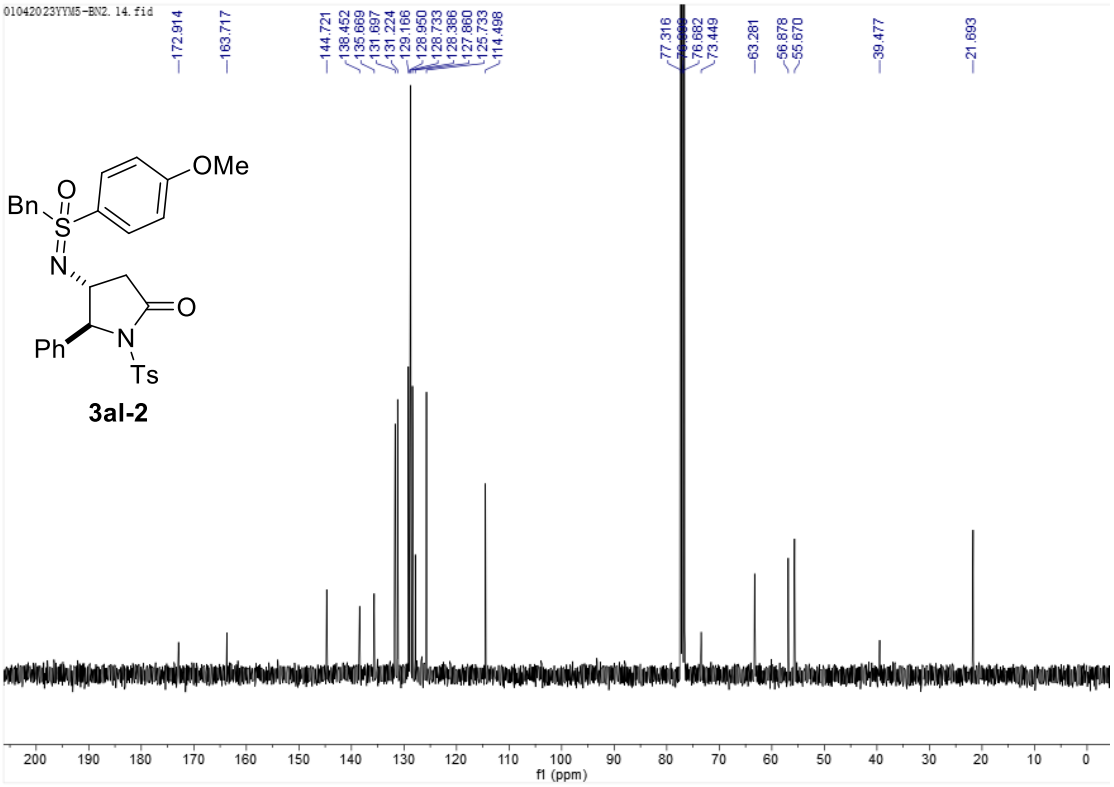
^{1}H NMR (400 MHz, $CDCl_3$) of **3al-1**



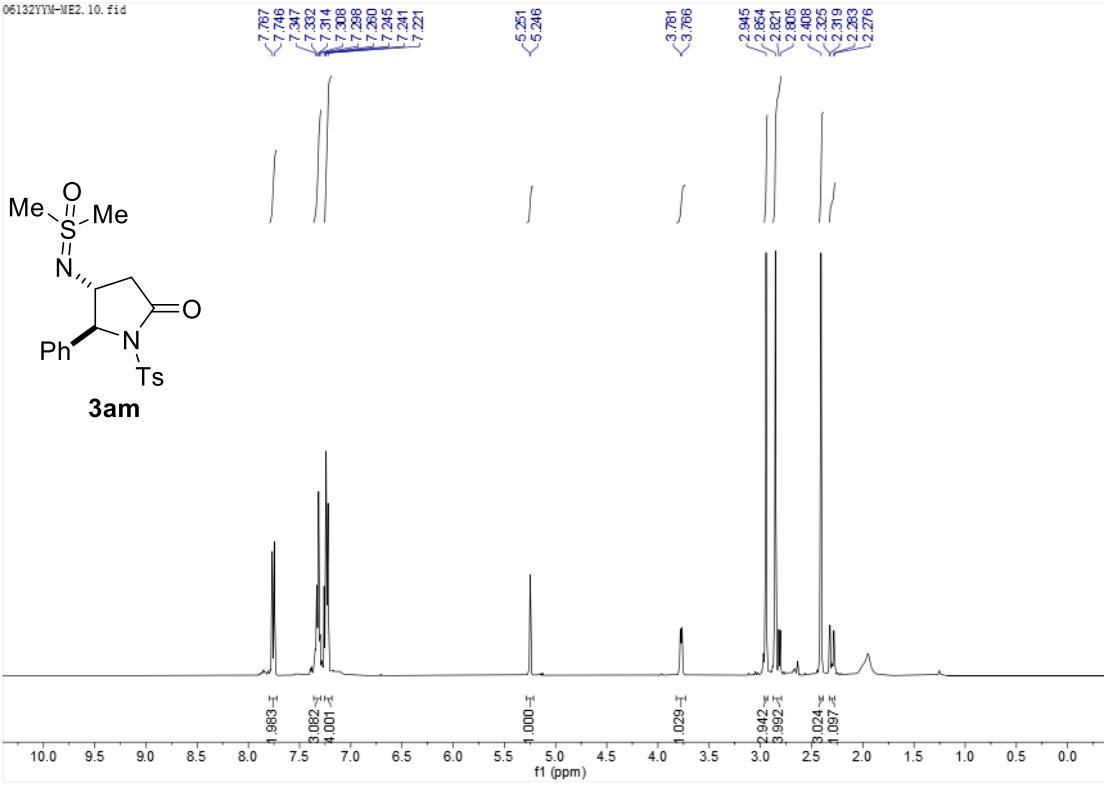
^{1}H NMR (400 MHz, $CDCl_3$) of **3al-2**



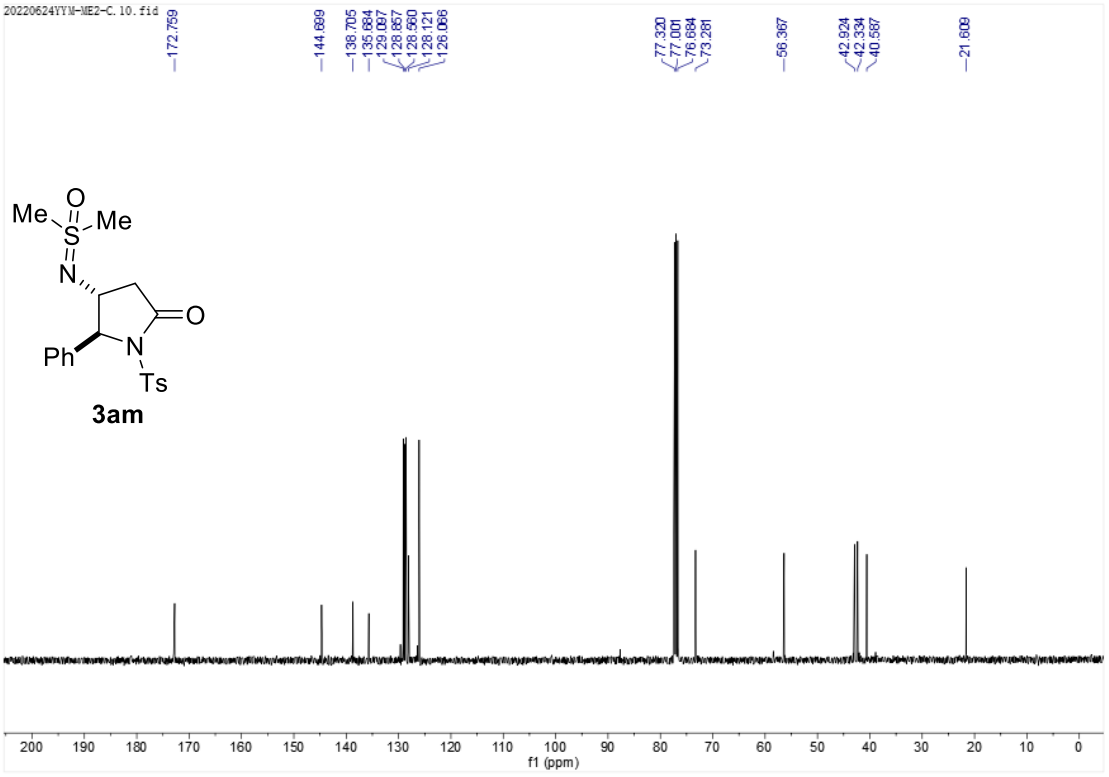
^{13}C NMR (101 MHz, $CDCl_3$) of **3al-2**



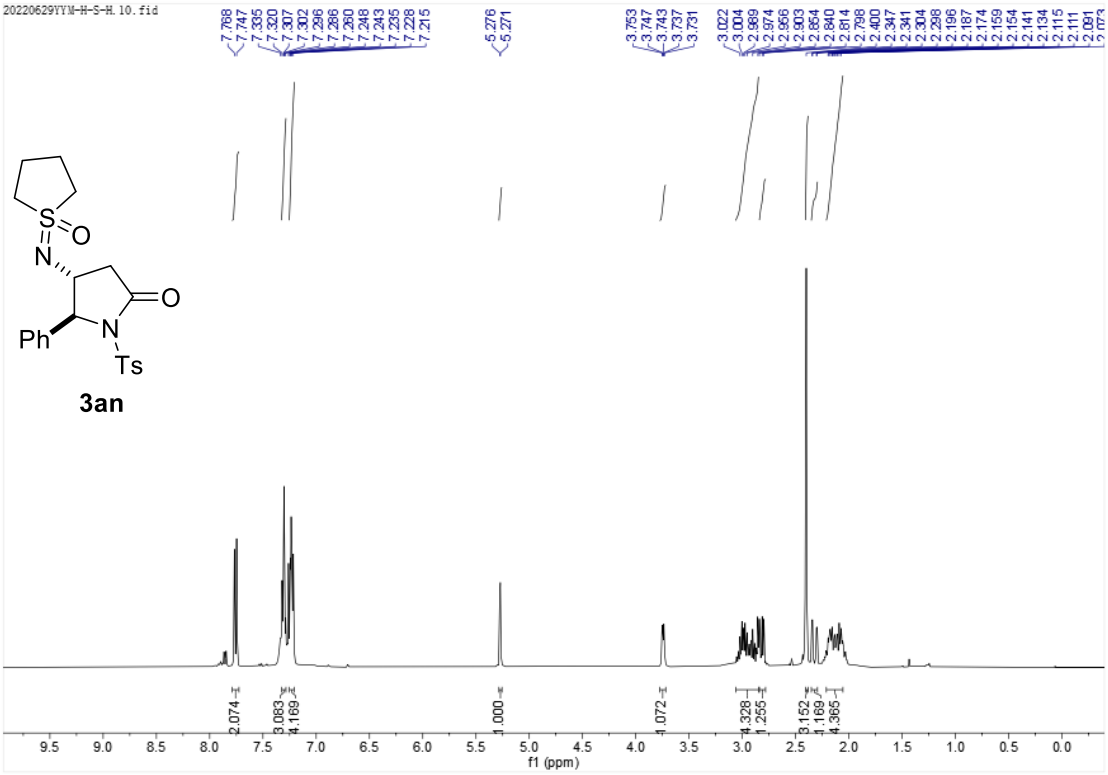
^{1}H NMR (400 MHz, $CDCl_3$) of **3am**



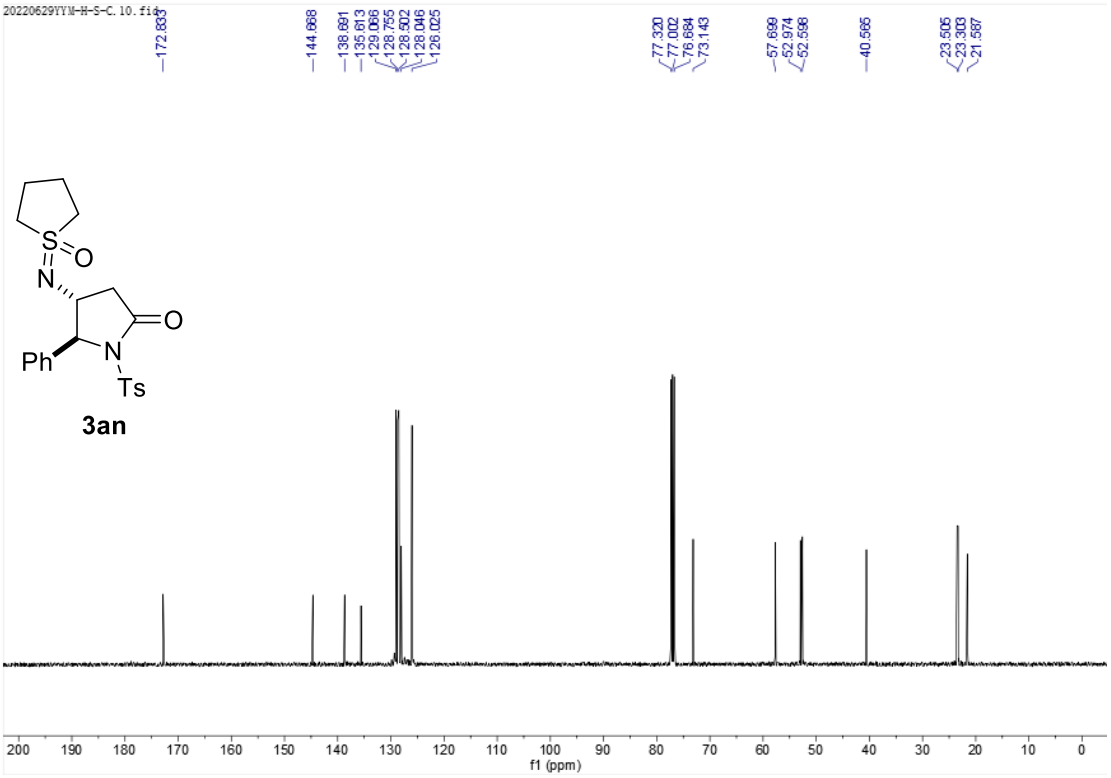
^{13}C NMR (101 MHz, $CDCl_3$) of **3am**



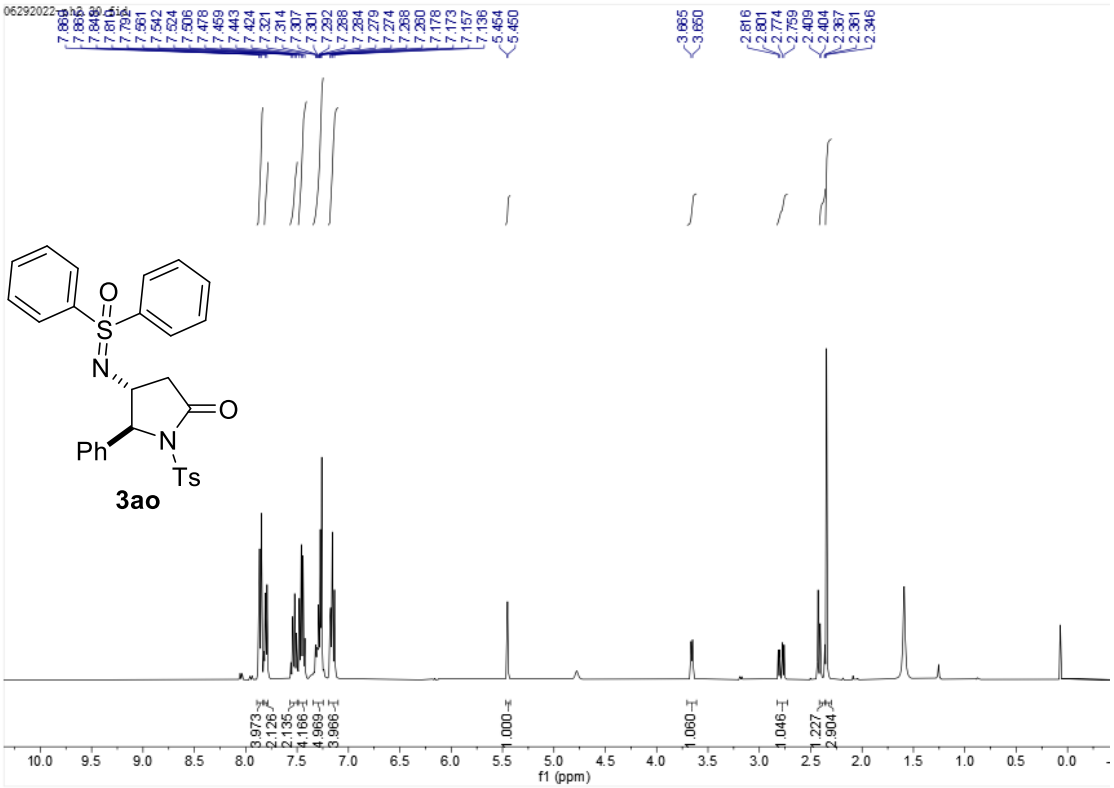
^{1}H NMR (400 MHz, $CDCl_3$) of **3an**



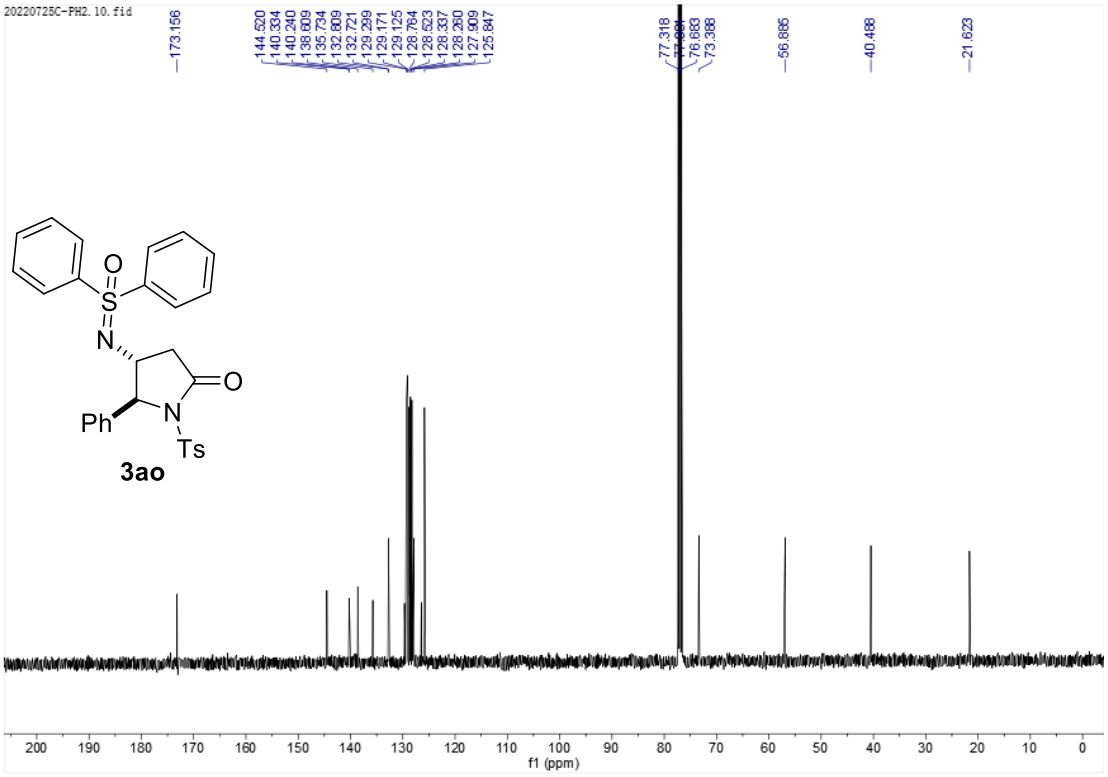
^{13}C NMR (101 MHz, $CDCl_3$) of **3an**



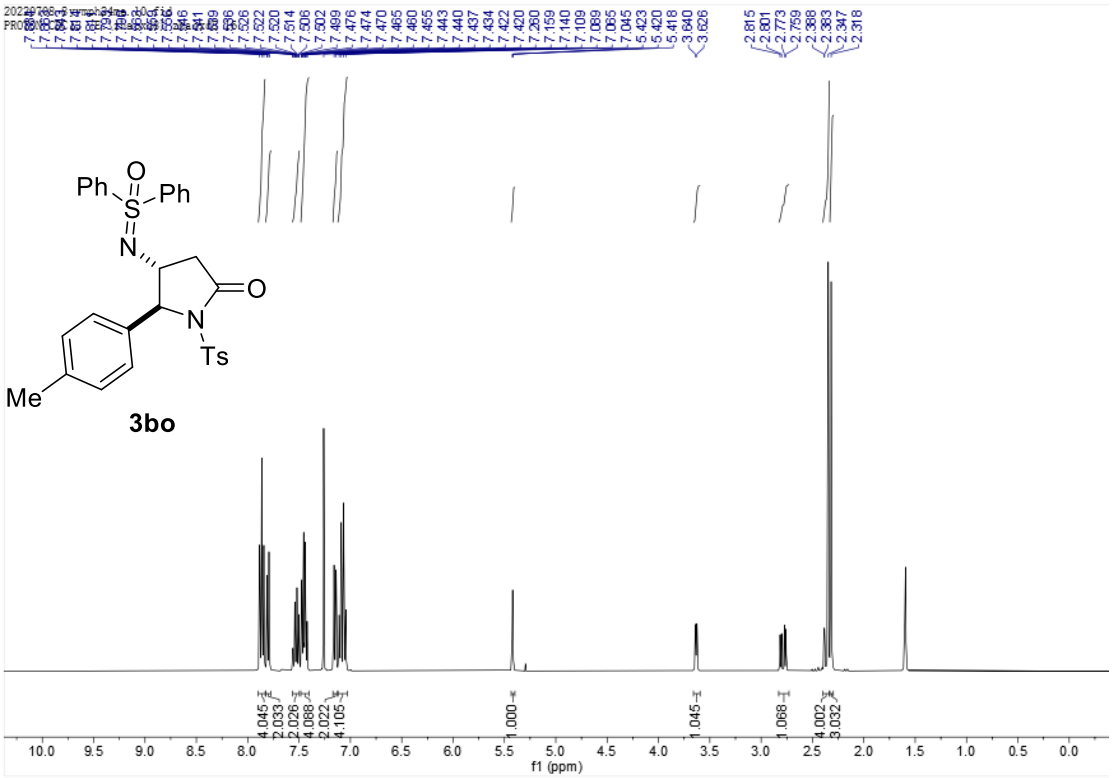
^{1}H NMR (400 MHz, $CDCl_3$) of **3ao**



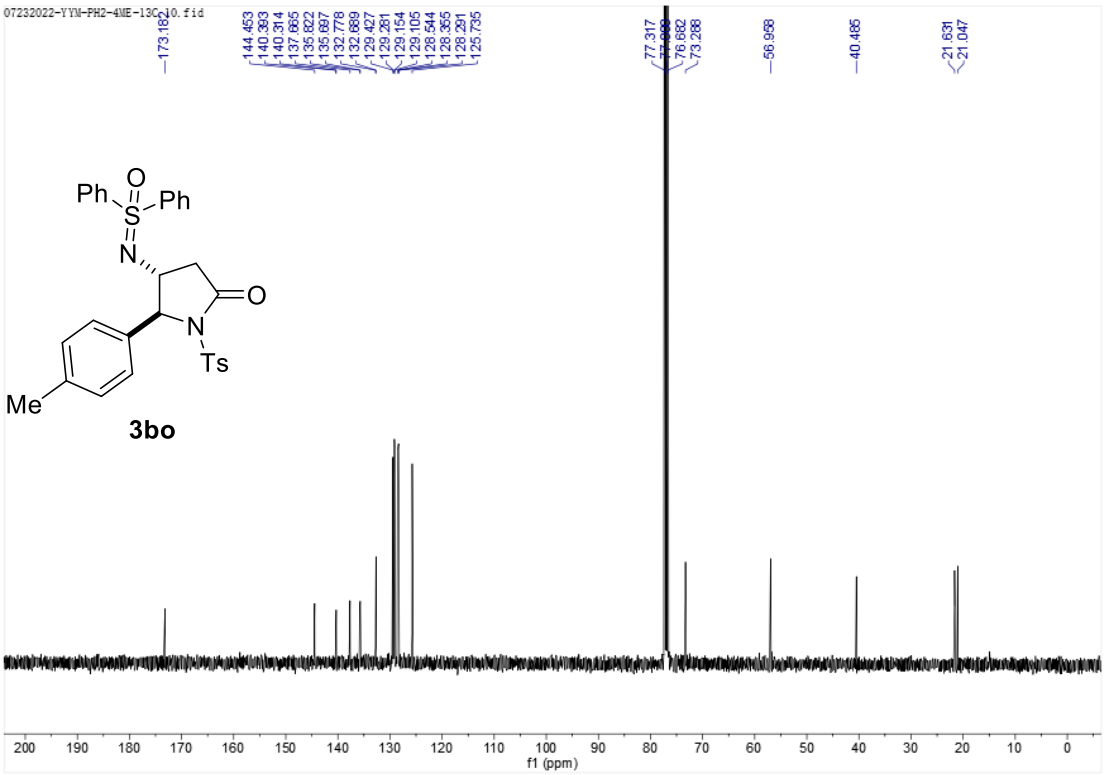
^{13}C NMR (101 MHz, $CDCl_3$) of **3ao**



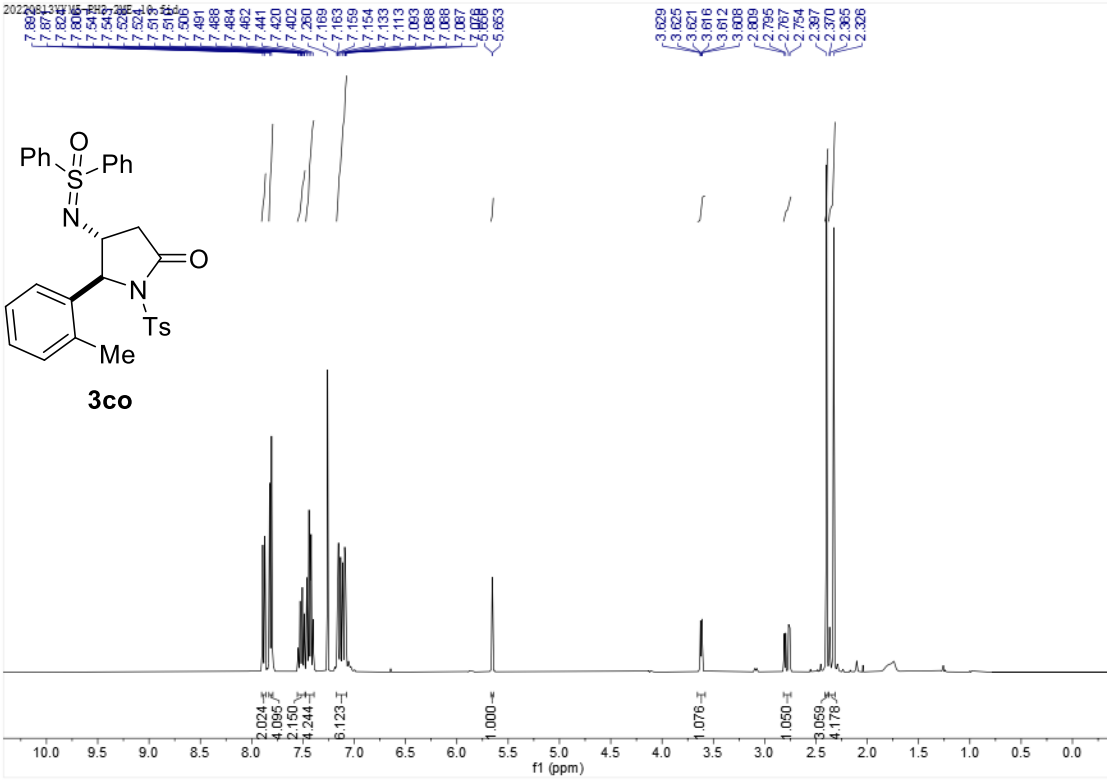
^{1}H NMR (400 MHz, $CDCl_3$) of **3bo**



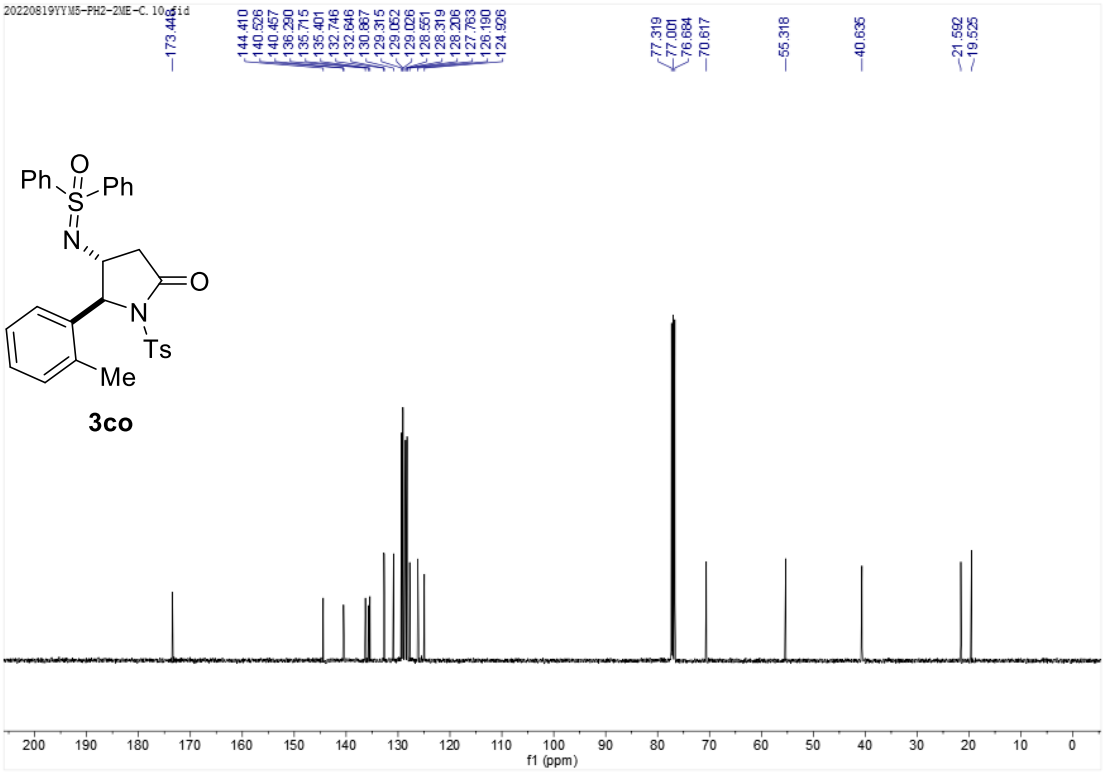
^{13}C NMR (101 MHz, $CDCl_3$) of **3bo**



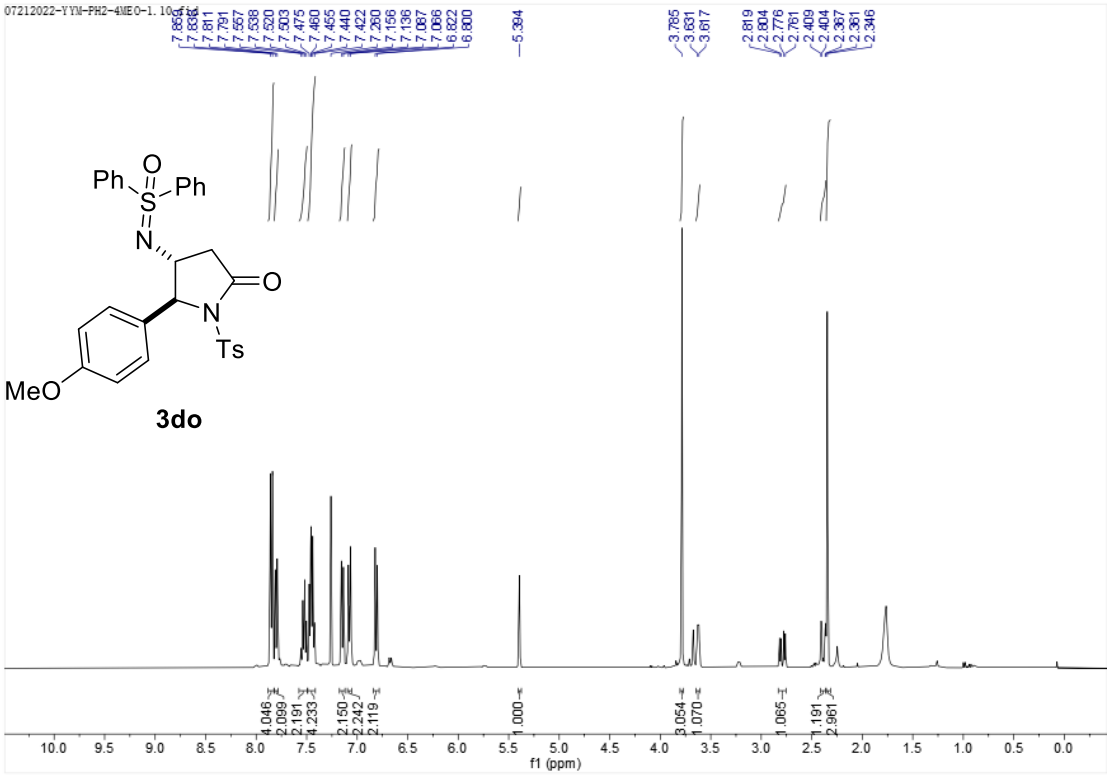
^{1}H NMR (400 MHz, $CDCl_3$) of **3co**



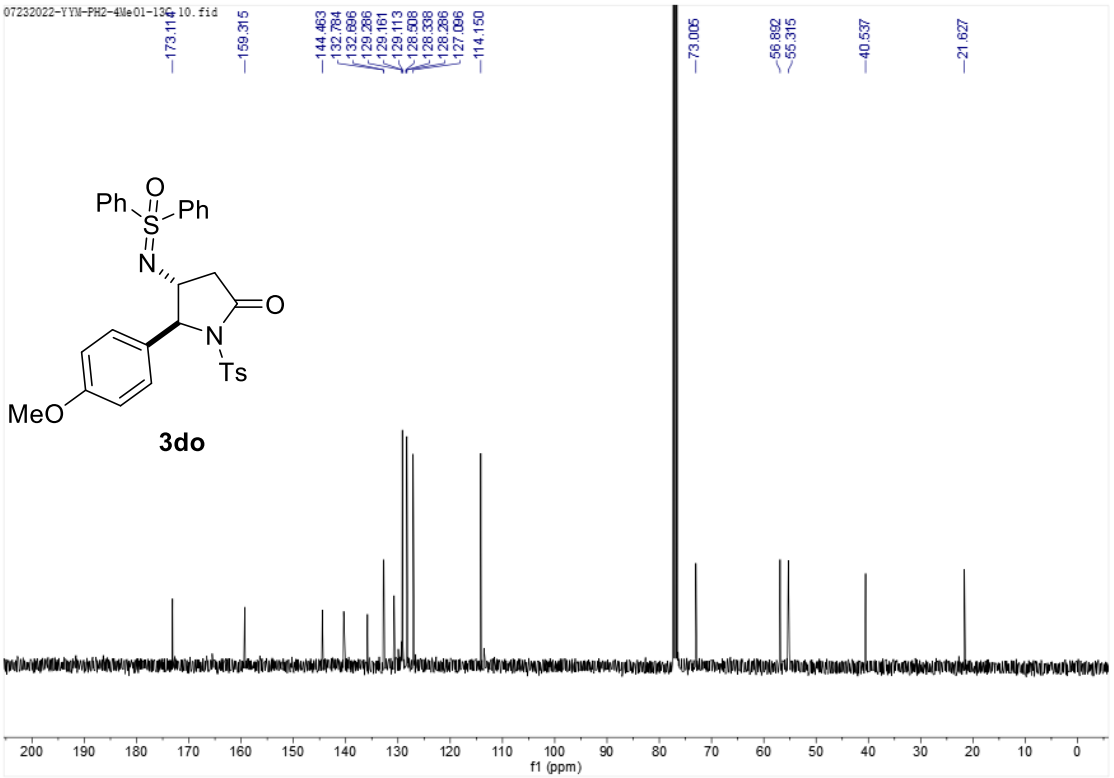
^{13}C NMR (101 MHz, $CDCl_3$) of **3co**



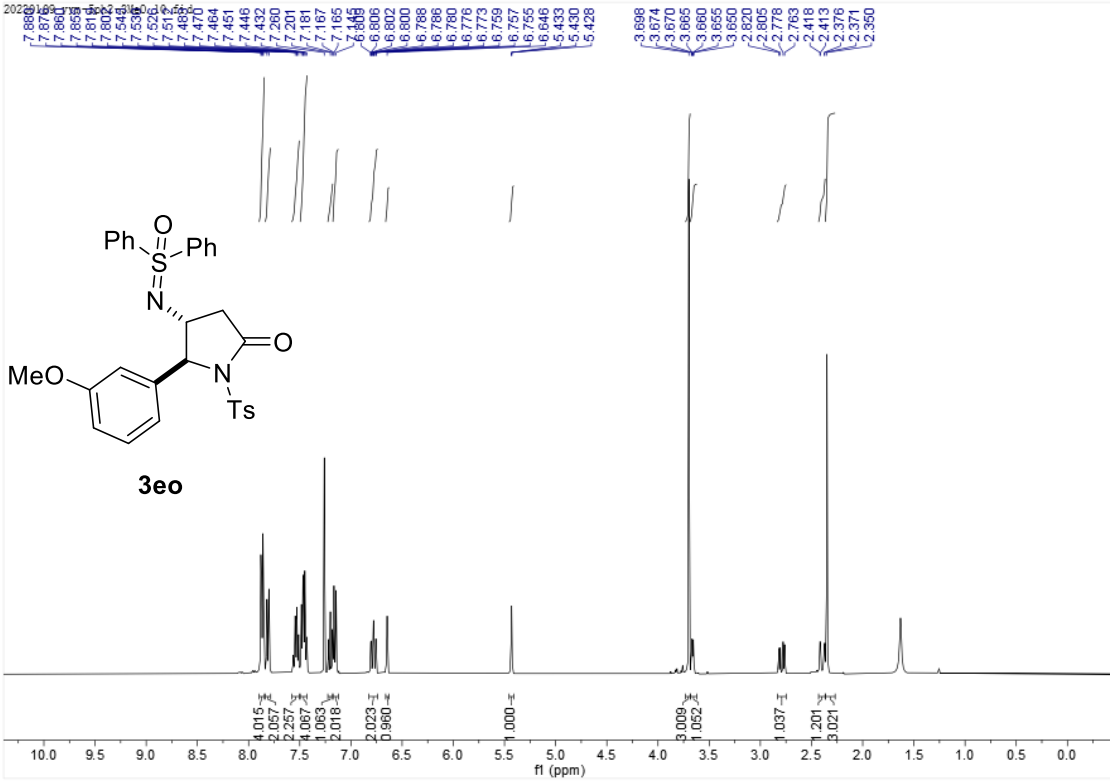
^{1}H NMR (400 MHz, $CDCl_3$) of **3do**



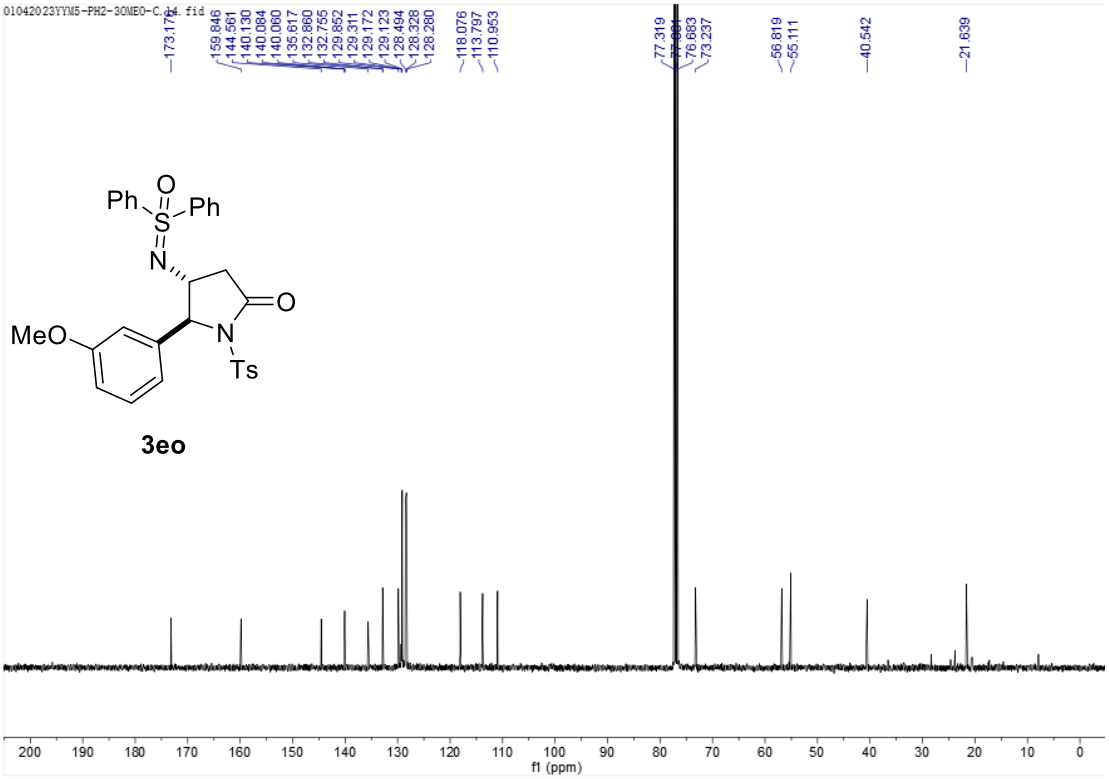
^{13}C NMR (101 MHz, $CDCl_3$) of **3do**



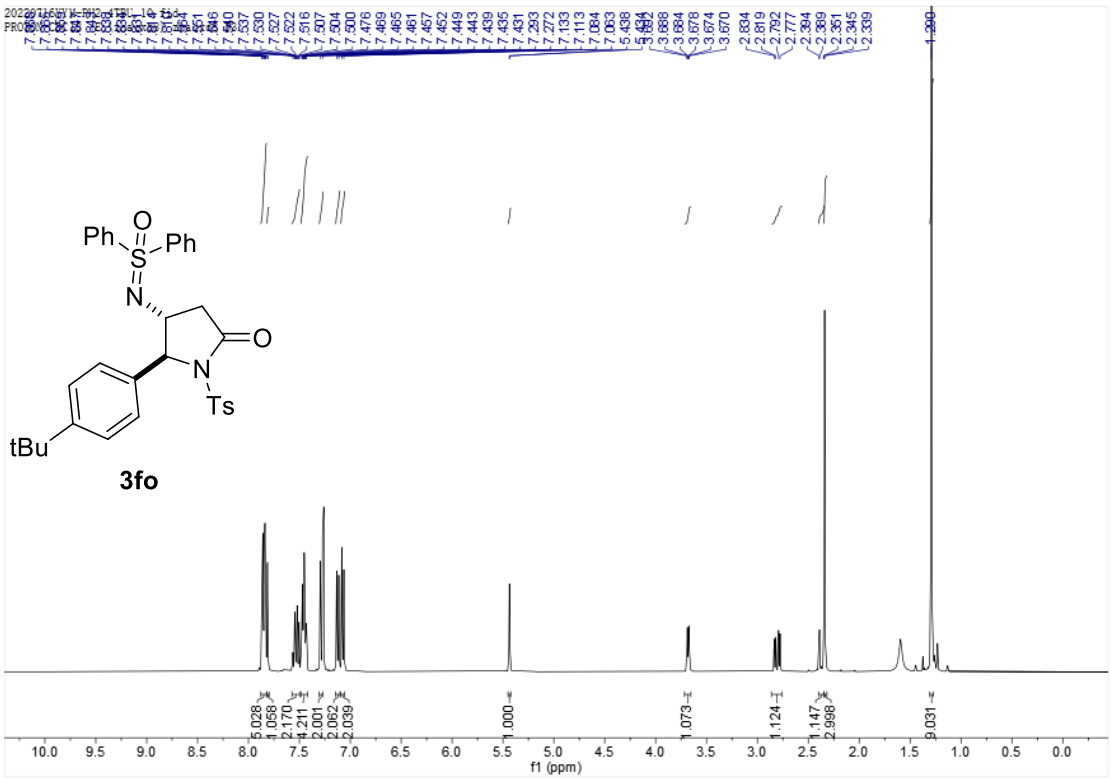
^{1}H NMR (400 MHz, $CDCl_3$) of **3eo**



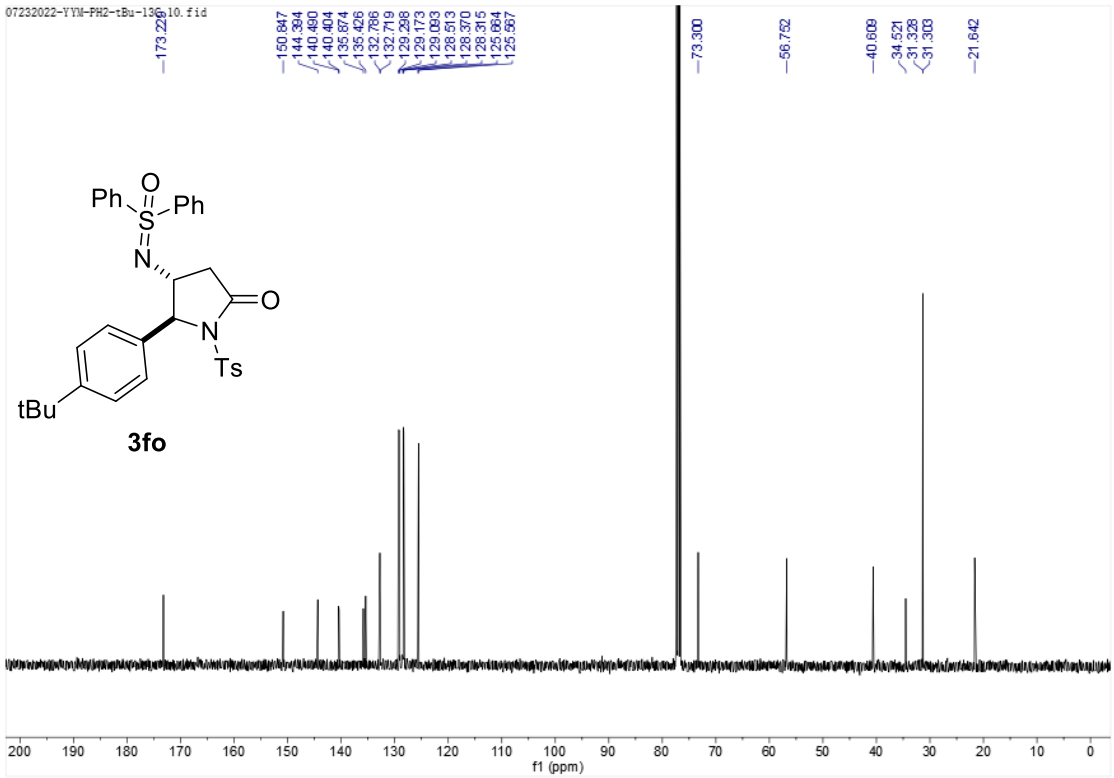
^{13}C NMR (101 MHz, $CDCl_3$) of **3eo**



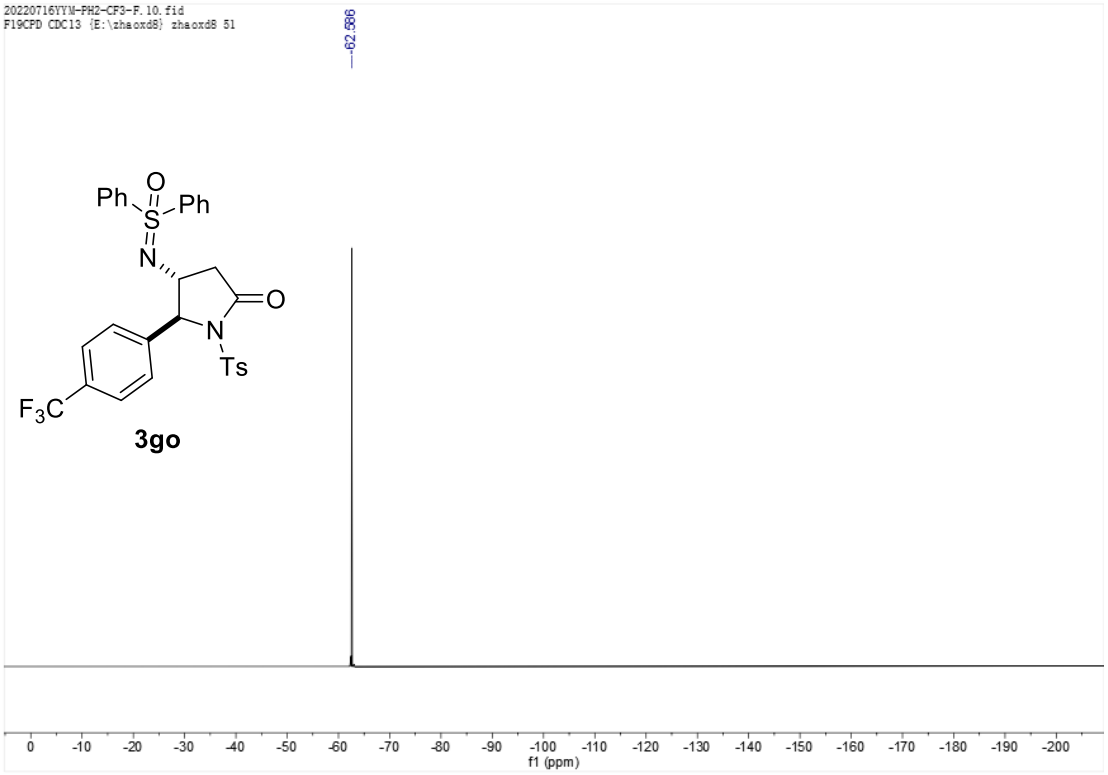
^{1}H NMR (400 MHz, $CDCl_3$) of **3fo**



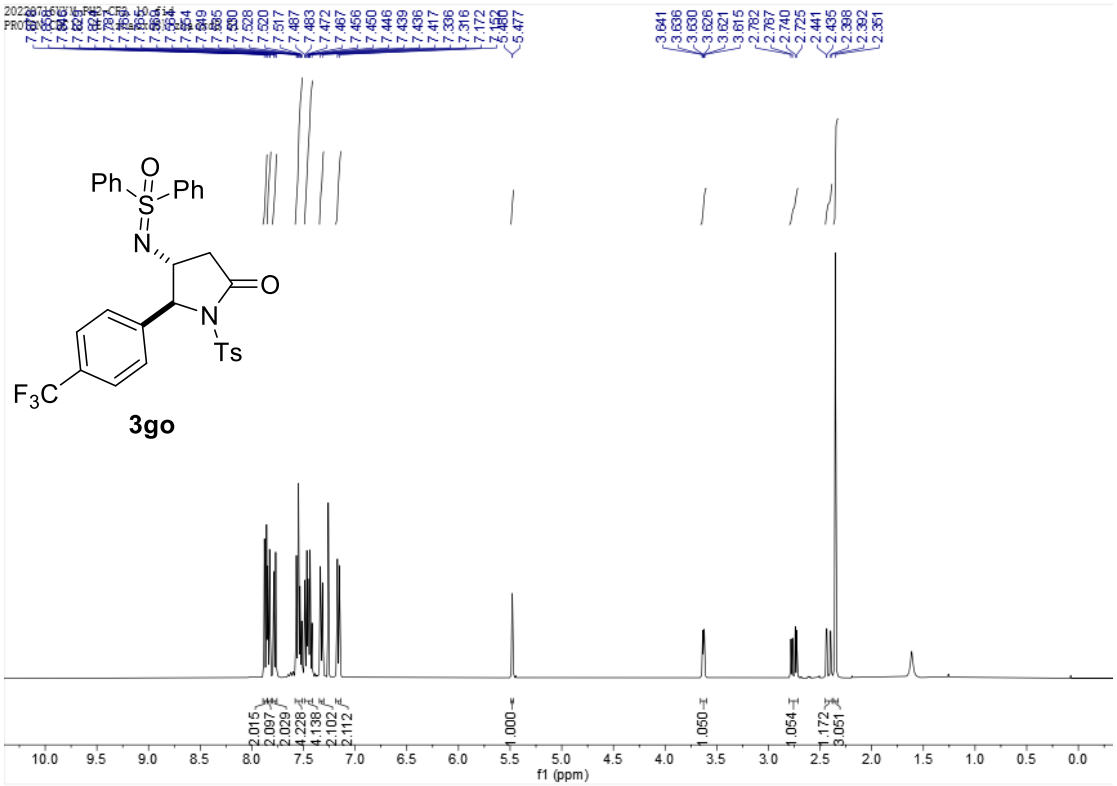
^{13}C NMR (101 MHz, $CDCl_3$) of **3fo**



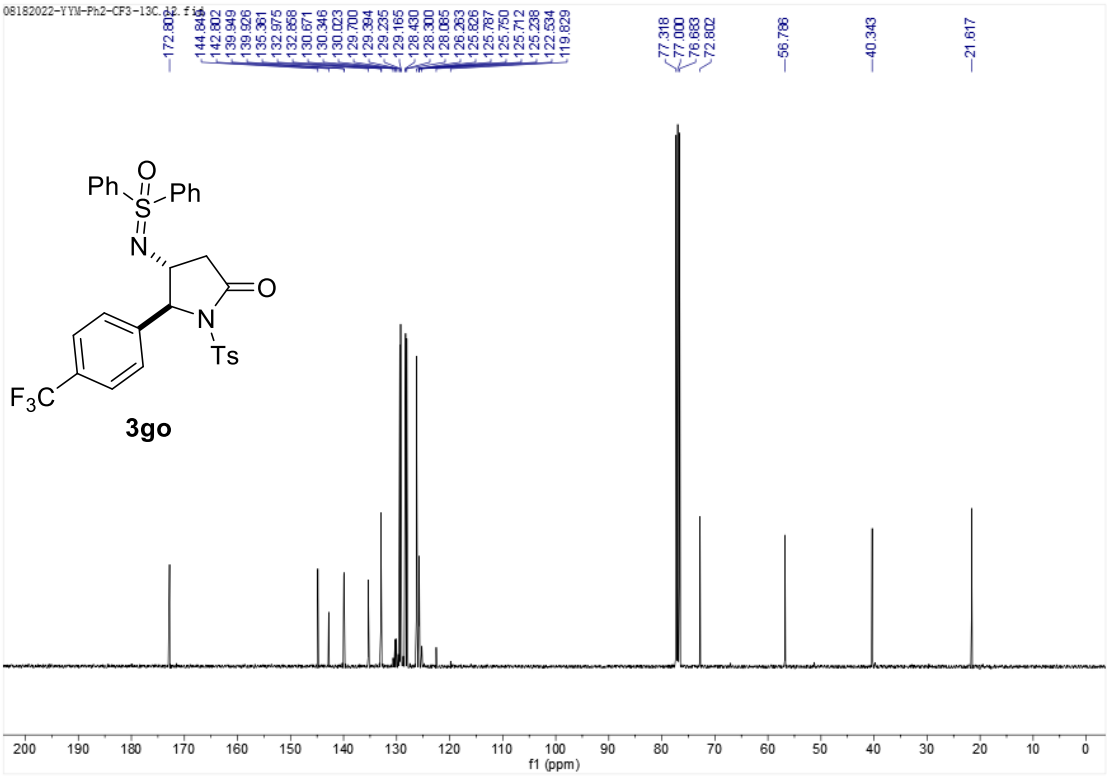
^{19}F NMR (376 MHz, $CDCl_3$) of **3go**



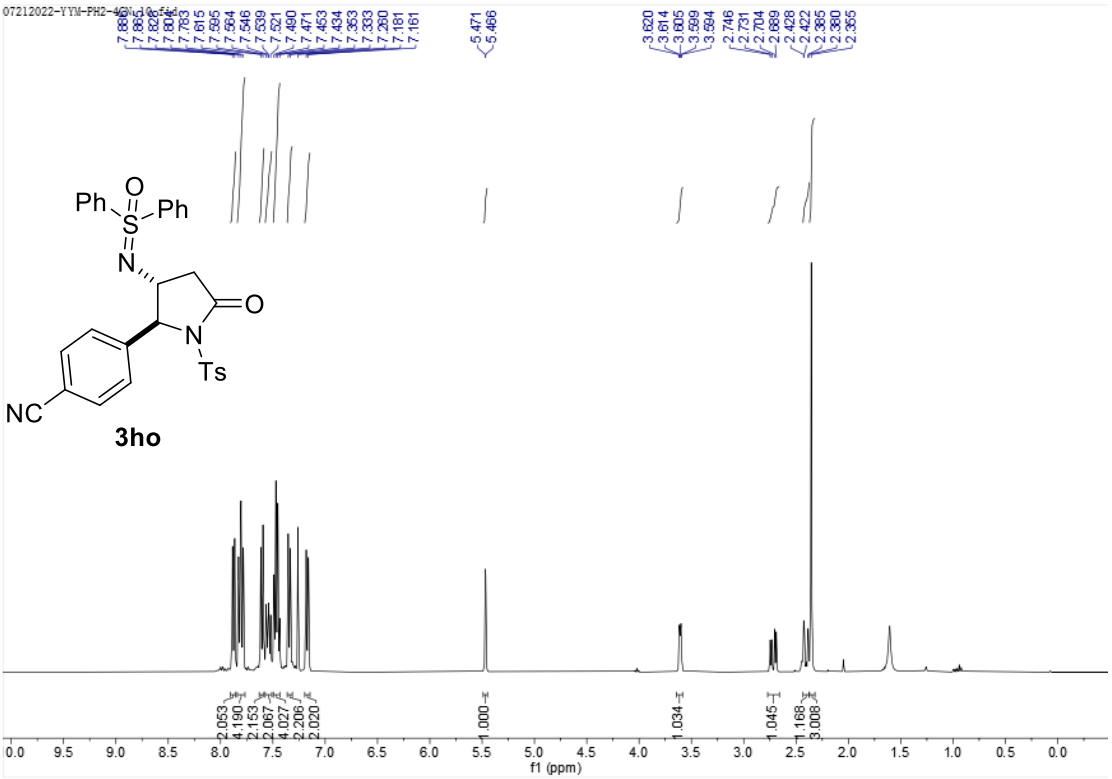
^{1}H NMR (400 MHz, $CDCl_3$) of **3go**



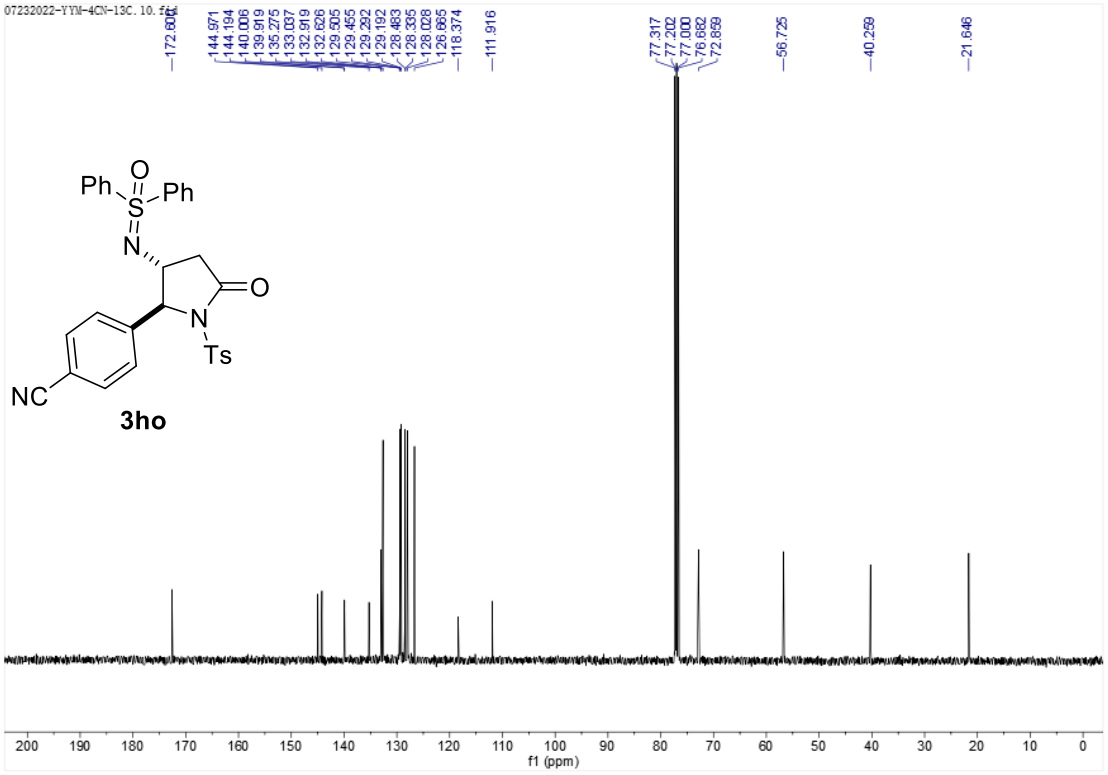
^{13}C NMR (101 MHz, $CDCl_3$) of **3go**



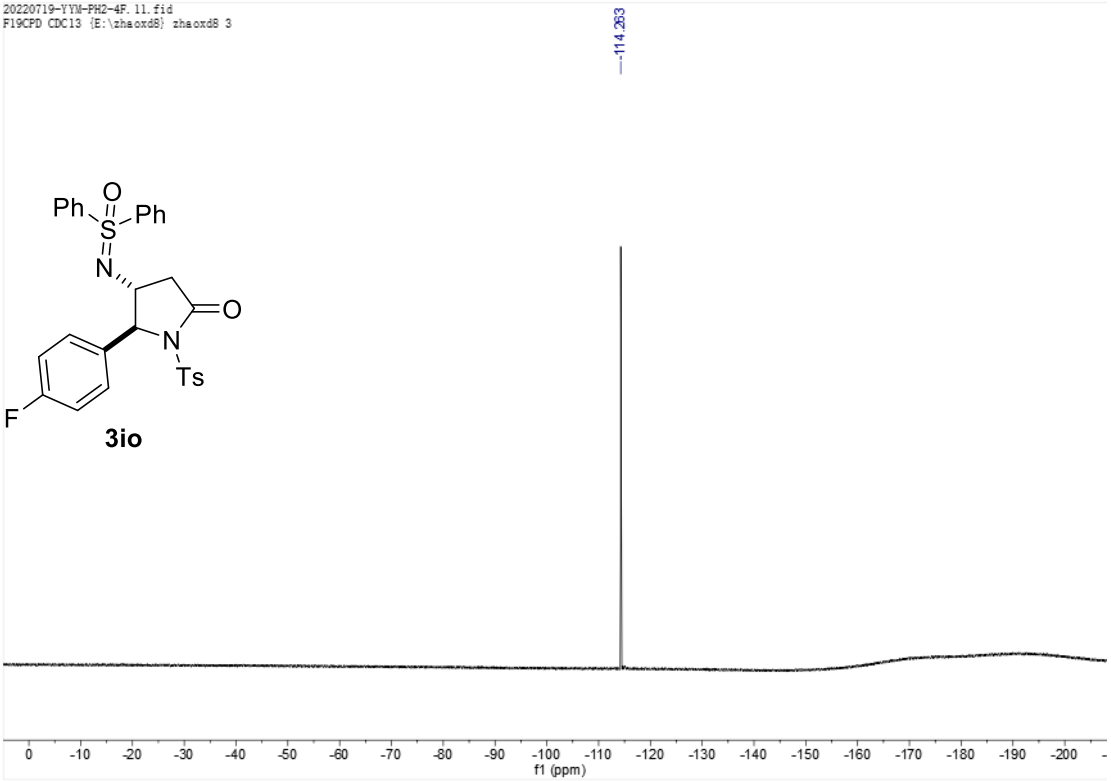
^{1}H NMR (400 MHz, $CDCl_3$) of **3ho**



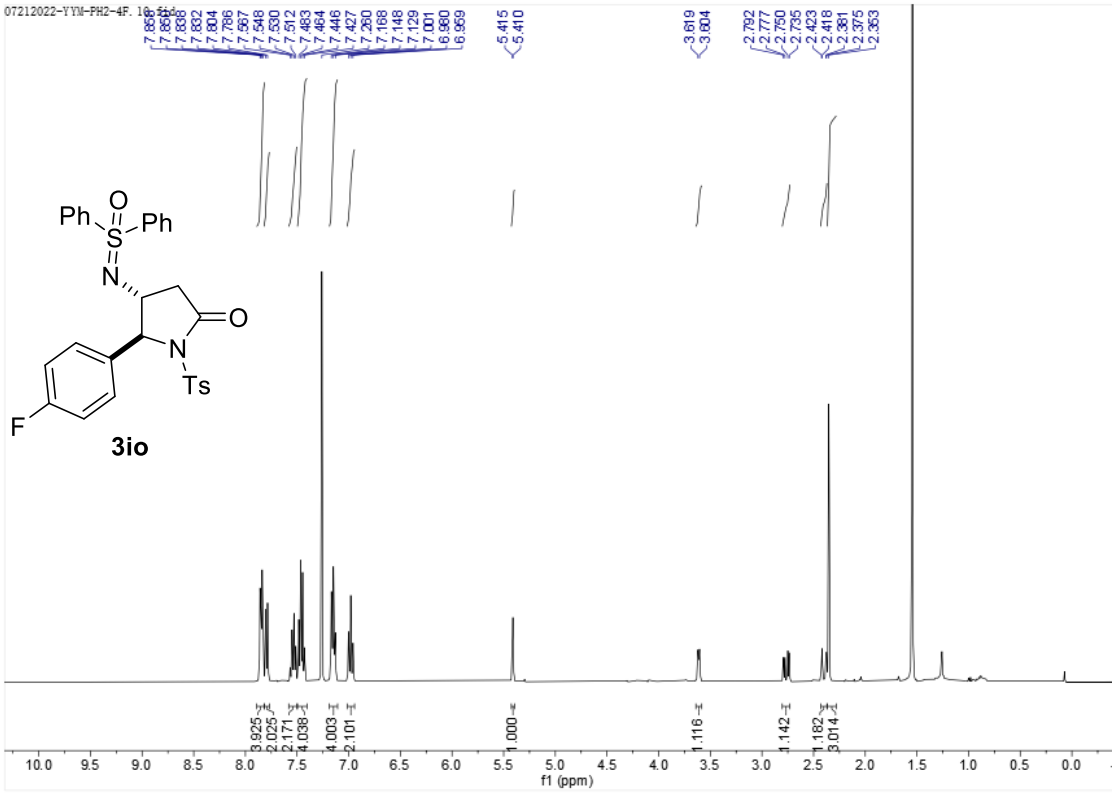
^{13}C NMR (101 MHz, $CDCl_3$) of **3ho**



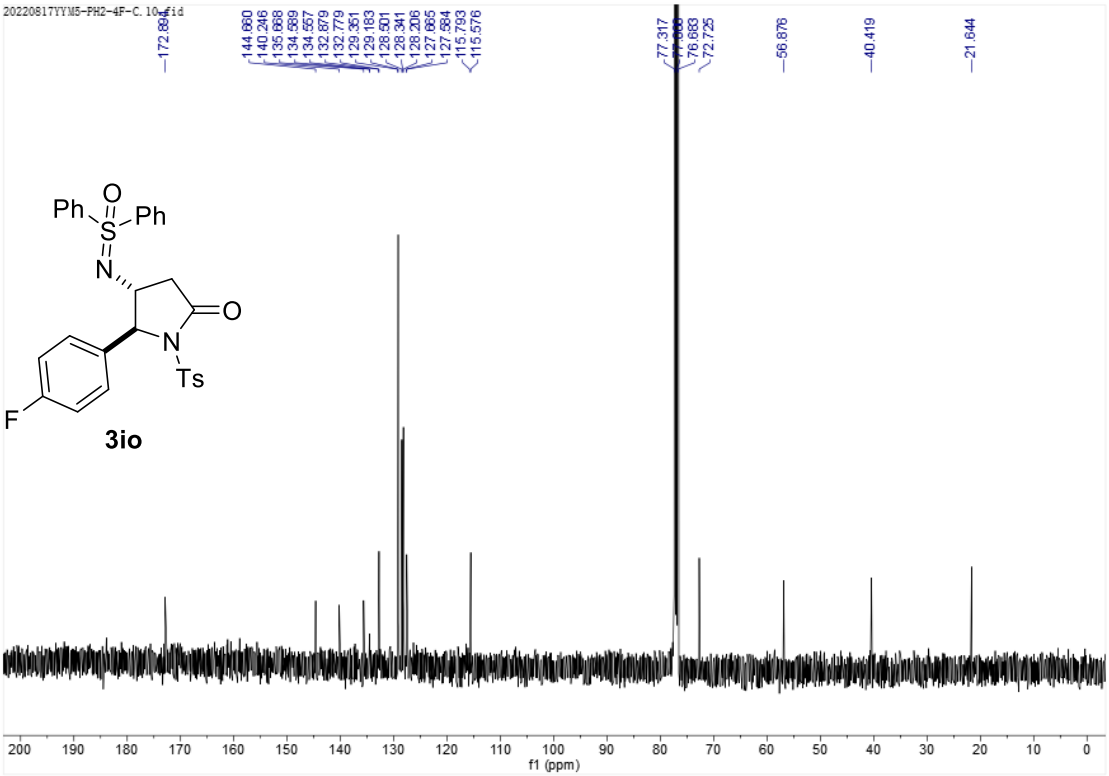
^{19}F NMR (376 MHz, $CDCl_3$) of **3io**



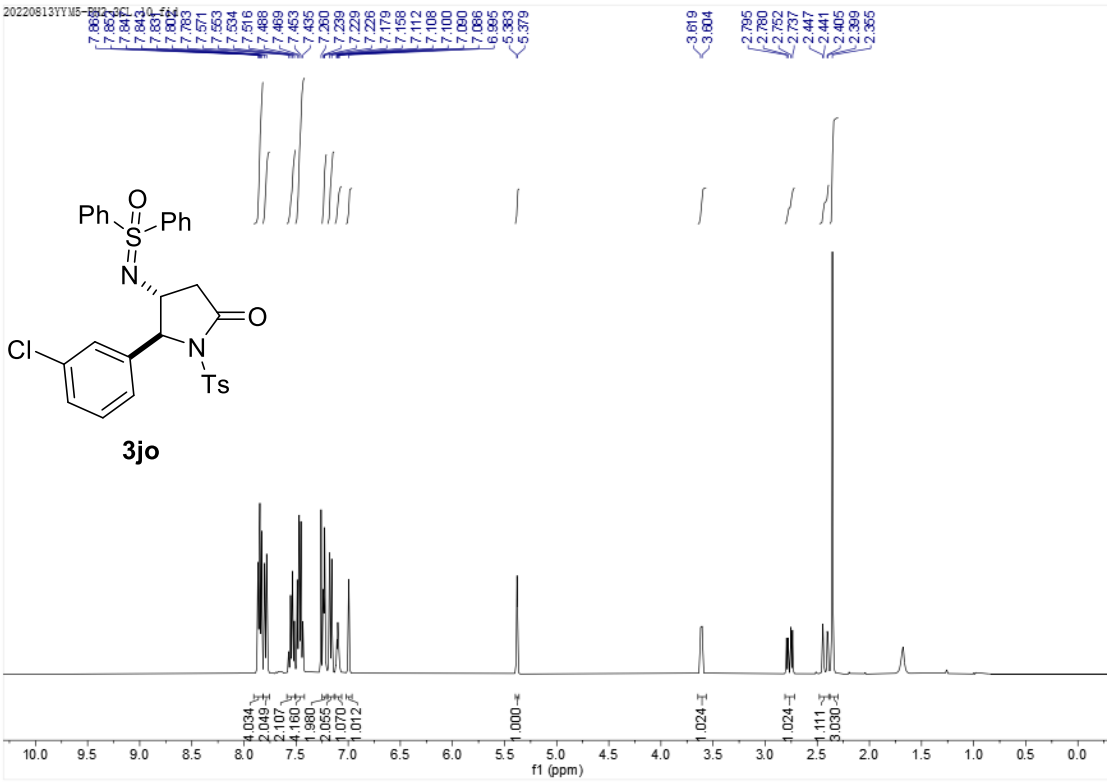
^{1}H NMR (400 MHz, $CDCl_3$) of **3io**



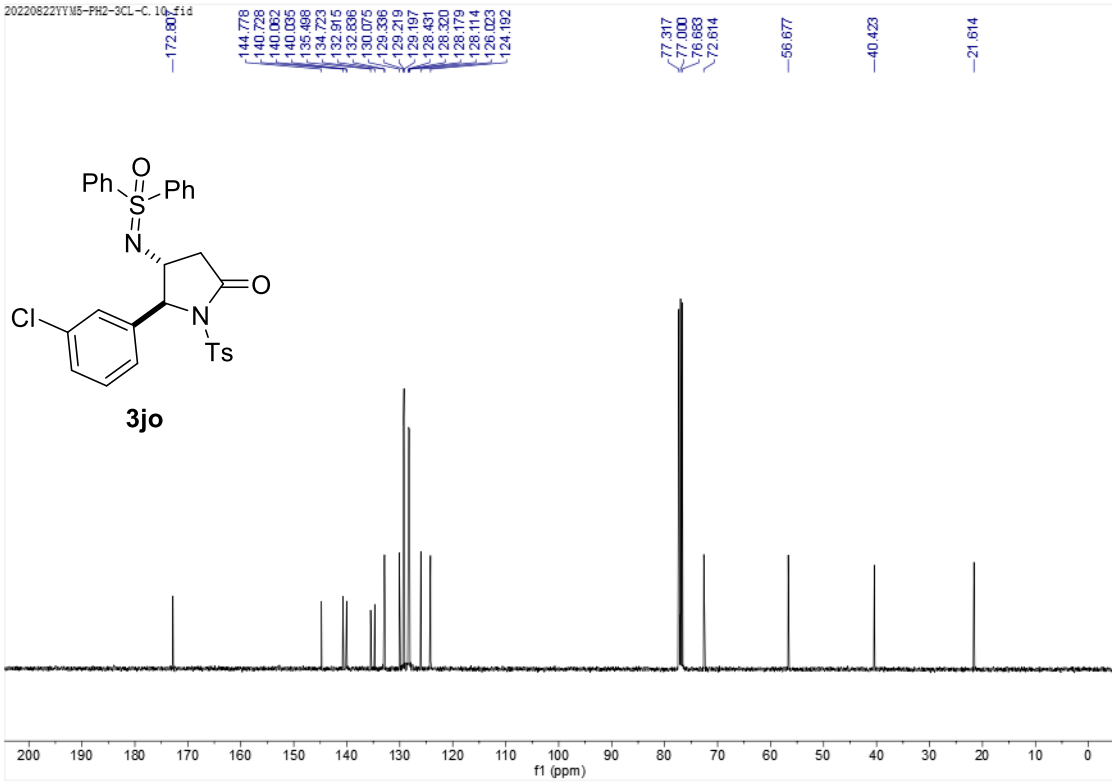
^{13}C NMR (101 MHz, $CDCl_3$) of **3io**



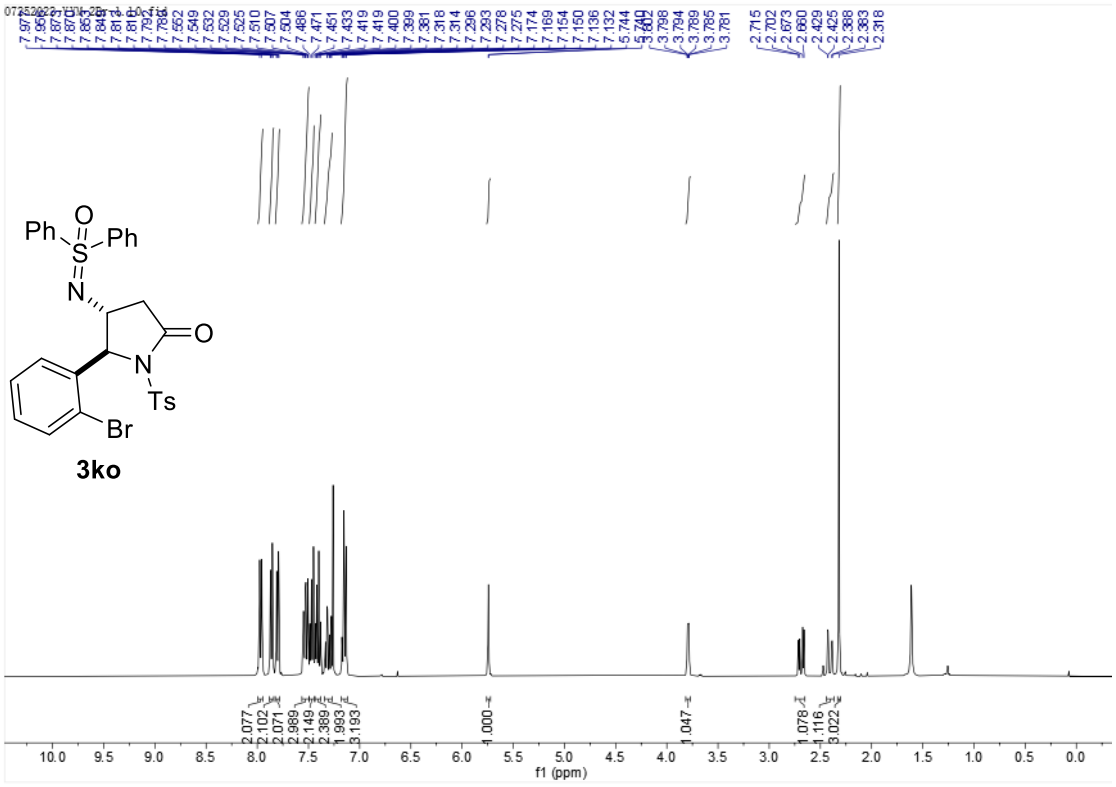
^{1}H NMR (400 MHz, $CDCl_3$) of **3jo**



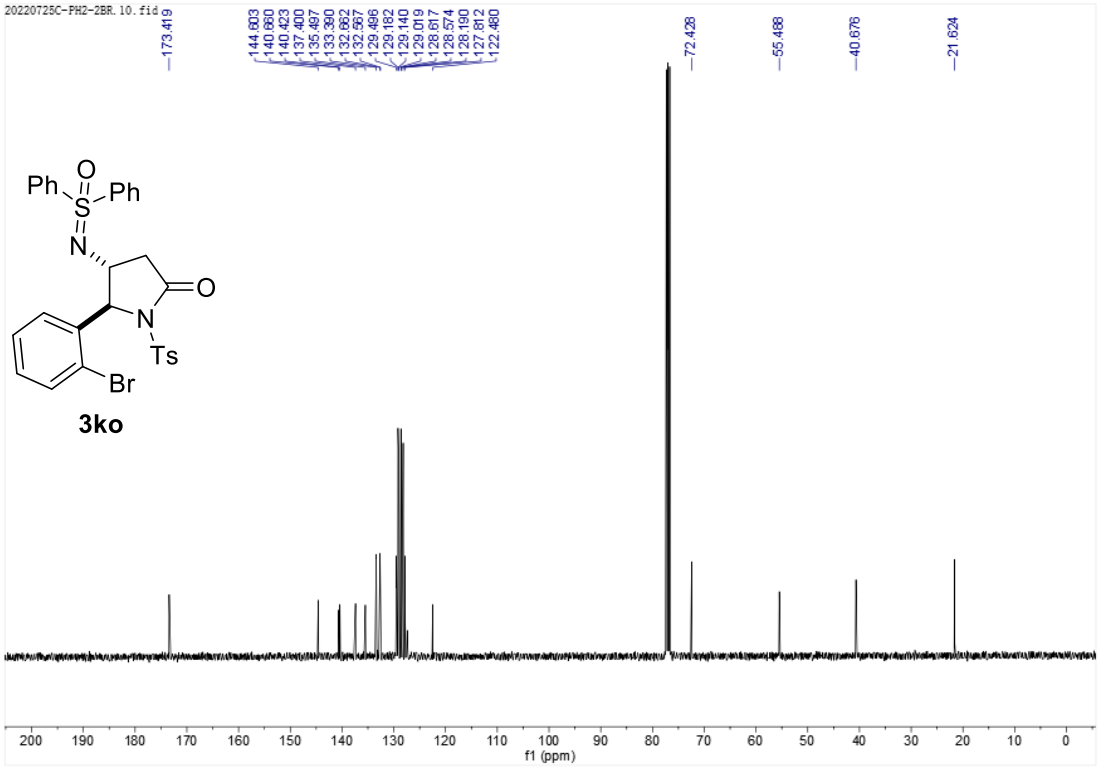
^{13}C NMR (101 MHz, $CDCl_3$) of **3jo**



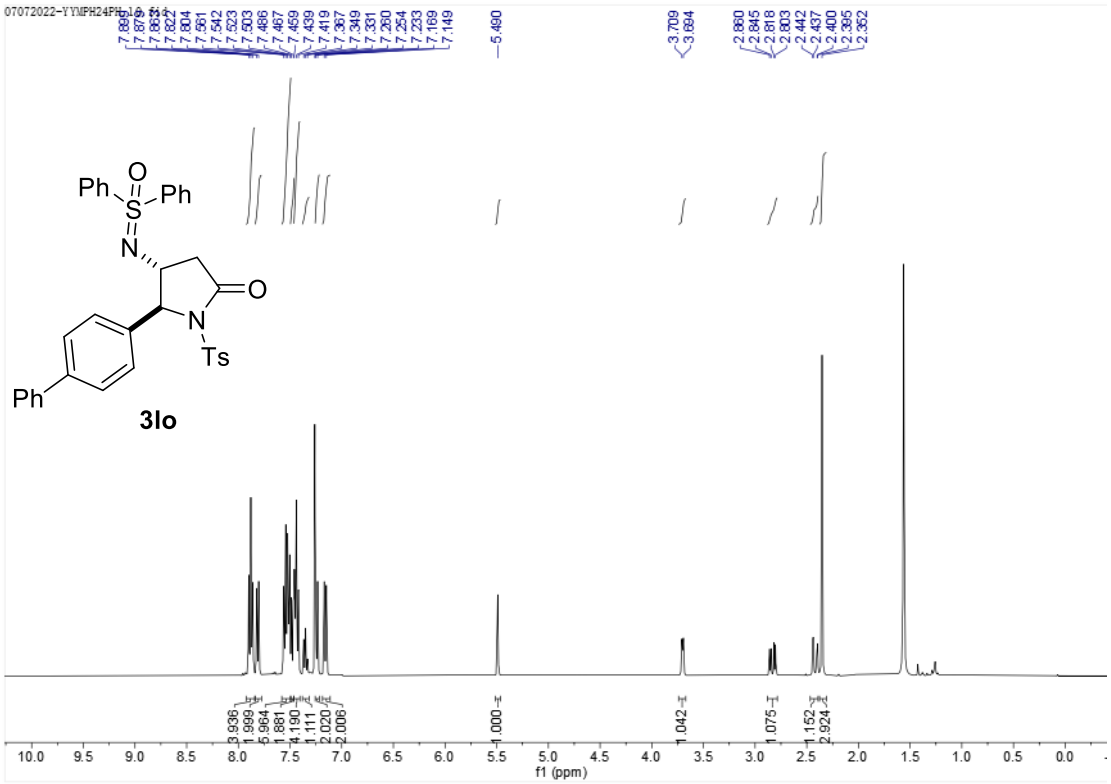
^{1}H NMR (400 MHz, $CDCl_3$) of **3ko**



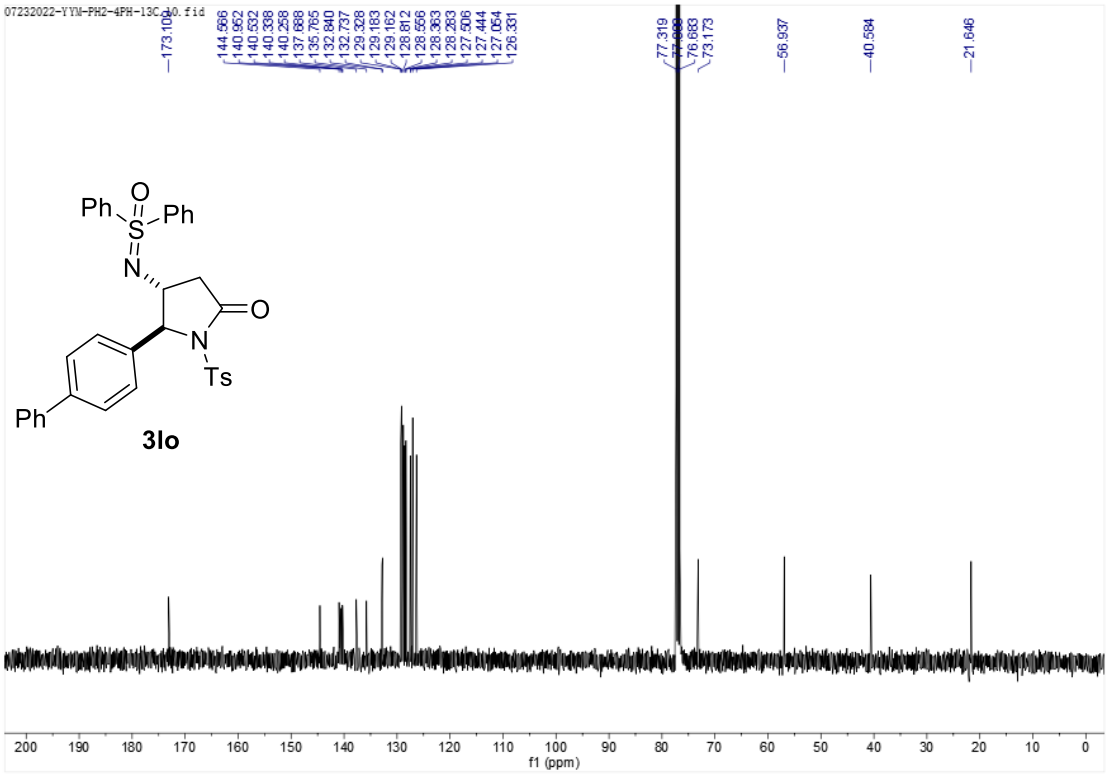
^{13}C NMR (101 MHz, $CDCl_3$) of **3ko**



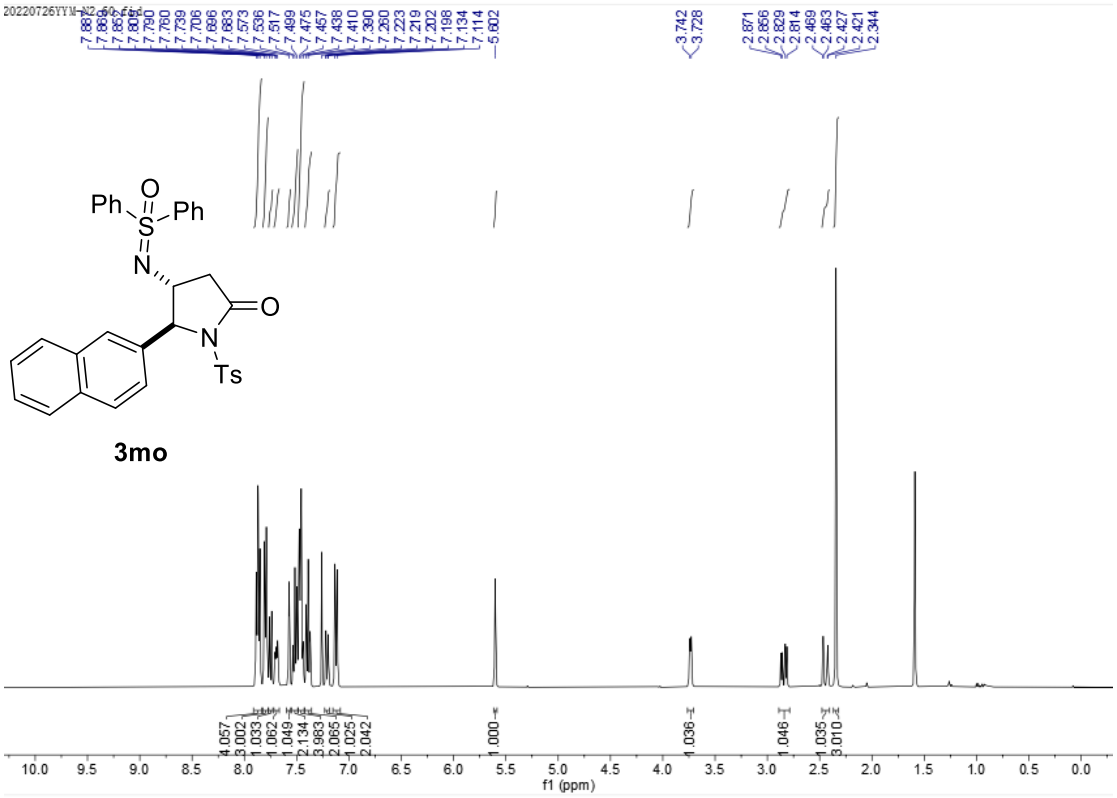
^{1}H NMR (400 MHz, $CDCl_3$) of **3lo**



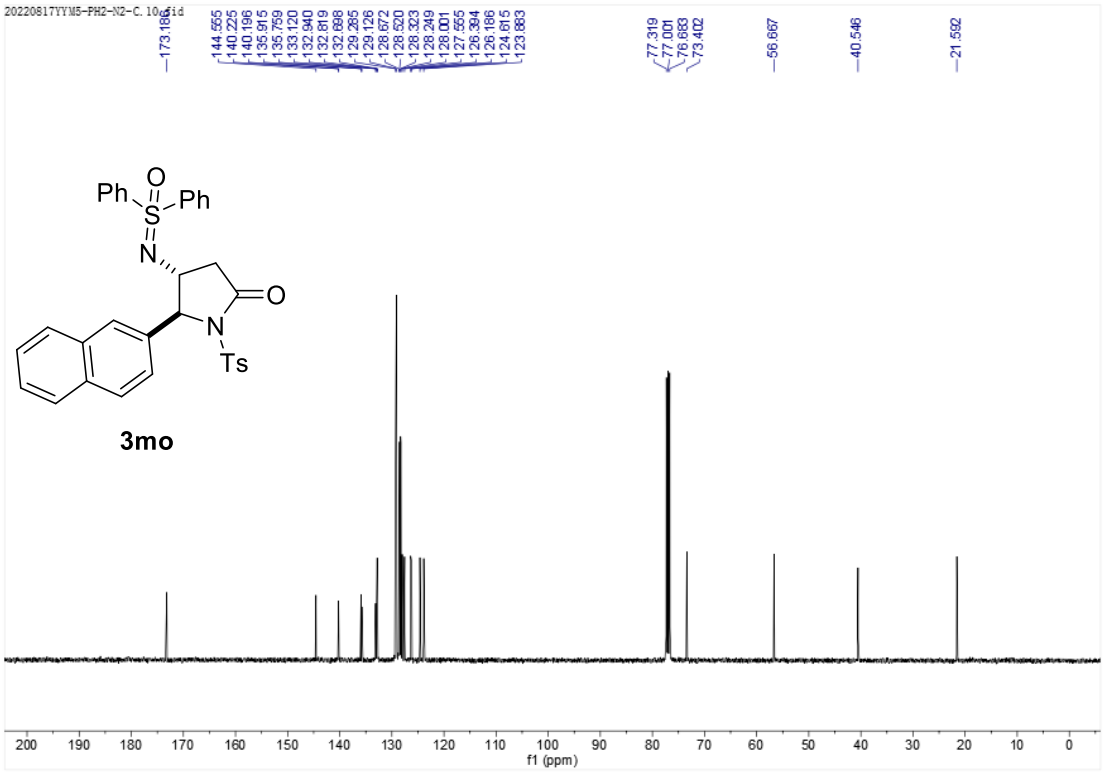
^{13}C NMR (101 MHz, $CDCl_3$) of **3lo**



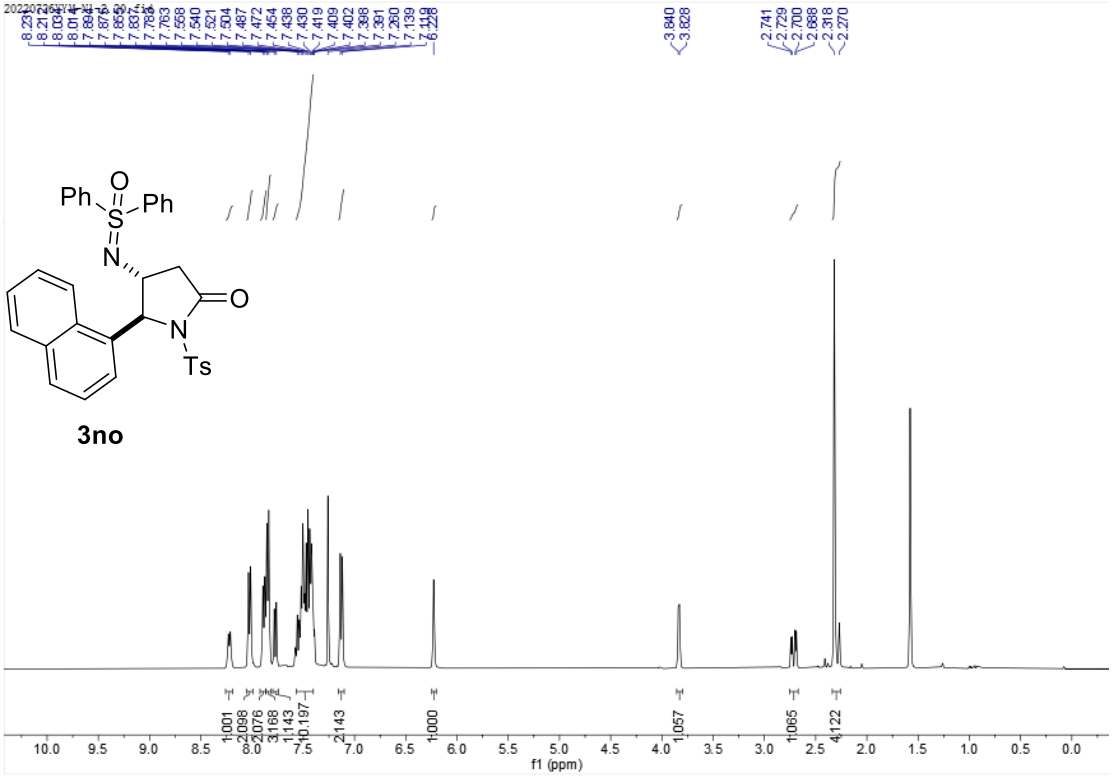
^{1}H NMR (400 MHz, $CDCl_3$) of **3mo**



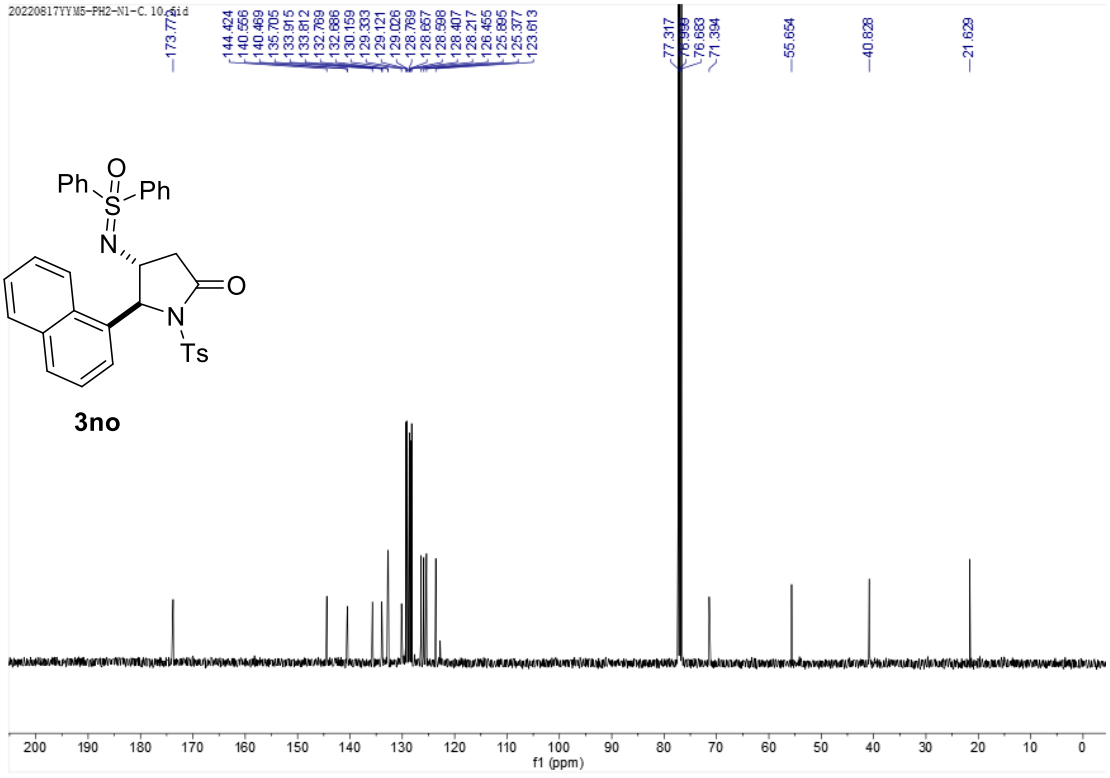
^{13}C NMR (101 MHz, $CDCl_3$) of **3am**



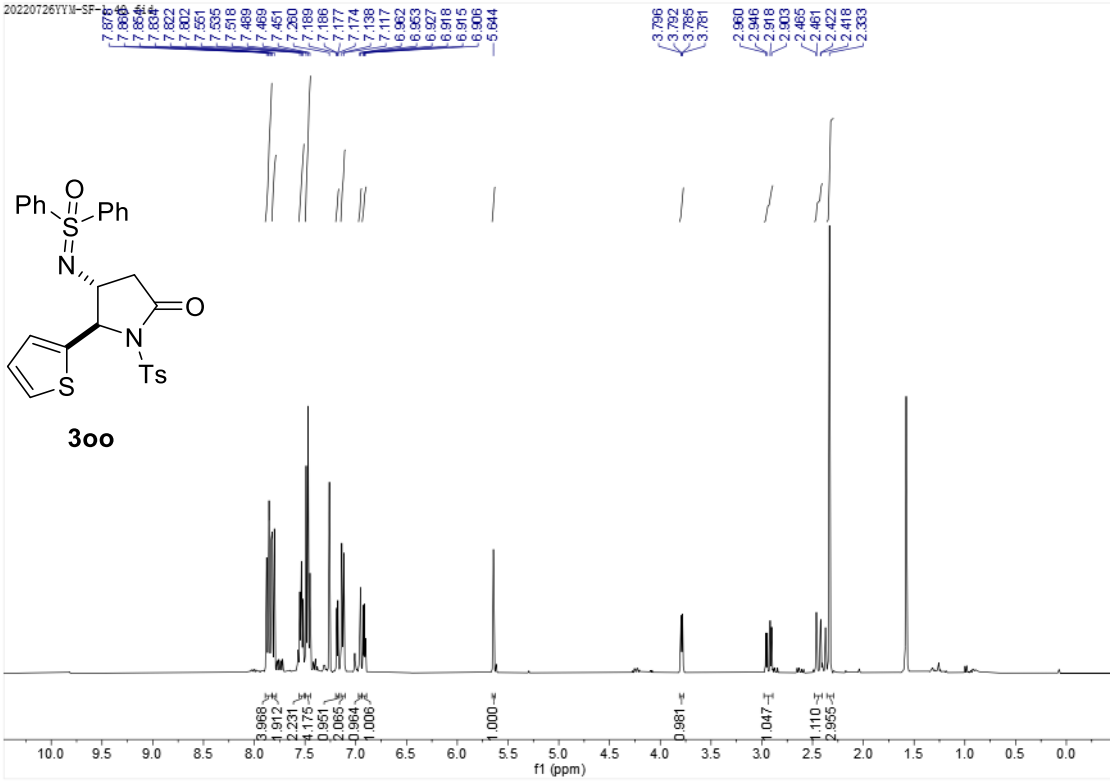
^{1}H NMR (400 MHz, $CDCl_3$) of **3no**



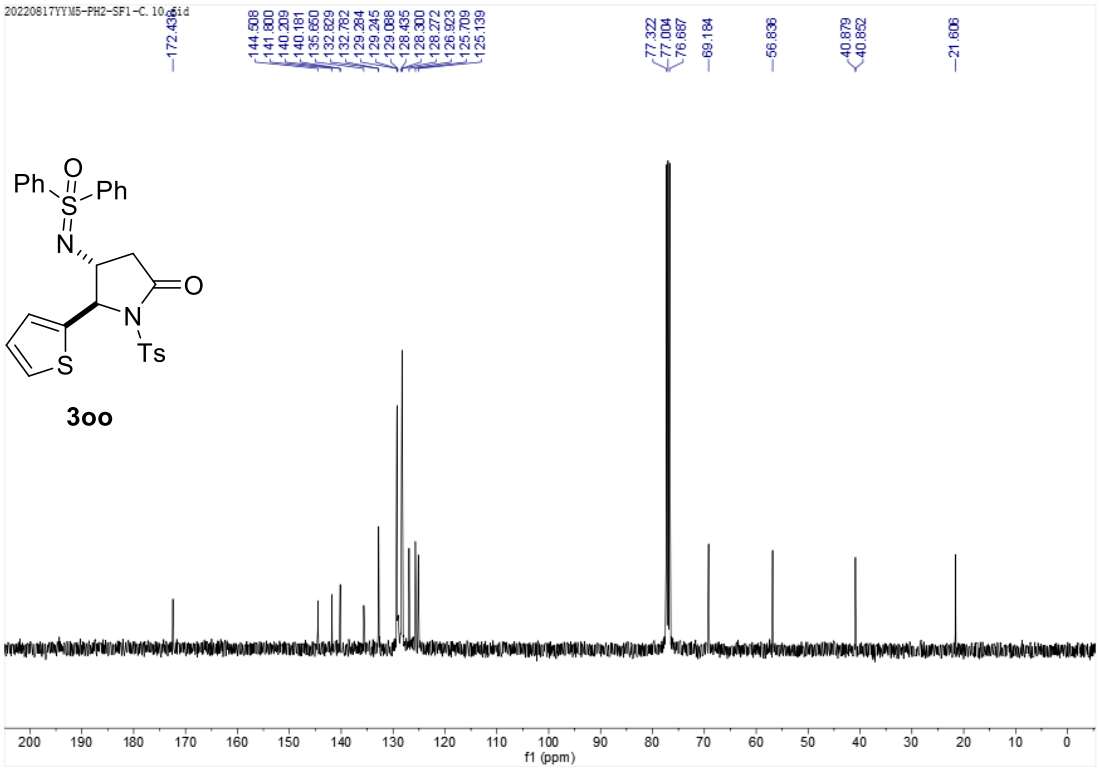
^{13}C NMR (101 MHz, $CDCl_3$) of **3no**



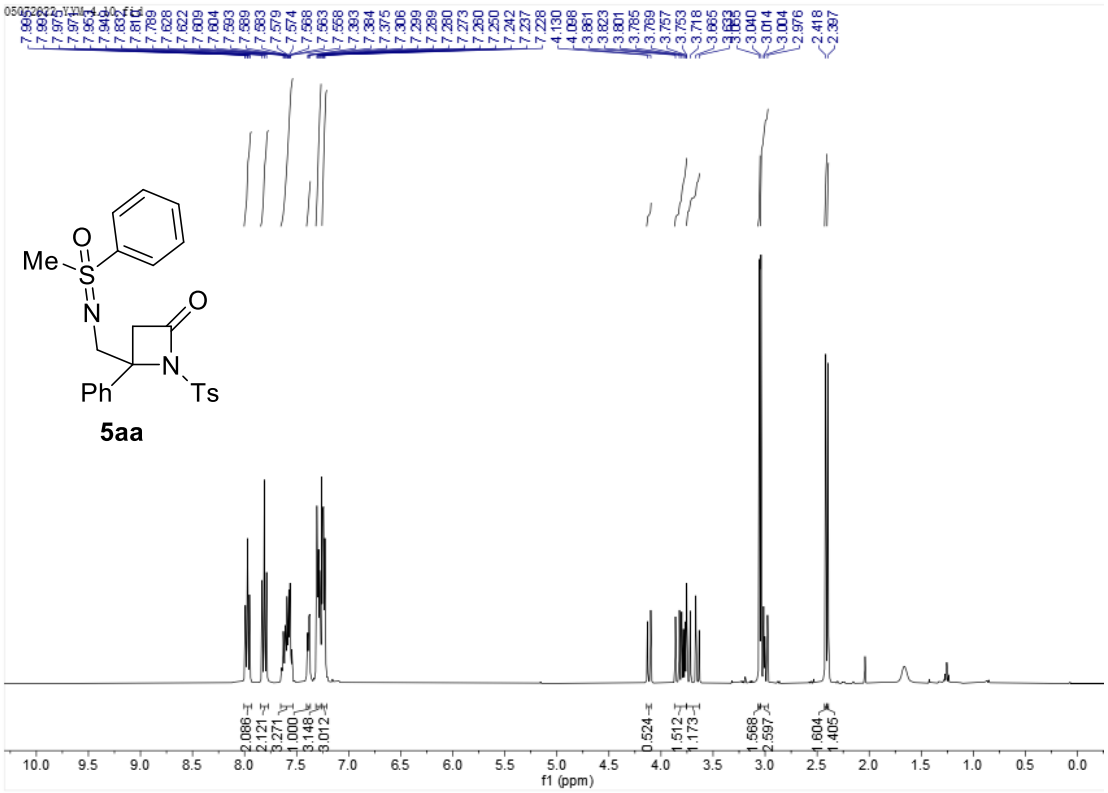
^{1}H NMR (400 MHz, $CDCl_3$) of **3oo**



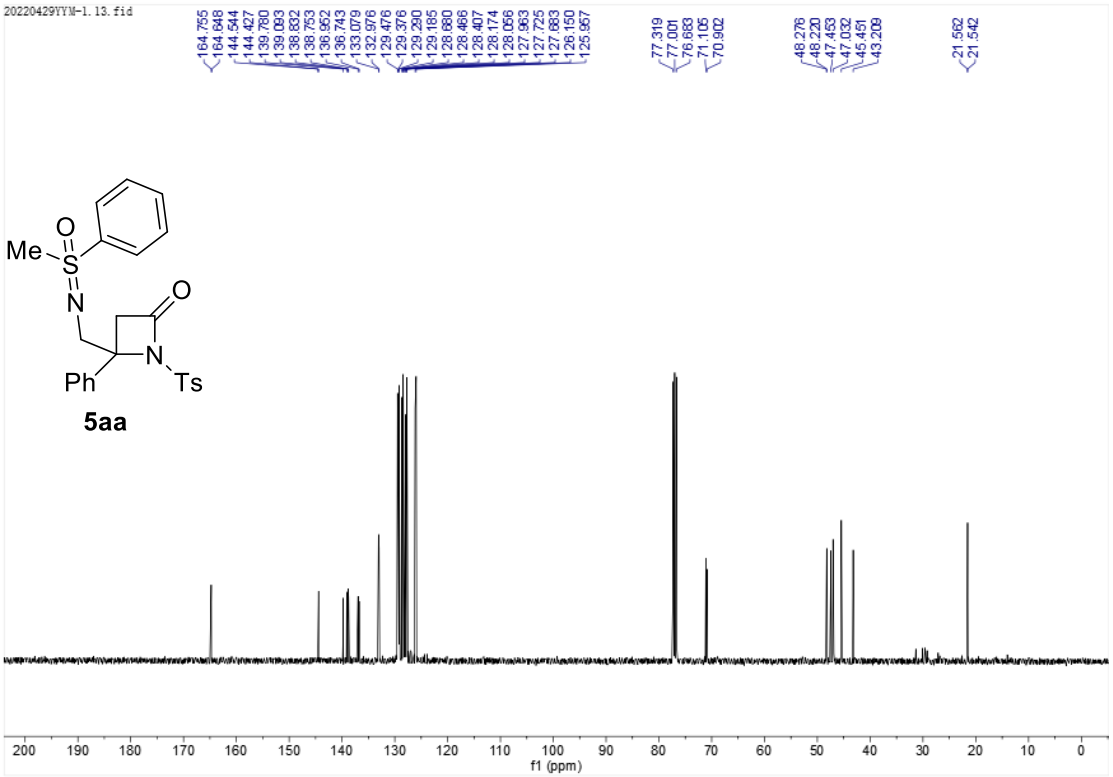
^{13}C NMR (101 MHz, $CDCl_3$) of **3oo**



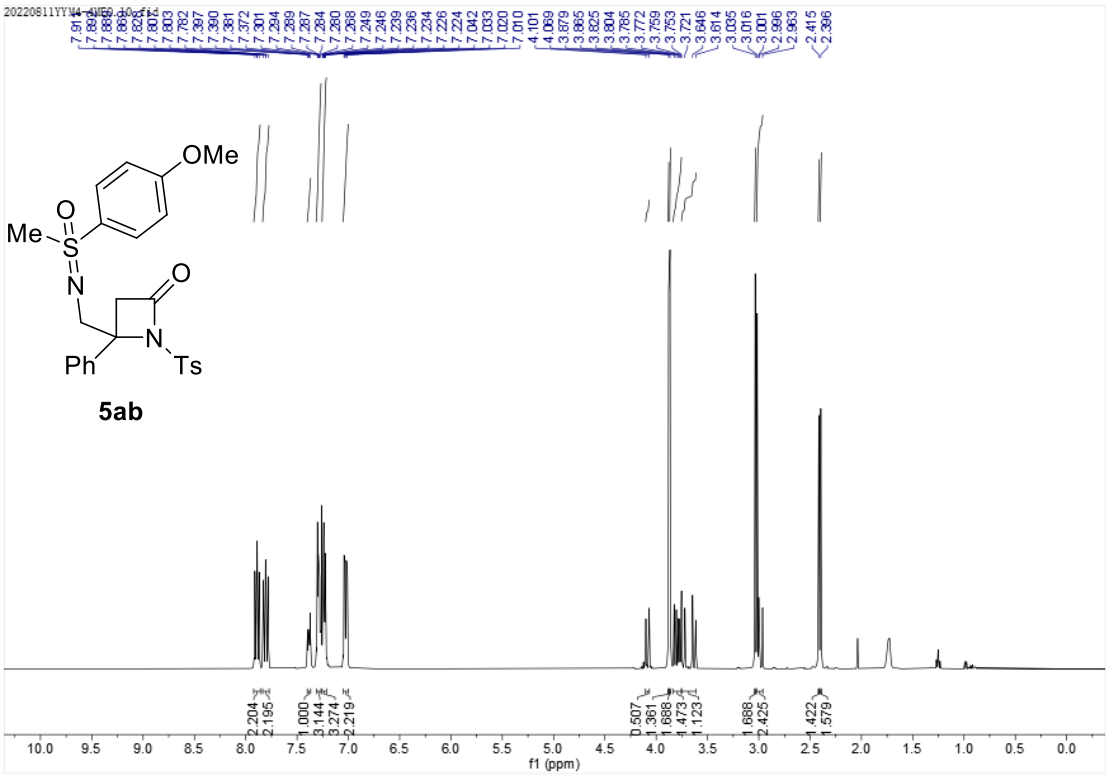
^{1}H NMR (400 MHz, $CDCl_3$) of **5aa**



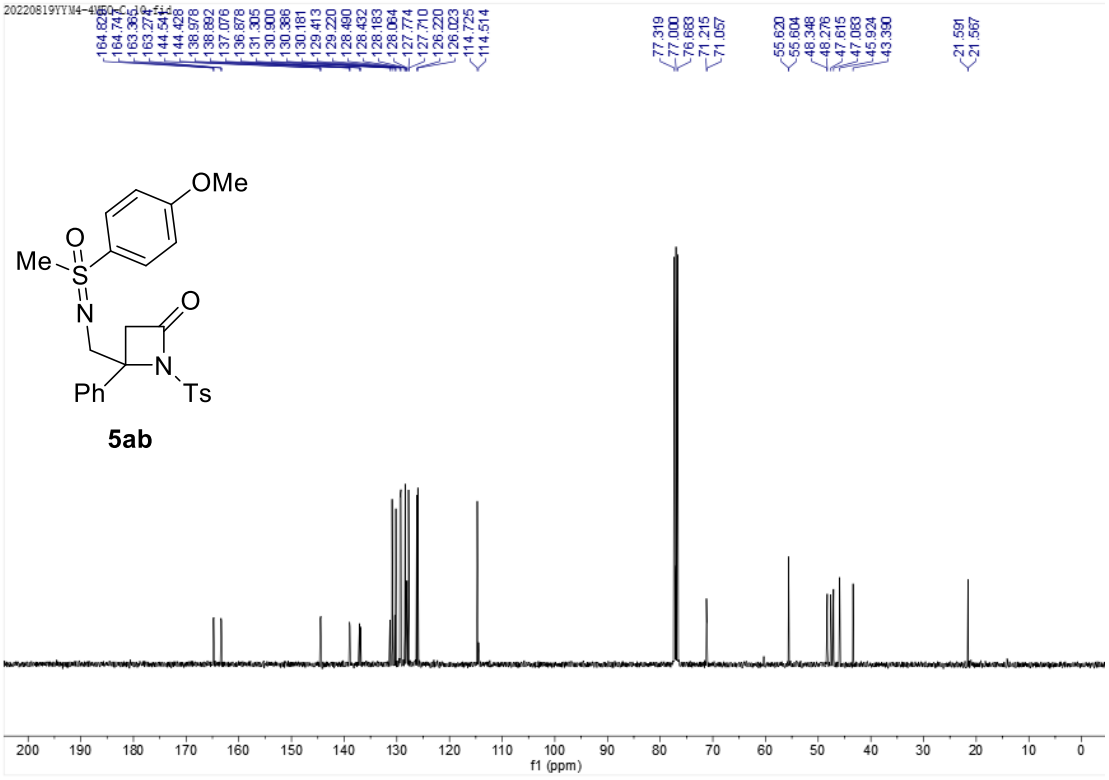
^{13}C NMR (101 MHz, $CDCl_3$) of **5aa**



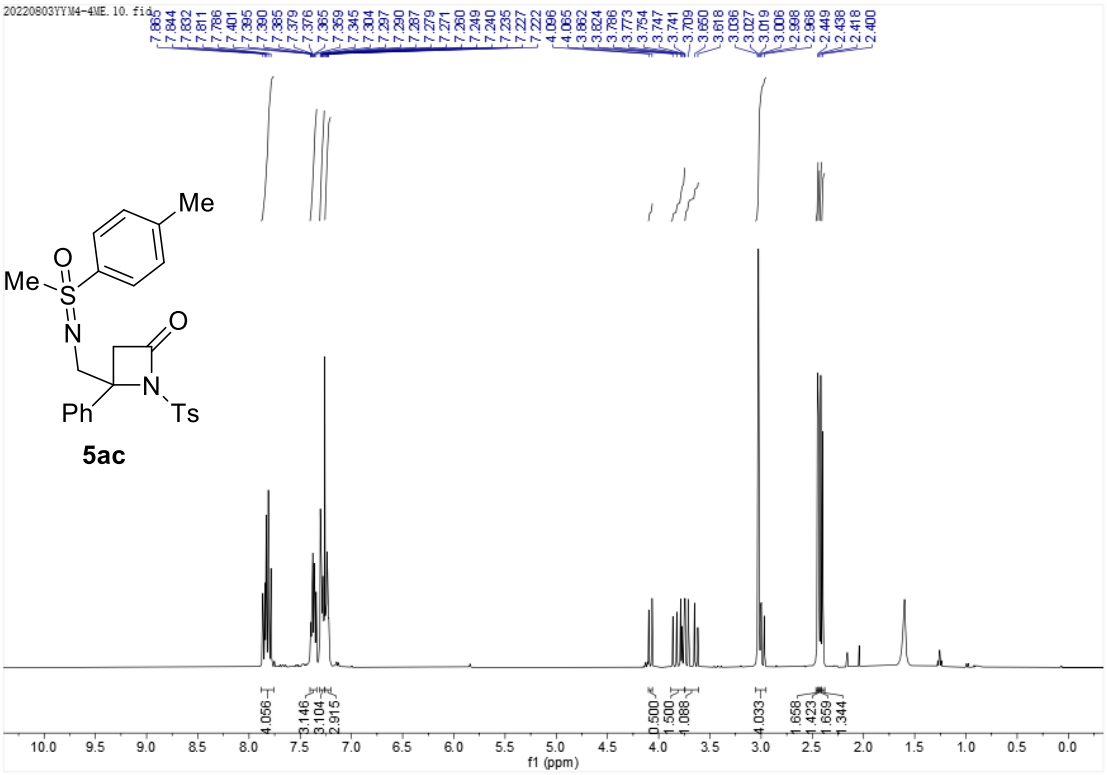
^{1}H NMR (400 MHz, $CDCl_3$) of **5ab**



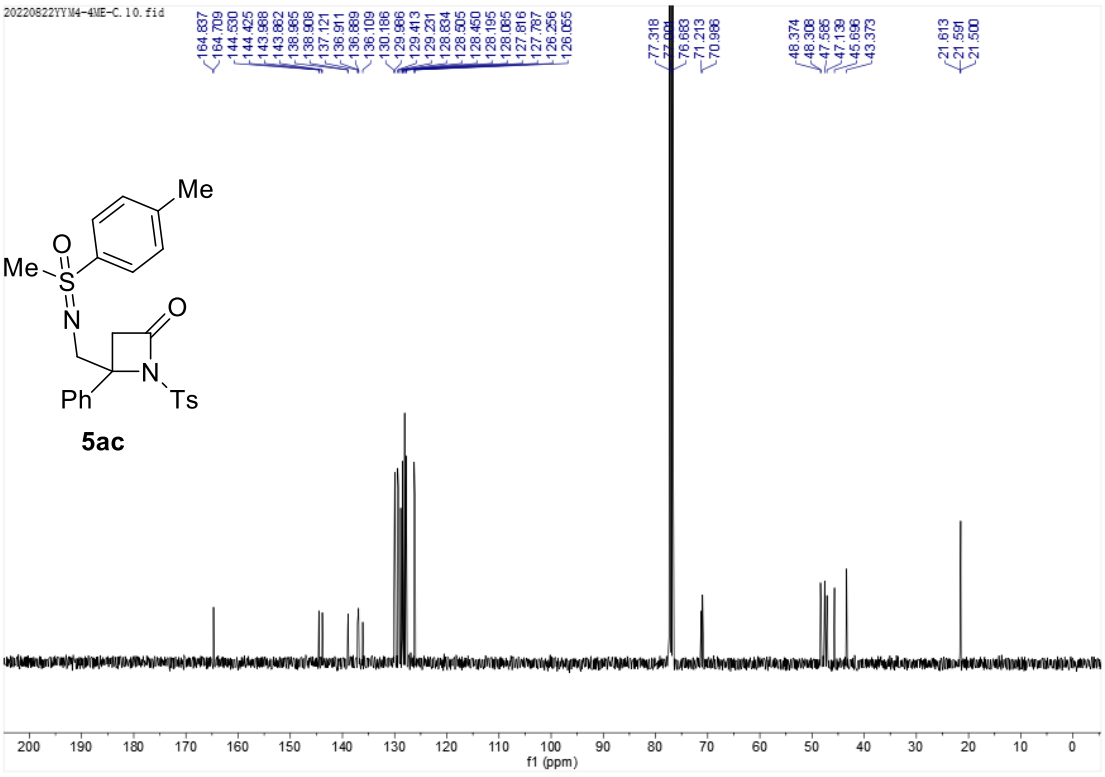
^{13}C NMR (101 MHz, $CDCl_3$) of **5ab**



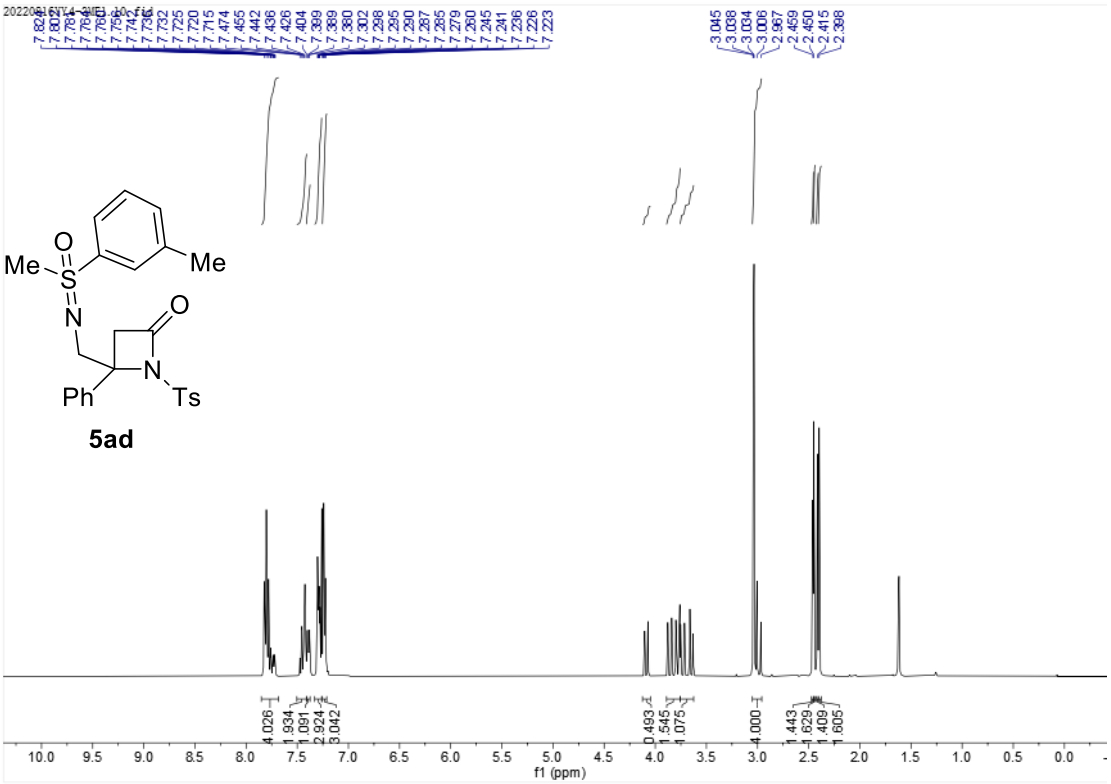
^{1}H NMR (400 MHz, $CDCl_3$) of **5ac**



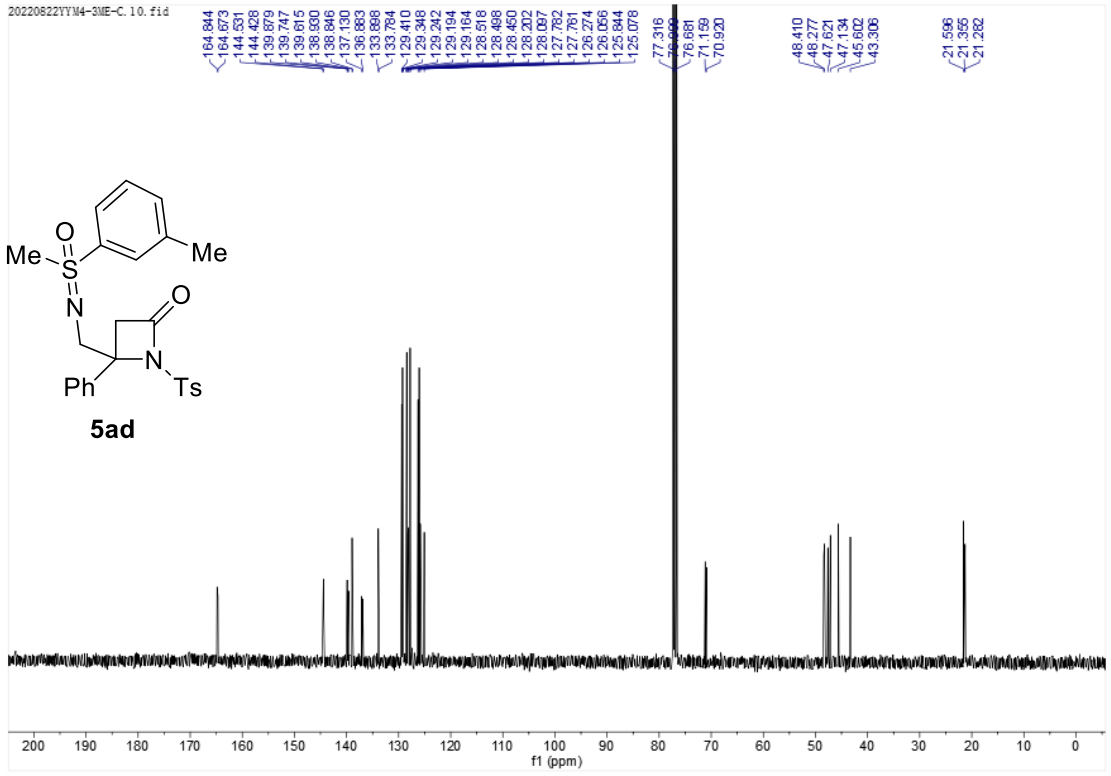
^{13}C NMR (101 MHz, $CDCl_3$) of **5ac**



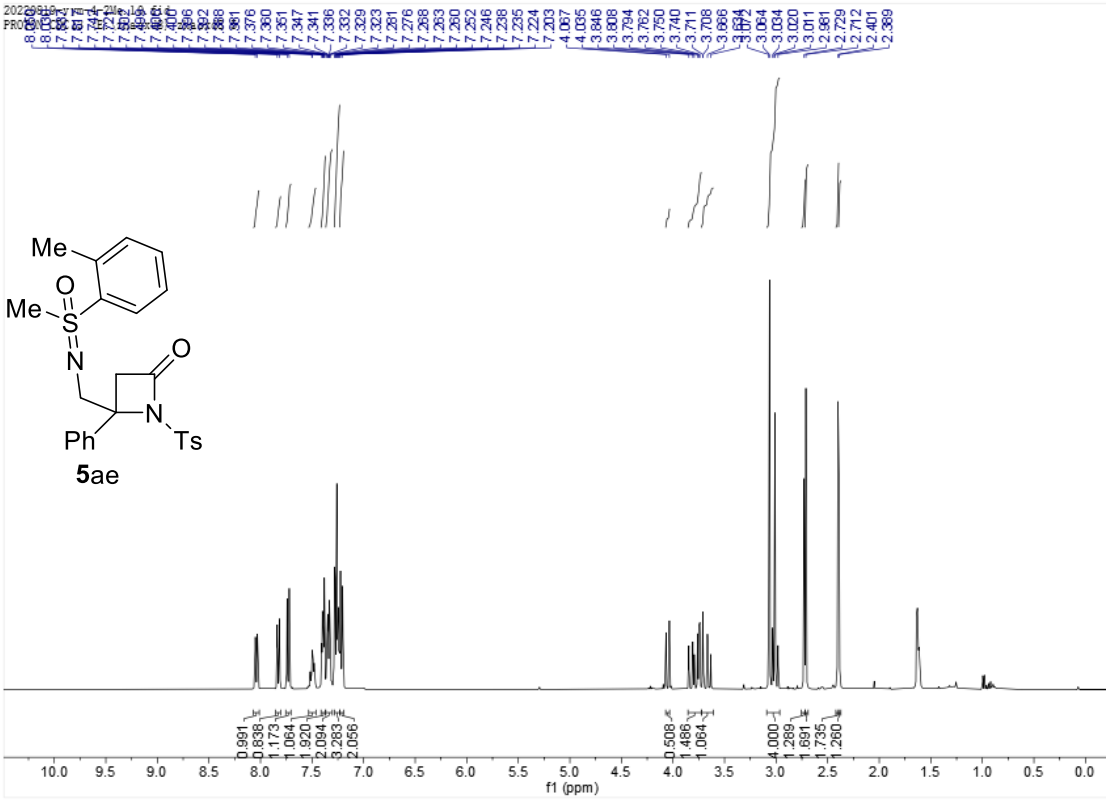
^{1}H NMR (400 MHz, $CDCl_3$) of **5ad**



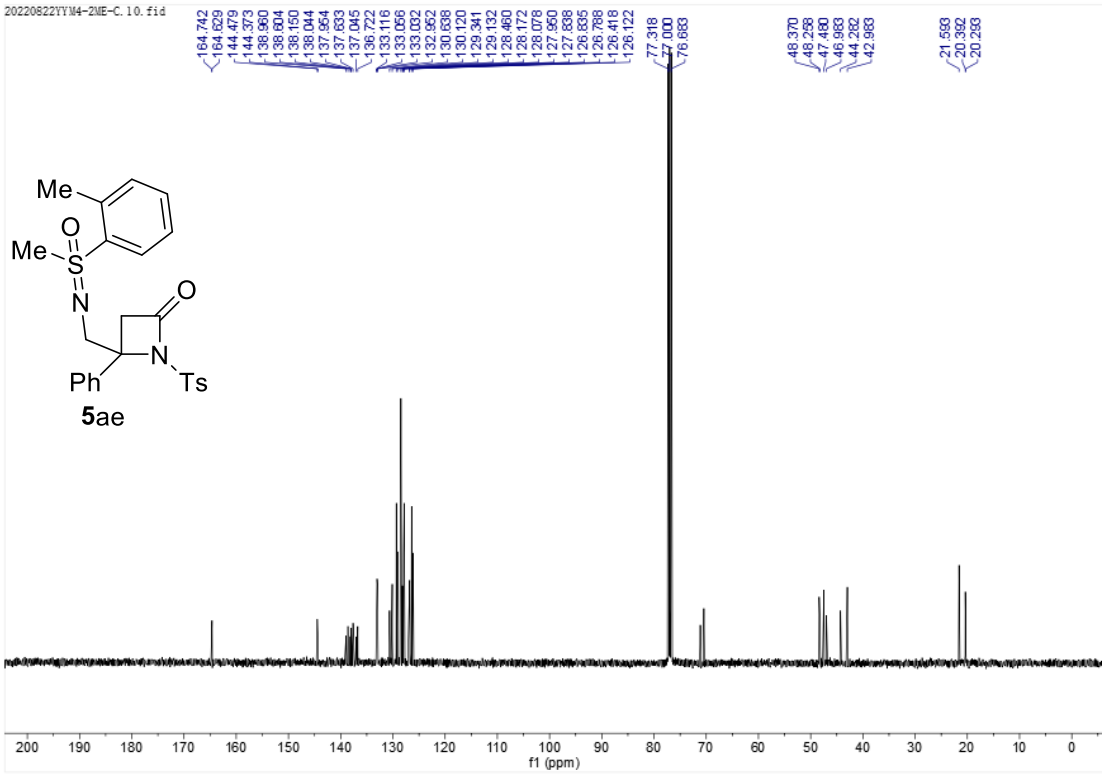
^{13}C NMR (101 MHz, $CDCl_3$) of **5ad**



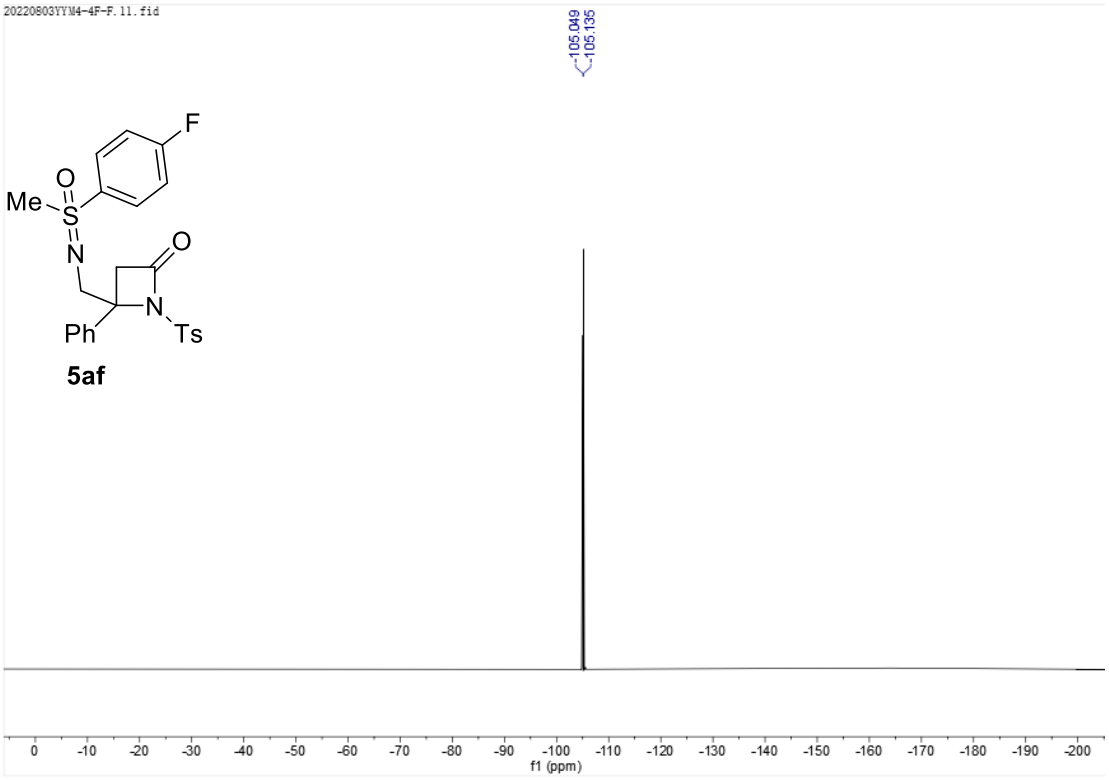
^{1}H NMR (400 MHz, $CDCl_3$) of **5ae**



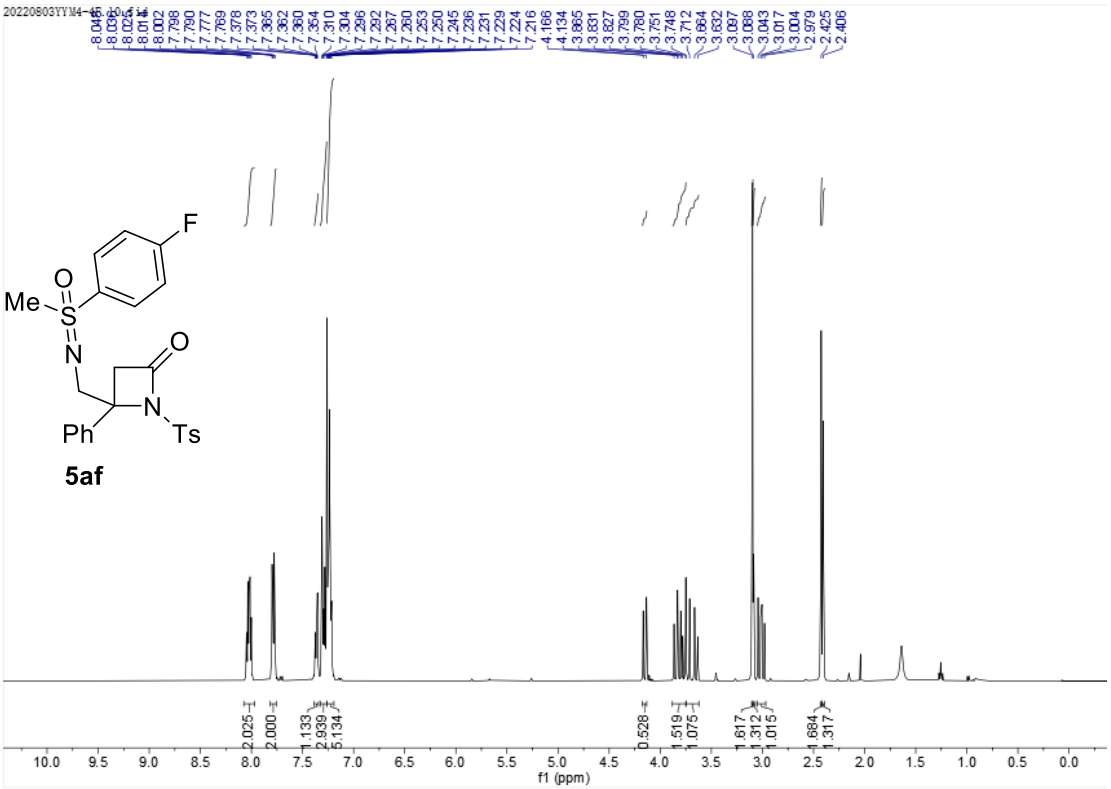
^{13}C NMR (101 MHz, $CDCl_3$) of **5ae**



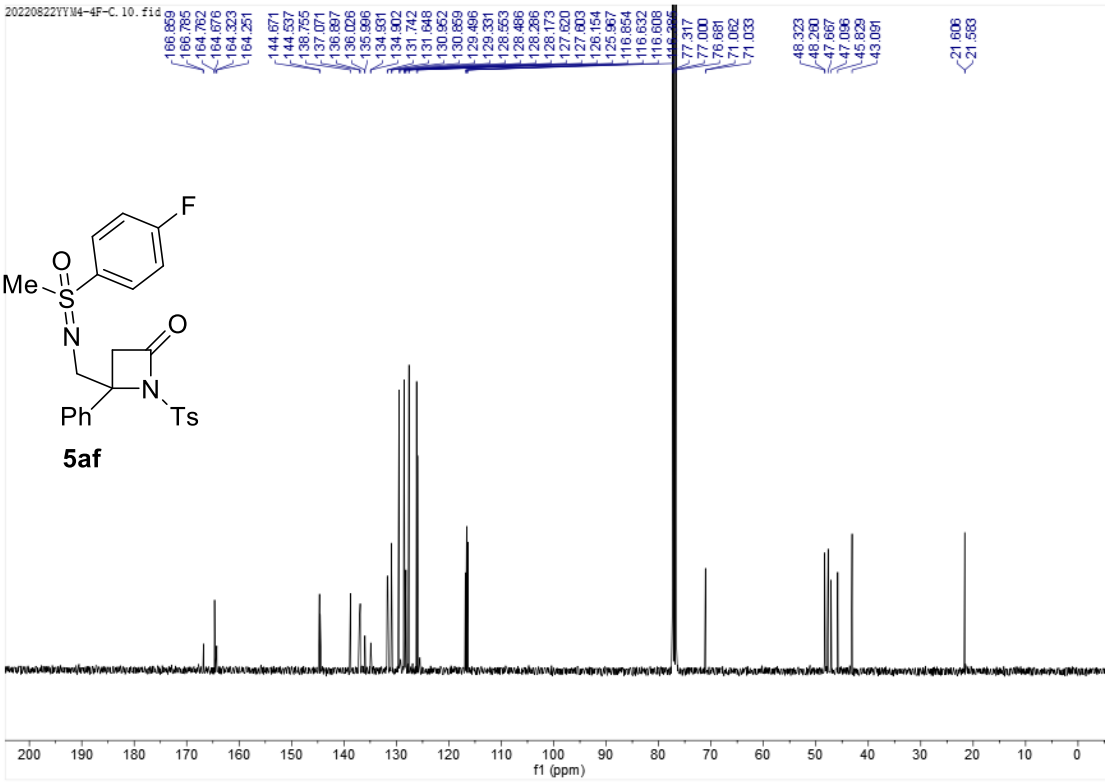
^{19}F NMR (376 MHz, $CDCl_3$) of **5af**



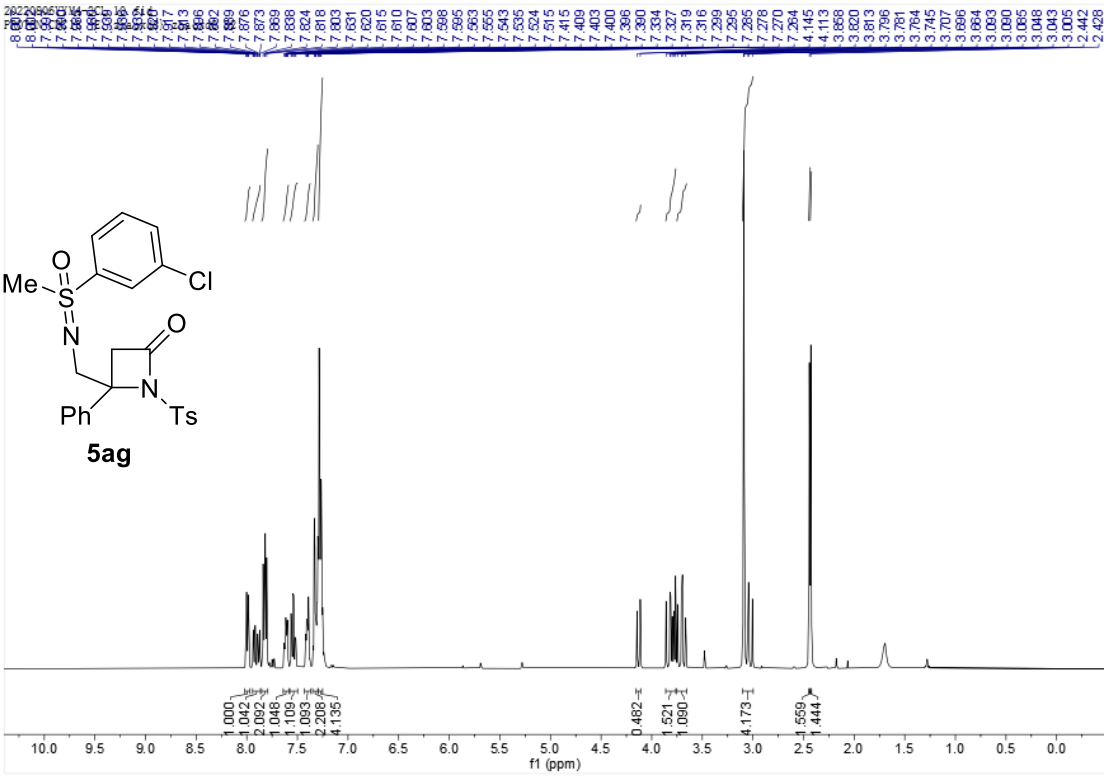
^{1}H NMR (400 MHz, $CDCl_3$) of **5af**



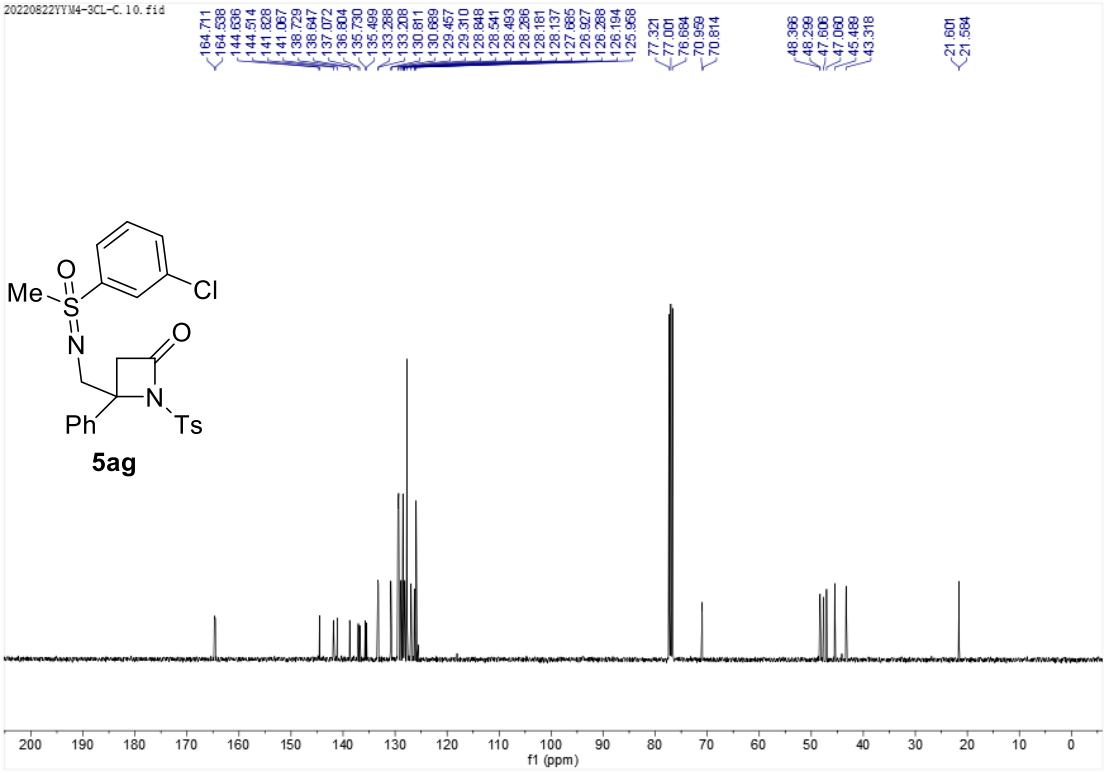
^{13}C NMR (101 MHz, $CDCl_3$) of **5af**



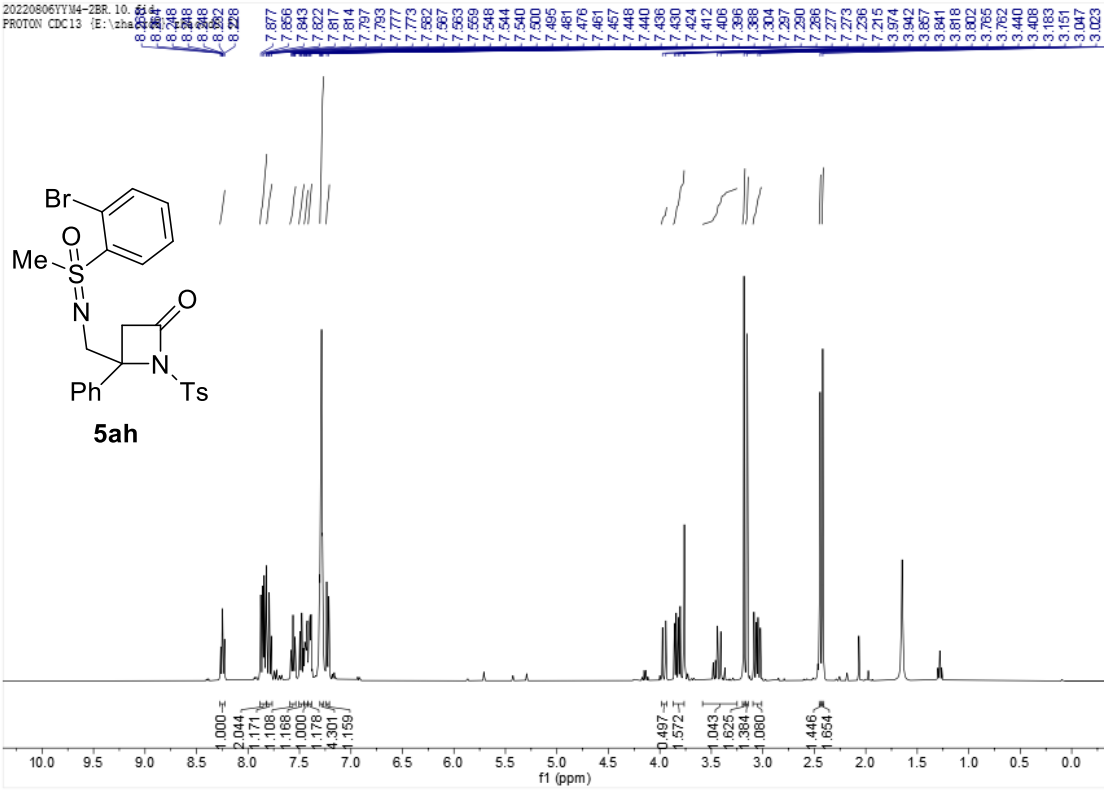
^{1}H NMR (400 MHz, $CDCl_3$) of **5ag**



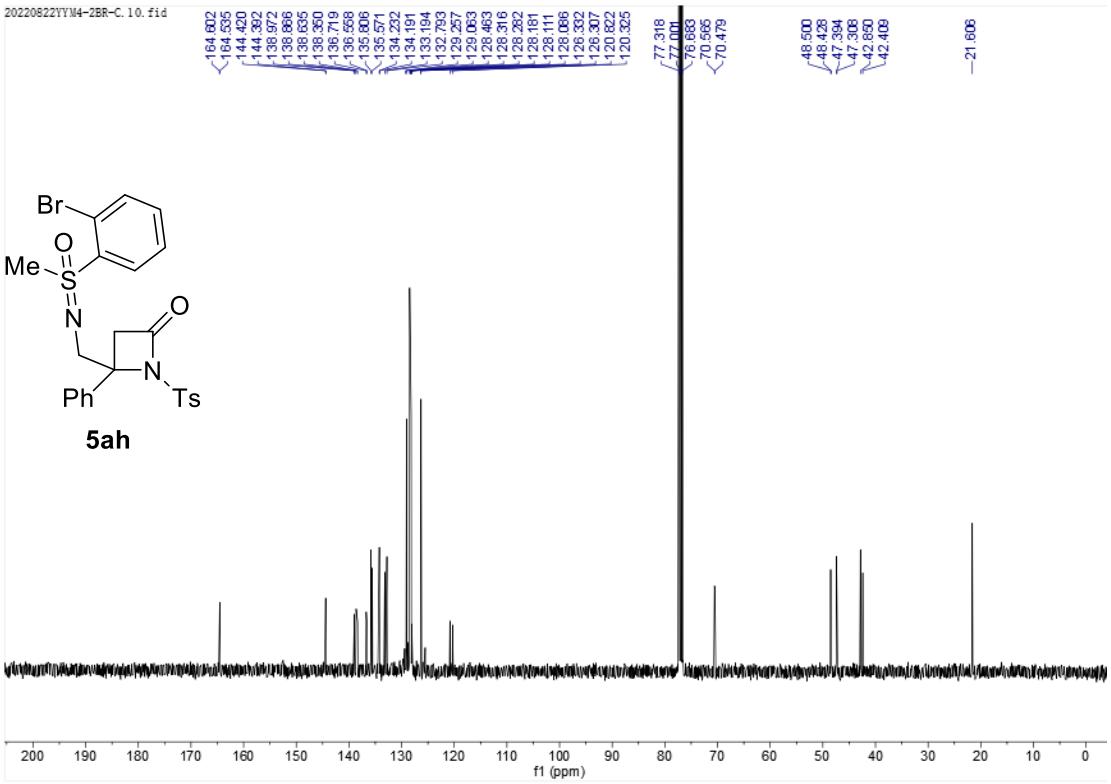
^{13}C NMR (101 MHz, $CDCl_3$) of **5ag**



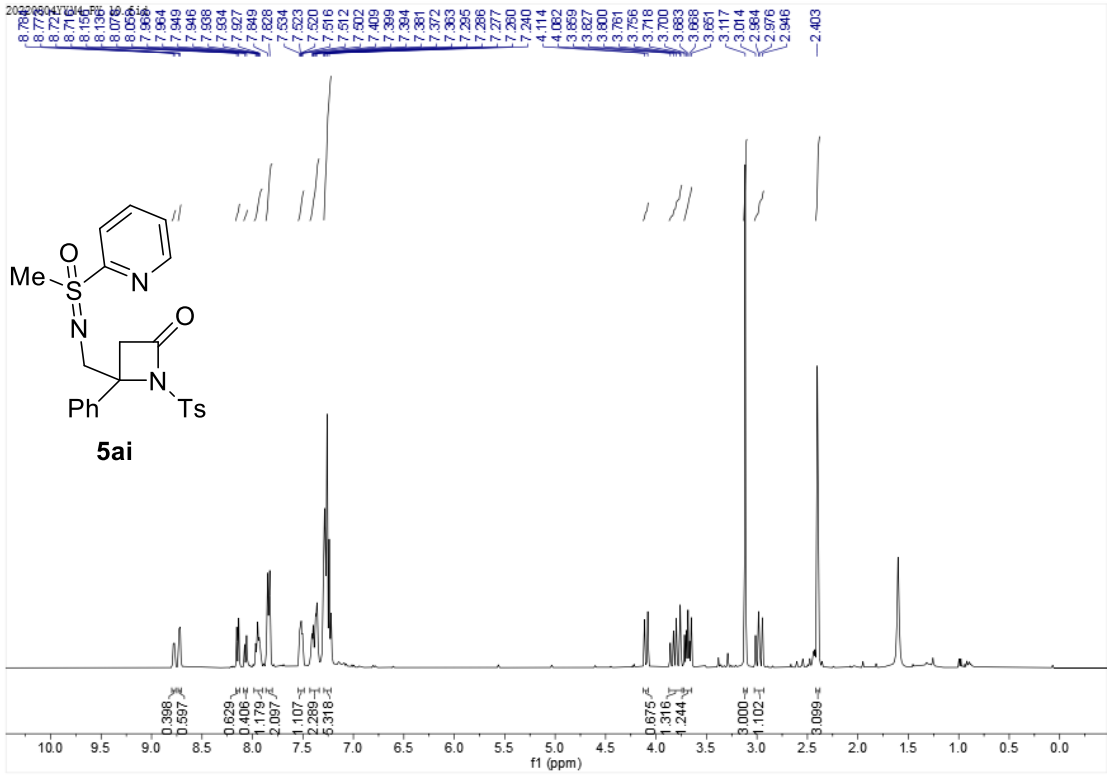
^{1}H NMR (400 MHz, $CDCl_3$) of **5ah**



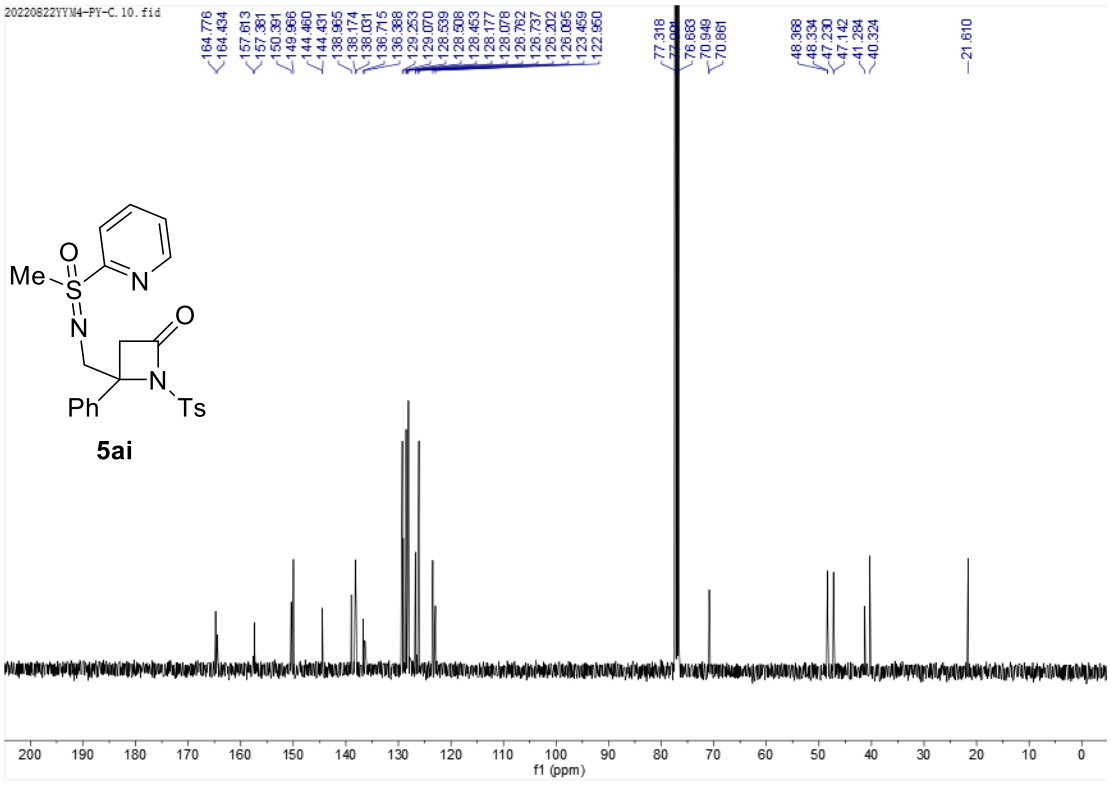
^{13}C NMR (101 MHz, $CDCl_3$) of **5ah**



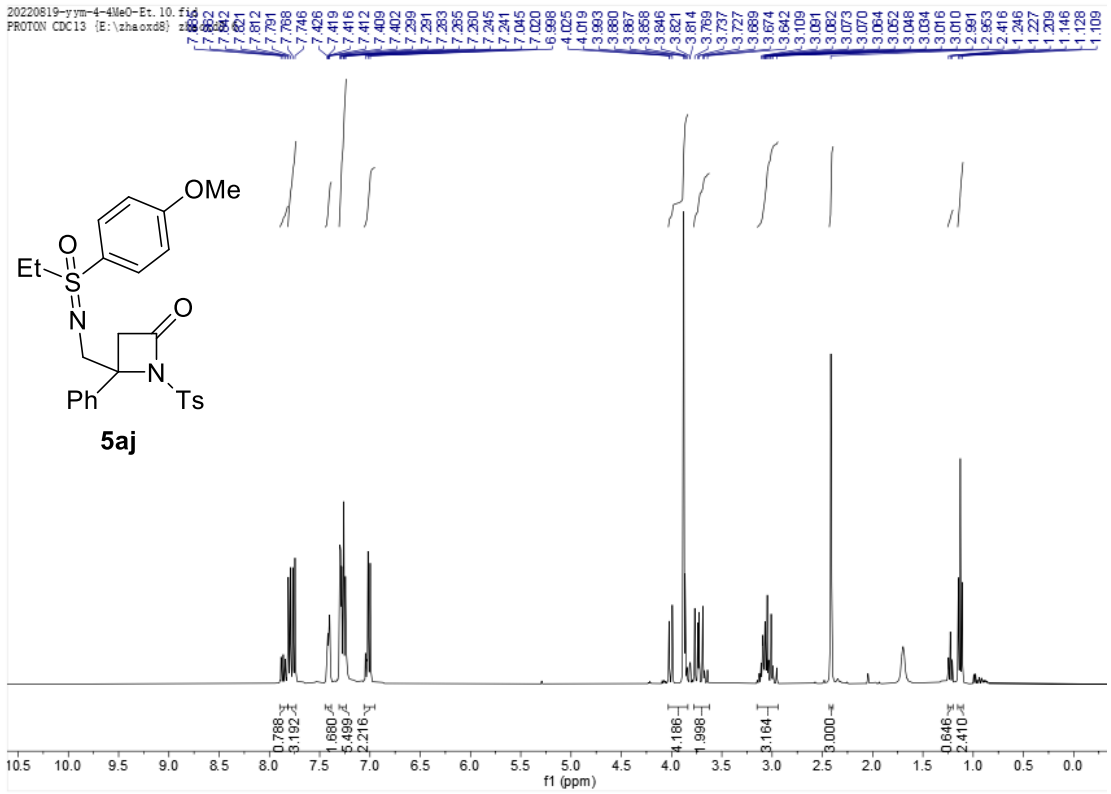
^{1}H NMR (400 MHz, $CDCl_3$) of **5ai**



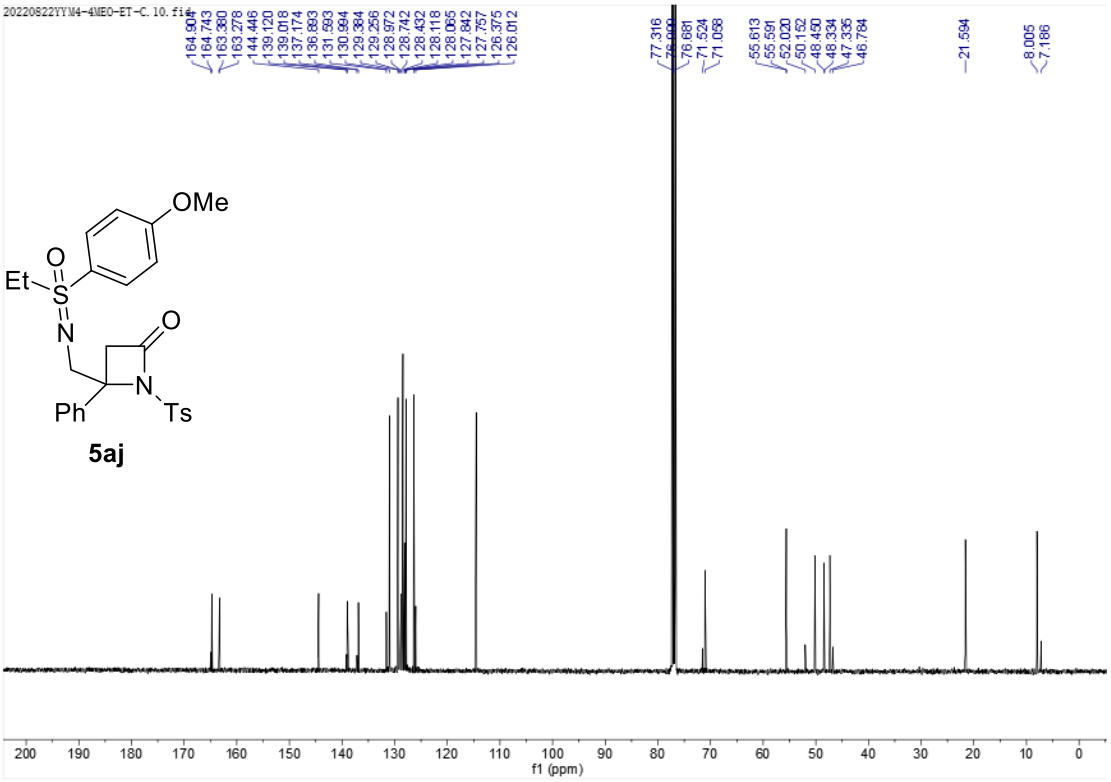
^{13}C NMR (101 MHz, $CDCl_3$) of **5ai**



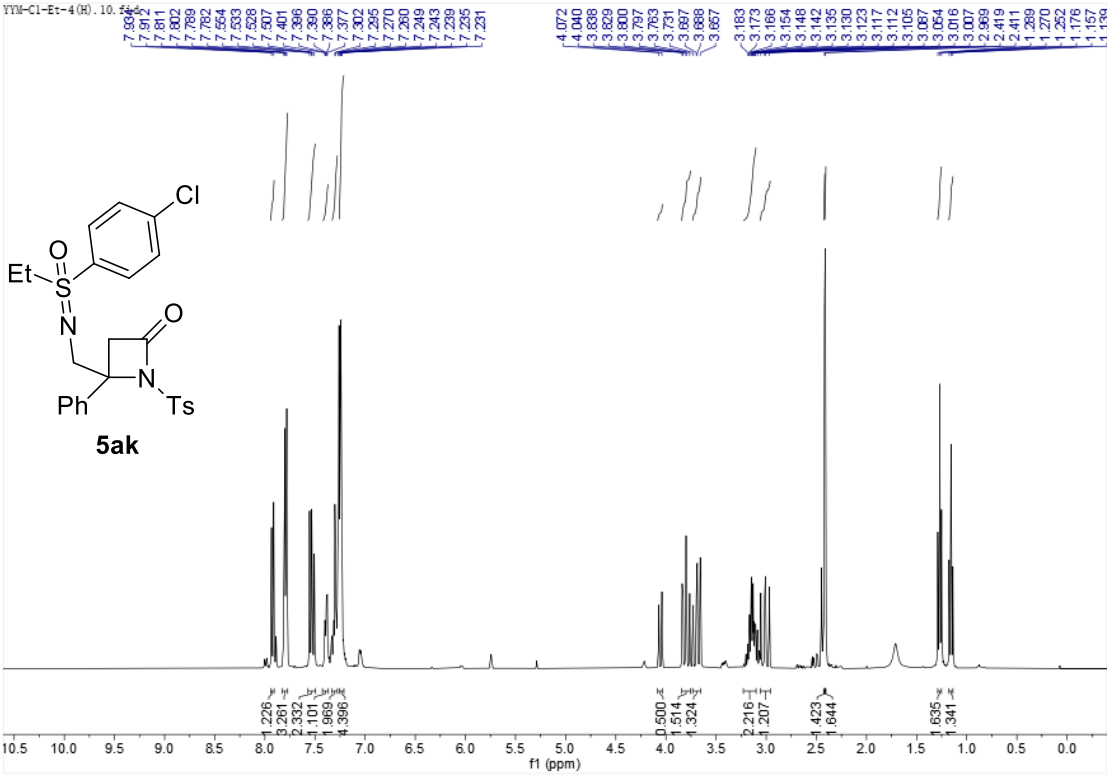
^{1}H NMR (400 MHz, $CDCl_3$) of **5aj**



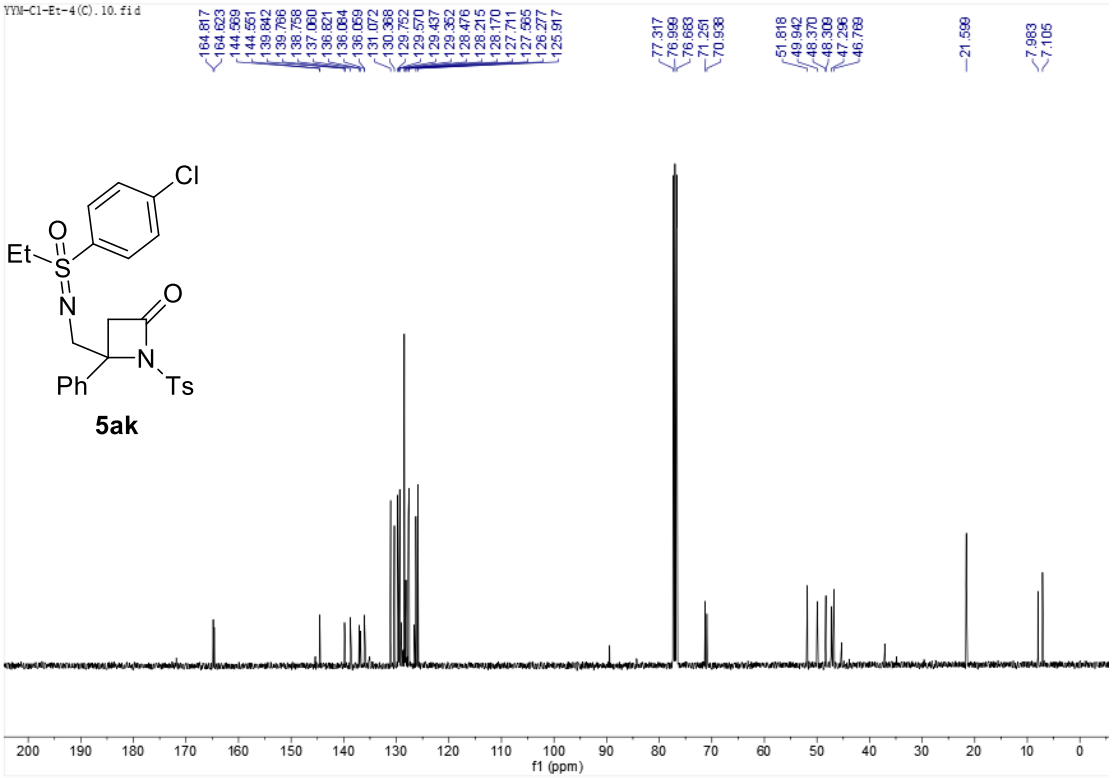
^{13}C NMR (101 MHz, $CDCl_3$) of **5aj**



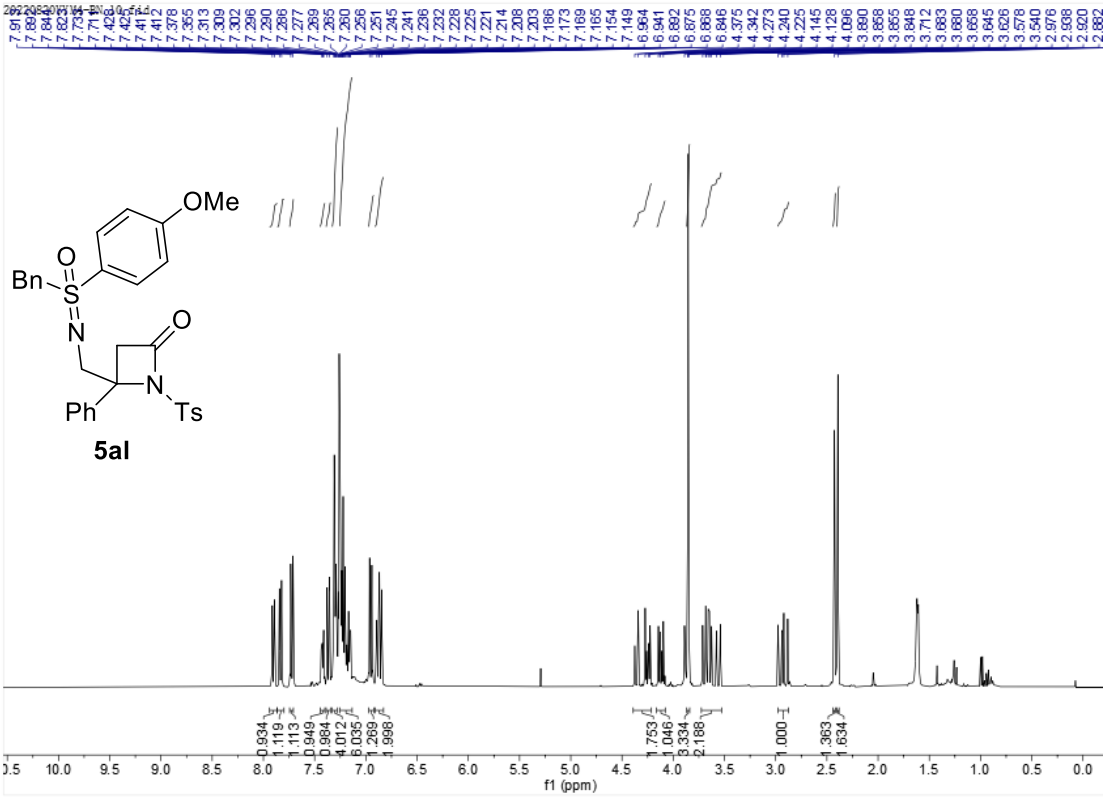
^{1}H NMR (400 MHz, $CDCl_3$) of **5ak**



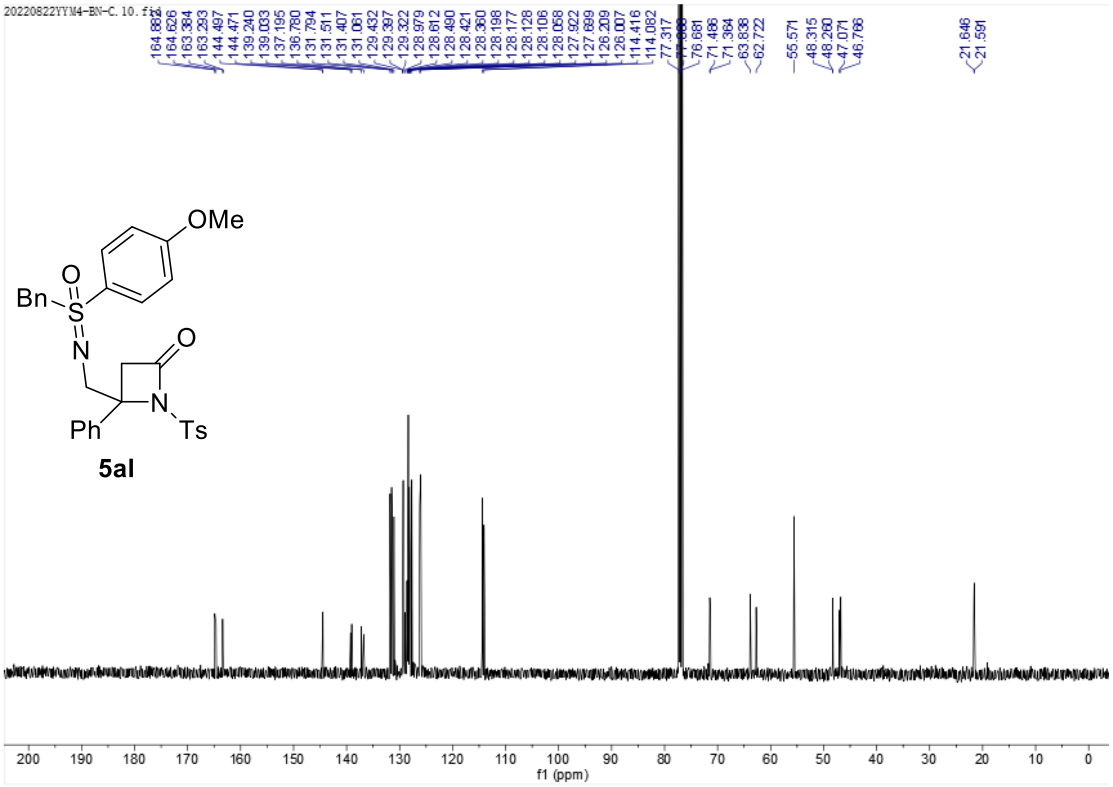
^{13}C NMR (101 MHz, $CDCl_3$) of **5ak**



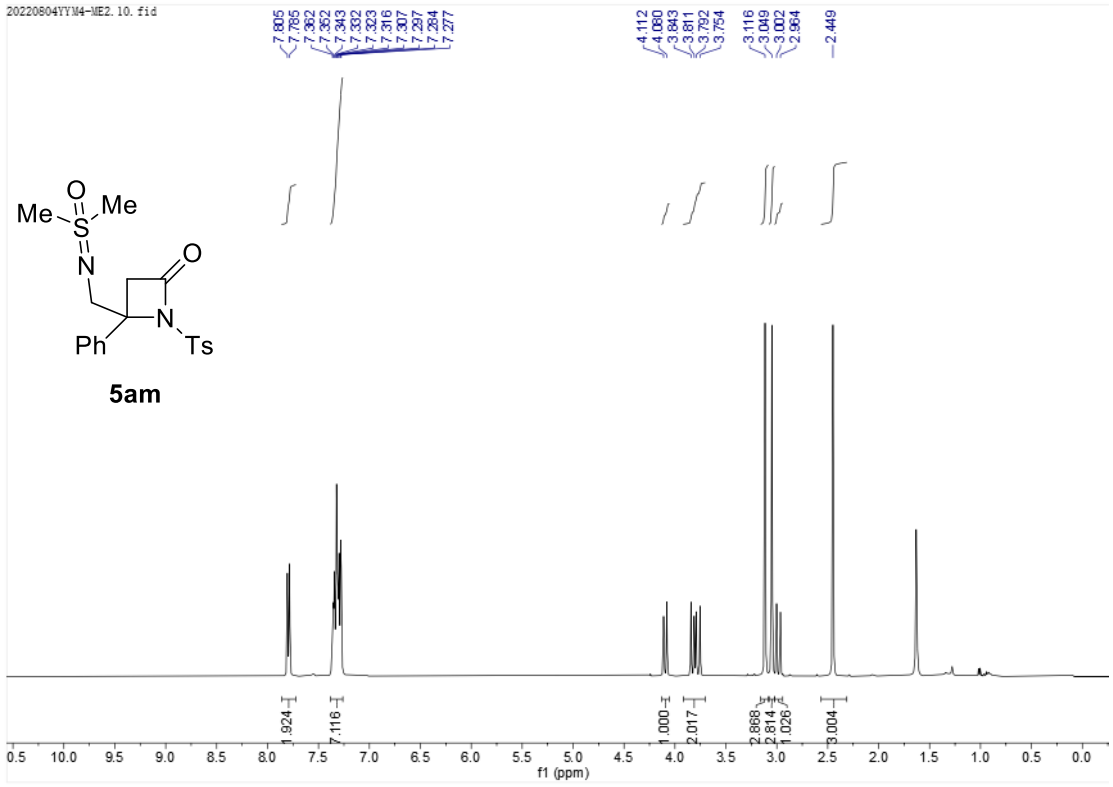
^{1}H NMR (400 MHz, $CDCl_3$) of **5al**



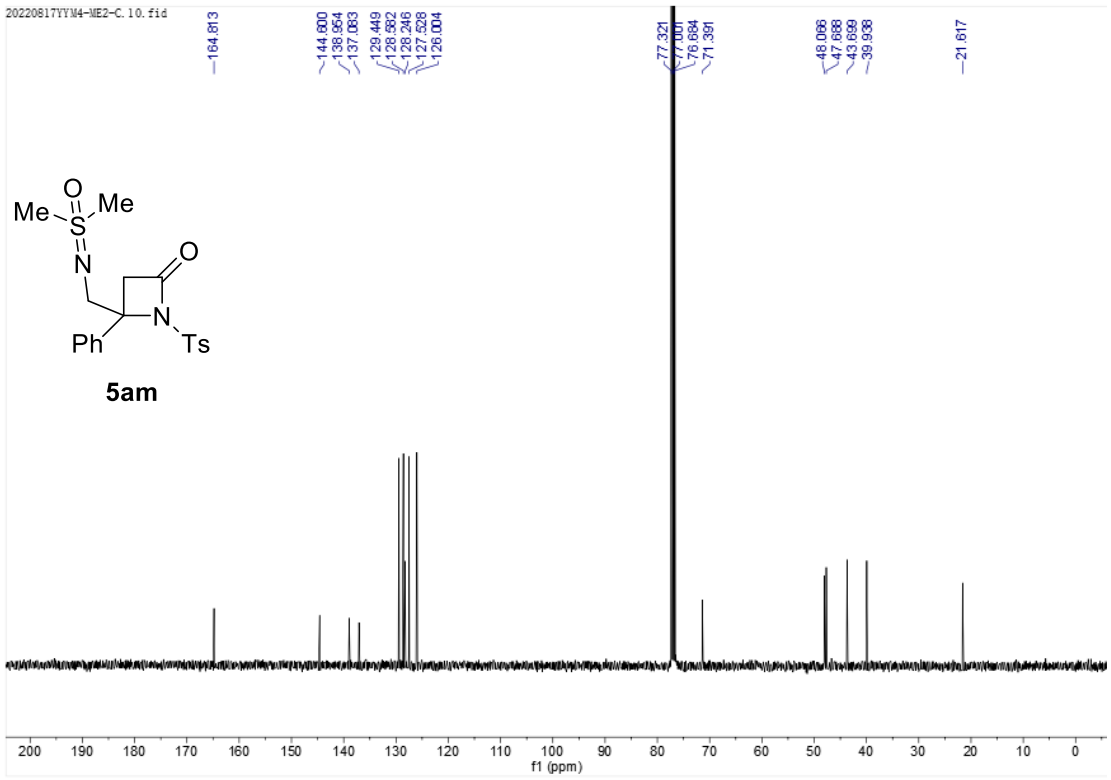
^{13}C NMR (101 MHz, $CDCl_3$) of **5al**



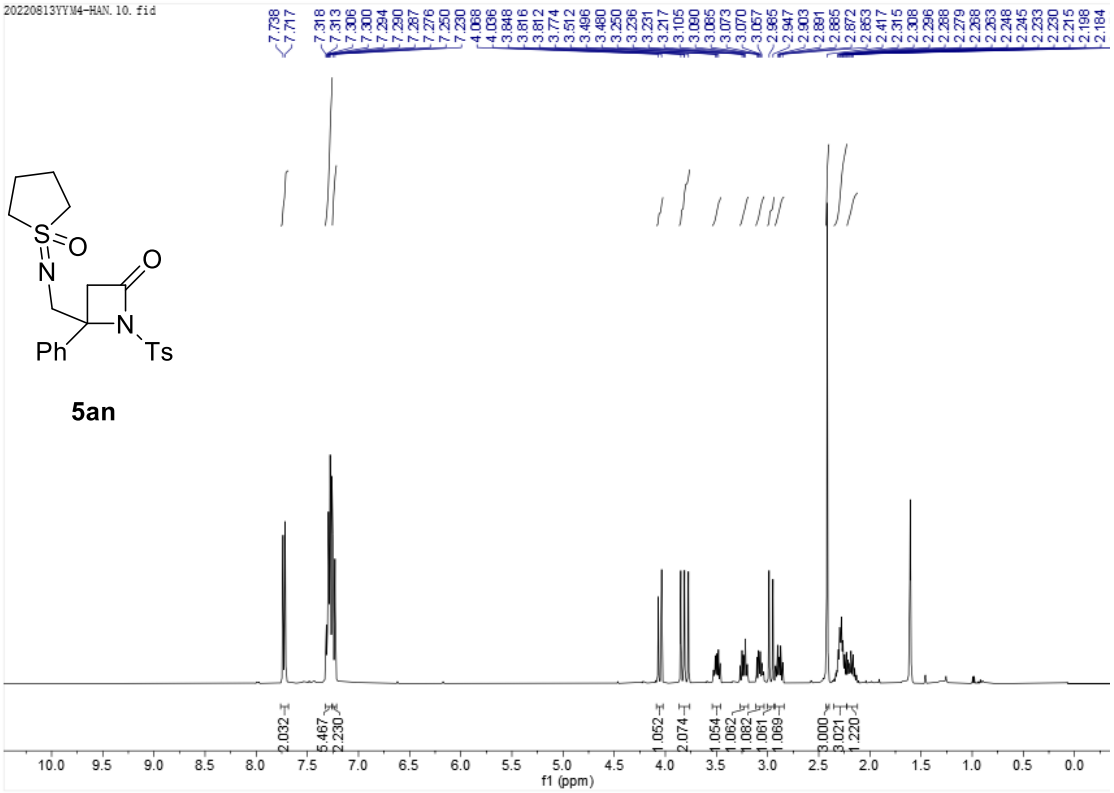
^{1}H NMR (400 MHz, $CDCl_3$) of **5am**



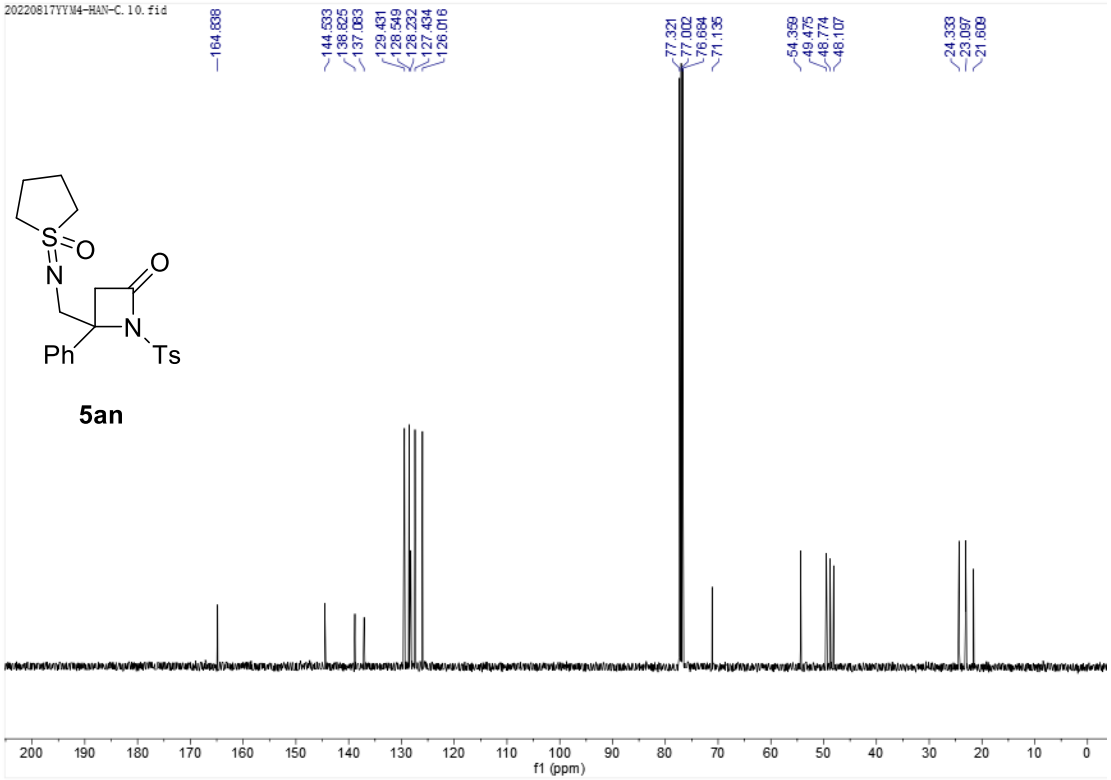
^{13}C NMR (101 MHz, $CDCl_3$) of **5am**



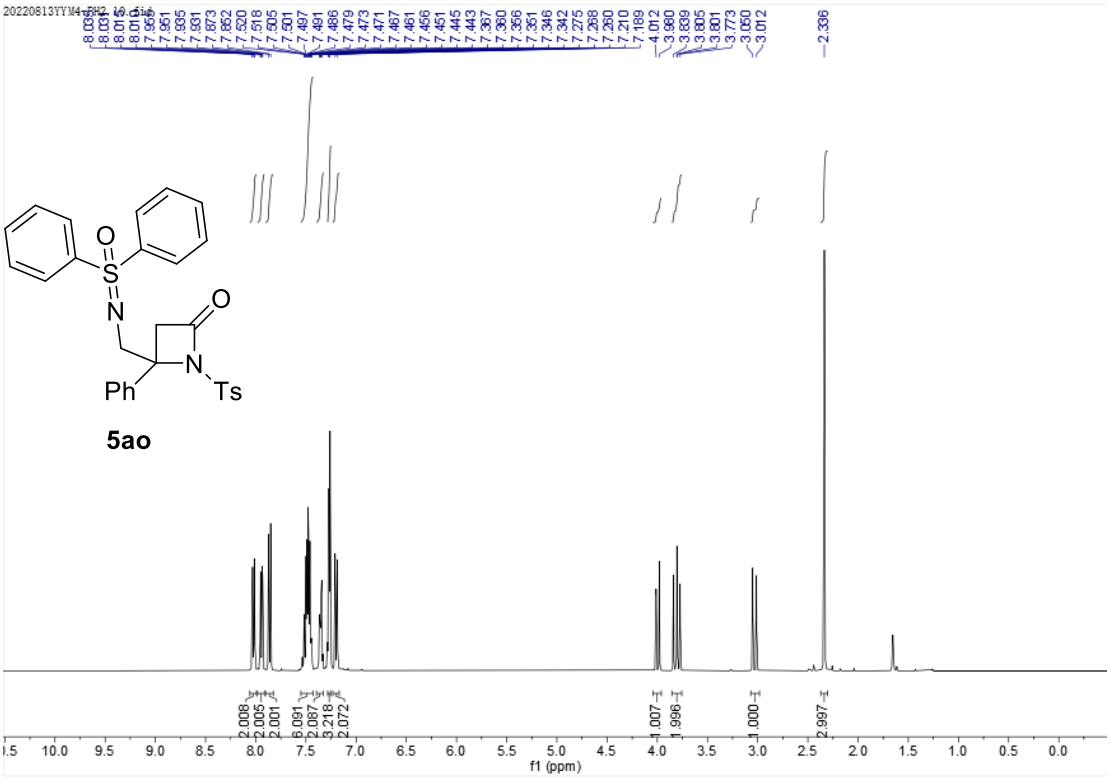
^{1}H NMR (400 MHz, $CDCl_3$) of **5an**



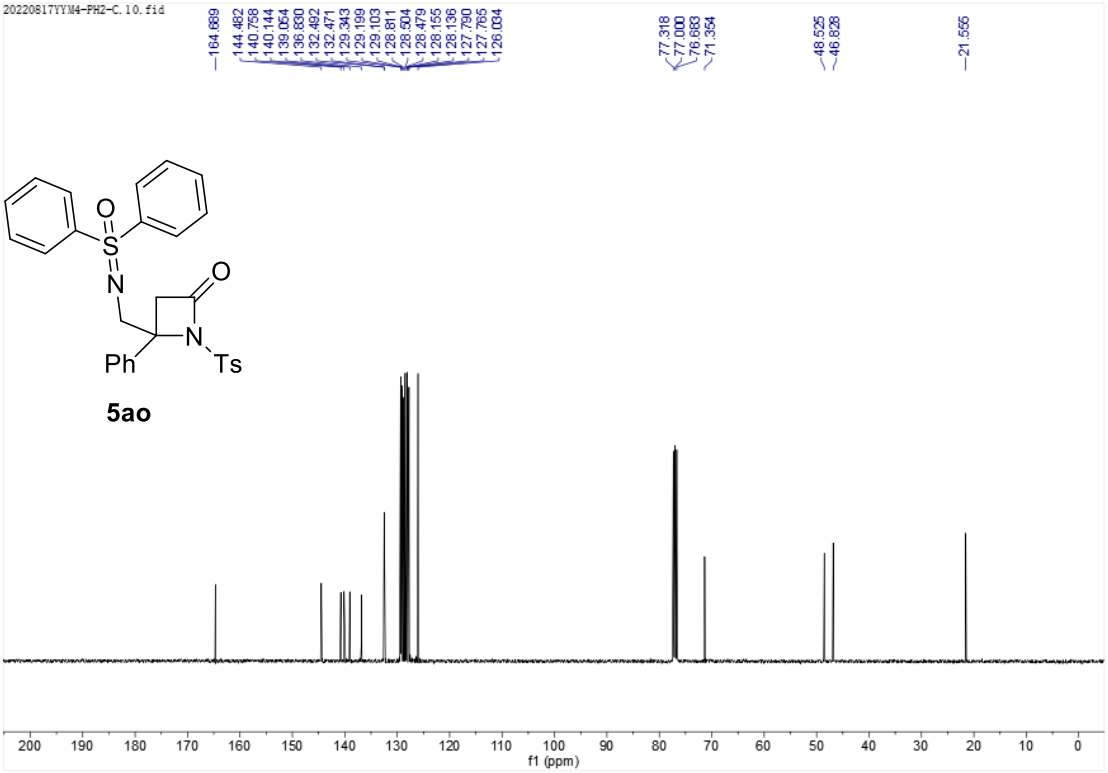
^{13}C NMR (101 MHz, $CDCl_3$) of **5j**



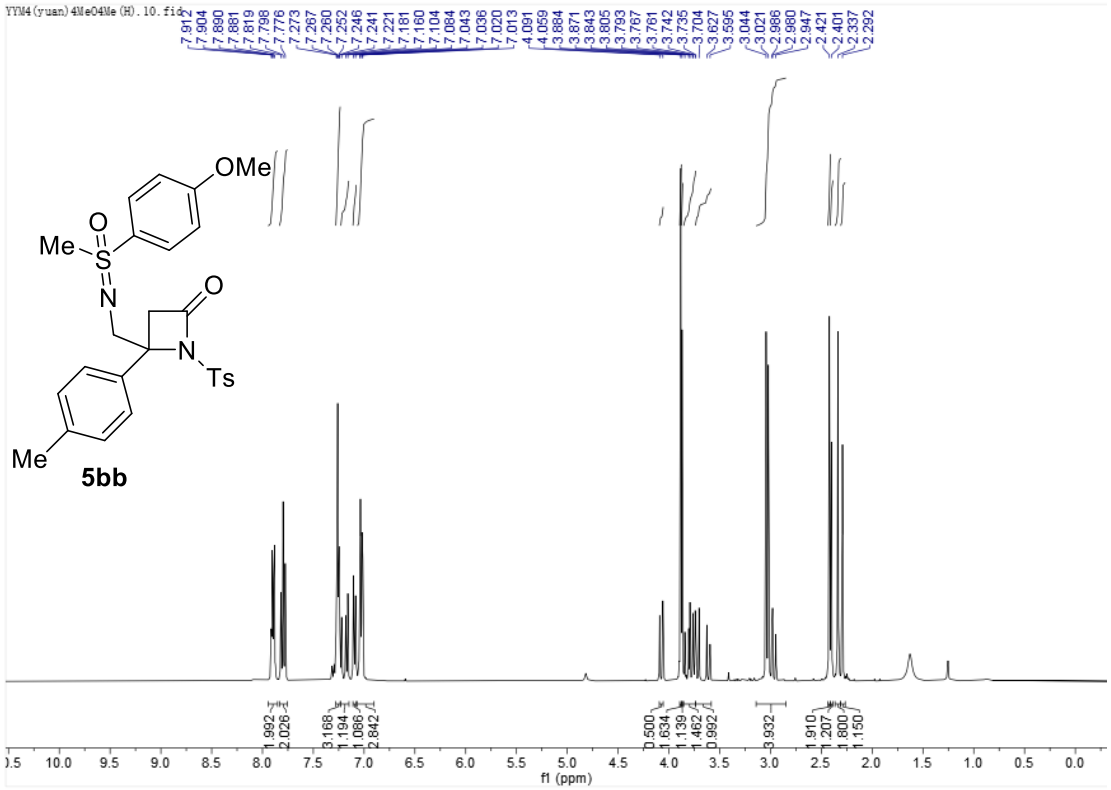
^{1}H NMR (400 MHz, $CDCl_3$) of **5ao**



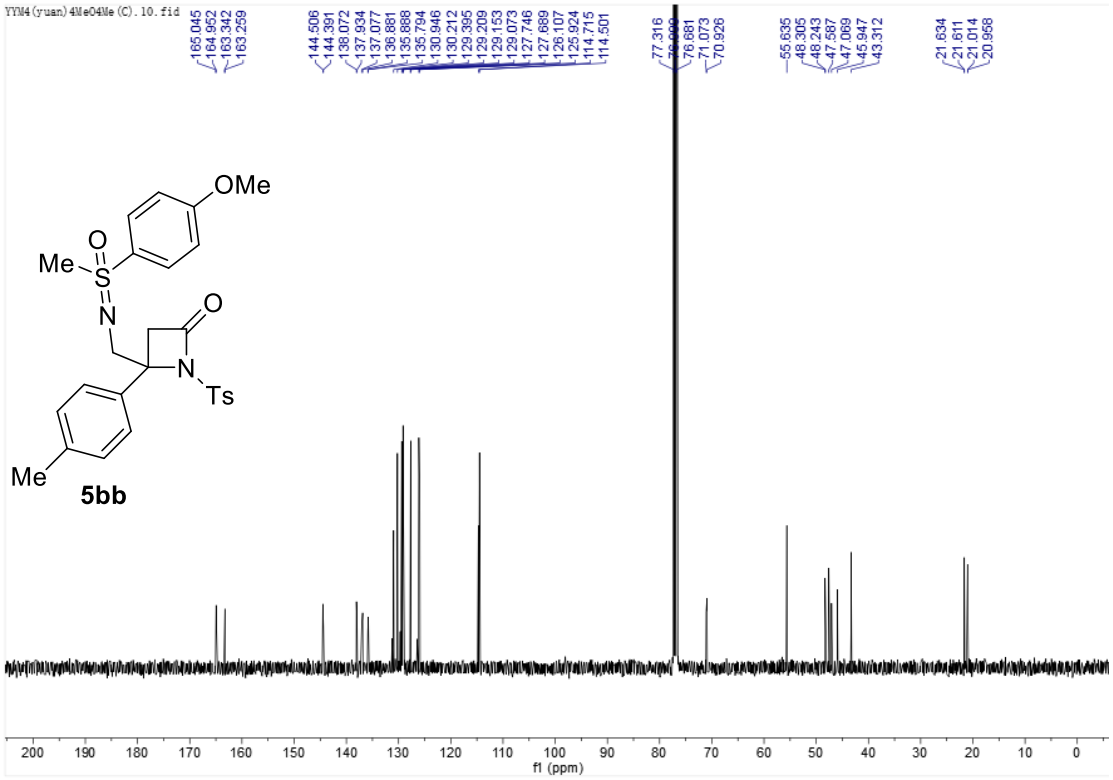
^{13}C NMR (101 MHz, $CDCl_3$) of **5ao**



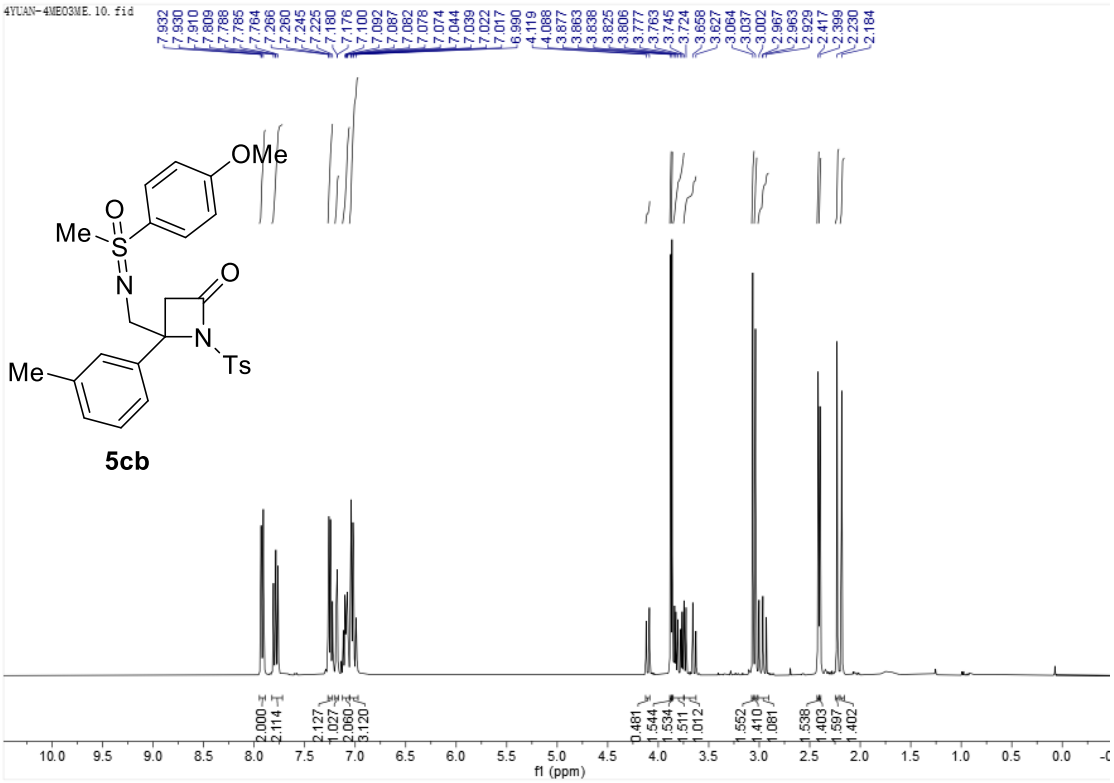
^{1}H NMR (400 MHz, $CDCl_3$) of **5bb**



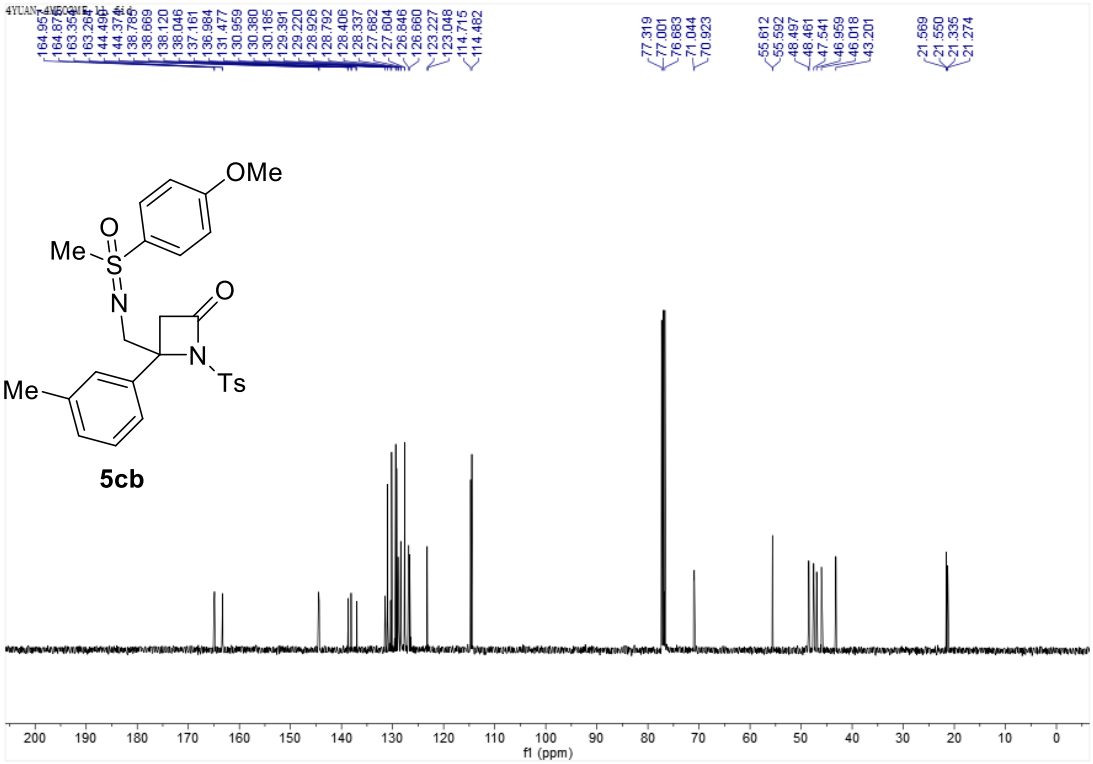
^{13}C NMR (101 MHz, $CDCl_3$) of **5bb**



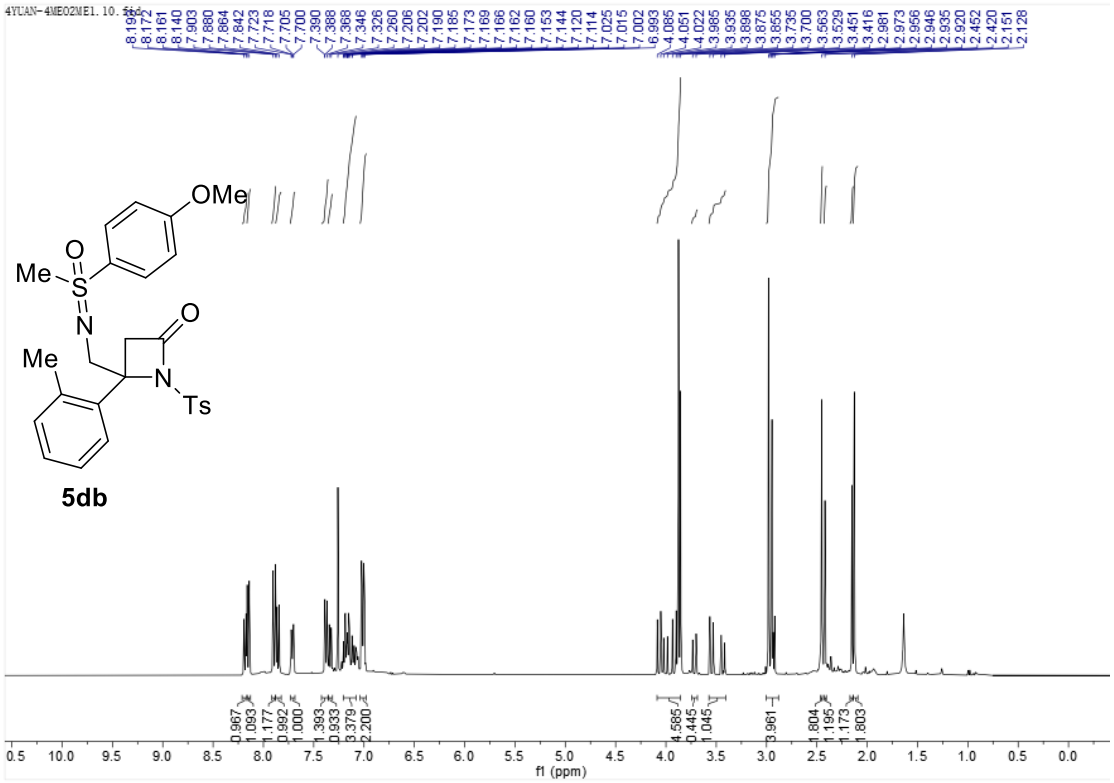
^{1}H NMR (400 MHz, $CDCl_3$) of **5cb**



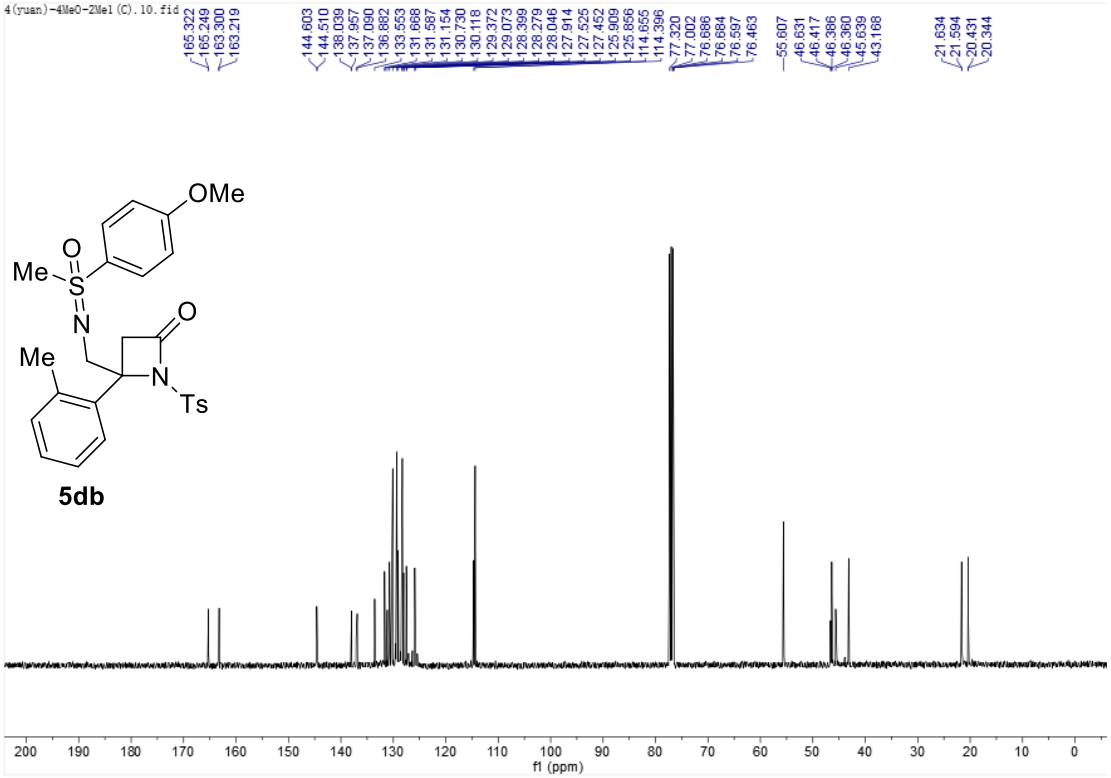
^{13}C NMR (101 MHz, $CDCl_3$) of **5cb**



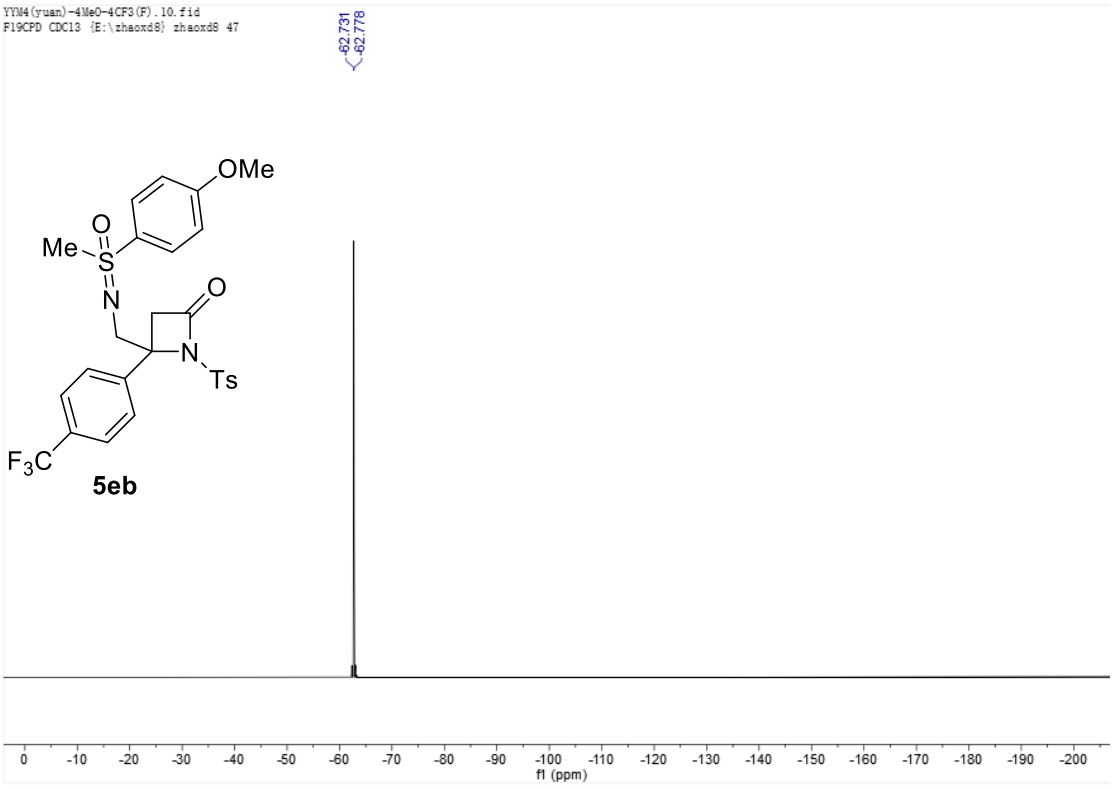
^{1}H NMR (400 MHz, $CDCl_3$) of **5db**



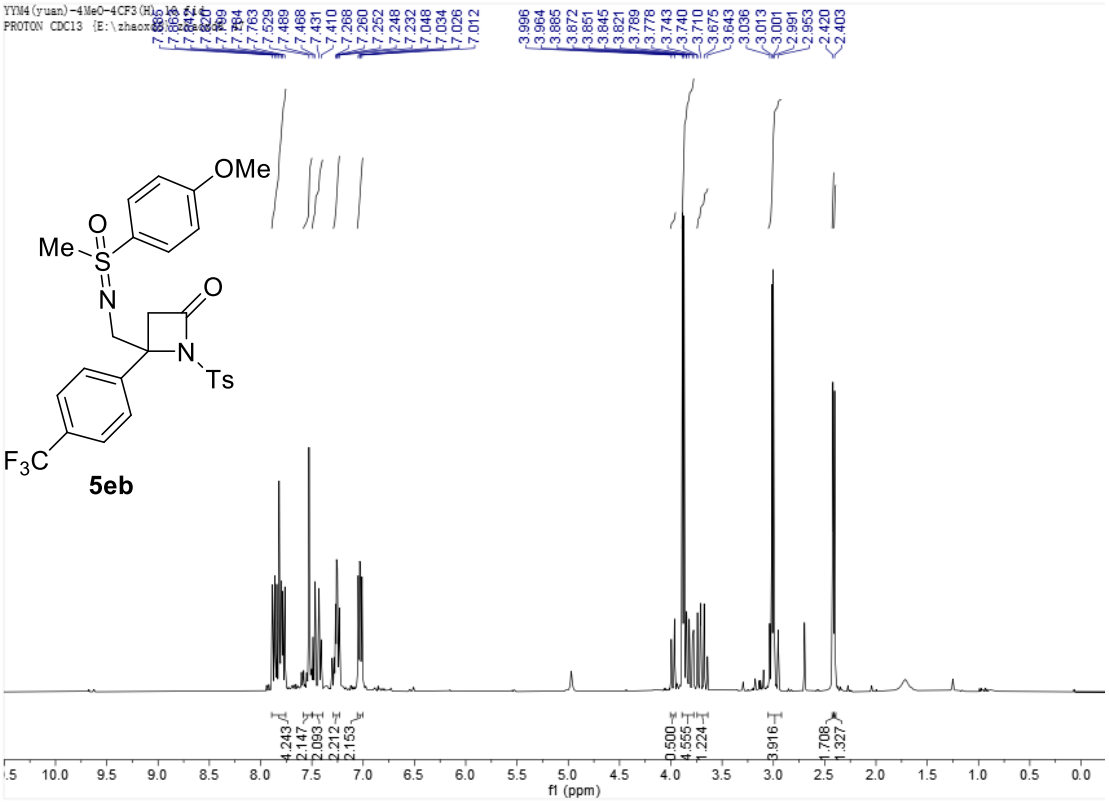
^{13}C NMR (101 MHz, $CDCl_3$) of **db**



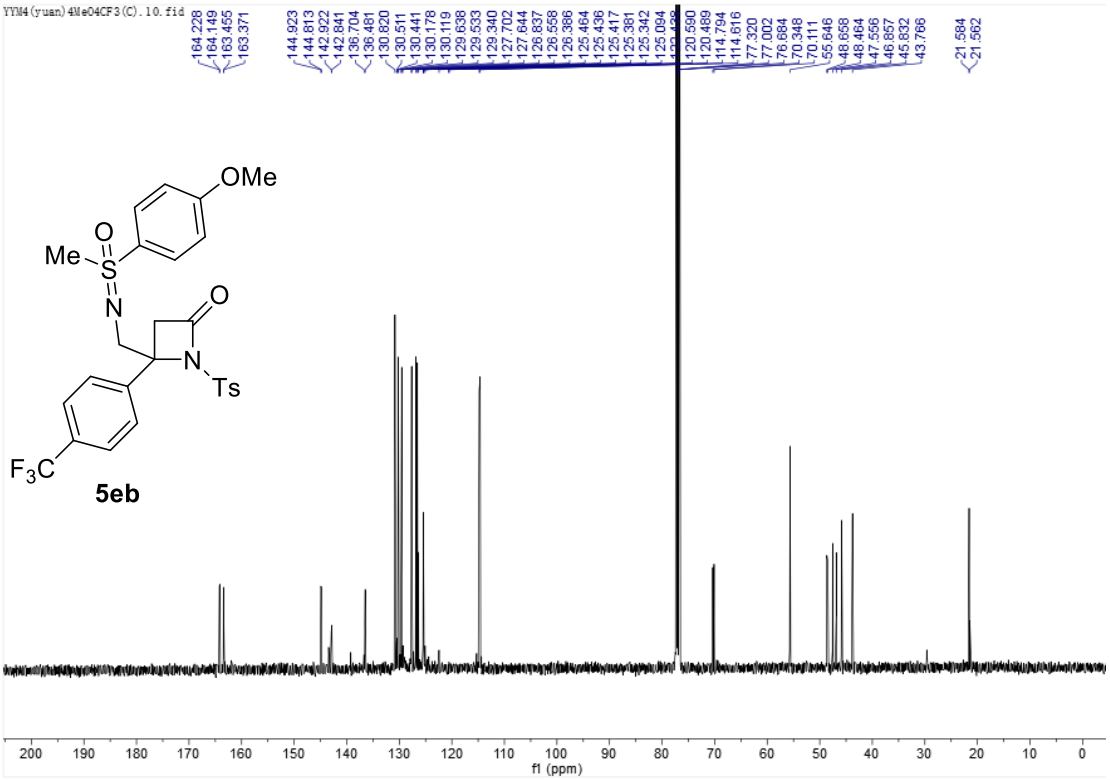
^{19}F NMR (376 MHz, $CDCl_3$) of **5eb**



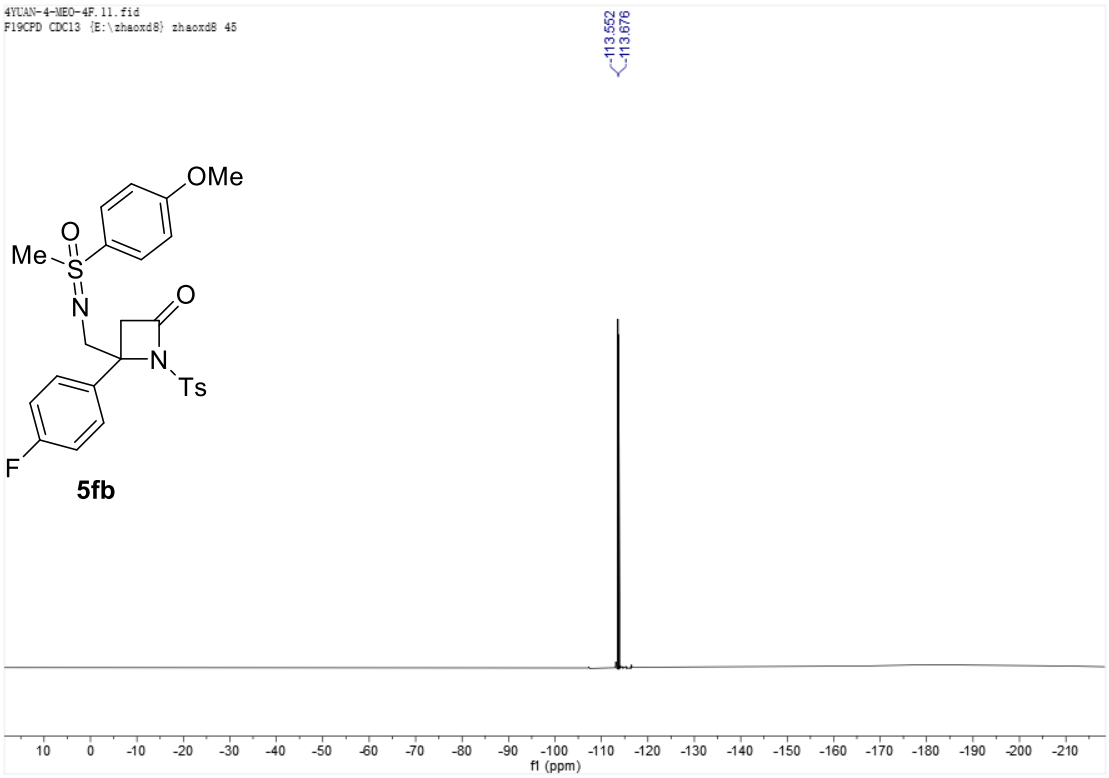
^{1}H NMR (400 MHz, $CDCl_3$) of **5eb**



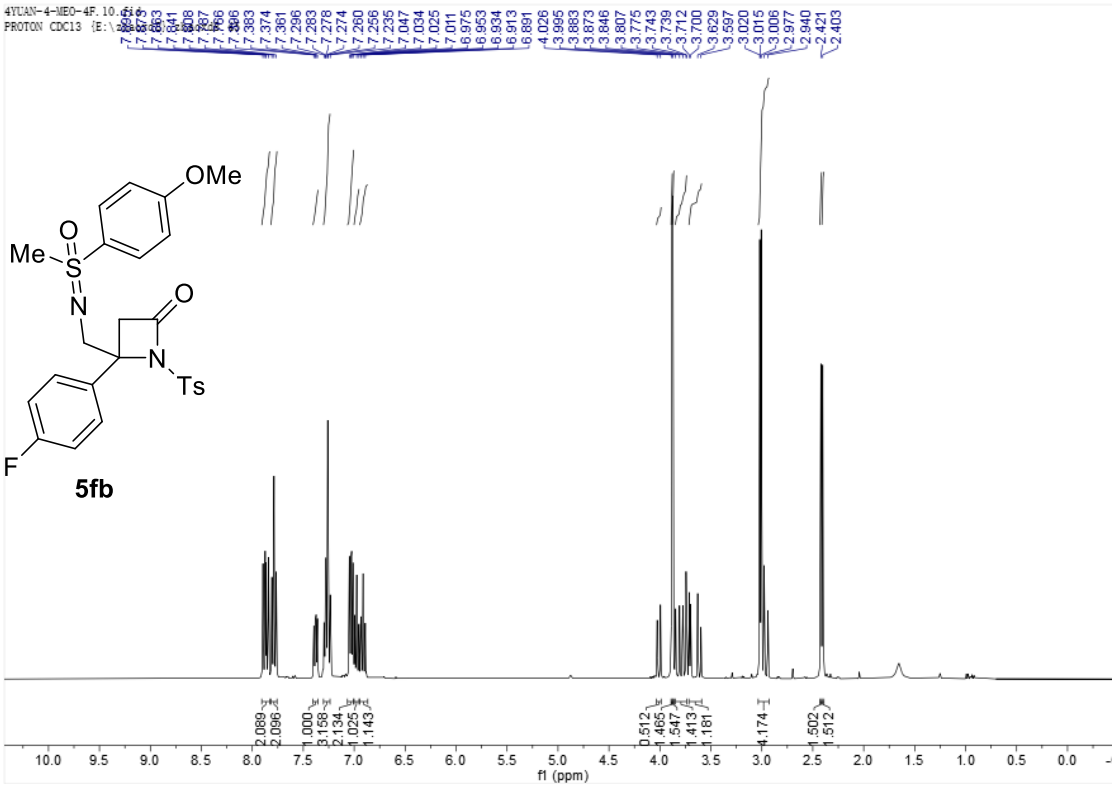
^{13}C NMR (101 MHz, $CDCl_3$) of **5eb**



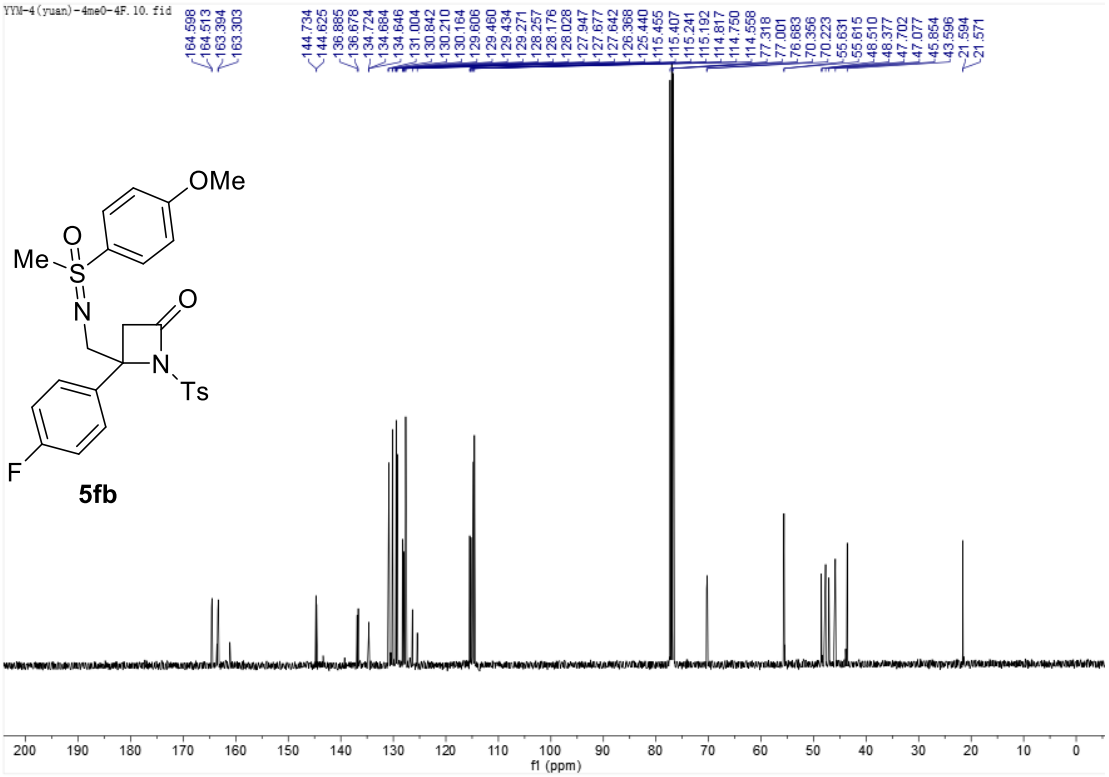
^{19}F NMR (376 MHz, $CDCl_3$) of **5fb**



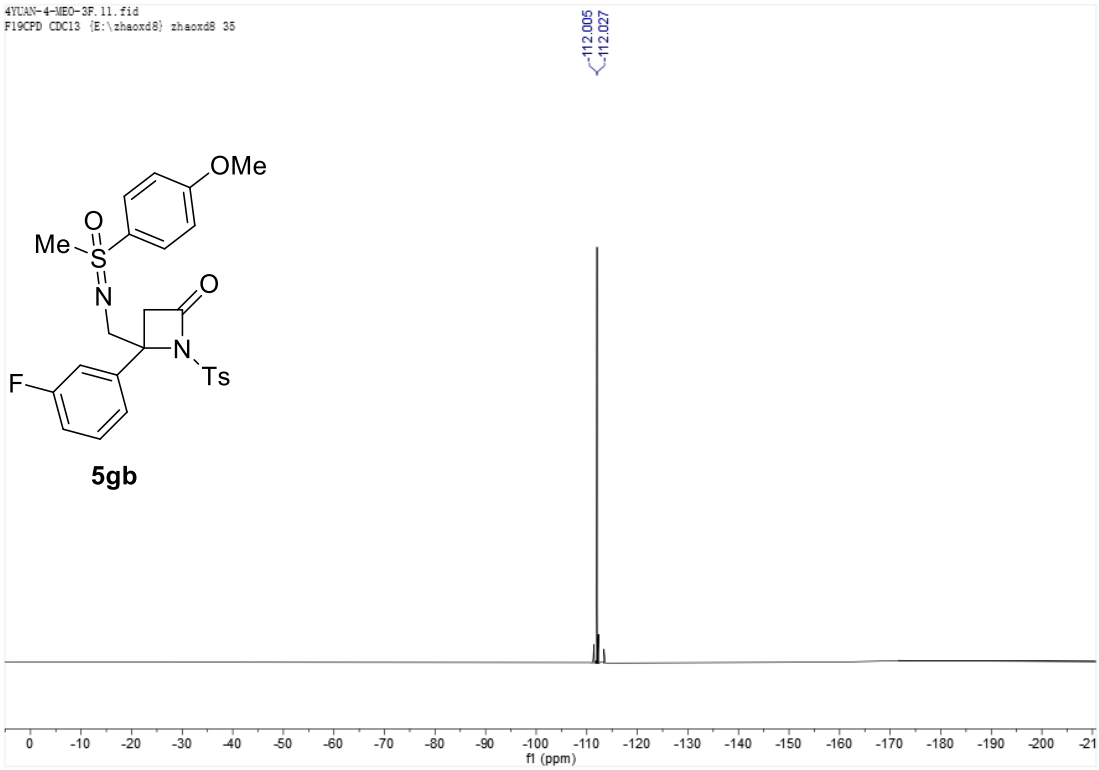
^{1}H NMR (400 MHz, $CDCl_3$) of **5fb**



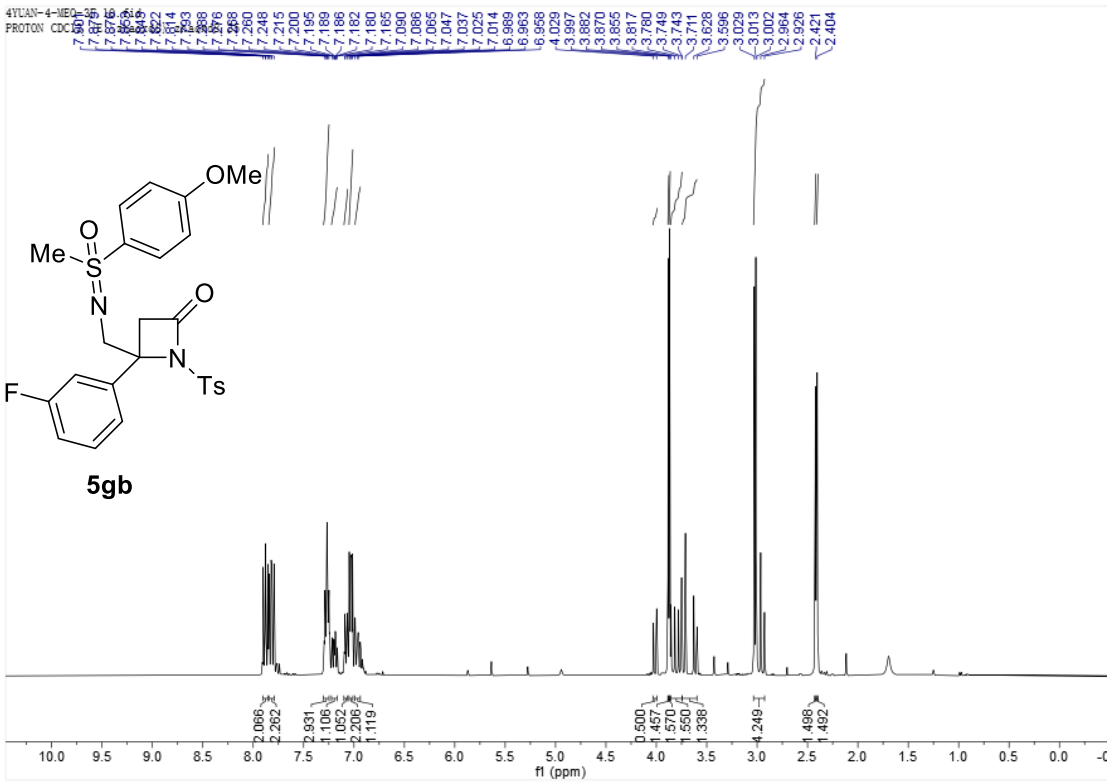
^{13}C NMR (101 MHz, $CDCl_3$) of **5fb**



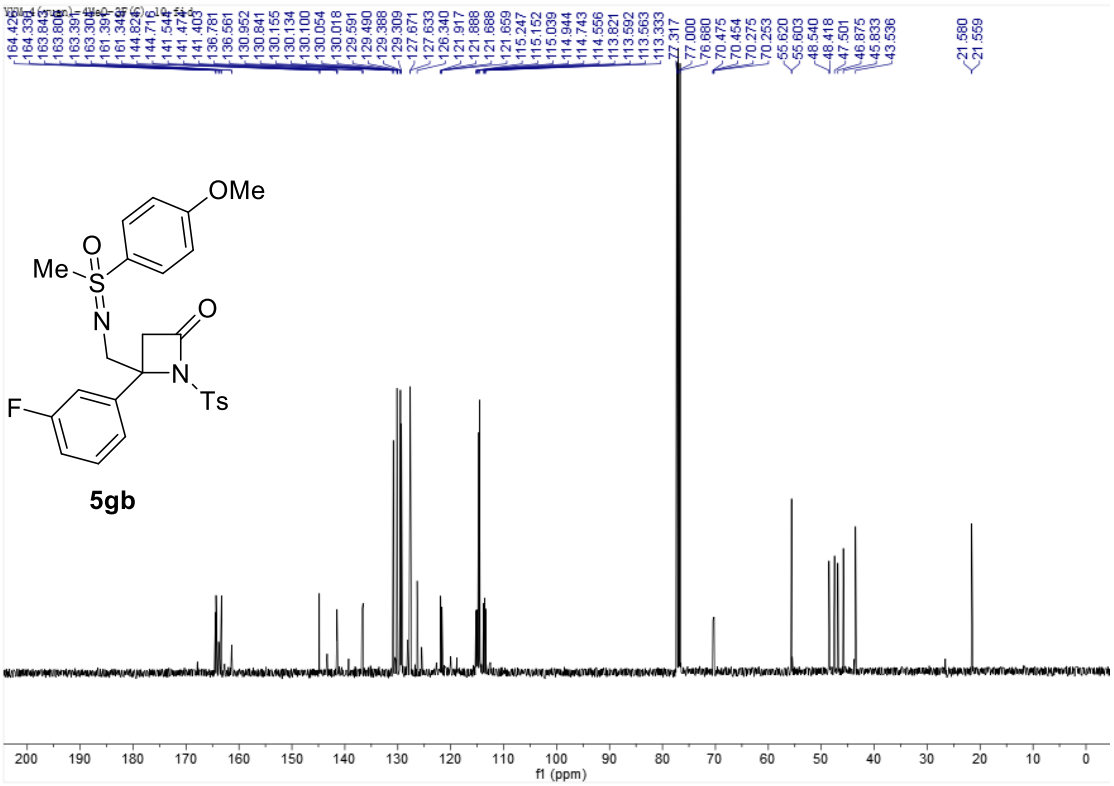
^{19}F NMR (376 MHz, $CDCl_3$) of **5gb**



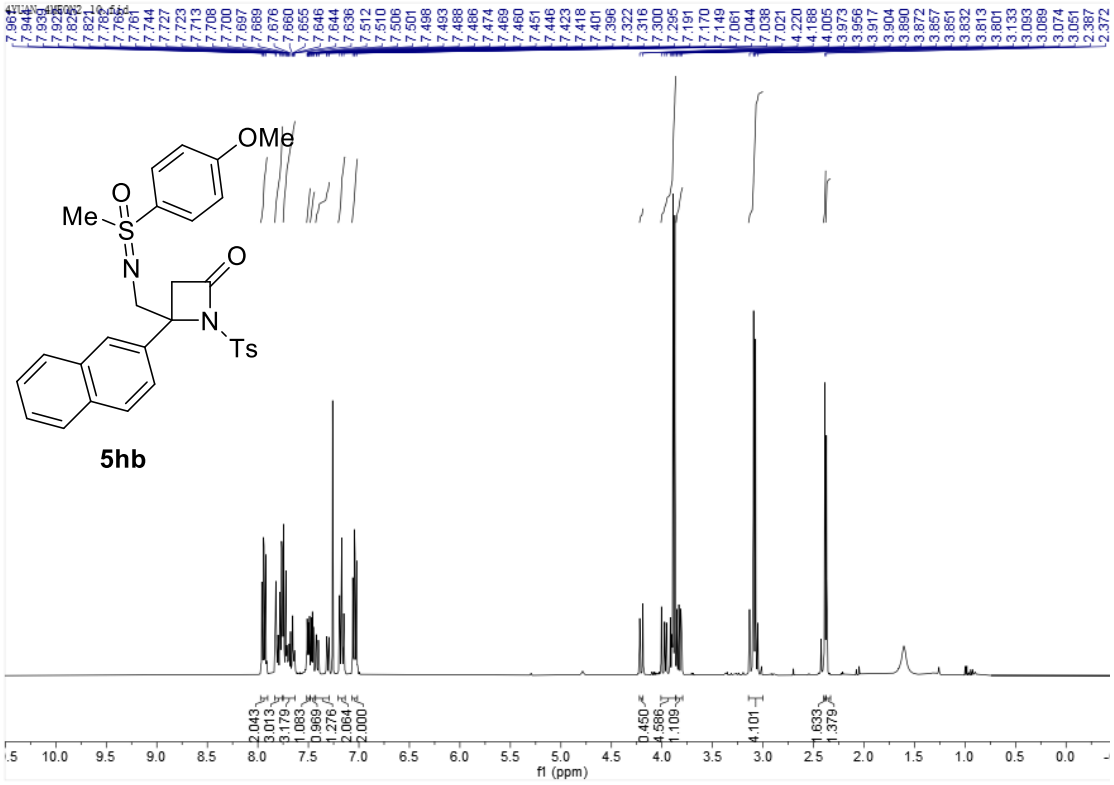
^{1}H NMR (400 MHz, $CDCl_3$) of **5gb**



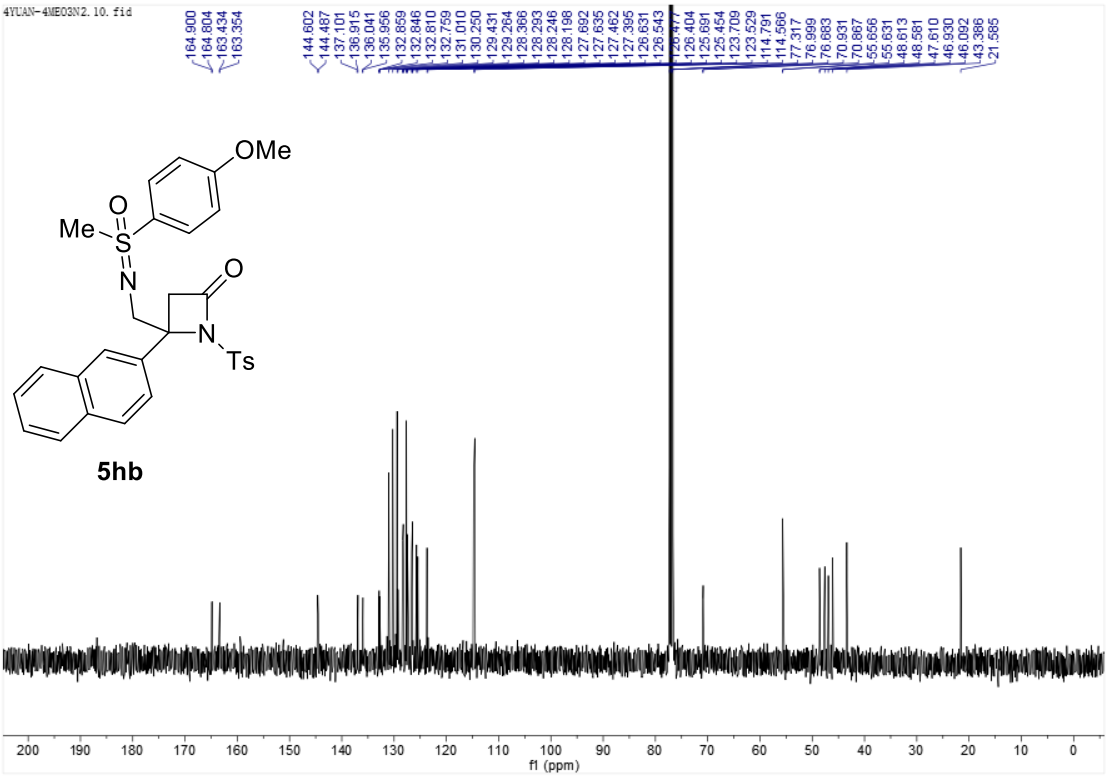
^{13}C NMR (101 MHz, $CDCl_3$) of **5gb**



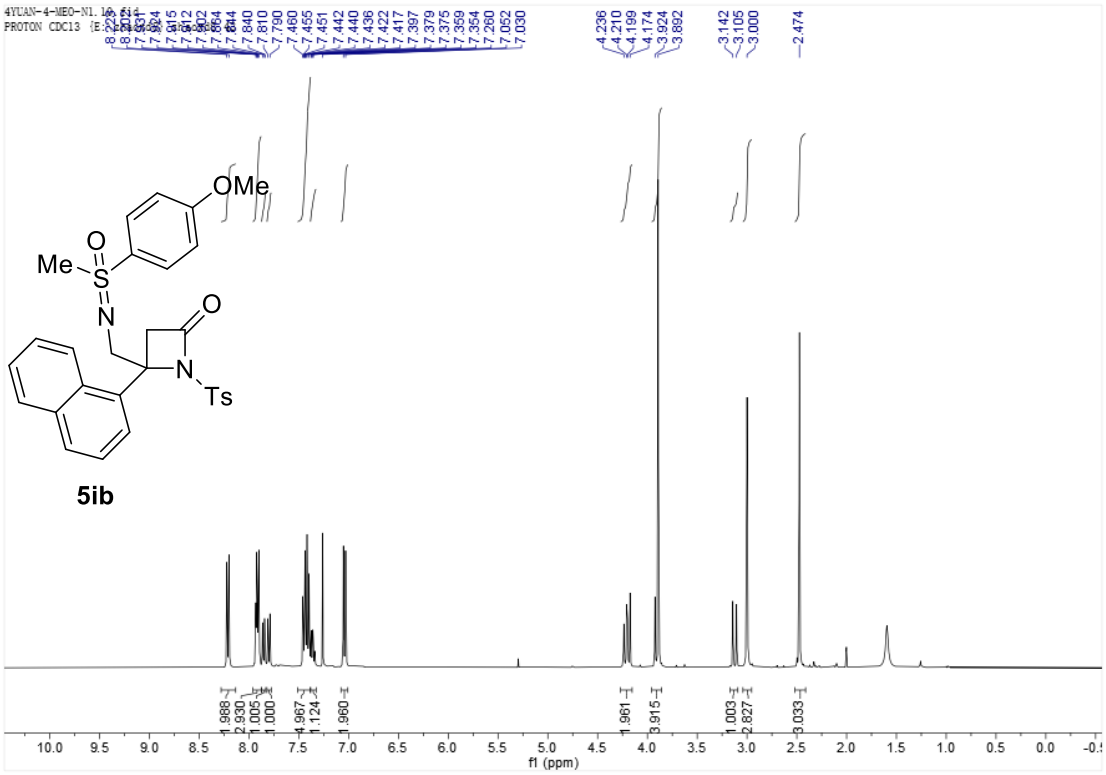
^{1}H NMR (400 MHz, $CDCl_3$) of **5hb**



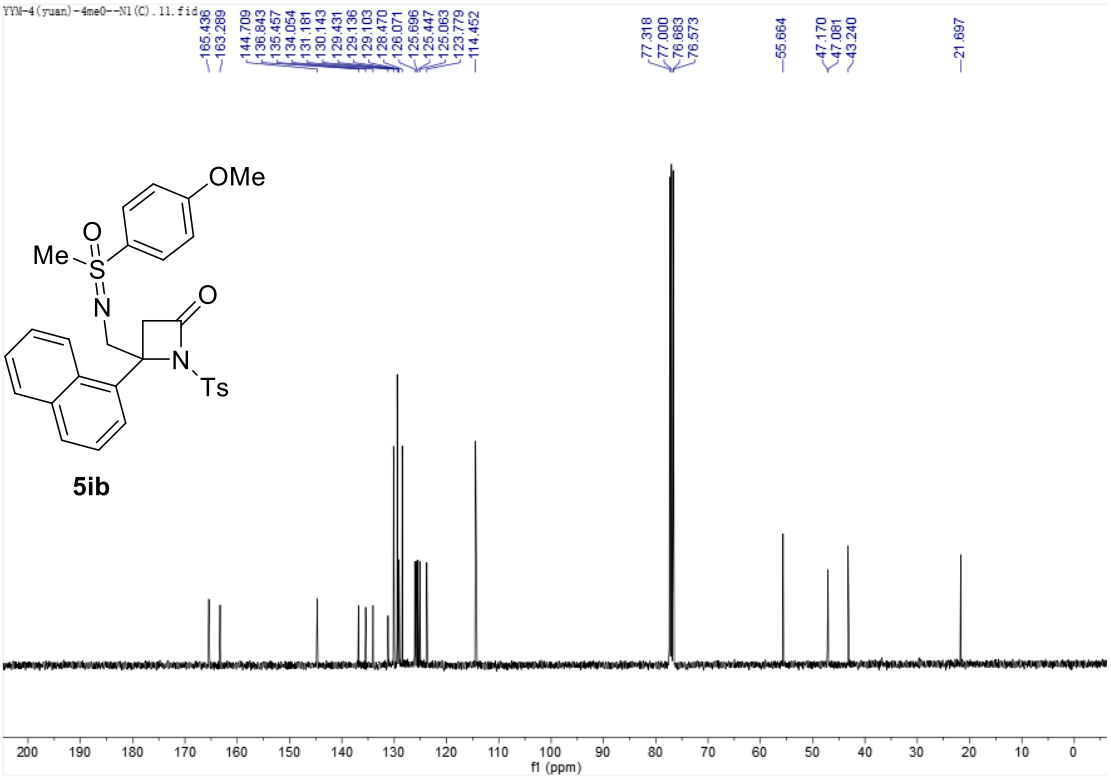
^{13}C NMR (101 MHz, $CDCl_3$) of **5hb**



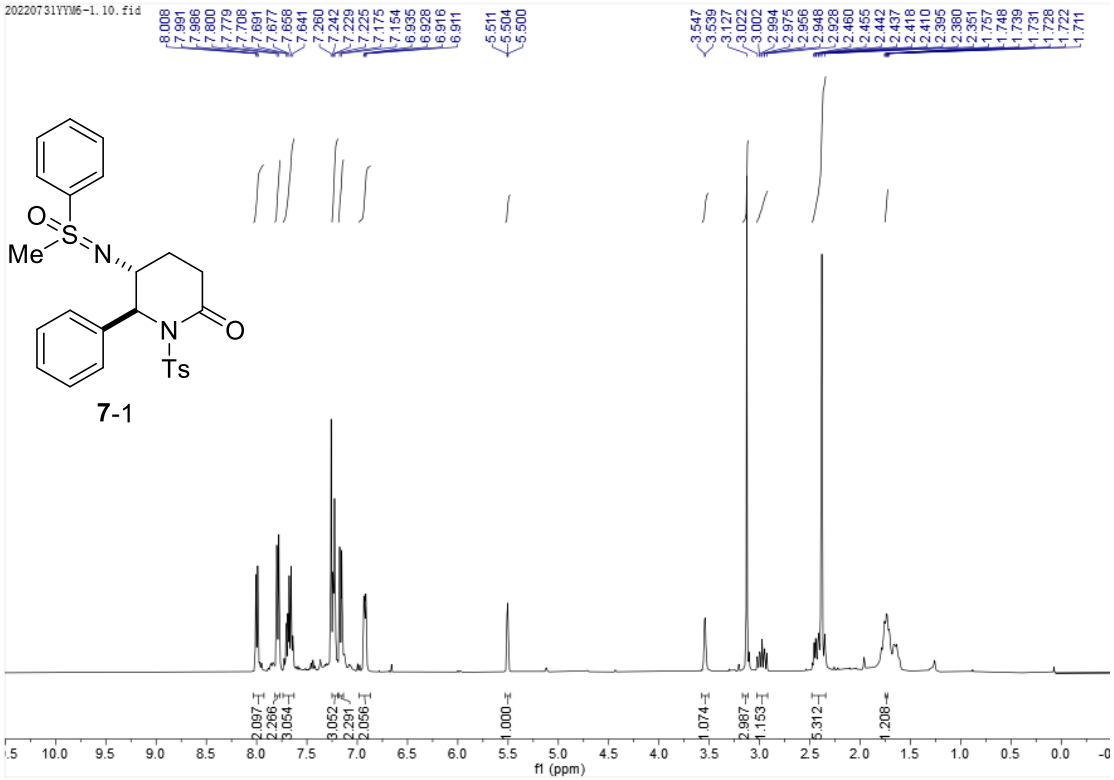
^{1}H NMR (400 MHz, $CDCl_3$) of **5ib**



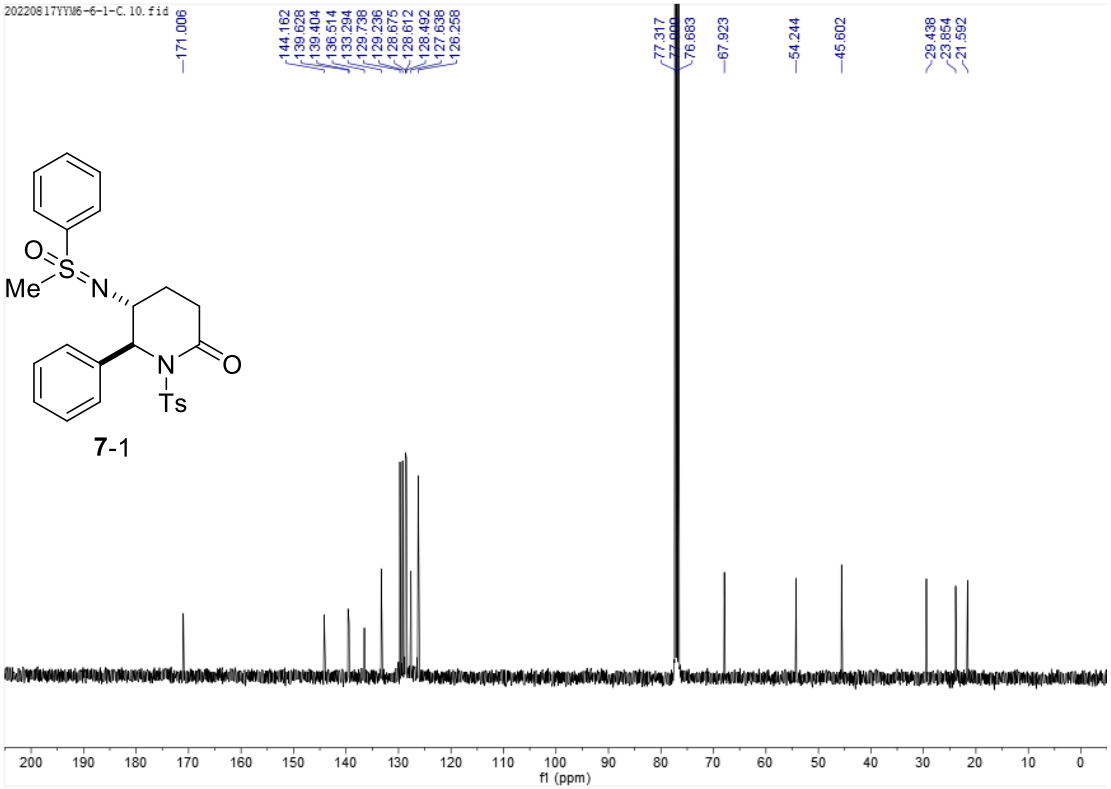
^{13}C NMR (101 MHz, $CDCl_3$) of **5ib**



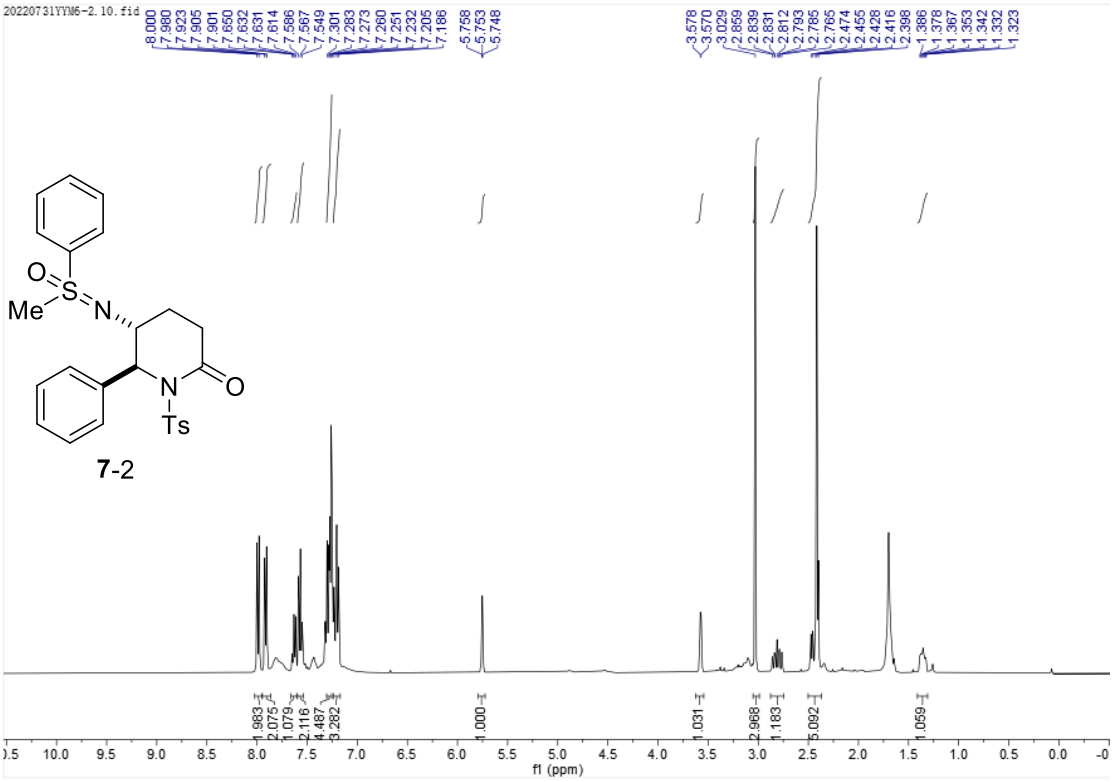
^{1}H NMR (400 MHz, $CDCl_3$) of **7-1**



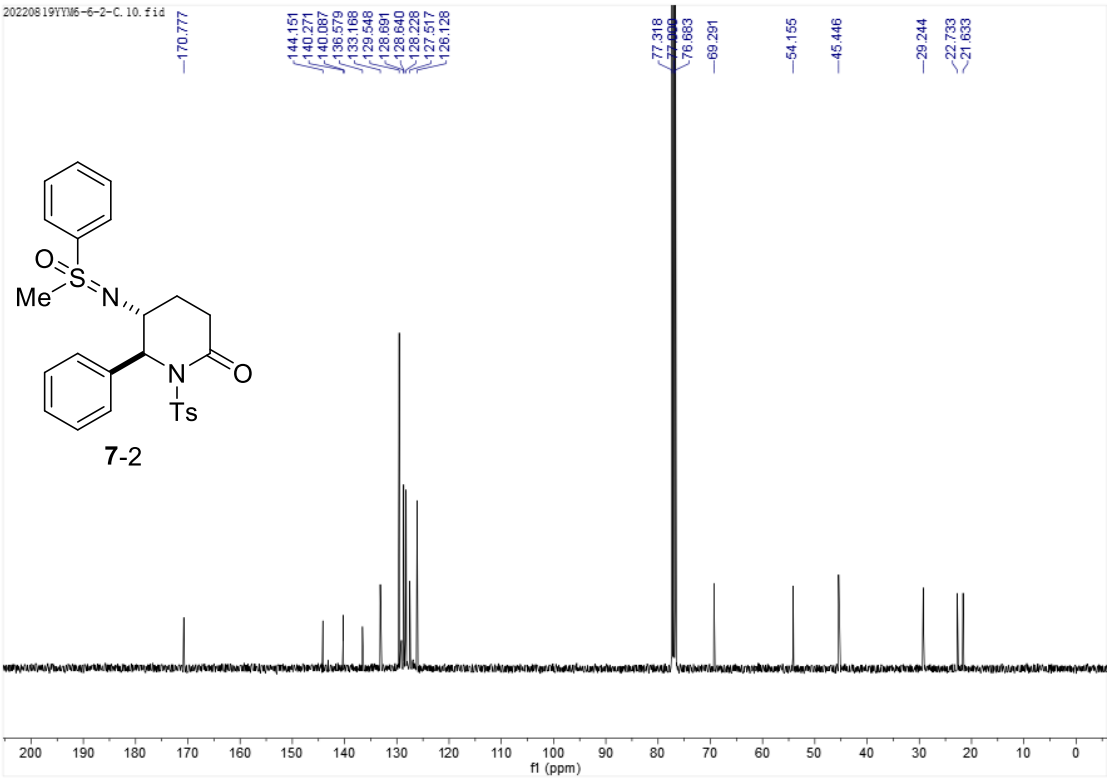
^{13}C NMR (101 MHz, $CDCl_3$) of **7-1**



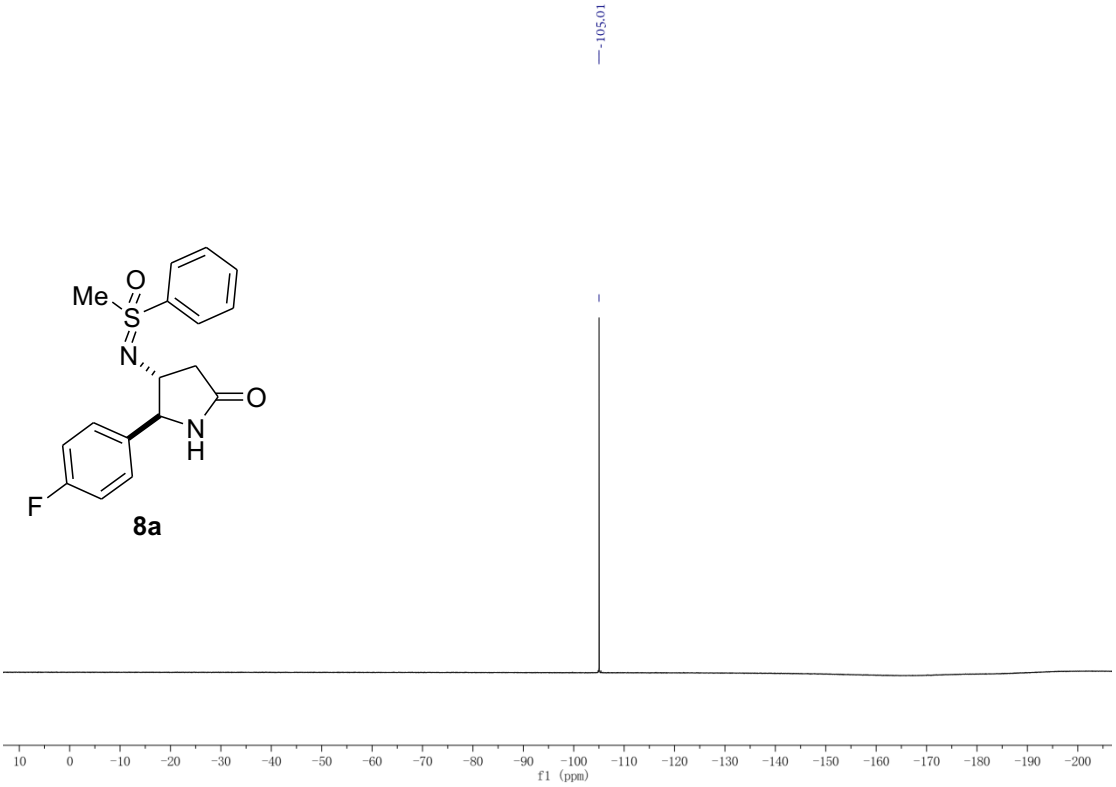
^{1}H NMR (400 MHz, $CDCl_3$) of **7-2**



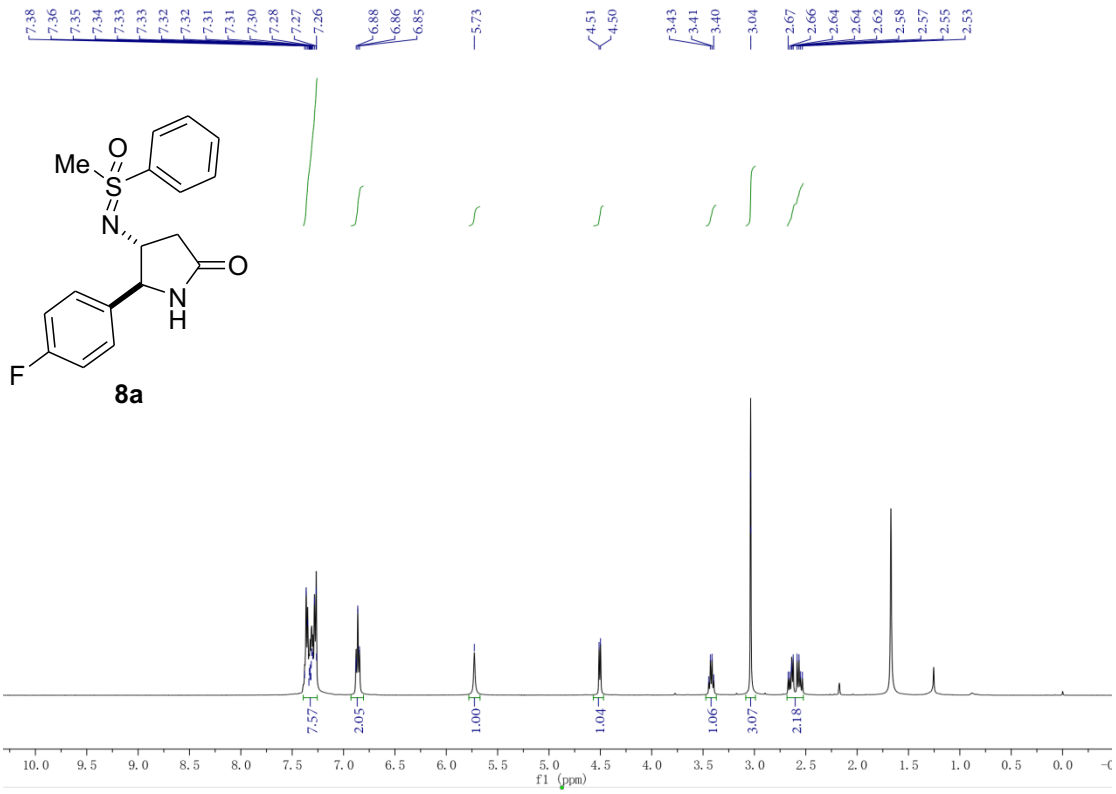
^{13}C NMR (101 MHz, $CDCl_3$) of **7-2**



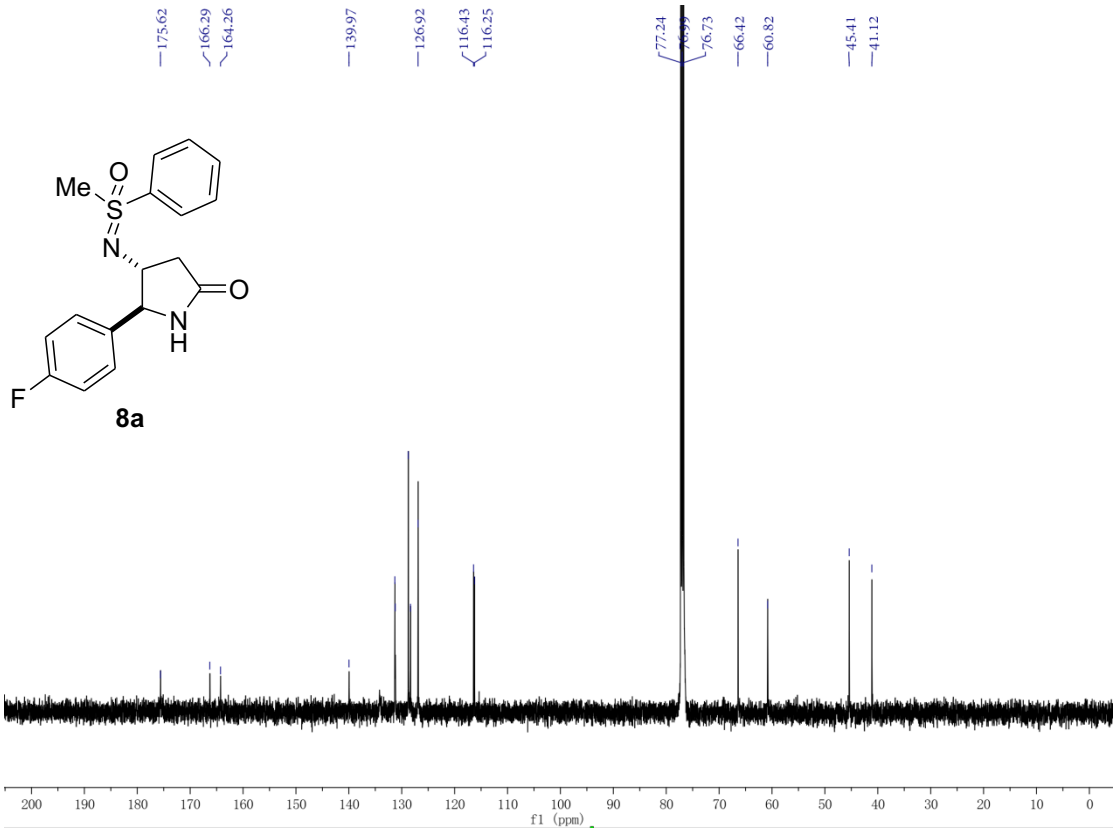
^{19}F NMR (471 MHz, $CDCl_3$) of **8a**



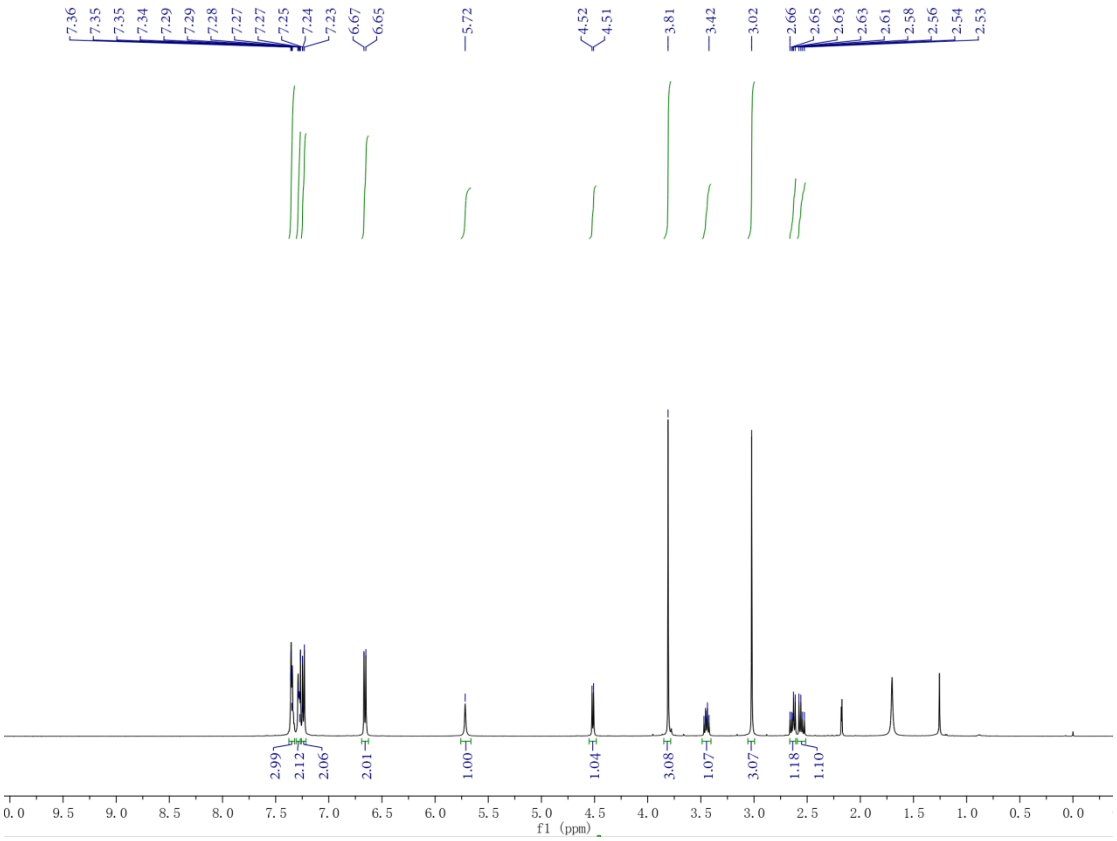
^{1}H NMR (500 MHz, CDCl3) of **8a**



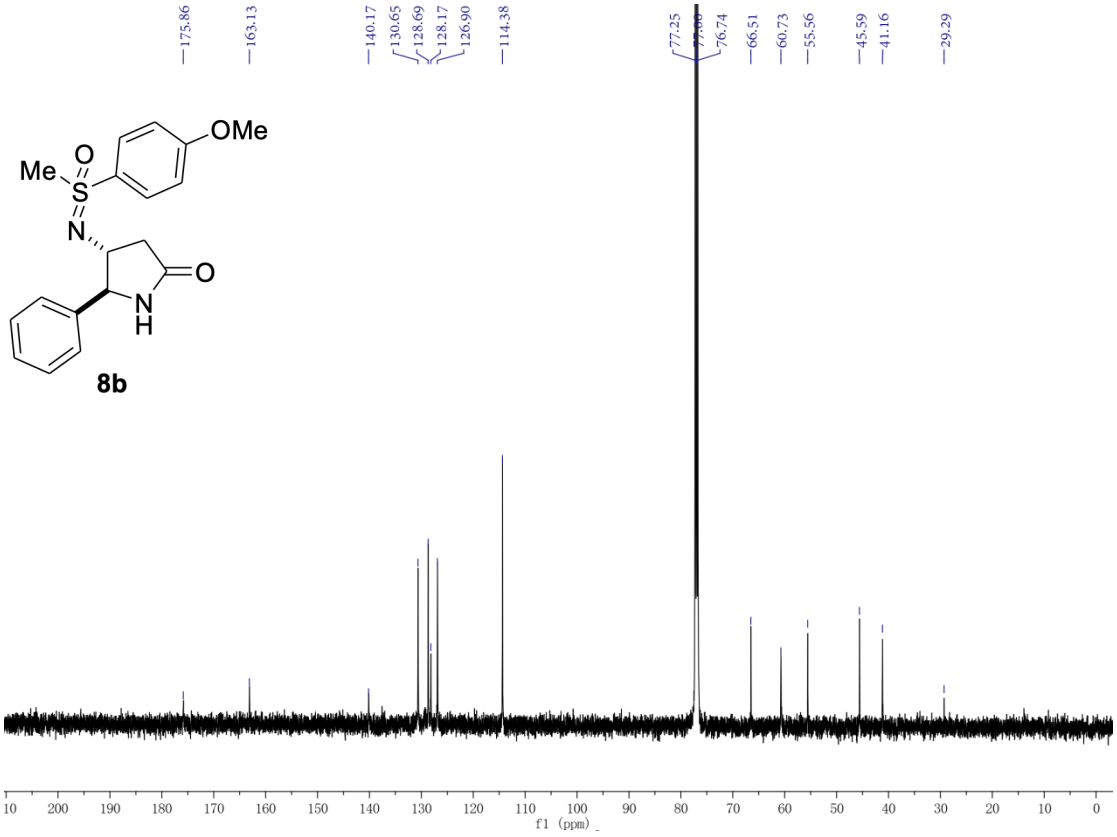
^{13}C NMR (126 MHz, $CDCl_3$) of **8a**



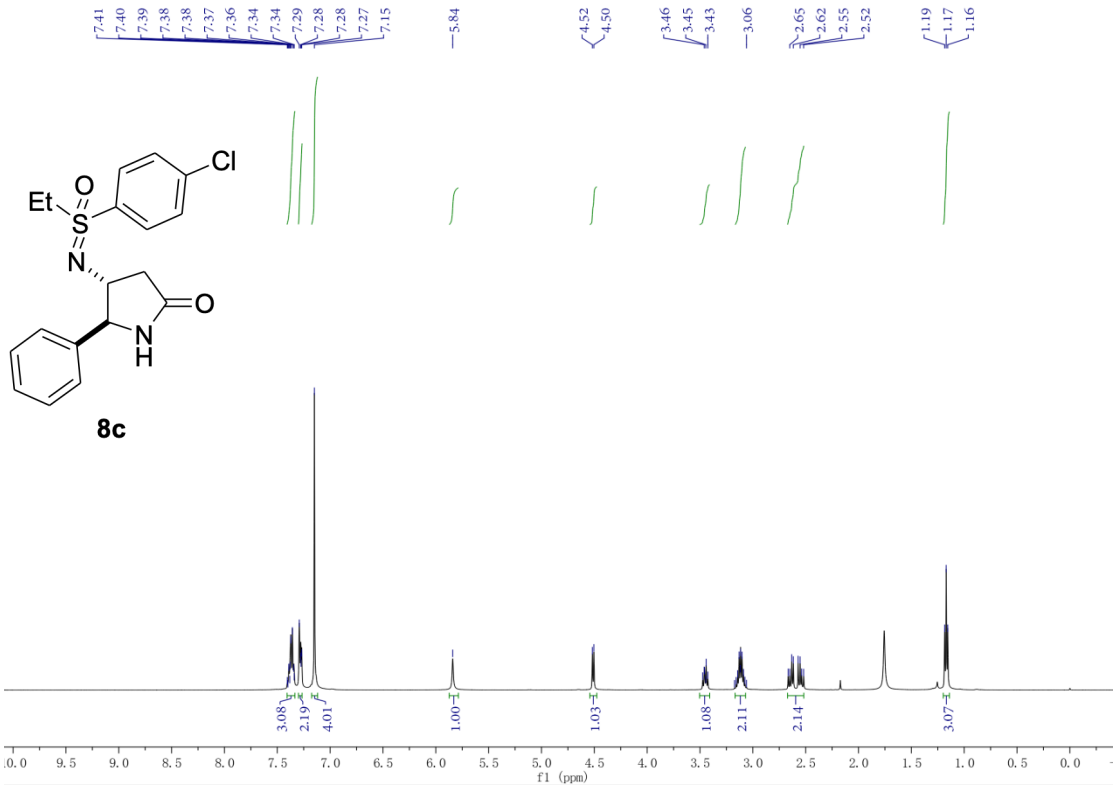
^{1}H NMR (500 MHz, $CDCl_3$) of **8b**



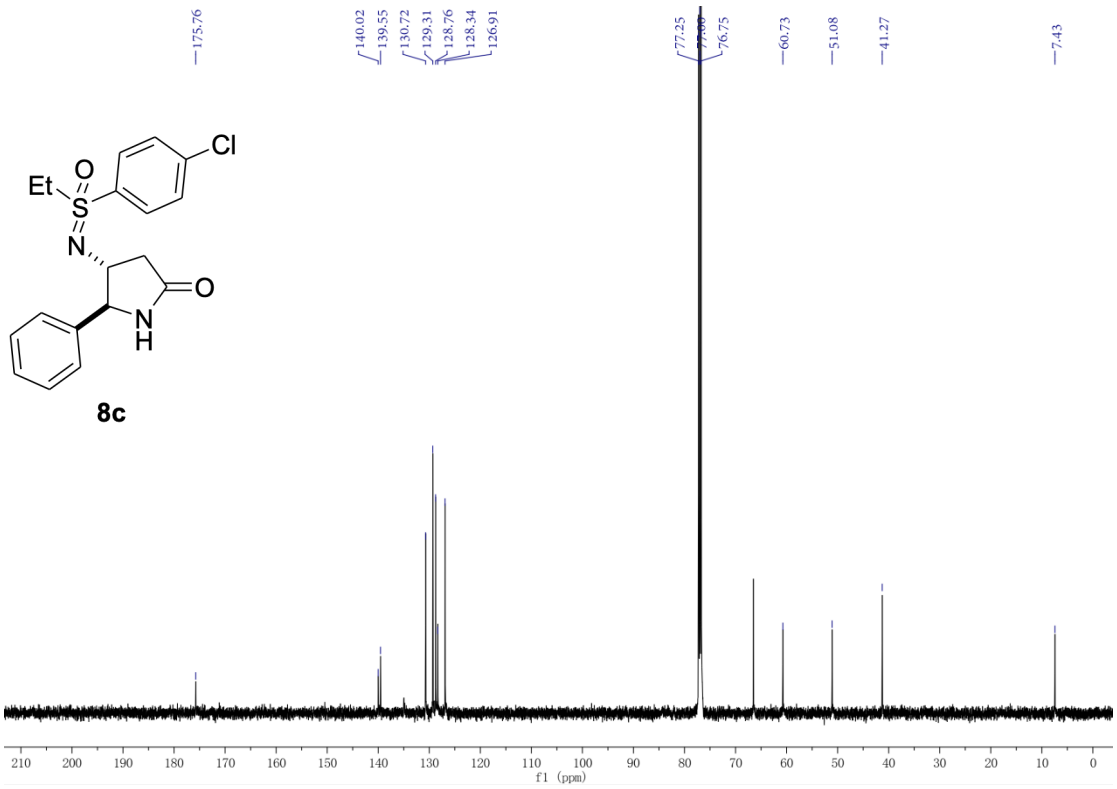
^{13}C NMR (126 MHz, $CDCl_3$) of **8b**



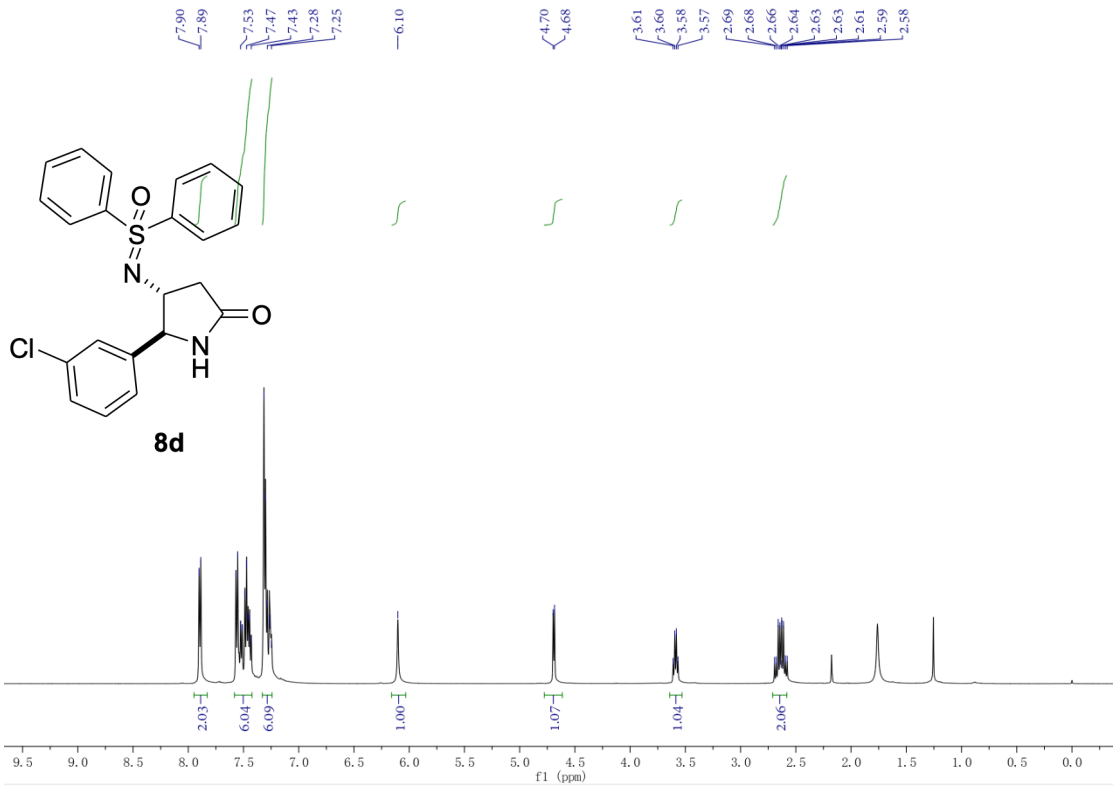
^{1}H NMR (500 MHz, $CDCl_3$) of **8c**



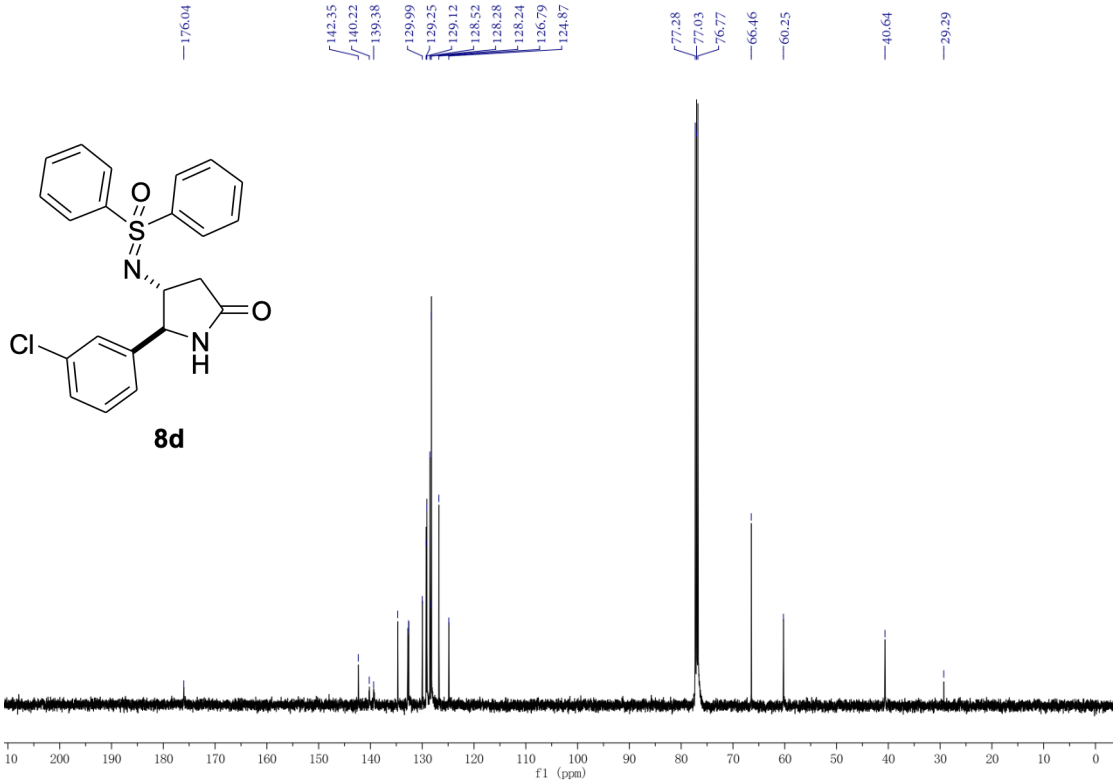
^{13}C NMR (126 MHz, $CDCl_3$) of **8c**



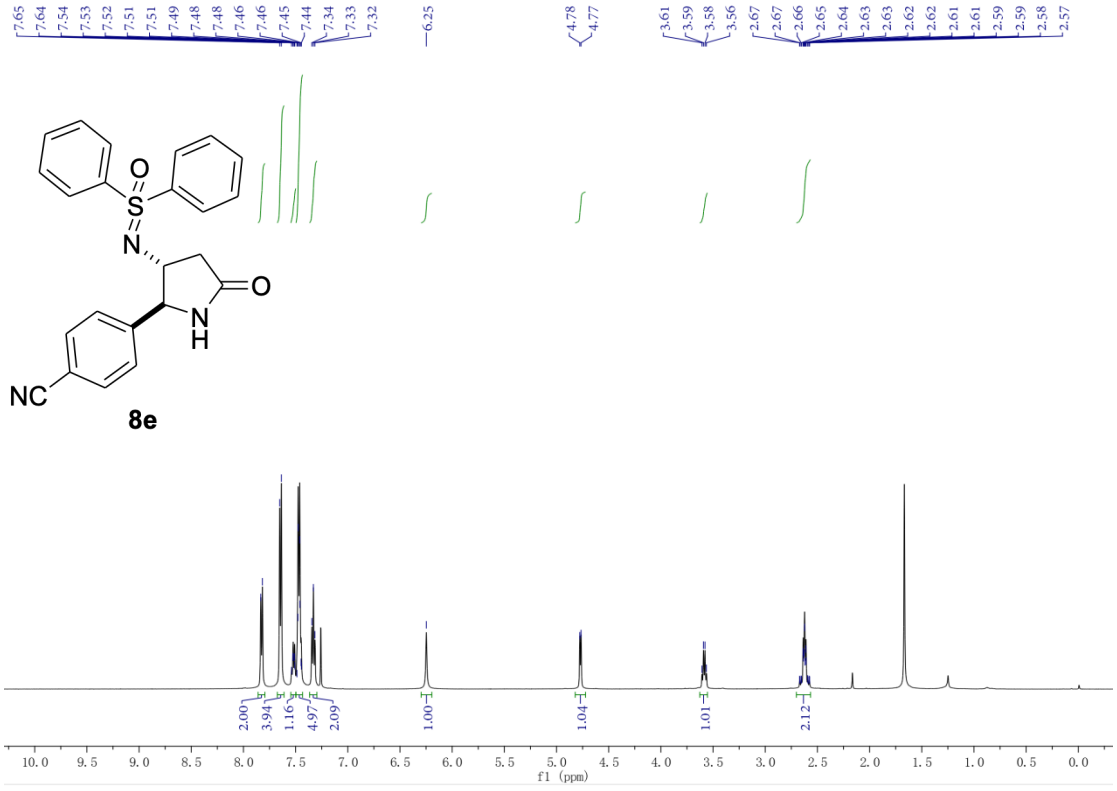
^{1}H NMR (500 MHz, $CDCl_3$) of **8d**



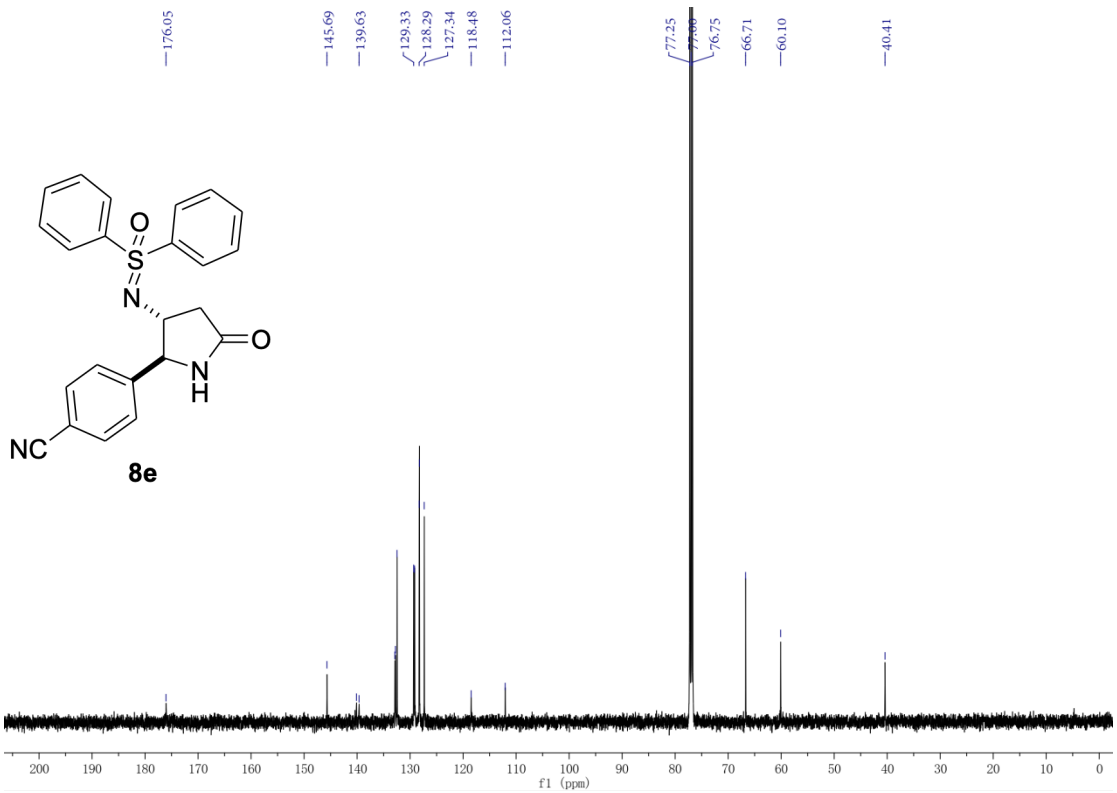
^{13}C NMR (126 MHz, $CDCl_3$) of **8d**



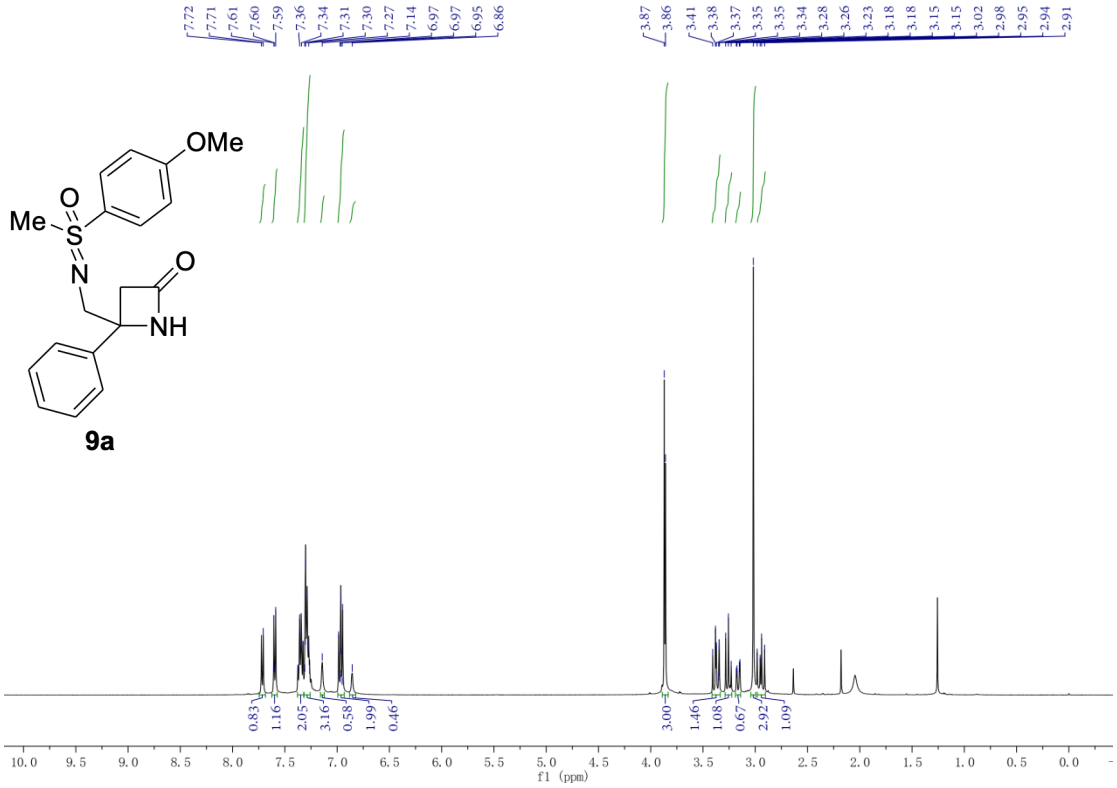
^{1}H NMR (500 MHz, $CDCl_3$) of **8e**



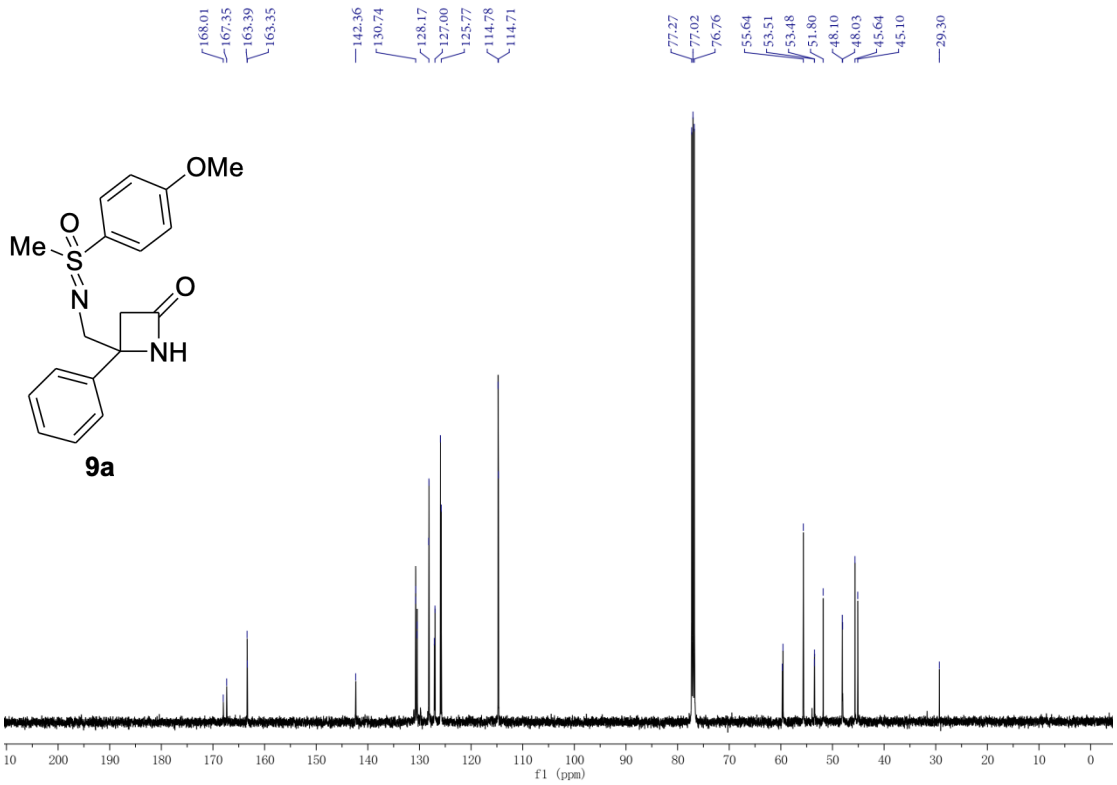
^{13}C NMR (126 MHz, $CDCl_3$) of **8e**



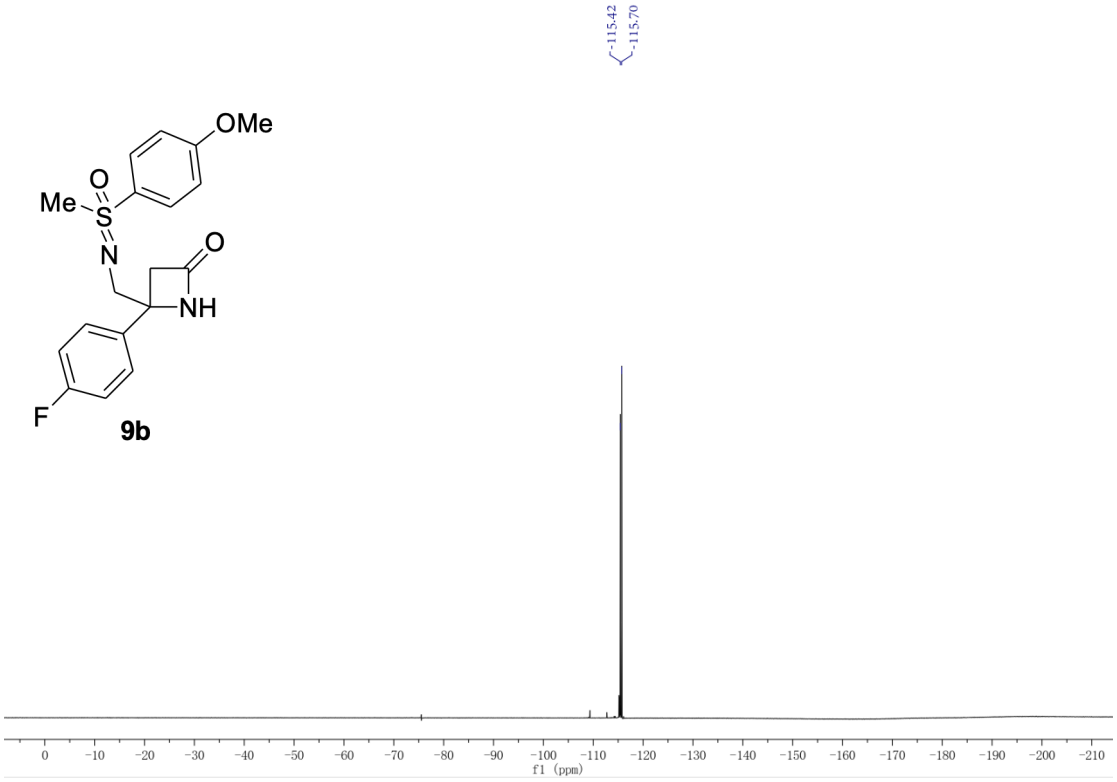
^{1}H NMR (500 MHz, $CDCl_3$) of **9a**



^{13}C NMR (126 MHz, $CDCl_3$) of **9a**



^{19}F NMR (471 MHz, $CDCl_3$) of **9b**



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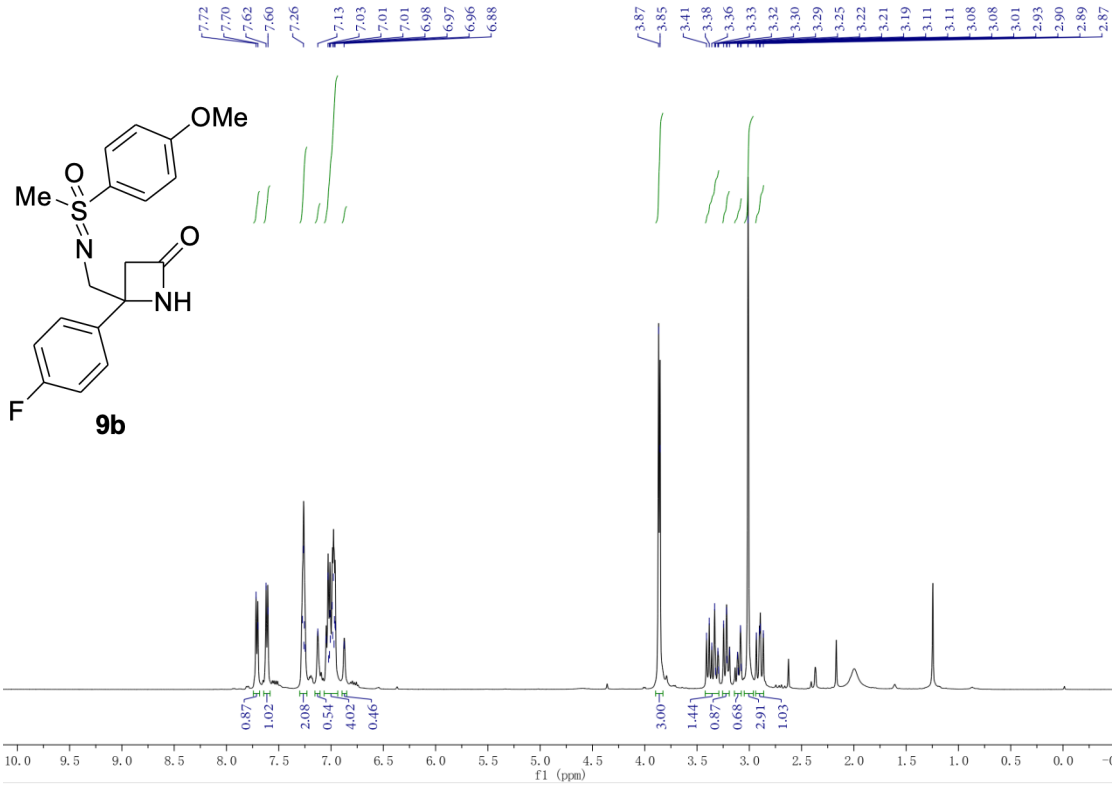
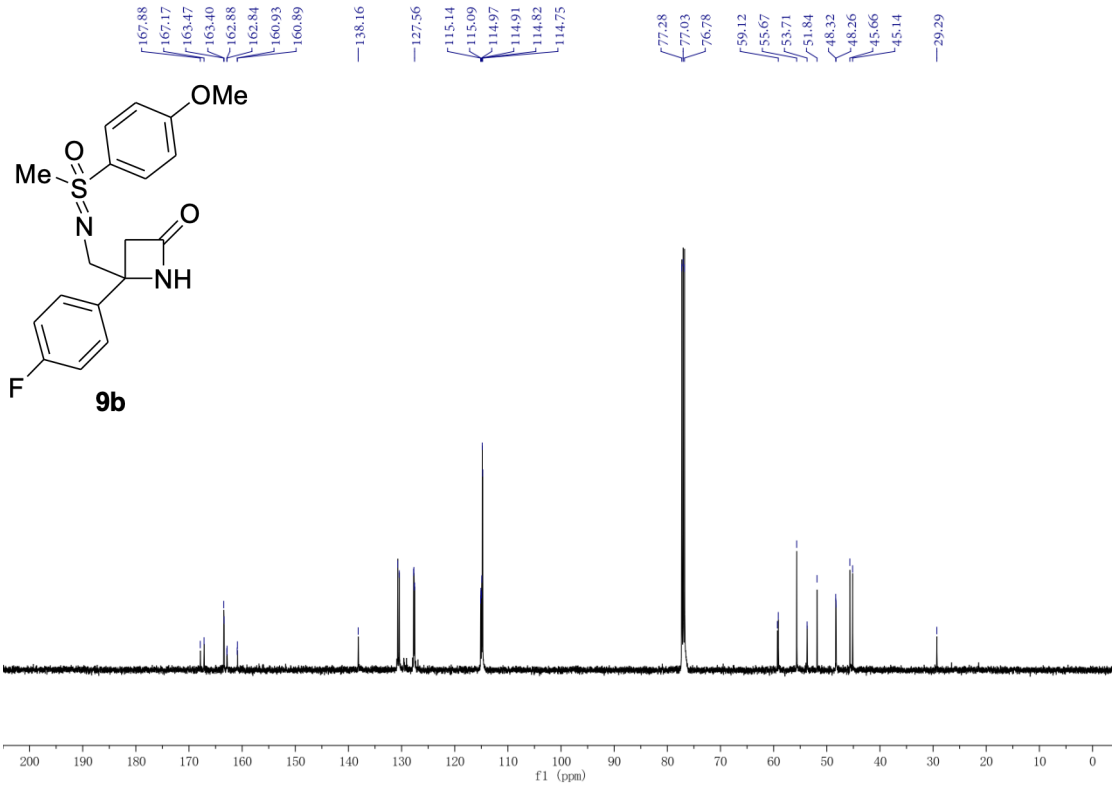


^{13}C NMR (126 MHz, $CDCl_3$) of **9b**



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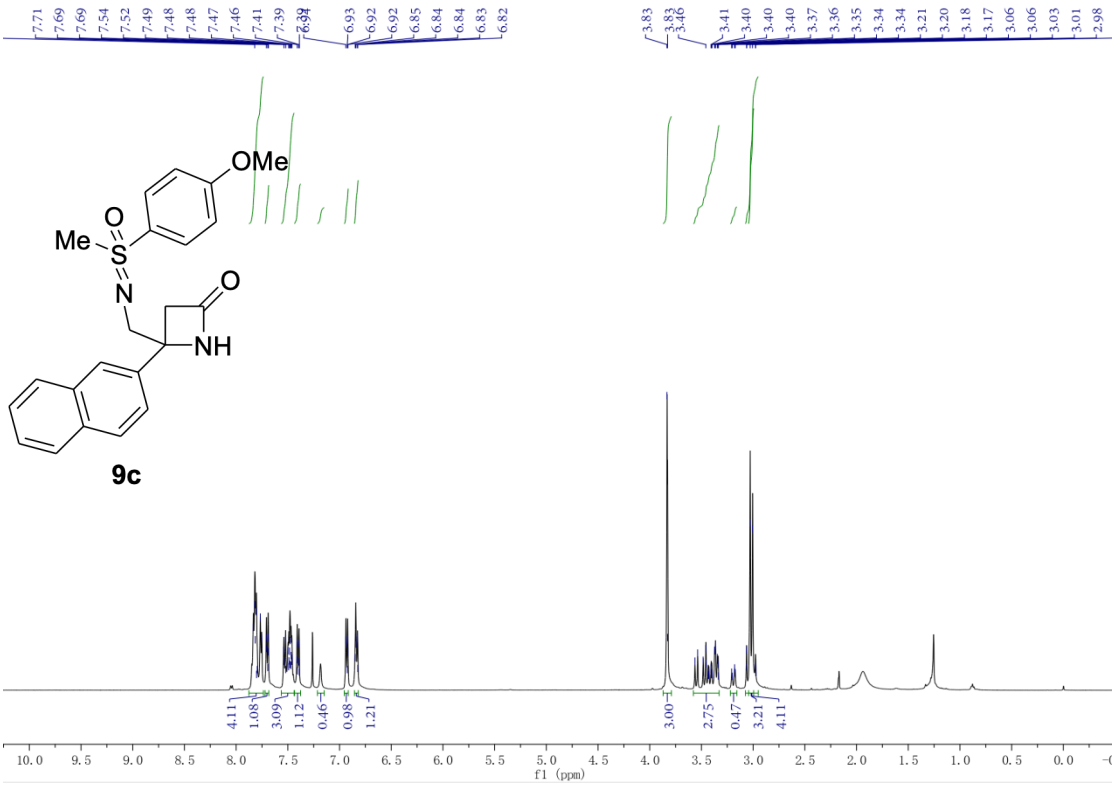

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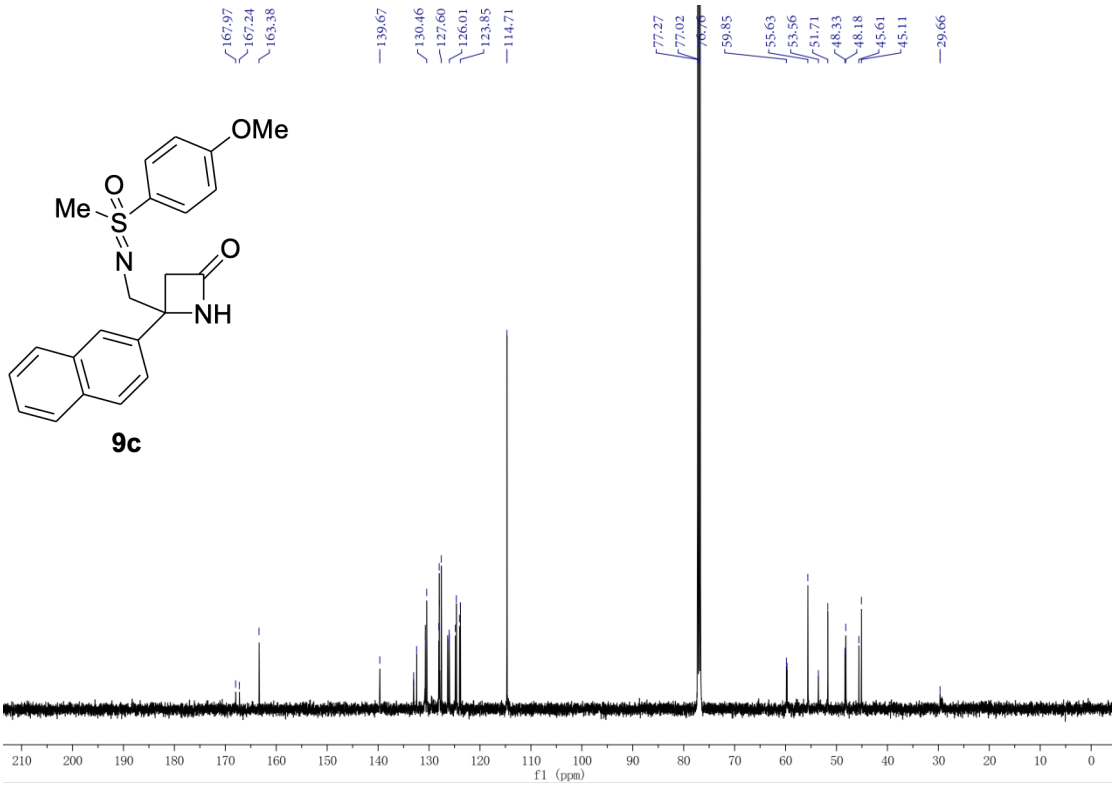

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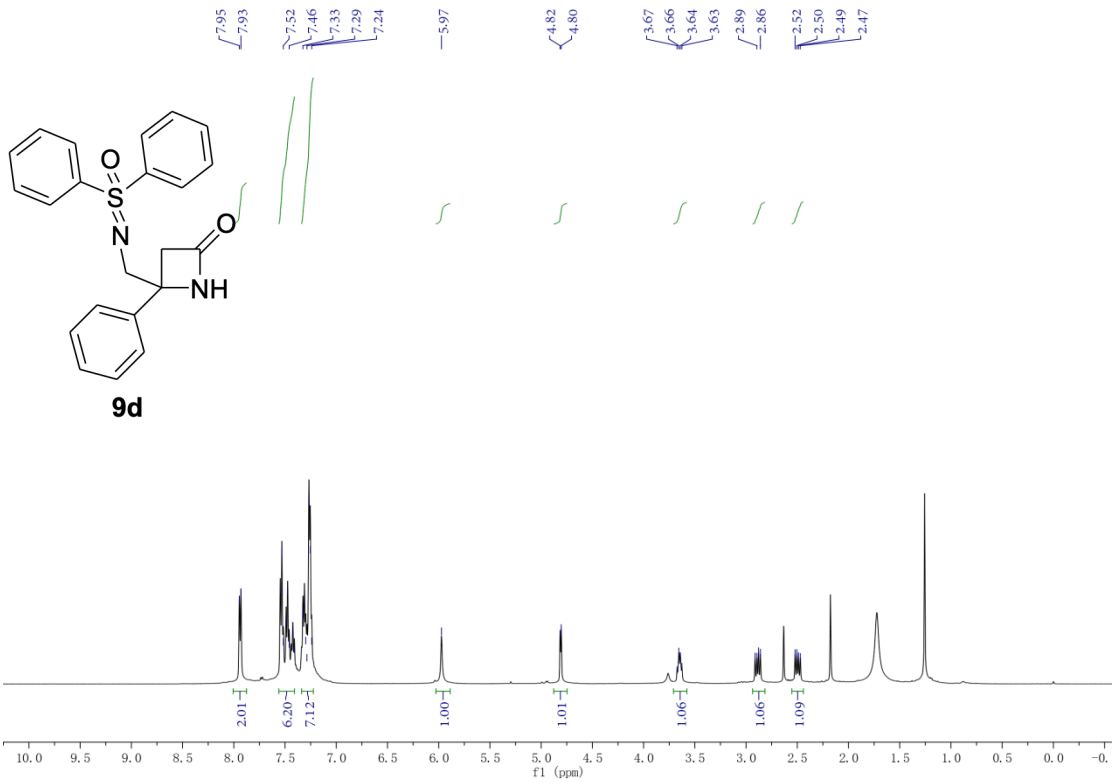

^{13}C NMR (126 MHz, $CDCl_3$) of **9d**