

transition metal-free C(sp³)-H selenation of β -ketosulfones

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Supporting Information

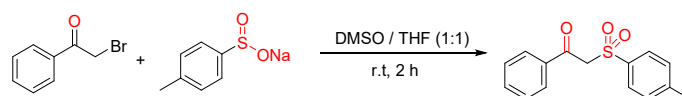
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1. General Experimental

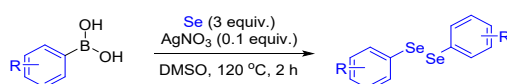
All reagents were purchased at the highest commercial quality and used without further purification. Reactions were monitored by thin layer chromatography (TLC) using ultra violet light (UV) as the visualizing agent. Flash column chromatography was performed on silica gel (particle size 200–300 mesh) and eluted with petroleum ether/ethyl acetate. Nuclear magnetic resonance spectra (NMR) were recorded on Bruker AV-600 instruments and were calibrated using residual undeuterated solvent as an internal reference (^1H NMR: CHCl_3 7.26 ppm, ^{13}C NMR: CHCl_3 77.16 ppm). High resolution mass spectra (HRMS) were recorded on a Q-TOF mass spectrometer (Agilent G6545B, Germany). The following abbreviations were used to indicate multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublets, dt = doublet of triplets, m = multiplet).

2. General procedure for preparation of β -ketosulfones compounds



Sodium sulfonates (RSO_2Na , 6.0 mmol) was added to a solution of substituted 2-bromoacetophenones (5.0 mmol) in a cosolvent of DMSO and THF (20 mL, v/v = 1:1) at rt. The reaction mixture was stirred at 2 h. The reaction mixture was partitioned with CH_2Cl_2 (3×30 mL) and water (30 mL). The combined organic layers were washed with brine, dried, filtered, and evaporated to afford crude β -ketosulfones under reduced pressure. Crude β -ketosulfones were recrystallized from EtOAc in nearly quantitative yields. β -Ketosulfones are known compounds and the analytical data are consistent with those in previous literature ¹.

3. General procedure for preparation of Diselenides compounds

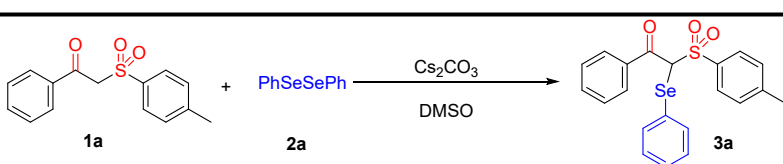


To a Schlenk tube were added arylboronic acid (0.4 mmol), selenium (1.2 mmol), AgNO_3 (0.04 mmol), and DMSO (2.0 mL). The mixture was stirred in a heating mantle preheated to 120 °C for 2 h. After cooled to room temperature, the reaction mixture was

diluted with H₂O (10 mL), and extracted with ethyl acetate (3×10 mL). The combined organic phase was washed with water and brine (30 mL), dried over anhydrous Na₂SO₄, and then evaporated under reduced pressure. The residue was purified by column chromatography to give the desired diselen ².

4. Optimization of reaction conditions

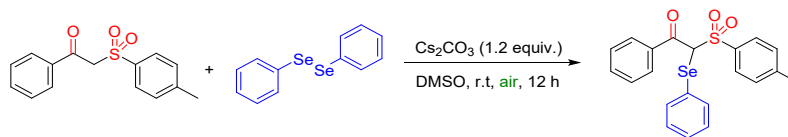
Table 4.1. Optimization of reaction conditions



Entry	Oxidant	Temperature	Time (h)	Yield
1	air	rt	4	42%
2	air	rt	6	63%
3	air	rt	8	85%
4	air	rt	10	91%
5	air	rt	12	93%
6	air	rt	14	94%
7	air	rt	24	93%
8	air	40 °C	6	85%
9	air	60 °C	2	80%
10	air	80 °C	1	78%

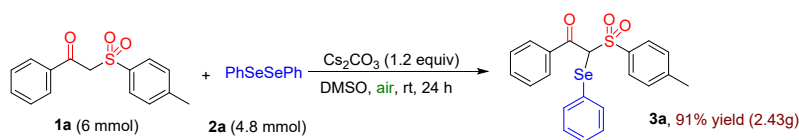
Reaction conditions: **1a** (0.2 mmol scale, 1 equiv), **2a** (0.8 equiv) Cs₂CO₃ (1.2 equiv), and DMSO (2 mL).

5 General procedure for the synthesis of product



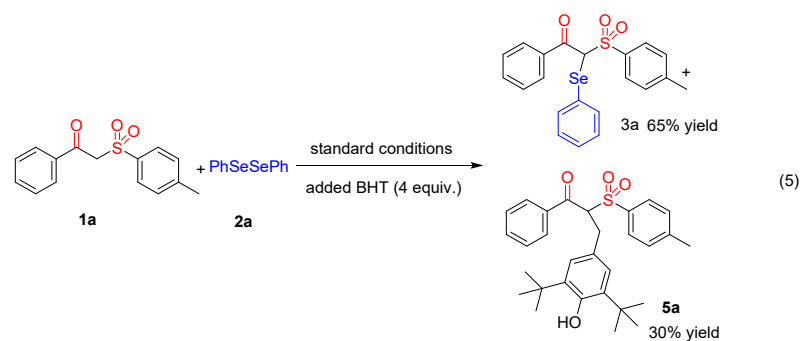
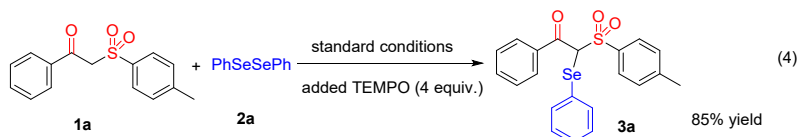
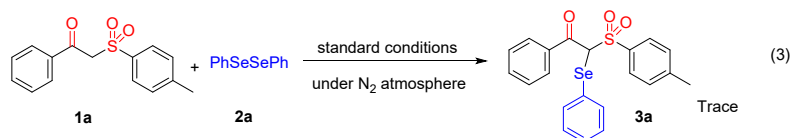
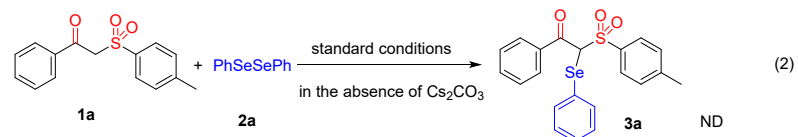
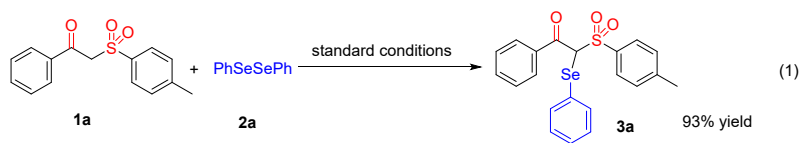
A mixture of β -ketosulfones **1** (0.20 mmol), diselenides **2** (0.16 mmol), and Cs_2CO_3 (0.45 mmol) in DMSO (2.0 mL) was placed in a test tube (25 mL) equipped with a magnetic stirring bar. The reaction mixture was stirred at room temperature for 12 h. After the reaction was completed, the mixture addition of satd aq NaCl (5 mL). Further stirring was followed by extraction with ethyl acetate (3 \times 15 mL). The organic layer was dried with anhydrous MgSO_4 , concentrated in vacuo and purified by flash silica gel chromatography using petroleum ether/ethyl acetate (8:1) to give the desired prod.

6. Gram-scale experiment



A mixture of β -ketosulfones **1a** (6 mmol), diselenides **2a** (4.8 mmol), and Cs_2CO_3 (7.2 mmol) in DMSO (30.0 mL) was placed in a Schlenk tube (100 mL) equipped with a magnetic stirring bar. The reaction mixture was stirred at room temperature for 24 h. After the reaction was completed, the mixture addition of satd aq NaCl (50 mL). Further stirring was followed by extraction with ethyl acetate (3 \times 30 mL). The organic layer was dried with anhydrous MgSO_4 , concentrated in vacuo and purified by flash silica gel chromatography using petroleum ether/ethyl acetate (8:1) to afford **3a** (2.34 g, 91 %) as white solid.

7. Control experiment

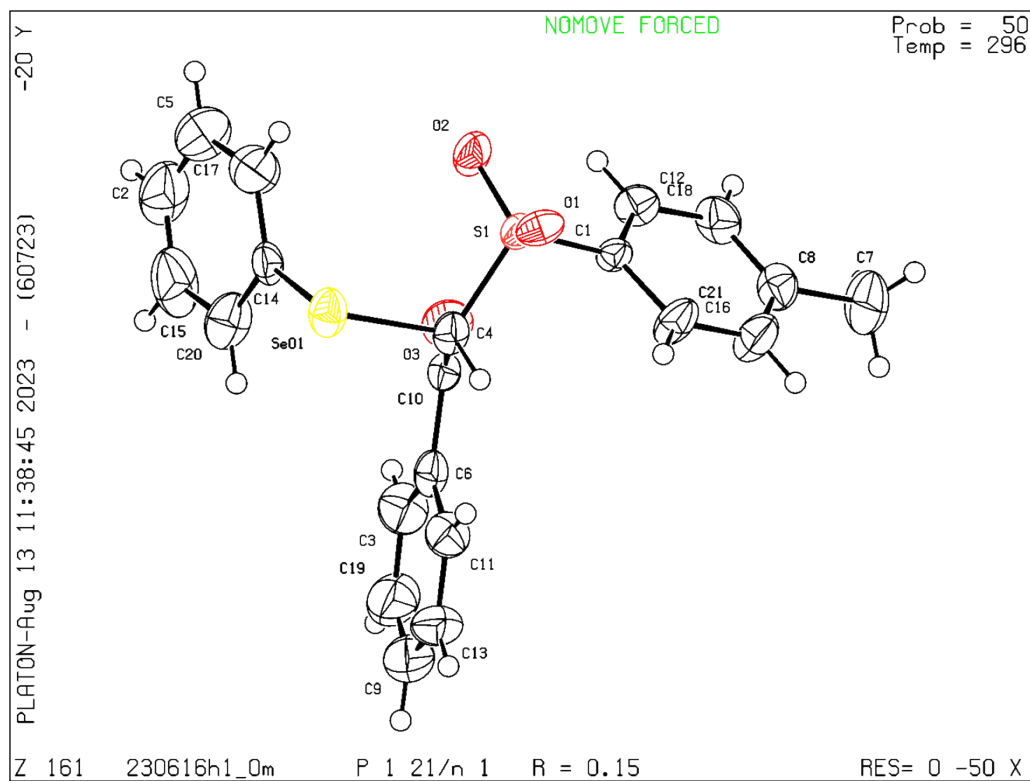


^a Standard conditions: **1a** (0.2 mmol), **2a** (0.16 mmol), Cs₂CO₃ (0.24 mmol), DMSO (2 mL), at room temperature, air, and 12 h. Isolated yields. ND = not detected.

8. X-Ray crystallographic data of products 3a**Table 8.1.** Crystal parameters of compound **3a** (CCDC: 2288402)

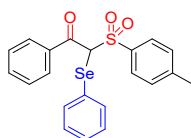
Bond precision:	C-C = 0.0242 Å		Wavelength=0.71073
Cell:	a=10.005(4)	b=11.035(4)	c=18.194(7)
	alpha=90	beta=101.800(7)	gamma=90
Temperature:	296 K		
	Calculated	Reported	
Volume	1966.3(13)	1966.2(13)	
Space group	P 21/n	P 1 21/n 1	
Hall group	-P 2yn	-P 2yn	
Moiety formula	C21 H18 O3 S Se	C21 H18 O3 S Se	
Sum formula	C21 H18 O3 S Se	C21 H18 O3 S Se	
Mr	429.37	429.37	
Dx,g cm-3	1.450	1.451	
Z	4	4	
Mu (mm-1)	2.033	2.033	
F000	872.0	872.0	
F000'	872.46		
h,k,lmax	13,14,23	13,14,23	
Nref	4710	4544	
Tmin,Tmax		0.569,0.746	
Tmin'			
Correction method=	# Reported T Limits: Tmin=0.569 Tmax=0.746 AbsCorr = MULTI-SCAN		
Data completeness=	0.965	Theta(max)= 27.928	
R(reflections)=	0.1494(3182)	wR2(reflections)= 0.4049(4544)	
S =	1.141	Npar= 237	

The crystal of product **3a** was obtained by slow evaporation in ethanol. The single crystal X-ray analysis determined the structure of product **3a** (Figure 7.1) as expected.



Displacement ellipsoids are drawn at 50% probability level.

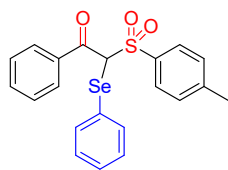
Figure 8.1. The crystal structure of compound **3a** (CCDC: 2288402).



3a
CCDC: 2288402

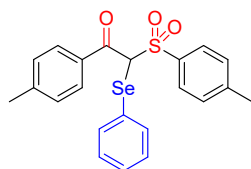
9. Analytical data for 3a-3v, 4a-4q, 5a

1-phenyl-2-(phenylselanyl)-2-tosylethan-1-one (3a)



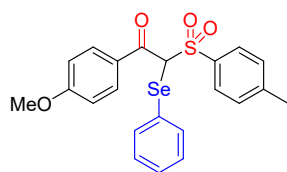
White solid, (80 mg, 93%), Mp: 95-97 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.90 (d, $J = 8.4$ Hz, 2H), 7.79 (d, $J = 7.22$ Hz, 2H), 7.58 (t, $J = 7.6$ Hz, 3H), 7.42 (t, $J = 6.6$ Hz, 3H), 7.37 (t, $J = 7.22$ Hz, 3H), 7.32 (d, $J = 7.8$ Hz, 2H), 7.28 (t, $J = 7.8$ Hz, 2H), 5.78 (s, 1H), 2.44 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.7, 145.6, 135.8, 135.2, 134.2, 134.1, 130.7, 129.7, 129.6, 129.4, 129.1, 128.9, 127.9, 68.4, 21.8. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{21}\text{H}_{19}\text{O}_3\text{SSe}$: 431.0215; found: 431.0216.

2-(phenylselanyl)-1-(p-tolyl)-2-tosylethan-1-one (3b)



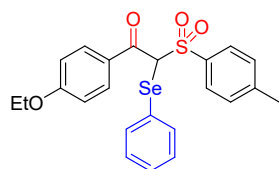
White solid, (75.8 mg, 85%), Mp: 119-120 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.89 (d, $J = 7.8$ Hz, 2H), 7.70 (d, $J = 8.4$ Hz, 2H), 7.60 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.37 (t, $J = 7.8$ Hz, 1H), 7.31 (d, $J = 7.8$ Hz, 2H), 7.28 (t, $J = 7.8$ Hz, 2H), 7.22 (d, $J = 8.4$ Hz, 2H), 5.76 (s, 1H), 2.43 (s, 3H), 2.40 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.3, 145.5, 145.5, 135.8, 134.1, 132.7, 130.7, 129.7, 129.6, 129.4, 129.3, 128.1, 68.5, 21.9, 21.9. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{22}\text{H}_{21}\text{O}_3\text{SSe}$: 445.0371; found: 445.0360.

1-(4-methoxyphenyl)-2-(phenylselanyl)-2-tosylethan-1-one (3c)



White solid, (82.7 mg, 90%), Mp: 81-83 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.88 (d, $J = 7.8$ Hz, 2H), 7.80 (d, $J = 9.0$ Hz, 2H), 7.60 (dd, $J = 7.8, 1.2$ Hz, 2H), 7.37 (t, $J = 7.2$ Hz, 1H), 7.31 (d, $J = 7.8$ Hz, 2H), 7.28 (t, $J = 7.8$ Hz, 2H), 6.89 (d, $J = 9.0$ Hz, 2H), 5.74 (s, 1H), 3.87 (s, 3H), 2.44 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 188.2, 164.5, 145.5, 135.7, 134.0, 131.7, 130.7, 129.6, 129.5, 129.4, 128.3, 128.1, 114.2, 68.7, 55.7, 21.9. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{22}\text{H}_{21}\text{O}_4\text{SSe}$: 461.0320; found: 461.0317.

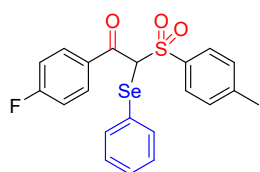
1-(4-ethoxyphenyl)-2-(phenylselanyl)-2-tosylethan-1-one (3d)



White solid, (89 mg, 92%), Mp: 111-112 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.87 (d, $J = 7.8$ Hz, 2H), 7.78 (d, $J = 9.0$ Hz,

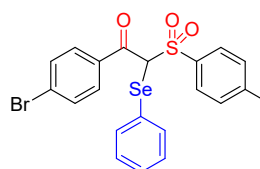
2H), 7.60 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.36 (t, $J = 7.2$ Hz, 1H), 7.30 (d, $J = 7.8$ Hz, 2H), 7.27 (d, $J = 7.2$ Hz, 2H), 6.86 (d, $J = 8.4$ Hz, 2H), 5.74 (s, 1H), 4.09 (q, $J = 7.2$ Hz, 2H), 2.43 (s, 3H), 1.43 (t, $J = 7.8$ Hz, 3H). ^{13}C NMR (151 MHz, CDCl_3) δ 188.1, 164.0, 145.4, 135.7, 134.0, 131.7, 130.9, 129.6, 129.5, 129.4, 128.3, 127.9, 114.6, 68.6, 64.1, 21.8, 14.7. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{23}\text{H}_{23}\text{O}_4\text{SSe}$: 475.0477; found: 475.0476.

1-(4-fluorophenyl)-2-(phenylselanyl)-2-tosylethan-1-one (3e)



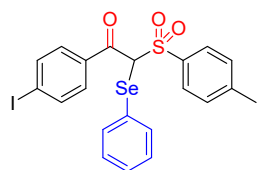
White solid, (84 mg, 94%), Mp: 83-85 °C; ^1H NMR (600 MHz, CDCl_3) δ 7.89 (d, $J = 8.4$ Hz, 2H), 7.84 (dd, $J = 8.4, 4.8$ Hz, 2H), 7.57 (d, $J = 7.2$ Hz, 2H), 7.37 (t, $J = 7.8$ Hz, 1H), 7.33 (d, $J = 8.4$ Hz, 2H), 7.28 (t, $J = 7.8$ Hz, 2H), 7.09 (t, $J = 8.4$ Hz, 2H), 5.72 (s, 1H), 2.44 (s, 3H). ^{13}C NMR (151 MHz, CDCl_3) δ 188.3, 167.3 (d, $J_{\text{C-F}} = 255.8$ Hz), 145.7, 135.8, 133.9, 132.0 (d, $J_{\text{C-F}} = 9.5$ Hz), 131.6 (d, $J_{\text{C-F}} = 2.6$ Hz), 130.7, 129.8, 129.7, 129.5, 127.9, 116.2 (d, $J_{\text{C-F}} = 21.8$ Hz), 68.6, 21.9. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{21}\text{H}_{18}\text{FO}_3\text{SSe}$: 449.0120; found: 449.0112.

1-(4-bromophenyl)-2-(phenylselanyl)-2-tosylethan-1-one (3f)



White solid, (96 mg, 94%), Mp: 93-94 °C; ^1H NMR (600 MHz, CDCl_3) δ 7.88 (d, $J = 8.4$ Hz, 2H), 7.65 (d, $J = 8.4$ Hz, 2H), 7.56 (t, $J = 5.4$ Hz, 4H), 7.38 (t, $J = 7.8$ Hz, 1H), 7.32 (d, $J = 7.8$ Hz, 2H), 7.28 (t, $J = 7.8$ Hz, 2H), 5.69 (s, 1H), 2.44 (s, 3H). ^{13}C NMR (151 MHz, CDCl_3) δ 188.8, 145.7, 135.8, 133.9, 133.9, 132.3, 130.7, 130.5, 129.9, 129.7, 129.7, 129.5, 127.8, 68.4, 21.9. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{21}\text{H}_{18}\text{BrO}_3\text{SSe}$: 508.9319; found: 508.9309.

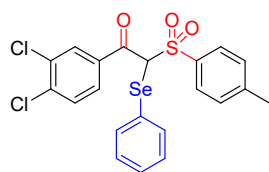
1-(4-iodophenyl)-2-(phenylselanyl)-2-tosylethan-1-one (3g)



White solid, (105.1 mg, 95%), Mp: 73-75 °C; ^1H NMR (600 MHz, CDCl_3) δ 7.88 (d, $J = 7.8$ Hz, 2H), 7.78 (d, $J = 8.4$ Hz, 2H), 7.57 (dd, $J = 7.8, 1.2$ Hz, 2H), 7.49 (d, $J = 9.0$ Hz, 2H), 7.38 (t, $J = 7.8$ Hz, 1H), 7.32 (d, $J = 7.8$ Hz, 2H), 7.28 (t, $J = 7.8$ Hz, 2H), 5.68 (s, 1H), 2.44 (s, 3H). ^{13}C NMR (151 MHz, CDCl_3) δ 189.1, 145.7, 138.3, 135.8,

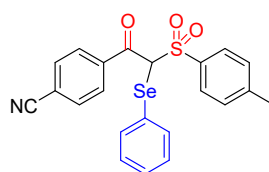
134.4, 133.9, 130.7, 130.3, 129.9, 129.7, 129.5, 127.8, 102.7, 68.4, 21.9. **HRMS** (+ESI-TOF): m/z $[M + H]^+$ calcd for $C_{21}H_{18}IO_3SSe$: 556.9181; found: 556.9172.

1-(3,4-dichlorophenyl)-2-(phenylselanyl)-2-tosylethan-1-one (3h)



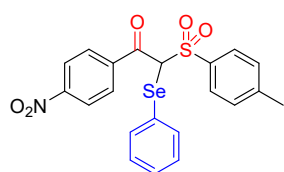
Yellow solid, (89.7 mg, 90%), Mp: 115-116 °C; 1H NMR (600 MHz, $CDCl_3$) δ 7.89 (d, $J = 8.4$ Hz, 2H), 7.80 (d, $J = 2.4$ Hz, 1H), 7.62 (dd, $J = 8.4, 1.8$ Hz, 1H), 7.57 (d, $J = 6.6$ Hz, 2H), 7.50 (d, $J = 8.4$ Hz, 1H), 7.40 (t, $J = 7.2$ Hz, 1H), 7.34 (d, $J = 8.4$ Hz, 2H), 7.30 (t, $J = 7.2$ Hz, 2H), 5.62 (s, 1H), 2.45 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 187.6, 145.9, 139.0, 135.9, 134.7, 133.9, 133.7, 131.0, 130.9, 130.7, 130.1, 129.8, 129.6, 128.0, 127.6, 68.5, 21.9, **HRMS** (+ESI-TOF): m/z $[M + H]^+$ calcd for $C_{21}H_{17}Cl_2O_3SSe$: 498.9435; found: 498.9426.

4-(2-(phenylselanyl)-2-tosylacetyl)benzonitrile(3i)



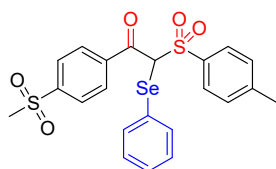
White solid, (89.3 mg, 98%), Mp: 111-112 °C; 1H NMR (600 MHz, $CDCl_3$) δ 7.89 (t, $J = 8.4$ Hz, 4H), 7.71 (d, $J = 8.4$ Hz, 2H), 7.52 (d, $J = 7.2$ Hz, 2H), 7.38 (t, $J = 7.8$ Hz, 1H), 7.34 (d, $J = 7.8$ Hz, 2H), 7.28 (t, $J = 7.8$ Hz, 2H), 5.70 (s, 1H), 2.45 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 188.5, 146.0, 138.2, 135.8, 133.8, 132.7, 130.6, 130.1, 129.8, 129.6, 129.4, 127.4, 117.7, 117.3, 68.5, 21.9. **HRMS** (+ESI-TOF): m/z $[M + H]^+$ calcd for $C_{22}H_{18}NO_3SSe$: 456.0167; found: 456.0168.

1-(4-nitrophenyl)-2-(phenylselanyl)-2-tosylethan-1-one (3j)



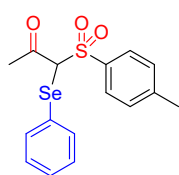
White solid, (86.0 mg, 91%), Mp: 118-120 °C; 1H NMR (600 MHz, $CDCl_3$) δ 8.25 (d, $J = 8.4$ Hz, 2H), 7.95 (d, $J = 8.4$ Hz, 2H), 7.91 (d, $J = 7.8$ Hz, 2H), 7.53 (d, $J = 7.2$ Hz, 2H), 7.39 (t, $J = 7.8$ Hz, 1H), 7.35 (d, $J = 7.8$ Hz, 2H), 7.28 (t, $J = 7.2$ Hz, 2H), 5.72 (s, 1H), 2.46 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 188.3, 150.8, 146.0, 139.7, 135.8, 133.8, 130.7, 130.2, 130.1, 129.8, 129.7, 127.4, 124.0, 68.7, 21.90. **HRMS** (+ESI-TOF): m/z $[M + H]^+$ calcd for $C_{21}H_{18}NO_5SSe$: 476.0065; found: 476.0063.

1-(4-(methylsulfonyl)phenyl)-2-(phenylselanyl)-2-tosylethan-1-one (3k)



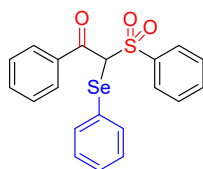
White solid, (89.3 mg, 88%), Mp: 149-150 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.98 (q, $J = 8.4\text{Hz}$, 4H), 7.90 (d, $J = 8.4\text{ Hz}$, 2H), 7.53 (d, $J = 7.2\text{ Hz}$, 2H), 7.38 (t, $J = 7.8\text{ Hz}$, 1H), 7.34 (d, $J = 8.4\text{ Hz}$, 2H), 7.28 (t, $J = 7.8\text{ Hz}$, 2H), 5.73 (s, 1H), 3.07 (s, 3H), 2.45 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 188.6, 146.0, 145.0, 139.2, 135.7, 133.8, 130.6, 130.1, 129.9, 129.8, 129.6, 128.0, 127.5, 68.6, 44.4, 21.9. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{22}\text{H}_{21}\text{O}_5\text{S}_2\text{Se}$: 508.9990; found: 508.9982.

1-(phenylselanyl)-1-tosylpropan-2-one (3l)



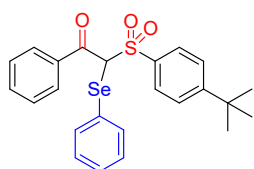
White solid, (70.9 mg, 96%), Mp: 92-93 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.83 (d, $J = 8.4\text{ Hz}$, 2H), 7.48 (d, $J = 7.2\text{ Hz}$, 2H), 7.35 – 7.33 (m, 3H), 7.27 – 7.24 (m, 3H), 4.77 (s, 1H), 2.46 (s, 3H), 2.45 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 196.7, 145.8, 135.2, 134.1, 129.8, 129.8, 129.7, 129.6, 127.5, 73.6, 29.0, 21.9. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{16}\text{H}_{17}\text{O}_3\text{SSe}$: 369.0058; found: 369.0053.

1-phenyl-2-(phenylselanyl)-2-(phenylsulfonyl)ethan-1-one (3m)

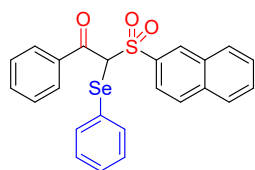


White solid, (81.8 mg, 98%), Mp: 156-157 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 8.03 (dd, $J = 8.4, 1.2\text{ Hz}$, 2H), 7.77 (dd, $J = 8.4, 1.2\text{ Hz}$, 2H), 7.63 (t, $J = 7.2\text{ Hz}$, 1H), 7.58 – 7.51 (m, 5H), 7.40 (t, $J = 8.4\text{ Hz}$, 2H), 7.36 (t, $J = 7.8\text{ Hz}$, 1H), 7.26 (t, $J = 7.8\text{Hz}$, 2H), 5.79 (s, 1H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.5, 137.1, 135.9, 135.1, 134.4, 134.3, 130.7, 129.8, 129.6, 129.1, 128.9, 128.8, 127.8, 68.2. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{20}\text{H}_{17}\text{O}_3\text{SSe}$: 417.0058; found: 417.0057.

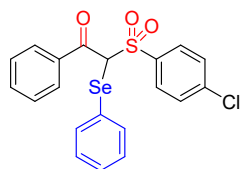
2-((4-(tert-butyl)phenyl)sulfonyl)-1-phenyl-2-(phenylselanyl)ethan-1-one(3n)



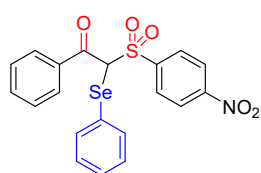
White solid, (91.5 mg, 94%), Mp: 120-121 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.97 (d, $J = 8.4\text{ Hz}$, 2H), 7.80 (d, $J = 7.8\text{ Hz}$, 2H), 7.59 (t, $J = 7.2\text{ Hz}$, 1H), 7.54 (dd, $J = 13.2, 8.4\text{ Hz}$, 4H), 7.43 (t, $J = 7.8\text{ Hz}$, 2H), 7.38 (t, $J = 7.8\text{ Hz}$, 1H), 7.27 (t, $J = 7.2\text{ Hz}$, 2H), 5.80 (s, 1H), 1.36 (s, 9H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.7, 158.4, 135.8, 135.3, 134.2, 134.1, 130.0, 129.7, 129.7, 129.0, 128.9, 127.9, 125.8, 68.4, 35.43, 31.2. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{24}\text{H}_{25}\text{O}_3\text{SSe}$: 473.0684; found: 473.0684.

2-(naphthalen-2-ylsulfonyl)-1-phenyl-2-(phenylselanyl)ethan-1-one(3o)

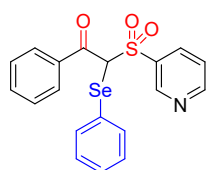
White solid, (92.4 mg, 96%), Mp: 125-126 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 8.61 (s, 1H), 7.99 (d, $J = 9.0$ Hz, 2H), 7.93 (d, $J = 9.0$ Hz, 1H), 7.90 (d, $J = 8.4$ Hz, 1H), 7.79 (d, $J = 7.2$ Hz, 2H), 7.67 (t, $J = 7.8$ Hz, 1H), 7.61 (t, $J = 8.4$ Hz, 1H), 7.55 (t, $J = 7.2$ Hz, 3H), 7.39 (t, $J = 7.8$ Hz, 2H), 7.33 (t, $J = 7.2$ Hz, 1H), 7.22 (t, $J = 7.8$ Hz, 2H), 5.89 (s, 1H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.5, 135.8, 135.7, 135.1, 134.4, 134.2, 132.9, 131.9, 129.8, 129.7, 129.6, 129.5, 129.0, 128.9, 128.8, 128.0, 127.8, 127.6, 124.9, 68.5. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{29}\text{H}_{19}\text{O}_3\text{SSe}$: 467.0215; found: 467.0214.

2-((4-chlorophenyl)sulfonyl)-1-phenyl-2-(phenylselanyl)ethan-1-one (3p)

White solid, (85.0 mg, 94%), Mp: 108-110 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.98 (d, $J = 8.4$ Hz, 2H), 7.80 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.59 (dd, $J = 16.2, 7.8$ Hz, 3H), 7.51 (d, $J = 8.4$ Hz, 2H), 7.44 (t, $J = 8.4$ Hz, 2H), 7.39 (t, $J = 7.8$ Hz, 1H), 7.30 (t, $J = 7.8$ Hz, 2H), 5.82 (s, 1H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.5, 141.3, 135.8, 135.4, 135.0, 134.5, 132.3, 130.0, 129.7, 129.0, 127.6, 68.1. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{20}\text{H}_{16}\text{ClO}_3\text{SSe}$: 450.9668; found: 450.9666.

2-((4-nitrophenyl)sulfonyl)-1-phenyl-2-(phenylselanyl)ethan-1-one (3q)

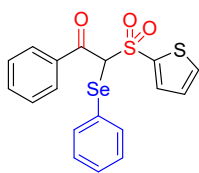
White solid, (87.1 mg, 94%), Mp: 154-155 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 8.37 (d, $J = 8.4$ Hz, 2H), 8.27 (d, $J = 8.4$ Hz, 2H), 7.80 (d, $J = 7.2$ Hz, 2H), 7.61 (d, $J = 7.8$ Hz, 3H), 7.45 (t, $J = 7.2$ Hz, 2H), 7.41 (t, $J = 7.2$ Hz, 1H), 7.32 (t, $J = 7.8$ Hz, 2H), 5.89 (s, 1H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.3, 151.2, 142.6, 135.9, 134.8, 134.7, 132.4, 130.3, 129.8, 129.1, 129.0, 127.3, 123.7, 67.9. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{21}\text{H}_{19}\text{O}_5\text{SSe}$: 477.0144; found: 477.0173.

1-phenyl-2-(phenylselanyl)-2-(pyridin-3-ylsulfonyl)ethan-1-one(3r)

Yellow solid, (78.6 mg, 94%), Mp: 140-141 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 9.26 (d, $J = 1.8$ Hz, 1H), 8.86 (dd, $J = 4.8, 1.8$ Hz, 1H), 8.36 – 8.34 (m, 1H), 7.81 (d, $J = 7.2$ Hz, 2H), 7.61 (t, $J = 7.8$ Hz,

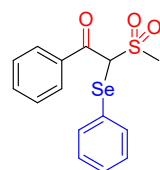
1H), 7.59 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.50 (dd, $J = 7.8, 4.8$ Hz, 1H), 7.45 (t, $J = 7.8$ Hz, 2H), 7.40 (t, $J = 7.2$ Hz, 1H), 7.30 (t, $J = 7.8$ Hz, 2H), 5.86 (s, 1H). ^{13}C NMR (151 MHz, CDCl_3) δ 189.5, 154.6, 151.5, 139.0, 135.9, 134.8, 134.6, 133.6, 130.1, 129.8, 129.1, 129.0, 127.4, 123.4, 67.9. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{19}\text{H}_{16}\text{O}_3\text{SSe}$: 418.0011; found: 418.0001.

1-phenyl-2-(phenylselanyl)-2-(thiophen-2-ylsulfonyl)ethan-1-one (3s)



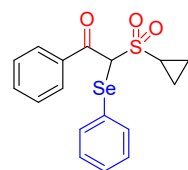
White solid, (83.1 mg, 98%), Mp: 160-161 °C; ^1H NMR (600 MHz, CDCl_3) δ 7.85 – 7.76 (m, 4H), 7.59 (d, $J = 7.8$ Hz, 3H), 7.43 (t, $J = 7.8$ Hz, 2H), 7.39 (t, $J = 7.2$ Hz, 1H), 7.29 (t, $J = 7.2$ Hz, 2H), 7.14 (t, $J = 4.2$ Hz, 2H), 5.87 (s, 1H). ^{13}C NMR (151 MHz, CDCl_3) δ 189.4, 137.5, 136.0, 135.8, 135.0, 134.4, 130.0, 129.6, 129.0, 127.7, 127.6, 68.6. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{18}\text{H}_{15}\text{O}_3\text{SSe}$: 422.9622; found: 422.9612.

2-(methylsulfonyl)-1-phenyl-2-(phenylselanyl)ethan-1-one (3t)



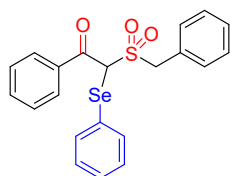
White solid, (69.8 mg, 98%), Mp: 126-127 °C; ^1H NMR (600 MHz, CDCl_3) δ 7.88 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.73 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.64 (t, $J = 7.8$ Hz, 1H), 7.48 (t, $J = 7.8$ Hz, 2H), 7.43 (t, $J = 7.8$ Hz, 1H), 7.35 (t, $J = 7.8$ Hz, 2H), 5.60 (s, 1H), 3.35 (s, 3H). ^{13}C NMR (151 MHz, CDCl_3) δ 190.6, 136.0, 134.8, 134.7, 130.2, 129.8, 129.1, 127.4, 65.6, 38.8. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{15}\text{H}_{15}\text{O}_3\text{SSe}$: 354.9902; found: 354.9894.

2-(cyclopropylsulfonyl)-1-phenyl-2-(phenylselanyl)ethan-1-one (3u)



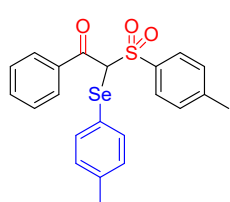
White solid, (72.1 mg, 95%), Mp: 106-107 °C; ^1H NMR (600 MHz, CDCl_3) δ 7.87 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.70 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.62 (t, $J = 7.8$ Hz, 1H), 7.46 (t, $J = 8.4$ Hz, 2H), 7.40 (t, $J = 7.2$ Hz, 1H), 7.32 (t, $J = 7.8$ Hz, 2H), 5.69 (s, 1H), 2.98 – 2.94 (m, 1H), 1.50 – 1.45 (m, 1H), 1.30 – 1.26 (m, 1H), 1.18 – 1.14 (m, 1H), 1.07–1.2 (m, 1H). ^{13}C NMR (151 MHz, CDCl_3) δ 190.2, 135.9, 135.0, 134.4, 129.9, 129.7, 129.1, 129.0, 127.8, 66.3, 29.0, 6.9, 5.1. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{17}\text{H}_{17}\text{O}_3\text{SSe}$: 381.0058; found: 381.0058.

2-(benzylsulfonyl)-1-phenyl-2-(phenylselanyl)ethan-1-one (3v)



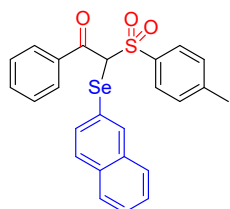
White solid, (82.6 mg, 96%), Mp: 108-109 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.72 (d, $J = 7.2$ Hz, 2H), 7.66 (d, $J = 7.2$ Hz, 2H), 7.61 (t, $J = 7.8$ Hz, 1H), 7.44 – 7.38 (m, 5H), 7.35 (t, $J = 7.8$ Hz, 1H), 7.32 – 7.29 (m, 4H), 5.54 (s, 1H), 4.83 (d, $J = 13.2$ Hz, 1H), 4.67 (d, $J = 13.2$ Hz, 1H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 190.2, 136.3, 134.8, 134.5, 131.5, 130.1, 129.7, 129.2, 129.1, 129.0, 128.9, 127.1, 126.8, 64.5, 57.6. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{21}\text{H}_{19}\text{O}_3\text{SSe}$: 431.0215; found: 431.0216.

1-phenyl-2-(p-tolylselanyl)-2-tosylethan-1-one (4a)



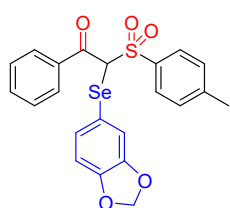
White solid, (79.1 mg, 89%), Mp: 145-147 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.90 (d, $J = 8.4$ Hz, 2H), 7.79 (d, $J = 7.2$ Hz, 2H), 7.57 (t, $J = 7.2$ Hz, 1H), 7.45 (d, $J = 7.8$ Hz, 2H), 7.41 (t, $J = 7.8$ Hz, 2H), 7.32 (d, $J = 7.8$ Hz, 2H), 7.08 (d, $J = 7.8$ Hz, 2H), 5.73 (s, 1H), 2.43 (s, 3H), 2.39 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.7, 145.5, 140.2, 136.1, 135.2, 134.2, 134.1, 130.7, 130.4, 129.4, 129.0, 128.9, 124.3, 68.4, 21.8, 21.34. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{22}\text{H}_{21}\text{O}_3\text{SSe}$: 445.0371; found: 445.0373.

2-(naphthalen-2-ylselanyl)-1-phenyl-2-tosylethan-1-one (4b)



Colorless oil, (79.3 mg, 83%) ; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.99 (s, 1H), 7.93 (d, $J = 8.4$ Hz, 2H), 7.82 (d, $J = 7.2$ Hz, 1H), 7.80 (d, $J = 7.2$ Hz, 2H), 7.74 (d, $J = 9$ Hz, 1H), 7.71 (d, $J = 9.0$ Hz, 1H), 7.62 (dd, $J = 8.4, 1.8$ Hz, 1H), 7.57 (t, $J = 7.2$ Hz, 1H), 7.54-7.50 (m, 2H), 7.40 (t, $J = 7.2$ Hz, 2H), 7.31 (d, $J = 8.4$ Hz, 2H), 5.86 (s, 1H), 2.42 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.7, 145.6, 135.8, 135.2, 134.2, 134.1, 133.7, 133.4, 131.8, 130.7, 129.5, 129.2, 129.1, 128.0, 127.9, 127.4, 126.9, 125.2, 68.4, 21.8. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{25}\text{H}_{21}\text{O}_3\text{SSe}$: 481.0371; found: 481.0367.

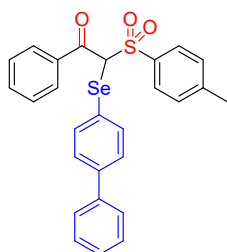
2-(benzo[d][1,3]dioxol-5-ylselanyl)-1-phenyl-2-tosylethan-1-one (4c)



White solid, (75.9 mg, 80%), Mp: 120-121 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.90 (d, $J = 7.8$ Hz, 2H), 7.80 (d, $J = 7.8$ Hz, 2H), 7.58 (t, $J = 7.2$ Hz, 1H), 7.43 (t, $J = 7.8$ Hz, 2H), 7.32 (d, $J = 8.4$ Hz, 2H), 7.03 – 7.00 (m, 2H), 6.68 (d, $J = 7.8$ Hz, 2H), 5.98 (s, 2H), 5.71 (s, 1H), 2.44 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.6, 149.5, 148.3, 145.6,

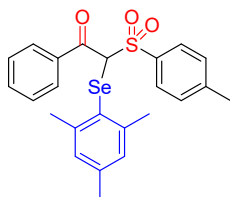
135.3, 134.2, 134.1, 131.1, 130.7, 129.5, 129.0, 128.9, 118.9, 116.5, 109.2, 101.7, 68.6, 21.8. **HRMS** (+ESI-TOF): m/z $[M + H]^+$ calcd for $C_{22}H_{19}O_5SSe$: 475.0113; found: 475.0113.

2-([1,1'-biphenyl]-4-ylselanyl)-1-phenyl-2-tosylethan-1-one (4d)



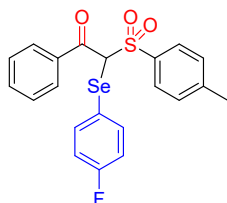
White solid, (94.1 mg, 93%), Mp: 141-142 °C; **1H NMR** (600 MHz, $CDCl_3$) δ 7.92 (d, $J = 8.4$ Hz, 2H), 7.83 (d, $J = 8.4$ Hz, 2H), 7.66 (d, $J = 7.2$ Hz, 2H), 7.60 – 7.57 (m, 3H), 7.50 (d, $J = 8.4$ Hz, 2H), 7.47 – 7.42 (m, 4H), 7.39 (t, $J = 8.4$ Hz, 1H), 7.33 (d, $J = 7.8$ Hz, 2H), 5.82 (s, 1H), 2.44 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 189.7, 145.6, 142.7, 140.0, 136.3, 135.2, 134.3, 134.1, 130.7, 129.5, 129.1, 129.0, 128.9, 128.2, 128.1, 127.2, 126.8, 68.5, 21.9. **HRMS** (+ESI-TOF): m/z $[M + H]^+$ calcd for $C_{27}H_{23}O_3SSe$: 507.0528; found: 507.0526.

2-(mesitylselanyl)-1-phenyl-2-tosylethan-1-one (4e)

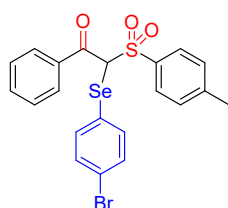


White solid, (57.2 mg, 61%), Mp: 125-126 °C; **1H NMR** (600 MHz, $CDCl_3$) δ 7.83 (d, $J = 7.8$ Hz, 2H), 7.73 (d, $J = 7.2$ Hz, 2H), 7.55 (t, $J = 7.2$ Hz, 1H), 7.36 (t, $J = 7.8$ Hz, 2H), 7.29 (d, $J = 8.4$ Hz, 2H), 6.89 (s, 2H), 5.50 (s, 1H), 2.42 (s, 3H), 2.38 (s, 6H), 2.26 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 191.2, 145.5, 144.0, 140.4, 135.5, 134.2, 134.1, 130.3, 129.5, 129.2, 129.1, 128.8, 127.1, 68.0, 24.5, 21.8, 21.2. **HRMS** (+ESI-TOF): m/z $[M + H]^+$ calcd for $C_{24}H_{25}O_3SSe$: 473.0684; found: 473.0685.

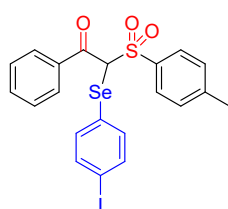
2-((4-fluorophenyl)selanyl)-1-phenyl-2-tosylethan-1-one (4f)



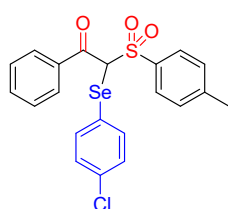
White solid, (109.8 mg, 93%), Mp: 121-122 °C; **1H NMR** (600 MHz, $CDCl_3$) δ 7.88 (d, $J = 7.8$ Hz, 2H), 7.78 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.60 – 7.55 (m, 3H), 7.42 (t, $J = 8.4$ Hz, 2H), 7.32 (d, $J = 7.8$ Hz, 2H), 6.96 (t, $J = 8.4$ Hz, 2H), 5.75 (s, 1H), 2.43 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 189.4, 164.8 (d, $J_{C-F} = 249.6$ Hz), 145.6, 138.7 (d, $J_{C-F} = 8.52$ Hz), 135.2, 134.3, 134.0, 130.6, 129.5, 129.0, 128.9, 122.3 (d, $J_{C-F} = 3.3$ Hz), 116.9 (d, $J_{C-F} = 21.6$ Hz), 68.2, 21.9. **HRMS** (+ESI-TOF): m/z $[M + H]^+$ calcd for $C_{21}H_{18}FO_3SSe$: 449.0120; found: 449.0111.

2-((4-bromophenyl)selanyl)-1-phenyl-2-tosylethan-1-one (4g)

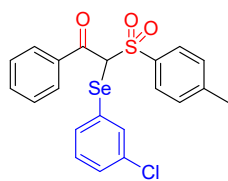
White solid, (88.0 mg, 87%), Mp: 138-139 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.87 (d, $J = 8.4$ Hz, 2H), 7.79 (d, $J = 7.2$ Hz, 2H), 7.59 (t, $J = 7.2$ Hz, 2H), 7.42 (dt, $J = 25.2, 8.4$ Hz, 6H), 7.31 (d, $J = 8.4$ Hz, 2H), 5.77 (s, 1H), 2.43 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.4, 145.7, 137.6, 135.1, 134.4, 133.9, 132.7, 130.6, 129.5, 129.1, 129.0, 126.4, 124.8, 68.2, 21.9. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{21}\text{H}_{18}\text{BrO}_3\text{SSe}$: 508.9320; found: 508.9318.

2-((4-iodophenyl)selanyl)-1-phenyl-2-tosylethan-1-one (4h)

White solid, (94.5 mg, 85%), Mp: 152-154 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.86 (d, $J = 7.8$ Hz, 2H), 7.79 (dd, $J = 8.4, 0.6$ Hz, 2H), 7.59 (t, $J = 7.8$ Hz, 3H), 7.43 (dd, $J = 8.1, 7.8$ Hz, 2H), 7.31 (d, $J = 8.4$ Hz, 4H), 5.77 (s, 1H), 2.43 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.4, 145.7, 138.7, 137.5, 135.1, 134.4, 133.9, 130.6, 129.5, 129.1, 129.0, 127.4, 96.6, 68.2, 21.87. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{21}\text{H}_{18}\text{IO}_3\text{SSe}$: 556.9181; found: 556.9179.

2-((4-chlorophenyl)selanyl)-1-phenyl-2-tosylethan-1-one (4i)

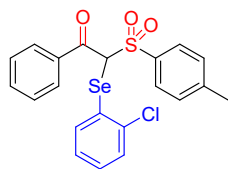
White solid, (81.8 mg, 88%), Mp: 119-121 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.87 (d, $J = 8.4$ Hz, 2H), 7.79 (d, $J = 7.8$ Hz, 2H), 7.59 (t, $J = 7.2$ Hz, 1H), 7.52 (d, $J = 8.4$ Hz, 2H), 7.43 (t, $J = 7.8$ Hz, 2H), 7.31 (d, $J = 7.8$ Hz, 2H), 7.24 (d, $J = 8.4$ Hz, 2H), 5.76 (s, 1H), 2.43 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) 189.4, 145.7, 137.4, 136.5, 135.1, 134.4, 133.9, 130.6, 129.8, 129.5, 129.0, 128.9, 125.7, 68.2, 21.9. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{21}\text{H}_{18}\text{ClO}_3\text{SSe}$: 462.9833; found: 462.9829.

2-((3-chlorophenyl)selanyl)-1-phenyl-2-tosylethan-1-one (4j)

White solid, (80.3 mg, 87%), Mp: 103-104 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.89 (d, $J = 7.8$ Hz, 2H), 7.82 (d, $J = 7.8$ Hz, 2H), 7.60 (t, $J = 7.2$ Hz, 1H), 7.45 (t, $J = 7.2$ Hz, 3H), 7.37 – 7.32 (m, 4H), 7.20 (t, $J = 7.8$ Hz, 1H), 5.80 (s, 1H), 2.45 (s, 3H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 189.4, 145.9, 135.3, 135.1, 134.9, 134.4, 133.8, 133.7, 130.7,

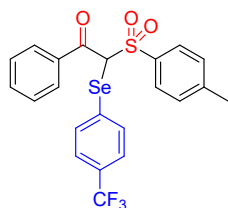
130.6, 130.0, 129.6, 129.1, 129.0, 128.9, 68.3, 21.9. **HRMS** (+ESI-TOF): m/z [M + H]⁺ calcd for C₂₁H₁₈ClO₃SSe: 464.9825; found: 464.9823.

2-((2-chlorophenyl)selanyl)-1-phenyl-2-tosylethan-1-one (4k)



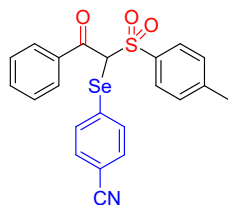
White solid, (78.6 mg, 85%), Mp: 100-102°C; ¹H NMR (600 MHz, CDCl₃) δ 7.91 (d, J = 7.8 Hz, 2H), 7.81 (d, J = 8.4 Hz, 3H), 7.60 (t, J = 7.2 Hz, 1H), 7.45 (t, J = 8.4 Hz, 2H), 7.40 (dd, J = 8.4, 1.2 Hz, 1H), 7.31 – 7.26 (m, 3H), 7.22 (td, J = 9.0, 1.8 Hz, 1H), 6.06 (s, 1H), 2.43 (s, 3H). ¹³C NMR (151 MHz, CDCl₃) δ 190.2, 145.8, 137.7, 136.6, 135.3, 134.4, 133.4, 130.7, 130.6, 130.0, 129.5, 129.4, 128.9, 128.5, 127.9, 67.7, 21.9. **HRMS** (+ESI-TOF): m/z [M + H]⁺ calcd for C₂₁H₁₈ClO₃SSe: 464.9825; found: 464.9824.

1-phenyl-2-tosyl-2-((4-(trifluoromethyl)phenyl)selanyl)ethan-1-one (4l)



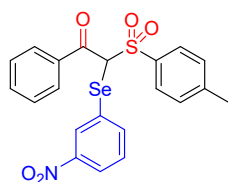
White solid, (82.6 mg, 83%), Mp: 123-124 °C; ¹H NMR (600 MHz, CDCl₃) δ 7.85 (d, J = 8.4 Hz, 2H), 7.81 (dd, J = 7.8, 0.6 Hz, 2H), 7.74 (d, J = 7.8 Hz, 2H), 7.60 (t, J = 7.2 Hz, 1H), 7.52 (d, J = 7.8 Hz, 2H), 7.44 (t, J = 8.4 Hz, 2H), 7.31 (d, J = 7.8 Hz, 2H), 5.86 (s, 1H), 2.43 (s, 3H). ¹³C NMR (151 MHz, CDCl₃) δ 189.4, 145.9, 135.6, 135.0, 134.5, 133.6, 132.4, 131.7 (q, J_{C-F} = 32.6 Hz), 130.6, 129.6, 129.1, 129.0, 126.3 (q, J_{C-F} = 4.0 Hz), 124.8 (q, J_{C-F} = 270.9 Hz), 68.2, 21.8. **HRMS** (+ESI-TOF): m/z [M + H]⁺ calcd for C₂₂H₁₈F₃O₃SSe: 499.0089; found: 499.0090.

4-((2-oxo-2-phenyl-1-tosylethyl)selanyl)benzotrile (4m)



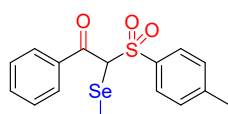
White solid, (79.6 mg, 87%), Mp: 156-157 °C; ¹H NMR (600 MHz, CDCl₃) δ 7.84 – 7.80 (m, 4H), 7.75 (d, J = 8.4 Hz, 2H), 7.60 (t, J = 7.2 Hz, 1H), 7.55 (d, J = 8.4 Hz, 2H), 7.44 (t, J = 7.8 Hz, 2H), 7.31 (d, J = 8.4 Hz, 2H), 5.90 (s, 1H), 2.43 (s, 3H). ¹³C NMR (151 MHz, CDCl₃) δ 189.2, 146.0, 135.4, 134.9, 134.6, 134.1, 133.0, 132.7, 130.6, 129.6, 129.1, 129.0, 118.9, 113.1, 68.1, 21.9. **HRMS** (+ESI-TOF): m/z [M + H]⁺ calcd for C₂₂H₁₈NO₃SSe: 456.0167; found: 456.0164.

2-(((3-nitrophenyl)selanyl)-1-phenyl-2-tosylethan-1-one (4n)



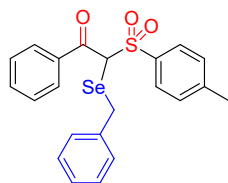
White solid, (87.4 mg, 89%), Mp: 147-149 °C; ^1H NMR (600 MHz, CDCl_3) δ 8.26 (t, $J = 1.8$ Hz, 1H), 8.20 (d, $J = 8.4$ Hz, 1H), 7.98 (d, $J = 7.2$ Hz, 1H), 7.84 (dd, $J = 16.2, 8.4$ Hz, 4H), 7.62 (t, $J = 7.8$ Hz, 1H), 7.49 – 7.44 (m, 3H), 7.32 (d, $J = 7.8$ Hz, 2H), 5.90 (s, 1H), 2.43 (s, 3H). ^{13}C NMR (151 MHz, CDCl_3) δ 189.1, 148.2, 146.1, 142.0, 134.9, 134.7, 133.5, 130.6, 130.4, 130.3, 130.0, 129.6, 129.1, 128.8, 124.6, 68.1, 21.9. HRMS (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{21}\text{H}_{18}\text{NO}_5\text{SSe}$: 476.0065; found: 476.0058.

2-(methylselanyl)-1-phenyl-2-tosylethan-1-one (4o)



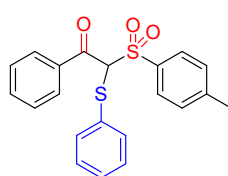
White solid, (55.3 mg, 75%), Mp: 118-119 °C; ^1H NMR (600 MHz, CDCl_3) δ 7.91 – 7.89 (m, 4H), 7.59 (t, $J = 7.8$ Hz, 1H), 7.45 (t, $J = 7.8$ Hz, 2H), 7.32 (d, $J = 8.4$ Hz, 2H), 5.63 (s, 1H), 2.43 (s, 3H), 2.16 (s, 3H). ^{13}C NMR (151 MHz, CDCl_3) δ 188.8, 145.5, 135.1, 134.2, 134.1, 130.5, 129.5, 130.0, 128.8, 61.8, 21.9, 7.2. HRMS (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{16}\text{H}_{17}\text{O}_3\text{SSe}$: 369.0058; found: 369.0061.

2-(benzylselanyl)-1-phenyl-2-tosylethan-1-one (4p)

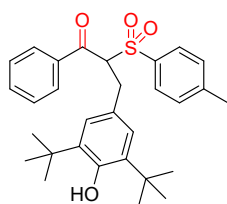


White solid, (69.0 mg, 78%), Mp: 127-128 °C; ^1H NMR (600 MHz, CDCl_3) δ 7.90 (d, $J = 8.4$ Hz, 2H), 7.48 (t, $J = 7.2$ Hz, 1H), 7.39 - 7.36 (m, 7.1 Hz, 4H), 7.34 - 7.30 (m, 5H), 7.25 (t, $J = 7.8$ Hz, 2H), 5.47 (s, 1H), 4.40 (d, $J = 11.4$ Hz, 1H), 3.96 (d, $J = 11.4$ Hz, 1H), 2.42 (s, 3H). ^{13}C NMR (151 MHz, CDCl_3) δ 189.64, 145.5, 136.8, 134.8, 134.1, 134.0, 130.8, 130.0, 129.3, 129.1, 128.7, 128.6, 127.8, 61.8, 30.9, 21.9. HRMS (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{22}\text{H}_{21}\text{O}_3\text{SSe}$: 445.0371; found: 445.0369.

1-phenyl-2-(phenylthio)-2-tosylethan-1-one (4q)³



White solid, (72.6 mg, 95%), m.p.: 85-87 °C; ^1H NMR (600 MHz, CDCl_3) δ 7.88 (t, $J = 8.4$ Hz, 4H), 7.61 (t, $J = 7.2$ Hz, 1H), 7.53 (d, $J = 6.6$ Hz, 2H), 7.46 (t, $J = 7.8$ Hz, 2H), 7.36 – 7.30 (m, 5H), 5.80 (s, 1H), 2.45 (s, 3H). ^{13}C NMR (151 MHz, CDCl_3) δ 189.6, 145.8, 135.3, 134.4, 133.6, 133.3, 132.4, 130.9, 129.6, 126.5, 129.4, 129.3, 129.0, 77.4, 77.2, 77.0, 75.7, 21.9.

3-(3,5-di-tert-butyl-4-hydroxyphenyl)-1-phenyl-2-tosylpropan-1-one (5a)

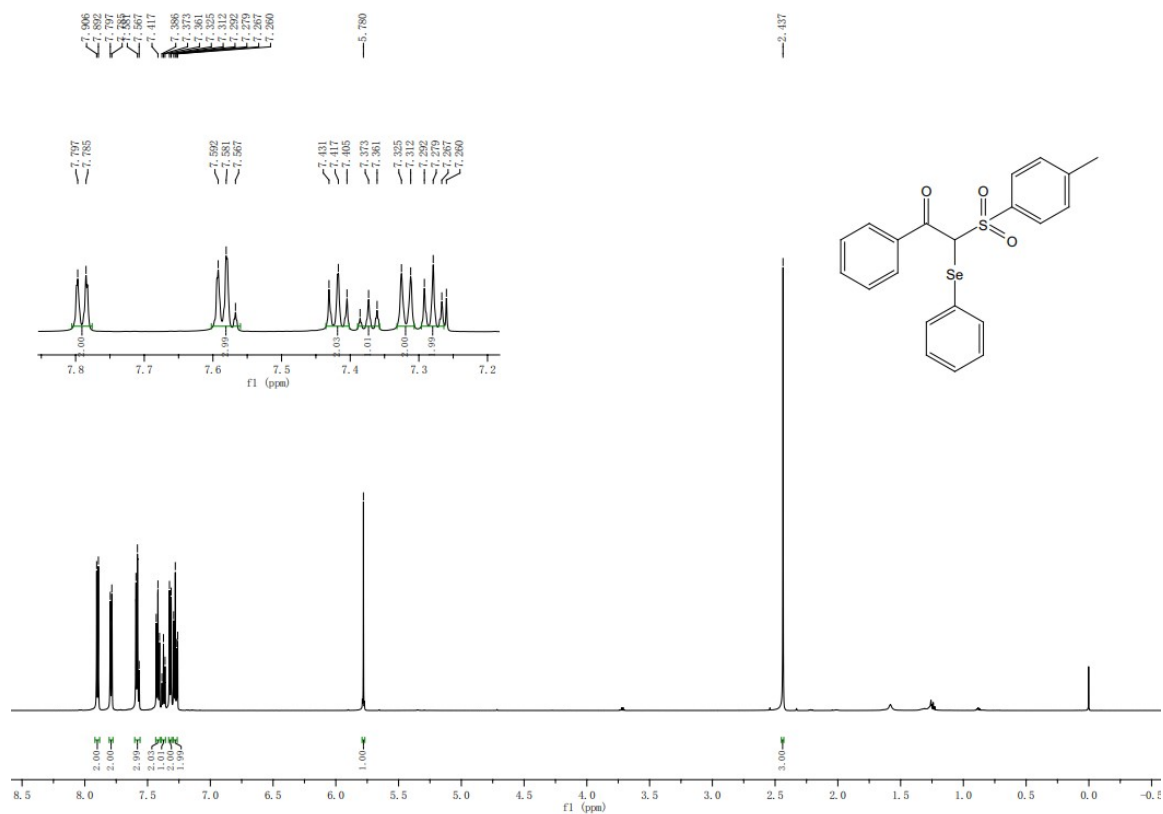
White solid, Mp: 166-167 °C; $^1\text{H NMR}$ (600 MHz, CDCl_3) δ 7.74 (d, $J = 8.4$ Hz, 2H), 7.68 (dd, $J = 8.4, 0.6$ Hz, 2H), 7.48 (t, $J = 7.2$ Hz, 1H), 7.35 – 7.32 (m, 4H), 6.78 (s, 2H), 5.28 (dd, $J = 12.0, 3.0$ Hz, 1H), 4.98 (s, 1H), 3.43 (dd, $J = 13.2, 3.0$ Hz, 1H), 3.24 (dd, $J = 13.2, 12.0$ Hz, 1H), 2.45 (s, 3H), 1.25 (s, 18H). $^{13}\text{C NMR}$ (151 MHz, CDCl_3) δ 193.5, 152.8, 145.5, 137.6, 136.3, 133.9, 133.7, 130.1, 129.7, 128.8, 128.6, 126.3, 125.4, 71.7, 34.8, 34.3, 30.2, 21.9. **HRMS** (+ESI-TOF): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{30}\text{H}_{36}\text{NaO}_4\text{S}$: 515.2227; found: 515.2224.

10. References

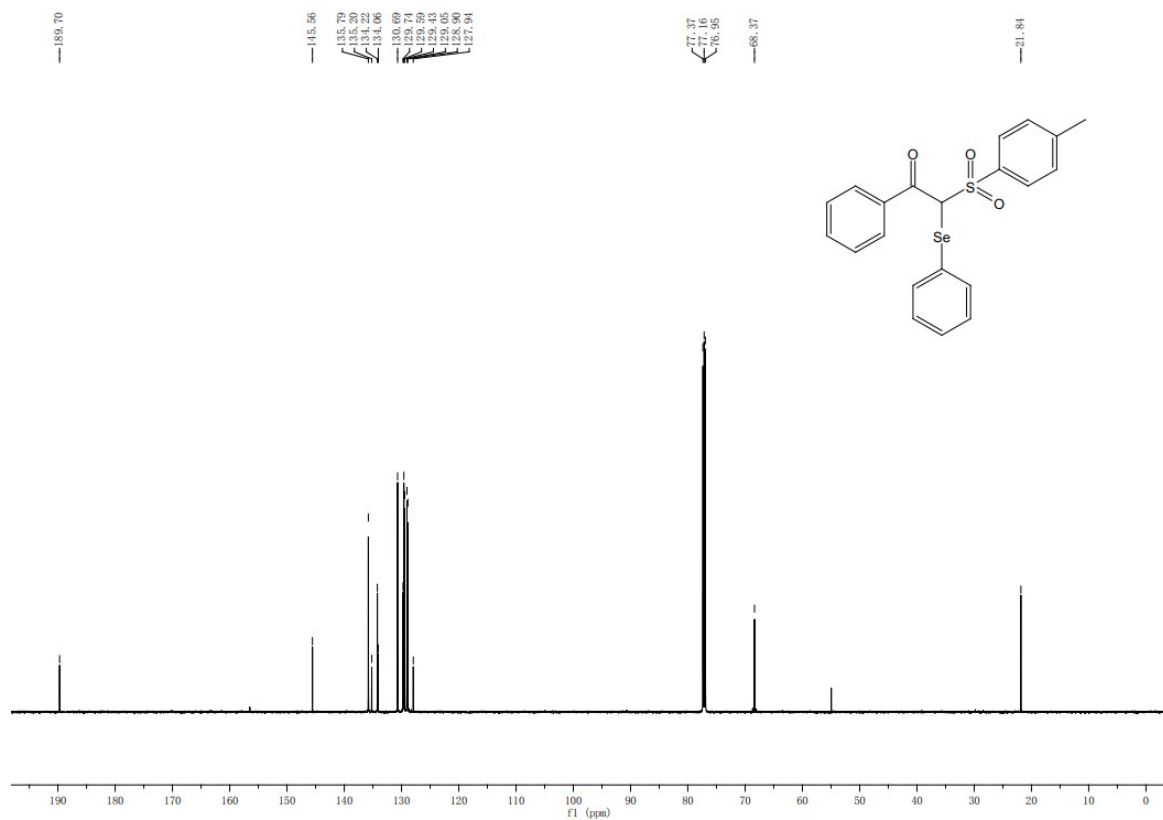
1. N. C. Hsueh, H. Y. Chen and M. Y. Chang, *J Org Chem.*, 2017, **82**, 13324-13332.
2. Y. T. Ma, C. Lin, X. B. Huang, M. C. Liu, Y. B. Zhou and H. Y. Wu, *Chem Commun.*, 2022, **58**, 6550-6553.
3. R. J. Reddy, J. J. Kumar and A. H. Kumari, *Eur J Org Chem.*, 2019, **2019**, 3771-3775.

11. Spectra Data

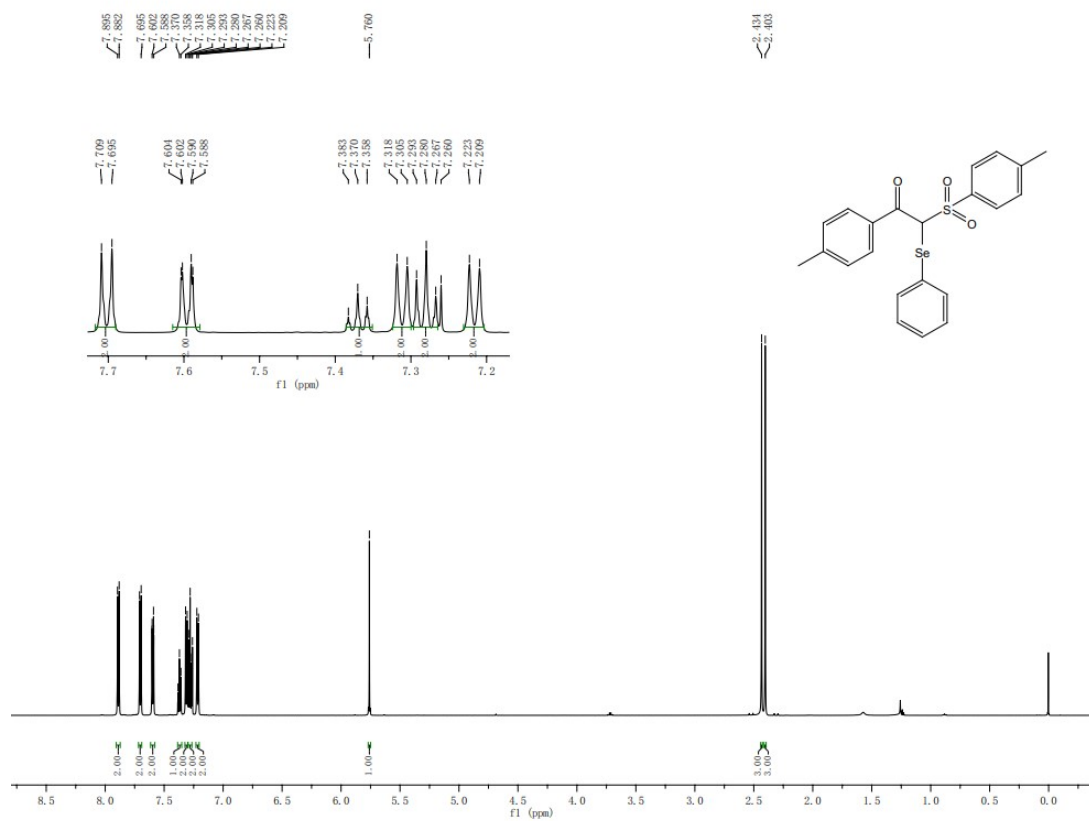
¹H NMR of **3a**



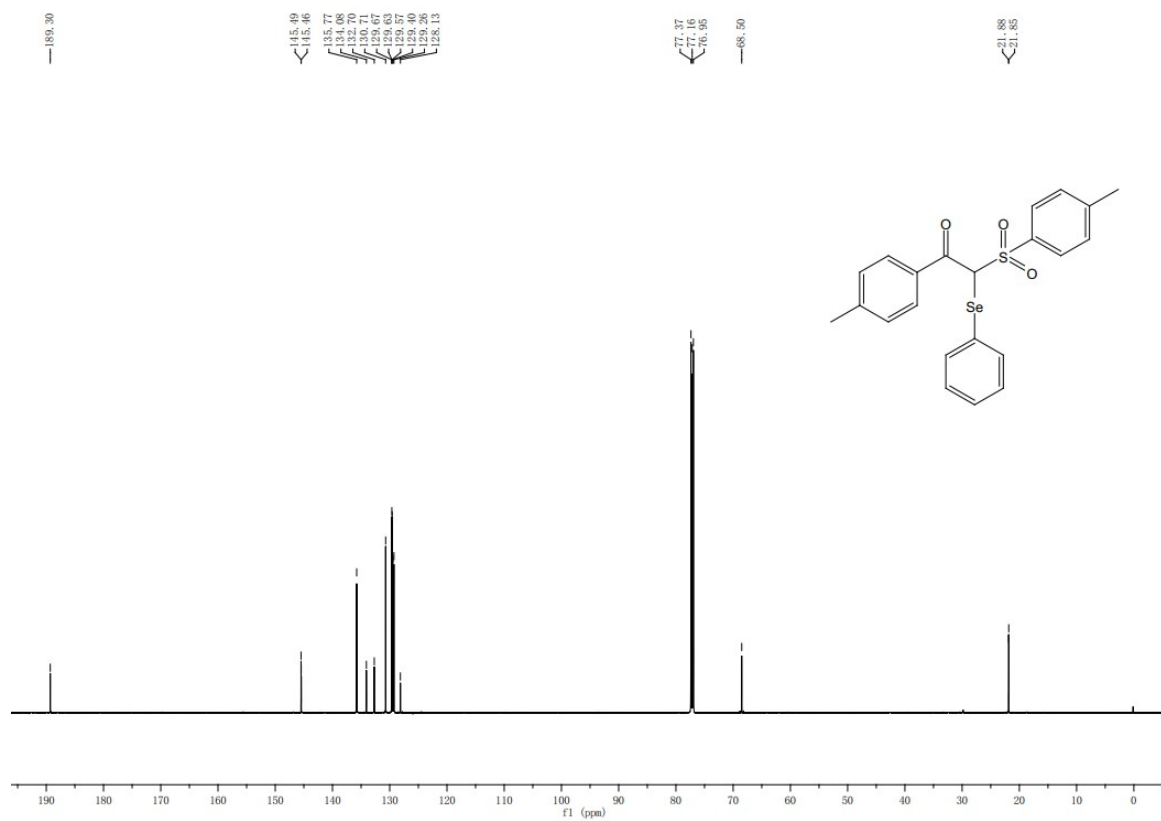
¹³C NMR of **3a**



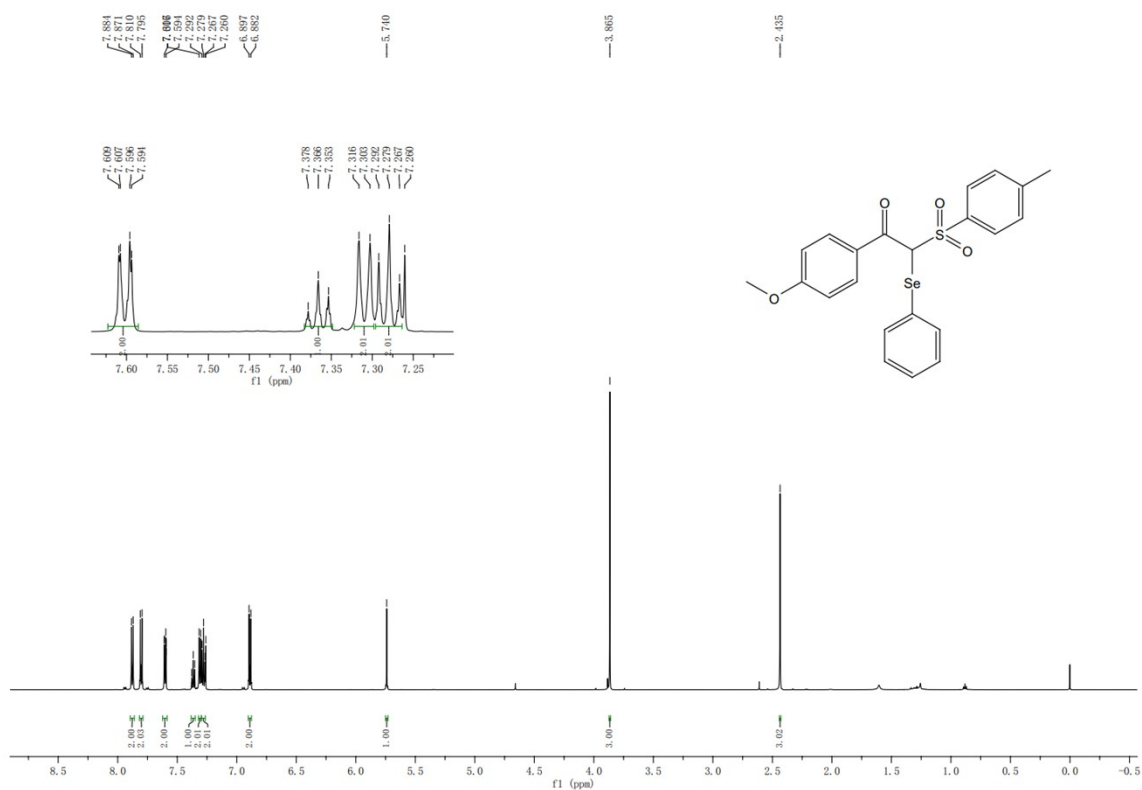
¹H NMR of **3b**



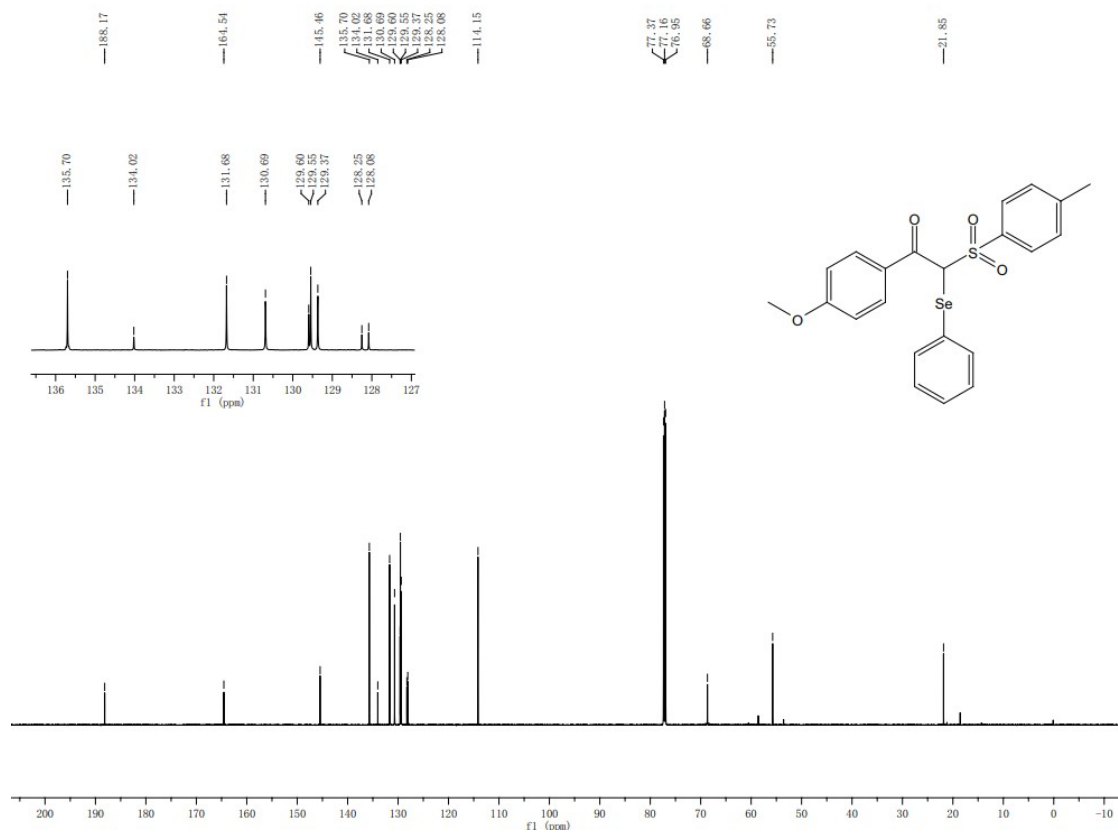
¹³C NMR of **3b**



¹H NMR of **3c**



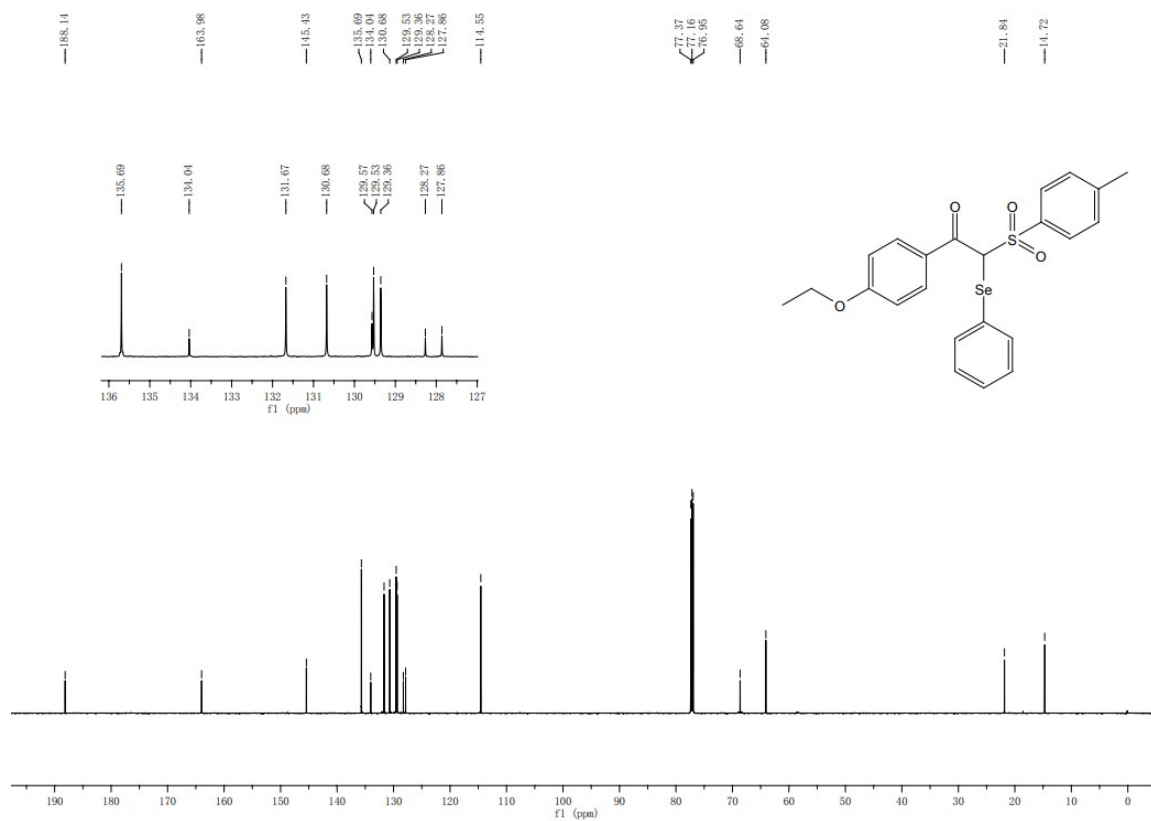
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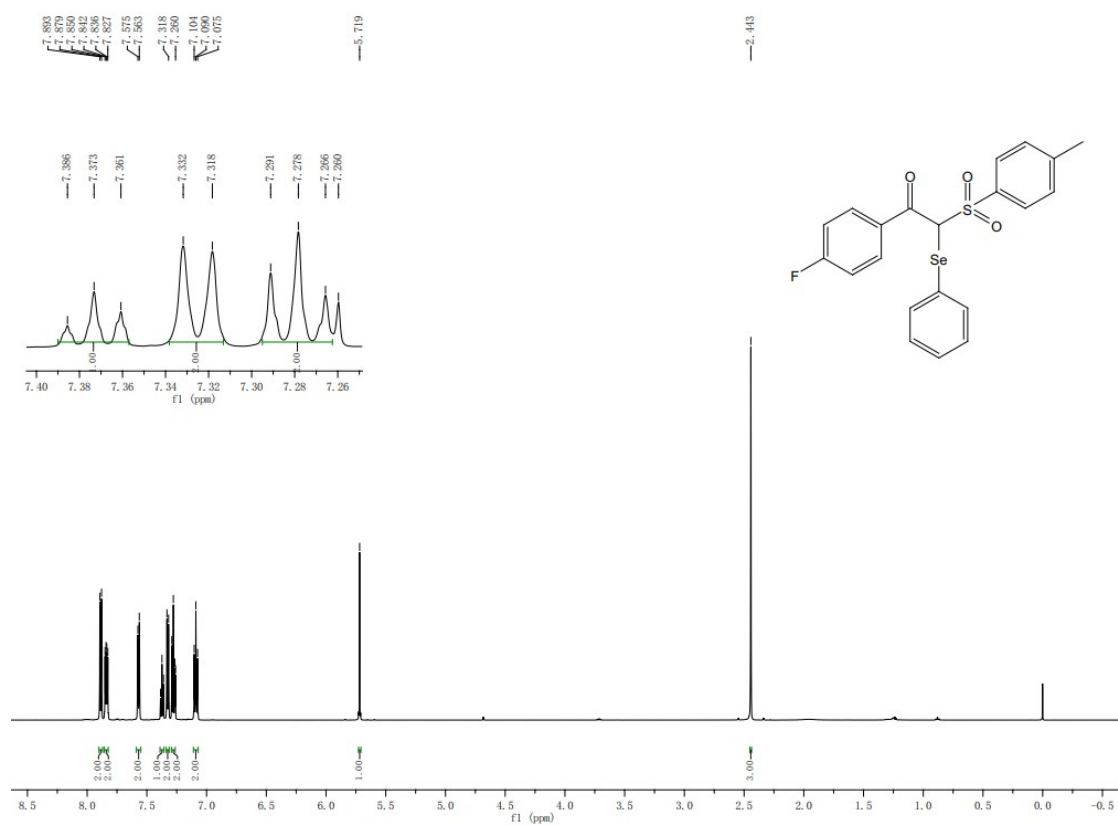
¹H NMR of 3d



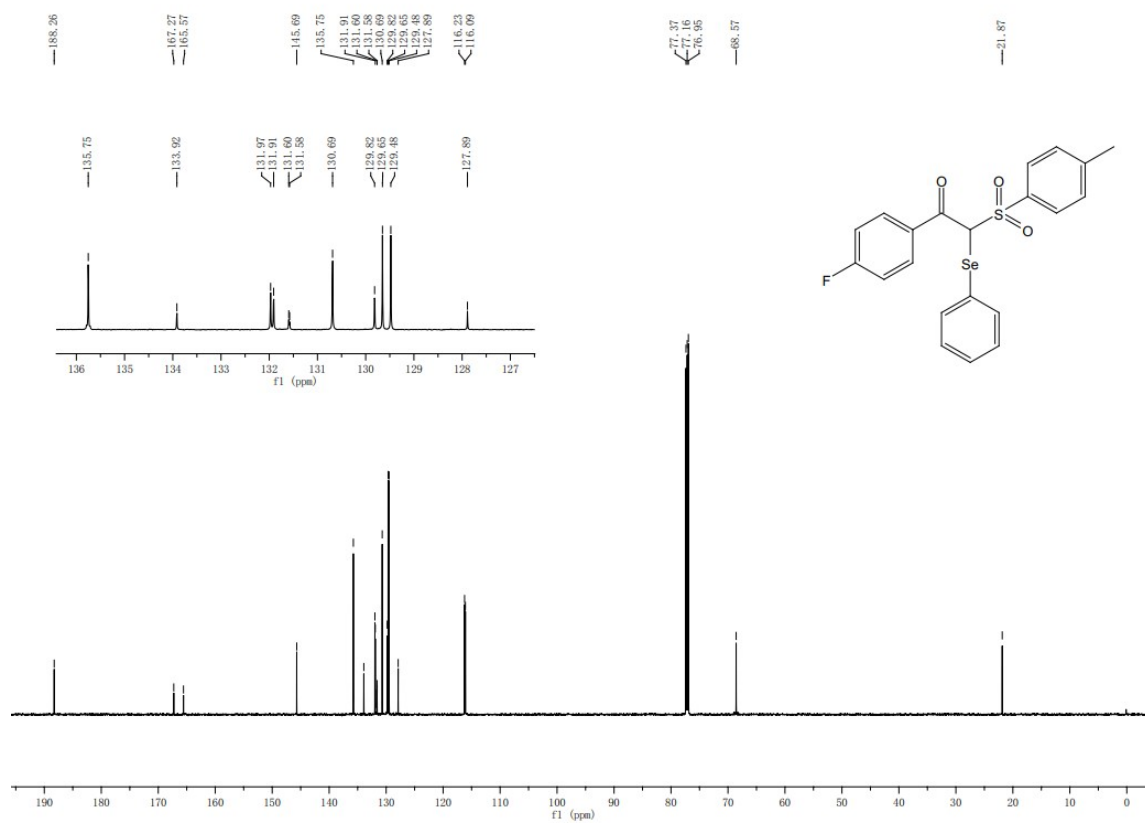
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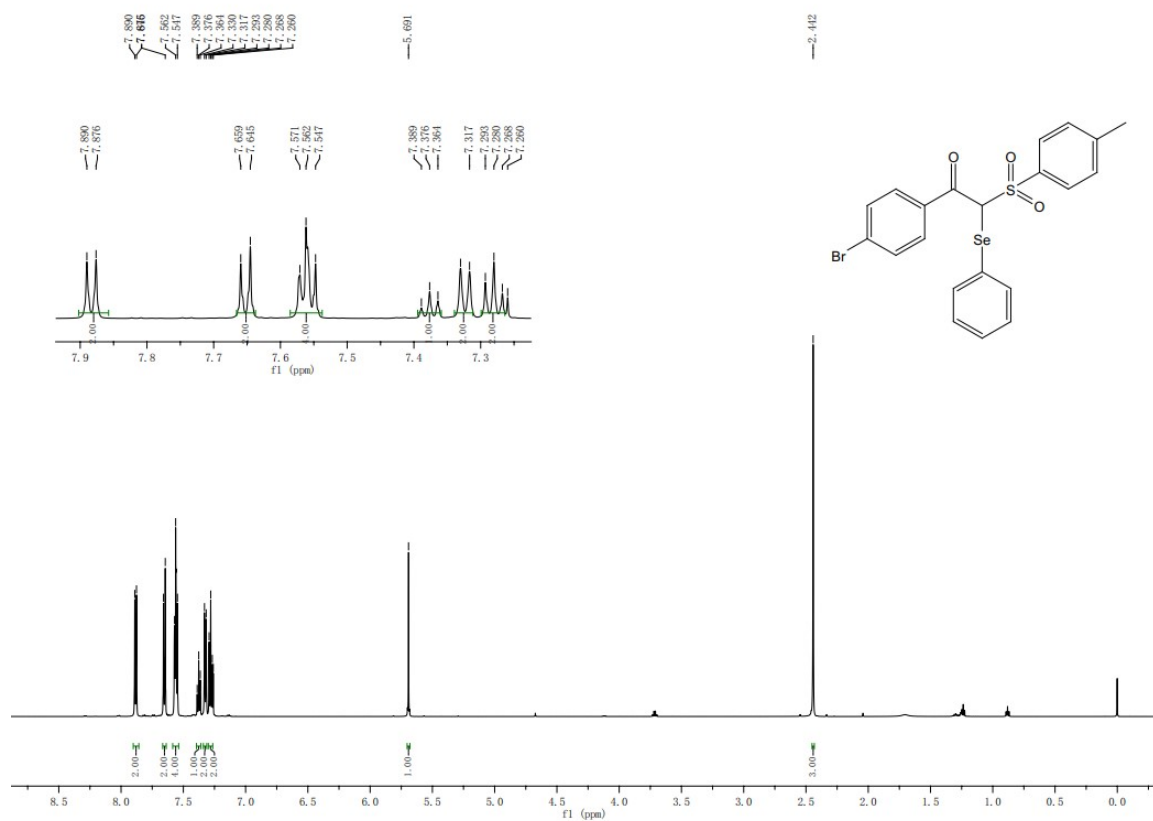
¹H NMR of 3e



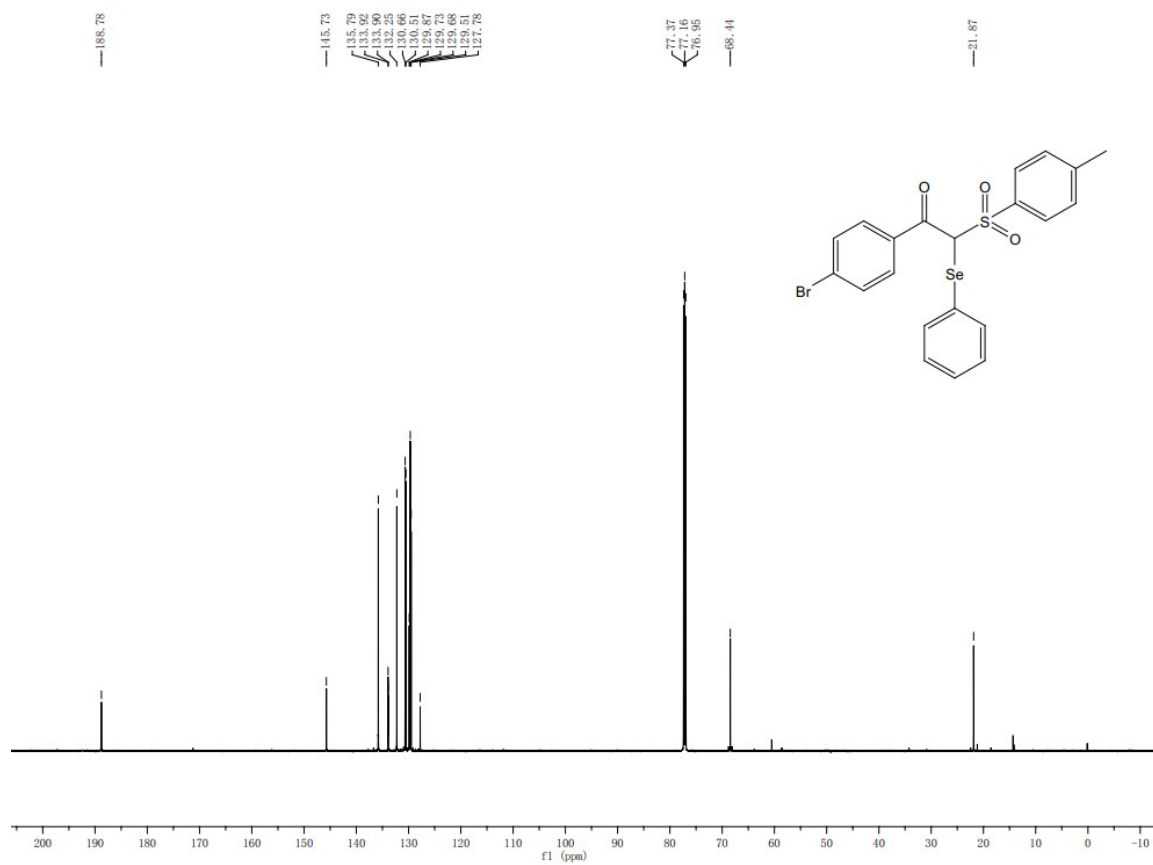
¹³C NMR of 3e



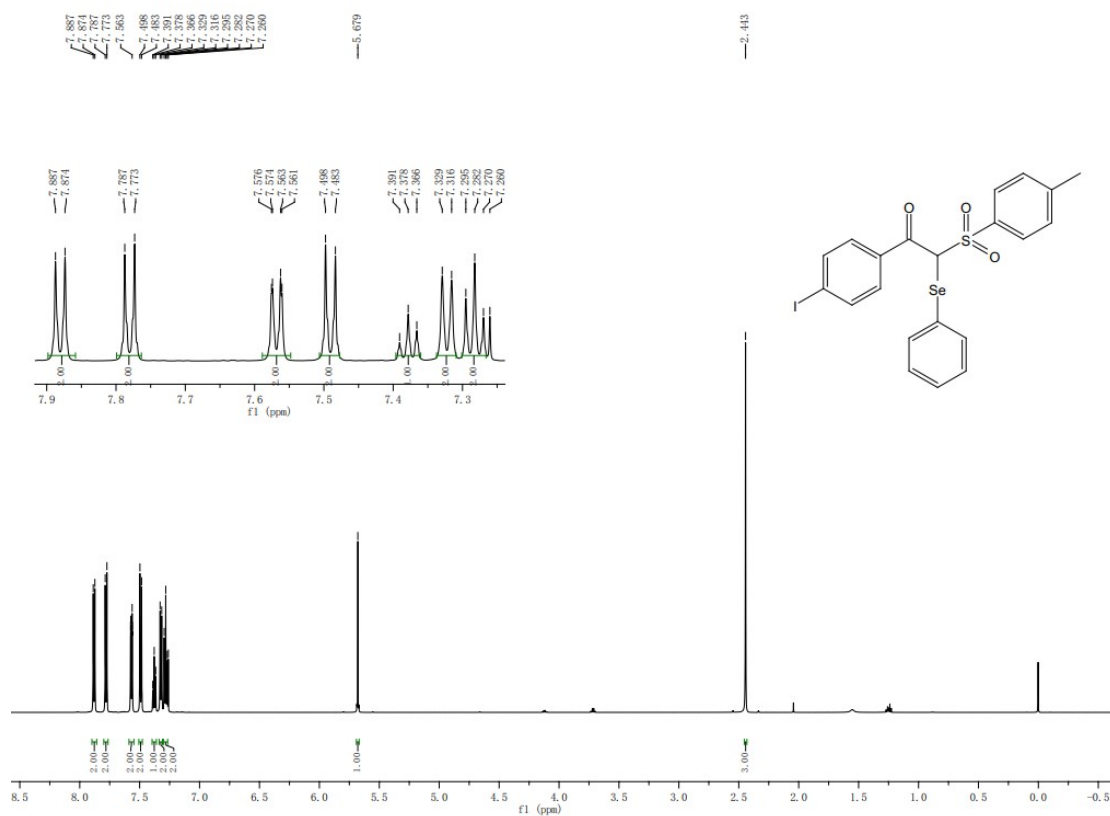
^1H NMR of **3f**



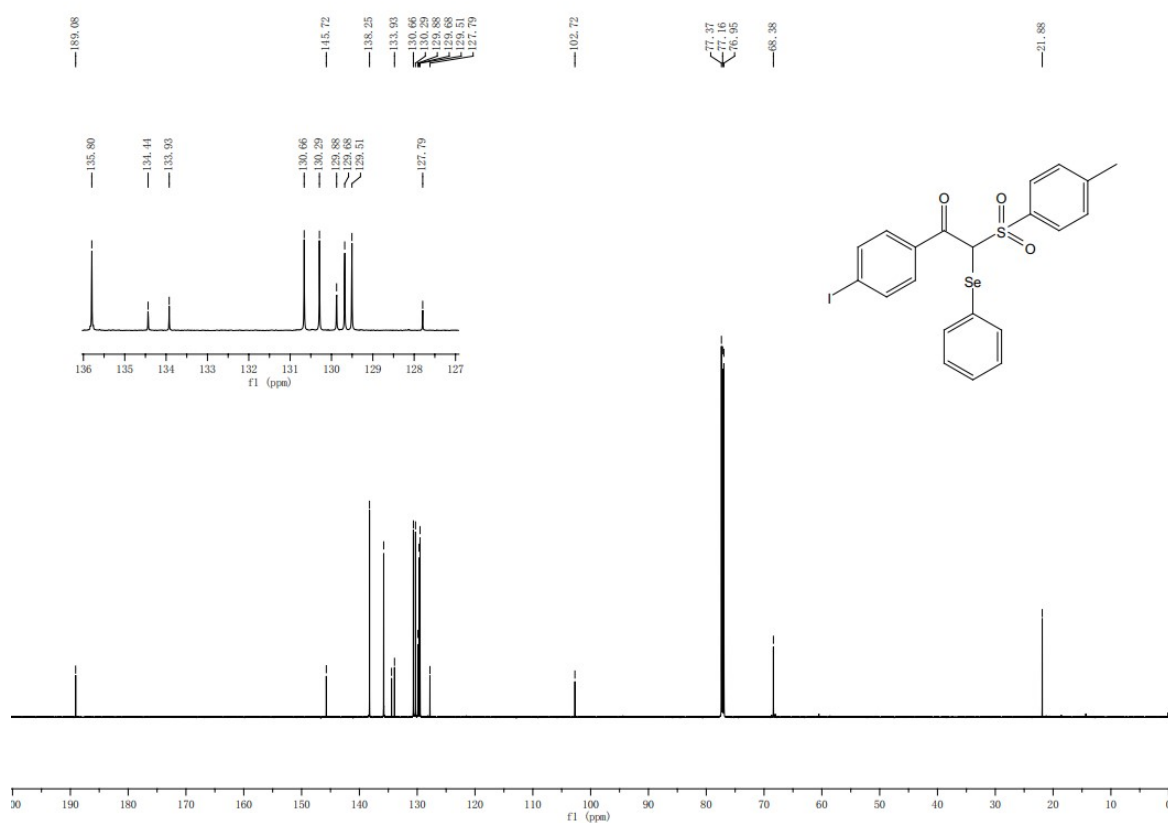
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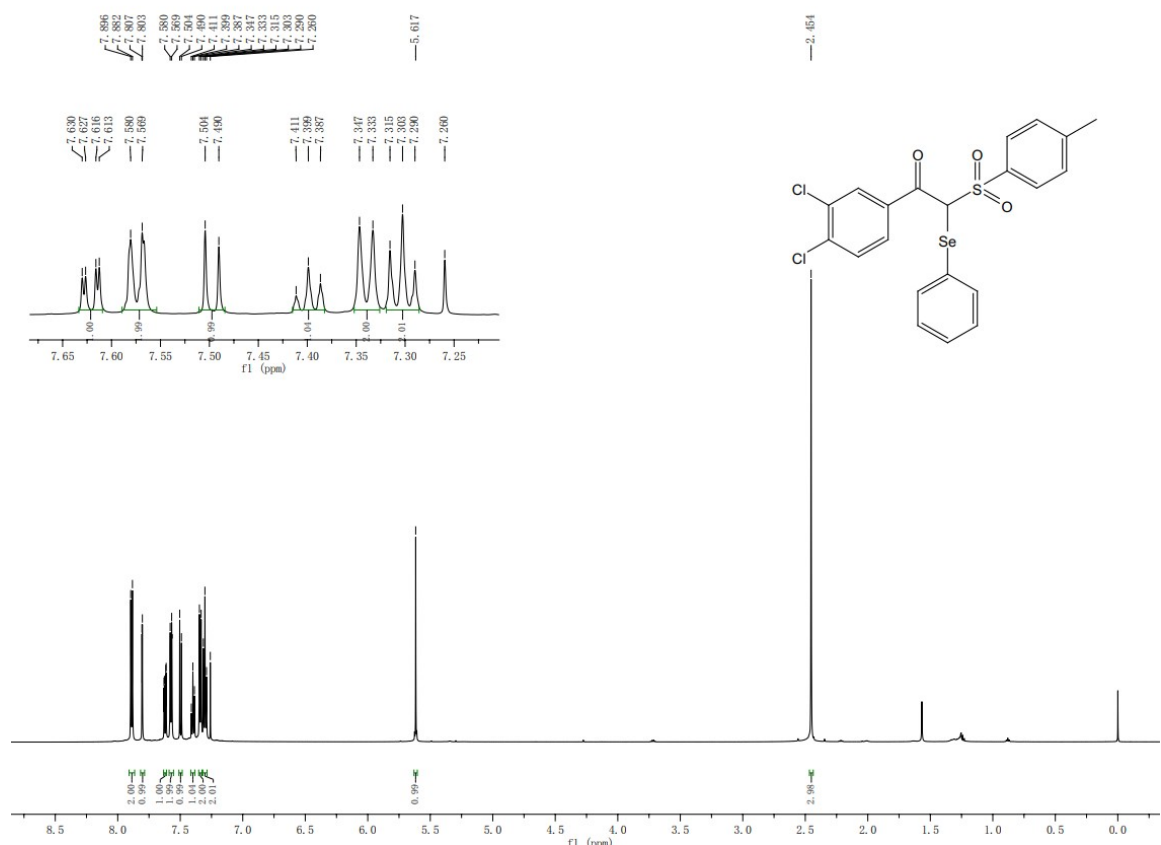
¹H NMR of 3g



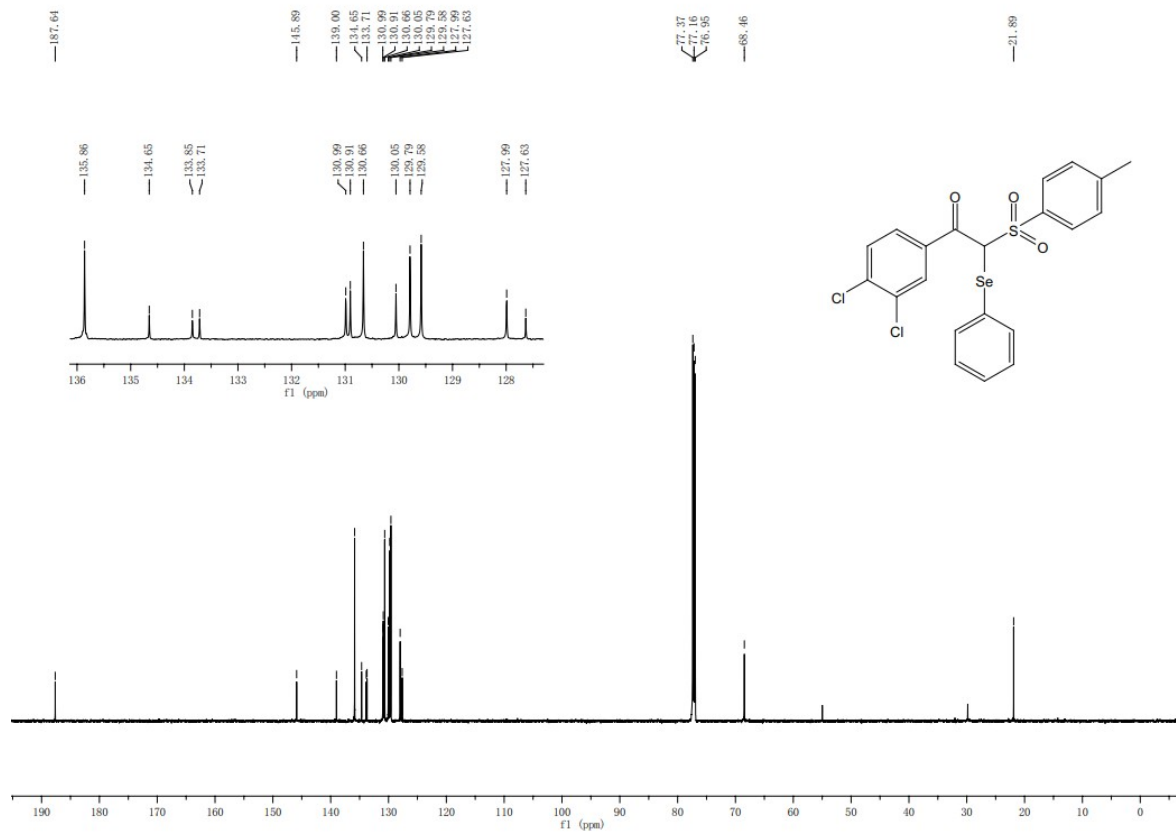
¹³C NMR of 3g



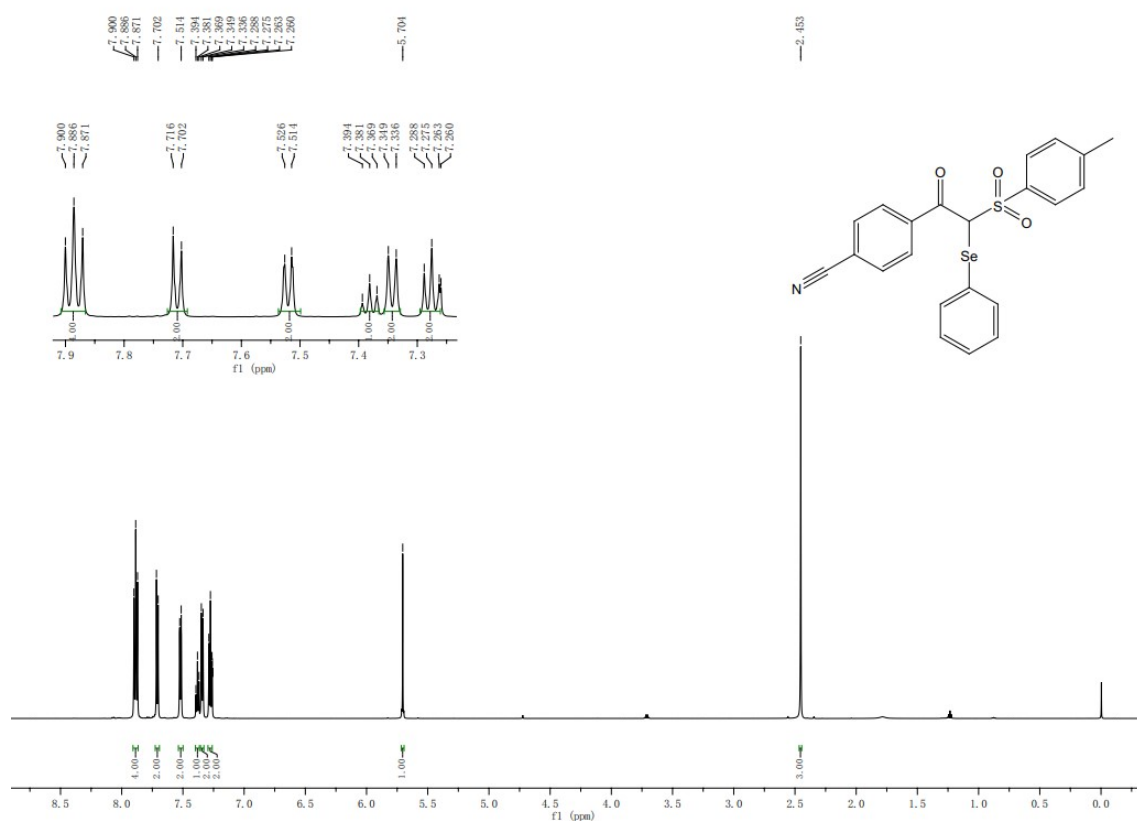
¹H NMR of 3h



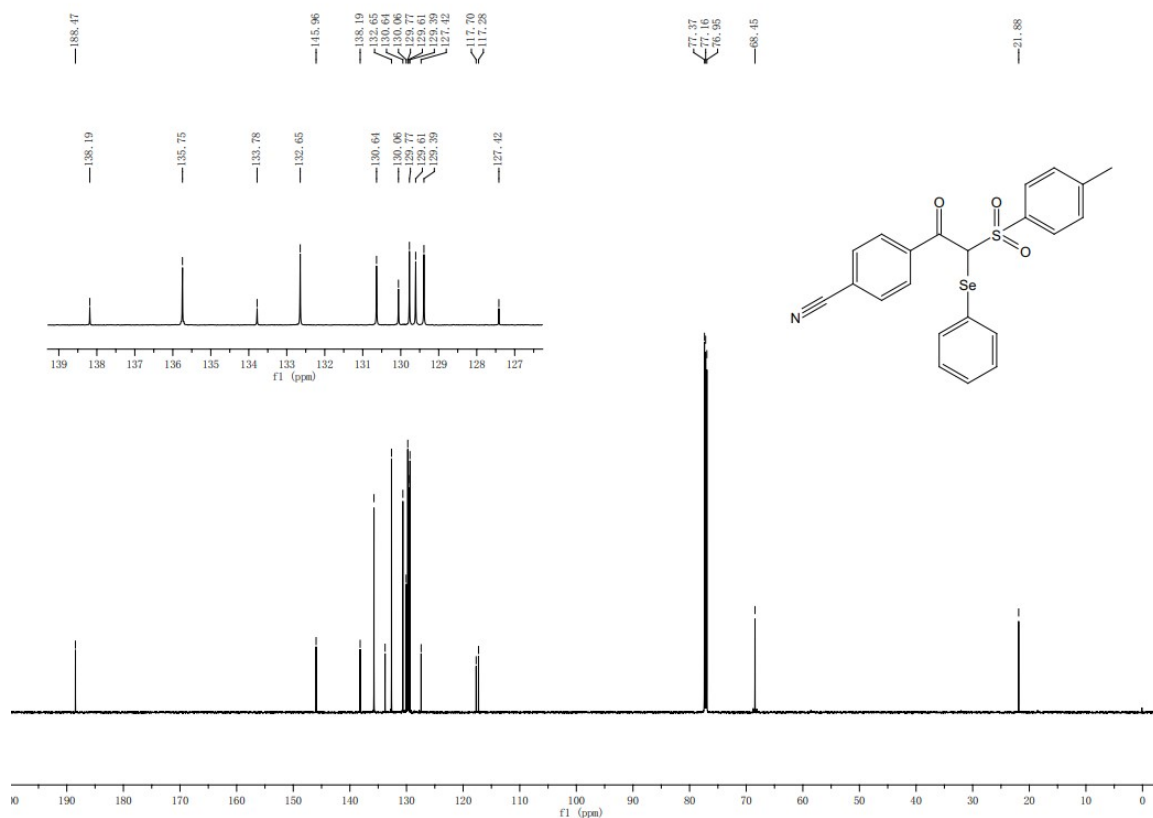
¹³C NMR of 3h



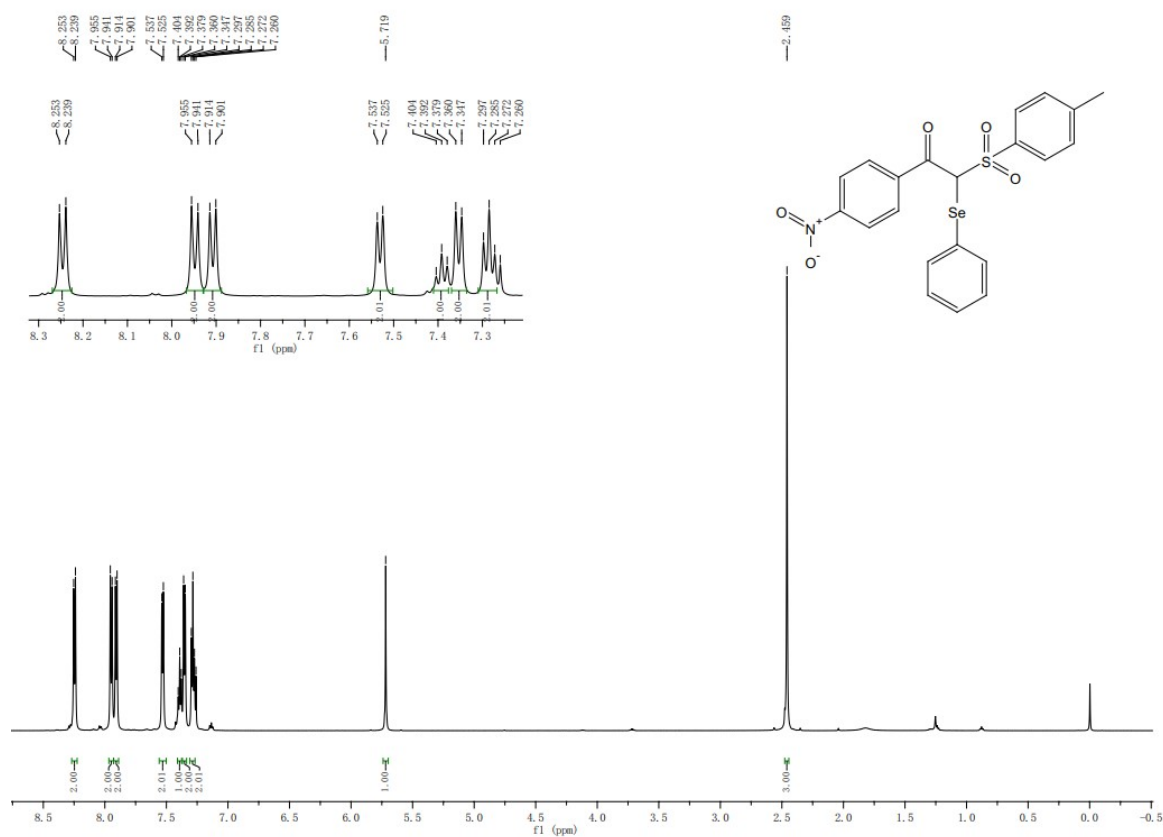
¹H NMR of **3i**



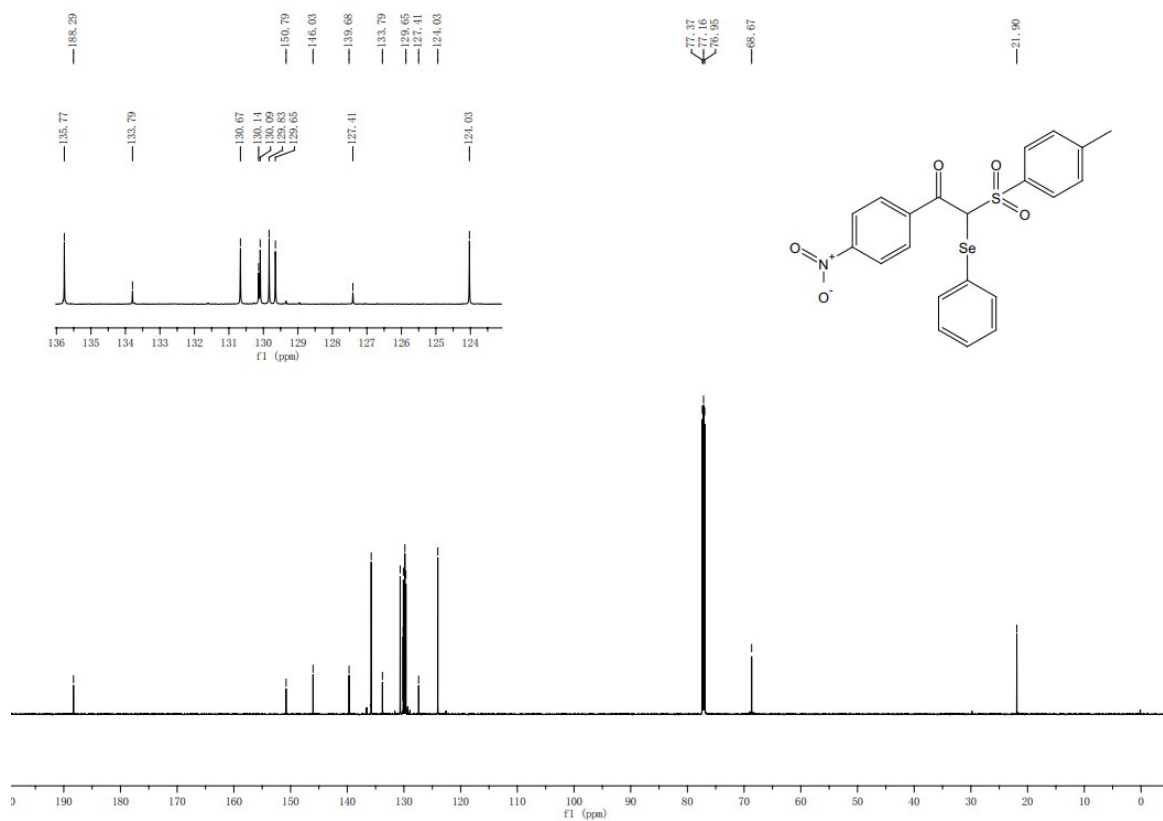
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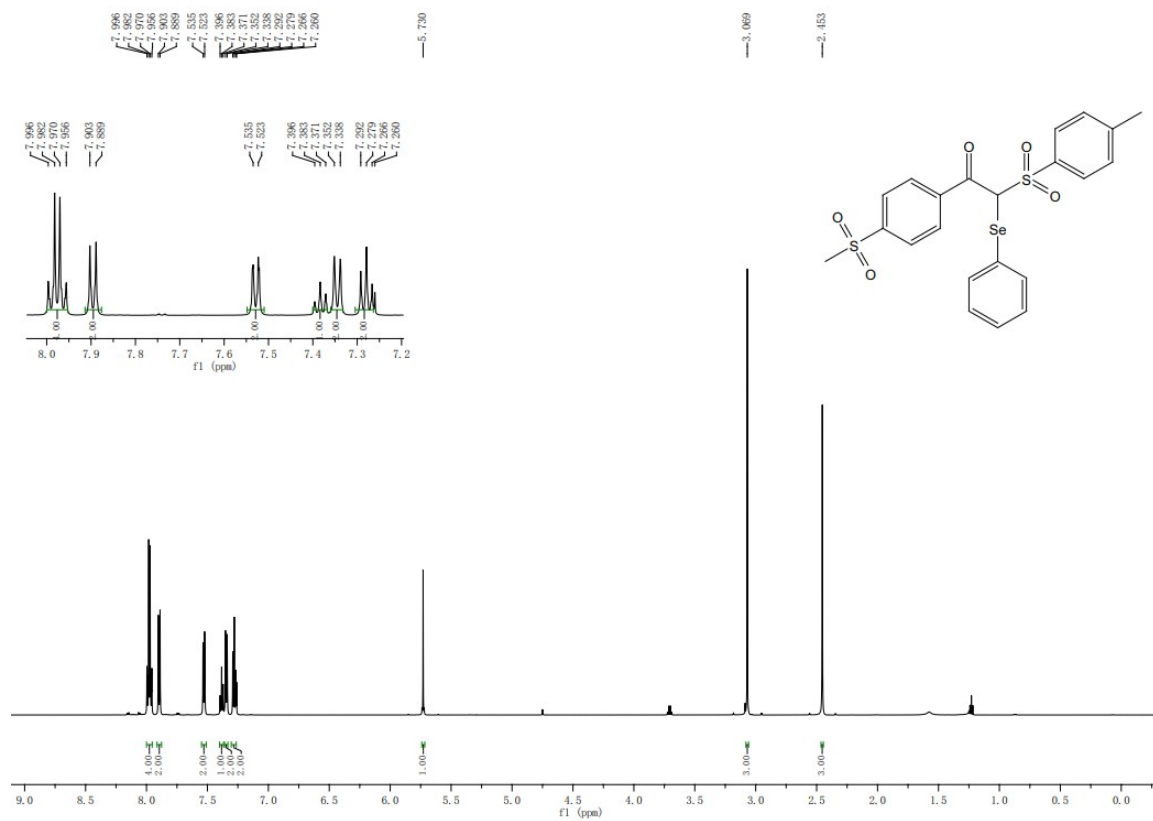
¹H NMR of 3j



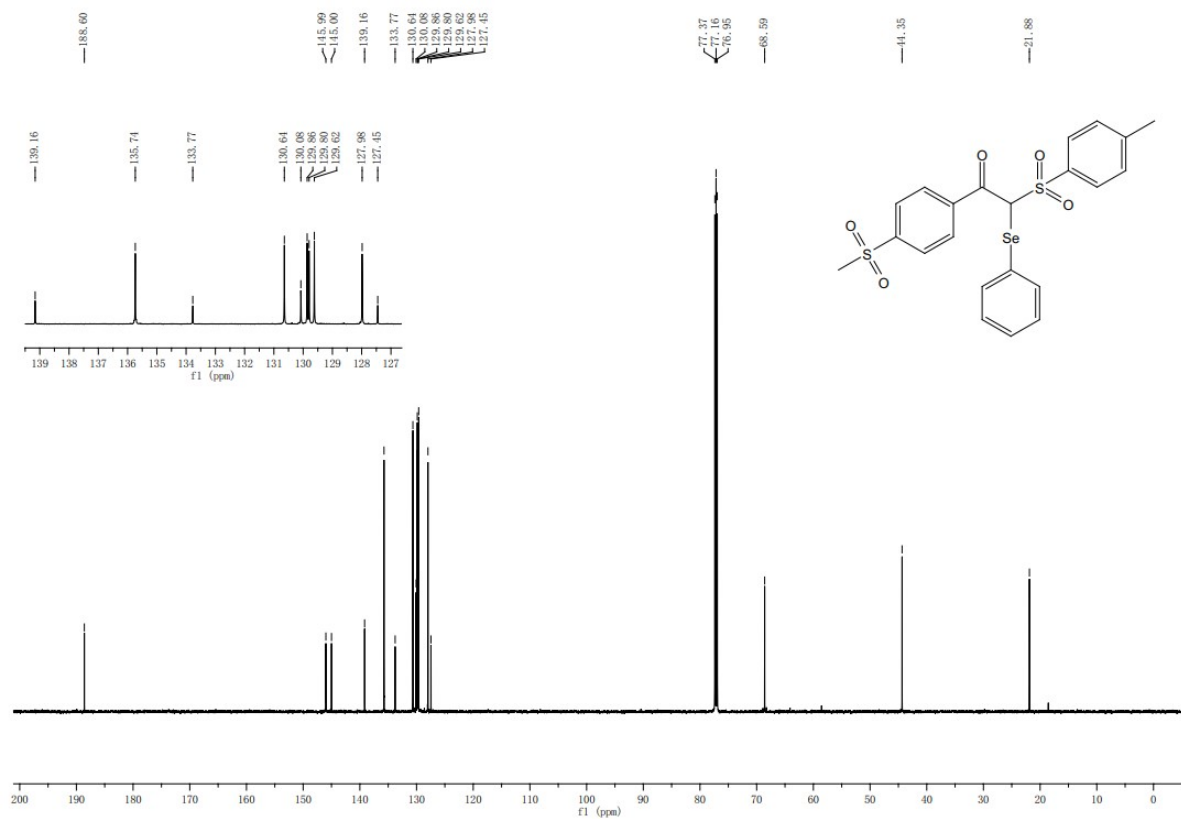
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¹H NMR of 3k



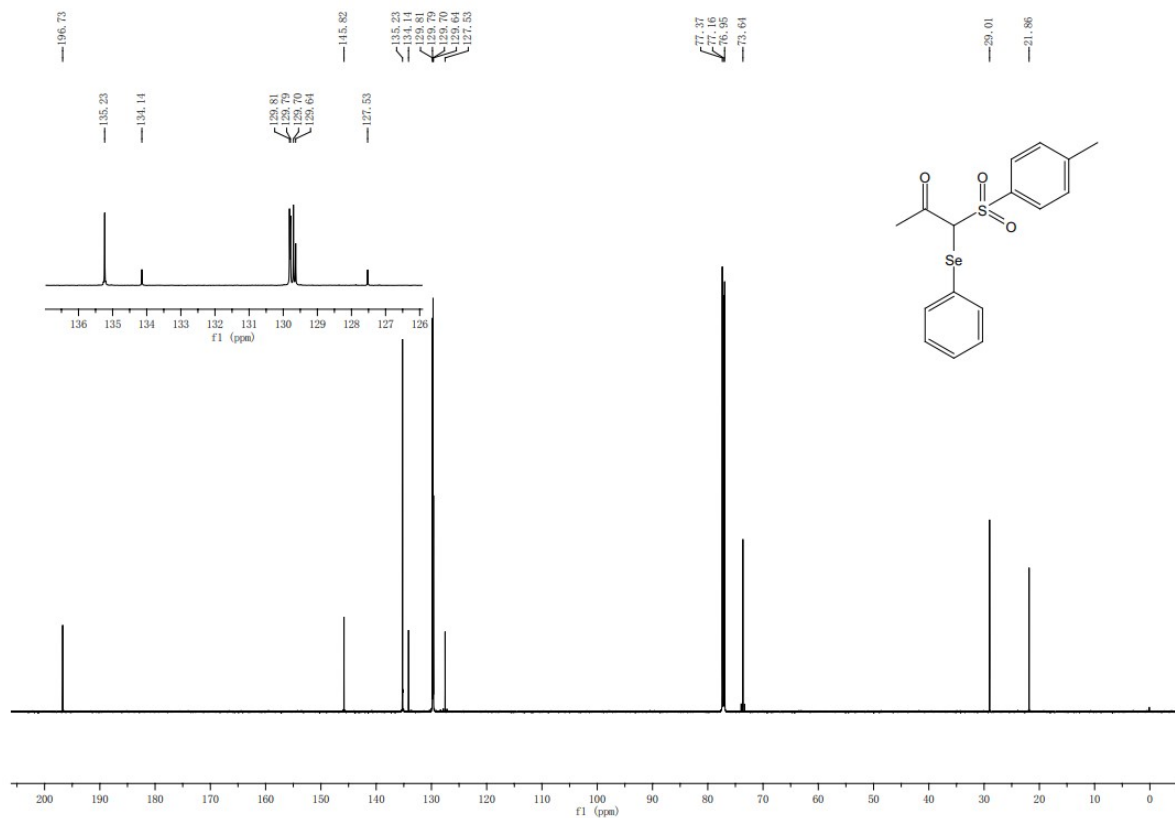
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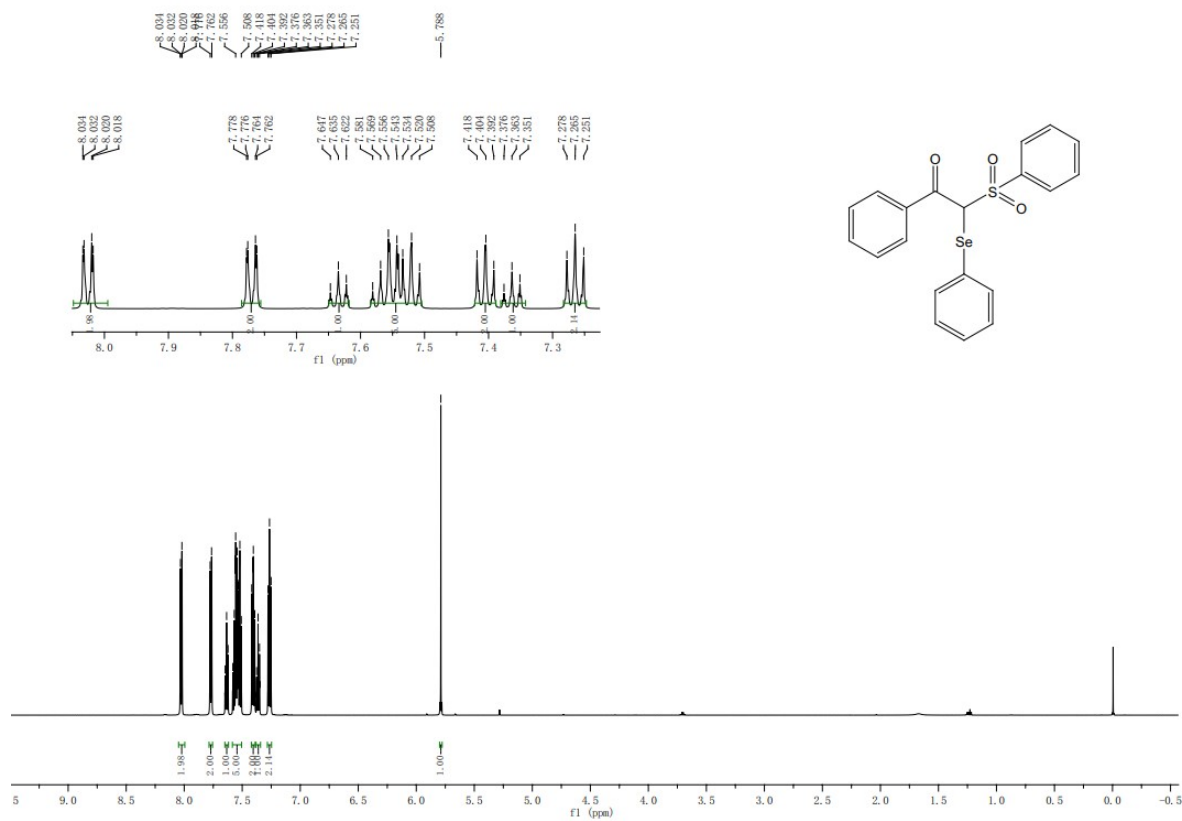
¹H NMR of **31**



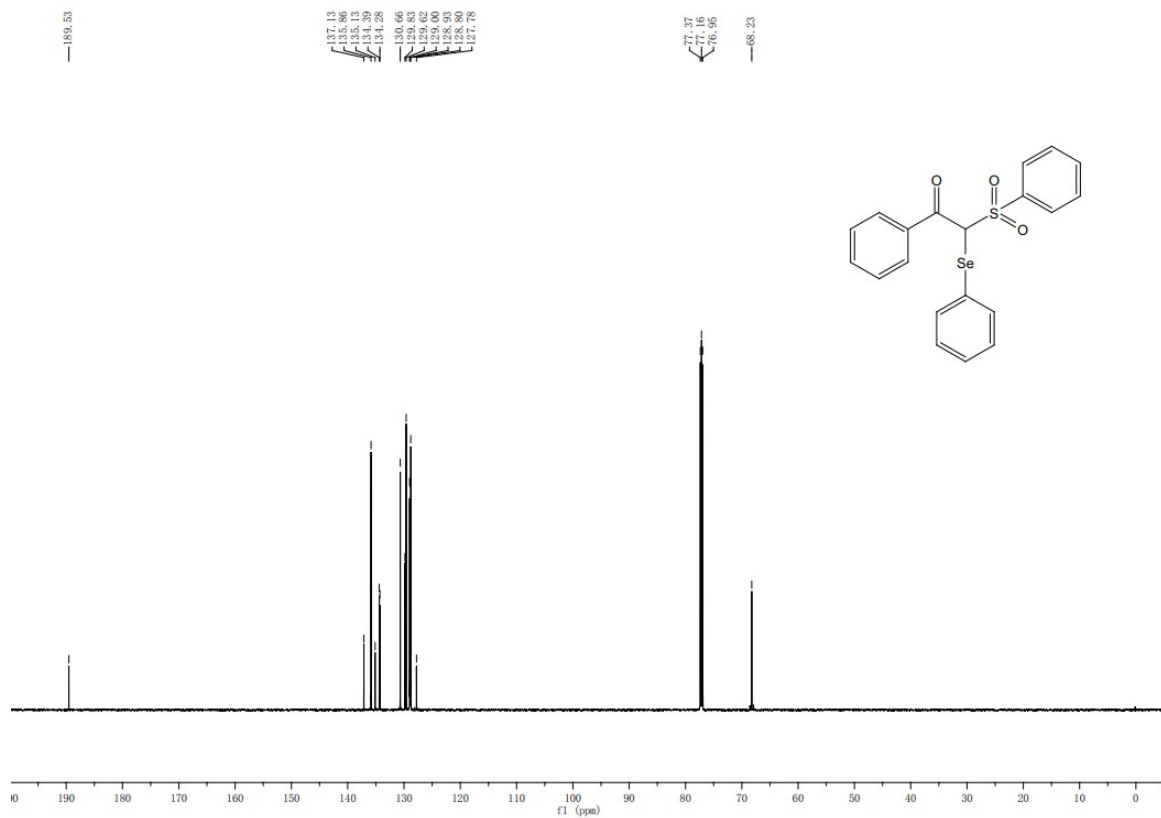
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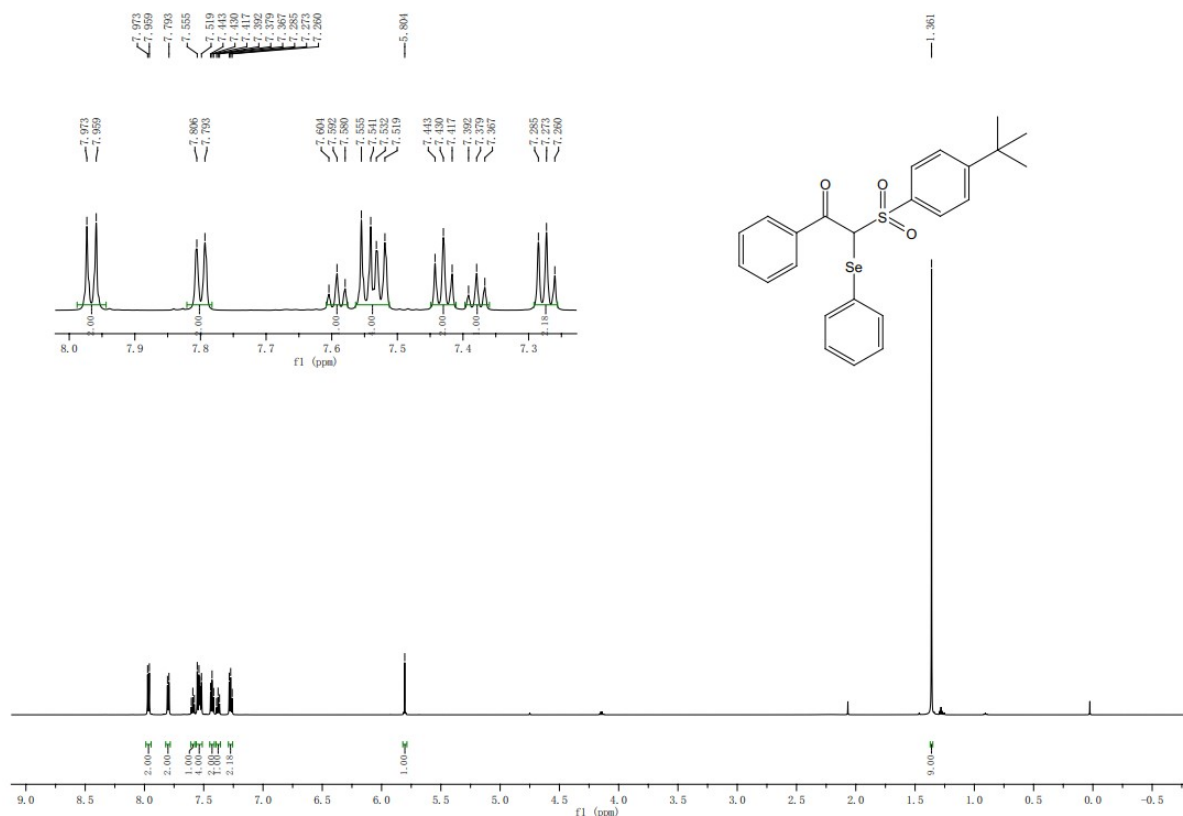
^1H NMR of **3m**



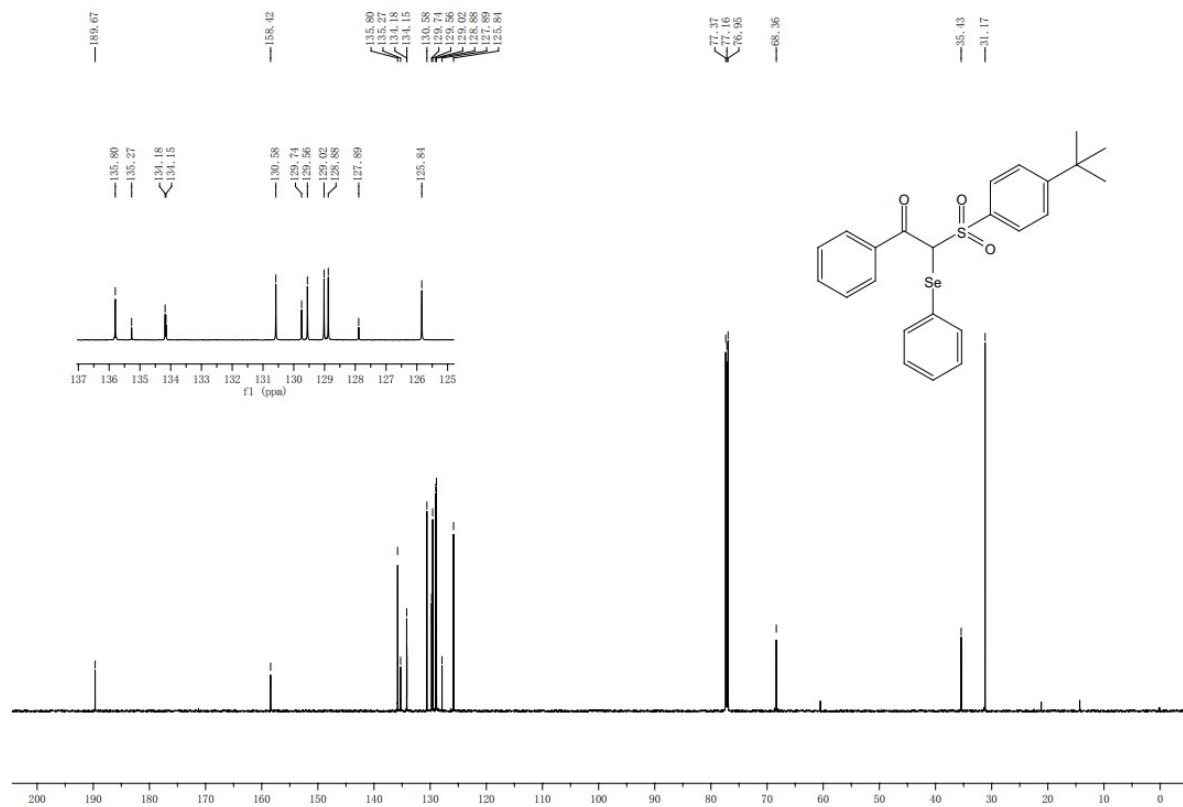
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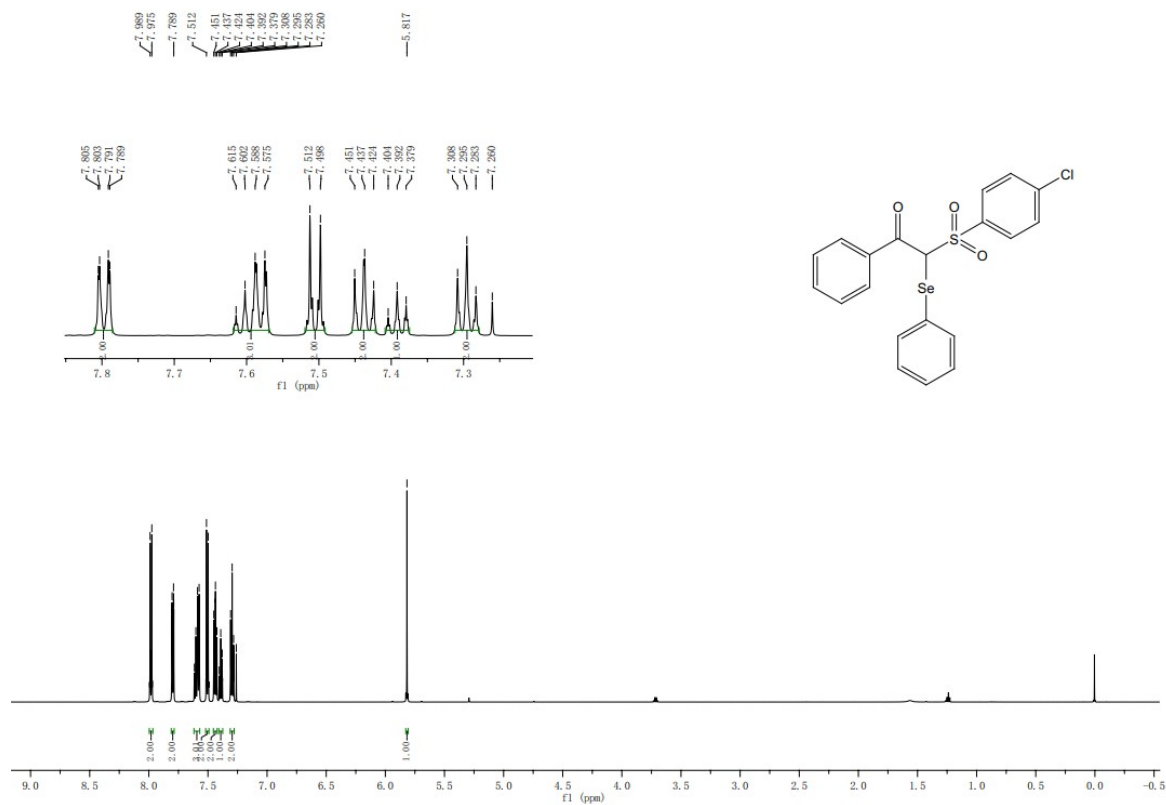
¹H NMR of 3n



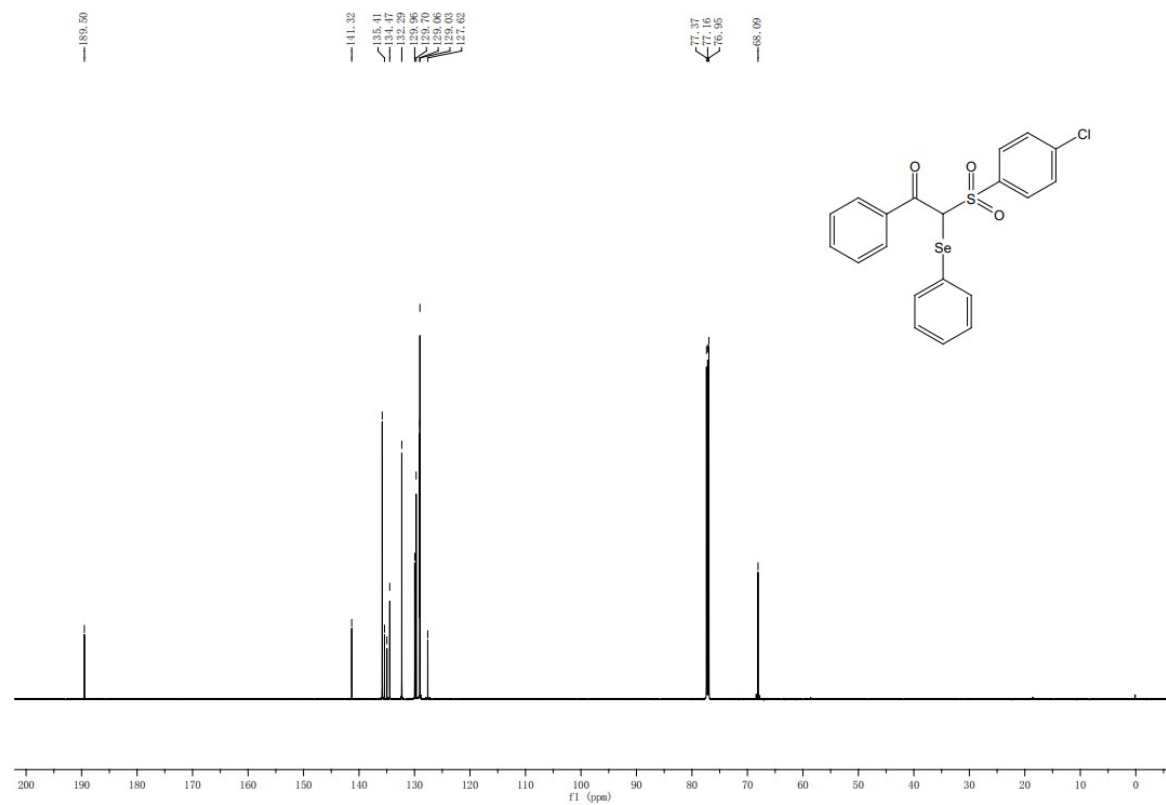
¹³C NMR of 3n



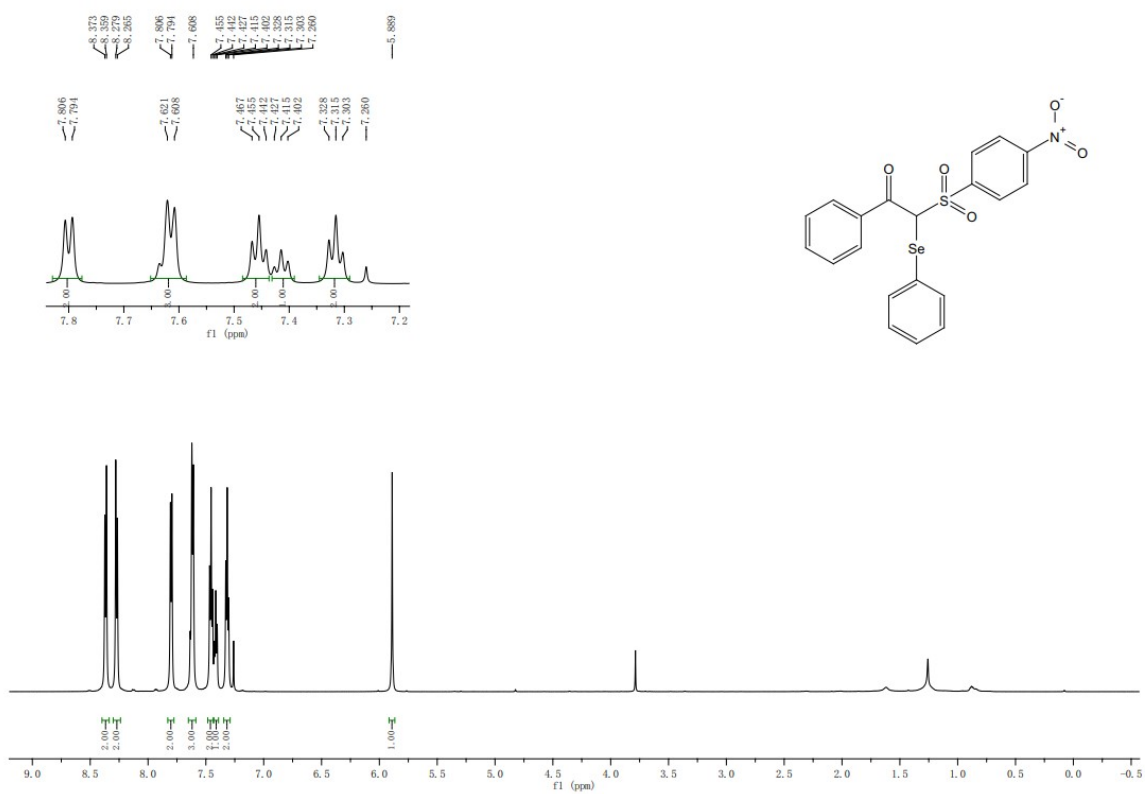
¹H NMR of 3p



¹³C NMR of 3p



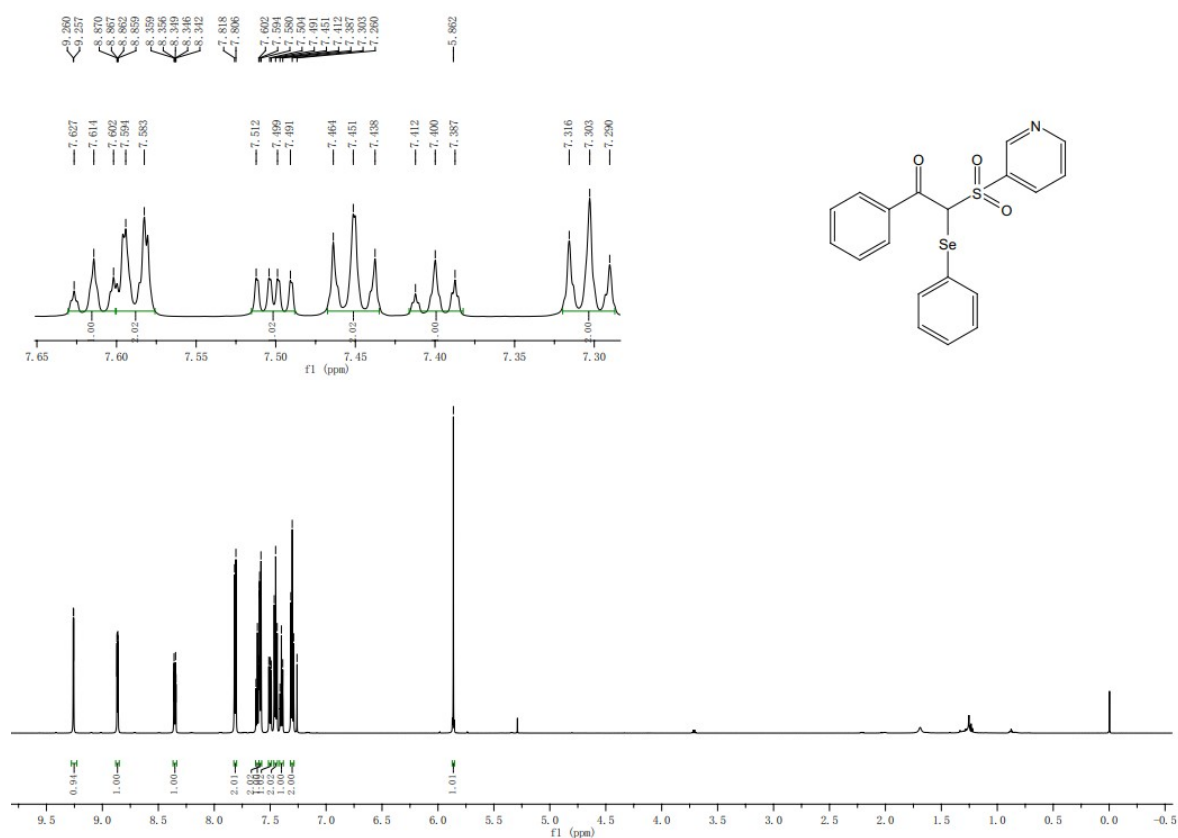
¹H NMR of 3q



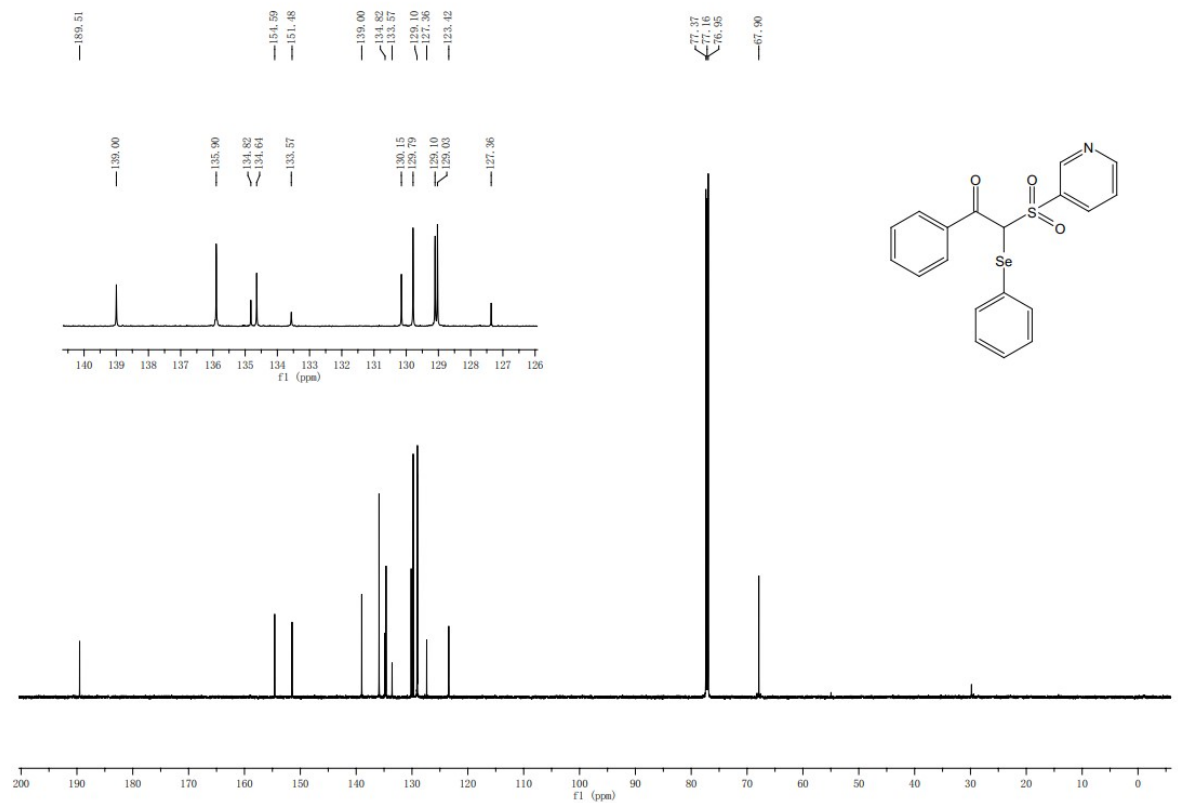
¹³C NMR of 3q



¹H NMR of **3r**

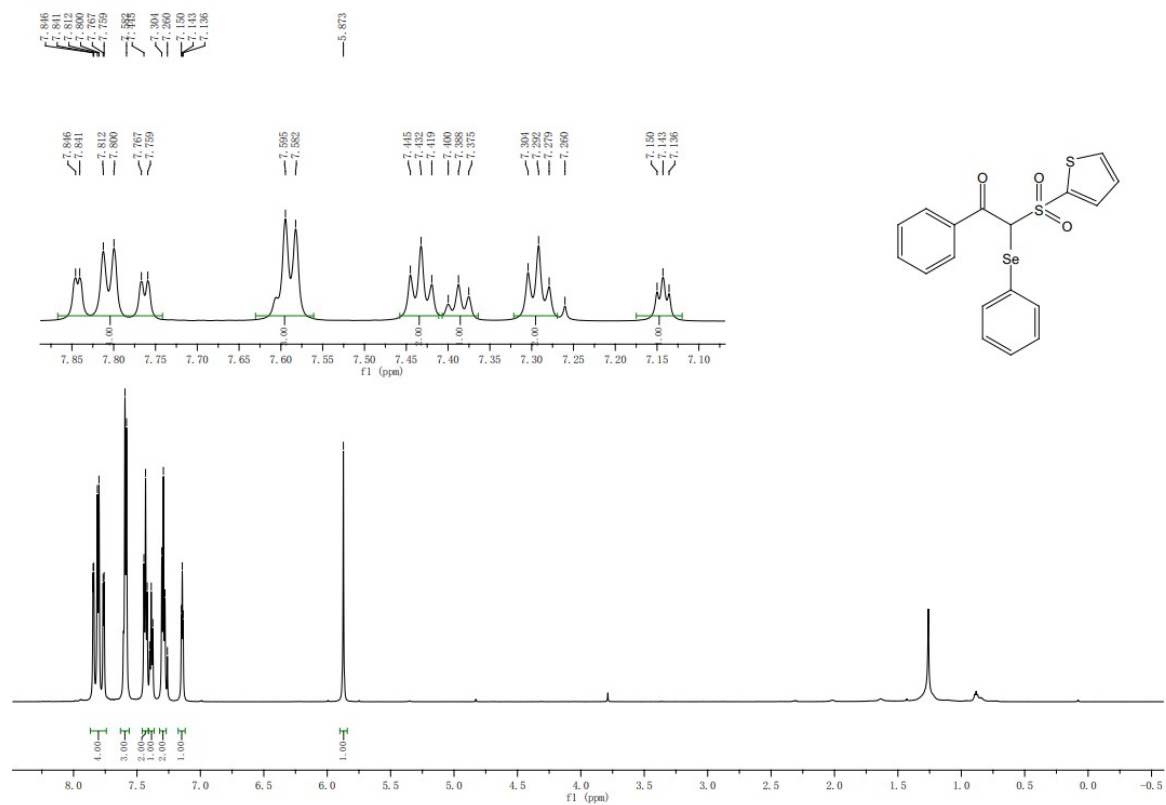


¹³C NMR of **3r**

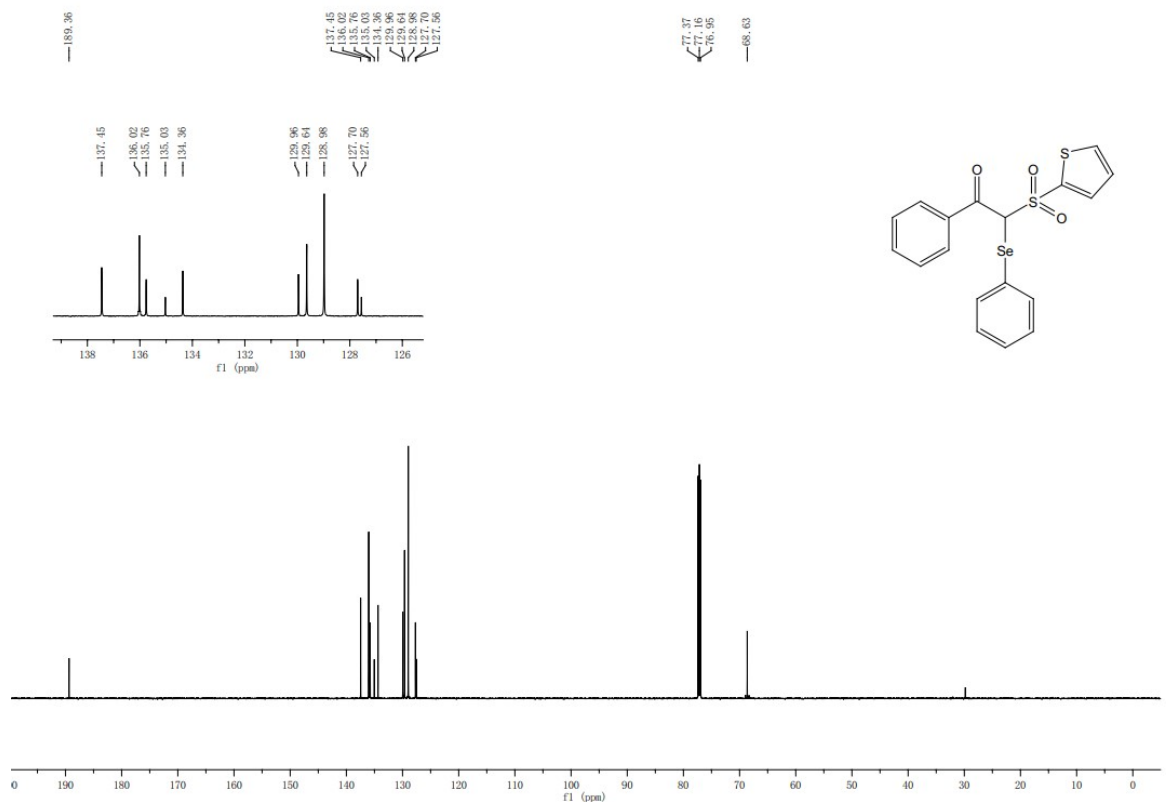


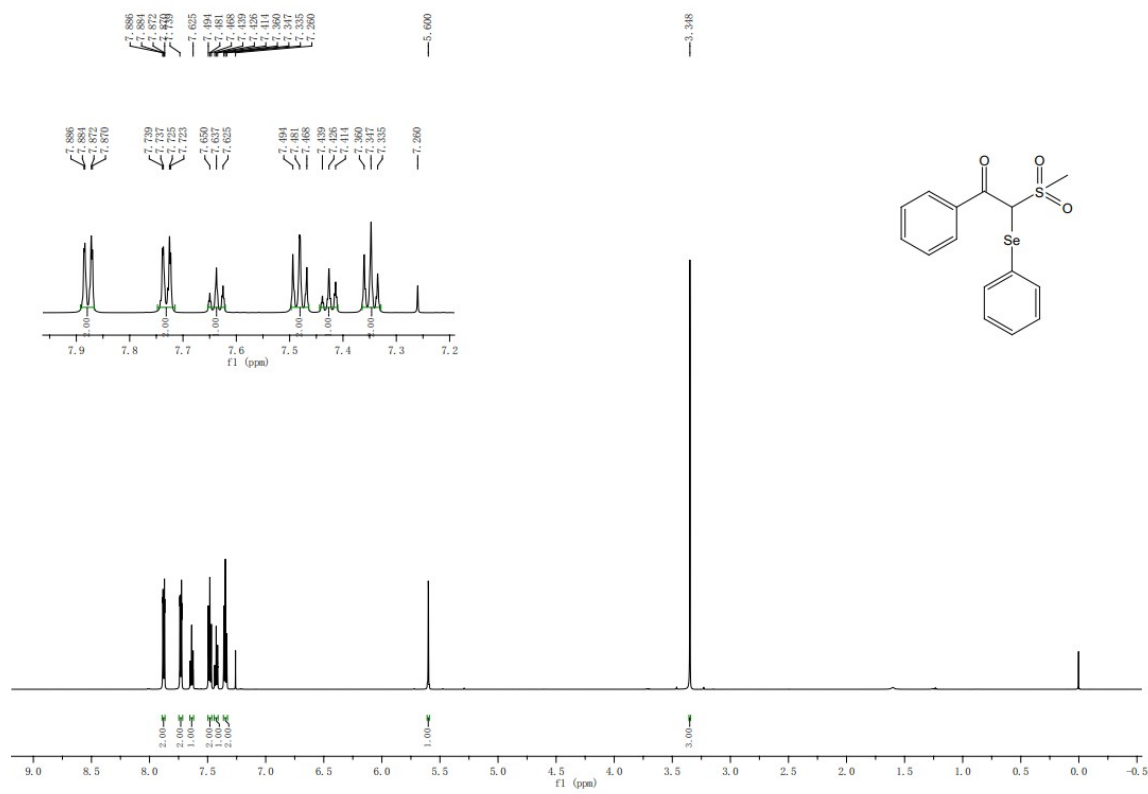
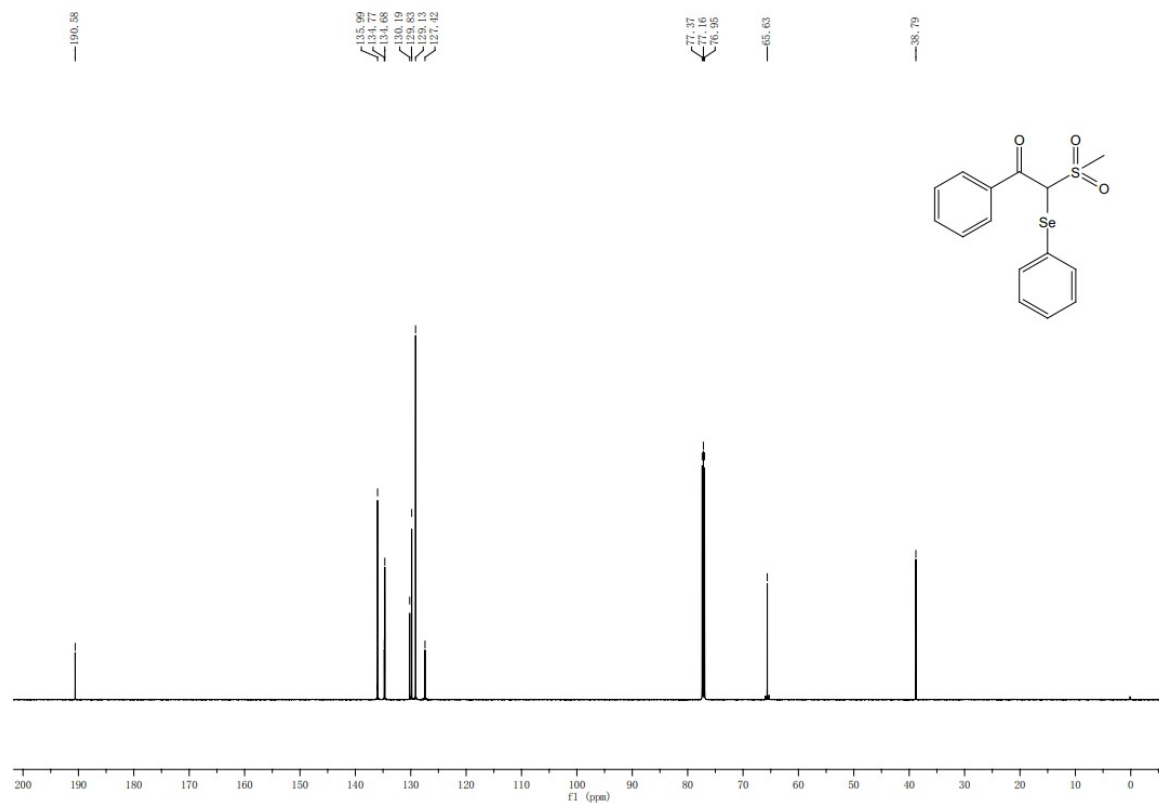
附录

¹H NMR of 3s



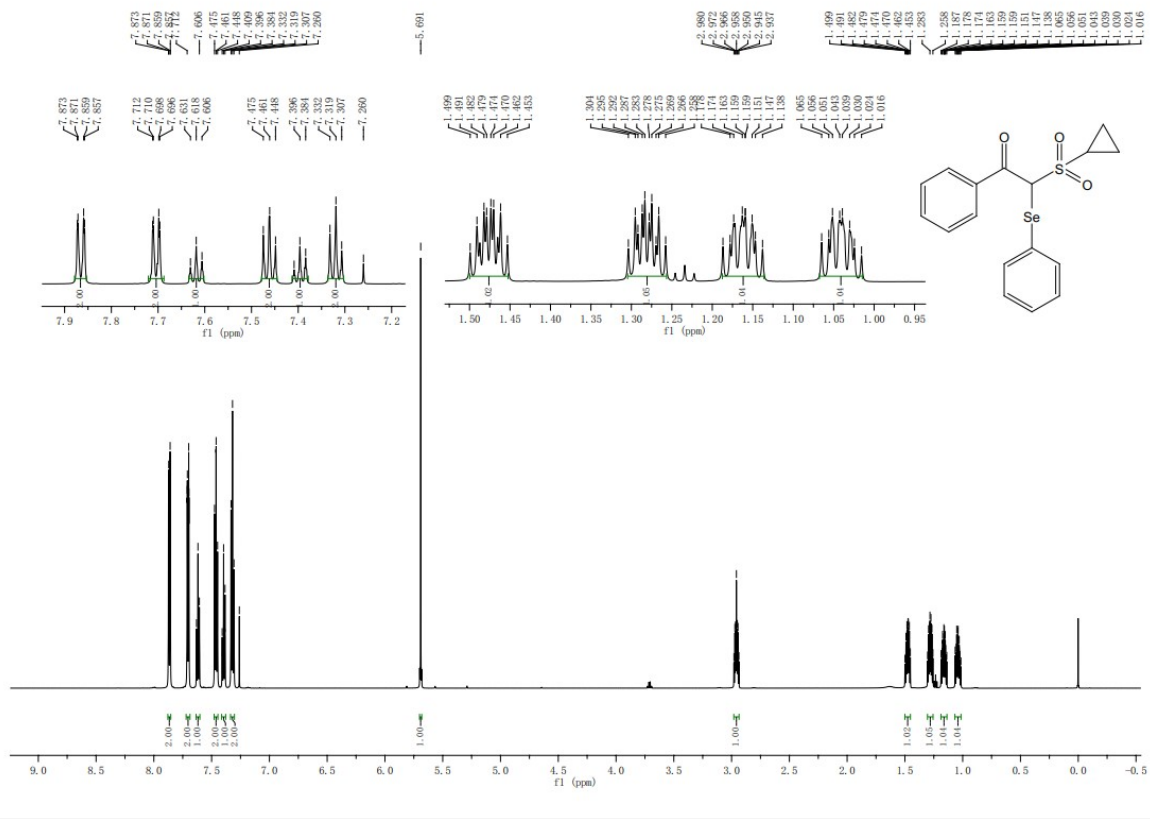
¹³C NMR of 3s



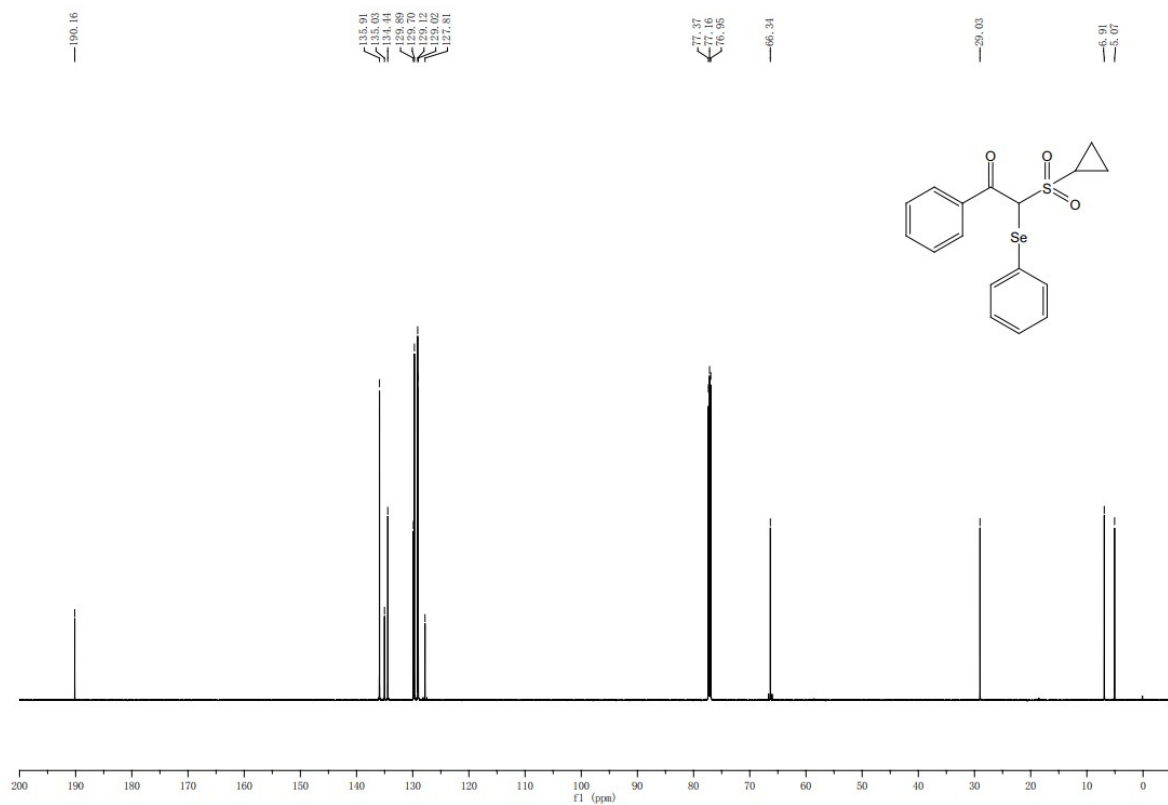
^1H NMR of **3t** ^{13}C NMR of **3t**

附录

¹H NMR of **3u**

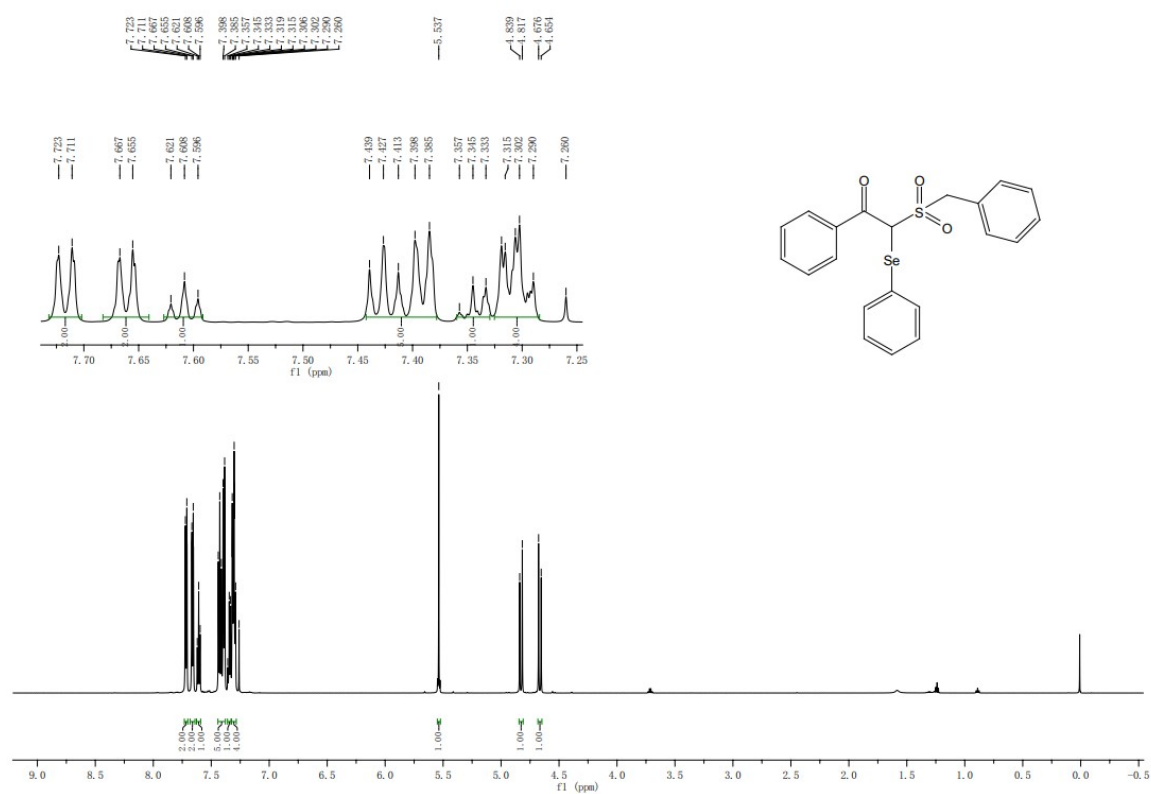


¹³C NMR of **3u**

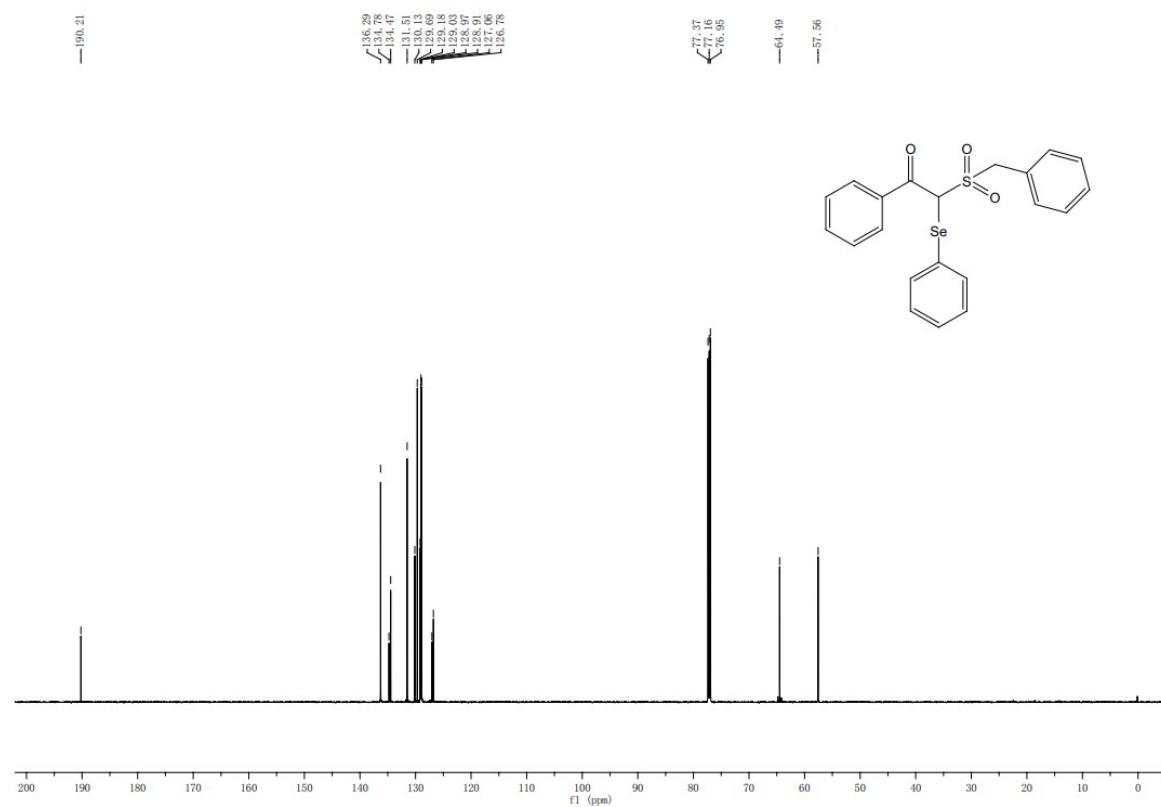


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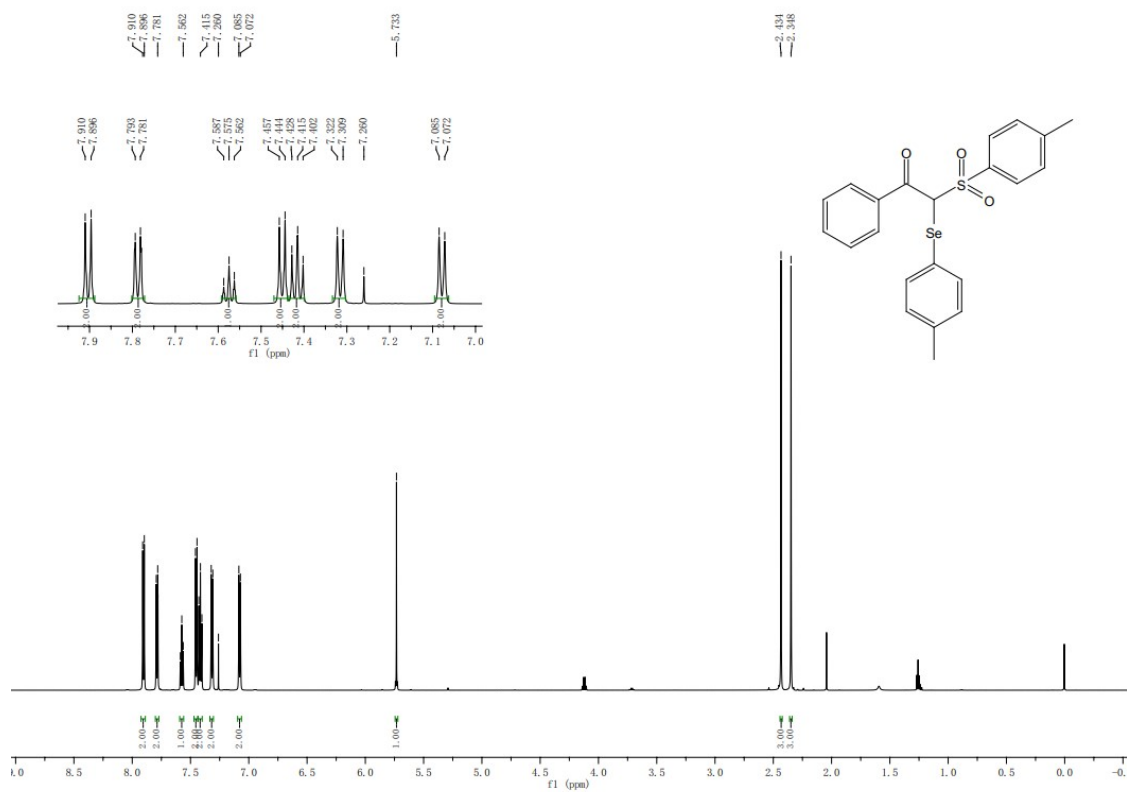
¹H NMR of 3v



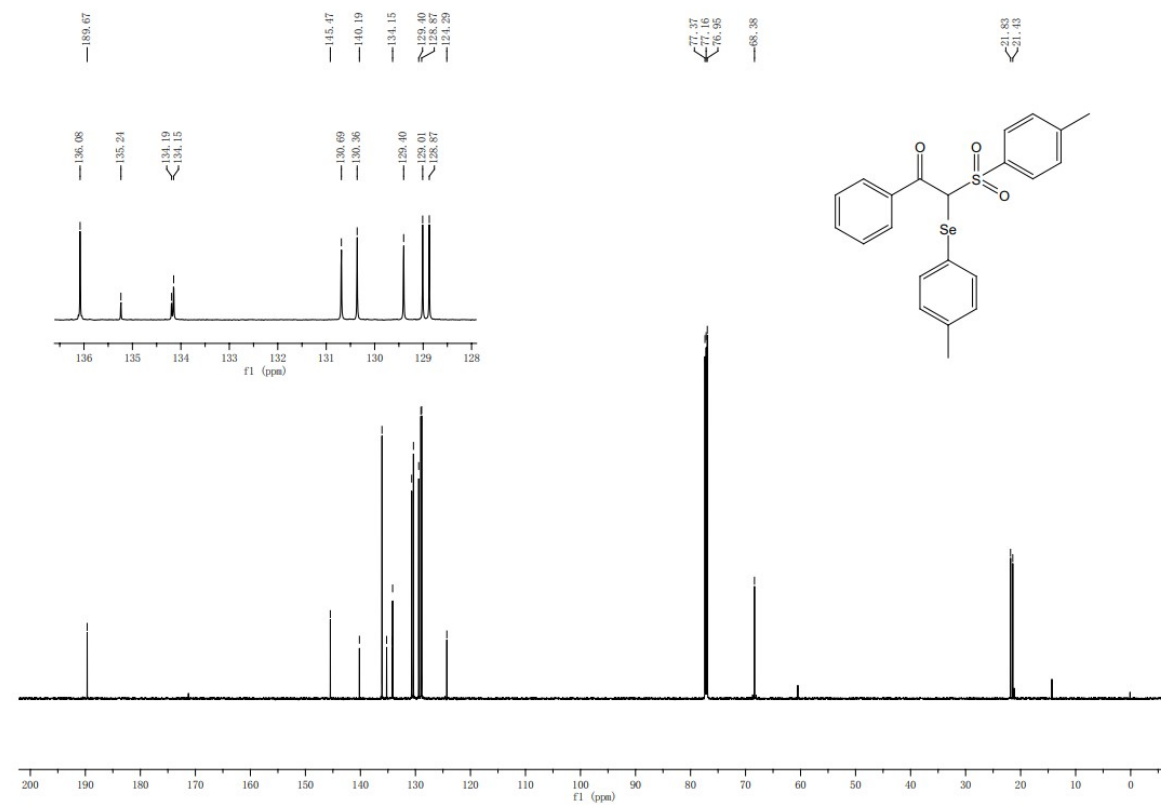
¹³C NMR of 3v



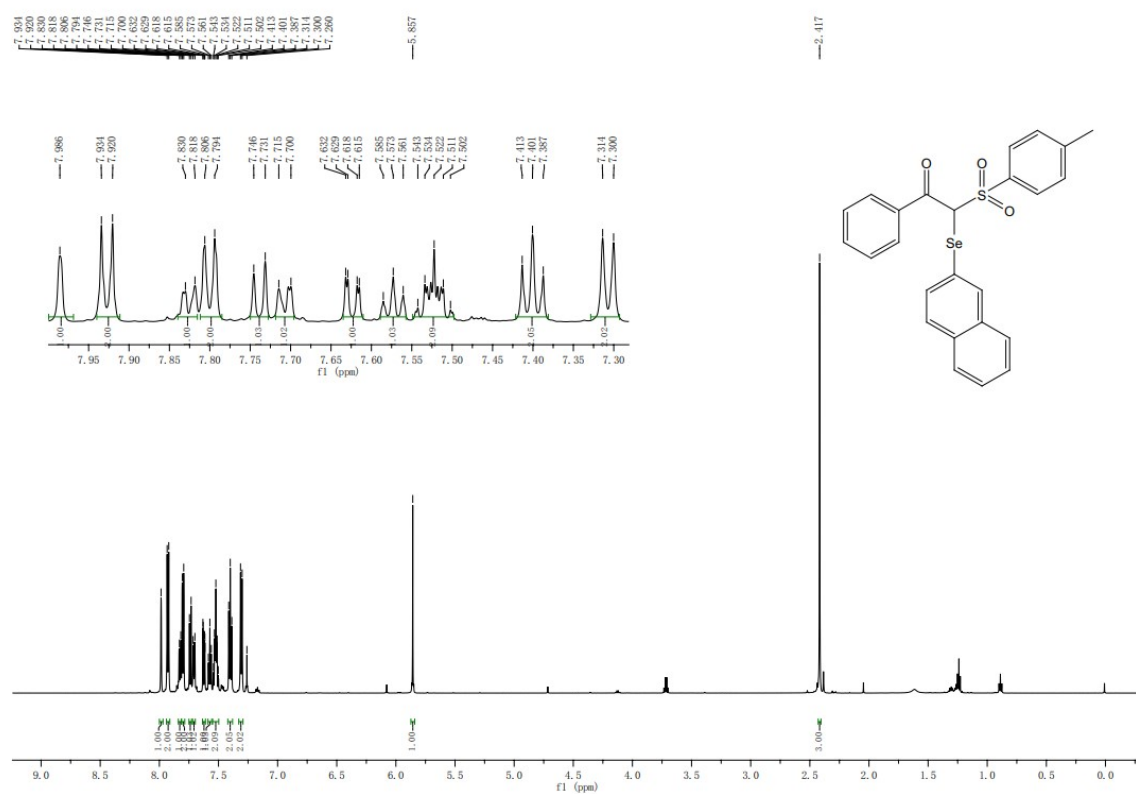
¹H NMR of 4a



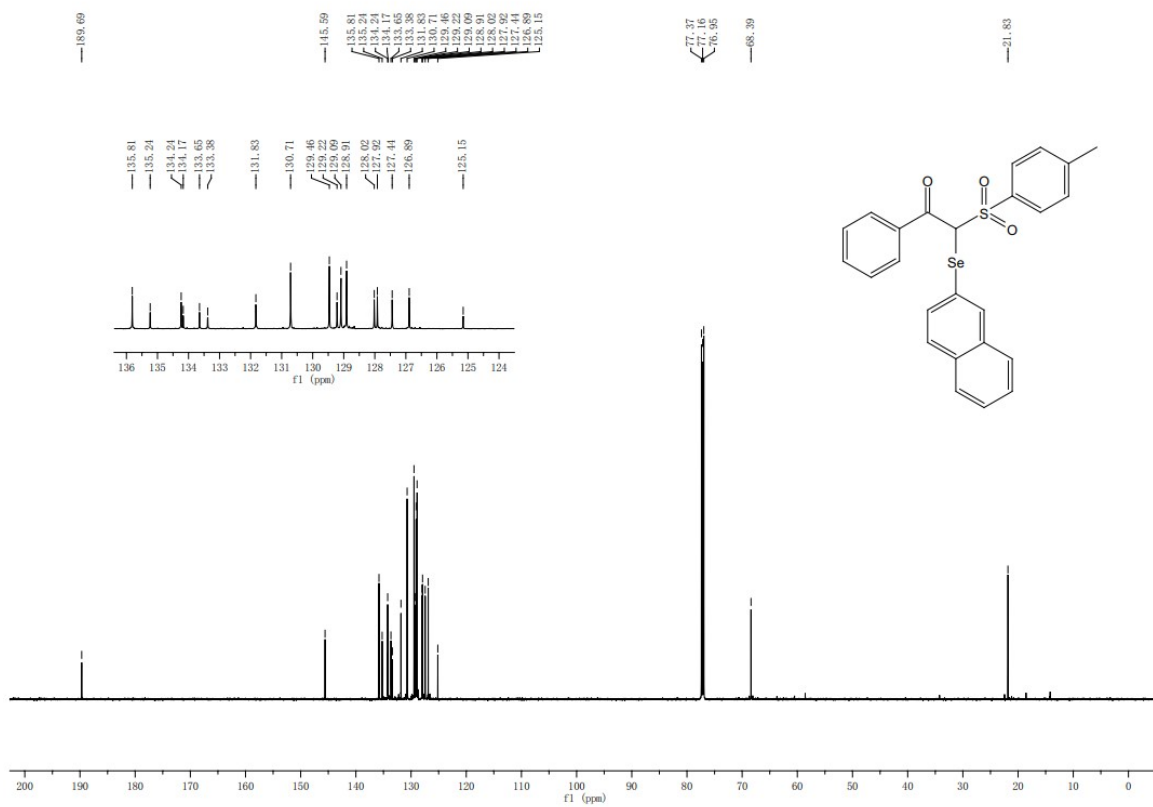
¹³C NMR of 4a



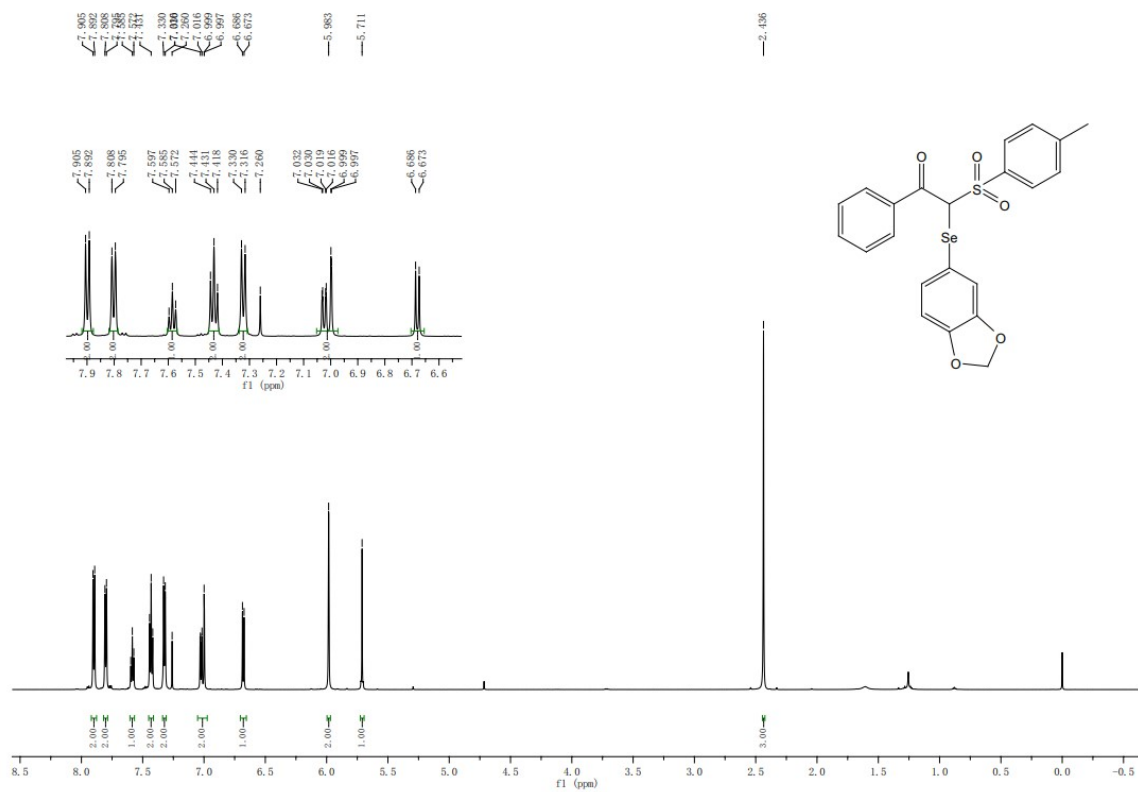
¹H NMR of 4b



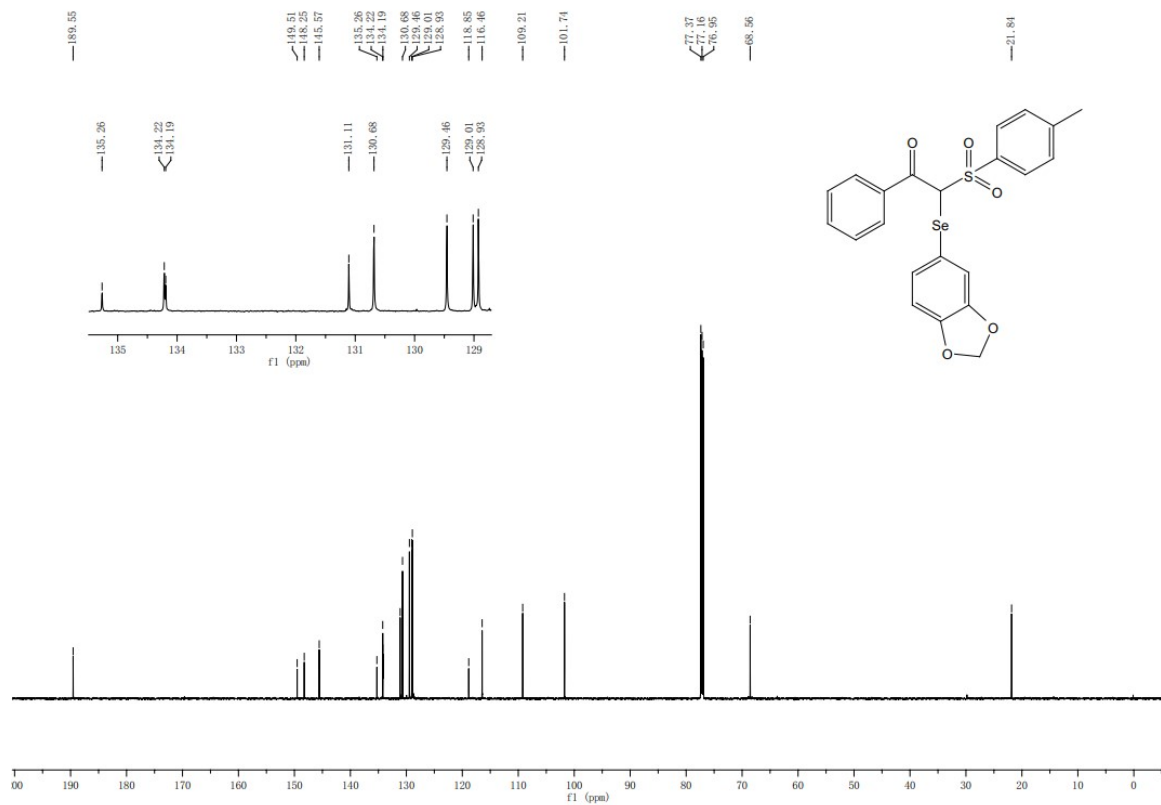
¹³C NMR of 4b



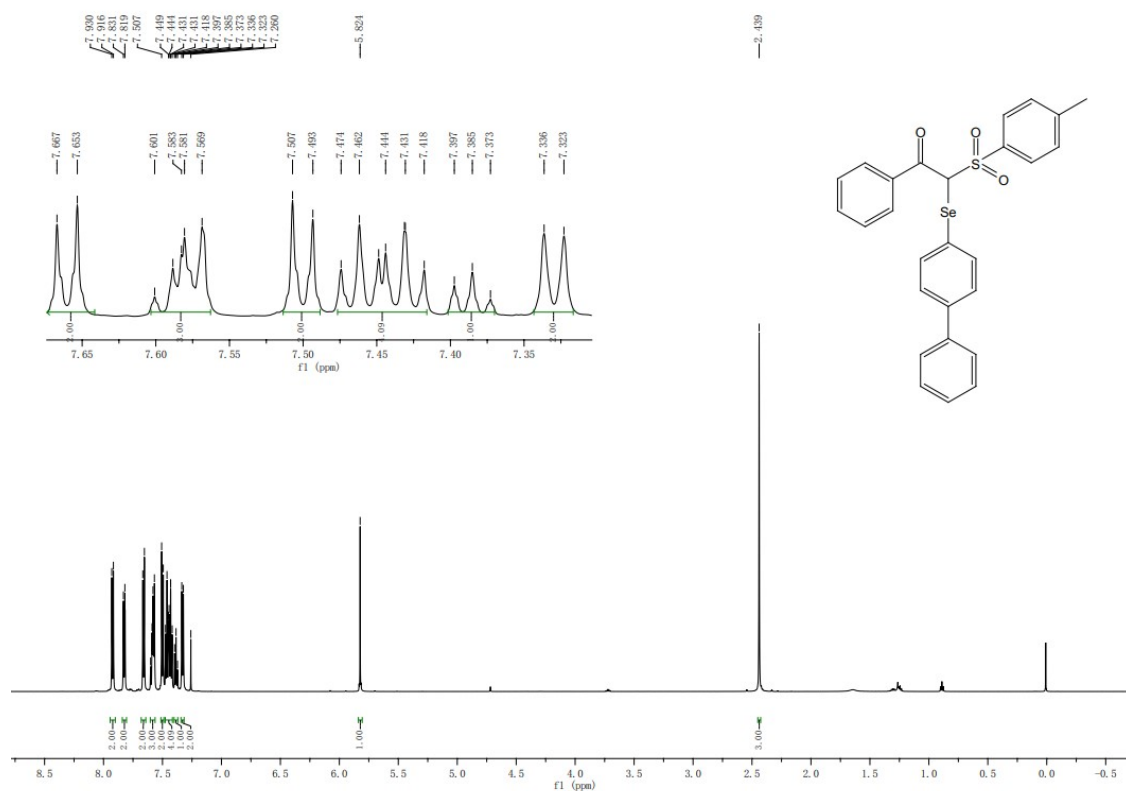
¹H NMR of 4c



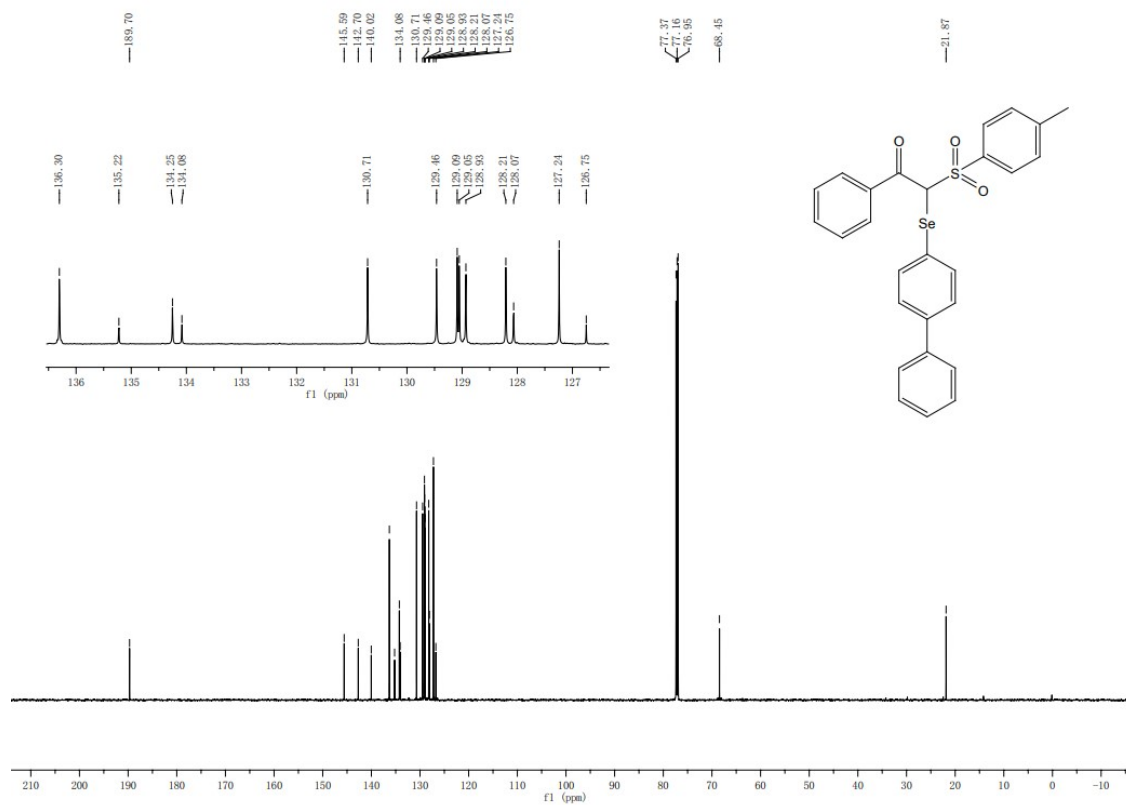
¹³C NMR of 4c



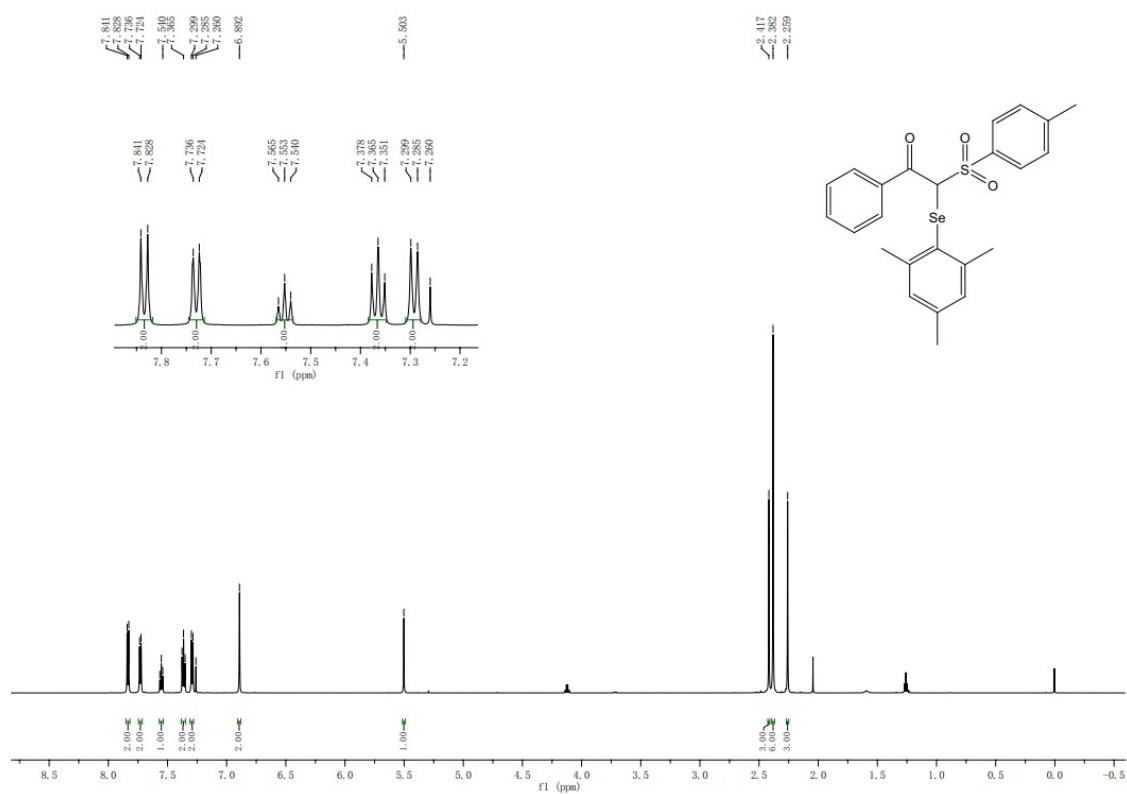
¹H NMR of 4d



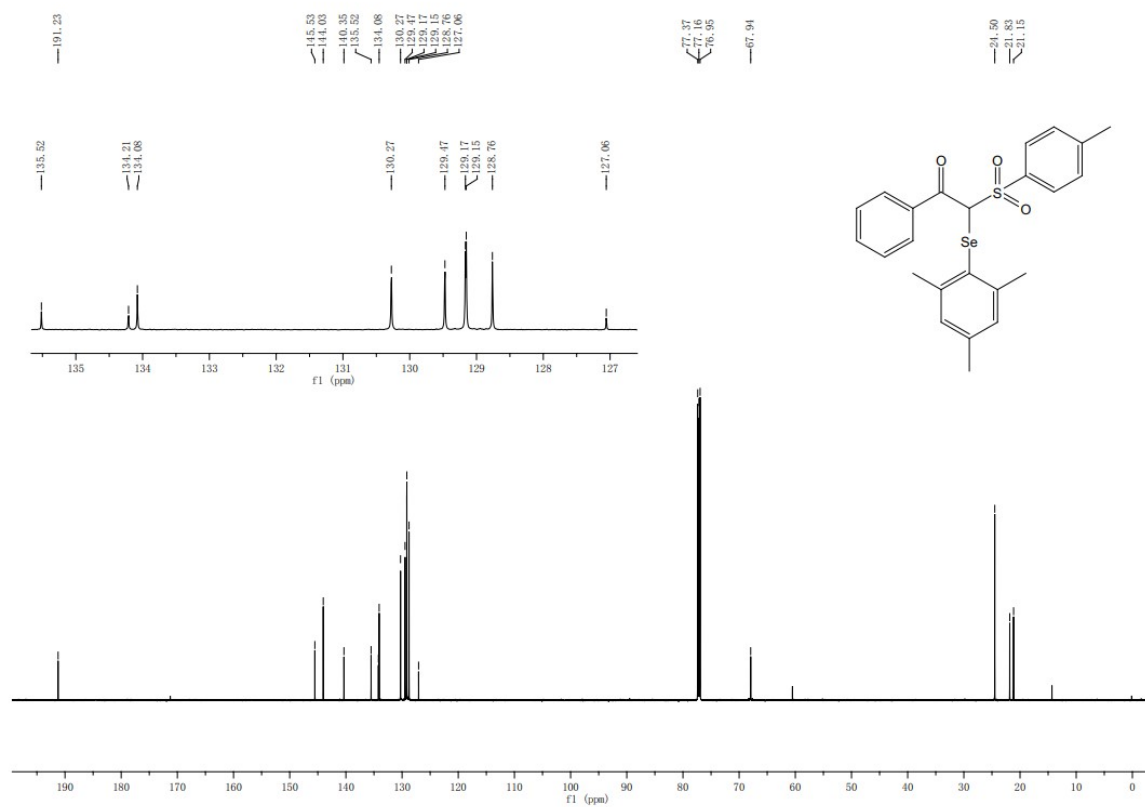
¹³C NMR of 4d

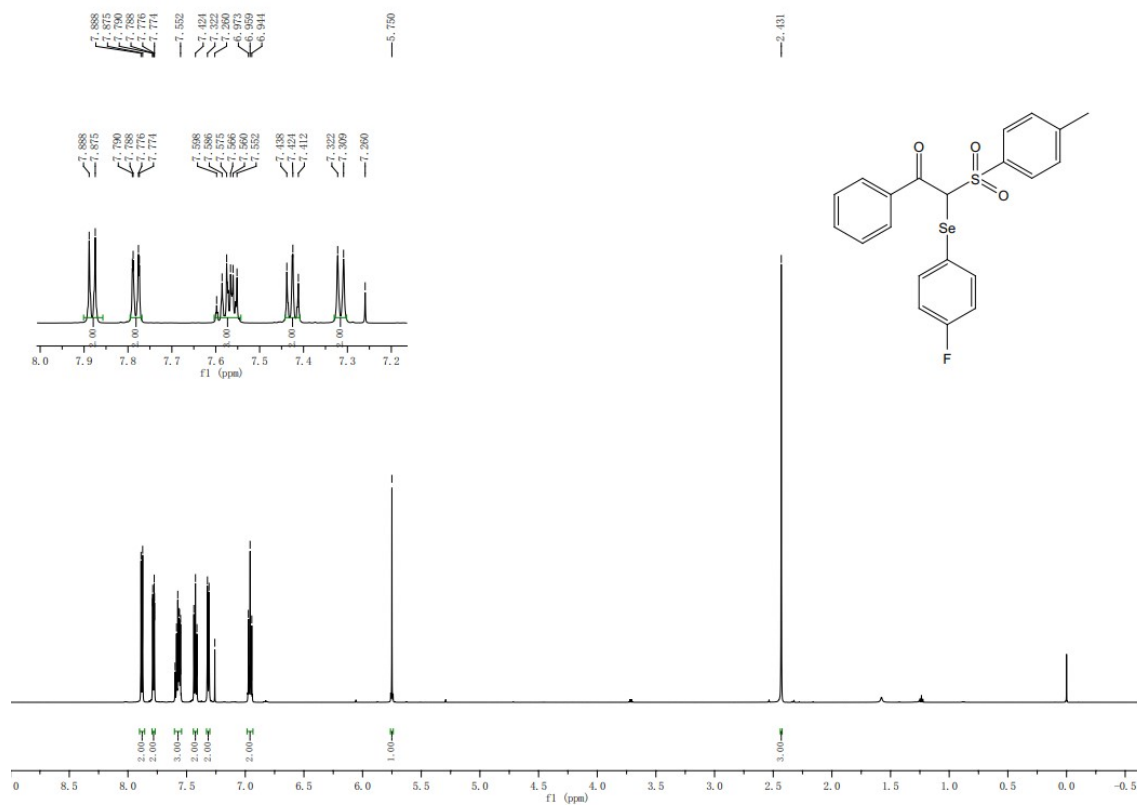
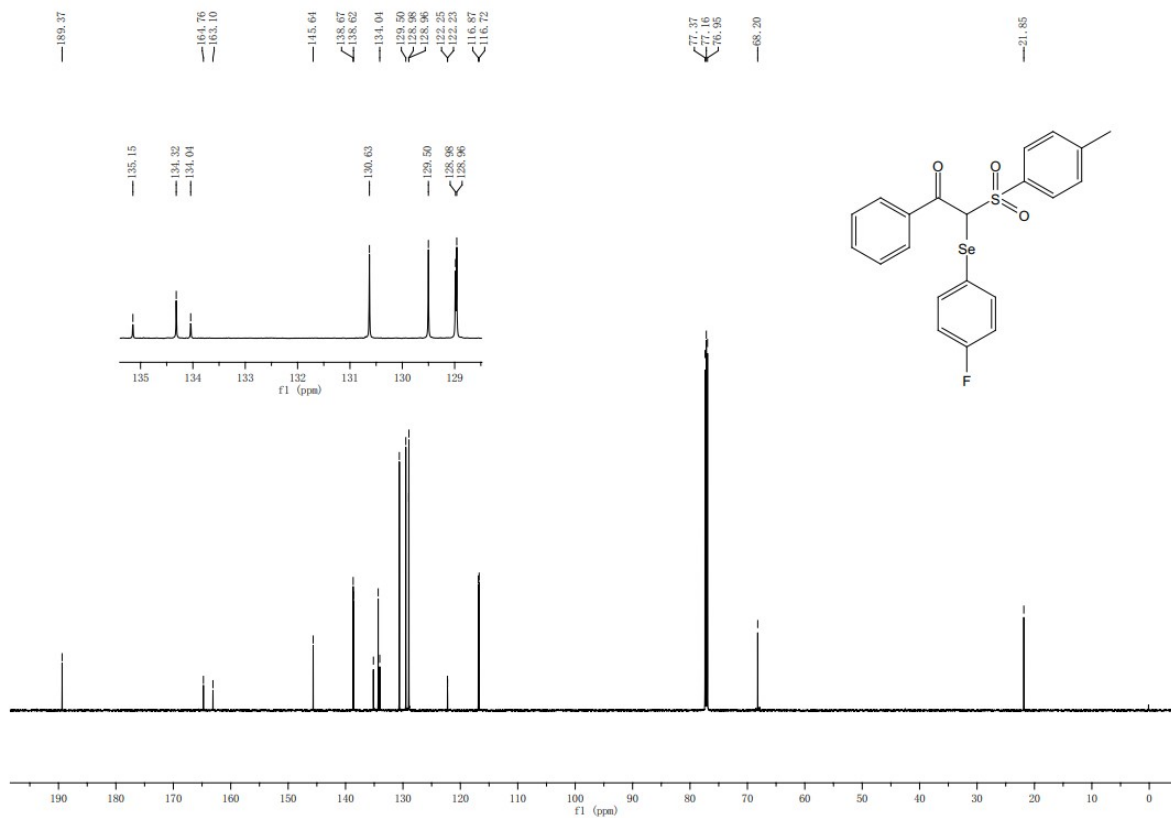


¹H NMR of 4e

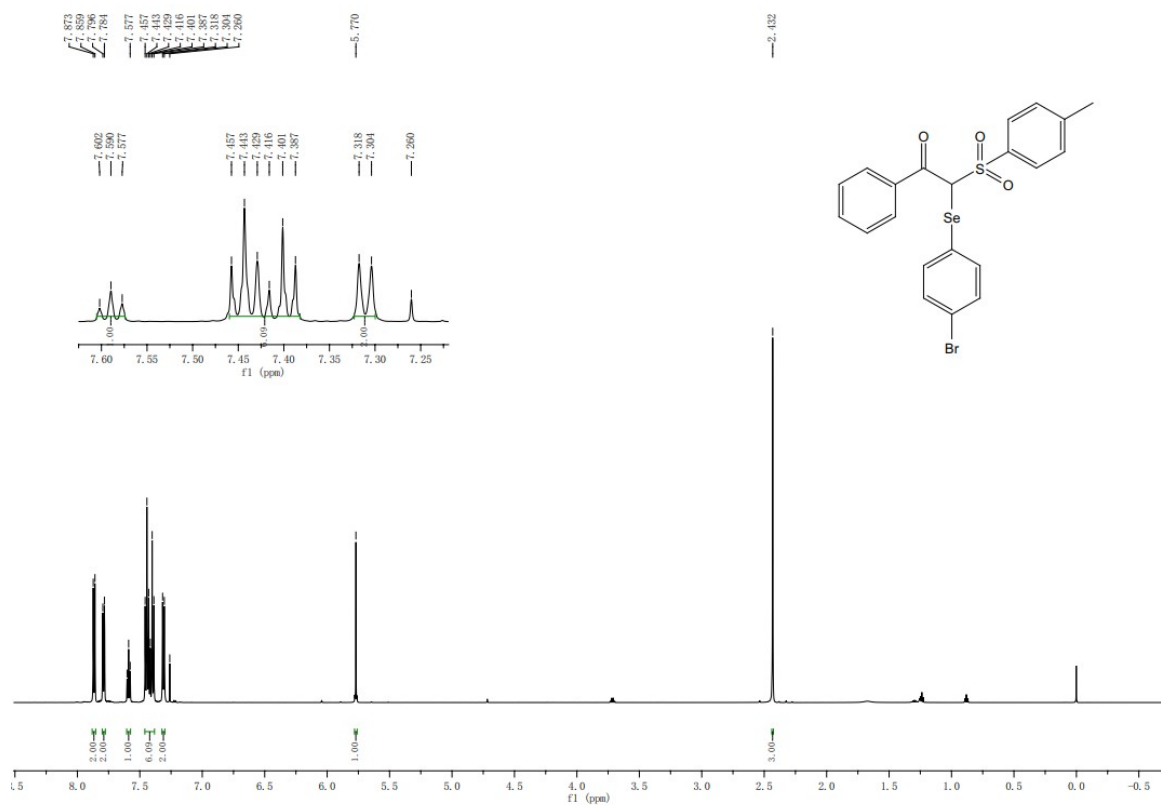


¹³C NMR of 4e

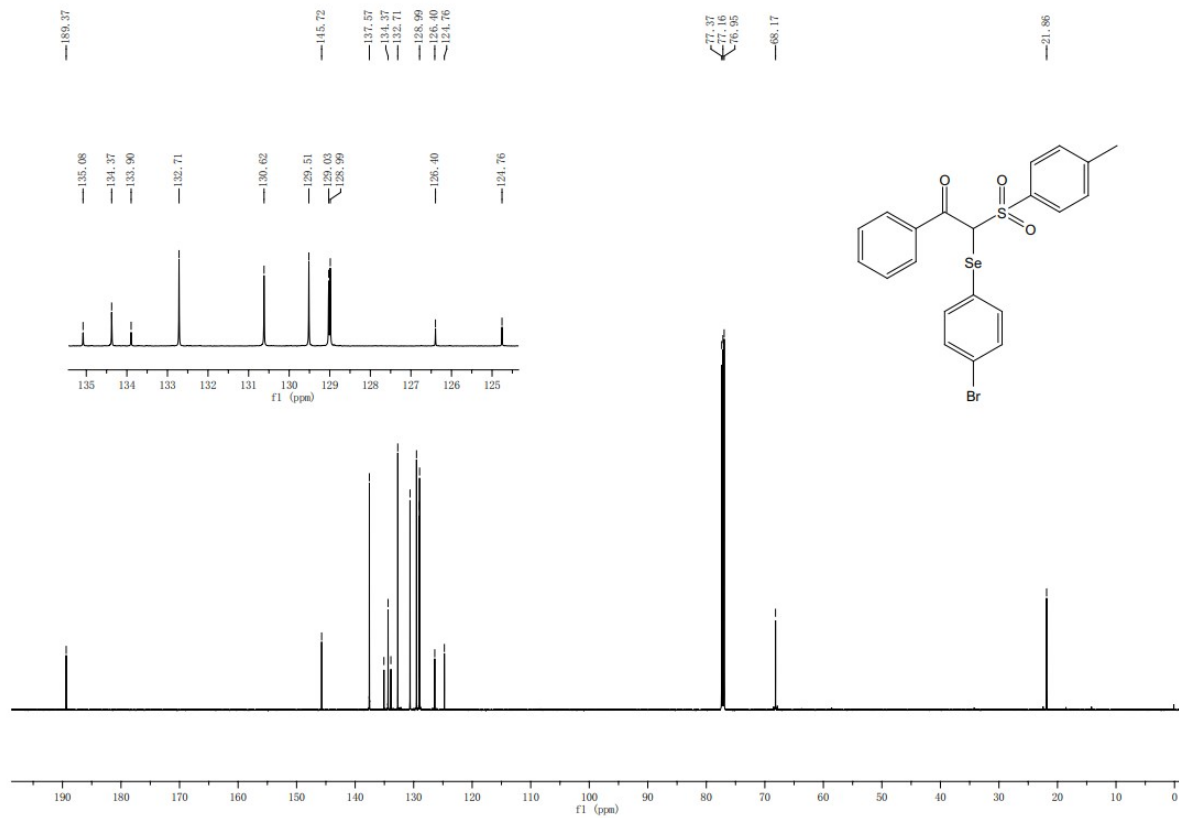


^1H NMR of 4f ^{13}C NMR of 4f

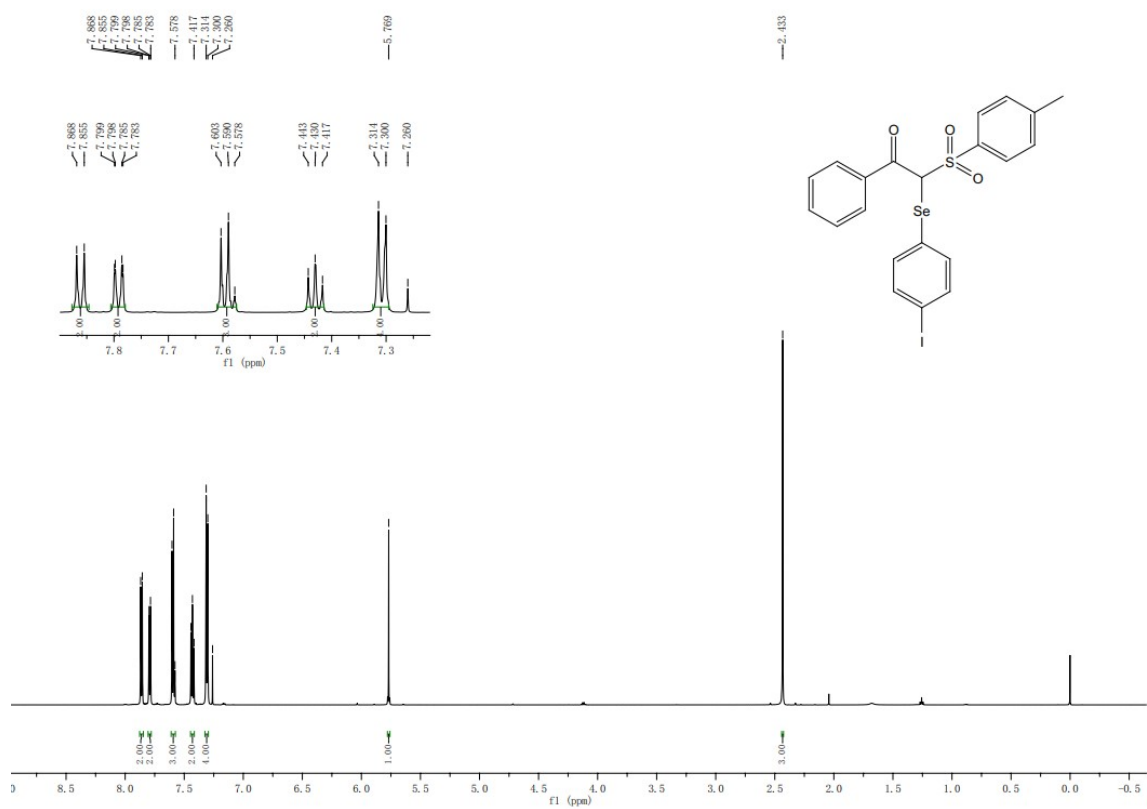
¹H NMR of 4g



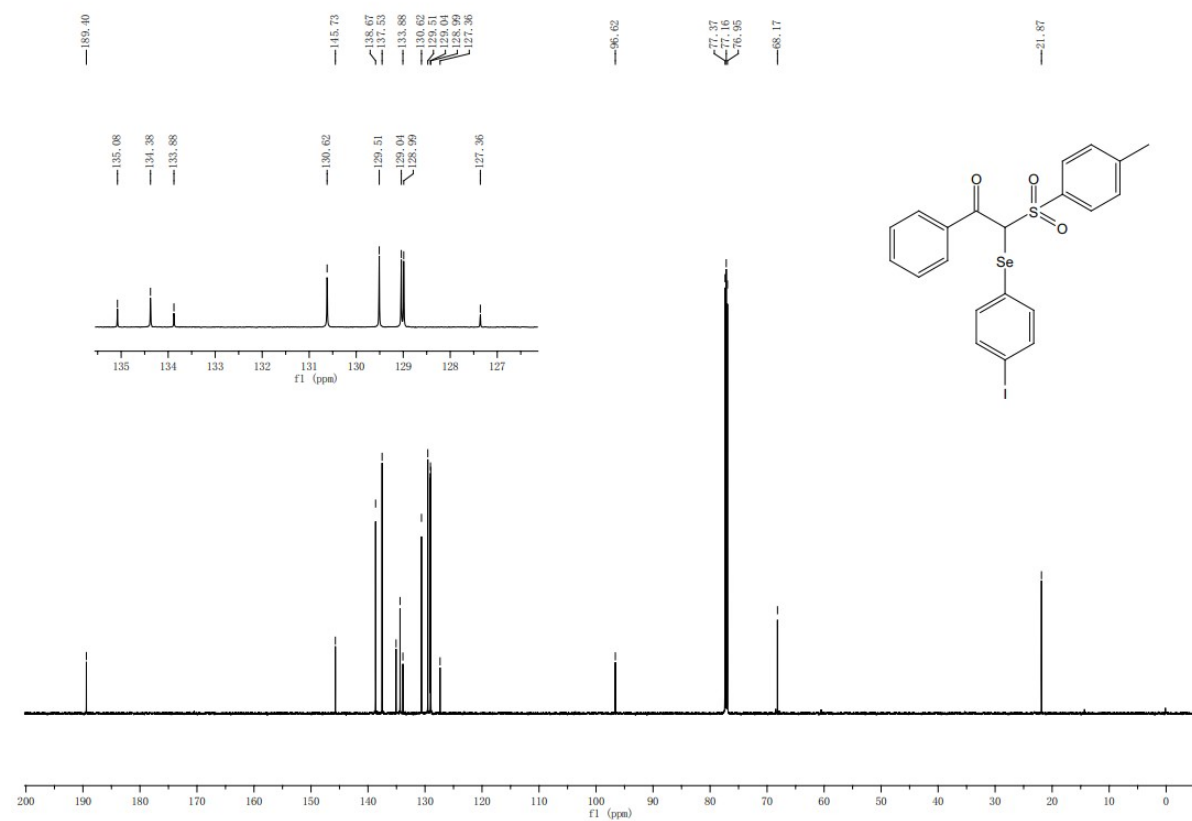
¹³C NMR of 4g



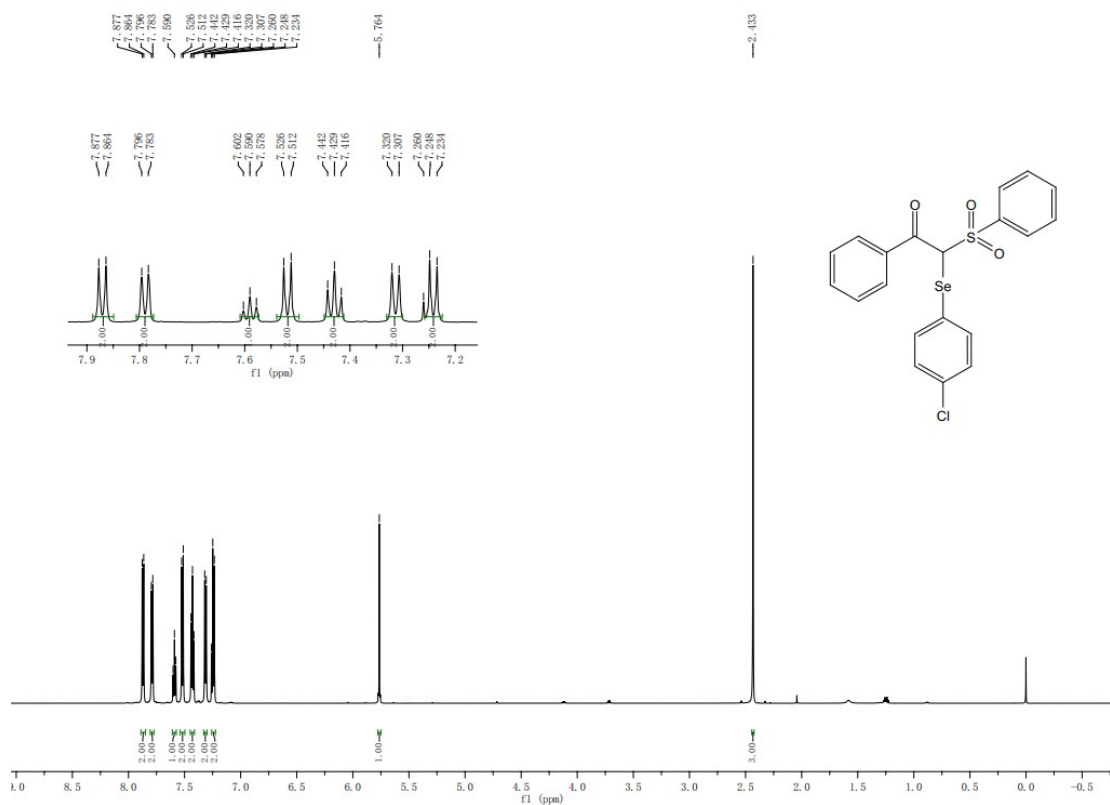
¹H NMR of 4h



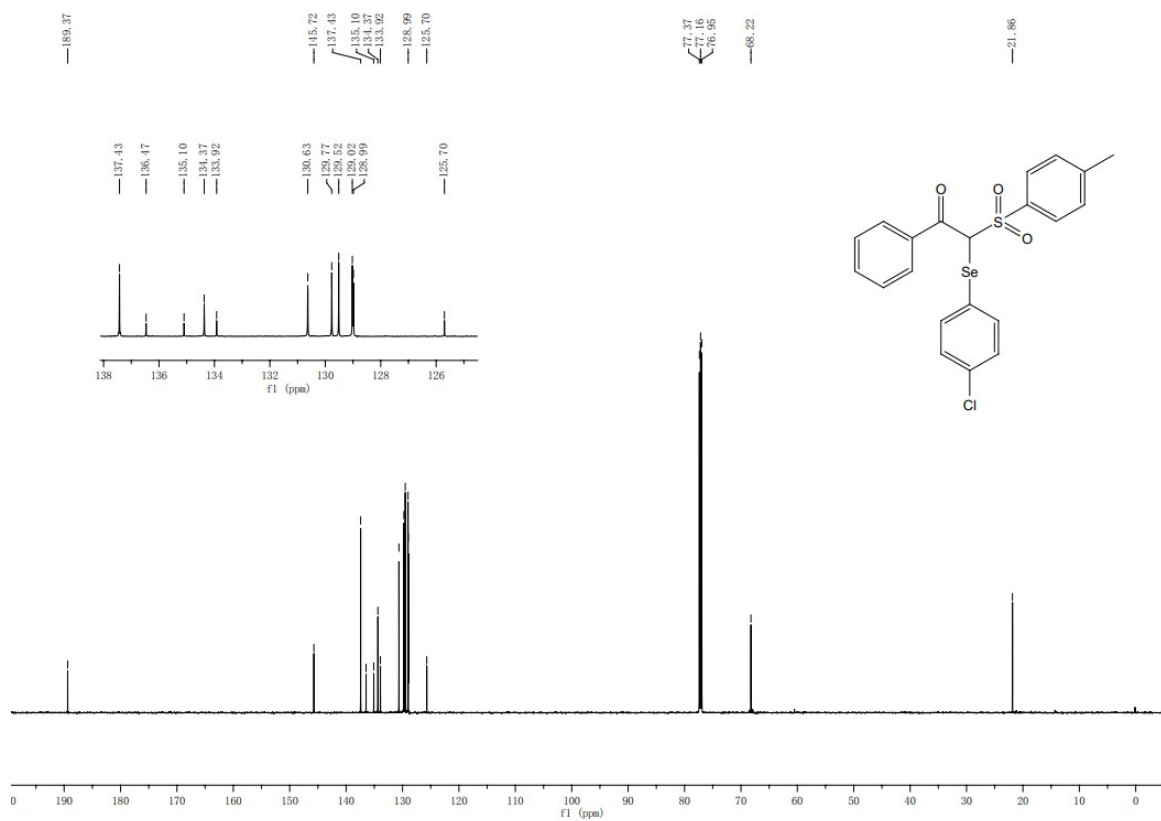
¹³C NMR of 4h



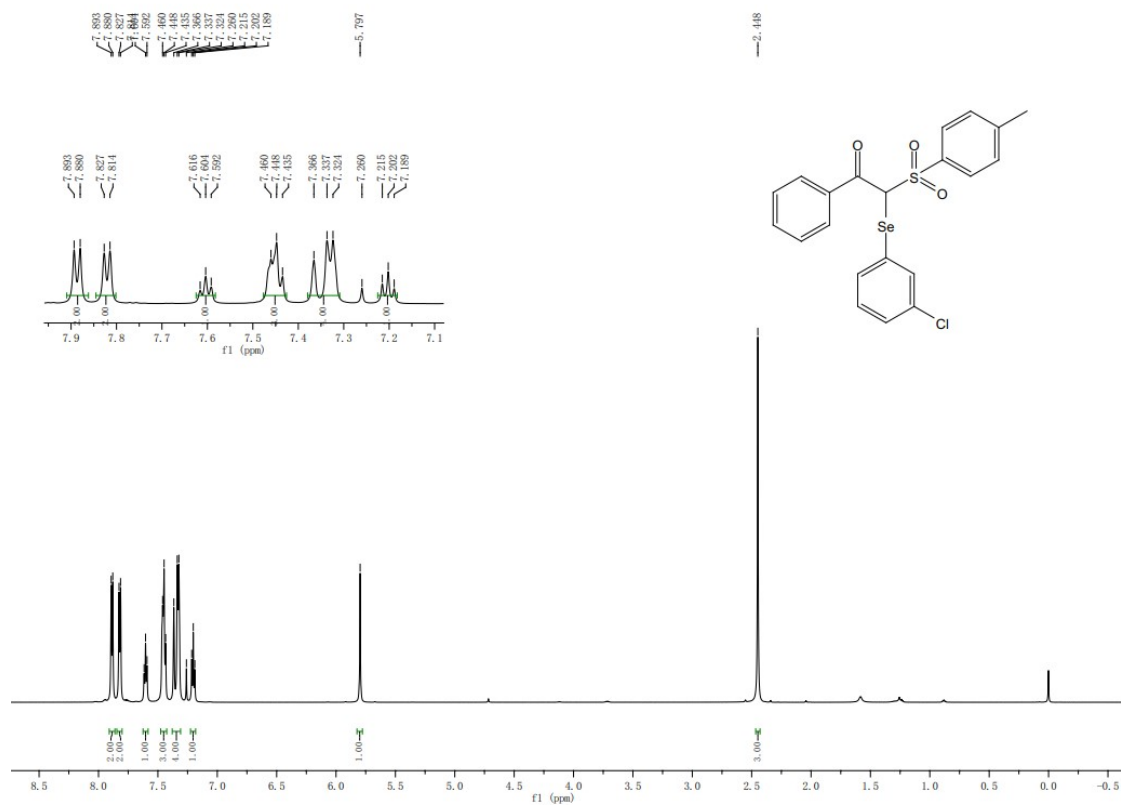
¹H NMR of 4i



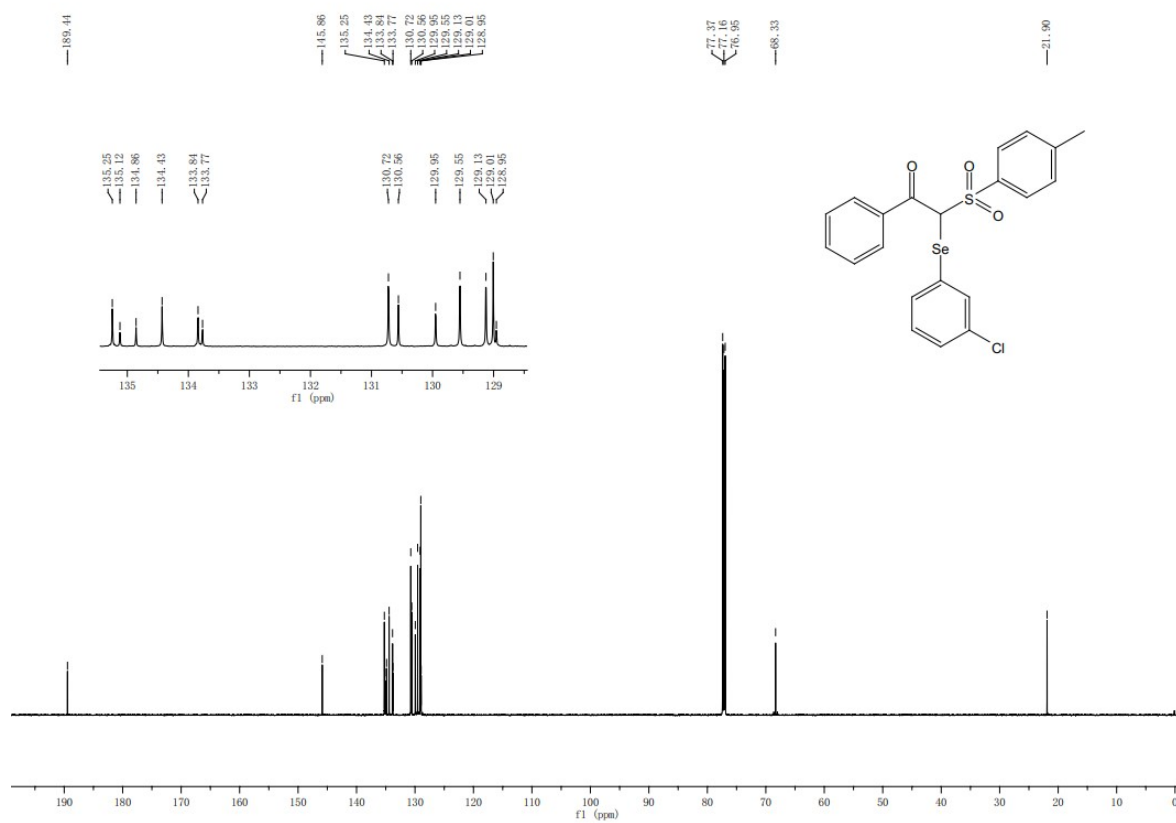
¹³C NMR of 4i



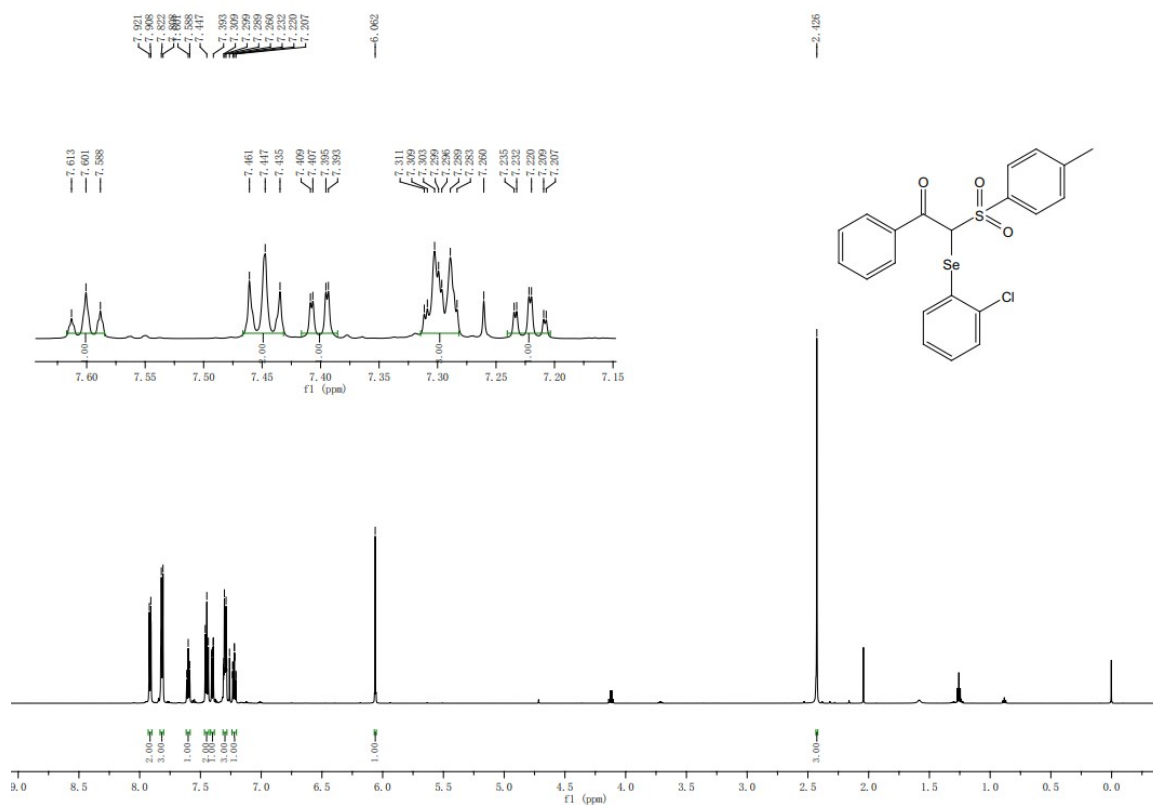
¹H NMR of 4j



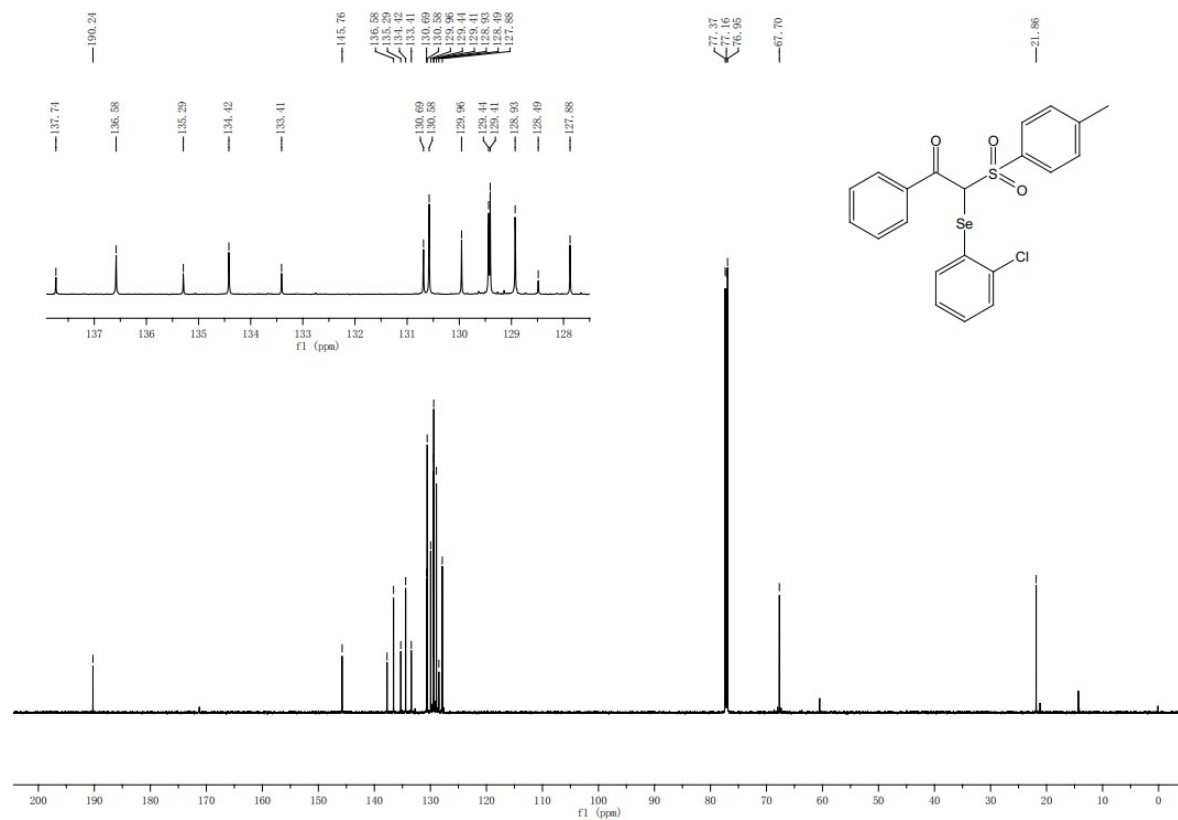
¹³C NMR of 4j



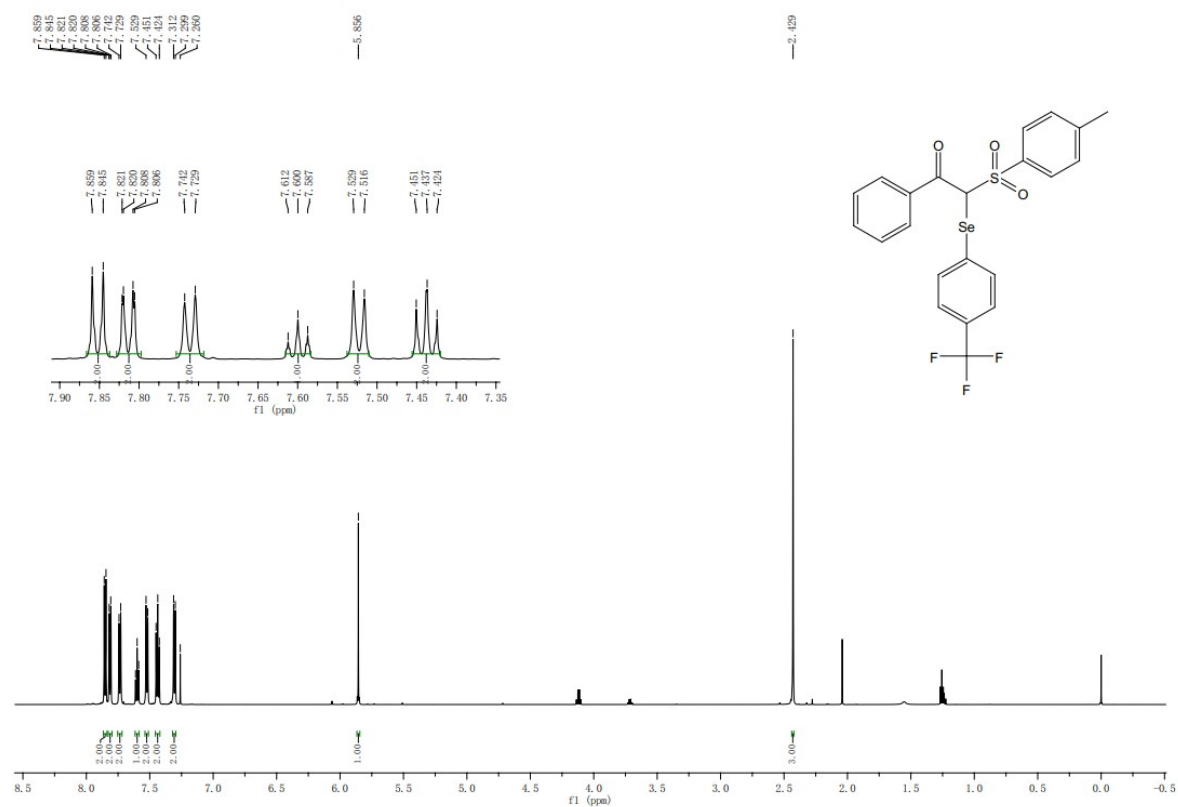
¹H NMR of 4k



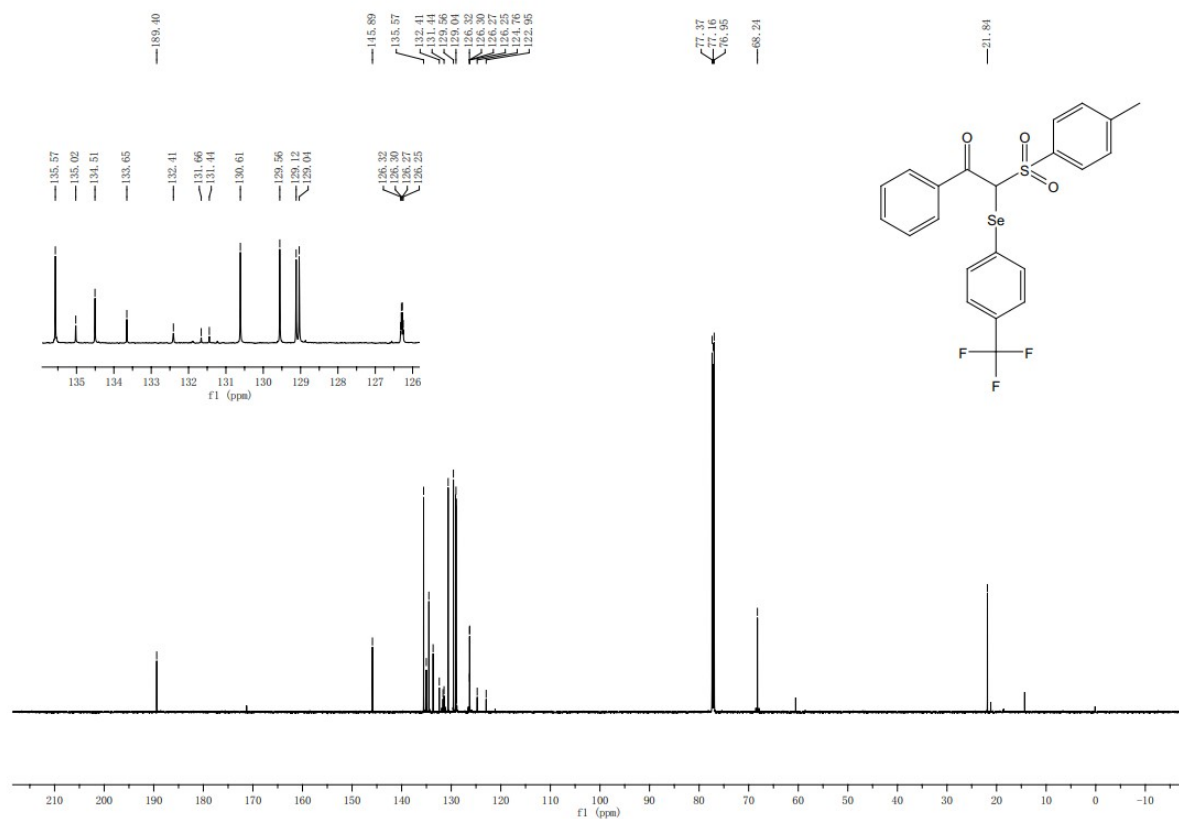
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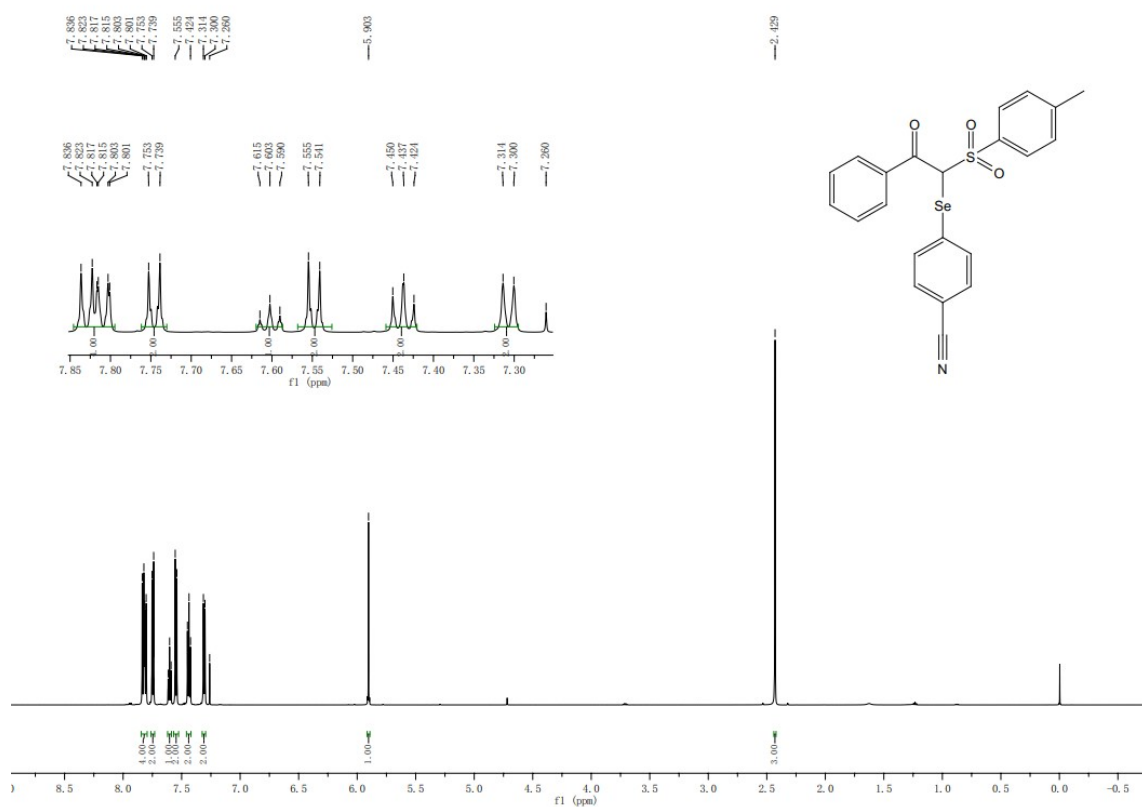
¹H NMR of 4l



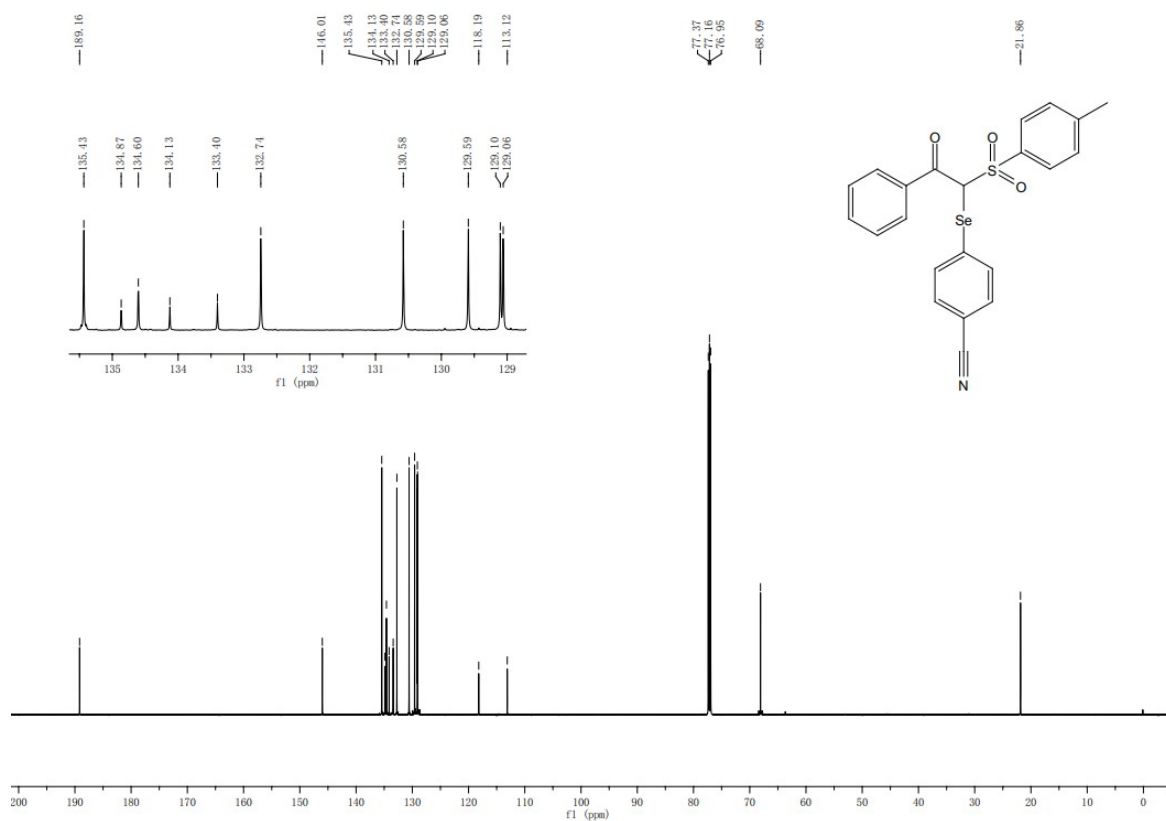
¹³C NMR of 4l



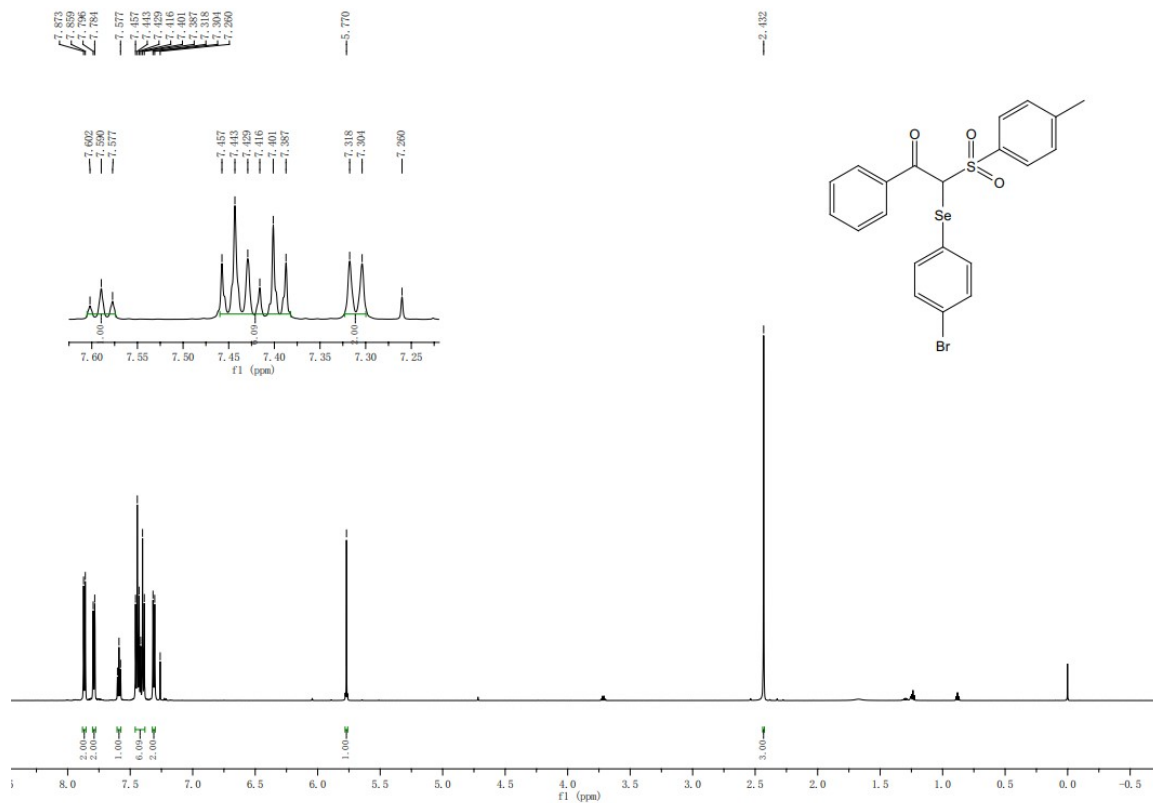
¹H NMR of 4m



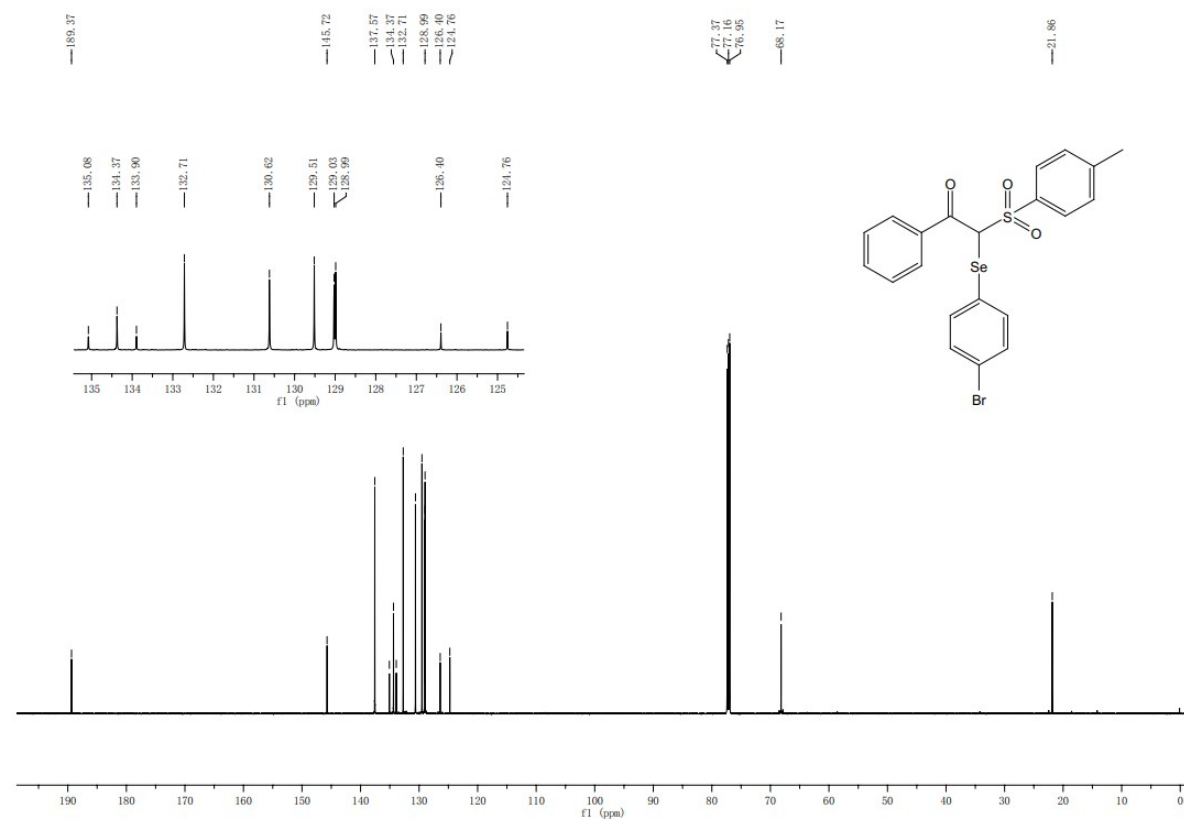
¹³C NMR of 4m



¹H NMR of **4n**



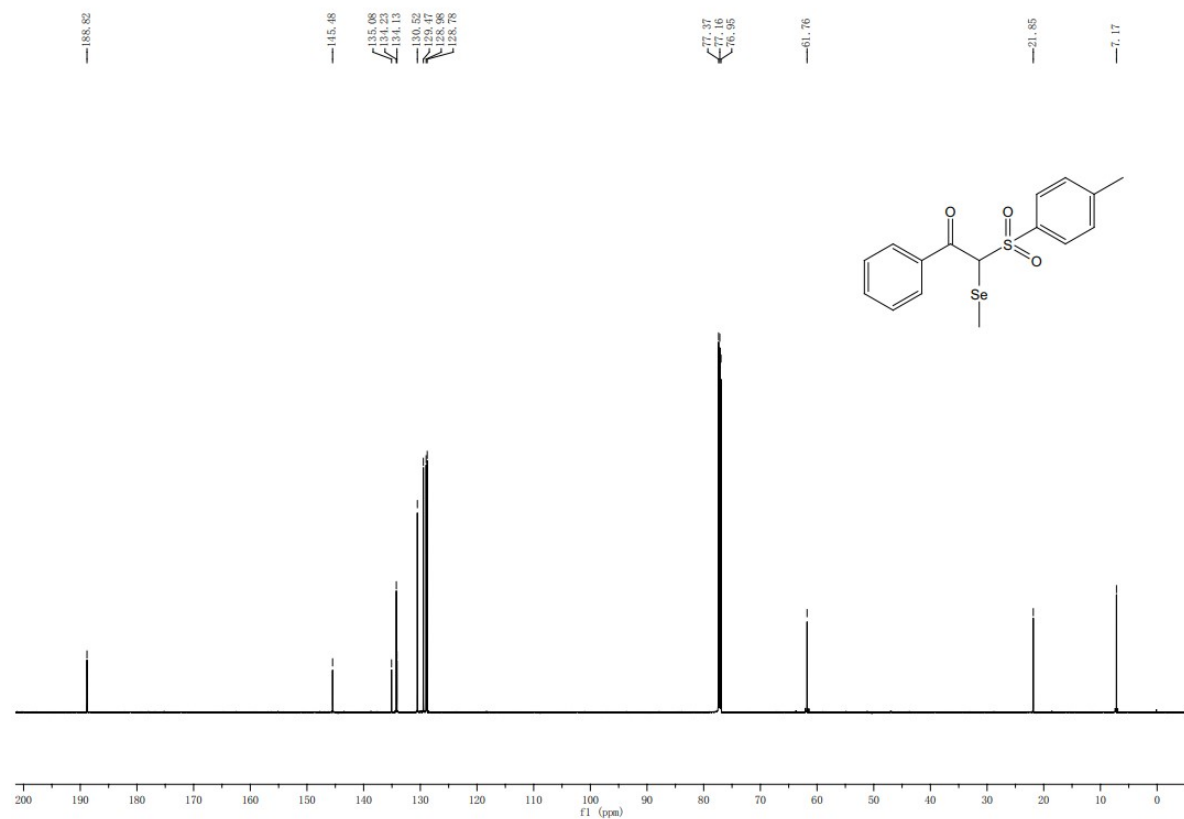
¹³C NMR of **4n**



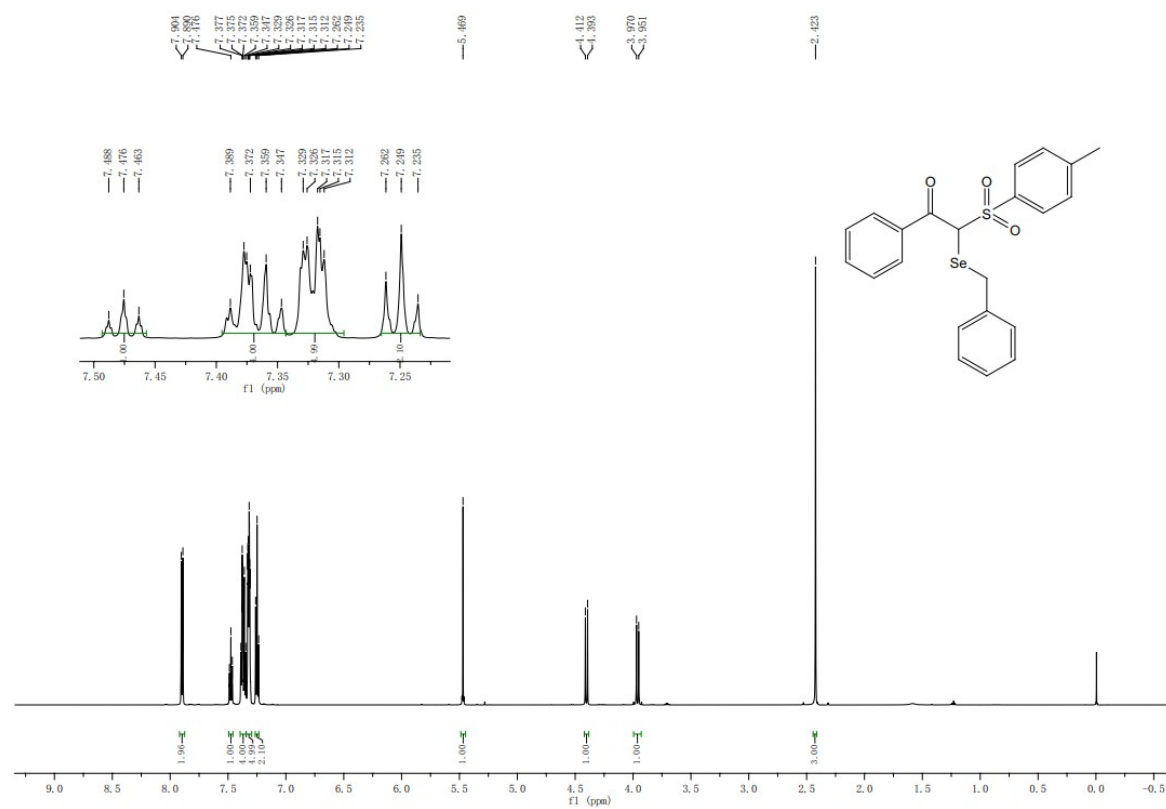
¹H NMR of **4o**



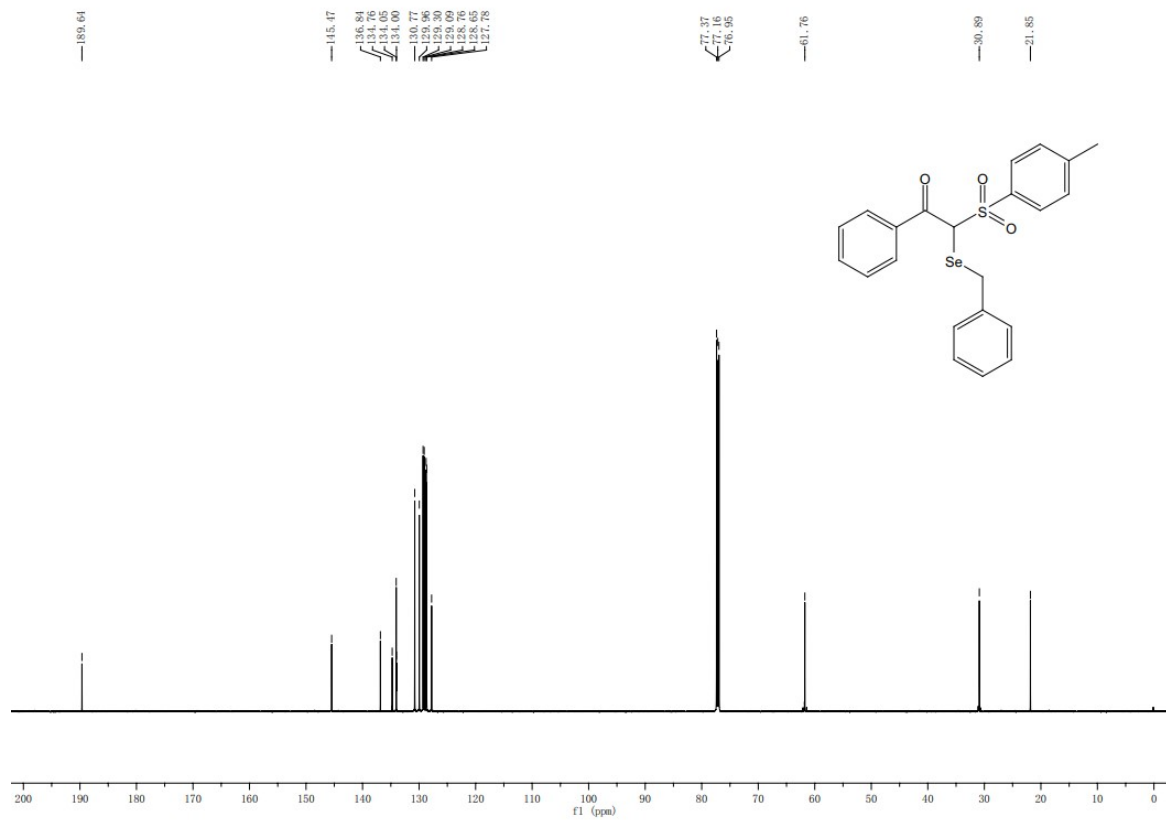
¹³C NMR of **4o**



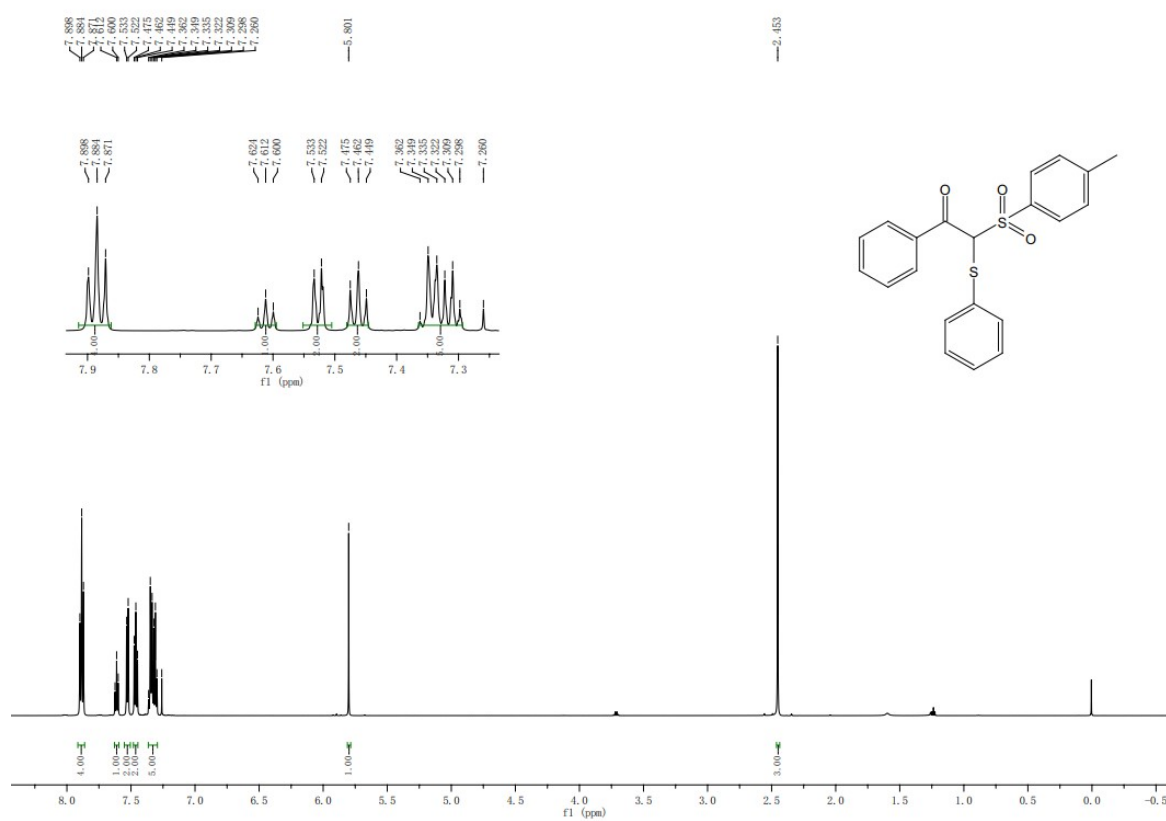
¹H NMR of 4p



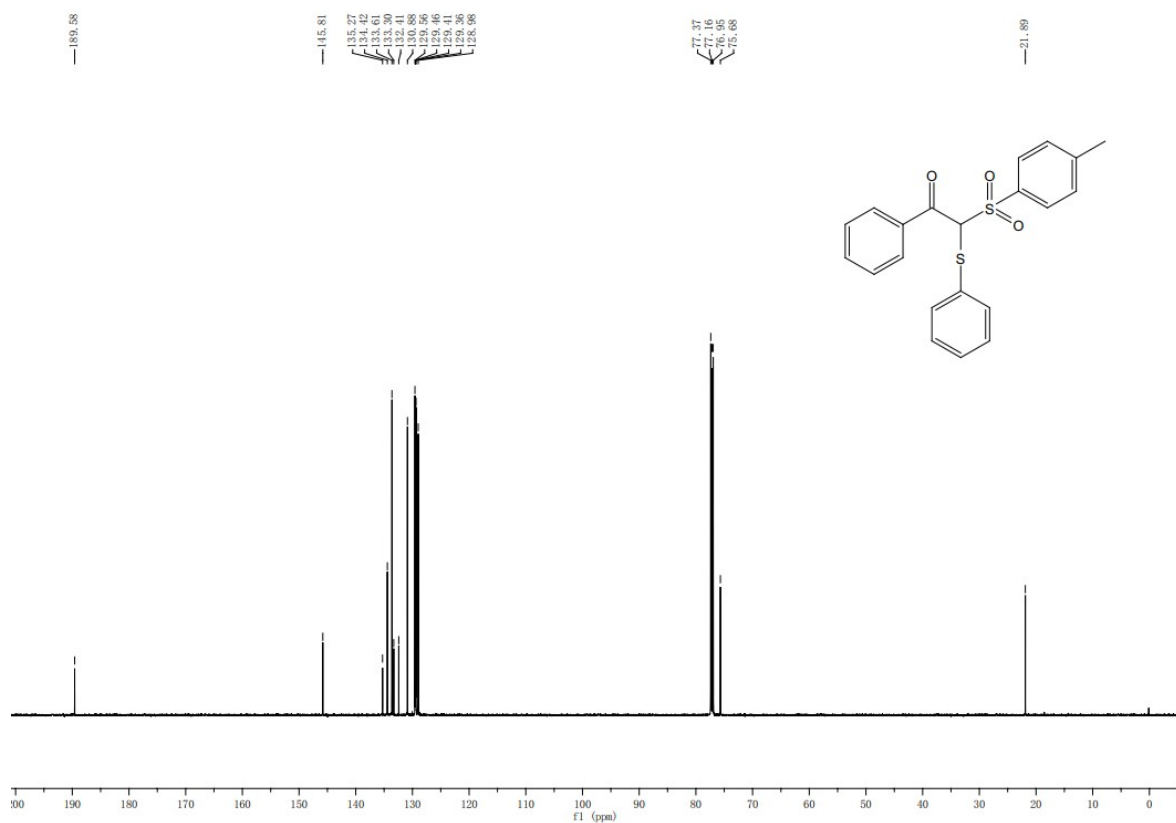
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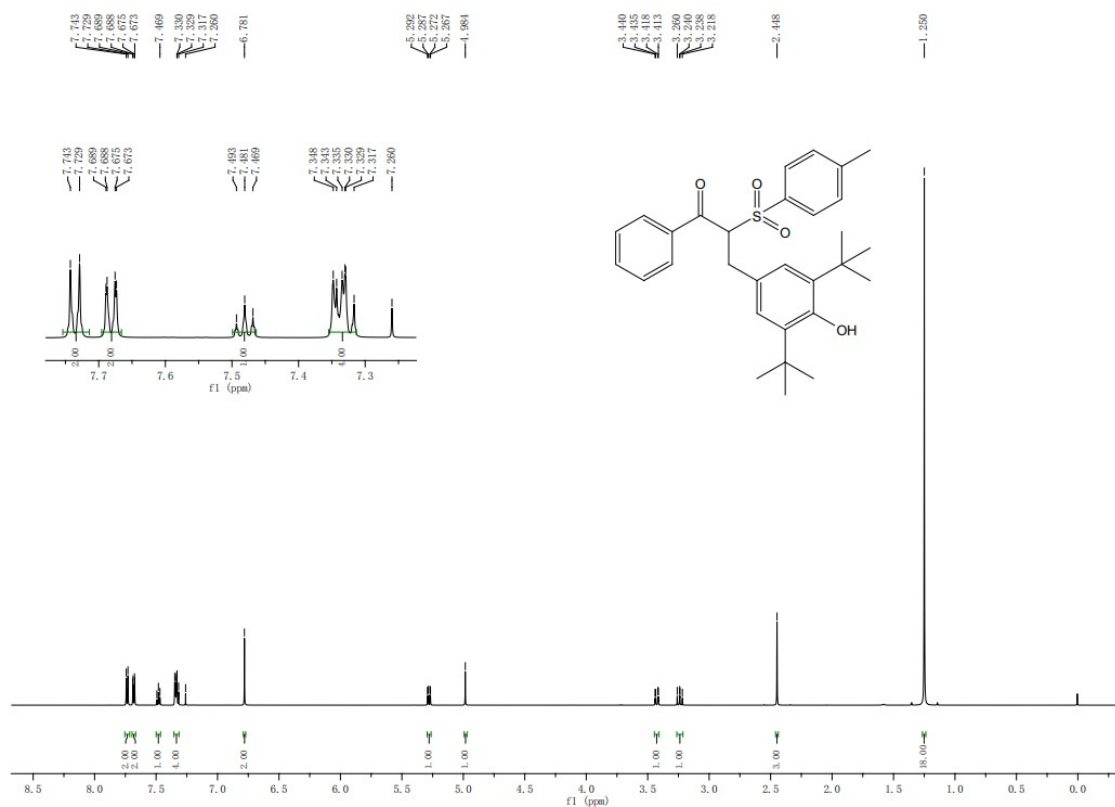
¹H NMR of 4q



¹³C NMR of 4q



¹H NMR of 5



¹³C NMR of 5

