Supporting Information

Palladium-Catalyzed Migratory Allylic Sulfonylation of Allylic Alcohols Using Sulfonyl Hydrazides

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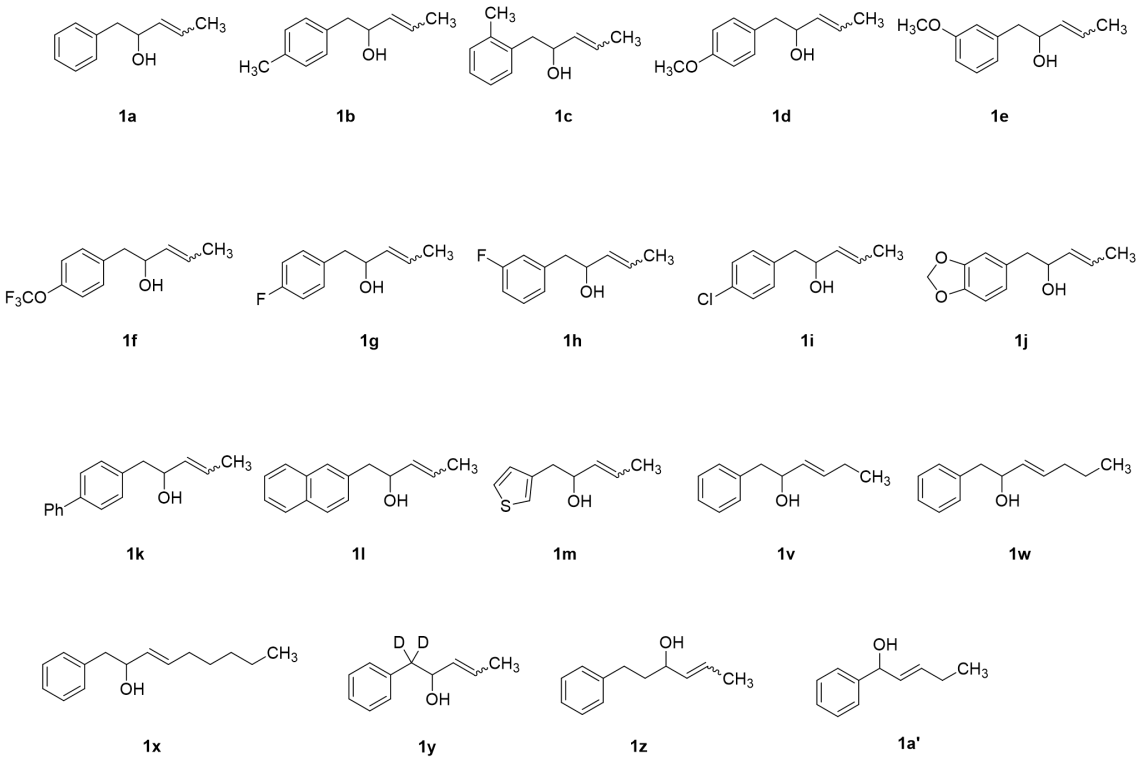
General information

Unless otherwise noted, all reactions were carried out in standard Schlenk techniques with magnetic stirring bar. Materials obtained from commercial suppliers were used directly without further purification. ^{1}H NMR spectra were recorded on a BRUKER 400 (400 MHz) spectrometer in $CDCl_3$. Chemical shifts are reported in ppm, using the residual solvent peak in $CDCl_3$ (H = 7.26) as internal standard. Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, dd = doublet of doublet, t = triplet, q = quartet, m = multiplet), coupling constants (Hz), and integration. ^{13}C NMR spectra were recorded on a BRUKER 400 (100 MHz) spectrometer in $CDCl_3$ with complete proton decoupling. Chemical shifts are reported in ppm with the deuterium solvent as the internal standard ($CDCl_3$: 77.0 ppm). HRMS were recorded using EI and ESI techniques.

Anhydrous tetrahydrofuran (THF), toluene, acetonitrile and dichloromethane (DCM) were obtained from solvent purification system. Unless otherwise noted, analytical grade solvents and commercially available reagents were used directly.

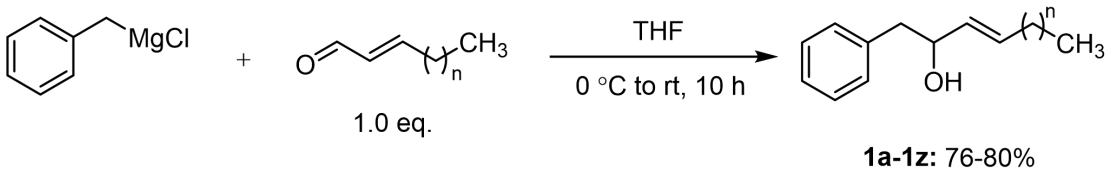
Reactions were monitored by thin layer chromatography (TLC) using pre-coated silica gel plates. Flash column chromatography was performed on silica gel 60 (particle size 300-400 mesh ASTM, purchased from Yantai, China).

Preparation of starting materials



1a, 1a', 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i, 1j, 1k, 1l, 1m, 1n, 1v, 1w, 1x, 1y and 1z are known compounds and prepared according to our previous work.[1]

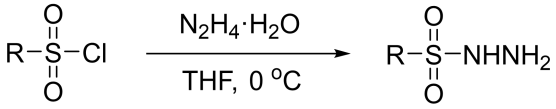
Synthesis of 3-en-2-ol (***1a-1z***)



To a solution of aldehyde (5 mmol) in dry THF (20 mL) under N_2 at 0 ℃ was added the benzyl magnesium chloride (5 mL, 5 mmol, 1.0 M in THF). Then reaction mixture was allowed to gradually warm to room temperature, and stirred for additional 10 h. After completion, the reaction was quenched by with saturated NH_4Cl (aq.) and diluted with EtOAc (10 mL). The organic layer was separated and the aqueous layer was extracted with EtOAc (10 mL×3). The combined organic layers were washed with brine (10 mL), dried over Na_2SO_4, and concentrated in

vacuo. The crude product was purified by column chromatography (eluent: petroleum ether/ethyl acetate = 40/1) gave the desired products.

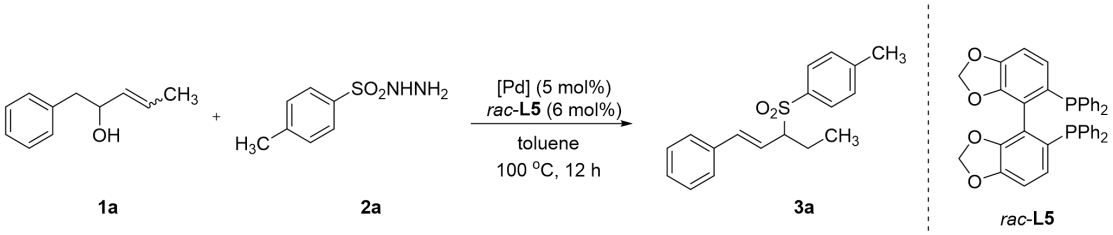
Synthesis of Sulfonyl Hydrazides



Sulfonyl hydrazides were prepared according to reported literature procedure.[2] To a solution of sulfonyl chloride (3.0 mmol) in THF (15 mL) was added dropwise hydrazine monohydrate (375 mg, 7.5 mmol) under nitrogen at 0 °C. After being vigorously stirring for 30 min at 0 °C, the reaction mixture was added ethyl acetate (3 × 20 mL), and washed with saturated brine (3 × 10 mL). The organic layers were separated, combined, and dried over sodium sulfate. After filtration, the mixture was concentrated and added to hexane (12 mL) over 5 min. The mixture was filtered, and the collected solid was dried in vacuum.

Optimization of the reaction conditions

Table S1. Screening of palladium sources

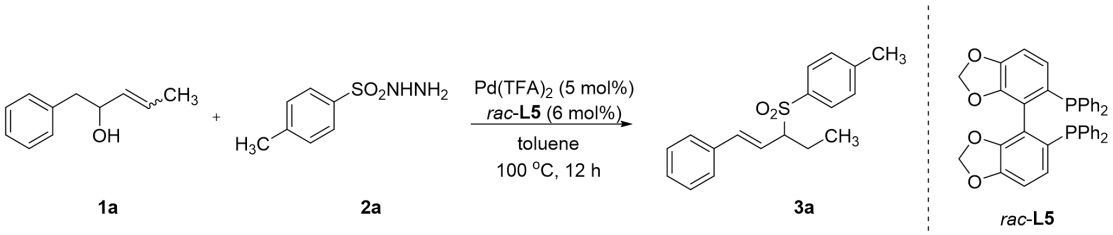


1a **2a** **3a** *rac*-**L5**

Entry	[Pd]	Yield of **3a** (%)[a]
1	$Pd_2(dba)_3$	20
2	$Pd(dba)_2$	20
3	$Pd_2(allyl)_2Cl_2$	17
4	$Pd(TFA)_2$	36
5	$PdCl_2$	20
6	$Pd(CN)_2Cl_2$	N.D.
7	$Pd(dppf)Cl_2$	N.D.
8	$Pd(OAc)_2$	30
9	$Pd(PPh_3)_2Cl_2$	14
10	$Pd(PPh_3)_4$	trace

Reaction conditions: the reaction was carried out with **1a** (0.20 mmol), **2a** (0.40 mmol), [Pd] (5 mol%), and *rac*-**L5** (6 mol%) in toluene (1.0 mL) at 100 °C for 12 h. [a]Yields were determined by ^1H NMR analysis using CH_2Br_2 as the internal standard.

Table S2. Screening of the ratio of **1a** to **2a**

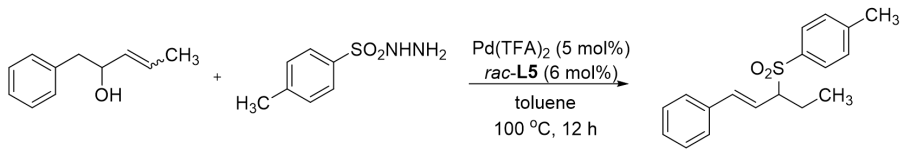


1a **2a** **3a** *rac*-**L5**

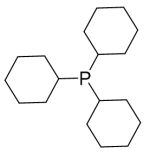
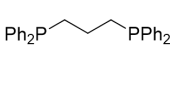
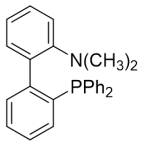
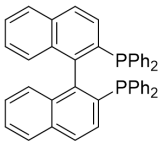
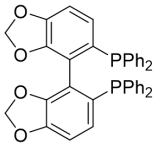
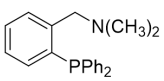
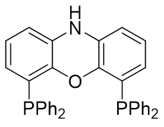
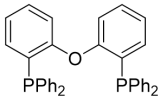
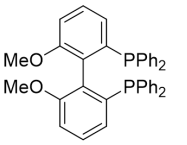
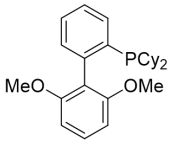
Entry	**1a** (mmol)	**2a** (mmol)	Yield of **3a** (%)[a]
1	2.0	4.0	36
2	3.0	2.0	63
3	4.0	2.0	72
4	5.0	2.0	70

Reaction conditions: the reaction was carried out with [Pd] (5 mol%), and *rac*-**L5** (6 mol%) in toluene (1.0 mL) at 100 °C for 12 h. [a]Yields were determined by ^{1}H NMR analysis using CH_2Br_2 as the internal standard.

Table S3. Screening of ligands



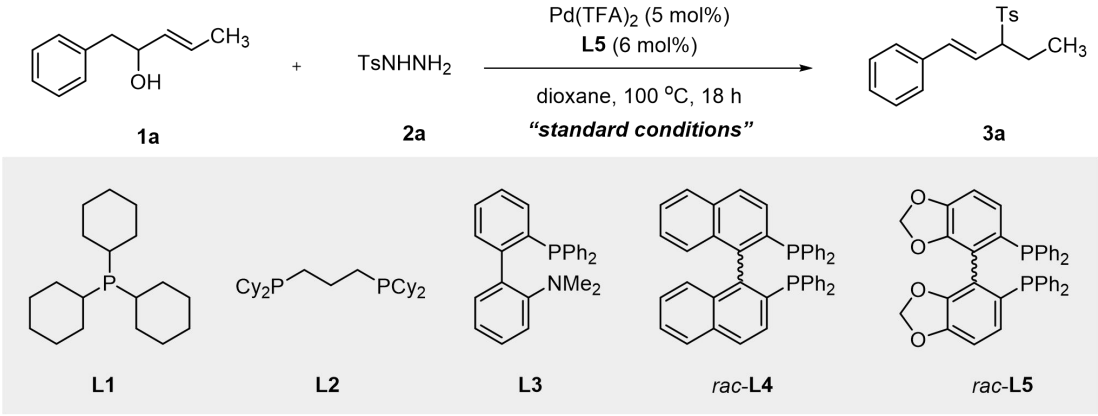
1a **2a** **3a**

				
L1 N.D.	**L2** N.D.	**L3** N.D.	**L4** 68%	**L5** 72%
				
L6 N.D.	**L7** N.D.	**L8** N.D.	**L9** 66%	**L10** N.D.

Reaction conditions: the reaction was carried out with $Pd(TFA)_2$ (5 mol%), and ligand (6 mol%) in toluene (1.0 mL) at 100 °C for 12 h. Yields were determined by ^{1}H NMR analysis using CH_2Br_2 as

the internal standard.

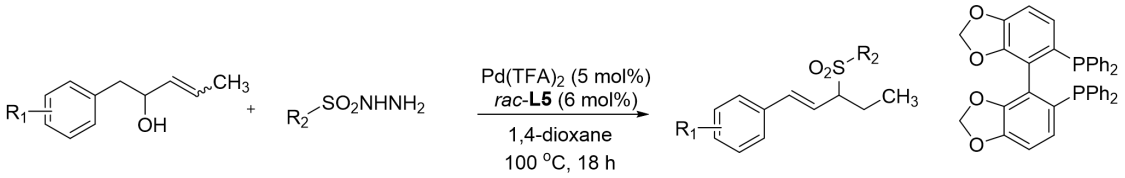
Table S4. Optimization of reaction conditions[a]



Entry	deviation from "***standard conditions***"	yield of **3a** (%)[b]
1	none	84 (81)
2	**L1** instead of **L5**	N.D.
3	**L2** instead of **L5**	N.D.
4	**L3** instead of **L5**	N.D.
5	**L4** instead of **L5**	70
6	70 °C instead of 100 °C	22
7	80 °C instead of 100 °C	70
8	DCE instead of dioxane	36
9	*n*hexane instead of dioxane	38
10	DME instead of dioxane	66
11	toluene instead of dioxane	80

[a]Unless otherwise noted, the reaction was carried out with **1a** (0.40 mmol), **2a** (0.20 mmol), $Pd(TFA)_2$ (5 mol%), and ligand (6 mol%) in indicated solvent (1.0 mL) at 100 °C for 18 h. [b]Yields were determined by ^1H NMR analysis using CH_2Br_2 as the internal standard, and value in parentheses is the isolated yield.

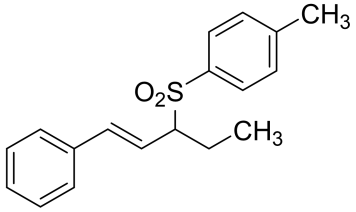
General procedure for the palladium-catalyzed migratory allylic sulfonylation of allylic alcohols



1 **2** **3** ***rac*-L5**

Under a nitrogen atmosphere, to a mixture of $Pd(TFA)_2$ (3.3 mg, 0.01 mmol), *rac*-**L5** (6.7 mg, 0.012 mmol), and sulfonyl hydrazide (0.2 mmol) was added a solution of allylic alcohol **1** (0.4 mmol) in 1,4-dioxane (1.0 mL). The reaction was sealed and stirred at 100 °C for 18 h. Subsequently, the reaction was cooled down to room temperature, and the mixture was evaporated and purified via column chromatography on silica gel (eluent: petroleum ether/ethyl acetate) to afford desired product.

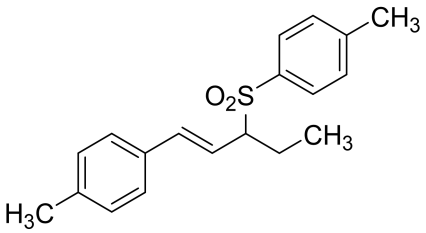
*(E)-1-Methyl-4-((1-phenylpent-1-en-3-yl)sulfonyl)benzene (**3a**, yxz-4-70)*[3]



3a

83% isolated yield from **1a** (eluent: petroleum ether/ethyl acetate = 30/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.3 Hz, 2H), 7.36-7.20 (m, 7H), 6.31 (d, *J* = 15.8 Hz, 1H), 5.90 (dd, *J* = 15.9, 9.4 Hz, 1H), 3.57-3.51 (m, 1H), 2.41 (s, 3H), 2.33-2.18 (m, 1H), 1.84-1.68 (m, 1H), 0.98 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 144.5, 138.0, 135.9, 134.6, 129.4, 129.1, 128.6, 128.3, 126.5, 121.1, 71.1, 21.6, 21.0, 11.3; HRMS (ESI) m/z calculated for $C_{18}H_{20}O_2SNa^+$ $[M+Na]^+$: 323.1076, found: 323.1076.

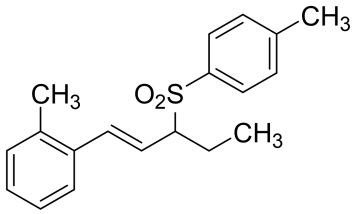
*(E)-1-Methyl-4-((1-(p-tolyl)pent-1-en-3-yl)sulfonyl)benzene (**3b**, yxz-4-75)*



3b

85% isolated yield from **1b** (eluent: petroleum ether/ethyl acetate = 30/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.3 Hz, 2H), 7.28 (d, *J* = 8.0 Hz, 2H), 7.22-7.05 (m, 4H), 6.27 (d, *J* = 15.8 Hz, 1H), 5.84 (dd, *J* = 15.8, 9.4 Hz, 1H), 3.55-3.49 (m, 1H), 2.41 (s, 3H), 2.33 (s, 3H), 2.30-2.19 (m, 1H), 1.81-1.68 (m, 1H), 0.98 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 144.4, 138.3, 137.9, 134.7, 133.2, 129.4, 129.3, 129.2, 126.4, 120.0, 71.1, 21.6, 21.2, 21.0, 11.3; HRMS (ESI) m/z calculated for $C_{19}H_{26}NO_2S^+$ $[M+NH_4]^+$: 332.1679, found: 332.1684.

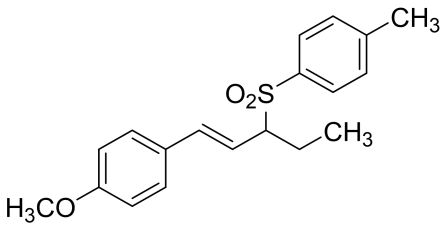
*(E)-1-Methyl-2-(3-tosylpent-1-en-1-yl)benzene (**3c**, yxz-4-74)*



3c

80% isolated yield from **1c** (eluent: petroleum ether/ethyl acetate = 30/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.72 (d, *J* = 8.3 Hz, 2H), 7.42-7.26 (m, 3H), 7.22-7.12 (m, 2H), 7.12-7.07 (m, 1H), 6.48 (d, *J* = 15.7 Hz, 1H), 5.77 (dd, *J* = 15.7, 9.5 Hz, 1H), 3.60-3.54 (m, 1H), 2.42 (s, 3H), 2.36-2.22 (m, 1H), 2.12 (s, 3H), 1.85-1.74 (m, 1H), 1.01 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 144.5, 136.2, 135.5, 135.2, 134.8, 130.2, 129.4, 129.2, 128.2, 126.2, 125.8, 122.7, 71.3, 21.6, 20.8, 19.4, 11.4; HRMS (ESI) m/z calculated for $C_{19}H_{26}NO_2S^+$ $[M+NH_4]^+$: 332.1679, found: 332.1682

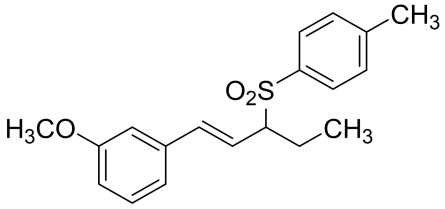
*(E)-1-Methoxy-4-(3-tosylpent-1-en-1-yl)benzene (**3d**, yxz-4-76)*



3d

79% isolated yield from **1d** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.3 Hz, 2H), 7.28 (d, *J* = 8.0 Hz, 2H), 7.22 (d, *J* = 8.7 Hz, 2H), 6.84 (d, *J* = 8.7 Hz, 2H), 6.25 (d, *J* = 15.8 Hz, 1H), 5.74 (dd, *J* = 15.8, 9.4 Hz, 1H), 3.80 (s, 3H), 3.54-3.48 (m, 1H), 2.41 (s, 3H), 2.29-2.17 (m, 1H), 1.82-1.69 (m, 1H), 0.97 (t, *J* = 7.5 Hz, 3H).; ^{13}C NMR (100 MHz, Chloroform-*d*) δ 159.7, 144.4, 137.5, 134.7, 129.4, 129.2, 128.7, 127.8, 118.6, 114.0, 71.2, 55.3, 21.6, 21.0, 11.3; HRMS (ESI) m/z calculated for $C_{19}H_{26}NO_3S^+$ $[M+NH_4]^+$: 348.1628, found: 348.1626.

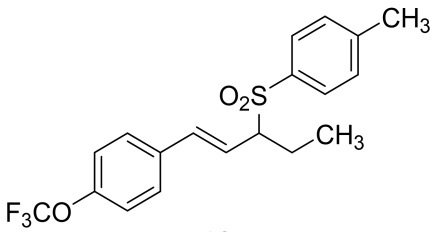
*(E)-1-Methoxy-3-(3-tosylpent-1-en-1-yl)benzene (**3e**, yxz-4-80)*



3e

71% isolated yield from **1e** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.3 Hz, 2H), 7.29 (d, *J* = 8.0 Hz, 2H), 7.22 (t, *J* = 7.7 Hz, 1H), 6.88-6.81 (m, 3H), 6.28 (d, *J* = 15.8 Hz, 1H), 5.90 (dd, *J* = 15.8, 9.4 Hz, 1H), 3.81 (s, 3H), 3.56-3.50 (m, 1H), 2.42 (s, 3H), 2.30-2.20 (m, 1H), 1.81-1.72 (m, 1H), 0.98 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 159.8, 144.5, 138.0, 137.3, 134.6, 129.6, 129.4, 129.2, 121.4, 119.2, 113.9, 111.8, 71.1, 55.2, 21.6, 21.0, 11.3; HRMS (ESI) m/z calculated for $C_{19}H_{26}NO_3S^+$ $[M+NH_4]^+$: 348.1628, found: 348.1635.

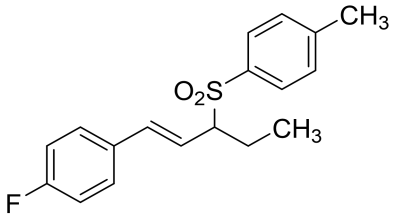
*(E)-1-Methyl-4-((1-(4-(trifluoromethoxy)phenyl)pent-1-en-3-yl)sulfonyl)benzene (**3f**, yxz-4-77)*



3f

60% isolated yield from **1f** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.1 Hz, 2H), 7.30 (d, *J* = 8.3 Hz, 4H), 7.16 (d, *J* = 8.4 Hz, 2H), 6.32 (d, *J* = 15.8 Hz, 1H), 5.89 (dd, *J* = 15.8, 9.4 Hz, 1H), 3.57-3.51 (m, 1H), 2.43 (s, 3H), 2.28-2.18 (m, 1H), 1.81-1.70 (m, 1H), 0.98 (t, *J* = 7.4 Hz, 3H); ^{19}F NMR (376 MHz, Chloroform-*d*) δ -57.8; ^{13}C NMR (100 MHz, Chloroform-*d*) δ 149.0, 144.6, 136.5, 134.6, 129.5, 129.3, 129.1, 127.8, 122.2, 121.1, 120.4 (q, *J* = 255.7 Hz), 71.0, 21.6, 21.1, 11.3; HRMS (ESI) m/z calculated for $C_{19}H_{23}F_3NO_3S^+$ $[M+NH_4]^+$: 402.1345, found: 402.1351.

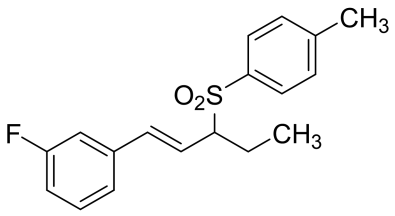
*(E)-1-Fluoro-4-(3-tosylpent-1-en-1-yl)benzene (**3g**, yxz-4-86)*



3g

60% isolated yield from **1g**(eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.3 Hz, 2H), 7.31-7.24 (m, 4H), 7.02-6.98 (m, 2H), 6.29 (d, *J* = 15.9 Hz, 1H), 5.82 (dd, *J* = 15.9, 9.4 Hz, 1H), 3.56-3.50 (m, 1H), 2.42 (s, 3H), 2.26-2.19 (m, 1H), 1.79-1.69 (m, 1H), 0.97 (t, *J* = 7.5 Hz, 3H); ^{19}F NMR (376 MHz, Chloroform-*d*) δ -113.1; ^{13}C NMR (100 MHz, Chloroform-*d*) δ 162.68 (d, *J* = 246.8 Hz), 144.5, 136.9, 134.6, 132.1, 129.3 (d, *J* = 3.1 Hz), 128.2, 128.1 (d, *J* = 7.8 Hz), 115.59 (d, *J* = 22.4 Hz), 71.0, 21.6, 21.1, 11.3; HRMS (ESI) m/z calculated for $C_{18}H_{23}FNO_2S^+$ $[M+NH_4]^+$: 336.1428, found: 336.1434.

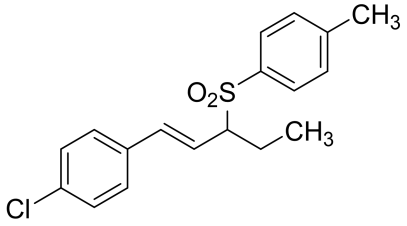
*(E)-1-Fluoro-3-(3-tosylpent-1-en-1-yl)benzene (**3h**, yxz-4-94)*



3h

57% isolated yield from **1h** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.3 Hz, 2H), 7.31-7.24 (m, 3H), 7.05 (d, *J* = 7.7 Hz, 1H), 6.98-6.93 (m, 2H), 6.29 (d, *J* = 15.8 Hz, 1H), 5.91 (dd, *J* = 15.8, 9.4 Hz, 1H), 3.57-3.51 (m, 1H), 2.43 (s, 3H), 2.26-2.21 (m, 1H), 1.79-1.72 (m, 1H), 0.98 (t, *J* = 7.5 Hz, 3H); ^{19}F NMR (376 MHz, Chloroform-*d*) δ -113.1; ^{13}C NMR (100 MHz, Chloroform-*d*) δ 163.0 (d, *J* = 243.8 Hz), 144.6, 138.2 (d, *J* = 7.4 Hz), 136.9 (d, *J* = 1.8 Hz), 134.6, 130.2 (d, *J* = 7.1 Hz), 129.5, 129.2, 122.7, 122.4 (d, *J* = 2.4 Hz), 115.2 (d, *J* = 21.6 Hz), 113.0 (d, *J* = 21.4 Hz), 70.9, 21.6, 21.1, 11.3; HRMS (ESI) m/z calculated for $C_{18}H_{23}FNO_2S^+$ $[M+NH_4]^+$: 336.1428, found: 336.1434.

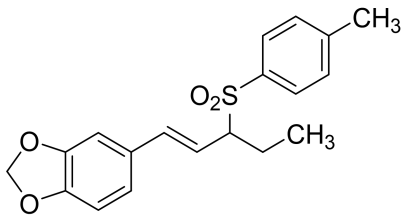
*(E)-1-Chloro-4-(3-tosylpent-1-en-1-yl)benzene (**3i**, yxz-4-84)*



3i

65% isolated yield from **1i** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.69 (d, *J* = 8.3 Hz, 2H), 7.30-7.26 (m, 4H), 7.21 (d, *J* = 8.5 Hz, 2H), 6.27 (d, *J* = 15.9 Hz, 1H), 5.88 (dd, *J* = 15.9, 9.4 Hz, 1H), 3.56-3.50 (m, 1H), 2.42 (s, 3H), 2.28-2.18 (m, 1H), 1.79-1.71 (m, 1H), 0.97 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 144.6, 136.8, 134.6, 134.4, 134.1, 129.5, 129.1, 128.8, 127.7, 121.8, 71.0, 21.6, 21.0, 11.3; HRMS (ESI) m/z calculated for $C_{18}H_{23}{}^{35}ClNO_2S^+$ $[M+NH_4]^+$: 352.1133, found: 352.1138.

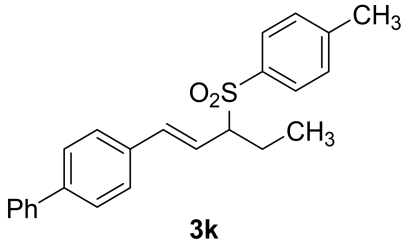
*(E)-5-(3-Tosylpent-1-en-1-yl)benzo[d][1,3]dioxole (**3j**, yxz-4-81)*



3j

65% isolated yield from **1j** (eluent: petroleum ether/ethyl acetate = 10/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.3 Hz, 2H), 7.29 (d, *J* = 8.0 Hz, 2H), 6.83 (s, 1H), 6.75-6.68 (m, 2H), 6.22 (d, *J* = 15.8 Hz, 1H), 5.96 (s, 2H), 5.70 (dd, *J* = 15.8, 9.4 Hz, 1H), 3.53-3.47 (m, 1H), 2.42 (s, 3H), 2.28-2.18 (m, 1H), 1.78-1.66 (m, 1H), 0.97 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 148.1, 147.8, 144.5, 137.7, 134.6, 130.4, 129.4, 129.2, 121.5, 119.1, 108.3, 105.7, 101.2, 71.1, 21.6, 21.1, 11.3; HRMS (ESI) m/z calculated for $C_{19}H_{24}NO_4S^+$ $[M+NH_4]^+$: 362.1421, found: 362.1424.

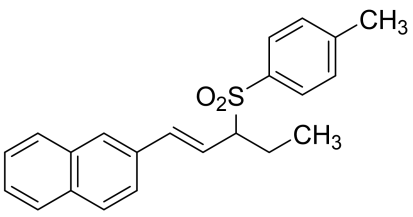
*(E)-4-(3-Tosylpent-1-en-1-yl)-1,1'-biphenyl (**3k**, yxz-4-87)*



3k

69% isolated yield from **1k** (eluent: petroleum ether/ethyl acetate = 20/1), white solid; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.72 (d, *J* = 8.3 Hz, 2H), 7.60-7.53 (m, 4H), 7.46-7.25 (m, 7H), 6.35 (d, *J* = 15.8 Hz, 1H), 5.95 (dd, *J* = 15.8, 9.4 Hz, 1H), 3.59-3.53 (m, 1H), 2.42 (s, 3H), 2.28-2.24 (m, 1H), 1.80-1.76 (m, 1H), 1.00 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 144.5, 141.1, 140.4, 137.6, 135.0, 134.7, 129.5, 129.2, 128.9, 127.5, 127.3, 127.1, 127.0, 121.2, 71.2, 21.7, 21.1, 11.4; HRMS (ESI) m/z calculated for $C_{24}H_{28}NO_2S^+$ $[M+NH_4]^+$: 394.1835, found: 394.1838.

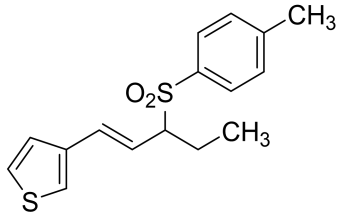
*(E)-2-(3-Tosylpent-1-en-1-yl)naphthalene (**3l**, yxz-4-83)*



3l

71% isolated yield from **1l** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.80-7.44 (m, 9H), 7.27 (d, *J* = 8.1 Hz, 2H), 6.46 (d, *J* = 15.8 Hz, 1H), 6.03 (dd, *J* = 15.8, 9.4 Hz, 1H), 3.63-3.57 (m, 1H), 2.40 (s, 3H), 2.34-2.24 (m, 1H), 1.87-1.75 (m, 1H), 1.01 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 144.5, 138.1, 134.6, 133.3, 133.3, 133.2, 129.4, 129.2, 128.3, 128.0, 127.7, 126.8, 126.4, 126.3, 123.3, 121.4, 71.2, 21.6, 21.0, 11.4; HRMS (ESI) m/z calculated for $C_{22}H_{26}NO_2S^+$ $[M+NH_4]^+$: 368.1679, found: 368.1684.

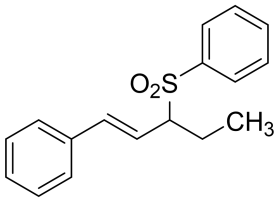
*(E)-3-(3-Tosylpent-1-en-1-yl)thiophene (**3m**, yxz-4-89)*



3m

67% isolated yield from **1m** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.72 (d, *J* = 8.3 Hz, 2H), 7.33-7.28 (m, 3H), 7.17 (d, *J* = 5.1 Hz, 1H), 7.12 (d, *J* = 2.9 Hz, 1H), 6.37 (d, *J* = 15.8 Hz, 1H), 5.76 (dd, *J* = 15.8, 9.4 Hz, 1H), 3.54-3.48 (m, 1H), 2.44 (s, 3H), 2.29-2.19 (m, 1H), 1.80-1.68 (m, 1H), 0.99 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 144.5, 138.6, 134.7, 132.1, 129.4, 129.2, 126.3, 124.8, 123.4, 120.7, 71.1, 21.6, 21.1, 11.3; HRMS (ESI) m/z calculated for $C_{16}H_{22}NO_2S_2^+$ $[M+NH_4]^+$: 324.1086, found: 324.1090.

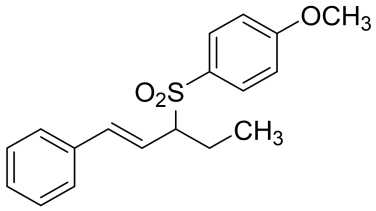
*(E)-((1-Phenylpent-1-en-3-yl)sulfonyl)benzene (**3n**, yxz-5-9)* [3]



3n

81% isolated yield from **1a** (eluent: petroleum ether/ethyl acetate = 20/1), white solid; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.87-7.85 (m, 2H), 7.65-7.61 (m, 1H), 7.54-7.50 (m, 2H), 7.33-7.27 (m, 5H), 6.30 (d, *J* = 15.9 Hz, 1H), 5.93 (dd, *J* = 15.9, 9.5 Hz, 1H), 3.62-3.56 (m, 1H), 2.35-2.25 (m, 1H), 1.85-1.77 (m, 1H), 1.02 (t, *J* = 7.3 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 138.3, 137.6, 135.8, 133.5, 129.1, 128.8, 128.6, 128.4, 126.5, 121.0, 71.1, 20.9, 11.3; HRMS (ESI) m/z calculated for $C_{17}H_{22}NO_2S^+$ $[M+NH_4]^+$: 304.1366, found: 304.1371.

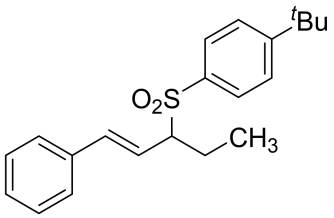
*(E)-1-Methoxy-4-((1-phenylpent-1-en-3-yl)sulfonyl)benzene (**3o**, yxz-5-6)*



3o

80% isolated yield from **1a**(eluent: petroleum ether/ethyl acetate = 15/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.77 (d, *J* = 8.9 Hz, 2H), 7.36-7.29 (m, 5H), 6.97 (d, *J* = 8.9 Hz, 2H), 6.34 (d, *J* = 15.9 Hz, 1H), 5.93 (dd, *J* = 15.9, 9.4 Hz, 1H), 3.88 (s, 3H), 3.58-3.52 (m, 1H), 2.31-2.23 (m, 1H), 1.82-1.74 (m, 1H), 1.01 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 163.6, 138.0, 135.9, 131.3, 129.1, 128.6, 128.3, 126.5, 121.3, 114.0, 71.3, 55.6, 21.1, 11.4; HRMS (ESI) m/z calculated for $C_{18}H_{20}O_3SNa^+$ $[M+Na]^+$: 339.1025, found: 339.1031.

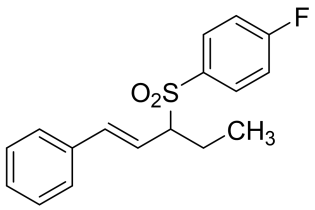
*(E)-1-(tert-Butyl)-4-((1-phenylpent-1-en-3-yl)sulfonyl)benzene (**3p**, yxz-5-21)*



3p

71% isolated yield from **1a** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.74 (d, *J* = 8.6 Hz, 2H), 7.49 (d, *J* = 8.6 Hz, 2H), 7.30-7.24 (m, 5H), 6.28 (d, *J* = 15.9 Hz, 1H), 5.91 (dd, *J* = 15.9, 9.4 Hz, 1H), 3.58-3.52 (m, 1H), 2.30-2.2 (m, 1H), 1.82-1.74 (m, 1H), 1.32 (s, 9H), 0.98 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 157.4, 138.2, 135.9, 134.5, 129.0, 128.6, 128.3, 126.5, 125.8, 121.1, 71.2, 35.2, 31.0, 21.0, 11.4; HRMS (ESI) m/z calculated for $C_{21}H_{30}NO_2S^+$ $[M+NH_4]^+$: 360.1992, found: 360.2000.

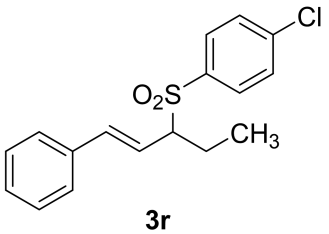
*(E)-1-Fluoro-4-((1-phenylpent-1-en-3-yl)sulfonyl)benzene (**3q**, yxz-5-7)* [3]



3q

71% isolated yield from **1a** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.86-7.82 (m, 2H), 7.34-7.18 (m, 5H), 7.18-7.15 (m, 2H), 6.28 (d, *J* = 15.9 Hz, 1H), 5.90 (dd, *J* = 15.9, 9.4 Hz, 1H), 3.57-3.52 (m, 1H), 2.31-2.25 (m, 1H), 1.83-1.75 (m, 1H), 1.01 (t, *J* = 7.5 Hz, 3H); ^{19}F NMR (376 MHz, Chloroform-*d*) δ -103.7; ^{13}C NMR (100 MHz, Chloroform-*d*) δ 165.7 (d, *J* = 253.7 Hz), 138.4, 135.6, 133.6 (d, *J* = 2.6 Hz), 132.0 (d, *J* = 9.3 Hz), 128.7, 128.5, 126.5, 120.8, 116.1 (d, *J* = 22.3 Hz), 71.3, 20.8, 11.3; HRMS (ESI) m/z calculated for $C_{17}H_{21}FNO_2S^+$ $[M+NH_4]^+$: 322.1272, found: 322.1275.

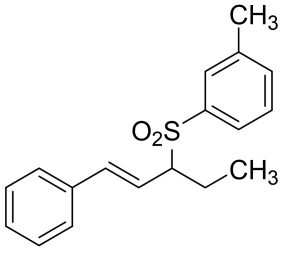
*(E)-1-Chloro-4-((1-phenylpent-1-en-3-yl)sulfonyl)benzene (**3r**, yxz-5-58)* [3]



3r

66% isolated yield from **1a** (eluent: petroleum ether/ethyl acetate = 20/1), white soild; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.76 (d, *J* = 8.4 Hz, 2H), 7.47 (d, *J* = 8.1 Hz, 2H), 7.34-7.29 (m, 5H), 6.31 (d, *J* = 15.9 Hz, 1H), 5.90 (dd, *J* = 15.9, 9.4 Hz, 1H), 3.59-3.53 (m, 1H), 2.30-2.23 (m, 1H), 1.84-1.72 (m, 1H), 1.00 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 140.31, 138.50, 136.06, 135.59, 130.60, 129.10, 128.67, 128.50, 126.52, 120.61, 71.15, 20.83, 11.27; HRMS (ESI) m/z calculated for $C_{17}H_{21}{}^{35}ClNO_2S^+$ $[M+NH_4]^+$: 338.0976, found: 338.0984.

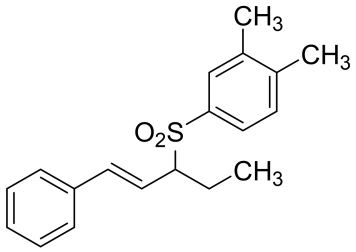
*(E)-1-Methyl-3-((1-phenylpent-1-en-3-yl)sulfonyl)benzene (**3s**, yxz-5-23)*



3s

75% isolated yield from **1a** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.64-7.61 (m, 2H), 7.42-7.35 (m, 2H), 7.33-7.24 (m, 5H), 6.28 (d, *J* = 15.9 Hz, 1H), 5.90 (dd, *J* = 15.9, 9.4 Hz, 1H), 3.58-3.52 (m, 1H), 2.35 (s, 3H), 2.29-2.22 (m, 1H), 1.82-1.76 (m, 1H), 0.99 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 139.0, 138.2, 137.4, 135.9, 134.3, 129.6, 128.6, 128.6, 128.3, 126.5, 126.3, 121.1, 71.1, 21.1, 20.9, 11.3; HRMS (ESI) m/z calculated for $C_{18}H_{24}NO_2S^+$ $[M+NH_4]^+$: 318.1522, found: 318.1529.

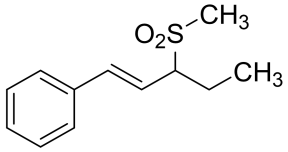
*(E)-1,2-Dimethyl-4-((1-phenylpent-1-en-3-yl)sulfonyl)benzene (**3t**, yxz-5-20)*



3t

68% isolated yield from **1a** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.61-7.53 (m, 2H), 7.29-7.23 (m, 6H), 6.32 (d, *J* = 15.9 Hz, 1H), 5.90 (dd, *J* = 15.9, 9.4 Hz, 1H), 3.56-3.50 (m, 1H), 2.34-2.21 (m, 7H), 1.81-1.69 (m, 1H), 0.98 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 143.2, 138.0, 137.5, 136.0, 134.8, 130.0, 129.9, 128.6, 128.3, 126.7, 126.5, 121.2, 71.1, 21.0, 20.0, 19.6, 11.4; HRMS (ESI) m/z calculated for $C_{19}H_{26}NO_2S^+$ $[M+NH_4]^+$: 332.1679, found: 332.1686.

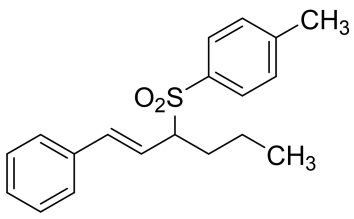
*(E)-(3-(Methylsulfonyl)pent-1-en-1-yl)benzene (**3u**, yxz-5-1)* [3]



3u

78% isolated yield from **1a** (eluent: petroleum ether/ethyl acetate = 20/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.44-7.41 (m, 2H), 7.38-7.29 (m, 3H), 6.70 (d, *J* = 15.9 Hz, 1H), 6.13 (dd, *J* = 15.9, 9.7 Hz, 1H), 3.55-3.49 (m, 1H), 2.86 (s, 3H), 2.34-2.24 (m, 1H), 1.87-1.79 (m, 1H), 1.05 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 138.0, 135.5, 128.8, 128.7, 126.7, 121.8, 70.0, 38.4, 19.7, 11.2; HRMS (ESI) m/z calculated for $C_{12}H_{16}NaO_2S^+$ $[M+Na]^+$: 247.0763, found: 247.0766.

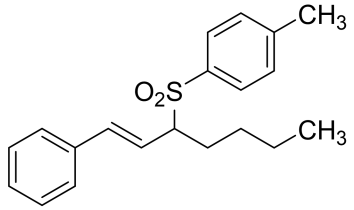
*(E)-1-Methyl-4-((1-phenylhex-1-en-3-yl)sulfonyl)benzene (**3v**, yxz-4-90)*



3v

55% isolated yield from **1v** (eluent: petroleum ether/ethyl acetate = 30/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.3 Hz, 2H), 7.33-7.24 (m, 7H), 6.29 (d, *J* = 15.9 Hz, 1H), 5.89 (dd, *J* = 15.9, 9.5 Hz, 1H), 3.66-3.60 (m, 1H), 2.41 (s, 3H), 2.18-2.11 (m, 1H), 1.78-1.72 (m, 1H), 1.50-1.44 (m, 1H), 1.34-1.27 (m, 1H), 0.92 (t, *J* = 7.3 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 144.5, 137.8, 135.9, 134.7, 129.4, 129.2, 128.6, 128.3, 126.5, 121.5, 69.4, 29.4, 21.6, 20.0, 13.6; HRMS (ESI) m/z calculated for $C_{19}H_{26}NO_2S^+$ $[M+NH_4]^+$: 332.1679, found: 332.1686.

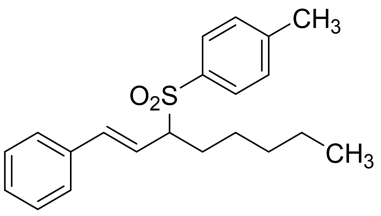
*(E)-1-Methyl-4-((1-phenylhept-1-en-3-yl)sulfonyl)benzene (**3w**, yxz-4-91)*



3w

49% isolated yield from **1w** (eluent: petroleum ether/ethyl acetate = 30/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.3 Hz, 2H), 7.33-7.25 (m, 7H), 6.28 (d, *J* = 15.9 Hz, 1H), 5.90 (dd, *J* = 15.9, 9.4 Hz, 1H), 3.64-3.58 (m, 1H), 2.41 (s, 3H), 2.22-2.18 (m, 1H), 1.76-1.73 (m, 1H), 1.41-1.25 (m, 4H), 0.87 (t, *J* = 6.7 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 144.4, 137.8, 135.9, 134.7, 129.4, 129.2, 128.6, 128.3, 126.5, 121.5, 69.7, 28.8, 27.1, 22.3, 21.6, 13.8.; HRMS (ESI) m/z calculated for $C_{20}H_{24}O_2SNa^+$ $[M+Na]^+$: 351.1389, found: 351.1389.

*(E)-1-Methyl-4-((1-phenyloct-1-en-3-yl)sulfonyl)benzene (**3x**, yxz-4-92)*



3x

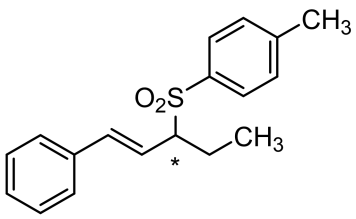
53% isolated yield from **1x** (eluent: petroleum ether/ethyl acetate = 30/1), colorless oil; ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (d, *J* = 8.2 Hz, 2H), 7.31-7.26 (m, 7H), 6.28 (d, *J* = 15.9 Hz, 1H), 5.89 (dd, *J* = 15.9, 9.4 Hz, 1H), 3.64-3.58 (m, 1H), 2.41 (s, 3H), 2.22-2.14 (m, 1H), 1.78-1.69 (m, 1H), 1.42-1.39 (m, 1H), 1.31-1.25 (m, 5H), 0.85 (t, *J* = 4.8 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 144.4, 137.8, 136.0, 134.7, 129.4, 129.2, 128.6, 128.3, 126.5, 121.5, 69.7, 31.3, 27.3, 26.4, 22.3, 21.6, 13.9; HRMS (ESI) m/z calculated for $C_{21}H_{30}NO_2S^+$ $[M+NH_4]^+$: 360.1992, found: 360.1997.

General procedure for asymmetric palladium-catalyzed migratory allylic sulfonylation of allylic alcohols

1 **2** **3** **L5**

Under a nitrogen atmosphere, to a mixture of $Pd(TFA)_2$ (3.3 mg, 0.01 mmol), **L5** (14.1 mg, 0.012 mmol), and sulfonyl hydrazide (0.4 mmol) was added a solution of allylic alcohol **1** (0.2 mmol) in toluene (1.0 mL). The reaction was sealed and stirred at 100 °C for 18 h. Subsequently, the reaction was cooled down to room temperature, and the mixture was evaporated and purified via column chromatography on silica gel (eluent: petroleum ether/ethyl acetate) to afford desired product.

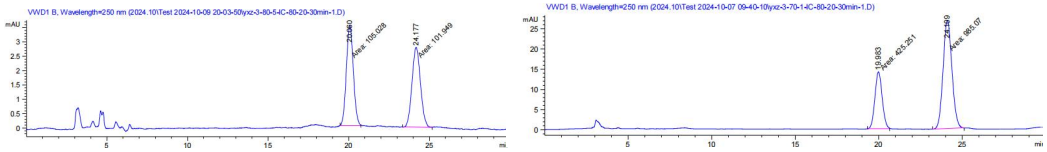
*(E)-1-Methyl-4-((1-phenylpent-1-en-3-yl)sulfonyl)benzene (**3a**, yxz-3-70)*[3]



3a

60% isolated yield from **1a** (eluent: petroleum ether/ethyl acetate = 30/1), colorless oil;

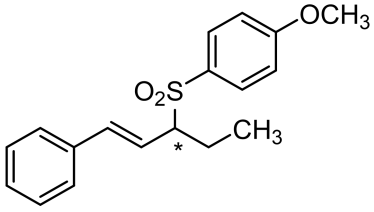
70:30 *er*; HPLC analysis: Chiralcel IC column; detected at 250 nm, 25 °C; 20% *i*-PrOH in *n*-hexane; flow = 1.0 mL/min; Retention time: 19.9 min (minor), 24.1 min (major).



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.060	MM	0.5017	105.02797	3.48889	50.7438
2	24.177	MM	0.6108	101.94913	2.78185	49.2562

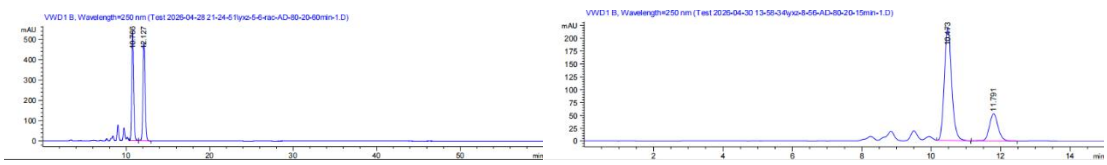
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	19.983	MM	0.5046	425.25107	14.04494	30.1528
2	24.109	MM	0.6148	985.06976	26.70535	69.8472

*(E)-1-Methoxy-4-((1-phenylpent-1-en-3-yl)sulfonyl)benzene (**3o**, yxz-8-56)* [3]



3o

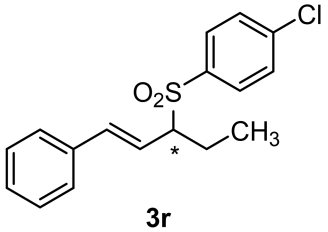
34% isolated yield from **1a**(eluent: petroleum ether/ethyl acetate = 15/1), colorless oil; 78:22 *er*; HPLC analysis: Chiralcel AD column; detected at 250 nm, 25 °C; 20% *i*-PrOH in *n*-hexane; flow = 1.0 mL/min; Retention time: 10.5 min (major), 11.8 min (minor).



Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.766	BB	0.2487	8688.19043	537.19696	49.8986
2	12.127	BB	0.2790	8723.51367	482.29193	50.1014

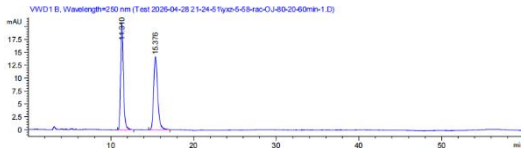
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.473	BB	0.2245	3208.88843	219.52364	77.8115
2	11.791	VB R	0.2683	915.03723	52.77918	22.1885

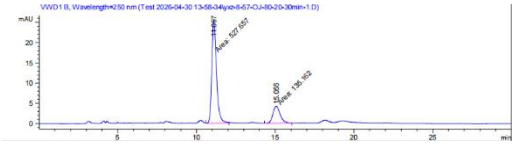
*(E)-1-Chloro-4-((1-phenylpent-1-en-3-yl)sulfonyl)benzene (**3r**, yxz-8-57)* [3]



3r

30% isolated yield from **1a** (eluent: petroleum ether/ethyl acetate = 20/1), white solid; 80:20 *er*; HPLC analysis: Chiralcel OJ column; detected at 250 nm, 25 °C; 20% *i*-PrOH in *n*-hexane; flow = 1.0 mL/min; Retention time: 11.0 min (major), 15.0 min (minor).

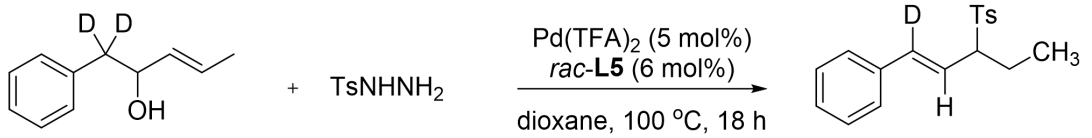




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.310	BB	0.3531	478.81076	20.75767	50.0632
2	15.376	BB	0.5148	477.60208	14.18531	49.9368

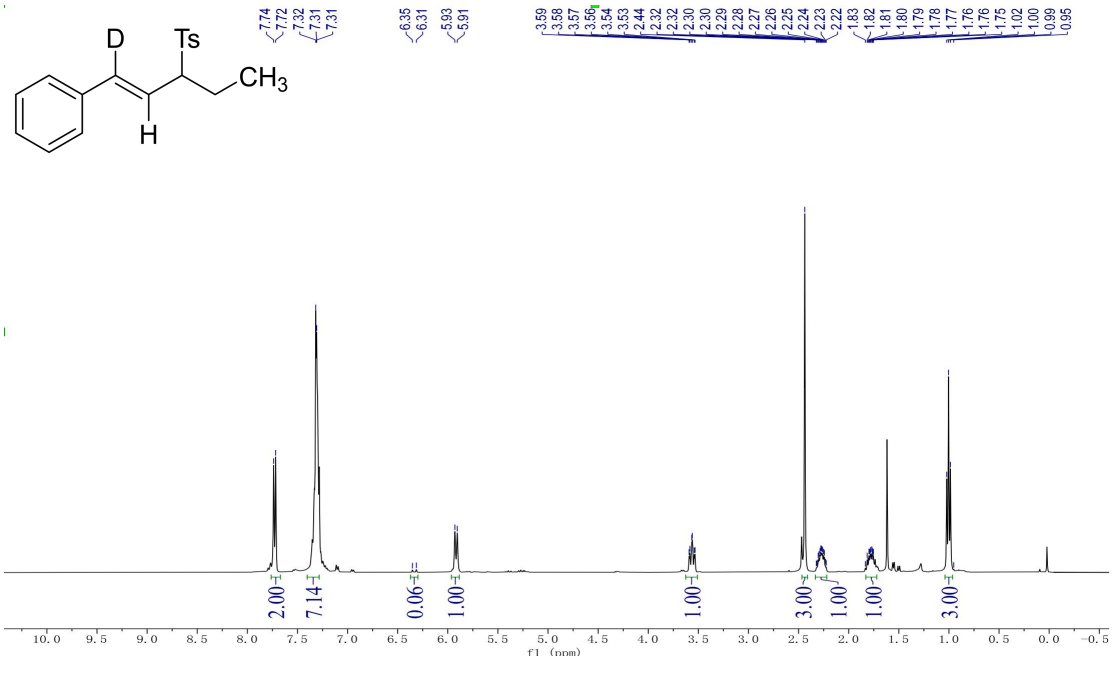
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.097	MM	0.3463	527.65662	25.39371	79.6080
2	15.055	MM	0.5320	135.16187	4.23439	20.3920

Deuterium labeling experiments



1a-*d*$_2$ **2** **3a-*d*,** 60% yield, 94% D

Under a nitrogen atmosphere, to a mixture of $Pd(TFA)_2$ (3.3 mg, 0.01 mmol), *rac*-**L5** (6.7 mg, 0.012 mmol), and sulfonyl hydrazide (0.2 mmol) was added a solution of **1a-*d*$_2$** (0.4 mmol) in 1,4-dioxane (1.0 mL). The reaction was sealed and stirred at 100 °C for 18 h. Subsequently, the reaction was cooled down to room temperature, and the mixture was evaporated and purified via column chromatography on silica gel (eluent: petroleum ether/ethyl acetate) to afford the desired product **3a-*d***: colorless oil.



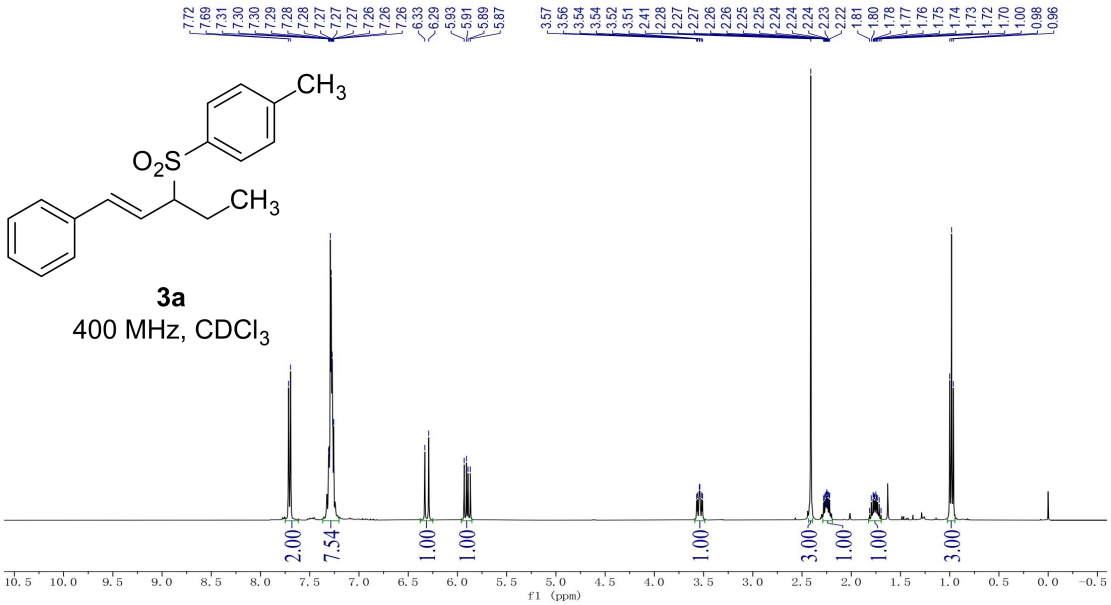
References

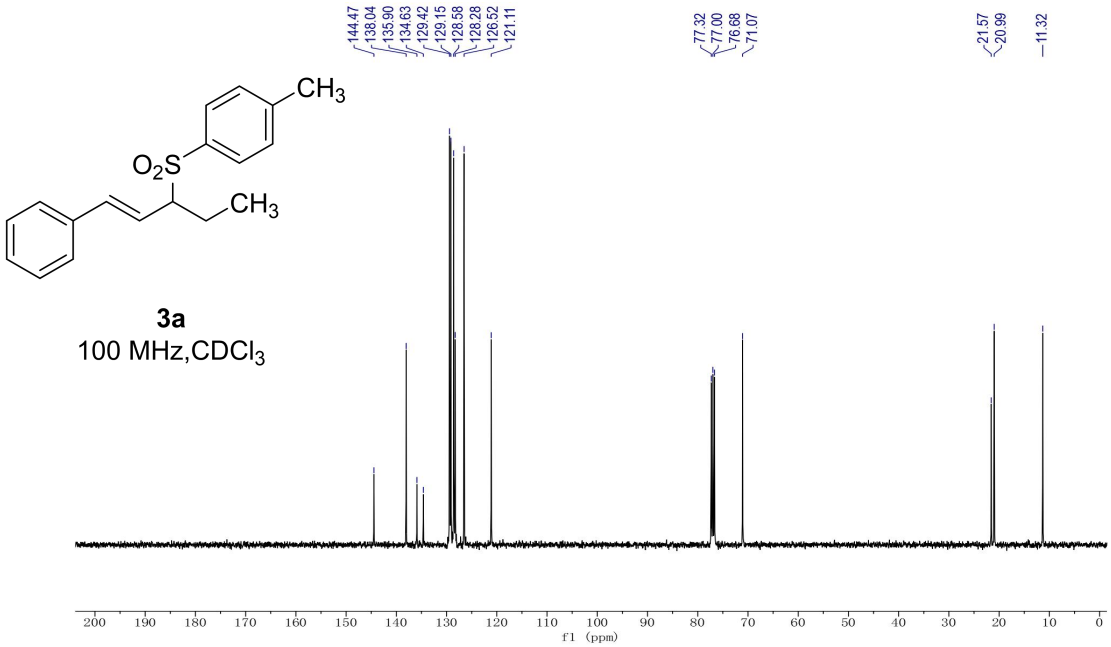
1. D. Zhao, B. Xu, C. Zhu, Migratory allylic arylation of 1,n-enols enabled by nickel catalysis. *Nat. Commun.* **2023**, *14*, 3308.

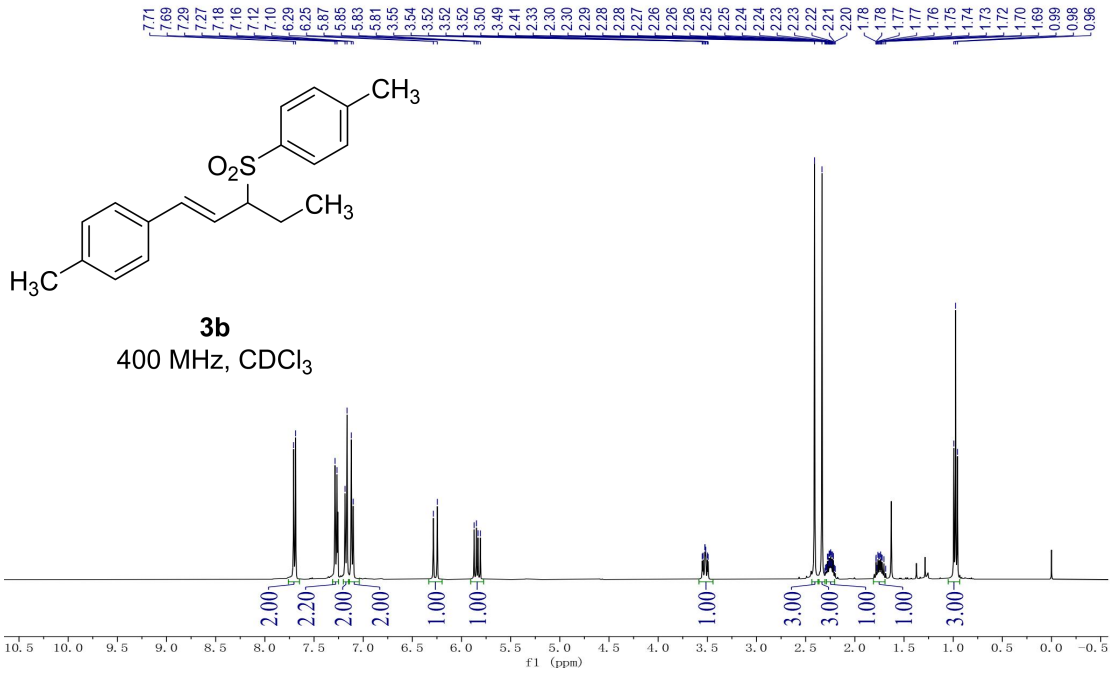
2. M.-M. Li, L. Cheng, L.-J. Xiao, J.-H. Xie,; Q.-L. Zhou, Palladium-Catalyzed Asymmetric Hydrosulfonylation of 1,3-Dienes with Sulfonyl Hydrazides. *Angew. Chem. Int. Ed.* **2021**, *60*, 2948.

3. Q. Zhang, D. Dong, W. Zi, Palladium-Catalyzed Regio- and Enantioselective Hydrosulfonylation of 1,3-Dienes with Sulfinic Acids : Scope, Mechanism, and Origin of Selectivity. *J. Am. Chem. Soc.* **2020**, *142*, 15860.

^{1}H NMR and ^{13}C NMR spectra for compounds



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5.81
3.55
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3.52
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3.50
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2.20
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1.78
1.77
1.77
1.76
1.75
1.74
1.73
1.72
1.70
1.69
0.99
0.98
0.96
CH3
O2S
CH3
H3C
3b
400 MHz, CDCl3
2.00
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2.00
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1.00
1.00
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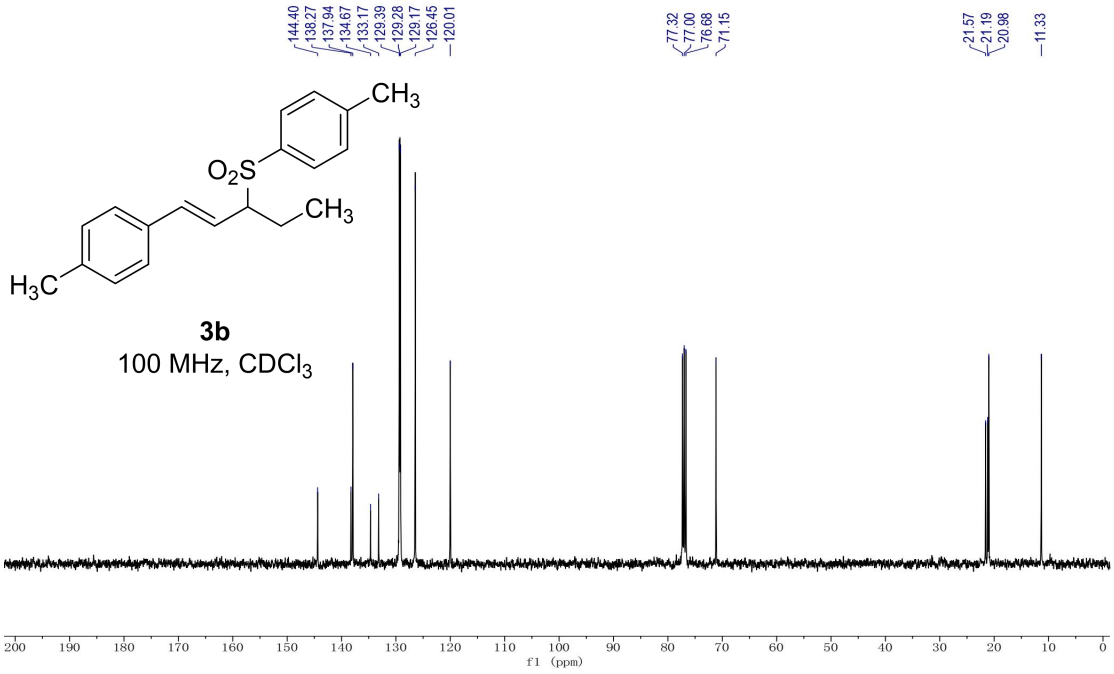
3.00
1.00
1.00
3.00
f1 (ppm)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20.98
11.33
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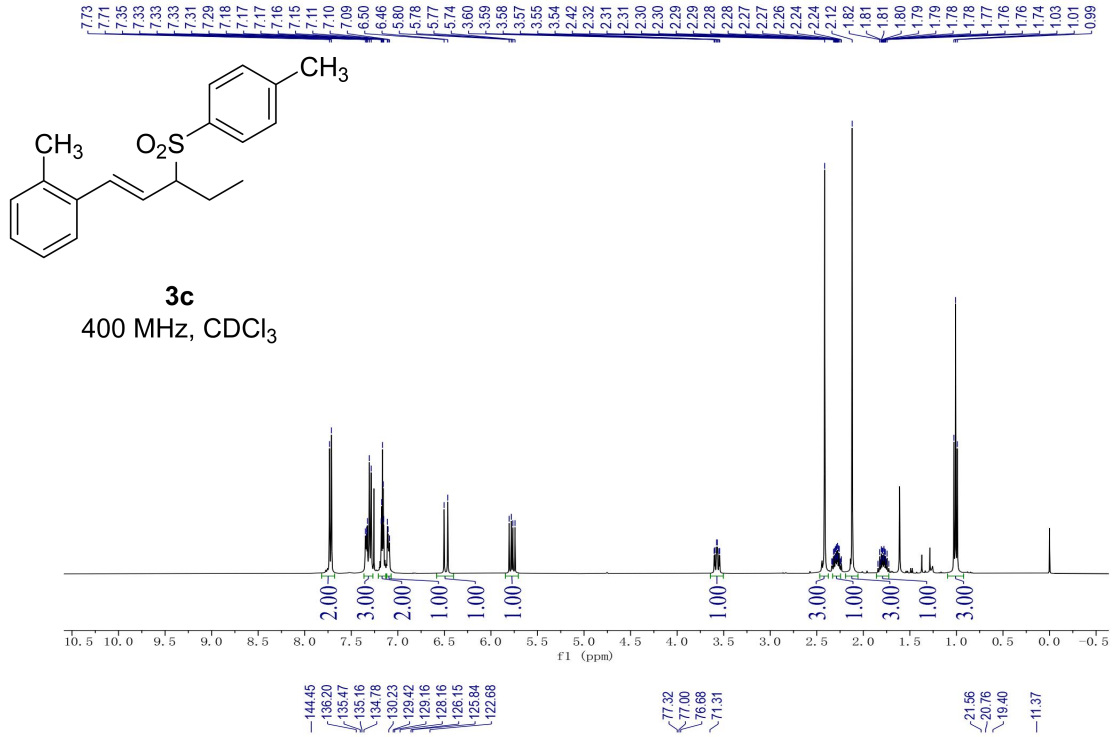
O2S
CH3
H3C
3b
100 MHz, CDCl3
f1 (ppm)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3.58
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1.03
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CH3
O2S
3c
400 MHz, CDCl3
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1.00
3.00
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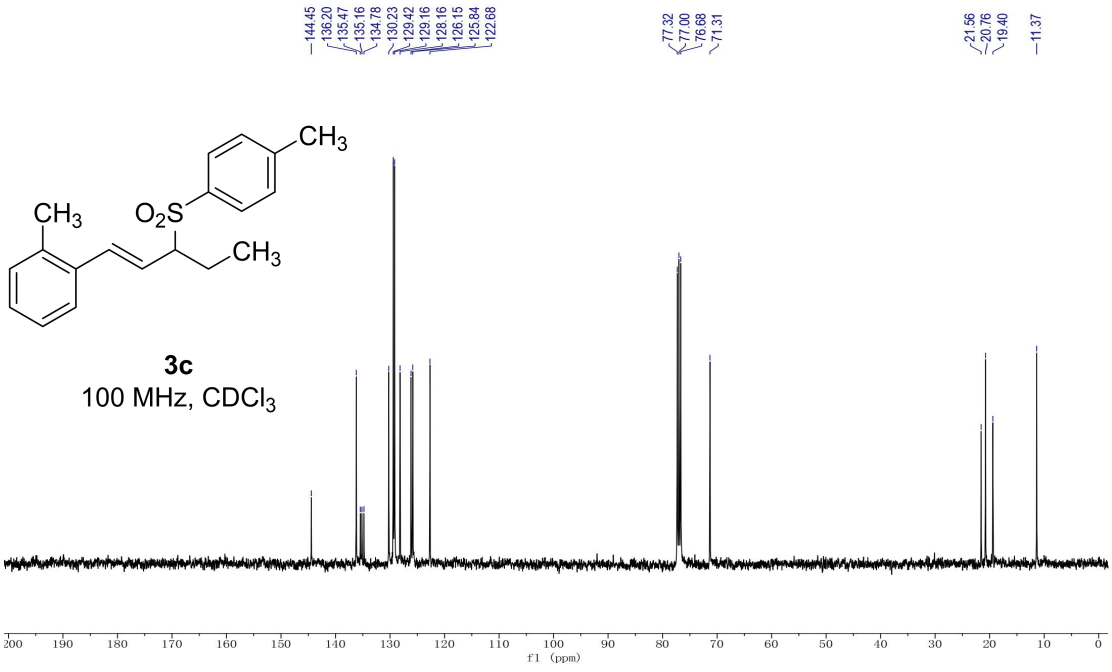
f1 (ppm)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77.00
76.68
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CH3
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CH3
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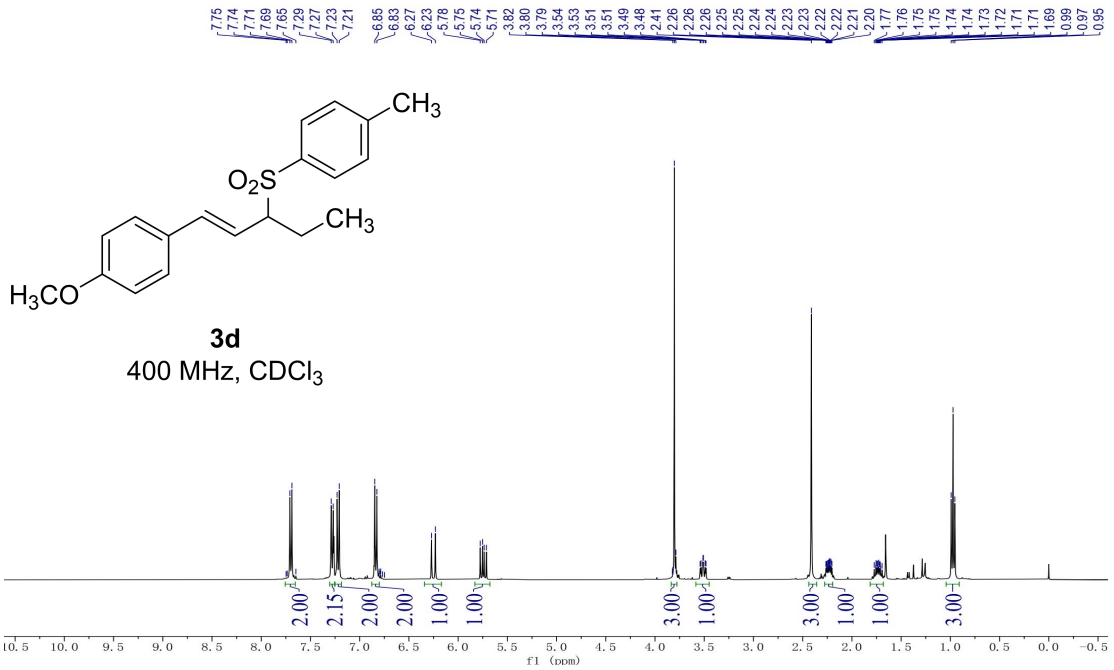
100 MHz, CDCl3
f1 (ppm)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3.82
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2.22
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2.21
2.20
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1.76
1.75
1.75
1.74
1.74
1.73
1.72
1.71
1.71
1.69
0.99
0.97
0.95
CH3
O2S
CH3
H3CO
3d
400 MHz, CDCl3
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3.00
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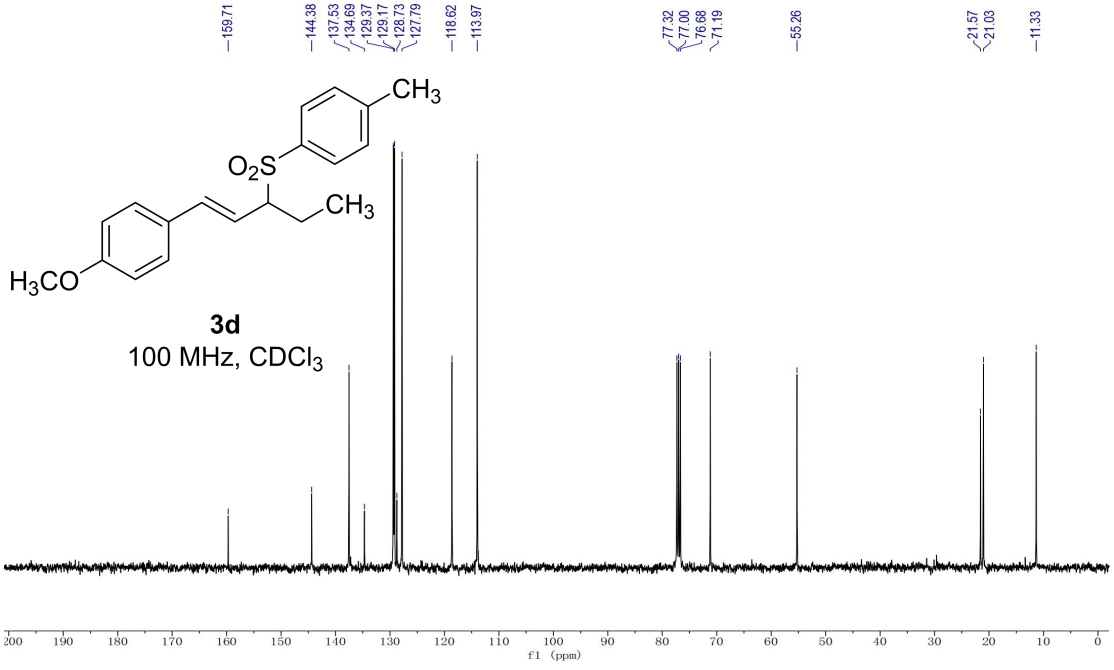
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H3CO
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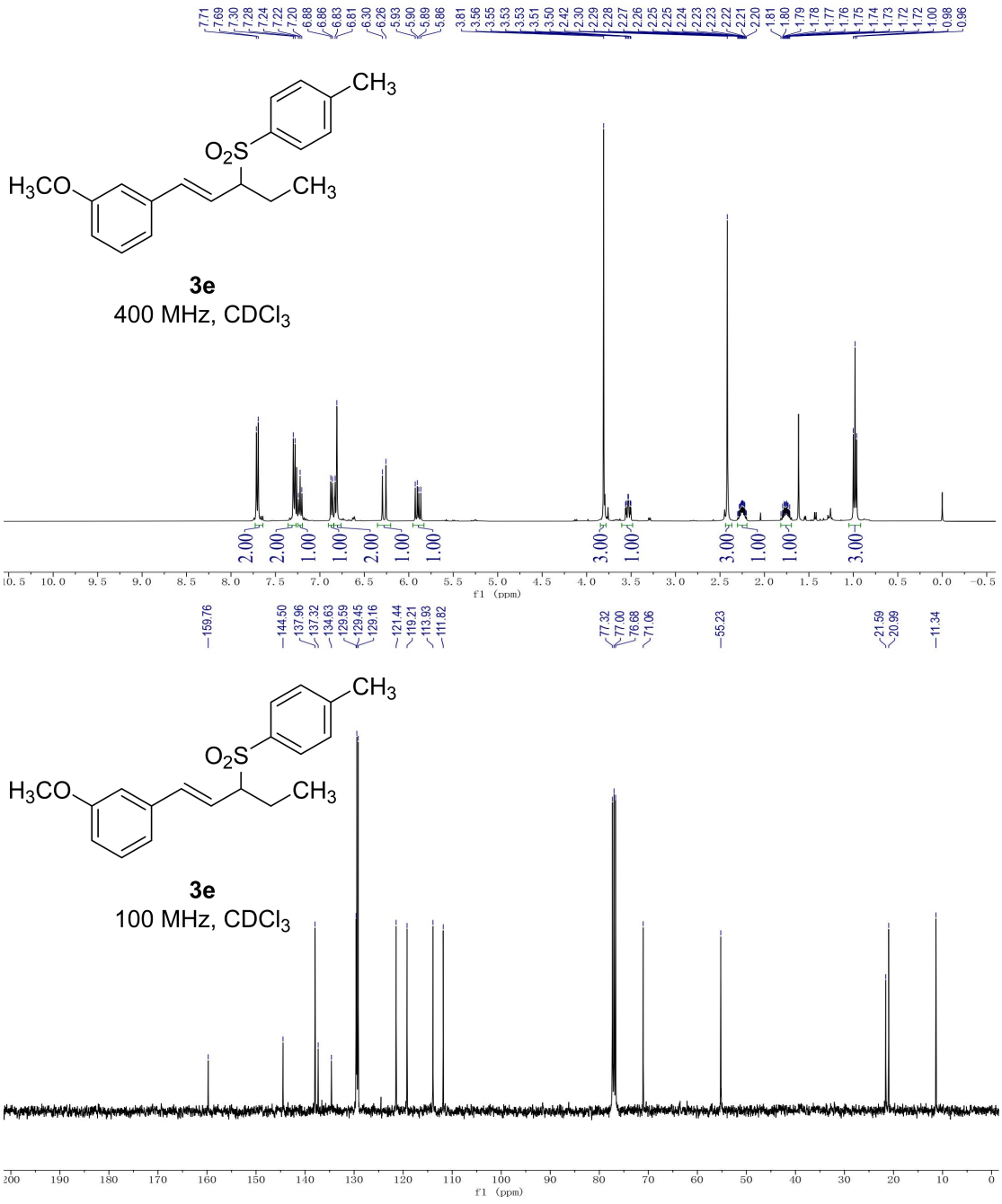
100 MHz, CDCl3
f1 (ppm)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1.75
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0.96
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O2S
H3CO
CH3
3e
400 MHz, CDCl3
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2.00
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2.00
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3.00
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1.00
3.00
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113.93
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77.00
76.68
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20.99
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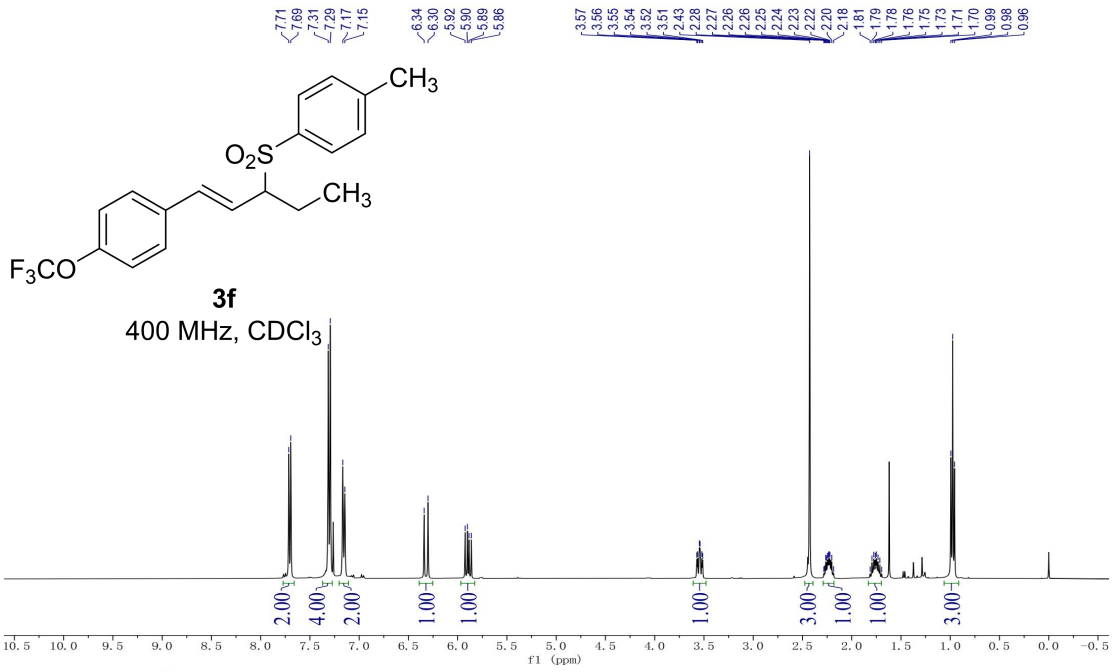
H3CO
CH3
3e
100 MHz, CDCl3
f1 (ppm)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1.70
0.99
0.98
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CH3
O2S
CH3
F3CO
3f
400 MHz, CDCl3
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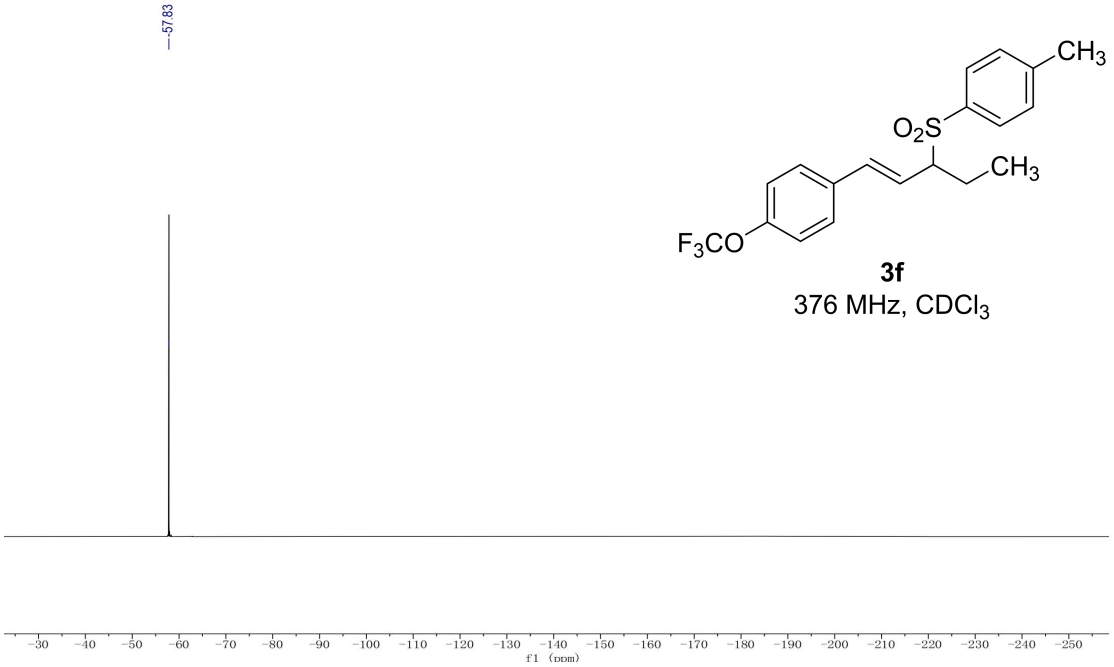
3.00
f1 (ppm)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CH3
F3CO
3f
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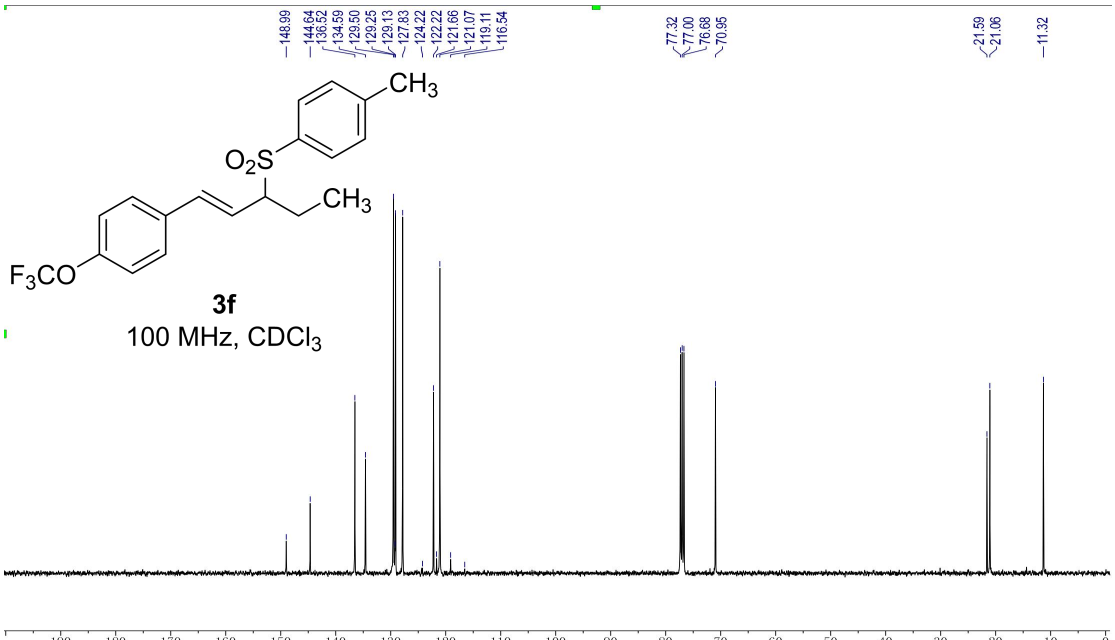
f1 (ppm)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116.54
77.32
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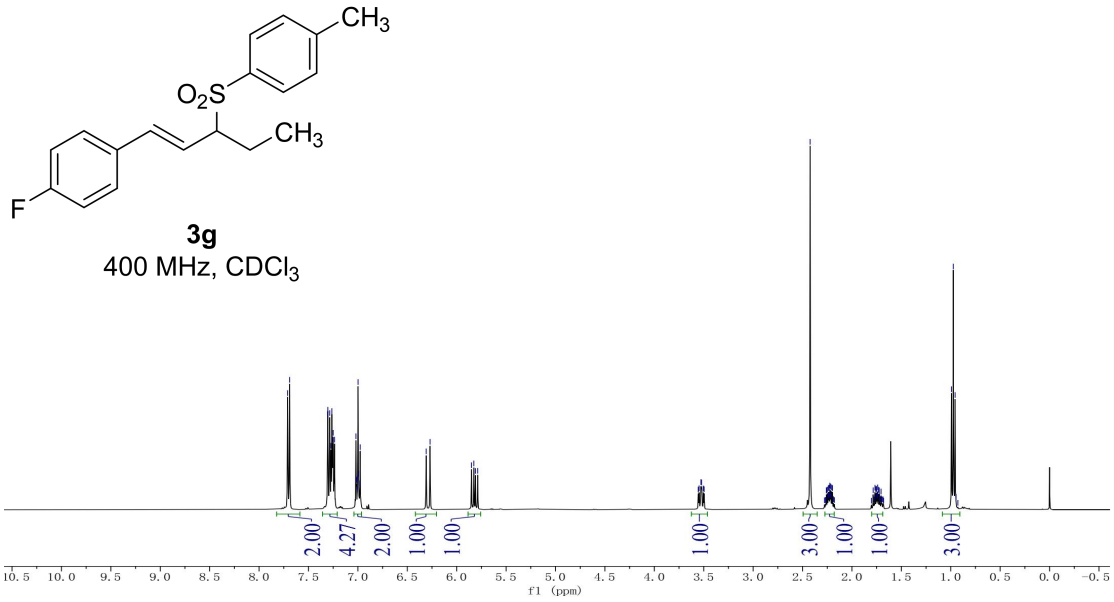
O2S
CH3
F3CO
3f
100 MHz, CDCl3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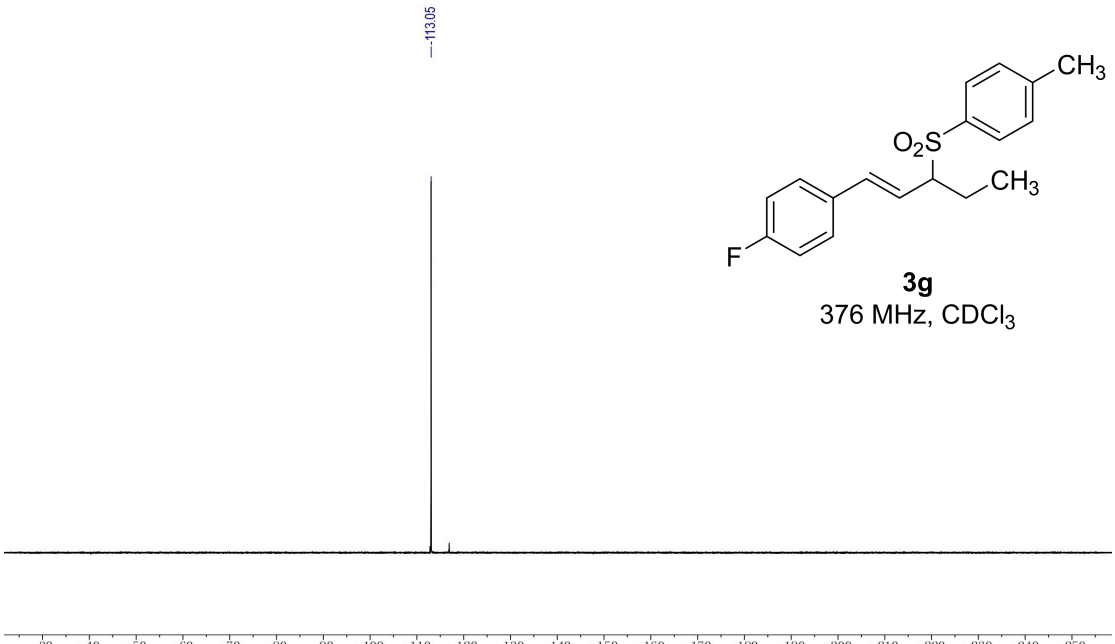
f1 (ppm)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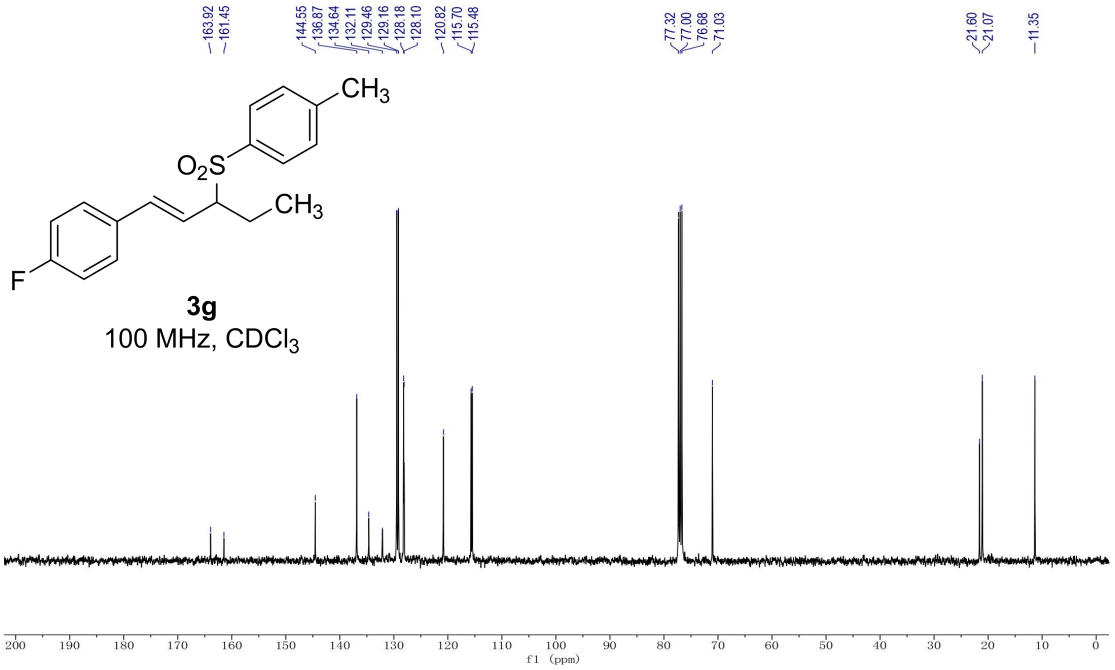
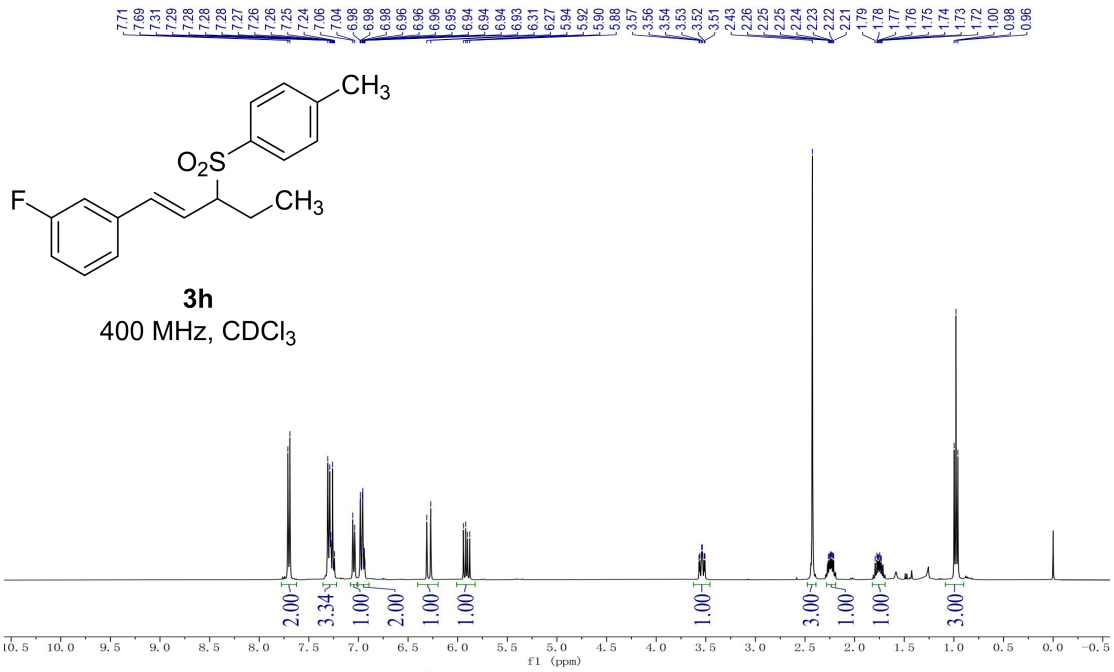
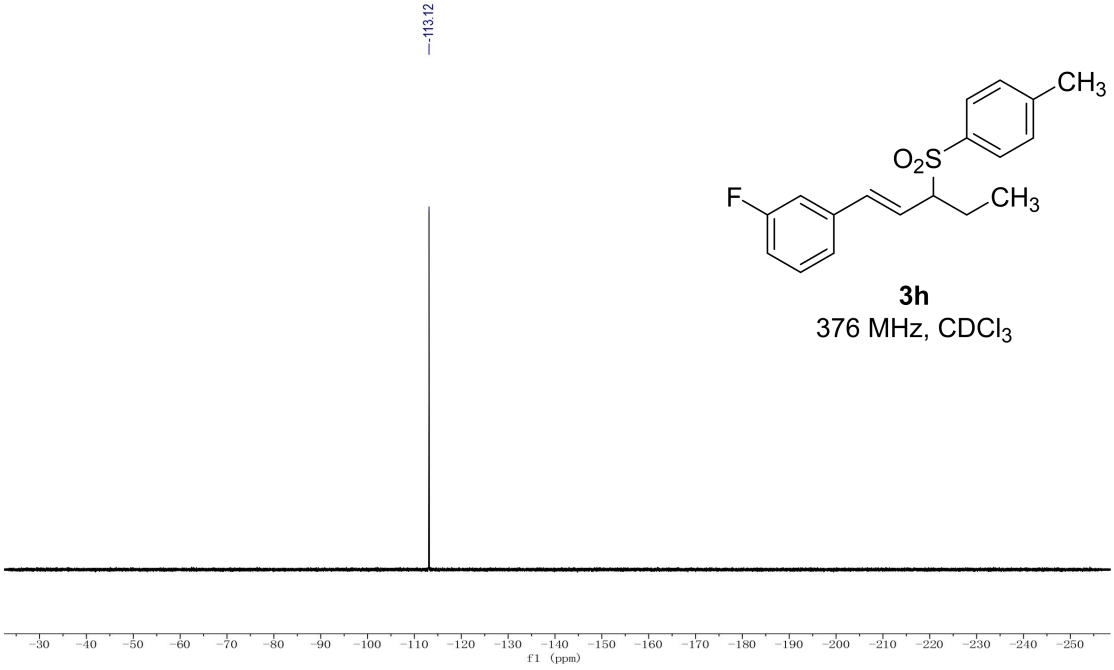
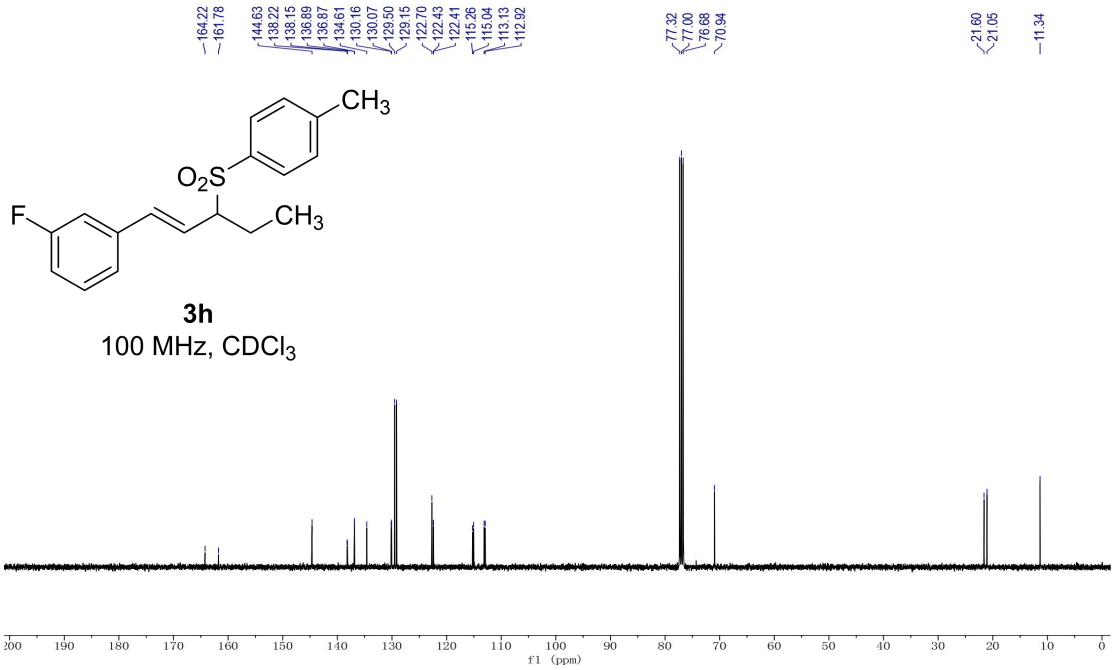
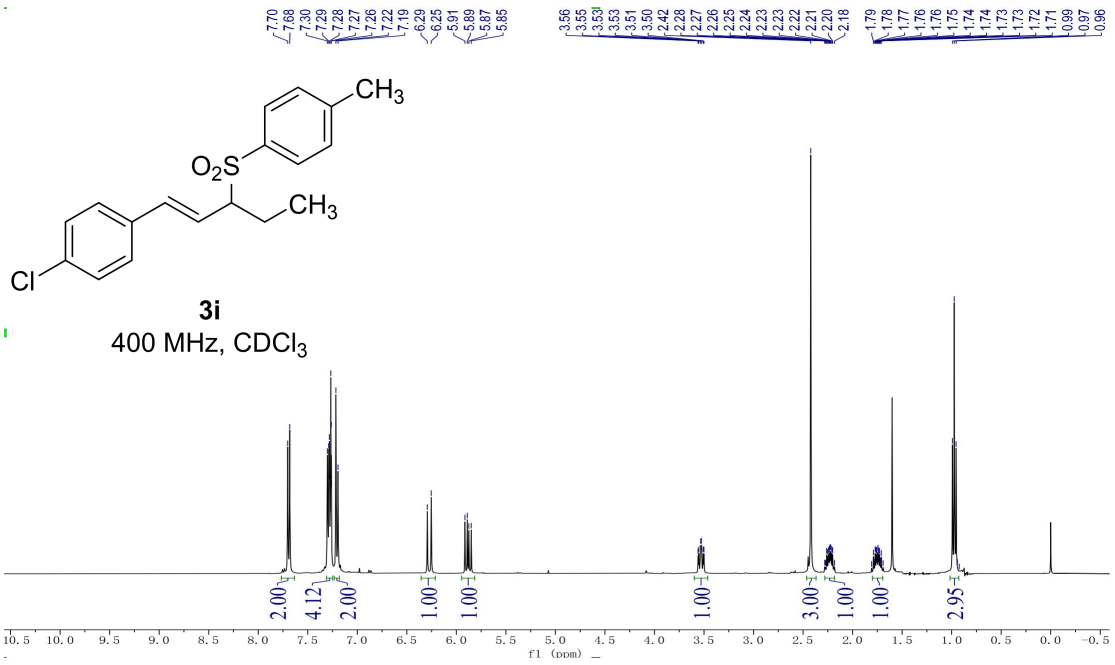
CH3
F
3g
376 MHz, CDCl3
f1 (ppm)

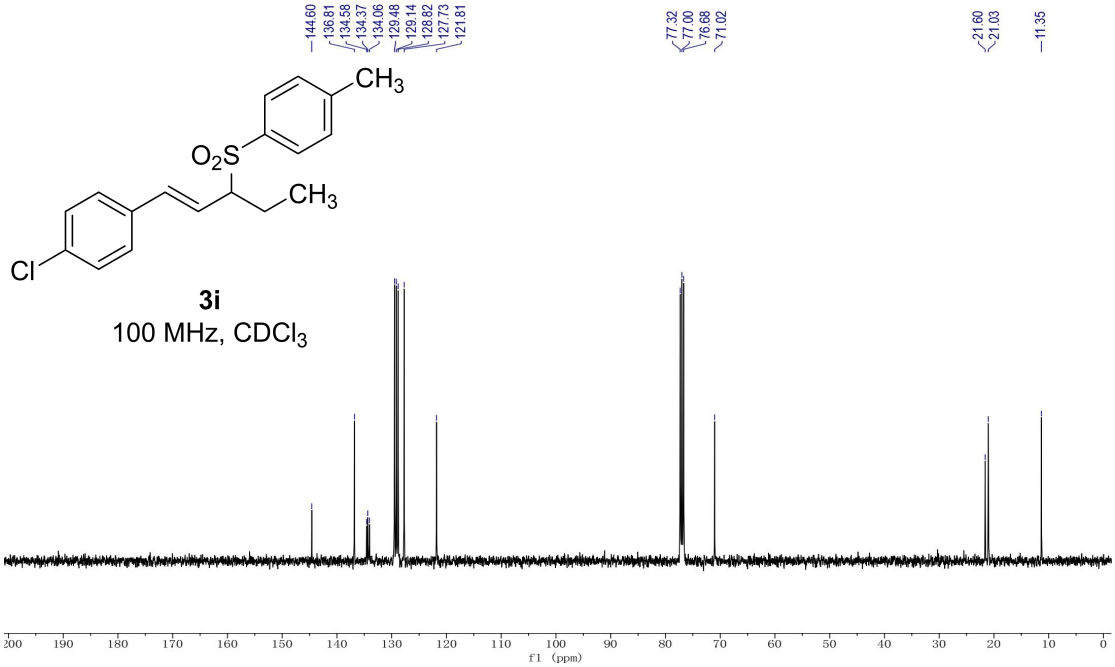

163.92
161.45
144.55
136.87
134.64
132.11
129.46
129.16
128.18
128.10
120.82
115.70
115.48
77.32
77.00
76.68
71.03
21.60
21.07
11.35
CH3
O2S
CH3
F
3g
100 MHz, CDCl3
f1 (ppm)

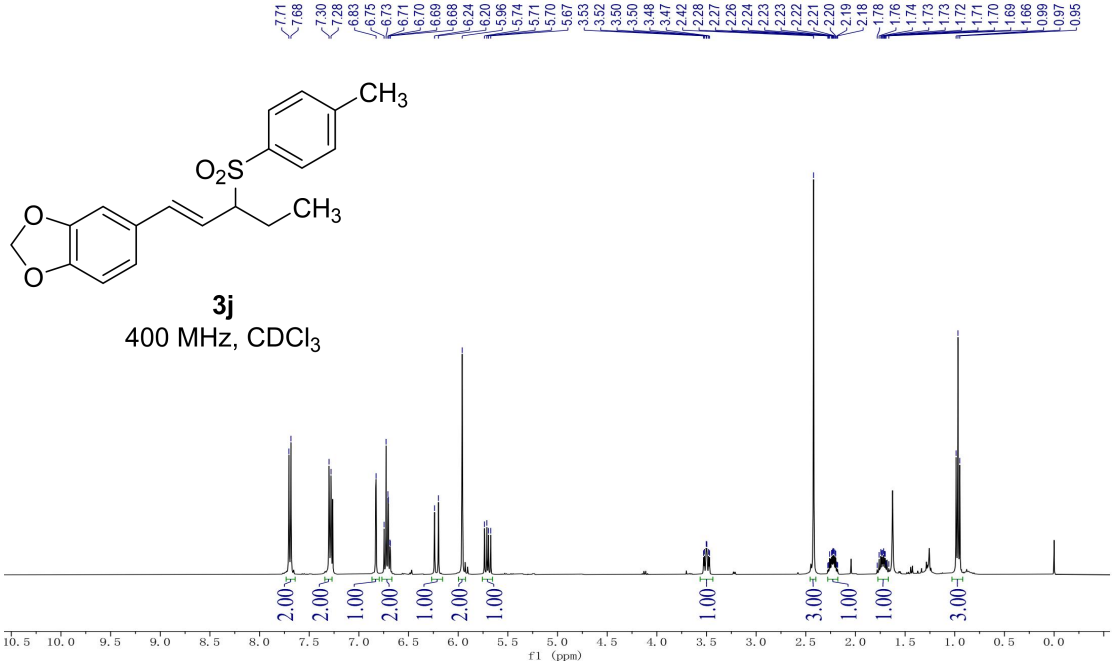

7.71
7.69
7.31
7.29
7.28
7.28
7.28
7.27
7.26
7.26
7.25
7.24
7.06
7.04
6.98
6.98
6.98
6.96
6.96
6.96
6.95
6.94
6.94
6.94
6.93
6.31
6.27
5.94
5.92
5.90
5.88
3.57
3.56
3.54
3.53
3.52
3.51
2.43
2.26
2.25
2.25
2.24
2.23
2.22
2.21
1.79
1.78
1.77
1.76
1.75
1.74
1.73
1.72
1.00
0.98
0.96
CH3
O2S
F
CH3
3h
400 MHz, CDCl3
2.00
3.34
1.00
2.00
1.00
1.00
1.00
3.00
1.00
1.00
3.00
f1 (ppm)

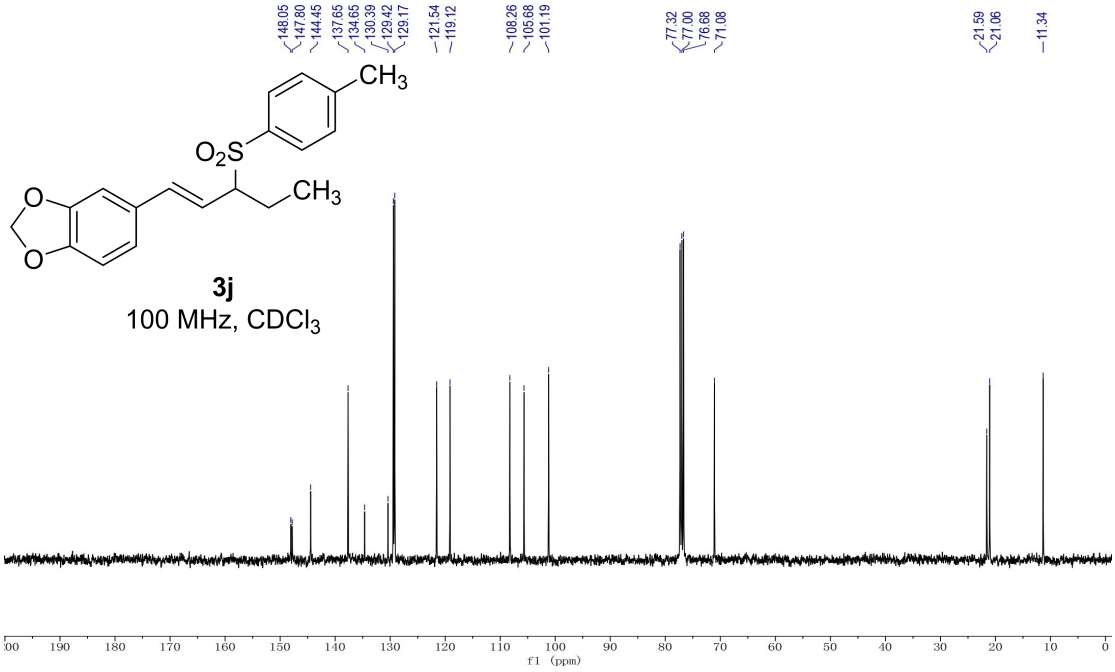

-113.12
CH3
O2S
F
CH3
3h
376 MHz, CDCl3
f1 (ppm)

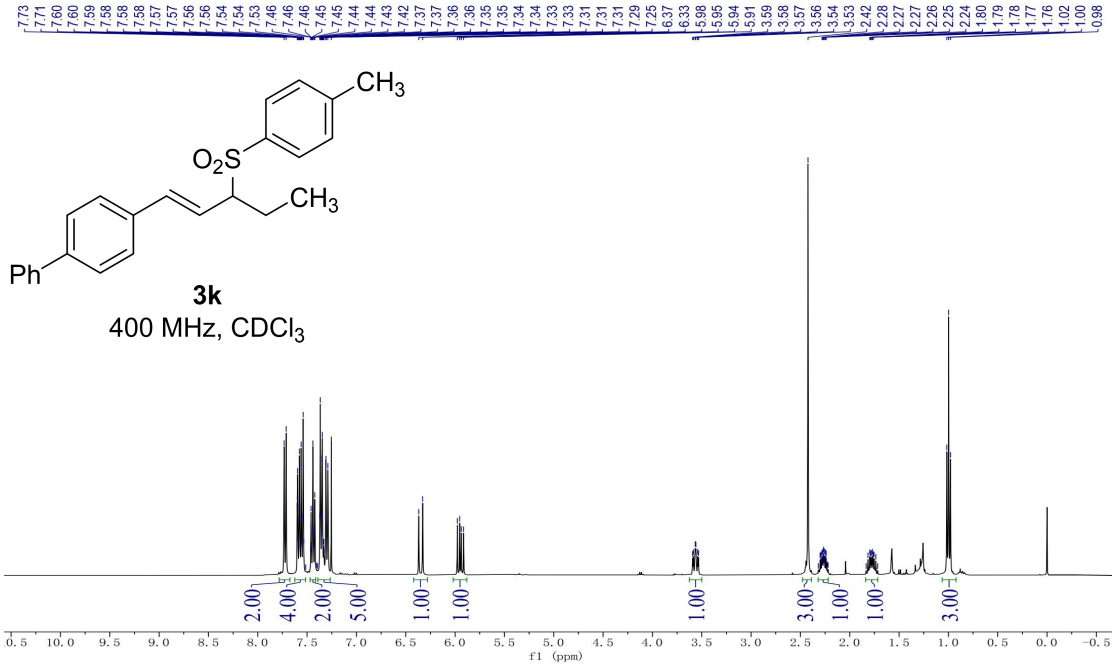

164.22
161.78
144.63
138.22
138.15
136.89
136.87
134.61
130.16
130.07
129.50
129.15
122.70
122.43
122.41
115.26
115.04
113.13
112.92
77.32
77.00
76.68
70.94
21.60
21.05
11.34
CH3
O2S
CH3
F
3h
100 MHz, CDCl3
f1 (ppm)

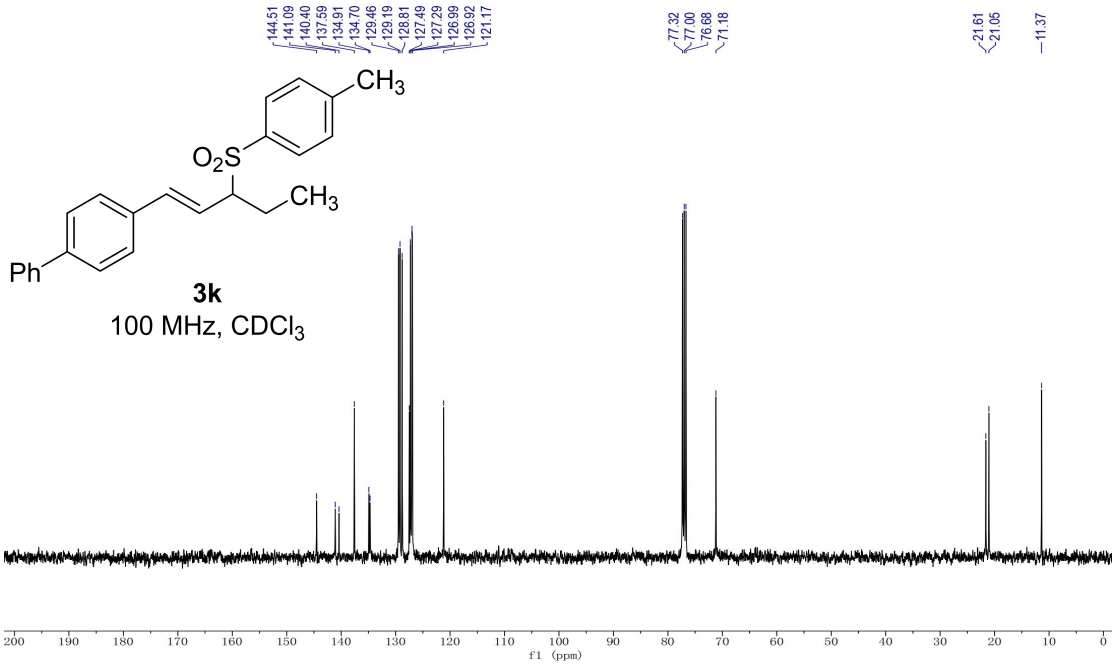

7.70
7.68
7.30
7.29
7.28
7.27
7.26
7.22
7.19
6.29
6.25
5.91
5.89
5.87
5.85
3.56
3.55
3.53
3.53
3.51
3.50
2.42
2.28
2.27
2.26
2.25
2.24
2.23
2.23
2.22
2.21
2.20
2.18
1.79
1.78
1.77
1.76
1.76
1.75
1.74
1.74
1.73
1.73
1.72
1.71
0.99
0.97
0.96
CH3
O2S
CH3
Cl
3i
400 MHz, CDCl3
2.00
4.12
2.00
1.00
1.00
1.00
3.00
1.00
1.00
2.95
f1 (ppm)

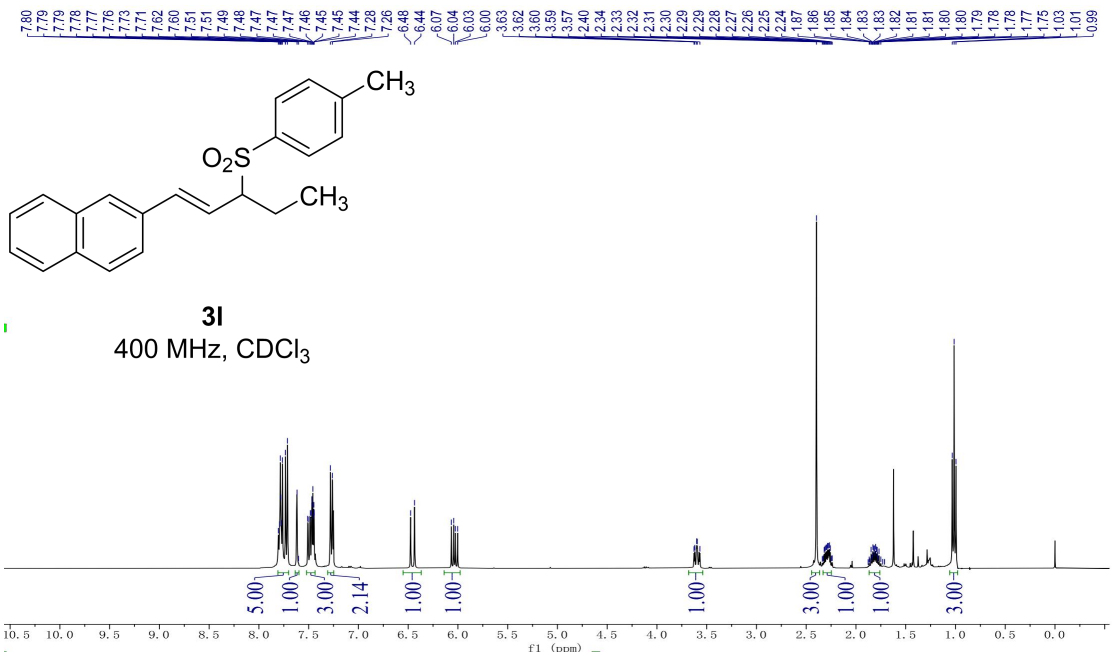

144.60
136.81
134.58
134.37
134.06
129.48
129.14
128.82
127.73
121.81
77.32
77.00
76.68
71.02
21.60
21.03
11.35
CH3
O2S
CH3
Cl
3i
100 MHz, CDCl3
f1 (ppm)

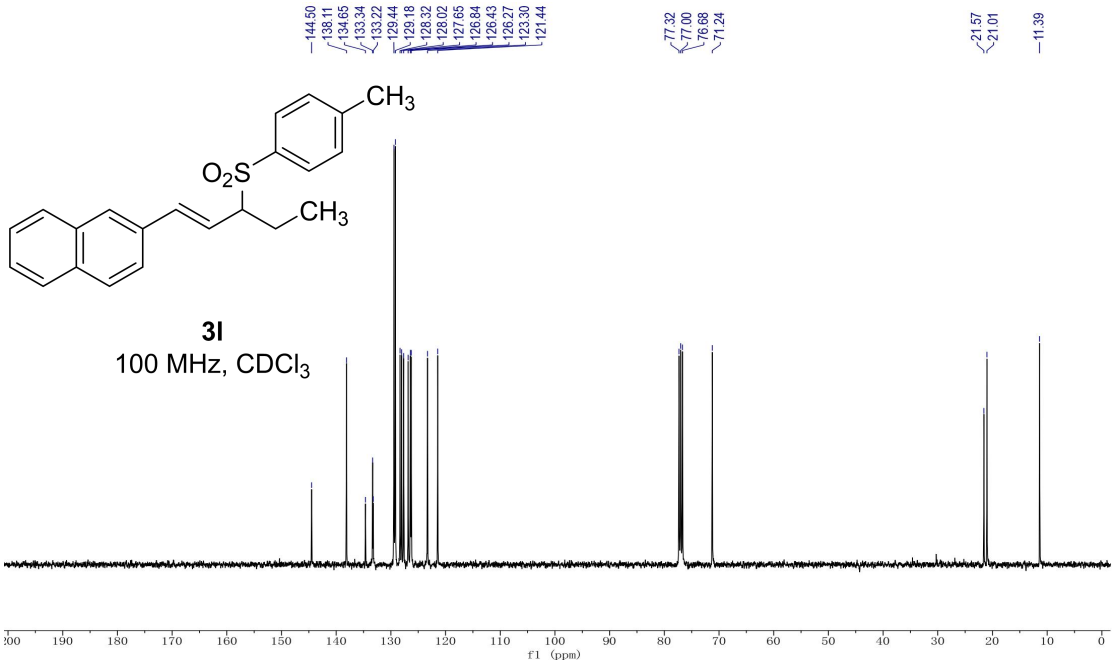

7.71
7.68
7.30
7.28
6.83
6.75
6.73
6.71
6.70
6.69
6.68
6.24
6.20
5.96
5.74
5.71
5.70
5.67
3.53
3.52
3.50
3.50
3.48
3.47
2.42
2.28
2.27
2.26
2.24
2.23
2.23
2.22
2.21
2.20
2.19
2.18
1.78
1.76
1.74
1.73
1.73
1.72
1.71
1.70
1.69
1.66
0.99
0.97
0.95
CH3
O2S
CH3
O
O
3j
400 MHz, CDCl3
2.00
2.00
1.00
2.00
1.00
2.00
1.00
1.00
3.00
1.00
1.00
3.00
f1 (ppm)


148.05
147.80
144.45
137.65
134.65
130.39
129.42
129.17
121.54
119.12
108.26
105.68
101.19
77.32
77.00
76.68
71.08
21.59
21.06
11.34
CH3
O2S
CH3
O
O
3j
100 MHz, CDCl3
f1 (ppm)


CH3
O2S
CH3
Ph
3k
400 MHz, CDCl3
2.00
4.00
2.00
5.00
1.00
1.00
1.00
3.00
1.00
1.00
3.00
f1 (ppm)

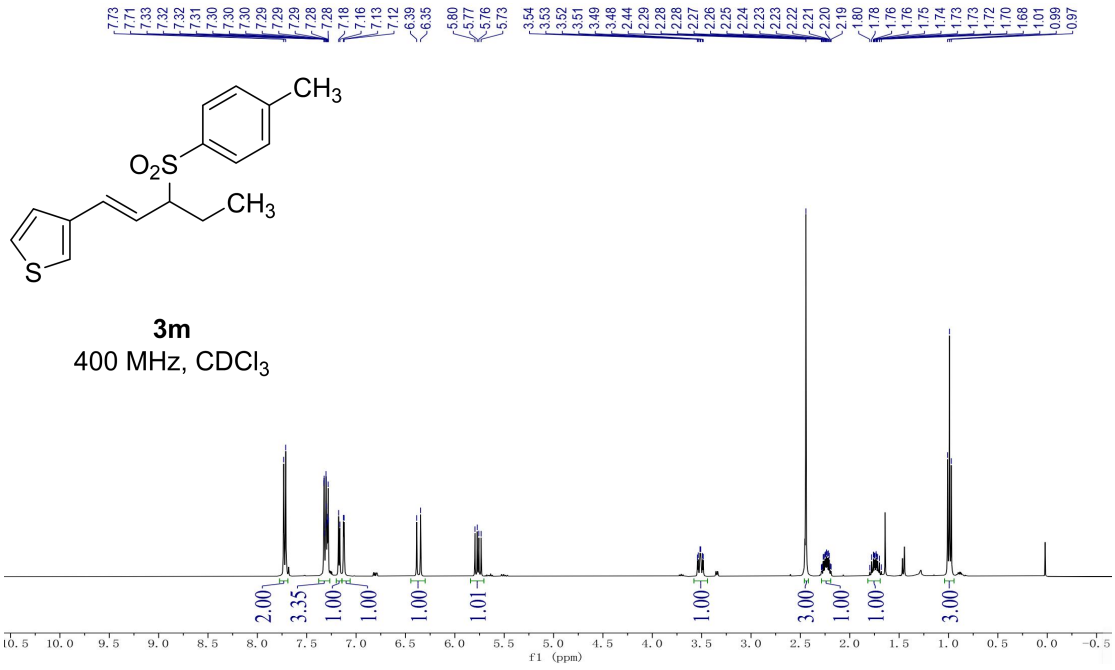

144.51
141.09
140.40
137.59
134.91
134.70
129.46
129.19
128.81
127.49
127.29
126.99
126.92
121.17
77.32
77.00
76.68
71.18
21.61
21.05
11.37
CH3
O2S
CH3
Ph
3k
100 MHz, CDCl3
f1 (ppm)


CH3
O2S
CH3
3l
400 MHz, CDCl3
5.00
1.00
3.00
2.14
1.00
1.00
1.00
3.00
1.00
1.00
3.00
f1 (ppm)



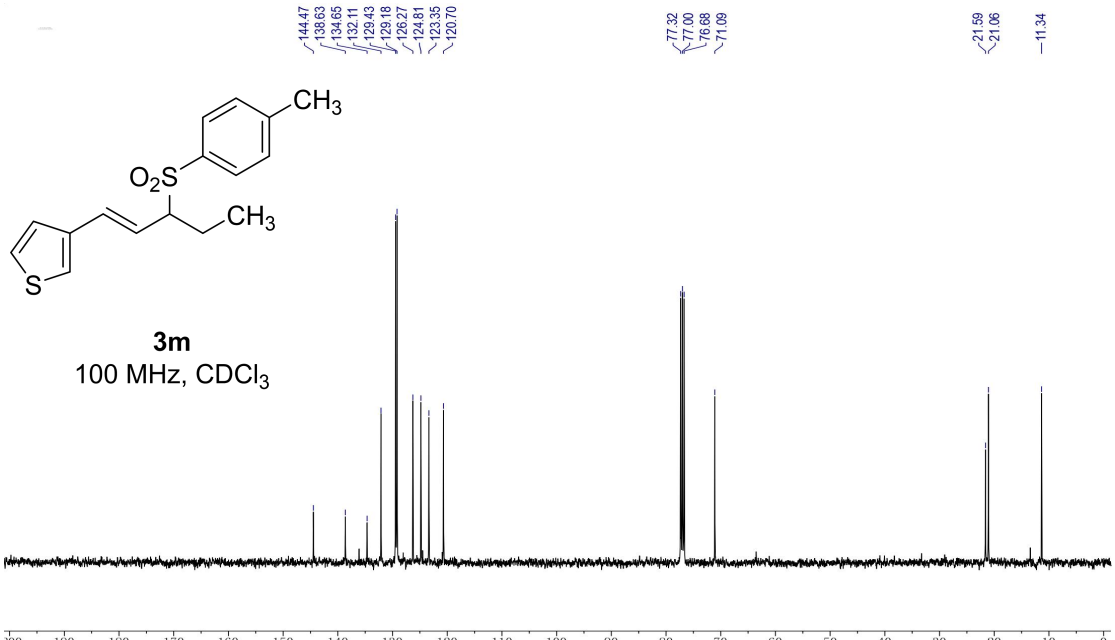
3l

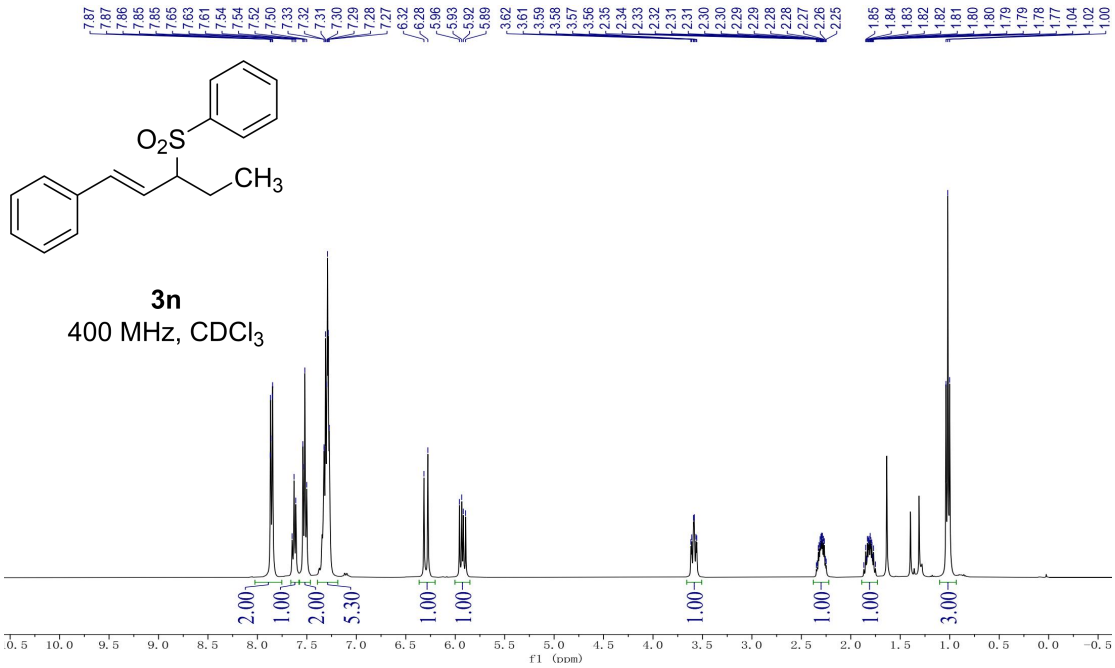
100 MHz, $CDCl_3$

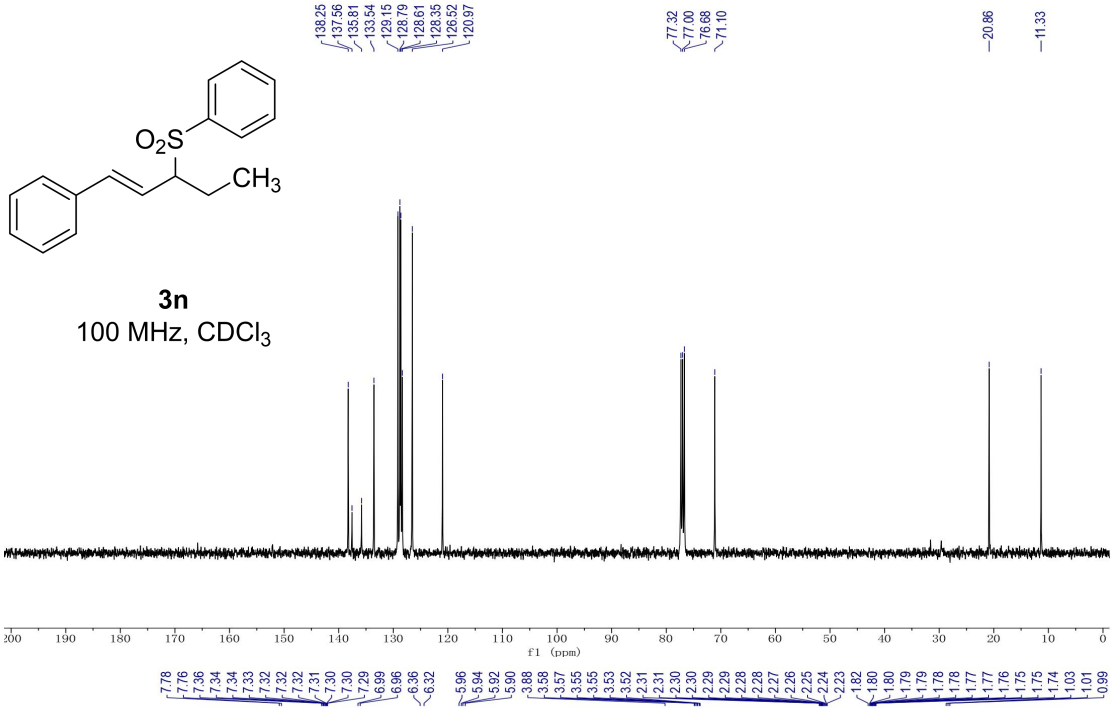


3m

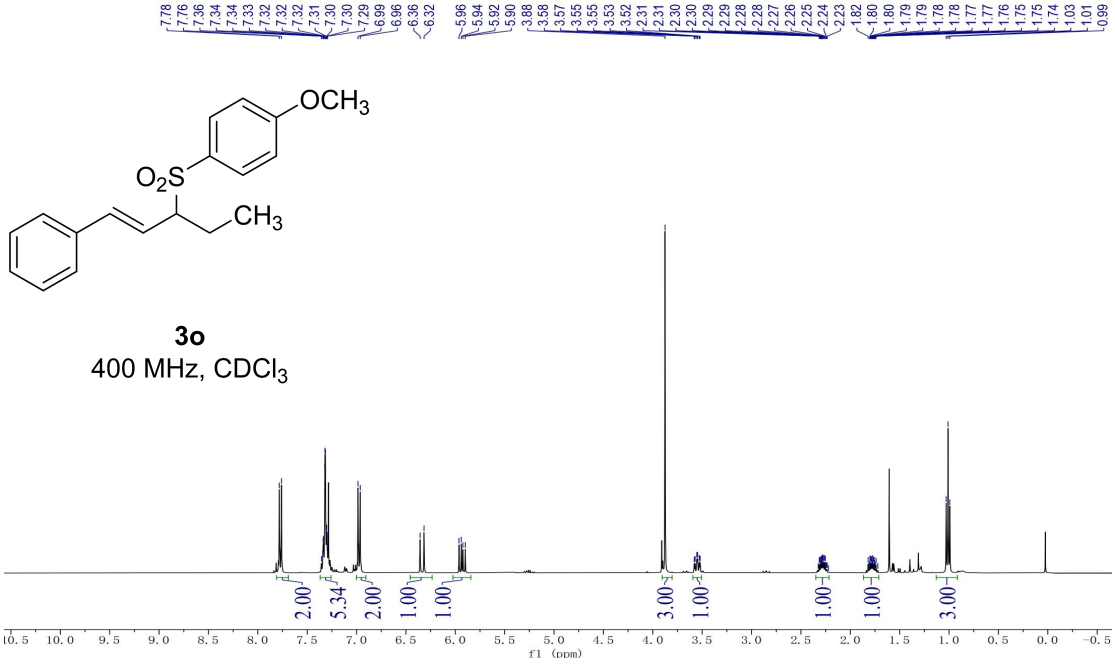
400 MHz, $CDCl_3$


144.47
138.63
134.65
132.11
129.43
129.18
126.27
124.81
123.35
120.70
77.32
77.00
76.68
71.09
21.59
21.06
11.34
CH3
O2S
CH3
S
3m
100 MHz, CDCl3
f1 (ppm)

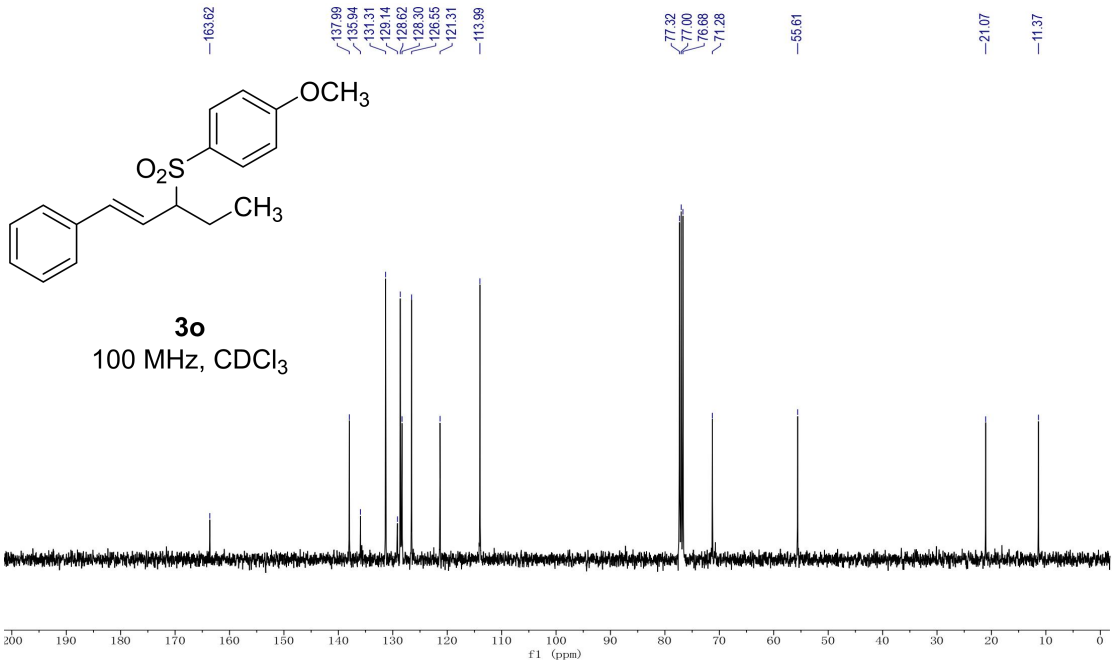

O2S
CH3
3n
400 MHz, CDCl3
2.00
1.00
2.00
5.30
1.00
1.00
1.00
1.00
1.00
3.00
f1 (ppm)



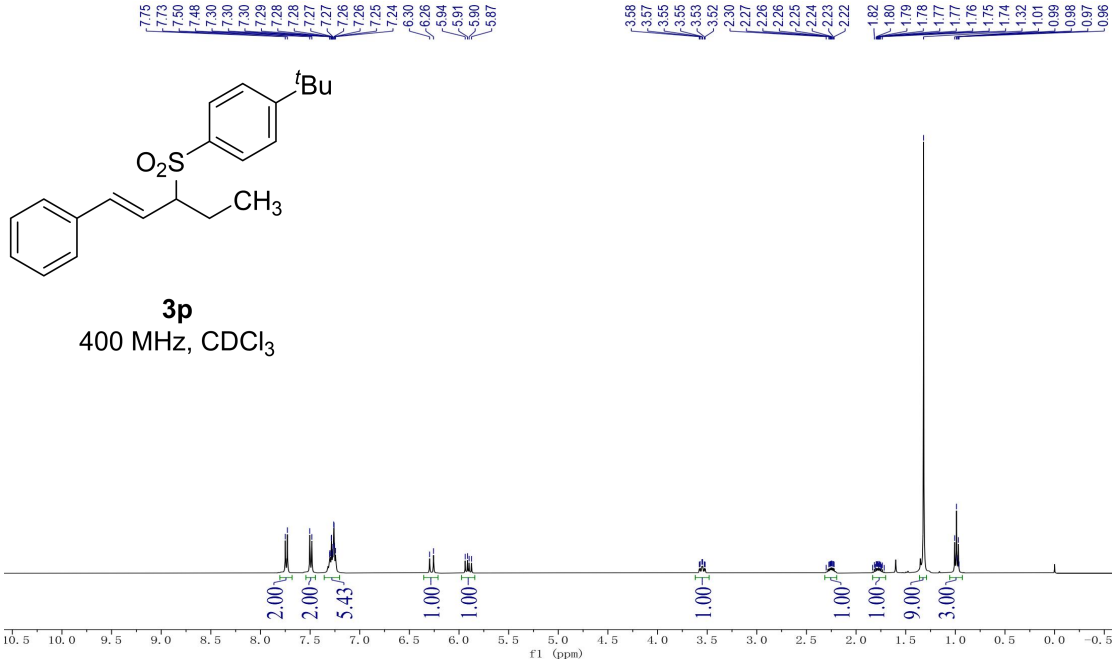
3n
100 MHz, $CDCl_3$



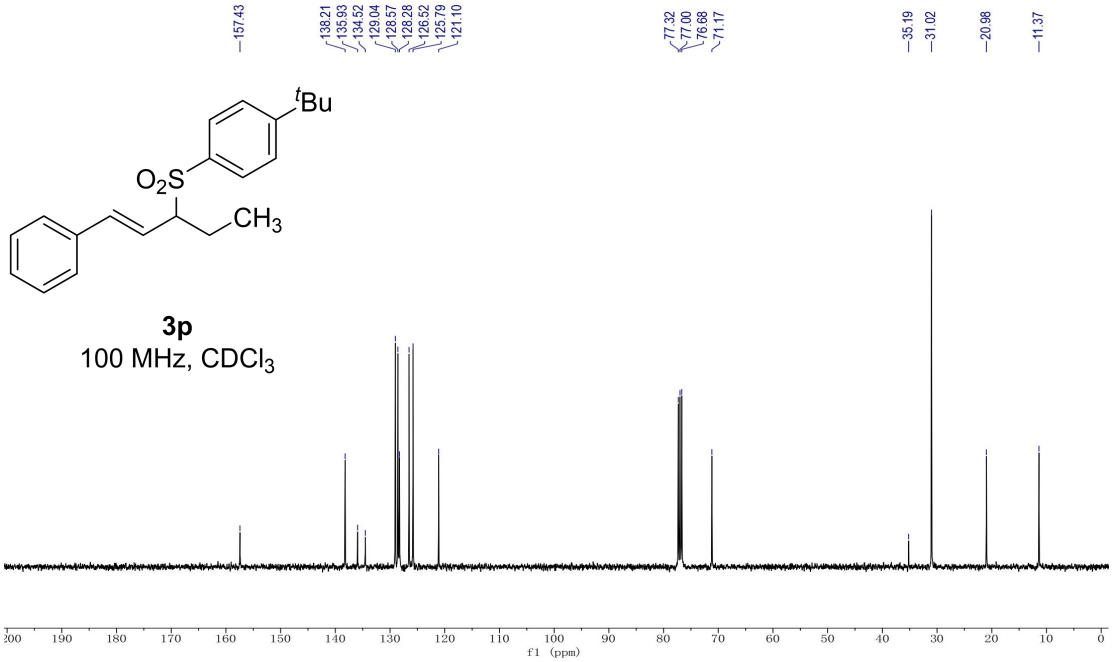
3o
400 MHz, $CDCl_3$

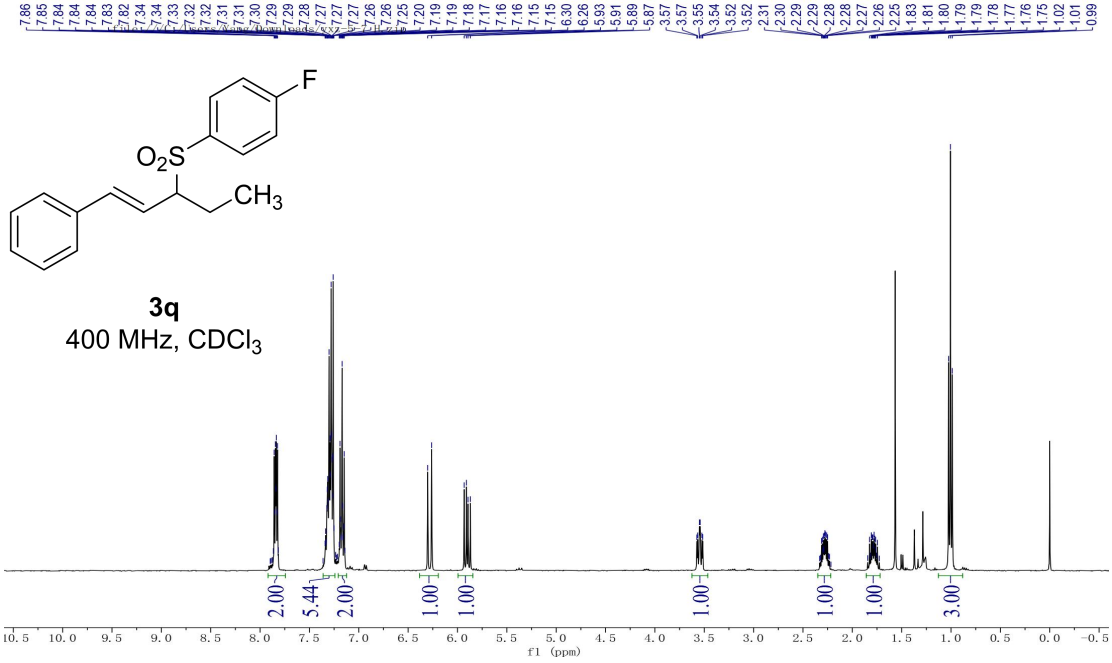


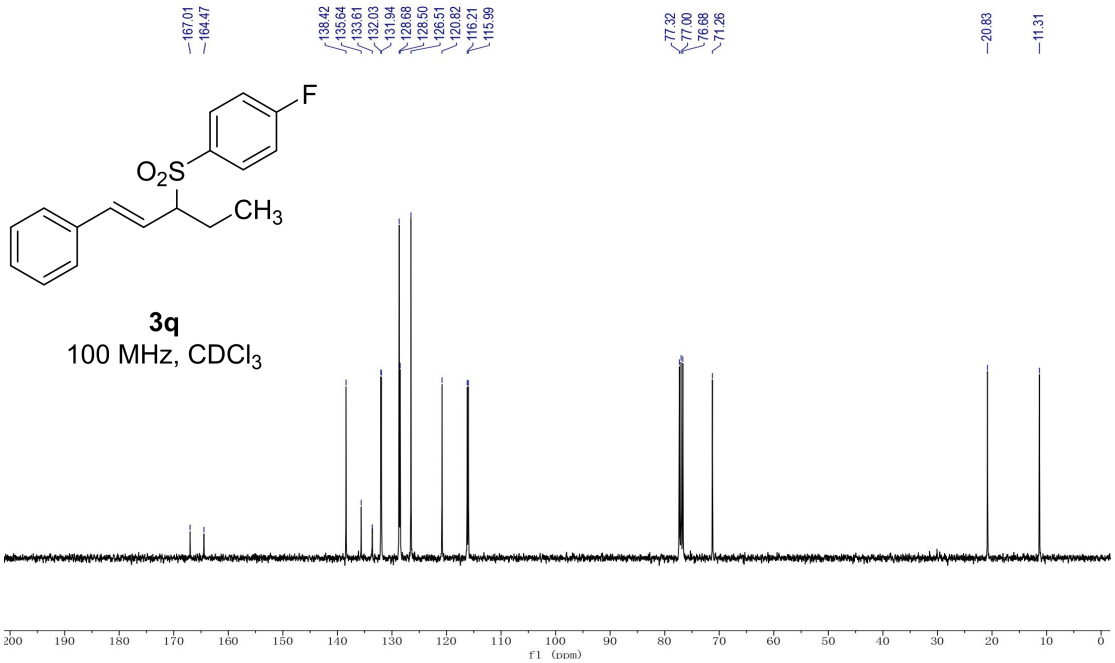
3o
100 MHz, $CDCl_3$

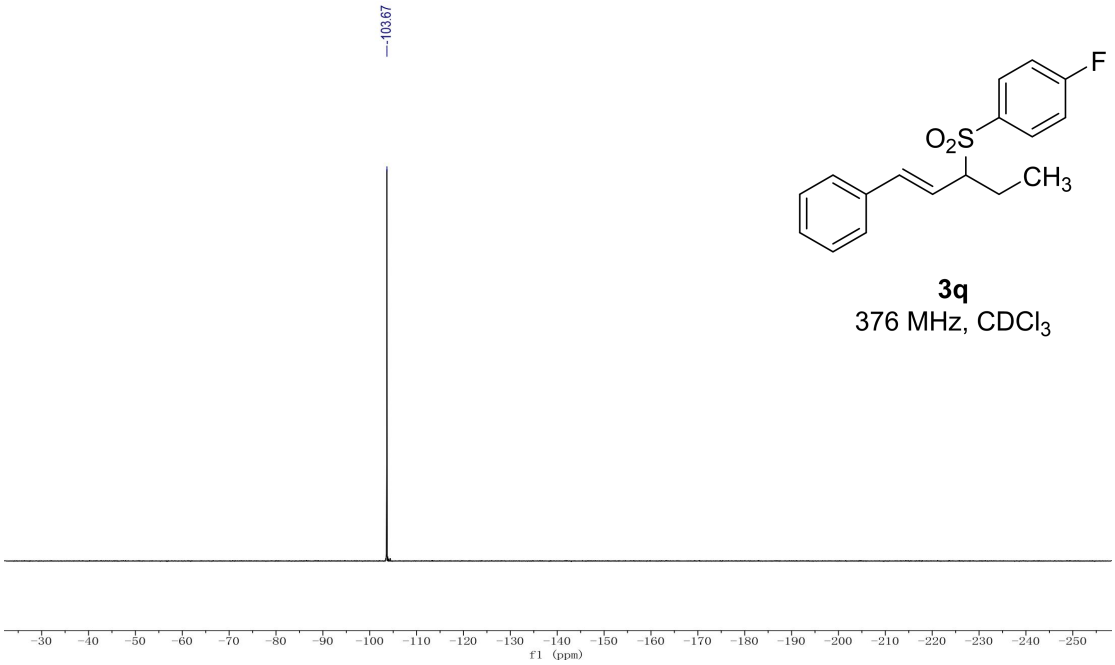


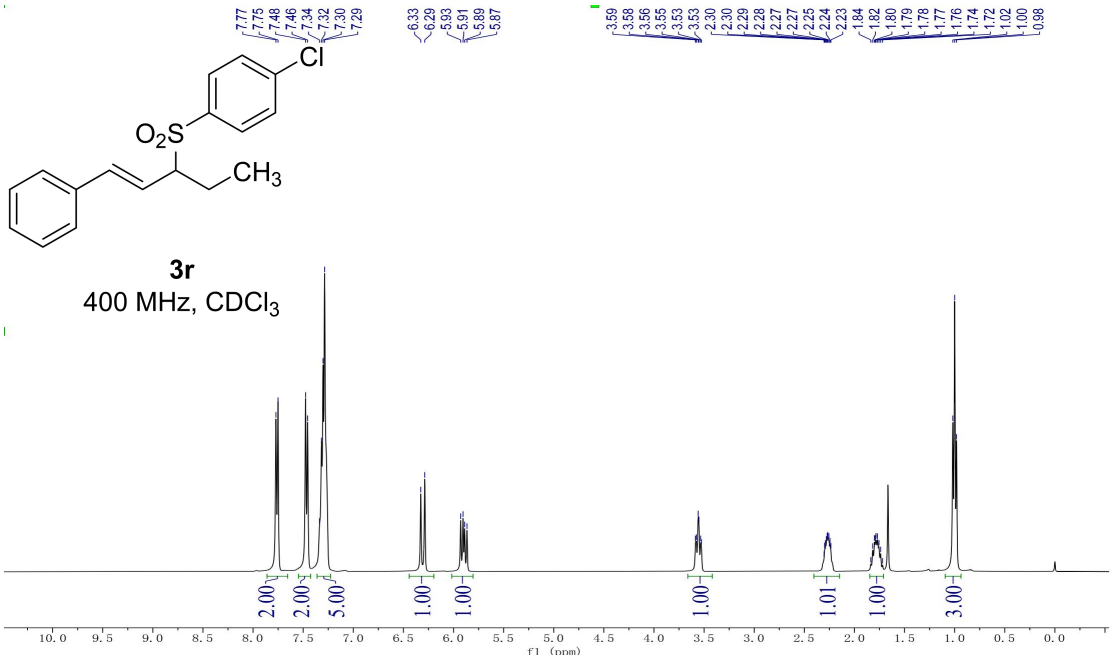
3p
400 MHz, $CDCl_3$

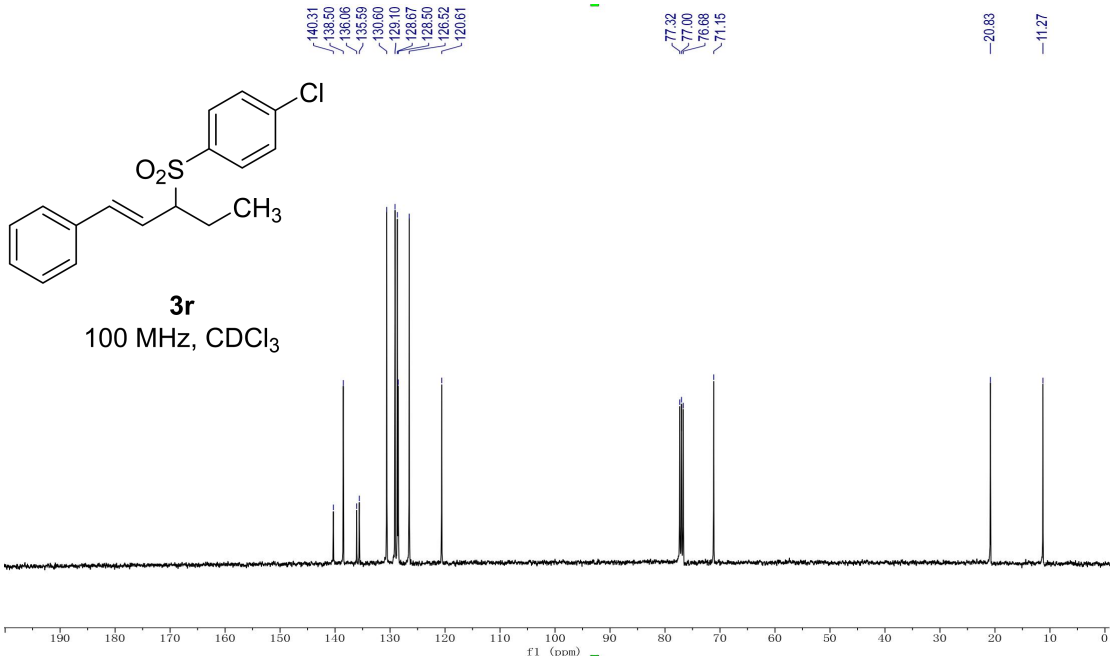

157.43
138.21
135.93
134.52
129.04
128.57
128.28
126.52
125.79
121.10
77.32
77.00
76.68
71.17
35.19
31.02
20.98
11.37
tBu
O2S
CH3
3p
100 MHz, CDCl3
f1 (ppm)

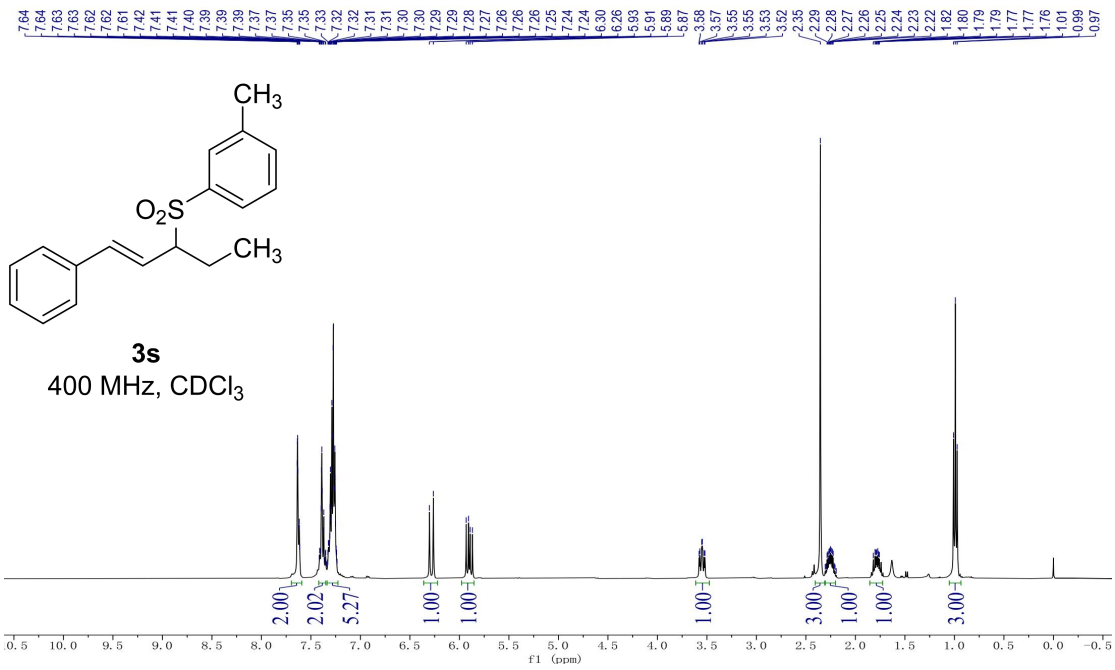

F
O2S
CH3
3q
400 MHz, CDCl3
2.00
5.44
2.00
1.00
1.00
1.00
1.00
1.00
3.00
f1 (ppm)

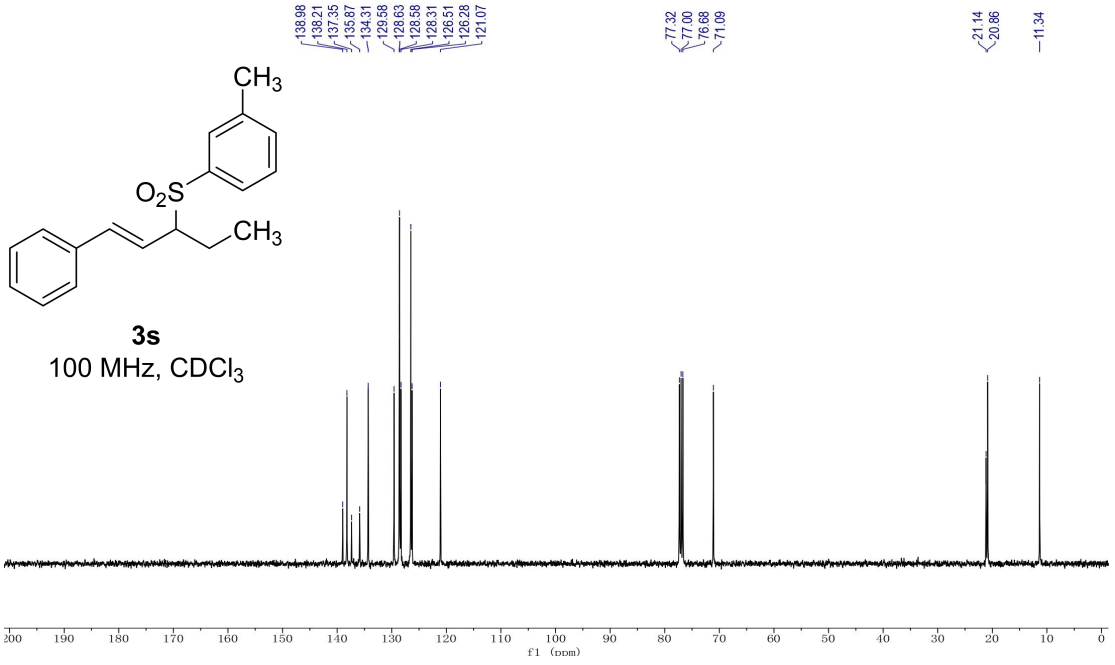

167.01
164.47
138.42
135.64
133.61
132.03
131.94
128.68
128.50
126.51
120.82
116.21
115.99
77.32
77.00
76.68
71.26
20.83
11.31
F
O2S
CH3
3q
100 MHz, CDCl3
f1 (ppm)

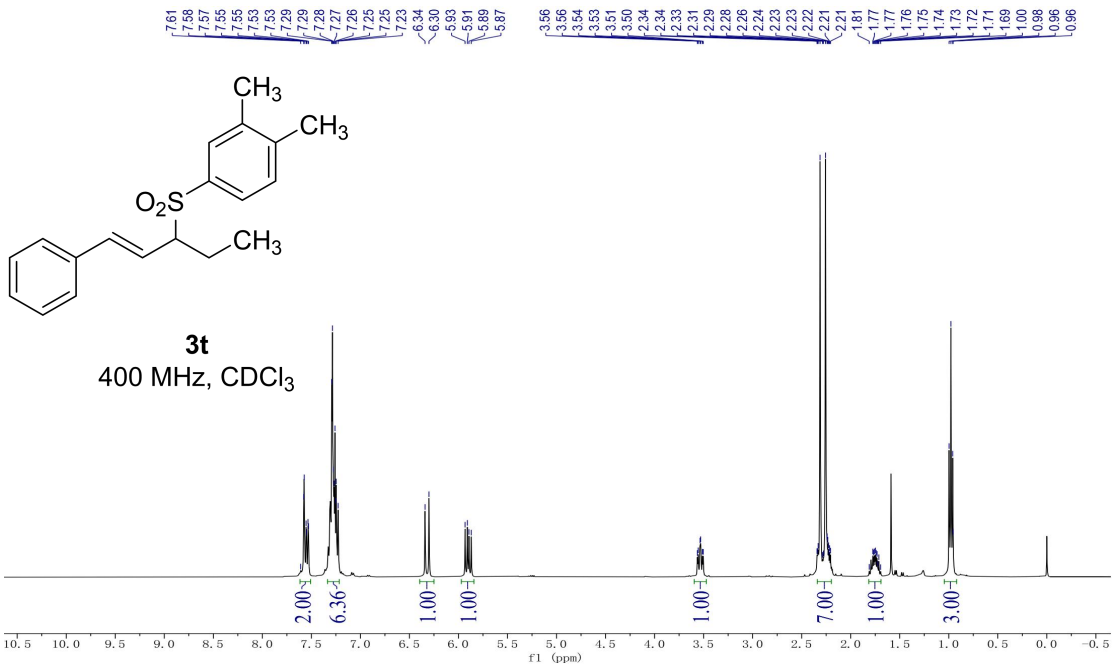

103.67
F
O2S
CH3
3q
376 MHz, CDCl3
f1 (ppm)

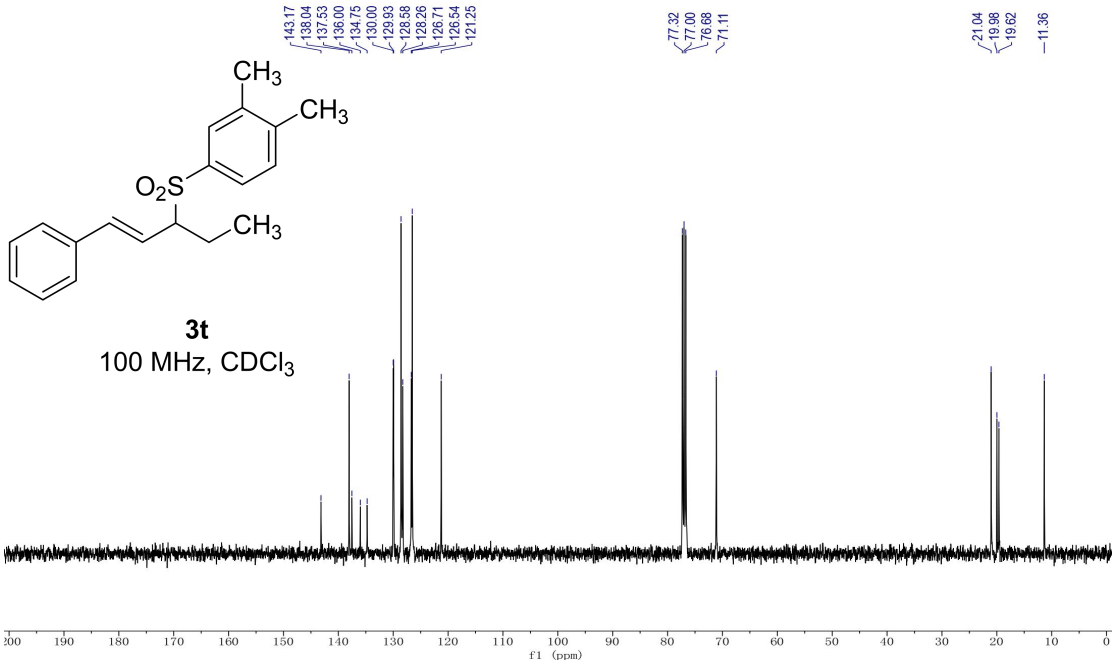

Cl
O2S
CH3
3r
400 MHz, CDCl3
f1 (ppm)

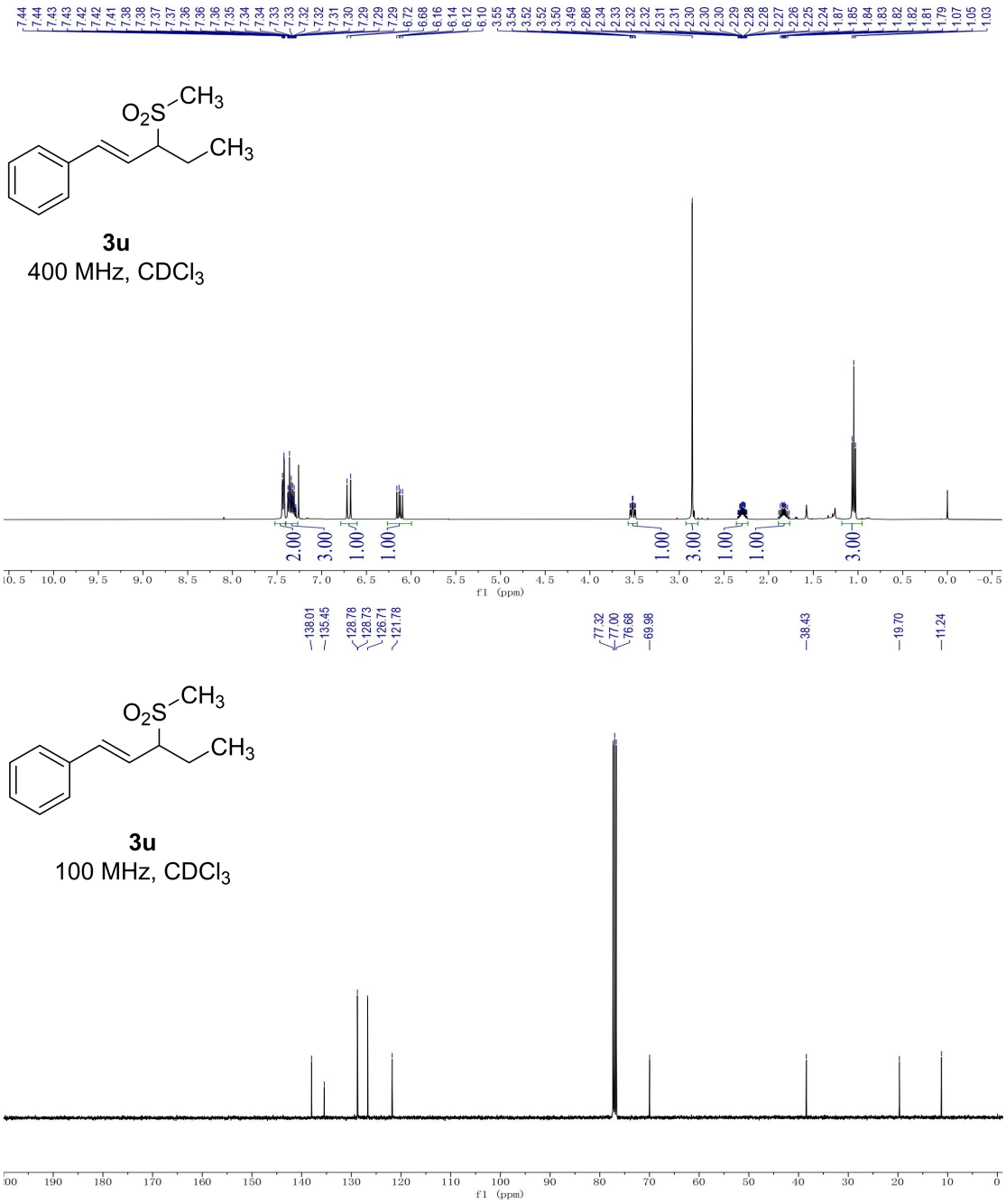

Cl
O2S
CH3
3r
100 MHz, CDCl3
f1 (ppm)

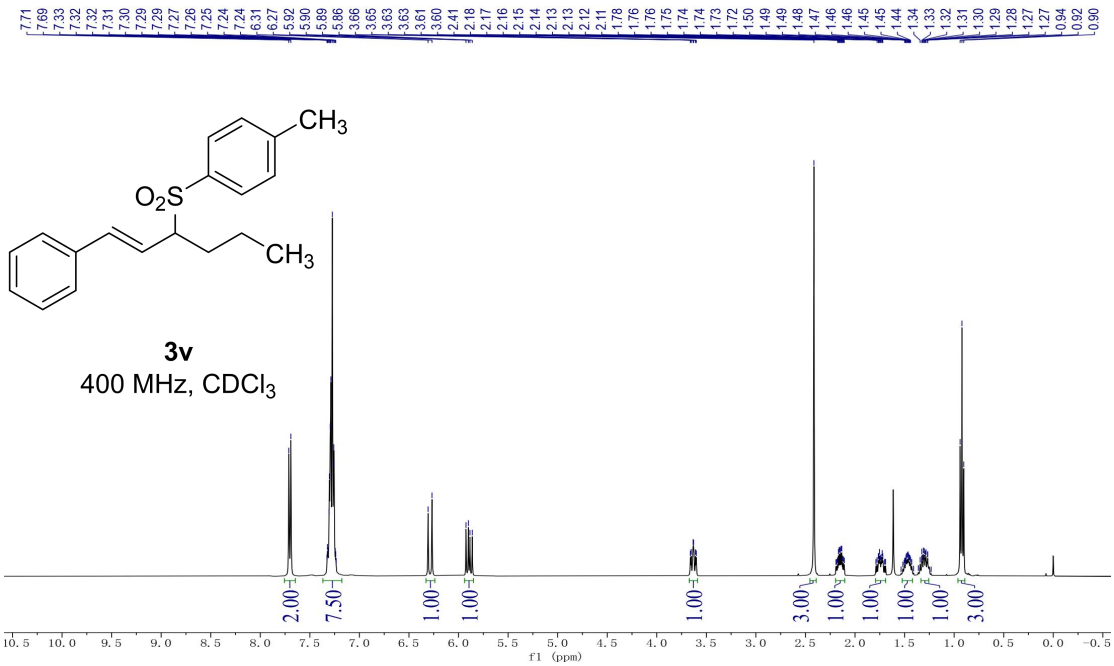

7.64 7.64 7.63 7.63 7.62 7.62 7.61 7.42 7.41 7.41 7.40 7.39 7.39 7.39 7.37 7.37 7.35 7.35 7.33 7.32 7.32 7.31 7.31 7.30 7.30 7.29 7.29 7.28 7.27 7.26 7.26 7.26 7.25 7.24 7.24 6.30 6.26 5.93 5.91 5.89 5.87 3.58 3.57 3.55 3.55 3.53 3.52 2.35 2.29 2.28 2.27 2.26 2.25 2.24 2.23 2.22 1.82 1.80 1.79 1.79 1.77 1.77 1.76 1.01 0.99 0.97
CH3
O2S
CH3
3s
400 MHz, CDCl3
2.00 2.02 5.27 1.00 1.00 1.00 3.00 1.00 1.00 3.00
f1 (ppm)

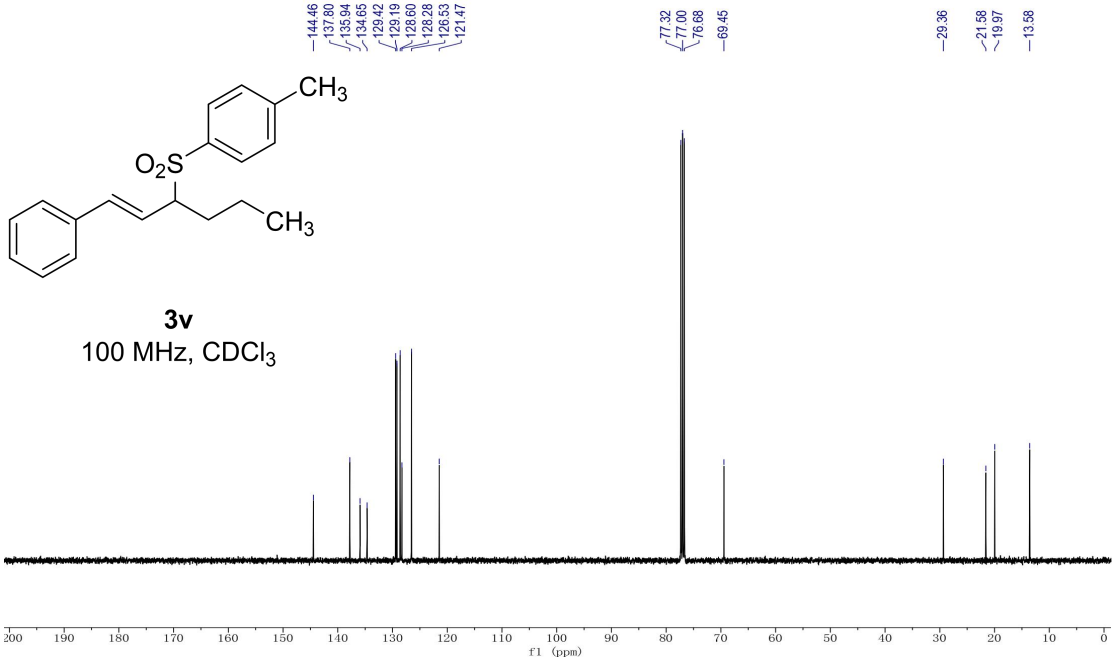

138.98 138.21 137.35 135.87 134.31 129.58 128.63 128.58 128.31 126.51 126.28 121.07
77.32 77.00 76.68 71.09
21.14 20.86 11.34
CH3
O2S
CH3
3s
100 MHz, CDCl3
f1 (ppm)

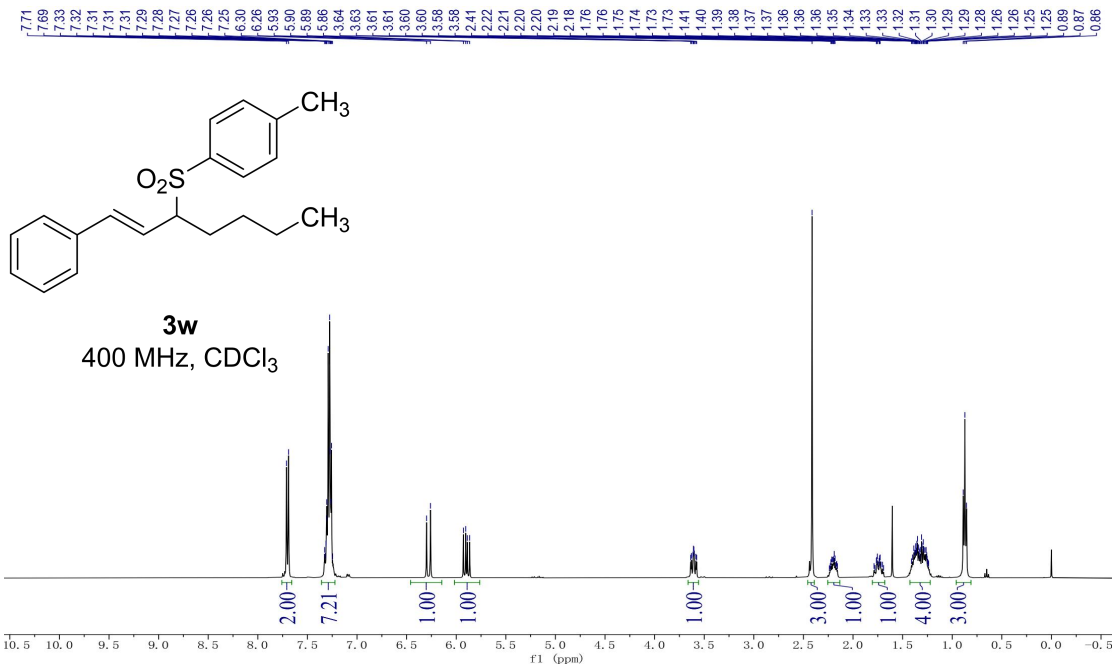

7.61 7.58 7.57 7.55 7.55 7.53 7.53 7.29 7.29 7.28 7.27 7.26 7.25 7.25 7.23 6.34 6.30 5.93 5.91 5.89 5.87
3.56 3.56 3.54 3.53 3.51 3.50 2.34 2.34 2.33 2.31 2.29 2.28 2.26 2.24 2.23 2.23 2.22 2.21 2.21 1.81 1.77 1.77 1.76 1.75 1.74 1.73 1.72 1.71 1.69 1.00 0.98 0.96 0.96
CH3
CH3
O2S
CH3
3t
400 MHz, CDCl3
2.00
6.36
1.00
1.00
1.00
7.00
1.00
3.00
f1 (ppm)

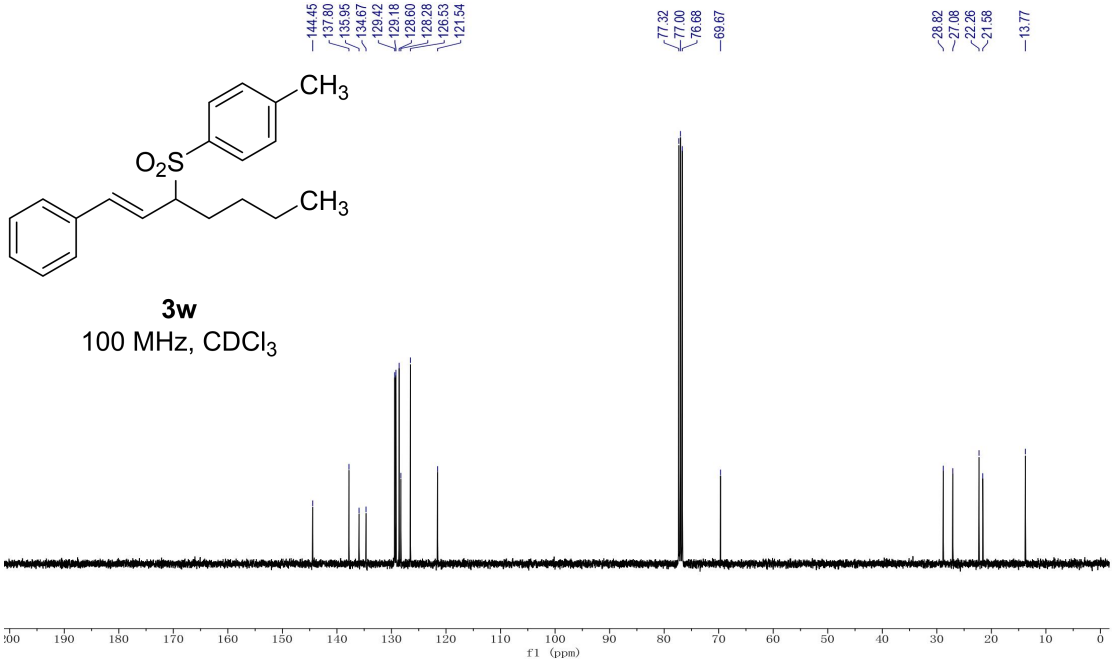

143.17 138.04 137.53 136.00 134.75 130.00 129.93 128.58 128.26 126.71 126.54 121.25
77.32 77.00 76.68 71.11
21.04 19.98 19.62 11.36
CH3
CH3
O2S
CH3
3t
100 MHz, CDCl3
f1 (ppm)

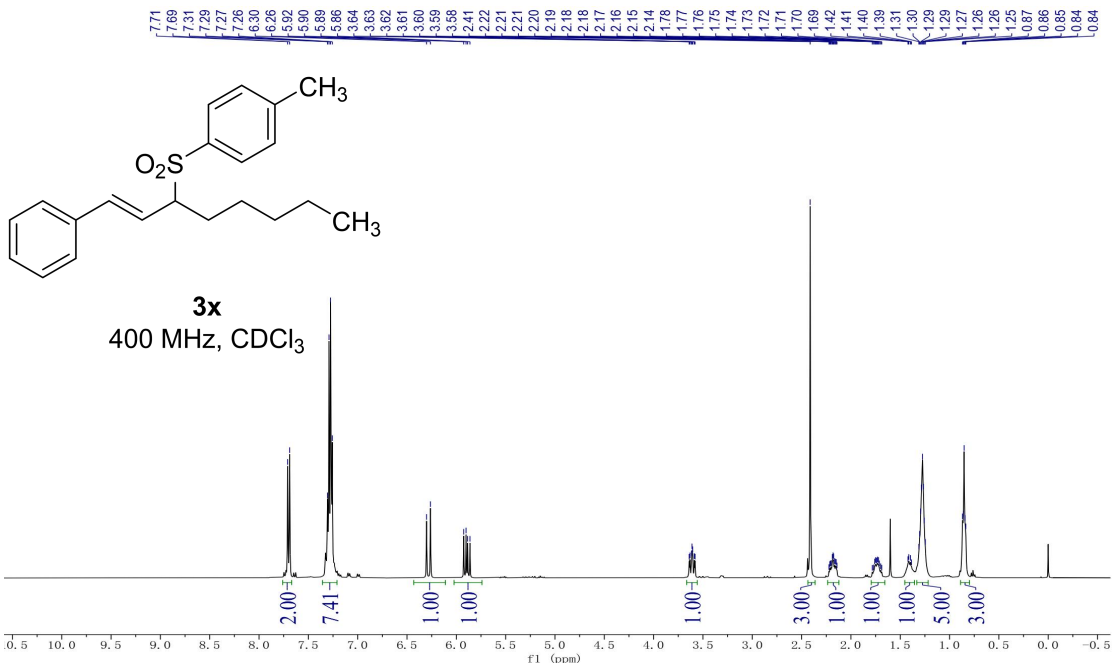

7.44 7.44 7.43 7.43 7.42 7.42 7.41 7.38 7.38 7.37 7.37 7.36 7.36 7.36 7.35 7.34 7.34 7.33 7.33 7.32 7.32 7.31 7.30 7.29 7.29 7.29 6.72 6.68 6.16 6.14 6.12 6.10
3.55 3.54 3.52 3.52 3.50 3.49 2.86 2.34 2.33 2.32 2.32 2.31 2.31 2.30 2.30 2.30 2.29 2.28 2.28 2.27 2.26 2.25 2.24 1.87 1.85 1.84 1.83 1.82 1.82 1.81 1.79 1.07 1.05 1.03
O2S CH3 CH3
3u
400 MHz, CDCl3
2.00 3.00 1.00 1.00 1.00 3.00 1.00 1.00 3.00
f1 (ppm)
138.01 135.45 128.78 128.73 126.71 121.78 77.32 77.00 76.68 69.98 38.43 19.70 11.24
O2S CH3 CH3
3u
100 MHz, CDCl3
f1 (ppm)

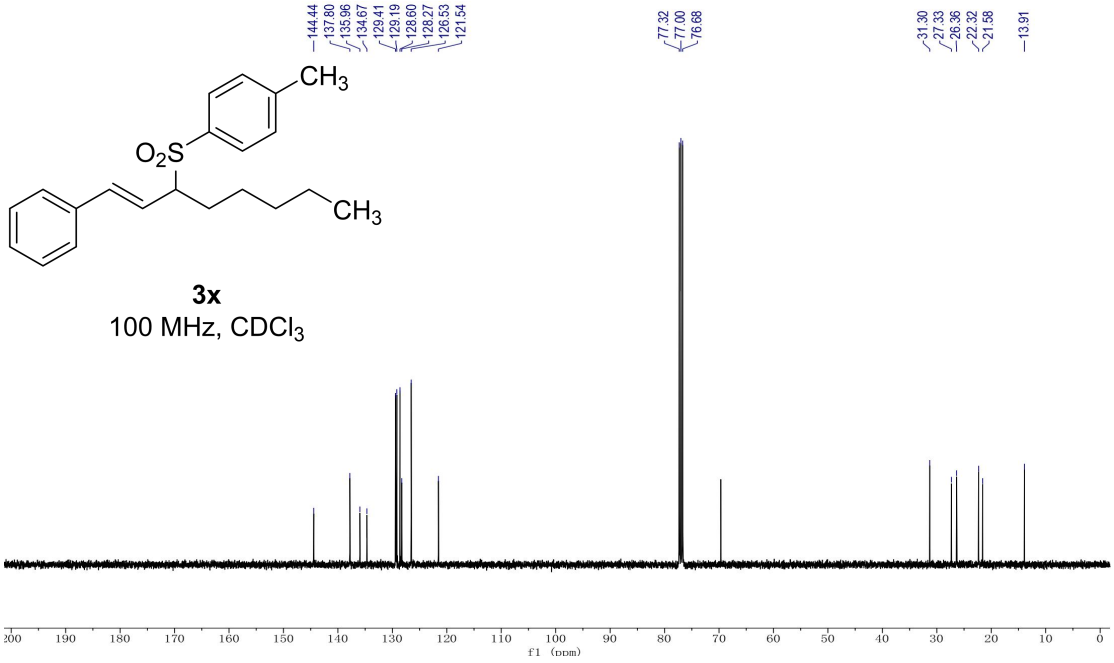

7.71
7.69
7.33
7.32
7.32
7.31
7.30
7.29
7.29
7.27
7.26
7.25
7.24
7.24
6.31
6.27
5.92
5.90
5.89
5.86
3.66
3.65
3.63
3.63
3.61
3.60
2.41
2.18
2.17
2.16
2.15
2.14
2.13
2.13
2.12
2.11
1.78
1.76
1.76
1.75
1.74
1.74
1.73
1.72
1.50
1.49
1.49
1.48
1.47
1.46
1.46
1.45
1.45
1.44
1.34
1.33
1.32
1.31
1.30
1.29
1.28
1.27
1.27
0.94
0.92
0.90
CH3
O2S
CH3
3v
400 MHz, CDCl3
2.00
7.50
1.00
1.00
1.00
3.00
1.00
1.00
1.00
1.00
3.00
f1 (ppm)


144.46
137.80
135.94
134.65
129.42
129.19
128.60
128.28
126.53
121.47
77.32
77.00
76.68
69.45
29.36
21.58
19.97
13.58
CH3
O2S
CH3
3v
100 MHz, CDCl3
f1 (ppm)


7.71 7.69 7.33 7.32 7.31 7.31 7.31 7.29 7.28 7.27 7.26 7.26 7.25 6.30 6.26 5.93 5.90 5.89 5.86 3.64 3.63 3.61 3.61 3.60 3.60 3.58 3.58 2.41 2.22 2.21 2.20 2.20 2.19 2.18 1.76 1.76 1.75 1.74 1.73 1.73 1.41 1.40 1.39 1.38 1.37 1.37 1.36 1.36 1.36 1.35 1.34 1.33 1.33 1.32 1.31 1.30 1.29 1.29 1.28 1.26 1.26 1.25 1.25 0.89 0.87 0.86
CH3
O2S
CH3
3w
400 MHz, CDCl3
2.00 7.21 1.00 1.00 1.00 3.00 1.00 1.00 4.00 3.00
f1 (ppm)


144.45 137.80 135.95 134.67 129.42 129.18 128.60 128.28 126.53 121.54
77.32 77.00 76.68 69.67
28.82 27.08 22.26 21.58 13.77
CH3
O2S
CH3
3w
100 MHz, CDCl3
f1 (ppm)


7.71
7.69
7.31
7.29
7.27
7.26
6.30
6.26
5.92
5.90
5.89
5.86
3.64
3.63
3.62
3.61
3.60
3.59
3.58
2.41
2.22
2.21
2.21
2.20
2.19
2.18
2.18
2.17
2.16
2.15
2.14
1.78
1.77
1.76
1.75
1.74
1.73
1.72
1.71
1.70
1.69
1.42
1.41
1.40
1.39
1.31
1.30
1.29
1.29
1.27
1.26
1.26
1.25
0.87
0.86
0.85
0.84
0.84
CH3
O2S
CH3
3x
400 MHz, CDCl3
2.00
7.41
1.00
1.00
1.00
3.00
1.00
1.00
1.00
5.00
3.00
f1 (ppm)


144.44
137.80
135.96
134.67
129.41
129.19
128.60
128.27
126.53
121.54
77.32
77.00
76.68
31.30
27.33
26.36
22.32
21.58
13.91
CH3
O2S
CH3
3x
100 MHz, CDCl3
f1 (ppm)