Supporting Information for

Base-controlled divergent synthesis of vinyl sulfones from (benzylsulfonyl)benzenes and paraformaldehyde

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General information

The reactions of 2a was carried out under an atmosphere of argo. other reactions were carried out under an atmosphere of air. Column chromatography was performed using silica gel (200-300 mesh). ^{1}H NMR , ^{13}C NMR and ^{19}F NMR spectra were recorded on Bruker-AV (400 , 100 , 376 MHz, respectively) instrument internally referenced to tetramethylsilane (TMS) or chloroform signals. Mass spectra were measured on Agilent 5975 GC-MS instrument (EI). High-resolution mass spectra were recorded at the Keeloud (shanghai) Biotechnology co. LTD. HRMS was conducted using electrospraying ionization (ESI) and was performed on a Thermo Scientific LTQ Orbitrap XL. The structures of known compounds were further corroborated by comparing their ^{1}H NMR, ^{13}C NMR, ^{19}F NMR data and MS data with those of literature. Most reagents were obtained from commercial suppliers (such as Energy Chemical, Aladdin and Tansoole) and used without further purification. The obtain of (benzylsulfonyl)benzene was according to the reported literature unless otherwise noted.

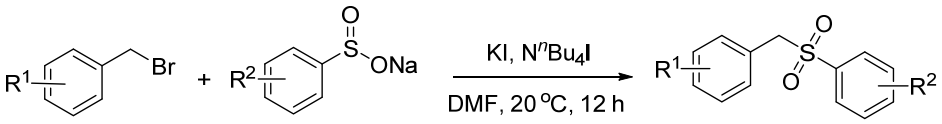
General procedure (2a)

A flat bottom reaction tube (10 mL) equipped with a stir bar was charged with paraformaldehyde(1.8 mmol, 54 mg), Et_3N (0.18 mmol, 23 μL), (benzylsulfonyl)benzene (0.2 mmol, 46.4 mg), and DMF (0.4 mL) under an atmosphere of argo. The sealed reaction vessel was stirred at 140 ^{o}C for 18 h. After cooling to room temperature, the reaction was diluted with ethyl acetate (15 mL). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product.

General procedure (3a)

A flat bottom reaction tube (10 mL) equipped with a stir bar was charged with paraformaldehyde(1 mmol, 30 mg), pyridine(0.2 mmol, 16 μL), (benzylsulfonyl)benzene (0.2 mmol, 46.4 mg), and DMF (1 mL) under air. The sealed reaction vessel was stirred at 120 ^{o}C for 18 h. After cooling to room temperature, the reaction was diluted with ethyl acetate (10 mL). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product.

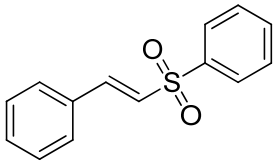
Preparation of aryl benzyl sulfone [1]



Sodium benzenesulfinate 6 (0.80 g, 5 mmol) was dissolved in DMF (30 mL), in which NBu_4I (0.18 g, 0.5 mmol), KI (1.0 g, 6 mmol) and benzyl bromide (1.02g, 6 mmol) were added. The mixture was stirred at room temperature for 12 h. After which, the DMF was removed by vacuum distillation and a residual yellow oil was obtained. The oil was purified by CC (25% EtOAc in hexanes) to give aryl benzyl sulfone.

Characterization data of products

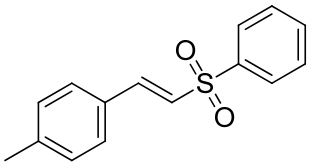
(*E*)-(2-(phenylsulfonyl)vinyl)benzene (2a)[2]



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and (benzylsulfonyl)benzene (46.4 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2a** as white solid(40.5 mg, 83% yield), mp 69-70 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.2 Hz, 2H), 7.69 (d, *J* = 15.4 Hz, 1H), 7.63 – 7.59 (m, 1H), 7.56 – 7.52 (m, 2H), 7.47 – 7.46 (m, 2H), 7.39 – 7.37 (m, 3H), 6.88 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.4, 140.5, 133.3, 132.1, 131.1, 129.2, 129.0, 128.5, 127.5, 127.0.

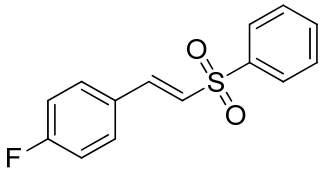
(*E*)-1-Methyl-4-[2-(phenylsulfonyl)vinyl]benzene (2b)[3]



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-methyl-4-((phenylsulfonyl)methyl)benzene (49.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2b** as white solid. (35.6 mg, 69% yield), mp 131-132 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.0 Hz, 2H), 7.69 – 7.52 (m, 4H), 7.38 (d, *J* = 7.6 Hz, 2H), 7.20 (d, *J* = 7.6 Hz, 2H), 6.81 (d, *J* = 15.4 Hz, 1H), 2.37 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.6, 141.8, 140.9, 133.2, 129.8, 129.7, 129.3, 128.6, 127.6, 126.0, 21.5.

(*E*)-1-Fluoro-4-[2-(phenylsulfonyl)vinyl]benzene (2c)[3]

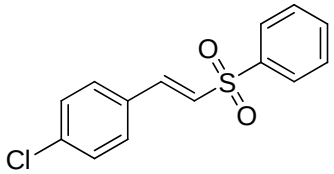


The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-fluoro-4-((phenylsulfonyl)methyl)benzene (50.0 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2c** as white solid (44.6 mg, 85% yield), mp 92-93 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.2 Hz, 2H), 7.68 – 7.62 (m, 2H), 7.56 (t, *J* = 7.4 Hz, 2H), 7.51 – 7.47 (m, 2H), 7.09 (t, *J* = 8.4 Hz, 2H), 6.80 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100 MHz,

$CDCl_3$) δ 164.3(d, *J* = 251.5 Hz), 141.1, 140.5, 133.4, 130.6(d, *J* = 87.1 Hz), 129.4, 128.5(d, *J* = 3.3 Hz), 127.6, 127.0(d, *J* = 1.9 Hz), 116.3(d, *J* = 21.9 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -107.7.

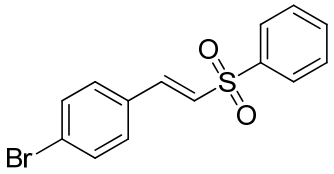
(*E*)-1-Chloro-4-[2-(phenylsulfonyl)vinyl]benzene (2d)[3]



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-chloro-4-((phenylsulfonyl)methyl)benzene (53.3 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2d** as white solid. (47.1 mg, 82% yield), mp 128-130 ^oC.

^1H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.0 Hz, 2H), 7.67 – 7.62 (m, 2H), 7.56 (t, *J* = 7.4 Hz, 2H), 7.43 – 7.36 (m, 4H), 6.84 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.0, 140.5, 137.3, 133.5, 130.8, 129.7, 129.4, 129.4, 127.9, 127.7.

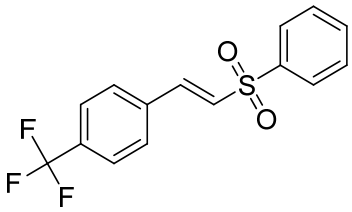
(*E*)-1-Bromo-4-[2-(phenylsulfonyl)vinyl]benzene (2e)[3]



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-bromo-4-((phenylsulfonyl)methyl)benzene (62.3 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2e** as white solid. (42.0 mg, 65% yield), mp 150-151 ^oC.

^1H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.0 Hz, 2H), 7.64 – 7.52 (m, 6H), 7.35 (d, *J* = 8.4 Hz, 2H), 6.86 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.0, 140.4, 133.5, 132.3, 131.2, 129.9, 129.4, 127.9, 127.7, 125.6.

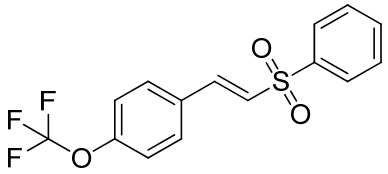
(*E*)-1-(Trifluoromethyl)-4-(2-(phenylsulfonyl)vinyl)benzene (2f)[3]



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-((phenylsulfonyl)methyl)-4-(trifluoromethyl)benzene (60.0 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2f** as white solid (18.7 mg, 30% yield), mp 132-133 ^oC.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 7.4 Hz, 2H), 7.73 – 7.65 (m, 4H), 7.61 – 7.56 (m, 4H), 6.95 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.4, 140.1, 135.7, 133.7, 132.6(q, *J* = 32.7 Hz), 130.0, 129.5, 128.7, 127.8, 126.0(q, *J* = 3.6 Hz), 123.6(q, *J* = 270.8 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.0.

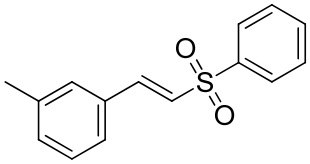
(*E*)-1-(2-(phenylsulfonyl)vinyl)-4-(trifluoromethoxy)benzene(2g)



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-((phenylsulfonyl)methyl)-4-(trifluoromethoxy)benzene (63.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2g** as white solid (24.3 mg, 37% yield), mp 90-92 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.2 Hz, 2H), 7. 69 – 7. 62 (m, 2H), 7.58 – 7.52 (m, 4H), 7.24 (d, *J* = 8.2 Hz, 2H), 6.85 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.0, 140.7, 140.4, 133.6, 130.9, 130.2, 129.5, 128.3, 127.7, 121.3, 117.7 (q, *J* = 254.1 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -57.7. HRMS m/z calcd for: $C_{15}H_{12}F_3O_3S^+$ $(M+H)^+$ 329.0454, found 329.0451.

(*E*)-1-Methyl-3-[2-(phenylsulfonyl)vinyl]benzene (2h)[3]



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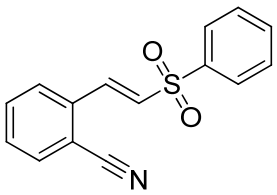
The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-methyl-3-((phenylsulfonyl)methyl)benzene (49.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2h** as white solid(29.0 mg, 56% yield), mp 105-106 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.4 Hz, 2H), 7.68 – 7.53 (m, 4H), 7.29 – 7.23 (m, 5H), 6.84 (d, *J* = 15.0 Hz, 1H), 2.36 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.7, 140.8, 138.8, 133.3, 132.3, 132.1, 129.3, 129.1, 129.0, 127.6, 127.0, 125.8, 21.3.

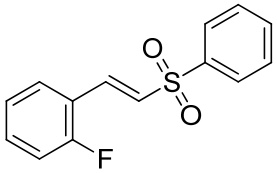
(*E*)-2-(2-(phenylsulfonyl)vinyl)benzonitrile(2i)



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 2-((phenylsulfonyl)methyl)benzonitrile (51.5 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2i** as white solid (11.8 mg, 22% yield), mp 121-122 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 (d, *J* = 7.2 Hz, 2H), 7.93 (d, *J* = 15.4 Hz, 1H), 7.73 (d, *J* = 7.8 Hz, 1H), 7.68 – 7.57 (m, 5H), 7.54 – 7.50 (m, 1H), 7.14 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.8, 137.3, 135.2, 133.8, 133.9, 133.1, 132.5, 130.9, 129.5, 128.1, 128.0, 116.7, 112.9. HRMS calcd for: $C_{15}H_{12}NO_2S^+$ $(M+H)^+$ 270.0583, found 270.0587.

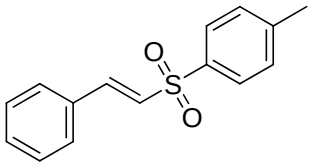
(*E*)-1-fluoro-2-(2-(phenylsulfonyl)vinyl)benzene (2j)



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-fluoro-2-((phenylsulfonyl)methyl)benzene (50.1 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2j** as white solid (45.6 mg, 87% yield), mp 130-131 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 7.2 Hz, 2H), 7.77 (d, *J* = 15.6 Hz, 1H), 7.66 – 7.54 (m, 3H), 7.49 – 7.38 (m, 2H), 7.20 – 7.09 (m, 2H), 7.03 (d, *J* = 15.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.5(d, *J* = 253.8 Hz), 140.4, 135.5, 133.5, 132.8(d, *J* = 8.9 Hz), 130.3(d, *J* = 2.6 Hz), 130.1(d, *J* = 8.6 Hz), 129.4, 127.7, 124.7(d, *J* = 3.6 Hz), 120.5(d, *J* = 11.7 Hz), 116.4(d, *J* = 21.6 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -112.3. HRMS calcd for: $C_{14}H_{12}FO_2S^+$ $(M+H)^+$ 263.0537, found 263.0532.

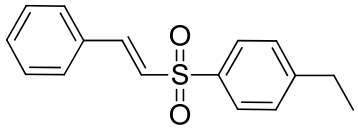
(*E*)-1-methyl-4-(styrylsulfonyl)benzene (2l)[2]



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-(benzylsulfonyl)-4-methylbenzene (49.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2l** as white solid(19.6 mg, 38% yield), mp 119-120 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 8.2 Hz, 2H), 7.66 (d, *J* = 15.4 Hz, 1H), 7.49 –7.47 (m, 2H), 7.42 – 7.34 (m, 5H), 6.85 (d, *J* = 15.4 Hz, 1H), 2.44 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.4, 142.0, 137.8, 132.5, 131.1, 130.0, 129.1, 128.5, 127.7, 127.6, 21.6.

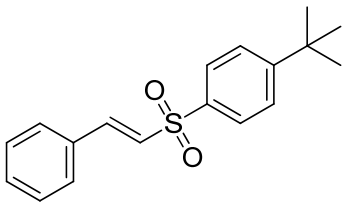
(*E*)-1-ethyl-4-(styrylsulfonyl)benzene(2m)



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-(benzylsulfonyl)-4-ethylbenzene (52.1 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2m** as white solid (26.7 mg, 49 % yield), mp 71-72 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 8.2 Hz, 2H), 7.67 (d, *J* = 15.4 Hz, 1H), 7.49 – 7.48(m, 2H), 7.41 – 7.36 (m, 5H), 6.85 (d, *J* = 15.4 Hz, 1H), 2.73 (q, *J* = 7.6 Hz, 2H), 1.26 (t, *J* = 7.6 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.5, 142.0, 137.9, 132.4, 131.1, 129.0, 128.8, 128.5, 127.8, 127.6, 28.9, 15.1. HRMS m/z calcd for: $C_{16}H_{17}O_2S^+$ $(M+H)^+$ 273.0944, found 273.0949.

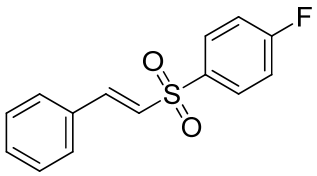
(*E*)-1-(tert-butyl)-4-(styrylsulfonyl)benzene (2n)



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-(benzylsulfonyl)-4-(tert-butyl)benzene (57.7 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2n** as white solid (46.9 mg, 78% yield), mp 111-112 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.0 Hz, 2H), 7.67 (d, *J* = 15.2 Hz, 1H), 7.55 (d, *J* = 7.2 Hz, 2H), 7.48 (d, *J* = 6.8 Hz, 2H), 7.40 – 7.37 (s, 3H), 6.86 (d, *J* = 15.2 Hz, 1H), 1.34 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.3, 141.9, 137.6, 132.4, 131.1, 129.0, 128.5, 127.6, 127.5, 126.4, 35.2, 31.0. HRMS calcd for: $C_{18}H_{21}O_2S^+$ $(M+H)^+$ 301.1257, found 301.1259.

(*E*)-1-fluoro-4-(styrylsulfonyl)benzene (2o)[2]

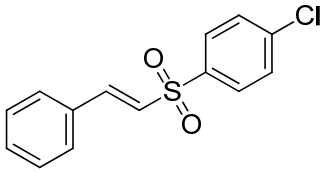


The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-(benzylsulfonyl)-4-fluorobenzene (50.0 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2o** as white solid (38.8 mg, 74% yield), mp 85-86 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 – 7.94 (m, 2H), 7.69 (d, *J* = 15.4 Hz, 1H), 7.50 – 7.48 (m, 2H), 7.43 – 7.38 (m, 3H), 7.25 – 7.20 (m, 2H), 6.85 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$)

δ 165.6(d, *J* = 254.4 Hz) , 142.6, 136.7, 132.1, 131.3, 130.5(d, *J* = 9.5 Hz), 129.1, 128.6, 127.0, 116.6(d, *J* = 22.5 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -103.9.

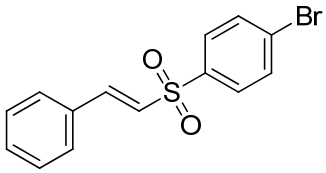
(*E*)-1-chloro-4-(styrylsulfonyl)benzene (2p)[2]



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-(benzylsulfonyl)-4-chlorobenzene (53.3 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2p** as white solid(38.5 mg, 69% yield), mp 82-83 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.6 Hz, 2H), 7.69 (d, *J* = 15.4 Hz, 1H), 7.54 – 7.49 (m, 4H), 7.44 – 7.38 (m, 3H), 6.84 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.1, 140.1, 139.2, 132.2, 131.4, 129.7, 129.2, 128.6, 126.8.

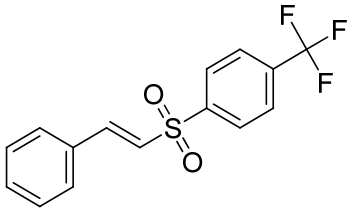
(*E*)-1-bromo-4-(styrylsulfonyl)benzene (2q)[2]



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-(benzylsulfonyl)-4-bromobenzene (62.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2q** as white solid (47.8 mg, 74% yield), mp 102-103 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.4 Hz, 2H), 7.71 – 7.66 (m, 3H), 7.50 – 7.39 (m, 5H), 6.83 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100MHz, $CDCl_3$) δ 143.1, 139.8, 132.7, 132.2, 131.5, 129.4, 129.2, 129.1, 128.7, 126.9.

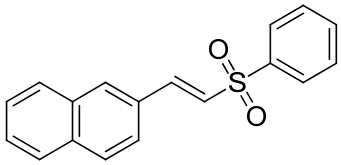
(*E*)-1-(styrylsulfonyl)-4-(trifluoromethyl)benzene (2r)[4]



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 1-(benzylsulfonyl)-4-(trifluoromethyl)benzene (60.0 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2r** as white solid (53.1 mg, 85% yield), mp 77-79 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09 (d, *J* = 8.0 Hz, 2H), 7.82 (d, *J* = 8.0 Hz, 2H), 7.75 (d, *J* = 15.4 Hz, 1H), 7.50 (d, *J* = 7.4 Hz, 2H), 7.41 – 7.39 (m, 3H), 6.86 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.3, 144.0, 135.0(q, *J* = 32.9 Hz), 131.9, 131.6, 129.1, 128.7, 128.2, 126.4(q, *J* = 3.7 Hz), 126.2, 123.1(q, *J* = 271.2 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.3.

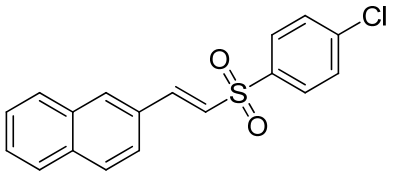
(*E*)-2-(2-(phenylsulfonyl)vinyl)naphthalene (2t)



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 2-((phenylsulfonyl)methyl)naphthalene (56.5 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2t** as white solid(30.6 mg, 52% yield), mp 98-100 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 (d, *J* = 7.2 Hz, 2H), 7.92 (s, 1H), 7.86 – 7.79 (m, 4H), 7.63 – 7.49 (m, 6H), 6.97 (d, *J* = 15.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.5, 140.7, 134.4, 133.3, 133.0, 131.0, 130.9, 129.7, 129.3, 128.9, 128.6, 127.8, 127.6, 127.2, 126.9, 123.3. HRMS calcd for: $C_{18}H_{15}O_2S^+$ $(M+H)^+$ 295.0787, found 295.0793.

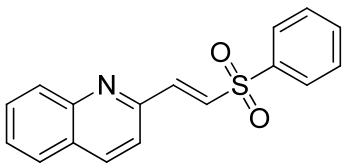
(*E*)-2-(2-((4-chlorophenyl)sulfonyl)vinyl)naphthalene (2u)



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 2-(((4-chlorophenyl)sulfonyl)methyl)naphthalene (63.3 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2u** as white solid (31.6 mg, 48% yield), mp 182-183 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 – 7.84 (m, 7H), 7.57 – 7.52 (m, 5H), 6.94 (d, *J* = 15.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.1, 140.0, 139.3, 134.5, 133.0, 131.1, 129.6, 129.7, 129.1, 129.0, 128.7, 127.9, 127.8, 127.0, 126.8, 123.3. HRMS calcd for: $C_{18}H_{14}ClO_2S^+$ $(M+H)^+$ 329.0397, found 329.0394.

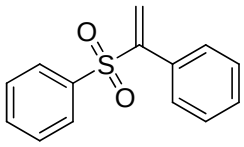
(*E*)-2-(2-(phenylsulfonyl)vinyl)quinoline (2v)



The reaction was conducted with paraformaldehyde (54 mg, 1.8 mmol), and 2-((phenylsulfonyl)methyl)quinoline (56.7 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 80:1) to yield the desired product **2v** as white solid (13.6 mg, 23% yield), mp 139-140 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.23 (d, *J* = 8.4 Hz, 1H), 8.10 (d, *J* = 8.2 Hz, 1H), 8.02 (d, *J* = 7.4 Hz, 2H), 7.85 (t, *J* = 11.8 Hz, 2H), 7.78 –7.74 (m, 1H), 7.67 – 7.55 (m, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.9, 147.9, 140.9, 140.1, 137.4, 133.7, 133.3, 130.6, 129.6, 129.4, 128.4, 128.0, 128.0, 127.6, 121.5. HRMS calcd for: $C_{17}H_{14}NO_2S^+$ $(M+H)^+$ 296.0739, found 296.0735.

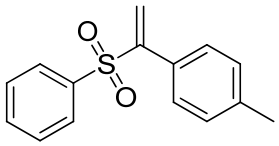
(1-(phenylsulfonyl)vinyl)benzene (3a)[6]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and (benzylsulfonyl)benzene (46.4 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3a** as white solid (41.9 mg, 86% yield), mp 70-71 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, *J* = 7.2 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.44 – 7.40 (m, 2H), 7.35 – 7.28 (m, 5H), 6.65 (s, 1H), 5.98 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.8, 138.5, 133.4, 132.3, 129.3, 129.1, 128.8, 128.3, 128.2, 126.0.

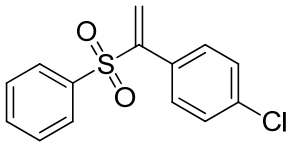
1-methyl-4-(1-(phenylsulfonyl)vinyl)benzene (3b)[6]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-methyl-4-((phenylsulfonyl)methyl)benzene (49.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3b** as white solid(38.7 mg, 75% yield), mp 85-86 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 7.2 Hz, 2H), 7.53 (t, *J* = 7.4 Hz, 1H), 7.41 (t, *J* = 7.8 Hz, 2H), 7.22 (d, *J* = 8.2 Hz, 2H), 7.07 (d, *J* = 7.8 Hz, 2H), 6.60 (s, 1H), 5.93 (s, 1H), 2.32 (s, 3H).^{13}C NMR (100 MHz, $CDCl_3$) δ 150.7, 139.4, 138.8, 133.3, 129.4, 129.0, 128.9, 128.8, 128.3, 125.5, 21.2.

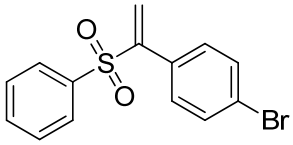
1-chloro-4-(1-(phenylsulfonyl)vinyl)benzene (3c)[7]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-chloro-4-((phenylsulfonyl)methyl)benzene (53.3 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3c** as white solid(44.5 mg, 80% yield), mp 71-73 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 7.2 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.29 – 7.24 (m, 4H), 6.64 (s, 1H), 5.96 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.7, 138.3, 135.6, 133.6, 130.8, 130.4, 129.0, 128.5, 128.2, 126.4.

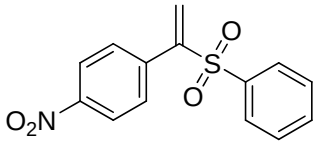
1-bromo-4-(1-(phenylsulfonyl)vinyl)benzene (3d)[7]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-bromo-4-((phenylsulfonyl)methyl)benzene (62.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3d** as yellow solid(45.2 mg, 70% yield), mp 76-77 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 7.2 Hz, 2H), 7.55 (t, *J* = 7.2 Hz, 1H), 7.45 – 7.40 (m, 4H), 7.20 (d, *J* = 8.4 Hz, 2H), 6.64 (s, 1H), 5.96 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.0, 138.4, 133.6, 131.5, 131.4, 130.6, 129.0, 128.3, 126.3, 123.9.

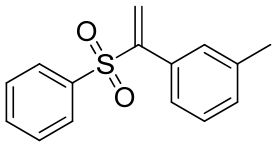
1-nitro-4-(1-(phenylsulfonyl)vinyl)benzene (3e)



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-nitro-4-((phenylsulfonyl)methyl)benzene (55.5 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3e** as white solid. (26.0 mg, 45% yield), mp 113-115 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (d, *J* = 8.4 Hz, 2H), 7.69 (d, *J* = 8.2 Hz, 2H), 7.60 – 7.53 (m, 3H), 7.45 (t, *J* = 7.6 Hz, 2H), 6.77 (s, 1H), 6.08 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.4, 148.3, 138.9, 138.0, 133.9, 130.1, 129.2, 128.3, 127.7, 123.5. HRMS (ESI) m/z calcd for: $C_{14}H_{12}NO_4S^+$ $(M+H)^+$ 290.0481, found 290.0488.

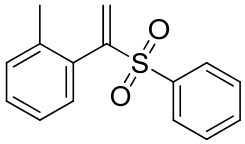
1-methyl-3-(1-(phenylsulfonyl)vinyl)benzene (3f)[7]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-methyl-3-((phenylsulfonyl)methyl)benzene (49.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3f** as white solid(42.3 mg, 82% yield), mp 82-83 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 7.3 Hz, 1H), 7.53 (t, *J* = 7.0 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 2H), 7.16 – 7.09 (m, 4H), 6.60 (s, 1H), 5.94 (s, 1H), 2.28 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.8, 138.6, 137.9, 133.3, 132.2, 130.0, 129.6, 128.8, 128.3, 128.1, 126.1, 125.7, 21.2.

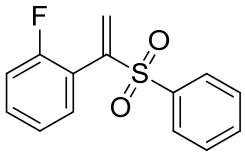
1-methyl-2-(1-(phenylsulfonyl)vinyl)benzene (3g)[6]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-methyl-2-((phenylsulfonyl)methyl)benzene (49.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3g** as white solid (44.9 mg, 87% yield), mp 80-81 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 – 7.58 (m, 3H), 7.44 (t, *J* = 7.8 Hz, 2H), 7.29 – 7.23 (m, 1H), 7.13 – 7.07 (m, 2H), 6.96 (d, *J* = 7.8 Hz, 1H), 6.77 (s, 1H), 5.84 (s, 1H), 1.95 (s, 3H).^{13}C NMR (100 MHz, $CDCl_3$) δ 149.9, 138.2, 137.7, 133.5, 131.4, 130.6, 130.1, 129.2, 128.9, 128.8, 126.9, 125.1, 19.2.

1-fluoro-2-(1-(phenylsulfonyl)vinyl)benzene (3h)

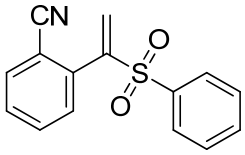


The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-fluoro-2-((phenylsulfonyl)methyl)benzene (50.0 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3h** as white solid (44.5 mg, 85% yield), mp 87-89 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 7.6 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.41 (t, *J* = 7.6 Hz, 3H), 7.33 – 7.28 (m, 1H), 7.10 (t, *J* = 7.4 Hz, 1H), 6.92 (t, *J* = 9.0 Hz, 1H), 6.85 (s, 1H), 6.03 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.8 (d, *J* = 248.9 Hz), 144.1, 138.2, 133.6, 131.7 (d, *J* = 1.7 Hz), 131.3(d, *J* = 8.0 Hz), 128.9, 128.8, 128.4, 123.7 (d, *J* = 3.8 Hz), 119.8 (d, *J* = 15.0 Hz),

115.5(d, J = 21.9 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -115.0. HRMS (ESI) m/z calcd for: $C_{14}H_{12}FO_2S^+$ $(M+H)^+$ 263.0537, found 263.0539.

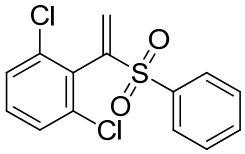
2-(1-(phenylsulfonyl)vinyl)benzonitrile (3i)



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 2-((phenylsulfonyl)methyl)benzonitrile (51.4 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3i** as white solid (26.9 mg, 49% yield), mp 99-100 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 (d, J = 7.4 Hz, 1H), 7.67 (d, J = 7.4 Hz, 2H) , 7.60(m, 2H), 7.54 (d, J = 7.4 Hz, 1H), 7.48 – 7.43 (m, 3H), 6.93 (s, 1H), 6.13 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.1, 137.5, 135.5, 134.0, 132.9, 132.3, 131.1, 129.7, 129.5, 129.2, 128.7, 116.4, 113.4. HRMS (ESI) m/z calcd for: $C_{15}H_{12}NO_2S^+$ $(M+H)^+$270.0583, found 270.0588.

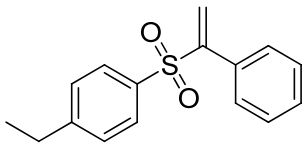
1,3-dichloro-2-(1-(phenylsulfonyl)vinyl)benzene (3j)



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1,3-dichloro-2-((phenylsulfonyl)methyl)benzene (51.4 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3j** as white solid (54.5 mg, 87% yield) , mp 113-114 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, J = 7.8 Hz, 2H), 7.57 (t, J = 7.4 Hz, 1H), 7.42 (t, J = 7.6 Hz, 2H), 7.26 – 7.17 (m, 3H), 6.85 (s, 1H), 5.98 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.2, 139.1, 136.4, 133.9, 131.4, 131.0, 130.8, 129.2, 129.1, 128.7, 128.6, 128.2. HRMS (ESI) m/z calcd for: $C_{14}H_{11}Cl_2O_2S^+$ $(M+H)^+$312.9851, found 312.9855.

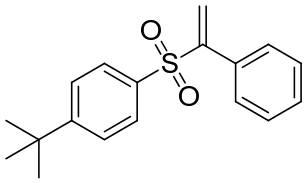
1-ethyl-4-((1-phenylvinyl)sulfonyl)benzene (3k)[2]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-(benzylsulfonyl)-4-ethylbenzene (52.0 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3k** as pale yellow viscous liquid (45.1 mg, 83% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, *J* = 8.4 Hz, 2H), 7.33 – 7.31 (m, 3H), 7.28 – 7.24 (m, 2H), 7.21 (d, *J* = 8.2 Hz, 2H), 6.59 (s, 1H), 5.93 (s, 1H), 2.65 (q, *J* = 7.6 Hz, 2H), 1.20 (t, *J* = 7.6 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.0, 150.4, 135.8, 132.5, 129.2, 129.0, 128.4, 128.3, 128.2, 125.5 , 28.7, 14.9.

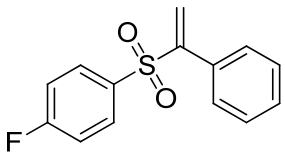
1-(tert-butyl)-4-((1-phenylvinyl)sulfonyl)benzene (3l)



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-(benzylsulfonyl)-4-(tert-butyl)benzene (57.7 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3l** as white solid (51.6 mg, 86% yield), mp 85-86 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (d, *J* = 8.4 Hz, 2H), 7.40 (d, *J* = 8.4 Hz, 2H), 7.35 – 7.31 (m, 3H), 7.28 – 7.24 (m, 2H), 6.58 (s, 1H), 5.93 (s, 1H), 1.28 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.2, 150.9, 135.6, 132.5, 129.2, 129.1, 128.2, 128.1, 125.8, 125.6, 35.1, 30.9. HRMS (ESI) m/z calcd for: $C_{18}H_{21}O_2S^+$ $(M+H)^+$301.1257, found 301.1255.

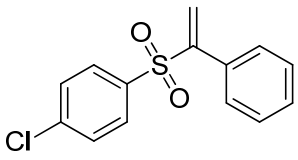
1-fluoro-4-((1-phenylvinyl)sulfonyl)benzene (3m)[8]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-(benzylsulfonyl)-4-fluorobenzene (50.0 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3m** as white solid. (43.4 mg, 83% yield), mp 92-93 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 – 7.66 (m, 2H), 7.36 – 7.26 (m, 5H), 7.06 (t, *J* = 8.6 Hz, 2H), 6.63 (s, 1H), 5.96 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.5 (d, *J* = 254.5 Hz), 150.7, 134.5 (d, *J* = 3.3 Hz), 132.1, 131.2 (d, *J* = 9.5 Hz), 129.4, 129.0, 128.3, 126.0, 116.1 (d, *J* = 22.8 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -102.3.

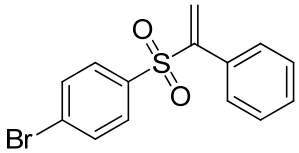
1-chloro-4-((1-phenylvinyl)sulfonyl)benzene (3n)[7]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-(benzylsulfonyl)-4-chlorobenzene (53.3 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3n** as white solid (38.3 mg, 69% yield), mp 87-88 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (d, J = 8.6 Hz, 2H), 7.37 – 7.28 (m, 7H), 6.65 (s, 1H), 5.98 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.4, 140.0, 137.1, 132.0, 129.7, 129.5, 129.1, 129.0, 128.3, 126.3.

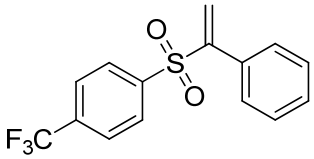
1-bromo-4-((1-phenylvinyl)sulfonyl)benzene (3o)[7]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-(benzylsulfonyl)-4-bromobenzene (62.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3o** as white solid (47.8 mg, 74% yield), mp 80-81 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (s, 4H), 7.38 – 7.27 (m, 5H), 6.65 (s, 1H), 5.99 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.4, 137.7, 132.1, 132.0, 129.8, 129.5, 129.4, 128.7, 128.4, 126.4.

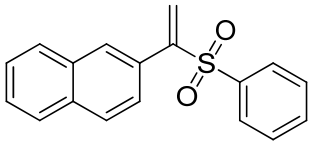
1-((1-phenylvinyl)sulfonyl)-4-(trifluoromethyl)benzene (3p)[7]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-(benzylsulfonyl)-4-(trifluoromethyl)benzene (60.0 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3p** as white solid (44.9 mg, 72% yield), mp 80-82 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (d, J = 12.2 Hz, 2H), 7.66 (d, J = 8.2 Hz, 2H), 7.38 – 7.27 (m, 5H), 6.70 (s, 1H), 6.05 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.1, 142.3, 134.9 (q, J = 32.8 Hz), 131.8, 129.6, 129.1, 128.8, 128.5, 127.2, 125.9 (q, J = 3.8 Hz), 123.0 (q, J = 271.5 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.2.

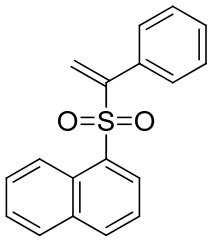
2-(1-(phenylsulfonyl)vinyl)naphthalene (3q)[7]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 2-((phenylsulfonyl)methyl)naphthalene (51.4 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3q** as white solid (36.5 mg, 62% yield), mp 71-72 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (s, 1H), 7.82 – 7.72 (m, 5H), 7.53 – 7.43 (m, 4H), 7.37 (t, *J* = 7.8 Hz, 2H), 6.74 (s, 1H), 6.08 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.8, 138.6, 133.4, 133.2, 132.6, 129.7, 128.9, 128.8, 128.3, 128.2, 128.0, 127.5, 127.0, 126.5, 126.6, 126.1.

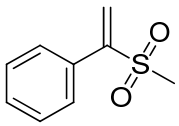
1-((1-phenylvinyl)sulfonyl)naphthalene (3r)[7]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 1-(benzylsulfonyl)naphthalene (56.4 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3r** as white solid (30.6 mg, 52% yield), mp 99-100 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.59 (d, *J* = 8.6 Hz, 1H), 8.12 (d, *J* = 7.4 Hz, 1H), 8.00 (d, *J* = 8.2 Hz, 1H), 7.89 (d, *J* = 8.0 Hz, 1H), 7.65 – 7.55 (m, 2H), 7.41 (t, *J* = 7.8 Hz, 1H), 7.23 – 7.10 (m, 5H), 6.77 (s, 1H), 6.04 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.2, 135.0, 133.6, 132.6, 132.0, 131.2, 129.0, 128.9, 128.5, 128.4, 128.1, 127.9, 126.6, 125.6, 123.9, 123.9.

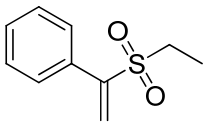
(1-(methylsulfonyl)vinyl)benzene (3s) [8]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and ((methylsulfonyl)methyl)benzene (34 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3s** as pale yellow viscous liquid (26.9 mg, 74% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 –7.62 (m, 2H), 7.48 – 7.41 (m, 3H), 6.54 (s, 1H), 6.03 (s, 1H), 2.80 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.9, 132.4, 129.8, 128.8, 128.5, 125.9, 40.5.

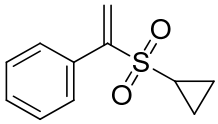
(1-(ethylsulfonyl)vinyl)benzene (3t) [6]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and ((ethylsulfonyl)methyl)benzene (36.8 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3t** as pale yellow viscous liquid (28.2 mg, 72% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (m, 2H), 7.46 – 7.39 (m, 3H), 6.52 (s, 1H), 6.08 (s, 1H), 2.85 (q, *J* = 7.4 Hz, 1H)., 1.22 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.8, 132.5, 129.7, 128.8, 128.5, 127.5, 46.2, 6.9.

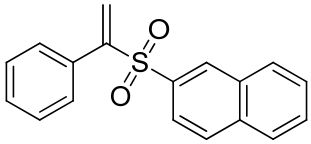
(1-(cyclopropylsulfonyl)vinyl)benzene (3u)[8]



The reaction was conducted with paraformaldehyde (30mg, 1.0 mmol), and ((cyclopropylsulfonyl)methyl)benzene (39.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3u** as pale yellow viscous liquid (32.8 mg, 79 % yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 (m, 2H), 6.42 (s, 1H), 5.94 (s, 1H), 2.25 – 2.20 (m, 1H), 1.12 – 1.11 (m, 2H), 0.89 – 0.88 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.6, 132.9, 129.5, 128.9, 128.5, 125.2, 29.4, 5.4.

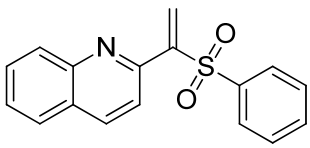
2-((1-phenylvinyl)sulfonyl)naphthalene (3v)[7]



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 2-(benzylsulfonyl)naphthalene (56.4 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3v** as white solid (35.8 mg, 61% yield), mp 90-91 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29 (s, 1H), 7.88 – 7.84 (m, 3H), 7.65 – 7.55 (m, 3H), 7.35 – 7.22 (m, 5H), 6.70 (s, 1H), 6.01 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.8, 135.5, 135.0, 132.4, 131.9, 130.1, 129.3, 129.3, 129.1, 129.1, 129.0, 128.2, 127.8, 127.4, 126.1, 122.9.

2-(1-(phenylsulfonyl)vinyl)quinoline (3w)

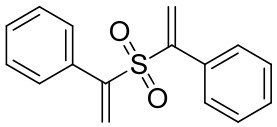


The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and 2-((phenylsulfonyl)methyl)quinoline (56.7 mg, 0.2 mmol). The residue was purified by column

chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3w** as yellow solid (29.5 mg, 50% yield), mp 89-90 ^{o}C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (d, *J* = 8.4 Hz, 1H), 7.97 – 7.89 (m, 4H), 7.80 (d, *J* = 7.4 Hz, 1H), 7.71 – 7.67 (m, 1H), 7.57 – 7.44 (m, 4H), 6.95 (s, 1H), 6.73 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.6, 150.2, 147.6, 139.7, 136.7, 133.4, 130.0, 129.5, 129.4, 128.8, 128.5, 127.5, 127.4, 127.3, 120.1. HRMS calcd for: $C_{17}H_{14}NO_2S^+$ $(M+H)^+$ 296.0739, found 296.0735.

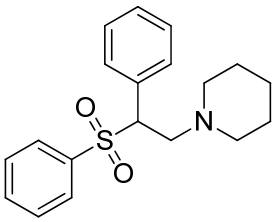
(sulfonylbis(ethene-1,1-diyl))dibenzene (3x)



The reaction was conducted with paraformaldehyde (30 mg, 1.0 mmol), and (sulfonylbis(methylene))dibenzene (49.2 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to yield the desired product **3x** as pale yellow viscous liquid (16.2 mg, 30% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.27 (m, 10H), 6.41 (s, 2H), 5.92 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.3, 132.2, 129.4, 128.9, 128.3, 128.0. HRMS calcd for: $C_{16}H_{15}O_2S^+$ $(M+H)^+$ 270.0715, found 270.0715.

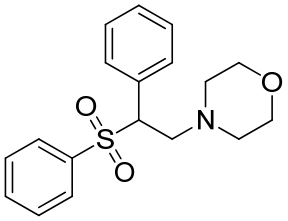
1-(2-phenyl-2-(phenylsulfonyl)ethyl)piperidine (5a)



Prepared α-substituted vinyl sulfones (0.2 mmol) with piperidine (37 μL, 0.4 mmol) reacting .The title compound was obtained as a white solid (48.1 mg, 73%), mp 100-101 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 – 7.52 (m, 3H), 7.39 (t, *J* = 7.8 Hz, 2H), 7.31 – 7.23 (m, 3H), 7.18 (d, *J* = 6.6 Hz, 2H), 4.35 – 4.31 (m, 1H), 3.50 – 3.46 (m, 1H), 3.10 – 3.05 (m, 1H), 2.28 – 2.22 (m, 4H), 1.33 – 1.28 (m, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.2, 133.2, 132.7, 129.9, 128.7, 128.5, 128.5, 128.3, 69.0, 57.2, 54.3, 25.6, 23.8. HRMS calcd for: $C_{19}H_{24}NO_2S^+$ $(M+H)^+$ 330.1522, found 330.1522.

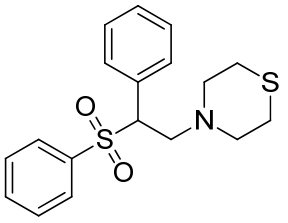
4-(2-phenyl-2-(phenylsulfonyl)ethyl)morpholine (5b)



Prepared α-substituted vinyl sulfones (0.2 mmol) with morpholine (35 μL, 0.4 mmol) reacting .The title compound was obtained as a white solid (47.7 mg, 72%), mp 108-110 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 – 7.53 (m, 3H), 7.39 (t, *J* = 7.8 Hz, 2H), 7.31 – 7.22 (m, 3H), 7.16 (d, *J* = 6.8 Hz, 2H), 4.34 – 4.32 (m, 1H), 3.51 – 3.45 (m, 5H), 3.13 –3.09 (m, 1H), 2.37 – 2.33 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.0, 133.4, 132.3, 129.8, 128.8, 128.7, 128.5, 128.4, 68.9, 66.5, 56.8, 53.3. HRMS calcd for: $C_{18}H_{22}NO_3S^+$ $(M+H)^+$ 332.1315, found 332.1317.

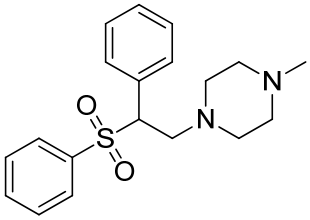
4-(2-phenyl-2-(phenylsulfonyl)ethyl)thiomorpholine (5c)



Prepared α-substituted vinyl sulfones (0.2 mmol) with thiomorpholine (41.3 mg, 0.4 mmol) reacting .The title compound was obtained as a white solid (52.1 mg, 75%), mp 129-130 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 –7.53 (m, 3H), 7.39 (t, *J* = 7.6 Hz, 2H), 7.29 – 7.23 (m, 3H), 7.16 (d, *J* = 7.2 Hz, 2H), 4.32– 4. 29 (m, 1H), 3.57 – 3. 52 (m, 1H), 3.20 – 3.14 (m, 1H), 2.68 – 2.60 (m, 4H), 2.43 – 2.39 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.1, 133.4, 132.5, 129.8, 128.7, 128.6, 128.4, 68.8, 57.3, 54.6, 27.6. HRMS calcd for: $C_{18}H_{22}NO_2S_2^+$ $(M+H)^+$ 348.1086, found 348.1086.

1-methyl-4-(2-phenyl-2-(phenylsulfonyl)ethyl)piperazine (5d)

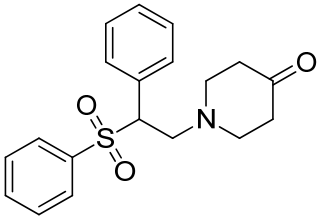


Prepared α-substituted vinyl sulfones (0.2 mmol) with 1-methylpiperazine (45 μL, 0.4 mmol) reacting. The title compound was obtained as a white solid (63.3 mg, 92%), mp 113-114 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (m, 3H), 7.39 (t, *J* = 7.8 Hz, 2H), 7.31 – 7.22 (m, 3H), 7.16 (d, *J* = 7.2 Hz, 2H), 4.34– 4.31 (m, 1H), 3.56 – 3.51 (m, 1H), 3.17 – 3.12 (m, 1H), 2.39 (s, 4H), 2.22 – 2.05 (m, 7H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.9, 133.3, 132.4, 129.8, 128.7, 128.6, 128.5,

128.3, 68.8, 56.2, 54.5, 52.6, 45.7. HRMS calcd for: $C_{19}H_{25}N_2O_2S^+$ $(M+H)^+$ 345.1631, found 345.1634.

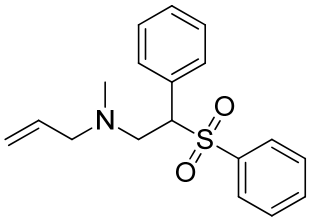
1-(2-phenyl-2-(phenylsulfonyl)ethyl)piperidin-4-one (5e)



Prepared α-substituted vinyl sulfones (0.2 mmol) with reacting piperidin-4-one•$HClH_2O$ (61.5 mg, 0.4 mmol) reacting. The title compound was obtained as a white solid (41.2 mg, 60%), mp 152-153 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 – 7.51 (m, 3H), 7.40 (t, *J* = 7.8 Hz, 2H), 7.35 – 7.22 (m, 4H), 7.18 (d, *J* = 6.8 Hz, 2H), 4.38 – 4.27 (m, 1H), 3.71 – 3.61 (m, 1H), 3.30 –3.25(m, 1H), 2.79 – 2.50 (m, 4H), 2.35 – 2.14 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 208.3, 138.0, 133.5, 132.1, 129.7, 128.8, 128.7, 128.6, 128.5, 128.5, 69.4, 55.4, 52.8, 40.8. HRMS calcd for: $C_{19}H_{22}NO_3S^+$ $(M+H)^+$ 344.1315, found 344.1305.

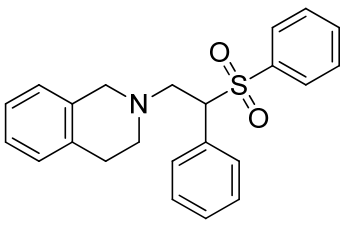
***N*-methyl-*N*-(2-phenyl-2-(phenylsulfonyl)ethyl)prop-2-en-1-amine (5f)**



Prepared α-substituted vinyl sulfones (0.2 mmol) with N-methylprop-2-en-1-amine (39 μL, 0.4 mmol) reacting .The title compound was obtained as a white solid (48.5 mg, 77%), mp 80-81 °C.

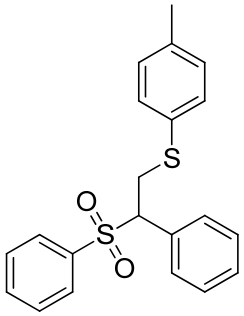
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 9.6 Hz, 3H), 7.38 (t, *J* = 7.6 Hz, 2H), 7.29 – 7.22 (m, 3H), 7.14 (d, *J* = 7.0 Hz, 2H), 5.69 – 5.59 (m, 1H), 5.09 – 5.05 (m, 2H), 4.31 –4.28 (m , 1H), 3.41 – 3.23 (m, 2H), 3.02 – 2.91 (m, 2H), 2.13 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.6, 134.8, 133.4, 132.2, 129.9, 128.8, 128.6, 128.5, 128.3, 118.0, 69.7, 60.8, 54.3, 42.3. HRMS calcd for: $C_{18}H_{22}NO_2S^+$ $(M+H)^+$ 316.1366, found 316.1364.

2-(2-phenyl-2-(phenylsulfonyl)ethyl)-1,2,3,4-tetrahydroisoquinoline (5g)



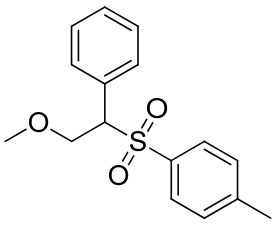
Prepared α-substituted vinyl sulfones (0.2 mmol) with 1,2,3,4-tetrahydroisoquinoline (51 μL, 0.4 mmol) reacting. The title compound was obtained as a white solid (65 mg, 86%), mp 124-125 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, *J* = 4.2 Hz, 1H), 7.50 (t, *J* = 7.4 Hz, 1H), 7.37 – 7.20(m, 7H), 7.11 – 7.00 (m, 3H), 6.90 (d, *J* = 8.4 Hz, 1H), 4.44 – 4.40 (m, 1H), 3.69 – 3.52 (m, 3H), 3.37 – 3.31 (m, 1H), 2.74 – 2.63 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.8, 134.1, 133.9, 133.3, 132.5, 129.9, 128.8, 128.7, 128.5, 128.4, 126.4, 126.1, 125.5, 69.6, 55.9, 55.6, 50.6, 28.7. HRMS calcd for $C_{23}H_{24}NO_2S^+$ $(M+H)^+$ 378.1522, found 378.1528.

(2-phenyl-2-(phenylsulfonyl)ethyl)(p-tolyl)sulfane (5h)



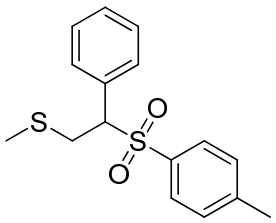
Prepared *α*-substituted vinyl sulfones (0.2 mmol) with 4-methylbenzenethiol (49.6 mg, 0.4 mmol) reacting. The title compound was obtained as a white solid (63.3 mg, 86%), mp 133-134 ^{o}C.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (t, *J* = 7.4 Hz, 1H), 7.48 (d, *J* = 8.0 Hz, 2H), 7.37 (t, *J* = 7.6 Hz, 2H), 7.31 (t, *J* = 7.2 Hz, 1H), 7.24 (t, *J* = 8.6 Hz, 3H), 7.12 (d, *J* = 8.0 Hz, 2H), 7.07 – 7.05 (m, 4H), 4.16 – 4.12 (m, 1H), 3.95 – 3.91 (m, 1H), 3.47 (t, *J* = 12.8 Hz, 1H), 2.33 (s, 3H).^{13}C NMR (100 MHz, $CDCl_3$) δ 137.3, 136.9, 133.7, 131.1, 130.8, 130.1, 130.0, 129.9, 129.1, 129.0, 128.7, 128.4, 70.3, 32.6, 21.1. HRMS calcd for: $C_{21}H_{21}O_2S_2^+$ $(M+H)^+$ 369.0977, found 369.0973.

1-((2-methoxy-1-phenylethyl)sulfonyl)-4-methylbenzen (5i)



Prepared (benzylsulfonyl)benzene (0.2 mmol), $(HCHO)_n$ (1 mmol), CH_3OH (0.8 mL).reacting. The title compound was obtained as a white solid (39.8 mg, 72%), mp 119-120 °C.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 (d, *J* = 8.2 Hz, 2H), 7.33 – 7.25 (m, 3H), 7.19 (d, *J* = 7.8 Hz, 4H), 4.40 – 4.37 (m, 1H), 4.28 – 4.26 (m, 1H), 4.07 – 4.03 (m, 1H), 3.30 (s, 3H), 2.39 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.6, 134.8, 131.2, 129.8, 129.2, 128.9, 128.9, 128.5, 70.7, 69.8, 59.1, 21.6. HRMS calcd for: $C_{16}H_{19}O_3S^+$ $(M+H)^+$ 291.1049, found 291.1051.

methyl(2-phenyl-2-tosylethyl)sulfane (5j)



Prepared (benzylsulfonyl)benzene (0.2 mmol), $(HCHO)_n$ (1 mmol), DMSO (1.5 mL).reacting. The title compound was obtained as a white solid (43.4 mg, 71%), mp 110-111 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (d, J = 7.6 Hz, 2H)), 7.33 – 7.24 (m, 4H), 7.19 – 7.13 (m, 3H), 4.23 (d, J = 14.2 Hz, 1H), 3.52 – 3.48 (m, 1H), 3.24 (t, J = 12.6, 1H), 2.39 (s, 3H), 1.97 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.8, 134.0, 131.5, 130.8, 129.9, 129.4, 129.0, 128.4, 32.1, 21.6, 16.2. HRMS calcd for: $C_{16}H_{19}O_2S_2^+$ $(M+H)^+$ 306.0748, found 306.0750.

Reference:

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[4] Y. L. Xu, X. T. Tang, W. G. Hu, W. Q. Wu, H. F. Jiang, *Green Chem*., **2014**, *16*, 3720.

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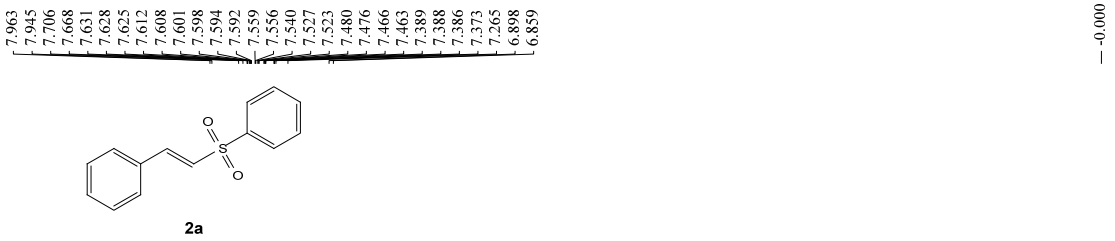
[6] Y. W. Fang, M. J. Yuan, J. C. Zhang, L. Zhang, X. P. Jin, R. F. Li, J. J. Li, *Tetrahedron Lett*., **2016**, *57*, 1460.

[7] H. M. Wang, Q. Q. Lu, C. W. Chiang, Y. Luo, J. F. Zhou, G. Y. Wang, A.W. Lei, *Angew. Chem. Int. Ed*. **2017**, *56*, 595.

[8] Y. M. Xi, B. L. Dong, E. McClain, Q. Y, Wang, T. Gregg, N. Akhmedov, J. Petersen, X. D .Shi, *Angew. Chem. Int. Ed*. **2014**, *53*, 4657 .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7.945
7.706
7.668
7.631
7.628
7.625
7.612
7.608
7.601
7.598
7.594
7.592
7.559
7.556
7.540
7.527
7.523
7.480
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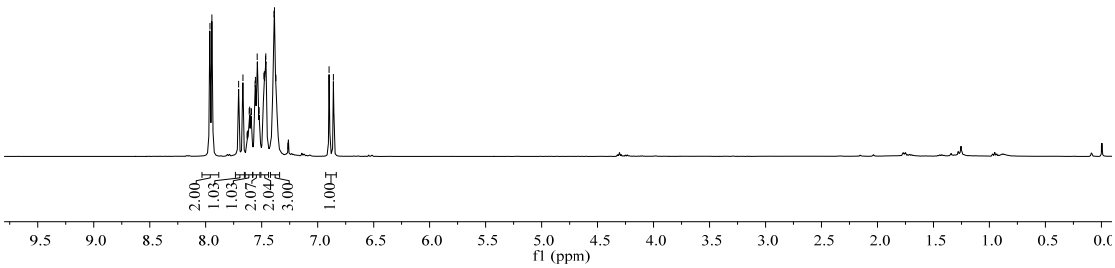
7.386
7.373
7.265
6.898
6.859
-0.000

2a


2.00
1.03
1.03
2.07
2.04
3.00
1.00
f1 (ppm)


142.348
140.462
133.296
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131.115
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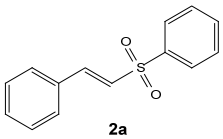
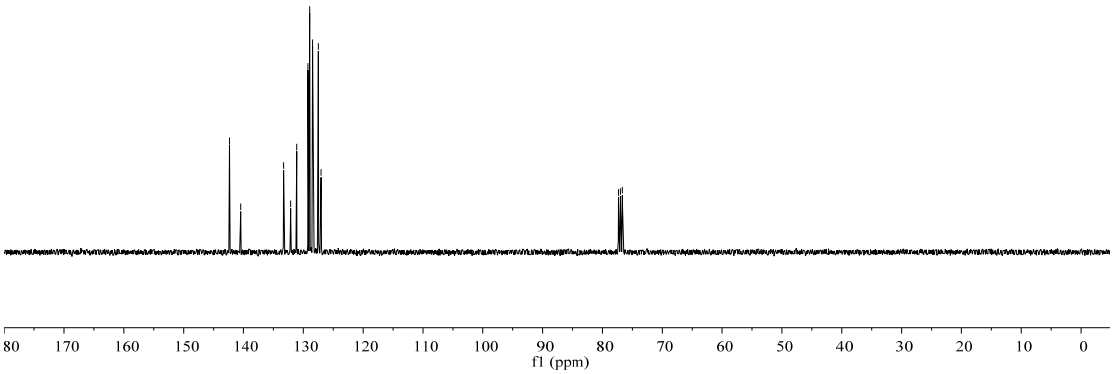
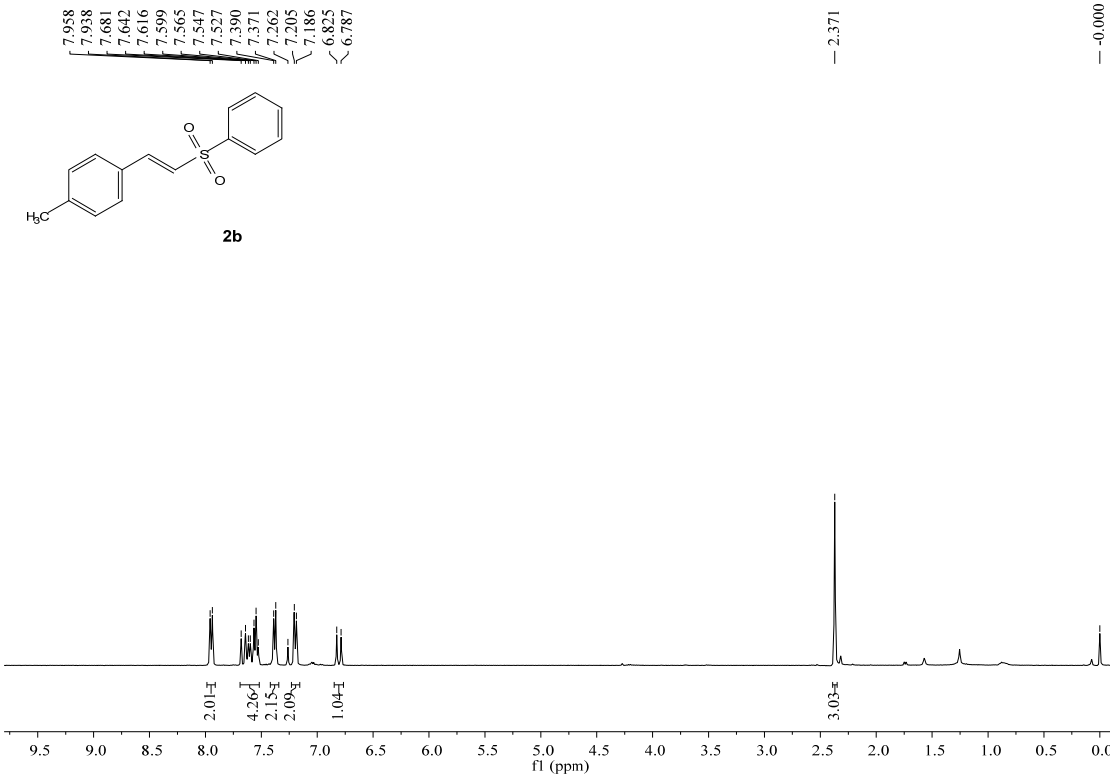
128.451
127.481
127.036
77.318
76.999
76.682



2a


f1 (ppm)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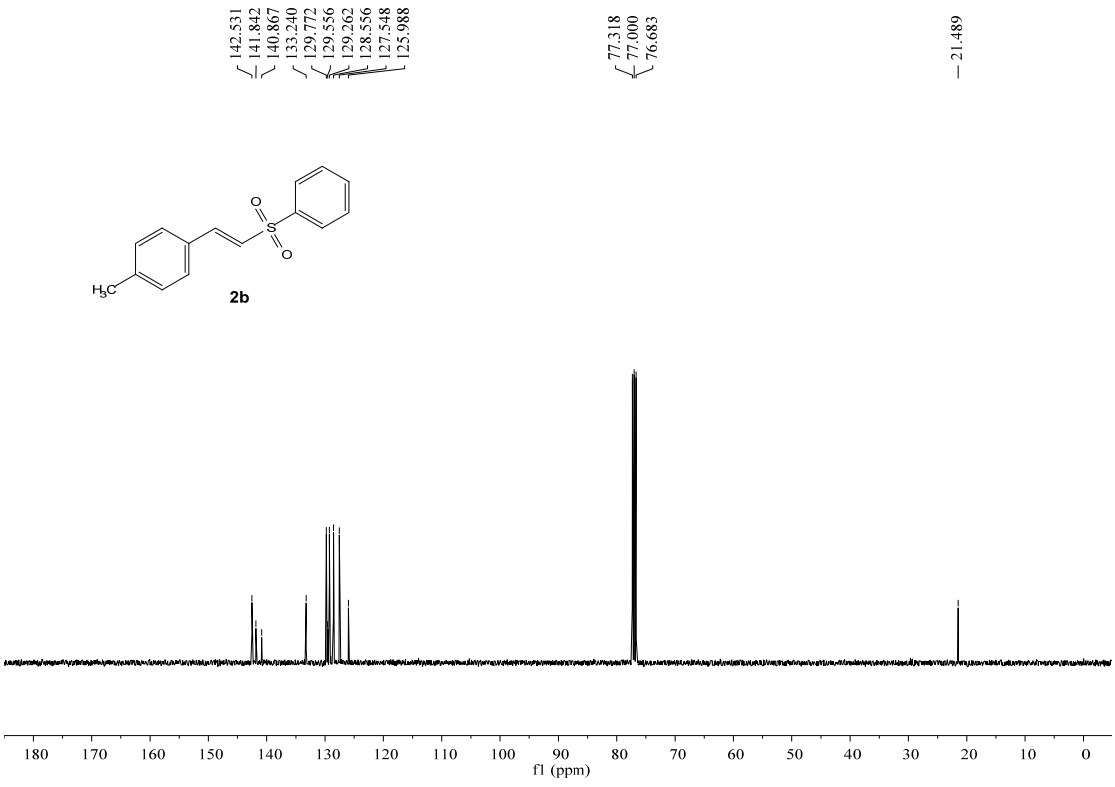
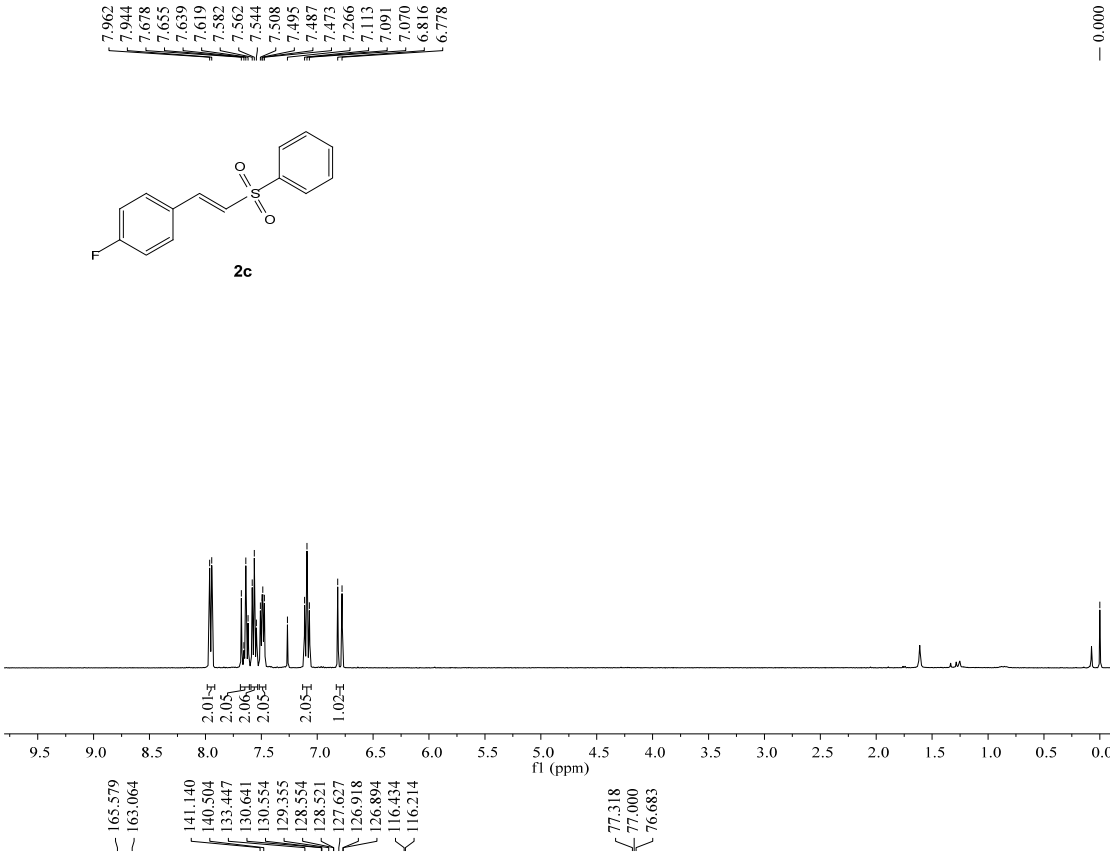
7.938
7.681
7.642
7.616
7.599
7.565
7.547
7.527
7.390
7.371
7.262
7.205
7.186
6.825
6.787
2.371
-0.000
O
S
O
H3C
2b
2.01
4.26
2.15
2.09
1.04
3.03
f1 (ppm)


142.531
141.842
140.867
133.240
129.772
129.556
129.262
128.556
127.548
125.988
77.318
77.000
76.683
21.489
O
S
O
H3C
2b
f1 (ppm)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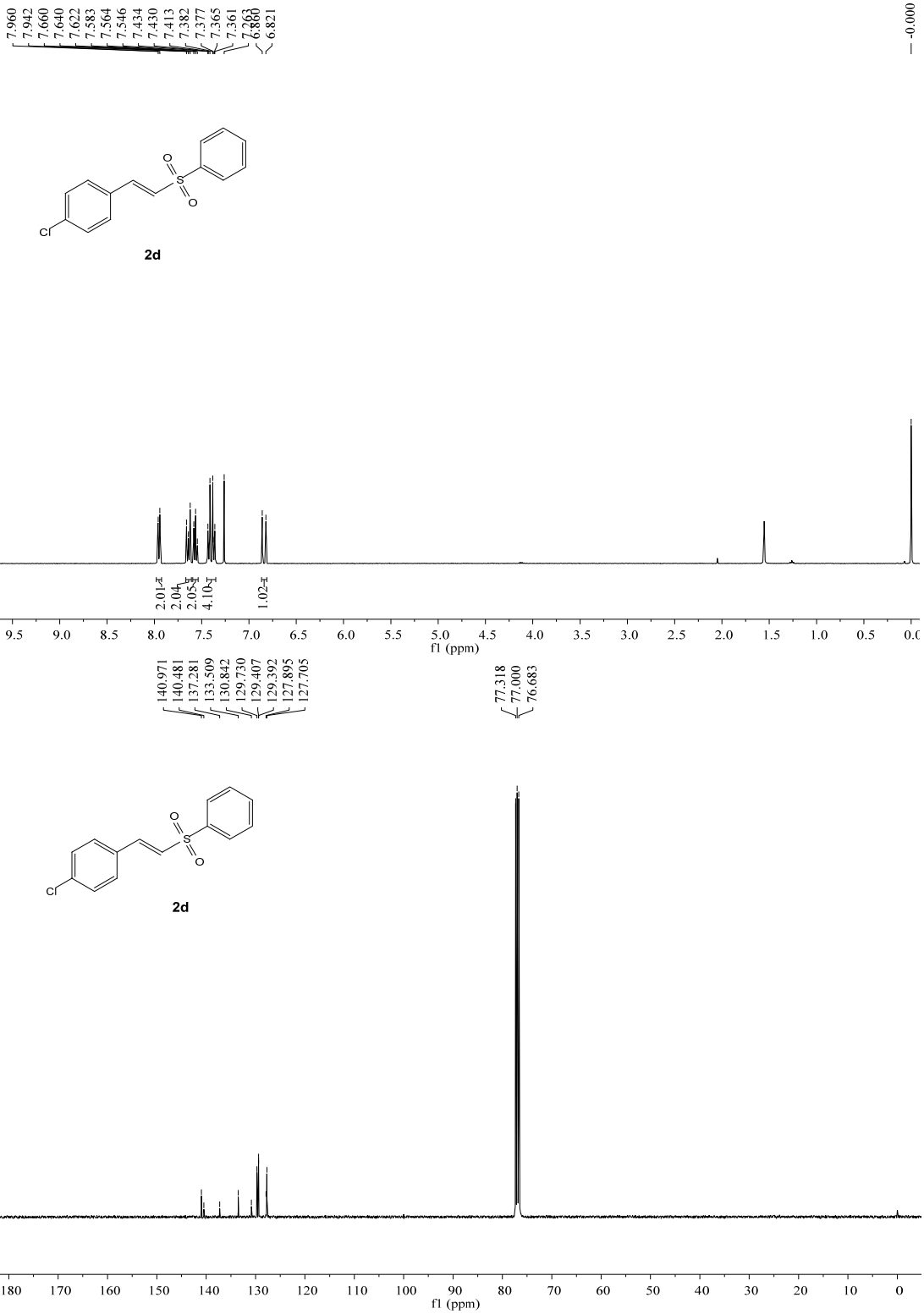
7.678
7.655
7.639
7.619
7.582
7.562
7.544
7.508
7.495
7.487
7.473
7.266
7.113
7.091
7.070
6.816
6.778
0.000
O
S
O
F
2c
2.01
2.05
2.06
2.05
2.05
1.02
f1 (ppm)
165.579
163.064
141.140
140.504
133.447
130.641
130.554
129.355
128.554
128.521
127.627
126.918
126.894
116.434
116.214
77.318
77.000
76.683
O
S
O
F
2c
f1 (ppm)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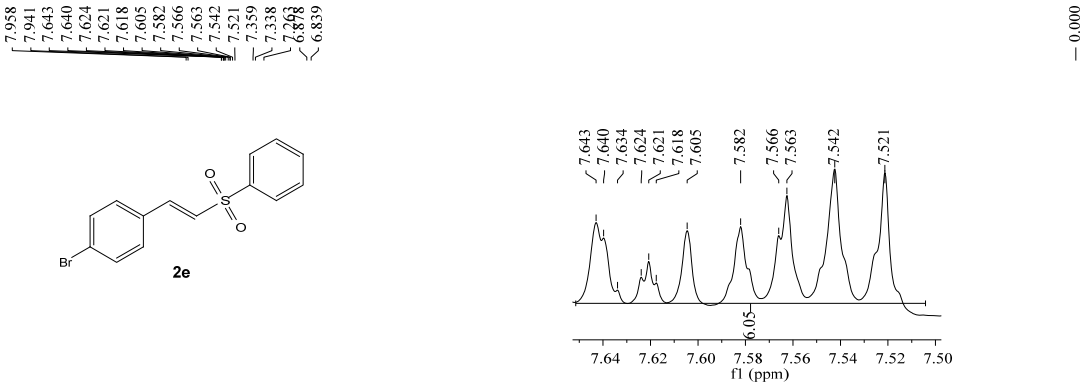
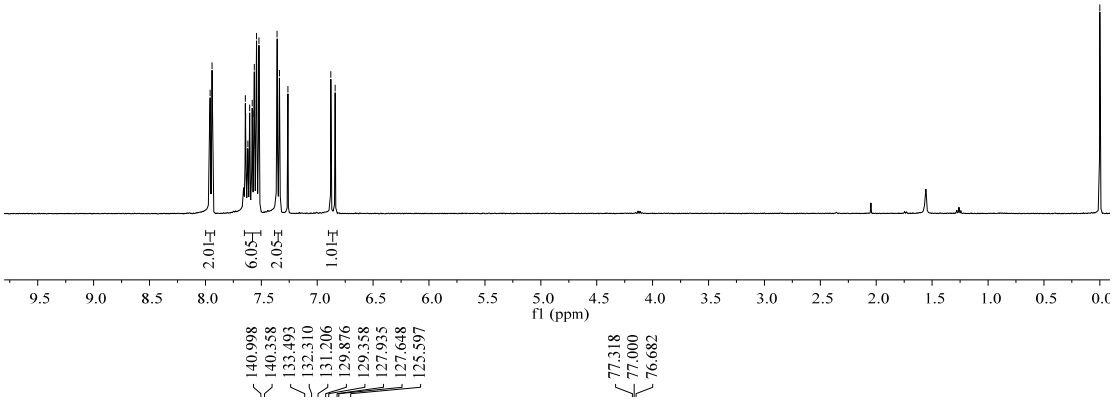
7.942
7.660
7.640
7.622
7.583
7.564
7.546
7.434
7.430
7.413
7.382
7.377
7.365
7.361
6.821
-0.000
O
S
O
Cl
2d
2.01
2.04
2.05
4.10
1.02
f1 (ppm)
140.971
140.481
137.281
133.509
130.842
129.730
129.407
129.392
127.895
127.705
77.318
77.000
76.683
O
S
O
Cl
2d
f1 (ppm)


7.958
7.941
7.643
7.640
7.624
7.621
7.618
7.605
7.582
7.566
7.563
7.542
7.521
7.359
7.338
6.863
6.858
6.839
0.000
O
S
O
Br
2e
7.643
7.640
7.634
7.624
7.621
7.618
7.605
7.582
7.566
7.563
7.542
7.521
6.05
7.64 7.62 7.60 7.58 7.56 7.54 7.52 7.50
f1 (ppm)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6.05
2.05
1.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

140.998
140.358
133.493
132.310
131.206
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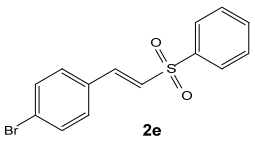
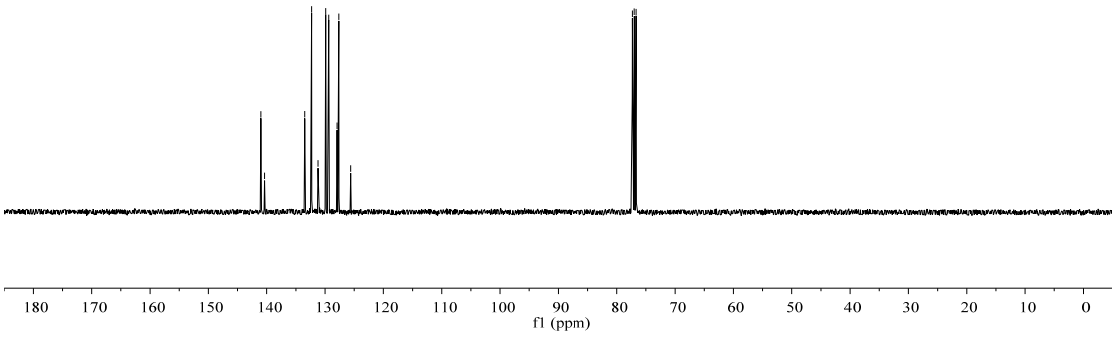
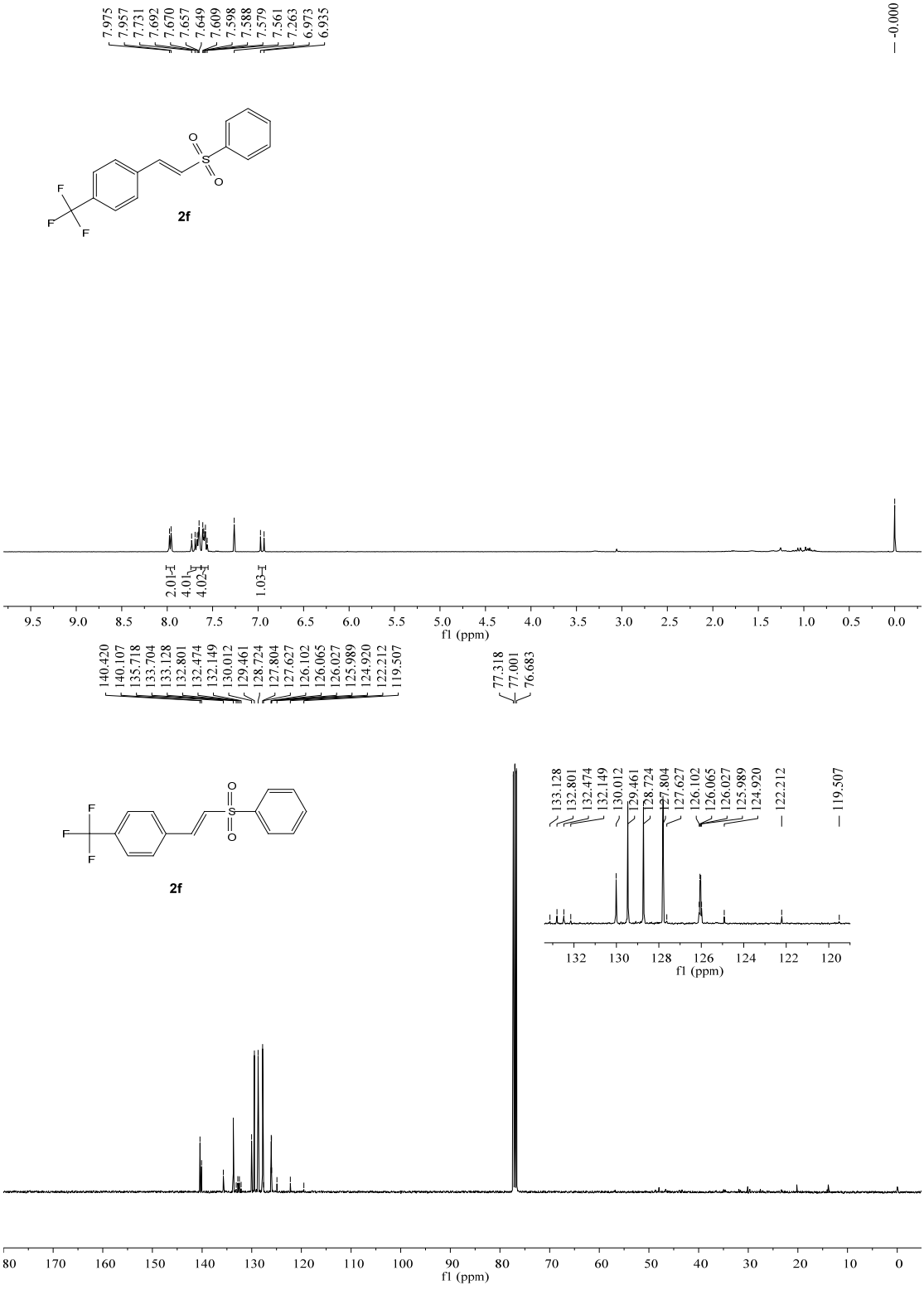
129.358
127.935
127.648
125.597
77.318
77.000
76.682


O
S
O
Br
2e


180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.657
7.649
7.609
7.598
7.588
7.579
7.561
7.263
6.973
6.935
-0.000
2f
2.01
4.01
4.02
1.03
f1 (ppm)
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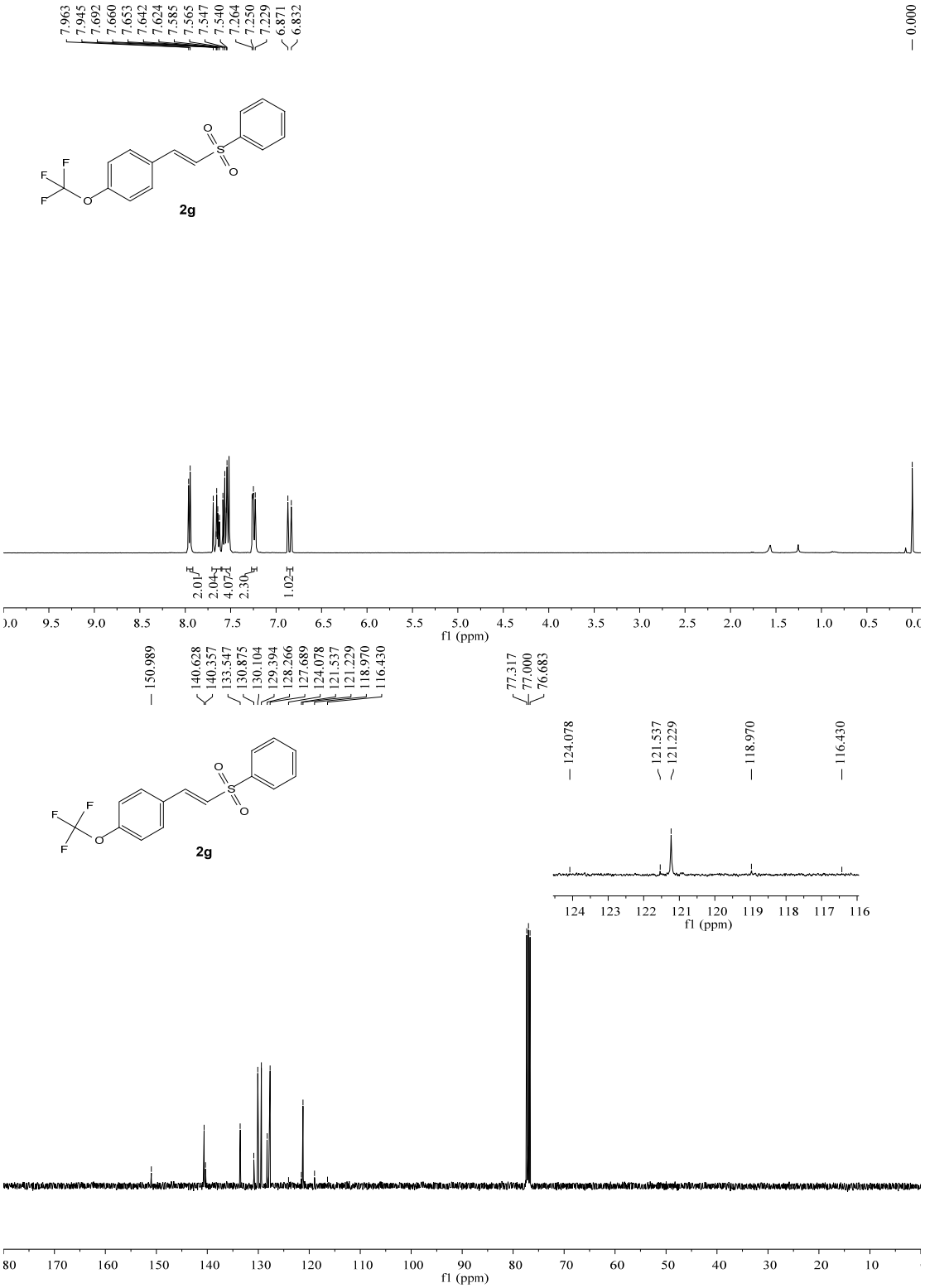
140.107
135.718
133.704
133.128
132.801
132.474
132.149
130.012
129.461
128.724
127.804
127.627
126.102
126.065
126.027
125.989
124.920
122.212
119.507
77.318
77.001
76.683
2f
133.128
132.801
132.474
132.149
130.012
129.461
128.724
127.804
127.627
126.102
126.065
126.027
125.989
124.920
122.212
119.507
f1 (ppm)
f1 (ppm)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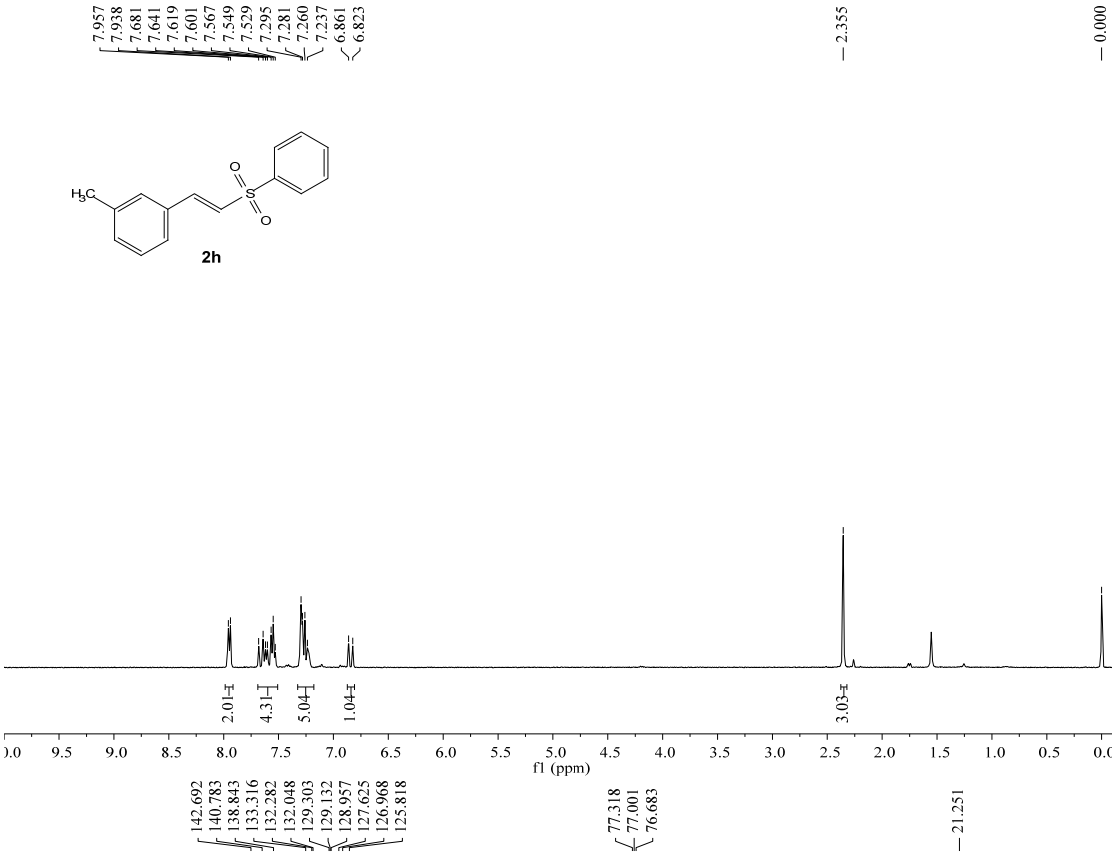
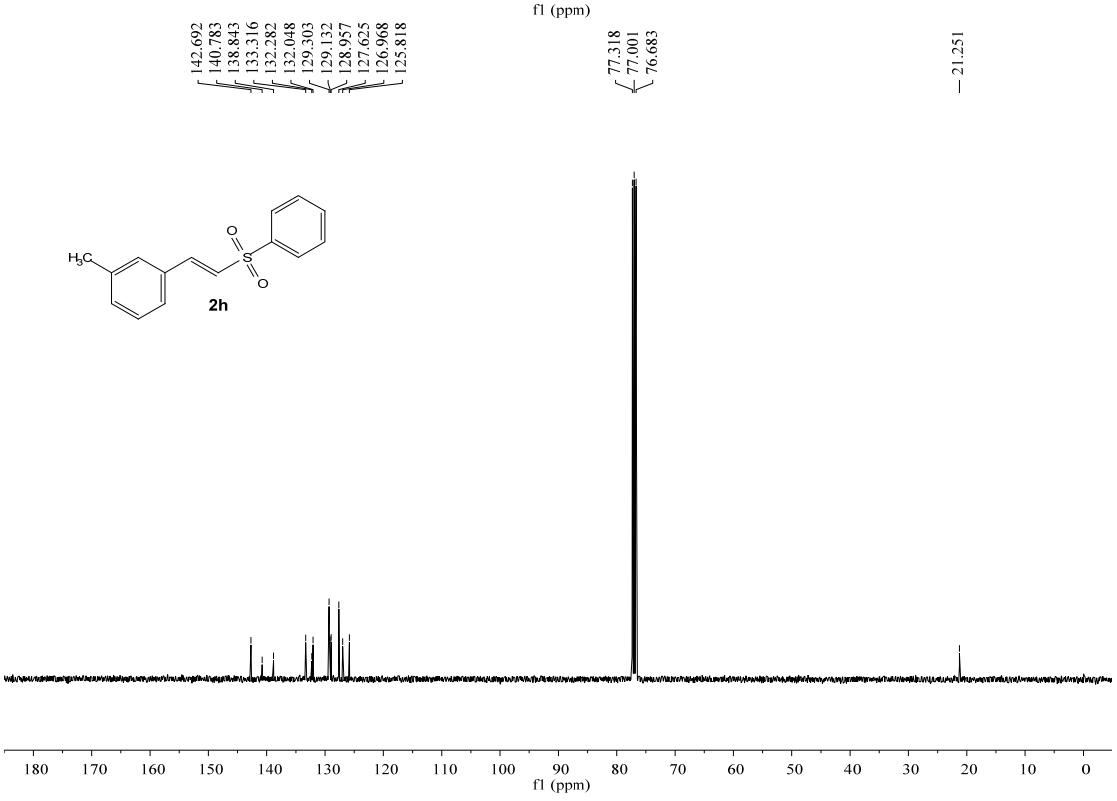
7.945
7.692
7.660
7.653
7.642
7.624
7.585
7.565
7.547
7.540
7.264
7.250
7.229
6.871
6.832
0.000
2g
2.01
2.04
4.07
2.30
1.02
f1 (ppm)
150.989
140.628
140.357
133.547
130.875
130.104
129.394
128.266
127.689
124.078
121.537
121.229
118.970
116.430
77.317
77.000
76.683
2g
124.078
121.537
121.229
118.970
116.430
f1 (ppm)
f1 (ppm)


7.957
7.938
7.681
7.641
7.619
7.601
7.567
7.549
7.529
7.295
7.281
7.260
7.237
6.861
6.823
2.355
0.000
2h
2.01
4.31
5.04
1.04
3.03
f1 (ppm)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132.282
132.048
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129.132
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127.625
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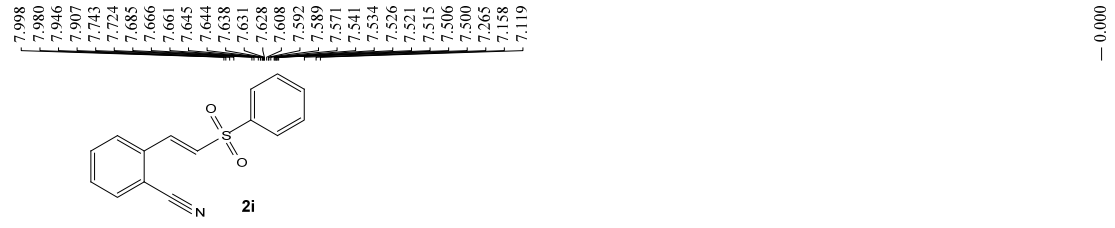
77.001
76.683
21.251
2h
f1 (ppm)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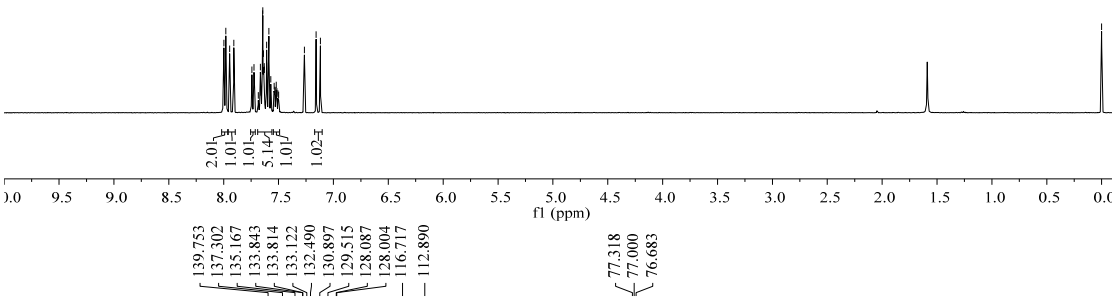
7.907
7.743
7.724
7.685
7.666
7.661
7.645
7.644
7.638
7.631
7.628
7.608
7.592
7.589
7.571
7.541
7.534
7.526
7.521
7.515
7.506
7.500
7.265
7.158
7.119
0.000
O
S
O
N

2i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1.01
1.01
5.14
1.01
1.02
f1 (ppm)

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133.122
132.490
130.897
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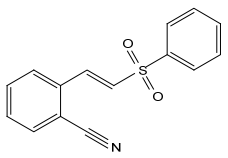
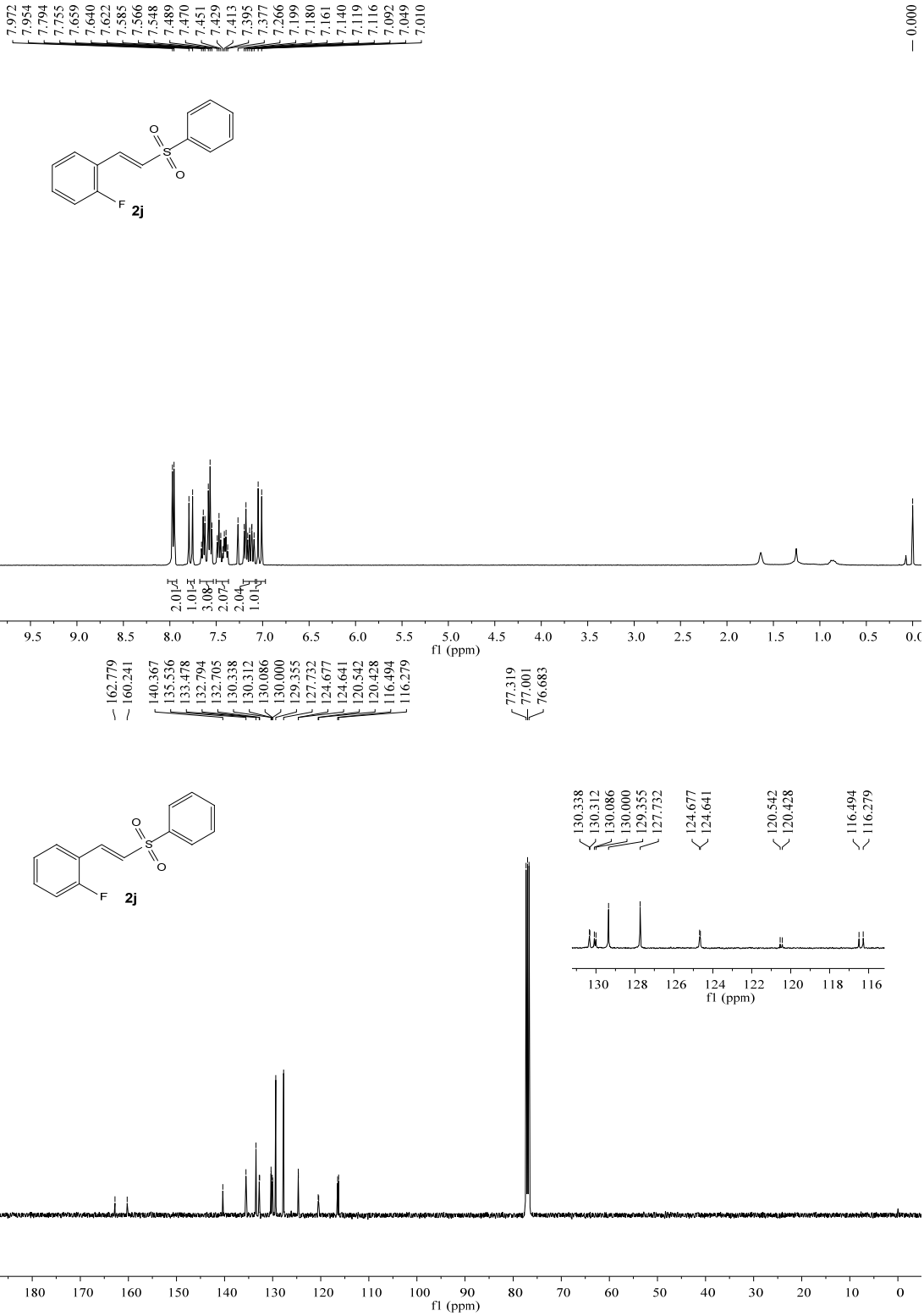
128.087
128.004
116.717
112.890
77.318
77.000
76.683


O
S
O
N

2i

f1 (ppm)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7.659
7.640
7.622
7.585
7.566
7.548
7.489
7.470
7.451
7.429
7.413
7.395
7.377
7.266
7.199
7.180
7.161
7.140
7.119
7.116
7.092
7.049
7.010
0.000
O
S
O
F
2j
2.01
1.01
3.08
2.07
2.04
1.01
f1 (ppm)
162.779
160.241
140.367
135.536
133.478
132.794
132.705
130.338
130.312
130.086
130.000
129.355
127.732
124.677
124.641
120.542
120.428
116.494
116.279
77.319
77.001
76.683
O
S
O
F
2j
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130.312
130.086
130.000
129.355
127.732
124.677
124.641
120.542
120.428
116.494
116.279
f1 (ppm)
f1 (ppm)


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7.820
7.680
7.642
7.491
7.487
7.482
7.479
7.473
7.467
7.418
7.415
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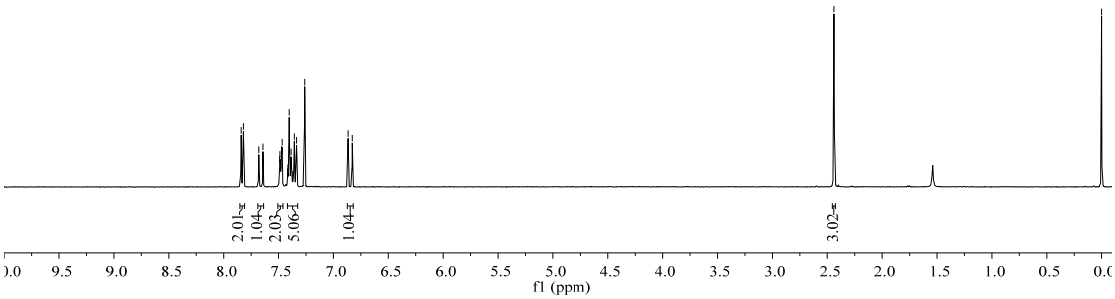
CH3
O
S
O

2l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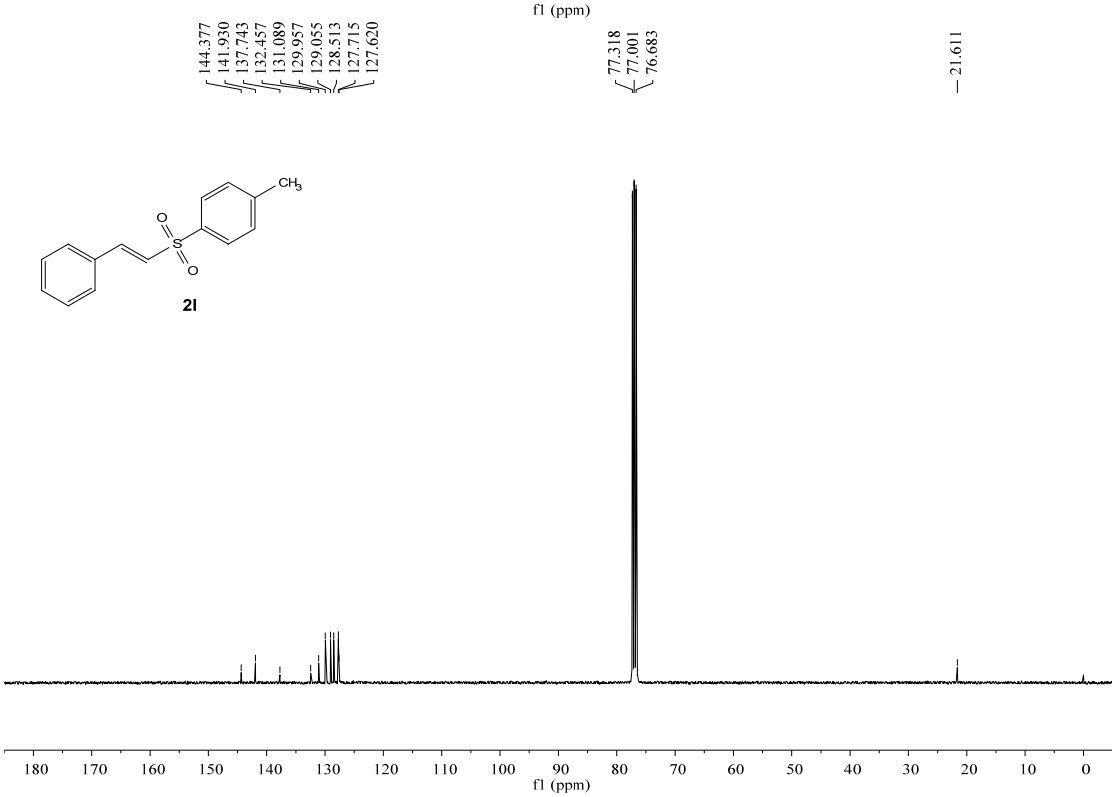
2.03
5.06
1.04
3.02
f1 (ppm)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131.089
129.957
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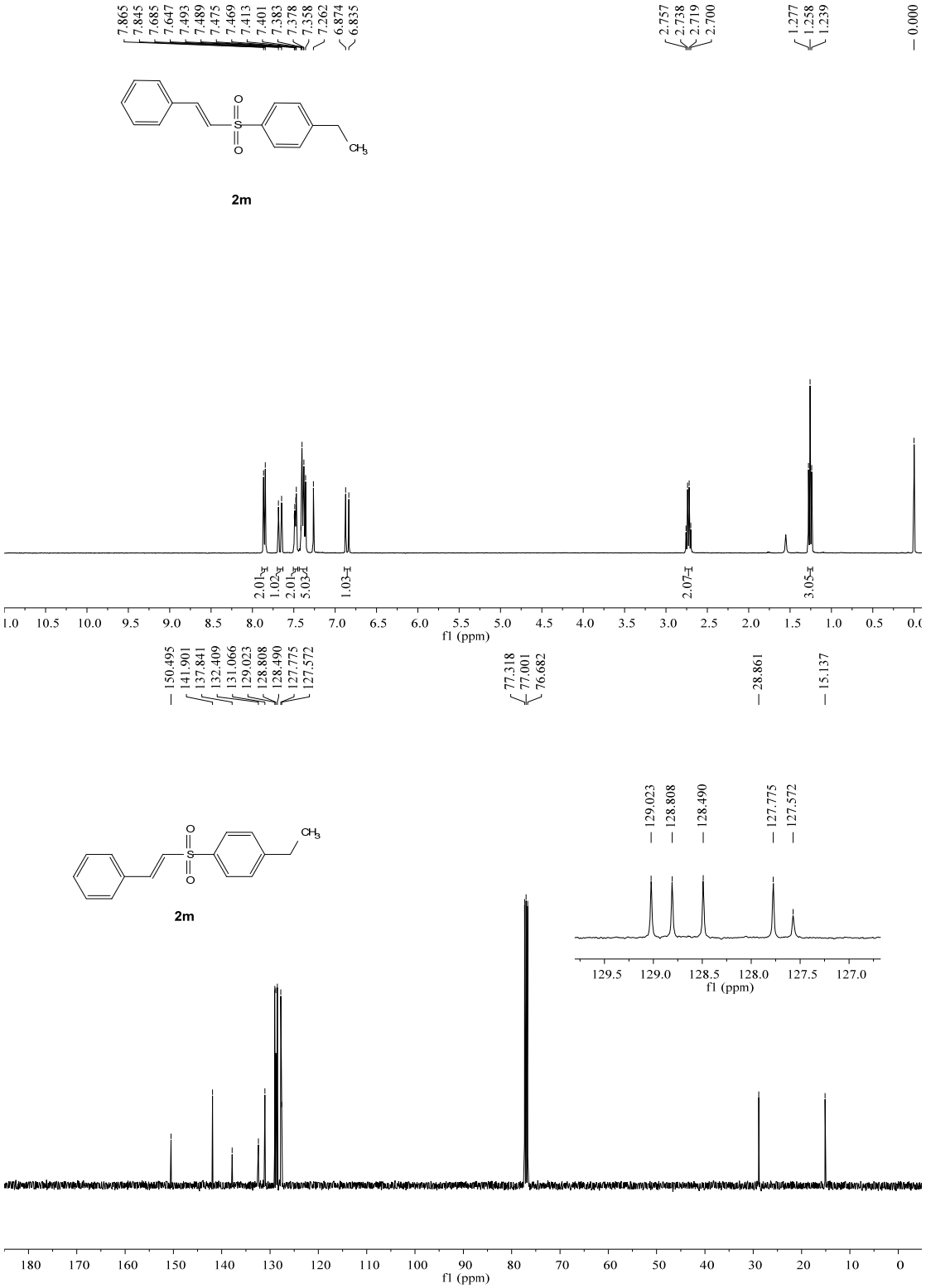
76.683
21.611
CH3
O
S
O
f1 (ppm)

2l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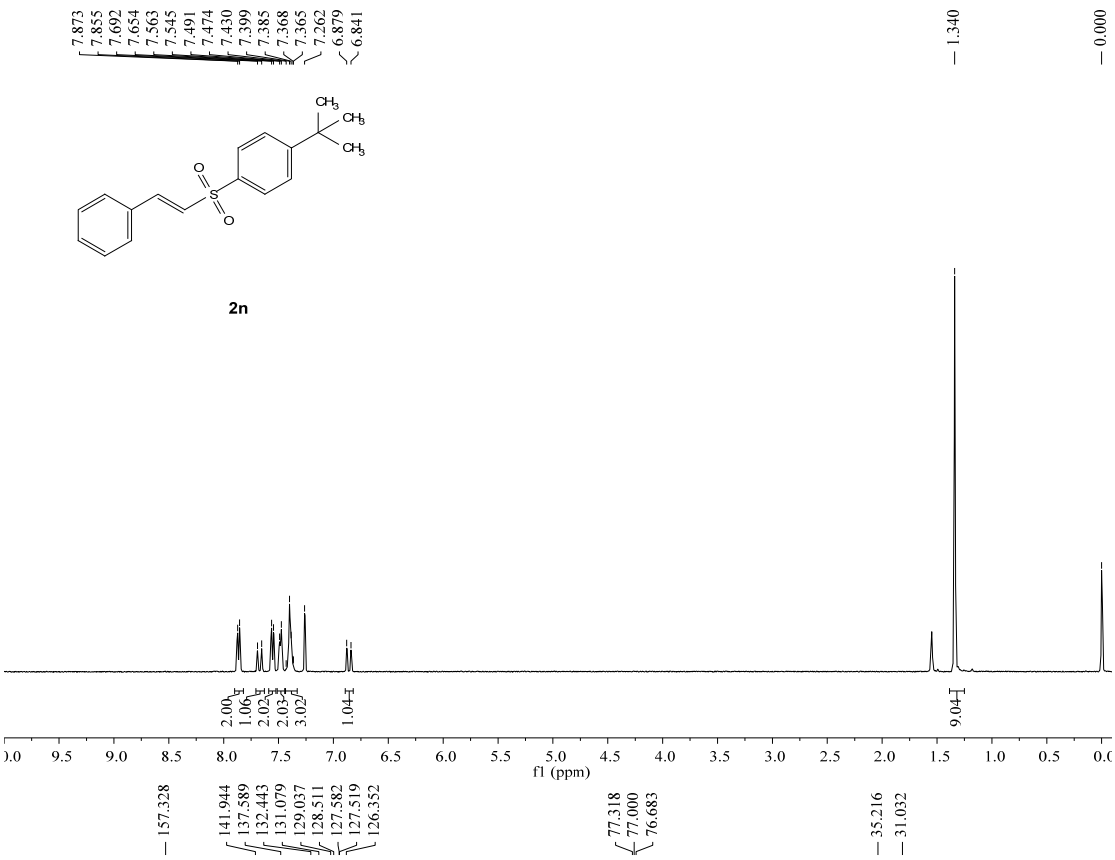
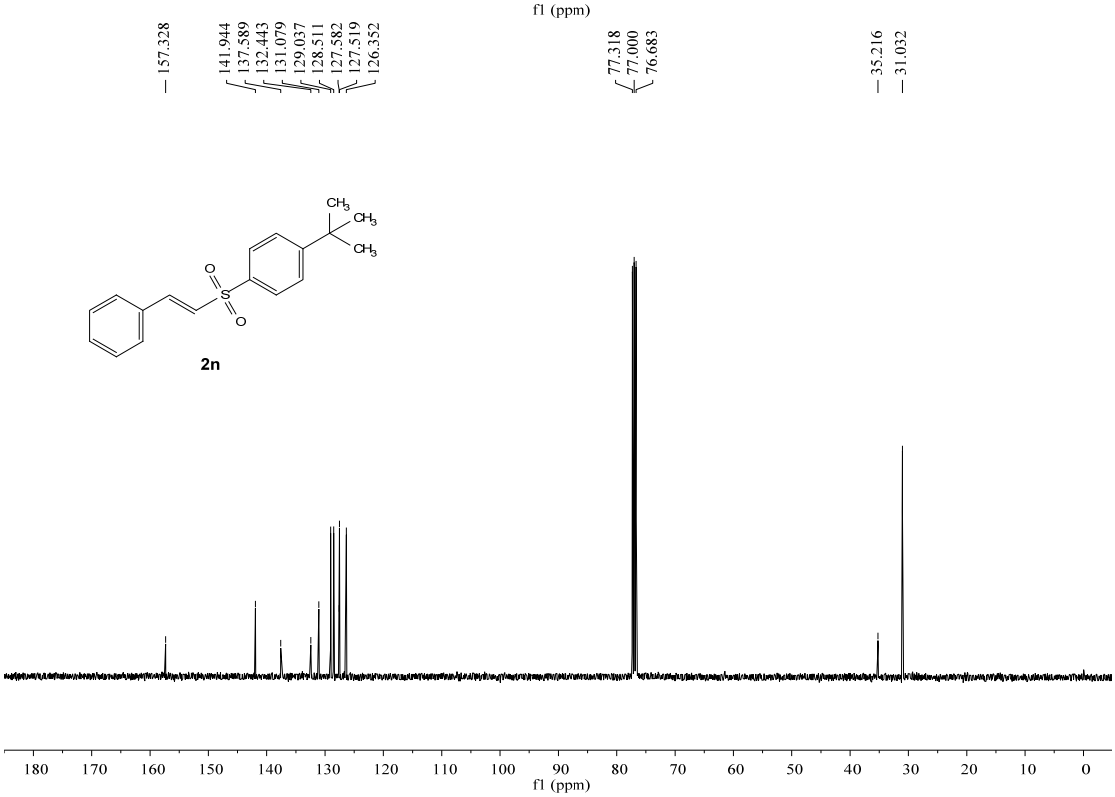
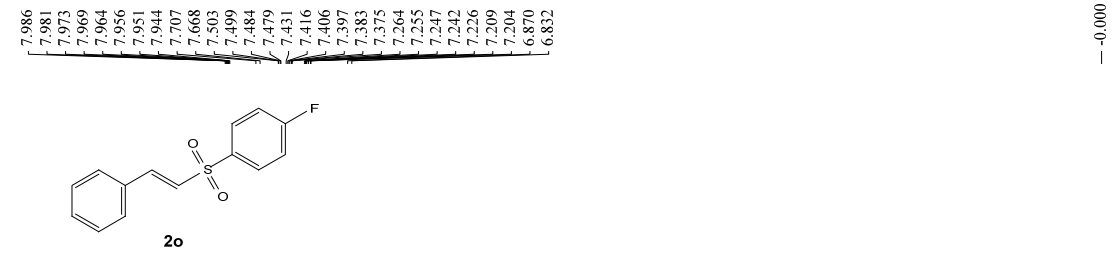
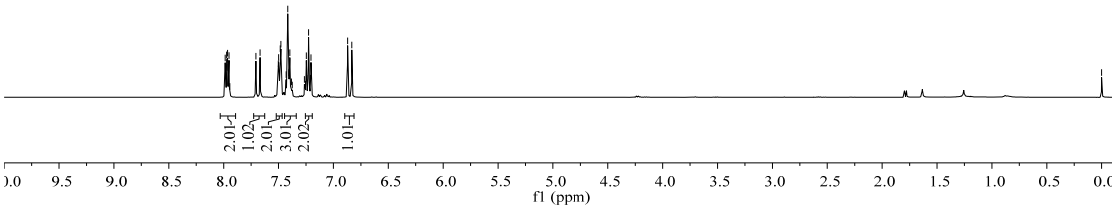
7.845
7.685
7.647
7.493
7.489
7.475
7.469
7.413
7.401
7.383
7.378
7.358
7.262
6.874
6.835
2.757
2.738
2.719
2.700
1.277
1.258
1.239
0.000
O
S
O
CH3
2m
2.01
1.02
2.01
5.03
1.03
2.07
3.05
f1 (ppm)
150.495
141.901
137.841
132.409
131.066
129.023
128.808
128.490
127.775
127.572
77.318
77.001
76.682
28.861
15.137
O
S
O
CH3
2m
129.023
128.808
128.490
127.775
127.572
f1 (ppm)

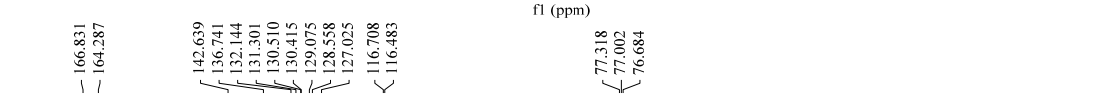

7.873
7.855
7.692
7.654
7.563
7.545
7.491
7.474
7.430
7.399
7.385
7.368
7.365
7.262
6.879
6.841
1.340
0.000
2n
2.00
1.06
2.02
2.03
3.02
1.04
9.04
f1 (ppm)

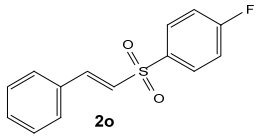

157.328
141.944
137.589
132.443
131.079
129.037
128.511
127.582
127.519
126.352
77.318
77.000
76.683
35.216
31.032
2n
f1 (ppm)


7.986
7.981
7.973
7.969
7.964
7.956
7.951
7.944
7.707
7.668
7.503
7.499
7.484
7.479
7.431
7.416
7.406
7.397
7.383
7.375
7.264
7.255
7.247
7.242
7.226
7.209
7.204
6.870
6.832
-0.000
F
O
S
O

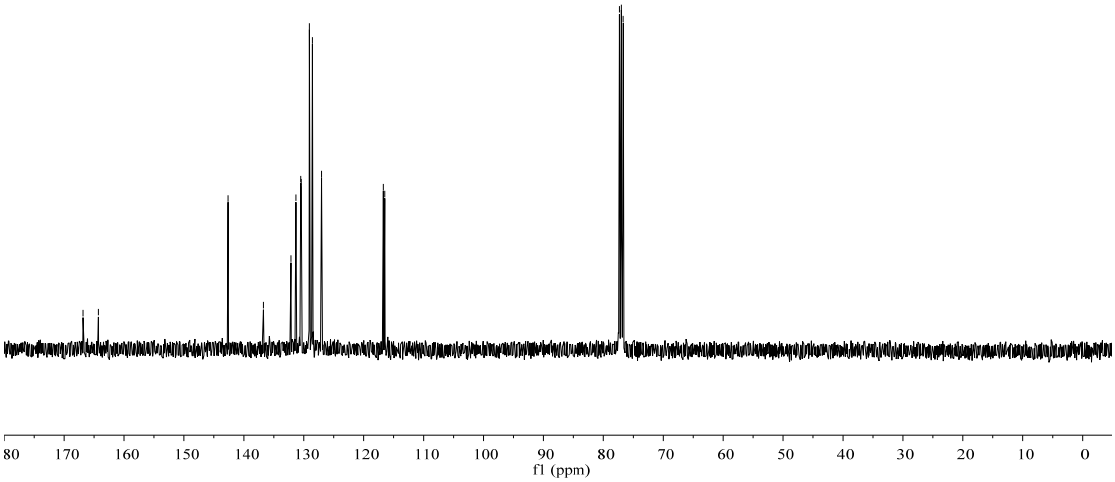
2o

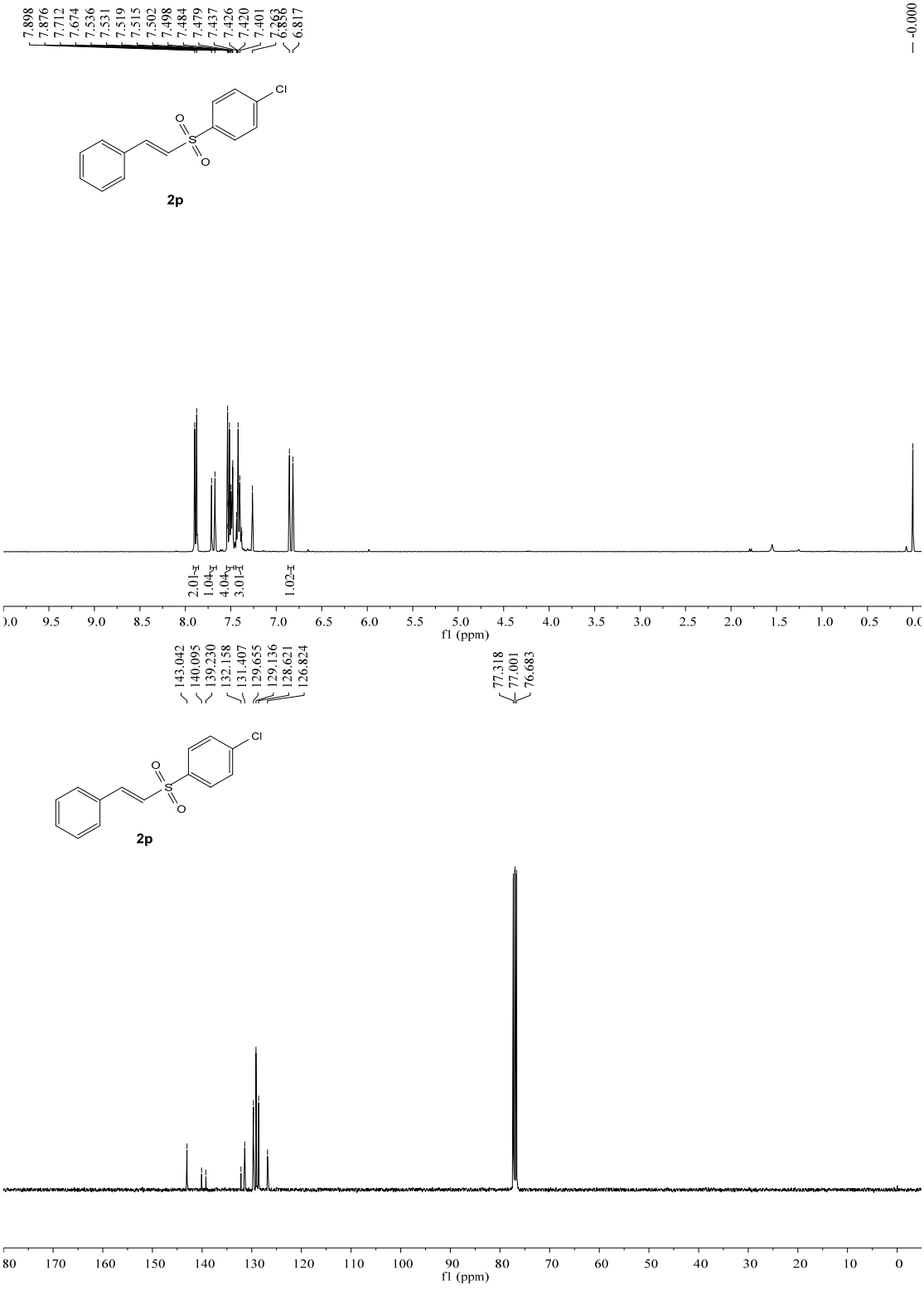

2.01
1.02
2.01
3.01
2.02
1.01
f1 (ppm)

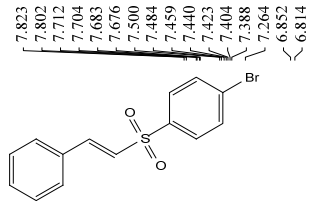

166.831
164.287
142.639
136.741
132.144
131.301
130.510
130.415
129.075
128.558
127.025
116.708
116.483
77.318
77.002
76.684


F
O
S
O

2o

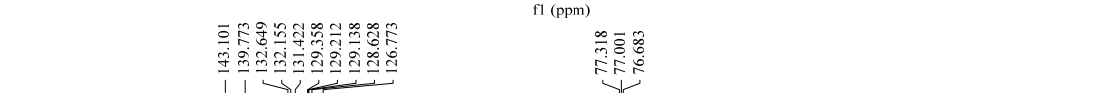

f1 (ppm)

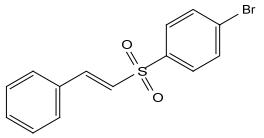

7.898
7.876
7.712
7.674
7.536
7.531
7.519
7.515
7.502
7.498
7.484
7.479
7.437
7.426
7.420
7.401
7.263
6.856
6.817
-0.000
Cl
O
S
O
2p
2.01
1.04
4.04
3.01
1.02
f1 (ppm)
143.042
140.095
139.230
132.158
131.407
129.655
129.136
128.621
126.824
77.318
77.001
76.683
Cl
O
S
O
2p
f1 (ppm)


7.823
7.802
7.712
7.704
7.683
7.676
7.500
7.484
7.459
7.440
7.423
7.404
7.388
7.264
6.852
6.814
Br
O
S
O

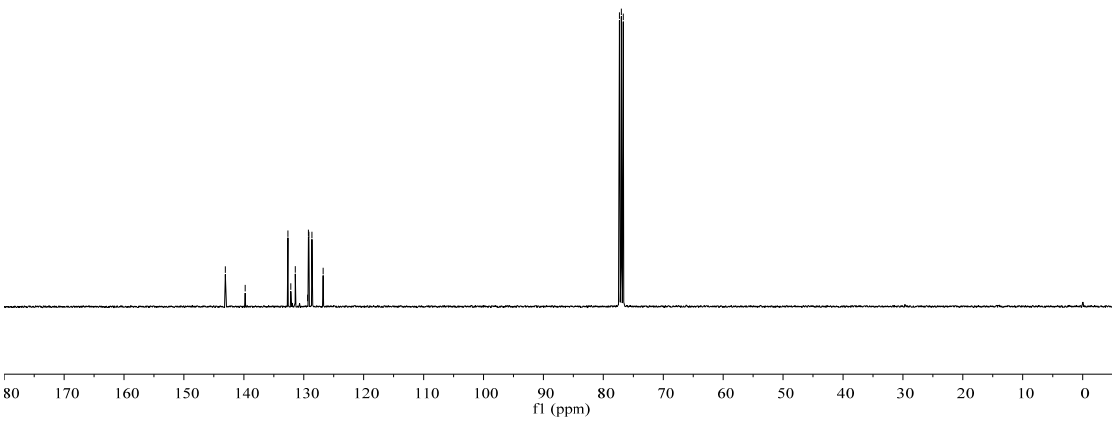
2q

0.000
2.01
3.02
5.02
1.02
f1 (ppm)

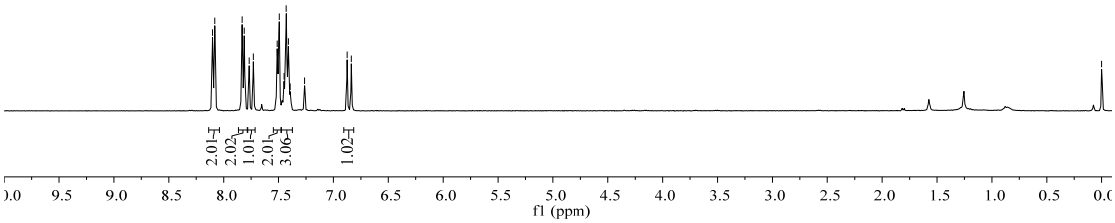

143.101
139.773
132.649
132.155
131.422
129.358
129.212
129.138
128.628
126.773
77.318
77.001
76.683

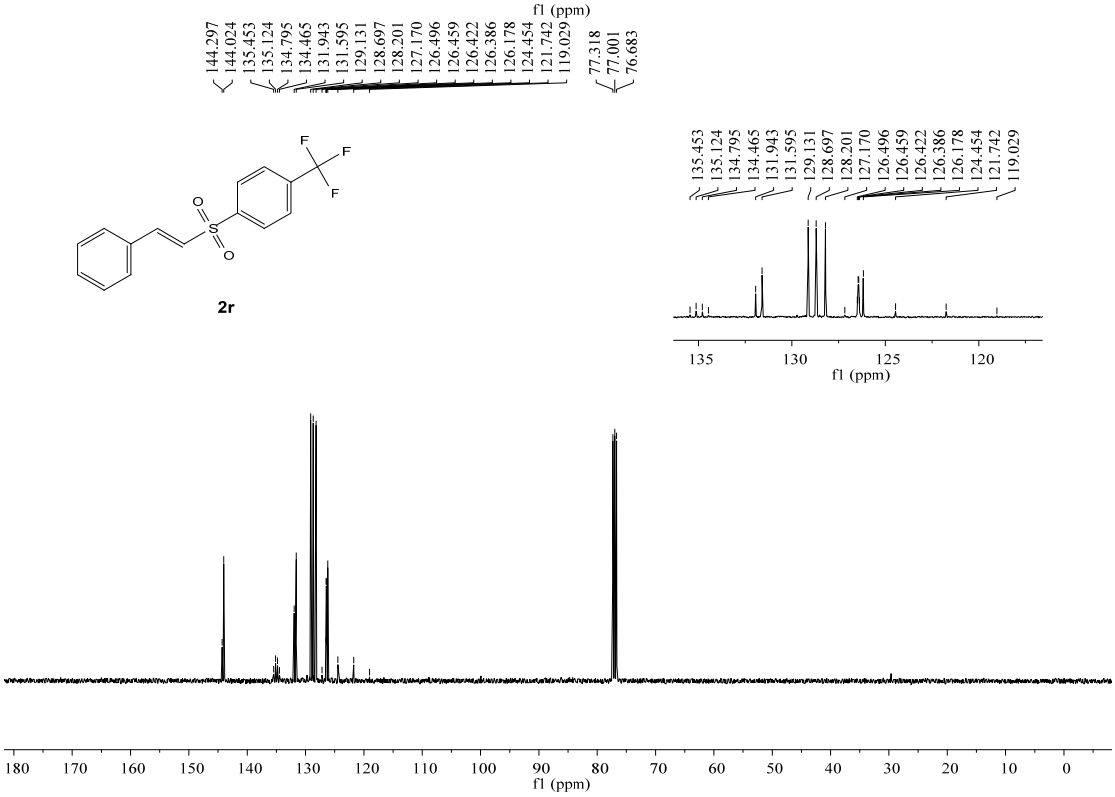

Br
O
S
O

2q


f1 (ppm)

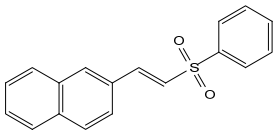

8.101
8.081
7.832
7.812
7.768
7.729
7.513
7.494
7.450
7.430
7.411
7.395
7.263
6.875
6.837
0.000
F
F
F
O
S
O
2r


2.01
2.02
1.01
2.01
3.06
1.02
f1 (ppm)

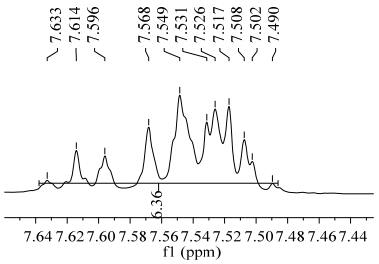

144.297
144.024
135.453
135.124
134.795
134.465
131.943
131.595
129.131
128.697
128.201
127.170
126.496
126.459
126.422
126.386
126.178
124.454
121.742
119.029
77.318
77.001
76.683
F
F
F
O
S
O
2r
135.453
135.124
134.795
134.465
131.943
131.595
129.131
128.697
128.201
127.170
126.496
126.459
126.422
126.386
126.178
124.454
121.742
119.029
f1 (ppm)
f1 (ppm)

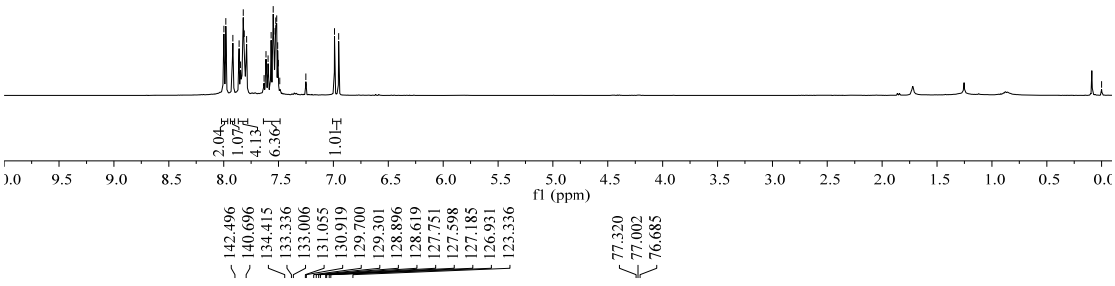

7.998
7.980
7.916
7.860
7.846
7.822
7.812
7.792
7.633
7.614
7.596
7.568
7.549
7.531
7.526
7.517
7.508
7.502
7.490
7.251
6.990
6.952


0.000


O
S
O

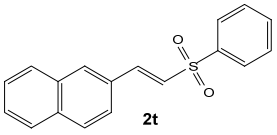
2t


7.633
7.614
7.596
7.568
7.549
7.531
7.526
7.517
7.508
7.502
7.490
6.36
7.64 7.62 7.60 7.58 7.56 7.54 7.52 7.50 7.48 7.46 7.44
f1 (ppm)

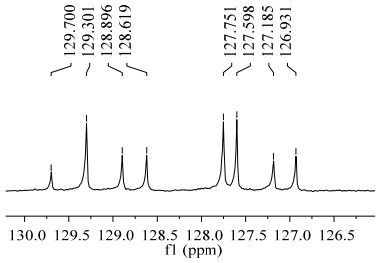

2.04
1.07
4.13
6.36
1.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

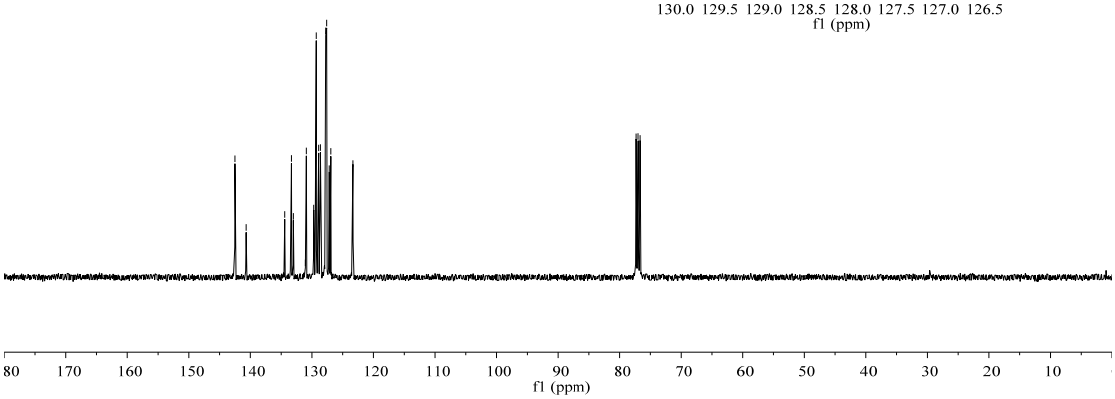
142.496
140.696
134.415
133.336
133.006
131.055
130.919
129.700
129.301
128.896
128.619
127.751
127.598
127.185
126.931
123.336

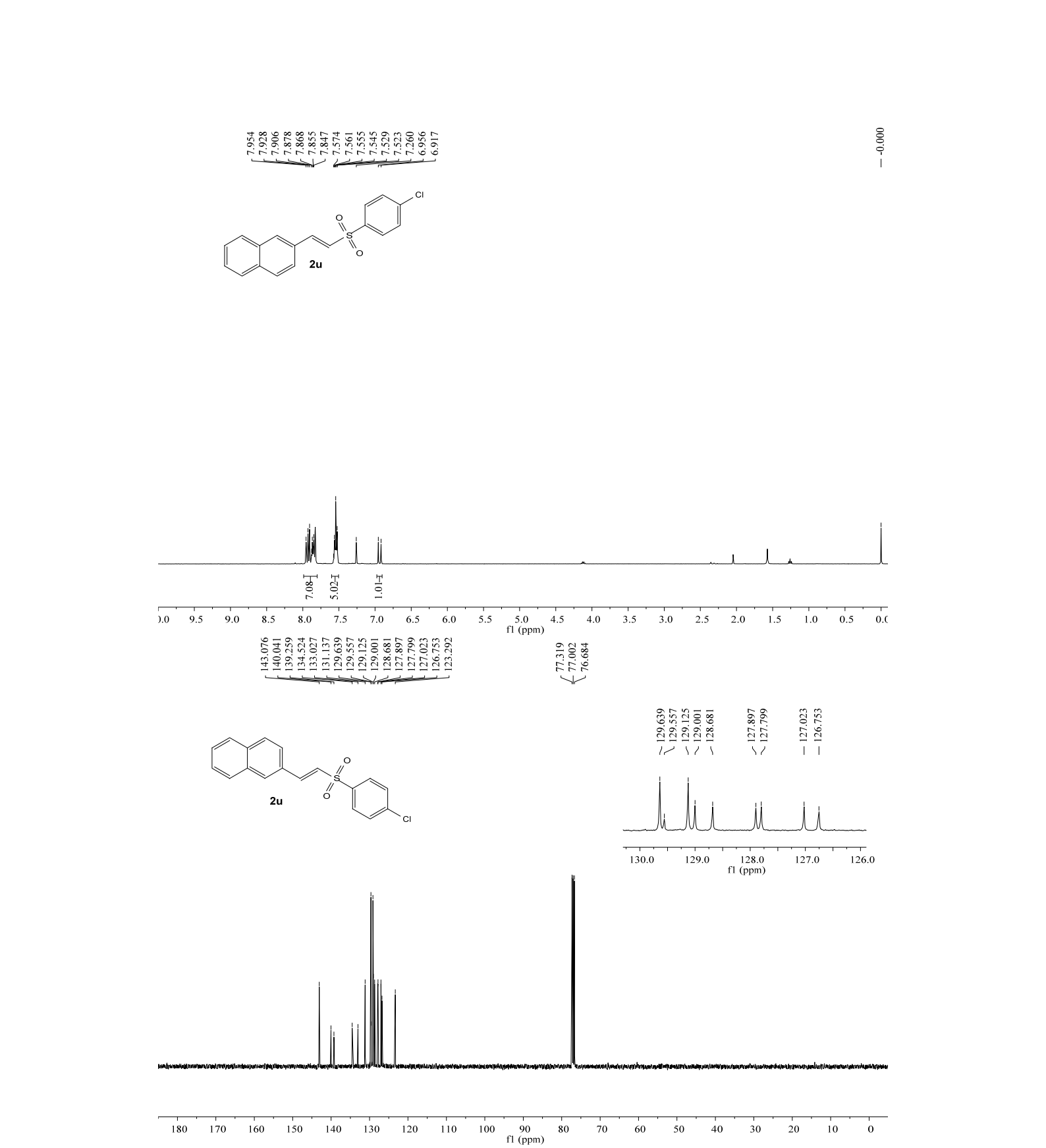
77.320
77.002
76.685

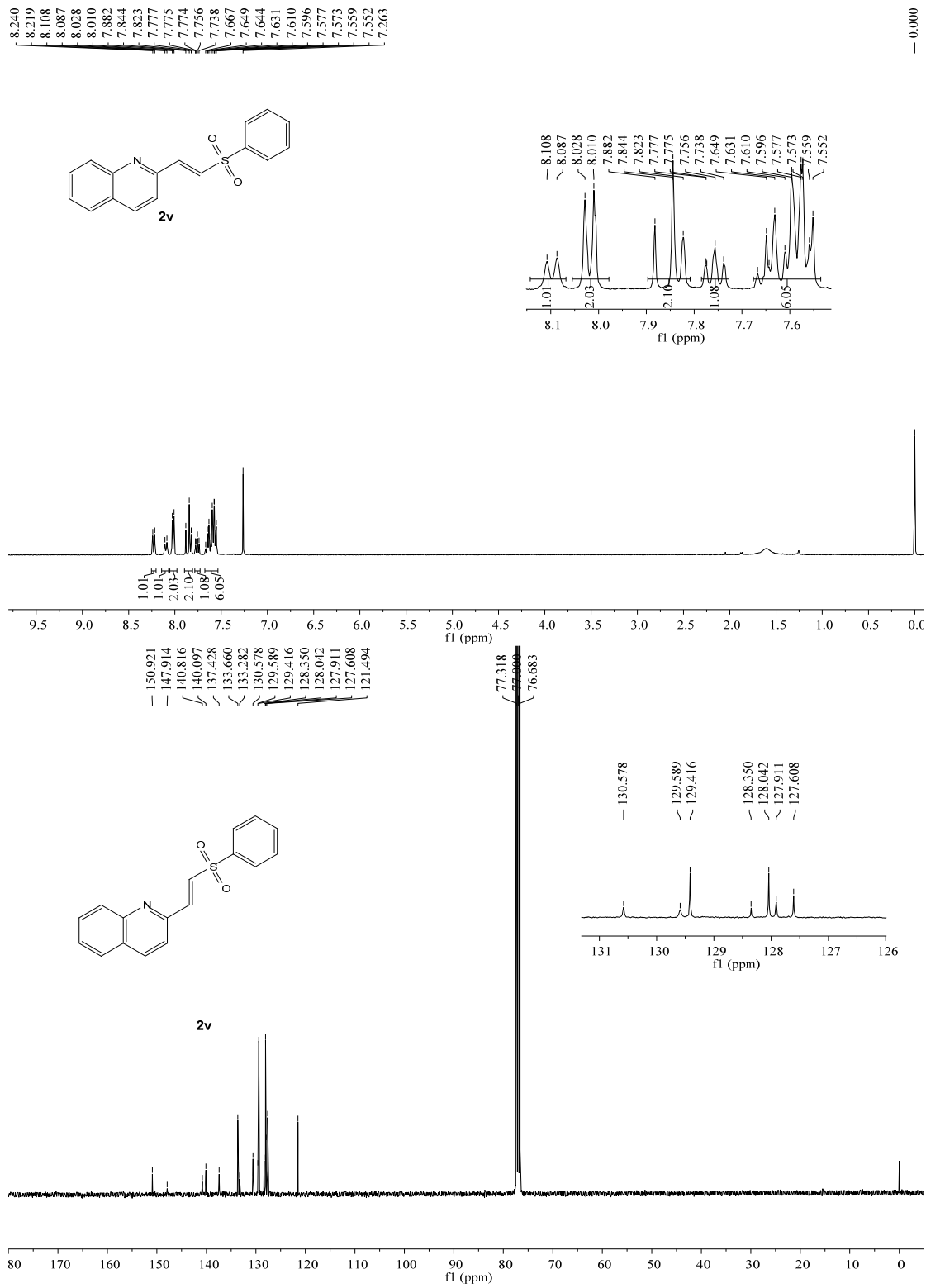

O
S
O

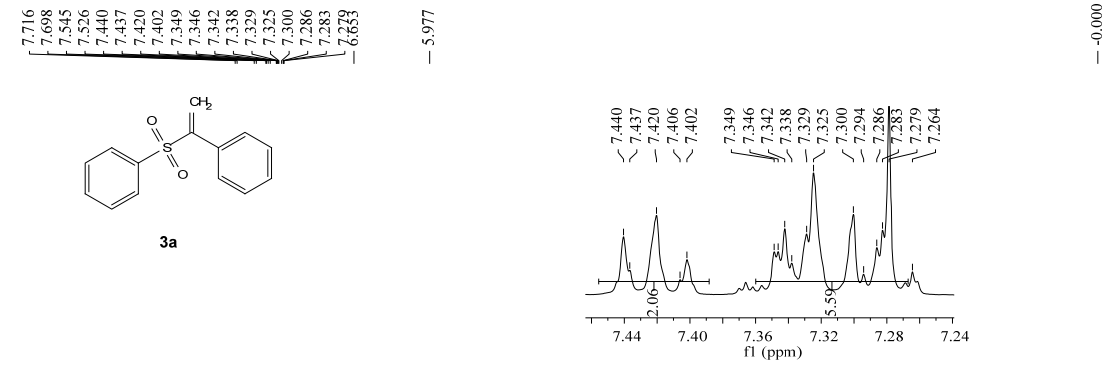
2t

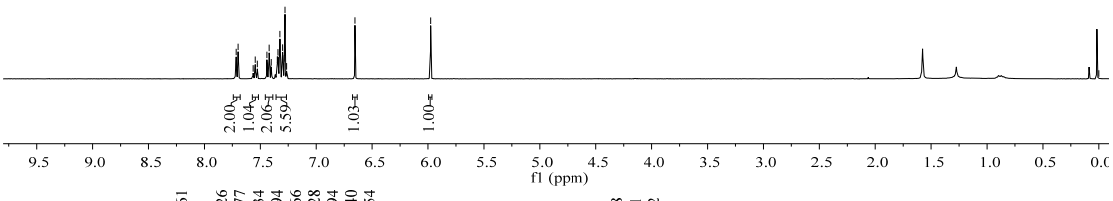

129.700
129.301
128.896
128.619
127.751
127.598
127.185
126.931
130.0 129.5 129.0 128.5 128.0 127.5 127.0 126.5
f1 (ppm)

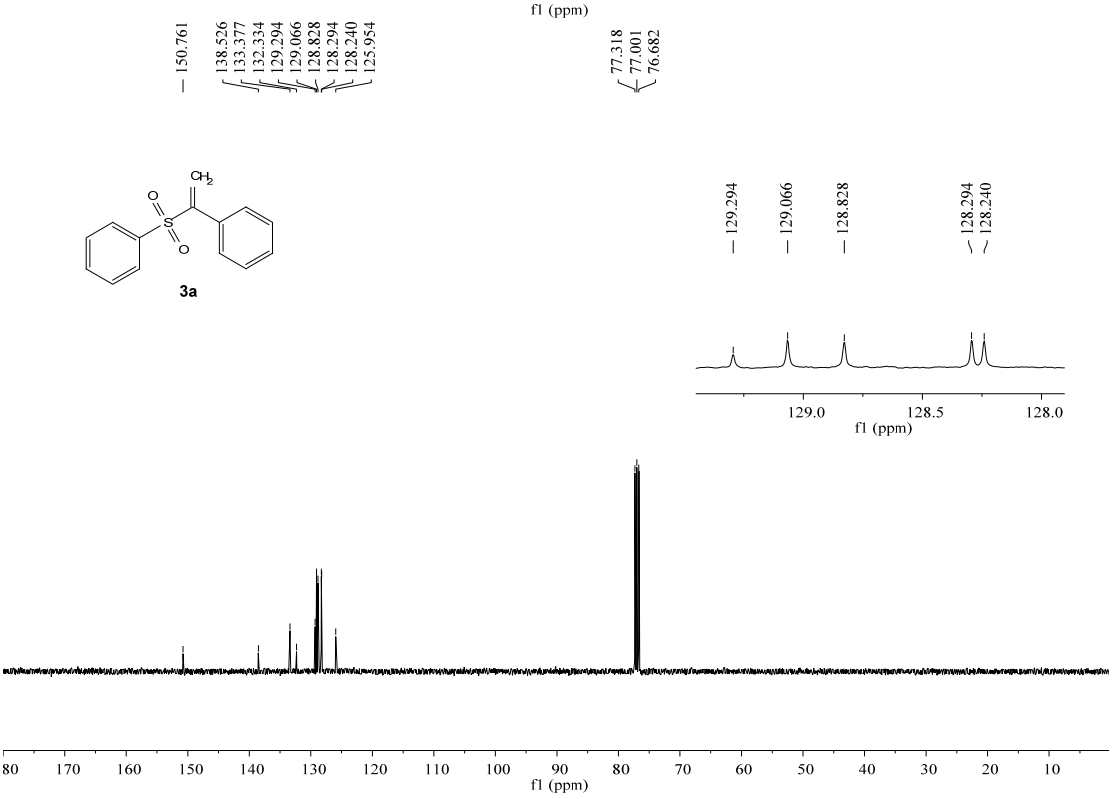

180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


7.954
7.928
7.906
7.878
7.868
7.855
7.847
7.574
7.561
7.555
7.545
7.529
7.523
7.260
6.956
6.917
-0.000
Cl
O
S
O
2u
7.08
5.02
1.01
f1 (ppm)
143.076
140.041
139.259
134.524
133.027
131.137
129.639
129.557
129.125
129.001
128.681
127.897
127.799
127.023
126.753
123.292
77.319
77.002
76.684
129.639
129.557
129.125
129.001
128.681
127.897
127.799
127.023
126.753
2u
Cl
f1 (ppm)
f1 (ppm)


8.240
8.219
8.108
8.087
8.028
8.010
7.882
7.844
7.823
7.777
7.775
7.774
7.756
7.738
7.667
7.649
7.644
7.631
7.610
7.596
7.577
7.573
7.559
7.552
7.263
0.000
2v
1.01
2.03
2.10
1.08
6.05
f1 (ppm)
150.921
147.914
140.816
140.097
137.428
133.660
133.282
130.578
129.589
129.416
128.350
128.042
127.911
127.608
121.494
77.318
76.683
2v
f1 (ppm)

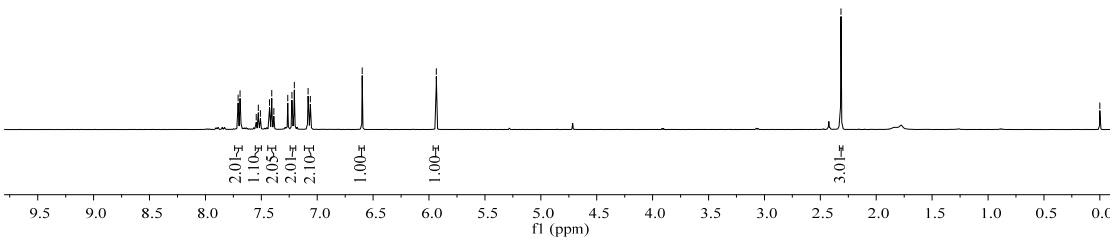

7.716
7.698
7.545
7.526
7.440
7.437
7.420
7.402
7.349
7.346
7.342
7.338
7.329
7.325
7.300
7.286
7.283
7.279
6.653
5.977
-0.000
3a
7.440
7.437
7.420
7.406
7.402
7.349
7.346
7.342
7.338
7.329
7.325
7.300
7.294
7.286
7.283
7.279
7.264
2.06
5.59
7.44
7.40
7.36
7.32
7.28
7.24
f1 (ppm)

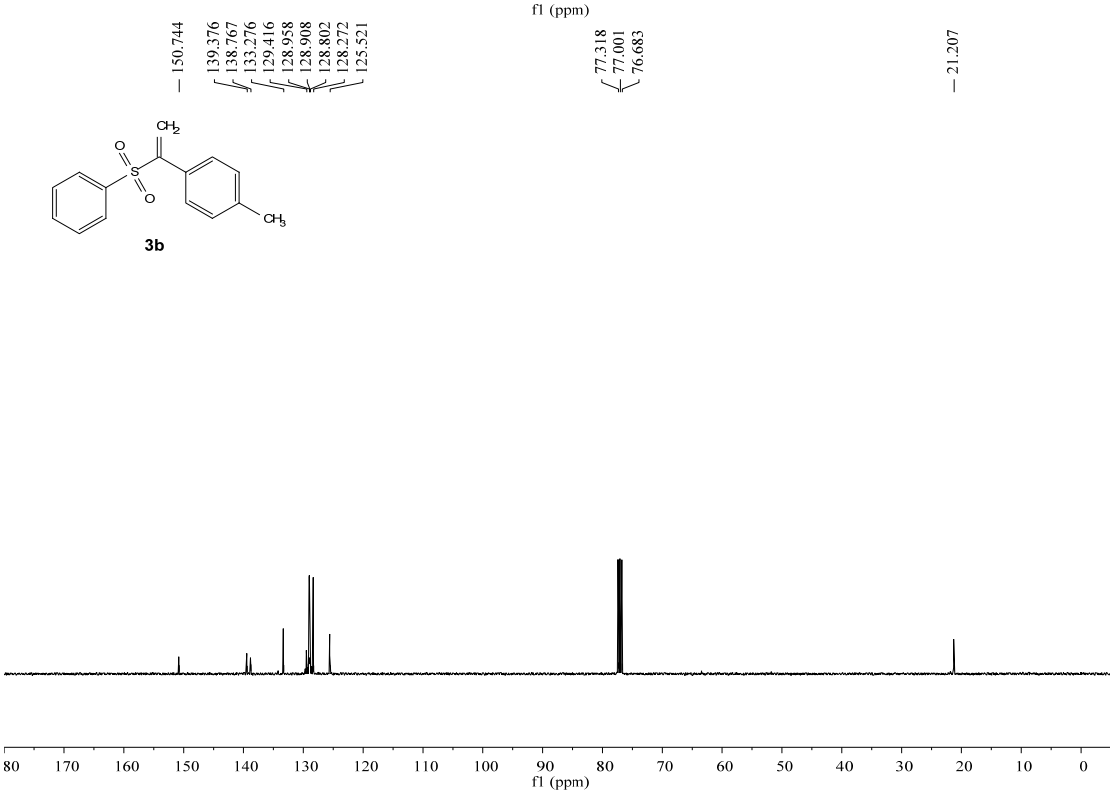

2.00
1.04
2.06
5.59
1.03
1.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


150.761
138.526
133.377
132.334
129.294
129.066
128.828
128.294
128.240
125.954
77.318
77.001
76.682
3a
129.294
129.066
128.828
128.294
128.240
129.0
128.5
128.0
f1 (ppm)
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

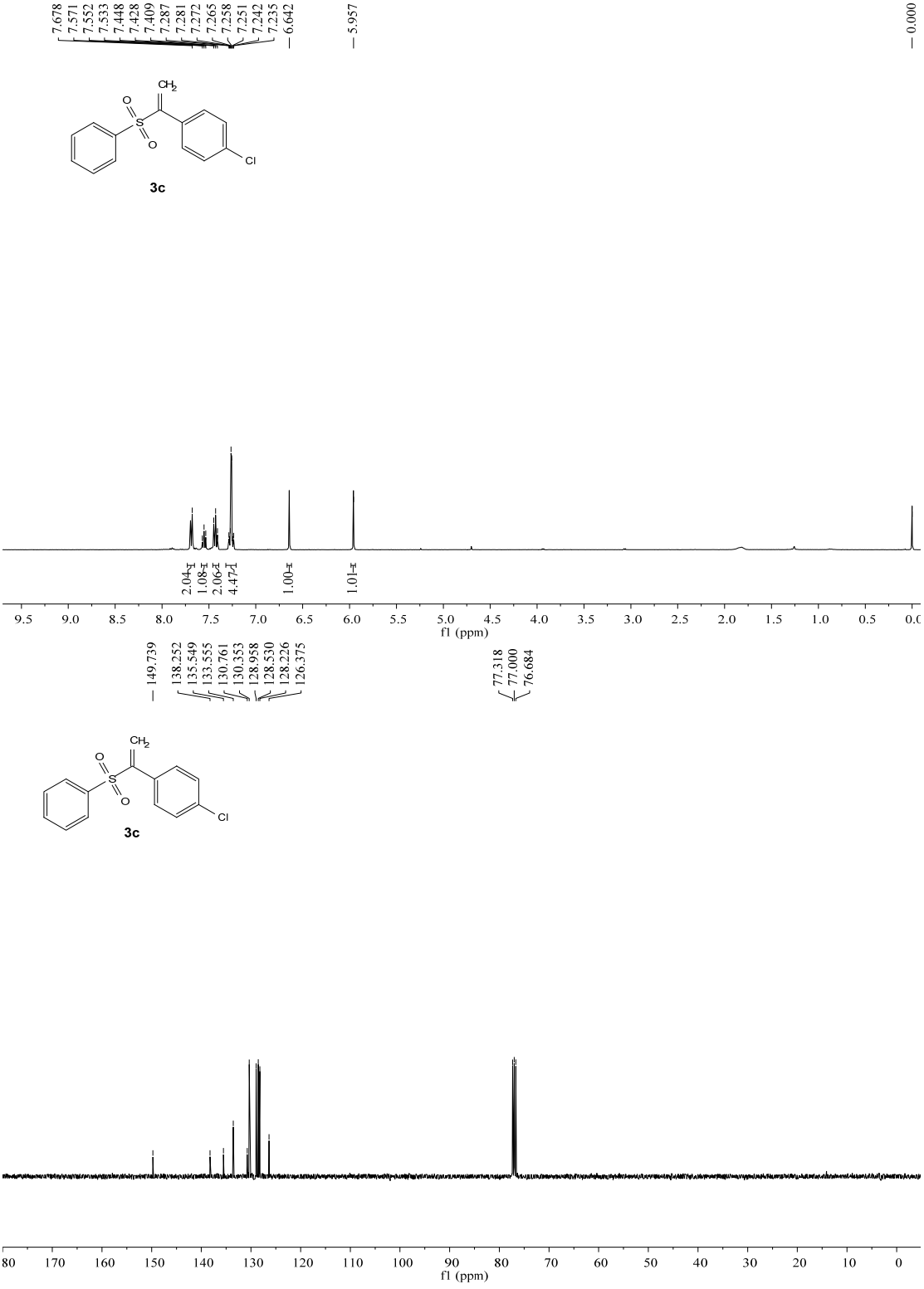

7.708
7.690
7.546
7.527
7.509
7.427
7.407
7.388
7.263
7.226
7.205
7.081
7.061
6.598
5.934
2.315
-0.000
CH2
O
S
O
CH3

3b


2.01
1.10
2.05
2.01
2.10
1.00
1.00
3.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

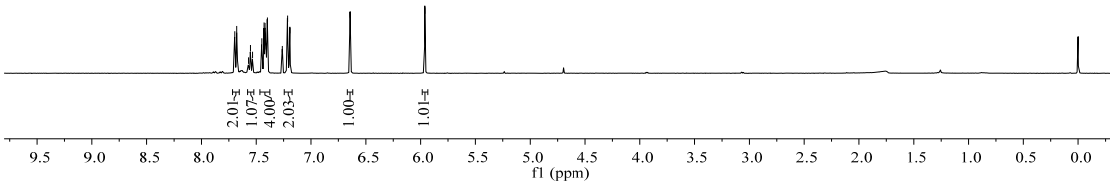

150.744
139.376
138.767
133.276
129.416
128.958
128.908
128.802
128.272
125.521
77.318
77.001
76.683
21.207
CH2
O
S
O
CH3
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

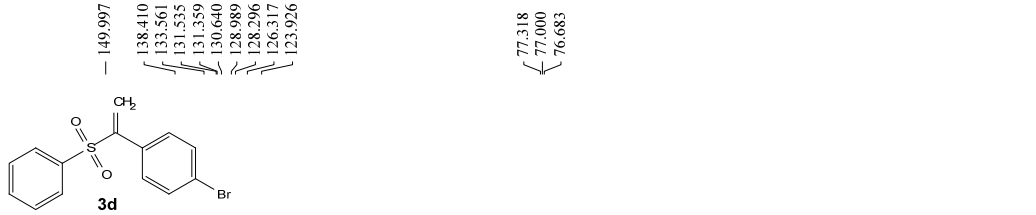
3b


7.678
7.571
7.552
7.533
7.448
7.428
7.409
7.287
7.281
7.272
7.265
7.258
7.251
7.242
7.235
6.642
5.957
0.000
CH2
O
S
O
Cl
3c
2.04
1.08
2.06
4.47
1.00
1.01
f1 (ppm)
149.739
138.252
135.549
133.555
130.761
130.353
128.958
128.530
128.226
126.375
77.318
77.000
76.684
CH2
O
S
O
Cl
3c
f1 (ppm)

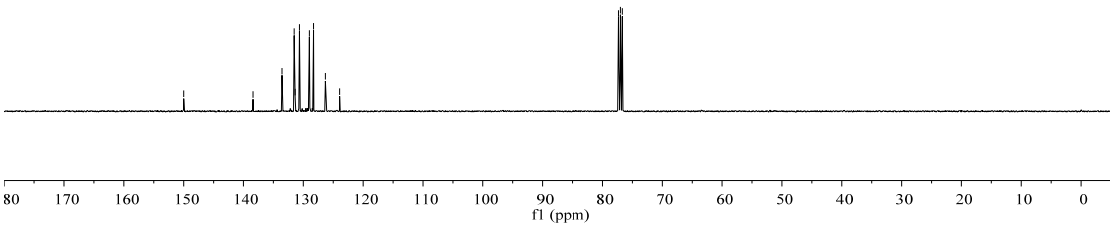

7.696
7.678
7.571
7.553
7.534
7.449
7.429
7.420
7.415
7.410
7.398
7.262
7.214
7.193
6.642
5.960
-0.000
CH2
O
S
O
Br

3d


2.01
1.07
4.00
2.03
1.00
1.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

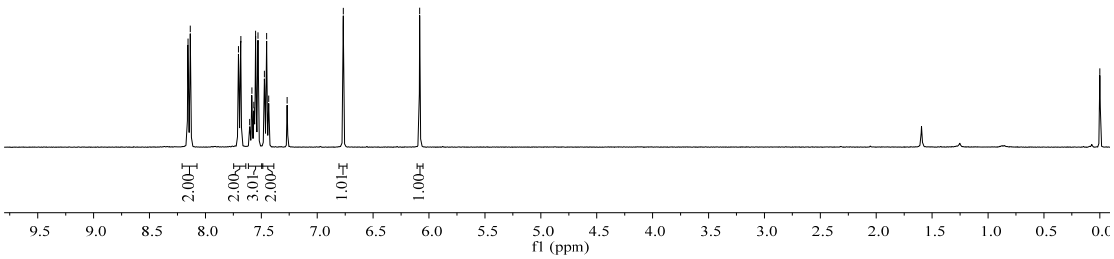

149.997
138.410
133.561
131.535
131.359
130.640
128.989
128.296
126.317
123.926
77.318
77.000
76.683
CH2
O
S
O
Br

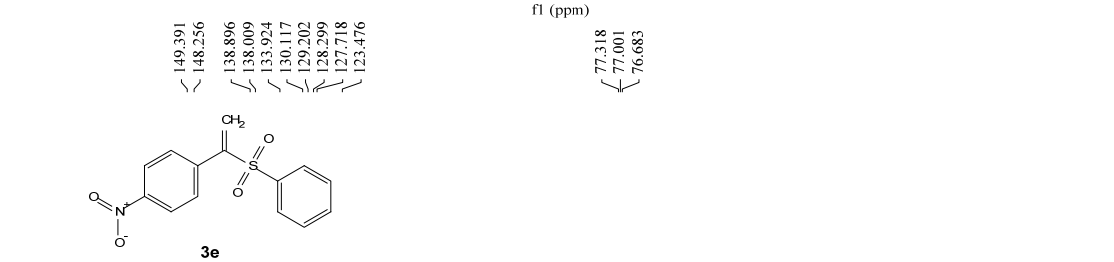
3d


180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

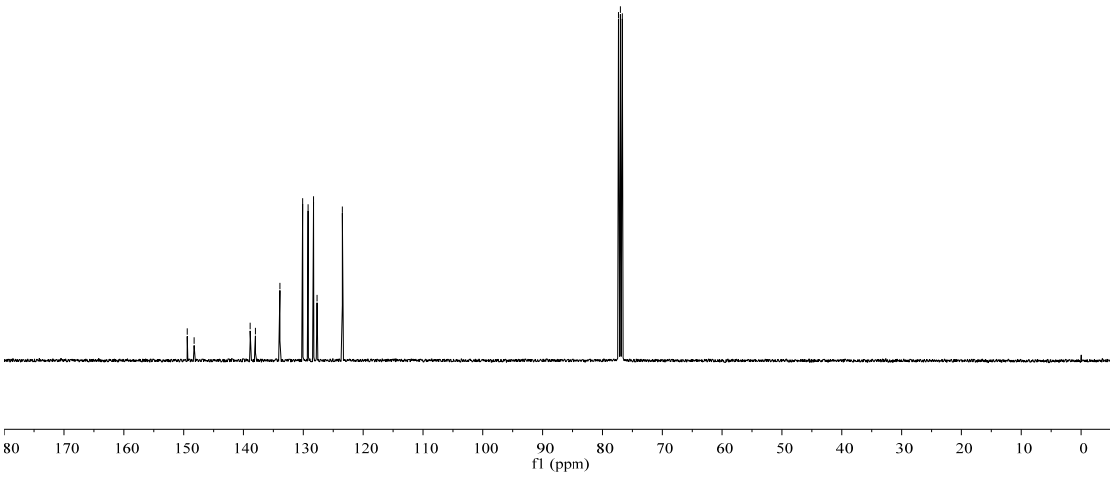

8.156
8.135
7.704
7.683
7.604
7.585
7.567
7.563
7.551
7.530
7.472
7.453
7.434
7.269
6.767
6.083
0.000
CH2
O
S
O
O
N+
O-

3e


2.00
2.00
3.01
2.00
1.01
1.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


149.391
148.256
138.896
138.009
133.924
130.117
129.202
128.299
127.718
123.476
77.318
77.001
76.683
CH2
O
S
O
O
N+
O-

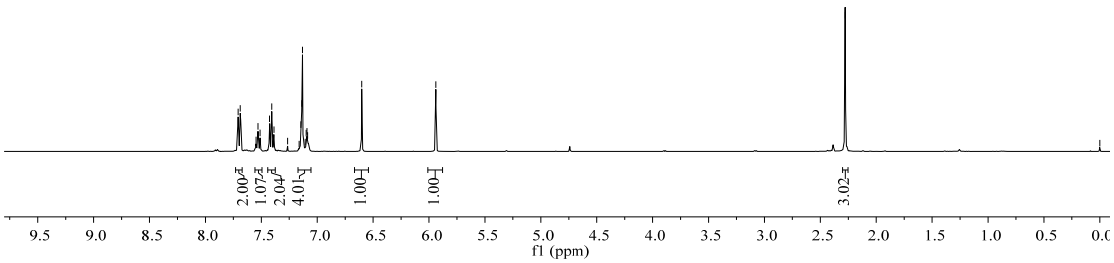
3e

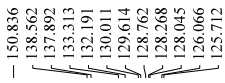

180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.707
7.689
7.546
7.529
7.511
7.426
7.406
7.387
7.266
7.162
7.146
7.138
7.132
7.108
7.099
7.092
7.086
6.602
5.939
2.277
0.000

CH2
O
S
O
CH3

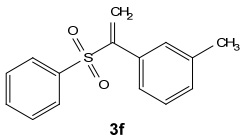
3f


2.00
1.07
2.04
4.01
1.00
1.00
3.02
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

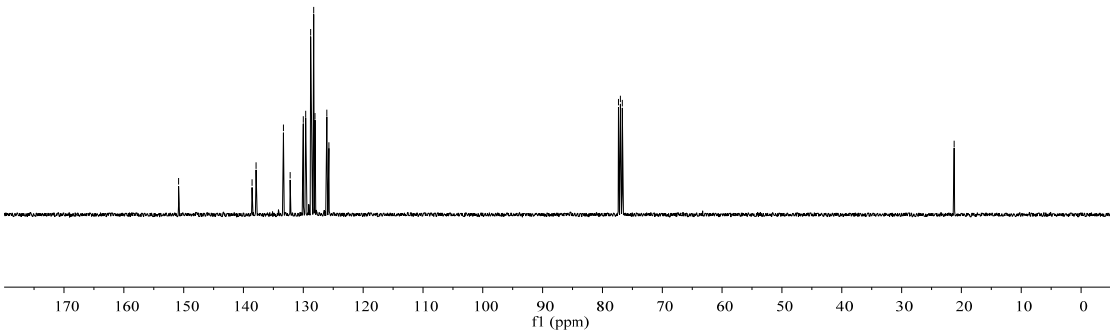

150.836
138.562
137.892
133.313
132.191
130.011
129.614
128.762
128.268
128.045
126.066
125.712

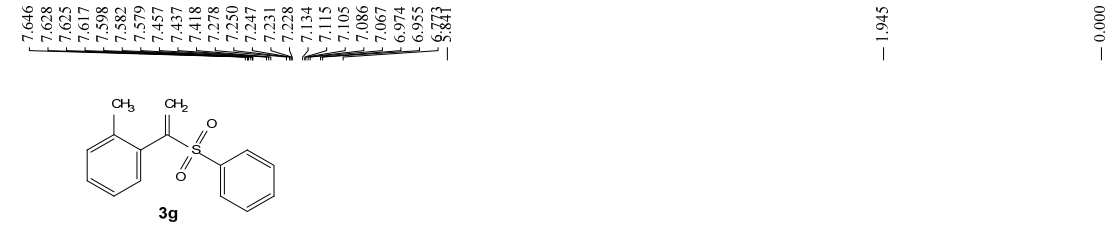

77.318
77.001
76.683


21.207


CH2
O
S
O
CH3

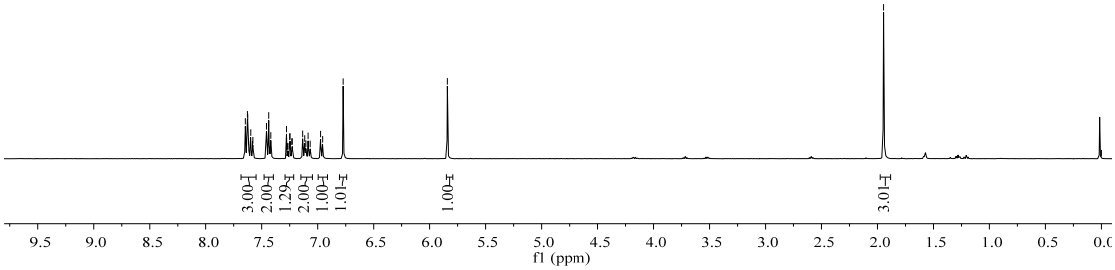
3f

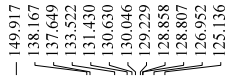

170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

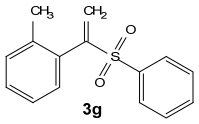

7.646
7.628
7.625
7.617
7.598
7.582
7.579
7.457
7.437
7.418
7.278
7.250
7.247
7.231
7.228
7.134
7.115
7.105
7.086
7.067
6.974
6.955
6.773
5.841
1.945
0.000

CH3
CH2
O
S
O

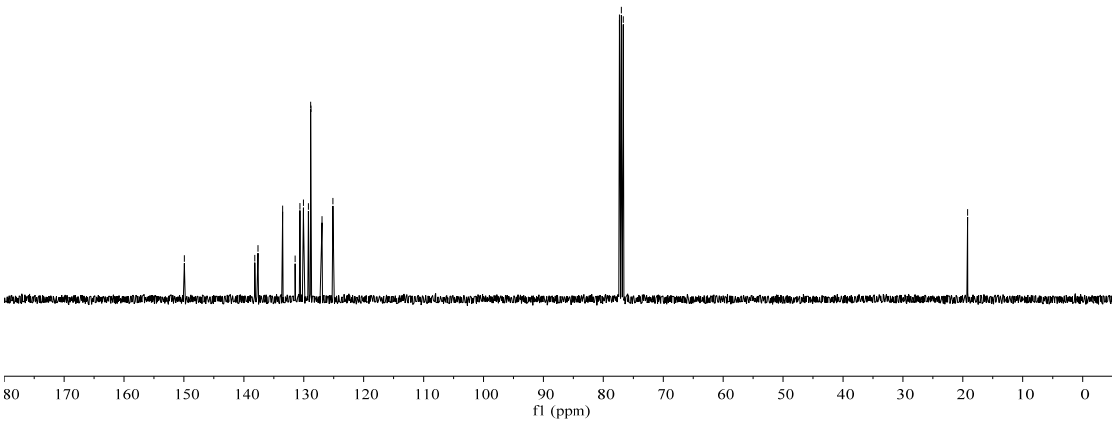
3g

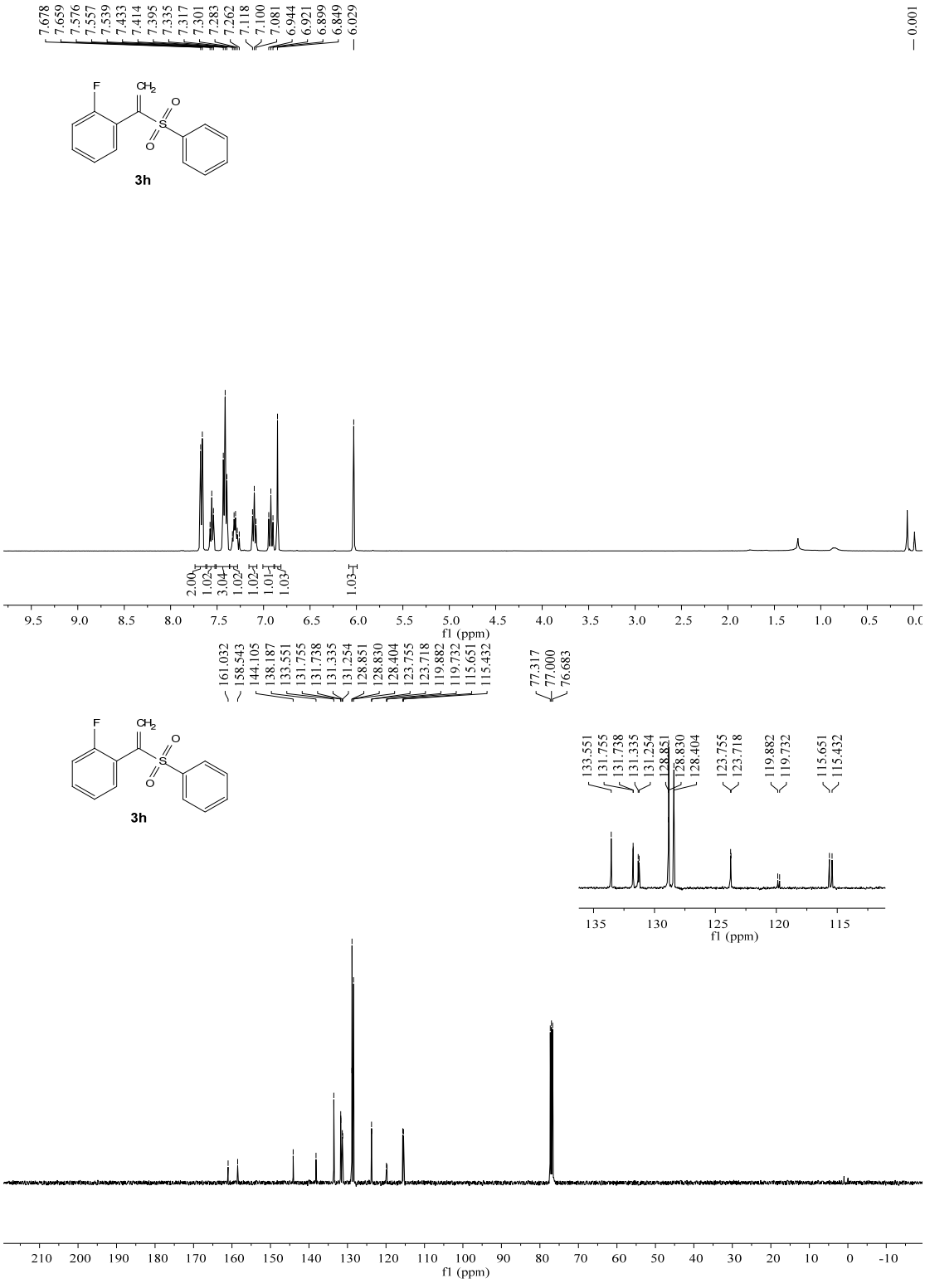

3.00
2.00
1.29
2.00
1.00
1.01
1.00
3.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

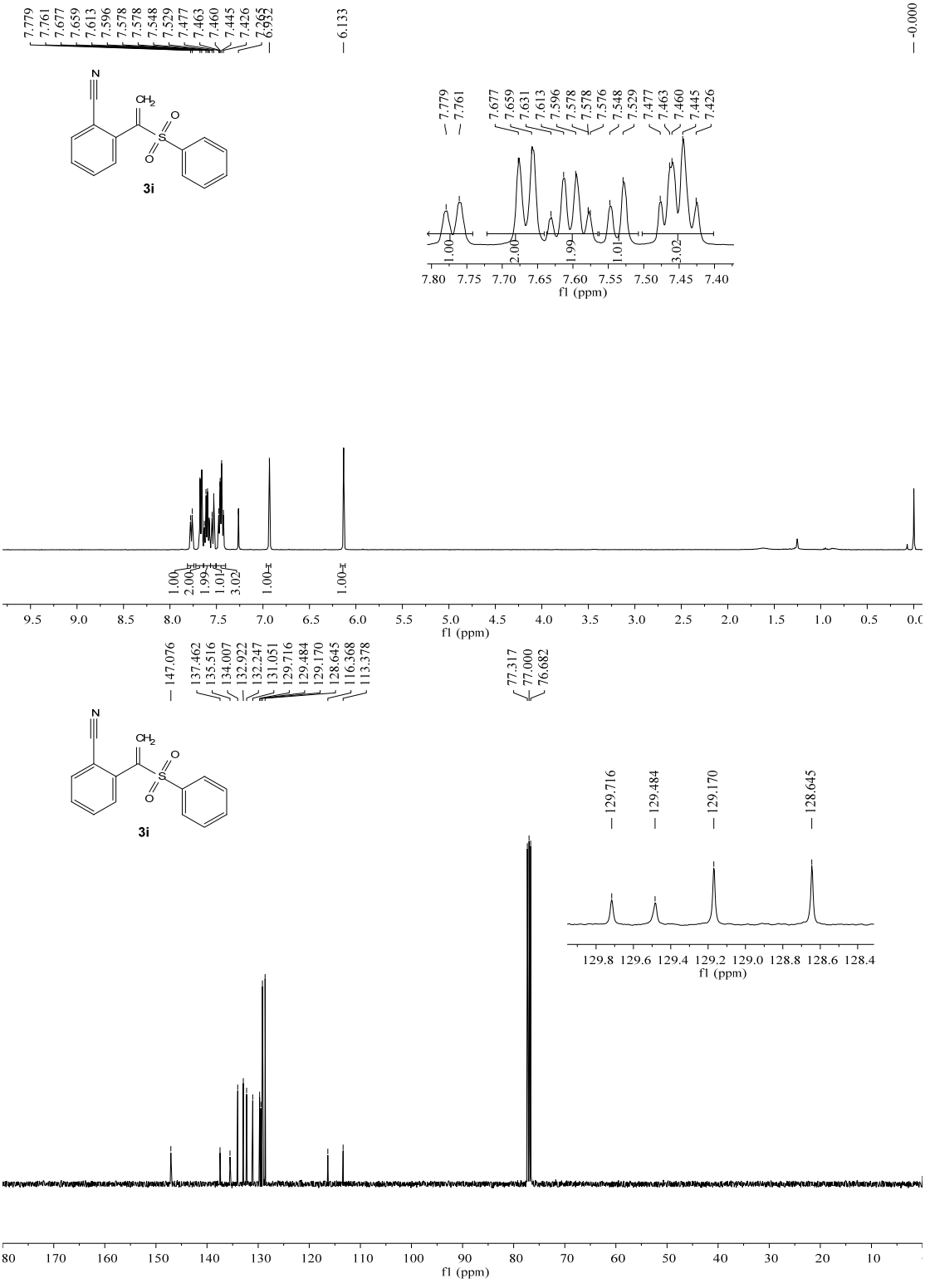

149.917
138.167
137.649
133.522
131.430
130.630
130.046
129.229
128.858
128.807
126.952
125.136
77.318
77.000
76.683
19.204

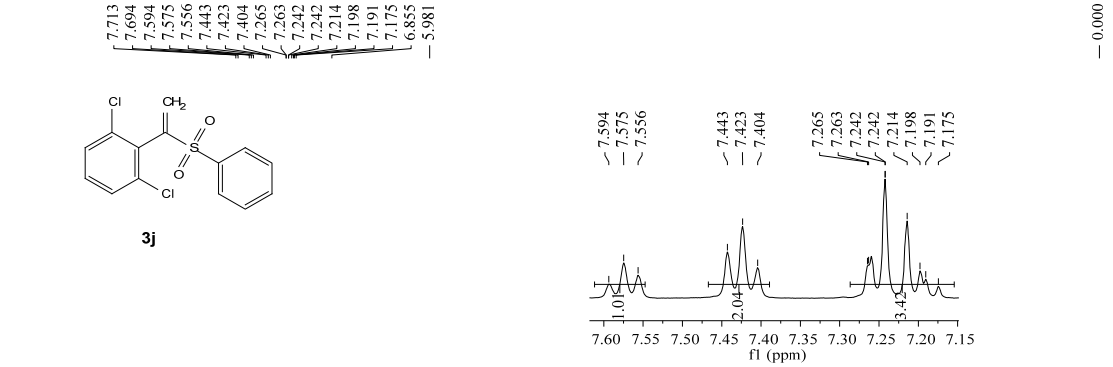

CH3
CH2
O
S
O

3g

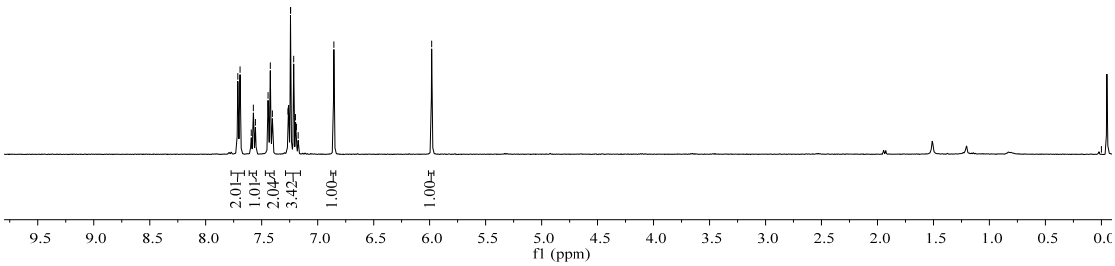

80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

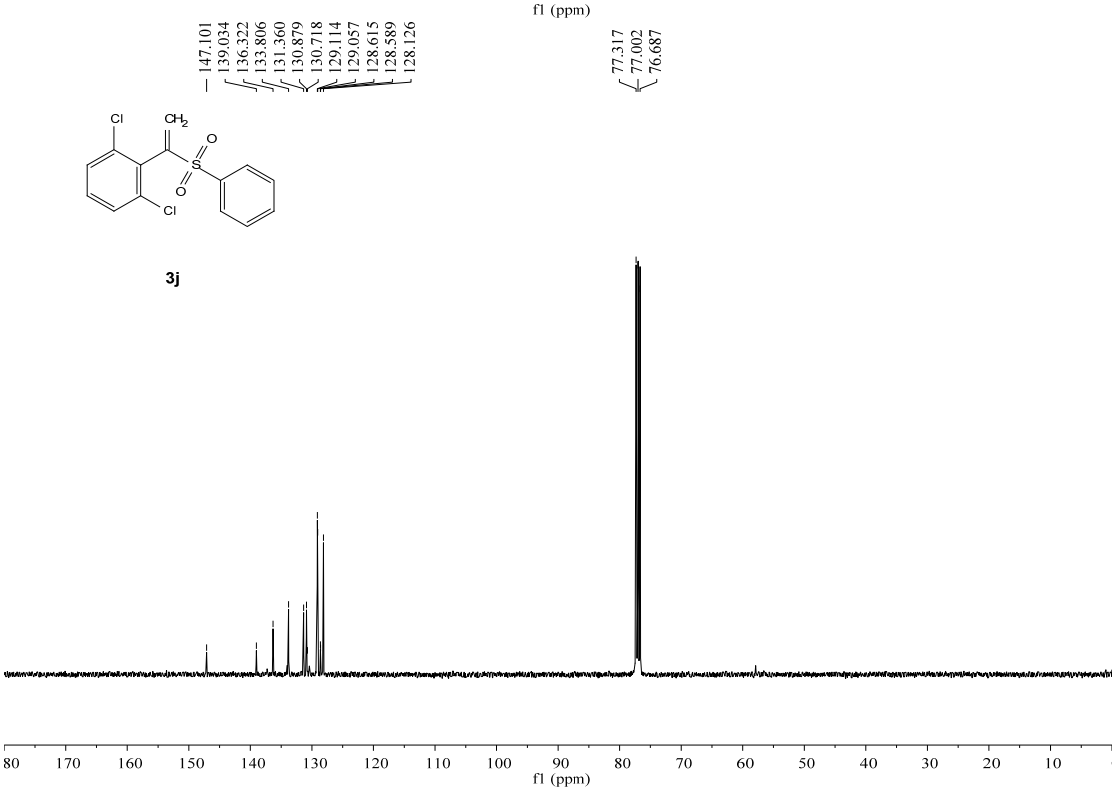

7.678
7.659
7.576
7.557
7.539
7.433
7.414
7.395
7.335
7.317
7.301
7.283
7.262
7.118
7.100
7.081
6.944
6.921
6.899
6.849
6.029
0.001
F
CH2
O
S
O
3h
2.00
1.02
3.04
1.02
1.02
1.01
1.03
1.03
f1 (ppm)
161.032
158.543
144.105
138.187
133.551
131.755
131.738
131.335
131.254
128.851
128.830
128.404
123.755
123.718
119.882
119.732
115.651
115.432
77.317
77.000
76.683
f1 (ppm)


7.779
7.761
7.677
7.659
7.613
7.596
7.578
7.578
7.548
7.529
7.477
7.463
7.460
7.445
7.426
6.133
-0.000
3i
1.00
2.00
1.99
1.01
3.02
1.00
1.00
fl (ppm)
147.076
137.462
135.516
134.007
132.922
132.247
131.051
129.716
129.484
129.170
128.645
116.368
113.378
77.317
77.000
76.682
3i
fl (ppm)


7.713
7.694
7.594
7.575
7.556
7.443
7.423
7.404
7.265
7.263
7.242
7.242
7.214
7.198
7.191
7.175
6.855
5.981
0.000
Cl
CH2
O
S
O
Cl
7.594
7.575
7.556
7.443
7.423
7.404
7.265
7.263
7.242
7.242
7.214
7.198
7.191
7.175
1.01
2.04
3.42
7.60 7.55 7.50 7.45 7.40 7.35 7.30 7.25 7.20 7.15
f1 (ppm)

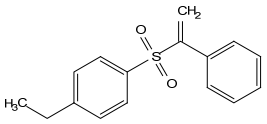
3j


2.01
1.01
2.04
3.42
1.00
1.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

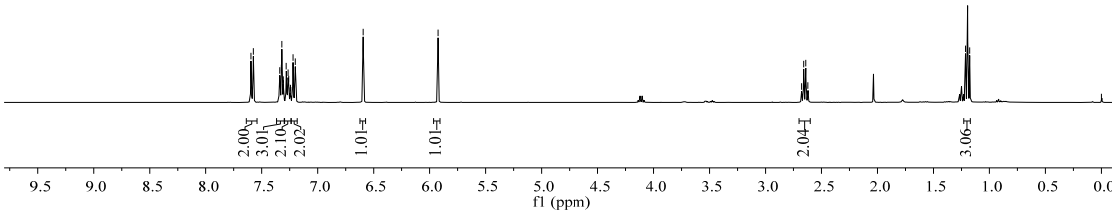

147.101
139.034
136.322
133.806
131.360
130.879
130.718
129.114
129.057
128.615
128.589
128.126
77.317
77.002
76.687
Cl
CH2
O
S
O
Cl
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

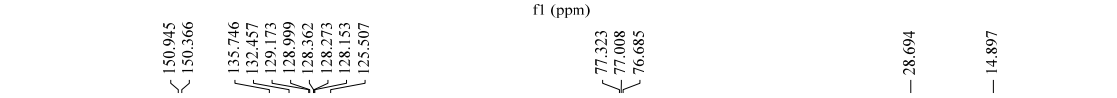
3j

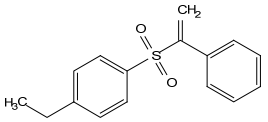

7.595
7.575
7.338
7.325
7.320
7.308
7.306
7.281
7.264
7.259
7.247
7.244
7.240
7.221
7.200
6.594
5.925
2.678
2.659
2.640
2.621
1.214
1.176
0.000


CH2
O
S
O
H3C

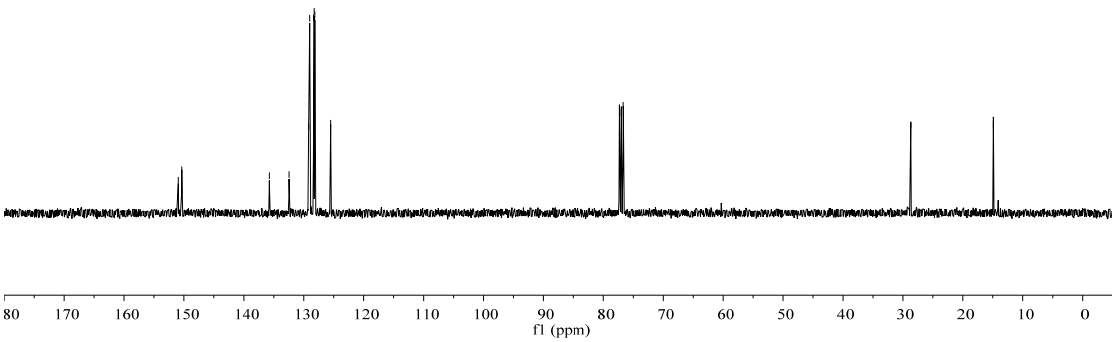
3K


2.00
3.01
2.10
2.02
1.01
1.01
2.04
3.06
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


150.945
150.366
135.746
132.457
129.173
128.999
128.362
128.273
128.153
125.507
77.323
77.008
76.685
28.694
14.897

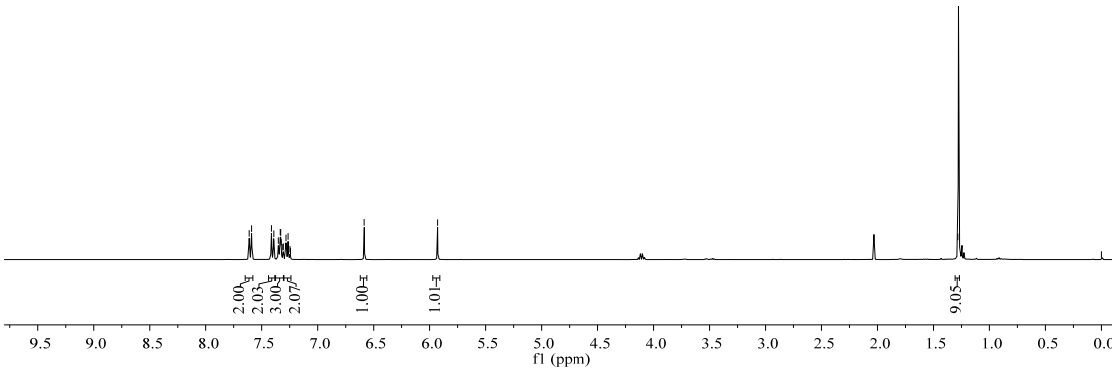

CH2
O
S
O
H3C

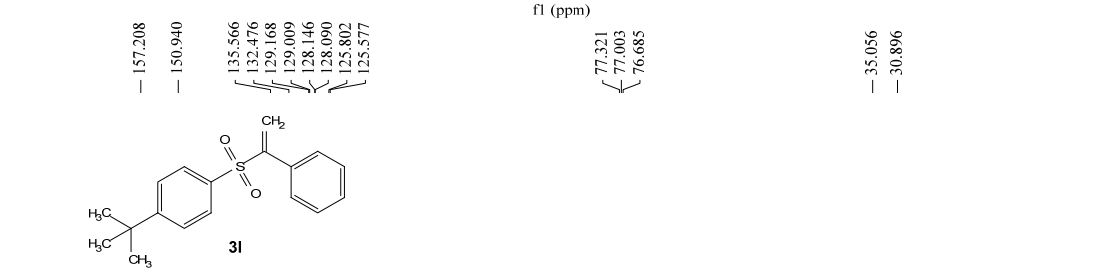
3k


80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

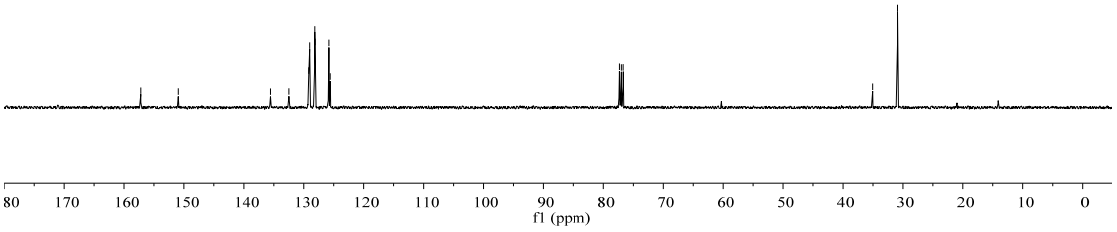

7.612
7.590
7.413
7.392
7.351
7.334
7.331
7.325
7.311
7.308
7.283
7.264
7.247
7.243
6.585
5.929
1.283
0.000
CH2
O
S
O
H3C
H3C
CH3

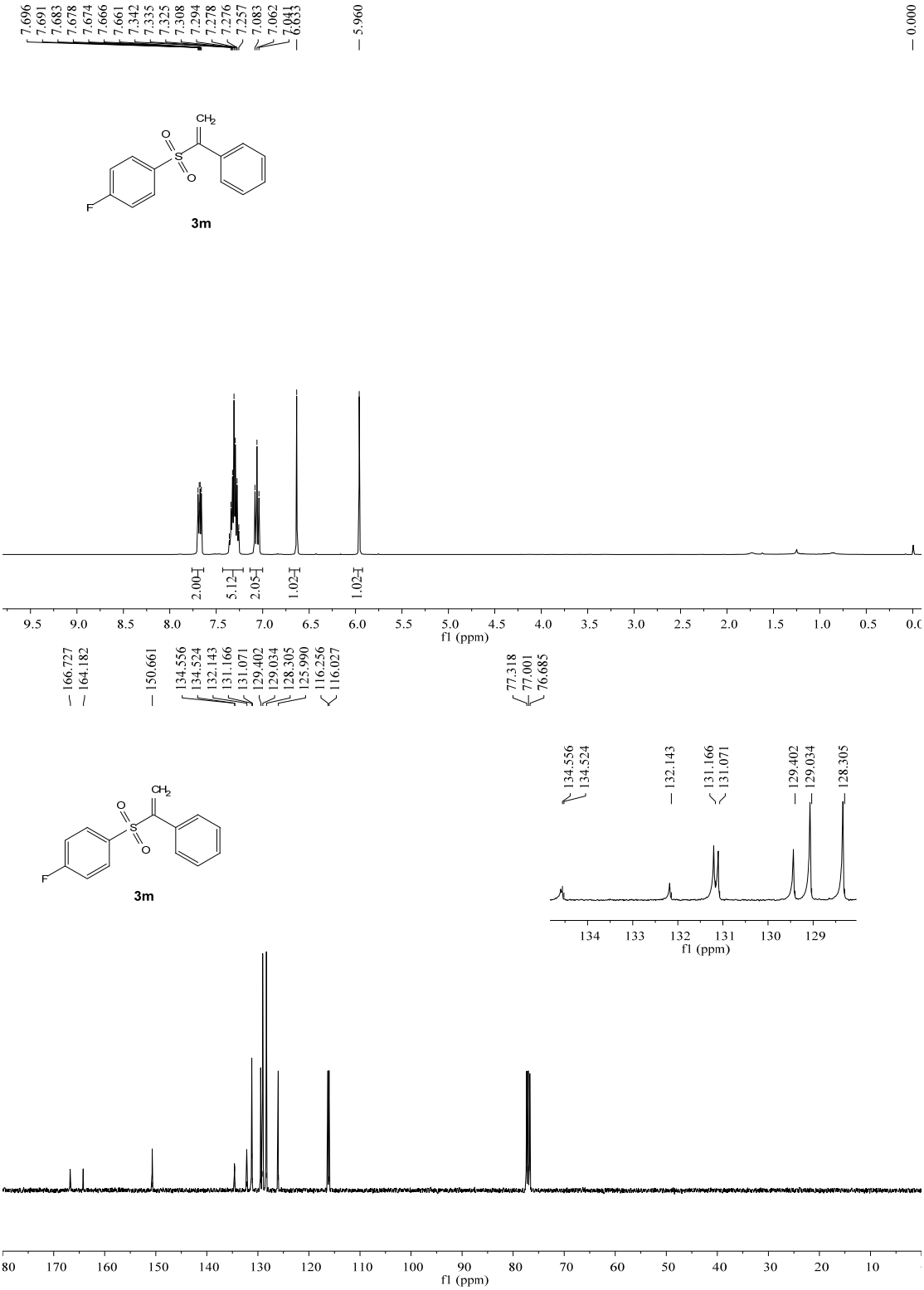
3l

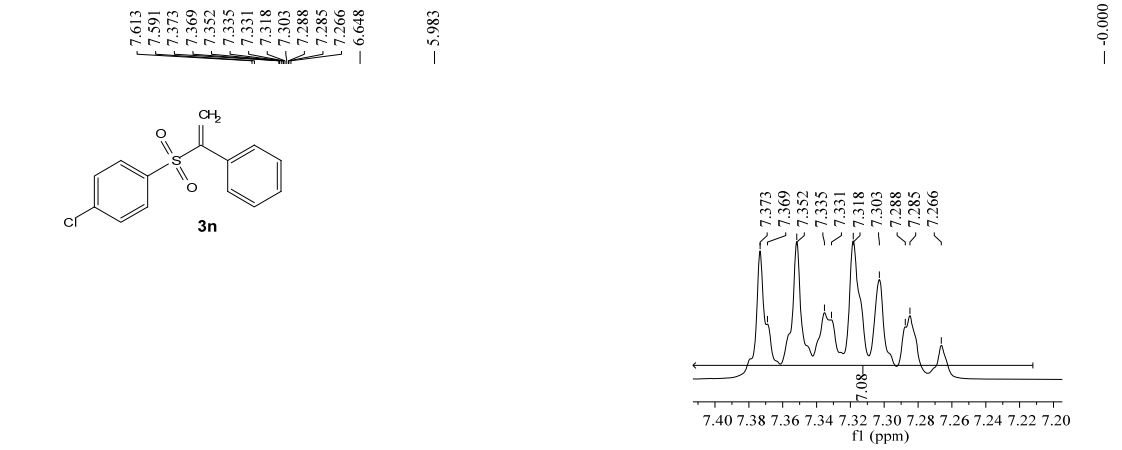

2.00
2.03
3.00
2.07
1.00
1.01
9.05
f1 (ppm)

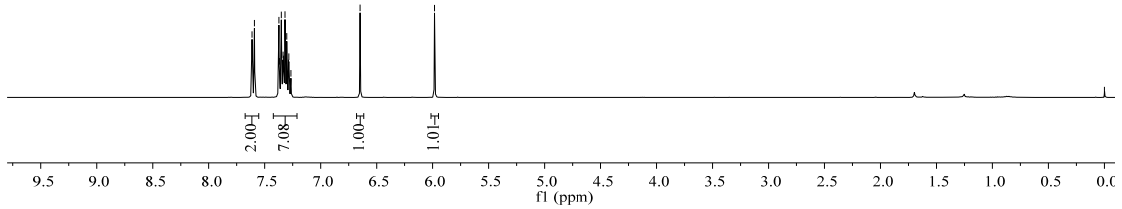

157.208
150.940
135.566
132.476
129.168
129.009
128.146
128.090
125.802
125.577
77.321
77.003
76.685
35.056
30.896
CH2
O
S
O
H3C
H3C
CH3

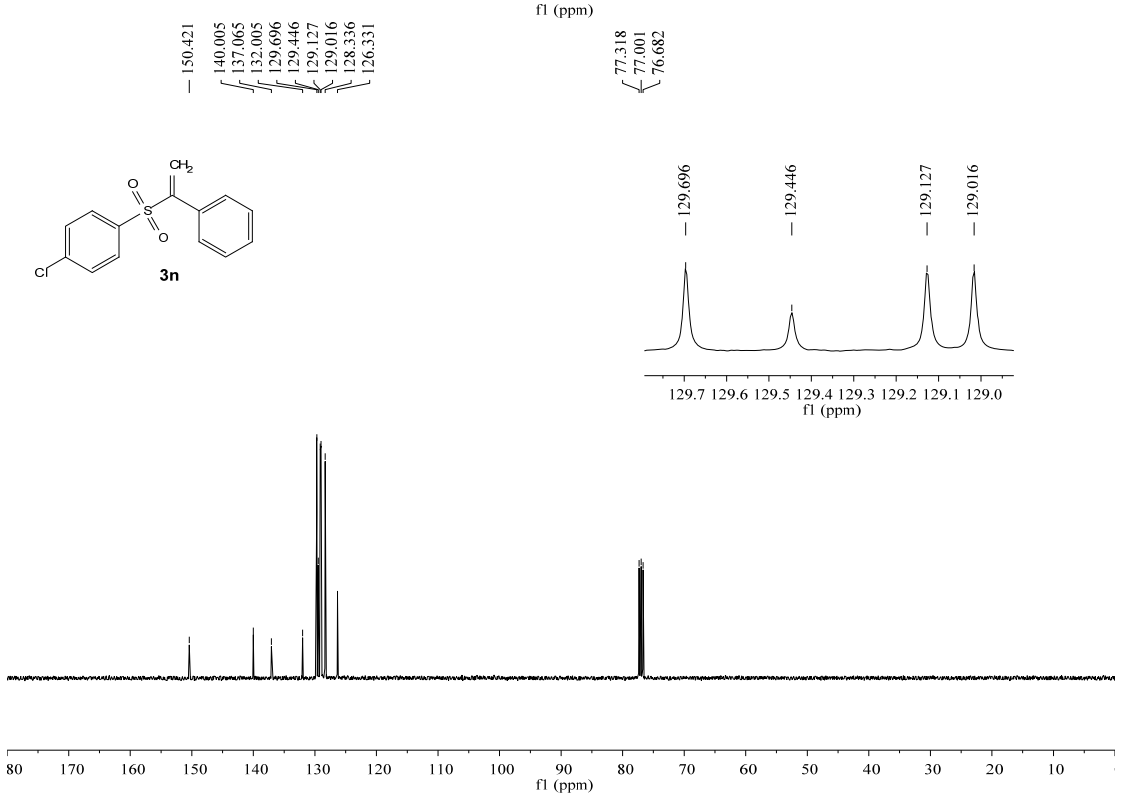
3l

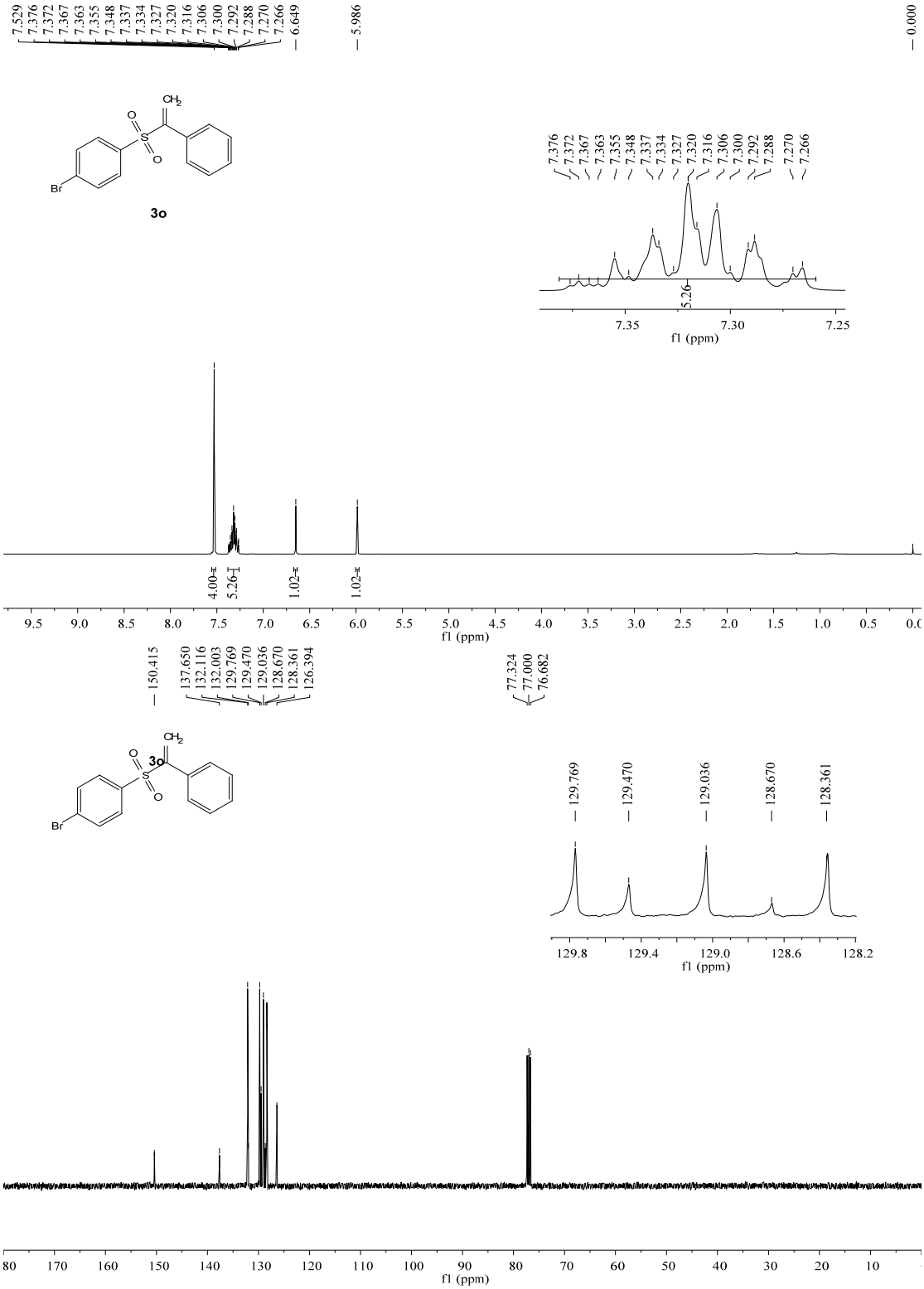

f1 (ppm)

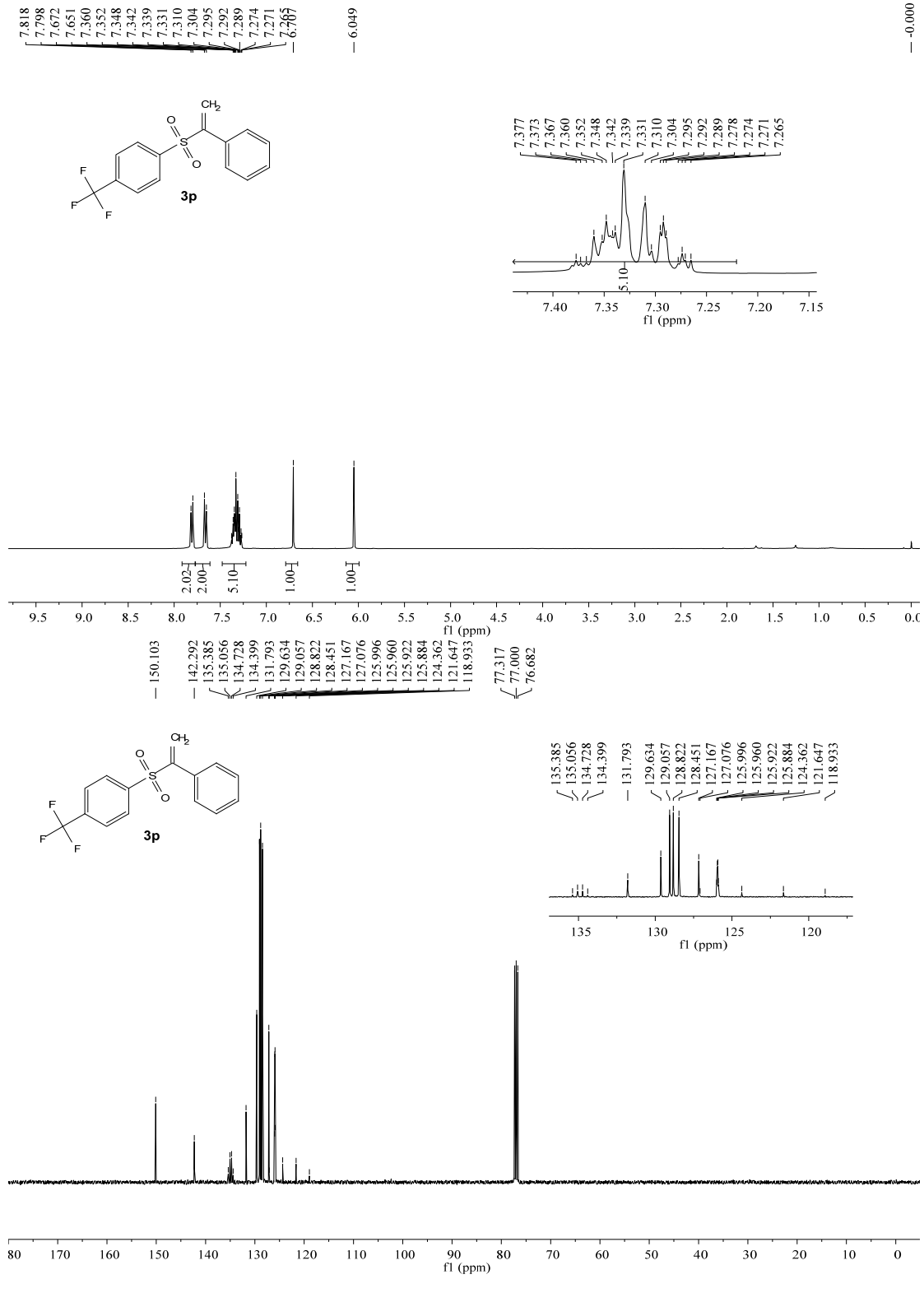

7.696
7.691
7.683
7.678
7.674
7.666
7.661
7.342
7.335
7.325
7.308
7.294
7.278
7.276
7.257
7.083
7.062
7.041
6.633
5.960
0.000
CH2
O
S
O
F
3m
2.00
5.12
2.05
1.02
1.02
fl (ppm)
166.727
164.182
150.661
134.556
134.524
132.143
131.166
131.071
129.402
129.034
128.305
125.990
116.256
116.027
77.318
77.001
76.685
fl (ppm)

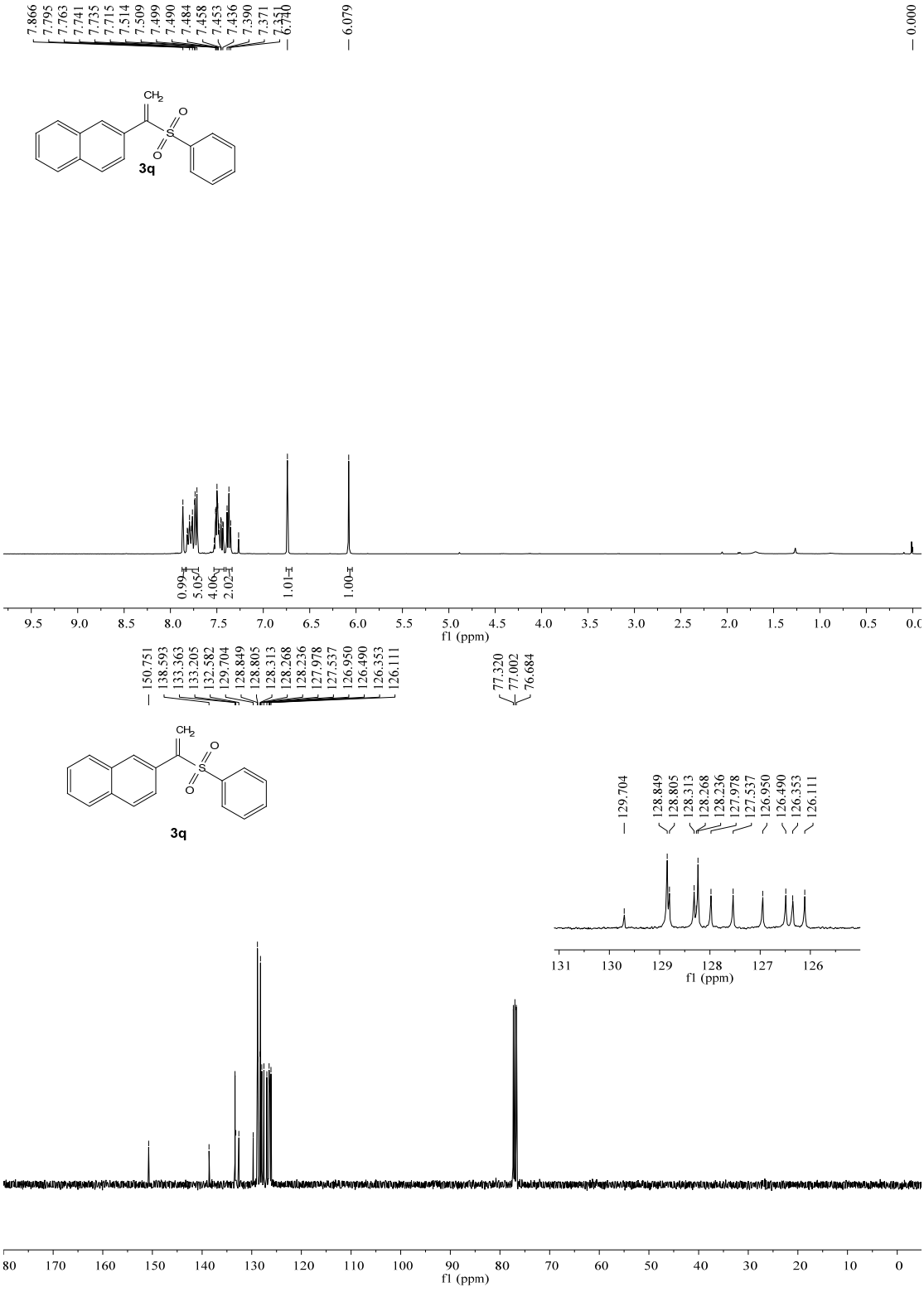

7.613
7.591
7.373
7.369
7.352
7.335
7.331
7.318
7.303
7.288
7.285
7.266
6.648
5.983
-0.000
CH2
O
S
O
Cl
3n
7.373
7.369
7.352
7.335
7.331
7.318
7.303
7.288
7.285
7.266
7.08
7.40 7.38 7.36 7.34 7.32 7.30 7.28 7.26 7.24 7.22 7.20
f1 (ppm)


2.00
7.08
1.00
1.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


150.421
140.005
137.065
132.005
129.696
129.446
129.127
129.016
128.336
126.331
77.318
77.001
76.682
CH2
O
S
O
Cl
3n
129.696
129.446
129.127
129.016
129.7 129.6 129.5 129.4 129.3 129.2 129.1 129.0
f1 (ppm)
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


7.529
7.376
7.372
7.367
7.363
7.355
7.348
7.337
7.334
7.327
7.320
7.316
7.306
7.300
7.292
7.288
7.270
7.266
6.649
5.986
0.000
CH2
O
S
O
Br
3o
7.376
7.372
7.367
7.363
7.355
7.348
7.337
7.334
7.327
7.320
7.316
7.306
7.300
7.292
7.288
7.270
7.266
5.26
7.35
7.30
7.25
f1 (ppm)
4.00
5.26
1.02
1.02
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
150.415
137.650
132.116
132.003
129.769
129.470
129.036
128.670
128.361
126.394
77.324
77.000
76.682
CH2
O
S
O
Br
3o
129.769
129.470
129.036
128.670
128.361
129.8
129.4
129.0
128.6
128.2
f1 (ppm)
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.818
7.798
7.672
7.651
7.360
7.352
7.348
7.342
7.339
7.331
7.310
7.304
7.295
7.292
7.289
7.274
7.271
7.265
6.049
-0.000
3p
5.10
fl (ppm)
2.02
2.00
5.10
1.00
1.00
150.103
142.292
135.385
135.056
134.728
134.399
131.793
129.634
129.057
128.822
128.451
127.167
127.076
125.996
125.960
125.922
125.884
124.362
121.647
118.933
77.317
77.000
76.682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7.763
7.741
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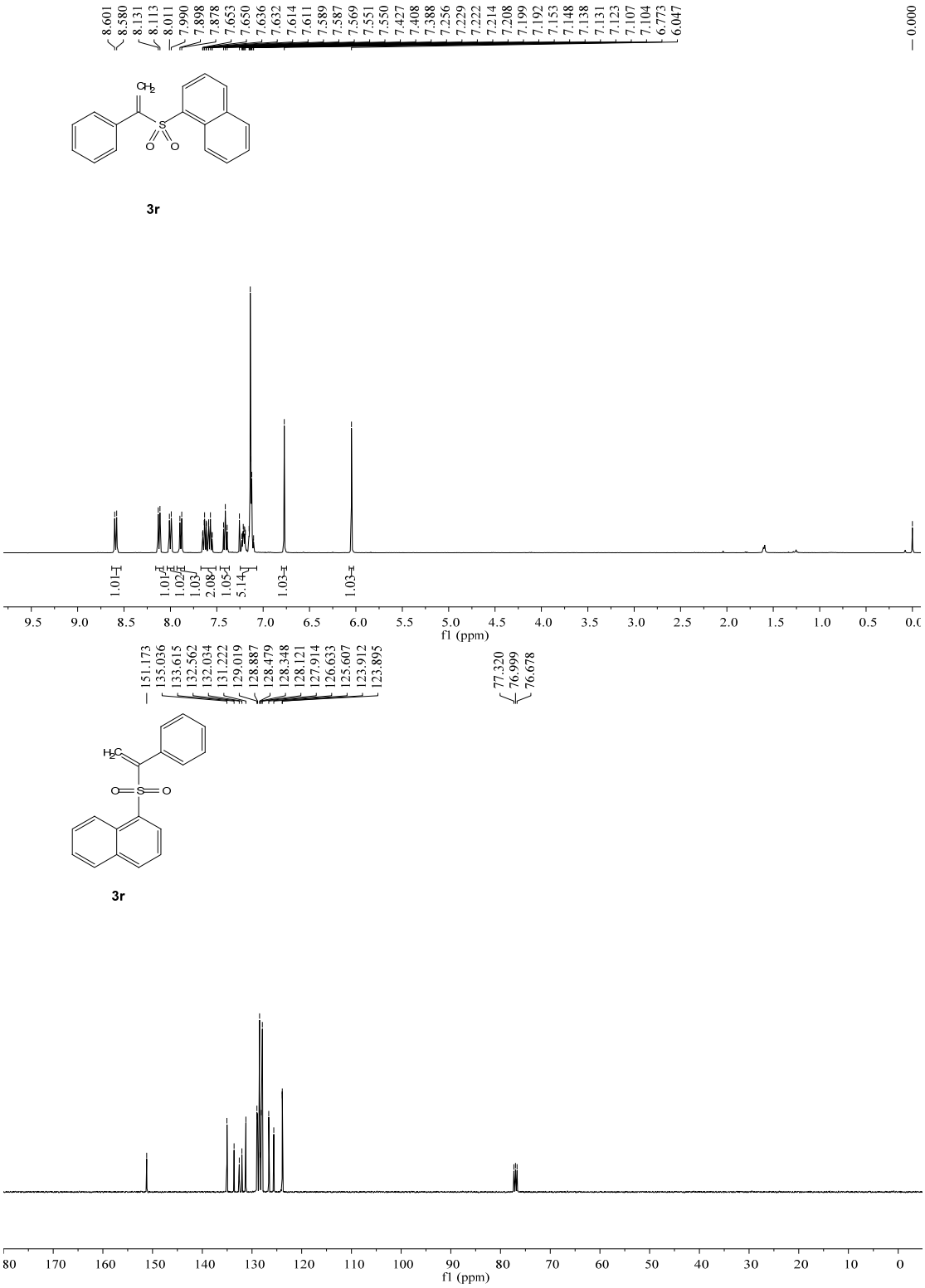
7.715
7.514
7.509
7.499
7.490
7.484
7.458
7.453
7.436
7.390
7.371
7.351
7.340
6.079
0.000
CH2
O
S
O
3q
0.99
5.05
4.06
2.02
1.01
1.00
f1 (ppm)
150.751
138.593
133.363
133.205
132.582
129.704
128.849
128.805
128.313
128.268
128.236
127.978
127.537
126.950
126.490
126.353
126.111
77.320
77.002
76.684
CH2
O
S
O
3q
129.704
128.849
128.805
128.313
128.268
128.236
127.978
127.537
126.950
126.490
126.353
126.111
f1 (ppm)
f1 (ppm)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8.580
8.131
8.113
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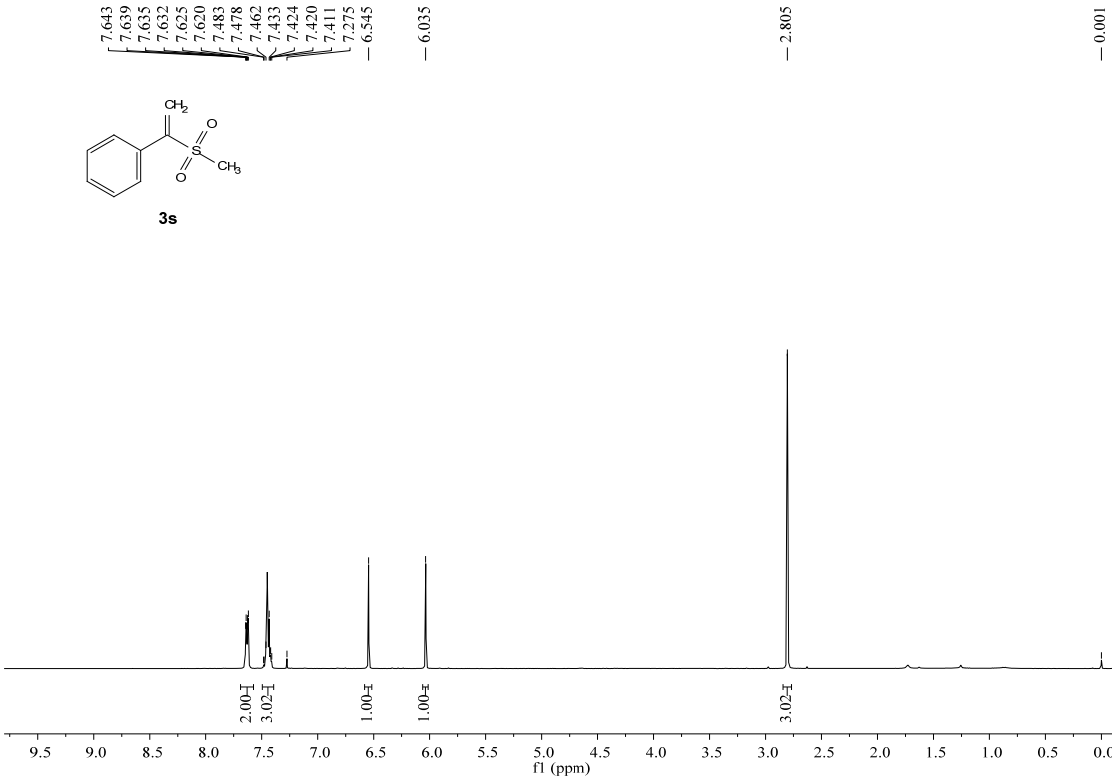
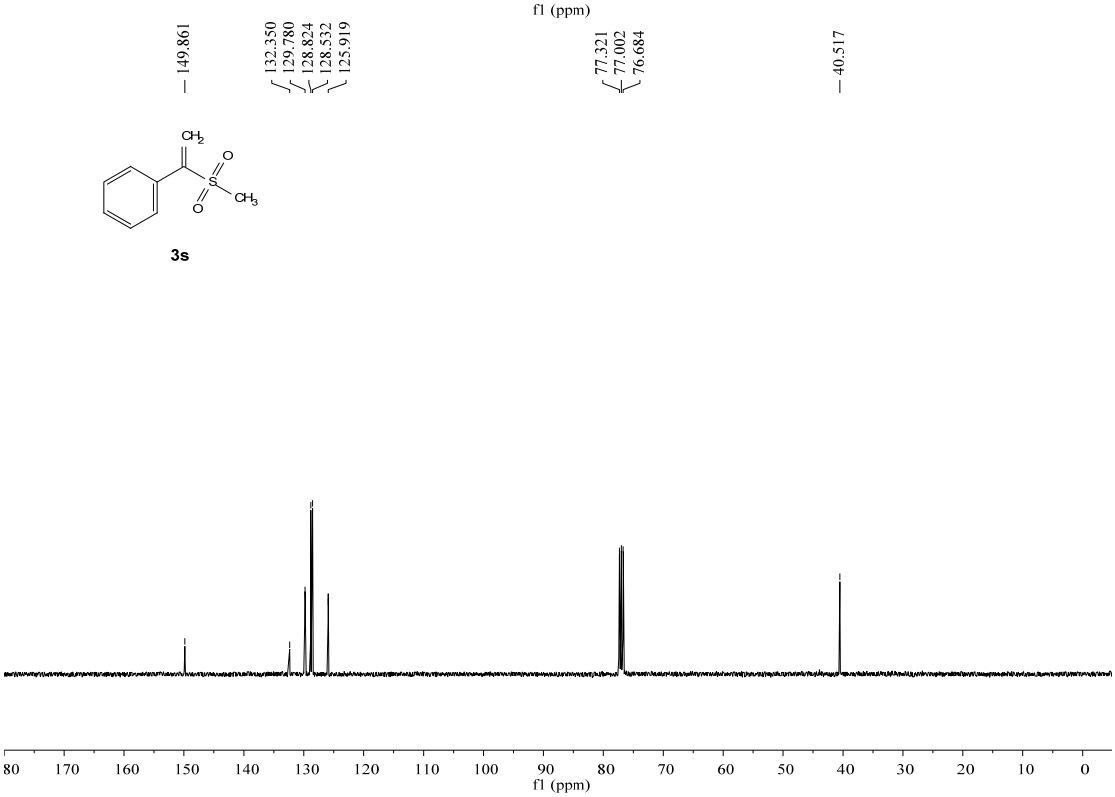
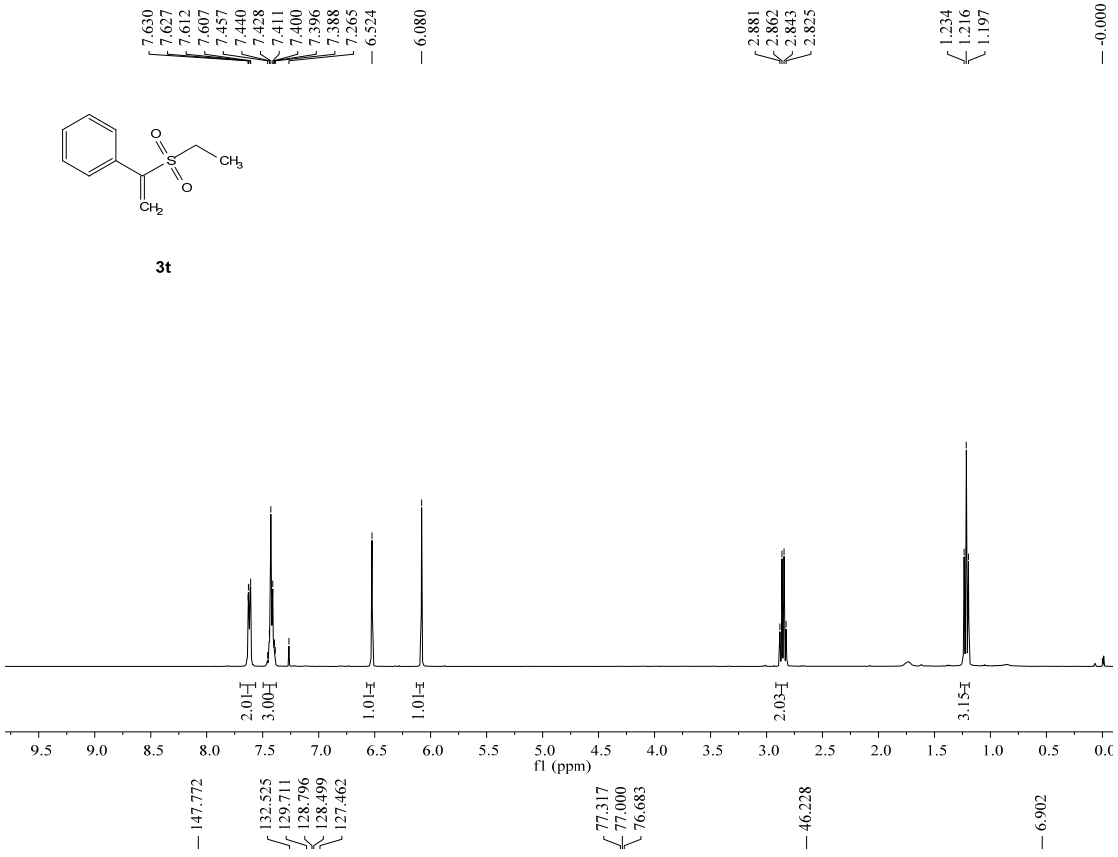
7.898
7.878
7.653
7.650
7.636
7.632
7.614
7.611
7.589
7.587
7.569
7.551
7.550
7.427
7.408
7.388
7.256
7.229
7.222
7.214
7.208
7.199
7.192
7.153
7.148
7.138
7.131
7.123
7.107
7.104
6.773
6.047
0.000
CH2
S
O
O
3r
1.01
1.01
1.02
1.03
2.08
1.05
5.14
1.03
1.03
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
151.173
135.036
133.615
132.562
132.034
131.222
129.019
128.887
128.479
128.348
128.121
127.914
126.633
125.607
123.912
123.895
77.320
76.999
76.678
H2C
O
S
O
3r
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.643
7.639
7.635
7.632
7.625
7.620
7.483
7.478
7.462
7.433
7.424
7.420
7.411
7.275
6.545
6.035
2.805
0.001
CH2
O
S
O
CH3
2.00
3.02
1.00
1.00
3.02
f1 (ppm)

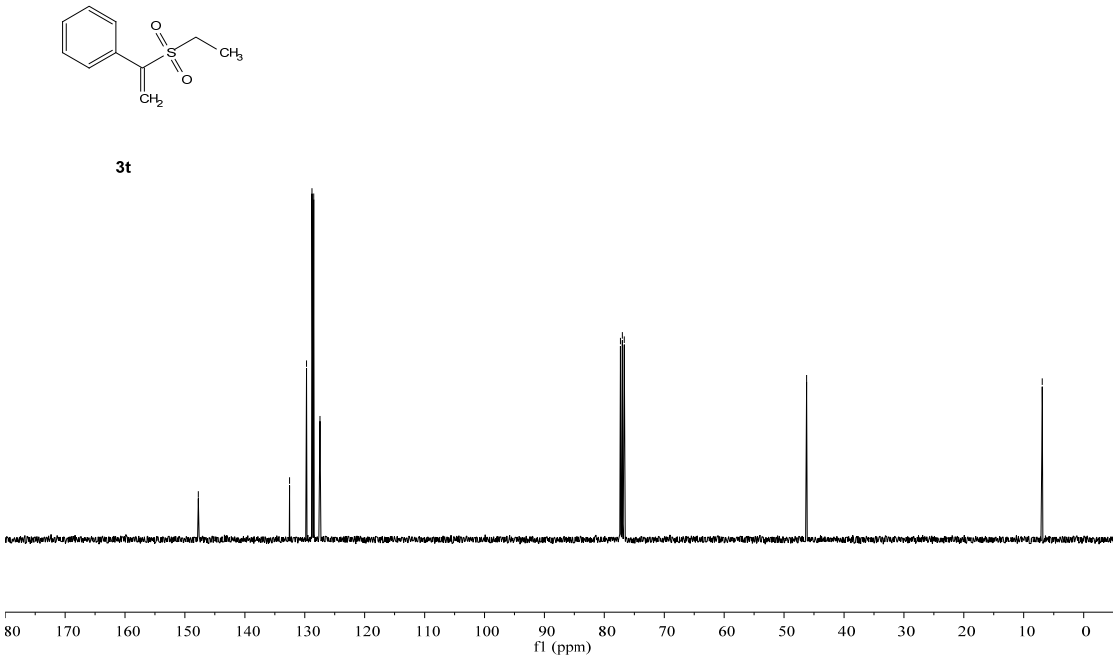
3s


149.861
132.350
129.780
128.824
128.532
125.919
77.321
77.002
76.684
40.517
CH2
O
S
O
CH3
f1 (ppm)

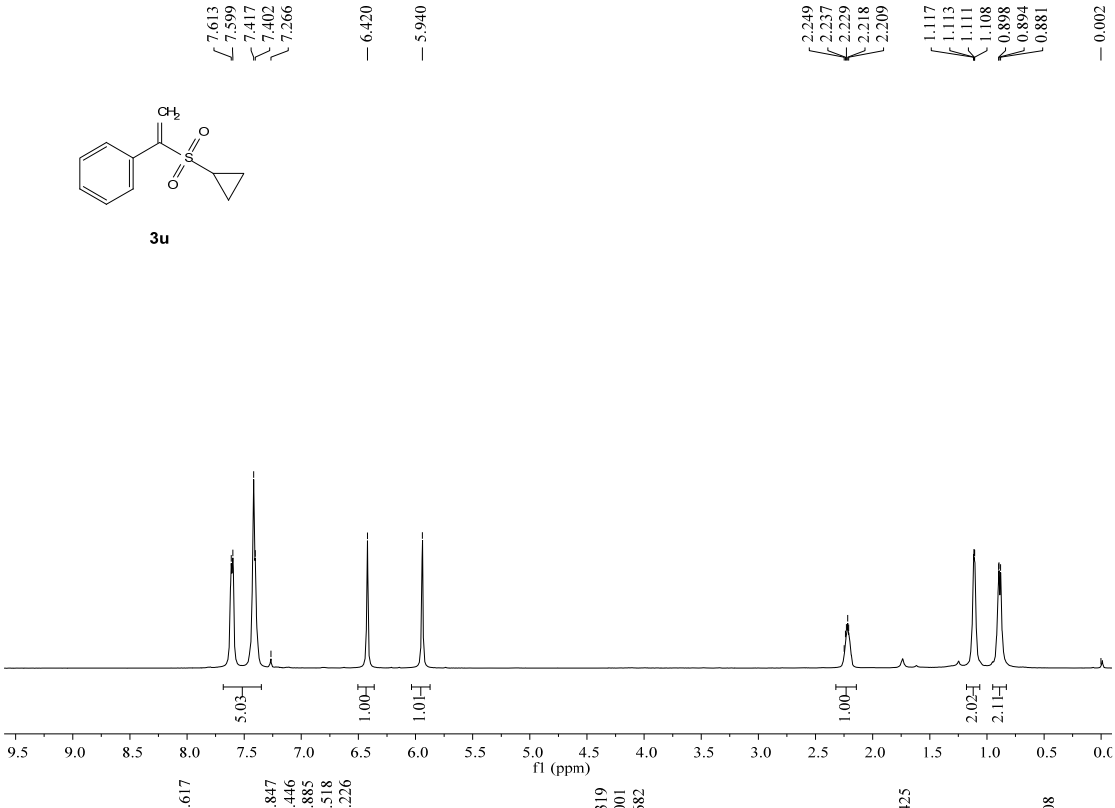
3s

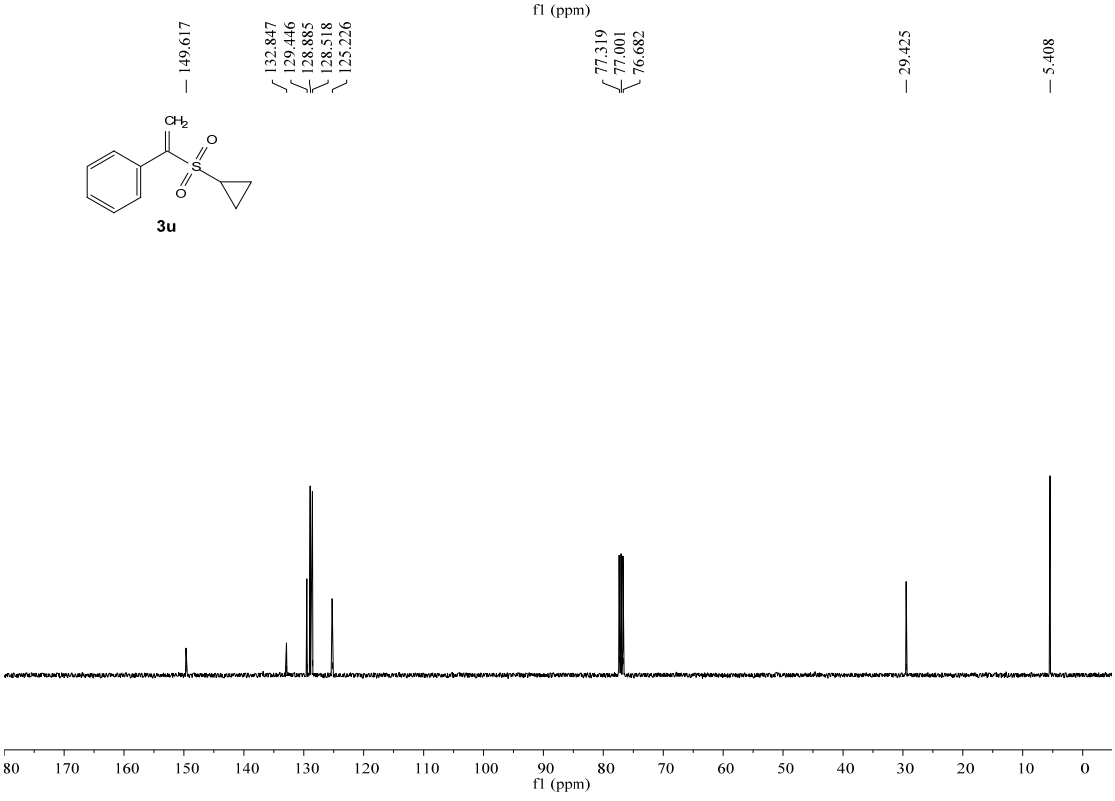

7.630
7.627
7.612
7.607
7.457
7.440
7.428
7.411
7.400
7.396
7.388
7.265
6.524
6.080
2.881
2.862
2.843
2.825
1.234
1.216
1.197
-0.000
O
S
O
CH3
CH2
2.01
3.00
1.01
1.01
2.03
3.15
f1 (ppm)

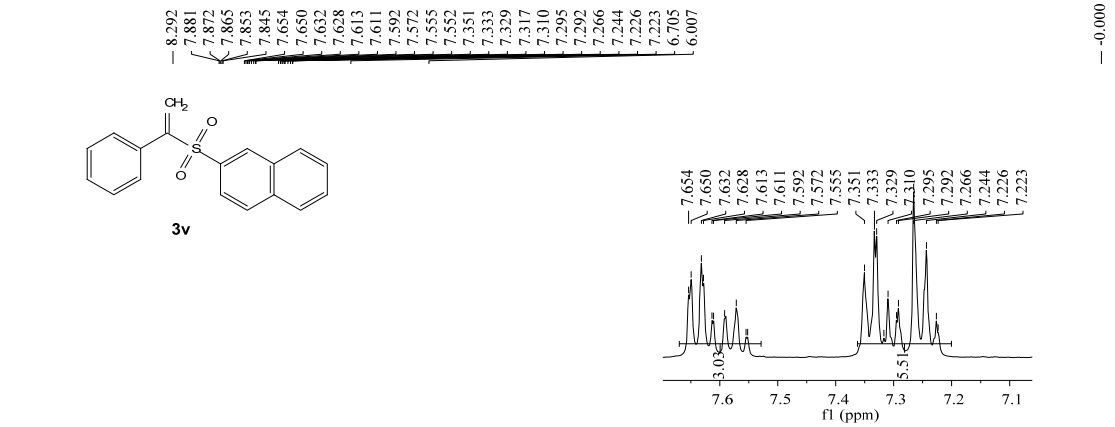
3t

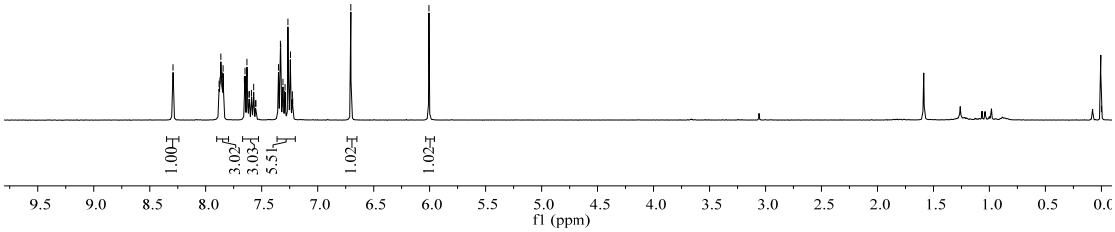

147.772
132.525
129.711
128.796
128.499
127.462
77.317
77.000
76.683
46.228
6.902
O
S
O
CH3
CH2
f1 (ppm)

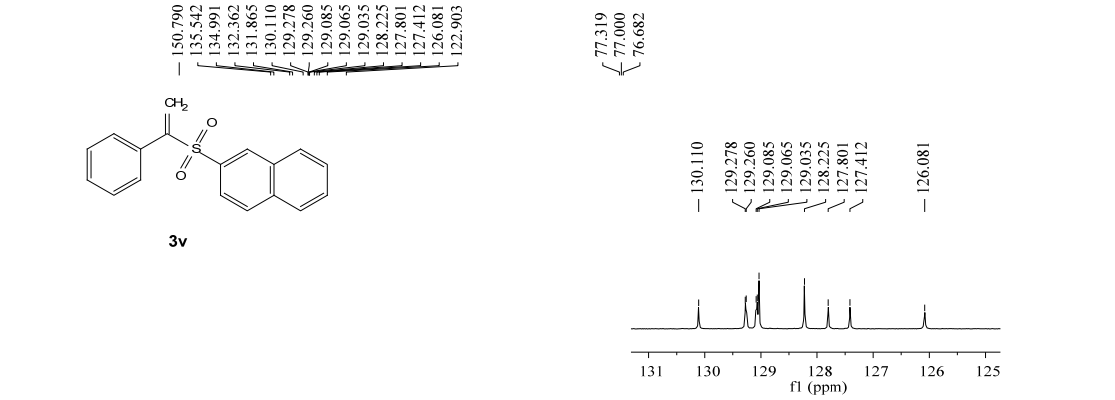
3t

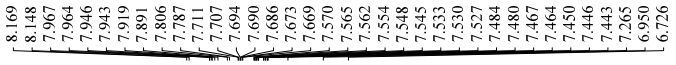

7.613
7.599
7.417
7.402
7.266
6.420
5.940
2.249
2.237
2.229
2.218
2.209
1.117
1.113
1.111
1.108
0.898
0.894
0.881
0.002
3u
5.03
1.00
1.01
1.00
2.02
2.11
f1 (ppm)

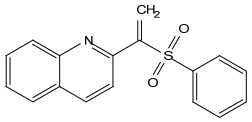

149.617
132.847
129.446
128.885
128.518
125.226
77.319
77.001
76.682
29.425
5.408
3u
f1 (ppm)


8.292
7.881
7.872
7.865
7.853
7.845
7.654
7.650
7.632
7.628
7.613
7.611
7.592
7.572
7.555
7.552
7.351
7.333
7.329
7.317
7.310
7.295
7.292
7.266
7.244
7.226
7.223
6.705
6.007
-0.000
3v
7.654
7.650
7.632
7.628
7.613
7.611
7.592
7.572
7.555
7.351
7.333
7.329
7.310
7.295
7.292
7.266
7.244
7.226
7.223
3.03
5.51
7.6
7.5
7.4
7.3
7.2
7.1
f1 (ppm)

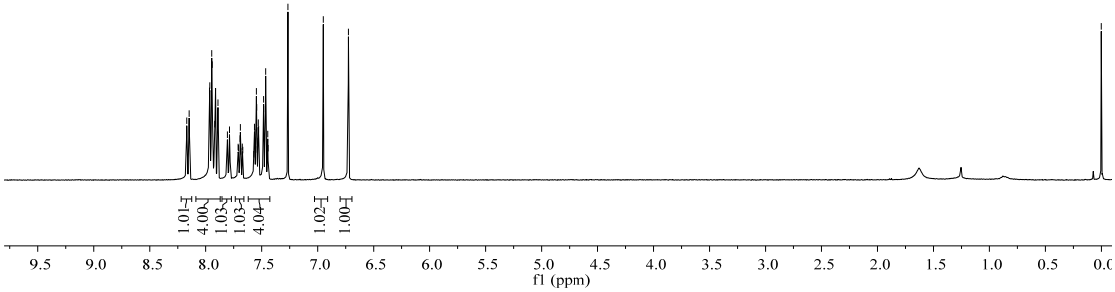

1.00
3.02
3.03
5.51
1.02
1.02
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

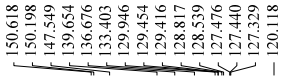

150.790
135.542
134.991
132.362
131.865
130.110
129.278
129.260
129.085
129.065
129.035
128.225
127.801
127.412
126.081
122.903
77.319
77.000
76.682
3v
130.110
129.278
129.260
129.085
129.065
129.035
128.225
127.801
127.412
126.081
131
130
129
128
127
126
125
f1 (ppm)
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


8.169
8.148
7.967
7.964
7.946
7.943
7.919
7.891
7.806
7.787
7.711
7.707
7.694
7.690
7.686
7.673
7.669
7.570
7.565
7.562
7.554
7.548
7.545
7.533
7.530
7.527
7.484
7.480
7.467
7.464
7.450
7.446
7.443
7.265
6.950
6.726
0.001

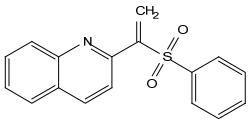

CH2
N
S
O
O

3w

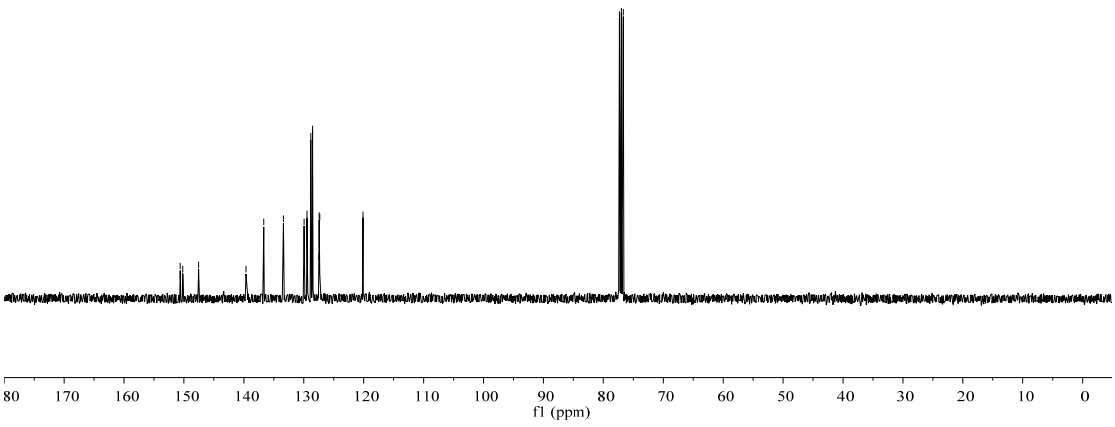

1.01
4.00
1.03
1.03
4.04
1.02
1.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

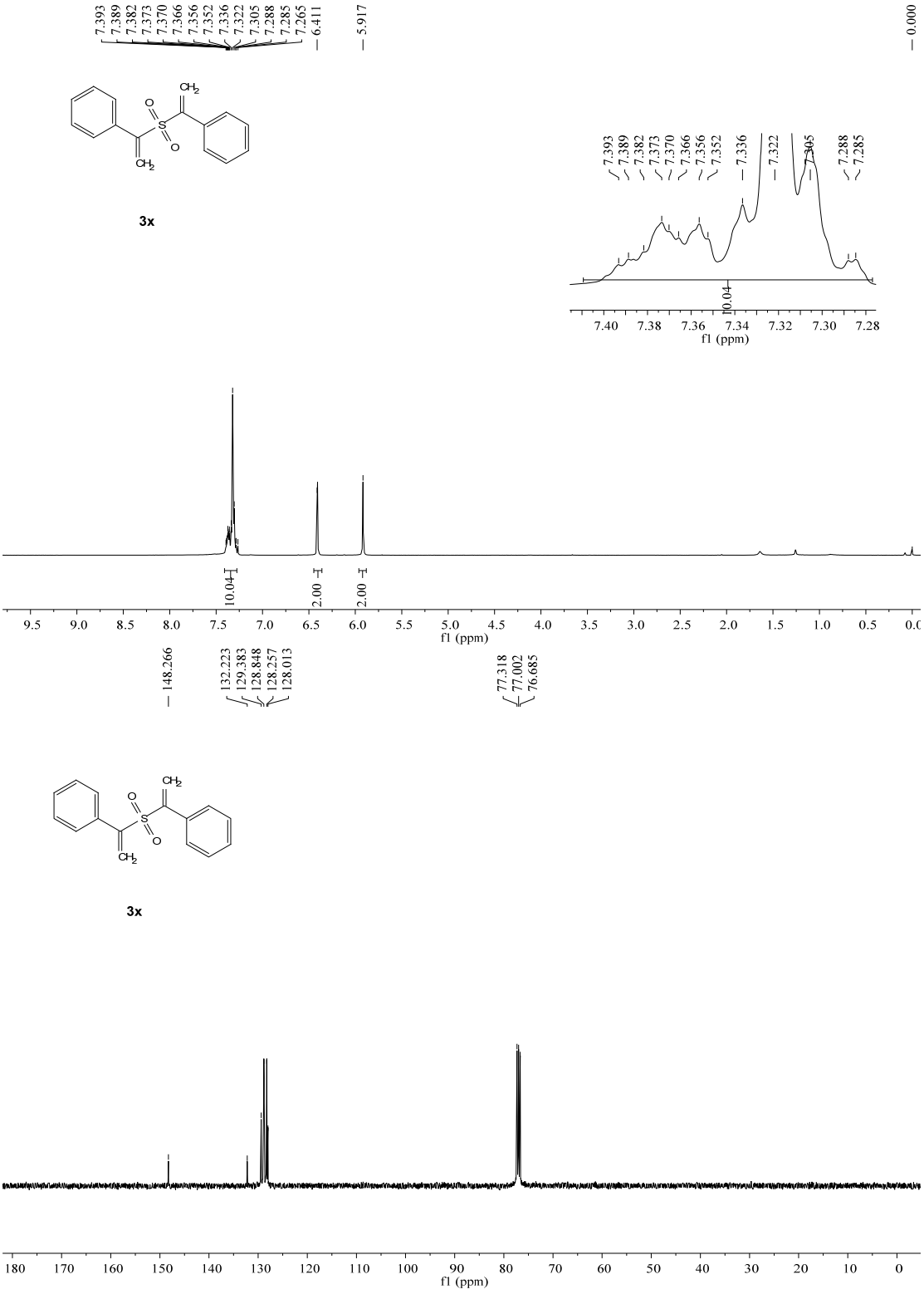

150.618
150.198
147.549
139.654
136.676
133.403
129.946
129.454
129.416
128.817
128.539
127.476
127.440
127.329
120.118


77.317
77.000
76.682


CH2
N
S
O
O

3w


80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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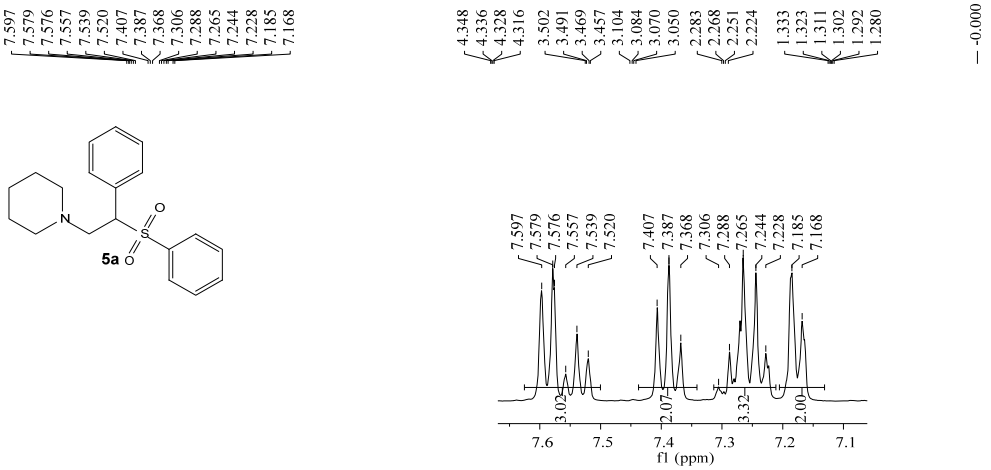
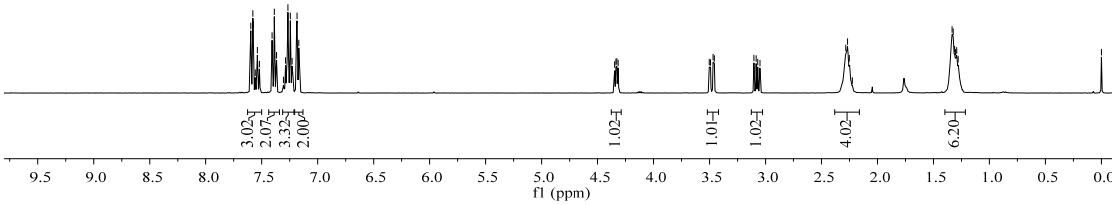
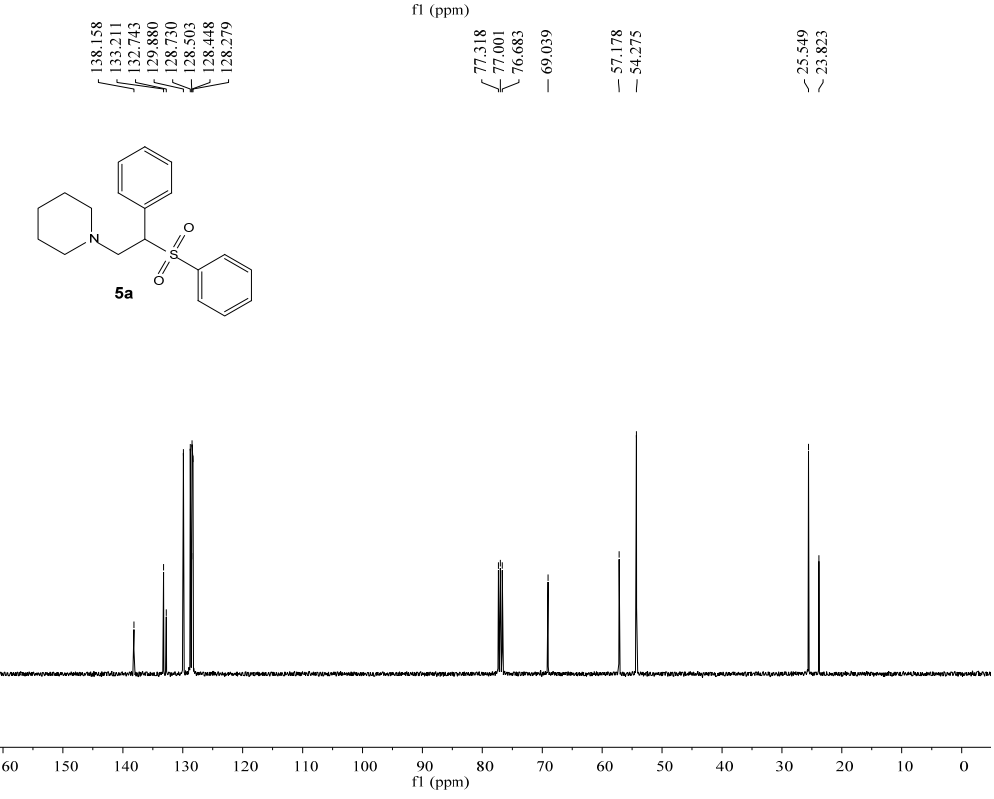
7.382
7.373
7.370
7.366
7.356
7.352
7.336
7.322
7.305
7.288
7.285
7.265
6.411
5.917
0.000
CH2
O
S
O
CH2
3x
10.04
2.00
2.00
fl (ppm)
148.266
132.223
129.383
128.848
128.257
128.013
77.318
77.002
76.685
3x
fl (ppm)


7.597
7.579
7.576
7.557
7.539
7.520
7.407
7.387
7.368
7.306
7.288
7.265
7.244
7.228
7.185
7.168
4.348
4.336
4.328
4.316
3.502
3.491
3.469
3.457
3.104
3.084
3.070
3.050
2.283
2.268
2.251
2.224
1.333
1.323
1.311
1.302
1.292
1.280
-0.000
5a
3.02
2.07
3.32
2.00
fl (ppm)


3.02
2.07
3.32
2.00
1.02
1.01
1.02
4.02
6.20
fl (ppm)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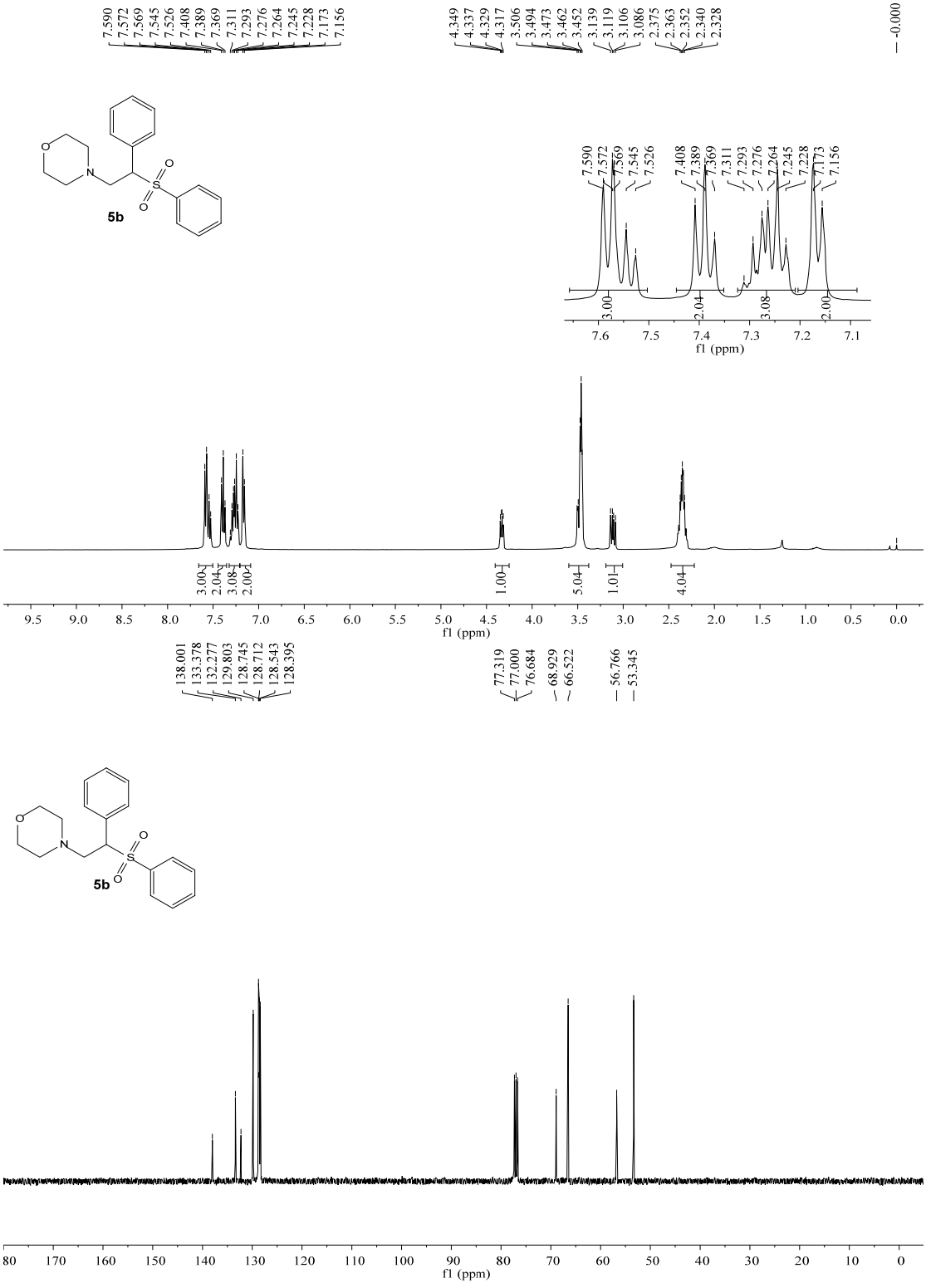
129.880
128.730
128.503
128.448
128.279
77.318
77.001
76.683
69.039
57.178
54.275
25.549
23.823
5a
fl (ppm)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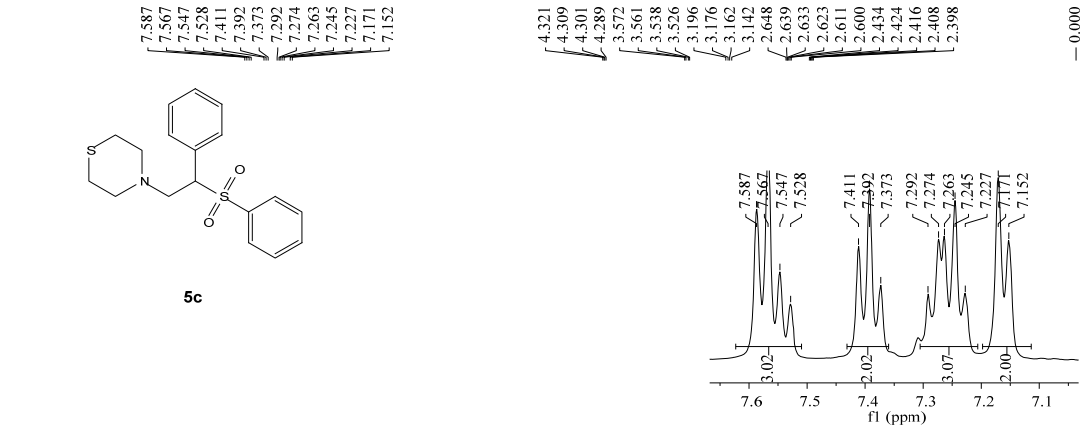
7.572
7.569
7.545
7.526
7.408
7.389
7.369
7.311
7.293
7.276
7.264
7.245
7.228
7.173
7.156
4.349
4.337
4.329
4.317
3.506
3.494
3.473
3.462
3.452
3.139
3.119
3.106
3.086
2.375
2.363
2.352
2.340
2.328
-0.000
5b
3.00
2.04
3.08
2.00
1.00
5.04
1.01
4.04
f1 (ppm)
138.001
133.378
132.277
129.803
128.745
128.712
128.543
128.395
77.319
77.000
76.684
68.929
66.522
56.766
53.345
5b
f1 (ppm)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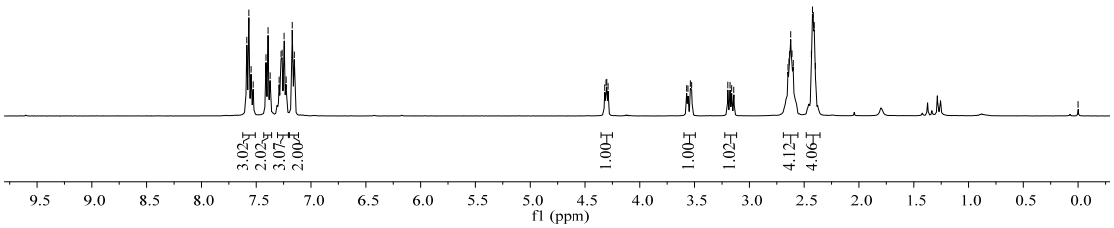
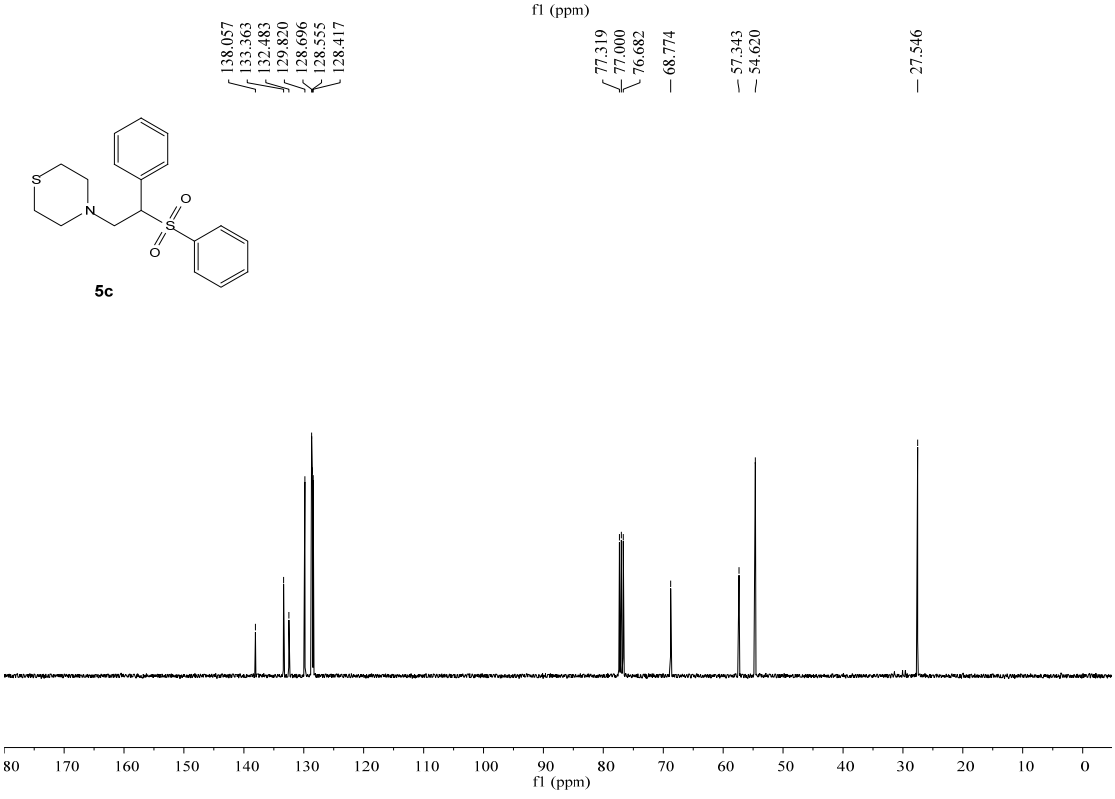
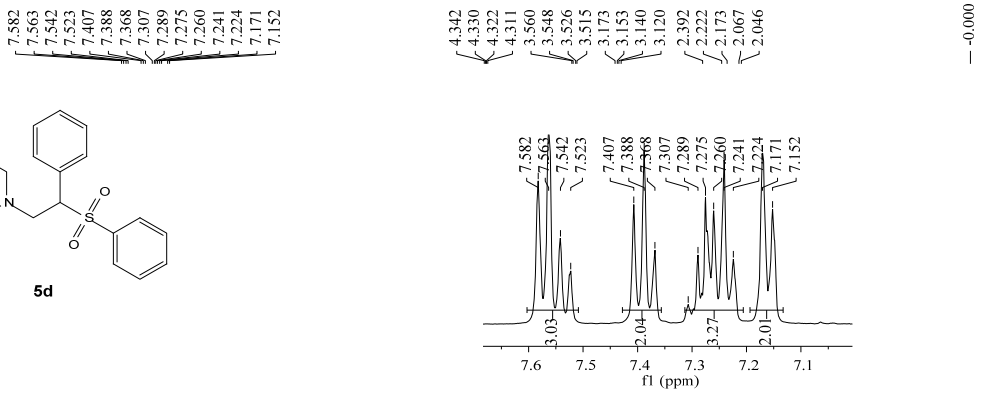
7.547
7.528
7.411
7.392
7.373
7.292
7.274
7.263
7.245
7.227
7.171
7.152
4.321
4.309
4.301
4.289
3.572
3.561
3.538
3.526
3.196
3.176
3.162
3.142
2.648
2.639
2.633
2.623
2.611
2.600
2.434
2.424
2.416
2.408
2.398
0.000
S
N
O
S
O
5c
3.02
2.02
3.07
2.00
7.6
7.5
7.4
7.3
7.2
7.1
f1 (ppm)


3.02
2.02
3.07
2.00
1.00
1.00
1.02
4.12
4.06
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


138.057
133.363
132.483
129.820
128.696
128.555
128.417
77.319
77.000
76.682
68.774
57.343
54.620
27.546
S
N
O
S
O
5c
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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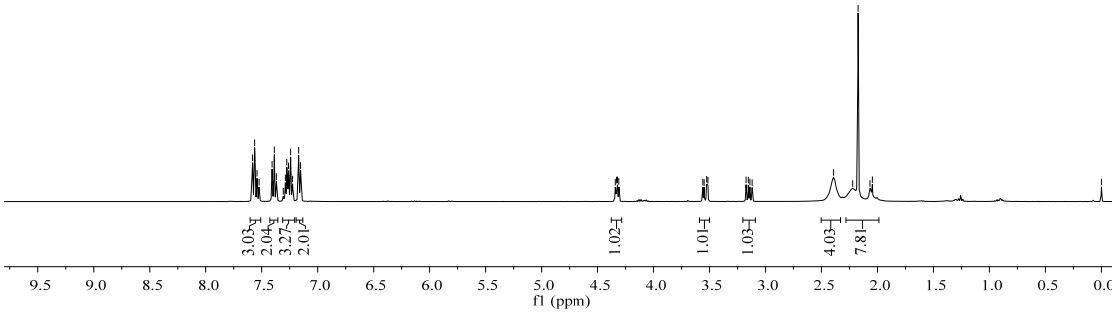
7.563
7.542
7.523
7.407
7.388
7.368
7.307
7.289
7.275
7.260
7.241
7.224
7.171
7.152
4.342
4.330
4.322
4.311
3.560
3.548
3.526
3.515
3.173
3.153
3.140
3.120
2.392
2.222
2.173
2.067
2.046
-0.000
H3C
N
N
O
S
O
5d
3.03
2.04
3.27
2.01
7.6
7.5
7.4
7.3
7.2
7.1
f1 (ppm)


3.03
2.04
3.27
2.01
1.02
1.01
1.03
4.03
7.81
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
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5.0
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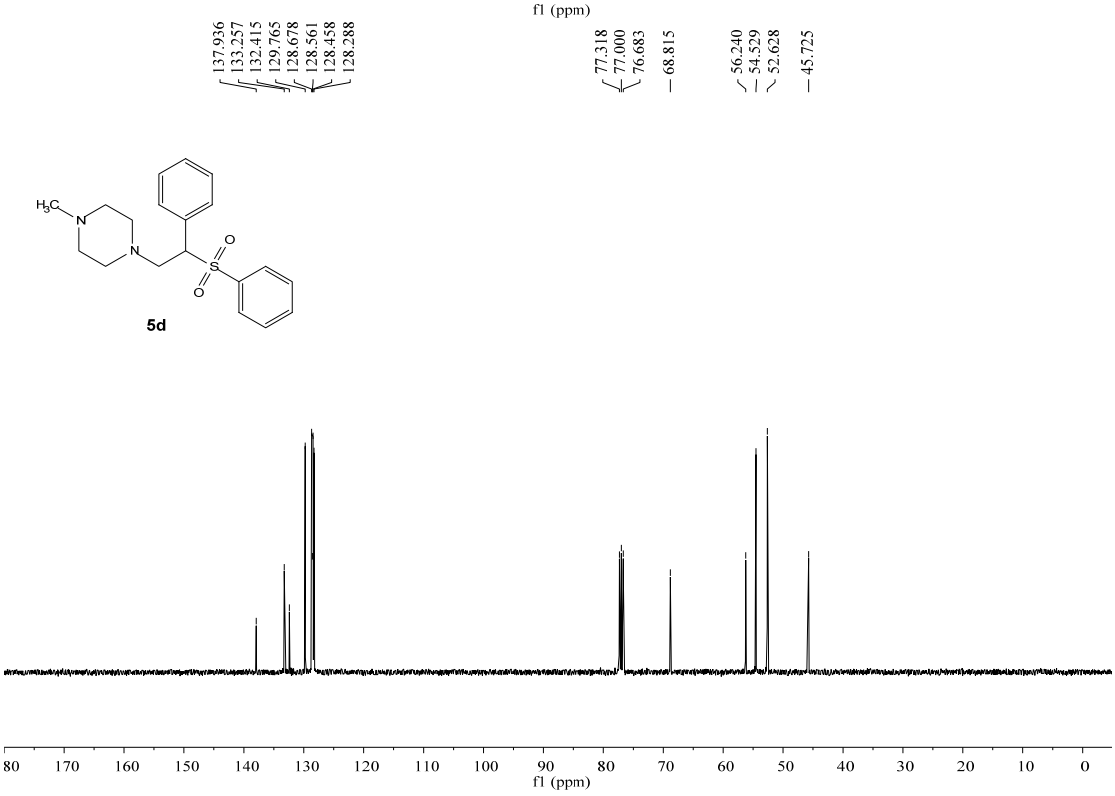
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)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129.765
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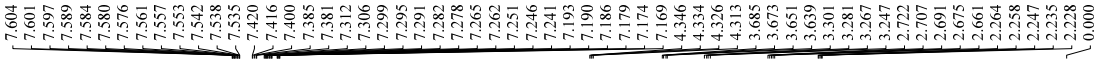
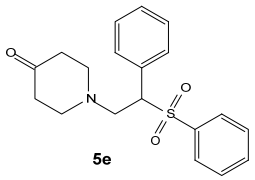
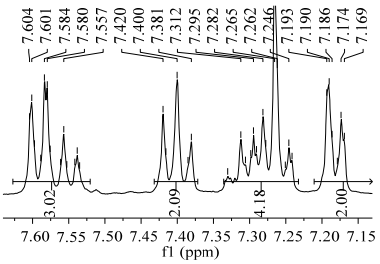
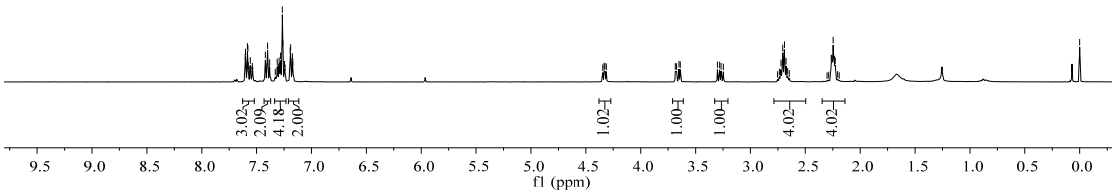
128.561
128.458
128.288
77.318
77.000
76.683
68.815
56.240
54.529
52.628
45.725
H3C
N
N
O
S
O
5d
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.604
7.601
7.597
7.589
7.584
7.580
7.576
7.561
7.557
7.553
7.542
7.538
7.535
7.420
7.416
7.400
7.385
7.381
7.312
7.306
7.299
7.295
7.291
7.282
7.278
7.265
7.262
7.251
7.246
7.241
7.193
7.190
7.186
7.179
7.174
7.169
4.346
4.334
4.326
4.313
3.685
3.673
3.651
3.639
3.301
3.281
3.267
3.247
2.722
2.707
2.691
2.675
2.661
2.264
2.258
2.247
2.235
2.228
0.000

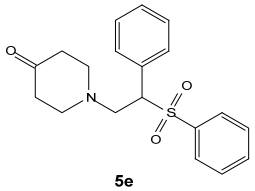

O
N
O
S
O
O

5e

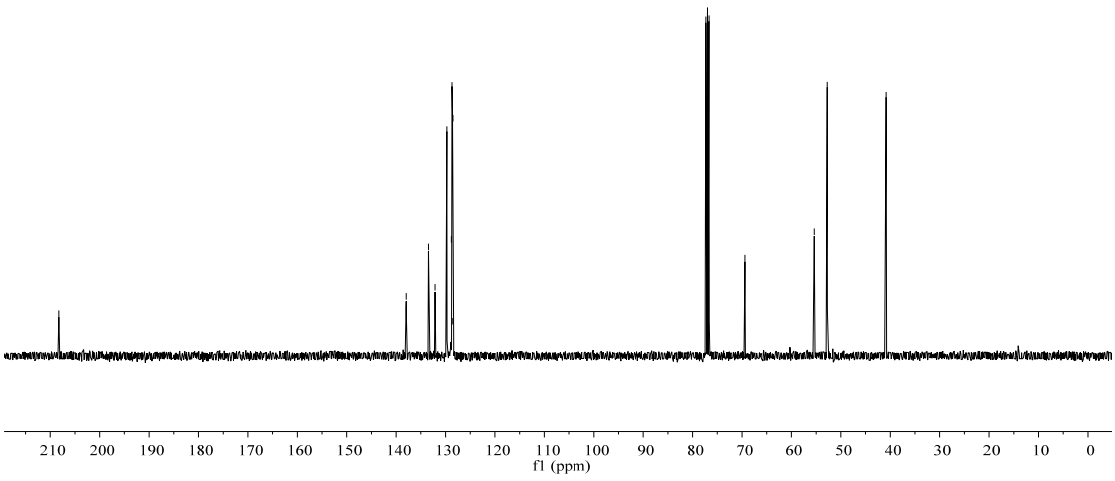

7.604
7.601
7.584
7.580
7.557
7.420
7.400
7.381
7.312
7.295
7.282
7.265
7.262
7.246
7.193
7.190
7.186
7.174
7.169
3.02
2.09
4.18
2.00
7.60 7.55 7.50 7.45 7.40 7.35 7.30 7.25 7.20 7.15
f1 (ppm)

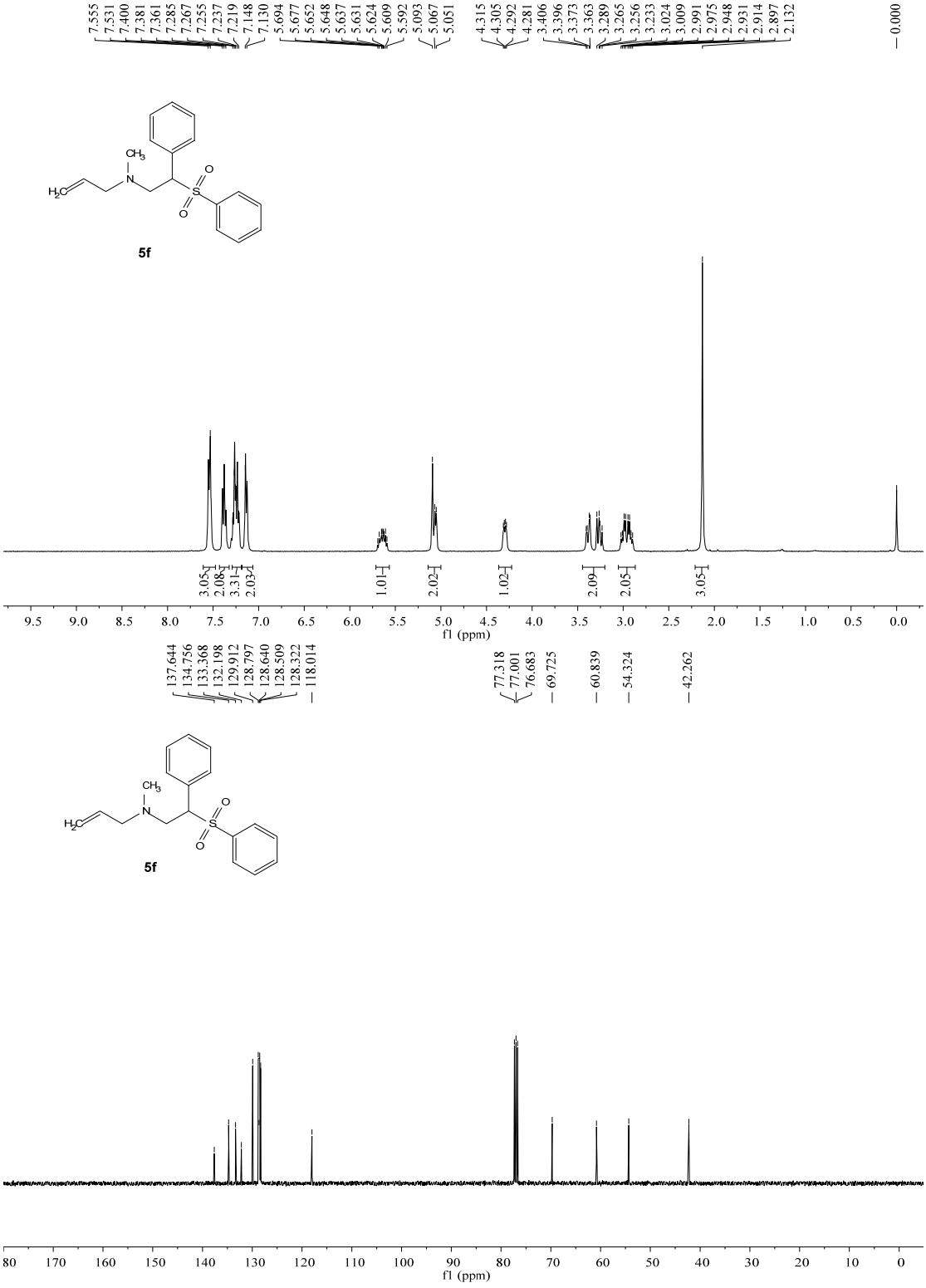

3.02
2.09
4.18
2.00
1.02
1.00
1.00
4.02
4.02
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

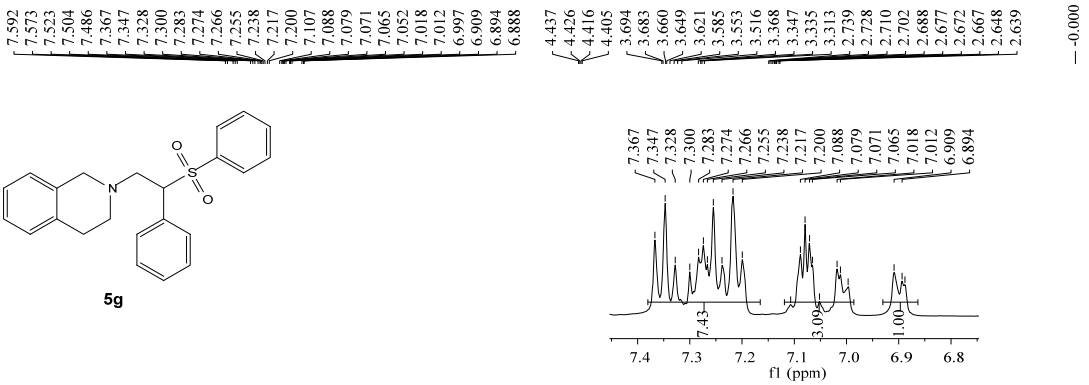

208.251
137.953
133.458
132.117
129.738
128.838
128.704
128.586
128.538
128.493
77.318
77.000
76.682
69.420
55.369
52.747
40.832


O
N
O
S
O
O

5e

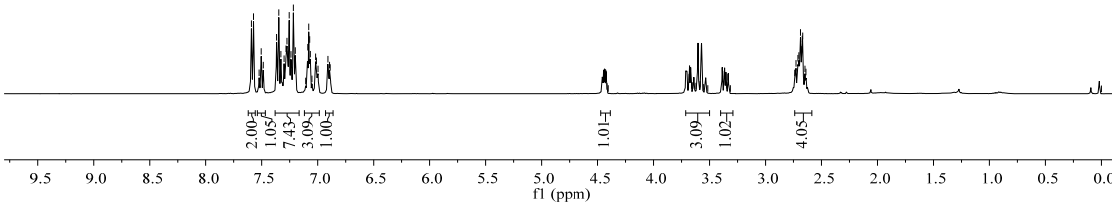

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

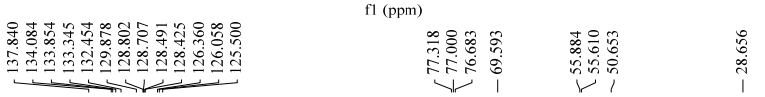

7.555
7.531
7.400
7.381
7.361
7.285
7.267
7.255
7.237
7.219
7.148
7.130
5.694
5.677
5.652
5.648
5.637
5.631
5.624
5.609
5.592
5.093
5.067
5.051
4.315
4.305
4.292
4.281
3.406
3.396
3.373
3.363
3.289
3.265
3.256
3.233
3.024
3.009
2.991
2.975
2.948
2.931
2.914
2.897
2.132
0.000
CH3
N
H2C
S
O
O
5f
3.05
2.08
3.31
2.03
1.01
2.02
1.02
2.09
2.05
3.05
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
137.644
134.756
133.368
132.198
129.912
128.797
128.640
128.509
128.322
118.014
77.318
77.001
76.683
69.725
60.839
54.324
42.262
CH3
N
H2C
S
O
O
5f
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

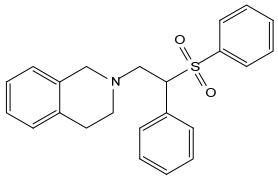

7.592
7.573
7.523
7.504
7.486
7.367
7.347
7.328
7.300
7.283
7.274
7.266
7.255
7.238
7.217
7.200
7.107
7.088
7.079
7.071
7.065
7.052
7.018
7.012
6.997
6.909
6.894
6.888
4.437
4.426
4.416
4.405
3.694
3.683
3.660
3.649
3.621
3.585
3.553
3.516
3.368
3.347
3.335
3.313
2.739
2.728
2.710
2.702
2.688
2.677
2.672
2.667
2.648
2.639
-0.000

5g

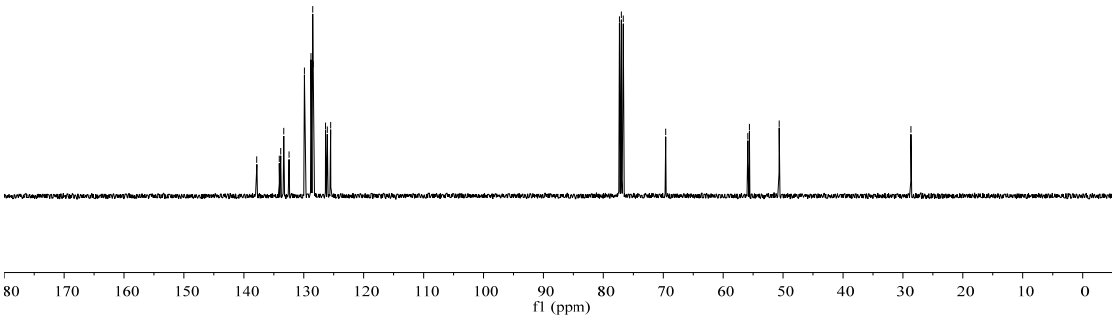
7.367
7.347
7.328
7.300
7.283
7.274
7.266
7.255
7.238
7.217
7.200
7.088
7.079
7.071
7.065
7.018
7.012
6.909
6.894
7.43
3.09
1.00
7.4
7.3
7.2
7.1
7.0
6.9
6.8
f1 (ppm)

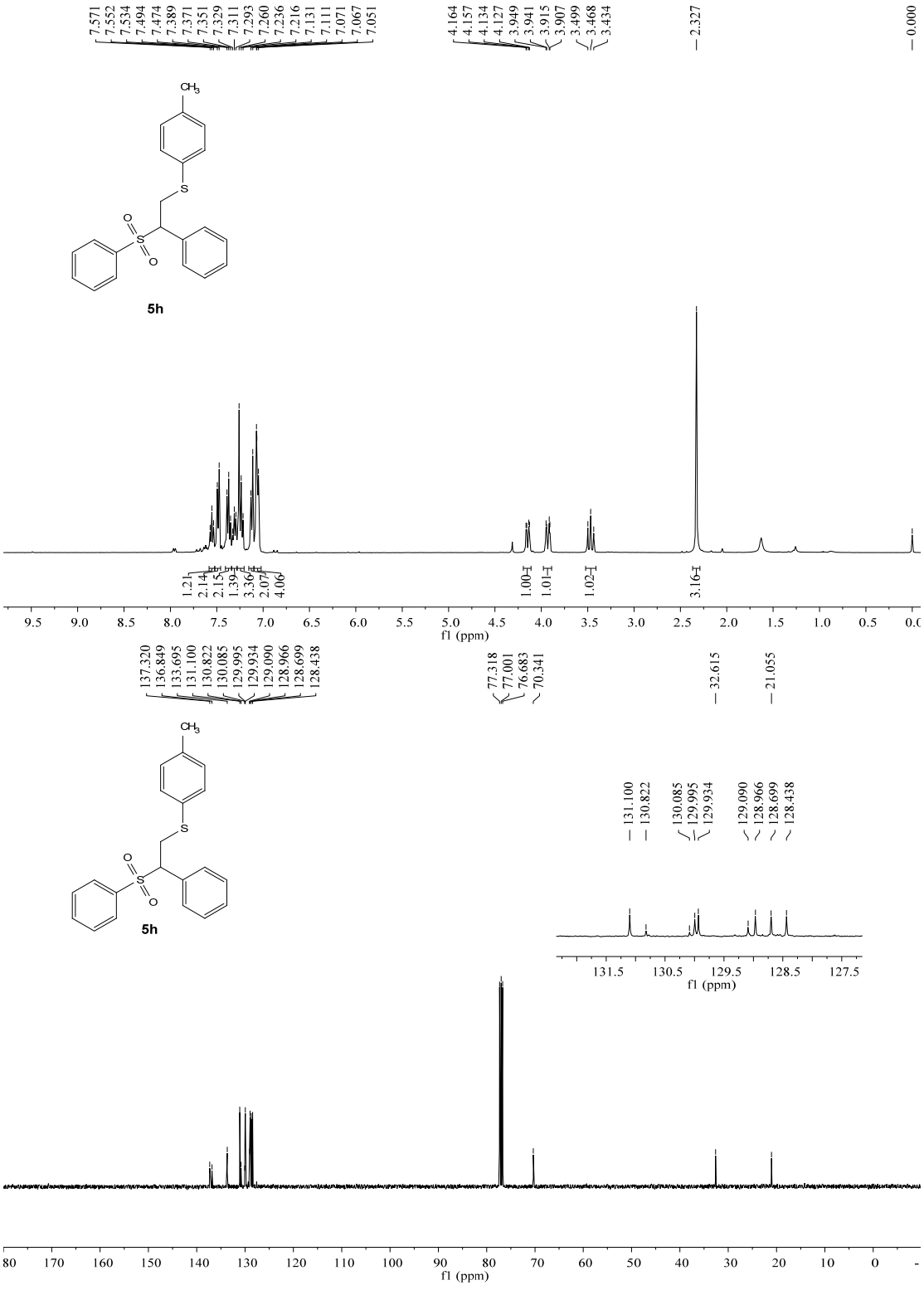

2.00
1.05
7.43
3.09
1.00
1.01
3.09
1.02
4.05
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

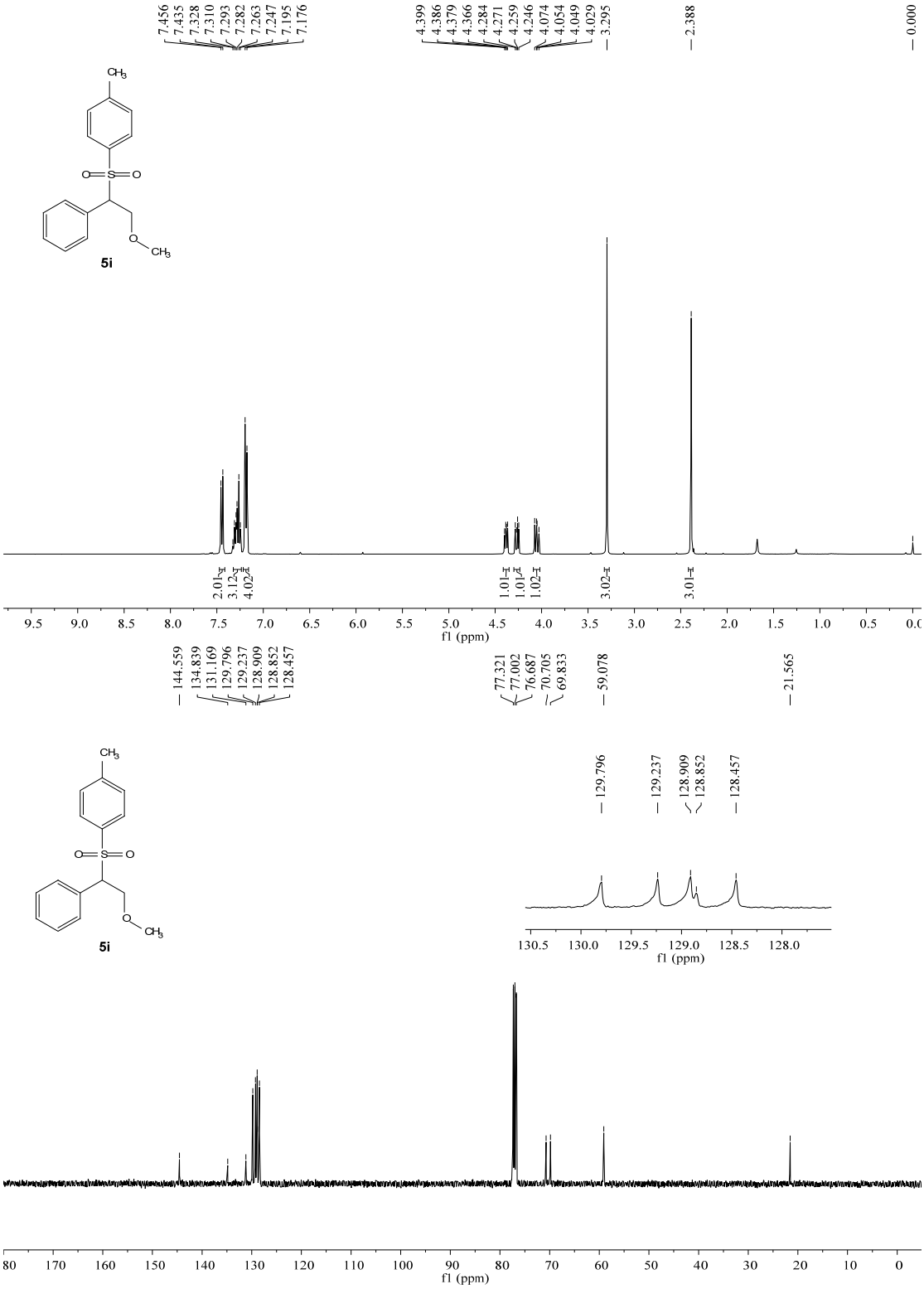

137.840
134.084
133.854
133.345
132.454
129.878
128.802
128.707
128.491
128.425
126.360
126.058
125.500
77.318
77.000
76.683
69.593
55.884
55.610
50.653
28.656

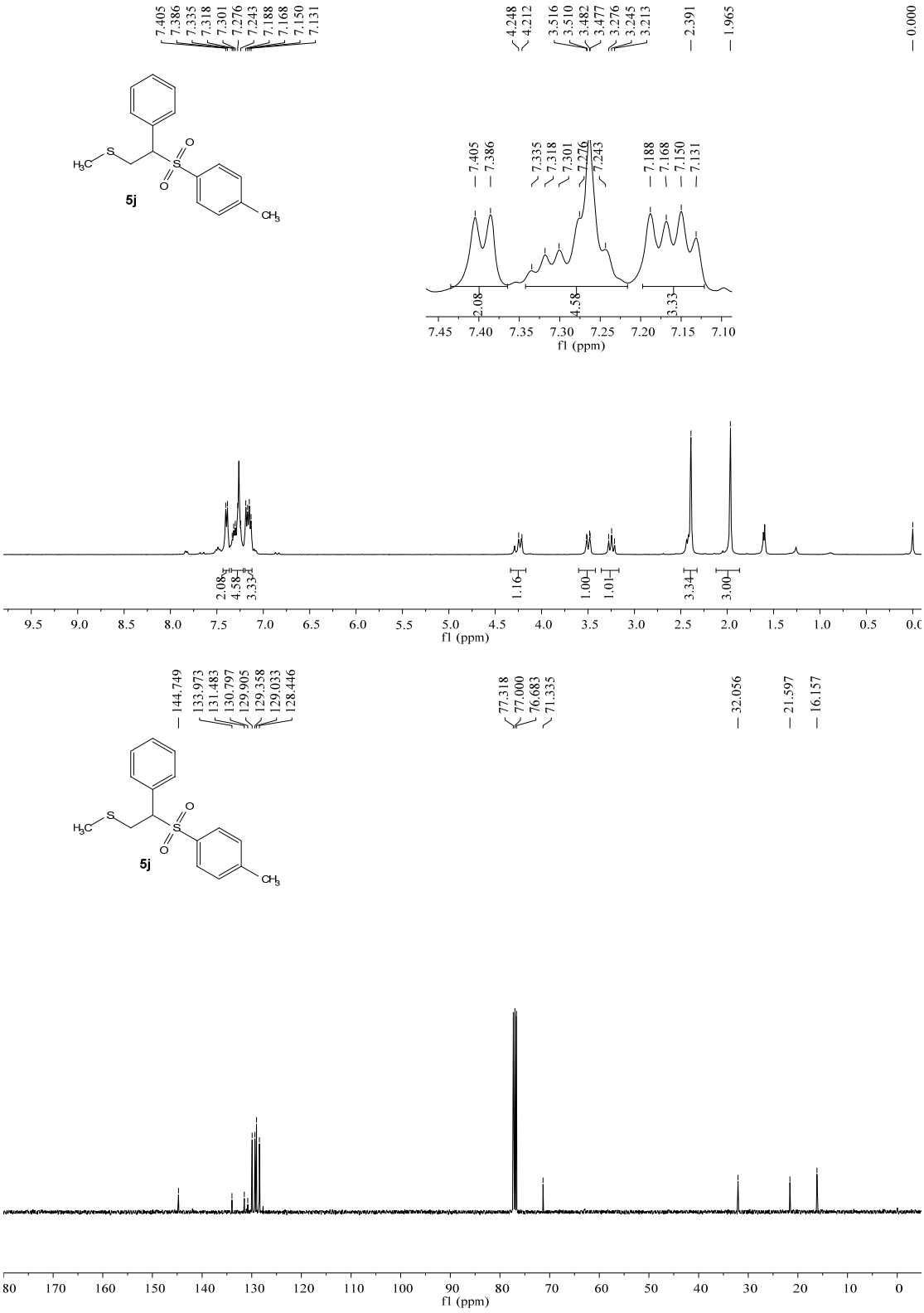


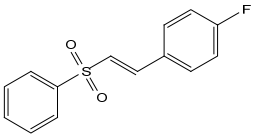
5g


80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.571
7.552
7.534
7.494
7.474
7.389
7.371
7.351
7.329
7.311
7.293
7.260
7.236
7.216
7.131
7.111
7.071
7.067
7.051
4.164
4.157
4.134
4.127
3.949
3.941
3.915
3.907
3.499
3.468
3.434
2.327
0.000
CH3
S
O
S
O
5h
1.21
2.14
2.15
1.39
3.36
2.07
4.06
1.00
1.01
1.02
3.16
fl (ppm)
137.320
136.849
133.695
131.100
130.822
130.085
129.995
129.934
129.090
128.966
128.699
128.438
77.318
77.001
76.683
70.341
32.615
21.055
131.100
130.822
130.085
129.995
129.934
129.090
128.966
128.699
128.438
fl (ppm)

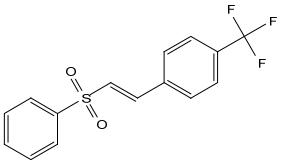

7.456
7.435
7.328
7.310
7.293
7.282
7.263
7.247
7.195
7.176
4.399
4.386
4.379
4.366
4.284
4.271
4.259
4.246
4.074
4.054
4.049
4.029
3.295
2.388
0.000
5i
2.01
3.12
4.02
1.01
1.01
1.02
3.02
3.01
f1 (ppm)
144.559
134.839
131.169
129.796
129.237
128.909
128.852
128.457
77.321
77.002
76.687
70.705
69.833
59.078
21.565
5i
f1 (ppm)
f1 (ppm)


7.405
7.386
7.335
7.318
7.301
7.276
7.243
7.188
7.168
7.150
7.131
4.248
4.212
3.516
3.510
3.482
3.477
3.276
3.245
3.213
2.391
1.965
0.000
5j
2.08
4.58
3.33
1.16
1.00
1.01
3.34
3.00
f1 (ppm)
144.749
133.973
131.483
130.797
129.905
129.358
129.033
128.446
77.318
77.000
76.683
71.335
32.056
21.597
16.157
5j
f1 (ppm)


F
O
S
O

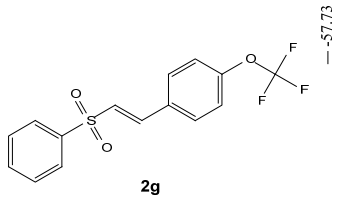
2c

-107.66
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


F
F
F
O
S
O

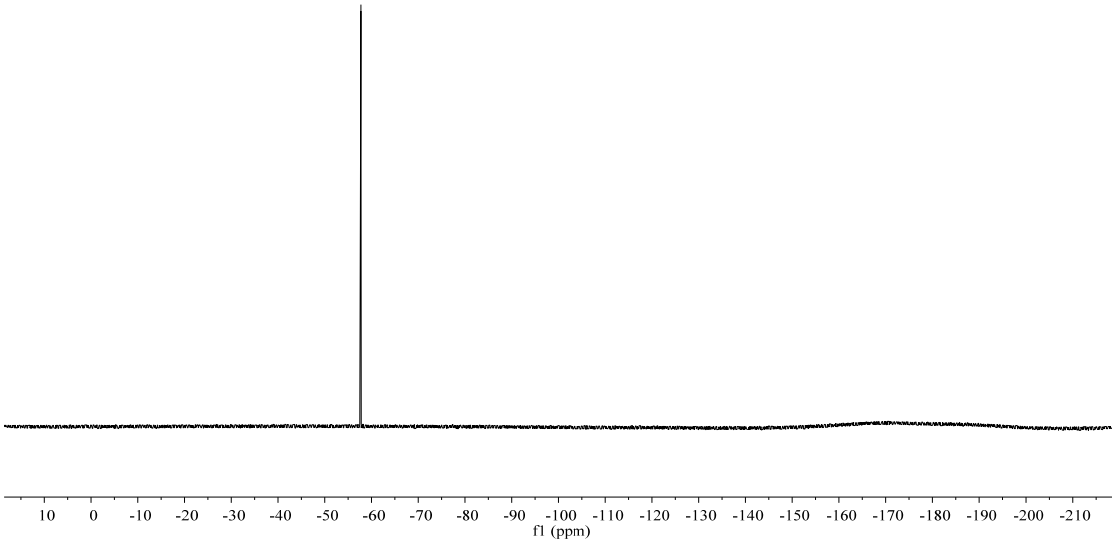
2f

-62.98
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

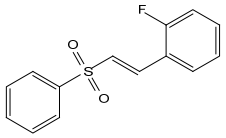


-57.73

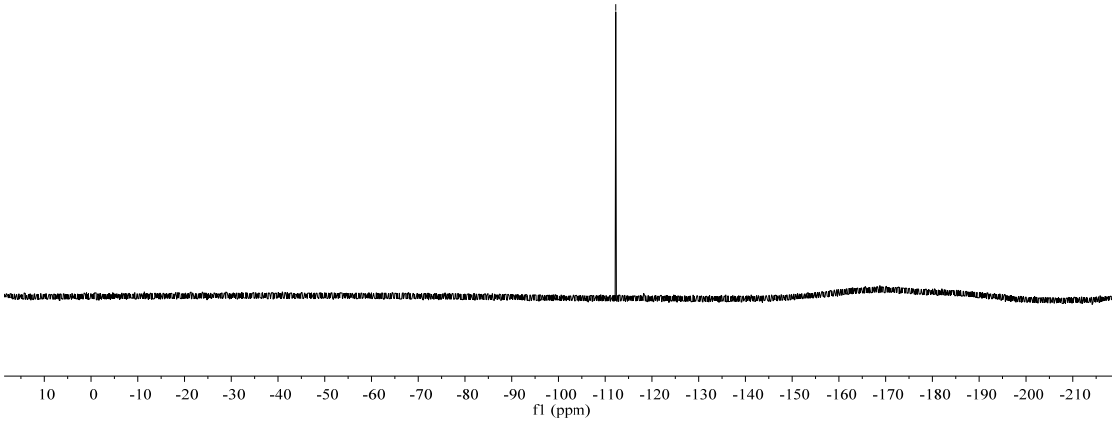
2g

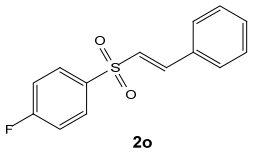


-112.26



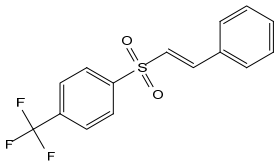
2j





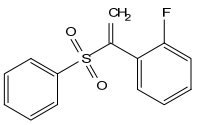
2o

-103.89
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)



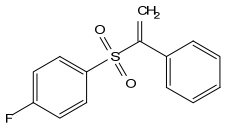
2r

-63.15
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)



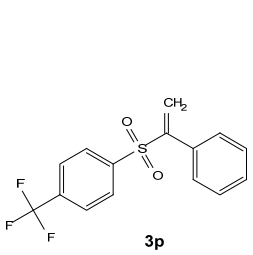
3h

-114.99
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)



3m

-102.27
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


CH2
O
S
O
F
F
F

3p

-63.23
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)