Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information

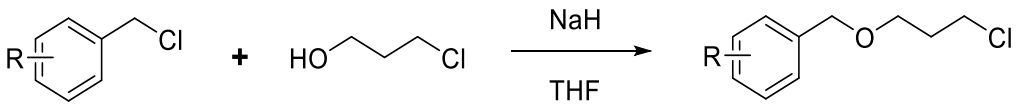
General Information

Unless otherwise noted, all chemicals used in the preparations of starting materials and in the nickel-catalyzed sulfonylation were commercially available and were used as received without further purifications. All catalytic reactions were carried out under nitrogen in reaction tubes. Column chromatography purifications were carried out using 200-300 mesh silica gel. The eluents for column chromatography and PTLC were presented as ratios of solvent volumes. Nuclear Magnetic Resonance spectra were recorded on a Bruker 400 MHz (100 MHz and 376 MHz for ^{13}C and ^{19}F, respectively) instruments at ambient temperature. All ^{1}H NMR spectra were measured in part per million (ppm) relative to the signals of tetramethylsilane (TMS, 0.00 ppm) added into the deuterated chloroform ($CDCl_3$, 7.26 ppm) unless otherwise stated. Data for ^{1}H NMR were reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, quint = quintet, m = multiplet, dd = doublet of doublets, dt = doublet of triplets, td = triplet of doublets, and br = broad signal), coupling constants, and integration. All ^{13}C NMR spectra were reported in ppm relative to tetramethylsilane (0.00 ppm) unless otherwise stated, and were obtained with complete ^{1}H decoupling. All GC analyses were performed on a Shimadzu GC-2014C with an FID detector. All GC-MS analyses were performed on a Shimadzu GCMS-QP2020NX. High-resolution mass spectra (HRMS) by electrospray ionization (ESI), atmospheric pressure chemical ionization (APCI), and atmospheric pressure photoionization (APPI) method were performed at the EPFL ISIC Mass Spectroscopy Service.

Preparation of Alkyl Chlorides

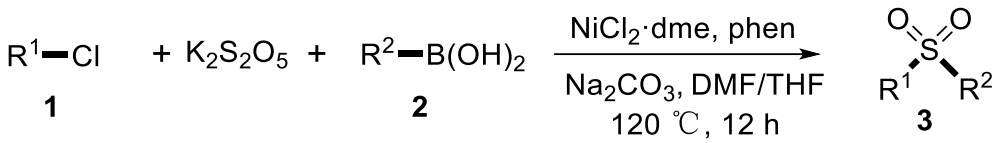
Substrates **1g**[1], **1o**[2], **1p**[2], **1r**[2] and **1s**[2] were synthesized via known method. **1l**[2], **1q**[2], **1t**[2], **1h**[3] and **1u - 1w**[3] were prepared by methods described in the references.

Preparation of Alkyl Chlorides **1i-1k**, **1m** and **1n**



A flame-dried flask was charged with benzyl chloride (5.0 mmol), 3-Chloro-1-propanol (0.52 g, 5.5 mmol, 1.1 equiv.), and DMF (10 mL) under nitrogen protection. NaH (241 mg (60 % dispersion in mineral oil), 10 mmol, 2 equiv.) was added in batches at 0 ºC, and the mixture was stirred for 2 hours. Then the mixture was allowed to warm to room temperature, and stirred for 4h after being added with NaH (0.5 mmol). The mixture was then quenched with ice water and extracted with ethyl acetate (3 x 25 mL). The combined organic phase was washed with water, and brine and dried with anhydrous Na_2SO_4, concentrated in vacuum. Purification by column chromatography affords desired product.

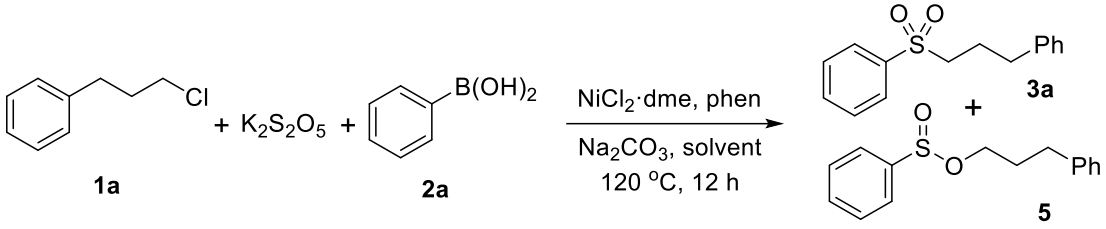
General Procedure for Nickel-Catalyzed Sulfonylation



An oven-dried 15 mL re-sealable screw-cap test tube equipped with a Teflon-coated magnetic stir bar was sequentially charged with phenylboronic acids **2** (1.2 equiv.), $K_2S_2O_5$ (1.1 equiv.), Na_2CO_3 (0.5 equiv.), $NiCl_2$·dme (10 mol%), 1,10-phenanthroline (15 mol%) in the glovebox. Then 1.5 mL DMF and 0.5 mL THF, alkyl chlorides **1** (0.2 mmol) were added into the tube in turn. All these procedures were conducted in the glovebox. The vial was sealed with a screw cap and removed from the glove box. Then the vial was placed on a heating base and irradiated at 120 °C for 12 h. After that, the vial was removed from the heating source and cooled to room temperature. The crude reaction mixture was then diluted with water (20 mL) and subsequently extracted with ethyl acetate (EA, 3 x 10 mL). The organic fractions were combined, washed with brine (1 x 10 mL), dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The crude product residue was purified by flash column chromatography using a solvent mixture (EA, petroleum ether) as an eluent to afford the purified product.

Summary of the effects of reaction parameters and conditions on the reaction efficiency

Table S1. Screening of Solvents

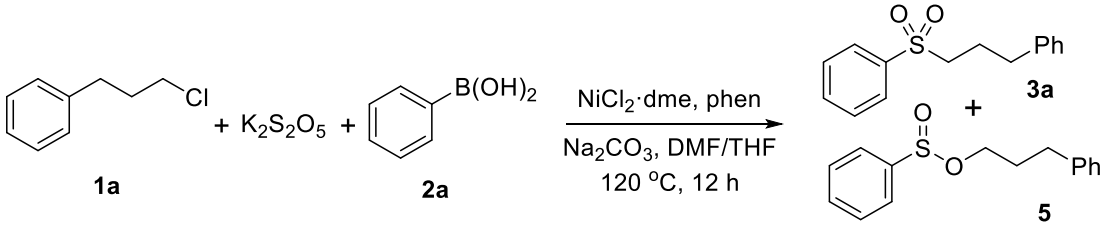


1a 2a

Entry	Solvent	**3a** Yield (%)[a]	**5** Yield (%)[a]
1	DMF 2 mL	75	9
2	DMA 2 mL	45	4
3	DMSO 2 mL	20	N.D.
4	NMP 2 mL	73	8
5	MeCN 2 mL	33	Trace
6	DCE 2 mL	Trace	N.D.
7	DMF/THF 1.5/0.5 mL	81	12
8	DMF/dioxane 1.5/0.5 mL	79	9

Reaction conditions： **1a** (0.2 mmol), $K_2S_2O_5$ (1.1 eq.), **2a** (1.5 eq.), $NiCl_2$·dme (10 mol%), 1,10-phenanthroline (15 mol%), Na_2CO_3 (2 eq.) and solvent, 12 h, 120 °C. [a] The yields were detected by GC using naphthalene as an internal standard.

Table S2. Screening of Temperatures

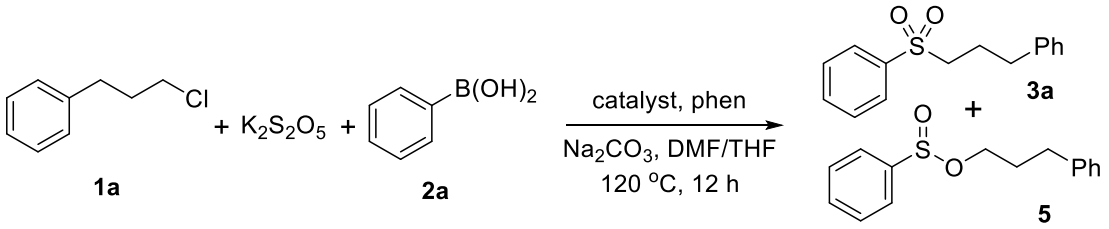


1a 2a

Entry	T / °C	**3a** Yield (%)[a]	**5** Yield (%)[a]
1	100	40	5
2	110	56	7
3	120	78	9

Reaction conditions： **1a** (0.2 mmol), $K_2S_2O_5$ (1.1 eq.), **2a** (1.5 eq.), $NiCl_2$·dme (10 mol%), 1,10-phenanthroline (15 mol%), Na_2CO_3 (2 eq.) and DMF/THF (1.5/0.5 mL), 12 h, T. [a] The yields were detected by GC using naphthalene as an internal standard.

Table S3. Screening of Transition Mental Catalysts

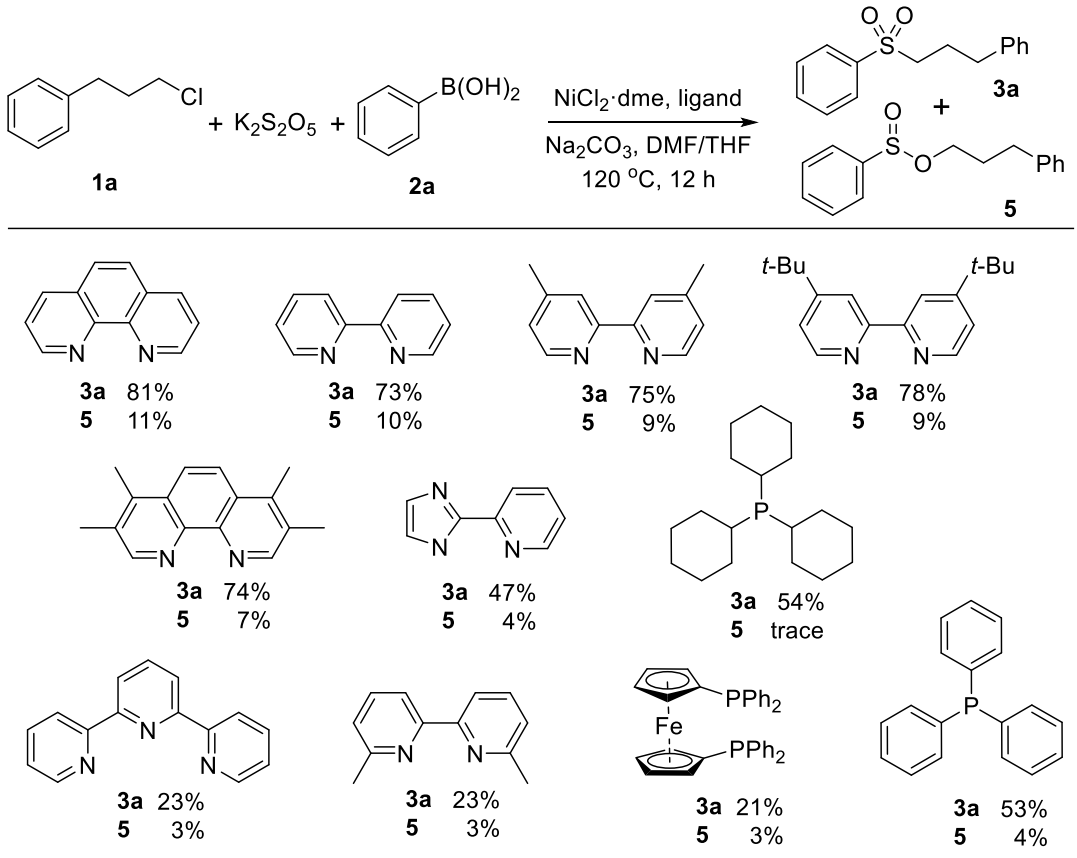


1a **2a**

Entry	Catalyst	**3a** Yield (%)[a]	**5** Yield (%)[a]
1	$NiCl_2$	82	11
2	$NiCl_2$·dme	84	11
3	$NiBr_2$	63	7
4	$NiBr_2$·dme	30	N.D.
5	NiI_2	35	N.D.
6	$Ni(acac)_2$	14	2
7	$Co(OAc)_2$	33	3
8	$CoBr_2$	59	2
9	$Cu(OAc)_2$	28	3
10	$CuBr_2$	7	trace
8	$FeBr_3$	36	trace

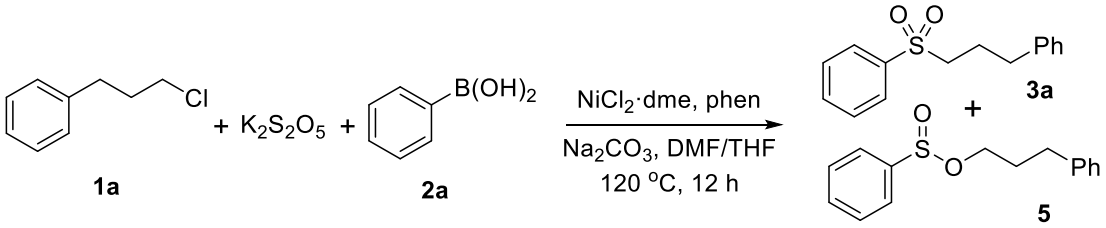
Reaction conditions： **1a** (0.2 mmol), $K_2S_2O_5$ (1.1 eq.), **2a** (1.5 eq.), catalyst (10 mol%), 1,10-phenanthroline (15 mol%), Na_2CO_3 (2 eq.) and DMF/THF (1.5/0.5 mL), 12 h, 120 °C. [a] The yields were detected by GC using naphthalene as an internal standard.

Table S4. Screening of Ligands



Reaction conditions: **1a** (0.2 mmol), $K_2S_2O_5$ (1.1 eq.), **2a** (1.5 eq.), $NiCl_2$·dme (10 mol%), ligand (15 mol%), Na_2CO_3 (2 eq.) and DMF/THF (1.5 mL/0.5 mL), 12 h, 120 °C. [a] The yields were detected by GC using naphthalene as an internal standard.

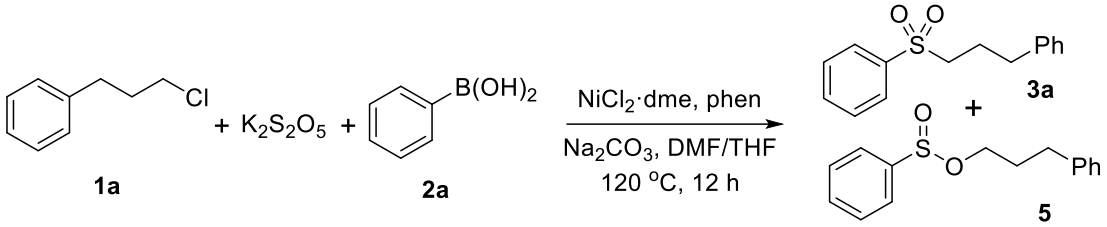
Table S5. Screening of Equivalent of $K_2S_2O_5$



Entry	The amount of $K_2S_2O_5$	**3a** Yield (%)[a]	**5** Yield (%)[a]
1	1 eq.	66	7
2	1.1 eq.	80	10
3	1.2 eq.	78	9
4	1.5 eq.	79	7

Reaction conditions： **1a** (0.2 mmol), $K_2S_2O_5$, **2a** (1.5 eq.), $NiCl_2$·dme (10 mol%), 1,10-phenanthroline (15 mol%), Na_2CO_3 (2 eq.) and DMF/THF (1.5/0.5 mL), 12 h, 120 °C. [a] The yields were detected by GC using naphthalene as an internal standard.

Table S6. Screening of Equivalent of **2a**

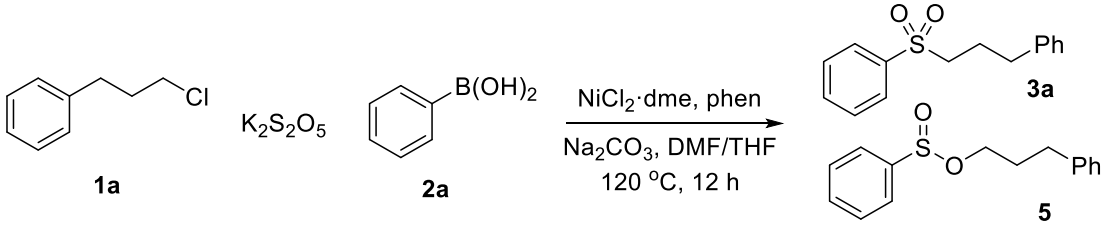


1a **2a**

Entry	The amount of **2a**	**3a** Yield (%)[a]	**5** Yield (%)[a]
1	1 eq.	75	8
2	1.2 eq.	80	10
3	1.5 eq.	83	10

Reaction conditions： **1a** (0.2 mmol), $K_2S_2O_5$, **2a** (1.5 eq.), $NiCl_2$·dme (10 mol%), 1,10-phenanthroline (15 mol%), Na_2CO_3 (2 eq.) and DMF/THF (1.5/0.5 mL), 12 h, 120 °C. [a] The yields were detected by GC using naphthalene as an internal standard.

Table S7. Screening of Bases

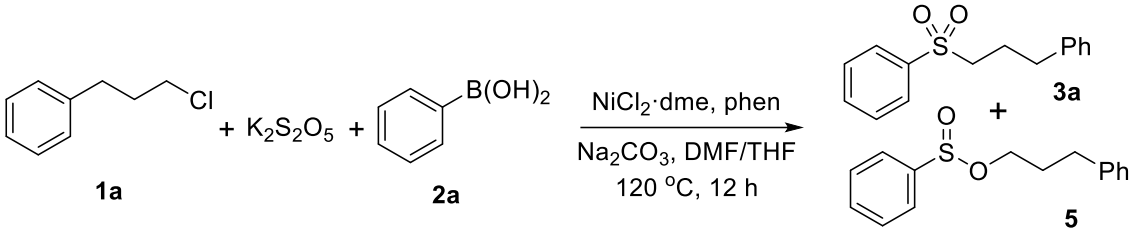


1a **2a**

Entry	Base	**3a** Yield (%)[a]	**5** Yield (%)[a]
1	Na_2CO_3	81	6
2	K_2CO_3	78	9
3	Cs_2CO_3	66	8
4	KF	66	5
5	KI	46	Trace
6	NaI	46	Trace
7	^{t}BuOLi	39	2
8	^{t}BuONa	4	n.d.
9	^{t}BuOK	17	Trace

Reaction conditions： **1a** (0.2 mmol), $K_2S_2O_5$, **2a** (1.5 eq.), $NiCl_2$·dme (10 mol%), 1,10-phenanthroline (15 mol%), base (2 eq.) and DMF/THF (1.5/0.5 mL), 12 h, 120 °C. [a] The yields were detected by GC using naphthalene as an internal standard.

Table S8. Screening of Equivalent of Na_2CO_3

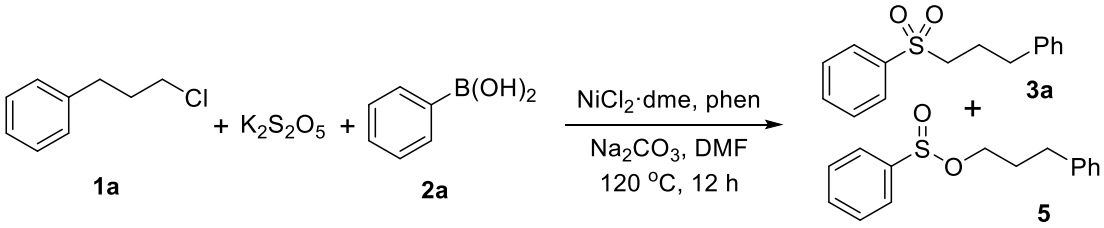


1a **2a**

Entry	The amount of Na_2CO_3	**3a** Yield (%)[a]	**5** Yield (%)[a]
1	2 equiv	81	9
2	1.5 equiv	79	10
3	1 equiv	80	8
4	0.5 equiv	84(82[b])	7

Reaction conditions: **1a** (0.2 mmol), $K_2S_2O_5$, **2a** (1.5 eq.), $NiCl_2$·dme (10 mol%), 1,10-phenanthroline (15 mol%), Na_2CO_3 and DMF/THF (1.5/0.5 mL), 12 h, 120 °C. [a] The yields were detected by GC using naphthalene as an internal standard. [b] Isolated yield.

Table S9. Screening of Reaction Conditions



1a **2a**

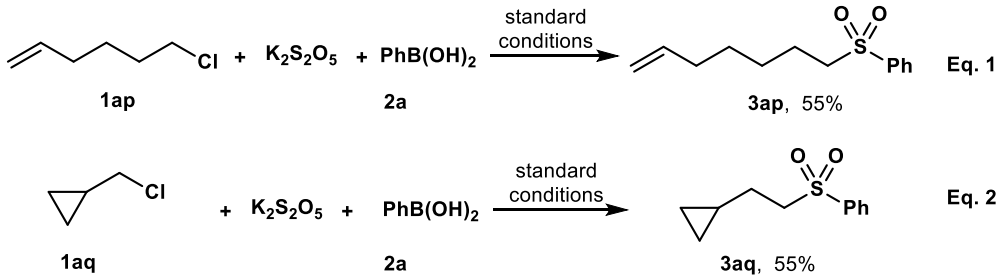
Entry	Deviation from standard conditions	**3a** Yield (%)[a]	**5** Yield (%)[a]
1	None	80	9
2	No [Ni]	8	2
3	No 1,10-phenanthroline	36	4
4	No Na_2CO_3	69	5

The standard reaction conditions: **1a** (0.2 mmol), $K_2S_2O_5$ (1.1 eq.), **2a** (1.5 eq.), $NiCl_2$·dme (10 mol%), 1,10-phenanthroline (15 mol%), Na_2CO_3 (2 eq.) and DMF (2 mL), 12 h, 120 °C. [a] The yields were detected by GC using naphthalene as an internal standard.

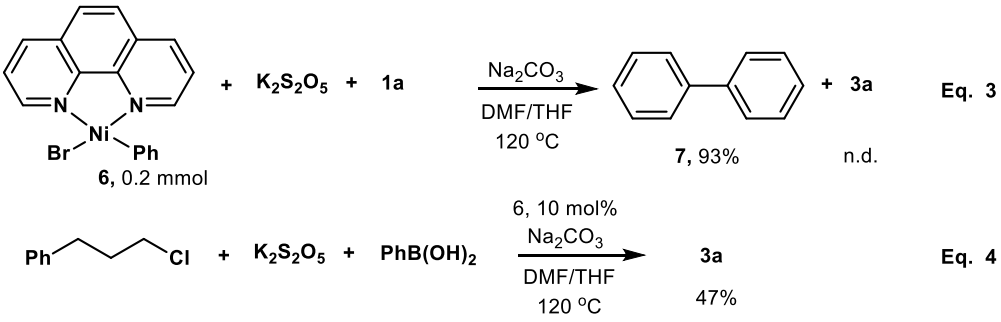
Control Experiments

Figure S1. Control Experiments

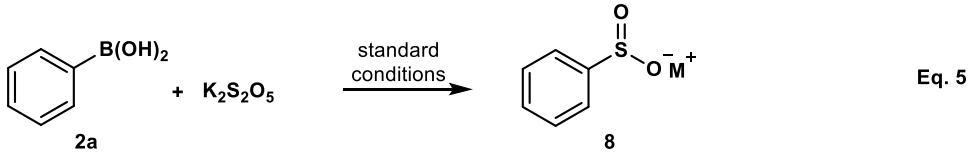
1) Reaction of radical clock



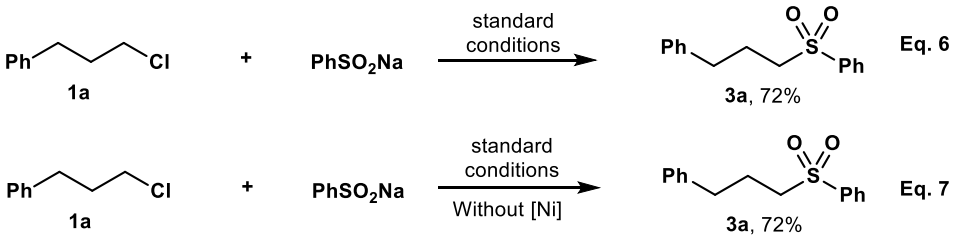
2) Pre-synthesis of intermediate **A**



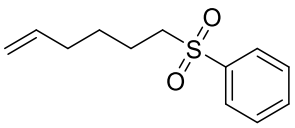
3) Aryl sulfinate intermediate trapping experiment



4) Alkylation of sodium benzenesulfite



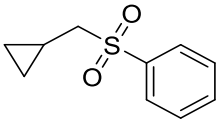
Equation 1 followed the General Procedure using 6-Chloro-1-hexene (0.2 mmol) and **2a** (1.2 equiv.) as the substrate. After purification, the isolated yield of **3ap** was 55%.



(hex-5-en-1-ylsulfonyl)benzene[4] **(3ap).** **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92 – 7.89 (m, 2H), 7.68 – 7.64 (m, 1H), 7.59 – 7.55 (m, 2H), 5.76 – 5.66 (m, 1H), 4.99 – 4.92 (m, 2H), 3.11 – 3.07 (m, 2H), 2.06 – 2.00 (m,

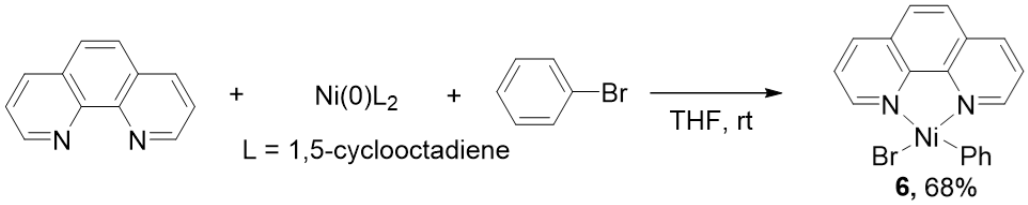
2H), 1.77 – 1.69 (m, 2H), 1.50 – 1.42 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.2, 137.5, 133.7, 129.3, 128.1, 115.4, 56.1, 33.0, 27.4, 22.1.

Equation 2 followed the General Procedure using (chloromethyl)cyclopropane (0.2 mmol) and **2a** (1.2 equiv.) as the substrate. After purification, the isolated yield of **3aq** was 55%.



((cyclopropylmethyl)sulfonyl)benzene [5] **(3aq). ^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.95 – 7.92 (m, 2H), 7.67 – 7.63 (m, 1H), 7.58 – 7.54 (m, 2H), 3.01 (d, J = 7.2 Hz, 2H), 1.04 – 0.94 (m, 1H), 0.57 – 0.52 (m, 2H), 0.13 – 0.09 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.3, 133.7, 129.1, 128.4, 61.4, 4.8, 4.4.

The pre-synthesis of nickel catalyst **6**[6]:



6, 68%

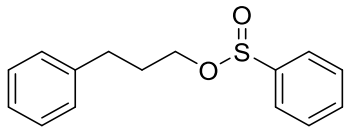
Add phenanthroline (1 mmol), Ni (cod)$_2$ (1 mmol) and THF (10 mL) to a 50 mL scintillation vial. After stirring the reaction mixture at room temperature for 5 min, add PhBr (1.2 equiv.) and reaction overnight. Concentrate under reduce pressure. Wash the solid several times with dry *n*-pentane and then dry under vacuum for 2 hours to obtain product in 68% yield.

The detection of sulfinate **8**[7]:

2a **8**

To a 50 mL Schlenk tube containing phenylboronic acid (**2a**) (0.2 mmol), of $NiCl_2$·dme (10 mol%), Na_2CO_3 (1 equiv), phen (15 mol%), $K_2S_2O_5$ (0.7 equiv), and the tube was purged with N_2 for 3 times, followed by 2 mL of DMF. The resulting mixture was stirred at 120 °C for 16 h. After cooling to room temperature, add ethanol and stir for a while, the mixture was filtered over Celite. The solvent was removed under reduced pressure. Then the remaining solid was extracted and recrystallized by MeCN to get a white solid. ^{1}H NMR (400 MHz, DMSO-d6) δ 7.45 (d, J = 7.3 Hz, 2H), 7.28 (t, J = 7.3 Hz, 2H), 7.21 (t, J = 7.2 Hz, 1H). ^{13}C NMR (101 MHz, DMSO-d6) δ 160.1, 128.3, 128.2, 124.7.

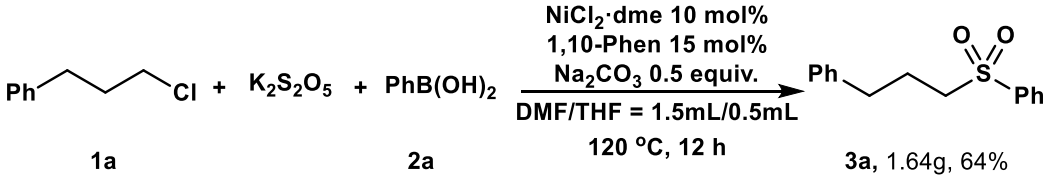
Equation 6 followed the General Procedure using sodium benzenesulfonate instead of $K_2S_2O_5$ and **2a** to afford sulfone **3a**. **Equation 7** followed the General Procedure using sodium benzenesulfonate instead of $K_2S_2O_5$ and **2a** to afford sulfone **3a** under metal-free conditions.



3-phenylpropyl benzenesulfinate (5): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 – 7.70 (m, 2H), 7.56 – 7.52 (m, 3H), 7.28 – 7.24 (m, 2H), 7.20 – 7.17 (m, 1H), 7.14 – 7.12 (m, 2H), 4.06 (dt, J = 10.0, 6.3 Hz, 1H), 3.64 (dt, J = 10.0, 6.3 Hz, 1H), 2.69 – 2.65 (m, 2H), 1.98 – 1.91 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.5, 140.9, 132.2, 129.1, 128.4, 128.4, 126.0, 125.2, 64.0, 31.9, 31.3.

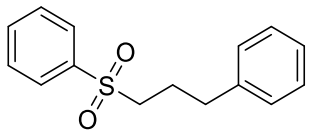
HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{15}H_{16}O_2SH^+$ 261.0944; Found 261.0949.

Scale up reaction



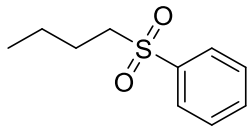
An oven-dried 50 mL re-sealable screw-cap test tube equipped with a Teflon-coated magnetic stir bar was sequentially charged with **2a** (1.46 g, 12 mmol, 1.2 equiv.), $K_2S_2O_5$ (2.44 g, 11 mmol, 1.1 equiv.), Na_2CO_3 (5.3 g, 5 eq, 0.5 equiv.), $NiCl_2$·dme (220 mg, 1 mmol, 10 mol%), 1,10-phenanthroline (252 mg, 1.45 mmol, 15 mol%) under N_2 atmosphere (glovebox). Then 15 mL DMF and 5 mL THF, **1a** (1.54 g, 10 mmol) were added into the tube via syringes in turn. The tube was capped with a pressure screw cap. Then the tube was placed on a heating base and irradiated at 120 ºC for 12 h. After which time the tube was removed from the heating source. The crude reaction mixture was then diluted with water, and subsequently extracted with EtOAc (3 x 30 mL). The organic fractions were combined, washed with brine (1 x 30 mL), dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The crude product residue was purified by flash column chromatography (silica gel; petroleum ether/ethyl acetate), giving the corresponding products **3a** (1.64 g) in 64% yield.

Analytical Data of Substrates and Products



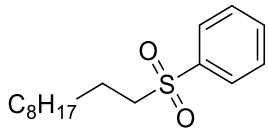
((3-phenylpropyl)sulfonyl)benzene[8] (**3a**): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 82% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 – 7.86 (m, 2H), 7.67 – 7.62 (m, 1H), 7.57 – 7.53 (m, 2H), 7.28 – 7.24 (m, 2H), 7.21 – 7.17 (m, 1H), 7.10 – 7.08 (m, 2H), 3.09 – 3.05 (m, 2H), 2.69 (t, J = 7.4 Hz, 2H), 2.08 – 2.00 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.9, 139.1, 133.7, 129.3, 128.7, 128.4, 128.1, 126.5, 55.5, 34.1, 24.2.



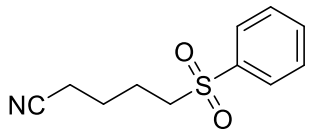
(butylsulfonyl)benzene[9] **(3b)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. Colorless liquid in 75% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 – 7.90 (m, 2H), 7.68 – 7.64 (m, 1H), 7.60 – 7.55 (m, 2H), 3.11 – 3.07 (m, 2H), 1.73 – 1.65 (m, 2H), 1.44 – 1.34 (m, 2H), 0.89 (t, J = 7.3 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.3, 133.7, 129.4, 128.1, 56.2, 24.7, 21.6, 13.6.



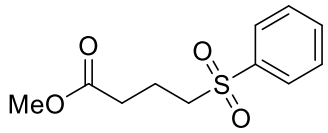
(decylsulfonyl)benzene[8] **(3c)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. Colorless liquid in 68% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 – 7.90 (m, 2H), 7.67 – 7.64 (m, 1H), 7.59 – 7.55 (m, 2H), 3.10 – 3.06 (m, 2H), 1.74 – 1.66 (m, 2H), 1.36 – 1.22 (m, 14H), 0.87 (t, J = 6.8 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.2, 133.6, 129.3, 128.1, 56.3, 31.9, 29.4, 29.2, 29.0, 28.3, 22.7 (d, J = 2.7 Hz), 14.1.



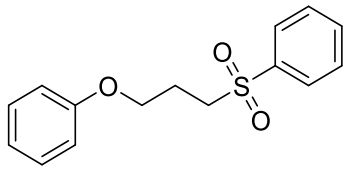
5-(phenylsulfonyl)pentanenitrile[10] **(3d)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. Colorless liquid in 72% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.88 (m, 2H), 7.69 – 7.64 (m, 1H), 7.60 – 7.55 (m, 2H), 3.14 – 3.10 (m, 2H), 2.39 – 2.34 (m, 2H), 1.90 –1.76 (m, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 138.7, 134.0, 129.5, 128.0, 118.9, 55.2, 24.1, 22.0, 16.9.



methyl-4-(phenylsulfonyl)butanoate[8] **(3e)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. Colorless liquid in 74% yield.

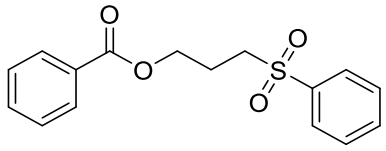
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 – 7.93 (m, 2H), 7.72 – 7.67 (m, 1H), 7.62 – 7.58 (m, 2H), 3.68 (s, 3H), 3.23 – 3.19 (m, 2H), 2.49 (t, J = 7.1 Hz, 2H), 2.09 – 2.02 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 172.6, 138.9, 133.9, 129.4, 128.1, 55.1, 51.8, 32.0, 18.3.



((3-phenoxypropyl)sulfonyl)benzene (3f): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. Colorless liquid in 73% yield.

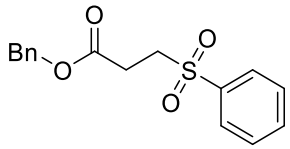
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 – 7.66 (m, 2H), 7.54 – 7.48 (m, 3H), 7.26 – 7.21 (m, 2H), 7.17 – 7.09 (m, 3H), 4.04 (dt, J = 9.9, 6.3 Hz, 1H), 3.61 (dt, J = 9.9, 6.3 Hz, 1H), 2.69 – 2.58 (m, 2H), 1.96 – 1.89 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.7, 141.0, 132.2, 129.1, 128.5, 126.1, 125.3, 63.9, 31.9, 31.4.

HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{16}O_3SNa^+$ 299.0712; Found 299.0713.



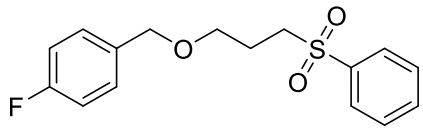
3-(phenylsulfonyl)propyl benzoate[11] **(3g)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 77% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 – 7.92 (m, 4H), 7.68 – 7.64 (m, 1H), 7.59 – 7.54 (m, 3H), 7.45 – 7.41 (m, 2H), 4.37 (t, J = 6.2 Hz, 2H), 3.29 – 3.25 (m, 2H), 2.24 – 2.17 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 166.2, 138.8, 134.0, 133.3, 129.7, 129.6, 129.5, 128.5, 128.1, 62.5, 53.3, 22.6.



benzyl-3-(phenylsulfonyl)propanoate[12] **(3h)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 61% yield.

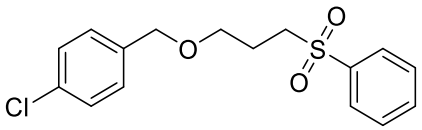
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 – 7.88 (m, 2H), 7.68 – 7.63 (m, 1H), 7.55 (t, J = 7.7 Hz, 2H), 7.38 – 7.29 (m, 5H), 5.06 (s, 2H), 3.46 – 3.42 (m, 2H), 2.80 – 2.77 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 169.9, 138.4, 135.2, 134.1, 129.5, 128.7, 128.6, 128.4, 128.2, 67.2, 51.5, 27.9.



1-fluoro-4-((3-(phenylsulfonyl)propoxy)methyl)benzene (3i): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 62% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.89 (m, 2H), 7.67 – 7.63 (m, 1H), 7.58 – 7.54 (m, 2H), 7.26 – 7.21 (m, 2H), 7.04 – 6.99 (m, 2H), 4.39 (s, 2H), 3.51 (t, J = 5.9 Hz, 2H), 3.23 – 3.20 (m, 2H), 2.04 – 1.98 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 162.4 (d, J = 245.8 Hz),139.1 133.8, 133.7 (d, J = 3.2 Hz), 129.4 (d, J = 8.1 Hz), 129.3, 128.1, 115.3 (d, J = 21.4 Hz), 72.3, 67.8, 53.5, 23.4. **^{19}F NMR** (377 MHz, $CDCl_3$) δ -114.43.

HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_{17}FO_3SNa^+$ 331.0775; Found 331.0769.

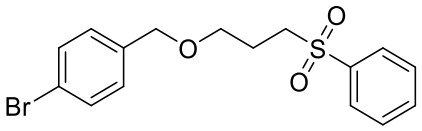


1-chloro-4-((3-(phenylsulfonyl)propoxy)methyl)benzene (3j): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 62% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 – 7.89 (m, 2H), 7.68 – 7.64 (m, 1H), 7.58 – 7.54 (m, 2H), 7.31 – 7.27 (m, 2H), 7.21 – 7.18 (m, 2H), 4.40 (s, 2H), 3.51 (t, J = 6.0 Hz, 2H), 3.24 – 3.20 (m, 2H), 2.05 – 1.98 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 139.1, 136.4, 133.8, 133.5, 129.3, 129.0, 128.6, 128.1, 72.2, 67.9, 53.5, 23.4.

HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_{17}ClO_3SNa^+$ 347.0479; Found 347.0479.

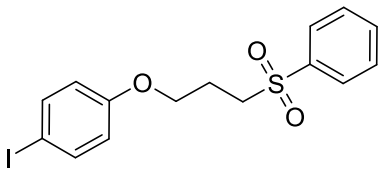


1-bromo-4-((3-(phenylsulfonyl)propoxy)methyl)benzene (3k): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 58% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.88 (m, 2H), 7.67 – 7.63 (m, 1H), 7.58 – 7.54 (m, 2H), 7.46 – 7.42 (m, 2H), 7.15 – 7.11 (m, 2H), 4.37 (s, 2H), 3.50 (t, J = 6.0 Hz, 2H), 3.23 – 3.19 (m, 2H), 2.04 – 1.97 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 139.1, 137.0, 133.8, 131.6, 129.4, 129.3, 128.1, 121.6, 72.2, 67.9, 53.5, 23.4.

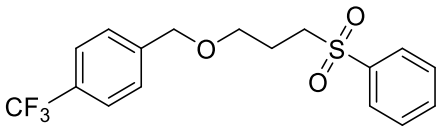
HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_{17}BrO_3SNa^+$ 390.9974; Found 390.9976.



1-iodo-4-(3-(phenylsulfonyl)propoxy)benzene (3l): The product was purified by silica gel column chromatography, using petroleum ether/EA = 8/1 (v/v) as an eluent. White solid in 44% yield.

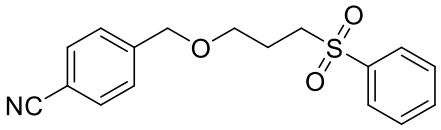
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 – 7.91 (m, 2H), 7.68 – 7.64 (m, 1H), 7.59 – 7.54 (m, 1H), 7.53 – 7.49 (m, 2H), 6.61 – 6.57 (m, 2H), 3.99 – 3.96 (m, 2H), 3.31 – 3.27 (m, 2H), 2.24 – 2.17 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 158.2, 139.0, 138.3, 133.9, 129.4, 128.0, 116.8, 83.3, 65.5, 53.2, 22.9.

HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{15}H_{15}IO_3SH^+$ 402.9859; Found 402.9858.



1-((3-(phenylsulfonyl)propoxy)methyl)-4-(trifluoromethyl)benzene (3m): The product was purified by silica gel column chromatography, using petroleum ether/EA = 8/1 (v/v) as an eluent. White solid in 61% yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92 – 7.89 (m, 2H), 7.68 – 7.63 (m, 1H), 7.59 – 7.54 (m, 4H), 7.37 (d, J = 7.9 Hz, 2H), 4.49 (s, 2H), 3.55 (t, J = 6.0 Hz, 2H), 3.25 – 3.22 (m, 2H), 2.08 – 2.01 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 142.0, 139.1, 133.8, 129.9 (d, J = 32.2 Hz), 129.4, 128.1, 127.5, 125.4 (q, J = 3.8 Hz)., 72.2, 68.1, 53.4, 23.3. **^{19}F NMR** (377 MHz, $CDCl_3$) δ -62.36.

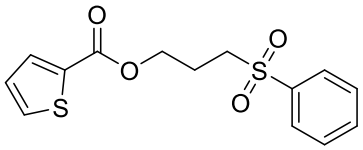
HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{17}H_{17}F_3O_3SNa^+$ 381.0743; Found 381.0733.



4-((3-(phenylsulfonyl)propoxy)methyl)benzonitrile (3n): The product was purified by silica gel column chromatography, using petroleum ether/EA = 4/1 (v/v) as an eluent. White solid in 47% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.89 (m, 2H), 7.68 – 7.55 (m, 5H), 7.37 (d, J = 8.0 Hz, 2H), 4.52 (s, 2H), 3.56 (t, J = 5.9 Hz, 2H), 3.25 – 3.21 (m, 2H), 2.08 – 2.01 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 143.5, 139.0, 133.8, 132.3, 129.4, 128.0, 127.7, 118.8, 111.4, 72.0, 68.3, 53.4, 23.3.

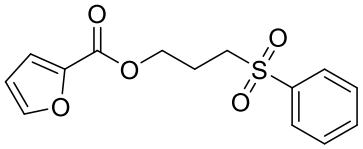
HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{17}H_{17}NO_3SNa^+$ 338.0821; Found 338.0830.



3-(phenylsulfonyl)propyl thiophene-2-carboxylate (3o): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White oil in 42% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 – 7.92 (m, 2H), 7.76 (dd, J = 3.8, 1.3 Hz, 1H), 7.69 – 7.65 (m, 1H), 7.60 – 7.56 (m, 3H), 7.11 – 7.09 (m, 1H), 4.35 (t, J = 6.2 Hz, 2H), 3.27 – 3.23 (m, 2H), 2.22 – 2.15 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 161.9, 138.8, 134.0, 133.8, 133.1, 132.9, 129.5, 128.1, 127.9, 62.7, 53.2, 22.7.

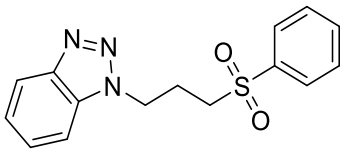
HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{14}H_{14}O_4S_2Na^+$ 333.0226; Found 333.0223.



3-(phenylsulfonyl)propyl furan-2-carboxylate (3p): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White oil in 56% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 – 7.90 (m, 2H), 7.68 – 7.64 (m, 1H), 7.59 – 7.55 (m, 3H), 7.15 (dd, J = 3.5, 0.8 Hz, 1H), 6.50 (dd, J = 3.5, 1.8 Hz, 1H), 4.35 (t, J = 6.2 Hz, 2H), 3.26 – 3.22 (m, 2H), 2.21 – 2.14 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 158.3, 146.6, 144.1, 138.8, 134.0, 129.5, 128.1, 118.4, 112.0, 62.4, 53.1, 22.6.

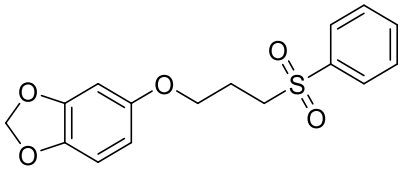
HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{14}H_{14}O_5SH^+$ 295.0635; Found 295.0628.



1-(3-(phenylsulfonyl)propyl)-1H-benzo[d][1,2,3]triazole (3q): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 42% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 – 7.87 (m, 2H), 7.84 – 7.80 (m, 2H), 7.66 – 7.62 (m, 1H), 7.56 – 7.52 (m, 2H), 7.41 – 7.36 (m, 2H), 4.84 (t, J = 6.5 Hz, 2H), 3.22 – 3.18 (m, 2H), 2.58 – 2.51 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.4, 138.7, 134.0, 129.4, 128.1, 126.6, 118.0, 54.5, 53.3, 23.4.

HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{15}H_{15}N_3O_2SH^+$ 302.0958; Found 302.0958.

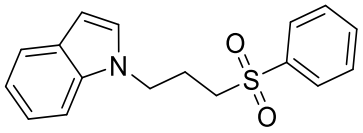


5-(3-(phenylsulfonyl)propoxy)benzo[d][1,3]dioxole (3r): The product was purified by silica gel column chromatography, using petroleum ether/EA = 8/1 (v/v) as an eluent. White solid in 64% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 – 7.92 (m, 2H), 7.68 – 7.64 (m, 1H), 7.59 – 7.55 (m, 2H), 6.66 (d, J = 8.5 Hz, 1H), 6.40 (d, J = 2.5 Hz, 1H), 6.23 (dd, J = 8.5, 2.5 Hz, 1H), 5.89 (s, 2H), 3.93 (t, J = 5.8 Hz, 2H), 3.31 – 3.28 (m, 2H), 2.21 – 2.14 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 153.8, 148.3, 142.0, 139.0, 133.8,

129.4, 128.1, 108.0, 105.7, 101.2, 98.1, 66.4, 53.3, 23.0.

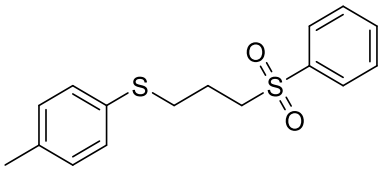
HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_{16}O_5SNa^+$ 343.0611; Found 343.0618.



1-(3-(phenylsulfonyl)propyl)-1H-indole (3s): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 66% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 – 7.83 (m, 2H), 7.65 – 7.60 (m, 2H), 7.54 – 7.50 (m, 2H), 7.29 – 7.25 (m, 1H), 7.20 – 7.16 (m, 1H), 7.12 – 7.05 (m, 2H), 6.49 (d, J = 3.1 Hz, 1H), 4.29 (t, J = 6.7 Hz, 2H), 3.00 – 2.96 (m, 2H), 2.32 – 2.25 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 138.9, 135.8, 133.9, 129.4, 128.7, 128.0, 127.7, 121.9, 121.2, 119.7, 109.2, 102.0, 53.0, 44.3, 23.6.

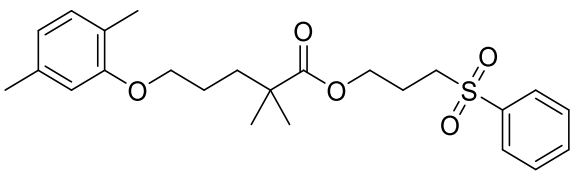
HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{17}NO_2SH^+$ 300.1053; Found 300.1058.



(3-(phenylsulfonyl)propyl)(p-tolyl)sulfane (3t): The product was purified by silica gel column chromatography, using petroleum ether/EA = 15/1 (v/v) as an eluent. White solid in 53% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 – 7.86 (m, 2H), 7.68 – 7.63 (m, 1H), 7.57 – 7.53 (m, 2H), 7.19 – 7.17 (m, 2H), 7.06 (d, J = 7.9 Hz, 2H), 3.27 – 3.23 (m, 2H), 2.91 (t, J = 6.8 Hz, 2H), 2.31 (s, 3H), 2.01 – 1.94 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.0, 137.1, 133.8, 131.3, 130.8, 129.9, 129.4, 128.1, 54.6, 33.4, 22.3, 21.1.

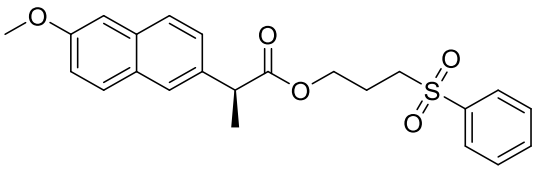
HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{16}H_{18}O_2S_2H^+$ 307.0821; Found 307.0829.



3-(phenylsulfonyl)propyl 5-(2,5-dimethylphenoxy)-2,2-dimethylpentanoate (3u): The product was

purified by silica gel column chromatography, using petroleum ether/EA = 5/1 (v/v) as an eluent. White solid in 50% yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92 – 7.89 (m, 2H), 7.68 – 7.63 (m, 1H), 7.57 – 7.53 (m, 2H), 7.00 (d, J = 7.4 Hz, 1H), 6.67 (d, J = 7.4 Hz, 1H), 6.61 (s, 1H), 4.12 (t, J = 6.2 Hz, 2H), 3.92 – 3.88 (m, 2H), 3.19 – 3.15 (m, 2H), 2.31 (s, 3H), 2.15 (s, 3H), 2.10 – 2.03 (m, 2H), 1.70 – 1.68 (m, 4H), 1.19 (s, 6H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 177.5, 156.9, 138.8, 136.5, 133.9, 130.4, 129.4, 128.1, 123.5, 120.8, 112.0, 67.8, 62.0, 53.2, 42.1, 37.0, 25.2, 25.1, 22.6, 21.4, 15.8.

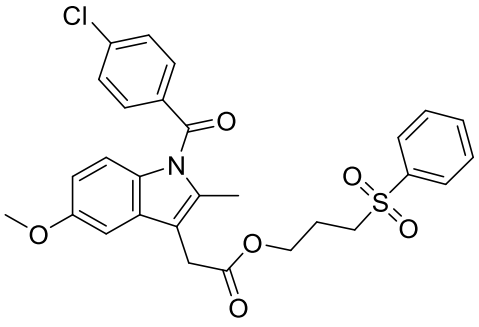
HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{32}O_5SNa^+$ 455.1863; Found 455.1858.



3-(phenylsulfonyl)propyl (S)-2-(6-methoxynaphthalen-2-yl)propanoate (3v): The product was purified by silica gel column chromatography, using petroleum ether/EA = 5/1 (v/v) as an eluent. White solid in 56% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 – 7.68 (m, 4H), 7.62 – 7.57 (m, 2H), 7.46 – 7.42 (m, 2H), 7.35 (dd, J = 8.5, 1.9 Hz, 1H), 7.18 – 7.12 (m, 2H), 4.19 – 4.06 (m, 2H), 3.92 (s, 3H), 3.81 (q, J = 7.1 Hz, 1H), 2.95 – 2.91 (m, 2H), 2.02 – 1.95 (m, 2H), 1.54 (d, J = 7.1 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 174.3, 157.7, 138.8, 135.4, 133.7, 129.3, 128.9, 127.8, 127.3, 126.0, 125.9, 119.2, 105.6, 62.2, 55.3, 52.8, 45.3, 22.3, 18.2.

HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{23}H_{24}O_5SNa^+$ 435.1237; Found 435.1232.

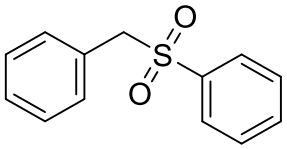


3-(phenylsulfonyl)propyl-2-(1-(4-chlorobenzoyl)-5-methoxy-2-methyl-1H-indol-3-yl)acetate (3w): The product was purified by silica gel column chromatography, using petroleum ether/EA = 3/1 (v/v) as an eluent. White solid in 57% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 – 7.79 (m, 2H), 7.67 – 7.62 (m, 3H), 7.56 – 7.52 (m, 2H), 7.49 – 7.45

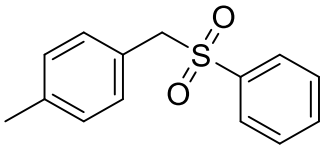
(m, 2H), 6.91 – 6.86 (m, 2H), 6.67 (dd, J = 9.0, 2.5 Hz, 1H), 4.16 (t, J = 6.1 Hz, 2H), 3.81 (s, 3H), 3.64 (s, 2H), 3.03 – 2.99 (m, 2H), 2.35 (s, 3H), 2.07 – 2.01 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 170.5, 168.3, 156.1, 139.4, 138.8, 136.0, 133.9, 133.8, 131.2, 130.8, 130.5, 129.4, 129.2, 128.0, 115.1, 112.2, 111.7, 101.2, 62.6, 55.7, 53.0, 30.3, 22.4, 13.3.

HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{28}H_{26}ClNO_6SH^+$ 540.1242; Found 540.1245.



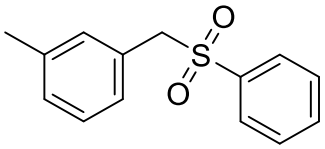
(benzylsulfonyl)benzene[13] **(3x)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. White solid in 83% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 – 7.58 (m, 3H), 7.44 (t, J = 7.8 Hz, 2H), 7.33 – 7.29 (m, 1H), 7.27 – 7.23 (m, 2H), 7.09 – 7.07 (m, 2H), 4.31 (s, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.8, 133.7, 130.8, 128.8, 128.7, 128.6, 128.5, 128.1, 62.8.



1-methyl-4-((phenylsulfonyl)methyl)benzene[8] **(3y)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. White solid in 87% yield.

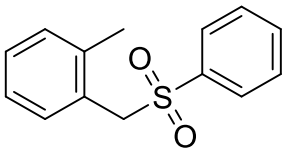
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 – 7.58 (m, 3H), 7.47 – 7.43 (m, 2H), 7.06 (d, J = 7.8 Hz, 2H), 6.96 (d, J = 8.1 Hz, 2H), 4.27 (s, 2H), 2.32 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 138.7, 138.0, 133.7, 130.7, 129.3, 128.9, 128.7, 125.0, 62.6, 21.2.



1-methyl-3-((phenylsulfonyl)methyl)benzene[14] **(3z)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. White solid in 86% yield.

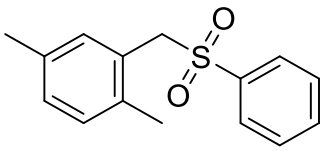
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 – 7.58 (m, 3H), 7.47 – 7.44 (m, 2H), 7.16 – 7.11 (m, 2H), 6.90 (s,

1H), 6.88 – 6.81 (m, 1H), 4.27 (s, 2H), 2.26 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 138.3, 138.0, 133.7, 131.6, 129.6, 128.9, 128.7, 128.5, 127.9, 127.9, 62.9, 21.3.



1-methyl-2-((phenylsulfonyl)methyl)benzene[15] **(3aa)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. White solid in 81% yield.

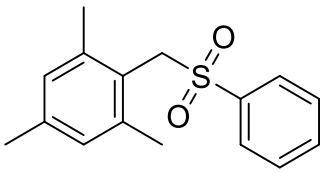
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 – 7.60 (m, 3H), 7.46 (t, J = 7.8 Hz, 2H), 7.24 – 7.20 (m, 1H), 7.13 – 7.08 (m, 2H), 7.03 – 7.01 (m, 1H), 4.38 (s, 2H), 2.11 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 138.3, 138.3, 133.8, 131.9, 130.7, 129.0, 129.0, 128.7, 126.6, 126.1, 60.1, 19.4.



1,4-dimethyl-2-((phenylsulfonyl)methyl)benzene (3ab). The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. White solid in 85% yield.

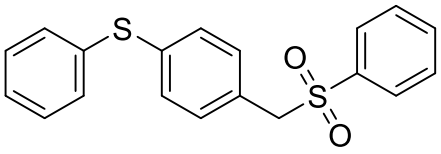
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 – 7.60 (m, 3H), 7.56 (t, J = 7.8 Hz, 2H), 7.04 – 6.98 (m, 2H), 6.82 (s, 1H), 4.33 (s, 2H), 2.21 (s, 3H), 2.05 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 138.4, 135.6, 135.1, 133.8, 132.6, 130.5, 129.7, 128.9, 128.7, 126.2, 60.1, 20.8, 18.9.

HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{15}H_{16}O_2SH^+$ 261.0944; Found 261.0953.



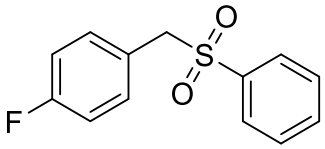
1,3,5-trimethyl-2-((phenylsulfonyl)methyl)benzene[15] **(3ac)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. White solid in 86% yield;.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 – 7.76 (m, 2H), 7.67 – 7.63 (m, 1H), 7.53 – 7.49 (m, 2H), 6.85 (s, 2H), 4.47 (s, 2H), 2.27 (s, 3H), 2.17 (s, 6H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.6, 139.0, 138.5, 133.8, 129.5, 129.2, 128.5, 122.3, 57.3, 21.0, 20.2.



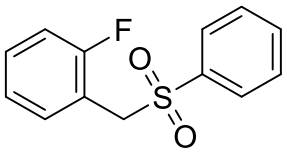
phenyl(4-((phenylsulfonyl)methyl)phenyl)sulfone[16] **(3ad)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 58% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 – 7.58 (m, 3H), 7.48 – 7.43 (m, 2H), 7.37 – 7.28 (m, 5H), 7.17 – 7.14 (m, 2H), 7.00 – 6.97 (m, 2H), 4.26 (s, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.9, 137.8, 134.4, 133.9, 132.0, 131.5, 130.1, 129.4, 129.0, 128.7, 127.8, 126.4, 62.5.



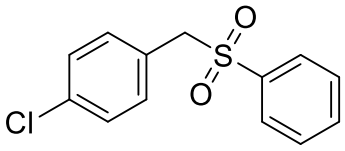
1-fluoro-4-((phenylsulfonyl)methyl)benzene[8] **(3ae)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. White solid in 79% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 – 7.59 (m, 3H), 7.47 (t, J = 7.8 Hz, 2H), 7.07 – 7.04 (m, 2H), 6.97 – 6.93 (m, 2H), 4.28 (s, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 163.1 (d, J = 248.6 Hz), 137.7, 133.9, 132.6 (d, J = 8.4 Hz), 129.1, 128.6, 124.0 (d, J = 3.4 Hz), 115.7 (d, J = 21.8 Hz), 62.0.



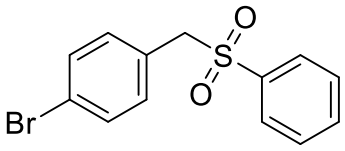
1-fluoro-2-((phenylsulfonyl)methyl)benzene[17] **(3af)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. White solid in 83% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 – 7.60 (m, 3H), 7.46 (t, J = 7.9 Hz, 2H), 7.33 – 7.28 (m, 2H), 7.14 – 7.10 (m, 1H), 6.94 – 6.89 (m, 1H), 4.40 (s, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 161.2 (d, J = 249.8 Hz), 137.9, 133.9, 132.7 (d, J = 2.8 Hz), 131.0 (d, J = 8.3 Hz), 129.0, 128.6, 124.4 (d, J = 3.8 Hz), 115.8 (d, J = 14.6 Hz), 115.5 (d, J = 21.7 Hz), 55.7 (d, J = 2.5 Hz).



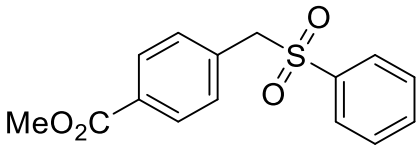
1-chloro-3-((phenylsulfonyl)methyl)benzene[8] **(3ag)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. White solid in 56% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 – 7.61 (m, 3H), 7.48 (t, J = 7.7 Hz, 2H), 7.26 – 7.23 (m, 2H), 7.02 (d, J = 8.4 Hz, 2H), 4.27 (s, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.7, 135.1, 134.0, 132.1, 129.1, 128.9, 128.7, 126.7, 62.2.



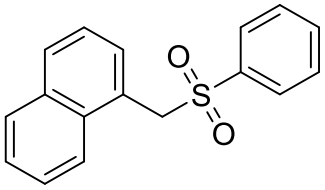
1-bromo-4-((phenylsulfonyl)methyl)benzene[8] **(3ah)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. White solid in 64% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 – 7.61 (m, 3H), 7.50 – 7.46 (m, 2H), 7.42 – 7.38 (m, 2H), 6.97 – 6.94 (m, 2H), 4.26 (s, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 137.7, 134.0, 132.4, 131.9, 129.1, 128.7, 127.2, 123.4, 62.2.



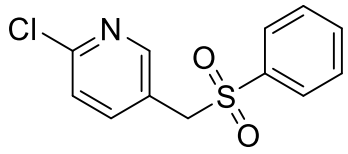
4-((phenylsulfonyl)methyl)benzoate[15] **(3ai)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 15/1 (v/v) as an eluent. White solid in 60% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 – 7.90 (m, 2H), 7.63 – 7.59 (m, 3H), 7.47 – 7.43 (m, 2H), 7.15 (d, J = 8.3 Hz, 2H), 4.35 (s, 2H), 3.90 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 166.6, 137.6, 134.0, 133.1, 130.9, 130.5, 129.8, 129.1, 128.6, 126.5, 62.6, 52.3.



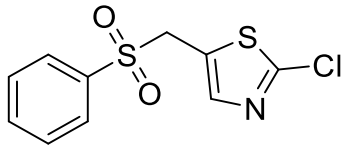
1-((phenylsulfonyl)methyl)naphthalene[15] **(3aj)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent White solid in 74% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 – 7.81 (m, 3H), 7.61 – 7.59 (m, 2H), 7.54 – 7.50 (m, 1H), 7.47 – 7.39 (m, 2H), 7.35 (t, J = 7.8 Hz, 3H), 7.22 – 7.20 (m, 1H), 4.83 (s, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 138.0, 133.7, 132.1, 130.6, 129.8, 128.9, 128.7, 126.7, 126.0, 125.1, 124.5, 123.6, 59.9.



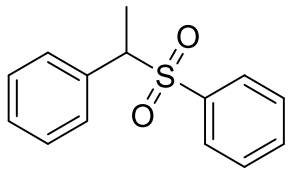
2-chloro-5-((phenylsulfonyl)methyl)pyridine[18] **(3ak)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 89% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, J = 2.5 Hz, 1H), 7.69 – 7.64 (m, 3H), 7.58 – 7.50 (m, 3H), 7.31 – 7.29 (m, 1H), 4.29 (s, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 152.1, 151.1, 140.8, 137.3, 134.4, 129.4, 128.5, 124.4, 123.5, 59.1.



2-chloro-5-((phenylsulfonyl)methyl)thiazole[18] **(3al)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 15/1 (v/v) as an eluent. White solid in 52% yield.

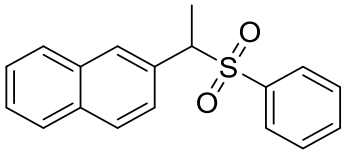
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 – 7.75 (m, 2H), 7.70 – 7.66 (m, 1H), 7.56 – 7.52 (m, 2H), 7.17 (s, 1H), 4.45 (s, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 153.8, 143.1, 136.9, 134.6, 129.5, 128.6, 126.4, 54.7.



((1-phenylethyl)sulfonyl)benzene[19] **(3am)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 20/1 (v/v) as an eluent. White solid in 74% yield.

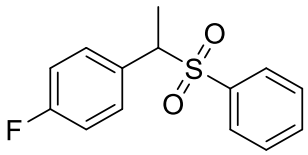
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.52 (m, 3H), 7.41 – 7.37 (m, 2H), 7.31 – 7.21 (m, 3H), 7.14 – 7.11 (m, 2H), 4.23 (q, J = 7.2 Hz, 1H), 1.77 (d, J = 7.2 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 136.9, 133.8,

133.6, 129.4, 129.2, 128.8, 128.7, 128.4, 66.1, 14.0.



2-(1-(phenylsulfonyl)ethyl)naphthalene[19] **(3an)**. The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 55% yield.

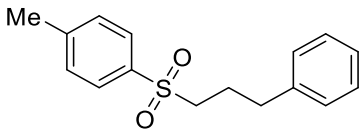
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 – 7.78 (m, 1H), 7.73 – 7.68 (m, 2H), 7.55 – 7.43 (m, 6H), 7.36 – 7.32 (m, 2H), 7.27 (dd, J = 8.5, 1.9 Hz, 1H), 4.40 (q, J = 7.1 Hz, 1H), 1.85 (d, J = 7.1 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 136.8, 133.6, 133.3, 132.9, 131.2, 129.3, 129.1, 128.7, 128.1, 128.1, 127.7, 126.7, 126.6, 126.4, 66.2, 14.3.



1-fluoro-4-(1-(phenylsulfonyl)ethyl)benzene (3ao). The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 72% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 – 7.54 (m, 3H), 7.44 – 7.40 (m, 2H), 7.13 – 7.10 (m, 2H), 6.96 – 6.91 (m, 2H), 4.23 (q, J = 7.2 Hz, 1H), 1.74 (d, J = 7.2 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 163.0 (d, J = 248.4 Hz), 136.7, 133.7, 131.2 (d, J = 8.4 Hz), 129.6 (d, J = 3.3 Hz), 129.2, 128.8, 115.5 (d, J = 21.6 Hz), 65.3, 14.2. **^{19}F NMR** (377 MHz, $CDCl_3$) δ -112.47.

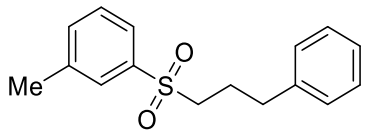
HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{14}H_{13}FO_2SH^+$ 265.0693; Found 265.0688.



1-methyl-4-((3-phenylpropyl)sulfonyl)benzene[13] **(4b)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 80% yield.

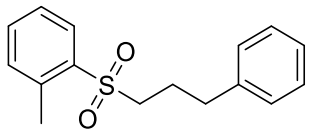
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 – 7.73 (m, 2H), 7.33 (d, J = 8.0 Hz, 2H), 7.27 – 7.23 (m, 2H), 7.20 – 7.16 (m, 1H), 7.10 – 7.08 (m, 2H), 3.06 – 3.02 (m, 2H), 2.67 (t, J = 7.5 Hz, 2H), 2.43 (s, 3H), 2.06 – 1.98

(m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 144.7, 140.0, 136.1, 129.9, 128.6, 128.4, 128.1, 126.4, 55.6, 34.1, 24.3, 21.7.



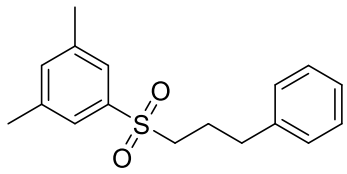
1-methyl -3-((3-phenylpropyl)sulfonyl)benzene[13] **(4c)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 79% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 – 7.64 (m, 2H), 7.45 – 7.40 (m, 2H), 7.28 – 7.24 (m, 2H), 7.21 – 7.16 (m, 1H), 7.10 – 7.08 (m, 2H), 3.08 – 3.04 (m, 2H), 2.68 (t, J = 7.5 Hz, 2H), 2.42 (s, 3H), 2.07 – 2.00 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.9, 139.6, 138.9, 134.5, 129.2, 128.6, 128.4, 128.3, 126.5, 125.2, 55.4, 34.1, 24.2, 21.4.



1-methyl-2-((3-phenylpropyl)sulfonyl)benzene[13] **(4d)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 25% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (dd, J = 8.0, 1.4 Hz, 1H), 7.50 (td, J = 7.5, 1.4 Hz, 1H), 7.38 – 7.34 (m, 1H), 7.31 – 7.24 (m, 3H), 7.21 – 7.17 (m, 1H), 7.10 – 7.06 (m, 2H), 3.13 – 3.08 (m, 2H), 2.70 (t, J = 7.4 Hz, 2H), 2.59 (s, 3H), 2.07 – 2.00 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.9, 137.9, 137.1, 133.7, 132.8, 130.3, 128.6, 128.4, 126.6, 126.5, 54.3, 34.0, 24.0, 20.3.

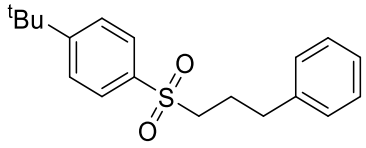


1,3-dimethyl-5-((3-phenylpropyl)sulfonyl)benzene (4e): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 78% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 (s, 2H), 7.28 – 7.24 (m, 3H), 7.21 – 7.16 (m, 1H), 7.11 – 7.08 (m, 2H), 3.07 – 3.03 (m, 2H), 2.68 (t, J = 7.5 Hz, 2H), 2.37 (s, 6H), 2.07 – 2.00 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$)

δ 140.0, 139.4, 138.8, 135.4, 128.6, 128.4, 126.4, 125.5, 55.4, 34.1, 24.2, 21.2.

HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{20}O_2SH^+$ 289.1257; Found 289.1257.

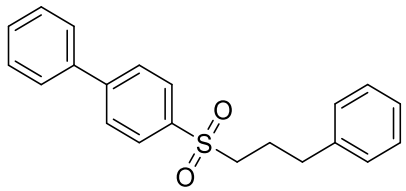


1-(tert-butyl)-4-((3-phenylpropyl)sulfonyl)benzene (4f): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 74% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 – 7.77 (m, 2H), 7.56 – 7.52 (m, 2H), 7.27 – 7.23 (m, 2H), 7.20 – 7.16 (m, 1H), 7.11 – 7.08 (m, 2H), 3.08 – 3.04 (m, 2H), 2.69 (t, J = 7.5 Hz, 2H), 2.09 – 2.01 (m, 2H), 1.34 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 157.6, 134.0, 136.1, 128.6, 128.4, 127.9, 126.4, 126.3, 55.5, 35.3, 34.1, 31.1, 24.2.

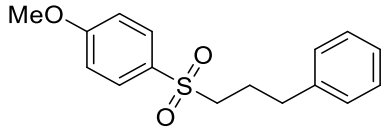
HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{19}H_{24}O_2SNa^+$ 339.1389; Found 339.1393.



4-((3-phenylpropyl)sulfonyl)-1,1'-biphenyl (4g): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 71% yield.

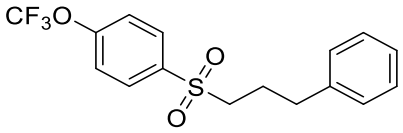
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, J = 8.0 Hz, 2H), 7.72 (d, J = 8.0 Hz, 2H), 7.60 – 7.58 (m, 2H), 7.49 – 7.39 (m, 3H), 7.27 – 7.21 (m, 2H), 7.19 – 7.16 (m, 1H), 7.10 – 7.08 (m, 2H), 3.11 – 3.08 (m, 2H), 2.69 (t, J = 7.4 Hz, 2H), 2.11-2.02 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 146.6, 139.9, 139.1, 137.5, 129.1, 128.7, 128.6, 128.6, 128.4, 128.0, 127.4, 126.4, 55.6, 34.1, 24.3.

HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{21}H_{20}O_2SNa^+$ 359.1076; Found 359.1080.



1-methoxy-4-((3-phenylpropyl)sulfonyl)benzene[13] **(4h)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 71% yield.

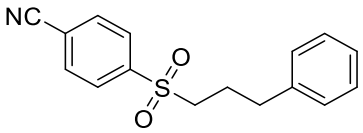
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 – 7.77 (m, 2H), 7.28 – 7.24 (m, 2H), 7.21 – 7.17 (m, 1H), 7.11 – 7.08 (m, 2H), 7.01 – 6.98 (m, 2H), 3.87 (s, 3H), 3.06 – 3.02 (m, 2H), 2.68 (t, J = 7.5 Hz, 2H), 2.07 – 1.98 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 163.7, 140.0, 130.6, 130.2, 128.6, 128.4, 126.4, 114.5, 55.8, 55.7, 34.1, 24.4.



1-((3-phenylpropyl)sulfonyl)-4-(trifluoromethoxy)benzene (4i): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 52% yield.

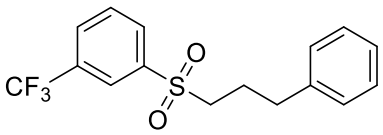
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 – 7.90 (m, 2H), 7.38 – 7.35 (m, 2H), 7.29 - 7.25 (m, 2H), 7.22 – 7.18 (m, 1H), 7.11 – 7.09 (m, 2H), 3.10 – 3.05 (m, 2H), 2.70 (t, J = 7.4 Hz, 2H), 2.09 - 2.01 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 153.0 (d, J = 1.9 Hz), 139.7, 137.3, 130.4, 128.7, 128.4, 126.6, 121.1, 120.2 (q, J = 259.8 Hz), 55.5, 34.0, 24.2. **^{19}F NMR** (377 MHz, $CDCl_3$) δ -57.54.

HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_{15}F_3O_3SNa^+$ 367.0586; Found 367.0581.



4-((3-phenylpropyl)sulfonyl)benzonitrile[13] **(4j)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 65% yield.

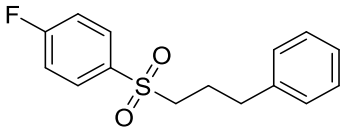
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 – 7.98 (m, 2H), 7.86 – 7.84 (m, 2H), 7.29 – 7.25 (m, 2H), 7.23 – 7.18 (m, 1H), 7.10 – 7.08 (m, 2H), 3.11 – 3.07 (m, 2H), 2.71 (t, J = 7.4 Hz, 2H), 2.08 – 2.00 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 143.2, 139.5, 133.1, 128.9, 128.8, 128.4, 126.7, 117.6, 117.1, 55.2, 34.0, 24.1.



1-((3-phenylpropyl)sulfonyl)-3-(trifluoromethyl)benzene[20] **(4k)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 66% yield.

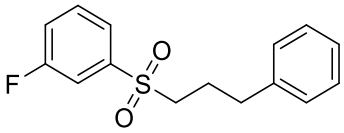
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (s, 1H), 8.16 (d, J = 8.1 Hz, 1H), 7.90 (d, J = 7.9 Hz, 1H), 7.71 (t, J =

7.8 Hz, 1H), 7.29-7.25 (m, 2H), 7.22 – 7.18 (m, 1H), 7.11 – 7.08 (m, 2H), 3.12 – 3.08 (m, 2H), 2.72 (t, J = 7.4 Hz, 2H), 2.11 – 2.03 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 140.4, 139.6, 132.1 (q, J = 33.6 Hz), 131.5, 130.5 (q, J = 3.6 Hz), 130.2, 128.7, 128.4, 126.6, 125.2 (q, J = 3.9 Hz), 123.1 (q, J = 273.1 Hz), 55.4, 34.0, 24.0.



1-fluoro-4-((3-phenylpropyl)sulfonyl)benzene[8] **(4l)**: The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 70% yield.

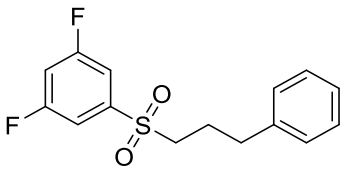
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.86 (m, 2H), 7.29 – 7.19 (m, 5H), 7.11 – 7.08 (m, 2H), 3.08 – 3.04 (m, 2H), 2.69 (t, J = 7.5 Hz, 2H), 2.07 – 2.00 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 165.8 (d, J = 256.2 Hz), 139.8, 135.1 (d, J = 3.2 Hz), 131.0 (d, J = 9.7 Hz), 128.7, 128.4, 126.5, 116.7 (d, J = 22.6 Hz), 55.6, 34.1, 24.3.



1-fluoro-3-((3-phenylpropyl)sulfonyl)benzene (4m): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 70% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (dt, J = 7.8, 1.3 Hz, 1H), 7.59 – 7.51 (m, 2H), 7.37 – 7.32 (m, 1H), 7.29 – 7.25 (m, 2H), 7.22 – 7.18 (m, 1H), 7.11 – 7.08 (m, 2H), 3.10 – 3.06 (m, 2H), 2.70 (t, J = 7.5 Hz, 2H), 2.08 – 2.01 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 162.5 (d, J = 252.5 Hz), 141.1 (d, J = 6.4 Hz), 139.7, 131.3 (d, J = 7.7 Hz), 128.7, 128.4, 126.6, 123.9 (d, J = 3.5 Hz), 121.1 (d, J = 21.1 Hz), 115.5 (d, J = 24.2 Hz), 55.3, 34.1, 24.2. **^{19}F NMR** (377 MHz, $CDCl_3$) δ -109.66.

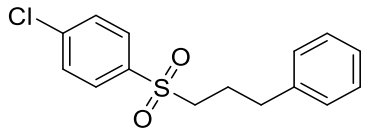
HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{15}H_{15}FO_2SH^+$ 279.0850; Found 279.0850.



1,3-difluoro-5-((3-phenylpropyl)sulfonyl)benzene (4n): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 62% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.38 (m, 2H), 7.31 – 7.26 (m, 2H), 7.24 – 7.19 (m, 1H), 7.12 – 7.07 (m, 3H), 3.10 – 3.06 (m, 2H), 2.72 (t, J = 7.4 Hz, 2H), 2.10 – 2.02 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 163.0 (dd, J = 256.0, 11.4 Hz), 142.4 (t, J = 7.9 Hz), 139.5, 128.8, 128.4, 126.7, 111.7 (dd, J = 28.0 Hz), 109.5 (t, J = 25.0 Hz), 55.2, 34.0, 24.1. **^{19}F NMR** (377 MHz, $CDCl_3$) δ -104.57.

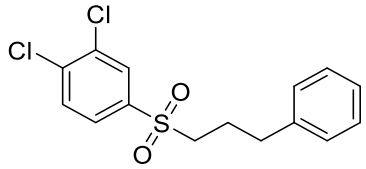
HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{15}H_{14}F_2O_2SNa^+$ 297.0755; Found 297.0752.



1-chloro-4-((3-phenylpropyl)sulfonyl)benzene (4o): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 65% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 – 7.79 (m, 2H), 7.54 – 7.50 (m, 2H), 7.29 – 7.25 (m, 2H), 7.22 – 7.18 (m, 1H), 7.14 – 7.08 (m, 2H), 3.08 – 3.04 (m, 2H), 2.70 (t, J = 7.4 Hz, 2H), 2.07 – 2.00 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 140.5, 139.7, 137.5, 129.7, 129.6, 128.7, 128.4, 126.5, 55.5, 34.1, 24.2.

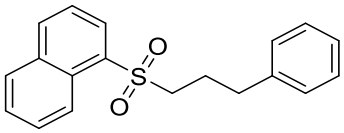
HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{15}ClO_2SNa^+$ 317.0373; Found 317.0374.



1,2-dichloro-4-((3-phenylpropyl)sulfonyl)benzene (4p): The product was purified by silica gel column chromatography, using petroleum ether/EA = 10/1 (v/v) as an eluent. White solid in 50% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, J = 2.0 Hz, 1H), 7.70 – 7.67 (m, 1H), 7.64 – 7.61 (m, 1H), 7.29 – 7.25 (m, 2H), 7.22 – 7.18 (m, 1H), 7.11 – 7.08 (m, 2H), 3.09 – 3.05 (m, 2H), 2.71 (t, J = 7.4 Hz, 2H), 2.08 – 2.00 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.5, 138.9, 138.8, 134.1, 131.5, 130.1, 128.7, 128.4, 127.2, 126.6, 54.8, 34.0, 24.1.

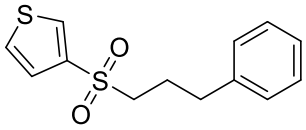
HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{14}Cl_2O_2SNa^+$ 350.9984; Found 350.9981.



1-((3-phenylpropyl)sulfonyl)naphthalene (4q): The product was purified by silica gel column chromatography, using petroleum ether/EA = 5/1 (v/v) as an eluent. White solid in 33% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.65 (d, J = 8.4 Hz, 1H)., 8.28 (dd, J = 7.4, 1.3 Hz, 1H), 8.12 (d, J = 8.3 Hz, 1H), 7.97 – 7.95 (m, 1H), 7.68 – 7.56 (m, 3H), 7.22 – 7.12 (m, 3H), 7.03 – 7.01 (m, 2H), 3.28 – 3.25 (m, 2H), 2.64 (t, J = 7.5 Hz, 2H), 2.07 – 1.99 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.9, 135.3, 134.3, 134.1, 130.7, 129.3, 128.9, 128.8, 128.6, 128.4, 127.1, 126.4, 124.5, 124.1, 55.0, 34.0, 24.2.

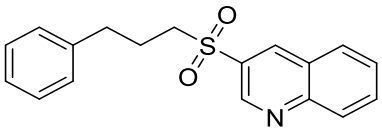
HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{19}H_{18}O_2SNa^+$ 333.0920; Found 333.0921.



3-((3-phenylpropyl)sulfonyl)thiophene (4r): The product was purified by silica gel column chromatography, using petroleum ether/EA = 8/1 (v/v) as an eluent. White solid in 65% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (dd, J = 3.1, 1.3 Hz, 1H), 7.45 (dd, J = 5.1, 3.1 Hz, 1H), 7.35 (dd, J = 5.1, 1.3 Hz, 1H), 7.30 – 7.25 (m, 2H), 7.22 – 7.18 (m, 1H), 7.12 – 7.10 (m, 2H), 3.12 – 3.08 (m, 2H), 2.71 (t, J = 7.5 Hz, 2H), 2.11 – 2.03 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 139.9, 139.7, 132.7, 128.7, 128.5, 128.4, 126.5, 126.0, 55.8, 34.1, 24.3.

HRMS (ESI/QTOF) m/z: $[M + Na]^+$ Calcd for $C_{13}H_{14}O_2S_2Na^+$ 289.0327; Found 289.0334.



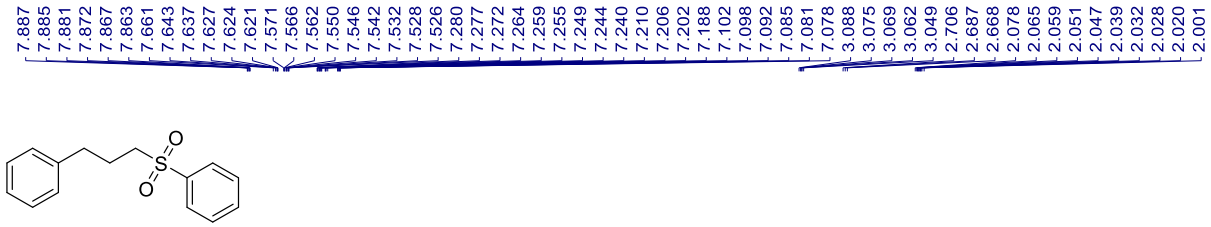
3-((3-phenylpropyl)sulfonyl)quinoline (4s): The product was purified by silica gel column chromatography, using petroleum ether/EA = 8/1 (v/v) as an eluent. White solid in 64% yield.

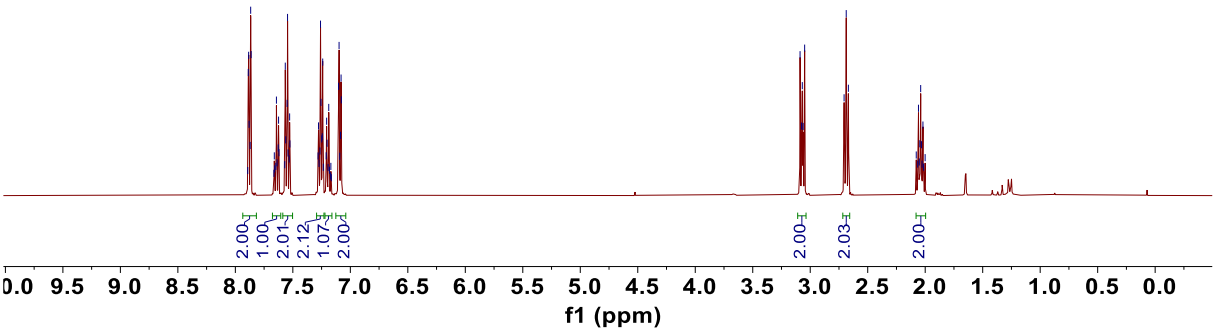
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.24 (d, J = 2.3 Hz, 1H), 8.72 (d, J = 2.3 Hz, 1H), 8.21 (d, J = 8.4 Hz, 1H), 7.97 – 7.89 (m, 2H), 7.72 – 7.68 (m, 1H), 7.25 – 7.14 (m, 3H), 7.09 – 7.06 (m, 2H), 3.21 – 3.17 (m, 2H),

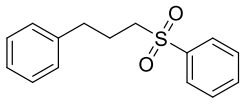
2.71 (t, J = 7.4 Hz, 2H), 2.14 – 2.06 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 149.8, 147.1, 139.5, 138.1, 133.0, 132.1, 129.7, 129.3, 128.7, 128.5, 128.4, 126.6, 126.3, 56.0, 34.1, 24.2.

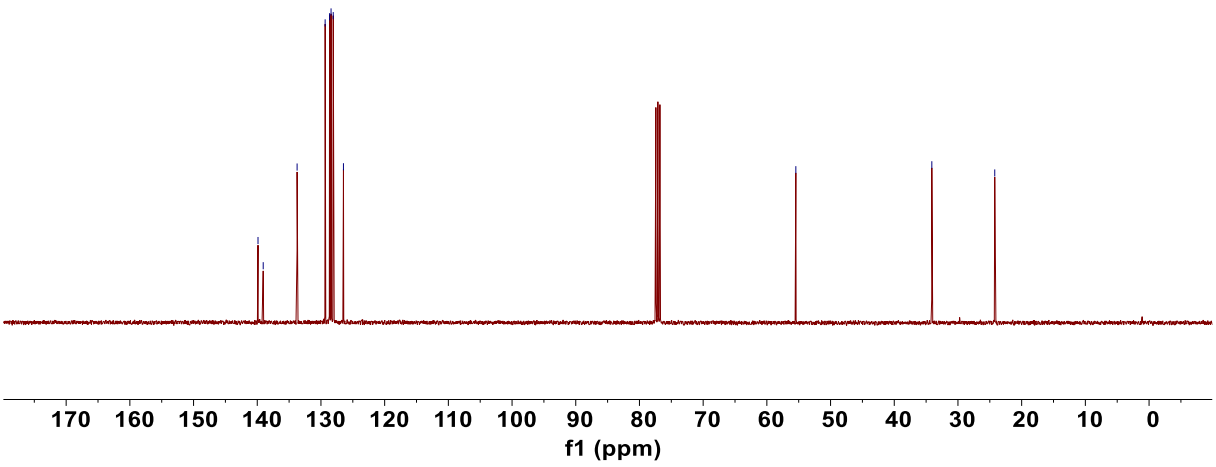
HRMS (ESI/QTOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{17}NO_2SH^+$ 312.1053; Found 312.1054.

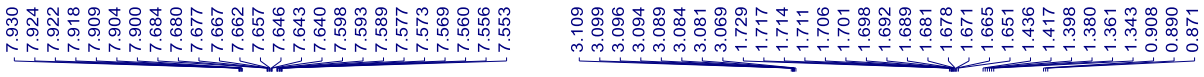
NMR Spectra of Substrates and Products







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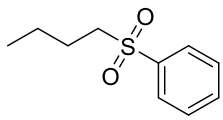
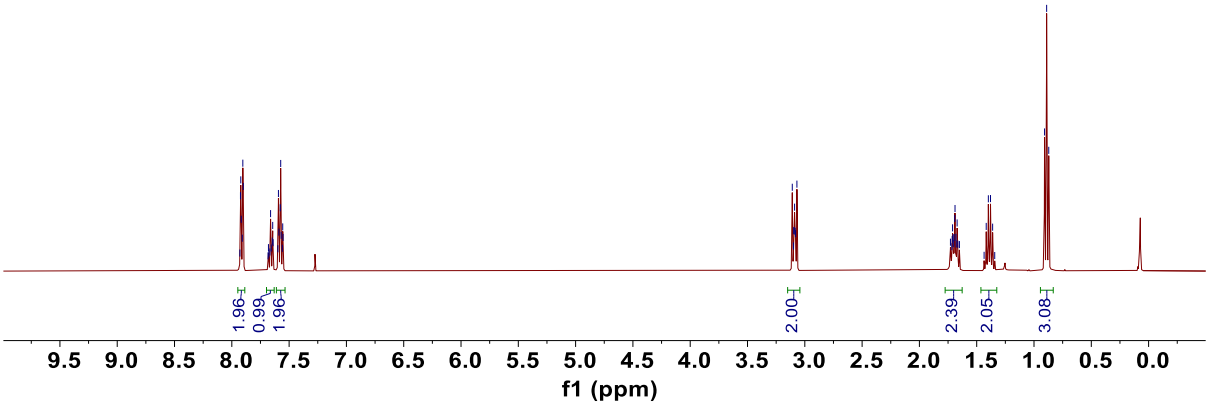
7.922
7.918
7.909
7.904
7.900
7.684
7.680
7.677
7.667
7.662
7.657
7.646
7.643
7.640
7.598
7.593
7.589
7.577
7.573
7.569
7.560
7.556
7.553
3.109
3.099
3.096
3.094
3.089
3.084
3.081
3.069
1.729
1.717
1.714
1.711
1.706
1.701
1.698
1.692
1.689
1.681
1.678
1.671
1.665
1.651
1.436
1.417
1.398
1.380
1.361
1.343
0.908
0.890
0.871

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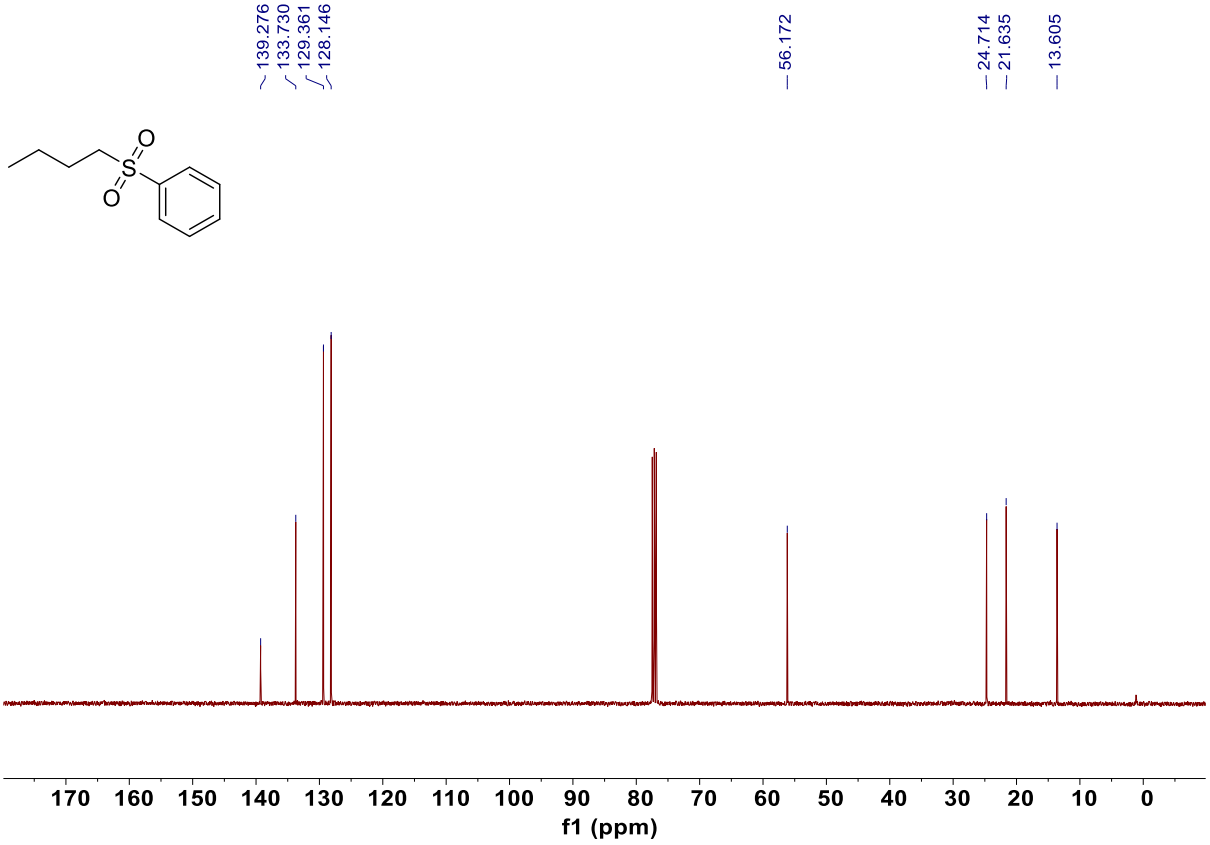
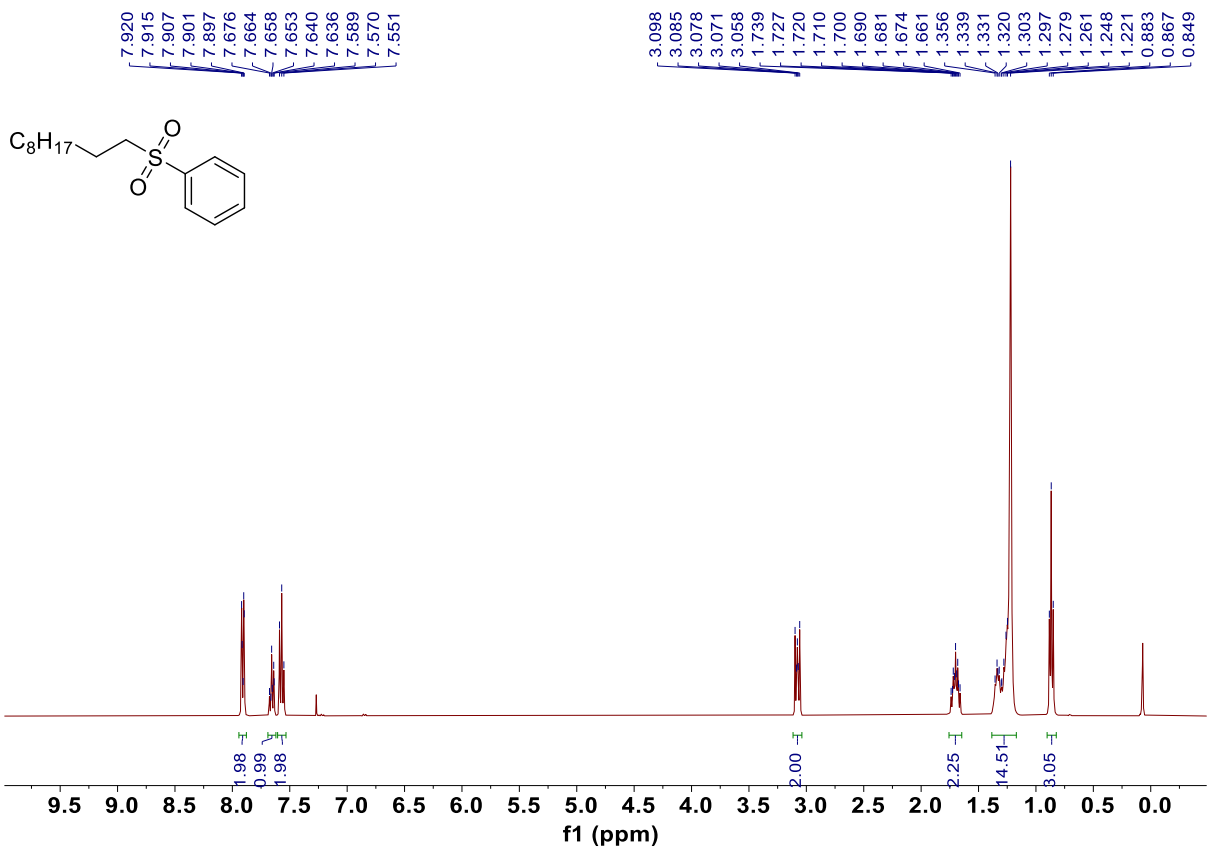
0.99
1.96
2.00
2.39
2.05
3.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


139.276
133.730
129.361
128.146
56.172
24.714
21.635
13.605
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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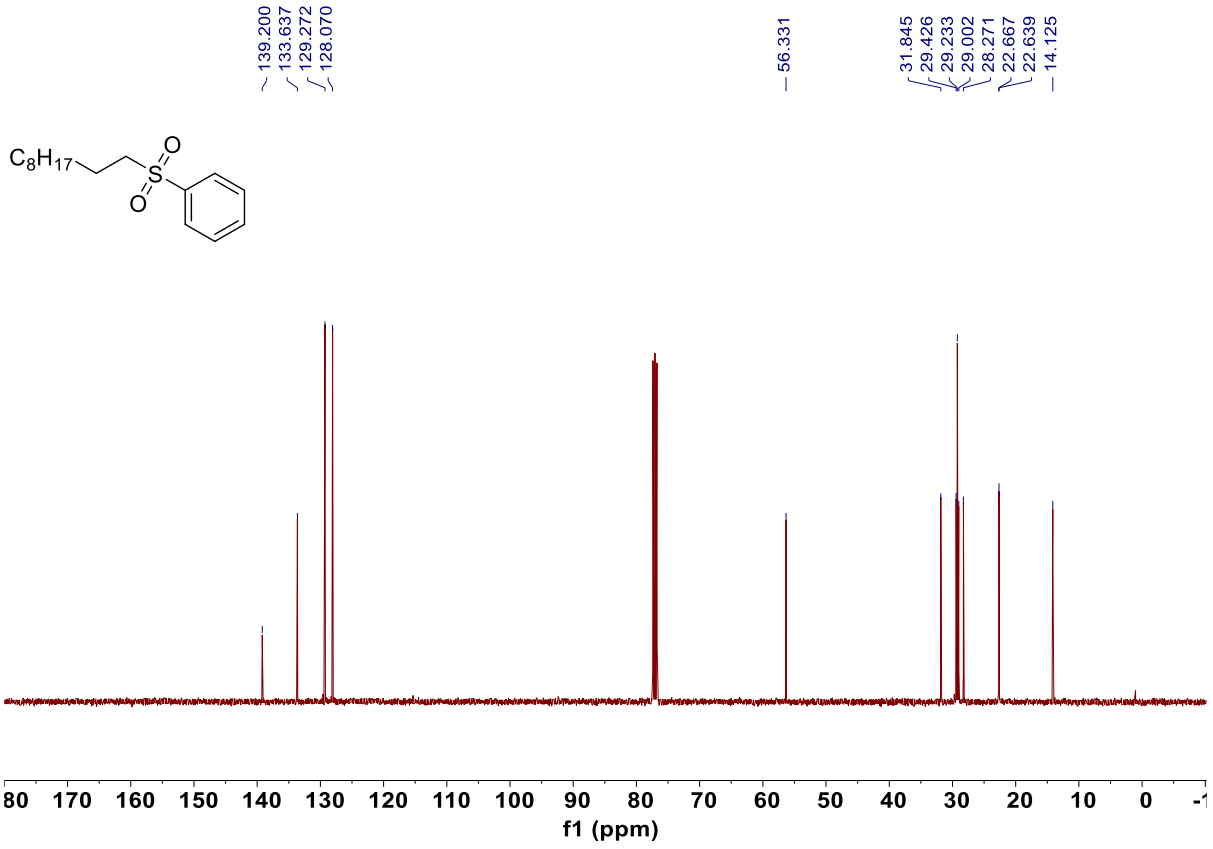
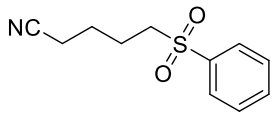
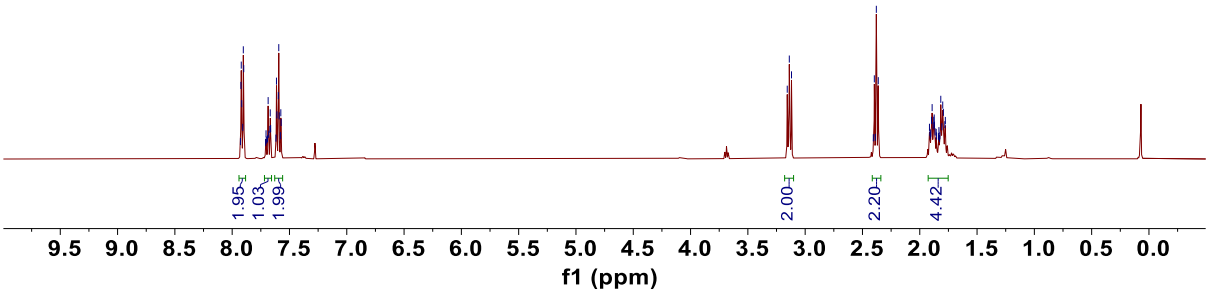
7.915
7.907
7.901
7.897
7.676
7.664
7.658
7.653
7.640
7.636
7.589
7.570
7.551
3.098
3.085
3.078
3.071
3.058
1.739
1.727
1.720
1.710
1.700
1.690
1.681
1.674
1.661
1.356
1.339
1.331
1.320
1.303
1.297
1.279
1.261
1.248
1.221
0.883
0.867
0.849
C8H17
O
S
O
O
1.98
0.99
1.98
2.00
2.25
14.51
3.05
9.5 9.0 8.5 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)


139.200
133.637
129.272
128.070
56.331
31.845
29.426
29.233
29.002
28.271
22.667
22.639
14.125
C8H17
O
S
O
O
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.928
7.924
7.921
7.917
7.908
7.903
7.899
7.708
7.705
7.702
7.692
7.686
7.681
7.671
7.668
7.664
7.618
7.613
7.610
7.597
7.593
7.590
7.580
7.576
7.573
3.156
3.138
3.119
2.405
2.396
2.388
2.379
2.362
1.915
1.898
1.892
1.884
1.878
1.874
1.871
1.833
1.817
1.807
1.800
1.794
1.781
1.777


NC
O
S
O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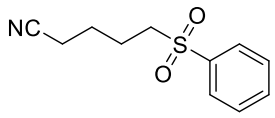
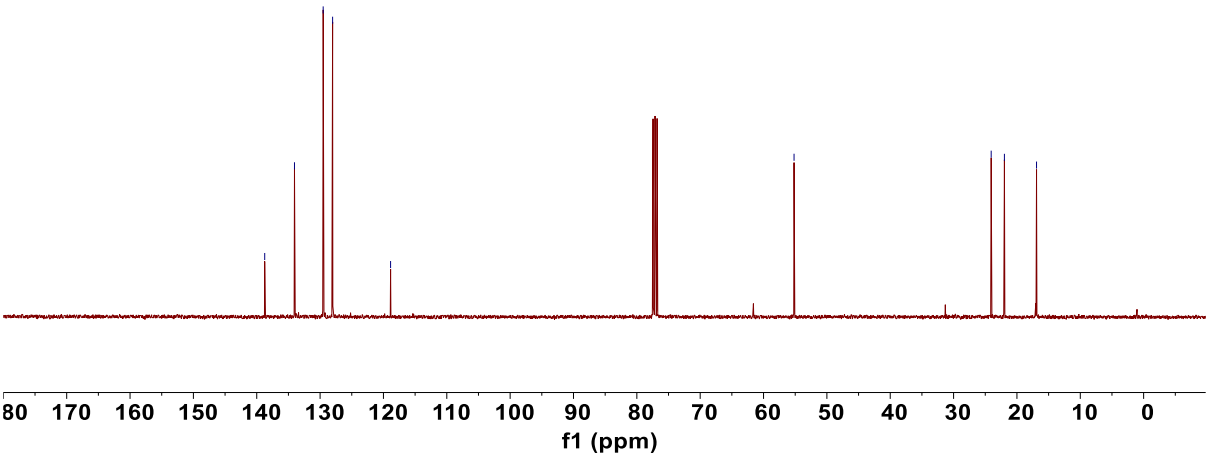
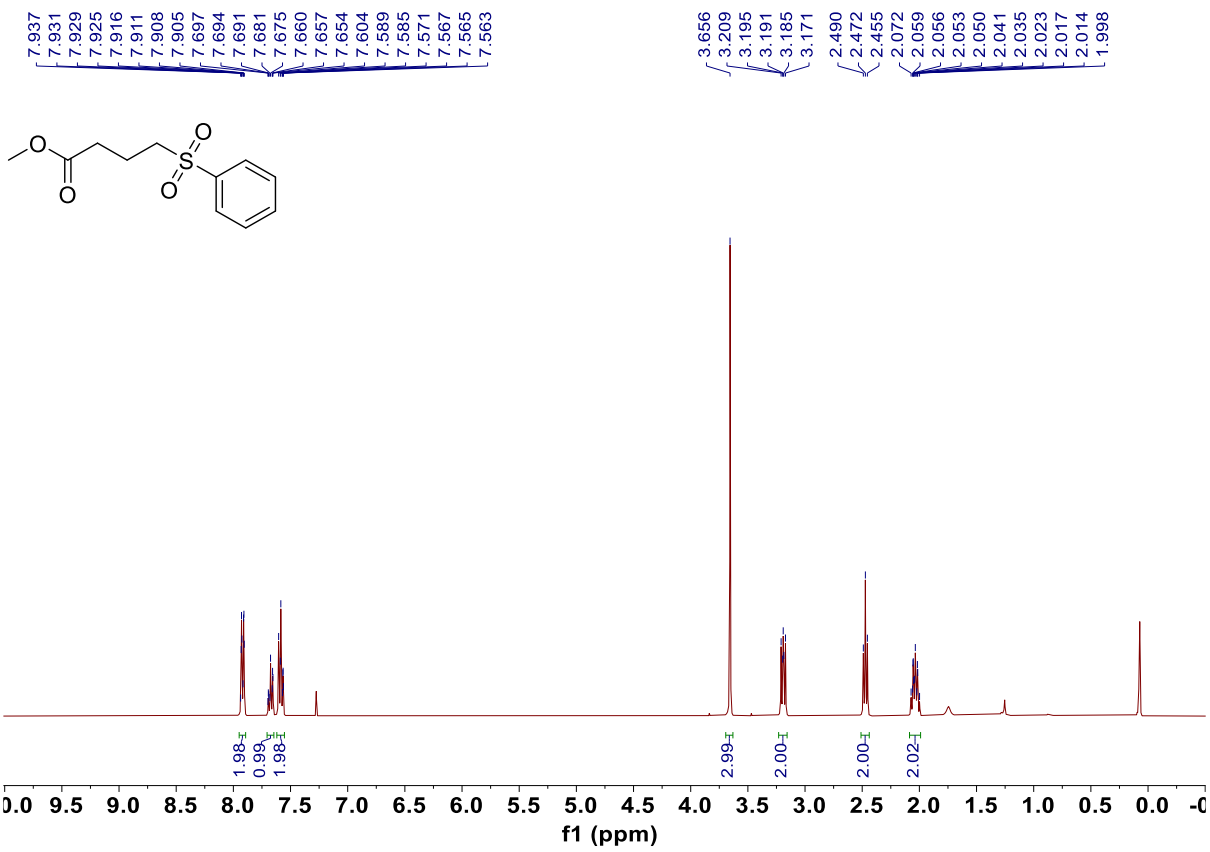
1.03
1.99
2.00
2.20
4.42
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


138.743
134.043
129.513
128.023
118.871
55.184
24.064
21.977
16.906


NC
O
S
O


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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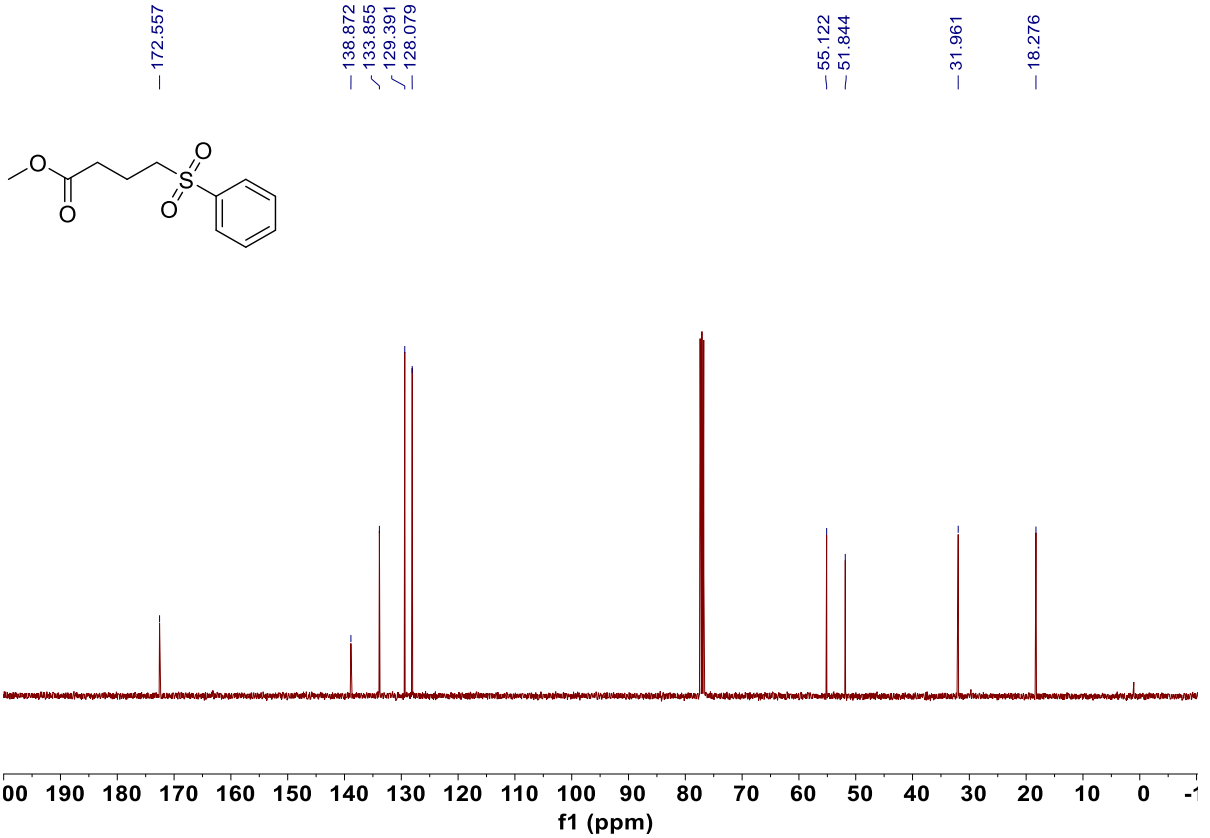
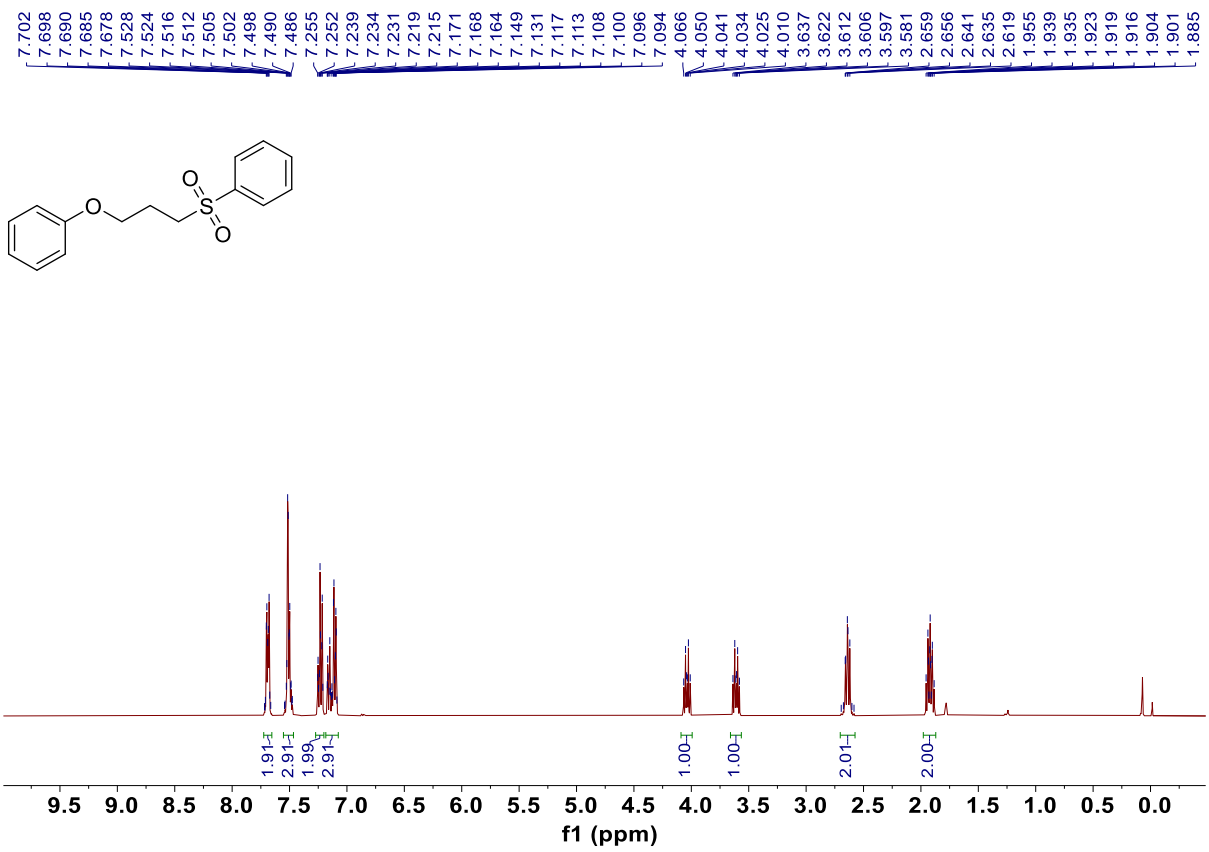
7.931
7.929
7.925
7.916
7.911
7.908
7.905
7.697
7.694
7.691
7.681
7.675
7.660
7.657
7.654
7.604
7.589
7.585
7.571
7.567
7.565
7.563
3.656
3.209
3.195
3.191
3.185
3.171
2.490
2.472
2.455
2.072
2.059
2.056
2.053
2.050
2.041
2.035
2.023
2.017
2.014
1.998
O
O
S
O
O
1.98
0.99
1.98
2.99
2.00
2.00
2.02
f1 (ppm)


172.557
138.872
133.855
129.391
128.079
55.122
51.844
31.961
18.276
O
O
S
O
O
f1 (ppm)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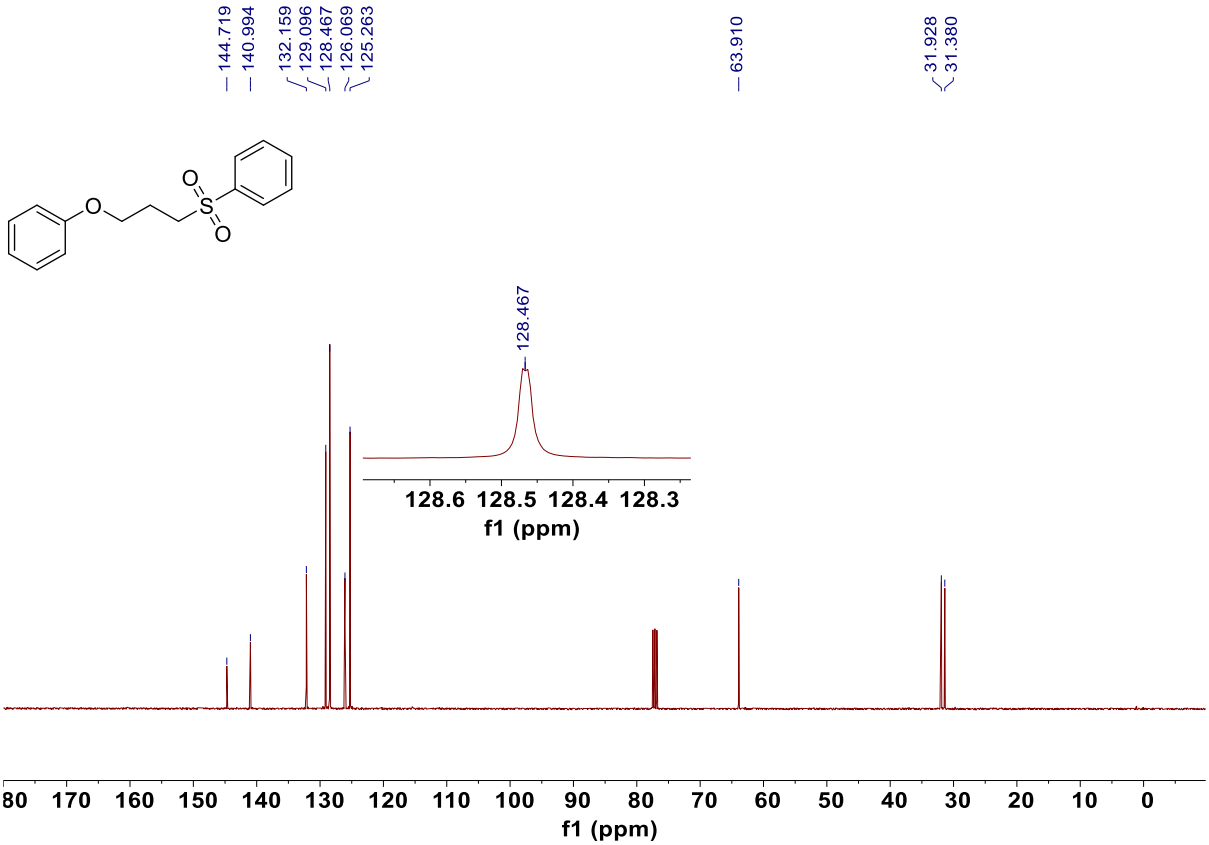
7.690
7.685
7.678
7.528
7.524
7.516
7.512
7.505
7.502
7.498
7.490
7.486
7.255
7.252
7.239
7.234
7.231
7.219
7.215
7.171
7.168
7.164
7.149
7.131
7.117
7.113
7.108
7.100
7.096
7.094
4.066
4.050
4.041
4.034
4.025
4.010
3.637
3.622
3.612
3.606
3.597
3.581
2.659
2.656
2.641
2.635
2.619
1.955
1.939
1.935
1.923
1.919
1.916
1.904
1.901
1.885
O
O
S
O
1.91
2.91
1.99
2.91
1.00
1.00
2.01
2.00
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)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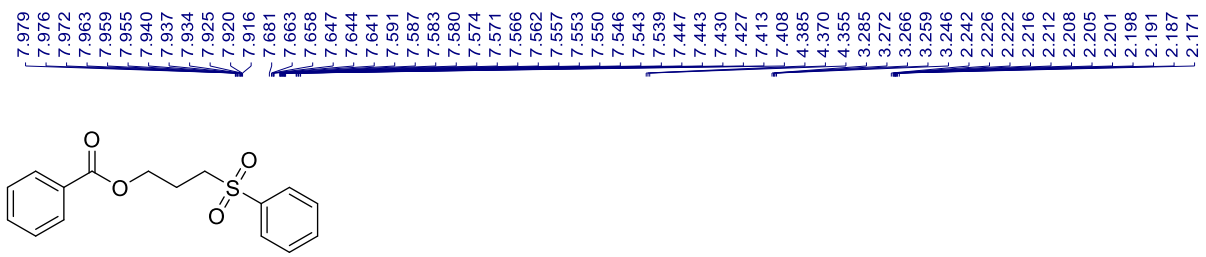
140.994
132.159
129.096
128.467
126.069
125.263
63.910
31.928
31.380
O
O
S
O
128.467
128.6 128.5 128.4 128.3
f1 (ppm)
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.972
7.963
7.959
7.955
7.940
7.937
7.934
7.925
7.920
7.916
7.681
7.663
7.658
7.647
7.644
7.641
7.591
7.587
7.583
7.580
7.574
7.571
7.566
7.562
7.557
7.553
7.550
7.546
7.543
7.539
7.447
7.443
7.430
7.427
7.413
7.408
4.385
4.370
4.355
3.285
3.272
3.266
3.259
3.246
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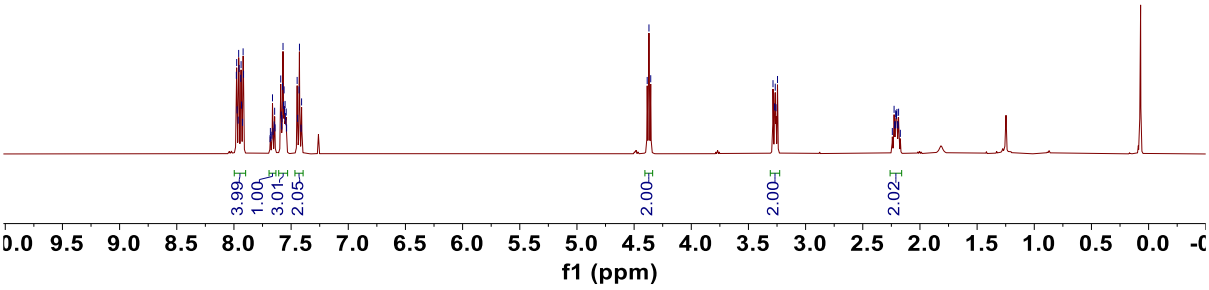
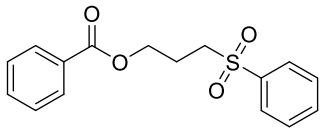
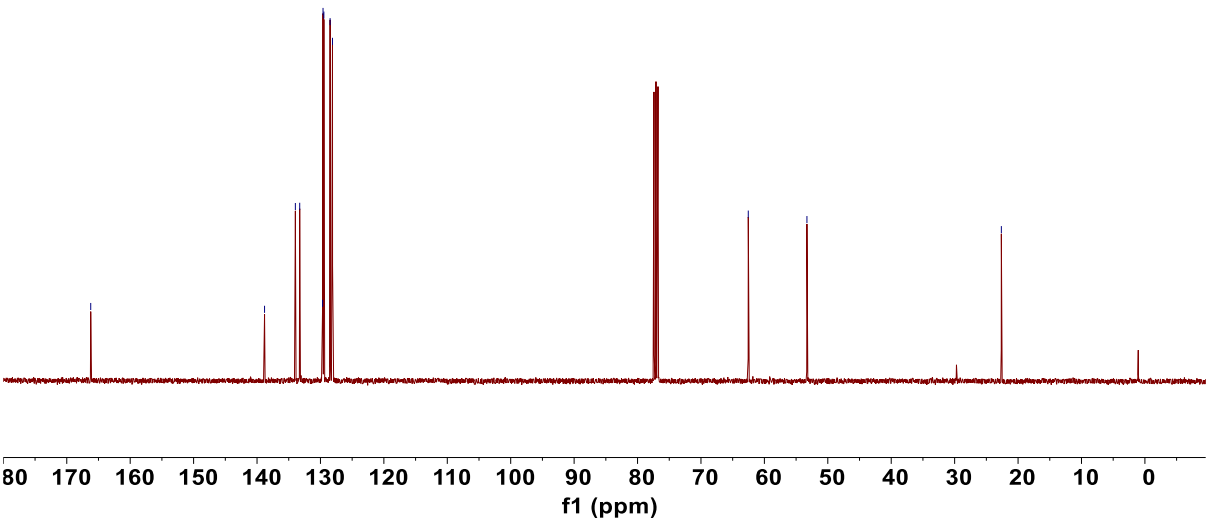
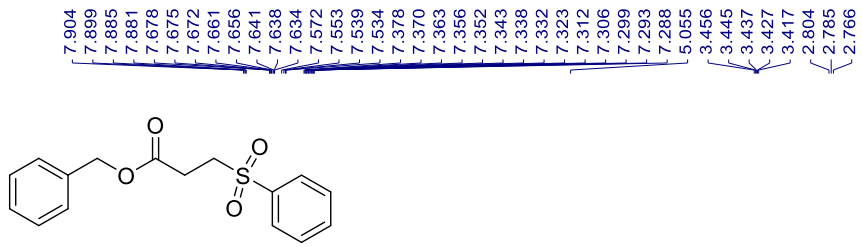
2.222
2.216
2.212
2.208
2.205
2.201
2.198
2.191
2.187
2.171


3.99
1.00
3.01
2.05
2.00
2.00
2.02
0.0 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)


166.222
138.813
133.955
133.270
129.664
129.592
129.461
128.477
128.100
62.540
53.292
22.635




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


7.904
7.899
7.885
7.881
7.678
7.675
7.672
7.661
7.656
7.641
7.638
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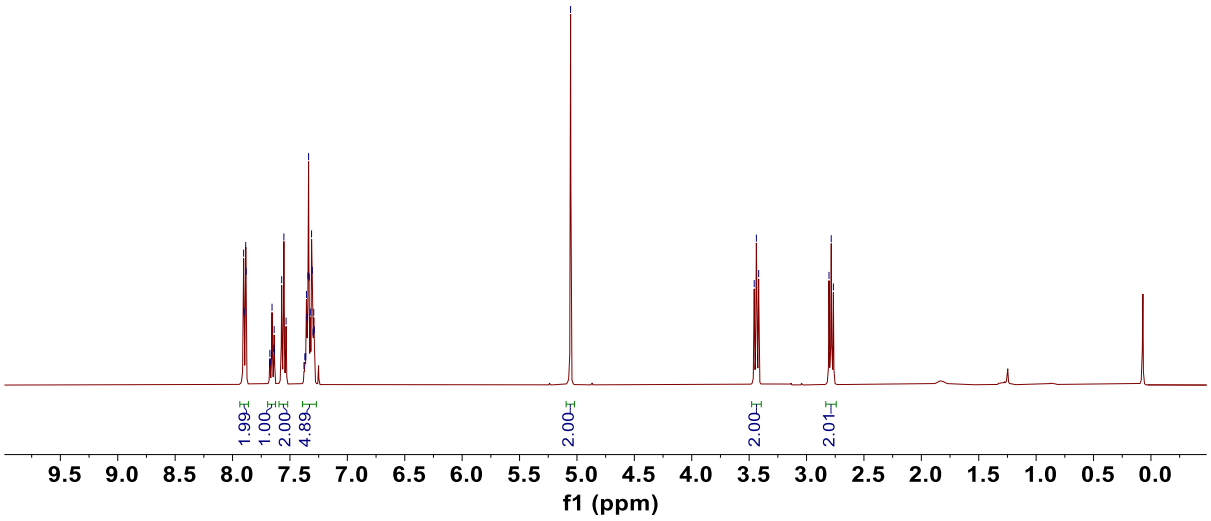
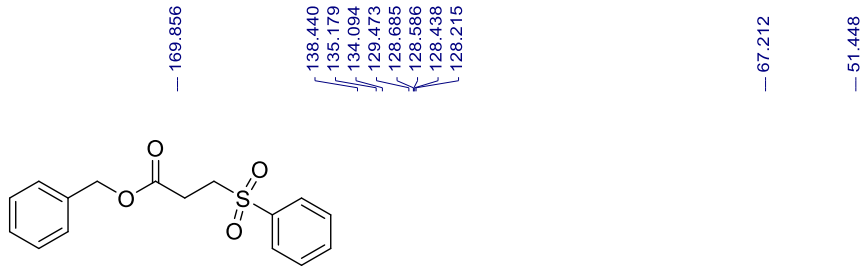
7.553
7.539
7.534
7.378
7.370
7.363
7.356
7.352
7.343
7.338
7.332
7.323
7.312
7.306
7.299
7.293
7.288
5.055
3.456
3.445
3.437
3.427
3.417
2.804
2.785
2.766


1.99
1.00
2.00
4.89
2.00
2.00
2.01
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)


169.856
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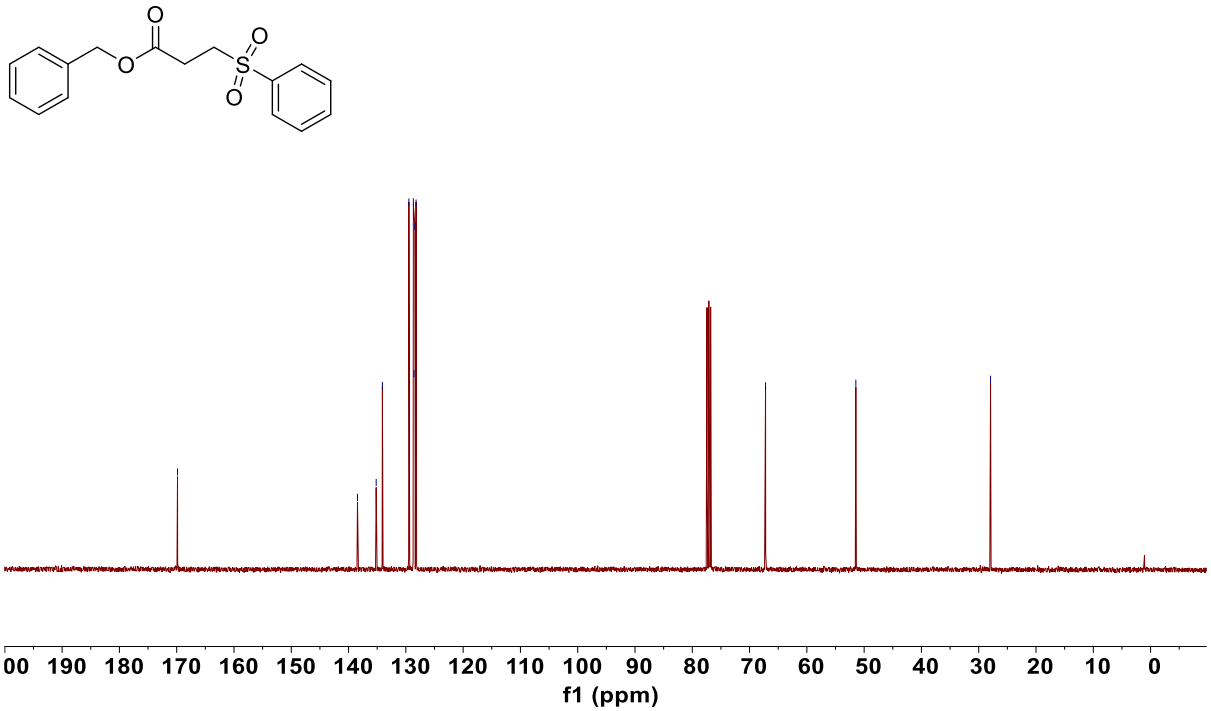
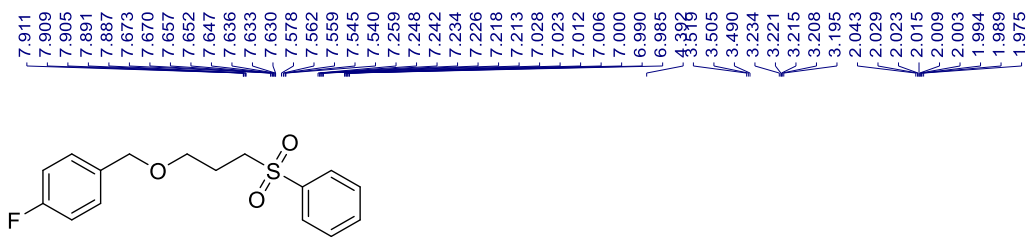
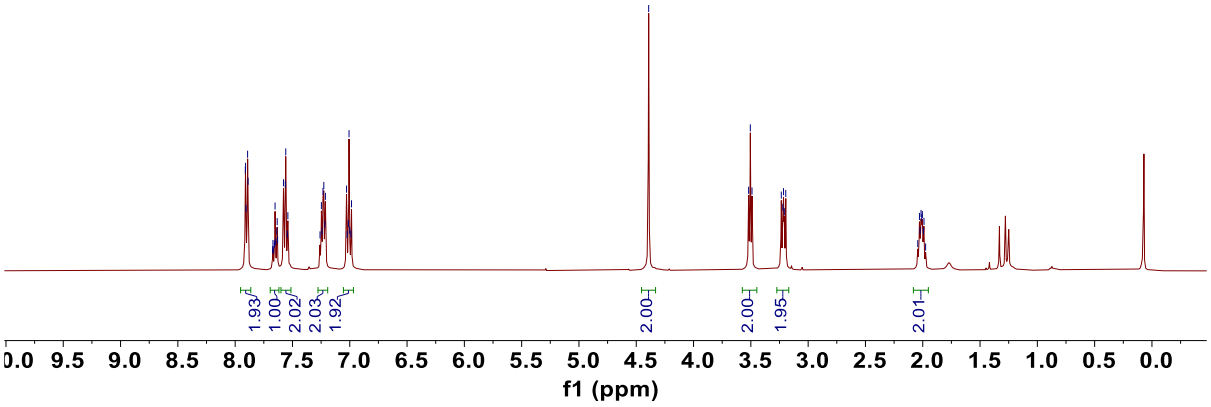
135.179
134.094
129.473
128.685
128.586
128.438
128.215
67.212
51.448
27.936

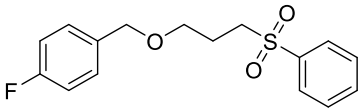

00 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

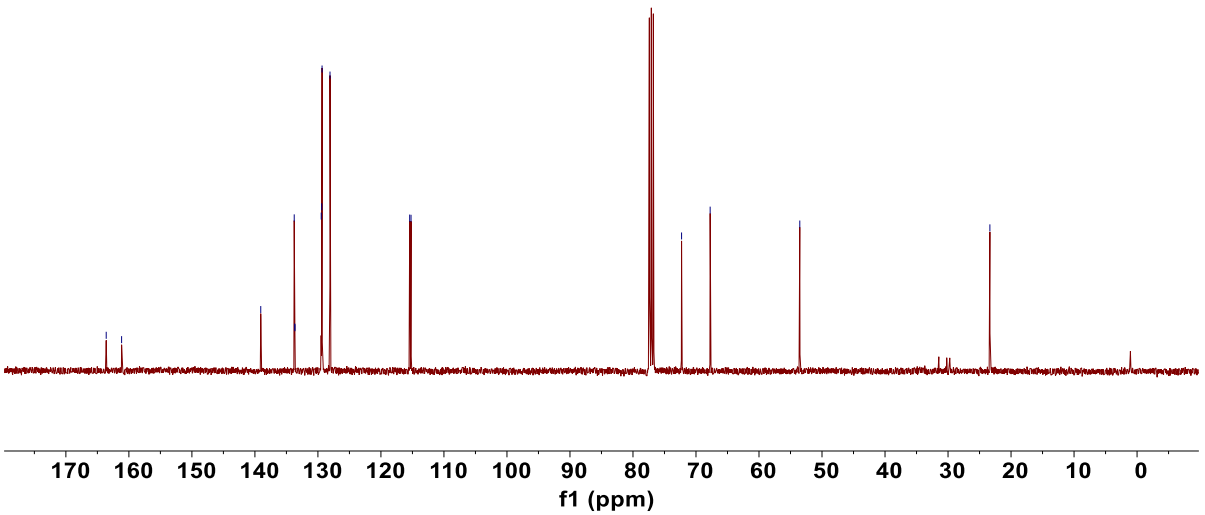

7.911
7.909
7.905
7.891
7.887
7.673
7.670
7.657
7.652
7.647
7.636
7.633
7.630
7.578
7.562
7.559
7.545
7.540
7.259
7.248
7.242
7.234
7.226
7.218
7.213
7.028
7.023
7.012
7.006
7.000
6.990
6.985
4.319
3.505
3.490
3.234
3.221
3.215
3.208
3.195
2.043
2.029
2.023
2.015
2.009
2.003
1.994
1.989
1.975

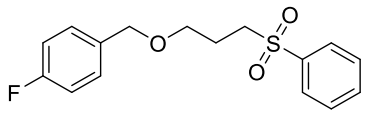
O
S
O
O
F


1.93
1.00
2.02
2.03
1.92
2.00
2.00
1.95
2.01
0.0 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)


163.598
161.156
139.073
133.761
133.681
133.649
129.475
129.395
129.342
128.082
115.436
115.224
72.287
67.752
53.526
23.358


O
S
O
O
F


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


F
O
S
O
O

-114.425
50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


7.915
7.912
7.909
7.900
7.895
7.891
7.676
7.663
7.658
7.652
7.642
7.639
7.636
7.584
7.580
7.567
7.564
7.560
7.550
7.545
7.543
7.313
7.306
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7.291
7.285
7.279
7.265
7.206
7.200
7.190
7.185
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3.494
3.239
3.225
3.219
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2.030
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2.016
2.010
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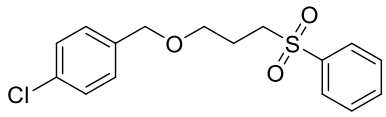
1.982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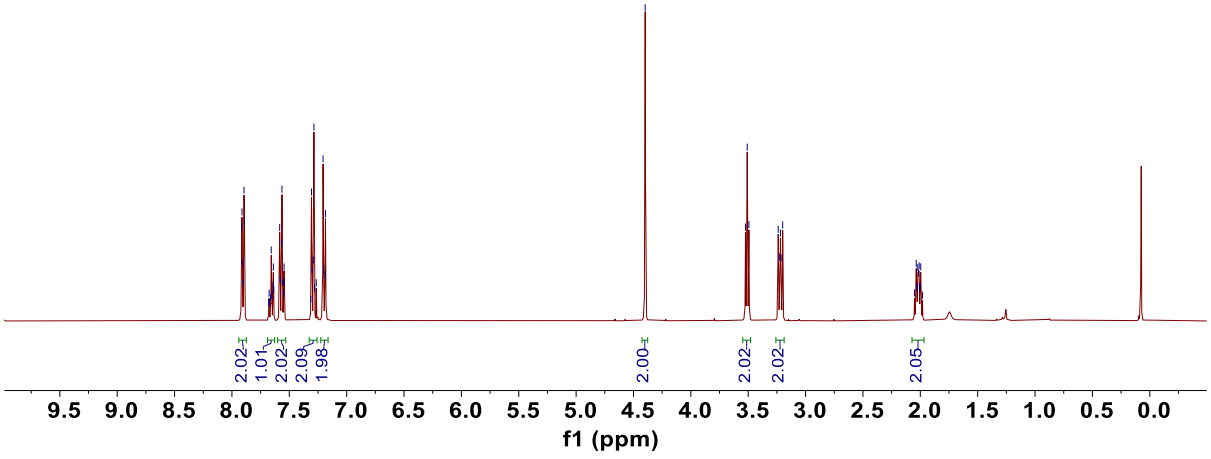
S
O
O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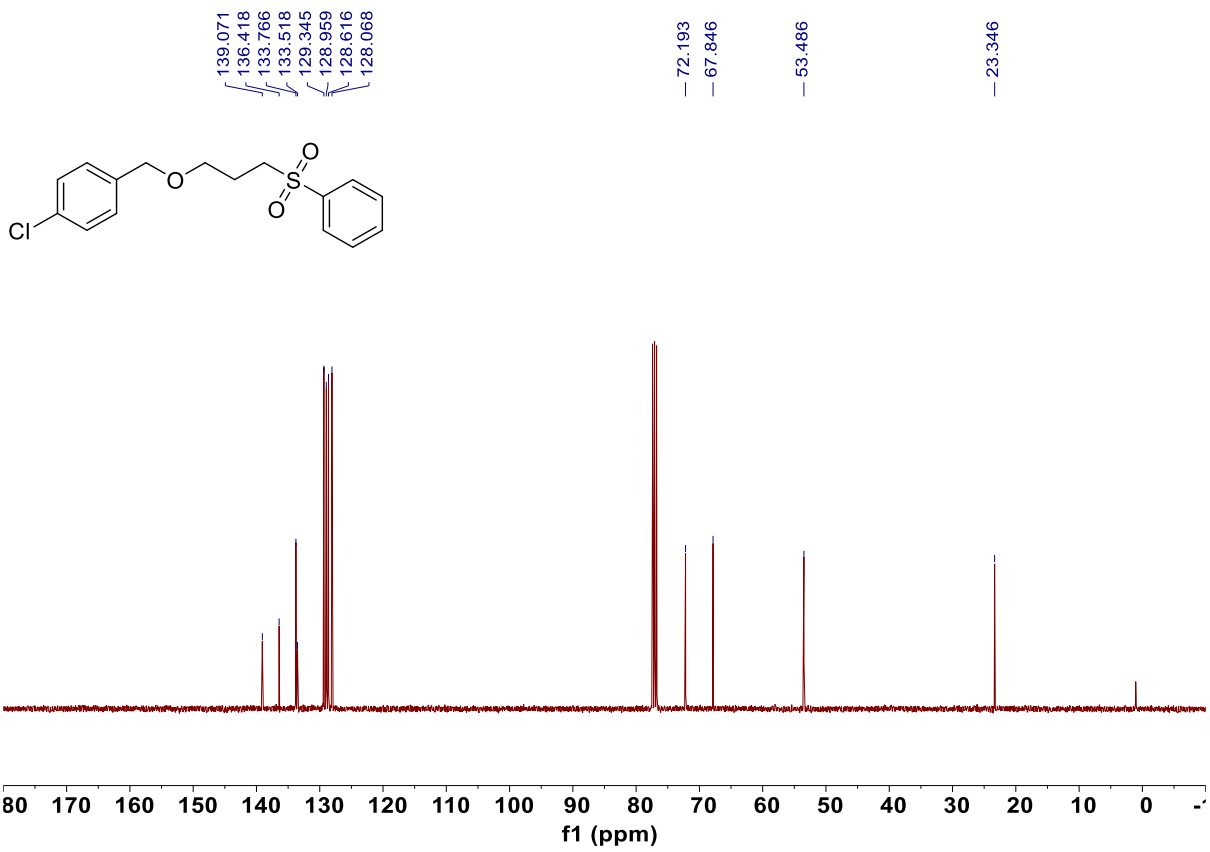
1.01
2.02
2.09
1.98
2.00
2.02
2.02
2.05
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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133.518
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128.616
128.068
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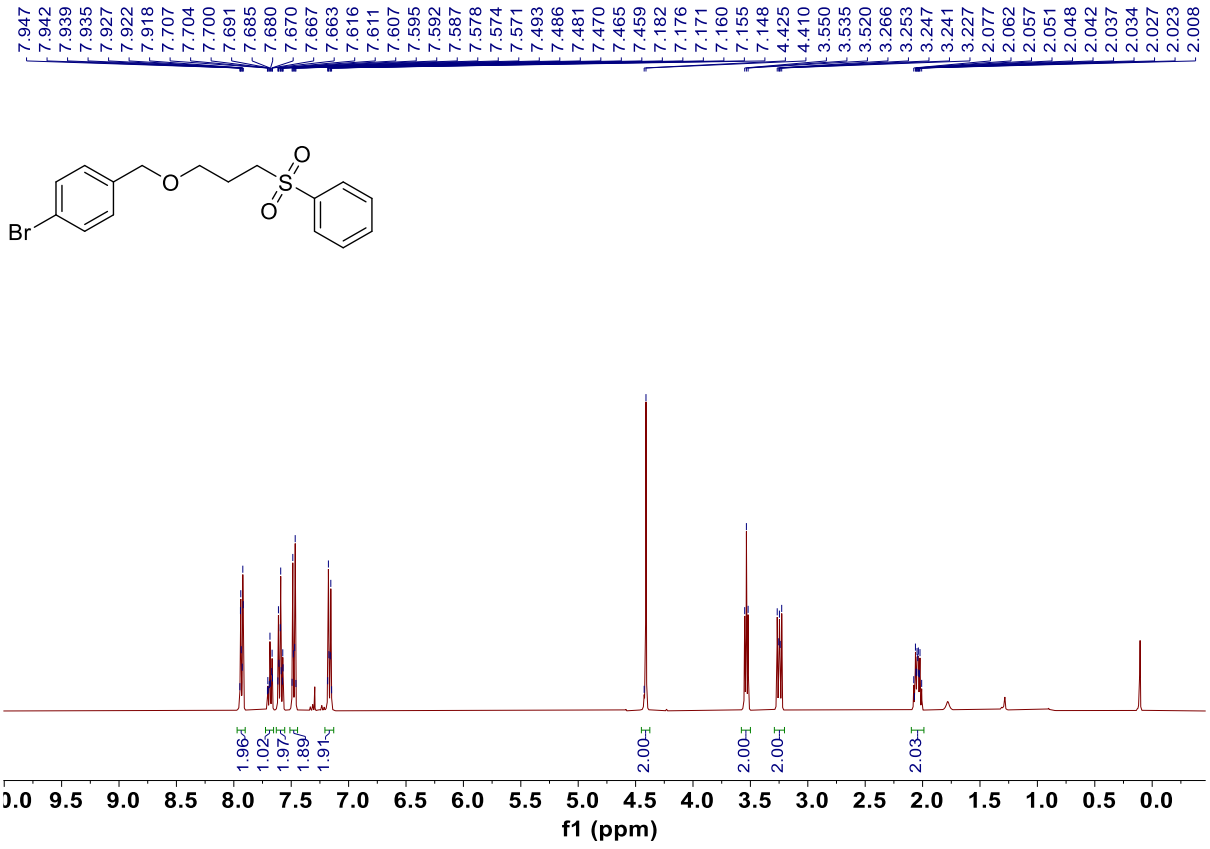
67.846
53.486
23.346
Cl
O
S
O
O
f1 (ppm)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7.939
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7.927
7.922
7.918
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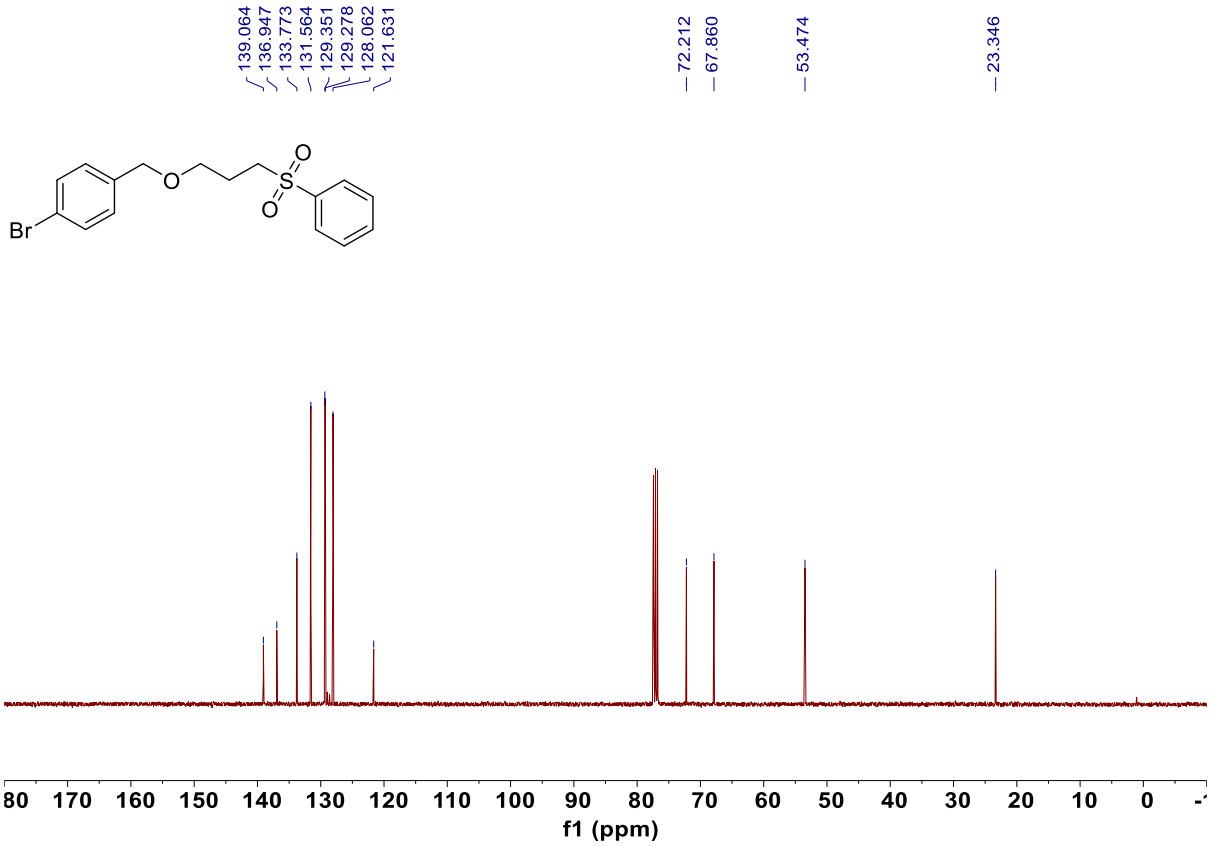
7.704
7.700
7.691
7.685
7.680
7.670
7.667
7.663
7.616
7.611
7.607
7.595
7.592
7.587
7.578
7.574
7.571
7.493
7.486
7.481
7.470
7.465
7.459
7.182
7.176
7.171
7.160
7.155
7.148
4.425
4.410
3.550
3.535
3.520
3.266
3.253
3.247
3.241
3.227
2.077
2.062
2.057
2.051
2.048
2.042
2.037
2.034
2.027
2.023
2.008
Br
O
S
O
O
1.96
1.02
1.97
1.89
1.91
2.00
2.00
2.00
2.03
f1 (ppm)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136.947
133.773
131.564
129.351
129.278
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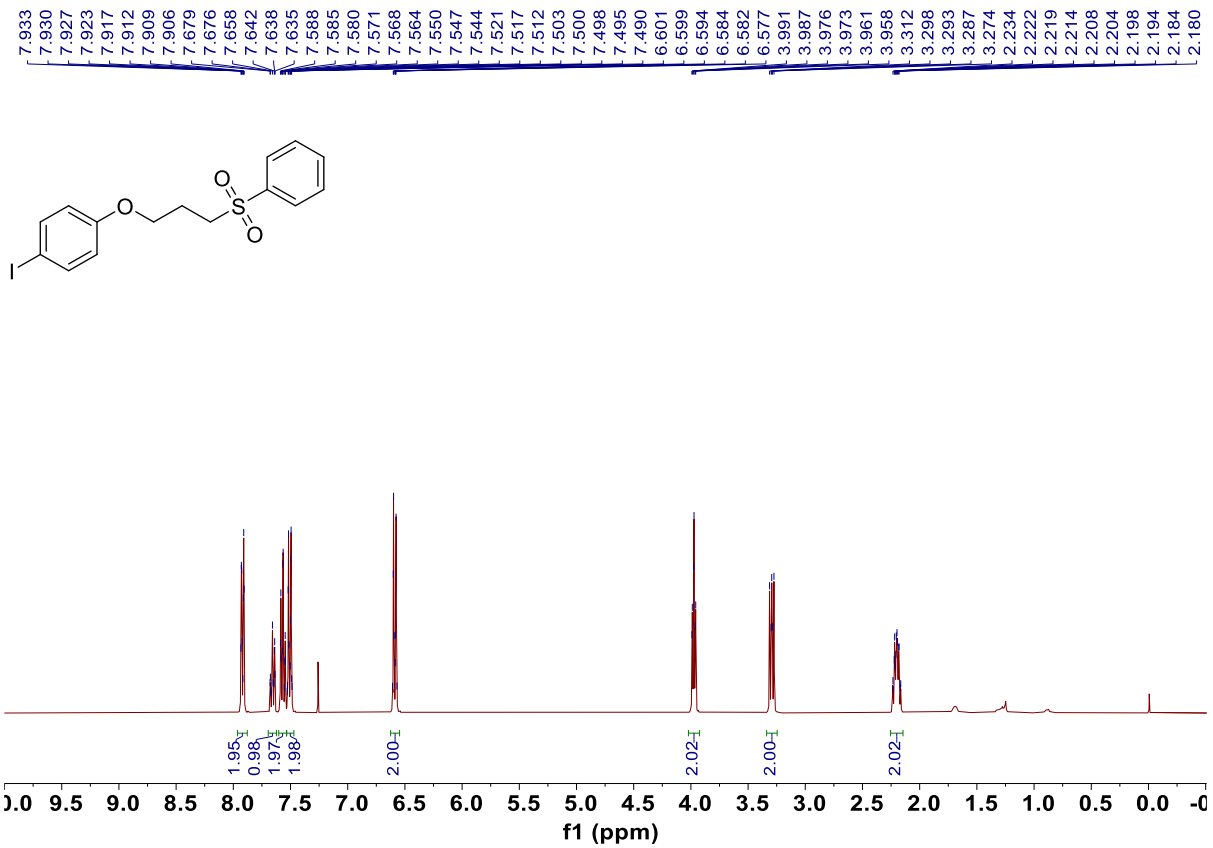
121.631
72.212
67.860
53.474
23.346
Br
O
S
O
O
f1 (ppm)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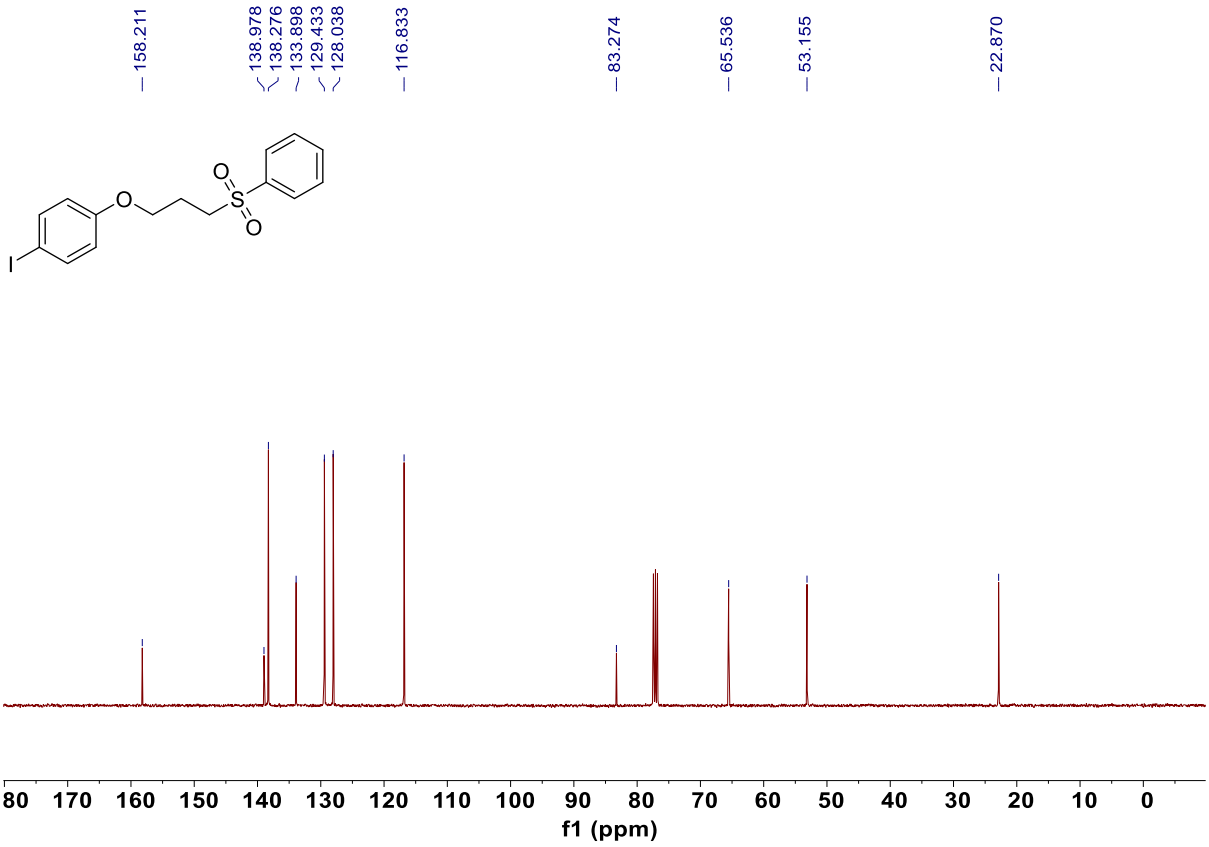
7.927
7.923
7.917
7.912
7.909
7.906
7.679
7.676
7.658
7.642
7.638
7.635
7.588
7.585
7.580
7.571
7.568
7.564
7.550
7.547
7.544
7.521
7.517
7.512
7.503
7.500
7.498
7.495
7.490
6.601
6.599
6.594
6.584
6.582
6.577
3.991
3.987
3.976
3.973
3.961
3.958
3.312
3.298
3.293
3.287
3.274
2.234
2.222
2.219
2.214
2.208
2.204
2.198
2.194
2.184
2.180
O
S
O
O
I
1.95
0.98
1.97
1.98
2.00
2.02
2.00
2.02
f1 (ppm)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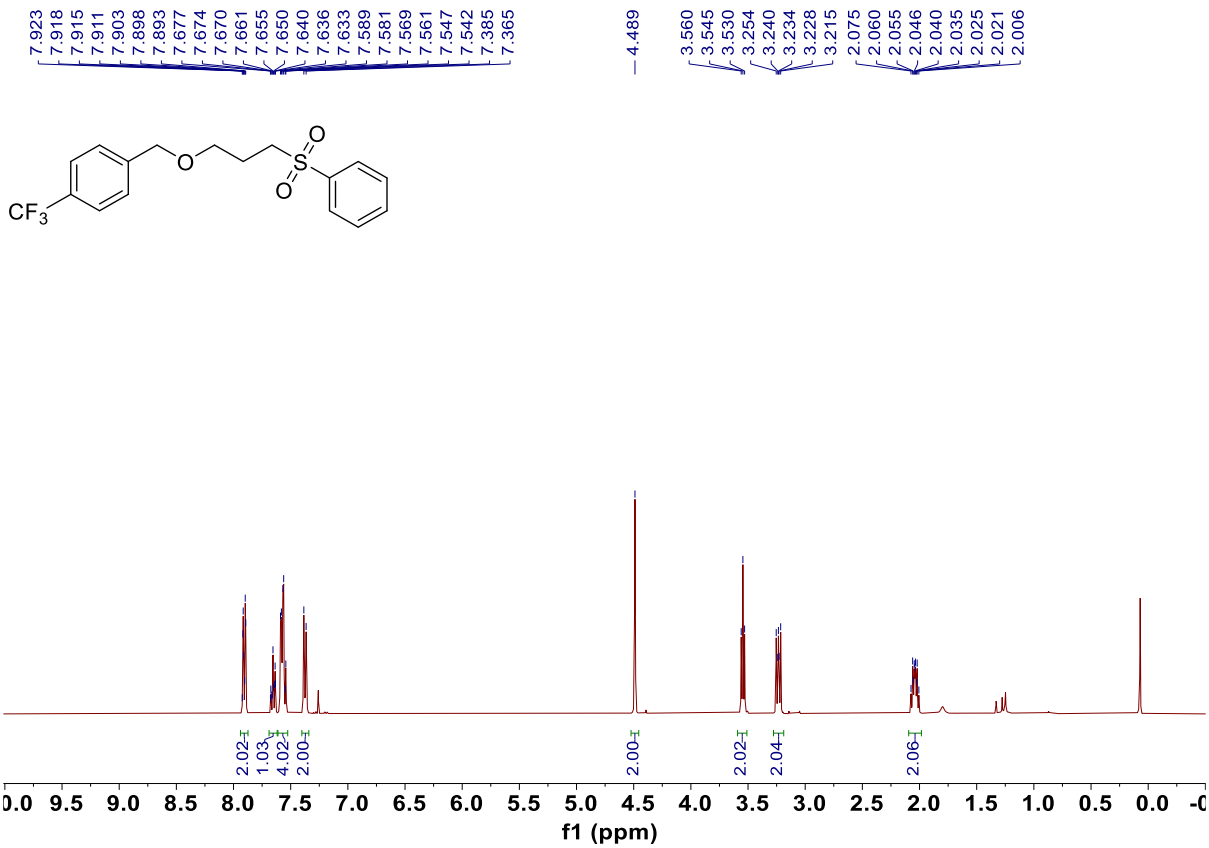
138.978
138.276
133.898
129.433
128.038
116.833
83.274
65.536
53.155
22.870
O
S
O
O
I
f1 (ppm)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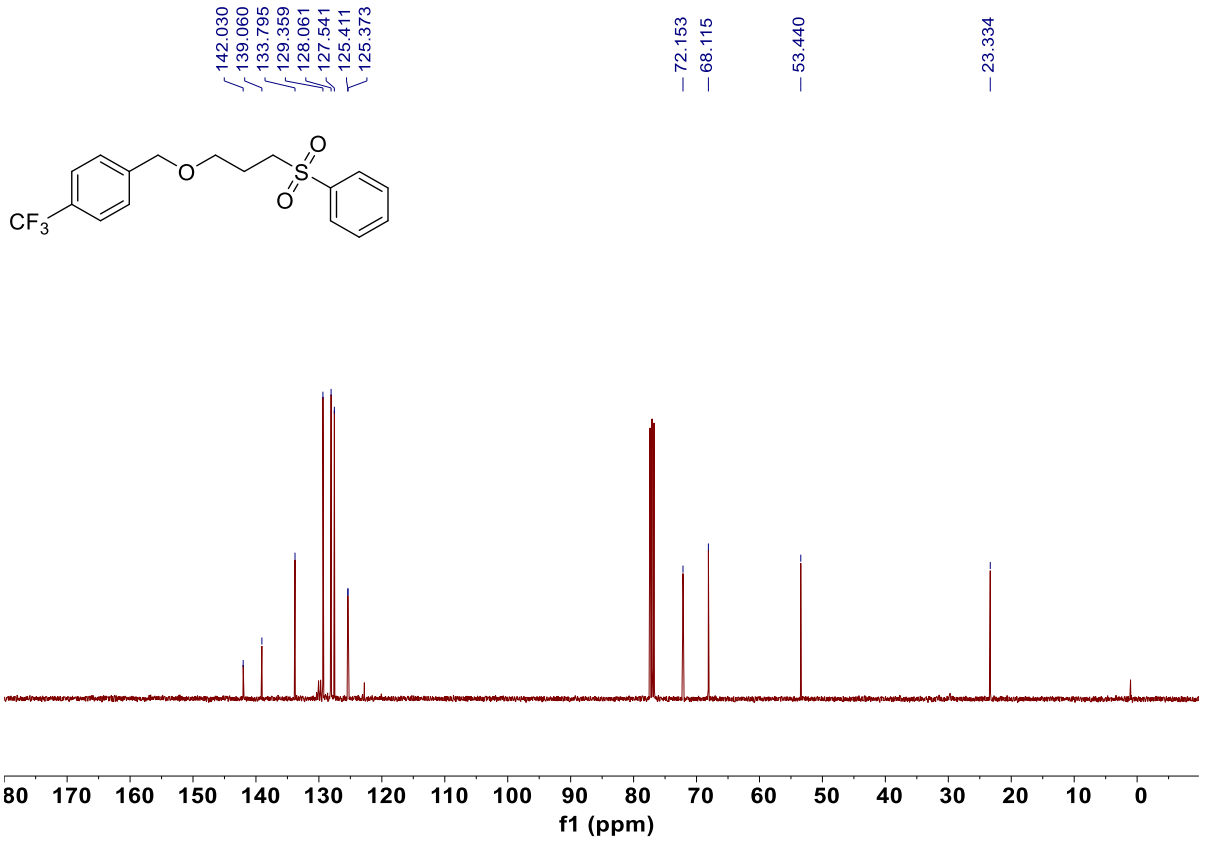
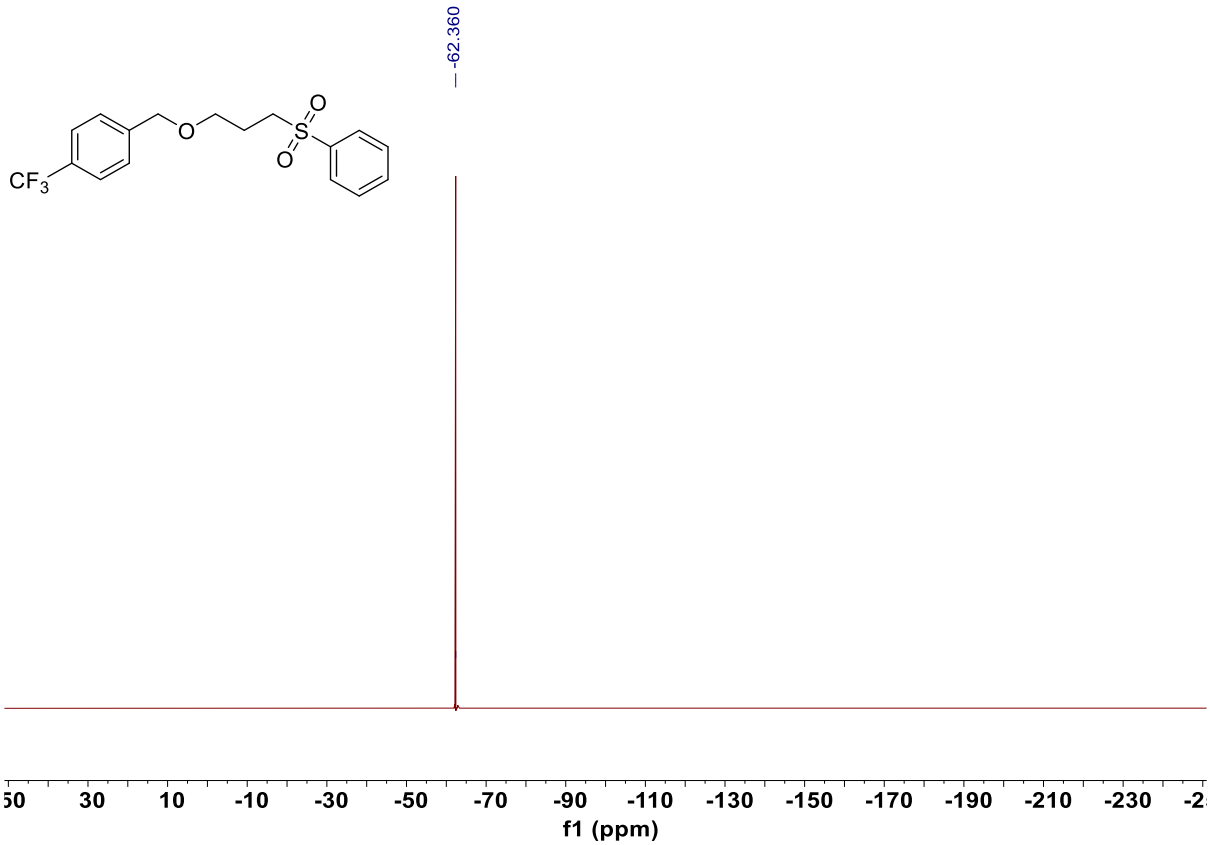
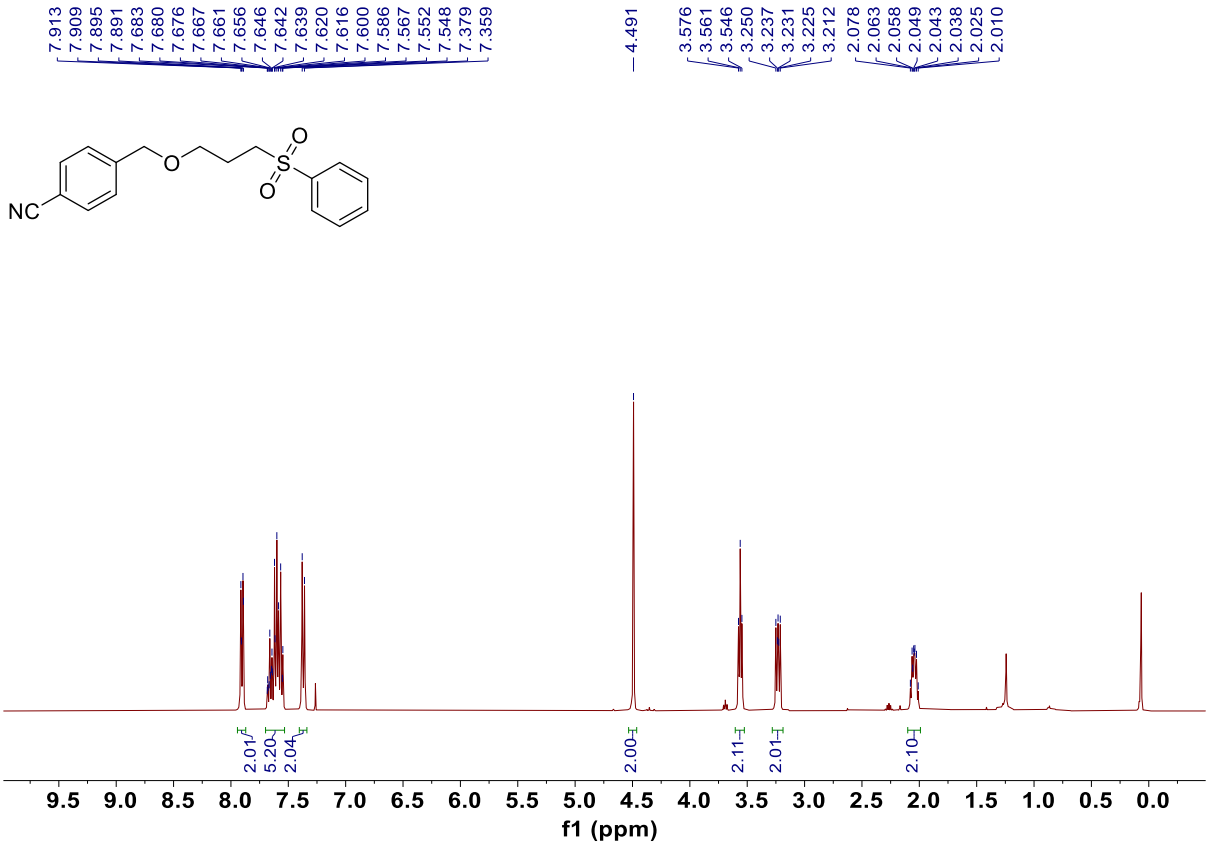
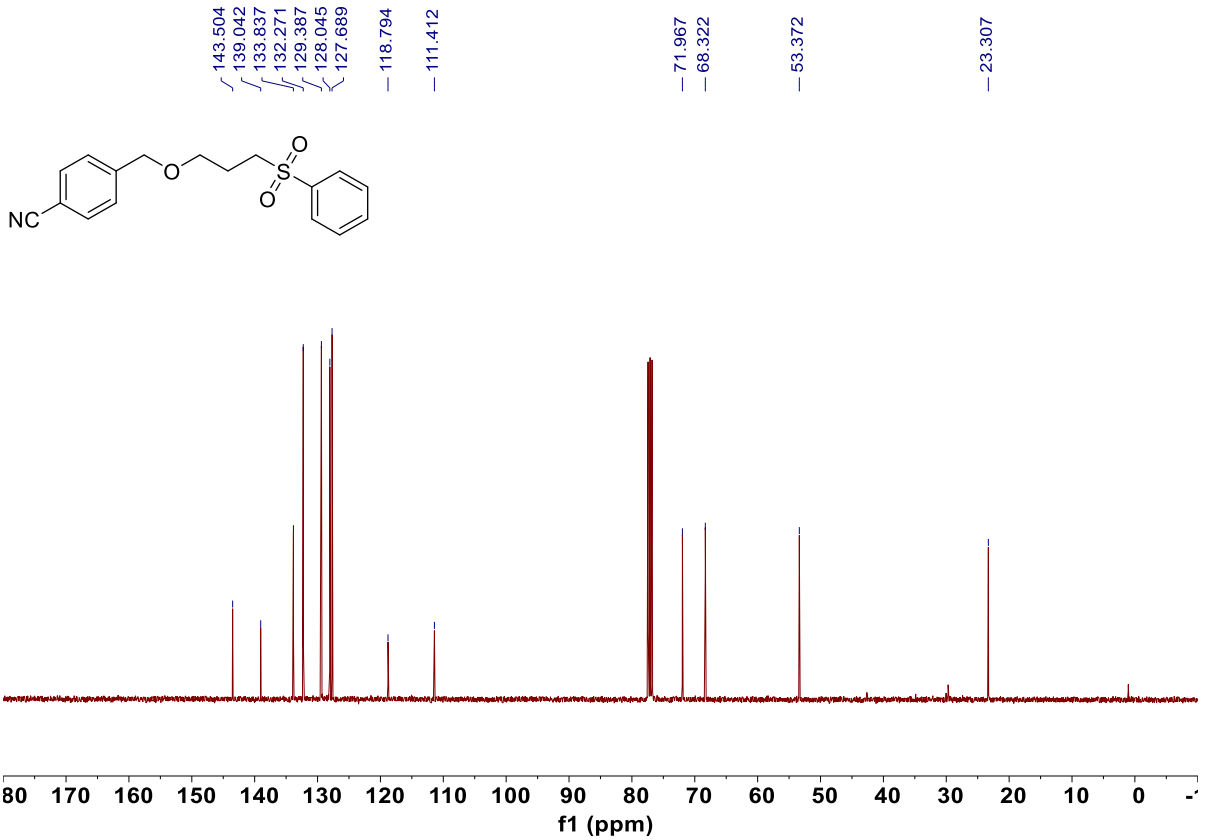
7.915
7.911
7.903
7.898
7.893
7.677
7.674
7.670
7.661
7.655
7.650
7.640
7.636
7.633
7.589
7.581
7.569
7.561
7.547
7.542
7.385
7.365
4.489
3.560
3.545
3.530
3.254
3.240
3.234
3.228
3.215
2.075
2.060
2.055
2.046
2.040
2.035
2.025
2.021
2.006
O
S
O
O
CF3
2.02
1.03
4.02
2.00
2.00
2.02
2.04
2.06
f1 (ppm)


142.030
139.060
133.795
129.359
128.061
127.541
125.411
125.373
72.153
68.115
53.440
23.334
O
S
O
O
CF3
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-62.360
O
S
O
O
CF3
50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


7.913
7.909
7.895
7.891
7.683
7.680
7.676
7.667
7.661
7.656
7.646
7.642
7.639
7.620
7.616
7.600
7.586
7.567
7.552
7.548
7.379
7.359
4.491
3.576
3.561
3.546
3.250
3.237
3.231
3.225
3.212
2.078
2.063
2.058
2.049
2.043
2.038
2.025
2.010
NC
O
S
O
O
2.01
5.20
2.04
2.00
2.11
2.01
2.10
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)


143.504
139.042
133.837
132.271
129.387
128.045
127.689
118.794
111.412
71.967
68.322
53.372
23.307
NC
O
S
O
O
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.949
7.943
7.941
7.937
7.928
7.923
7.919
7.770
7.767
7.760
7.757
7.694
7.691
7.688
7.678
7.672
7.667
7.657
7.654
7.650
7.601
7.597
7.584
7.581
7.576
7.573
7.563
7.560
7.111
7.102
7.099
7.089
4.364
4.348
4.333
3.274
3.260
3.254
3.248
3.234
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2.196
2.192
2.188
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2.182
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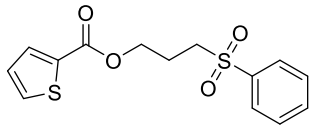
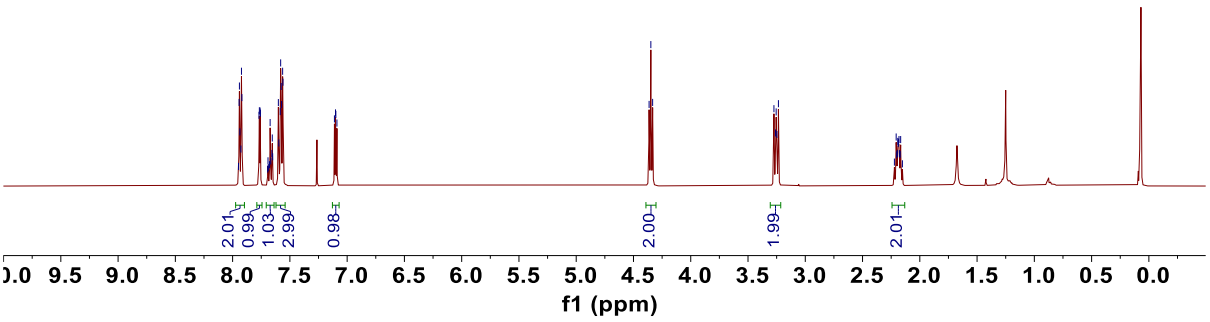
2.171
2.167
2.152

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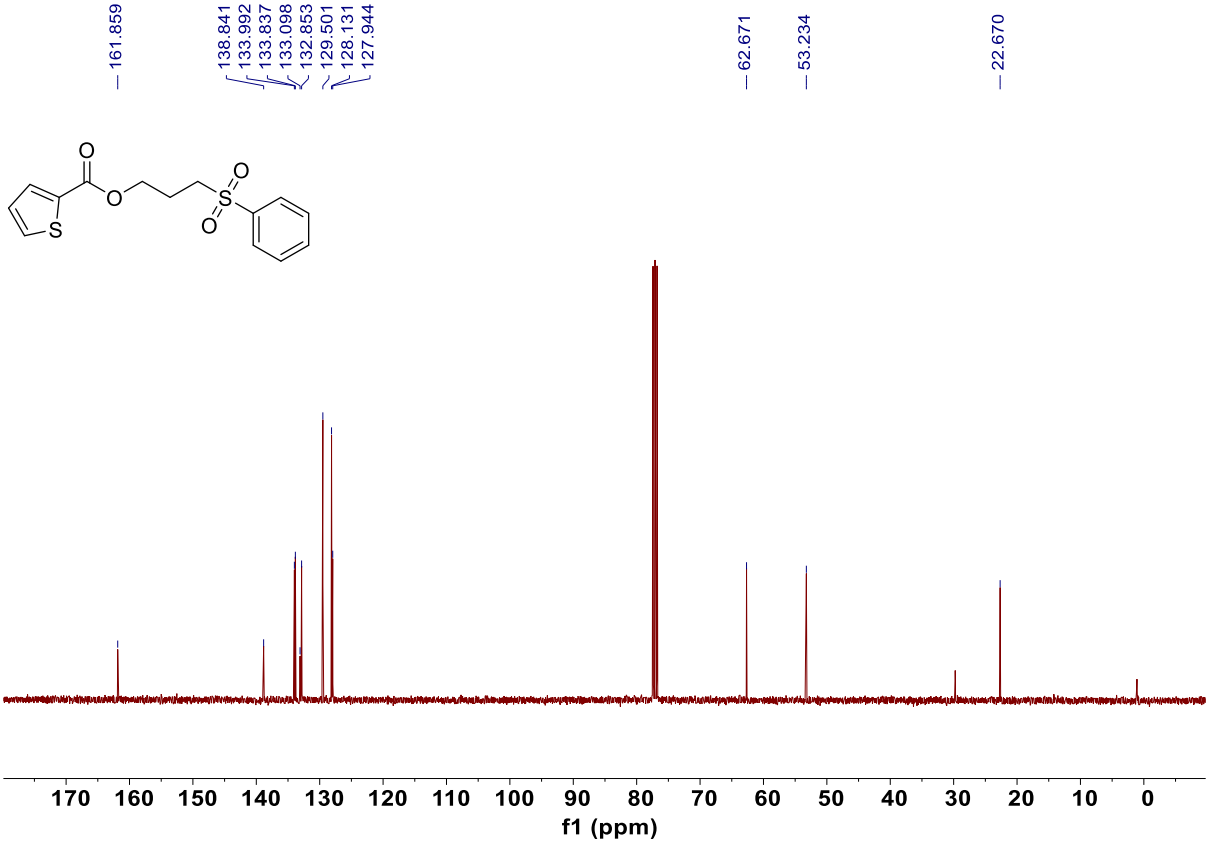
0.99
1.03
2.99
0.98
2.00
1.99
2.01
f1 (ppm)


161.859
138.841
133.992
133.837
133.098
132.853
129.501
128.131
127.944
62.671
53.234
22.670
f1 (ppm)


7.934
7.928
7.925
7.922
7.913
7.908
7.904
7.680
7.667
7.662
7.657
7.646
7.643
7.640
7.594
7.589
7.585
7.573
7.569
7.565
7.562
7.555
7.551
7.549
7.151
7.149
7.142
7.140
6.507
6.503
6.498
6.494
4.364
4.349
3.246
3.240
3.233
3.220
2.210
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2.190
2.185
2.181
2.179
2.176
2.174
2.170
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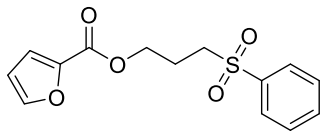
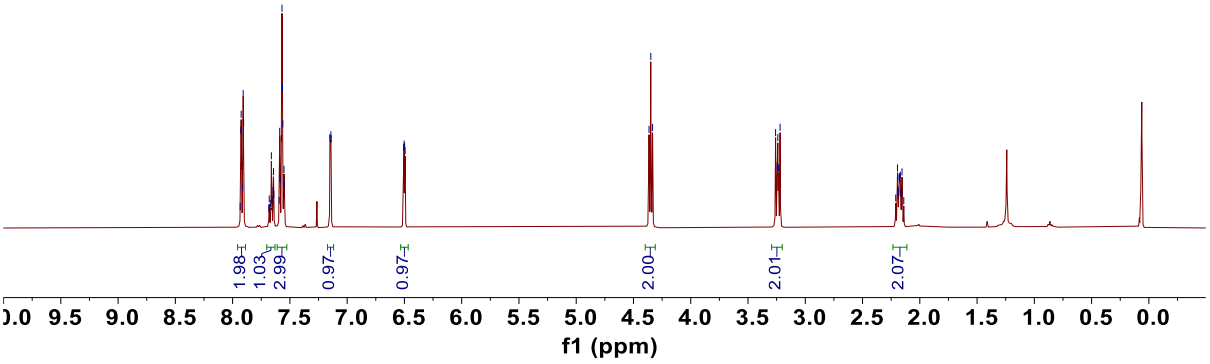
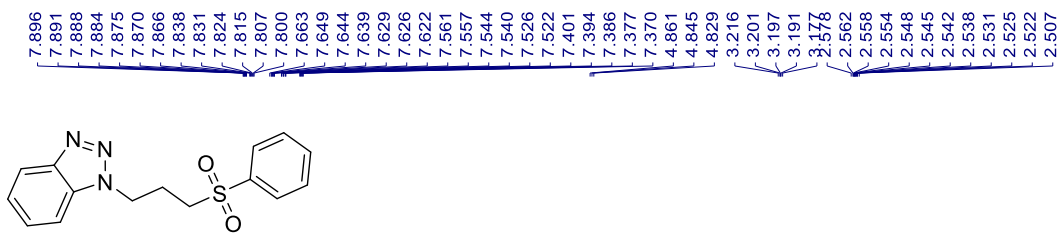
2.159
2.155
2.140




1.98
1.03
2.99
0.97
0.97
2.00
2.01
2.07
f1 (ppm)


158.301
146.631
144.120
138.772
133.962
129.450
128.084
118.425
111.986
62.441
53.143
22.592
f1 (ppm)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7.870
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7.838
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7.824
7.815
7.807
7.800
7.663
7.649
7.644
7.639
7.629
7.626
7.622
7.561
7.557
7.544
7.540
7.526
7.522
7.401
7.394
7.386
7.377
7.370
4.861
4.845
4.829
3.216
3.201
3.197
3.191
3.177
3.158
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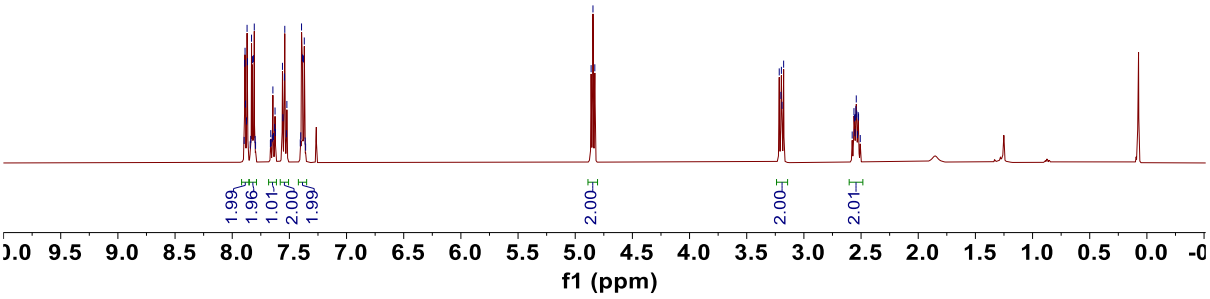
2.522
2.507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1.96
1.01
2.00
1.99
2.00
2.00
2.01
f1 (ppm)


144.430
138.662
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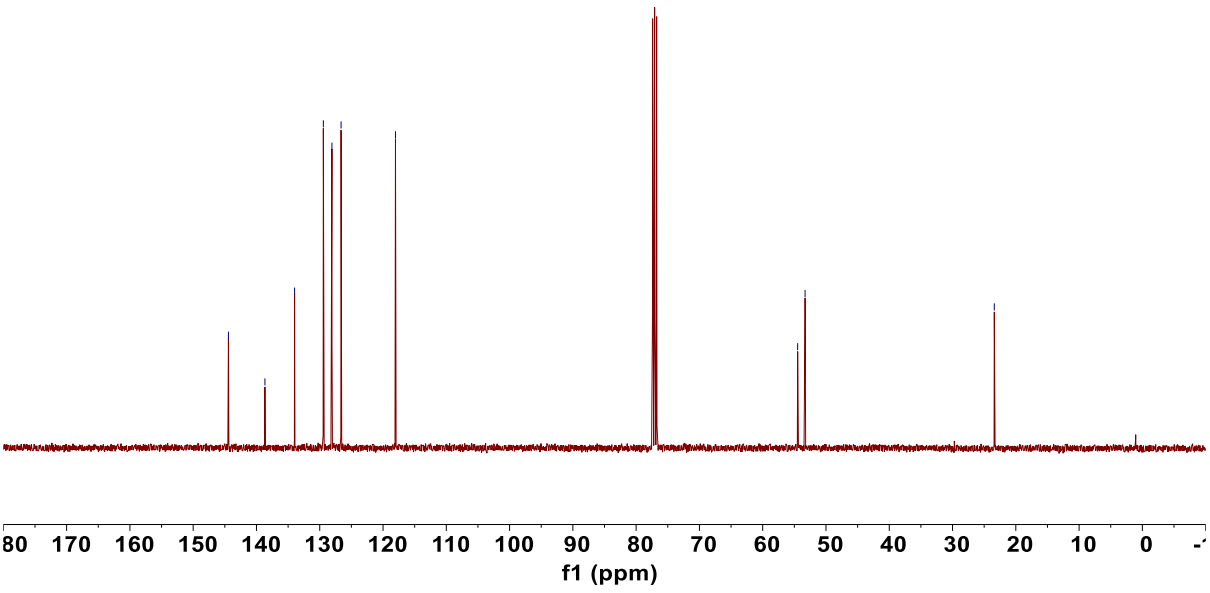
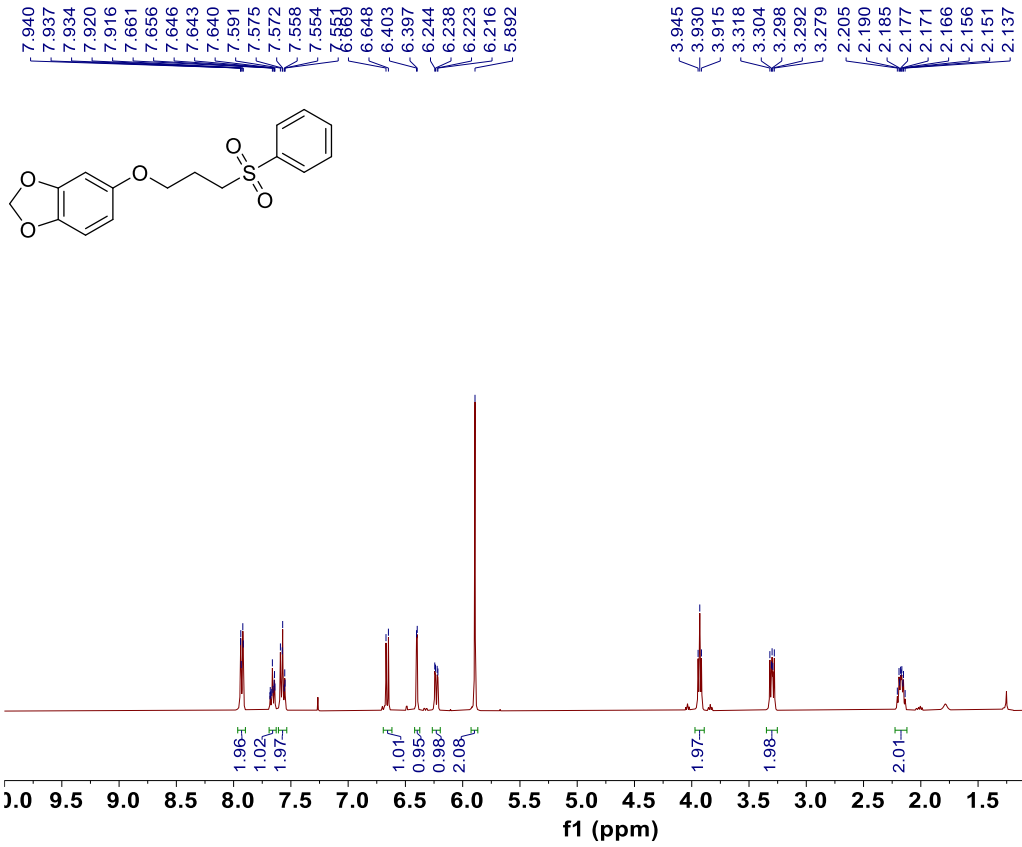
128.074
126.629
118.031
54.474
53.299
23.401


f1 (ppm)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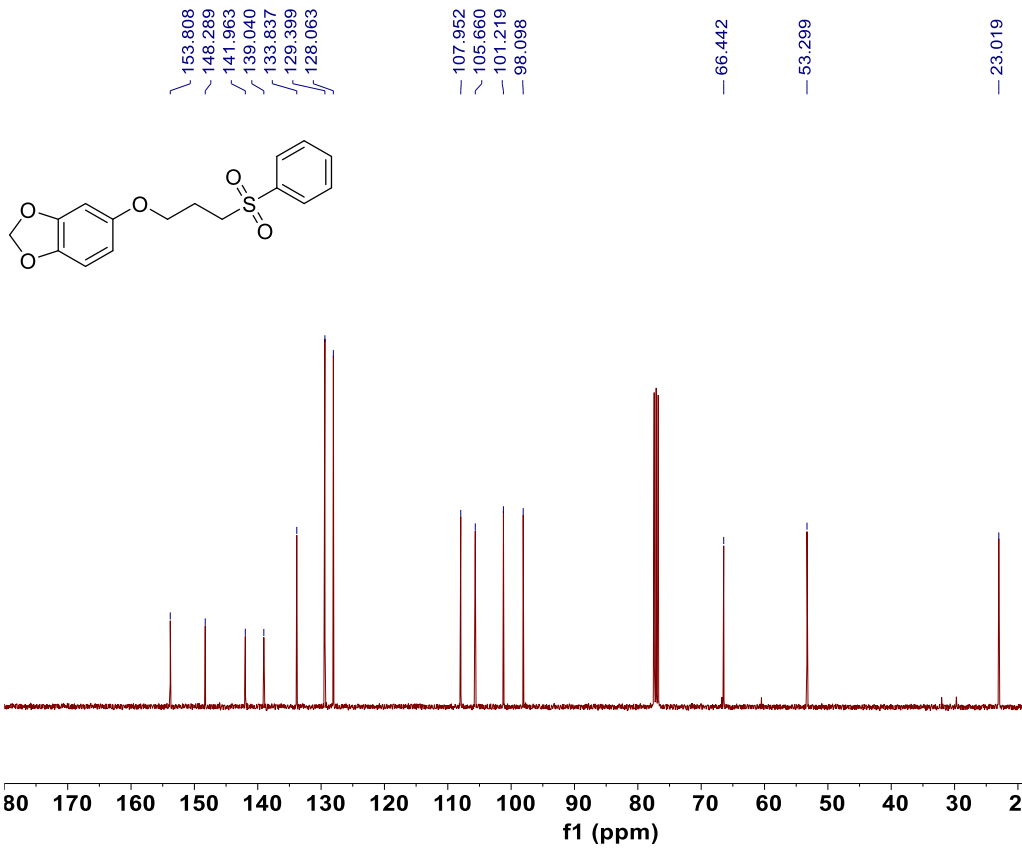
7.646
7.643
7.640
7.591
7.575
7.572
7.558
7.554
6.669
6.648
6.403
6.397
6.244
6.238
6.223
6.216
5.892
3.945
3.930
3.915
3.318
3.304
3.298
3.292
3.279
2.205
2.190
2.185
2.177
2.171
2.166
2.156
2.151
2.137
1.96
1.02
1.97
1.01
0.95
0.98
2.08
1.97
1.98
2.01
f1 (ppm)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141.963
139.040
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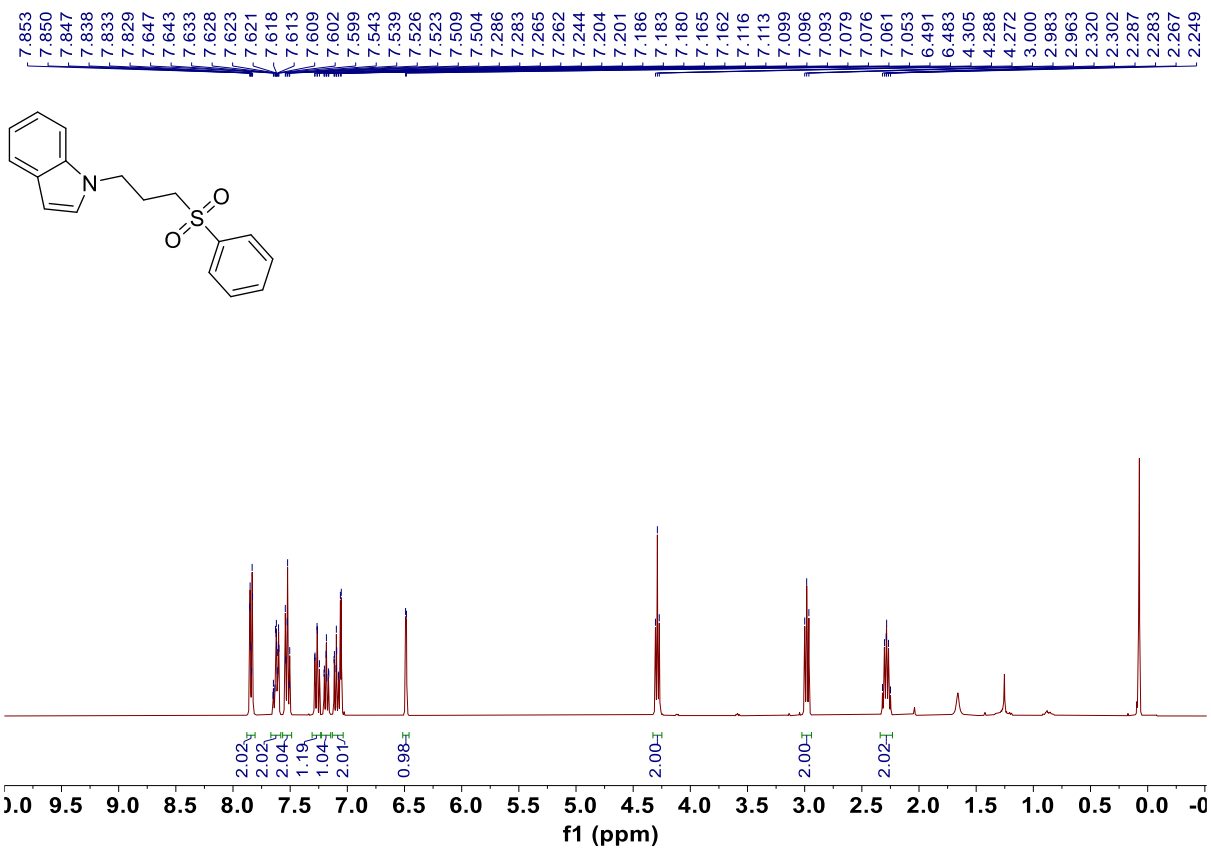
128.063
107.952
105.660
101.219
98.098
66.442
53.299
23.019
f1 (ppm)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7.643
7.633
7.628
7.623
7.621
7.618
7.613
7.609
7.602
7.599
7.543
7.539
7.526
7.523
7.509
7.504
7.286
7.283
7.265
7.262
7.244
7.204
7.201
7.186
7.183
7.180
7.165
7.162
7.116
7.113
7.099
7.096
7.093
7.079
7.076
7.061
7.053
6.491
6.483
4.305
4.288
4.272
3.000
2.983
2.963
2.320
2.302
2.287
2.283
2.267
2.249
N
S
O
O
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2.02
2.04
1.19
1.04
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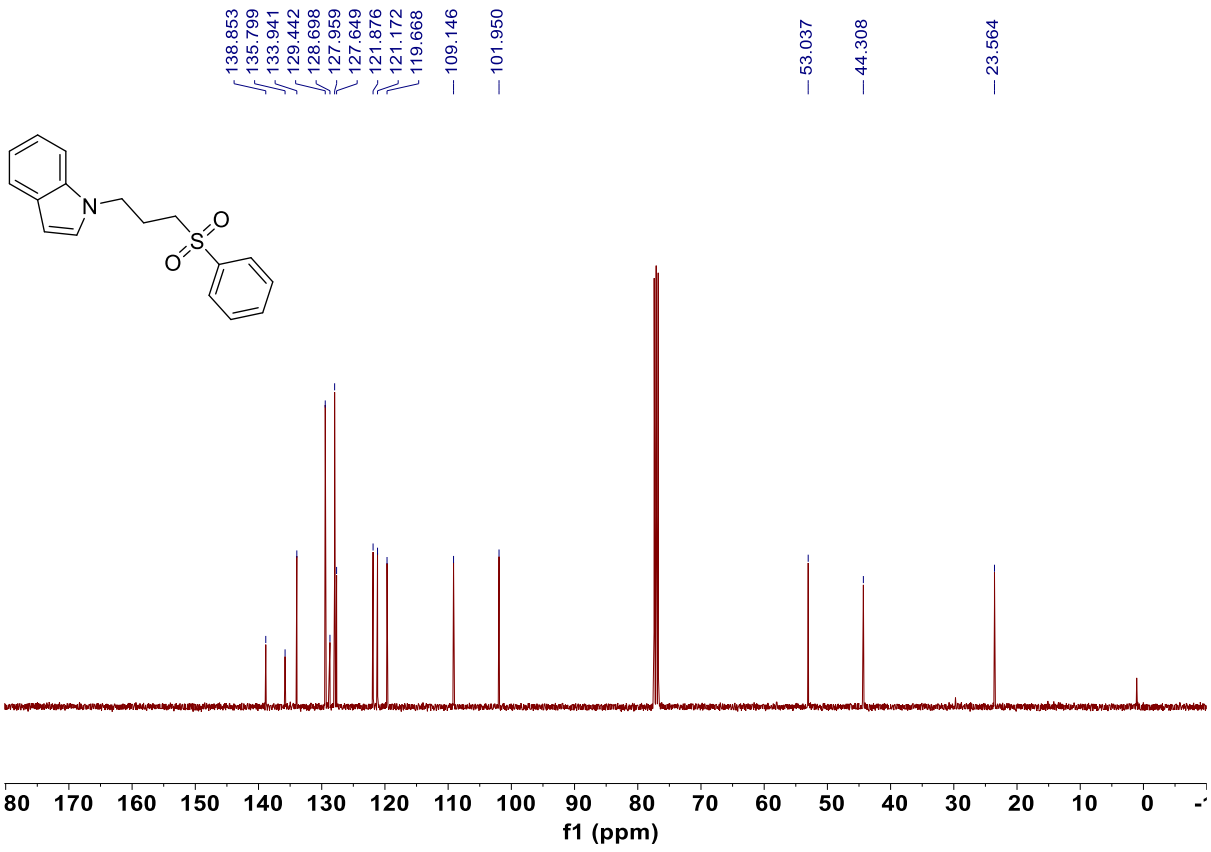
2.00
2.02
f1 (ppm)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23.564
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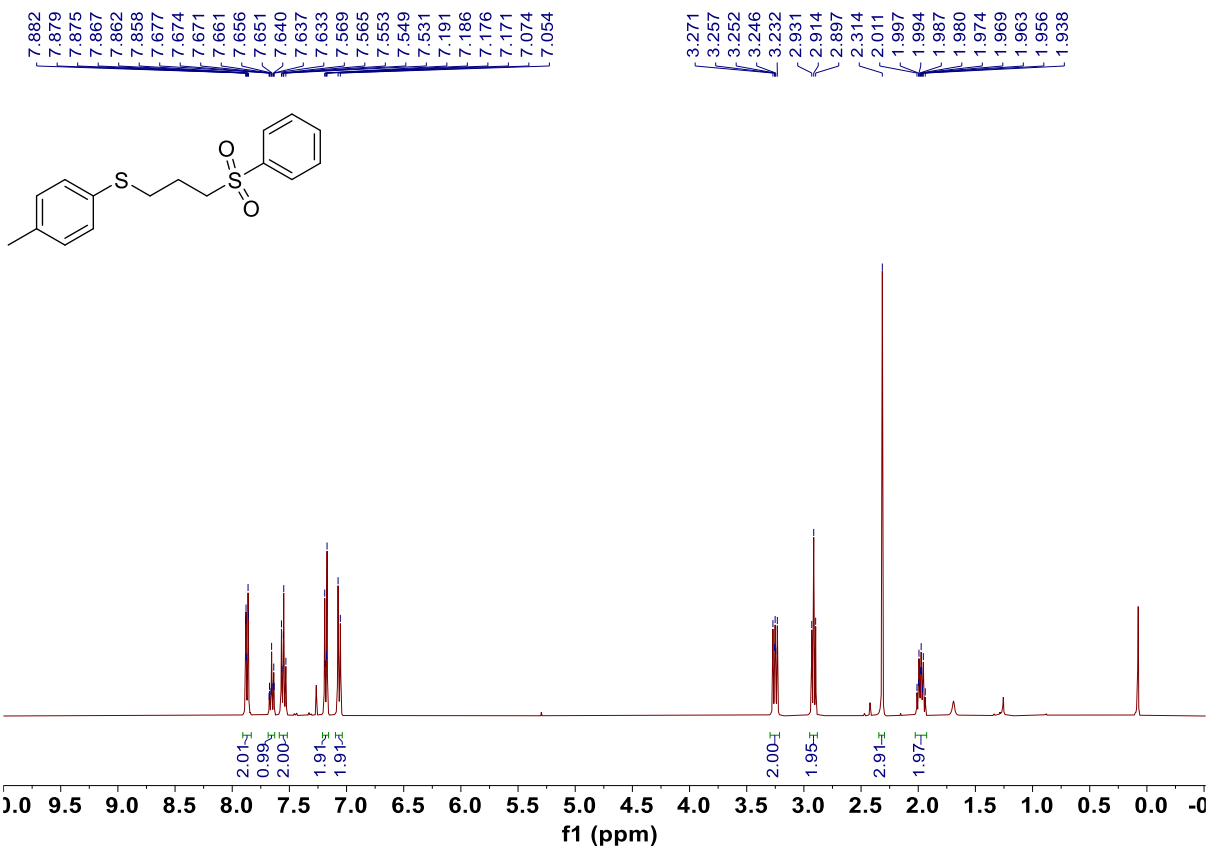
S
O
O
f1 (ppm)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7.661
7.656
7.651
7.640
7.637
7.633
7.569
7.565
7.553
7.549
7.531
7.191
7.186
7.176
7.171
7.074
7.054
3.271
3.257
3.252
3.246
3.232
2.931
2.914
2.897
2.314
2.011
1.997
1.994
1.987
1.980
1.974
1.969
1.963
1.956
1.938
O
S
O
S
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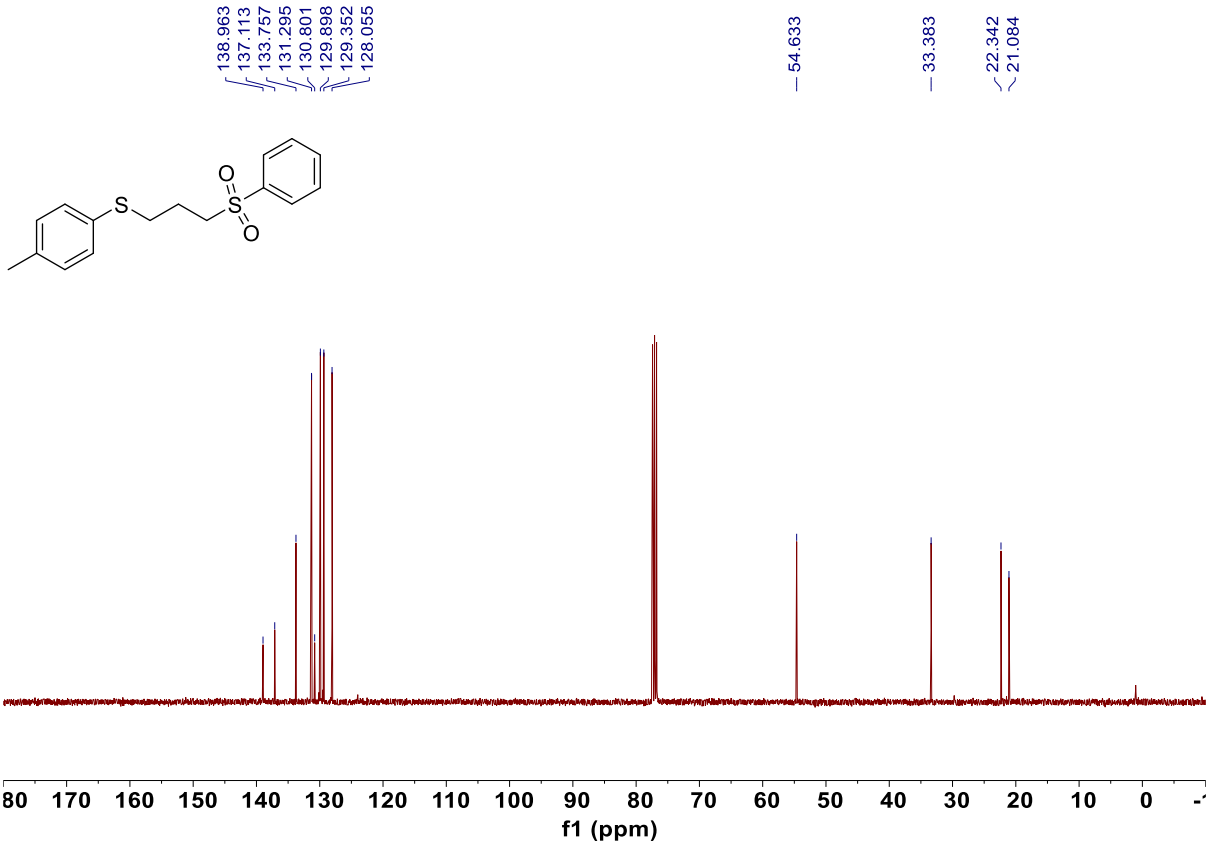
0.99
2.00
1.91
1.91
2.00
1.95
2.91
1.97
f1 (ppm)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131.295
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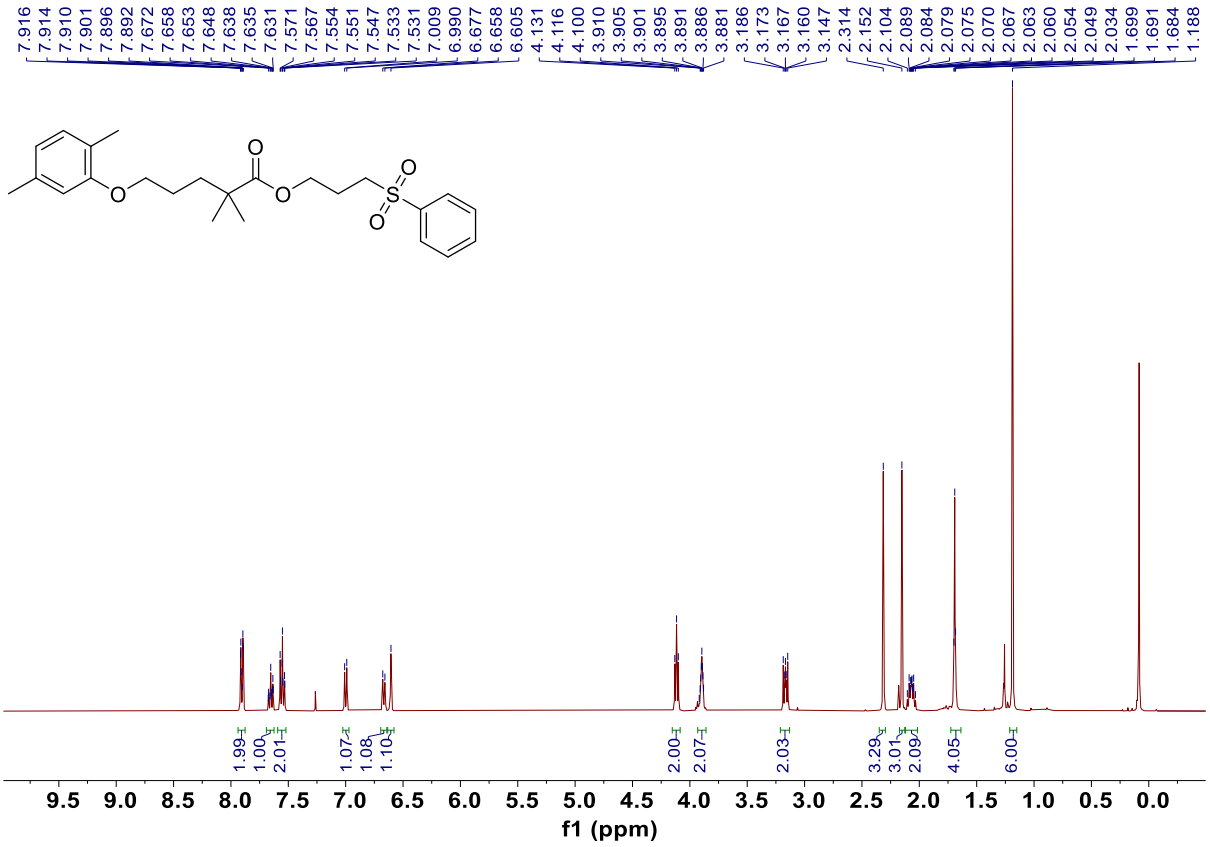
128.055
54.633
33.383
22.342
21.084
O
S
O
S
f1 (ppm)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7.635
7.631
7.571
7.567
7.554
7.551
7.547
7.533
7.531
7.009
6.990
6.677
6.658
6.605
4.131
4.116
4.100
3.910
3.905
3.901
3.895
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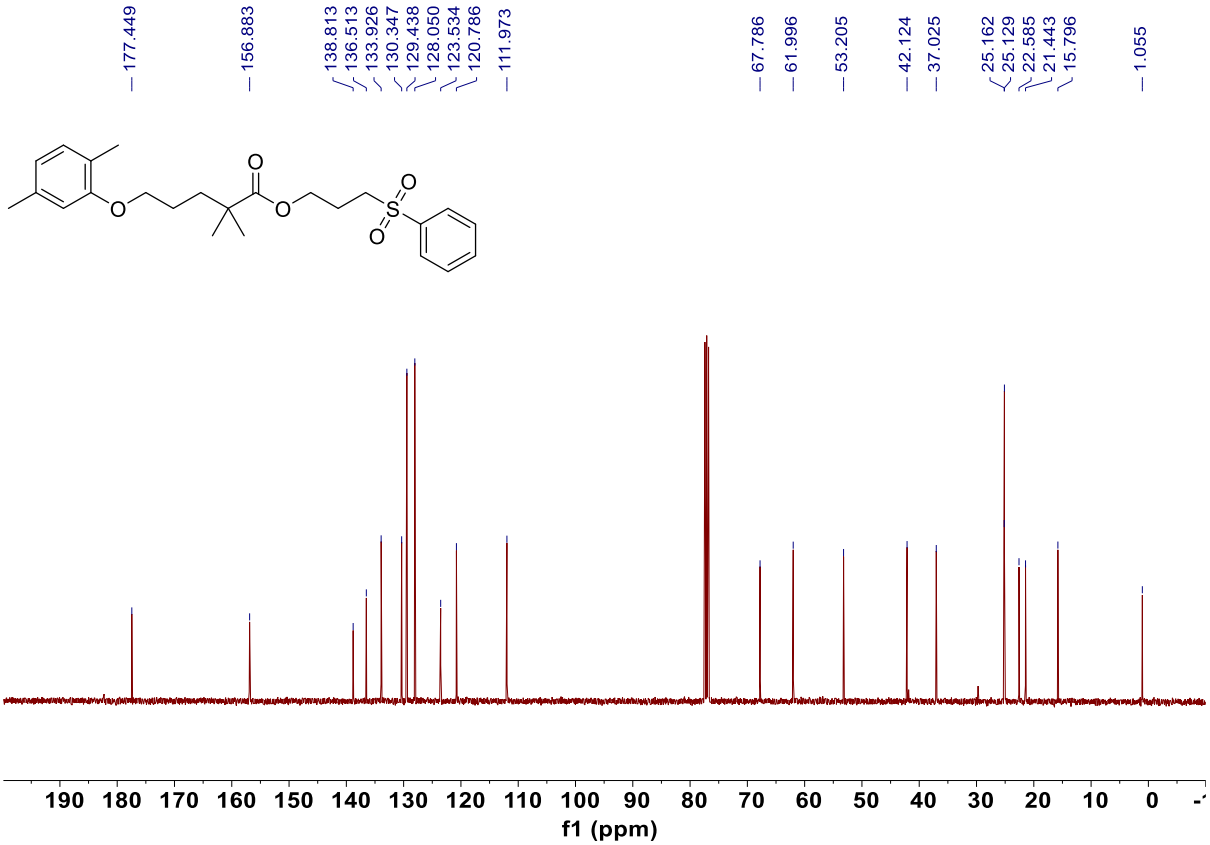
3.886
3.881
3.186
3.173
3.167
3.160
3.147
2.314
2.152
2.104
2.089
2.084
2.079
2.075
2.070
2.067
2.063
2.060
2.054
2.049
2.034
1.699
1.691
1.684
1.188
1.99
1.00
2.01
1.07
1.08
1.10
2.00
2.07
2.03
3.29
3.01
2.09
4.05
6.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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123.534
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67.786
61.996
53.205
42.124
37.025
25.162
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22.585
21.443
15.796
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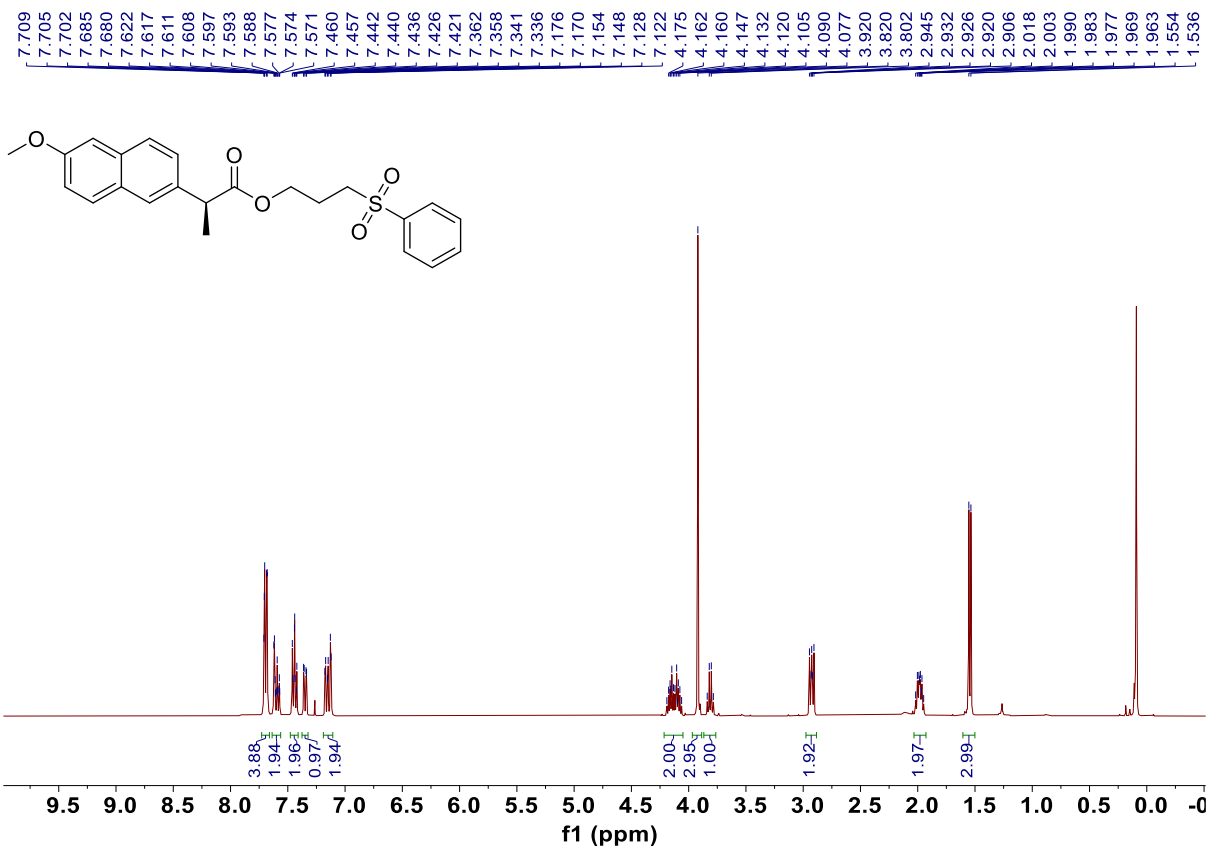
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.571
7.460
7.457
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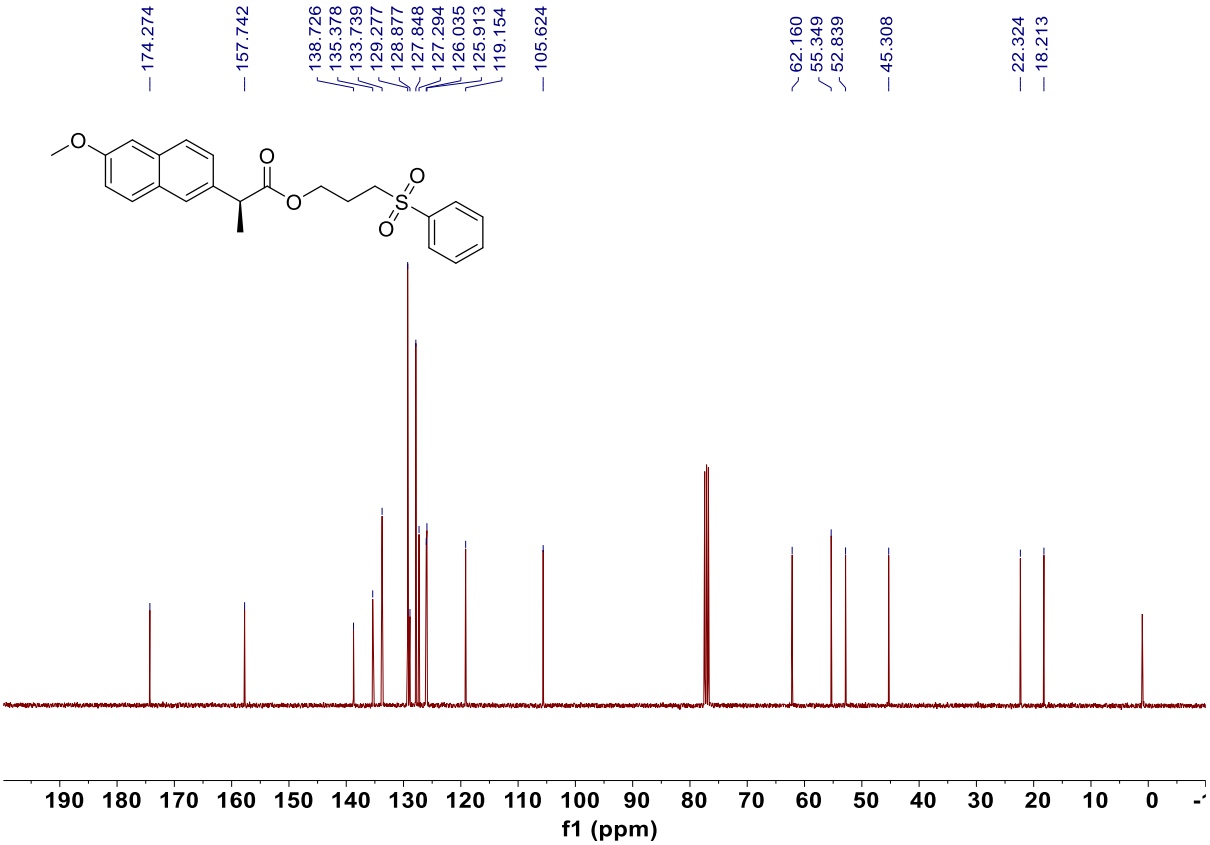
7.440
7.436
7.426
7.421
7.362
7.358
7.341
7.336
7.176
7.170
7.154
7.148
7.128
7.122
4.175
4.162
4.160
4.147
4.132
4.120
4.105
4.090
4.077
3.920
3.820
3.802
2.945
2.932
2.926
2.920
2.906
2.018
2.003
1.990
1.983
1.977
1.969
1.963
1.554
1.536
O
O
O
O
S
O
3.88
1.94
1.96
0.97
1.94
2.00
2.95
1.00
1.92
1.97
2.99
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)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105.624
62.160
55.349
52.839
45.308
22.324
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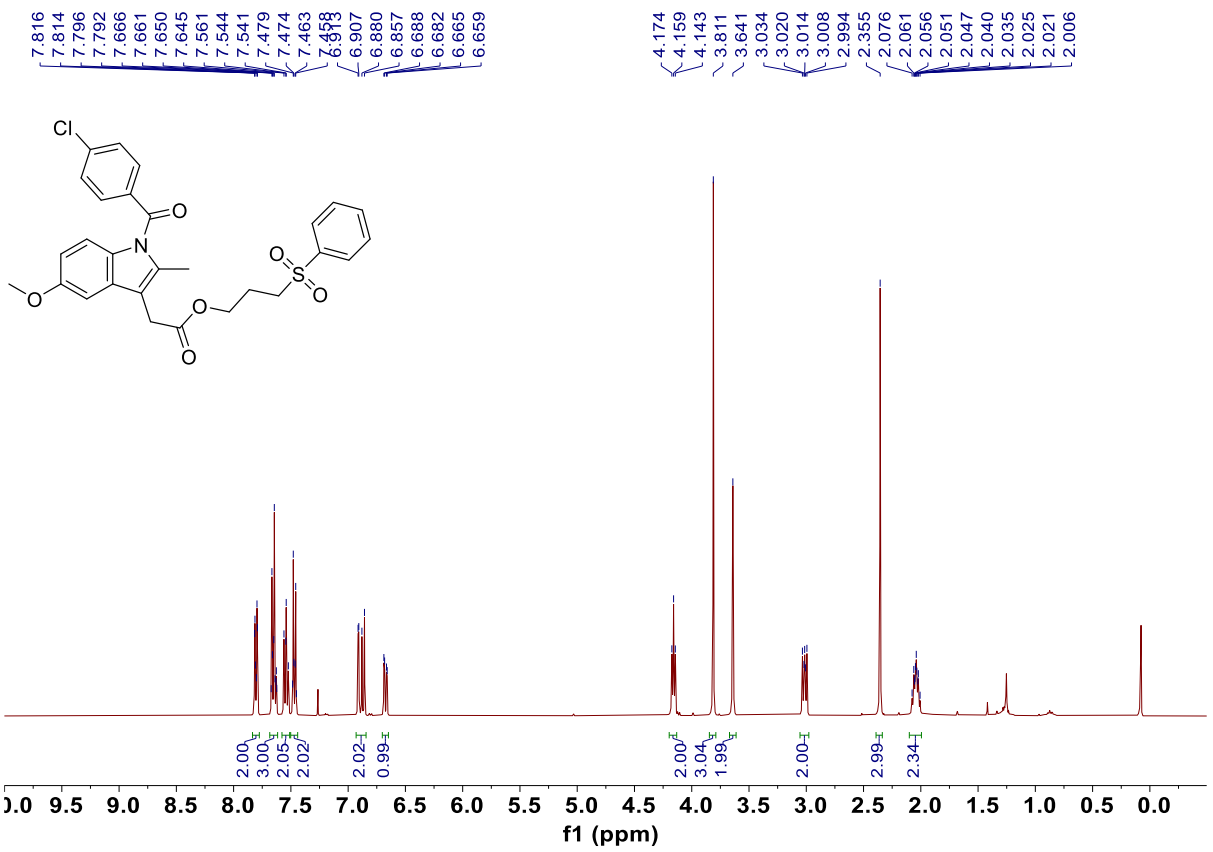
O
O
O
O
S
O
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.645
7.561
7.544
7.541
7.479
7.474
7.463
7.458
6.913
6.907
6.880
6.857
6.688
6.682
6.665
6.659
4.174
4.159
4.143
3.811
3.641
3.034
3.020
3.014
3.008
2.994
2.355
2.076
2.061
2.056
2.051
2.047
2.040
2.035
2.025
2.021
2.006
Cl
O
N
O
O
S
O
O
O
O
2.00
3.00
2.05
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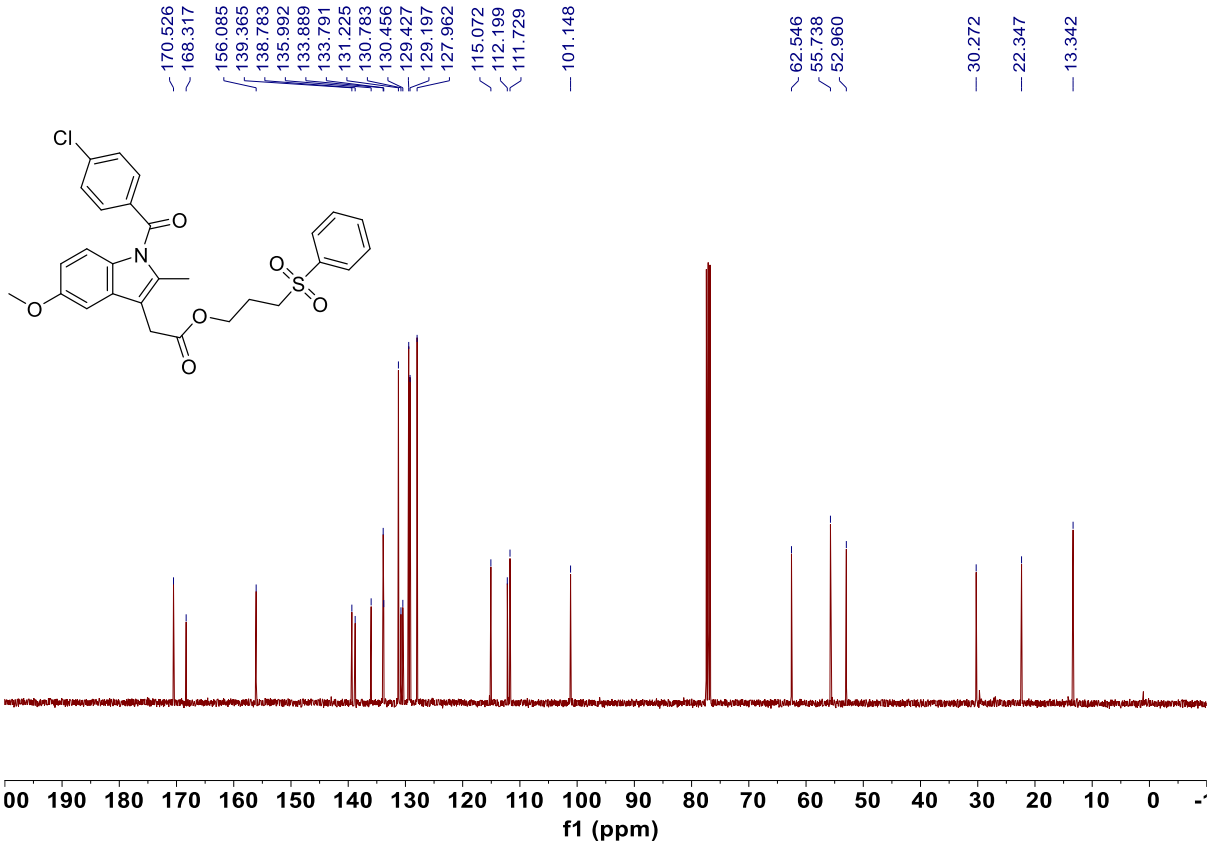
2.02
0.99
2.00
3.04
1.99
2.00
2.99
2.34
f1 (ppm)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156.085
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127.962
115.072
112.199
111.729
101.148
62.546
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22.347
13.342
Cl
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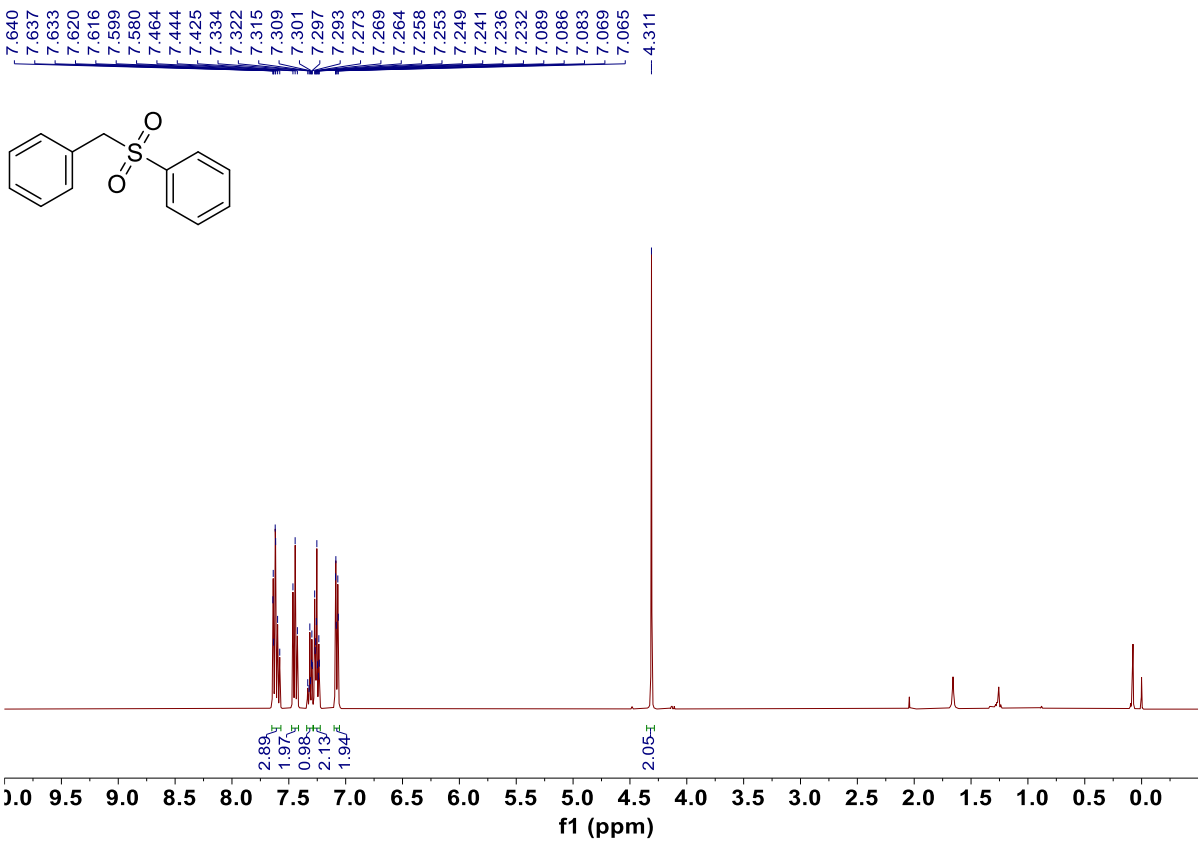
N
O
O
S
O
O
O
O
f1 (ppm)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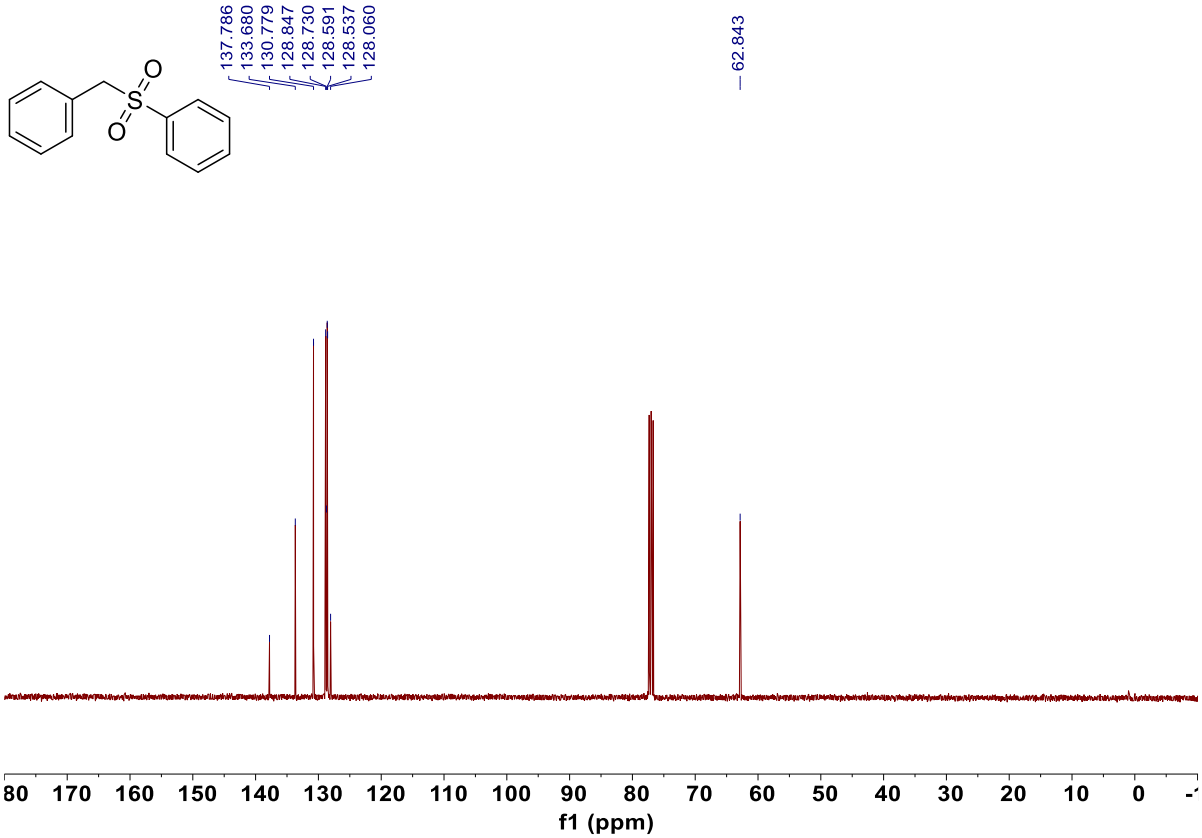
7.599
7.580
7.464
7.444
7.425
7.334
7.322
7.315
7.309
7.301
7.297
7.293
7.273
7.269
7.264
7.258
7.253
7.249
7.241
7.236
7.232
7.089
7.086
7.083
7.069
7.065
4.311
2.89
1.97
0.98
2.13
1.94
2.05
f1 (ppm)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130.779
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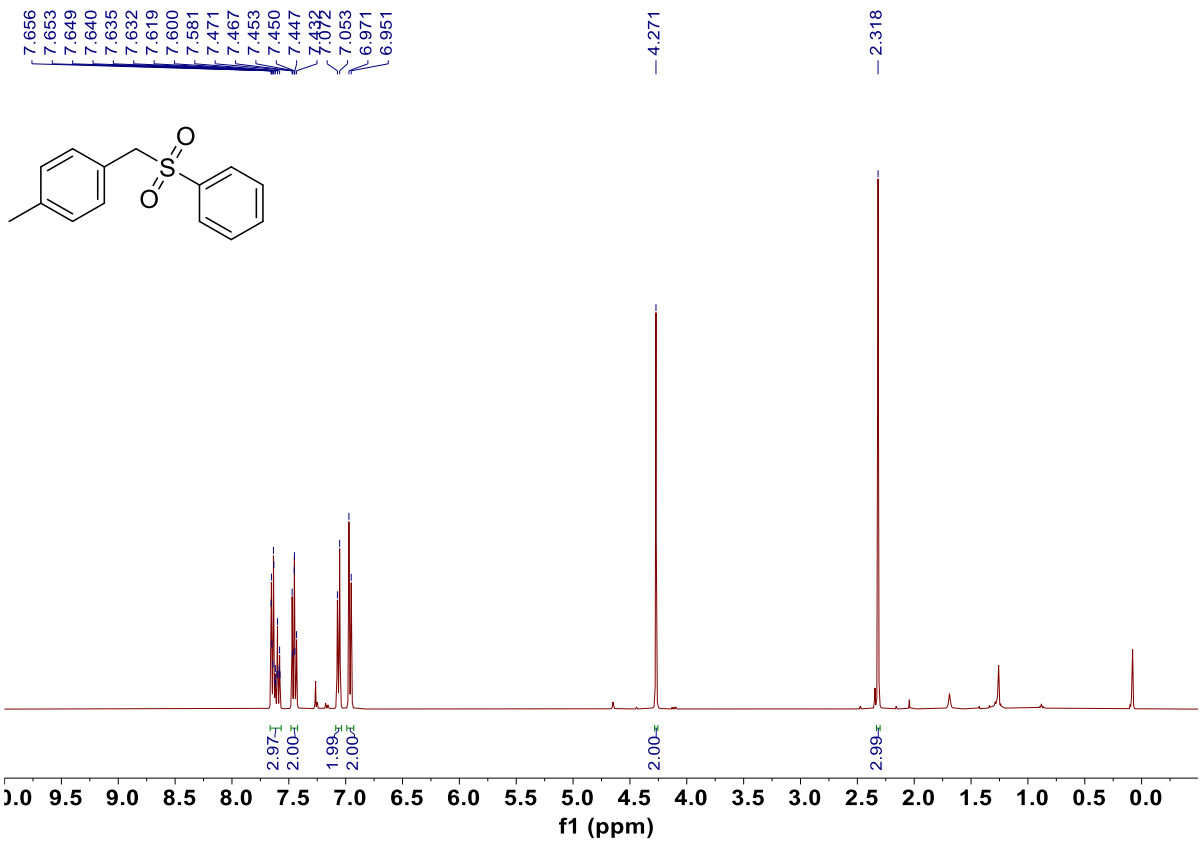
128.730
128.591
128.537
128.060
62.843
f1 (ppm)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7.653
7.649
7.640
7.635
7.632
7.619
7.600
7.581
7.471
7.467
7.453
7.450
7.447
7.432
7.072
7.053
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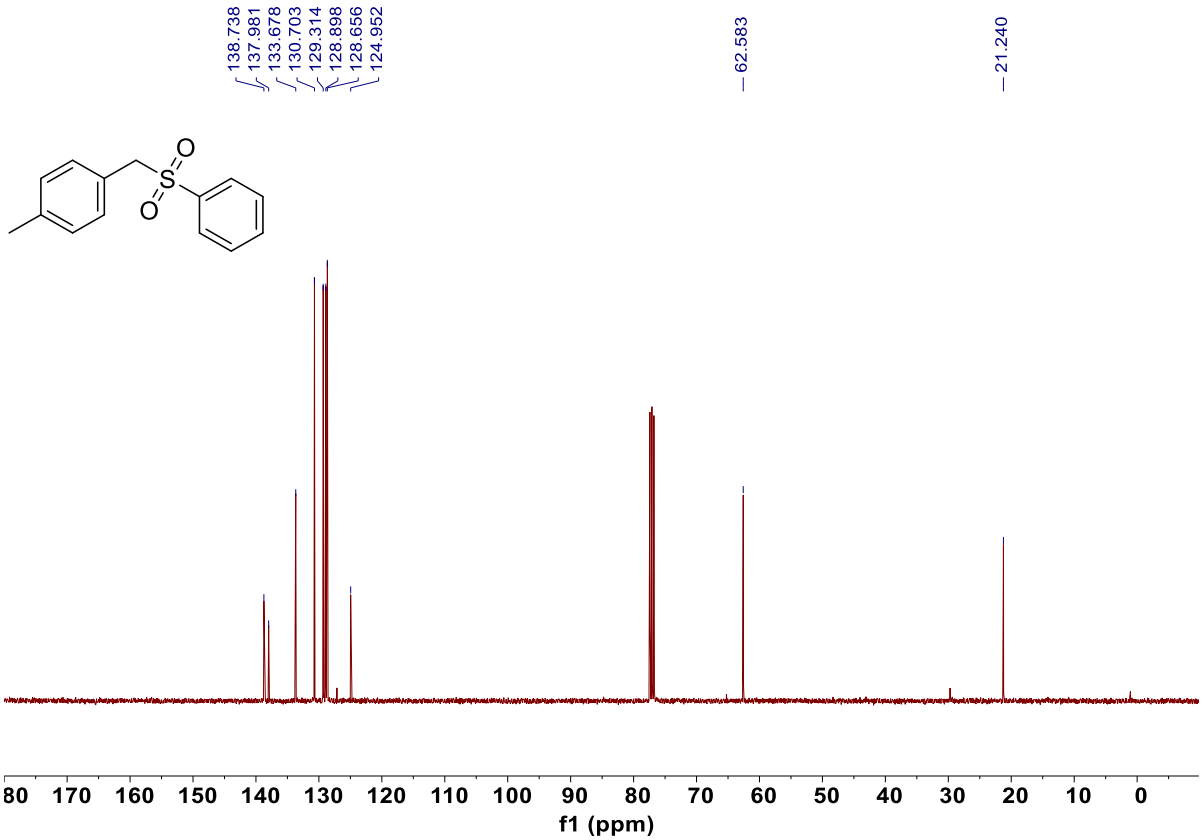
6.951
4.271
2.318
2.97
2.00
1.99
2.00
2.00
2.99
f1 (ppm)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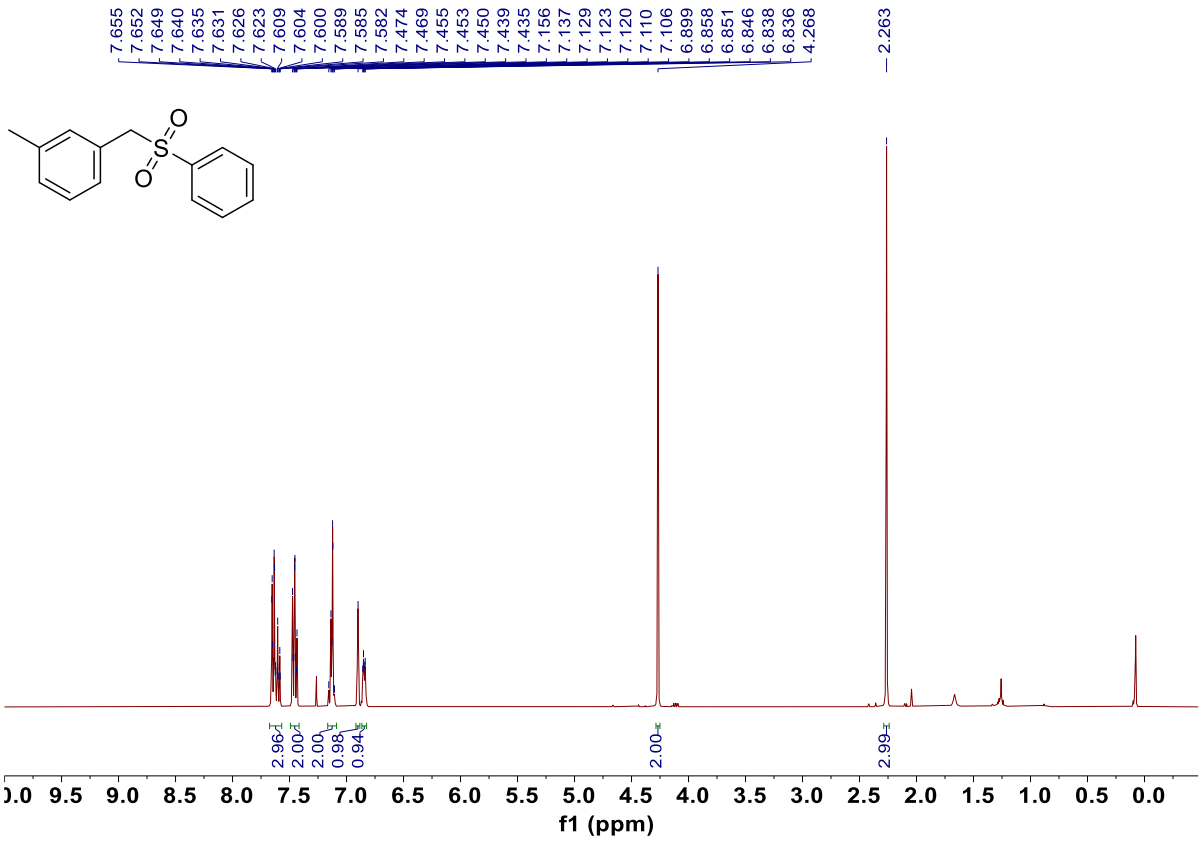
128.898
128.656
124.952
62.583
21.240
f1 (ppm)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7.649
7.640
7.635
7.631
7.626
7.623
7.609
7.604
7.600
7.589
7.585
7.582
7.474
7.469
7.455
7.453
7.450
7.439
7.435
7.156
7.137
7.129
7.123
7.120
7.110
7.106
6.899
6.858
6.851
6.846
6.838
6.836
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2.263
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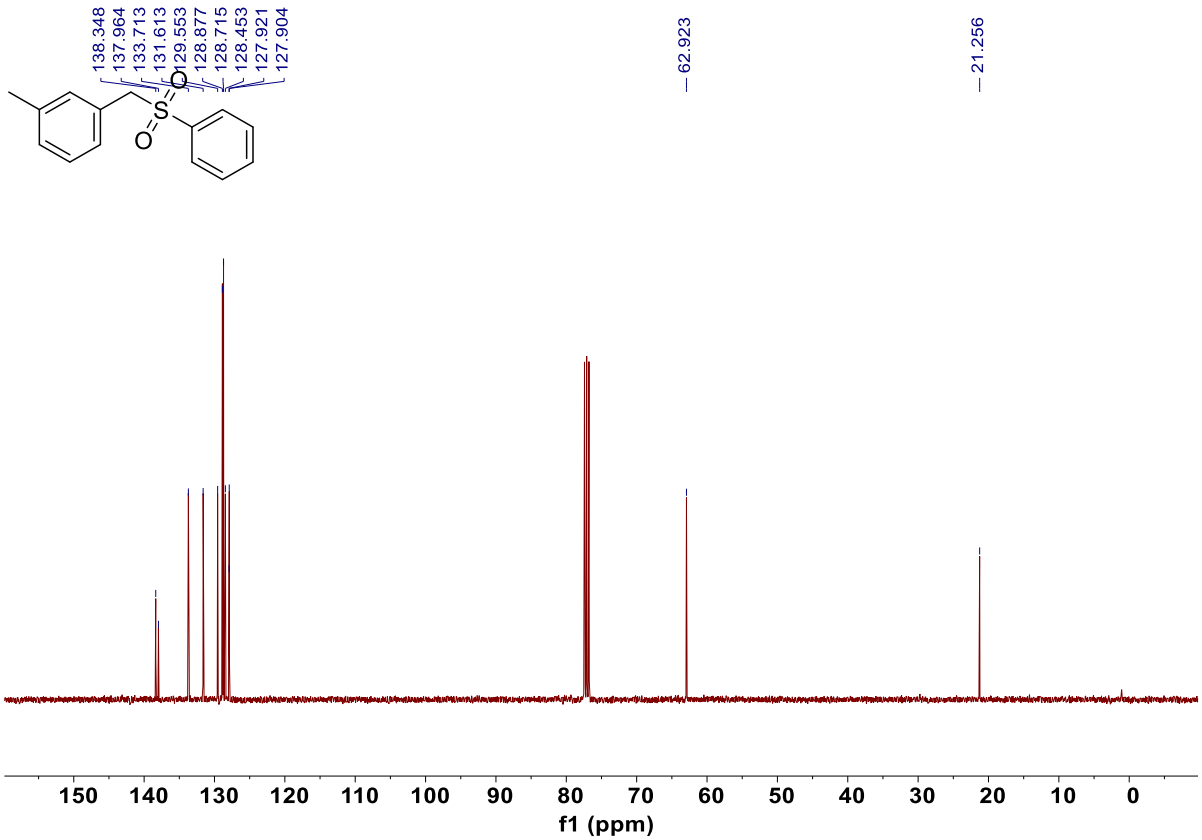
S
O
2.96
2.00
2.00
0.98
0.94
2.00
2.99
f1 (ppm)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128.715
128.453
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127.904
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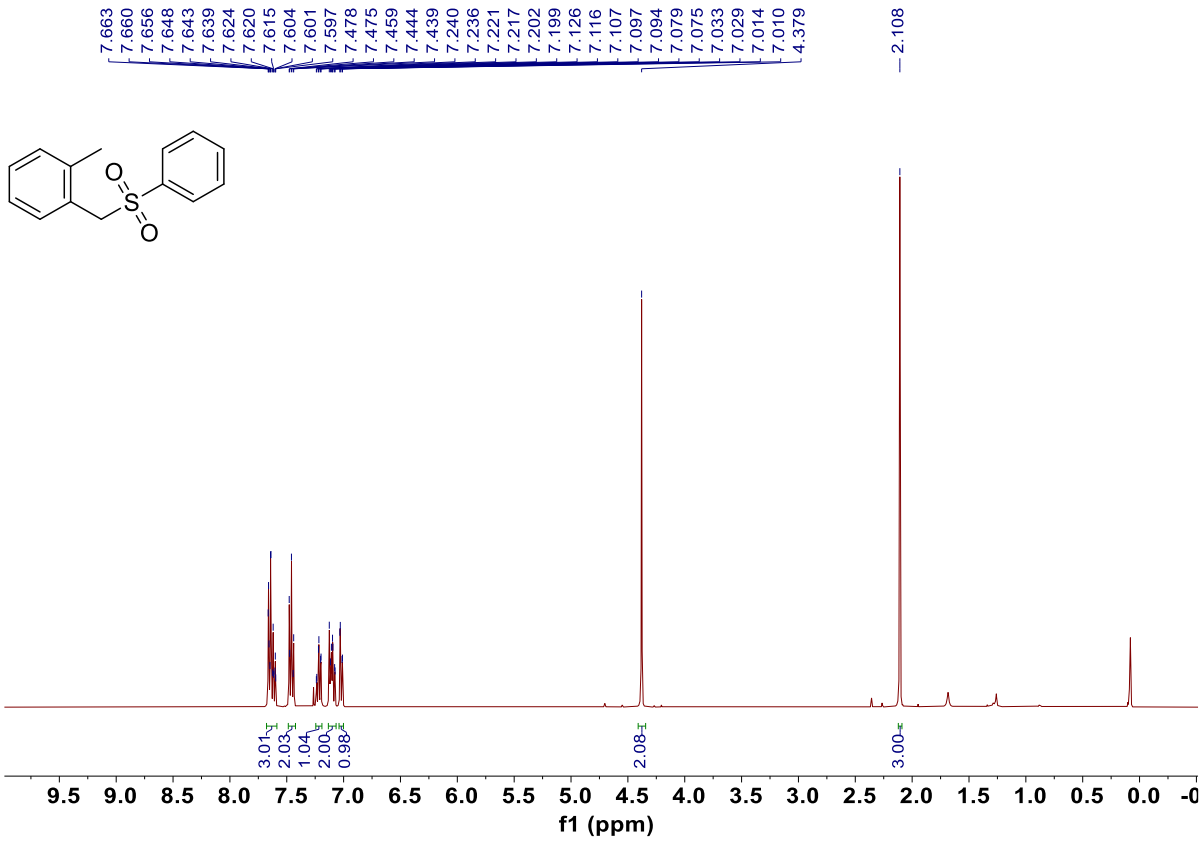
21.256
O
S
O
f1 (ppm)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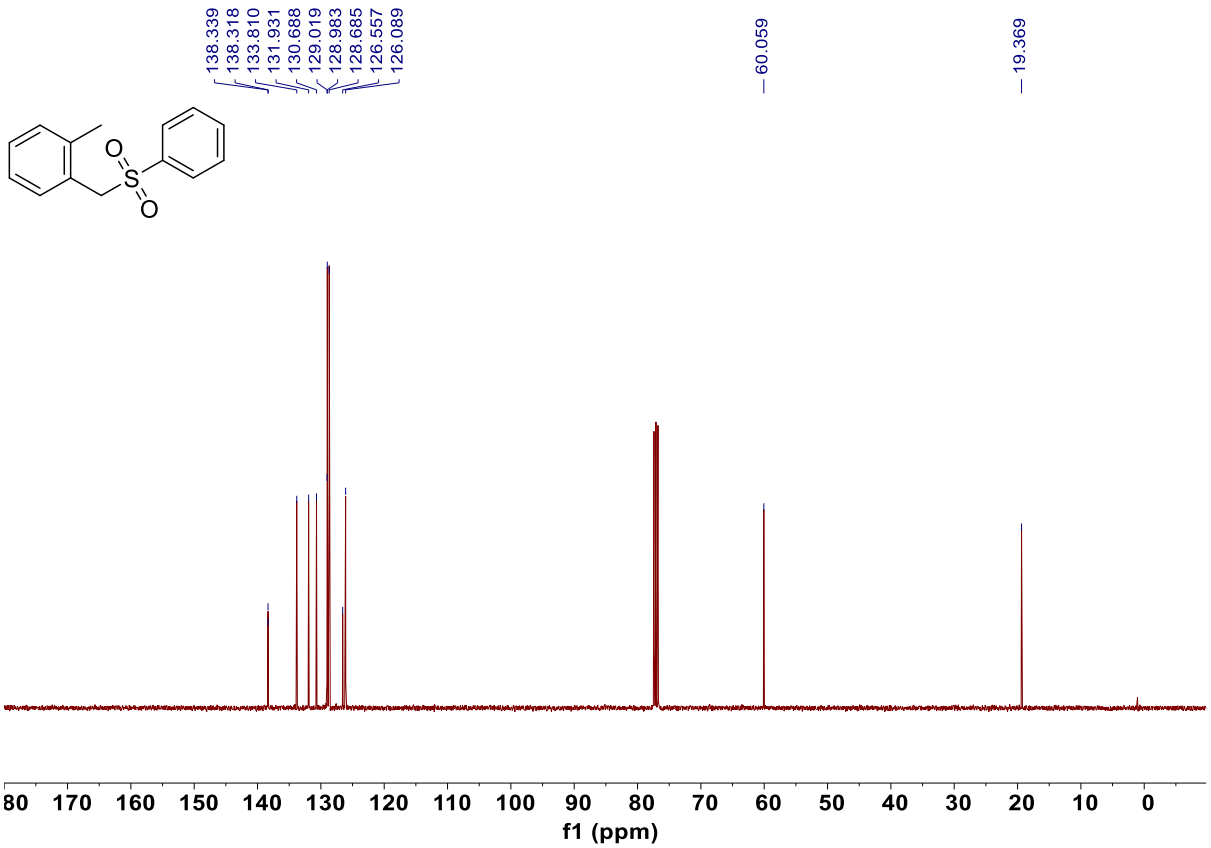
7.639
7.624
7.620
7.615
7.604
7.601
7.597
7.478
7.475
7.459
7.444
7.439
7.240
7.236
7.221
7.217
7.202
7.199
7.126
7.116
7.107
7.097
7.094
7.079
7.075
7.033
7.029
7.014
7.010
4.379
2.108
O
S
O
3.01
2.03
1.04
2.00
0.98
2.08
3.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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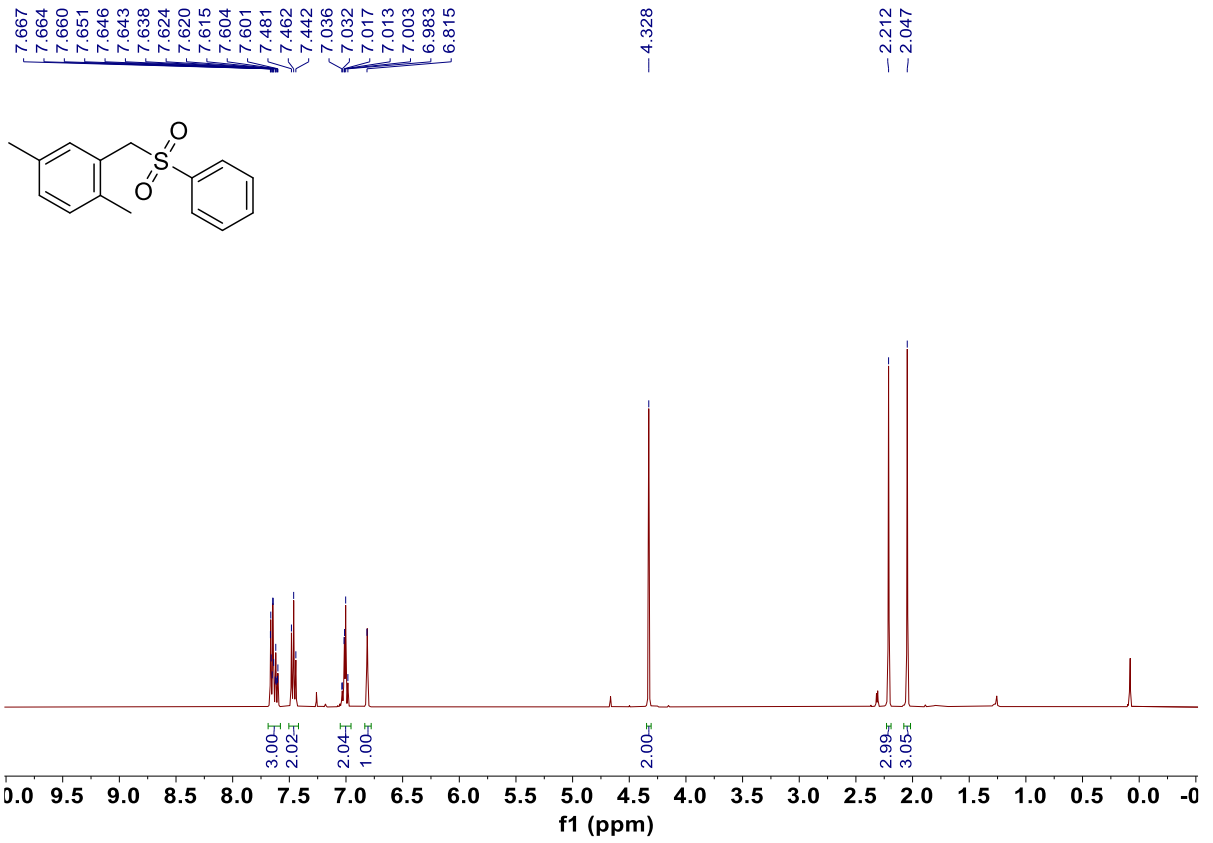
130.688
129.019
128.983
128.685
126.557
126.089
60.059
19.369
O
S
O
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.643
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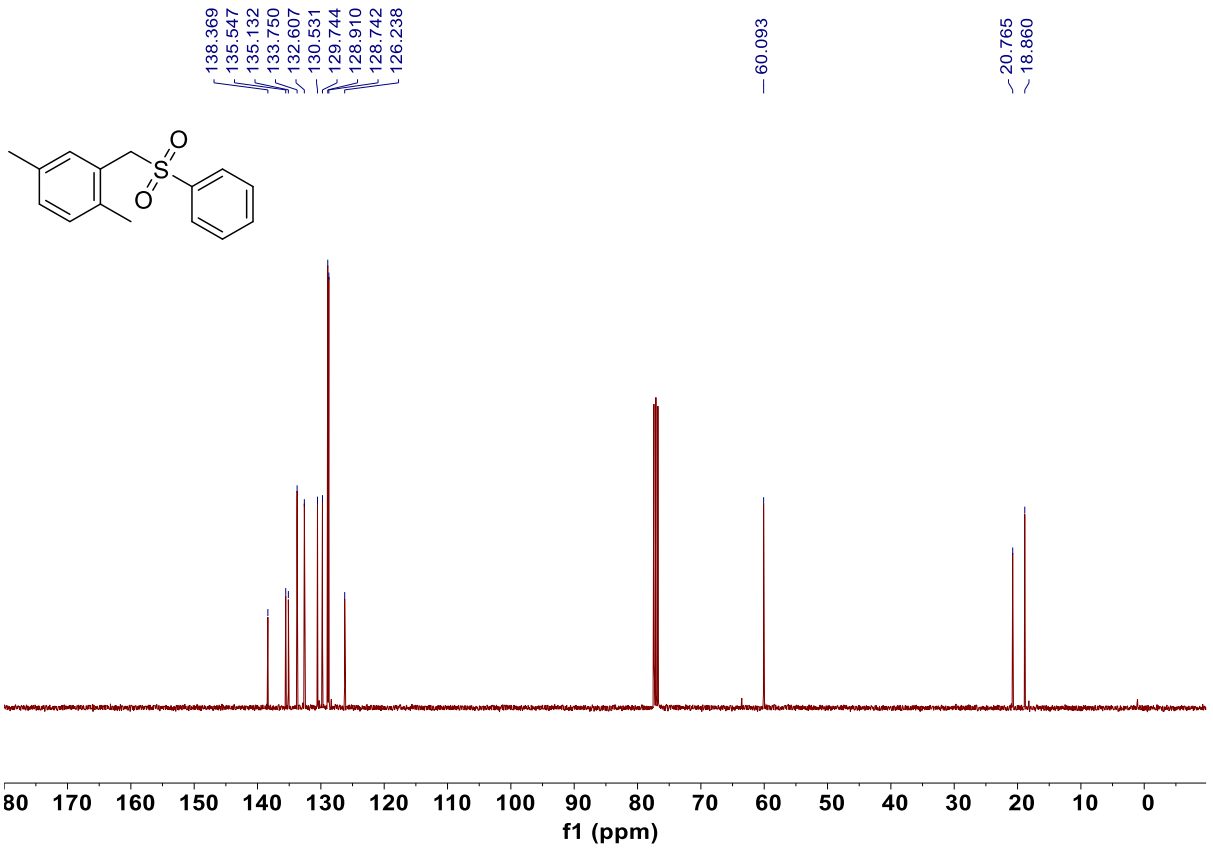
7.624
7.620
7.615
7.604
7.601
7.481
7.462
7.442
7.036
7.032
7.017
7.013
7.003
6.983
6.815
4.328
2.212
2.047
3.00
2.02
2.04
1.00
2.00
2.99
3.05
f1 (ppm)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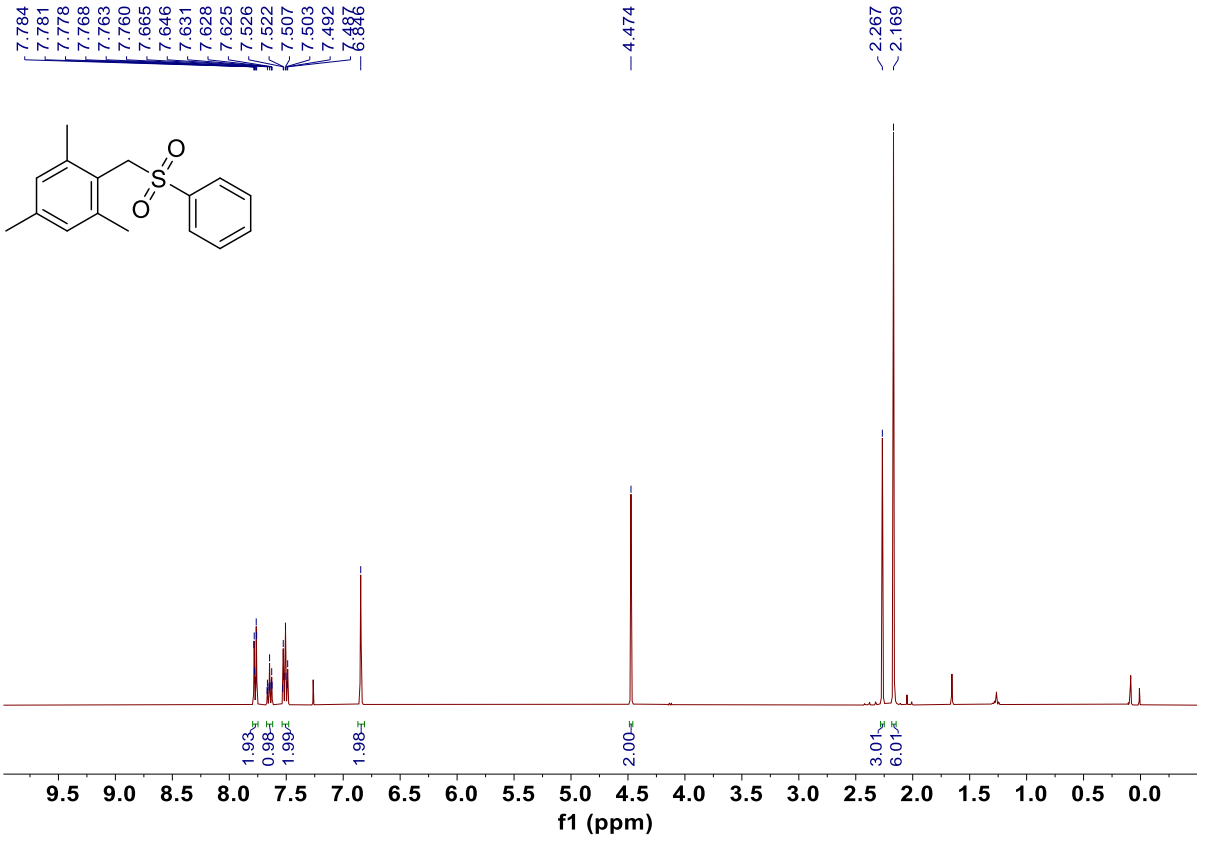
130.531
129.744
128.910
128.742
126.238
60.093
20.765
18.860
f1 (ppm)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7.646
7.631
7.628
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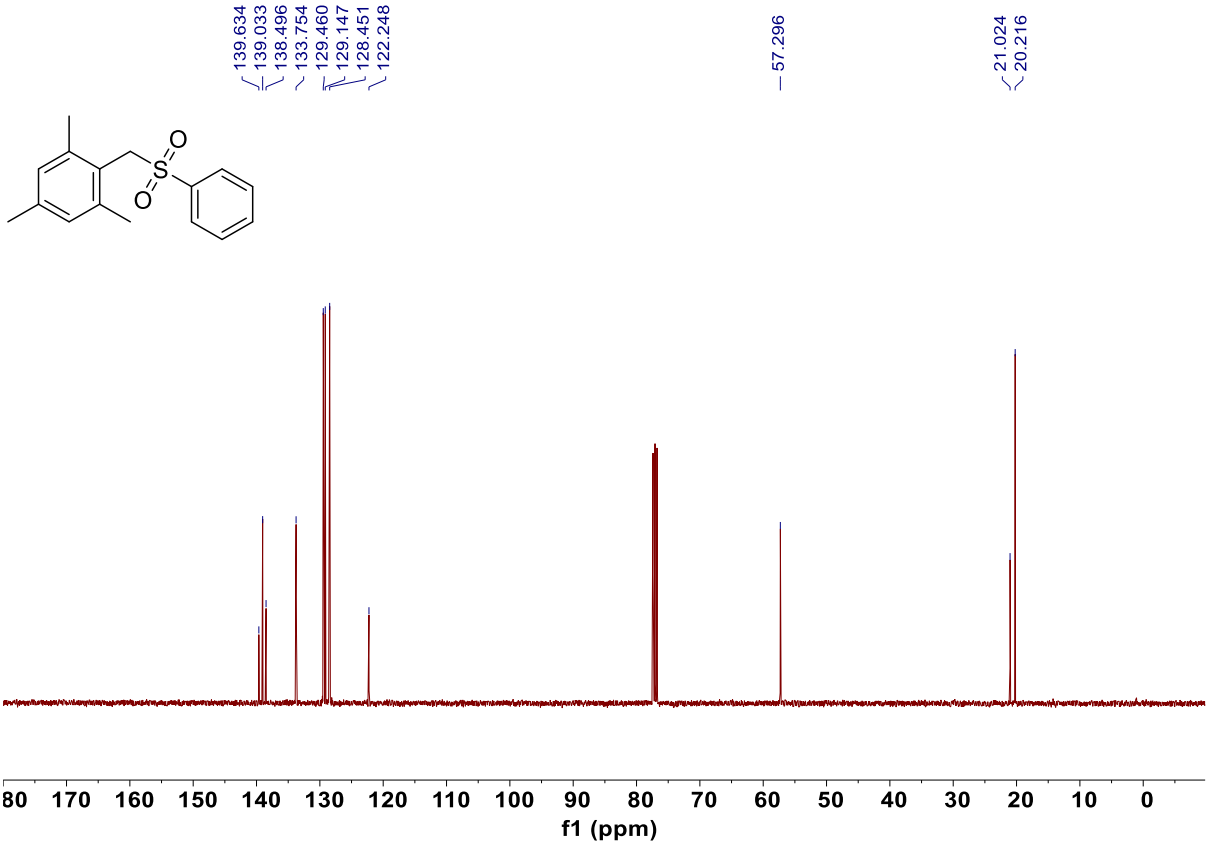
7.522
7.507
7.503
7.492
7.487
7.484
4.474
2.267
2.169
1.93
0.98
1.99
1.98
2.00
3.01
6.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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129.147
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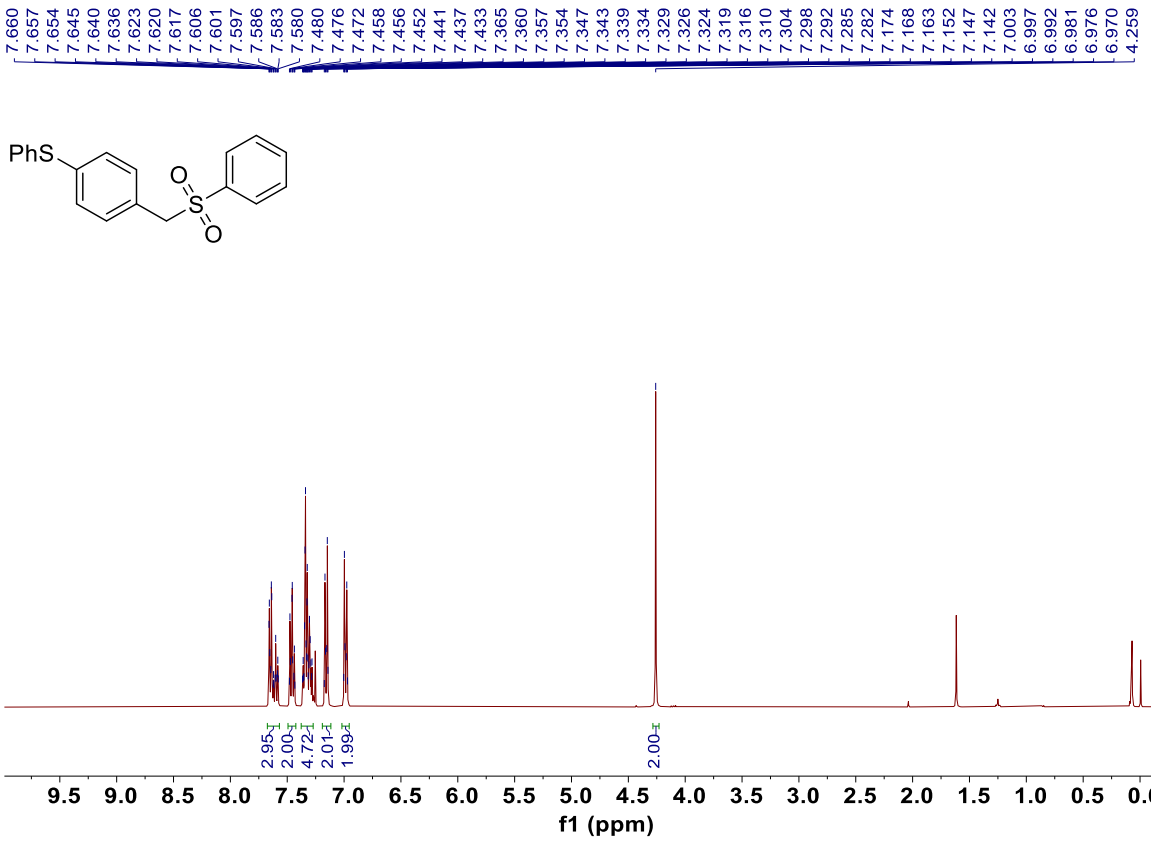
122.248
57.296
21.024
20.216
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.583
7.580
7.480
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7.452
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7.437
7.433
7.365
7.360
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7.354
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7.304
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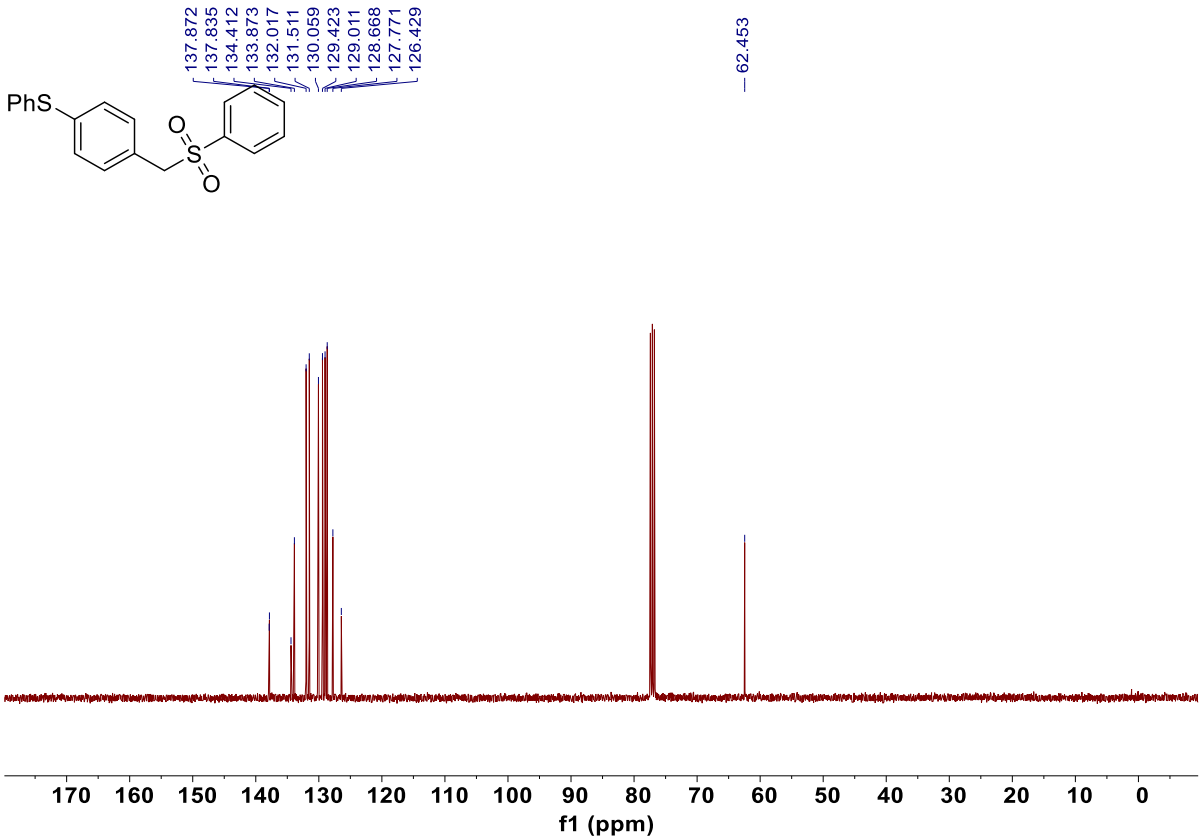
7.285
7.282
7.174
7.168
7.163
7.152
7.147
7.142
7.003
6.997
6.992
6.981
6.976
6.970
4.259
PhS
O
S
O
2.95
2.00
4.72
2.01
1.99
2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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62.453
PhS
O
S
O
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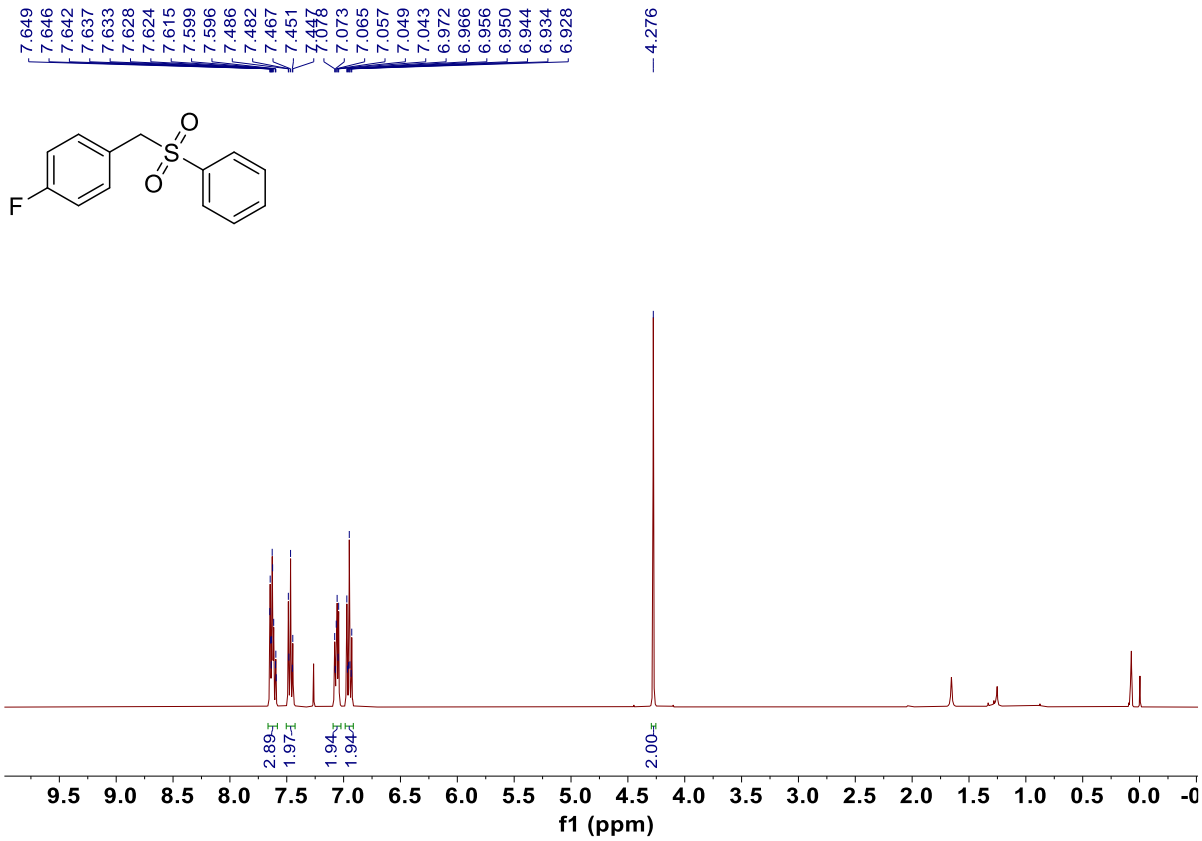
f1 (ppm)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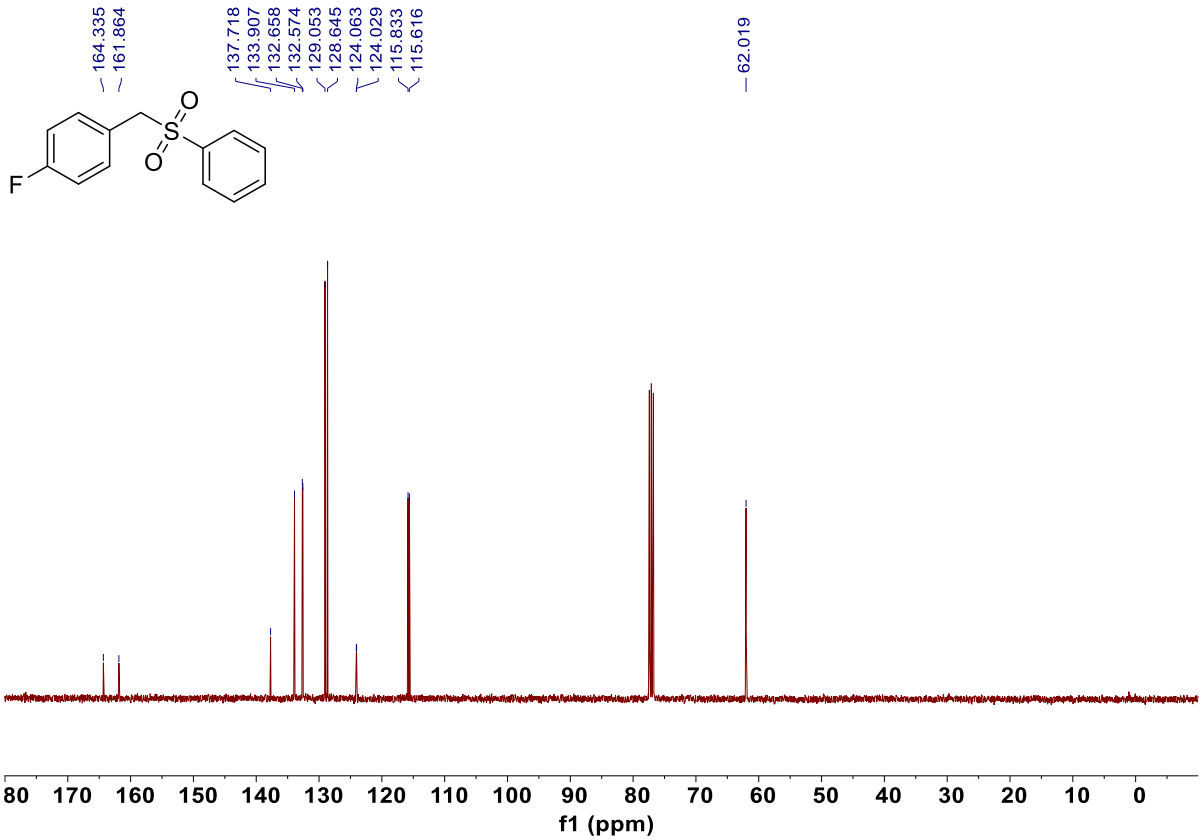
7.451
7.447
7.078
7.073
7.065
7.057
7.049
7.043
6.972
6.966
6.956
6.950
6.944
6.934
6.928
4.276
F
O
S
O
2.89
1.97
1.94
1.94
2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0
f1 (ppm)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128.645
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115.616
62.019
F
O
S
O
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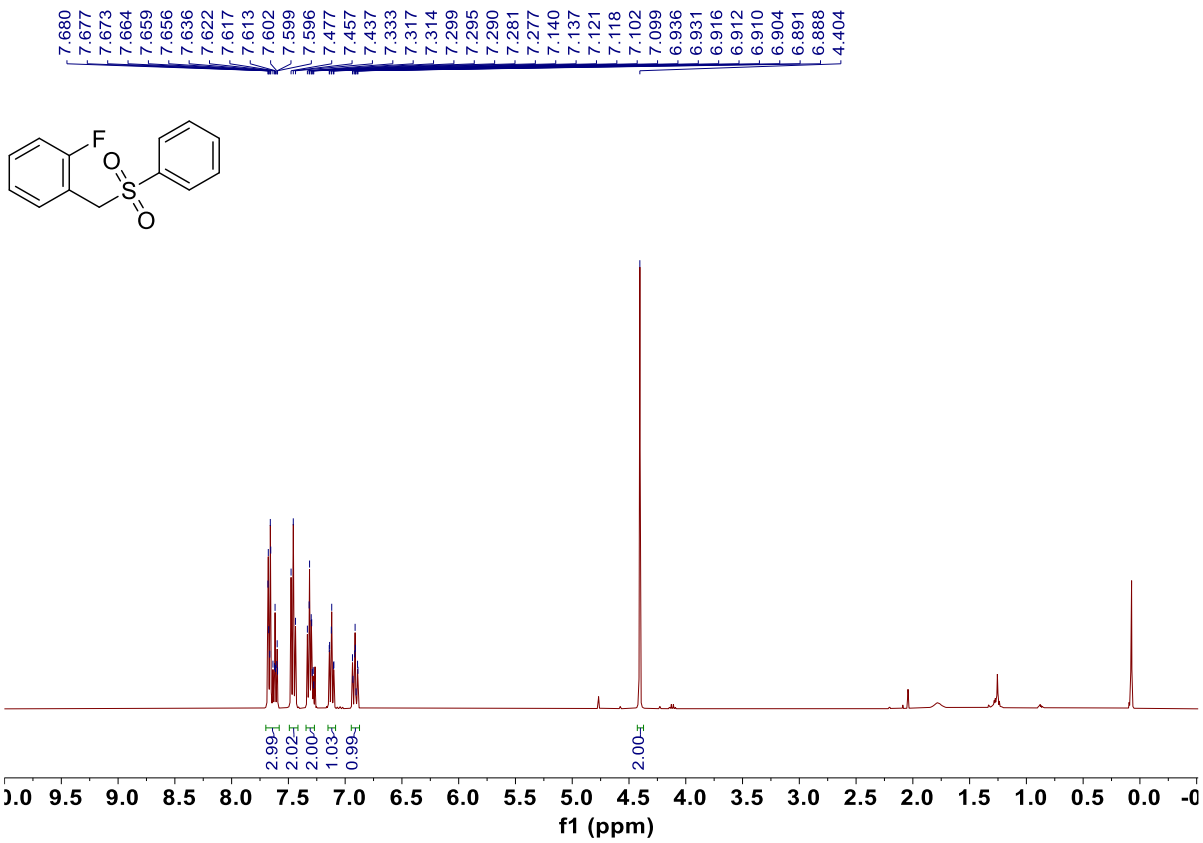
f1 (ppm)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7.477
7.457
7.437
7.333
7.317
7.314
7.299
7.295
7.290
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7.277
7.140
7.137
7.121
7.118
7.102
7.099
6.936
6.931
6.916
6.912
6.910
6.904
6.891
6.888
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F
O
S
O
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2.00
1.03
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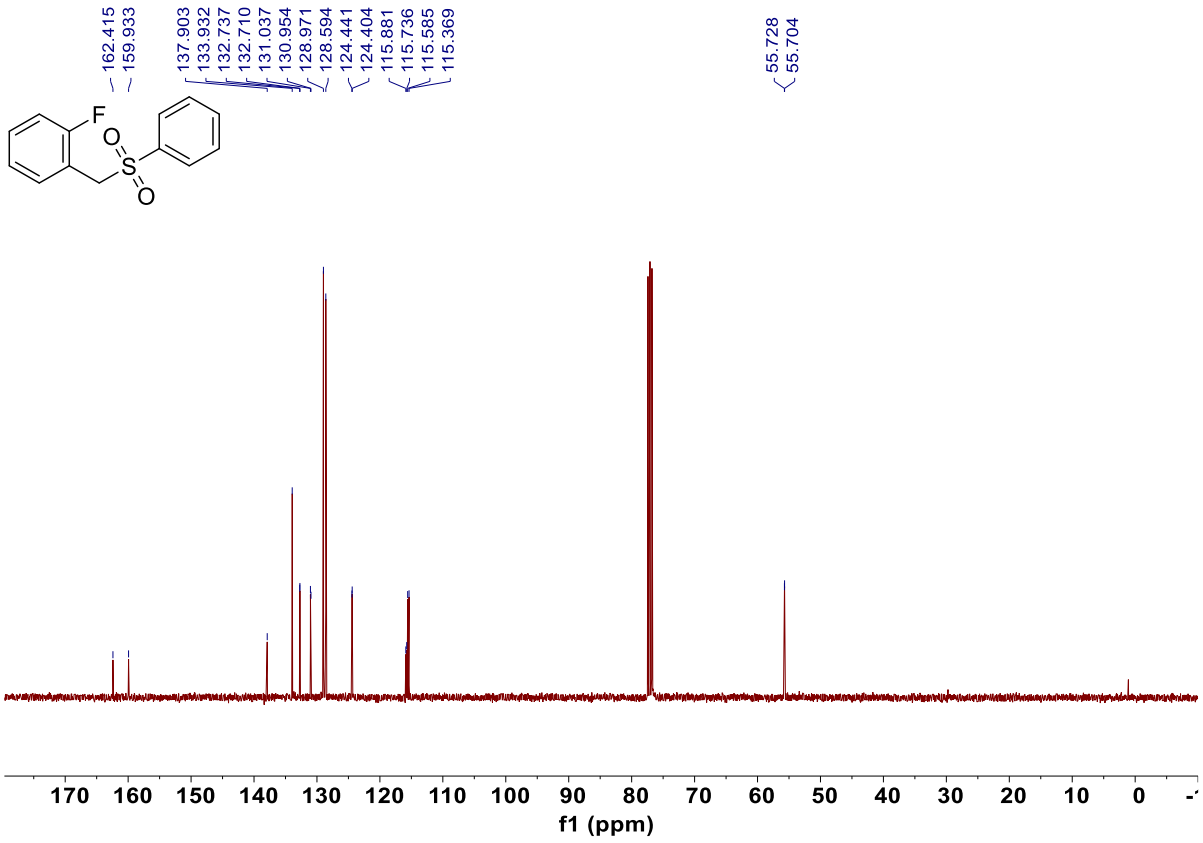
2.00
f1 (ppm)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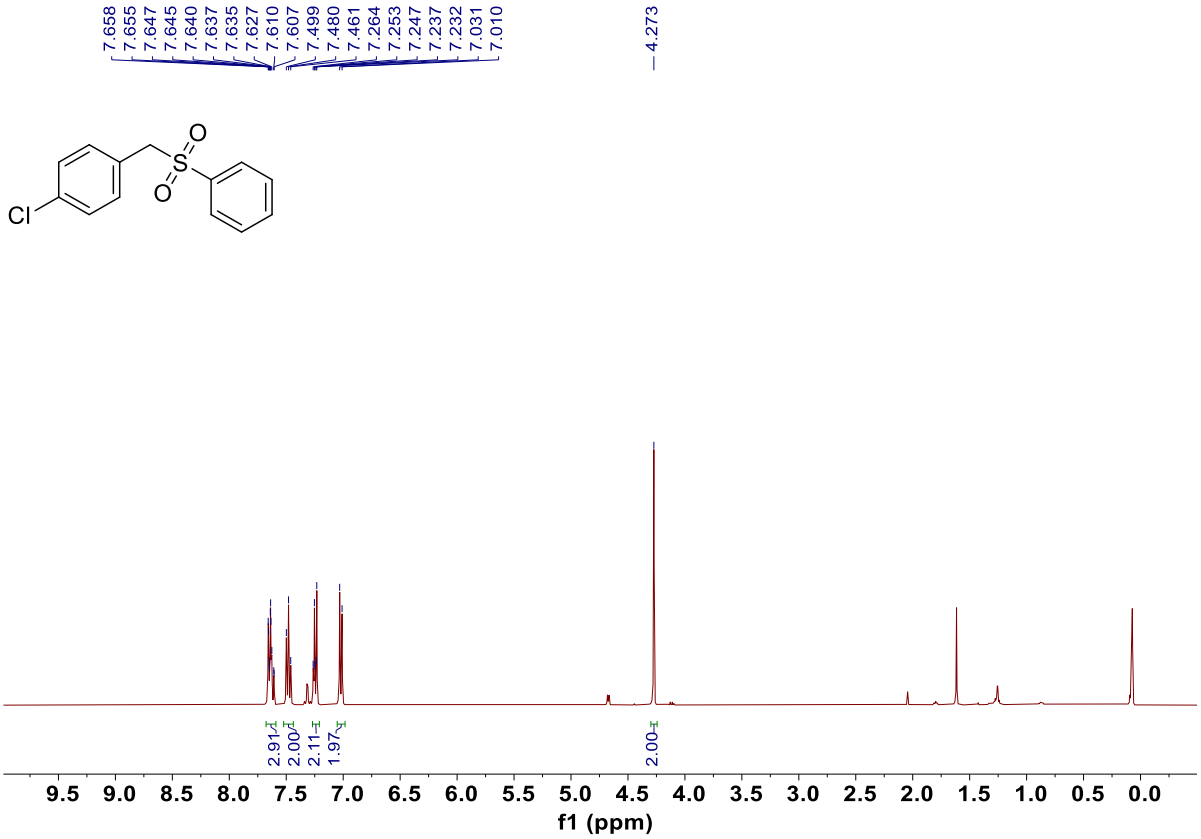
55.704
F
O
S
O
f1 (ppm)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7.264
7.253
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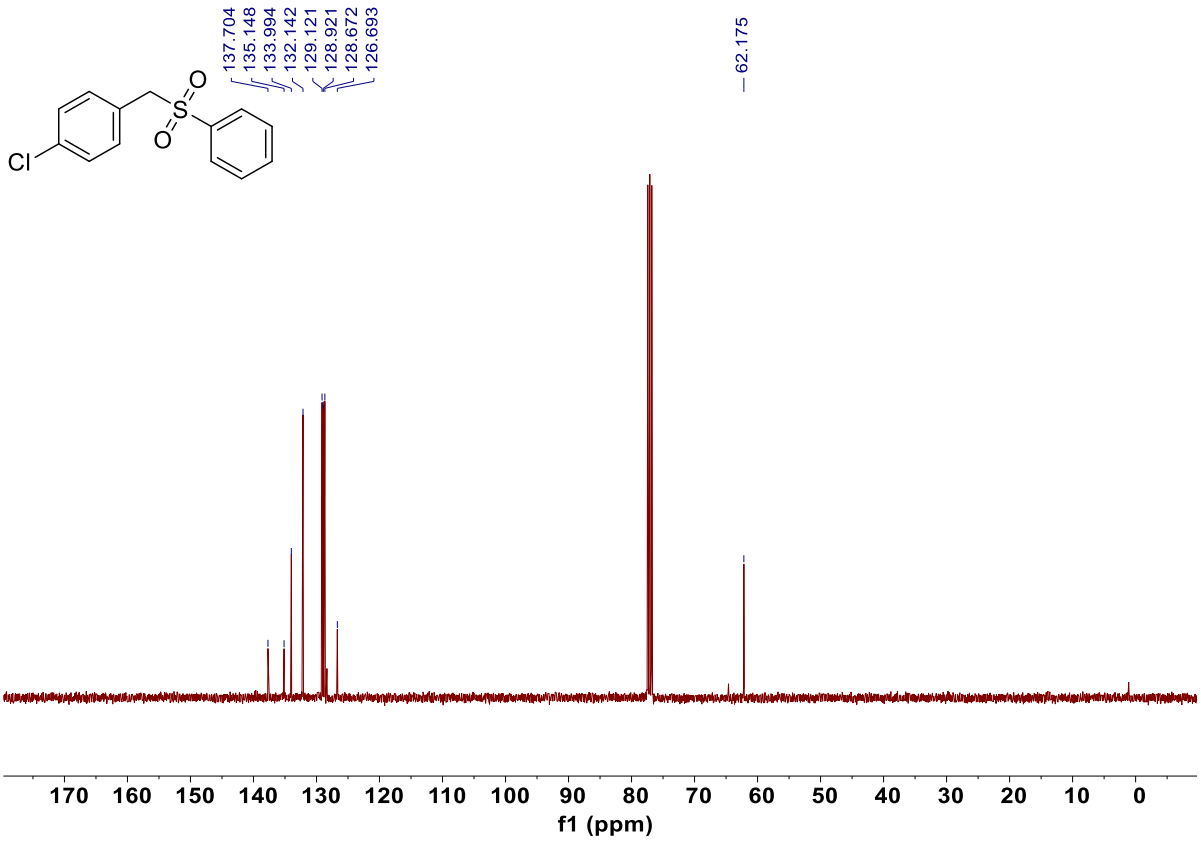
7.237
7.232
7.031
7.010
4.273
Cl
O
S
O
2.91
2.00
2.11
1.97
2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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Cl
O
S
O
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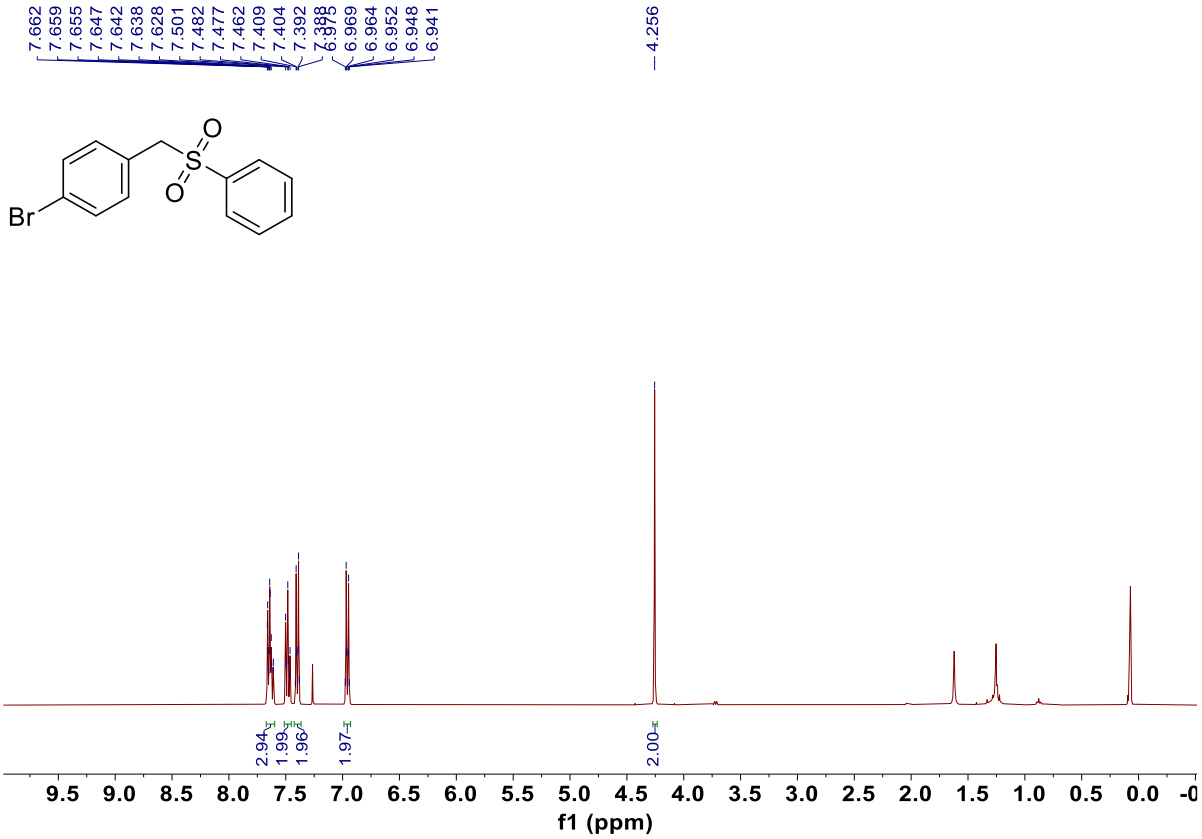
f1 (ppm)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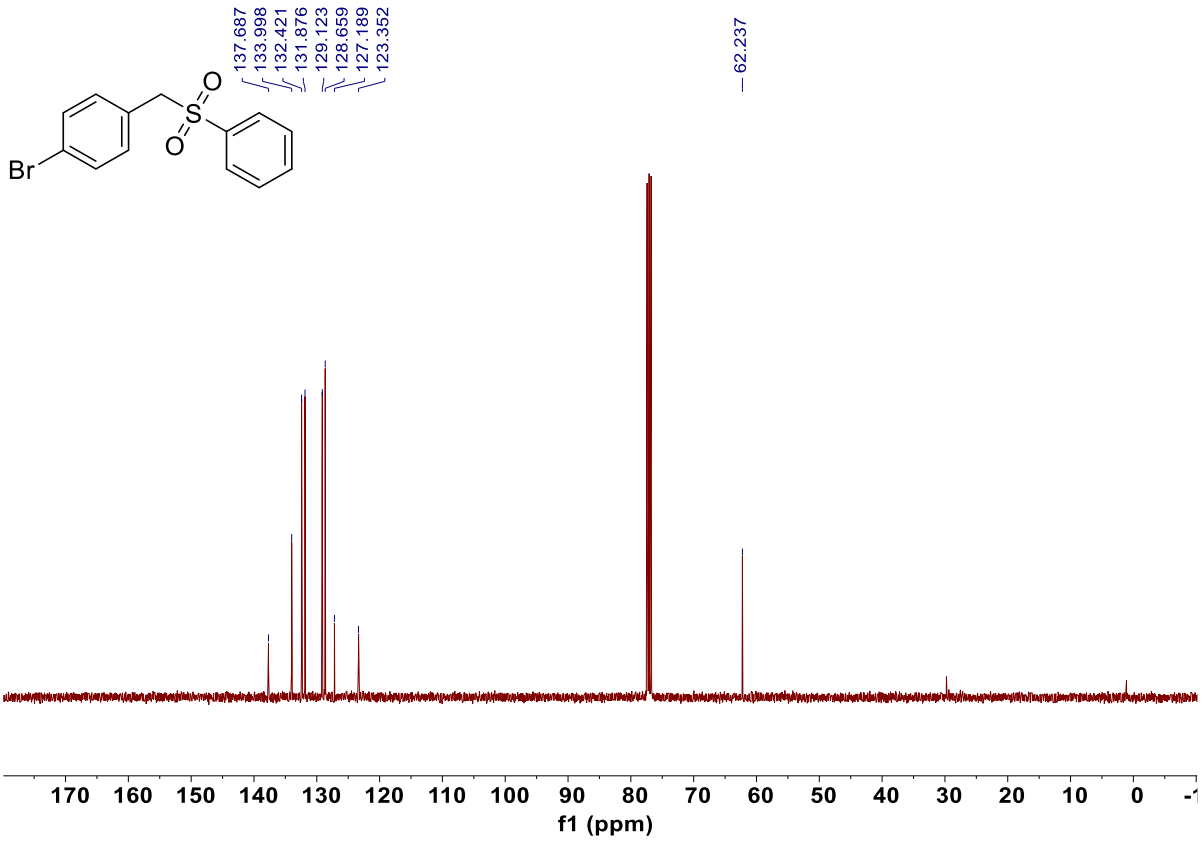
7.392
6.975
6.969
6.964
6.952
6.948
6.941
4.256
Br
O
S
O
2.94
1.99
1.96
1.97
2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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133.998
132.421
131.876
129.123
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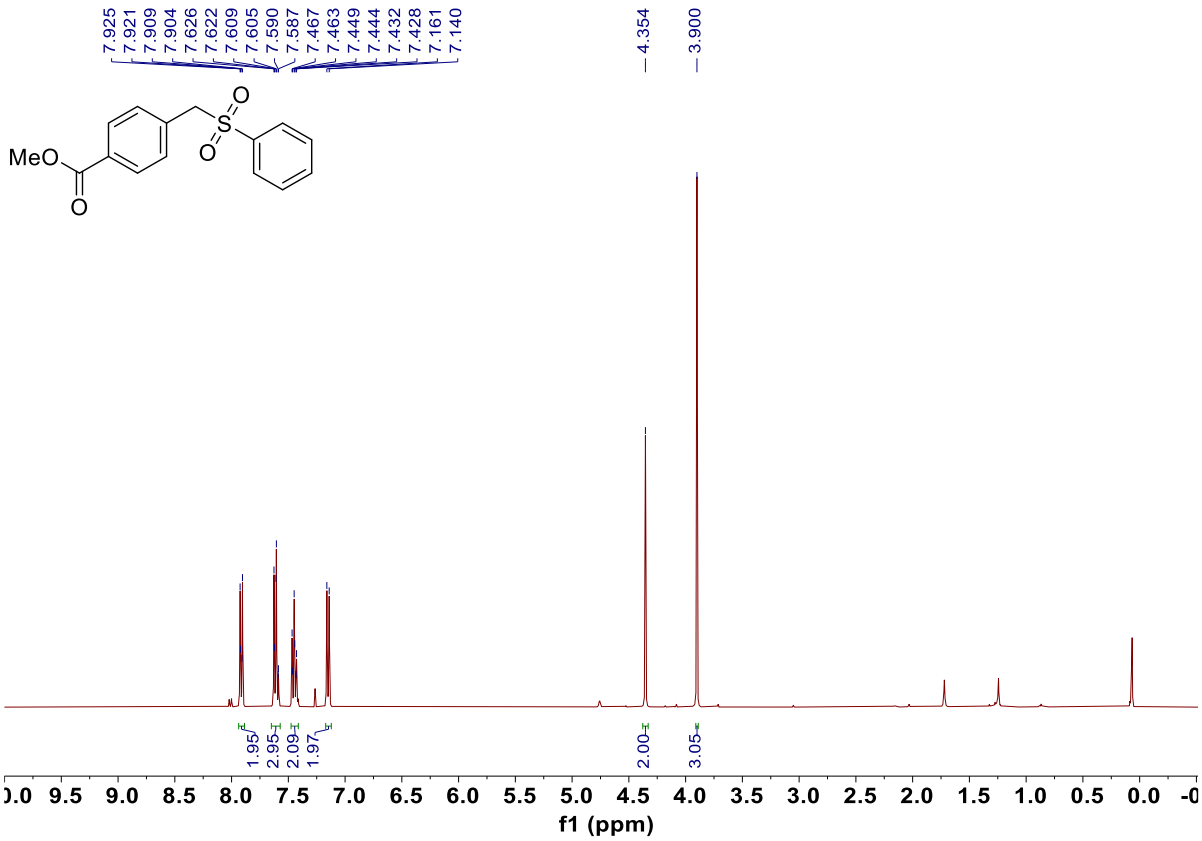
123.352
62.237
Br
O
S
O
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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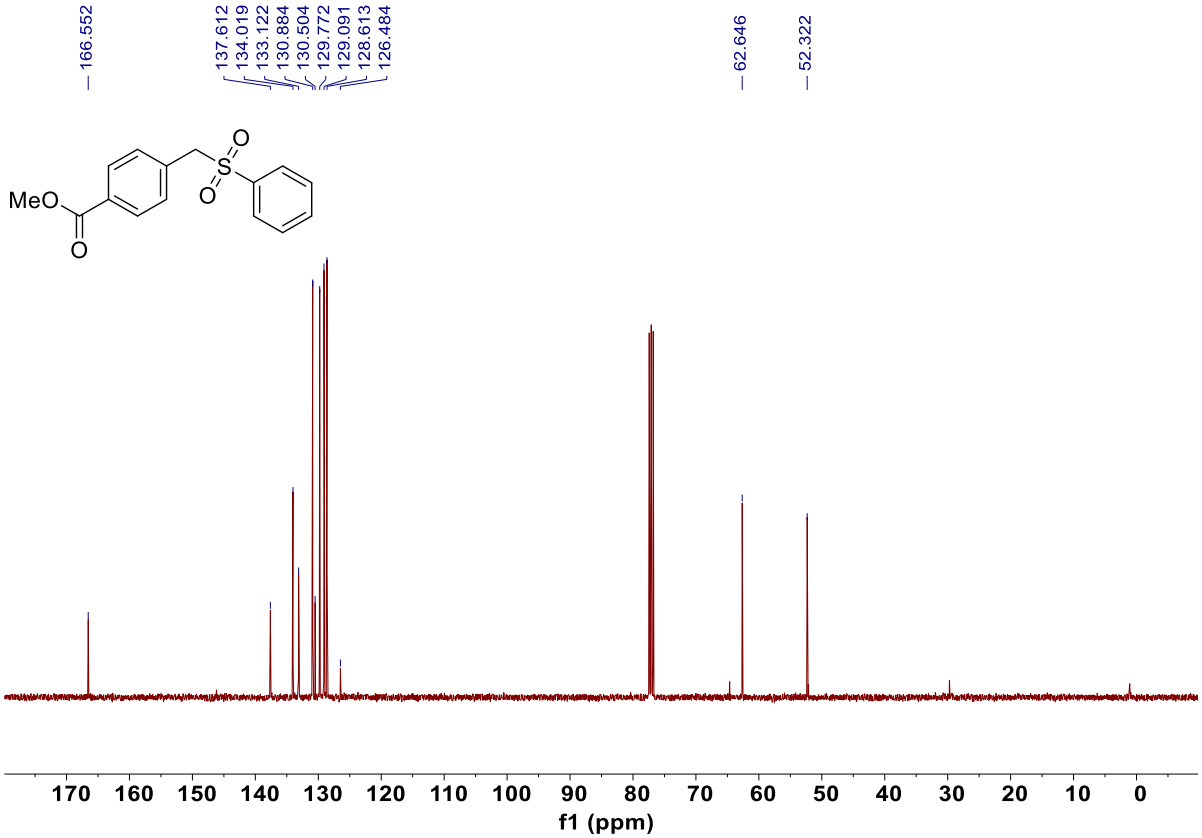
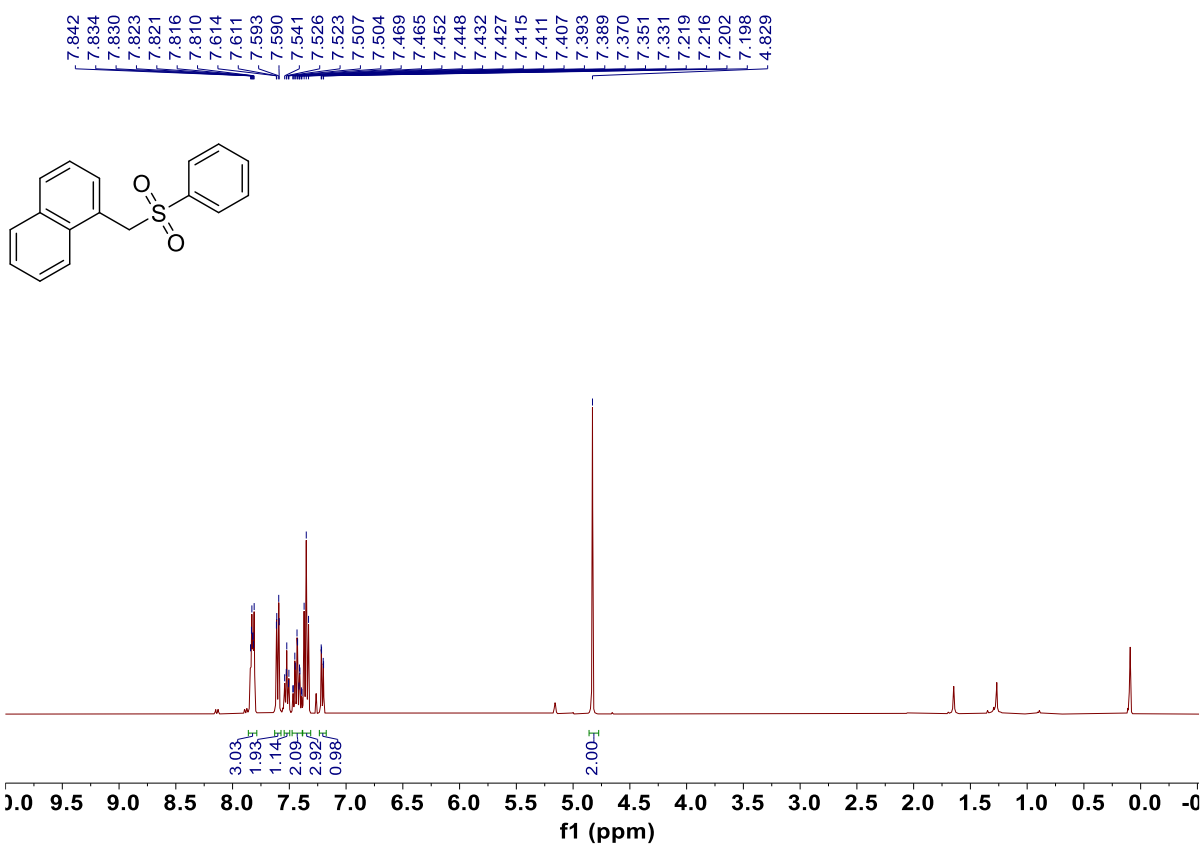
7.921
7.909
7.904
7.626
7.622
7.609
7.605
7.590
7.587
7.467
7.463
7.449
7.444
7.432
7.428
7.161
7.140
4.354
3.900
MeO
O
O
S
O
1.95
2.95
2.09
1.97
2.00
3.05
f1 (ppm)


166.552
137.612
134.019
133.122
130.884
130.504
129.772
129.091
128.613
126.484
62.646
52.322
MeO
O
O
S
O
f1 (ppm)


7.842
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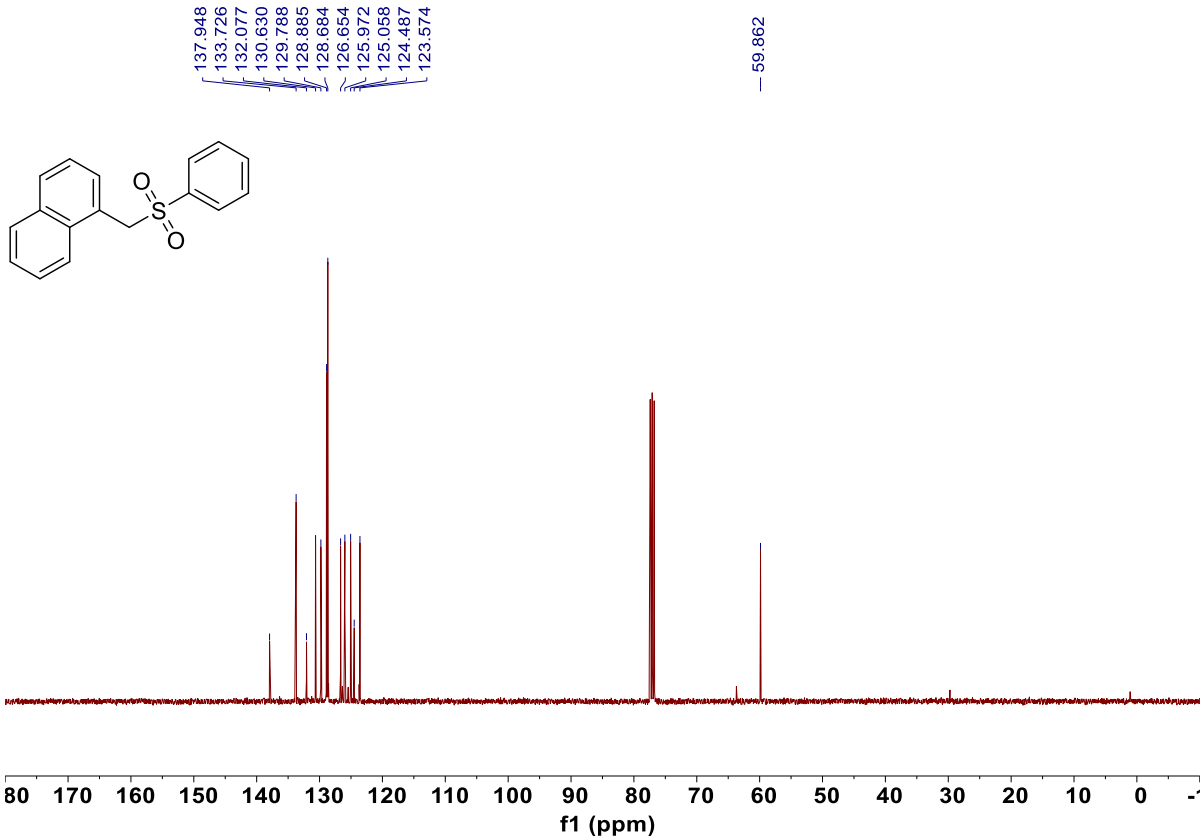
7.830
7.823
7.821
7.816
7.810
7.614
7.611
7.593
7.590
7.541
7.526
7.523
7.507
7.504
7.469
7.465
7.452
7.448
7.432
7.427
7.415
7.411
7.407
7.393
7.389
7.370
7.351
7.331
7.219
7.216
7.202
7.198
4.829
O
S
O
3.03
1.93
1.14
2.09
2.92
0.98
2.00
f1 (ppm)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132.077
130.630
129.788
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126.654
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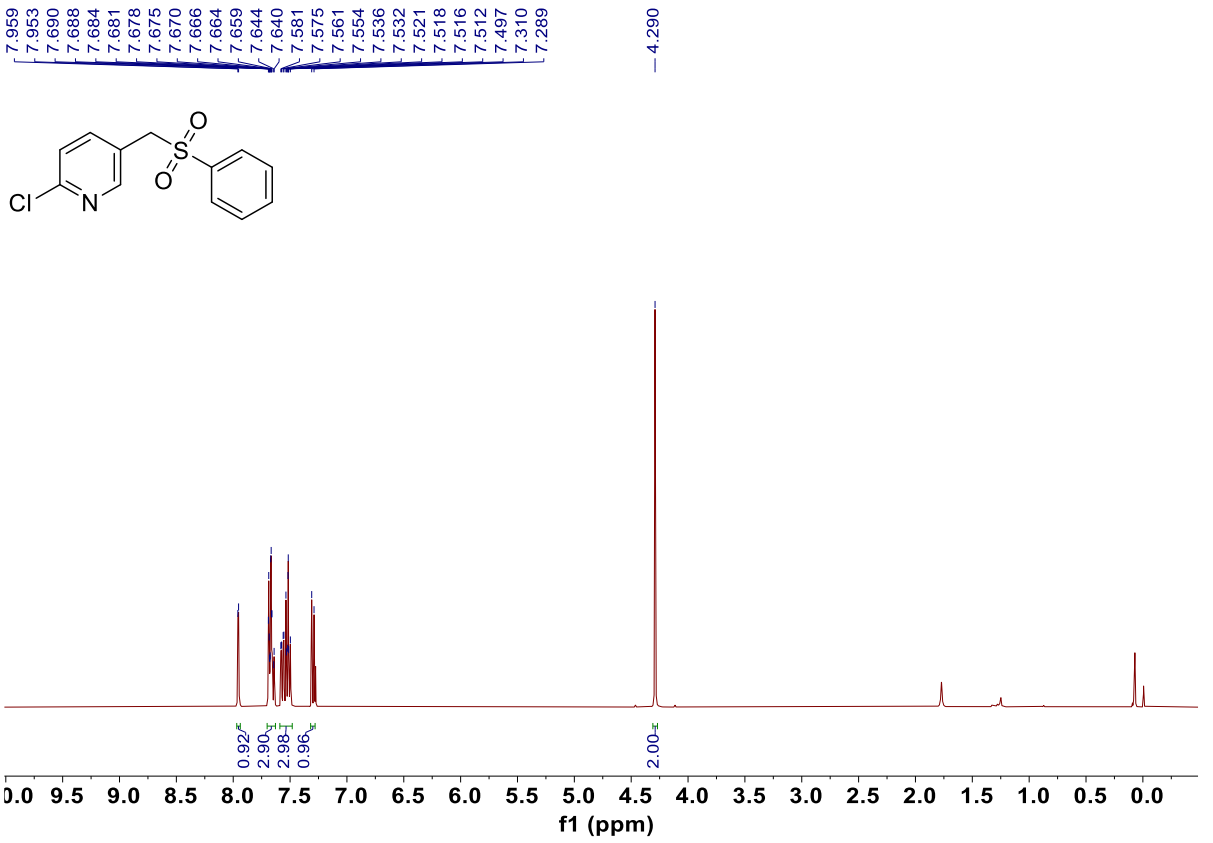
125.058
124.487
123.574
59.862
O
S
O
f1 (ppm)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7.953
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7.688
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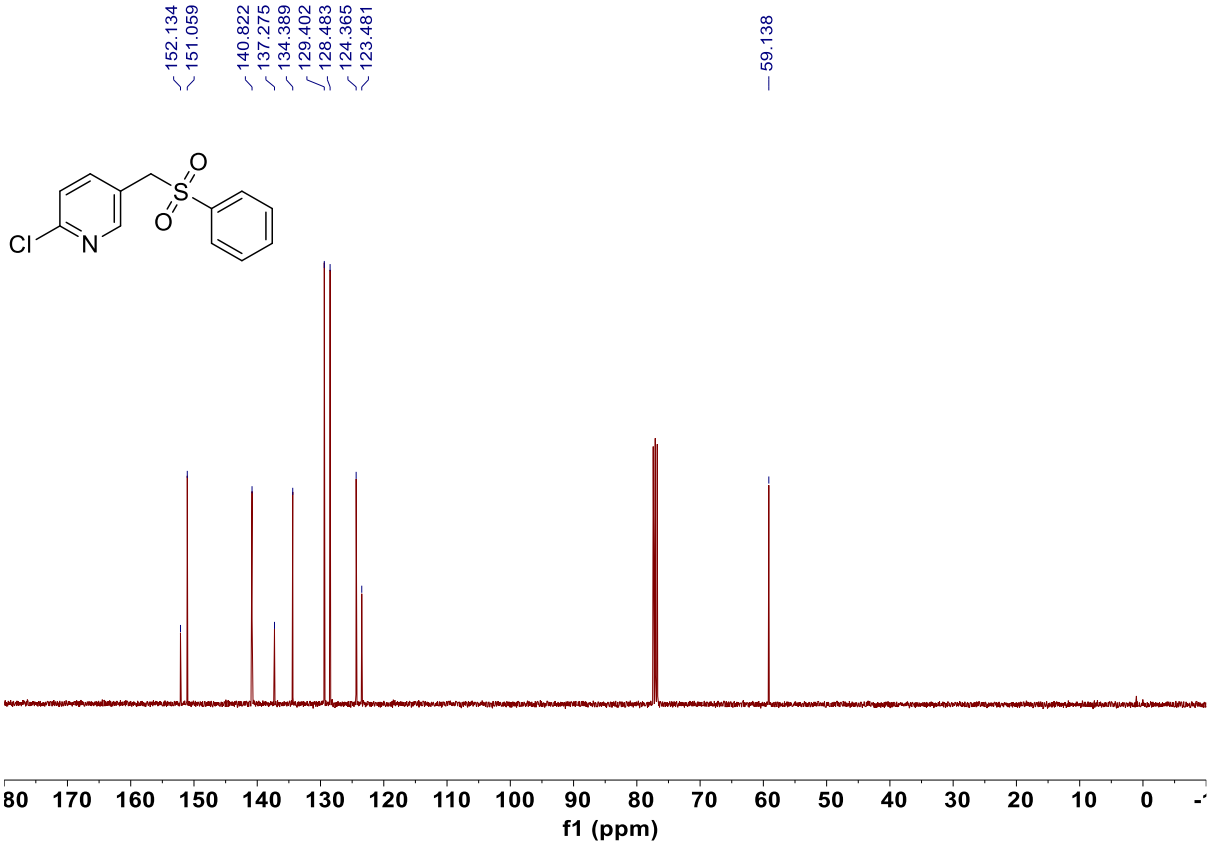
7.681
7.678
7.675
7.670
7.666
7.664
7.659
7.644
7.640
7.581
7.575
7.561
7.554
7.536
7.532
7.521
7.518
7.516
7.512
7.497
7.310
7.289
4.290
Cl
N
O
S
O
0.92
2.90
2.98
0.96
2.00
f1 (ppm)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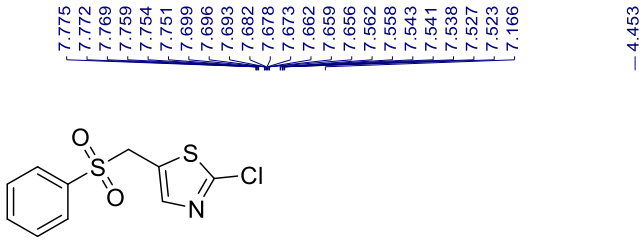
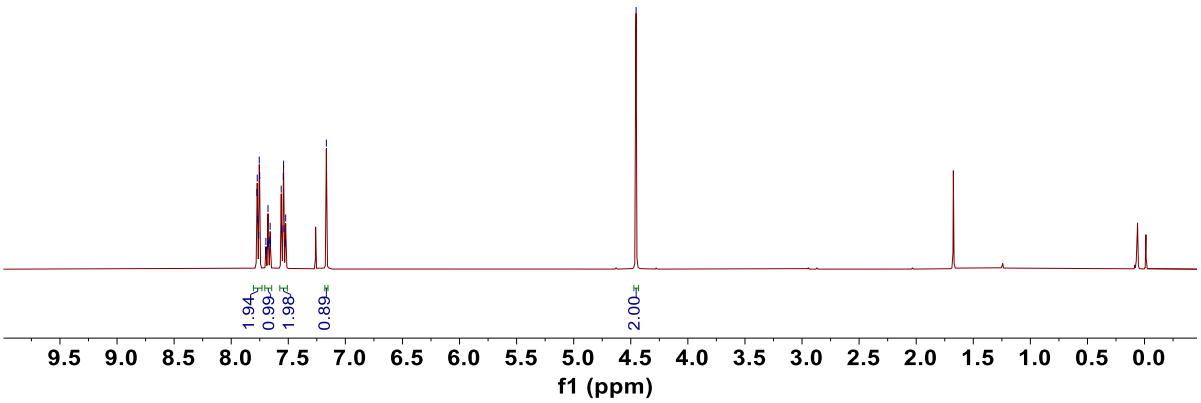
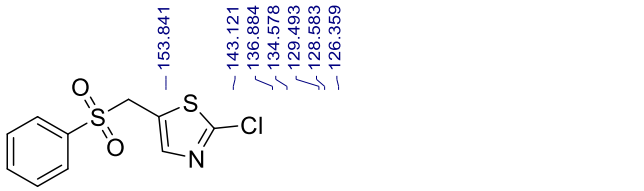
151.059
140.822
137.275
134.389
129.402
128.483
124.365
123.481
59.138
Cl
N
O
S
O
f1 (ppm)


7.775
7.772
7.769
7.759
7.754
7.751
7.699
7.696
7.693
7.682
7.678
7.673
7.662
7.659
7.656
7.562
7.558
7.543
7.541
7.538
7.527
7.523
7.166
4.453
O
S
O
S
N
Cl


1.94
0.99
1.98
0.89
2.00
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)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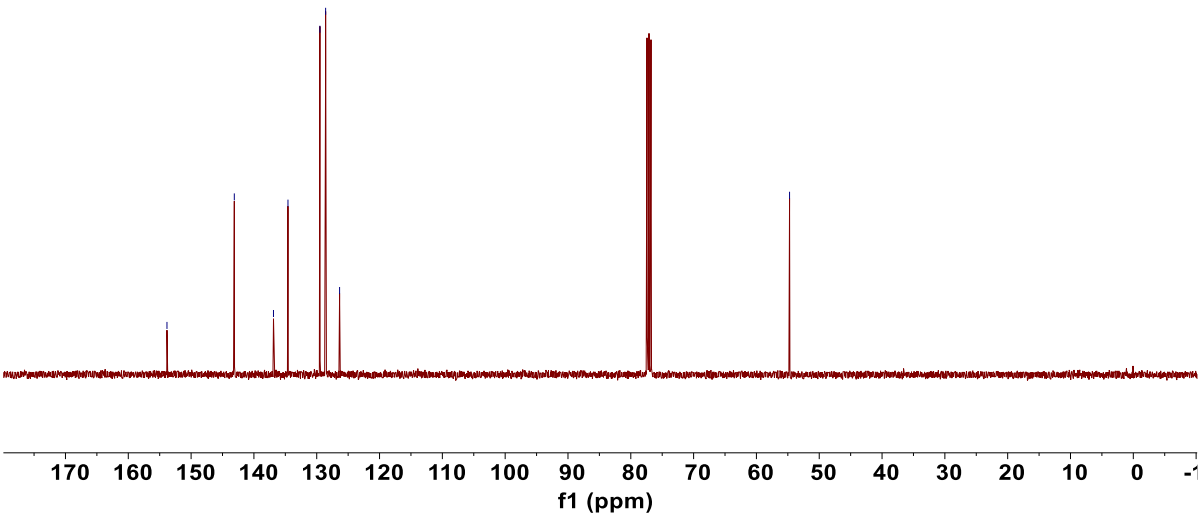
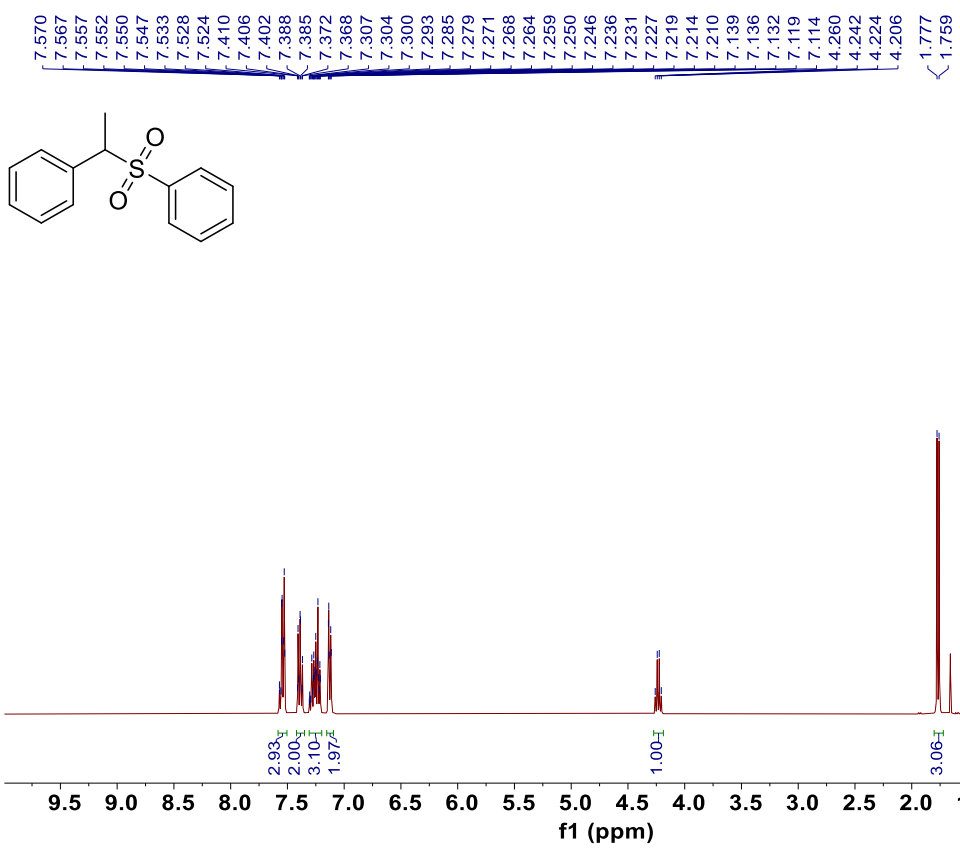
134.578
129.493
128.583
126.359
54.725
O
S
O
S
N
Cl


170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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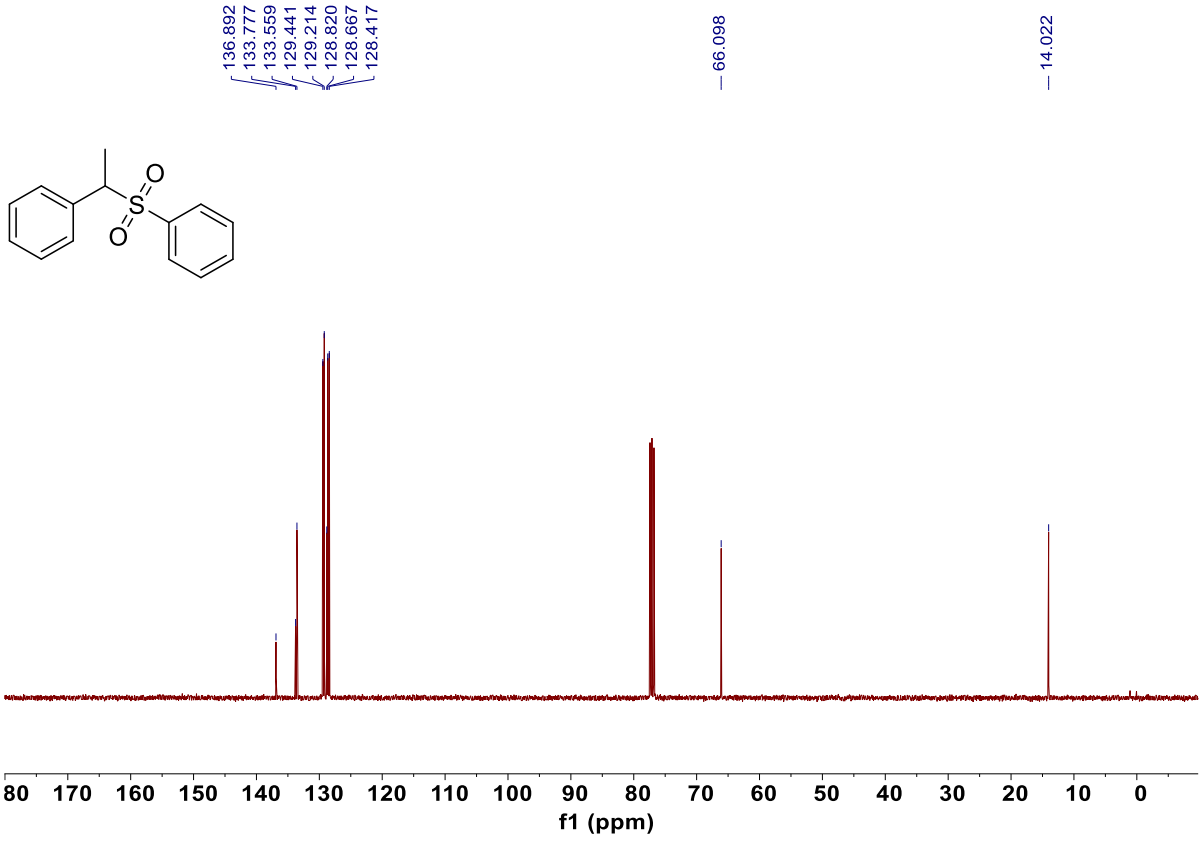
7.557
7.552
7.550
7.547
7.533
7.528
7.524
7.410
7.406
7.402
7.388
7.385
7.372
7.368
7.307
7.304
7.300
7.293
7.285
7.279
7.271
7.268
7.264
7.259
7.250
7.246
7.236
7.231
7.227
7.219
7.214
7.210
7.139
7.136
7.132
7.119
7.114
4.260
4.242
4.224
4.206
1.777
1.759
O
S
O
2.93
2.00
3.10
1.97
1.00
3.06
9.5 9.0 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 -0
f1 (ppm)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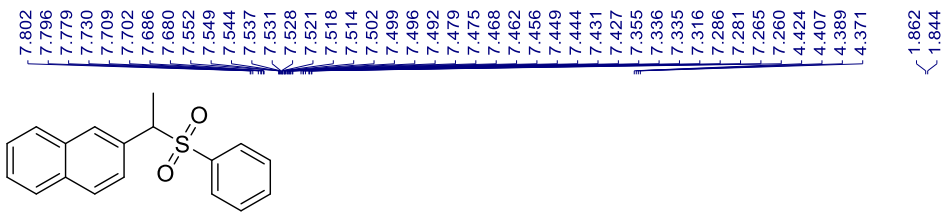
133.559
129.441
129.214
128.820
128.667
128.417
66.098
14.022
O
S
O
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.702
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7.680
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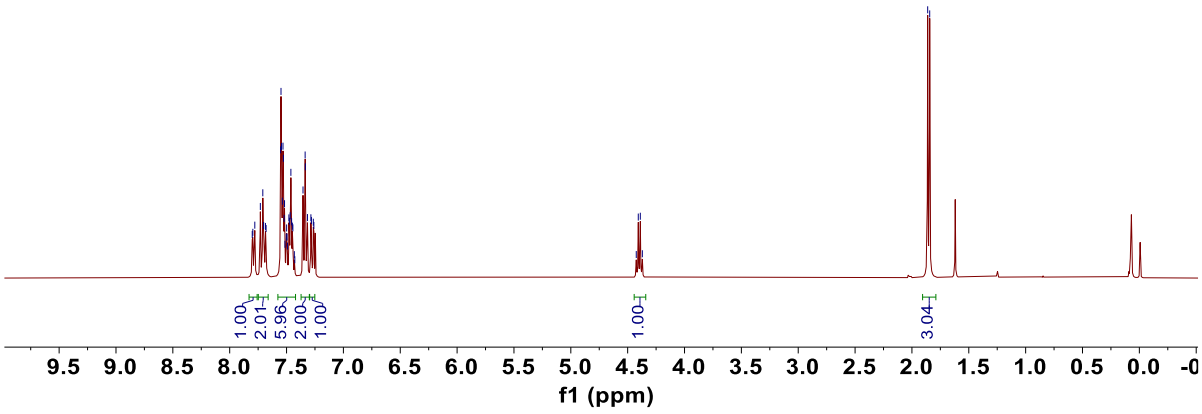
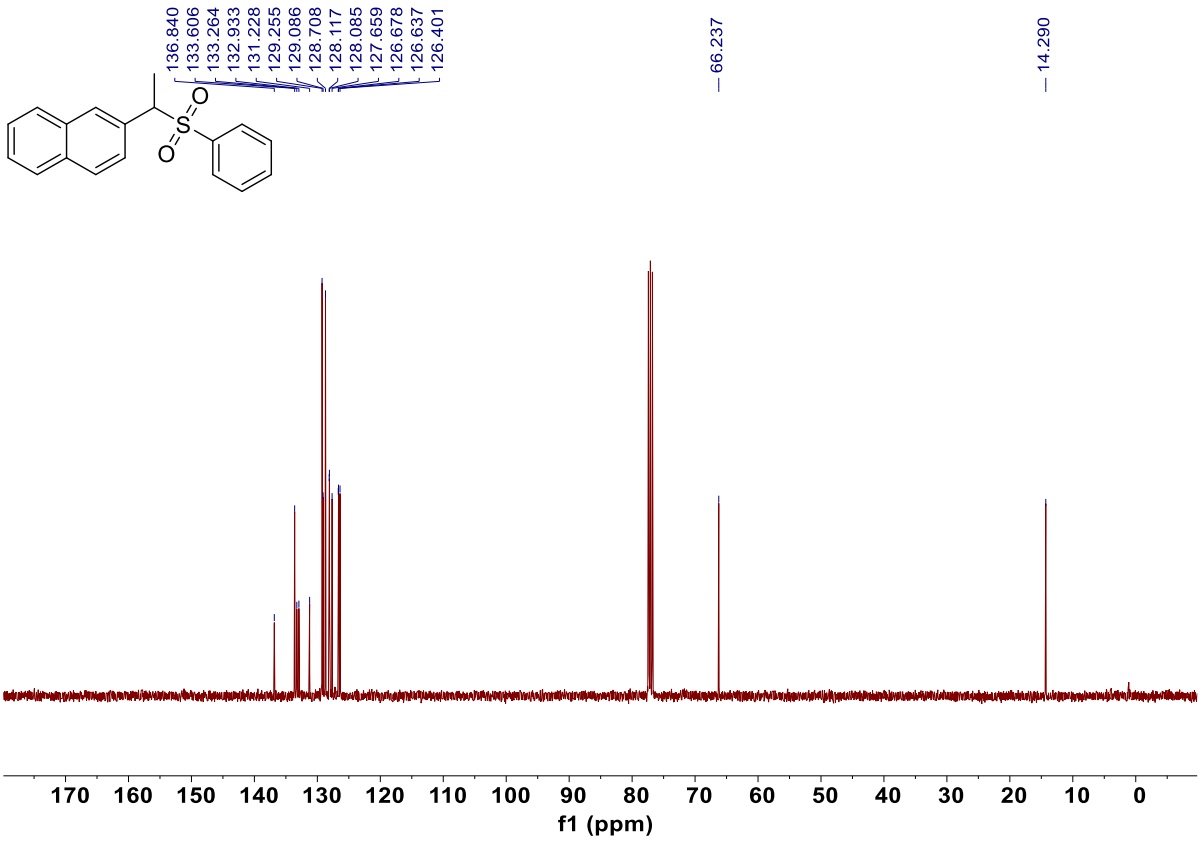
7.549
7.544
7.537
7.531
7.528
7.521
7.518
7.514
7.502
7.499
7.496
7.492
7.479
7.475
7.468
7.462
7.456
7.449
7.444
7.431
7.427
7.355
7.336
7.335
7.316
7.286
7.281
7.265
7.260
4.424
4.407
4.389
4.371
1.862
1.844
O
S
O
O


1.00
2.01
5.96
2.00
1.00
1.00
3.04
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 -0
f1 (ppm)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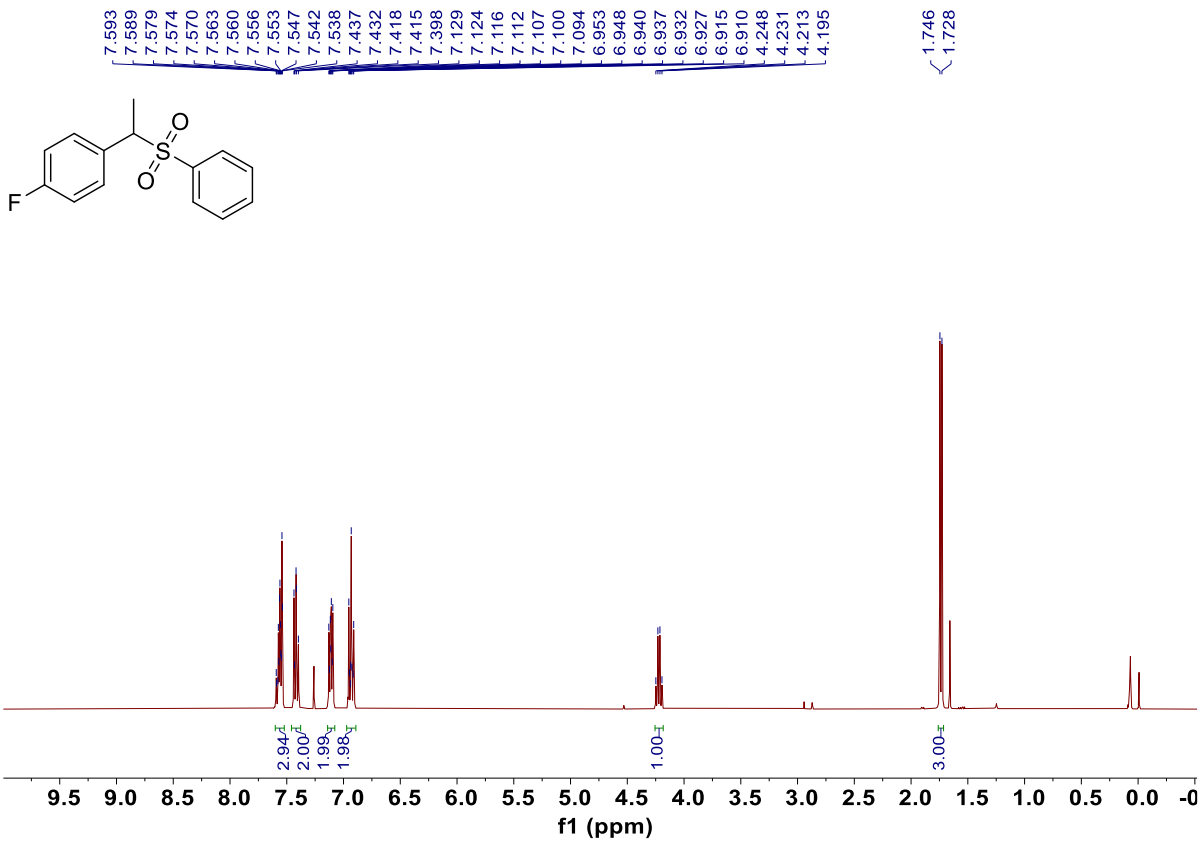
133.606
133.264
132.933
131.228
129.255
129.086
128.708
128.117
128.085
127.659
126.678
126.637
126.401
66.237
14.290
O
S
O
O
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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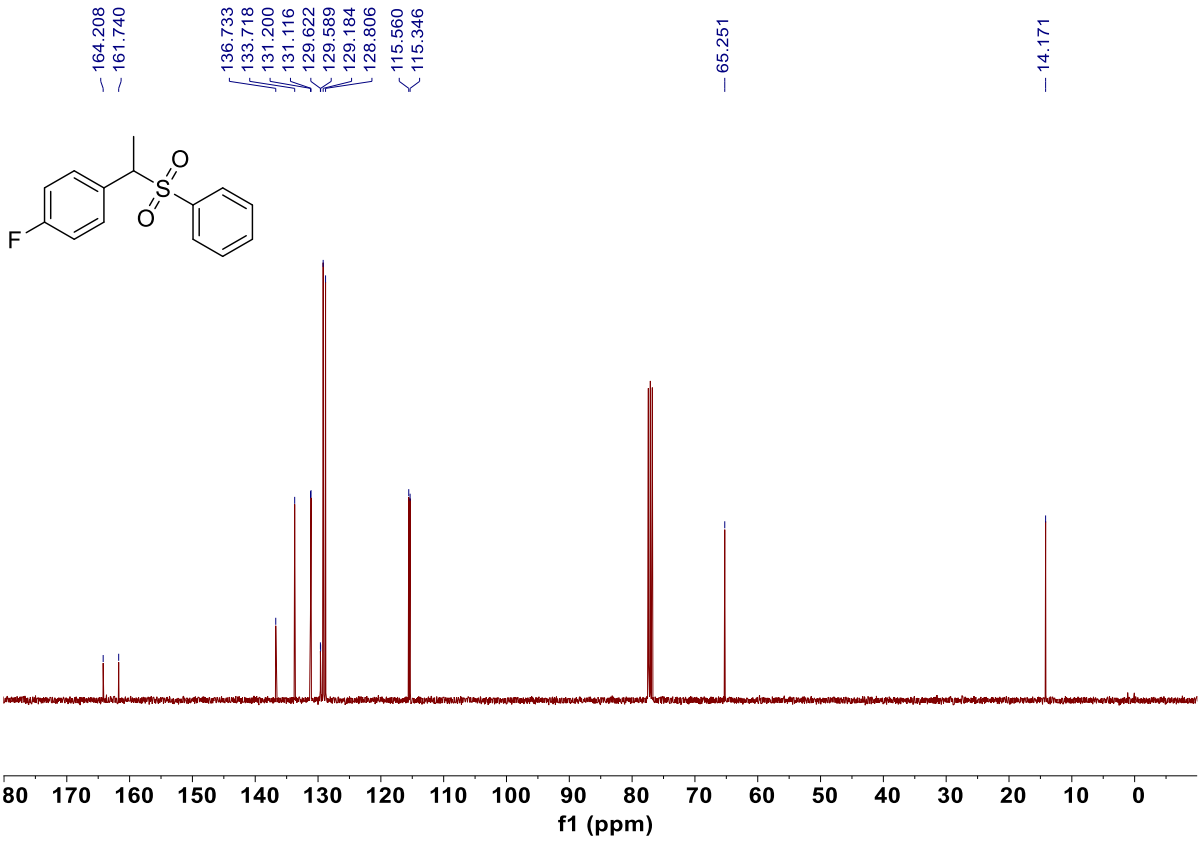
7.556
7.553
7.547
7.542
7.538
7.437
7.432
7.418
7.415
7.398
7.129
7.124
7.116
7.112
7.107
7.100
7.094
6.953
6.948
6.940
6.937
6.932
6.927
6.915
6.910
4.248
4.231
4.213
4.195
1.746
1.728
F
O
S
O
2.94
2.00
1.99
1.98
1.00
3.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0
f1 (ppm)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131.116
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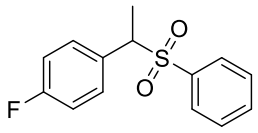
129.589
129.184
128.806
115.560
115.346
65.251
14.171
F
O
S
O
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


F
S
O
O

-112.473
10
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
f1 (ppm)


7.804
7.800
7.788
7.783
7.388
7.368
7.324
7.320
7.316
7.308
7.303
7.299
7.296
7.288
7.284
7.252
7.249
7.245
7.236
7.230
7.224
7.216
7.212
7.209
7.149
7.145
7.139
7.132
7.127
7.125
3.114
3.101
3.094
3.087
3.074
2.742
2.723
2.704
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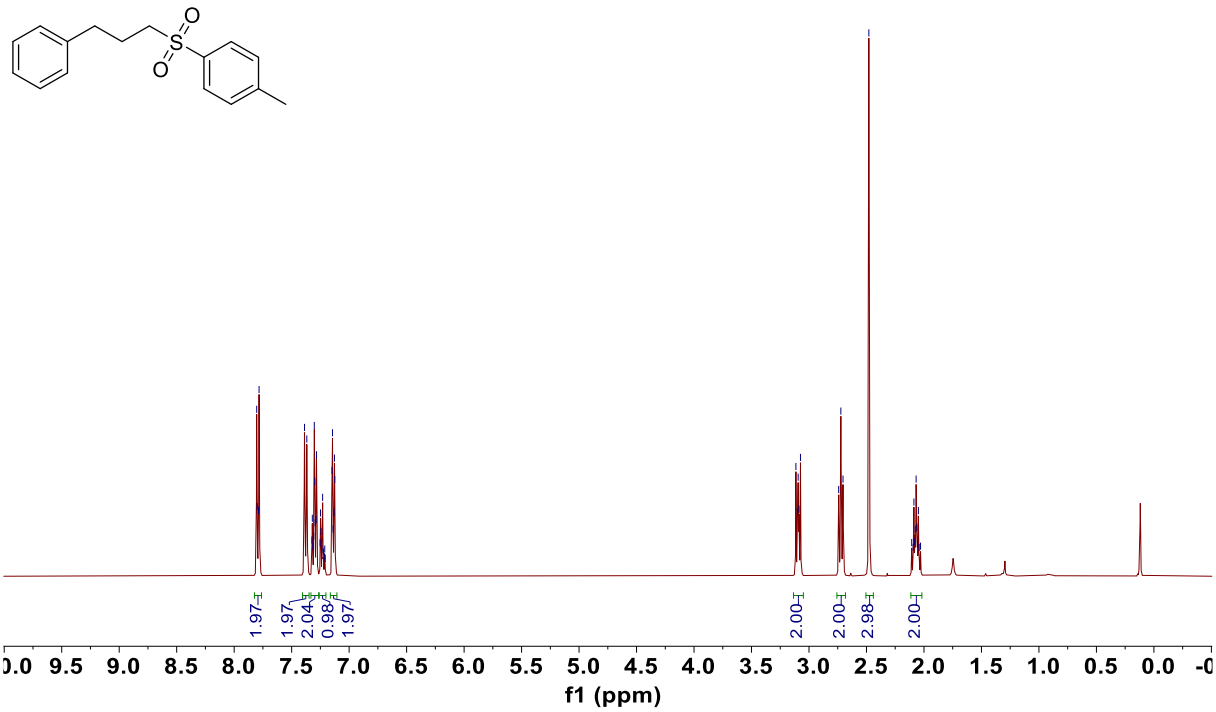
2.043
2.030


S
O
O
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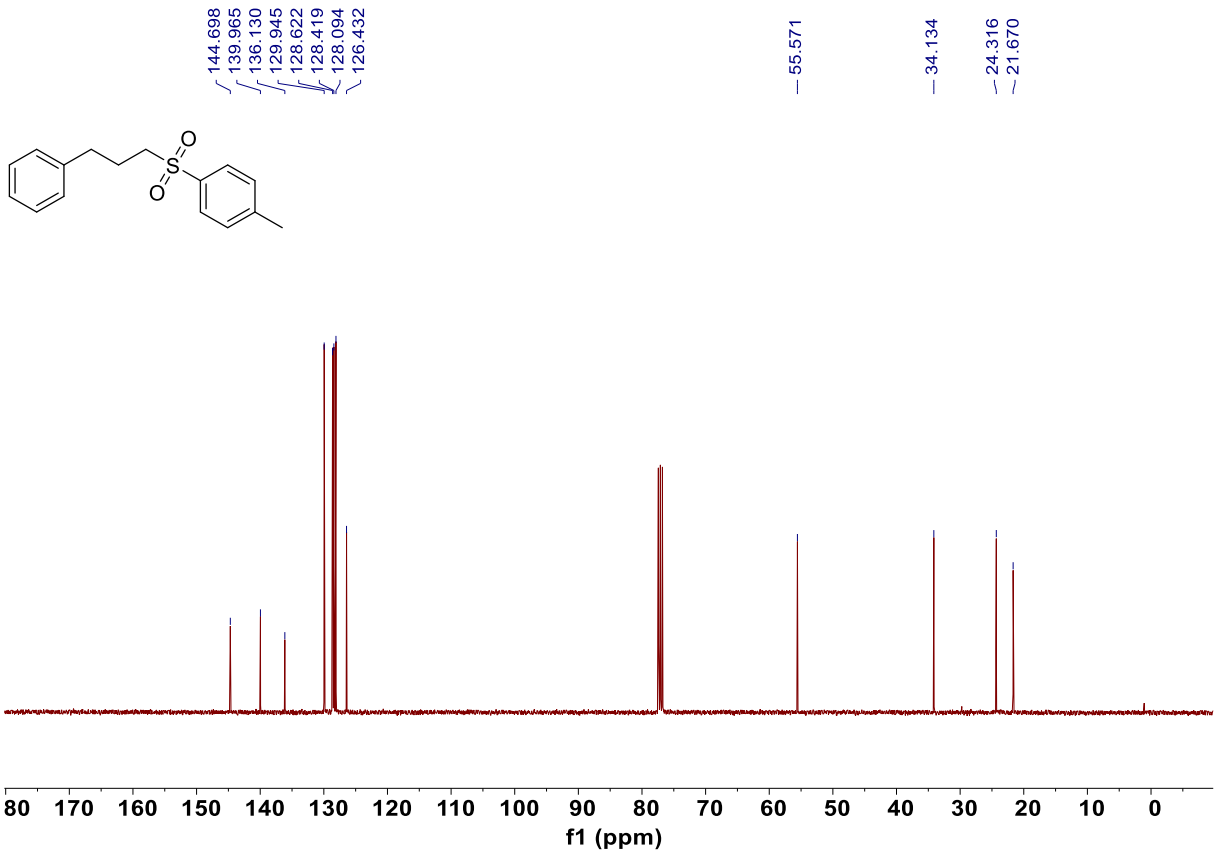
1.97
2.04
0.98
1.97
2.00
2.00
2.98
2.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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128.094
126.432
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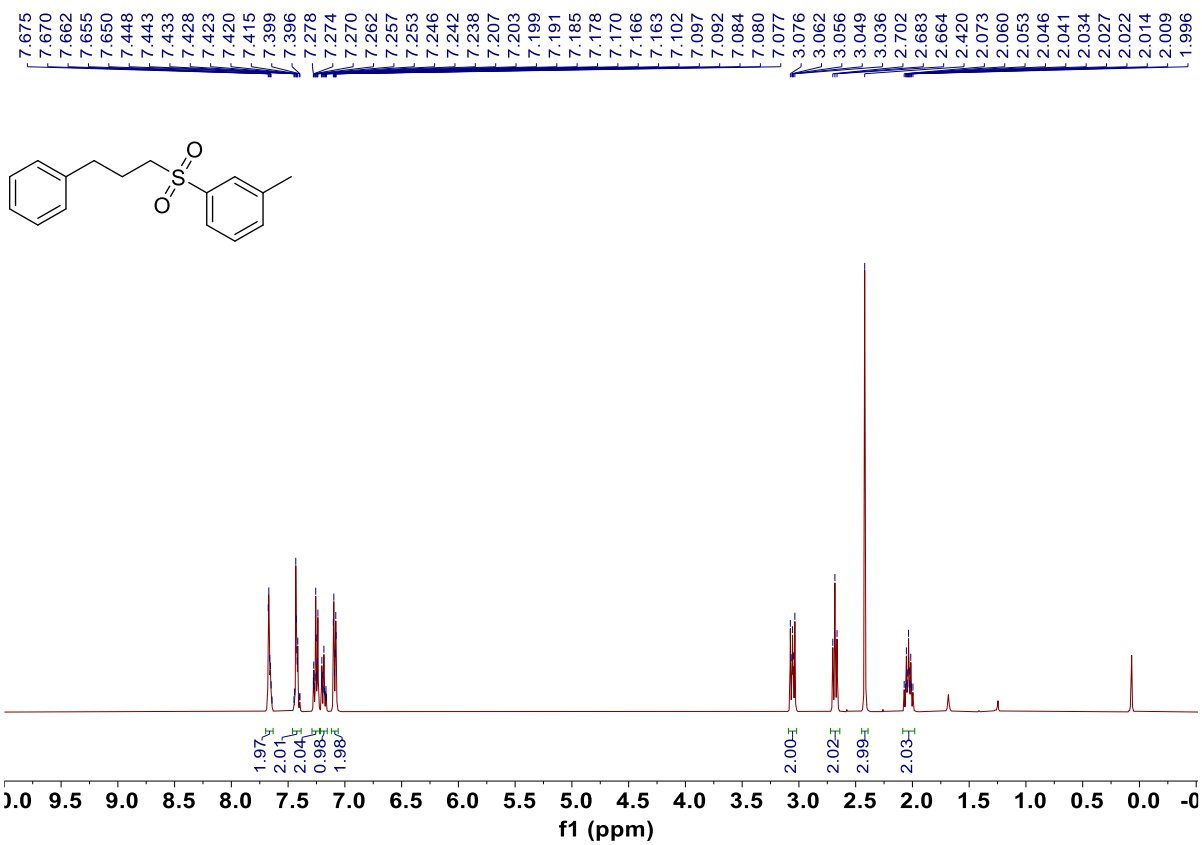
21.670
f1 (ppm)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7.655
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7.443
7.433
7.428
7.423
7.420
7.415
7.399
7.396
7.278
7.274
7.270
7.262
7.257
7.253
7.246
7.242
7.238
7.207
7.203
7.199
7.191
7.185
7.178
7.170
7.166
7.163
7.102
7.097
7.092
7.084
7.080
7.077
3.076
3.062
3.056
3.049
3.036
2.702
2.683
2.664
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2.073
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2.053
2.046
2.041
2.034
2.027
2.022
2.014
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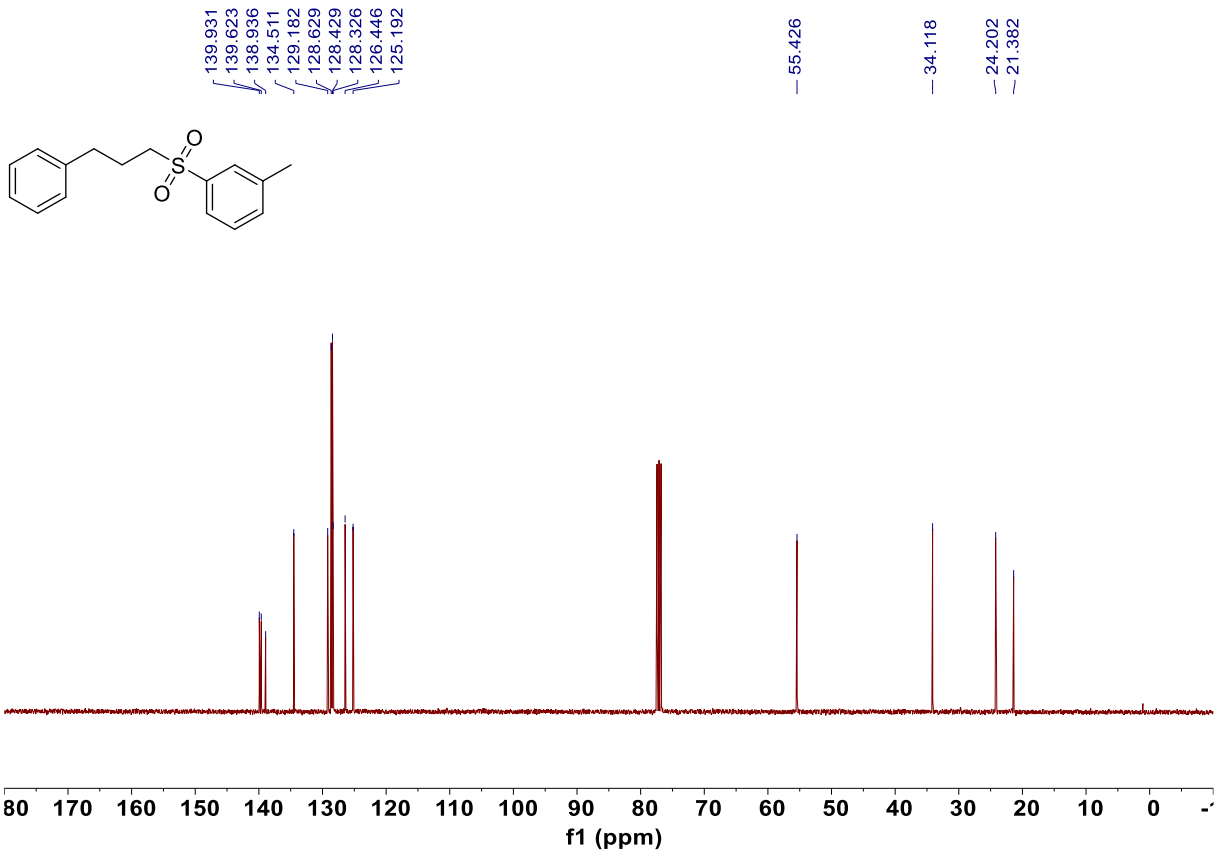
2.01
2.04
0.98
1.98
2.00
2.02
2.99
2.03
f1 (ppm)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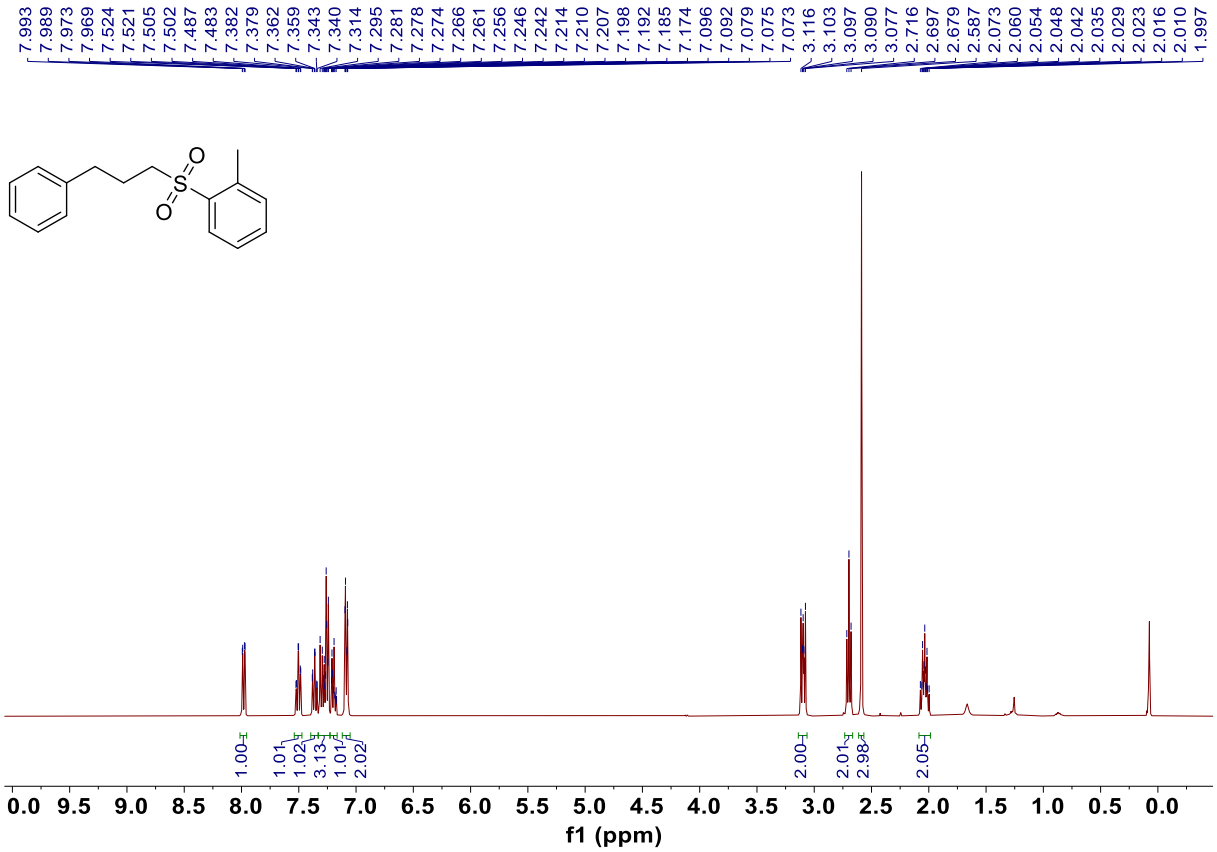
128.326
126.446
125.192
55.426
34.118
24.202
21.382
f1 (ppm)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7.502
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7.362
7.359
7.343
7.340
7.314
7.295
7.281
7.278
7.274
7.266
7.261
7.256
7.246
7.242
7.214
7.210
7.207
7.198
7.192
7.185
7.174
7.096
7.092
7.079
7.075
7.073
3.116
3.103
3.097
3.090
3.077
2.716
2.697
2.679
2.587
2.073
2.060
2.054
2.048
2.042
2.035
2.029
2.023
2.016
2.010
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1.02
3.13
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2.00
2.01
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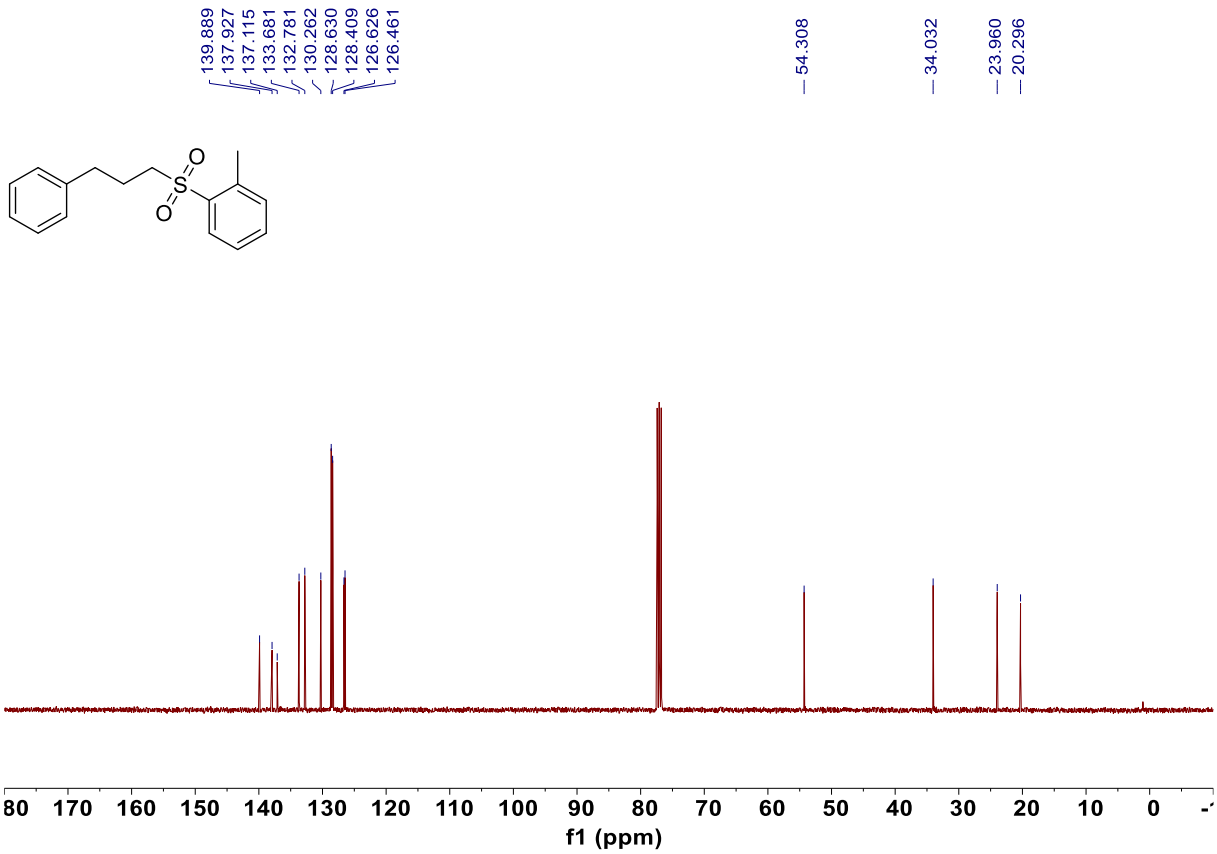
2.05
f1 (ppm)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137.115
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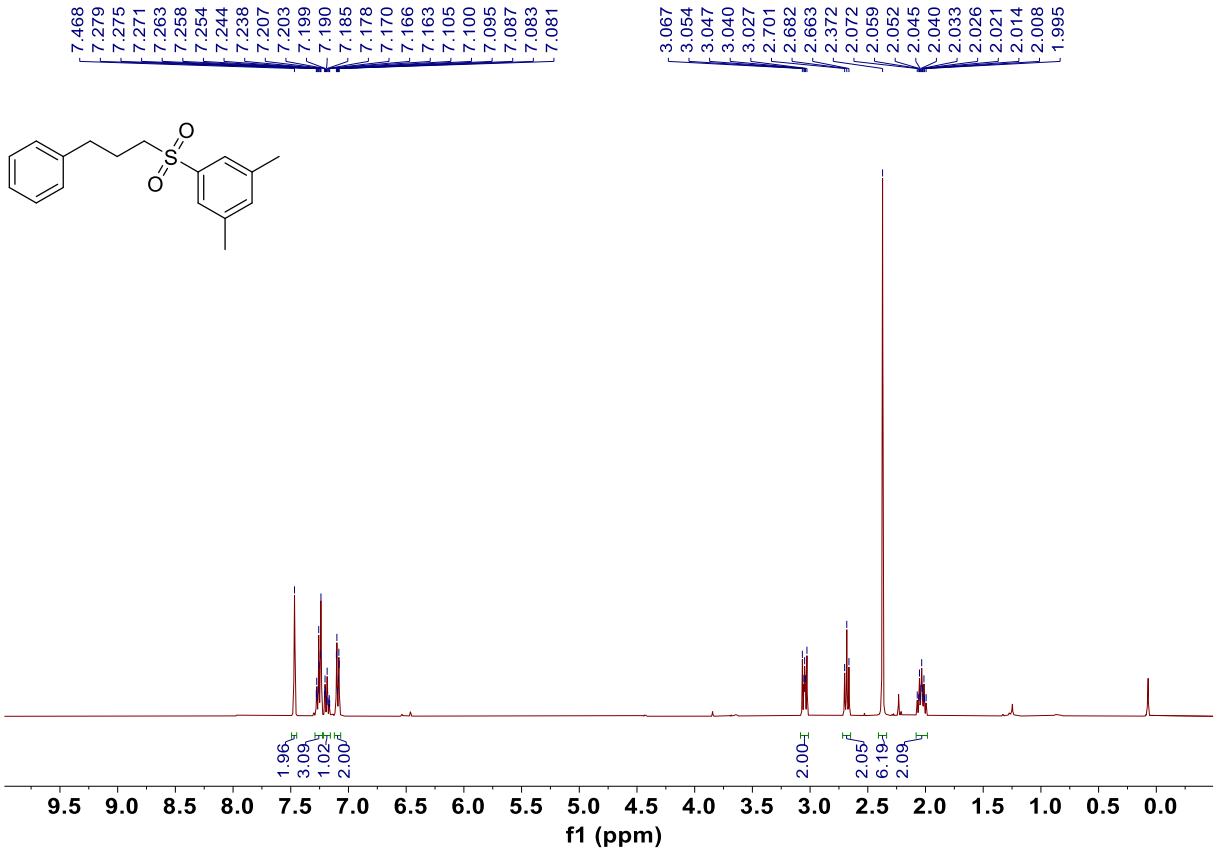
128.409
126.626
126.461
54.308
34.032
23.960
20.296
f1 (ppm)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7.190
7.185
7.178
7.170
7.166
7.163
7.105
7.100
7.095
7.087
7.083
7.081
3.067
3.054
3.047
3.040
3.027
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2.663
2.372
2.072
2.059
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2.045
2.040
2.033
2.026
2.021
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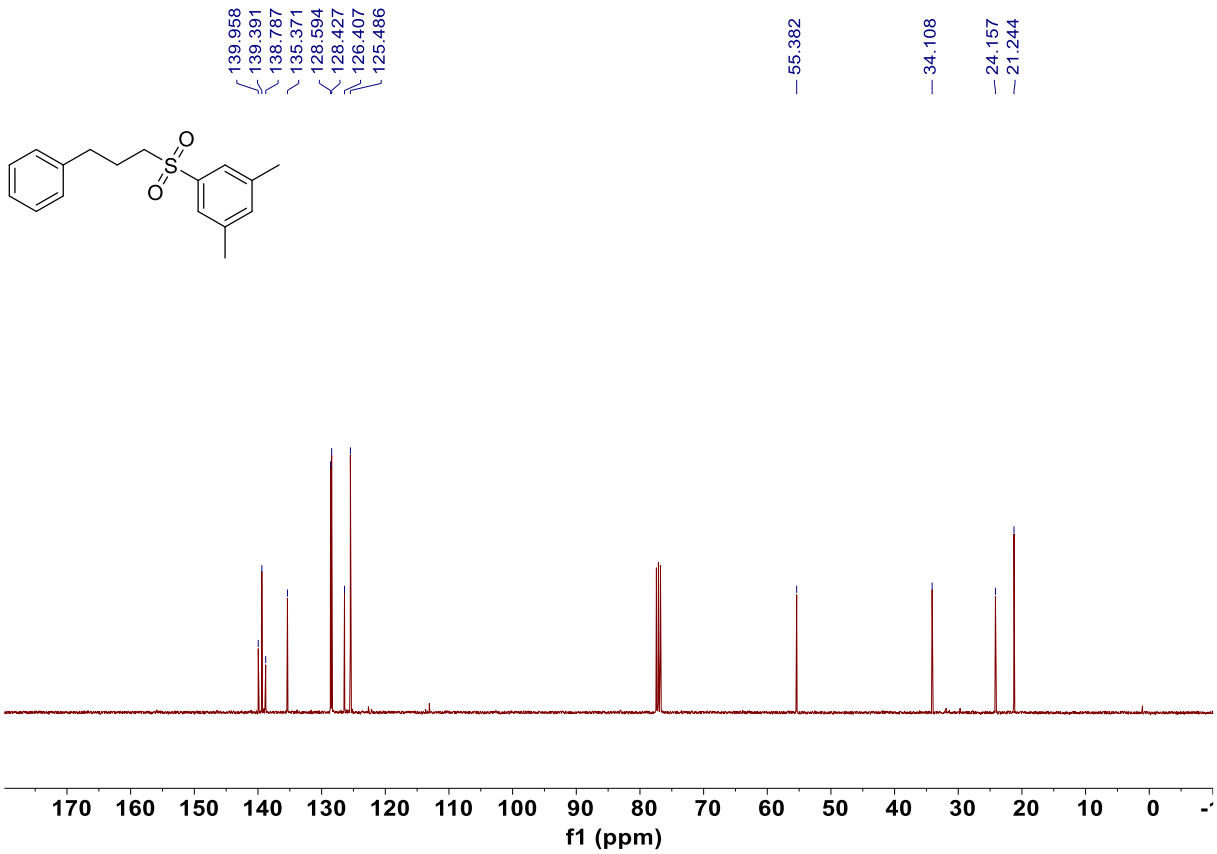
1.02
2.00
2.00
2.05
6.19
2.09
f1 (ppm)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128.427
126.407
125.486
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34.108
24.157
21.244
O
O
S
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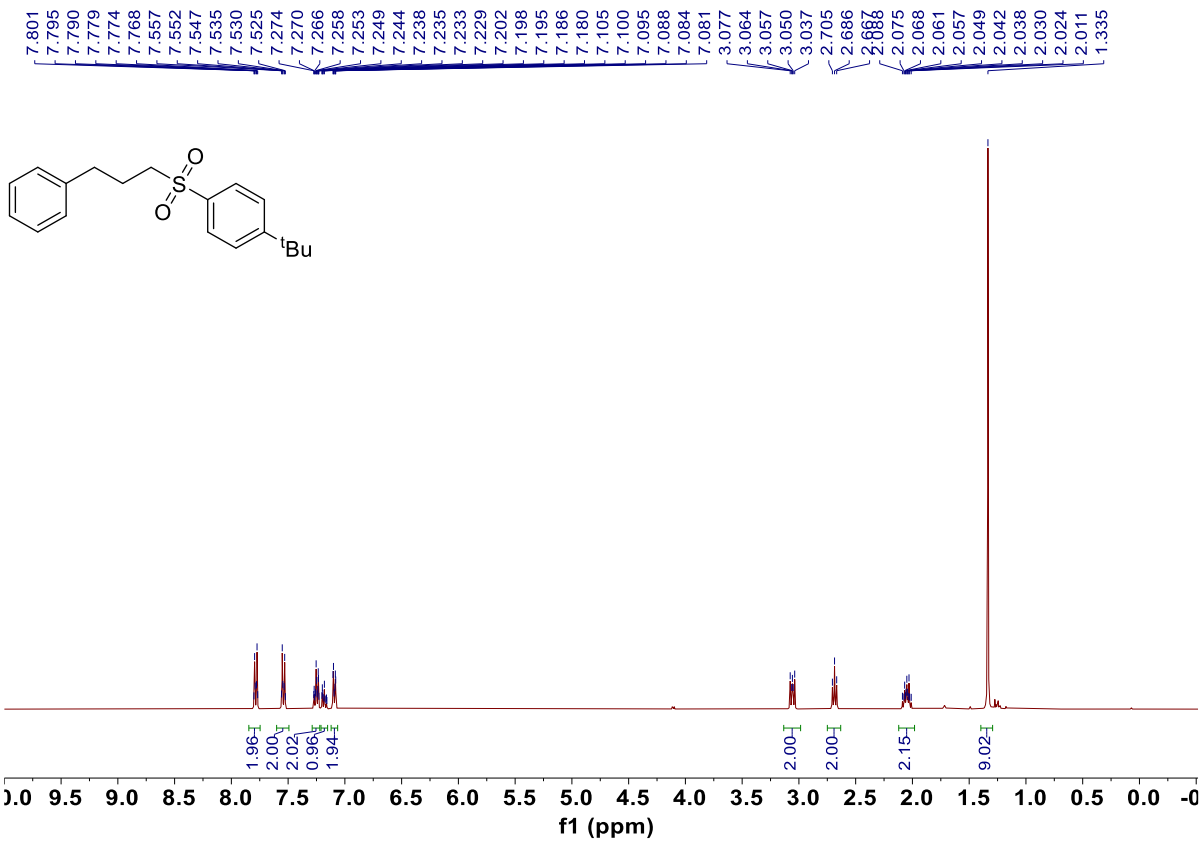
f1 (ppm)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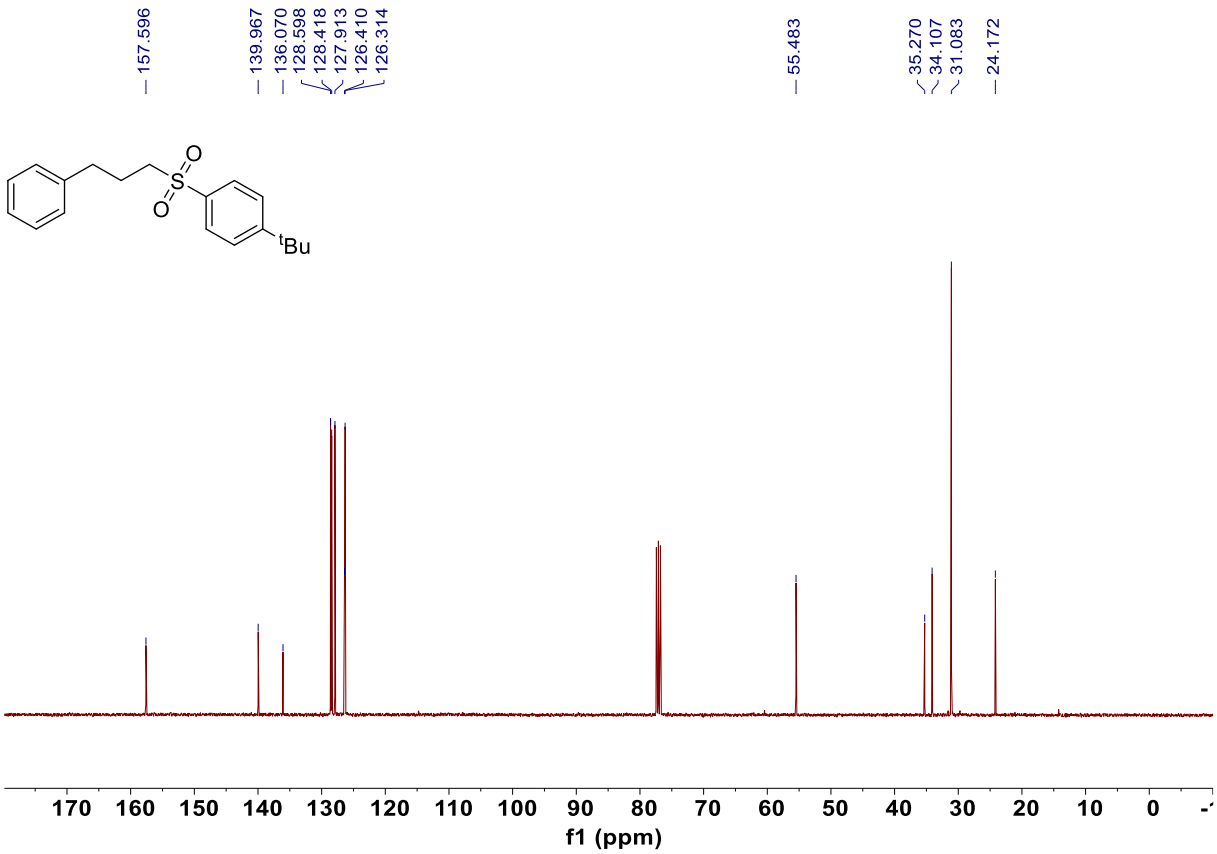
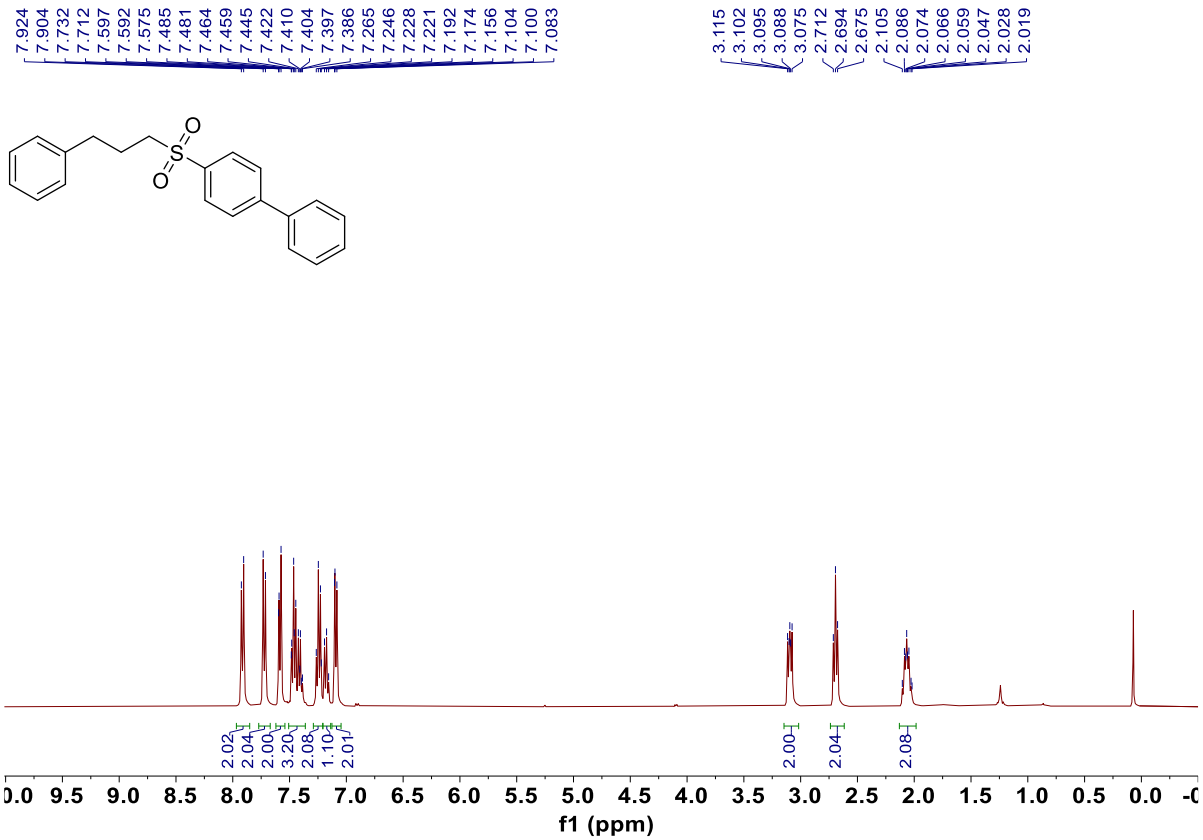
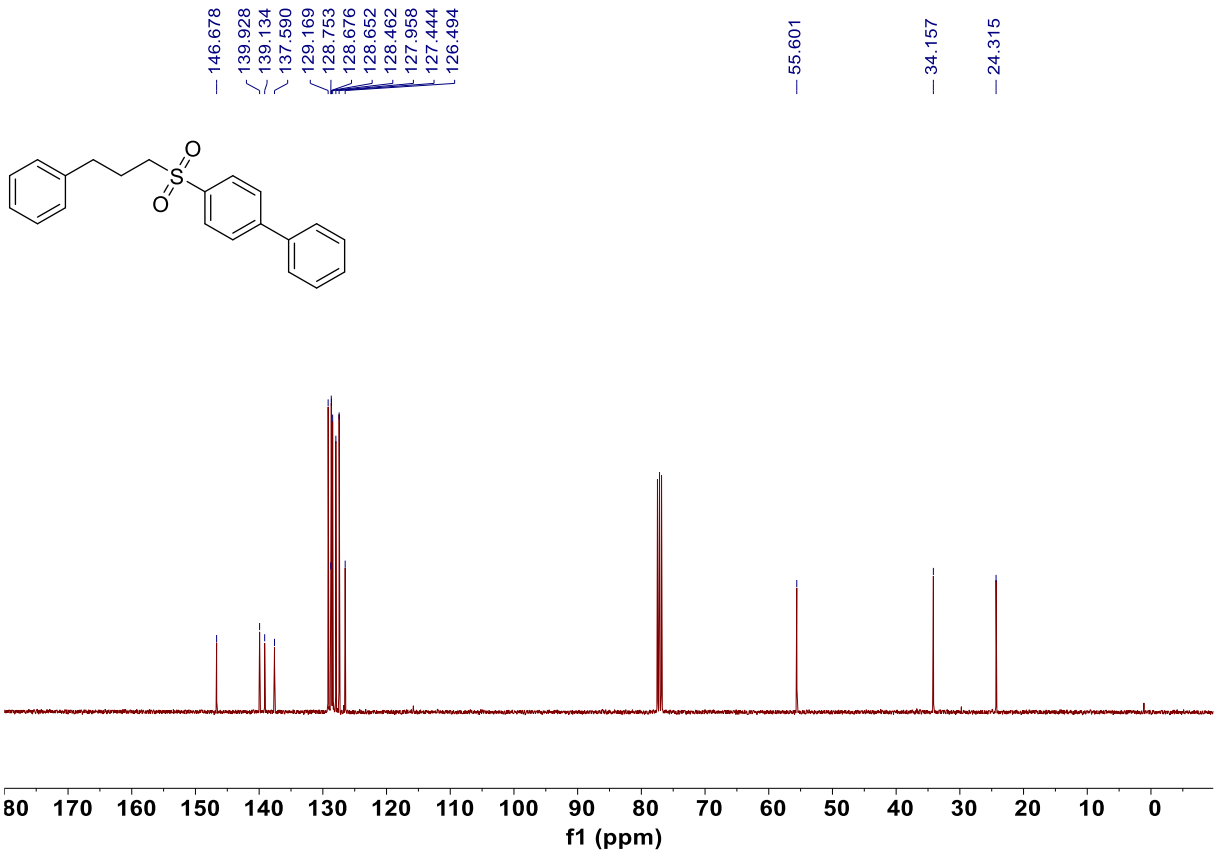
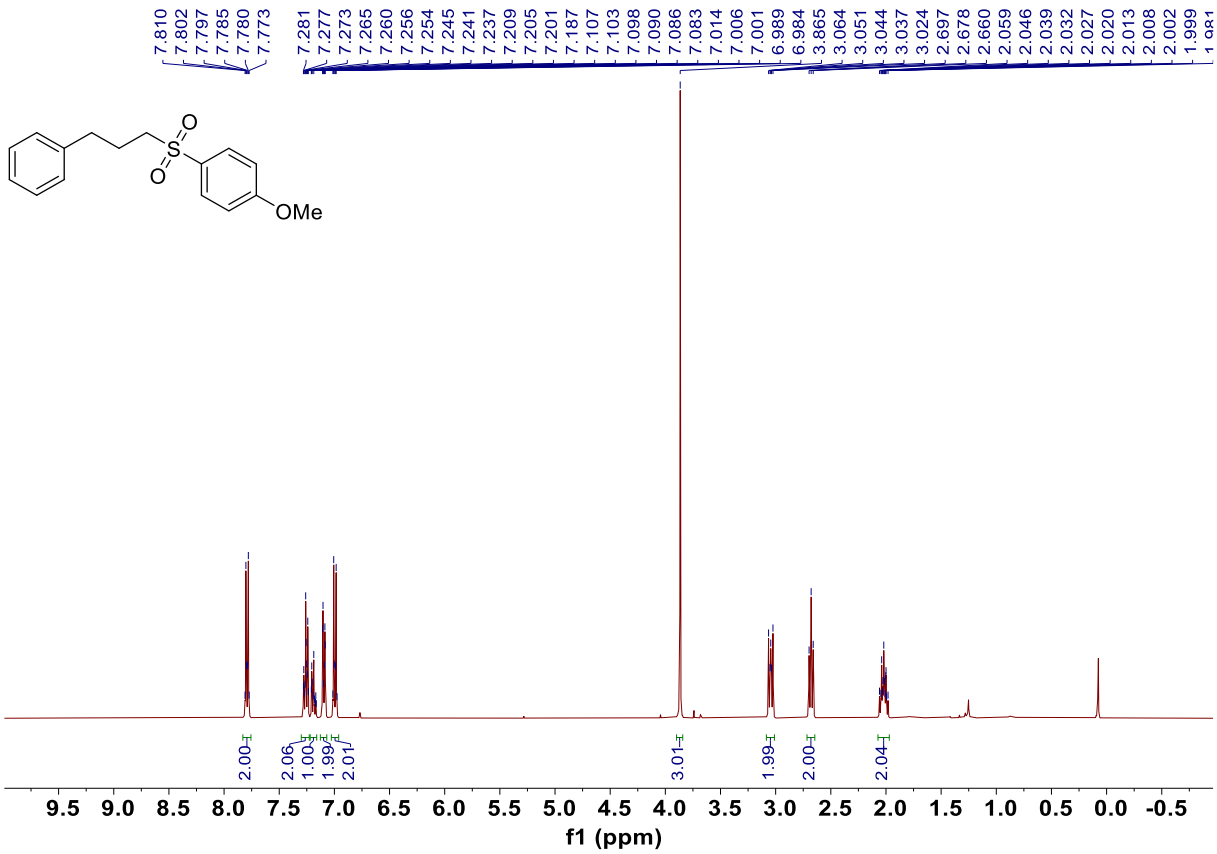
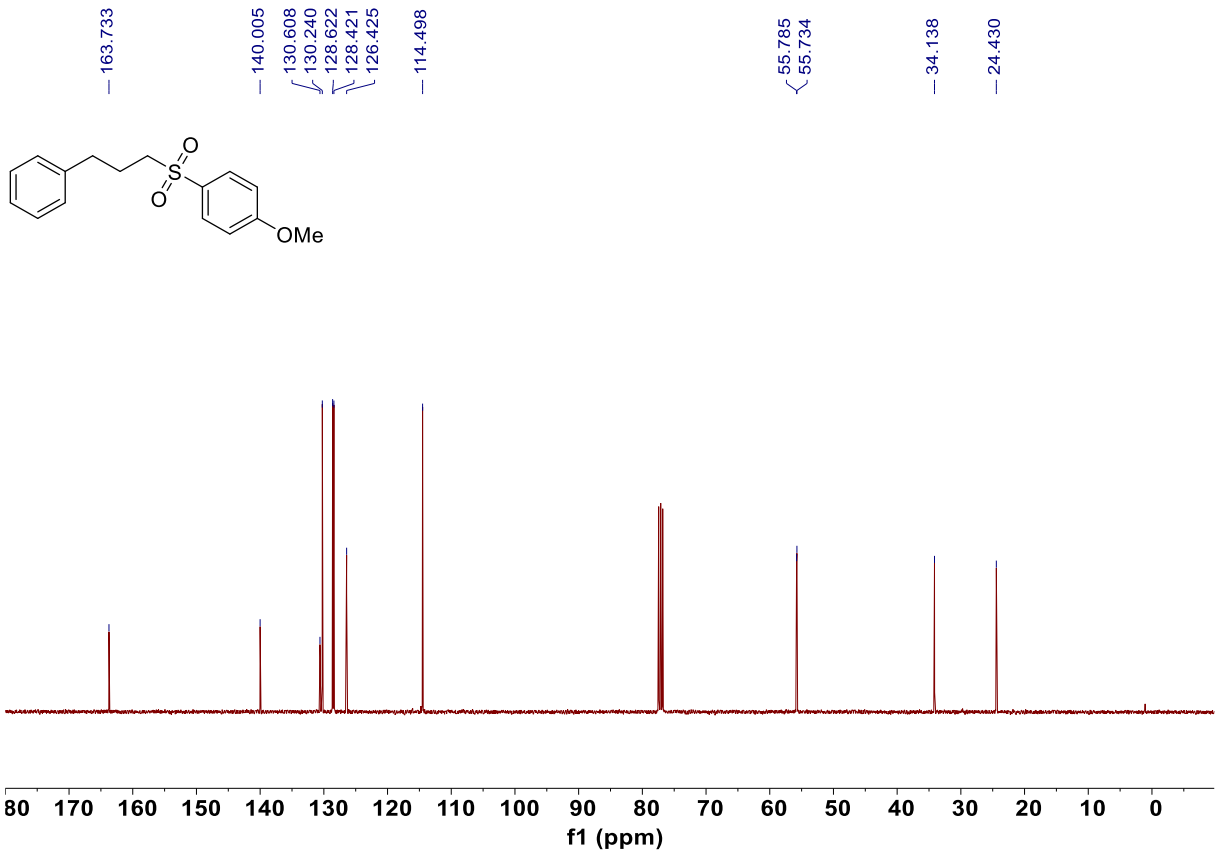
7.525
7.274
7.270
7.266
7.258
7.253
7.249
7.244
7.238
7.235
7.233
7.229
7.202
7.198
7.195
7.186
7.180
7.105
7.100
7.095
7.088
7.084
7.081
3.077
3.064
3.057
3.050
3.037
2.705
2.686
2.075
2.068
2.061
2.057
2.049
2.042
2.038
2.030
2.024
2.011
1.335
O
O
S
tBu
1.96
2.00
2.02
0.96
1.94
2.00
2.00
2.15
9.02
f1 (ppm)

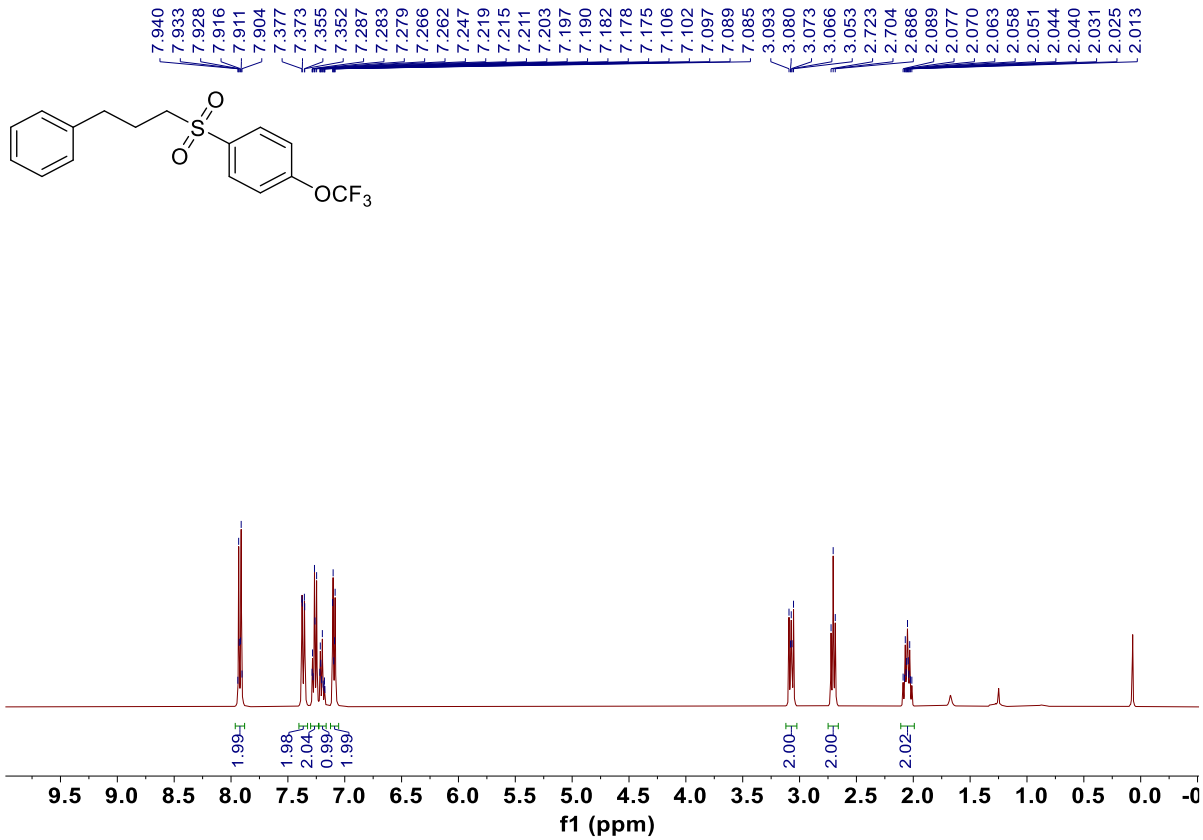

157.596
139.967
136.070
128.598
128.418
127.913
126.410
126.314
55.483
35.270
34.107
31.083
24.172
tBu
f1 (ppm)

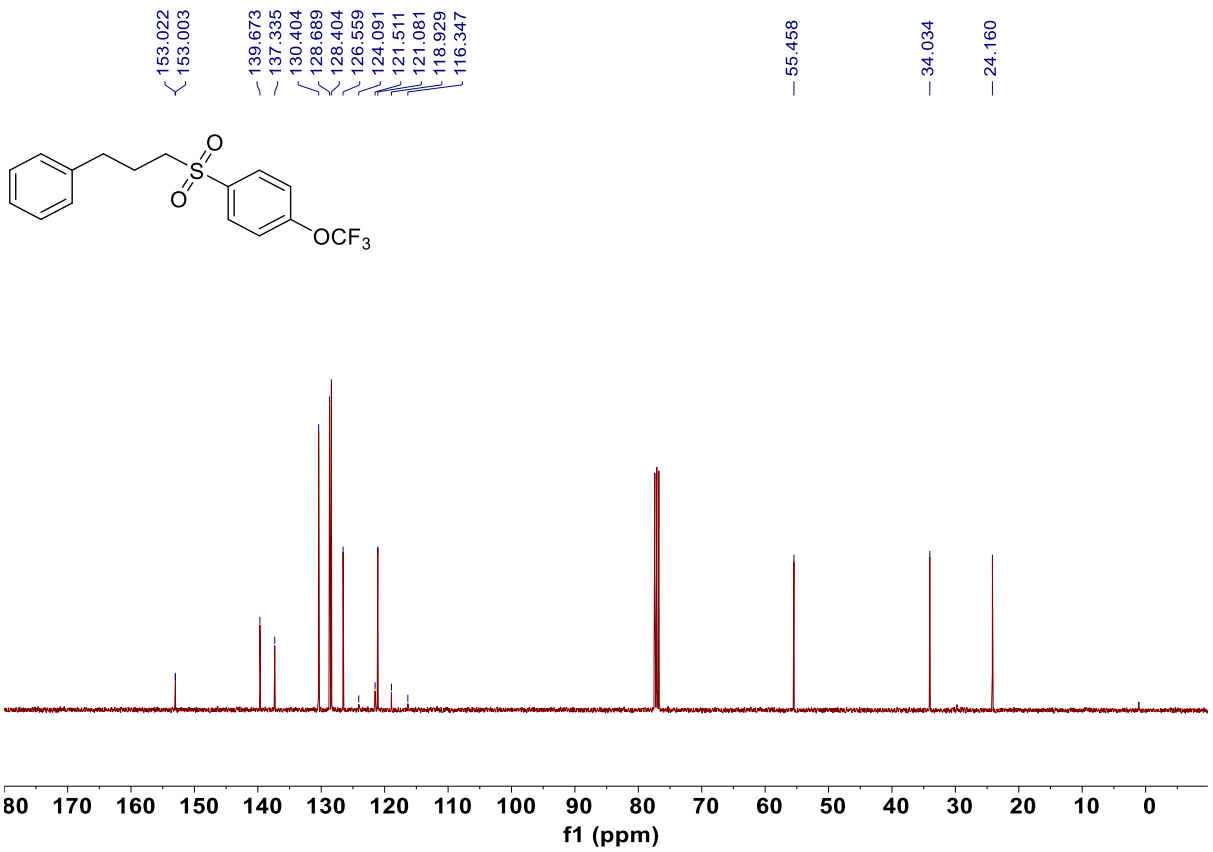

7.924
7.904
7.732
7.712
7.597
7.592
7.575
7.485
7.481
7.464
7.459
7.445
7.422
7.410
7.404
7.397
7.386
7.265
7.246
7.228
7.221
7.192
7.174
7.156
7.104
7.100
7.083
3.115
3.102
3.095
3.088
3.075
2.712
2.694
2.675
2.105
2.086
2.074
2.066
2.059
2.047
2.028
2.019
2.02
2.04
2.00
3.20
2.08
1.10
2.01
2.00
2.04
2.08
f1 (ppm)

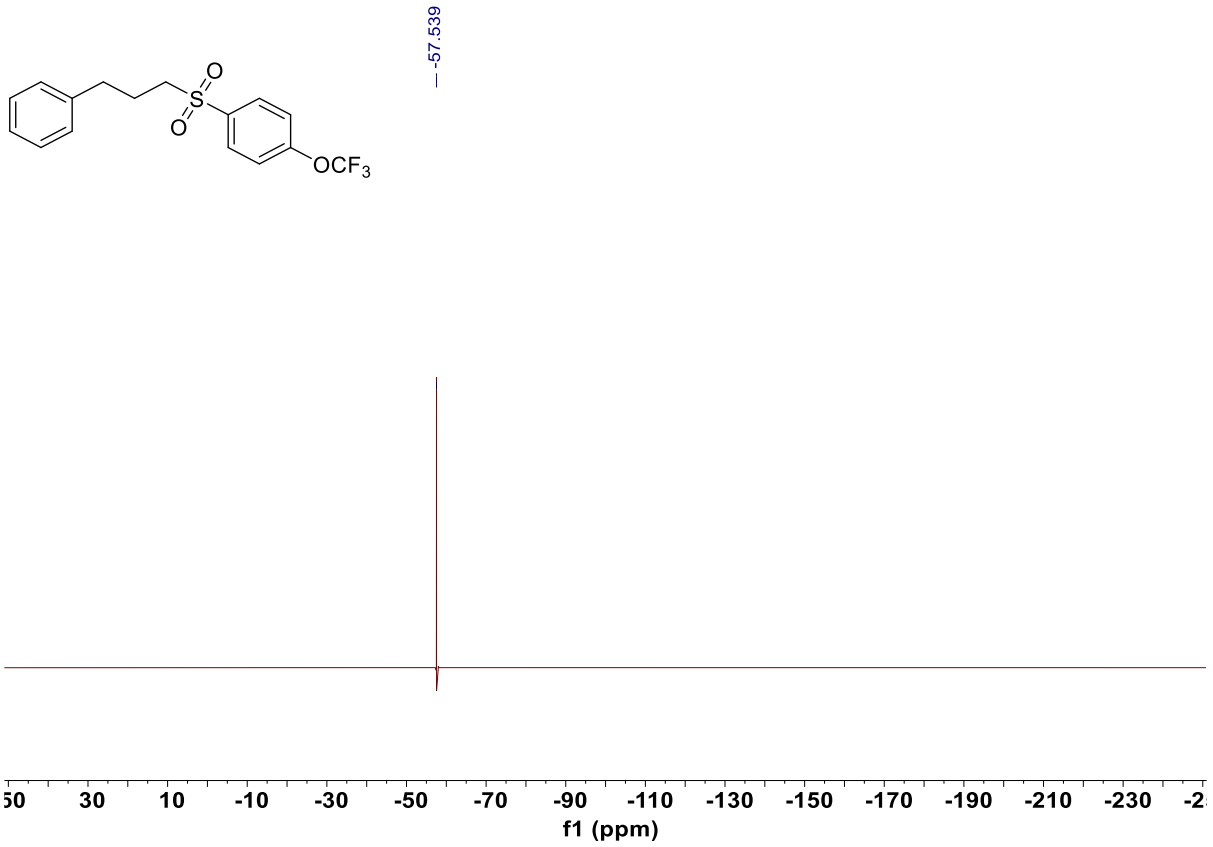

146.678
139.928
139.134
137.590
129.169
128.753
128.676
128.652
128.462
127.958
127.444
126.494
55.601
34.157
24.315
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

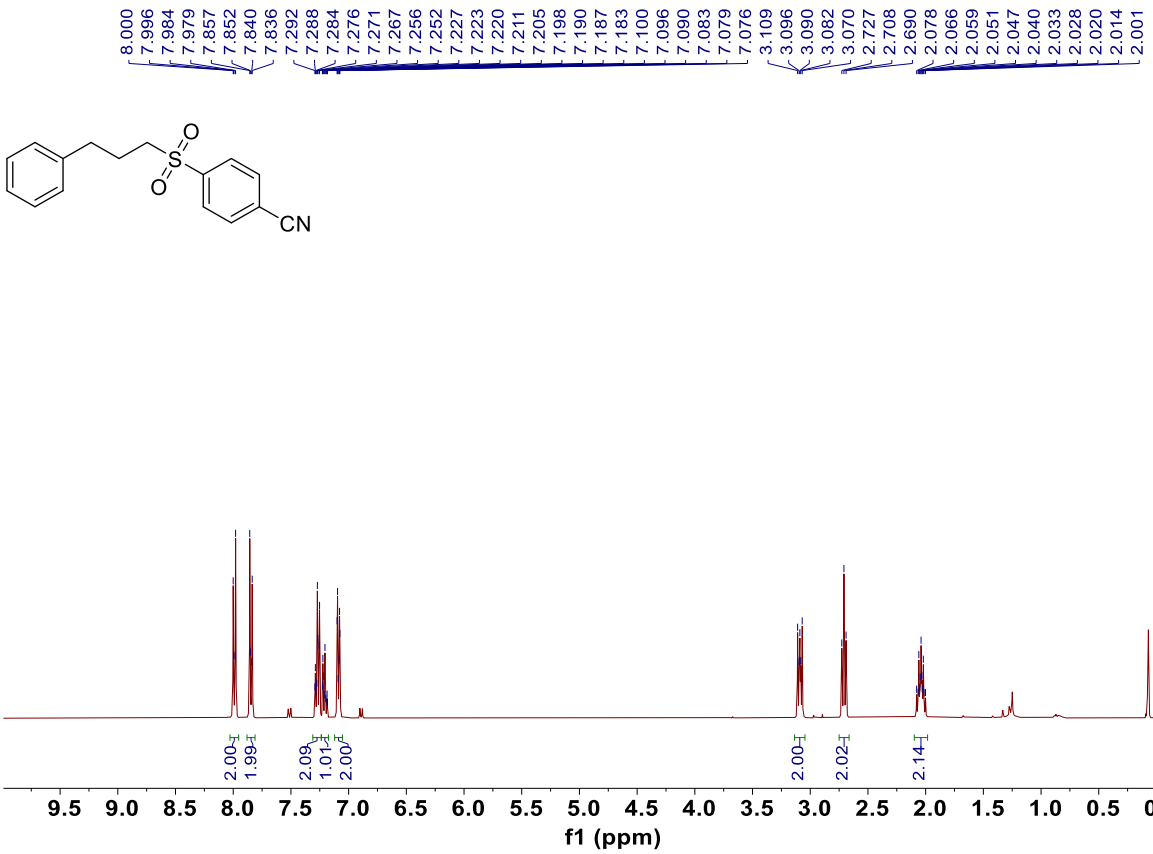

7.810
7.802
7.797
7.785
7.780
7.773
7.281
7.277
7.273
7.265
7.260
7.256
7.254
7.245
7.241
7.237
7.209
7.205
7.201
7.187
7.107
7.103
7.098
7.090
7.086
7.083
7.014
7.006
7.001
6.989
6.984
3.865
3.064
3.051
3.044
3.037
3.024
2.697
2.678
2.660
2.059
2.046
2.039
2.032
2.027
2.020
2.013
2.008
2.002
1.999
OMe
2.00
2.06
1.00
1.99
2.01
3.01
1.99
2.00
2.04
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 -0.5
f1 (ppm)

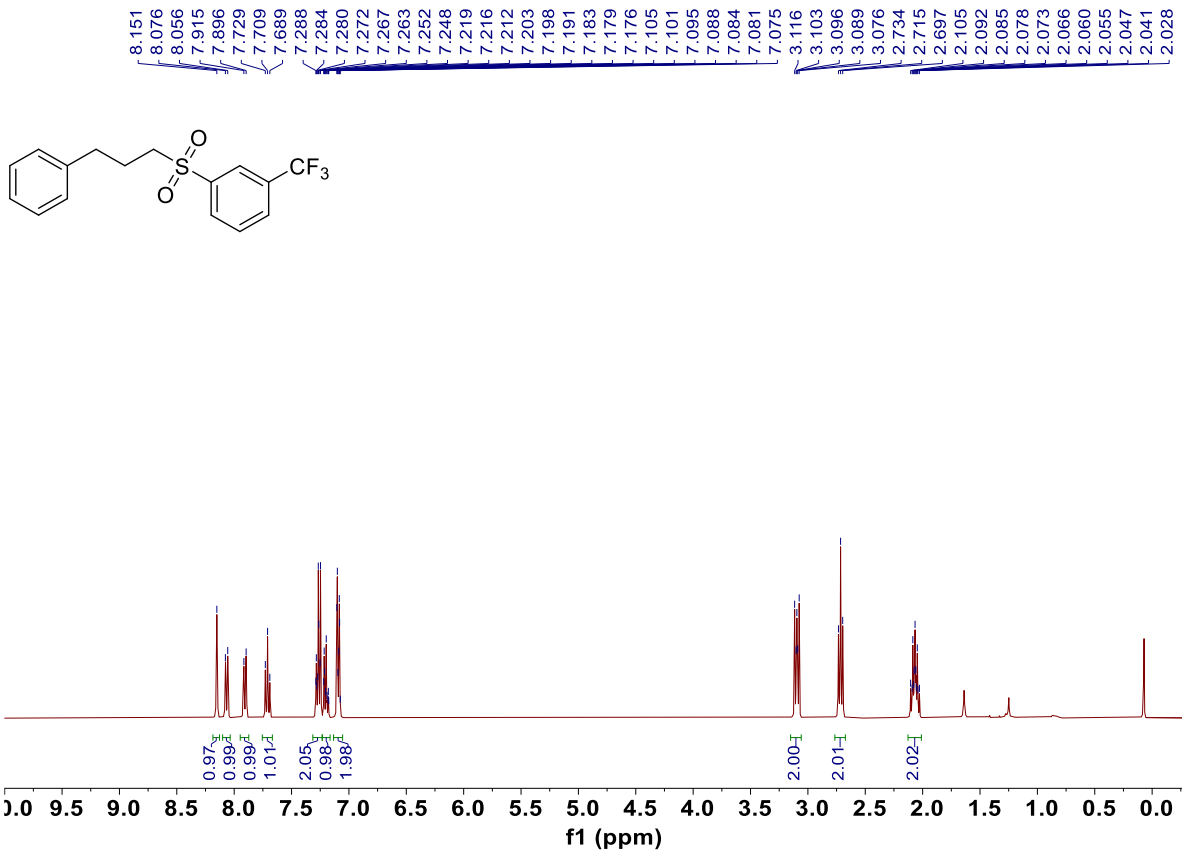

163.733
140.005
130.608
130.240
128.622
128.421
126.425
114.498
55.785
55.734
34.138
24.430
O
S
O
OMe
f1 (ppm)

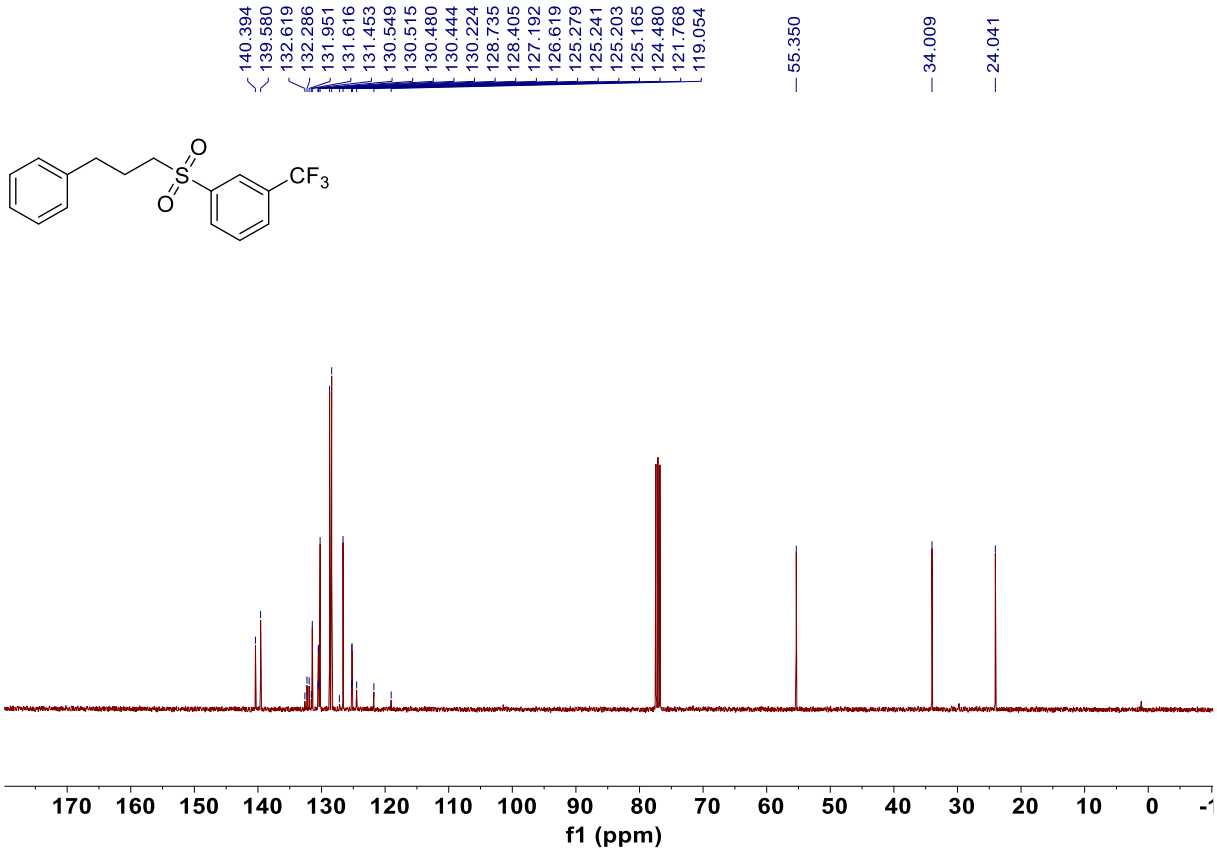

7.940
7.933
7.928
7.916
7.911
7.904
7.377
7.373
7.355
7.352
7.287
7.283
7.279
7.266
7.262
7.247
7.219
7.215
7.211
7.203
7.197
7.190
7.182
7.178
7.175
7.106
7.102
7.097
7.089
7.085
3.093
3.080
3.073
3.066
3.053
2.723
2.704
2.686
2.089
2.077
2.070
2.063
2.058
2.051
2.044
2.040
2.031
2.025
2.013
O
S
O
OCF3
1.99
1.98
2.04
0.99
1.99
2.00
2.00
2.02
f1 (ppm)


153.022
153.003
139.673
137.335
130.404
128.689
128.404
126.559
124.091
121.511
121.081
118.929
116.347
55.458
34.034
24.160
O
S
O
OCF3
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

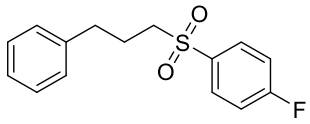

-57.539
O
S
O
OCF3
50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)

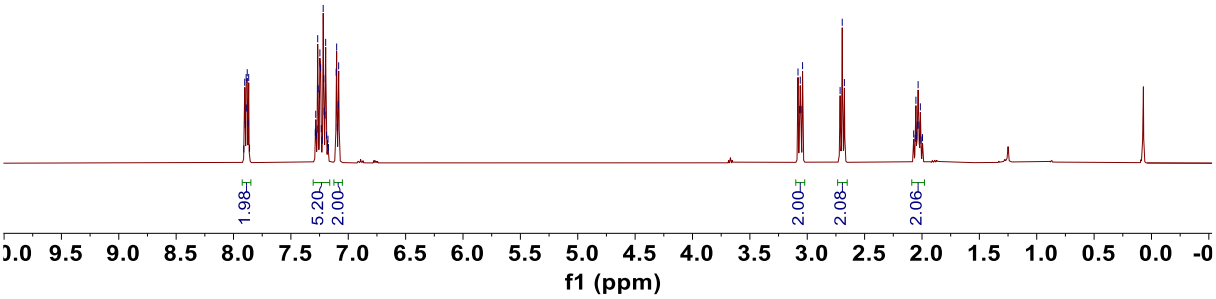

8.000
7.996
7.984
7.979
7.857
7.852
7.840
7.836
7.292
7.288
7.284
7.276
7.271
7.267
7.256
7.252
7.227
7.223
7.220
7.211
7.205
7.198
7.190
7.187
7.183
7.100
7.096
7.090
7.083
7.079
7.076
3.109
3.096
3.090
3.082
3.070
2.727
2.708
2.690
2.078
2.066
2.059
2.051
2.047
2.040
2.033
2.028
2.020
2.014
2.001
O
S
O
CN
2.00
1.99
2.09
1.01
2.00
2.00
2.02
2.14
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)
143.143
139.448
133.129
128.844
128.740
128.379
126.648
117.565
117.113
55.194
33.979
24.054
O
S
O
CN
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


8.151
8.076
8.056
7.915
7.896
7.729
7.709
7.689
7.288
7.284
7.280
7.272
7.267
7.263
7.252
7.248
7.219
7.216
7.212
7.203
7.198
7.191
7.183
7.179
7.176
7.105
7.101
7.095
7.088
7.084
7.081
7.075
3.116
3.103
3.096
3.089
3.076
2.734
2.715
2.697
2.105
2.092
2.085
2.078
2.073
2.066
2.060
2.055
2.047
2.041
2.028
O
S
O
CF3
0.97
0.99
0.99
1.01
2.05
0.98
1.98
2.00
2.01
2.02
f1 (ppm)


140.394
139.580
132.619
132.286
131.951
131.616
131.453
130.549
130.515
130.480
130.444
130.224
128.735
128.405
127.192
126.619
125.279
125.241
125.203
125.165
124.480
121.768
119.054
55.350
34.009
24.041
O
S
O
CF3
f1 (ppm)

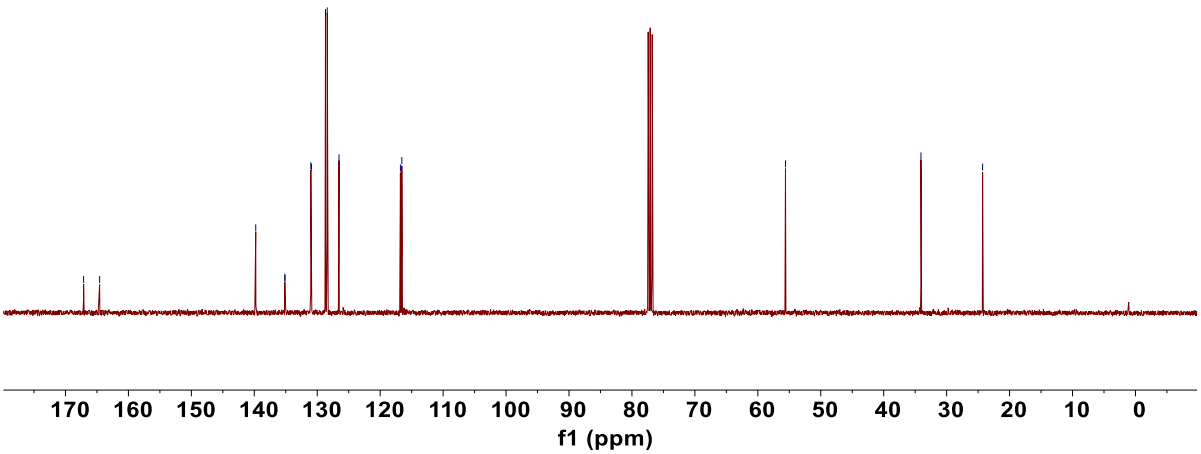

7.910
7.902
7.897
7.890
7.885
7.880
7.873
7.868
7.860
7.287
7.284
7.279
7.271
7.266
7.262
7.251
7.247
7.240
7.235
7.227
7.219
7.214
7.210
7.202
7.197
7.189
7.181
7.177
7.173
7.105
7.101
7.096
7.088
7.084
3.081
3.067
3.061
3.054
3.041
2.714
2.695
2.676
2.072
2.059
2.053
2.046
2.041
2.034
2.027
2.022
2.014
2.008
1.995

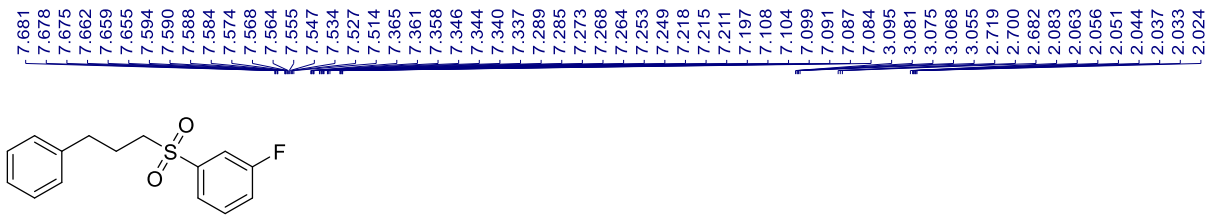

O
S
O
F


1.98
5.20
2.00
2.00
2.08
2.06
f1 (ppm)


167.121
164.576
139.770
135.154
135.122
131.018
130.922
128.691
128.413
126.540
116.785
116.560
55.605
34.079
24.285

O
S
O
F


f1 (ppm)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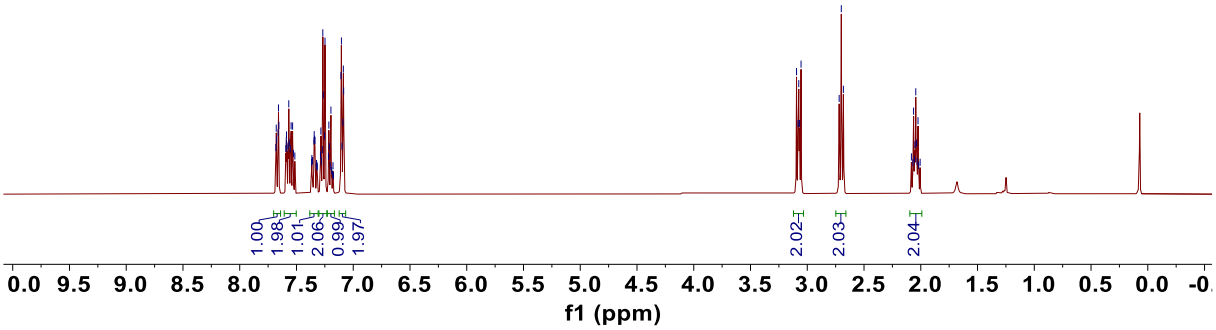
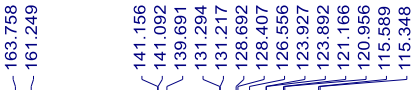
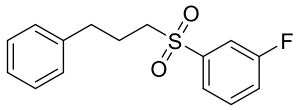
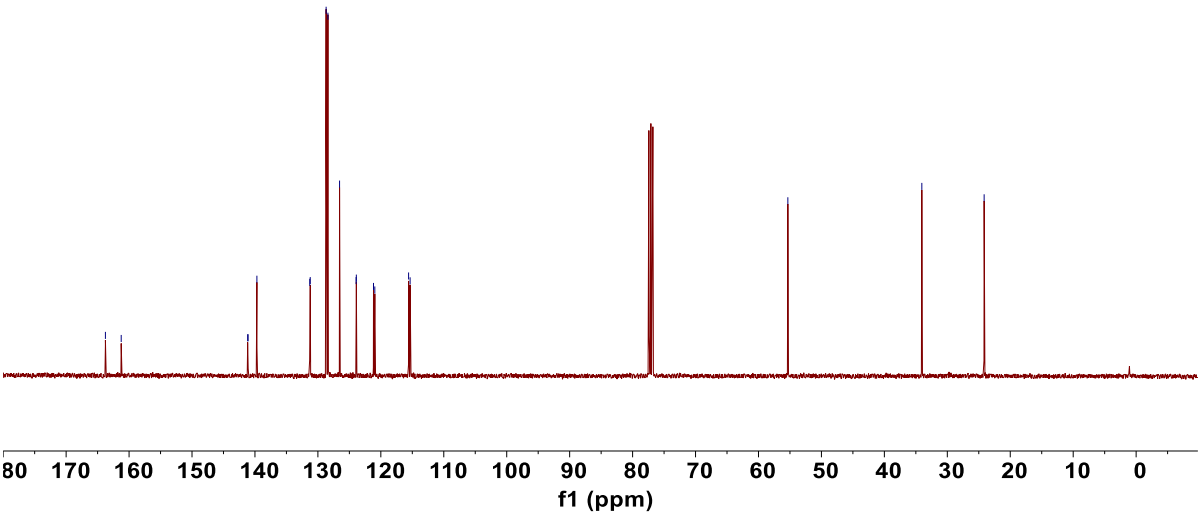
7.678
7.675
7.662
7.659
7.655
7.594
7.590
7.588
7.584
7.574
7.568
7.564
7.555
7.547
7.534
7.527
7.514
7.365
7.361
7.358
7.346
7.344
7.340
7.337
7.289
7.285
7.273
7.268
7.264
7.253
7.249
7.218
7.215
7.211
7.197
7.108
7.104
7.099
7.091
7.087
7.084
3.095
3.081
3.075
3.068
3.055
2.719
2.700
2.682
2.083
2.063
2.056
2.051
2.044
2.037
2.033
2.024

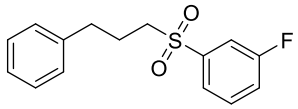
O
S
O
F


1.00
1.98
1.01
2.06
0.99
1.97
2.02
2.03
2.04
0.0 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 -0
f1 (ppm)


163.758
161.249
141.156
141.092
139.691
131.294
131.217
128.692
128.407
126.556
123.927
123.892
121.166
120.956
115.589
115.348
55.335
34.048
24.149

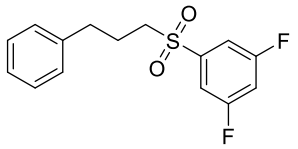

O
S
O
F

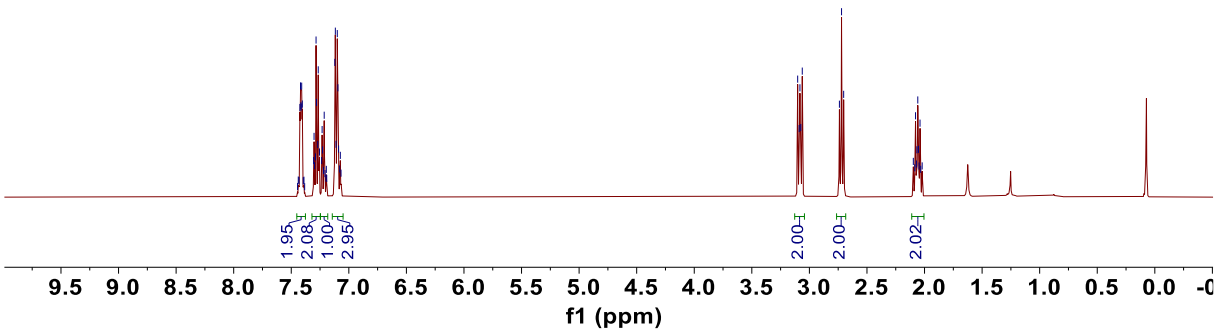

80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

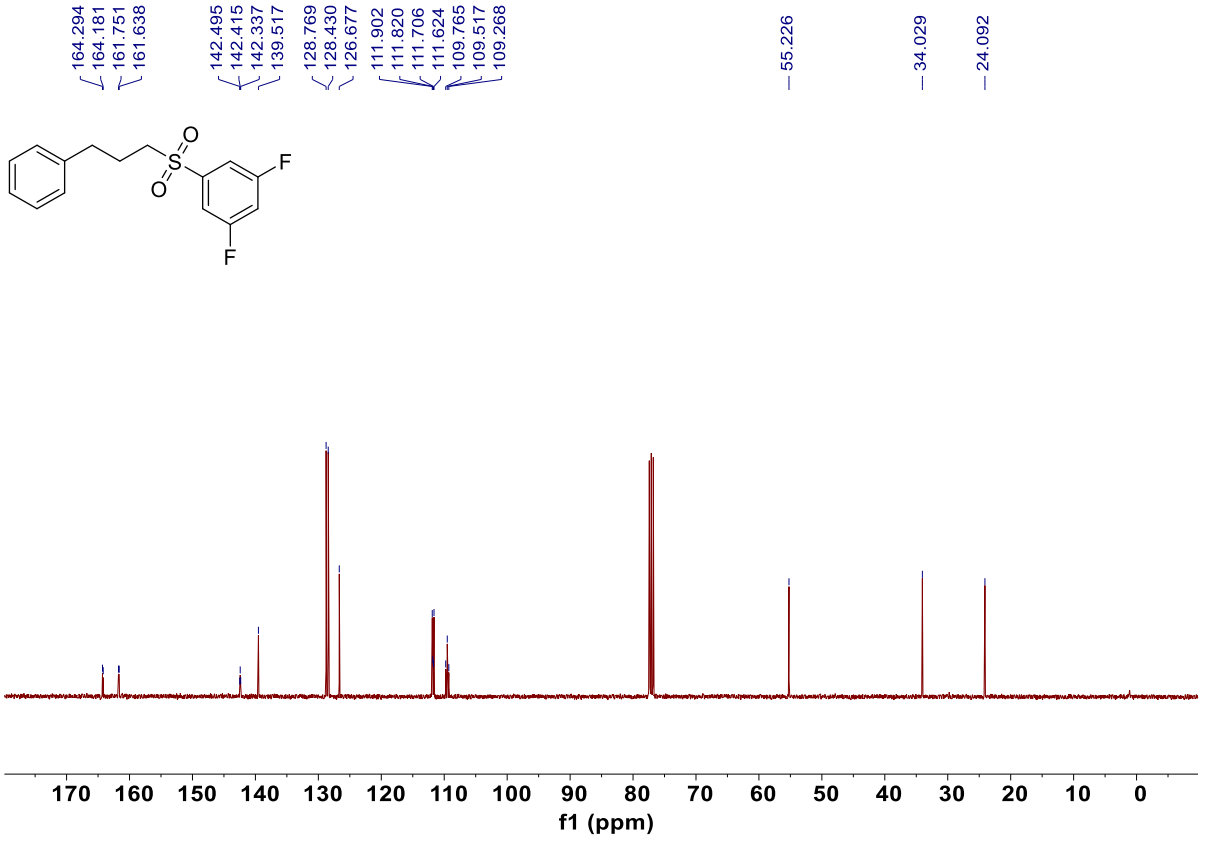

O
S
O
F

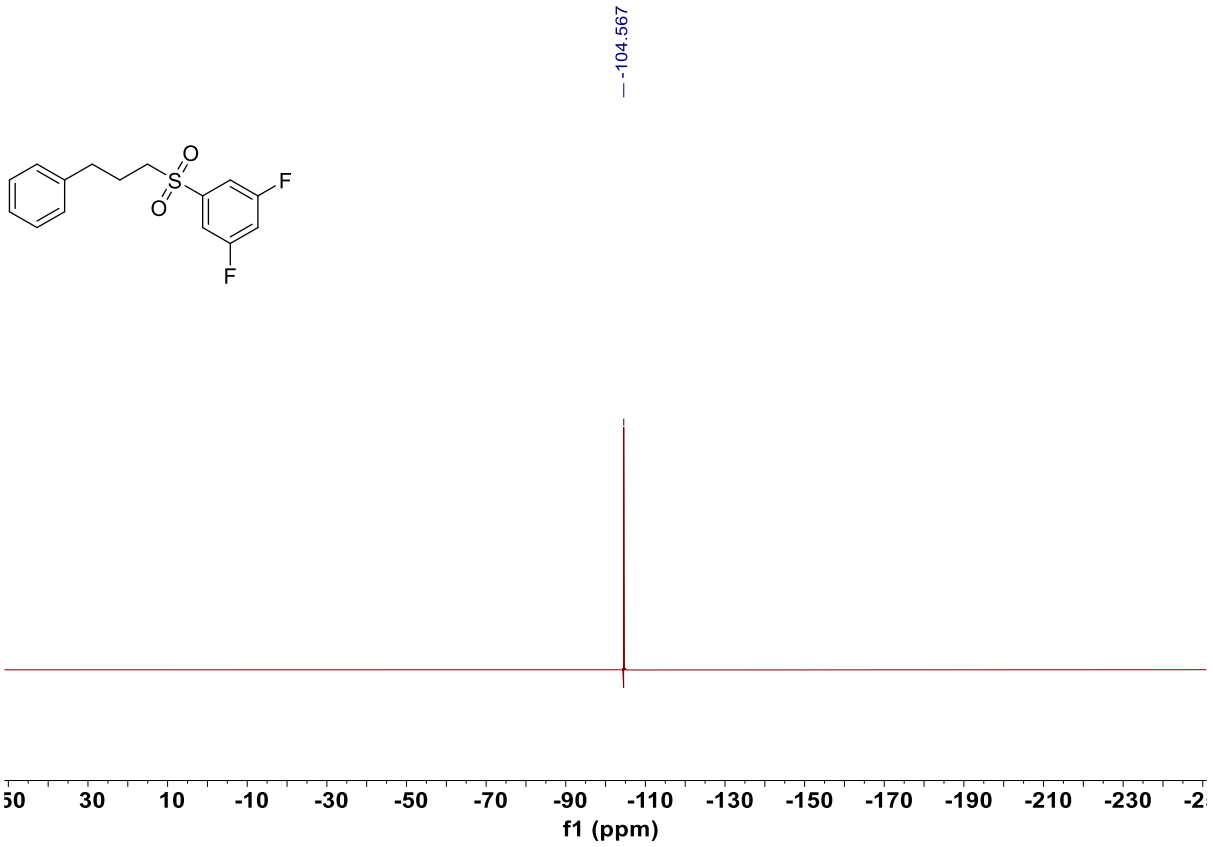
-109.655
50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230 -2
f1 (ppm)


7.439
7.425
7.420
7.416
7.413
7.409
7.404
7.306
7.302
7.298
7.290
7.285
7.281
7.270
7.266
7.255
7.236
7.232
7.228
7.220
7.214
7.207
7.199
7.195
7.192
7.122
7.117
7.111
7.100
7.095
7.089
7.080
7.074
7.068
3.102
3.089
3.082
3.075
3.062
2.739
2.721
2.085
2.078
2.071
2.066
2.059
2.052
2.048
2.039
2.033
2.020


O
S
O
F
F


1.95
2.08
1.00
2.95
2.00
2.00
2.02
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)


164.294
164.181
161.751
161.638
142.495
142.415
142.337
139.517
128.769
128.430
126.677
111.902
111.820
111.706
111.624
109.765
109.517
109.268
55.226
34.029
24.092
O
S
O
F
F
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-104.567
O
S
O
F
F
50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


7.823
7.817
7.812
7.800
7.795
7.789
7.538
7.532
7.527
7.515
7.510
7.504
7.292
7.288
7.284
7.276
7.271
7.267
7.255
7.251
7.223
7.219
7.215
7.207
7.201
7.194
7.186
7.182
7.107
7.103
7.097
7.090
7.086
7.083
3.081
3.068
3.061
3.054
3.041
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2.053
2.046
2.041
2.034
2.027
2.022
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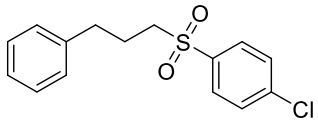
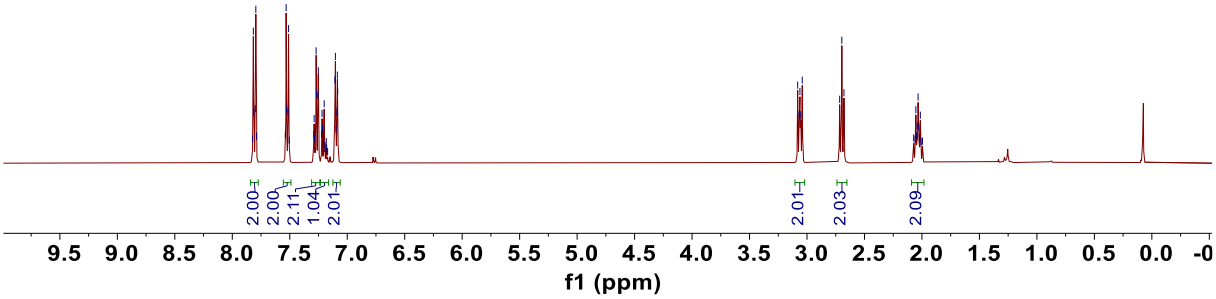
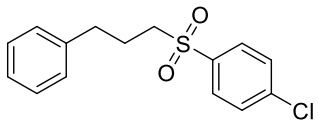
2.008
1.995

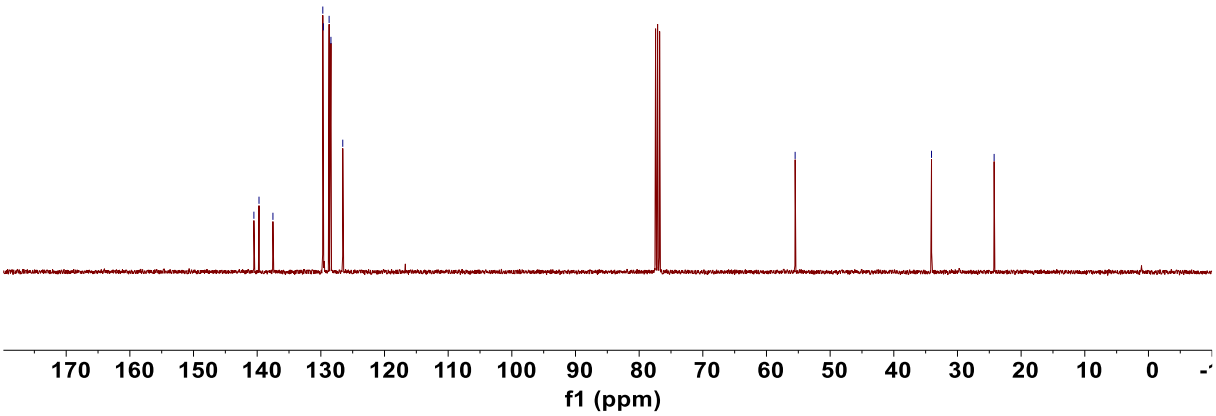

O
S
O
Cl

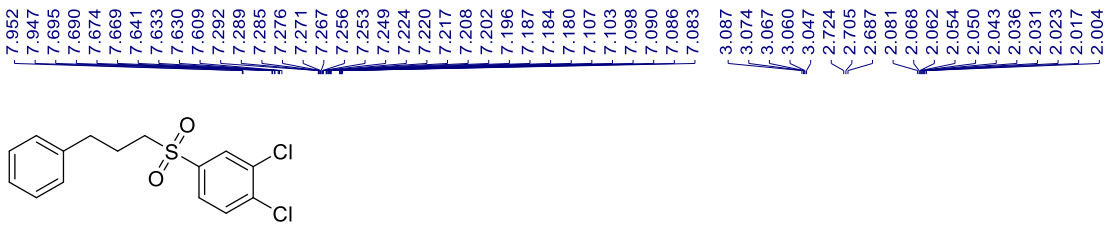

2.00
2.00
2.11
1.04
2.01
2.01
2.03
2.09
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0
f1 (ppm)


140.516
139.715
137.525
129.691
129.605
128.700
128.414
126.557


55.499
34.077
24.241


O
S
O
Cl


170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -
f1 (ppm)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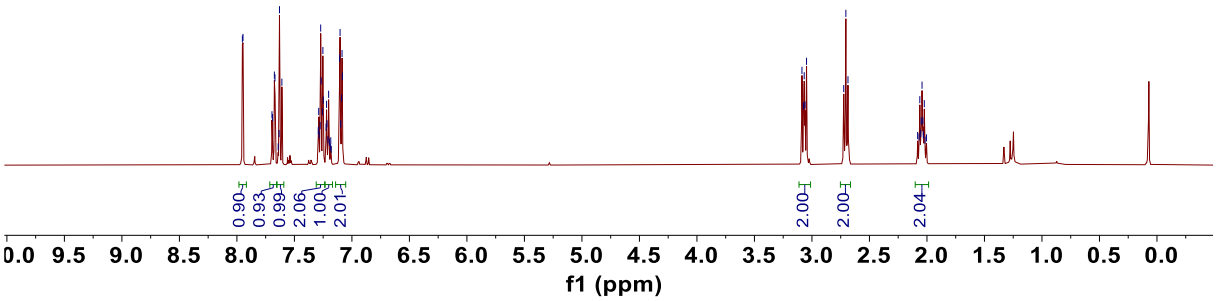
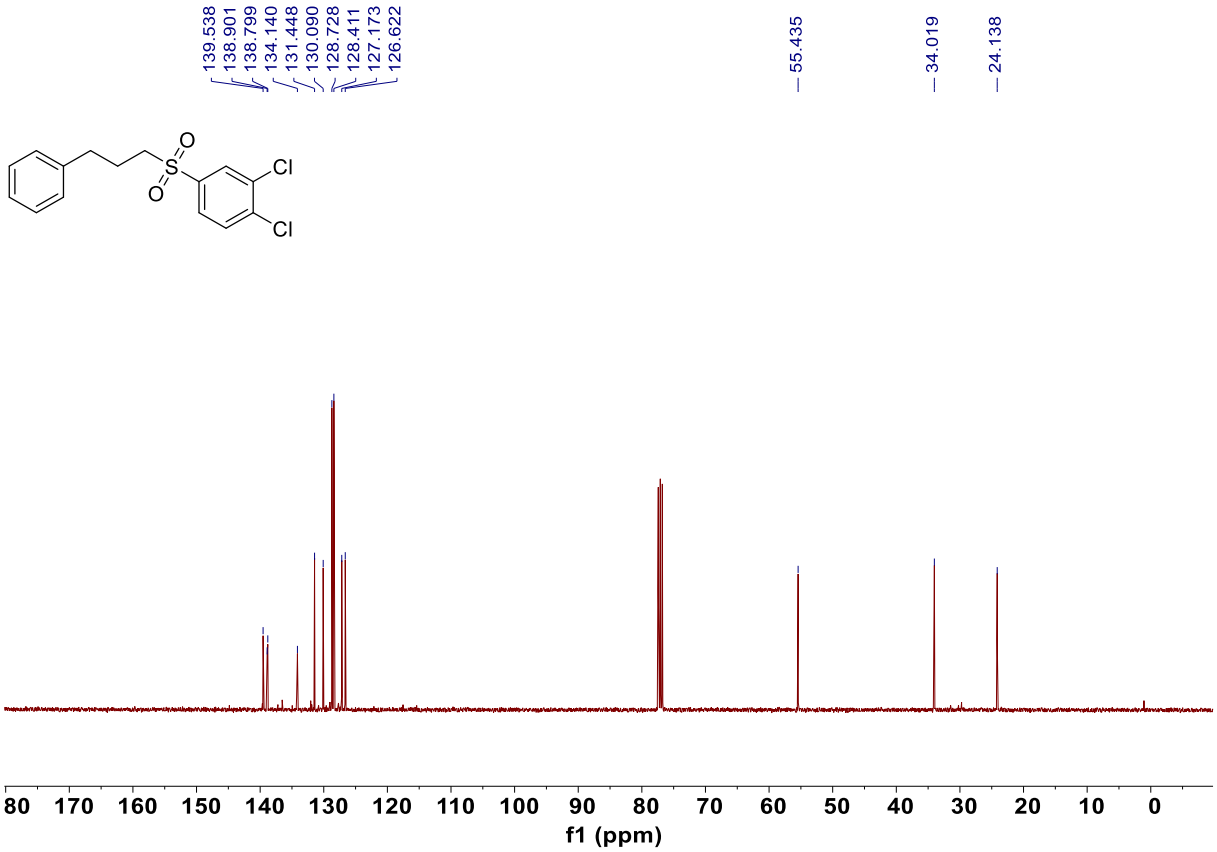
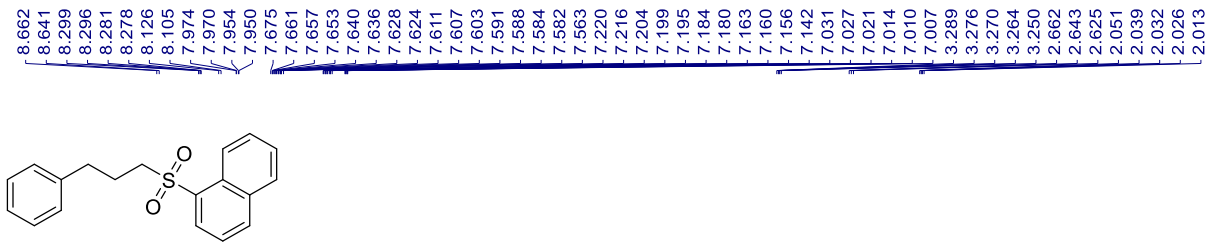
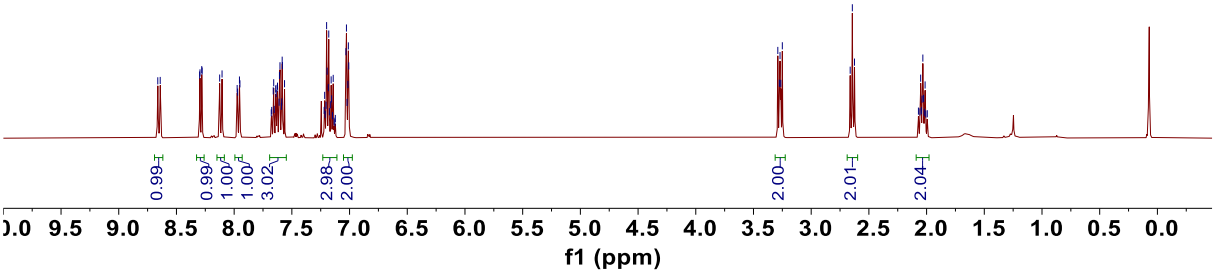
7.947
7.695
7.690
7.674
7.669
7.641
7.633
7.630
7.609
7.292
7.289
7.285
7.276
7.271
7.267
7.256
7.253
7.249
7.224
7.220
7.217
7.208
7.202
7.196
7.187
7.184
7.180
7.107
7.103
7.098
7.090
7.086
7.083
3.087
3.074
3.067
3.060
3.047
2.724
2.705
2.687
2.081
2.068
2.062
2.054
2.050
2.043
2.036
2.031
2.023
2.017
2.004
O
S
O
Cl
Cl


0.90
0.93
0.99
2.06
1.00
2.01
2.00
2.00
2.04
0.0 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)


139.538
138.901
138.799
134.140
131.448
130.090
128.728
128.411
127.173
126.622
55.435
34.019
24.138
O
S
O
Cl
Cl
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

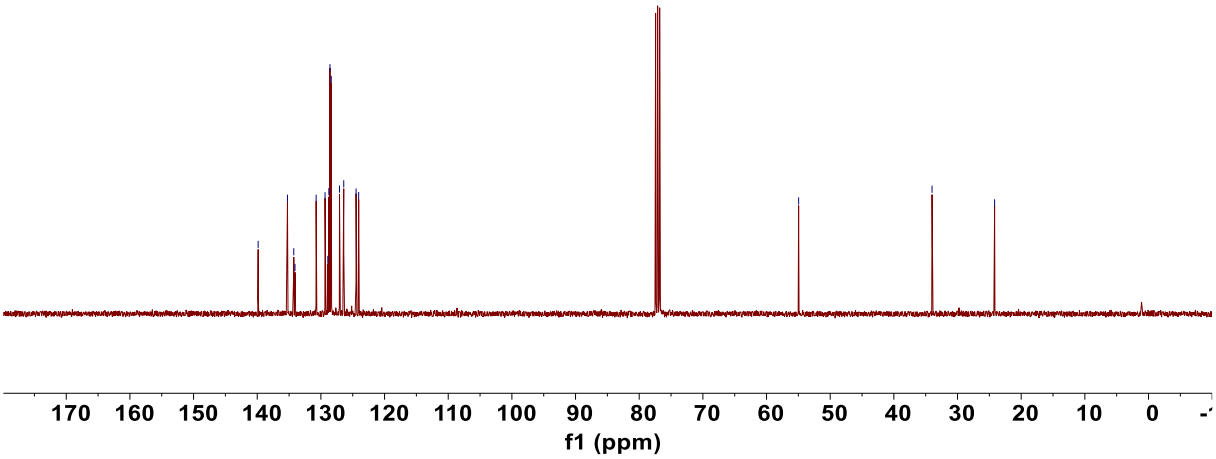

8.662
8.641
8.299
8.296
8.281
8.278
8.126
8.105
7.974
7.970
7.954
7.950
7.675
7.661
7.657
7.653
7.640
7.636
7.628
7.624
7.611
7.607
7.603
7.591
7.588
7.584
7.582
7.563
7.220
7.216
7.204
7.199
7.195
7.184
7.180
7.163
7.160
7.156
7.142
7.031
7.027
7.021
7.014
7.010
7.007
3.289
3.276
3.270
3.264
3.250
2.662
2.643
2.625
2.051
2.039
2.032
2.026
2.013

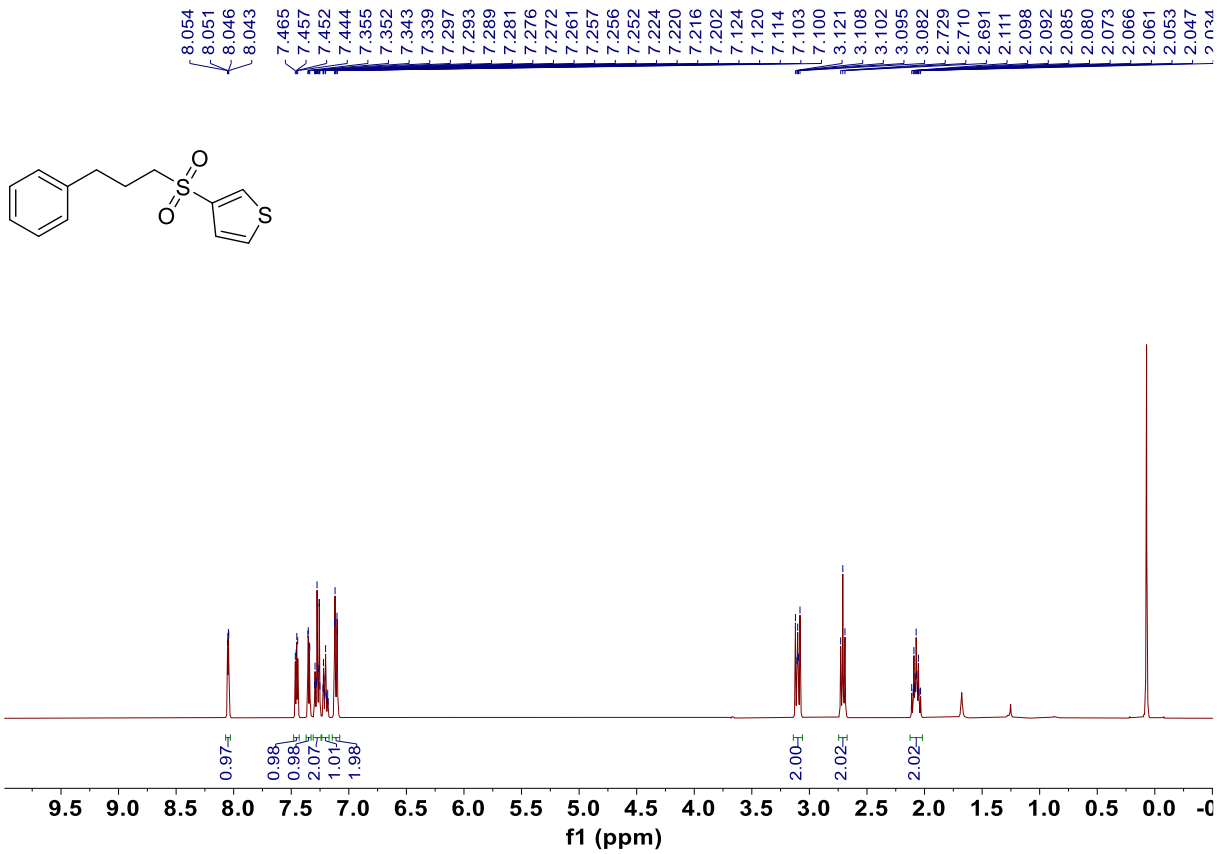
O
S
O


0.99
0.99
1.00
1.00
3.02
2.98
2.00
2.00
2.01
2.04
f1 (ppm)


139.857
135.251
134.259
134.069
130.748
129.349
128.913
128.752
128.576
128.371
127.075
126.412
124.476
124.065
54.959
34.002
24.174

O
S
O


f1 (ppm)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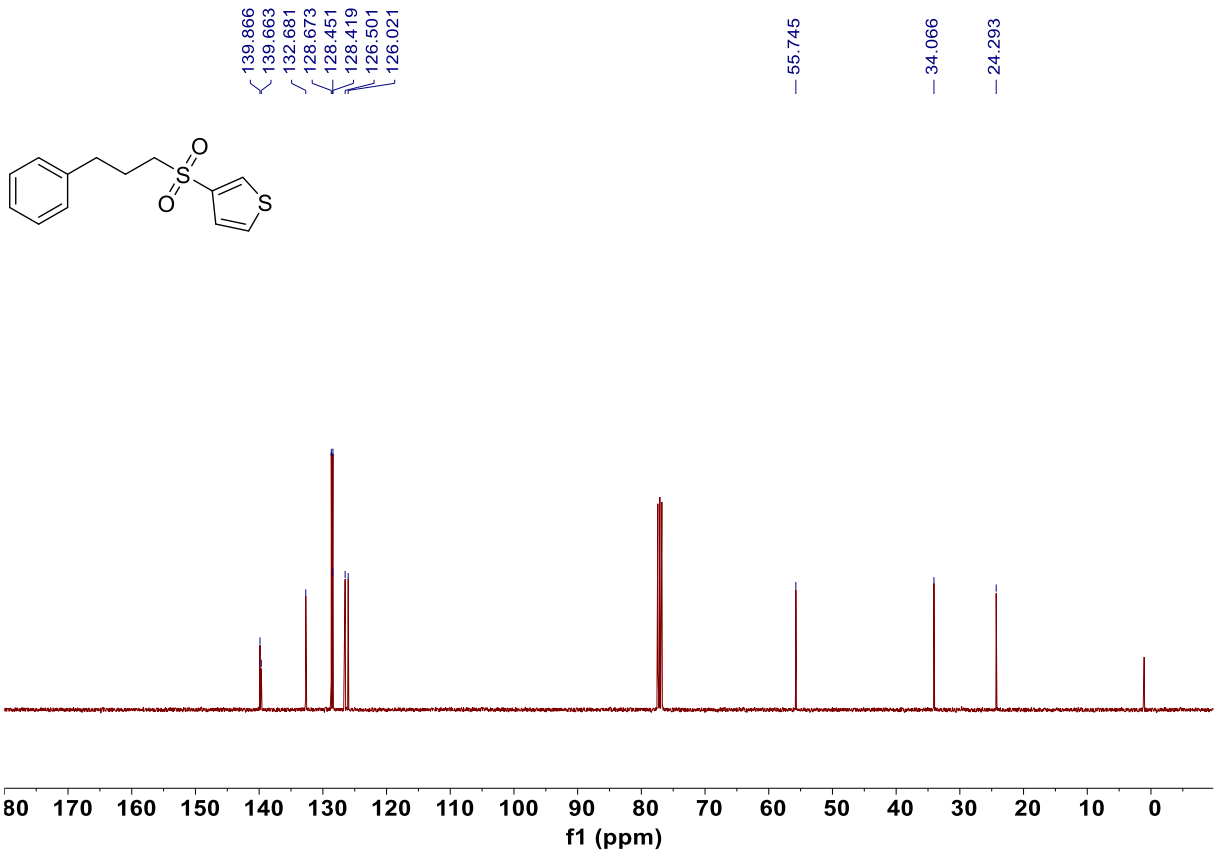
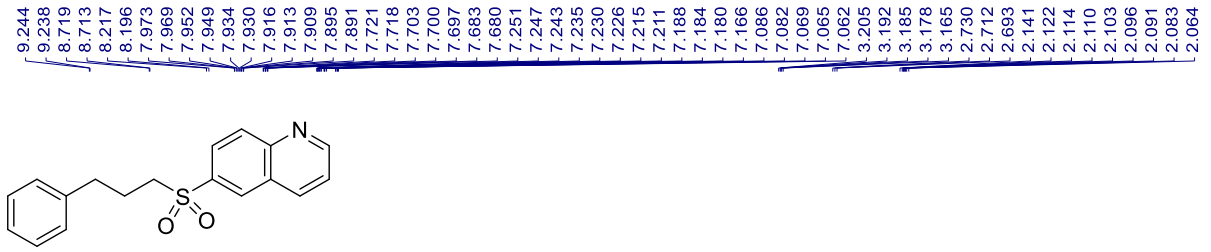
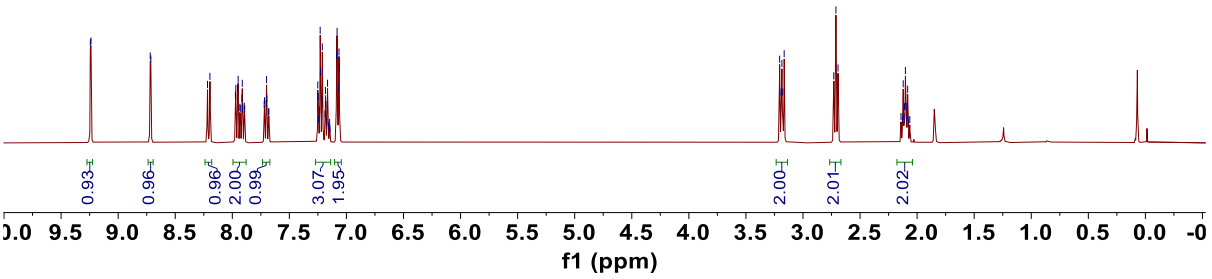
8.051
8.046
8.043
7.465
7.457
7.452
7.444
7.355
7.352
7.343
7.339
7.297
7.293
7.289
7.281
7.276
7.272
7.261
7.257
7.256
7.252
7.224
7.220
7.216
7.202
7.124
7.120
7.114
7.103
7.100
3.121
3.108
3.102
3.095
3.082
2.729
2.710
2.691
2.111
2.098
2.092
2.085
2.080
2.073
2.066
2.061
2.053
2.047
0.97
0.98
0.98
2.07
1.01
1.98
2.00
2.02
2.02
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)


139.866
139.663
132.681
128.673
128.451
128.419
126.501
126.021
55.745
34.066
24.293
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

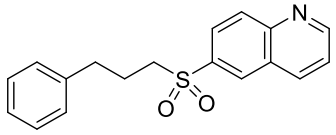

9.244
9.238
8.719
8.713
8.217
8.196
7.973
7.969
7.952
7.949
7.934
7.930
7.916
7.913
7.909
7.895
7.891
7.721
7.718
7.703
7.700
7.697
7.683
7.680
7.251
7.247
7.243
7.235
7.230
7.226
7.215
7.211
7.188
7.184
7.180
7.166
7.086
7.082
7.069
7.065
7.062
3.205
3.192
3.185
3.178
3.165
2.730
2.712
2.693
2.141
2.122
2.114
2.110
2.103
2.096
2.091
2.083
2.064

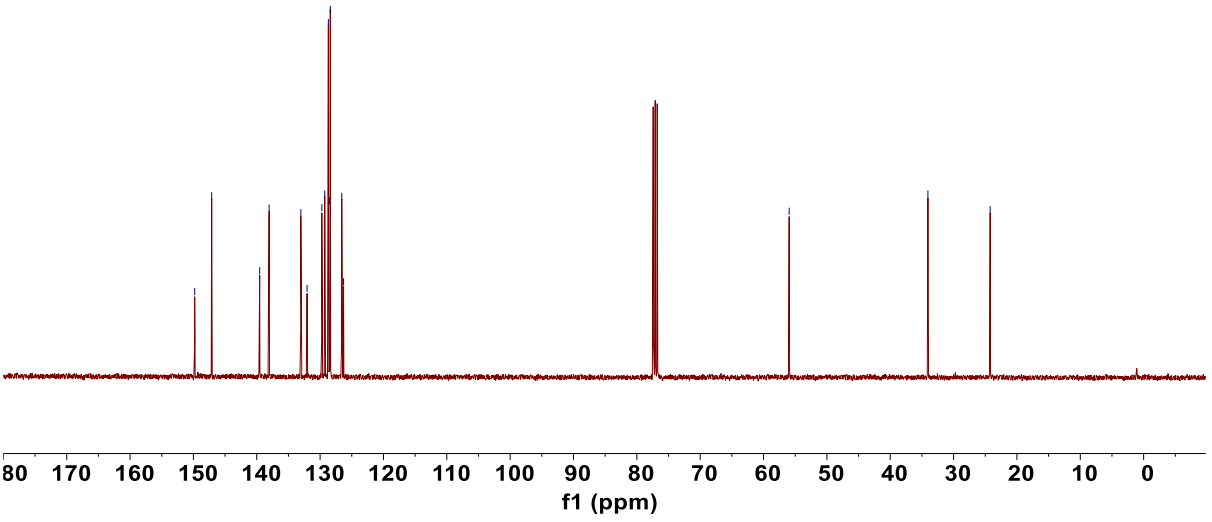
N
S
O
O

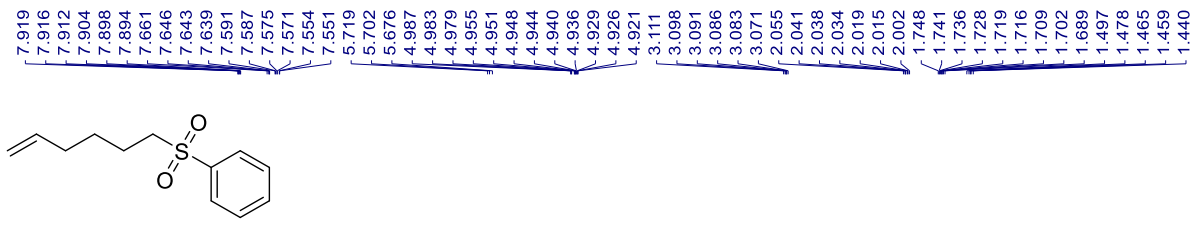

0.93
0.96
0.96
2.00
0.99
3.07
1.95
2.00
2.01
2.02
f1 (ppm)

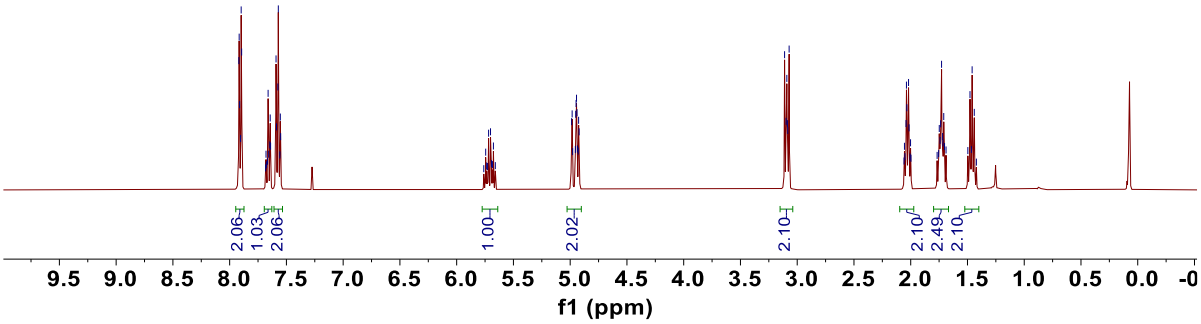

149.795
147.112
139.535
138.047
133.042
132.056
129.725
129.268
128.694
128.536
128.389
126.582
126.297

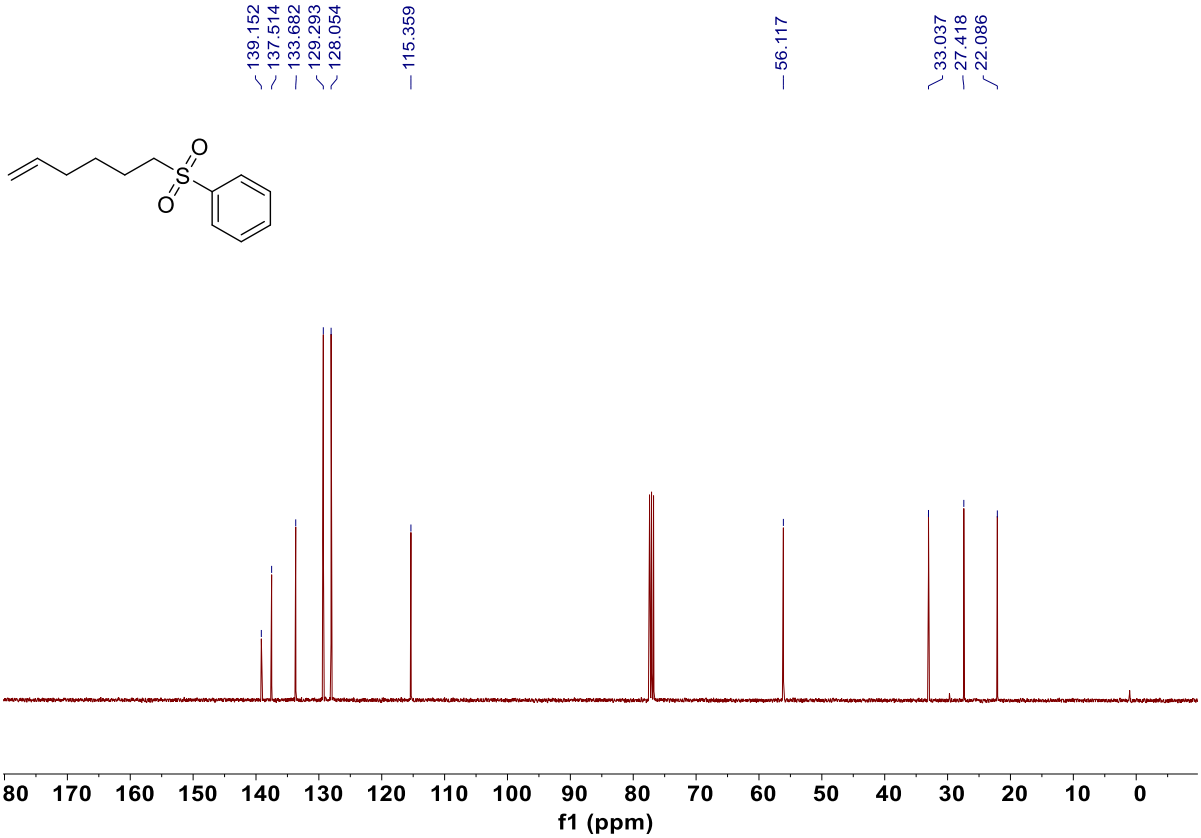

55.953
34.051
24.225

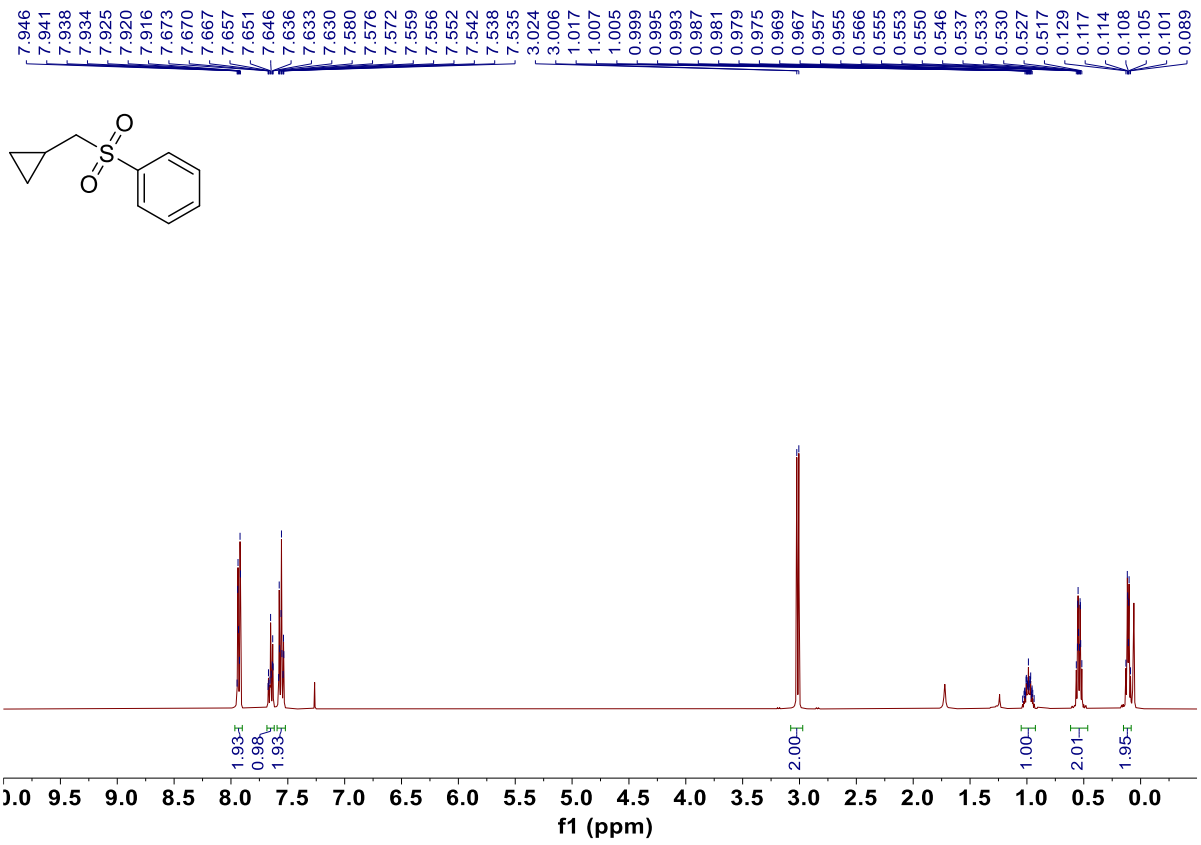

N
S
O
O

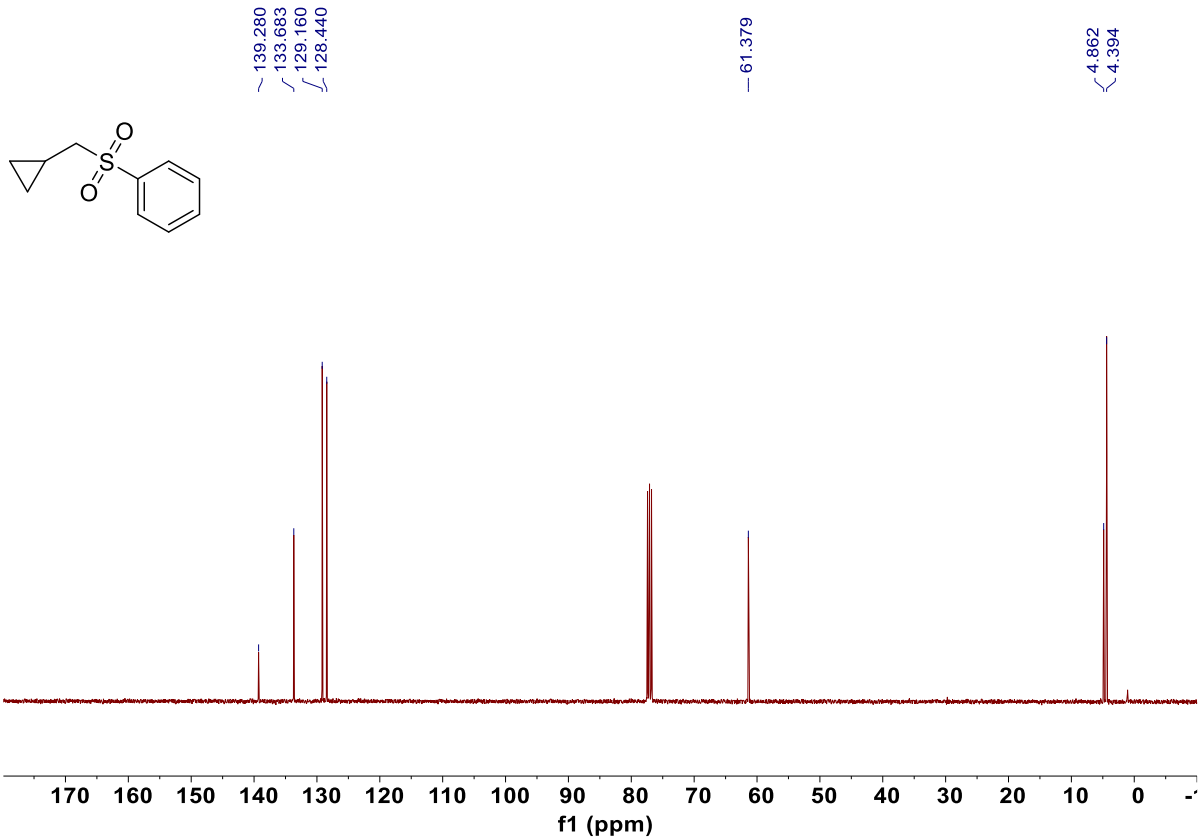

f1 (ppm)


7.919
7.916
7.912
7.904
7.898
7.894
7.661
7.646
7.643
7.639
7.591
7.587
7.575
7.571
7.554
7.551
5.719
5.702
5.676
4.987
4.983
4.979
4.955
4.951
4.948
4.944
4.940
4.936
4.929
4.926
4.921
3.111
3.098
3.091
3.086
3.083
3.071
2.055
2.041
2.038
2.034
2.019
2.015
2.002
1.748
1.741
1.736
1.728
1.719
1.716
1.709
1.702
1.689
1.497
1.478
1.465
1.459
1.440


2.06
1.03
2.06
1.00
2.02
2.10
2.10
2.49
2.10
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 -0
f1 (ppm)


139.152
137.514
133.682
129.293
128.054
115.359
56.117
33.037
27.418
22.086
80 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.946
7.941
7.938
7.934
7.925
7.920
7.916
7.673
7.670
7.667
7.657
7.651
7.646
7.636
7.633
7.630
7.580
7.576
7.572
7.559
7.556
7.552
7.542
7.538
7.535
3.024
3.006
1.017
1.007
1.005
0.999
0.995
0.993
0.987
0.981
0.979
0.975
0.969
0.967
0.957
0.955
0.566
0.555
0.553
0.550
0.546
0.537
0.533
0.530
0.527
0.517
0.129
0.117
0.114
0.108
0.105
0.101
0.089
O
S
O
O
1.93
0.98
1.93
2.00
1.00
2.01
1.95
f1 (ppm)


139.280
133.683
129.160
128.440
61.379
4.862
4.394
O
S
O
O
f1 (ppm)


7.778
7.773
7.766
7.760
7.754
7.602
7.595
7.590
7.584
7.580
7.576
7.333
7.330
7.326
7.313
7.309
7.298
7.294
7.289
7.250
7.246
7.243
7.233
7.228
7.222
7.210
7.195
7.191
7.185
7.173
4.144
4.128
4.119
4.112
4.103
4.087
3.726
3.718
3.702
3.693
3.686
3.677
3.661
2.744
2.736
2.732
2.717
2.712
2.695
2.032
2.016
2.012
2.000
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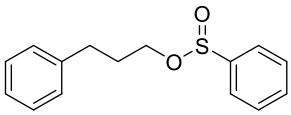
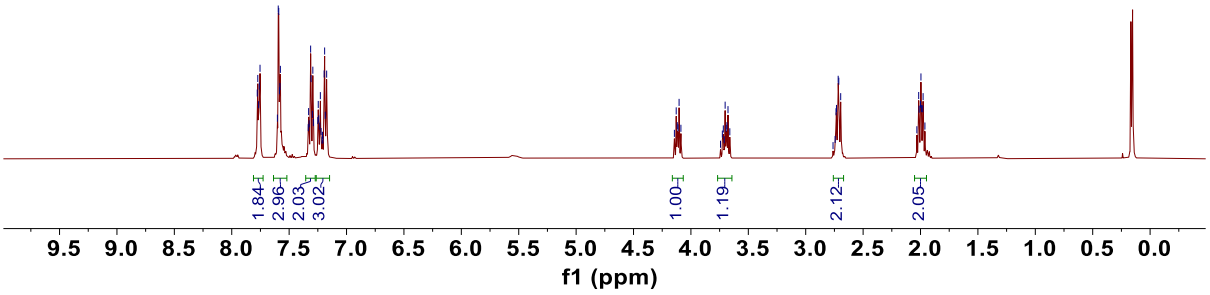
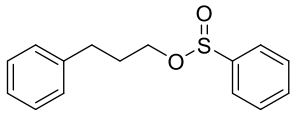
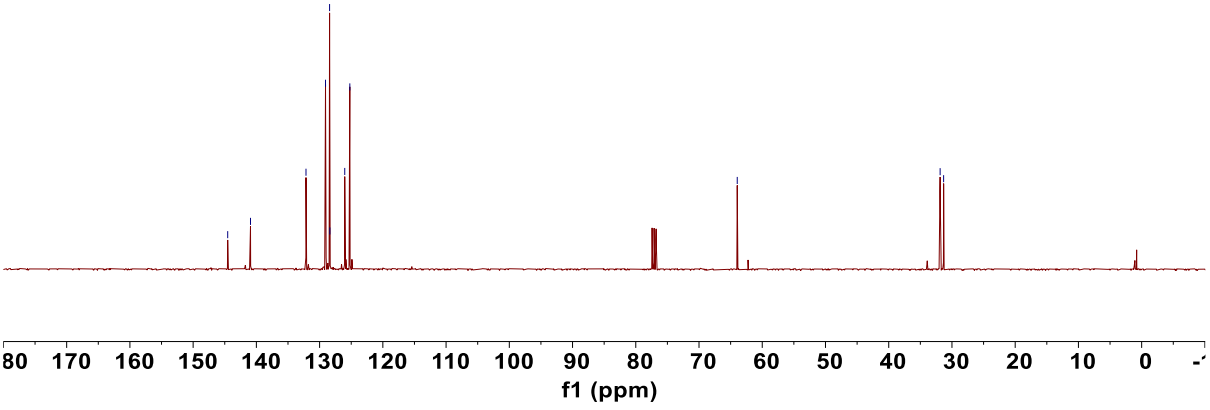
1.992
1.981
1.977
1.962

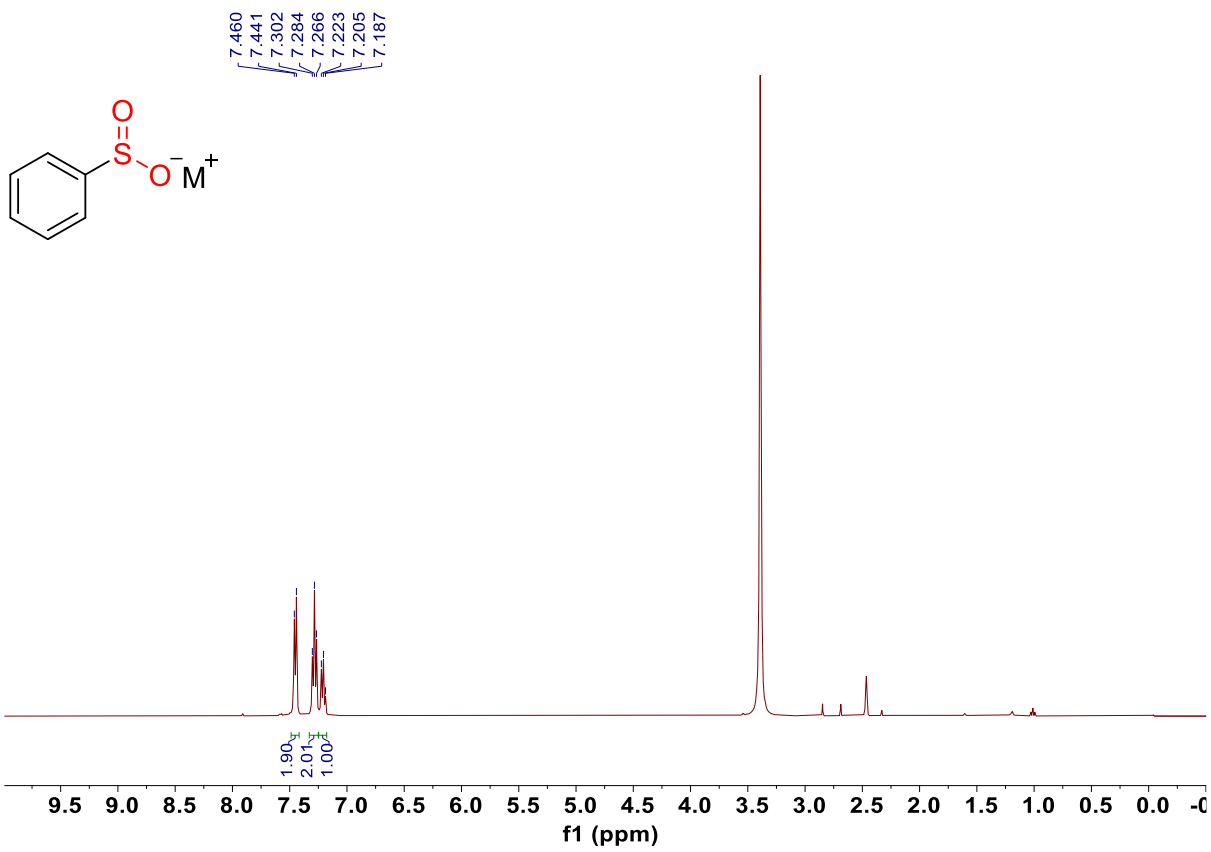


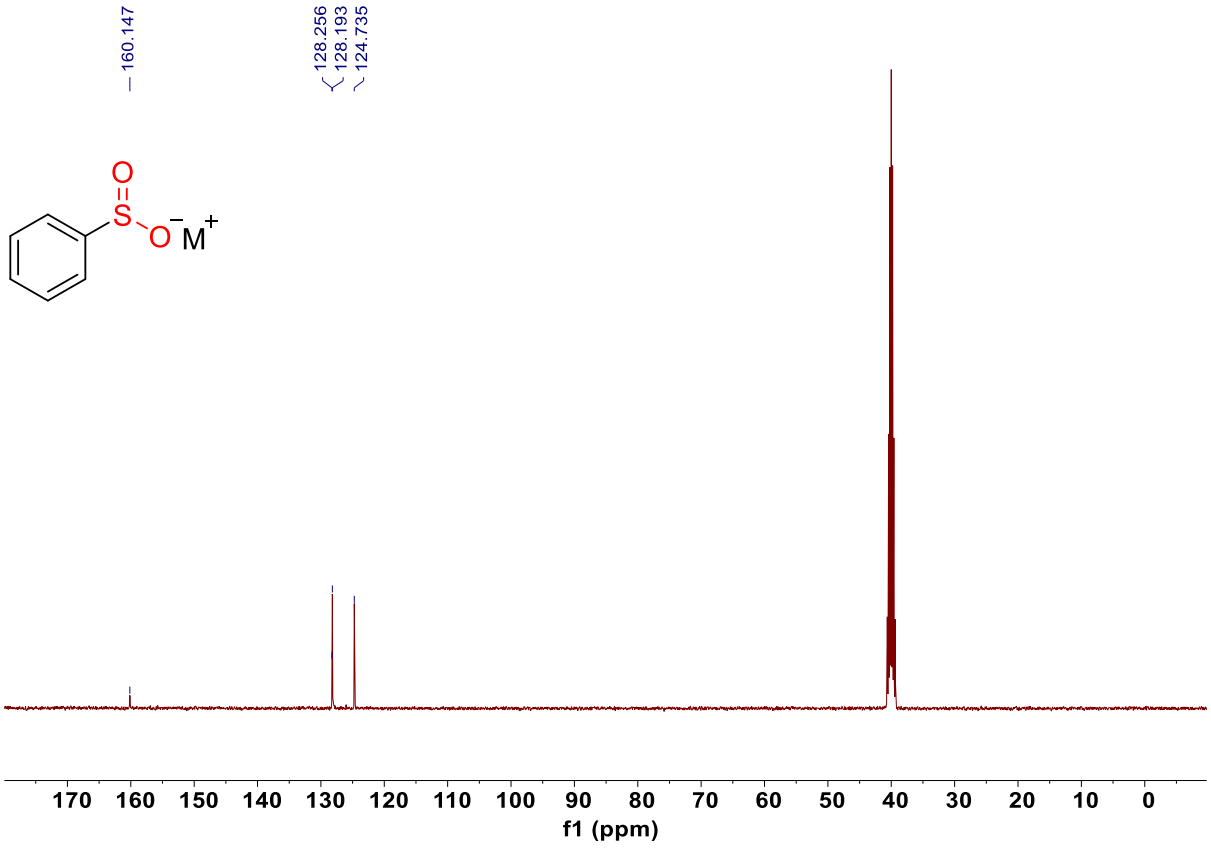

1.84
2.96
2.03
3.02
1.00
1.19
2.12
2.05
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


144.534
140.930
132.153
129.065
128.424
128.380
126.026
125.223
63.954
31.870
31.317




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


7.460
7.441
7.302
7.284
7.266
7.223
7.205
7.187
O
S
O
M+
1.90
2.01
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)


160.147
128.256
128.193
124.735
O
S
O
M+
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

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