Supporting Information

Stereoselective synthesis of vinyl sulfones via silver-catalyzed sulfonylation of styrenes

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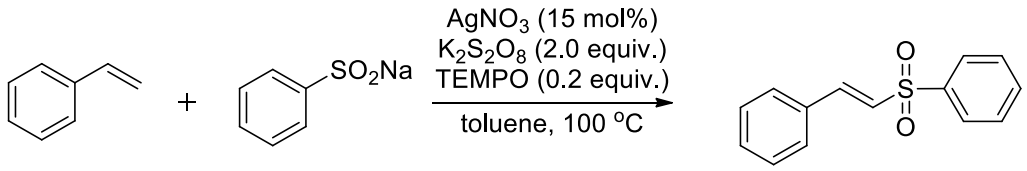
I General Consideration:

All reagents and solvents were purchased commercially, and used without further purification. Thin-layer chromatography (TLC) was carried out on TLC Alumina sheets with silica gel 60 F_{254} (Merck) and visualized by exposure to UV light (254 nm). Flash column chromatography was performed using Tsingdao silica gel (200-300). Reagents were purchased at the highest commercial quality and used without further purification, unless otherwise stated. With $CDCl_3$ as solvents, ^1H NMR and ^{13}C NMR were recorded at room temperature on the Brueker spectrometer (400 MHz ^1H, 101 MHz ^{13}C). The chemical-shifts scale is based on internal TMS. Data for ^1H NMR and ^{13}C NMR are reported as follows: chemical shift (δ, ppm), multiplicity, integration, and coupling constant (Hz).

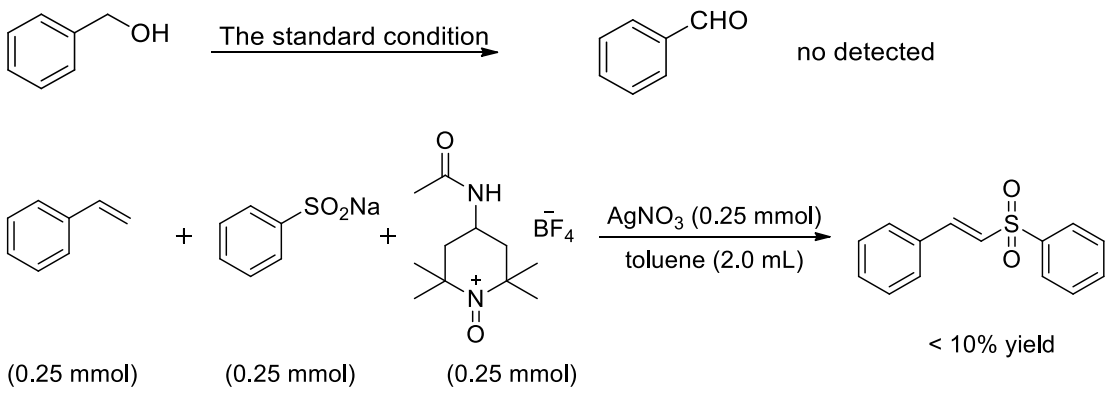
II General Procedure:



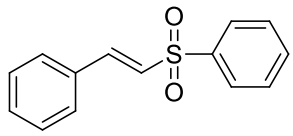
1a **2a** **3a**

Styrene **1a** (0.2 mmol, 20.8 mg), sodium benzenesulfinate **2a** (0.2 mmol, 32.8 mg), $AgNO_3$ (0.03 mmol, 5.1 mg), $K_2S_2O_8$ (0.4 mmol, 108.0 mg), TEMPO (0.04 mmol, 6.2 mg) and toluene (1.0 mL) were added to a 35 mL Schlenk flask equipped with a high-vacuum PTFE valve-to-glass seal. Then the flask was stirred at 100 °C for 10 hours. After the reaction was quenched by addition of water, the mixture was extracted with dichloromethane, and the combined organic layer was dried over sodium sulfate. Concentration in vacuo followed by silica gel column purification with petroleum ether/ethyl acetate gave the desired product **3a** with 82% yield.

Ⅲ Controlled experimenrt



IV Characterization Data for Selected Compounds



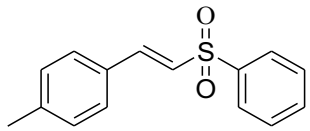
(*E*)-(2-(phenylsulfonyl)vinyl)benzene 3a[1] Yield: 82%; Yellow solid; Melting Point: 67-68 ^{o}C; Yellow solid;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, J = 4.0 Hz, 2H), 7.69 (d, J = 16.0 Hz, 1H), 7.64(t, J = 8.0 Hz, 1H), 7.55 (t, J = 8.0 Hz, 2H), 7.49 (d, J = 4.0 Hz, 2H), 7.40 (d, J = 4.0Hz, 3H), 6.97 (d, J = 16.0 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 142.5, 140.7, 133.4, 132.3, 131.2, 129.3, 129.1, 128.5, 127.6, 127.2;

IR : 3059, 2924, 1615, 1492, 1447, 1309, 1146, 1084, 975, 817, 749, 689 cm^{-1};

MS: m/z $C_{14}H_{12}O_2S$ 244.3 (M+).



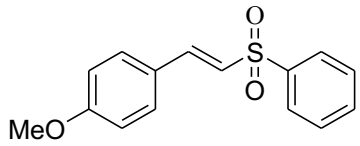
(*E*)-1-Methyl-4-(2-(phenylsulfonyl)vinyl)benzene 3b[2] Yield: 85%; Melting Point: 138 ^{o}C； White solid；

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 5.3 Hz, 2H), 7.58 (d, *J* = 15.4 Hz, 1H), 7.52 (d, *J* = 7.2 Hz, 1H) 7.51-7.53 (m, 2H) 7.29 (t, *J* = 10.1 Hz, 2H), 7.12 (d, *J* = 8.0 Hz, 2H), 6.73 (d, *J* = 15.4 Hz, 1H), 2.29 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 141.5, 140.8, 139.8, 132.2, 128.7, 128.5, 128.2, 127.5, 126.5, 124.9, 20.5;

IR: 3054, 2920, 1606, 1447, 1147, 1084 cm^{-1};

MS: m/z $C_{15}H_{14}O_2S$ 258.3 (M+).



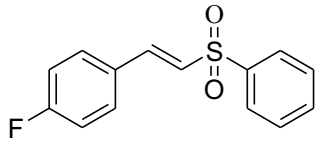
(*E*)-1-Methoxyl-4-(2-(phenylsulfonyl)vinyl)benzene 3c[2] Yield: 88%; Melting Point: 120 ^{o}C； White solid；

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.6 Hz, 2H), 7.58 (d, *J* = 14.4 Hz, 1H), 7.50 (d, *J* = 8.0 Hz, 1H), 7.47 (t, *J* = 8.0 Hz, 2H), 7.36 (d, *J* = 8.8 Hz, 2H), 6.83 (d, *J* = 14.4 Hz, 2H), 6.64 (d, *J* = 15.3 Hz, 1H), 3.76 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 161.0, 141.2, 140.0, 132.1, 129.3, 128.2, 126.4, 123.9, 123.3, 113.4, 54.4;

IR: 3056, 2934, 1602, 1446, 1145, 1085 cm^{-1};

MS: m/z $C_{15}H_{14}O_3S$ 274.3 (M+).



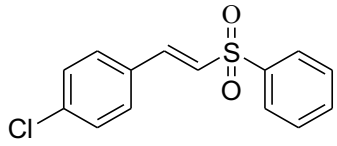
(*E*)-1-Fluoro-4-(2-(phenylsulfonyl)vinyl)benzene 3d[2] Yield: 77%; Melting Point: 108-110 °C； White solid；

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 7.6 Hz, 2H), 7.61-7.51 (m, 2H), 7.48 (t, *J* = 7.5 Hz, 2H), 7.41 (dd, *J* = 8.1, 5.6 Hz, 2H), 7.01 (t, *J* = 8.5 Hz, 2H), 6.72 (d, *J* = 15.4 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 164.3 (d, $J_{C\text{-}F}$= 251.5 Hz), 141.2, 140.6, 133.5, 129.4, 130.6(d, $J_{C\text{-}F}$ = 7.7 Hz), 127.7, 128.6 (d, *J* = 3.4 Hz), 127.0 (d, $J_{C\text{-}F}$= 2.3 Hz), 116.3 (d, $J_{C\text{-}F}$= 21.9 Hz);

IR: 3057, 1617, 1446, 1146, 1085 cm^{-1}.

MS: m/z $C_{14}H_{11}FO_2S$ 262.1 (M+).



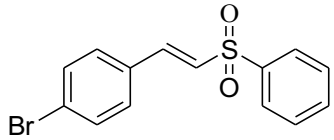
(*E*)-1-Chloro-4-(2-(phenylsulfonyl)vinyl)benzene 3e[2] Yield: 68%; Melting Point: 131 °C； White solid；

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.7 Hz, 2H), 7.56 (d, *J* = 15.4 Hz, 1H), 7.55 (d, *J* = 8.6 Hz, 1H), 7.49 (t, *J* = 7.7 Hz, 2H), 7.35 (d, *J* = 8.6 Hz, 2H), 7.29 (d, *J* = 8.5 Hz, 2H), 6.76 (d, *J* = 15.4 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 141.0, 140.4, 137.2, 133.5, 130.8, 129.7, 129.4, 127.9, 127.7;

IR: 3058, 1613, 1486, 1145, 1083 cm^{-1}；

MS: m/z $C_{14}H_{11}ClO_2S$ 278.7 (M+).



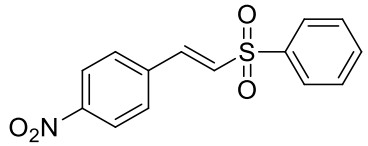
(*E*)-1-Bromo-4-(2-(phenylsulfonyl)vinyl)benzene 3f[2]Yield: 80%; Melting Point: 150 °C； White solid；

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.0 Hz, 2H), 7.59 – 7.56 (m, 1H), 7.56 – 7.52 (m, 1H), 7.52-7.47 (m, 2H), 7.46 (d, *J* = 8.5 Hz, 2H), 7.28 (d, *J* = 8.3 Hz, 2H), 6.79 (d, *J* = 15.4 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 140.0, 139.3, 132.5, 131.3, 130.2, 128.9, 128.3, 126.9, 126.6, 124.6;

IR: 3052, 2920, 1653, 1516, 1462, 1382, 1247, 1078, 815, 749 cm^{-1}；

MS: m/z $C_{14}H_{11}BrO_2S$ 323.2 (M+).



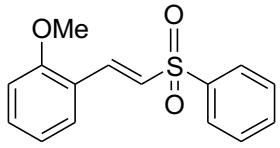
(*E*)-1-Nitro-4-(2-(phenylsulfonyl)vinyl)benzene 3g[3] Yield: 61%; Melting Point: 169-170 ^{o}C； Yellow solid；

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (d, *J* = 7.9 Hz, 2H), 7.90 (d, *J* = 7.3 Hz, 2H), 7.66 (d, *J* = 15.5 Hz, 1H), 7.58 (d, *J* = 8.8 Hz, 3H), 7.52 (t, *J* = 7.8 Hz, 2H), 6.93 (d, *J* = 15.6 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 147.9, 138.7, 138.2, 137.3, 132.9, 130.6, 128.5, 128.2, 126.9, 123.2;

IR: 3064, 2925, 1595, 1520, 1346, 1308, 1275, 1147, 811, 751 cm^{-1}；

MS: m/z $C_{14}H_{11}NO_4S$ 289.3 (M+).



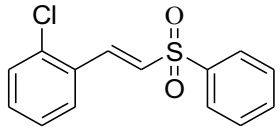
(*E*)-2-Methoxyl-4-(2-(phenylsulfonyl)vinyl)benzene 3h[5] Yield: 69%; Melting Point: 93-94 ^{o}C； White solid；

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.0 Hz, 2H), 7.82 (d, *J* = 15.5 Hz, 1H), 7.55-7.49 (m, 1H), 7.46 (t, *J* = 7.7 Hz, 2H), 7.38-7.26 (m, 2H), 7.00 (d, *J* = 15.5Hz, 1H), 6.92-6.81 (m, 2H), 3.80 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 157.8, 140.1, 137.5, 132.0, 131.4, 129.7, 128.2, 126.8, 126.5, 120.1, 119.7, 110.2, 54.4;

IR : 3052, 2920, 1648, 1465, 1385, 1277, 1142, 1023, 766, 638 cm^{-1}；

MS: m/z $C_{16}H_{16}O_3S$ 288.4 (M+).



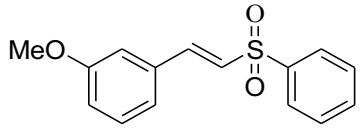
(*E*)-2-Chloro-4-(2-(phenylsulfonyl)vinyl)benzene 3i[2] Yield: 65%; Melting Point: 98-100 ^{o}C； White solid；

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, *J* = 15.4 Hz, 1H), 7.90 (d, *J* = 8.0 Hz, 2H), 7.57 (t, *J* = 7.3 Hz, 1H), 7.50 (t, *J* = 7.7 Hz, 2H), 7.44 (d, *J* = 7.7 Hz, 1H), 7.36 (d, *J* = 8.0 Hz, 1H), 7.27 (t, *J* = 7.6 Hz, 1H), 7.19 (t, *J* = 7.4 Hz, 1H), 6.83 (d, *J* = 15.5 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 139.2, 137.4, 134.3, 132.5, 130.9, 129.6, 129.4, 129.0, 128.3, 127.2, 126.8, 126.1;

IR : 3057, 3029, 1612, 1596, 1466, 1440, 1321. 1144, 1035, 965, 693, 660 cm^{-1}；

MS: m/z $C_{14}H_{11}ClO_2S$ 278.8 (M+).



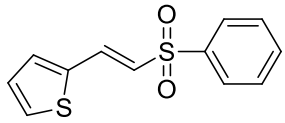
(*E*)-3-Methoxyl-4-(2-(phenylsulfonyl)vinyl)benzene 3j[6] Yield: 74%; Melting Point: 120 ^{o}C； White solid；

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 7.4 Hz, 2H), 7.58 (d, *J* = 15.4 Hz, 1H), 7.54 (d, *J* = 7.3 Hz, 1H), 7.48 (t, *J* = 7.5 Hz, 2H), 7.23 (t, *J* = 7.9 Hz, 1H), 7.00 (d, *J* = 7.6 Hz, 1H), 6.92-6.86 (m, 2H), 6.78 (d, *J* = 15.4 Hz, 1H), 3.74 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 158.9, 141.4, 139.6, 132.6, 132.4, 129.1, 128.3, 126.6, 126.5, 120.2, 116.1, 112.3, 54.34;

IR : 3050, 2923, 1579, 1460, 1385, 1276, 1143, 1123, 1085, 747, 619 cm^{-1}；

MS: m/z $C_{15}H_{14}O_3S$ 274.3(M+).



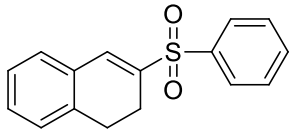
(*E*)-2-(2-(phenylsulfonyl)vinyl)thiophene 3k[3] Yield: 70%; Melting Point: 93-94^{o}C； Brown solid；

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.0 Hz, 2H), 7.80 (d, *J* = 16.0 Hz, 1H), 7.62 (t, *J* = 8.0 Hz, 1H), 7.55 (t, *J* = 8.0 Hz, 2H), 7.45 (d, *J* = 4.0 Hz, 1H), 7.26 (s, 1H), 7.13-7.05 (m, 1H), 6.65 (d, *J* = 16.0 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 140.8, 136.9, 136.1, 133.3, 132.5, 130.0, 129.3, 128.3, 127.7, 126.4;

IR : 3049, 2920, 1602, 1445, 1385, 1277, 1123, 1045, 805, 749 cm^{-1}；

MS: m/z $C_{12}H_{10}O_2S_2$ 250.3.0(M+).

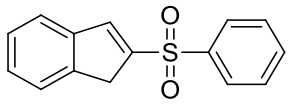


3-(phenylsulfonyl)-1,2-dihydronaphthalene 3l[8] Yield:81%; Melting Point:115-116 ^{o}C; White solid;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (t, *J* =8 Hz 2H), 7.60 (t, *J* = 8 Hz, 2H), 7.53 (t, *J* = 12 Hz, 2H), 7.29-7.21(m, *J* = 3H), 7.11(t, *J* = 8 Hz, 1H), 2.86 (t, *J* = 8 Hz, 2H), 2.49 (t, J = 8 Hz, 2H);

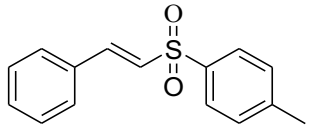
^{13}C NMR (101 MHz, $CDCl_3$) δ 139.7, 138.1, 135.5, 135.2, 133.3, 130.9, 130.5, 129.2, 129.0, 127.9, 127.8, 127.1, 27.5, 21.7;

MS: m/z $C_{16}H_{14}O_2S$ 270.4 (M+).

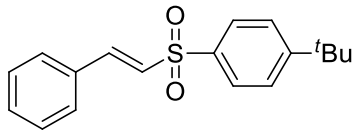


2-(phenylsulfonyl)-1H-indene 3m[9] Yield: 84%; Melting Point: 110-112 ^{o}C; White solid;

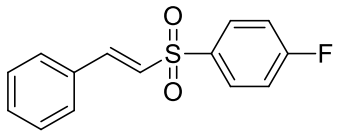
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 (d, *J* = 8.0 Hz, 2H), 7.70(s,1H), 7.60 (t, *J* = 4.0 Hz, 1H), 7.54 (t, *J* = 8 Hz, 3H), 7.43 (t, *J* = 8.0 Hz, 1H), 7.34 (t, *J* = 4.0 Hz, 2H), 3.64 (s, 2H);
^{13}C NMR (101 MHz, $CDCl_3$) δ 145.3, 144.3, 141.0, 140.6, 133.3, 129.3, 128.3, 127.7, 127.4, 124.4, 124.0, 37.83;
MS: m/z $C_{15}H_{12}O_2S$ 256.3 (M+).



(*E*)-1-(4-Methylphenyl)sulfonyl-2-phenylethene 4a[(1)] Yield: 85%; Melting Point: 126 °C； White solid；
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (d, *J* = 8.2 Hz, 2H), 7.59 (d, *J* = 15.4 Hz, 1H), 7.40 (d, *J* = 5.3 Hz, 2H), 7.32 (t, *J* = 5.8 Hz, 3H), 7.27 (d, *J* = 8.2 Hz, 2H), 6.78 (d, *J* = 15.4 Hz, 1H), 2.36(s, 3H);
^{13}C NMR (101 MHz, $CDCl_3$) δ 143.6, 141.1, 136.9, 131.6, 130.3, 129.1, 128.2, 127.7, 126.9, 126.7, 20.8;
IR : 3056, 2920, 1659, 1549, 1299, 1120, 973, 815, 748, 685 cm^{-1}；
MS: m/z $C_{15}H_{14}O_2S$ 258.3 (M+).

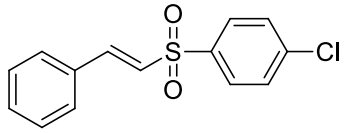


(*E*)-1-(tert-butyl)-4-(styrylsulfonyl)benzene 4b[(4)] Yield: 83%; Yellow oil；
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 4.0 Hz, 2H), 7.67 (d, *J* = 16.0 Hz, 1H), 7.57 (d, *J* = 8.0 Hz, 2H), 7.48 (d, *J* = 8.0 Hz, 2H), 7.42-7.40 (m, 3H), 6.86 (d, *J* = 16.0 Hz, 1H), 1.34 (s, 9H);
^{13}C NMR (101 MHz, $CDCl_3$) δ 157.3, 141.9, 137.7, 132.4, 131.1, 129.0, 128.5, 127.6, 127.5, 126. 4, 35.2, 31.0;
IR : 3060, 2922, 1669, 1551, 1310, 1122, 973, 870， 815, 755, 680 cm^{-1}；
MS: m/z $C_{18}H_{20}O_2S$ 300.4 (M+).



(*E*)-1-fluoro-4-(styrylsulfonyl)benzene 4c[(1)] Yield: 77%; Melting Point: 95-96 °C; White solid;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (dd, *J* = 8.0 Hz, 2.4 Hz, 2H), 7.69 (d, *J* = 12.0 Hz, 1H), 7.49 (d, *J* = 8.0 Hz, 2H), 7.41 (d, *J* = 4.0 Hz, 3H), 7.22 (t, *J* = 8.0 Hz, 2H), 6.85 (d, *J* = 16.0 Hz, 1H);
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.9 (d, $J_{C\text{-}F}$ = 257.5 Hz), 142.6, 136.8 (d, $J_{C\text{-}F}$ = 3.0 Hz), 132.2, 131.3, 130.5 (d, $J_{C\text{-}F}$ = 10.1 Hz), 129.1, 128.6, 127.1, 116.7 (d, $J_{C\text{-}F}$ = 12.1 Hz);
IR : 3058, 2919, 1654, 1563, 1410, 1272, 1138, 1079, 806, 751 cm^{-1};

MS: m/z $C_{14}H_{11}FO_2S$ m/z 262.3 (M+).



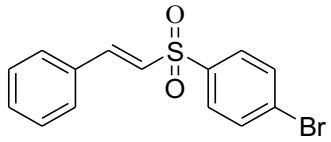
(*E*)-1-chloro-4-(styrylsulfonyl)benzene 4d(1) Yield: 71%; Melting Point: 107-108 °C; White solid;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.0 Hz, 2H), 7.69 (d, *J* = 16.0 Hz, 1H), 7.55-7.45 (m, 4H), 7.41 (t, *J* = 8.0 Hz, 3H), 6.84 (d, *J* = 16.0 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.0, 140.1, 139.2, 132.1, 131,4, 129.6, 129.1, 128.6, 126.8;

IR : 3060, 2925, 1614, 1578, 1476, 1394, 1318, 1147, 1088, 816, 753 cm^{-1};

MS: m/z $C_{14}H_{11}ClO_2S$ 278.8 (M+).



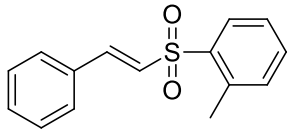
(*E*)-1-(4-Bromophenyl)sulfonyl-2-phenylethene 4e(1) Yield: 72%; Melting Point: 103.5-104.5 °C； White solid;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.3 Hz, 2H), 7.62 (d, *J* = 15.4 Hz, 1H), 7.58 (d, *J* = 8.3 Hz, 2H) 7.40 (d, *J* = 6.0 Hz, 2H), 7.35-7.31 (m, 3H), 6.76 (d, *J* = 15.4 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 142.0, 138.7, 131.6, 131.1, 130.4, 128.2, 128.1, 127.6, 125.7;

IR : 3055, 2924, 1663, 1516, 1462, 1382, 1247, 1078, 811, 750 cm^{-1}；

MS: m/z $C_{14}H_{11}BrO_2S$ 323.2 (M+).



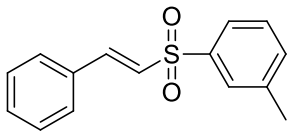
(*E*)-1-methyl-2-(styrylsulfonyl)benzene 4f(1) Yield: 63%; Yellow oil；

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12 (d, *J* = 8.0 Hz, 1H), 7.69 (d, *J* = 16.0Hz, 1H), 7.51 (t, *J* = 8.0 Hz, 3H), 7.40 (t, *J* = 4.0 Hz, 4H), 7.30 (d, *J* = 8.0 Hz, 1H), 6.85 (d, *J* = 16Hz, 1H), 2.64 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 142.8, 138.0, 133.6, 132.6, 132.4, 131.2, 129.4, 129.1, 128.6, 126.7, 126.7, 20.3;

IR : 3055, 2921, 1659, 1540, 1295, 1125, 977, 815, 748, 685 cm^{-1}；

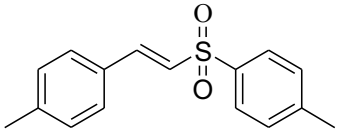
MS: m/z $C_{15}H_{14}O_2S$ 258.3(M+).



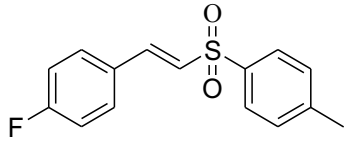
(*E*)-1-methyl-3-(styrylsulfonyl)benzene 4g(1) Yield: 76%; Yellow oil;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 (s, 2H), 7.70 (d, *J* = 16.0Hz,1H), 7.61 (d, *J* = 8.0

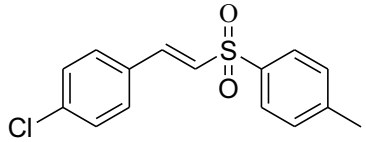
Hz, 2H), 7.46-7.37 (m, 5H), 6.88 (d, *J* = 16.0 Hz, 1H), 2.46 (s, 3H);
^{13}C NMR (101 MHz, $CDCl_3$) δ 142.2, 140.5, 139.6, 134.2, 132.4, 131.2, 129.2, 129.1, 128.6, 127.9, 127.4, 124.8, 21.3;
IR : 3056, 2920, 1655, 1549, 1295, 1124, 973, 815, 748, 684 cm^{-1};
MS: m/z $C_{15}H_{15}O_2S$ 258.3(M+).



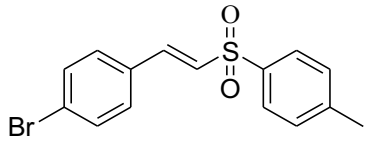
(*E*)-1-Methyl-4-(2-tosylvinyl)benzene 4h[(1)] Yield: 86%; Melting Point:152-155 ^oC; White solid;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (d, *J* = 8.1 Hz, 2H), 7.55 (d, *J* = 15.4 Hz, 1H), 7.29 (d, *J* = 8.0, Hz, 2H), 7.26 (d, *J* = 8.2, Hz, 2H), 7.11 (d, *J* = 7.9 Hz, 2H), 6.72 (d, *J* = 15.4 Hz, 1H), 2.36 (s, 3H), 2.29 (s, 3H);
^{13}C NMR (101 MHz, $CDCl_3$) δ 143.2, 140.9, 140.7, 136.9, 128.9, 128.7, 128.6,127.5, 126.6, 125.3, 20.6, 20.5;
IR : 3057, 2925, 1658, 1546, 1299, 1125, 976, 815, 748, 684 cm^{-1};
MS: m/z $C_{16}H_{16}O_2S$ 272.4(M+).



(*E*)-1-Fluoro-4-(2-tosylvinyl)benzene 4i[(1)] Yield: 71%; White oil;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (d, *J* = 8.1 Hz, 2H), 7.54 (d, *J* = 15.4 Hz, 1H), 7.40 (d, *J* = 8.3 Hz, 2H), 7.27 (d, *J* = 8.0 Hz, 2H), 7.00 (t, *J* = 8.5 Hz, 2H), 6.71 (d, *J* = 15.4 Hz, 1H), 2.36 (s, 3H);
^{13}C NMR (101 MHz, $CDCl_3$) δ 164.3 (d, $J_{C\text{-}F}$= 251.2 Hz), 143.4, 139.6, 136.7, 129.6, 129.5, 127.7 (d, $J_{C\text{-}F}$= 3.4 Hz), 126.4, 126.3, 115.3 (d, $J_{C\text{-}F}$ = 21.9 Hz), 20.6;
IR: 3058, 3020, 1620, 1446, 1146, 1086, 970 cm^{-1}.
MS: m/z $C_{15}H_{13}FO_2S$ 276.3 (M+).



(*E*)-1-Chloro-4-(2-tosylvinyl)benzene 4j[(1)] Yield: 77%; Melting Point:139-142 ^oC; White solid;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (d, *J* = 8.2 Hz, 2H), 7.53 (d, *J* = 15.4 Hz, 1H), 7.33 (d, *J* = 8.5 Hz, 2H), 7.29 (d, *J* = 2.6 Hz, 2H), 7.27 (d, *J* = 2.1 Hz, 1H), 6.76 (d, *J* = 15.4 Hz, 1H), 2.36 (s, 3H);
^{13}C NMR (101 MHz, $CDCl_3$) δ 143.5, 139.4, 136.4, 136.1, 129.9, 129.0, 128.6, 128.3, 127.2, 126.7, 20.6;
IR : 3057, 3028, 1620, 1596, 1466, 1144, 1035, 968, 693, 664 cm^{-1};
MS: m/z $C_{15}H_{13}ClO_2S$ 292.7 (M+).



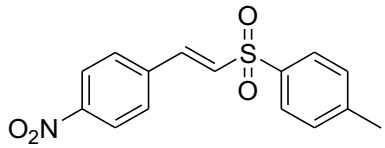
(*E*)-1-Bromo-4-(2-tosylvinyl)benzene 4k(1) Yield: 73%; Melting Point:163-164 ^{o}C, White solid;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (d, *J* = 8.2 Hz, 2H), 7.51 (d, *J* = 15.4 Hz, 1H), 7.45 (d, *J* = 8.4 Hz, 2H), 7.27 (t, *J* = 7.6 Hz, 4H), 6.77 (d, *J* = 15.4 Hz, 1H), 2.37(s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 143.5, 139.4, 136.4, 131.3, 130.3, 128.9, 128.7, 127.3, 126.7, 124.4, 20.6;

IR: 3053, 2920, 1652, 1516, 1462, 1384, 1247, 1079, 817, 754 cm^{-1};

MS: m/z $C_{15}H_{13}BrO_2S$ 337.2 (M+).



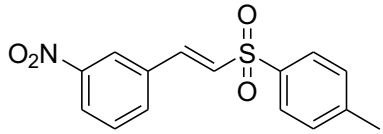
(*E*)-1- Nitro -4-(2-tosylvinyl)benzene 4l(7) Yield: 69%; Yellow solid;

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.17 (d, *J* = 8.5 Hz, 2H), 7.77 (d, *J* = 8.0 Hz, 2H), 7.56 (d, *J* = 8.5 Hz, 3H), 7.30 (d, *J* = 8.0 Hz, 2H), 6.93 (d, *J* = 15.5 Hz, 1H), 2.38 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 147.9, 144.1, 137.6, 137.5, 135.7, 131.0, 129.1, 128.1, 126.9, 123.2, 20.6;

IR: 3067, 2922, 1595, 1520, 1347, 1275, 1147, 815, 751 cm^{-1};

MS: m/z $C_{15}H_{13}NO_4S$ 303.3 (M+).



(*E*)-3- Nitro -4-(2-tosylvinyl)benzene 4m(1) Yield: 60%; Yellow oil;

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25 (s, 1H), 8.20-8.14 (m, 1H), 7.77 (d, *J* = 8.1 Hz, 2H), 7.72 (d, *J* = 7.7 Hz, 1H), 7.62 (d, *J* = 15.4 Hz, 1H), 7.53 (t, *J* = 8.0 Hz, 1H), 7.30 (d, *J* = 8.0 Hz, 2H), 6.95 (d, *J* = 15.4 Hz, 1H), 2.38 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$) δ 147.6, 143.9, 137. 8, 135.8, 133.2, 133.2, 130.0, 129.2, 129.1, 126.9, 124.2, 121.7, 20.6;

IR: 3068, 2920, 1599, 1526, 1346, 1270, 1148, 811, 752 cm^{-1};

MS: m/z $C_{15}H_{13}NO_4S$ 303.3 (M+).

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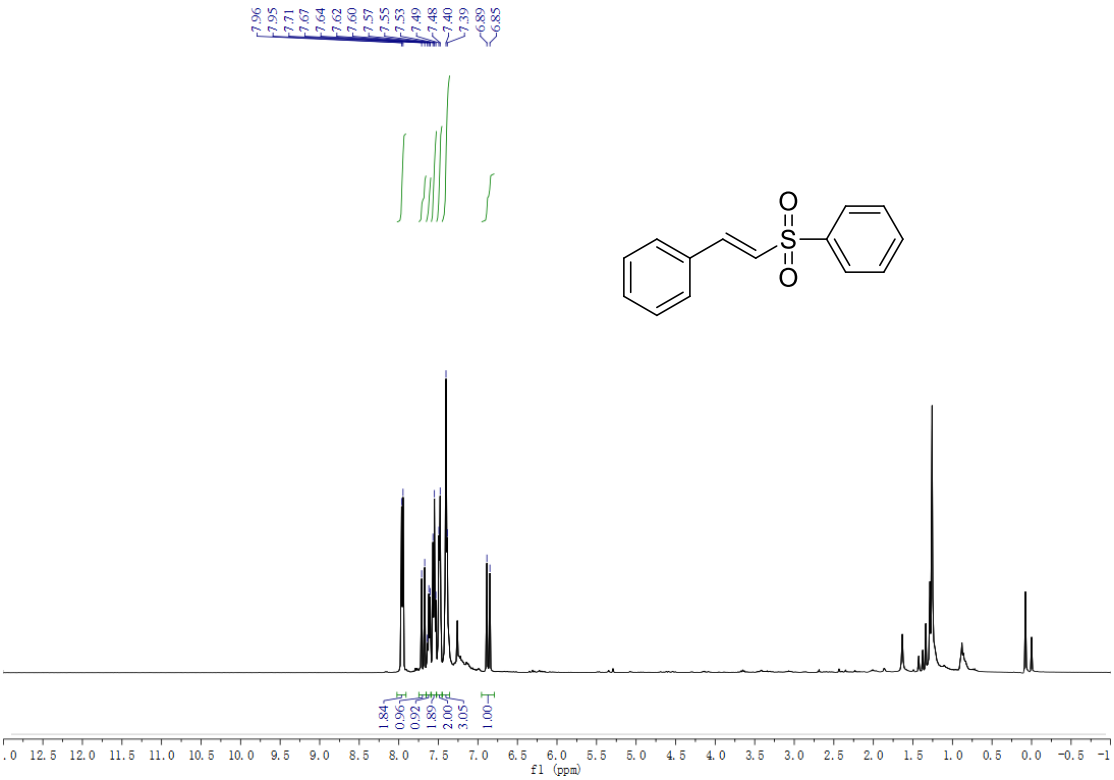
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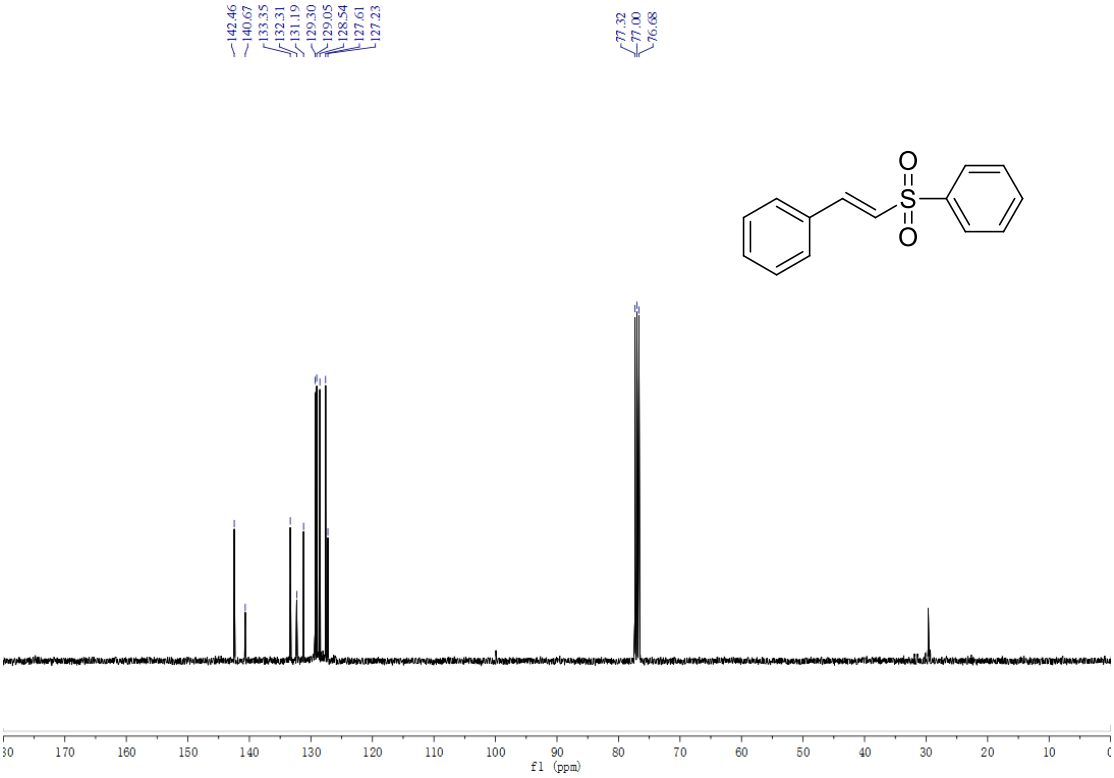
7.95
7.71
7.67
7.64
7.62
7.60
7.57
7.55
7.53
7.49
7.48
7.40
7.39
6.89
6.85
O
S
O
1.84
0.96
0.92
1.89
2.00
3.05
1.00
f1 (ppm)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127.23
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77.00
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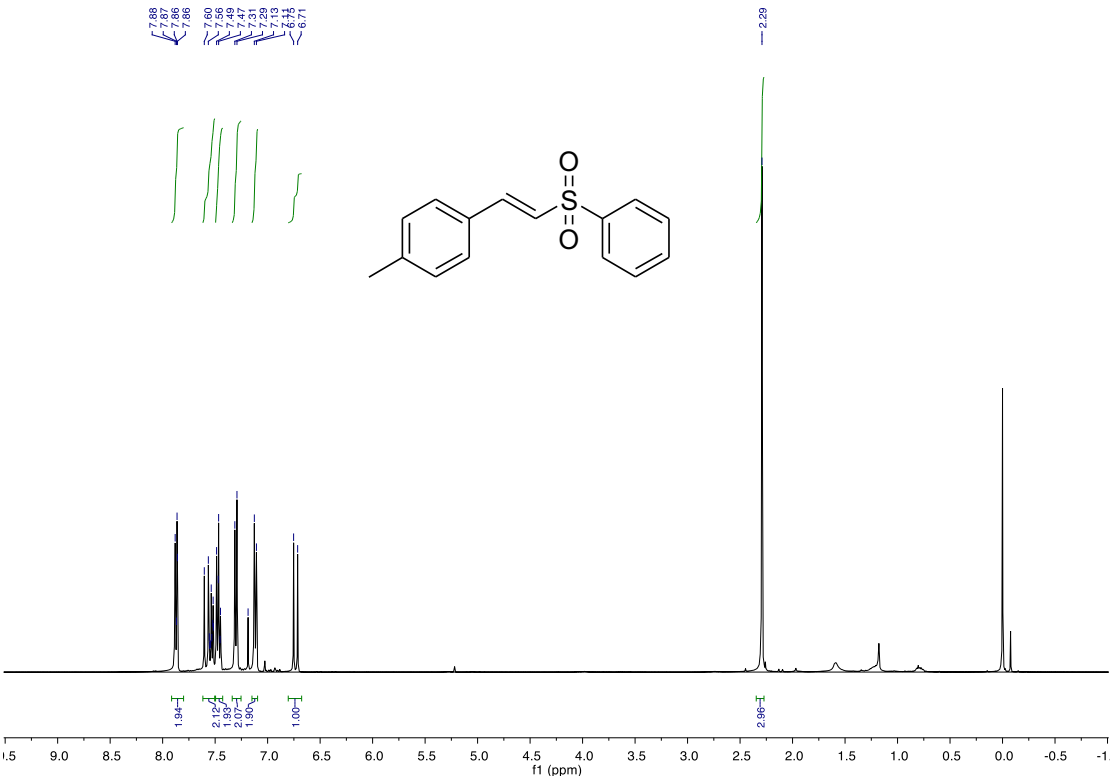
S
O
f1 (ppm)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7.87
7.86
7.86
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7.56
7.49
7.47
7.31
7.29
7.13
6.72
6.71
2.29
O
S
O
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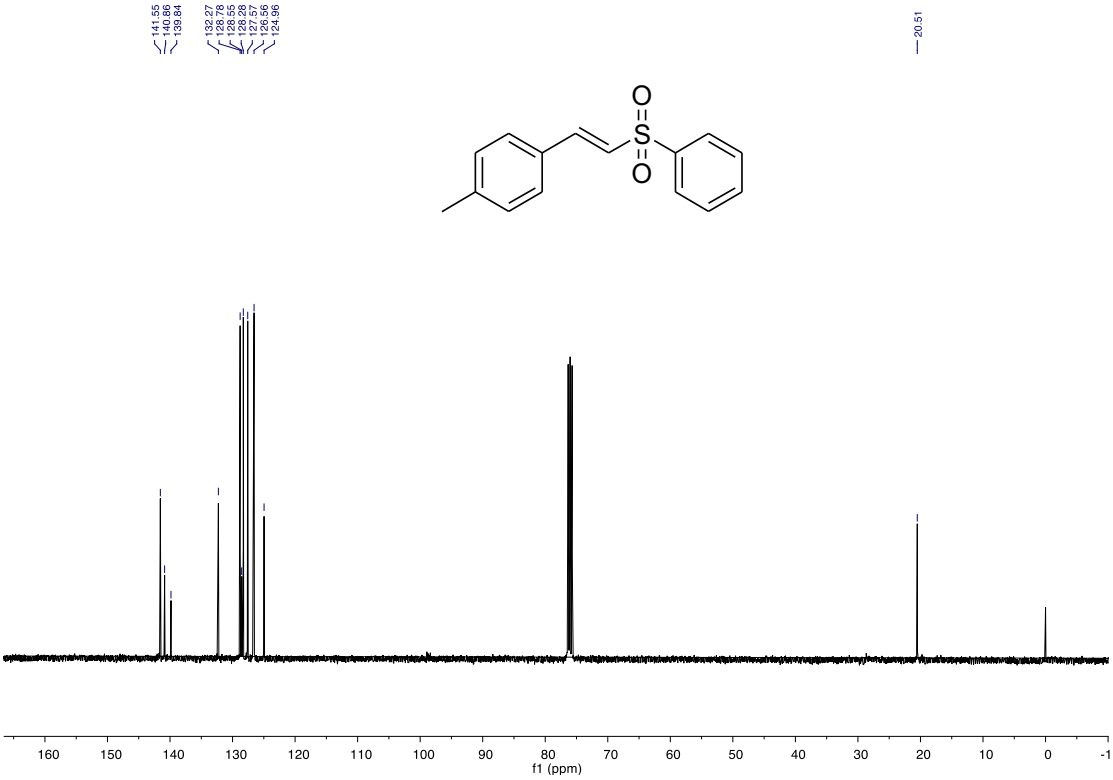
2.12
1.93
2.07
1.90
1.00
2.96
f1 (ppm)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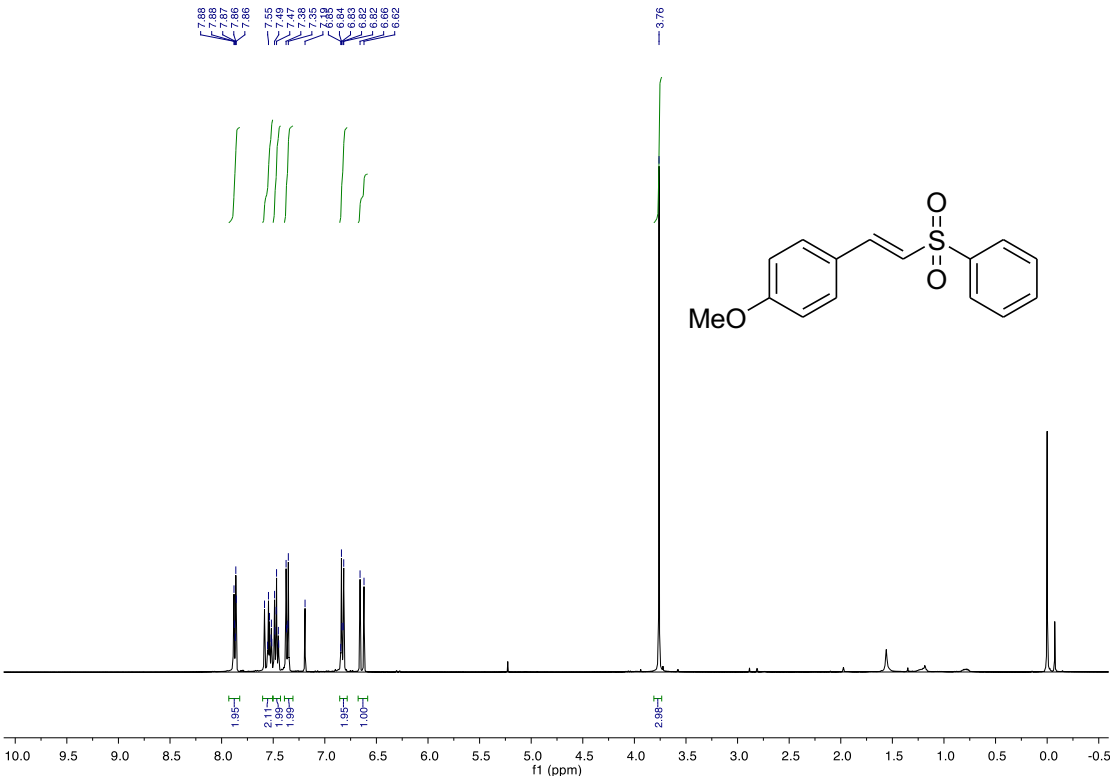
127.57
126.56
124.96
20.51
O
S
O
f1 (ppm)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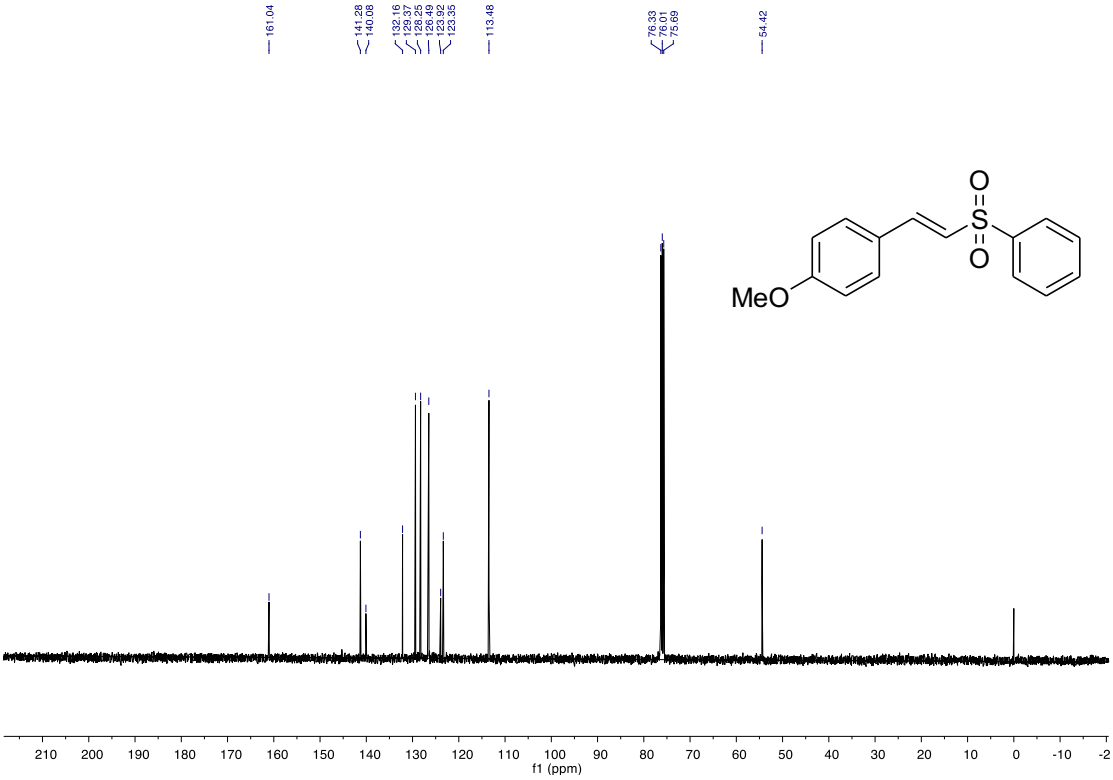
7.86
7.86
7.55
7.49
7.47
7.38
7.35
6.84
6.83
6.82
6.82
6.66
6.62
3.76
O
S
O
MeO
1.95
2.11
1.93
1.99
1.95
1.00
2.98
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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S
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MeO
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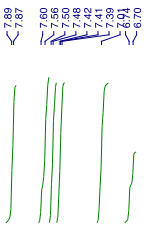
f1 (ppm)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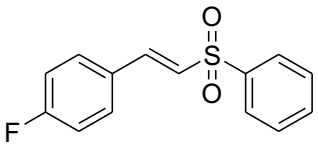
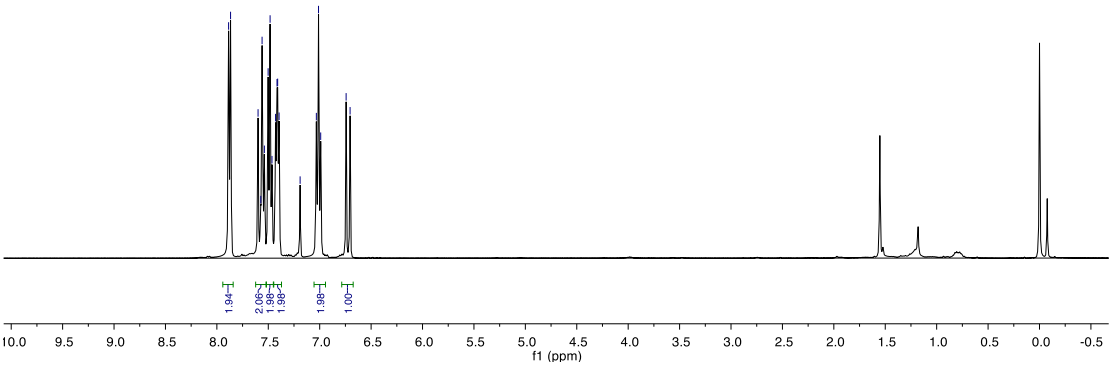

O
S
O
F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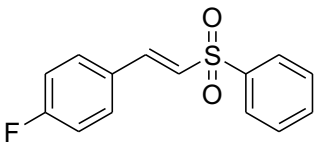
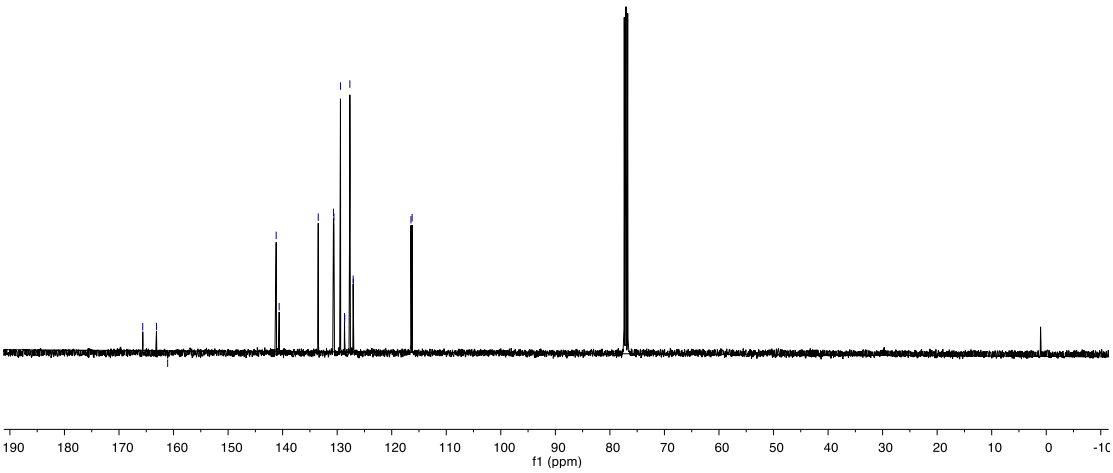
2.06
1.98
1.98
1.98
1.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


165.64
163.13
161.08
141.18
140.63
130.47
130.46
130.59
129.39
128.65
128.62
127.67
127.07
127.04
116.47
116.25


O
S
O
F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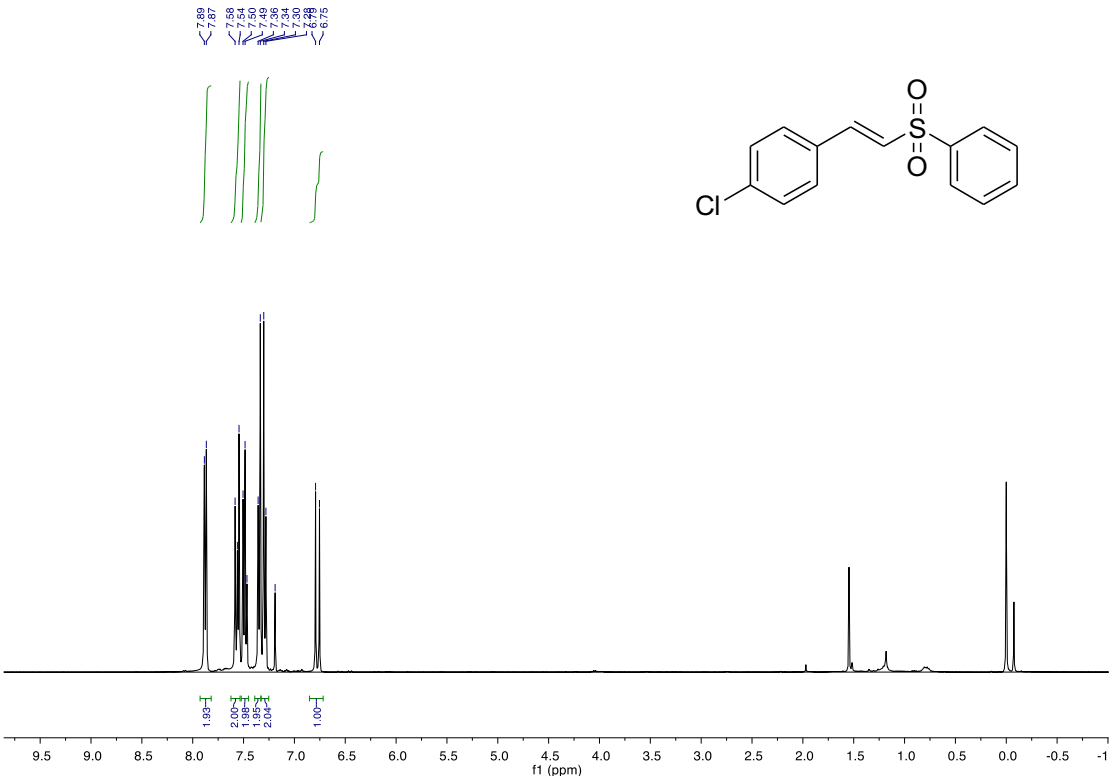
f1 (ppm)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7.40
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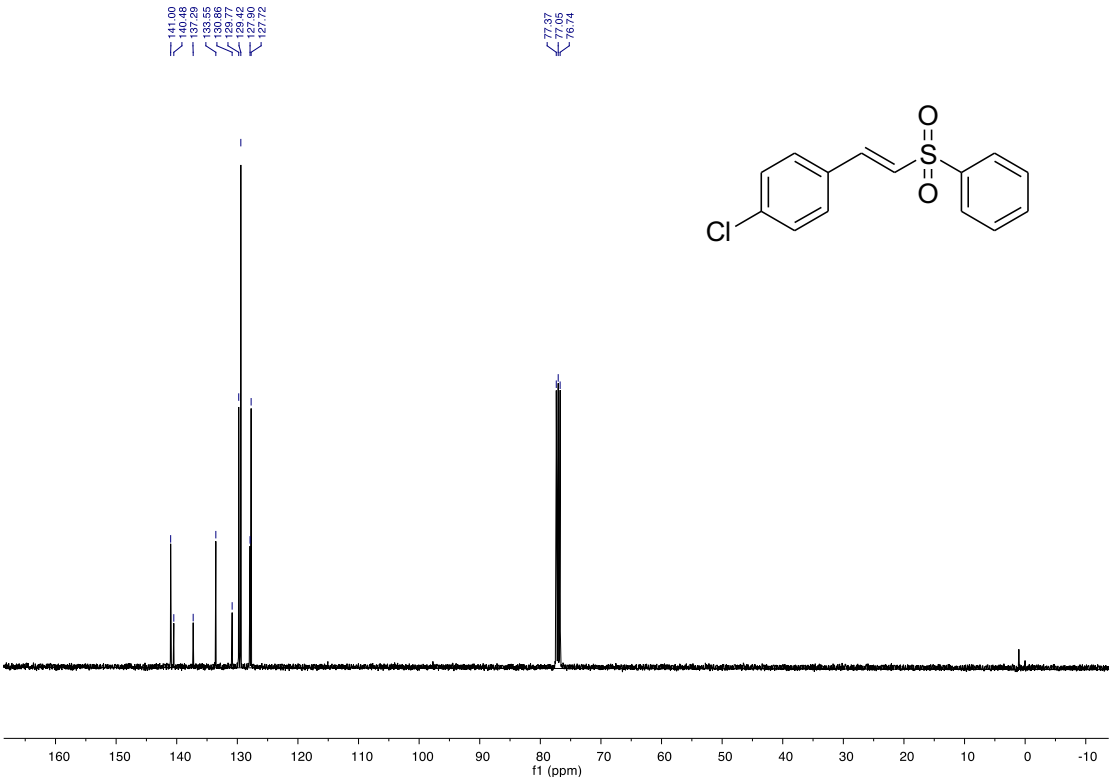
7.34
7.30
6.79
6.75
O
S
O
Cl
1.93
2.00
1.98
1.95
2.04
1.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)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S
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Cl
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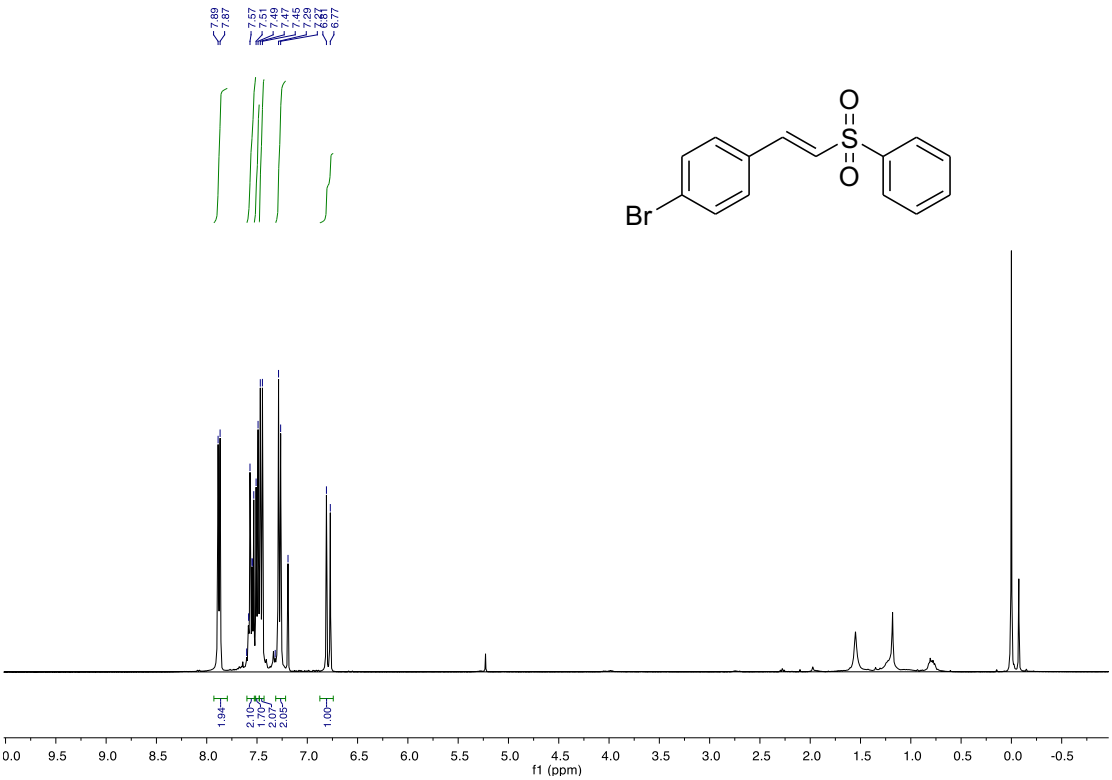
f1 (ppm)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O
Br
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2.10
1.70
2.07
2.05
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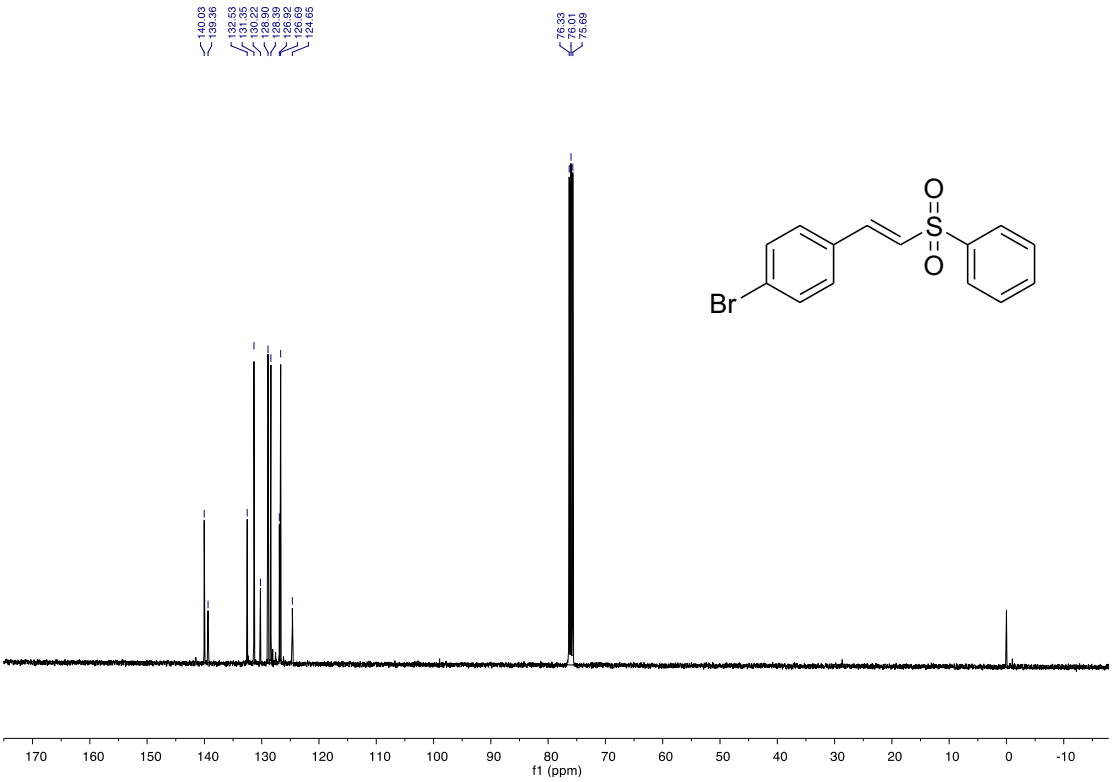
0.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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131.35
130.22
128.60
128.39
126.92
126.69
124.65
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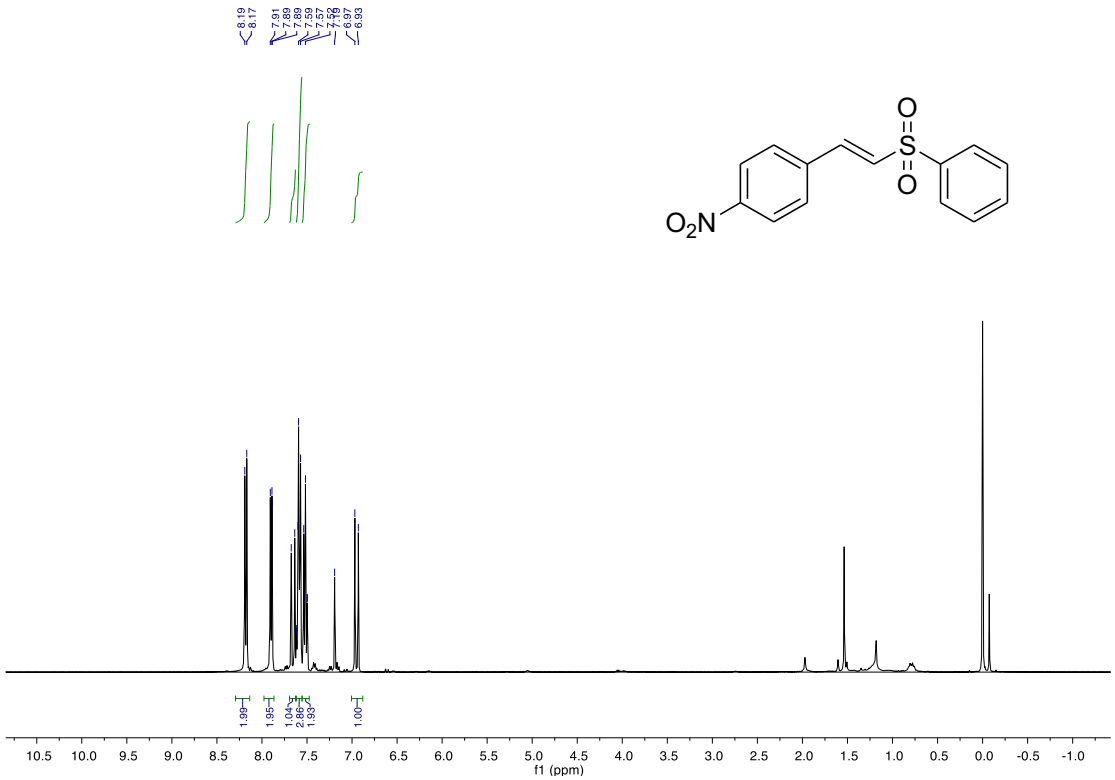
75.69
O
S
O
Br
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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8.17
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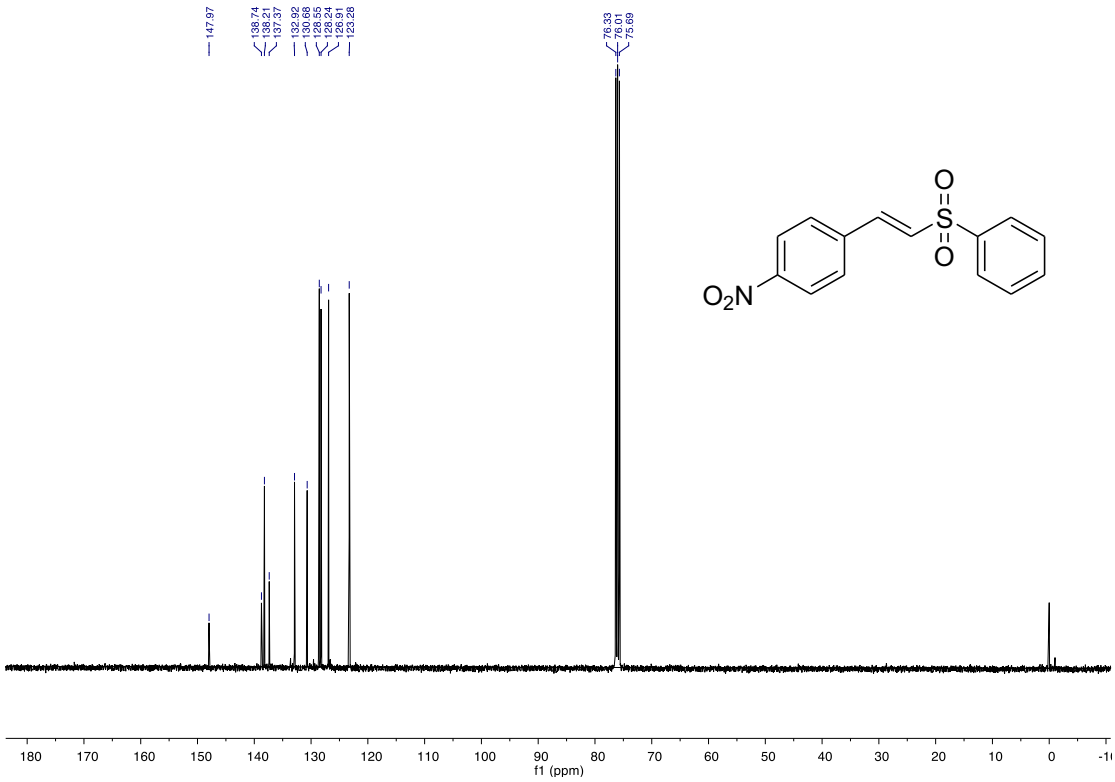
7.59
7.57
7.56
6.97
6.93
O
S
O
O2N
1.99
1.95
1.04
2.86
1.93
1.00
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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138.21
137.37
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130.68
128.55
128.24
126.91
123.28
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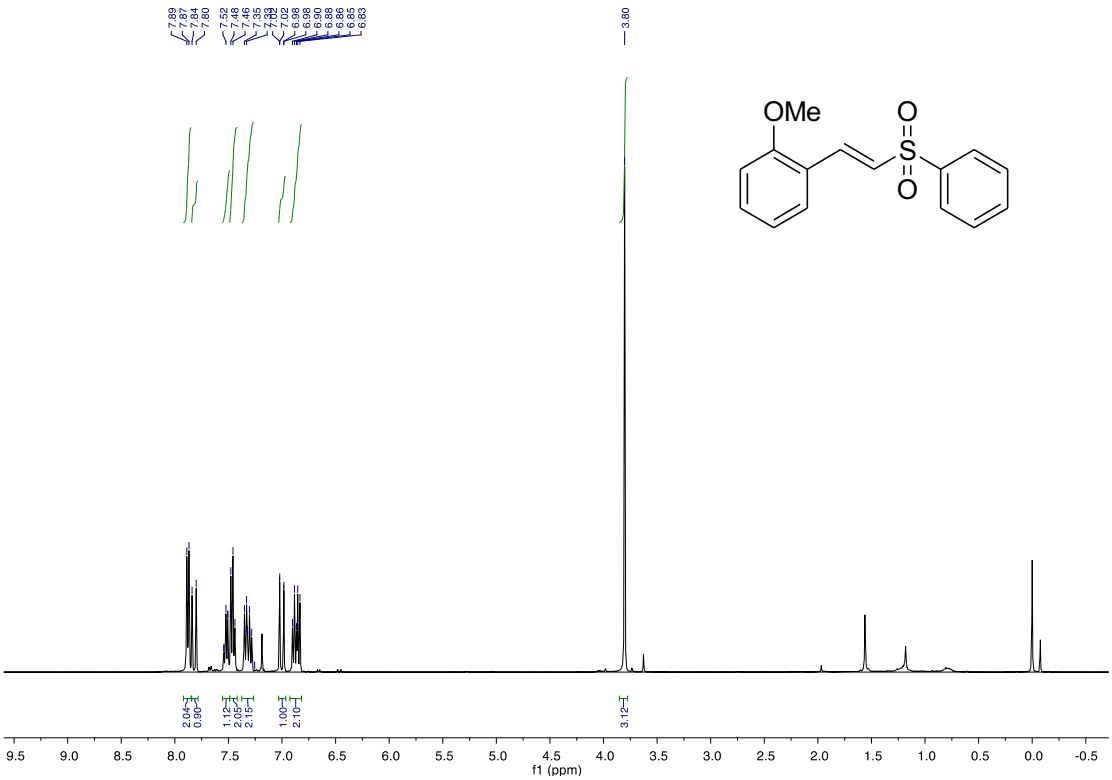
76.01
75.68
O
S
O
O2N
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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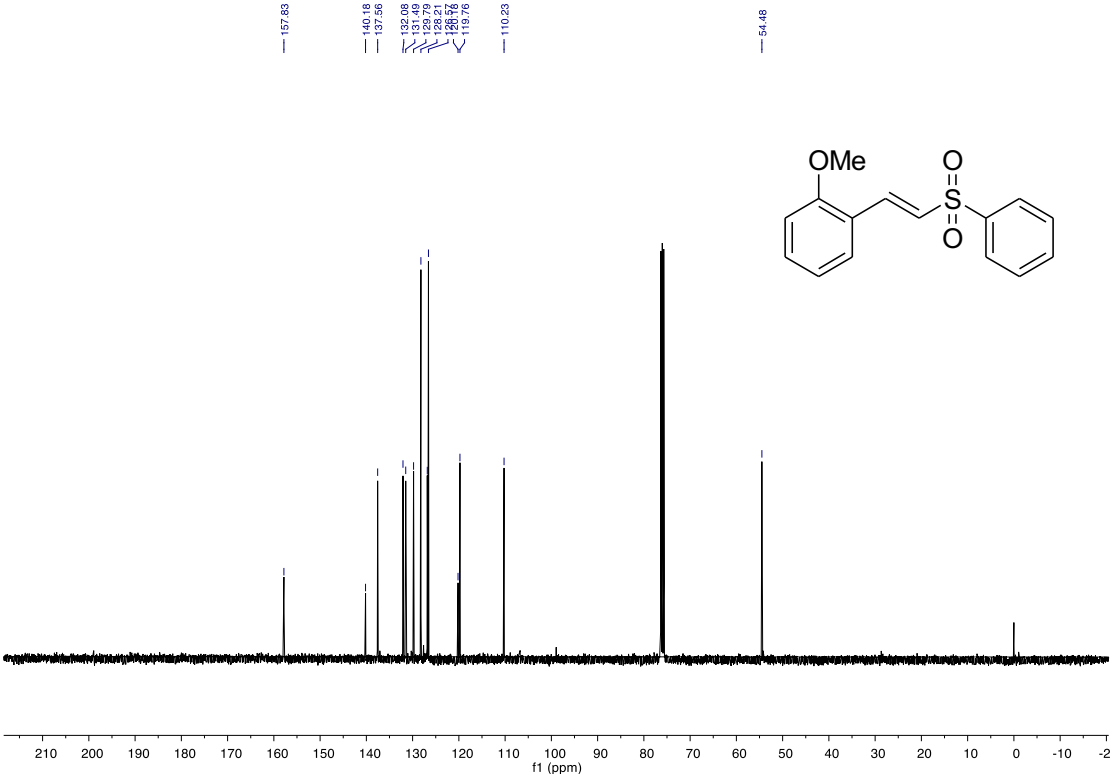
7.87
7.84
7.80
7.52
7.48
7.46
7.35
7.03
7.02
6.98
6.90
6.88
6.86
6.85
6.83
3.80
OMe
O
S
O
2.04
0.90
1.12
2.04
2.15
1.00
2.10
3.12
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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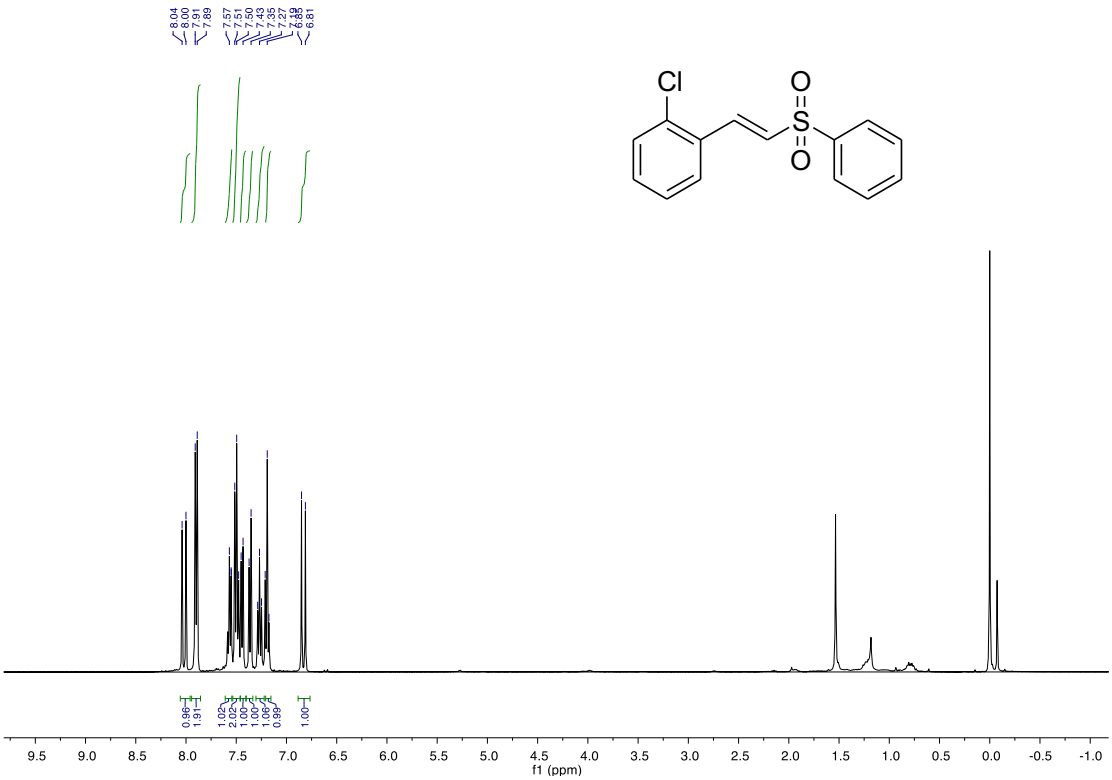
132.08
131.49
129.79
128.21
126.57
126.16
119.76
110.23
54.48
OMe
O
S
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -2
f1 (ppm)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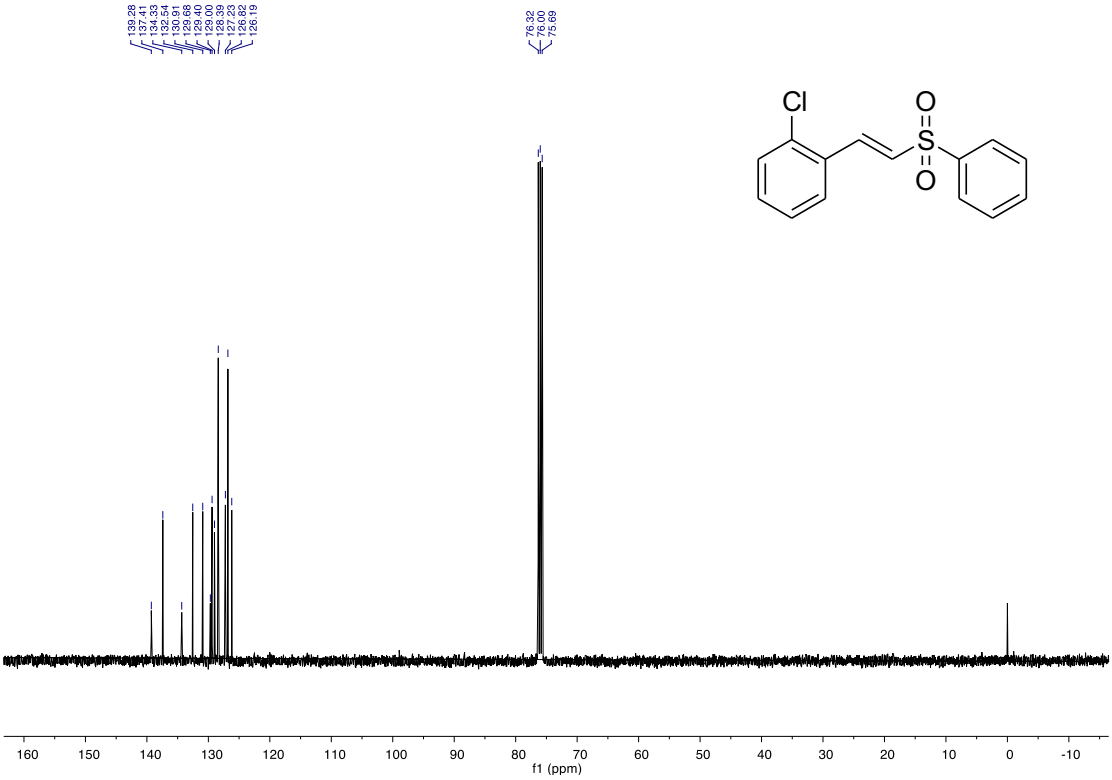
8.00
7.91
7.89
7.57
7.55
7.50
7.43
7.35
7.27
6.88
6.81
Cl
O
S
O
0.96
1.91
1.02
2.02
1.00
1.00
1.00
0.99
1.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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137.41
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129.40
129.00
128.39
127.23
126.82
126.19
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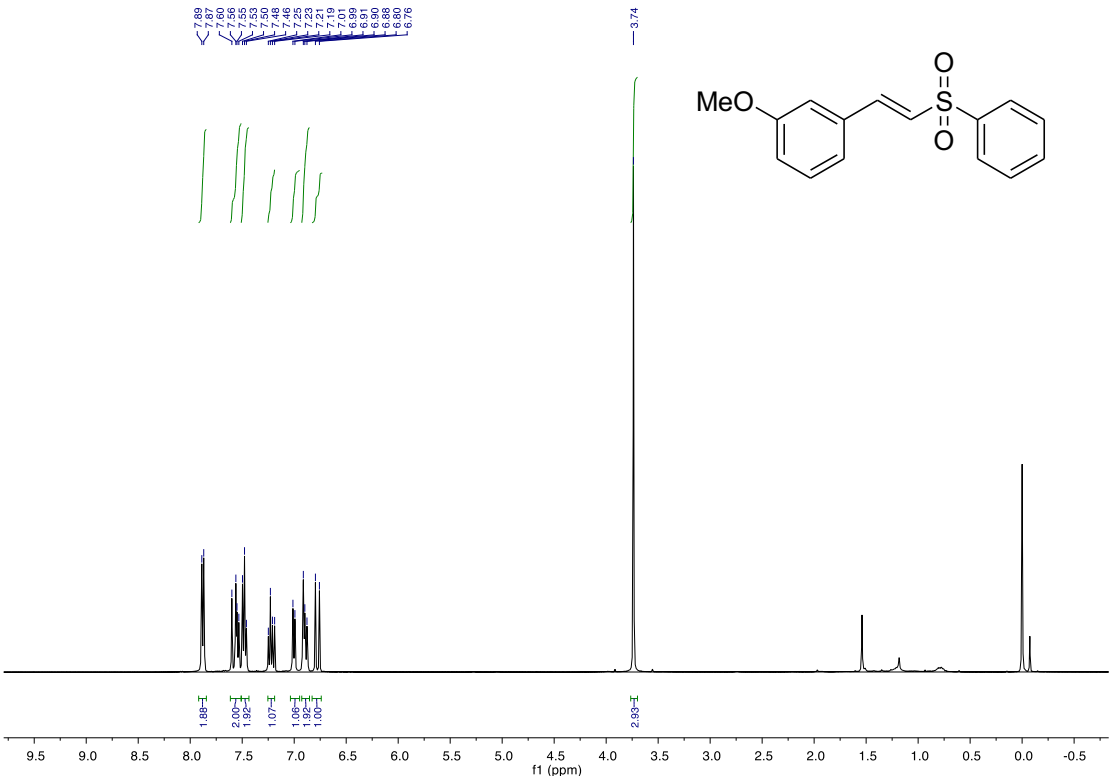
S
O
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.89
7.87
7.60
7.56
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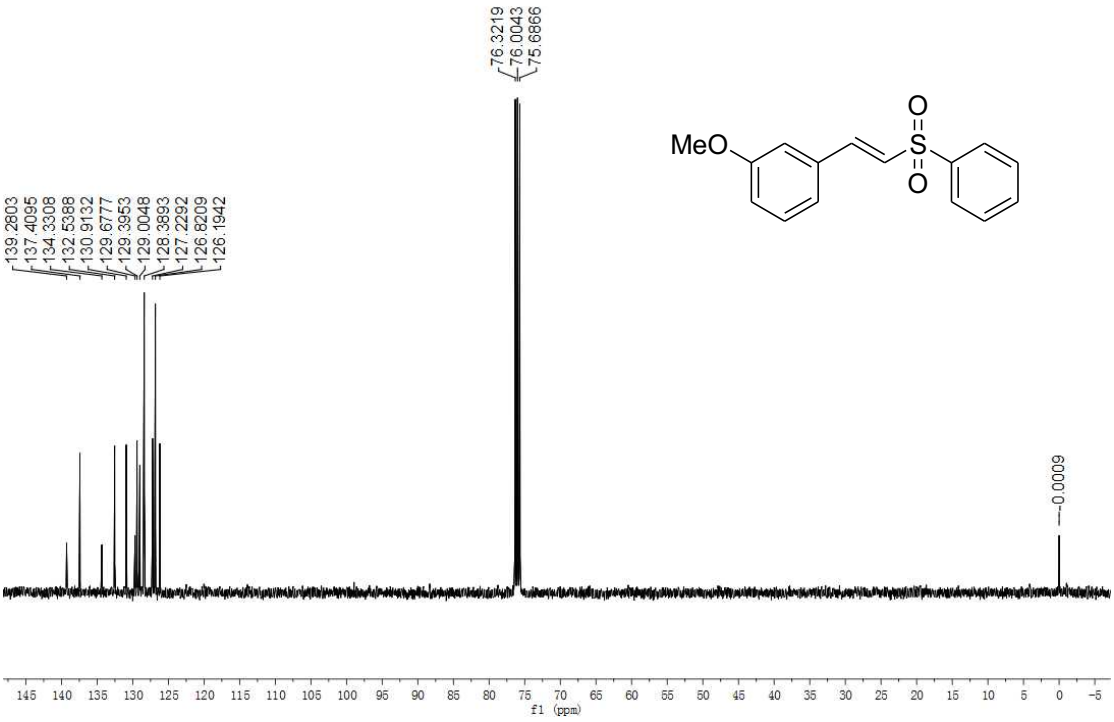
7.53
7.50
7.48
7.46
7.25
7.23
7.21
7.19
7.01
6.99
6.91
6.90
6.88
6.80
6.76
3.74
MeO
O
S
O
1.88
2.00
1.92
1.07
1.06
1.02
1.00
2.99
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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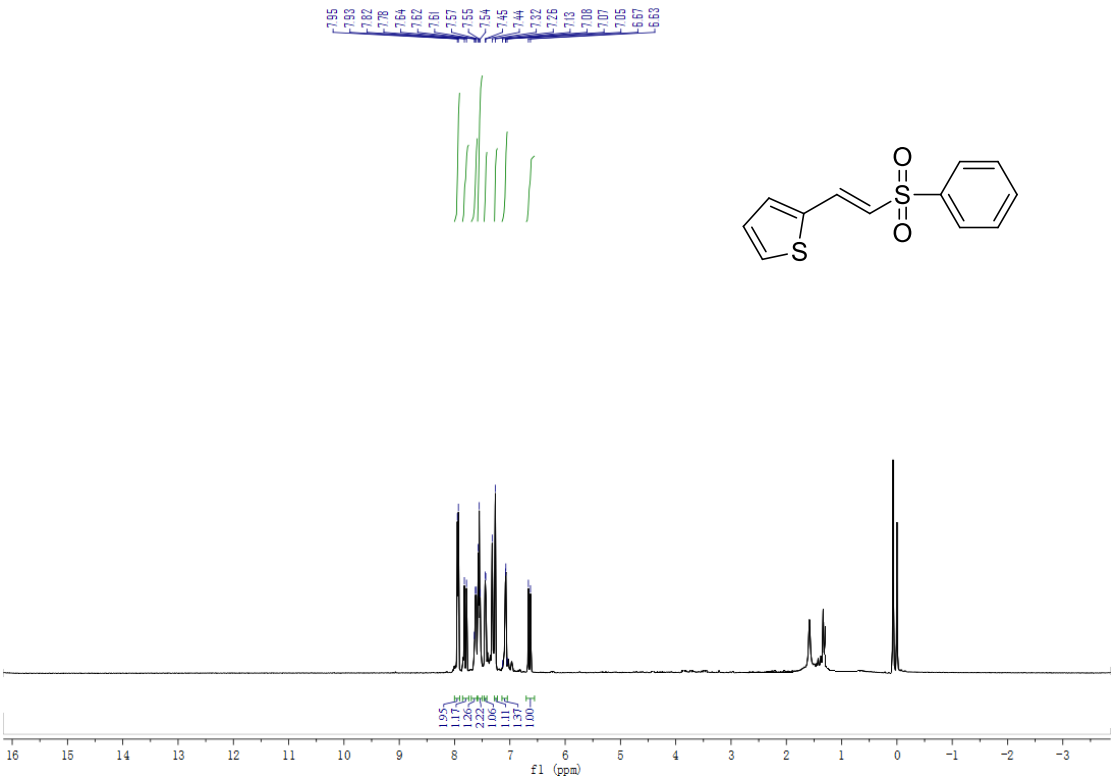
137.4095
134.3308
132.5388
130.9132
129.6777
129.3953
129.0048
128.3893
127.2292
126.8209
126.1942
0.0009
MeO
O
S
O
145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5
f1 (ppm)


7.95
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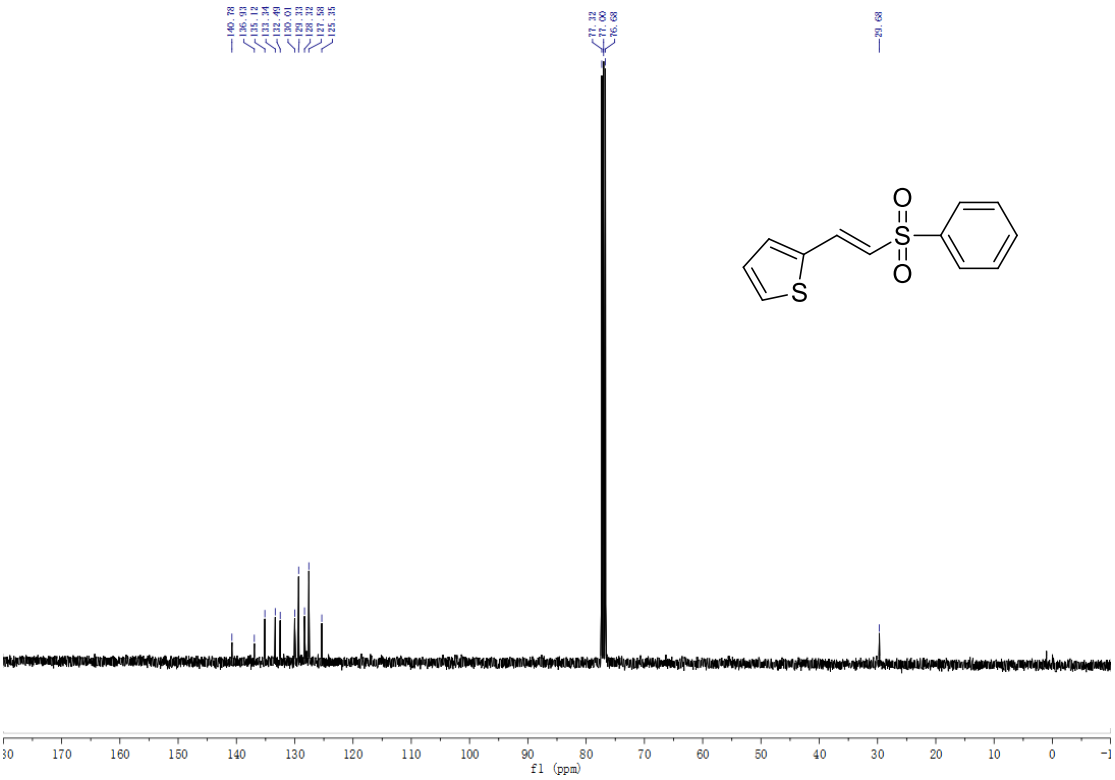
7.57
7.55
7.54
7.45
7.44
7.32
7.26
7.13
7.08
7.07
7.05
6.67
6.63
O
S
O
S
1.95
1.17
1.26
2.22
1.06
1.11
1.57
1.00
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)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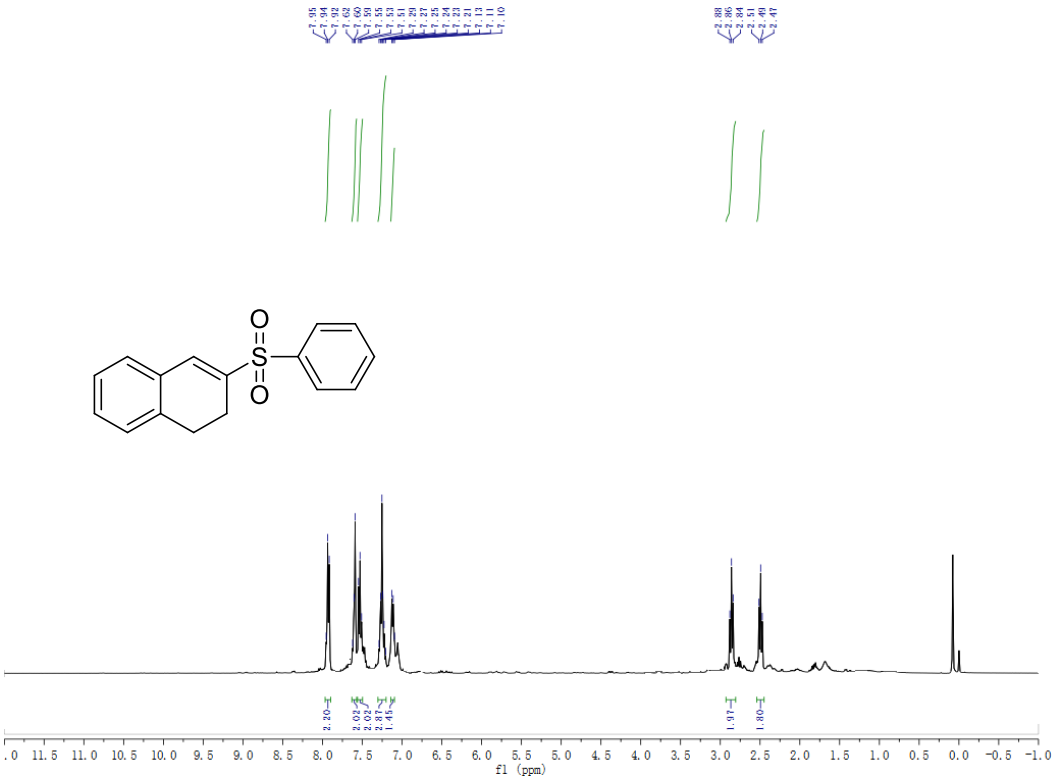
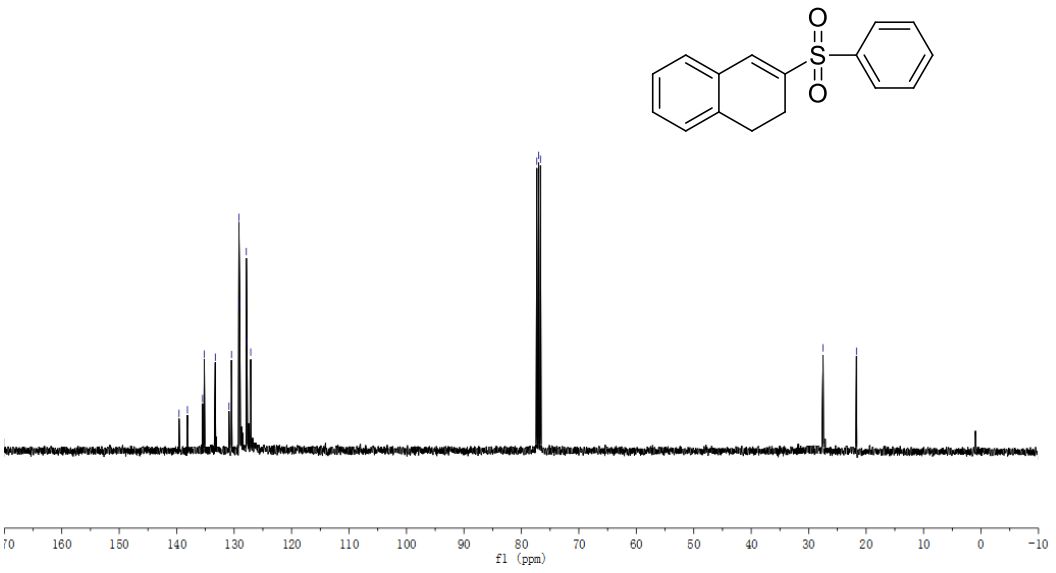
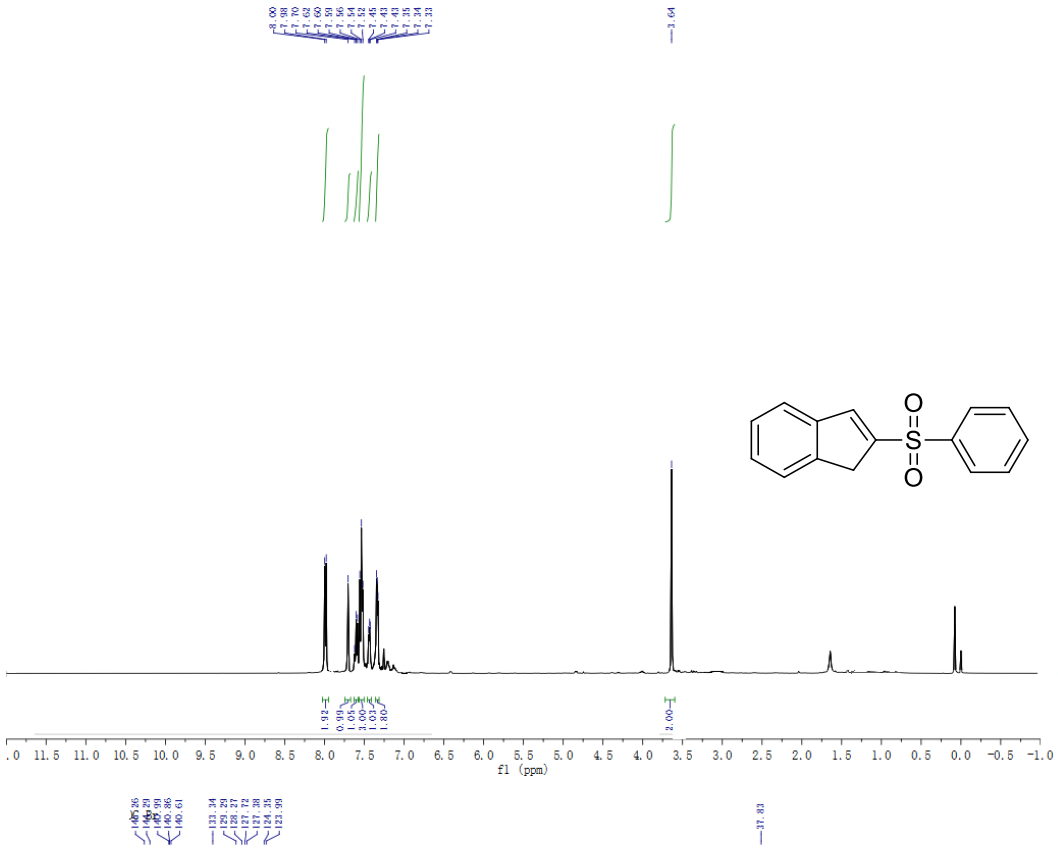
136.93
135.12
133.34
132.49
130.01
129.33
128.32
127.58
125.35
77.32
77.00
76.68
29.68
O
S
O
S
30 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)


f1 (ppm)


f1 (ppm)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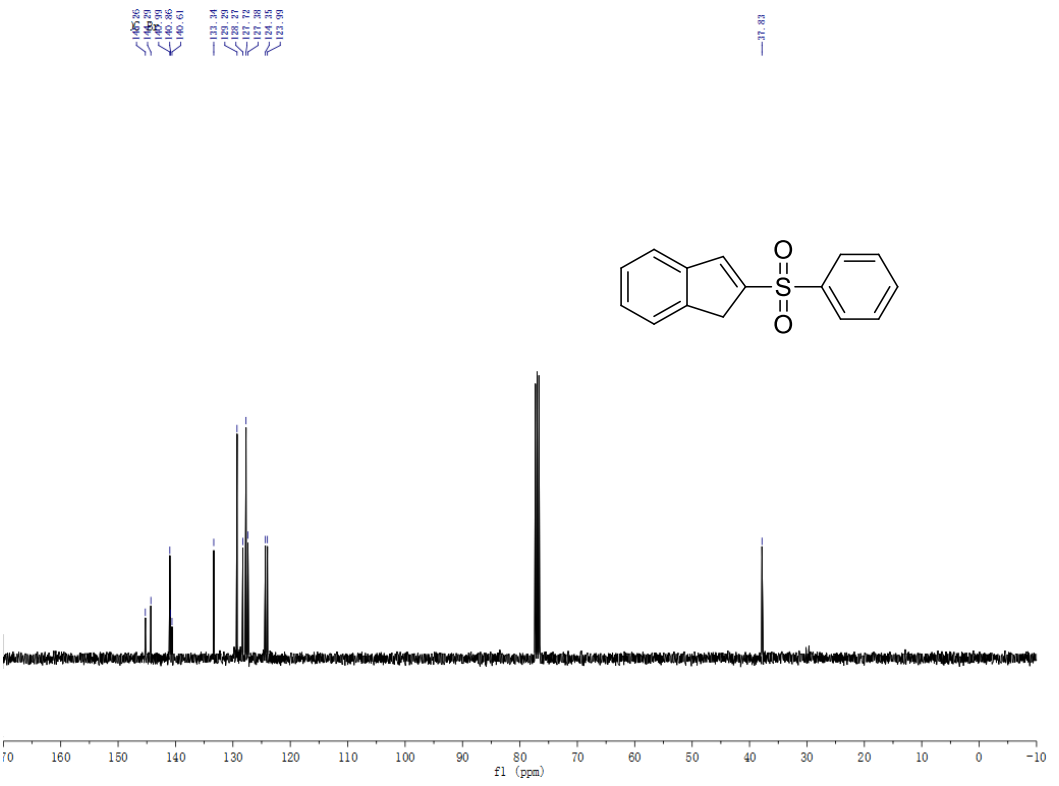
7.68
7.66
7.59
7.56
7.54
7.53
7.45
7.43
7.35
7.34
7.33
3.64
1.92
0.99
1.05
1.00
1.03
1.80
2.06
f1 (ppm)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139.29
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135.35
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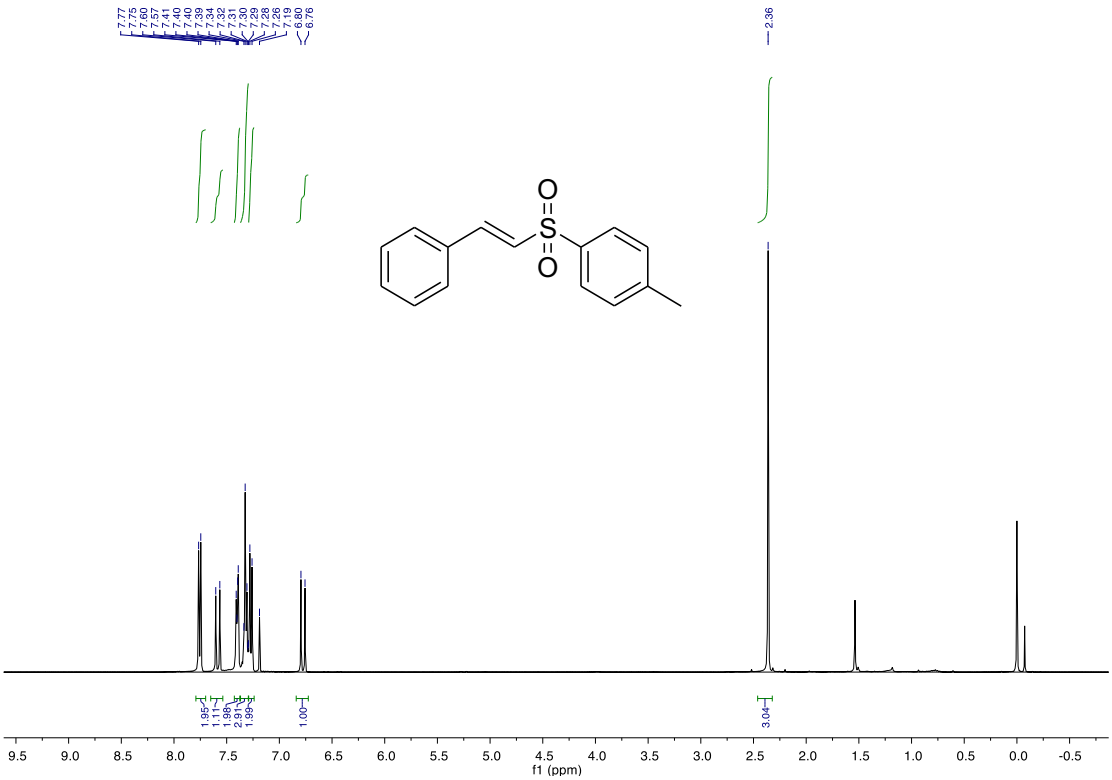
133.34
128.30
128.27
127.72
127.38
124.35
123.99
37.83
f1 (ppm)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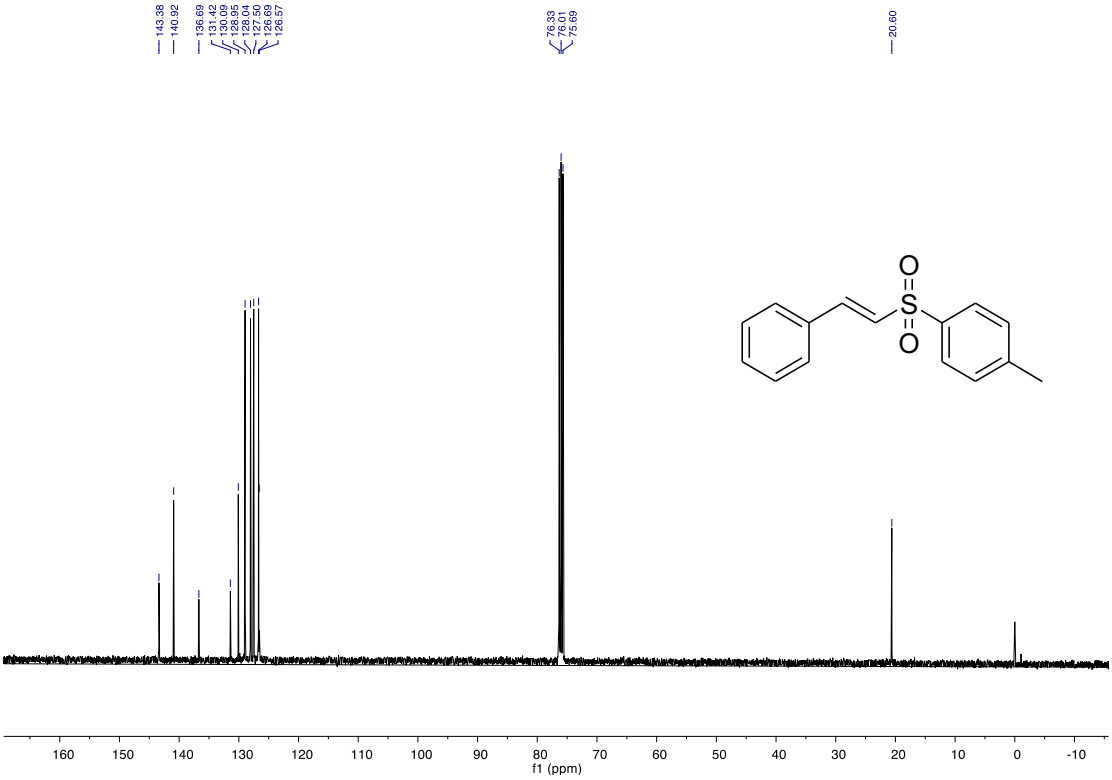
7.40
7.39
7.34
7.32
7.31
7.30
7.29
7.28
7.26
7.19
6.80
6.76
2.36
O
S
O
1.95
1.11
1.96
2.00
1.92
1.00
3.04
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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140.92
136.69
131.42
130.09
128.95
128.04
127.50
126.69
126.57
76.33
76.01
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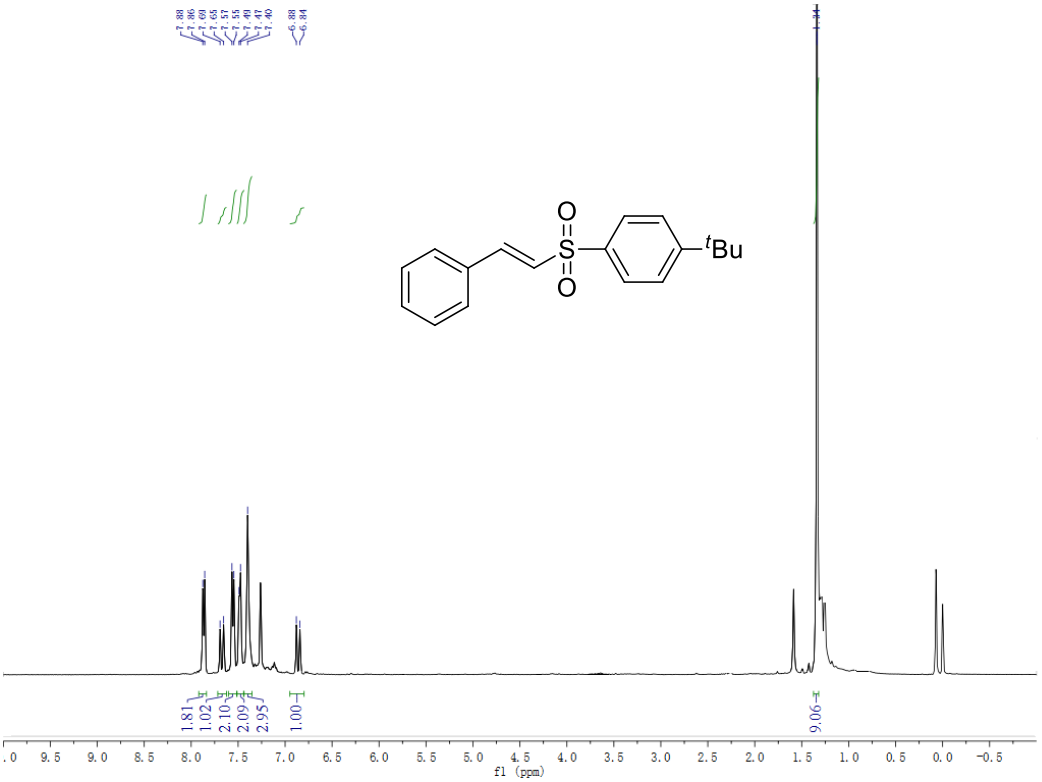
O
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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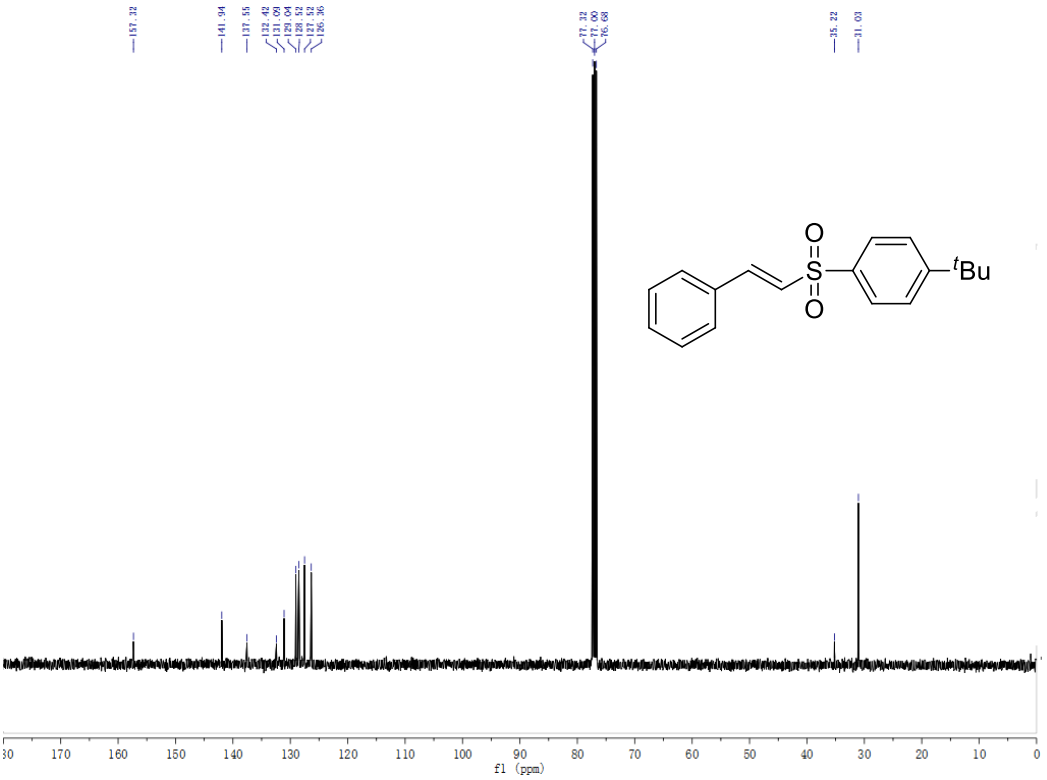
7.86
7.60
7.55
7.57
7.55
7.49
7.47
7.40
6.88
6.84
O
S
O
tBu
1.81
1.02
2.10
2.09
2.95
1.00
9.06
f1 (ppm)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129.04
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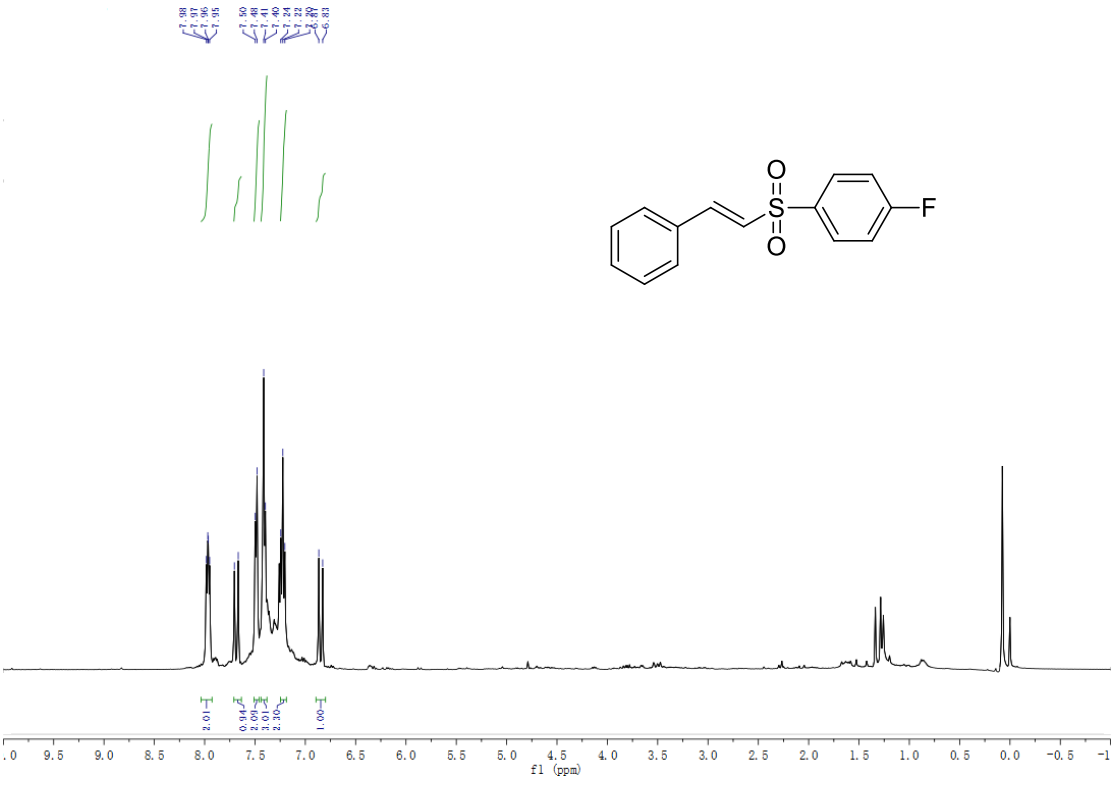
77.32
77.00
76.68
35.22
31.03
O
S
O
tBu
f1 (ppm)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7.97
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7.95
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7.48
7.41
7.40
7.24
7.22
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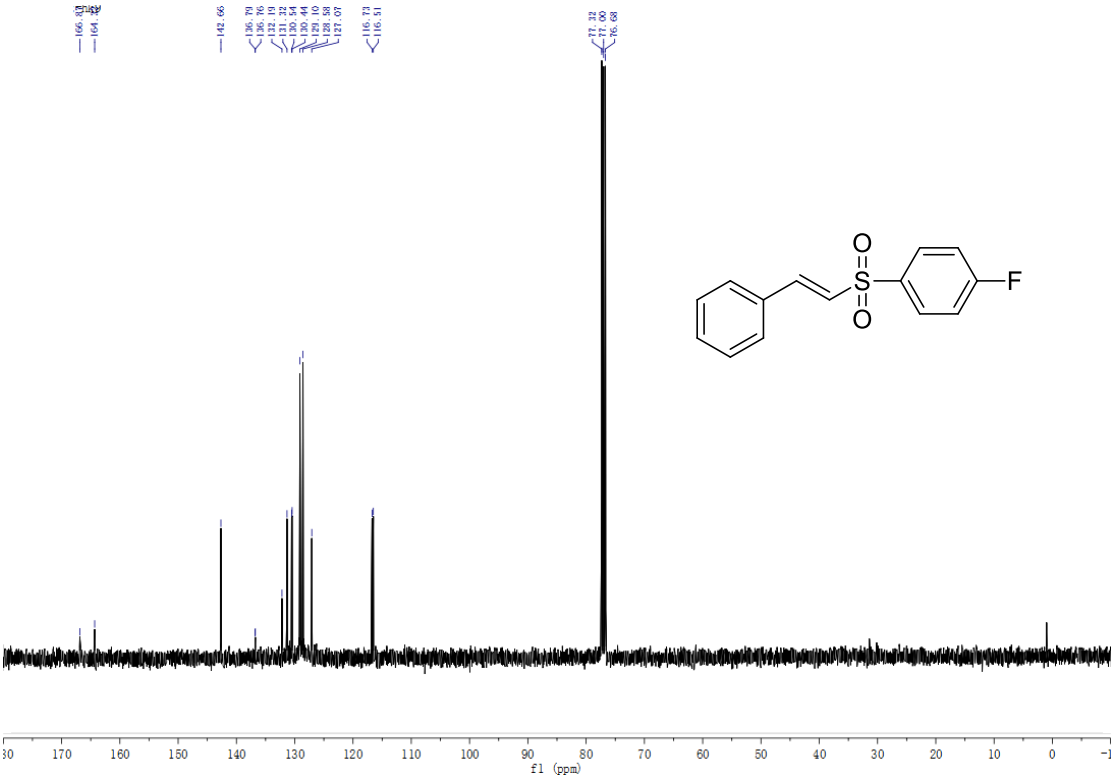
O
S
O
F
2.01
0.94
2.09
2.01
2.30
1.00
f1 (ppm)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131.32
130.54
130.44
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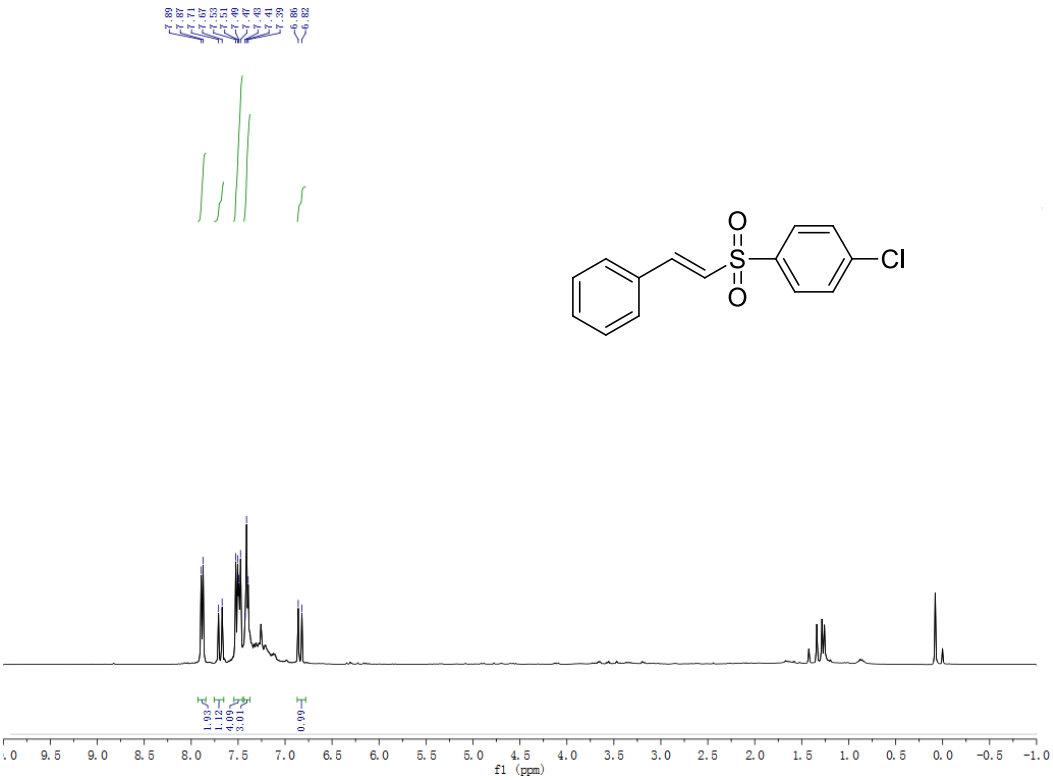
127.07
116.71
116.51
77.32
77.00
76.68
O
S
O
F
f1 (ppm)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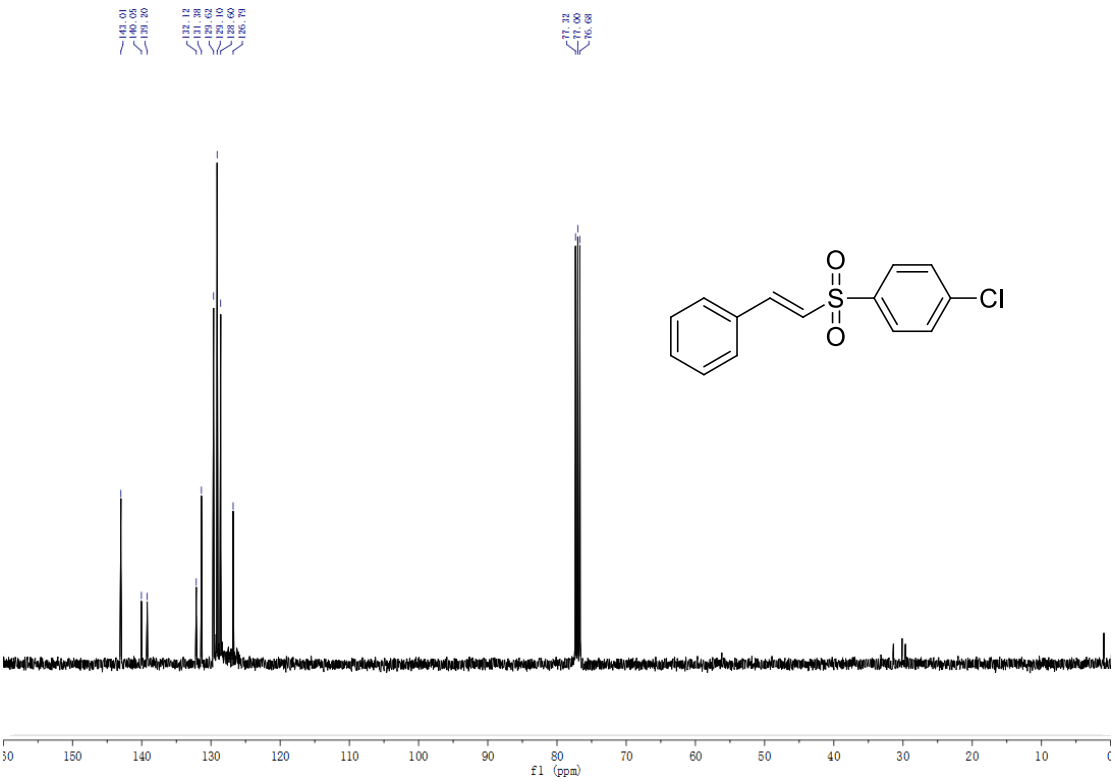
7.53
7.51
7.49
7.47
7.43
7.41
7.39
6.86
6.82
O
S
O
Cl
1.93
1.12
4.09
3.01
0.99
f1 (ppm)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140.05
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132.12
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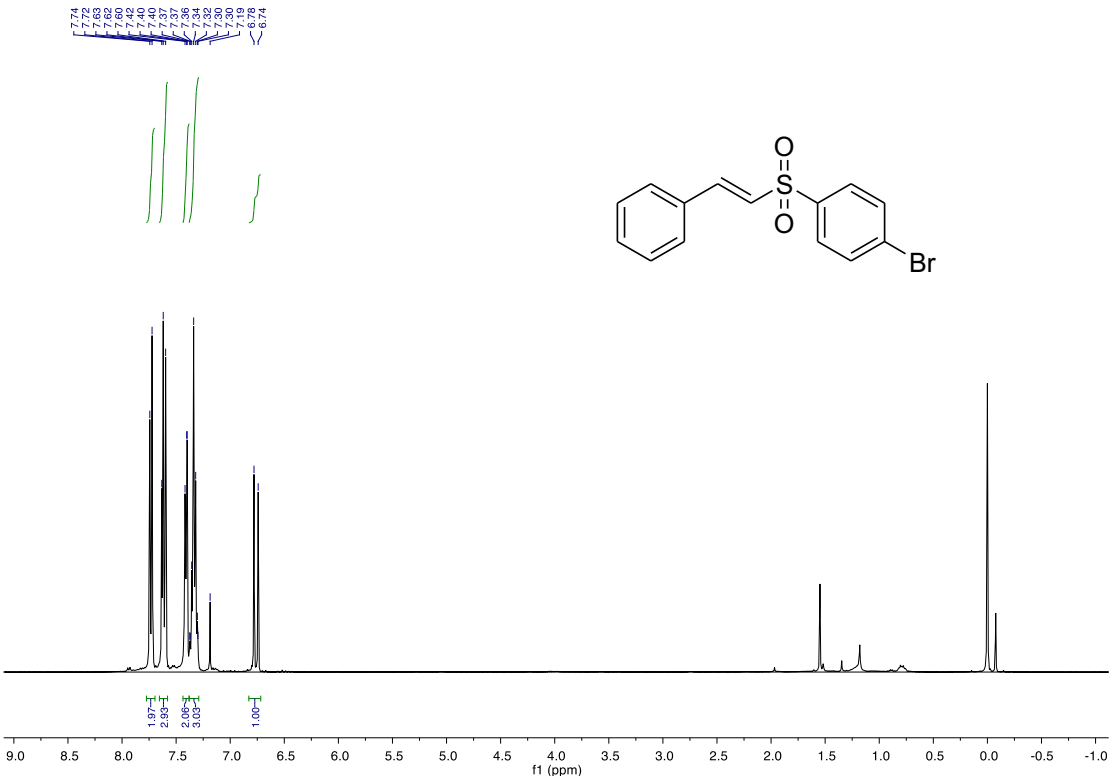
129.10
128.60
126.79
77.32
77.00
76.68
O
S
O
Cl
f1 (ppm)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7.40
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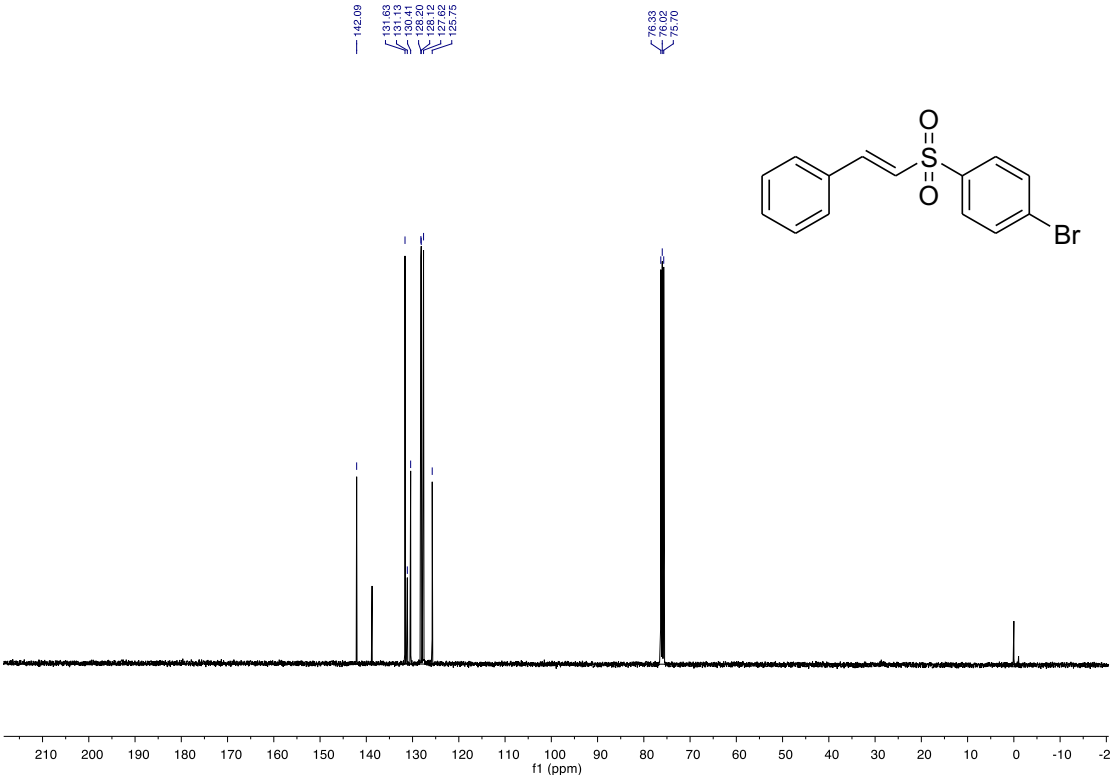
7.37
7.36
7.34
7.32
7.30
7.30
7.19
6.78
6.74
O
S
O
Br
1.97
2.93
2.06
3.03
1.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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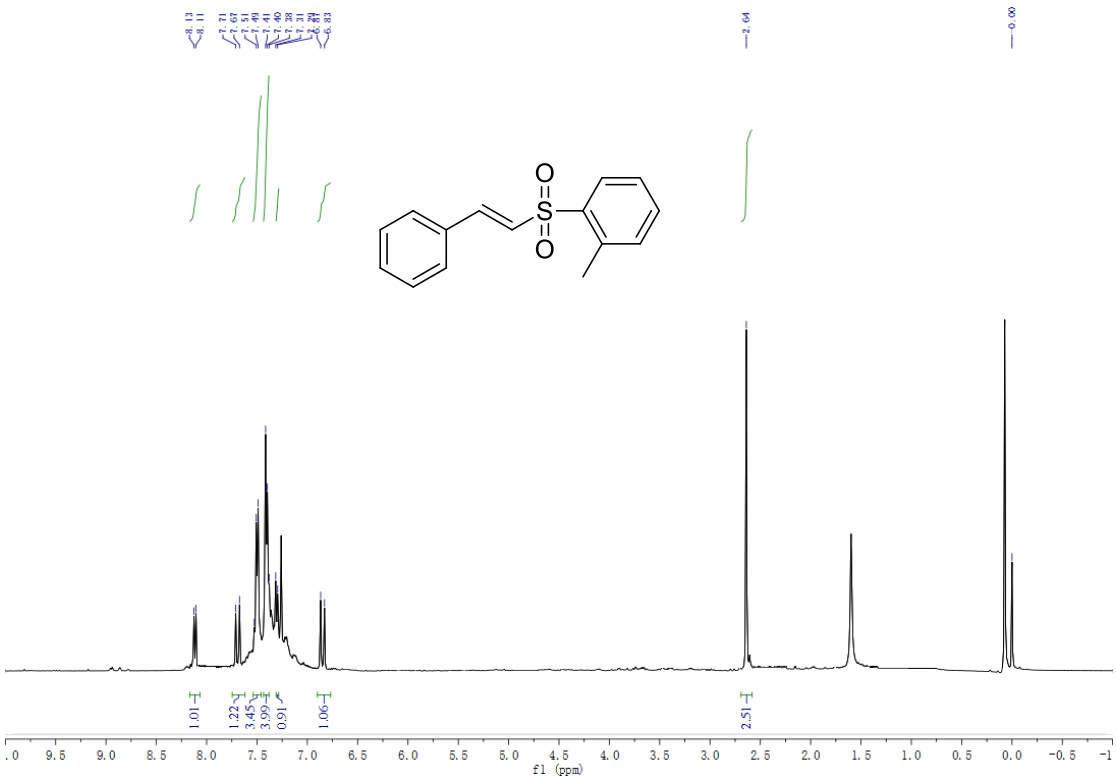
128.12
127.62
125.75
76.33
76.02
75.70
O
S
O
Br
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -2
f1 (ppm)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7.38
7.31
7.29
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0.00
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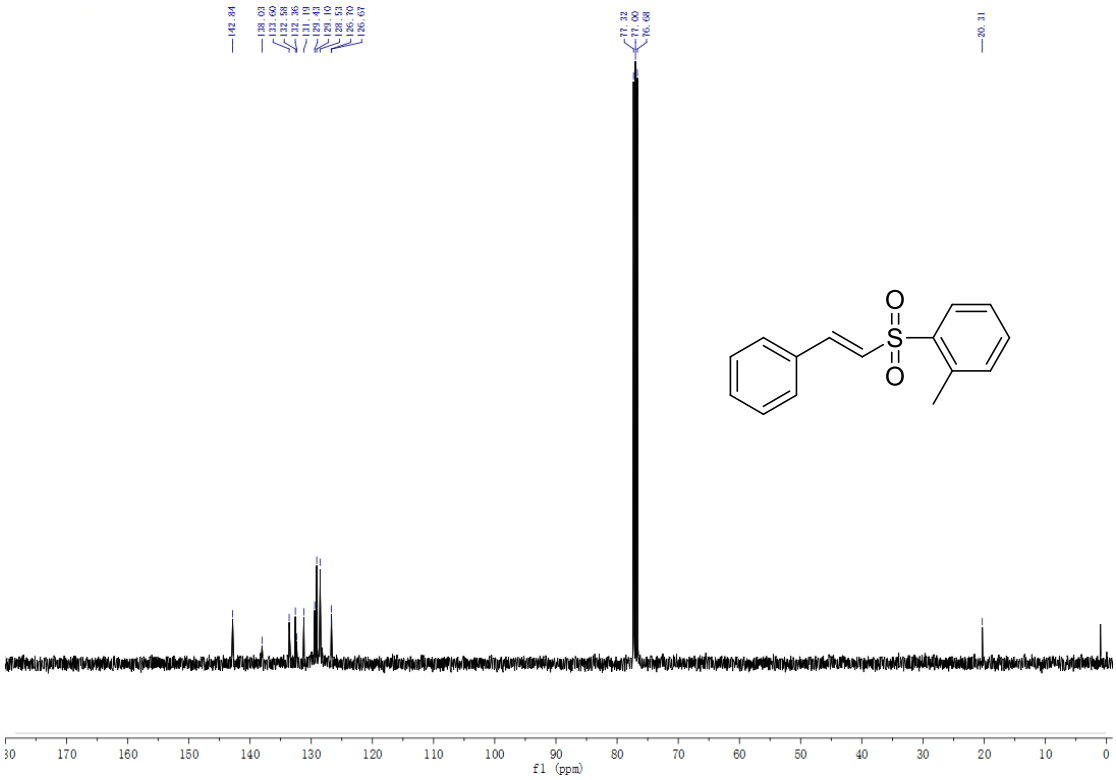
1.22
3.45
3.99
0.91
1.06
2.51
f1 (ppm)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126.67
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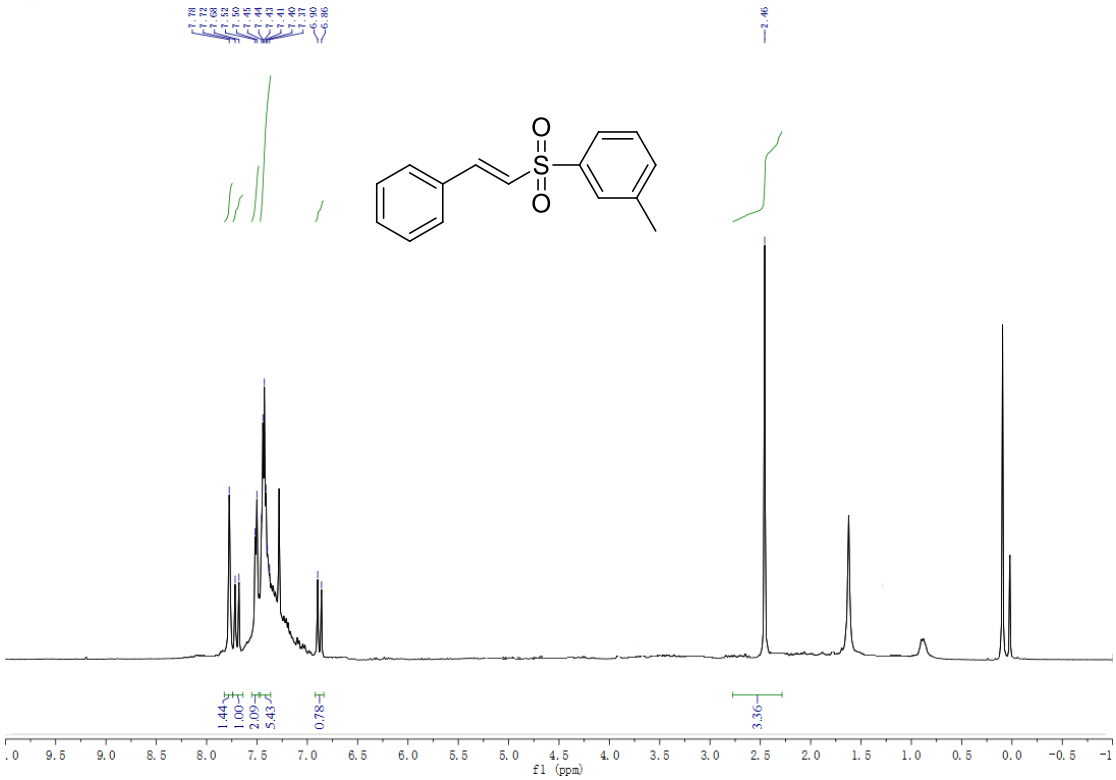
77.00
76.68
20.31
f1 (ppm)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7.43
7.41
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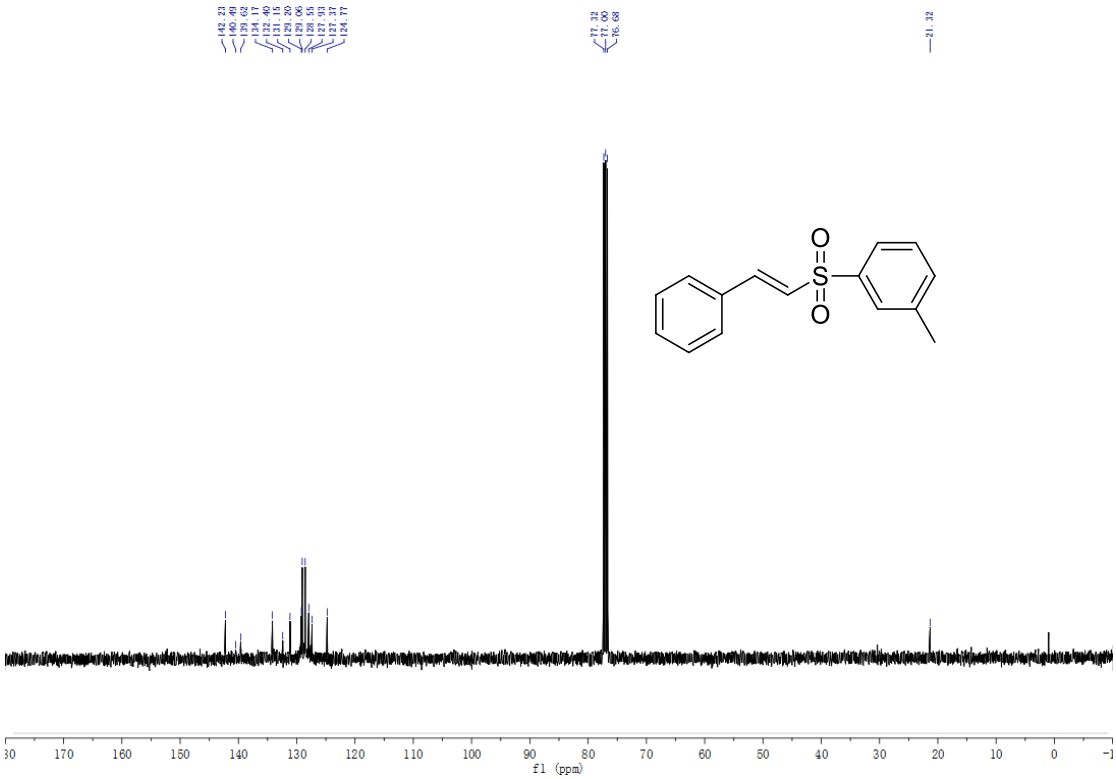
6.86
2.46
1.44
1.00
2.09
5.43
0.78
3.36
f1 (ppm)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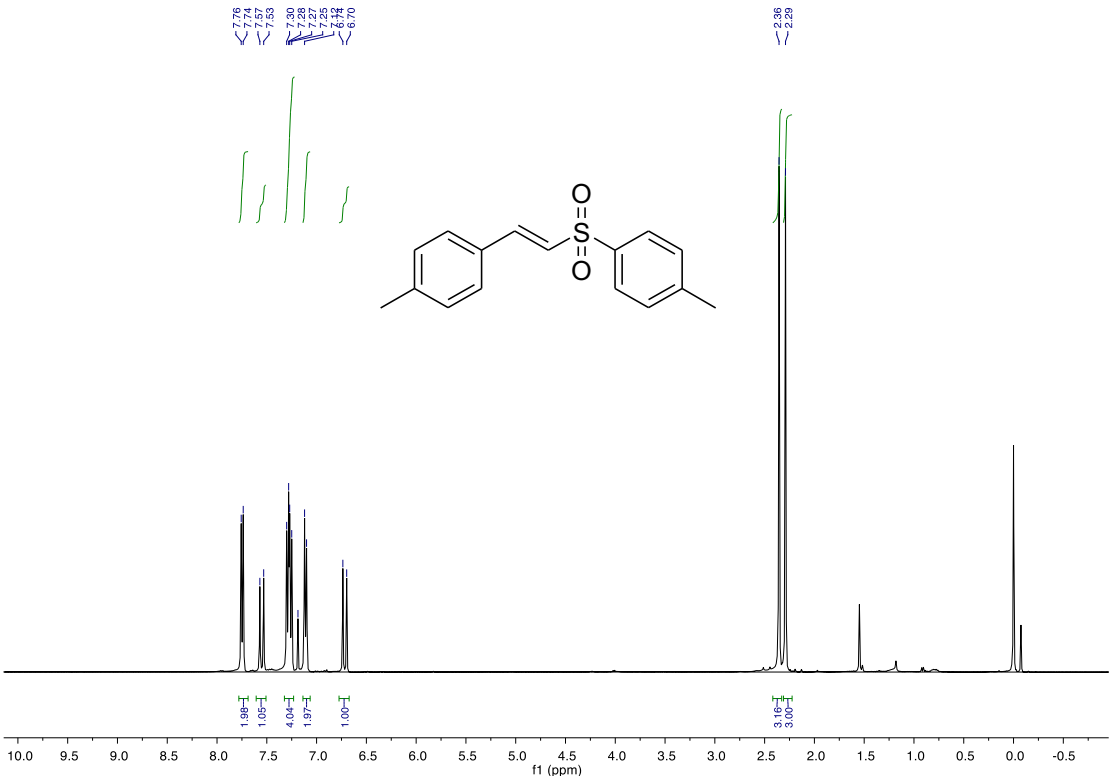
128.55
128.33
127.37
124.77
77.32
77.00
76.68
21.32
f1 (ppm)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7.27
7.25
6.74
6.70
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2.29
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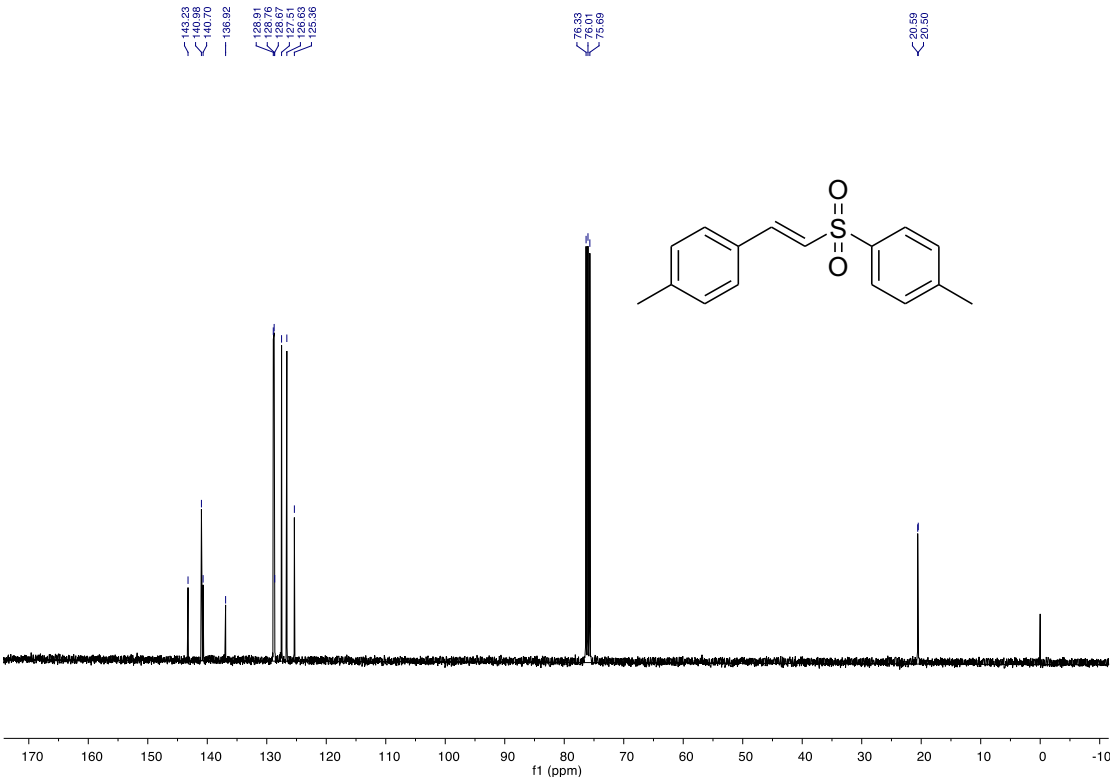
1.97
1.00
3.16
3.00
f1 (ppm)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128.76
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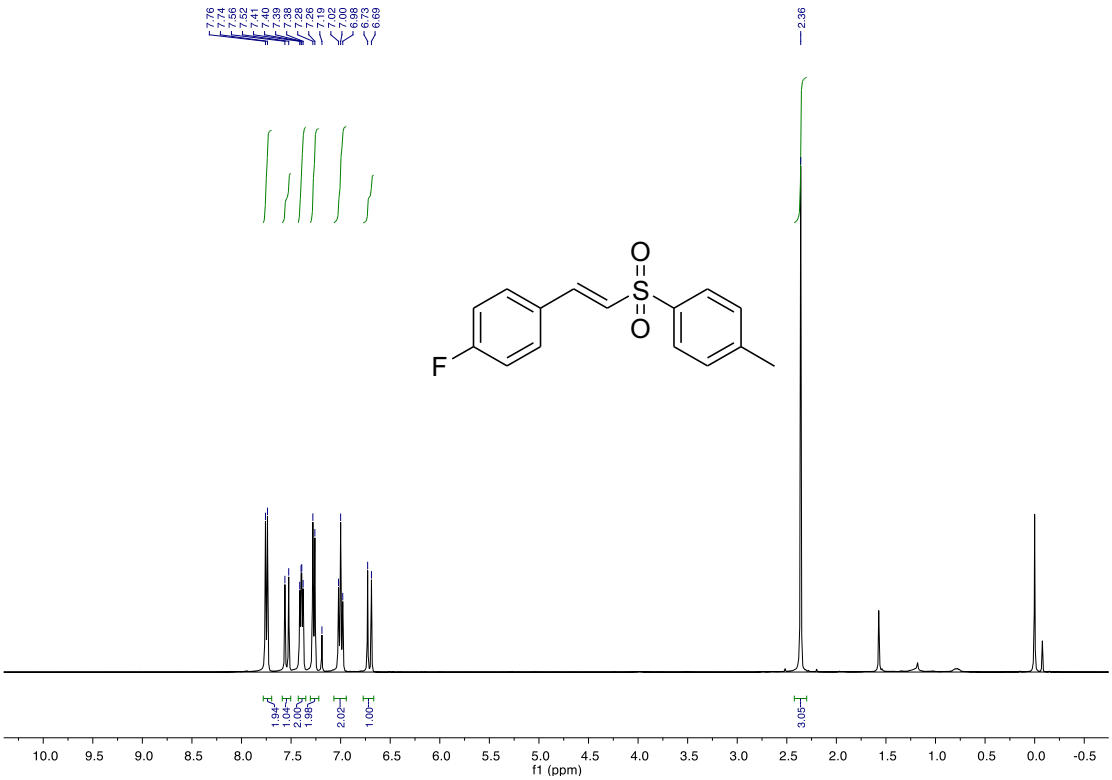
127.51
126.63
125.36
76.33
76.01
75.68
20.59
20.50
f1 (ppm)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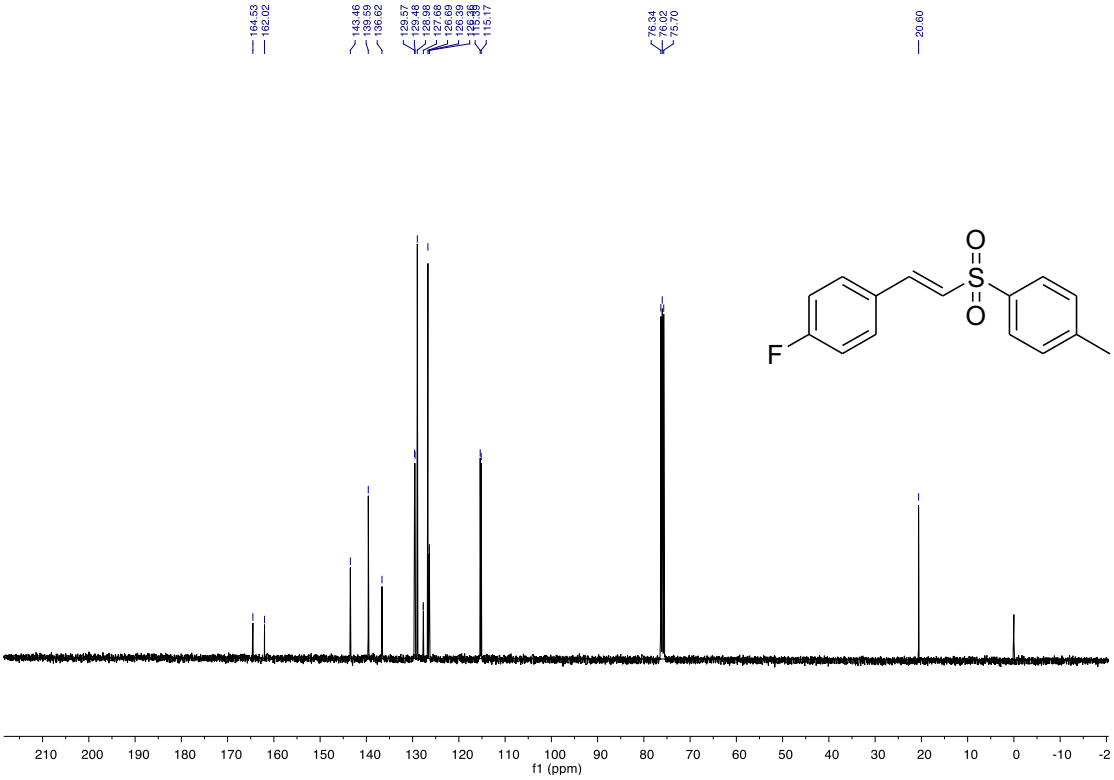
7.28
7.26
7.19
7.02
7.00
6.98
6.73
6.69
2.36
O
S
O
F
1.94
1.04
2.05
1.96
2.02
1.00
3.05
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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126.69
126.39
116.38
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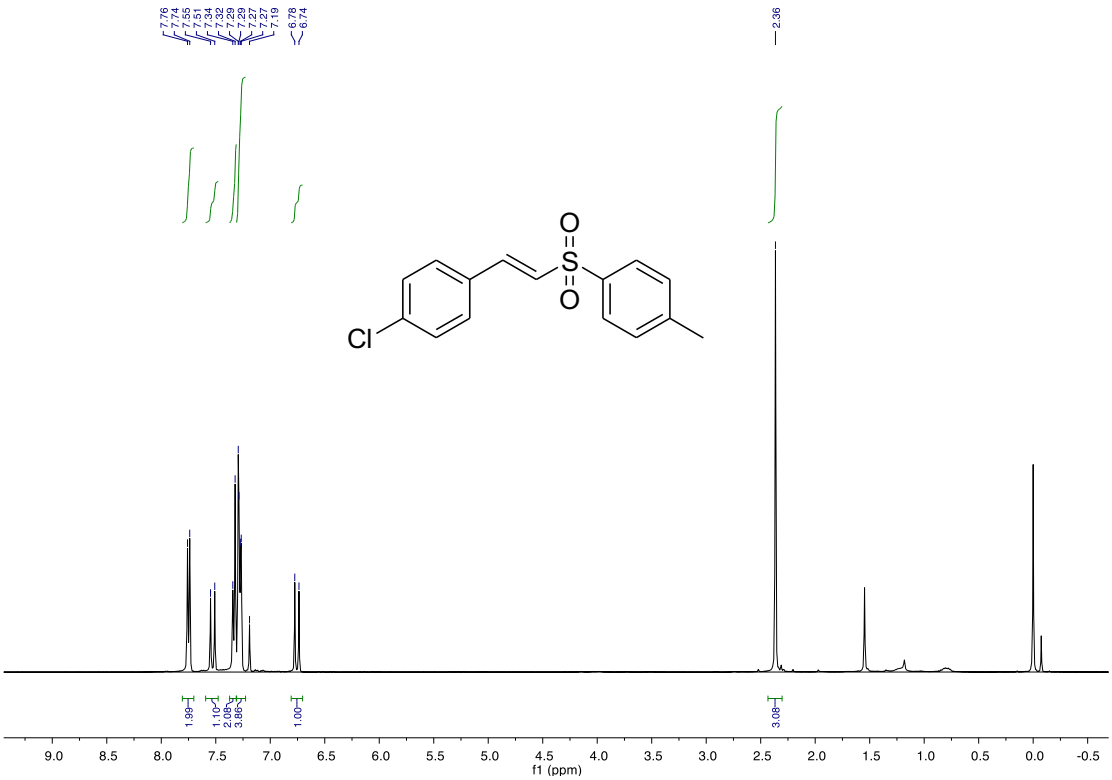
76.34
76.02
75.70
20.60
O
S
O
F
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -2
f1 (ppm)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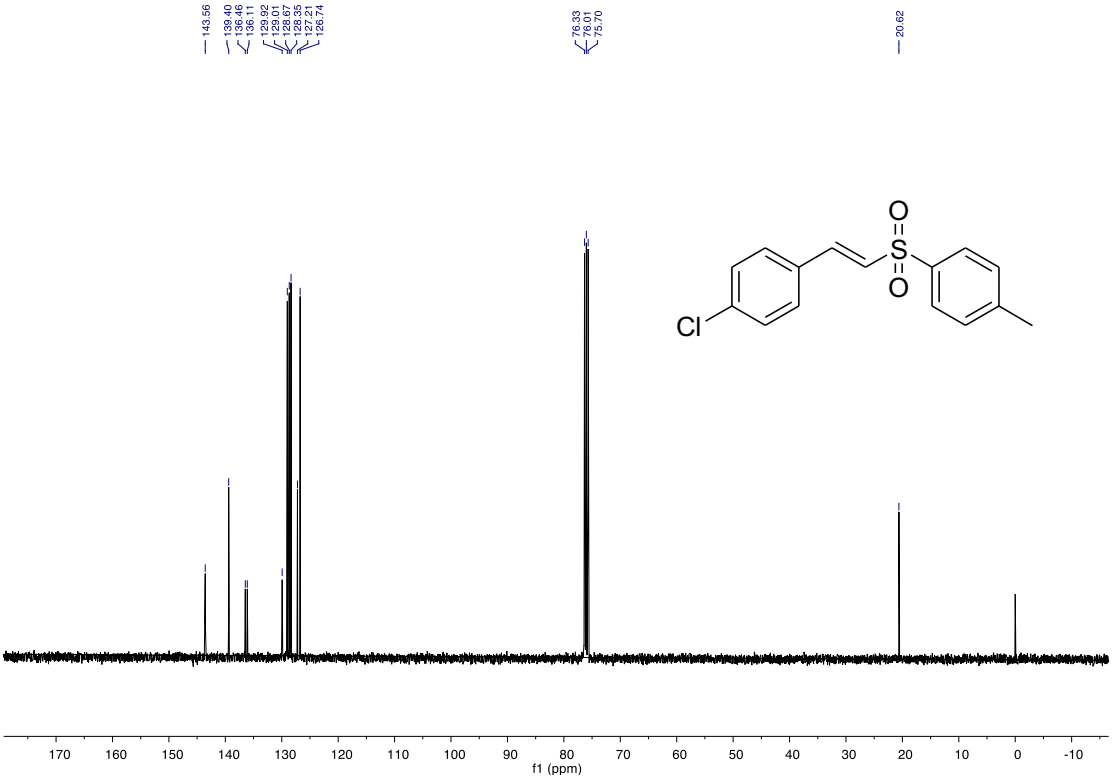
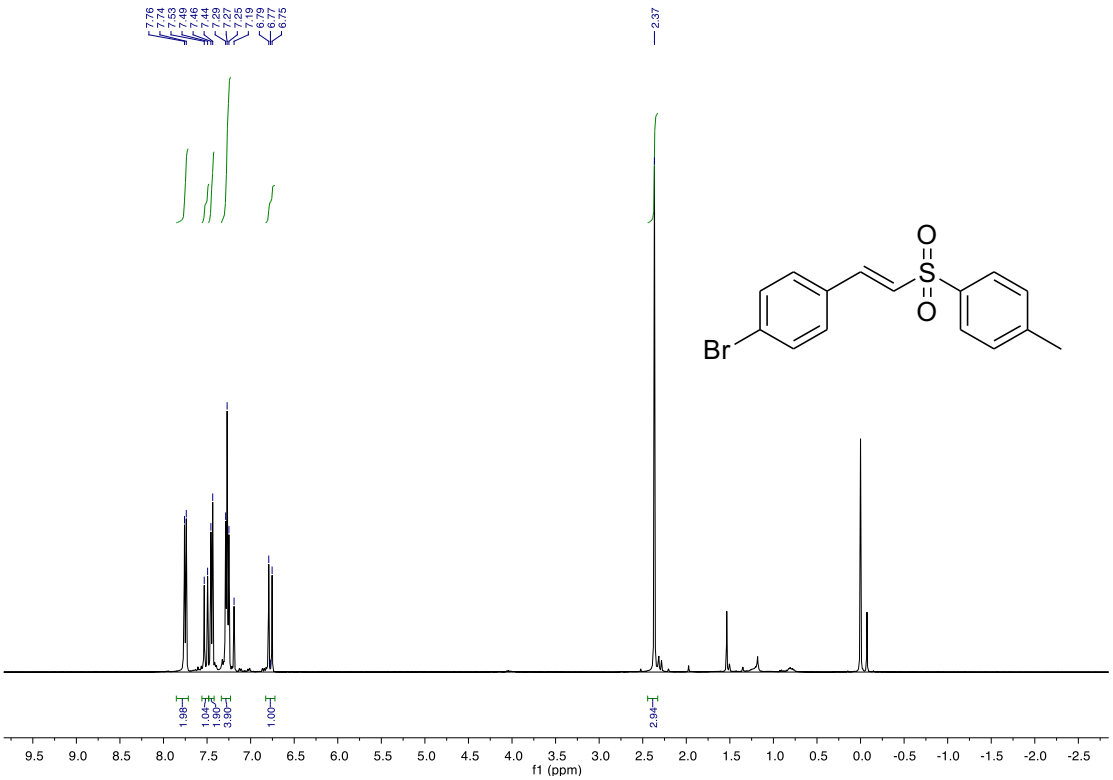
7.74
7.55
7.51
7.34
7.32
7.29
7.29
7.27
7.27
7.19
6.78
6.74
2.36
O
S
O
Cl
1.99
1.10
2.08
3.86
1.00
3.08
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


143.56
139.40
136.46
136.11
129.92
129.01
128.67
128.35
127.21
126.74
78.83
76.01
75.70
20.62
O
S
O
Cl
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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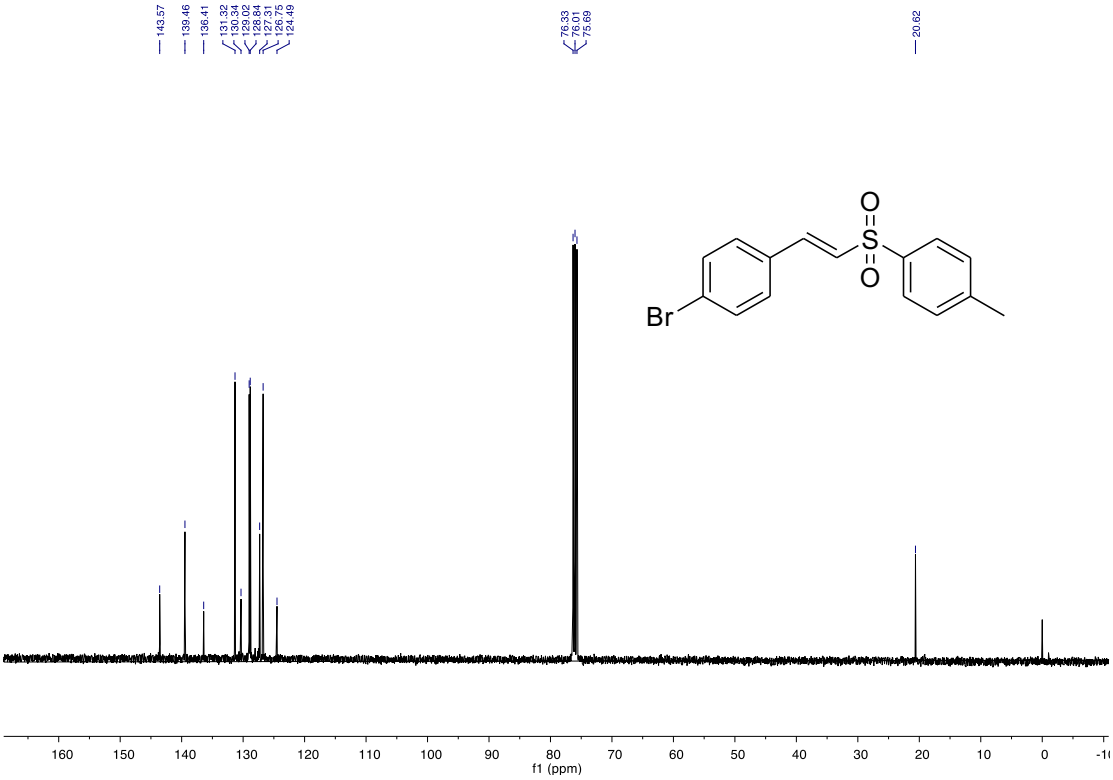
7.74
7.53
7.49
7.46
7.44
7.29
7.27
7.15
7.10
6.79
6.77
6.75
2.37
Br
O
S
O
1.98
1.04
1.90
3.90
1.00
2.94
f1 (ppm)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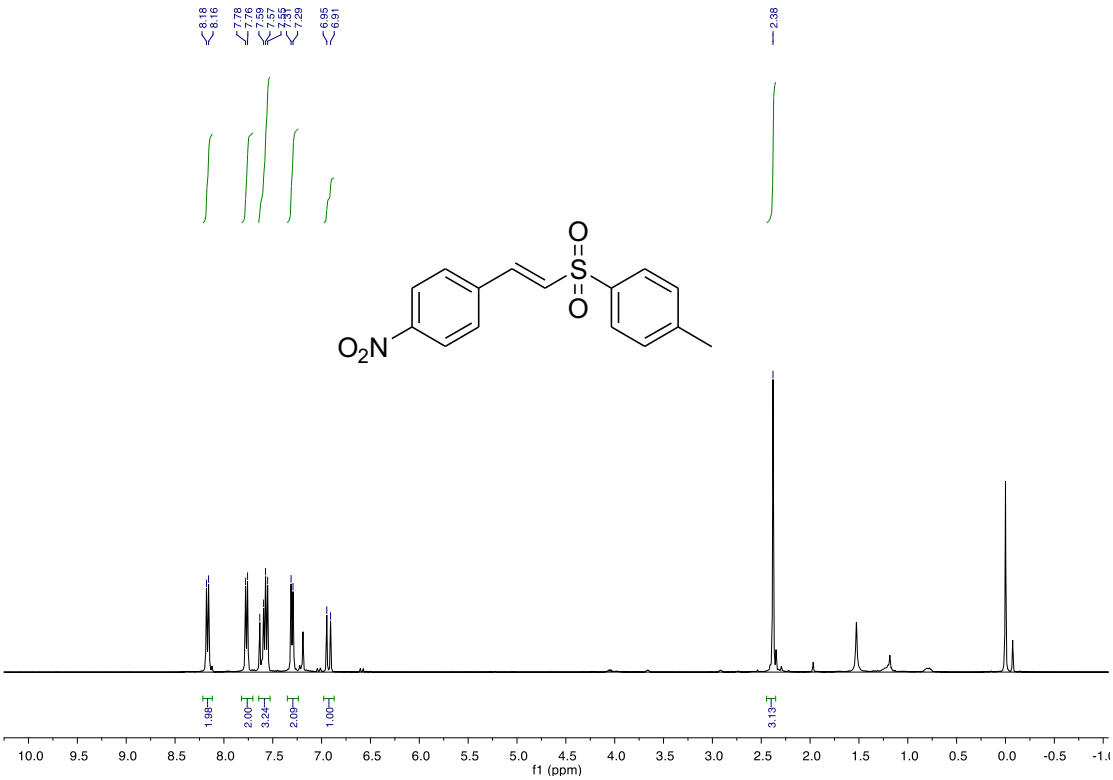
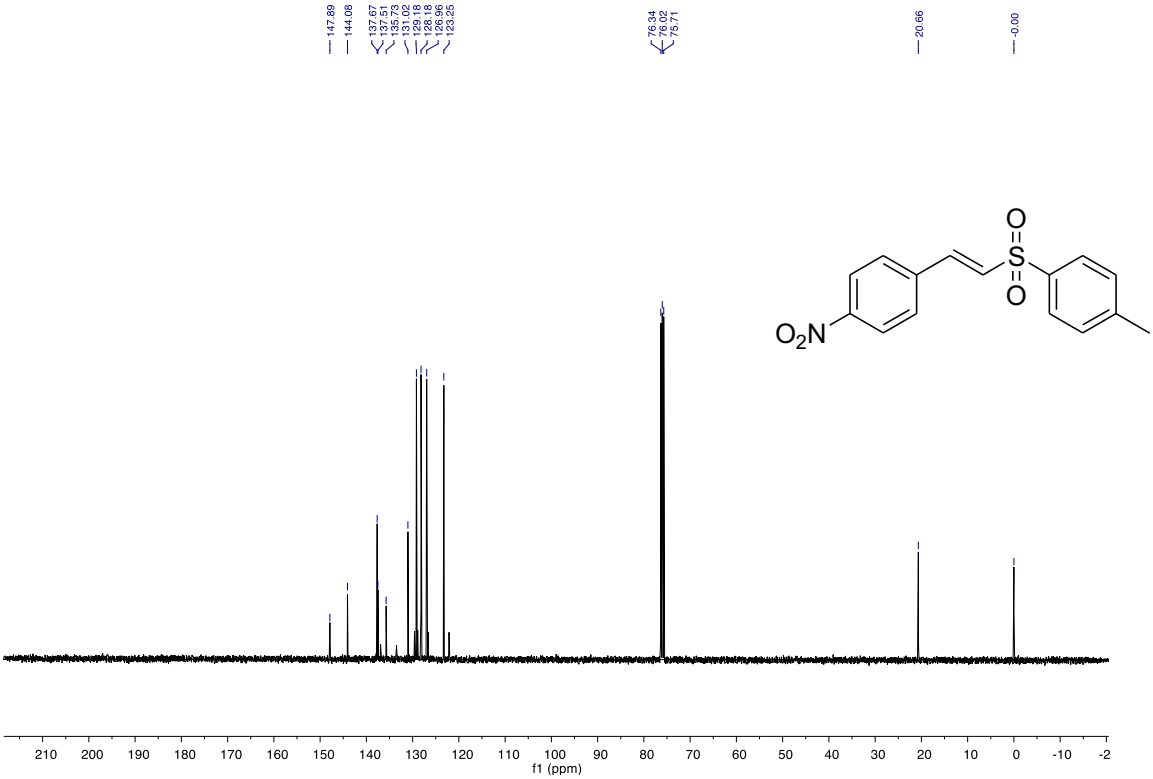
139.46
136.41
131.32
130.34
129.02
128.84
127.31
126.75
124.49
76.33
76.01
75.69
20.62
Br
O
S
O
f1 (ppm)


8.18
8.16
7.78
7.76
7.59
7.57
7.35
7.29
6.95
6.91
2.38
O
S
O
O2N
1.98
2.00
3.24
2.09
1.00
3.13
f1 (ppm)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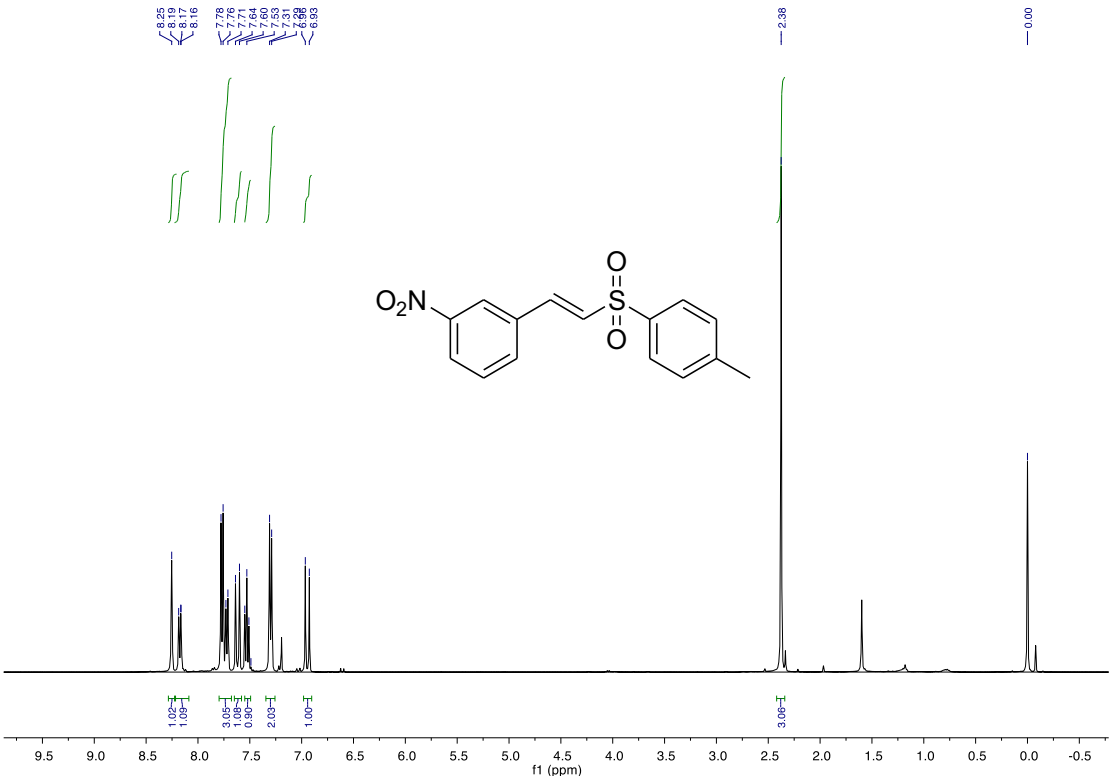
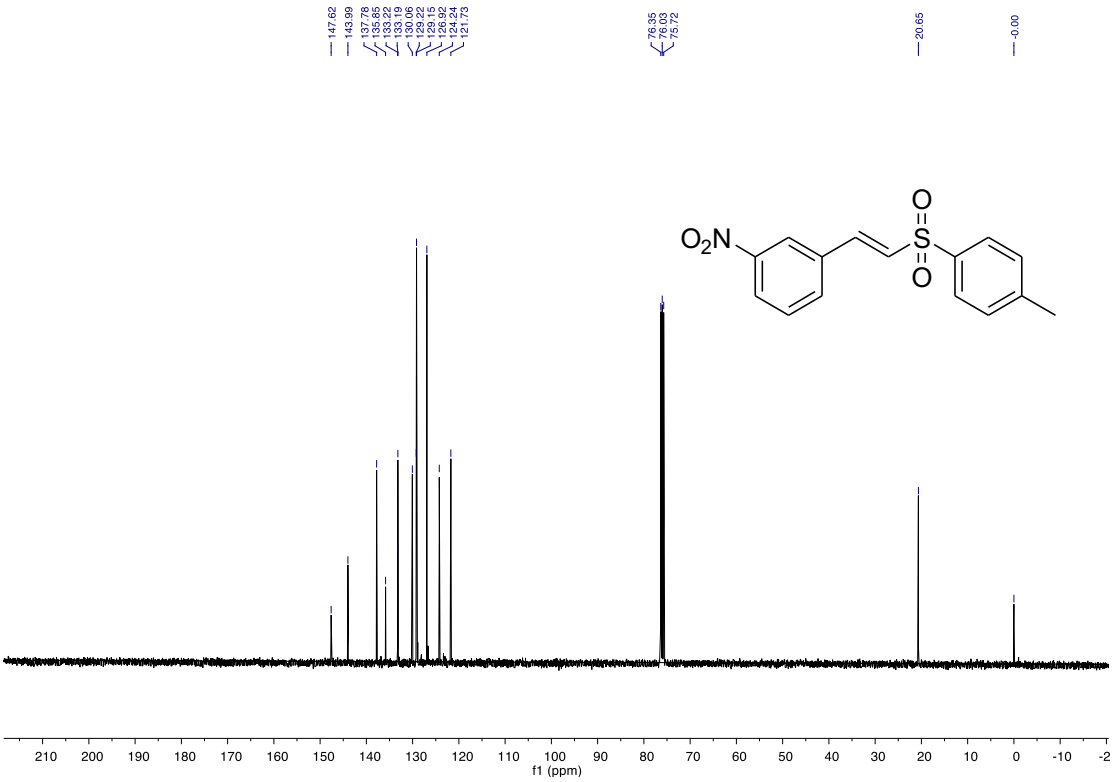
144.08
137.67
137.51
135.73
131.02
129.18
128.18
126.96
123.25
76.34
76.02
75.71
20.66
-0.00
O
S
O
O2N
f1 (ppm)


8.25
8.19
8.17
8.16
7.78
7.76
7.71
7.64
7.60
7.53
7.31
6.98
6.93
2.38
0.00
O2N
O
S
O
1.02
1.09
3.08
1.00
0.90
2.03
1.00
3.06
f1 (ppm)


147.62
143.99
137.78
135.85
133.22
133.19
130.06
129.22
129.15
126.92
124.24
121.73
76.35
76.03
75.72
20.65
-0.00
O2N
O
S
O
f1 (ppm)