Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

Copper-Catalyzed Divergent Oxidative Pathways of 2-Naphthol Derivatives:

ortho-Naphthoquinones *versus* 2-BINOLs

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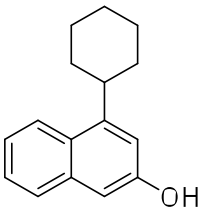
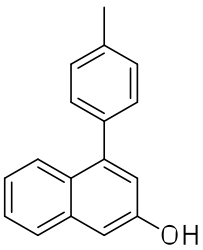
General Methods. The progress of all reactions was monitored by thin-layer chromatography on Dynamic Adsorbent, Inc. precoated silica gel plates (250 μm) and visualized by ultra-violet light or by staining with $KMnO_4$ stain. 2-Naphthol derivatives were prepared by literature method.[1] The ^1H NMR and ^{13}C NMR spectra were obtained on Varian 600 MHz/Bruker 500 MHz Fourier transform spectrometers. Chemical Shifts are reported in units of parts per million downfield from tetramethylsilane and all coupling constants are reported in Hertz. The infrared spectra were obtained using a Thermo Nicolet 6700 IR Spectrometer. Silica gel (32-64u, Dynamic Adsorbent, Inc.) was used for air-flashed chromatography.

Syntheses of 2-Naphthol Derivatives

Syntheses of 4-substituted-2-napthols were previously reported.[1] Additional 2-napthol derivatives (**1d**, **1f**, **1k-n**) were prepared and characterized.

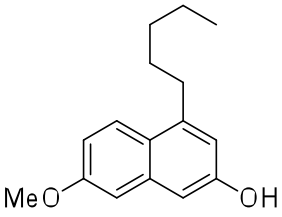


4-Cyclohexylnaphthalen-2-ol (1d) : 348 mg (75%); ^1H NMR ($CDCl_3$, 600 MHz): δ 8.02 (d, 1H, J = 8.5 Hz), 7.66-7.71 (m, 1H), 7.39-7.43 (m, 1H), 7.33-7.37 (m, 1H), 6.99-7.03 (m, 2H), 5.01 (s, 1H), 3.27-3.33 (m, 1H), 1.89-2.05 (m, 4H), 1.81-1.87 (m, 1H), 1.49-1.59 (m, 4H), 1.28-1.38 (m, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 153.1, 146.5, 135.2, 127.3, 126.9, 126.0, 123.3, 123.2, 114.4, 107.5, 39.2, 34.1 (2C), 27.1 (2C), 26.4; IR (neat): 3026, 2957, 2922, 2857, 1660, 1169, 920, 756 cm^{-1}; HRMS-CI m/z 227.1430 [$(MH)^+$; calcd for $C_{16}H_{19}O$: 227.1430].

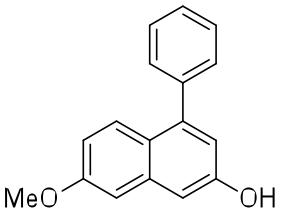


4-(*p*-Tolyl)naphthalen-2-ol (1f): 272 mg (58%); ^1H NMR ($CDCl_3$, 600 MHz): δ 7.80-7.94 (m, 1H), 7.66-7.78 (m, 1H), 7.40-7.47 (m, 1H), 7.35-7.40 (m, 2H), 7.25-7.33 (m, 3H), 7.14-7.18 (m, 1H), 7.06 (d, 1H, J = 2.5 Hz), 5.33 (s, 1H), 2.47 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 152.7, 142.4, 137.1, 137.1, 135.2, 129.7,

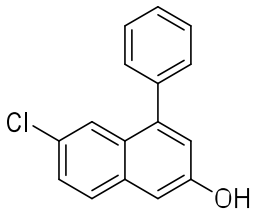
128.9, 127.3, 126.7, 126.4, 126.1, 123.6, 118.6, 108.9, 21.2; IR (neat): 3380, 2922, 2857, 1620, 1583,1509, 1346., 1169, 823, 751 cm^{-1}; HRMS-CI m/z 235.1118 $[(MH)^+$; calcd for $C_{17}H_{15}O$: 235.1117].



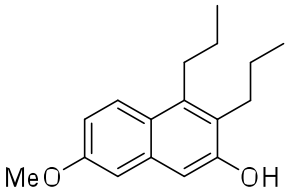
7-Methoxy-4-pentylnaphthalen-2-ol (1k): 381 mg (78%); ^1H NMR ($CDCl_3$, 600 MHz): δ 7.85 (d, 1H, *J* = 9.2 Hz), 7.02 (dd, 1H, *J* = 9.2, 2.6 Hz), 6.98 (d, 1H, *J* = 2.6 Hz), 6.91 (d, 1H, *J* = 2.4 Hz), 6.81 (d, 1H, *J* = 2.6 Hz), 5.25 (s, 1H), 3.90 (s, 3H), 2.92-2.99 (m, 2H), 1.68-1.75 (m, 2H), 1.30-1.43 (m, 4H), 0.90 (t, 3H, *J* = 7.5 HZ); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 157.8, 153.6, 141.6, 136.6, 125.5, 122.8, 115.6, 115.3, 107.1, 105.5, 55.2, 32.9, 31.9, 30.4, 22.5, 14.0; IR (neat): 3310, 2956, 2930, 2852, 1614, 1597, 1245, 1181, 754 cm^{-1}; HRMS-CI m/z 245.1533 $[(MH)^+$; calcd for $C_{16}H_{21}O_2$: 245.1535].



7-Methoxy-4-phenylnaphthalen-2-ol (1l): 330 mg (66%); ^1H NMR ($CDCl_3$, 600 MHz): δ 7.62-7.74 (m, 1H), 7.38-7.51 (m, 5H), 7.00-7.10 (m, 2H), 6.88-6.97 (m, 2H), 5.24 (s, 1H), 3.91 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 158.1, 153.3, 142.3, 140.2, 136.6, 129.8, 128.2, 127.6, 127.4, 122.6, 116.2, 116.1, 108.4, 105.0, 55.2; IR (neat): 3392, 3056, 3020, 2935, 1624, 1514, 1224, 1035, 862, 758 cm^{-1}; HRMS-CI m/z 251.1067 $[(MH)^+$; calcd for $C_{17}H_{15}O_2$: 251.1066].



6-Chloro-4-phenylnaphthalen-2-ol (1m): 280 mg (55%); ^1H NMR ($CDCl_3$, 600 MHz): δ 7.68-7.74 (m, 2H), 7.46-7.51 (m, 2H), 7.42-7.47 (m, 3H), 7.20 (dd, 1H, *J* = 9.2, 2.5 Hz), 7.08 (d, 1H, *J* = 2.5 Hz), 7.05 (d, 1H, *J* = 2.5 Hz), 5.24 (s, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 153.5, 142.6, 139.5, 132.4, 129.7, 128.3, 127.8, 127.7, 125.6, 125.3(2), 125.3(0), 124.5, 118.8, 108.3; IR (neat): 3324, 3021, 2859, 1624, 1392, 1166., 821, 701 cm^{-1}; HRMS-CI m/z 255.0587 $[(MH)^+$; calcd for $C_{16}H_{12}ClO$: 255.0570].



7-Methoxy-3,4-dipropylnaphthalen-2-ol (1n): 440 mg (85%); ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.78-7.83 (m, 1H), 6.99 (dd, 1H, *J* = 9.2, 2.7 Hz), 6.93 (d, 1H, *J* = 2.7 Hz), 6.89 (s, 1H), 4.96 (s, 1H), 3.89 (s, 3H), 2.89-3.09 (m, 2H), 2.59-2.89 (m, 2H), 1.60-1.69 (m, 4H), 1.09 (t, 3H, *J* = 7.3 Hz), 1.05 (t, 3H, *J* = 7.3 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 157.1, 152.9, 138.1, 134.6, 126.3, 125.8, 123.2, 115.5, 107.1, 105.0, 55.2, 30.9, 28.8, 24.4, 23.5, 14.7, 14.5; IR (neat): 3068, 2927, 2857, 1620, 1514, 1224, 1166., 1035, 862, 754cm^{-1}; HRMS-CI m/z 259.1698 [$(MH)^+$; calcd for $C_{17}H_{23}O_2$: 259.1693].

Characterization of the Compounds in Scheme 2

4-Pentylnaphthalene-1,2-dione (2a): 91 mg (80%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.13 (dd, 1H, *J* = 7.55, 1.42 Hz), 7.64-7.70 (m, 1H), 7.53-7.58 (m, 1H), 7.48-7.52 (m, 1H), 6.37 (s, 1H), 2.69 (t, 2H, *J* = 7.71 Hz), 1.64-1.72 (m, 2H), 1.32-1.49 (m, 4H), 0.91 (t, 3H, *J* = 7.08 Hz); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 180.6, 179.7, 157.6, 135.4, 135.0, 131.5, 130.5, 130.2, 126.3, 126.1, 33.3, 31.6, 27.9, 22.4, 13.9; IR (neat): 2959, 2923, 2871, 1698, 1672, 1450, 1325, 816, 772 cm^{-1}; HRMS-CI m/z 229.1120 [$(MH)^+$; calcd for $C_{15}H_{17}O_2$: 229.1223].

4-Decylnaphthalene-1,2-dione (2b): 121 mg (71%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.12 (dd, 1H, *J* = 7.67, 1.45 Hz), 7.63-7.70 (m, 1H), 7.53-7.58 (m, 1H), 7.47-7.53 (m, 1H), 6.36 (s, 1H), 2.69 (t, 2H, *J* = 7.58 Hz), 1.62-1.72 (m, 2H), 1.41-1.49 (m, 2H), 1.18-1.36 (m, 12H), 0.87 (t, 3H, *J* = 6.76 Hz); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 180.6, 179.7, 157.7, 135.4, 135.0, 131.5, 130.5, 130.1, 126.3, 126.1, 33.4, 31.8, 29.6, 29.5(5), 29.5(1), 29.3, 29.2, 28.3, 22.6, 14.1; IR (neat): 2954, 2923, 2865, 1700, 1668, 1432, 1325, 817, 772 cm^{-1}; HRMS-CI m/z 299.2010 [$(MH)^+$; calcd for $C_{20}H_{27}O_2$: 299.2006].

4-Cyclopentylnaphthalene-1,2-dione (2c): 81 mg (72%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.12-8.15 (m, 1H), 7.63-7.68 (m, 2H), 7.47-7.52 (m, 1H), 6.43 (s, 1H), 3.25-3.33 (m, 1H), 2.05-2.17 (m, 2H), 1.71-1.89 (m, 4H), 1.56-1.72 (m, 2H); ^{13}C NMR ($CDCl_3$, 125 MHz,): 181.1,

179.8, 161.2, 135.5, 135.4, 131.5, 130.4, 130.1, 126.3, 123.2, 41.5, 32.4, 25.1; IR (neat): 2934, 2918, 2832, 1695, 1653, 1454, 1336, 822, 769 cm^{-1}; HRMS-CI m/z 227.1072 $[(MH)^+$; calcd for $C_{15}H_{15}O_2$: 227.1067].

4-Cyclohexylnaphthalene-1,2-dione (**2d**): 102 mg (85%), red amorphous solid; ^1H NMR ($CDCl_3$, 600 MHz): δ 8.15 (dd, 1H, *J* = 7.6, 1.5 Hz), 7.61-7.72 (m, 1H), 7.65-7.56 (m, 1H), 7.45-7.54 (m, 1H), 6.39 (s, 1H), 2.76-2.86 (m, 1H), 1.80-2.06 (m, 4H), 1.80-1.86 (m, 1H), 1.44-1.54 (m, 2H), 1.24-1.44 (m, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 181.0, 179.8, 162.0, 135.3, 134.7, 131.7, 130.4, 130.3, 125.4, 123.9, 39.8, 32.6, 26.5, 26.0; IR (neat): 2965, 2942, 2852, 1712, 1695, 1662, 1424, 1350, 1283, 831, 775 cm^{-1}; HRMS-CI m/z 242.1222 $[(MH)^+$; calcd for $C_{16}H_{17}O_2$: 241.1223].

4-Phenylnaphthalene-1,2-dione (2e): 86 mg (73%), red glue solid; ^1H NMR ($CDCl_3$, 500 MHz): δ 8.14-8.30 (m, 1H), 7.56-7.59 (m, 1H), 7.48-7.56 (m, 4H), 7.40-7.46 (m, 2H), 7.23-7.28 (m, 1H), 6.40 (s, 1H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 180.5, 179.5, 157.0, 136.5, 135.1(9), 135.1(4), 131.7, 130.8, 130.5, 129.7, 129.6, 128.8, 128.1, 127.5; IR (neat): 2955, 2939, 2860, 1698, 1660, 14124, 1350, 1283, 667 cm^{-1}; HRMS-CI m/z 235.0755$[(MH)^+$; calcd for $C_{16}H_{11}O_2$: 235.0754].

4-(*p*-Tolyl)naphthalene-1,2-dione (2f): 92 mg (74%), red glue solid; ^1H NMR ($CDCl_3$, 600 MHz): δ 8.16-8.22 (m, 1H), 7.46-7.61 (m, 2H), 7.29-7.39 (m, 5H), 6.41 (s, 1H), 2.45 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 180.5, 179.6, 157.2, 140.0, 135.2, 135.1, 133.6, 131.7, 130.7, 130.5, 129.6, 129.5, 128.1, 127.3, 21.4; IR (neat): 3214, 2948, 2868, 1665, 1534, 1341, 1210, 841 cm^{-1}; HRMS-CI m/z 249.0910 $[(MH)^+$; calcd for $C_{17}H_{13}O_2$: 249.0910].

4-(4-(*tert*-Butyl)phenyl)naphthalene-1,2-dione (2g): 113 mg (78%), red glue solid; ^1H NMR ($CDCl_3$, 600 MHz): δ 8.14-8.26 (m, 1H), 7.56-7.61 (m, 1H), 7.48-7.55 (m, 3H), 7.33-7.41 (m, 3H), 6.42 (s, 1H), 1.39 (s, 9H); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 180.5, 179.7, 157.2, 153.2, 135.2, 135.0, 133.5, 131.7, 130.7, 130.5, 129.7, 128.0, 127.3(8), 125.7, 34.9, 31.2; IR (neat): 3015, 2963, 2868, 1698, 1587, 1341, 1210, 841, 756 cm^{-1}; HRMS-CI m/z 291.1374 $[(MH)^+$; calcd for $C_{20}H_{19}O_2$: 291.1379].

3,4-Diphenylnaphthalene-1,2-dione (2h): 107 mg (69%), red glue solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.21 (dd, 1H, *J* = 7.15, 1.55 Hz), 7.46-7.55 (m, 2H), 7.23-7.32 (m, 3H), 7.08-7.19 (m, 5H), 7.03-7.08 (m, 1H), 6.92-7.01 (m, 2H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 180.6, 179.1, 152.6, 142.6, 138.5, 136.8, 135.7, 135.4, 133.4, 131.2, 130.3, 130.2, 130.1, 129.1, 128.2(8), 128.2(6), 127.5, 127.4; IR (neat): 2958, 2865, 1697, 1665, 1448, 1210, 934 cm^{-1}; HRMS-CI m/z 311.1065[$(MH)^+$; calcd for $C_{22}H_{15}O_2$: 311.1067].

3-Methyl-4-phenylnaphthalene-1,2-dione (2i): 96 mg (77%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.09 (dd, 1H, *J* = 7.42, 1.48 Hz), 7.49-7.54 (m, 2H), 7.42-7.48 (m, 2H), 7.35-7.40 (m, 1H), 7.17-7.23 (m, 2H), 6.78 (d, 1H, *J* = 7.74 Hz), 1.78 (s, 3H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 181.7, 179.3, 152.1, 137.2, 136.2, 155.4, 124.3, 130.6, 129.9, 129.5, 129.2, 129.0, 128.5, 127.9, 13.5; IR (neat): 2954, 2942, 2832, 1700, 1654, 1424, 1350, 954, 772 cm^{-1}; HRMS-CI m/z 249.0894[$(MH)^+$; calcd for $C_{17}H_{13}O_2$: 249.0910].

3,4-Dipropylnaphthalene-1,2-dione (2j): 105 mg (87%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.07 (dd, 1H, *J* = 7.70, 1.56 Hz), 7.59-7.66 (m, 1H), 7.46-7.53 (m, 1H), 7.38-7.44 (m, 1H), 2.66-2.74 (m, 2H), 2.46-2.52 (m, 2H), 1.57-1.71 (m, 2H), 1.42-1.52 (m, 2H), 1.11 (t, 3H, *J* = 7.54 Hz), 0.98 (t, 3H, *J* = 7.46 Hz); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 181.2, 179.8, 151.4, 138.2, 136.0, 135.6, 131.1, 129.8, 129.4, 126.2, 31.6, 28.4, 22.7(4), 22.7(1), 14.5, 14.4; IR (neat): 3054, 2958, 2942, 2864, 1695, 1659, 1424, 1283, 1121, 822, 753 cm^{-1}; HRMS-CI m/z 243.1380[$(MH)^+$; calcd for $C_{16}H_{19}O_2$: 243.1380].

7-Methoxy-4-pentylnaphthalene-1,2-dione (2k): 97 mg (75%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.63 (d, 1H, *J* = 2.9 Hz), 7.46 (d, 1H, *J* = 8.7 Hz), 7.14 (dd, 1H, *J* = 8.7, 2.9 Hz), 6.24 (s, 1H), 3.90 (s, 3H), 2.52-2.72 (m, 2H), 1.62-1.77 (m, 2H), 1.27-1.52 (m, 4H), 1.92 (t, 3H, *J* = 7.2 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 180.8, 179.8, 161.4, 158.2, 133.0, 127.9, 123.9, 121.3, 114.4, 109.9, 55.8, 33.5, 31.6, 28.0, 22.4, 13.9; IR (neat): 2952, 2929, 1658, 1595, 1563, 1289, 1240, 984, 846 cm^{-1}; HRMS-CI m/z 259.1327 [$(MH)^+$; calcd for $C_{16}H_{19}O_3$: 259.1328].

7-Methoxy-4-phenylnaphthalene-1,2-dione (2l): 92 mg (70%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.70 (d, 1H, *J* = 2.8 Hz), 7.43-7.56 (m, 3H), 7.39-7.46 (m, 2H), 7.20 (d, 1H, *J* = 8.7 Hz), 7.04 (dd, 1H, *J* = 8.7, 2.9 Hz), 6.28 (s, 1H), 3.91 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 180.6, 179.6, 161.6, 157.5, 136.9, 133.2, 131.3, 129.6, 128.7, 128.0, 125.0, 120.8, 115.1, 55.8; IR (neat): 3078, 2946, 1697, 1596, 1294, 1117, 993, 702 cm^{-1}; HRMS-CI m/z 265.0858 [$(MH)^+$; calcd for $C_{17}H_{13}O_3$: 265.0859].

6-Chloro-4-phenylnaphthalene-1,2-dione (2m): 95 mg (71%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.15 (d, 1H *J* = 2.3 Hz), 7.47-7.50 (m, 4H), 7.39-7.44 (m, 2H), 7.25 (s, 1H), 6.43 (s, 1H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 179.7, 178.5, 156.1, 137.7, 136.1, 134.8, 133.4, 132.7, 130.8, 130.4, 129.9, 129.0, 128.0, 127.4; IR (neat): 3060, 1660, 1574, 1276, 1200, 771, 700 cm^{-1}; HRMS-CI m/z 269.0361 [$(MH)^+$; calcd for $C_{16}H_{10}ClO_2$: 269.0363].

7-Methoxy-3,4-dipropylnaphthalene-1,2-dione (2n): 109 mg (80%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 600 MHz): δ 7.58 (d, 1H, *J* = 2.9 Hz), 7.41 (d, 1H, *J* = 8.7 Hz), 7.12 (dd, 1H, *J* = 8.7, 2.9 Hz), 3.88 (s, 3H), 2.52-2.78 (m, 2H), 2.30-2.52 (m, 2H), 1.60-1.70 (m, 2H), 1.39-1.50 (m, 2H), 1.11 (t, 3H, *J* = 7.3 Hz), 0.98 (t, 3H, *J* = 7.3 Hz); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 181.2, 179.7, 160.4, 151.9, 135.6, 132.4, 129.0, 127.9, 121.7, 113.7, 55.7, 31.7, 28.1, 22.7, 22.7, 14.5, 14.3; IR (neat): 2958, 2867, 2690, 2652, 1484, 1259, 1039, 846 cm^{-1}; HRMS-CI m/z 273.1485 [$(MH)^+$; calcd for $C_{17}H_{21}O_3$: 273.1484].

4-(4-Chlorobutyl)naphthalene-1,2-dione (2o): 90 mg (72%), brown amorphous solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.14 (dd, 1H, *J* = 7.88, 1.10 Hz), 7.65-7.72 (m, 1H), 7.49-7.58 (m, 2H), 6.38 (s, 1H), 3.61 (t, 2H, *J* = 6.61 Hz), 2.70-2.76 (m, 2H), 1.79-1.97 (m, 4H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 180.6, 179.6, 156.6, 135.5, 134.7, 131.5, 130.7, 130.3, 126.5, 126.0, 44.3, 32.5, 32.1, 25.4; IR (neat): 2952, 2936, 2852, 1700, 1662, 1412, 1323, 817, 772, 654 cm^{-1}; HRMS-CI m/z 249.0682[$(MH)^+$; calcd for $C_{14}H_{14}ClO_2$: 249.0677].

2-(3-(3,4-Dioxo-3,4-dihydronaphthalen-1-yl)propyl)isoindoline-1,3-dione (2p): 100 mg (58%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.13 (dd, 1H, *J* = 7.99, 1.43 Hz), 7.83-7.88 (m, 2H), 7.71-7.76 (m, 2H), 7.64-7.68 (m, 1H), 7.48-7.54 (m, 2H), 6.41 (s, 1H), 3.87 (t, 2H, *J* = 7.06 Hz), 2.75-2.82 (m, 2H), 2.03-2.15 (m, 2H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 199.6, 167.5, 143.6, 136.9, 132.8(4), 132.8(3) 131.4, 130.8, 128.4, 123.8, 120.8(7), 120.8(4), 120.8(2), 104.2, 43.8, 43.5, 21.1; IR (neat): 3061, 3026, 2930, 2861, 1702, 1684, 1658, 1234, 920, 756 cm^{-1}; HRMS-CI m/z 346.1090[$(MH)^+$; calcd for $C_{21}H_{16}NO_4$: 346.1074].

Methyl 4-(3,4-dioxo-3,4-dihydronaphthalen-1-yl)butanoate (2q): 106 mg (78%), yellow amorphous solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.13 (dd, 1H, *J* = 7.85, 1.25 Hz), 7.60-7.72 (m, 2H), 7.47-7.55 (m, 1H), 6.36 (s, 1H), 3.70 (s, 3H), 2.70-2.80 (m, 2H), 2.44-2.54 (m, 2H), 1.94-2.10 (m, 2H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 180.6, 179.5, 173.2, 156.5, 135.6., 134.6, 131.5, 130.7, 130.3, 126.6, 126.3, 51.7, 33.1, 32.7, 23.4; IR (neat): 2965, 2942, 2852, 1712, 1695, 1662, 1424, 1350, 1283, 831, 775 cm^{-1}; HRMS-CI m/z 259.0961[$(MH)^+$; calcd for $C_{15}H_{15}O_4$: 259.0966].

4-(Naphthalen-2-yloxy)naphthalene-1,2-dione (2r): 102 mg (68%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.88-7.93 (m, 2H), 7.96 (d, 1H, *J* = 8.8 Hz), 7.88-7.93 (m, 1H), 7.77-7.87 (m, 2H), 7.66-7.71 (m, 1H), 7.63 (d, 1H, *J* = 2.4 Hz), 7.52-7.59 (m, 2H), 7.29 (dd, 1H, *J* = 8.8, 2.4 Hz), 5.71 (s, 1H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 179.5, 179.2, 168.8, 149.8, 135.1, 133.8, 131.9, 131.7, 131.6, 130.7, 130.5, 129.4, 127.9, 127.6, 127.3, 126.5, 124.9, 120.1, 118.6, 106.6; IR (neat): 3063, 2924, 2854, 1698, 1651, 1564, 1361, 1230, 1201, 864 cm^{-1}; HRMS-CI m/z 301.0854 [$(MH)^+$; calcd for $C_{20}H_{13}O_3$: 301.0858].

Naphthalene-1,4-dione (2s): 69 mg (87%); ^{1}H NMR ($CDCl_3$, 600 MHz): δ 8.06-8.10 (m, 2H), 7.74-7.78 (m, 2H), 6.98 (s, 2H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 184.9, 138.6, 133.9, 131.8, 126.3; ^{1}H NMR and ^{13}C NMR spectra for this compound is consistent with previously reported literature data.[2]

Characterization of the Compounds in Scheme 3

4,4'-Dipentyl-[1,1'-binaphthalene]-2,2'-diol (3a): 162 mg (76%), light yellow solid, mp 92-95 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.08 (d, 2H, *J* = 8.43 Hz), 7.34-7.41 (m, 2H), 7.24-7.31 (m, 4H), 7.16-7.21 (m. 2H), 5.02 (br s, 2H), 3.04-3.22 (m, 4H), 1.79-1.95 (m, 4H), 1.34-1.61 (m, 8H), 0.89 (t, 6H, *J* = 7.27 Hz); ^{13}C NMR (CDCl3, 125 MHz,): 152.4, 143.0, 134.0, 128.1, 126.9, 125.0, 124.3, 123.7, 117.4, 109.0, 33.1, 32.1, 30.2, 22.6, 14.1; IR (neat): 3506, 3364, 3056, 2925, 1622, 1597, 1384, 782, 701 cm^{-1}; HRMS-CI m/z 427.2640 [$(MH)^+$; calcd for $C_{30}H_{35}O_2$: 427.2632].

4,4'-Didecyl-[1,1'-binaphthalene]-2,2'-diol (3b): 207 mg (73%), light yellow solid, mp 115-120 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.09 (d, 2H, *J* = 8.42 Hz), 7.36-7.42 (m, 2H), 7.27-7.31 (m, 2H), 7.25-7.28 (m, 2H), 7.17-7.22 (m, 2H), 5.02 (br s, 2H), 3.09-3.26 (m, 4H), 1.79-1.98 (m, 4H), 1.50-1.61 (m, 4H), 1.40-1.49 (m, 4H), 1.23-1.40 (m, 20H), 0.91 (t, 6H, *J* = 7.18 Hz); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 152.4, 143.0, 134.0, 128.1, 126.9, 125.0, 124.3, 123.7, 117.4, 109.0, 33.2, 31.9, 30.5, 29.9, 29.7, 29.6(9), 29.6(3), 29.4, 22.7, 14.1; IR (neat): 3505, 3361, 3062, 3018, 2926, 1622, 1574, 1495, 1384, 1152, 741, 702 cm^{-1}; HRMS-CI m/z 567.4192 [$(MH)^+$; calcd for $C_{40}H_{55}O_2$: 567.4197].

4,4'-Dicyclopentyl-[1,1'-binaphthalene]-2,2'-diol (3c): 150 mg (71%), light yellow solid, mp 102-107 °C; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 8.20 (d, 2H, *J* = 8.23 Hz), 7.34-7.42 (m, 4H), 7.24-7.32 (m, 2H), 7.17-7.22 (m, 2H), 5.03 (s, 2H), 3.80-3.97 (m, 2H), 2.17-2.39 (m, 4H), 1.76-2.06 (m, 12H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 152.6, 146.4, 134.1, 128.5, 126.9, 125.0, 124.4, 123.6, 114.1, 108.8, 41.2, 33.7, 25.4; IR (neat): 3526, 3076, 2923, 1652, 1513, 1166, 742, 660 cm-1; HRMS-CI m/z 423.2315 [$(MH)^+$; calcd for $C_{30}H_{31}O_2$: 423.2319].

4,4'-Diphenyl-[1,1'-binaphthalene]-2,2'-diol (3d): 133 mg (61%), red amorphous solid; ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.95-8.01 (m, 2H), 7.60-7.66 (m, 4H), 7.54-7.60 (m, 4H), 7.48-7.54 (m, 2H), 7.39 (s, 2H), 7.31-7.37 (m, 6H), 5.20 (s, 2H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 152.5, 144.1, 140.1,

134.1, 130.2, 128.5, 128.0, 127.8, 127.4, 126.8, 124.7, 124.1, 118.7, 110.5; IR (neat): 3526, 3072, 3015, 2955, 2868, 1596, 1135 cm^{-1}; HRMS-CI m/z 439.1678 [$(MH)^+$; calcd for $C_{32}H_{23}O_2$: 439.1693].

3,3',4,4'-Tetrapropyl-[1,1'-binaphthalene]-2,2'-diol (3e): 159 mg (70%), light yellow solid, mp 105-110 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 8.11 (d, 2H, *J* = 8.30 Hz), 7.34-7.43 (m, 2H), 7.21-7.29 (m, 2H), 7.12-7.17 (m, 2H), 5.17 (s, 2H), 3.13-3.31 (m, 4H), 2.89-3.03 (m, 4H), 1.61-1.99 (m, 8H), 1.24 (t, 6H, *J* = 7.24Hz), 1.10 (t, 6H, *J* = 7.27 Hz); ^{13}C NMR (CDCl3, 125 MHz,): δ 151.8, 139.4, 132.4, 129.3, 128.3, 126.0, 124.8, 124.5, 123.6, 109.2, 31.0, 29.5, 24.5, 23.6, 14.9, 14.6; IR (neat): 3365, 3054, 3018, 2934, 1700, 1652, 1166, 922, 782 cm^{-1}; HRMS-CI m/z 455.2944 [$(MH)^+$; calcd for $C_{32}H_{39}O_2$: 455.2945].

3,3',4,4'-Tetraphenyl-[1,1'-binaphthalene]-2,2'-diol (3f): 136 mg (46%), red amorphous solid; ^1H NMR ($CDCl_3$, 500 MHz): δ 8.21 (d, 2H, *J* = 8.45 Hz), 7.56-7.61 (m, 2H), 7.52 (d, 2H, *J* = 8.51 Hz), 7.29-7.33 (m, 2H), 7.18-7.28 (m, 12H), 7.13-7.17 (m, 4H), 7.09-7.13 (m, 4H), 5.81 (s, 2H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 147.0, 139.3, 137.9, 135.6, 130.9, 130.7(5), 130.7(2), 130.0, 128.7, 128.0, 127.6, 127.4(5), 127.4(2), 127.4(0), 126.9, 124.2, 122.9, 113.3; IR (neat): 3522, 3065, 3033, 2954, 2748, 1592, 1135 cm^{-1}; HRMS-CI m/z 591.2312 [$(MH)^+$; calcd for $C_{44}H_{31}O_2$: 591.2322].

3,3'-Dimethyl-4,4'-diphenyl-[1,1'-binaphthalene]-2,2'-diol (3g): 156 mg (67%), dark yellow solid, mp 115-119 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 7.06-7.64 (m, 4H), 7.39-7.55 (m, 8H), 7.21-7.33 (m, 6H), 5.36 (s, 2H), 2.28 (s, 6H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 151.8, 141.8, 139.4, 131.9, 130.2, 129.1, 128.5, 127.3, 127.0, 126.3, 125.1, 124.2, 123.8, 110.1, 14.5; IR (neat): 3506, 3364, 3056, 1622, 1597, 1384, 782, 701 cm^{-1}; HRMS-CI m/z 467.2015 [$(MH)^+$; calcd for $C_{34}H_{27}O_2$: 467.2006].

6,6'-Dichloro-4,4'-dipentyl-[1,1'-binaphthalene]-2,2'-diol (3h): 154 mg (62%), dark yellow sticky solid; ^1H NMR ($CDCl_3$, 500 MHz): δ 8.31 (d, 2H, *J* = 2.05 Hz), 7.53-7.56 (m, 2H), 7.48-7.52 (m, 2H), 7.32-7.35 (m, 2H), 5.29 (s, 2H), 3.32-3.42 (m, 4H), 2.03-2.23 (m, 4H), 1.66-1.85 (m, 8H), 1.26 (t, 6H, *J* = 7.16 Hz); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 152.6, 142.5, 132.3, 129.9, 129.0, 127.7, 126.5, 123.5,

118.4, 108.7, 32.9, 32.0, 30.0, 22.6, 14.0; IR (neat): 3515. 3062, 2913, 1698, 1381, 1099, 652 cm^{-1}; HRMS-CI m/z 495.1850 [$(MH)^+$; calcd for $C_{30}H_{33}Cl_2O_2$: 495.1852].

4,4'-Bis(4-chlorobutyl)-[1,1'-binaphthalene]-2,2'-diol (3i): 145 mg (62%), dark yellow glue solid; ^1H NMR ($CDCl_3$, 500 MHz): δ 8.08 (d, 2H, *J* = 8.21 Hz), 7.36-7.43 (m, 2H), 7.24-7.33 (m, 4H), 7.16-7.22 (m, 2H), 5.01 (s, 2H), 3.58-3.75 (m, 4H), 3.10-3.30 (m, 4H), 1.94-2.10 (m, 8H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 152.3, 141.9, 134.1, 128.0, 127.1, 125.1, 124.2, 123.9, 117.6, 109.3, 44.8, 32.5, 32.3, 27.7; IR (neat): 2291, 2941, 1700. 1384, 817, 7562, 652 cm^{-1}; HRMS-CI m/z 467.1545 [$(MH)^+$; calcd for $C_{28}H_{29}Cl_2O_2$: 467.1539].

Dimethyl 4,4'-(2,2'-dihydroxy-[1,1'-binaphthalene]-4,4'-diyl)dibutanoate (3j): 170 mg (70%), light yellow solid, mp 127-130 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 8.10 (d, 2H, *J* = 8.37 Hz), 7.36-7.42 (m, 2H), 7.23-7.32 (m, 4H), 7.15-7.20 (m, 2H), 5.07 (s, 2H), 3.67 (s, 6H), 3.02-3.29 (m, 4H), 2.39-2.64 (m, 4H), 2.07-2.30 (m, 4H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 173.7, 152.3, 141.5, 134.1, 128.0, 127.1, 125.0, 124.2, 123.9, 117.9, 109.5, 51.6, 33.7, 32.4, 25.5; IR (neat): 3396, 2951, 1733, 1700, 1384, 1202, 759 cm^{-1}; HRMS-CI m/z 487.2100 [$(MH)^+$; calcd for $C_{30}H_{31}O_6$: 487.2115].

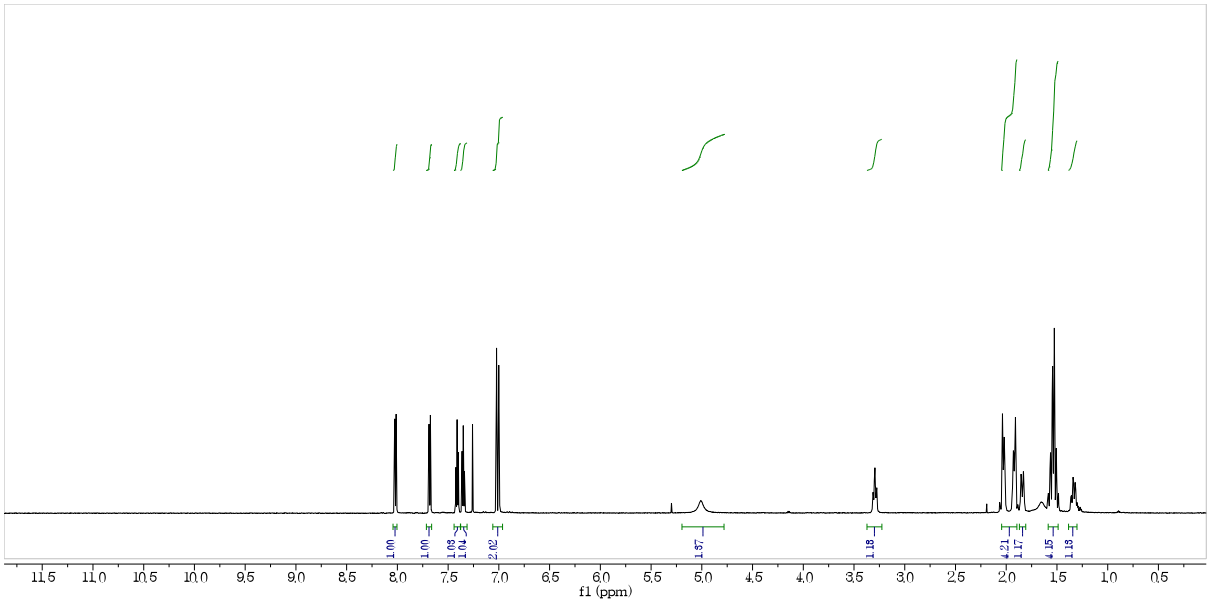
2,2'-((2,2'-Dihydroxy-[1,1'-binaphthalene]-4,4'-diyl)bis(propane-3,1-diyl))bis(isoindoline-1,3-dione) (3k): 178 mg (54%), light yellow solid, mp 131-136 °C; ^1H NMR ($CDCl_3$, 500 MHz): δ 7.99 (d, 2H, *J* = 8.32 Hz), 7.80-7.88 (m, 4H), 7.67-7.74 (m, 4H), 7.27-7.35 (m, 4H), 7.19-7.24 (m, 2H), 7.09-7.14 (m, 2H), 5.30 (s, 2H), 3.77-4.03 (m, 4H), 3.06-3.35 (m, 4H), 2.20-2.43 (m, 4H); ^{13}C NMR ($CDCl_3$, 125 MHz,): δ 168.4, 152.5, 140.8, 134.1, 133.9, 132.0, 127.9, 127.0, 125.1, 123.9, 123.8, 123.2, 117.8, 109.6, 37.8, 30.2, 28.7; IR (neat): 3391, 3061, 3026, 2954, 2861, 1698, 1684, 1211, 920, 748 cm^{-1}; HRMS-CI m/z 661.2320 [$(MH)^+$; calcd for $C_{42}H_{33}N_2O_6$: 661.2333].

((4-Pentylnaphthalene-1,2-diyl)bis(oxy))bis(tert-butyldimethylsilane) (5a): The compound was prepared by known procedure.[3] ^1H NMR ($CDCl_3$, 600 MHz): δ 8.11 (d, 1H, *J* = 8.5 Hz), 7.90 (d, 1H, *J* = 8.4 Hz), 7.38-7.41 (m, 1H), 7.32-7.35 (m, 1H), 6.95 (s, 1H), 2.91-3.01 (m, 2H),

1.69-1.76 (m, 2H), 1.35-1.42 (m, 4H), 1.12 (s, 9H), 1.00 (s, 9H), 0.91 (t, 3H, J = 7.6 Hz), 0.24 (s, 6H), 0.13 (s, 6H); ^{13}C NMR ($CDCl_3$, 150 MHz,): δ 141.6, 137.9, 132.4, 130.0, 128.3, 124.4, 123.6, 123.3, 123.0, 122.6, 32.4, 31.9, 30.3, 26.2, 26.1, 22.6, 18.6(4), 18.6(3), 14.0, -3.5(4), -3.5(9); IR (neat): 3061, 3026, 2964, 2861, 1684, 1594, 1211, 920, 851 cm^{-1}; MS (EI) m/z = 485.3 (M^+).

References

1. Kim, H. Y.; Oh, K. S. *Org. Lett.* **2014**, *16*, 5934-5936.
2. Suchord, D.; Kane, R.; Roe, B.; Zimmermann, E.; Jung, C.; Waske, P.A.; Mattay, J.; Oelgemoller, M. *Tetrahedron*, **2006**, *62*, 1467-1473.
3. Keller, S. N.; Veltri, N.; Sutherland, T. C. *Org. Lett.* **2013**, *15*, 4798-4801.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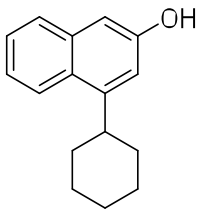
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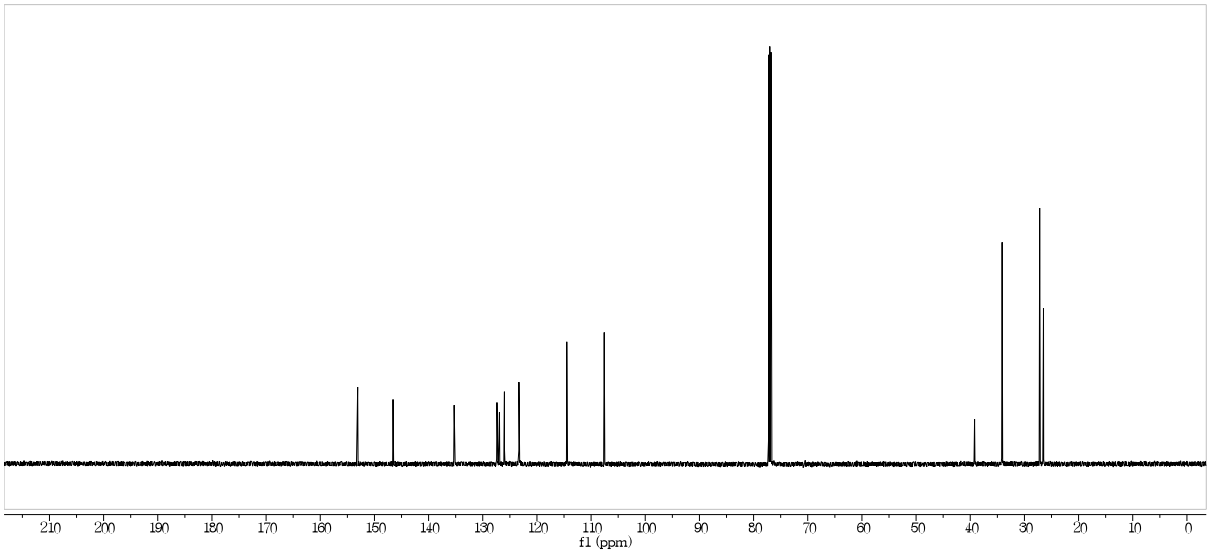
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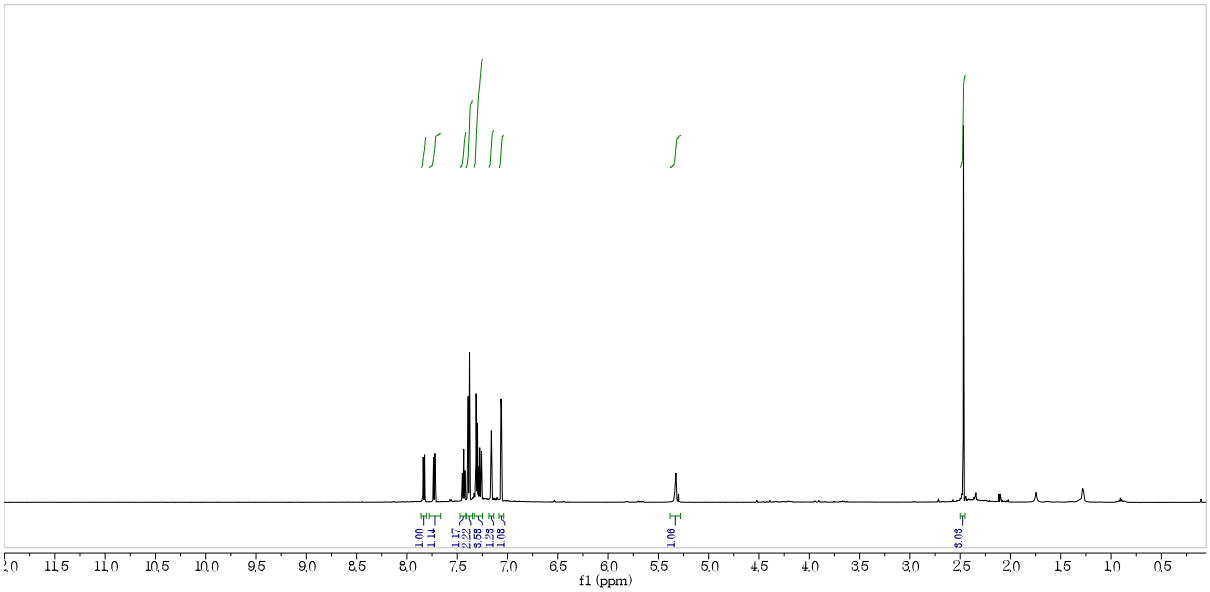

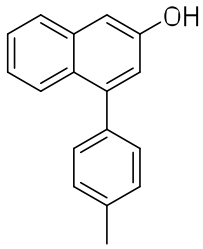

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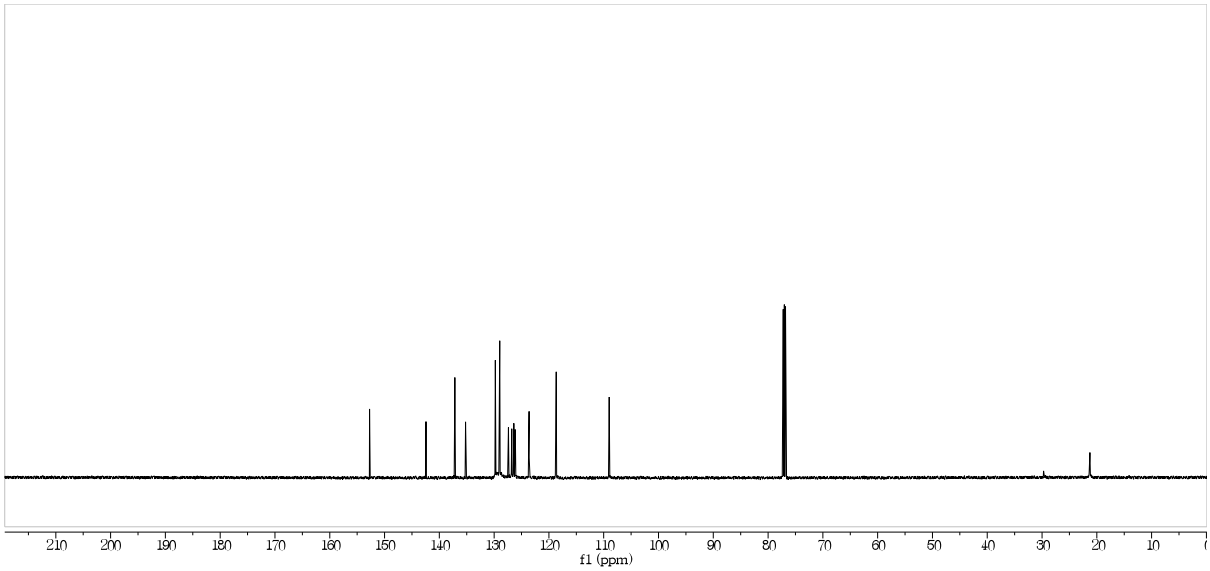

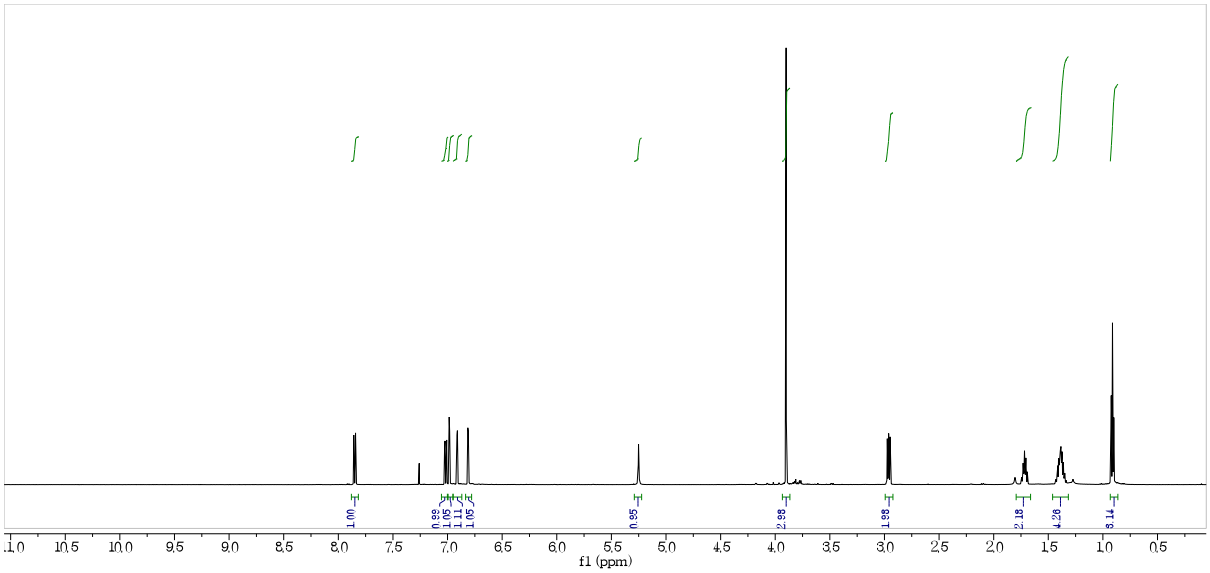

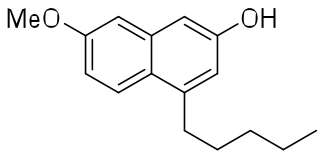

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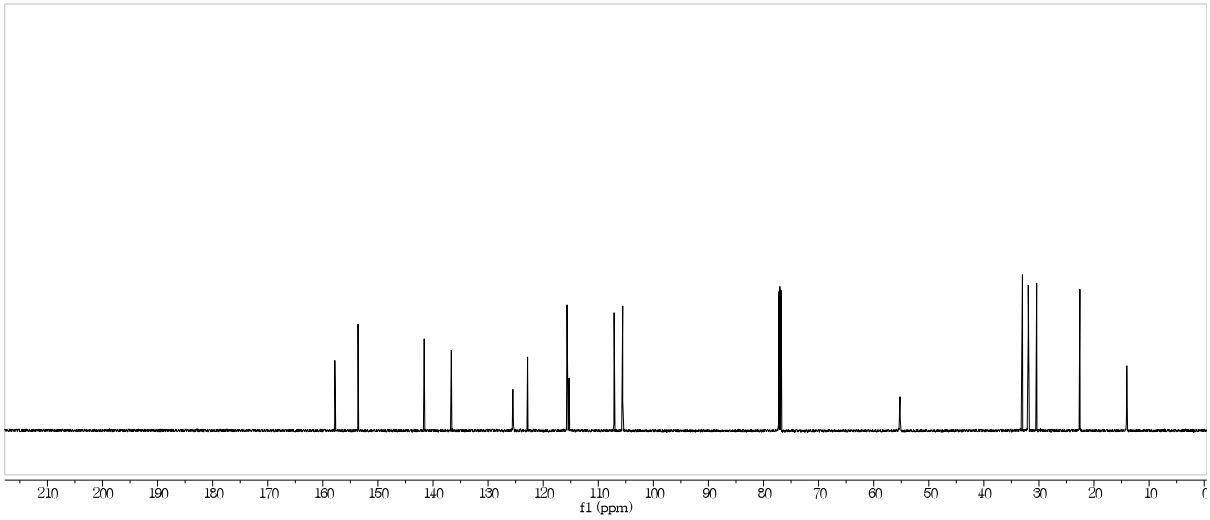

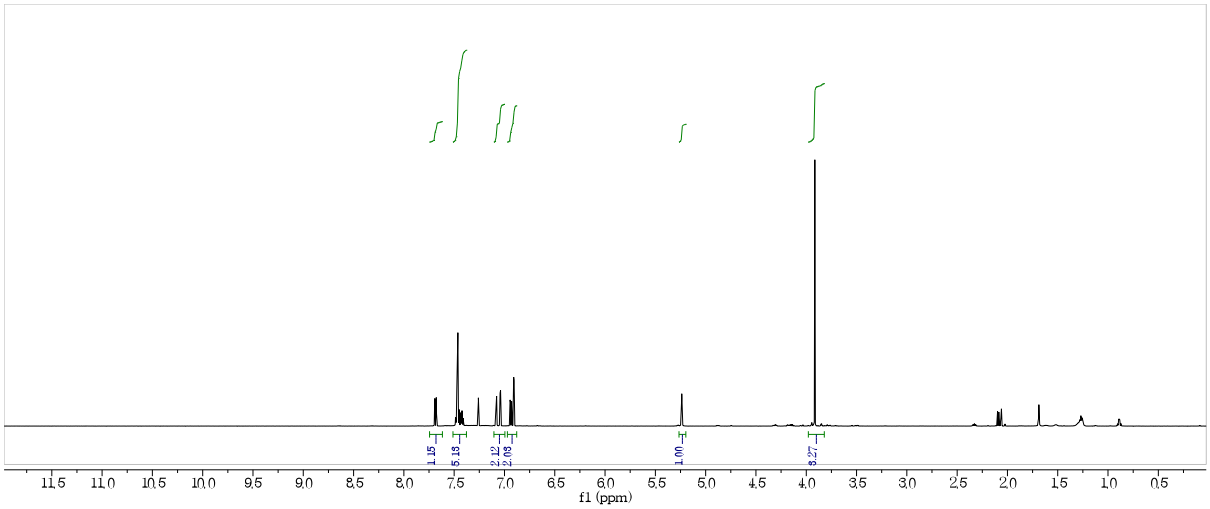
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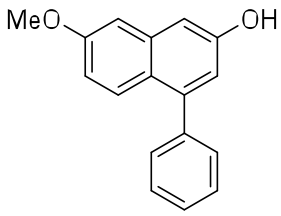
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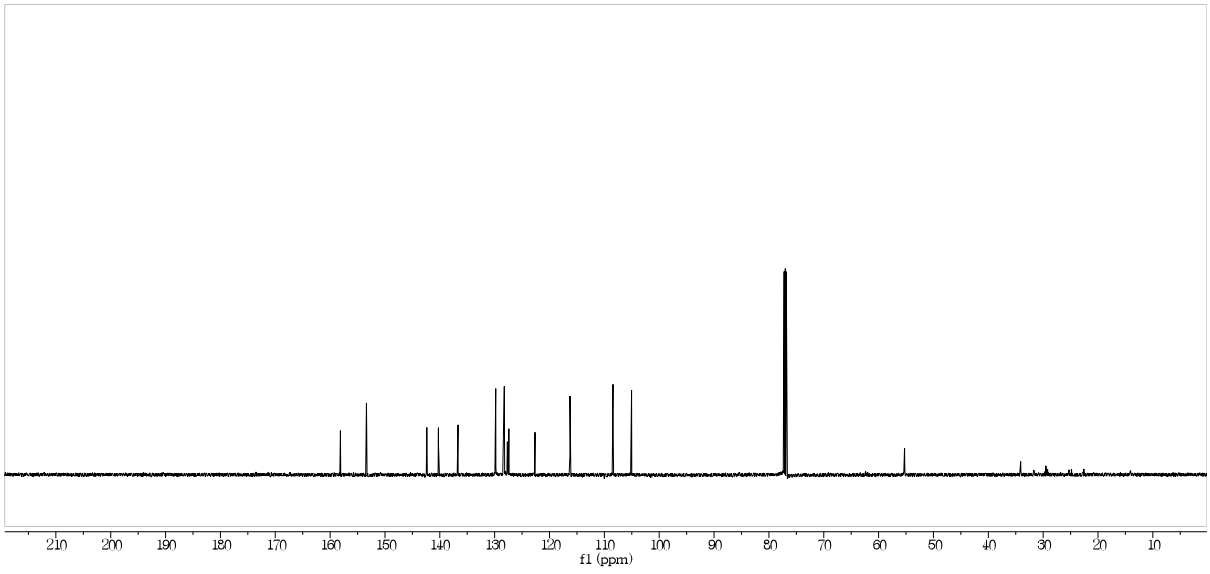
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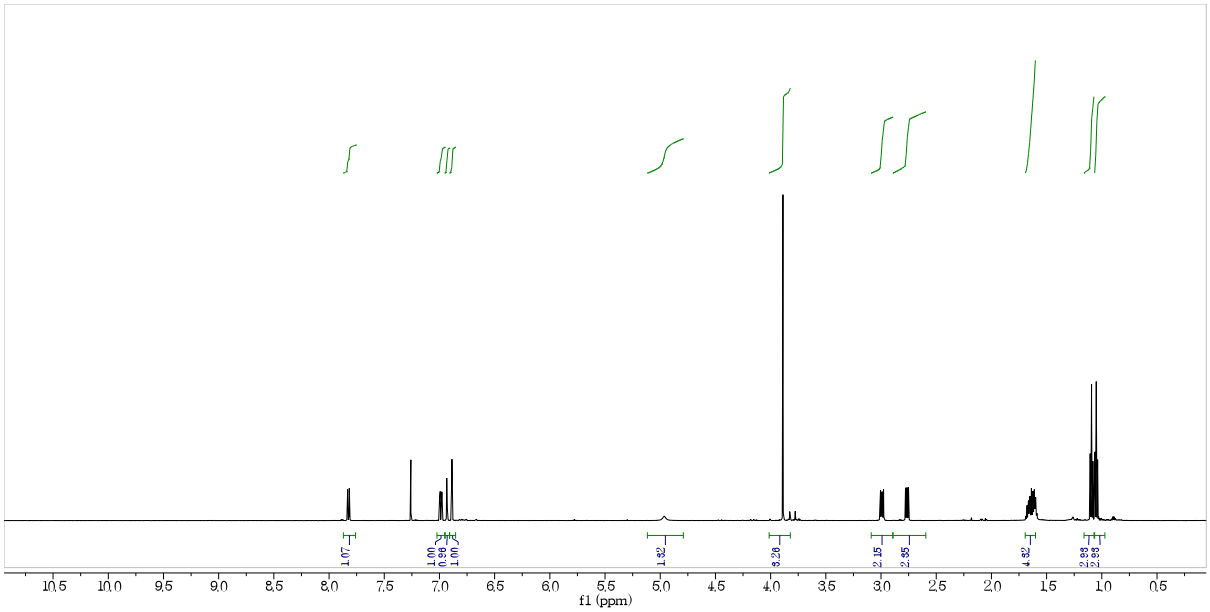
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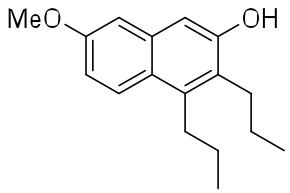
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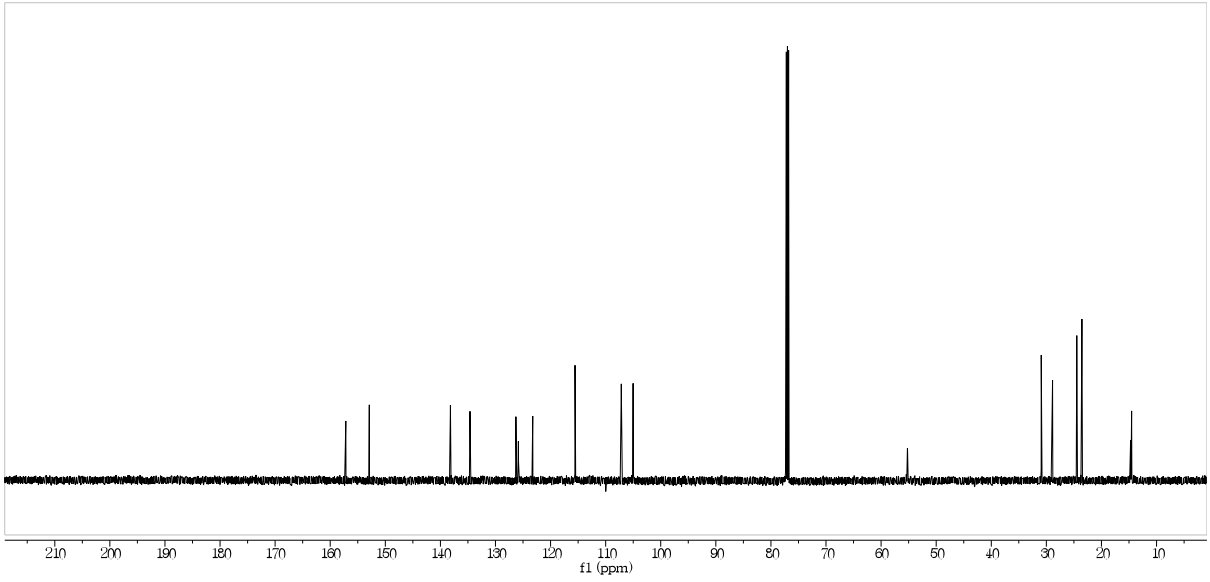
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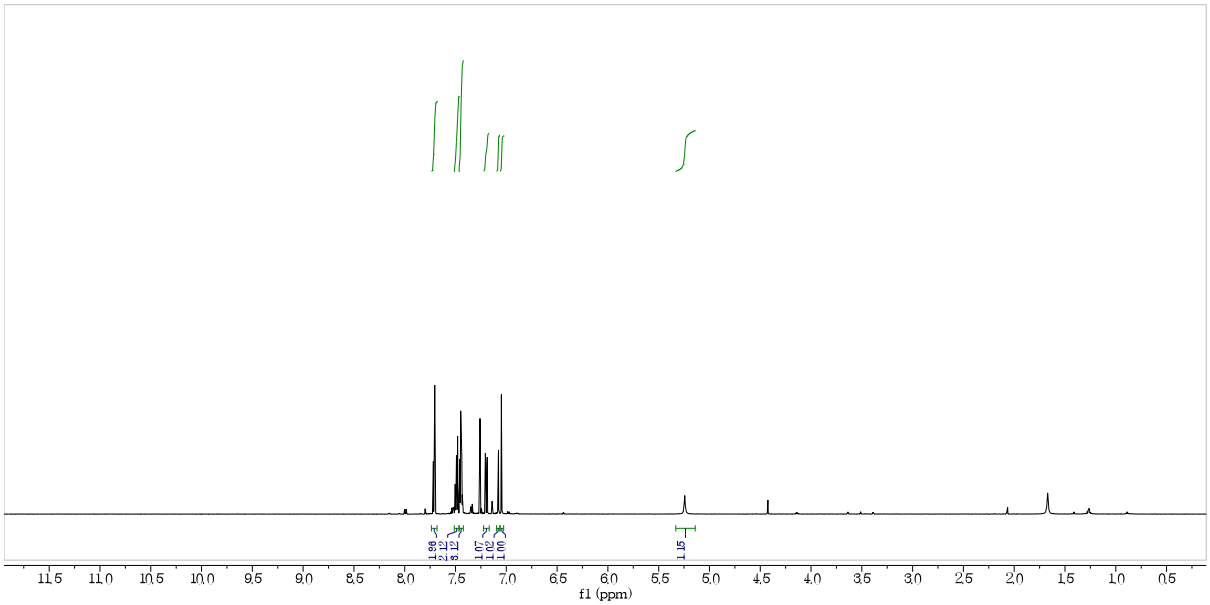
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1.00
1.15
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
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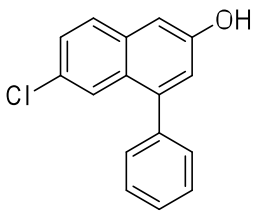
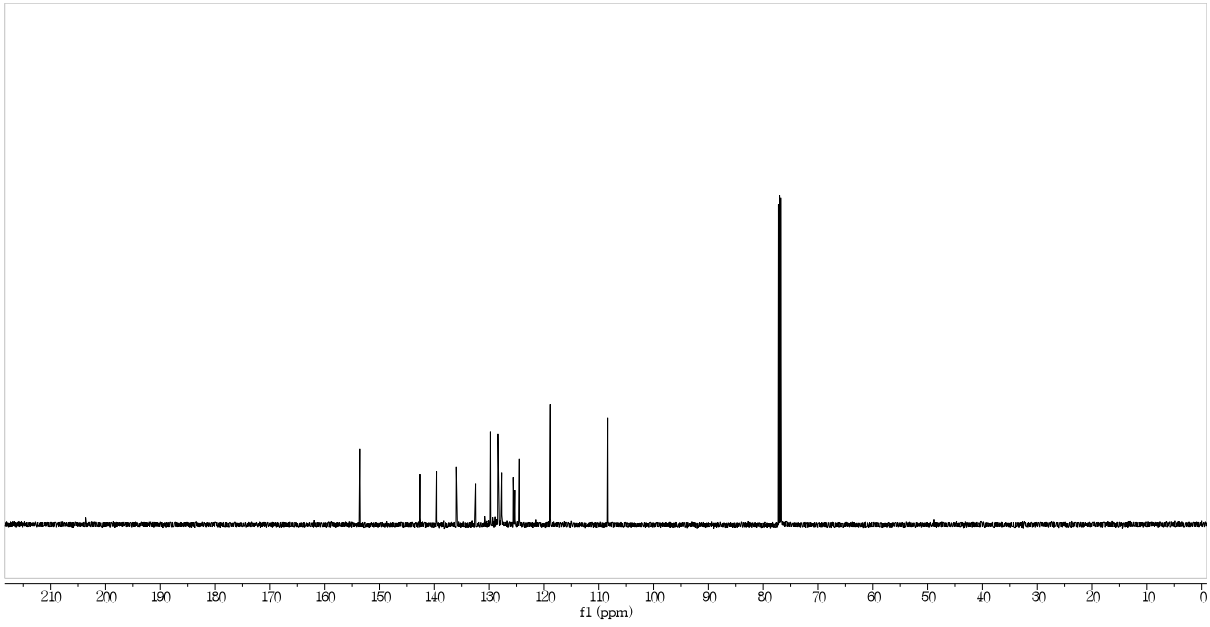

OH
Cl

1m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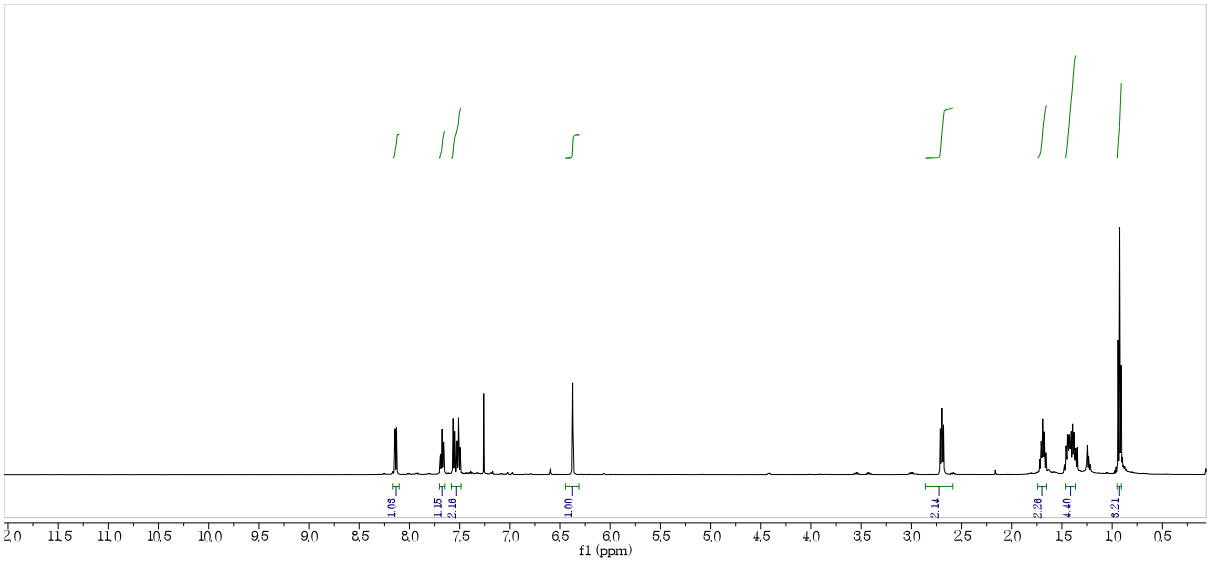

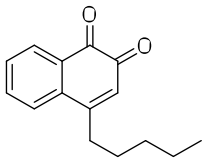

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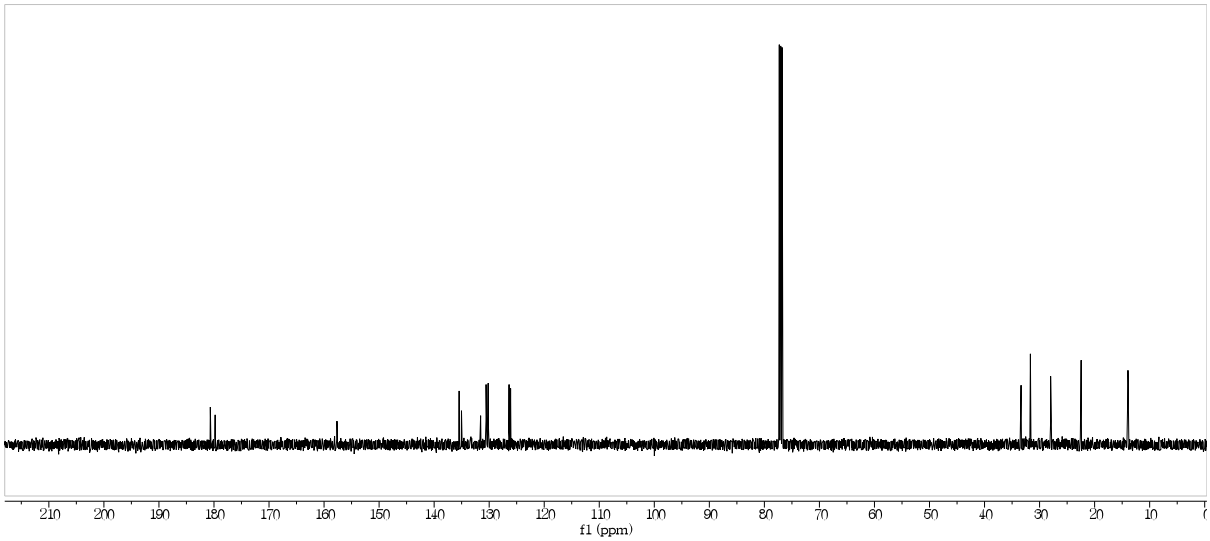

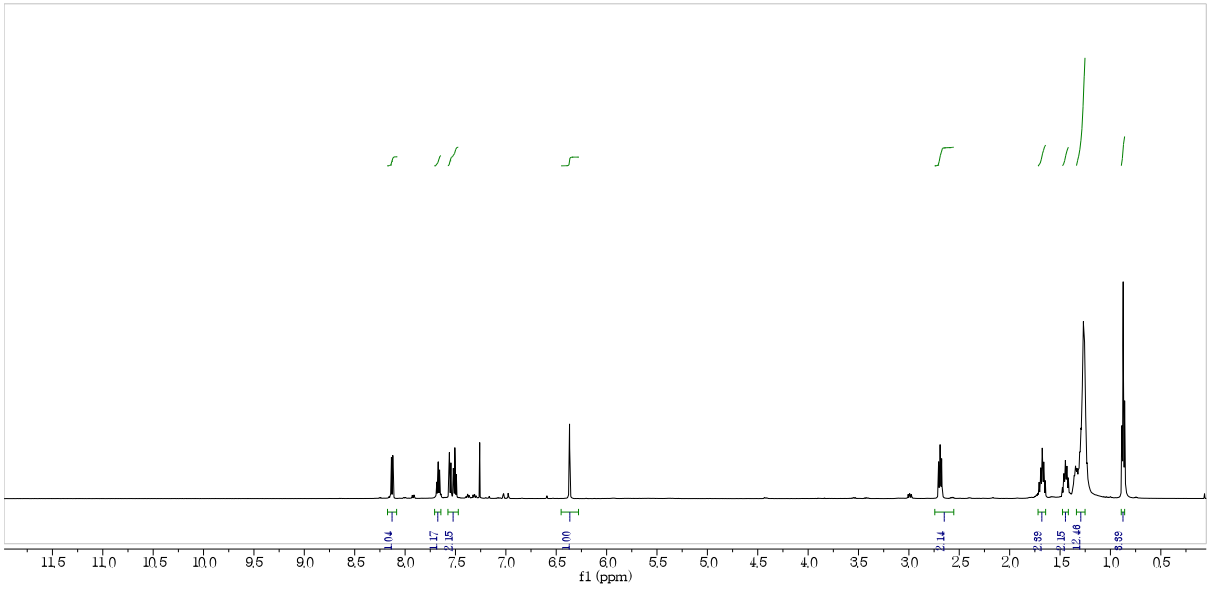

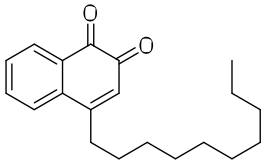

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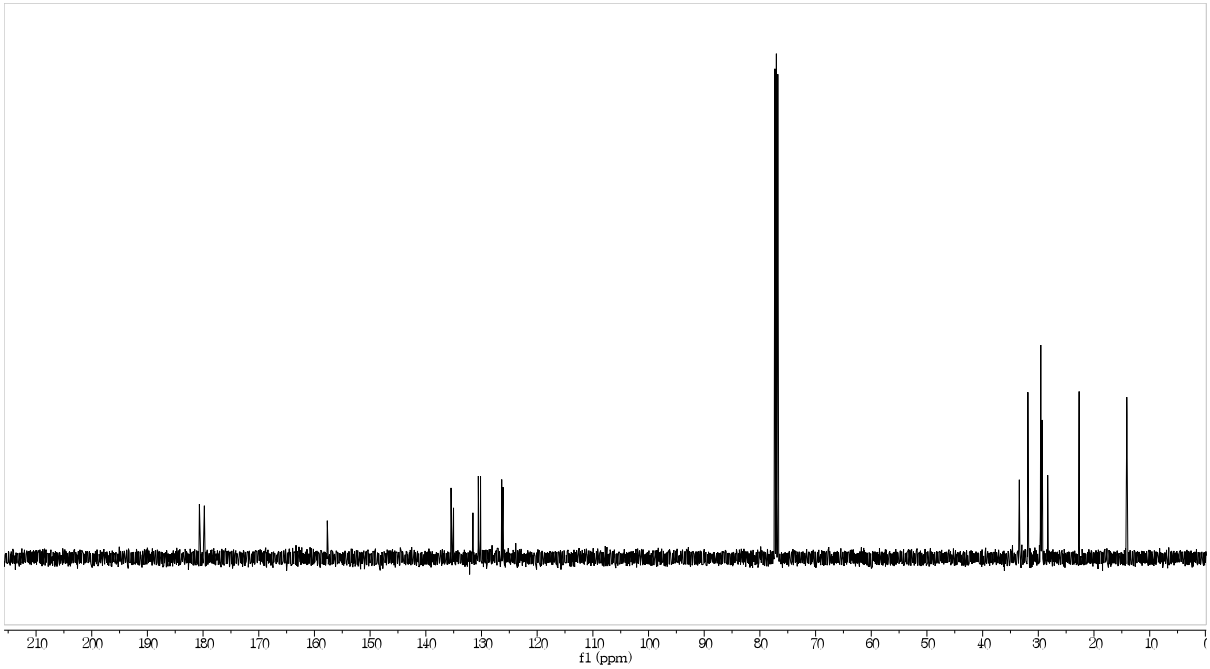

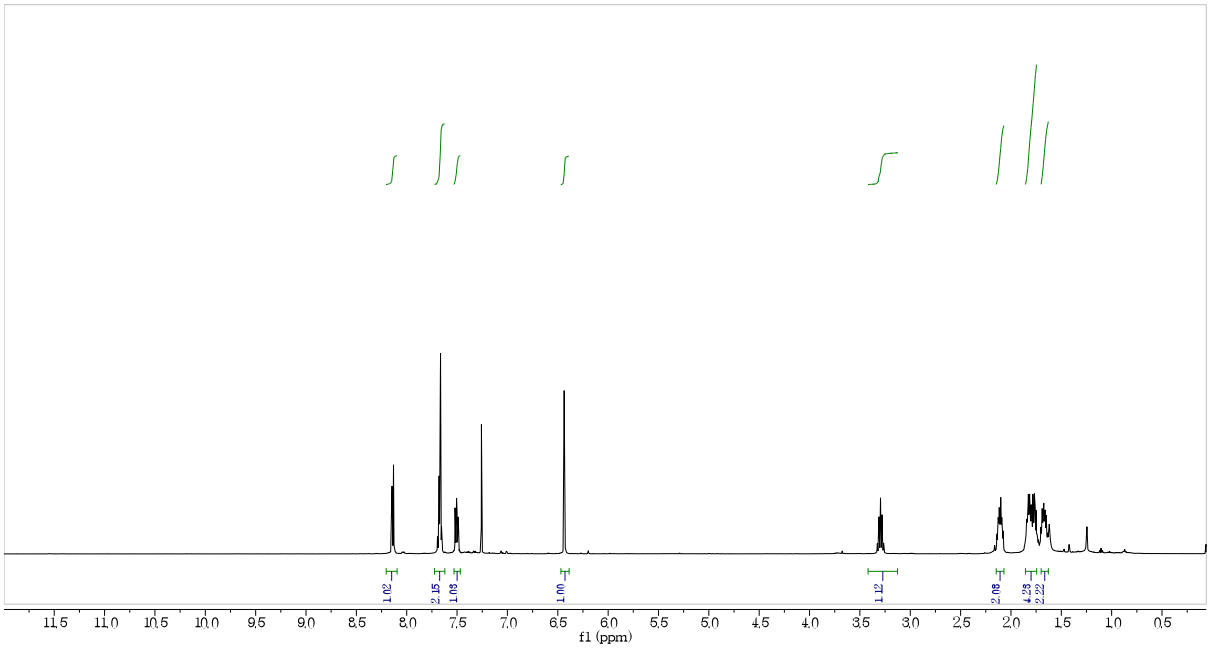
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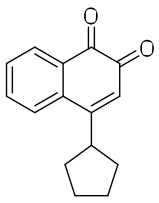
1.12
2.08
4.23
2.22
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)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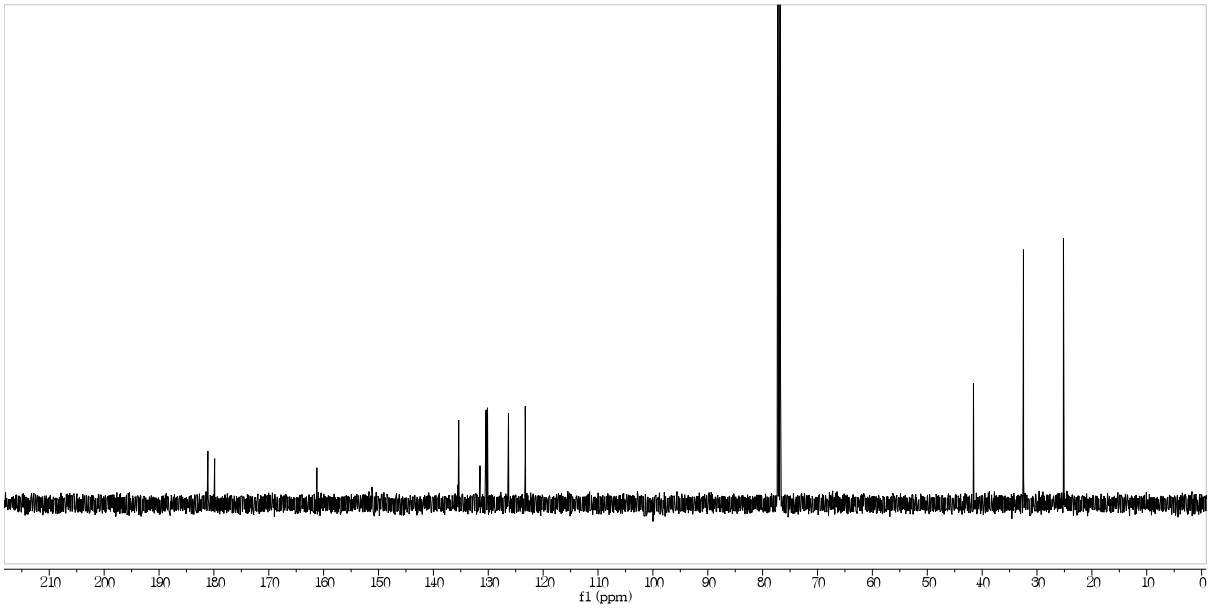
2c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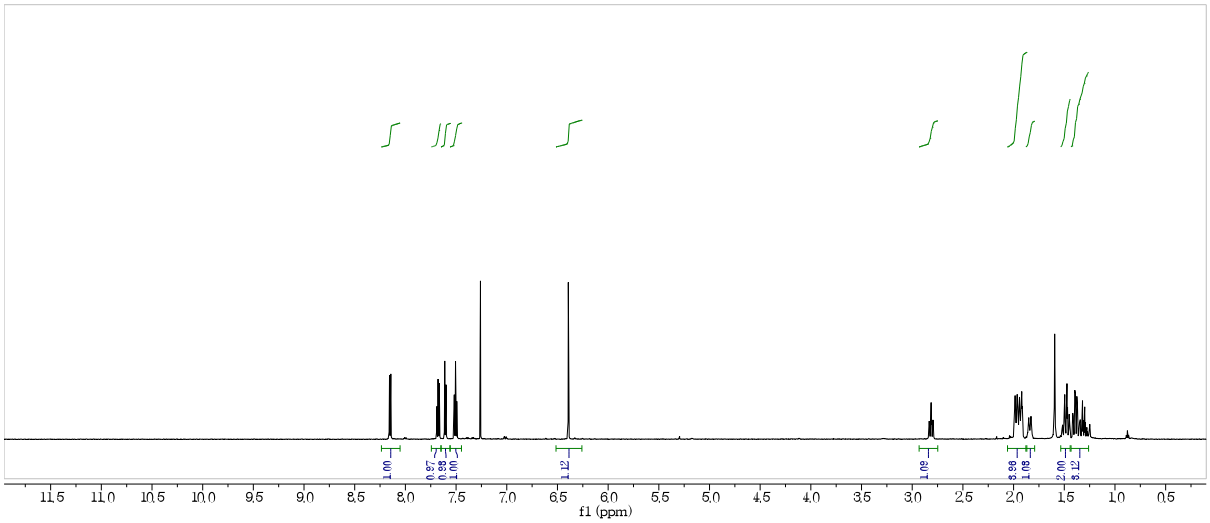
f1 (ppm)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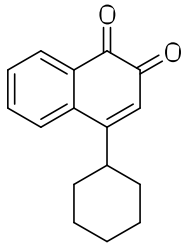
1.09
2.00
8.12
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)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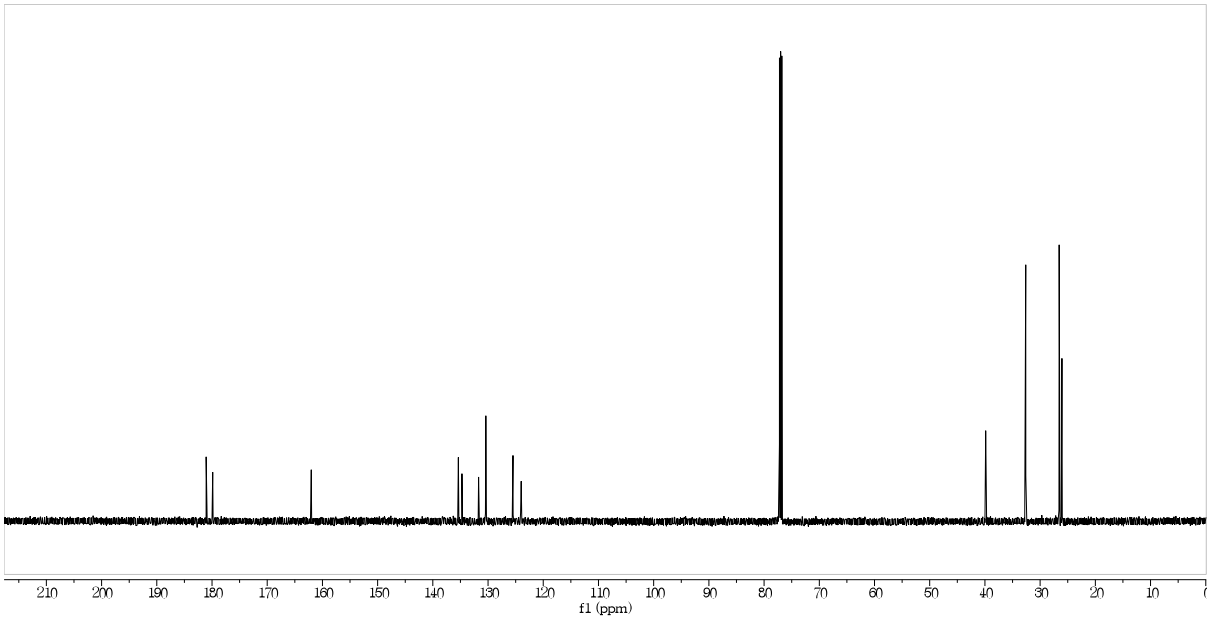
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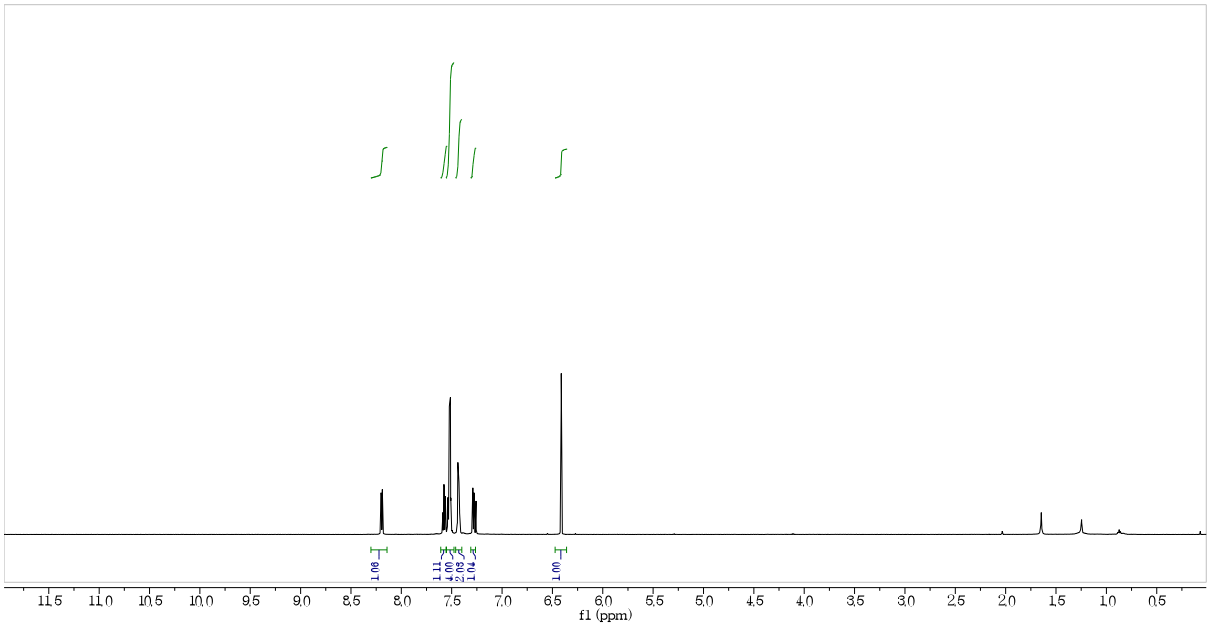
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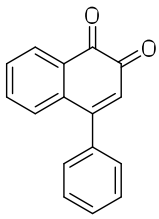
4.00
2.02
1.04
1.00
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)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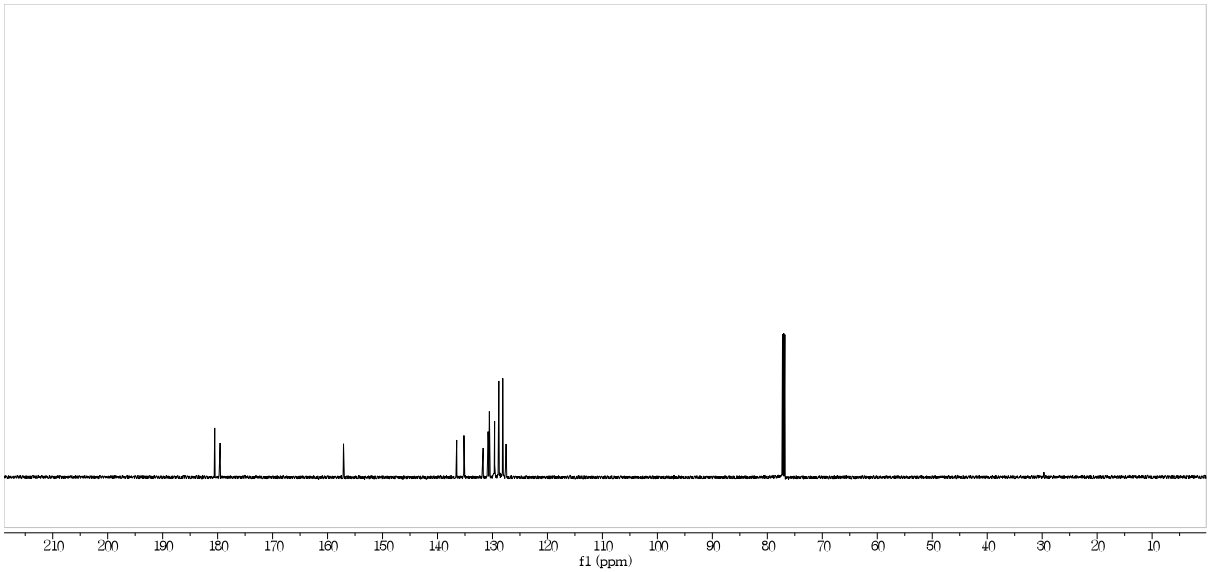
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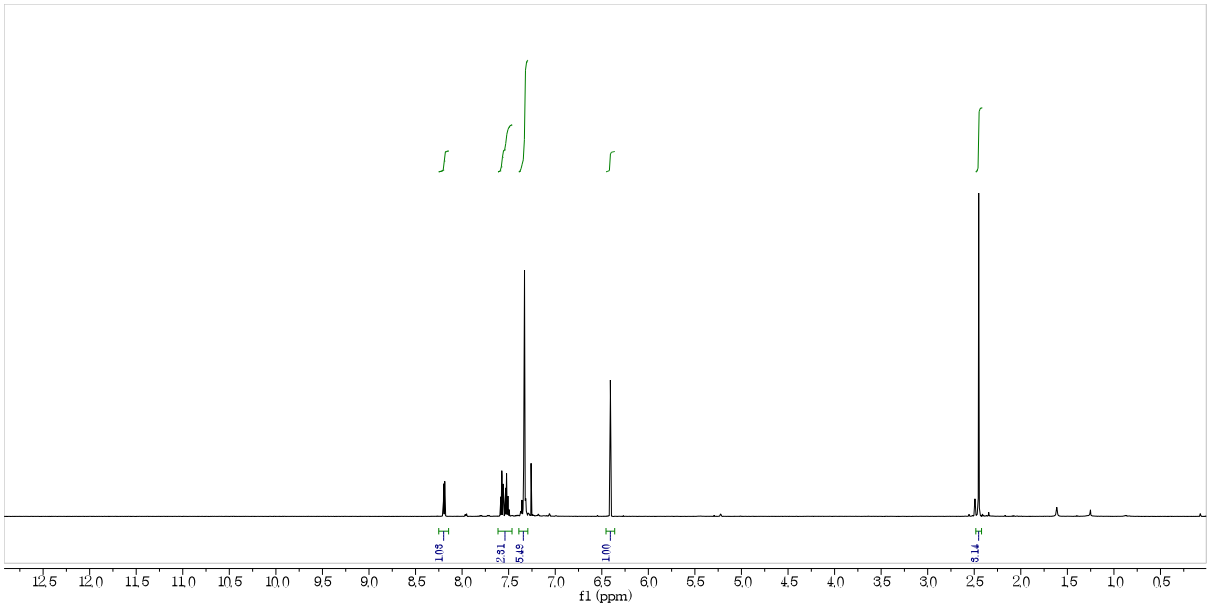
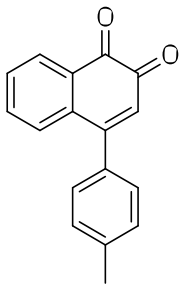
f1 (ppm)





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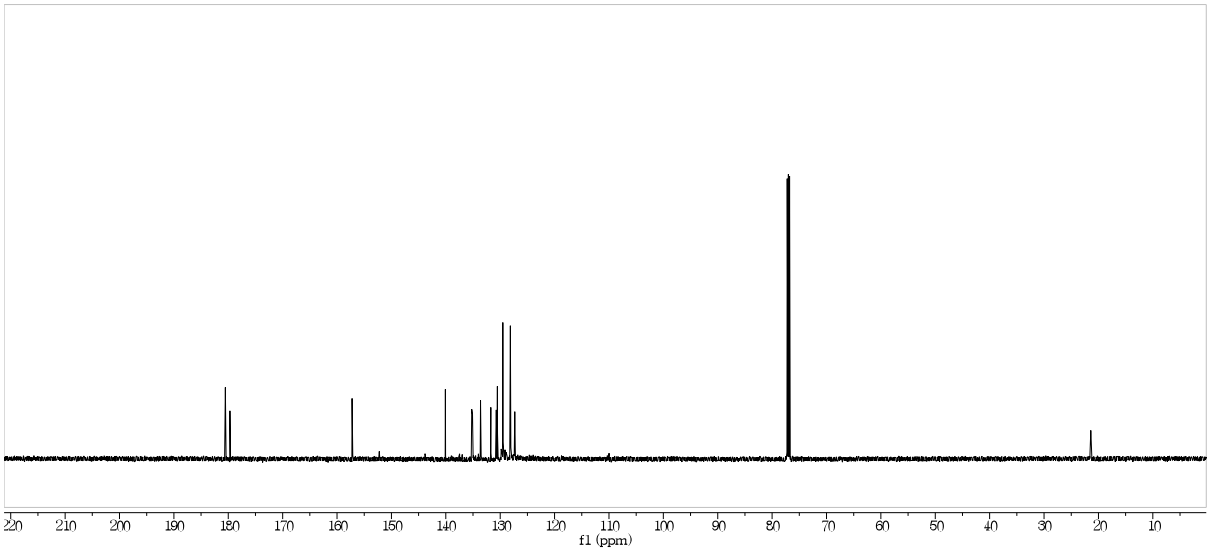

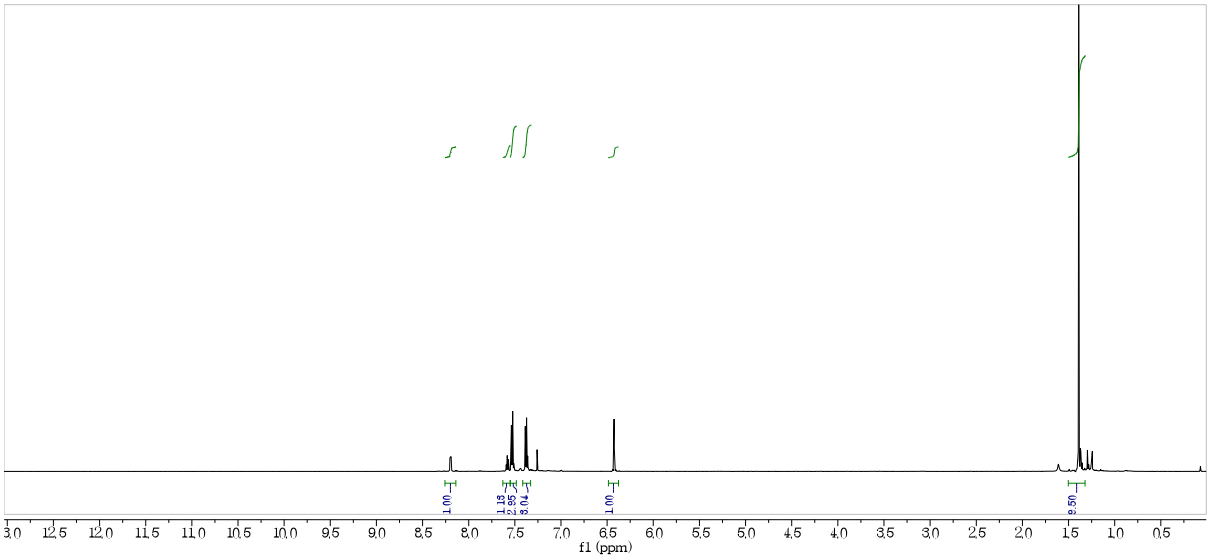

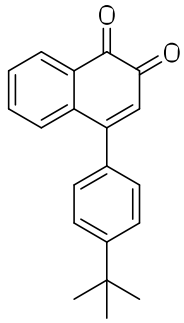

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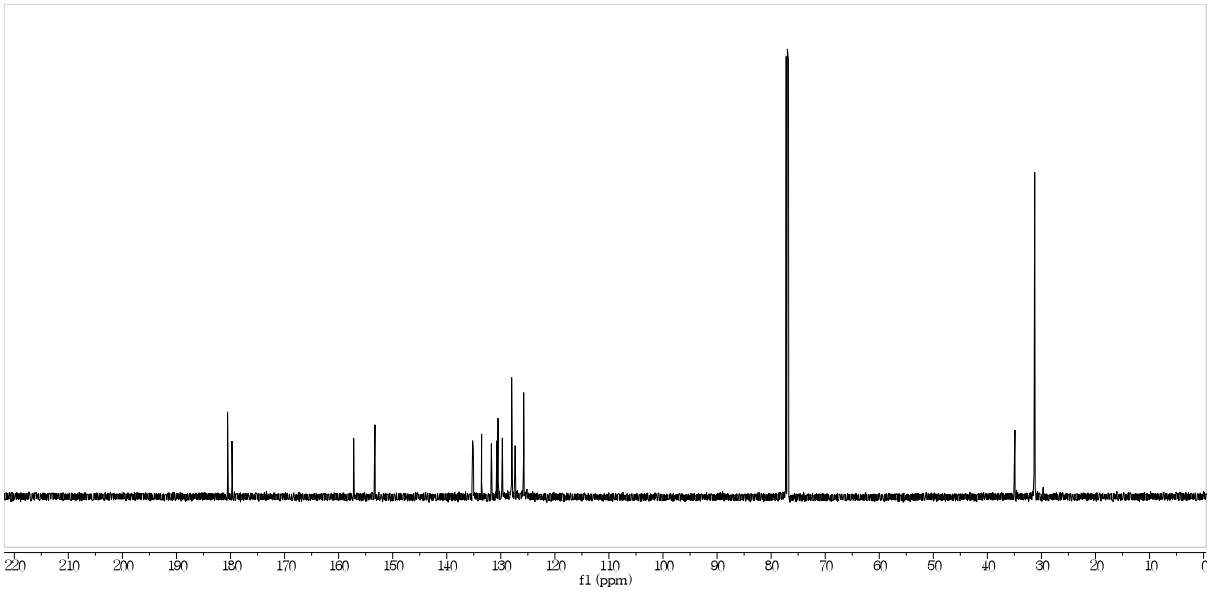

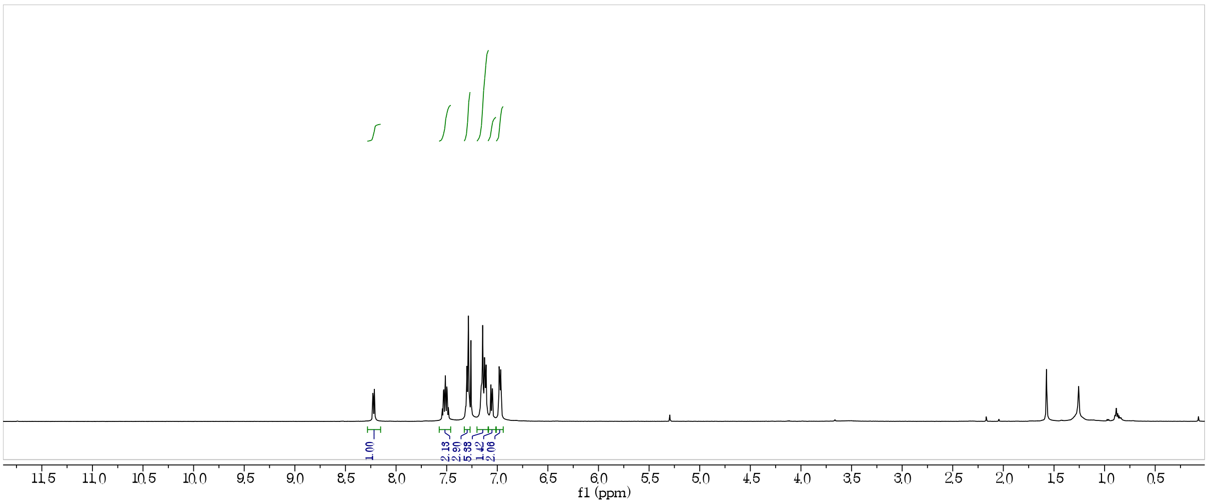
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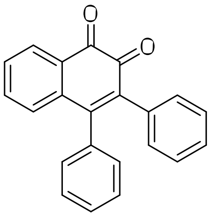
f1 (ppm)



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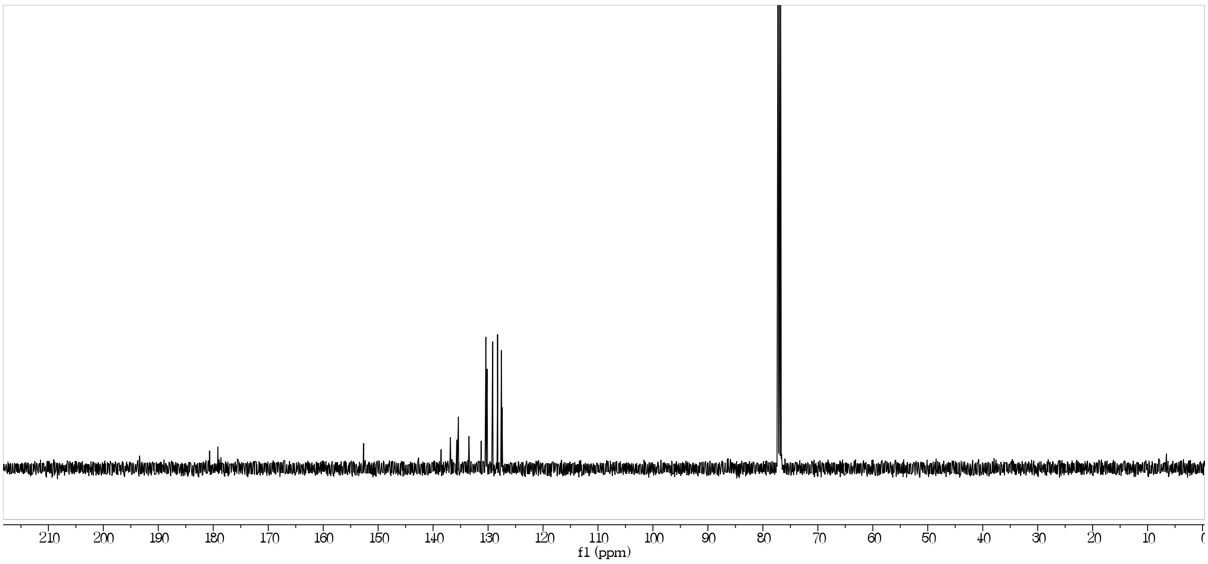
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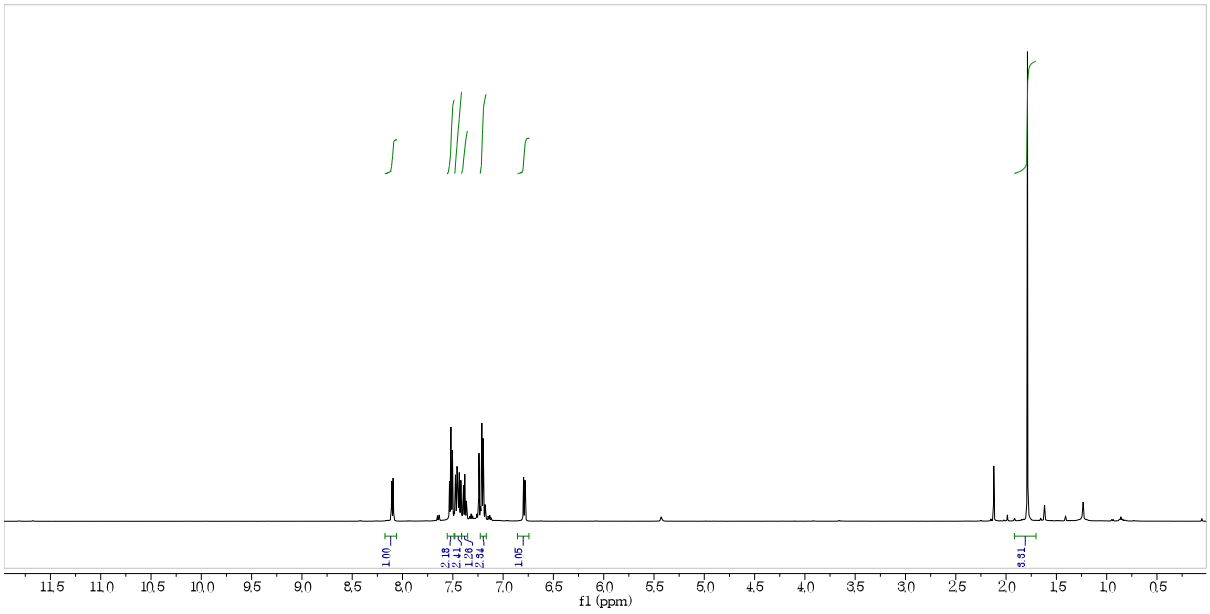
f1 (ppm)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1.05
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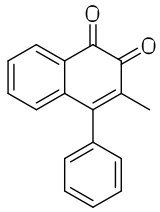
f1 (ppm)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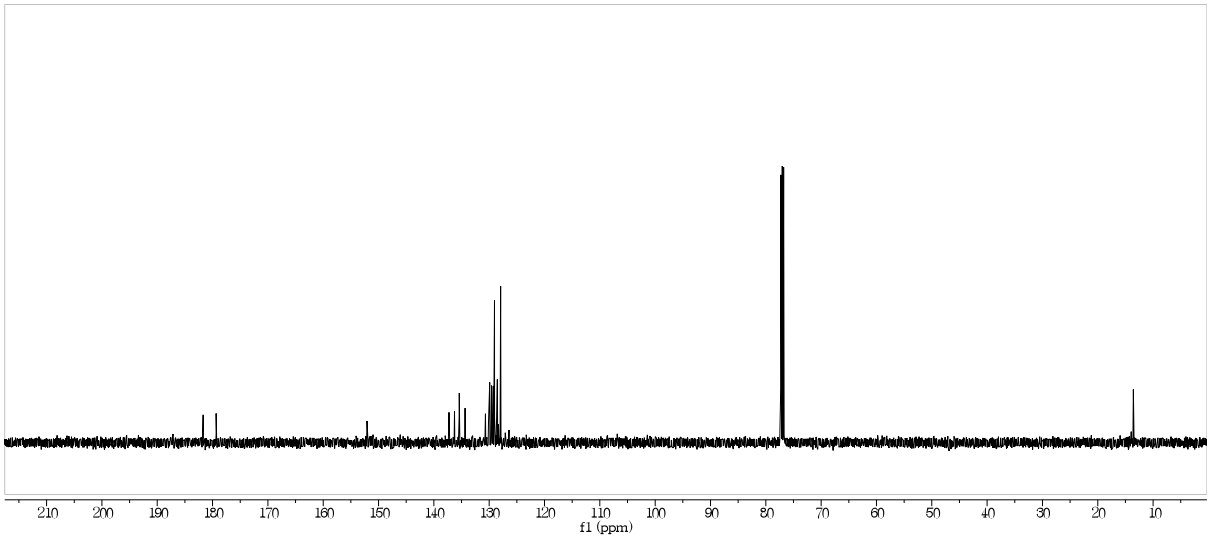
2i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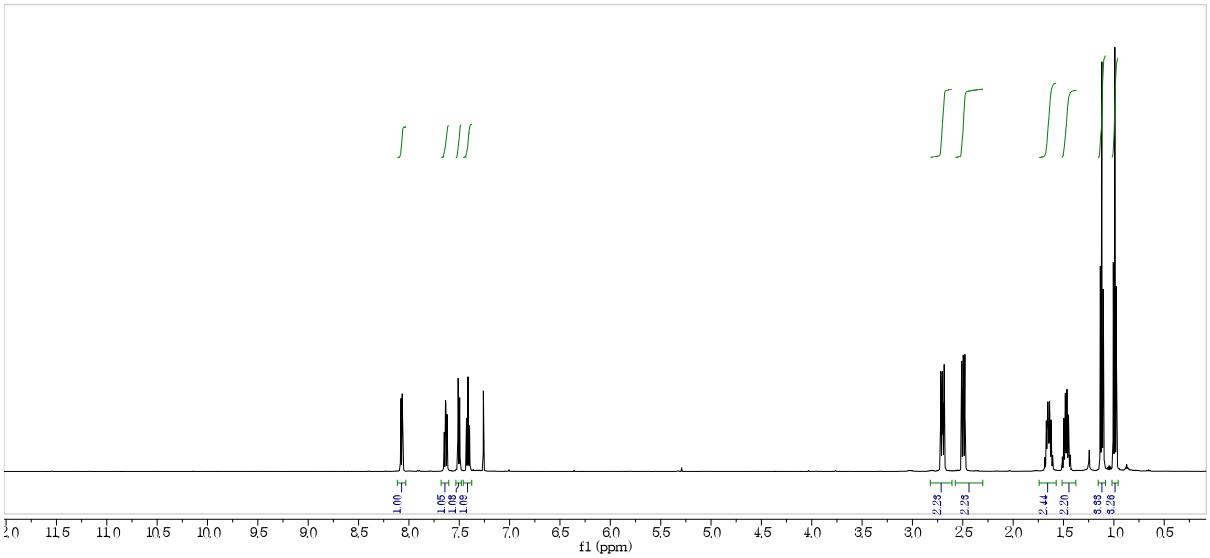

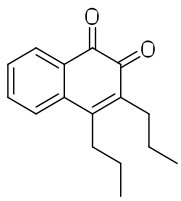

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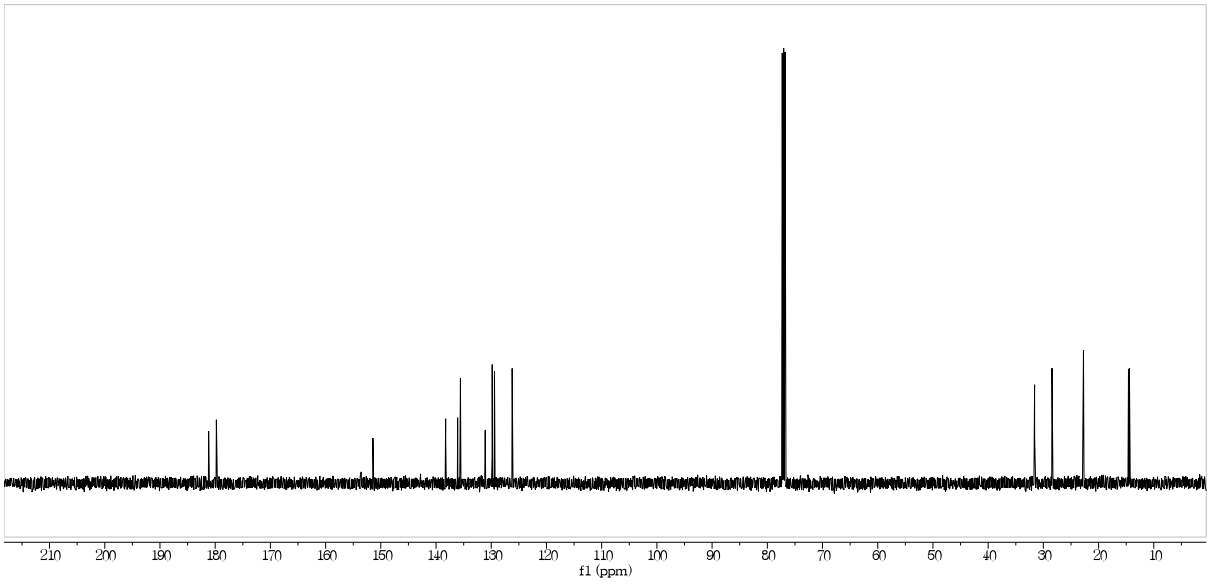

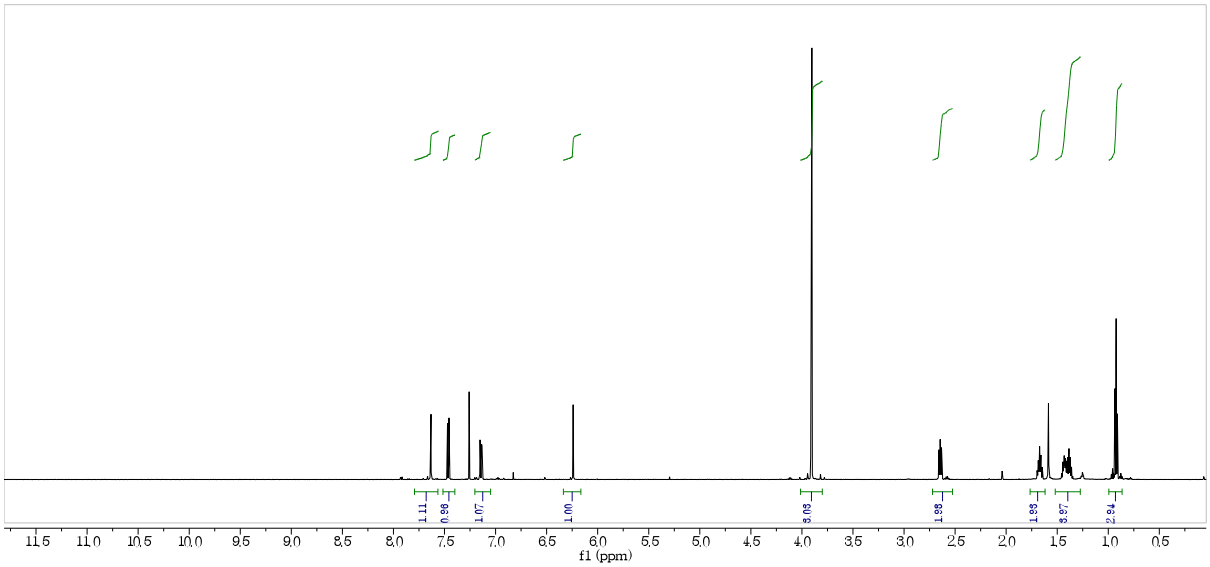

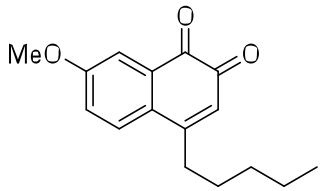

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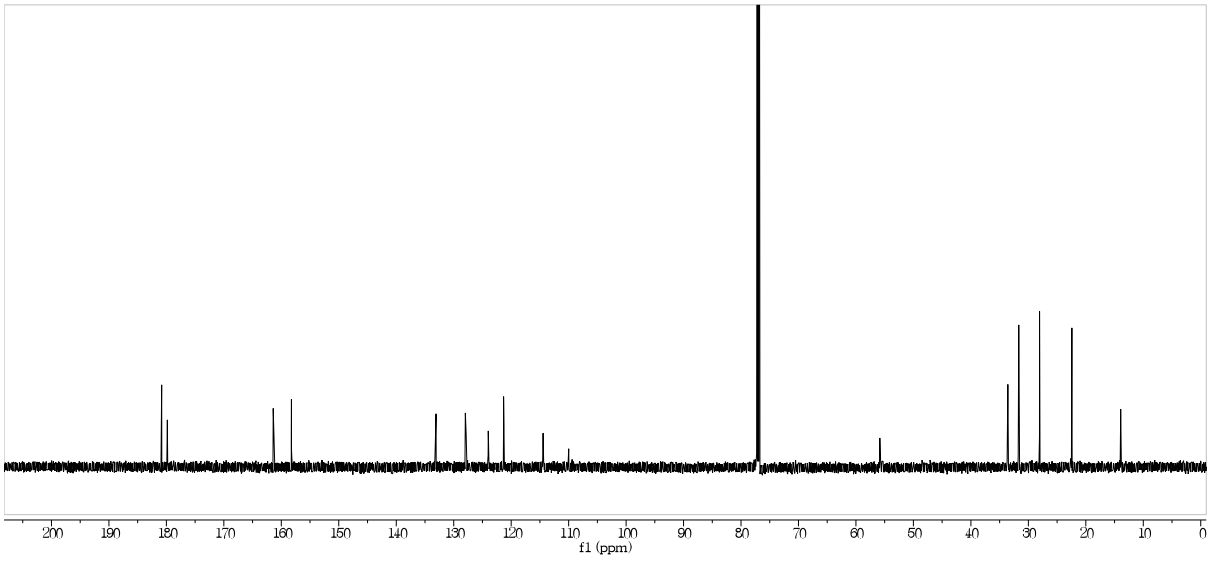

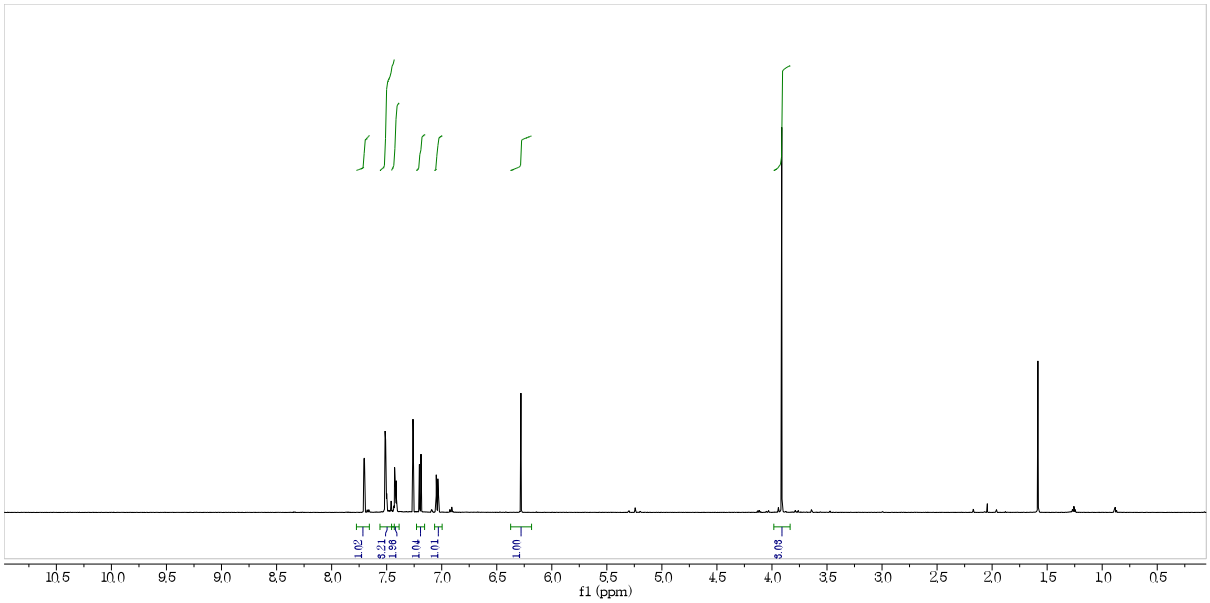

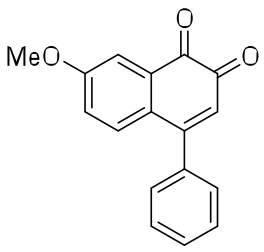

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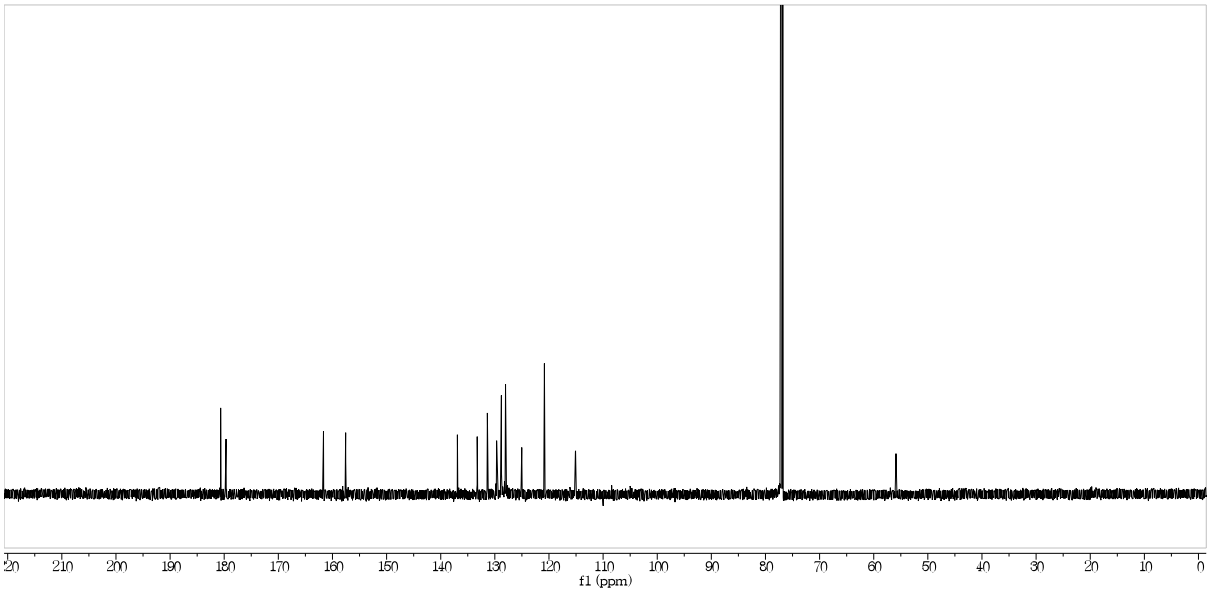

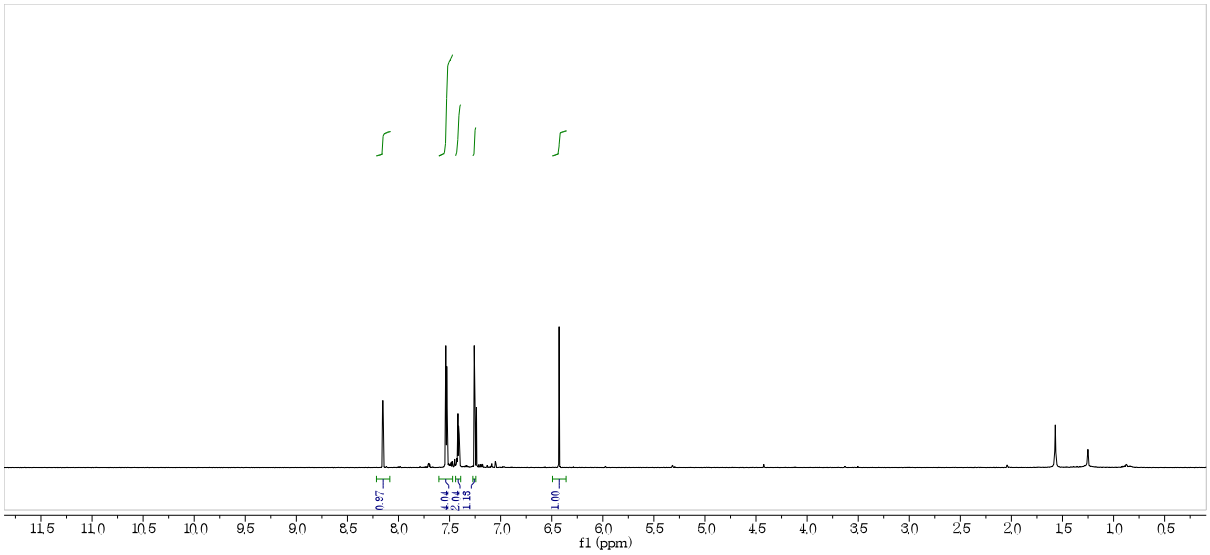

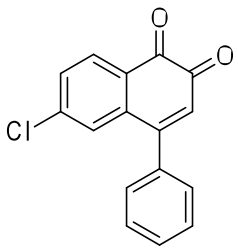

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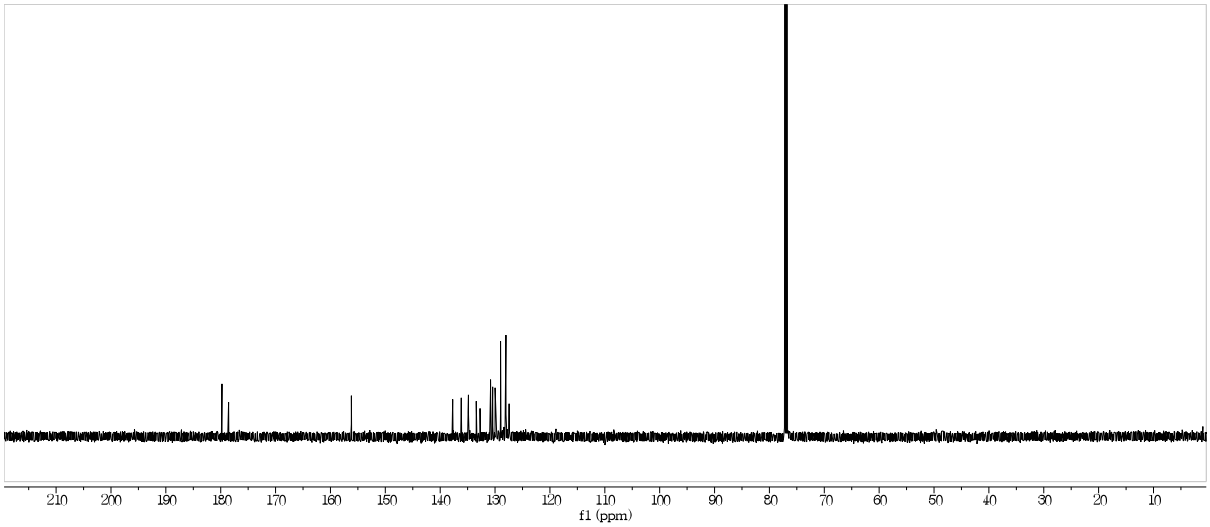

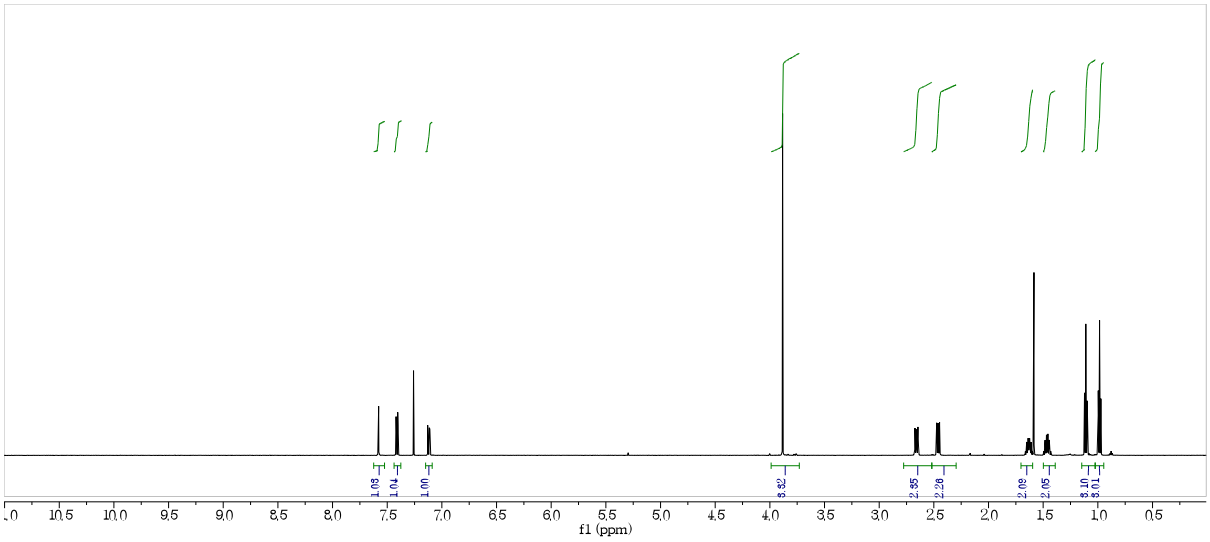

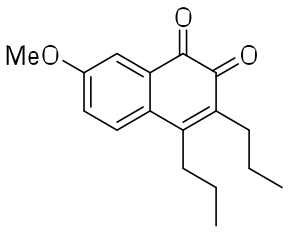

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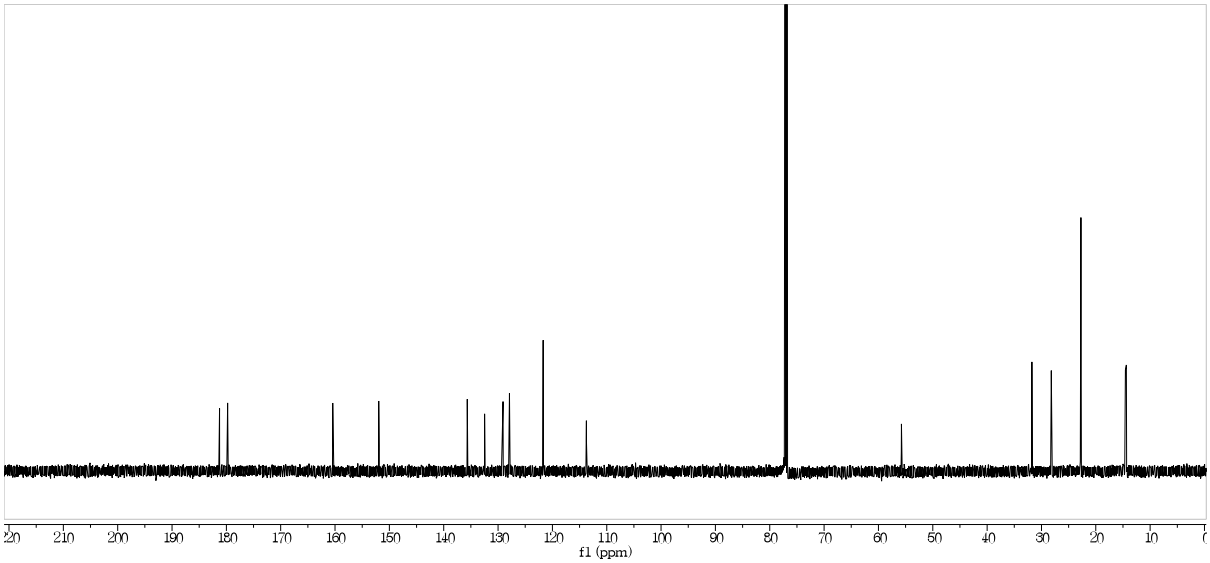

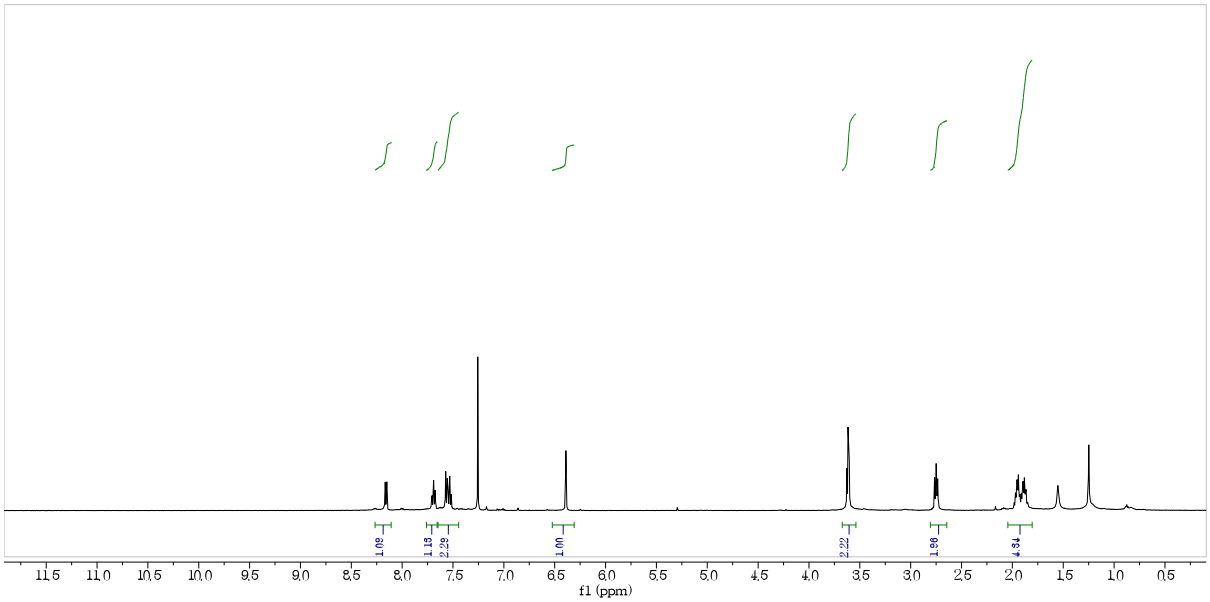
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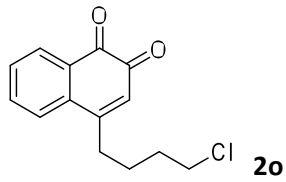
1.00
2.22
1.80
4.84
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)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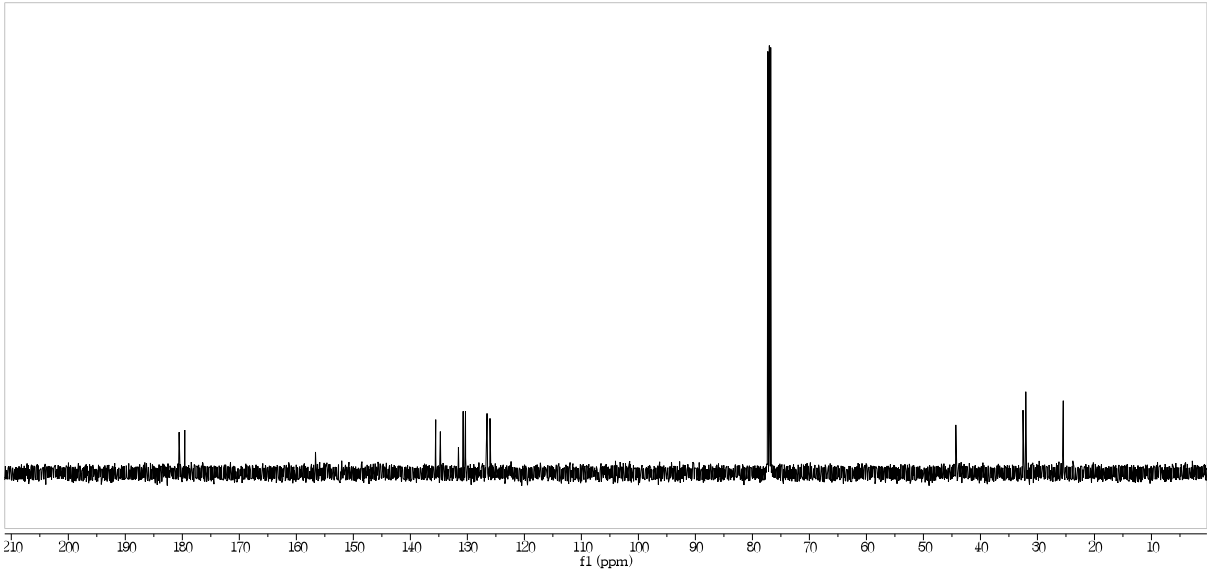
O
Cl

2o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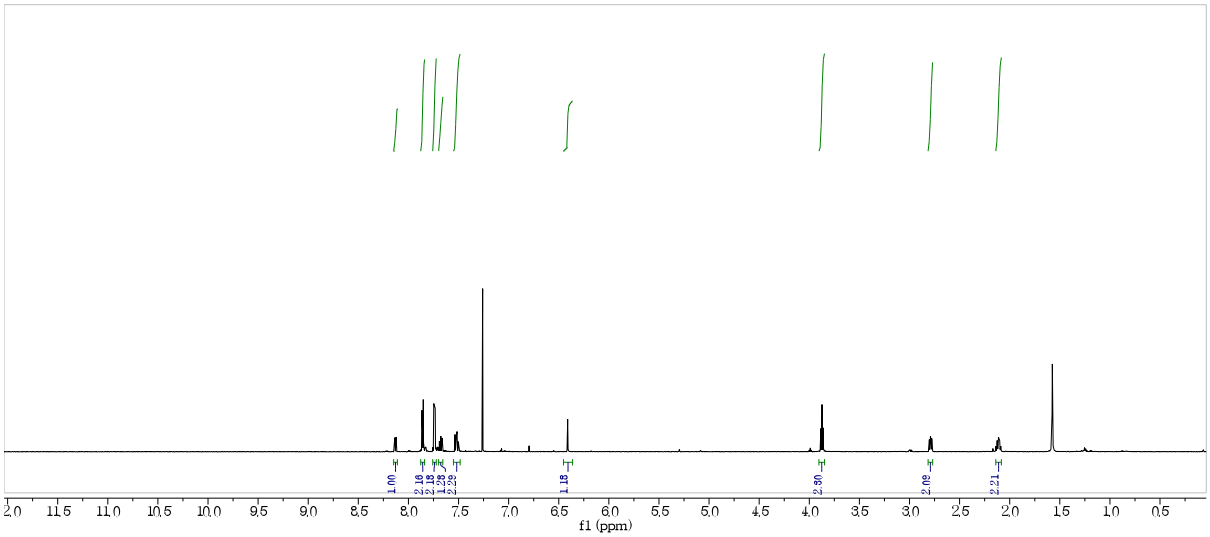

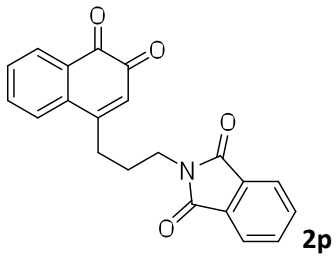

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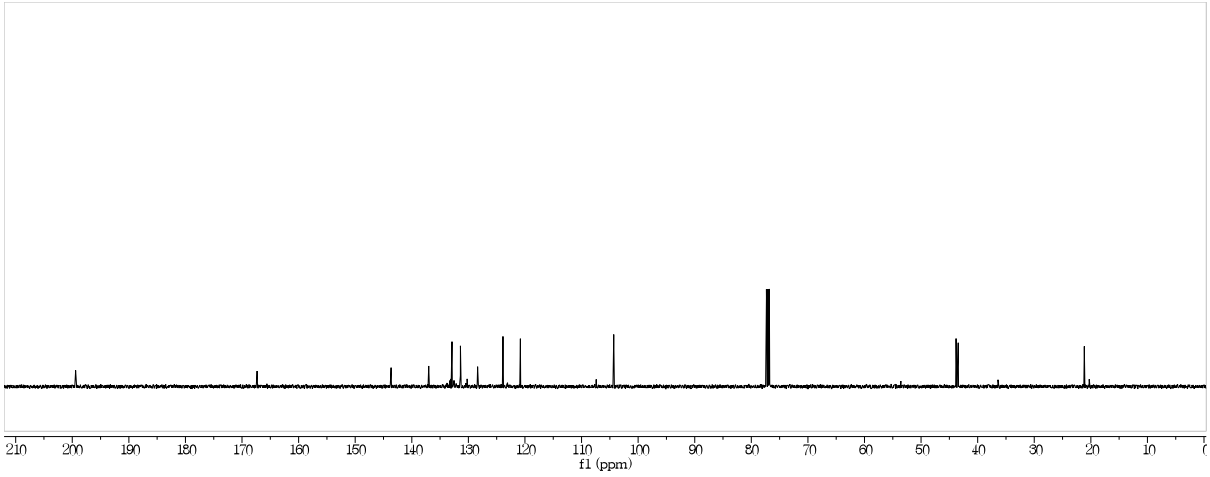

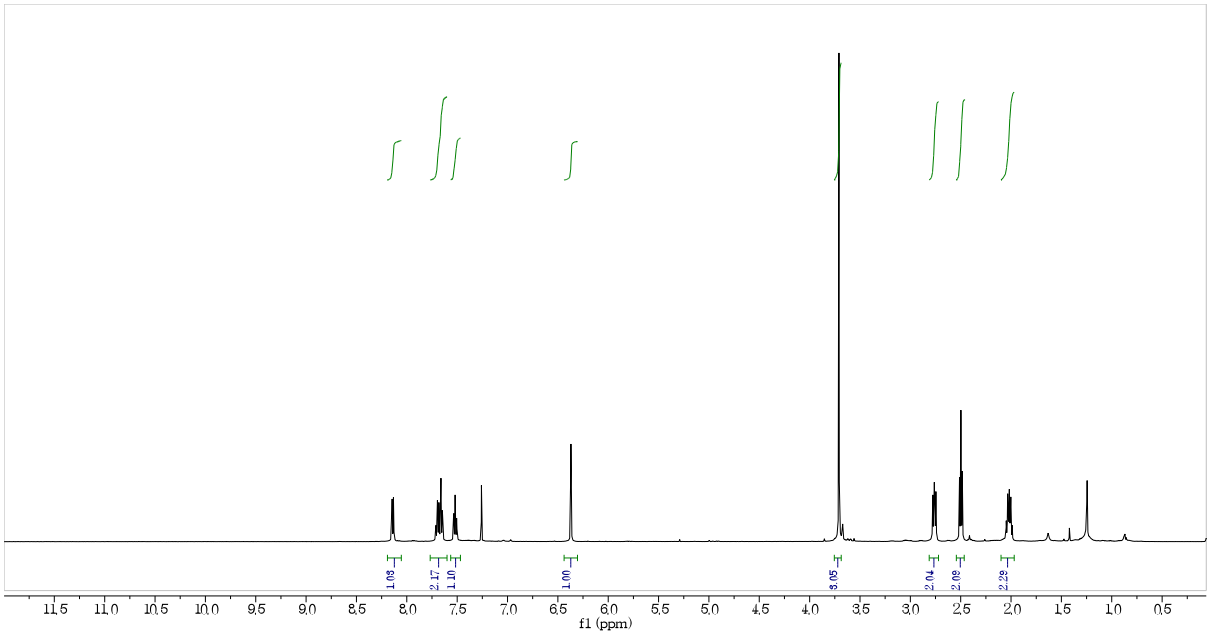
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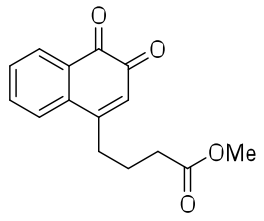
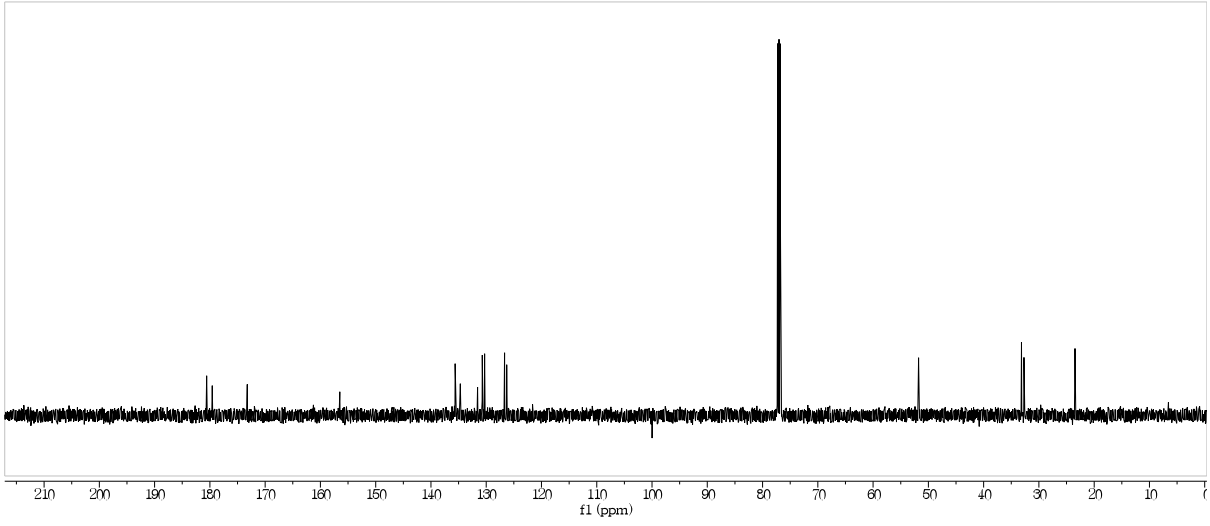
2.08
2.28
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


O
O
OMe
O

2q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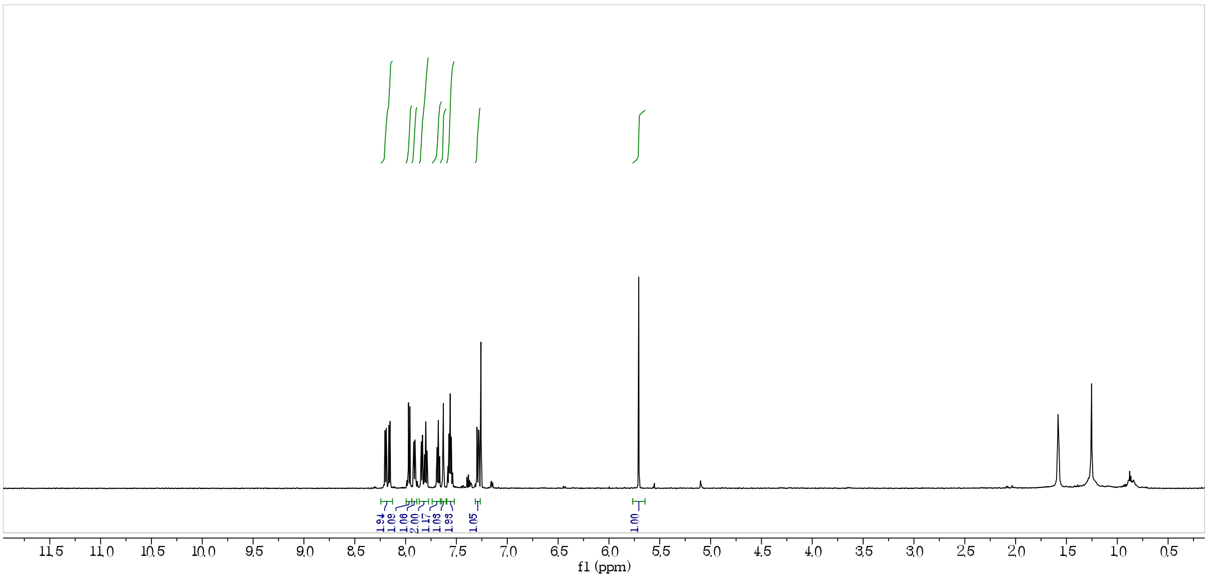
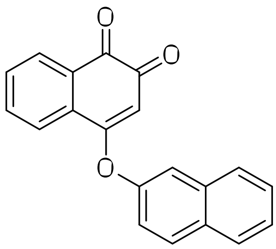
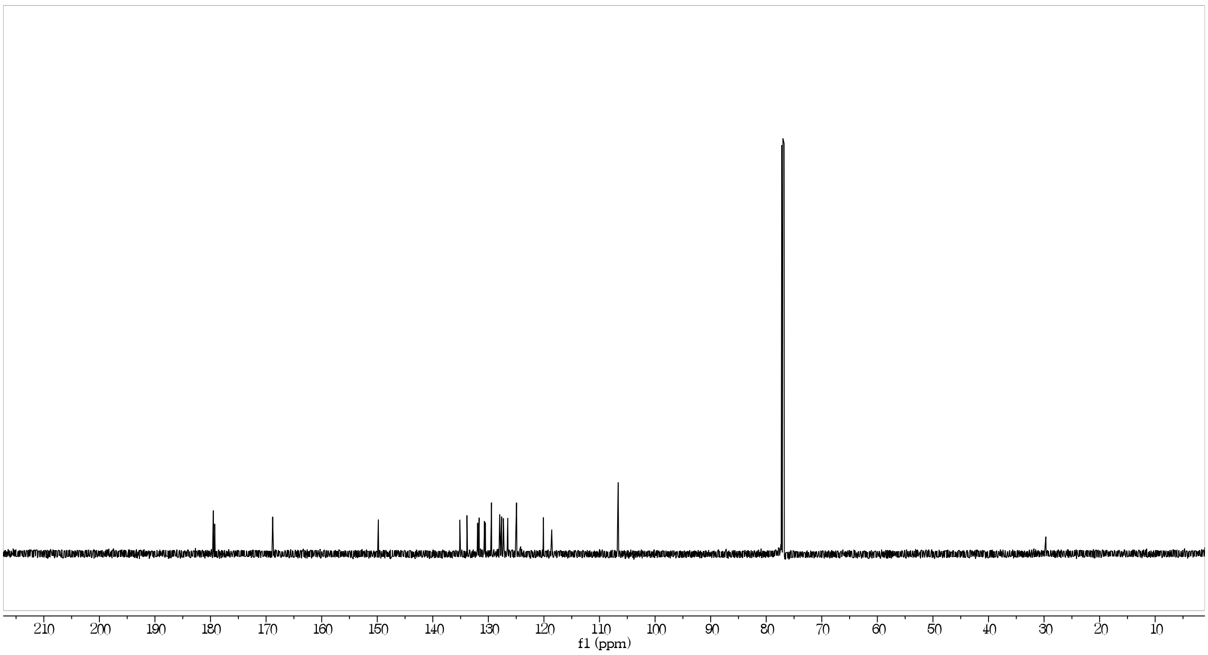
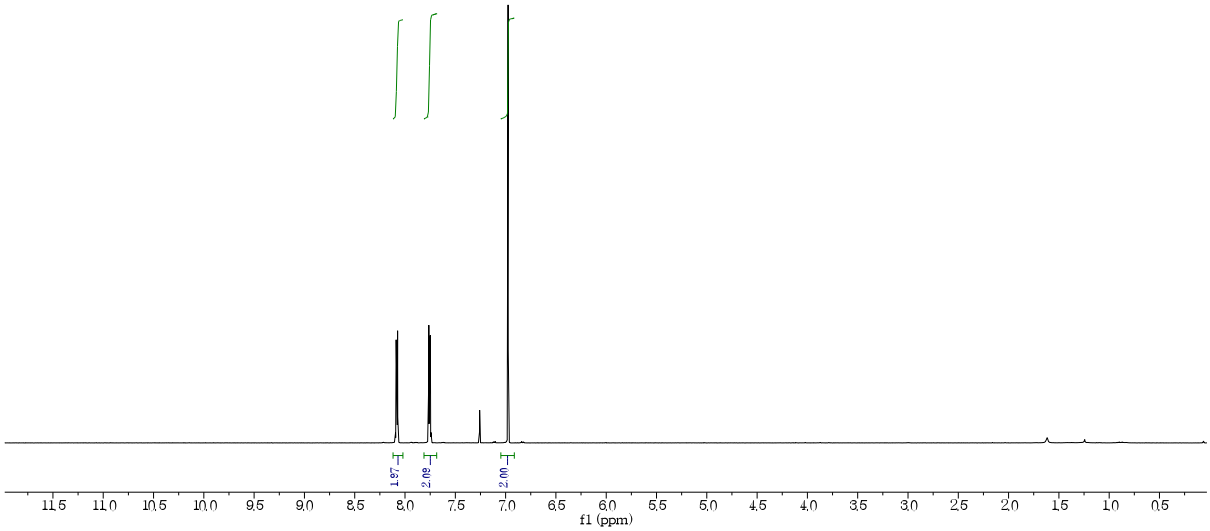
f1 (ppm)

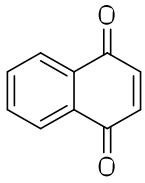




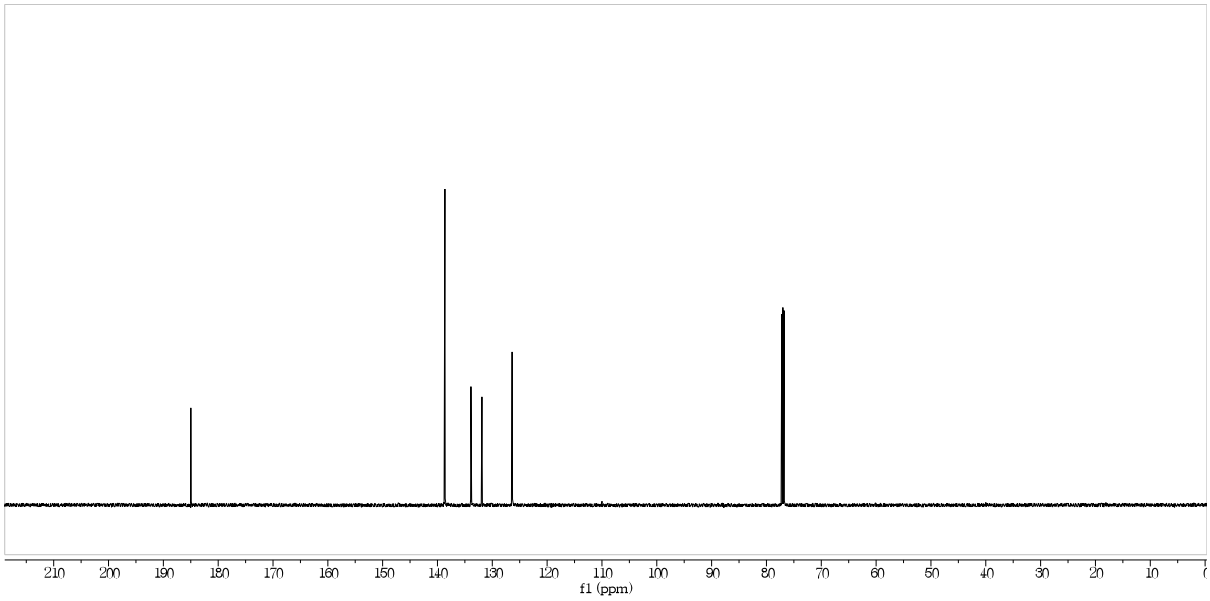
2r




1.87
2.08
2.00
11.5 11.0 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
f1 (ppm)


O
O

2s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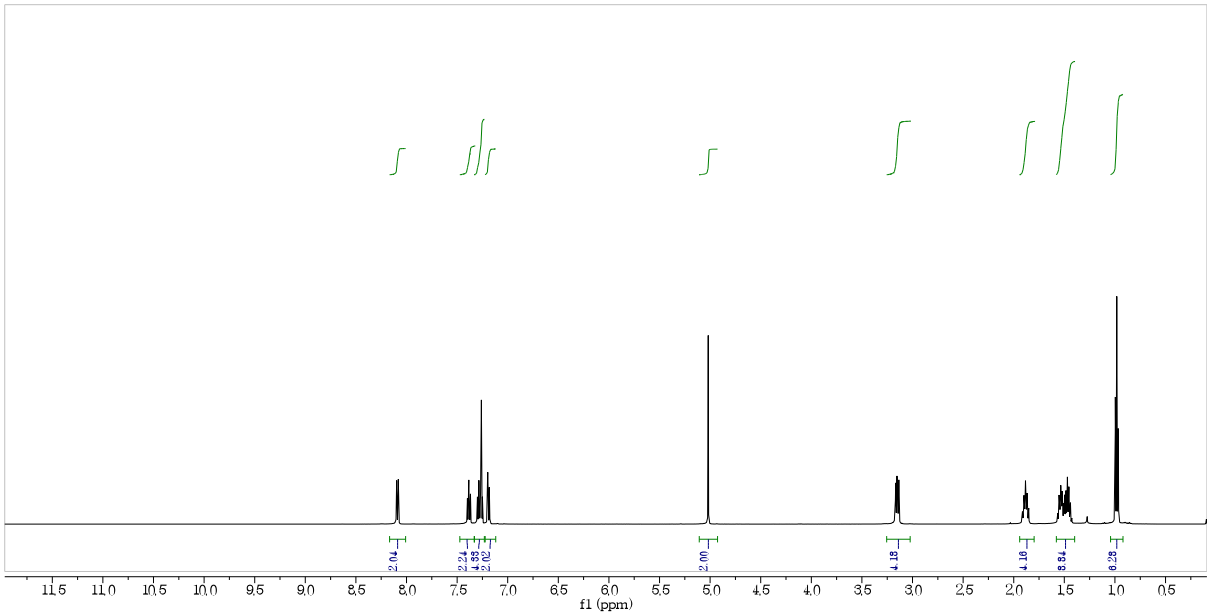
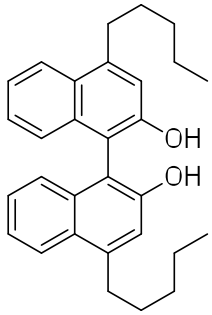
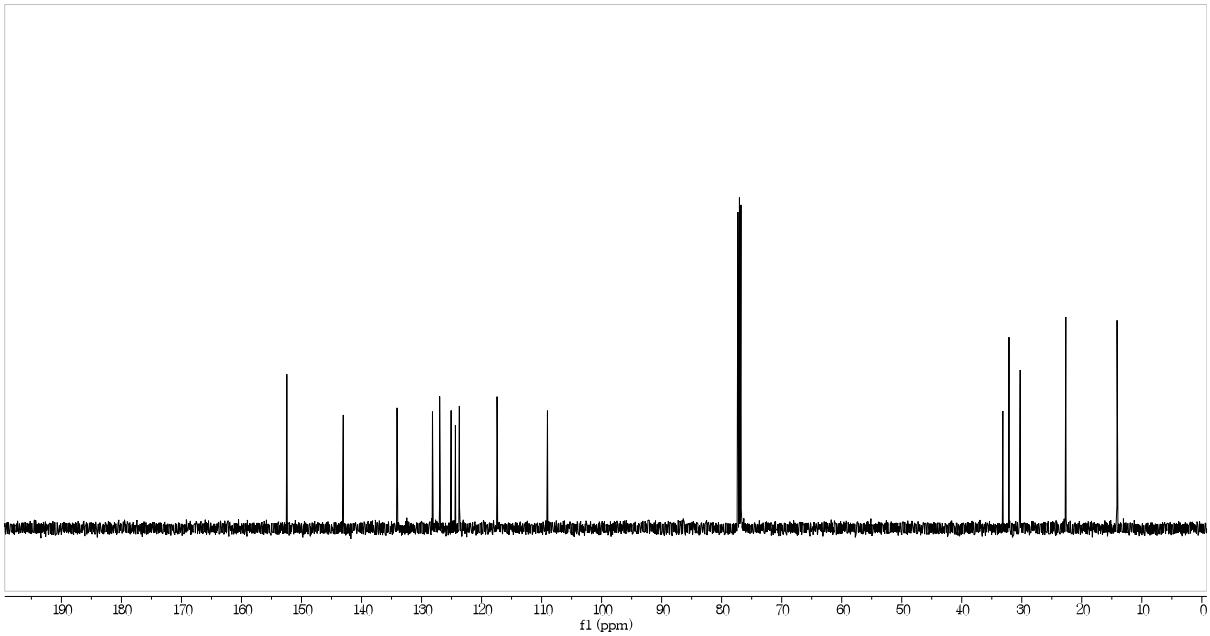
f1 (ppm)


2.04
2.24
4.53
2.02
2.00
4.18
4.16
8.84
6.28
11.5 11.0 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
f1 (ppm)


OH
OH

3a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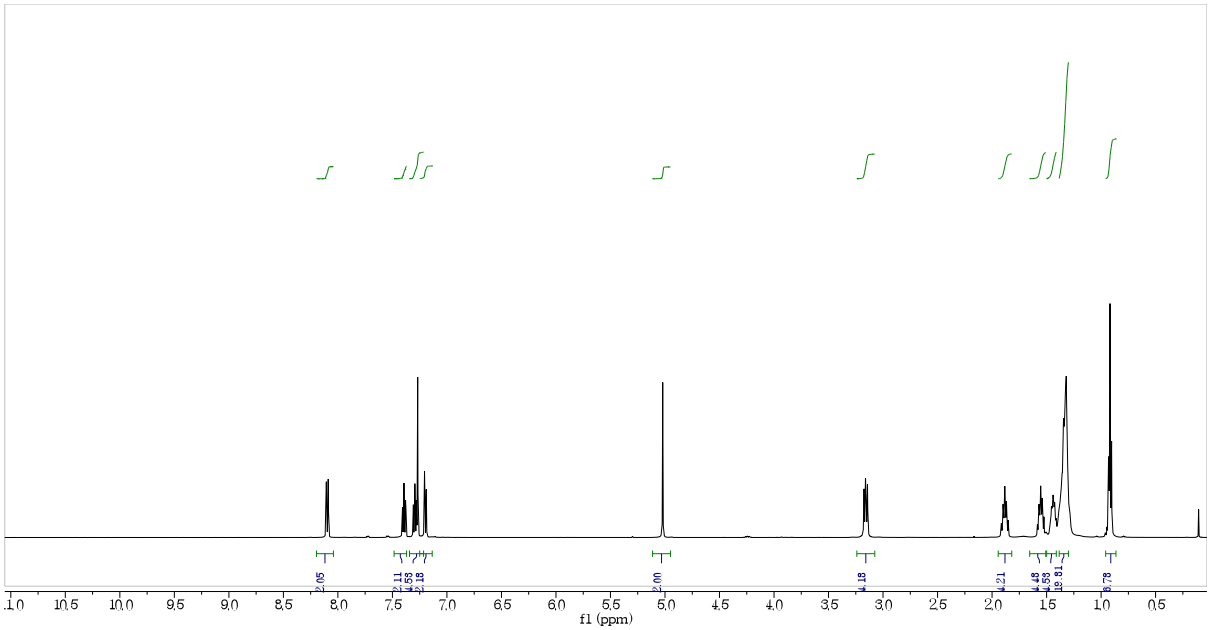
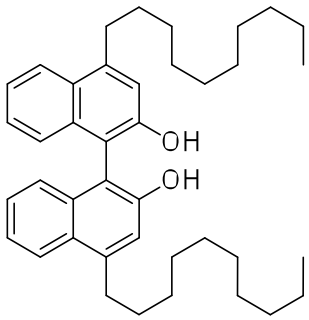
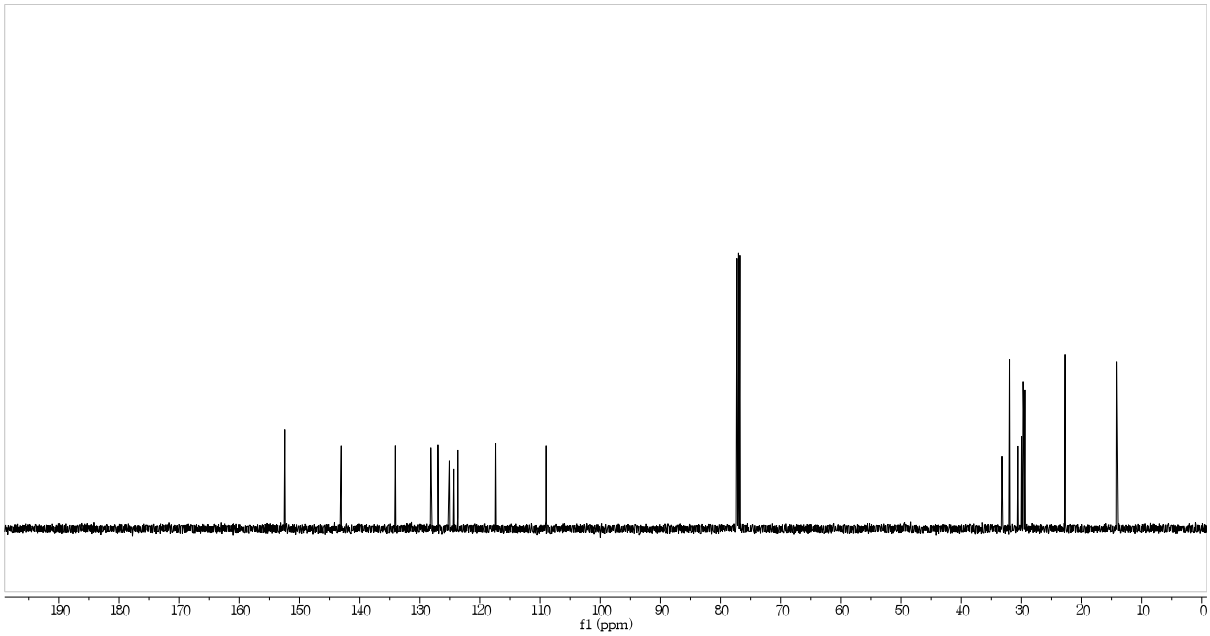
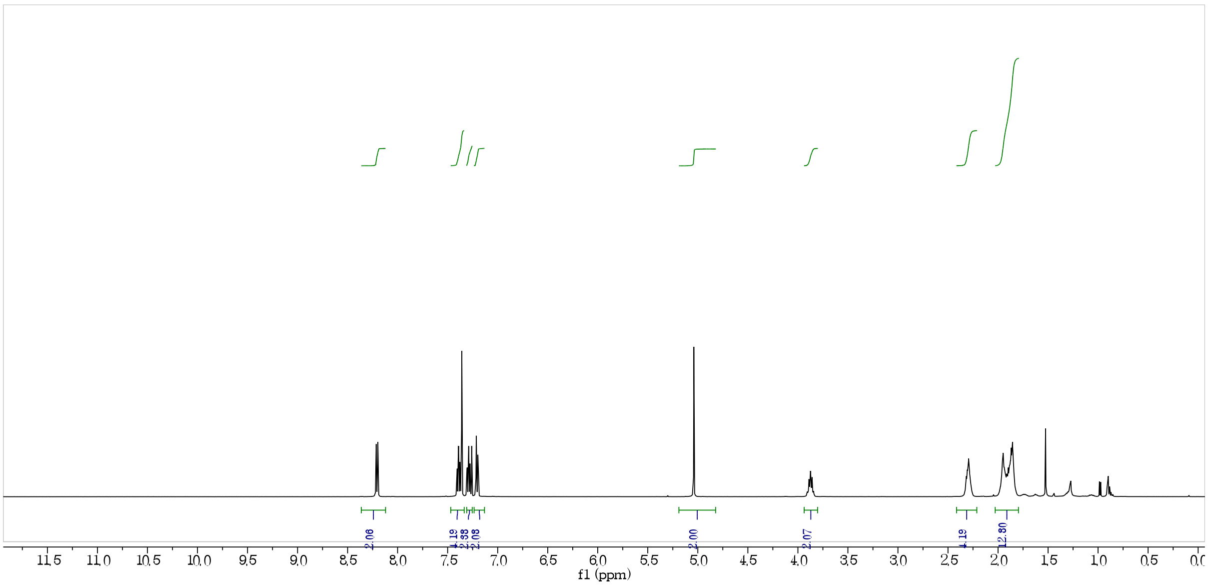
f1 (ppm)

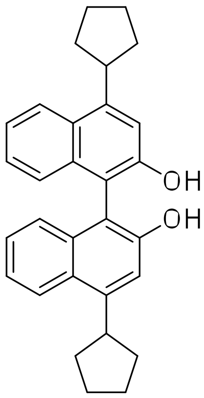




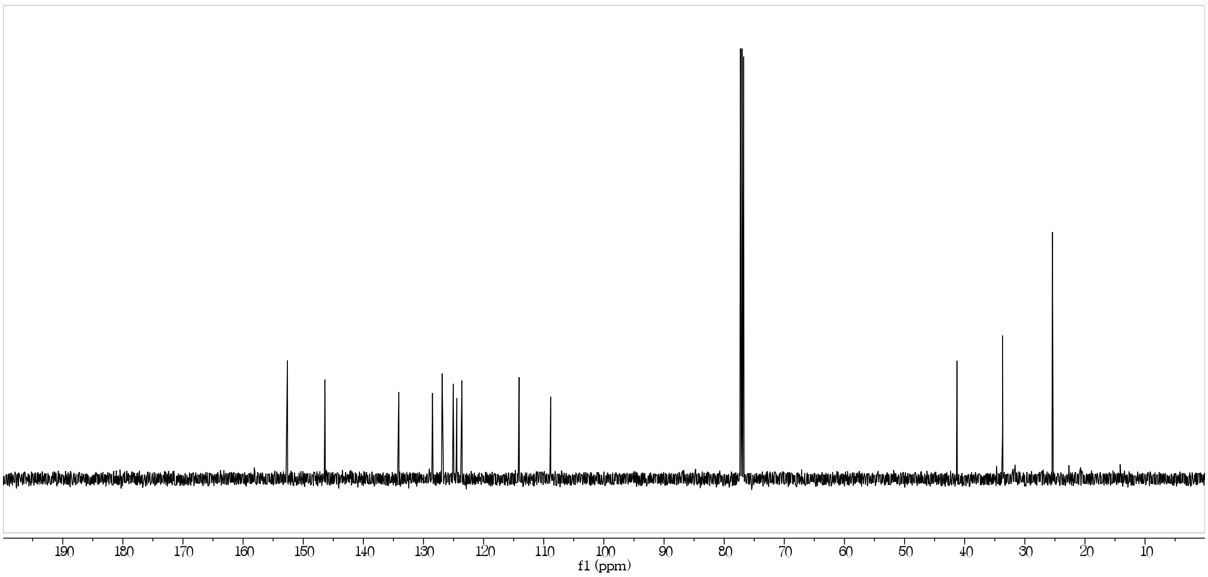
3b

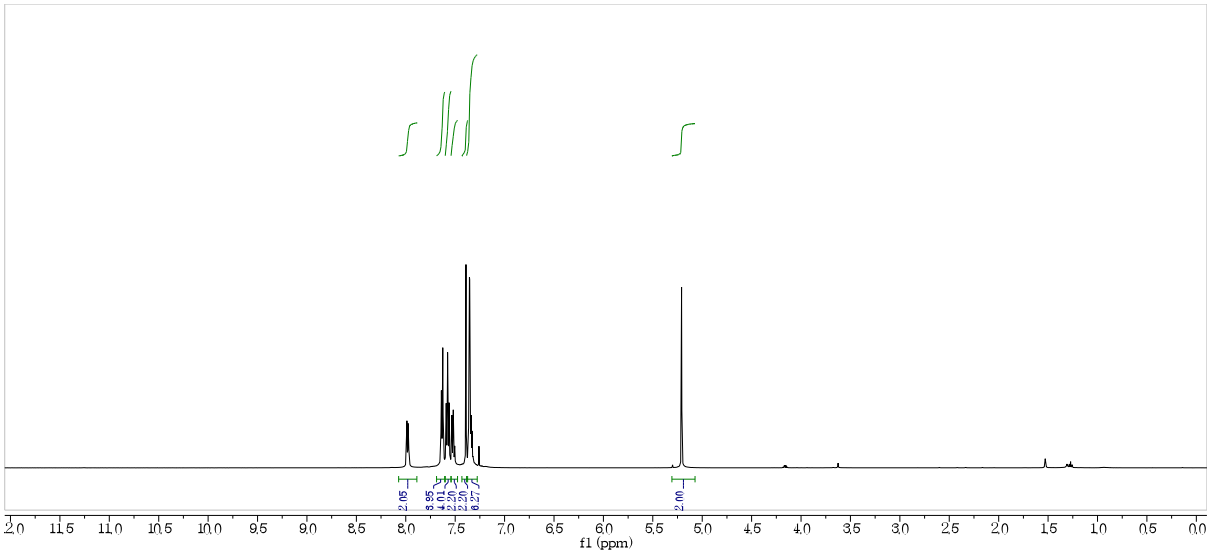


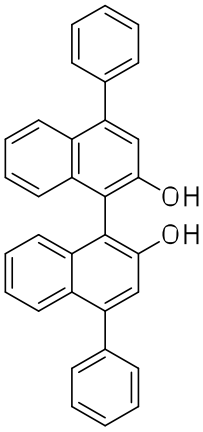

2.06
1.19
2.53
2.08
2.00
2.07
4.19
12.80
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


OH
OH

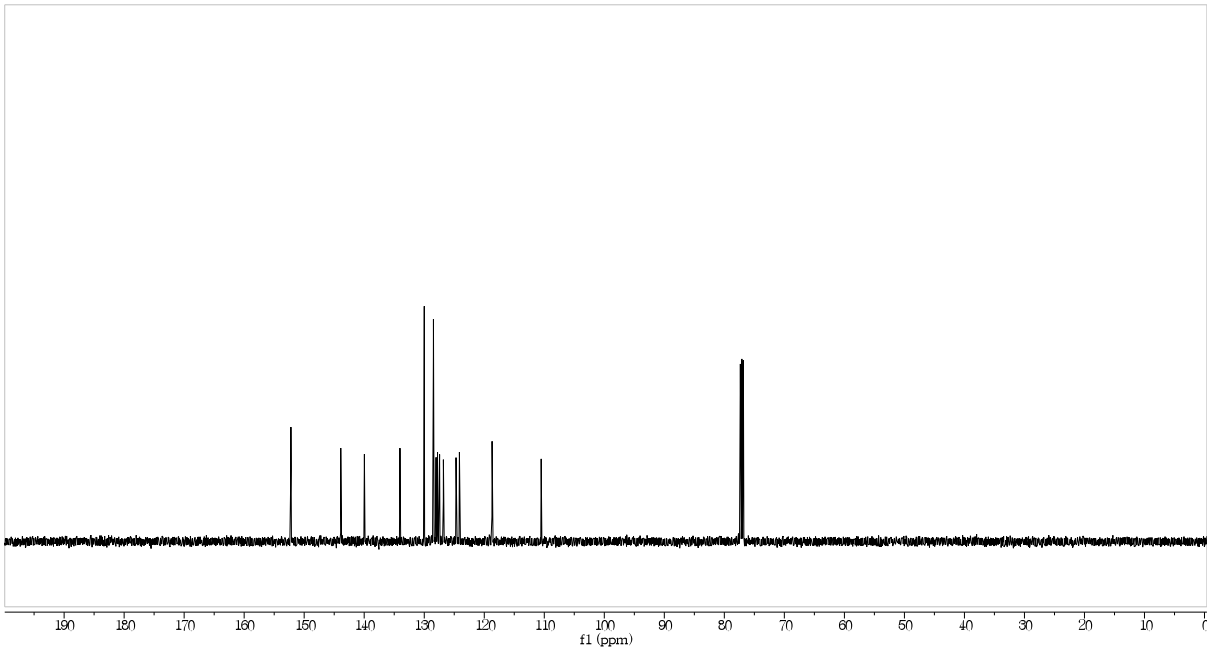
3c

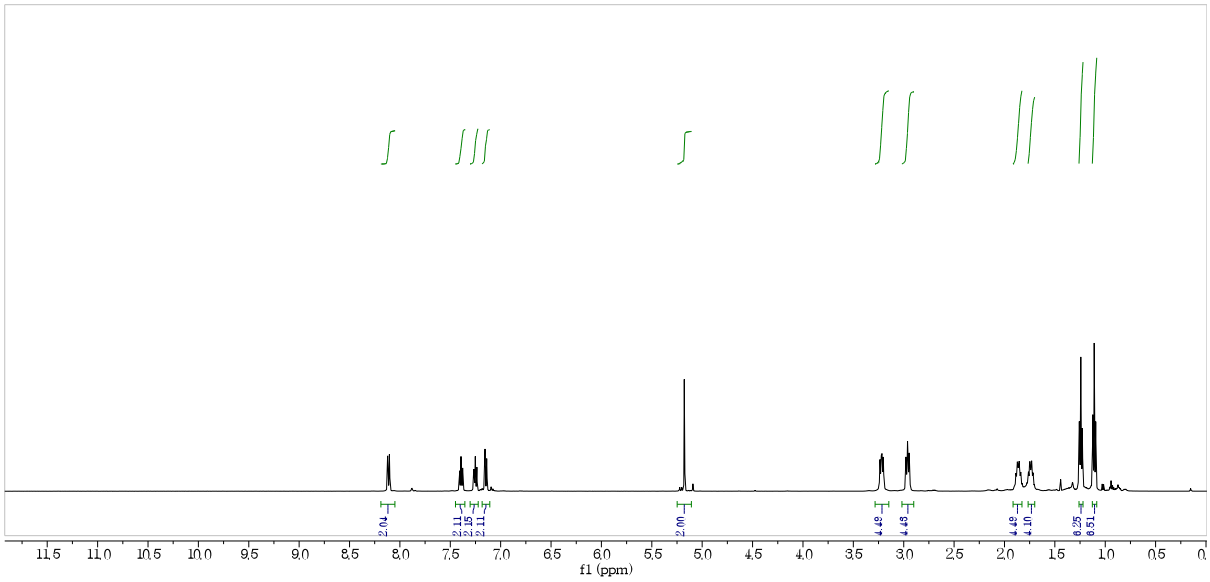

190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

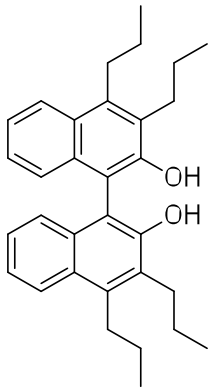




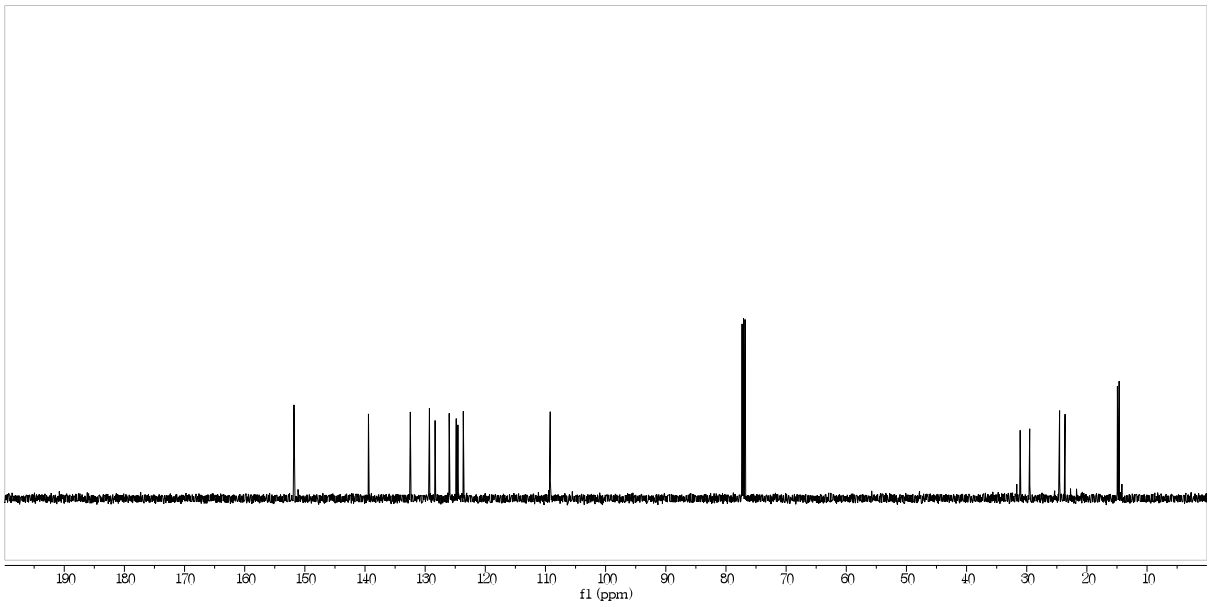
3d

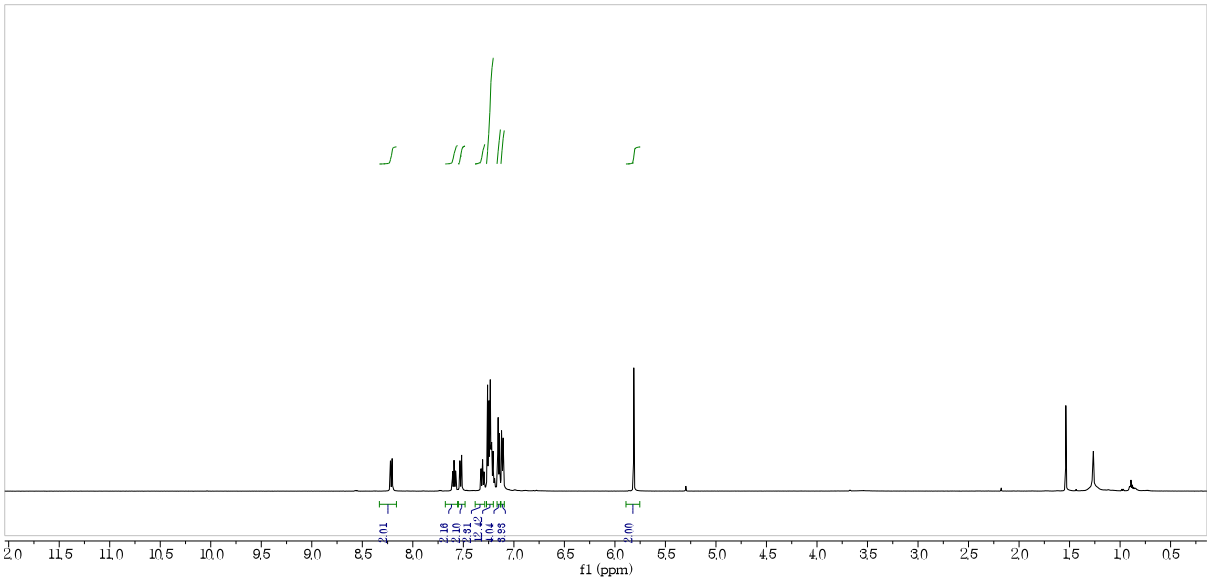


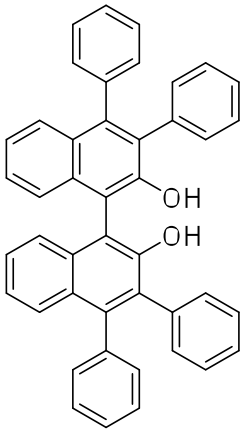




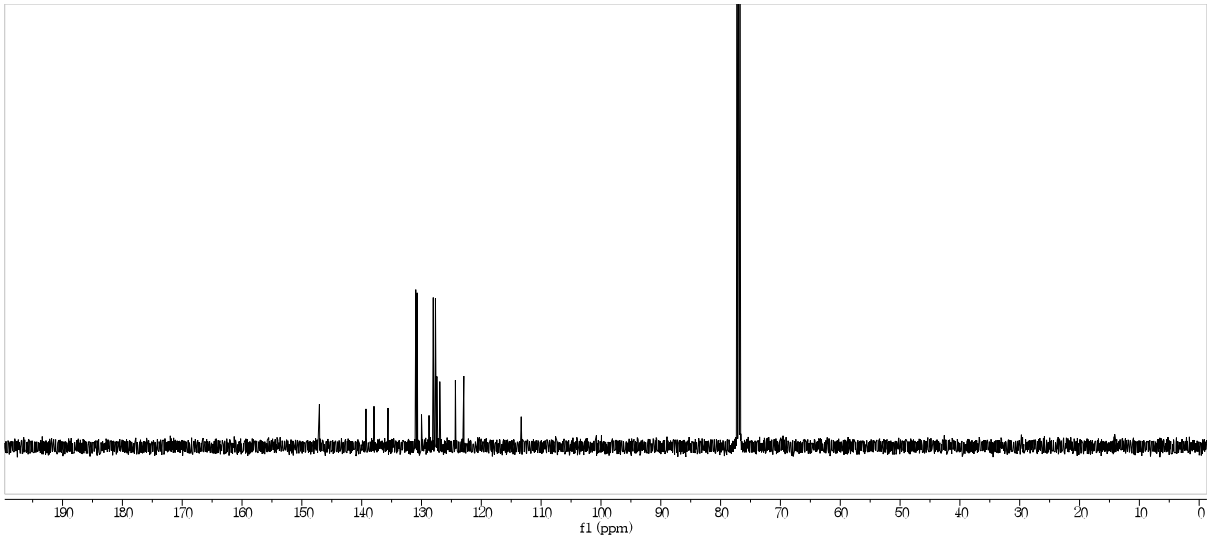
3e

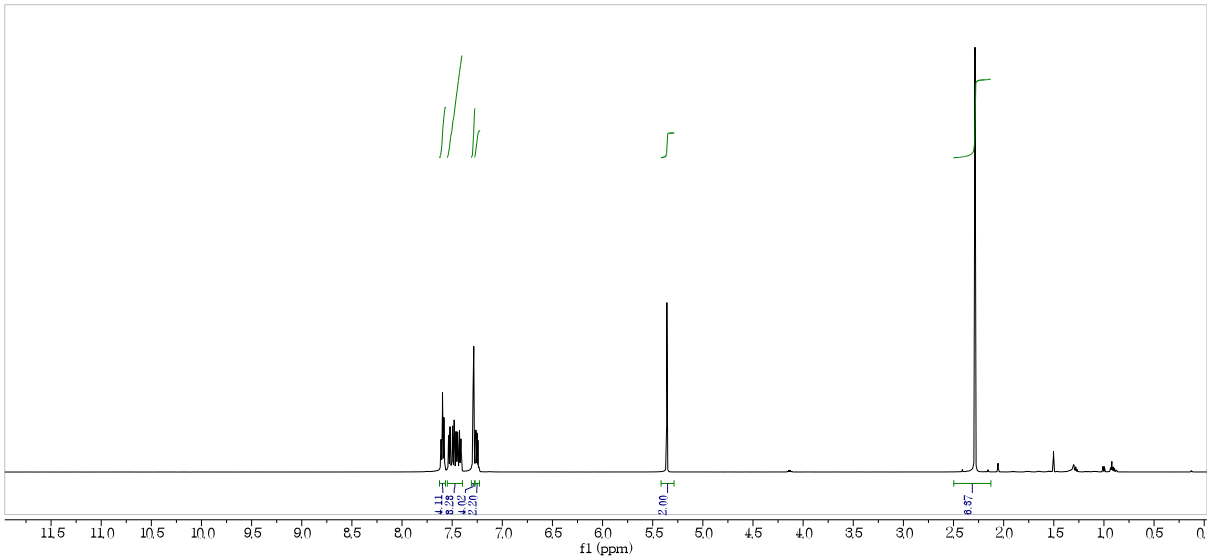


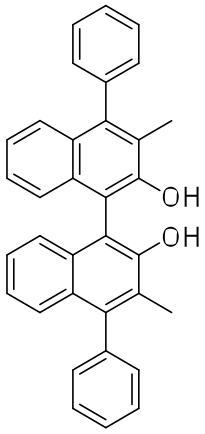




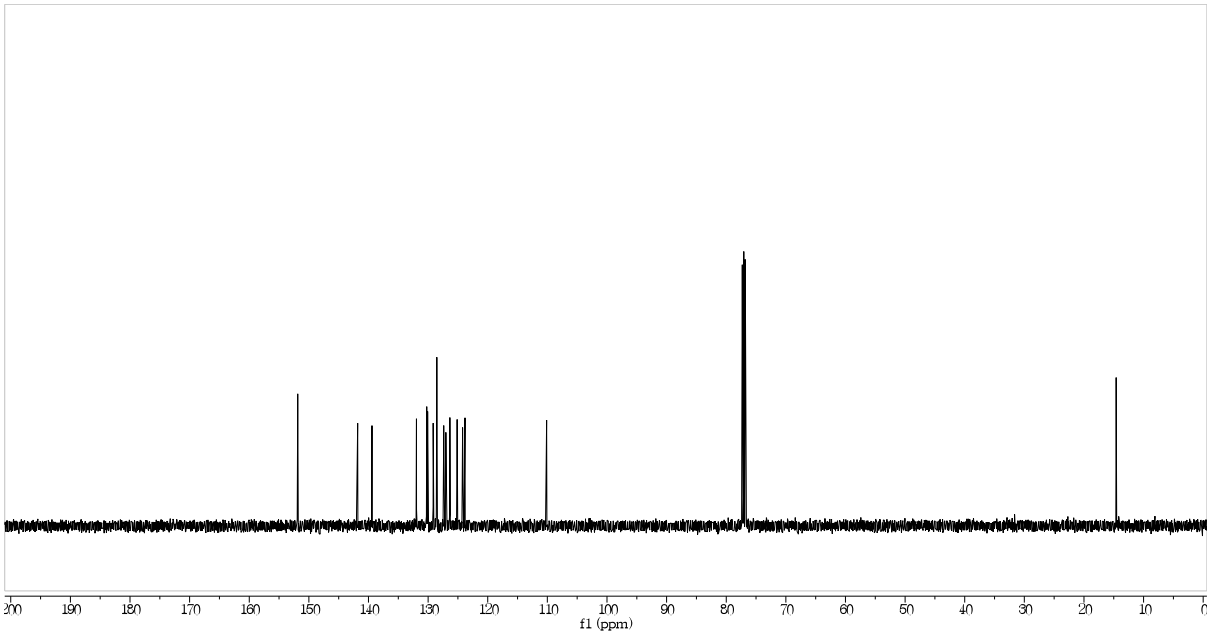
3f

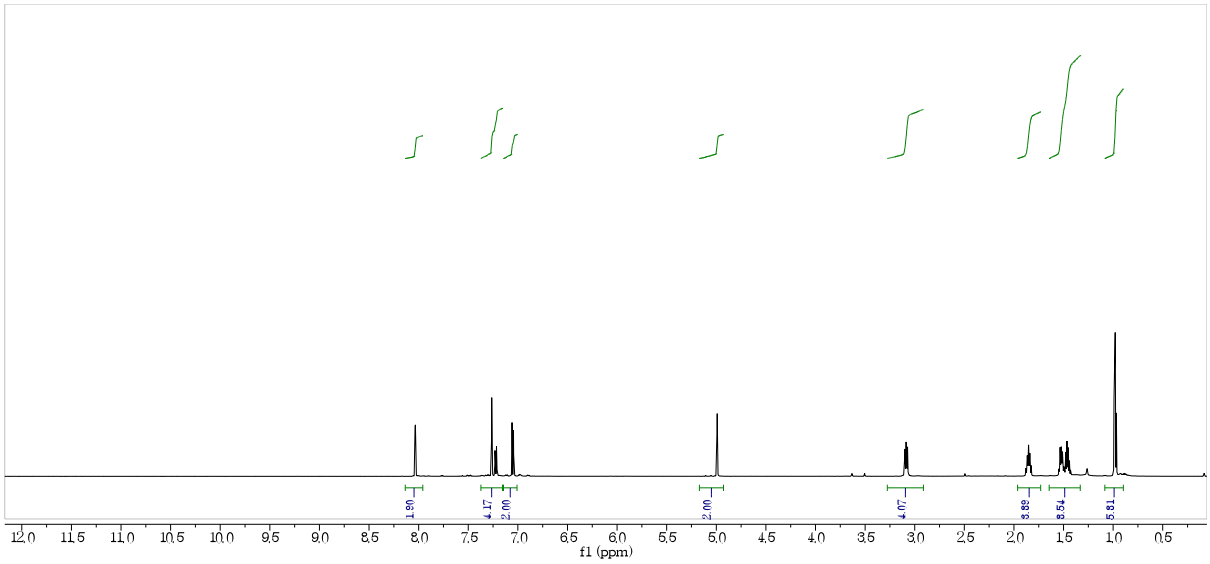


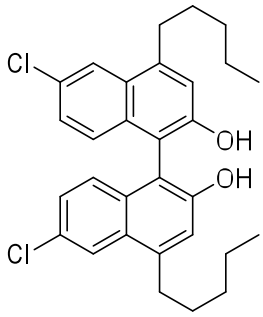




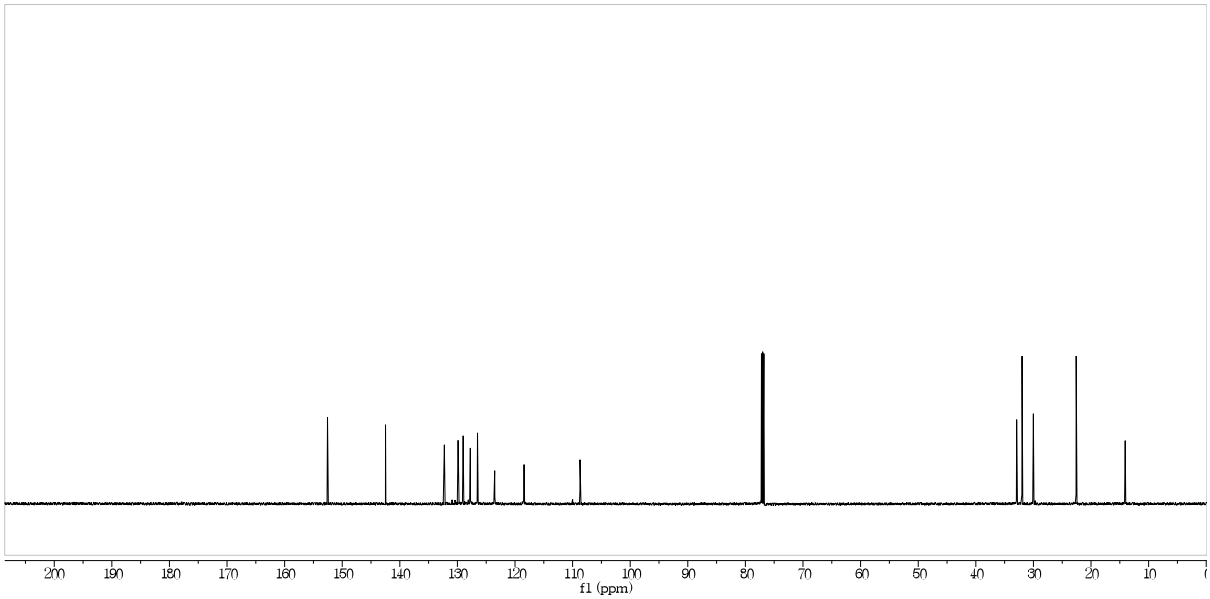
3g




1.90
4.17
2.00
2.00
4.07
3.89
8.54
5.81
12.0 11.5 11.0 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
f1 (ppm)


Cl
OH
OH
Cl

3h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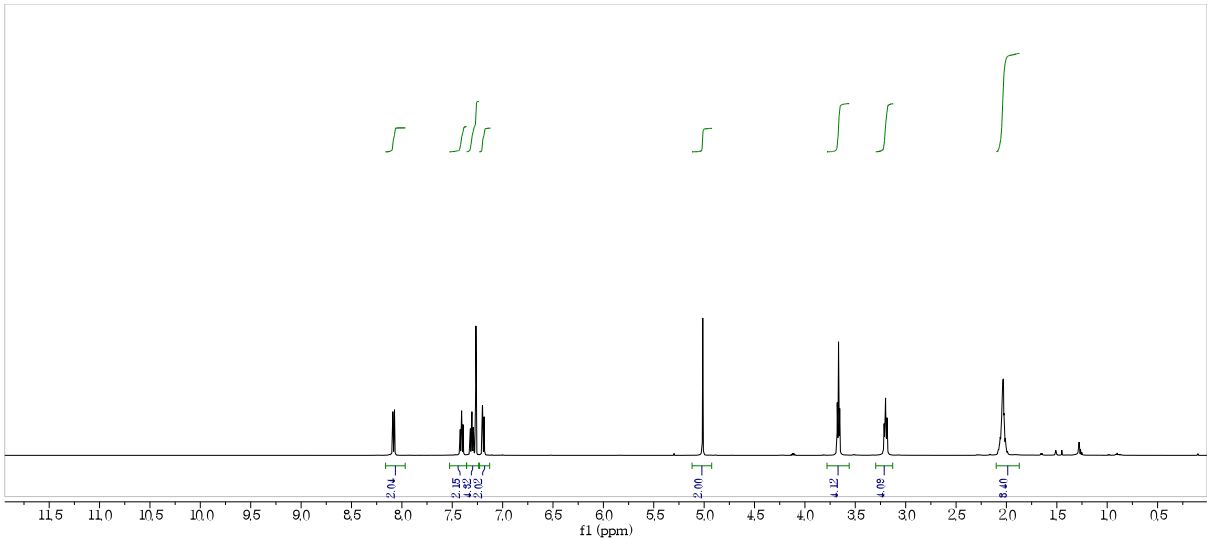
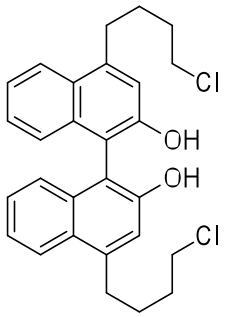
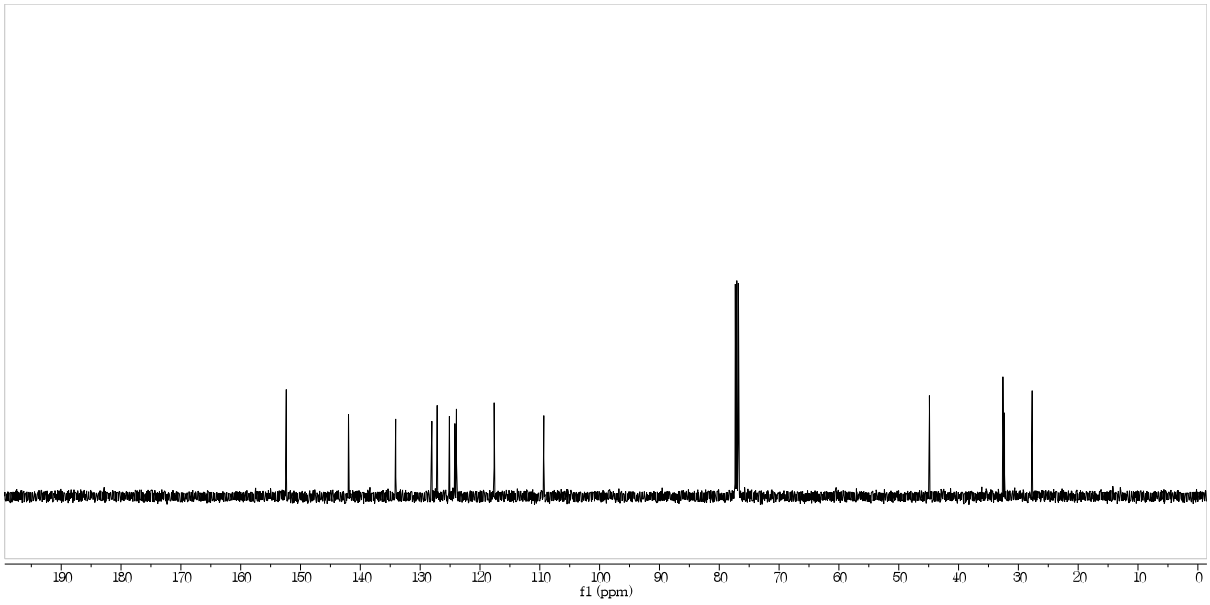
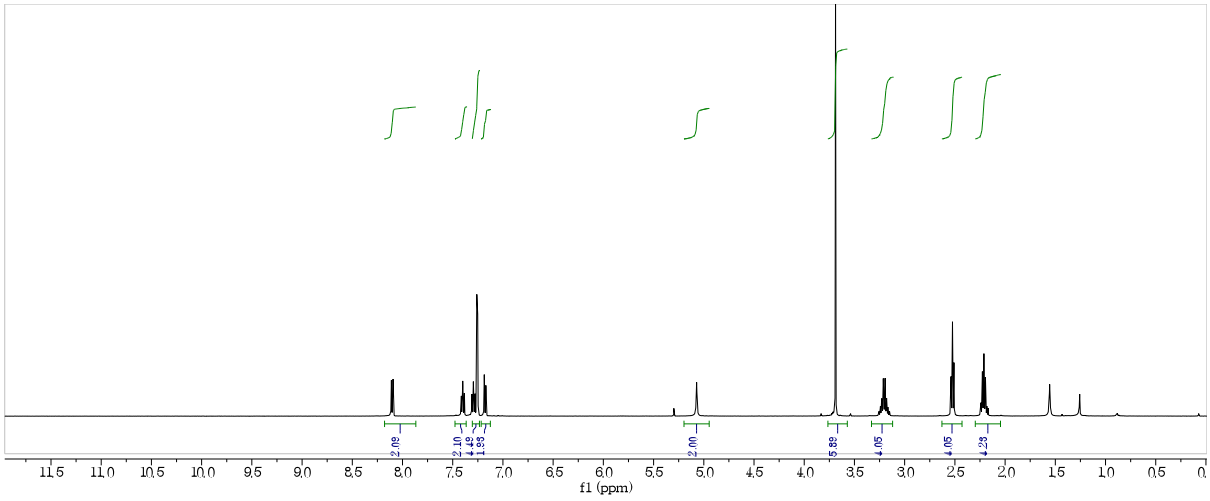
f1 (ppm)

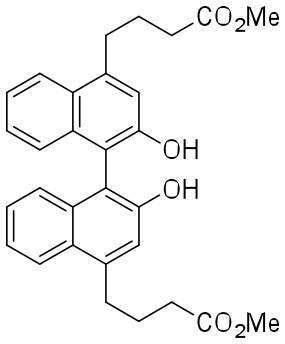




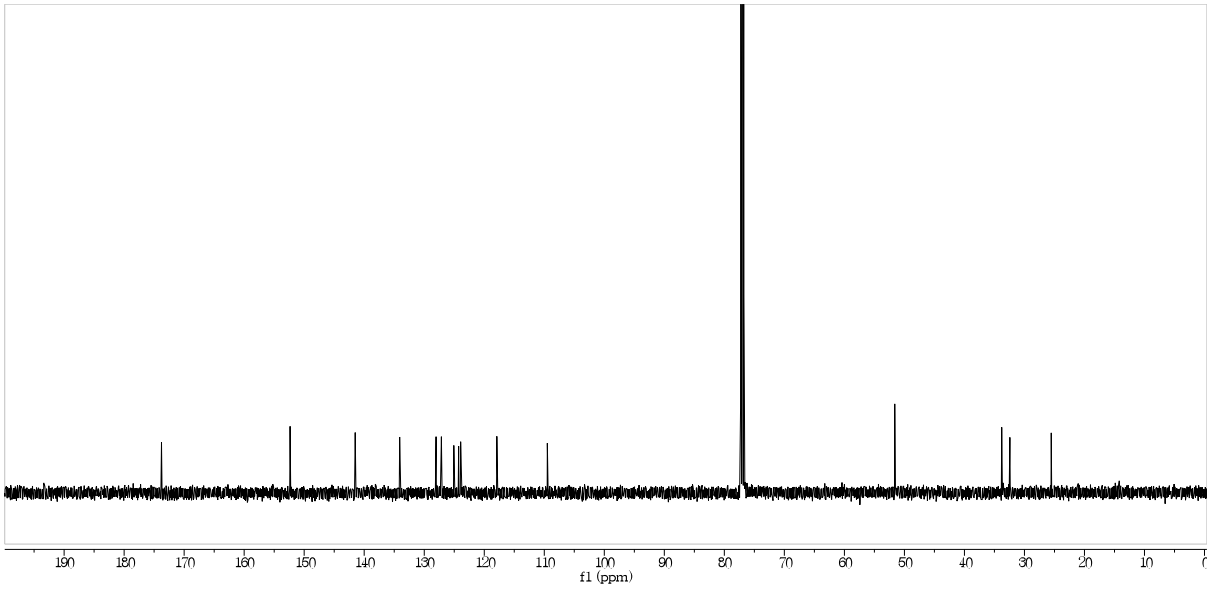
3i

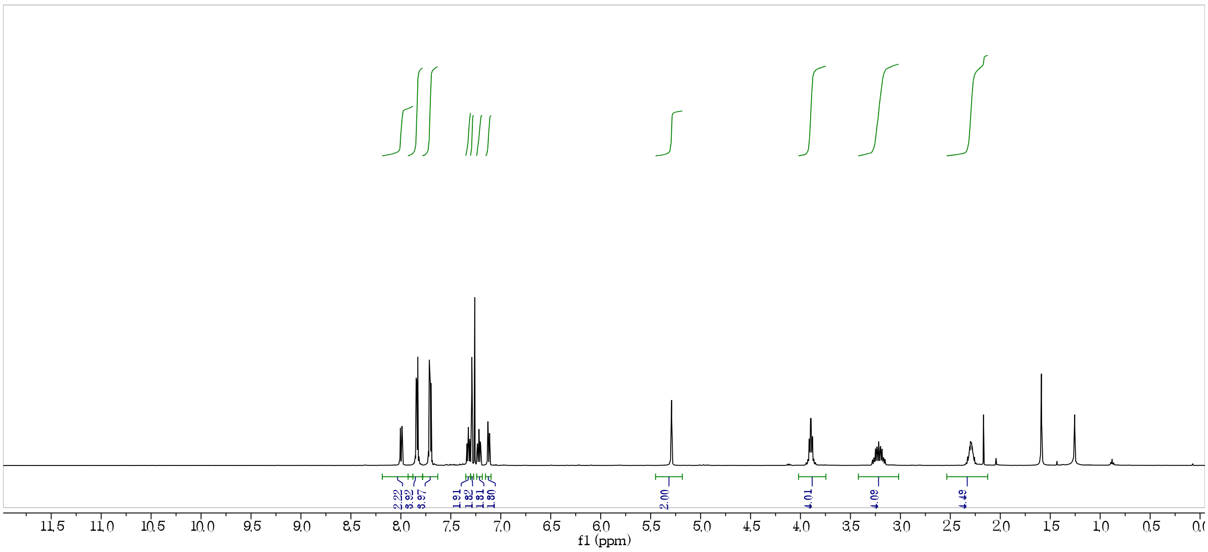


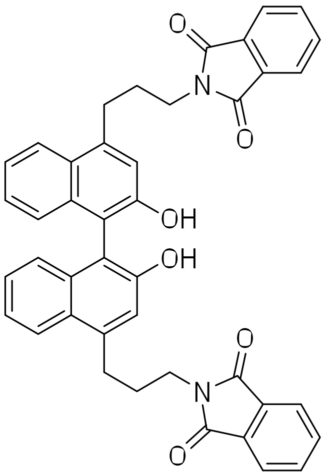




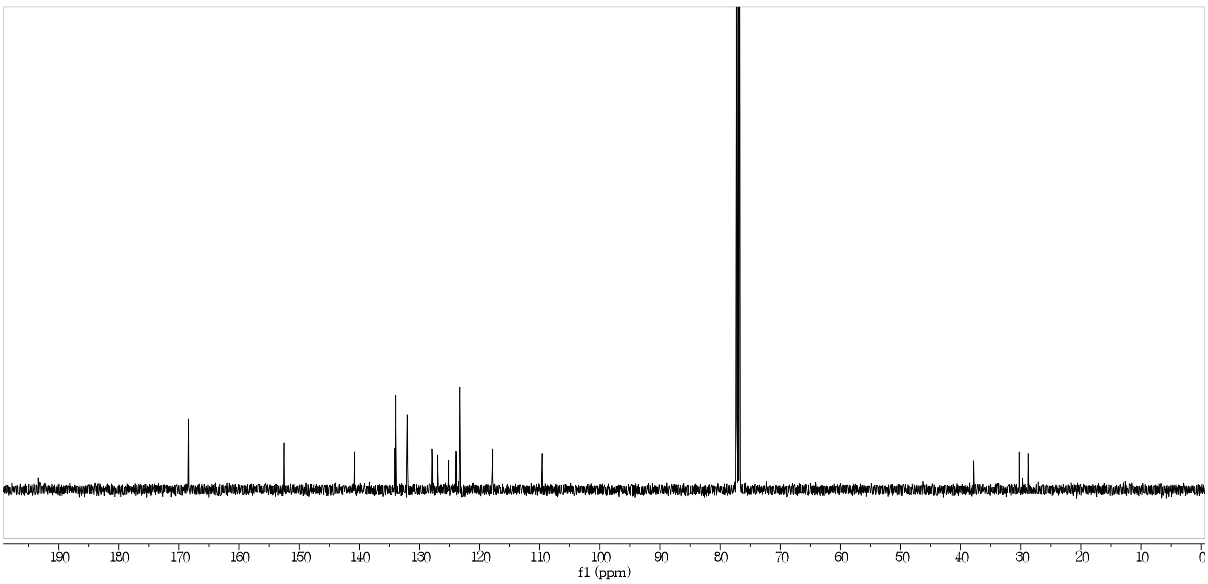
3j




2.22
8.92
8.97
1.91
1.82
1.81
1.80
2.00
4.01
4.08
4.49
11.5 11.0 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
f1 (ppm)


O
N
O
OH
OH
O
N
O

3k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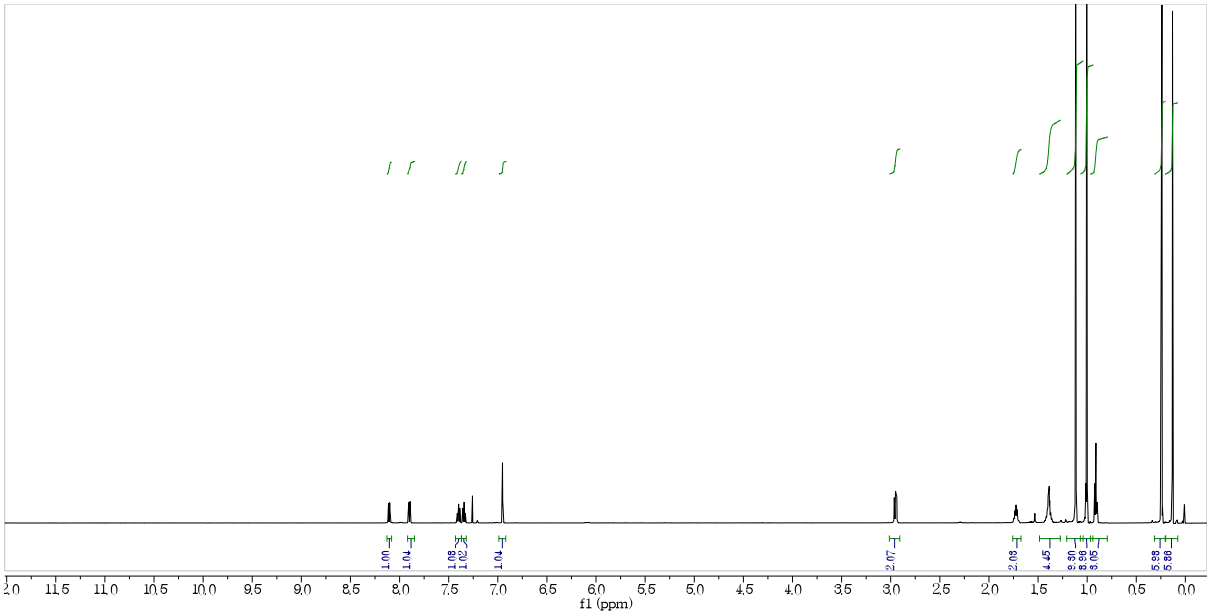
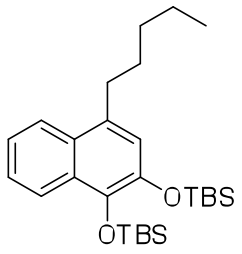
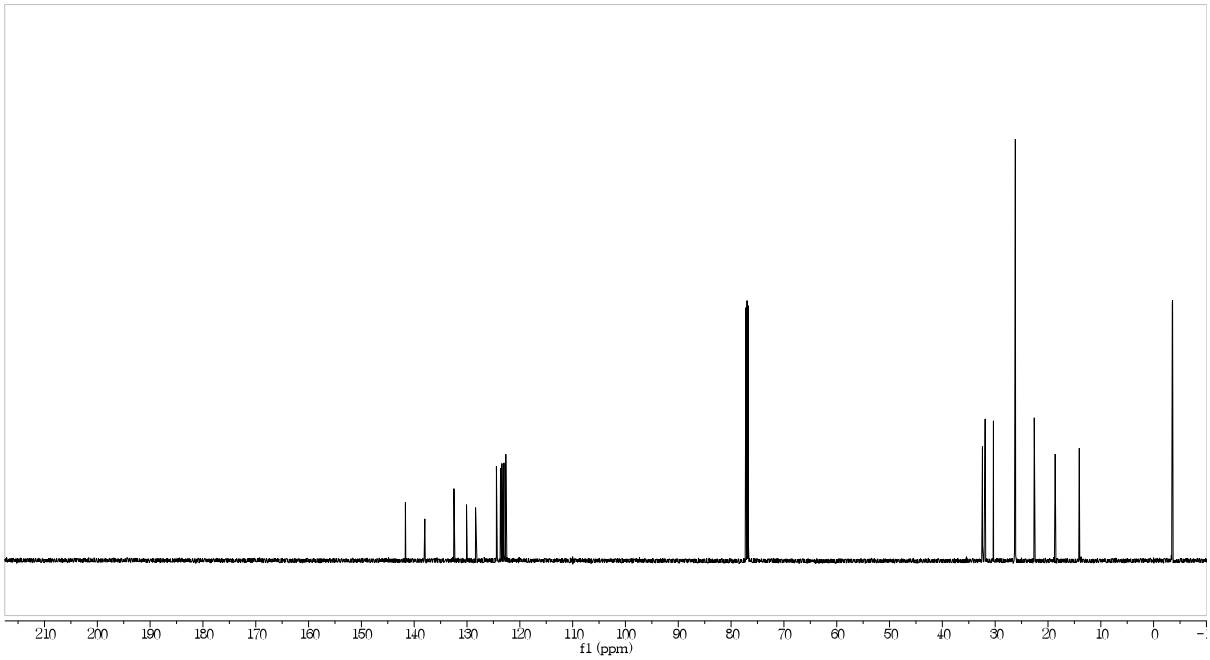
f1 (ppm)


1.00
1.04
1.08
1.02
1.04
2.07
2.03
4.45
3.80
3.59
3.05
5.68
5.68
f1 (ppm)


OTBS
OTBS

5a


f1 (ppm)