BEILSTEIN JOURNAL OF ORGANIC CHEMISTRY

Supporting Information

for

A novel and efficient synthesis of phenanthrene derivatives via palladium/norbornadiene-catalyzed domino one-pot reaction

Yue Zhong, Wen-Yu Wu, Shao-Peng Yu, Tian-Yuan Fan, Hai-Tao Yu, Nian-Guang Li, Zhi-Hao Shi, Yu-Ping Tang and Jin-Ao Duan

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Spectral data of products, and ^{1}H NMR and ^{13}C NMR spectra for the products

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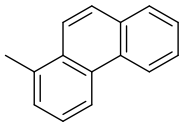
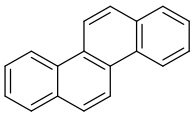
1. Spectral data of products

1-Methylphenanthrene (y-1)



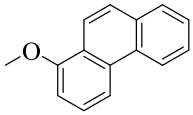
Following the general procedure on a 0.30 mmol scale, compound **y-1** (56.5 mg, 98 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.71 (d, *J* = 8.2 Hz, 1H), 8.59 (d, *J* = 8.3 Hz, 1H), 7.96 (d, *J* = 9.1 Hz, 1H), 7.90 (d, *J* = 8.9 Hz, 1H), 7.79 (d, *J* = 9.1 Hz, 1H), 7.68 – 7.62 (m, 1H), 7.61 – 7.57 (m, 1H), 7.57 – 7.52 (m, 1H), 7.45 (d, *J* = 7.1 Hz, 1H), 2.76 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 134.91, 131.70, 130.85, 130.71, 130.39, 128.51, 127.80, 126.72, 126.58, 126.45, 126.18, 122.99, 122.90, 120.90, 19.99. HRMS (ESI) calcd. for $C_{15}H_{12}$ $[M+H]^+$:193.1017, found 193.1014; $[M+Na]^+$: 215.0837, found 215.0835.

Chrysene (y-2)



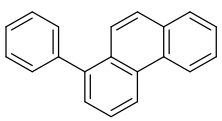
Following the general procedure on a 0.30 mmol scale, compound **y-2** (43.8 mg, 64 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.82 (d, *J* = 8.4 Hz, 2H), 8.76 (d, *J* = 9.0 Hz, 2H), 8.04 (t, *J* = 8.2 Hz, 4H), 7.74 (m, *J* = 8.3, 7.0, 1.3 Hz, 2H), 7.71 – 7.64 (m, 2H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 132.18, 130.56, 128.57, 128.22, 127.35, 126.68, 126.38, 123.16, 121.22. HRMS (ESI) calcd. for $C_{18}H_{12}$ $[M+H]^+$:229.1017, found 229.1012; $[M+Na]^+$: 251.0837, found 251.0834.

1-Methoxyphenanthrene (y-3)



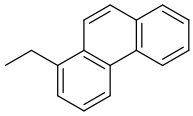
Following the general procedure on a 0.30 mmol scale, compound **y-3** (58.1 mg, 93 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.70 (d, *J* = 8.2 Hz, 1H), 8.31 (d, *J* = 8.4 Hz, 1H), 8.26 (d, *J* = 9.1 Hz, 1H), 7.92 (dd, *J* = 7.9, 1.1 Hz, 1H), 7.78 (d, *J* = 9.1 Hz, 1H), 7.68 – 7.58 (m, 3H), 7.04 (d, *J* = 7.8 Hz, 1H), 4.07 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 154.99, 131.27, 130.54, 129.09, 127.56, 125.69, 125.62, 125.43, 125.08, 122.22, 119.39, 114.04, 104.86, 54.76. HRMS (ESI) calcd. for $C_{15}H_{12}O$ $[M+H]^+$:209.0966, found 209.0970; $[M+Na]^+$: 231.0786, found 231.0789.

1-Phenylphenanthrene (y-4)



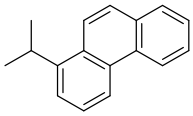
Following the general procedure on a 0.30 mmol scale, compound **y-4** (67.14 mg, 88 %) was obtained as colorless oil. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.78 (dd, *J* = 8.3, 4.6 Hz, 2H), 7.91 (d, *J* = 7.8 Hz, 1H), 7.84 (d, *J* = 9.2 Hz, 1H), 7.75 – 7.69 (m, 3H), 7.66 – 7.62 (m, 1H), 7.58 (dd, *J* = 7.2, 1.0 Hz, 1H), 7.54 (d, *J* = 4.3 Hz, 4H), 7.51 – 7.46 (m, 1H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 141.14, 141.04, 131.76, 130.71, 130.44, 130.25, 129.95, 128.49, 128.30, 127.92, 127.27, 126.89, 126.72, 126.68, 125.98, 124.63, 122.99, 122.17. HRMS (ESI) calcd. for $C_{20}H_{14}$ $[M+H]^+$:255.1174, found 255.1178; $[M+Na]^+$: 277.0993, found 277.0995.

1-Ethylphenanthrene (y-5)



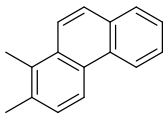
Following the general procedure on a 0.30 mmol scale, compound **y-5** (56.3 mg, 91 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.74 (d, *J* = 7.8 Hz, 1H), 8.63 (d, *J* = 8.4 Hz, 1H), 8.05 (d, *J* = 9.2 Hz, 1H), 7.93 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.81 (d, *J* = 9.2 Hz, 1H), 7.75 – 7.56 (m, 3H), 7.51 (d, *J* = 7.1 Hz, 1H), 3.21 (q, *J* = 7.5 Hz, 2H), 1.45 (t, *J* = 7.6 Hz, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 141.05, 131.67, 130.91, 130.68, 130.08, 128.46, 126.73, 126.56, 126.46, 126.36, 126.22, 123.01, 122.58, 120.91, 15.54. HRMS (ESI) calcd. for $C_{16}H_{14}$ $[M+H]^+$:207.1174, found 207.1179; $[M+Na]^+$: 229.0993, found 277.0999.

1-Isopropylphenanthrene (y-6)



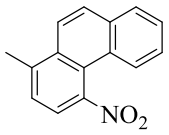
Following the general procedure on a 0.30 mmol scale, compound **y-6** (59.5 mg, 90 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.76 (d, *J* = 8.2 Hz, 1H), 8.65 (d, *J* = 8.2 Hz, 1H), 8.14 (d, *J* = 9.3 Hz, 1H), 7.94 (d, *J* = 7.7 Hz, 1H), 7.83 (d, *J* = 9.3 Hz, 1H), 7.71 – 7.60 (m, 4H), 3.88 (m, 1H), 1.49 (d, *J* = 6.8 Hz, 6H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 145.27, 131.49, 130.94, 130.64, 129.58, 128.33, 126.64, 126.51, 126.42, 126.34, 123.01, 122.73, 122.08, 120.65, 28.84, 23.75. HRMS (ESI) calcd. for $C_{17}H_{16}$ $[M+H]^+$:221.1330, found 221.1327; $[M+Na]^+$: 243.1150, found 243.1148.

1,2-Dimethylphenanthrene (y-7)



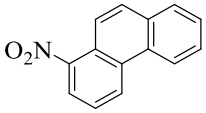
Following the general procedure on a 0.30 mmol scale, compound **y-7** (53.8 mg, 87 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.71 (d, *J* = 8.3 Hz, 1H), 8.52 (d, *J* = 8.5 Hz, 1H), 8.06 (d, *J* = 9.2 Hz, 1H), 7.92 (d, *J* = 7.9 Hz, 1H), 7.80 (d, *J* = 9.2 Hz, 1H), 7.67 (m, 1H), 7.62 – 7.58 (m, 1H), 7.51 (d, *J* = 8.5 Hz, 1H), 2.70 (s, 3H), 2.57 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 134.39, 132.31, 131.14, 130.94, 130.78, 129.08, 128.73, 128.31, 126.64, 126.44, 126.06, 122.88, 122.69, 120.19, 20.91, 15.04. HRMS (ESI) calcd. for $C_{16}H_{14}$ $[M+H]^+$:207.1174, found 207.1171; $[M+Na]^+$: 229.0993, found 229.0989.

1-Methyl-4-nitrophenanthrene (y-8)



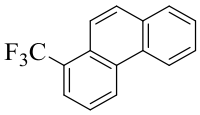
Following the general procedure on a 0.30 mmol scale, compound **y-8** (60.5 mg, 85 %) was obtained as light yellow solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.48 (s, 1H), 8.76 (d, *J* = 8.3 Hz, 1H), 8.25 (s, 1H), 8.00 – 7.96 (m, 3H), 7.81 – 7.76 (m, 1H), 7.74 – 7.70 (m, 1H), 2.85 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 145.33, 137.02, 134.61, 131.90, 130.85, 130.80, 130.00, 128.89, 127.87, 127.81, 123.15, 122.05, 121.00, 117.23, 20.17. HRMS (ESI) calcd. for $C_{15}H_{11}NO_2$ $[M+H]^+$:238.0868, found 238.0872; $[M+Na]^+$: 260.0687, found 260.0683.

1-Nitrophenanthrene (y-9)



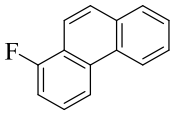
Following the general procedure on a 0.30 mmol scale, compound **y-9** (50.2 mg, 75 %) was obtained as light yellow solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.99 (d, *J* = 8.4 Hz, 1H), 8.71 (d, *J* = 8.2 Hz, 1H), 8.32 (d, *J* = 9.3 Hz, 1H), 8.21 (d, *J* = 8.7 Hz, 1H), 7.98 (d, *J* = 9.1 Hz, 2H), 7.79 – 7.70 (m, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 147.87, 131.77, 131.59, 130.63, 129.24, 128.82, 127.96, 127.93, 127.78, 125.12, 124.18, 123.24, 122.92, 120.12. HRMS (ESI) calcd. for $C_{14}H_9NO_2$ $[M+H]^+$:224.0712, found 224.0716; $[M+Na]^+$: 246.0531, found 246.0537.

1-(Trifluoromethyl)phenanthrene (y-10)



Following the general procedure on a 0.30 mmol scale, compound **y-10** (70.2 mg, 95 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.92 (d, *J* = 8.4 Hz, 1H), 8.71 (d, *J* = 8.2 Hz, 1H), 8.14 (dd, *J* = 9.3, 1.9 Hz, 1H), 8.00 (d, *J* = 7.4 Hz, 1H), 7.96 (d, *J* = 9.0 Hz, 1H), 7.91 (d, *J* = 9.3 Hz, 1H), 7.76 – 7.67 (m, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 130.49, 130.21, 128.88, 127.84, 127.61, 127.29, 126.33, 126.21, 125.84, 125.56, 125.20, 124.05, 123.79, 121.75, 121.04. HRMS (ESI) calcd. for $C_{15}H_9F_3$ $[M+H]^+$:247.0735, found 247.0739; $[M+Na]^+$: 269.0554, found 269.0558.

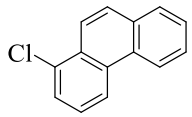
1-Fluorophenanthrene (y-11)



Following the general procedure on a 0.30 mmol scale, compound **y-11** (51.2 mg, 87 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.69 (d, *J* = 8.2 Hz, 1H), 8.49 (d, *J* = 8.4 Hz, 1H), 8.07 (d, *J* = 9.1 Hz, 1H), 7.95 (d, *J* = 7.6 Hz, 1H), 7.83 (d, *J* = 9.0 Hz, 1H), 7.73 – 7.69 (m, 1H), 7.68 – 7.65 (m, 1H), 7.61 (m, 1H), 7.32 (dd, *J* = 9.8, 7.6 Hz, 1H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 160.23, 158.24, 132.12,

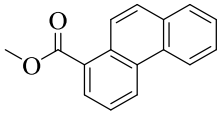
132.08, 132.02, 129.59, 129.57, 128.73, 127.34, 127.32, 127.06, 126.95, 126.46, 126.39, 122.96, 121.57, 121.45, 118.49, 118.43, 118.36, 118.33, 111.04, 110.88. HRMS (ESI) calcd. for $C_{14}H_9F$ $[M+H]^+$:197.0767, found 197.0773; $[M+Na]^+$: 219.0586, found 219.0589.

1-Chlorophenanthrene (y-12)



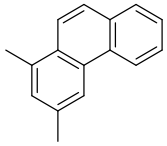
Following the general procedure on a 0.30 mmol scale, compound **y-12** (54.9 mg, 86 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.71 (d, *J* = 8.2 Hz, 1H), 8.66 (d, *J* = 8.4 Hz, 1H), 8.27 (d, *J* = 9.2 Hz, 1H), 7.96 (d, *J* = 7.7 Hz, 1H), 7.89 (d, *J* = 9.2 Hz, 1H), 7.72 (m, 2H), 7.69 – 7.65 (m, 1H), 7.61 – 7.57 (m, 1H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 132.70, 131.89, 131.88, 129.93, 129.32, 128.70, 128.21, 127.18, 127.07, 127.06, 126.43, 122.95, 122.50, 121.62. HRMS (ESI) calcd. for $C_{14}H_9Cl$ $[M+H]^+$:213.0471, found 213.0475; $[M+Na]^+$: 235.0290, found 235.0297.

1-Phenanthrenecarboxylic acid, methyl ester (y-13)



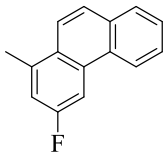
Following the general procedure on a 0.30 mmol scale, compound **y-13** (66.6 mg, 94 %) was obtained as light yellow oil. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.93 (d, *J* = 8.4 Hz, 1H), 8.81 (d, *J* = 9.3 Hz, 1H), 8.71 (d, *J* = 8.2 Hz, 1H), 8.24 (dd, *J* = 7.4, 1.0 Hz, 1H), 7.97 – 7.93 (m, 1H), 7.90 (d, *J* = 9.3 Hz, 1H), 7.73 – 7.64 (m, 3H), 4.06 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 168.42, 131.61, 130.93, 130.63, 130.03, 129.81, 128.76, 128.53, 128.22, 127.10, 127.07, 126.90, 125.28, 123.74, 122.78, 52.30. HRMS (ESI) calcd. for $C_{16}H_{12}O_2$ $[M+H]^+$:237.0916, found 237.0912; $[M+Na]^+$: 259.0735, found 259.0731.

1,3-Dimethylphenanthrene (y-14)



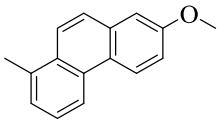
Following the general procedure on a 0.30 mmol scale, compound **y-14** (58.8 mg, 95 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.74 (d, *J* = 8.2 Hz, 1H), 8.43 (s, 1H), 7.94 (dd, *J* = 15.2, 8.0 Hz, 2H), 7.77 (d, *J* = 9.1 Hz, 1H), 7.68 (m, 1H), 7.65 – 7.60 (m, 1H), 7.34 (s, 1H), 2.77 (s, 3H), 2.63 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 135.73, 134.66, 131.84, 130.48, 130.38, 129.62, 128.75, 128.43, 126.30, 126.27, 125.72, 122.93, 122.77, 120.56, 22.06, 19.84. HRMS (ESI) calcd. for $C_{16}H_{14}$ $[M+H]^+$:207.1174, found 207.1179; $[M+Na]^+$: 229.0993, found 229.0997.

3-Fluoro-1-methylphenanthrene (y-15)



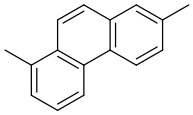
Following the general procedure on a 0.30 mmol scale, compound **y-15** (60.6 mg, 95 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.58 (d, *J* = 8.1 Hz, 1H), 8.21 (dd, *J* = 11.0, 2.2 Hz, 1H), 7.96 – 7.90 (m, 2H), 7.76 (d, *J* = 9.1 Hz, 1H), 7.70 – 7.63 (m, 2H), 7.25 (d, *J* = 9.1 Hz, 1H), 2.78 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 161.26, 158.83, 136.89, 136.80, 131.01, 130.94, 129.15, 129.10, 127.51, 126.54, 125.97, 125.55, 124.82, 124.79, 122.10, 121.39, 115.78, 115.54, 104.72, 104.51, 18.93. HRMS (ESI) calcd. for $C_{15}H_{11}F$ $[M+H]^+$:211.0923, found 211.0918; $[M+Na]^+$: 233.0742, found 233.0739.

7-Methoxy-1-methylphenanthrene (z-1)



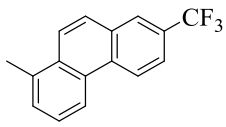
Following the general procedure on a 0.30 mmol scale, compound **z-1** (62.7 mg, 94 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.63 (d, *J* = 8.9 Hz, 1H), 8.51 (d, *J* = 8.4 Hz, 1H), 7.98 (d, *J* = 9.1 Hz, 1H), 7.75 (d, *J* = 9.1 Hz, 1H), 7.58 – 7.52 (m, 1H), 7.42 (d, *J* = 7.1 Hz, 1H), 7.31 (m, 2H), 4.00 (s, 3H), 2.78 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 158.20, 134.88, 133.07, 130.52, 129.82, 126.81, 126.25, 126.22, 125.07, 124.61, 123.49, 120.41, 117.20, 108.34, 55.41, 19.92. HRMS (ESI) calcd. for $C_{16}H_{14}O$ $[M+H]^+$:223.1123, found 223.1128; $[M+Na]^+$: 245.0942, found 245.0948.

1,7-Dimethylphenanthrene (z-2)



Following the general procedure on a 0.30 mmol scale, compound **z-2** (56.3 mg, 91 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.62 (d, *J* = 8.5 Hz, 1H), 8.58 (d, *J* = 8.3 Hz, 1H), 7.96 (d, *J* = 9.1 Hz, 1H), 7.75 (d, *J* = 9.1 Hz, 1H), 7.71 (s, 1H), 7.58 – 7.54 (m, 1H), 7.51 (dd, *J* = 8.5, 1.7 Hz, 1H), 7.45 (d, *J* = 7.0 Hz, 1H), 2.79 (s, 3H), 2.60 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 136.12, 134.81, 131.80, 130.45, 130.36, 128.51, 128.35, 127.98, 127.31, 126.42, 126.05, 122.85, 120.66, 21.45, 19.95. HRMS (ESI) calcd. for $C_{16}H_{14}$ $[M+H]^+$:207.1174, found 207.1179; $[M+Na]^+$: 229.0993, found 229.0999.

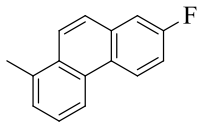
1-Methyl-7-(trifluoromethyl)phenanthrene (z-3)



Following the general procedure on a 0.30 mmol scale, compound **z-3** (64.0 mg, 82 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.82 (d, *J* = 8.7 Hz, 1H), 8.62 (d, *J* = 8.3 Hz, 1H), 8.21 (s,

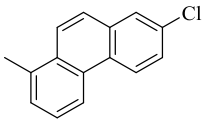
1H), 8.09 (d, *J* = 9.1 Hz, 1H), 7.86 (dd, *J* = 9.0, 2.9 Hz, 2H), 7.66 – 7.60 (m, 1H), 7.55 (d, *J* = 7.1 Hz, 1H), 2.81 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 135.22, 132.67, 131.51, 130.92, 129.69, 128.86, 126.76, 126.45, 125.82, 125.78, 124.37, 123.90, 122.36, 122.33, 121.23, 19.94. HRMS (ESI) calcd. for $C_{16}H_{11}F_3$[M+H]$^+$:261.0891, found 261.0886; [M+Na]$^+$: 283.0711, found 283.0708.

7-Fluoro-1-methylphenanthrene (z-4)



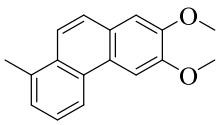
Following the general procedure on a 0.30 mmol scale, compound **z-4** (53.6 mg, 85 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.69 (dd, *J* = 9.1, 5.4 Hz, 1H), 8.53 (d, *J* = 8.4 Hz, 1H), 8.01 (d, *J* = 9.1 Hz, 1H), 7.74 (d, *J* = 9.1 Hz, 1H), 7.62 – 7.53 (m, 2H), 7.48 (d, *J* = 7.1 Hz, 1H), 7.42 (m, 1H), 2.79 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 162.21, 160.25, 135.08, 133.05, 132.98, 130.30, 130.29 , 130.18, 127.61, 127.29, 127.27, 126.58, 125.91, 125.88, 125.38, 125.31, 124.20, 120.67, 115.61, 115.42, 112.43, 112.27, 19.95. HRMS (ESI) calcd. for $C_{15}H_{11}F$ [M+H]$^+$:211.0923, found 211.0928; [M+Na]$^+$: 233.0742, found 233.0749.

7-Chloro-1-methylphenanthrene (z-5)



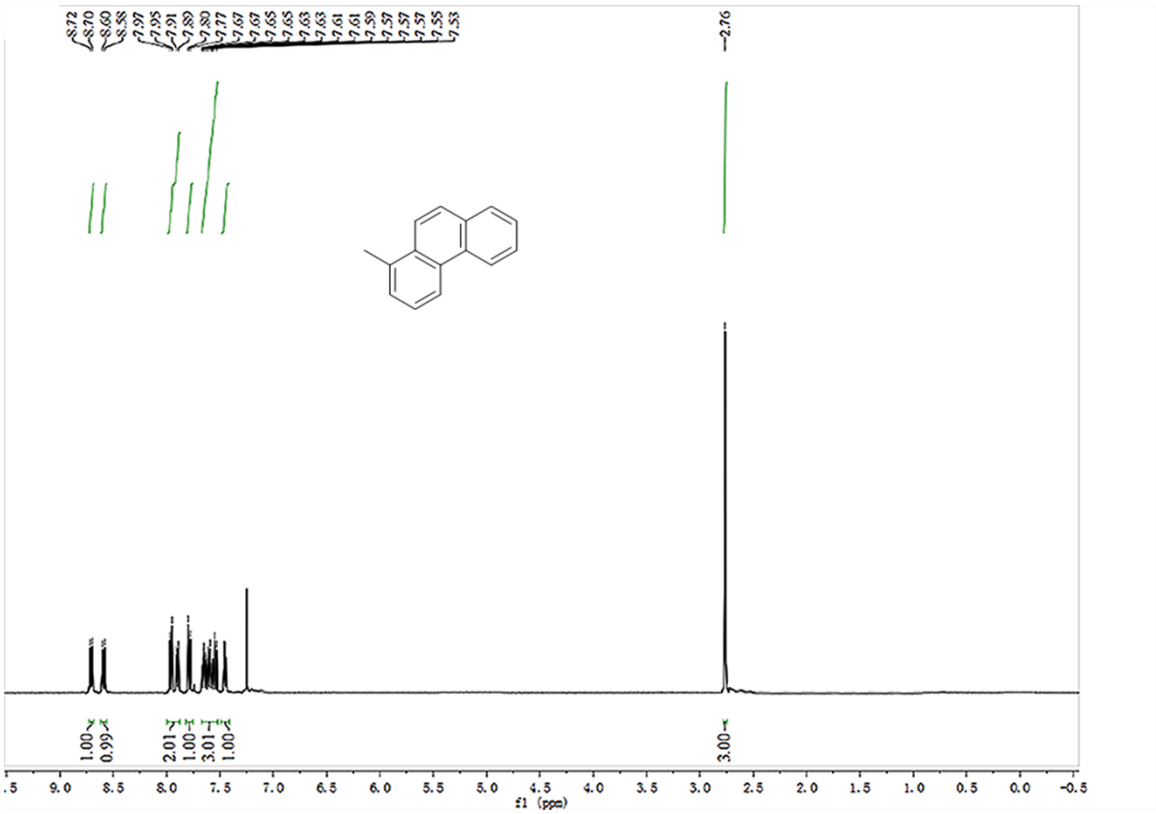
Following the general procedure on a 0.30 mmol scale, compound **z-5** (59.2 mg, 87 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.63 (d, *J* = 8.9 Hz, 1H), 8.53 (d, *J* = 8.4 Hz, 1H), 8.00 (d, *J* = 9.1 Hz, 1H), 7.89 (d, *J* = 2.2 Hz, 1H), 7.72 – 7.69 (m, 1H), 7.63 – 7.57 (m, 2H), 7.49 (d, *J* = 7.1 Hz, 1H), 2.78 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 135.10, 132.68, 132.20, 130.67, 129.97, 128.99, 128.05, 127.34, 126.99, 126.60, 125.59, 124.67, 124.19, 120.76, 19.93. HRMS (ESI) calcd. for $C_{15}H_{11}Cl$ [M+H]$^+$:227.0628, found 227.0623; [M+Na]$^+$: 249.0447, found 249.0443.

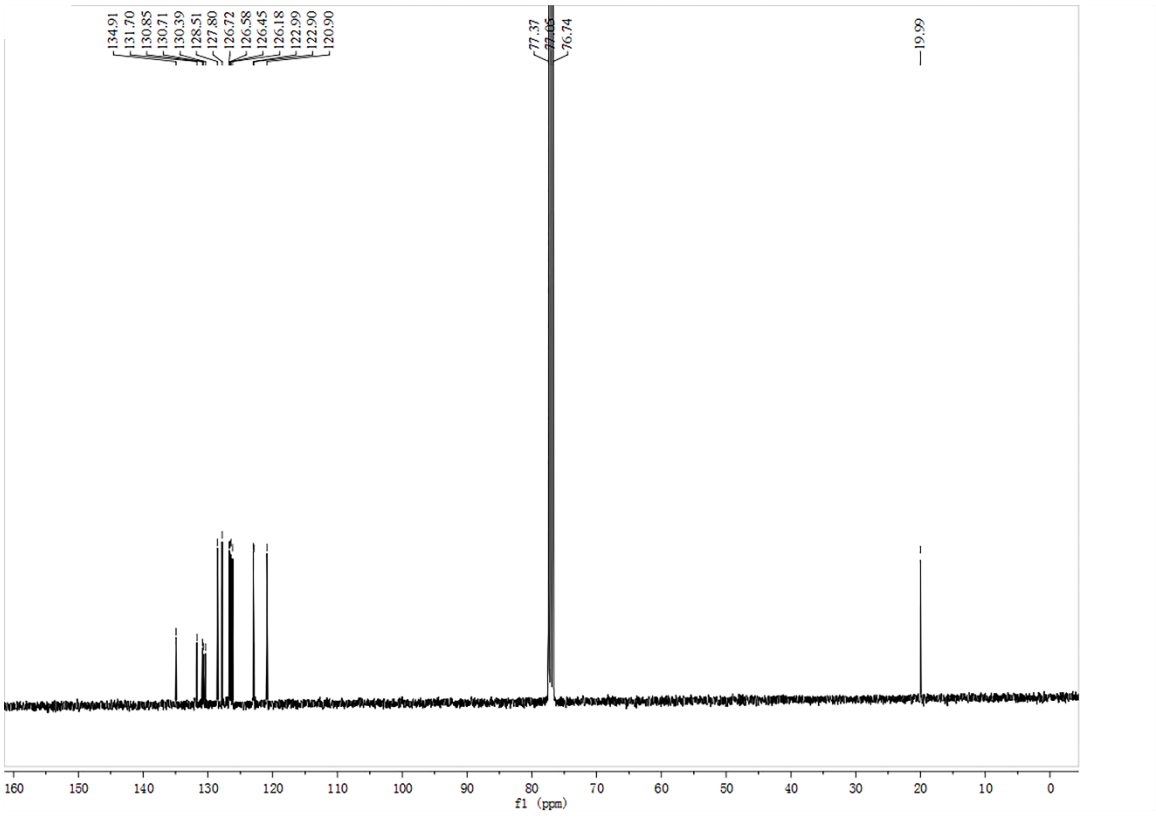
6,7-Dimethoxy-1-methylphenanthrene (z-6)

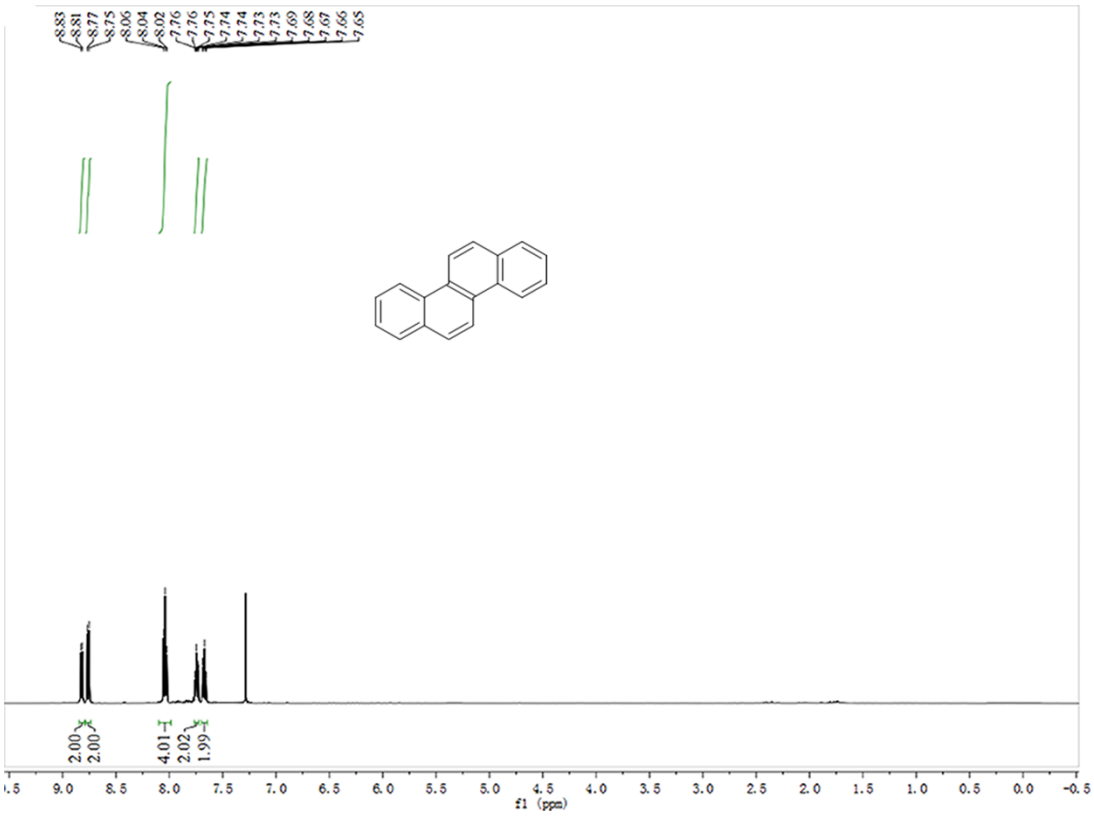


Following the general procedure on a 0.30 mmol scale, compound **z-6** (71.9 mg, 95 %) was obtained as white solid. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.44 (d, *J* = 8.4 Hz, 1H), 8.03 (s, 1H), 7.87 (d, *J* = 9.0 Hz, 1H), 7.70 (d, *J* = 9.0 Hz, 1H), 7.58 – 7.48 (m, 1H), 7.40 (d, *J* = 7.0 Hz, 1H), 7.25 (s, 1H), 4.12 (s, 3H), 4.06 (s, 3H), 2.76 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 149.32, 149.25, 134.96, 130.14, 129.74, 126.83, 126.74, 125.76, 125.73, 125.26, 121.19, 120.41, 108.09, 103.63, 55.99, 55.91, 20.01. HRMS (ESI) calcd. for $C_{17}H_{16}O_2$ [M+H]$^+$:253.1229, found 253.1224; [M+Na]$^+$: 275.1048, found 275.1043.

2. ^{1}H NMR and ^{13}C NMR spectra for the products



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7.65
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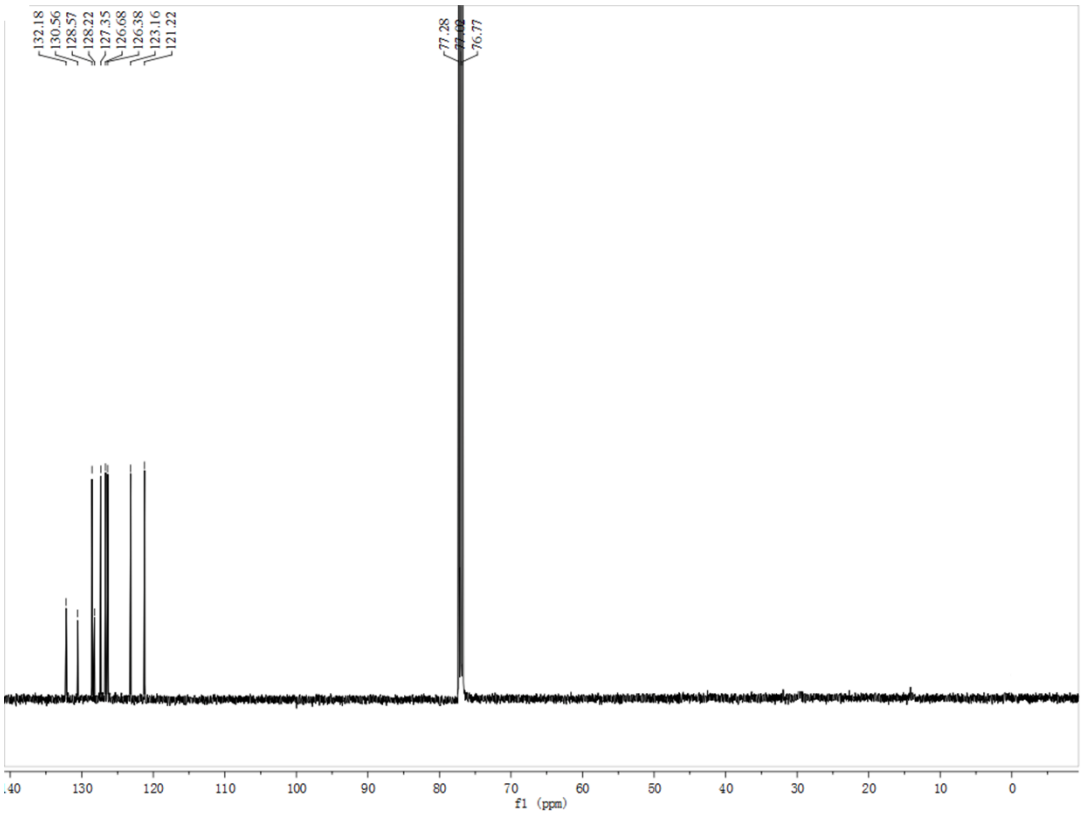
4.01
2.02
1.99
f1 (ppm)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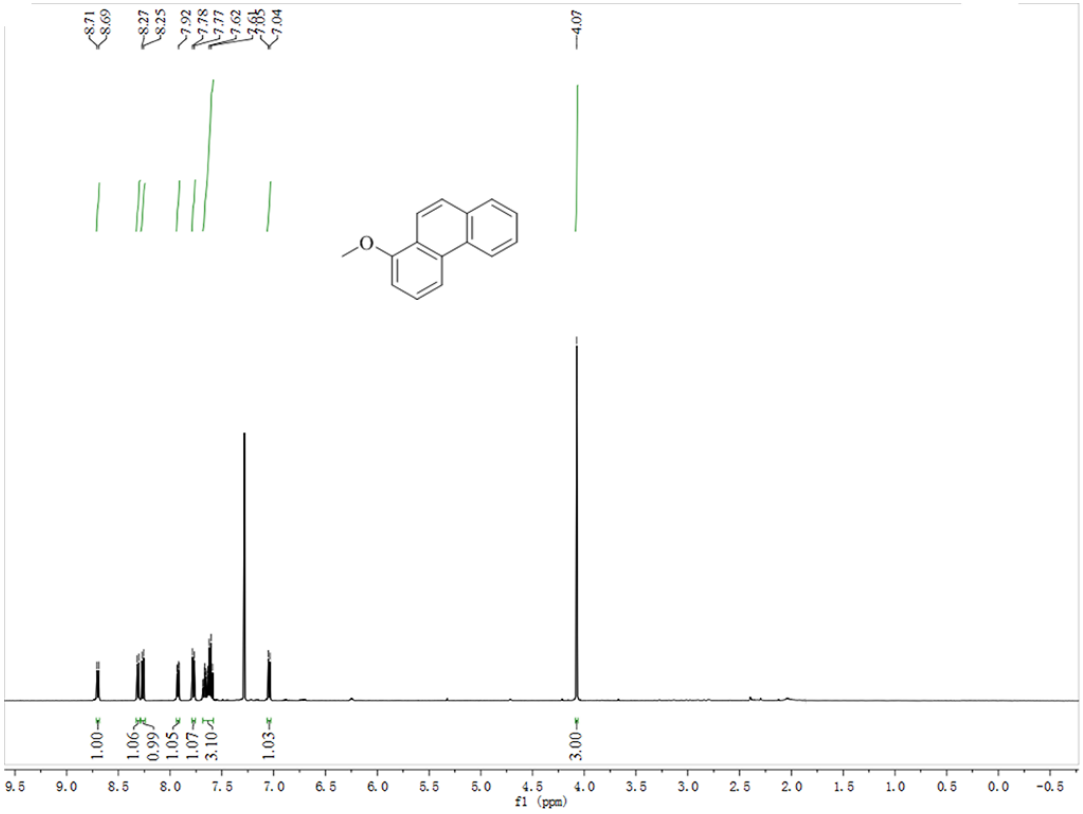
f1 (ppm)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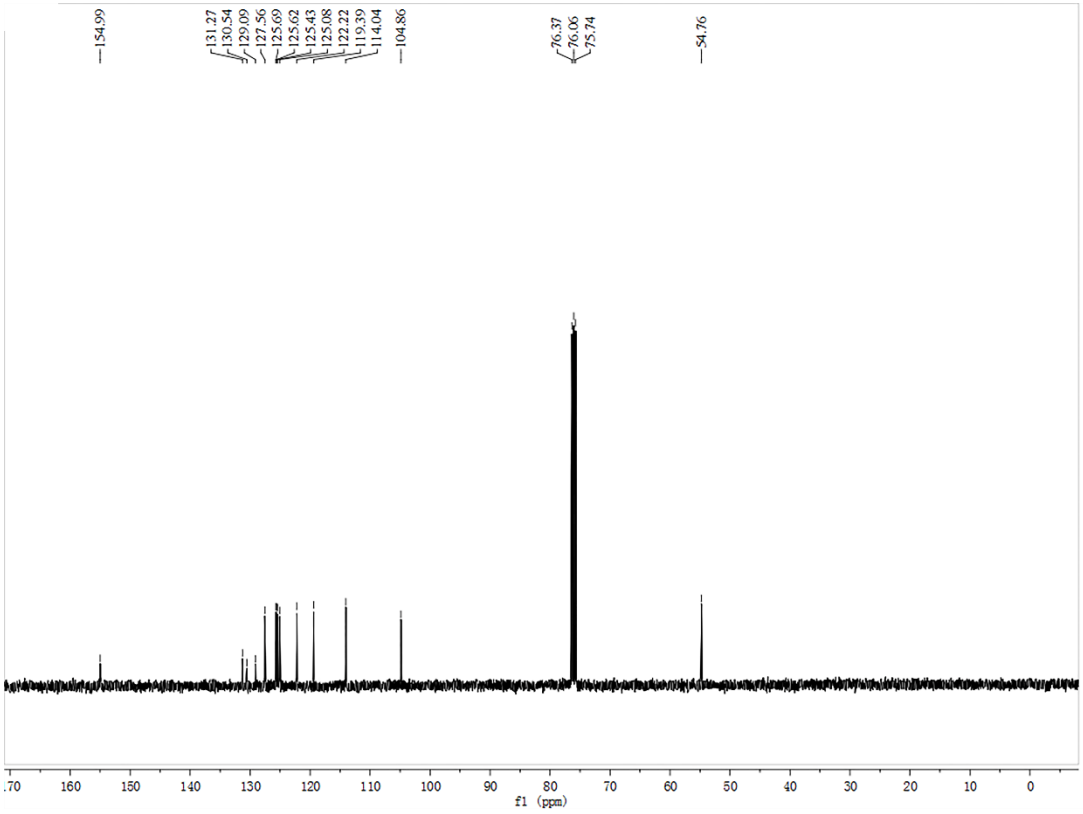
3.00
f1 (ppm)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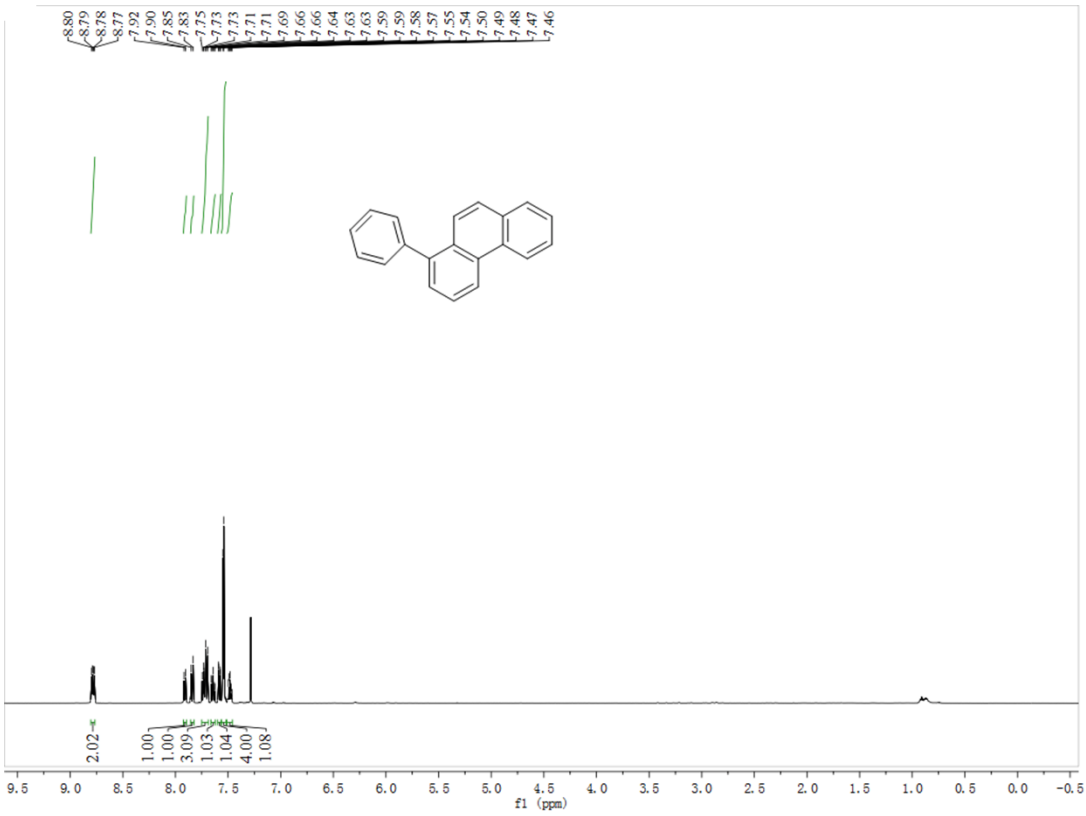
54.76
f1 (ppm)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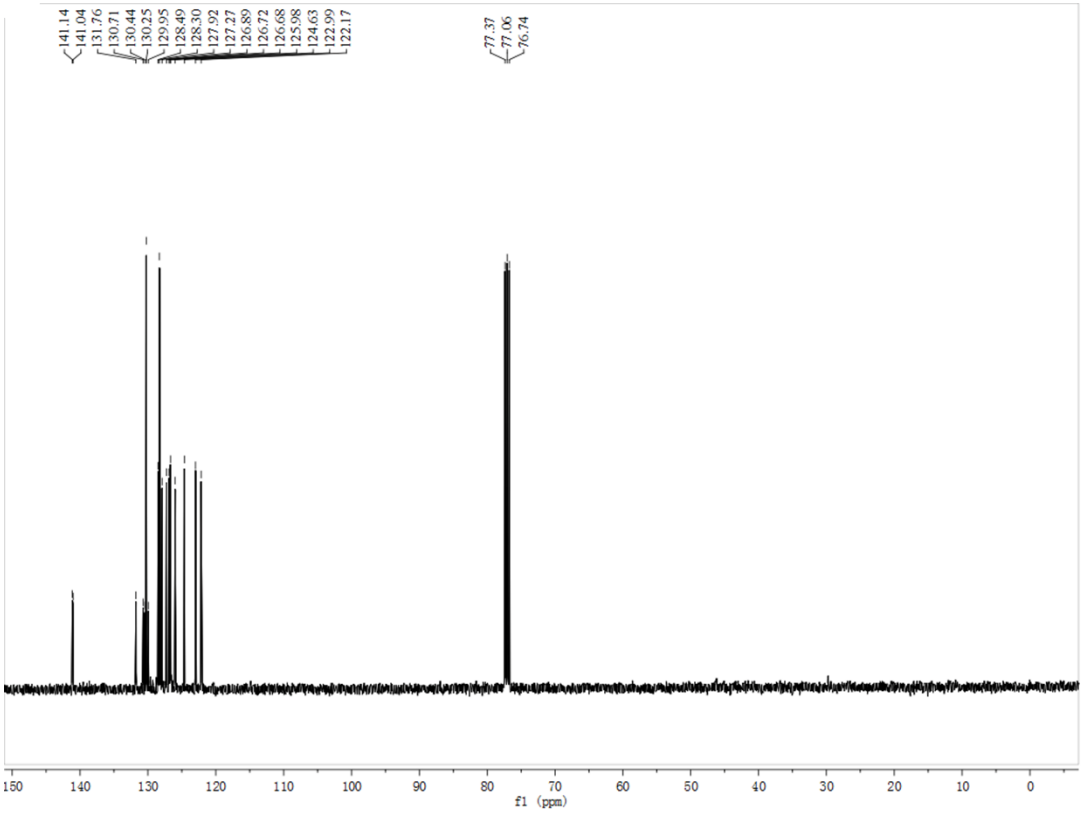
1.08
f1 (ppm)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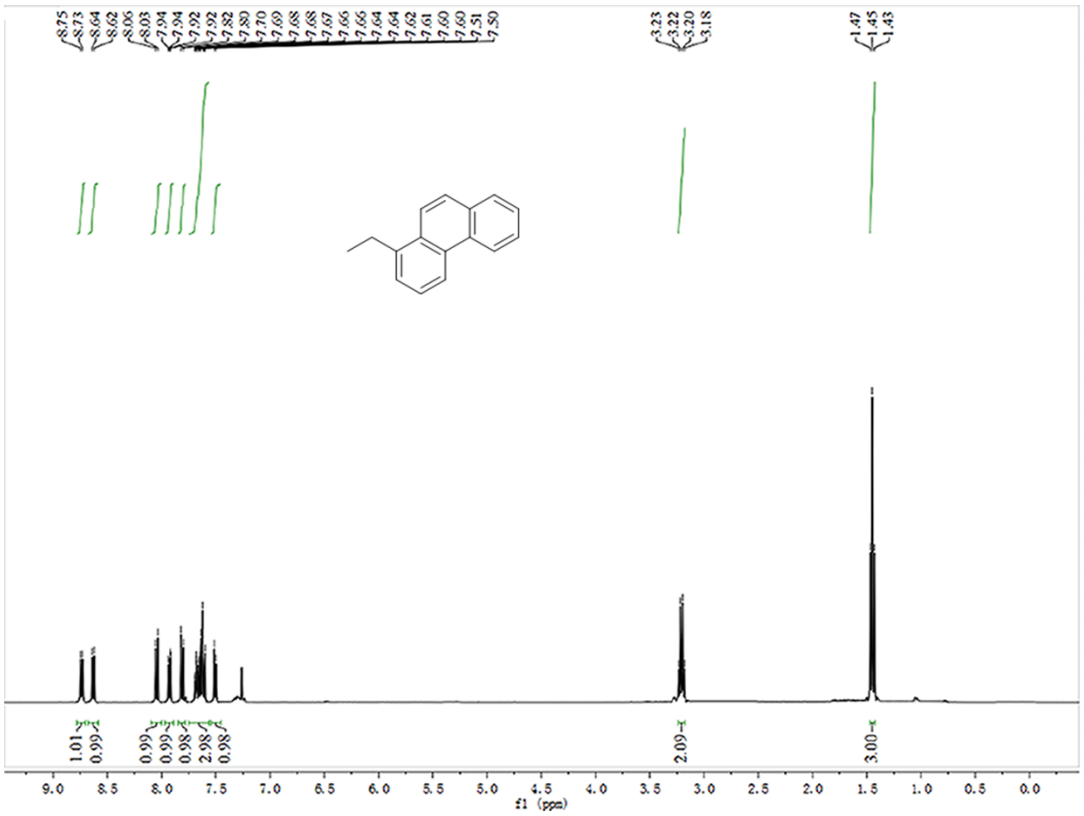
76.74
f1 (ppm)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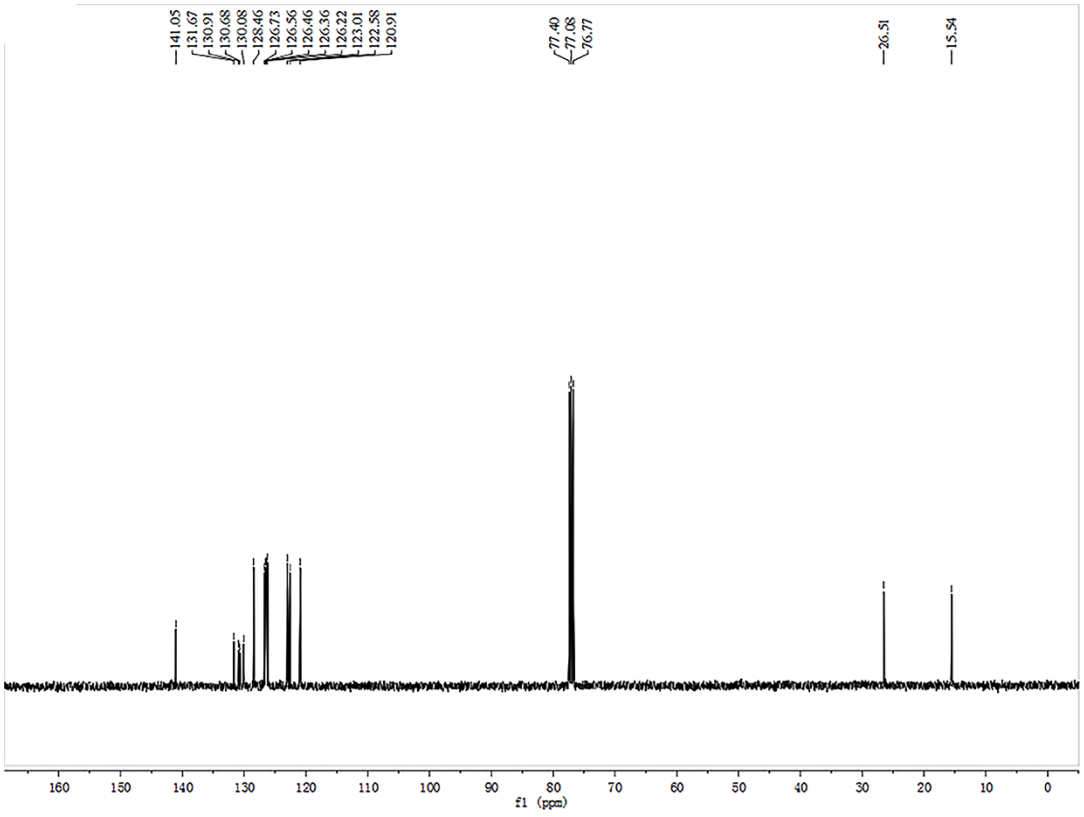
f1 (ppm)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76.77
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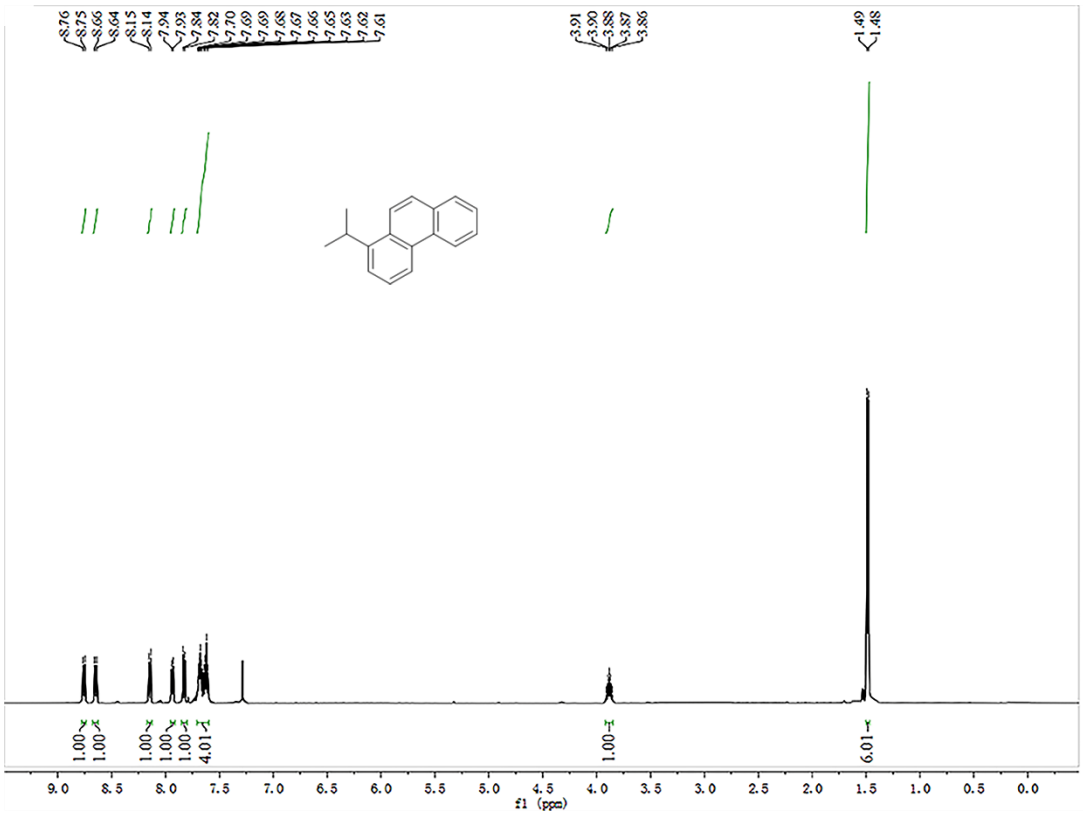
f1 (ppm)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7.61
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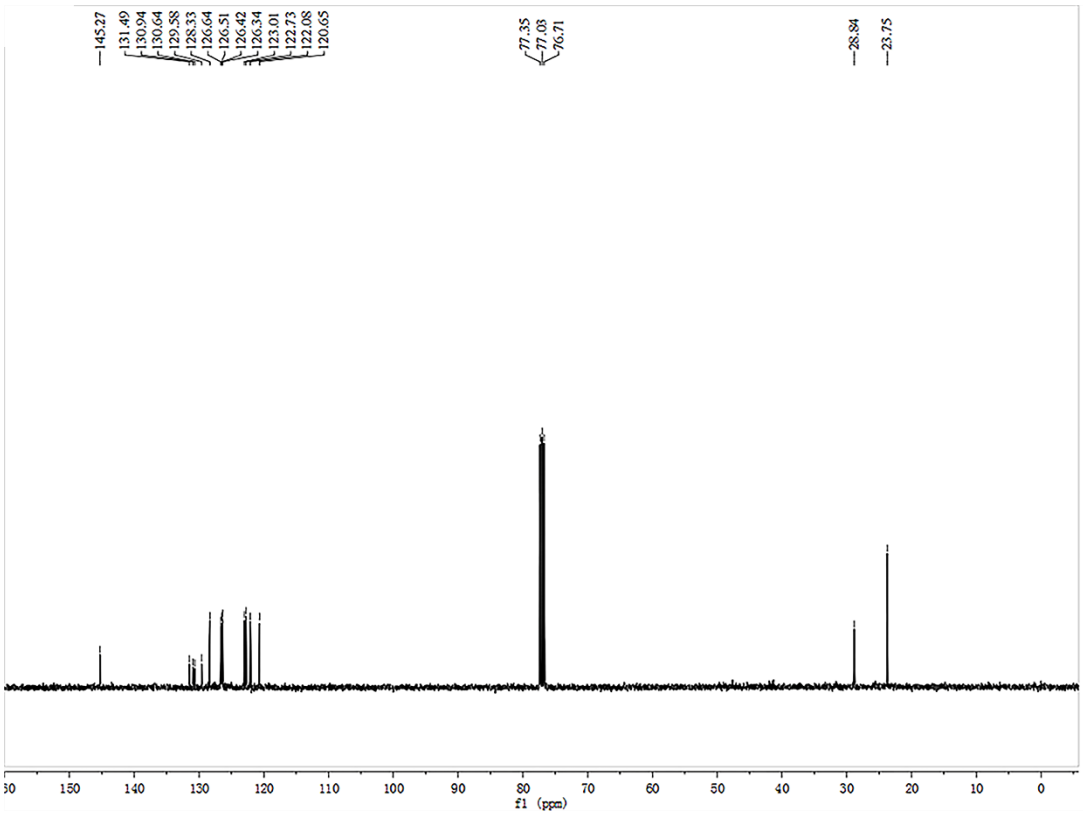
f1 (ppm)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76.71
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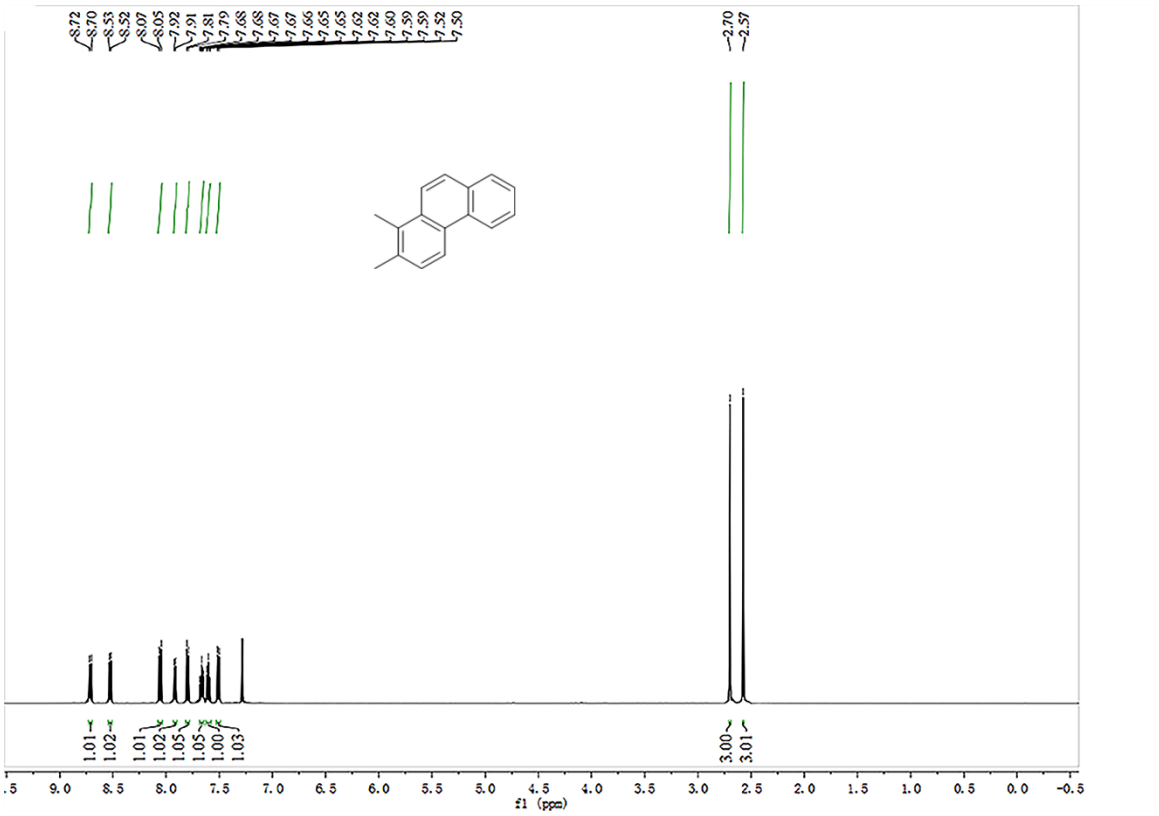
f1 (ppm)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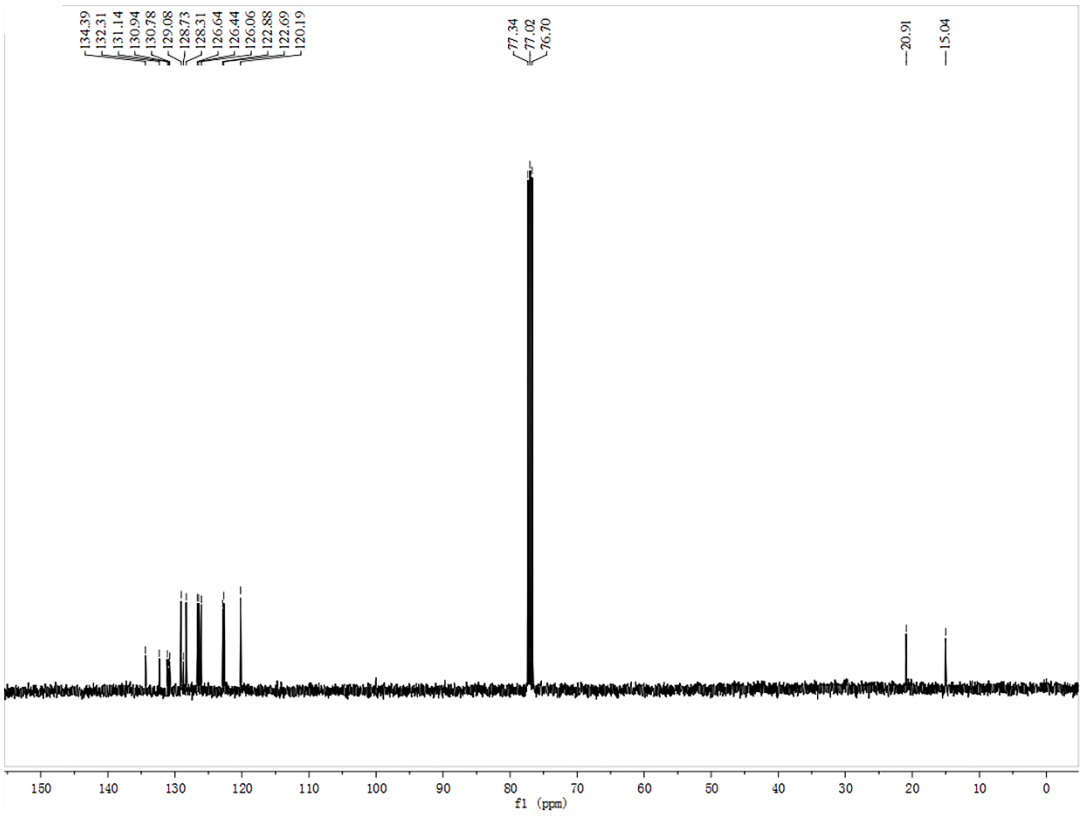
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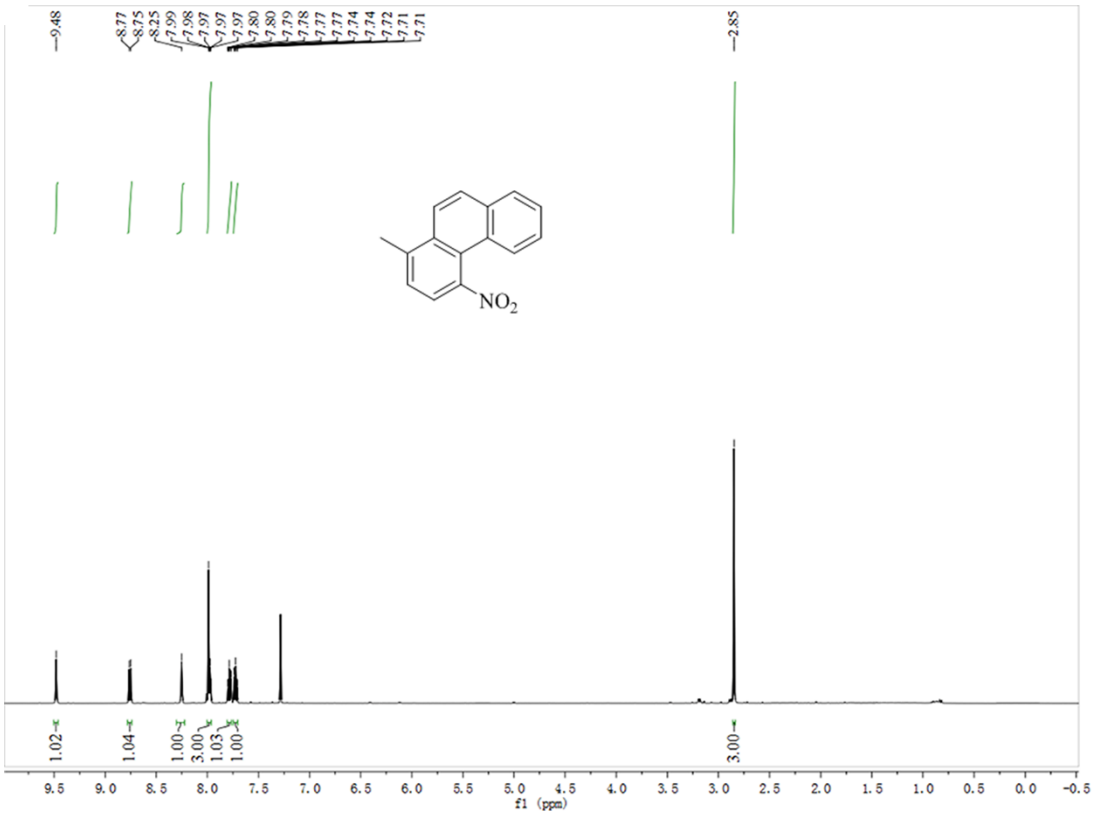
f1 (ppm)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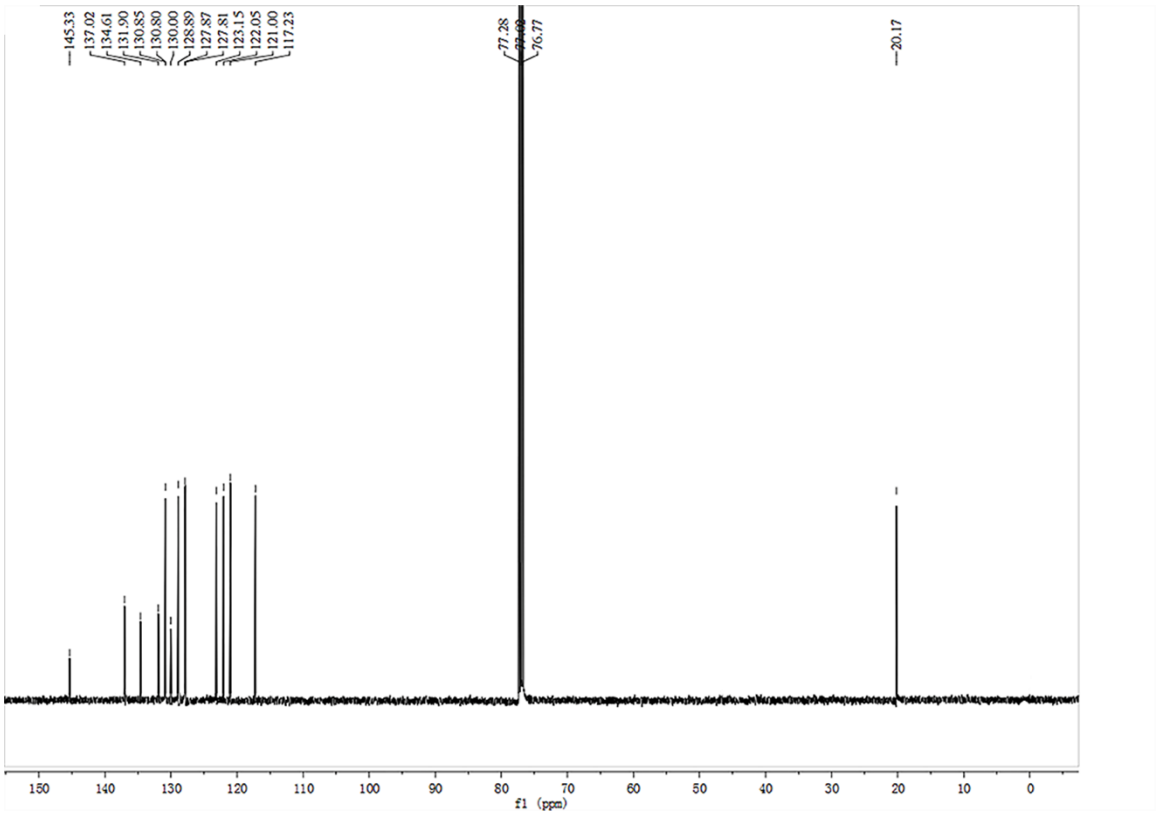
3.00
f1 (ppm)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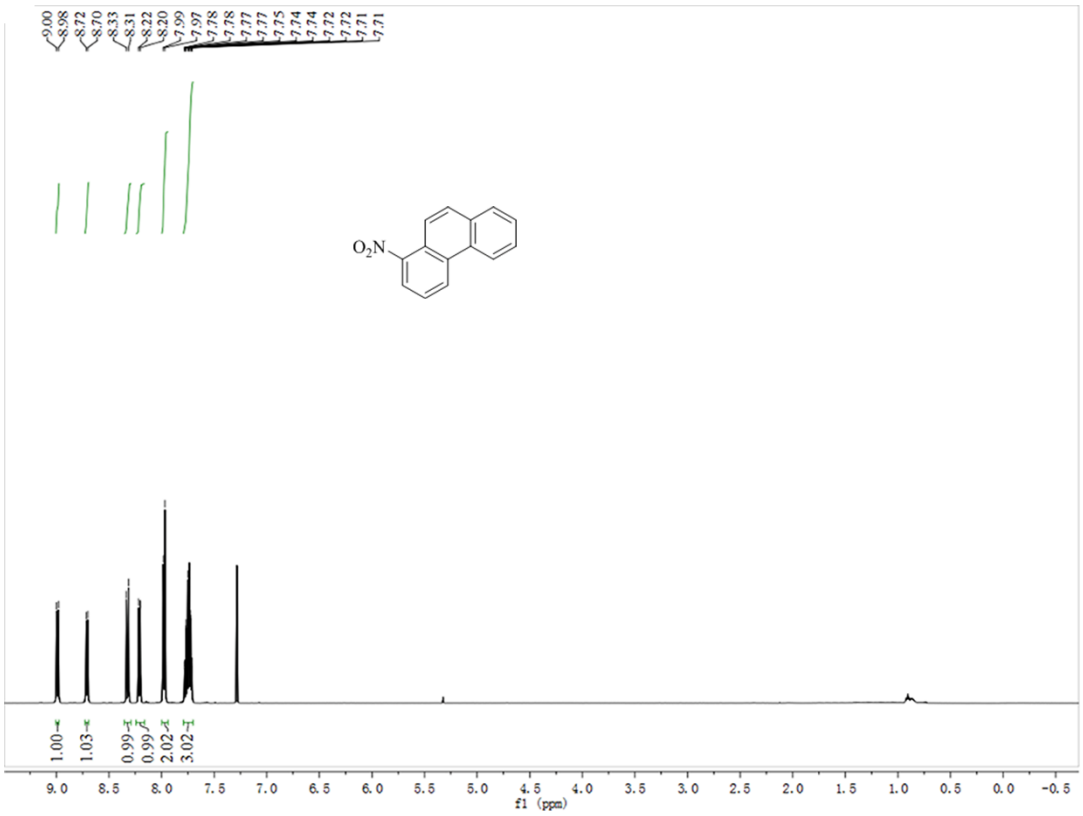
f1 (ppm)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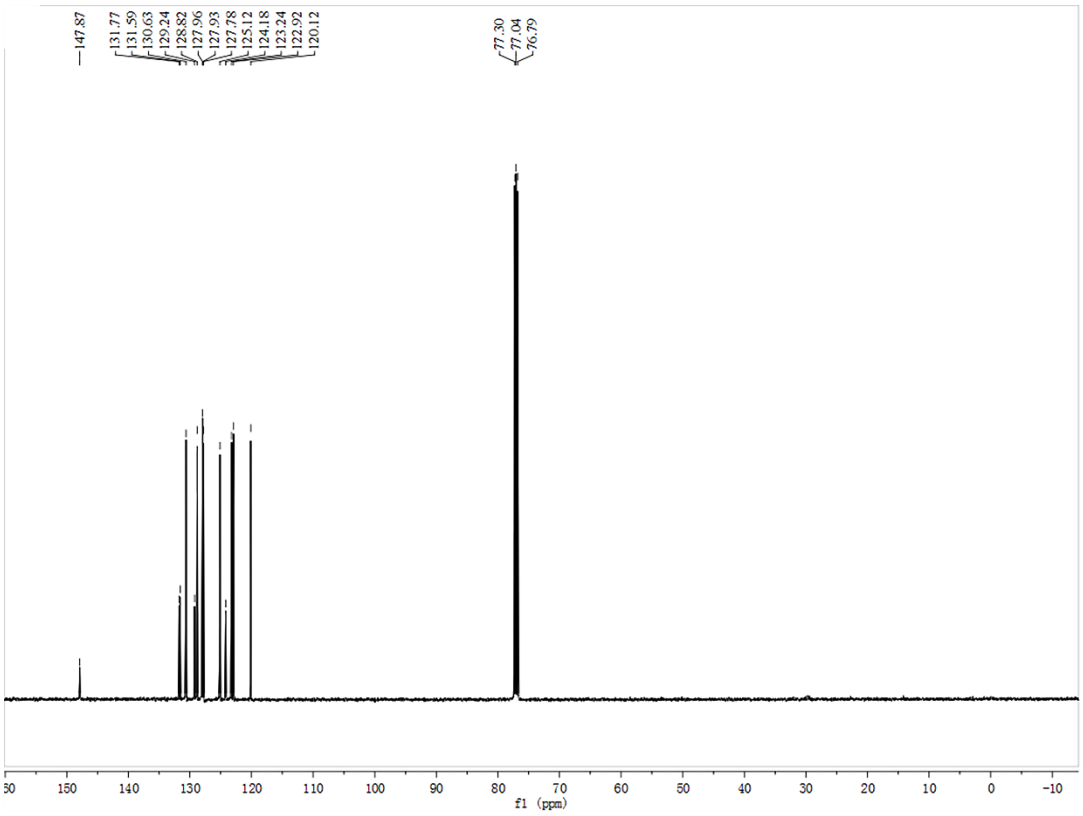
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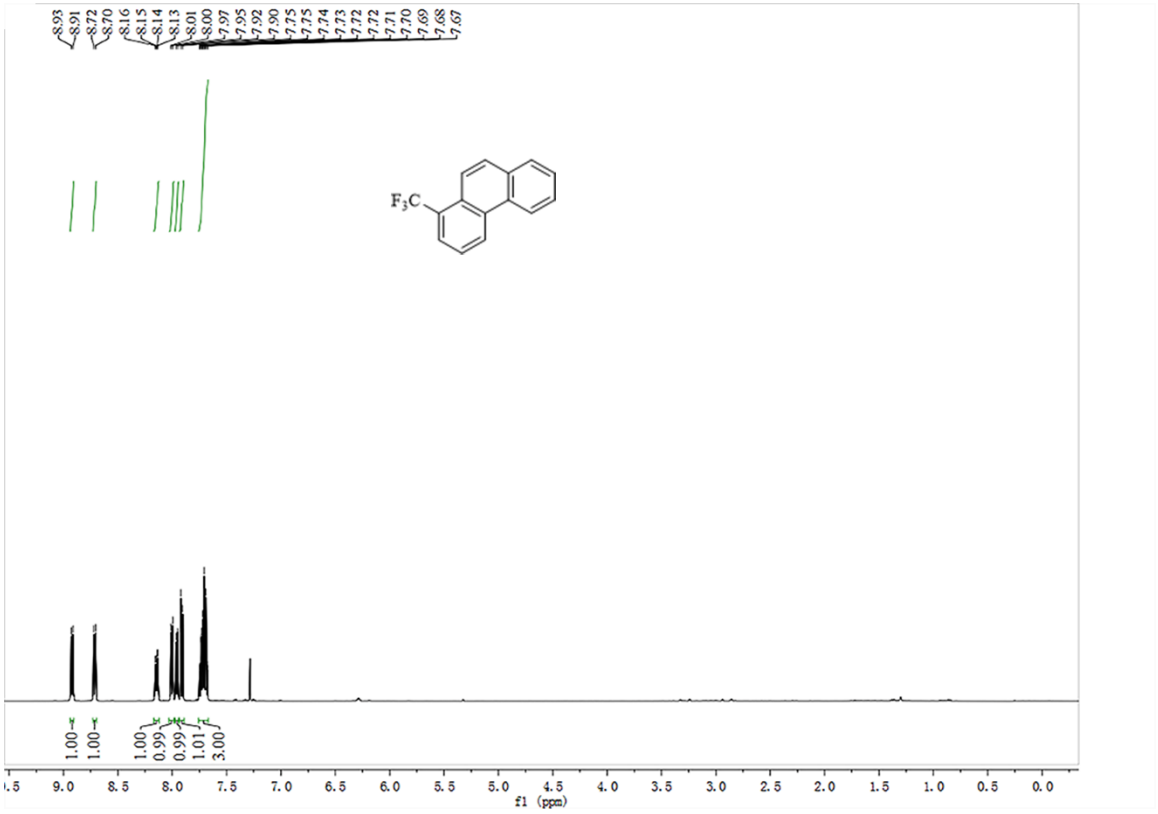
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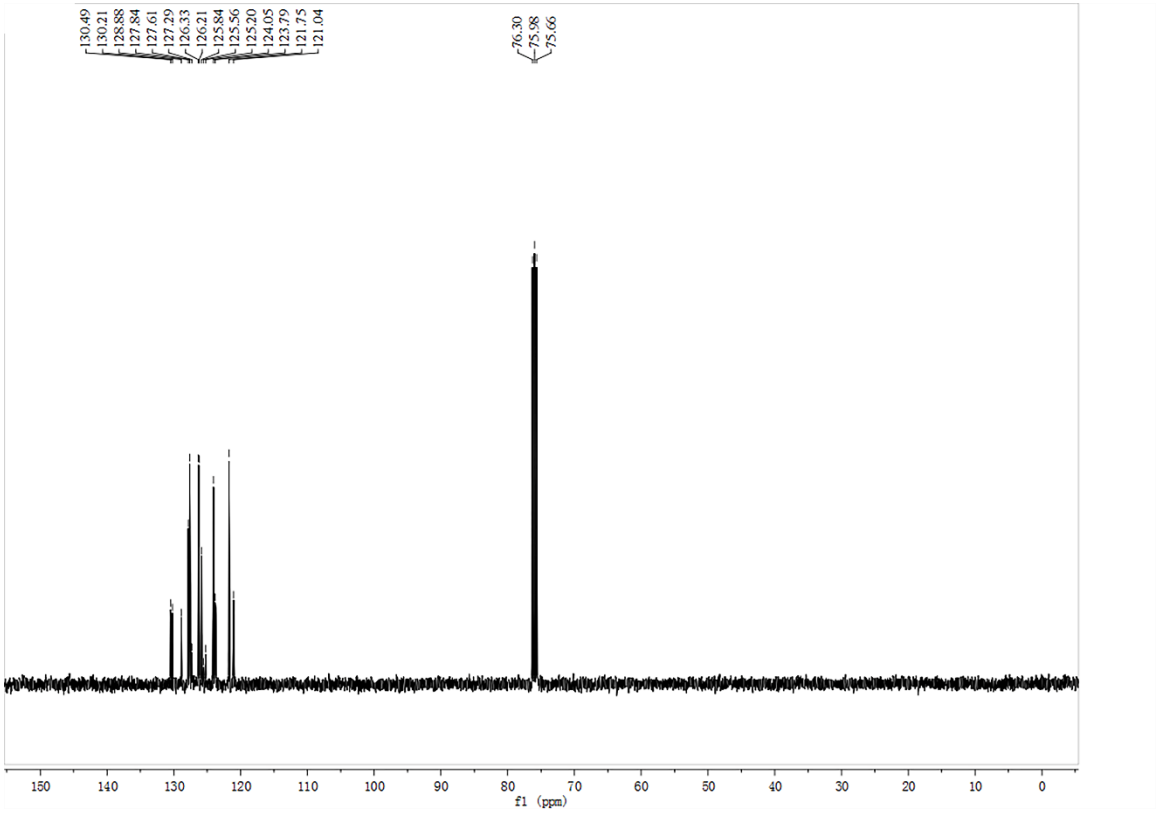
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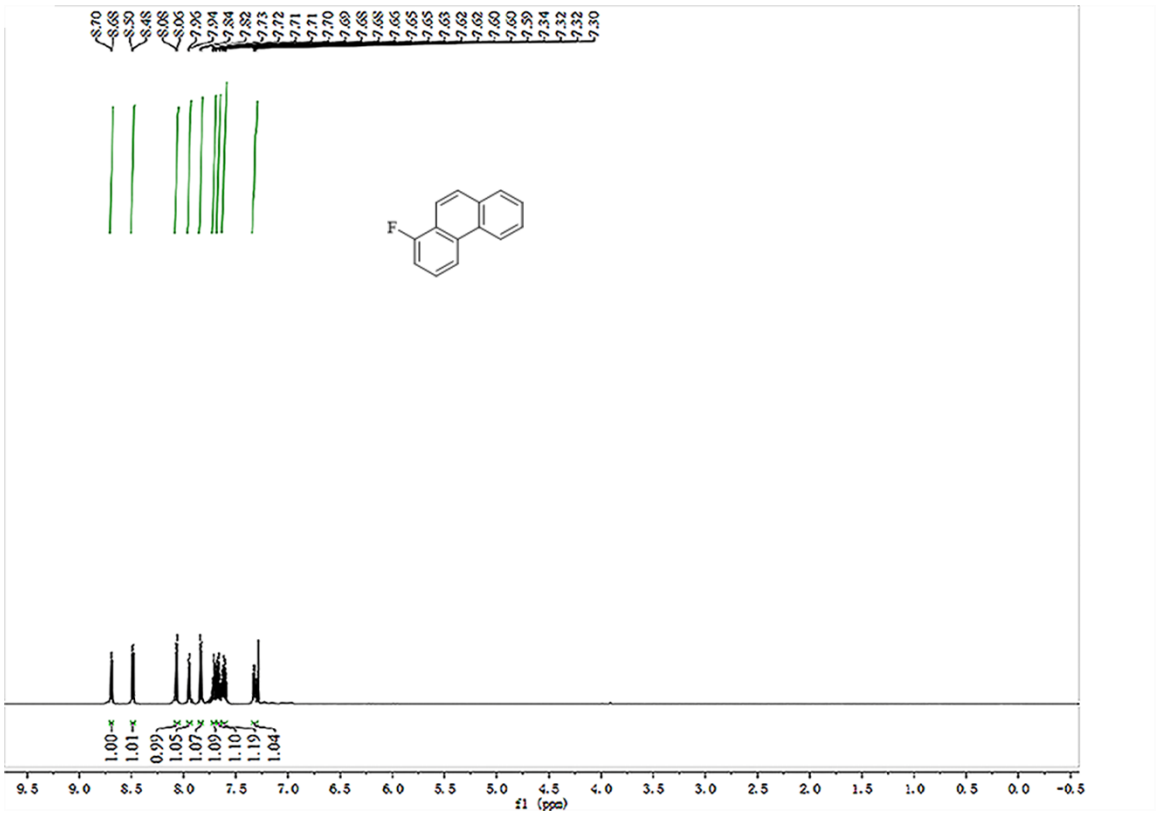
f1 (ppm)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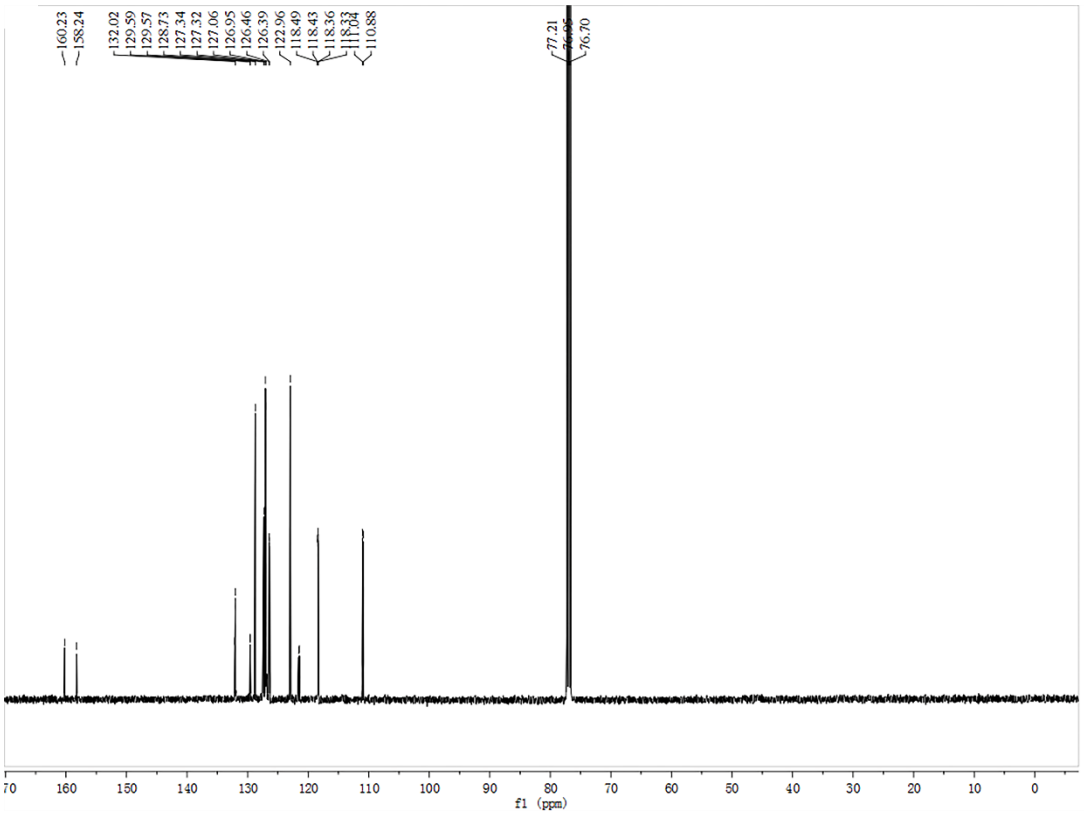
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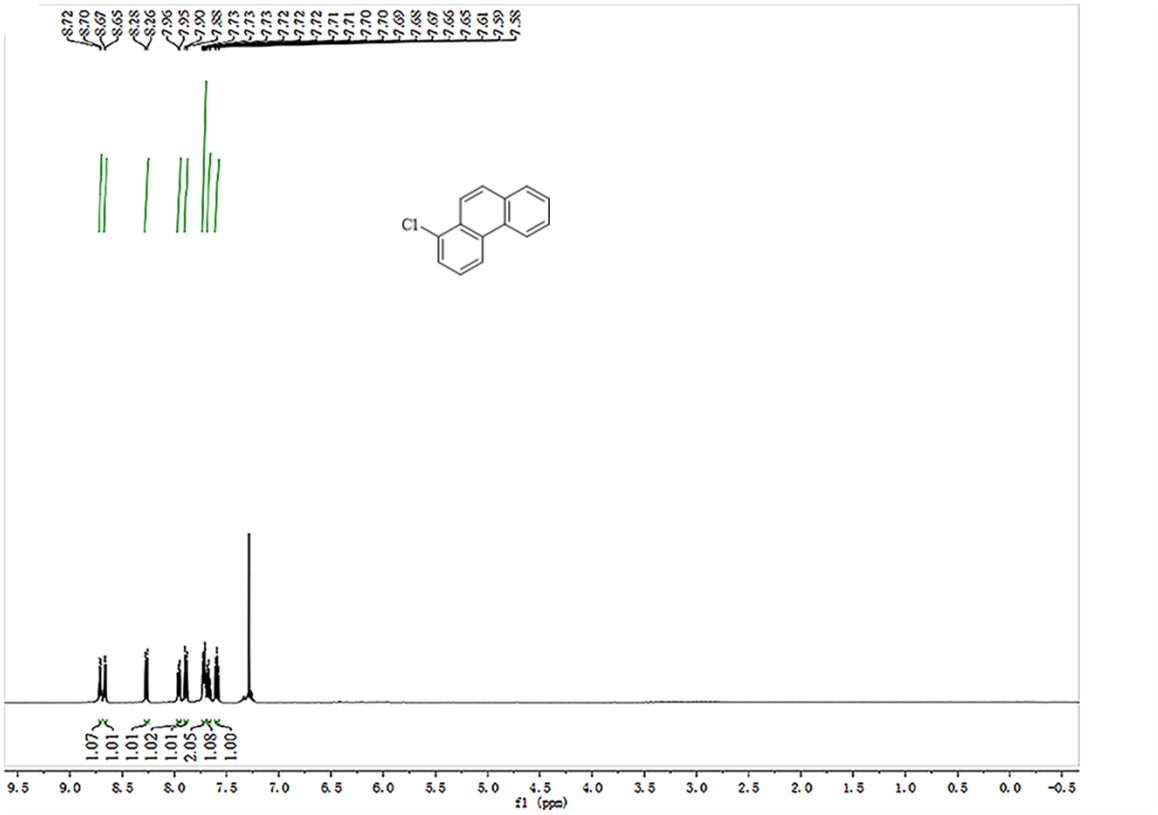
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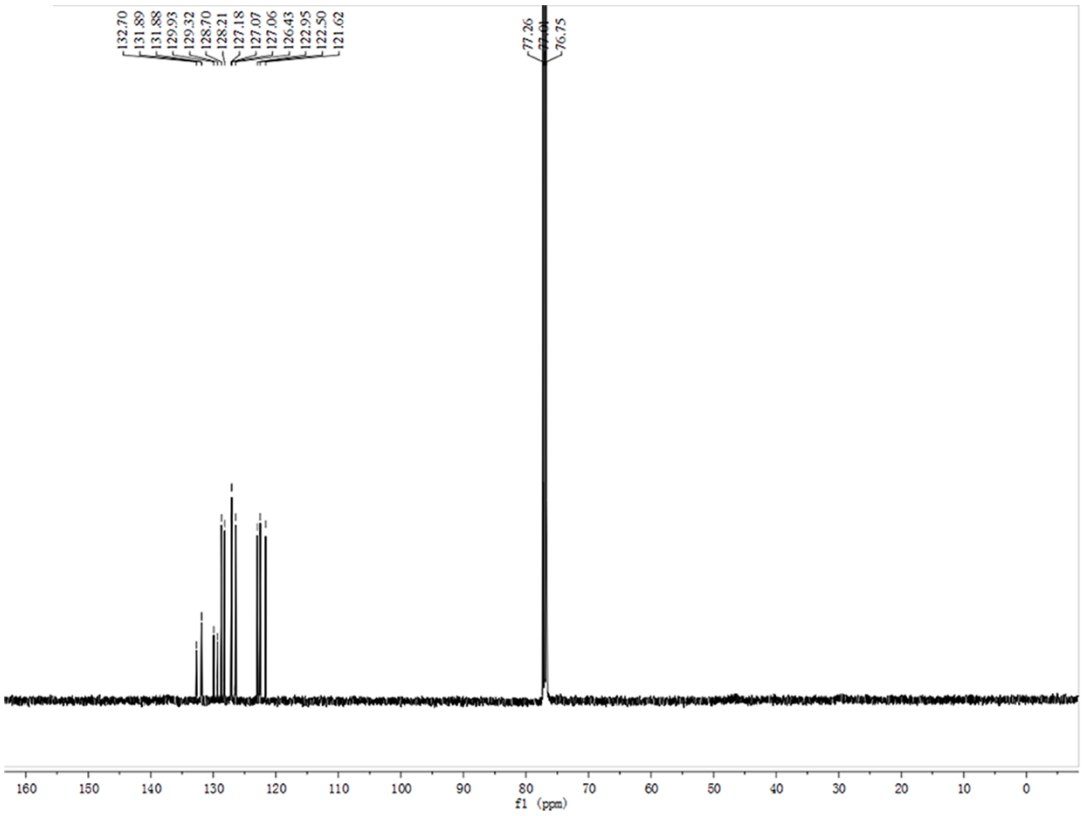
1.08
1.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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127.18
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127.06
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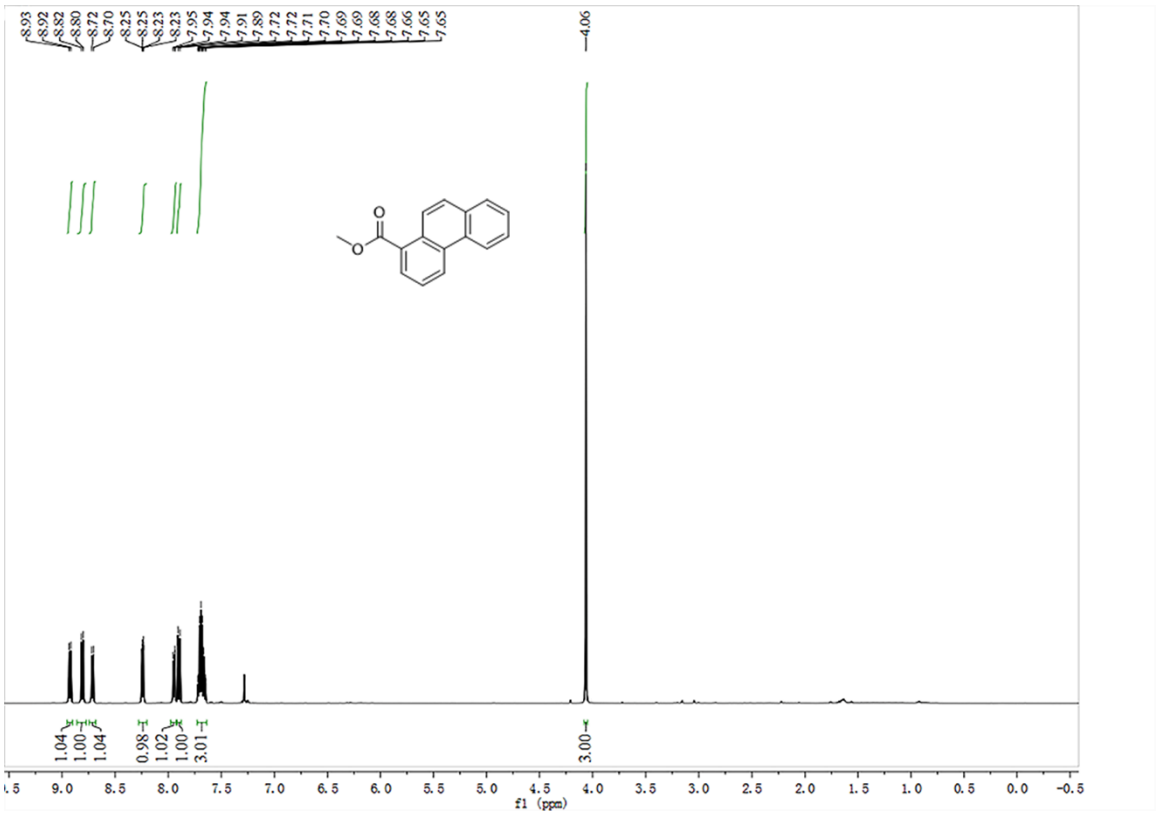
122.50
121.62
77.26
77.01
76.75
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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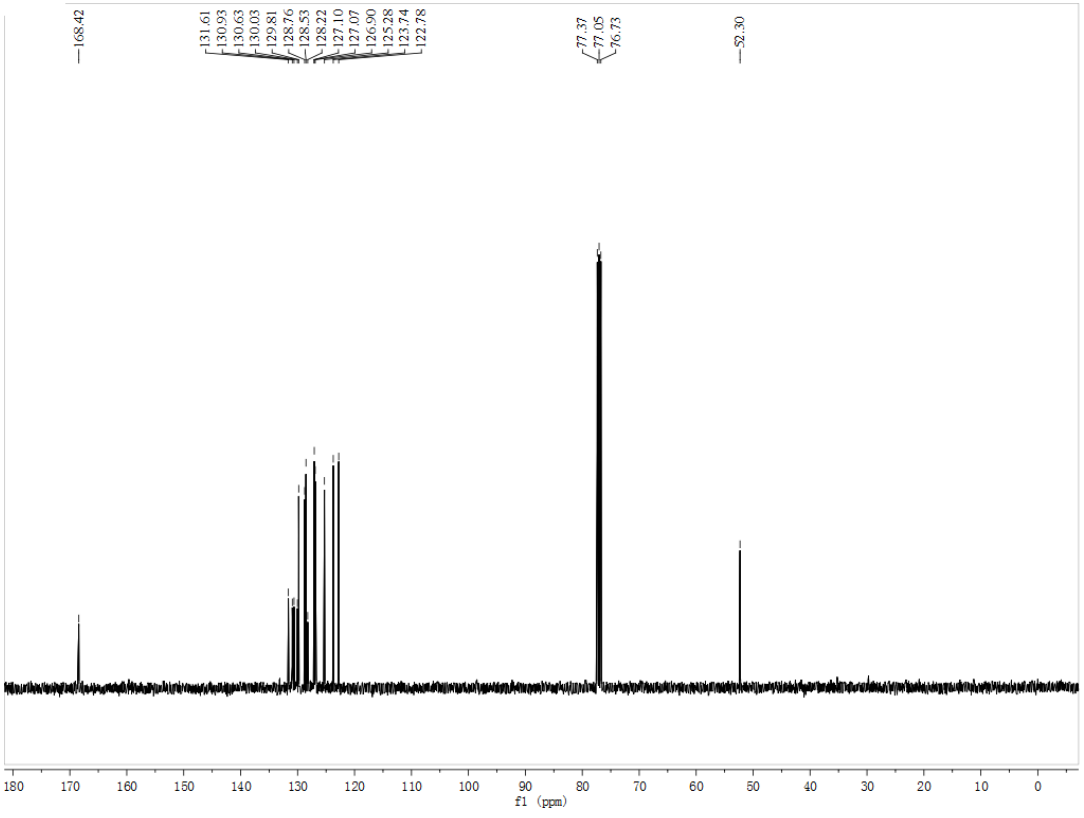
8.70
8.25
8.25
8.23
8.23
7.95
7.94
7.94
7.91
7.80
7.72
7.72
7.71
7.70
7.69
7.69
7.68
7.68
7.66
7.65
7.65
4.06
1.04
1.00
1.04
0.98
1.02
1.00
3.01
3.00
f1 (ppm)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128.53
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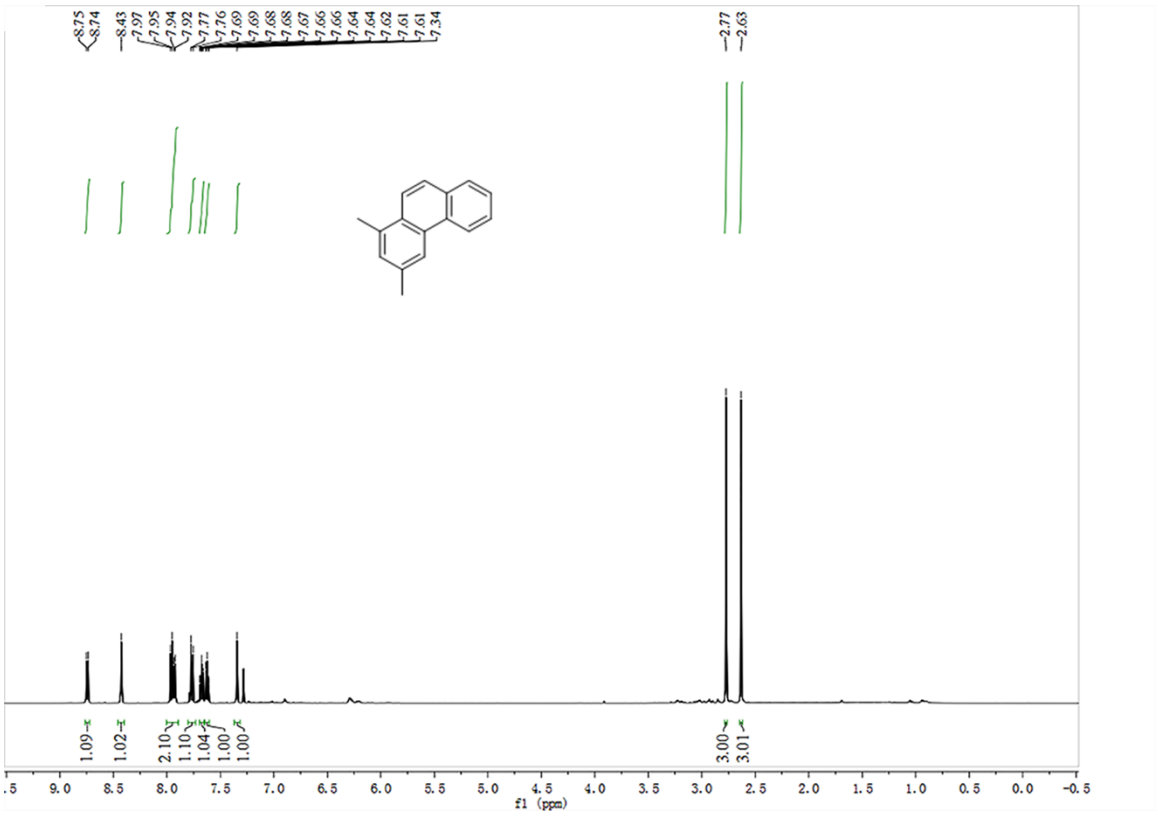
126.90
125.28
123.74
122.78
77.37
77.05
76.73
52.30
f1 (ppm)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7.68
7.68
7.67
7.66
7.66
7.64
7.64
7.62
7.61
7.61
7.34
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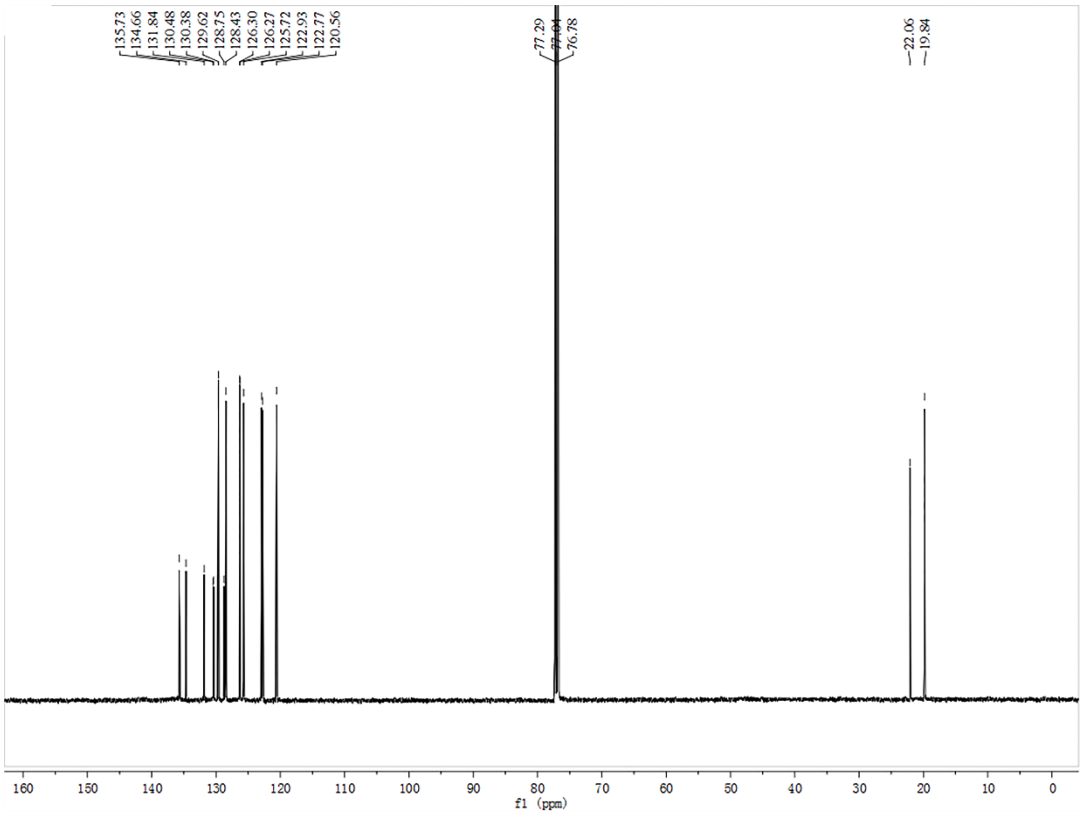
1.10
1.04
1.00
1.00
3.00
3.01
f1 (ppm)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129.62
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128.43
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126.27
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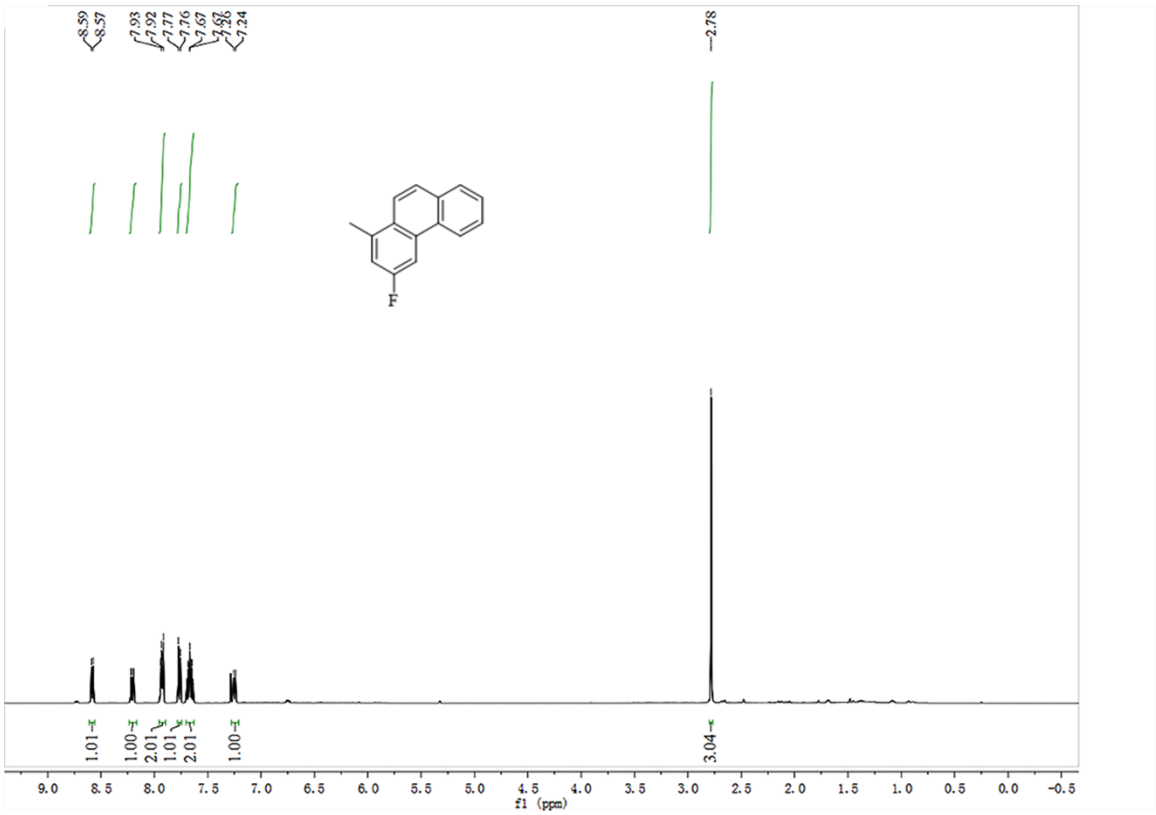
122.93
122.77
120.56
77.29
77.04
76.78
22.06
19.84
f1 (ppm)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7.76
7.67
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7.24
2.78
F
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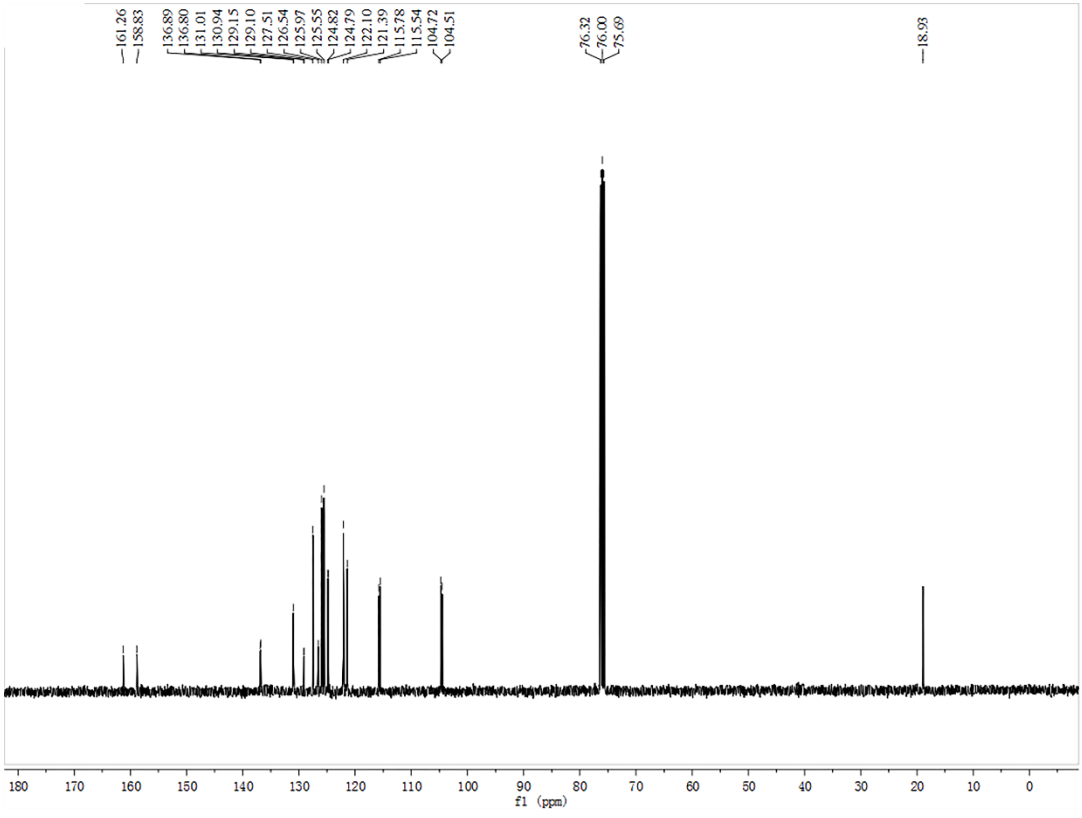
1.00
2.01
1.01
2.01
1.00
3.04
f1 (ppm)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130.94
129.15
129.10
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125.97
125.55
124.82
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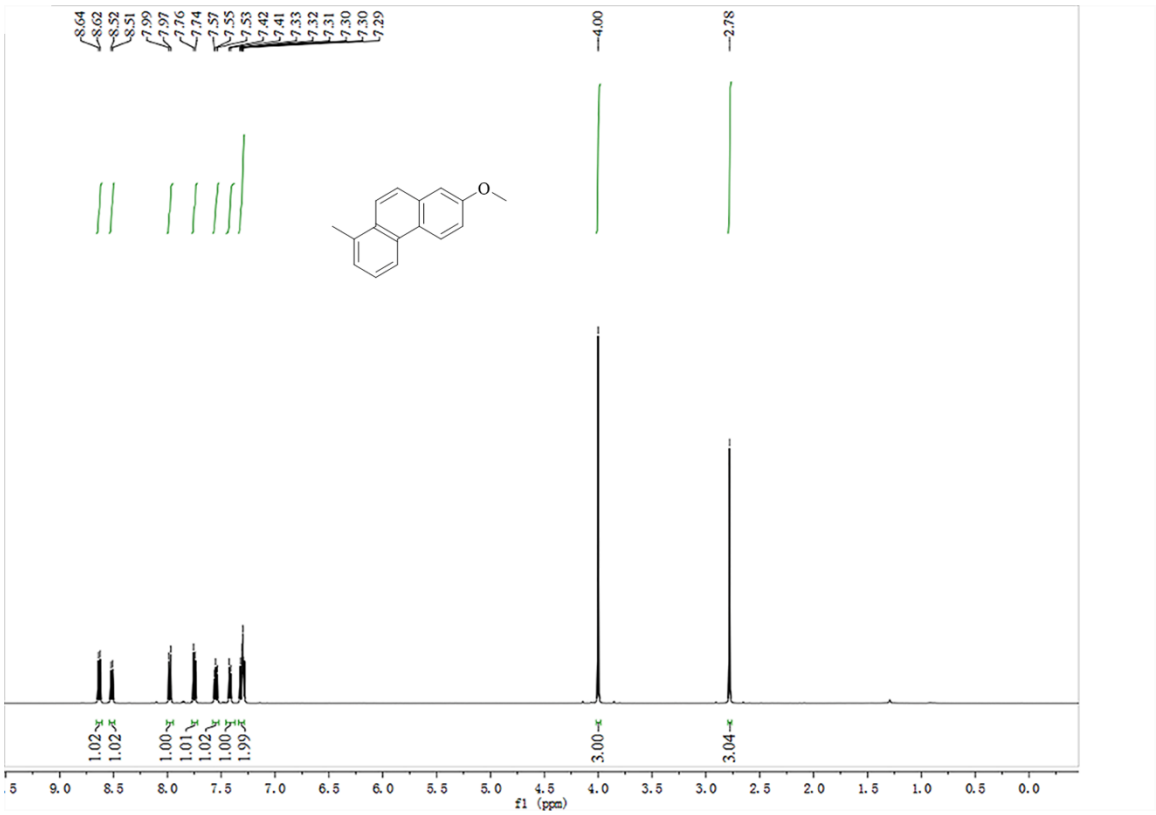
115.78
115.54
104.72
104.51
76.32
76.00
75.69
18.93
f1 (ppm)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7.53
7.42
7.41
7.33
7.32
7.31
7.30
7.30
7.29
4.00
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O
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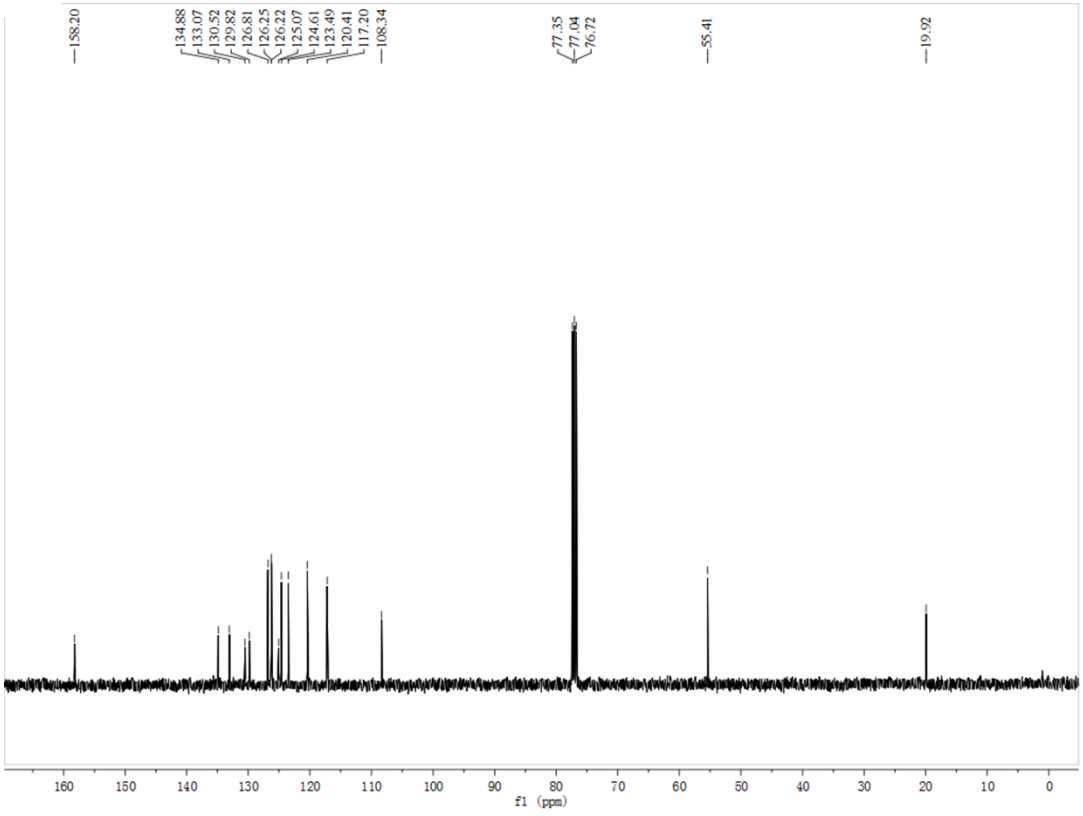
1.02
1.00
1.01
1.02
1.00
1.99
3.00
3.04
f1 (ppm)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126.25
126.22
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120.41
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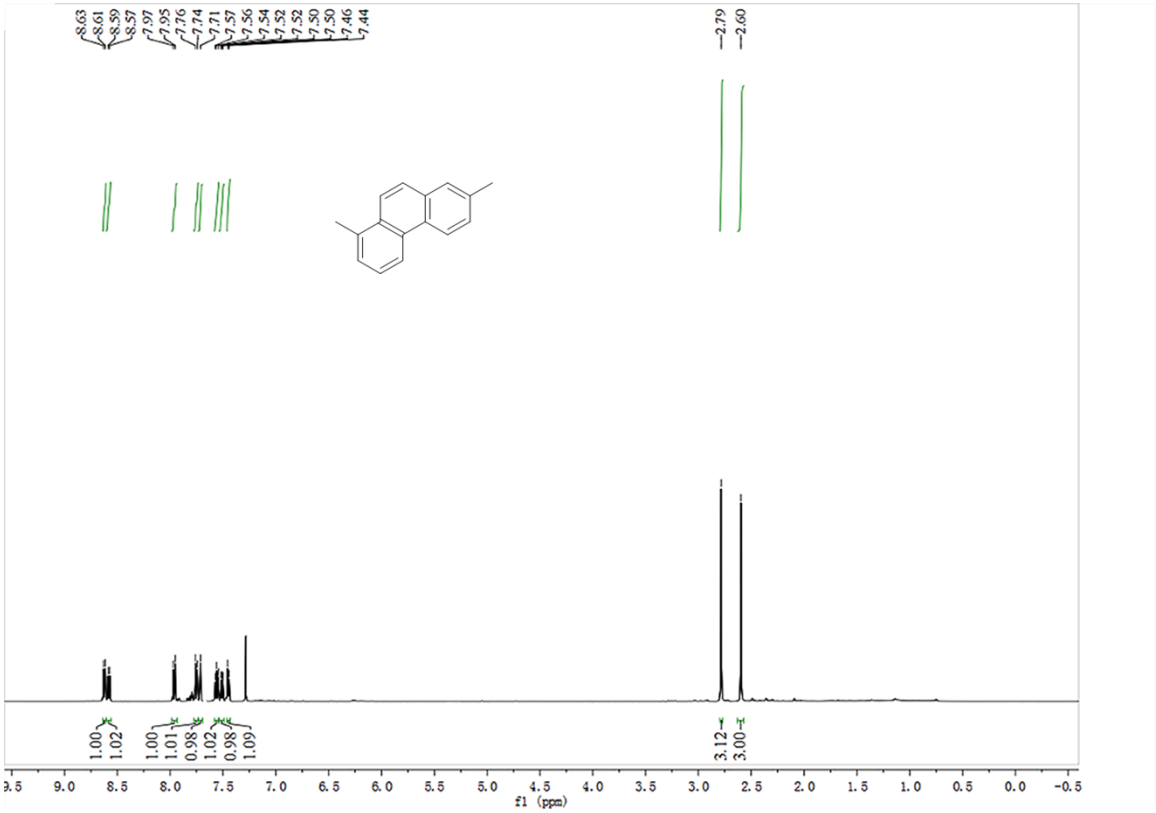
77.35
77.04
76.72
55.41
19.92
f1 (ppm)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7.52
7.52
7.50
7.50
7.46
7.44
2.79
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0.98
1.02
0.98
1.09
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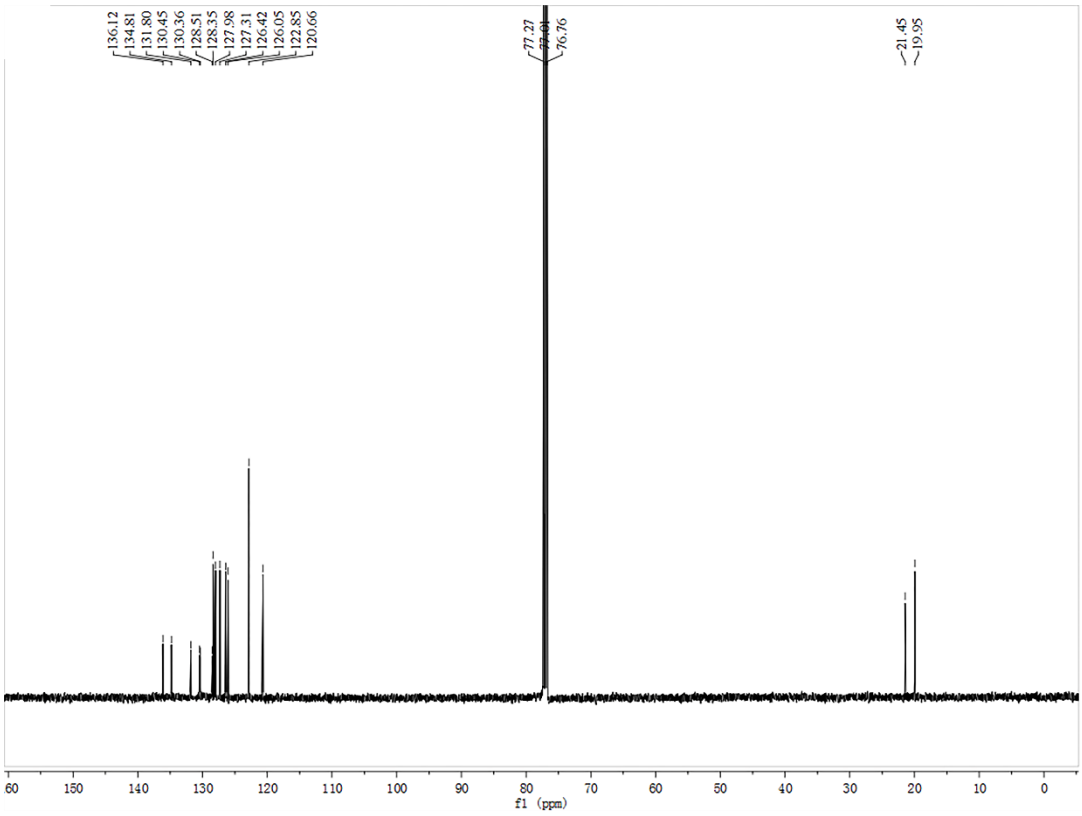
3.00
f1 (ppm)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128.35
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127.31
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126.05
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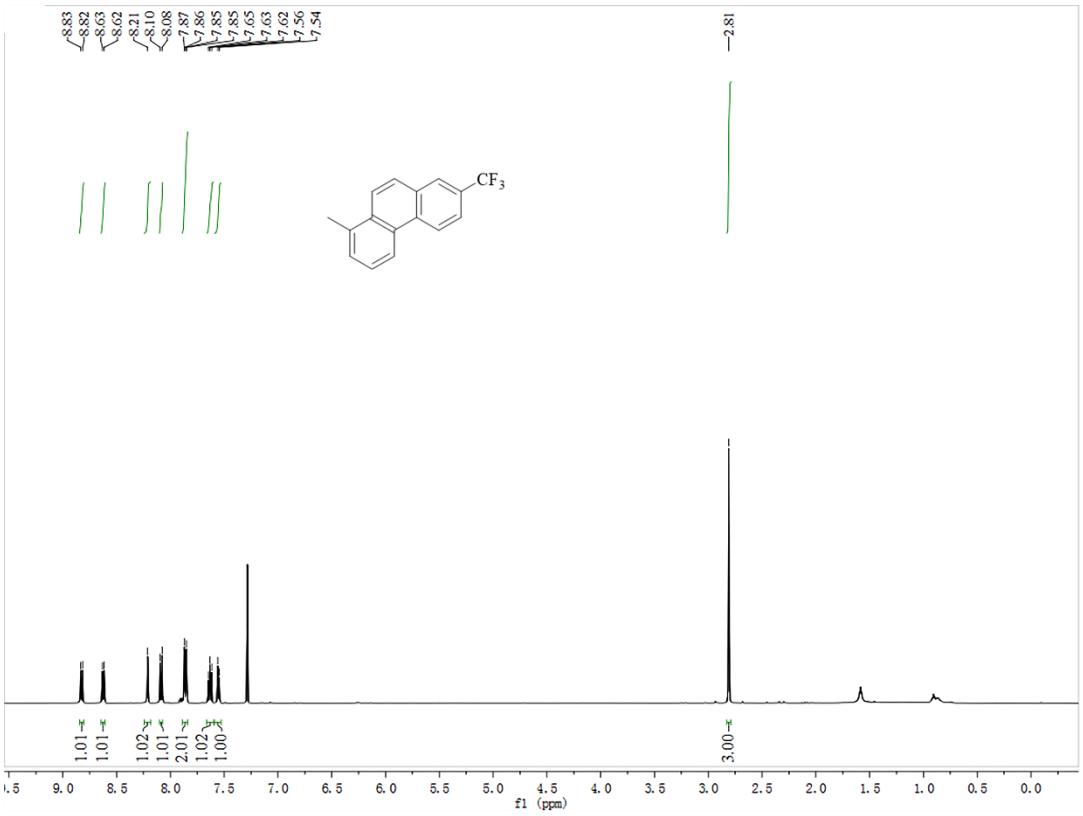
77.01
76.76
21.45
19.95
f1 (ppm)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8.62
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8.10
8.08
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7.86
7.85
7.85
7.65
7.63
7.62
7.56
7.54
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1.02
1.01
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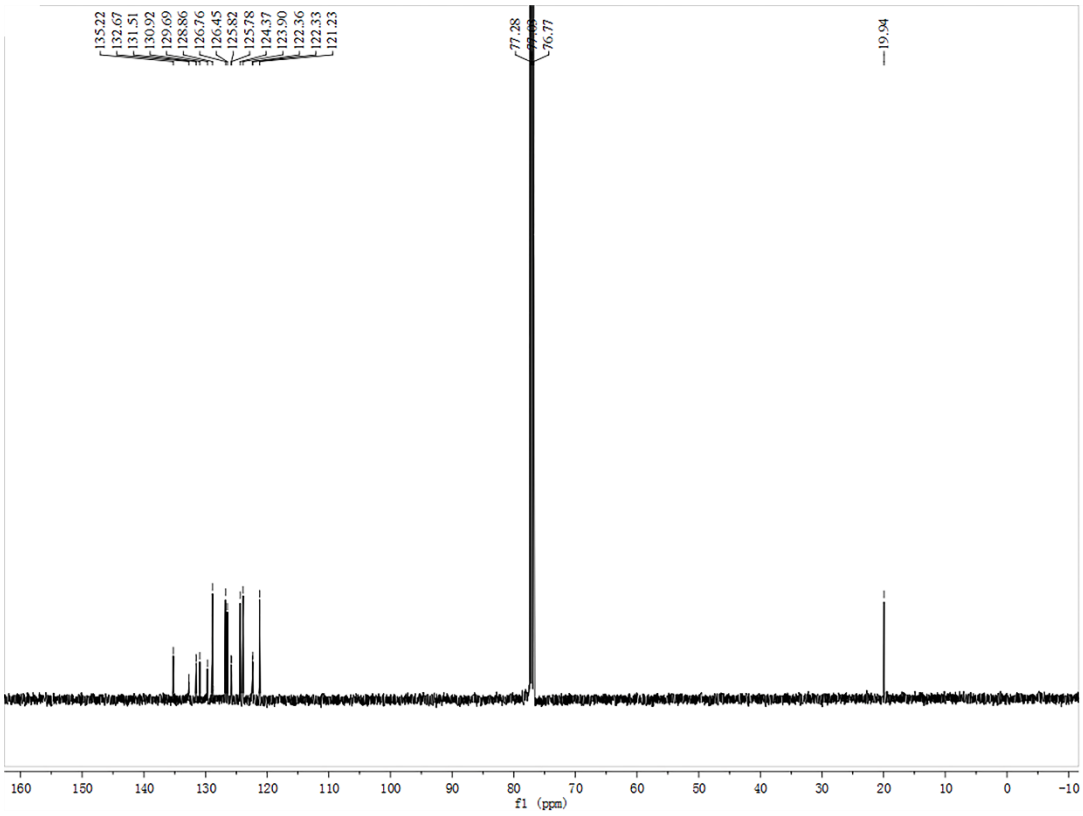
3.00
f1 (ppm)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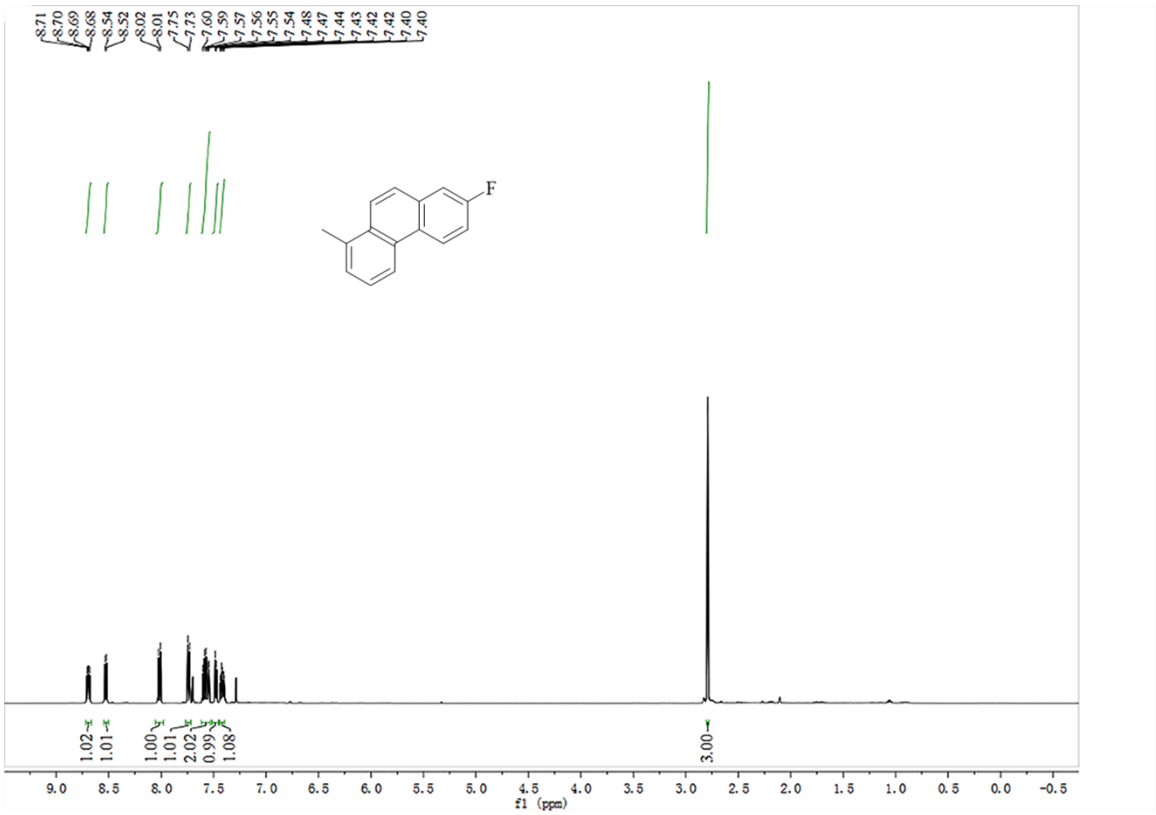
122.33
121.23
77.28
76.77
19.94
f1 (ppm)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7.57
7.56
7.55
7.54
7.48
7.47
7.44
7.43
7.42
7.42
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7.40
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1.00
1.01
2.02
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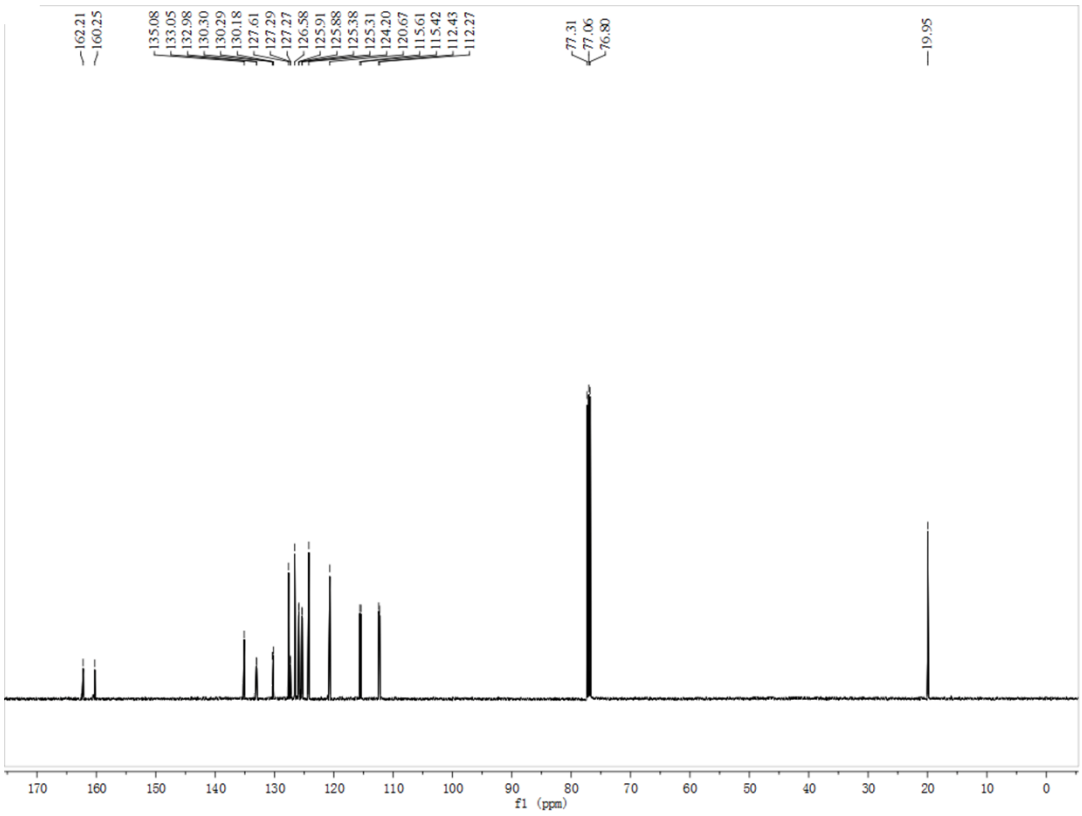
1.08
3.00
f1 (ppm)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127.29
127.27
126.58
125.91
125.88
125.38
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115.61
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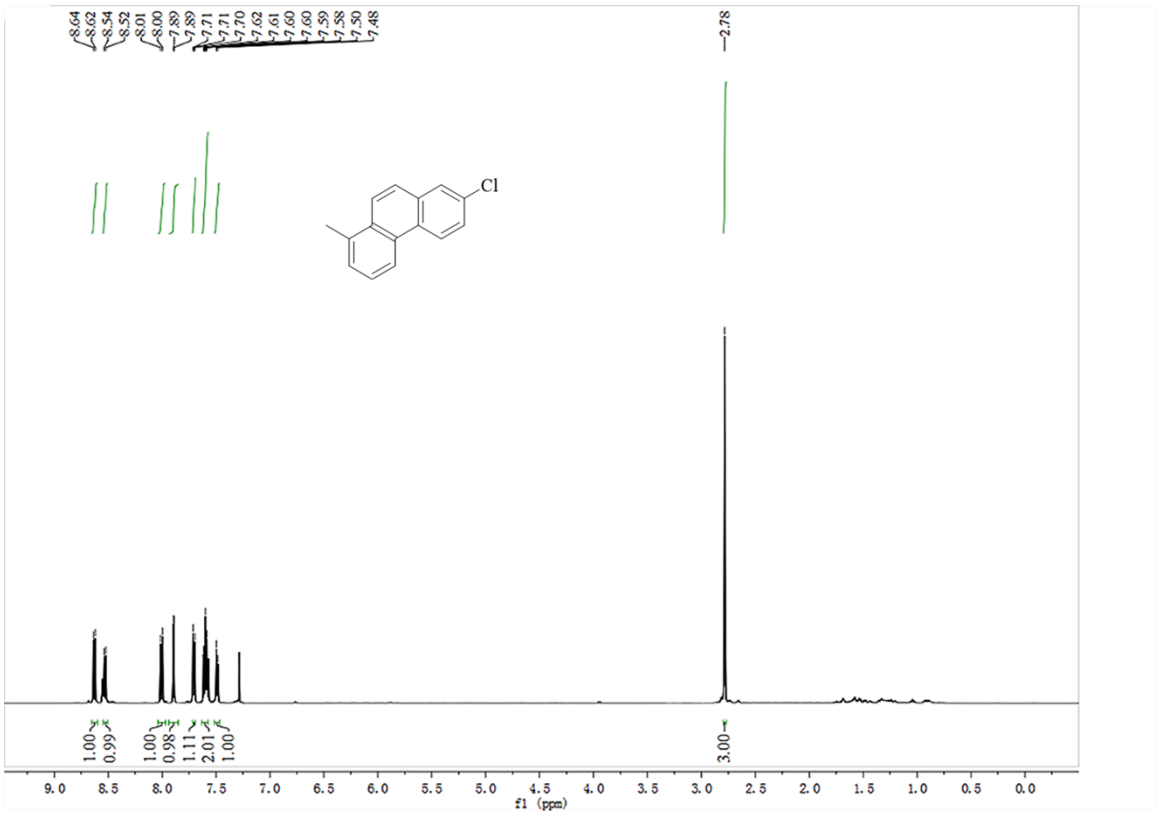
112.27
77.31
77.06
76.80
19.95
f1 (ppm)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7.58
7.50
7.48
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Cl
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1.00
0.98
1.11
2.01
1.00
3.00
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8.0
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7.0
6.5
6.0
5.5
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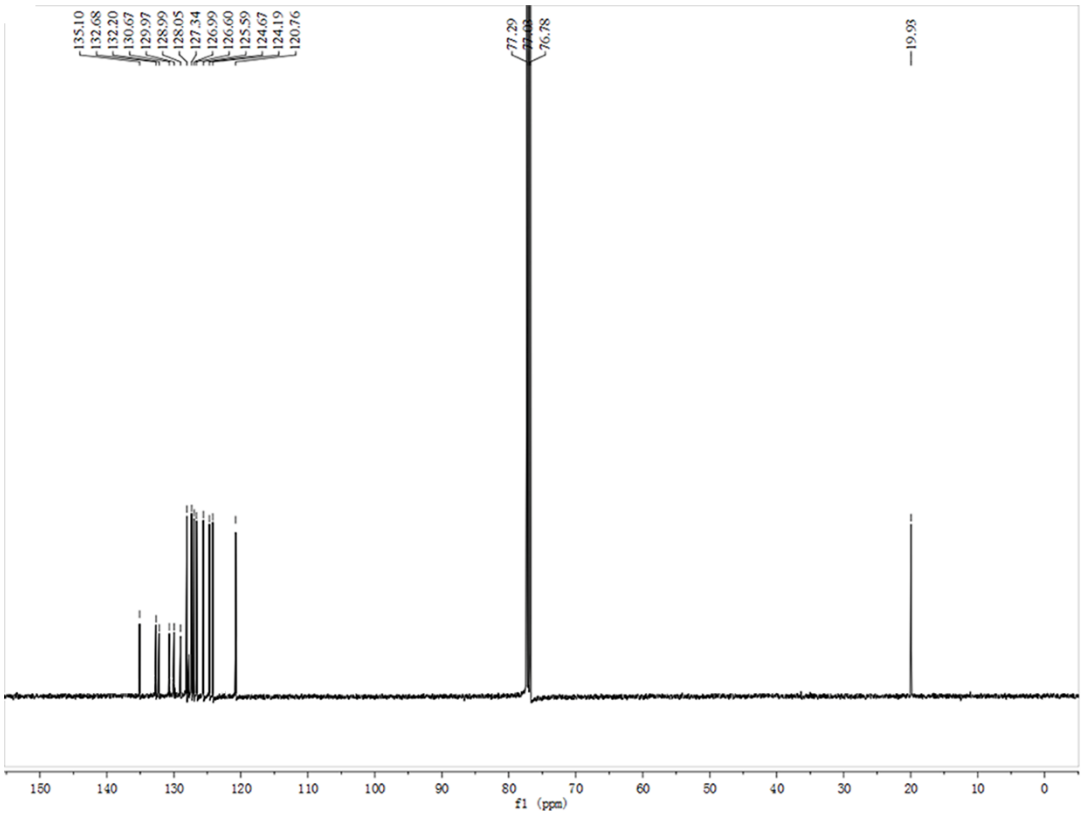
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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128.05
127.34
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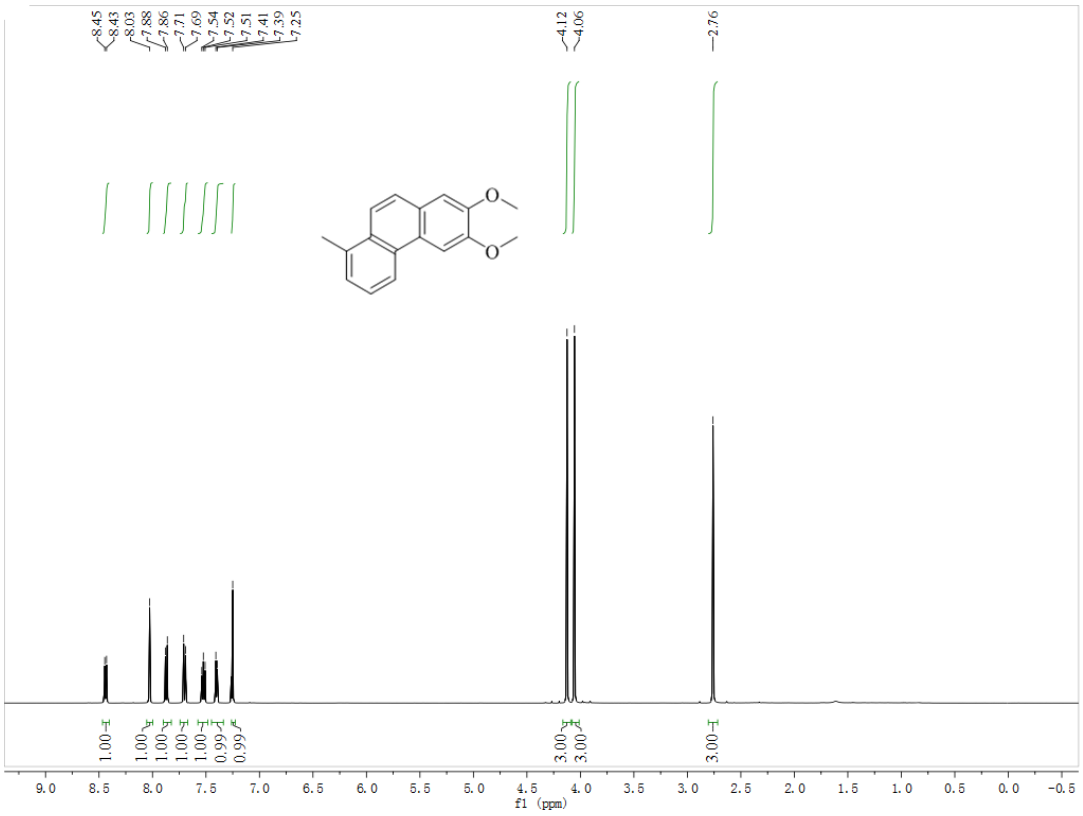
126.60
125.59
124.67
124.19
120.76
77.29
77.03
76.78
19.93
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.51
7.41
7.39
7.25
4.12
4.06
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1.00
1.00
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3.00
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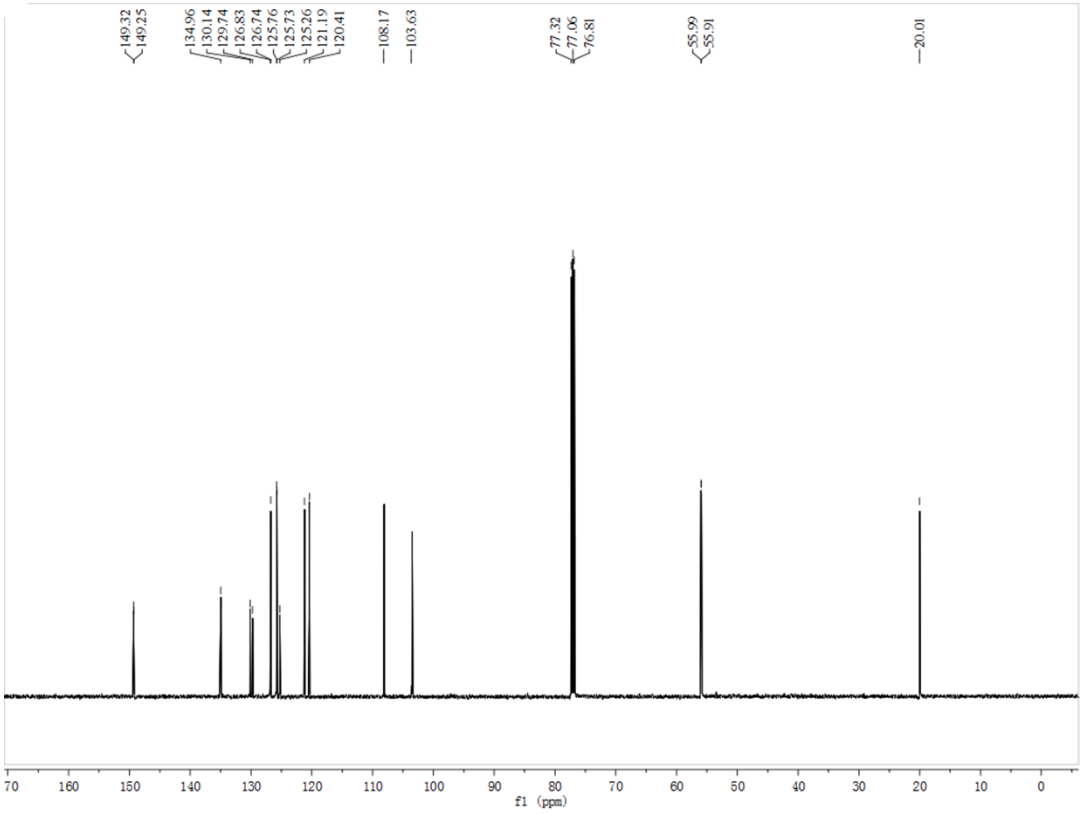
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120.41
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103.63
77.32
77.06
76.81
55.99
55.91
20.01
f1 (ppm)