Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Chemoselective metal-free indole arylation with cyclohexanones

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General information

All reactions were carried out under an atmosphere of air unless otherwise noted. Column chromatography was performed using silica gel 48-75 μm. ^{1}H NMR and ^{13}C NMR spectra were recorded on Bruker-AV (400 and 100 MHz, respectively) instrument internally referenced to tetramethylsilane (TMS) or chloroform signals. Mass spectra were measured on Agilent 5975 GC-MS instrument (EI). High-resolution mass spectra were recorded at the Institute of Chemistry, Chinese Academy of Sciences. The structures of known compounds were further corroborated by comparing their ^{1}H NMR, ^{13}C NMR data and MS data with those of literature. Most reagents were obtained from commercial suppliers and used without further purification.

General procedure for indole arylation

Sulfur powder (25.6 mg, 0.8 mmol), 1-methyl-1*H*-indole (**1a**, 26.0 μL, 0.2 mmol), cyclohexanone (**2a**, 52 μL, 0.5 mmol), boron trifluoride diethyl etherate (25.0 μL, 0.2 mmol), 1,1-diphenylethylene (0.4 mmol, 69 μL), DMF (0.6 mL) were added to a 10 mL reaction vessel. The sealed reaction vessel under air atmosphere was stirred at 150 ^{o}C for 16 h. After cooling to room temperature, the reaction was diluted with ethyl acetate (5 mL) and washed with saturated salt water. The organic layer was separated, and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer was dried over sodium sulfate, the volatiles were removed under reduced pressure. The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3aa** as light yellow liquid (34.8 mg, 84% yield).

7 mmol scale: Sulfur powder (896 mg, 28 mmol), 1-methyl-1*H*-indole (**1a**, 910 μL, 7 mmol), 4-(*tert*-butyl)cyclohexan-1-one (**2g**, 2750 mg, 17.5 mmol), boron trifluoride diethyl etherate (875 μL, 7 mmol), 1,1-diphenylethylene (14 mmol, 2415 μL), DMF (7 mL) were added to a 50 mL reaction vessel. The reaction vessel under air atmosphere was stirred at 150 ^{o}C for 16 h. After cooling to room temperature, the reaction was diluted with ethyl acetate (5 mL) and washed with saturated salt water. The organic layer was separated, and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer was dried over sodium sulfate, the volatiles were removed under reduced pressure. The residue was purified by column

chromatography on silica gel (petroleum ether/EtOAc = 400:1) to yield the desired product **3ag** as pale yellow liquid (1325 mg, 72% yield).

General procedure for benzothienoindole synthesis

Sulfur powder (25.6 mg, 0.8 mmol), 1-methyl-1*H*-indole (**1a**, 38.0 μL, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol), iodine (50.8 mg, 0.2 mmol), NMP (0.6 mL) were added to a 10 mL reaction vessel. The sealed reaction vessel under air atmosphere was stirred at 150 ^{o}C for 16 h. After cooling to room temperature, the reaction was diluted with ethyl acetate (5 mL) and washed with saturated salt water. The organic layer was separated, and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer was dried over sodium sulfate, the volatiles were removed under reduced pressure. The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 200:1, R_f = 0.3) to yield the desired product **4aa** as pale yellow solid (30.7 mg, 65% yield).

General procedure for 2,3-diphenylindole synthesis

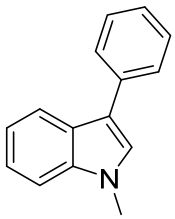
0.2 mmol scale: Iodine bromide (105 mg, 0.5 mmol), 1-methyl-2-phenyl-1*H*-indole (**5a**, 62 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol), 1,1-diphenylethylene (0.4 mmol, 69 μL), DMAc (0.6 mL) were added to a 10 mL reaction vessel. The sealed reaction vessel under air atmosphere was stirred at 150 ^{o}C for 16 h. After cooling to room temperature, the reaction was diluted with ethyl acetate (5 mL) and washed with saturated salt water. The organic layer was separated, and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer was dried over sodium sulfate, the volatiles were removed under reduced pressure. The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **6aa** as white solid (52.6 mg, 93% yield).

6 mmol scale: Iodine bromide (3150 mg, 15 mmol), 1-methyl-2-phenyl-1*H*-indole (**5a**, 1920 mg, 9 mmol), cyclohexanone (**2a**, 630 μL, 6 mmol), 1,1-diphenylethylene (12 mmol, 2070 μL), DMAc (9 mL) were added to a 50 mL reaction vessel. The reaction vessel under air atmosphere was stirred at 150 ^{o}C for 16 h. After cooling to room temperature, the reaction was diluted with ethyl acetate (5 mL) and washed with saturated salt water. The organic layer was separated, and the aqueous layer was extracted with ethyl acetate for three times. The combined organic layer

was dried over sodium sulfate, the volatiles were removed under reduced pressure. The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1) to yield the desired product **6aa** as white solid (1188 mg, 70% yield).

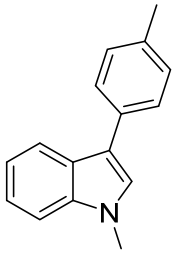
Characterization data of products

1-Methyl-3-phenyl-1*H*-indole (3aa, CAS: 30020-98-5)[1]



The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 26.0 μL, 0.2 mmol), cyclohexanone (**2a**, 52 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3aa** as pale yellow liquid (34.8 mg, 84% yield). ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.93 (d, J = 8.0 Hz, 1H), 7.68-7.63 (m, 2H), 7.43 (t, J = 7.56 Hz, 2H), 7.36 (d, J = 8.2 Hz, 1H), 7.30-7.22 (m, 3H), 7.21-7.16 (m, 1H), 3.83 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-d) δ 137.4, 135.6, 128.7, 127.3, 126.5, 126.1, 125.7, 121.9, 119.9, 119.9, 116.7, 109.5, 32.9.

1-Methyl-3-(*p*-tolyl)-1*H*-indole (3ab, CAS: 154796-08-4)[2]

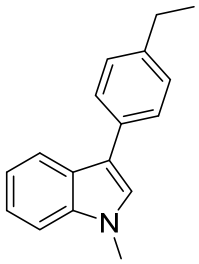


The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 26.0 μL, 0.2 mmol), 4-methylcyclohexanone (**2b**, 61 uL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3ab** as pale yellow liquid (38.9 mg, 88% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.92 (d, J = 8.0 Hz, 1H), 7.54 (d, J = 8.1 Hz, 2H), 7.35 (d, J = 8.2 Hz, 1H), 7.29-7.23 (m, 3H), 7.20-7.15 (m, 2H), 3.82 (s, 3H), 2.39 (s, 3H); ^{13}C NMR (100

MHz, Chloroform-*d*) δ 137.4, 135.3, 132.7, 129.4, 127.2, 126.2, 126.2, 121.9, 119.9, 119.7, 116.6, 109.4, 32.8, 21.1.

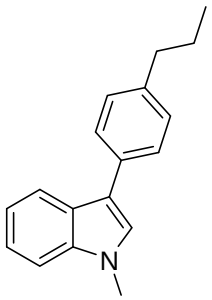
3-(4-Ethylphenyl)-1-methyl-1*H*-indole (3ac)



The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 26.0 μL, 0.2 mmol), 4-ethylcyclohexanone (**2c**, 70 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3ac** as pale yellow liquid (39.5 mg, 84% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.93 (d, *J* = 8.0 Hz, 1H), 7.57 (d, *J* = 8.1 Hz, 2H), 7.34 (d, *J* = 8.2 Hz, 1H), 7.29-7.23 (m, 3H), 7.20-7.15 (m, 2H), 3.81 (s, 3H), 2.69 (q, *J* = 7.6 Hz, 2H), 1.29 (t, *J* = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 141.7, 137.4, 132.9, 128.2, 127.3, 126.3, 126.2, 121.8, 120.0, 119.7, 116.7, 109.4, 32.8, 28.6, 15.6; HRMS (ESI) m/z calcd for $C_{17}H_{18}N^+$ $(M+H)^+$ 236.1434, found 236.1434.

1-Methyl-3-(4-propylphenyl)-1*H*-indole (3ad)

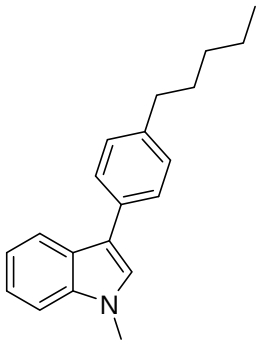


The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 26.0 μL, 0.2 mmol), 4-*n*-propylcyclohexanone (**2d**, 77 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3ad** as pale yellow liquid (42.3 mg, 85% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.93 (d, *J* = 8.0 Hz, 1H), 7.56 (d, *J* = 7.7 Hz, 2H), 7.34 (d, *J*

= 8.2 Hz, 1H), 7.29-7.22 (m, 3H), 7.20-7.14 (m, 2H), 3.80 (s, 3H), 2.62 (t, *J* = 7.7 Hz, 2H), 1.75-1.63 (m, 2H), 0.98 (t, *J* = 7.3 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 140.1, 137.4, 132.9, 128.9, 127.2, 126.3, 126.2, 121.8, 120.0, 119.7, 116.7, 109.4, 37.8, 32.8, 24.6, 13.9; HRMS (ESI) m/z calcd for $C_{18}H_{20}N^+$ $(M+H)^+$ 250.1590, found 250.1591.

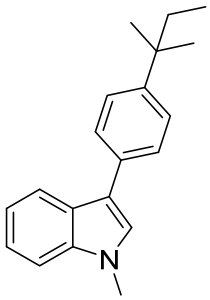
1-Methyl-3-(4-pentylphenyl)-1*H*-indole (3ae)



The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 26.0 μL, 0.2 mmol), 4-*n*-pentylcyclohexanone (**2e**, 94 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3ae** as pale yellow liquid (49.3 mg, 89% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.93 (d, *J* = 8.0 Hz, 1H), 7.56 (d, *J* = 8.0 Hz, 2H), 7.34 (d, *J* = 8.2 Hz, 1H), 7.29-7.23 (m, 3H), 7.20-7.15 (m, 2H), 3.82 (s, 3H), 2.64 (t, *J* = 7.6 Hz, 2H), 1.71-1.61 (m, 2H), 1.40-1.33 (m, 4H), 0.91 (t, *J* = 6.5 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 140.4, 137.4, 132.9, 128.7, 127.2, 126.3, 126.2, 121.8, 120.0, 119.7, 116.7, 109.4, 35.6, 32.8, 31.6, 31.3, 22.6, 14.0; HRMS (ESI) m/z calcd for $C_{20}H_{24}N^+$ $(M+H)^+$ 278.1903, found 278.1908.

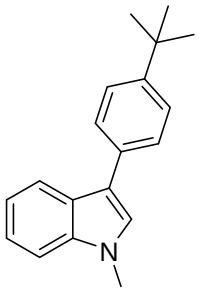
1-Methyl-3-(4-(*tert*-pentyl)phenyl)-1*H*-indole (3af)



The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 26.0 μL, 0.2 mmol), 4-*ter*t-pentylcyclohexanone (**2f**, 94 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3af** as pale yellow liquid (45.4 mg, 82% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.96 (d, J = 8.0 Hz, 1H), 7.61-7.56 (m, 2H), 7.41-7.37 (m, 2H), 7.30 (d, J = 8.2 Hz, 1H), 7.29-7.22 (m, 1H), 7.20-7.15 (m, 2H), 3.80 (s, 3H), 1.68 (q, J = 7.4 Hz, 2H), 1.33 (s, 6H), 0.74 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 146.9, 137.4, 132.6, 126.8, 126.3, 126.3, 126.2, 121.8, 120.1, 119.7, 116.6, 109.4, 37.7, 36.9, 32.8, 28.5, 9.2; HRMS (ESI) m/z calcd for $C_{20}H_{24}N^+$ $(M+H)^+$ 278.1903, found 278.1902.

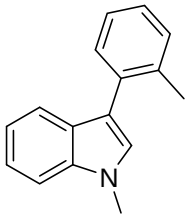
3-(4-(*tert*-Butyl)phenyl)-1-methyl-1*H*-indole (3ag)



The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 26.0 μL, 0.2 mmol), 4-*tert*-butylcyclohexanone (**2g**, 77 mg, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3ag** as pale yellow liquid (46.8 mg, 89% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 (d, J = 8.0 Hz, 1H), 7.62-7.56 (m, 2H), 7.48-7.43 (m, 2H), 7.28 (d, J = 8.2 Hz, 1H), 7.29-7.23 (m, 1H), 7.20-7.15 (m, 2H), 3.81 (s, 3H), 1.37 (s, 9H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 148.5, 137.4, 132.7, 127.0, 126.3, 126.2, 125.6, 121.8, 120.0, 119.7, 116.6, 109.4, 34.5, 32.8, 31.4; HRMS (ESI) m/z calcd for $C_{19}H_{22}N^+$ $(M+H)^+$ 264.1747, found 264.1744.

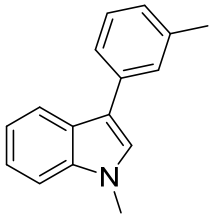
1-Methyl-3-(*o*-tolyl)-1*H*-indole (3ai, CAS: 883141-51-3)[2]



The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 26.0 μL, 0.2 mmol), 2-methylcyclohexanone (**2i**, 63 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **3ai** as pale yellow liquid (26.5 mg, 60% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.52 (d, *J* = 7.9 Hz, 1H), 7.44-7.35 (m, 2H), 7.33-7.29 (m, 1H), 7.28-7.22 (m, 3H), 7.13 (t, *J* = 7.5 Hz, 1H), 7.04 (s, 1H), 3.84 (s, 3H), 2.33 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 136.7, 134.5, 130.9, 130.3, 127.6, 127.5, 127.5, 126.5, 125.6, 121.7, 120.2, 119.4, 115.9, 109.3, 32.8, 20.8.

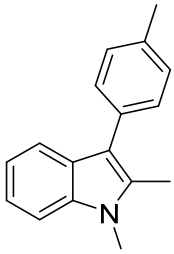
1-Methyl-3-(*m*-tolyl)-1*H*-indole (3aj)



The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 26.0 μL, 0.2 mmol), 3-methylcyclohexanone (**2j**, 62 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **3aj** as pale yellow liquid (34.5 mg, 78% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 (d, *J* = 8.0 Hz, 1H), 7.46 (d, *J* = 7.7 Hz, 2H), 7.33 (q, *J* = 7.9 Hz, 2H), 7.29-7.23 (m, 1H), 7.21-7.15 (m, 2H), 7.08 (d, *J* = 7.6 Hz, 1H), 3.81 (s, 3H), 2.41 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 138.2, 137.4, 135.5, 128.6, 128.1, 126.5, 126.5, 126.2, 124.4, 121.9, 120.0, 119.8 116.8, 109.5, 32.8, 21.6; HRMS (ESI) m/z calcd for $C_{16}H_{16}N^+$ $(M+H)^+$ 222.1277, found 222.1274.

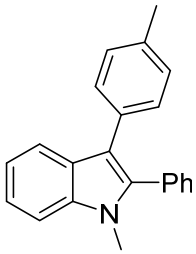
1,2-Dimethyl-3-(*p*-tolyl)-1*H*-indole (3bb)



The reaction was conducted with 1,2-dimethyl-1*H*-indole (**1b**, 29 mg, 0.2 mmol), 4-methylcyclohexanone (**2b**, 61 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3bb** as pale yellow solid (29.1 mg, 62% yield), mp 127-129 ^oC.

^1H NMR (400 MHz, Chloroform-*d*) δ 7.64 (d, *J* = 7.9 Hz, 1H), 7.38 (d, *J* = 8.0 Hz, 2H), 7.33-7.25 (m, 3H), 7.23-7.17 (m, 1H), 7.12-7.06 (m, 1H), 3.72 (s, 3H), 2.47 (s, 3H), 2.41 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 136.5, 135.2, 133.1, 132.7, 129.5, 129.2, 127.0, 121.0, 119.5, 118.7, 113.9, 108.6, 29.6, 21.2, 11.0; HRMS (ESI) m/z calcd for $C_{17}H_{18}N^+$ $(M+H)^+$ 236.1434, found 236.1430.

1-Methyl-2-phenyl-3-(*p*-tolyl)-1*H*-indole (3cb or 6ab)[4]



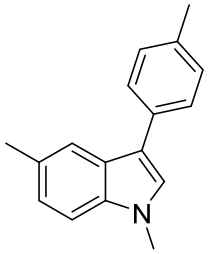
Condition A: The reaction was conducted with 1-methyl-2-phenyl-1*H*-indole (**1c**, 42 mg, 0.2 mmol), 4-methylcyclohexanone (**2b**, 61 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3cb** as white solid (20.7 mg, 35% yield).

Condition C: The reaction was conducted with 1-methyl-2-phenyl-1*H*-indole (**5a**, 62 mg, 0.3 mmol), 4-methylcyclohexanone (**2b**, 26 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1) to yield the desired product **6ab** as white solid (55.2 mg, 93% yield).

^1H NMR (400 MHz, Chloroform-*d*) δ 7.78 (d, *J* = 8.0 Hz, 1H), 7.42-7.26 (m, 7H), 7.22-7.14 (m,

3H), 7.07 (d, *J* = 7.8 Hz, 2H), 3.64 (s, 3H), 2.31 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.5, 137.3, 134.9, 132.1, 132.0, 131.1, 129.7, 128.9, 128.3, 127.9, 127.0, 122.1, 120.0, 119.6, 114.9, 109.5, 30.9, 21.1.

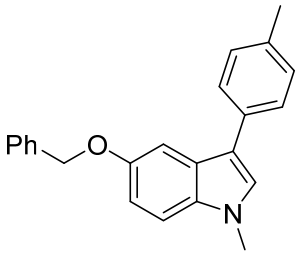
1,5-Dimethyl-3-(*p*-tolyl)-1*H*-indole (3eb)



The reaction was conducted with 1,5-dimethyl-1*H*-indole (**1e**, 29 mg, 0.2 mmol), 4-methylcyclohexanone (**2b**, 61 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3eb** as pale yellow solid (37.6 mg, 80% yield), mp 48-51 ^{o}C.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.64 (d, *J* = 0.72 Hz, 1H), 7.48 (dd, *J* = 8.1, 1.8 Hz, 2H), 7.27-7.22 (m, 3H), 7.15 (s, 1H), 7.09 (d, *J* = 8.3 Hz, 1H), 3.79 (s, 3H), 2.47 (s, 3H), 2.39 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ 135.8, 135.1, 132.8, 129.4, 129.0, 127.2, 126.4, 126.3, 123.4, 119.5, 116.1, 109.1, 32.8, 21.6, 21.1; HRMS (ESI) m/z calcd for $C_{17}H_{18}N^{+}$ $(M+H)^{+}$ 236.1434, found 236.1431.

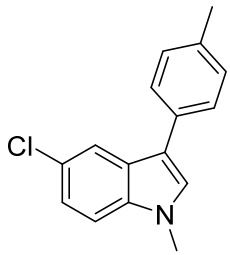
5-(Benzyloxy)-1-methyl-3-(*p*-tolyl)-1*H*-indole (3fb)



The reaction was conducted with 5-(benzyloxy)-1-methyl-1*H*-indole (**1f**, 47.4 mg, 0.2 mmol), 4-methylcyclohexanone (**2b**, 61 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 50:1, R_f = 0.3) to yield the desired product **3fb** as pale yellow solid (48.4 mg, 74% yield), mp 126-129 ^{o}C.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.51-7.43 (m, 5H), 7.37 (t, *J* = 7.6 Hz, 2H), 7.30 (t, *J* = 7.3 Hz, 1H), 7.25-7.19 (m, 3H), 7.13 (s, 1H), 6.99 (d, *J* = 9.9 Hz, 1H), 5.09 (s, 2H), 3.74 (s, 3H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 153.5, 137.6, 135.1, 132.9, 132.7, 129.4, 128.5, 127.7, 127.6, 127.0, 126.9, 126.4, 116.1, 112.8, 110.2, 103.5, 71.0, 32.9, 21.1; HRMS (ESI) m/z calcd for $C_{23}H_{22}NO^+$ $(M+H)^+$ 328.1696, found 328.1694.

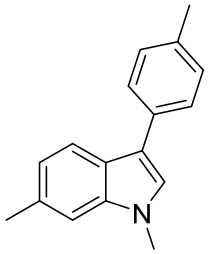
5-Chloro-1-methyl-3-(*p*-tolyl)-1*H*-indole (3gb)



The reaction was conducted with 5-chloro-1-methyl-1*H*-indole (**1g**, 33 mg, 0.2 mmol), 4-methylcyclohexanone (**2b**, 61 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **3gb** as pale yellow liquid (30.6 mg, 60% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.86 (s, 1H), 7.47 (d, *J* = 7.9 Hz, 2H), 7.27-7.19 (m, 4H), 7.18 (s, 1H), 3.77 (s, 3H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 135.8, 135.6, 131.9, 129.5, 127.4, 127.1, 127.1, 125.6, 122.1, 119.3, 116.4, 110.5, 33.0, 21.1; HRMS (ESI) m/z calcd for $C_{16}H_{15}ClN^+$ $(M+H)^+$ 256.0888, found 256.0885.

1,6-Dimethyl-3-(*p*-tolyl)-1*H*-indole (3hb, CAS: 32030324)[1]

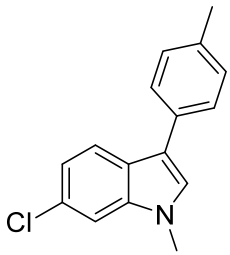


The reaction was conducted with 1,6-dimethyl-1*H*-indole (**1h**, 29 mg, 0.2 mmol), 4-methylcyclohexanone (**2b**, 61 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired

product **3hb** as pale yellow liquid (38.5 mg, 82% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.80 (dd, *J* = 8.3, 1.3 Hz, 1H), 7.57-7.50 (m, 2H), 7.23 (d, *J* = 8.4 Hz, 2H), 7.12 (d, *J* = 8.2 Hz, 2H), 7.00 (d, *J* = 8.2 Hz, 1H), 3.76 (s, 3H), 2.51 (s, 3H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.8, 135.1, 132.8, 131.7, 129.4, 127.1, 125.6, 124.0, 121.5, 119.6, 116.4, 109.4, 32.7, 21.8, 21.1.

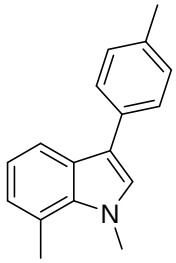
6-Chloro-1-methyl-3-(*p*-tolyl)-1*H*-indole (3ib)



The reaction was conducted with 6-chloro-1-methyl-1*H*-indole (**1i**, 33 mg, 0.2 mmol), 4-methylcyclohexanone (**2b**, 61 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **3ib** as pale yellow solid (30.6 mg, 60% yield), mp 67-69 ^{o}C.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.80 (d, *J* = 8.5 Hz, 1H), 7.50 (d, *J* = 8.0 Hz, 2H), 7.34 (d, *J* = 1.5 Hz, 1H), 7.25 (d, *J* = 6.4 Hz, 2H), 7.17 (s, 1H), 7.13 (dd, *J* = 8.5, 1.7 Hz, 1H). 3.79 (s, 3H), 2.40 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.7, 135.6, 132.0, 129.5, 127.8, 127.1, 126.7, 124.7, 120.8, 120.3, 116.8, 109.4, 32.8, 21.1; HRMS (ESI) m/z calcd for $C_{16}H_{15}ClN^+$ $(M+H)^+$ 256.0886, found 256.0884.

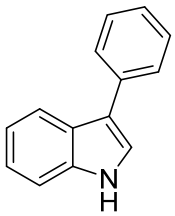
1,7-Dimethyl-3-(*p*-tolyl)-1*H*-indole (3jb)



^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.73 (d, *J* = 7.9 Hz, 1H), 7.50 (d, *J* = 8.0 Hz, 2H), 7.24 (d, *J*

= 7.4 Hz, 2H), 7.08-7.00 (m, 2H), 6.95 (d, *J* = 7.0 Hz, 1H), 4.09 (s, 3H), 2.79 (s, 3H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 136.1, 135.3, 132.6, 129.4, 128.1, 127.5, 127.4, 124.5, 121.4, 120.0, 118.0, 116.5, 36.9, 21.1, 19.8; HRMS (ESI) m/z calcd for $C_{17}H_{18}N^+$ $(M+H)^+$ 236.1434, found 236.1431.

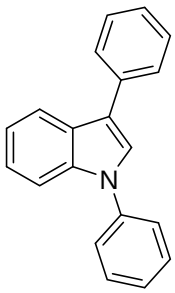
3-Phenyl-1*H*-indole (3ka, CAS: 1504-16-1)[8]



The reaction was conducted with 1*H*-indole (**1k**, 23 mg, 0.2 mmol), cyclohexanone (**2a**, 52 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10:1, R_f = 0.3) to yield the desired product **3ka** as light yellow solid (13.5 mg, 35% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.13 (s, 1H), 7.94 (d, *J* = 7.8 Hz, 1H), 7.70-7.63 (m, 2H), 7.43 (t, *J* = 7.7 Hz, 2H), 7.37 (d, *J* = 7.9 Hz, 1H), 7.31-7.15 (m, 4H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 136.6, 135.5, 128.7, 127.4, 125.9, 125.7, 122.4, 121.8, 120.3, 119.8, 118.2, 111.4.

1,3-diphenyl-1*H*-indole (3la, CAS: 20538-11-8)[9]

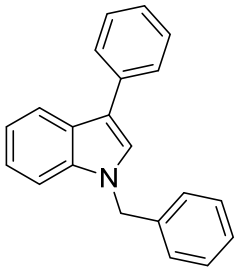


The reaction was conducted with 1-phenyl-1*H*-indole (**1l**, 39 mg, 0.2 mmol), cyclohexanone (**2a**, 52 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **3la** as colourless liquid (17.8 mg, 33% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.02-7.96 (m, 1H), 7.74-7.69 (m, 2H), 7.59 (dd, *J* = 7.1, 1.6

Hz, 1H), 7.57-7.51 (m, 4H), 7.50-7.44 (m, 3H), 7.39-7.34 (m, 1H), 7.33-7.21 (m, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 139.5, 136.6, 135.1, 129.7, 128.8, 127.6, 127.1, 126.6, 126.2, 125.5, 124.5, 122.8, 120.9, 120.1, 119.1, 110.8.

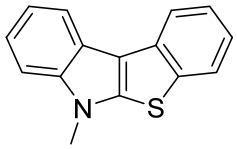
1-Benzyl-3-phenyl-1*H*-indole (3ma, CAS: 23073-17-8)[10]



The reaction was conducted with 1-benzyl-1*H*-indole (**1m**, 41 mg, 0.2 mmol), cyclohexanone (**2a**, 52 μL, 0.5 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **3ma** as pale yellow liquid (27.2 mg, 48% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.96 (d, *J* = 7.8 Hz, 1H), 7.69-7.64 (m, 2H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.34-7.29 (m, 2H), 7.27-7.14 (m, 7H), 5.30 (s, 2H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.2, 137.1, 135.5, 128.8, 128.7, 127.7, 127.3, 126.9, 126.4, 125.9, 125.8, 122.1, 120., 120.0, 117.3, 109.9, 50.1.

6-Methyl-6*H*-benzo[4,5]thieno[2,3-*b*]indole (4aa, CAS: 1269621-22-8)[5]

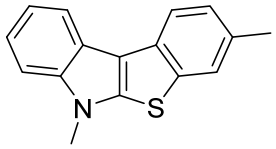


The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 38.0 μL, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 200:1, R_f = 0.3) to yield the desired product **4aa** as pale yellow solid (30.7 mg, 65% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.05 (d, *J* = 7.8 Hz, 1H), 7.97 (dd, *J* = 6.4, 2.0 Hz, 1H), 7.79 (d, *J* = 8.0 Hz, 1H), 7.48-7.43 (m, 1H), 7.39-7.35 (m, 1H), 7.33-7.26 (m, 2H), 7.25-7.21 (m, 1H), 3.80 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 143.4, 141.7, 138.0, 133.3, 125.1, 123.7,

122.6, 121.8, 121.4, 120.5, 120.0, 118.8, 116.6, 109.2, 32.3.

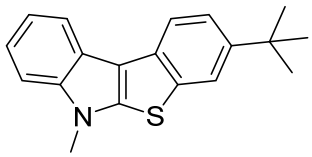
3,6-Dimethyl-6*H*-benzo[4,5]thieno[2,3-*b*]indole (4ab)[5]



The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 38.0 μL, 0.3 mmol), 4-methylcyclohexanone (**2b**, 26 μL, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 200:1, R_f = 0.3) to yield the desired product **4ab** as pale yellow solid (41.7 mg, 83% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.98-7.94 (m, 1H), 7.91 (d, J = 8.0 Hz, 1H), 7.56 (s, 1H), 7.34-7.31 (m, 1H), 7.27-7.22 (m, 3H), 3.76 (s, 3H), 2.46 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 142.7, 141.6, 138.2, 131.5, 130.8, 126.4, 123.7, 122.5, 121.2, 120.1, 119.8, 118.7, 116.4, 109.1, 32.2, 21.5.

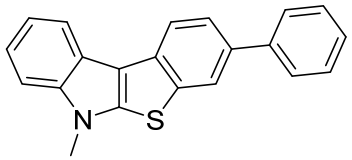
3-(*tert*-butyl)-6-methyl-6*H*-benzo[4,5]thieno[2,3-*b*]indole (4ac)



The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 38.0 μL, 0.3 mmol), 4-*tert*-butylcyclohexanone (**2c**, 31 mg, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 200:1, R_f = 0.3) to yield the desired product **4ac** as pale yellow liquid (46.9 mg, 80% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.00-7.95 (m, 2H), 7.81 (s, 1H), 7.54-7.49 (m, 1H), 7.37-7.33 (m, 1H), 7.30-7.23 (m, 2H), 3.82 (s, 3H), 1.41 (s, 9H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 145.2, 143.1, 141.6, 138.2, 130.8, 122.9, 122.6, 121.2, 120.1, 120.0, 119.8, 118.7, 116.4, 109.1, 34.8, 32.3, 31.7; HRMS (ESI) m/z calcd for $C_{19}H_{20}NS^+$ $(M+H)^+$ 294.1311, found 294.1317.

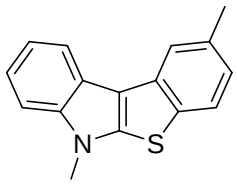
6-Methyl-3-phenyl-6*H*-benzo[4,5]thieno[2,3-*b*]indole (4ad)[5]



The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 38.0 μL, 0.3 mmol), 4-phenylcyclohexanone (**2d**, 35 mg, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 200:1, R_f = 0.3) to yield the desired product **4ad** as pale yellow solid (26.3 mg, 42% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.12 (d, *J* = 8.2 Hz, 1H), 7.99 (dd, *J* = 6.4, 1.4 Hz, 2H), 7.74 -7.67 (m, 3H), 7.50-7.42 (m, 3H), 7.37-7.30 (m, 3H), 3.92 (s, 3H); ^{13}C NMR (101 MHz, Chloroform-*d*) δ 143.7, 141.7, 141.2, 138.8, 135.2, 132.4, 128.8, 127.1, 126.9, 124.6, 122.6, 122.2, 121.6, 120.6, 120.1, 118.9, 116.4, 109.3, 32.4.

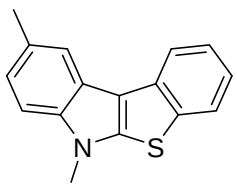
2,6-Dimethyl-6*H*-benzo[4,5]thieno[2,3-*b*]indole (4af)[5]



The reaction was conducted with 1-methyl-1*H*-indole (**1a**, 38.0 μL, 0.3 mmol), 3-methylcyclohexanone (**2f**, 26 μL, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 200:1, R_f = 0.3) to yield the desired product **4af** as pale yellow solid (35.1 mg, 70% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.99 (dd, *J* = 6.5, 2.0 Hz, 1H), 7.87 (s, 1H), 7.67 (d, *J* = 8.2 Hz, 1H), 7.39-7.36 (m, 1H), 7.32-7.26 (m, 2H), 7.06 (d, *J* = 8.1 Hz, 1H), 3.84 (s, 3H), 2.54 (s, 3H); ^{13}C NMR (101 MHz, Chloroform-*d*) δ 143.8, 141.7, 135.0, 134.9, 133.4, 123.3, 122.6, 121.3, 121.0, 119.9, 118.8, 116.4, 109.2, 32.3, 21.7.

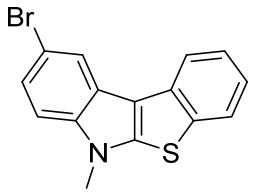
6,9-Dimethyl-6*H*-benzo[4,5]thieno[2,3-*b*]indole (4ba)[5]



The reaction was conducted with 1,5-dimethyl-1*H*-indole (**1b**, 43.5 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 200:1, R_f = 0.3) to yield the desired product **4ba** as pale yellow solid (30.1 mg, 60% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.06 (d, *J* = 7.8 Hz, 1H), 7.83-7.78 (m, 2H), 7.46 (t, *J* = 7.5 Hz, 1H), 7.30-7.20 (m, 2H), 7.13 (d, *J* = 8.3 Hz, 1H), 3.85 (s, 3H), 2.56 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 143.5, 140.2, 137.9, 133.4, 129.3, 125.1, 123.6, 122.8, 122.8, 121.7, 120.5, 118.8, 116.3, 108.9, 32.4, 21.5.

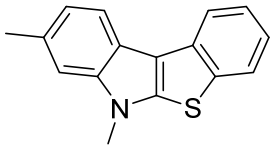
9-Bromo-6-methyl-6*H*-benzo[4,5]thieno[2,3-*b*]indole (4ca)[5]



The reaction was conducted with 5-bromo-1-methyl-1*H*-indole (**1c**, 63 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 200:1, R_f = 0.25) to yield the desired product **4ca** as pale yellow solid (29.0 mg, 46% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.08-8.05 (m, 1H), 7.98 (d, *J* = 7.9 Hz, 1H), 7.78 (d, *J* = 8.0 Hz, 1H), 7.46 (t, *J* = 7.5 Hz, 1H), 7.36 (dd, *J* = 8.7, 1.8 Hz, 1H), 7.28-7.24 (m, 1H), 7.21 (d, *J* = 8.6 Hz, 1H), 3.81 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 144.5, 140.3, 137.9, 132.7, 125.3, 124.1, 123.9, 123.7, 122.3, 121.3, 120.6, 115.9, 113.2, 110.5, 32.4.

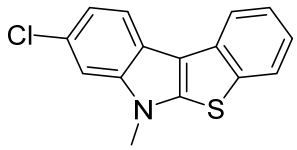
6,8-Dimethyl-6*H*-benzo[4,5]thieno[2,3-*b*]indole (4da)[5]



The reaction was conducted with 1,6-dimethyl-1*H*-indole (**1d**, 43.5 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 200:1, R_f = 0.3) to yield the desired product **4da** as pale yellow solid (32.1 mg, 64% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.03 (d, J = 7.8 Hz, 1H), 7.87 (d, J = 8.0 Hz, 1H), 7.79 (d, J = 8.0 Hz, 1H), 7.48-7.42 (m, 1H), 7.25-7.17 (m, 2H), 7.10 (d, J = 8.0 Hz, 1H), 3.83 (s, 3H), 2.55 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 142.8, 142.2, 137.9, 133.3, 131.4, 125.0, 123.7, 123.7, 121.6, 121.4, 120.4, 118.4, 116.5, 109.5, 32.2, 21.9.

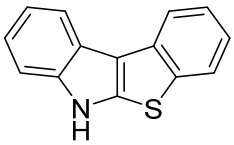
8-Chloro-6-methyl-6*H*-benzo[4,5]thieno[2,3-*b*]indole (4ea)[5]



The reaction was conducted with 6-chloro-1-methyl-1*H*-indole (**1e**, 50 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 200:1, R_f = 0.25) to yield the desired product **4ea** as white solid (29.3 mg, 54% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.96 (d, J = 7.8 Hz, 1H), 7.79 (t, J = 8.7 Hz, 2H), 7.45 (t, J = 7.6 Hz, 1H), 7.32 (d, J = 1.5 Hz, 1H), 7.27 – 7.18 (m, 2H), 3.76 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 143.9, 142.0, 138.0, 132.8, 127.4, 125.2, 123.7, 122.2, 121.0, 120.5, 120.4, 119.3, 116.5, 109.4, 32.3.

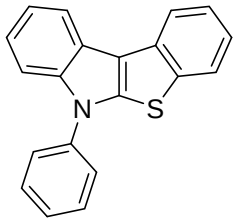
6*H*-Benzo[4,5]thieno[2,3-*b*]indole (4fa, CAS: 111550-86-8)[11]



The reaction was conducted with 1*H*-indole (**1f**, 36 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5:1, R_f = 0.3) to yield the desired product **4fa** as pale yellow solid (20.1 mg, 45% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.45 (s, 1H), 8.10 (d, J = 7.8 Hz, 1H), 8.05-8.00 (m, 1H), 7.80 (d, J = 8.0 Hz, 1H), 7.51-7.45 (m, 2H), 7.31-7.25 (m, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 141.3, 139.9, 138.5, 132.7, 125.1, 123.6, 122.8, 122.4, 122.1, 120.7, 120.6, 119.1, 118.7, 111.4.

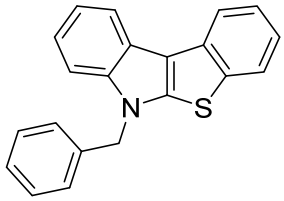
6-Phenyl-6*H*-benzo[4,5]thieno[2,3-*b*]indole (4ga, CAS: 1269621-16-0)[12]



The reaction was conducted with 1-phenyl-1*H*-indole (**1g**, 58 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **4ga** as pale yellow solid (16.7 mg, 28% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.11 (d, J = 7.9 Hz, 1H), 8.08-8.04 (m, 1H), 7.77 (d, J = 8.0 Hz, 1H), 7.72-7.67 (m, 2H), 7.58 (q, J = 8.2, 7.6 Hz, 3H), 7.51-7.46 (m, 1H), 7.41 (t, J = 7.4 Hz, 1H), 7.35-7.25 (m, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 142.6, 141.1, 138.5, 137.7, 132.9, 130.0, 127.3, 125.2, 124.0, 123.6, 123.4, 122.5, 122.2, 121.0, 120.7, 119.0, 118.7, 110.7.

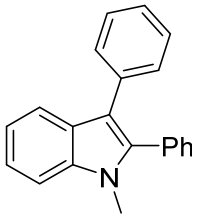
6-Benzyl-6*H*-benzo[4,5]thieno[2,3-*b*]indole (4ha, CAS: 1269621-18-2)[13]



The reaction was conducted with 1-benzyl-1*H*-indole (**1h**, 62 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol), sulfur powder (25.6 mg, 0.8 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **4ha** as pale yellow solid (34.4 mg, 55% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.07 (d, J = 7.8 Hz, 1H), 8.04-8.00 (m, 1H), 7.72 (d, J = 8.0 Hz, 1H), 7.47-7.38 (m, 2H), 7.29-7.25 (m, 5H), 7.23-7.18 (m, 3H), 5.36 (s, 2H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 142.8, 141.5, 138.3, 135.6, 133.0, 128.9, 128.1, 127.4, 125.1, 123.5, 122.8, 122.0, 121.7, 120.5, 120.2, 118.9, 117.4, 109.7, 49.8.

1-Methyl-2,3-diphenyl-1*H*-indole (6aa, CAS: 6121-45-5)[3]

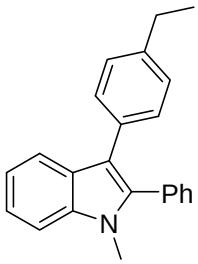


The reaction was conducted with 1-methyl-2-phenyl-1*H*-indole (**5a**, 62 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **6aa** as white solid (52.6 mg, 93% yield).

From 2-chlorocyclohexanone: The reaction was conducted with 1-methyl-2-phenyl-1H-indole (**5a**, 62 mg, 0.3 mmol), 2-chlorocyclohexanone (**2a'**, 27 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **6aa** as white solid (34.0 mg, 60% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.79 (d, *J* = 8.0 Hz, 1H), 7.42-7.34 (m, 4H), 7.33-7.23 (m, 7H), 7.21-7.13 (m, 2H), 3.66 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-d) δ 137.7, 137.3, 135.2, 131.9, 131.1, 129.8, 128.4, 128.1, 128.0, 126.9, 125.5, 122.1, 120.2, 119.6, 115.0, 109.6, 30.9.

3-(4-Ethylphenyl)-1-methyl-2-phenyl-1*H*-indole (6ac)

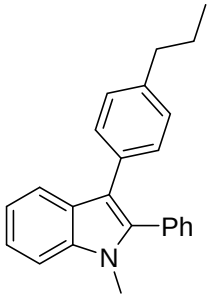


The reaction was conducted with 1-methyl-2-phenyl-1H-indole (**5a**, 62 mg, 0.3 mmol), 4-ethylcyclohexanone (**2c**, 29 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **6ac** as colorless oil liquid (56.6 mg, 91% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.79 (d, *J* = 7.9 Hz, 1H), 7.41-7.25 (m, 7H), 7.24-7.14 (m, 3H), 7.09 (d, *J* = 8.2 Hz, 2H), 3.64 (s, 3H), 2.62 (q, *J* = 7.6 Hz, 2H), 1.23 (t, *J* = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 141.2, 137.5, 137.3, 132.3, 132.0, 131.1, 129.7, 128.3, 127.9, 127.6, 127.0, 122.1, 120.0, 119.7, 115.0, 109.5, 30.9, 28.5, 15.3; HRMS (ESI) m/z calcd for

$C_{23}H_{22}N^+$ $(M+H)^+$ 312.1747, found 312.1746.

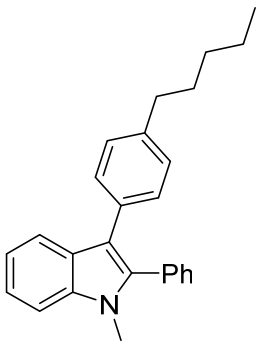
1-Methyl-2-phenyl-3-(4-propylphenyl)-1*H*-indole (6ad)



The reaction was conducted with 1-methyl-2-phenyl-1*H*-indole (**5a**, 62 mg, 0.3 mmol), 4-propylcyclohexanone (**2d**, 32 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **6ad** as colorless oil liquid (59.8 mg, 92% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.79 (d, J = 7.9 Hz, 1H), 7.41-7.25 (m, 7H), 7.22-7.14 (m, 3H), 7.07 (d, J = 8.0 Hz, 2H), 3.65 (s, 3H), 2.54 (t, J = 7.6 Hz, 3H), 1.69-1.57 (m, 2H), 0.94 (t, J = 7.3 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 139.8, 137.5, 137.3, 132.3, 132.0, 131.2, 129.6, 128.3, 128.2, 127.9, 127.0, 122.0, 120.0, 119.7, 115.0, 109.5, 37.8, 30.9, 24.4, 14.0; HRMS (ESI) m/z calcd for $C_{24}H_{24}N^+$ $(M+H)^+$ 326.1903, found 326.1904.

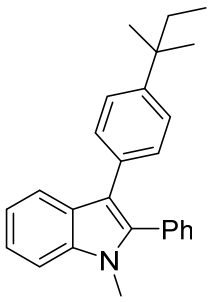
1-Methyl-3-(4-pentylphenyl)-2-phenyl-1*H*-indole (6ae)



The reaction was conducted with 1-methyl-2-phenyl-1H-indole (**5a**, 62 mg, 0.3 mmol), 4-*n*-pentylcyclohexanone (**2e**, 39 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.4) to yield the desired product **6ae** as colorless oil liquid (63.5 mg, 90% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.82-7.77 (m, 1H), 7.41-7.25 (m, 7H), 7.23-7.14 (m, 3H), 7.10-7.04 (m, 2H), 3.64 (s, 3H), 2.56 (t, J = 7.8 Hz, 2H), 1.66-1.56 (m, 2H), 1.38-1.27 (m, 4H), 0.89 (t, J = 6.0 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 140.1, 137.6, 137.4, 132.4, 132.1, 131.3, 129.7, 128.4, 128.3, 128.00, 127.1, 122.1, 120.1, 119.8, 115.1, 109.6, 35.7, 31.8, 31.6, 31.0, 22.7, 14.2; HRMS (ESI) m/z calcd for $C_{26}H_{28}N^+$ $(M+H)^+$ 354.2216, found 354.2212.

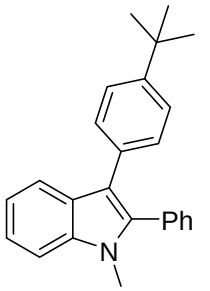
1-Methyl-3-(4-(*tert*-pentyl)phenyl)-2-phenyl-1*H*-indole (6af)



The reaction was conducted with 1-methyl-2-phenyl-1*H*-indole (**5a**, 62 mg, 0.3 mmol), 4-*tert*-pentylcyclohexanone (**2f**, 38 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **6af** as colorless oil liquid (65.7 mg, 93% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.81 (d, J = 7.9 Hz, 1H), 7.42-7.25 (m, 7H), 7.24-7.13 (m, 5H), 3.65 (s, 3H), 1.61 (q, J = 8.5 Hz, 2H), 1.26 (s, 6H), 0.68 (t, J = 7.4 Hz 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 146.5, 137.5, 137.3, 132.1, 131.9, 131.2, 129.3, 128.3, 127.9, 127.1, 125.7, 122.0, 120.0, 119.8, 115.0, 109.5, 37.6, 36.9, 30.9, 28.3, 9.2; HRMS (ESI) m/z calcd for $C_{26}H_{28}N^+$ $(M+H)^+$ 354.2216, found 354.2213.

3-(4-(*tert*-Butyl)phenyl)-1-methyl-2-phenyl-1*H*-indole (6ag)

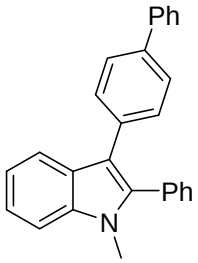


The reaction was conducted with 1-methyl-2-phenyl-1*H*-indole (**5a**, 62 mg, 0.3 mmol), 4-*tert*-butylcyclohexanone (**2g**, 31 mg, 0.2 mmol). The residue was purified by column

chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **6ag** as colorless oil liquid (64.4 mg, 95% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.82 (d, *J* = 7.9 Hz, 1H), 7.41-7.32 (m, 6H), 7.31-7.21 (m, 5H), 7.20-7.14 (m, 1H), 3.64 (s, 3H), 1.30 (s, 9H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 148.0, 137.5, 137.3, 132.1 132.1, 131.2, 129.3, 128.3, 127.9, 127.0, 125.0, 122.0, 120.0, 119.8, 114.9, 109.5, 34.4, 31.4, 30.9; HRMS (ESI) m/z calcd for $C_{25}H_{26}N^+$ $(M+H)^+$ 340.2060, found 340.2057.

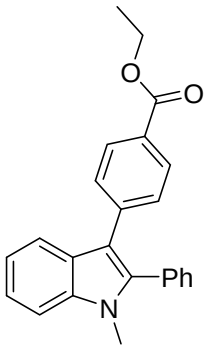
3-([1,1'-Biphenyl]-4-yl)-1-methyl-2-phenyl-1*H*-indole (6ah, CAS: 1160172-08-6)[6]



The reaction was conducted with 1-methyl-2-phenyl-1*H*-indole (**5a**, 62 mg, 0.3 mmol), 4-phenylcyclohexanone (**2h**, 35 mg, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **6ah** as white solid (61.0 mg, 85% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.85 (d, *J* = 7.9 Hz, 1H), 7.61-7.56 (m, 2H), 7.50 (d, *J* = 8.3 Hz, 2H), 7.43-7.34 (m, 10H), 7.33-7.26 (m, 2H), 7.23-7.18 (m, 1H), 3.66 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 140.9, 138.0, 137.8, 137.3, 134.3, 131.9, 131.2, 130.1, 128.7, 128.4, 128.1, 126.9, 126.9, 126.8, 126.8, 122.2, 120.2, 119.6, 114.6, 109.6, 31.02.

Ethyl 4-(1-methyl-2-phenyl-1*H*-indol-3-yl)benzoate (5ai, CAS: 1160172-07-5)[6]

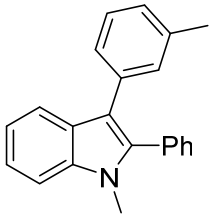


The reaction was conducted with 1-methyl-2-phenyl-1*H*-indole (**5a**, 62 mg, 0.3 mmol), ethyl

4-cyclohexanonecarboxylate (**2i**, 32 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 50:1, R_f = 0.3) to yield the desired product **6ai** as colorless oil liquid (45.4 mg, 64% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.93 (d, *J* = 8.4 Hz, 2H), 7.80 (d, *J* = 7.9 Hz, 1H), 7.44-7.28 (m, 9H), 7.19-7.15 (m, 1H), 4.35 (q, *J* = 7.1 Hz, 2H), 3.67 (s, 3H), 1.37 (t, *J* = 7.1 Hz, 3H); ^{13}C NMR (101 MHz, Chloroform-*d*) δ 166.8, 140.3, 138.5, 137.4, 131.5, 131.0, 129.5, 129.4, 128.6, 128.4, 127.2, 126.5, 122.4, 120.6, 119.3, 114.1, 109.8, 60.7, 30.9, 14.3.

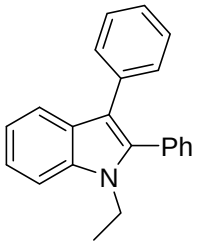
1-Methyl-2-phenyl-3-(*m*-tolyl)-1*H*-indole (6aj)[4]



The reaction was conducted with 1-methyl-2-phenyl-1*H*-indole (**5a**, 62 mg, 0.3 mmol), 3-methylcyclohexanone (**2j**, 26 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6aj** as white solid (55.2 mg, 93% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.79 (d, *J* = 8.0 Hz, 1H), 7.42-7.26 (m, 7H), 7.22-7.10 (m, 3H), 7.04 (d, *J* = 7.4 Hz, 1H), 6.98 (d, *J* = 7.4 Hz, 1H), 3.65 (s, 3H), 2.27 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.7, 137.5, 137.3, 135.0, 131.9, 131.1, 130.5, 128.3, 128.3, 128.0, 127.9, 126.9, 126.2, 122.1, 120.1, 119.7, 115.1, 109.5, 30.9, 21.5.

1-Ethyl-2,3-diphenyl-1*H*-indole (6ba, CAS: 55653-99-1)[3]

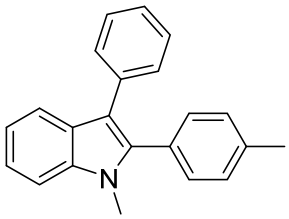


The reaction was conducted with 1-ethyl-2,3-diphenyl-1*H*-indole (**5b**, 66 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **6ba** as white

solid (52.9 mg, 89% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.80 (d, J = 7.9 Hz, 1H), 7.43 (d, J = 8.2 Hz, 1H), 7.40-7.32 (m, 5H), 7.31-7.21 (m, 5H), 7.20-7.11 (m, 2H), 4.12 (q, J = 7.2 Hz, 2H), 1.28 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.2, 136.0, 135.2, 132.2, 131.0, 129.8, 128.4, 128.1, 128.1, 127.2, 125.4, 122.0, 120.1, 119.7, 115.3, 109.8, 38.6, 15.4.

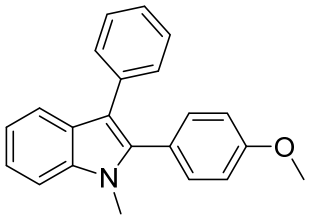
1-methyl-3-phenyl-2-(*p*-tolyl)-1H-indole (6ca)[4]



The reaction was conducted with 1-methyl-2-(*p*-tolyl)-1*H*-indole (**5c**, 66 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6ca** as white solid (50.5 mg, 85% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.79 (d, J = 7.9 Hz, 1H), 7.39 (d, J = 8.2 Hz, 1H), 7.34-7.24 (m, 5H), 7.22-7.14 (m, 6H), 3.65 (s, 3H), 2.38 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.8, 137.2, 135.3, 131.0, 129.8, 129.1, 128.8, 128.1, 127.0, 125.4, 122.0, 120.1, 119.5, 114.9, 109.5, 30.9, 21.3.

2-(4-Methoxyphenyl)-1-methyl-3-phenyl-1*H*-indole (6da)

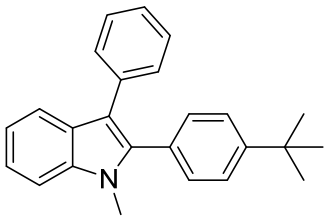


The reaction was conducted with 2-(4-methoxyphenyl)-1-methyl-1*H*-indole (**5d**, 71 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 50:1, R_f = 0.3) to yield the desired product **6da** as white solid (55.1 mg, 88% yield), mp 169-171 ^{o}C.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.78 (d, J = 7.9 Hz, 1H), 7.39 (d, J = 8.2 Hz, 1H), 7.34-7.22

(m, 7H), 7.21-7.13 (m, 2H), 6.94-6.88 (m, 2H), 3.83 (s, 3H), 3.66 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 159.4, 137.6, 137.2, 135.4, 132.3, 129.8, 128.1, 126.9, 125.3, 124.0, 122.0, 120.1, 119.4, 114.7, 113.9, 109.5, 55.2, 30.8; HRMS (ESI) m/z calcd for $C_{22}H_{20}NO^+$ $(M+H)^+$ 314.15394, found 314.15375.

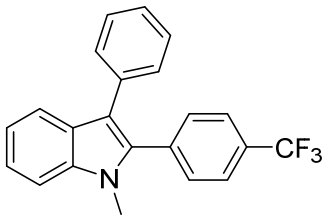
2-(4-(*tert*-Butyl)phenyl)-1-methyl-3-phenyl-1*H*-indole (6ea)



The reaction was conducted with 2-(4-(*tert*-butyl)phenyl)-1-methyl-1*H*-indole (**5e**, 79 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **6ea** as colorless oil liquid (61.7 mg, 91% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.78 (d, *J* = 7.9 Hz, 1H), 7.42-7.35 (m, 3H), 7.34-7.21 (m, 8H), 7.20-7.14 (m, 2H), 3.67 (s, 3H), 1.34 (s, 9H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 150.9, 137.9, 137.2, 135.4, 130.7, 129.9, 128.7, 128.1, 127.0, 125.3, 125.2, 122.0, 120.1, 119.5, 114.8, 109.5, 34.7, 31.3, 31.0; HRMS (ESI) m/z calcd for $C_{25}H_{26}N^+$ $(M+H)^+$ 340.206, found 340.2059.

1-Methyl-3-phenyl-2-(4-(trifluoromethyl)phenyl)-1*H*-indole (6fa, CAS: 1160172-09-7)[6]

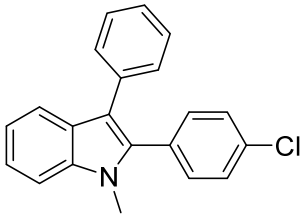


The reaction was conducted with 1-methyl-2-(4-(trifluoromethyl)phenyl)-1*H*-indole (**5f**, 83 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6fa** as white solid (56.9 mg, 81% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.77 (d, *J* = 8.0 Hz, 1H), 7.62 (d, *J* = 8.1 Hz, 2H), 7.46-7.40 (m, 3H), 7.36-7.25 (m, 5H), 7.23-7.17 (m, 2H) 3.68 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*)

δ 137.6, 135.9, 135.7, 134.6, 131.4, 129.9, 129.9 (q, J = 32 Hz), 128.4, 126.9, 125.9, 125.3 (q, J = 3.8 Hz), 124.1, (q, J = 271 Hz), 122.8, 120.5, 119.8, 116.2, 109.7, 31.1.

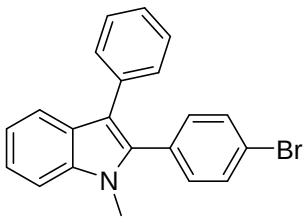
2-(4-Chlorophenyl)-1-methyl-3-phenyl-1*H*-indole (6ga)



The reaction was conducted with 2-(4-chlorophenyl)-1-methyl-1*H*-indole (**5g**, 72 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6ga** as white solid (53.9 mg, 85% yield), mp 162-164 ℃.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.77 (d, *J* = 7.9 Hz, 1H), 7.40 (d, *J* = 8.2 Hz, 1H), 7.38-7.31 (m, 3H), 7.30-7.25 (m, 5H), 7.24-7.16 (m, 3H), 3.66 (s, 3H)； ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.4, 136.3, 134.8, 134.1, 132.4, 130.3, 129.8, 128.7, 128.3, 126.9, 125.7, 122.4, 120.3, 119.7, 115.5, 109.6, 30.9; HRMS (ESI) m/z calcd for $C_{21}H_{17}ClN^+$ $(M+H)^+$ 318.1044, found 318.1048.

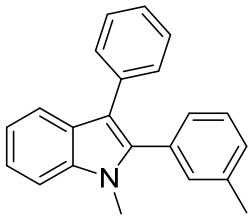
2-(4-Bromophenyl)-1-methyl-3-phenyl-1*H*-indole (6ha)



The reaction was conducted with 2-(4-bromophenyl)-1-methyl-1*H*-indole (**5h**, 86 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6ha** as white solid (60.6 mg, 84% yield), mp 185-188 ℃.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.72 (d, *J* = 7.9 Hz, 1H), 7.48-7.43 (m, 2H), 7.36 (d, *J* = 8.2 Hz, 1H), 7.29-7.22 (m, 5H), 7.20-7.12 (m, 4H), 3.62 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.4, 136.3, 134.8, 132.7, 131.7, 130.8, 129.8, 128.3, 126.9, 125.7, 122.5, 122.4, 120.3, 119.7, 115.5, 109.6, 31.0; HRMS (ESI) m/z calcd for $C_{21}H_{17}BrN^+$ $(M+H)^+$ 362.0539, found 362.0543.

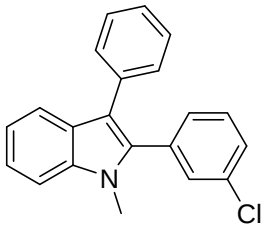
1-Methyl-3-phenyl-2-(*m*-tolyl)-1*H*-indole (6ia)



The reaction was conducted with 1-methyl-2-(*m*-tolyl)-1*H*-indole (**5i**, 67 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6ia** as colorless oil liquid (53.5 mg, 90% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.79 (d, *J* = 7.9 Hz, 1H), 7.39 (d, *J* = 8.2 Hz, 1H), 7.34-7.22 (m, 6H), 7.21-7.08 (m, 5H), 3.65 (s, 3H), 2.33 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.9, 137.9, 137.3, 135.3, 131.8, 131.6, 129.8, 128.8, 128.3, 128.2, 128.1, 126.9, 125.4, 122.0, 120.1, 119.6, 114.9, 109.5, 30.9, 21.4; HRMS (ESI) m/z calcd for $C_{22}H_{20}N^+$ $(M+H)^+$ 298.1590, found 298.1589.

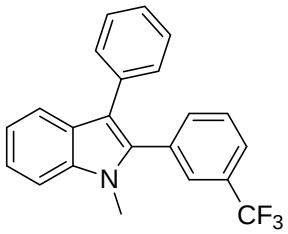
2-(3-Chlorophenyl)-1-methyl-3-phenyl-1*H*-indole (6ja)



The reaction was conducted with 2-(3-chlorophenyl)-1-methyl-1*H*-indole (**5j**, 73 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6ja** as colorless oil liquid (42.5 mg, 67% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.77 (d, *J* = 8.0 Hz, 1H), 7.40 (d, *J* = 8.2 Hz, 1H), 7.36-7.25 (m, 8H), 7.24-7.16 (m, 3H), 3.66 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.4, 135.9, 134.7, 134.2, 133.8, 130.8, 129.8, 129.7, 129.5, 128.3, 128.2, 126.8, 125.8, 122.5, 120.3, 119.8, 115.8, 109.6, 31.0; HRMS (ESI) m/z calcd for $C_{21}H_{17}ClN^+$ $(M+H)^+$ 318.10440, found 318.10416.

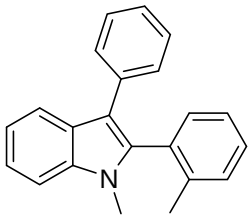
1-Methyl-3-phenyl-2-(3-(trifluoromethyl)phenyl)-1*H*-indole (6ka)



The reaction was conducted with 1-methyl-2-(3-(trifluoromethyl)phenyl)-1*H*-indole (**5k**, 83 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6ka** as colorless oil liquid (54.1 mg, 77% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.77 (d, *J* = 8.0 Hz, 1H), 7.58 (s, 2H), 7.49-7.39 (m, 3H), 7.36-7.24 (m, 5H), 7.22-7.16 (m, 2H), 3.68 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.5, 135.8, 134.5, 134.5, 132.7, 130.80 (q, *J* = 32.4 Hz), 129.9, 128.9, 128.3, 127.7 (q, *J* = 3.8 Hz), 126.9, 125.9, 124.67 (q, *J* = 3.8 Hz), 123.9 (q, *J* = 270.8 Hz), 122.7, 120.4, 119.8, 116.1, 109.7, 31.04; HRMS (ESI) m/z calcd for $C_{22}H_{17}F_3N^+$ $(M+H)^+$ 352.1308, found 352.1304.

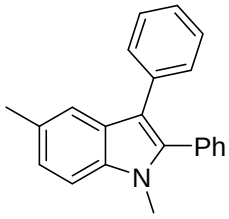
1-Methyl-3-phenyl-2-(*o*-tolyl)-1*H*-indole (6la)[4]



The reaction was conducted with 1-methyl-2-(*o*-tolyl)-1*H*-indole (**5l**, 67 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6la** as colorless oil liquid (41.0 mg, 69% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.86 (d, *J* = 7.9 Hz, 1H), 7.41 (d, *J* = 8.2 Hz, 1H), 7.36-7.18 (m, 10H), 7.16-7.10 (m, 1H), 3.52 (s, 3H), 2.01 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 138.6, 137.1, 137.0, 135.4, 131.7, 131.6, 130.1, 128.9, 128.7, 128.1, 126.7, 125.7, 125.3, 121.8, 120.0, 119.6, 114.9, 109.4, 30.3, 19.8.

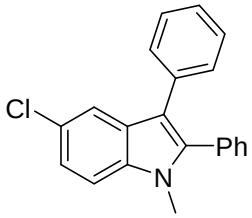
1,5-Dimethyl-2,3-diphenyl-1*H*-indole (6ma, CAS: 36362-82-0)[3]



The reaction was conducted with 1,5-dimethyl-2-phenyl-1*H*-indole (**5m**, 67 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6ma** as colourless liquid (50.1 mg, 85% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.57 (s, 1H), 7.39-7.33 (m, 3H), 7.32-7.19 (m, 7H), 7.18-7.10 (m, 2H), 3.63 (s, 3H), 2.46 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.8, 135.8, 135.4, 132.0, 131.1, 129.9, 129.5, 128.3, 128.1, 127.9, 127.1, 125.4, 123.7, 119.1, 114.6, 109.2, 30.9, 21.5.

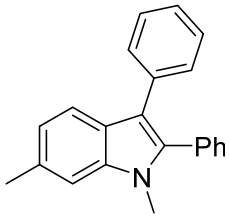
5-Chloro-1-methyl-2,3-diphenyl-1*H*-indole (6na)[3]



The reaction was conducted with 5-chloro-1-methyl-2-phenyl-1*H*-indole (**5n**, 73 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6na** as white solid (46.9 mg, 74% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.70 (s, 1H), 7.40-7.35 (m, 3H), 7.33-7.29 (m, 3H), 7.28-7.21 (m, 5H), 7.20-7.15 (m, 1H), 3.64 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 138.9, 135.7, 134.5, 131.3, 131.0, 129.7, 128.4, 128.3, 128.3, 128.0, 125.9, 125.8, 122.3, 118.9, 114.8, 110.6, 31.11.

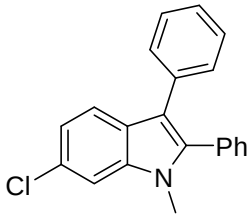
1,6-Dimethyl-2,3-diphenyl-1*H*-indole (6oa, CAS: 1610871-11-8)[3]



The reaction was conducted with 1,6-dimethyl-2-phenyl-1*H*-indole (**5o**, 67 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6oa** as white solid (39.2 mg, 66% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.67 (d, *J* = 8.1 Hz, 1H), 7.40-7.34 (m, 3H), 7.33-7.22 (m, 6H), 7.20 (s, 1H), 7.18-7.13 (m, 1H), 7.05-7.00 (m, 1H), 3.64 (s, 3H), 2.54 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.7, 137.1, 135.4, 132.1, 132.0, 131.1, 129.8, 128.3, 128.1, 127.9, 125.4, 124.8, 121.9, 119.3, 114.9, 109.5, 30.8, 21.9.

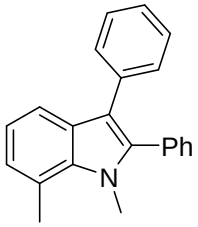
6-Chloro-1-methyl-2,3-diphenyl-1*H*-indole (6pa)[7]



The reaction was conducted with 6-chloro-1-methyl-2-phenyl-1*H*-indole (**5p**, 73 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6pa** as white solid (50.1 mg, 79% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.67 (d, *J* = 8.5 Hz, 1H), 7.42-7.35 (m, 4H), 7.33-7.29 (m, 2H), 7.28-7.23 (m, 4H), 7.21-7.16 (m, 1H), 7.14 (d, *J* = 8.5 Hz, 1H), 3.63 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 138.2, 137.7, 134.6, 131.4, 131.0, 129.7, 128.4, 128.31, 128.2, 127.9, 125.8, 125.5, 120.7 120.5, 115.2, 109.6, 31.0.

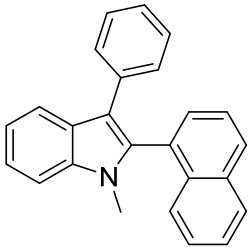
1,7-Dimethyl-2,3-diphenyl-1*H*-indole (6qa, CAS: 1610871-13-0)[3]



The reaction was conducted with 1,7-dimethyl-2-phenyl-1*H*-indole (**5q**, 67 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.35) to yield the desired product **6qa** as white solid (39.2 mg, 66% yield).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.59 (d, J = 7.4 Hz, 1H), 7.40-7.28 (m, 5H), 7.25 (d, J = 4.3 Hz, 4H), 7.20-7.13 (m, 1H), 7.07-6.98 (m, 2H), 3.89 (s, 3H), 2.85 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 138.9, 136.5, 135.3, 132.1, 131.3, 130.0, 128.3, 128.1, 128.0, 127.9, 125.5, 125.2, 121.4, 120.3, 117.7, 115.6, 34.3, 20.4.

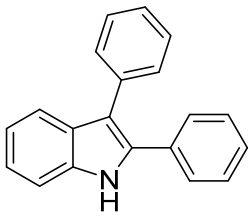
1-Methyl-2-(naphthalen-1-yl)-3-phenyl-1*H*-indole (6ra)



The reaction was conducted with 1-methyl-2-(naphthalen-1-yl)-1*H*-indole (**5r**, 86 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 400:1, R_f = 0.3) to yield the desired product **6ra** as white solid (40.0 mg, 60% yield), mp 213-215 ℃.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.91 (d, J = 8.0 Hz, 3H), 7.60 (d, J = 8.4 Hz, 1H), 7.52-7.45 (m, 2H), 7.44-7.32 (m, 4H), 7.27-7.22 (m, 3H), 7.09 (t, J = 7.4 Hz, 2H), 7.09-7.03 (m, 1H), 3.44 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 137.2, 136.0, 135.2, 133.4, 133.4, 130.0, 129.7, 129.1, 129.0, 128.4, 128.1, 127.3, 126.9, 126.8, 126.1, 125.9, 125.4, 122.1, 120.1, 119.8, 116.3, 109.5, 30.6; HRMS (ESI) m/z calcd for $C_{25}H_{20}N^+$ $(M+H)^+$ 334.1590, found 334.1589.

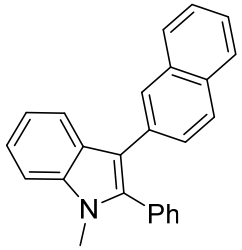
2,3-diphenyl-1H-indole (6sa, CAS: 3469-20-3)[14]



The reaction was conducted with 2-phenyl-1*H*-indole (**5s**, 60 mg, 0.3 mmol), cyclohexanone (**2a**, 21 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 15:1, R_f = 0.25) to yield the desired product **6sa** as yellow solid (35.0 mg, 65% yield)

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.19 (s, 1H), 7.67 (d, *J* = 7.7 Hz, 1H), 7.45-7.34 (m, 7H), 7.31-7.21 (m, 5H), 7.14 (dt, *J* = 7.9, 4.1 Hz, 1H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 135.9, 135.0, 134.1, 132.7, 130.1, 128.7, 128.5, 128.2, 128.1, 127.7, 126.2, 122.7, 120.4, 119.7, 115.0, 110.9.

1-Methyl-3-(naphthalen-1-yl)-2-phenyl-1*H*-indole (6ak)



The reaction was conducted with 1-methyl-2-phenyl-1H-indole (**5a**, 62 mg, 0.3 mmol), 2-tetralone (**2k**, 27 μL, 0.2 mmol). The residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 200:1, R_f = 0.3) to yield the desired product **6ak** as pale green solid (55.3 mg, 83% yield), mp 157-159 ^{o}C.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.88 (d, *J* = 8.4 Hz, 2H), 7.77-7.69 (m, 2H), 7.65 (d, *J* = 8.5 Hz, 1H), 7.44-7.28 (m, 10H), 7.21 (t, *J* = 7.4 Hz, 1H), 3.67 (s, 3H); ^{13}C NMR (100 MHz, Chloroform-*d*) δ 138.0, 137.4, 133.7, 132.9, 131.8, 131.6, 131.1, 128.6, 128.4, 128.1, 128.0, 127.7, 127.5, 127.5, 127.1, 125.7, 125.2, 122.3, 120.3, 119.6, 114.9, 109.6, 30.9; HRMS (ESI) m/z calcd for $C_{25}H_{20}N^+$ $(M+H)^+$ 334.1590, found 334.1589.

References

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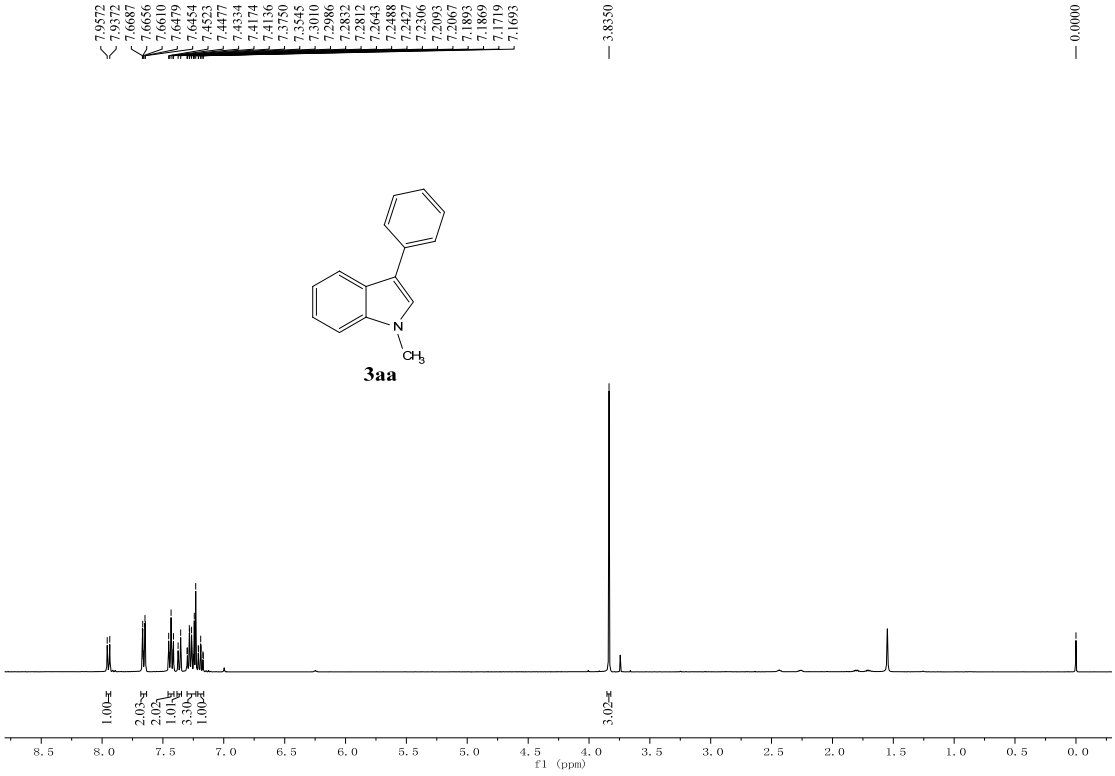
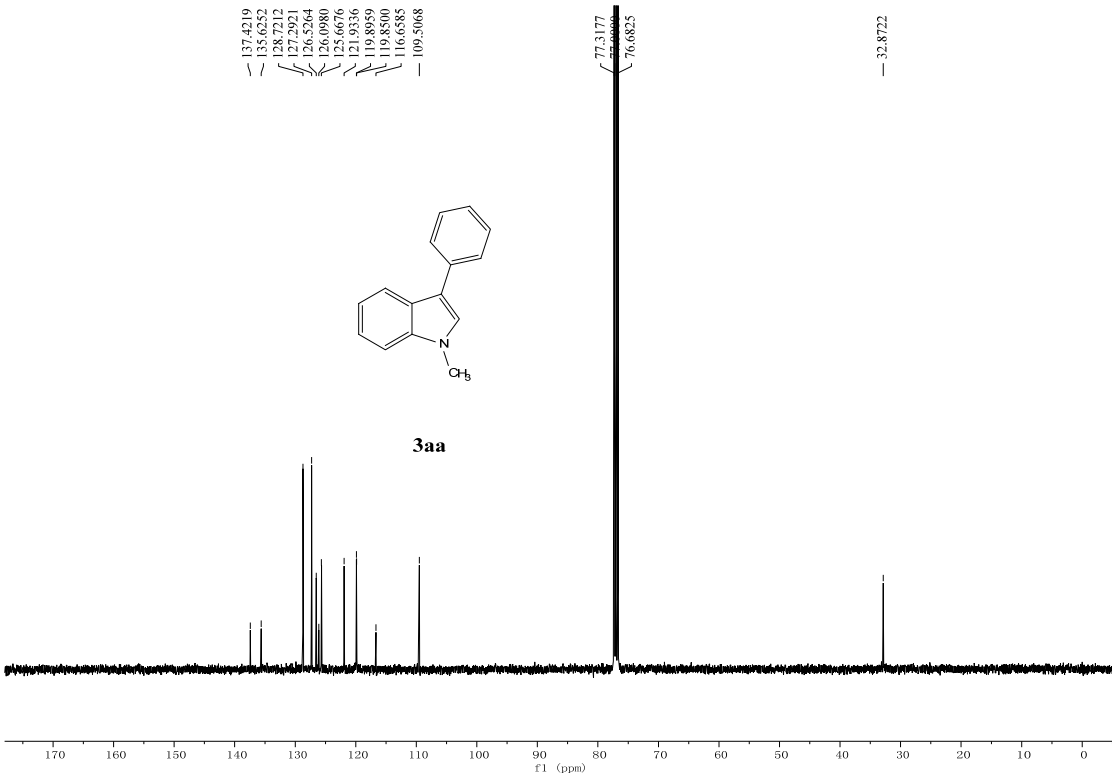
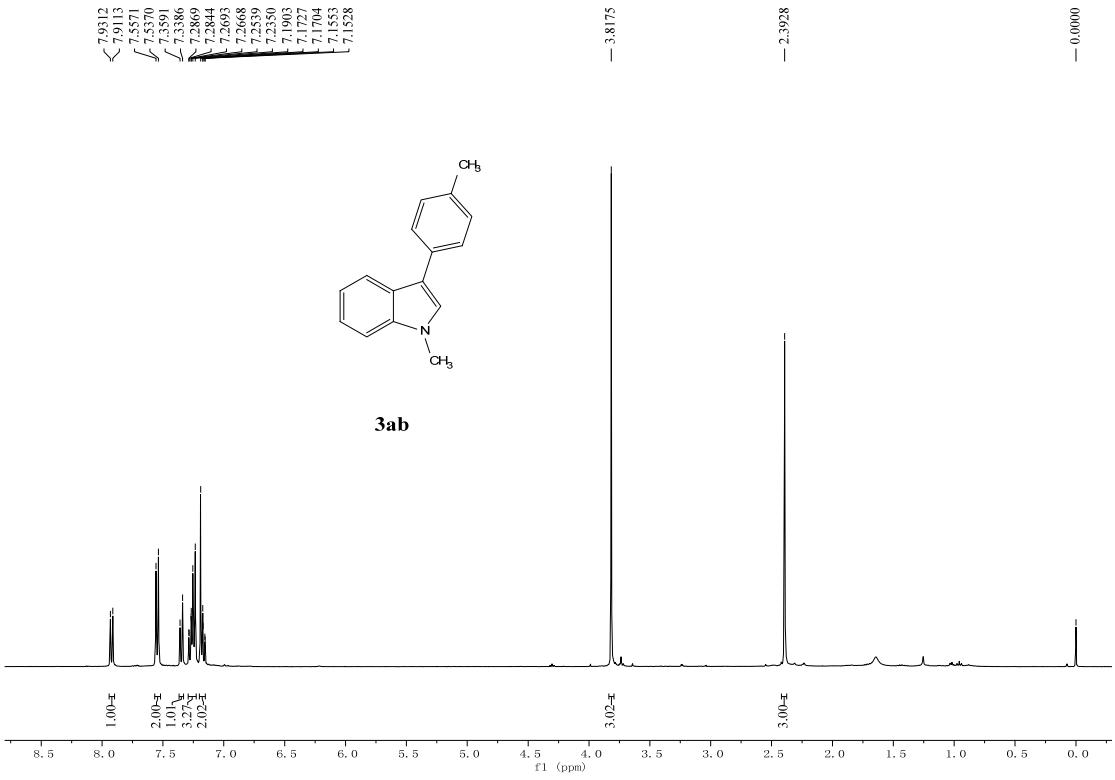
^{1}H NMR and ^{13}C NMR spectra of products



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f1 (ppm)

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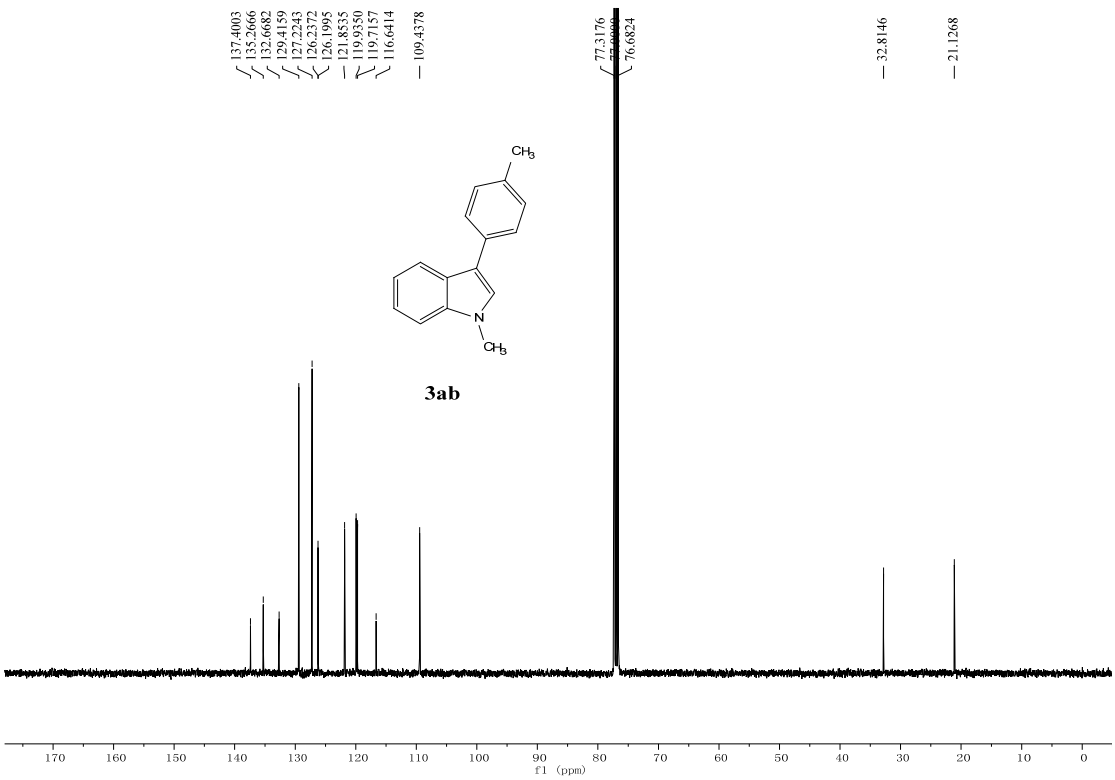
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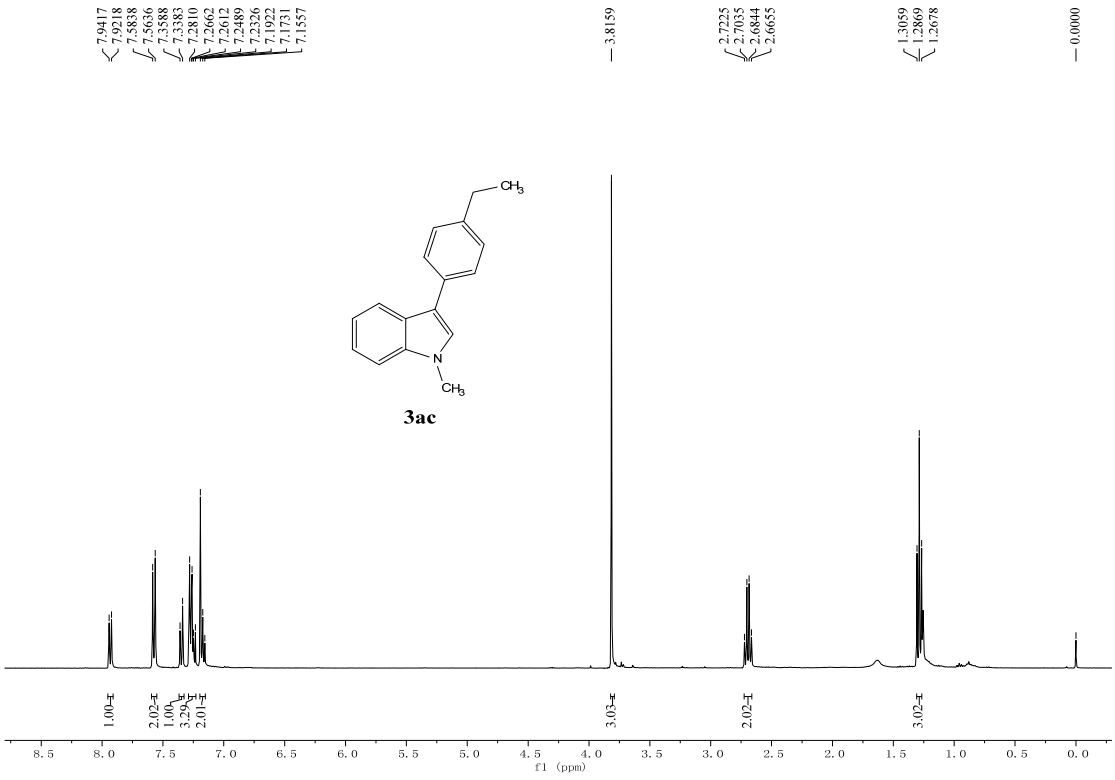
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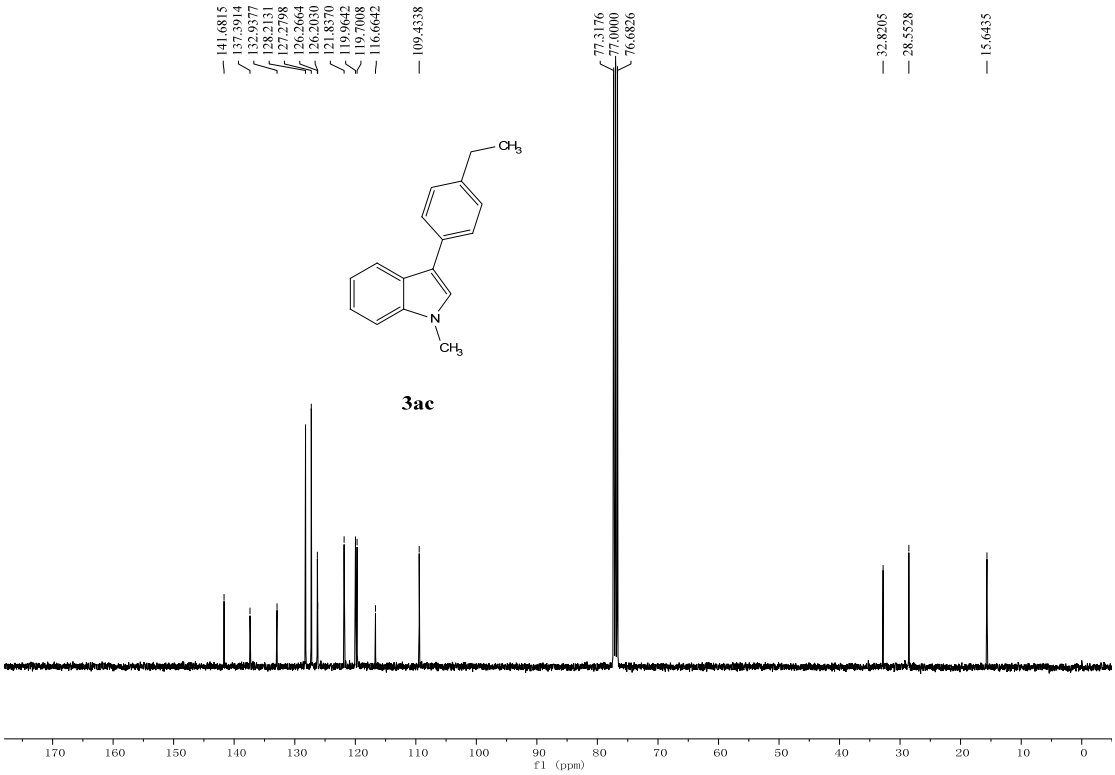
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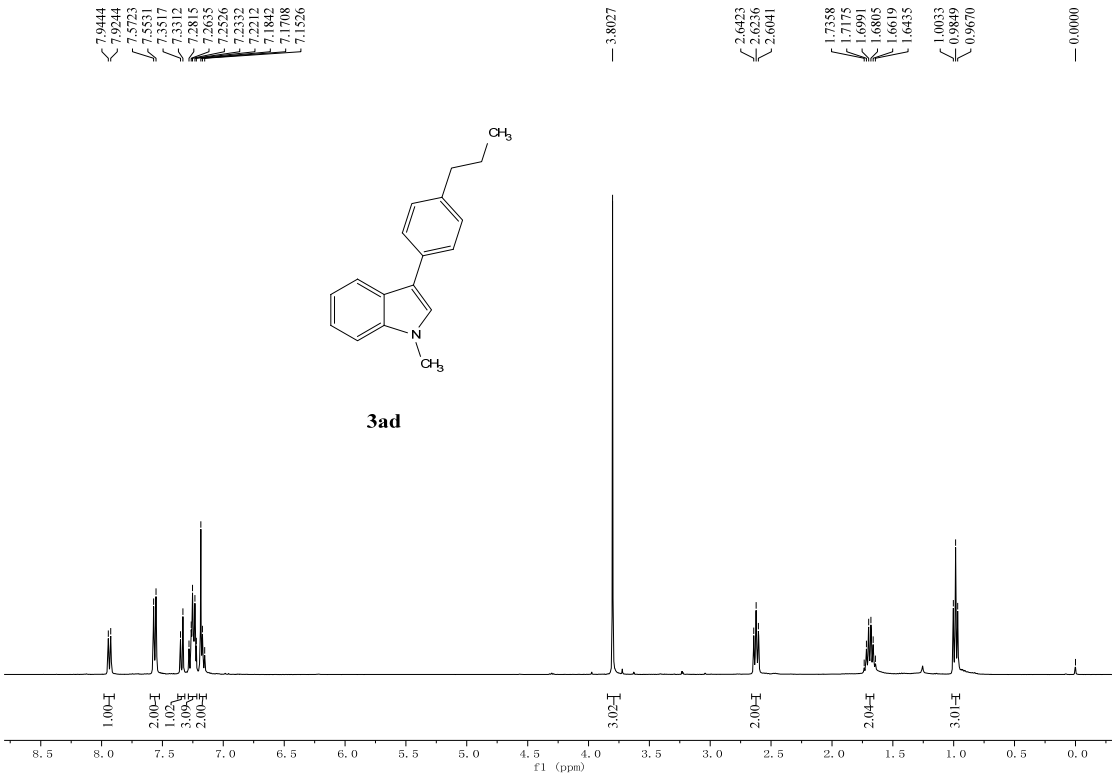
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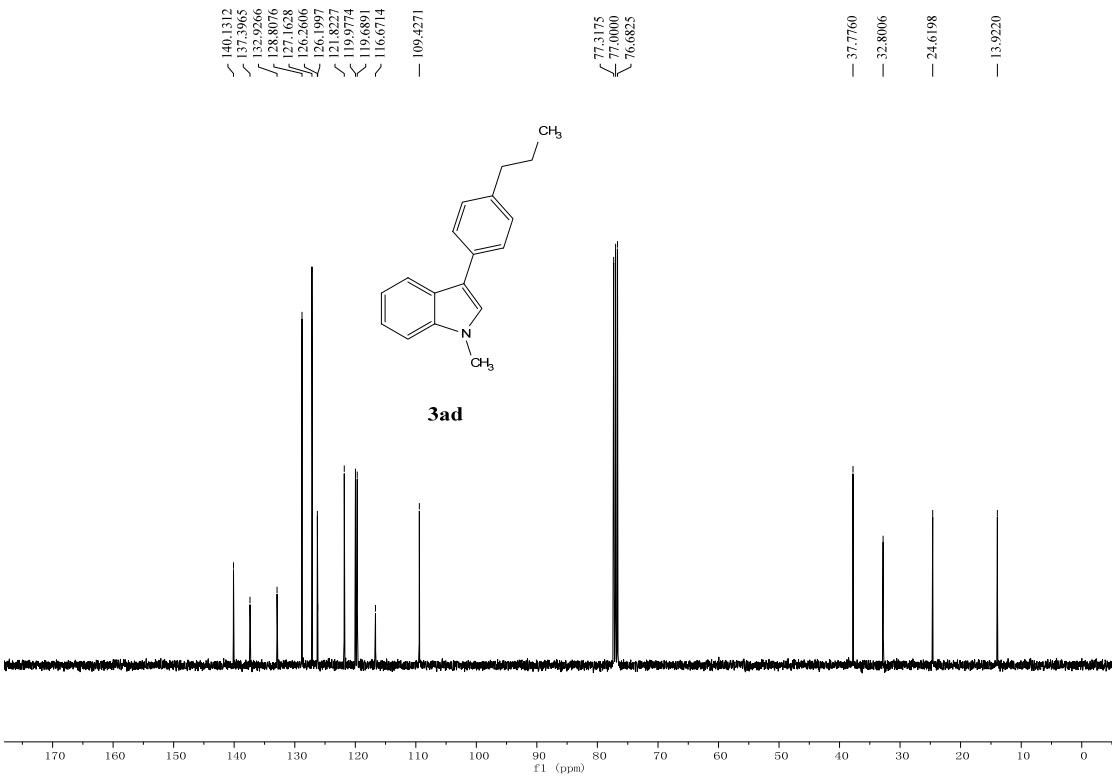
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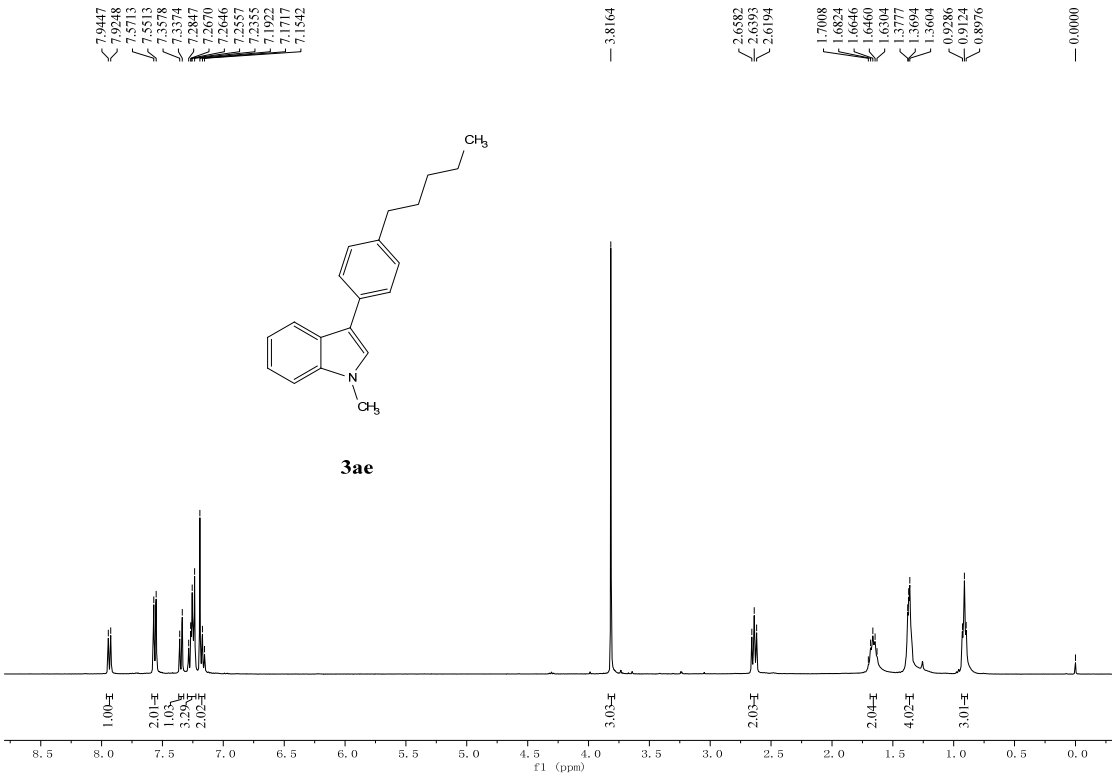
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7.1542
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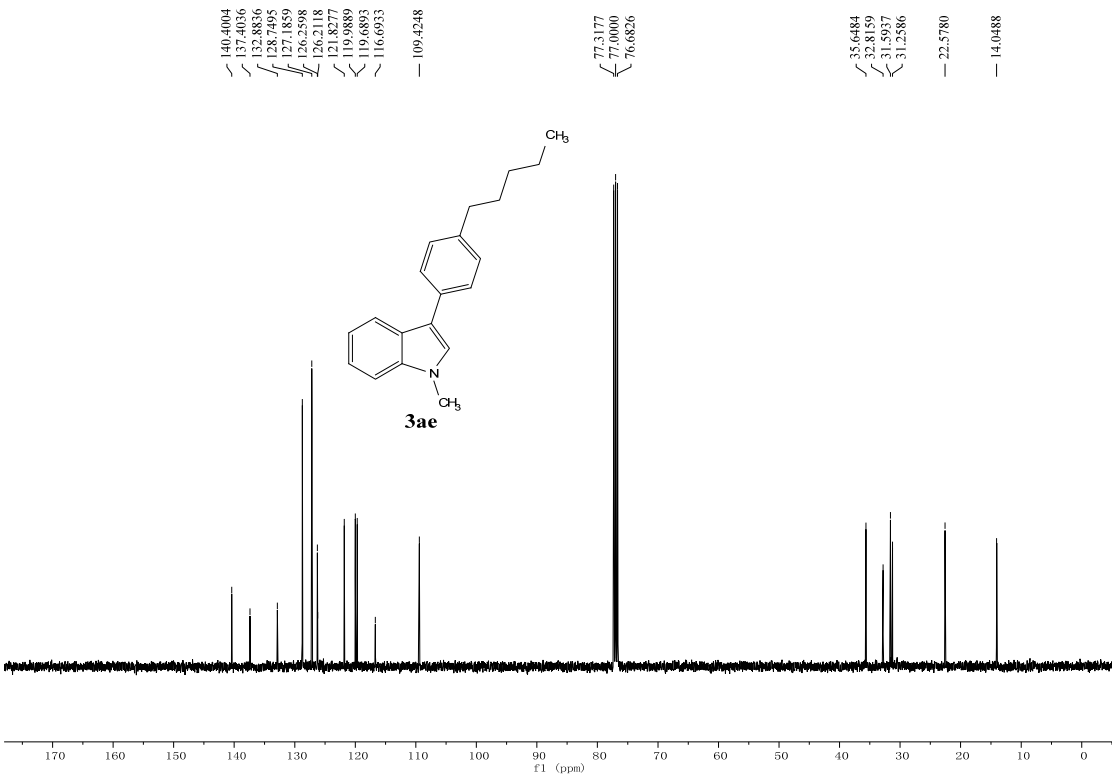
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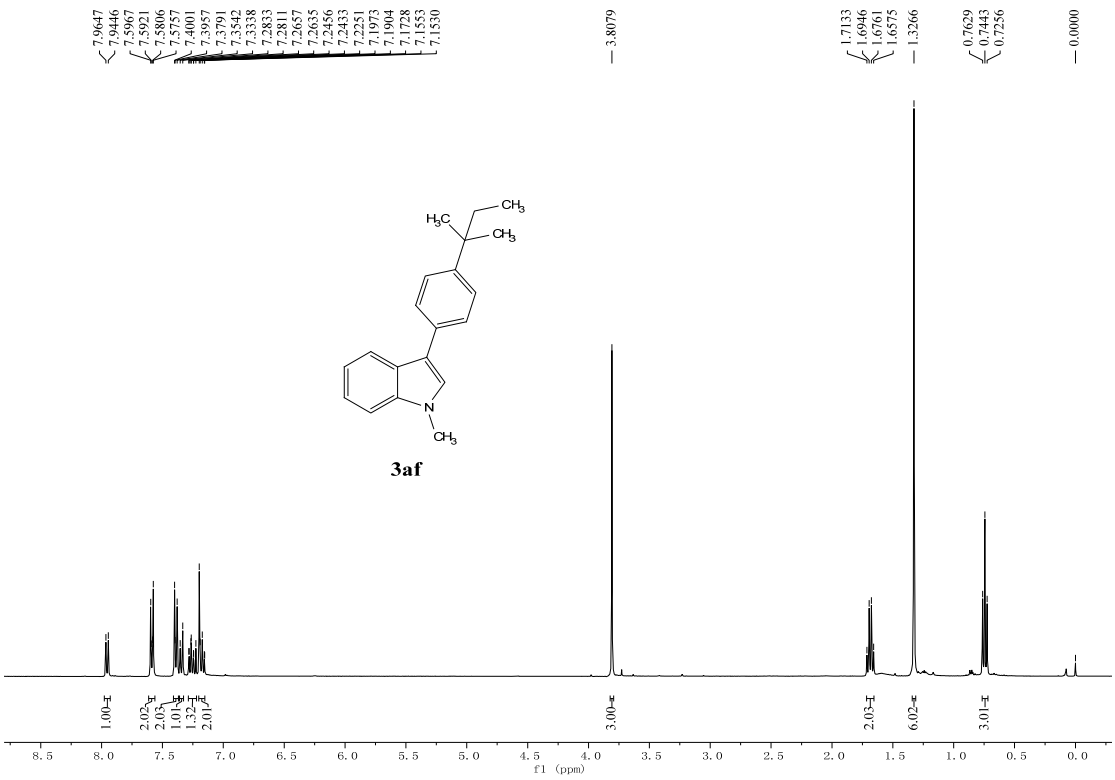
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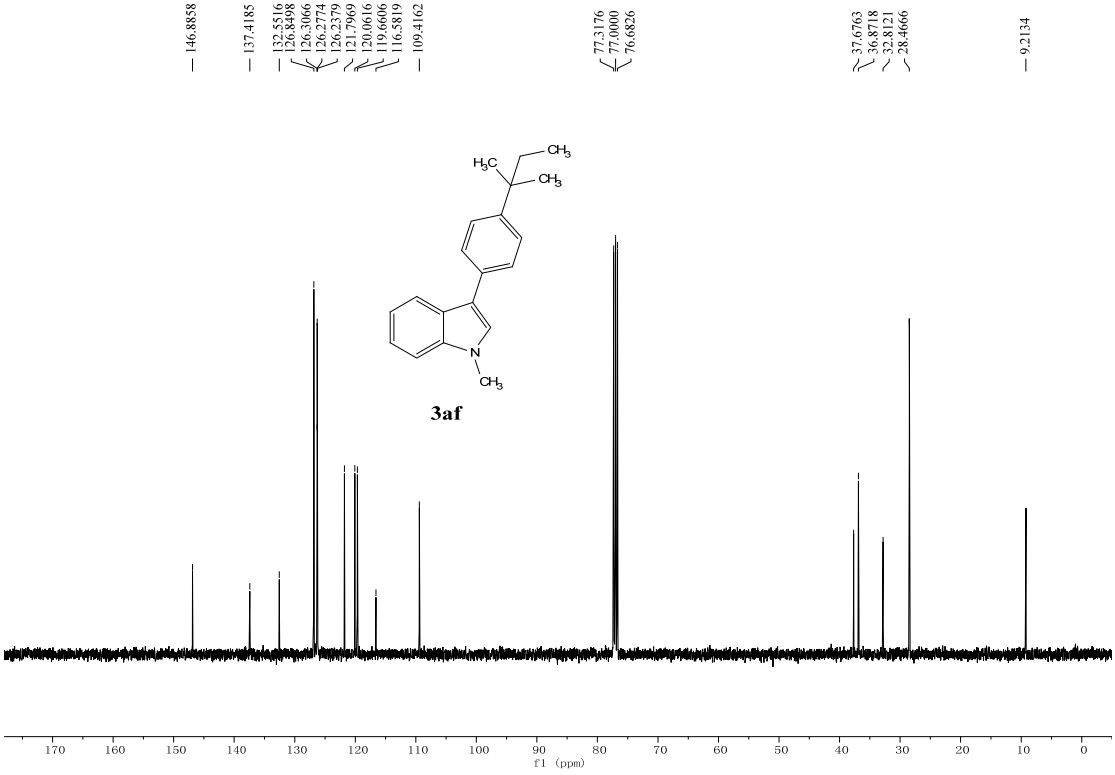
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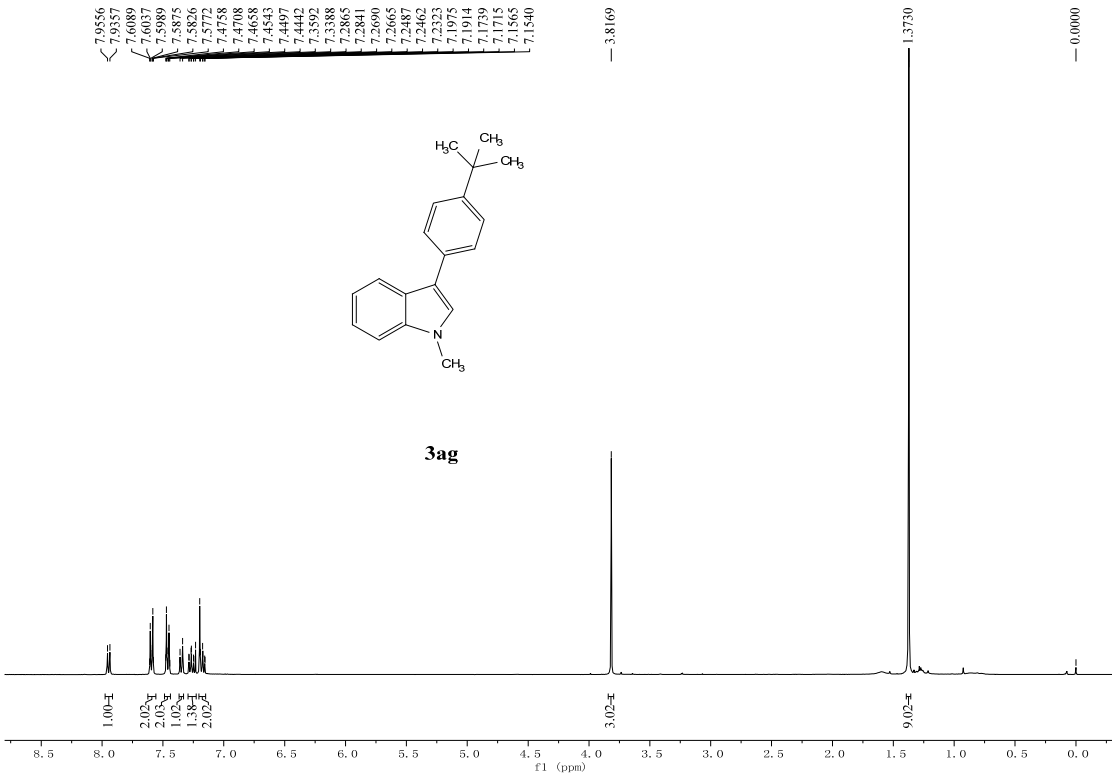
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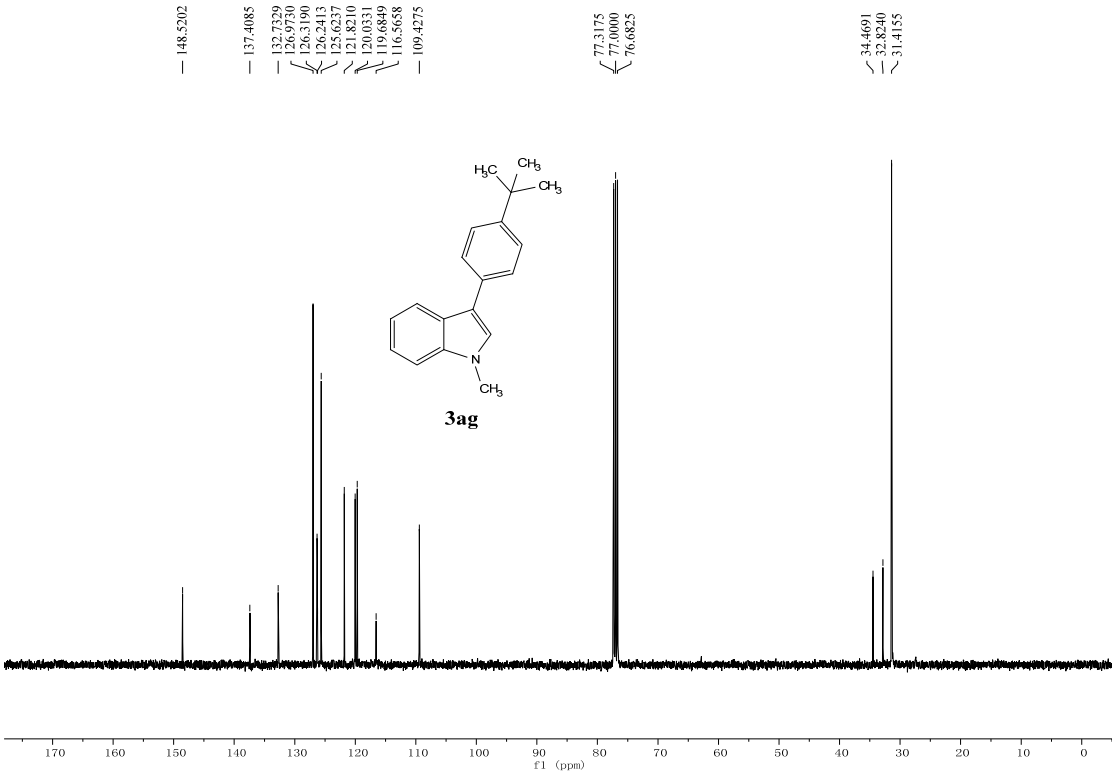
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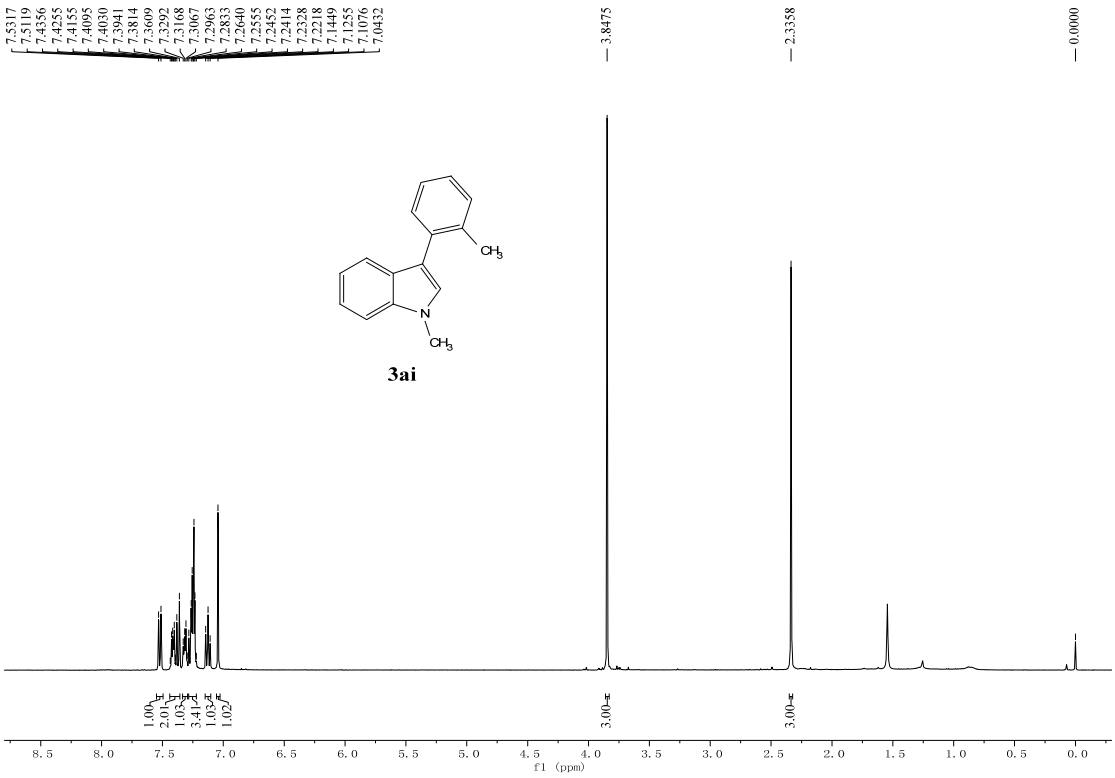
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2.01
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3.41
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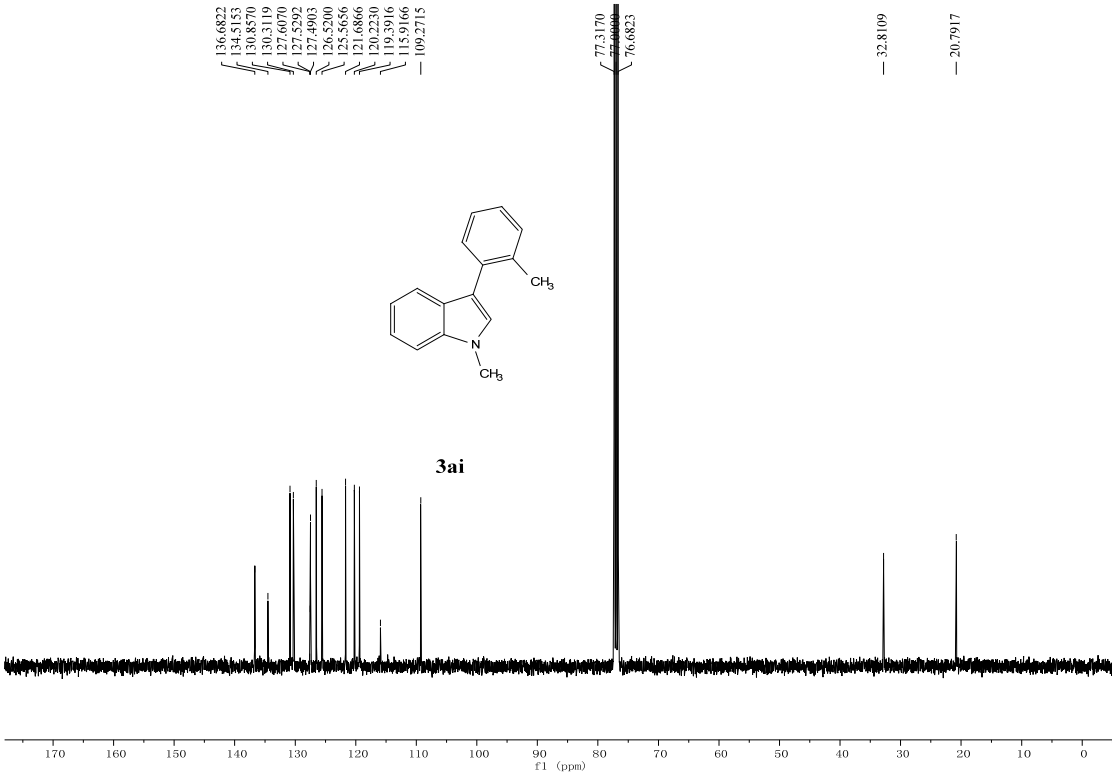
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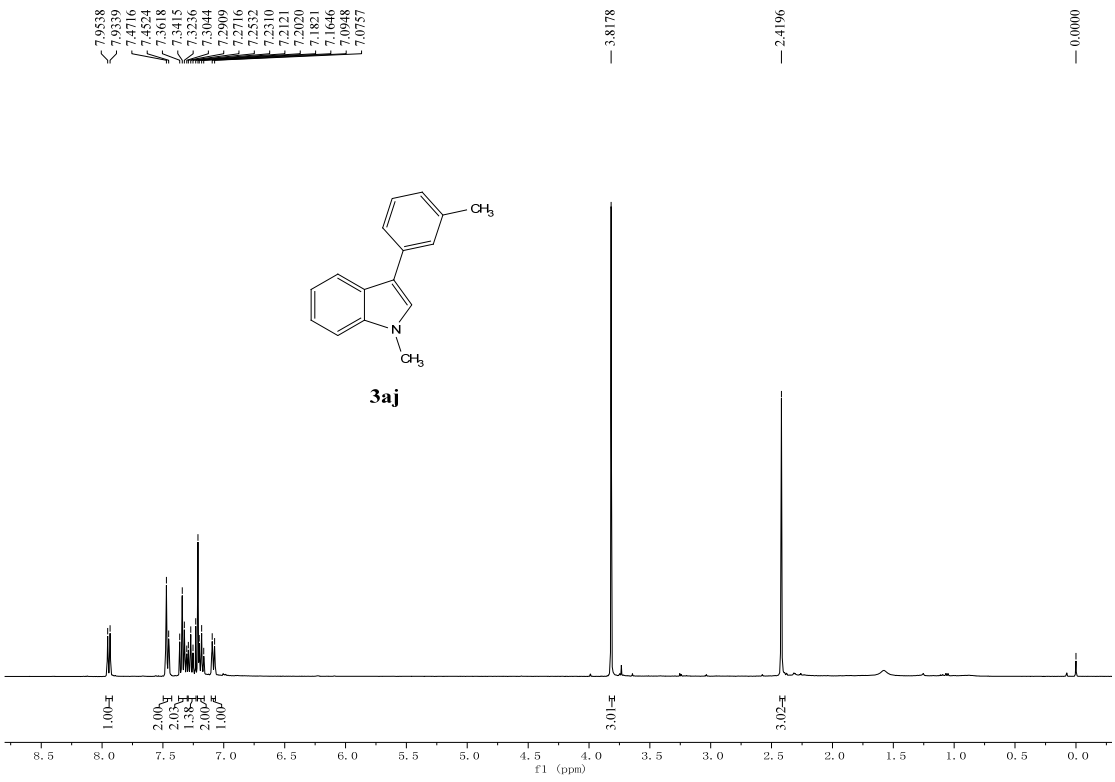
3ai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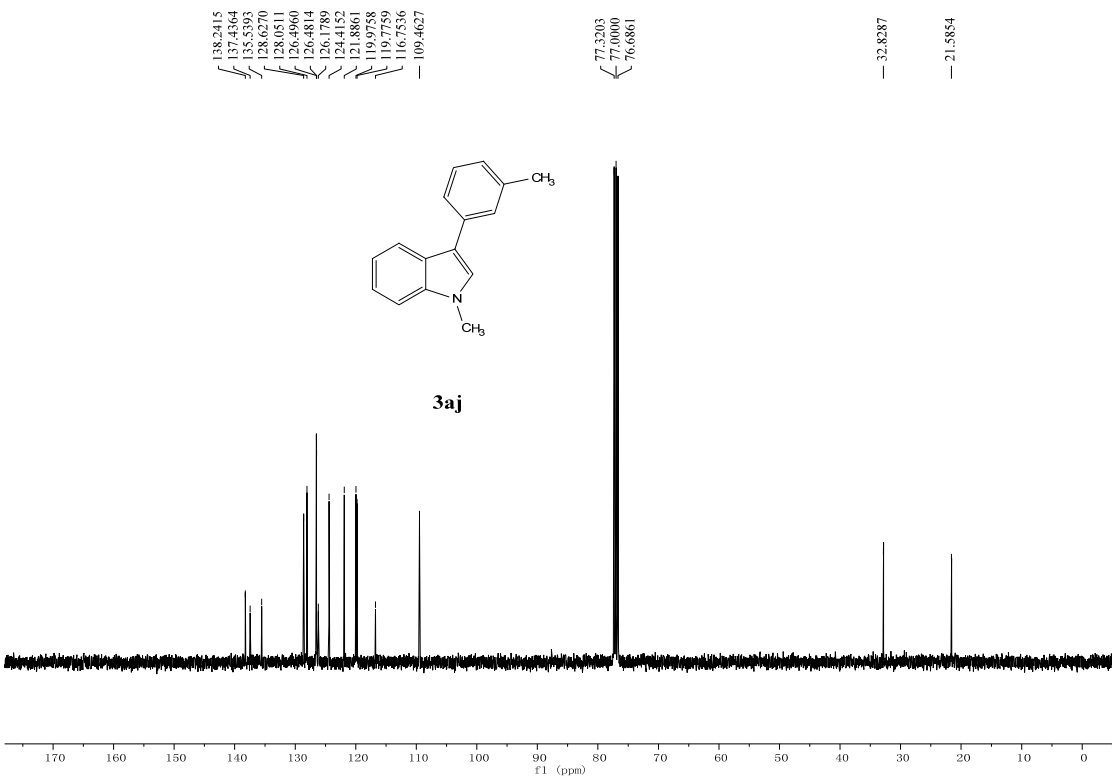
f1 (ppm)

3aj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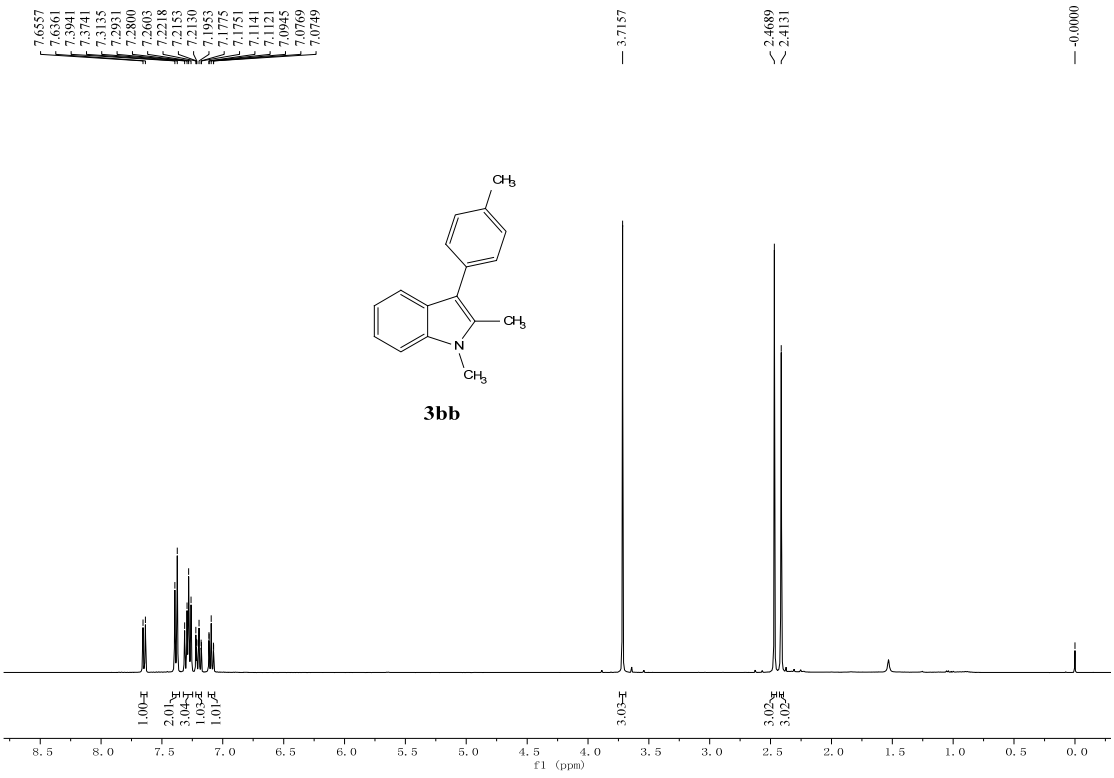
3aj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3.02
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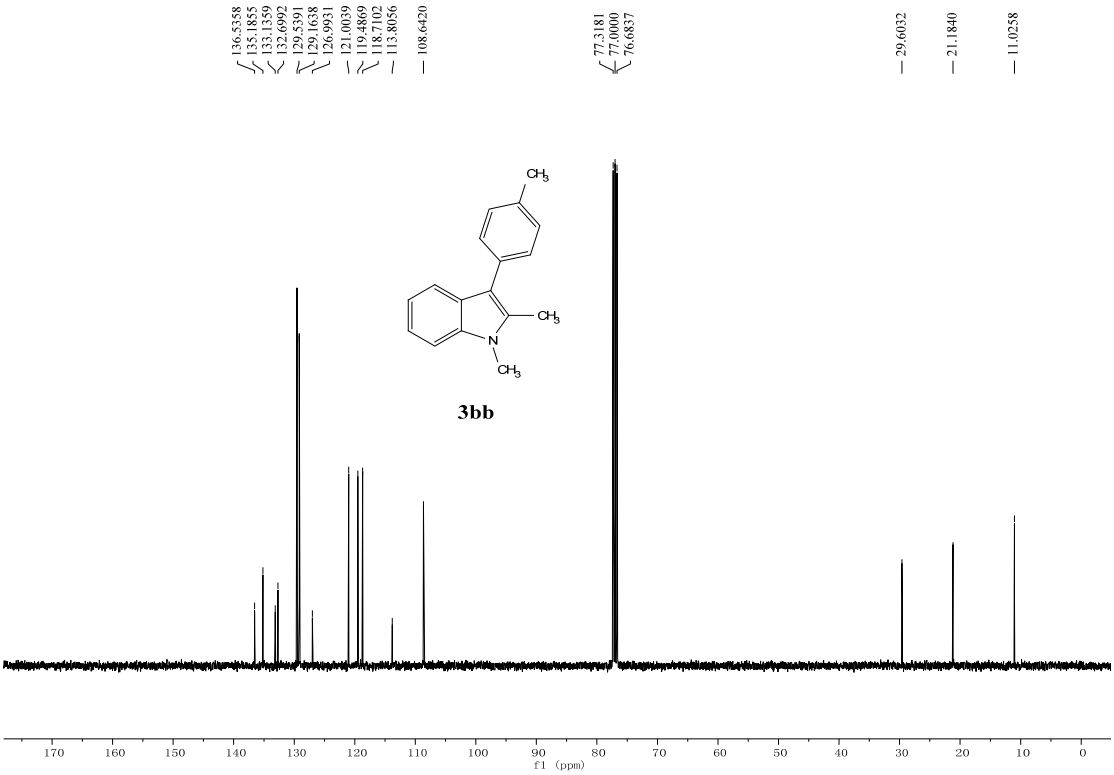
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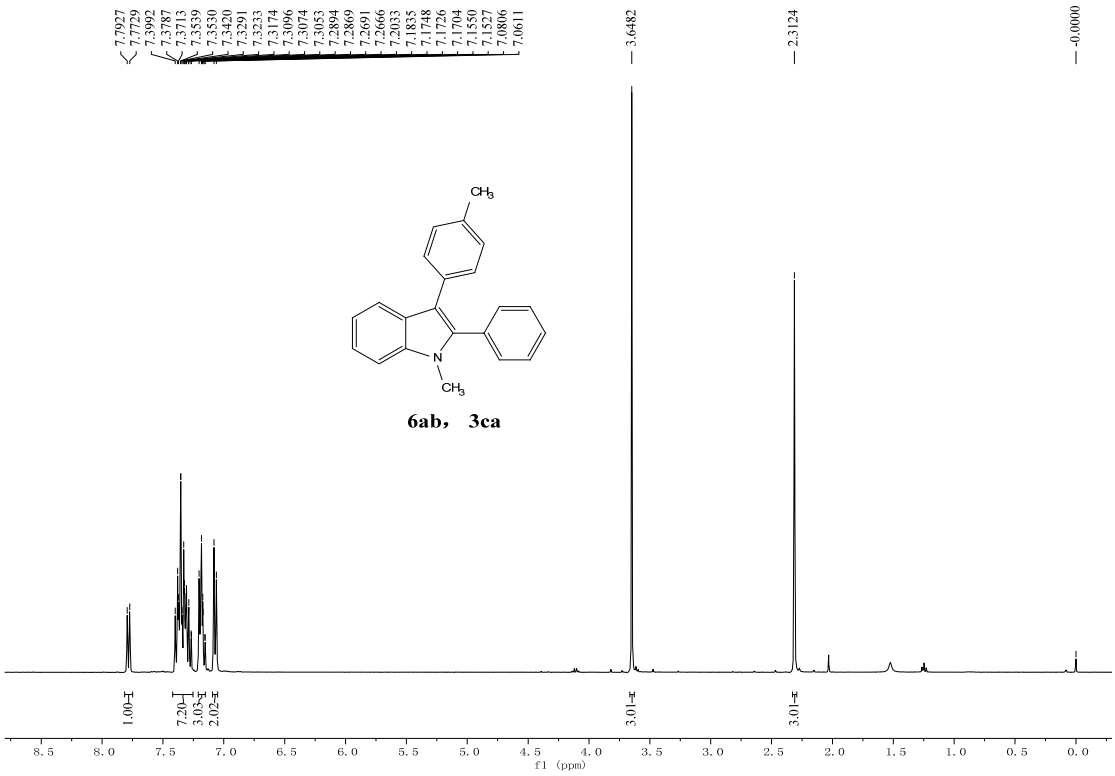

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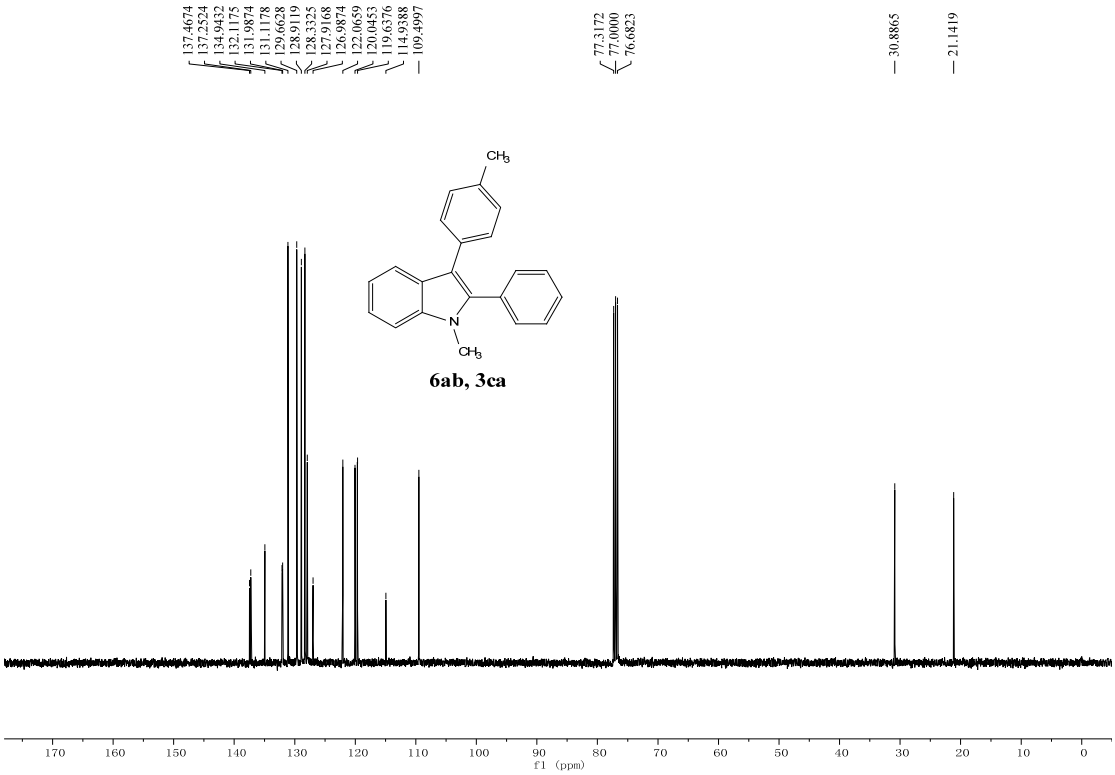

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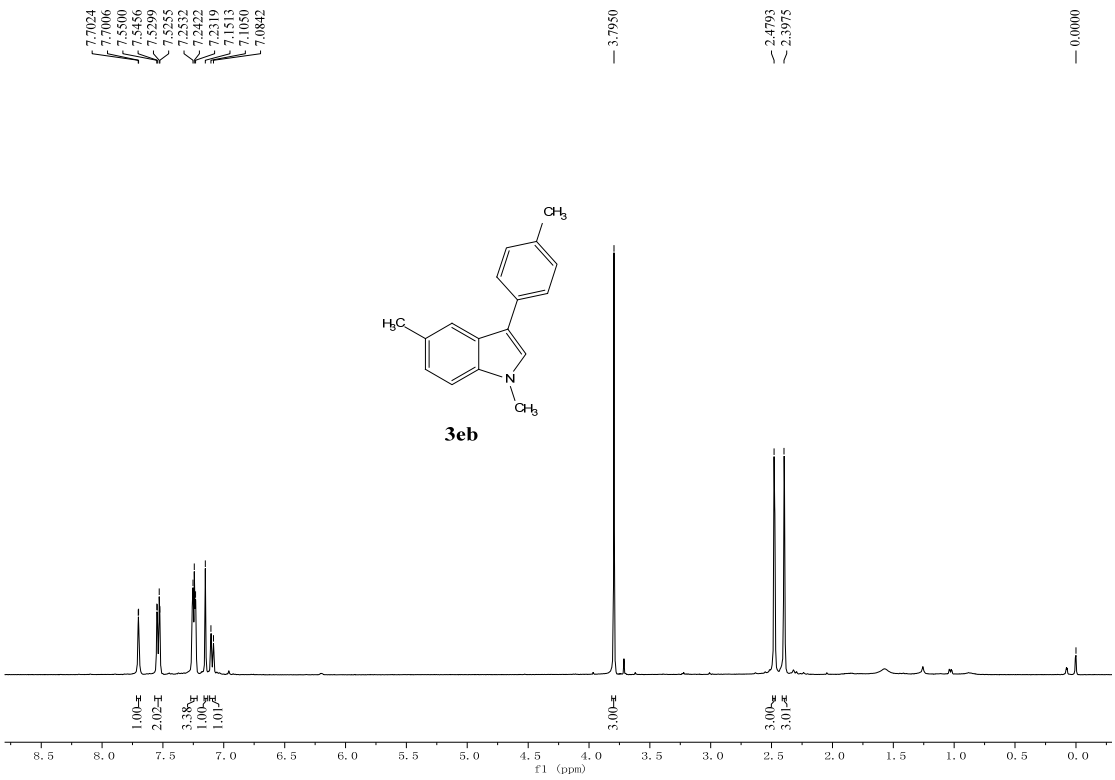
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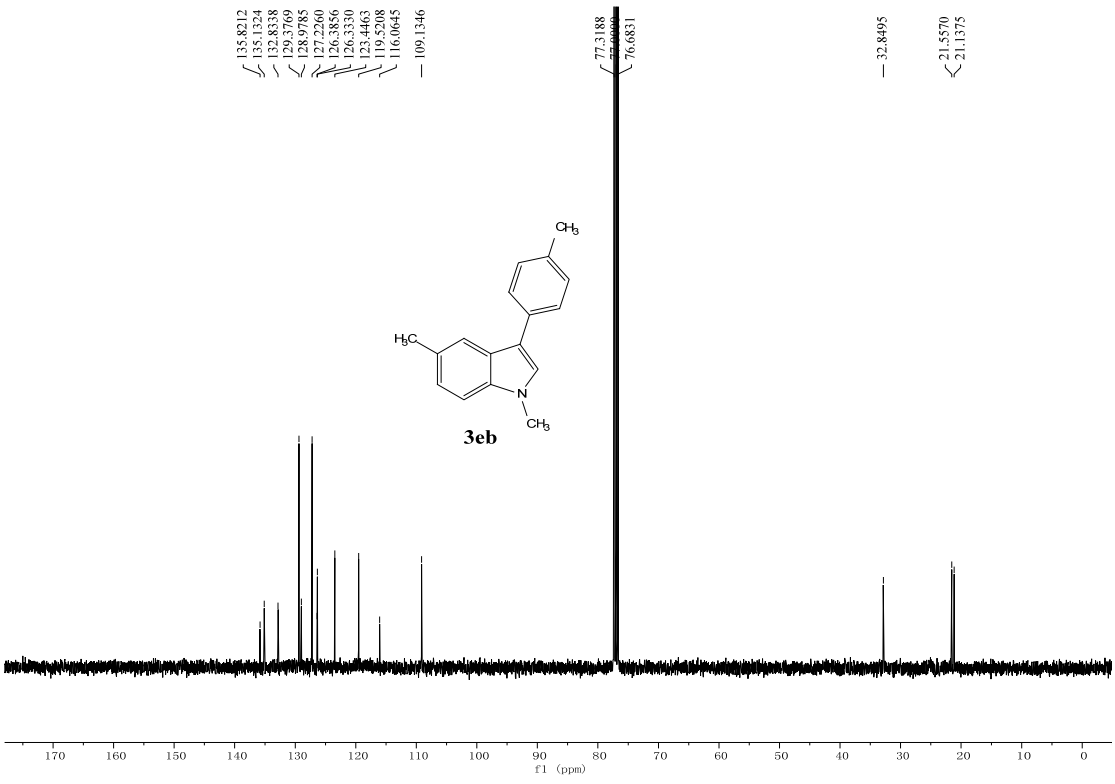
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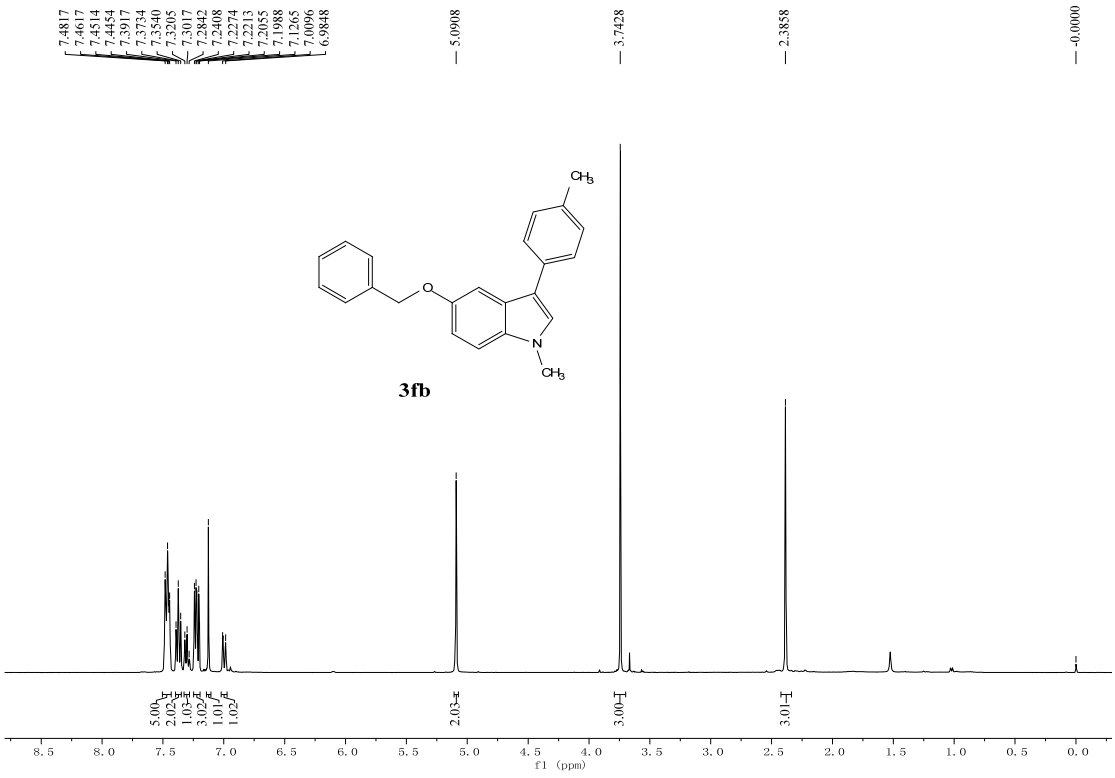
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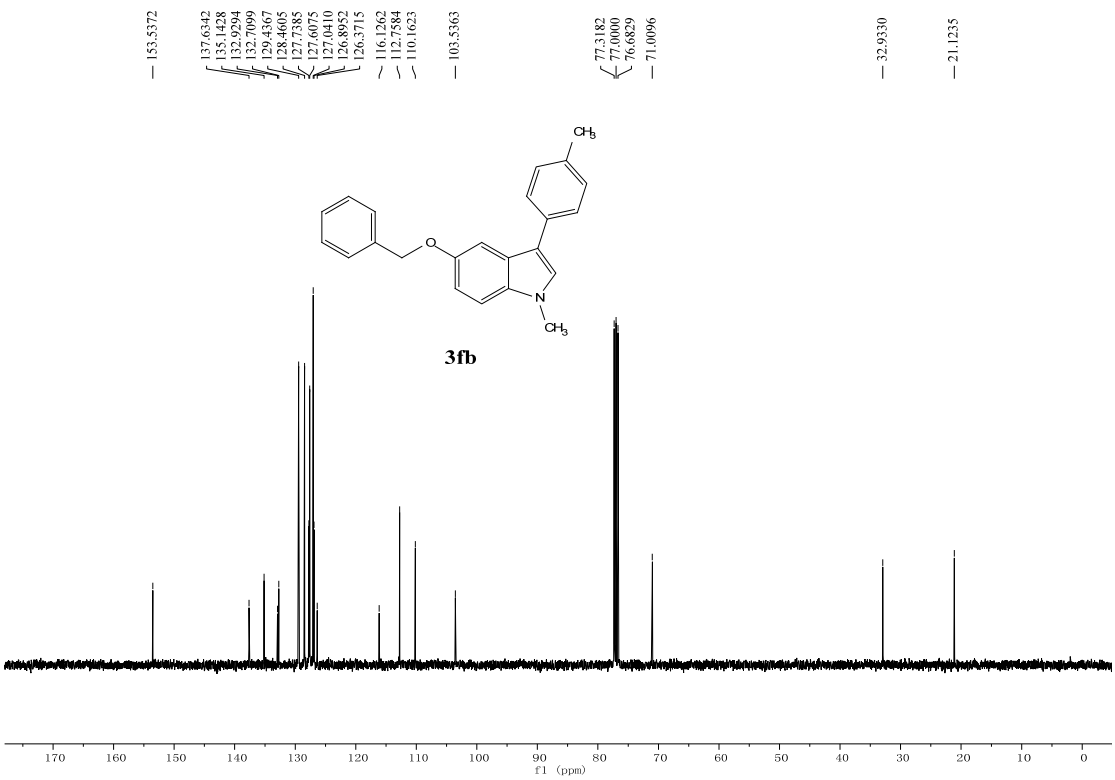
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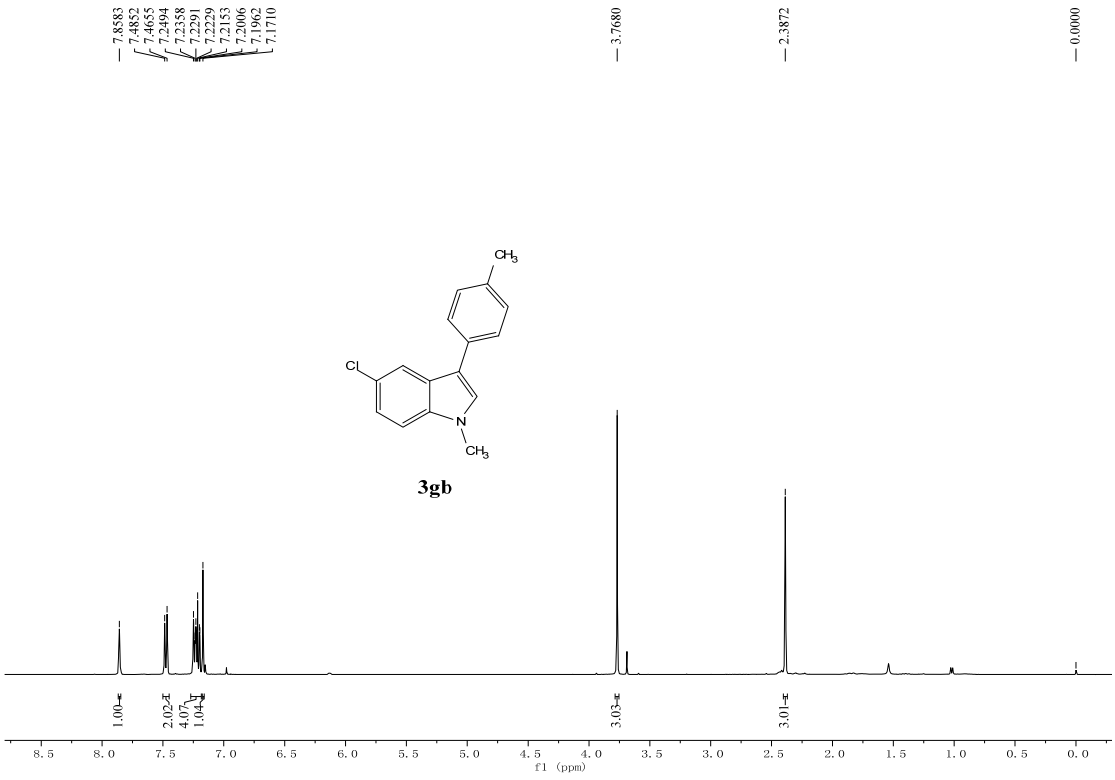
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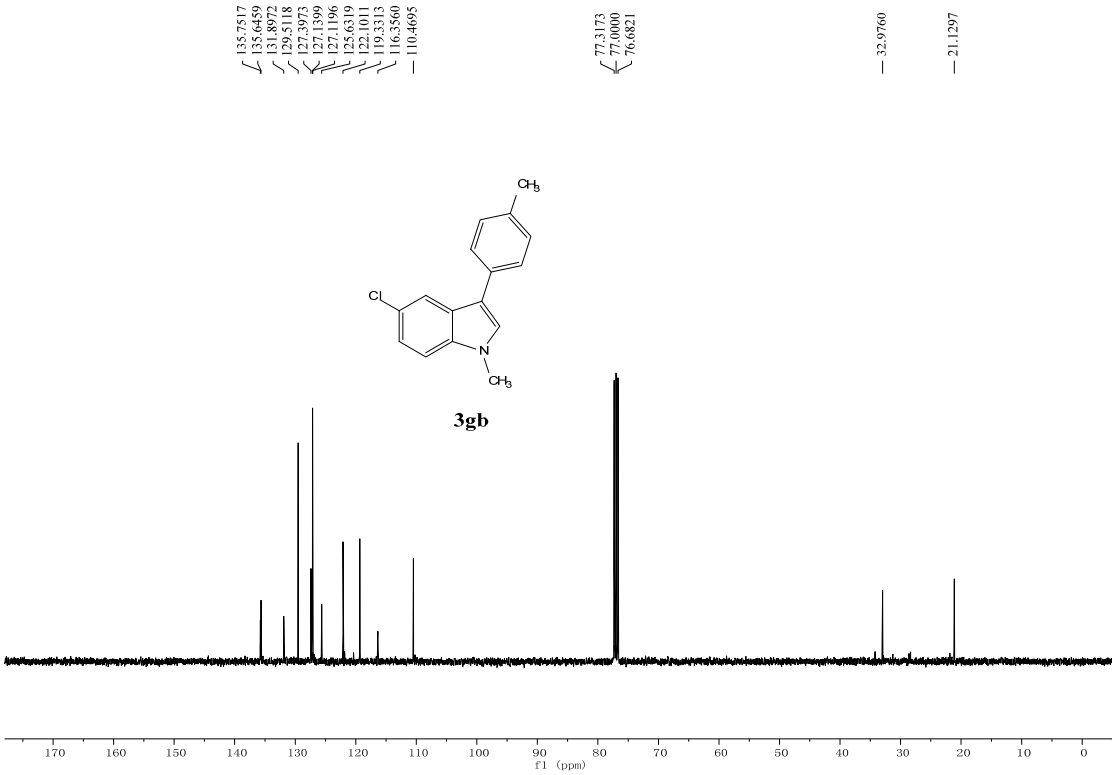
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119.3313
116.3560
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Cl
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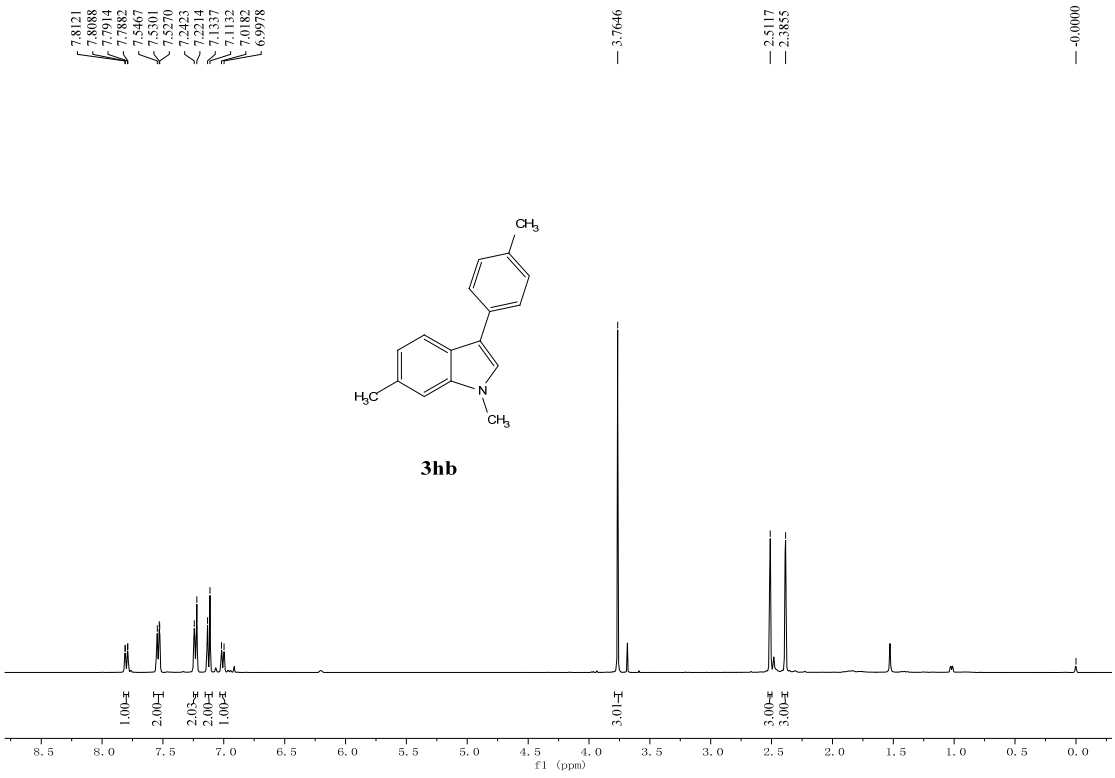
CH3
3gb
f1 (ppm)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7.0182
6.9978
3.7646
2.5117
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2.00
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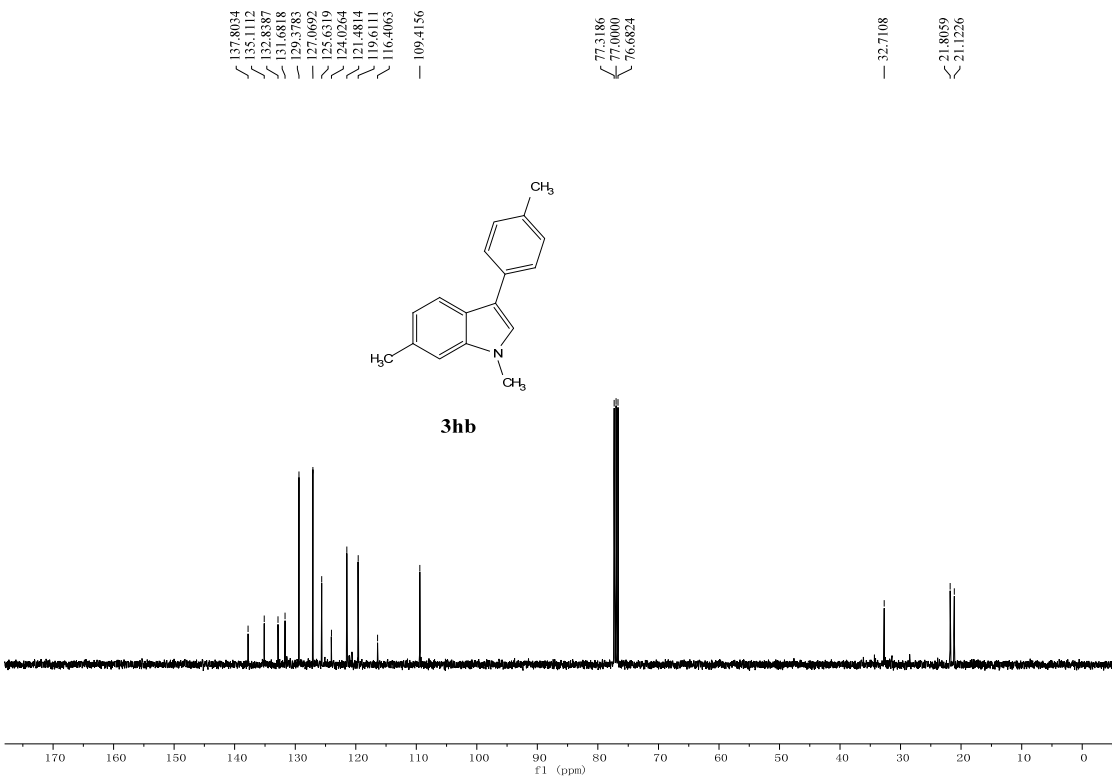
2.00
1.00
3.01
3.00
3.00
f1 (ppm)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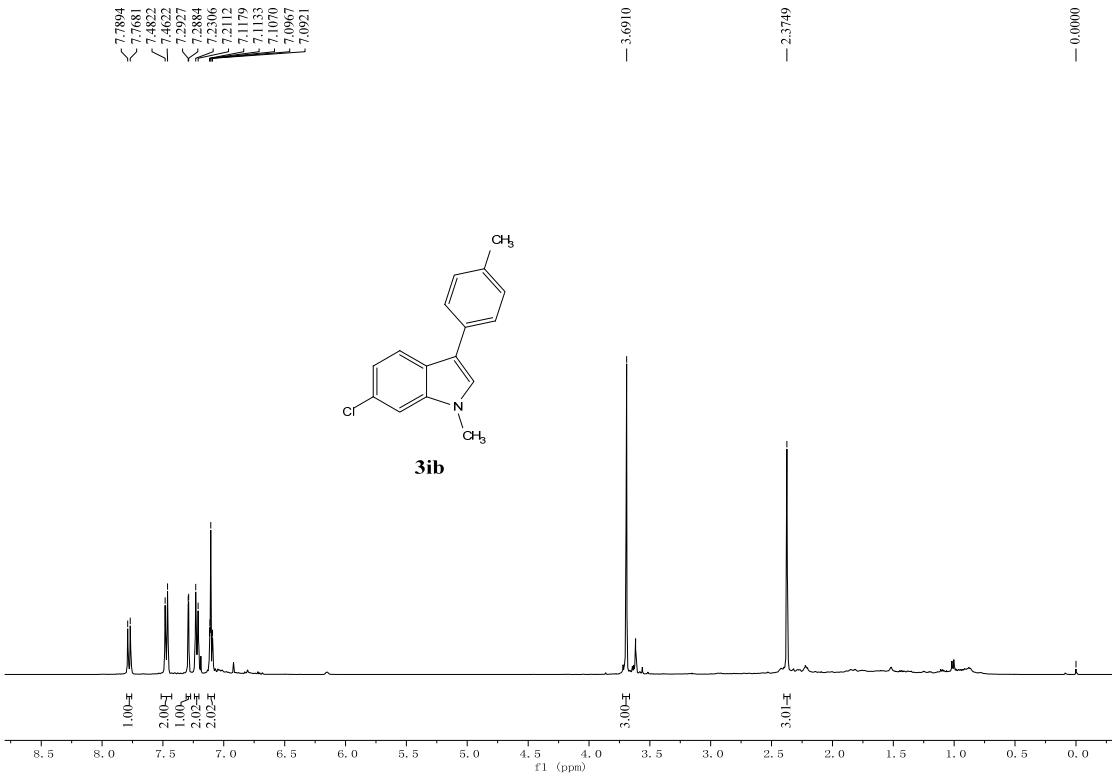
3hb
f1 (ppm)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7.1070
7.0967
7.0921
3.6910
2.3749
0.0000
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CH3
3ib
1.00
2.00
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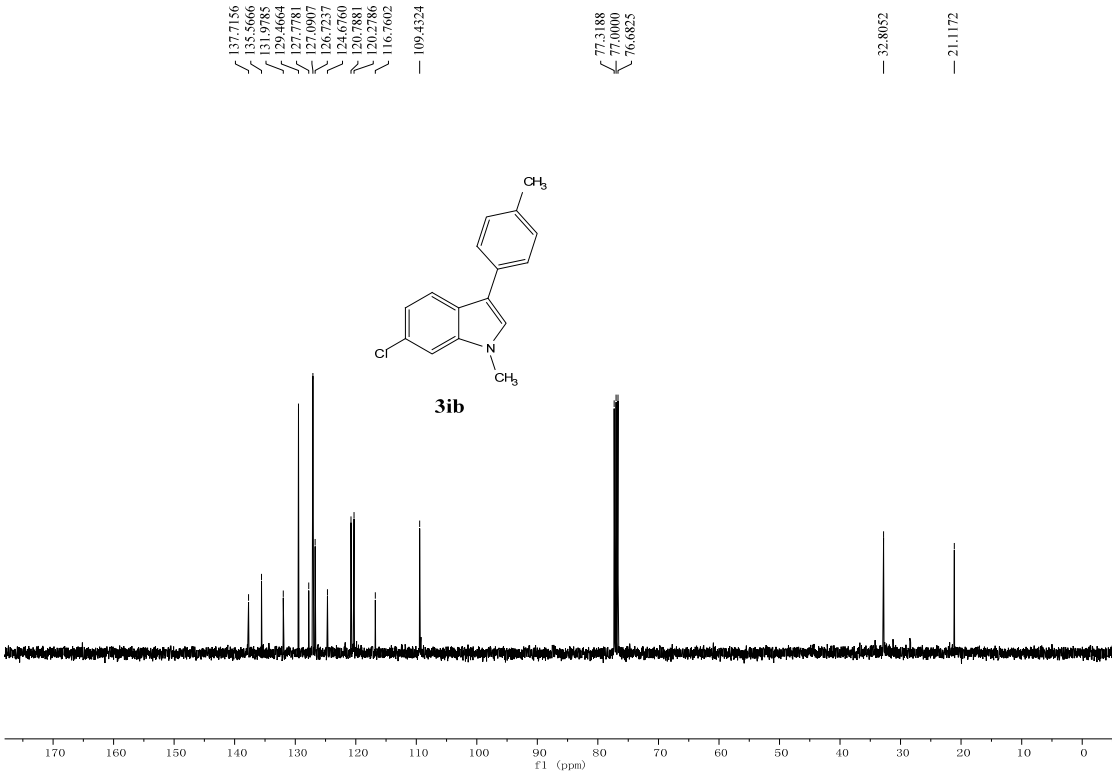
2.02
3.00
3.01
f1 (ppm)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Cl
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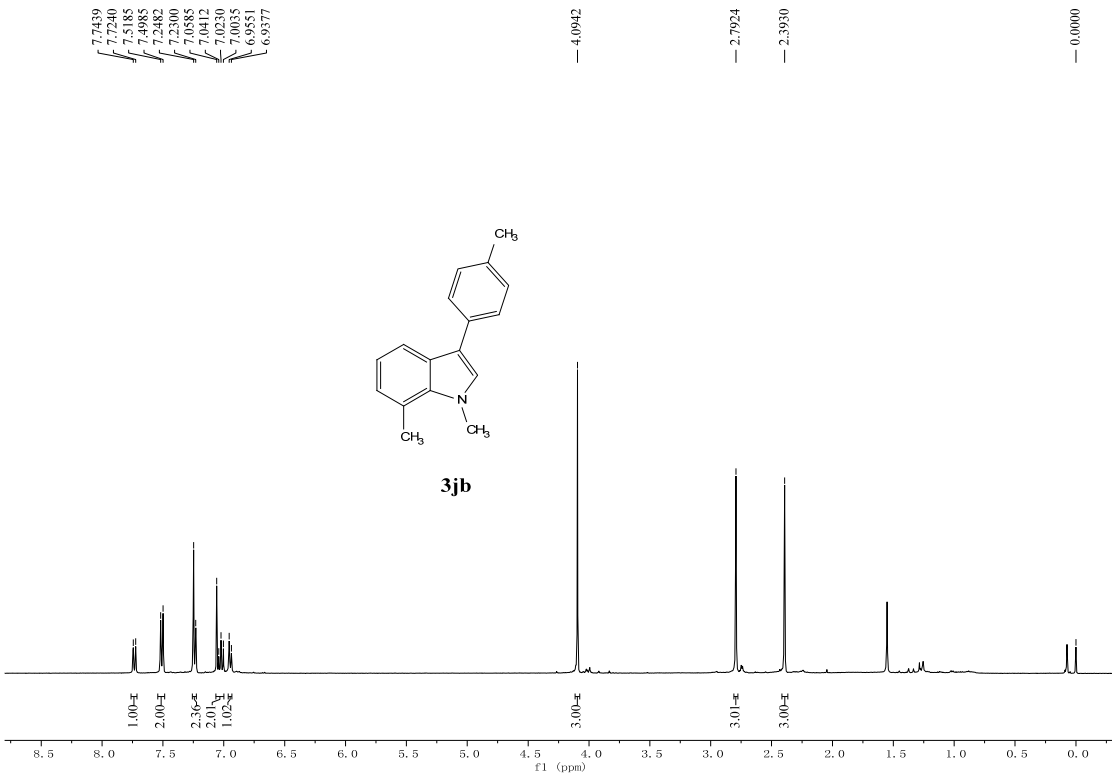
3ib
f1 (ppm)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6.9377
4.0942
2.7924
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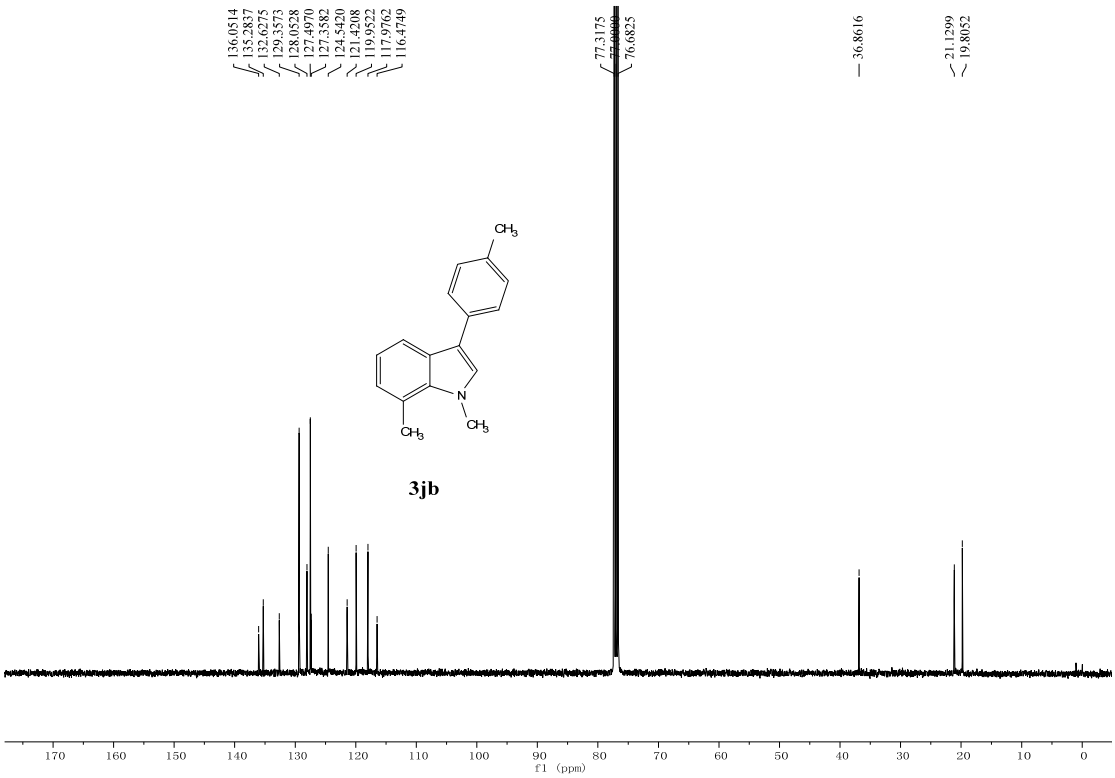
3.00
f1 (ppm)

3jb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f1 (ppm)

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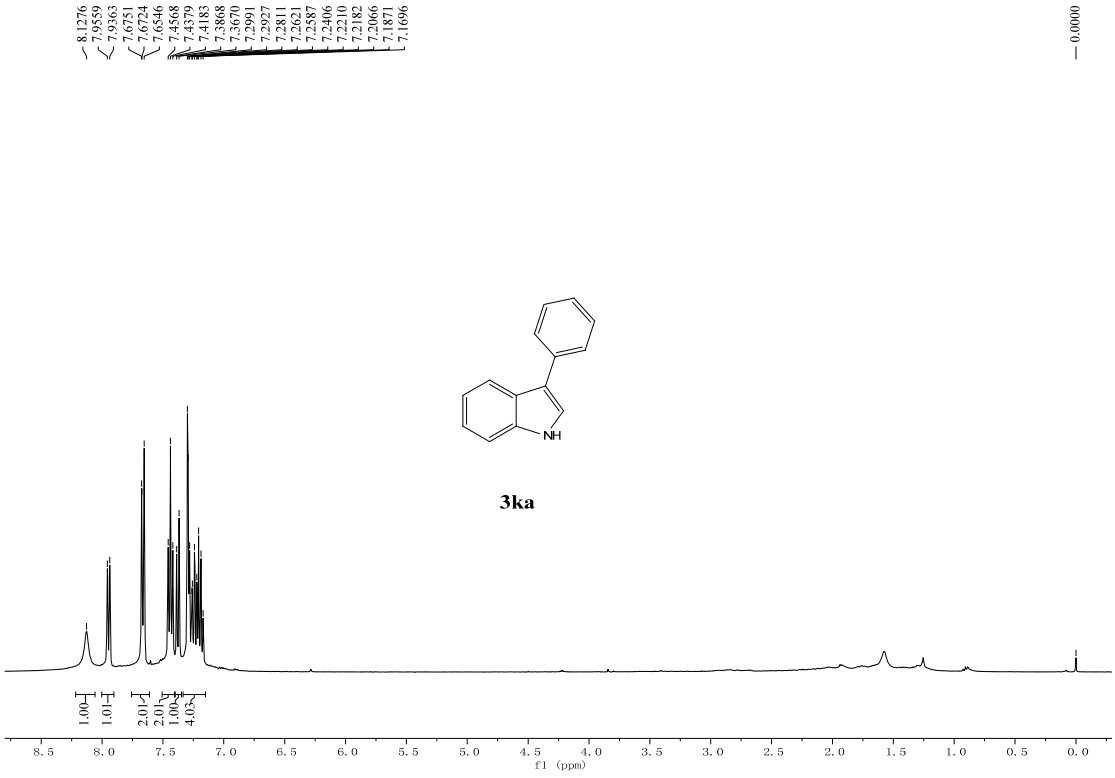
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7.2927
7.2811
7.2621
7.2587
7.2406
7.2210
7.2182
7.2066
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NH
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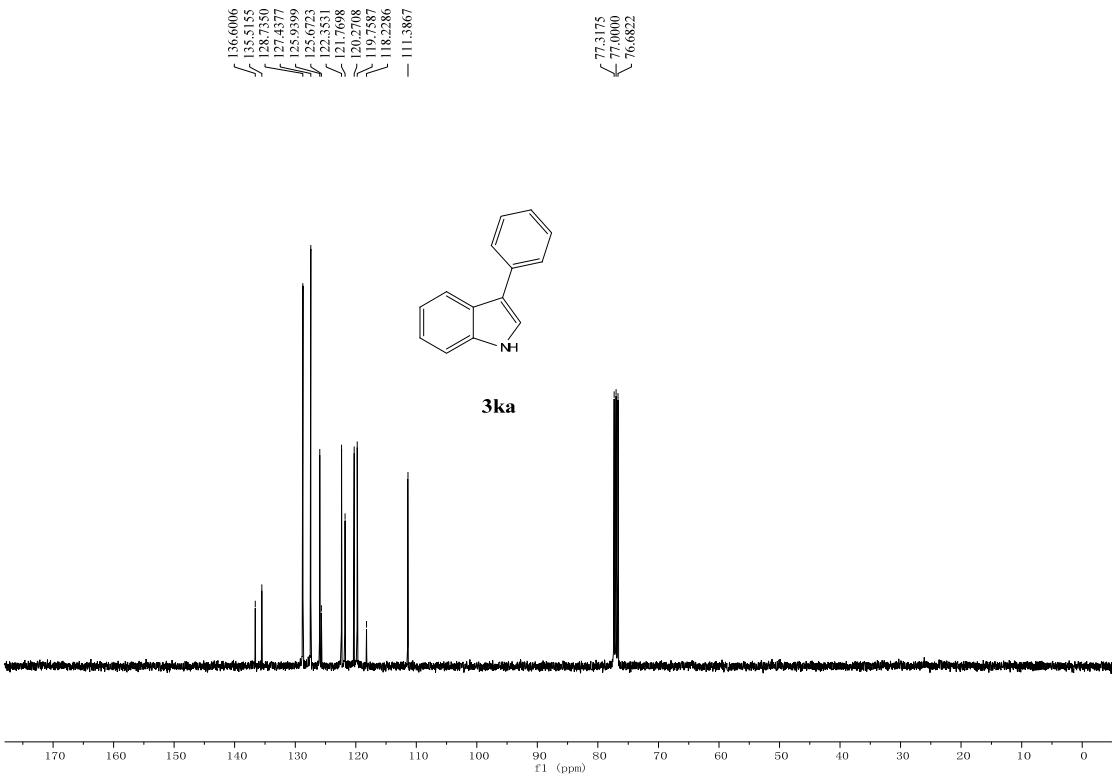
4.03
f1 (ppm)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77.0000
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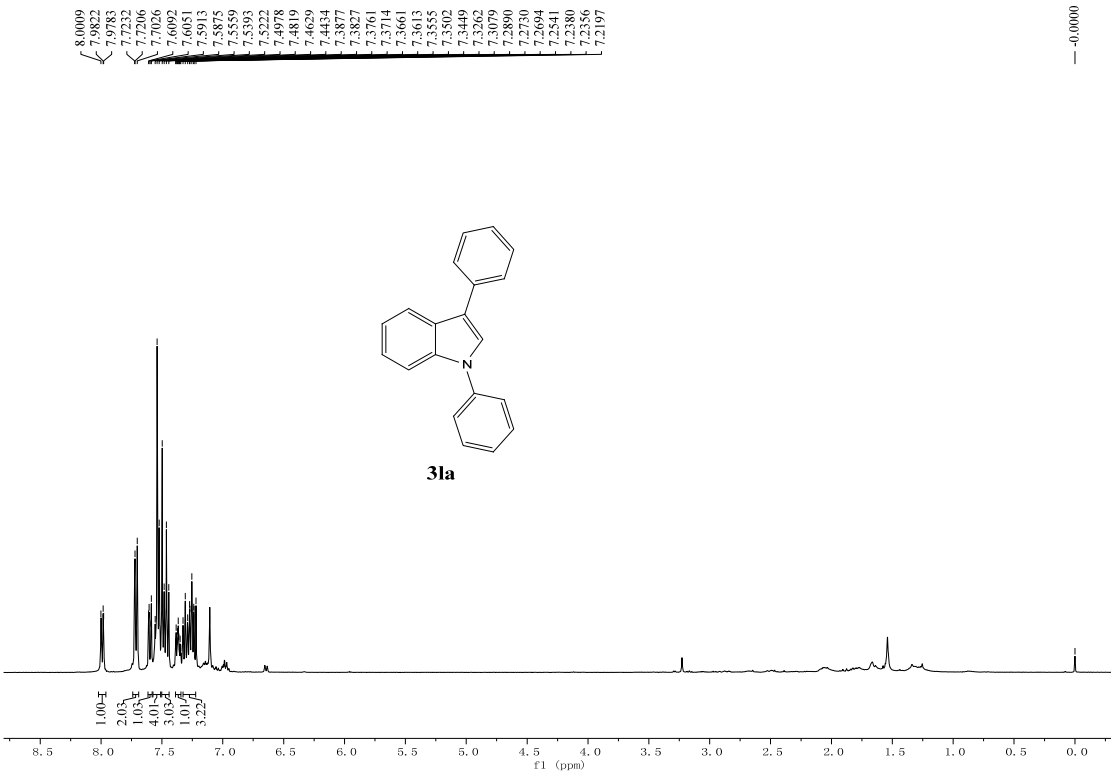
NH
3ka
f1 (ppm)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7.5559
7.5393
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7.4978
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7.4629
7.4434
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7.3827
7.3761
7.3714
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7.3613
7.3555
7.3502
7.3449
7.3262
7.3079
7.2890
7.2730
7.2694
7.2541
7.2380
7.2356
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4.01
3.03
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3.22
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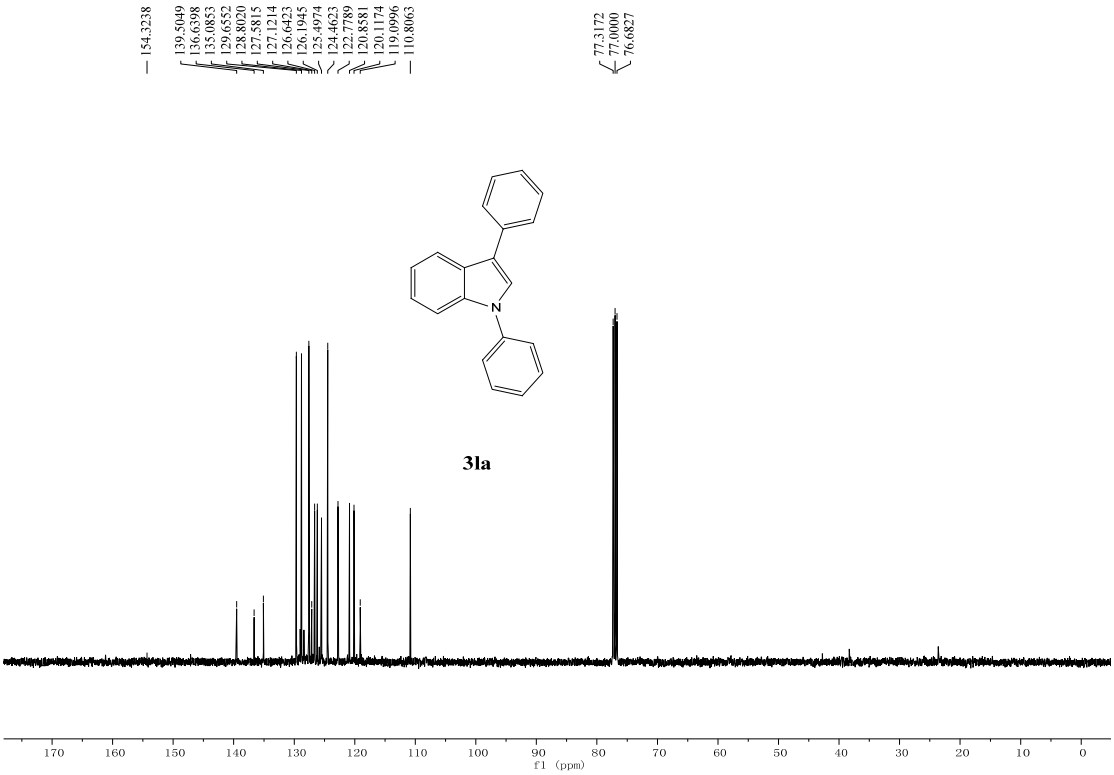
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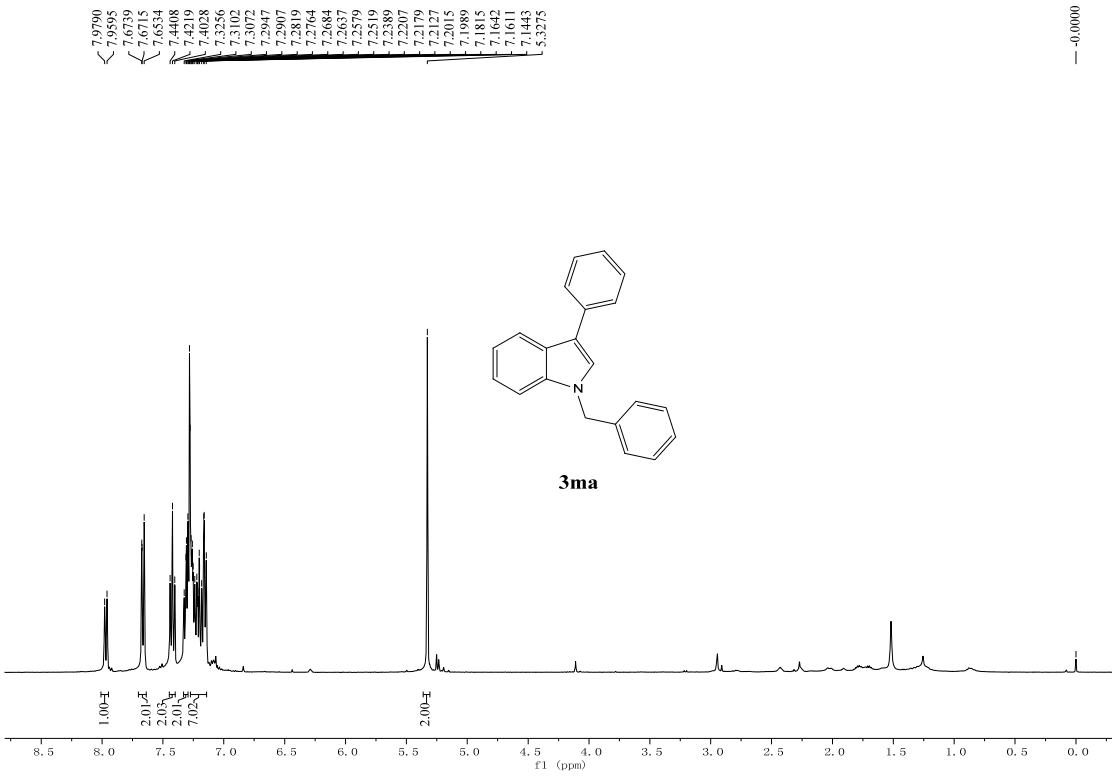
f1 (ppm)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7.2947
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7.2819
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7.2684
7.2637
7.2579
7.2519
7.2389
7.2207
7.2179
7.2127
7.2015
7.1989
7.1815
7.1642
7.1611
7.1443
5.3275
-0.0000
3ma
1.00
2.01
2.05
2.01
7.02
2.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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3.0
2.5
2.0
1.5
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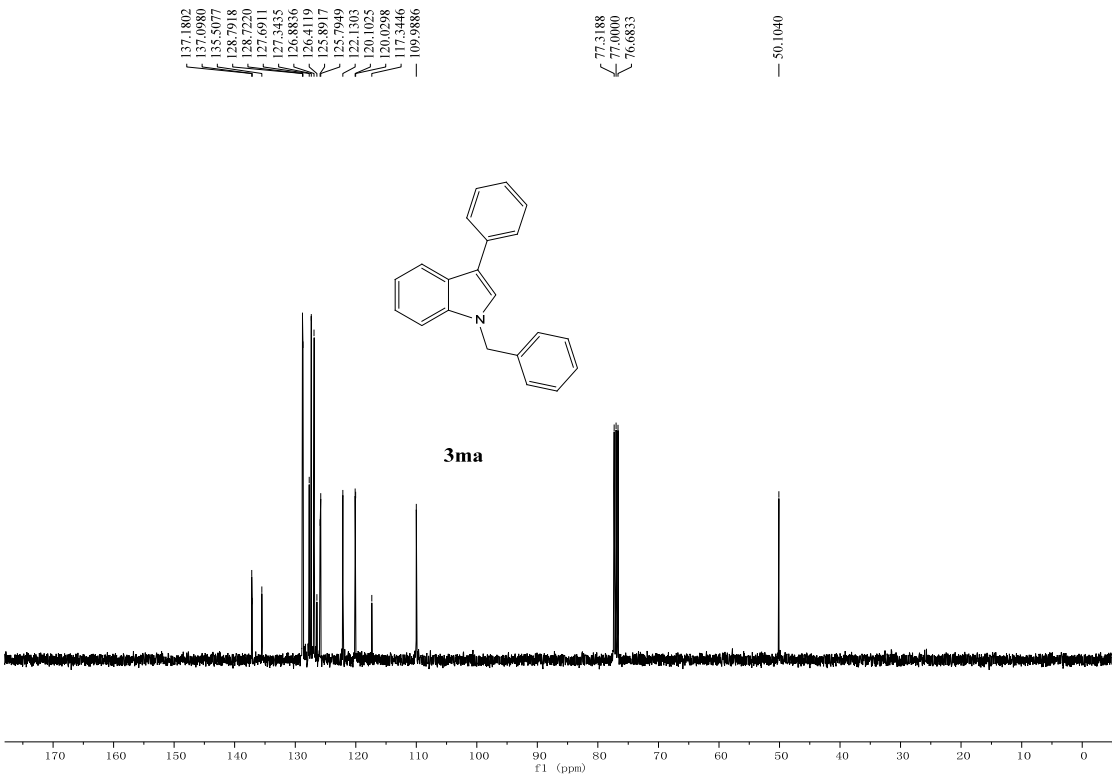
0.0
f1 (ppm)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50.1040
3ma
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130
120
110
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90
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70
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50
40
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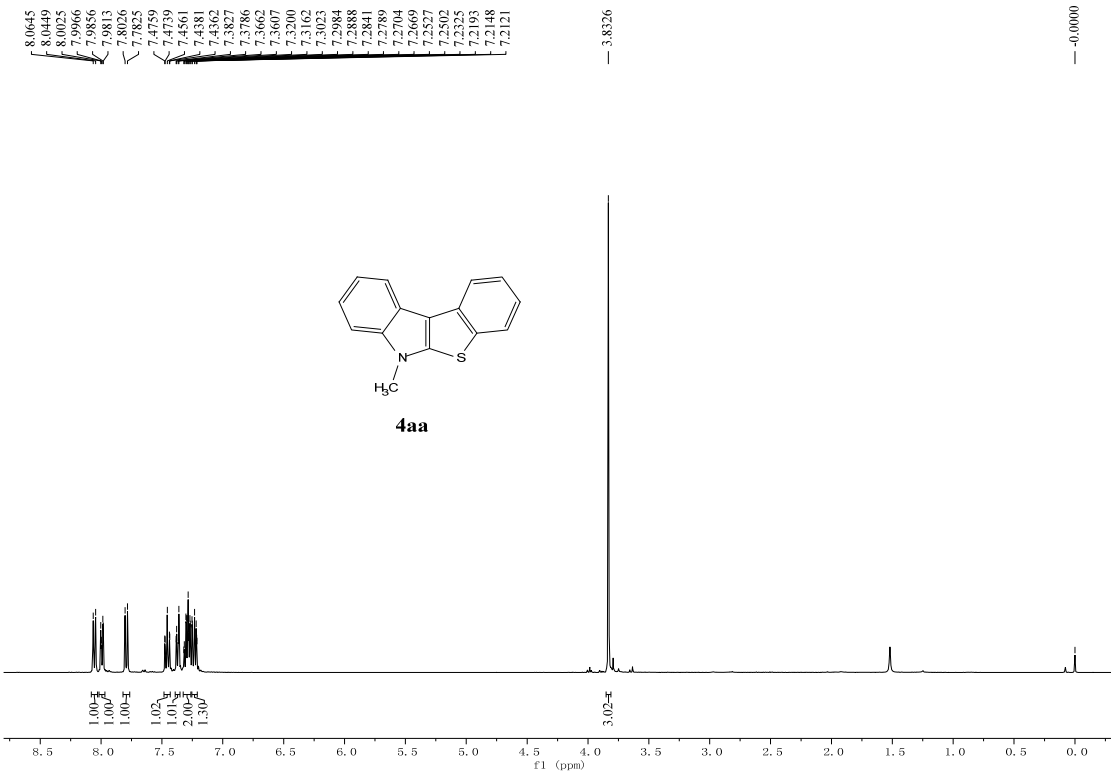
20
10
0
f1 (ppm)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7.4381
7.4362
7.3827
7.3786
7.3662
7.3607
7.3200
7.3162
7.3023
7.2984
7.2888
7.2841
7.2789
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7.2669
7.2527
7.2502
7.2325
7.2193
7.2148
7.2121
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-0.0000
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S
H3C
4aa
1.00
1.00
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1.01
2.00
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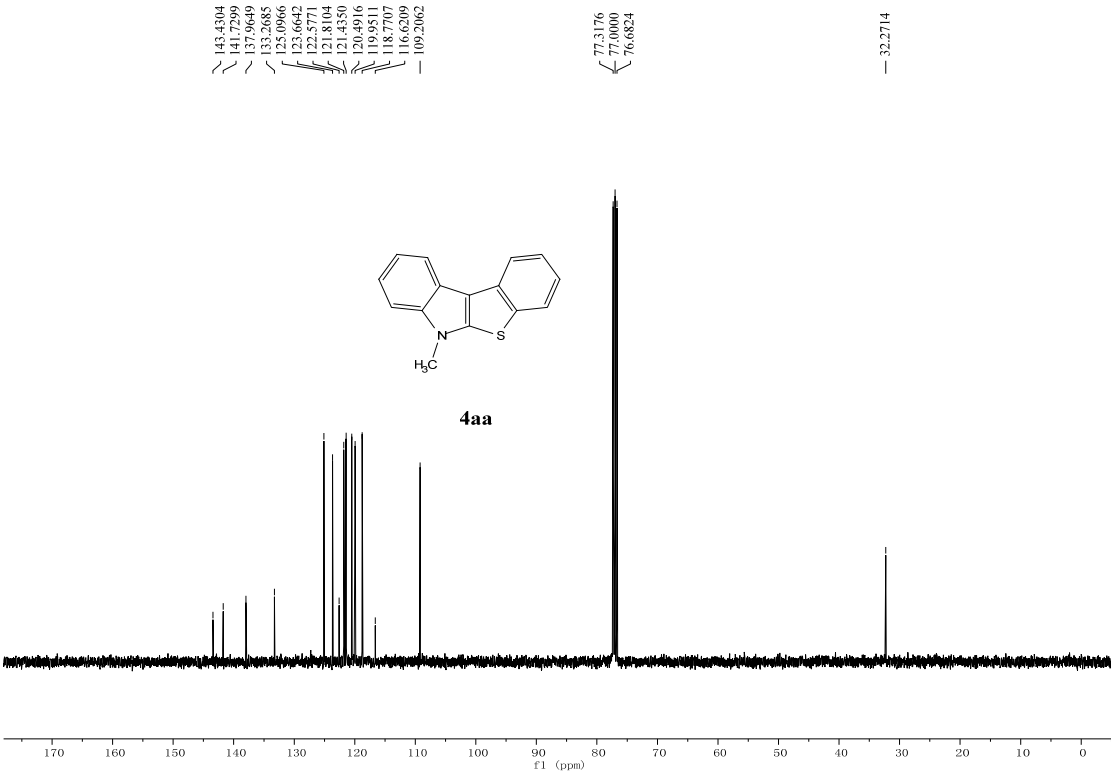
3.02
f1 (ppm)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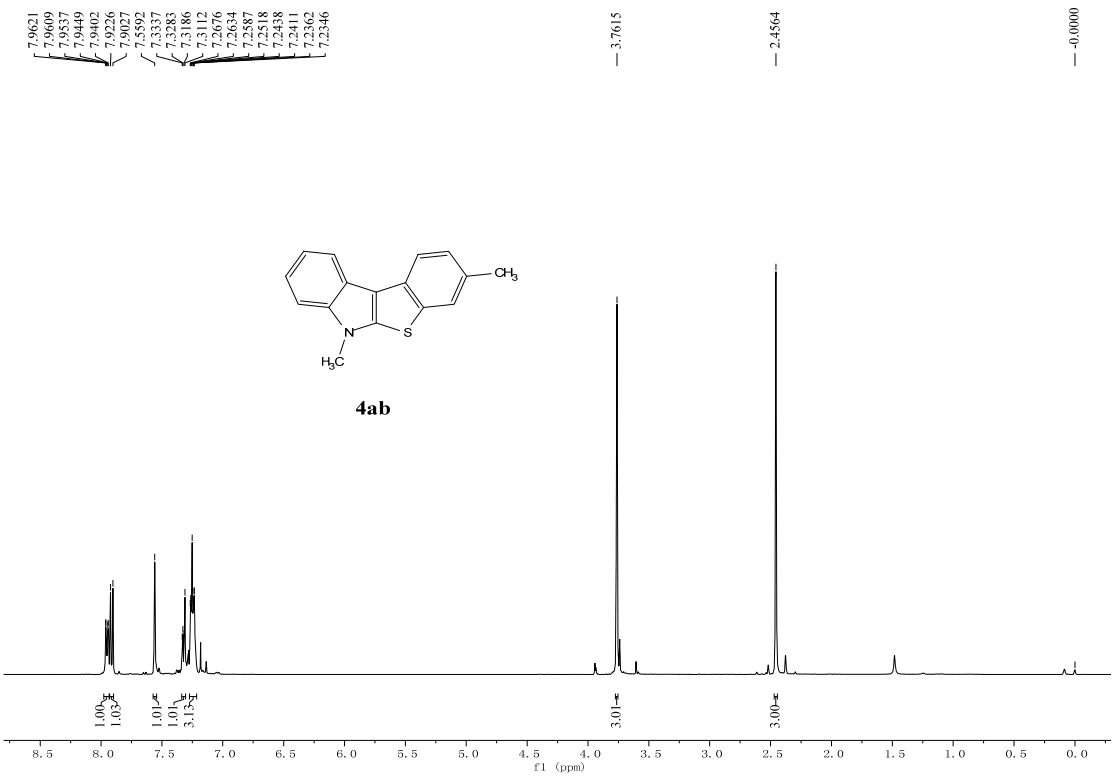
32.2714
N
S
H3C
4aa
f1 (ppm)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7.3186
7.3112
7.2676
7.2634
7.2587
7.2518
7.2438
7.2411
7.2362
7.2346
3.7615
2.4564
-0.0000
CH3
N
S
H3C
4ab
1.00
1.03
1.01
1.01
3.13
3.01
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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2.5
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1.0
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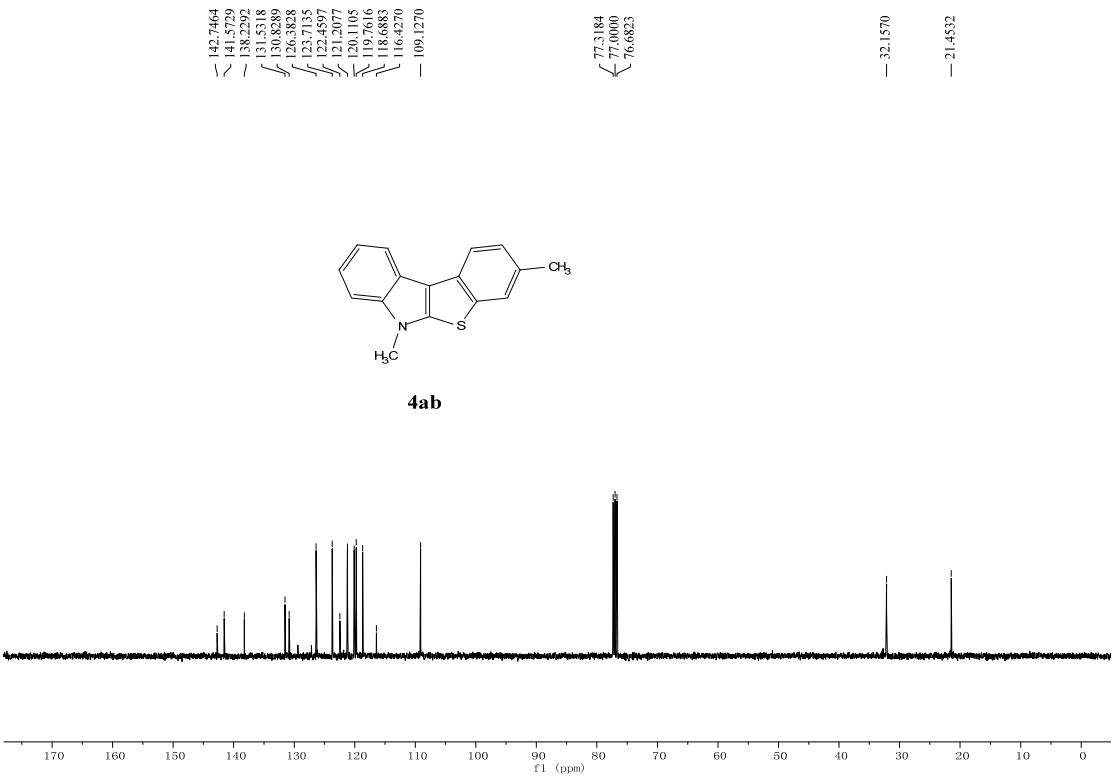
0.0
f1 (ppm)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119.7616
118.6883
116.4270
109.1270
77.3184
77.0000
76.6823
32.1570
21.4532
CH3
N
S
H3C
4ab
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160
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120
110
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70
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50
40
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20
10
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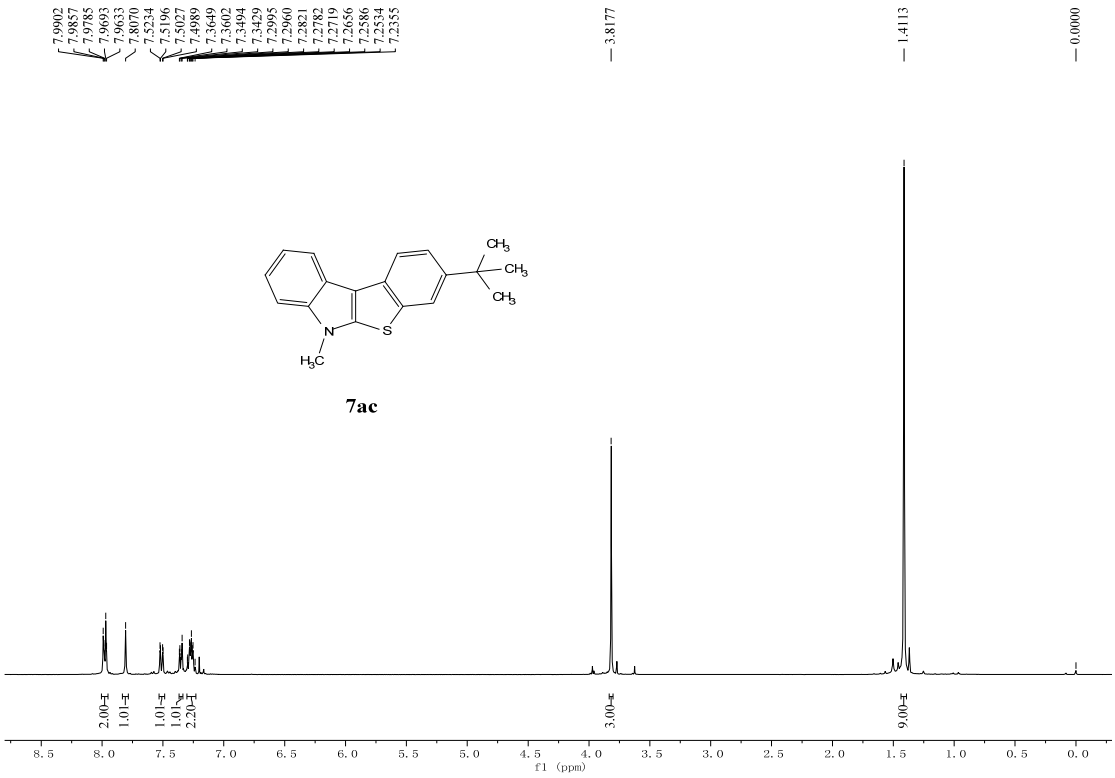
f1 (ppm)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7.3602
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7.3429
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7.2960
7.2821
7.2782
7.2719
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7.2586
7.2534
7.2355
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CH3
CH3
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S
H3C
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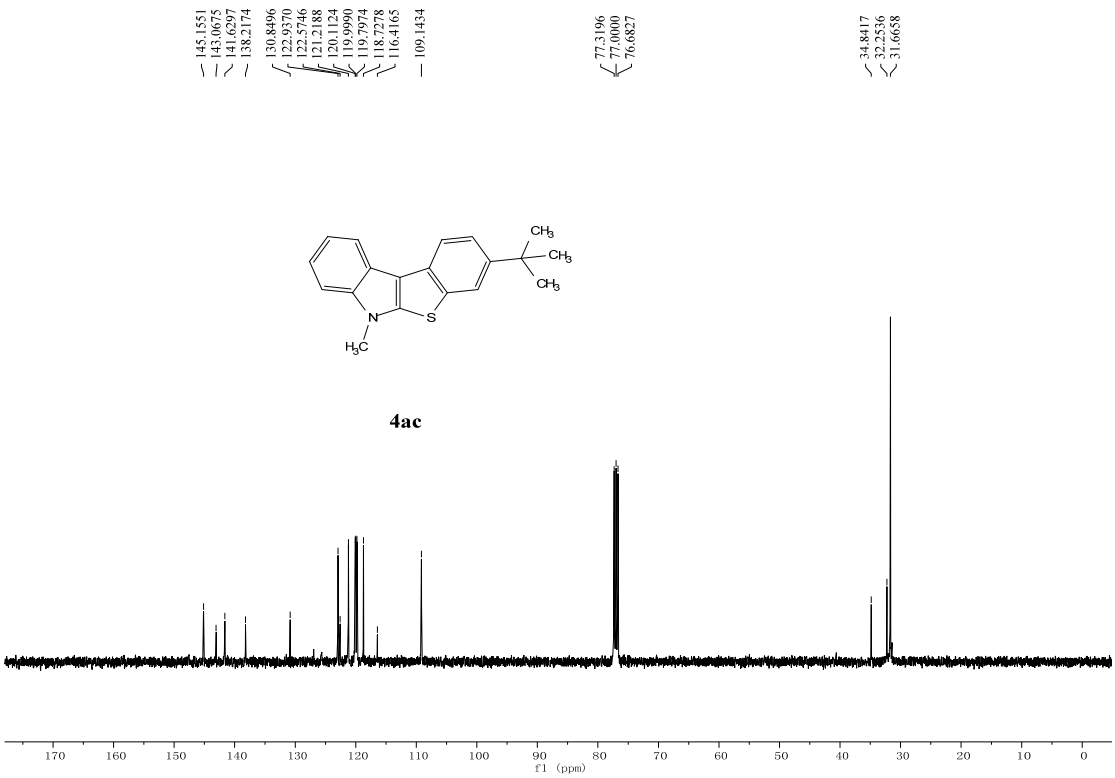
1.01
1.01
2.20
3.00
9.00
f1 (ppm)

7ac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116.4165
109.1434
77.3196
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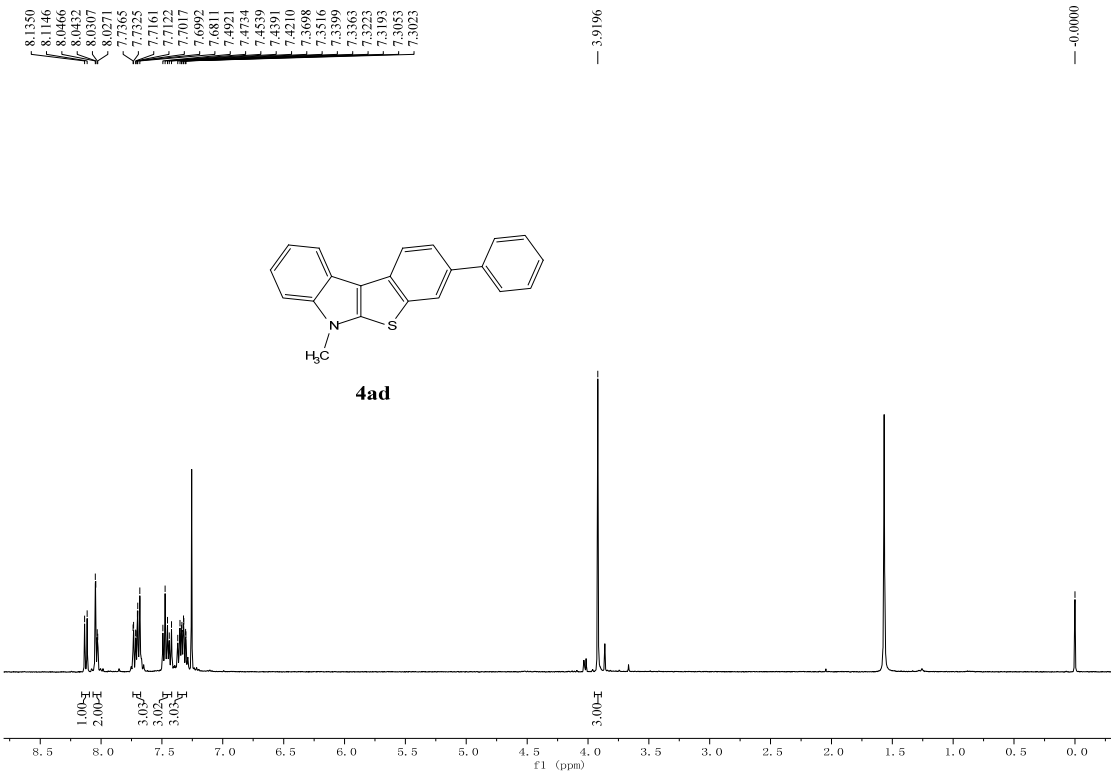
31.6658
CH3
CH3
CH3
N
S
H3C
f1 (ppm)

4ac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7.3223
7.3193
7.3053
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2.00
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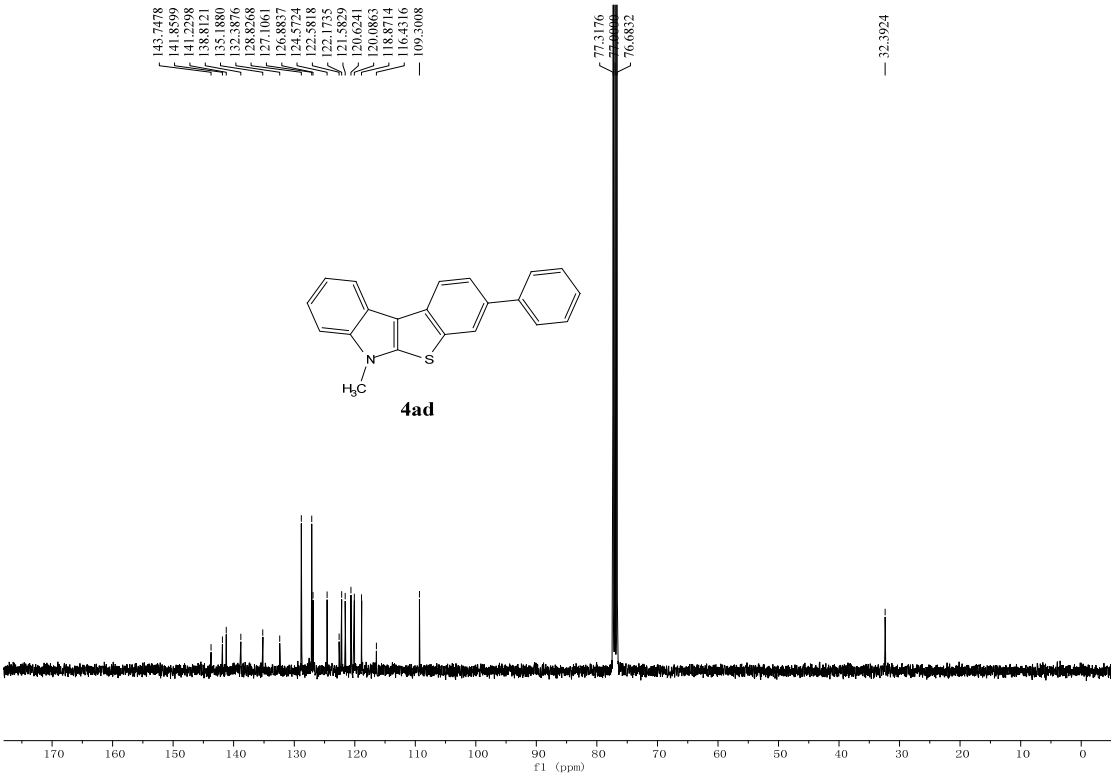
3.02
3.03
3.00
f1 (ppm)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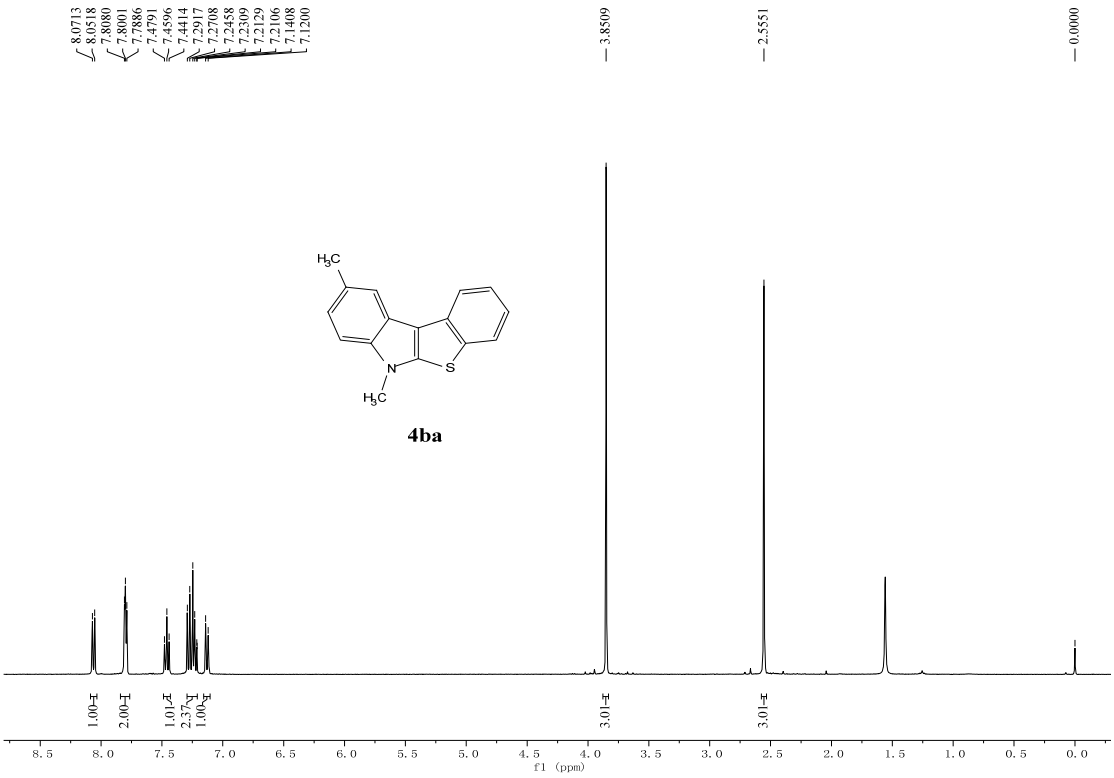
4ad
f1 (ppm)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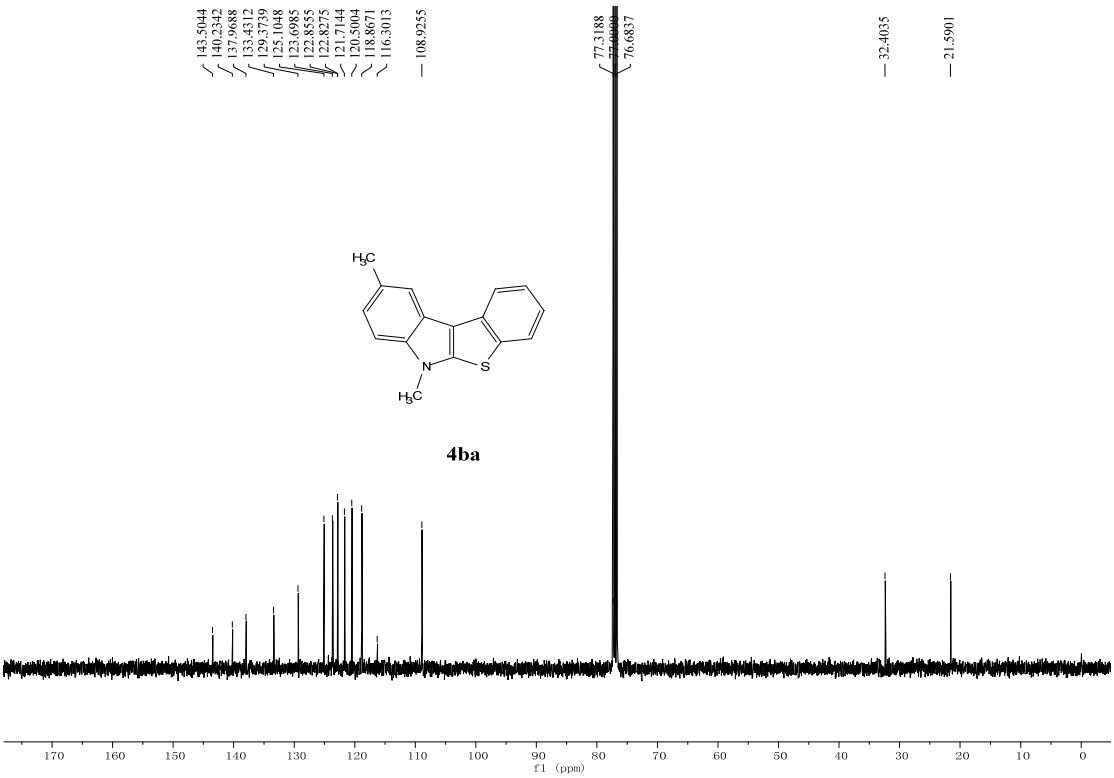
7.2458
7.2309
7.2129
7.2106
7.1408
7.1200
3.8509
2.5551
0.0000
1.00
2.00
1.01
2.37
1.00
3.01
3.01
f1 (ppm)

H3C
N
S
H3C

4ba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116.3013
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76.6837
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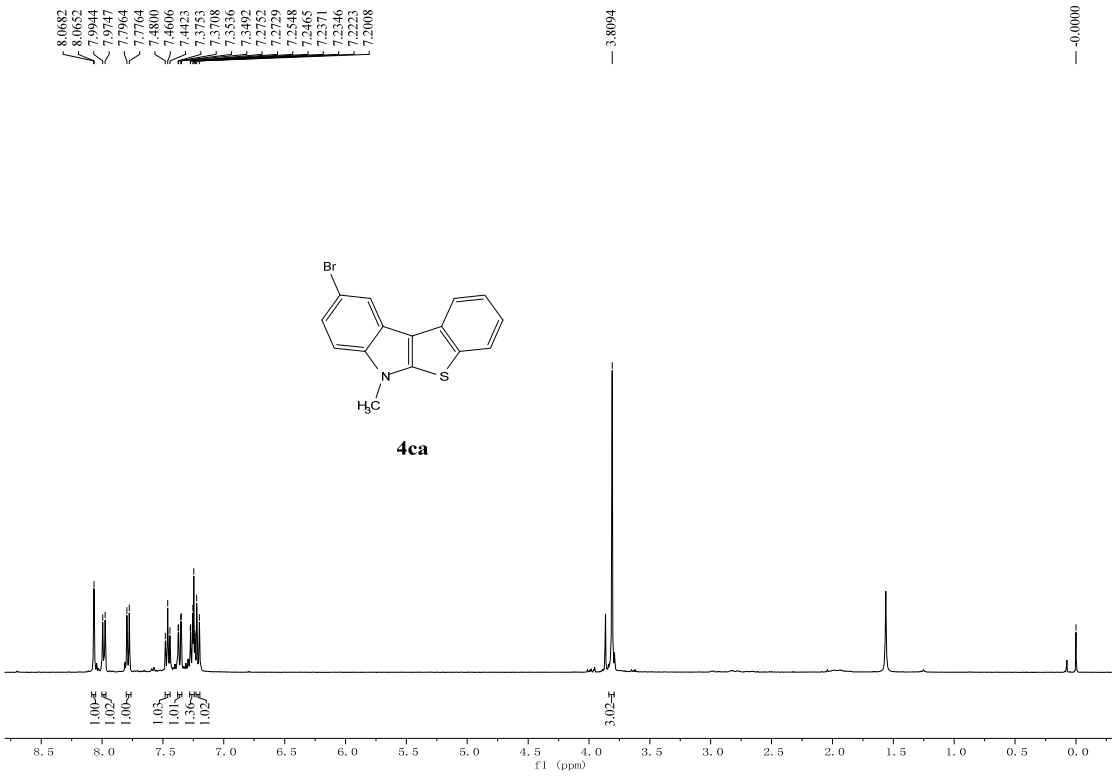
21.5901
f1 (ppm)

H3C
N
S
H3C

4ba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7.3492
7.2752
7.2729
7.2548
7.2465
7.2371
7.2346
7.2223
7.2008
3.8094
-0.0000
Br
N
S
H3C
4ca
1.00
1.02
1.00
1.03
1.01
1.36
1.02
3.02
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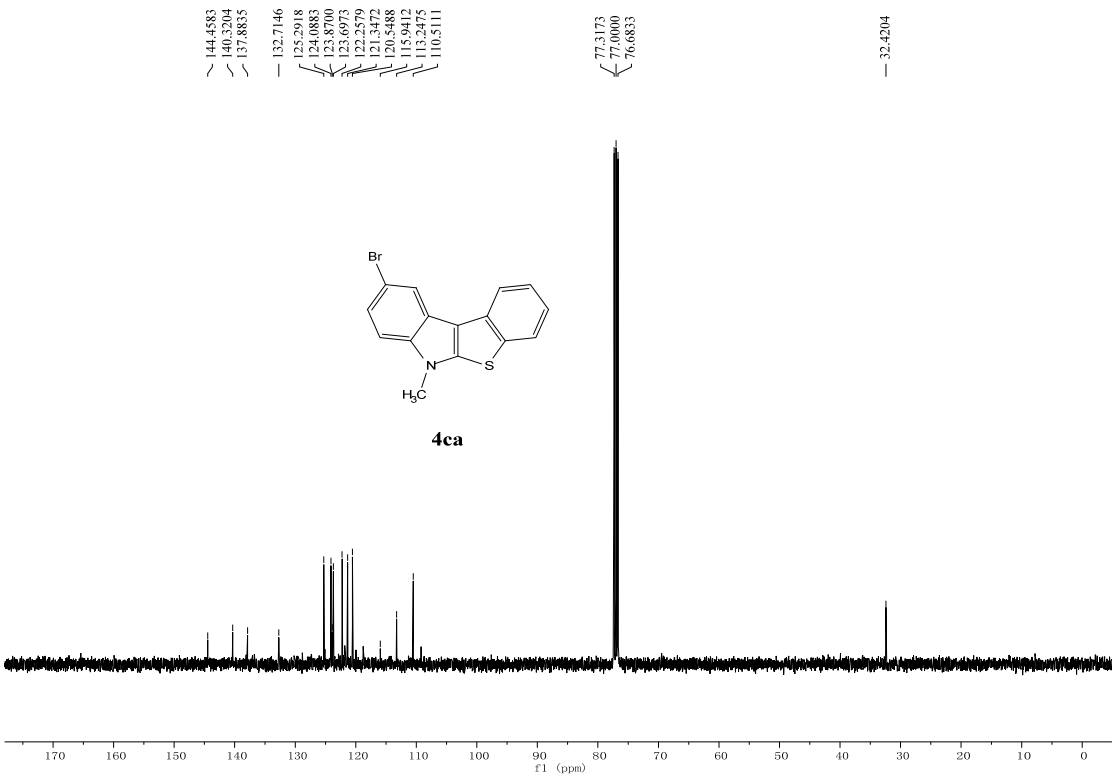
f1 (ppm)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77.3173
77.0000
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Br
N
S
H3C
4ca
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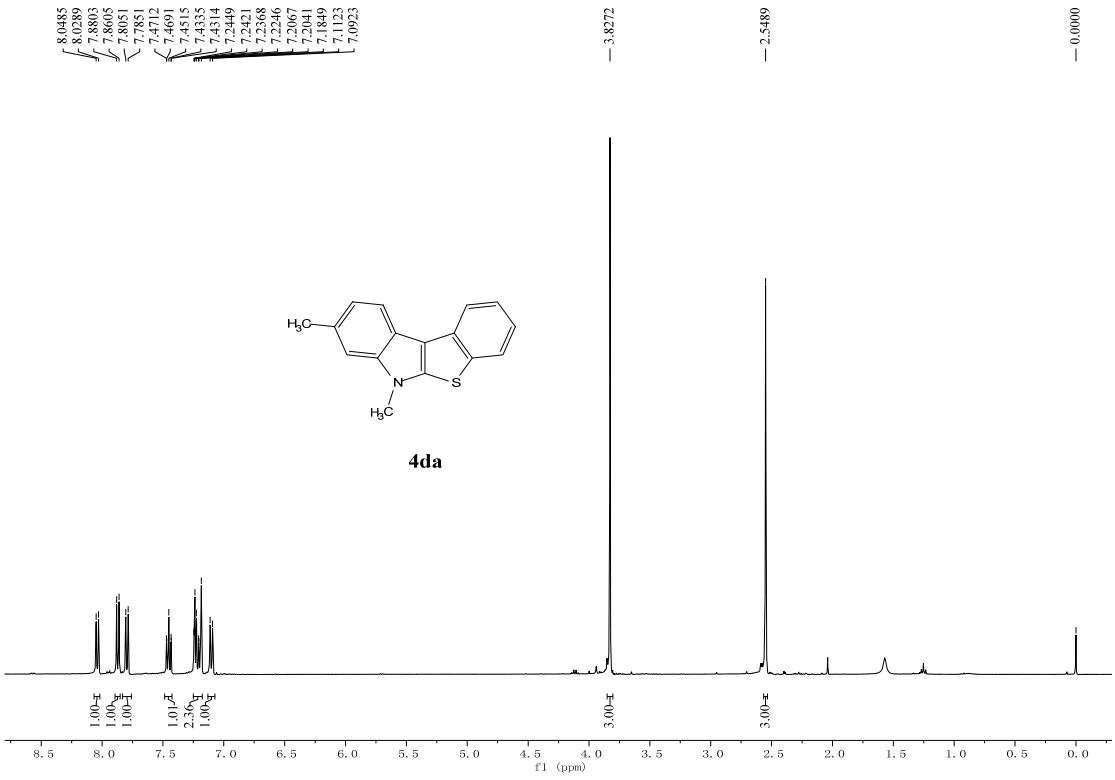
f1 (ppm)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7.2421
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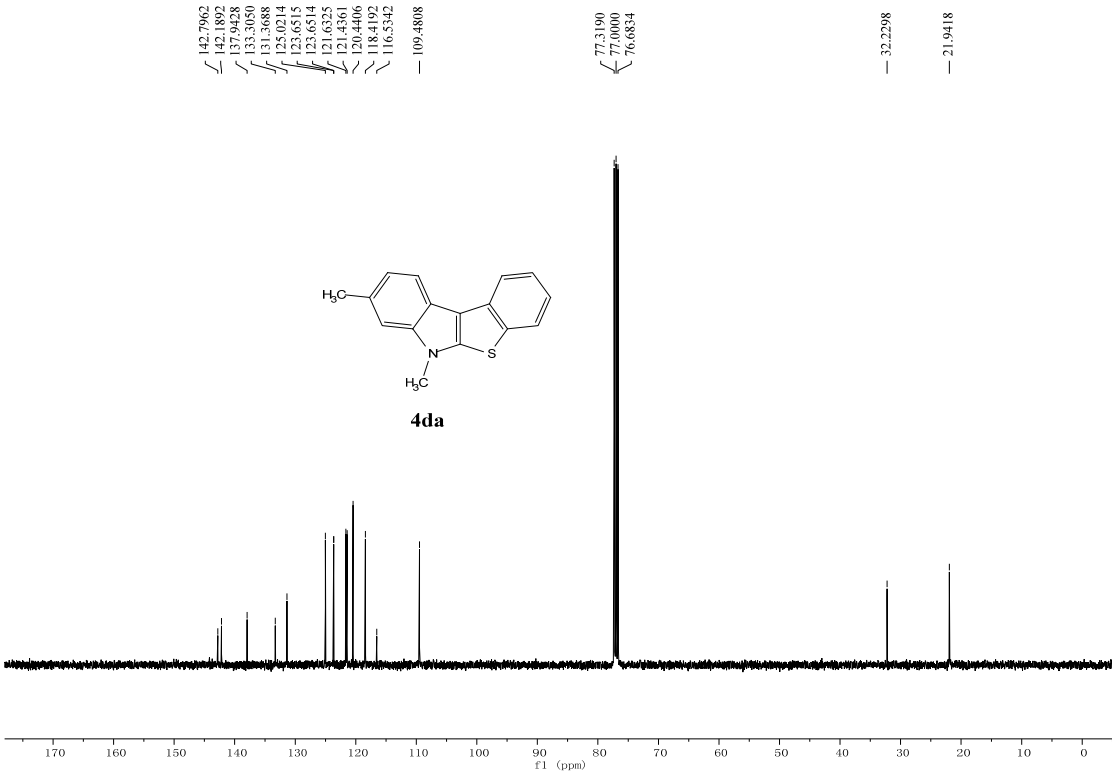
7.2041
7.1849
7.1123
7.0923
3.8272
2.5489
0.0000
1.00
1.00
1.00
1.01
2.36
1.00
3.00
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

H3C
N
S
H3C

4da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123.6515
123.6514
121.6325
121.4361
120.4406
118.4192
116.5342
109.4808
77.3190
77.0000
76.6834
32.2298
21.9418
170
160
150
140
130
120
110
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50
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30
20
10
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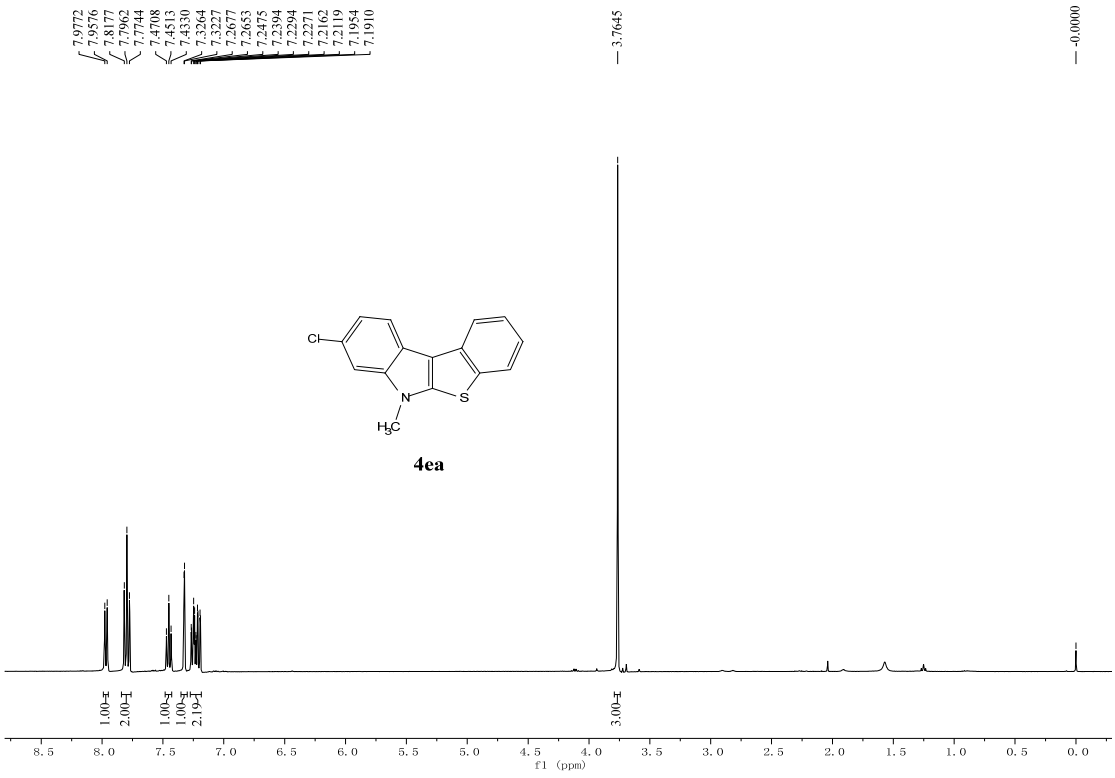
f1 (ppm)

H3C
N
S
H3C

4da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7.2653
7.2475
7.2394
7.2294
7.2271
7.2162
7.2119
7.1954
7.1910
3.7645
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S
H3C
4ea
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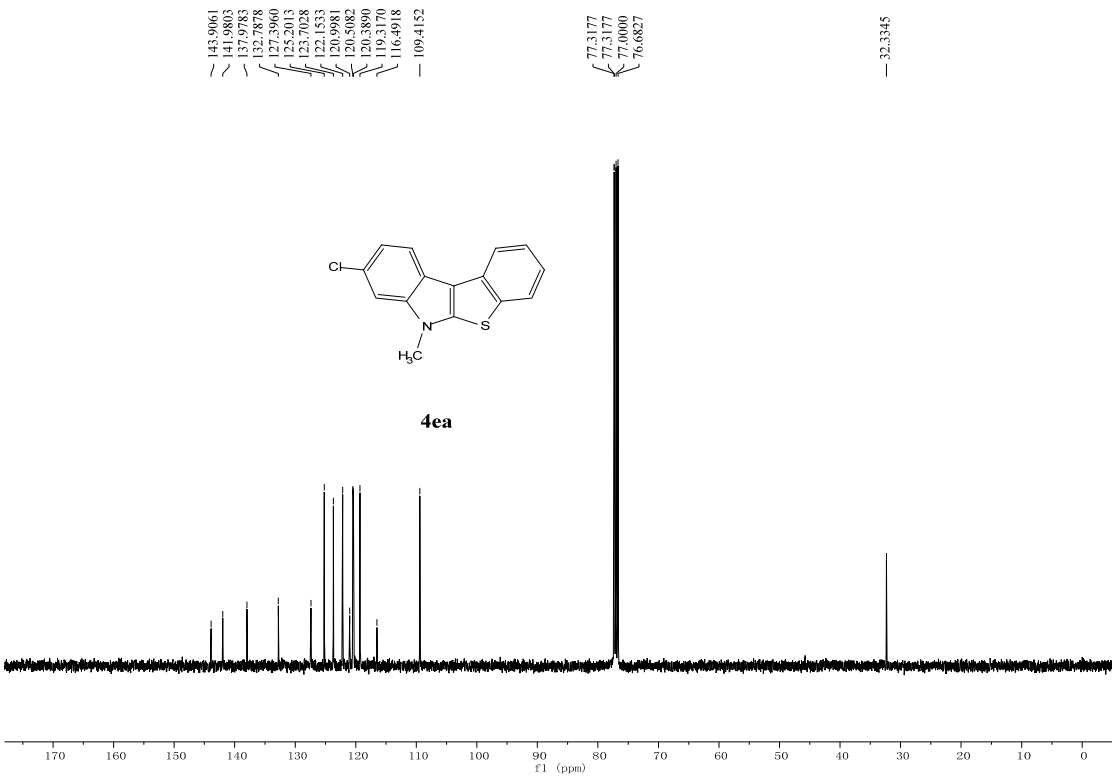
3.00
f1 (ppm)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116.4918
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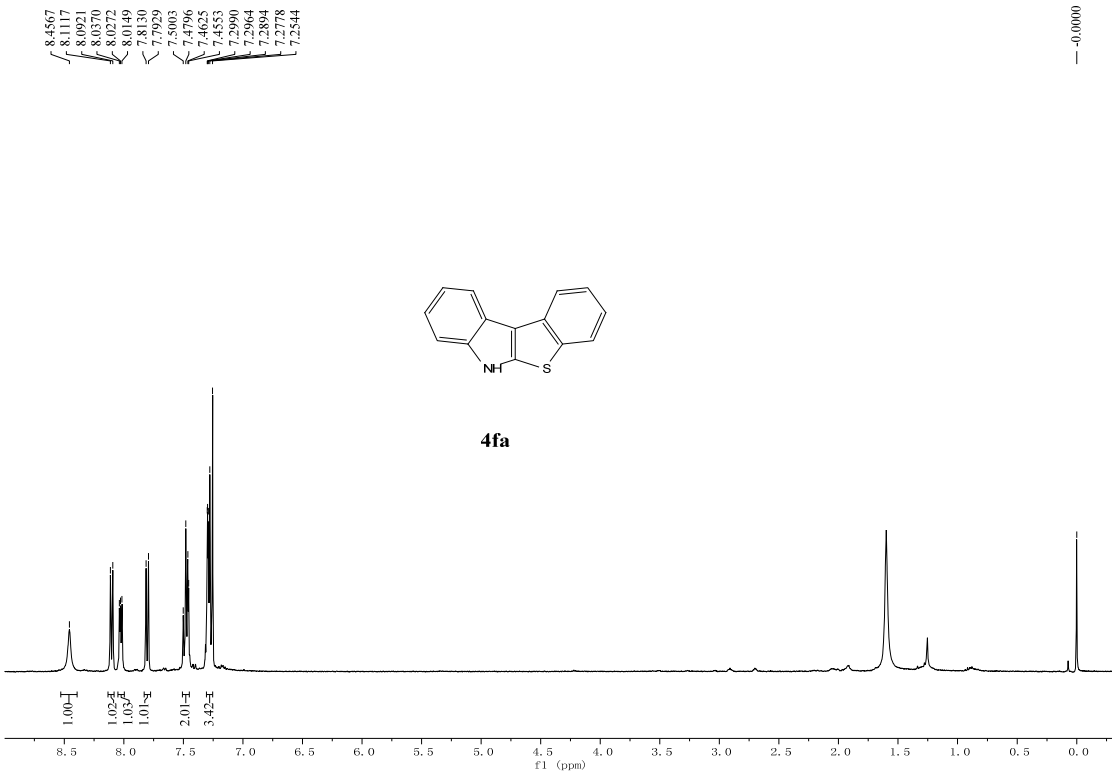
Cl
N
S
H3C
4ea
f1 (ppm)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S
4fa
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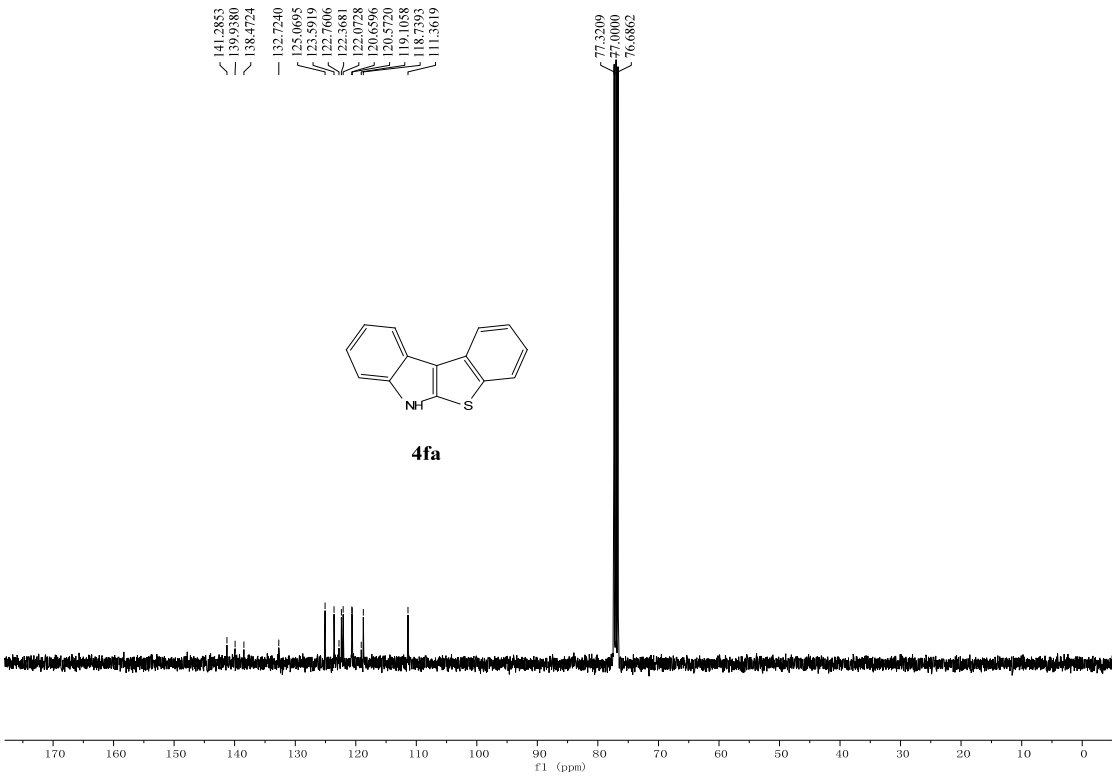
1.03
1.01
2.01
3.42
f1 (ppm)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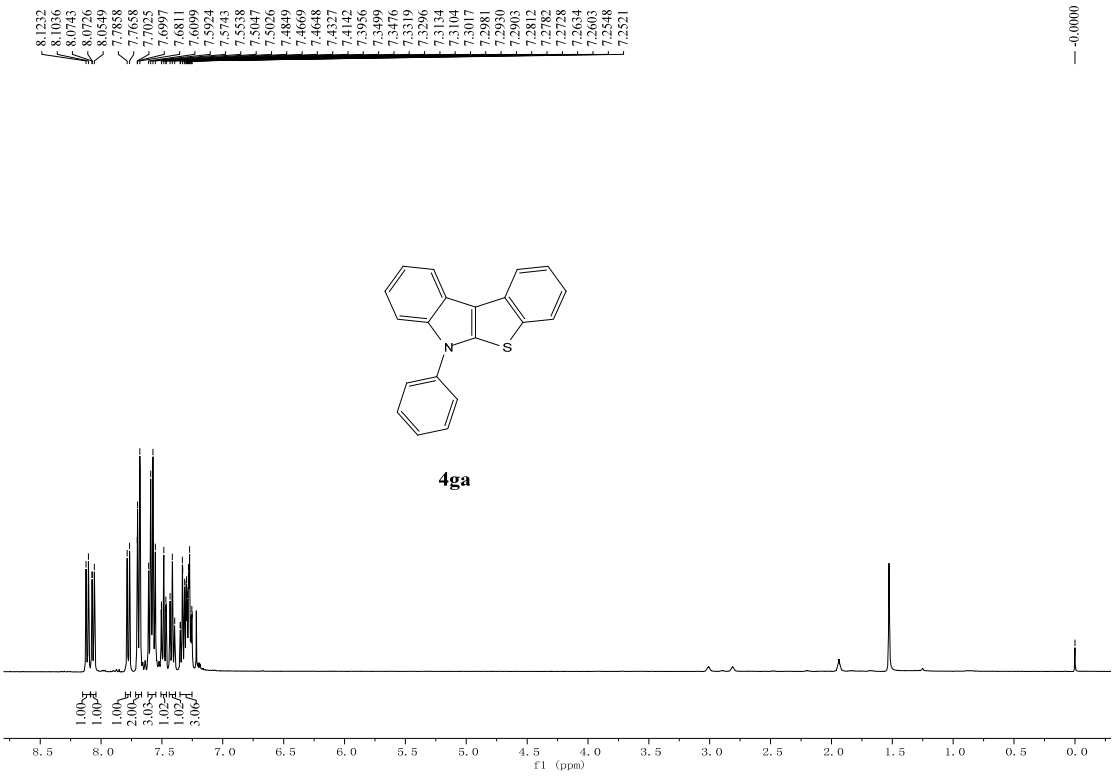
NH
S
4fa
f1 (ppm)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7.5924
7.5743
7.5538
7.5047
7.5026
7.4849
7.4669
7.4648
7.4327
7.4142
7.3956
7.3499
7.3476
7.3319
7.3296
7.3134
7.3104
7.3017
7.2981
7.2930
7.2903
7.2812
7.2782
7.2728
7.2634
7.2603
7.2548
7.2521
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4ga
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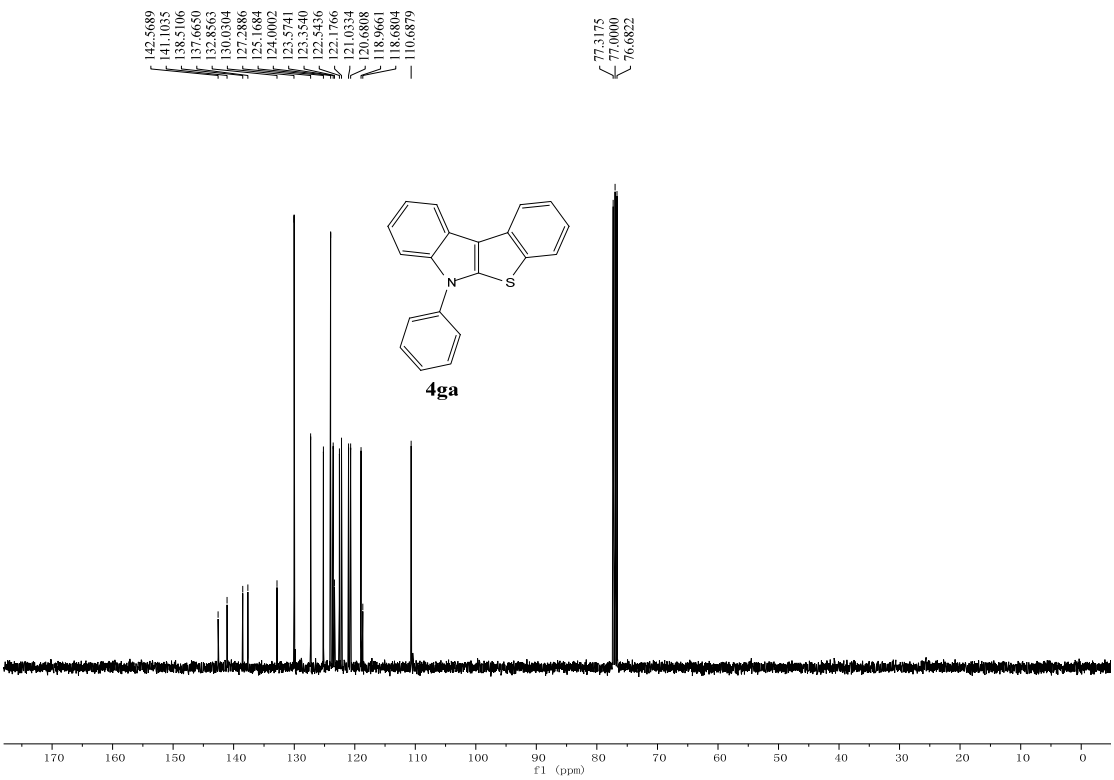
1.00
1.00
2.00
3.03
1.02
1.02
3.06
f1 (ppm)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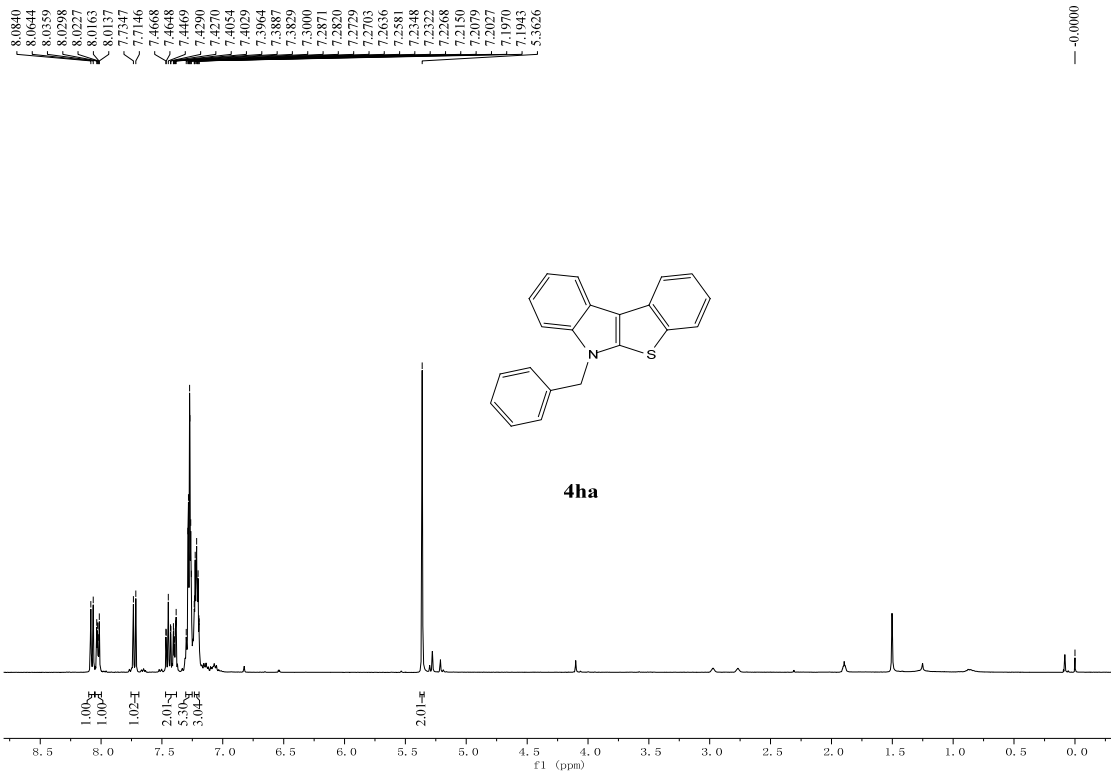
4ga
f1 (ppm)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7.4648
7.4469
7.4290
7.4270
7.4054
7.4029
7.3964
7.3887
7.3829
7.3000
7.2871
7.2820
7.2729
7.2703
7.2636
7.2581
7.2348
7.2322
7.2268
7.2150
7.2079
7.2027
7.1970
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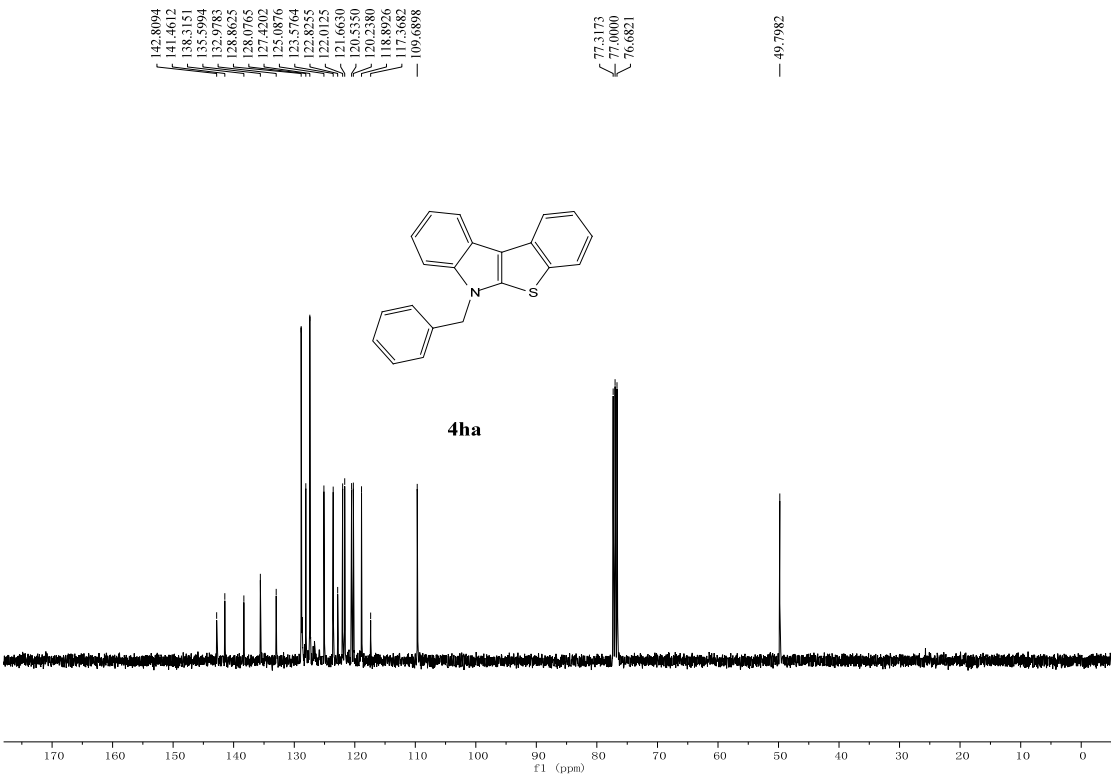
4ha
1.00
1.00
1.02
2.01
5.30
3.04
2.01
f1 (ppm)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122.0125
121.6630
120.5350
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76.6821
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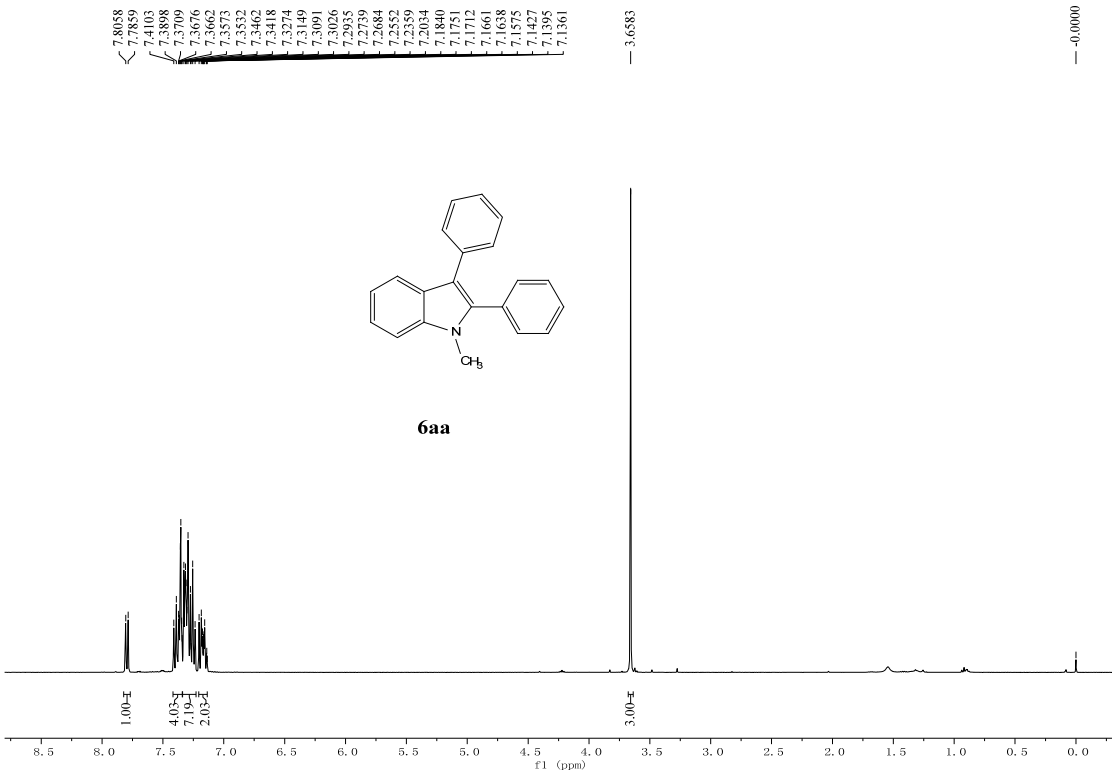
4ha
f1 (ppm)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7.3532
7.3462
7.3418
7.3274
7.3149
7.3091
7.3026
7.2935
7.2739
7.2684
7.2552
7.2359
7.2034
7.1840
7.1751
7.1712
7.1661
7.1638
7.1575
7.1427
7.1395
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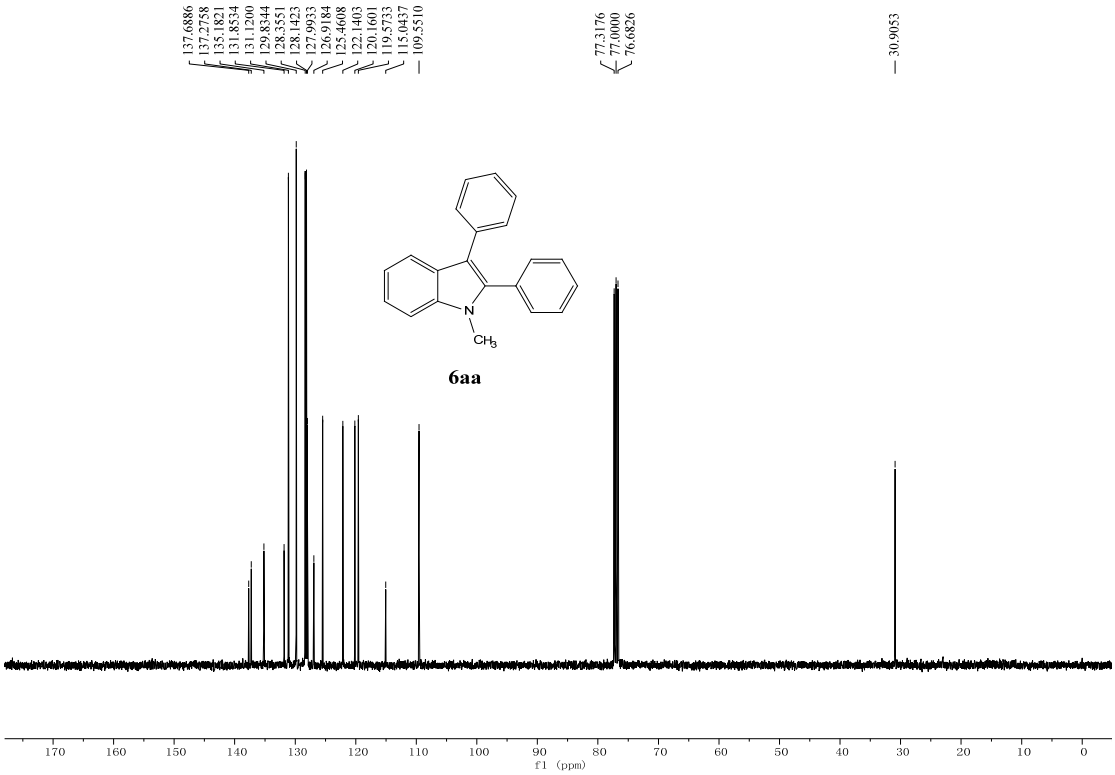
-0.0000
N
CH3
1.00
4.03
7.19
2.03
3.00
f1 (ppm)

6aa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128.1423
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126.9184
125.4608
122.1403
120.1601
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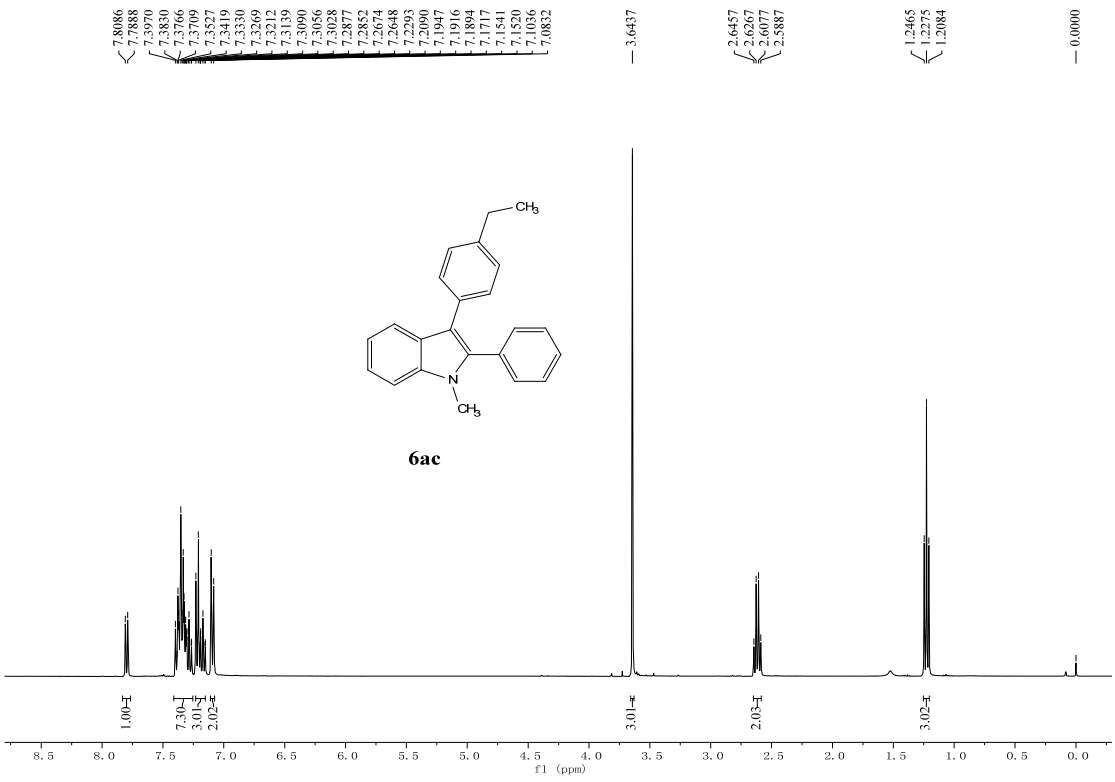
109.5510
77.3176
77.0000
76.6826
30.9053
N
CH3
f1 (ppm)

6aa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7.3139
7.3090
7.3056
7.3028
7.2877
7.2852
7.2674
7.2648
7.2293
7.2090
7.1947
7.1916
7.1894
7.1717
7.1541
7.1520
7.1036
7.0832
3.6437
2.6457
2.6267
2.6077
2.5887
1.2465
1.2275
1.2084
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CH3
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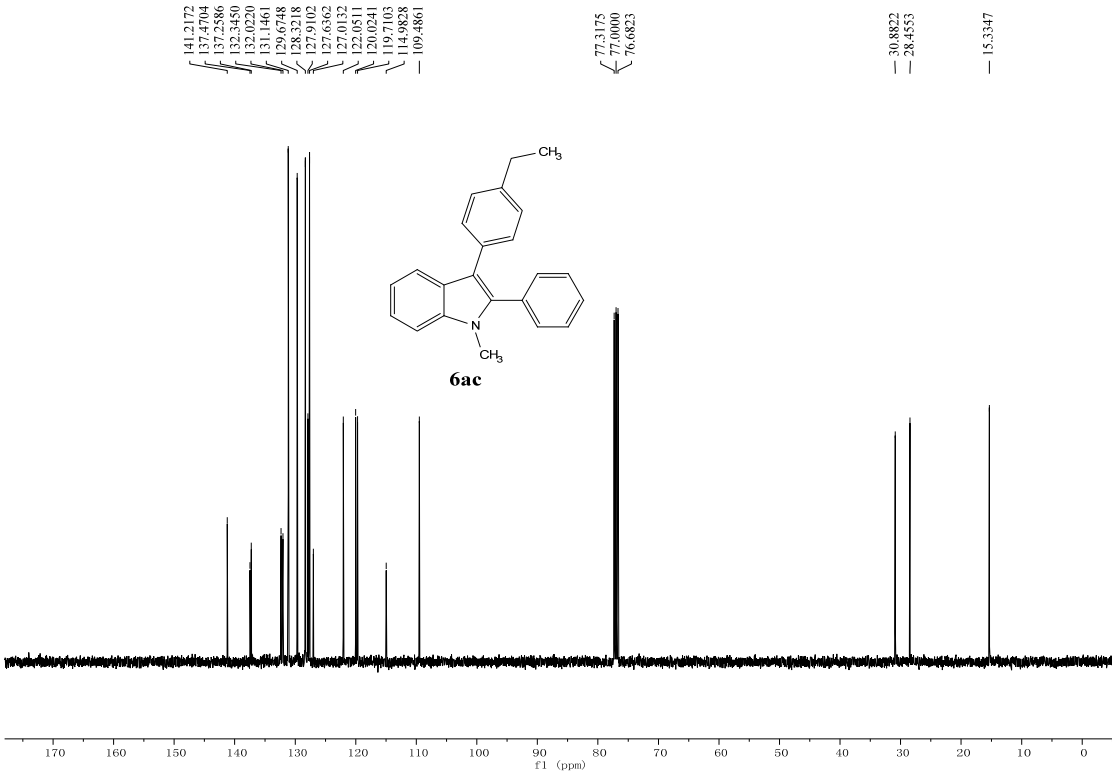
CH3
1.00
7.30
3.01
2.02
3.01
2.03
3.02
f1 (ppm)

6ac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122.0511
120.0241
119.7103
114.9828
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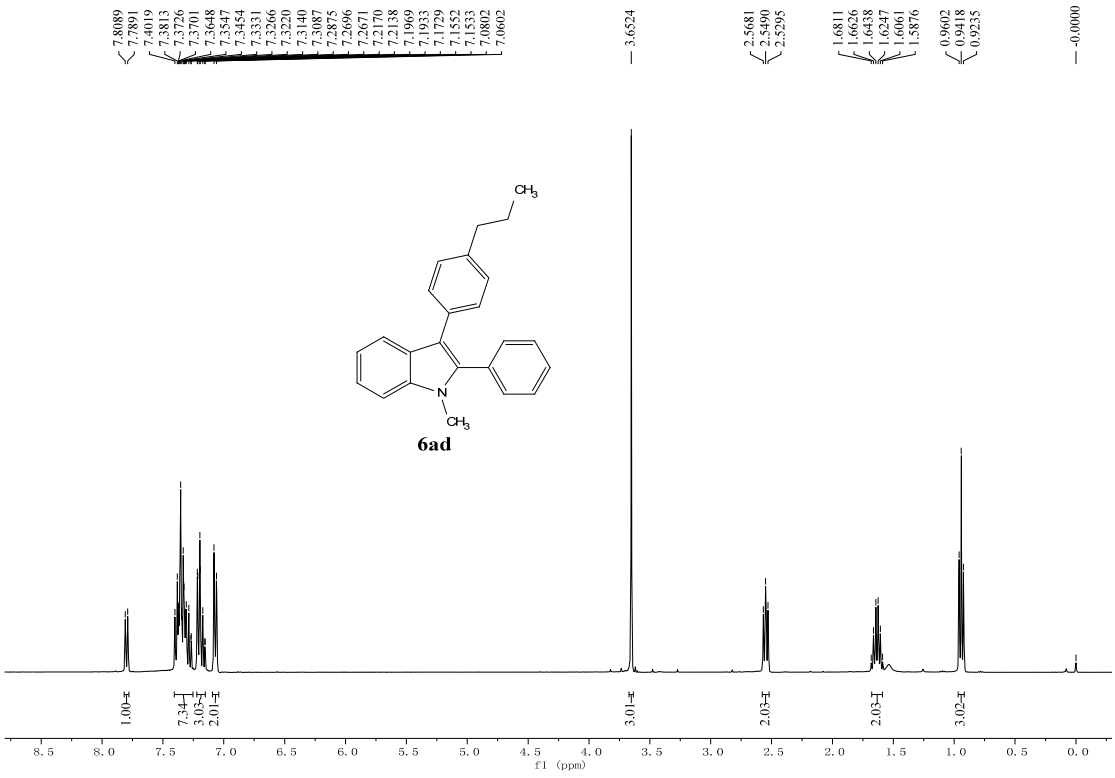
CH3
N
CH3
f1 (ppm)

6ac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7.3087
7.2875
7.2696
7.2671
7.2170
7.2138
7.1969
7.1933
7.1729
7.1552
7.1533
7.0802
7.0602
3.6524
2.5681
2.5490
2.5295
1.6811
1.6626
1.6438
1.6247
1.6061
1.5876
0.9602
0.9418
0.9235
-0.0000
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CH3
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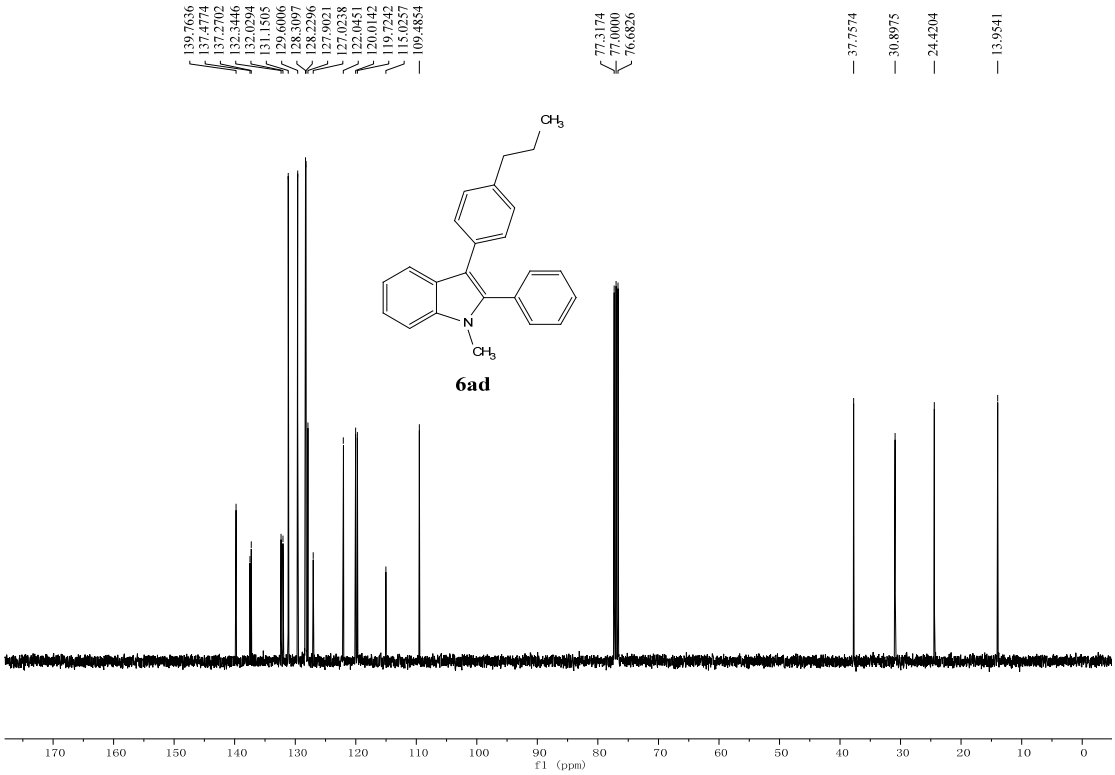
1.00
7.34
3.03
2.01
3.01
2.03
2.03
3.02
f1 (ppm)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122.0451
120.0142
119.7242
115.0257
109.4854
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CH3
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CH3
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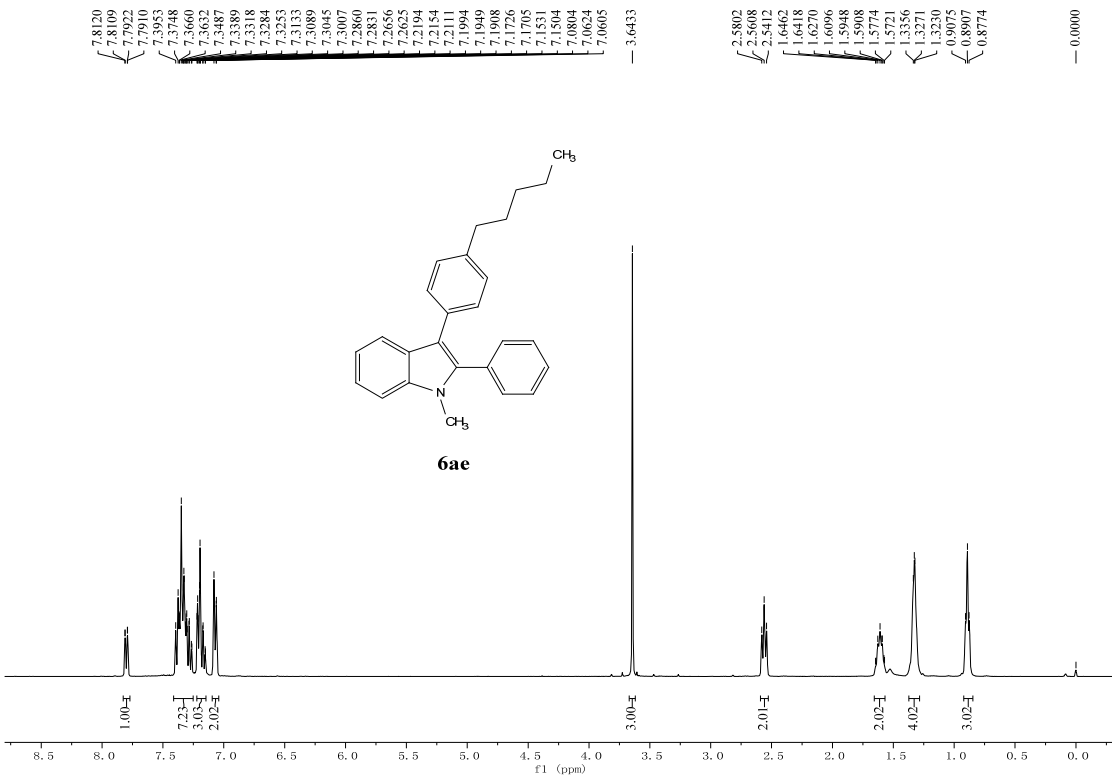
f1 (ppm)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7.3284
7.3253
7.3133
7.3089
7.3045
7.3007
7.2860
7.2831
7.2656
7.2625
7.2194
7.2154
7.2111
7.1994
7.1949
7.1908
7.1726
7.1705
7.1531
7.1504
7.0804
7.0624
7.0605
3.6433
2.5802
2.5608
2.5412
1.6462
1.6418
1.6270
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1.5948
1.5908
1.5774
1.5721
1.3356
1.3271
1.3230
0.9075
0.8907
0.8774
0.0000
CH3
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CH3
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3.00
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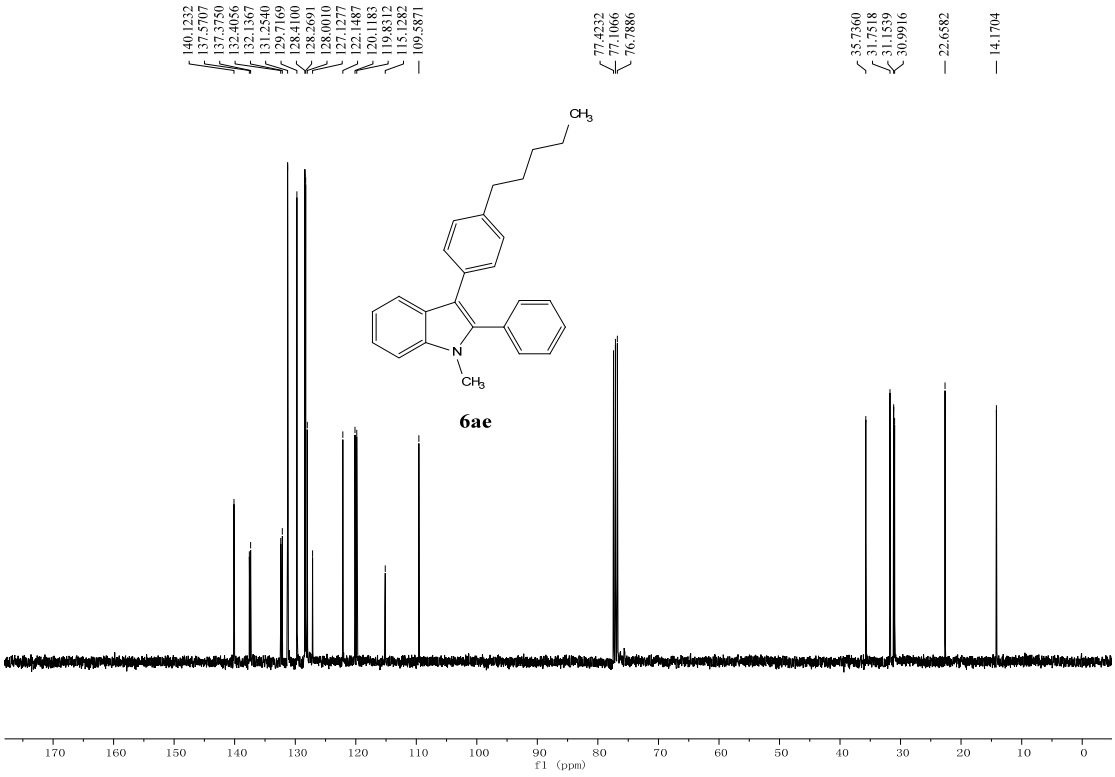
2.02
4.02
3.02
f1 (ppm)

6ae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120.1183
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115.1282
109.5871
77.4232
77.1066
76.7886
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22.6582
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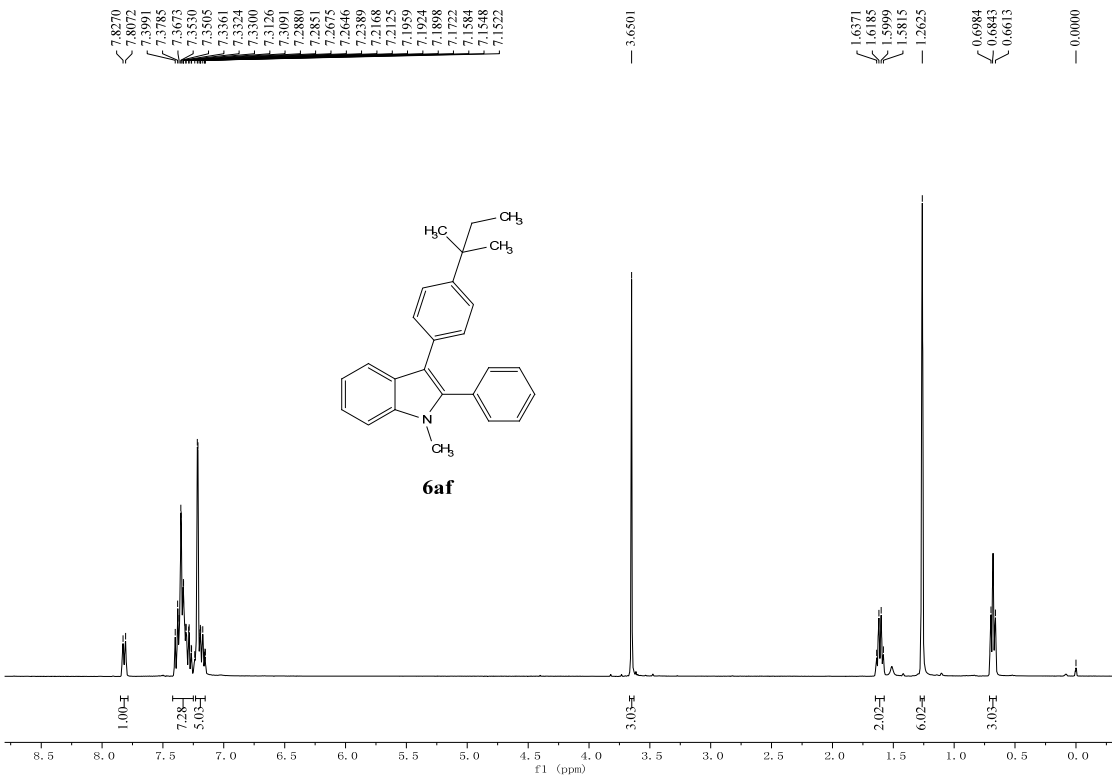
CH3
N
CH3
f1 (ppm)

6ae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7.3091
7.2880
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7.1924
7.1898
7.1722
7.1584
7.1548
7.1522
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1.6371
1.6185
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3.03
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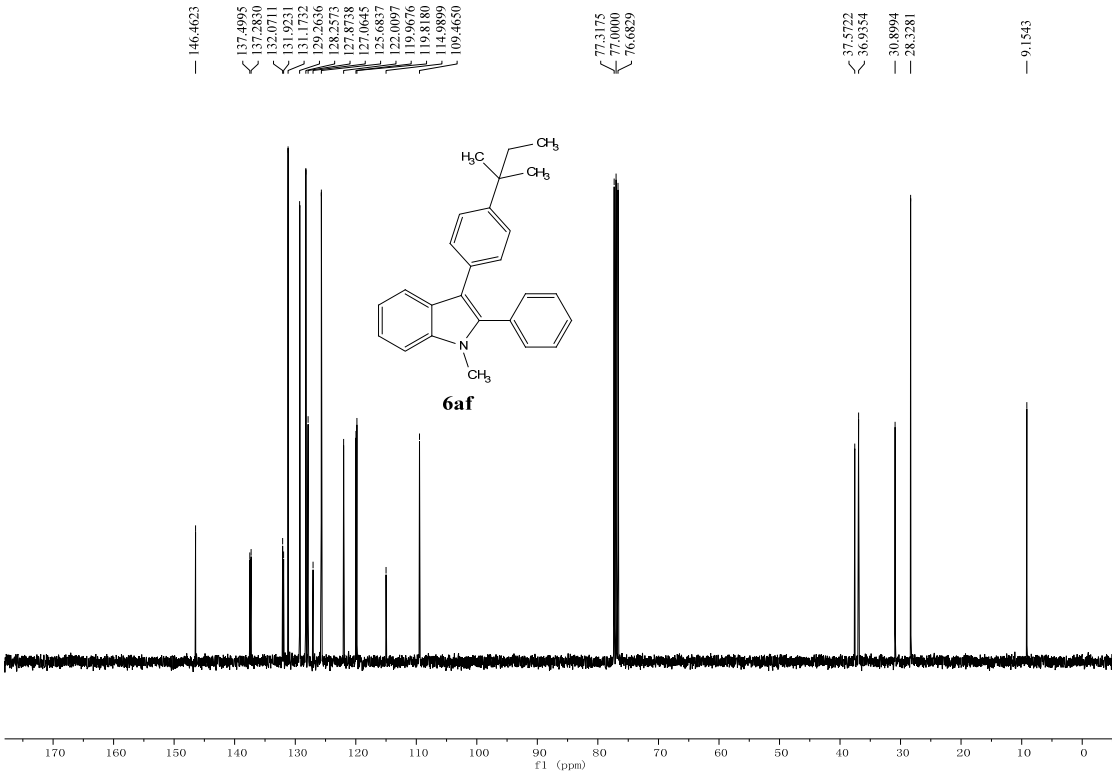
f1 (ppm)

6af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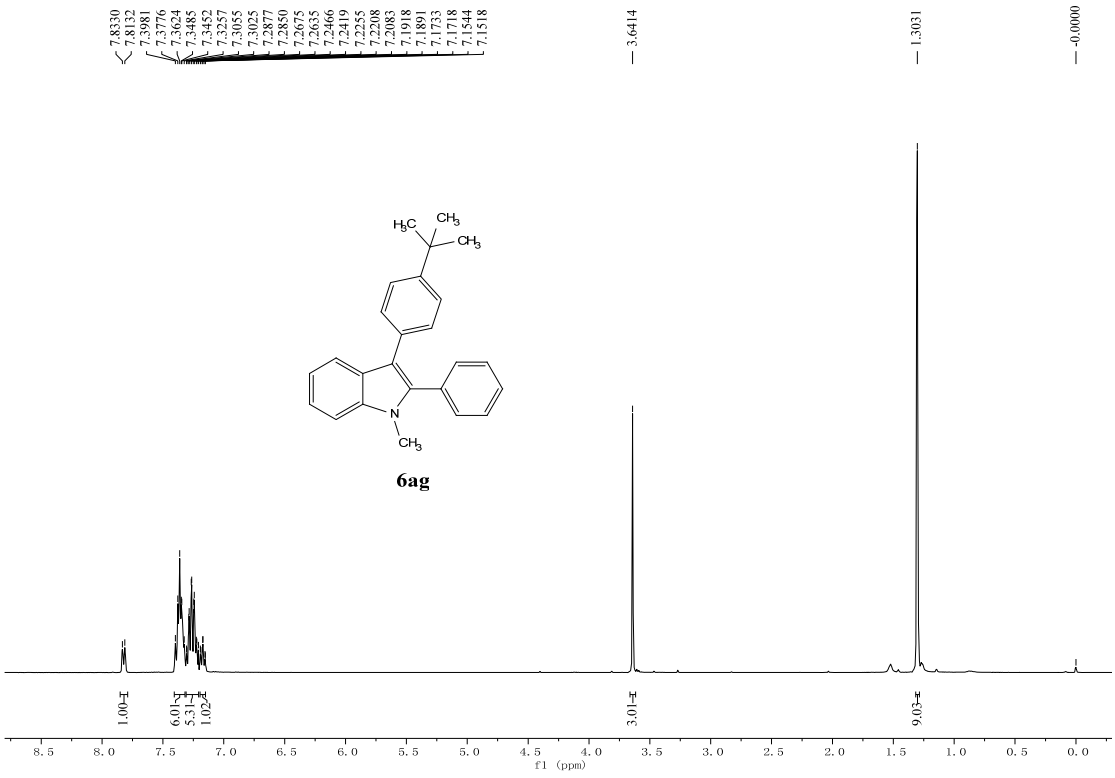
f1 (ppm)

6af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7.2850
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7.2635
7.2466
7.2419
7.2255
7.2208
7.2083
7.1918
7.1891
7.1733
7.1718
7.1544
7.1518
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5.31
1.02
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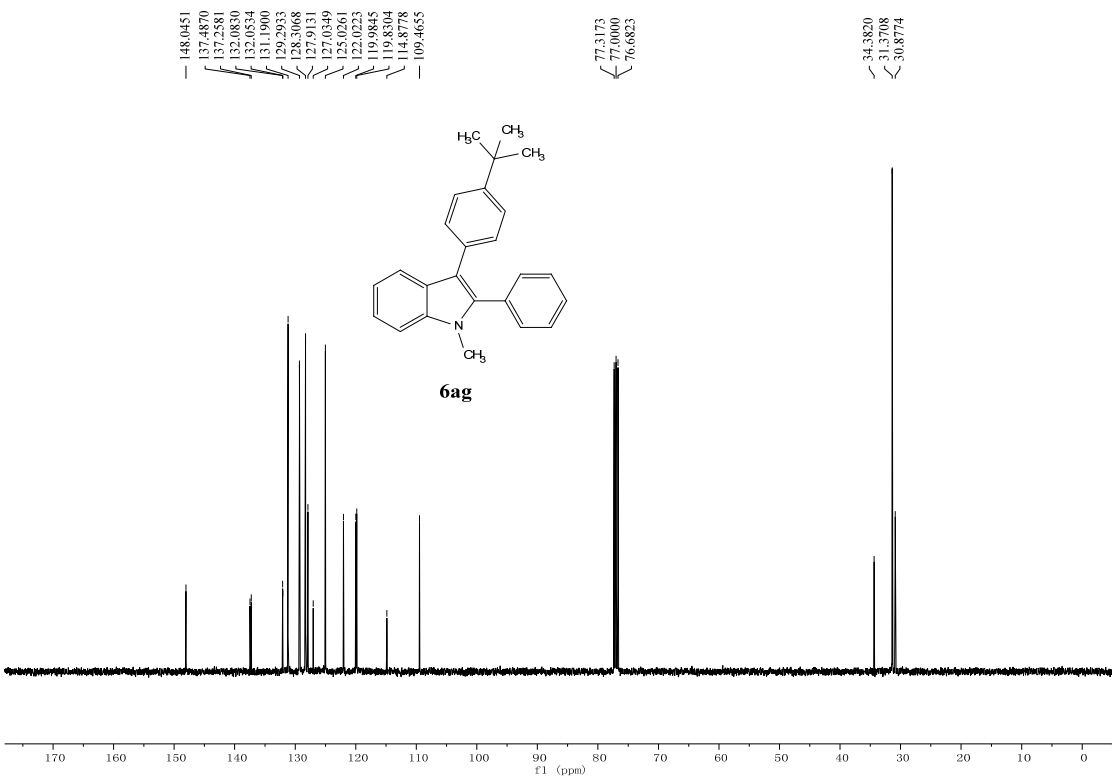
9.03
f1 (ppm)

6ag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122.0223
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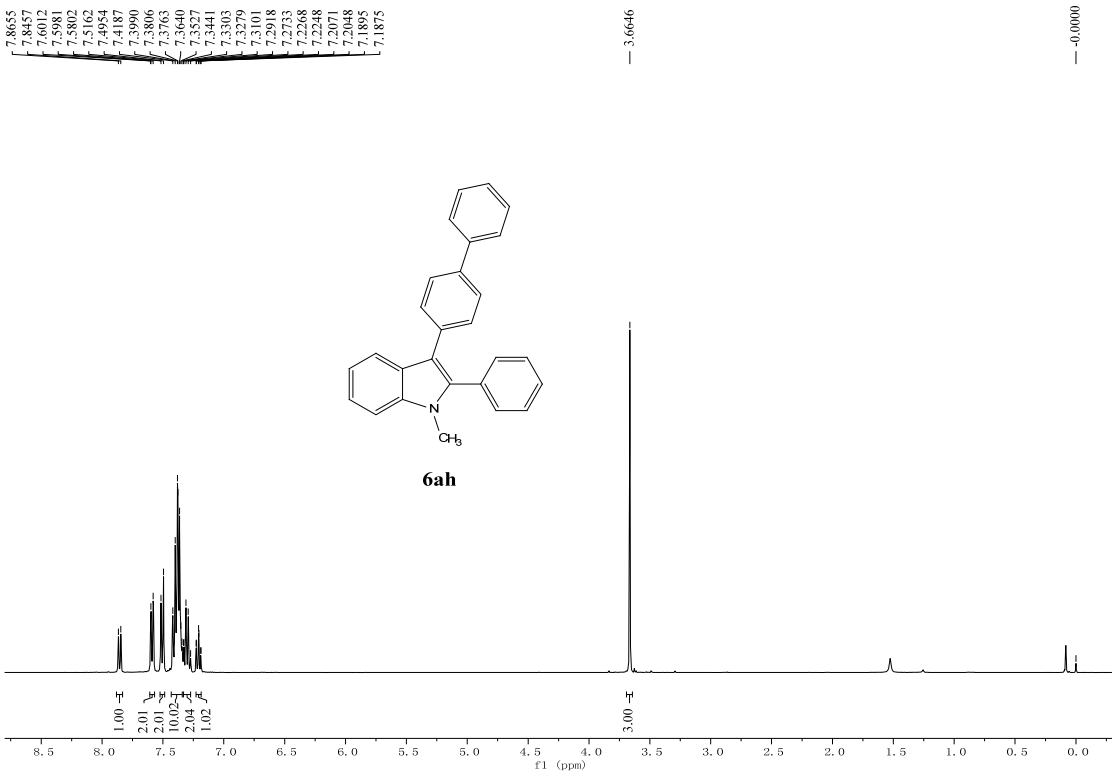
f1 (ppm)

6ag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7.3527
7.3441
7.3303
7.3279
7.3101
7.2918
7.2733
7.2268
7.2248
7.2071
7.2048
7.1895
7.1875
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6ah
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2.01
10.02
2.04
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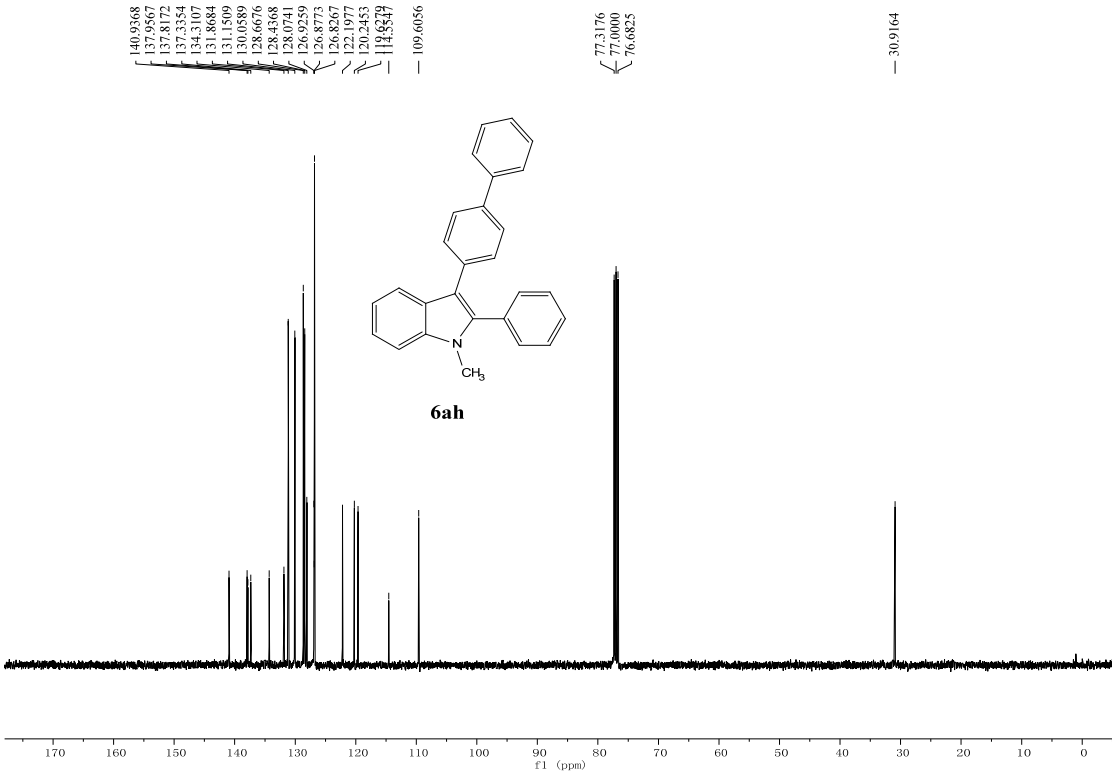
3.00
f1 (ppm)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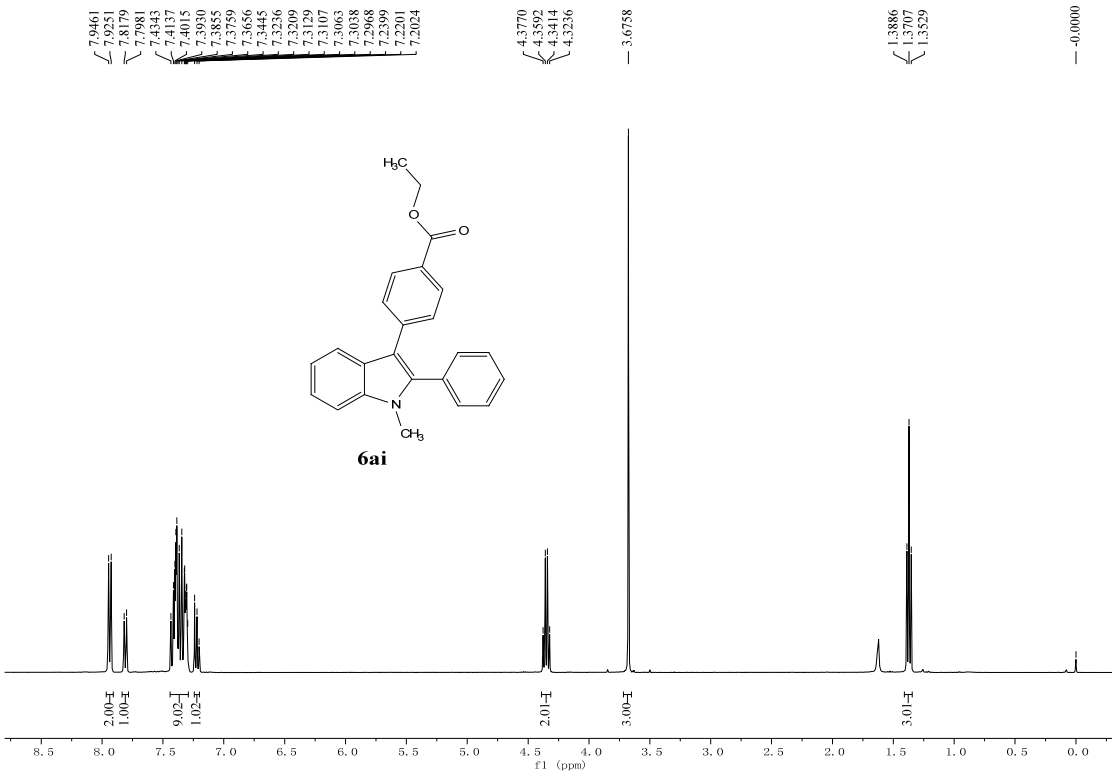
6ah
f1 (ppm)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7.3129
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7.3063
7.3038
7.2968
7.2399
7.2201
7.2024
4.3770
4.3592
4.3414
4.3236
3.6758
1.3886
1.3707
1.3529
-0.0000
H3C
O
O
N
CH3
6ai
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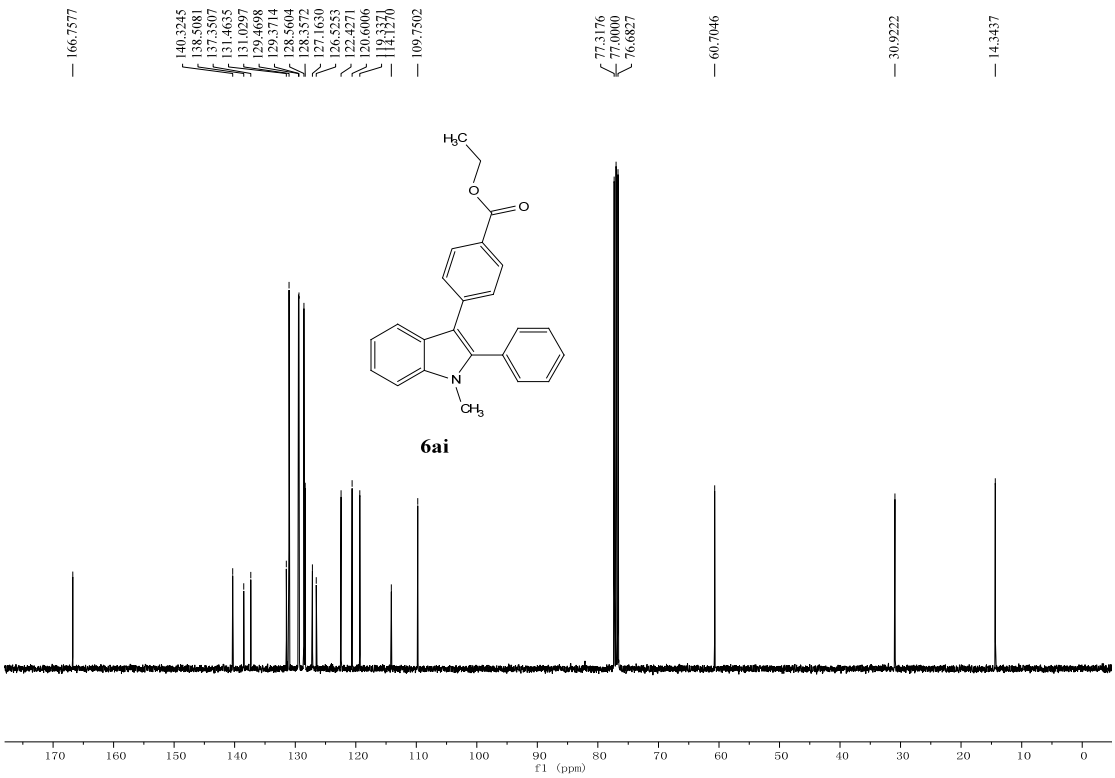
1.02
2.01
3.00
3.01
f1 (ppm)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77.0000
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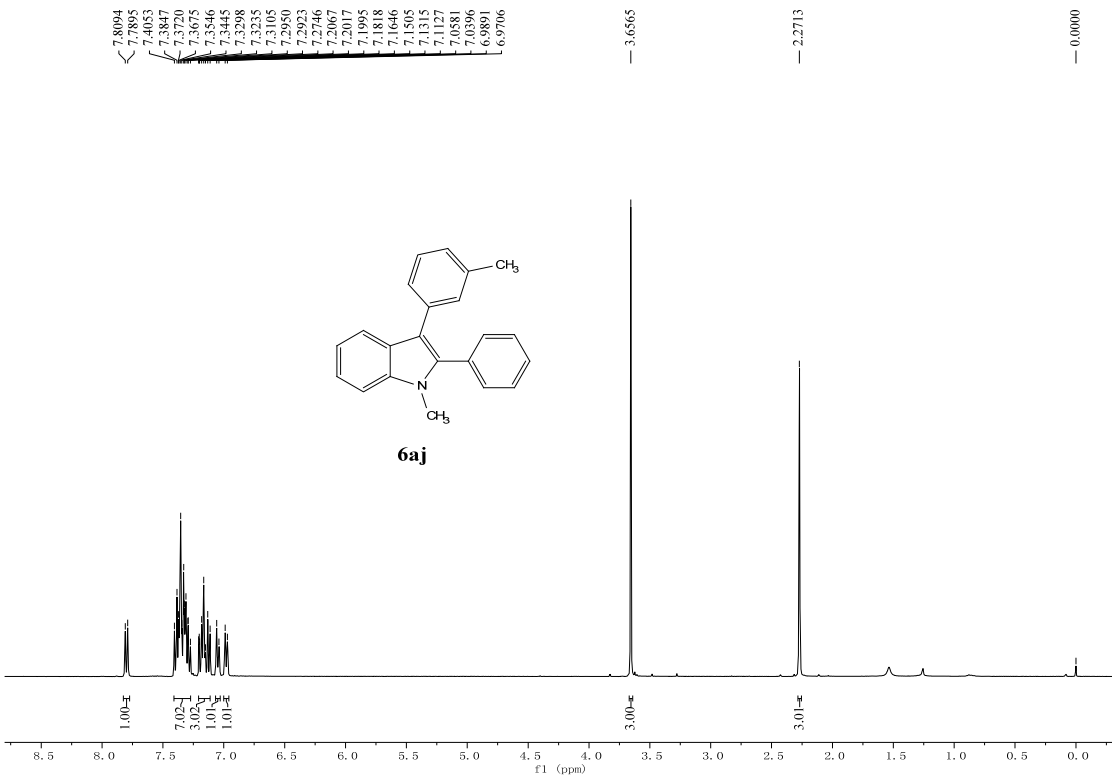
60.7046
30.9222
14.3437
H3C
O
O
N
CH3
6ai
f1 (ppm)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7.3105
7.2950
7.2923
7.2746
7.2067
7.2017
7.1995
7.1818
7.1646
7.1505
7.1315
7.1127
7.0581
7.0396
6.9891
6.9706
3.6565
2.2713
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CH3
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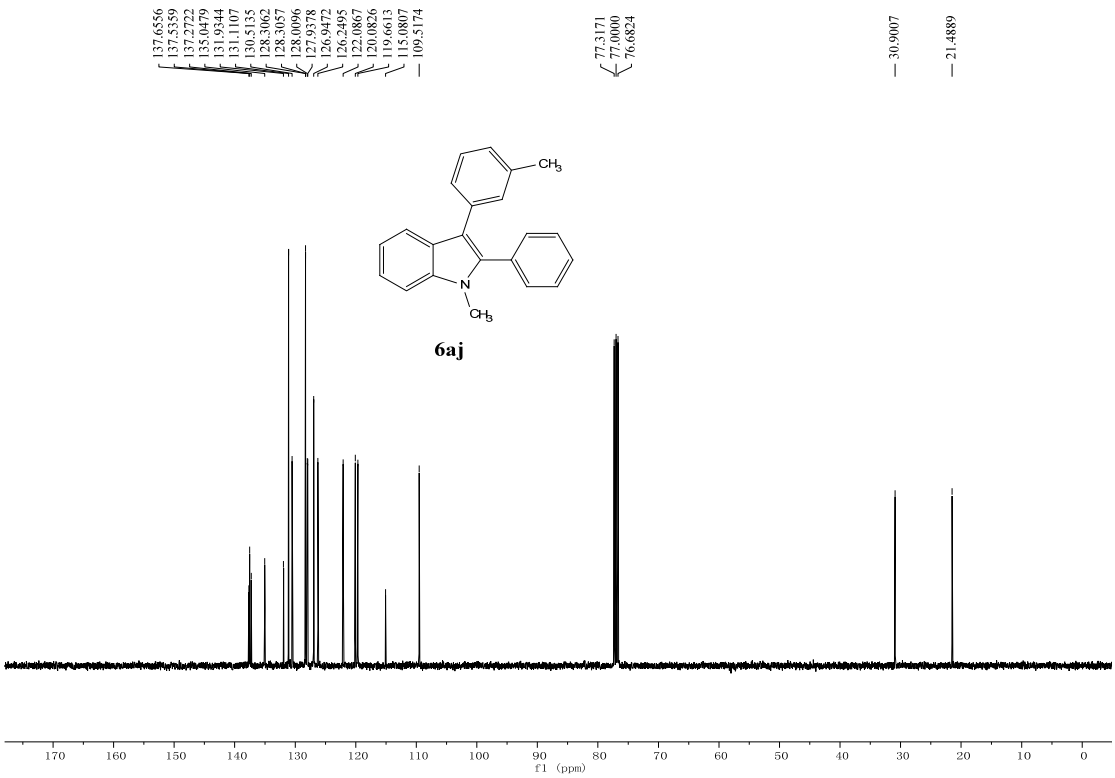
3.02
1.01
1.01
3.00
3.01
f1 (ppm)

6aj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122.0867
120.0826
119.6613
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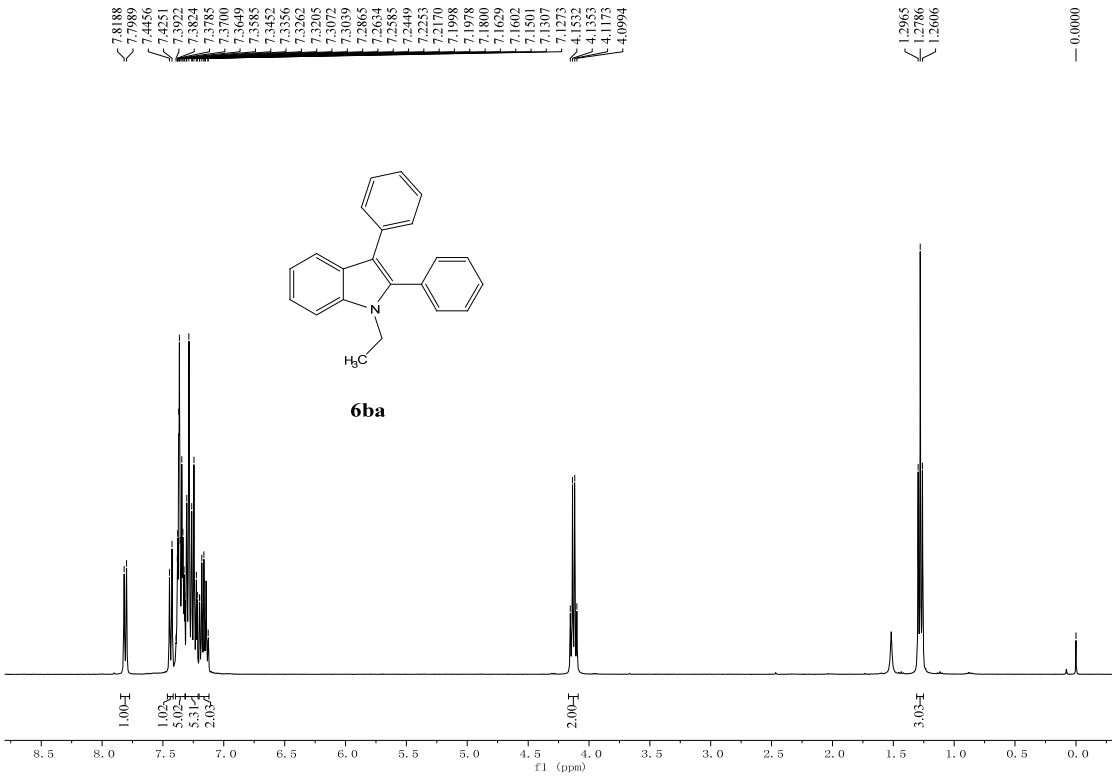
CH3
f1 (ppm)

6aj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7.3072
7.3039
7.2865
7.2634
7.2585
7.2449
7.2253
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7.1978
7.1800
7.1629
7.1602
7.1501
7.1307
7.1273
4.1532
4.1353
4.1173
4.0994
1.2965
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1.2606
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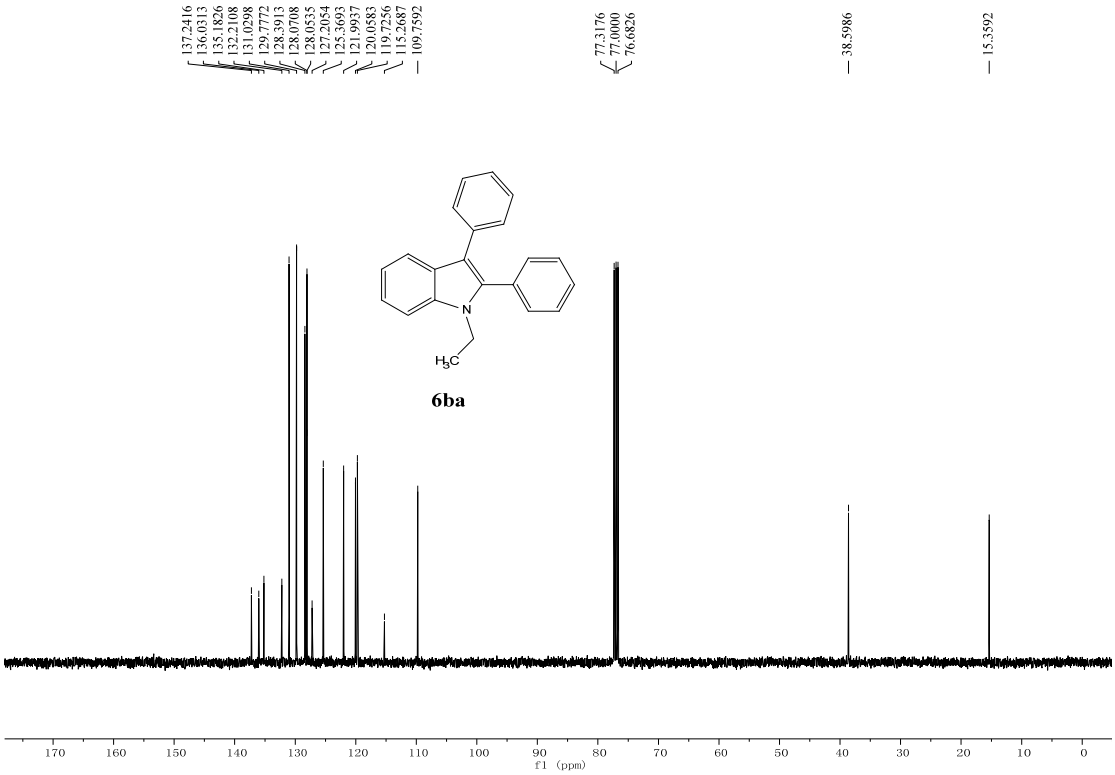
1.02
5.02
5.31
2.03
2.00
3.03
f1 (ppm)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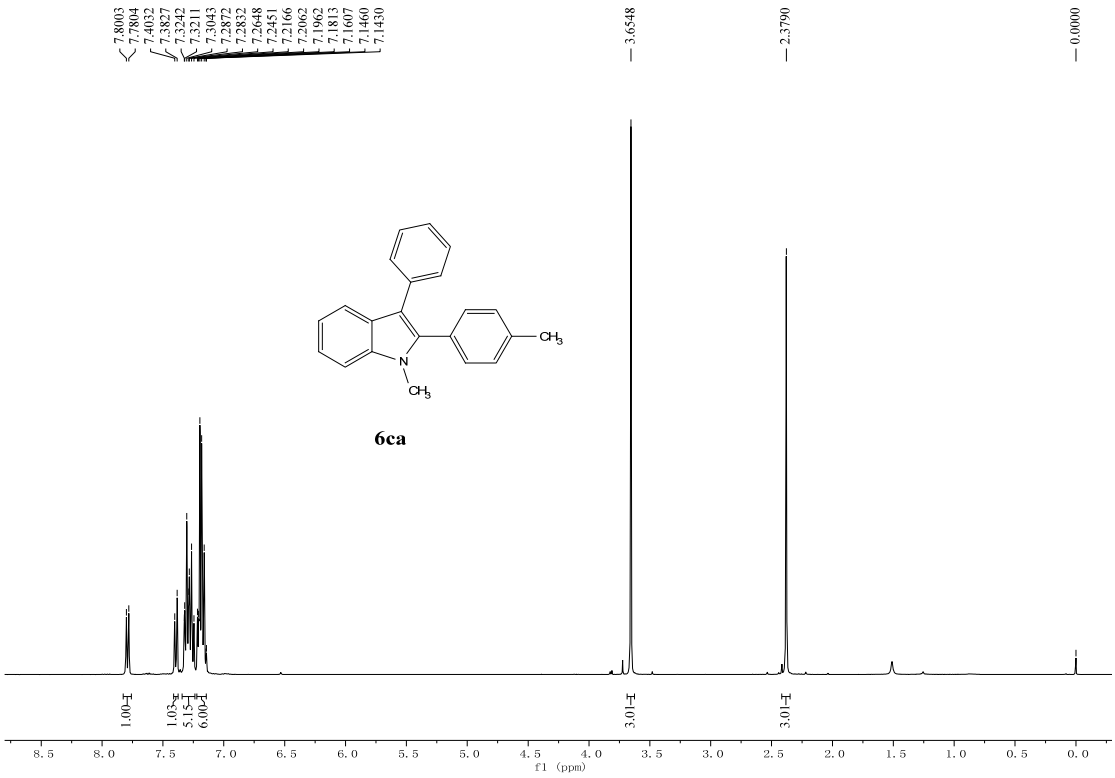
f1 (ppm)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7.2166
7.2062
7.1962
7.1813
7.1607
7.1460
7.1430
3.6548
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N
CH3
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1.03
5.15
6.00
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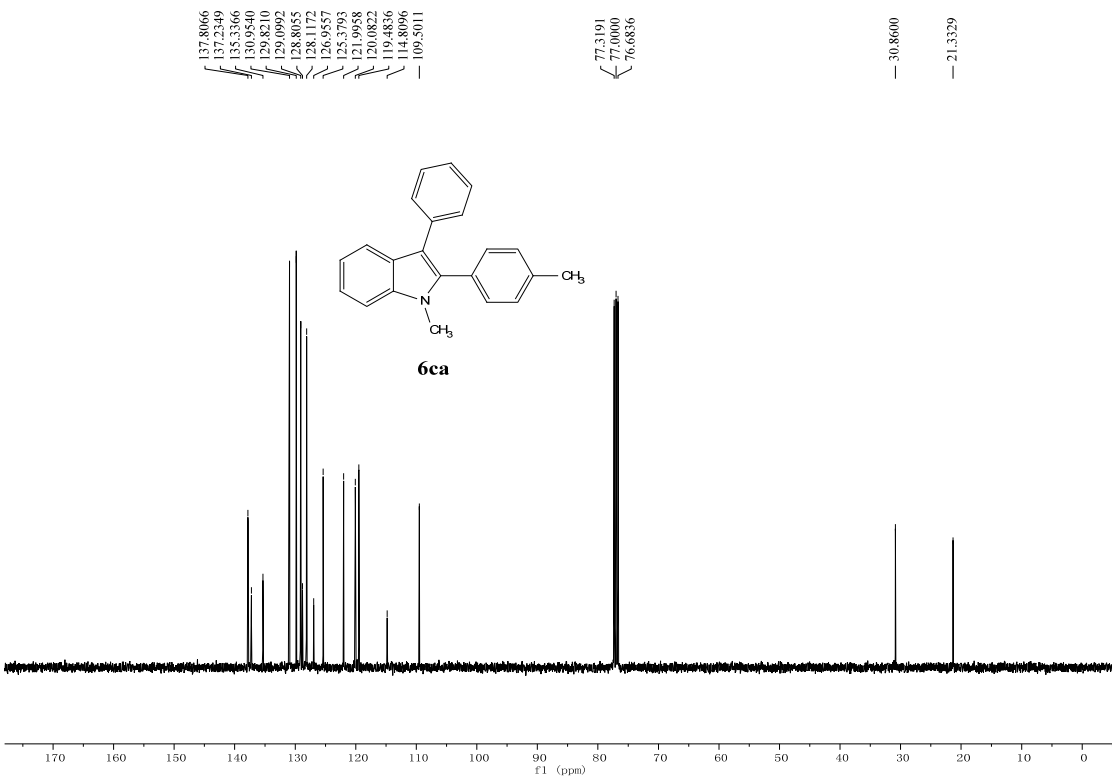
3.01
f1 (ppm)

6ca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CH3
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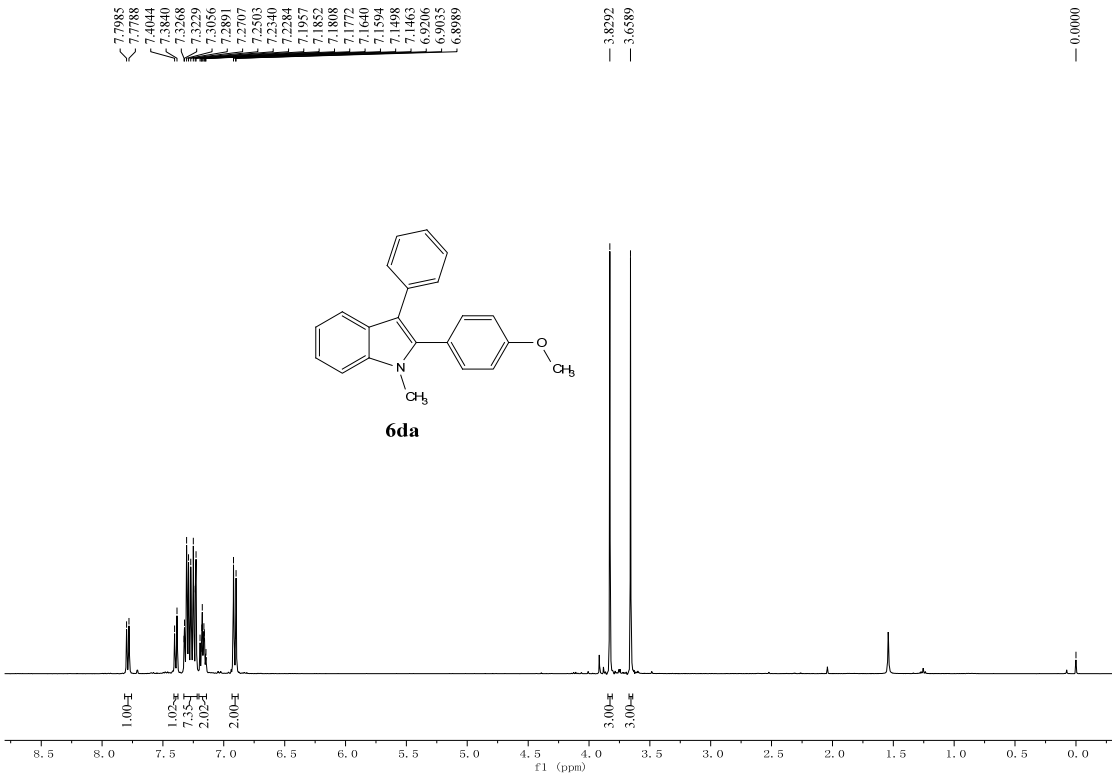
CH3
f1 (ppm)

6ca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7.1957
7.1852
7.1808
7.1772
7.1640
7.1594
7.1498
7.1463
6.9206
6.9035
6.8989
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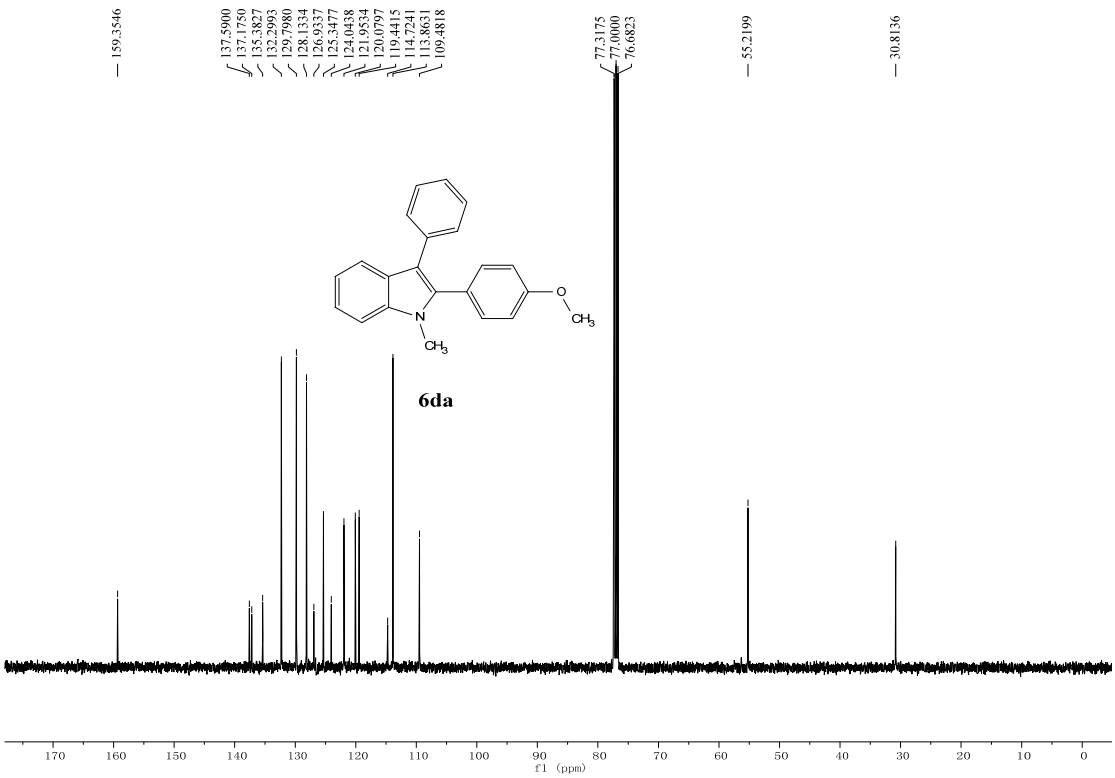
1.02
7.35
2.02
2.00
3.00
3.00
f1 (ppm)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120.0797
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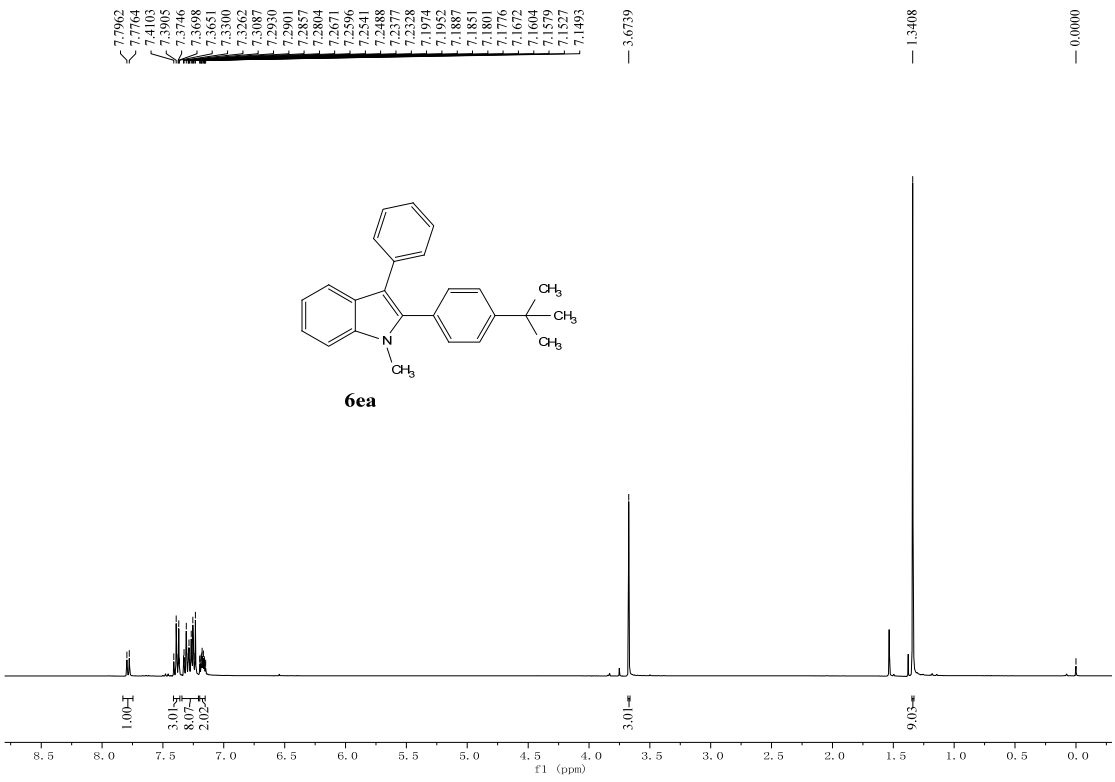
f1 (ppm)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7.2901
7.2857
7.2804
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7.2596
7.2541
7.2488
7.2377
7.2328
7.1974
7.1952
7.1887
7.1851
7.1801
7.1776
7.1672
7.1604
7.1579
7.1527
7.1493
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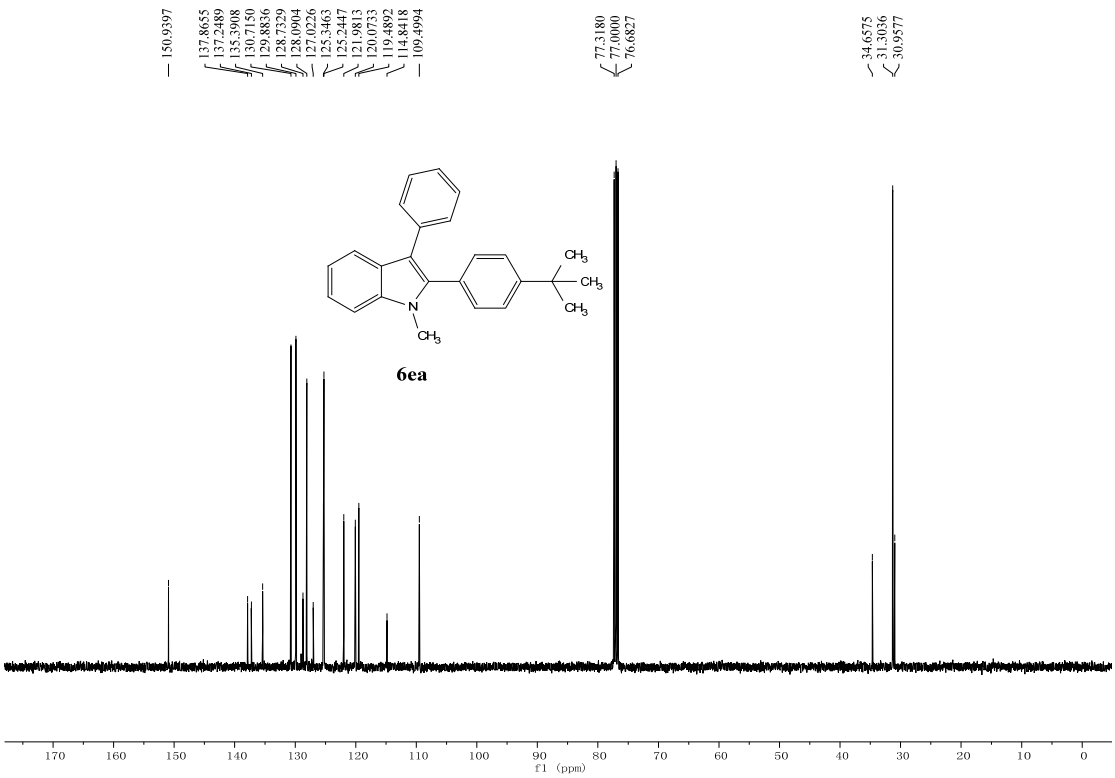
1.00
3.01
8.07
2.02
3.01
9.03
f1 (ppm)

6ea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120.0733
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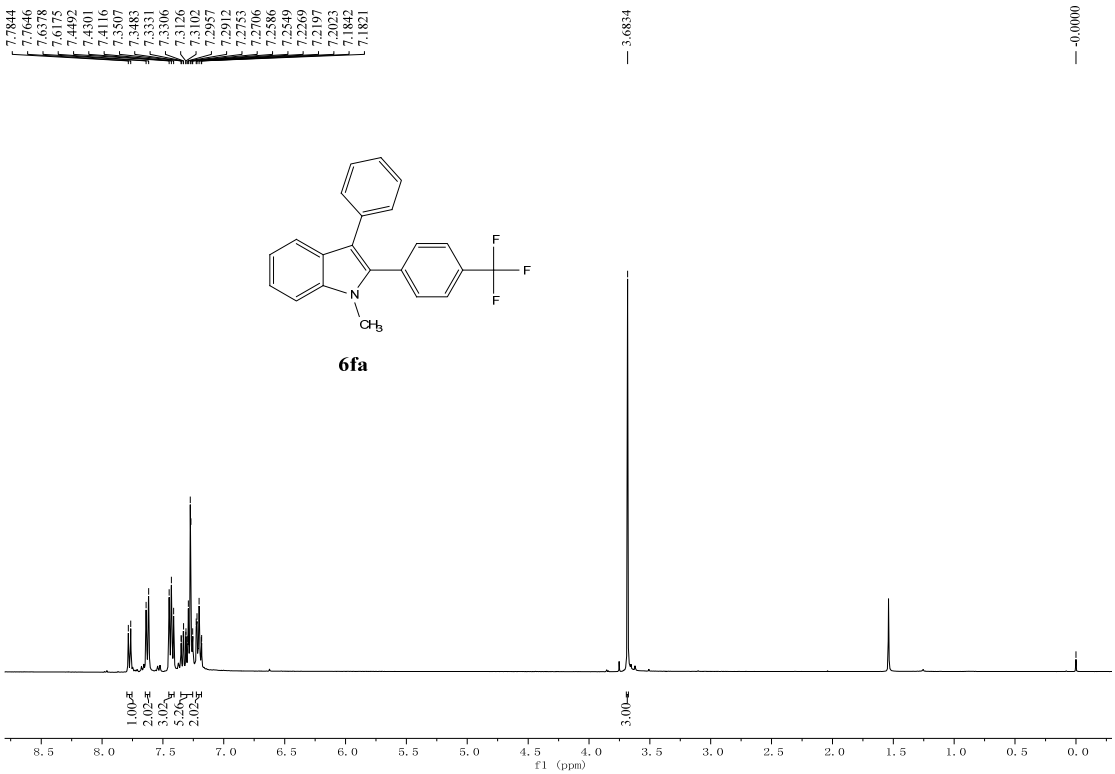
76.6827
34.6575
31.3036
30.9577
f1 (ppm)

6ea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7.2912
7.2753
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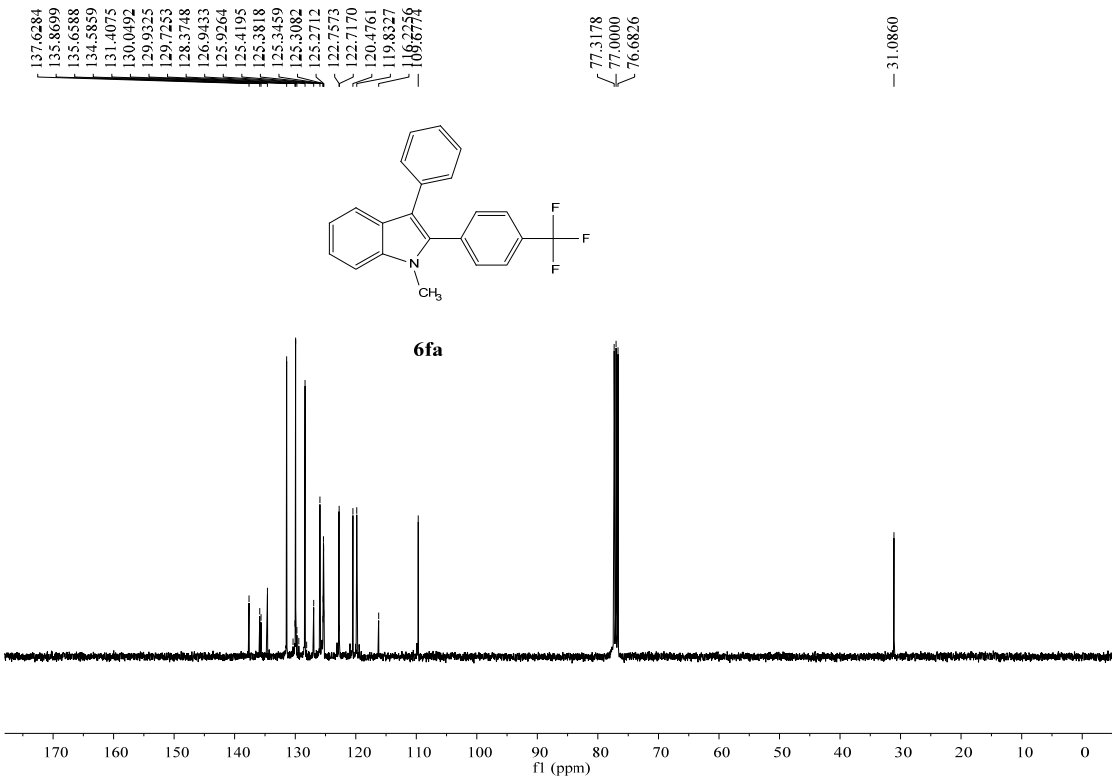
7.2549
7.2269
7.2197
7.2023
7.1842
7.1821
3.6834
-0.0000
F
F
F
N
CH3
1.00
2.02
3.02
5.26
2.02
3.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

6fa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120.4761
119.8327
116.2256
110.6774
77.3178
77.0000
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F
F
F
N
CH3
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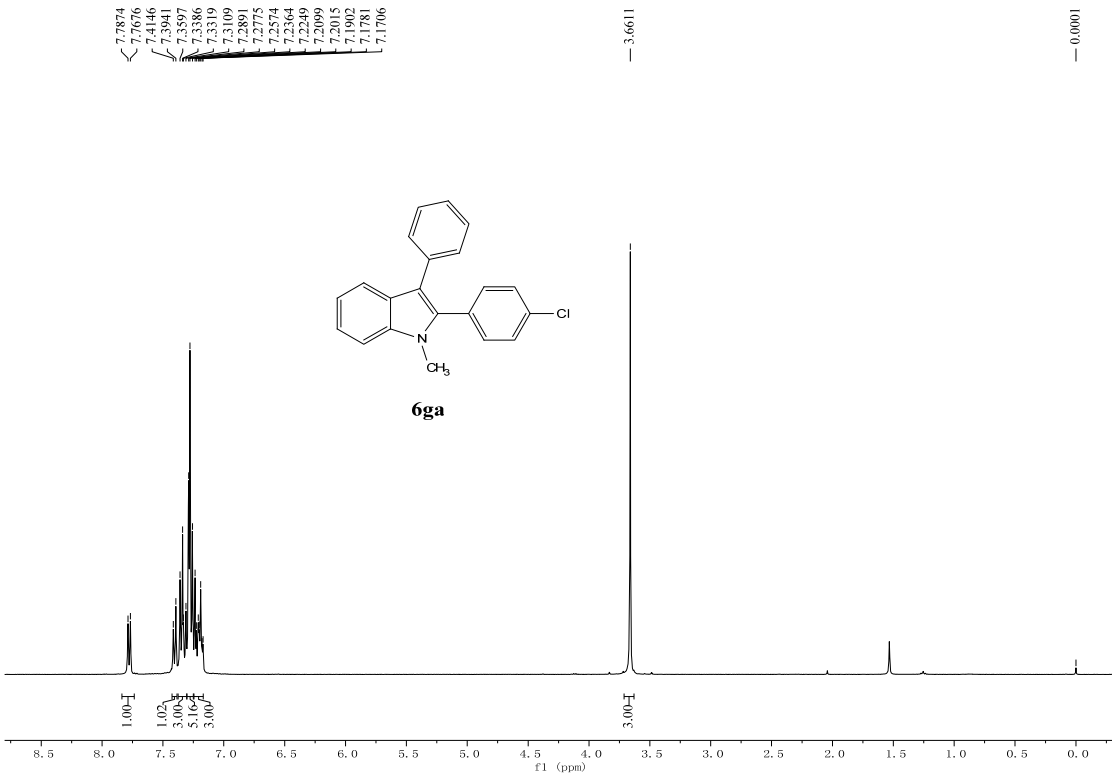
f1 (ppm)

6fa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7.2574
7.2364
7.2249
7.2099
7.2015
7.1902
7.1781
7.1706
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N
CH3
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1.02
3.00
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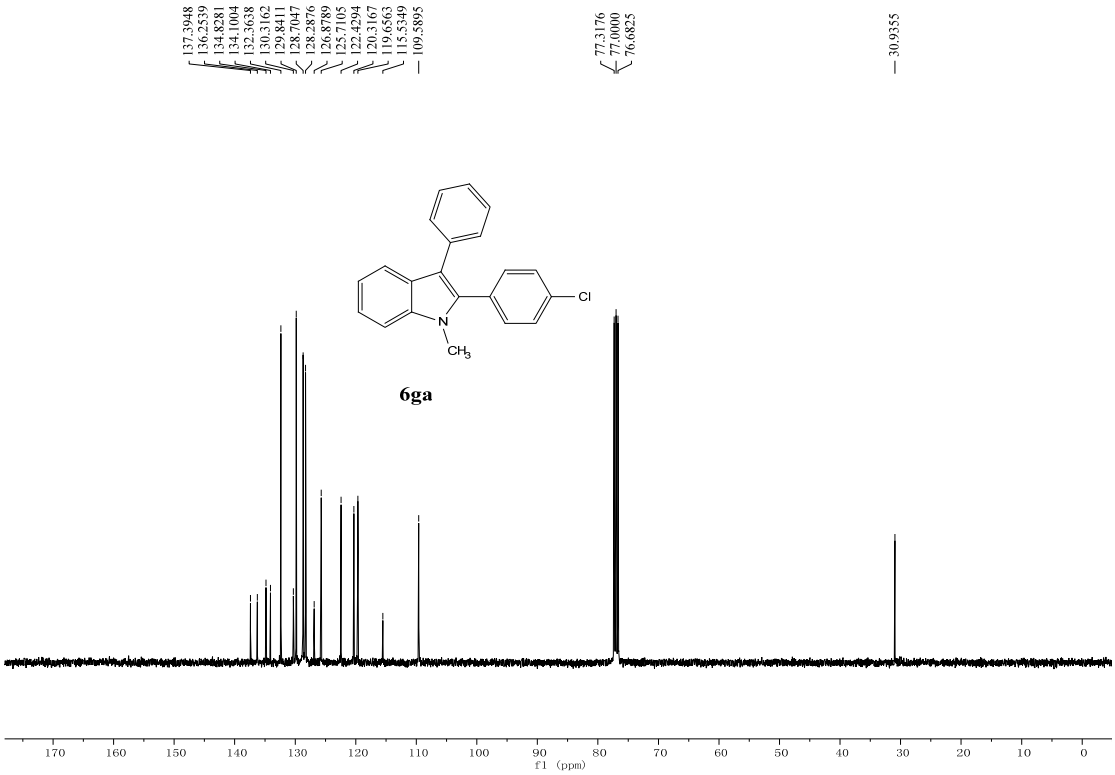
3.00
3.00
f1 (ppm)

6ga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122.4294
120.3167
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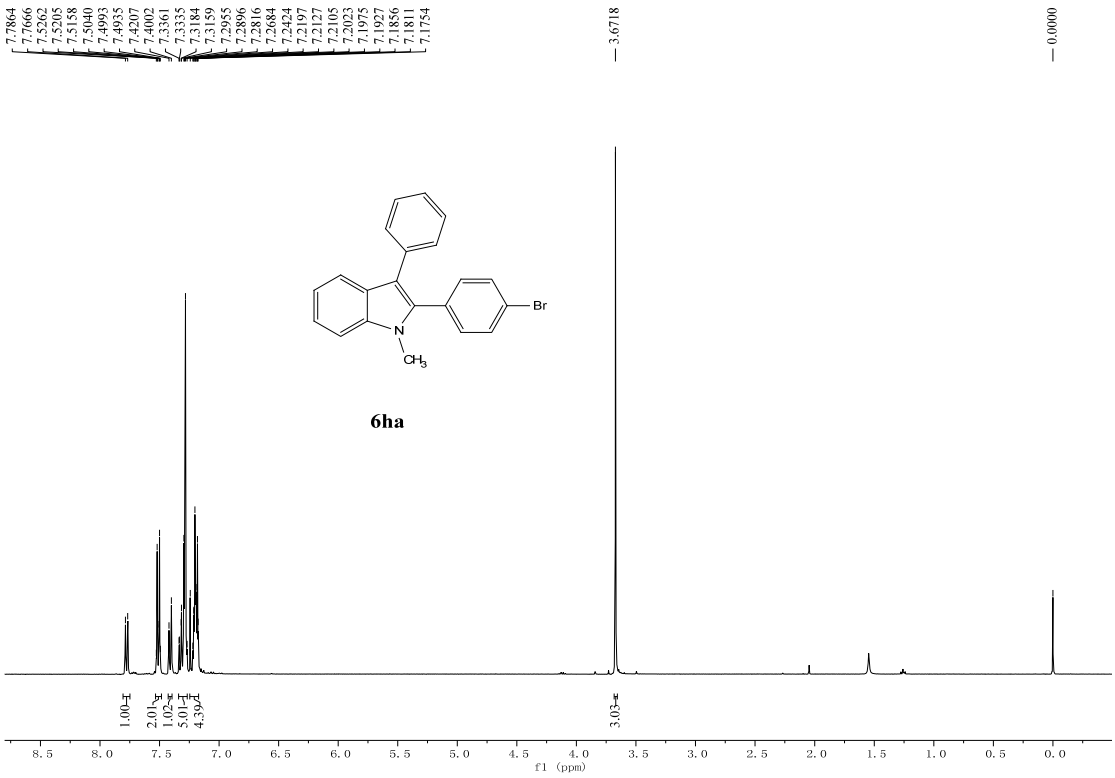
Cl
N
CH3
f1 (ppm)

6ga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7.3184
7.3159
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7.2896
7.2816
7.2684
7.2424
7.2197
7.2127
7.2105
7.2023
7.1975
7.1927
7.1856
7.1811
7.1754
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CH3
6ha
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1.02
5.01
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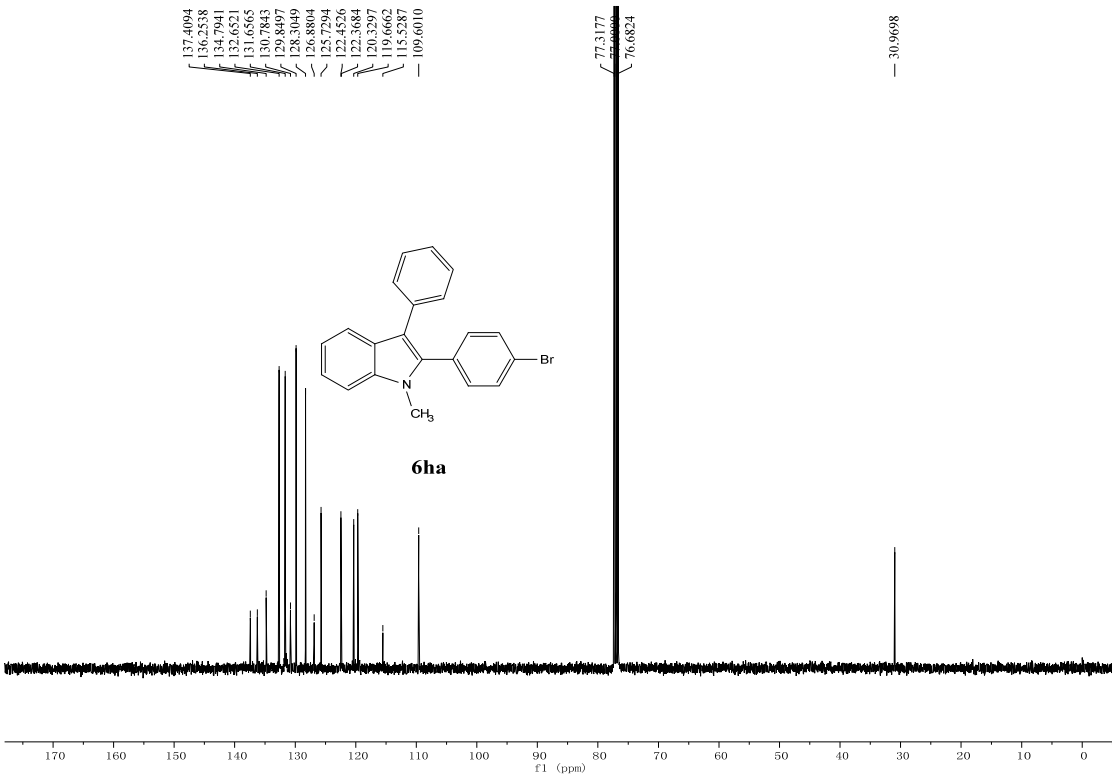
3.03
f1 (ppm)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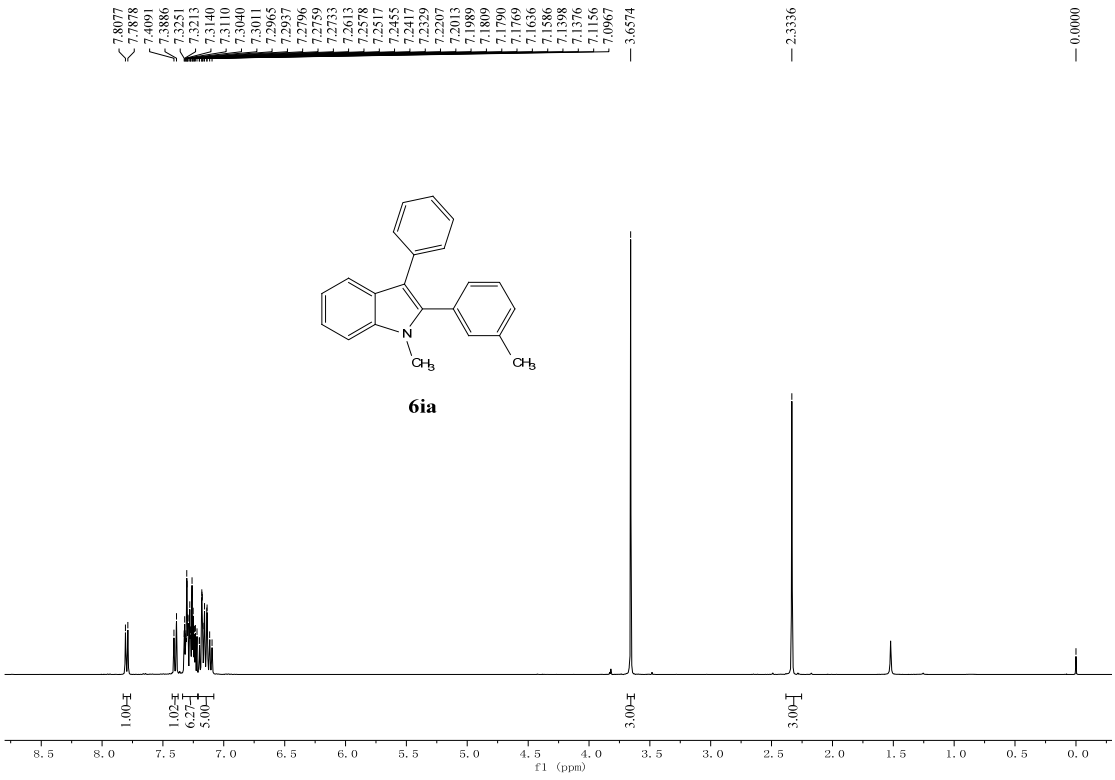
CH3
6ha
f1 (ppm)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7.1989
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7.1790
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7.1376
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CH3
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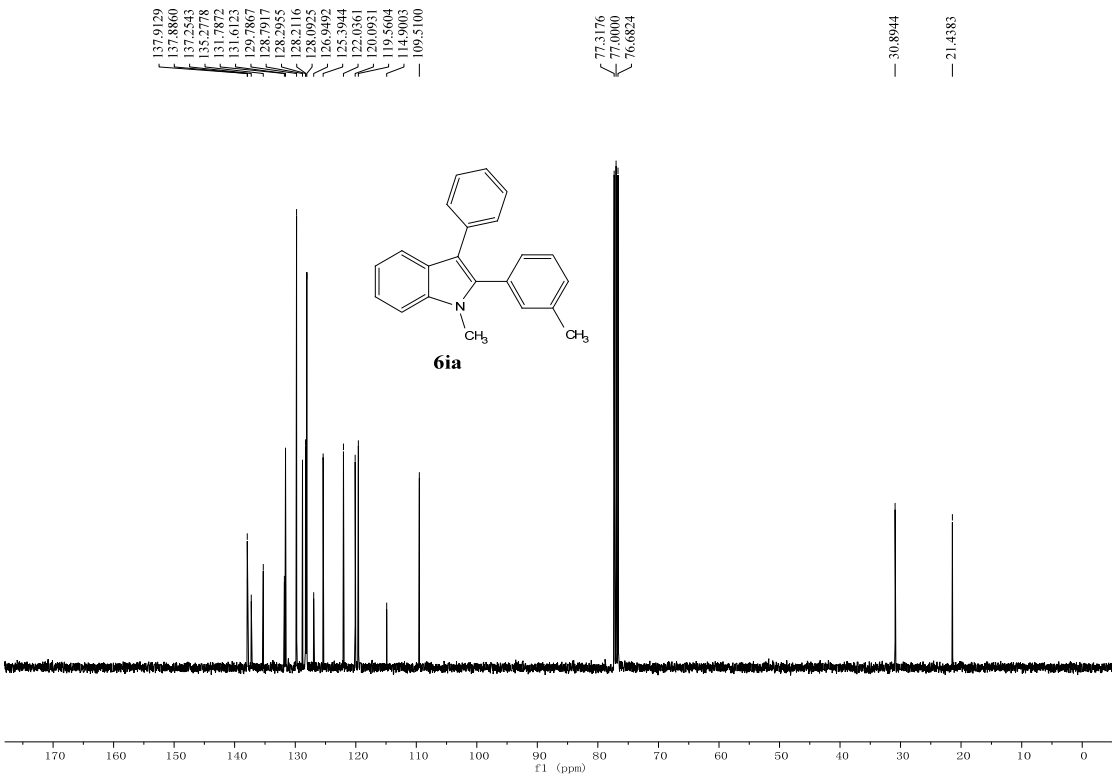
f1 (ppm)

6ia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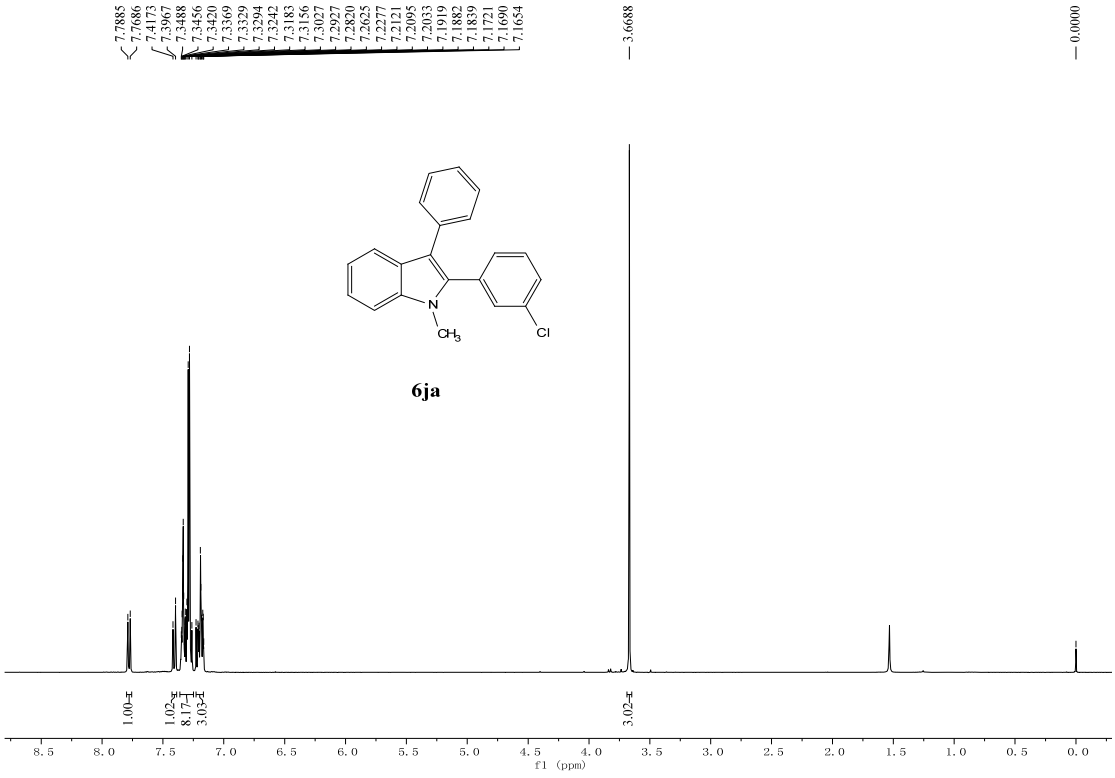
CH3
f1 (ppm)

6ia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7.2033
7.1919
7.1882
7.1839
7.1721
7.1690
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CH3
Cl
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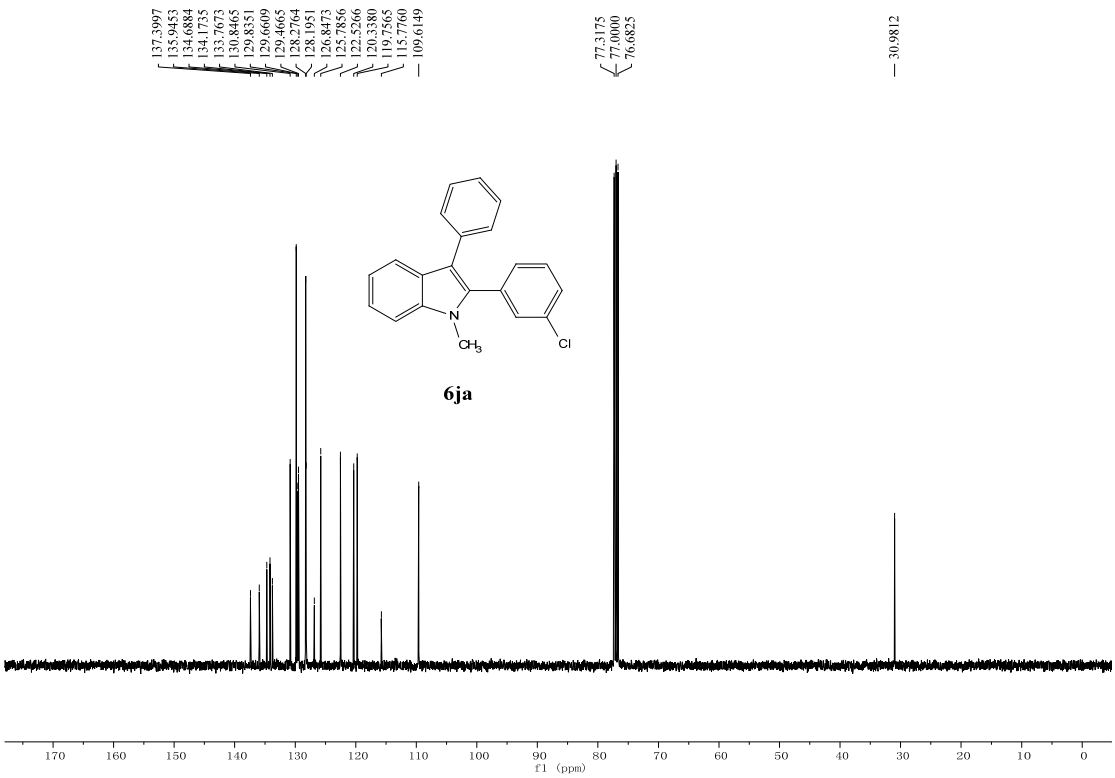
3.02
f1 (ppm)

6ja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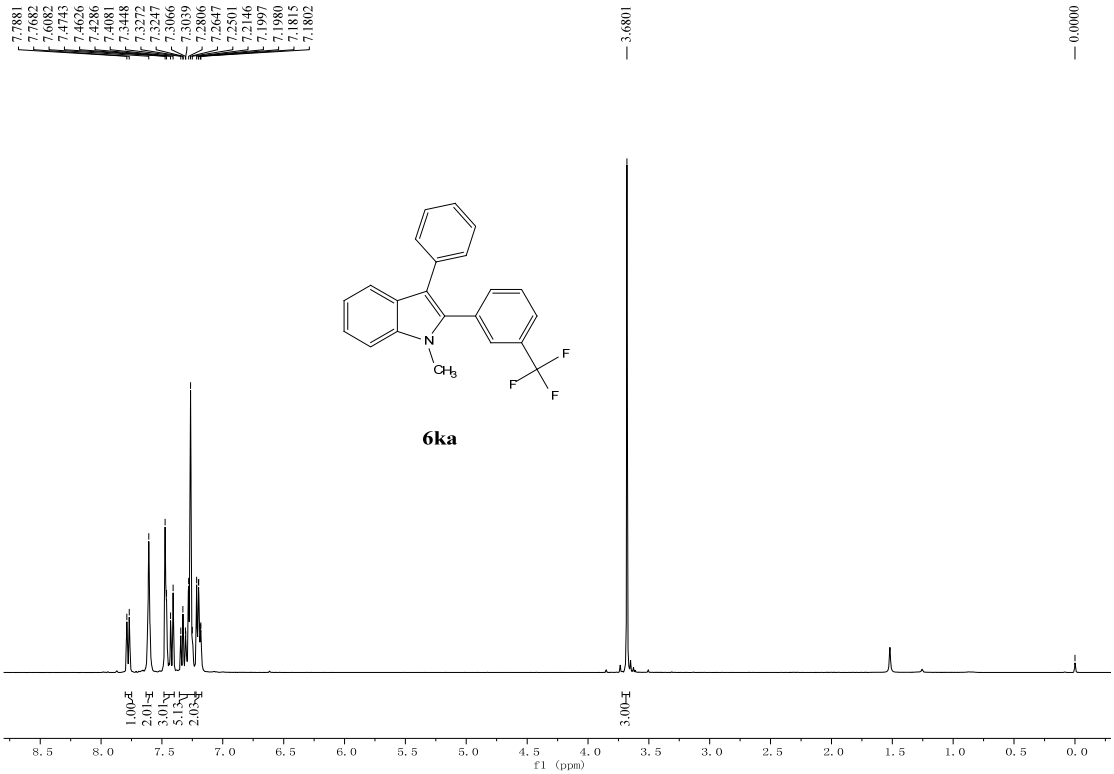
CH3
Cl
f1 (ppm)

6ja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7.3039
7.2806
7.2647
7.2501
7.2146
7.1997
7.1980
7.1815
7.1802
3.6801
0.0000
N
CH3
F
F
F
1.00
2.01
3.01
5.13
2.03
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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4.0
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3.0
2.5
2.0
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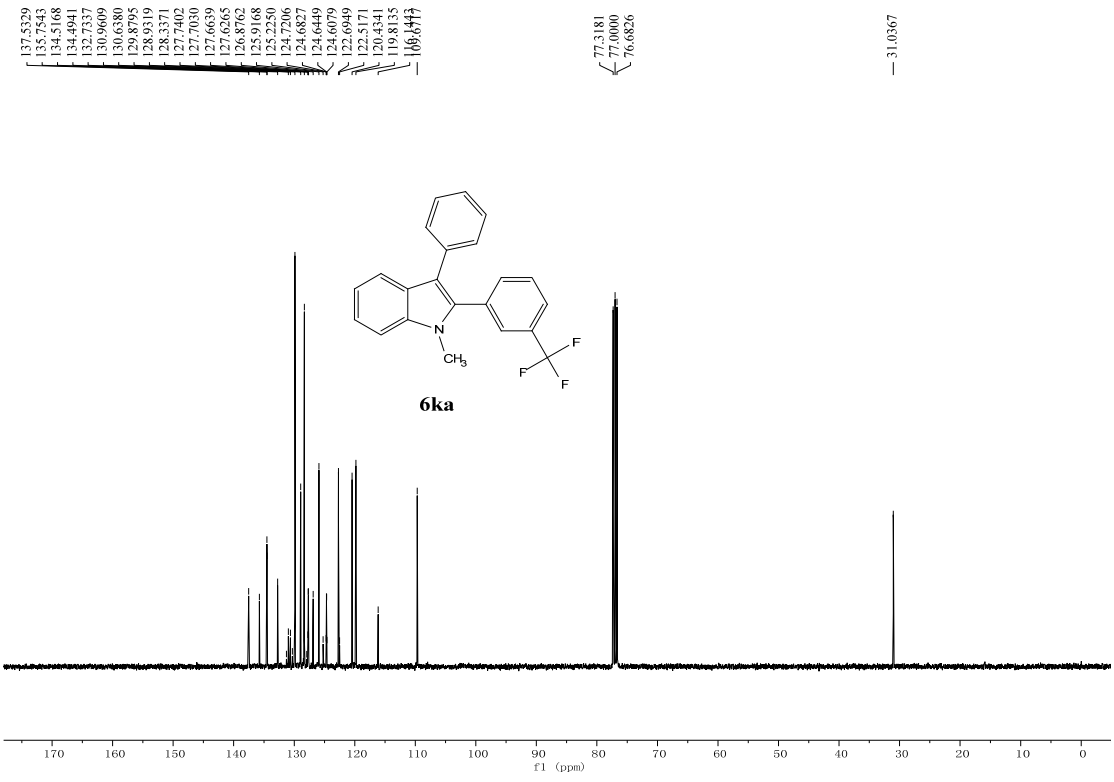
f1 (ppm)

6ka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122.5171
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77.0000
76.6826
31.0367
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CH3
F
F
F
170
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140
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50
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30
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10
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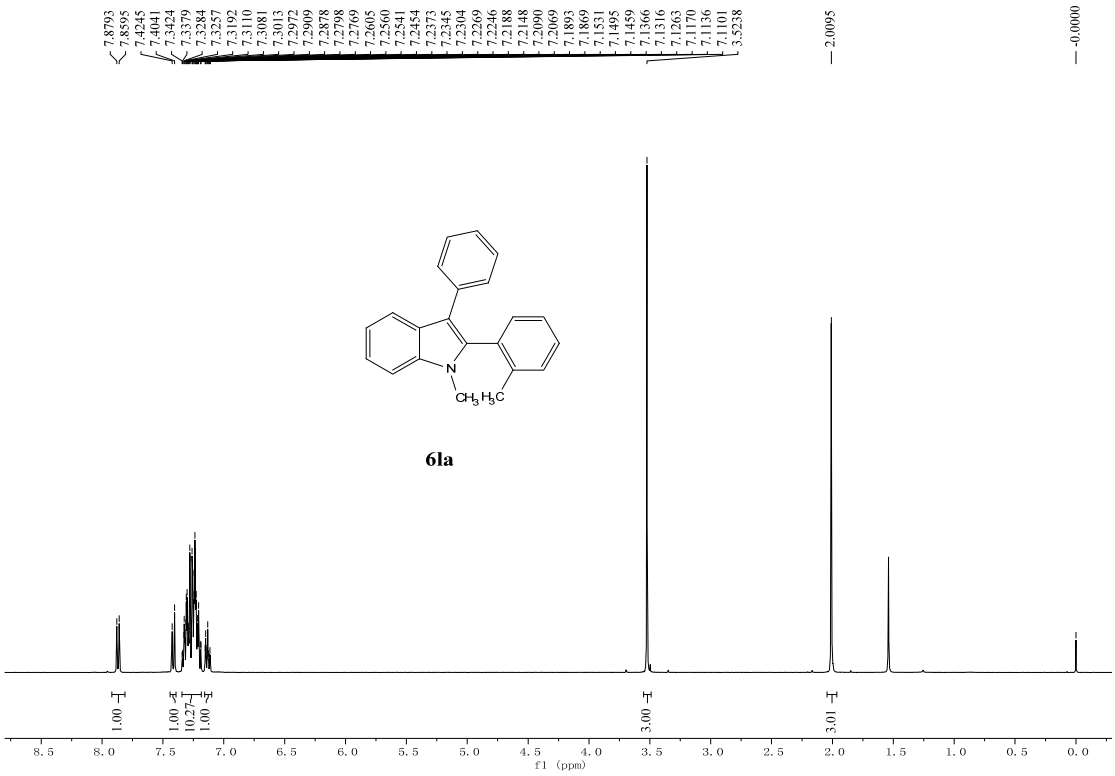
f1 (ppm)

6ka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7.2878
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7.2188
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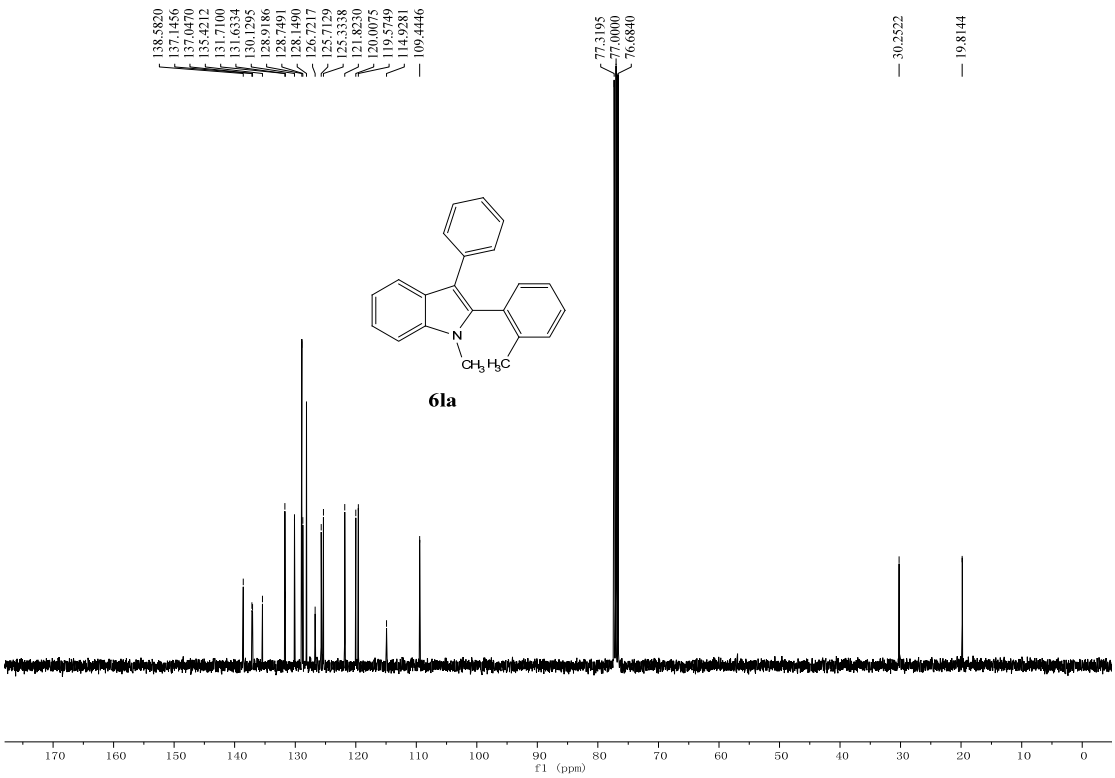
1.00
10.27
1.00
3.00
3.01
f1 (ppm)

6la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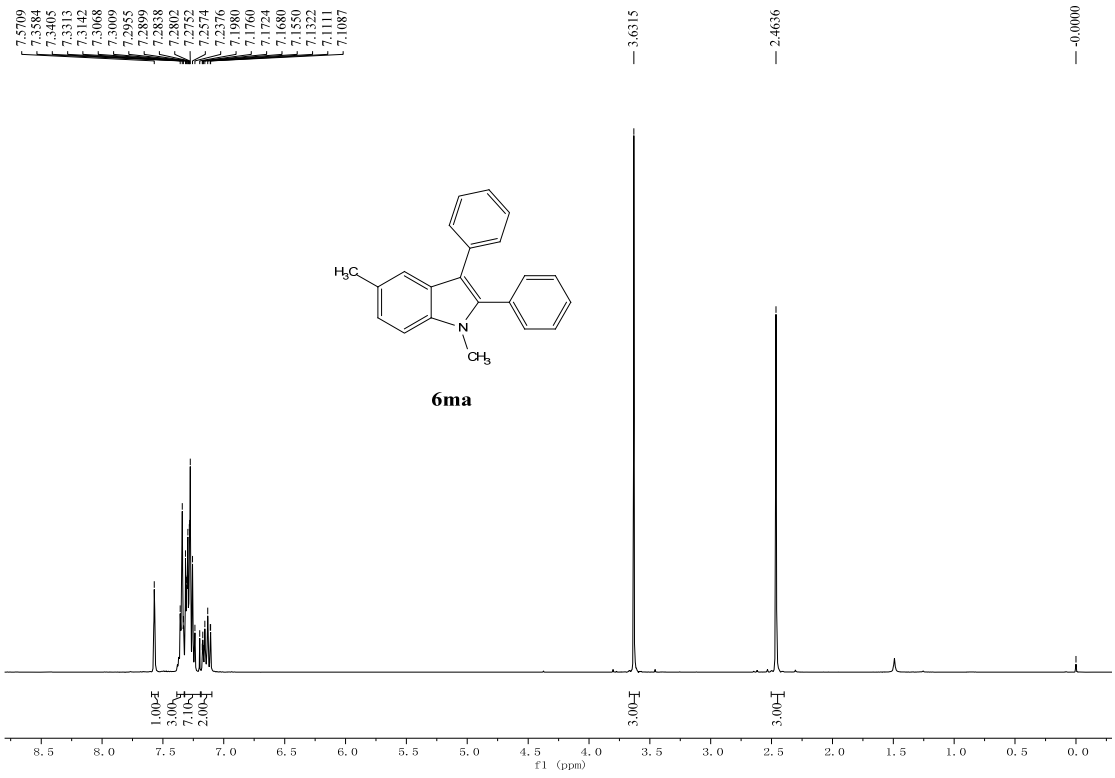
N
CH3 H3C
f1 (ppm)

6la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7.1680
7.1550
7.1322
7.1111
7.1087
3.6315
2.4636
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CH3
6ma
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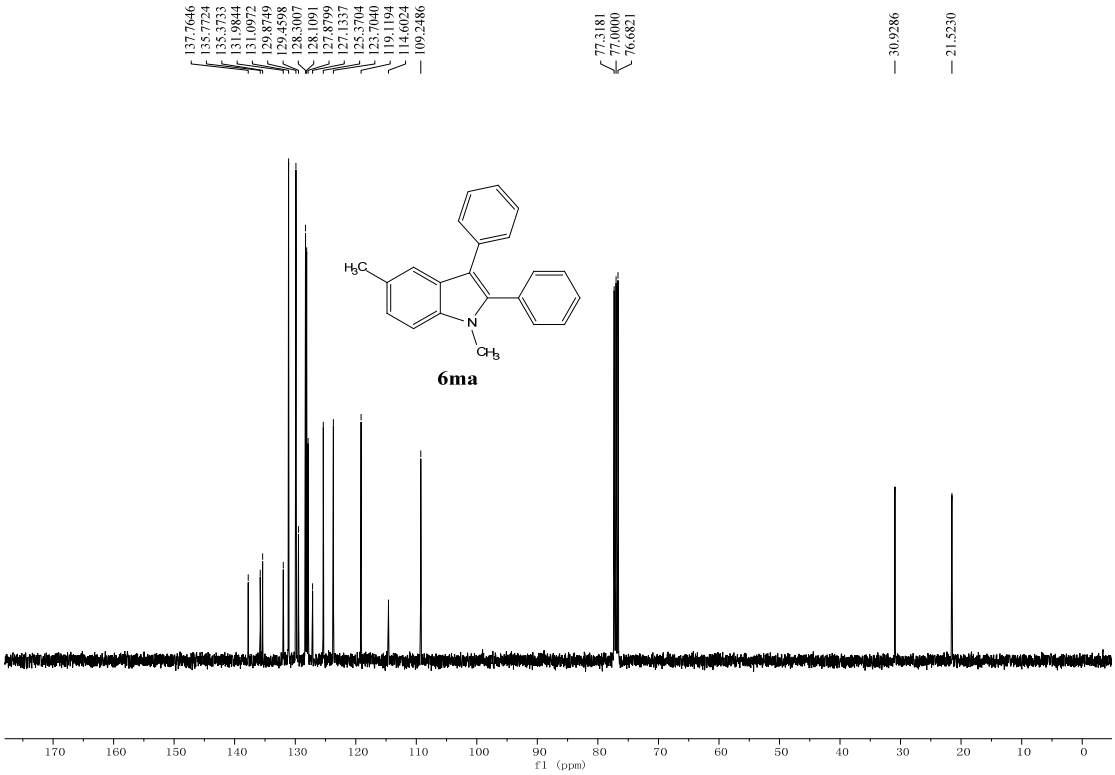
3.00
7.10
2.00
3.00
3.00
f1 (ppm)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125.3704
123.7040
119.1194
114.6024
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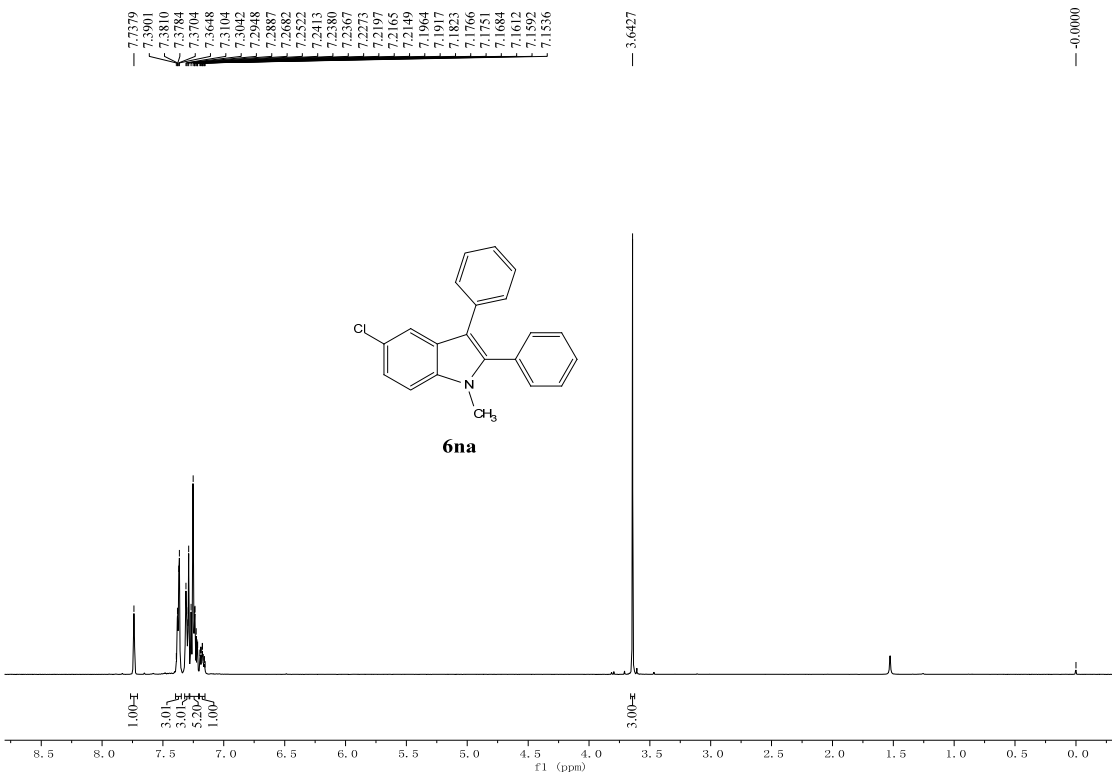
30.9286
21.5230
H3C
N
CH3
6ma
f1 (ppm)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7.3810
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7.3704
7.3648
7.3104
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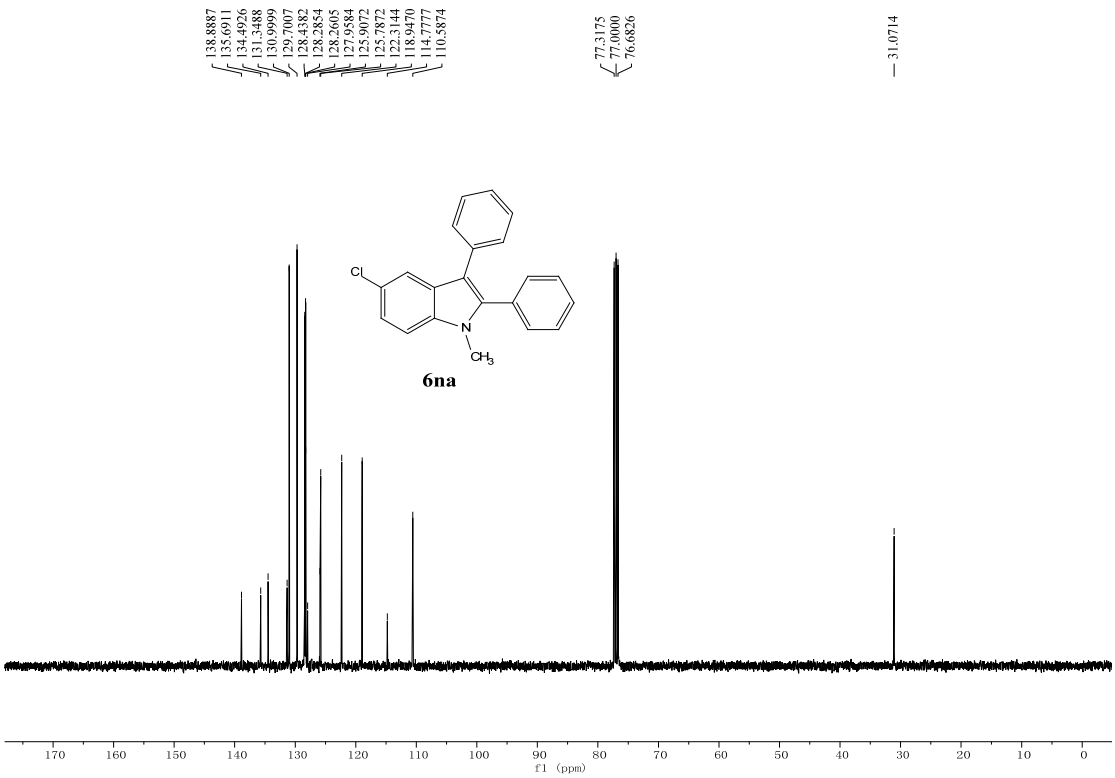
7.2948
7.2887
7.2682
7.2522
7.2413
7.2380
7.2367
7.2273
7.2197
7.2165
7.2149
7.1964
7.1917
7.1823
7.1766
7.1751
7.1684
7.1612
7.1592
7.1536
3.6427
-0.0000
Cl
N
CH3
6na
1.00
3.01
3.01
5.20
1.00
3.00
f1 (ppm)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134.4926
131.3488
130.9999
129.7007
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128.2605
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125.9072
125.7872
122.3144
118.9470
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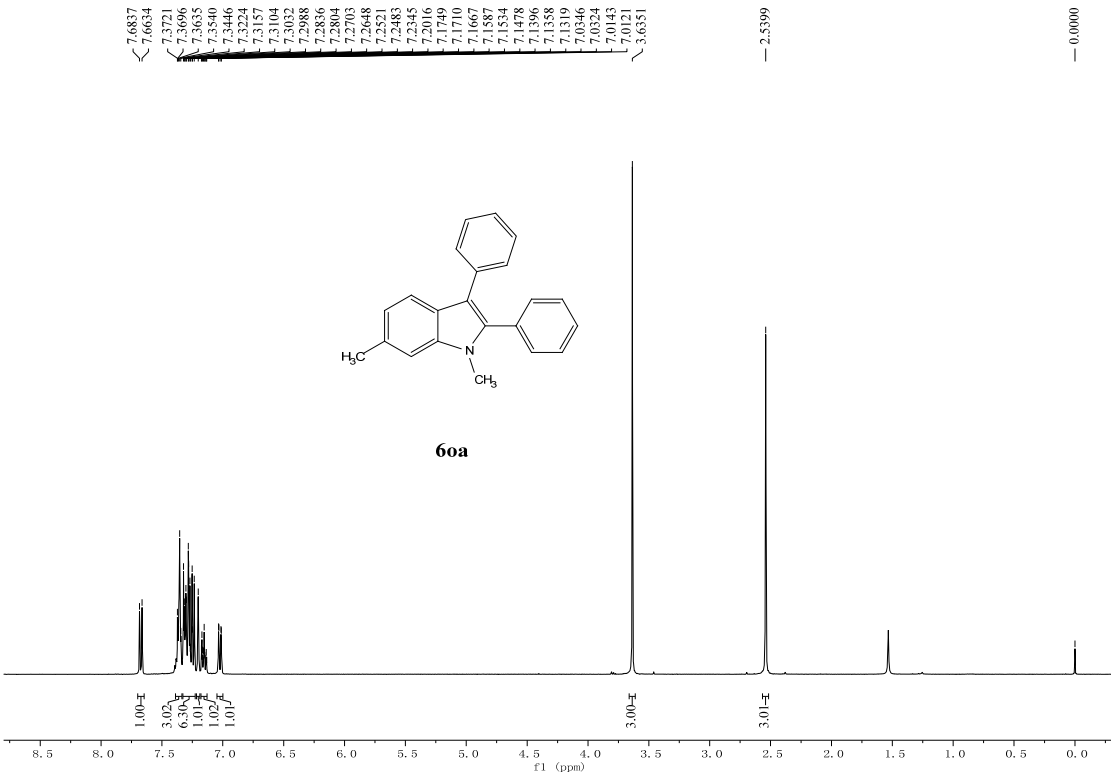
77.3175
77.0000
76.6826
31.0714
Cl
N
CH3
6na
f1 (ppm)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7.3721
7.3696
7.3635
7.3540
7.3446
7.3224
7.3157
7.3104
7.3032
7.2988
7.2836
7.2804
7.2703
7.2648
7.2521
7.2483
7.2345
7.2016
7.1749
7.1710
7.1667
7.1587
7.1534
7.1478
7.1396
7.1358
7.1319
7.0346
7.0324
7.0143
7.0121
3.6351
2.5399
0.0000
H3C
N
CH3
6oa
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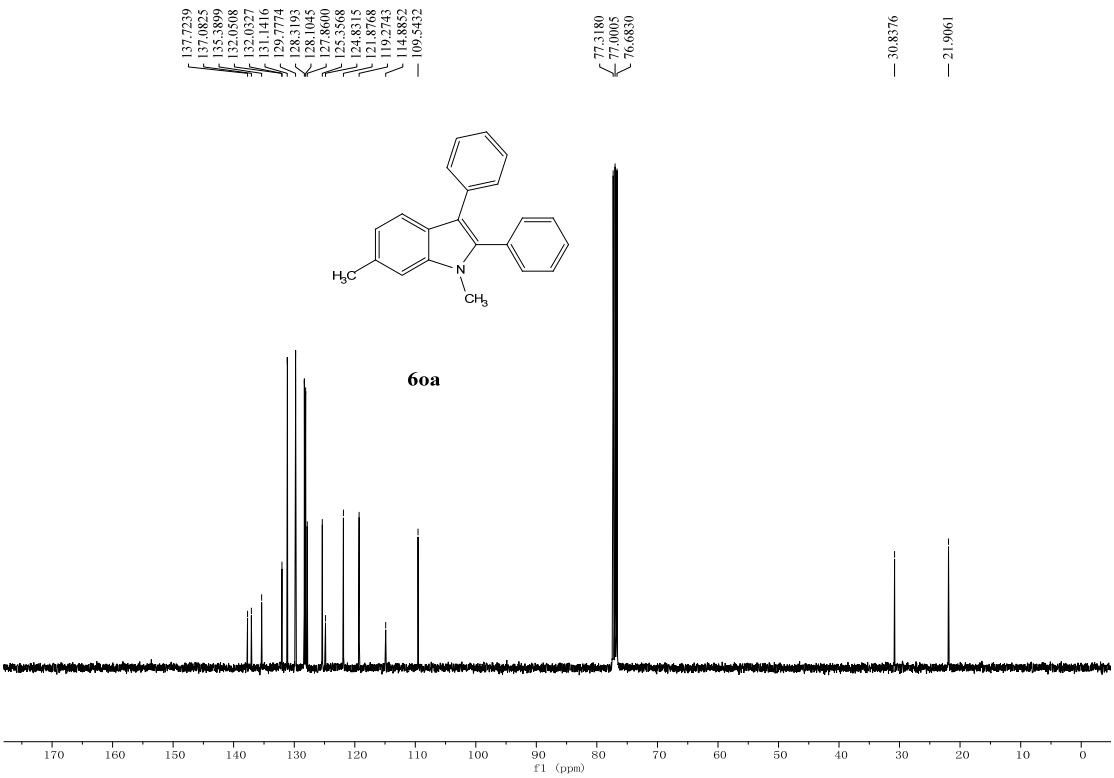
3.02
6.30
1.01
1.02
1.01
3.00
3.01
f1 (ppm)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137.0825
135.3899
132.0508
132.0327
131.1416
129.7774
128.3193
128.1045
127.8600
125.3568
124.8315
121.8768
119.2743
114.8852
109.5432
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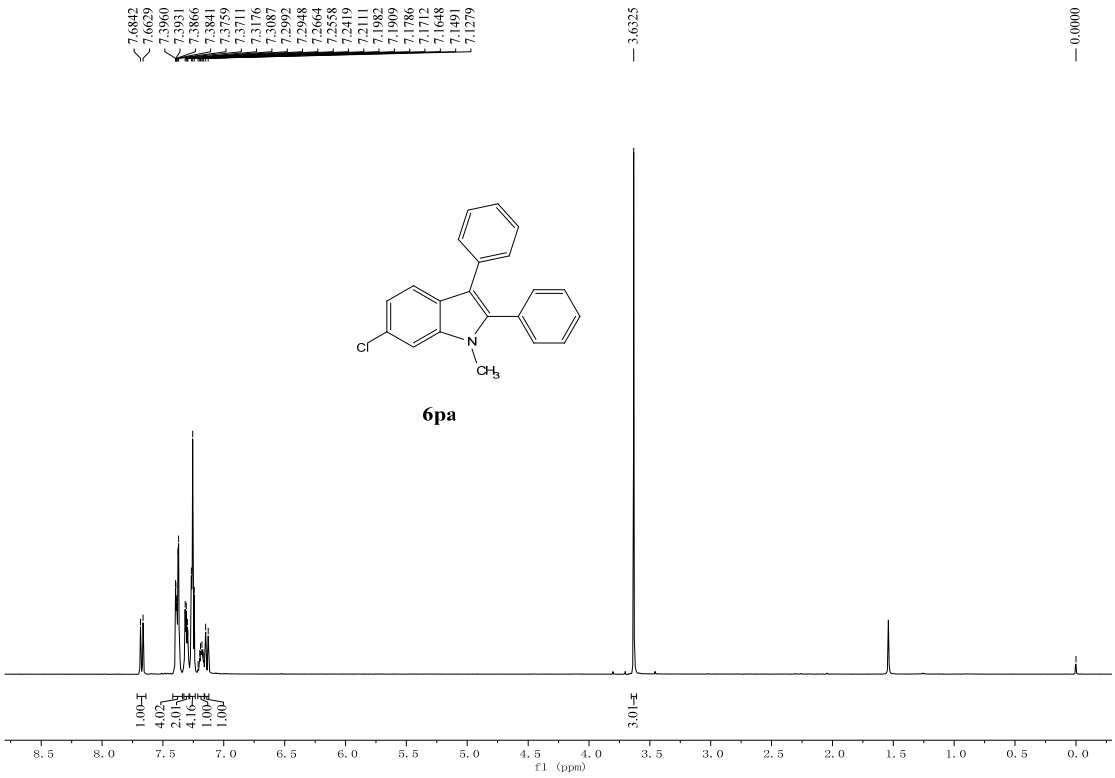
H3C
N
CH3
6oa
f1 (ppm)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7.3960
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7.3866
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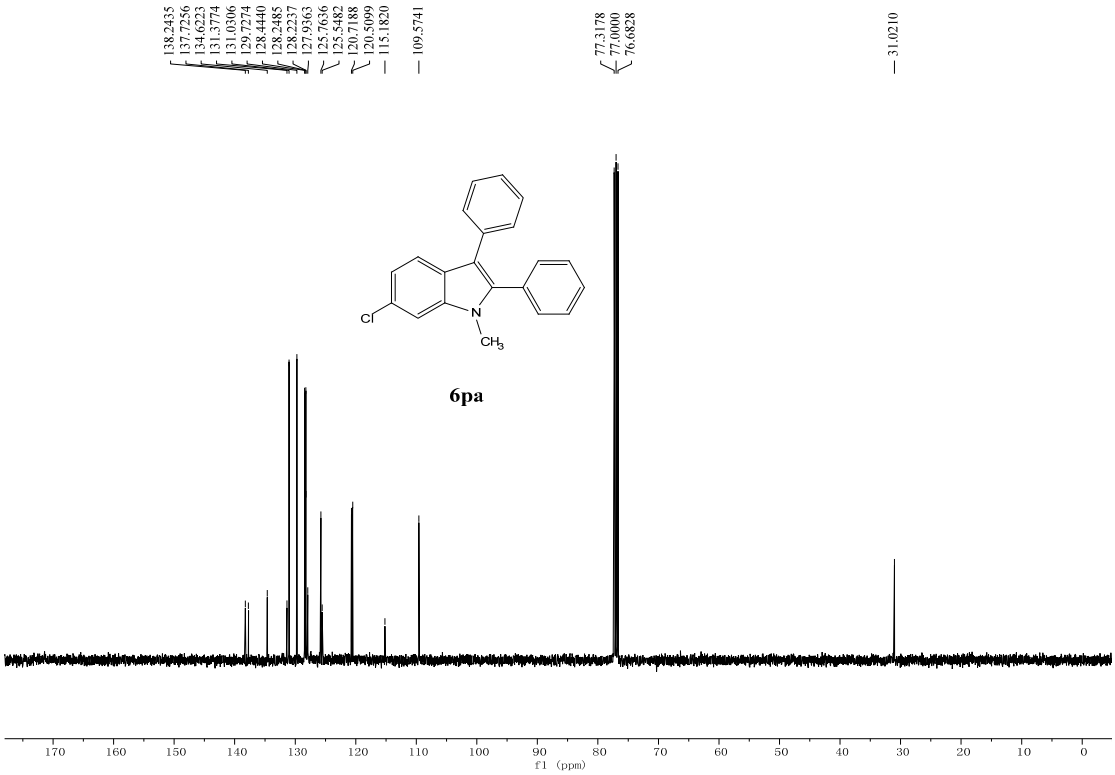
7.3759
7.3711
7.3176
7.3087
7.2992
7.2948
7.2664
7.2558
7.2419
7.2111
7.1982
7.1909
7.1786
7.1712
7.1648
7.1491
7.1279
3.6325
0.0000
Cl
N
CH3
1.00
4.02
2.01
4.16
1.00
1.00
3.01
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

6pa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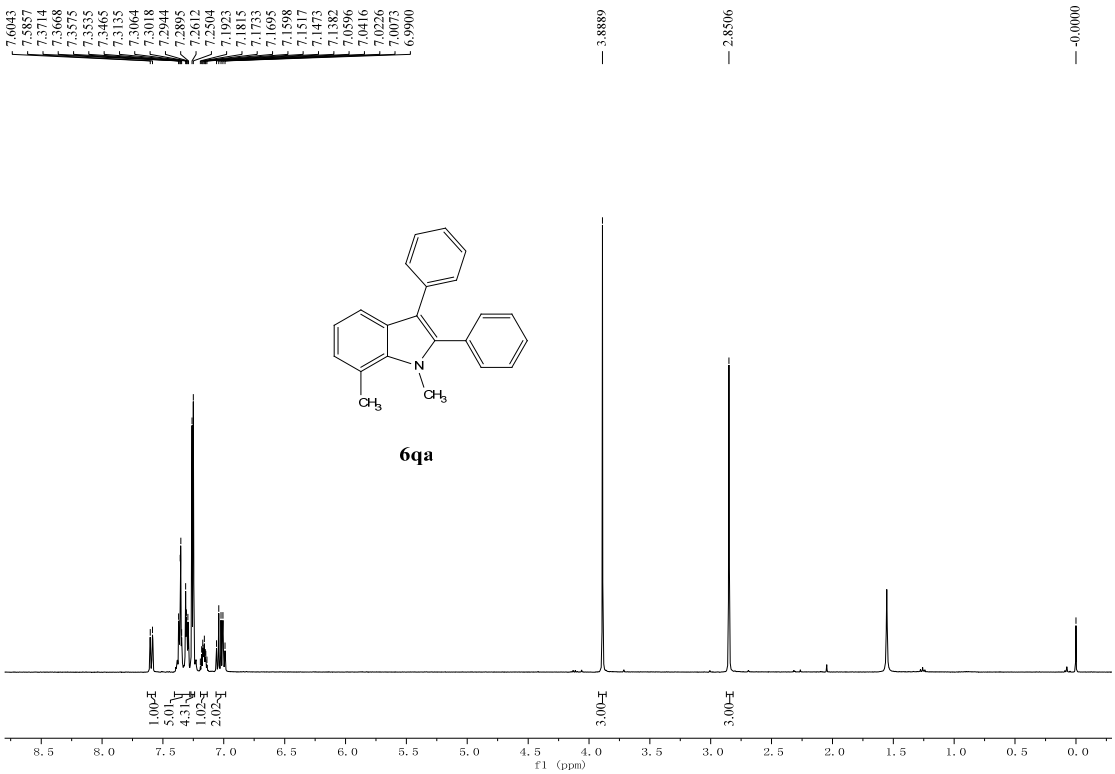
134.6223
131.3774
131.0306
129.7274
128.4440
128.2485
128.2237
127.9363
125.7636
125.5482
120.7188
120.5099
115.1820
109.5741
77.3178
77.0000
76.6828
31.0210
Cl
N
CH3
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

6pa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7.5857
7.3714
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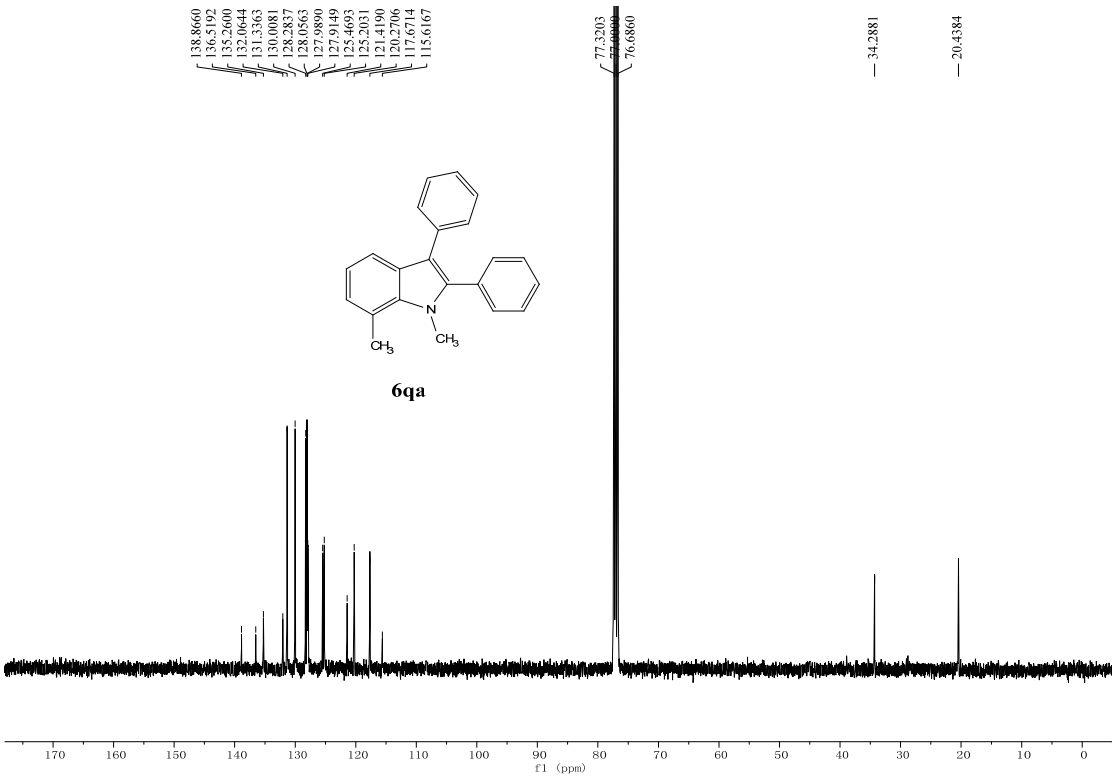
7.3575
7.3535
7.3465
7.3135
7.3064
7.3018
7.2944
7.2895
7.2612
7.2504
7.1923
7.1815
7.1733
7.1695
7.1598
7.1517
7.1473
7.1382
7.0596
7.0416
7.0226
7.0073
6.9900
3.8889
2.8506
-0.0000
N
CH3
CH3
1.00
5.01
4.31
1.02
2.02
3.00
3.00
f1 (ppm)

6qa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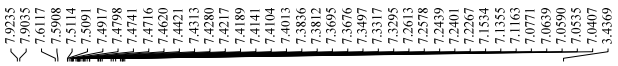
135.2600
132.0644
131.3363
130.0081
128.2837
128.0563
127.9890
127.9149
125.4693
125.2031
121.4190
120.2706
117.6714
115.6167
77.3203
77.0000
76.6860
34.2881
20.4384
N
CH3
CH3
f1 (ppm)

6qa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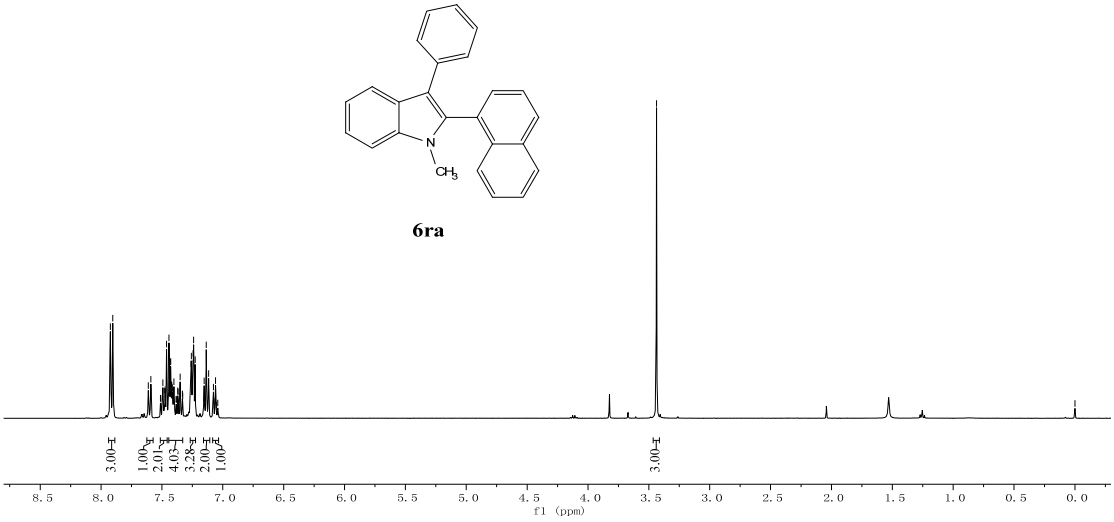
7.9035
7.6117
7.5908
7.5114
7.5091
7.4917
7.4798
7.4741
7.4716
7.4620
7.4421
7.4313
7.4280
7.4217
7.4189
7.4141
7.4104
7.4013
7.3836
7.3812
7.3695
7.3676
7.3497
7.3317
7.3295
7.2613
7.2578
7.2439
7.2401
7.2267
7.1534
7.1355
7.1163
7.0771
7.0639
7.0590
7.0535
7.0407
3.4369
0.0000


N
CH3
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1.00
2.01
4.03
3.28
2.00
1.00
3.00
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)

6ra


137.2235
136.0255
135.1582
133.4335
133.4157
130.0404
129.7364
129.0921
129.0490
128.3760
128.0606
127.2866
126.8756
126.7811
126.0687
125.8614
125.3742
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120.1159
119.7520
116.2789
109.4686
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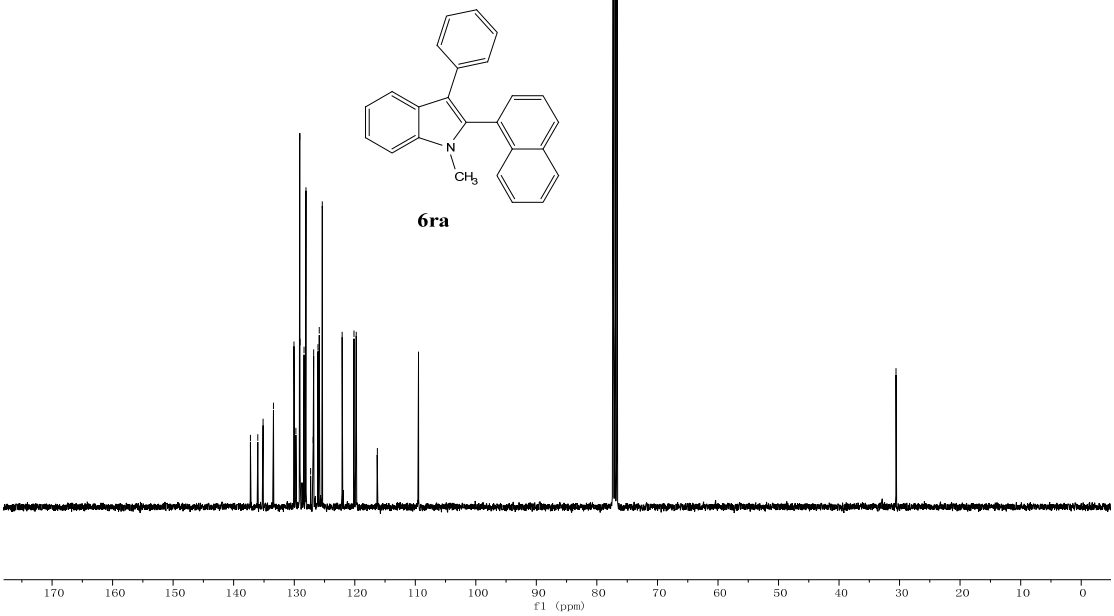
77.0000
76.6832
30.5839


N
CH3
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

6ra


8.1921
7.6892
7.6699
7.4436
7.4402
7.4230
7.4199
7.4127
7.4084
7.3888
7.3647
7.3621
7.3463
7.3181
7.3017
7.2832
7.2637
7.2504
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7.2125
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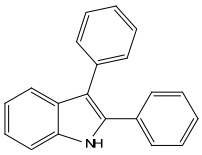
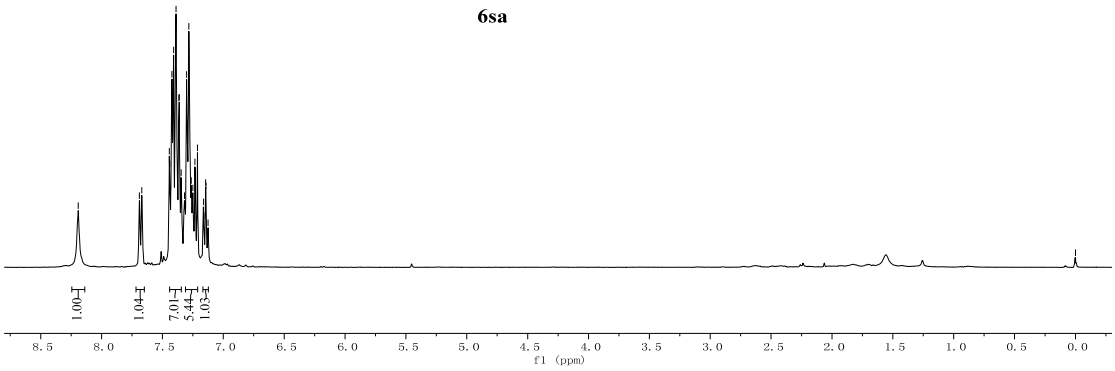
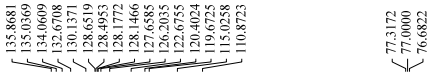
7.1599
7.1450
7.1428
7.1253
7.1226
0.0000


NH

6sa


1.00
1.04
7.01
5.44
1.03
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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128.1466
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122.6755
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119.6725
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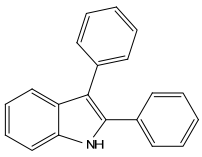
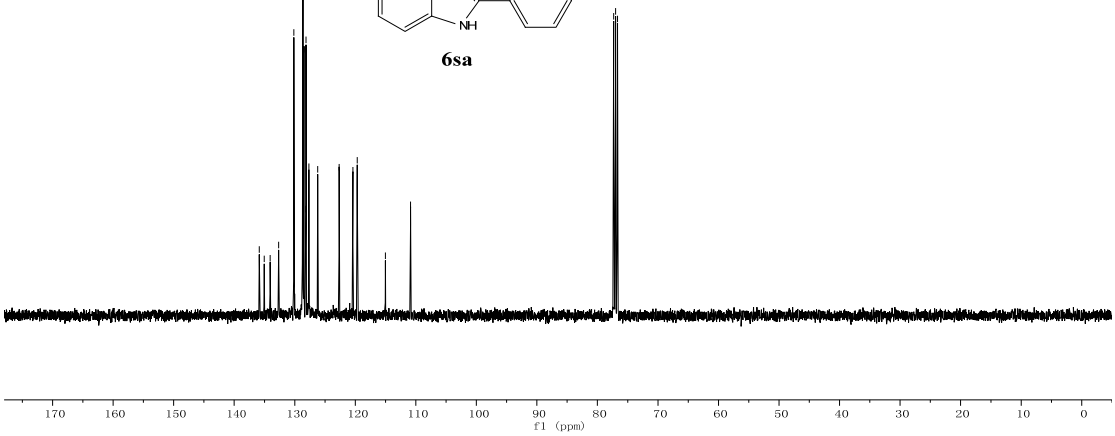
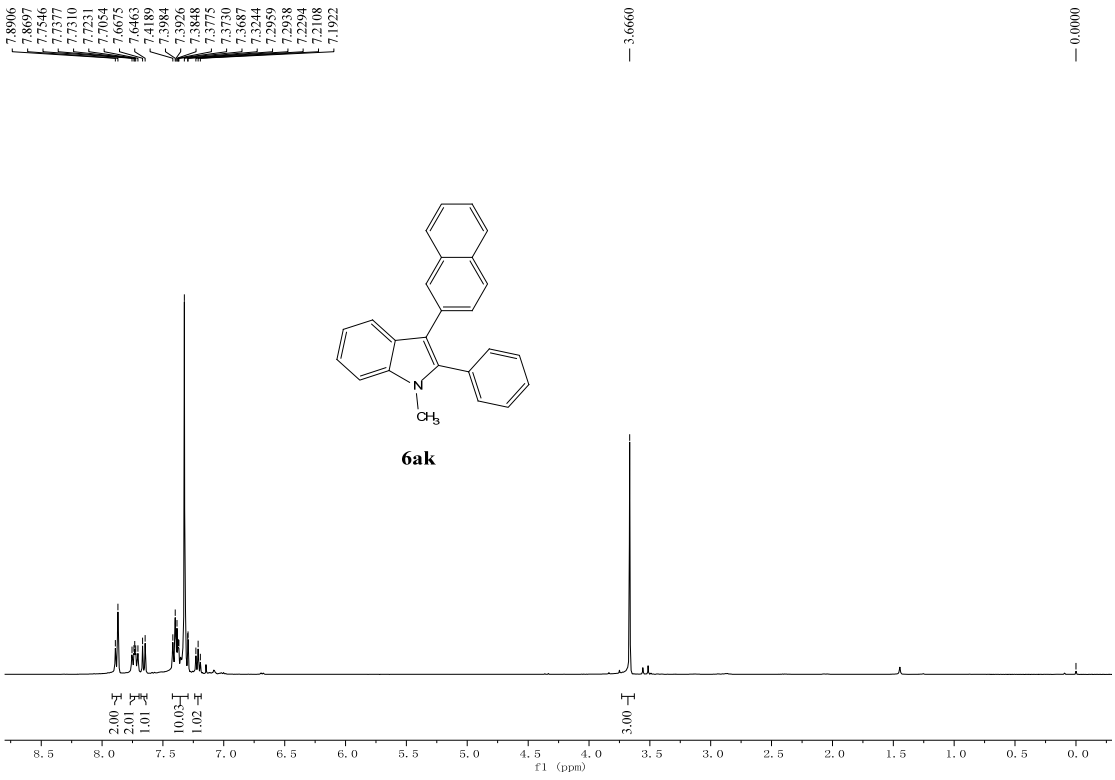
110.8723
77.3172
77.0000
76.6822


NH

6sa


170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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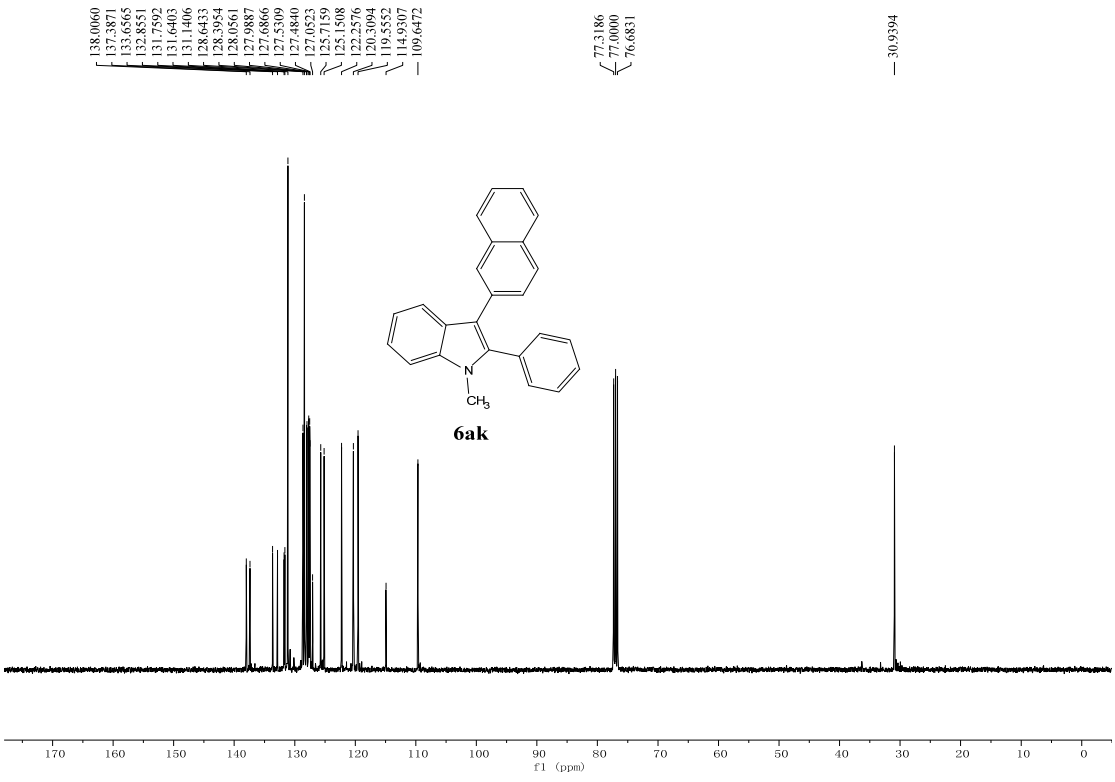
7.8697
7.7546
7.7377
7.7310
7.7231
7.7054
7.6675
7.6463
7.4189
7.3984
7.3926
7.3848
7.3775
7.3730
7.3687
7.3244
7.2959
7.2938
7.2294
7.2108
7.1922
3.6660
0.0000
N
CH3
6ak
2.00
2.01
1.01
10.03
1.02
3.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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128.3954
128.0561
127.9887
127.6866
127.5309
127.4840
127.0523
125.7159
125.1508
122.2576
120.3094
119.5552
114.9307
109.6472
77.3186
77.0000
76.6831
30.9394
N
CH3
6ak
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)