Supporting Information

Synthesis of 3,3-Disubstituted Oxindoles from N-Arylacrylamides and Unactivated Alkyl Bromides via Nickel-Catalyzed Cascade Cyclization and Their Inhibitory Effect on NO Release

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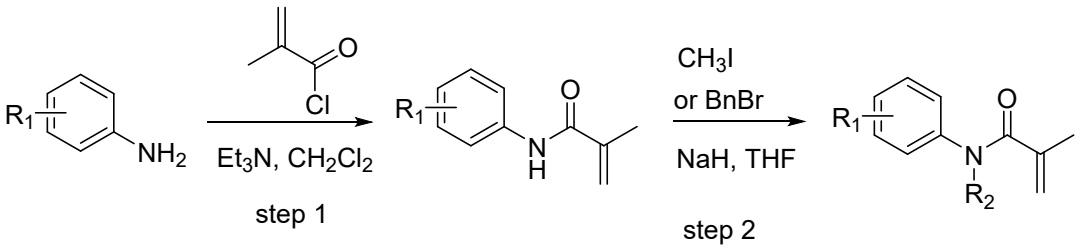
1. General information

All solvents and reagents involved in the experiments were purchased from commercial sources and some reagents were dried or protected by inert gas protection according to standard methods before use. Electrolytic manganese powder was about 200 mesh (99.9%, metals basis). Reactions were mainly monitored by thin layer chromatography (TLC) using silica gel HSGF254 with ultraviolet fluorescence at 254 nm. All compounds were purified by silica gel column chromatography (200–300 mesh). The ^{1}H (400 Hz) and ^{13}C (100 Hz) NMR spectra of compounds were determined by Bruker av400 (Bruker, GER) or JNM- ECZ400S (JEOL Ltd., JPN) instrument, and the internal standard was tetramethylsilane (TMS). High-resolution mass spectra (HR-MS) were recorded by using Agilent QTOF6520 (Agilent Technologies Co. Ltd., USA), or Q ExactiveTM Orbitrap MS system (Thermo Scientific, USA).

2. General procedures for acrylamide substrates

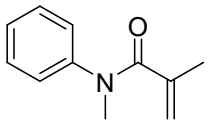


Step 1: A round flask equipped with a magnetic stirring bar was charged with anilines derivatives (4 mmol), Et_3N (6 mmol), and DCM (20 mL). Then methacryloyl chloride (5 mmol) was added into the solution. After being stirred at room temperature overnight, the reaction mixture was added water. The organic phase was separated and the aqueous layer was extracted with DCM. The combined organic phase was washed with saturated brine and dried over Na_2SO_4, then concentrated under vacuum. The product was purified by column chromatography on silica gel using petroleum ether/ethyl acetate as the eluent.

Step 2: A round flask was charged with a magnetic stirring bar, the amides (1.2 mmol) obtained in the up step, MeI or BnBr (2.4 mmol), and THF (6 mL). The reaction mixture was cooled to 0℃, and then NaH (4.8 mmol) was added carefully. After 4 hours, water was added into the mixture. The organic phase was separated and the aqueous layer was extracted with EtOAc. The combined organic phase was washed with saturated brine and dried over Na_2SO_4. The solvent was removed by rotary evaporation and the residue was transferred to a short column on silica gel using petroleum ether/ethyl acetate as the eluent to pure product.

3. Characterization of the substrates

N-methyl-N-phenylmethacrylamide (7a)

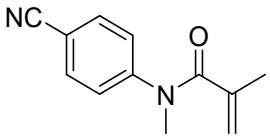


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.31 (m, 2H), 7.28 – 7.22 (m, 2H), 7.16 – 7.11 (m, 2H), 5.06 – 4.97 (m, 2H), 3.35 (s, 3H), 1.76 (dd, *J* = 1.7, 1.1 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.08, 144.75, 140.81, 129.30, 126.98, 126.60, 119.43, 37.74, 20.36.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{11}H_{13}NO$ 176.1070; Found 176.1070.

N-methyl-N-(4-cyanophenyl)methacrylamide (7b)

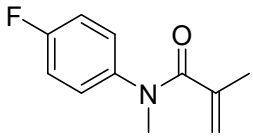


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 – 7.62 (m, 2H), 7.32 (dd, *J* = 8.5, 3.2 Hz, 2H), 5.15 (d, *J* = 2.5 Hz, 1H), 5.01 (d, *J* = 4.5 Hz, 1H), 3.44 – 3.34 (m, 3H), 1.85 (dd, *J* = 4.1, 1.5 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.63, 148.64, 140.10, 133.19, 126.61, 120.39, 118.26, 109.96, 37.35, 20.09.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{12}H_{12}N_2O$ 201.1022; Found 201.1019.

N-methyl-N-(4-fluorophenyl)methacrylamide (7c)

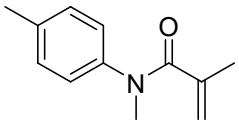


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22 – 7.11 (m, 2H), 7.05 (dtd, *J* = 8.7, 4.0, 2.0 Hz, 2H), 5.06 (s, 1H), 4.99 (s, 1H), 3.34 (dd, *J* = 3.5, 1.7 Hz, 3H), 1.78 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.93, 162.41, 159.95, 140.59, 128.31, 128.23, 119.32, 116.24, 116.01, 37.77, 20.30.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{11}H_{12}FNO$ 194.0976; Found 194.0974.

N-methyl-N-(p-tolyl)methacrylamide (7d)

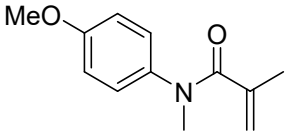


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 – 7.13 (m, 3H), 7.05 (d, *J* = 7.3 Hz, 1H), 4.94 (s, 2H), 3.21 (s, 3H), 2.26 (s, 3H), 1.73 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.97, 143.17, 140.54, 134.85, 131.32, 128.17, 127.92, 126.95, 118.46, 36.67, 20.24, 17.64.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{12}H_{15}NO$ 190.1226; Found 190.1224.

N-methyl-N-(4-methoxyphenyl)methacrylamide (7e)

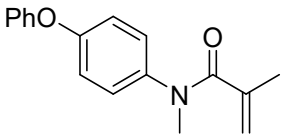


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.11 – 6.99 (m, 2H), 6.92 – 6.80 (m, 2H), 5.07-4.93 (d, *J* = 11.6 Hz, 2H), 3.86 – 3.73 (m, 3H), 3.33 – 3.24 (m, 3H), 1.74 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.16, 158.38, 140.96, 137.42, 127.80, 118.97, 114.42, 55.89, 37.85, 20.82.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{12}H_{15}NO_2$ 206.1176; Found 206.1774.

N-methyl-N-(4-phenoxyphenyl)methacrylamide (7f)

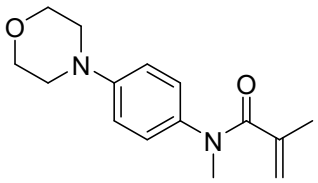


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.33 (m, 2H), 7.17 – 7.06 (m, 3H), 7.04 – 6.93 (m, 4H), 5.07 (t, *J* = 1.5 Hz, 1H), 5.02 (t, *J* = 1.1 Hz, 1H), 3.33 (s, 3H), 1.77 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.13, 156.70, 156.25, 140.84, 139.62, 129.98, 128.00, 123.89, 119.32, 119.08, 37.91, 20.45.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{17}NO_2$ 268.1332; Found 268.1328.

N-methyl-N-(4-morpholinophenyl)methacrylamide (7g)

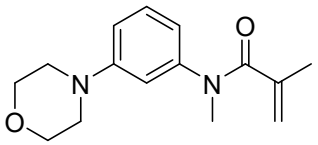


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.03 (d, *J* = 7.0 Hz, 2H), 6.85 (d, *J* = 7.1 Hz, 2H), 5.01 (d, *J* = 6.4 Hz, 2H), 3.92 – 3.80 (m, 4H), 3.35 – 3.24 (m, 3H), 3.16 (dd, *J* = 4.8, 2.9 Hz, 4H), 1.74 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.22, 149.99, 141.07, 136.56, 127.48, 118.97, 115.78, 66.87, 49.08, 37.83, 20.47.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{20}N_2O_2$ 261.1598; Found 261.1595.

N-methyl-N-(3-morpholinophenyl)methacrylamide (7h)

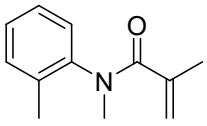


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23 (t, J = 8.3 Hz, 1H), 6.82 – 6.77 (m, 1H), 6.65 (dd, J = 4.3, 2.2 Hz, 2H), 5.09 – 4.99 (m, 2H), 3.92 – 3.81 (m, 4H), 3.33 (s, 3H), 3.18 – 3.07 (m, 4H), 1.77 (t, J = 1.4 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.04, 152.10, 145.68, 141.01, 129.86, 119.12, 117.84, 113.97, 113.94, 66.81, 49.05, 37.74, 20.41.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{20}N_2O_2$ 261.1598; Found 261.1595.

N-methyl-N-(o-tolyl)methacrylamide (7i)



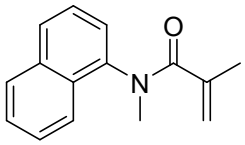
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.07 (dd, *J* = 7.2, 4.1 Hz, 2H), 6.96 (dd, *J* = 6.5, 4.4 Hz, 2H), 4.93 (d, *J* = 12.8 Hz, 2H), 3.33 – 3.20 (m, 3H), 2.27 (d, *J* = 5.7 Hz, 3H), 1.68 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.10, 143.25, 140.64, 134.96, 131.37, 128.25, 127.96, 126.98, 118.51,

36.75, 20.31, 17.71.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{12}H_{15}NO$ 190.1226; Found 190.1224.

N-methyl-N-(naphthalen-1-yl)methacrylamide (7j)

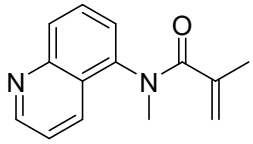


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (dd, *J* = 7.7, 5.1 Hz, 2H), 7.80 (d, *J* = 8.5 Hz, 1H), 7.59 – 7.48 (m, 2H), 7.42 (t, *J* = 7.8 Hz, 1H), 7.29 – 7.22 (m, 1H), 4.90 (s, 1H), 4.75 (s, 1H), 3.39 (s, 3H), 1.69 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.02, 141.08, 140.55, 134.68, 130.21, 128.75, 128.37, 127.28, 126.62, 125.68, 125.49, 122.82, 117.93, 37.66, 20.42.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{15}NO$ 226.1226; Found 226.1224.

N-methyl-N-(quinolin-5-yl)methacrylamide (7k)

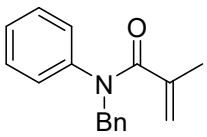


^{1}H NMR (400 MHz, $CDCl_3$) δ 8.98 (d, *J* = 4.3 Hz, 1H), 8.23 (d, *J* = 8.3 Hz, 1H), 8.11 (d, *J* = 8.5 Hz, 1H), 7.71 (t, *J* = 8.0 Hz, 1H), 7.65 – 7.48 (m, 1H), 7.38 (d, *J* = 7.1 Hz, 1H), 4.84 (d, *J* = 24.2 Hz, 2H), 3.42 (s, 3H), 1.70 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.76, 150.95, 149.11, 140.94, 140.26, 131.13, 129.76, 129.12, 125.88, 125.45, 122.06, 118.53, 37.88, 20.30.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{14}N_2O$ 227.1179; Found 227.1178.

N-benzyl-N-phenylmethacrylamide (7l)

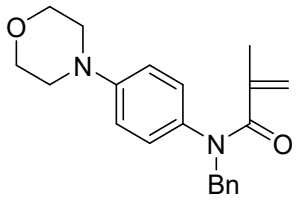


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 – 7.12 (m, 8H), 6.98 – 6.93 (m, 2H), 5.04 – 4.92 (m, 4H), 1.77 (d, J = 1.5 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.93, 143.28, 140.85, 137.63, 129.17, 128.53, 127.55, 127.43, 127.21, 119.54, 53.27, 20.51.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{14}N_2O$ 252.1383; Found 252.1372.

N-benzyl-N-(4-morpholinophenyl)methacrylamide (12)

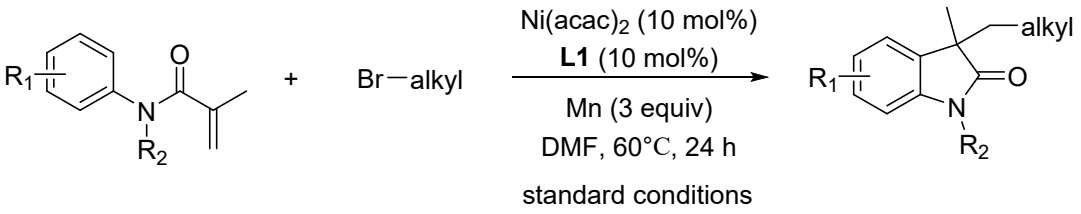


^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 – 7.17 (m, 5H), 6.91 – 6.68 (m, 4H), 5.06 – 4.85 (m, 4H), 3.82 (td, J = 4.8, 1.7 Hz, 4H), 3.11 (td, J = 4.7, 1.6 Hz, 4H), 1.75 (t, J = 1.3 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.14, 150.01, 141.11, 137.79, 134.97, 128.65, 128.47, 127.33, 118.98, 115.47, 66.85, 53.32, 48.94, 20.58.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{24}N_2O_2$ 337.1911; Found 337.1921.

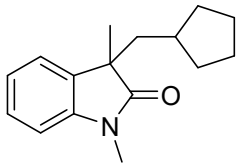
4. General procedures for nickel-catalyzed cascade cyclization to synthesis 3,3-disubstituted oxindoles



To a 1.5 mL headspace vial were added N-arylacrylamides (0.2 mmol), $Ni(acac)_2$ (0.02 mmol), 4,4'-Di-tert-butyl-2,2'-dipyridyl (0.02 mmol) and Mn powder (0.6 mmol) the vial was transferred to glove box, and DMF (400 μL) and bromides (0.6 mmol) was added. The vial was capped, and the reaction was performed at 60 °C for 24 h. The organic phase was added to separating funnel containing water and EtOAc, the aqueous layer was extracted with EtOAc. The combined organic phase was washed with saturated brine and dried over Na_2SO_4. The solvent was removed by rotary evaporation and the residue was transferred to a short column on silica gel using petroleum ether/ethyl acetate as the eluent to pure product.

5. Characterization of the products

3-(cyclopentylmethyl)-1,3-dimethylindolin-2-one (9aa)



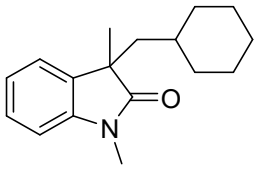
White oil, 61% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.24 (m, 1H), 7.17 (dd, *J* = 7.3, 1.3 Hz, 1H), 7.05 (td, *J* = 7.5, 1.0 Hz, 1H), 6.84 (d, *J* = 7.8 Hz, 1H), 3.22 (s, 3H), 2.07 (dd, *J* = 13.7, 7.2 Hz, 1H), 1.89 (dd, *J* = 13.7, 5.9 Hz, 1H), 1.52 – 1.37 (m, 4H), 1.34 (s, 3H), 1.32 – 1.21 (m, 4H), 1.01 (dq, *J* = 11.4, 8.7, 8.2 Hz, 1H), 0.88 – 0.77 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 181.19, 143.36, 134.51, 127.64, 122.94, 122.35, 107.93, 48.57, 44.55, 37.30, 33.86, 32.83, 26.27, 25.37, 25.00, 24.93.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{21}NO$ 244.1696; Found 244.1682.

3-(cyclohexylmethyl)-1,3-dimethylindolin-2-one (9ab)



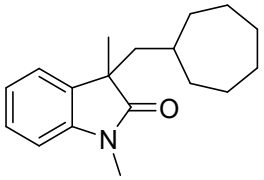
White oil, 30% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.23 (m, 2H), 7.16 (dd, *J* = 7.4, 1.4 Hz, 1H), 7.06 (td, *J* = 7.5, 1.1 Hz, 1H), 6.87 – 6.80 (m, 1H), 3.22 (s, 3H), 1.93 (dd, *J* = 14.0, 6.8 Hz, 1H), 1.72 (dd, *J* = 14.1, 5.2 Hz, 1H), 1.50 – 1.44 (m, 2H), 1.33 (s, 1H), 1.31 (s, 3H), 1.27 (d, *J* = 11.0 Hz, 2H), 1.03 – 0.89 (m, 4H), 0.88 – 0.70 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 181.26, 143.21, 134.52, 127.60, 122.80, 122.41, 108.02, 47.95, 45.50, 34.81, 34.55, 33.62, 26.27, 26.21, 26.17, 26.10.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{23}NO$ 258.1852; Found 258.1849.

3-(cycloheptylmethyl)-1,3-dimethylindolin-2-one (9ac)

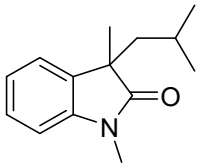


White oil, 54% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.22 (m, 1H), 7.19 – 7.14 (m, 1H), 7.06 (td, *J* = 7.4, 1.0 Hz, 1H), 6.84 (d, *J* = 7.8 Hz, 1H), 3.21 (s, 3H), 1.98 (dd, *J* = 14.0, 6.8 Hz, 1H), 1.75 (dd, *J* = 14.0, 4.7 Hz, 1H), 1.52 – 1.34 (m, 7H), 1.32 (s, 3H), 1.30 – 1.23 (m, 1H), 1.18 – 1.10 (m, 3H), 1.09 – 0.96 (m, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 181.24, 143.26, 134.38, 127.62, 122.88, 122.39, 107.99, 48.24, 46.06, 36.26, 35.95, 34.56, 28.57, 26.25, 25.99, 25.95, 25.91.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{18}H_{25}NO$ 272.2009; Found 272.1992.

3-isobutyl-1,3-dimethylindolin-2-one (9ad)



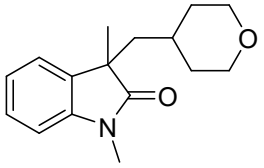
White oil, 61% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 – 7.22 (m, 1H), 7.16 (dd, *J* = 7.3, 0.8 Hz, 1H), 7.06 (t, *J* = 7.5 Hz, 1H), 6.85 (dd, *J* = 7.9, 0.9 Hz, 1H), 3.22 (d, *J* = 0.8 Hz, 3H), 1.94 (dd, *J* = 13.7, 7.9 Hz, 1H), 1.76 (dd, *J* = 13.9, 5.4 Hz, 1H), 1.32 (s, 3H), 1.29 – 1.18 (m, 1H), 0.68 – 0.63 (m, 3H), 0.61 (dd, *J* = 6.7, 0.7 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 181.20, 143.29, 134.32, 127.65, 122.90, 122.41, 108.03, 48.17, 46.82, 26.26, 26.21, 25.61, 24.19, 22.91.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{14}H_{19}NO$ 218.1539; Found 218.1522.

1,3-dimethyl-3-((tetrahydro-2H-pyran-4-yl)methyl)indolin-2-one (9ae)



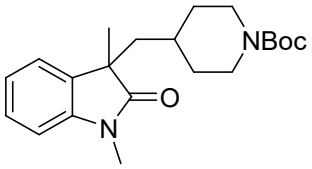
White oil, 39% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.22 (m, 2H), 7.15 (ddd, *J* = 7.4, 1.3, 0.6 Hz, 1H), 7.05 (td, *J* = 7.5, 1.1 Hz, 1H), 6.83 (dt, *J* = 7.8, 0.8 Hz, 1H), 3.81 – 3.61 (m, 2H), 3.21 (s, 3H), 3.17 – 3.02 (m, 2H), 1.98 (dd, *J* = 14.0, 5.8 Hz, 1H), 1.76 (dd, *J* = 14.0, 5.0 Hz, 1H), 1.32 (s, 3H), 1.27 – 1.23 (m, 2H), 1.21 – 1.16 (m, 1H), 1.10 – 1.04 (m, 1H), 1.03 – 0.96 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 180.11, 156.33, 143.11, 128.23, 122.89, 122.72, 108.16, 53.50, 42.81, 31.08, 28.46, 28.43, 26.27, 25.76.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{21}NO_2$ 218.1539; Found 218.1522.

tert-butyl 4-((1,3-dimethyl-2-oxoindolin-3-yl)methyl)piperidine-1 carboxylate (9af)



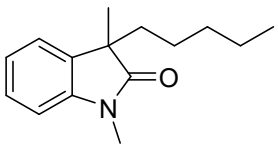
White oil, 68% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 – 7.25 (m, 1H), 7.17 (d, *J* = 7.3 Hz, 1H), 7.07 (t, *J* = 7.5 Hz, 1H), 6.86 (d, *J* = 7.8 Hz, 1H), 3.85 (s, 2H), 3.23 (s, 3H), 2.49 – 2.38 (m, 2H), 1.99 (dd, *J* = 14.1, 6.2 Hz, 1H), 1.77 (dd, *J* = 14.1, 5.2 Hz, 1H), 1.40 (s, 9H), 1.33 (s, 4H), 1.27 (d, *J* = 10.5 Hz, 2H), 1.13 – 1.02 (m, 3H), 0.90 (dd, *J* = 12.7, 4.0 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 180.84, 154.75, 143.06, 134.09, 127.89, 122.76, 122.65, 108.22, 79.23, 47.80, 44.47, 33.23, 33.10, 32.56, 31.50, 30.26, 29.75, 28.48, 26.32, 26.22.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{30}N_2O_3$ 381.2149; Found 381.2124.

1,3-dimethyl-3-pentylindolin-2-one (9ag)



White oil, 17% yield.

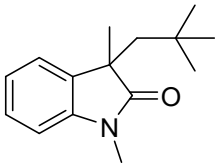
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.26 (s, 5H), 7.16 (ddd, *J* = 7.4, 1.4, 0.6 Hz, 1H), 7.06 (td, *J* = 7.5, 1.1 Hz, 1H), 6.84 (d, *J* = 7.8 Hz, 1H), 3.21 (s, 3H), 1.88 (ddd, *J* = 13.3, 12.2, 4.7 Hz, 1H), 1.71 (ddd, *J* = 13.3, 12.2, 4.4 Hz, 1H), 1.34 (s, 3H), 1.23 – 1.08 (m, 4H), 1.05 – 0.94 (m, 1H), 0.89 – 0.74 (m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 180.99, 143.43, 134.45, 127.64, 122.54, 122.48, 107.92, 48.53, 38.56,

31.98, 26.17, 24.16, 23.86, 22.39, 14.03.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{21}NO$ 232.1696; Found 232.1682.

1,3-dimethyl-3-neopentylindolin-2-one (9ah)



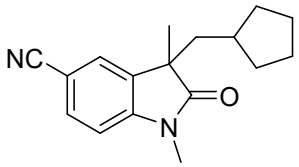
White oil, 19% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 – 7.22 (m, 2H), 7.19 (d, *J* = 7.4 Hz, 1H), 7.02 (td, *J* = 7.5, 1.0 Hz, 1H), 6.84 (d, *J* = 7.5 Hz, 1H), 3.21 (s, 3H), 2.14 (d, *J* = 12.5 Hz, 1H), 1.85 (d, *J* = 14.4 Hz, 1H), 1.60 (s, 1H), 1.28 (s, 3H), 1.24 (s, 1H), 0.60 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 207.07, 181.16, 142.95, 134.31, 127.62, 122.07, 108.11, 50.88, 47.49, 31.85, 31.00, 30.88, 28.35, 26.31.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{21}NO$ 232.1696; Found 232.1682.

3-(cyclopentylmethyl)-1,3-dimethyl-2-oxoindoline-5-carbonitrile (9ba)



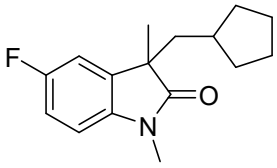
Yellow oil, 54% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (dd, *J* = 8.1, 1.6 Hz, 1H), 7.42 (d, *J* = 1.6 Hz, 1H), 6.91 (d, *J* = 8.1 Hz, 1H), 3.25 (s, 3H), 2.10 (dd, *J* = 13.8, 7.1 Hz, 1H), 1.91 (dd, *J* = 13.8, 5.8 Hz, 1H), 1.53 – 1.43 (m, 2H), 1.36 (s, 3H), 1.34 – 1.19 (m, 5H), 1.00 (dq, *J* = 10.7, 8.1, 7.6 Hz, 1H), 0.92 – 0.77 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 180.77, 147.25, 135.55, 133.20, 126.28, 119.47, 108.39, 105.49, 48.46, 44.37, 37.23, 33.90, 32.81, 26.52, 25.15, 24.95, 24.90.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{20}N_2O$ 268.1576; Found 268.1572

3-(cyclopentylmethyl)-5-fluoro-1,3-dimethylindolin-2-one (9ca)



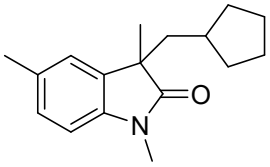
White solid, 59% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.97 – 6.87 (m, 2H), 6.73 (dd, *J* = 8.4, 4.2 Hz, 1H), 3.18 (s, 3H), 2.05 (dd, *J* = 13.8, 7.1 Hz, 1H), 1.84 (dd, *J* = 13.7, 5.9 Hz, 1H), 1.47 – 1.34 (m, 4H), 1.31 (s, 3H), 1.28 – 1.22 (m, 3H), 1.03 – 0.95 (m, 1H), 0.80 (ddd, *J* = 15.1, 7.7, 4.0 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 180.78, 160.60, 158.21, 139.27, 136.32, 113.89, 113.66, 111.23, 110.99, 108.34, 108.26, 49.09, 44.45, 37.27, 33.84, 32.78, 26.41, 25.29, 24.97, 24.92.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{23}NO$ 262.1602; Found 262.1588.

3-(cyclopentylmethyl)-1,3,5-trimethylindolin-2-one (9da)



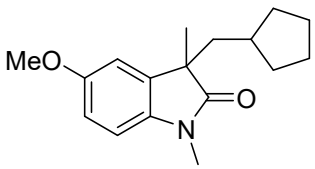
White oil, 55% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.99 (dd, *J* = 6.3, 4.1 Hz, 2H), 6.95 – 6.90 (m, 1H), 3.50 (s, 3H), 2.59 (s, 3H), 2.04 (dd, *J* = 13.7, 7.3 Hz, 1H), 1.85 (dd, *J* = 13.7, 5.8 Hz, 1H), 1.53 – 1.37 (m, 3H), 1.36 – 1.21 (m, 8H), 1.01 (dq, *J* = 12.0, 8.7 Hz, 1H), 0.89 – 0.75 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 181.91, 141.12, 135.14, 131.34, 122.24, 120.87, 119.50, 47.83, 44.82, 37.23, 33.88, 32.78, 29.60, 25.81, 25.04, 24.93, 19.16.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{23}NO$ 258.1852; Found 258.1837.

3-(cyclopentylmethyl)-5-methoxy-1,3-dimethylindolin-2-one (9ea)



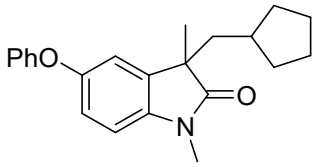
White oil, 65% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.78 – 6.69 (m, 3H), 3.78 (s, 3H), 3.17 (s, 3H), 2.03 (dd, *J* = 13.7, 7.1 Hz, 1H), 1.83 (dd, *J* = 13.7, 5.7 Hz, 1H), 1.50 – 1.33 (m, 4H), 1.30 (s, 3H), 1.27 – 1.18 (m, 3H), 0.98 (dq, *J* = 11.0, 8.5, 8.1 Hz, 1H), 0.83 (tq, *J* = 8.9, 4.6, 4.1 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 180.83, 156.00, 136.98, 135.98, 111.49, 110.77, 107.67, 56.60, 48.99, 44.50, 37.29, 33.86, 32.14, 26.35, 25.45, 25.00, 24.91.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{23}NO_2$ 274.1802; Found 274.1785

3-(cyclopentylmethyl)-1,3-dimethyl-5-phenoxyindolin-2-one (9fa)



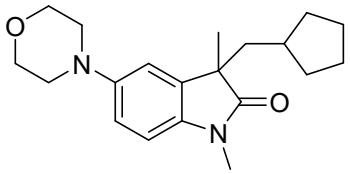
White solid, 40% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 – 7.27 (m, 2H), 7.08 – 7.02 (m, 1H), 6.96 – 6.91 (m, 4H), 6.78 (d, *J* = 8.2 Hz, 1H), 3.21 (s, 3H), 2.06 (dd, *J* = 13.7, 6.9 Hz, 1H), 1.81 (dd, *J* = 13.7, 6.3 Hz, 1H), 1.44 (dt, *J* = 14.4, 8.8 Hz, 3H), 1.39 – 1.34 (m, 1H), 1.32 (s, 3H), 1.31 – 1.19 (m, 3H), 1.00 (dq, *J* = 11.3, 8.3 Hz, 1H), 0.87 – 0.75 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 180.92, 158.56, 152.28, 139.43, 136.30, 129.77, 122.68, 118.88, 117.61, 115.84, 108.49, 49.05, 44.50, 37.36, 33.89, 32.96, 26.42, 25.33, 25.01, 24.94.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{25}NO_2$ 336.1958; Found 336.1955.

3-(cyclopentylmethyl)-1,3-dimethyl-5-morpholinoindolin-2-one (9ga)



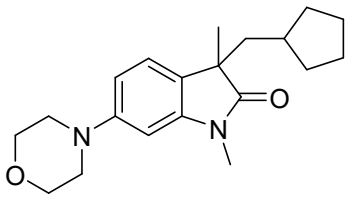
White solid, 39% yield.

^{1}H NMR (400 MHz, CDCl3) δ 6.84 – 6.69 (m, 3H), 3.89 – 3.84 (m, 4H), 3.17 (s, 3H), 3.08 (dd, *J* = 5.8, 3.4 Hz, 4H), 2.04 (dd, *J* = 13.7, 7.2 Hz, 1H), 1.83 (dd, *J* = 13.7, 5.7 Hz, 1H), 1.46 – 1.39 (m, 2H), 1.36 (d, *J* = 7.0 Hz, 1H), 1.31 (s, 3H), 1.27 – 1.22 (m, 3H), 0.99 (dq, *J* = 11.1, 8.1 Hz, 1H), 0.87 – 0.76 (m, 1H).

^{13}C NMR (101 MHz, CDCl3) δ 180.85, 147.83, 137.30, 135.62, 115.10, 113.19, 108.11, 67.09, 51.07, 48.96, 44.59, 37.30, 33.90, 32.74, 26.33, 25.54, 25.01, 24.92.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{28}N_2O_2$ 329.2224; Found 329.2220

3-(cyclopentylmethyl)-1,3-dimethyl-6-morpholinoindolin-2-one (9ha)



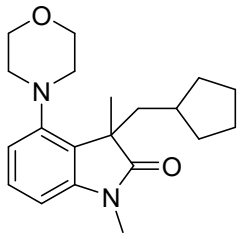
White solid, 20% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.02 (d, *J* = 8.1 Hz, 1H), 6.55 (dd, *J* = 8.1, 2.2 Hz, 1H), 6.41 (d, *J* = 2.2 Hz, 1H), 3.93 – 3.82 (m, 4H), 3.23 – 3.13 (m, 7H), 2.00 (dd, *J* = 13.7, 7.0 Hz, 1H), 1.83 (dd, *J* = 13.7, 5.6 Hz, 1H), 1.46 – 1.38 (m, 2H), 1.36 (d, *J* = 7.4 Hz, 1H), 1.29 (s, 3H), 1.27 – 1.23 (m, 3H), 1.04 – 0.91 (m, 1H), 0.87 – 0.80 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 181.84, 151.62, 144.39, 125.94, 123.37, 108.97, 96.91, 67.03, 49.85, 48.09, 44.63, 37.31, 33.95, 32.78, 26.22, 25.46, 25.03, 24.96.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{28}N_2O_2$ 329.2224; Found 329.2220.

3-(cyclopentylmethyl)-1,3-dimethyl-4-morpholinoindolin-2-one (9ha')



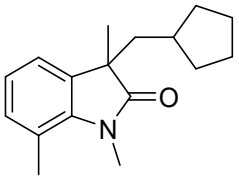
White oil, 20% yield.

^{1}H NMR (400 MHz, CDCl3) δ 7.31 (d, *J* = 8.4 Hz, 1H), 6.87 (d, *J* = 11.5 Hz, 1H), 6.68 (d, *J* = 6.3 Hz, 2H), 3.92 – 3.82 (m, 4H), 3.24 (s, 3H), 3.20 – 3.10 (m, 4H), 2.51 – 2.37 (m, 1H), 1.79 – 1.64 (m, 2H), 1.54 – 1.38 (m, 4H), 1.33 – 1.14 (m, 2H), 1.03 (d, *J* = 6.6 Hz, 3H), 0.95 – 0.79 (m, 2H).

^{13}C NMR (101 MHz, CDCl3) δ 177.19, 152.43, 145.34, 130.30, 118.52, 114.64, 114.31, 66.84, 48.97, 41.03, 38.07, 37.43, 35.87, 32.96, 32.62, 25.11, 25.08, 18.67.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{28}N_2O_2$ 329.2224; Found 329.2220.

3-(cyclopentylmethyl)-1,3,7-trimethylindolin-2-one (9ia)



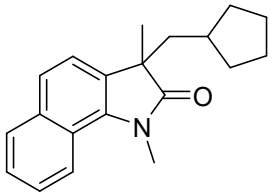
White oil, 52% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.05 (d, *J* = 7.9 Hz, 1H), 6.98 (d, *J* = 1.8 Hz, 1H), 6.72 (d, *J* = 7.8 Hz, 1H), 3.19 (s, 3H), 2.35 (s, 3H), 2.04 (dd, *J* = 13.6, 7.2 Hz, 1H), 1.87 (dd, *J* = 13.7, 5.6 Hz, 1H), 1.53 – 1.35 (m, 4H), 1.32 (s, 3H), 1.29 – 1.23 (m, 3H), 1.00 (dq, *J* = 11.1, 8.1 Hz, 1H), 0.89 – 0.75 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 181.17, 140.99, 134.55, 131.81, 127.84, 123.78, 107.63, 48.60, 44.53, 37.29, 33.89, 32.71, 26.29, 25.44, 25.05, 24.91, 21.26.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{23}NO$ 258.1852; Found 258.1837.

3-(cyclopentylmethyl)-1,3-dimethyl-1,3-dihydro-2H-benzo[g]indol-2-one (9ja)



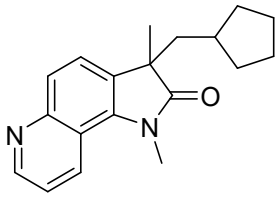
White solid, 48% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (dd, *J* = 8.2, 1.1 Hz, 1H), 7.56 – 7.48 (m, 2H), 7.46 – 7.38 (m, 2H), 6.93 (dd, *J* = 7.5, 1.0 Hz, 1H), 3.52 (s, 3H), 2.46 (dd, *J* = 13.7, 7.5 Hz, 1H), 1.99 (dd, *J* = 13.6, 5.2 Hz, 1H), 1.70 (s, 3H), 1.48 – 1.35 (m, 4H), 1.25 – 1.11 (m, 3H), 1.06 – 0.95 (m, 1H), 0.83 – 0.71 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 173.96, 138.71, 137.02, 133.36, 126.97, 126.35, 125.80, 123.26, 122.47, 119.86, 108.15, 51.35, 47.30, 37.65, 33.84, 32.41, 32.09, 29.69, 25.08, 24.79.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{23}NO$ 294.1852; Found 294.1834

3-(cyclopentylmethyl)-1,3-dimethyl-1,3-dihydro-2H-pyrrolo[2,3-f]quinolin-2-one (9ka)



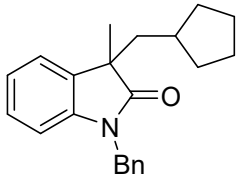
White solid, 56% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.87 (d, *J* = 4.6 Hz, 1H), 7.75 (d, *J* = 8.5 Hz, 1H), 7.64 (t, *J* = 8.1 Hz, 1H), 7.28 – 7.24 (m, 1H), 6.95 (d, *J* = 7.6 Hz, 1H), 3.50 (s, 3H), 2.46 (dd, *J* = 13.7, 7.6 Hz, 1H), 1.97 (dd, *J* = 13.7, 5.0 Hz, 1H), 1.66 (s, 3H), 1.35 (dt, *J* = 10.7, 6.7 Hz, 3H), 1.19 (dd, *J* = 19.2, 8.1 Hz, 3H), 1.03 – 0.94 (m, 1H), 0.82 – 0.76 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.88, 150.92, 149.21, 148.14, 137.07, 130.32, 123.65, 117.70, 115.54, 108.33, 50.57, 47.15, 37.60, 33.89, 32.30, 31.56, 29.74, 25.03, 24.70.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{22}N_2O$ 294.1732; Found 294.1725

1-benzyl-3-(cyclopentylmethyl)-3-methylindolin-2-one (9la)



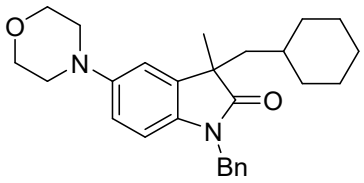
Yellow oil, 32% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (d, *J* = 4.4 Hz, 4H), 7.27 – 7.21 (m, 1H), 7.19 – 7.11 (m, 2H), 7.01 (td, *J* = 7.5, 1.0 Hz, 1H), 6.73 (d, *J* = 7.8 Hz, 1H), 4.92 (s, 2H), 2.15 (dd, *J* = 13.7, 6.4 Hz, 1H), 1.89 (dd, *J* = 13.7, 6.6 Hz, 1H), 1.40 (s, 7H), 1.32 – 1.21 (m, 2H), 1.13 (dt, *J* = 11.6, 7.0 Hz, 1H), 1.07 – 0.96 (m, 1H), 0.75 (dq, *J* = 11.9, 8.6 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 181.15, 142.49, 136.25, 134.63, 128.76, 127.62, 127.55, 127.50, 123.03, 122.34, 109.02, 48.61, 44.37, 43.81, 37.50, 33.71, 33.36, 25.79, 25.03, 24.68.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{25}NO$ 320.2009; Found 320.1990.

1-benzyl-3-(cyclohexylmethyl)-3-methyl-5-morpholinoindolin-2-one (13)



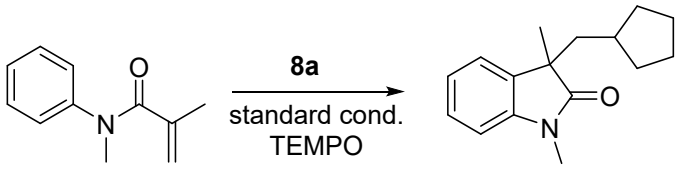
White oil, 50% yield.

^{1}H NMR (400 MHz, CDCl3) δ 7.29 – 7.26 (m, 4H), 7.24 – 7.20 (m, 1H), 6.81 (d, J = 2.3 Hz, 1H), 6.67 (dd, J = 8.4, 2.4 Hz, 1H), 6.62 (d, J = 8.4 Hz, 1H), 5.01 (d, J = 15.5 Hz, 1H), 4.74 (d, J = 15.5 Hz, 1H), 3.85 (dd, J = 5.3, 4.2 Hz, 4H), 3.04 (td, J = 4.3, 2.5 Hz, 4H), 1.96 (dd, J = 14.0, 6.3 Hz, 1H), 1.70 (dd, J = 14.0, 5.8 Hz, 1H), 1.52 – 1.40 (m, 4H), 1.34 (s, 3H), 1.20 – 1.10 (m, 1H), 1.06 – 0.89 (m, 4H), 0.89 – 0.80 (m, 1H), 0.75 – 0.63 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 180.82, 147.78, 136.34, 136.13, 135.79, 128.75, 127.56, 127.51, 115.07, 112.89, 109.34, 67.06, 50.96, 48.41, 45.59, 43.86, 34.87, 34.43, 34.05, 26.79, 26.17, 26.09.

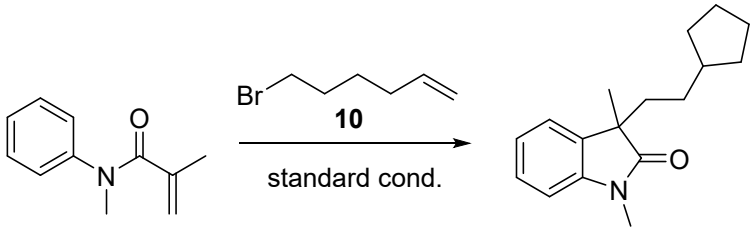
HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{27}H_{34}N_2O_2$ 419.2693; Found 419.2702.

6. Procedures for mechanistic experiments.



7a **9aa**, 0%

To a 1.5 mL headspace vial were added **7a** (0.2 mmol), $Ni(acac)_2$ (0.02 mmol), 4,4'-Di-tert-butyl-2,2'-dipyridyl (0.02 mmol), TEMPO (0.3 mmol) and Mn powder (0.6 mmol). The vial was transferred to glove box, and DMF (400 μL) and **8a** (0.6 mmol) was added. The vial was capped, and the reaction was performed at 60 °C for 24 h. No product was detected by TLC.



7a **11**, 58%

To a 1.5 mL headspace vial were added **7a** (0.2 mmol), $Ni(acac)_2$ (0.02 mmol), 4,4'-Di-tert-butyl-2,2'-dipyridyl (0.02 mmol) and Mn powder (0.6 mmol). The vial was transferred to glove box, and DMF (400 μL) and **10** (0.6 mmol) was added. The vial was capped, and the reaction was performed at 60 °C for 24 h. The organic phase was separated and the aqueous layer was extracted with ethyl ether. The combined organic phase was washed with saturated brine and dried over sodium sulfate. The solvent was removed by rotary evaporation and the residue was transferred to a short column on silica gel using petroleum ether/ethyl acetate as the eluent to give **11** as white oil in 58% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.26 (s, 4H), 7.16 (dd, *J* = 7.3, 1.3 Hz, 1H), 7.06 (td, *J* = 7.4, 1.0 Hz, 1H), 6.84 (d, *J* = 7.7 Hz, 1H), 3.21 (s, 3H), 1.90 (td, *J* = 12.9, 4.5 Hz, 1H), 1.73 (td, *J* = 13.0, 4.2 Hz, 1H), 1.65 (ddd, *J* = 12.2, 6.0, 3.1 Hz, 2H), 1.58 (d, *J* = 7.0 Hz, 1H), 1.53 – 1.45 (m, 2H), 1.45 – 1.41 (m,

1H), 1.35 (s, 3H), 1.27 – 1.13 (m, 1H), 1.06 – 0.86 (m, 3H), 0.80 (tdd, *J* = 12.6, 7.0, 4.2 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 180.96, 143.44, 134.45, 127.62, 122.49, 107.93, 48.51, 40.22, 37.76, 32.57, 32.53, 30.73, 26.18, 25.21, 23.91.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{23}NO$ 258.1852; Found 258.1847.

7. Cytotoxicity was determined by MTT assay

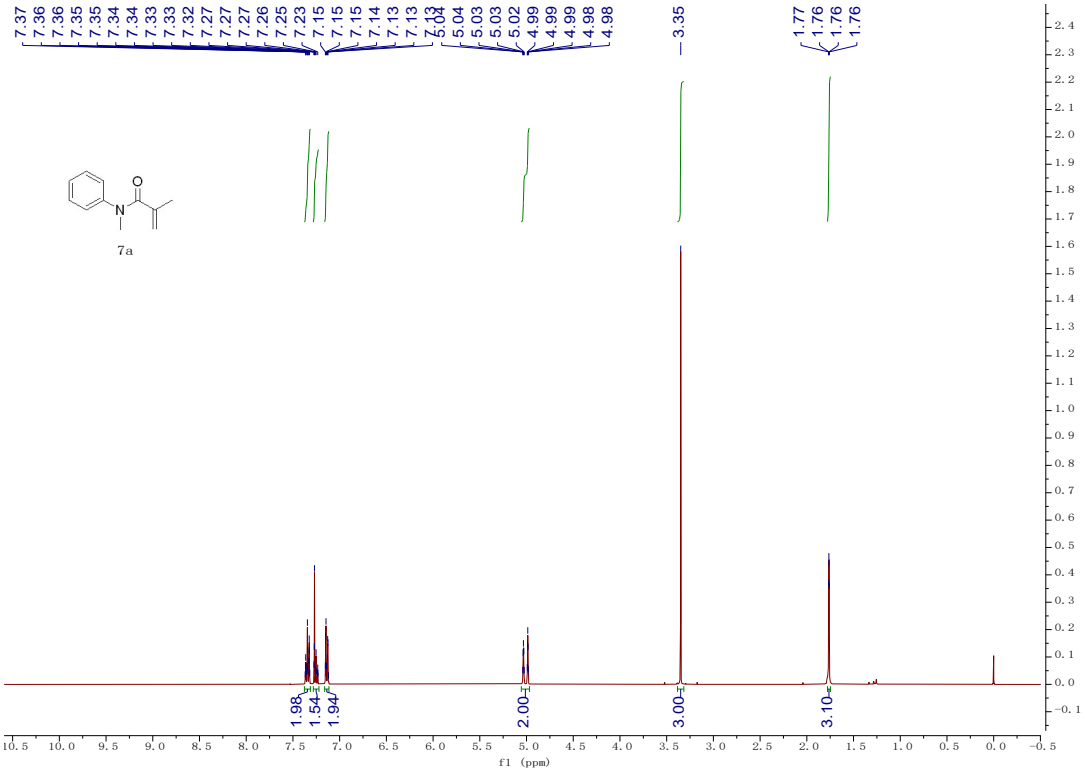
RAW264.7 cells were plated at the concentration of 5×10^4 /well in a 96-well plate and cultured for 24 h. Supernatants were removed and replaced with fresh medium after 24 h. The cells were then treated with synthesized compounds at a concentration of 40 μM or vehicle DMSO for 24 h. Following incubation of the compounds, MTT (5 mg/mL, 20.0 μL) was added into each well of 96-well plates for 4 h. The medium was removed, and 150.0 μL of DMSO was added to each well to dissolve the MTT-formazan crystals. DMSO was used as the vehicle control. The absorbance value (OD value) was recorded at 570 nm by an Absorbance Microplate Reader (Spectra Max iD3).

8. Assay for NO production

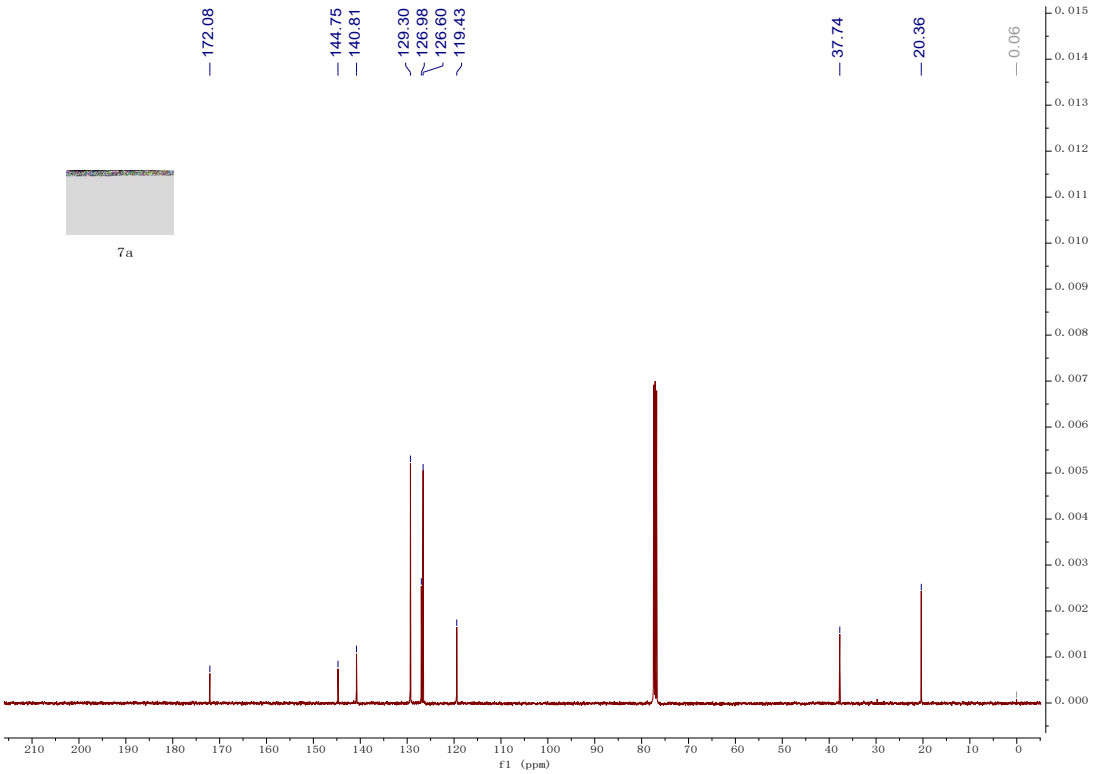
NO production was quantified by nitrite accumulation in the culture medium using the Griess reaction. RAW264.7 cells were plated at the concentration of 5×10^4 /well in a 96-well plate and cultured for 24 h. Supernatants were removed and replaced with fresh medium after 24 h. RAW264.7 cells were pretreated with compounds (10 μM) for 2 h and then stimulated with or without LPS (1 μg/mL) for 24 h. The isolated supernatants were mixed with an equal volume of Griess reagent. $NaNO_2$ was used to generate a standard curve, and nitrite production was determined by measuring the optical density at 540 nm by a microplate reader.

9. Copies of NMR Spectra

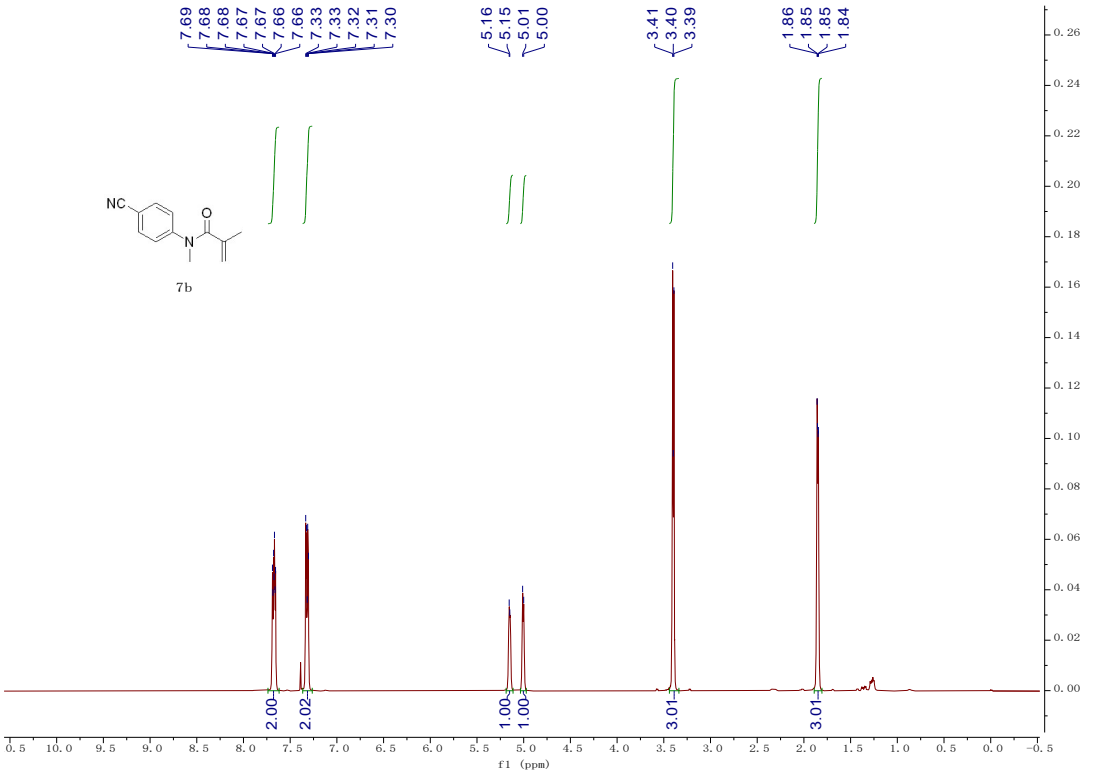
^{1}H NMR of compound 7a in $CDCl_3$ at 400 MHz



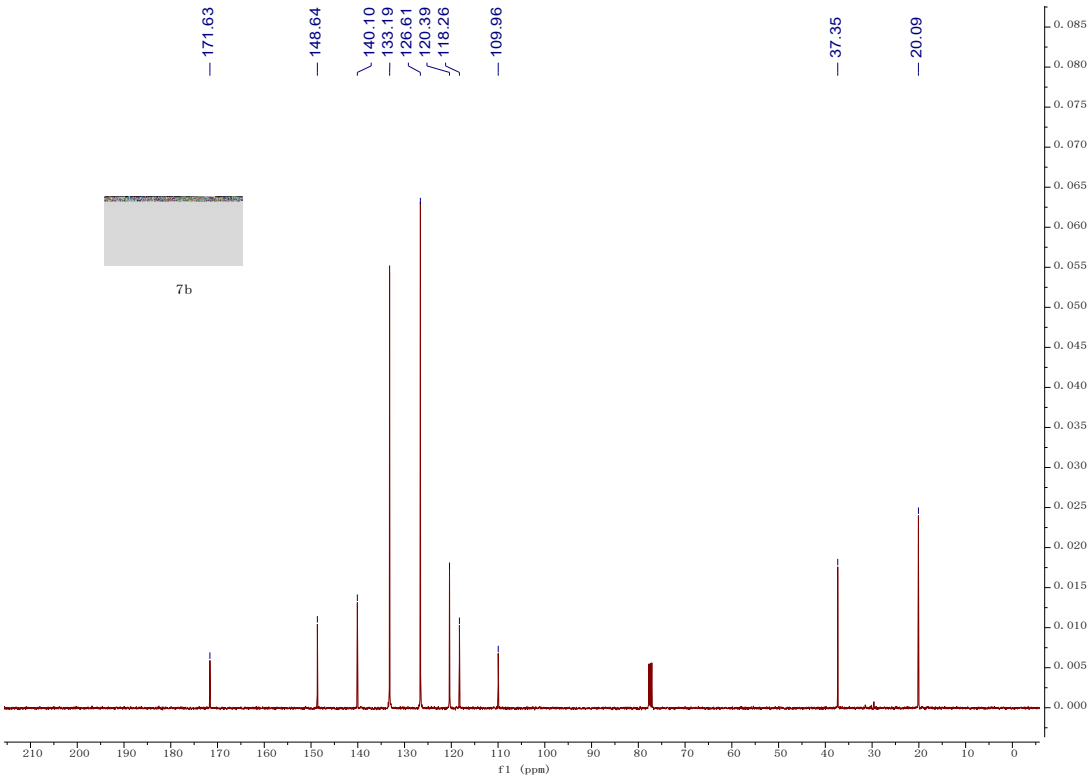
^{13}C NMR of compound 7a in $CDCl_3$ at 101 MHz



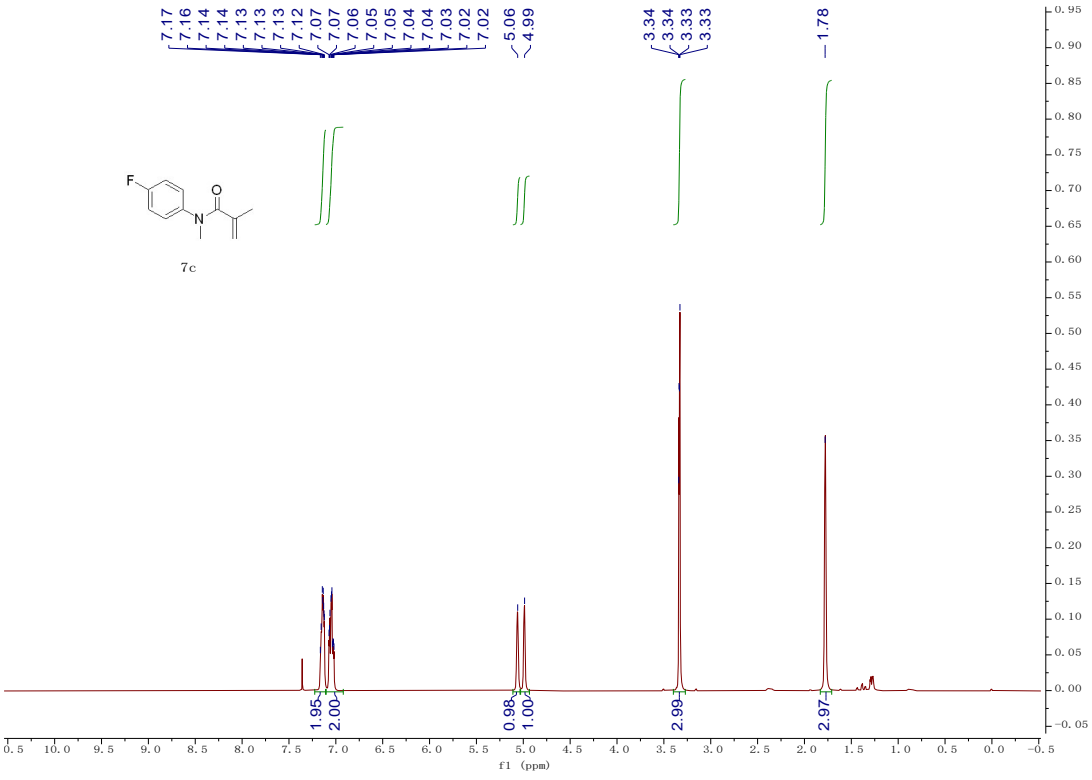
^{1}H NMR of compound 7b in $CDCl_3$ at 400 MHz



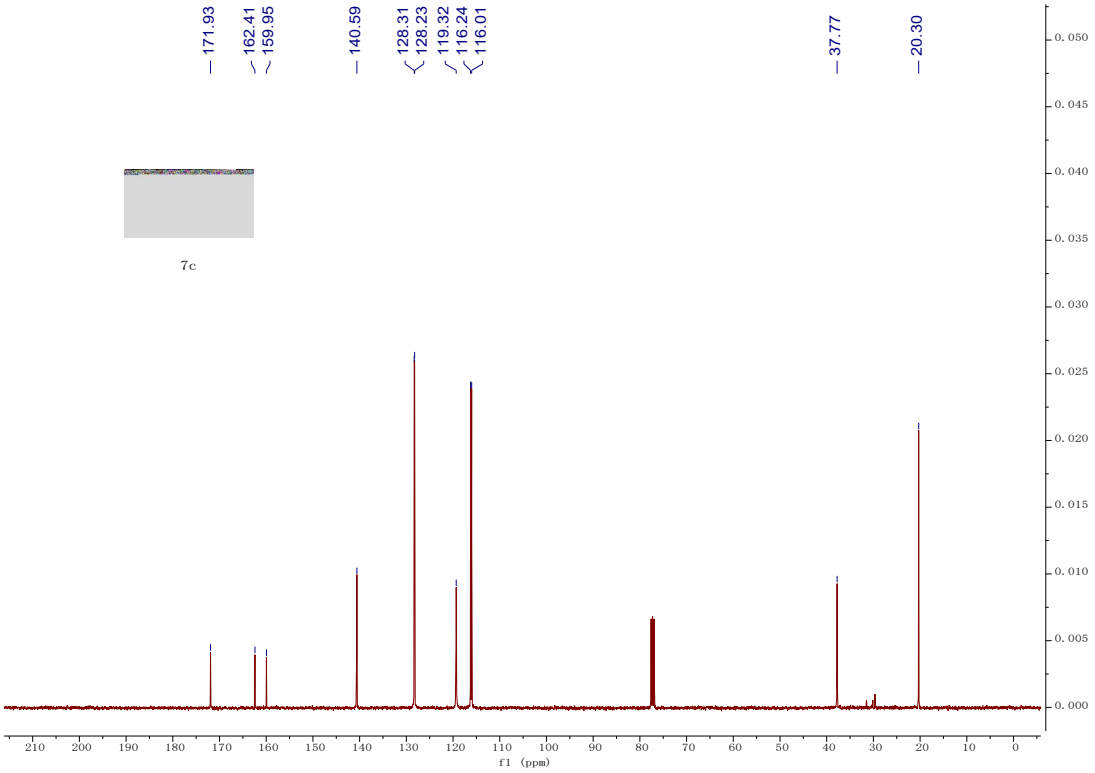
^{13}C NMR of compound 7b in $CDCl_3$ at 101 MHz



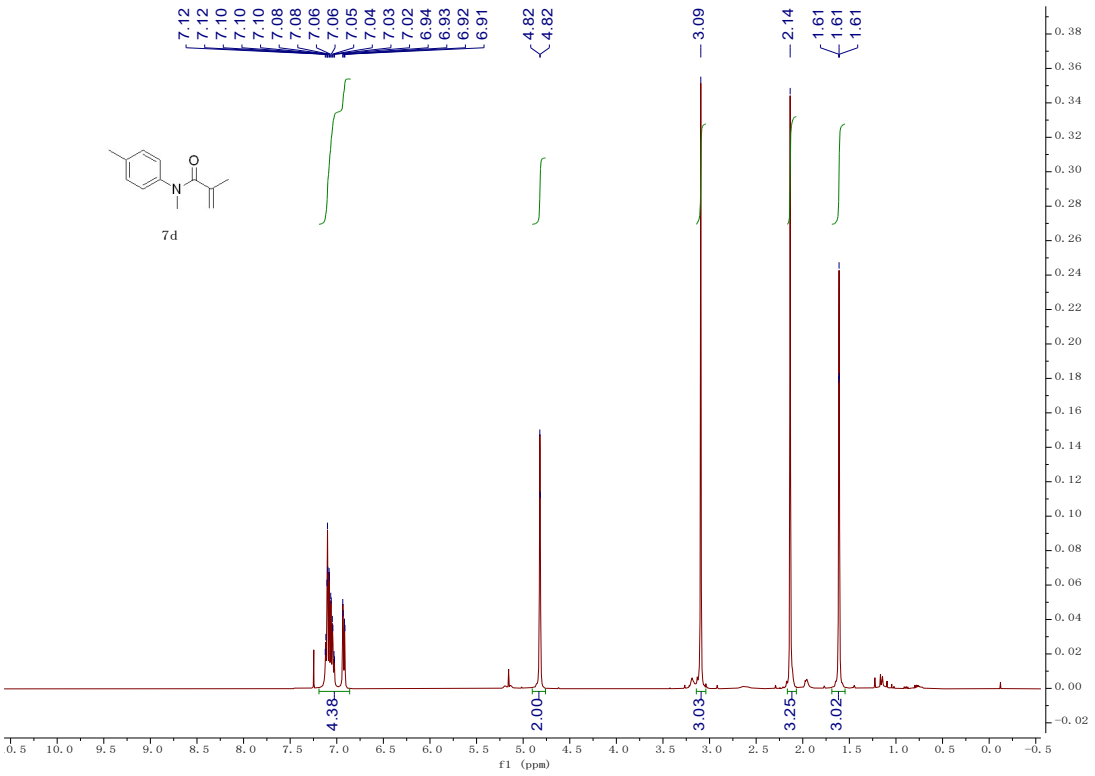
^{1}H NMR of compound 7c in $CDCl_3$ at 400 MHz



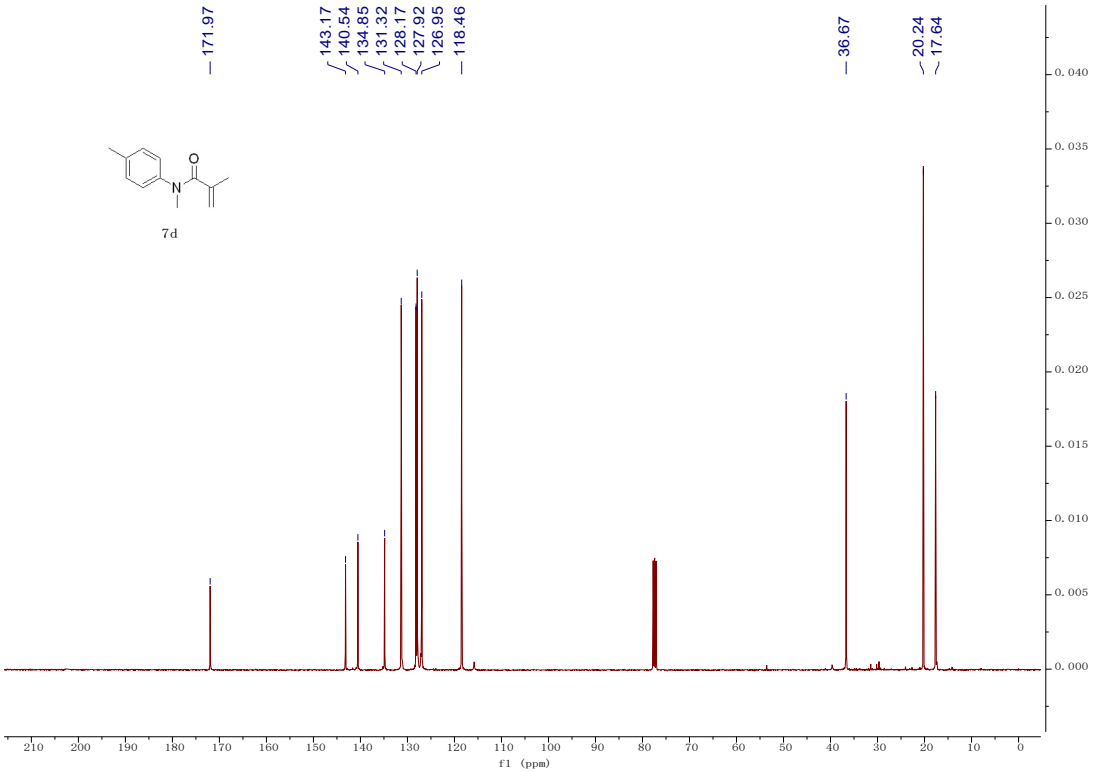
^{13}C NMR of compound 7c in $CDCl_3$ at 101 MHz



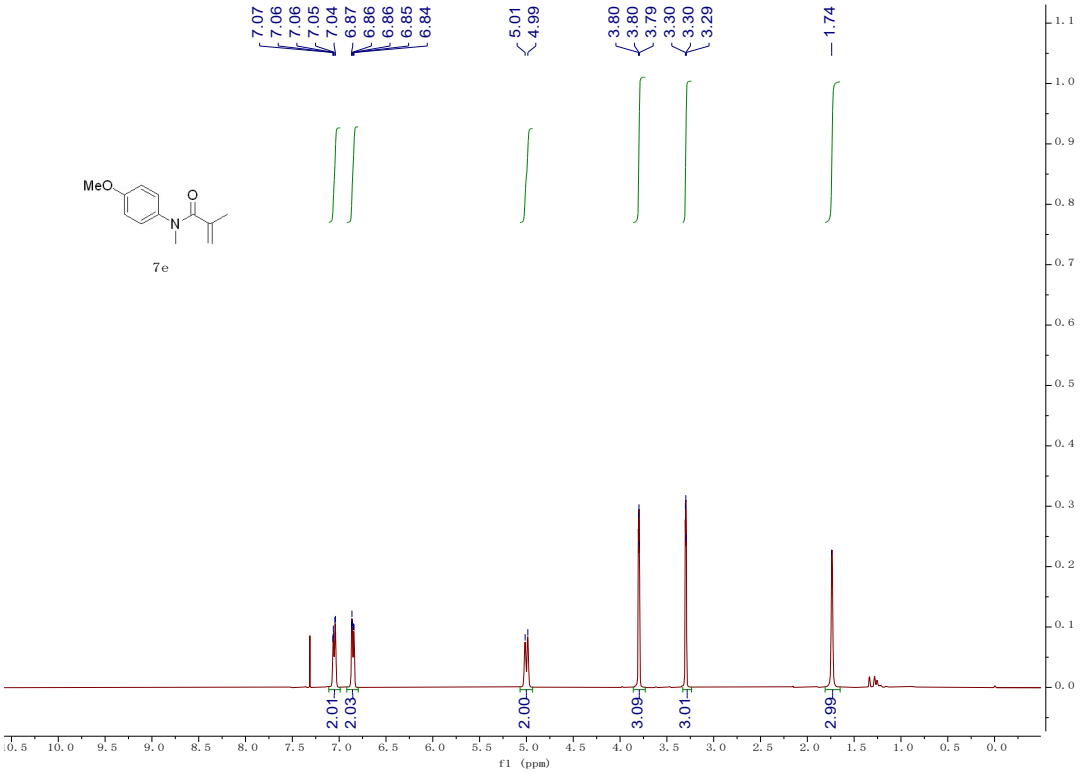
^{1}H NMR of compound 7d in $CDCl_3$ at 400 MHz



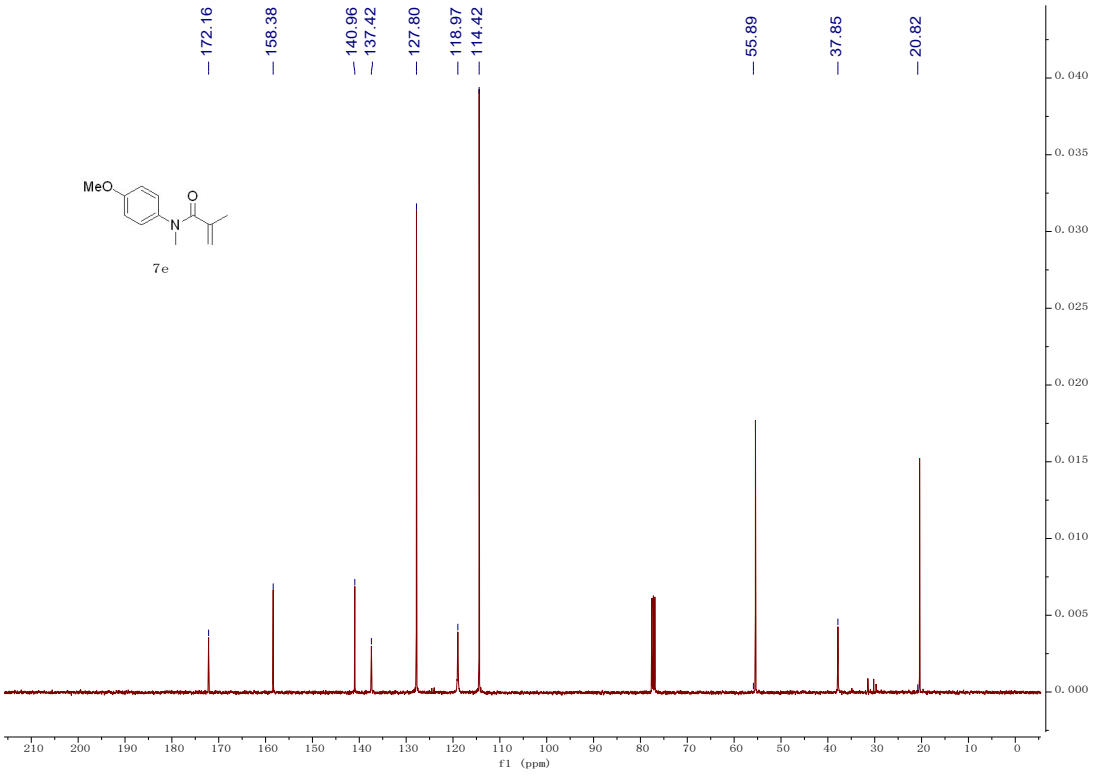
^{13}C NMR of compound 7d in $CDCl_3$ at 101 MHz



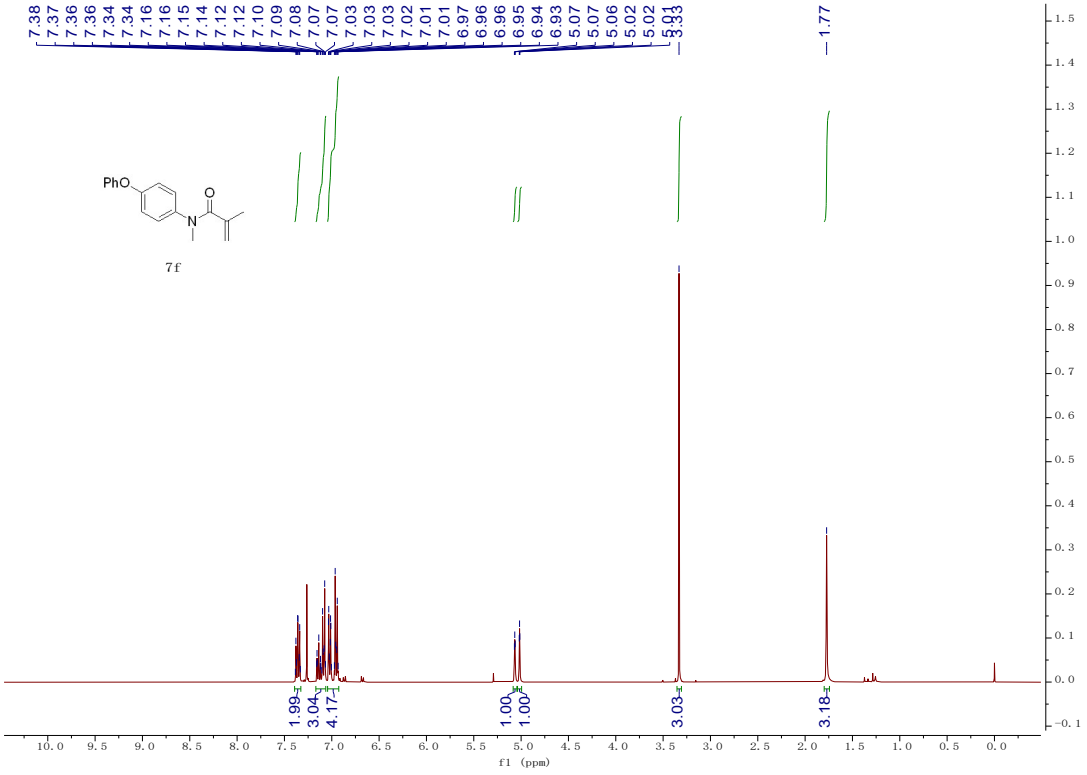
^{1}H NMR of compound 7e in $CDCl_3$ at 400 MHz



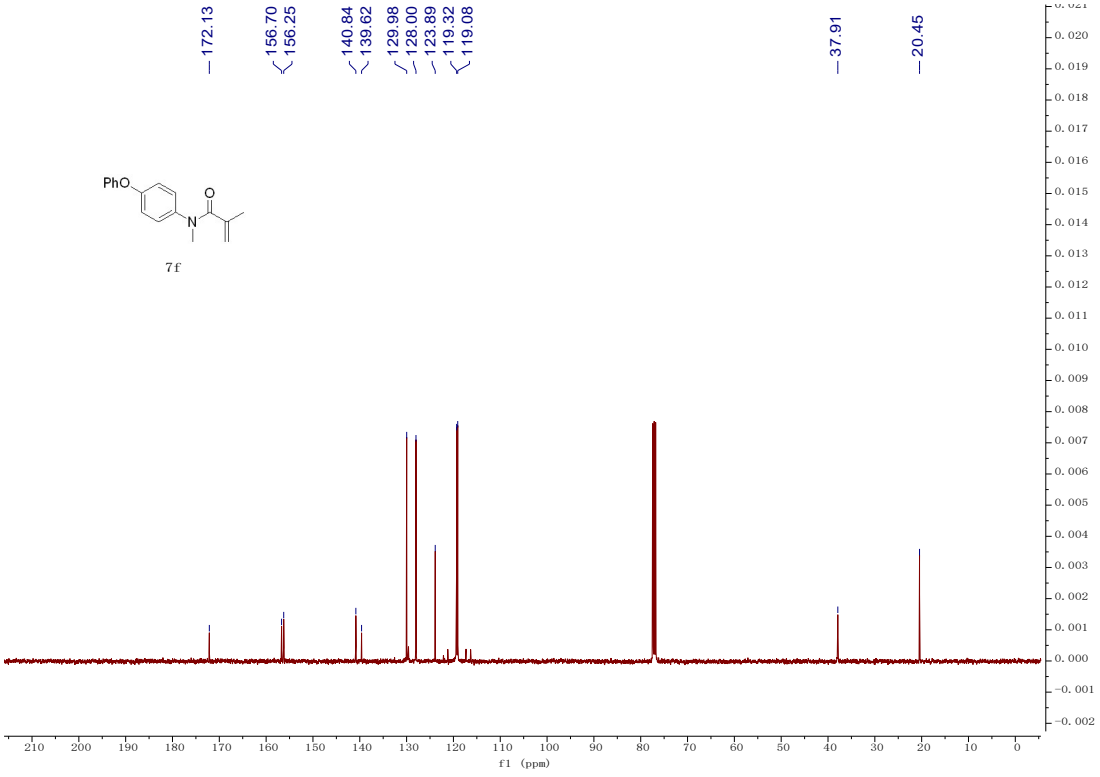
^{13}C NMR of compound 7e in $CDCl_3$ at 101 MHz



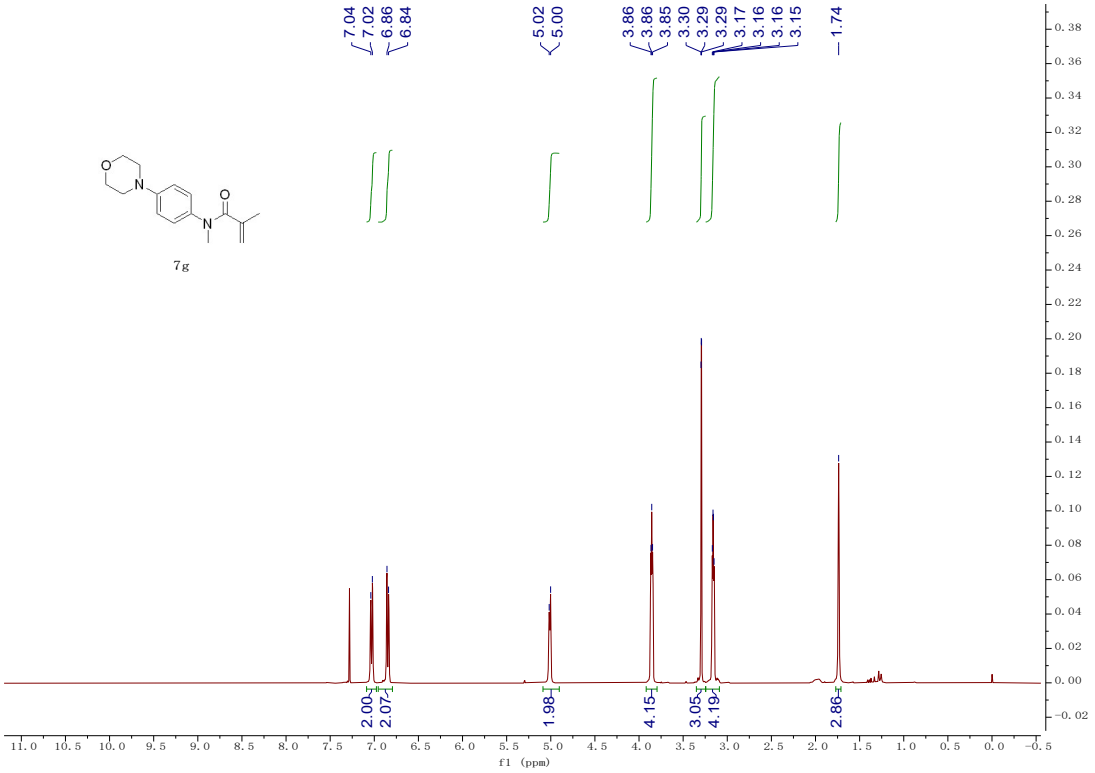
^{1}H NMR of compound 7f in $CDCl_3$ at 400 MHz



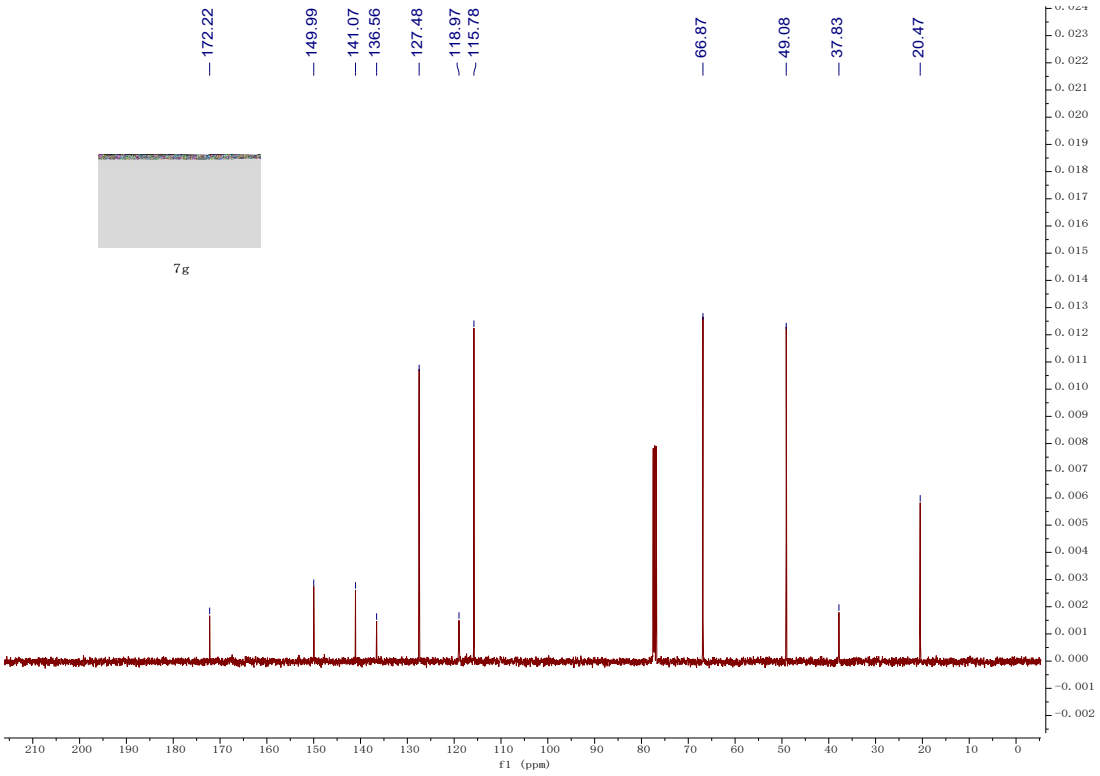
^{13}C NMR of compound 7f in $CDCl_3$ at 101 MHz



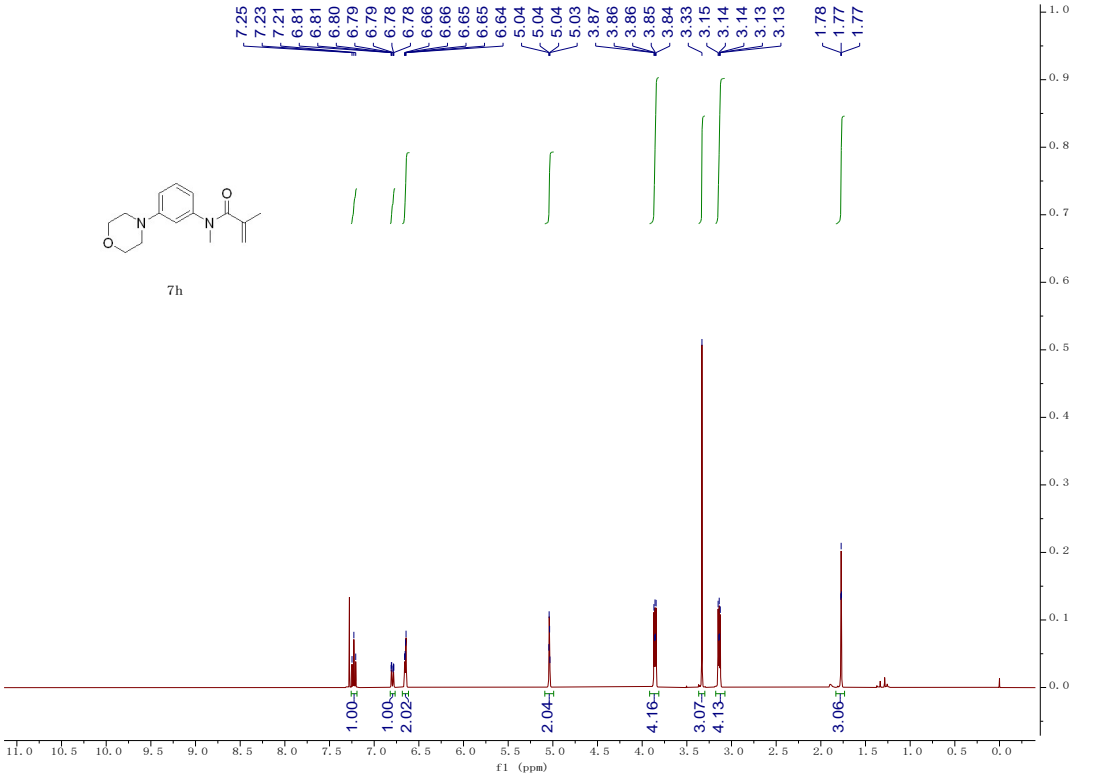
^{1}H NMR of compound 7g in $CDCl_3$ at 400 MHz



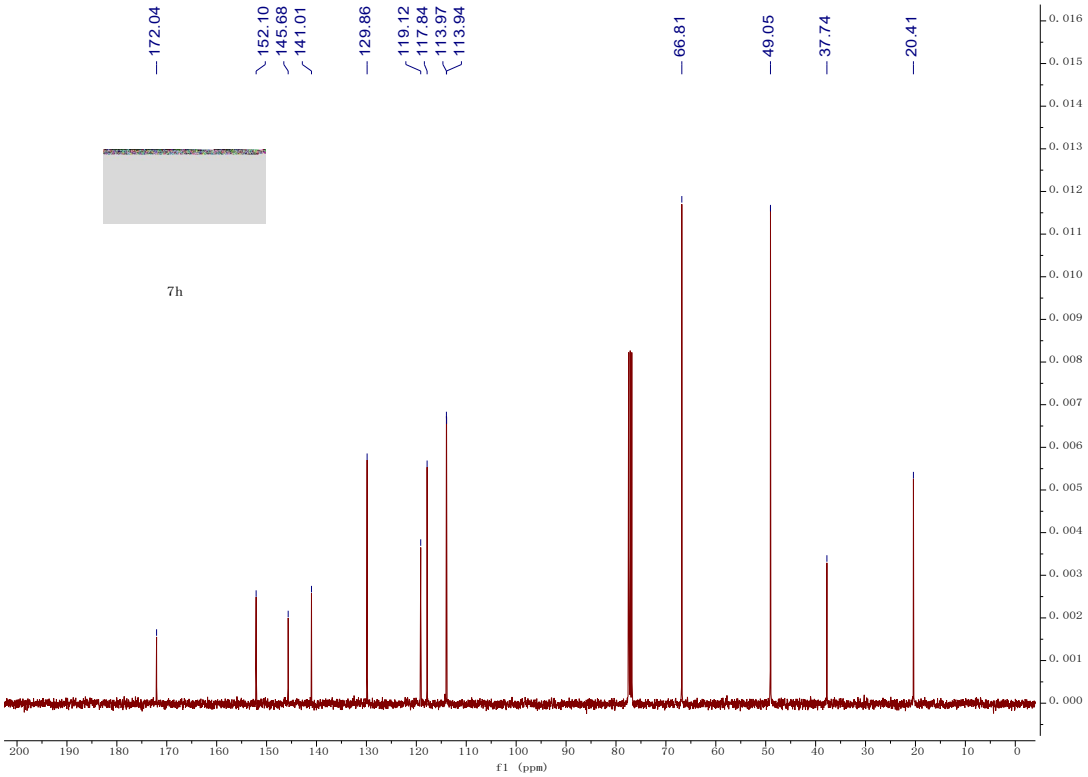
^{13}C NMR of compound 7g in $CDCl_3$ at 101 MHz



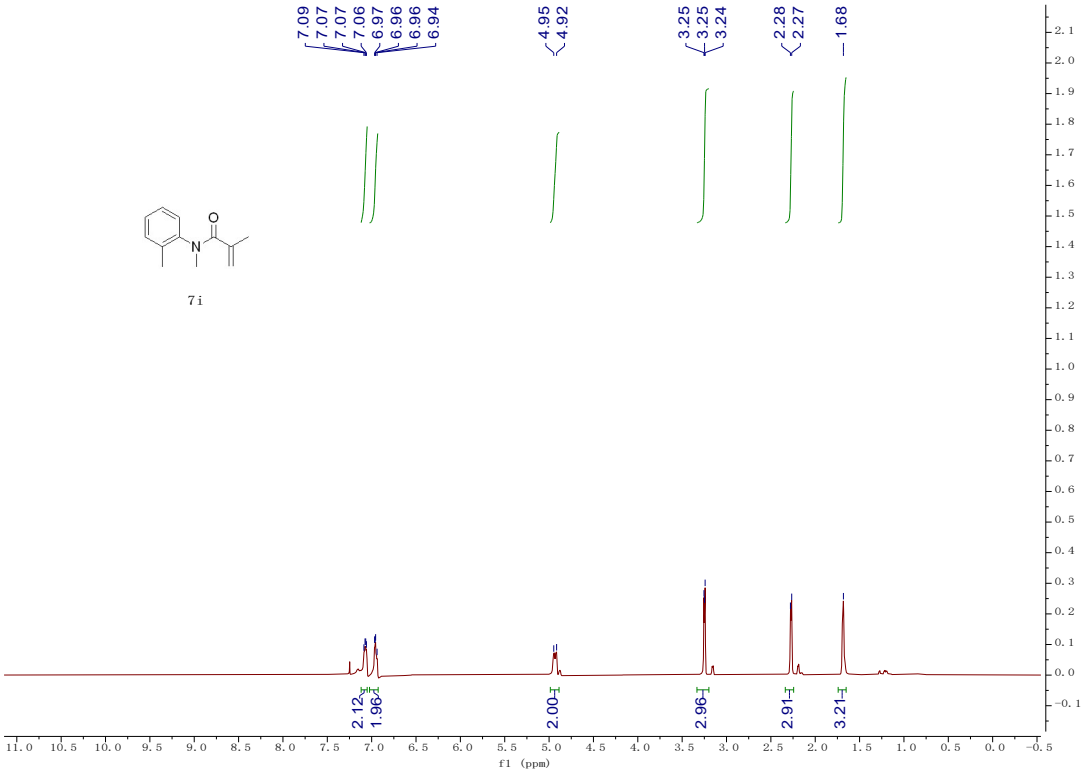
^{1}H NMR of compound 7h in $CDCl_3$ at 400 MHz



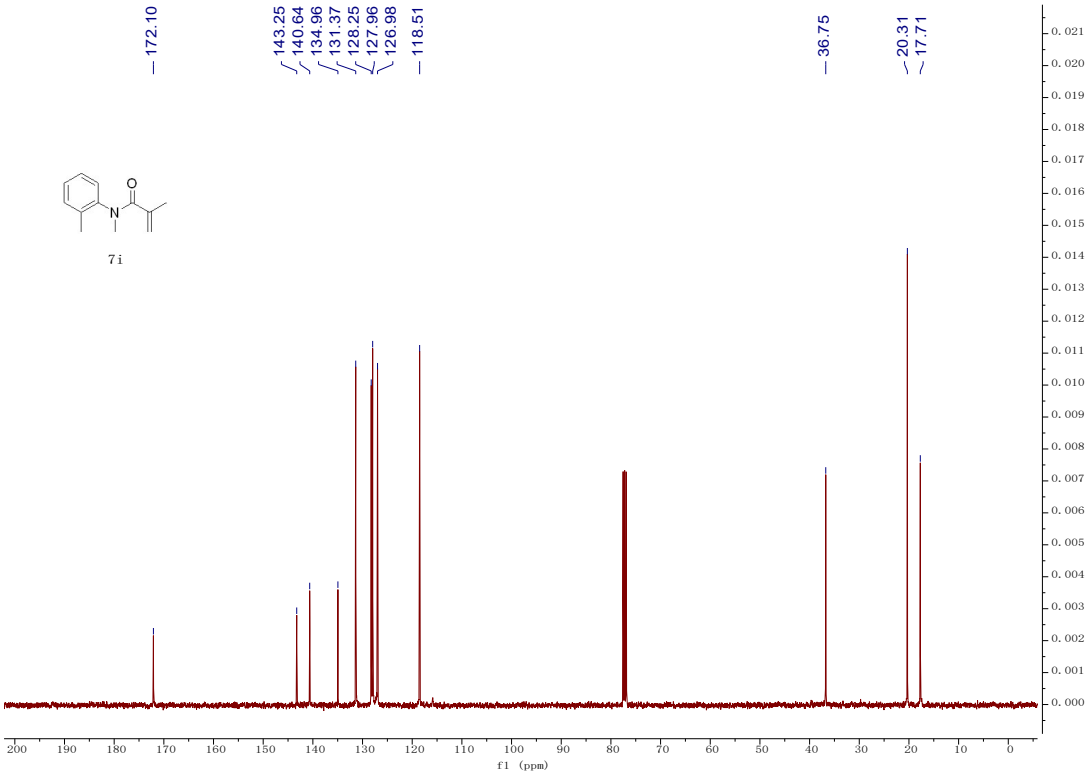
^{13}C NMR of compound 7h in $CDCl_3$ at 101 MHz



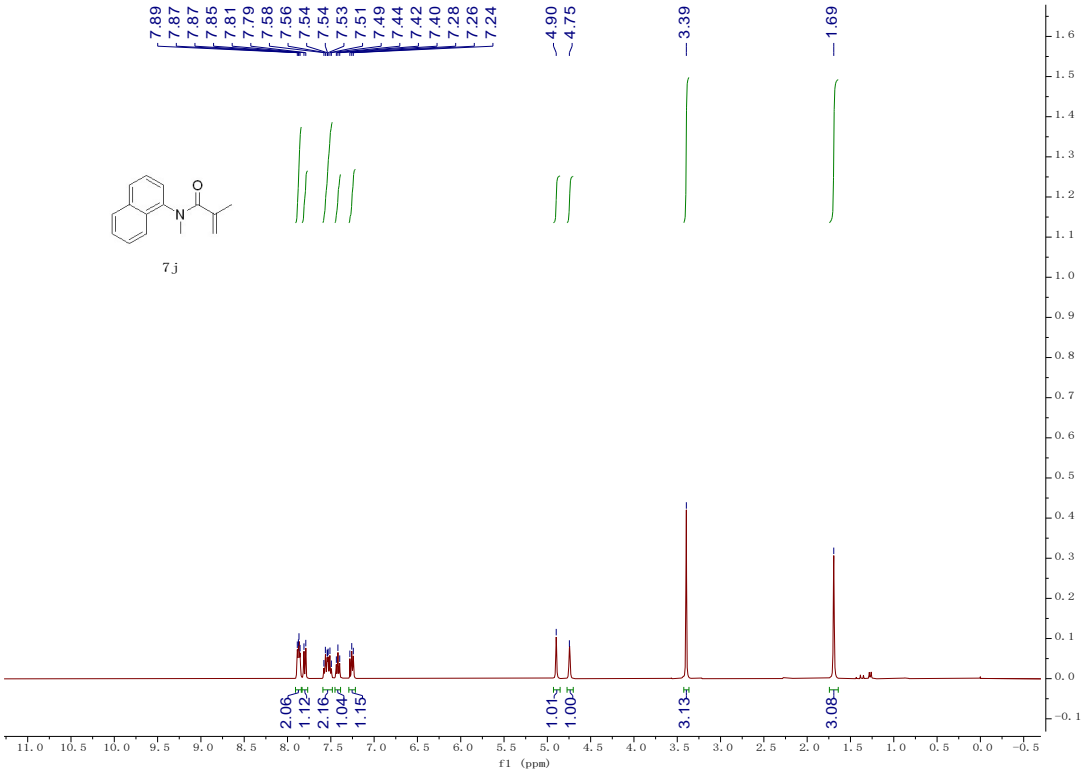
^{1}H NMR of compound 7i in $CDCl_3$ at 400 MHz



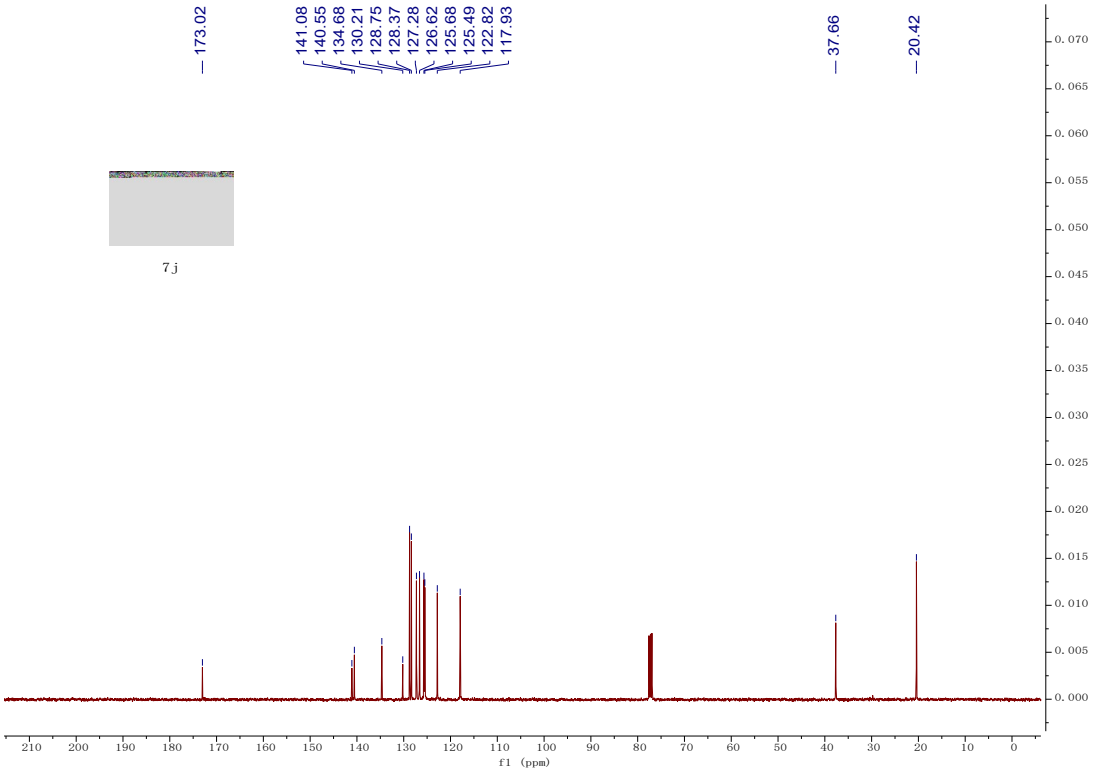
^{13}C NMR of compound 7i in $CDCl_3$ at 101 MHz



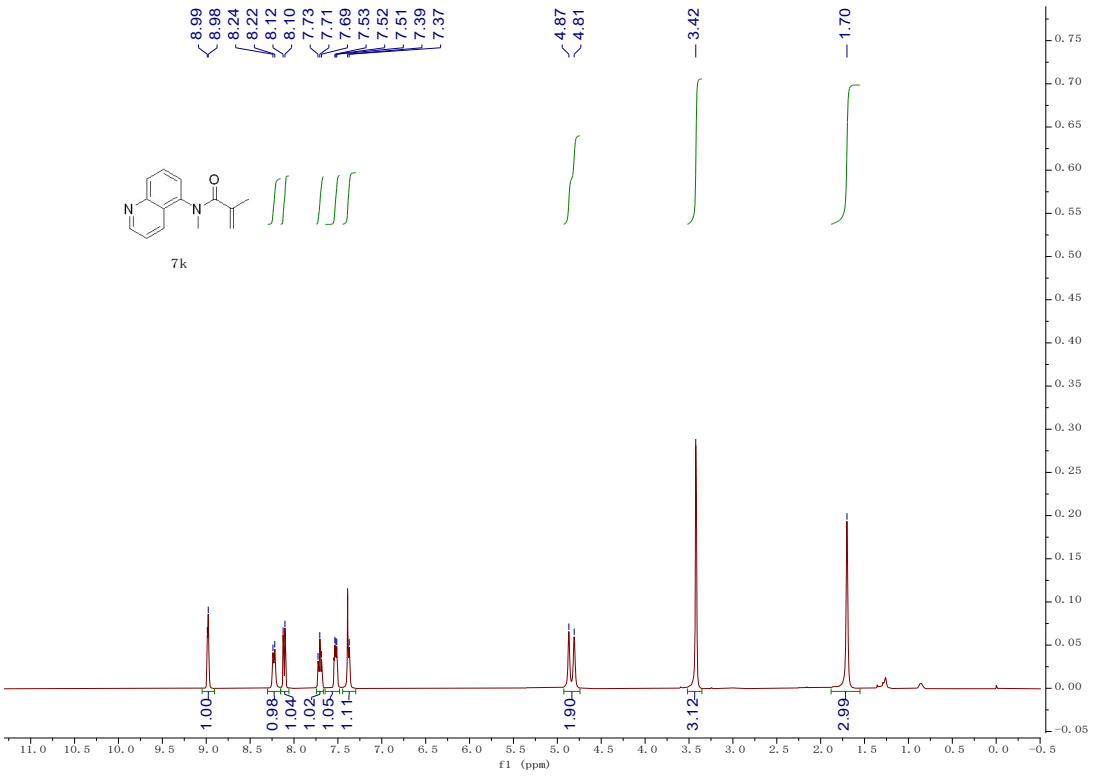
^{1}H NMR of compound 7j in $CDCl_3$ at 400 MHz



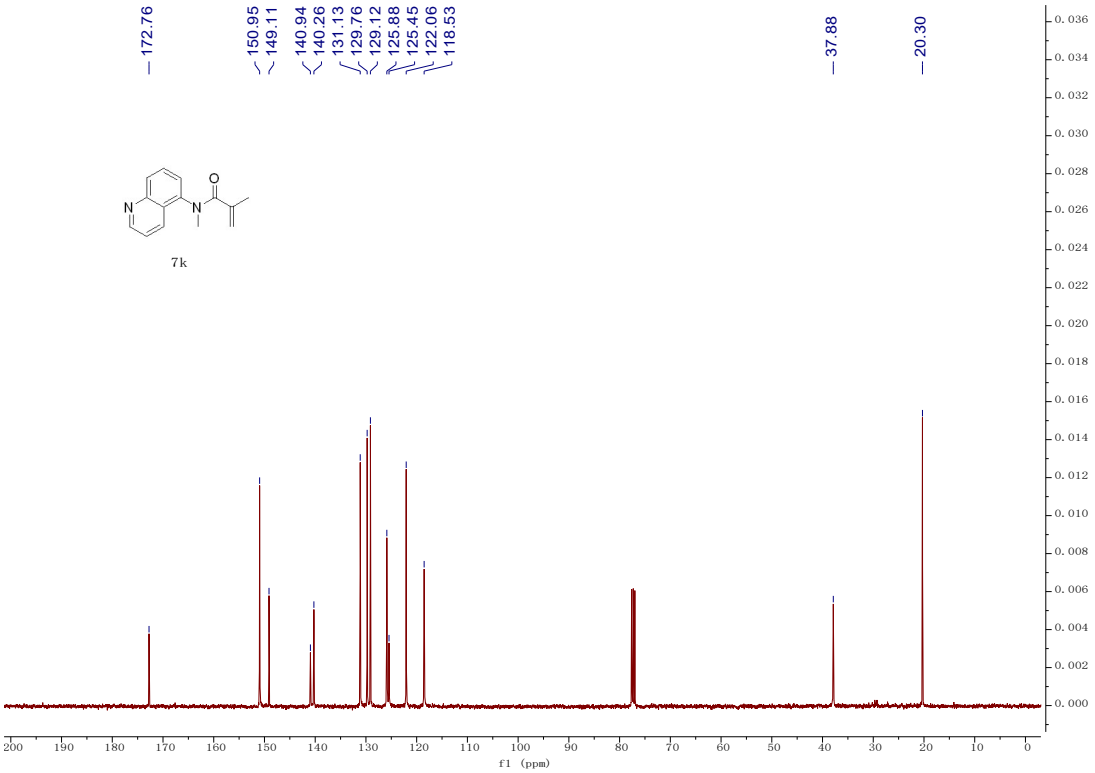
^{13}C NMR of compound 7j in $CDCl_3$ at 101 MHz



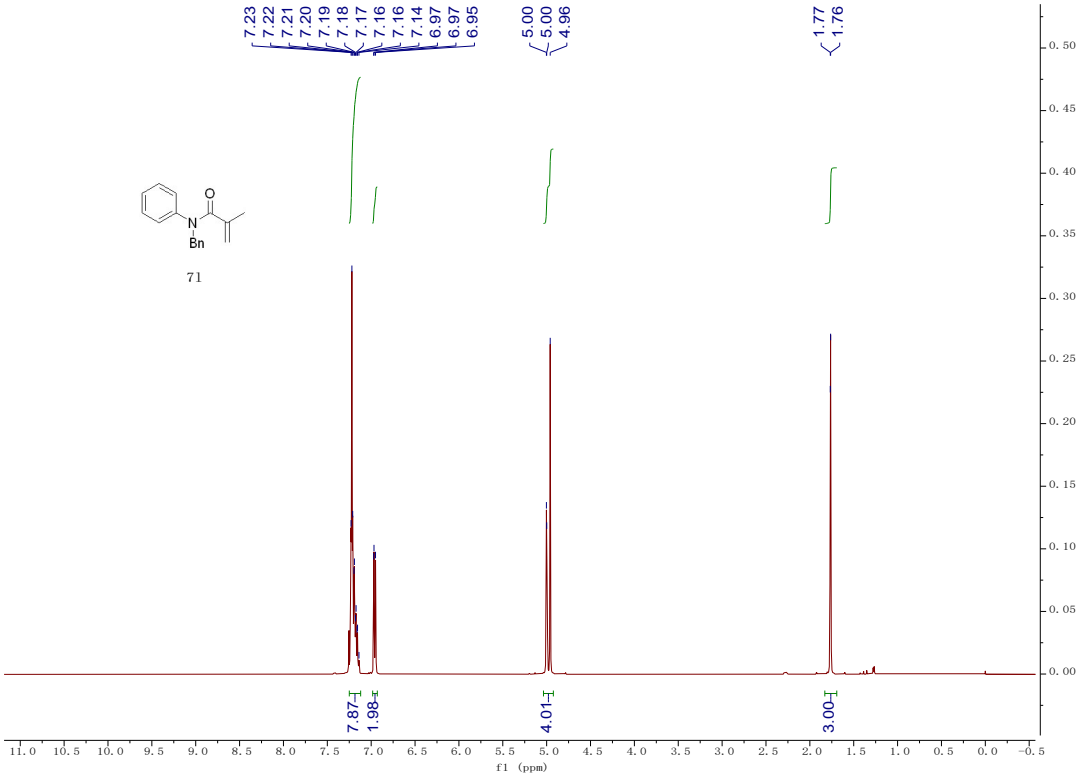
^{1}H NMR of compound 7k in $CDCl_3$ at 400 MHz



^{13}C NMR of compound 7k in $CDCl_3$ at 101 MHz

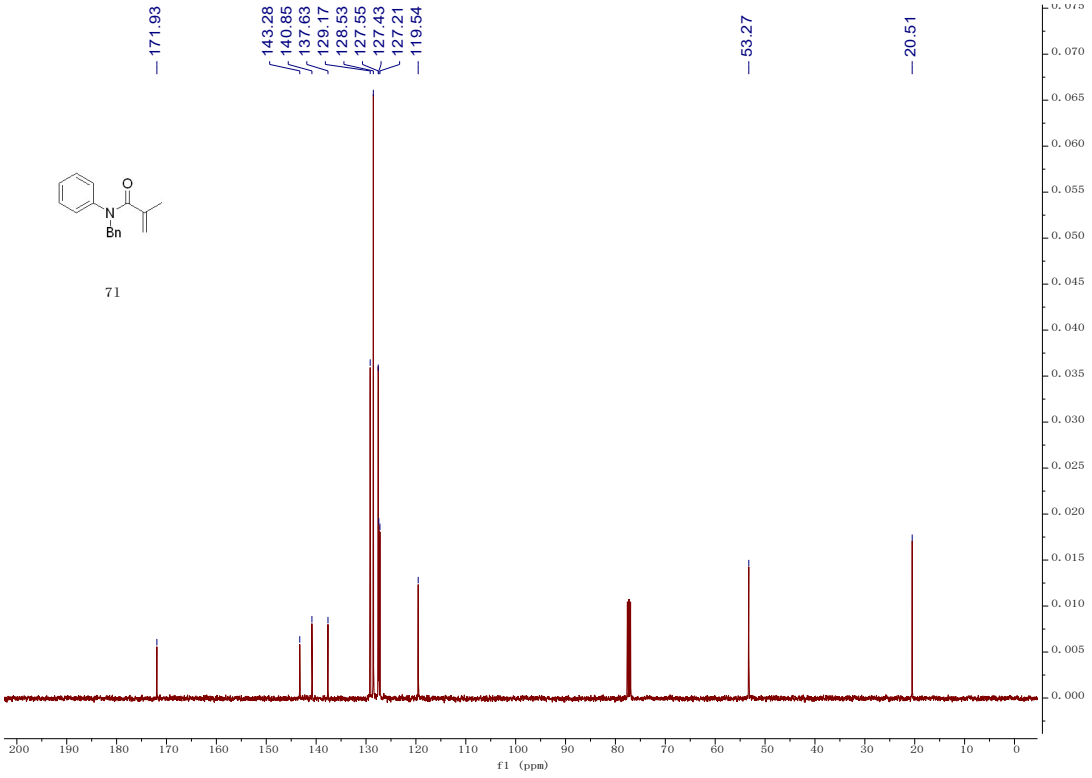


^{1}H NMR of compound 7l in $CDCl_3$ at 400 MHz



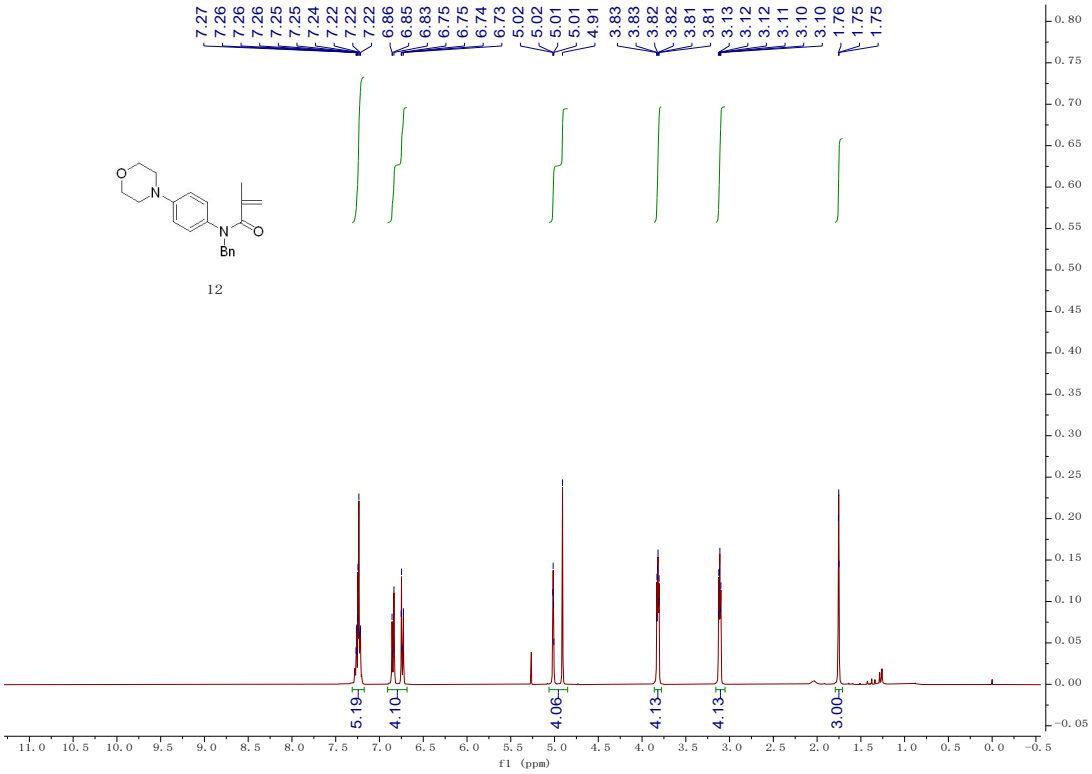
71

^{13}C NMR of compound 7l in $CDCl_3$ at 101 MHz

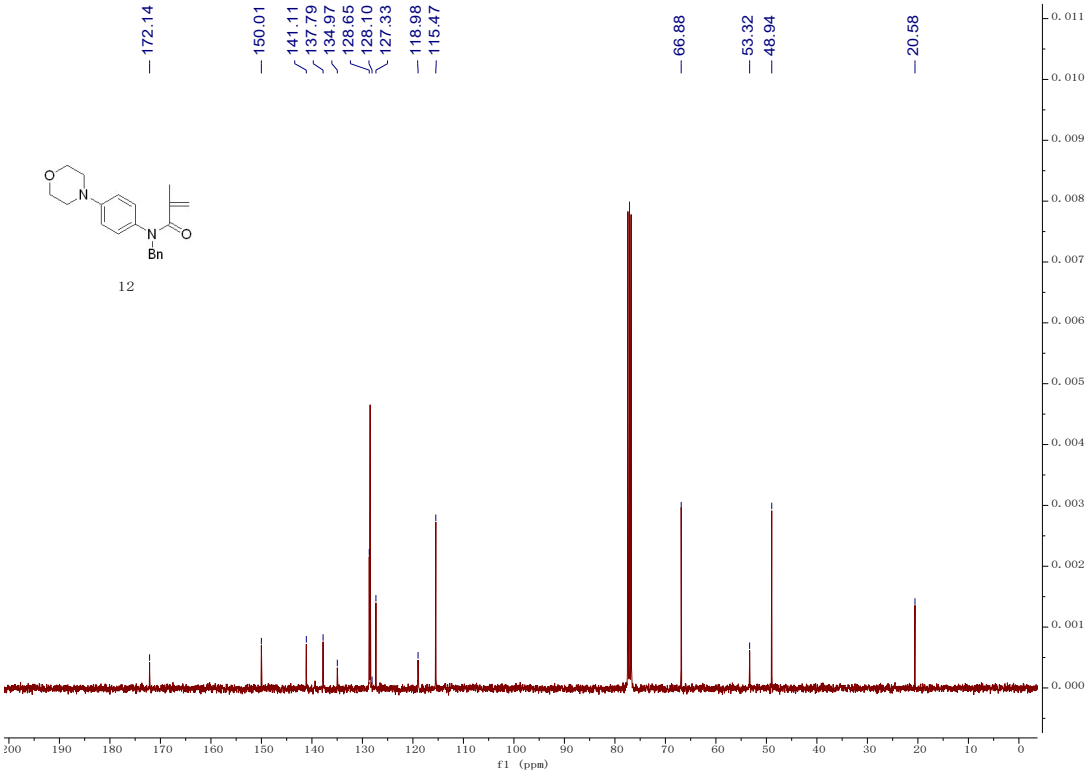


71

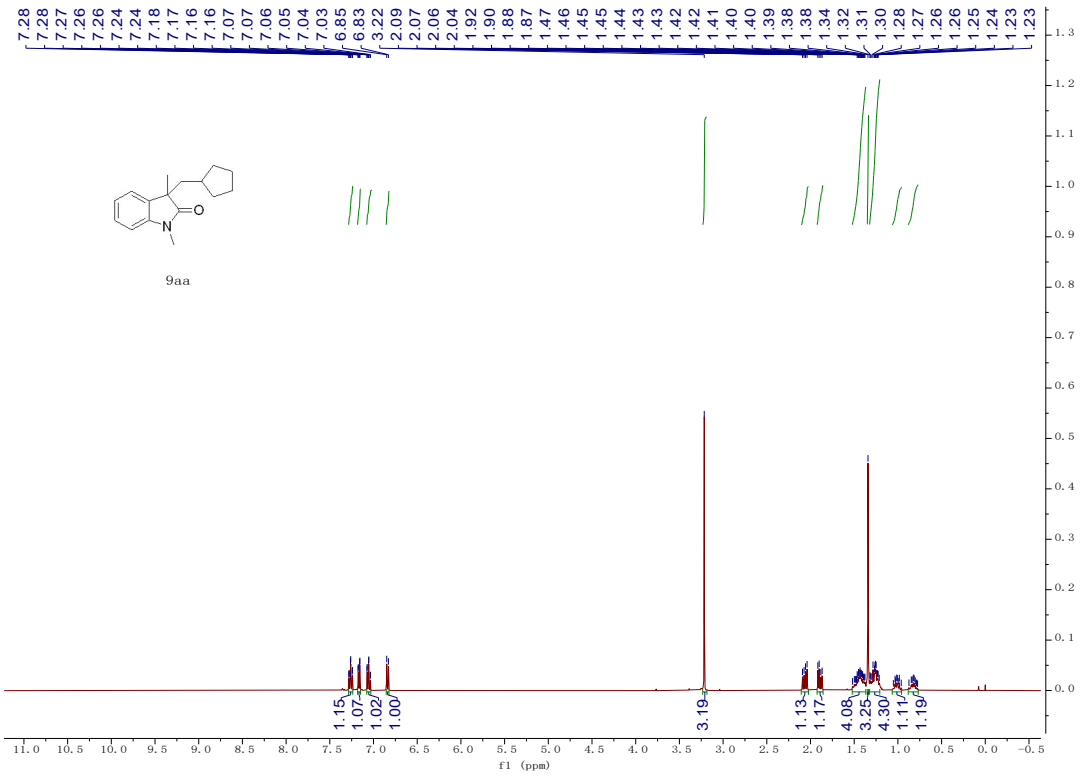
^{1}H NMR of compound 12 in $CDCl_3$ at 400 MHz



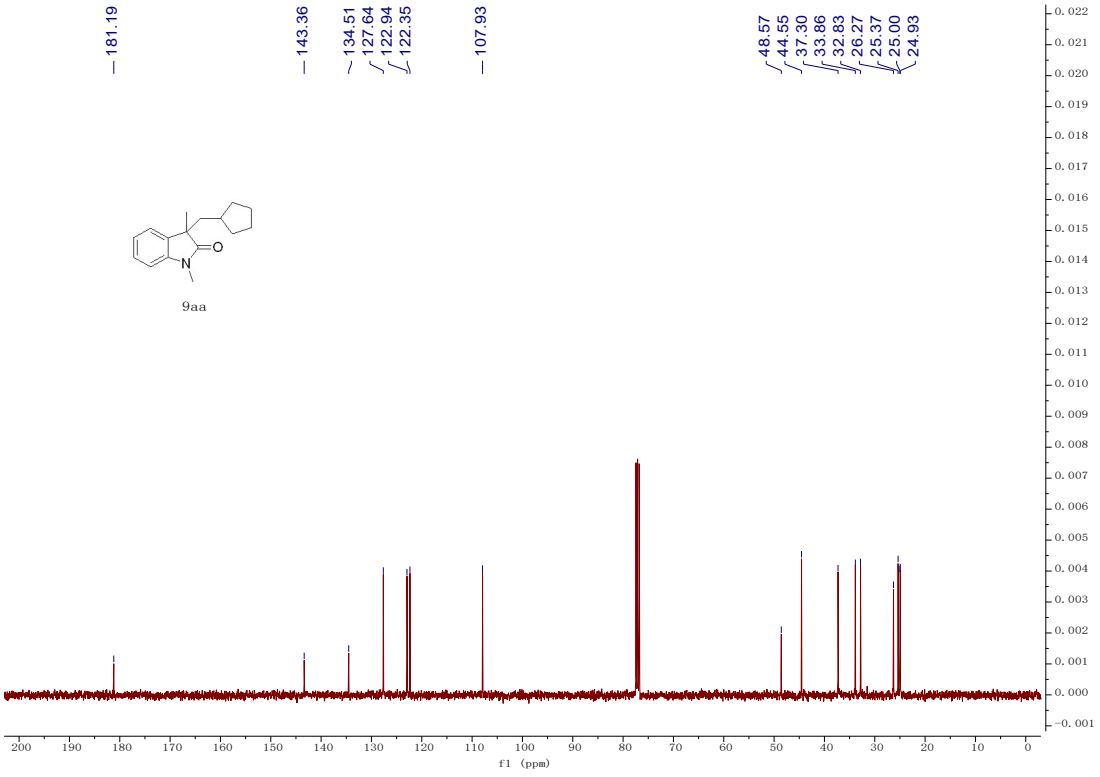
^{13}C NMR of compound 12 in $CDCl_3$ at 101 MHz



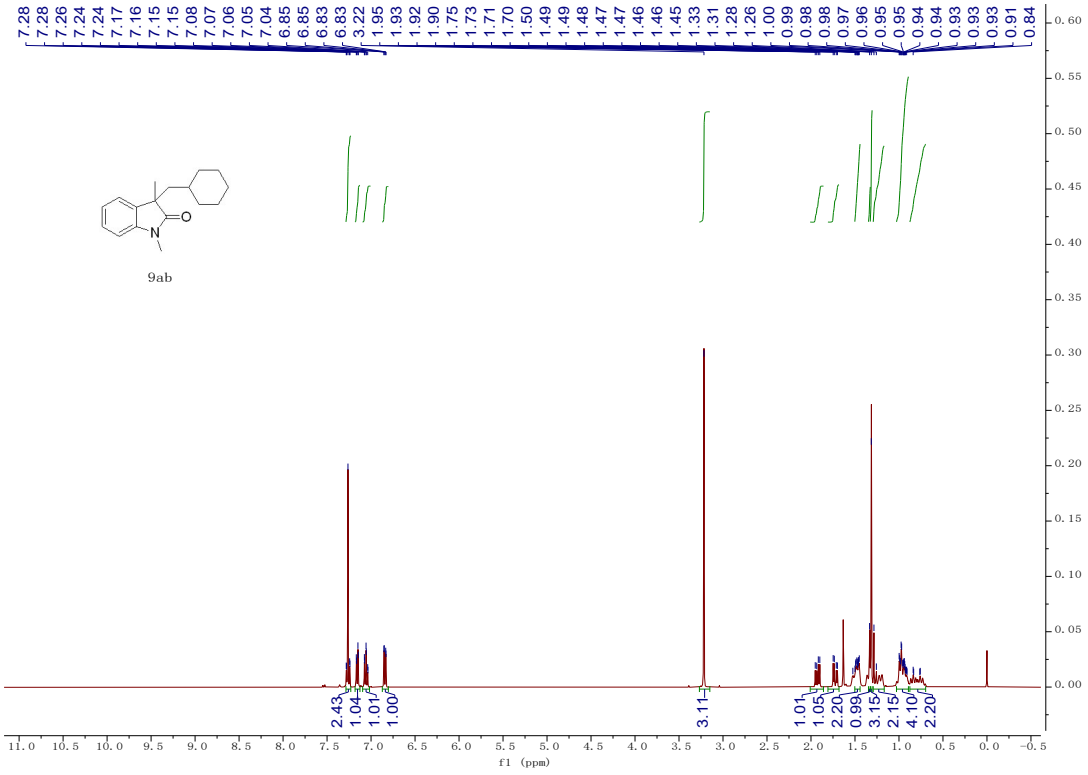
^{1}H NMR of compound 9aa in $CDCl_3$ at 400 MHz



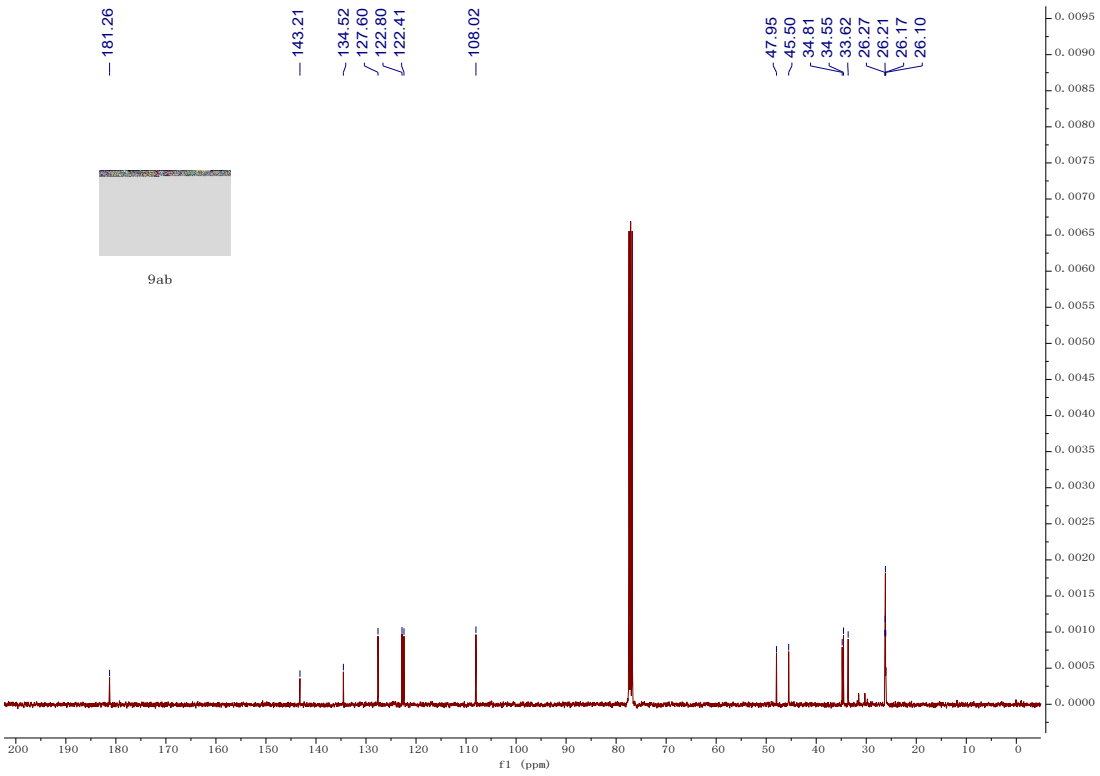
^{13}C NMR of compound 9aa in $CDCl_3$ at 101 MHz



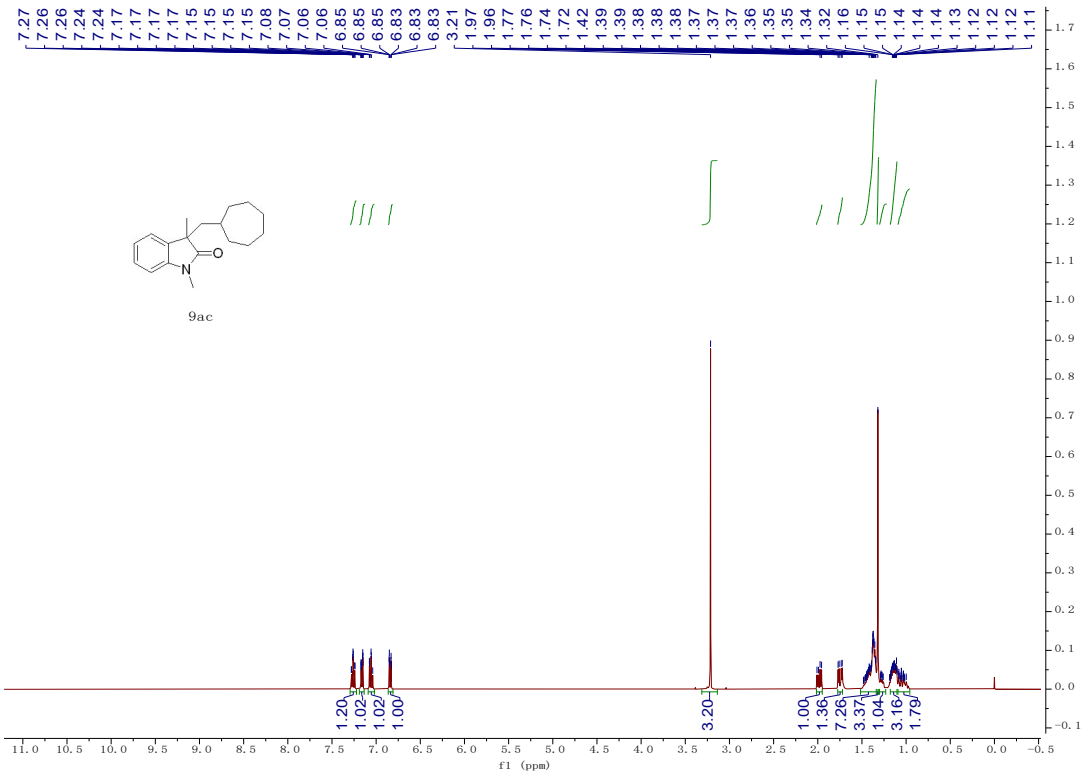
^{1}H NMR of compound 9ab in $CDCl_3$ at 400 MHz



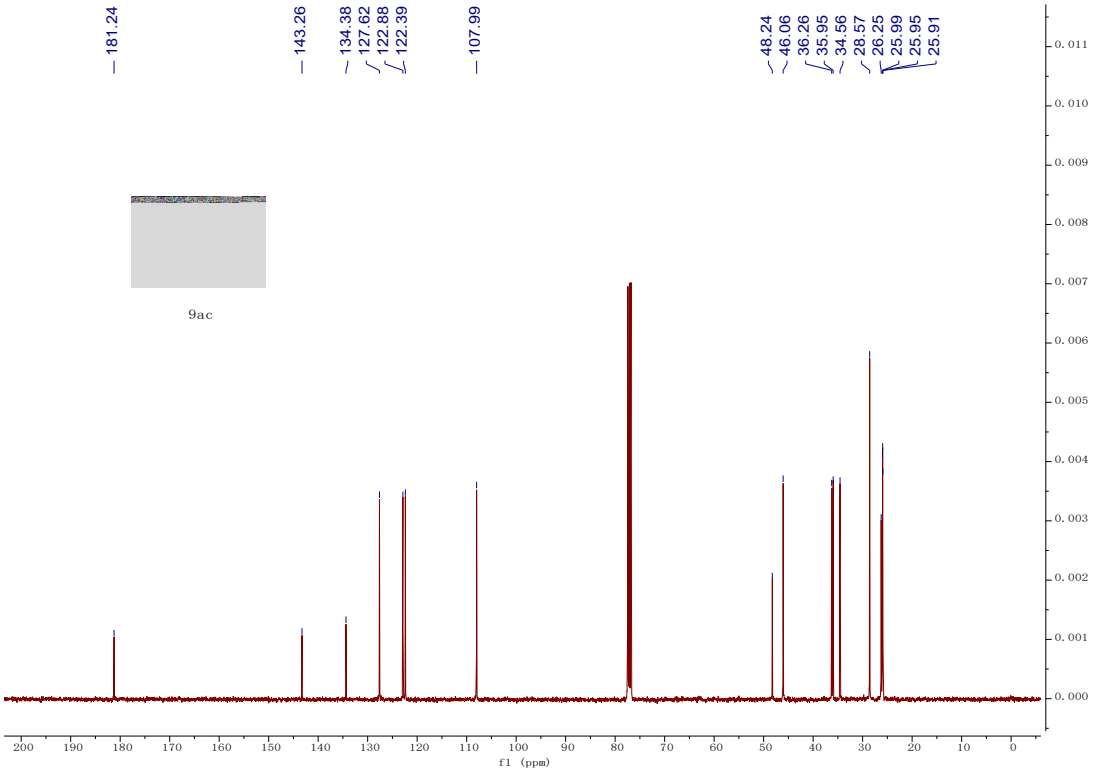
^{13}C NMR of compound 9ab in $CDCl_3$ at 101 MHz



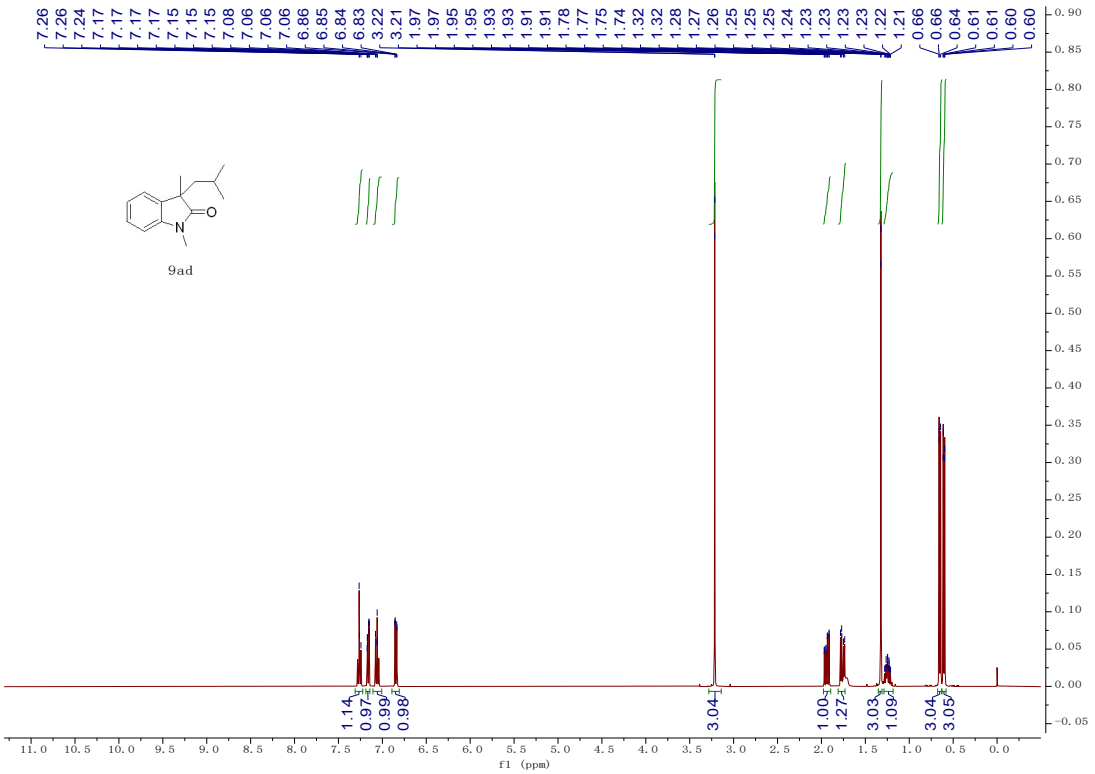
^{1}H NMR of compound 9ac in $CDCl_3$ at 400 MHz



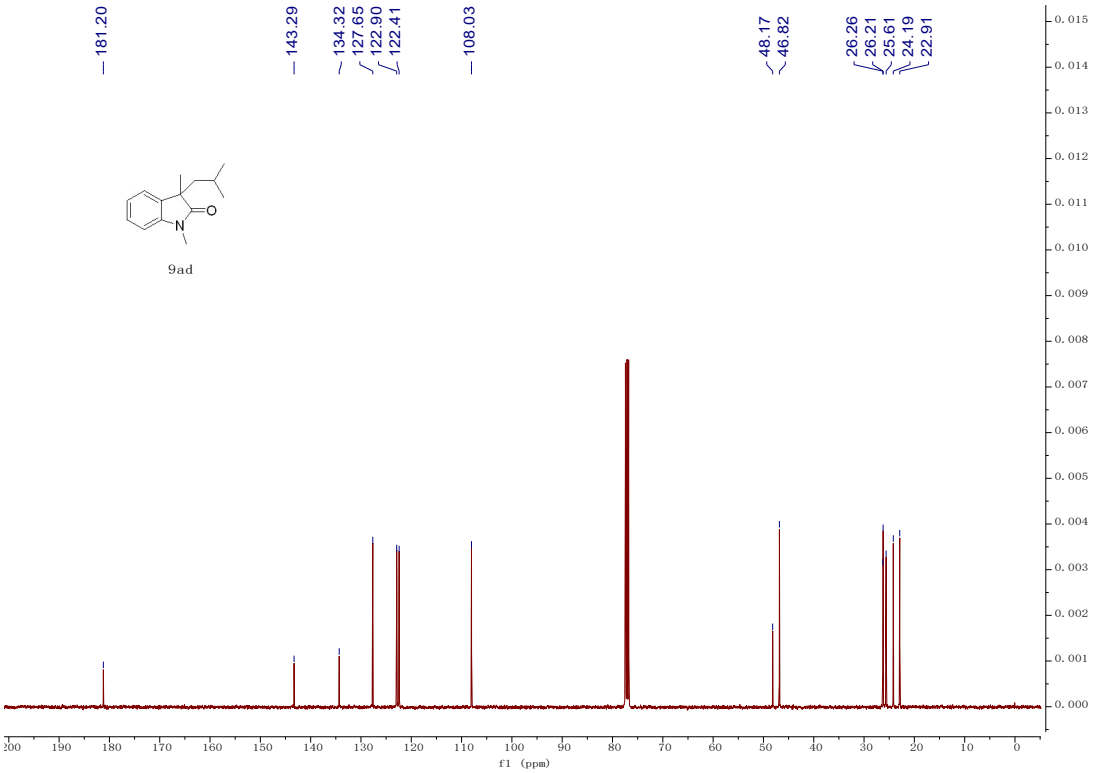
^{13}C NMR of compound 9ac in $CDCl_3$ at 101 MHz



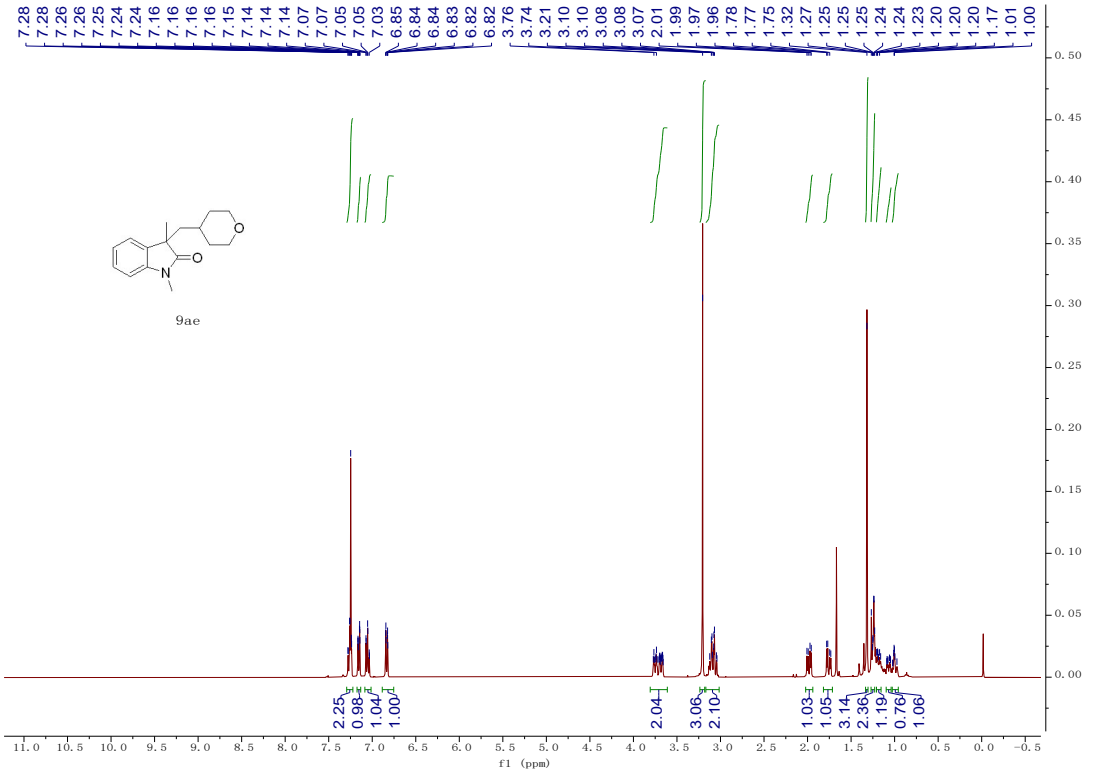
^{1}H NMR of compound 9ad in $CDCl_3$ at 400 MHz



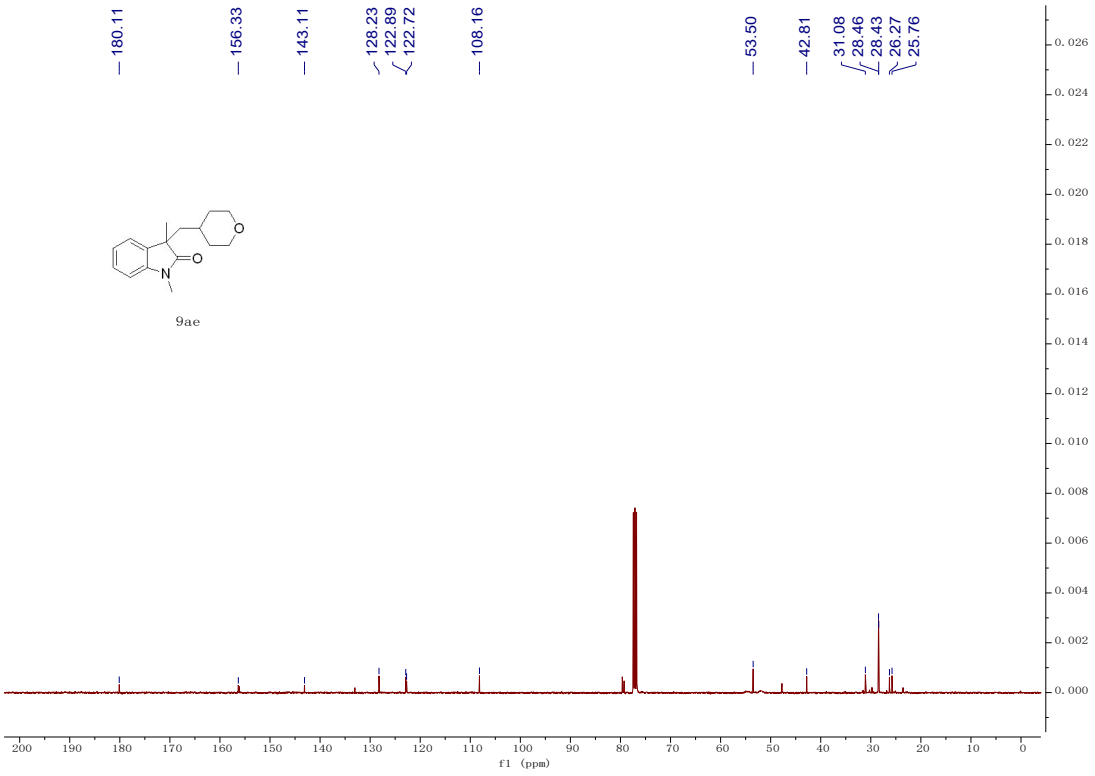
^{13}C NMR of compound 9ad in $CDCl_3$ at 101 MHz



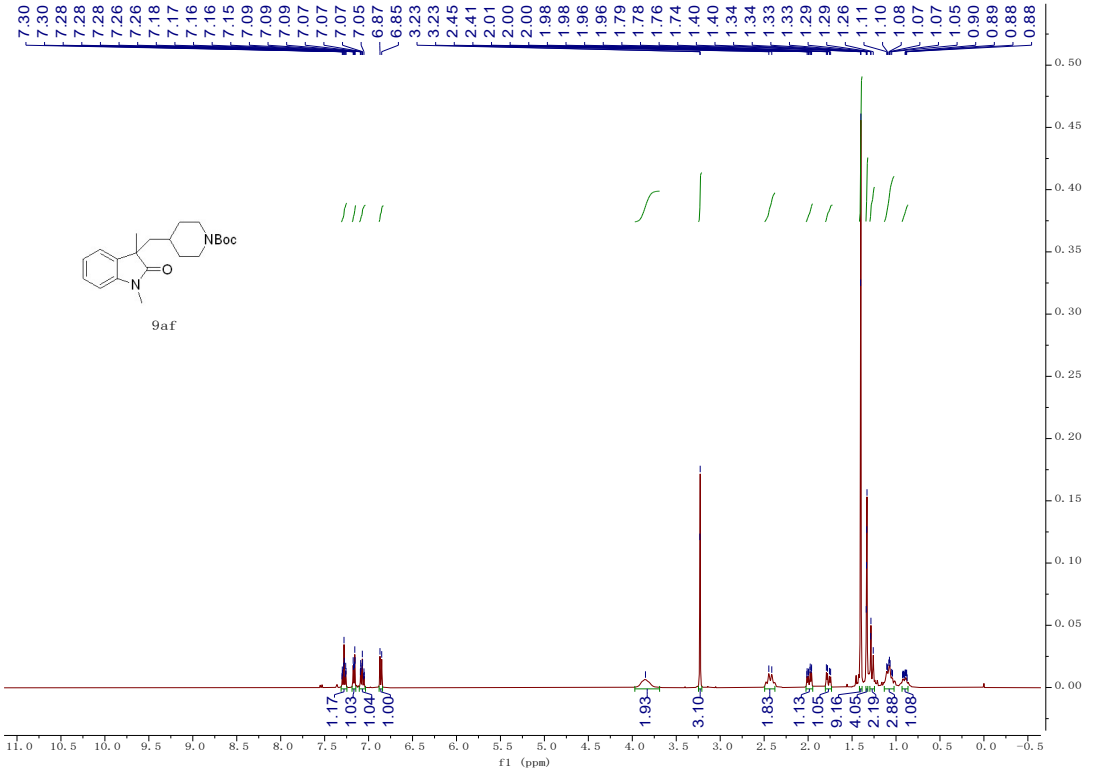
^{1}H NMR of compound 9ae in $CDCl_3$ at 400 MHz



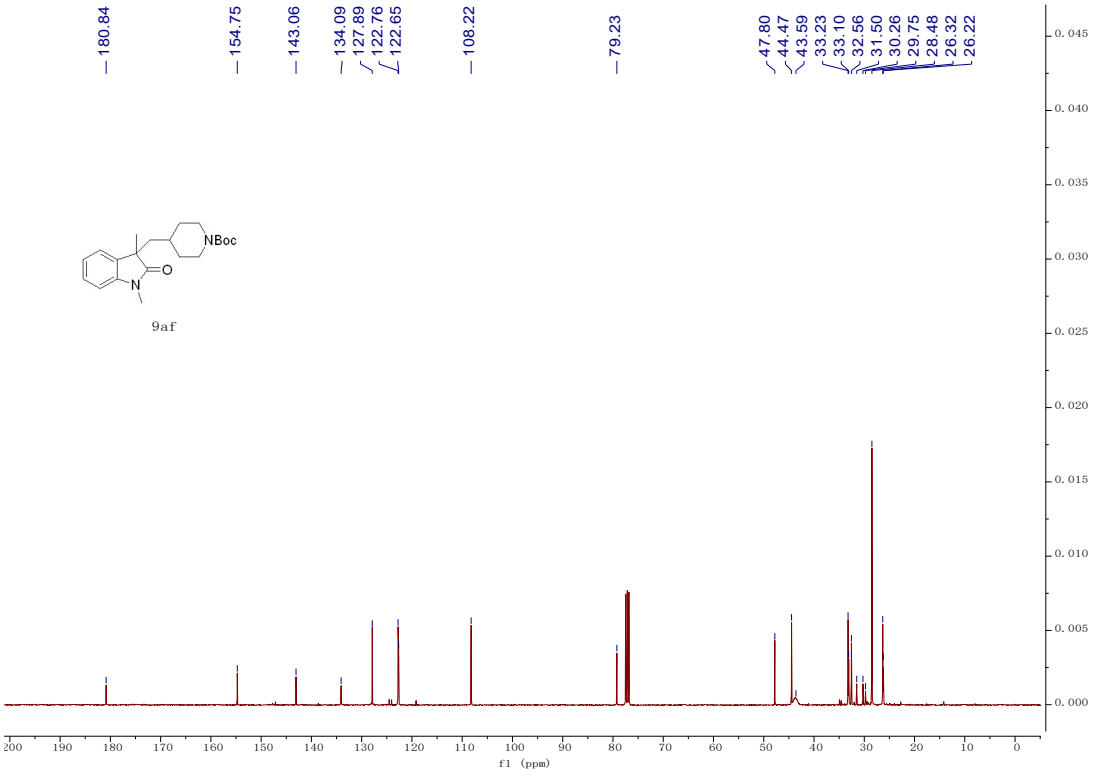
^{13}C NMR of compound 9ae in $CDCl_3$ at 101 MHz



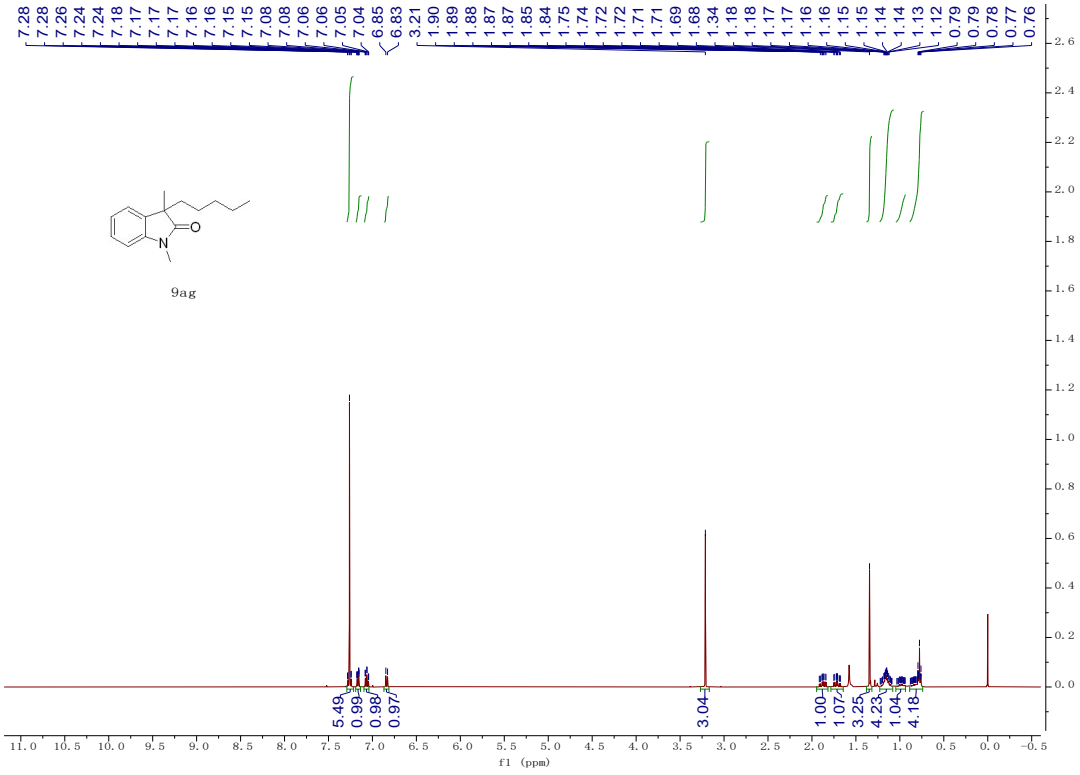
^{1}H NMR of compound 9af in $CDCl_3$ at 400 MHz



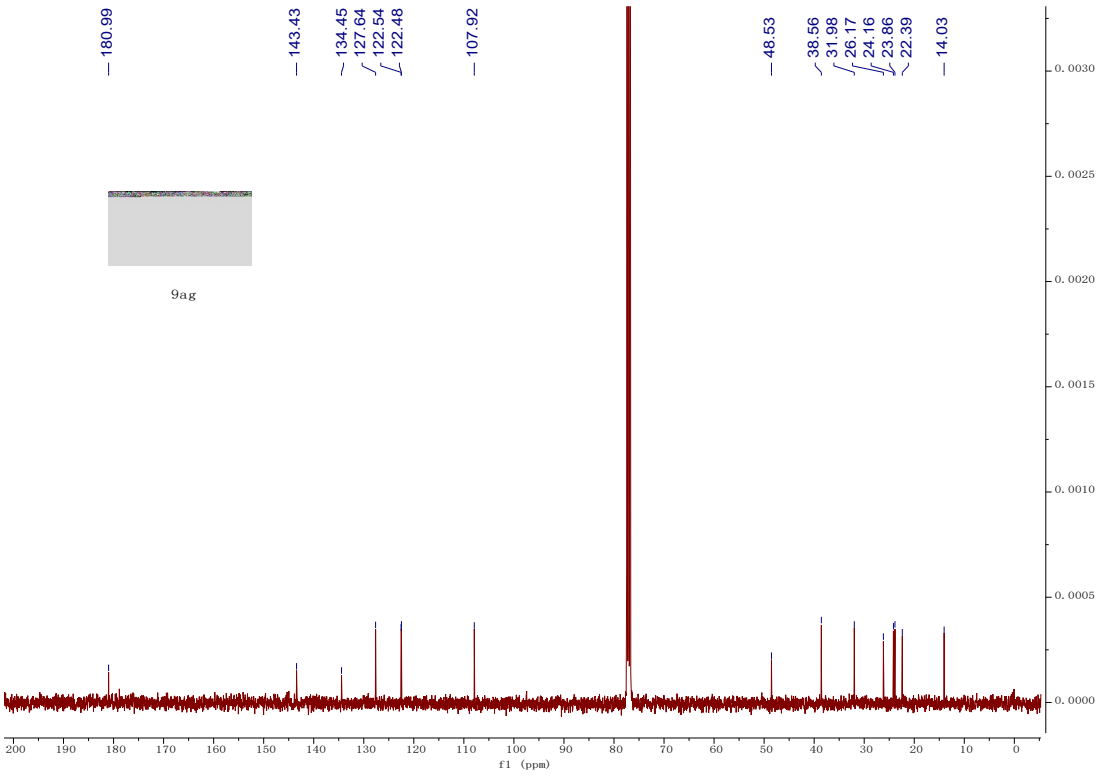
^{13}C NMR of compound 9af in $CDCl_3$ at 101 MHz



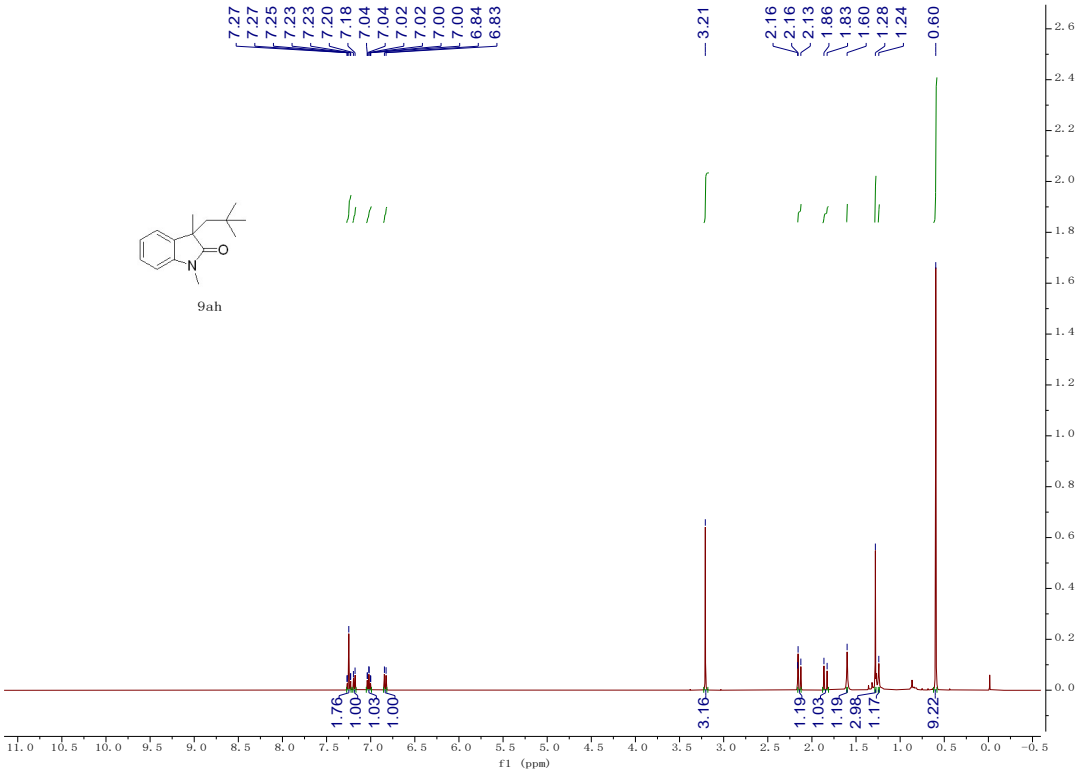
^{1}H NMR of compound 9ag in $CDCl_3$ at 400 MHz



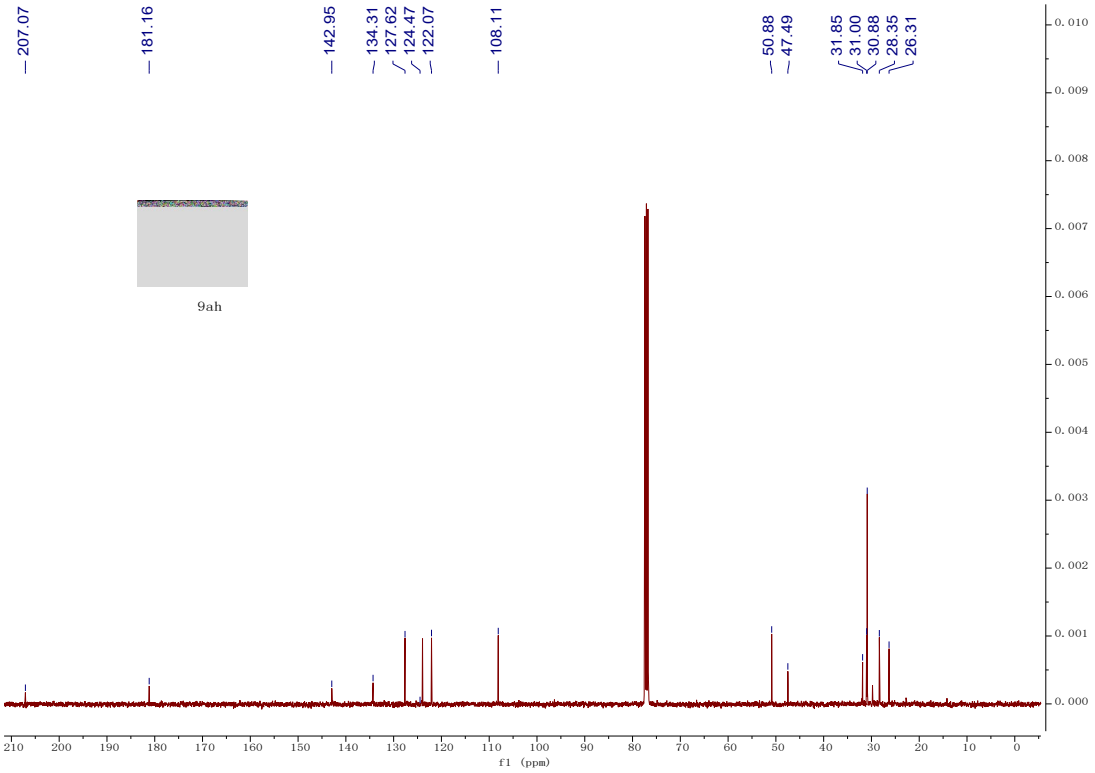
^{13}C NMR of compound 9ag in $CDCl_3$ at 101 MHz



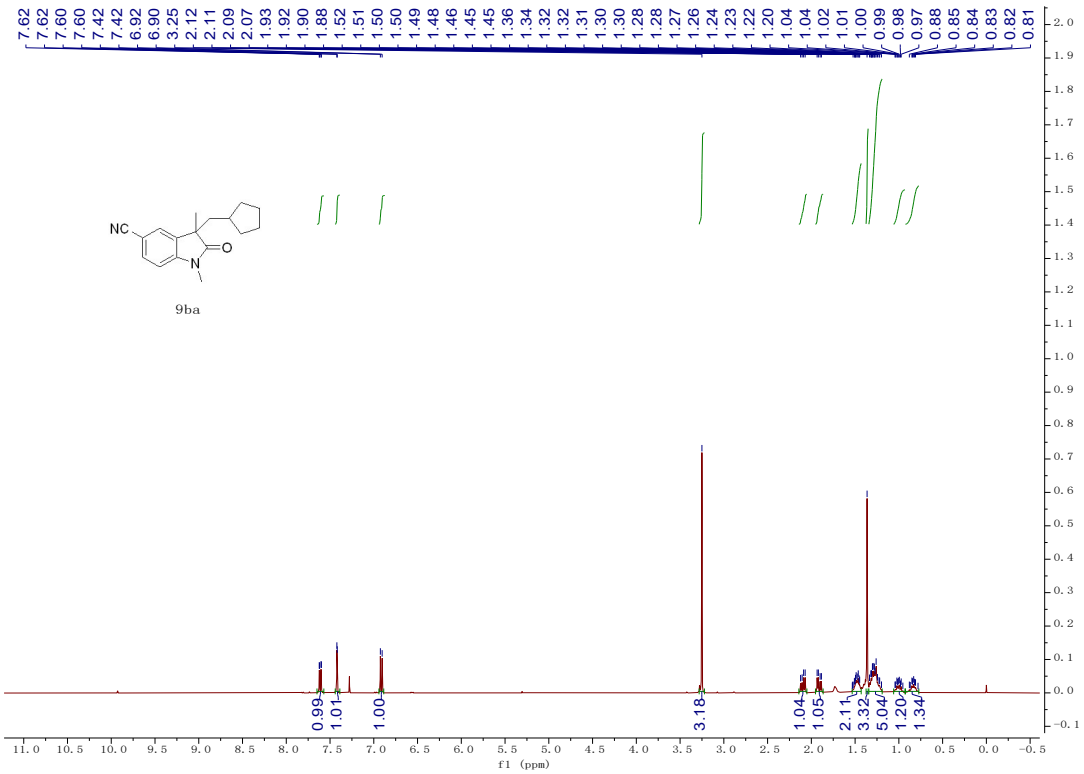
^{1}H NMR of compound 9ah in $CDCl_3$ at 400 MHz



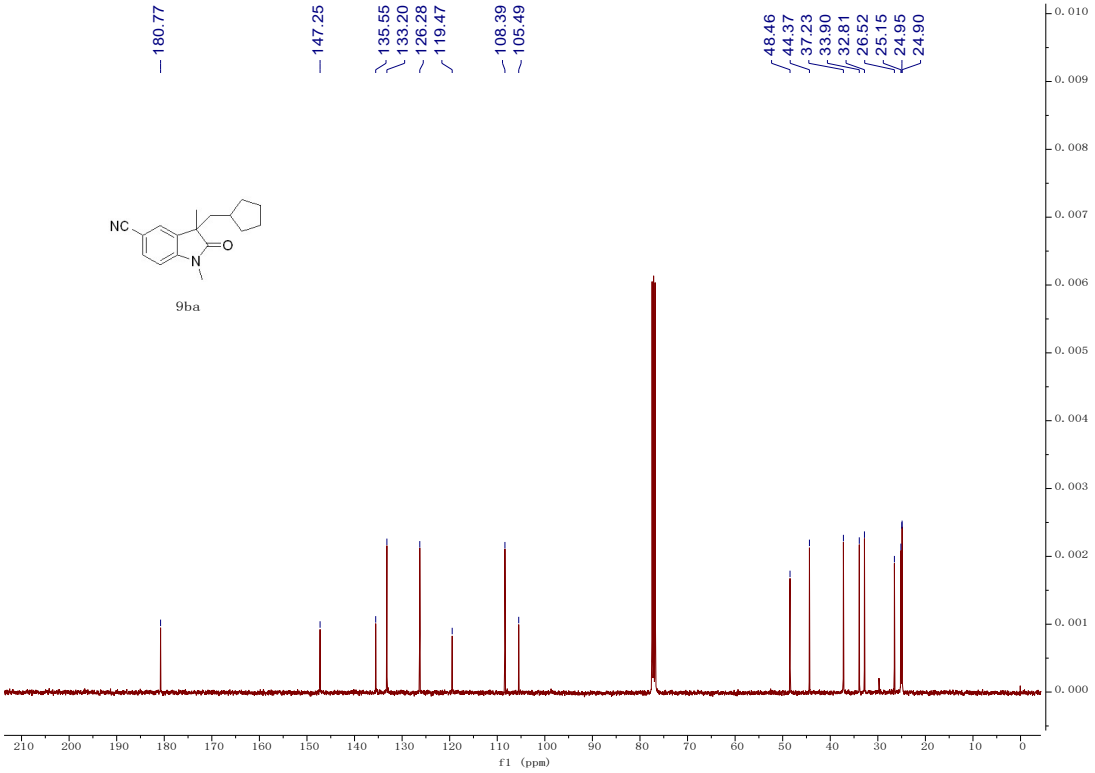
^{13}C NMR of compound 9ah in $CDCl_3$ at 101 MHz



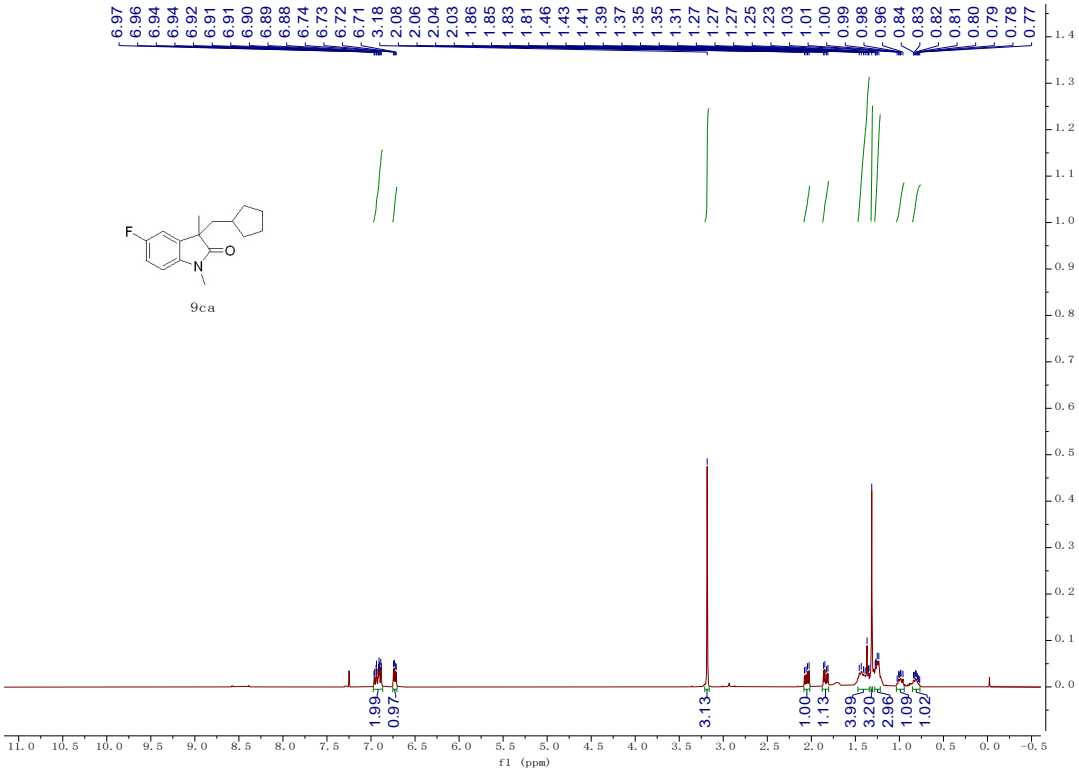
^{1}H NMR of compound 9ba in $CDCl_3$ at 400 MHz



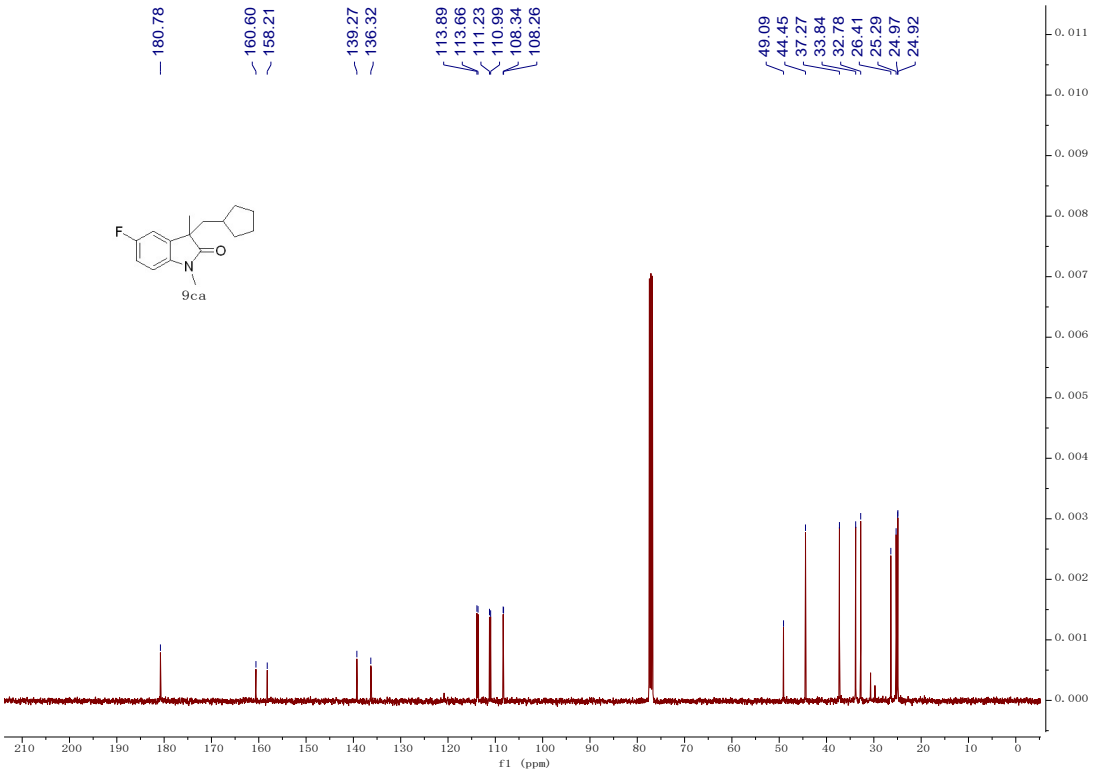
^{13}C NMR of compound 9ba in $CDCl_3$ at 101 MHz



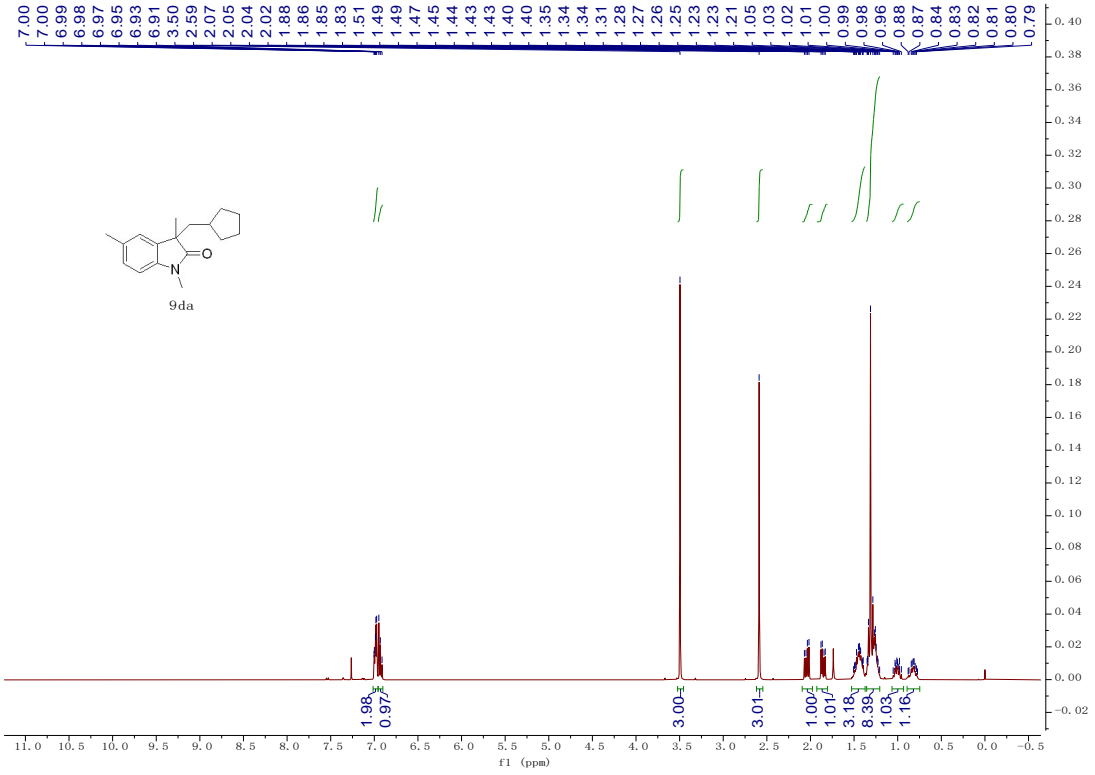
^{1}H NMR of compound 9ca in $CDCl_3$ at 400 MHz



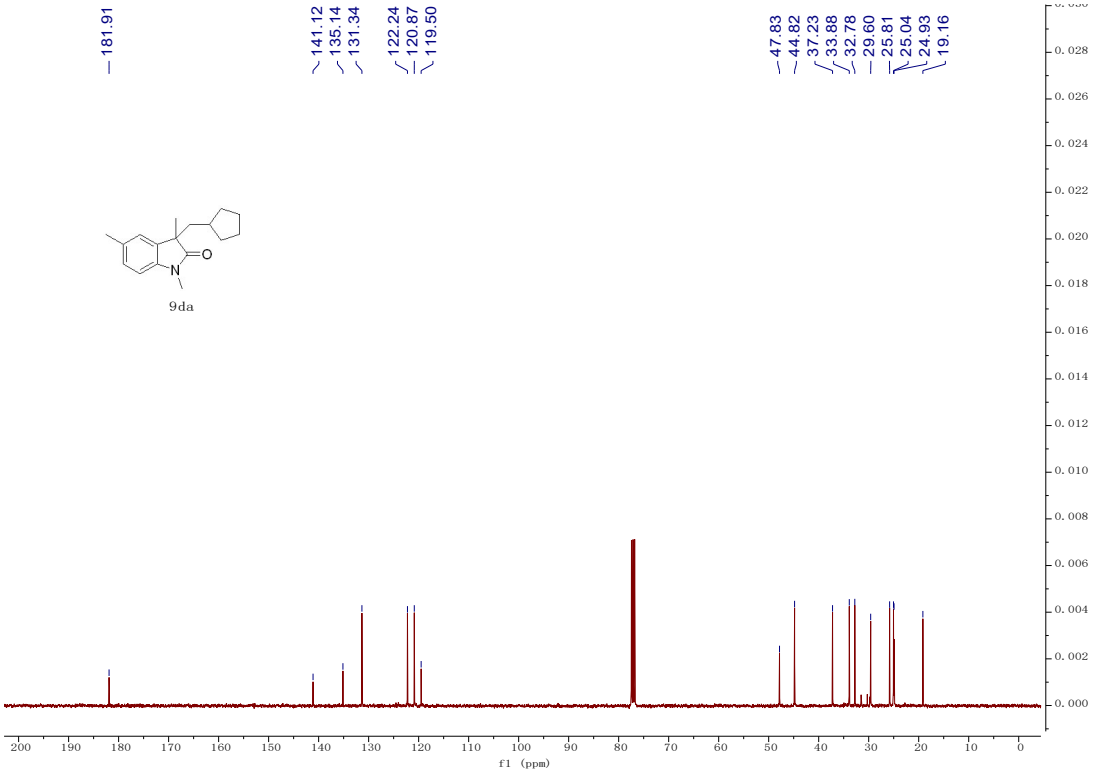
^{13}C NMR of compound 9ca in $CDCl_3$ at 101 MHz



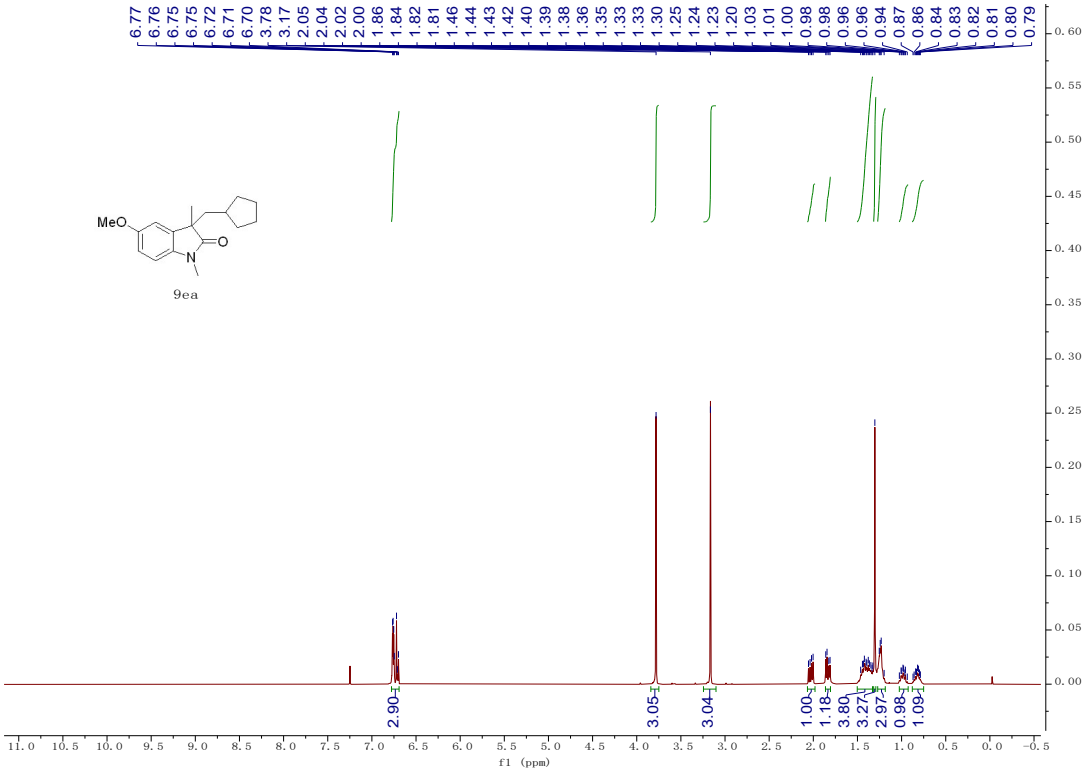
^{1}H NMR of compound 9da in $CDCl_3$ at 400 MHz



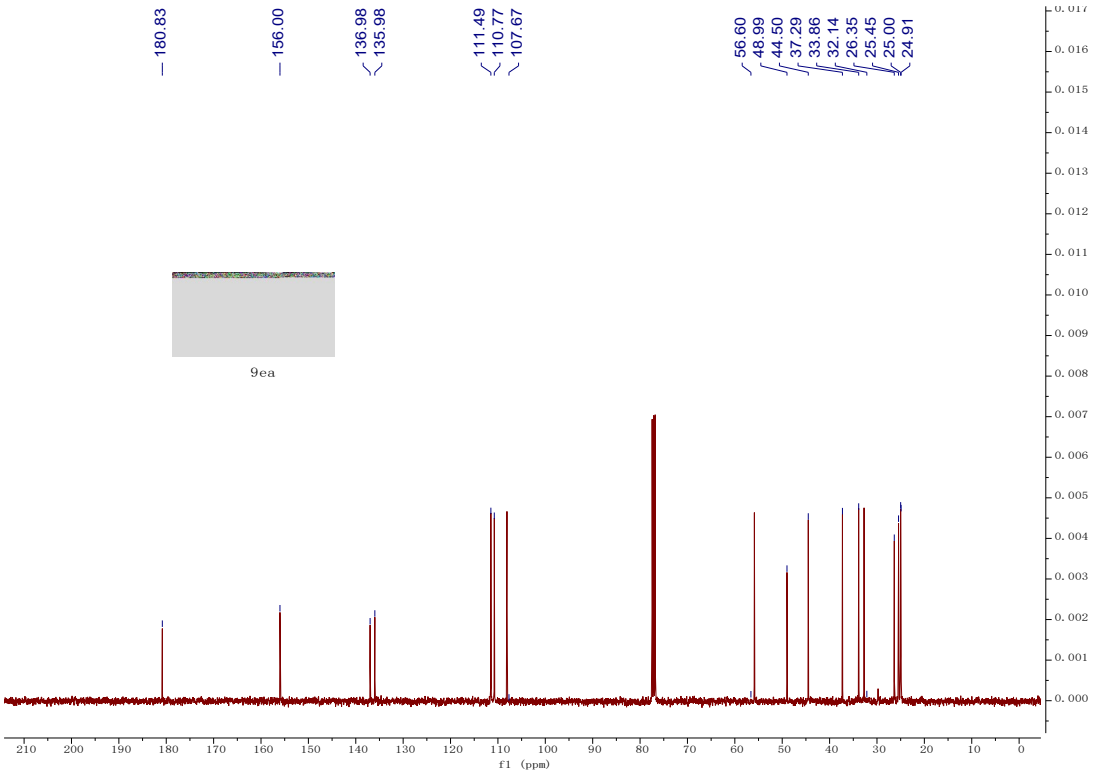
^{13}C NMR of compound 9da in $CDCl_3$ at 101 MHz



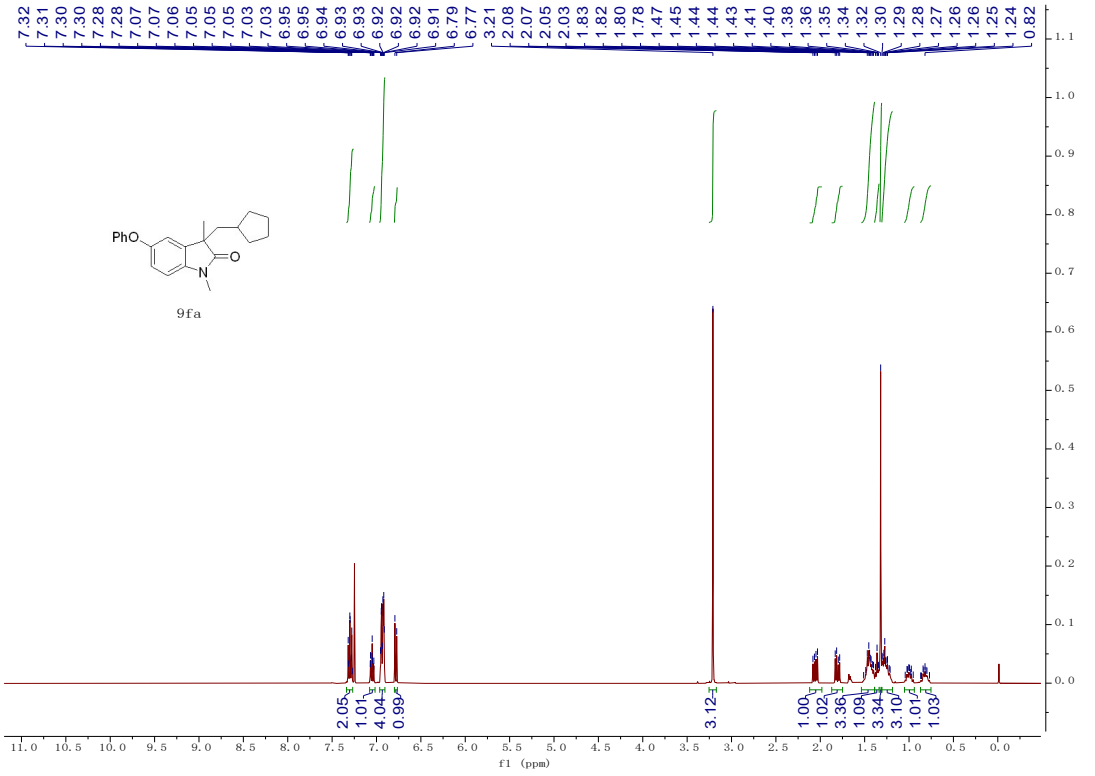
^{1}H NMR of compound 9ea in $CDCl_3$ at 400 MHz



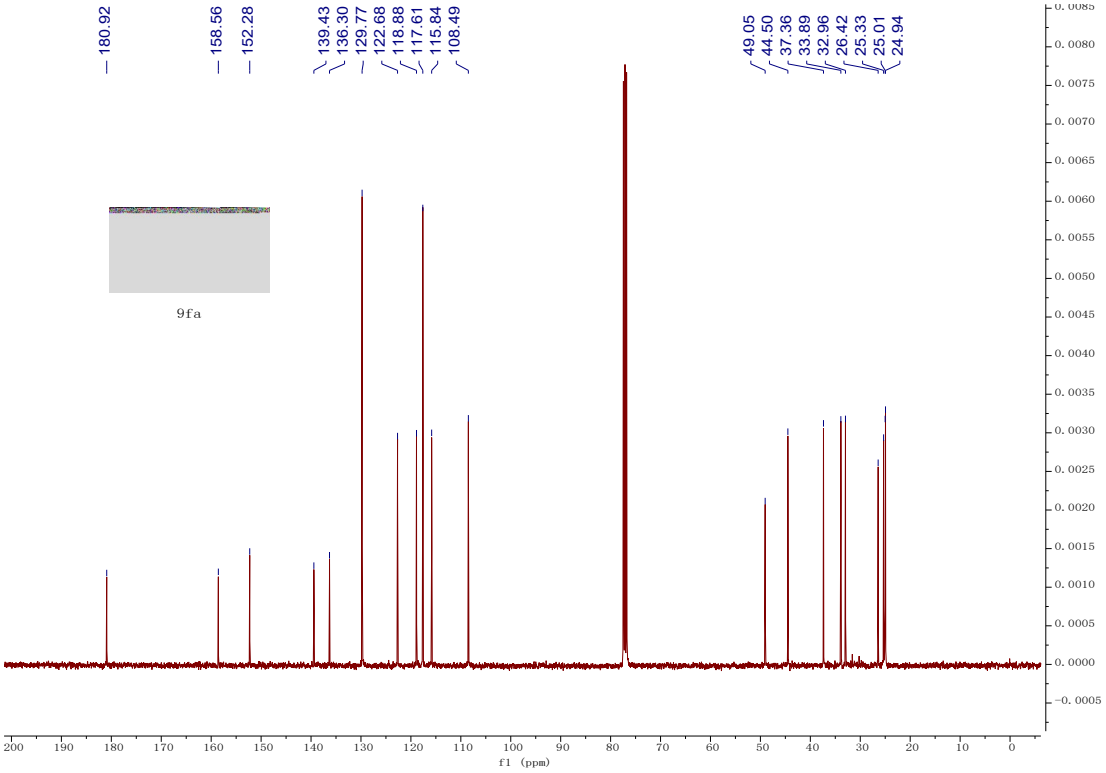
^{13}C NMR of compound 9ea in $CDCl_3$ at 101 MHz



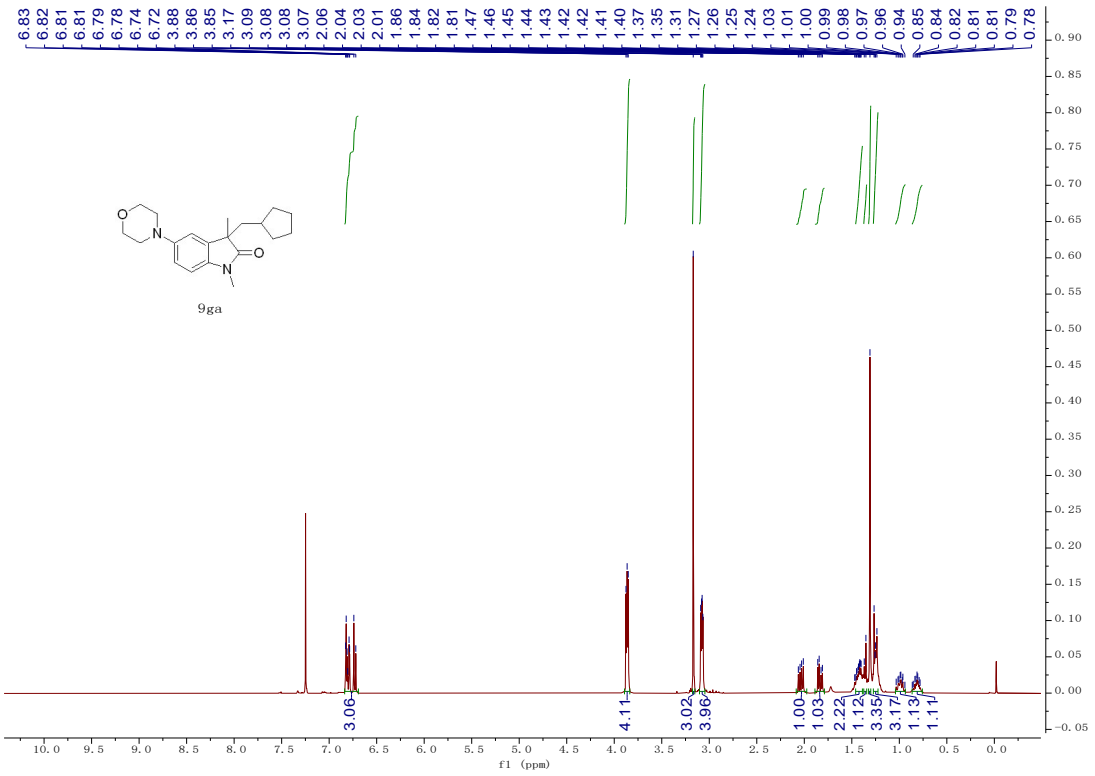
^{1}H NMR of compound 9fa in $CDCl_3$ at 400 MHz



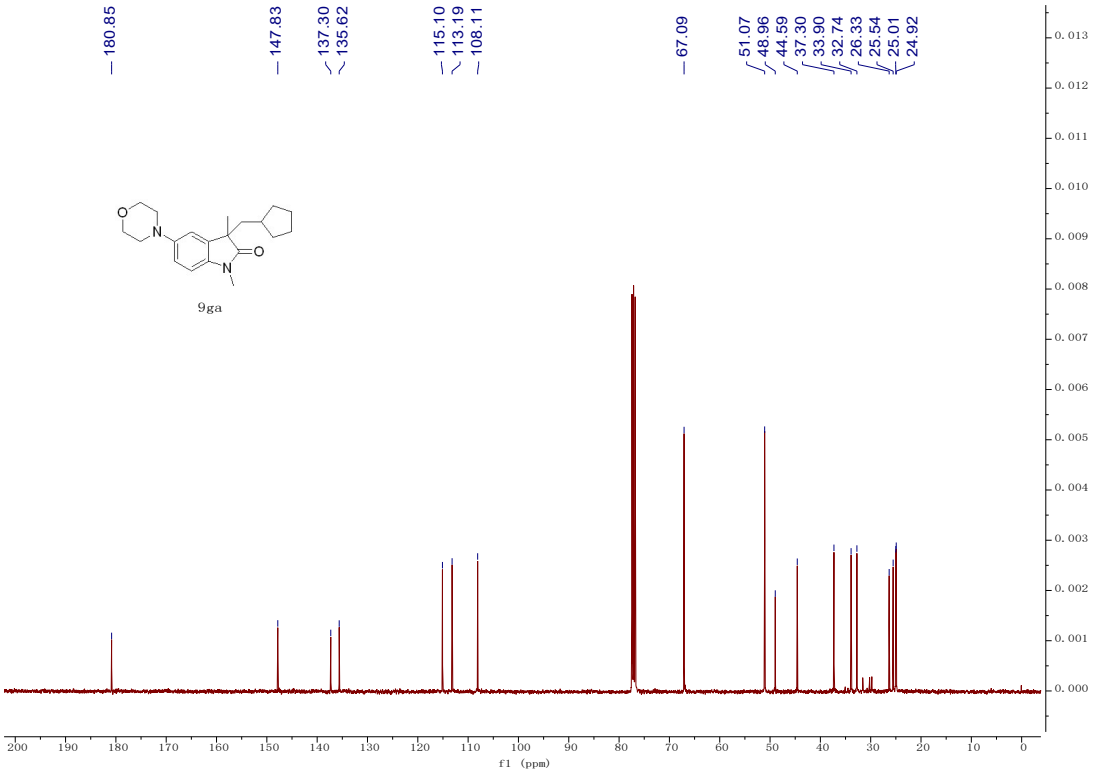
^{13}C NMR of compound 9fa in $CDCl_3$ at 101 MHz



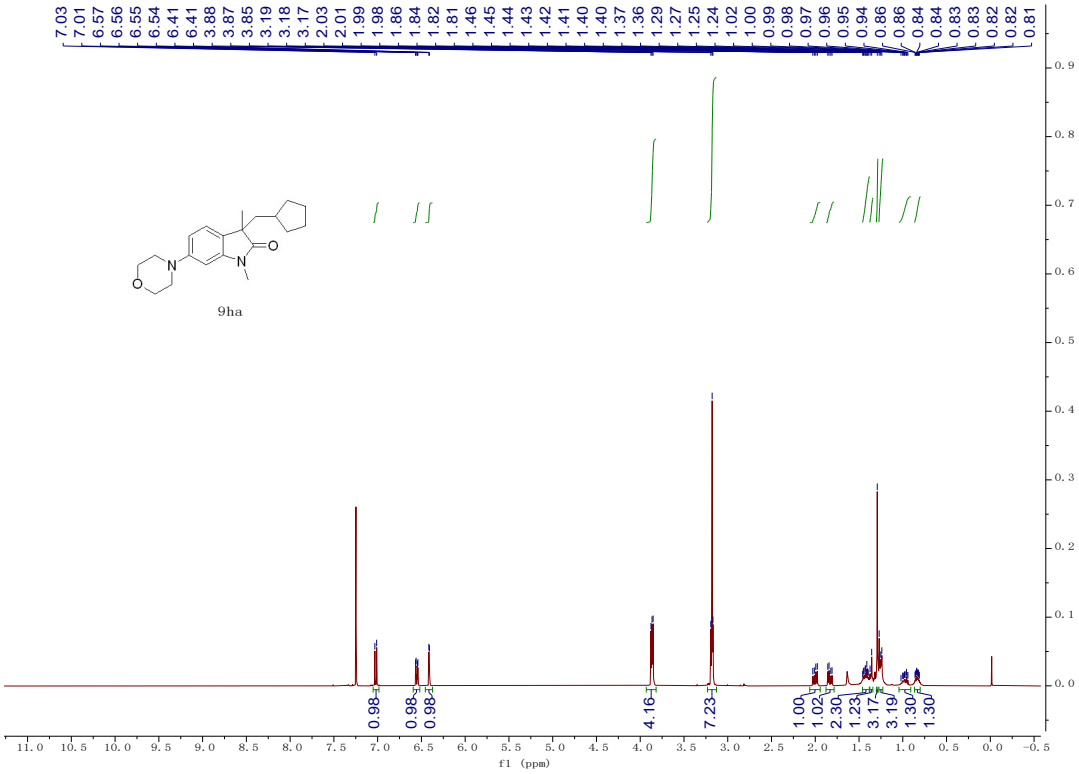
^{1}H NMR of compound 9ga in $CDCl_3$ at 400 MHz



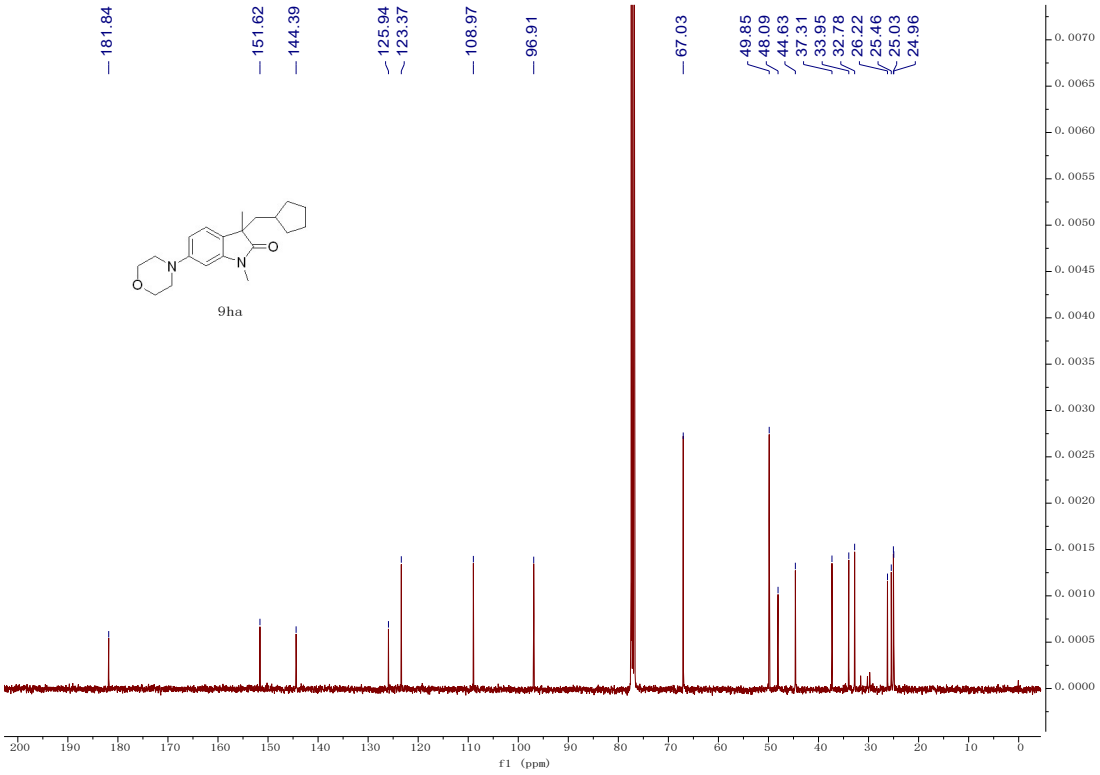
^{13}C NMR of compound 9ga in $CDCl_3$ at 101 MHz



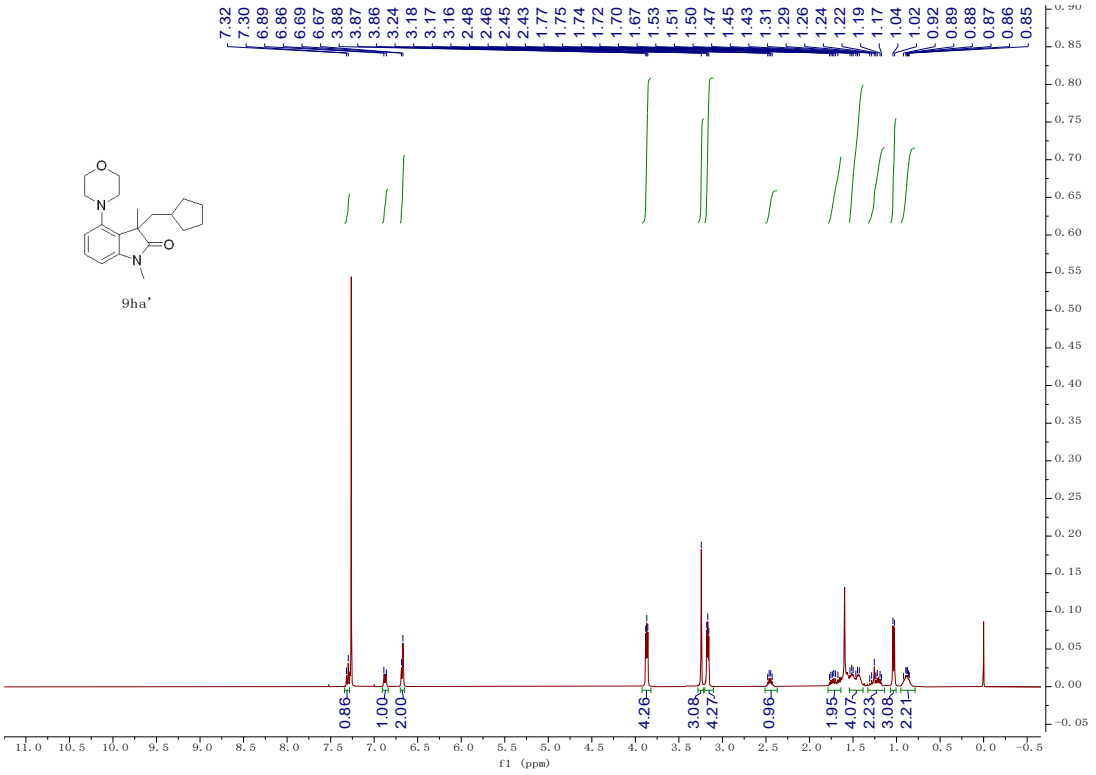
^{1}H NMR of compound 9ha in $CDCl_3$ at 400 MHz



^{13}C NMR of compound 9ha in $CDCl_3$ at 101 MHz

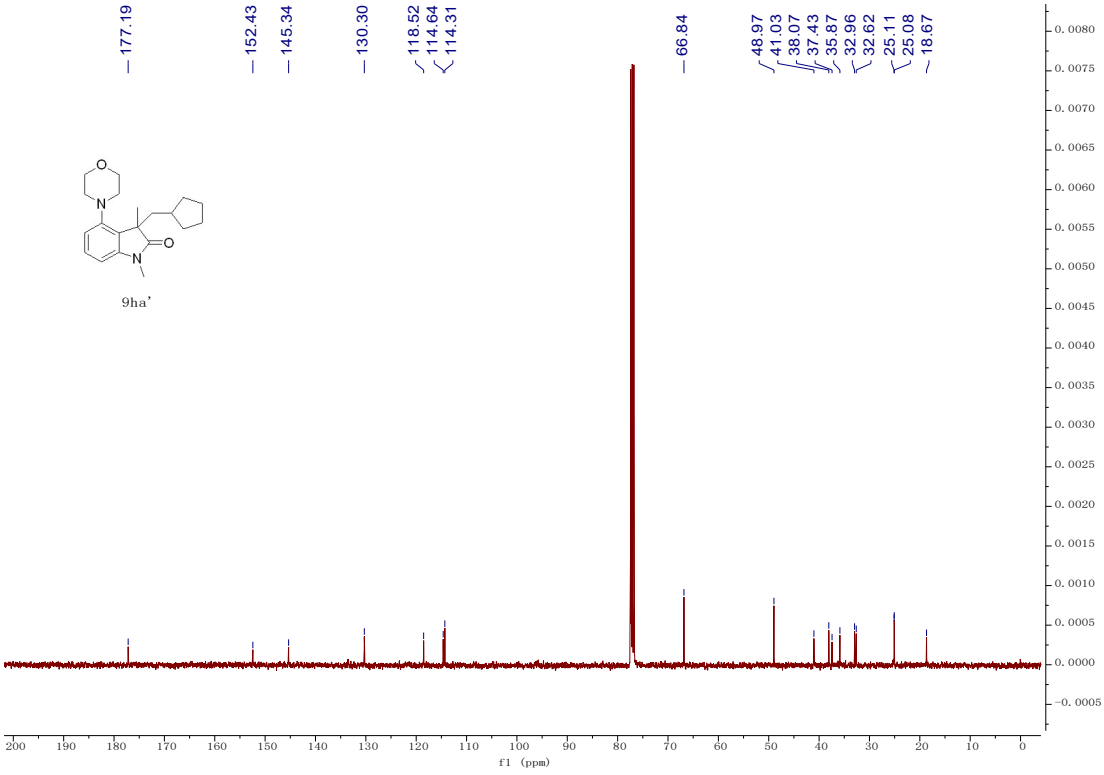


^{1}H NMR of compound 9ha' in $CDCl_3$ at 400 MHz



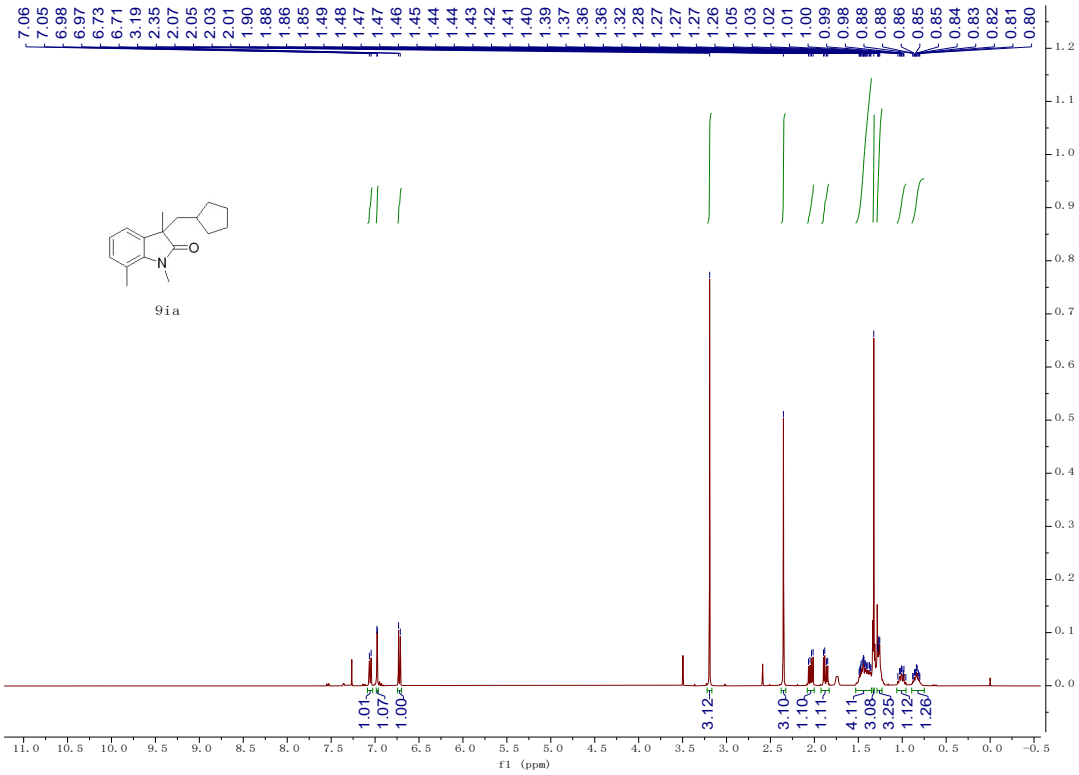
9ha'

^{13}C NMR of compound 9ha' in $CDCl_3$ at 101 MHz

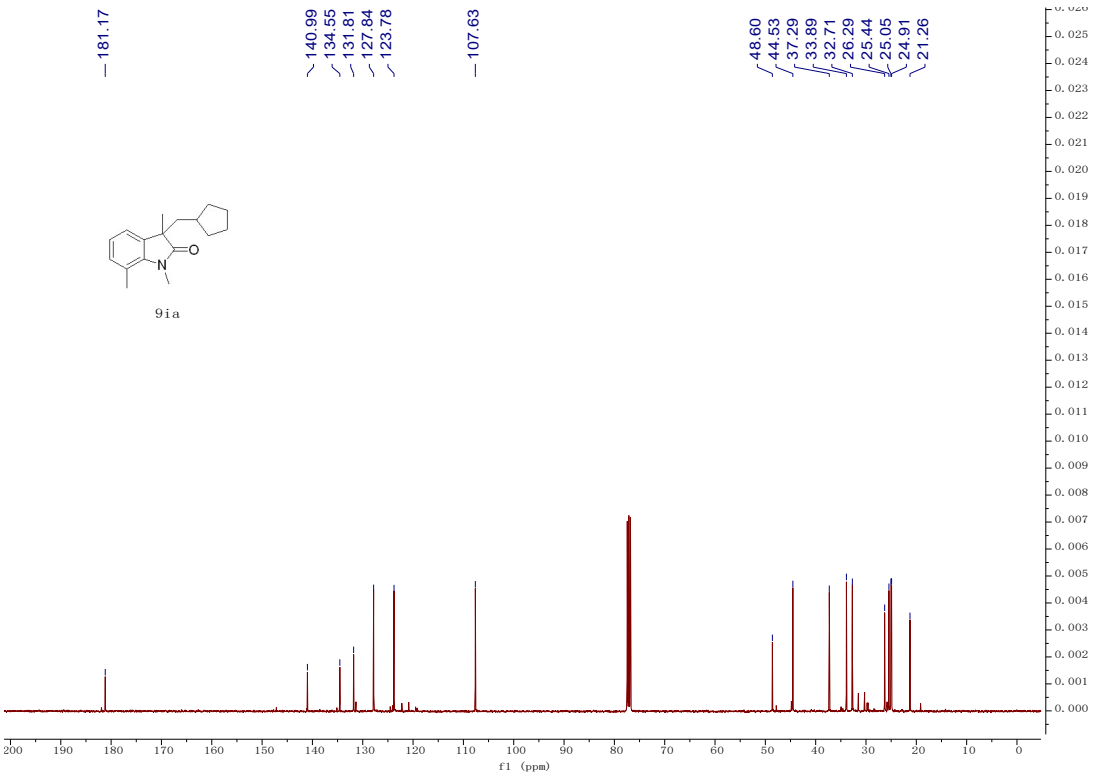


9ha'

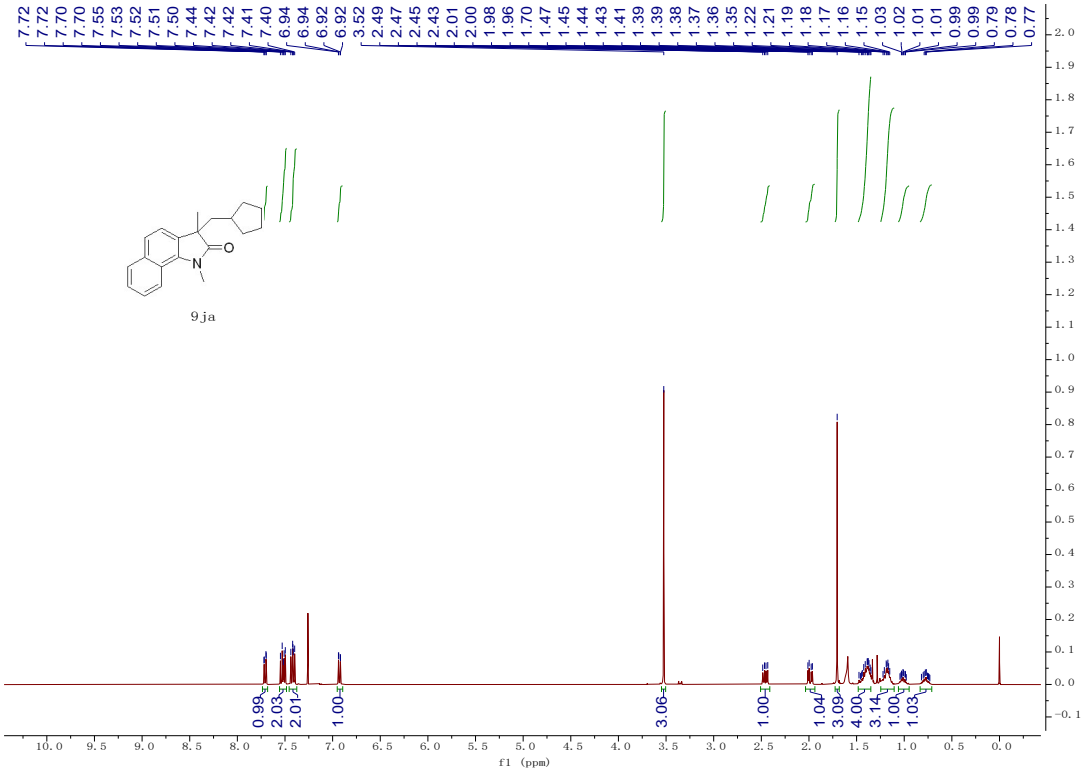
^{1}H NMR of compound 9ia in $CDCl_3$ at 400 MHz



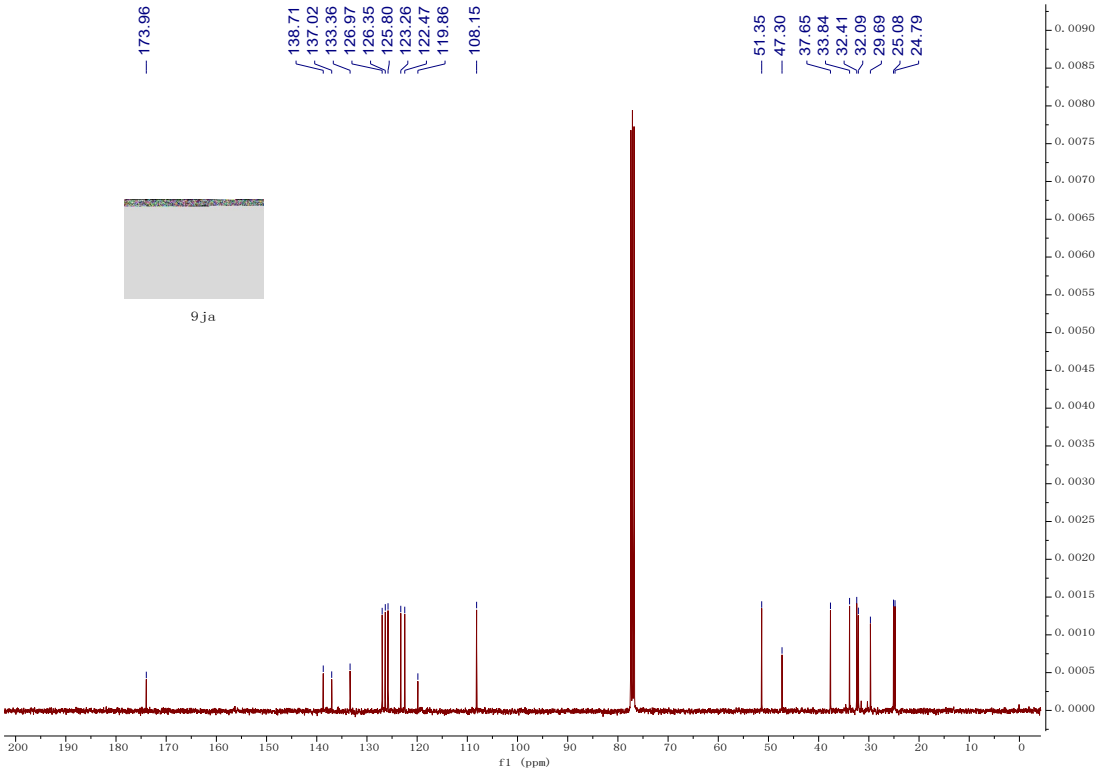
^{13}C NMR of compound 9ia in $CDCl_3$ at 101 MHz



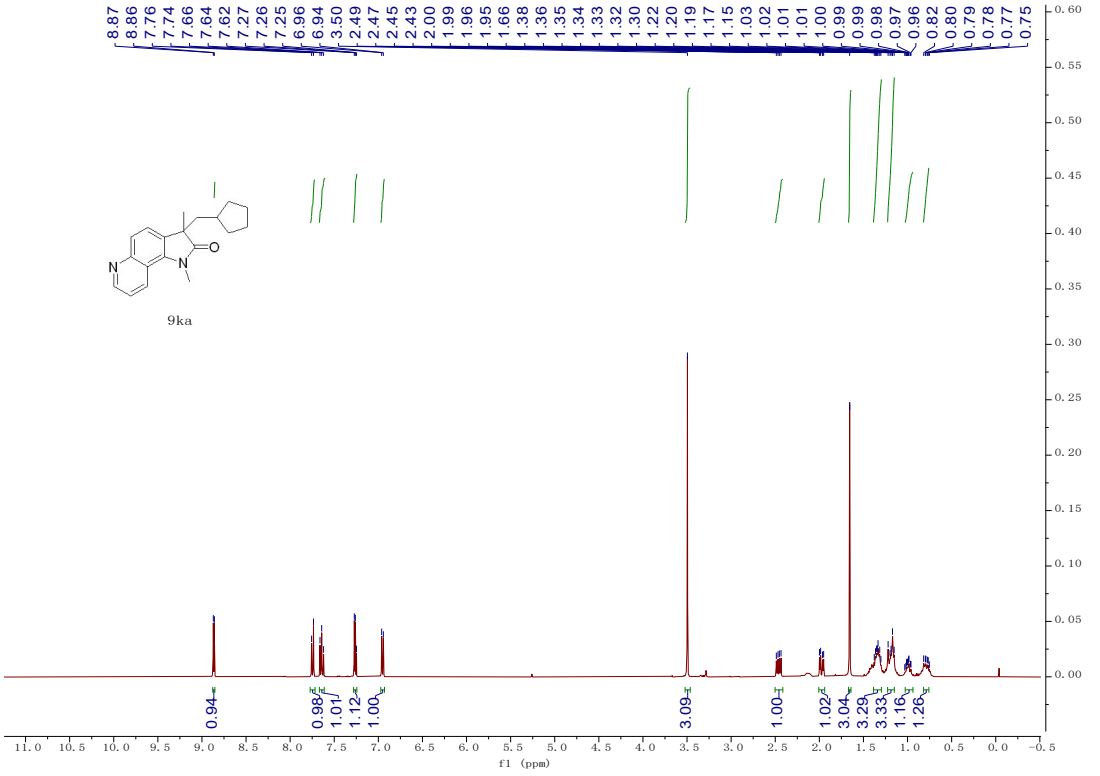
^{1}H NMR of compound 9ja in $CDCl_3$ at 400 MHz



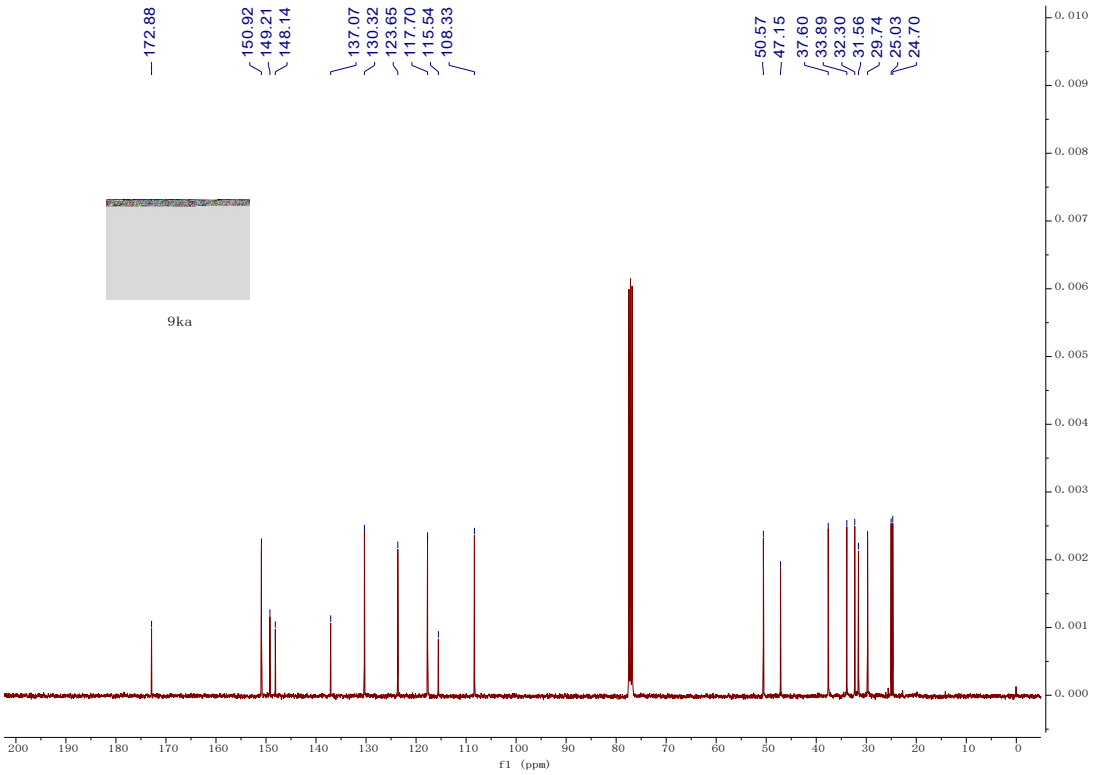
^{13}C NMR of compound 9ja in $CDCl_3$ at 101 MHz



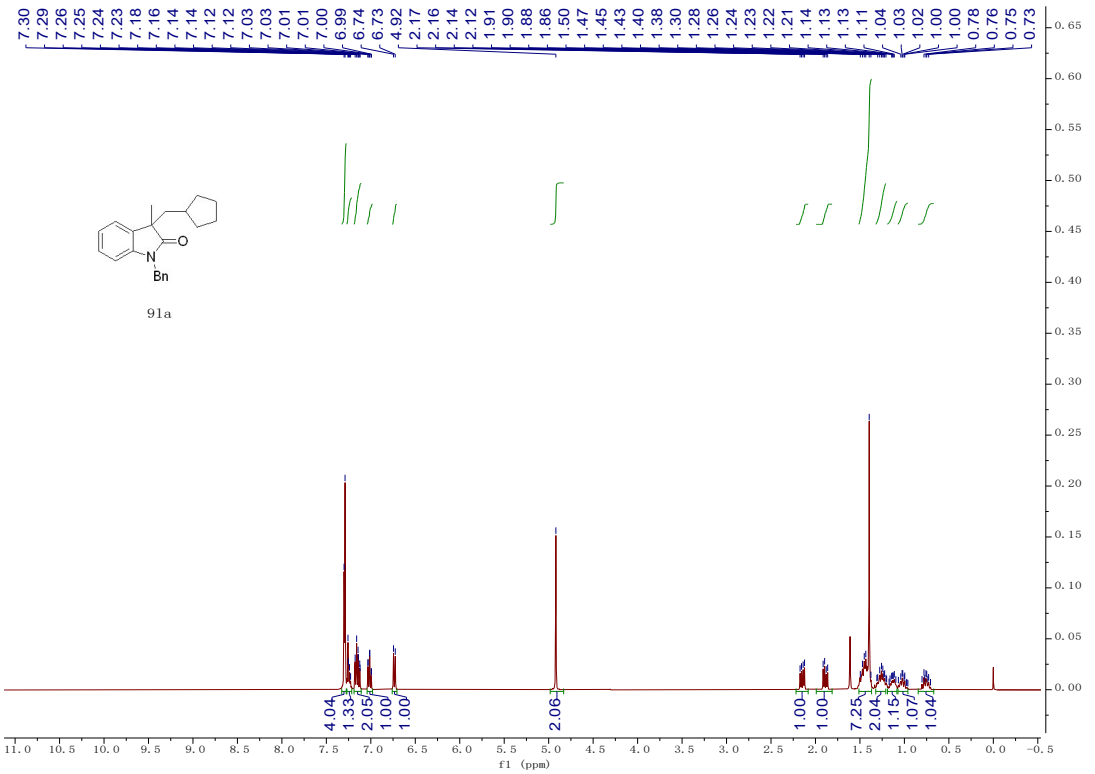
^{1}H NMR of compound 9ka in $CDCl_3$ at 400 MHz



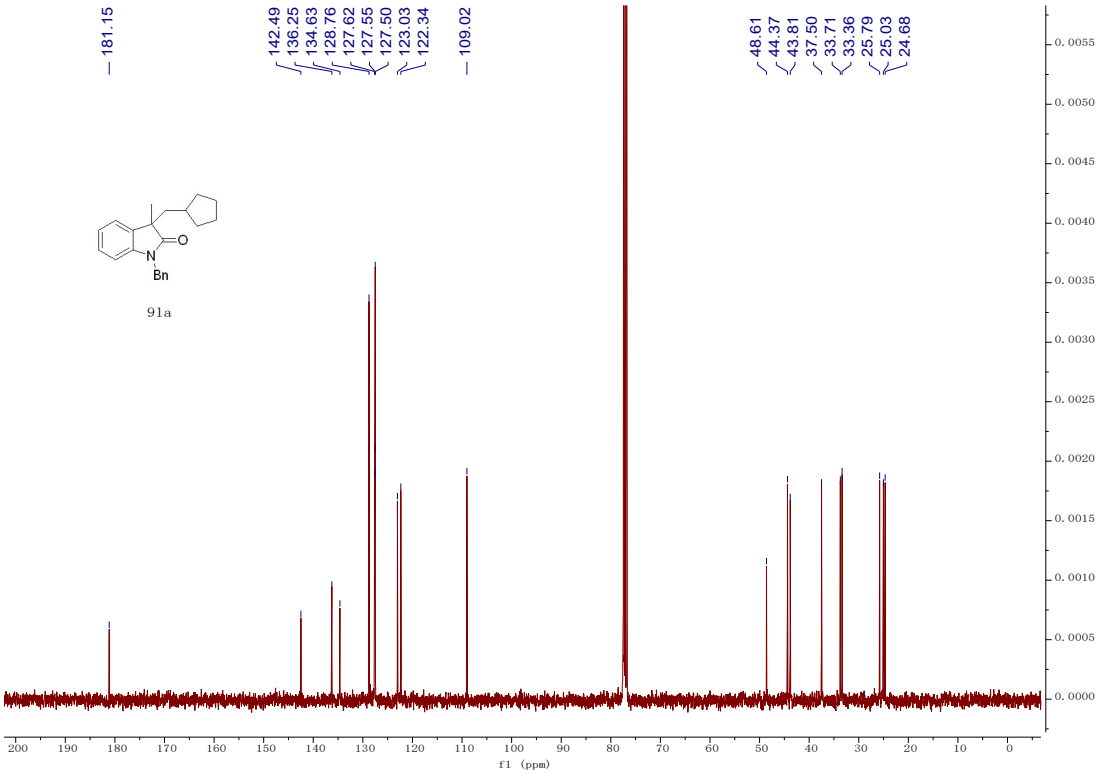
^{13}C NMR of compound 9ka in $CDCl_3$ at 101 MHz



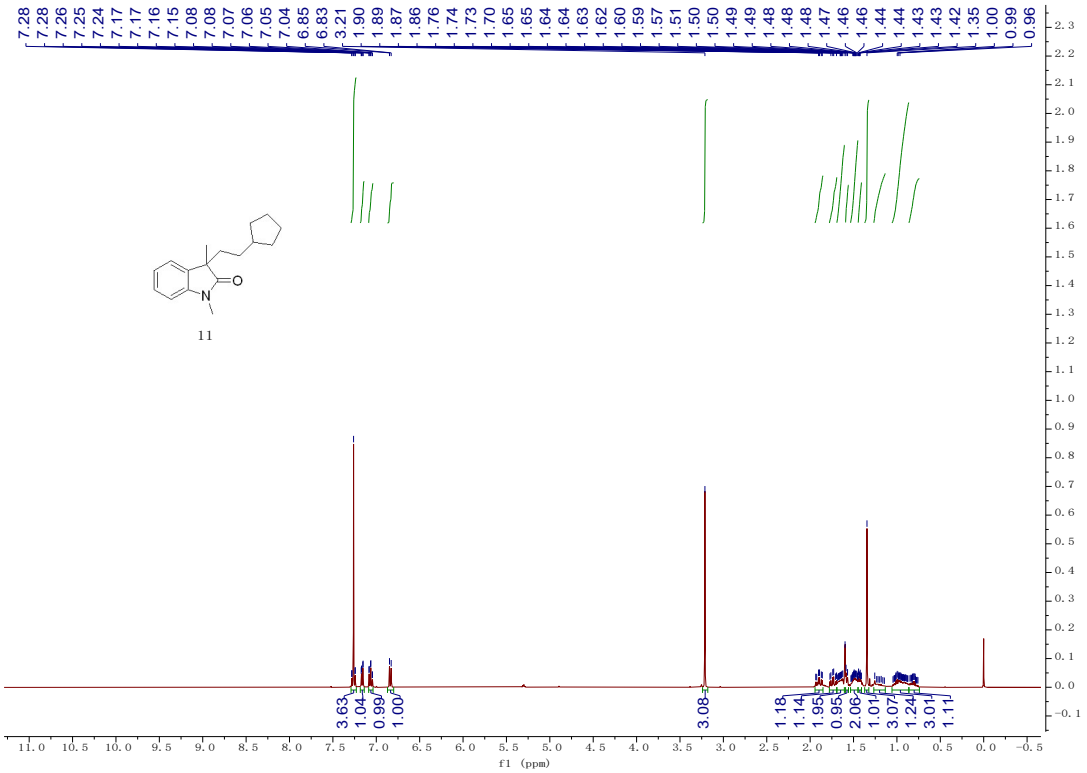
^{1}H NMR of compound 9la in $CDCl_3$ at 400 MHz



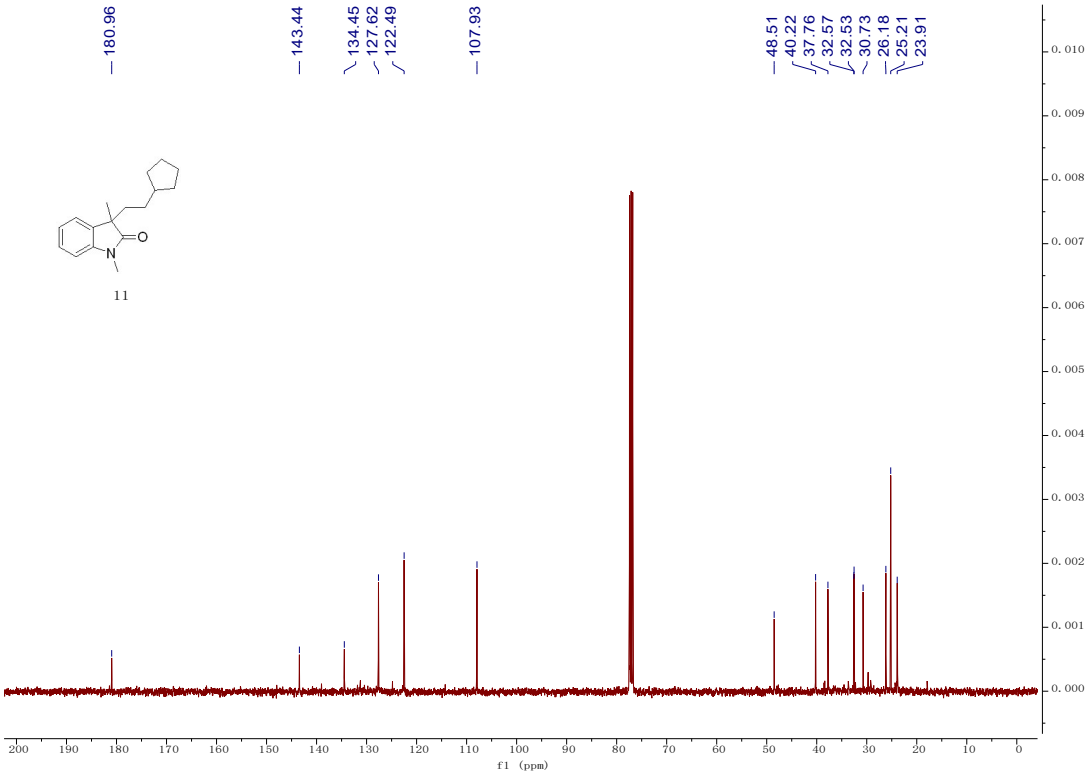
^{13}C NMR of compound 9la in $CDCl_3$ at 101 MHz



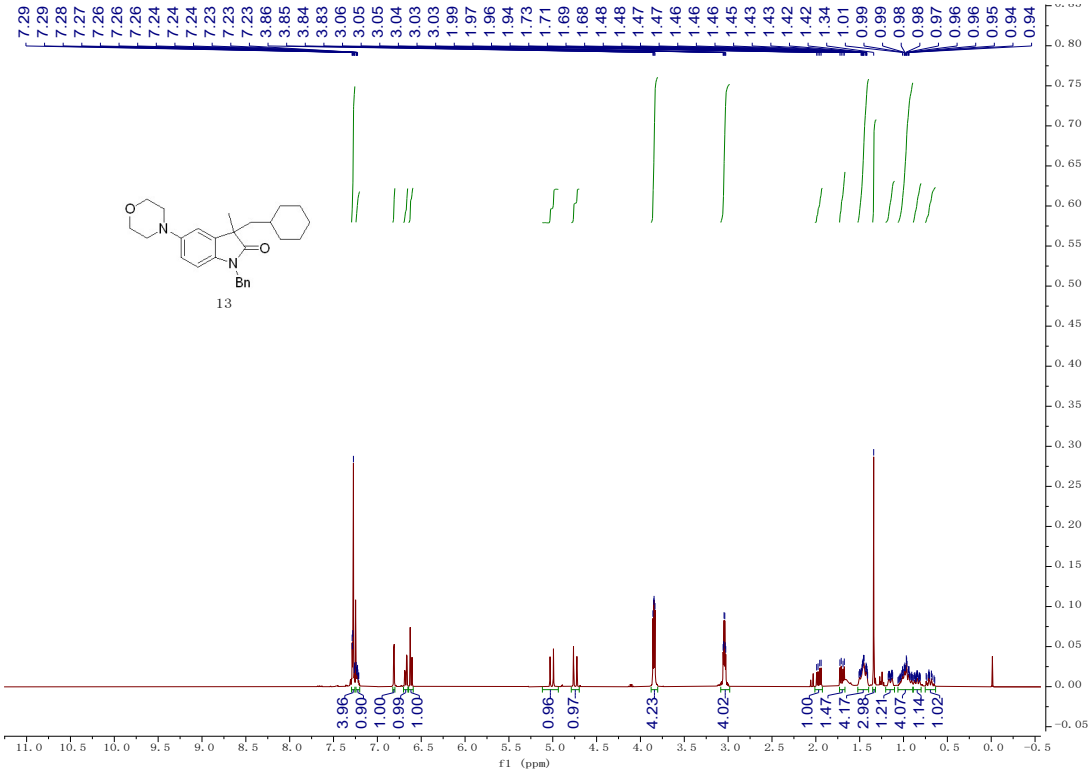
^{1}H NMR of compound 11 in $CDCl_3$ at 400 MHz



^{13}C NMR of compound 11 in $CDCl_3$ at 101 MHz



^{1}H NMR of compound 13 in $CDCl_3$ at 400 MHz



^{13}C NMR of compound 13 in $CDCl_3$ at 101 MHz