Electronic Supplementary Information

TFA-catalyzed solvent-free dearomative cyanidation of isoquinoline using $(Boc)_2O$ as acylation agent

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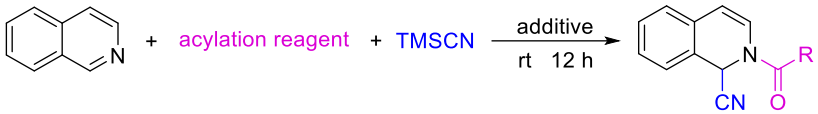
1. General Information

Unless otherwise specified, reagents and solvents were purchased from common commercial suppliers and were used without further purification. Monitoring of the reaction was performed by thin layer chromatography (TLC) and high performance liquid chromatography (HPLC). Flash column chromatography was performed using silica gel (200-300 mesh) typically using a n-hexane/ethyl acetate eluent system. 600 MHz ^{1}H NMR and 151 MHz ^{13}C NMR spectra were recorded on the Varian VMS-600 spectrometer, respectively. NMR standards were used as follows: ^{1}H NMR spectroscopy: δ= 7.26 ppm ($CDCl_3$). ^{13}C NMR spectroscopy: δ = 77.00 ppm ($CDCl_3$). The chemical shifts in ppm (δ scale), Reported in units of scale and coupling constant in Hertz (Hz). High-resolution mass spectra (HRMS) was obtained on Agilent 6502 Q-TOF HPLC and mass spectrometry.

2. General Procedure for the Synthesis of Products 4-41



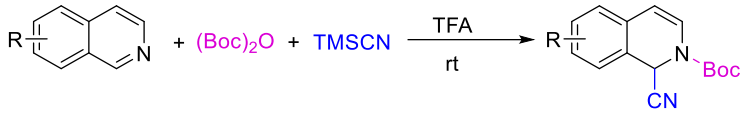
1a 2 3a 4-41

General synthesis method under solvent-free conditions: A mixture of isoquinoline (129 mg, 1.0 mmol), acylation reagent (1.1 mmol) and TMSCN (109 mg, 1.1 mmol) was stirred at room temperature for about 0.5 h, then TFA (0.05 mmol, 3.8 μL) was added, continue stirring for 12 h. The reaction process was monitored by TLC. After the reaction was completed, the reaction mixture can be directly purified by flash column chromatography.

General synthesis method under solvent-free conditions without the addition of TFA: A mixture of isoquinoline (129 mg, 1.0 mmol), acylation reagent (1.1 mmol) and TMSCN (109 mg, 1.1 mmol) was stirred at room temperature for 12 h. The reaction process was monitored by TLC. After the reaction was completed, the reaction mixture can be directly purified by flash column chromatography.

Synthesis of iodine, cyano or nitro substituted products method with the addition of CH_3CN: Iodine, cyano or nitro substituted isoquinoline derivatives (1.0 mmol) were dissolved in 0.5 mL MeCN. Then $(Boc)_2O$ (240 mg, 1.1 mmol) and TMSCN (109 mg, 1.1 mmol) was added and the mixture was stirred at room temperature for about 0.5 h, then TFA (3.8 μL) was added. The reaction process was monitored by TLC. After the reaction was completed, the reaction mixture can be directly purified by flash column chromatography.

3. 100 mmol-scale Reaction



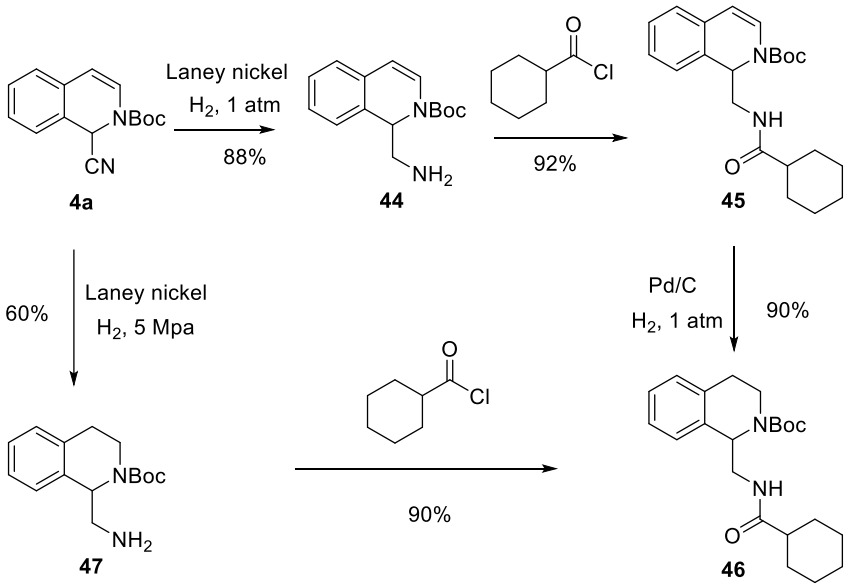
1 2a 3a

Entry	R	Time/h	Yield [b] (%)
1	H	5	96(87)[c]
2	5-Br	12	98(92)[c]
3	5-NO_2	24	93(86)[c]

[a]Reaction conditions: **1** (100 mmol), **2** (105 mmol), **3a** (105 mmol), TFA (5 mmol), stirring at room temperature. [b]Yield was determined by HPLC. [c]Crystallization yield.

A mixture of isoquinoline **1** (100 mmol), $(Boc)_2O$ (22.9g, 105 mmol) and TMSCN (10.4 g, 105 mmol) was stirred at room temperature for about 0.5 h, then TFA (5 mmol, 380 μL) was added and the mixture was stirred at room temperature. The total yields for the three isoquinoline derivatives were found to be 96%, 98%, and 93% respectively by HPLC. The target compound products were obtained directly through ethanol (50 mL) crystallization, yielding 87%, 92%, and 86% respectively.

4. Synthetic Utilities: Procedure for the Preparation of Compounds 44-50



Procedure for the synthesis of compound **44**: To a solution of compound **4a** (256 mg, 1 mmol) in ethanol (10 mL) was added Raney nickel (50 mg), and the reaction mixture was stirred at room temperature for 12 h under hydrogen atmosphere (1 atm). After that, the reaction mixture was filtered and concentrated under vacuum, the

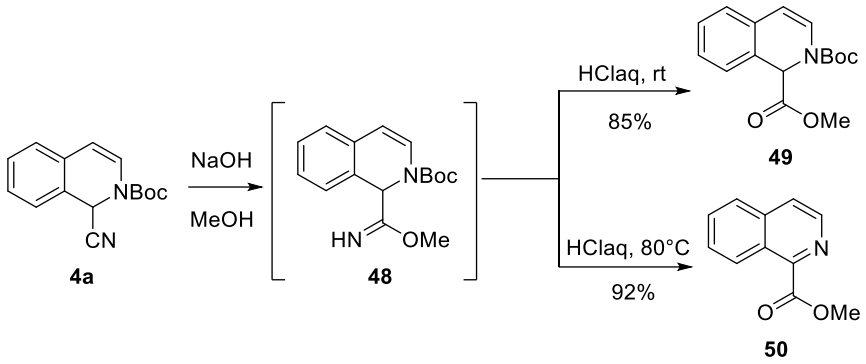
resulting residue was purified by flash column chromatography (silica gel, PE/EA = 5:1) to afford compound **44** (229 mg, 88%).

Procedure for the synthesis of compound **45**: A mixture of compound **44** (150 mg, 0.58 mmol), triethylamine (71 mg, 0.7 mmol) and anhydrous dichloromethane (5 mL) was stirred in a three necked flask. Cyclohexane formyl chloride (94 mg, 0.64 mmol) was added slowly and the mixture was stirred at room temperature for 3 h. The reaction was quenched by saturated $NaHCO_3$ solution, organic layer was separated, washed with saturated NaCl solution and dried over anhydrous Na_2SO_4, then filtered and the solvent was removed under vacuum. The residue was purified by flash column chromatography (silica gel, PE/EA = 5:1) to afford compound **45** (197.5 mg, 92%).

Procedure for the synthesis of compound **46**: To a solution of compound **45** (111mg, 0.3 mmol) in anhydrous ethanol (5 mL) was added Pd/C (0.015 mmol, 0.05 equiv), and the reaction mixture was stirred at room temperature for 3 h under hydrogen atmosphere (1 atm). After that, the reaction mixture was filtered and concentrated under vacuum, the resulting residue was purified by flash column chromatography (silica gel, PE/EA = 3:1) to afford compound **46** (100.5 mg, 90%).

Procedure for the synthesis of compound **47**: To a solution of compound **4a** (256 mg, 1 mmol) in ethanol (10 mL) was added Raney nickel (50 mg), and the reaction mixture was stirred at 80 ℃ for 12 h under hydrogen atmosphere (5 Mpa). After that, the reaction mixture was filtered and concentrated under vacuum, the resulting residue was purified by flash column chromatography (silica gel, PE/EA = 5:1) to afford compound **47** (157 mg, 60%).

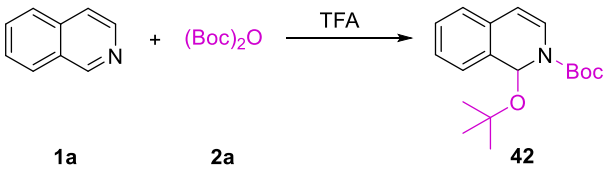
Procedure for the synthesis of compound **46**: A mixture of compound **47** (78.5 mg, 0.3 mmol), triethylamine (36.4 mg, 0.36 mmol) and anhydrous dichloromethane (5 mL) was stirred in a three necked flask. Cyclohexane formyl chloride (48.5 mg, 0.33 mmol) was added slowly and the mixture was stirred at room temperature for 3 h. The reaction was quenched by saturated $NaHCO_3$ solution, organic layer was separated, washed with saturated NaCl solution and dried over anhydrous Na_2SO_4, then filtered and the solvent was removed under vacuum. The residue was purified by flash column chromatography (silica gel, PE/EA = 5:1) to afford compound **46** (100.5 mg, 90%).



Procedure for the synthesis of compound **49**: To a solution of compound **4a** (256 mg, 1 mmol) in methanol (5 mL) was added NaOH (80 mg, 2 mmol), and the reaction mixture was stirred at room temperature for 5 h，then 1N HClaq (5 mL) was added and the mixture was stirred at room temperature for another 12 h. After that, the reaction mixture was concentrated under vacuum, the resulting residue was added saturated $NaHCO_3$ solution, extracted with CH_2Cl_2 (2×10 mL) and dried (Na_2SO4). The combined extracts were concentrated under vacuum and purified by flash column chromatography (silica gel, PE/EA = 10:1) to afford compound **49** (245 mg, 85%).

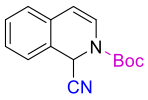
Procedure for the synthesis of compound **50**: To a solution of compound **4a** (256 mg, 1 mmol) in methanol (5 mL) was added NaOH (80 mg, 2 mmol), and the reaction mixture was stirred at room temperature for 5 h，then 1N HClaq (5 mL) was added and the mixture was stirred at 80 ℃ for 12 h. After that, the reaction mixture was concentrated under vacuum, the resulting residue was added saturated $NaHCO_3$ solution, extracted with CH_2Cl_2 (2×10 mL) and dried (Na_2SO_4). The combined extracts were concentrated under vacuum and purified by flash column chromatography (silica gel, PE/EA = 3:1) to afford compound **50** (172 mg, 92%).

5. Procedure for the preparation of tert-butyl 1-(tert-butoxy) isoquinoline-2(1H)-carboxylate 42



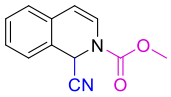
A mixture of isoquinoline **1a** (1.29 g, 10 mmol) and $(Boc)_2O$ (2.3 g, 10.5 mmol) was stirred in a round-bottom flask at room temperature for 0.5 h, then TFA (0.25 mmol, 20 μL) was added and the mixture was stirred at room temperature for 5 h. The target compound products were obtained directly through n-hexane (5 mL) crystallization, affording product **42** as white powder in 83% yield (2.5 g).

6. NMR Spectra



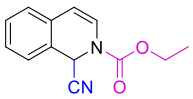
4a

Tert-butyl 1-cyanoisoquinoline-2(1*H*)-carboxylate (4a). White solid 253 mg, yield 99%; m.p. 107-108.5℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.33 (dd, J = 7.3, 1.8 Hz, 1H), 7.29-7.22 (m, 2H), 7.15 (d, J = 7.6 Hz, 1H), 6.82 (d, J = 7.9 Hz, 1H), 6.36 (s, 1H), 6.01-5.94 (m, 1H), 1.54 (s, 9H). ^{13}C NMR (151 MHz, $CDCl_3$): major: δ 150.85, 130.41, 129.92, 127.90, 126.43, 125.48, 124.57, 123.83, 116.78, 108.35, 83.65, 45.46, 28.08. minor: δ 150.60, 130.52, 130.03, 127.66, 126.43, 125.65, 124.57, 123.49, 116.78, 108.03, 84.03, 46.84, 28.08; HRMS (m/z) calcd for $C_{10}H_8NO_2$ $[M\text{-}CN\text{-}t\text{-}Bu+H]^+$ 174.0550, found 174.0548.



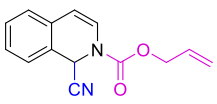
4b

Methyl 1-cyanoisoquinoline-2(1H)-carboxylate (4b). Colorless oil 119 mg, yield 56%; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.36 (dd, J = 7.4, 1.6 Hz, 1H), 7.30-7.20 (m, 2H), 7.17 (d, J = 7.5 Hz, 1H), 6.86 (d, J = 7.9 Hz, 1H), 6.37 (s, 1H), 6.01 (d, J = 7.9 Hz, 1H), 3.90 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$): major: δ 152.76, 130.18, 130.08, 128.17, 126.43, 125.72, 124.39, 123.71, 116.51, 109.26, 54.26, 46.01. minor: δ 152.35, 130.18, 127.98, 126.43, 125.83, 123.71, 123.47, 116.51, 109.26, 54.26, 46.53; HRMS (m/z) calcd for $C_{11}H_{10}NO_2$ $[M\text{-}CN]^+$ 188.0706, found 188.0712.



4c

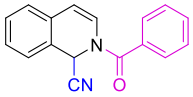
Ethyl 1-cyanoisoquinoline-2(1H)-carboxylate (4c). Colorless oil 207 mg, yield 91%; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.36 (dd, J = 7.4, 1.6 Hz, 1H), 7.27 (d, J = 11.3 Hz, 2H), 7.16 (d, J = 7.6 Hz, 1H), 6.88 (d, J = 7.9 Hz, 1H), 6.38 (s, 1H), 6.01 (d, J = 7.9 Hz, 1H), 4.45-4.30 (m, 2H), 1.35 (t, J = 7.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$): major: δ 152.26, 130.19, 130.04, 128.10, 126.43, 125.67, 124.45, 123.88, 116.57, 109.04, 63.66, 45.90, 14.40. minor: δ 151.88, 130.37, 130.19, 127.90, 126.43, 125.79, 123.79, 123.49, 116.57, 108.93, 63.66, 46.50, 14.40; HRMS (m/z) calcd for $C_{12}H_{12}NO_2$ $[M\text{-}CN]^+$ 202.0863, found 202.0860.



4d

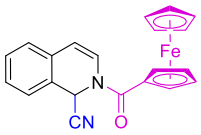
Allyl 1-cyanoisoquinoline-2(1H)-carboxylate (4d). Colorless oil 131 mg, yield 55%; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.36 (dd, J = 7.4, 1.6 Hz, 1H), 7.27 (d, J = 16.3 Hz, 2H), 7.17 (d, J = 7.6 Hz, 1H), 6.90 (d, J = 7.9 Hz, 1H), 6.38 (s, 1H), 6.02 (d, J = 7.9 Hz, 1H), 6.00-5.93 (m, 1H), 5.38 (d, J = 17.4 Hz, 1H), 5.31 (d, J = 10.5 Hz, 1H), 4.87-4.73 (m, 2H). ^{13}C NMR (151 MHz, $CDCl_3$): major: δ 152.01, 131.37, 130.20, 130.09, 128.18, 126.44, 125.74, 124.36, 123.69, 119.31, 116.49, 109.35, 68.00, 45.98. minor: δ

151.62, 131.37, 130.20, 127.99, 126.44, 125.85, 123.78, 123.47, 119.58, 116.49, 109.24, 68.00, 46.50; HRMS (m/z) calcd for $C_{13}H_{12}NO_2$ $[M\text{-}CN]^+$ 214.0863, found 214.0866.



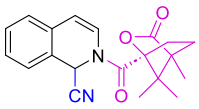
4e

2-benzoyl-1,2-dihydroisoquinoline-1-carbonitrile (4e). Light yellow solid 161 mg, yield 62%; m.p. 125.3-127°C; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.62-7.61 (m, 1H), 7.60 (d, J = 1.4 Hz, 1H), 7.58-7.54 (m, 1H), 7.48 (d, J = 7.9 Hz, 2H), 7.43-7.39 (m, 1H), 7.37-7.32 (m, 2H), 7.23 (d, J = 7.4 Hz, 1H), 6.63 (s, 1H), 6.57 (s, 1H), 6.07 (d, J = 7.9 Hz, 1H). ^{13}C NMR (151 MHz, $CDCl_3$): δ 168.73, 132.16, 132.01, 130.27, 130.20, 129.22, 128.67, 128.46, 126.74, 126.13, 125.77, 124.43, 116.36, 109.98, 44.92; HRMS (m/z) calcd for $C_{16}H_{12}NO$ $[M\text{-}CN]^+$ 234.0913, found 234.0918.



4f

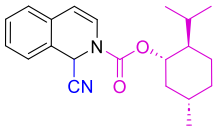
2-(1-chlorocarbonylferrocene)-1,2-dihydroisoquinoline-1-carbonitrile (4f). Orange solid 269 mg, yield 73%; m.p. 147.5-148.5°C; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.40 (ddd, J = 7.6, 6.3, 2.5 Hz, 1H), 7.33 (dd, J = 6.3, 1.2 Hz, 2H), 7.30 (dd, J = 7.7, 1.1 Hz, 1H), 7.23 (d, J = 7.2 Hz, 1H), 6.52 (s, 1H), 6.12 (d, J = 7.7 Hz, 1H), 4.82 (t, 1H), 4.71 (s, 1H), 4.50-4.49 (m, 1H), 4.48-4.46 (m, 1H), 4.27 (s, 5H). ^{13}C NMR (151 MHz, $CDCl_3$): δ 169.80, 130.58, 130.06, 128.18, 126.67, 126.34, 125.59, 124.78, 116.50, 109.45, 73.53, 73.42, 71.56, 70.71, 70.19, 69.60, 45.18.



4g

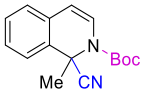
2-((1S,4R)-4,7,7-trimethyl-3-oxo-2-oxabicyclo [2.2.1] heptane-1-carbonyl)-1,2-dihydroisoquinoline-1-carbonitrile (4g). Light yellow oil 27 mg, yield 8%; ^{1}H-NMR (600 MHz, $CDCl_3$): The compound exists as a 34:66 mixture of carbamate rotamers. Signals corresponding to the major rotamer: δ7.48 (d, J = 8.0 Hz, 1H), 7.37 (dd, J = 7.5, 2.4 Hz, 1H), 7.32-7.28 (m, 2H), 7.20 (dd, J = 7.7, 3.2 Hz, 1H), 6.67 (s, 1H), 6.11 (d, J = 8.0 Hz, 1H), 2.40-2.31 (m, 1H), 2.09-1.97 (m, 1H), 1.95-1.89 (m, 1H), 1.71 (ddd, J = 13.4, 9.3, 4.2 Hz, 1H), 1.19 (s, 2H), 1.15 (s, 2H), 1.14 (s, 4H), 1.11 (s, 1H). Signals corresponding to the minor rotamer: δ 7.38 (dd, J = 6.6, 2.2 Hz, 1H), 7.32-7.28 (m, 2H), 7.24 (d, J = 7.9 Hz, 1H), 7.19 (d, J = 7.4 Hz, 1H), 6.52 (s, 1H), 6.09 (d, J = 7.9 Hz, 1H), 2.53 (ddd, J = 13.6, 10.8, 4.3 Hz, 1H), 2.21 (ddd, J = 13.8, 9.0, 4.2 Hz, 1H), 2.09-1.97 (m, 1H), 1.77 (ddd, J = 13.5, 9.4, 4.3 Hz, 1H), 1.19 (s, 2H), 1.15 (s, 2H), 1.13 (s, 4H), 1.11 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$): Signals corresponding to the major rotamer: δ 177.47, 164.91, 130.24, 129.72, 128.35, 126.59, 125.79, 124.66, 124.33, 116.19, 111.51, 92.10, 55.21, 53.96, 44.09, 31.69, 28.87, 17.12, 16.93, 9.55. Signals corresponding to the minor rotamer: δ 177.47, 165.82, 130.28, 129.89, 128.24, 126.56, 125.82, 124.53,

124.37, 116.16, 110.76, 92.40, 55.91, 53.83, 44.53, 31.49, 29.13, 17.44, 16.54, 9.53; HRMS (m/z) calcd for $C_{19}H_{20}NO_3$ [M-CN]$^+$ 310.1438, found 310.1442.



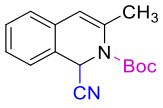
4h

(1S,2R,5S)-2-isopropyl-5-methylcyclohexyl 1-cyanoisoquinoline-2(1H)-carboxylate (4h). Colorless oil 216 mg, yield 64%; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.36 (dd, J = 7.2, 1.7 Hz, 1H), 7.30-7.23 (m, 2H), 7.16 (d, J = 7.6 Hz, 1H), 6.90-6.84 (m, 1H), 6.38 (s, 1H), 6.05-5.96 (m, 1H), 4.85-4.73 (m, 1H), 2.20-2.02 (m, 1H), 1.99-1.78 (m, 1H), 1.78-1.68 (m, 2H), 1.65-1.03 (m, 5H), 1.03-0.71 (m, 10H). ^{13}C NMR (151 MHz, $CDCl_3$): The compound exists as a 51:49 mixture of carbamate rotamers. Signals corresponding to the major rotamer: δ 151.86, 129.98, 128.00, 126.41, 125.58, 124.63, 123.96, 116.65, 108.90, 108.68, 78.21, 47.10, 45.86, 41.08, 40.87, 34.03, 31.38, 26.43, 26.20, 23.42, 23.30, 21.90, 20.78, 20.61, 16.38, 16.32; HRMS (m/z) calcd for $C_{20}H_{26}NO_2$ [M-CN]$^+$ 312.1958, found 312.1957.



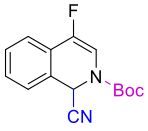
5

Tert-butyl 1-cyano-1-methylisoquinoline-2(1*H*)-carboxylate (5). Light yellow oil 73 mg, yield 27%; ^{1}H-NMR (600 MHz, CDCl3): δ 7.56 (d, J = 2.4 Hz, 1H), 7.27-7.22 (m, 2H), 7.00 (d, J = 2.3 Hz, 1H), 6.85 (d, J = 8.2 Hz, 1H), 5.65 (d, J = 8.3 Hz, 1H), 1.89 (s, 3H), 1.61 (s, 9H). ^{13}C NMR (151 MHz, CDCl3): δ 151.00, 130.47, 129.16, 128.18, 127.55, 126.09, 124.93, 124.12, 119.87, 104.60, 84.33, 56.66, 28.09, 27.38. HRMS (m/z) calcd for $C_{11}H_{10}NO_2$ [M-CN-*t*−Bu+H]$^+$ 188.0707, found 188.0706.



7

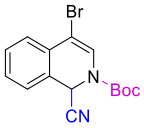
Tert-butyl 1-cyano-3-methylisoquinoline-2(1*H*)-carboxylate (7). Light yellow solid 185 mg, yield 68%; m.p. 104.5-105°C; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.37-7.30 (m, 1H), 7.26-7.22 (m, 2H), 7.13 (d, J = 7.4 Hz, 1H), 6.41 (s, 1H), 6.13 (d, J = 1.3 Hz, 1H), 2.31 (s, 3H), 1.52 (s, 9H). ^{13}C NMR (151 MHz, $CDCl_3$): δ 151.44, 135.43, 131.46, 129.76, 127.34, 125.60, 125.48, 124.80, 117.22, 114.04, 83.43, 47.22, 28.15, 21.67. HRMS (m/z) calcd for $C_{11}H_{10}NO_2$ [M-CN-*t*−Bu+H]$^+$ 188.0707, found 188.0699.



8

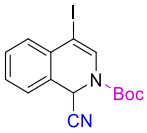
Tert-butyl 1-cyano-4-fluoroisoquinoline-2(1*H*)-carboxylate (8). White solid 229 mg, yield 84%; m.p. 136.5-137°C; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.50-7.42 (m, 2H), 7.41-7.34 (m, 1H), 7.31 (d, J = 7.7 Hz, 1H), 6.82 (d, J = 6.7 Hz, 1H), 6.38 (s, 1H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.73, 147.04 (d, J = 240.1 Hz), 130.04, 129.52, 126.32 (d, J = 3.9 Hz), 125.95 (d, J = 24.3 Hz), 124.02 (d, J =

6.1 Hz), 120.38, 116.32, 108.82 (d, J = 41.0 Hz), 83.98, 45.39, 28.07. minor: δ 150.11, 147.28 (d, J = 240.1 Hz), 130.19, 129.25, 126.32 (d, J = 3.9 Hz), 126.21 (d, J = 31.7 Hz), 123.76 (d, J = 5.0 Hz), 120.36, 116.22, 108.78 (d, J = 42.3 Hz), 84.37, 46.84, 28.07. HRMS (m/z) calcd for $C_{10}H_7FNO_2$ [M-CN-*t*–Bu+H]$^+$ 192.0456, found 192.0462.



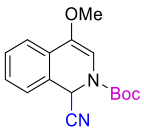
9

Tert-butyl 4-bromo-1-cyanoisoquinoline-2(1*H*)-carboxylate (9). White solid 322 mg, yield 96%; m.p. 90-90.5℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.56 (s, 1H), 7.45 (td, J = 7.7, 1.4 Hz, 1H), 7.35 (t, J = 7.5 Hz, 2H), 7.24 (s, 1H), 6.37 (s, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 149.95, 130.33, 129.74, 129.25, 126.26, 125.76, 125.31, 124.00, 116.32, 103.24, 84.55, 45.52, 28.05. minor: δ 149.69, 130.33, 129.74, 128.96, 126.26, 125.88, 125.31, 123.69, 116.32, 103.04, 84.80, 46.98, 28.05. HRMS (m/z) calcd for $C_{10}H_7BrNO_2$ [M-CN-*t*–Bu+H]$^+$ 251.9655, found 251.9654.



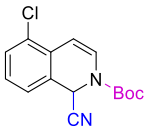
10

Tert-butyl 1-cyano-4-iodoisoquinoline-2(1*H*)-carboxylate (10). Yellow solid 365 mg, yield 95%; m.p. 103.5-104.5℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.53-7.42 (m, 2H), 7.32 (d, J = 8.1 Hz, 2H), 7.17 (d, J = 7.5 Hz, 1H), 6.36 (s, 1H), 1.62-1.53 (m, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 149.70, 131.20, 130.91, 130.53, 129.81, 129.21, 126.33, 123.73, 116.39, 84.60, 75.41, 45.56, 28.05. minor: δ 149.70, 131.20, 130.91, 130.53, 130.04, 128.92, 126.33, 123.32, 116.39, 84.60, 74.81, 47.03, 28.05. HRMS (m/z) calcd for $C_{10}H_7INO_2$ [M-CN-*t*–Bu+H]$^+$ 299.9516, found 299.9518.



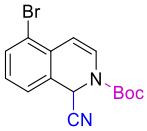
11

Tert-butyl 1-cyano-4-methoxyisoquinoline-2(1*H*)-carboxylate (11). White solid 277 mg, yield 97%; m.p. 149-149.5℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.57 (d, J = 7.1 Hz, 1H), 7.41 (t, J = 7.7 Hz, 1H), 7.37-7.31 (m, 1H), 7.27 (d, J = 6.4 Hz, 1H), 6.38 (s, 1H), 6.24 (s, 1H), 3.80 (s, 3H), 1.53 (s, 9H). ^{13}C NMR (151 MHz, $CDCl_3$): major: δ 151.26, 142.89, 129.68, 128.90, 128.68, 125.83, 125.24, 121.92, 116.84, 101.83, 82.97, 55.71, 45.36, 28.14. minor: δ 150.75, 142.89, 129.85, 128.59, 128.43, 125.78, 124.77, 121.95, 116.67, 101.56, 83.45, 55.67, 46.75, 28.14. HRMS (m/z) calcd for $C_{11}H_{10}NO_3$ [M-CN-*t*–Bu+H]$^+$ 204.0656, found 204.0656.



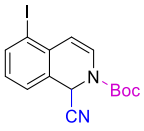
12

Tert-butyl 5-chloro-1-cyanoisoquinoline-2(1*H*)-carboxylate (12). White solid 126 mg, yield 87%; m.p. 160.2-161.2℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.38 (dd, J = 8.0, 1.4 Hz, 1H), 7.18 (d, J = 7.8 Hz, 1H), 7.16 (s, 1H), 6.93 (d, J = 8.1 Hz, 1H), 6.36 (s, 1H), 6.34 (s, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.57, 130.73, 128.63, 128.42, 128.16, 126.11, 125.46, 124.97, 116.31, 104.75, 84.11, 45.38, 28.05. minor: δ 150.28, 130.77, 128.63, 128.42, 128.16, 126.11, 125.46, 124.97, 116.31, 104.25, 84.49, 46.75, 28.05. HRMS (m/z) calcd for $C_{10}H_7ClNO_2$ $[M\text{-}CN\text{-}t\text{–}Bu+H]^+$ 208.0160, found 208.0166.



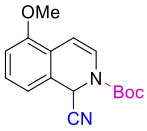
13

Tert-butyl 5-bromo-1-cyanoisoquinoline-2(1*H*)-carboxylate (13). White solid 328 mg, yield 98%; m.p. 160-161℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.57 (d, J = 8.1 Hz, 1H), 7.19 (s, 1H), 7.11 (t, J = 7.8 Hz, 1H), 6.92 (d, J = 8.2 Hz, 1H), 6.34 (d, J = 7.9 Hz, 1H), 6.32 (s, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.53, 134.04, 130.28, 128.68, 126.35, 125.67, 125.49, 121.01, 116.32, 107.29, 84.13, 45.50, 28.05. minor: δ 150.24, 134.04, 130.28, 128.42, 126.35, 125.67, 125.17, 121.01, 116.32, 106.81, 84.51, 46.87, 28.05. HRMS (m/z) calcd for $C_{10}H_7BrNO_2$ $[M\text{-}CN\text{-}t\text{–}Bu+H]^+$ 251.9655, found 251.9658.



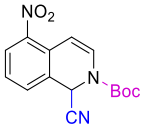
14

Tert-butyl 1-cyano-5-iodoisoquinoline-2(1*H*)-carboxylate (14). Light yellow solid 367 mg, yield 96%; m.p. 151.5-152℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.84 (dd, J = 8.0, 1.1 Hz, 1H), 7.21 (d, J = 7.5 Hz, 1H), 6.95 (t, J = 7.8 Hz, 1H), 6.88 (d, J = 8.2 Hz, 1H), 6.31 (s, 1H), 6.21 (d, J = 8.0 Hz, 1H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.48, 140.68, 133.36, 128.97, 126.66, 126.65, 124.76, 116.36, 112.17, 96.59, 84.13, 45.74, 28.06. minor: δ 150.21, 140.68, 133.36, 128.71, 126.66, 126.65, 124.45, 116.36, 111.71, 96.78, 84.51, 47.10, 28.06. HRMS (m/z) calcd for $C_{10}H_7INO_2$ $[M\text{-}CN\text{-}t\text{–}Bu+H]^+$ 299.9516, found 299.9512.



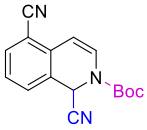
15

Tert-butyl 1-cyano-5-methoxyisoquinoline-2(1*H*)-carboxylate (15). Light yellow solid 133 mg, yield 93%; m.p. 135.6-136.4℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.22 (t, J = 8.0 Hz, 1H), 6.86 (d, J = 8.3 Hz, 1H), 6.84 (d, J = 7.6 Hz, 1H), 6.79 (d, J = 8.0 Hz, 1H), 6.33 (s, 2H), 3.86 (s, 3H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 154.35, 150.97, 128.77, 125.00, 123.58, 119.77, 118.44, 116.77, 111.50, 103.24, 83.47, 55.64, 45.32, 28.08. minor: δ 154.35, 150.66, 128.51, 124.60, 123.58, 119.94, 118.44, 116.77, 111.50, 102.73, 83.87, 55.64, 46.70, 28.08. HRMS (m/z) calcd for $C_{11}H_{10}NO_3$ $[M\text{-}CN\text{-}t\text{–}Bu+H]^+$ 204.0656, found 204.0657.



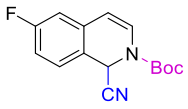
16

Tert-butyl 1-cyano-5-nitroisoquinoline-2(1*H*)-carboxylate (16). Yellow solid 277 mg, yield 92%; m.p. 151.5-152℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 8.04 (d, J = 8.3 Hz, 1H), 7.51 (s, 1H), 7.39 (t, J = 7.9 Hz, 1H), 7.07 (d, J = 6.6 Hz, 1H), 6.77 (s, 1H), 6.45 (s, 1H), 1.56 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.13, 144.77, 131.49, 129.15, 127.66, 126.48, 126.25, 125.72, 115.78, 102.90, 84.86, 45.25, 28.00. minor: δ 149.76, 144.77, 131.49, 129.15, 127.66, 126.59, 126.25, 125.92, 115.78, 102.35, 85.15, 46.67, 28.00. HRMS (m/z) calcd for $C_9H_7N_2O_2$ [M-CN-CO_2t−Bu+H]$^+$ 175.0503, found 175.0501.



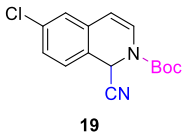
17

Tert-butyl 1,5-dicyanoisoquinoline-2(1H)-carboxylate (17). White solid 270 mg, yield 96%; m.p. 163-164℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.64 (d, J = 7.8 Hz, 1H), 7.47 (d, J = 7.7 Hz, 1H), 7.34 (t, J = 7.9 Hz, 1H), 7.06 (d, J = 8.3 Hz, 1H), 6.41 (s, 1H), 6.30 (d, J = 8.0 Hz, 1H), 1.56 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.26, 133.81, 130.68, 128.36, 127.82, 124.58, 116.51, 115.85, 108.36, 104.43, 84.80, 45.08, 28.00, 27.37. minor: δ 149.92, 133.81, 130.68, 128.36, 127.82, 124.58, 116.51, 115.85, 108.36, 103.97, 85.14, 46.45, 28.00, 27.37. HRMS (m/z) calcd for $C_{11}H_7N_2O_2$ [M-CN-t−Bu+H]$^+$ 199.0503, found 199.0503.



18

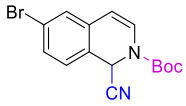
Tert-butyl 1-cyano-6-fluoroisoquinoline-2(1*H*)-carboxylate (18). White solid 257 mg, yield 94%; m.p. 101-101.5℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.25-7.20 (m, 1H), 6.98-6.92 (m, 1H), 6.88 (d, J = 7.9 Hz, 1H), 6.85 (d, J = 9.0 Hz, 1H), 6.35 (s, 1H), 5.96-5.89 (m, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 163.47 (d, J = 248.2 Hz), 150.66, 132.68 (d, J = 9.1 Hz), 128.18, 125.73, 119.53, 116.57, 114.58 (d, J = 22.8 Hz), 112.19 (d, J = 22.7 Hz), 107.45, 84.01, 45.00, 28.05. minor: δ 163.47 (d, J = 248.2 Hz), 150.41, 132.86 (d, J = 9.1 Hz), 128.12, 125.73, 119.19, 116.57, 114.36 (d, J = 21.1 Hz), 112.33 (d, J = 21.1 Hz), 107.13, 84.37, 46.37, 28.05. HRMS (m/z) calcd for $C_{10}H_7FNO_2$ [M-CN-t−Bu+H]$^+$ 192.0456, found 192.0460.



19

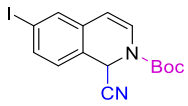
Tert-butyl 6-chloro-1-cyanoisoquinoline-2(1*H*)-carboxylate (19). Light yellow oil 276 mg, yield 95%; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.22 (s, 1H), 7.18 (s, 1H), 7.14 (s, 1H), 6.87 (d, J = 8.1 Hz, 1H), 6.34 (s, 1H), 5.94-5.87 (m, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.64, 135.88, 132.14,

127.67, 127.45, 125.84, 125.32, 122.01, 116.39, 107.13, 84.07, 45.02, 28.05. minor: δ 150.35, 135.88, 132.14, 127.67, 127.45, 125.84, 125.44, 121.70, 116.39, 106.79, 84.44, 46.39, 28.05. HRMS (m/z) calcd for $C_{10}H_7ClNO_2$ [M-CN-*t*−Bu+H]$^+$ 208.0160, found 208.0160.



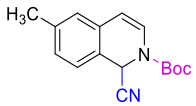
20

Tert-butyl 6-bromo-1-cyanoisoquinoline-2(1*H*)-carboxylate (20). White solid 308 mg, yield 92%; m.p. 97-97.5℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.38 (d, J = 8.2 Hz, 1H), 7.30 (s, 1H), 7.12 (d, J = 8.2 Hz, 1H), 6.87 (d, J = 8.0 Hz, 1H), 6.32 (s, 1H), 5.93-5.86 (m, 1H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.63, 132.40, 130.61, 128.23, 127.88, 125.86, 123.98, 122.50, 116.29, 107.01, 84.08, 45.07, 28.06. minor: δ 150.35, 132.40, 130.39, 128.23, 127.88, 125.86, 123.98, 122.19, 116.29, 106.65, 84.46, 46.46, 28.06. HRMS (m/z) calcd for $C_{10}H_7BrNO_2$ [M-CN-*t*−Bu+H]$^+$ 251.9655, found 251.9652.



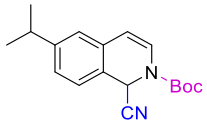
21

Tert-butyl 1-cyano-6-iodoisoquinoline-2(1*H*)-carboxylate (21). Light yellow solid 348 mg, yield 91%; m.p. 73-74℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.58 (d, J = 8.2 Hz, 1H), 7.50 (s, 1H), 6.98 (d, J = 8.0 Hz, 1H), 6.85 (d, J = 7.9 Hz, 1H), 6.30 (s, 1H), 5.87 (s, 1H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.63, 136.59, 134.14, 132.43, 127.92, 125.75, 123.17, 116.28, 106.82, 95.71, 84.06, 45.14, 28.06. minor: δ 150.36, 136.37, 134.28, 132.43, 127.92, 125.75, 122.82, 116.28, 106.47, 95.71, 84.45, 46.52, 28.06. HRMS (m/z) calcd for $C_{10}H_7INO_2$ [M-CN-*t*−Bu+H]$^+$ 299.9516, found 299.9525.



22

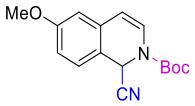
Tert-butyl 1-cyano-6-methylisoquinoline-2(1*H*)-carboxylate (22). White solid 251mg, yield 93%; m.p. 73.5-74℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.12 (s, 1H), 7.07 (s, 1H), 6.96 (s, 1H), 6.81 (d, J = 7.8 Hz, 1H), 6.32 (s, 1H), 5.96-5.89 (m, 1H), 2.34 (s, 3H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.89, 139.90, 130.20, 128.57, 126.24, 126.10, 124.47, 121.07, 116.94, 108.38, 83.52, 45.31, 28.08, 21.20. minor: δ 150.66, 140.03, 130.30, 128.34, 126.24, 126.10, 124.38, 120.72, 116.94, 108.07, 83.91, 46.68, 28.08, 21.20. HRMS (m/z) calcd for $C_{11}H_{10}NO_2$ [M-CN-*t*−Bu+H]$^+$ 188.0707, found 188.0707.



23

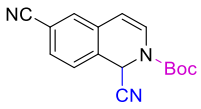
Tert-butyl 1-cyano-6-isopropylisoquinoline-2(1*H*)-carboxylate (23). Light yellow oil 296 mg, yield 99%; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.16 (s, 1H), 7.13 (s, 1H), 7.01 (s, 1H), 6.81 (d, J = 7.7 Hz, 1H), 6.33 (s, 1H), 5.99-5.93 (m, 1H), 2.89 (hept, J = 6.9 Hz, 1H), 1.54 (s, 9H), 1.25 (s, 6H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.94, 150.91, 130.28, 126.37, 126.13, 124.40, 123.56, 121.40, 116.96, 108.67,

83.50, 45.32, 33.94, 28.09, 23.78. minor: δ 151.06, 150.67, 130.28, 126.37, 125.87, 124.40, 123.77, 121.03, 116.96, 108.33, 83.90, 46.71, 33.94, 28.09, 23.80. HRMS (m/z) calcd for $C_{13}H_{14}NO_2$ [M-CN-*t*–Bu+H]$^+$ 216.1020, found 216.1024.



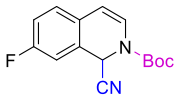
24

Tert-butyl 1-cyano-6-methoxyisoquinoline-2(1*H*)-carboxylate (24). Yellow solid 283 mg, yield 99%; m.p. 89-89.5°C; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.15 (d, J = 8.5 Hz, 1H), 6.83 (d, J = 7.8 Hz, 1H), 6.78 (d, J = 8.5 Hz, 1H), 6.66 (s, 1H), 6.30 (s, 1H), 5.95-5.88 (m, 1H), 3.81 (s, 3H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 160.77, 150.89, 131.75, 127.59, 124.99, 117.08, 116.21, 113.34, 110.74, 108.32, 83.67, 55.44, 45.18, 28.13. minor: δ 160.77, 150.69, 131.90, 127.59, 124.99, 117.08, 115.80, 113.34, 110.74, 108.03, 84.05, 55.44, 46.55, 28.13. HRMS (m/z) calcd for $C_{11}H_{10}NO_3$ [M-CN-*t*–Bu+H]$^+$ 204.0656, found 204.0658.



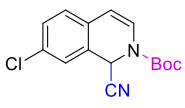
25

Tert-butyl 1,6-dicyanoisoquinoline-2(1*H*)-carboxylate (25). White solid 278 mg, yield 99%; m.p. 117.1-117.6°C; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.53 (s, 1H), 7.43 (s, 1H), 7.38 (s, 1H), 6.95 (d, J = 8.3 Hz, 1H), 6.42 (s, 1H), 5.96 (s, 1H), 1.55 (s, 9H).^{13}C NMR (151 MHz, $CDCl_3$): major: δ 150.41, 131.81, 131.02, 128.60, 127.36, 126.85, 117.78, 115.73, 114.15, 106.32, 84.54, 45.10, 28.01, 27.36. minor: δ 150.07, 131.81, 130.80, 128.60, 127.36, 126.85, 117.78, 115.73, 114.15, 105.95, 84.90, 46.48, 28.01, 27.36. HRMS (m/z) calcd for $C_{10}H_7N_2$ [M-CN-CO_2*t*–Bu+H]$^+$ 155.0604, found 155.0600.



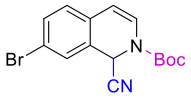
26

Tert-butyl 1-cyano-7-fluoroisoquinoline-2(1*H*)-carboxylate (26). White solid 246 mg, yield 90%; m.p. 145.8-146.5°C; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.15-7.10 (m, 1H), 7.05 (d, J = 8.5 Hz, 1H), 6.99 (d, J = 8.3 Hz, 1H), 6.79 (d, J = 8.1 Hz, 1H), 6.33 (s, 1H), 5.98-5.92 (m, 1H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 161.87 (d, J = 249.3 Hz), 150.82, 127.13 (d, J = 8.3 Hz), 126.81, 125.43 (d, J = 7.7 Hz), 124.00, 117.01 (d, J = 21.0 Hz), 116.28, 113.72, 107.52, 83.89, 45.24, 28.07. minor: δ 161.75 (d, J = 249.2 Hz), 150.48, 127.19 (d, J = 10.6 Hz), 126.81, 125.06 (d, J = 3.0 Hz), 124.00, 117.08 (d, J = 21.1 Hz), 116.28, 113.88, 107.16, 84.29, 46.60, 28.07. HRMS (m/z) calcd for $C_{10}H_7FNO_2$ [M-CN-*t*–Bu+H]$^+$ 192.0456, found 192.0454.



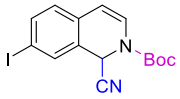
27

Tert-butyl 7-chloro-1-cyanoisoquinoline-2(1*H*)-carboxylate (27). White solid 267 mg, yield 92%; m.p. 183.1-183.7℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.31 (dd, J = 8.2, 2.1 Hz, 1H), 7.28-7.24 (m, 1H), 7.09 (d, J = 8.3 Hz, 1H), 6.84 (d, J = 8.0 Hz, 1H), 6.33 (s, 1H), 5.98-5.91 (m, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.67, 133.19, 130.10, 129.03, 126.74, 126.61, 125.14, 124.96, 116.27, 107.43, 84.01, 45.07, 28.05. minor: δ 150.35, 132.95, 130.10, 129.03, 126.74, 126.61, 125.14, 124.96, 116.27, 107.10, 84.41, 46.42, 28.05. HRMS (m/z) calcd for $C_{10}H_7ClNO_2$ [M-CN-*t*−Bu+H]$^+$ 208.0160, found 208.0155.



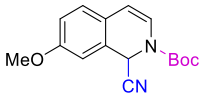
28

Tert-butyl 7-bromo-1-cyanoisoquinoline-2(1*H*)-carboxylate (28). White solid 311 mg, yield 93%; m.p. 171.7-172.3℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.46 (dd, J = 8.2, 2.0 Hz, 1H), 7.41 (s, 1H), 7.02 (d, J = 8.2 Hz, 2H), 6.33 (s, 1H), 5.93 (t, J = 8.7 Hz, 1H), 1.54 (s, 9H).^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.64, 146.71, 133.04, 129.45, 126.84, 125.11, 120.92, 116.28, 107.48, 84.03, 44.91, 28.05, 27.38. minor: δ 150.33, 146.71, 133.04, 129.45, 126.97, 125.38, 120.66, 116.28, 107.17, 84.44, 46.25, 28.05, 27.38. HRMS (m/z) calcd for $C_{10}H_7BrNO_2$ [M-CN-*t*−Bu+H]$^+$ 251.9655, found 251.9661.



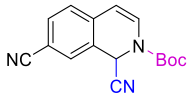
29

Tert-butyl 1-cyano-7-iodoisoquinoline-2(1*H*)-carboxylate (29). Light yellow solid 344 mg, yield 90%; m.p. 163-163.6℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.65 (d, J = 8.1 Hz, 1H), 7.58 (s, 1H), 6.89 (d, J = 8.1 Hz, 1H), 6.85 (d, J = 8.0 Hz, 1H), 6.31 (s, 1H), 5.95-5.88 (m, 1H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.60, 138.97, 135.17, 129.98, 126.95, 125.50, 125.31, 116.31, 107.58, 91.77, 84.02, 44.57, 28.06. minor: δ 150.30, 138.97, 135.17, 130.11, 127.10, 125.50, 125.31, 116.31, 107.26, 91.46, 84.43, 45.92, 28.06. HRMS (m/z) calcd for $C_{10}H_7INO_2$ [M-CN-*t*−Bu+H]$^+$ 299.9516, found 299.9521.



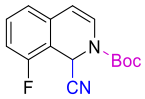
30

Tert-butyl 1-cyano-7-methoxyisoquinoline-2(1*H*)-carboxylate (30). White solid 251 mg, yield 88%; m.p. 135.6-136℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.08 (d, J = 8.4 Hz, 1H), 6.87 (dd, J = 8.4, 2.6 Hz, 1H), 6.78 (d, J = 2.7 Hz, 1H), 6.71 (d, J = 7.8 Hz, 1H), 6.30 (s, 1H), 5.97-5.90 (m, 1H), 3.82 (s, 3H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 159.37, 151.05, 126.81, 125.21, 123.30, 122.36, 116.75, 115.50, 111.95, 108.22, 83.45, 55.51, 45.62, 28.10. minor: δ 159.22, 150.70, 126.94, 124.81, 123.30, 122.26, 116.75, 115.50, 112.13, 107.84, 83.85, 55.51, 46.98, 28.10. HRMS (m/z) calcd for $C_{11}H_{10}NO_3$ [M-CN-*t*−Bu+H]$^+$ 204.0656, found 204.0655.



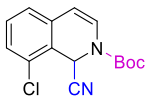
31

Tert-butyl 1,7-dicyanoisoquinoline-2(1*H*)-carboxylate (31). White solid 270 mg, yield 96%; m.p. 188.5-189.1℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.62 (dd, J = 8.0, 1.7 Hz, 1H), 7.55 (s, 1H), 7.24 (d, J = 8.0 Hz, 1H), 6.99 (d, J = 8.3 Hz, 1H), 6.42 (s, 1H), 5.99 (s, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.24, 134.93, 133.73, 130.03, 128.02, 125.85, 124.33, 117.95, 115.83, 110.92, 106.81, 84.71, 44.86, 28.00. minor: δ 149.98, 134.93, 133.73, 130.03, 128.02, 125.85, 124.12, 117.95, 115.83, 110.92, 106.52, 85.12, 46.23, 28.00. HRMS (m/z) calcd for $C_{11}H_7N_2O_2$ [M-CN-*t*–Bu+H]$^+$ 199.0503, found 199.0494.



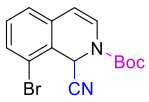
32

Tert-butyl 1-cyano-8-fluoroisoquinoline-2(1*H*)-carboxylate (32). White solid 235 mg, yield 86%; m.p. 79.5-80℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.31 (td, J = 8.0, 5.7 Hz, 1H), 6.99 (d, J = 8.8 Hz, 1H), 6.93 (d, J = 7.7 Hz, 1H), 6.87 (d, J = 7.8 Hz, 1H), 6.64 (s, 1H), 5.99-5.92 (m, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 158.43 (d, J = 249.3 Hz), 150.65, 132.38, 131.16 (d, J = 8.3 Hz), 125.59, 120.90, 115.79, 114.44 (d, J = 19.9 Hz), 111.19 (d, J = 15.8 Hz), 107.35, 84.02, 39.65, 28.05. minor: δ 158.43 (d, J = 249.3 Hz), 150.43, 132.53, 131.31 (d, J = 6.0 Hz), 125.59, 121.05, 115.79, 114.20 (d, J = 21.0 Hz), 110.86 (d, J = 15.3 Hz), 107.09, 84.49, 40.84, 28.05. HRMS (m/z) calcd for $C_{10}H_7FNO_2$ [M-CN-*t*–Bu+H]$^+$ 192.0456, found 192.0461.



33

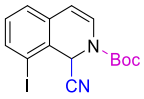
Tert-butyl 8-chloro-1-cyanoisoquinoline-2(1*H*)-carboxylate (33). White solid 270 mg, yield 93%; m.p. 97.4-98.4℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.31-7.23 (m, 2H), 7.06-7.02 (m, 1H), 6.86 (d, J = 7.8 Hz, 1H), 6.72 (s, 1H), 5.92 (d, J = 7.8 Hz, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.65, 132.60, 132.13, 130.67, 128.21, 125.53, 123.79, 121.91, 115.60, 107.71, 84.01, 43.06, 28.06. minor: δ 150.38, 132.83, 131.97, 130.82, 127.99, 125.53, 123.96, 121.48, 115.60, 107.51, 84.39, 44.26, 28.06. HRMS (m/z) calcd for $C_{10}H_7ClNO_2$ [M-CN-*t*–Bu+H]$^+$ 208.0160, found 208.0169.



34

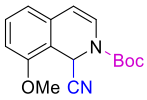
Tert-butyl 8-bromo-1-cyanoisoquinoline-2(1*H*)-carboxylate (34). White solid 328 mg, yield 98%; m.p. 95-95.5℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.46 (d, J = 8.1 Hz, 1H), 7.20 (t, J = 7.8 Hz, 1H), 7.08 (d, J = 7.6 Hz, 1H), 6.85 (d, J = 7.9 Hz, 1H), 6.71 (s, 1H), 5.91 (d, J = 7.9 Hz, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.63, 132.96, 131.44, 130.99, 125.61, 124.45, 123.66, 122.15,

115.62, 107.99, 84.02, 45.71, 28.09. minor: δ 150.34, 133.21, 131.44, 131.15, 125.61, 124.63, 123.20, 122.15, 115.62, 107.84, 84.37, 46.98, 28.09. HRMS (m/z) calcd for $C_{10}H_7BrNO_2$ [M-CN-*t*–Bu+H]$^+$ 251.9655, found 251.9656.



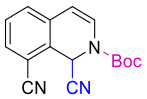
35

Tert-butyl 1-cyano-8-iodoisoquinoline-2(1*H*)-carboxylate (35). White solid 344 mg, yield 90%; m.p. 120-121°C; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.74-7.68 (m, 1H), 7.10 (d, *J* = 1.3 Hz, 1H), 7.05 (t, *J* = 7.7 Hz, 1H), 6.82 (d, *J* = 7.9 Hz, 1H), 6.62 (s, 1H), 5.86 (d, *J* = 7.8 Hz, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.57, 138.08, 132.85, 131.27, 126.96, 125.64, 125.42, 115.69, 108.50, 97.57, 84.02, 50.89, 28.10. minor: δ 150.23, 137.79, 133.12, 131.43, 126.44, 125.64, 125.42, 115.69, 108.42, 97.57, 84.30, 52.35, 28.03 HRMS (m/z) calcd for $C_{10}H_7INO_2$ [M-CN-*t*–Bu+H]$^+$ 299.9516, found 299.9516.



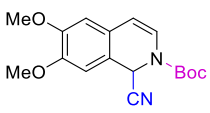
36

Tert-butyl 1-cyano-8-methoxyisoquinoline-2(1*H*)-carboxylate (36). White solid 269 mg, yield 94%; m.p. 142.5-143.4°C; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.27 (t, *J* = 8.0 Hz, 1H), 6.82 (d, *J* = 7.9 Hz, 1H), 6.79 (d, *J* = 8.3 Hz, 1H), 6.73 (d, *J* = 7.6 Hz, 1H), 6.65 (s, 1H), 5.93-5.86 (m, 1H), 3.89 (s, 3H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 155.09, 150.92, 131.39, 130.45, 124.89, 117.56, 116.74, 112.12, 109.65, 107.87, 83.38, 55.66, 40.33, 28.06. minor: δ 155.09, 150.92, 131.56, 130.57, 124.76, 117.81, 116.67, 111.69, 109.47, 107.56, 83.78, 55.74, 41.53, 28.06. HRMS (m/z) calcd for $C_{11}H_{10}NO_3$ [M-CN-*t*–Bu+H]$^+$ 204.0656, found 204.0658.



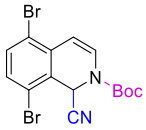
37

Tert-butyl 1,8-dicyanoisoquinoline-2(1*H*)-carboxylate (37). White solid 258 mg, yield 92%; m.p. 157.6-158°C; ^{1}H-NMR (600 MHz, $CDCl_3$) δ 7.56 (s, 1H), 7.46 (t, *J* = 7.7 Hz, 1H), 7.39 (s, 1H), 6.95 (d, *J* = 6.1 Hz, 1H), 6.73 (s, 1H), 5.98 (d, *J* = 7.0 Hz, 1H), 1.56 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 150.25, 132.21, 131.30, 130.37, 129.45, 126.71, 126.08, 115.44, 115.01, 110.79, 106.79, 84.57, 43.74, 28.01. minor: δ 150.25, 132.21, 131.02, 130.37, 129.58, 126.71, 125.79, 115.44, 115.01, 110.79, 106.79, 85.15, 45.07, 28.01. HRMS (m/z) calcd for $C_{10}H_7N_2$ [M-CN-CO_2*t*–Bu+H]$^+$ 155.0604, found 155.0605.



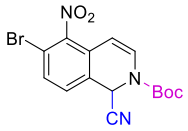
38

Tert-butyl 1-cyano-6,7-dimethoxyisoquinoline-2(1*H*)-carboxylate (38). Light yellow solid 303 mg, yield 96%; m.p. 150.5-151.3℃; ^{1}H NMR (600 MHz, $CDCl_3$) δ 6.73 (s, 2H), 6.65 (s, 1H), 6.28 (s, 1H), 5.92-5.85 (m, 1H), 3.88 (s, 6H), 1.53 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: *δ* 150.99, 150.05, 148.79, 123.69, 122.90, 116.93, 115.88, 109.34, 108.45, 108.23, 83.47, 56.17, 56.01, 45.37, 28.08. minor: *δ* 150.70, 150.05, 148.60, 123.84, 122.82, 116.93, 115.34, 109.34, 108.55, 107.82, 83.87, 56.17, 56.01, 46.76, 28.08. HRMS (m/z) calcd for $C_{12}H_{12}NO_4$ [M-CN-*t*−Bu+H]$^+$ 234.0761, found 234.0767.



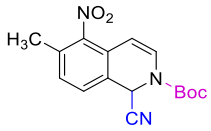
39

Tert-butyl 5,8-dibromo-1-cyanoisoquinoline-2(1*H*)-carboxylate (39). Yellow solid 323 mg, yield 78%; m.p. 129.5-130℃; ^{1}H-NMR (600 MHz, $CDCl_3$): *δ* 7.44 (s, 1H), 7.31 (d, *J* = 8.5 Hz, 1H), 6.95 (d, *J* = 8.3 Hz, 1H), 6.71 (s, 1H), 6.34-6.26 (m, 1H), 1.56 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: *δ* 150.32, 134.87, 132.54, 132.02, 127.40, 125.16, 121.05, 119.77, 115.18, 107.17, 84.51, 45.91, 28.05. minor: *δ* 150.32, 134.87, 132.82, 131.76, 127.40, 124.68, 121.05, 119.77, 115.18, 106.89, 84.82, 47.18, 28.05. HRMS (m/z) calcd for $C_{10}H_6Br_2NO_2$ [M-CN-*t*−Bu+H]$^+$ 331.8740, found 331.8739.



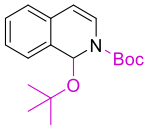
40

Tert-butyl 6-bromo-1-cyano-5-nitroisoquinoline-2(1*H*)-carboxylate (40). Yellow solid 270 mg, yield 71%; m.p. 169-169.5℃; ^{1}H-NMR (600 MHz, $CDCl_3$): *δ* 7.56 (d, *J* = 8.2 Hz, 1H), 7.27 (s, 1H), 7.04 (d, *J* = 8.1 Hz, 1H), 6.41 (s, 1H), 5.80 (d, *J* = 8.1 Hz, 1H), 1.55 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: *δ* 150.03, 146.89, 132.15, 129.41, 129.01, 125.09, 124.24, 115.33, 114.82, 100.65, 85.20, 44.69, 27.98. minor: *δ* 150.03, 146.89, 132.15, 129.41, 129.01, 125.09, 124.24, 115.33, 114.82, 100.11, 85.20, 46.09, 27.98. HRMS (m/z) calcd for $C_9H_6BrN_2O_2$ [M-CN-CO_2*t*−Bu+H]$^+$ 252.9608, found 252.9611.



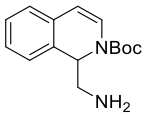
41

Tert-butyl 1-cyano-6-methyl-5-nitroisoquinoline-2(1*H*)-carboxylate (41). Yellow solid 280 mg, yield 89%; m.p. 188.3-189℃; ^{1}H-NMR (600 MHz, $CDCl_3$): *δ* 7.29 (d, *J* = 7.9 Hz, 1H), 7.20 (d, *J* = 7.9 Hz, 1H), 6.98 (d, *J* = 8.4 Hz, 1H), 6.39 (s, 1H), 5.87 (d, *J* = 8.2 Hz, 1H), 2.34 (s, 3H), 1.54 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: *δ* 150.28, 147.03, 131.90, 130.25, 128.27, 128.14, 123.26, 123.02, 115.92, 101.56, 84.66, 44.89, 28.00, 17.61. minor: *δ* 149.95, 147.03, 131.90, 129.98, 128.27, 128.14, 123.26, 122.68, 115.92, 101.02, 84.96, 46.30, 28.00, 17.61. HRMS (m/z) calcd for $C_{11}H_9N_2O_4$ [M-CN-*t*−Bu+H]$^+$ 233.0557, found 233.0559.



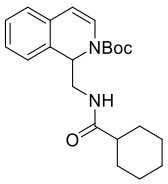
42

Tert-butyl 1-(tert-butoxy)isoquinoline-2(1*H*)-carboxylate (42). White solid 2.5 g; yield 82.5%; m.p. 118.5-119℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.41-7.27 (m, 1H), 7.25-7.16 (m, 2H), 6.88 (d, J = 7.5 Hz, 1H), 6.66 (s, 1H), 6.10 (d, J = 7.6 Hz, 1H), 1.52 (s, 9H), 1.27 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$) ^{13}C NMR (151 MHz, $CDCl_3$): δ 152.07, 131.37, 130.03, 128.03, 126.77, 126.41, 124.99, 124.13, 109.34, 81.87, 75.36, 74.35, 28.73, 28.26.



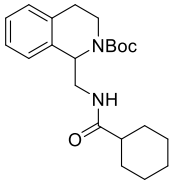
44

Tert-butyl 1-(aminomethyl)isoquinoline-2(1*H*)-carboxylate (44). Light yellow oil 229 mg; yield 88%; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.21 (d, J = 7.3 Hz, 1H), 7.17 (d, J = 7.4 Hz, 1H), 7.09 (d, J = 7.4 Hz, 1H), 7.05 (d, J = 7.4 Hz, 1H), 6.81 (d, J = 7.9 Hz, 1H), 5.73 (d, J = 7.8 Hz, 1H), 5.25 (t, J = 6.6 Hz, 1H), 2.88-2.77 (m, 2H), 1.52 (s, 9H), 1.35 (s, 2H). ^{13}C NMR (151 MHz, $CDCl_3$): major: δ 152.26, 130.70, 130.57, 127.84, 126.71, 126.67, 125.44, 124.57, 107.51, 81.64, 57.53, 45.97, 28.22. minor: δ 152.48, 131.10, 130.34, 127.99, 126.54, 126.49, 125.67, 124.73, 107.77, 81.72, 58.84, 46.35, 28.29. HRMS (m/z) calcd for $C_{15}H_{21}N_2O_2$ $[M+H]^+$ 261.1598, found 261.1597.



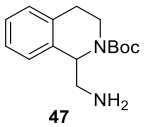
45

Tert-butyl 1-(cyclohexanecarboxamidomethyl)isoquinoline-2(1*H*)-carboxylate (45). White solid 197.5mg; yield 92%; m.p. 102-103℃; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.22 (d, J = 7.3 Hz, 1H), 7.18 (d, J = 7.4 Hz, 1H), 7.10 (s, 1H), 7.07 (s, 1H), 6.72 (d, J = 7.9 Hz, 1H), 6.15 (s, 1H), 5.80 (d, J = 7.8 Hz, 1H), 5.53 (dd, J = 10.3, 4.0 Hz, 1H), 3.73-3.65 (m, 1H), 3.14-3.08 (m, 1H), 2.07-1.98 (m, 1H), 1.89-1.80 (m, 2H), 1.79-1.74 (m, 2H), 1.68-1.63 (m, 1H), 1.52 (s, 9H), 1.40-1.31 (m, 2H), 1.24-1.13 (m, 3H). ^{13}C-NMR (151 MHz, $CDCl_3$): δ 176.26, 153.15, 130.50, 129.84, 128.18, 127.08, 126.43, 124.71, 108.03, 82.09, 53.78, 45.44, 43.98, 29.63, 29.51, 28.19, 25.77. HRMS (m/z) calcd for $C_{22}H_{31}N_2O_3$ $[M+H]^+$ 371.2330, found 371.2335.



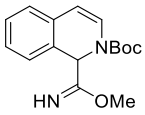
46

Tert-butyl 1-(cyclohexanecarboxamidomethyl)-3, 4-dihydroisoquinoline-2(1*H*)-carboxylate (46). Colorless oil 100.5 mg; yield 90%; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.22-7.11 (m, 4H), 6.56 (s, 1H), 5.32 (s, 1H), 3.93 (d, J = 11.8 Hz, 1H), 3.77-3.61 (m, 1H), 3.50-3.13 (m, 2H), 3.01-2.69 (m, 2H), 2.11-2.02 (m, 1H), 1.92-1.86 (m, 2H), 1.80-1.75 (m, 2H), 1.69-1.64 (m, 1H), 1.49 (s, 9H), 1.44-1.35 (m, 2H), 1.28-1.18 (m, 3H). ^{13}C-NMR (151 MHz, $CDCl_3$): δ 176.49, 156.41, 134.70, 134.24, 128.83, 127.22, 127.14, 126.37, 80.34, 53.28, 45.46, 38.88, 29.71, 29.56, 28.53, 28.39, 25.78, 25.75. HRMS (m/z) calcd for $C_{22}H_{33}N_2O_3$ $[M+H]^+$ 373.2486, found 373.2483.



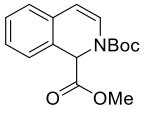
47

Tert-butyl 1-(aminomethyl)-3,4-dihydroisoquinoline-2(1*H*)-carboxylate (47). Light yellow oil 157 mg; yield 60%; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.24-7.08 (m, 4H), 5.13 (s, 1H), 3.93 (s, 1H), 3.35 (s, 1H), 3.06-2.82 (m, 3H), 2.77-2.74 (m, 1H), 2.06 (s, 2H), 1.48 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 155.89, 135.10, 134.63, 128.72, 127.28, 126.79, 126.16, 80.01, 56.99, 47.25, 39.04, 28.44. minor: δ 155.23, 135.10, 134.87, 129.05, 127.02, 126.79, 126.16, 80.01, 57.96, 47.40, 37.37, 28.44. HRMS (m/z) calcd for $C_{15}H_{22}N_2O_2$ $[M+H]^+$ 263.1755, found 263.1765.



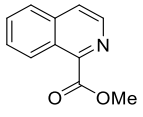
48

Tert-butyl 1-(imino(methoxy)methyl)isoquinoline-2(1*H*)-carboxylate (48). Light yellow oil 120 mg; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.30-7.26 (m, 1H), 7.25-7.22 (m, 1H), 7.22-7.13 (m, 2H), 7.05 (d, J = 6.8 Hz, 1H), 6.93 (d, J = 7.8 Hz, 1H), 5.88 (s, 1H), 5.78 (d, J = 7.8 Hz, 1H), 3.69 (s, 3H), 1.53 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 170.80, 151.67, 130.02, 128.51, 127.99, 127.59, 127.03, 125.07, 124.81, 107.39, 82.53, 57.01, 53.72, 28.17. minor: δ 170.23, 152.01, 130.18, 128.64, 127.99, 127.51, 126.81, 125.07, 124.81, 107.74, 82.53, 58.53, 53.72, 28.05. HRMS (m/z) calcd for $C_{16}H_{21}N_2O_3$ $[M+H]^+$ 289.1547, found 289.1553.



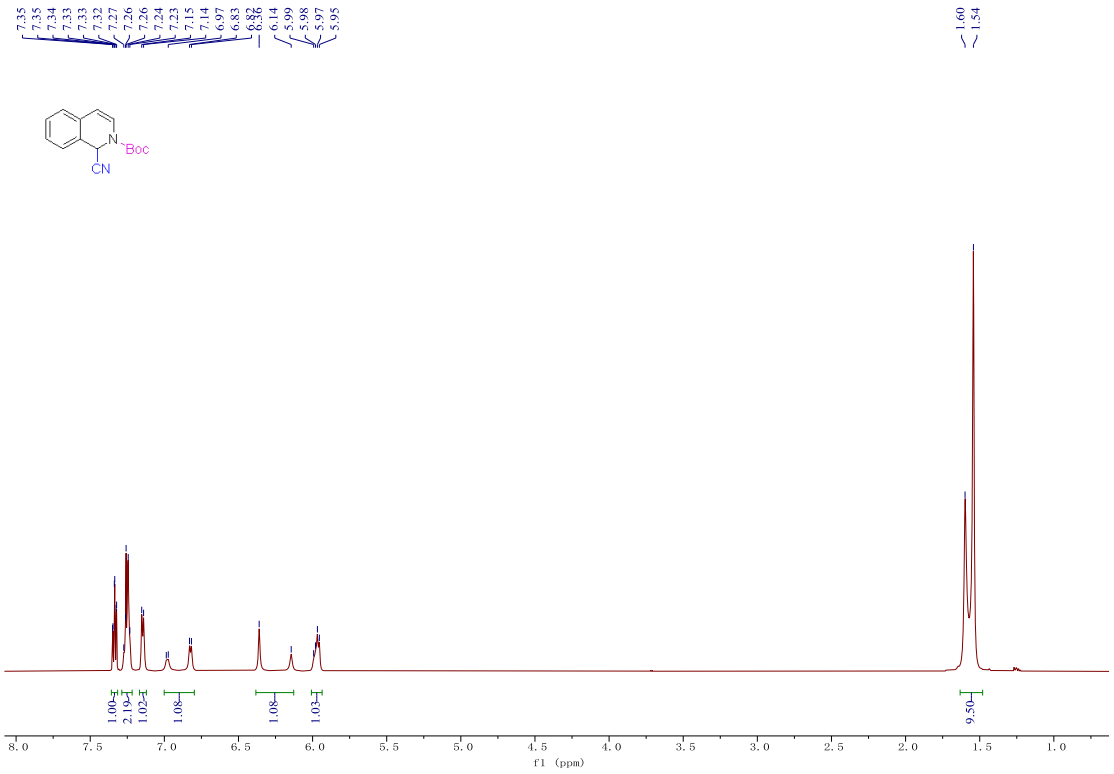
49

2-(tert-butyl) 1-methyl isoquinoline-1,2(1H)-dicarboxylate (49). Light yellow oil 245 mg; yield 85%; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 7.36 (d, J = 7.1 Hz, 1H), 7.25-7.20 (m, 1H), 7.19-7.13 (m, 1H), 7.02 (d, J = 7.5 Hz, 1H), 6.96 (d, J = 7.9 Hz, 1H), 5.91 (s, 1H), 5.69 (d, J = 8.0 Hz, 1H), 3.67 (s, 3H), 1.53 (s, 9H). ^{13}C-NMR (151 MHz, $CDCl_3$): major: δ 170.23, 152.04, 130.48, 128.65, 128.10, 126.82, 126.12, 125.79, 124.63, 106.00, 82.38, 57.53, 52.59, 28.17. minor: δ 170.57, 152.02, 130.61, 128.80, 127.73, 126.62, 126.29, 126.04, 124.91, 105.74, 82.36, 58.89, 52.51, 28.08. HRMS (m/z) calcd for $C_{11}H_{12}NO_2$ [M-CO_2t−Bu+H]$^+$ 190.0863, found 190.0860.

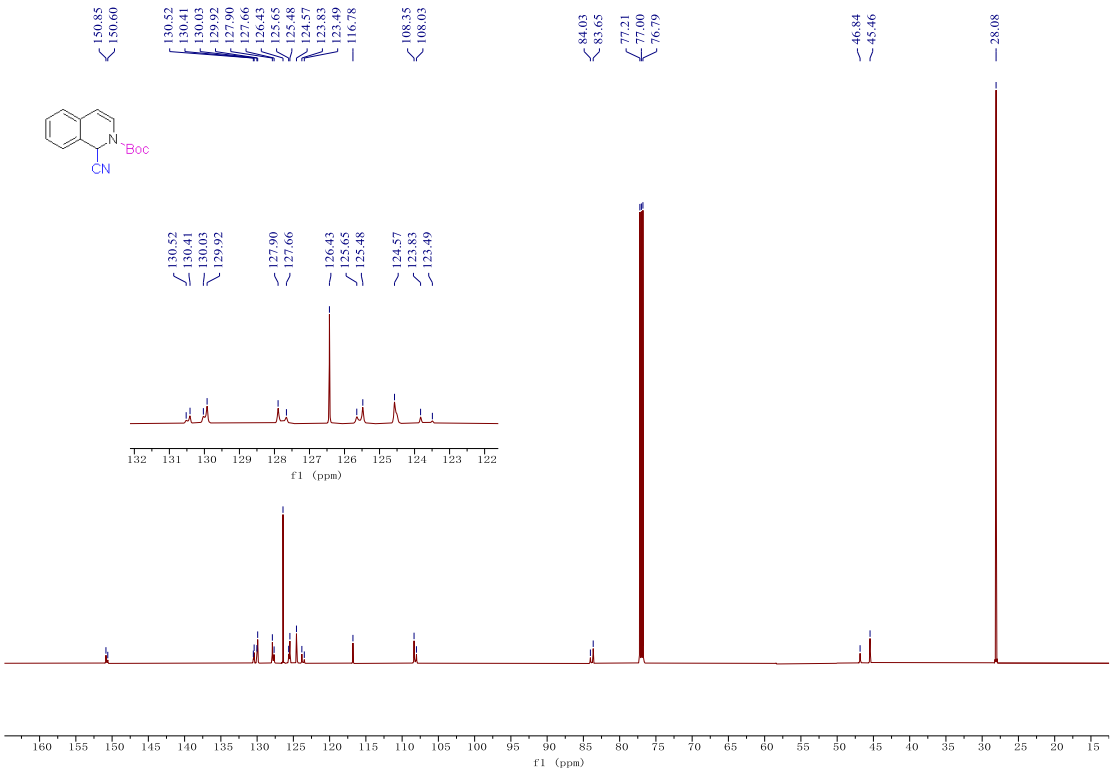


50

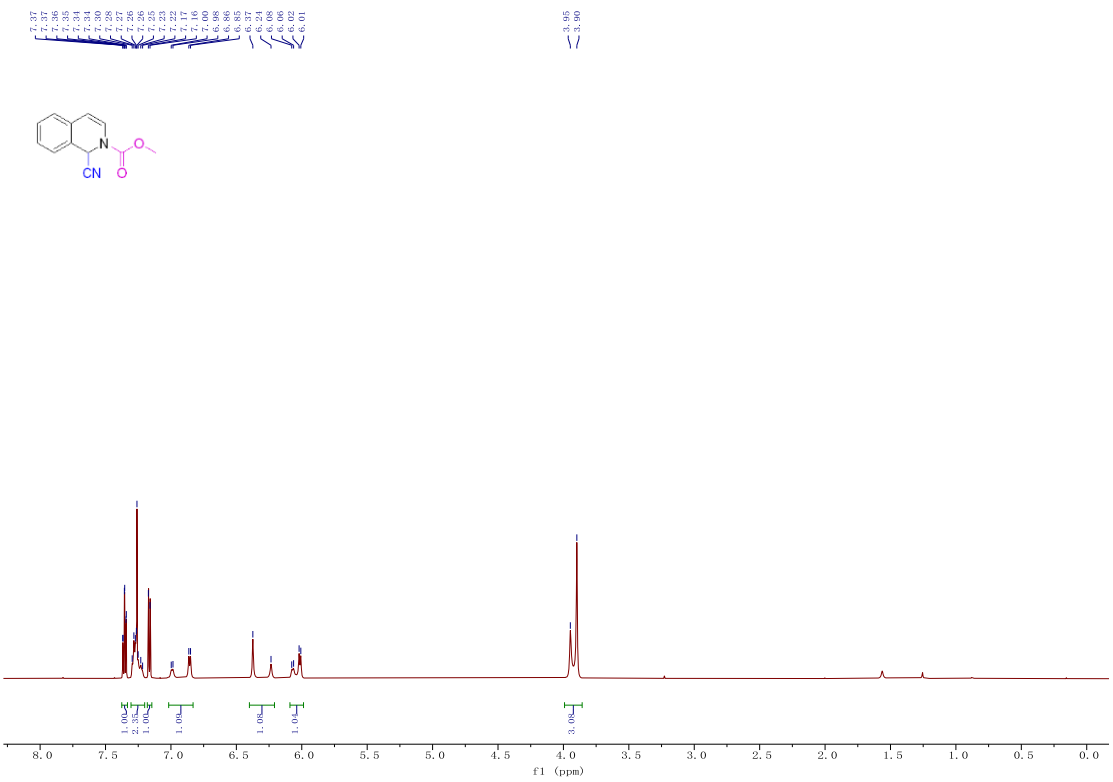
Methyl isoquinoline-1-carboxylate (50). Colorless oil 172 mg; yield 92%; ^{1}H-NMR (600 MHz, $CDCl_3$): δ 8.83 (d, J = 8.5 Hz, 1H), 8.62 (d, J = 5.5 Hz, 1H), 7.87 (d, J = 8.2 Hz, 1H), 7.82 (d, J = 5.5 Hz, 1H), 7.74-7.70 (m, 1H), 7.70-7.66 (m, 1H), 4.09 (s, 3H). ^{13}C-NMR (151 MHz, $CDCl_3$): δ 166.21, 148.08, 141.51, 136.88, 130.54, 128.77, 127.08, 126.85, 126.33, 124.30, 52.96. HRMS (m/z) calcd for $C_{11}H_{10}NO_2$ $[M+H]^+$ 188.0707, found 188.0711.



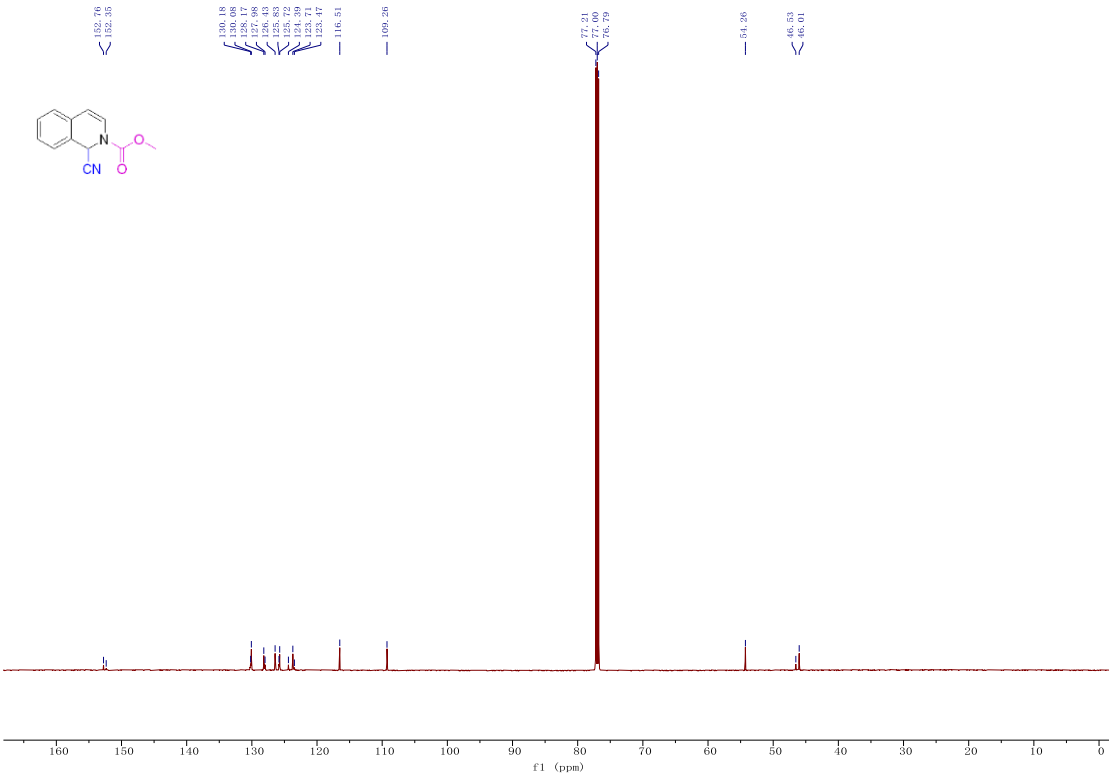
^{1}H NMR spectra of compound 4a



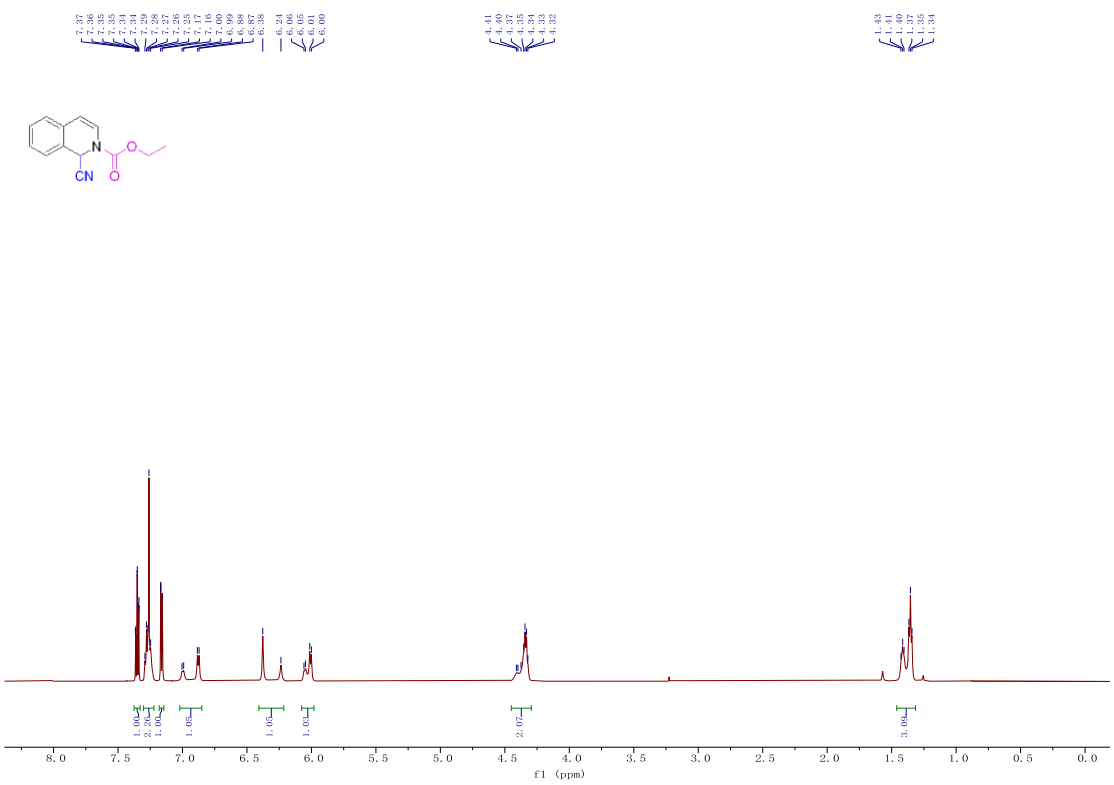
^{13}C NMR spectra of compound 4a



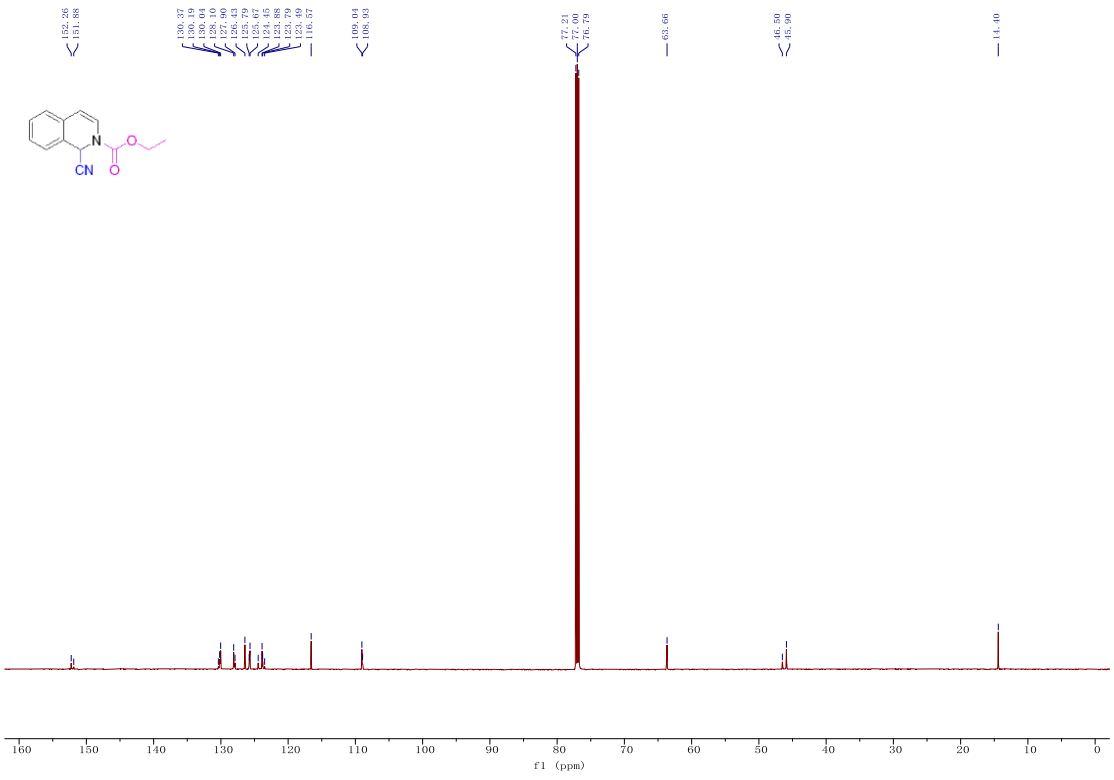
^{1}H NMR spectra of compound 4b



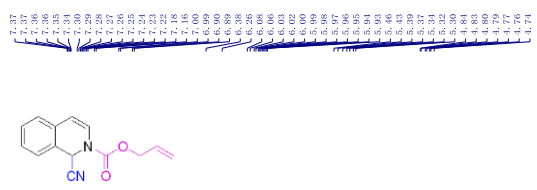
^{13}C NMR spectra of compound 4b

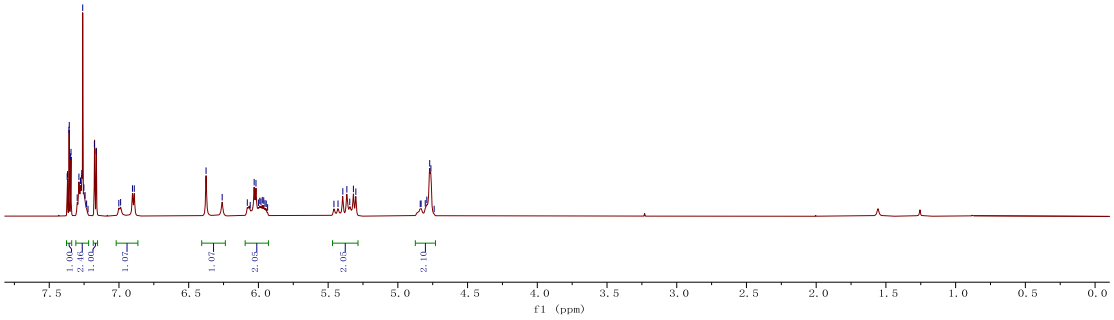


^{1}H NMR spectra of compound 4c

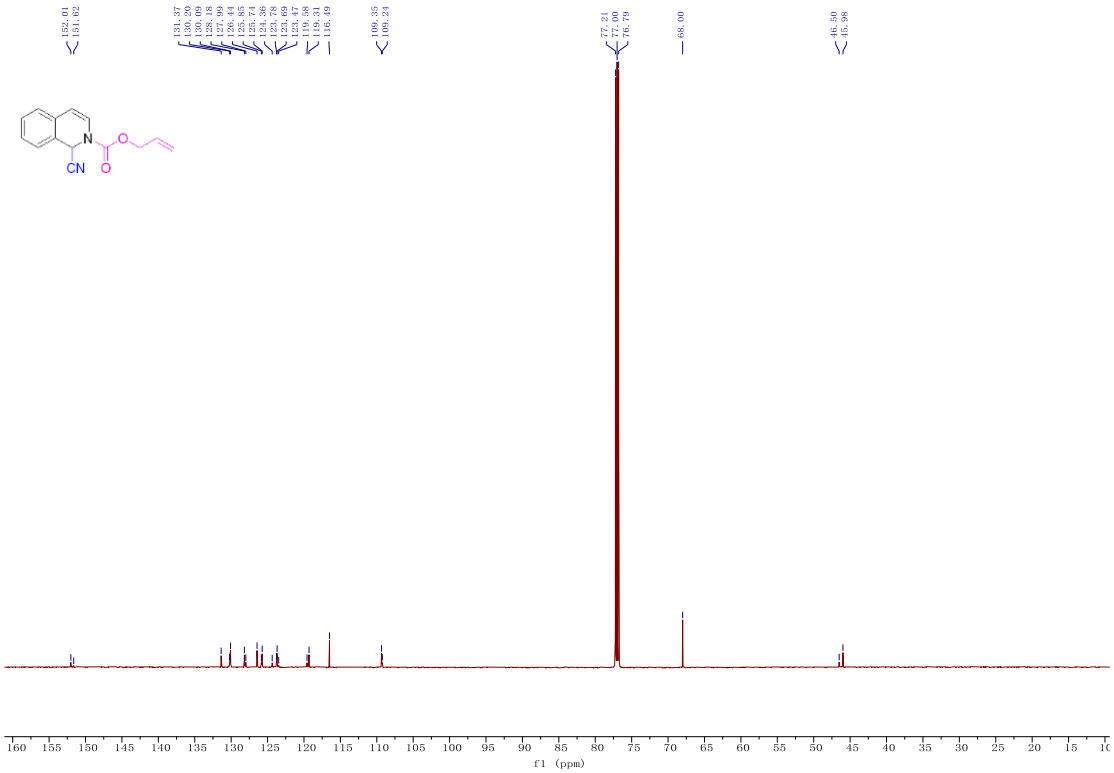


^{13}C NMR spectra of compound 4c

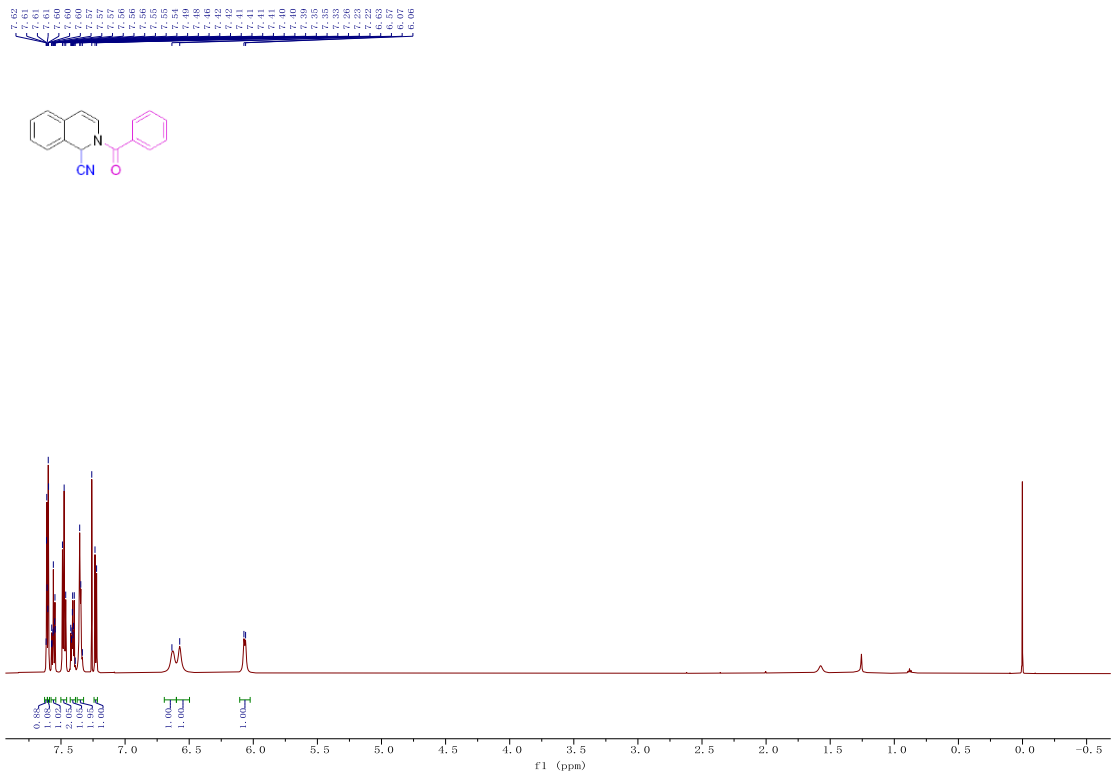




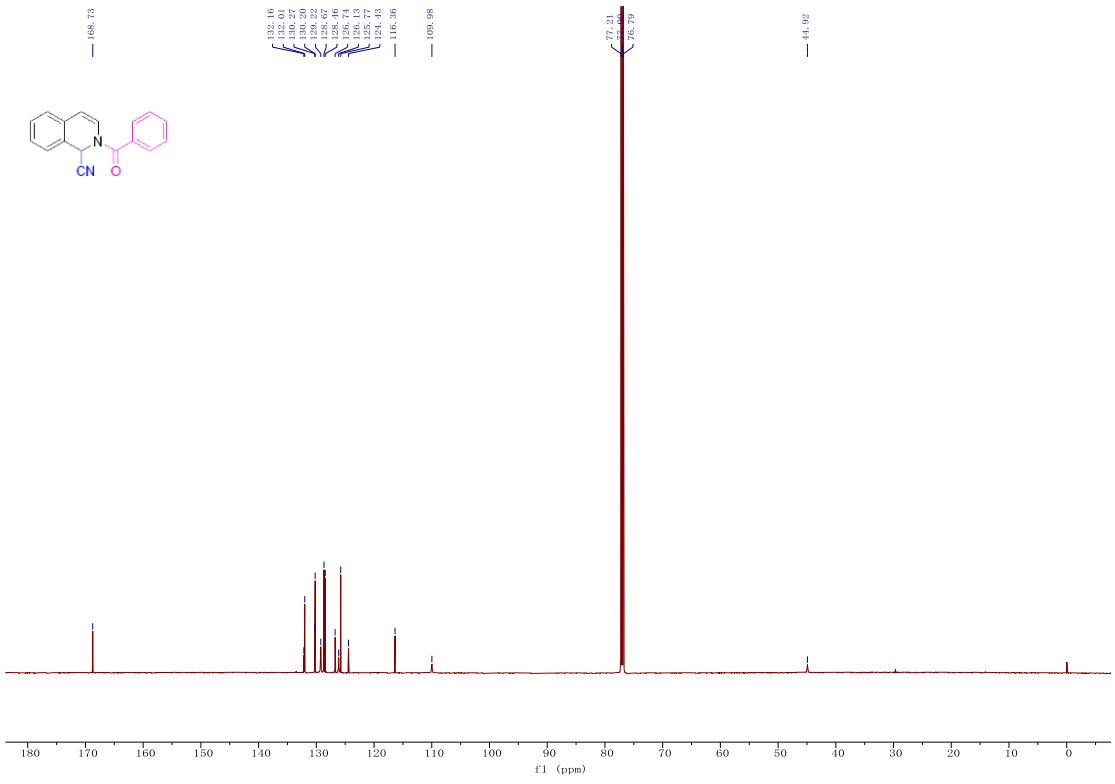
^{1}H NMR spectra of compound 4d



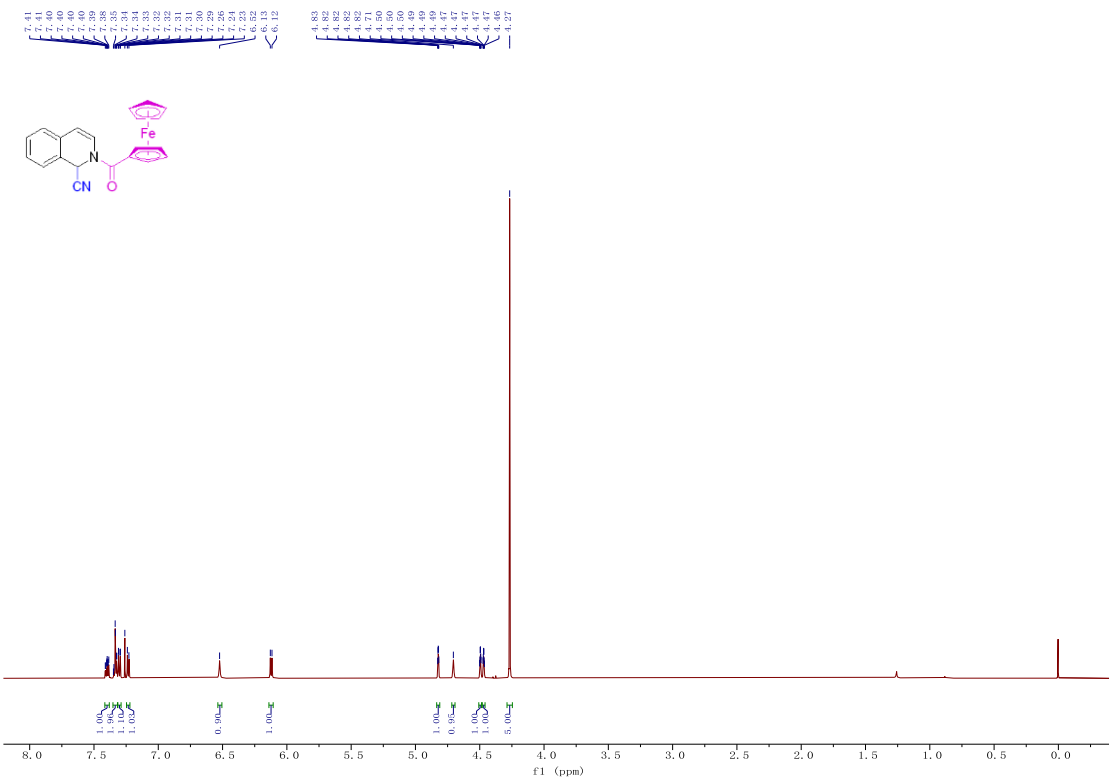
^{13}C NMR spectra of compound 4d



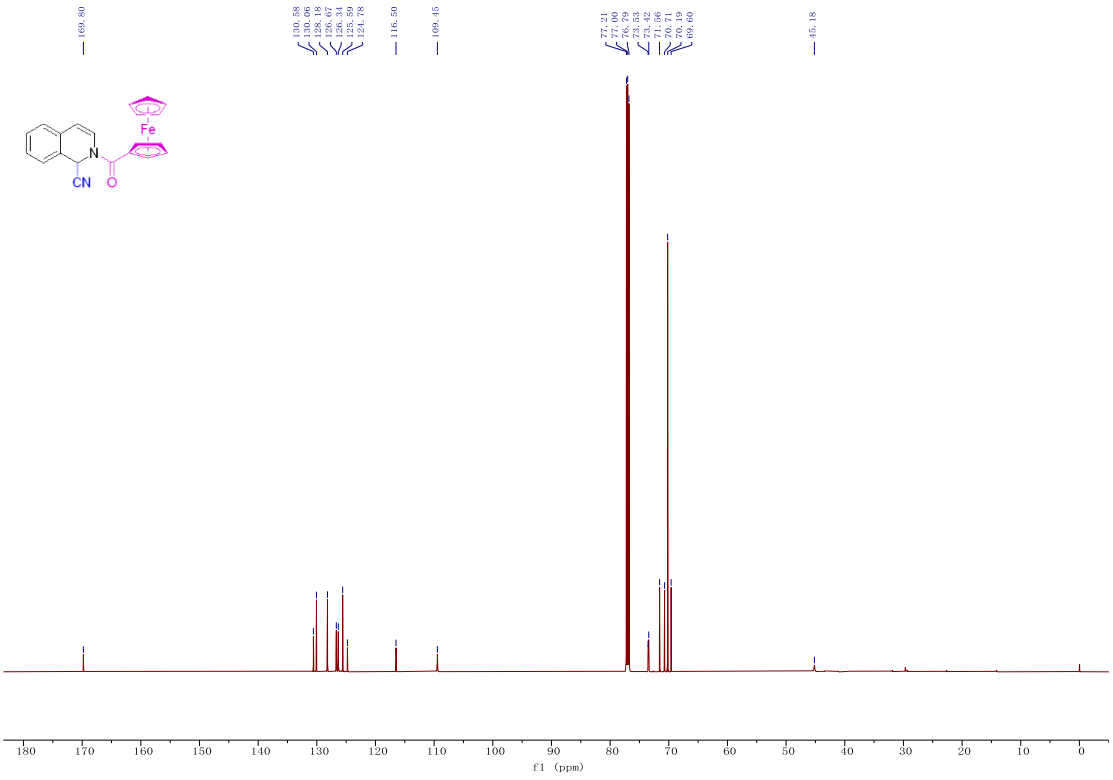
^{1}H NMR spectra of compound 4e



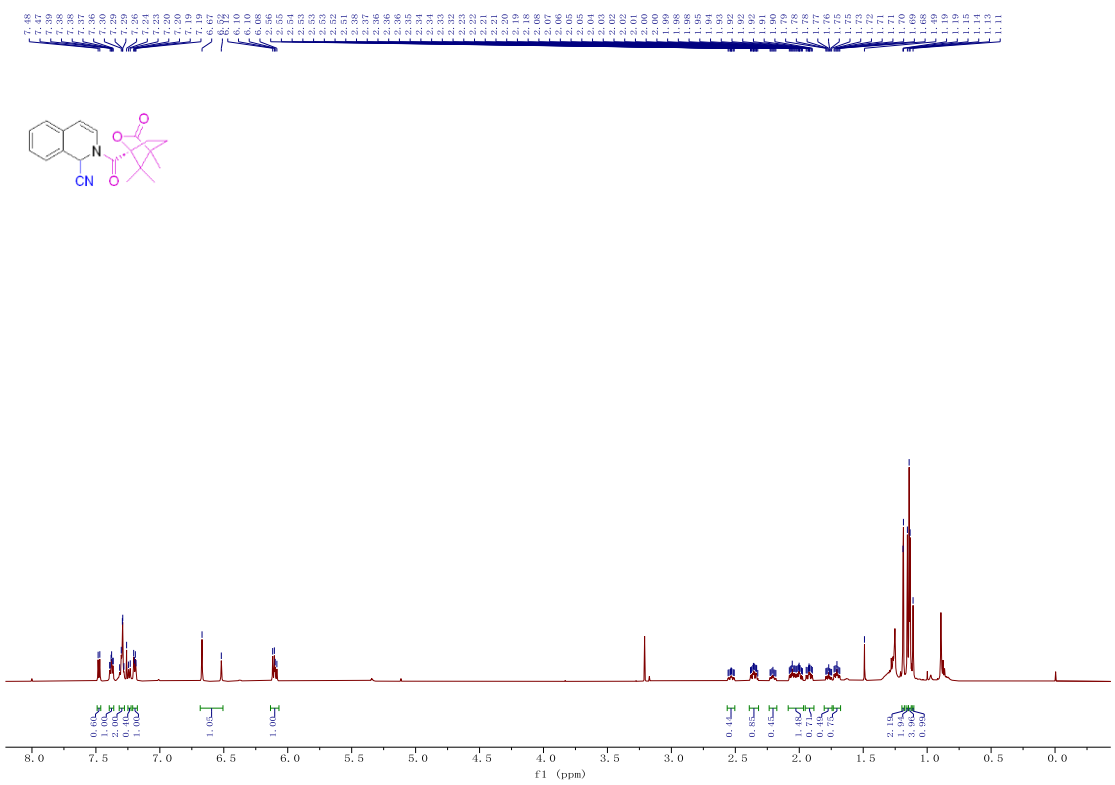
^{13}C NMR spectra of compound 4e



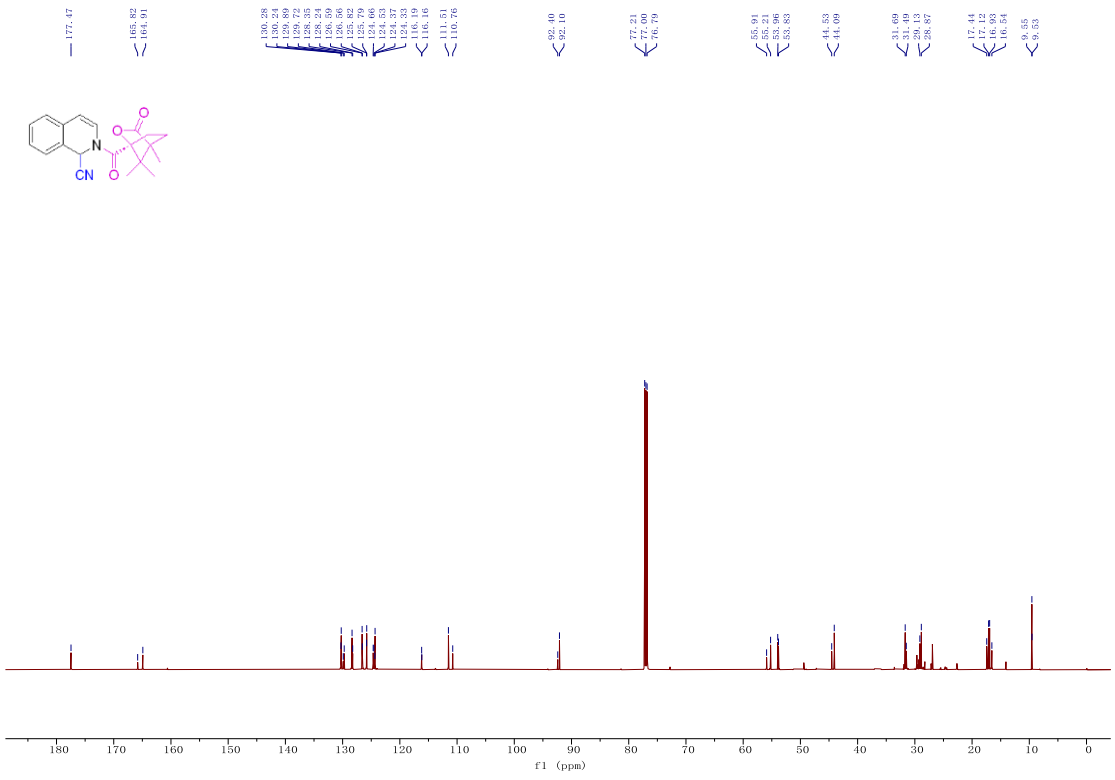
^{1}H NMR spectra of compound 4f



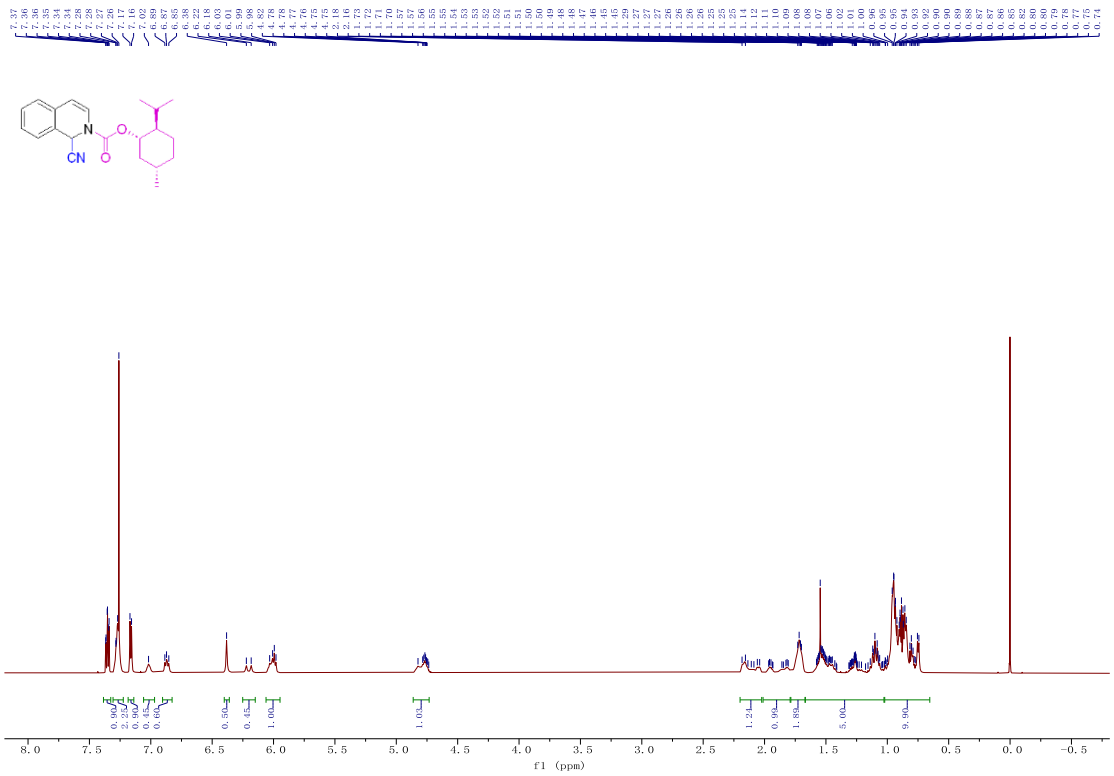
^{13}C NMR spectra of compound 4f



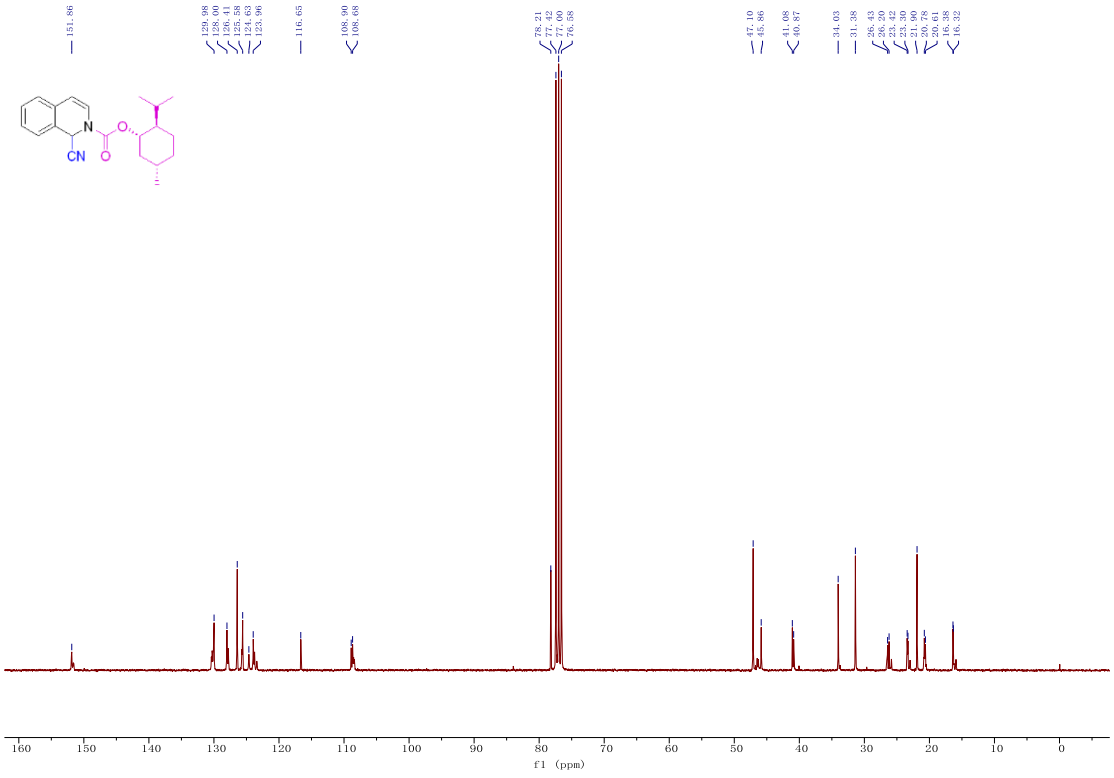
^{1}H NMR spectra of compound 4g



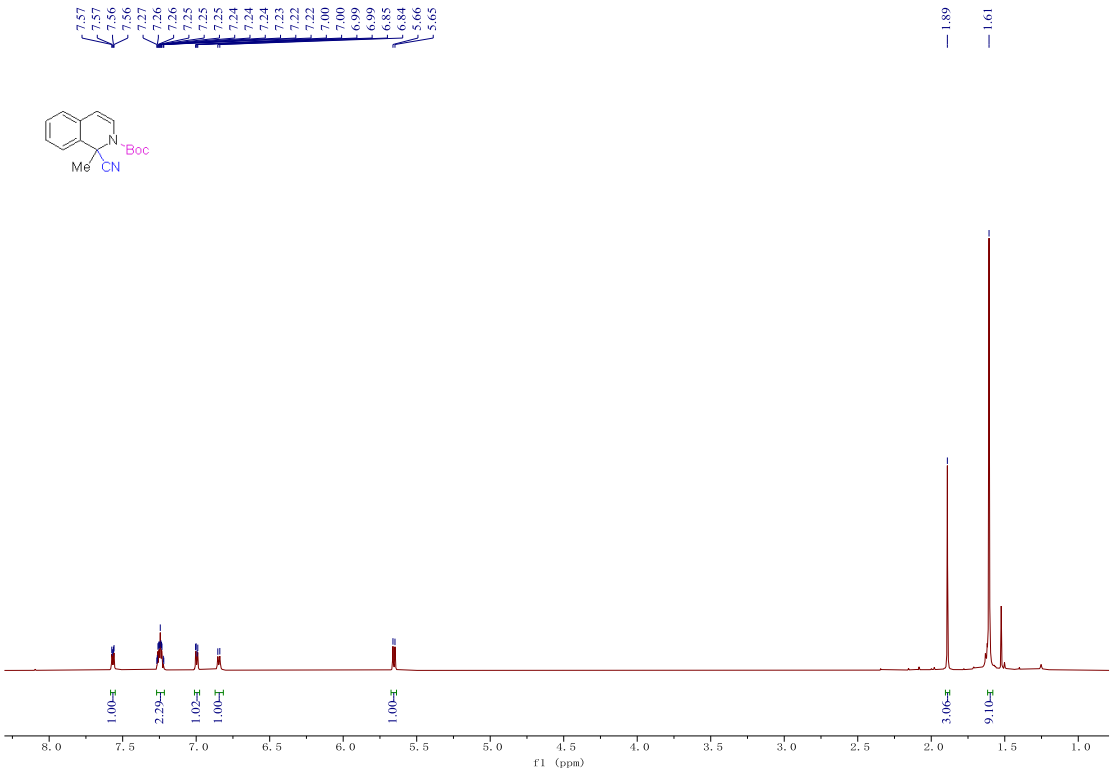
^{13}C NMR spectra of compound 4g



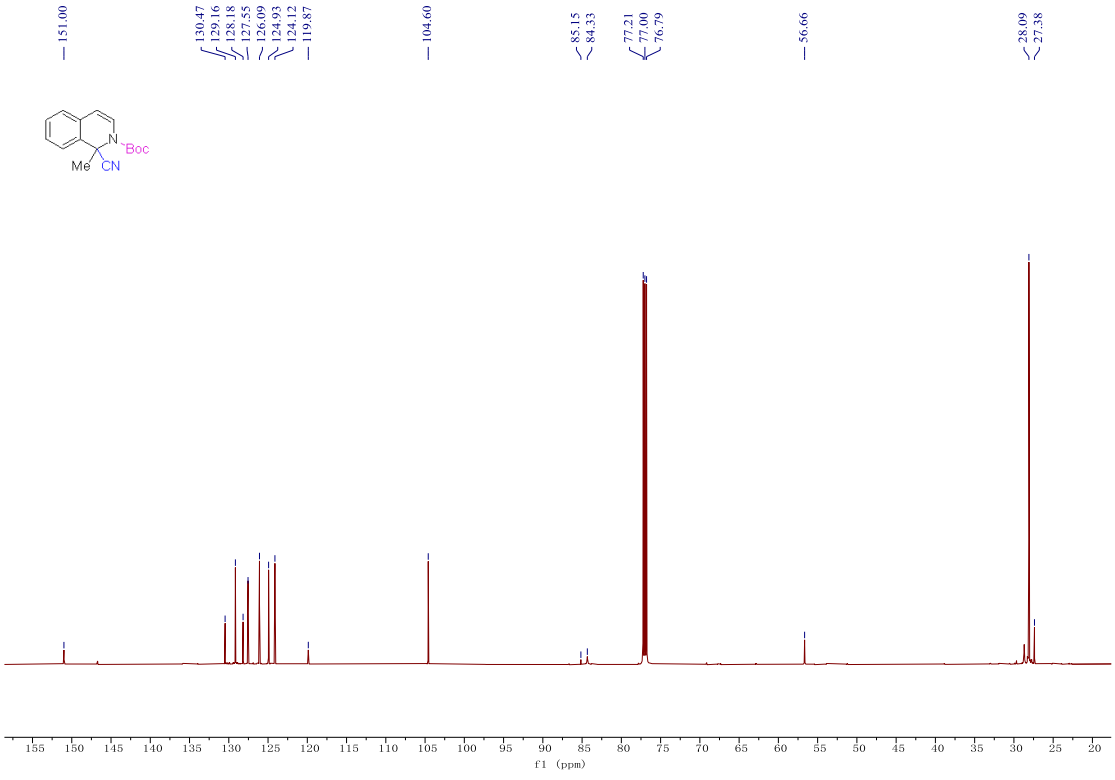
^{1}H NMR spectra of compound 4h



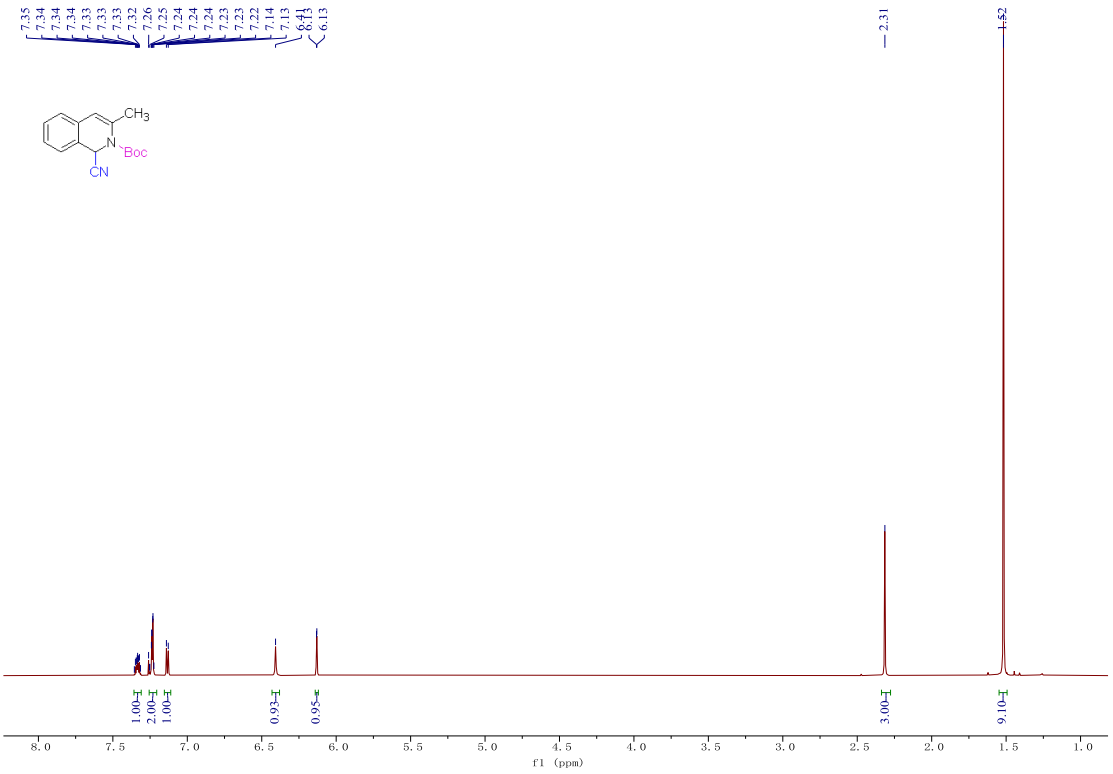
^{13}C NMR spectra of compound 4h



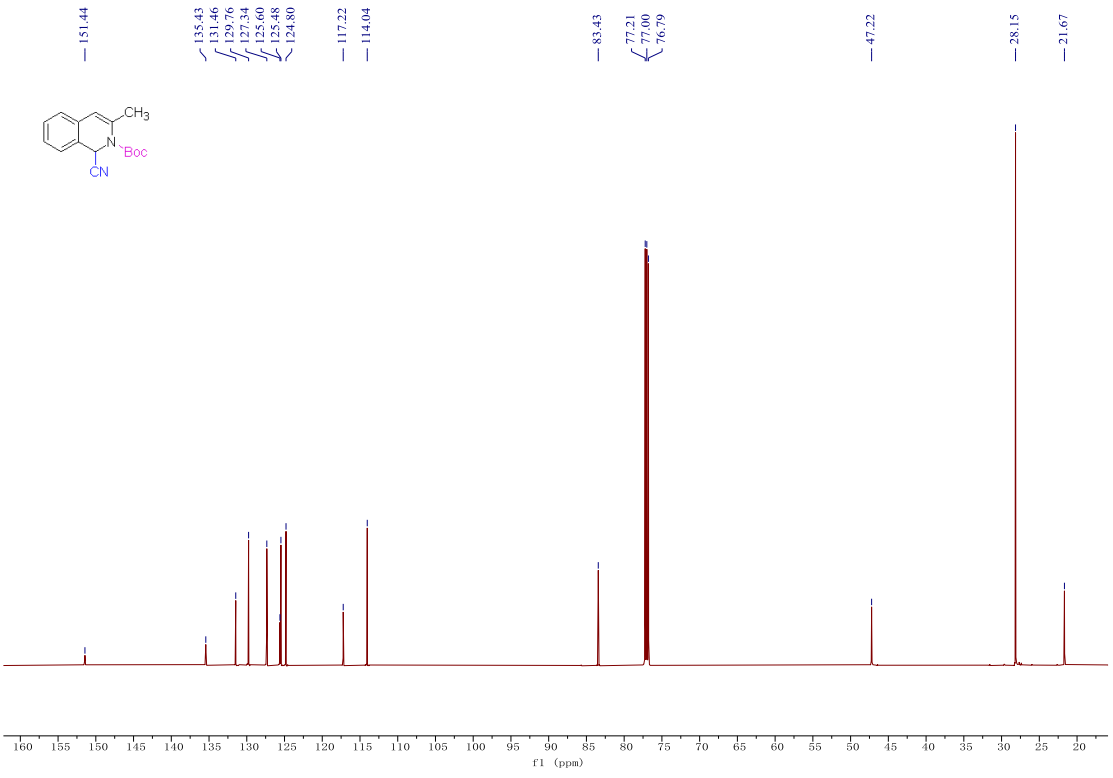
^{1}H NMR spectra of compound 5



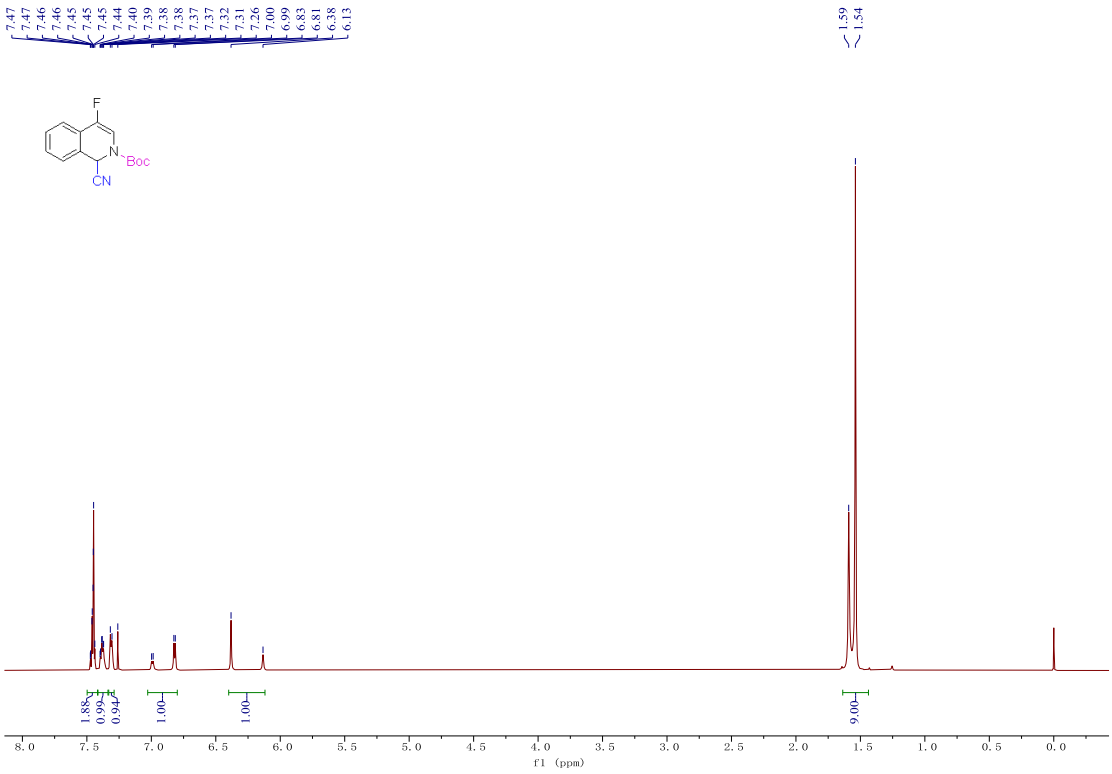
^{13}C NMR spectra of compound 5



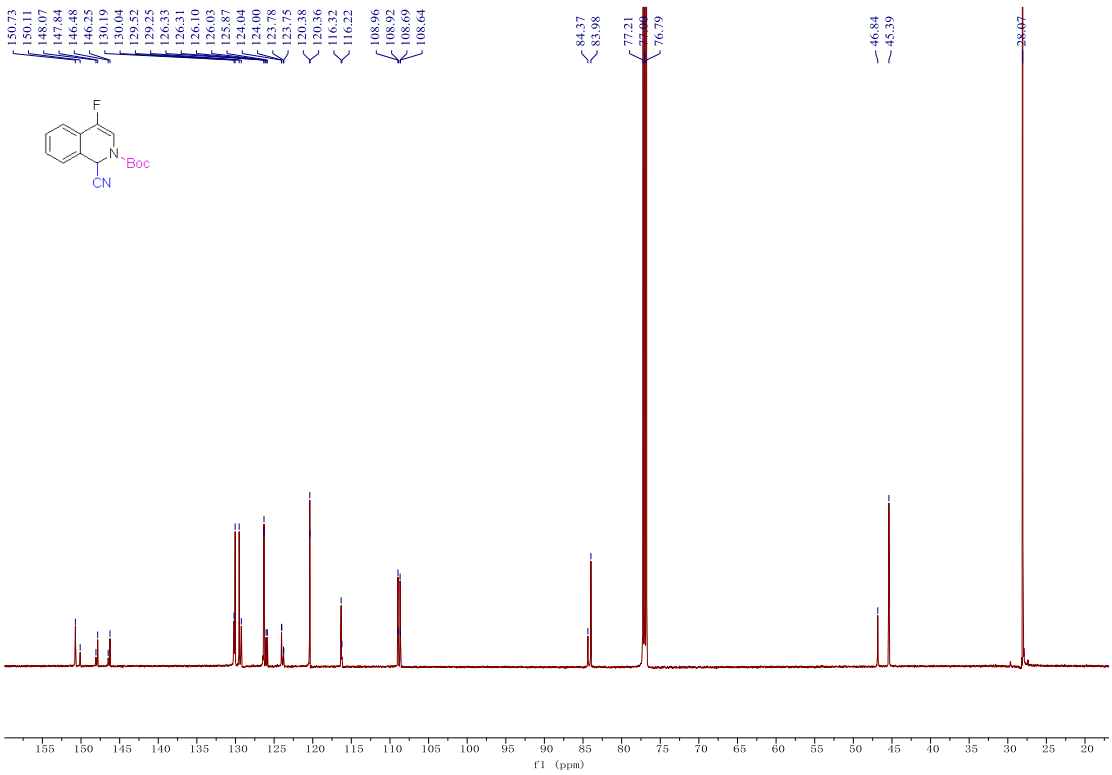
^{1}H NMR spectra of compound 7



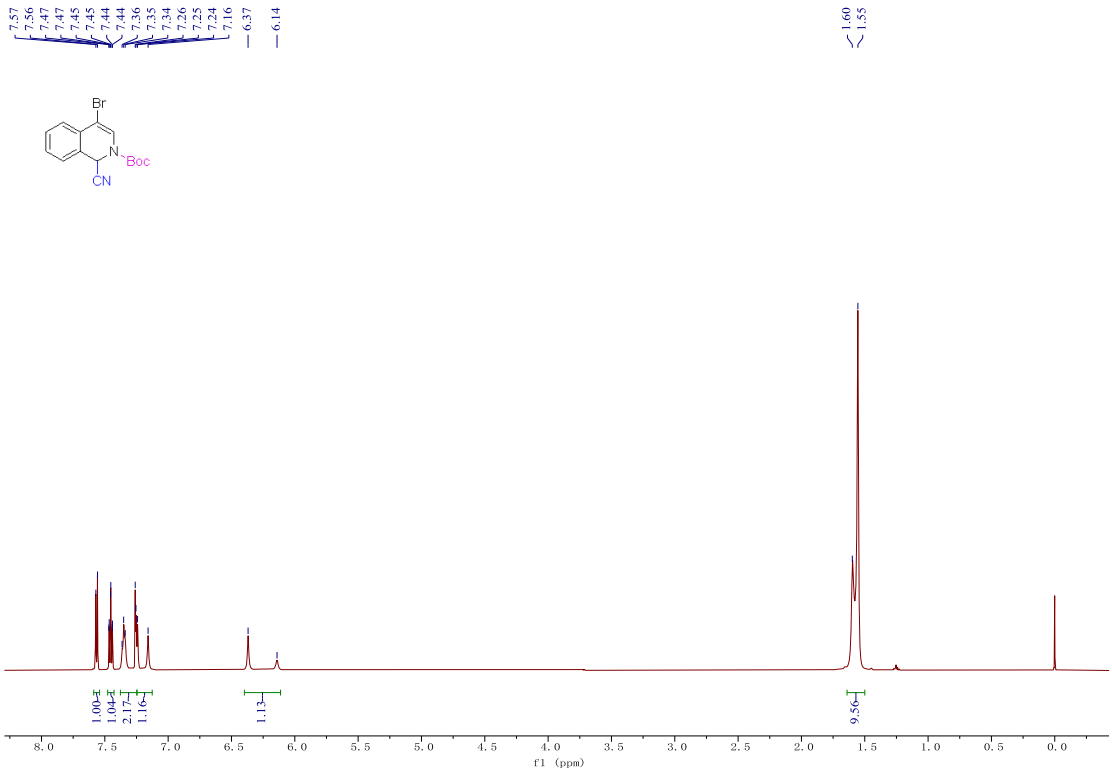
^{13}C NMR spectra of compound 7



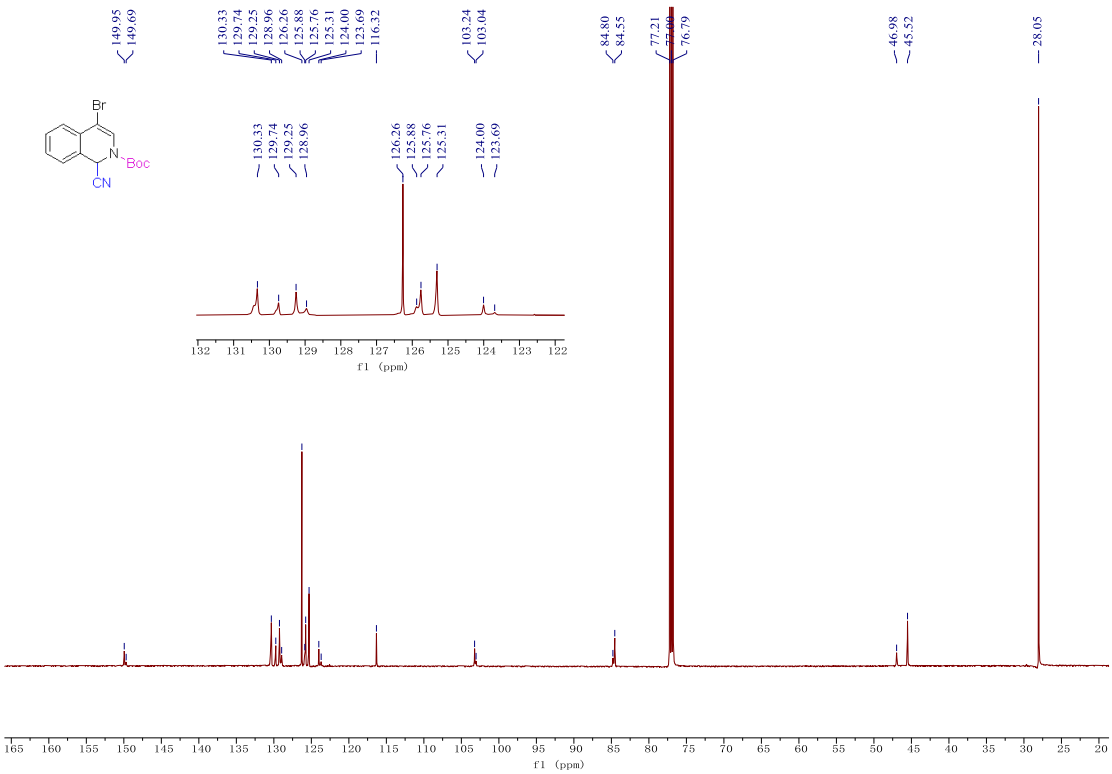
^{1}H NMR spectra of compound 8



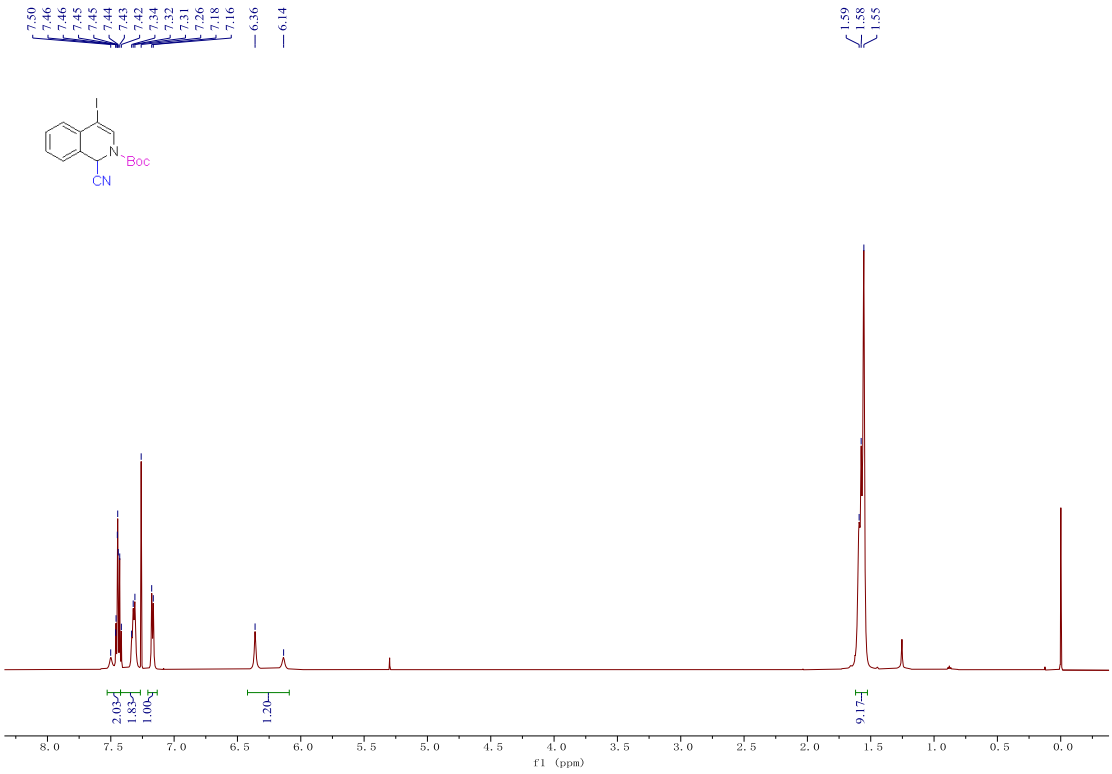
^{13}C NMR spectra of compound 8



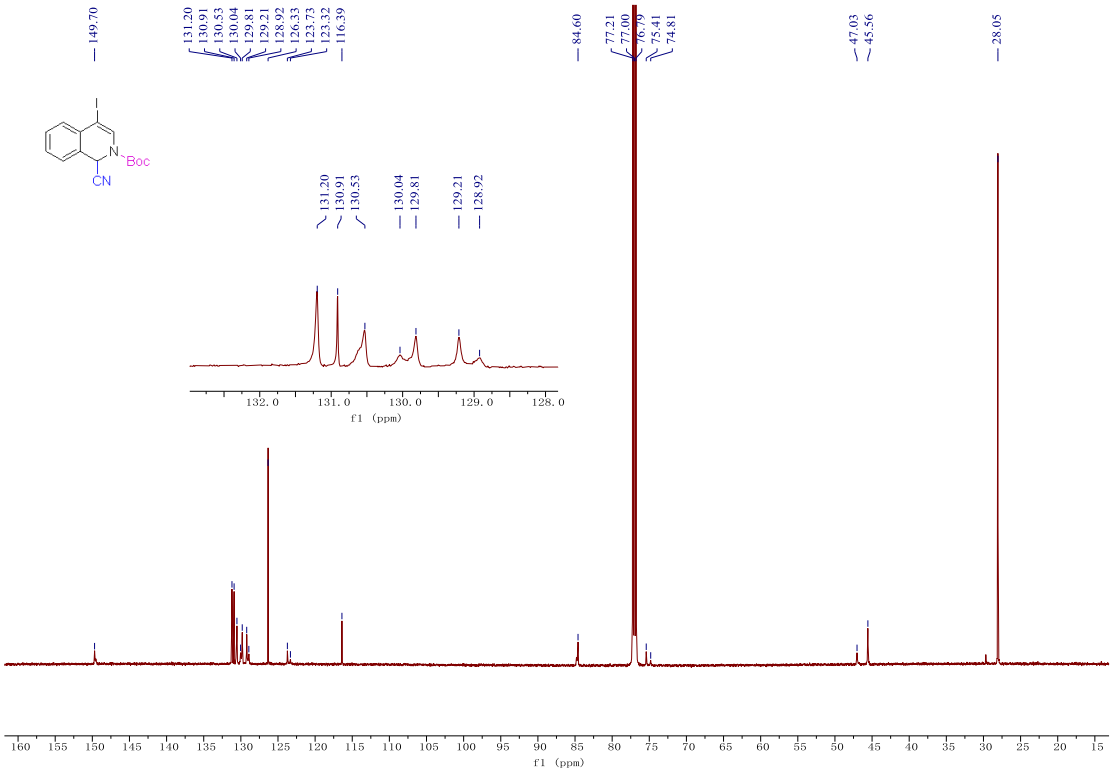
^{1}H NMR spectra of compound 9



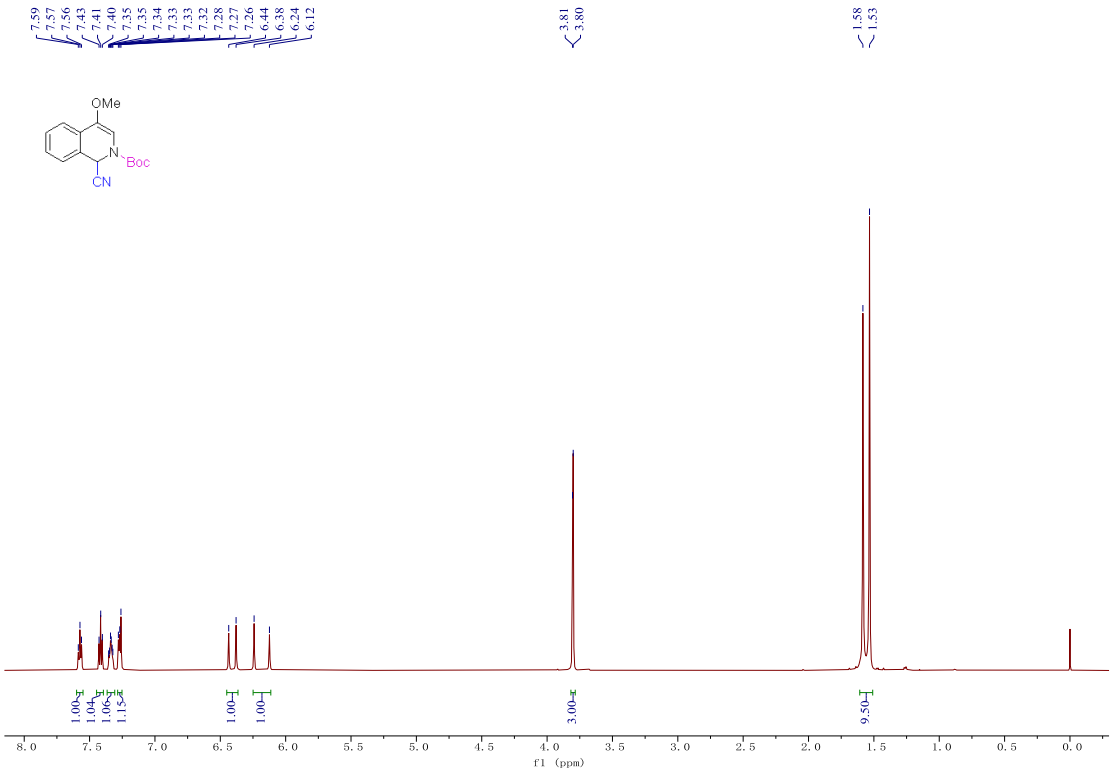
^{13}C NMR spectra of compound 9



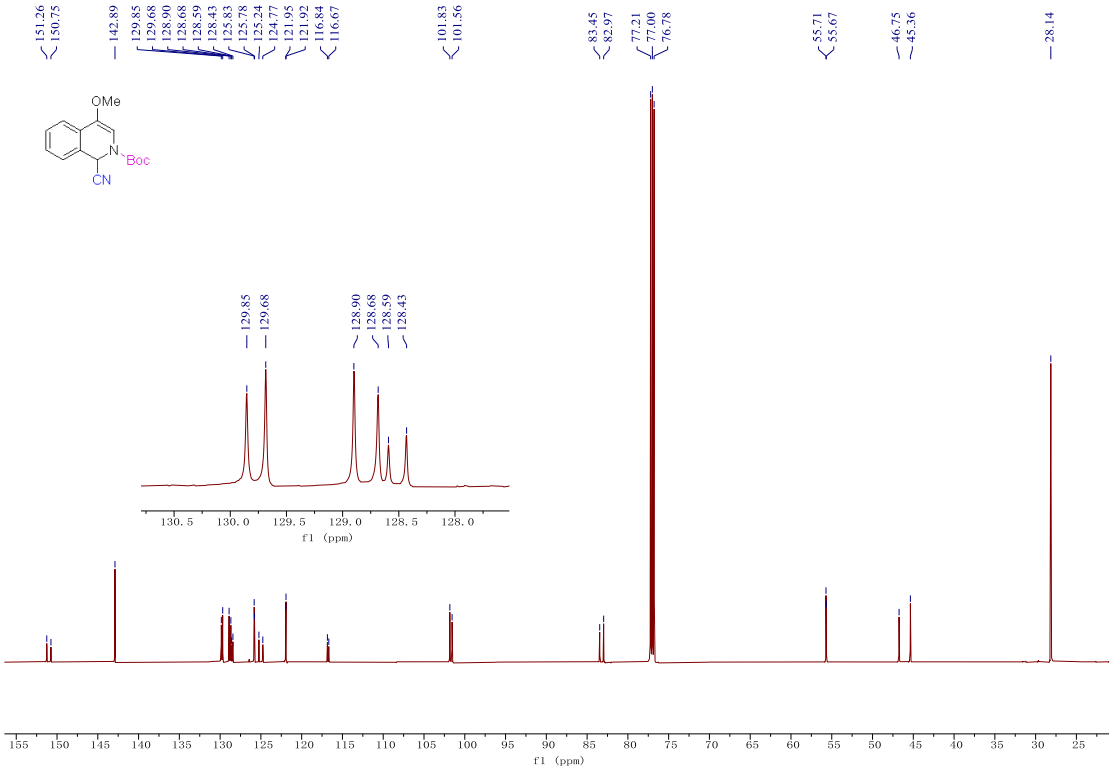
^{1}H NMR spectra of compound 10



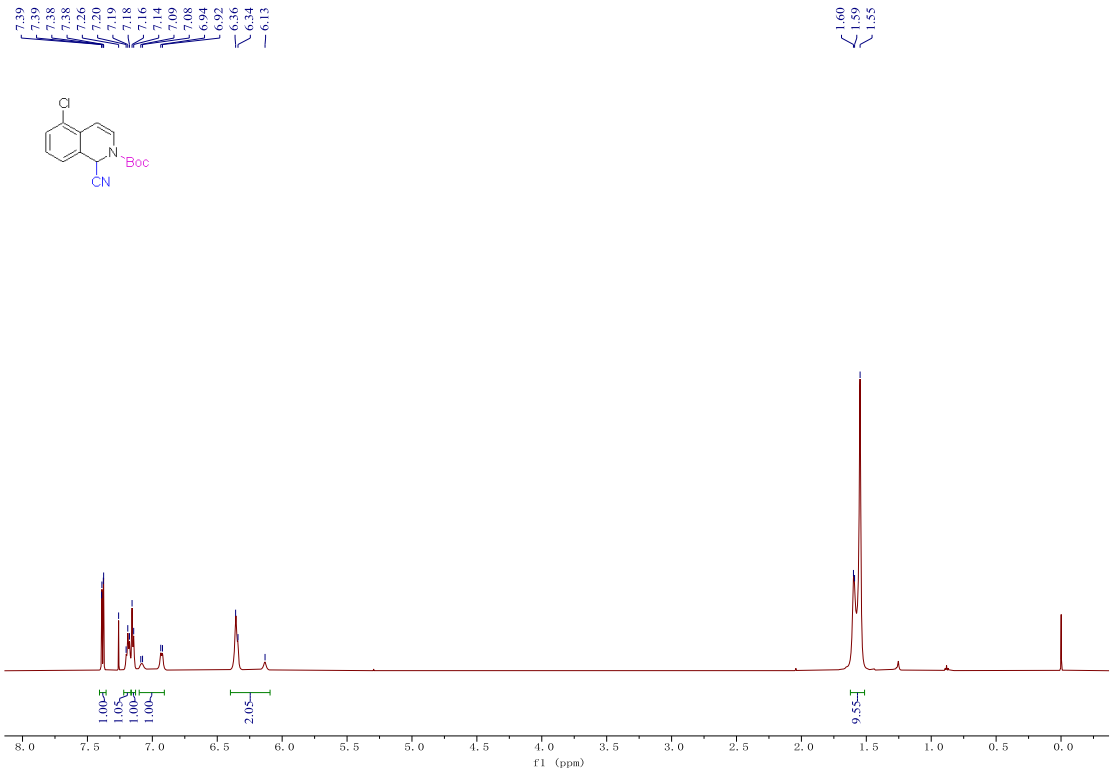
^{13}C NMR spectra of compound 10



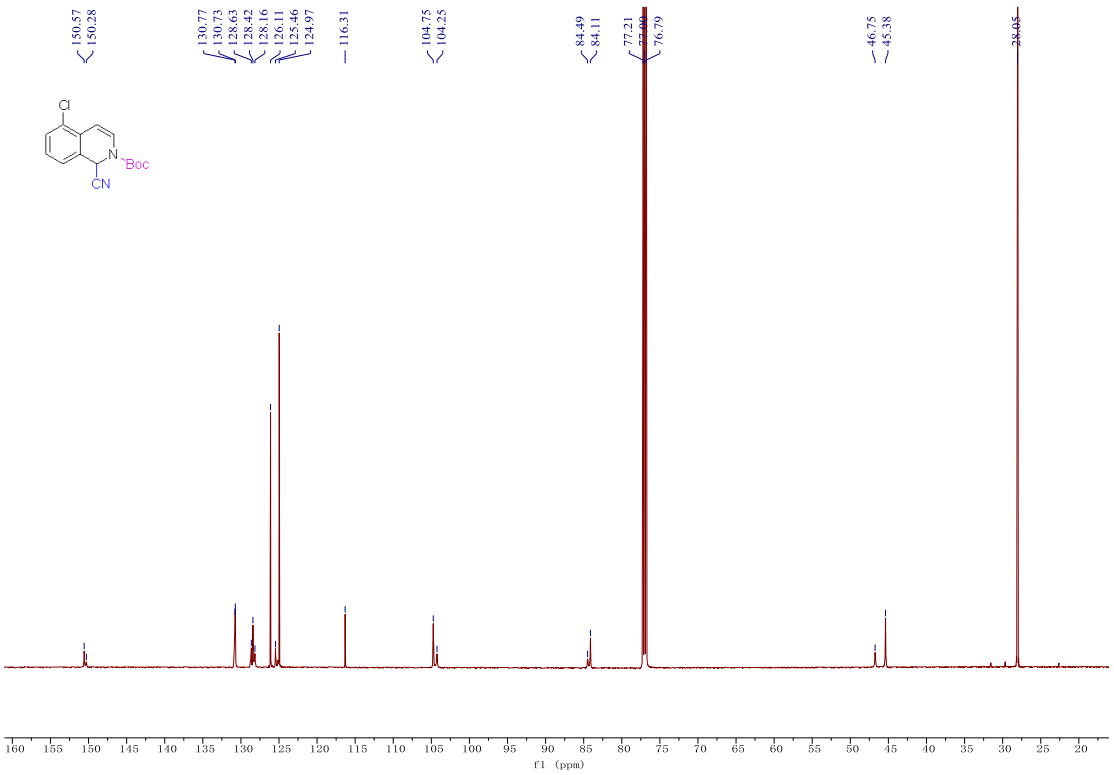
^{1}H NMR spectra of compound 11



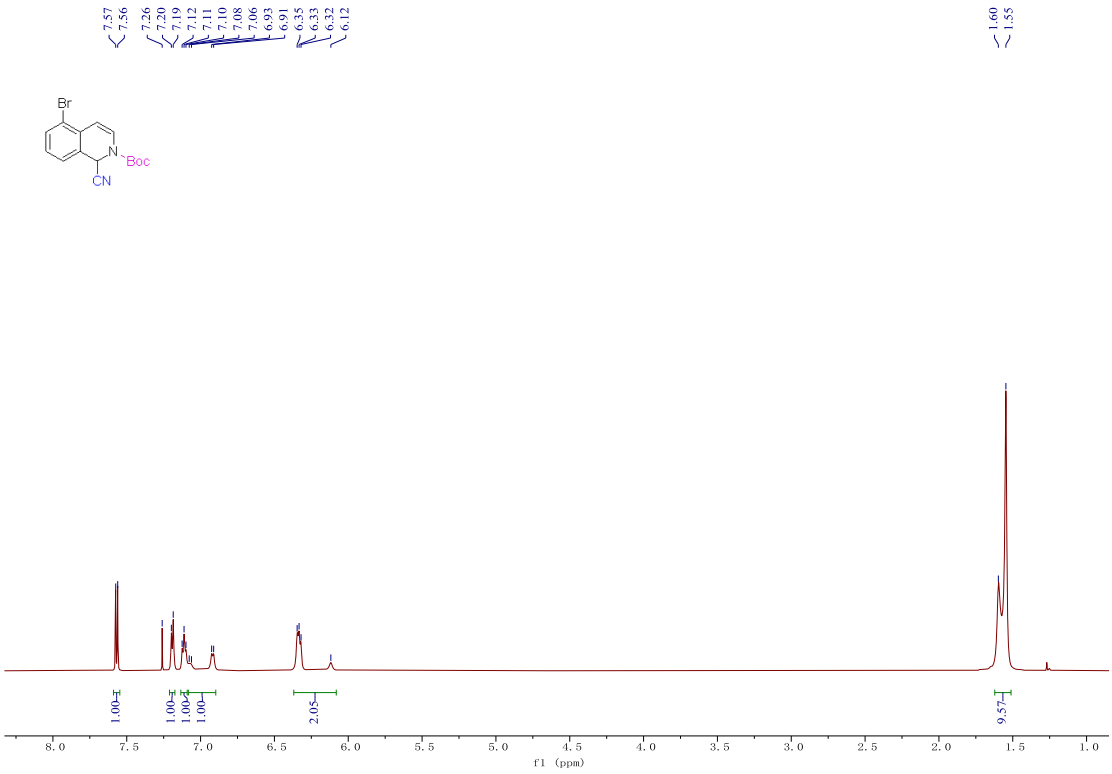
^{13}C NMR spectra of compound 11



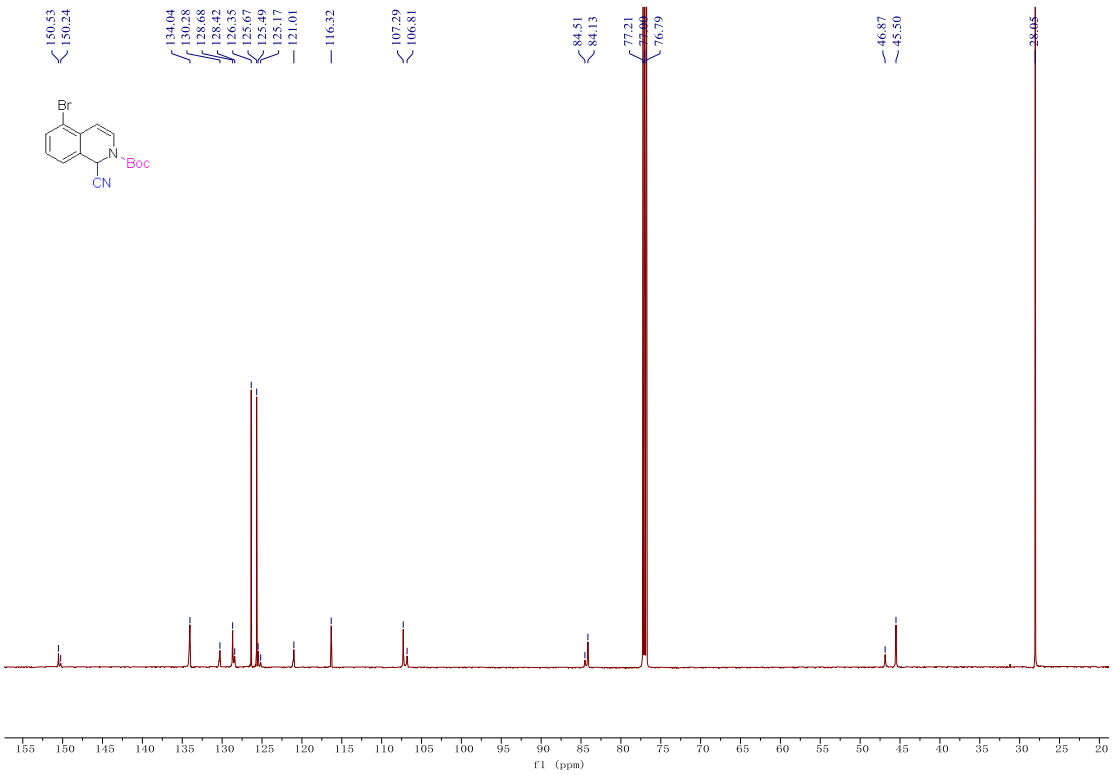
^{1}H NMR spectra of compound 12



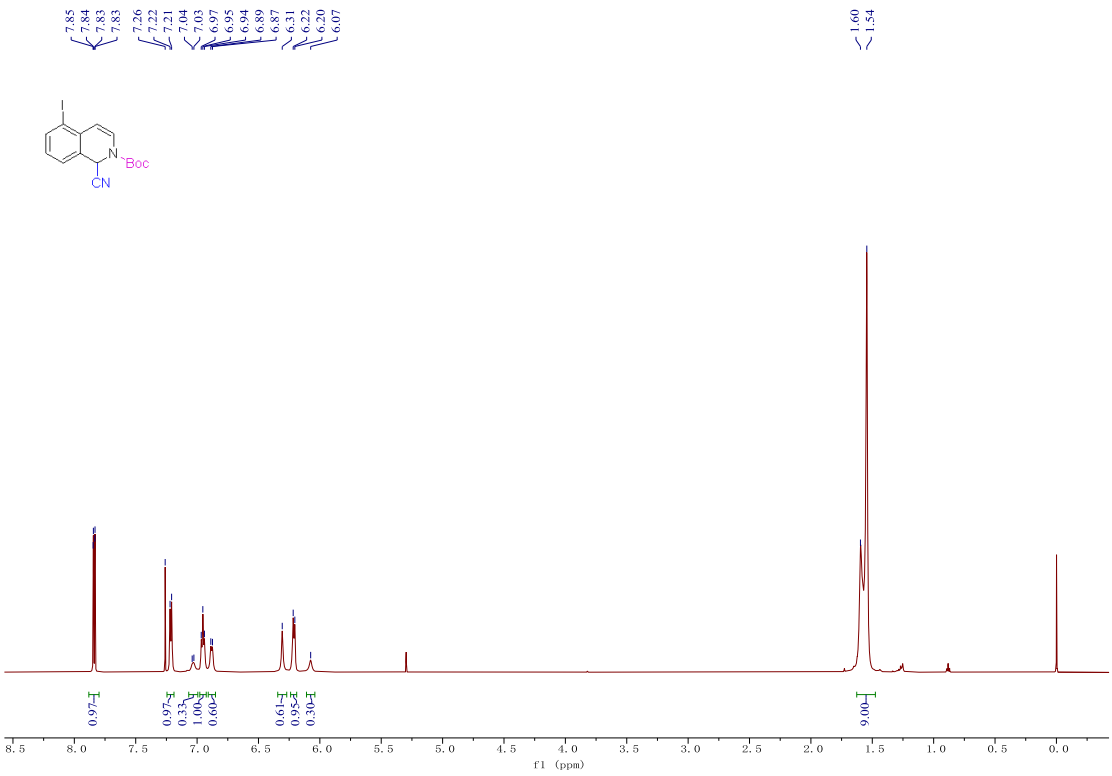
^{13}C NMR spectra of compound 12



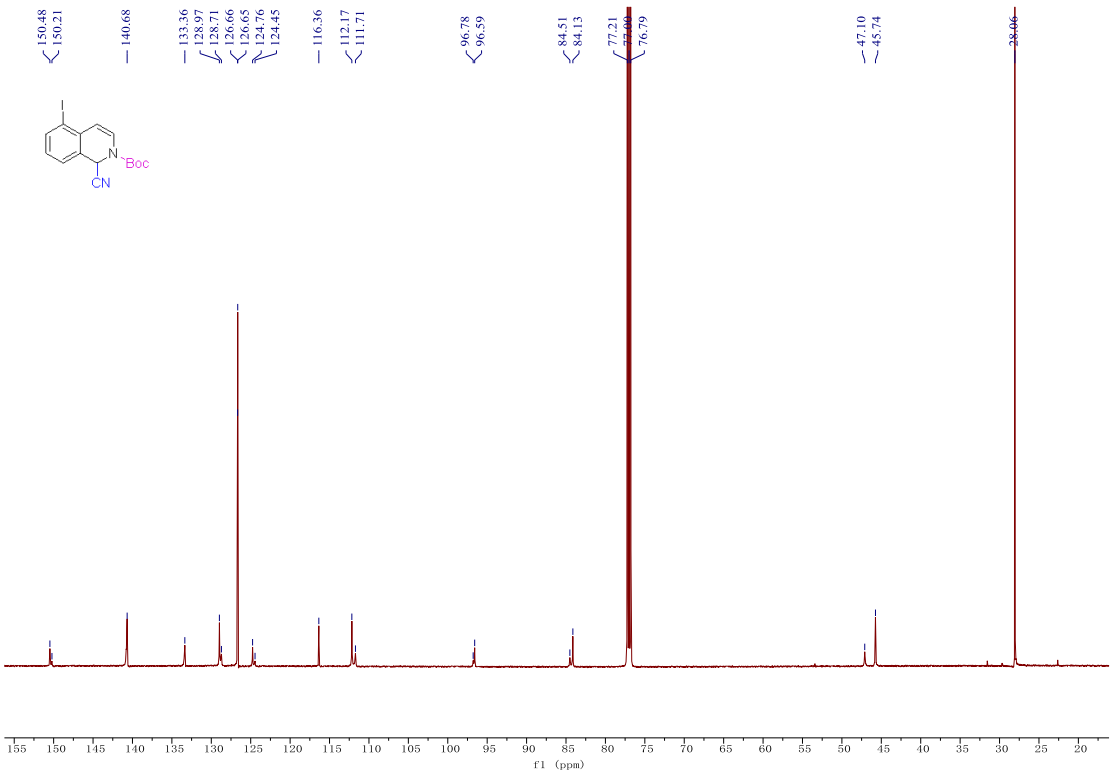
^{1}H NMR spectra of compound 13



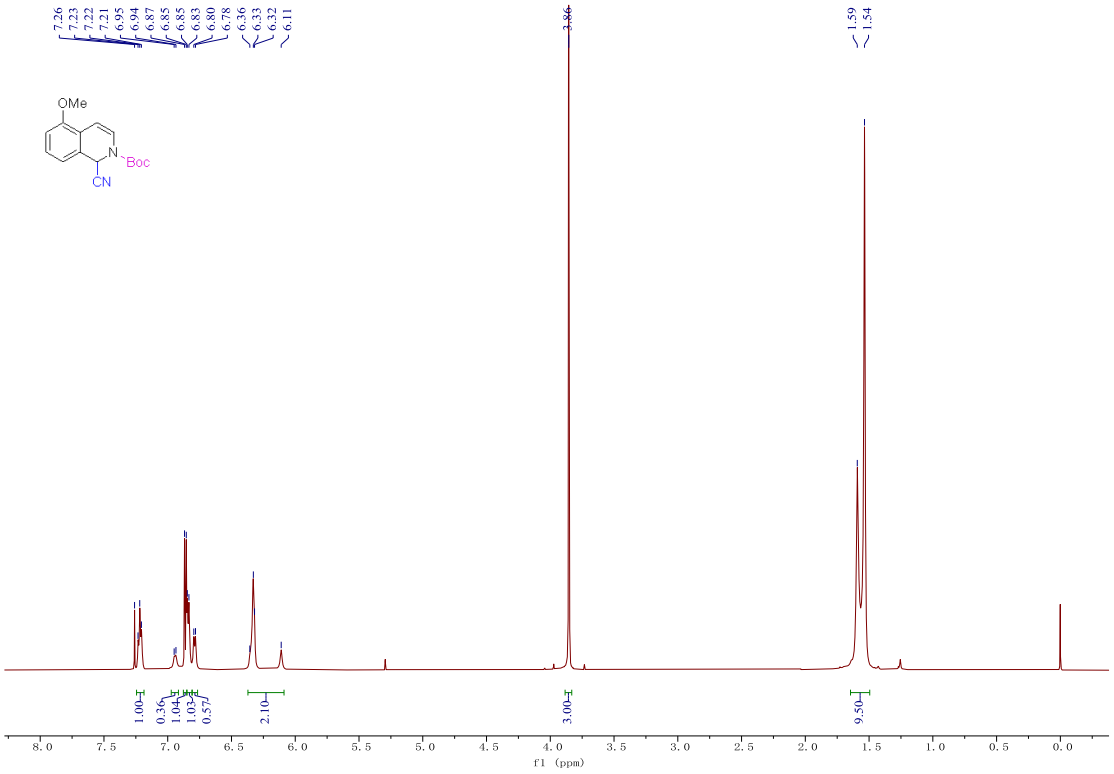
^{13}C NMR spectra of compound 13



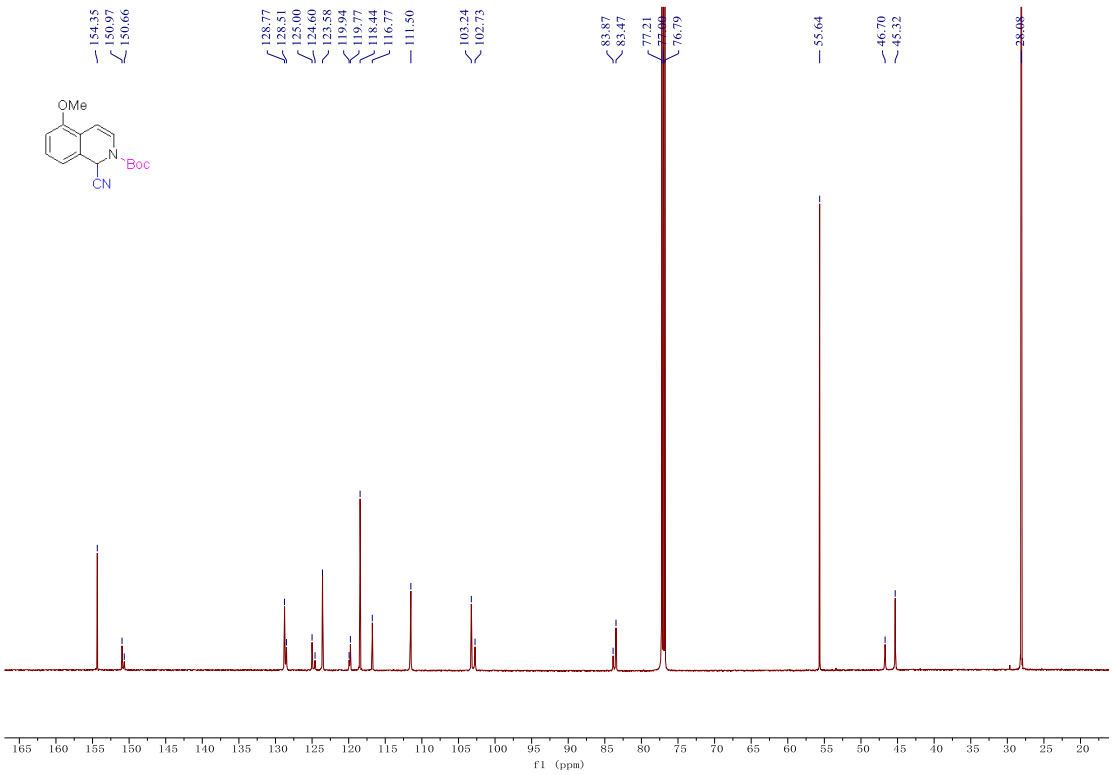
^{1}H NMR spectra of compound 14



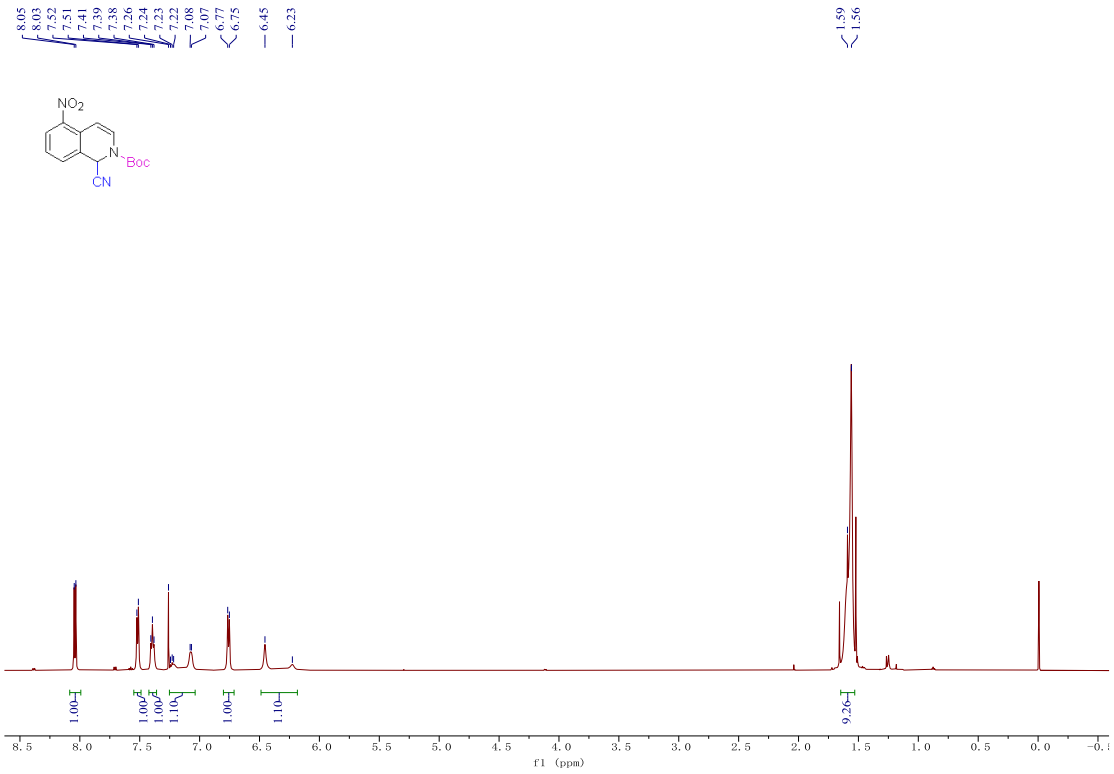
^{13}C NMR spectra of compound 14



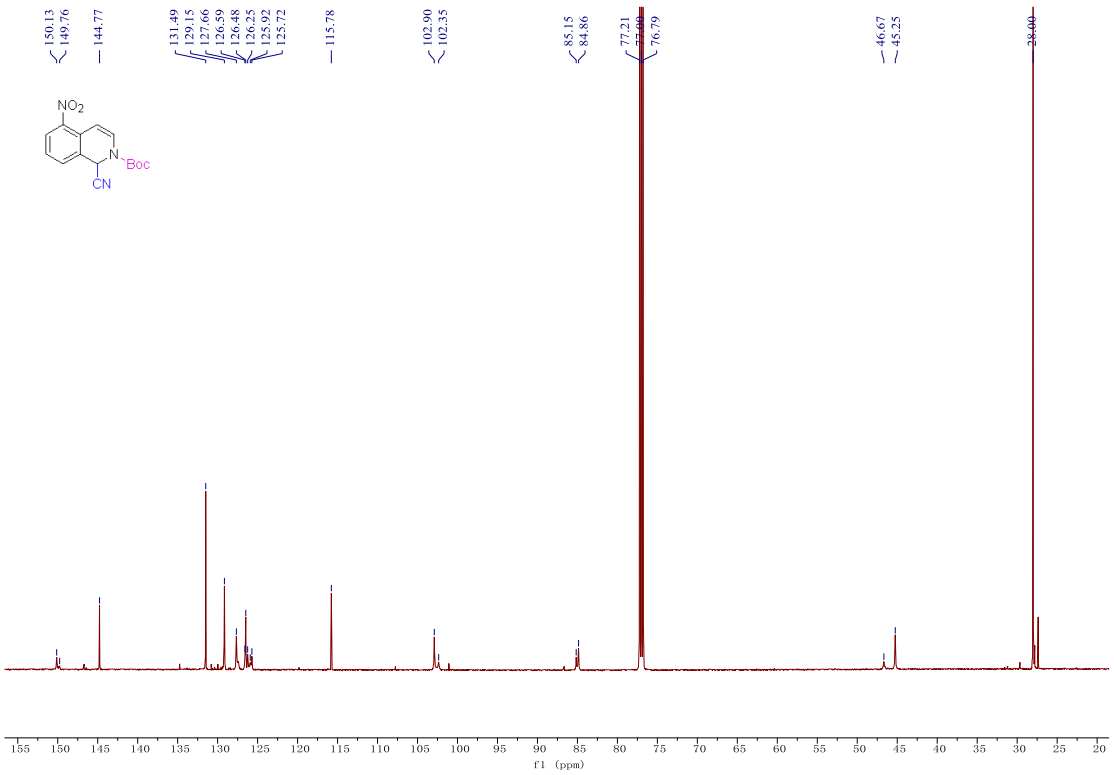
^{1}H NMR spectra of compound 15



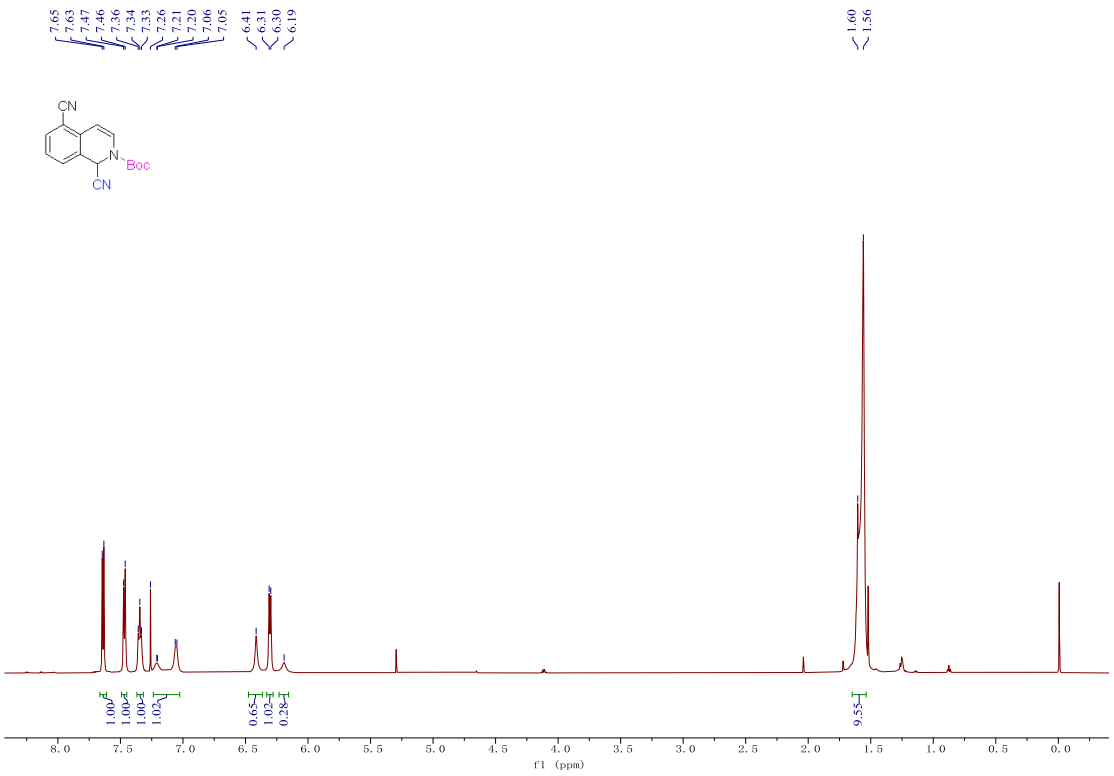
^{13}C NMR spectra of compound 15



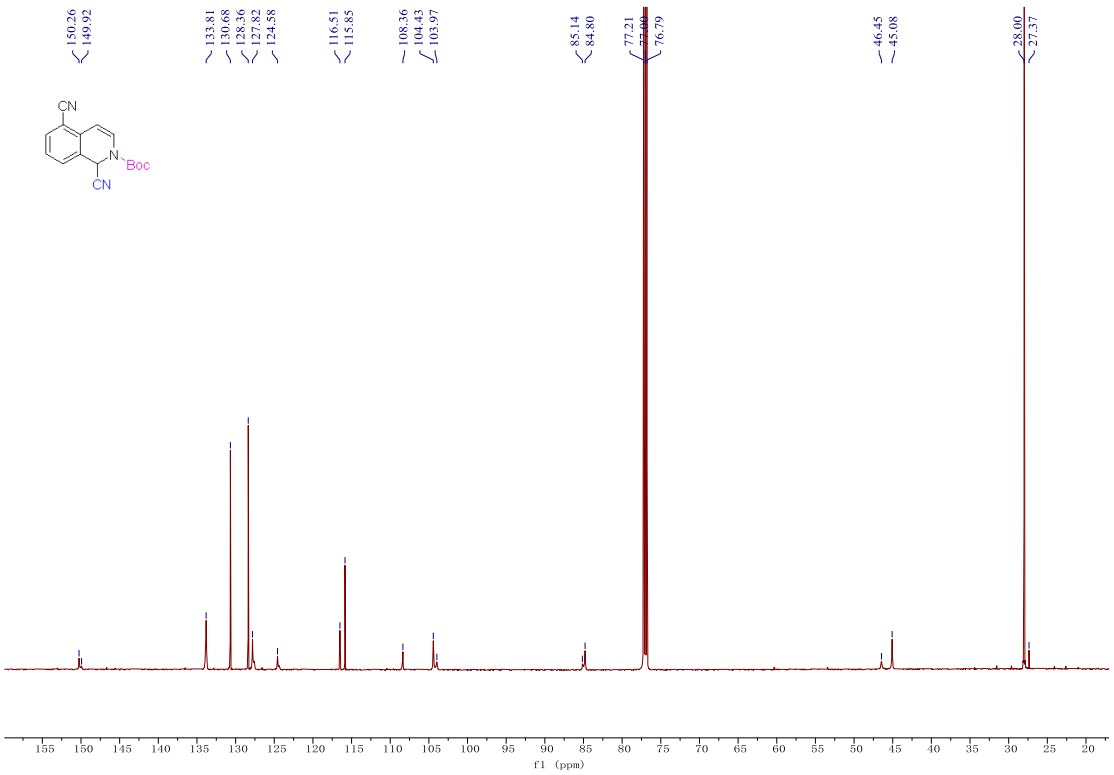
^{1}H NMR spectra of compound 16



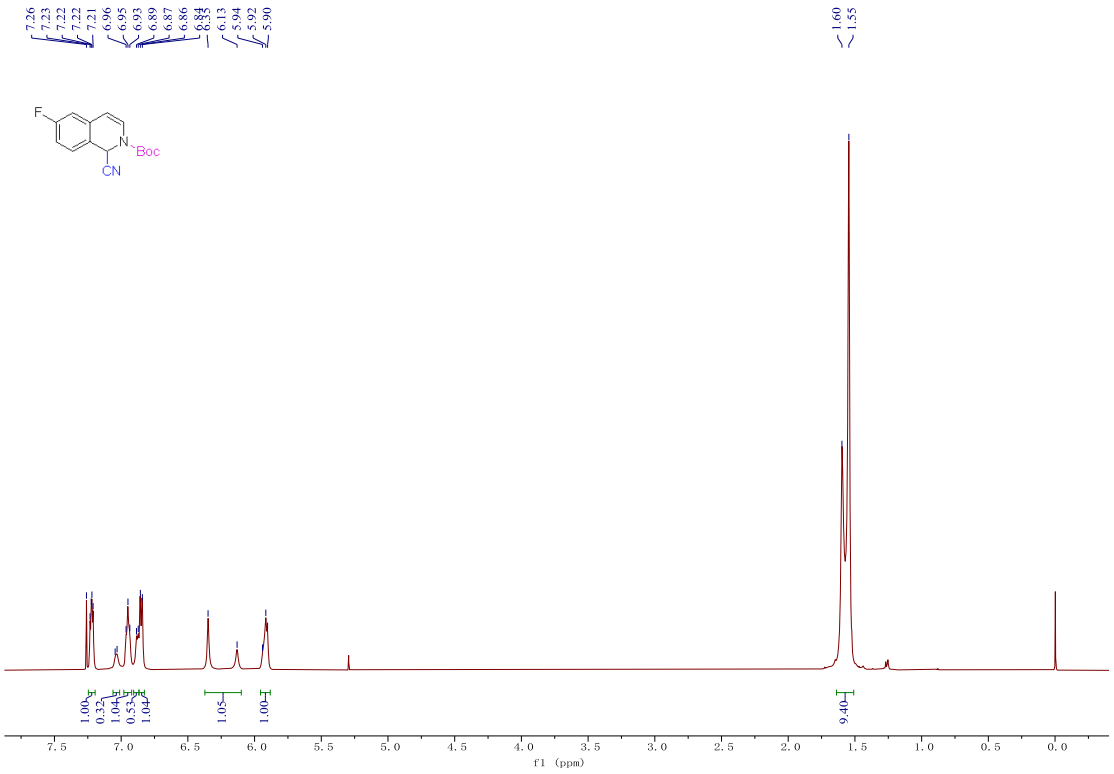
^{13}C NMR spectra of compound 16



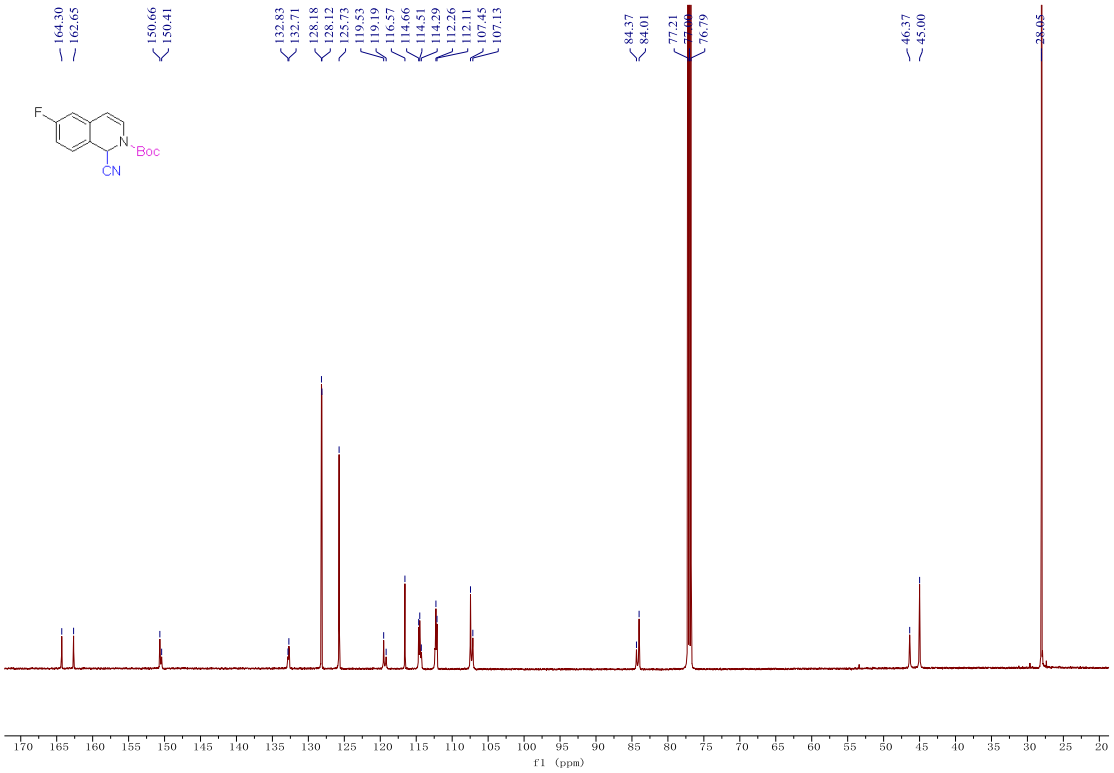
^{1}H NMR spectra of compound 17



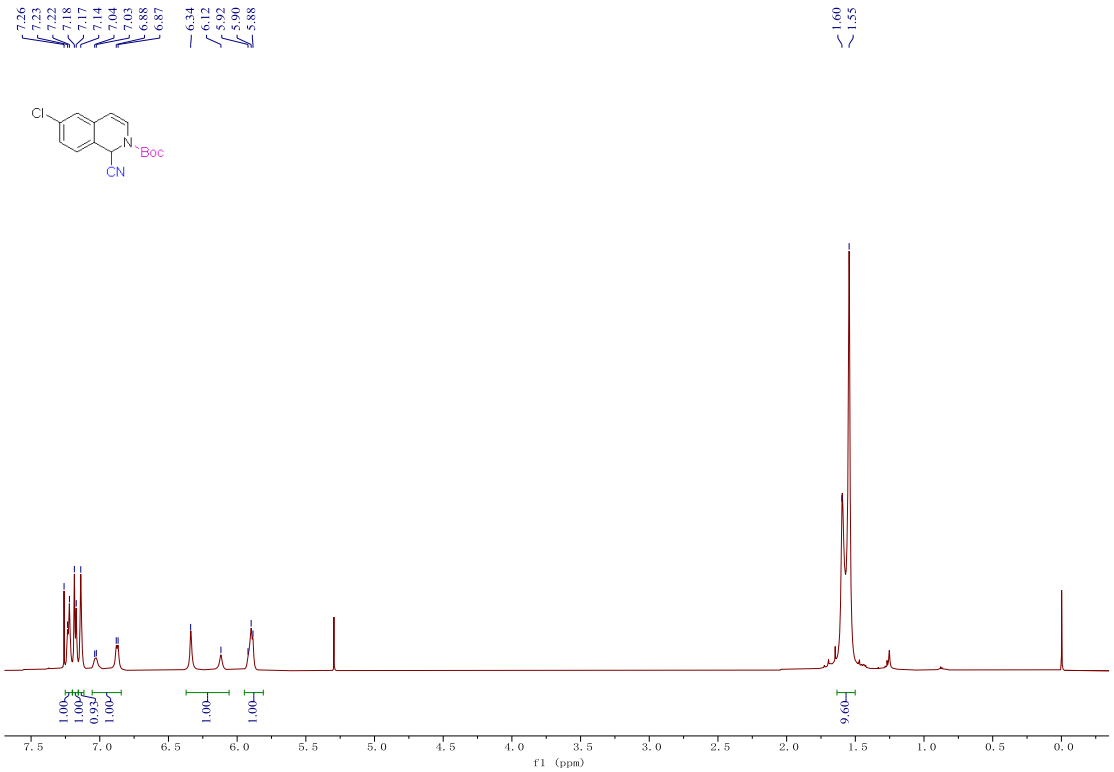
^{13}C NMR spectra of compound 17



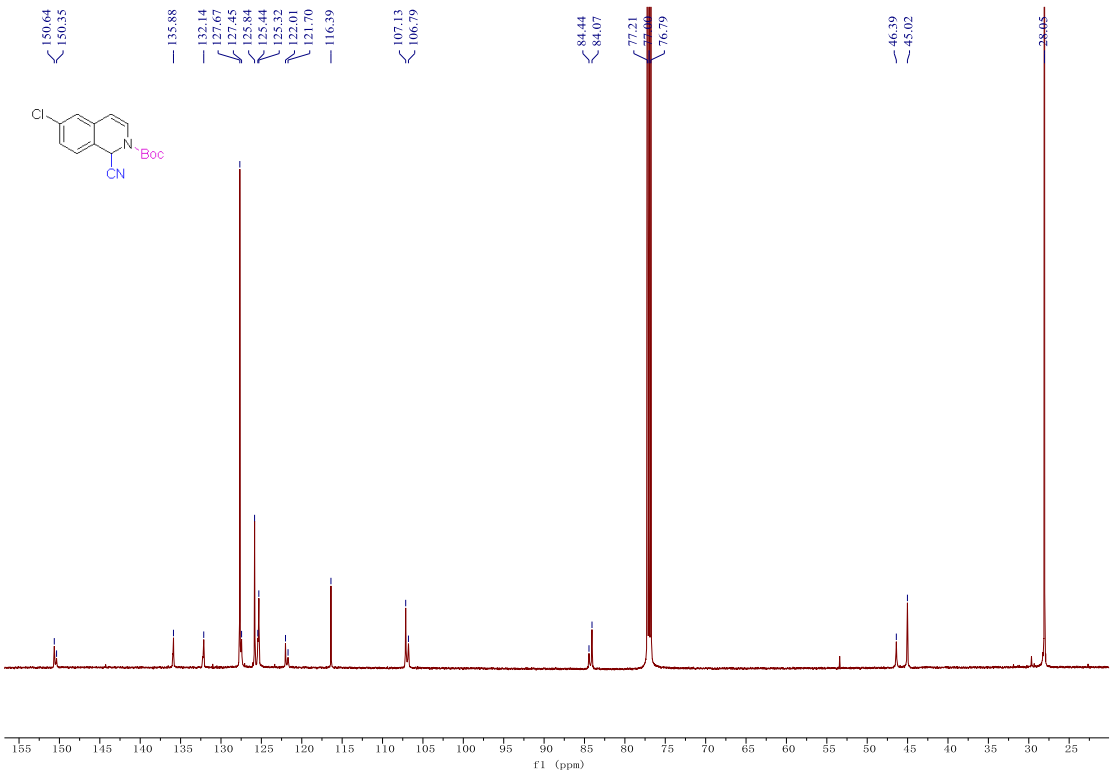
^{1}H NMR spectra of compound 18



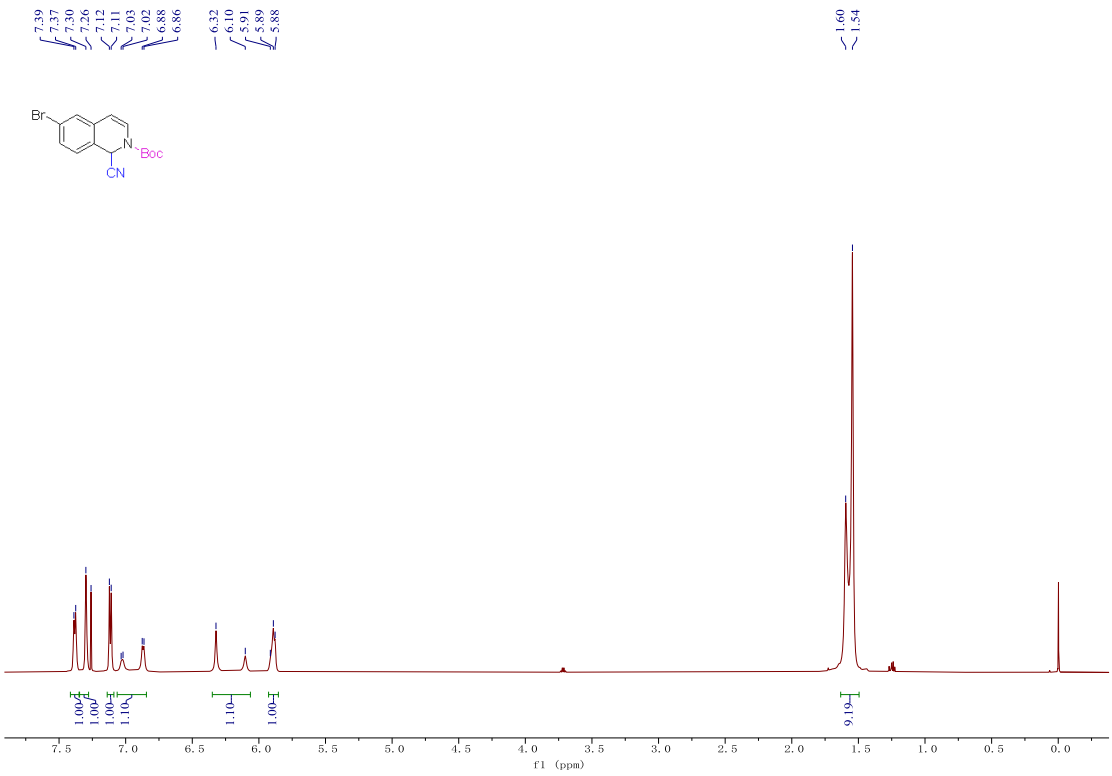
^{13}C NMR spectra of compound 18



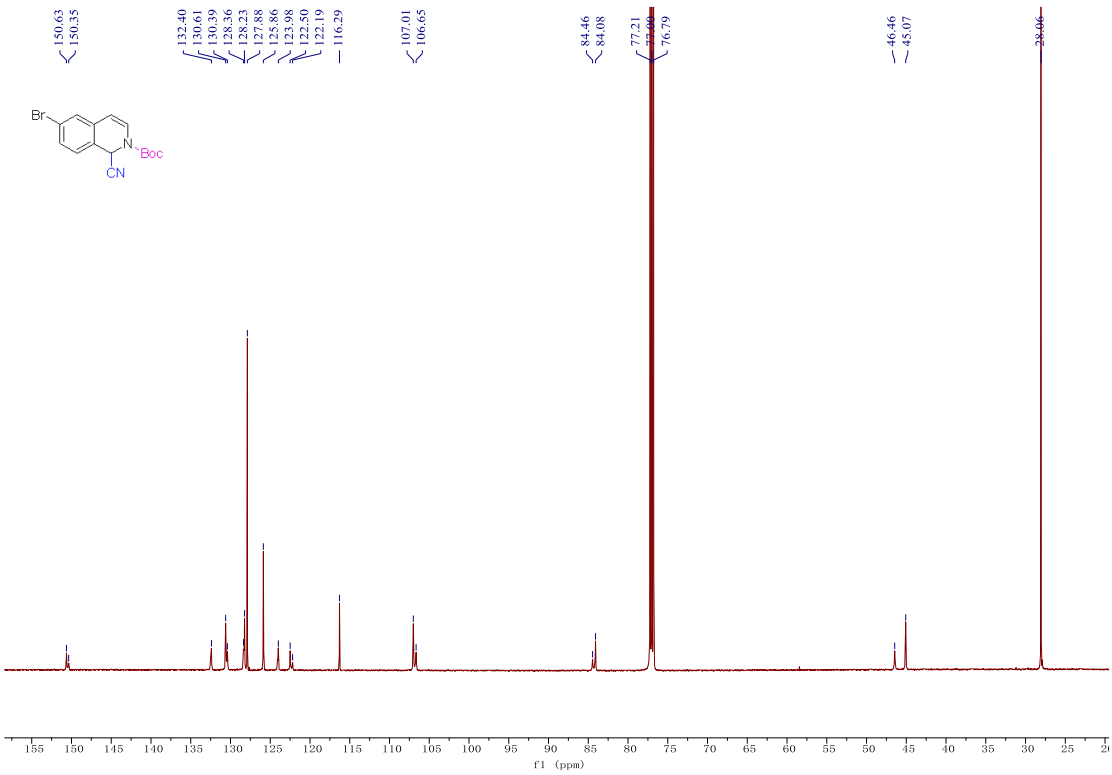
^{1}H NMR spectra of compound 19



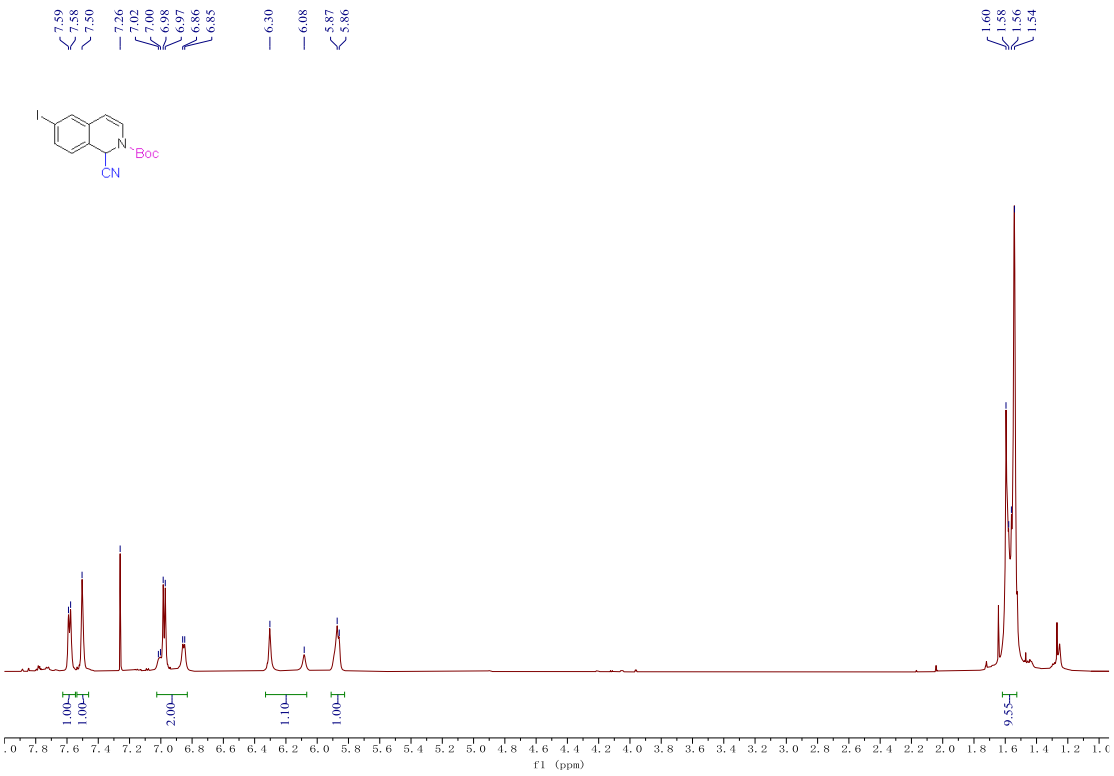
^{13}C NMR spectra of compound 19



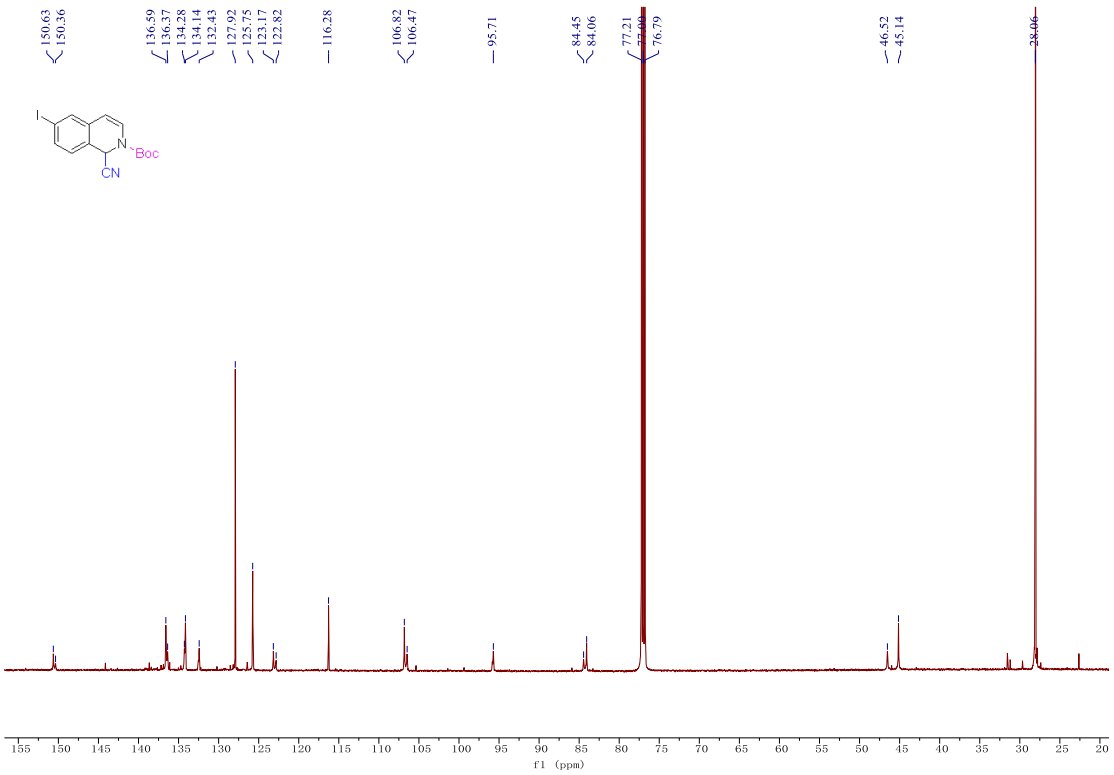
^{1}H NMR spectra of compound 20



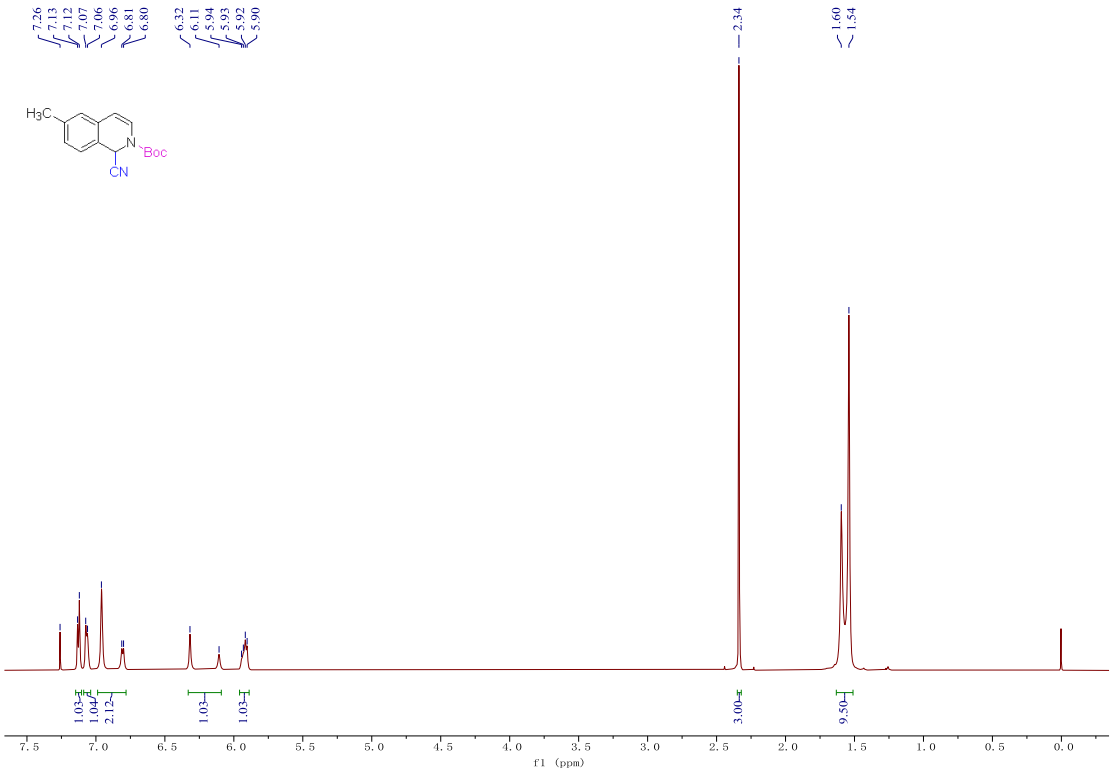
^{13}C NMR spectra of compound 20



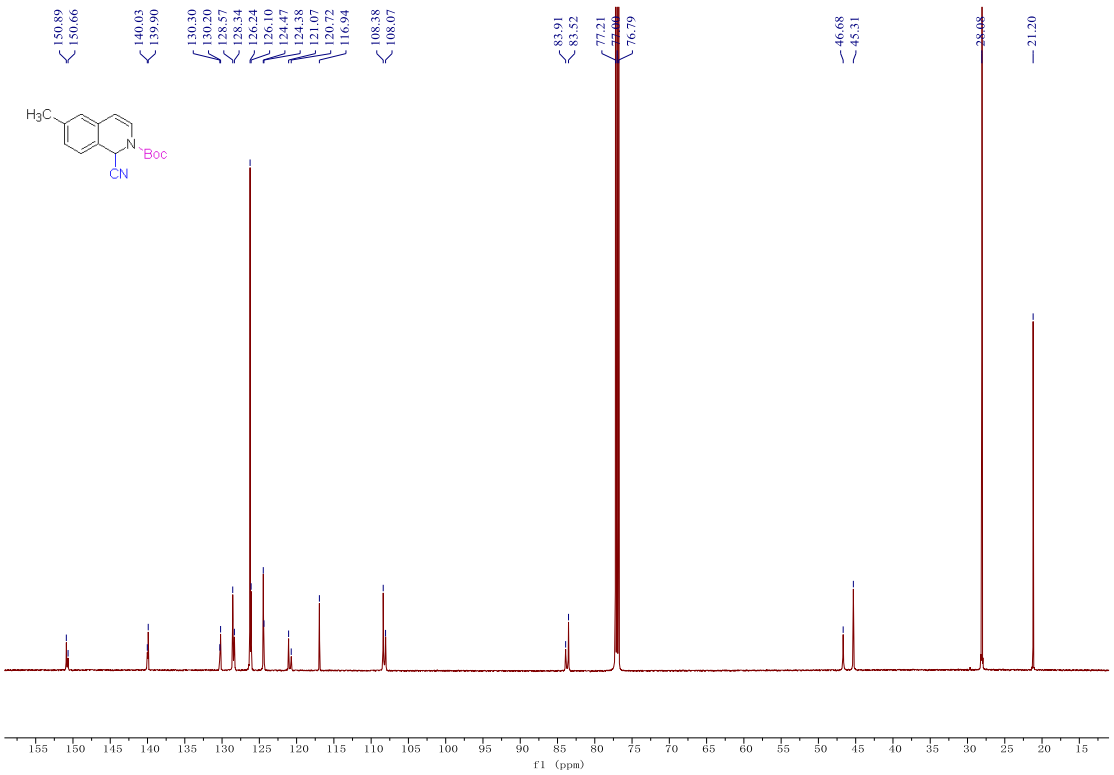
^{1}H NMR spectra of compound 21



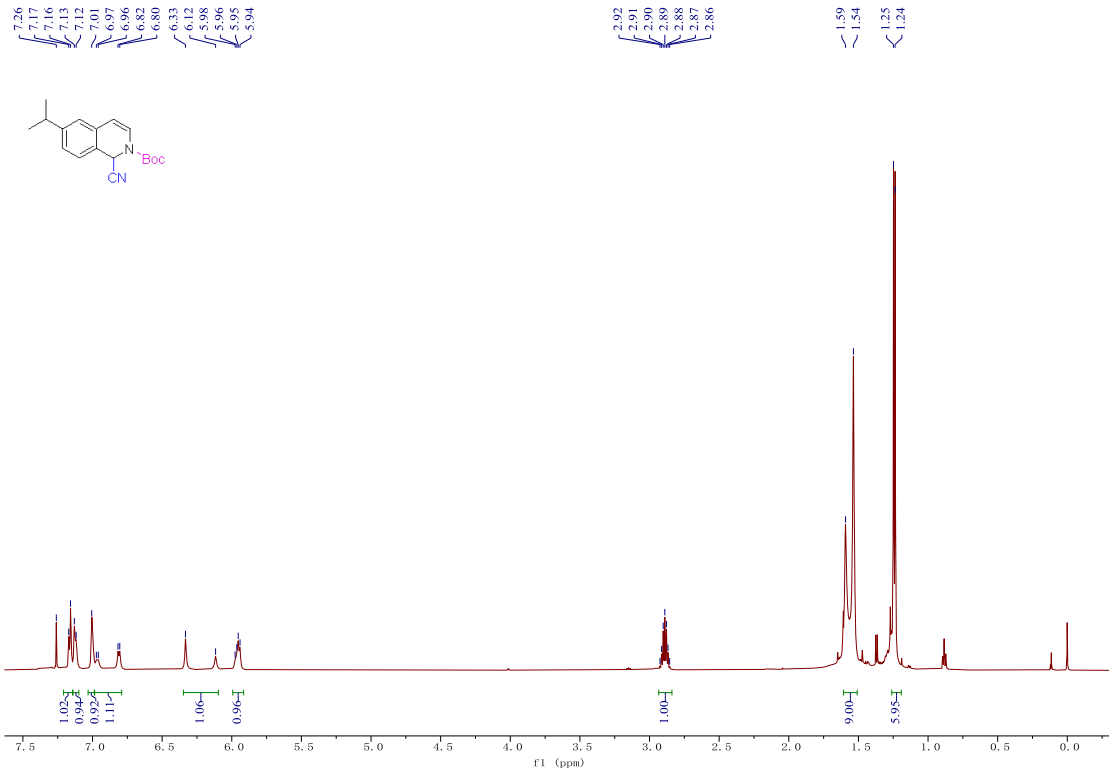
^{13}C NMR spectra of compound 21



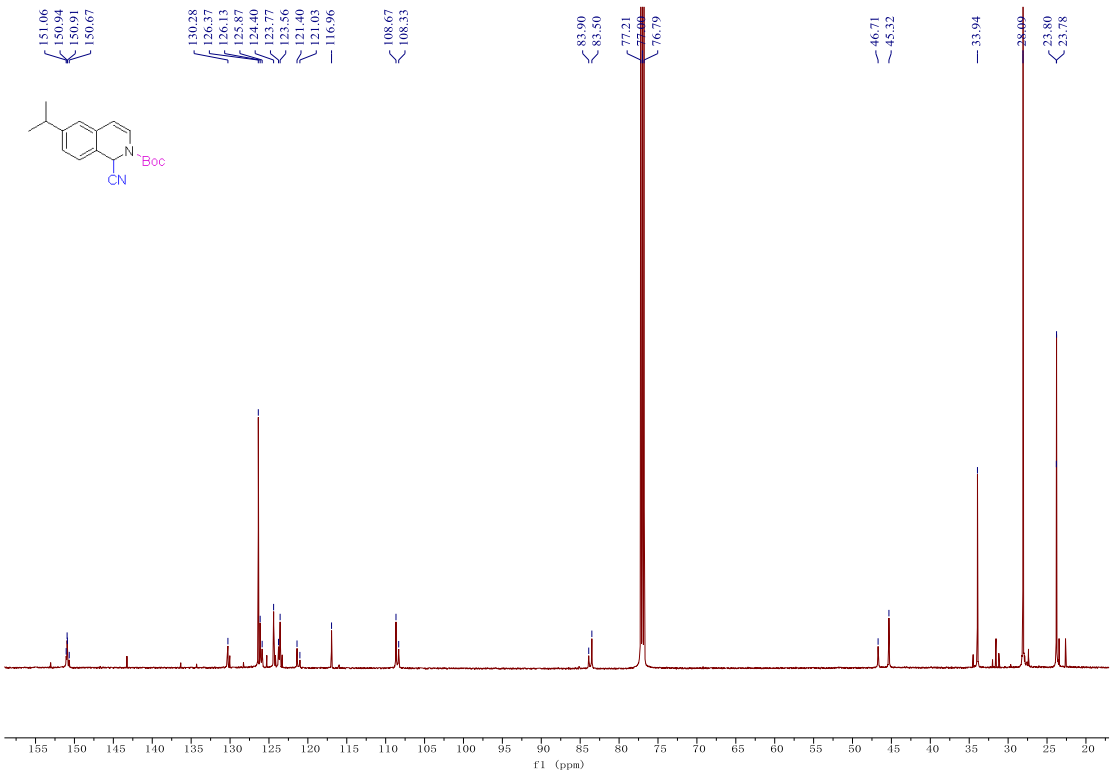
^{1}H NMR spectra of compound 22



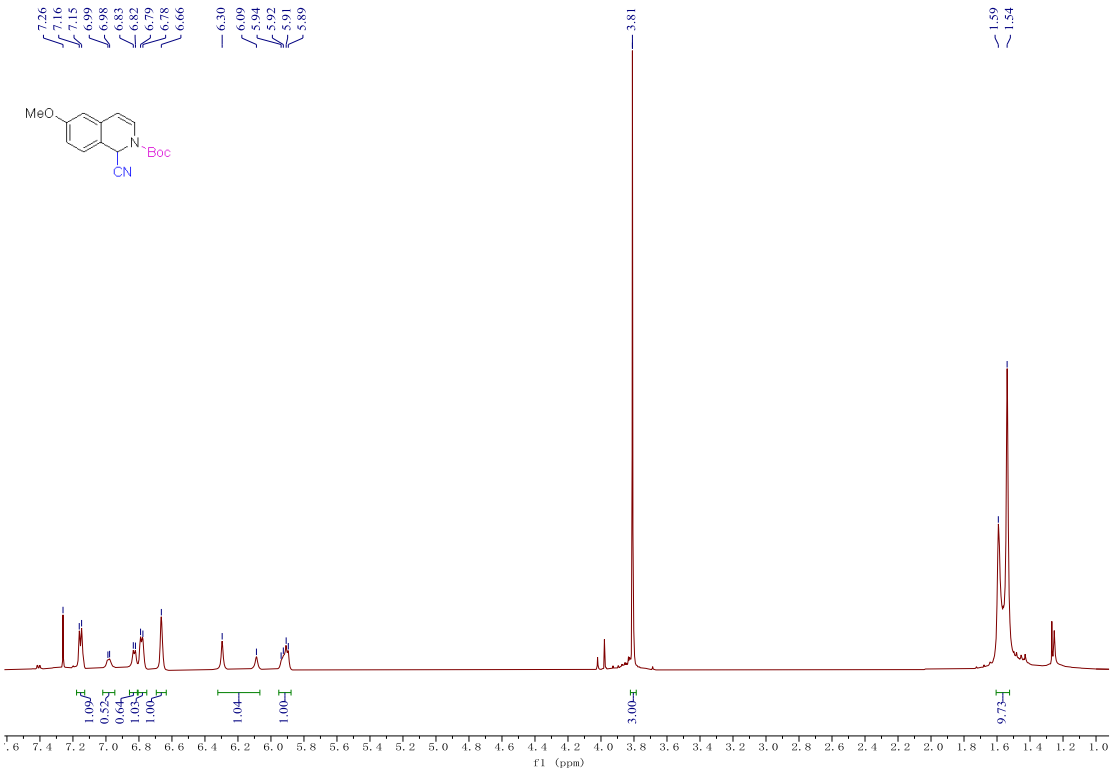
^{13}C NMR spectra of compound 22



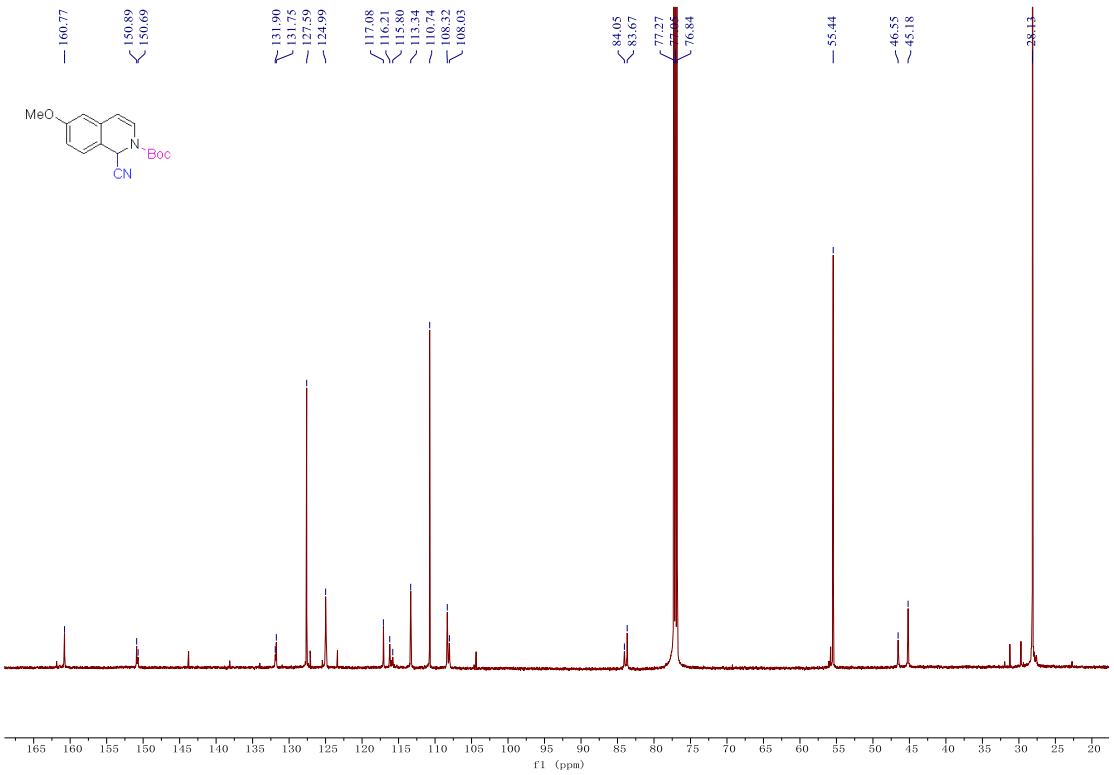
^{1}H NMR spectra of compound 23



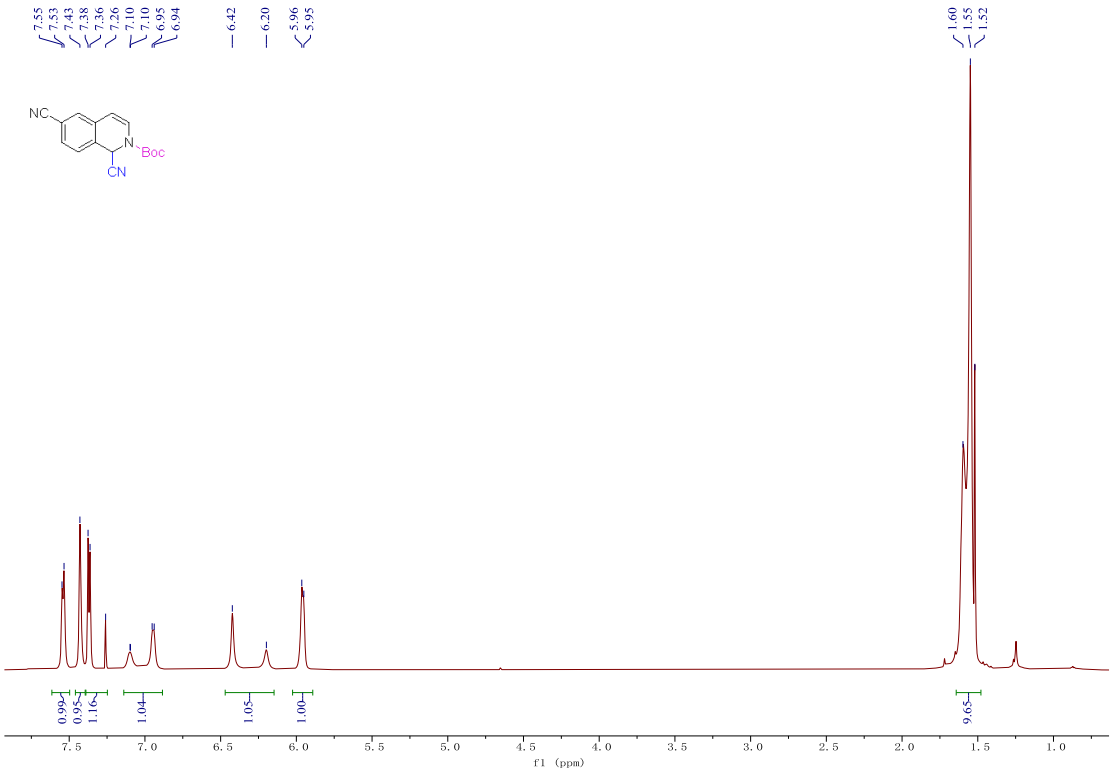
^{13}C NMR spectra of compound 23



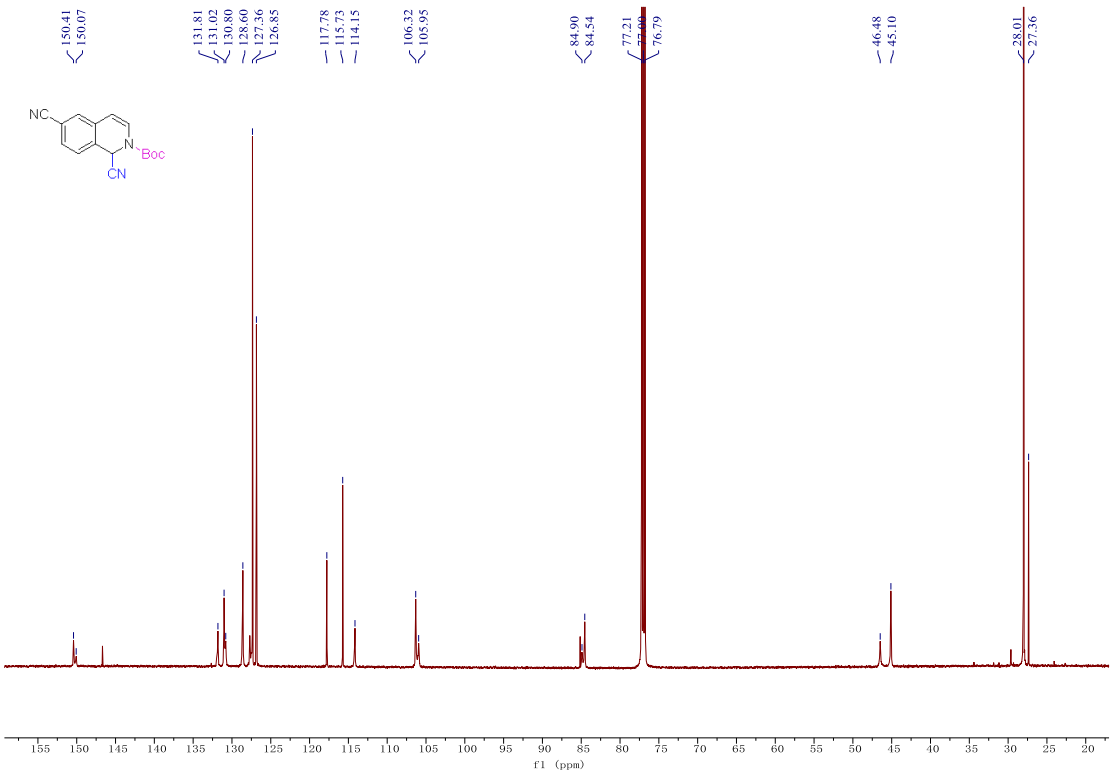
^{1}H NMR spectra of compound 24



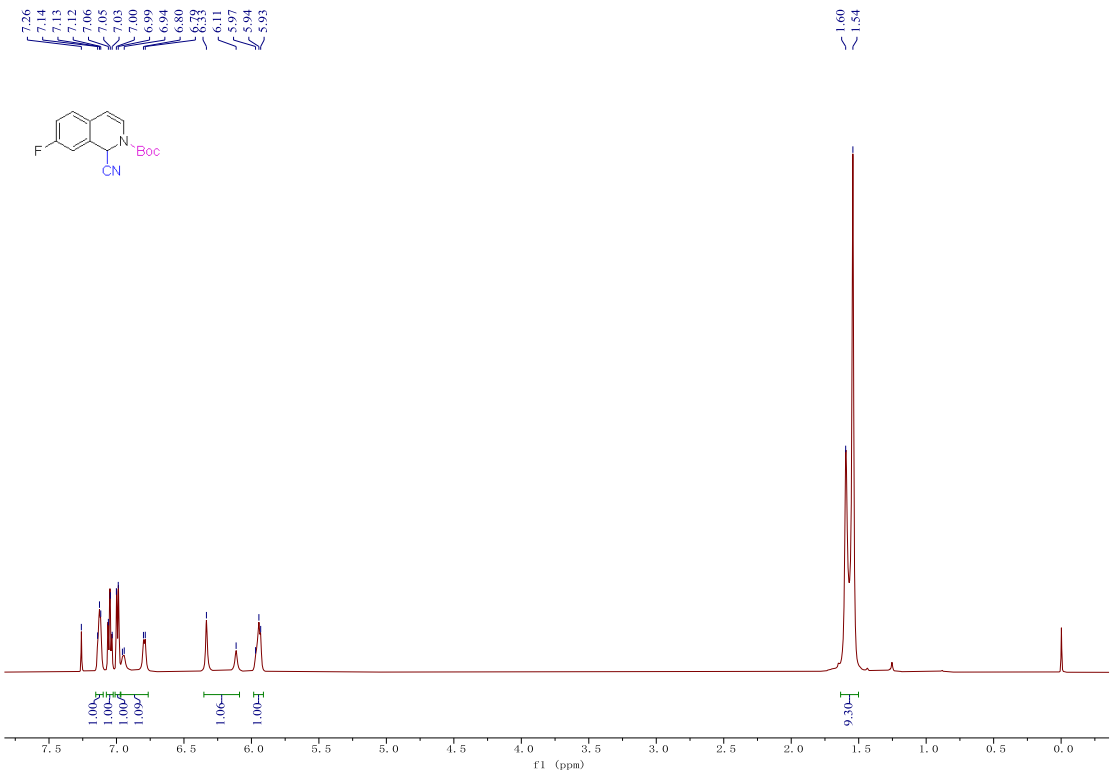
^{13}C NMR spectra of compound 24



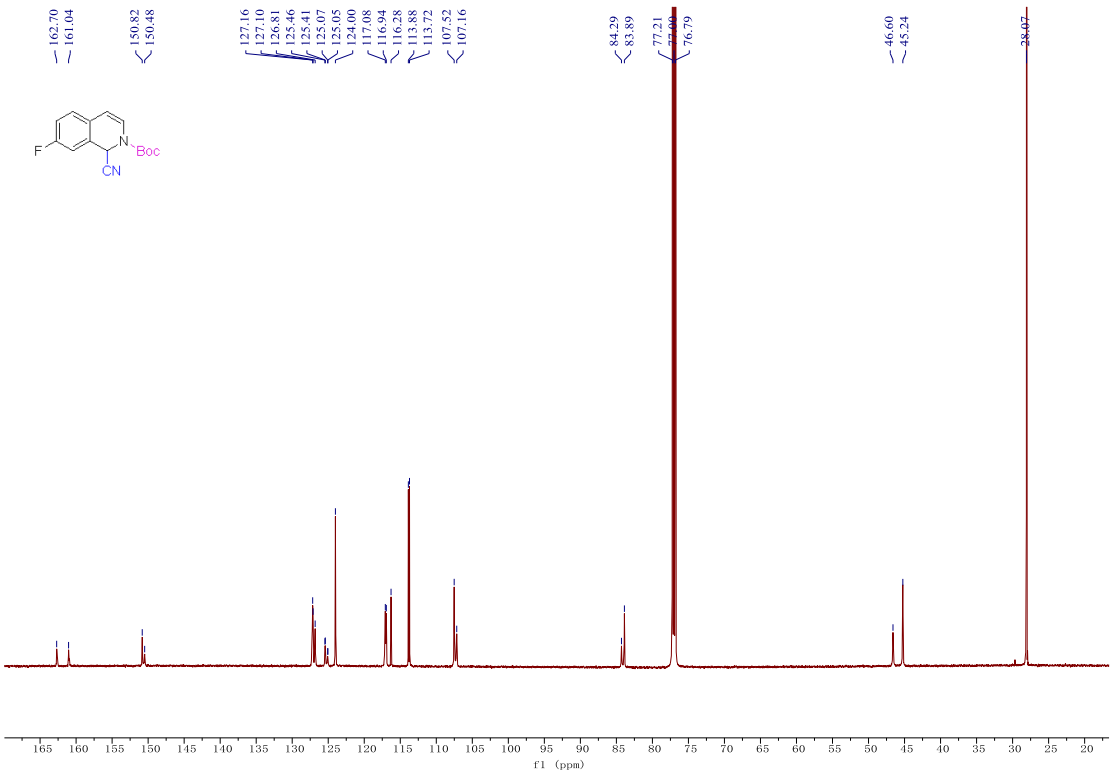
^{1}H NMR spectra of compound 25



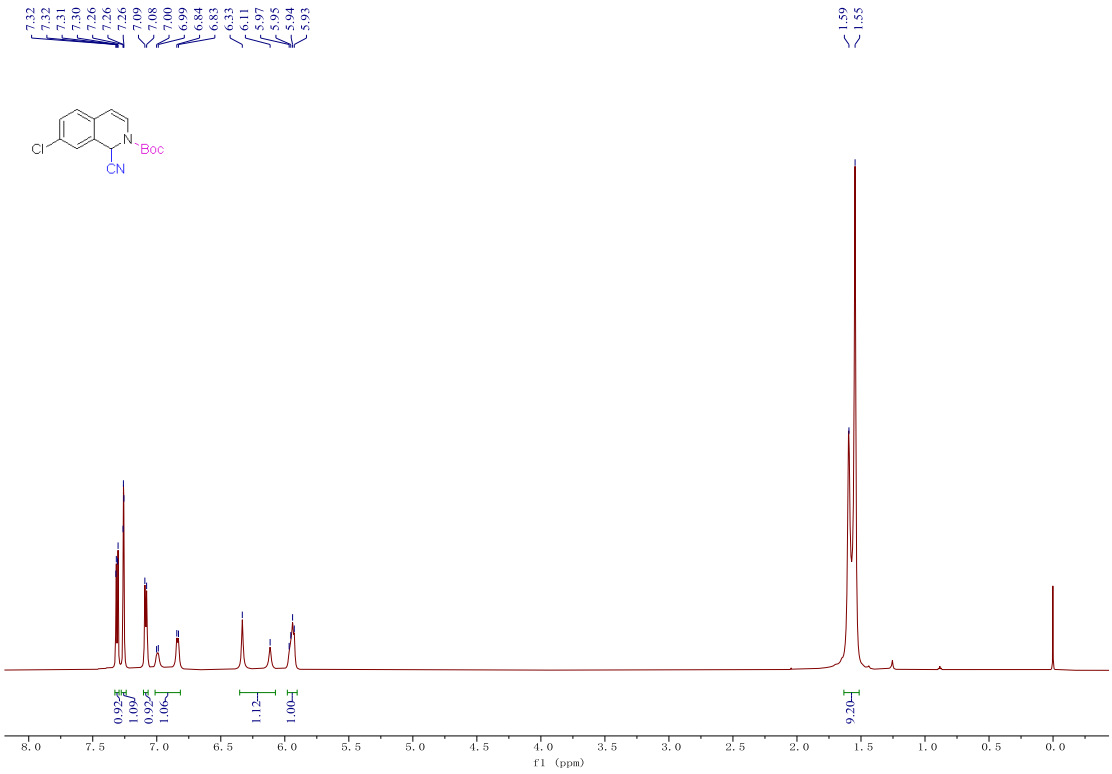
^{13}C NMR spectra of compound 25



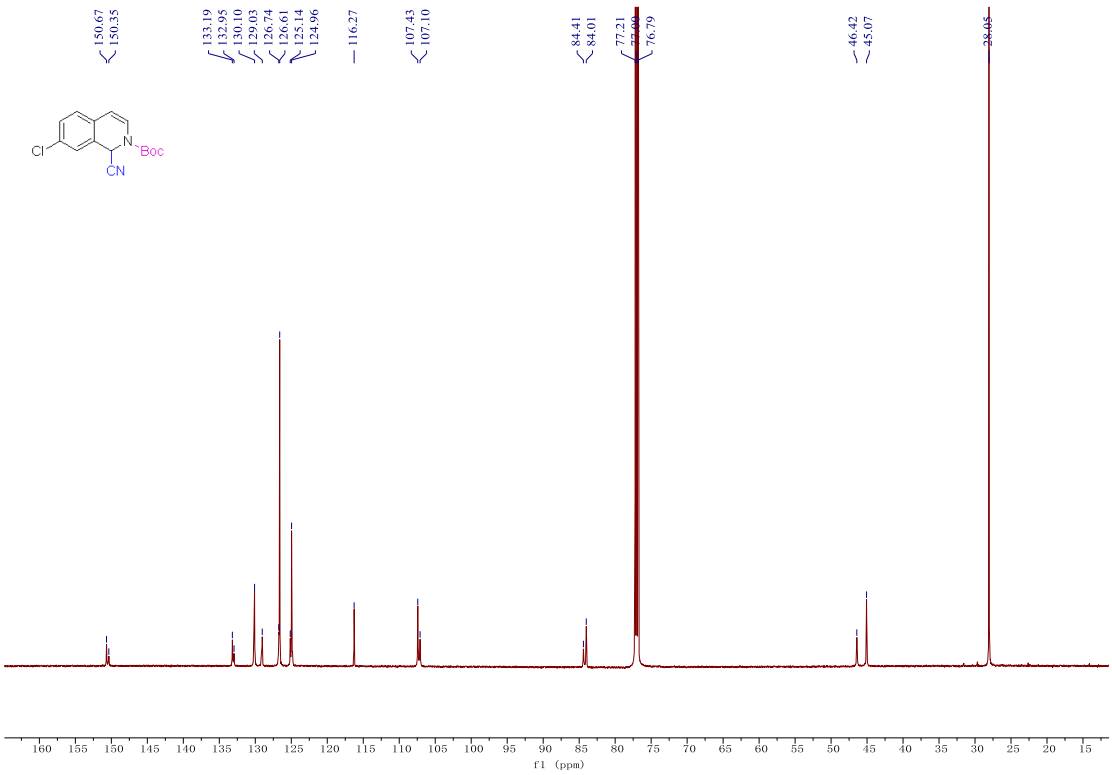
^{1}H NMR spectra of compound 26



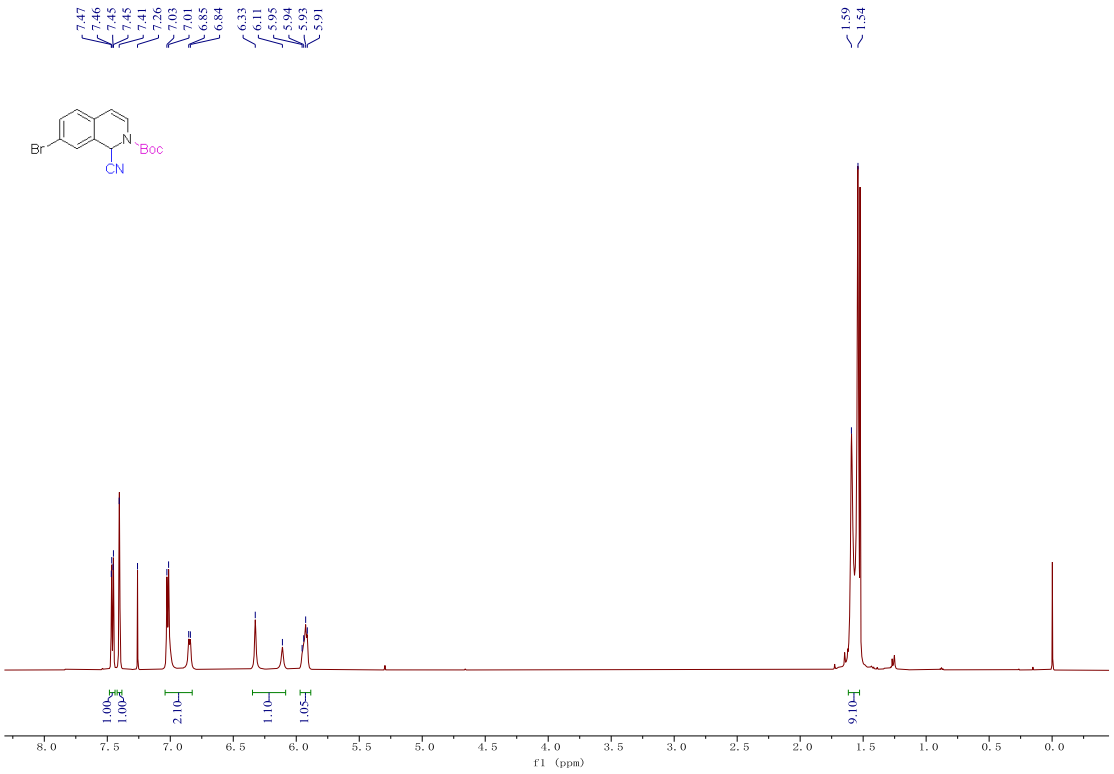
^{13}C NMR spectra of compound 26



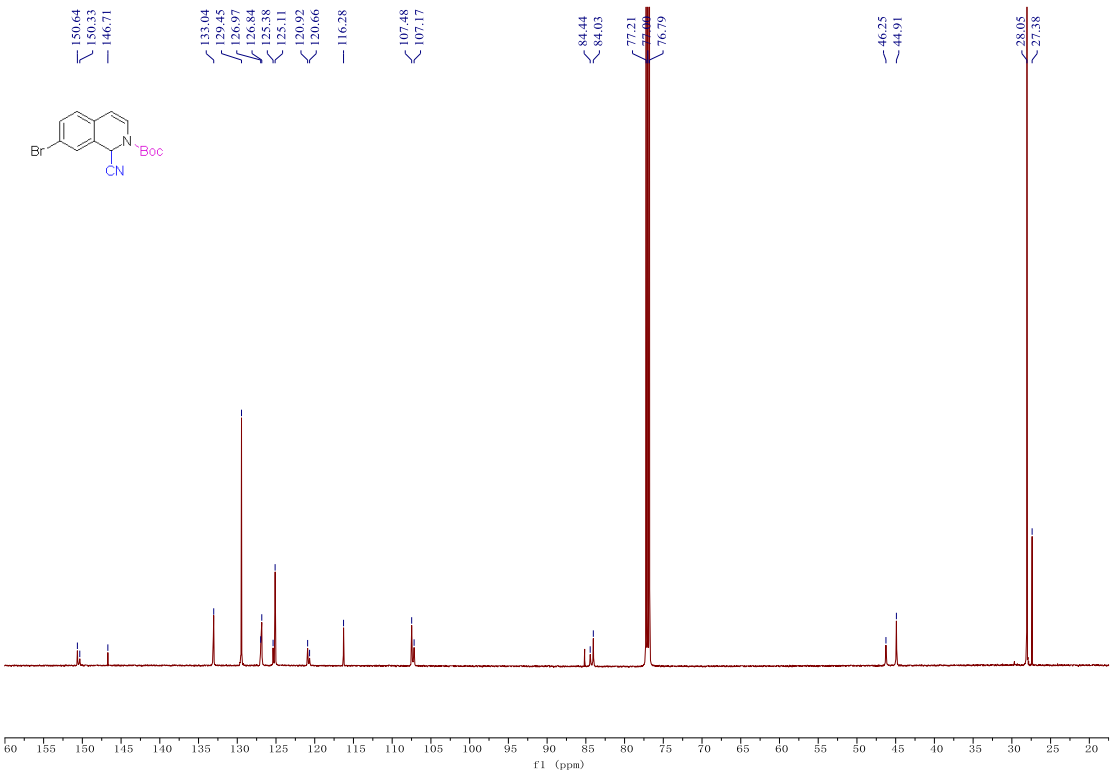
^{1}H NMR spectra of compound 27



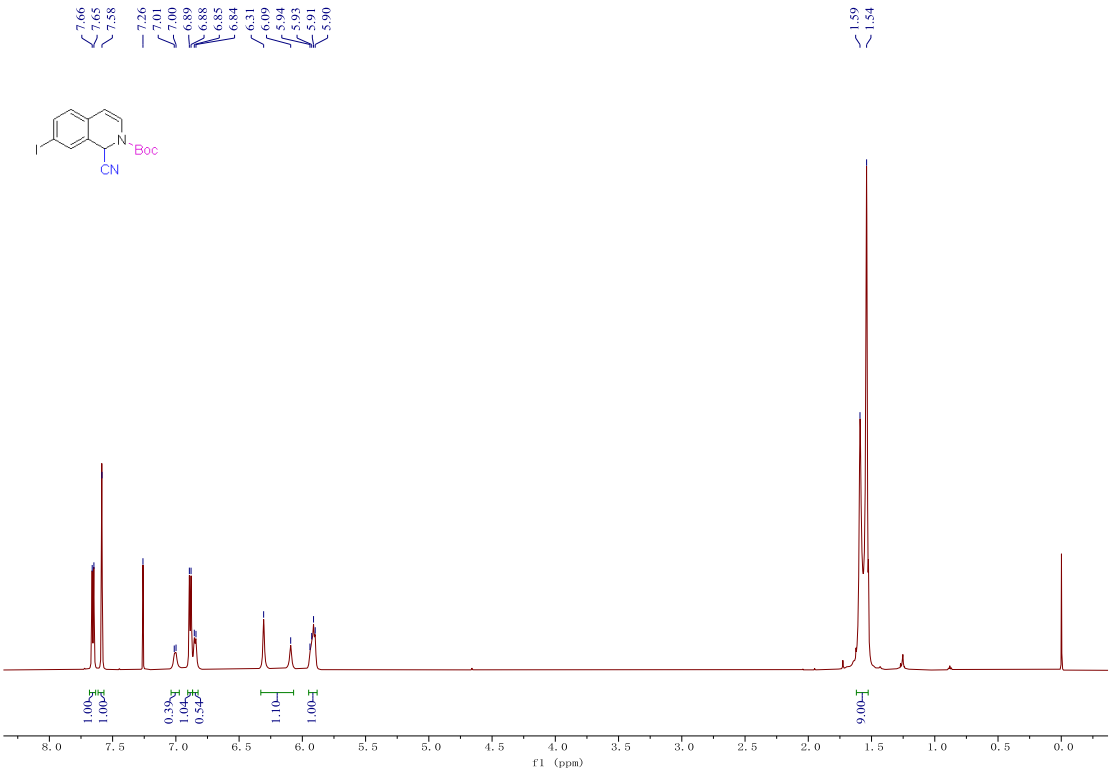
^{13}C NMR spectra of compound 27



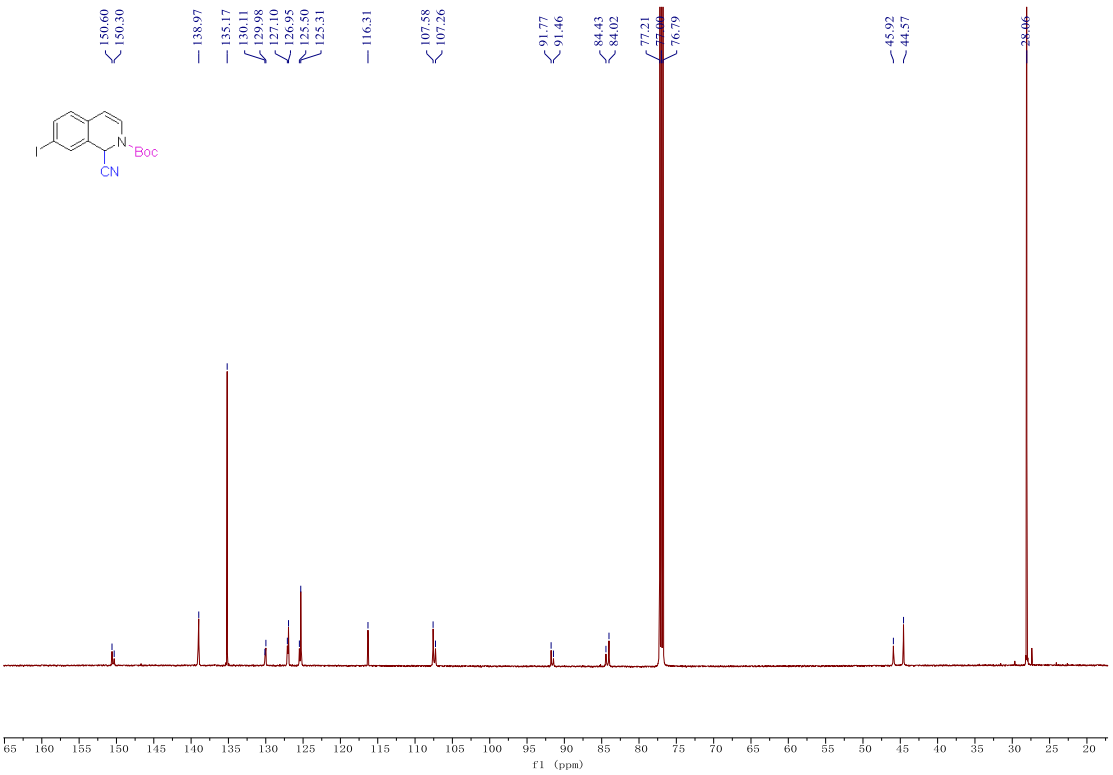
^{1}H NMR spectra of compound 28



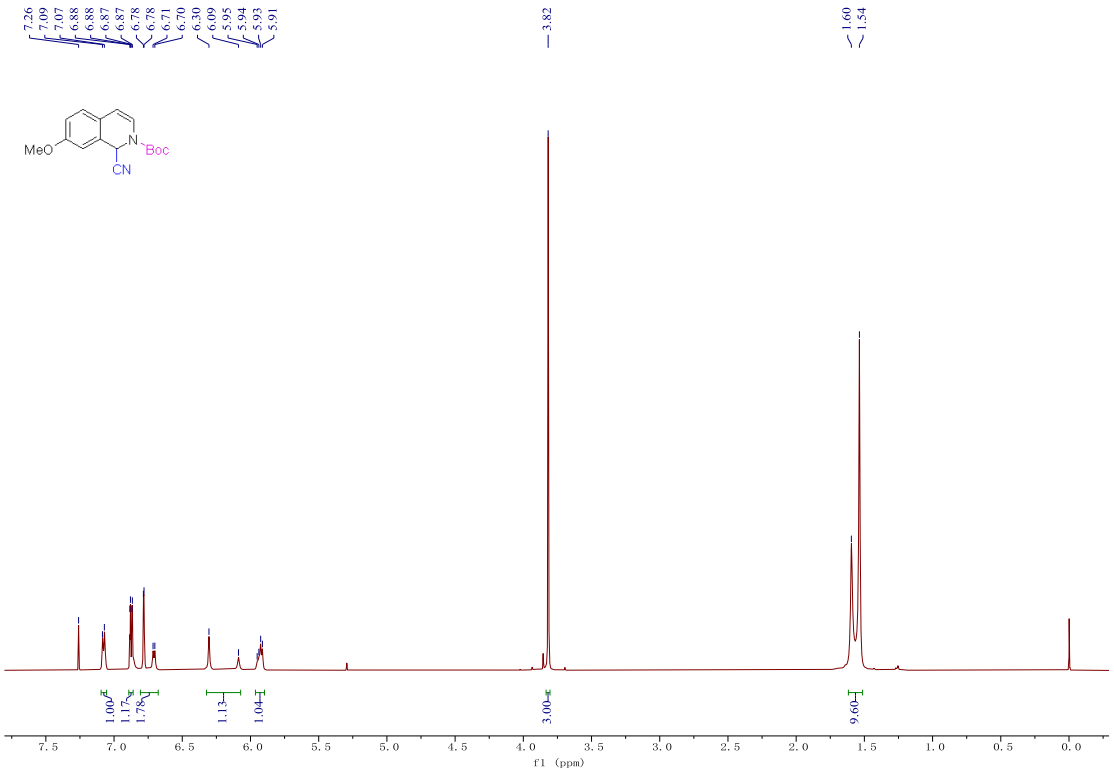
^{13}C NMR spectra of compound 28



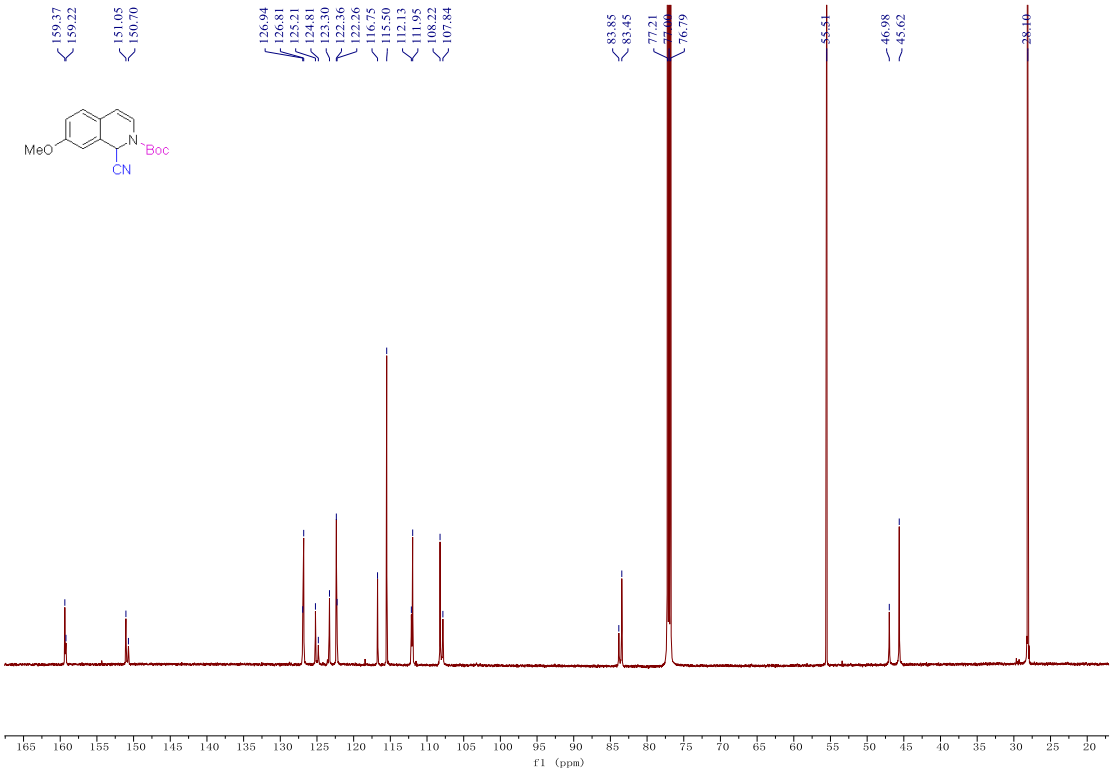
^{1}H NMR spectra of compound 29



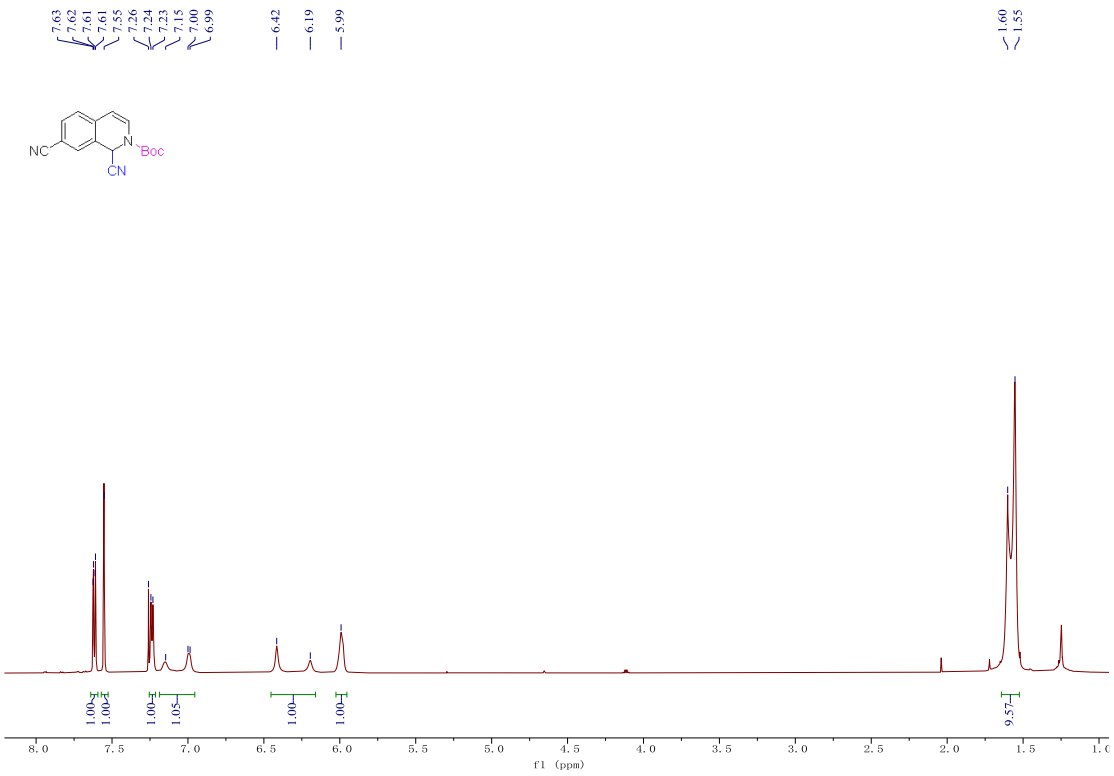
^{13}C NMR spectra of compound 29



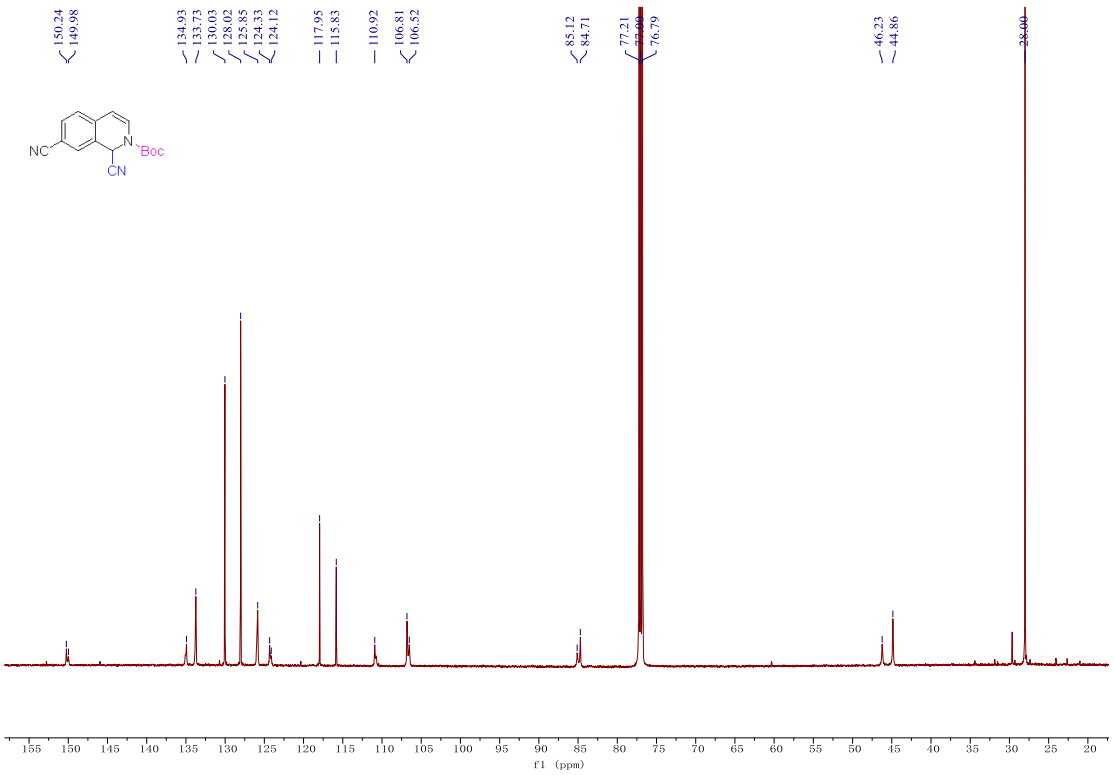
^{1}H NMR spectra of compound 30



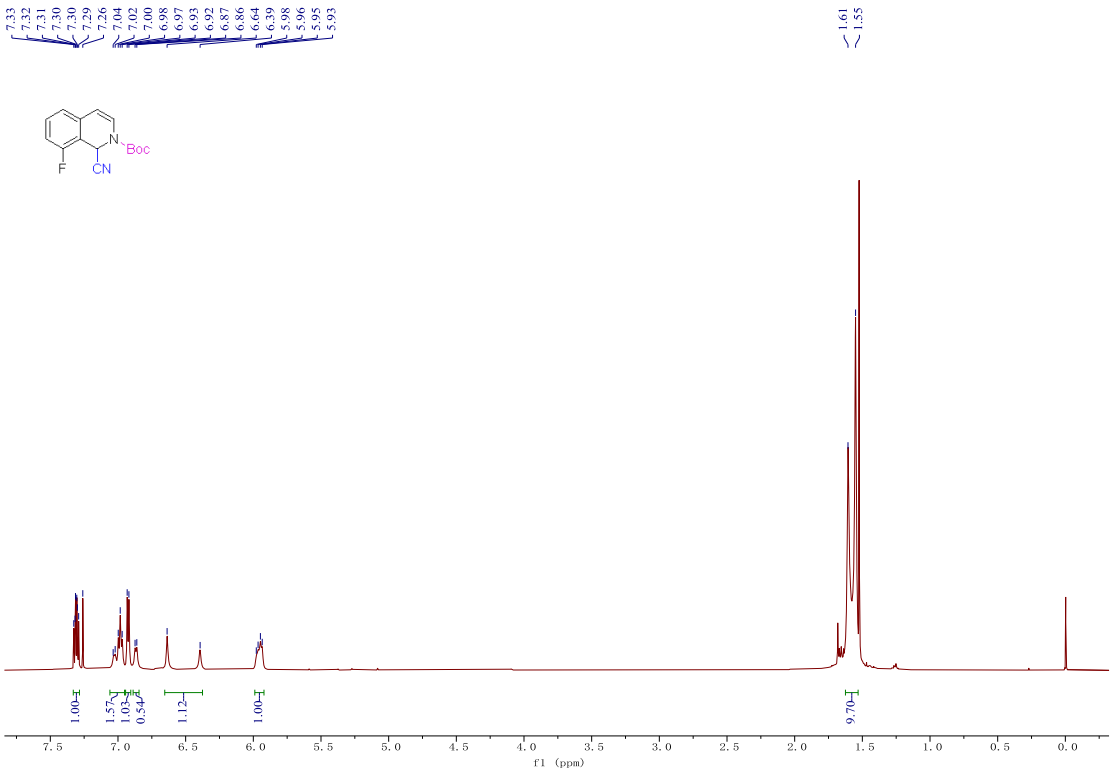
^{13}C NMR spectra of compound 30



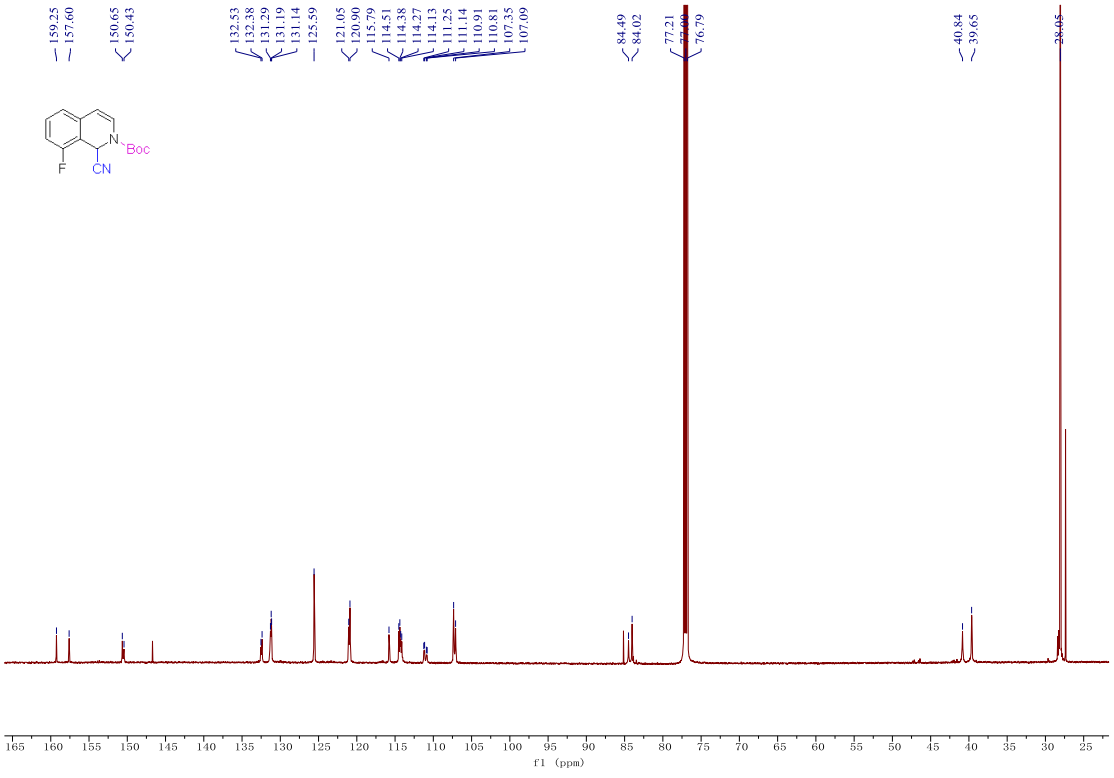
^{1}H NMR spectra of compound 31



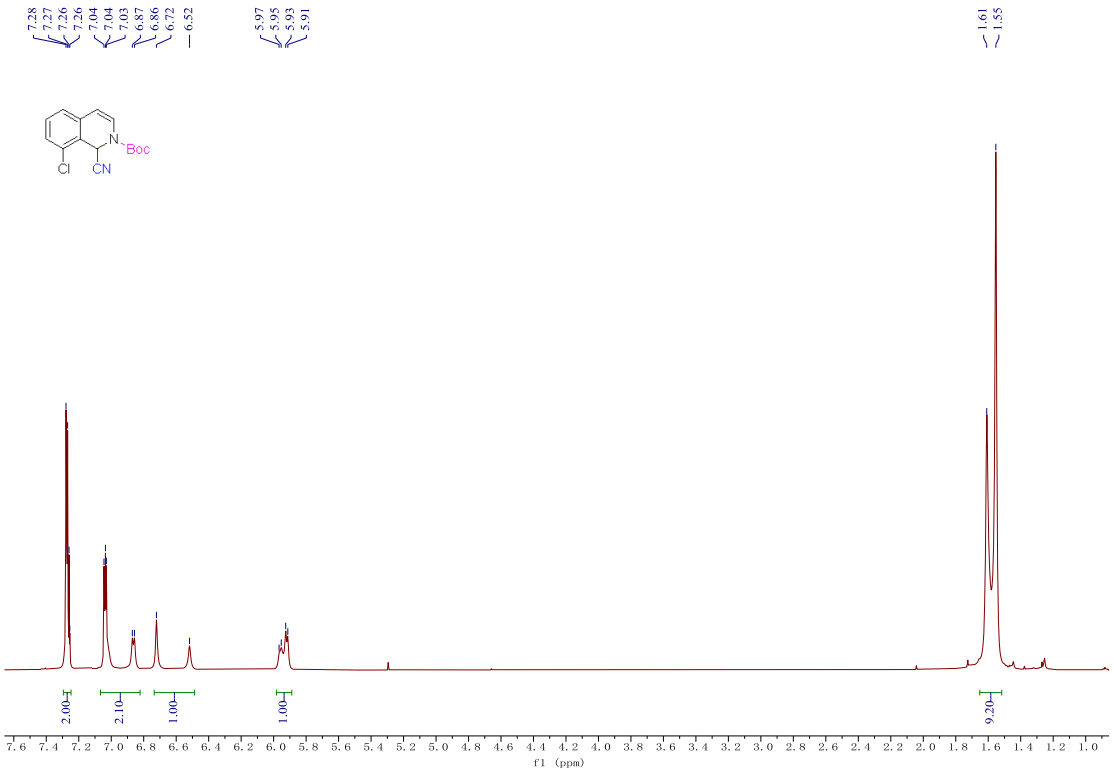
^{13}C NMR spectra of compound 31



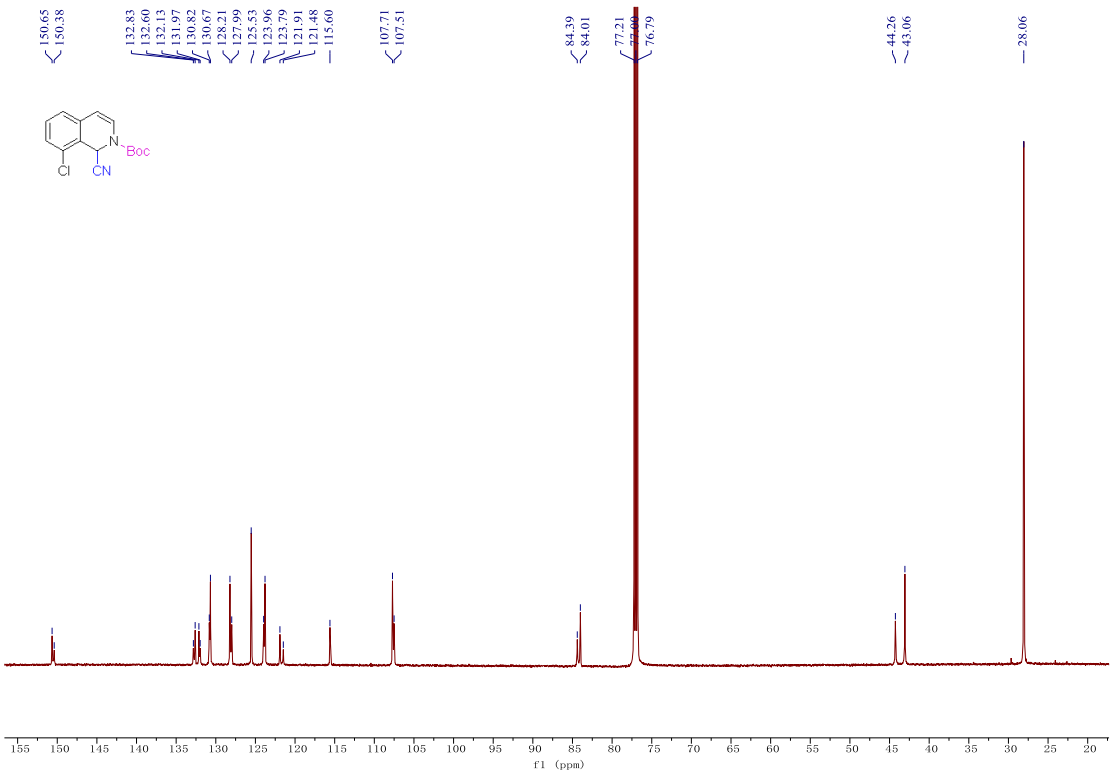
^{1}H NMR spectra of compound 32



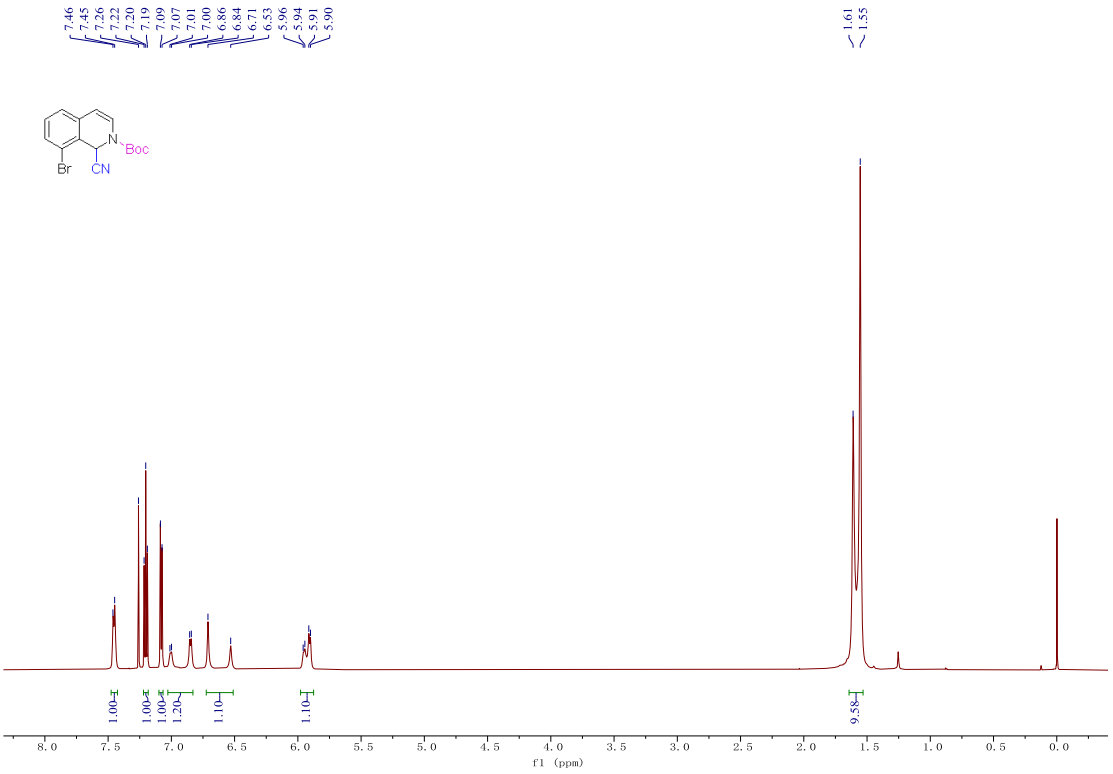
^{13}C NMR spectra of compound 32



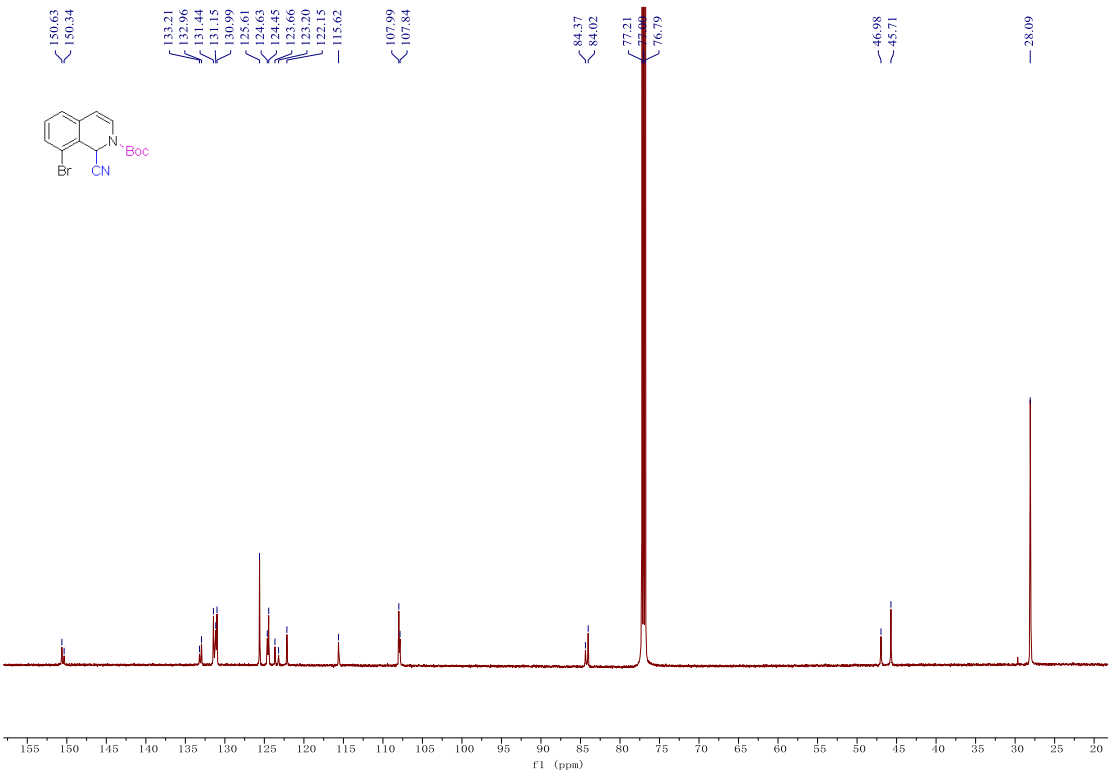
^{1}H NMR spectra of compound 33



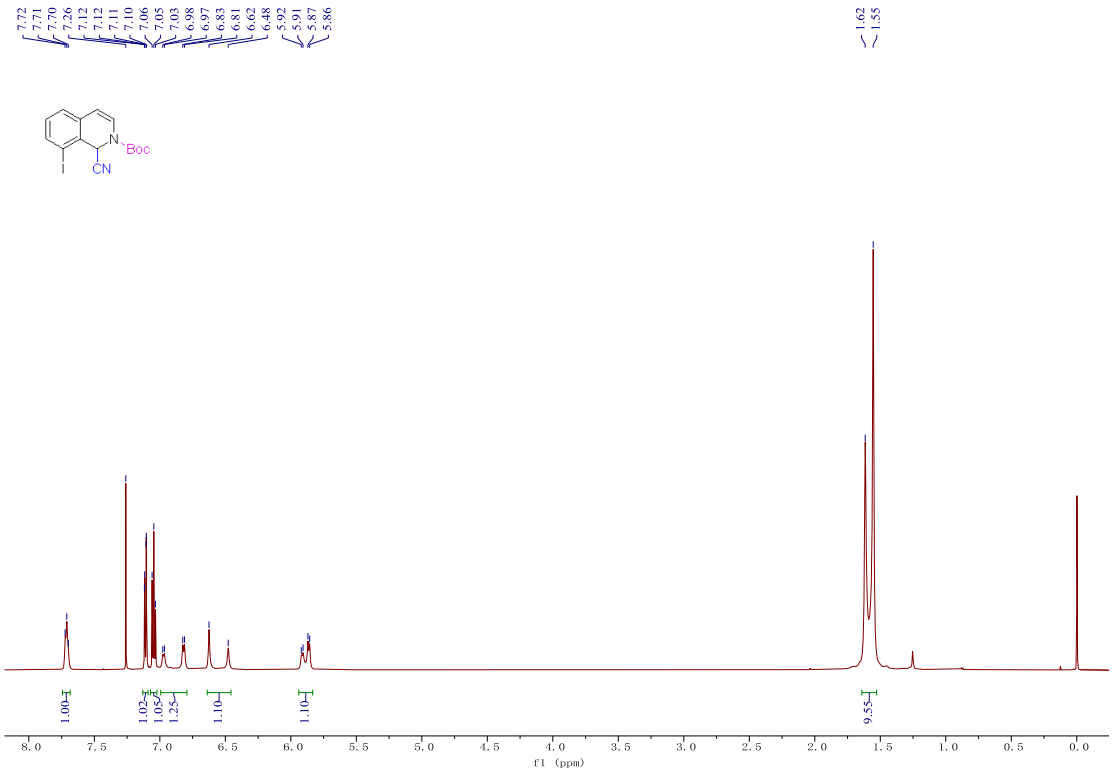
^{13}C NMR spectra of compound 33



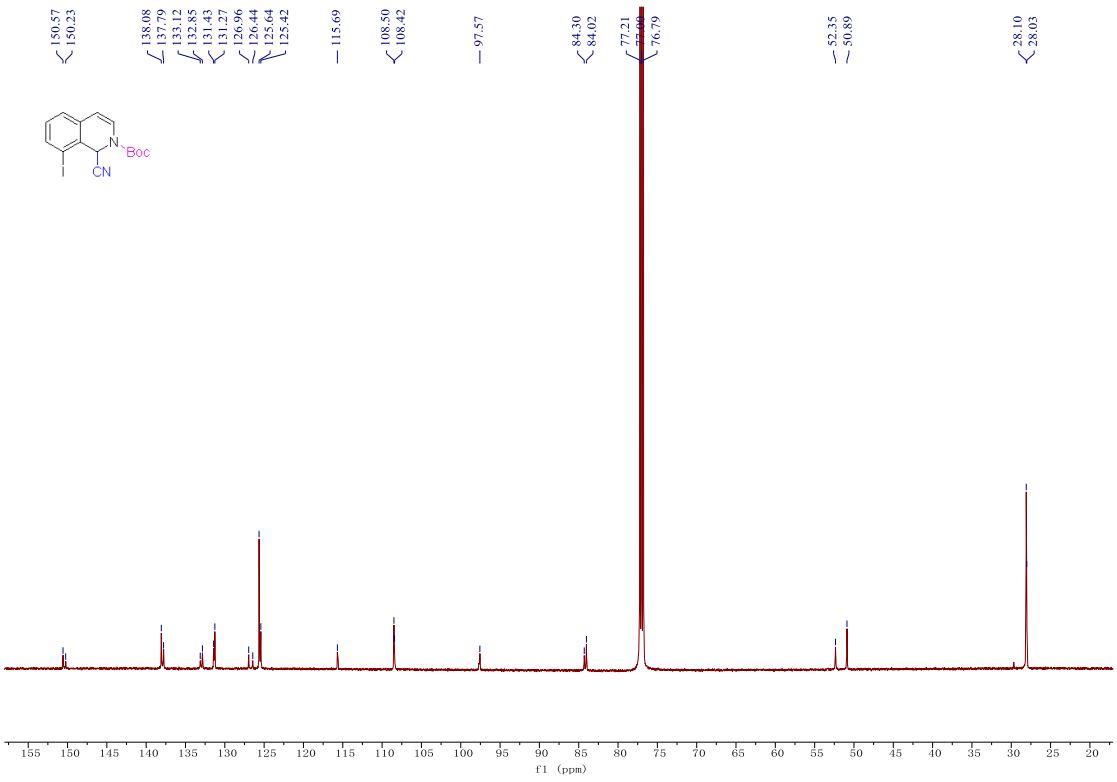
^{1}H NMR spectra of compound 34



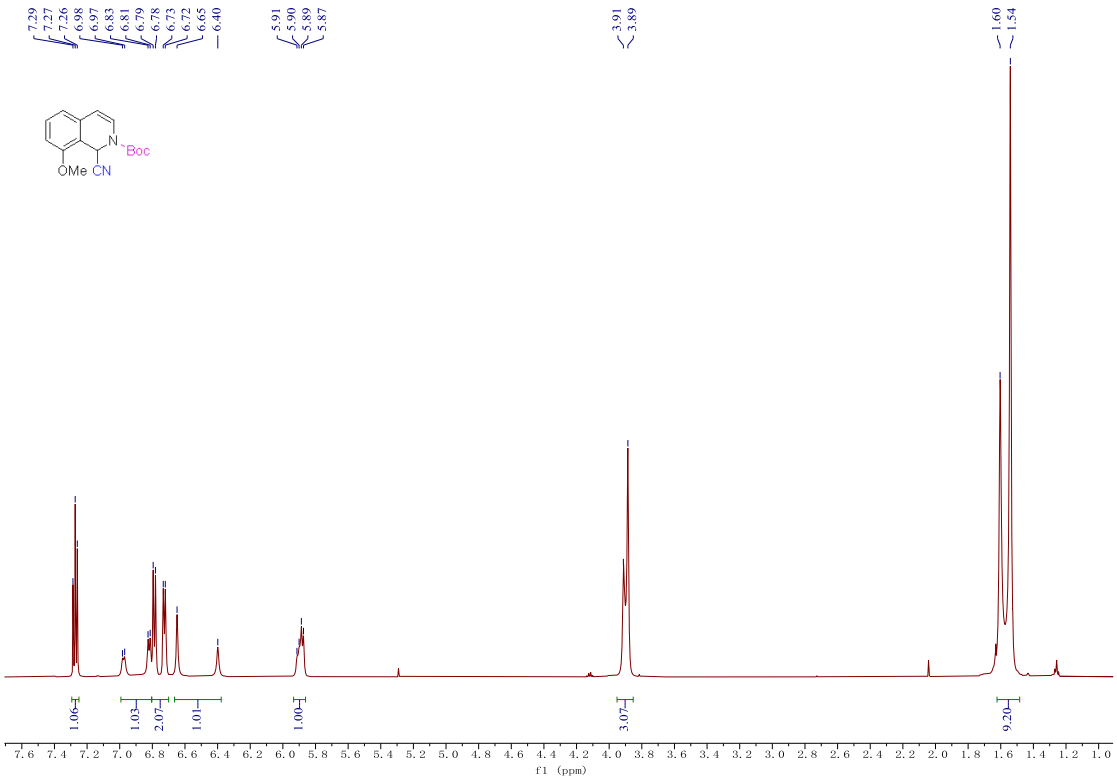
^{13}C NMR spectra of compound 34



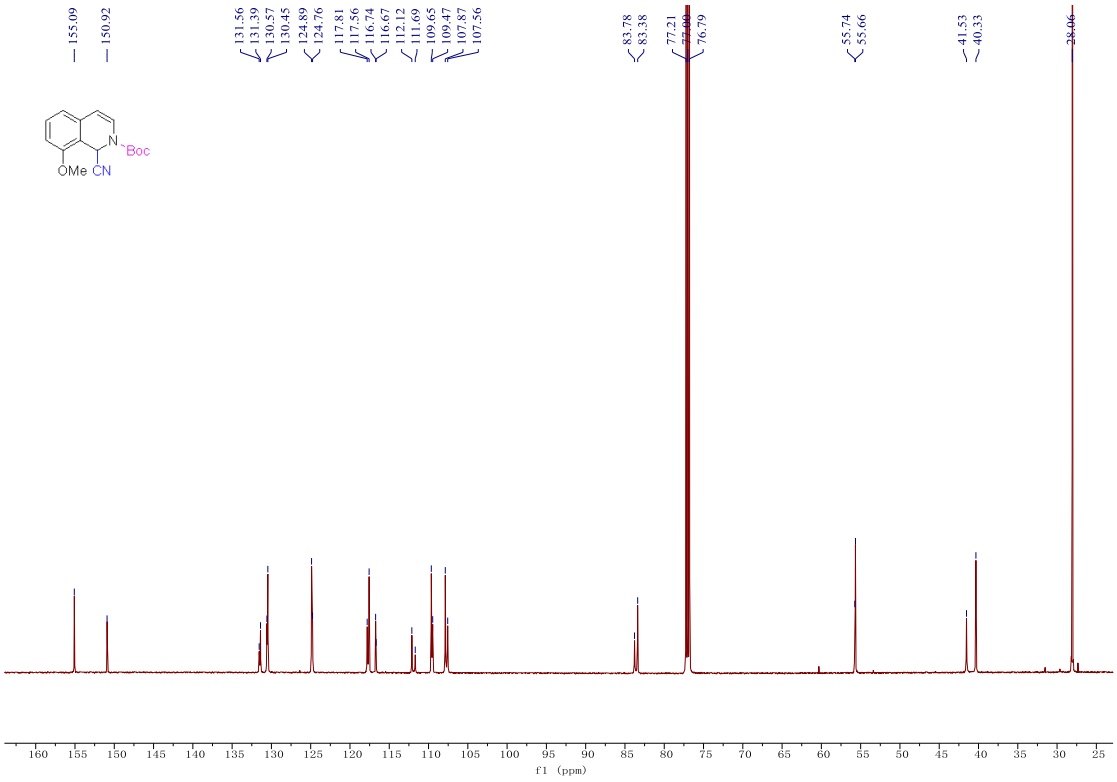
^{1}H NMR spectra of compound 35



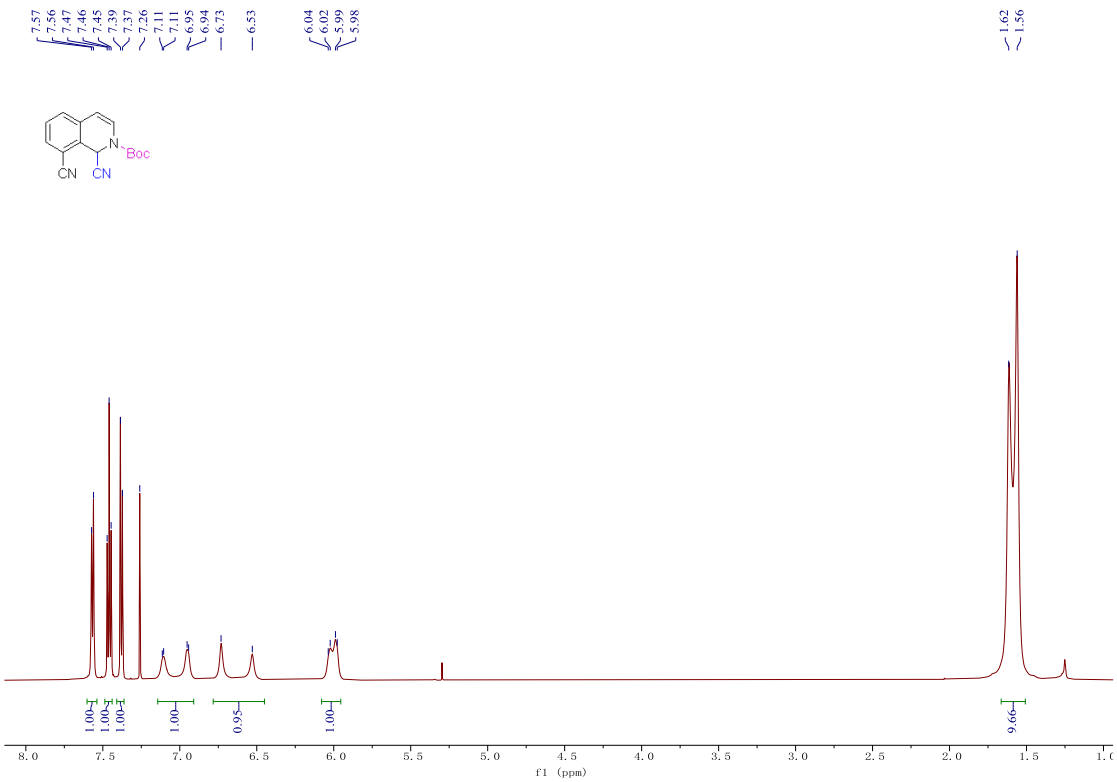
^{13}C NMR spectra of compound 35



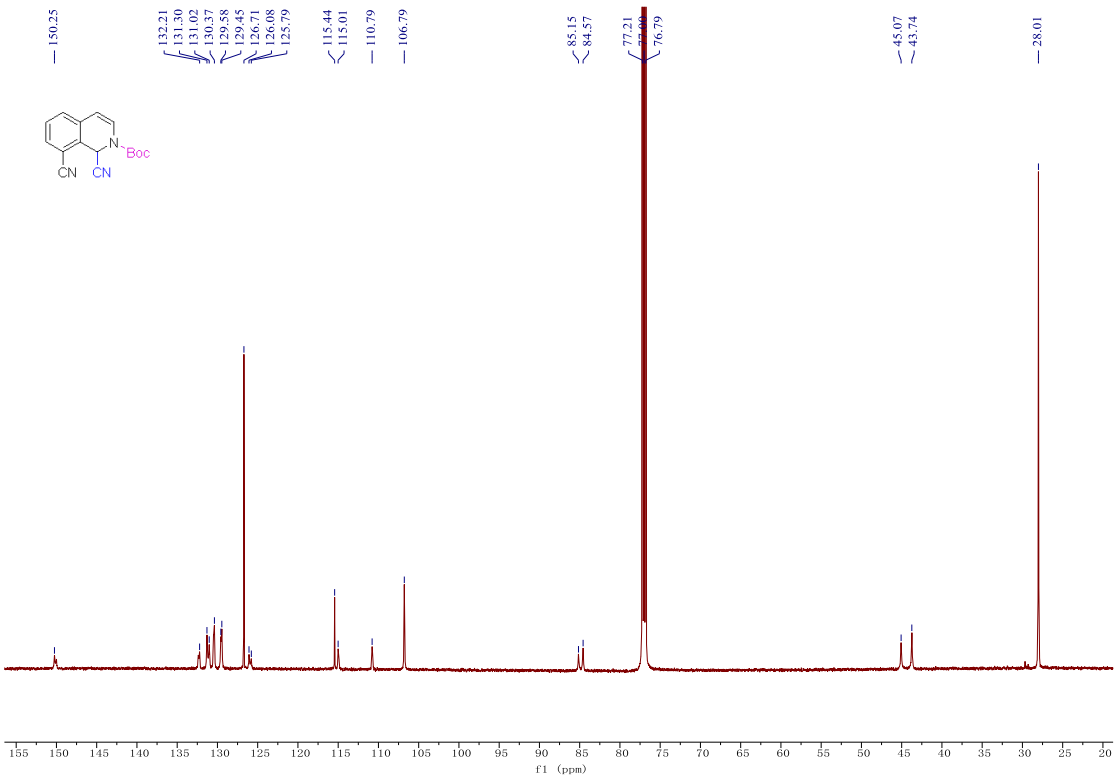
^{1}H NMR spectra of compound 36



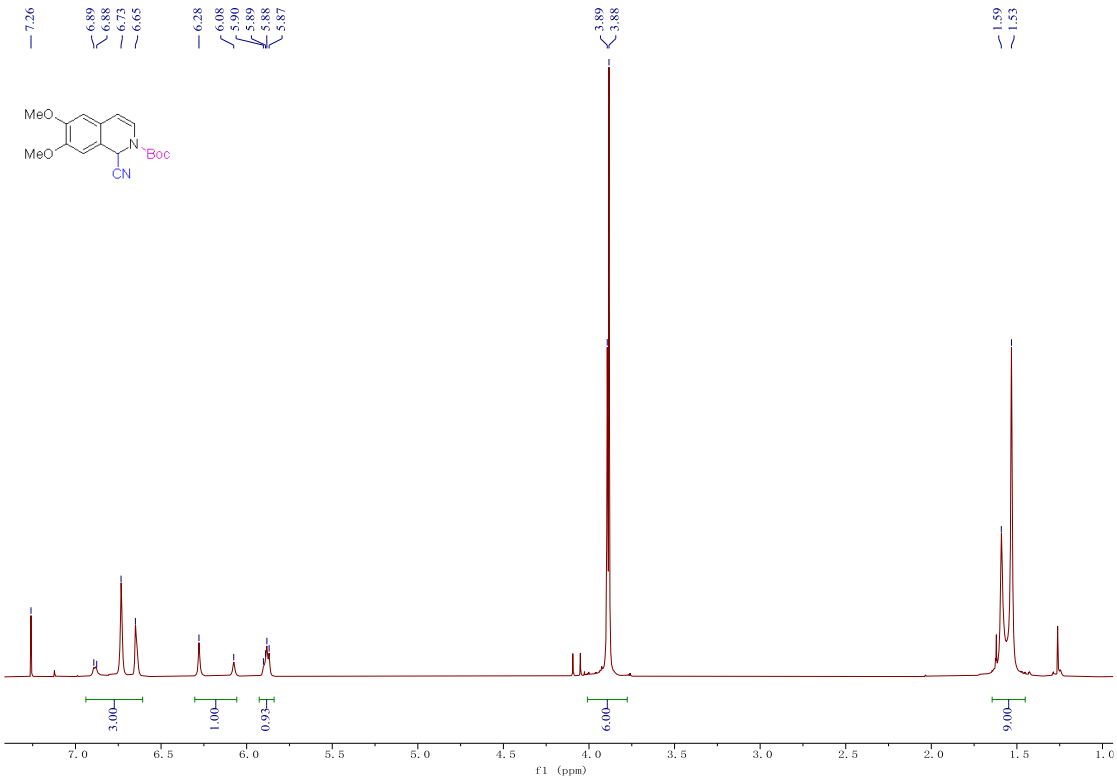
^{13}C NMR spectra of compound 36



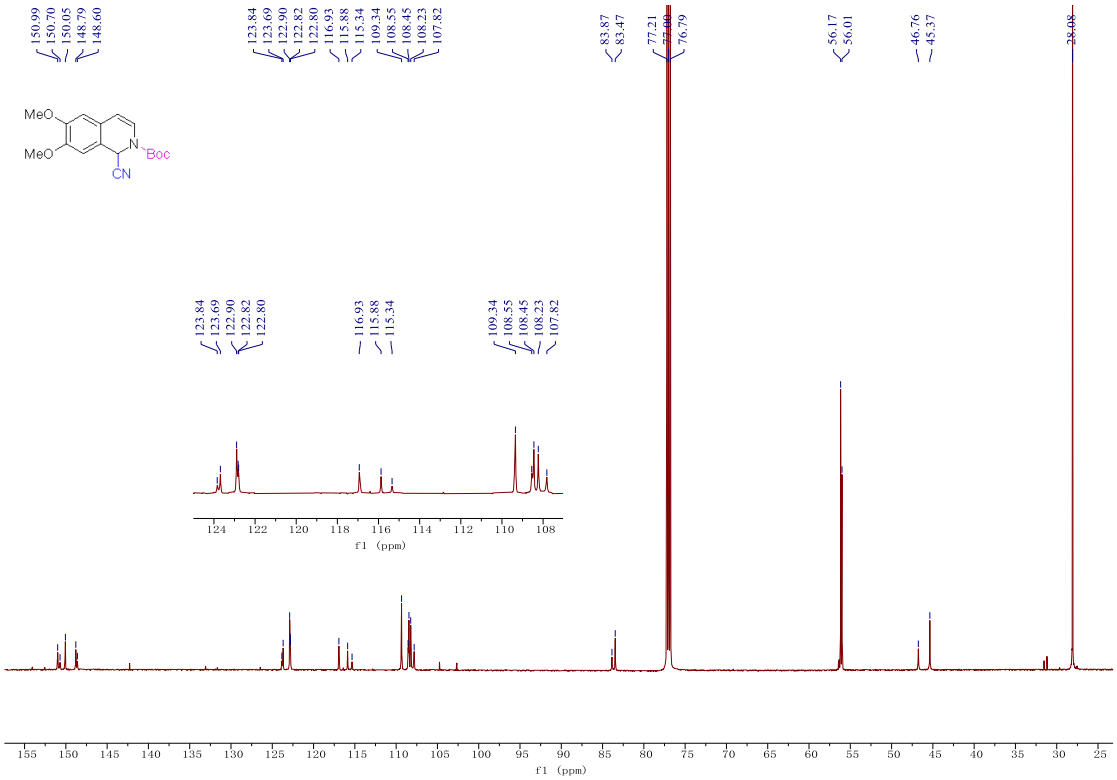
^{1}H NMR spectra of compound 37



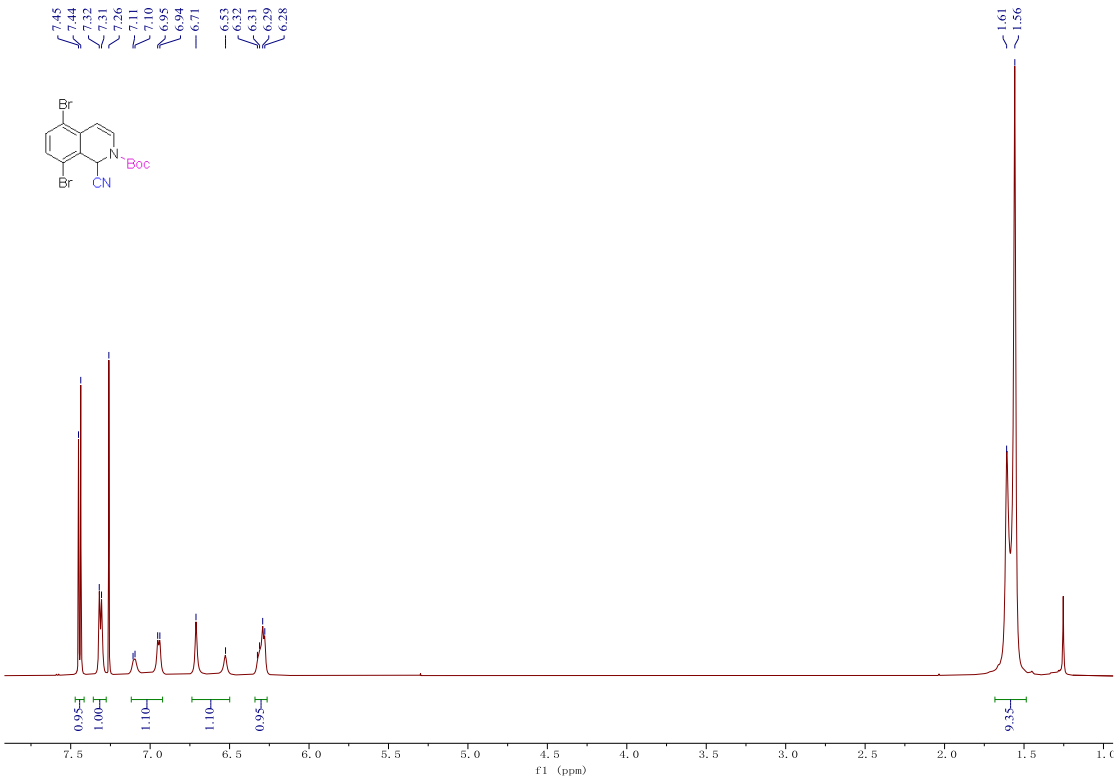
^{13}C NMR spectra of compound 37



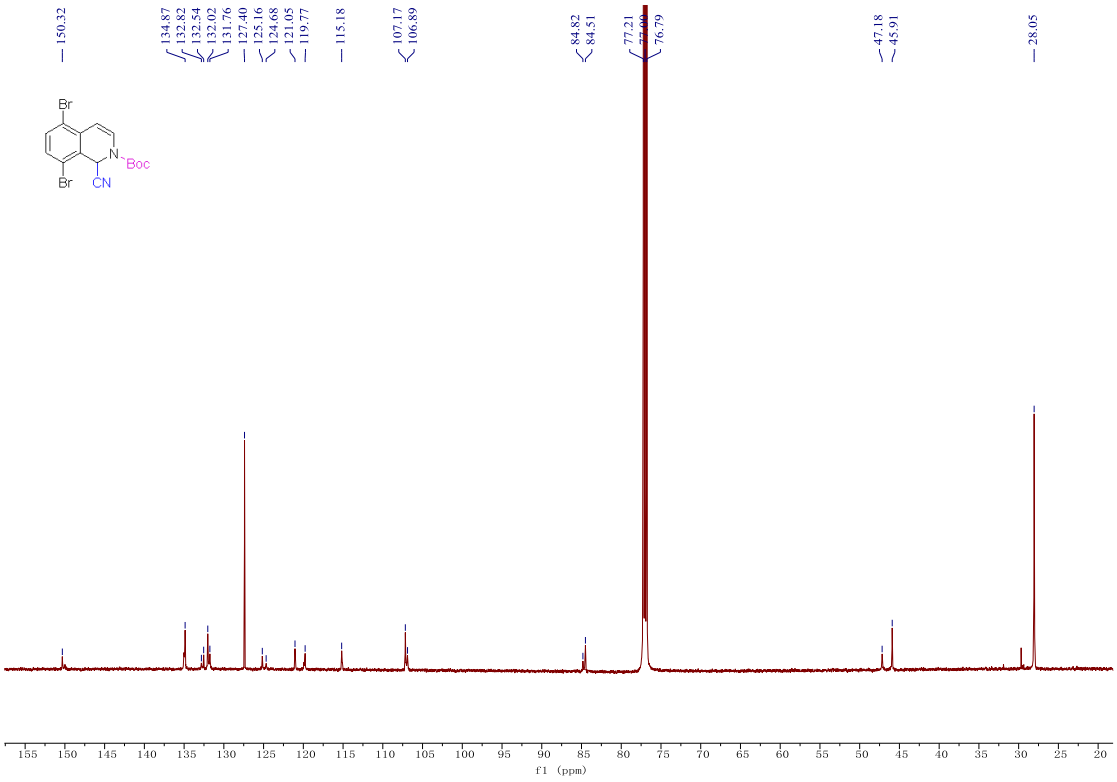
^{1}H NMR spectra of compound 38



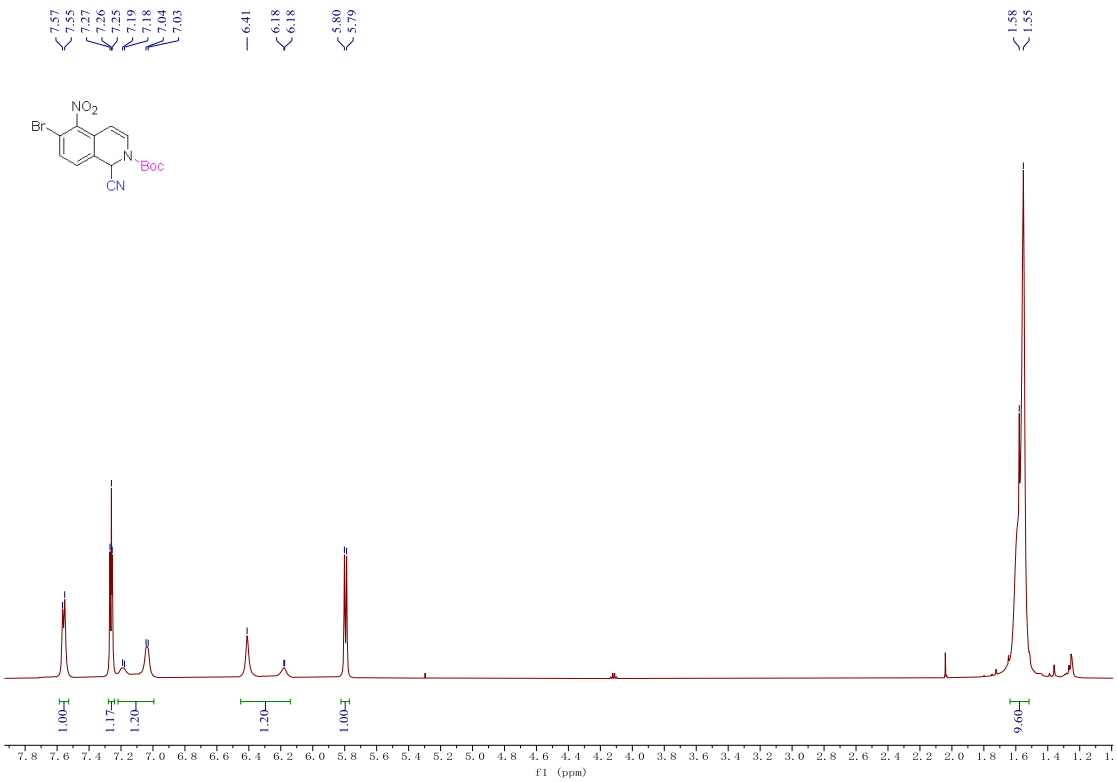
^{13}C NMR spectra of compound 38



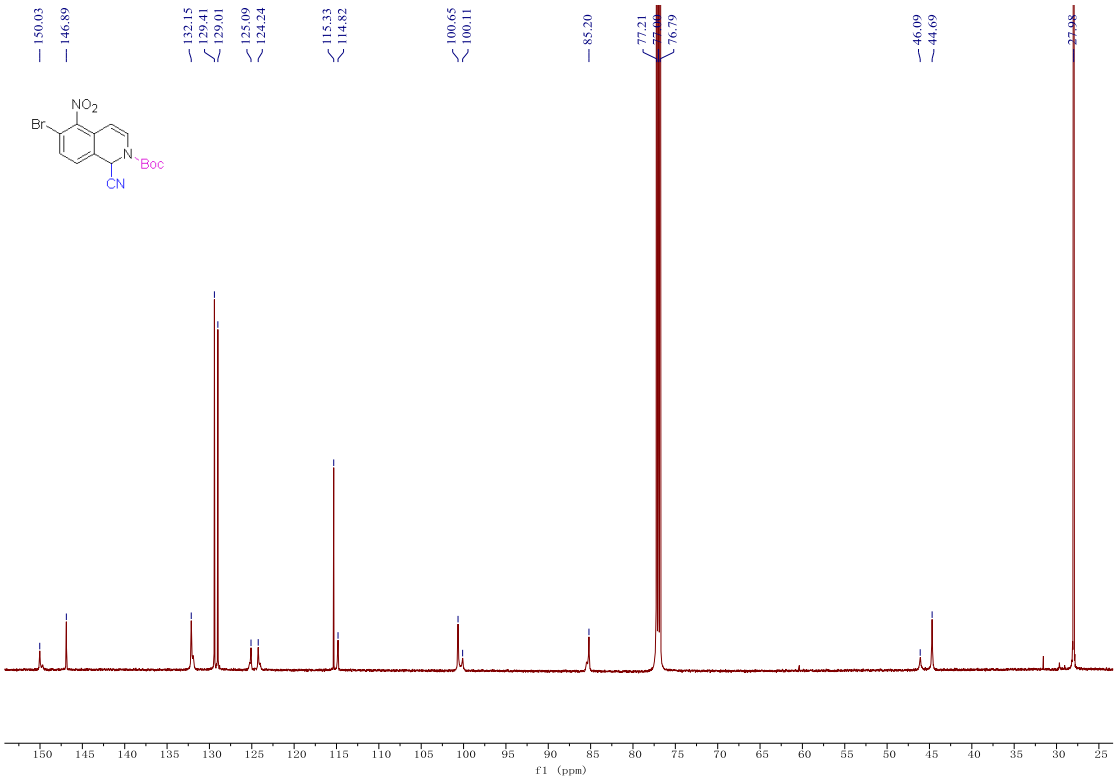
^{1}H NMR spectra of compound 39



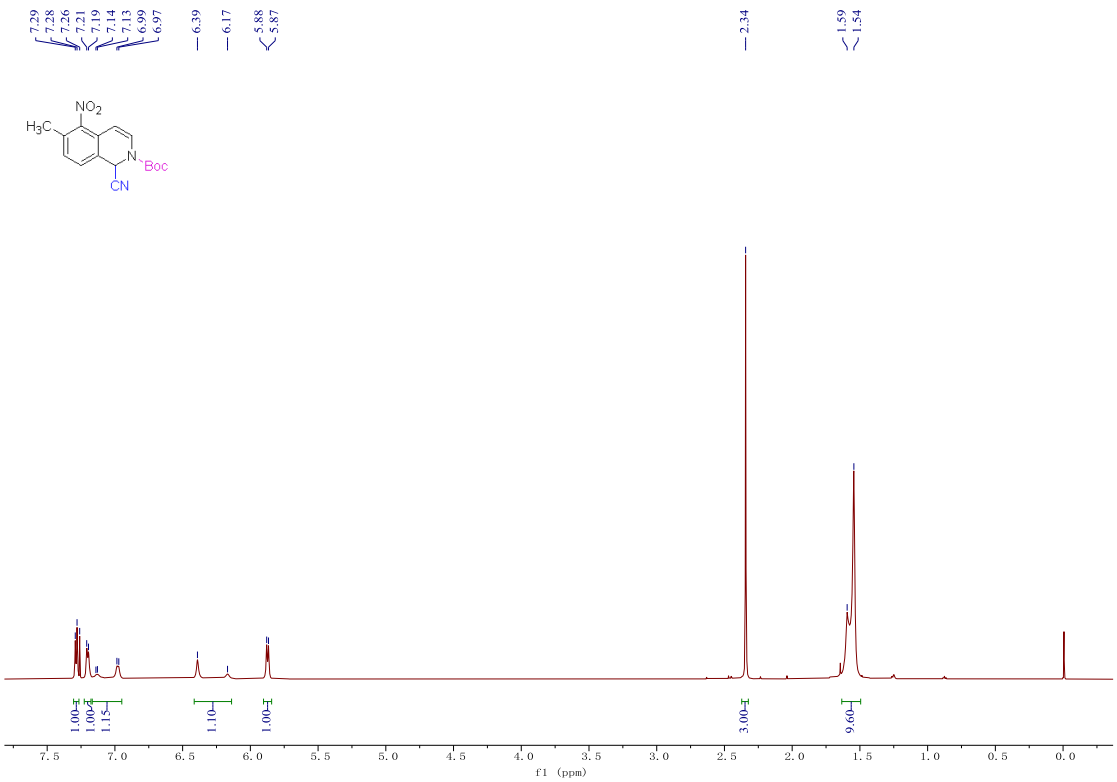
^{13}C NMR spectra of compound 39



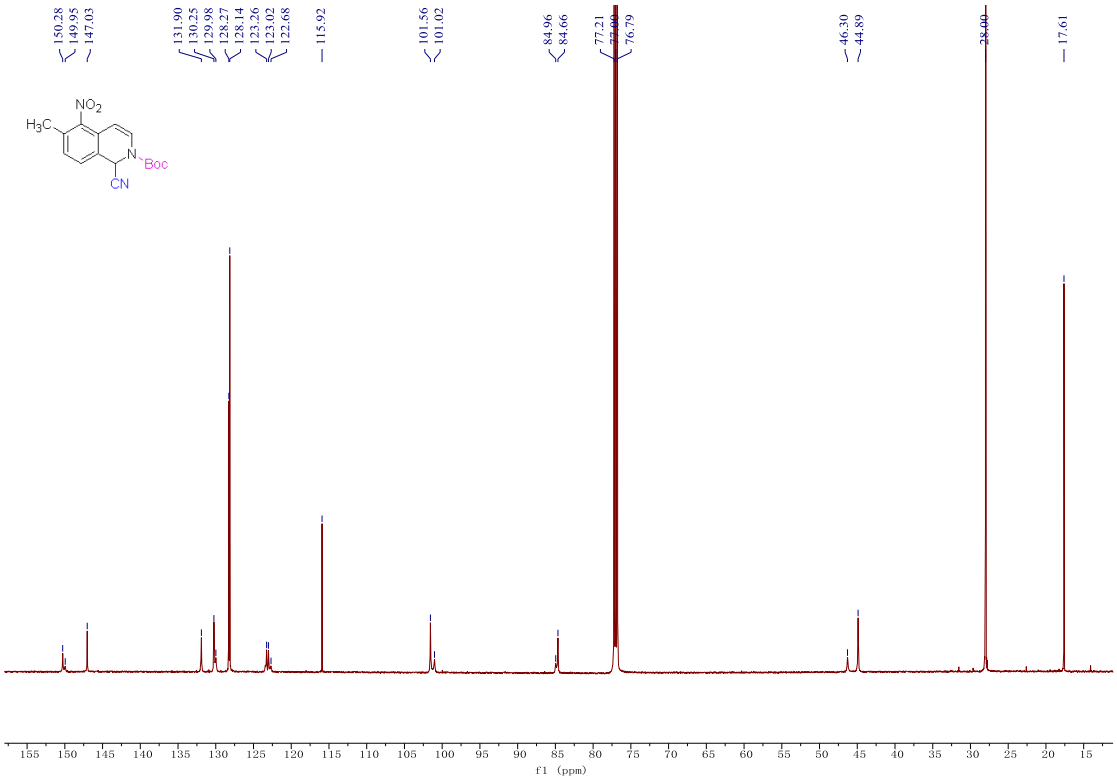
^{1}H NMR spectra of compound 40



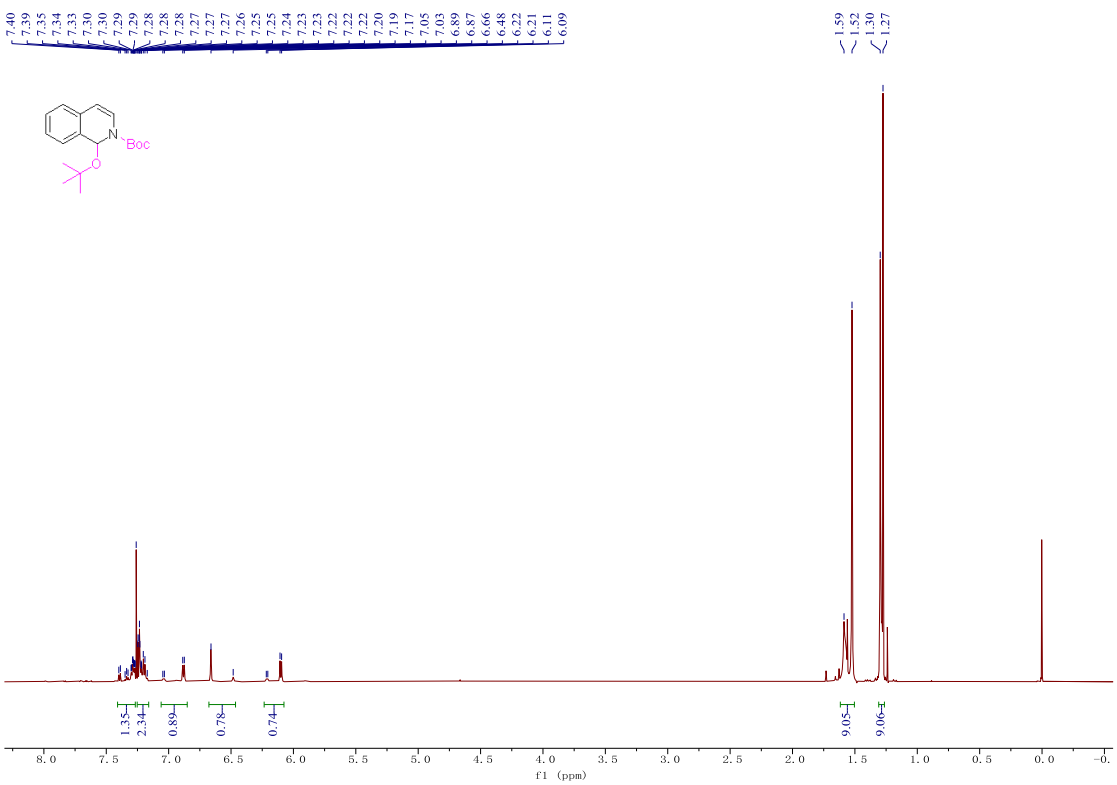
^{13}C NMR spectra of compound 40



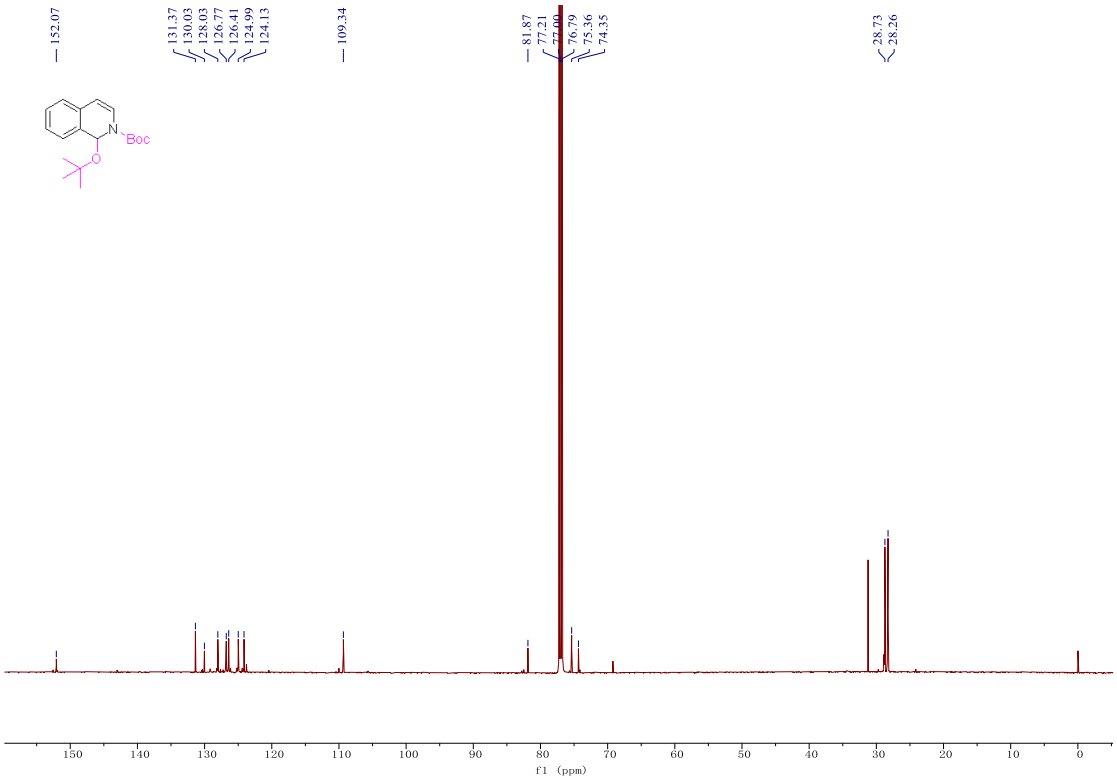
^{1}H NMR spectra of compound 41



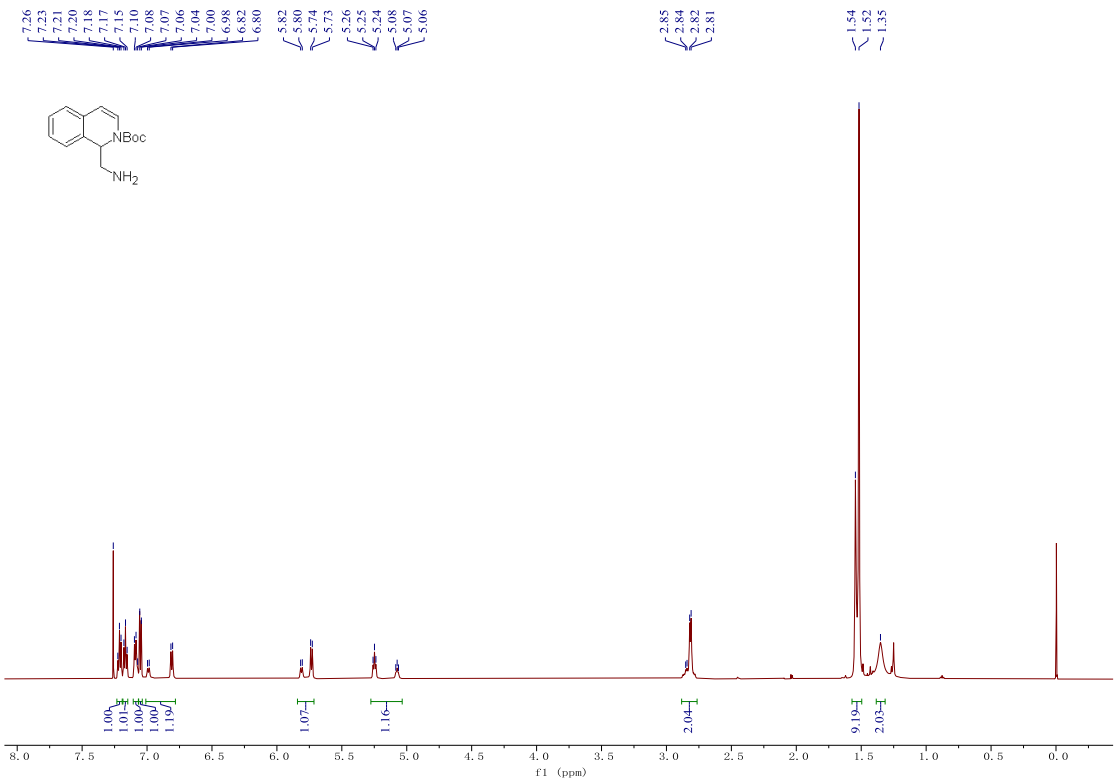
^{13}C NMR spectra of compound 41



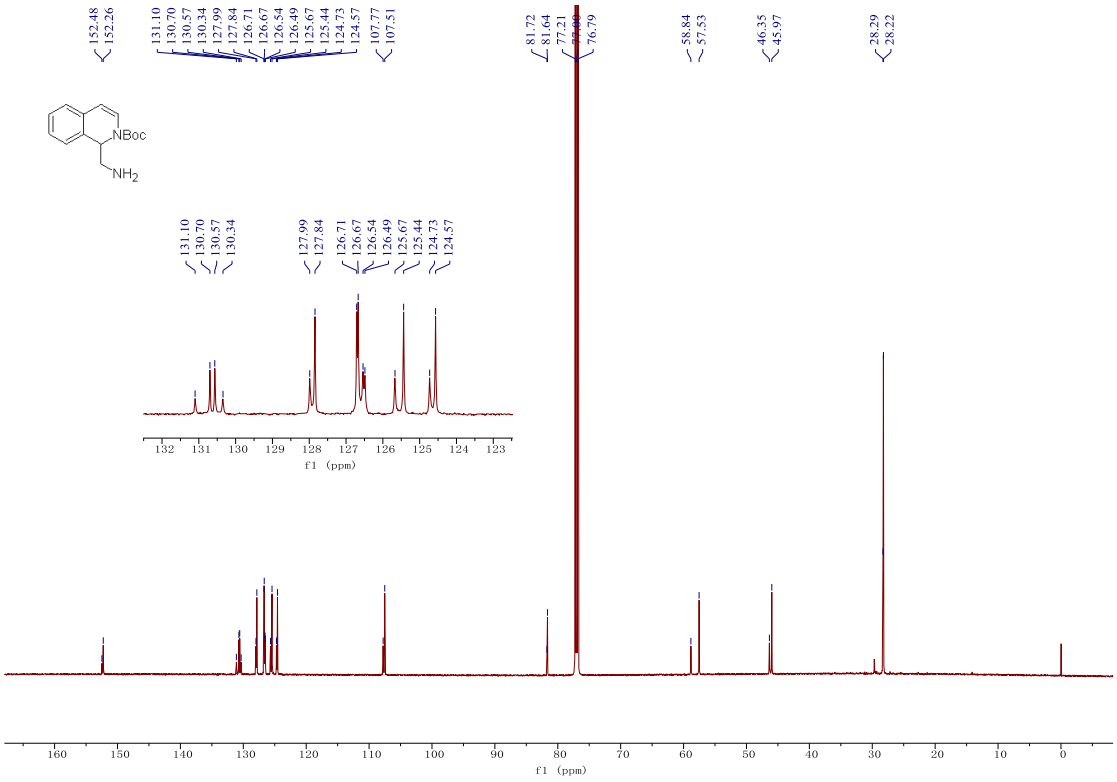
^{1}H NMR spectra of compound 42



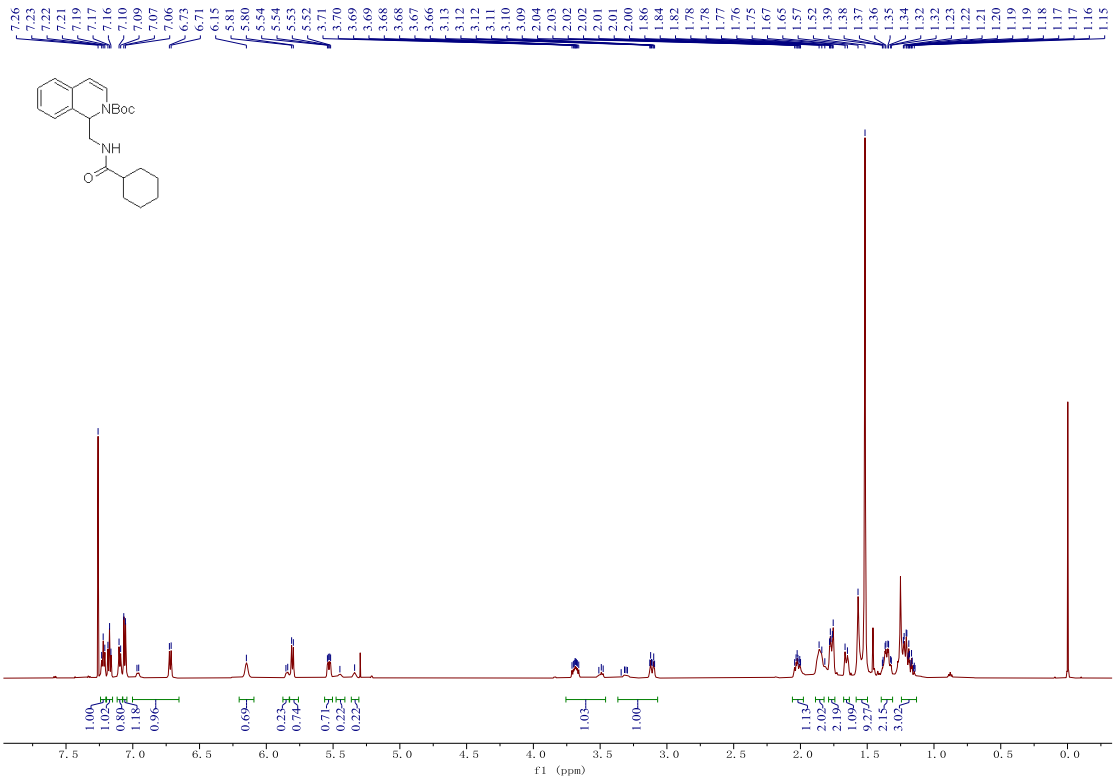
^{13}C NMR spectra of compound 42



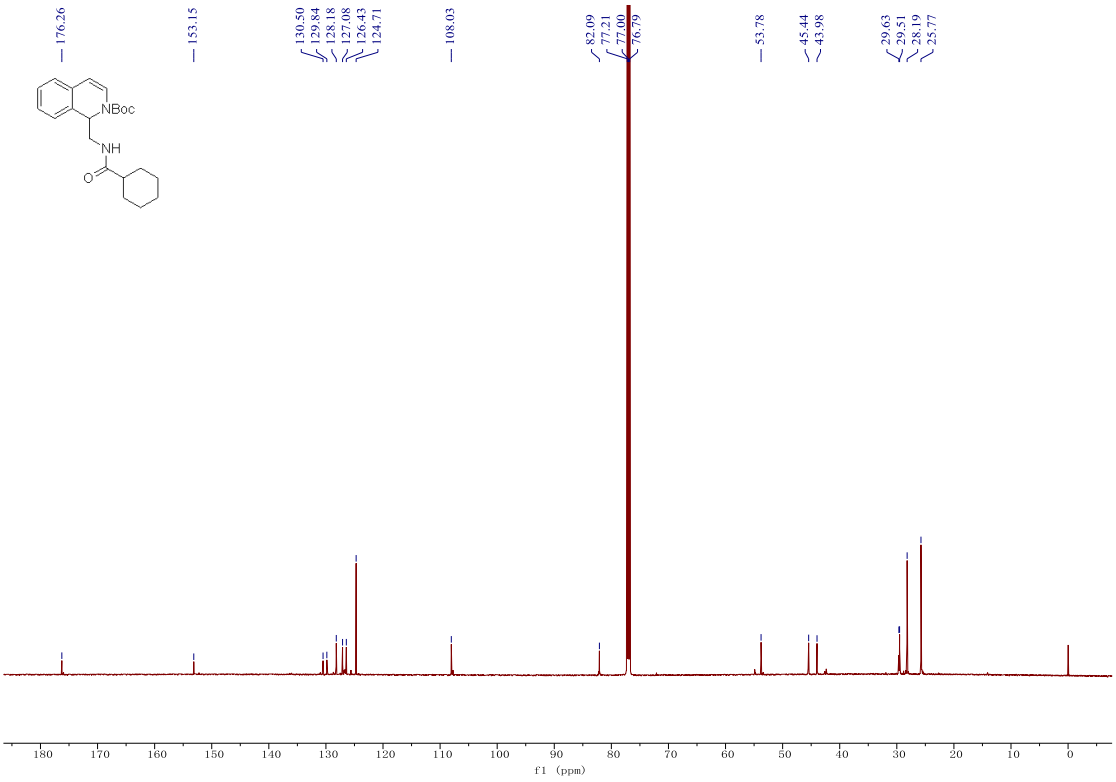
^{1}H NMR spectra of compound 44



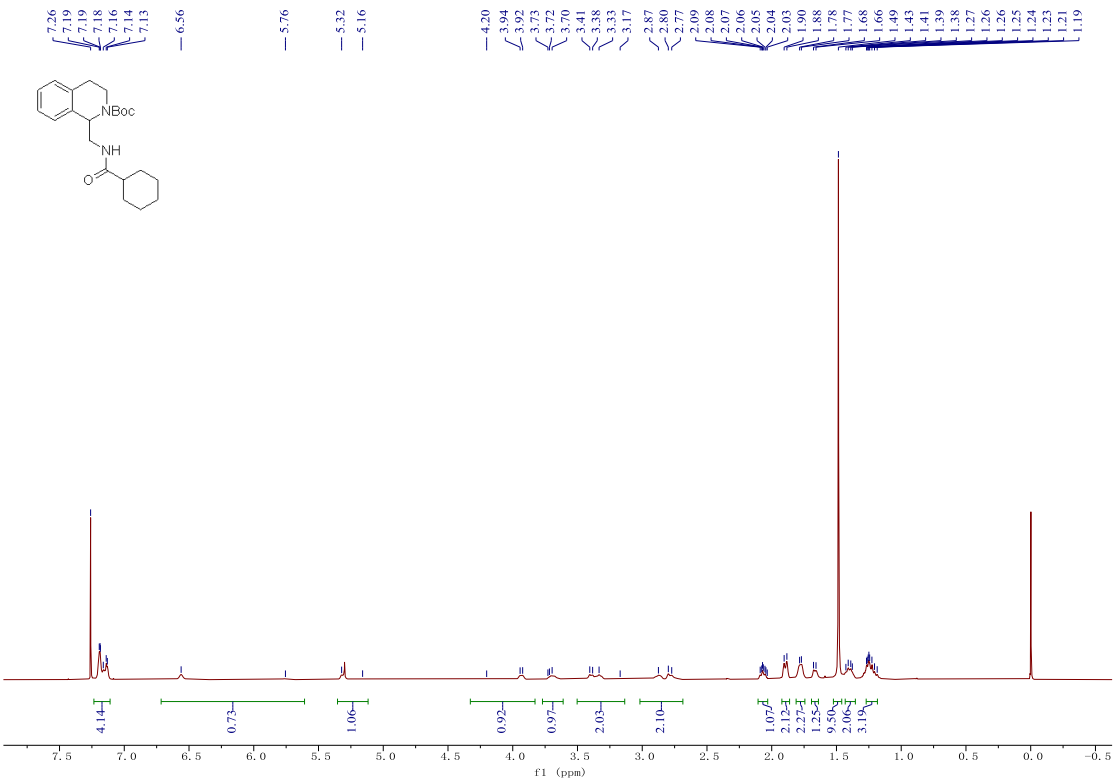
^{13}C NMR spectra of compound 44



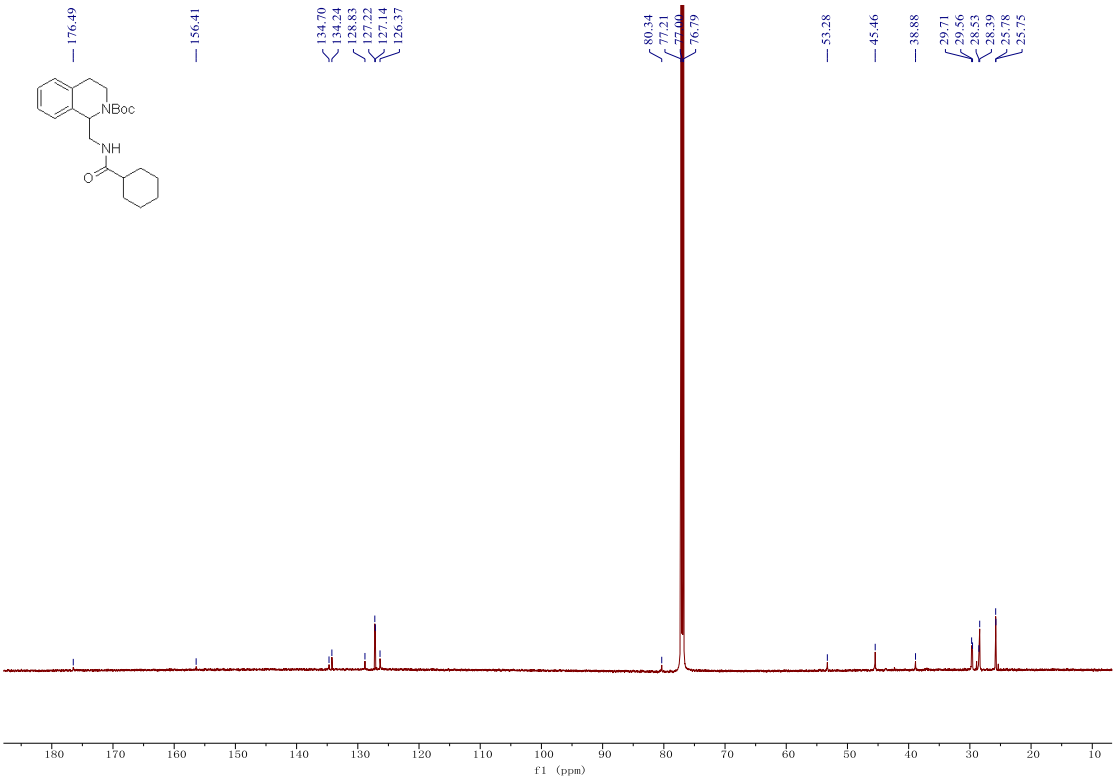
^{1}H NMR spectra of compound 45



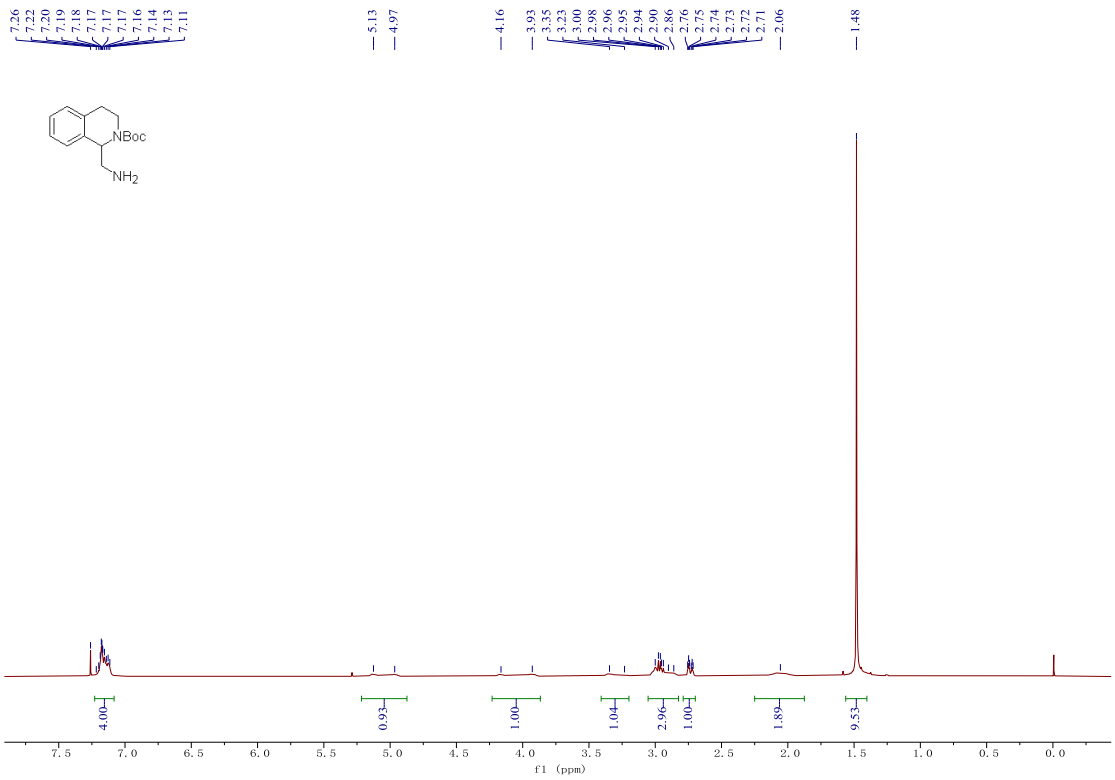
^{13}C NMR spectra of compound 45



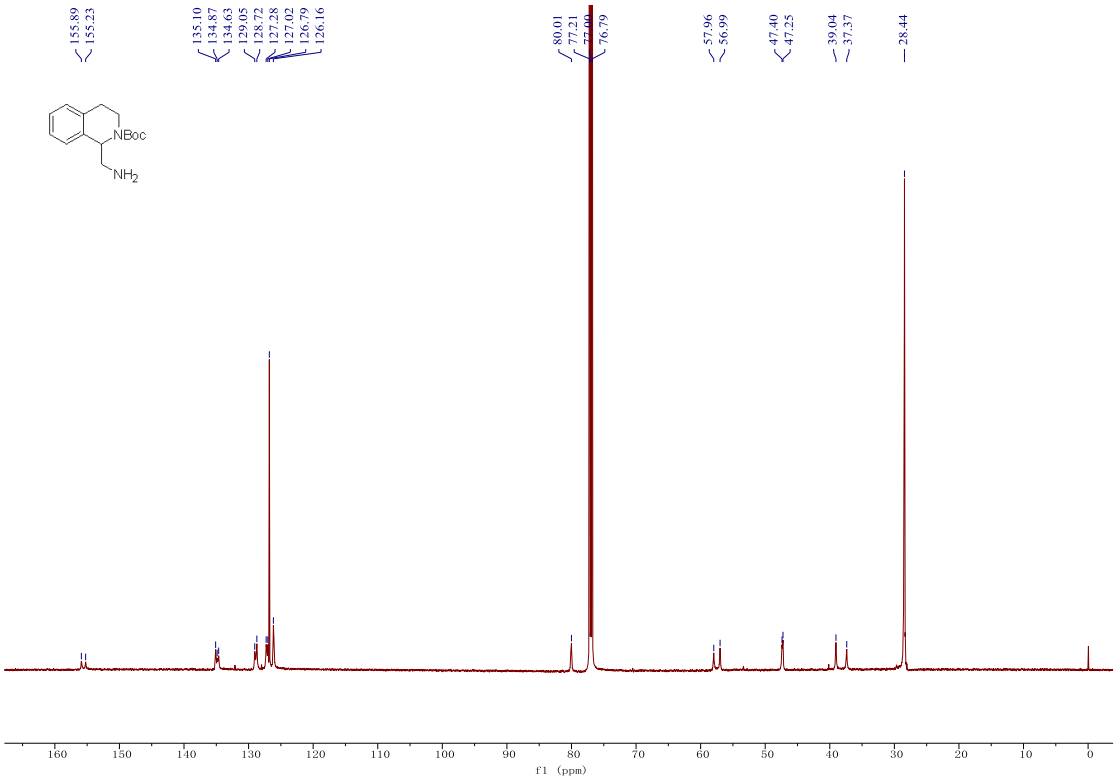
^{1}H NMR spectra of compound 46



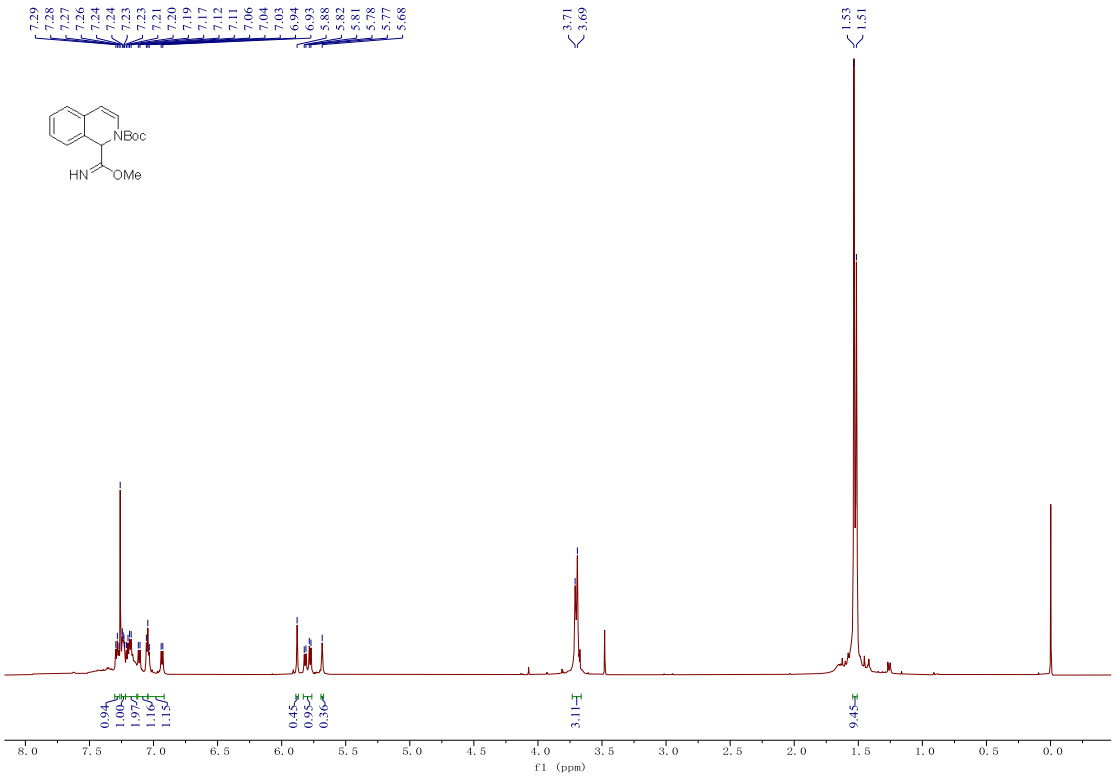
^{13}C NMR spectra of compound 46



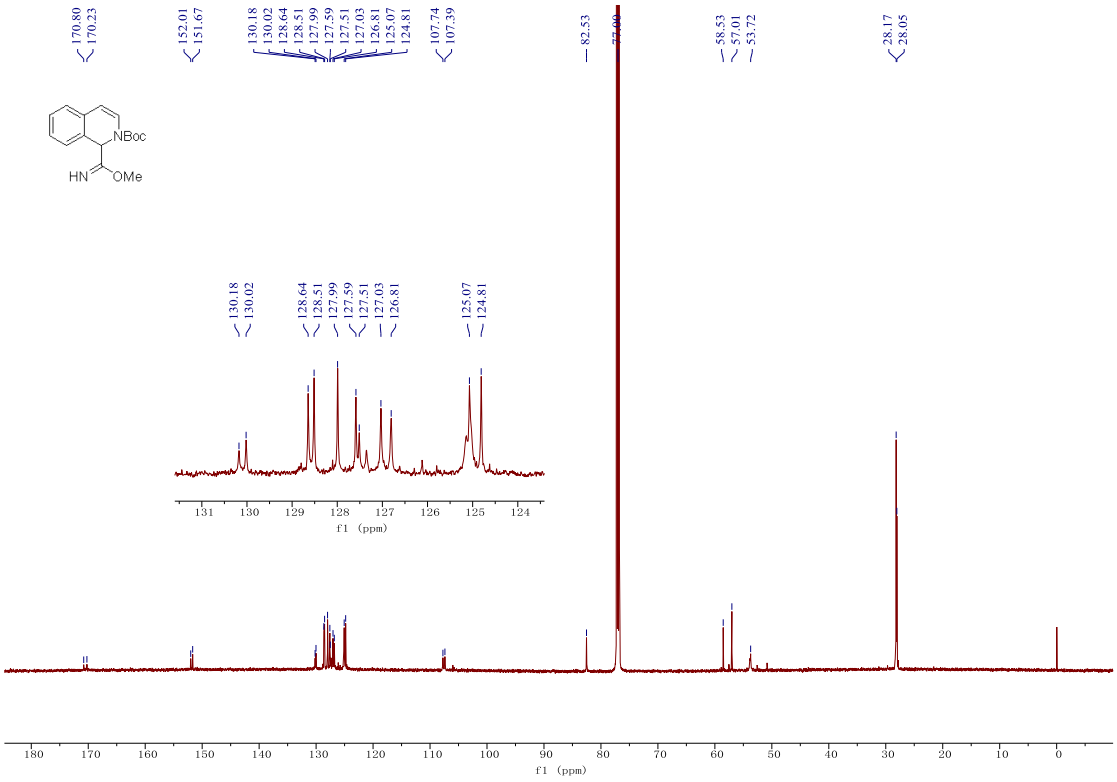
^{1}H NMR spectra of compound 47



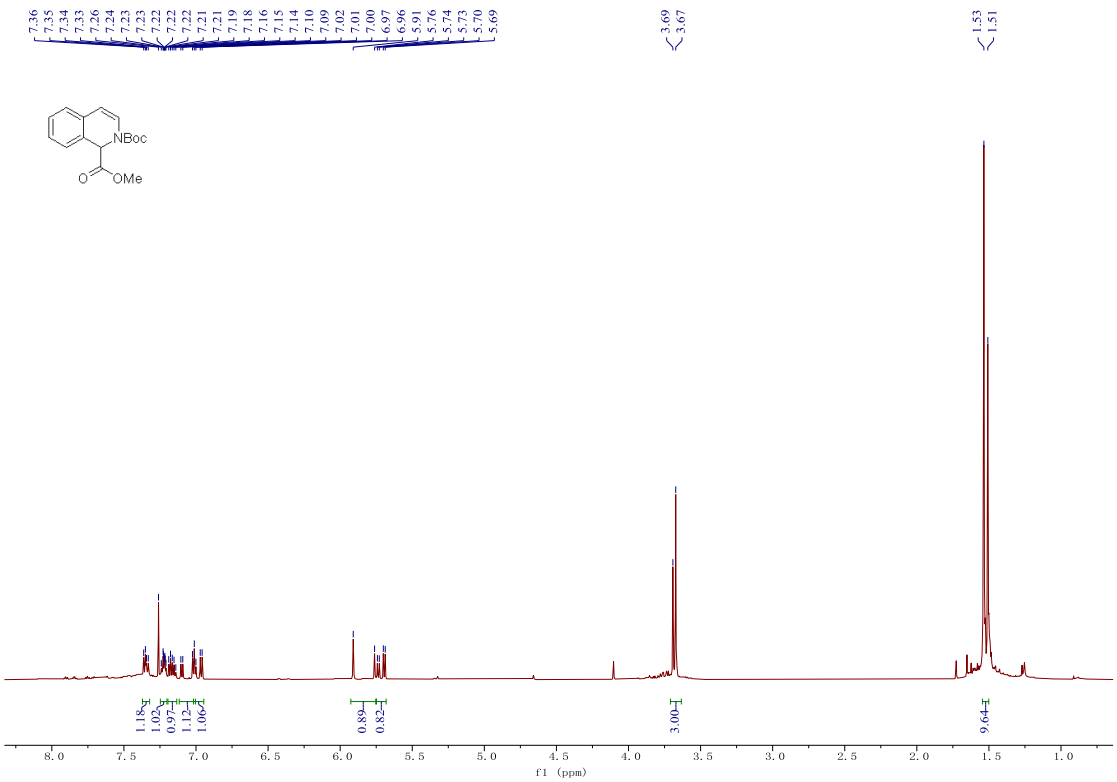
^{13}C NMR spectra of compound 47



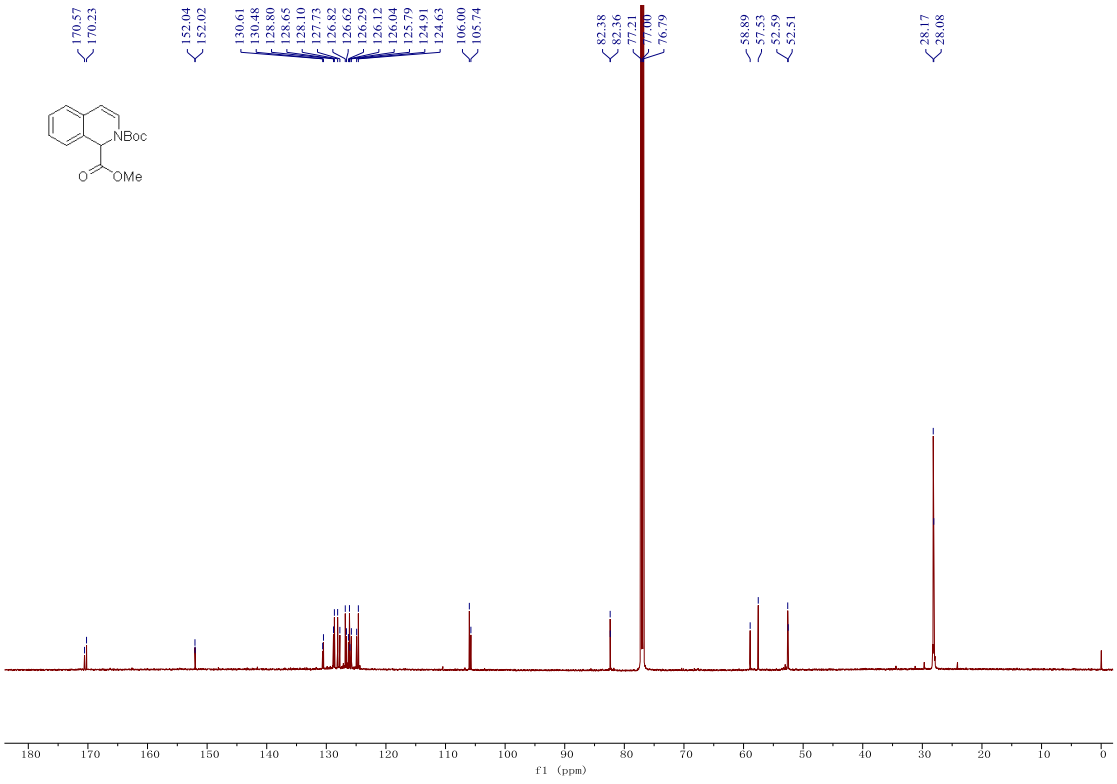
^{1}H NMR spectra of compound 48



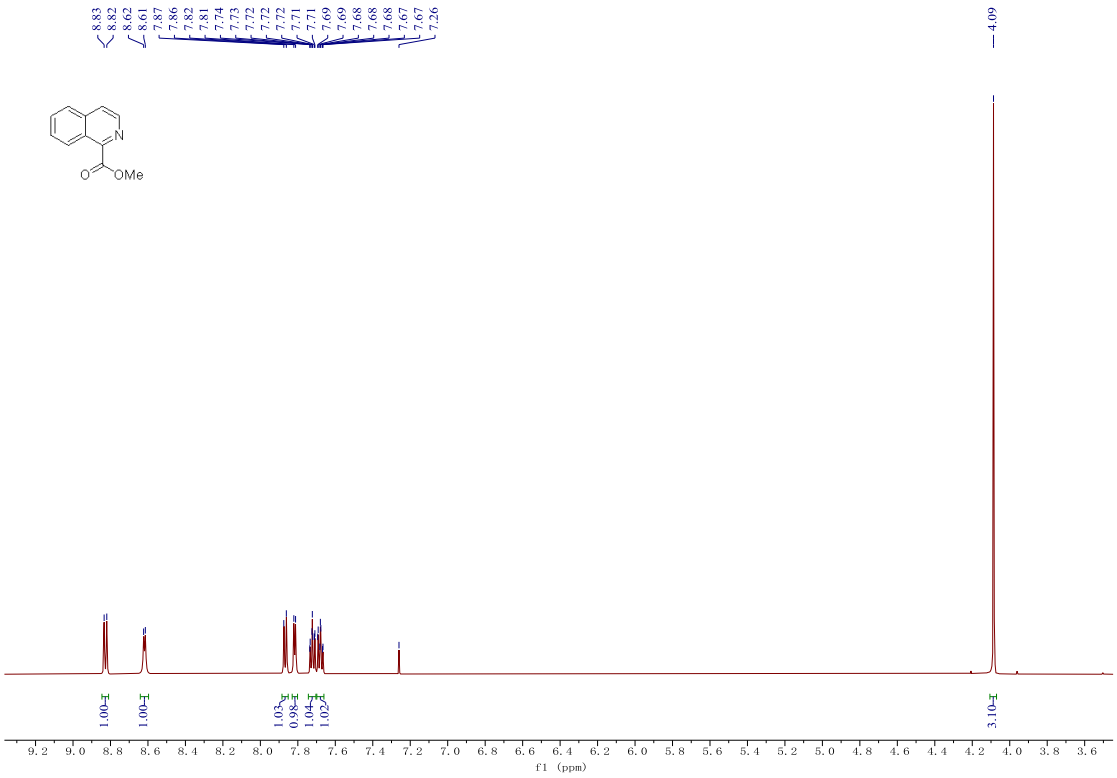
^{13}C NMR spectra of compound 48



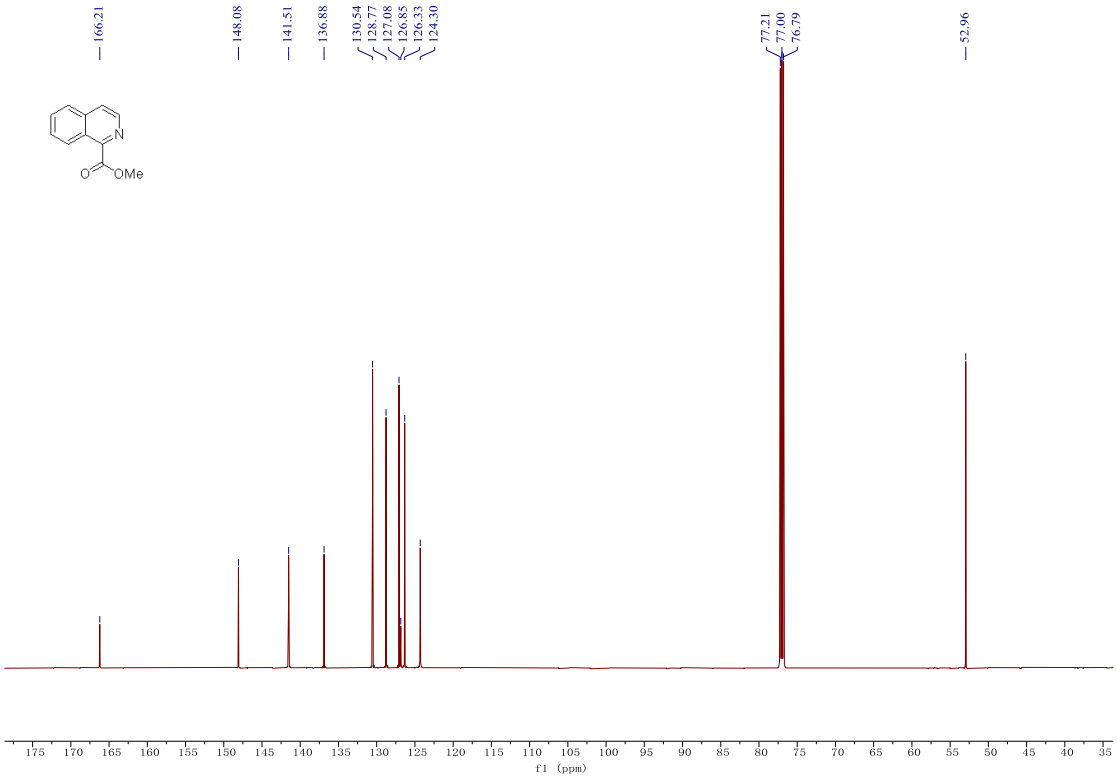
^{1}H NMR spectra of compound 49



^{13}C NMR spectra of compound 49

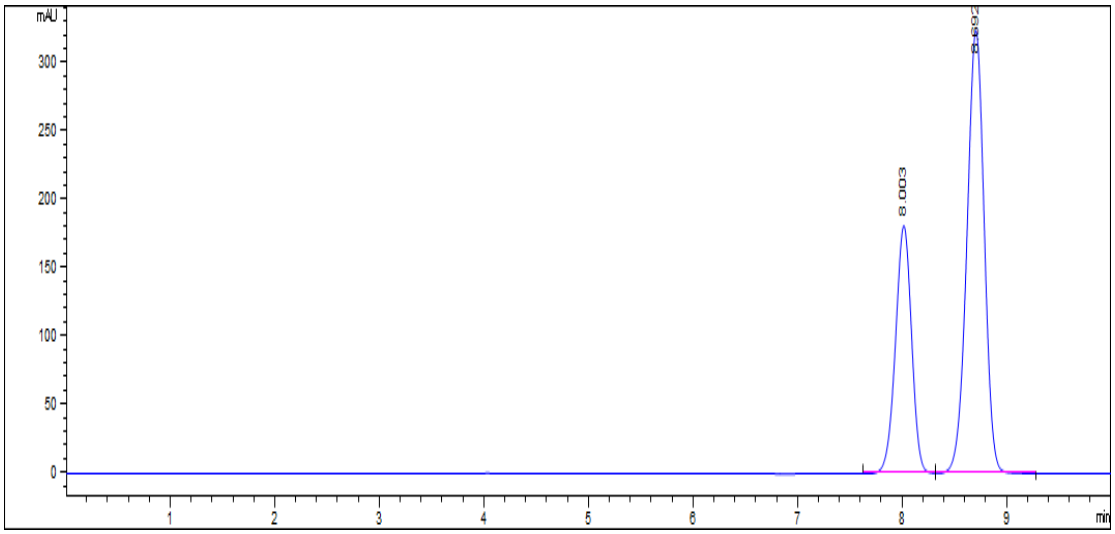


^{1}H NMR spectra of compound 50



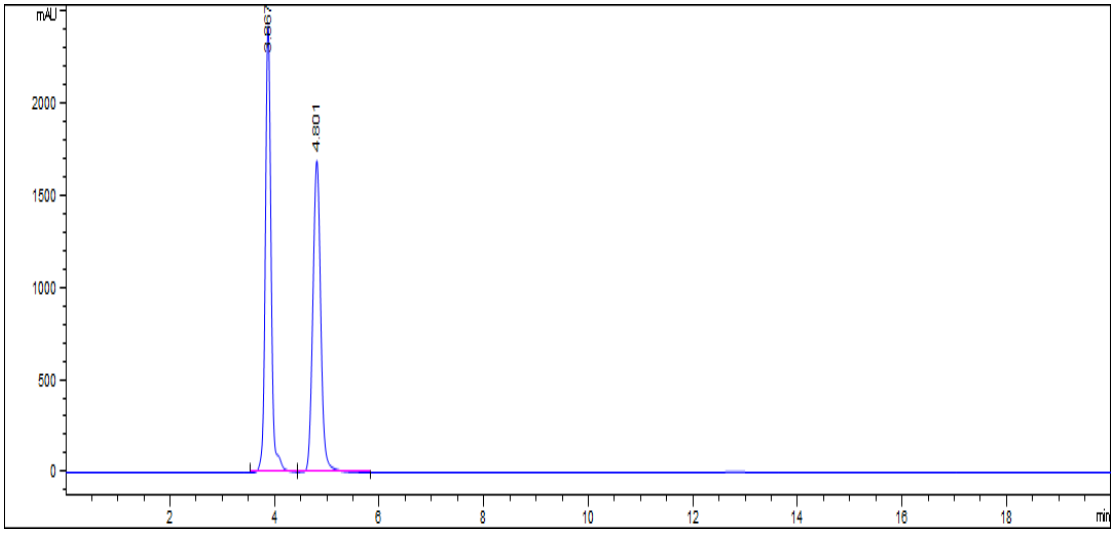
^{13}C NMR spectra of compound 50

7. HPLC of chiral acyl chloride as acylating agent for cyanation reaction



#	Time (min)	Area (mAU*s)	Height(mAU)	Area %
1	8.003	1944	182.1	34.156
2	8.692	3747.6	325.6	65.844

Fig. 1 HPLC for compound 4g



#	Time (min)	Area (mAU*s)	Height(mAU)	Area %
1	3.867	18484.6	2415.7	51.070
2	4.801	17710.3	1684.6	48.930

Fig. 2 HPLC for compound 4h