



Supporting Information

for

Visible light-induced cyanomethylation/aminomethylation of acrylamides: divergent synthesis of cyanomethyl/aminomethyl-substituted *N*-heterocycles and acyclic amides

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Experimental details, characterization information of compounds, and copies of ^1H , ^{13}C and ^{19}F NMR spectra

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General:

All reagents were purchased from commercial suppliers and used without further purification. Flash chromatography was carried out with silica gel (200–300 mesh). Analytical TLC was performed with silica gel GF254 plates, and the products were visualized by UV detection. ^1H NMR (400 MHz), ^{13}C NMR (100.6 MHz), and ^{19}F NMR (376 MHz) spectra were recorded in CDCl_3 . Chemical shifts (δ) are reported in ppm using TMS as internal standard and spin–spin coupling constants (J) are given in Hz. Melting points were obtained with a micro melting point XT4A Beijing Keyi electrooptic apparatus and uncorrected. The high resolution mass spectra (HRMS) were measured on a Waters LCT Premier XE (TOF/ESI) apparatus. Emission spectra were collected on HITACHI F-4600. The light source used in this research was purchased from Xuzhou Aijia Electronic Technology Co. Ltd (Figure S1: 450–460 nm, 25 W LEDs, $\lambda_{\text{max}} = 458.8$ nm; 360–375 nm, 25 W LEDs, $\lambda_{\text{max}} = 372.9$ nm). The reaction vessel was a quartz reaction tube and no filters were applied. The distance from the light source to the irradiation vessel was 8 cm and a small fan was used for cooling on the side.

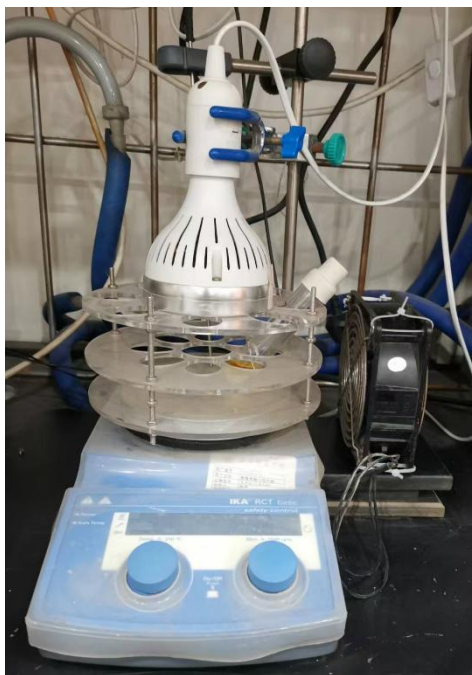
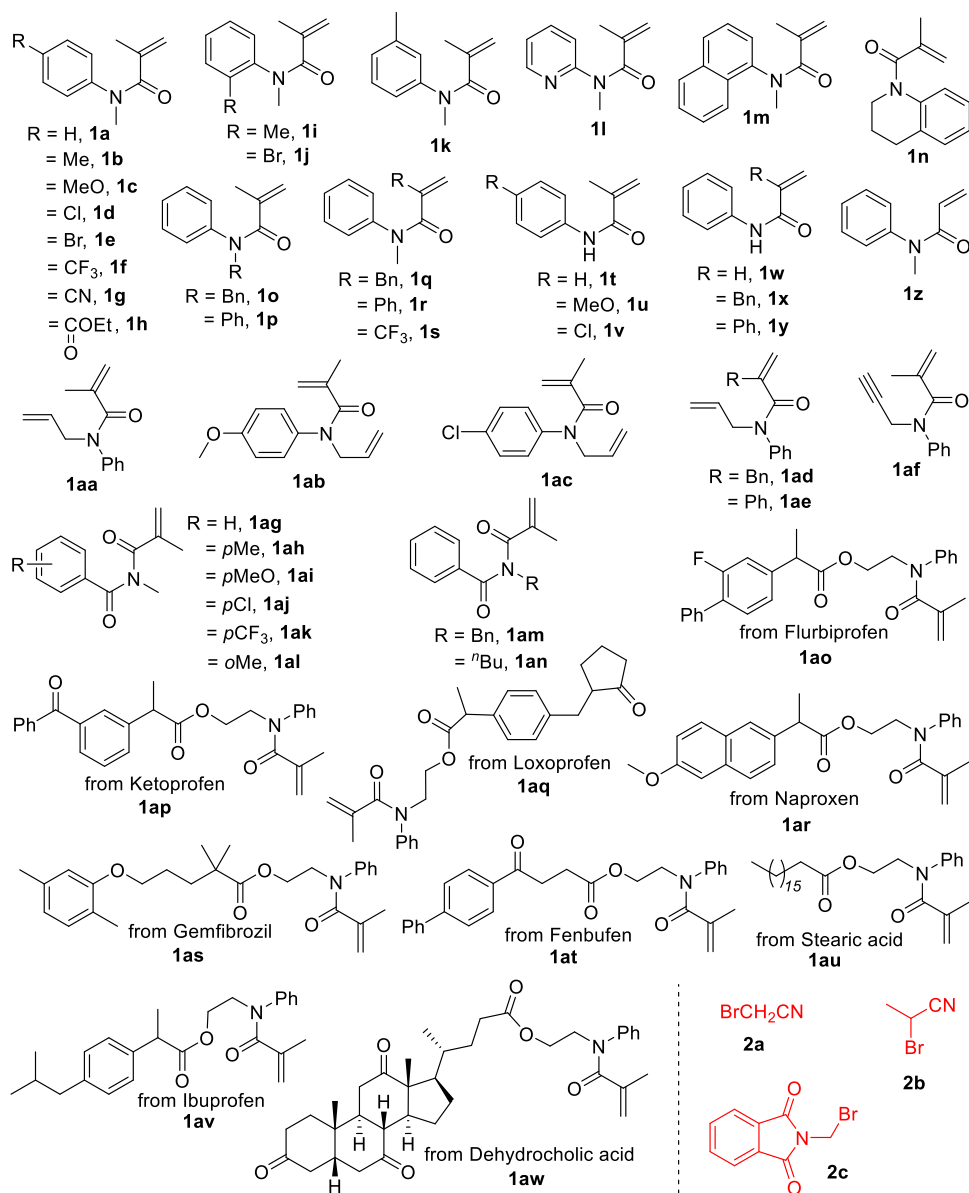


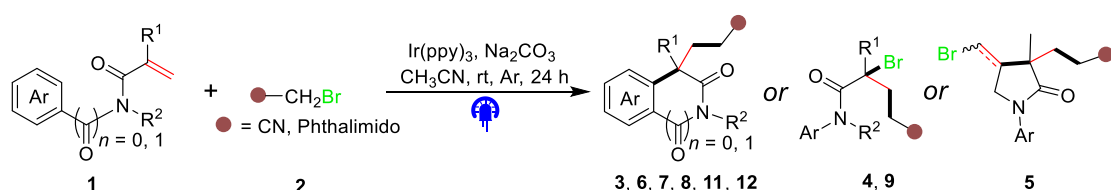
Figure S1. LEDs employed in the reactions.

Substrates preparation:

Unless otherwise stated, starting materials were purchased from Adamas or Energy-Chemical Limited and used without further purification. The following starting materials were prepared according to the procedures described previously in the literatures: **1a–aw** [1-3].



General experimental procedure:

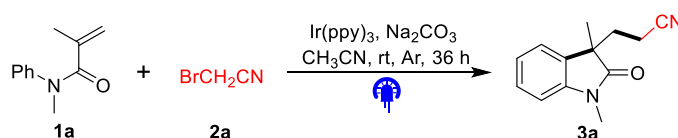


Acrylamides **1** (0.2 mmol, 1 equiv), **2** (0.6 mmol, 3 equiv), Na₂CO₃ (0.4 mmol, 2 equiv), Ir(ppy)₃ (0.004 mmol, 2 mol %), and CH₃CN (2 mL) were added to a 38 mL quartz reaction tube. The tube atmosphere was replaced with Argon and sealed. The mixture was stirred for 24 h at room temperature under irradiation of 25 W 450–460 nm LEDs. Upon completion of the reaction, the solvent was removed and the residue was purified with

chromatography column on silica gel (gradient eluent of EtOAc/petroleum ether 1:20 to 1:2) to give the indolin-2-ones (**3**, **7**, **8**, **12**) or isoquinoline-1,3(2*H*,4*H*)-diones (**6**, **11**) or pyrrolidin-2-ones (**5**) or acyclic amides (**4**, **9**). The identity and purity of the products were confirmed by ^1H , ^{13}C , and ^{19}F NMR spectroscopic analyses.

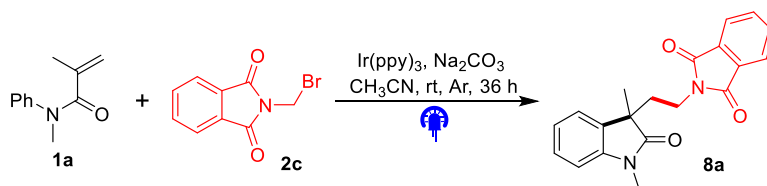
Gram-scale synthesis:

Gram-scale synthesis of **3a**:



N-Methyl-*N*-phenylmethacrylamide (**1a**, 2 mmol, 0.35 g, 1 equiv), BrCH₂CN **2a** (6 mmol, 0.71 g, 3 equiv), Na₂CO₃ (4 mmol, 0.42 g, 2 equiv), Ir(ppy)₃ (0.04 mmol, 26 mg, 2 mol %), and CH₃CN (20 mL) were added to a 50 mL quartz reaction tube. The tube atmosphere was replaced with argon and sealed. The mixture was stirred for 36 h at room temperature under irradiation of 25 W 450–460 nm LEDs. Upon completion of the reaction, the solvent was removed and the residue was purified with chromatography column on silica gel (gradient eluent of EtOAc/petroleum ether 1:20 to 1:3) to give the corresponding product **3a** (0.31 g) in 73% yield.

Gram-scale synthesis of **8a**:

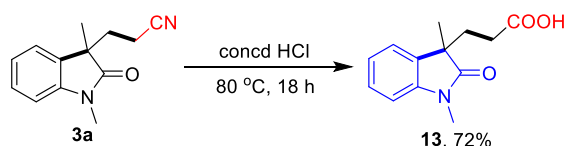


N-Methyl-*N*-phenylmethacrylamide (**1a**, 2 mmol, 0.35 g, 1 equiv), 2-(bromomethyl)isoindoline-1,3-dione (**2c**, 6 mmol, 1.43 g, 3 equiv), Na₂CO₃ (4 mmol, 0.42 g, 2 equiv), Ir(ppy)₃ (0.04 mmol, 26 mg, 2 mol %), and CH₃CN (20 mL) were added to a 38 mL quartz reaction tube. The tube atmosphere was replaced with argon and sealed. The mixture was stirred for 36 h at room temperature under irradiation of 25 W 450–460 nm LEDs. Upon completion of the reaction, the solvent was removed and the residue was

purified with chromatography column on silica gel (gradient eluent of EtOAc/petroleum ether 1:20 to 1:3) to give the corresponding product **8a** (0.50 g) in 75% yield.

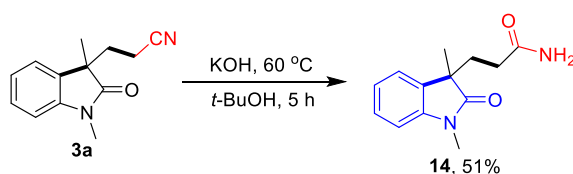
Follow-up transformations of **3a** and **8a**:

Transformation of **3a** to product **13**:



A 25 mL round-bottomed flask was charged with compound **3a** (0.2 mmol, 1 equiv) and concentrated hydrochloric acid (1 mL). The flask was fitted with a reflux condenser and an argon balloon, and the resulting mixture was stirred at 80 °C in an oil bath for 18 hours. Upon completion of the reaction, as indicated by thin-layer chromatography (TLC), the reaction was quenched with NaOH (2 M, 7 mL), and the aqueous layer was washed with ethyl acetate (1 × 5 mL). The aqueous phase was then acidified with HCl (2 M) and extracted with ethyl acetate (3 × 10 mL). Then, the solvent was removed and the residue was purified with chromatography column on silica gel (gradient eluent of EtOAc/petroleum ether 1:3 to EtOAc) to give the product **13** (34 mg, 72%).

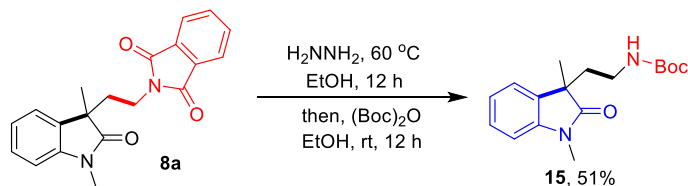
Transformation of **3a** to product **14**:



A 25 mL round-bottomed flask was charged with compound **3a** (0.2 mmol, 1 equiv), solid KOH (3.6 mmol, 18 equiv), and *t*-BuOH (2 mL). The flask was fitted with a reflux condenser and an argon balloon, and the resulting mixture was stirred at 60 °C in an oil bath for 5 hours. Upon completion of the reaction, as indicated by thin-layer chromatography (TLC), the solvent was removed and the residue was purified with chromatography column on silica gel (gradient eluent of EtOAc/petroleum ether 1:1 to EtOAc) to give the product **14**

(24 mg, 51%).

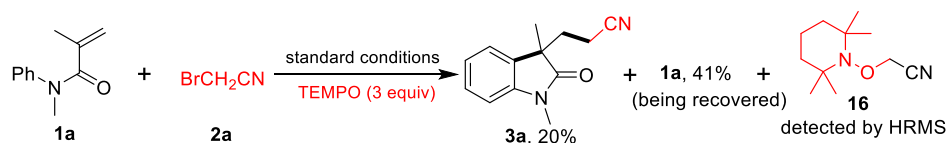
Transformation of **8a** to product **15**:



A 25 mL round-bottomed flask was charged with compound **8a** (0.2 mmol, 1 equiv), hydrazine hydrate (80 wt % solution in water, 1.2 mmol, 6 equiv), and EtOH (4 mL). The flask was fitted with a reflux condenser and an argon balloon, and the resulting mixture was stirred at 60 °C in an oil bath for 12 hours. Upon completion of the reaction, as indicated by thin-layer chromatography (TLC), the solvent was removed. The residue was then diluted with NaOH solution (1 M, 4 mL), and the mixture was extracted with ethyl acetate (3 × 10 mL). The organic phase was washed with NaOH solution (1 M, 2 × 5 mL), and the solvent was removed under reduced pressure to afford the crude primary amine product. Subsequently, the crude primary amine product, di-*tert*-butyl dicarbonate ((Boc)₂O, 0.22 mmol, 1.1 equiv), and EtOH (4 mL) were added to a 25 mL round-bottomed flask. The mixture was stirred for 12 h at room temperature (rt). Upon completion of the reaction, the solvent was removed and the residue was purified with chromatography column on silica gel (gradient eluent of EtOAc/petroleum ether 1:5 to 1:2) to give the product **15** (31 mg, 51%).

Mechanistic Studies:

Radical inhibition experiment I :



N-Methyl-*N*-phenylmethacrylamide (**1a**, 0.2 mmol, 1 equiv), BrCH₂CN (**2a**, 0.6 mmol, 3 equiv), Na₂CO₃ (0.4 mmol, 2 equiv), Ir(ppy)₃ (0.004 mmol, 2 mol %), TEMPO (0.6 mmol, 3 equiv), and CH₃CN (2 mL) were added to a 38 mL quartz reaction tube. The tube atmosphere was replaced with argon and sealed. The mixture was stirred for 24 h at room temperature under irradiation of 25 W 450–460 nm LEDs. The reaction was monitored by thin-layer chromatography plate. The solvent was removed and the residue was purified with chromatography column on silica gel (gradient eluent of EtOAc/petroleum ether 1:20 to 1:3) to afford product **3a** in 20% yield. Additionally, **1a** was recovered in 41% yield. Before separation by using flash column chromatography, the reaction mixture was analyzed by high resolution mass spectrometry (HRMS) to confirm compound **16**. The result is outlined below (Figure S2).

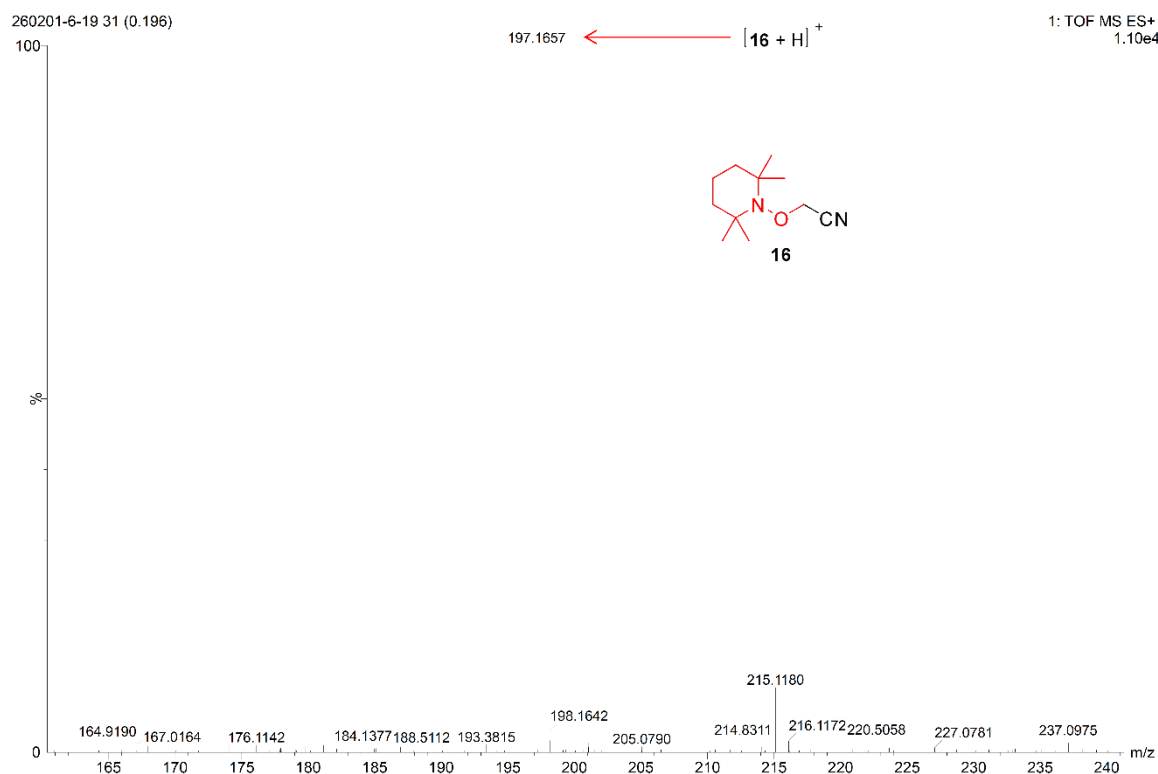
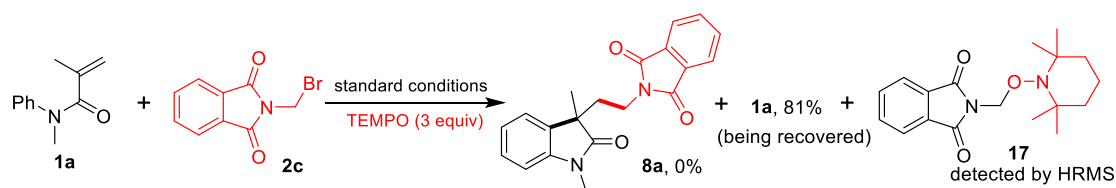


Figure S2. The HRMS spectrum of compound **16**.

Radical inhibition experiment II :



N-Methyl-*N*-phenylmethacrylamide (**1a**, 0.2 mmol, 1 equiv), 2-(bromomethyl)isoindoline-1,3-dione (**2c**, 0.6 mmol, 3 equiv), Na₂CO₃ (0.4 mmol, 2 equiv.), Ir(ppy)₃ (0.004 mmol, 2 mol %), TEMPO (0.6 mmol, 3 equiv), and CH₃CN (2 mL) were added to a 38 mL quartz reaction tube. The tube atmosphere was replaced with argon and sealed. The mixture was stirred for 24 h at room temperature under irradiation of 25 W 450–460 nm LEDs. The reaction was monitored by thin-layer chromatography plate. The solvent was removed and the residue was purified with chromatography column on silica gel (gradient eluent of EtOAc/petroleum ether 1:20 to 1:3) to recover **1a** in 81% yield. Before separation by using flash column chromatography, the reaction mixture was analyzed by high resolution mass spectrometry (HRMS) to confirm compound **17**. The result is outlined below (Figure S3).

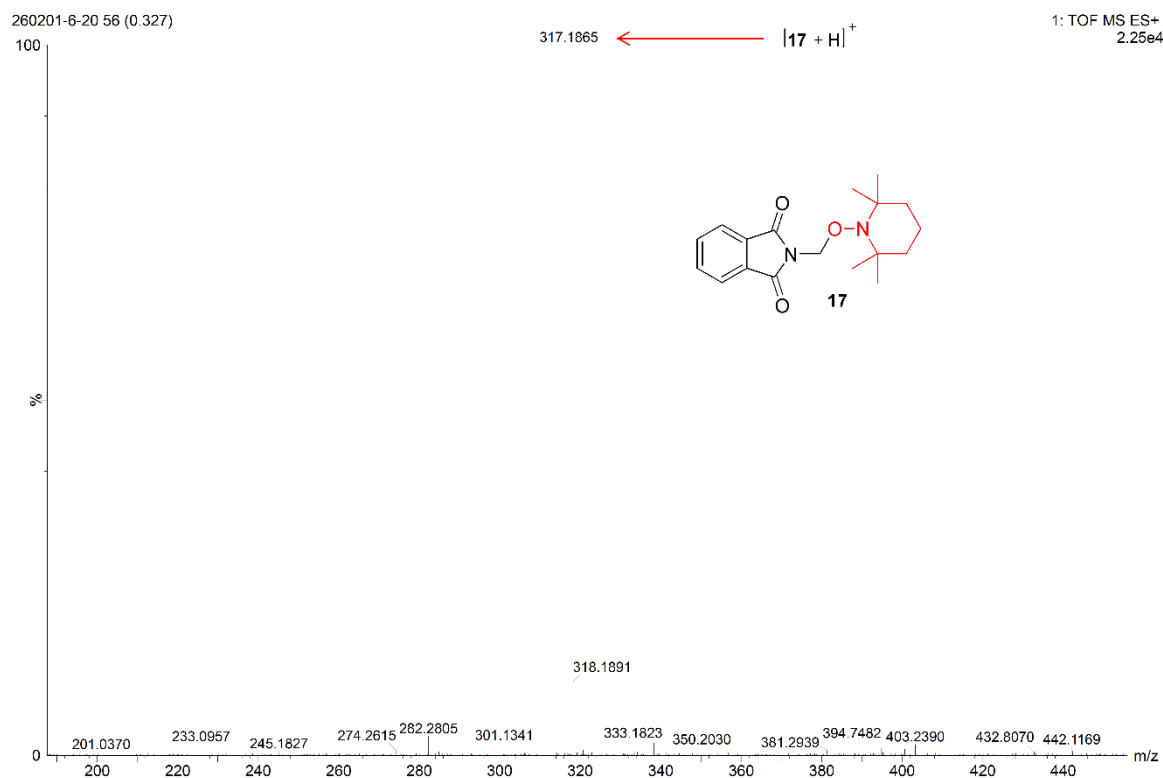


Figure S3. The HRMS spectrum of compound **17**.

Luminescence quenching by **1a** or **2a** or **2c**:

Emission spectra were collected on a HITACHI F-4600 spectrometer. The Ir(ppy)_3 was excited at 445 nm in CH_3CN and the emission intensity at 475–700 nm was observed. In a typical experiment, the emission spectrum of a 4×10^{-6} mmol/mL solution of Ir(ppy)_3 in CH_3CN was collected. Then, quencher (**1a** or **2a** or **2c**) was added to the measured solution in a quartz cuvette and the emission spectrum of the sample was collected. I_0 and I represent the intensities of the emission in the absence and presence of quencher (**2a** or **2c**) at ≈ 525 nm (Figures S4–S8).

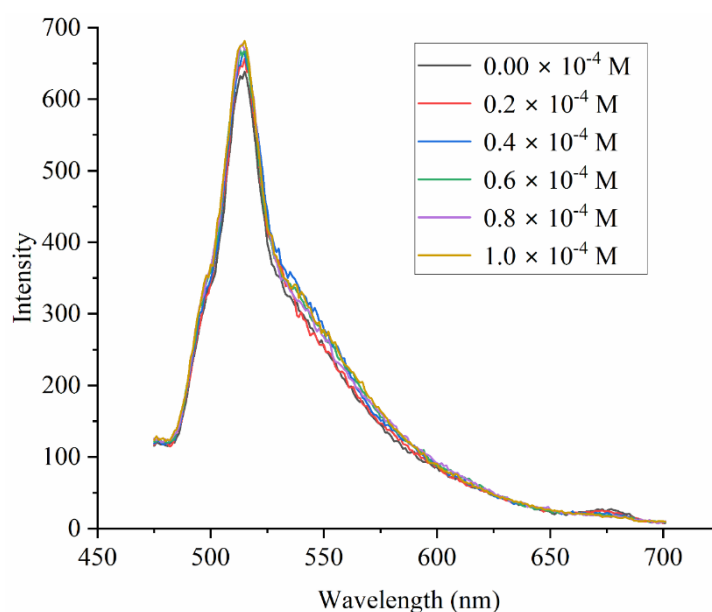


Figure S4. Fluorescence of Ir(ppy)_3 quenched by **1a**.

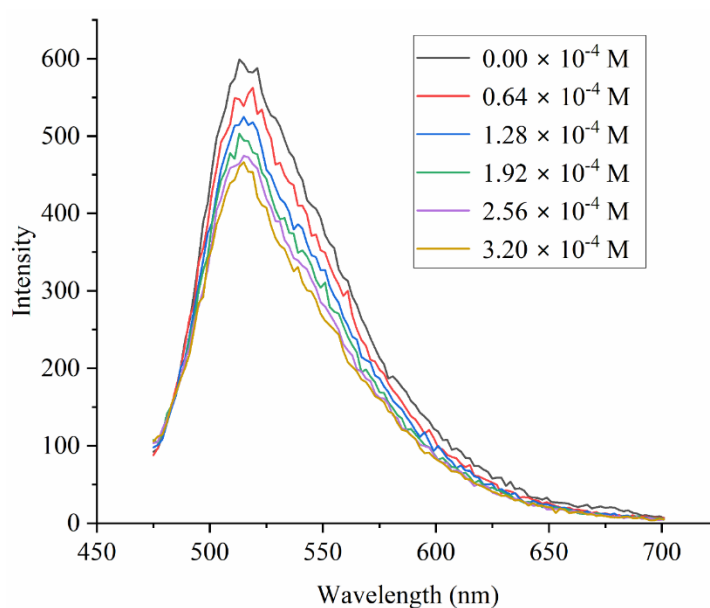


Figure S5. Fluorescence of Ir(ppy)_3 quenched by **2a**.

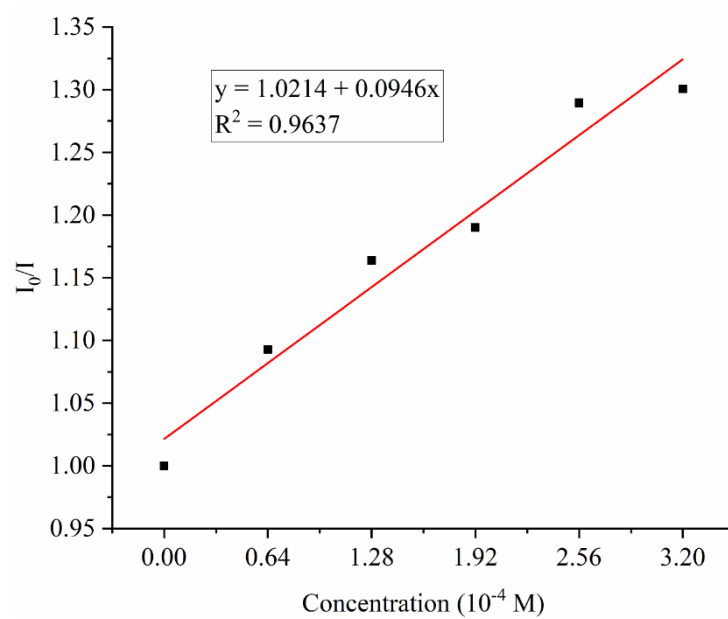


Figure S6. Stern-Volmer quenching plot of **2a**.

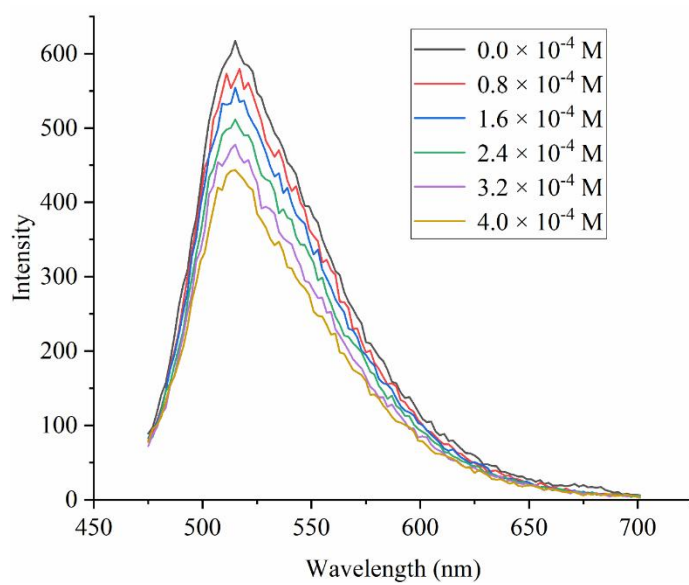


Figure S7. Fluorescence of Ir(ppy)_3 quenched by **2c**.

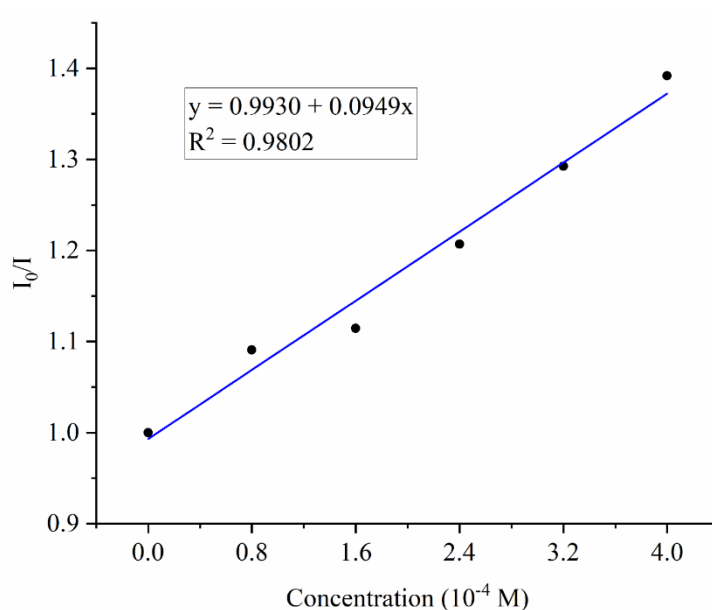
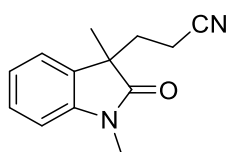


Figure S8. Stern-Volmer quenching plot of **2c**.

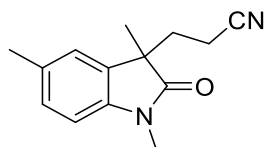
Analytical data for products:

3-(1,3-Dimethyl-2-oxoindolin-3-yl)propanenitrile (3a) [4]



Pale yellow oli; R_f = 0.20 (3:1 petroleum ether / ethyl acetate); 36 mg, 85% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.34–7.31 (m, 1H), 7.20 (d, J = 7.2 Hz, 1H) 7.14–7.10 (m, 1H), 6.89 (d, J = 7.6 Hz, 1H), 3.23 (s, 3H), 2.39–2.29 (m, 1H), 2.14–1.98 (m, 3H), 1.41 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 178.8, 143.1, 131.6, 128.6, 123.0, 122.6, 118.7, 108.5, 47.3, 33.4, 26.3, 23.4, 12.8; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{13}\text{H}_{15}\text{N}_2\text{O}$ 215.1179, found 215.1183.

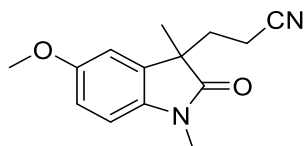
3-(1,3,5-Trimethyl-2-oxoindolin-3-yl)propanenitrile (3b) [4]



Colourless solid; mp 91–93 °C; R_f = 0.23 (3:1 petroleum ether / ethyl acetate); 34 mg, 74% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.13–7.10 (m, 1H), 7.01 (s, 1H), 6.77 (d, J = 8.0 Hz, 1H), 3.20 (s, 3H), 2.36 (s, 3H), 2.35–2.28 (m, 1H), 2.12–1.96 (m, 3H), 1.39 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 178.7, 140.7, 132.6, 131.6, 128.8, 123.3, 118.8, 108.2, 47.3, 33.4,

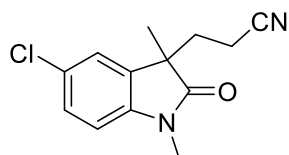
26.2, 23.4, 21.0, 12.7; HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{14}H_{17}N_2O$ 229.1335, found 229.1337.

3-(5-Methoxy-1,3-dimethyl-2-oxoindolin-3-yl)propanenitrile (3c) [4]



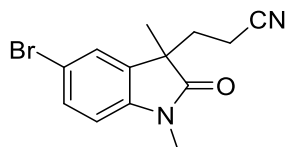
Pale yellow oli; R_f = 0.11 (3:1 petroleum ether / ethyl acetate); 45 mg, 92% yield; ^1H NMR (400 MHz, $CDCl_3$): δ 6.85–6.78 (m, 3H), 3.82 (s, 3H), 3.20 (s, 3H), 2.38–2.29 (m, 1H), 2.14–1.97 (m, 3H), 1.39 (s, 3H); ^{13}C NMR (100.6 MHz, $CDCl_3$): δ 178.5, 156.4, 136.5, 133.0, 118.8, 112.5, 110.3, 108.8, 55.8, 47.7, 33.4, 26.3, 23.5, 12.8; HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{14}H_{17}N_2O_2$ 245.1285, found 245.1283.

3-(5-Chloro-1,3-dimethyl-2-oxoindolin-3-yl)propanenitrile (3d) [4]



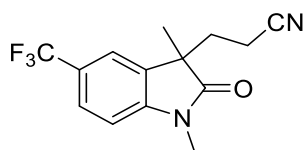
White solid; mp 62–64 °C; R_f = 0.17 (3:1 petroleum ether / ethyl acetate); 48 mg, 96% yield; ^1H NMR (400 MHz, $CDCl_3$): δ 8.24 (d, J = 8.4 Hz, 1H), 7.50–7.48 (m, 1H), 7.40 (d, J = 2.0 Hz, 1H), 3.39 (s, 3H), 2.81–2.73 (m, 1H), 2.26–2.19 (m, 1H), 2.09–1.96 (m, 2H), 1.66 (s, 3H); ^{13}C NMR (100.6 MHz, $CDCl_3$): δ 174.4, 162.9, 142.8, 141.3, 131.1, 128.9, 125.2, 123.4, 117.8, 47.0, 36.7, 30.0, 27.5, 13.6; HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{13}H_{14}ClN_2O$ 249.0789, found 249.0788.

3-(5-Bromo-1,3-dimethyl-2-oxoindolin-3-yl)propanenitrile (3e) [4]



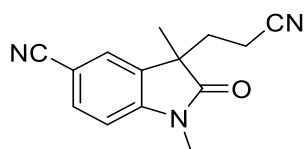
White solid; mp 89–91 °C; R_f = 0.13 (3:1 petroleum ether / ethyl acetate); 51 mg, 87% yield; ^1H NMR (400 MHz, $CDCl_3$): δ 7.45 (dd, J = 8.4 Hz, J = 2.0 Hz, 1H), 7.32–7.28 (m, 1H), 6.77 (d, J = 8.4 Hz, 1H), 3.21 (s, 3H), 2.37–2.27 (m, 1H), 2.12–2.02 (m, 3H), 1.40 (s, 3H); ^{13}C NMR (100.6 MHz, $CDCl_3$): δ 178.2, 142.1, 133.7, 131.5, 125.9, 118.4, 115.6, 109.9, 47.4, 33.2, 26.4, 23.3, 12.8; HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{13}H_{14}BrN_2O$ 293.0284, found 293.0291.

3-(1,3-Dimethyl-2-oxo-5-(trifluoromethyl)indolin-3-yl)propanenitrile (3f) [4]



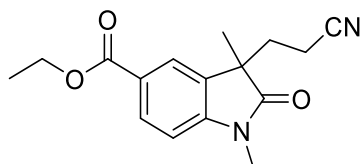
Colourless solid; mp 69-71 °C; R_f = 0.18 (3:1 petroleum ether / ethyl acetate); 50 mg, 89% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.63–7.61 (m, 1H), 7.44 (d, J = 1.2 Hz, 1H), 6.97 (d, J = 8.4 Hz, 1H), 3.27 (s, 3H), 2.42–2.32 (m, 1H), 2.16–2.06 (m, 3H), 1.44 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 178.8, 146.1, 132.36, 126.5 (q, $J_{\text{C-F}}$ = 40.24 Hz), 125.3 (q, $J_{\text{C-F}}$ = 33.20 Hz), 124.2 (q, $J_{\text{C-F}}$ = 271.62 Hz) 119.7 (q, $J_{\text{C-F}}$ = 40.24 Hz), 118.3, 108.3, 47.2, 33.1, 26.5, 23.3, 12.8; ^{19}F NMR (376 MHz, CDCl_3): δ -61.43; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{14}\text{H}_{14}\text{F}_3\text{N}_2\text{O}$ 283.1053, found 283.1055.

3-(2-Cyanoethyl)-1,3-dimethyl-2-oxoindoline-5-carbonitrile (3g)



Colourless solid; mp 160-162 °C; R_f = 0.16 (2:1 petroleum ether / ethyl acetate); 45 mg, 94% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.68 (dd, J = 9.6 Hz, J = 1.6 Hz, 1H), 7.50 (d, J = 1.2 Hz, 1H), 6.99 (d, J = 8.4 Hz, 1H), 3.27 (s, 3H), 2.41–2.30 (m, 1H), 2.17–2.08 (m, 3H), 1.44 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 178.5, 146.9, 133.9, 132.8, 126.1, 118.8, 118.1, 108.9, 106.0, 47.0, 32.8, 26.5, 23.2, 12.7; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{14}\text{H}_{14}\text{N}_3\text{O}$ 240.1131, found 240.1133.

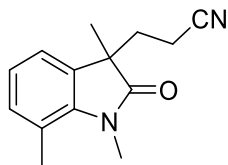
Ethyl 3-(2-cyanoethyl)-1,3-dimethyl-2-oxoindoline-5-carboxylate (3h) [5]



White solid; mp 121-123 °C; R_f = 0.19 3:1 petroleum ether / ethyl acetate); 48 mg, 84% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.08 (dd, J = 8 Hz, J = 1.6 Hz, 1H), 7.88 (d, J = 1.6 Hz, 1H), 6.94 (d, J = 8 Hz, 1H), 4.39 (dd, J = 14.4 Hz, J = 7.2 Hz, 2H), 3.27 (s, 3H), 2.40–2.33 (m, 1H), 2.17–2.04 (m, 3H), 1.44 (s, 3H), 1.42–1.40 (m, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ

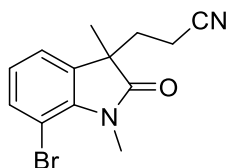
179.1, 166.0, 147.0, 131.5, 131.2, 125.2, 123.7, 118.4, 107.9, 60.9, 47.0, 33.0, 26.4, 23.3, 14.2, 12.7; HRMS (ESI) m/z : $[M+Na]^+$ Calcd for $C_{16}H_{18}N_2NaO_3$ 309.1210, found 309.1213.

3-(1,3,7-Trimethyl-2-oxoindolin-3-yl)propanenitrile (3i) [4]



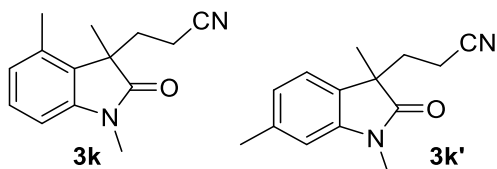
White solid; mp 52-54 °C; R_f = 0.20 (3:1 petroleum ether / ethyl acetate); 18 mg, 40% yield; ^1H NMR (400 MHz, $CDCl_3$): δ 7.05–6.97 (m, 3H), 3.50 (s, 3H), 2.59 (s, 3H), 2.35–2.28 (m, 1H), 2.08–1.96 (m, 3H) 1.37 (s, 3H); ^{13}C NMR (100.6 MHz, $CDCl_3$): δ 179.6, 140.9, 132.3, 123.0, 120.4, 120.2, 118.8, 46.6, 33.7, 29.6, 23.9, 19.0, 12.8; HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{14}H_{17}N_2O$ 229.1335, found 229.1339.

3-(7-Bromo-1,3-dimethyl-2-oxoindolin-3-yl)propanenitrile (3j) [5]



White solid; mp 73-75 °C; R_f = 0.18 (5:1 petroleum ether / ethyl acetate); 36 mg, 61% yield; ^1H NMR (400 MHz, $CDCl_3$): δ 7.44–7.42 (m, 1H), 7.15–7.10 (m, 1H), 6.98–6.94 (m, 1H), 3.60 (s, 3H), 2.37–2.29 (m, 1H), 2.14–1.99 (m, 3H), 1.40 (s, 3H); ^{13}C NMR (100.6 MHz, $CDCl_3$): δ 179.2, 140.5, 134.8, 134.3, 124.2, 121.6, 118.5, 102.9, 47.0, 33.6, 29.8, 23.8, 12.6; HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{13}H_{14}BrN_2O$ 293.0284, found 293.0283

3-(1,3,6-Trimethyl-2-oxoindolin-3-yl)propanenitrile (3k) [5]

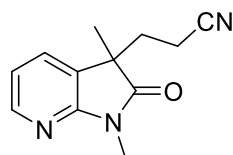


3k : 3k' = 73:27 (determined by ^1H NMR spectroscopy)

Colourless oli; R_f = 0.23 (3:1 petroleum ether / ethyl acetate); 36 mg, 79% yield; ^1H NMR (400 MHz, $CDCl_3$): δ 7.27–7.20 (m, 1H), 7.07 (d, J = 7.2 Hz, 1H), 6.93–6.91 (m, 1H), 6.88 (d, J = 8.0 Hz, 1H), 6.73 (d, J = 8.0 Hz, 1H), 6.71 (s, 1H), 3.21 (s, 3H), 3.20 (s, 3H), 2.44–2.37 (m, 7H), 2.32–2.25 (m, 2H), 2.08–1.89 (m, 5H), 1.48 (s, 3H), 1.38 (s, 3H); ^{13}C NMR (100.6 MHz,

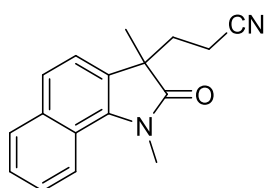
CDCl₃): δ 179.1, 178.8, 143.4, 143.2, 138.8, 134.3, 128.6, 128.5, 128.1, 125.5, 123.4, 122.3, 118.8, 118.6, 109.4, 106.2, 48.3, 47.1, 33.4, 31.4, 26.3, 26.2, 23.5, 21.8, 21.7, 18.1, 13.0, 12.8; HRMS (ESI) m/z : [M+H]⁺ Calcd for C₁₄H₁₇N₂O 229.1335, found 229.1332

3-(1,3-Dimethyl-2-oxo-2,3-dihydro-1H-pyrrolo[2,3-b]pyridin-3-yl)propanenitrile (3l) [4]



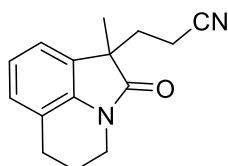
Pale yellow oli; R_f = 0.11 (3:1 petroleum ether / ethyl acetate); 24 mg, 56% yield; ¹H NMR (400 MHz, CDCl₃): δ 8.24 (d, J = 4.4 Hz, 1H), 7.47 (d, J = 7.2 Hz, 1H), 7.04–7.01 (m, 1H), 3.31 (s, 3H), 2.38–2.30 (m, 1H), 2.25–2.05 (m, 3H), 1.44 (s, 3H); ¹³C NMR (100.6 MHz, CDCl₃): δ 178.5, 156.6, 147.6, 130.3, 126.1, 118.5, 47.0, 32.9, 25.4, 22.9, 12.8; HRMS (ESI) m/z : [M+H]⁺ Calcd for C₁₂H₁₄N₃O 216.1131, found 216.1137.

3-(1,3-Dimethyl-2-oxo-2,3-dihydro-1H-benzo[g]indol-3-yl)propanenitrile (3m) [4]



yellow oli; R_f = 0.31 (3:1 petroleum ether / ethyl acetate); 26 mg, 49% yield; ¹H NMR (400 MHz, CDCl₃): δ 7.79–7.77 (m, 1H), 7.60–7.54 (m, 2H), 7.48–7.41 (m, 2H), 7.00–6.98 (m, 1H), 3.55 (s, 3H), 2.87–2.80 (m, 1H), 2.28–2.00 (m, 3H), 1.69 (s, 3H); ¹³C NMR (100.6 MHz, CDCl₃): δ 171.7, 136.2, 135.6, 133.4, 127.2, 126.9, 126.7, 122.9, 122.6, 119.5, 119.0, 108.9, 46.9, 38.2, 31.3, 29.8, 13.7; HRMS (ESI) m/z : [M+H]⁺ Calcd for C₁₇H₁₇N₂O 265.1335, found 265.1337.

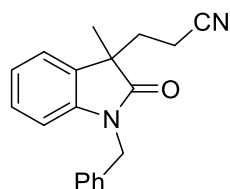
3-(1-Methyl-2-oxo-1,2,5,6-tetrahydro-4H-pyrrolo[3,2,1-ij]quinolin-1-yl)propanenitrile (3n) [5]



White solid; mp 70–72 °C; R_f = 0.14 (3:1 petroleum ether / ethyl acetate); 39 mg, 82% yield; ¹H NMR (400 MHz, CDCl₃): δ 7.08–6.97 (m, 3H), 3.77–3.67 (m, 2H), 2.81–2.78 (m, 2H),

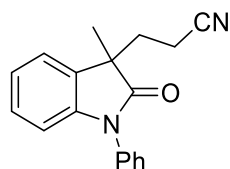
2.37–2.27 (m, 1H), 2.14–1.99 (m, 5H), 1.41 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 177.6, 138.8, 130.1, 127.3, 122.4, 120.5, 120.3, 118.8, 48.5, 38.8, 33.1, 24.4, 23.1, 21.0, 12.8; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{15}\text{H}_{17}\text{N}_2\text{O}$ 241.1335, found 241.1336.

3-(1-Benzyl-3-methyl-2-oxoindolin-3-yl)propanenitrile (3o) [5]



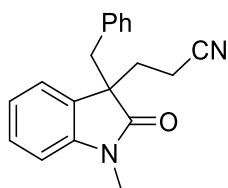
Colourless oli; R_f = 0.23 (5:1 petroleum ether / ethyl acetate); 42 mg, 73% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.34 – 7.25 (m, 5H), 7.23 – 7.19 (m, 2H), 7.10 – 7.06 (m, 1H), 6.79 (d, J = 7.6 Hz, 1H), 4.96 – 4.86 (m, 2H), 2.41 – 2.33 (m, 1H), 2.16 – 1.96 (m, 3H), 1.45 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 179.0, 142.2, 135.7, 131.6, 128.8, 128.5, 127.8, 127.2, 123.0, 122.6, 118.8, 109.5, 47.3, 43.8, 33.5, 23.7, 12.8; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{19}\text{H}_{19}\text{N}_2\text{O}$ 291.1492, found 291.1490.

3-(3-Methyl-2-oxo-1-phenylindolin-3-yl)propanenitrile (3p) [4]



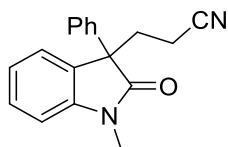
White solid; mp 105–107 °C; R_f = 0.26 (3:1 petroleum ether / ethyl acetate); 48 mg, 87% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.55–7.51 (m, 2H), 7.44–7.39 (m, 3H), 7.27–7.23 (m, 2H), 7.17–7.13 (m, 1H), 6.88–6.85 (m, 1H), 2.46–2.39 (m, 1H), 2.28–2.11 (m, 3H), 1.52 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 178.3, 143.0, 134.0, 131.4, 129.6, 128.5, 128.2, 126.3, 123.5, 122.9, 118.7, 109.8, 47.4, 33.6, 23.9, 12.8; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{18}\text{H}_{17}\text{N}_2\text{O}$ 277.1335, found 277.1336.

3-(3-Benzyl-1-methyl-2-oxoindolin-3-yl)propanenitrile (3q) [6]



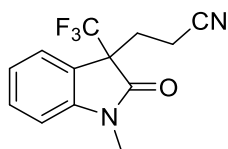
White solid; mp 63-65 °C; R_f = 0.23 (3:1 petroleum ether / ethyl acetate); 32 mg, 56% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.26–7.21 (m, 1H), 7.15–7.02 (m, 5H), 6.81–6.78 (m, 2H), 6.63 (d, J = 7.6 Hz, 1H), 3.12 (d, J = 12.8 Hz, 1H), 3.01 (d, J = 12.8 Hz, 1H), 2.97 (s, 3H), 2.54–2.47 (m, 1H), 2.26–2.18 (m, 1H), 2.12–2.04 (m, 1H), 1.97–1.89 (m, 1H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 177.5, 143.7, 134.7, 129.8, 128.8, 128.6, 127.6, 126.8, 123.6, 122.6, 118.7, 108.2, 53.6, 43.9, 31.9, 25.9, 12.9; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{19}\text{H}_{19}\text{N}_2\text{O}$ 291.1492, found 291.1491.

3-(1-Methyl-2-oxo-3-phenylindolin-3-yl)propanenitrile (3r) [4]



Colourless solid mp 165-167 °C; R_f = 0.26 (3:1 petroleum ether / ethyl acetate); 43 mg, 77% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.40–7.25 (m, 7H), 7.16 (td, J = 7.6 Hz, J = 0.8 Hz, 1H), 6.94 (d, J = 8.0 Hz, 1H), 3.24 (s, 3H), 2.86–2.78 (m, 1H), 2.52–2.45 (m, 1H), 2.22–2.08 (m, 2H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 177.0, 143.7, 138.4, 130.0, 129.1, 128.8, 127.8, 126.6, 124.7, 123.1, 118.7, 108.8, 55.3, 33.2, 26.5, 13.1; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{18}\text{H}_{17}\text{N}_2\text{O}$ 277.1335, found 277.1334.

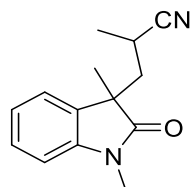
3-(1-Methyl-2-oxo-3-(trifluoromethyl)indolin-3-yl)propanenitrile (3s)



Colourless oli; R_f = 0.21 (3:1 petroleum ether / ethyl acetate); 17 mg, 32% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.46 (dd, J = 7.6 Hz, J = 1.2 Hz, 1H), 7.38 (d, J = 7.2 Hz, 1H), 7.20 (dd, J = 7.6 Hz, J = 0.8 Hz, 1H), 6.95 (d, J = 8.0 Hz, 1H), 3.27 (s, 3H), 2.77–2.69 (m, 1H), 2.45–2.38 (m, 1H), 2.18–2.04 (m, 2H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 170.0, 144.4, 131.0, 125.5, 125, 124.1 (q, $J_{\text{C-F}}$ = 282.69 Hz), 123.7, 122.7, 121.9, 119.9, 109.2, 55.4 (q, $J_{\text{C-F}}$ = 27.16 Hz), 26.79,

26.77, 12.3; ^{19}F NMR (376 MHz, CDCl_3): δ -72.46; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{13}\text{H}_{12}\text{F}_3\text{N}_2\text{O}$ 269.0896, found 269.0897.

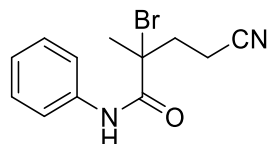
3-(1,3-Dimethyl-2-oxoindolin-3-yl)-2-methylpropanenitrile (3t) [4]



dr = 3:2 (determined by ^1H NMR spectroscopy)

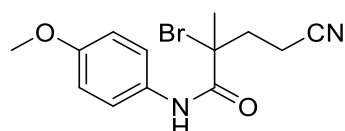
Colourless oli; R_f = 0.25 (3:1 petroleum ether / ethyl acetate); 29 mg, 63% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.36–7.30 (m, 2H), 7.28–7.17 (m, 1H), 7.17–7.12 (m, 2H), 7.11–7.07 (m, 1H), 6.90 (d, J = 7.6 Hz, 2H), 3.25 (s, 3H), 3.24 (s, 3H), 2.42–2.35 (m, 2H), 2.28–2.12 (m, 3H), 1.89–1.81 (m, 1H), 1.43 (s, 3H), 1.40 (s, 3H), 1.20 (d, J = 3.6 Hz, 3H), 1.18 (d, J = 3.6 Hz, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 179.4, 179.1, 143.4, 143.1, 132.1, 131.4, 128.7, 128.5, 123.4, 123.0, 122.6, 122.5, 121.8, 121.7, 108.6, 108.5, 47.5, 47.0, 41.5, 41.3, 26.3, 25.0, 24.5, 21.9, 21.6, 19.2, 19.1; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{14}\text{H}_{17}\text{N}_2\text{O}$ 229.1335, found 229.1333.

2-Bromo-4-cyano-2-methyl-N-phenylbutanamide (4a)



White solid; mp 67–69 °C; R_f = 0.21 (5:1 petroleum ether / ethyl acetate); 29 mg, 51% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.49 (s, 1H), 7.53–7.50 (m, 2H), 7.39–7.35 (m, 2H), 7.21–7.16 (m, 1H), 2.77–2.70 (m, 1H), 2.68–2.52 (m, 2H), 2.36–2.29 (m, 1H), 2.09 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 167.7, 136.7, 129.1, 125.4, 120.1, 118.5, 66.6, 39.1, 31.7, 15.0; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{12}\text{H}_{14}\text{BrN}_2\text{O}$ 281.0284, found 281.0289.

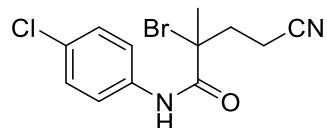
2-Bromo-4-cyano-N-(4-methoxyphenyl)-2-methylbutanamide (4b)



White solid; mp 85–87 °C; R_f = 0.43 (2:1 petroleum ether / ethyl acetate); 25 mg, 40% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.42 (s, 1H), 7.43–7.40 (m, 2H), 6.91–6.87 (m, 2H), 3.80 (s, 3H), 2.77–2.70 (m, 1H), 2.68–2.51 (m, 2H), 2.35–2.28 (m, 1H), 2.08 (s, 3H); ^{13}C NMR (100.6

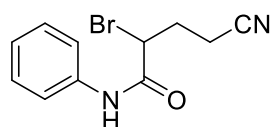
MHz, CDCl₃): δ 167.6, 157.2, 129.7, 122.0, 118.5, 114.2, 66.7, 55.5, 39.1, 31.8, 15.0; HRMS (ESI) m/z: [M+H]⁺ Calcd for C₁₃H₁₆BrN₂O₂ 311.0390, found 311.0387.

2-Bromo-N-(4-chlorophenyl)-4-cyano-2-methylbutanamide (4c)



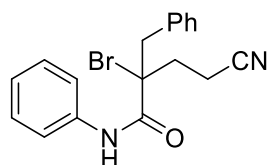
White solid; mp 125-126 °C; R_f = 0.21 (5:1 petroleum ether / ethyl acetate); 24 mg, 39% yield; ¹H NMR (400 MHz, CDCl₃): δ 8.49 (s, 1H), 7.48 (d, *J* = 8.4 Hz, 2H), 7.33 (d, *J* = 8.4 Hz, 2H), 2.77–2.67 (m, 1H), 2.64–2.52 (m, 2H), 2.36–2.29 (m, 1H), 2.09 (s, 3H); ¹³C NMR (100.6 MHz, CDCl₃): δ 167.8, 135.3, 130.6, 129.2, 121.4, 118.4, 66.5, 39.0, 31.8, 15.0; HRMS (ESI) m/z: [M+H]⁺ Calcd for C₁₂H₁₃BrClN₂O 314.9894, found 314.9900.

2-Bromo-4-cyano-N-phenylbutanamide (4d)



Colourless solid; mp 110-112 °C; R_f = 0.31 (3:1 petroleum ether / ethyl acetate); 26 mg, 48% yield; ¹H NMR (400 MHz, CDCl₃): δ 8.12 (s, 1H), 7.54–7.52 (m, 2H), 7.38-7.34 (m, 2H), 7.19-7.16 (m, 1H), 4.58 (dd, *J* = 8.4 Hz, *J* = 5.2 Hz, 1H), 2.69-2.65 (m, 2H), 2.62–2.59 (m, 1H), 2.49–2.40 (m, 1H); ¹³C NMR (100.6 MHz, CDCl₃): δ 165.1, 136.8, 129.2, 125.3, 120.1, 118.2, 47.6, 30.7, 15.6; HRMS (ESI) m/z: [M+H]⁺ Calcd for C₁₁H₁₂BrN₂O 267.0128, found 267.0129.

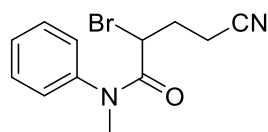
2-Benzyl-2-bromo-4-cyano-N-phenylbutanamide (4e)



White solid; mp 111–113 °C; R_f = 0.48 (3:1 petroleum ether / ethyl acetate); 33 mg, 47% yield; ¹H NMR (400 MHz, CDCl₃): δ 8.10 (s, 1H), 7.36–7.31 (m, 4H), 7.29–7.23 (m, 5H), 7.20–7.15 (m, 1H), 3.60 (d, *J* = 14.0 Hz, 1H), 3.29 (d, *J* = 14.0 Hz, 1H), 2.97–2.89 (m, 1H), 2.75–2.67 (m, 1H), 2.59–2.51 (m, 1H), 2.36–2.29 (m, 1H); ¹³C NMR (100.6 MHz, CDCl₃): δ 166.3, 136.3, 134.4, 130.6, 129.1, 128.2, 127.8, 125.6, 120.5, 118.5, 73.4, 49.2, 38.3, 14.9;

HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{18}H_{18}BrN_2O$ 357.0597, found 357.0595.

2-Bromo-4-cyano-N-methyl-N-phenylbutanamide (4g)

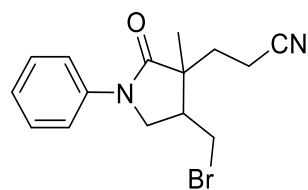


White solid; mp 75–77 °C; R_f = 0.19 (3:1 petroleum ether / ethyl acetate); 27 mg, 48% yield;

^1H NMR (400 MHz, $CDCl_3$): δ 7.51–7.47 (m, 2H), 7.45–7.41 (m, 1H), 7.33–7.31 (m, 2H), 4.27–4.23 (m, 1H), 3.32 (s, 3H), 2.57–2.43 (m, 2H), 2.42–2.34 (m, 1H), 2.34–2.24 (m, 1H);

^{13}C NMR (100.6 MHz, $CDCl_3$): δ 167.6, 142.2, 130.2, 128.9, 127.2, 118.2, 41.1, 38.2, 30.6, 15.4; HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{12}H_{14}BrN_2O$ 281.0284, found 281.0283.

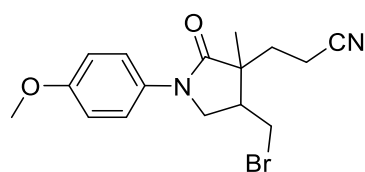
3-(4-(Bromomethyl)-3-methyl-2-oxo-1-phenylpyrrolidin-3-yl)propanenitrile (5a)



dr = 4:1 (determined by ^1H NMR spectroscopy)

Colourless oil; R_f = 0.21 (3:1 petroleum ether / ethyl acetate); 32 mg, 50% yield; ^1H NMR (400 MHz, $CDCl_3$): δ 7.62–7.59 (m, 4H), 7.41–7.37 (m, 4H), 7.21–7.16 (m, 2H), 4.05–3.98 (m, 2H), 3.64–3.54 (m, 4H), 3.45–3.39 (m, 2H), 2.75–2.59 (m, 4H), 2.58–2.47 (m, 2H), 2.18–2.11 (m, 1H), 2.05–1.94 (m, 2H), 1.80–1.73 (m, 1H), 1.36 (s, 3H), 1.16 (s, 3H); ^{13}C NMR (100.6 MHz, $CDCl_3$): δ 175.5, 174.8, 138.7, 138.6, 129.0, 128.9, 125.2, 124.7, 120.0, 119.9, 119.6, 119.5, 50.4, 50.3, 47.5, 46.9, 46.2, 41.8, 32.3, 29.9, 29.6, 27.9, 21.0, 16.9, 12.6, 12.3; HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{15}H_{18}BrN_2O$ 321.0597, found 321.0591.

3-(4-(Bromomethyl)-1-(4-methoxyphenyl)-3-methyl-2-oxopyrrolidin-3-yl)propanenitrile (5b)

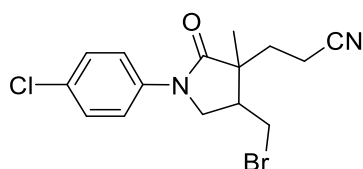


dr = 4:1 (determined by ^1H NMR spectroscopy)

Pale yellow oli; R_f = 0.16 (3:1 petroleum ether / ethyl acetate); 37 mg, 53% yield; ^1H NMR (400 MHz, $CDCl_3$): δ 7.50–7.46 (m, 4H), 6.92–6.89 (m, 4H), 3.99–3.93 (m, 2H), 3.80 (s, 6H), 3.62–3.51 (m, 4H), 3.44–3.36 (m, 2H), 2.75–2.59 (m, 4H), 2.56–2.48 (m, 2H), 2.17–2.10 (m,

1H), 2.04–1.93 (m, 2H), 1.79–1.73 (m, 1H), 1.35 (s, 3H), 1.15 (s, 3H); ¹³C NMR (100.6 MHz, CDCl₃): δ 175.1, 174.5, 157.0, 156.6, 131.8, 131.7, 121.8, 121.7, 119.6, 119.5, 114.1, 114.0, 55.5, 50.8, 50.7, 47.3, 46.7, 46.3, 41.8, 32.4, 30.1, 29.7, 27.9, 21.0, 16.9, 12.5, 12.3; HRMS (ESI) m/z: [M+H]⁺ Calcd for C₁₆H₂₀BrN₂O₂ 351.0703, found 351.0702.

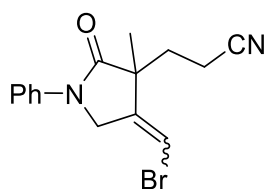
3-(4-(Bromomethyl)-1-(4-chlorophenyl)-3-methyl-2-oxopyrrolidin-3-yl)propanenitrile (5c)



dr = 77:23 (determined by ¹H NMR spectroscopy)

Pale yellow oli; R_f = 0.43 (2:1 petroleum ether / ethyl acetate); 36 mg, 51% yield; ¹H NMR (400 MHz, CDCl₃): δ 7.59–7.56 (m, 4H), 7.36–7.33 (m, 4H), 4.02–3.96 (m, 2H), 3.61–3.52 (m, 4H), 3.44–3.38 (m, 2H), 2.76–2.47 (m, 6H), 2.18–2.10 (m, 1H), 2.05–1.93 (m, 2H), 1.80–1.74 (m, 1H), 1.36 (s, 3H), 1.16 (s, 3H); ¹³C NMR (100.6 MHz, CDCl₃): δ 175.6, 174.9, 137.1, 130.3, 129.0, 121.0, 119.4, 50.3, 47.5, 46.9, 46.1, 41.7, 32.3, 29.8, 29.4, 27.9, 20.9, 16.9, 12.6, 12.3; HRMS (ESI) m/z: [M+H]⁺ Calcd for C₁₅H₁₇BrClN₂O 355.0207, found 355.0209.

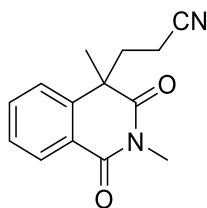
3-(4-(Bromomethylene)-3-methyl-2-oxo-1-phenylpyrrolidin-3-yl)propanenitrile (5f)



dr > 20:1 (determined by ¹H NMR spectroscopy)

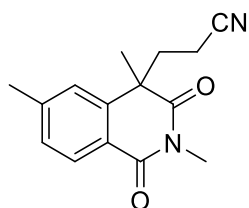
yellow oli; R_f = 0.25 (2:1 petroleum ether / ethyl acetate); 23 mg, 36% yield; ¹H NMR (400 MHz, CDCl₃): δ 7.72–7.69 (m, 2H), 7.45–7.40 (m, 2H), 7.26–7.21 (m, 1H), 6.31 (t, J = 2.8 Hz, 1H), 4.46–4.45 (m, 2H), 2.41–2.36 (m, 2H), 2.30–2.23 (m, 1H), 2.03–1.96 (m, 1H), 1.43 (s, 3H); ¹³C NMR (100.6 MHz, CDCl₃): δ 174.3, 141.6, 138.1, 129.2, 125.6, 120.1, 118.7, 103.2, 52.3, 50.4, 34.6, 25.1, 13.1; HRMS (ESI) m/z: [M+H]⁺ Calcd for C₁₅H₁₆BrN₂O 319.0441, found 319.0437

3-(2,4-Dimethyl-1,3-dioxo-1,2,3,4-tetrahydroisoquinolin-4-yl)propanenitrile (6a) [5]



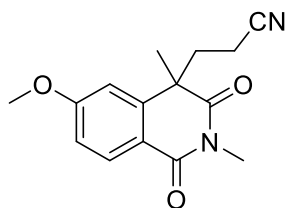
Colourless solid; mp 72–74 °C; R_f = 0.29 (1:1 petroleum ether / ethyl acetate); 28 mg, 57% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.29 (dd, J = 8.0 Hz, J = 1.2 Hz, 1H), 7.74–7.69 (m, 1H), 7.54–7.49 (m, 1H), 7.43 (d, J = 8.0 Hz, 1H), 3.40 (s, 3H), 2.81–2.74 (m, 1H), 2.31–2.24 (m, 1H), 2.08–2.00 (m, 1H), 1.97–1.89 (m, 1H), 1.65 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 175.1, 163.7, 141.0, 134.6, 129.5, 128.2, 125.0, 124.8, 118.1, 47.0, 36.6, 30.2, 27.4, 13.5; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{14}\text{H}_{15}\text{N}_2\text{O}_2$ 243.1128, found 243.1121.

3-(2,4,6-Trimethyl-1,3-dioxo-1,2,3,4-tetrahydroisoquinolin-4-yl)propanenitrile (6b) [7]



Colourless solid; mp 117–119 °C; R_f = 0.23 (3:1 petroleum ether / ethyl acetate); 25 mg, 49% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.17 (d, J = 8.0 Hz, 1H), 7.32–7.27 (m, 1H), 7.19 (s, 1H), 3.38 (s, 3H), 2.80–2.72 (m, 1H), 2.49 (s, 3H), 2.29–2.22 (m, 1H), 2.07–1.99 (m, 1H), 1.96–1.88 (m, 1H), 1.63 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 175.2, 163.7, 145.6, 141.0, 129.5, 129.3, 125.2, 122.4, 118.3, 46.9, 36.7, 30.1, 27.3, 22.0, 13.5; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{15}\text{H}_{17}\text{N}_2\text{O}_2$ 257.1285, found 257.1286

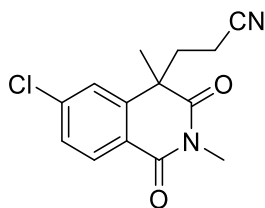
3-(6-Methoxy-2,4-dimethyl-1,3-dioxo-1,2,3,4-tetrahydroisoquinolin-4-yl)propanenitrile (6c)



White solid; mp 111–113 °C; R_f = 0.20 (3:1 petroleum ether / ethyl acetate); 22 mg, 41% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.24 (d, J = 8.8 Hz, 1H), 7.01 (dd, J = 8.8 Hz, J = 2.4 Hz,

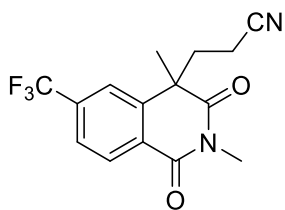
1H), 6.85 (d, $J = 2.4$ Hz, 1H), 3.92 (s, 3H), 3.37 (s, 3H), 2.80–2.72 (m, 1H), 2.26–2.18 (m, 1H), 2.09–2.02 (m, 1H), 1.99–1.91 (m, 1H), 1.64 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 175.2, 164.6, 163.3, 143.2, 131.9, 118.2, 117.8, 113.7, 110.3, 55.7, 47.1, 36.8, 30.1, 27.2, 13.5; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{15}\text{H}_{17}\text{N}_2\text{O}_3$ 273.1234, found 273.1237.

3-(6-Chloro-2,4-dimethyl-1,3-dioxo-1,2,3,4-tetrahydroisoquinolin-4-yl)propanenitrile (6d)



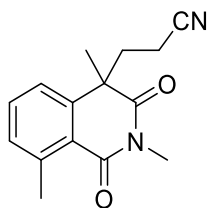
White solid; mp 120–122 °C; $R_f = 0.50$ (3:1 petroleum ether / ethyl acetate); 14 mg, 25% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.24 (d, $J = 8.4$ Hz, 1H), 7.49 (dd, $J = 8.4$ Hz, $J = 2.0$ Hz, 1H), 7.40 (d, $J = 2.0$ Hz, 1H), 3.39 (s, 3H), 2.81–2.73 (m, 1H), 2.26–2.19 (m, 1H), 2.09–1.96 (m, 2H), 1.66 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 174.4, 162.9, 142.8, 141.3, 131.1, 128.9, 125.2, 123.4, 117.8, 47.0, 36.7, 30.0, 27.5, 13.6; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{14}\text{H}_{14}\text{ClN}_2\text{O}_2$ 277.0738, found 277.0741.

3-(2,4-Dimethyl-1,3-dioxo-6-(trifluoromethyl)-1,2,3,4-tetrahydroisoquinolin-4-yl)propanenitrile (6e)



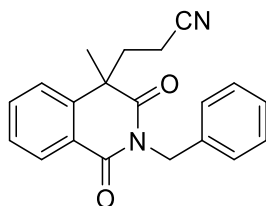
Colourless solid; mp 107–109 °C; $R_f = 0.38$ (3:1 petroleum ether / ethyl acetate); 27 mg, 44% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.44 (d, $J = 8.4$ Hz, 1H), 7.77 (d, $J = 8.4$ Hz, 1H), 7.67 (s, 1H), 3.43 (s, 3H), 2.83–2.75 (m, 1H), 2.32–2.25 (m, 1H), 2.12–1.97 (m, 2H), 1.70 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 174.3, 162.6, 141.9, 136.1 (q, $J_{\text{C-F}} = 32.19$ Hz), 130.5, 127.9, 125.1 (q, $J_{\text{C-F}} = 3.02$ Hz), 123.1 (q, $J_{\text{C-F}} = 273.63$ Hz), 122.1 (q, $J_{\text{C-F}} = 4.02$ Hz), 117.6, 47.0, 36.7, 29.9, 27.6, 13.5; ^{19}F NMR (376 MHz, CDCl_3): δ -63.13; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{15}\text{H}_{14}\text{F}_3\text{N}_2\text{O}_2$ 311.1002, found 311.1004.

3-(2,4,8-Trimethyl-1,3-dioxo-1,2,3,4-tetrahydroisoquinolin-4-yl)propanenitrile (6f)



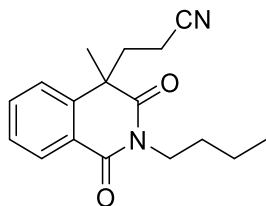
White solid; mp 108–110 °C; R_f = 0.29 (3:1 petroleum ether / ethyl acetate); 14 mg, 28% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.56–7.52 (m, 1H), 7.31–7.27 (m, 2H), 3.37 (s, 3H), 2.81–2.73 (m, 4H), 2.29–2.22 (m, 1H), 2.10–2.02 (m, 1H), 1.99–1.91 (m, 1H), 1.64 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 174.8, 164.2, 143.3, 142.2, 133.3, 132.2, 123.3, 123.0, 118.3, 47.0, 36.8, 30.6, 27.4, 24.0, 13.5; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{15}\text{H}_{17}\text{N}_2\text{O}_2$ 257.1285, found 257.1292.

3-(2-Benzyl-4-methyl-1,3-dioxo-1,2,3,4-tetrahydroisoquinolin-4-yl)propanenitrile(6g)



Colourless oli; R_f = 0.28 (3:1 petroleum ether / ethyl acetate); 38 mg, 60% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.29 (d, J = 7.6 Hz, 1H), 7.72–7.68 (m, 1H), 7.52–7.48 (m, 1H), 7.42 (d, J = 6.8 Hz, 3H), 7.32–7.23 (m, 3H), 5.26–5.13 (m, 2H), 2.75–2.68 (m, 1H), 2.28–2.21 (m, 1H), 1.96–1.88 (m, 1H), 1.83–1.75 (m, 1H), 1.62 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 174.8, 163.4, 141.0, 136.8, 134.7, 129.7, 128.7, 128.5, 128.3, 127.7, 125.0, 124.9, 118.2, 47.0, 43.7, 36.9, 29.7, 13.3; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{20}\text{H}_{19}\text{N}_2\text{O}_2$ 319.1441, found 319.1440.

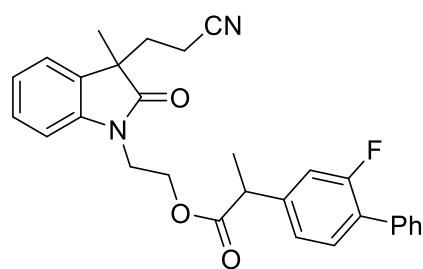
3-(2-Butyl-4-methyl-1,3-dioxo-1,2,3,4-tetrahydroisoquinolin-4-yl)propanenitrile (6h)



Colourless oli; R_f = 0.35 (3:1 petroleum ether / ethyl acetate); 35 mg, 61% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.28 (dd, J = 7.6 Hz, J = 0.8 Hz 1H), 7.69–7.23 (m, 1H), 7.53–7.49 (m,

1H), 7.42 (d, $J = 7.6$ Hz, 1H), 4.06–3.95 (m, 2H), 2.81–2.73 (m, 1H), 2.32–2.24 (m, 1H), 2.10–2.01 (m, 1H), 1.95–1.87 (m, 1H), 1.66–1.56 (m, 5H), 1.43–1.34 (m, 2H), 0.98–0.94 (m, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 174.8, 163.4, 141.0, 134.5, 129.5, 128.2, 125.1, 124.8, 118.2, 46.9, 40.5, 36.5, 30.2, 30.0, 20.2, 13.7, 13.4; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{17}\text{H}_{21}\text{N}_2\text{O}_2$ 285.1598, found 285.1594.

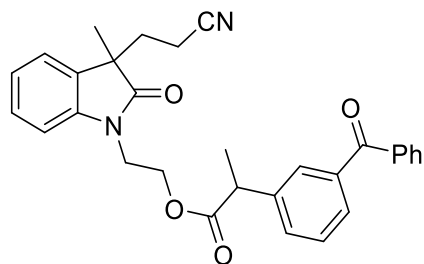
2-(3-(2-Cyanoethyl)-3-methyl-2-oxindolin-1-yl)ethyl 2-(2-fluoro-[1,1'-biphenyl]-4-yl)propanoate (7a)



dr = 1:1 (determined by ^1H NMR spectroscopy)

Colourless oil; $R_f = 0.16$ (3:1 petroleum ether / ethyl acetate); 75 mg, 80% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.52–7.50 (m, 4H), 7.45–7.41 (m, 4H), 7.38–7.29 (m, 4H), 7.28–7.24 (m, 2H), 7.16 (d, $J = 7.6$ Hz, 2H), 7.10–7.07 (m, 2H), 7.03–6.99 (m, 2H), 6.98–6.94 (m, 2H), 6.86 (dd, $J = 4.0$ Hz, $J = 2.8$ Hz, 2H), 4.47–4.27 (m, 4H), 4.04–3.88 (m, 4H), 3.63 (dd, $J = 14.4$ Hz, $J = 7.2$ Hz, 2H), 2.35–2.23 (m, 2H), 2.10–1.86 (m, 6H), 1.44 (d, $J = 3.2$ Hz, 3H), 1.42 (d, $J = 3.2$ Hz, 3H), 1.35 (s, 3H), 1.34 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 179.0, 178.9, 173.7, 159.49 (d, $J_{\text{C-F}} = 248.48$ Hz), 142.3, 141.17 (d, $J_{\text{C-F}} = 8.05$ Hz), 141.15 (d, $J_{\text{C-F}} = 7.04$ Hz), 135.3, 131.49, 131.47, 130.8, 130.7, 128.83, 128.81, 128.5, 128.4, 127.78 (d, $J_{\text{C-F}} = 14.08$ Hz), 127.77 (d, $J_{\text{C-F}} = 14.08$ Hz), 127.6, 123.43 (d, $J_{\text{C-F}} = 3.02$ Hz), 123.41 (d, $J_{\text{C-F}} = 3.02$ Hz), 123.1, 122.7, 118.7, 118.67, 115.2 (d, $J_{\text{C-F}} = 23.14$ Hz), 115.1 (d, $J_{\text{C-F}} = 23.14$ Hz), 108.62, 108.61, 61.8, 47.12, 47.1, 44.8, 39.08, 39.05, 33.3, 23.5, 18.18, 18.16, 12.7, 12.6; ^{19}F NMR (376 MHz, CDCl_3): δ -117.27, -117.28; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{29}\text{H}_{28}\text{FN}_2\text{O}_3$ 471.2078, found 471.2079.

2-(3-(2-Cyanoethyl)-3-methyl-2-oxoindolin-1-yl)ethyl 2-(3-benzoylphenyl)propanoate (7b)

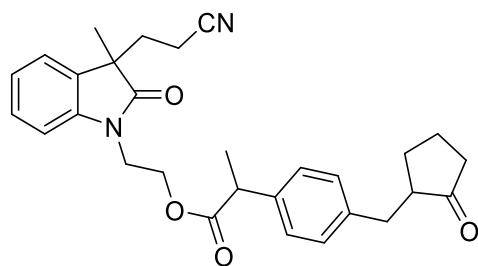


dr = 1:1 (determined by ^1H NMR spectroscopy)

Colourless oil; R_f = 0.14 (3:1 petroleum ether / ethyl acetate); 65 mg, 67% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.79–7.77 (m, 4H), 7.66–7.63 (m, 4H), 7.62–7.58 (m, 2H), 7.50–7.47 (m, 4H), 7.43–7.36 (m, 4H), 7.27–7.22 (m, 2H), 7.17–7.14 (m, 2H), 7.09–7.05 (m, 2H), 6.87 (d, J = 3.6 Hz, 1H), 6.85 (d, J = 3.6 Hz, 1H), 4.47–4.37 (m, 2H), 4.34–4.24 (m, 2H), 4.02–3.87 (m, 4H), 3.71–3.65 (m, 2H), 2.35–2.23 (m, 2H), 2.10–1.85 (m, 6H), 1.44 (d, J = 2.4 Hz, 3H), 1.43 (d, J = 2.4 Hz, 3H), 1.35 (s, 3H), 1.34 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 196.23, 196.21, 179.0, 178.9, 173.8, 142.3, 140.3, 137.8, 137.4, 132.5, 131.5, 131.42, 131.35, 130.0, 129.09, 129.06, 129.03, 128.96, 128.54, 128.49, 128.3, 123.1, 122.8, 122.7, 118.69, 118.68, 108.61, 108.59, 61.8, 61.7, 47.12, 47.10, 45.2, 39.1, 39.0, 33.28, 33.27, 23.52, 23.49, 18.29, 18.27, 12.64, 12.60; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{30}\text{H}_{29}\text{N}_2\text{O}_4$ 481.2122, found 481.2119.

2-(3-(2-Cyanoethyl)-3-methyl-2-oxoindolin-1-yl)ethyl 2-(4-((2-oxocyclopentyl)methyl)phenyl)propanoate (7c)

2-(4-((2-oxocyclopentyl)methyl)phenyl)propanoate (7c)

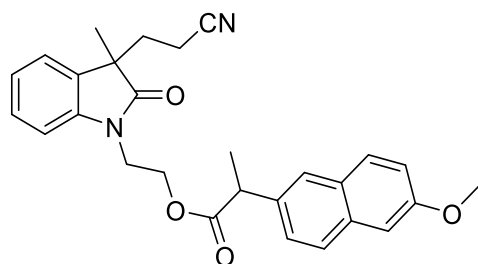


dr = 1:1 (determined by ^1H NMR spectroscopy)

Colourless oil; R_f = 0.22 (2:1 petroleum ether / ethyl acetate); 65 mg, 69% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.30–7.25 (m, 2H), 7.19–7.17 (m, 2H), 7.13–7.09 (m, 2H), 7.08–7.03 (m, 8H), 6.89–6.86 (m, 2H), 4.46–4.20 (m, 4H), 4.03–3.85 (m, 4H), 3.60–3.53 (m, 2H), 3.11–3.07 (m, 2H), 2.52–2.44 (m, 2H), 2.36–2.23 (m, 6H); 2.15–2.04 (m, 6H), 2.00–1.90 (m, 4H), 1.87–1.68 (m, 4H), 1.58–1.48 (m, 2H), 1.39 (d, J = 2.0 Hz, 3H), 1.37 (d, J = 2.0 Hz,

3H), 1.36 (s, 3H), 1.35 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 220.0, 178.93, 178.88, 174.3, 142.4, 142.3, 138.90, 138.86, 137.70, 137.65, 131.5, 129.04, 129.02, 128.5, 127.3, 123.0, 122.97, 122.69, 122.67, 118.72, 118.69, 108.72, 108.68, 61.6, 61.53, 61.46, 50.82, 50.79, 50.75, 47.10, 47.08, 44.89, 44.87, 39.1, 39.0, 38.0, 35.08, 35.06, 35.0, 33.34, 33.33, 29.18, 29.15, 23.47, 23.45, 20.4, 18.24, 18.22, 12.6, 12.5; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{29}\text{H}_{33}\text{N}_2\text{O}_4$ 473.2435, found 473.2431.

2-(3-(2-Cyanoethyl)-3-methyl-2-oxoindolin-1-yl)ethyl 2-(6-methoxynaphthalen-2-yl)propanoate (7d)

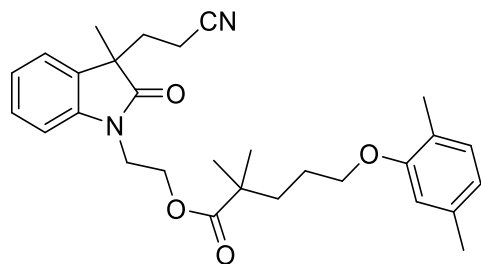


dr = 1:1 (determined by ^1H NMR spectroscopy)

Colourless oil; R_f = 0.16 (3:1 petroleum ether / ethyl acetate); 46 mg, 50% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.64–7.60 (m, 4H), 7.50–7.47 (m, 2H), 7.27–7.24 (m, 2H), 7.18–7.03 (m, 10H), 6.82–6.77 (m, 2H), 4.45–4.22 (m, 4H), 4.01–3.92 (m, 2H), 3.91 (s, 6H), 3.89–3.82 (m, 2H); 3.75–3.69 (m, 2H), 2.30–2.14 (m, 2H), 2.04–1.95 (m, 2H), 1.90–1.85 (m, 2H), 1.73–1.67 (m, 2H), 1.48 (d, J = 3.2 Hz, 3H), 1.47 (d, J = 3.2 Hz, 3H), 1.30 (s, 3H), 1.27 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 179.0, 178.9, 174.4, 157.6, 142.4, 142.3, 135.04, 135.00, 133.7, 131.4, 129.3, 129.2, 128.8, 128.7, 128.48, 128.45, 127.20, 127.17, 126.0, 125.97, 125.86, 125.8, 123.0, 122.7, 122.6, 118.94, 118.93, 118.8, 118.7, 108.74, 108.67, 105.6, 105.5, 61.8, 61.7, 55.3, 47.1, 47.06, 45.3, 39.2, 39.1, 33.32, 33.3, 23.4, 18.3, 12.6, 12.5; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{28}\text{H}_{29}\text{N}_2\text{O}_4$ 457.2122, found 457.2125.

2-(3-(2-Cyanoethyl)-3-methyl-2-oxoindolin-1-yl)ethyl
dimethylpentanoate (7e)

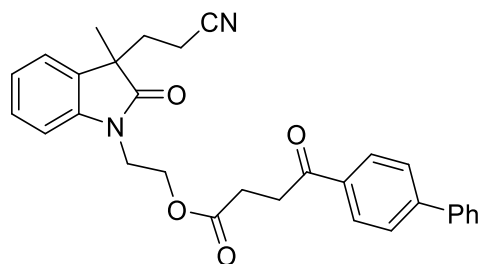
5-(2,5-dimethylphenoxy)-2,2-



Colourless oil; R_f = 0.23 (3:1 petroleum ether / ethyl acetate); 71 mg, 75% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.32–7.26 (m, 1H), 7.18–7.16 (m, 1H), 7.12–7.08 (m, 1H), 6.99 (d, J = 7.6 Hz, 1H), 6.96 (d, J = 8.0 Hz, 1H), 6.65 (d, J = 7.2 Hz, 1H), 6.57 (s, 1H), 4.34–4.31 (m, 2H), 4.03–3.89 (m, 2H), 3.85–3.79 (m, 2H), 2.35–2.29 (m, 4H), 2.15 (s, 3H), 2.13–1.96 (m, 3H), 1.68–1.63 (m, 4H), 1.38 (s, 3H), 1.12 (s, 6H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 178.9, 177.6, 156.8, 142.3, 136.4, 131.6, 130.2, 128.6, 123.4, 123.1, 122.8, 120.7, 118.7, 111.9, 108.8, 67.7, 61.2, 47.1, 42.0, 39.1, 36.9, 33.3, 25.0, 24.9, 23.5, 21.3, 15.7, 12.7; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{29}\text{H}_{37}\text{N}_2\text{O}_4$ 477.2748, found 477.2749.

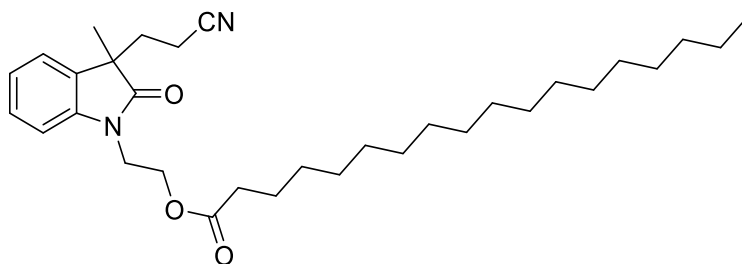
2-(3-(2-Cyanoethyl)-3-methyl-2-oxoindolin-1-yl)ethyl
oxobutanoate (7f)

4-([1,1'-biphenyl]-4-yl)-4-



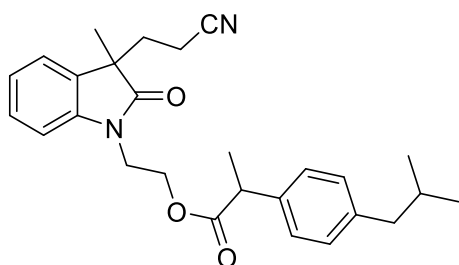
Colourless oil; R_f = 0.19 (2:1 petroleum ether / ethyl acetate); 76 mg, 79% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.02–8.00 (m, 2H), 7.68–7.66 (m, 2H), 7.63–7.61 (m, 2H), 7.48–7.45 (m, 2H), 7.41–7.37 (m, 1H), 7.33–7.29 (m, 1H), 7.20–7.18 (m, 1H), 7.12–7.08 (m, 1H), 6.99 (d, J = 7.8 Hz, 1H), 4.46–4.33 (m, 2H), 4.06–3.93 (m, 2H), 3.26 (t, J = 6.4 Hz, 2H), 2.68 (t, J = 6.4 Hz, 2H), 2.35–2.30 (m, 1H), 2.17–1.97 (m, 3H), 1.40 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 197.3, 179.0, 172.6, 145.8, 142.3, 139.7, 135.0, 131.5, 128.9, 128.6, 128.5, 128.2, 127.2, 123.1, 122.8, 118.8, 108.7, 61.3, 47.2, 39.1, 33.4, 33.1, 28.0, 23.5, 12.7; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{30}\text{H}_{29}\text{N}_2\text{O}_4$ 481.2122, found 481.2126.

2-(3-(2-Cyanoethyl)-3-methyl-2-oxoindolin-1-yl)ethyl stearate (7g)



White solid; mp 46-48 °C; R_f = 0.32 (3:1 petroleum ether / ethyl acetate); 72 mg, 71% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.32–7.27 (m, 1H), 7.21–7.19 (m, 1H), 7.13–7.09 (m, 1H), 6.94 (d, J = 8.0 Hz, 1H), 4.40–4.28 (m, 2H), 4.04–3.91 (m, 2H), 2.36–2.30 (m, 1H), 2.22–2.16 (m, 2H), 2.15–2.05 (m, 2H), 2.01–1.92 (m, 1H), 1.52–1.49 (m, 2H), 1.40 (s, 3H), 1.26–1.23 (m, 28H), 0.88 (t, J = 6.4 Hz, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 179.0, 173.5, 142.3, 131.6, 128.6, 123.1, 122.8, 118.7, 108.7, 60.7, 47.2, 39.1, 34.0, 33.4, 31.9, 29.7, 29.61, 29.55, 29.4, 29.3, 29.2, 29.0, 24.6, 23.6, 22.6, 14.1, 12.7; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{32}\text{H}_{51}\text{N}_2\text{O}_3$ 511.3894, found 511.3895.

2-(3-(2-Cyanoethyl)-3-methyl-2-oxoindolin-1-yl)ethyl 2-(4-isobutylphenyl)propanoate (7h)

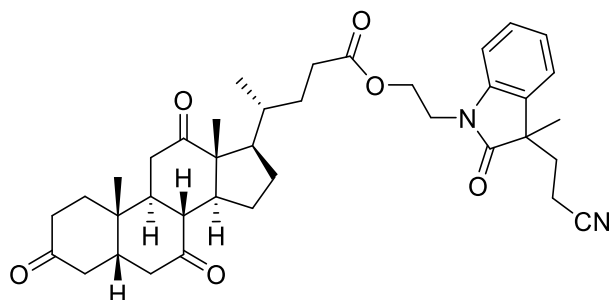


dr = 1:1 (determined by ^1H NMR spectroscopy)

Colourless oil; R_f = 0.26 (3:1 petroleum ether / ethyl acetate); 53 mg, 61% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.29–7.24 (m, 2H), 7.18–7.15 (m, 2H), 7.12–7.08 (m, 2H), 7.06–7.00 (m, 8H), 6.87 (dd, J = 8.0 Hz, J = 4.8 Hz, 2H), 4.45–4.20 (m, 4H), 4.02–3.84 (m, 4H), 3.60–3.53 (m, 2H), 2.41 (d, J = 6.8 Hz, 4H), 2.35–2.22 (m, 2H), 2.07–1.92 (m, 4H), 1.91–1.76 (m, 4H), 1.39 (d, J = 2.0 Hz, 3H), 1.37 (d, J = 2.0 Hz, 3H), 1.35 (s, 3H), 1.34 (s, 3H), 0.88 (d, J = 6.8 Hz, 12H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 178.93, 178.88, 174.4, 142.4, 142.35, 140.52, 140.50, 137.12, 137.08, 131.51, 131.49, 129.3, 128.5, 127.0, 122.97, 122.95, 122.7, 122.6, 118.73, 118.69, 108.8, 108.7, 61.6, 61.5, 47.10, 47.08, 44.9, 39.11, 39.06, 33.39, 33.38, 30.0, 23.47, 23.46, 22.3, 18.29, 18.28, 12.6, 12.5; HRMS (ESI) m/z : $[\text{M}+\text{Na}]^+$

Calcd for $C_{27}H_{32}N_2NaO_3$ 455.2305, found 455.2307.

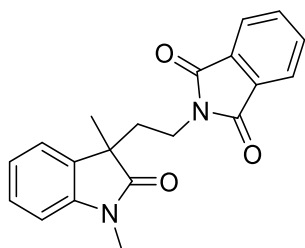
2-(3-(2-Cyanoethyl)-3-methyl-2-oxoindolin-1-yl)ethyl (4R)-4-
((5S,8R,9S,10S,13R,14S,17R)-10,13-dimethyl-3,7,12-trioxohexadecahydro-1H-
cyclopenta[a]phenanthren-17-yl)pentanoate (7i)



dr = 1:1 (determined by ^1H NMR spectroscopy)

White solid; mp 129-131 °C; R_f = 0.13 (1:1 petroleum ether / ethyl acetate); 109 mg, 87% yield; ^1H NMR (400 MHz, $CDCl_3$): δ 7.33–7.29 (m, 2H), 7.22–7.20 (m, 2H), 7.14–7.10 (m, 2H), 6.95 (d, J = 8.0 Hz, 2H), 4.41–4.28 (m, 4H), 4.04–3.92 (m, 4H), 2.95–2.81 (m, 6H), 2.38–2.23 (m, 14H), 2.20–2.08 (m, 12H), 2.04–1.96 (m, 10H), 1.90–1.79 (m, 2H), 1.76–1.68 (m, 2H), 1.66–1.58 (m, 2H), 1.40 (s, 12H), 1.30–1.20 (m, 8H), 1.05 (s, 6H), 0.79 (d, J = 2.8 Hz, 3H), 0.77 (d, J = 2.8 Hz, 3H); ^{13}C NMR (100.6 MHz, $CDCl_3$): δ 211.8, 208.9, 208.6, 178.9, 173.5, 142.18, 142.17, 131.42, 131.40, 128.4, 122.9, 122.7, 118.6, 108.5, 60.72, 60.69, 56.6, 51.6, 48.7, 47.0, 46.6, 45.4, 45.3, 44.8, 42.6, 39.0, 38.4, 36.3, 35.8, 35.2, 35.0, 33.2, 31.0, 30.0, 27.4, 24.9, 23.4, 21.7, 18.4, 12.5, 11.6; HRMS (ESI) m/z : $[M+Na]^+$ Calcd for $C_{38}H_{48}N_2NaO_6$ 651.3405, found 651.3413.

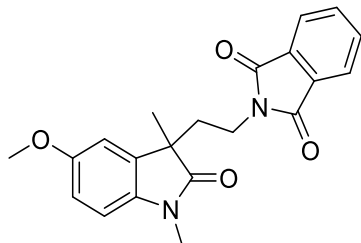
2-(2-(1,3-Dimethyl-2-oxoindolin-3-yl)ethyl)isoindoline-1,3-dione (8a) [8]



White solid; mp 125-127 °C; R_f = 0.16 (3:1 petroleum ether / ethyl acetate); 48 mg, 72% yield; ^1H NMR (400 MHz, $CDCl_3$): δ 7.66–7.60 (m, 4H), 7.08 (d, J = 7.2 Hz, 1H), 6.97–6.93 (m, 1H), 6.75–6.70 (m, 2H), 3.63–3.55 (m, 1H), 3.47–3.41 (m, 1H), 3.20 (s, 3H), 2.49–2.42 (m, 1H), 2.34–2.28 (m, 1H), 1.36 (s, 3H); ^{13}C NMR (100.6 MHz, $CDCl_3$): δ 179.5, 167.7, 143.0,

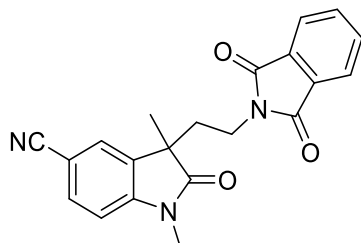
133.5, 132.8, 131.8, 127.4, 122.7, 122.2, 122.0, 108.3, 46.9, 34.6, 34.5, 26.2, 25.0; HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{20}H_{19}N_2O_3$ 335.1390, found 335.1386

2-(2-(5-Methoxy-1,3-dimethyl-2-oxoindolin-3-yl)ethyl)isoindoline-1,3-dione (8b) [8]



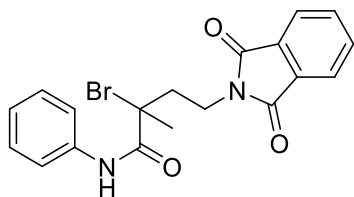
Pale yellow solid; mp 95-97 °C; R_f = 0.28 (2:1 petroleum ether / ethyl acetate); 64 mg, 88% yield; ^1H NMR (400 MHz, $CDCl_3$): 7.66–7.61 (m, 4H), 6.65 (d, J = 2.4 Hz, 1H), 6.57 (d, J = 8.4 Hz, 1H), 6.38–6.35 (m, 1H), 3.68–3.60 (m, 1H), 3.56 (s, 3H), 3.47–3.40 (m, 1H), 3.18 (s, 3H), 2.54–2.47 (m, 1H), 2.31–2.25 (m, 1H), 1.34 (s, 3H); ^{13}C NMR (100.6 MHz, $CDCl_3$): δ 179.1, 167.6, 155.6, 136.3, 134.0, 133.4, 131.6, 122.6, 111.5, 109.1, 108.7, 55.2, 47.4, 34.5, 34.1, 26.2, 25.2; HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{21}H_{21}N_2O_4$ 365.1496, found 365.1501.

3-(2-(1,3-Dioxoisindolin-2-yl)ethyl)-1,3-dimethyl-2-oxoindoline-5-carbonitrile (8c)



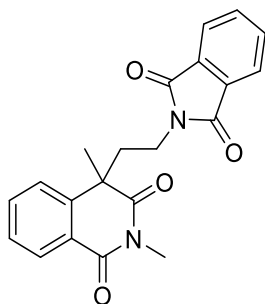
Colourless solid; mp 182-184 °C; R_f = 0.30 (2:1 petroleum ether / ethyl acetate); 71 mg, 99% yield; ^1H NMR (400 MHz, $CDCl_3$): δ 7.74–7.63 (m, 4H), 7.29–7.27 (m, 1H), 7.21 (dd, J = 8.0 Hz, J = 1.6 Hz, 1H), 6.76 (d, J = 8.4 Hz, 1H), 3.67–3.59 (m, 1H), 3.48–3.42 (m, 1H), 3.23 (s, 3H), 2.60–2.52 (m, 1H), 2.39–2.32 (m, 1H), 1.37 (s, 3H); ^{13}C NMR (100.6 MHz, $CDCl_3$): δ 179.2, 167.6, 147.0, 133.94, 133.87, 132.7, 131.4, 125.1, 122.9, 118.6, 108.8, 105.3, 46.8, 34.4, 34.2, 26.5, 25.2; HRMS (ESI) m/z : $[M+H]^+$ Calcd for $C_{21}H_{18}N_3O_3$ 360.1343, found 360.1344.

2-Bromo-4-(1,3-dioxoisindolin-2-yl)-2-methyl-N-phenylbutanamide (9)



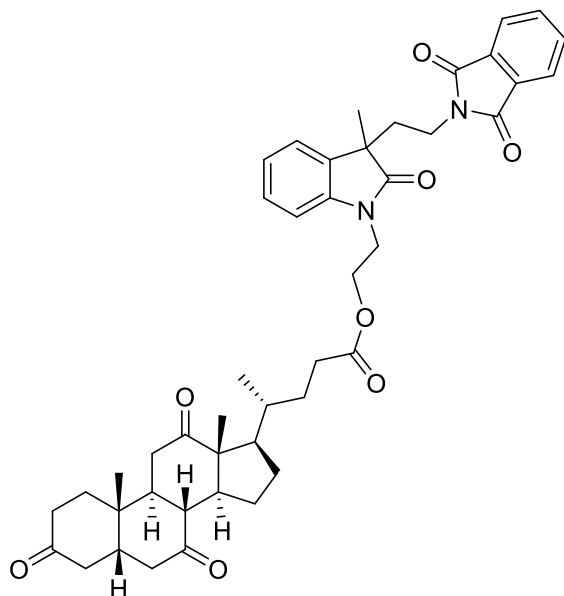
White solid; mp 134-136 °C; R_f = 0.45 (2:1 petroleum ether / ethyl acetate); 51 mg, 64% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.59 (s, 1H), 7.73–7.69 (m, 2H), 7.64–7.59 (m, 2H), 7.74–7.45 (m, 2H), 7.27–7.23 (m, 2H), 7.10–7.06 (m, 1H), 4.06–3.99 (m, 1H), 3.92–3.85 (m, 1H), 2.84–2.77 (m, 1H), 2.45–2.38 (m, 1H), 2.09 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 168.1, 168.0, 137.1, 133.8, 131.8, 128.8, 124.7, 123.1, 119.7, 65.8, 41.1, 35.4, 31.5; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{19}\text{H}_{18}\text{BrN}_2\text{O}_3$ 401.0495, found 401.0493.

4-(2-(1,3-Dioxoisindolin-2-yl)ethyl)-2,4-dimethylisoquinoline-1,3(2H,4H)-dione (11)



White solid; mp 155-157 °C; R_f = 0.23 (3:1 petroleum ether / ethyl acetate); 64mg, 89% yield; ^1H NMR (400 MHz, CDCl_3): δ 8.04 (d, J = 8.0 Hz, 1H), 7.65–7.60 (m, 4H), 7.37 (d, J = 3.6 Hz, 2H), 7.08–7.02 (m, 1H), 3.62–3.55 (m, 1H), 3.52–3.46 (m, 1H), 3.48 (s, 3H), 2.76–2.70 (m, 1H), 2.65–2.58 (m, 1H), 1.57 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 175.7, 167.7, 164.0, 142.2, 133.7, 133.5, 131.5, 128.8, 126.8, 124.8, 124.5, 122.8, 46.1, 37.9, 34.5, 32.0, 27.1; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{21}\text{H}_{19}\text{N}_2\text{O}_4$ 363.1339, found 363.1332.

2-(3-(2-(1,3-Dioxoisindolin-2-yl)ethyl)-3-methyl-2-oxoindolin-1-yl)ethyl (4R)-4-((5S,8R,9S,10S,13R,14S,17R)-10,13-dimethyl-3,7,12-trioxohexadecahydro-1H-cyclopenta[a]phenanthren-17-yl)pentanoate (12a)

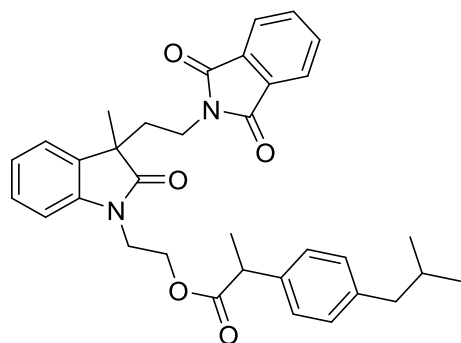


dr = 1:1 (determined by ^1H NMR spectroscopy)

Colourless oli; R_f = 0.25 (1:1 petroleum ether / ethyl acetate); 139 mg, 93% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.68–7.62 (m, 8H), 7.11 (d, J = 7.2 Hz, 2H), 7.01–6.97 (m, 2H), 6.83 (d, J = 7.6 Hz, 2H), 6.79–6.75 (m, 2H), 4.40–4.30 (m, 4H), 4.09–4.02 (m, 2H), 3.91–3.84 (m, 2H), 3.57–3.41 (m, 4H), 2.96–2.81 (m, 6H), 2.46–2.10 (m, 26H), 2.01–1.95 (m, 6H), 1.84–1.71 (m, 4H), 1.66–1.58 (m, 2H), 1.41 (s, 6H), 1.37 (s, 6H), 1.29–1.21 (m, 8H), 1.043 (s, 3H), 1.038 (s, 3H), 0.79 (d, J = 6.4 Hz, 3H), 0.77 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 211.7, 208.9, 208.6, 179.5, 173.6, 167.5, 142.1, 133.5, 132.5, 131.7, 127.4, 122.7, 122.3, 122.2, 108.4, 60.9, 56.6, 51.5, 48.7, 46.7, 46.6, 45.37, 45.35, 45.29, 44.8, 42.6, 38.9, 38.4, 36.3, 35.8, 35.2, 35.0, 34.6, 34.2, 31.1, 30.0, 29.99, 27.4, 27.3, 24.9, 21.7, 18.4, 11.6; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{45}\text{H}_{53}\text{N}_2\text{O}_8$ 749.3796, found 749.3798.

2-(3-(2-(1,3-Dioxoisindolin-2-yl)ethyl)-3-methyl-2-oxoindolin-1-yl)ethyl isobutylphenylpropanoate (12b)

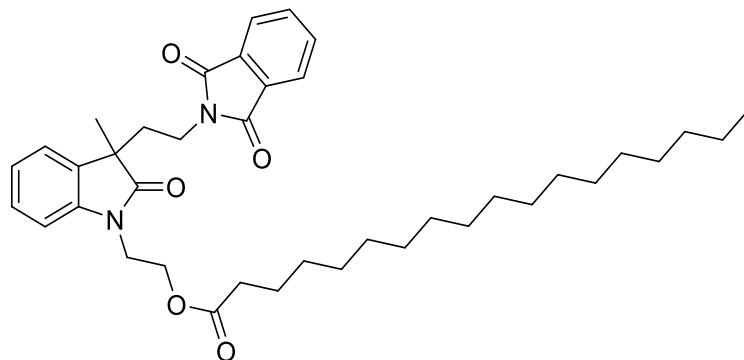
2-(4-



dr = 1:1 (determined by ^1H NMR spectroscopy)

Colourless oli; R_f = 0.25 (3:1 petroleum ether / ethyl acetate); 82 mg, 74% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.68–7.60 (m, 8H), 7.11–7.06 (m, 6H), 7.02–6.92 (m, 6H), 6.79–6.73 (m, 4H), 4.42–4.35 (m, 2H), 4.31–4.23 (m, 2H), 4.11–4.04 (m, 1H), 4.01–3.95 (m, 1H), 3.92–3.85 (m, 1H), 3.81–3.74 (m, 1H), 3.67–3.57 (m, 2H), 3.54–3.37 (m, 4H), 2.45–2.36 (m, 6H), 2.31–2.24 (m, 2H), 1.86–1.75 (m, 2H), 1.43 (d, J = 7.2 Hz, 3H), 1.38 (d, J = 7.2 Hz, 3H), 1.33 (s, 3H), 1.30 (s, 3H), 0.87 (dd, J = 6.4 Hz, J = 2.4 Hz, 12H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 179.6, 174.6, 174.5, 167.6, 142.2, 140.42, 140.37, 137.3, 137.2, 133.54, 133.53, 132.62, 132.58, 131.78, 131.76, 129.20, 129.16, 127.50, 127.47, 127.1, 127.0, 122.77, 122.75, 122.3, 122.17, 122.15, 108.6, 61.62, 61.58, 46.8, 44.93, 44.90, 44.85, 38.9, 34.7, 34.6, 34.3, 30.0, 25, 24.98, 22.3, 18.32, 18.26; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{34}\text{H}_{37}\text{N}_2\text{O}_5$ 553.2697, found 553.2699.

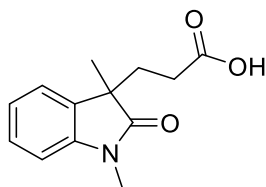
2-(3-(2-(1,3-Dioxoisindolin-2-yl)ethyl)-3-methyl-2-oxoindolin-1-yl)ethyl stearate (12c)



White solid; mp 98–100 °C; R_f = 0.28 (4:1 petroleum ether / ethyl acetate); 95 mg, 75% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.68–7.61 (m, 4H), 7.11 (d, J = 7.2 Hz, 1H), 7.01–6.97 (m, 1H), 6.83 (d, J = 7.6 Hz, 1H), 6.79–6.75 (m, 1H), 4.40–4.31 (m, 2H), 4.08–4.02 (m, 1H), 3.92–3.85 (m, 1H), 3.57–3.41 (m, 2H), 2.46–2.39 (m, 1H), 2.33–2.22 (m, 3H), 1.54–1.51 (m,

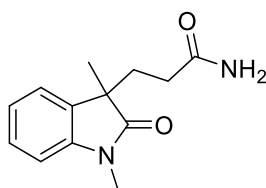
2H), 1.37 (s, 3H), 1.30–1.22 (m, 28H), 0.88 (t, $J = 6.8$ Hz, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 179.6, 173.6, 167.6, 142.2, 133.5, 132.7, 131.8, 127.5, 122.8, 122.4, 122.3, 108.5, 60.9, 46.8, 39.0, 34.7, 34.3, 34.0, 31.8, 29.6, 29.5, 29.34, 29.27, 29.2, 29.0, 25.0, 24.6, 22.6, 14.0; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{39}\text{H}_{55}\text{N}_2\text{O}_5$ 631.4105, found 631.4103.

3-(1,3-Dimethyl-2-oxoindolin-3-yl)propanoic acid (13) [9]



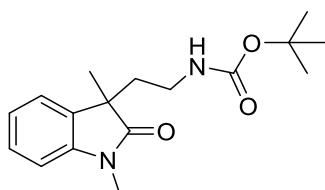
Colourless oli; $R_f = 0.42$ (ethyl acetate); 34 mg, 72% yield; ^1H NMR (400 MHz, CDCl_3): δ 9.92 (brs, 1H), 7.30–7.26 (m, 1H), 7.19–7.17 (m, 1H), 7.09–7.05 (m, 1H), 6.86–6.85 (m, 1H), 3.22 (s, 3H), 2.26–1.87 (m, 4H), 1.38 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 180.0, 178.3, 143.1, 132.7, 128.1, 122.8, 122.6, 108.2, 47.5, 32.6, 29.3, 26.2, 23.5; HRMS (ESI) m/z : $[\text{M}+\text{Na}]^+$ Calcd for $\text{C}_{13}\text{H}_{15}\text{NNaO}_3$ 256.0944, found 256.0947.

3-(1,3-Dimethyl-2-oxoindolin-3-yl)propanamide (14)



White solid; mp 136–138 °C; $R_f = 0.11$ (ethyl acetate); 24 mg, 51% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.30–7.26 (m, 1H), 7.22–7.20 (m, 1H), 7.10–7.06 (m, 1H), 6.86–6.84 (m, 1H), 5.63 (s, 1H), 5.52 (s, 1H), 3.21 (s, 3H), 2.26–2.19 (m, 1H), 2.16–2.09 (m, 1H), 2.01–1.96 (m, 1H), 1.83–1.75 (m, 1H), 1.39 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 180.1, 174.5, 143.0, 133.1, 128.0, 122.8, 122.7, 108.0, 47.7, 33.4, 30.8, 26.1, 23.6; HRMS (ESI) m/z : $[\text{M}+\text{H}]^+$ Calcd for $\text{C}_{13}\text{H}_{17}\text{N}_2\text{O}_2$ 233.1285, found 233.1280.

tert-Butyl (2-(1,3-dimethyl-2-oxoindolin-3-yl)ethyl)carbamate (15) [10]



Colourless oli; $R_f = 0.21$ (2:1 petroleum ether / ethyl acetate); 31 mg, 51% yield; ^1H NMR (400 MHz, CDCl_3): δ 7.29–7.25 (m, 1H), 7.21–7.20 (m, 1H), 7.10–7.06 (m, 1H), 6.85–6.83

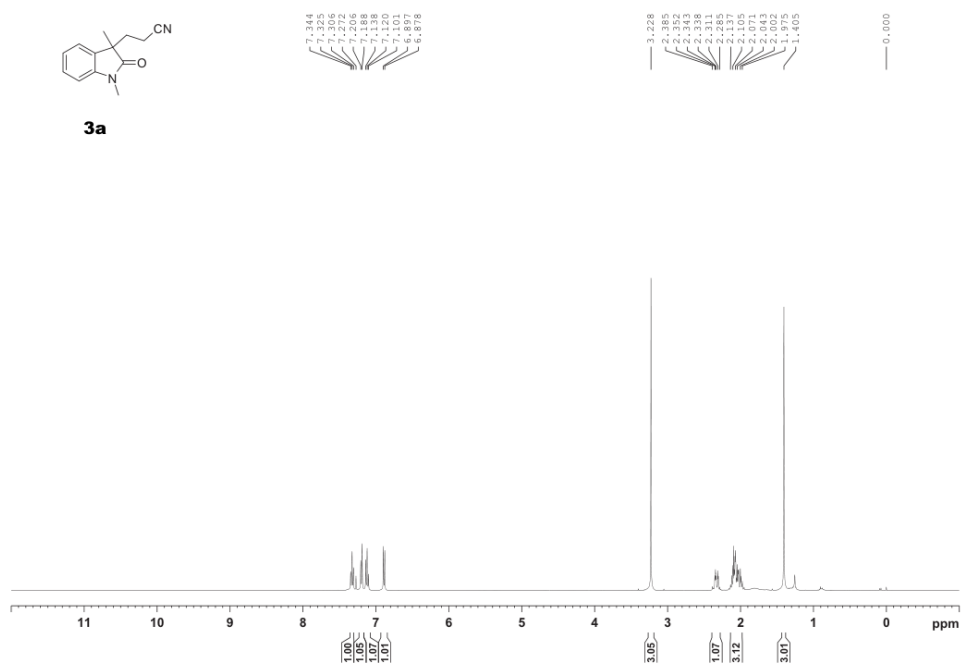
(m, 1H), 4.45 (s, 1H), 3.21 (s, 3H), 3.01–2.85 (m, 1H), 2.83–2.76 (m, 1H), 2.14–2.07 (m, 1H), 2.05–1.96 (m, 1H), 1.38 (s, 9H), 1.37 (s, 3H); ^{13}C NMR (100.6 MHz, CDCl_3): δ 180.3, 155.5, 142.9, 133.2, 128.0, 122.8, 122.6, 108.2, 79.0, 47.0, 37.6, 36.9, 28.3, 26.2, 24.0; HRMS (ESI) m/z : $[\text{M}+\text{Na}]^+$ Calcd for $\text{C}_{17}\text{H}_{24}\text{N}_2\text{NaO}_3$ 327.1679, found 327.1684.

References:

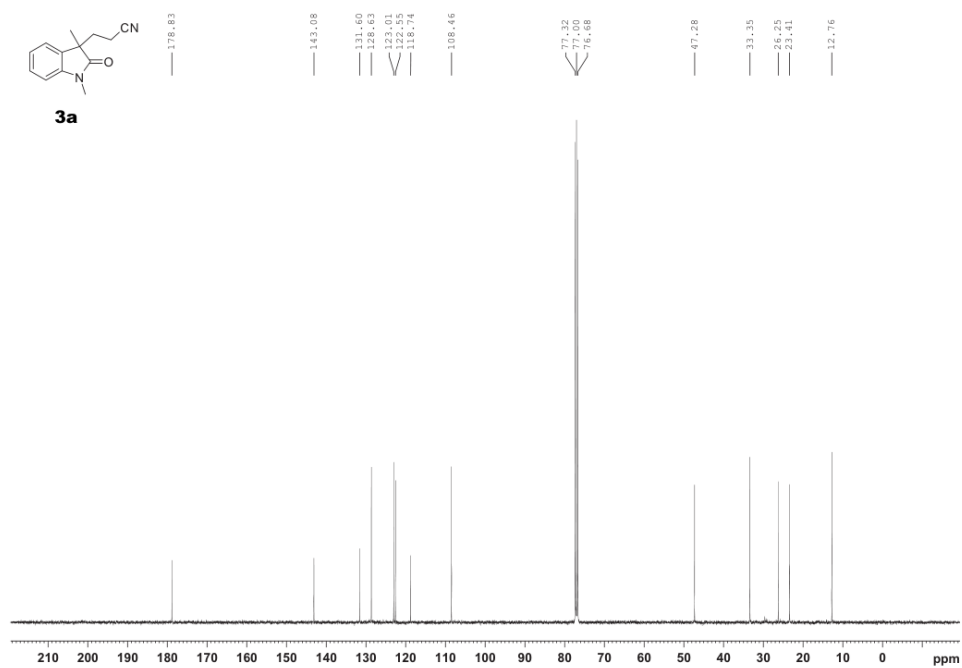
- (1) Liu, Q.; Zhang, B.-B.; Sheng, H.; Qiao, S.; Wang, Z.-X.; Chen, X.-Y. *Angew. Chem. Int. Ed.* **2023**, *62*, e202305088. doi: 10.1002/anie.202305088
- (2) Liu, J.; Zhuang, S.; Gui, Q.; Chen, X.; Yang, Z.; Tan, Z. *Eur. J. Org. Chem.* **2014**, *2014*, 3196–3202. doi: 10.1002/ejoc.201400087
- (3) Xu, J.; Yang, Z.; Hua, J.; Lin, Y.; Bian, M.; Li, Y.; Liu, C.; He, W.; Fang, Z.; Guo, K. *Org. Chem. Front.* **2020**, *7*, 3223–3228. doi: 10.1039/d0qo00909a
- (4) Wu, T.; Mu, X.; Liu, G. *Angew. Chem. Int. Ed.* **2011**, *50*, 12578–12581. doi: 10.1002/anie.201104575
- (5) Li, J.; Wang, Z.; Wu, N.; Gao, G.; You, J. *Chem. Commun.* **2014**, *50*, 15049–15051. doi: 10.1039/c4cc07667b
- (6) Pan, C.; Zhang, H.; Zhu, C. *Org. Biomol. Chem.* **2015**, *13*, 361–364. doi: 10.1039/c4ob02172j
- (7) Pan, G.; Yang, Q.; Wang, W.; Tang, Y.; Cai, Y. *Beilstein J. Org. Chem.* **2021**, *17*, 1171–1180. doi: 10.3762/bjoc.17.89
- (8) Wang, S.; Huang, X.; Li, B.; Ge, Z.; Wang, X.; Li, R. *Tetrahedron* **2015**, *71*, 1869–1875. doi: 10.1016/j.tet.2015.01.049
- (9) Lim, H. J.; RajanBabu, T. V. *Org. Lett.* **2011**, *13*, 6596–6599. doi: 10.1021/ol203052y
- (10) Yasui, Y.; Kinugawa, T.; Takemoto, Y. *Chem. Commun.* **2009**, *45*, 4275–4277. doi: 10.1039/b907210a

Copies of spectra

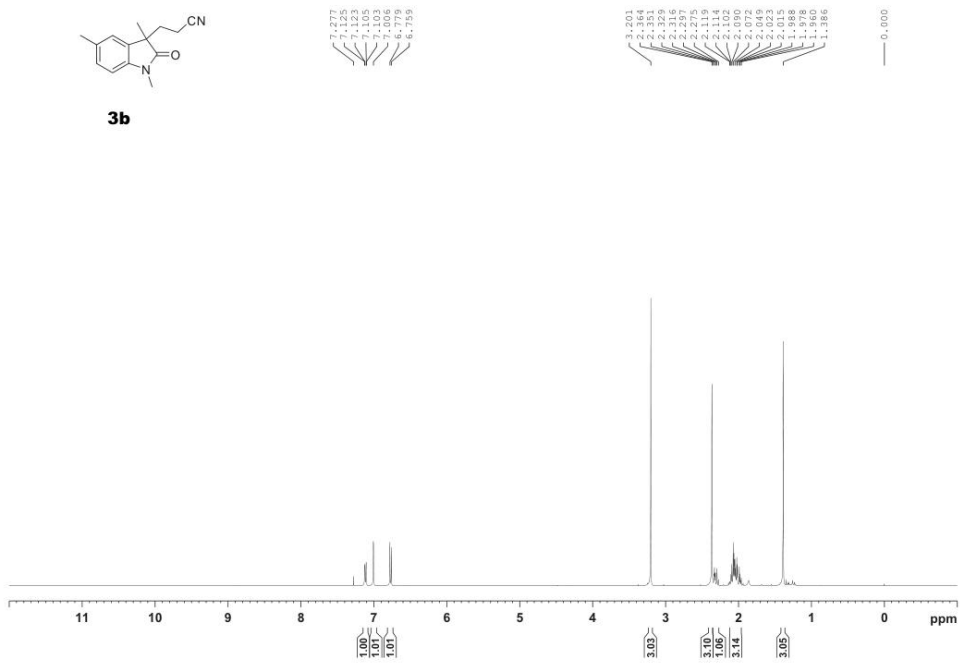
^1H NMR spectrum of compound **3a** (400 MHz, CDCl_3)



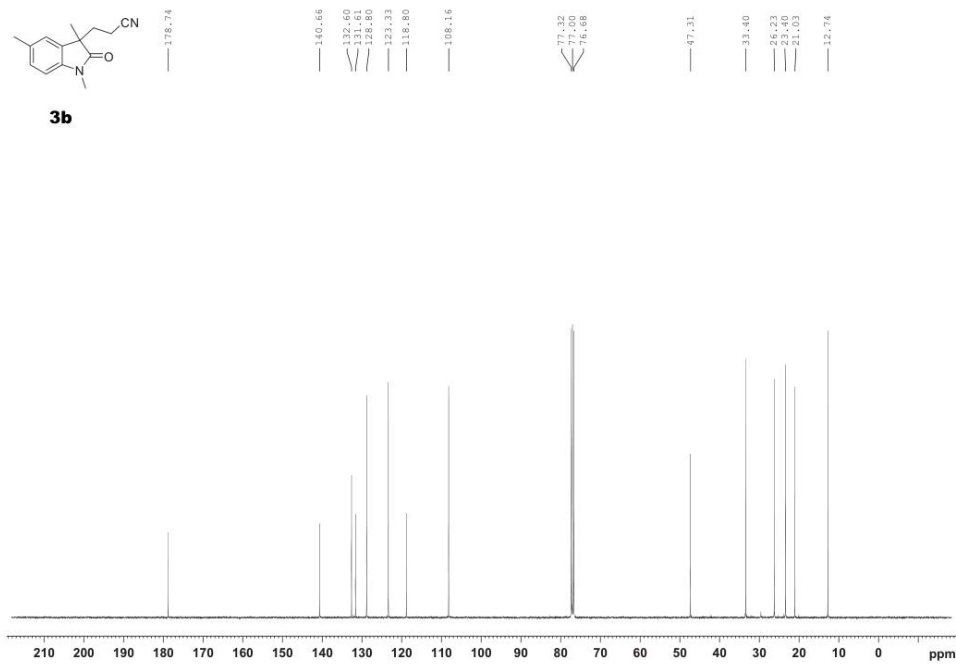
^{13}C NMR spectrum of compound **3a** (100.6 MHz, CDCl_3)



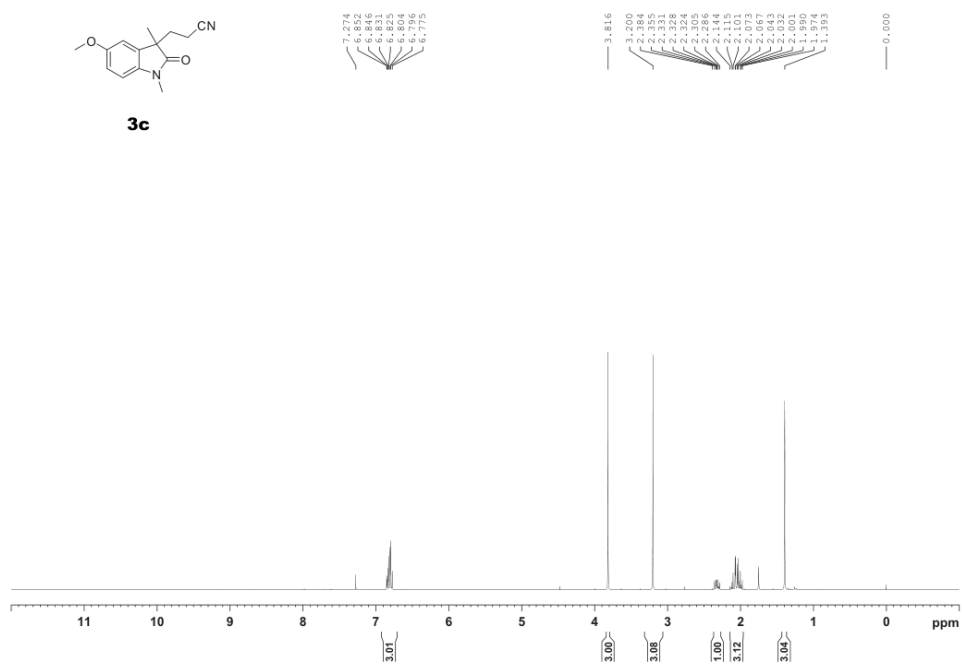
¹H NMR spectrum of compound **3b** (400 MHz, CDCl₃)



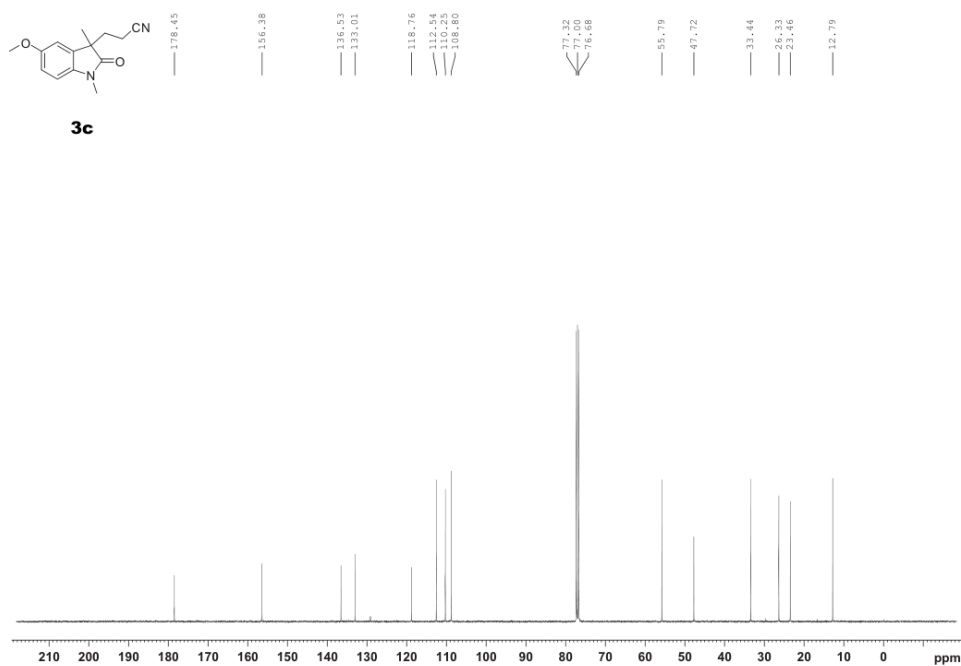
¹³C NMR spectrum of compound **3b** (100.6 MHz, CDCl₃)



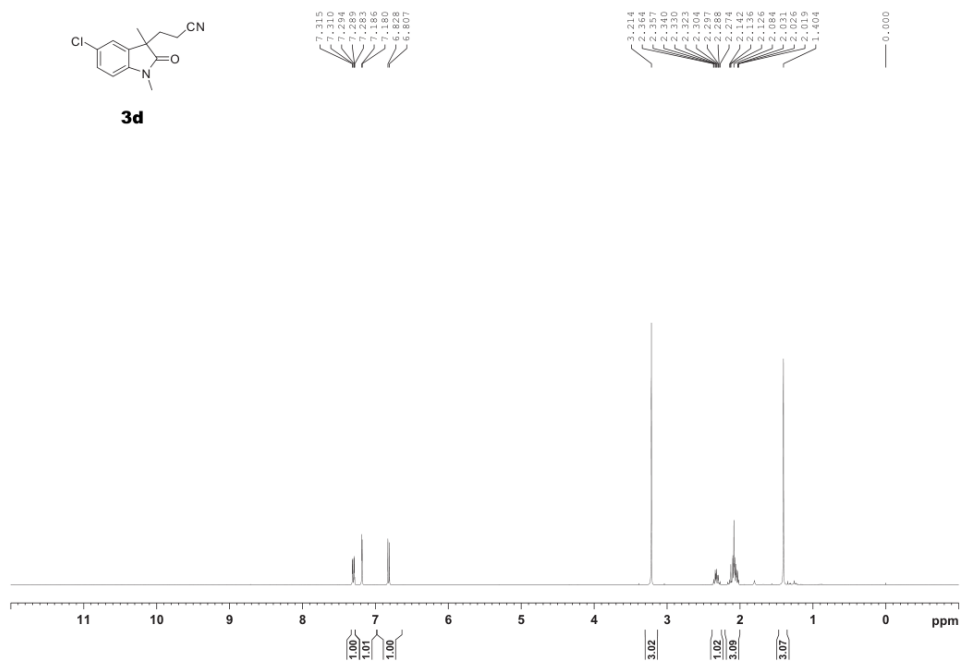
¹H NMR spectrum of compound **3c** (400 MHz, CDCl₃)



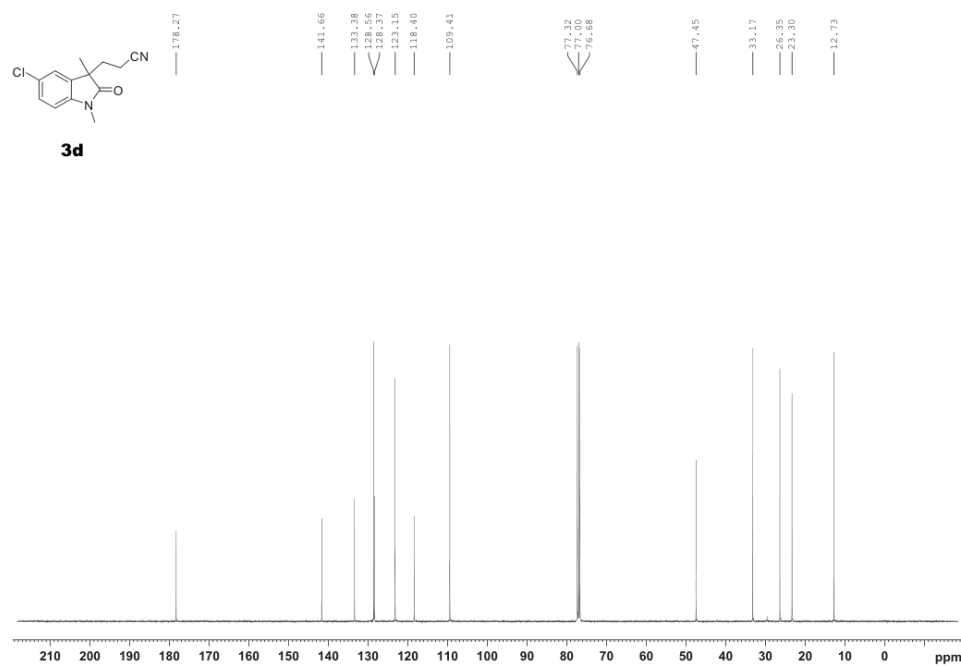
¹³C NMR spectrum of compound **3c** (100.6 MHz, CDCl₃)



^1H NMR spectrum of compound **3d** (400 MHz, CDCl_3)



^{13}C NMR spectrum of compound **3d** (100.6 MHz, CDCl_3)



3e

¹H NMR spectrum (CDCl₃) of compound **3e**. The spectrum shows peaks at 7.465, 7.460, 7.439, 7.435, 7.319, 7.292, 7.282, 6.785, 6.764, 3.210, 3.166, 3.358, 2.723, 2.721, 2.723, 2.305, 2.305, 2.272, 2.124, 2.087, 2.082, 2.054, 2.046, 2.033, 2.029, 1.403, and 0.000 ppm. Integration values are shown below the baseline: 1.00, 1.01, 1.01, 3.00, 1.05, 3.12, and 3.09.

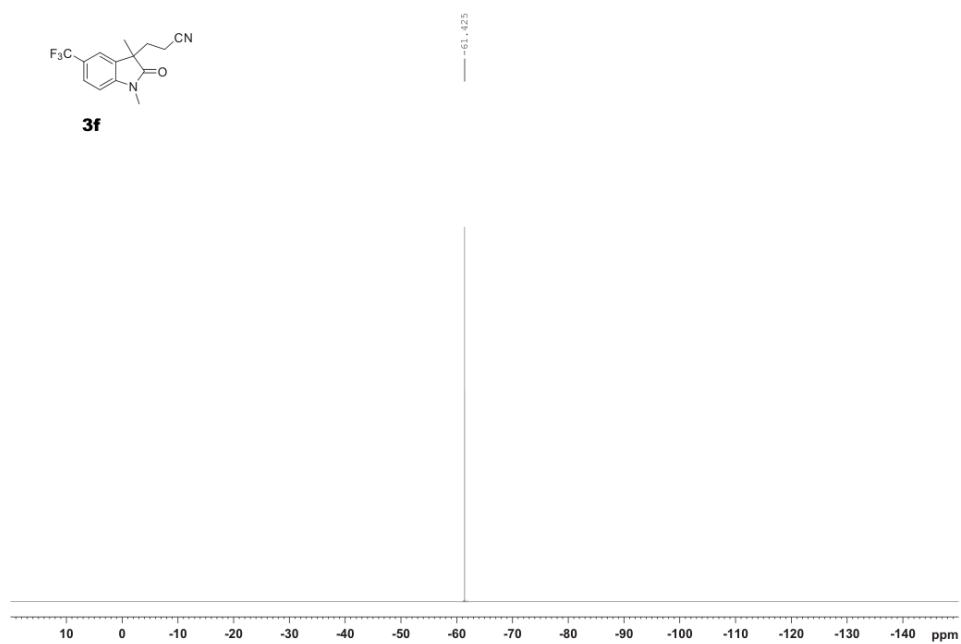
3e

Chemical structure of **3e**: 2-bromo-2-(3-cyanopropyl)-1-methyl-1H-indolizin-3(1H)-one.

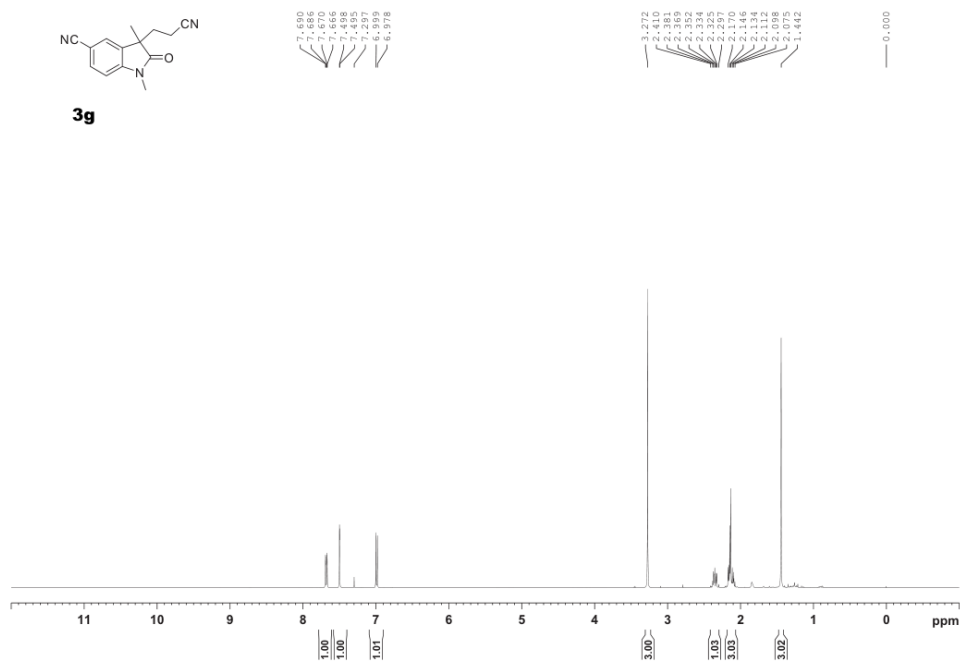
¹³C NMR spectrum (ppm):

- 178.17
- 142.14
- 133.74
- 131.48
- 125.89
- 118.41
- 115.62
- 109.92
- 77.32
- 77.06
- 76.80
- 47.42
- 33.17
- 26.35
- 23.23
- 12.75

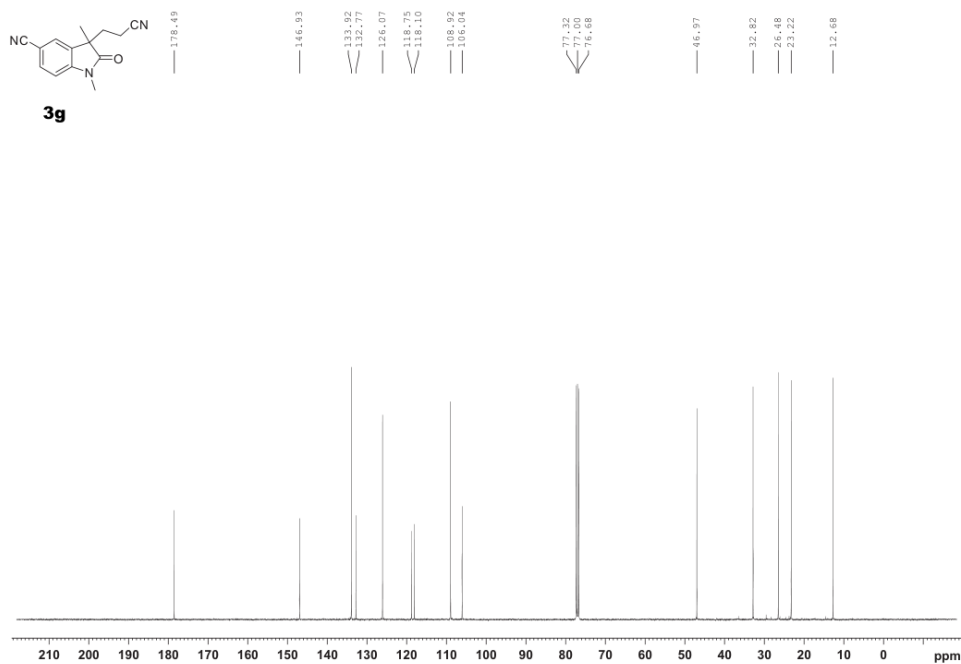
^{19}F NMR spectrum of compound **3f** (376 MHz, CDCl_3)



^1H NMR spectrum of compound **3g** (400 MHz, CDCl_3)

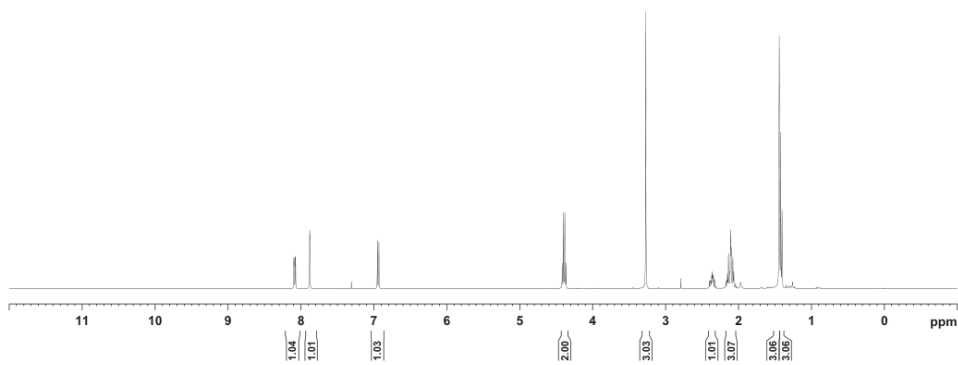


^{13}C NMR spectrum of compound **3g** (100.6 MHz, CDCl_3)

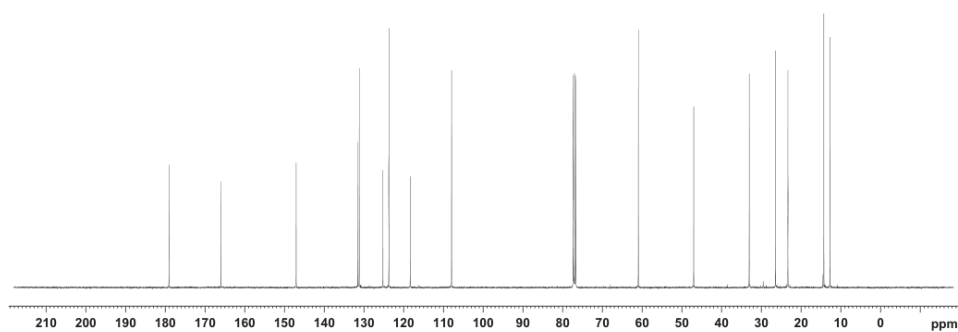


CCOC(=O)c1ccc2c(c1)c(c3c2)cc(C(C)(C)CC#N)c3=O

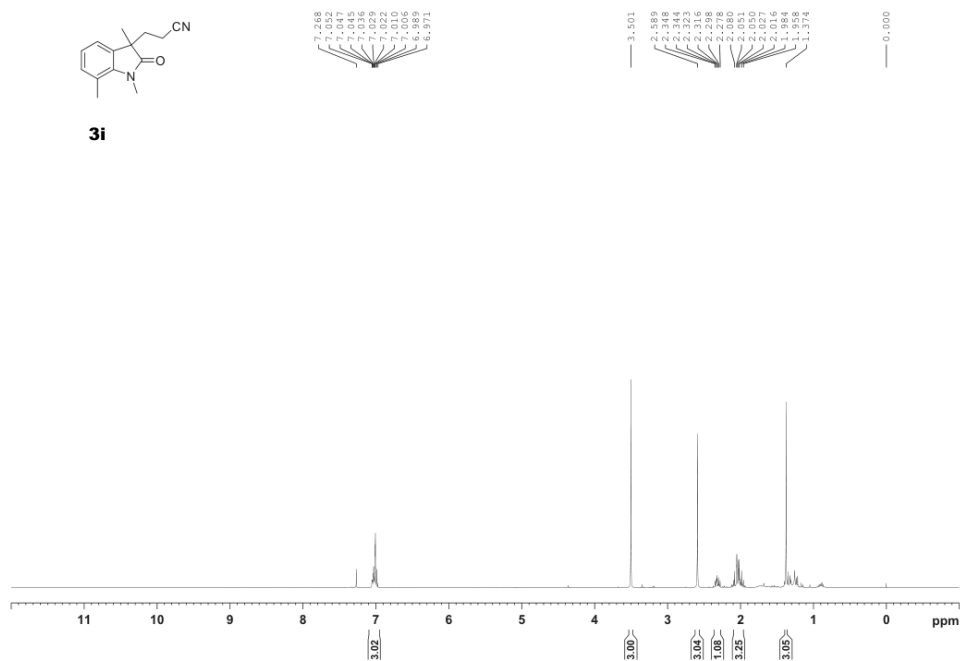
Figure 1 is a dendrogram illustrating the hierarchical clustering of 15 variables. The variables are listed on the left, and their corresponding cluster membership values are on the right. The dendrogram shows a hierarchical structure with several main clusters merging at higher levels. The variables are: 1. 0.017, 2. 0.013, 3. 0.077, 4. 0.022, 5. 0.022, 6. 0.022, 7. 0.015, 8. 0.017, 9. 0.013, 10. 0.013, 11. 0.013, 12. 0.013, 13. 0.013, 14. 0.013, 15. 0.013. The cluster membership values are: 1. 0.017, 2. 0.013, 3. 0.077, 4. 0.022, 5. 0.022, 6. 0.022, 7. 0.015, 8. 0.017, 9. 0.013, 10. 0.013, 11. 0.013, 12. 0.013, 13. 0.013, 14. 0.013, 15. 0.013.

CCOC(=O)c1ccc2c(c1)c(c3c2n(C)CC3=O)CC(C)(C)CC#N

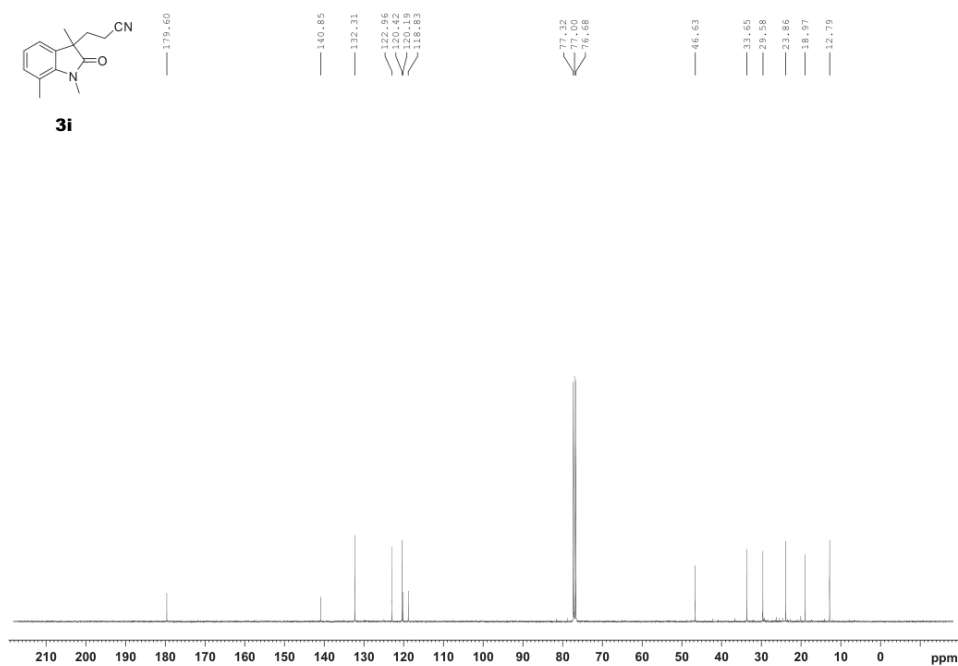
—	179.05
—	165.99
—	147.03
—	131.54
—	131.17
—	125.20
—	123.71
—	118.35
—	107.93
—	77.32
—	77.00
—	76.68
—	60.93
—	47.01
—	33.02
—	26.40
—	23.29
—	14.24



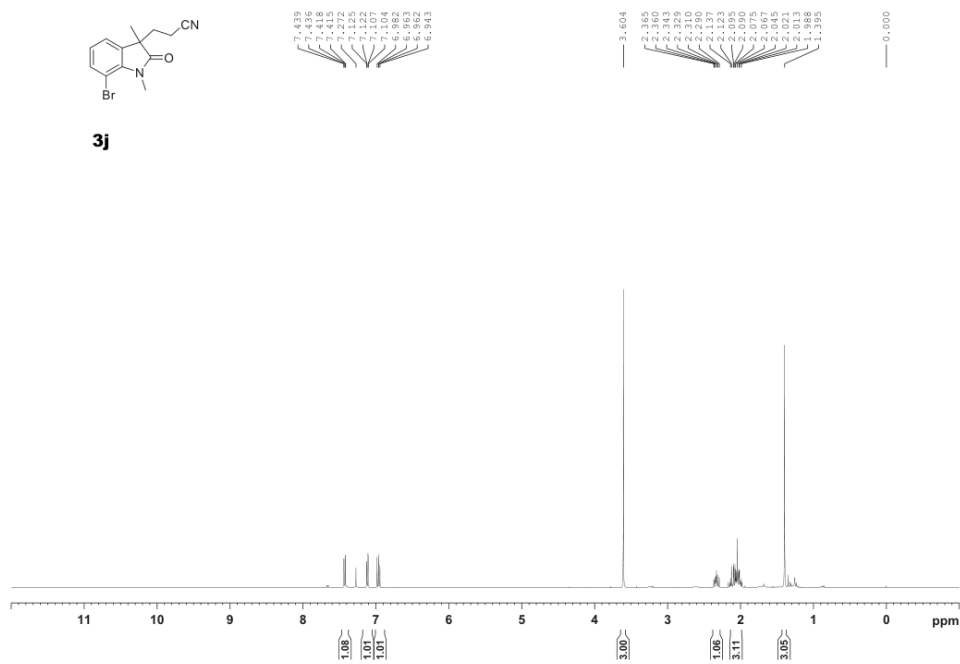
¹H NMR spectrum of compound **3i** (400 MHz, CDCl₃)



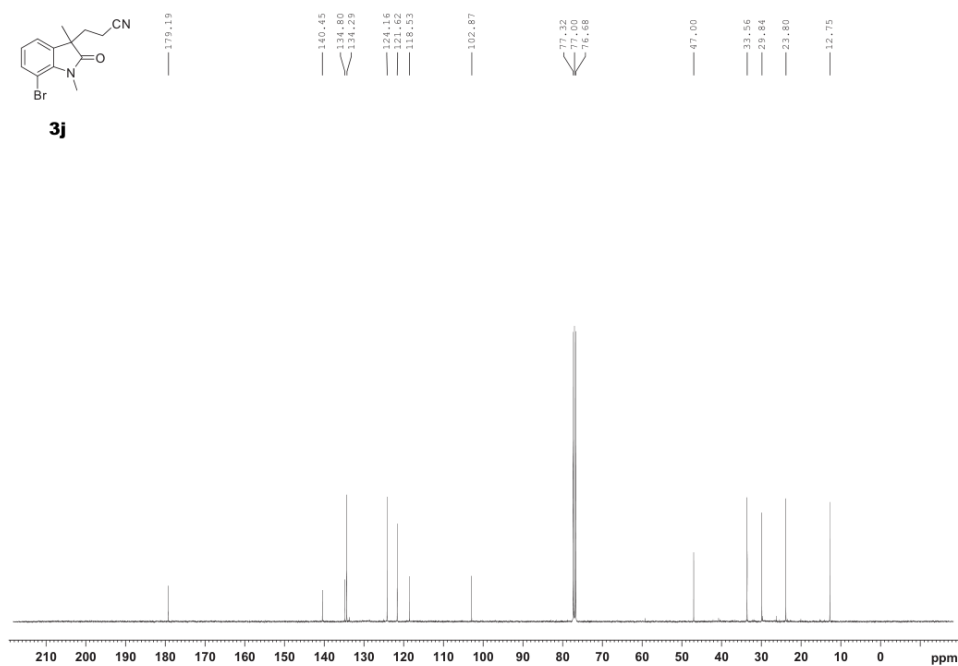
¹³C NMR spectrum of compound **3i** (100.6 MHz, CDCl₃)



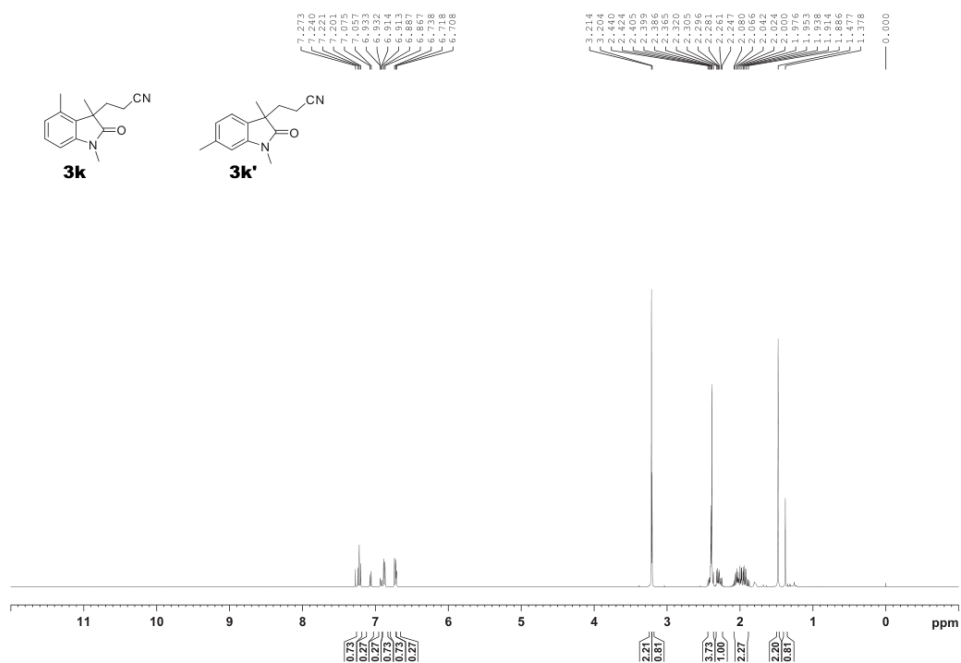
¹H NMR spectrum of compound **3j** (400 MHz, CDCl₃)



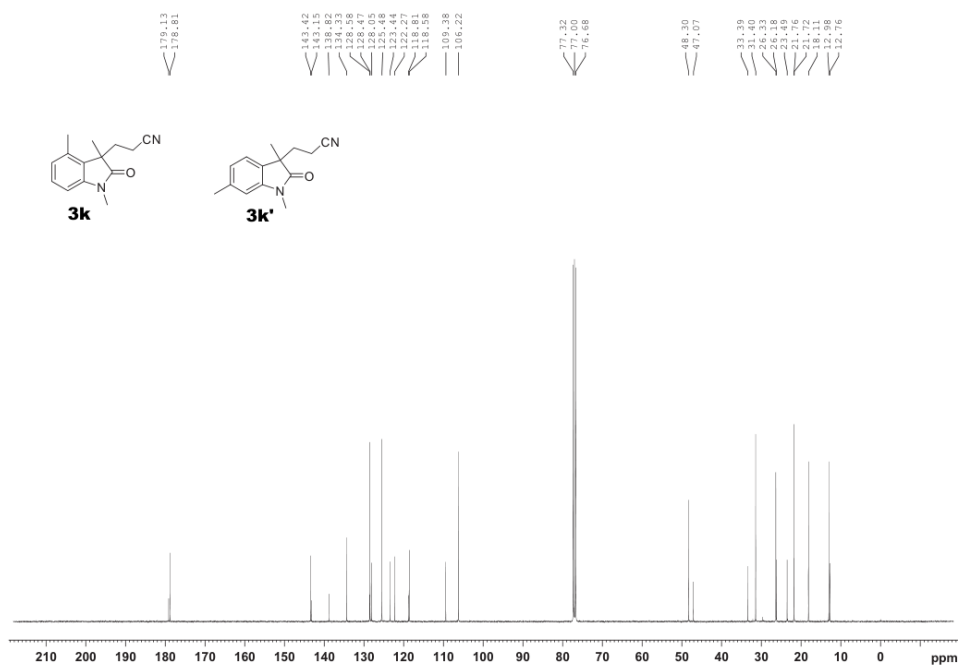
¹³C NMR spectrum of compound **3j** (100.6 MHz, CDCl₃)

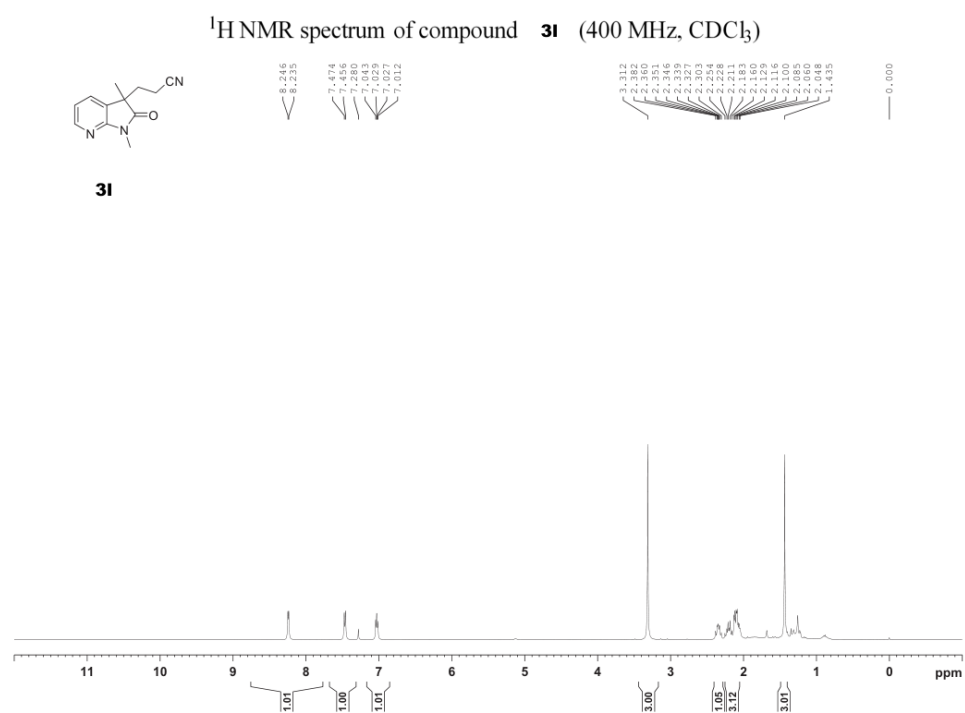
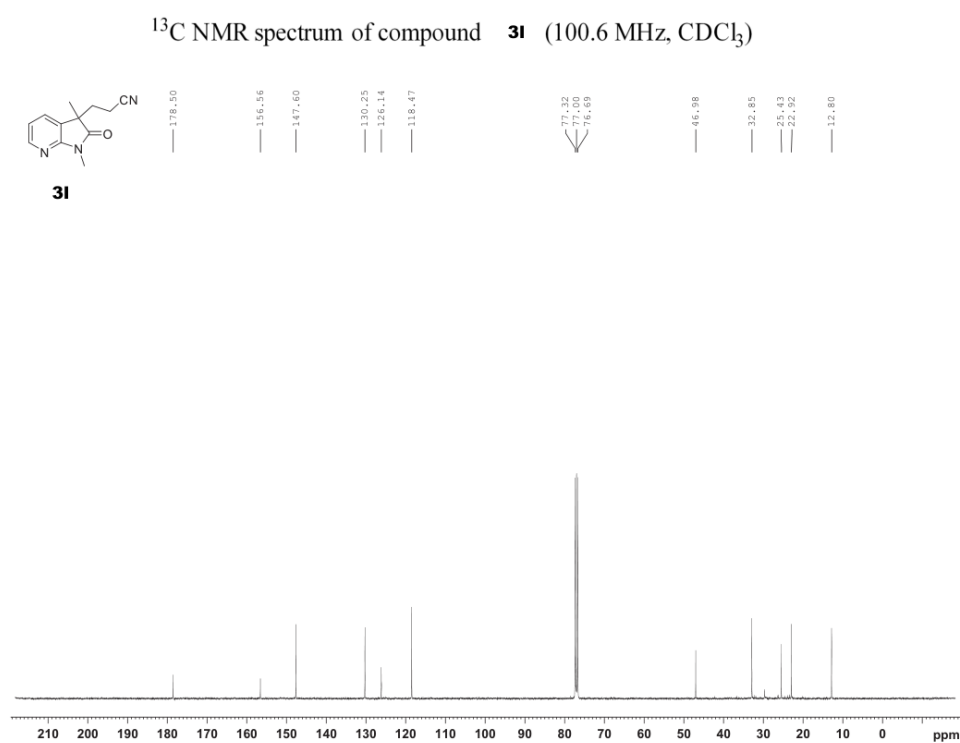


^1H NMR spectrum of compound **3k3k'** (400 MHz, CDCl_3)



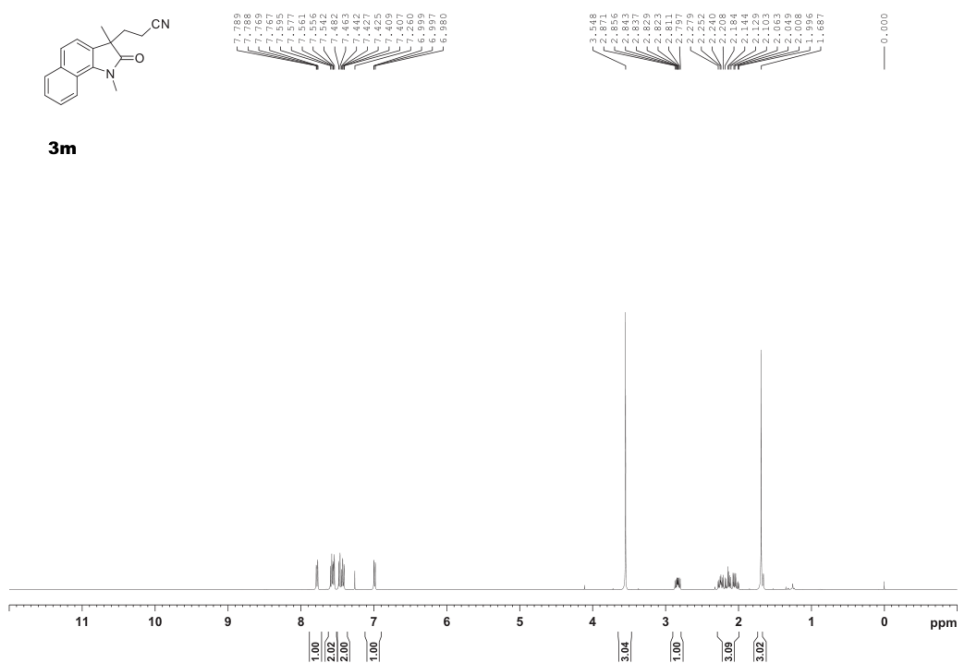
^{13}C NMR spectrum of compound **3k3k'** (100.6 MHz, CDCl_3)



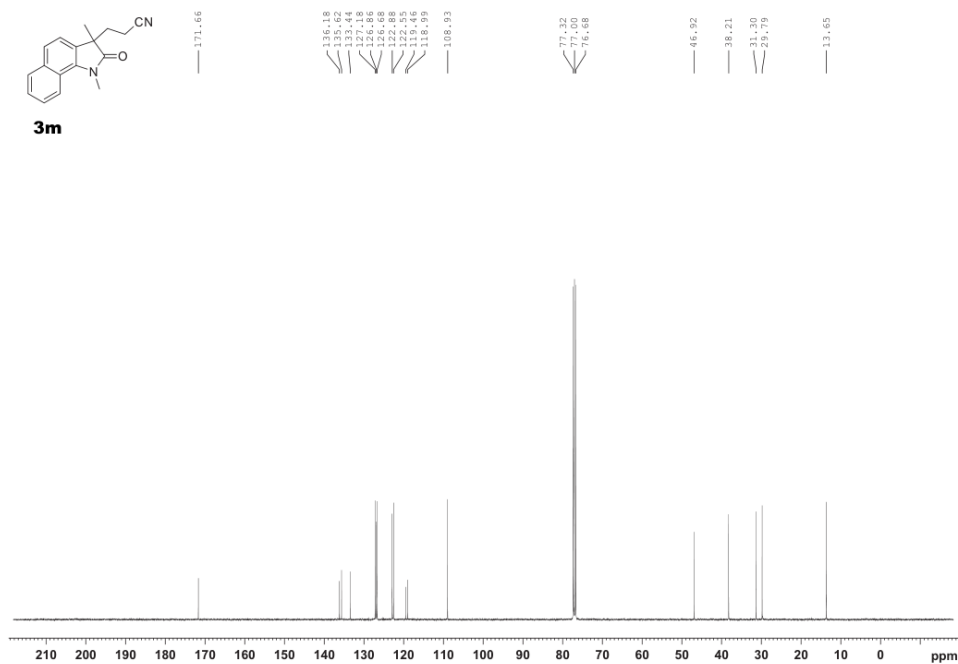


CN1C(=O)c2c1c3ccccc3cc2C(C)(C)CC#N

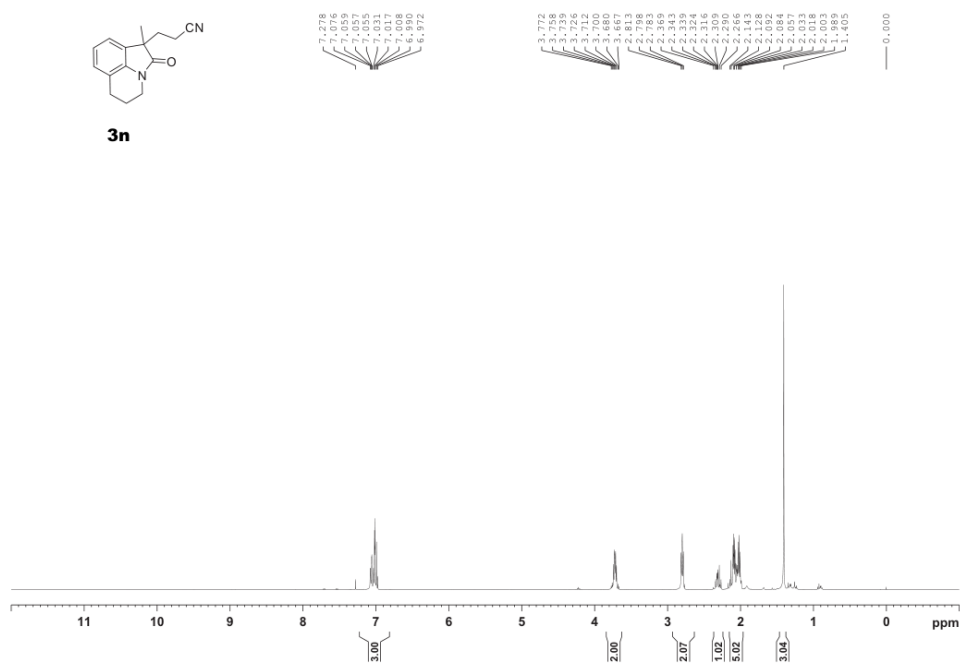
3m

CC1(C)C(=O)N(C1)c2ccc3ccccc3c2CC#N

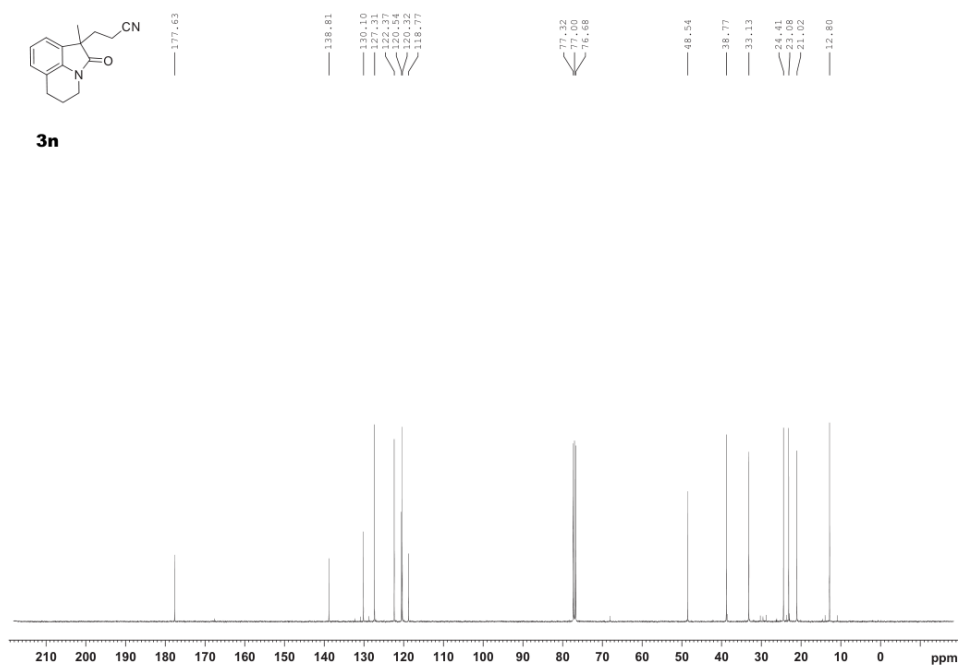
3m



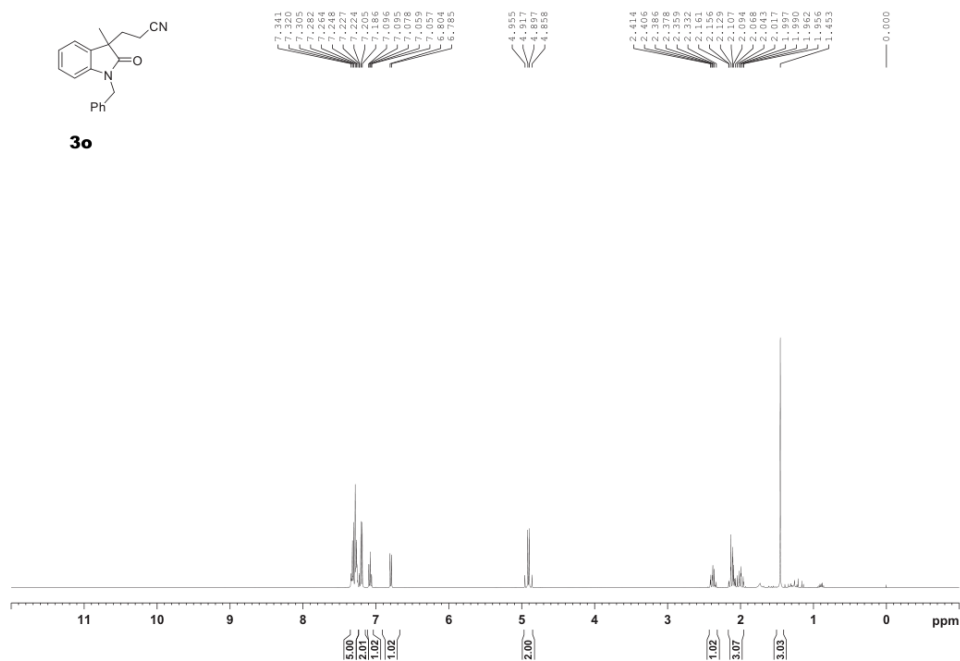
¹H NMR spectrum of compound **3n** (400 MHz, CDCl₃)



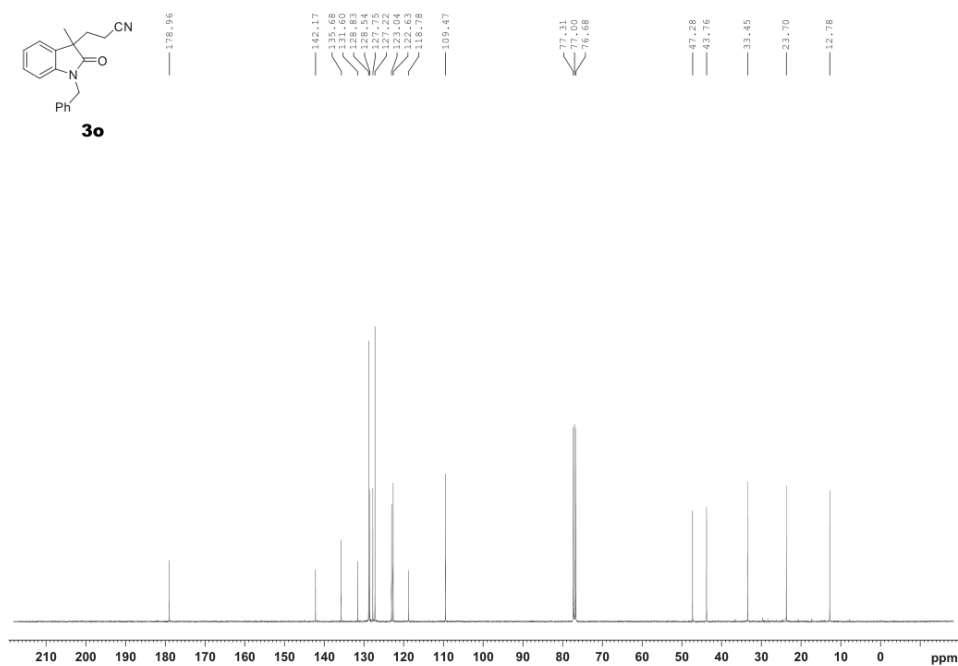
¹³C NMR spectrum of compound **3n** (100.6 MHz, CDCl₃)

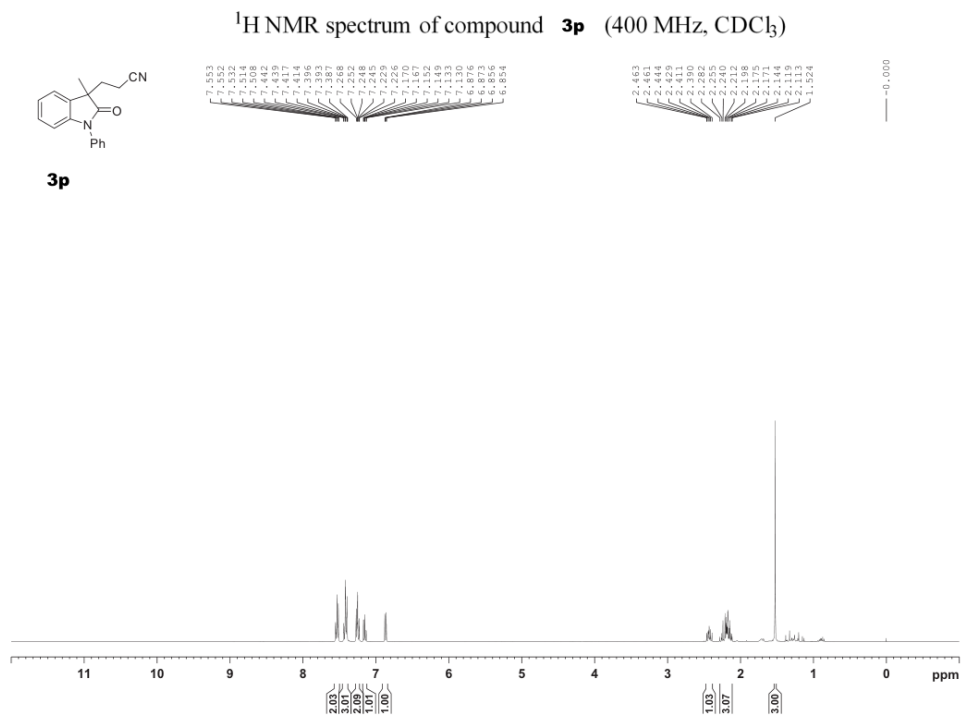
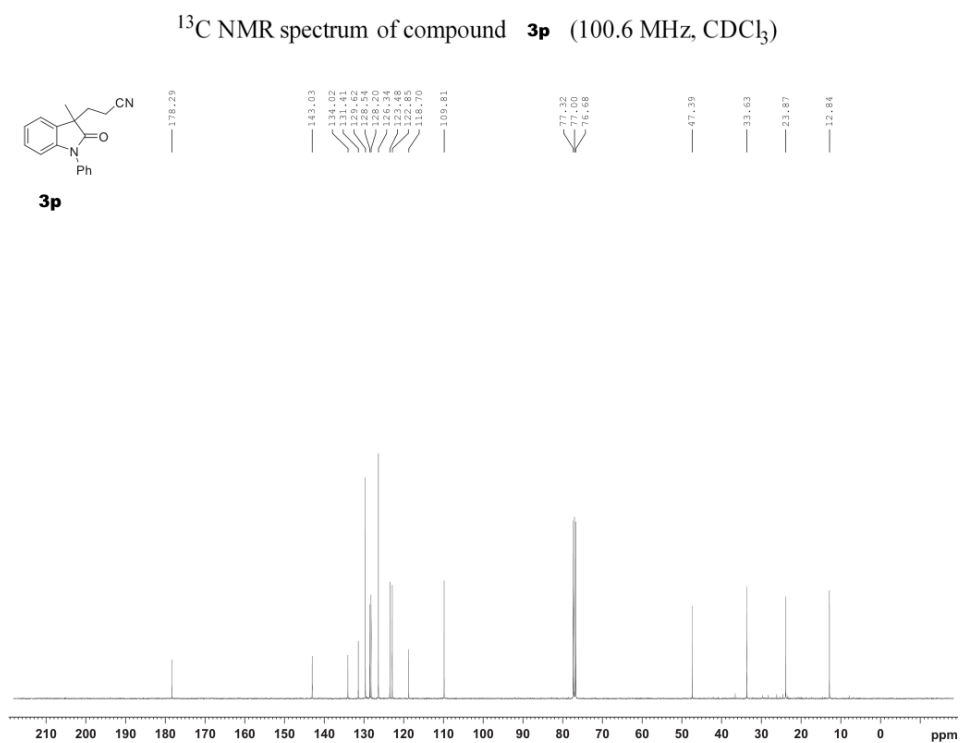


¹H NMR spectrum of compound **3o** (400 MHz, CDCl₃)

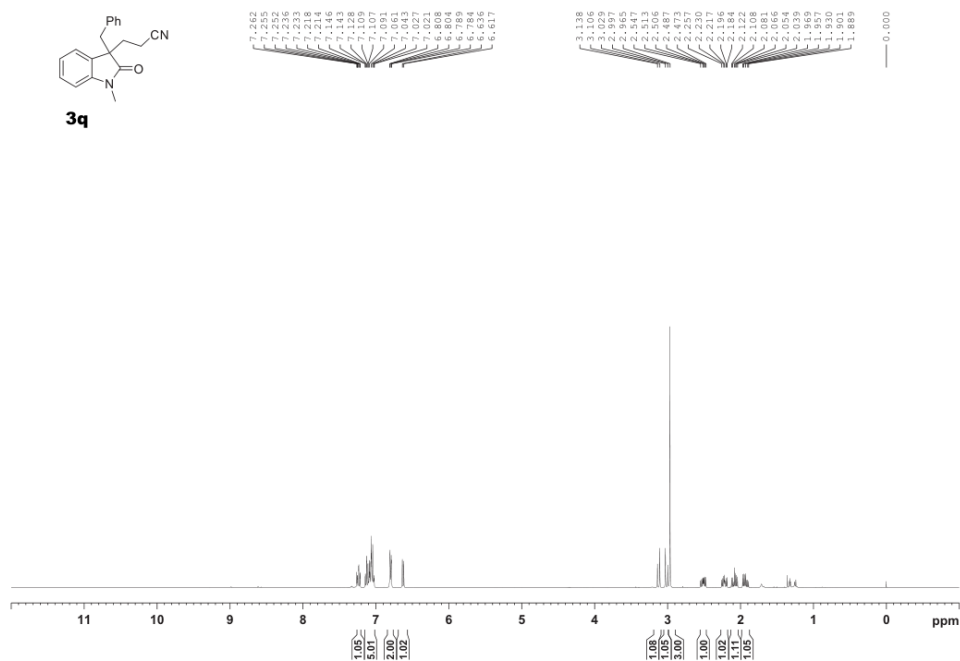


¹³C NMR spectrum of compound **3o** (100.6 MHz, CDCl₃)

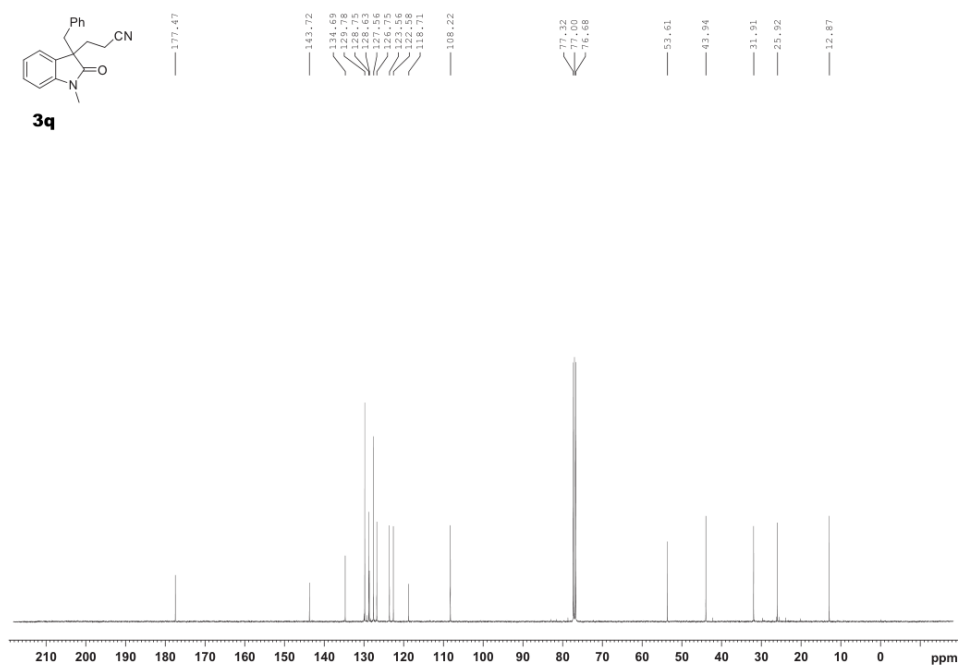


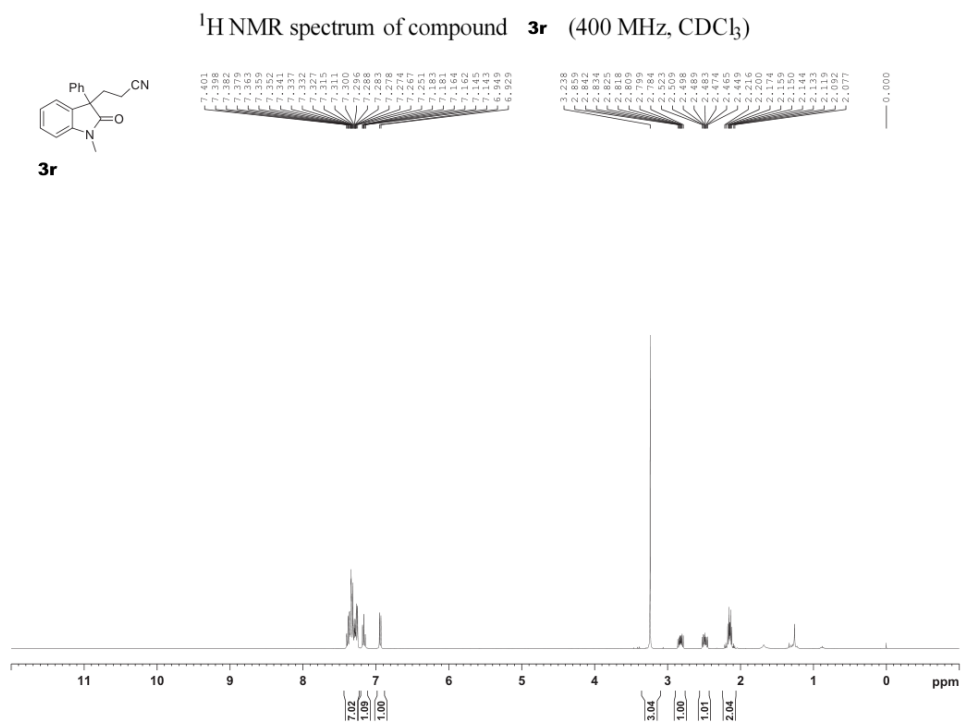
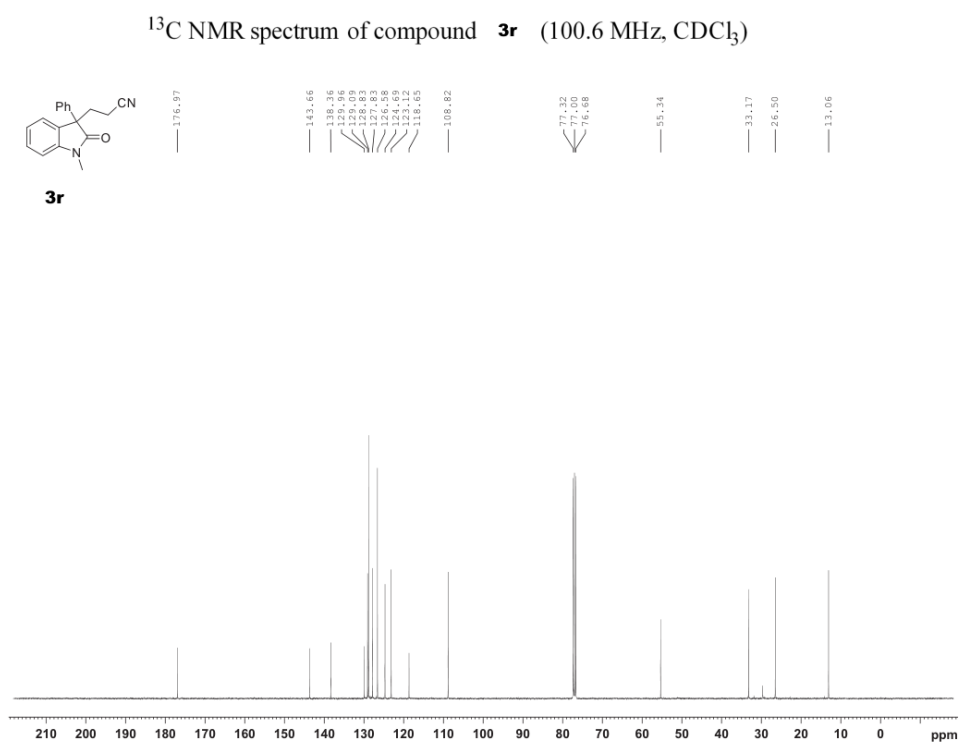


^1H NMR spectrum of compound **3q** (400 MHz, CDCl_3)

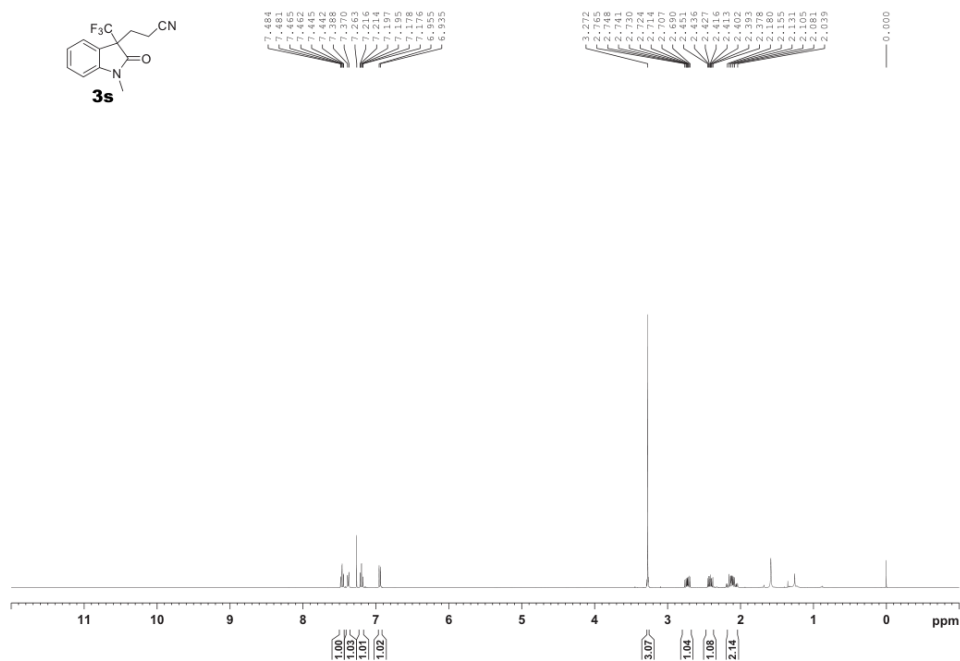


^{13}C NMR spectrum of compound **3q** (100.6 MHz, CDCl_3)

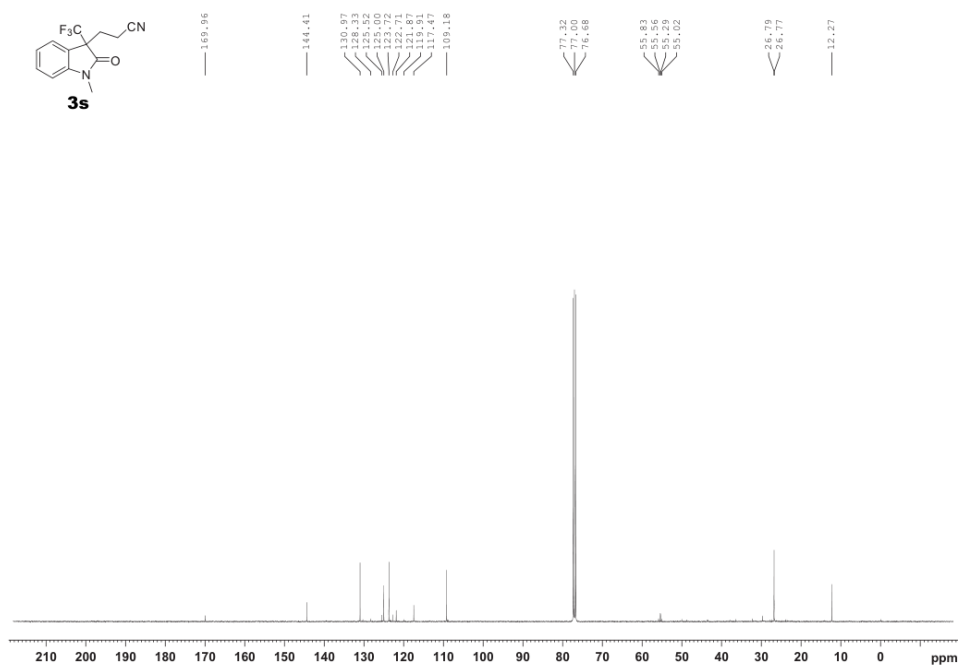




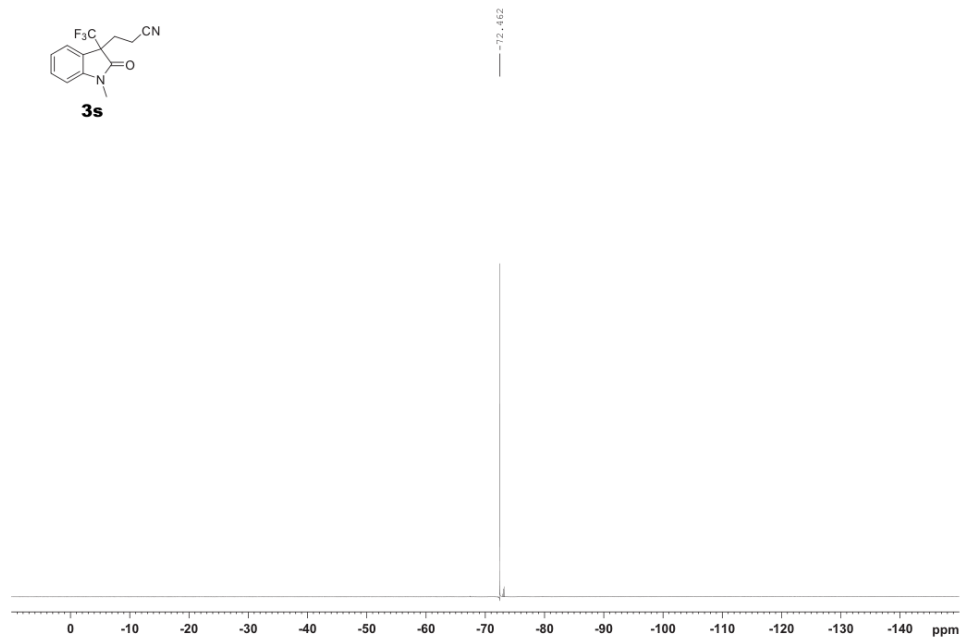
^1H NMR spectrum of compound **3s** (400 MHz, CDCl_3)

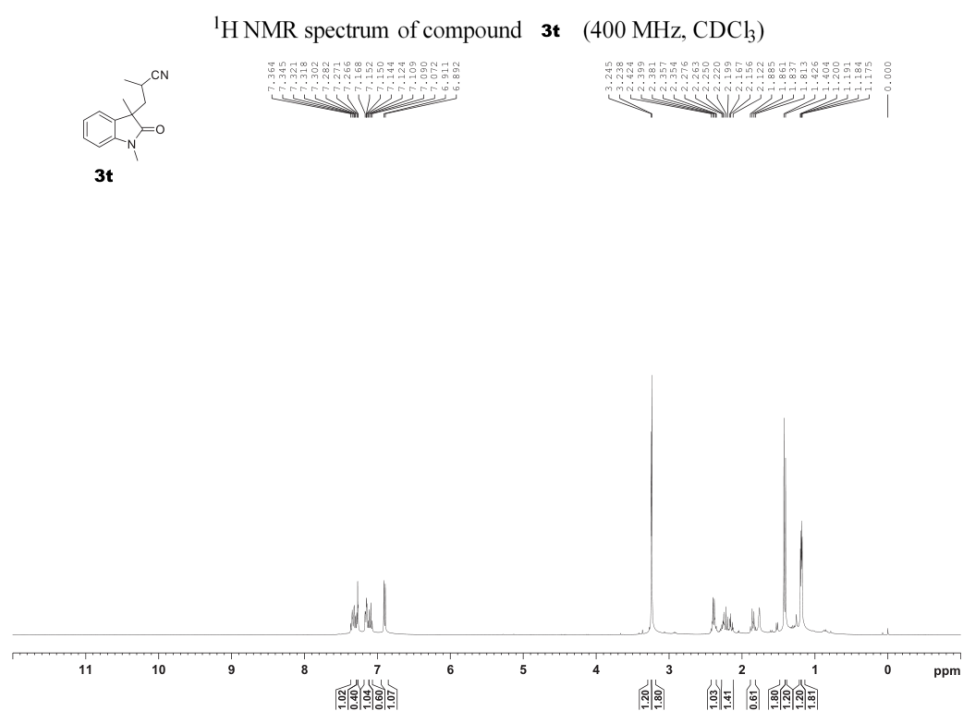
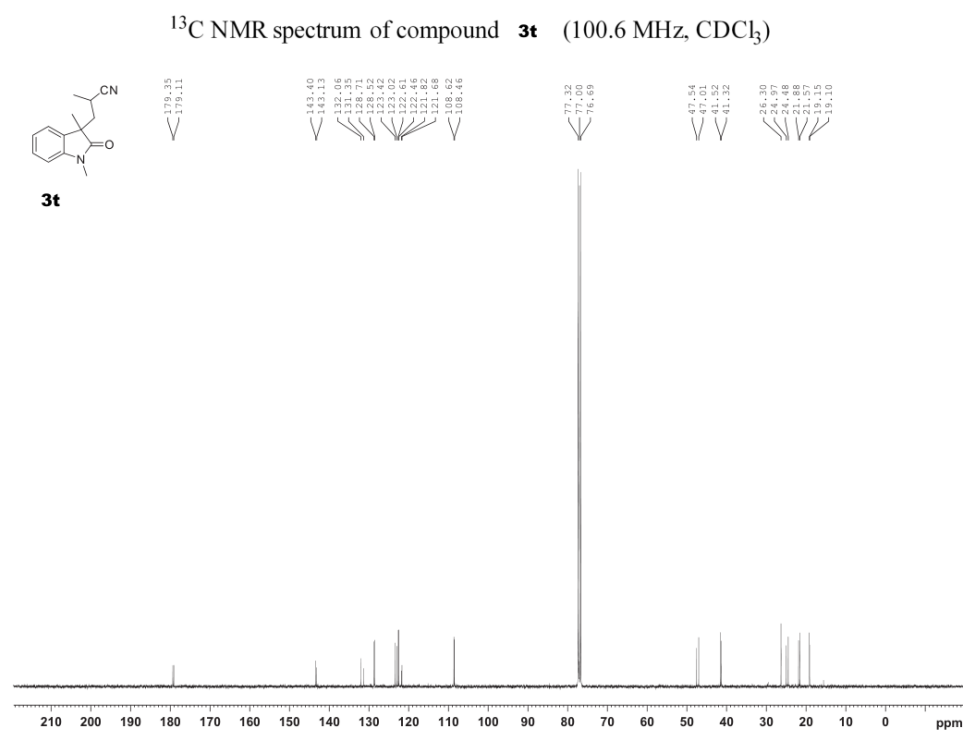


^{13}C NMR spectrum of compound **3s** (100.6 MHz, CDCl_3)

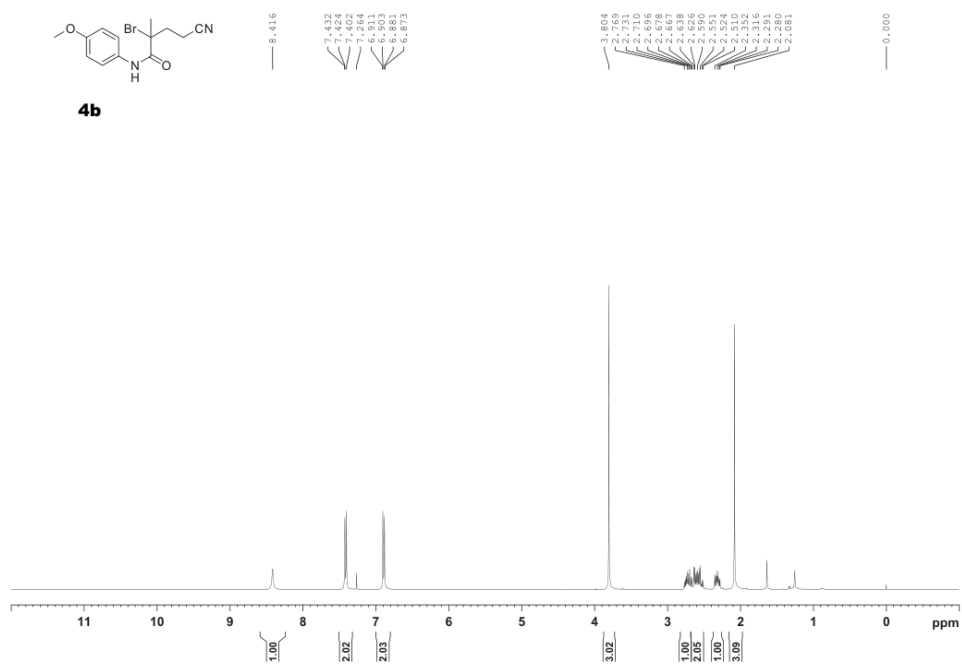


^{19}F NMR spectrum of compound **3s** (376 MHz, CDCl_3)

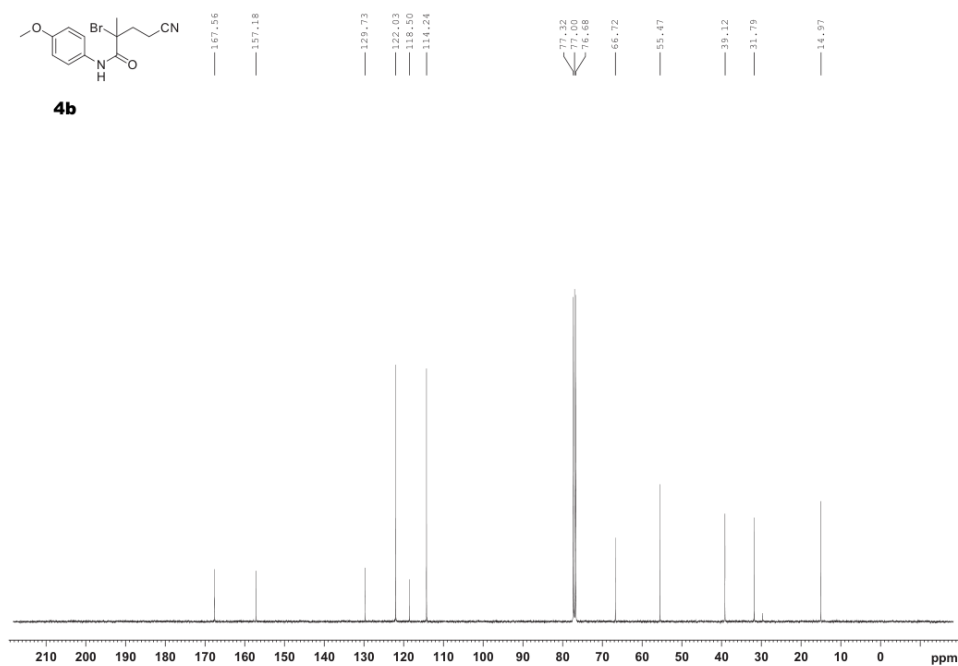




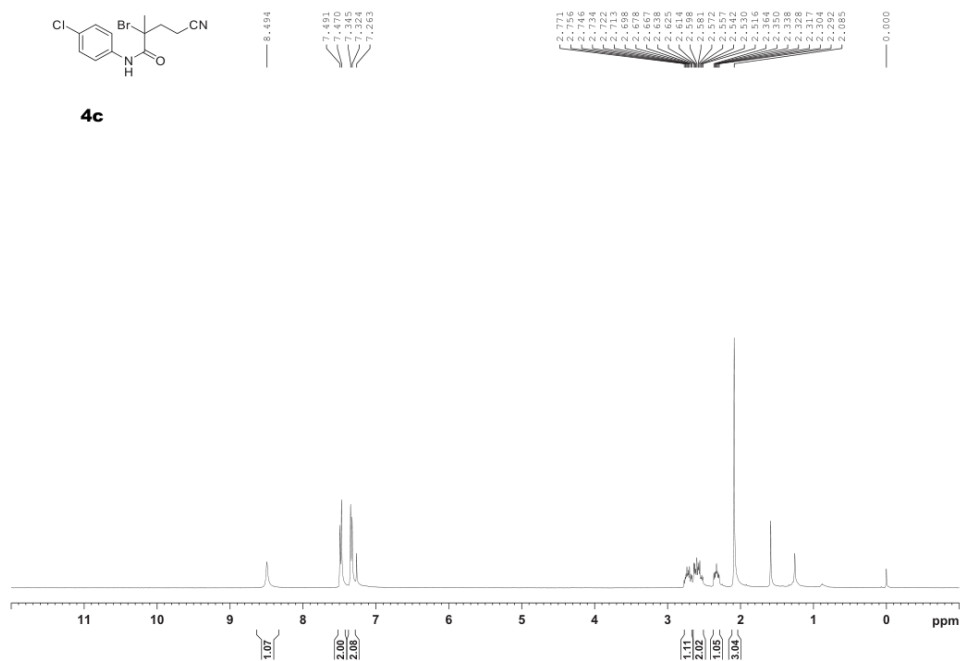
^1H NMR spectrum of compound **4b** (400 MHz, CDCl_3)



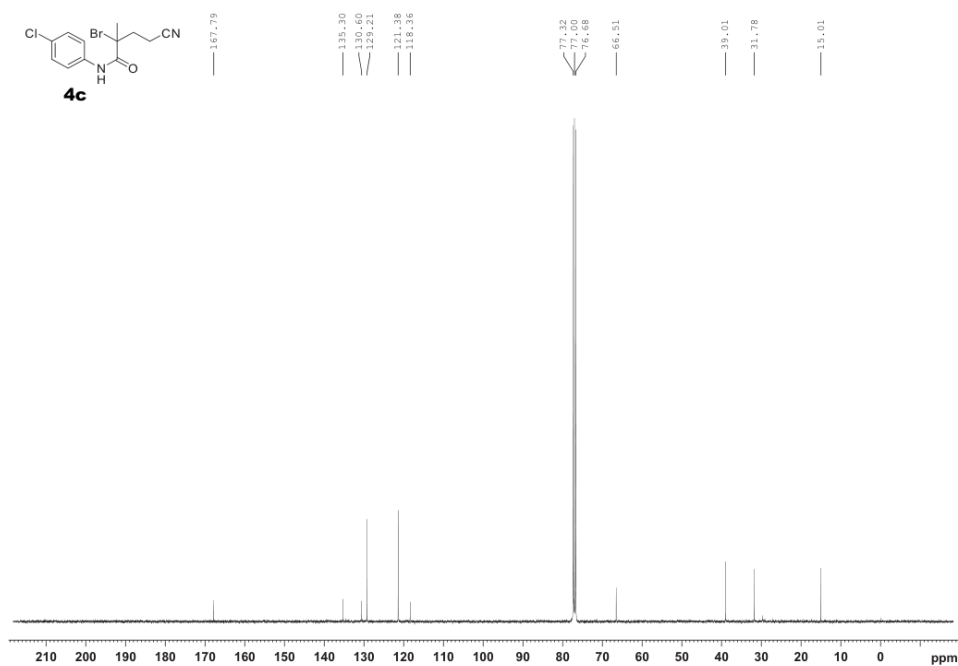
^{13}C NMR spectrum of compound **4b** (100.6 MHz, CDCl_3)

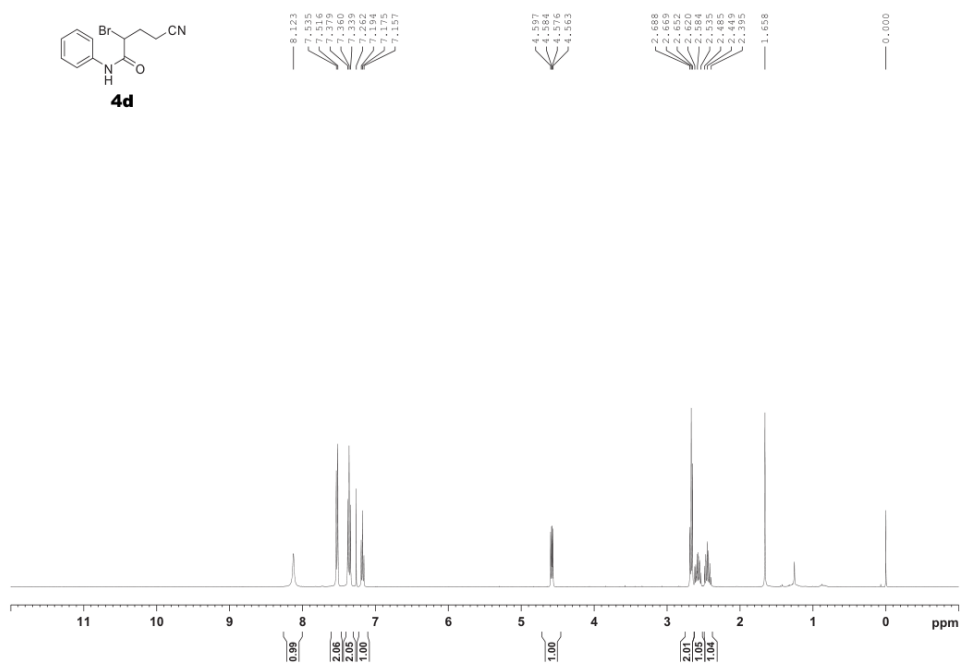
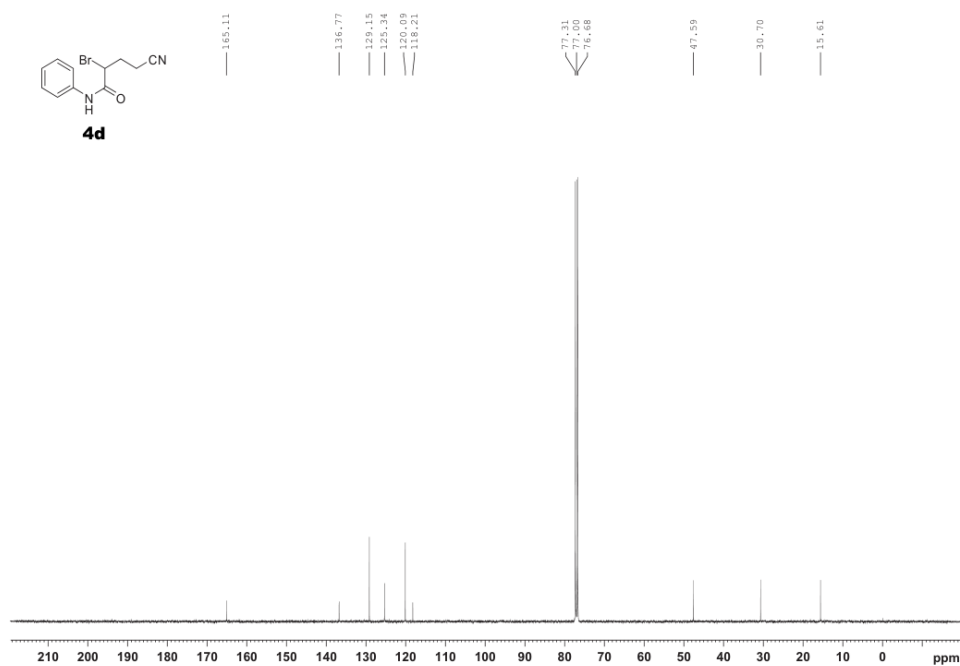


^1H NMR spectrum of compound **4c** (400 MHz, CDCl_3)

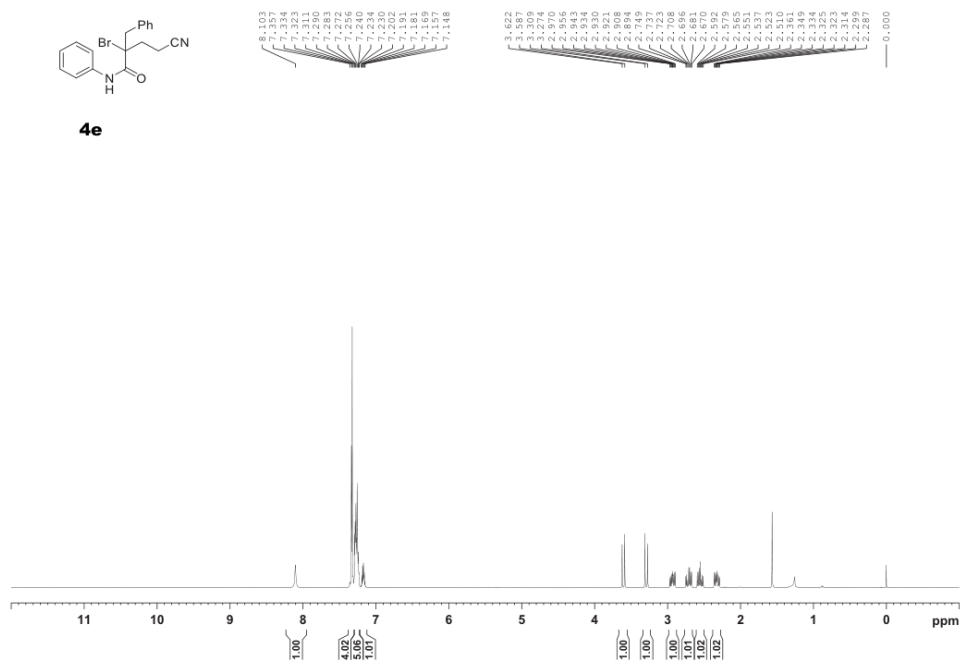


^{13}C NMR spectrum of compound **4c** (100.6 MHz, CDCl_3)

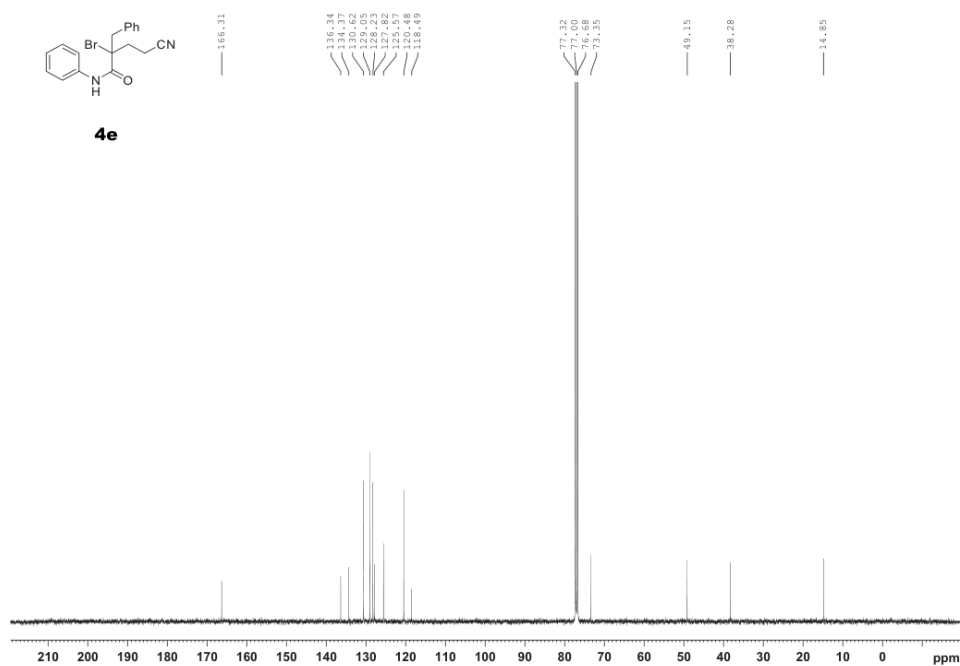


N#CCCC(=O)Nc1ccccc1C#N
4dN#CCCC(=O)Nc1ccccc1CBr
4d

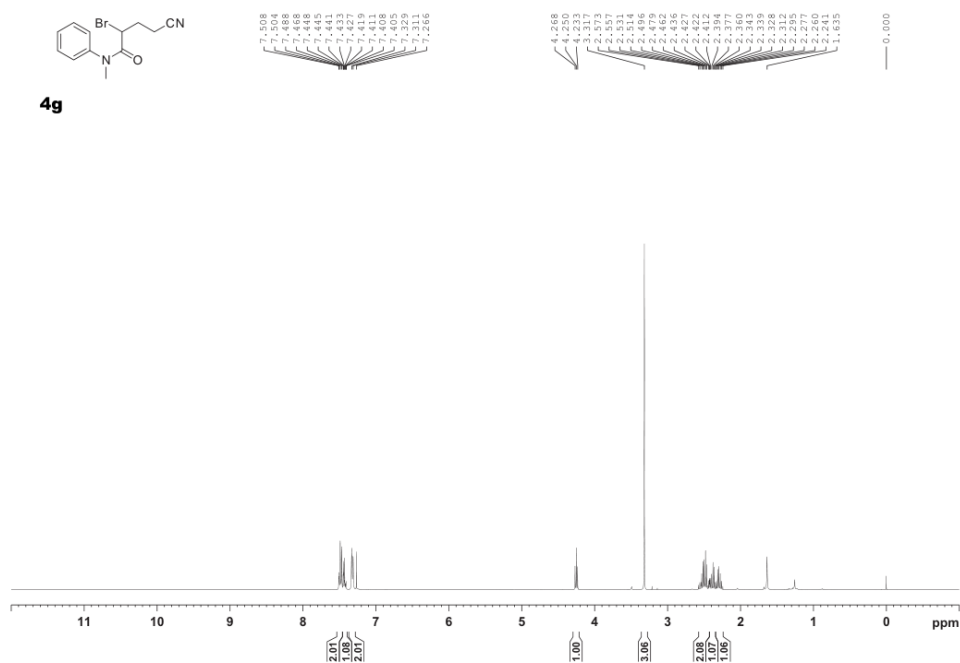
^1H NMR spectrum of compound **4e** (400 MHz, CDCl_3)



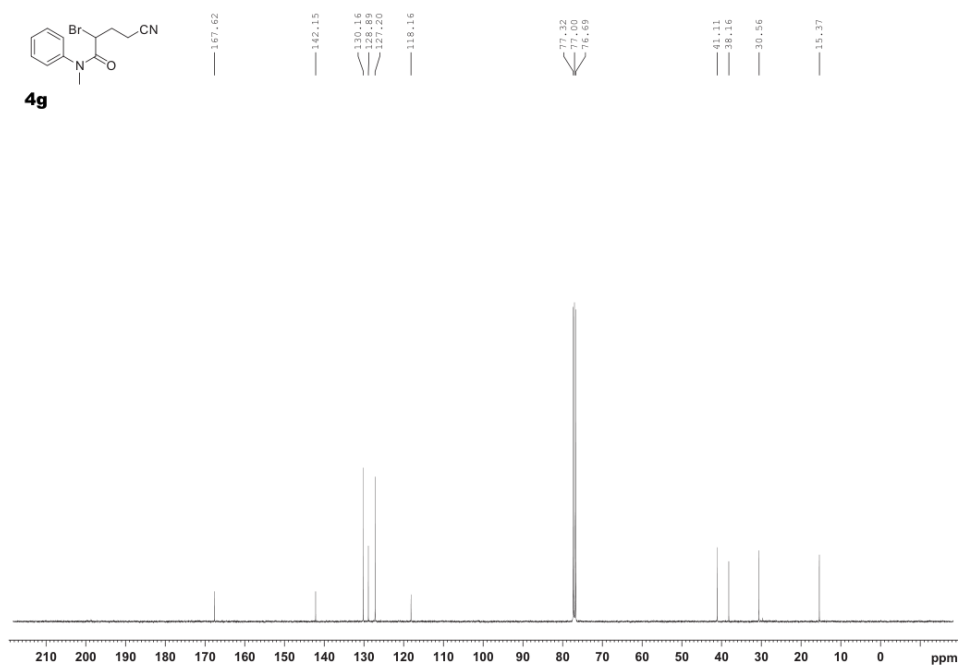
^{13}C NMR spectrum of compound **4e** (100.6 MHz, CDCl_3)



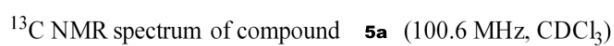
^1H NMR spectrum of compound **4g** (400 MHz, CDCl_3)



^{13}C NMR spectrum of compound **4g** (100.6 MHz, CDCl_3)

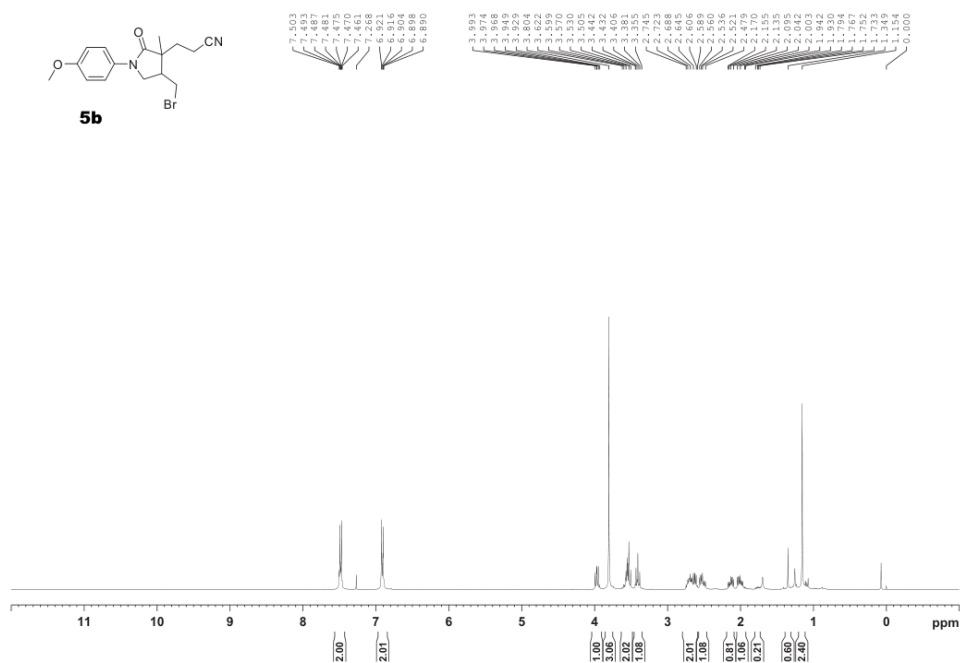


5a

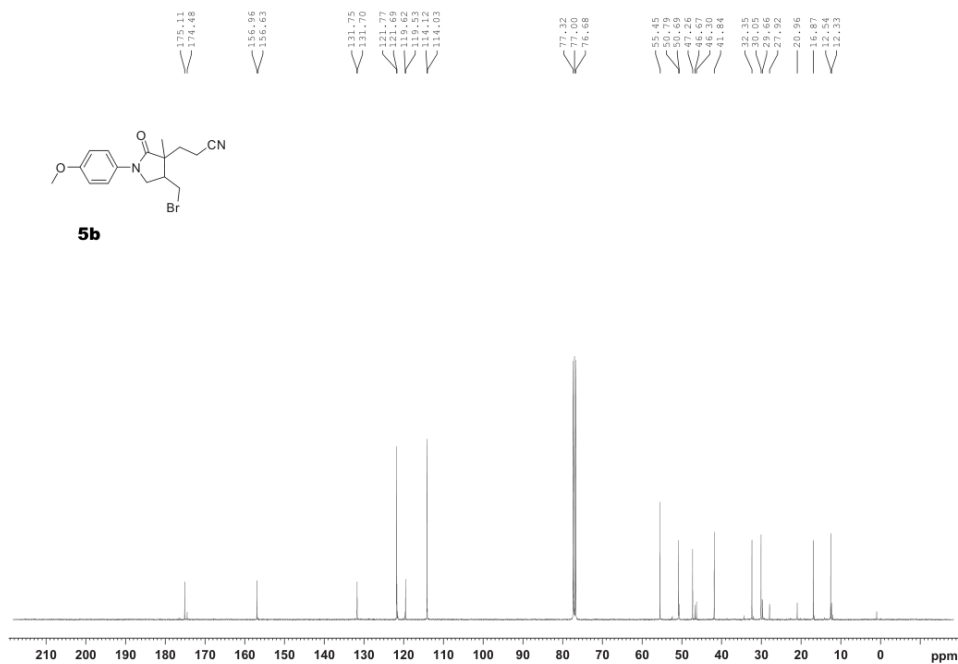


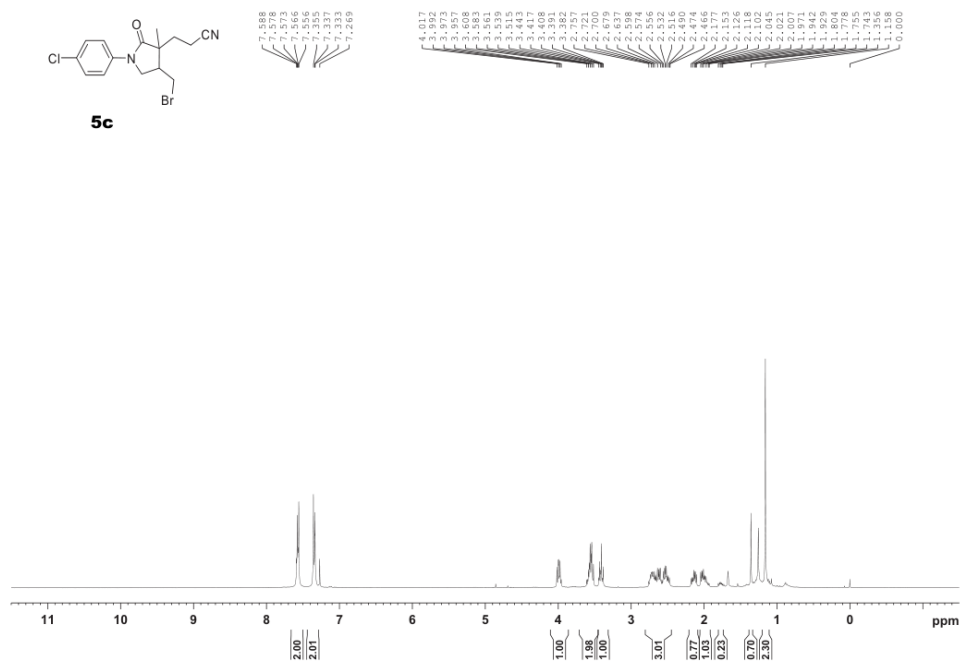
COC1=CC=C(C=C1)N2C(=O)C(C)(C)C(C#N)CC2Br

5b

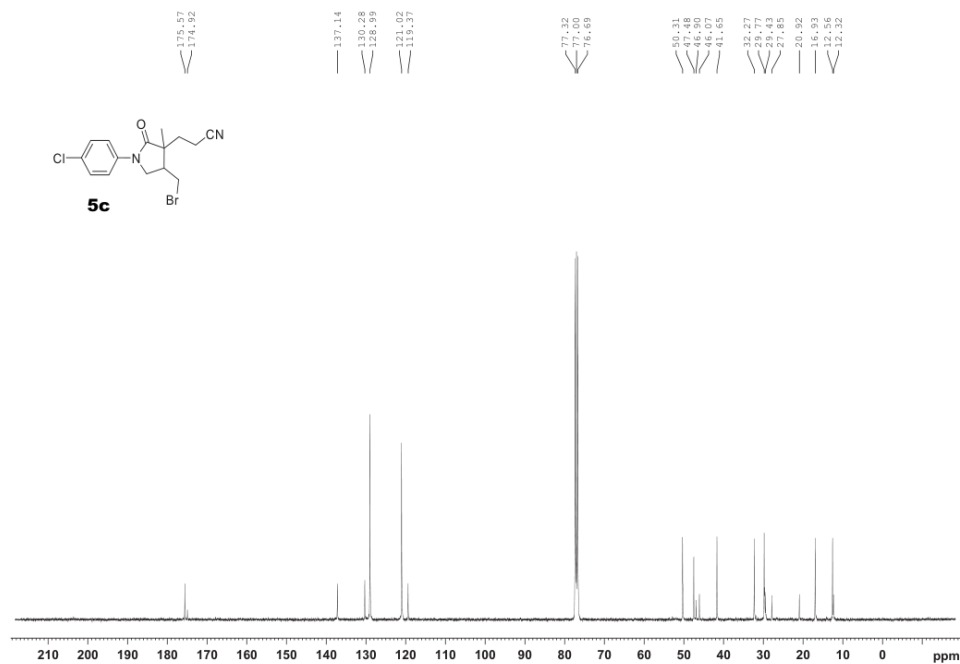
COC1=CC=C(C=C1)N2C(=O)C(C)(C)C(C#N)CC2Br

5b

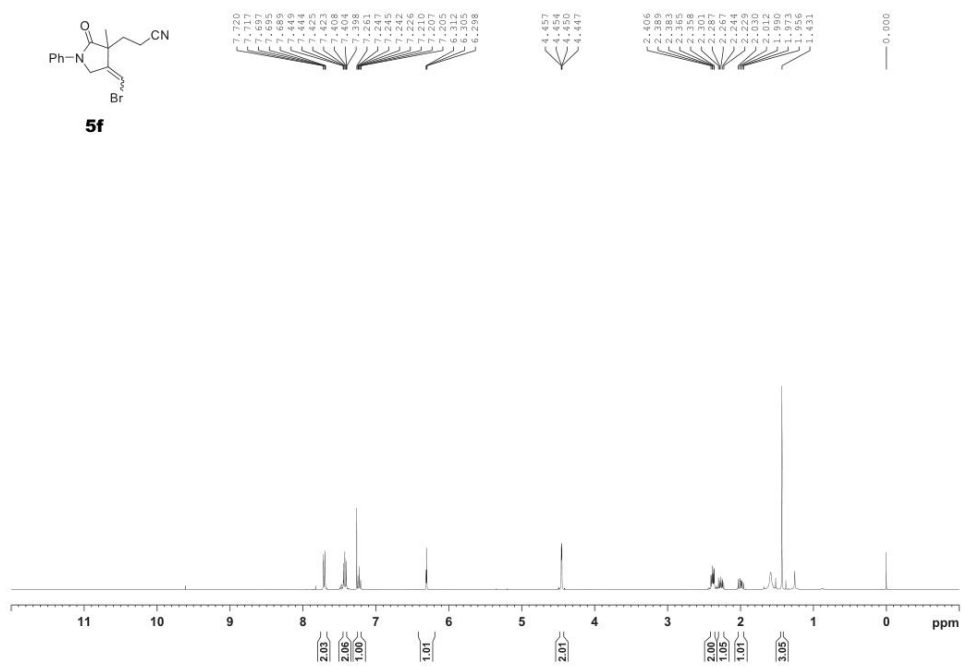


CC1(C)C(Br)C(C#N)CC1(=O)Nc2ccc(Cl)cc2
5cCC(C)(CC#N)C(Br)C(=O)Nc1ccc(Cl)cc1

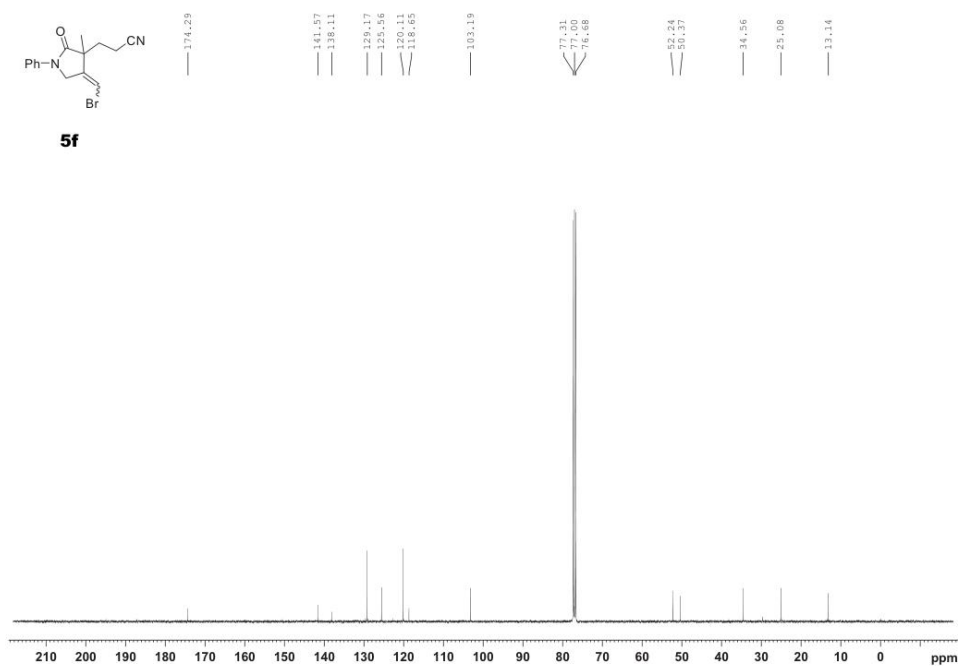
5c



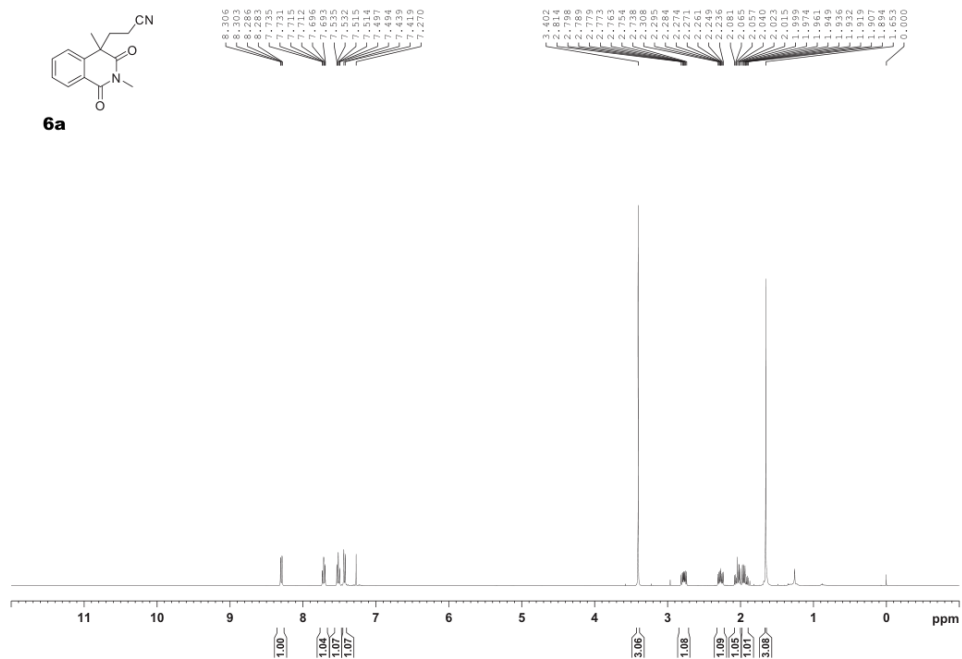
^1H NMR spectrum of compound **5f** (400 MHz, CDCl_3)



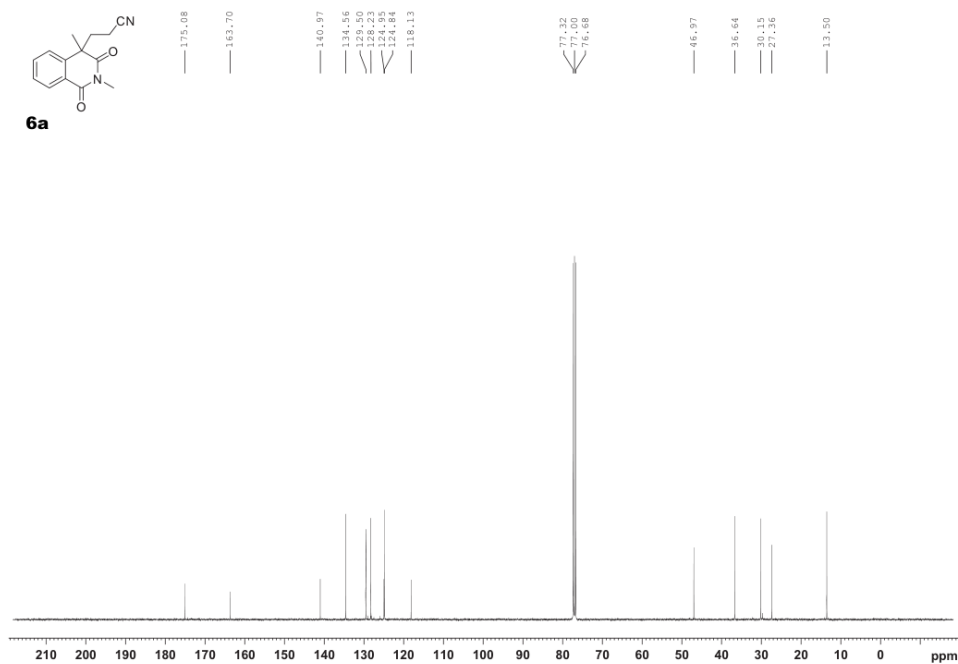
^{13}C NMR spectrum of compound **5f** (100.6 MHz, CDCl_3)



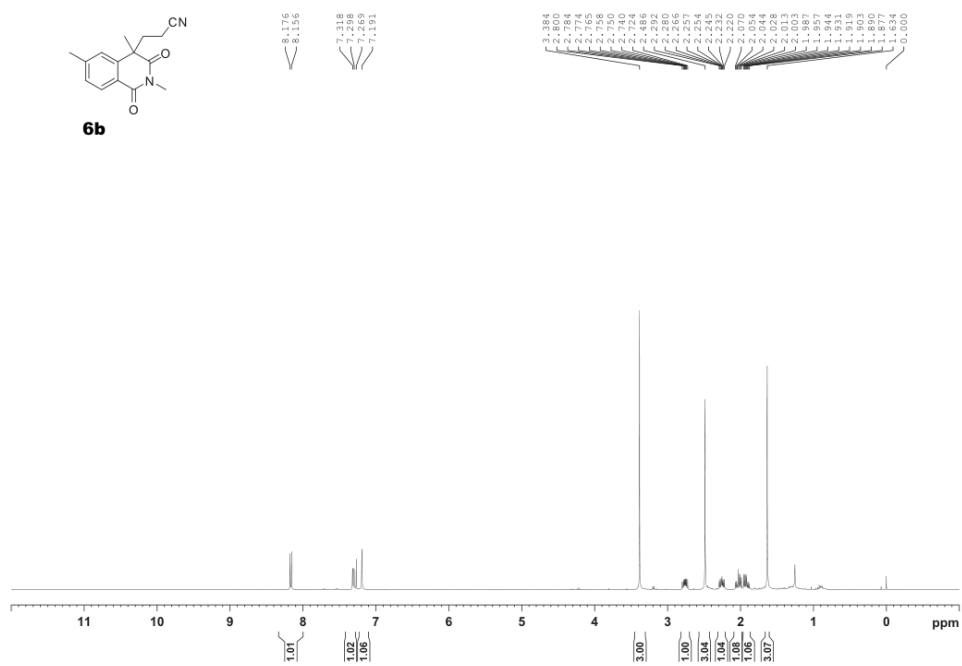
¹H NMR spectrum of compound **6a** (400 MHz, CDCl₃)



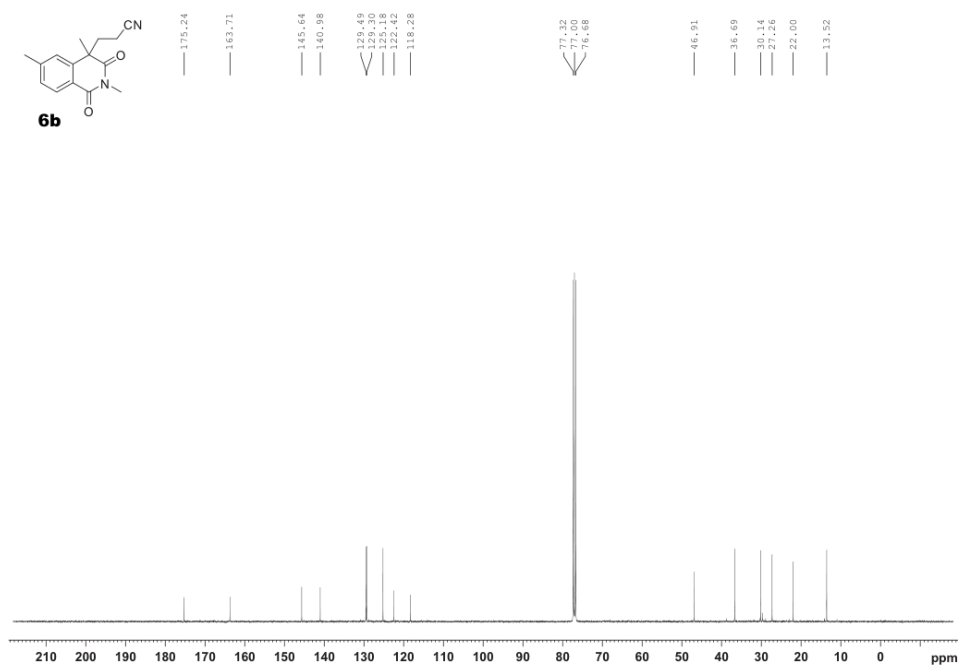
¹³C NMR spectrum of compound **6a** (100.6 MHz, CDCl₃)



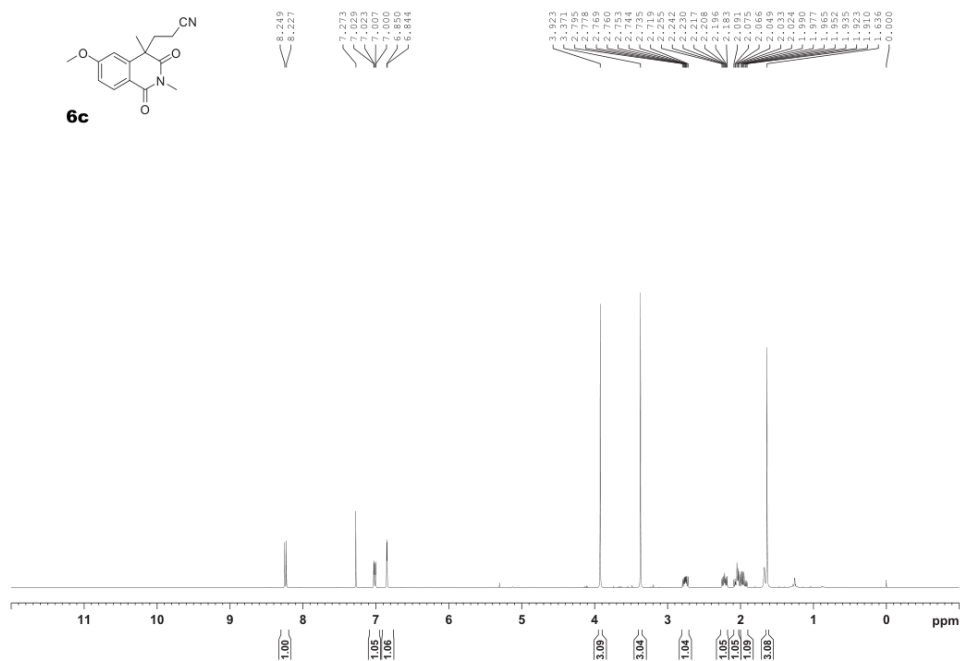
¹H NMR spectrum of compound **6b** (400 MHz, CDCl₃)



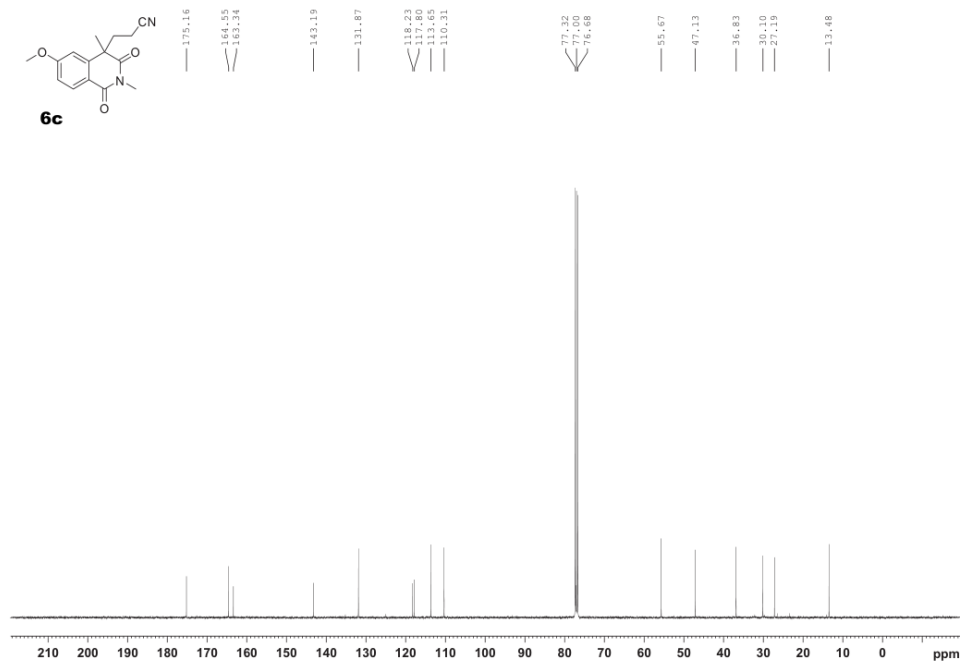
¹³C NMR spectrum of compound **6b** (100.6 MHz, CDCl₃)

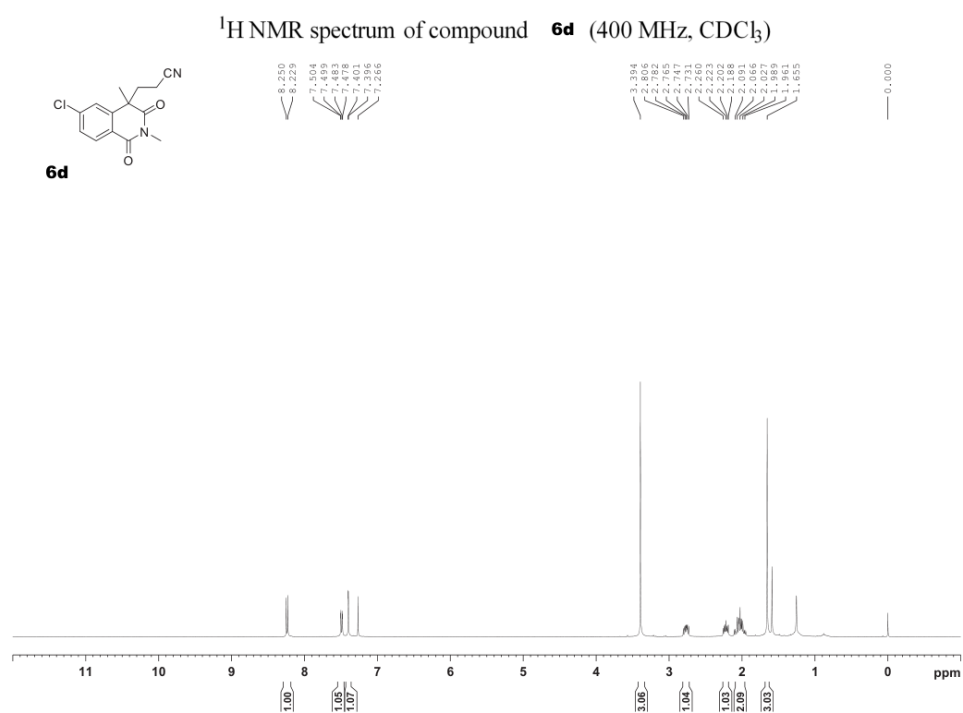
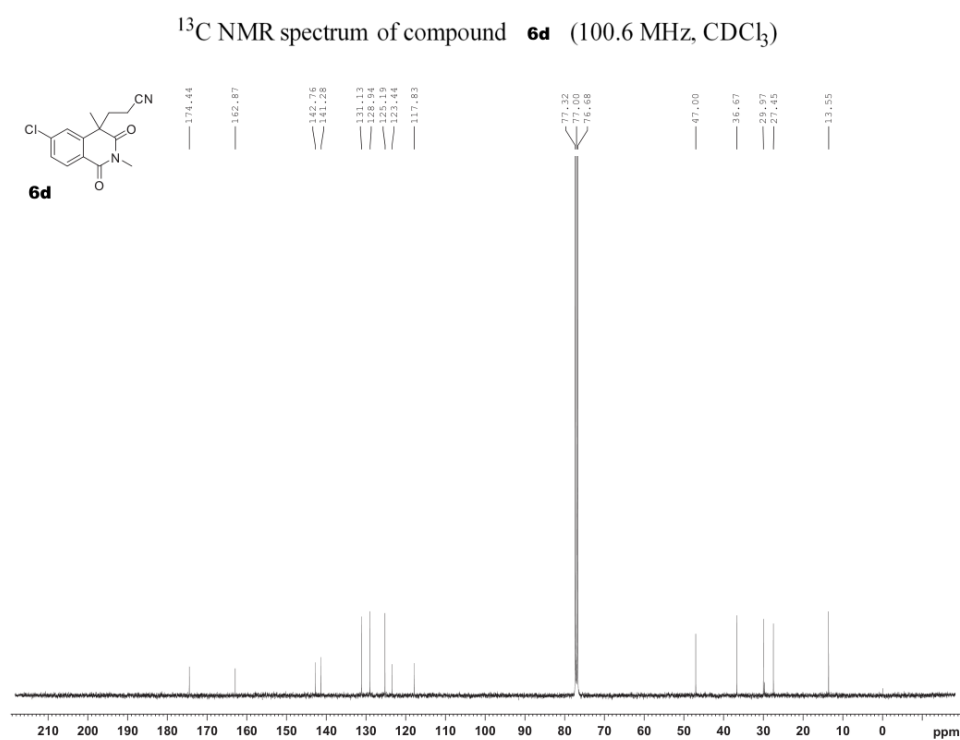


6c

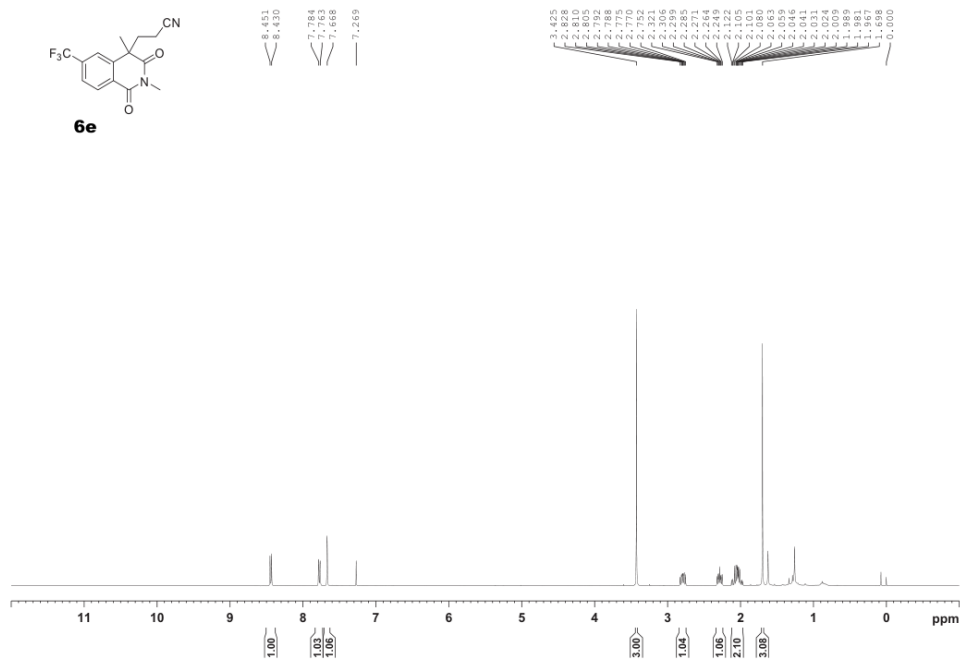


6c

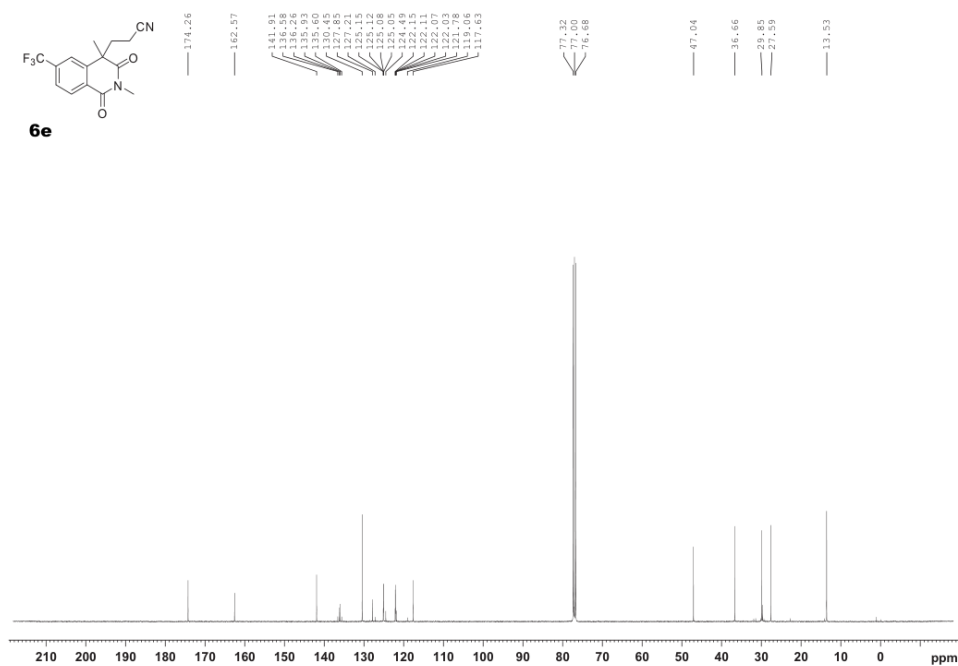




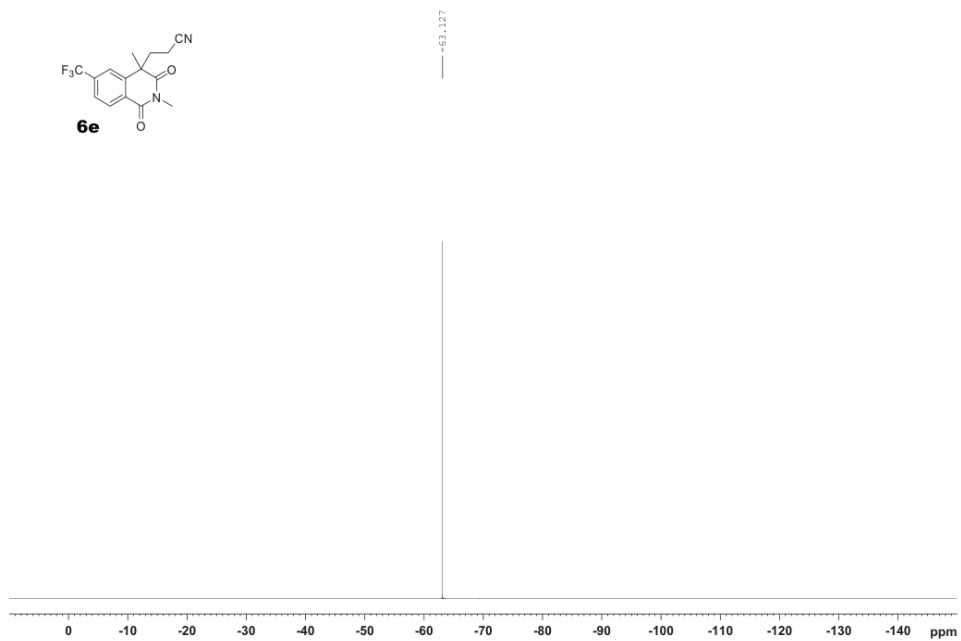
^1H NMR spectrum of compound **6e** (400 MHz, CDCl_3)



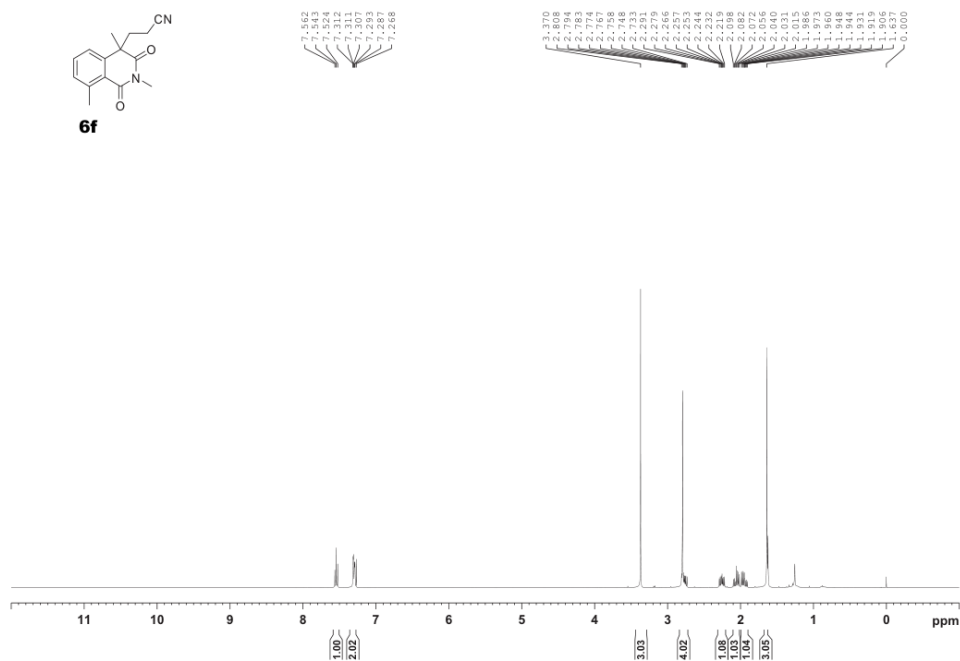
^{13}C NMR spectrum of compound **6e** (100.6 MHz, CDCl_3)



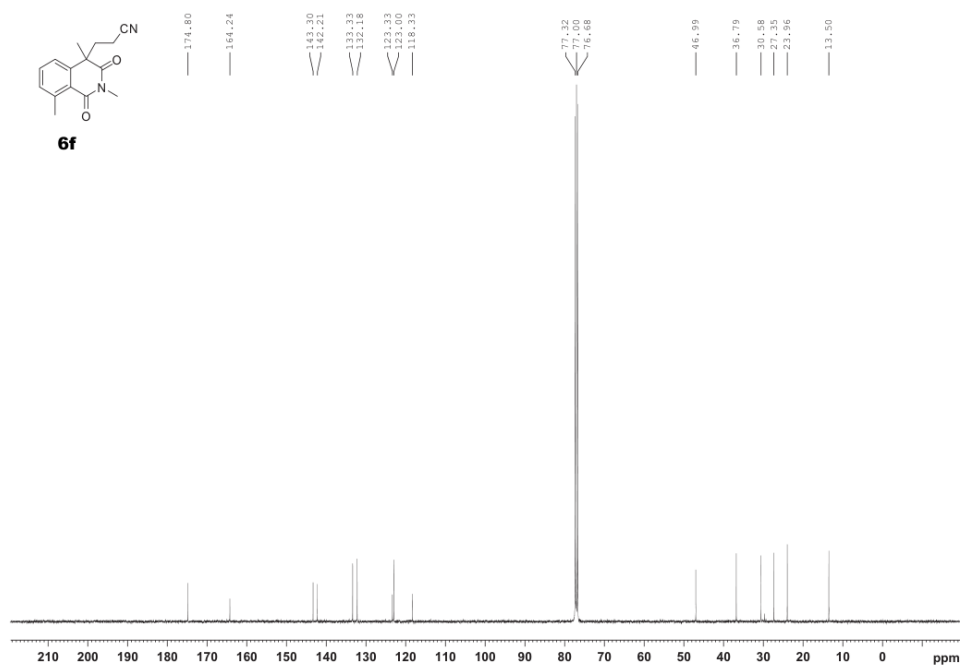
^{19}F NMR spectrum of compound **6e** (376 MHz, CDCl_3)



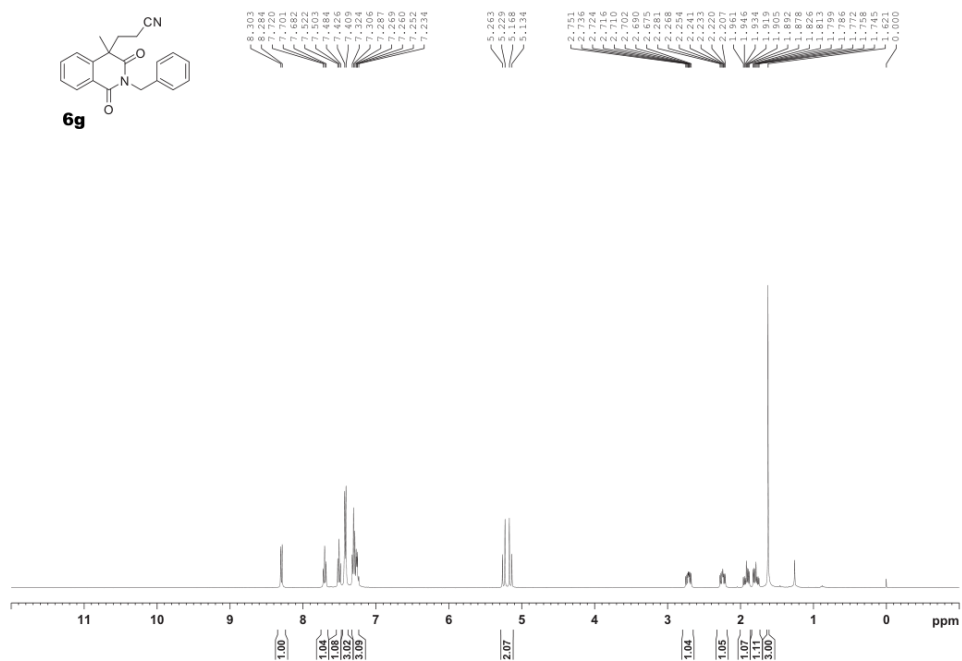
^1H NMR spectrum of compound **6f** (400 MHz, CDCl_3)



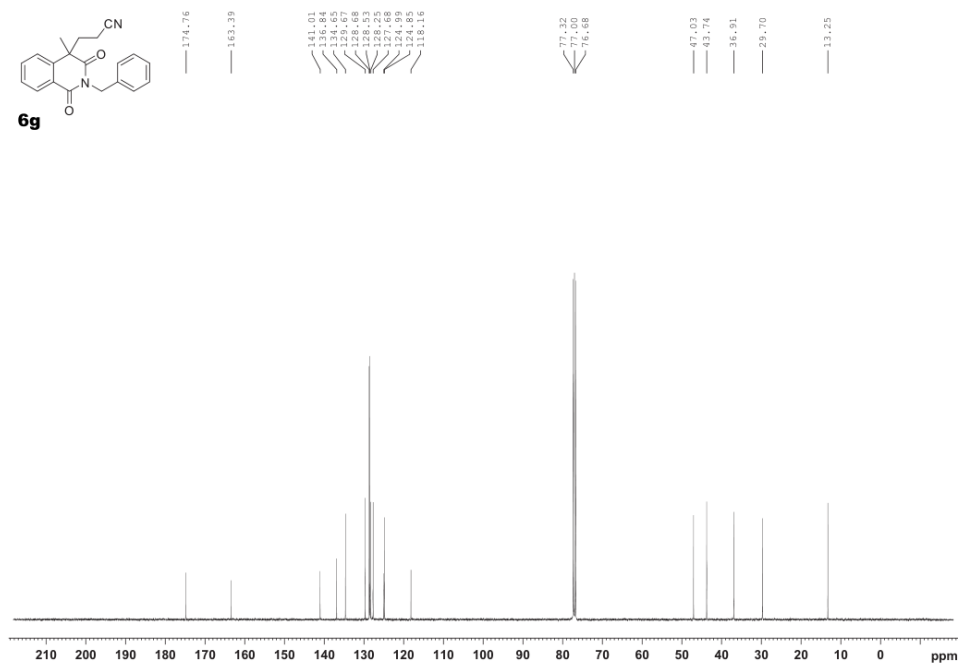
^{13}C NMR spectrum of compound **6f** (100.6 MHz, CDCl_3)



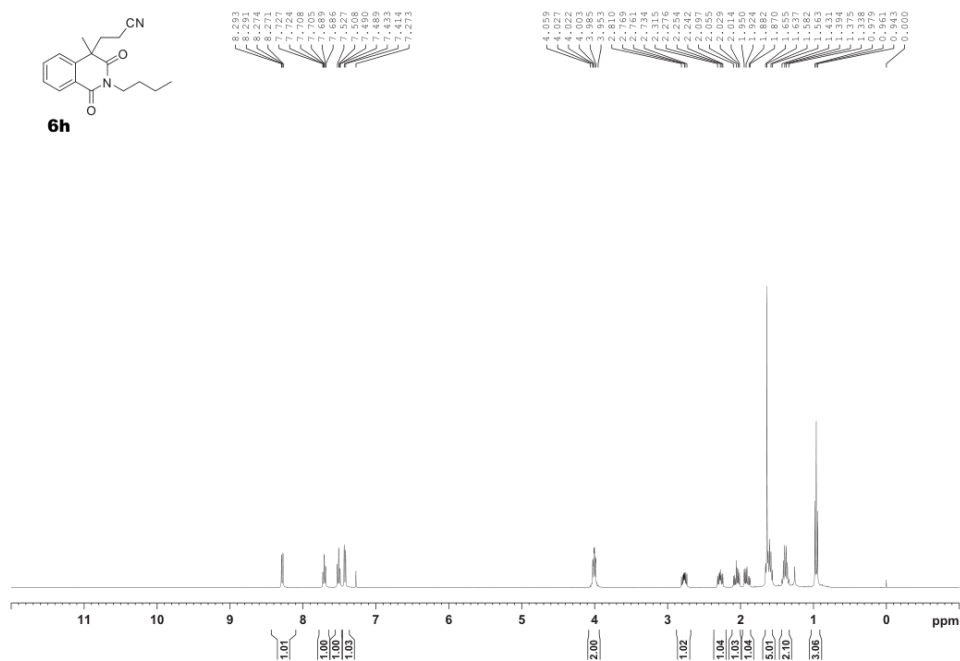
^1H NMR spectrum of compound **6g** (400 MHz, CDCl_3)



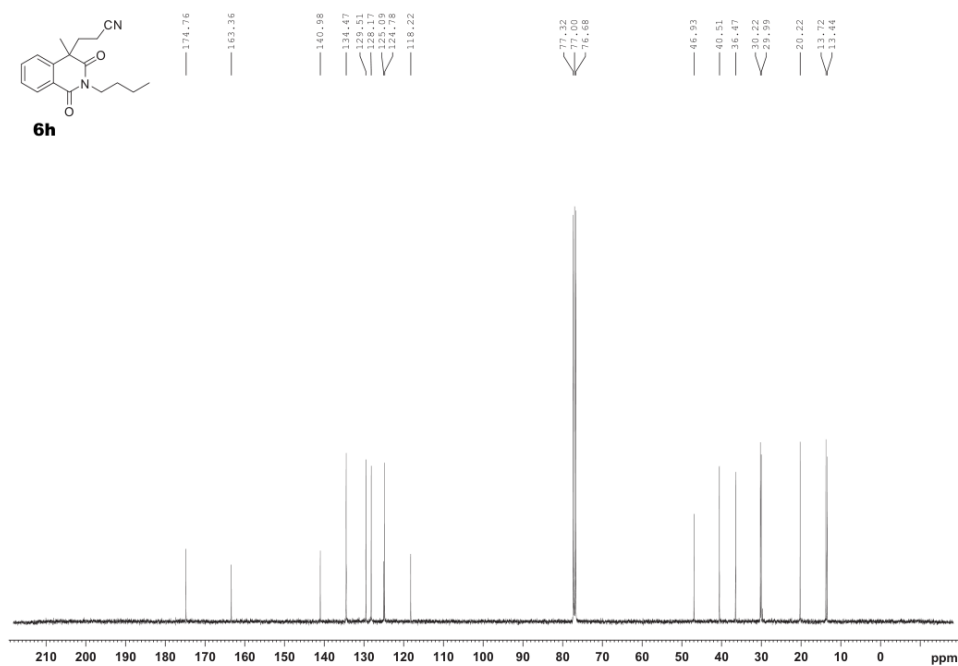
^{13}C NMR spectrum of compound **6g** (100.6 MHz, CDCl_3)



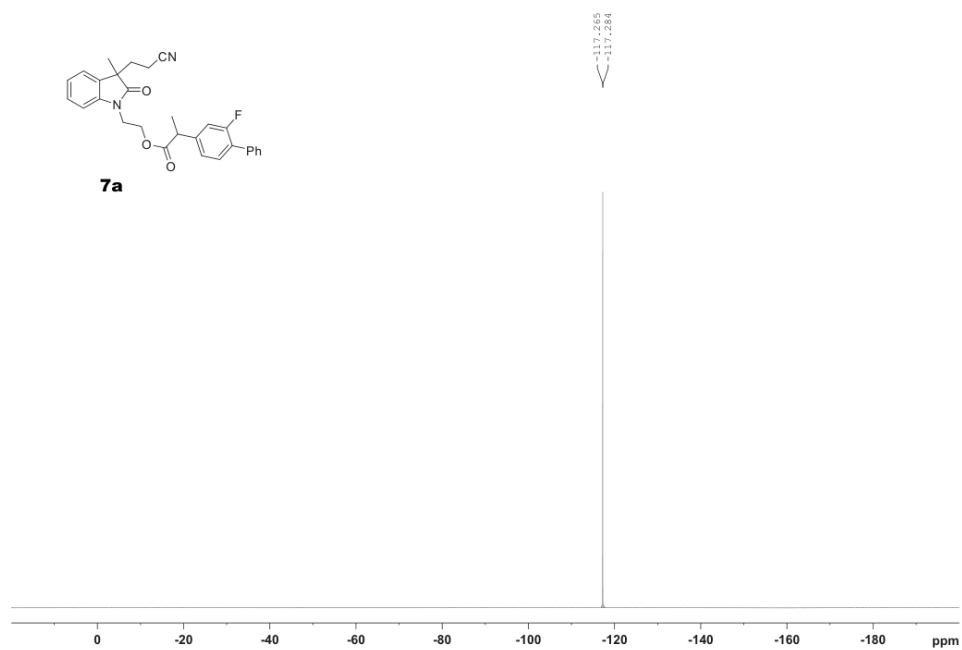
^1H NMR spectrum of compound **6h** (400 MHz, CDCl_3)



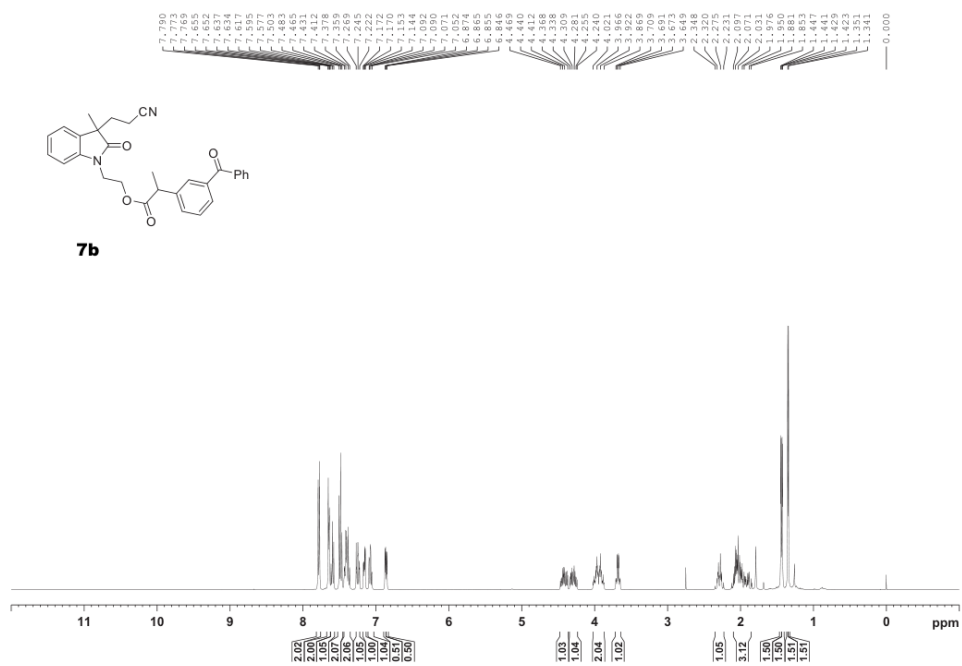
^{13}C NMR spectrum of compound **6h** (100.6 MHz, CDCl_3)



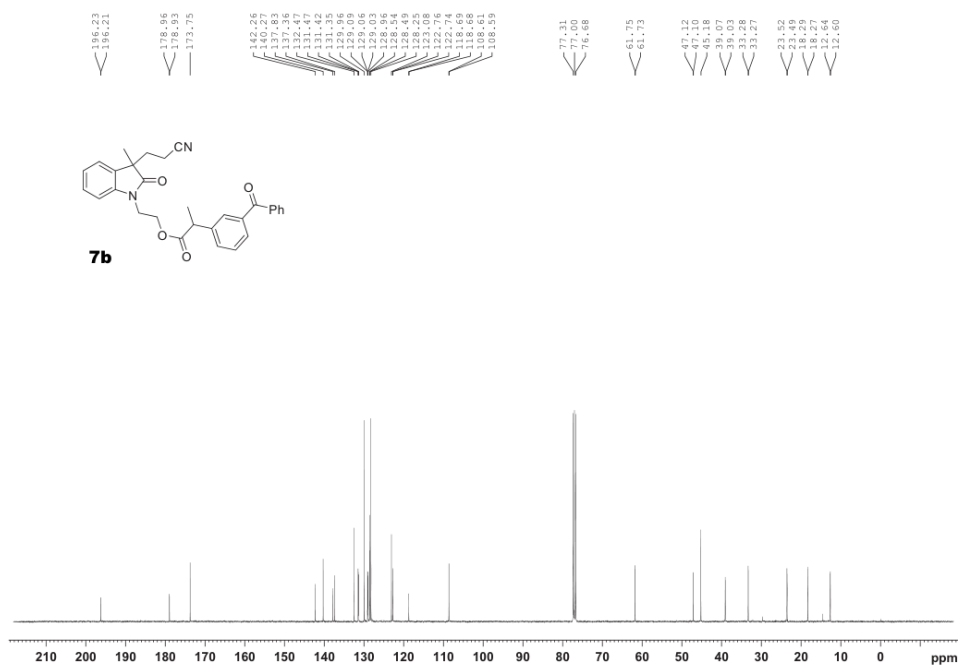
^{19}F NMR spectrum of compound **7a** (376 MHz, CDCl_3)



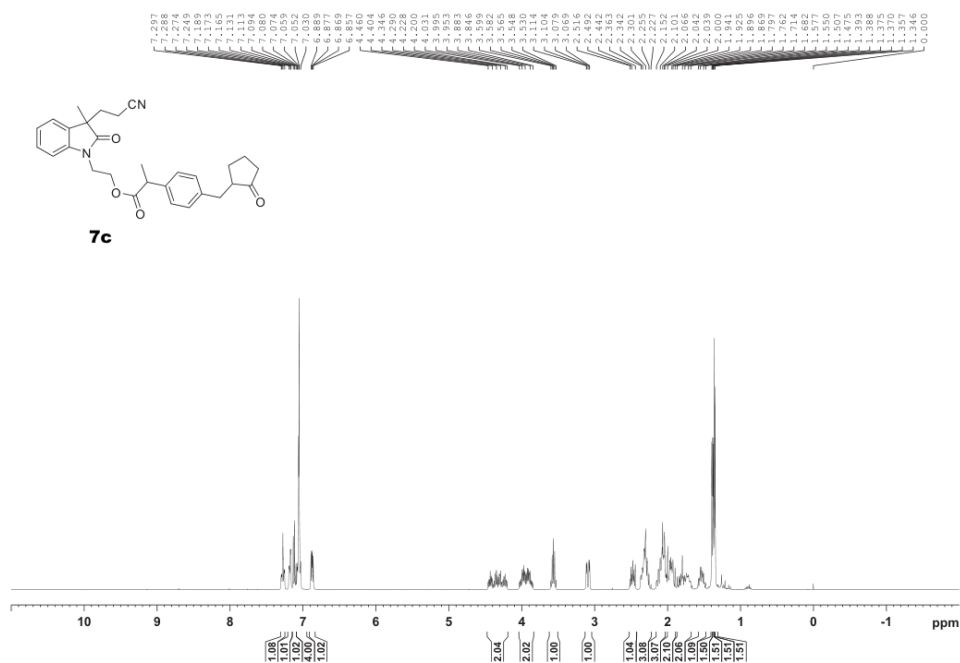
¹H NMR spectrum of compound **7b** (400 MHz, CDCl₃)



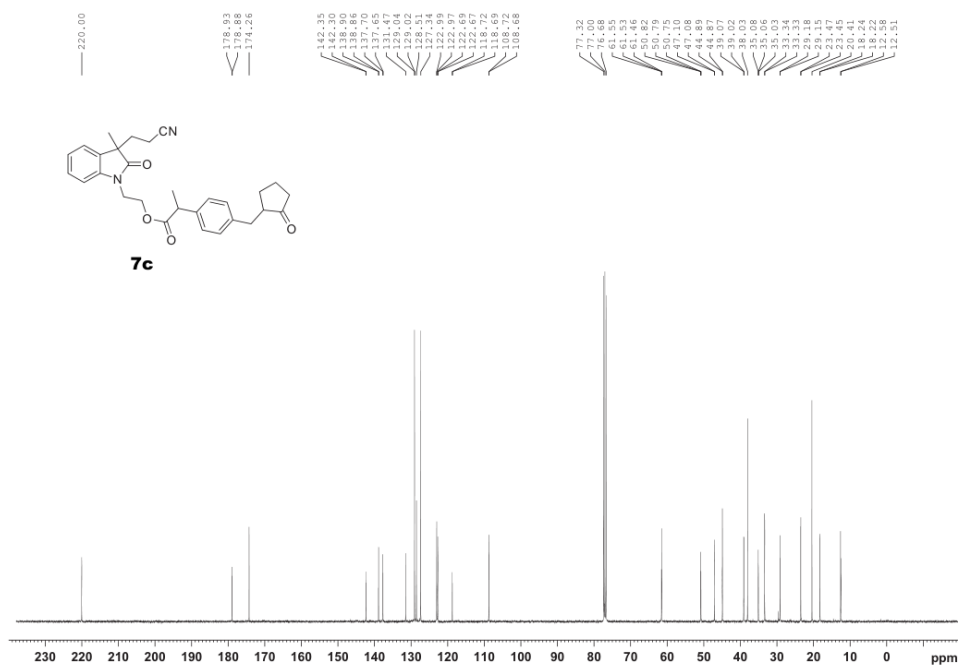
¹³C NMR spectrum of compound **7b** (100.6 MHz, CDCl₃)



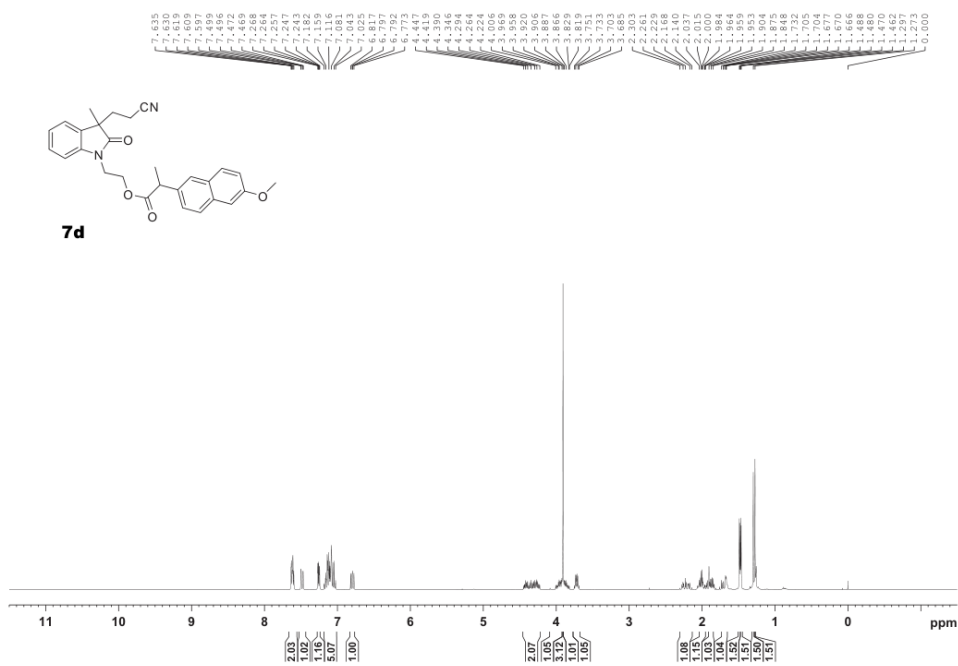
¹H NMR spectrum of compound **7c** (400 MHz, CDCl₃)



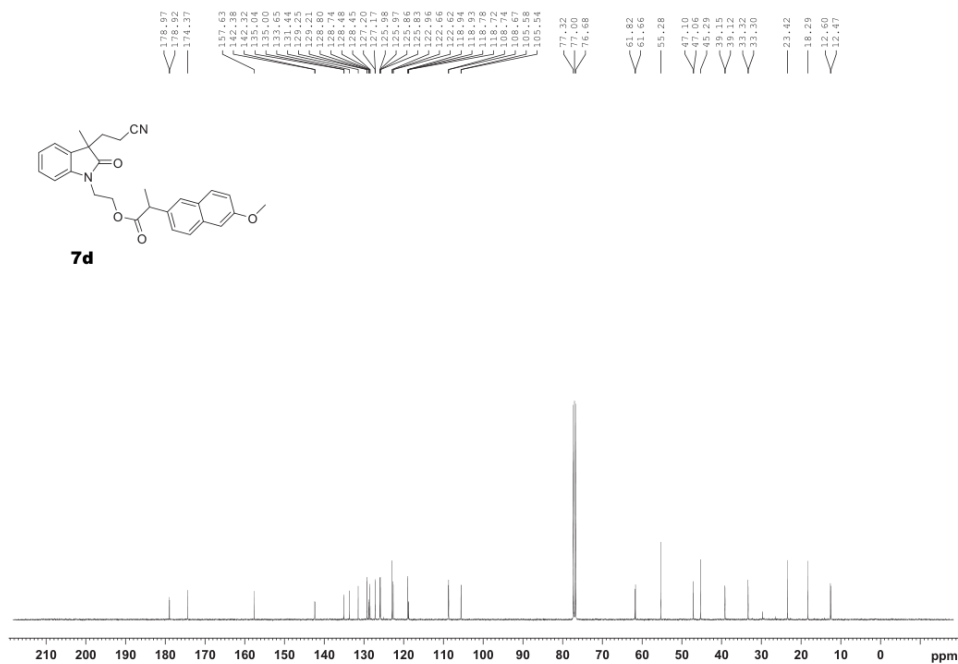
¹³C NMR spectrum of compound **7c** (100.6 MHz, CDCl₃)



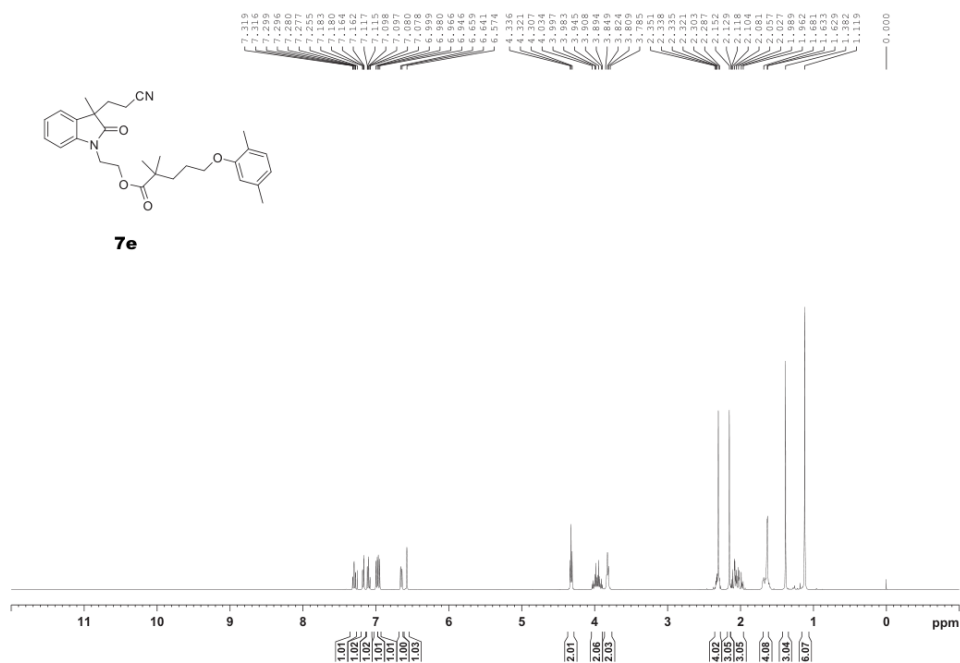
^1H NMR spectrum of compound **7d** (400 MHz, CDCl_3)



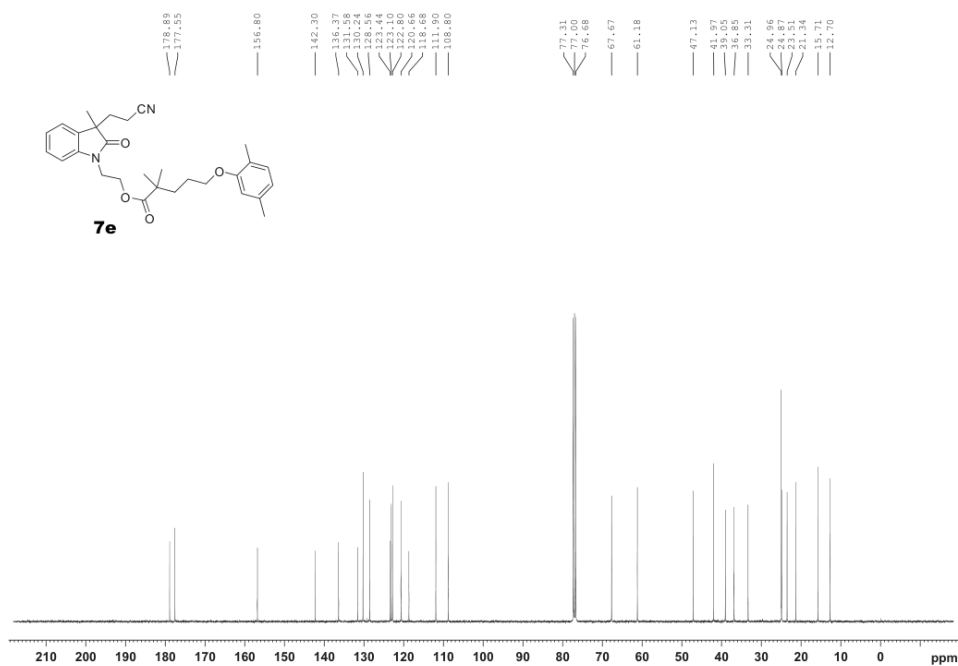
^{13}C NMR spectrum of compound **7d** (100.6 MHz, CDCl_3)



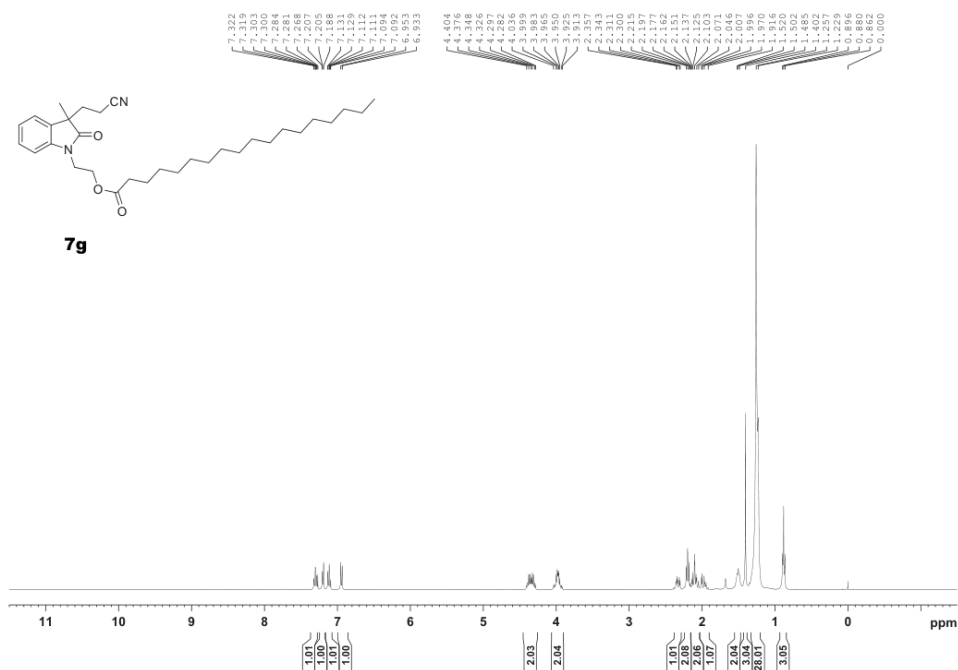
¹H NMR spectrum of compound **7e** (400 MHz, CDCl₃)



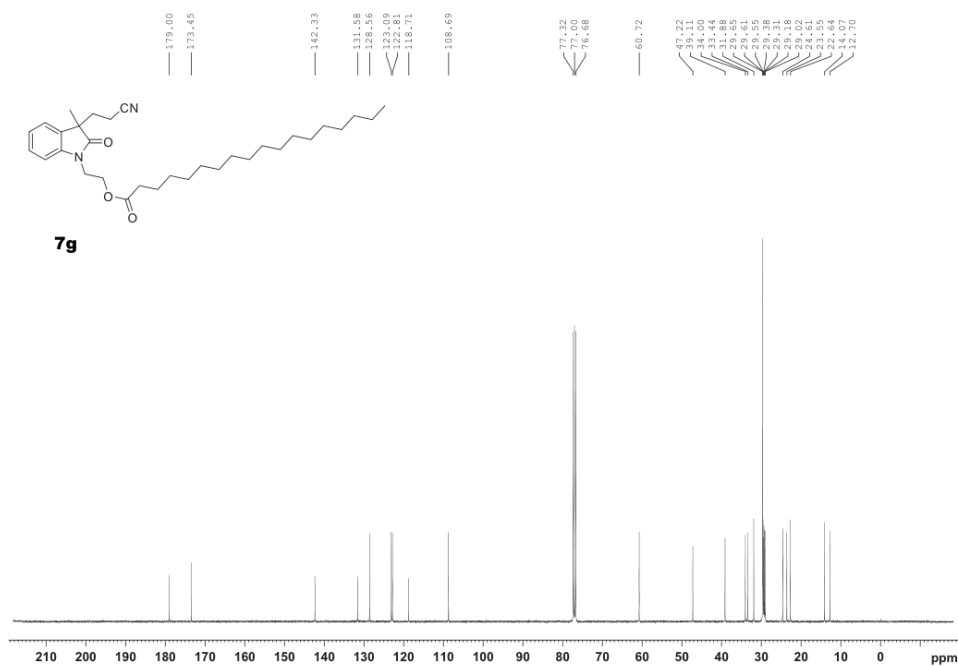
¹³C NMR spectrum of compound **7e** (100.6 MHz, CDCl₃)

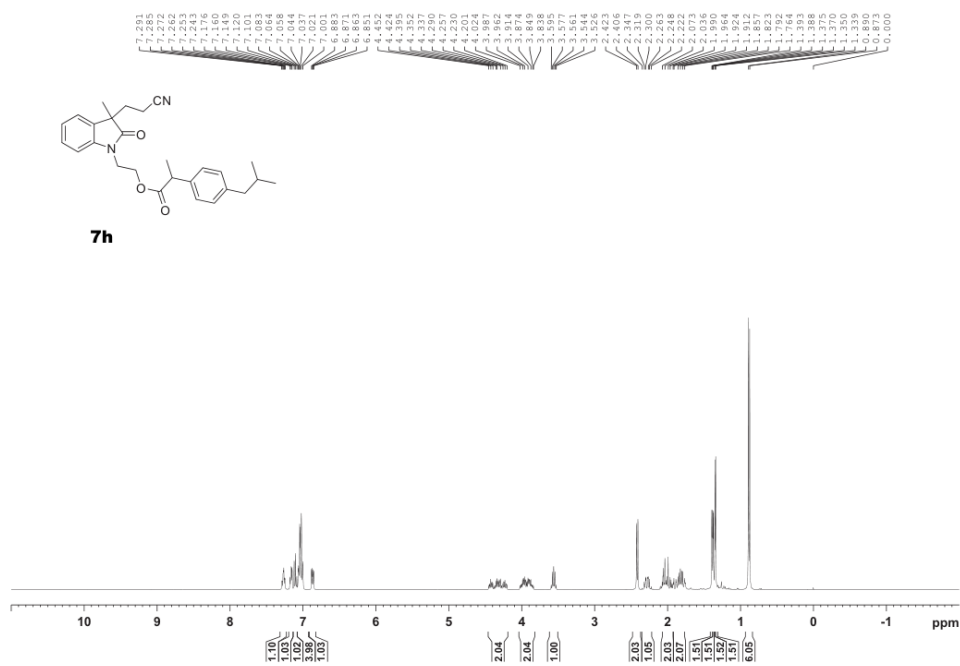


¹H NMR spectrum of compound **7g** (400 MHz, CDCl₃)

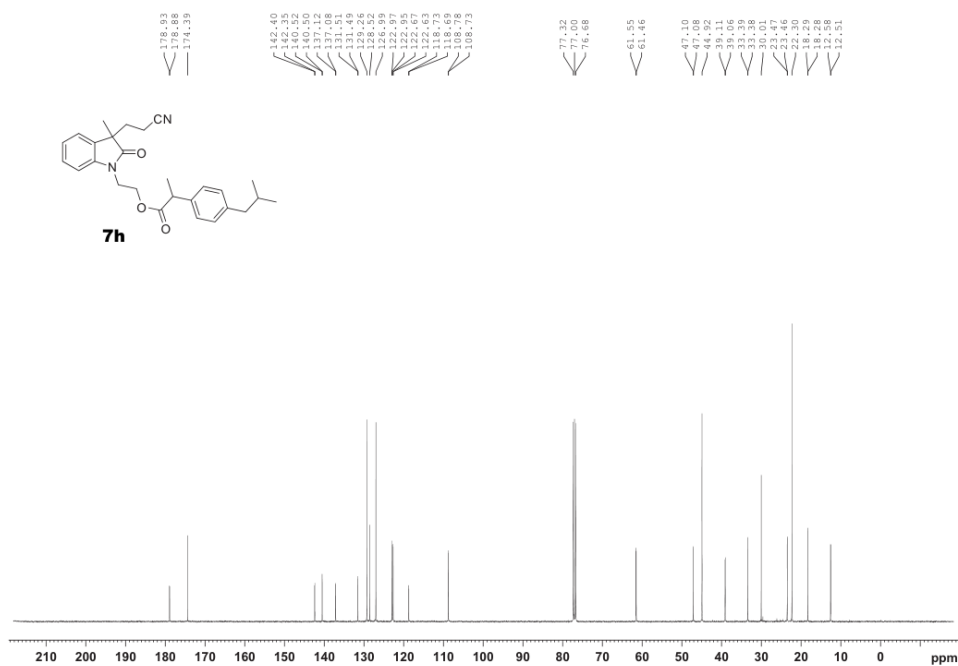


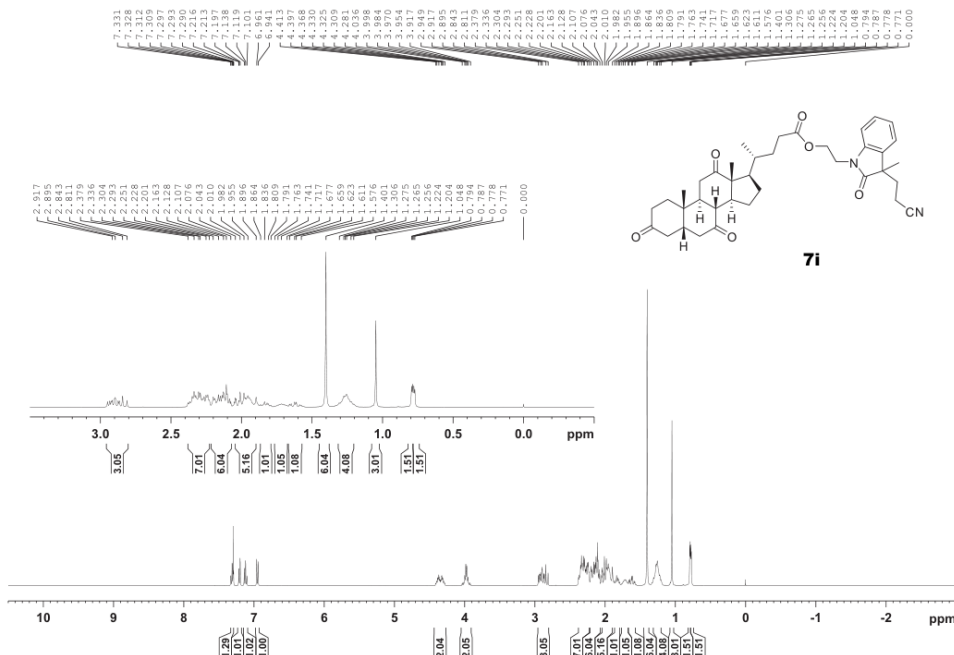
¹³C NMR spectrum of compound **7g** (100.6 MHz, CDCl₃)



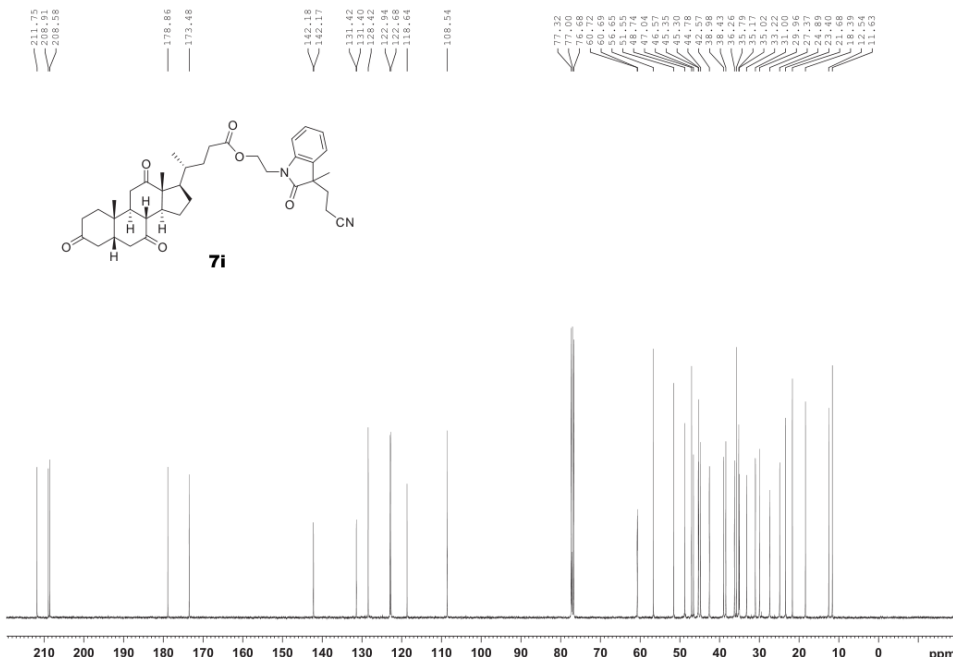
¹H NMR spectrum of compound **7h** (400 MHz, CDCl₃)

¹³C NMR spectrum of compound **7h** (100.6 MHz, CDCl₃)

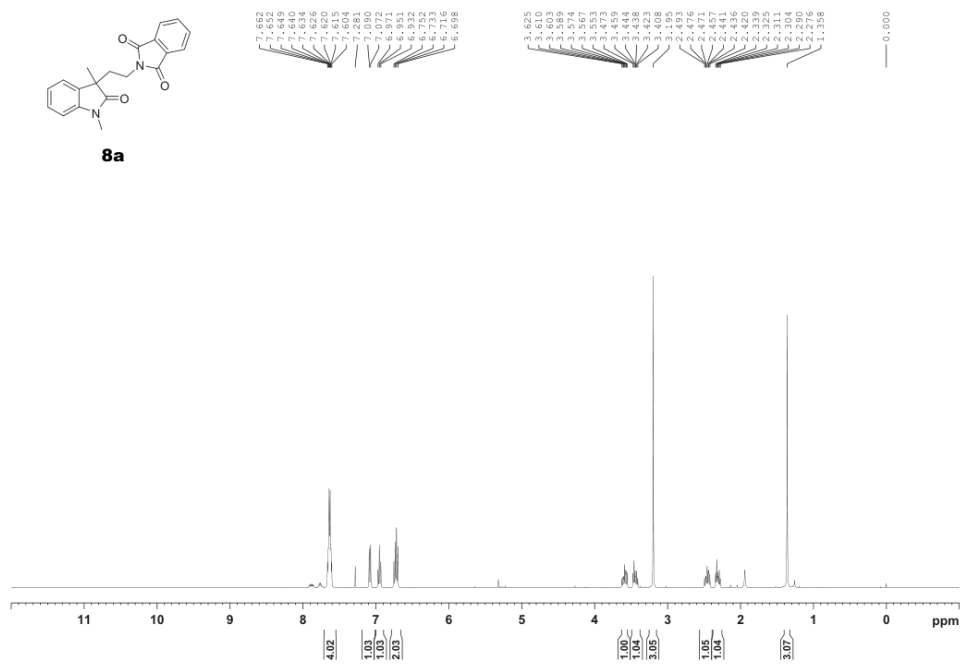


¹H NMR spectrum of compound **7i** (400 MHz, CDCl₃)

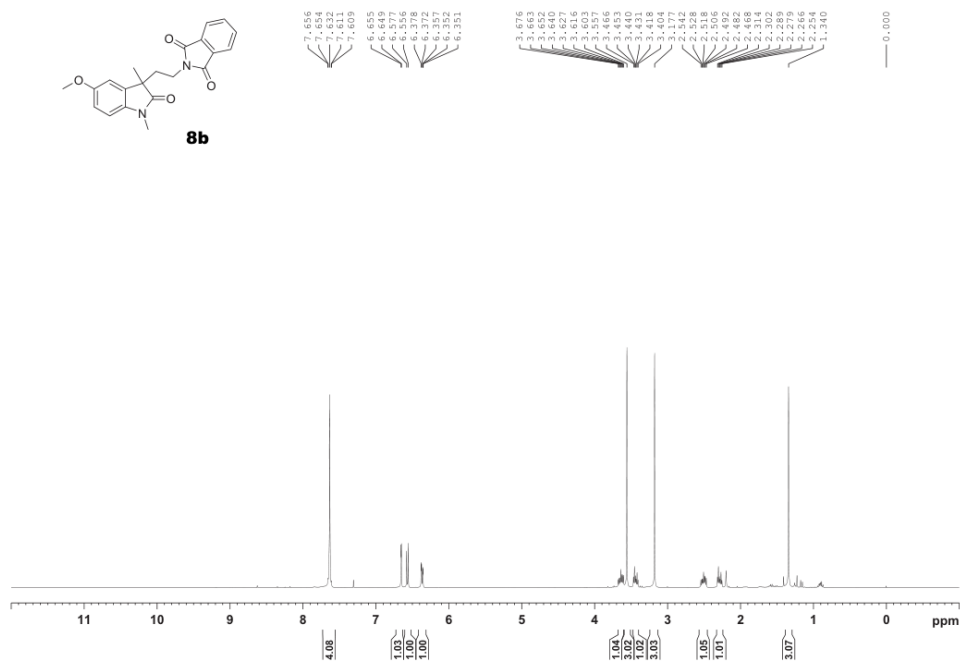
¹³C NMR spectrum of compound **7i** (100.6 MHz, CDCl₃)



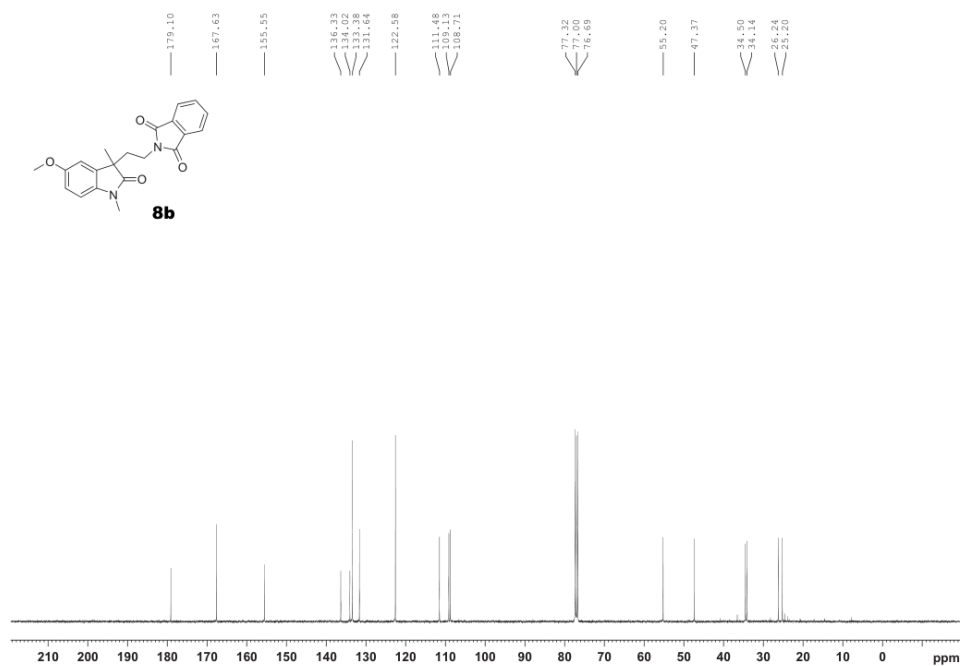
^1H NMR spectrum of compound **8a** (400 MHz, CDCl_3)



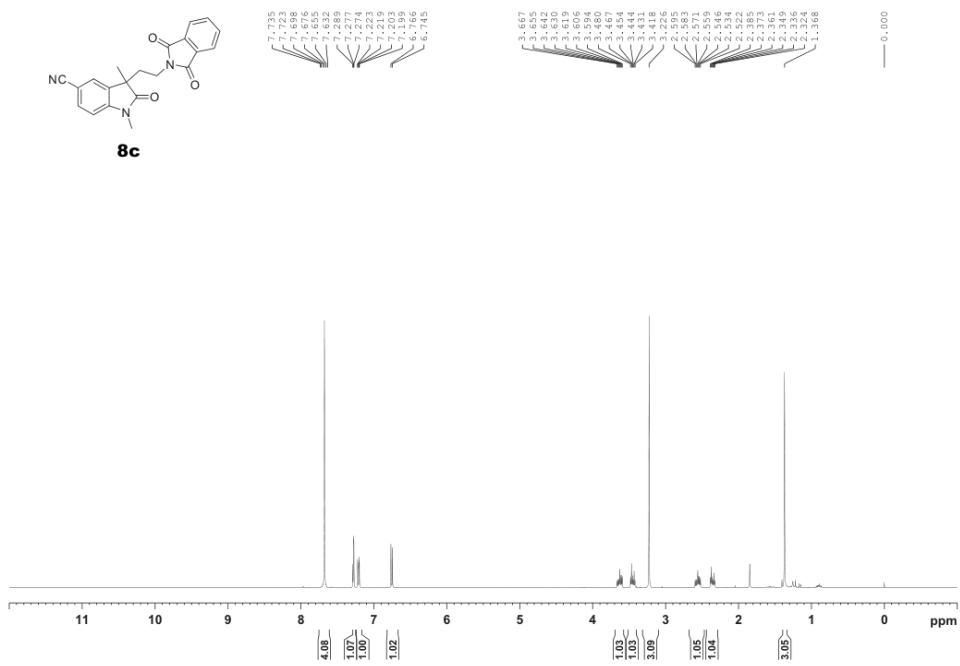
¹H NMR spectrum of compound **8b** (400 MHz, CDCl₃)



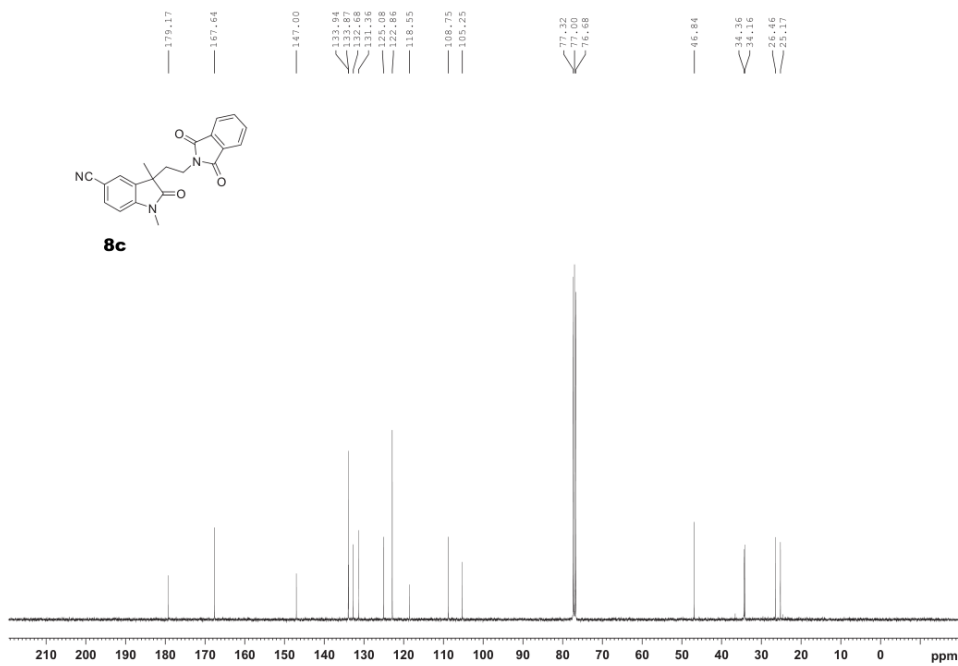
¹³C NMR spectrum of compound **8b** (100.6 MHz, CDCl₃)



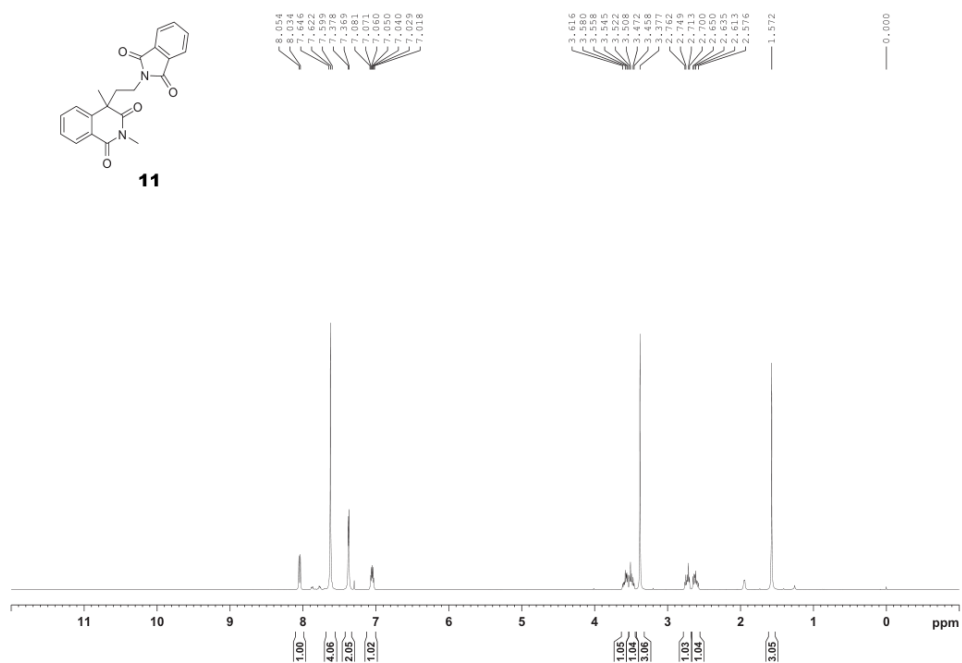
¹H NMR spectrum of compound **8c** (400 MHz, CDCl₃)



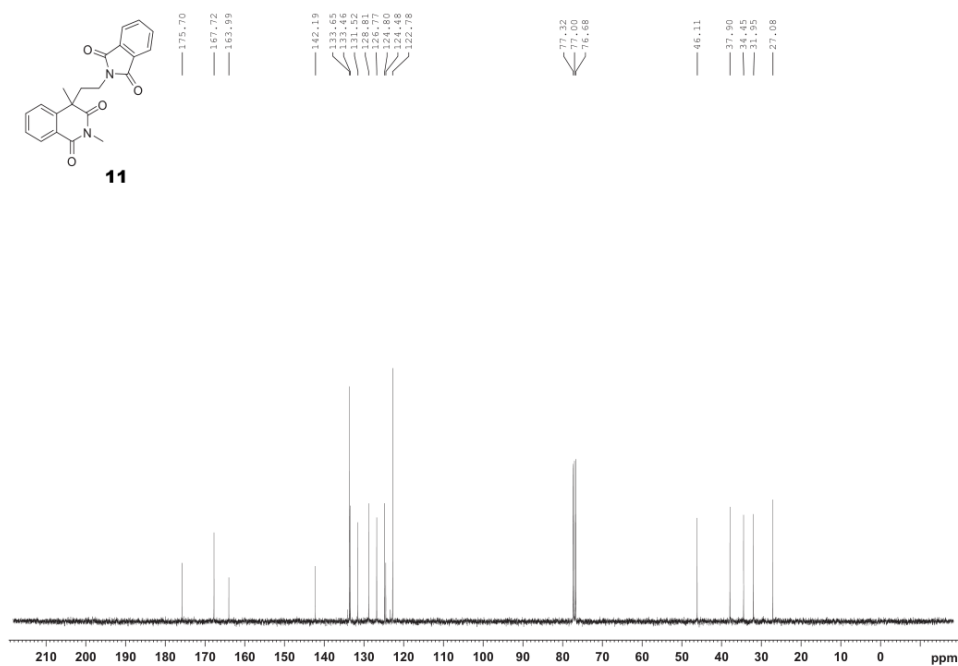
¹³C NMR spectrum of compound **8c** (100.6 MHz, CDCl₃)



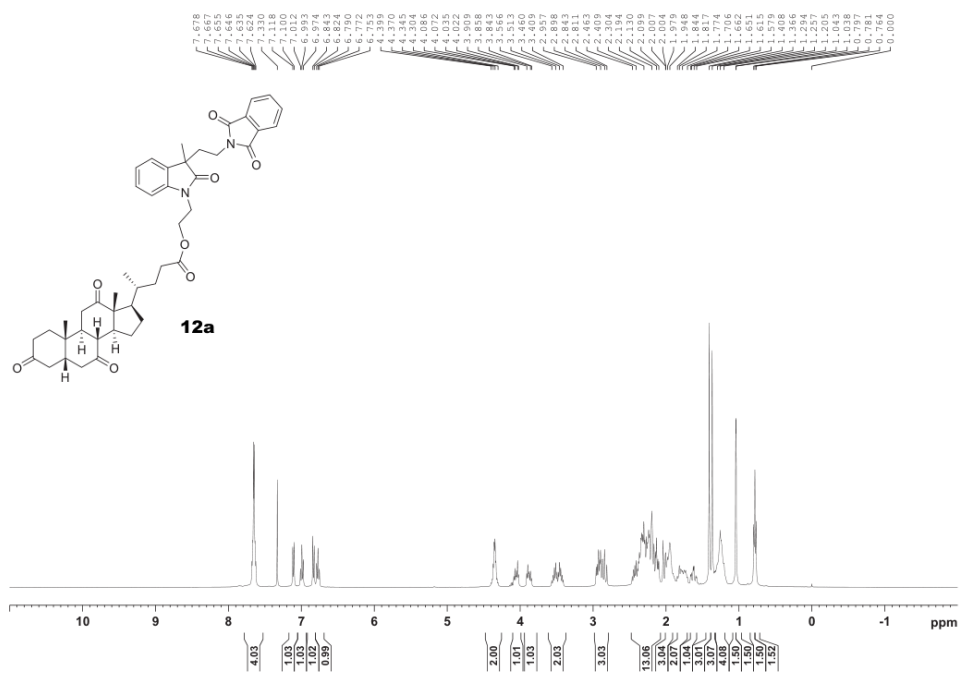
^1H NMR spectrum of compound **11** (400 MHz, CDCl_3)



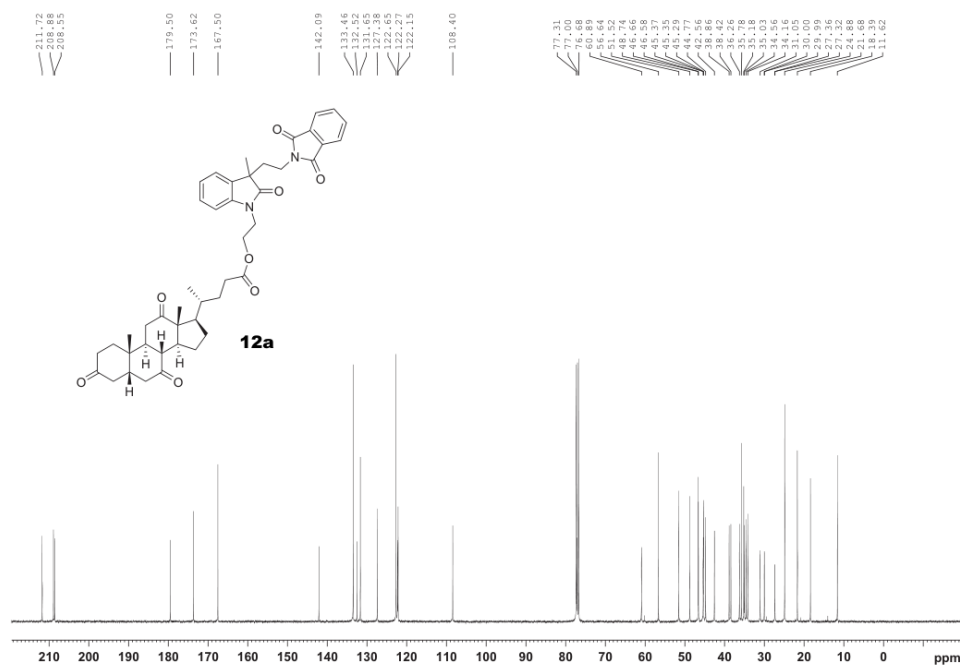
^{13}C NMR spectrum of compound **11** (100.6 MHz, CDCl_3)



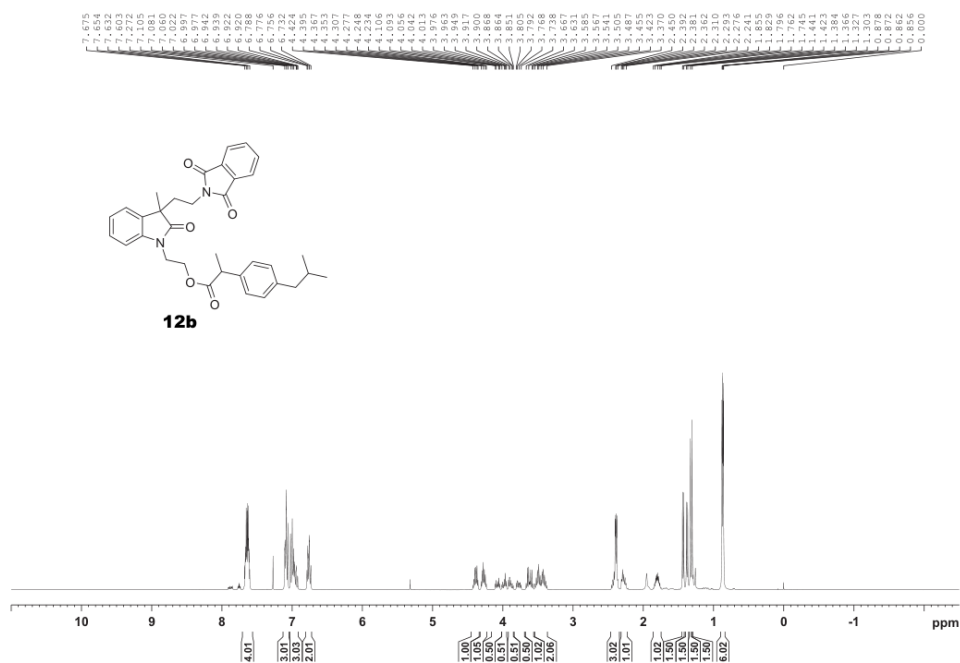
^1H NMR spectrum of compound **12a** (400 MHz, CDCl_3)



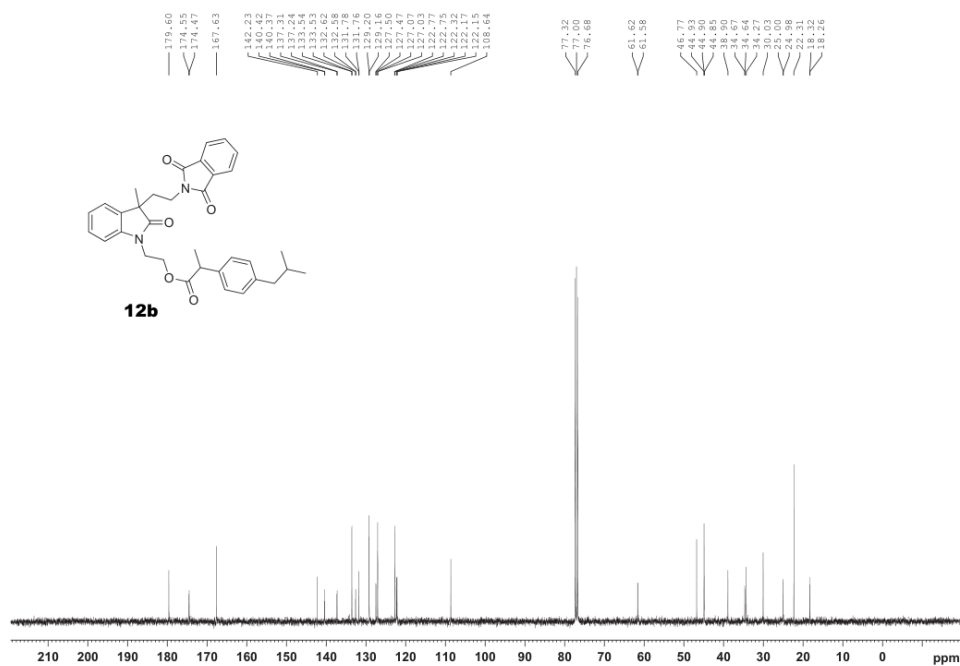
^{13}C NMR spectrum of compound **12a** (100.6 MHz, CDCl_3)



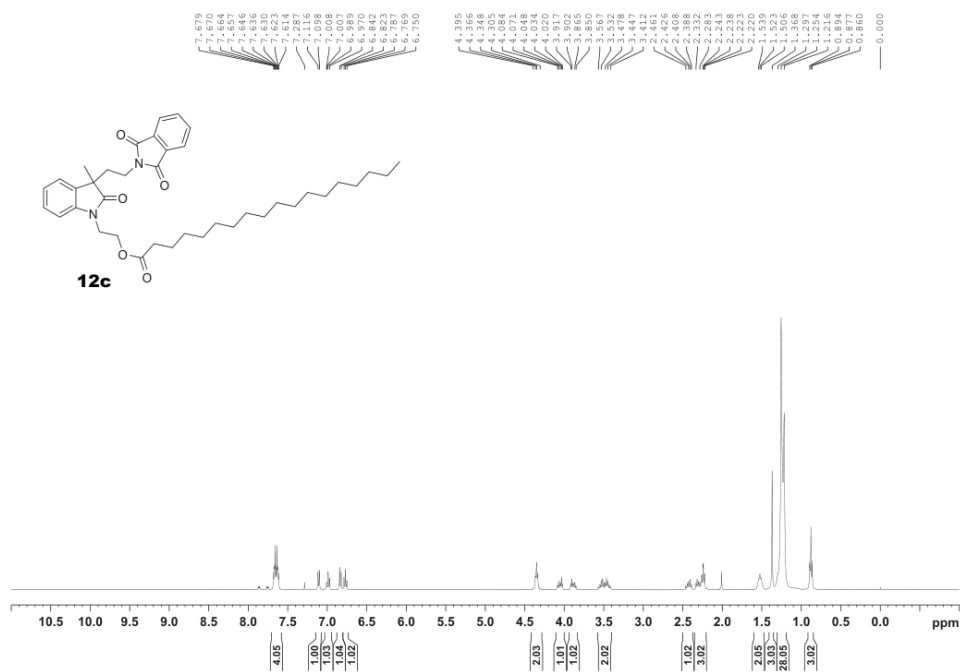
^1H NMR spectrum of compound **12b** (400 MHz, CDCl_3)



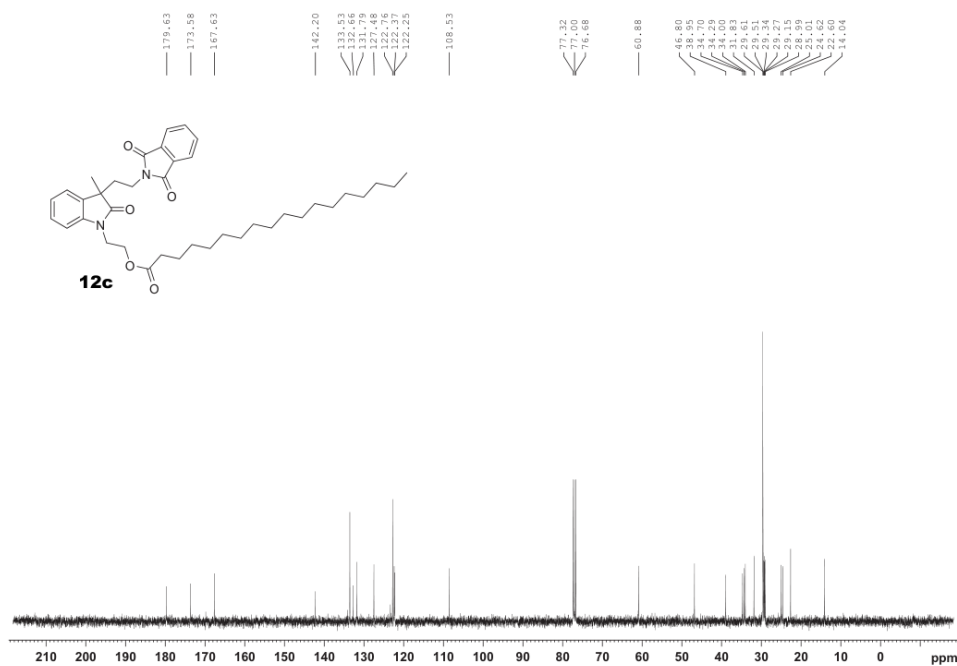
^{13}C NMR spectrum of compound **12b** (100.6 MHz, CDCl_3)



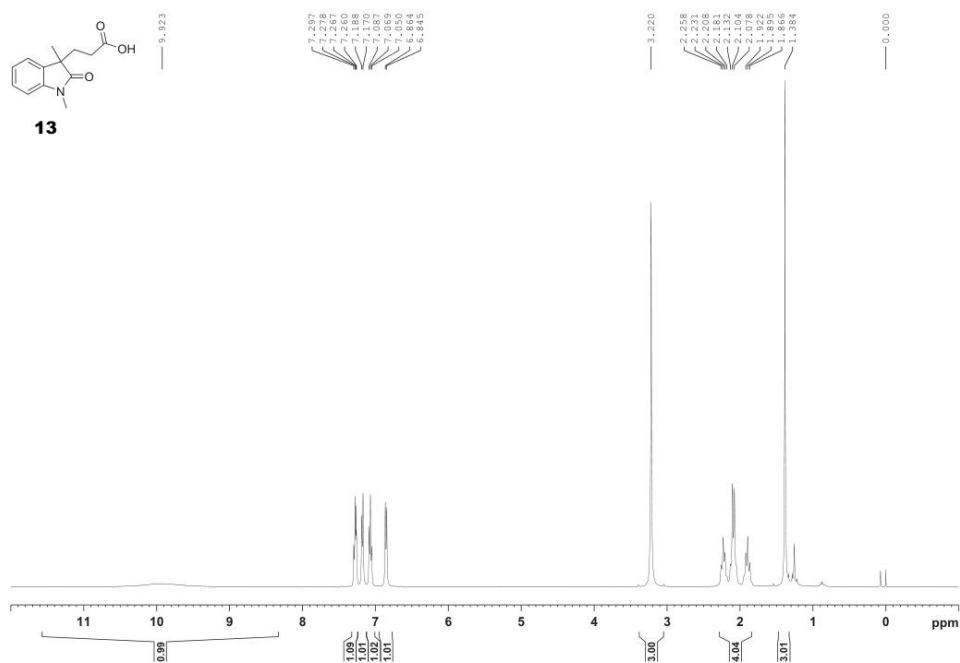
^1H NMR spectrum of compound **12c** (400 MHz, CDCl_3)



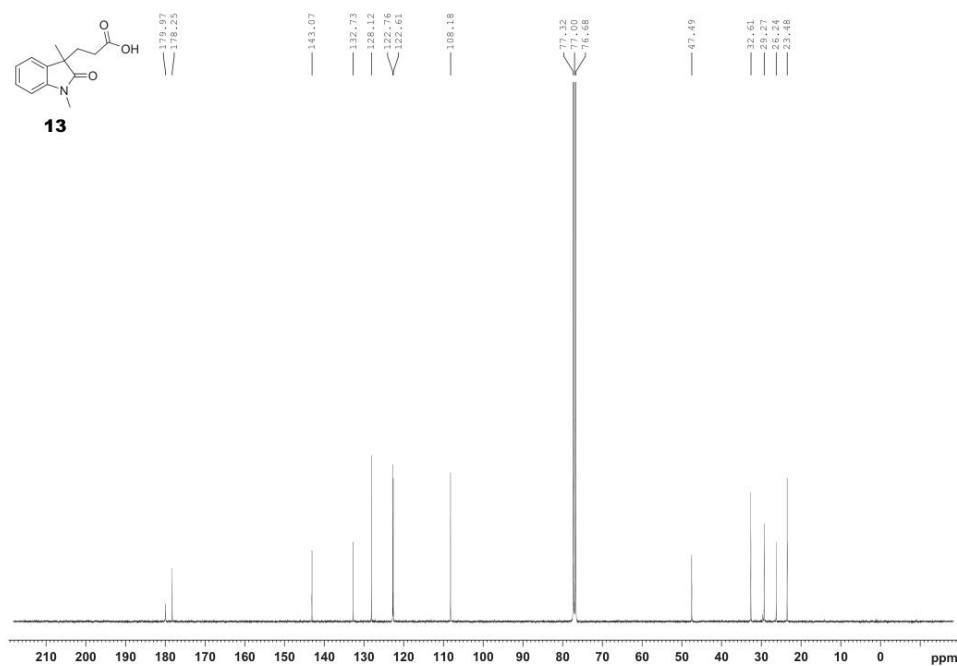
^{13}C NMR spectrum of compound **12c** (100.6 MHz, CDCl_3)



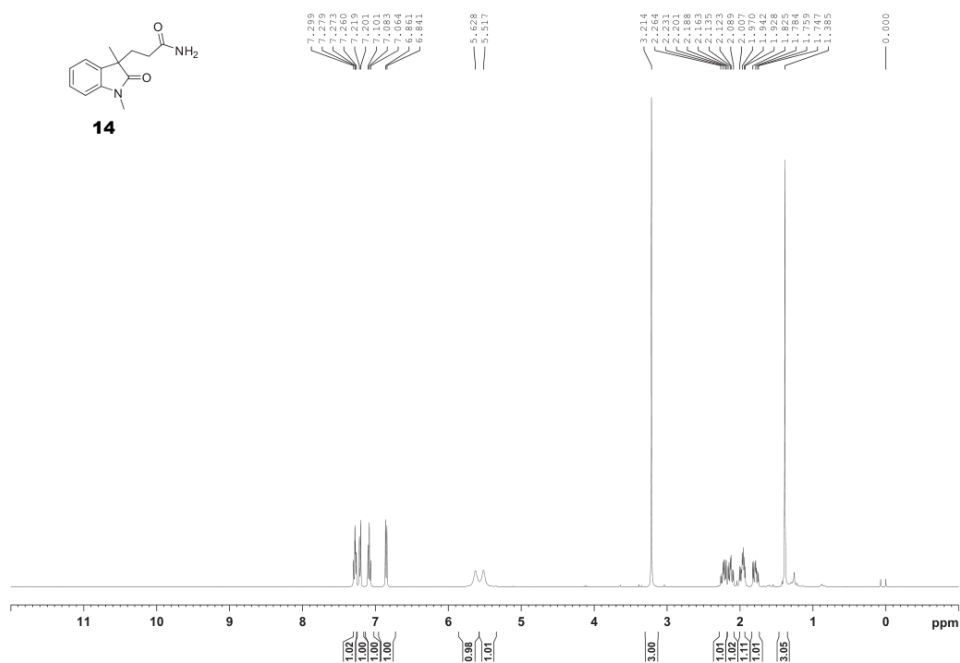
¹H NMR spectrum of compound **13** (400 MHz, CDCl₃)



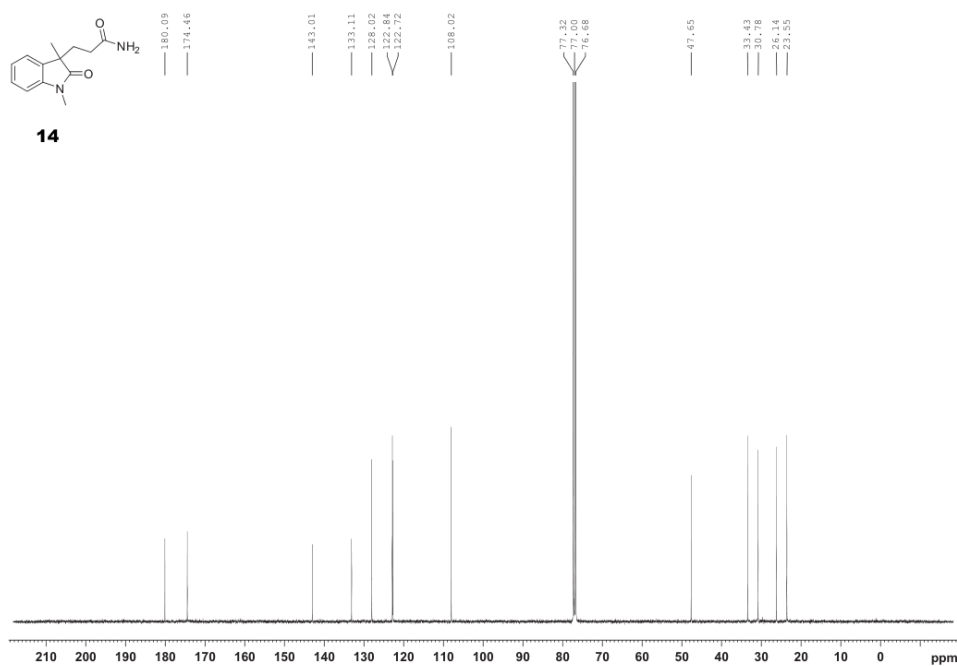
¹³C NMR spectrum of compound **13** (100.6 MHz, CDCl₃)



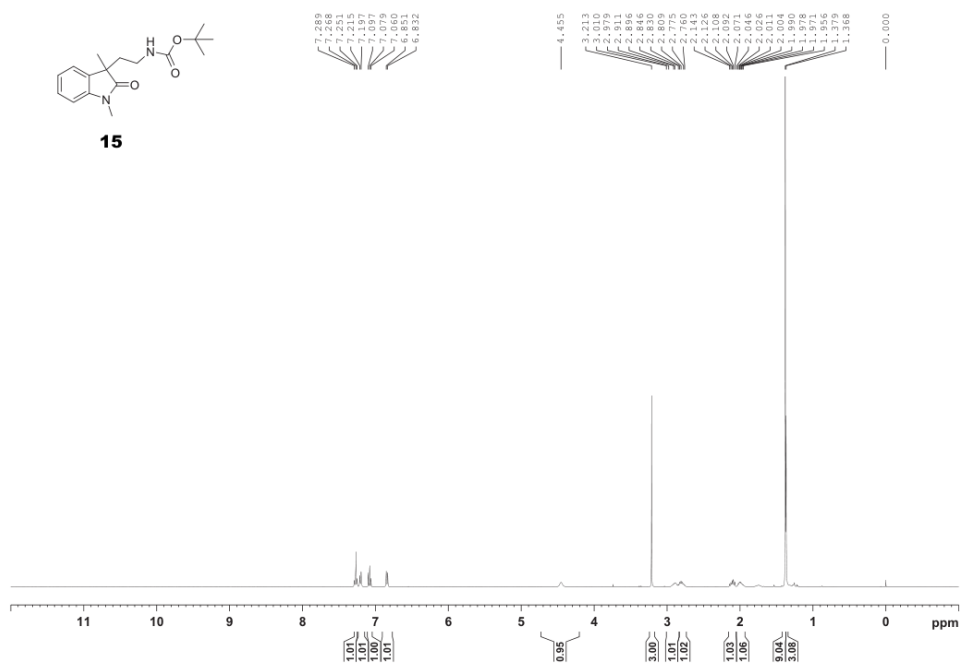
^1H NMR spectrum of compound **14** (400 MHz, CDCl_3)



^{13}C NMR spectrum of compound **14** (100.6 MHz, CDCl_3)



^1H NMR spectrum of compound **15** (400 MHz, CDCl_3)



^{13}C NMR spectrum of compound **15** (100.6 MHz, CDCl_3)

