

Hydride Transfer Involved Redox-Neutral Cascade Cyclizations for Construction of Spirocyclic Bisoxindoles Featuring a [3,4]-Fused Oxindole Moiety

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Supporting Information

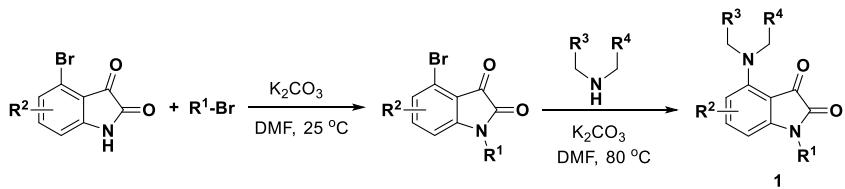
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1. General Information

Unless otherwise noted, all reagents were commercial available (from Adamas-beta) and used as received. All the solvents used in the reaction were distilled prior to use. Molecular sieves were activated at 550 °C for 6 h before use. Thin layer chromatography (TLC) was used to monitor the reaction on Merck 60 F254 precoated silica gel plate (0.2 mm thickness). TLC spots were visualized by UV-light irradiation on Spectroline Model ENF-24061/F 254 nm. The products were purified by flash column chromatography (200-300 mesh silica gel) eluted with the gradient of petroleum ether and ethyl acetate. Proton nuclear magnetic resonance spectra (¹H NMR) were recorded on a Bruker 500 MHz NMR spectrometer (CDCl₃ or DMSO-d₆ solvent). The chemical shifts were reported in parts per million (ppm), downfield from SiMe₄ (δ 0.0) and relative to the signal of chloroform-d (δ 7.26, singlet) or dimethyl sulfoxide-d₆ (δ 2.54, singlet). Multiplicities were given as: s (singlet); d (doublet); t (triplet); q (quartet); dd (doublets of doublet) or m (multiplets). The number of protons for a given resonance is indicated by nH. Coupling constants were reported as a *J* value in Hz. Carbon nuclear magnetic resonance spectra (¹³C NMR) were referenced to the appropriate residual solvent peak. High resolution mass spectral analysis (HRMS) was performed on Waters XEVO G2 Q-TOF.

2. General Procedure

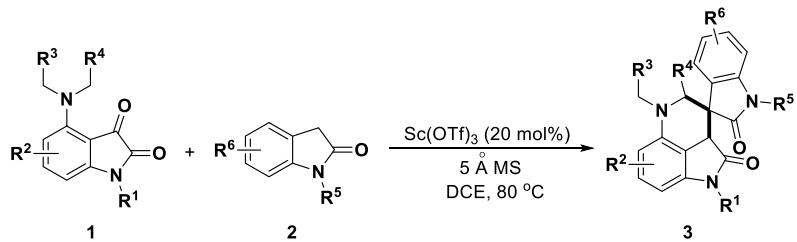
2.1 General Procedure for the Synthesis of C4-Amine-Substituted Isatins



A round-bottomed flask was charged with 4-bromoindoline-2,3-dione (5 mmol), brominated alkanes (6.5 mmol), K₂CO₃ (6.5 mmol) and DMF (100.0 mL). The mixture was stirred at room temperature under an air atmosphere. Upon completion of the reaction as indicated by TLC analysis, water (60 mL) was added. The mixture was extracted with dichloromethane (3 x 80 mL). The combined organic extracts were dried (MgSO₄) and the solvent was evaporated under reduced pressure and the residue was directly purified by flash column chromatography on silica gel (eluent: ethyl acetate/petroleum ether, 1:15) to afford the desired N-substituted 4-bromoindoline-2,3-diones.

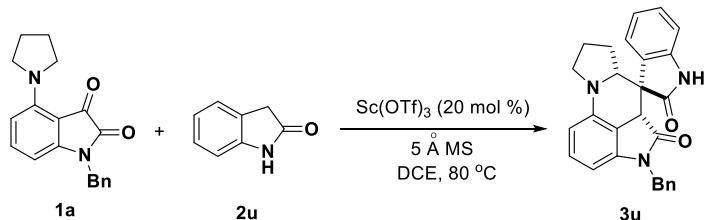
Then the round-bottomed flask was charged with N-substituted 4-bromoindoline-2,3-diones (4 mmol), secondary amines (6 mmol), K₂CO₃ (8 mmol) and DMF (50.0 mL). The mixture was stirred at 80 °C under an air atmosphere and monitored by TLC analysis. Upon completion of the reaction, water (50 mL) was added. The mixture was extracted with dichloromethane (3 x 50 mL). The combined organic extracts were dried (MgSO₄) and the solvent evaporated under reduced pressure and the residue was directly purified by flash column chromatography on silica gel (eluent: ethyl acetate/petroleum ether, 1:20) to afford the desired C4-amine substituted isatins **1**.

2.2 General Procedure for the Synthesis of Spirocyclic Bisoxindoles



An oven-dried reaction tube was charged with C-4 hydride donor substituted isatins **1** (0.1 mmol), indolin-2-ones **2** (0.15 mmol), Sc(OTf)₃ (20 mol %), 5 Å MS (50 mg) and distilled DCE (1 mL). The reaction mixture was stirred vigorously at 80 °C and monitored by TLC. After the consumption of **1**, the reaction mixture was directly purified by flash column chromatography (column chromatography eluent, petroleum ether/ethyl acetate = 20/1) to afford products **3**.

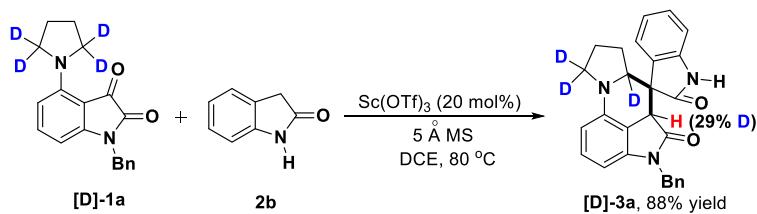
2.3 General Procedure for the Large-Scale Synthesis of Spirocyclic Bisoxindole **3u**



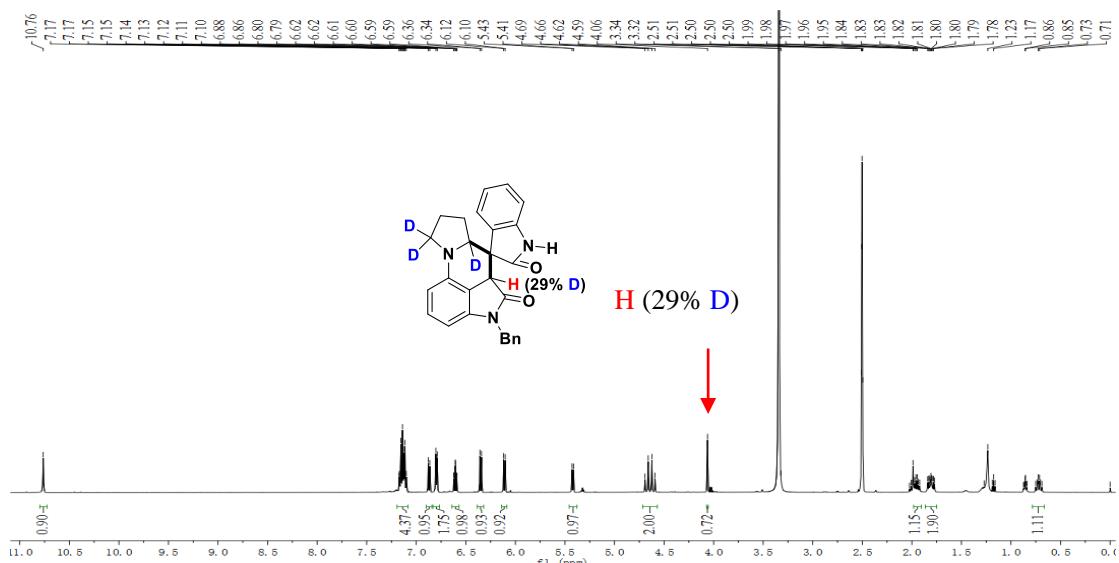
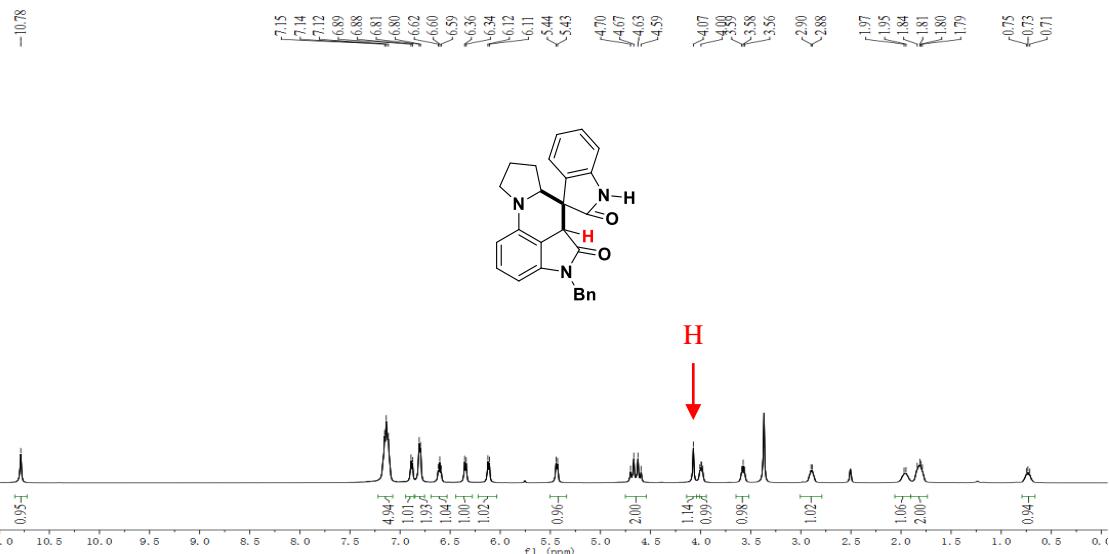
An oven-dried round-bottom flask was charged with C-4 pyrrolidine substituted isatin **1a** (1 mmol), indolin-2-one **2u** (1.5 mmol), Sc(OTf)₃ (20 mol %), 5 Å MS (500 mg) and distilled DCE (10 mL). The reaction mixture was stirred vigorously at 80 °C and monitored by TLC. After the consumption of **1a**, the reaction mixture was directly purified by flash column chromatography (column chromatography eluent, petroleum ether/ethyl acetate = 20/1) to afford product **3u** (328 mg) in 78% yield.

3. Deuterium Labeling Experiments

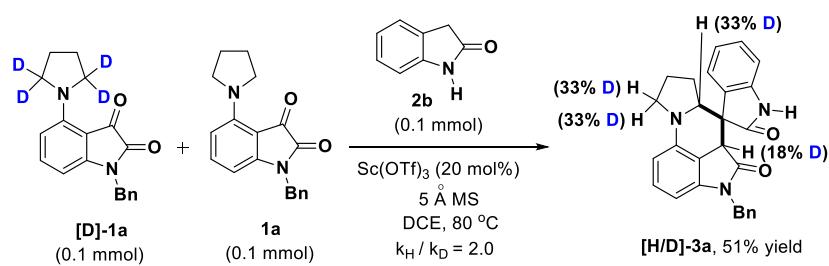
(1)



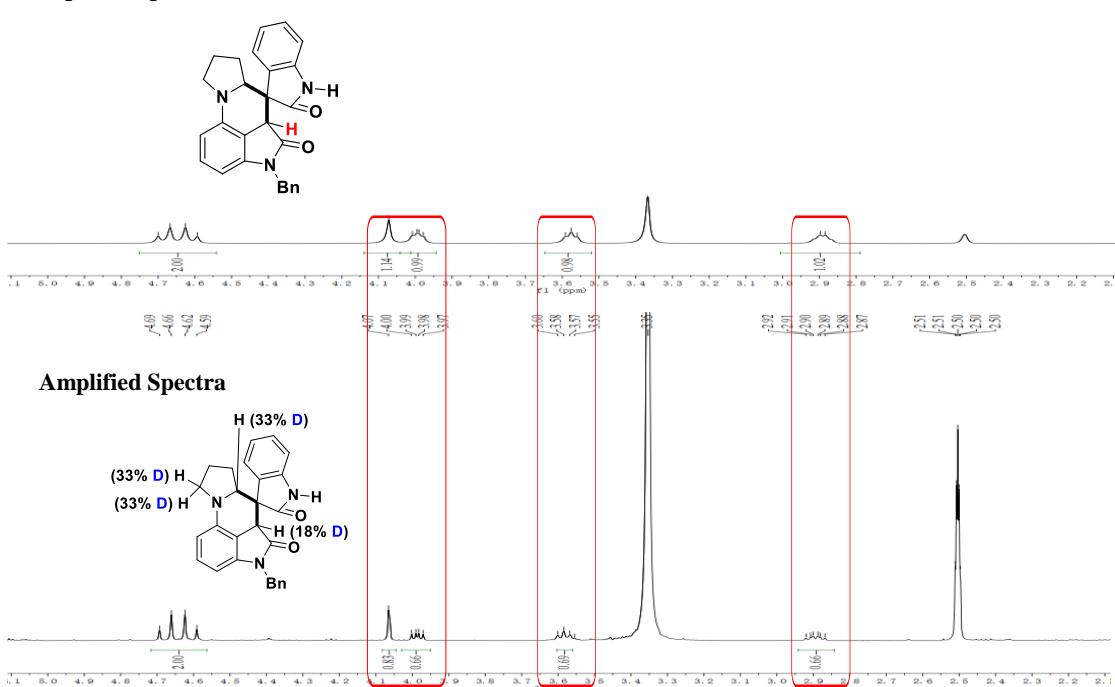
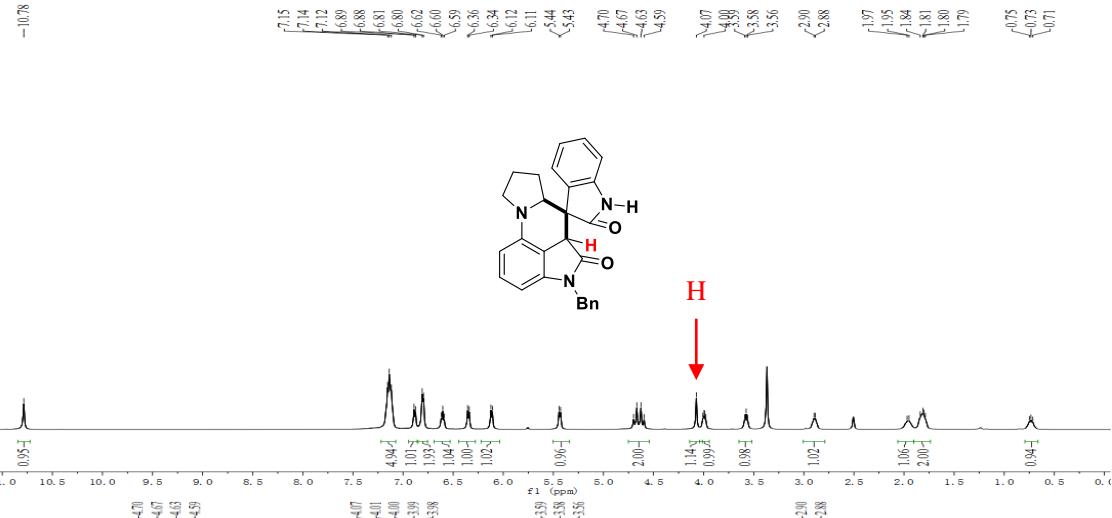
An oven-dried reaction tube was charged with C-4 hydride donor substituted isatins **[D]-1a** (0.1 mmol), indolin-2-ones **2b** (0.15 mmol), Sc(OTf)₃ (20 mol%), 5 Å MS (50 mg) and distilled DCE (1 mL). The reaction mixture was stirred vigorously at 80 °C and monitored by TLC. After the consumption of **1**, the reaction mixture was directly purified by flash column chromatography (column chromatography eluent, petroleum ether/ethyl acetate = 20/1) to afford product **[D]-3a**. The deuterated ratio was measured by ¹H NMR. The deuteration (29% D) at C-3 position of product **[D]-3a** fully corroborated the occurrence of intramolecular [1,5]-hydride transfer, while the loss of deuterated ratio might be ascribed to the continuous enol tautomerism of cyclic amide.



(2)

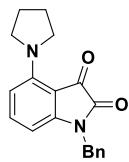


An oven-dried reaction tube was charged with C-4 hydride donor substituted isatins **[D]-1a** (0.1 mmol), C-4 hydride donor substituted isatins **1a** (0.1 mmol), indolin-2-ones **2b** (0.1 mmol), Sc(OTf)₃ (20 mol%), 5 Å MS (50 mg) and distilled DCE (1 mL). The reaction mixture was stirred vigorously at 80 °C for 3 h. Then the reaction mixture was directly purified by flash column chromatography (column chromatography eluent, petroleum ether/ethyl acetate = 20/1) to afford product **[H/D]-3a**. The deuterated ratio was measured by ¹H NMR.



4. Characterization Data of Products

1-benzyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1a)

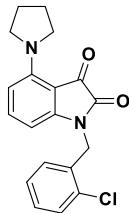


Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.4 g, 90% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.29 (d, *J* = 25.2 Hz, 5H), 7.12 (t, *J* = 8.1 Hz, 1H), 6.33 (d, *J* = 8.9 Hz, 1H), 5.97 (d, *J* = 7.3 Hz, 1H), 4.89 (s, 2H), 3.60 (s, 4H), 2.00 (s, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.98, 160.16, 150.38, 148.08, 137.34, 135.60, 128.77, 127.69, 127.27, 111.40, 102.65, 97.86, 51.62,

43.74, 25.62 ppm. **HRMS (ESI):** calcd. for $C_{19}H_{19}N_2O_2$ [M+H]⁺: 307.1441, found: 307.1443.

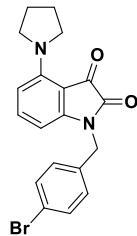
1-(2-chlorobenzyl)-4-(pyrrolidin-1-yl)indoline-2,3-dione (1b)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.5 g, 89% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.39 (d, *J* = 7.6 Hz, 1H), 7.24 – 7.16 (m, 3H), 7.13 (t, *J* = 8.1 Hz, 1H), 6.36 (d, *J* = 8.9 Hz, 1H), 5.92 (d, *J* = 7.2 Hz, 1H), 5.01 (s, 2H), 3.62 (s, 4H), 2.01 (s, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.61, 160.27, 149.98, 148.06, 137.47, 132.74, 132.59, 129.57, 128.80, 127.82, 127.15, 111.63, 102.57, 97.66, 51.63, 41.07, 25.58 ppm. **HRMS (ESI):** calcd. for $C_{19}H_{18}ClN_2O_2$ [M+H]⁺: 341.1051, found: 341.1054.

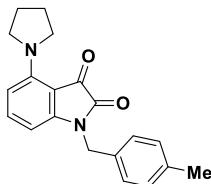
1-(4-bromobenzyl)-4-(pyrrolidin-1-yl)indoline-2,3-dione (1c)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.7 g, 91% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.45 (d, *J* = 7.4 Hz, 2H), 7.20 (d, *J* = 7.7 Hz, 2H), 7.12 (t, *J* = 8.0 Hz, 1H), 6.35 (d, *J* = 8.7 Hz, 1H), 5.92 (d, *J* = 7.2 Hz, 1H), 4.84 (s, 2H), 3.60 (s, 4H), 2.00 (s, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.69, 160.13, 150.04, 148.14, 137.31, 134.67, 131.93, 129.02, 121.67, 111.62, 102.62, 97.62, 51.67, 43.17, 25.62 ppm. **HRMS (ESI):** calcd. for $C_{19}H_{18}BrN_2O_2$ [M+H]⁺: 385.0546, found: 385.0547.

1-(4-methylbenzyl)-4-(pyrrolidin-1-yl)indoline-2,3-dione (1d)

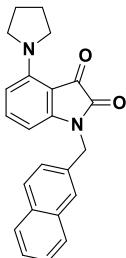


Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.5 g, 92% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.21 (d, *J* = 7.6 Hz, 2H), 7.15 – 7.07 (m, 3H), 6.32 (d, *J* = 8.9 Hz, 1H), 5.98 (d, *J* = 7.3 Hz, 1H), 4.85 (s, 2H), 3.59 (s, 4H), 2.31 (s, 3H), 1.99 (s, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 178.07, 160.11, 150.43, 148.05, 137.40, 137.33, 132.57, 129.42, 127.29, 111.32, 102.65,

97.89, 51.59, 43.50, 25.61, 21.06 ppm. **HRMS (ESI)**: calcd. for $C_{20}H_{21}N_2O_2$ [M+H]⁺: 321.1598, found: 321.1597.

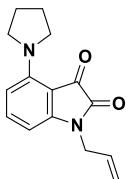
1-(naphthalen-2-ylmethyl)-4-(pyrrolidin-1-yl)indoline-2,3-dione (1e)



Flash column chromatography on a silica gel (ethyl acetate: petroleum ether, 1:15) afforded the product (1.4 g, 79% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.82 – 7.74 (m, 4H), 7.49 – 7.39 (m, 3H), 7.06 (dd, *J* = 8.7, 7.6 Hz, 1H), 6.30 (d, *J* = 8.9 Hz, 1H), 6.00 (d, *J* = 7.3 Hz, 1H), 5.04 (s, 2H), 3.58 (s, 4H), 2.00 – 1.90 (m, 4H); **¹³C NMR** (126 MHz, CDCl₃) δ 177.93, 160.24, 150.31, 148.06, 137.33, 133.22, 133.07, 132.79, 128.73, 127.70, 127.66, 126.32, 126.08, 126.03, 125.12, 111.43, 102.64, 97.94, 51.60, 43.96, 25.59 ppm. **HRMS (ESI)**: calcd. for $C_{23}H_{21}N_2O_2$ [M+H]⁺: 357.1598, found: 357.1599.

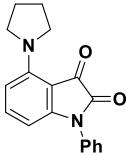
1-allyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1f)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.2 g, 93% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.20 (t, *J* = 8.1 Hz, 1H), 6.37 (d, *J* = 8.9 Hz, 1H), 6.07 (d, *J* = 7.3 Hz, 1H), 5.84 (ddt, *J* = 16.0, 10.4, 5.3 Hz, 1H), 5.25 (dd, *J* = 21.6, 13.8 Hz, 2H), 4.33 (d, *J* = 5.1 Hz, 2H), 3.60 (s, 4H), 2.01 (d, *J* = 5.8 Hz, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 178.04, 159.74, 150.49, 148.06, 137.34, 131.32, 117.74, 111.31, 102.59, 97.60, 51.60, 42.28, 25.62 ppm. **HRMS (ESI)**: calcd. for $C_{15}H_{17}N_2O_2$ [M+H]⁺: 257.1285, found: 257.1283.

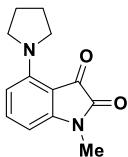
1-phenyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1g)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.3 g, 86% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.51 (t, *J* = 7.5 Hz, 2H), 7.40 (t, *J* = 9.1 Hz, 3H), 7.16 (t, *J* = 8.1 Hz, 1H), 6.41 (d, *J* = 8.9 Hz, 1H), 6.00 (d, *J* = 7.3 Hz, 1H), 3.64 (s, 4H), 2.03 (s, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.45, 159.30, 151.28, 148.32, 137.33, 133.48, 129.56, 128.29, 126.61, 111.50, 102.82, 98.32, 51.71, 25.65 ppm. **HRMS (ESI)**: calcd. for $C_{18}H_{17}N_2O_2$ [M+H]⁺: 293.1285, found: 293.1287.

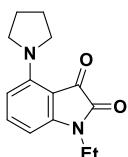
1-methyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1h)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.0 g, 90% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.23 (t, *J* = 8.0 Hz, 1H), 6.38 (d, *J* = 8.9 Hz, 1H), 6.06 (d, *J* = 7.2 Hz, 1H), 3.60 (s, 4H), 3.20 (s, 3H), 2.00 (s, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 178.27, 160.07, 151.42, 147.91, 137.36, 111.46, 102.38, 96.72, 51.59, 26.12, 25.62 ppm. **HRMS (ESI)**: calcd. for C₁₃H₁₅N₂O₂ [M+H]⁺: 231.1128, found: 231.1130.

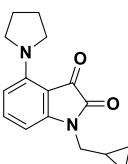
1-ethyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1i)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.1 g, 88 % yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.22 (t, *J* = 8.1 Hz, 1H), 6.37 (d, *J* = 8.9 Hz, 1H), 6.08 (d, *J* = 7.3 Hz, 1H), 3.74 (d, *J* = 7.2 Hz, 2H), 3.59 (s, 3H), 2.00 (s, 4H), 1.28 (t, *J* = 7.2 Hz, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 178.56, 159.71, 150.44, 148.16, 137.37, 111.26, 102.64, 96.88, 51.62, 34.74, 25.68, 13.06 ppm. **HRMS (ESI)**: calcd. for C₁₄H₁₇N₂O₂ [M+H]⁺: 245.1285, found: 245.1288.

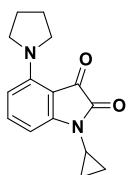
1-(cyclopropylmethyl)-4-(pyrrolidin-1-yl)indoline-2,3-dione (1j)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.1 g, 85% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.23 (t, *J* = 8.1 Hz, 1H), 6.37 (d, *J* = 8.9 Hz, 1H), 6.15 (d, *J* = 7.3 Hz, 1H), 3.60 (s, 4H), 3.57 (d, *J* = 7.0 Hz, 2H), 2.00 (s, 4H), 1.23 – 1.11 (m, 1H), 0.53 (q, *J* = 5.2 Hz, 2H), 0.40 (t, *J* = 5.1 Hz, 2H); **¹³C NMR** (125 MHz, CDCl₃) δ 178.56, 160.08, 151.08, 148.16, 137.36, 111.20, 102.64, 97.21, 51.64, 44.33, 25.68, 9.87, 3.99 ppm; **HRMS (ESI)**: calcd. for C₁₆H₁₉N₂O₂ [M+H]⁺: 271.1441, found: 271.1443.

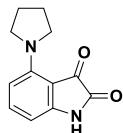
1-cyclopropyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1k)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.1 g, 86% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.28 – 7.23 (m, 1H), 6.38 (t, *J* = 7.7 Hz, 2H), 3.58 (s, 4H), 2.63 (d, *J* = 3.4 Hz, 1H), 2.00 (s, 4H), 1.05 (q, *J* = 6.1 Hz, 2H), 0.96 (s, 2H); **¹³C NMR** (125 MHz, CDCl₃) δ 178.29, 160.42, 151.74, 147.78, 137.43, 110.98, 102.54, 98.07, 51.56, 25.62, 22.04, 6.14 ppm. **HRMS (ESI)**: calcd. for C₁₅H₁₇N₂O₂ [M+H]⁺: 257.1285, found: 257.1286.

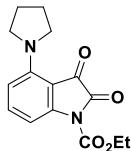
4-(pyrrolidin-1-yl)indoline-2,3-dione (1l)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.0 g, 95% yield) as a red solid.

¹H NMR (500 MHz, DMSO) δ 10.82 (s, 1H), 7.24 (t, *J* = 8.0 Hz, 1H), 6.38 (d, *J* = 8.9 Hz, 1H), 6.04 (d, *J* = 7.2 Hz, 1H), 3.50 (s, 4H), 1.92 (s, 4H); **¹³C NMR** (125 MHz, DMSO) δ 179.38, 160.98, 150.44, 148.10, 138.58, 110.95, 103.27, 99.15, 51.60, 25.60 ppm. **HRMS (ESI)**: calcd. for C₁₂H₁₃N₂O₂ [M+H]⁺: 217.0972, found: 217.0974.

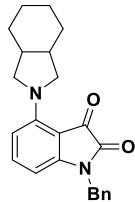
ethyl 2,3-dioxo-4-(pyrrolidin-1-yl)indoline-1-carboxylate (1m)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (0.9 g, 90% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.34 (t, *J* = 7.7 Hz, 1H), 7.27 (d, *J* = 7.5 Hz, 1H), 6.54 (d, *J* = 8.7 Hz, 1H), 4.48 (q, *J* = 6.6 Hz, 2H), 3.57 (s, 4H), 2.03 (s, 4H), 1.45 (t, *J* = 6.7 Hz, 3H); **¹³C NMR** (125 MHz, CDCl₃) δ 174.29, 157.93, 150.20, 148.67, 146.61, 138.04, 112.20, 105.16, 103.18, 63.71, 51.93, 25.71, 14.26 ppm. **HRMS (ESI)**: calcd. for C₁₅H₁₇N₂O₂ [M+H]⁺: 289.1183, found: 289.1188.

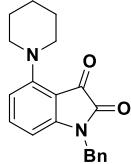
1-benzyl-4-(octahydro-2H-isoindol-2-yl)indoline-2,3-dione (1n)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.5 g, 90% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.29 (d, *J* = 25.9 Hz, 5H), 7.10 (t, *J* = 8.0 Hz, 1H), 6.31 (d, *J* = 8.9 Hz, 1H), 5.96 (d, *J* = 7.2 Hz, 1H), 4.89 (s, 2H), 3.55 (d, *J* = 58.6 Hz, 4H), 2.33 (s, 2H), 1.62 (dd, *J* = 37.6, 10.0 Hz, 6H), 1.51 – 1.36 (m, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.92, 160.20, 150.38, 148.73, 137.24, 135.65, 128.77, 127.68, 127.30, 111.22, 102.53, 97.66, 43.74, 36.97, 25.63, 22.65 ppm. **HRMS (ESI)**: calcd. for C₂₃H₂₅N₂O₂ [M+H]⁺: 361.1911, found: 361.1918.

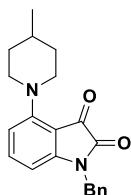
1-benzyl-4-(piperidin-1-yl)indoline-2,3-dione (1o)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.3 g, 88% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.31 (s, 5H), 7.18 (t, *J* = 8.0 Hz, 2H), 6.48 (d, *J* = 8.7 Hz, 1H), 6.07 (t, *J* = 11.3 Hz, 1H), 4.88 (s, 2H), 3.38 (s, 4H), 1.75 (s, 4H), 1.66 (s, 2H); **¹³C NMR** (125 MHz, CDCl₃) δ 178.01, 159.60, 151.70, 151.13, 138.24, 135.39, 128.75, 127.71, 127.24, 112.91, 105.21, 99.88, 51.86, 43.70, 25.94, 24.03 ppm. **HRMS (ESI)**: calcd. for C₂₀H₂₁N₂O₂ [M+H]⁺: 321.1598, found: 321.1590.

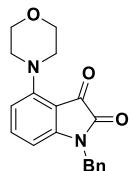
1-benzyl-4-(4-methylpiperidin-1-yl)indoline-2,3-dione (1p)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.4 g, 82 % yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.30 (s, 5H), 7.18 (t, *J* = 8.0 Hz, 1H), 6.47 (d, *J* = 8.7 Hz, 1H), 6.08 (d, *J* = 7.3 Hz, 1H), 4.86 (s, 2H), 3.77 (d, *J* = 12.4 Hz, 2H), 2.99 (t, *J* = 12.2 Hz, 2H), 1.75 (d, *J* = 12.8 Hz, 2H), 1.41 (q, *J* = 11.9 Hz, 2H), 0.97 (t, *J* = 9.6 Hz, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.86, 159.44, 151.39, 150.92, 138.19, 135.26, 128.61, 127.57, 127.11, 112.91, 105.04, 99.81, 51.01, 43.52, 34.00, 30.38, 21.56 ppm. **HRMS (ESI)**: calcd. for C₂₁H₂₃N₂O₂ [M+H]⁺: 335.1754, found: 335.1757.

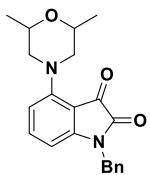
1-benzyl-4-morpholinoindoline-2,3-dione (1q)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.4 g, 87% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.36 – 7.25 (m, 6H), 6.48 (d, *J* = 8.7 Hz, 1H), 6.20 (d, *J* = 7.5 Hz, 1H), 4.90 (s, 2H), 3.90 (s, 4H), 3.39 (d, *J* = 2.9 Hz, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 178.63, 159.12, 151.55, 151.41, 138.94, 135.13, 128.85, 127.87, 127.27, 112.21, 105.86, 101.43, 66.73, 50.61, 43.84 ppm. **HRMS (ESI)**: calcd. for C₁₉H₁₉N₂O₃ [M+H]⁺: 323.1390, found: 323.1395.

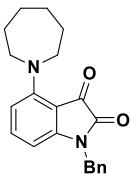
1-benzyl-4-(2,6-dimethylmorpholino)indoline-2,3-dione (1r)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.4 g, 82% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.35 – 7.20 (m, 6H), 6.46 (d, *J* = 8.7 Hz, 1H), 6.16 (d, *J* = 7.5 Hz, 1H), 4.90 (s, 2H), 3.94 – 3.82 (m, 2H), 3.64 (d, *J* = 12.2 Hz, 2H), 2.69 (t, *J* = 11.2 Hz, 2H), 1.25 (d, *J* = 6.1 Hz, 6H); **¹³C NMR** (125 MHz, CDCl₃) δ 178.49, 159.28, 151.47, 150.97, 138.80, 135.20, 128.86, 127.86, 127.29, 112.44, 105.53, 100.93, 71.83, 55.80, 43.84, 18.71 ppm. **HRMS (ESI)**: calcd. for C₂₁H₂₃N₂O₃ [M+H]⁺: 351.1709, found: 351.1710.

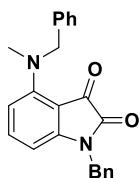
4-(azepan-1-yl)-1-benzylindoline-2,3-dione (1s)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.5 g, 92% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.32 (d, *J* = 1.8 Hz, 4H), 7.27 (d, *J* = 3.4 Hz, 1H), 7.12 (t, *J* = 8.1 Hz, 1H), 6.47 (d, *J* = 9.0 Hz, 1H), 6.00 (d, *J* = 7.2 Hz, 1H), 4.89 (s, 2H), 3.70 (d, *J* = 4.1 Hz, 4H), 1.80 (s, 4H), 1.57 (s, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.64, 159.93, 150.89, 150.63, 137.22, 135.59, 128.76, 127.69, 127.32, 112.24, 102.92, 98.04, 53.02, 43.75, 28.10, 27.36 ppm. **HRMS (ESI)**: calcd. for C₂₁H₂₃N₂O₂ [M+H]⁺: 335.1754, found: 335.1757.

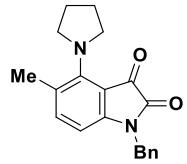
1-benzyl-4-(benzyl(methyl)amino)indoline-2,3-dione (1t)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.6g, 93% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.31 (t, *J* = 5.7 Hz, 5H), 7.29 – 7.23 (m, 3H), 7.15 (dd, *J* = 11.0, 4.2 Hz, 3H), 6.43 (d, *J* = 8.9 Hz, 1H), 6.08 (d, *J* = 7.4 Hz, 1H), 4.89 (s, 2H), 4.75 (s, 2H), 3.09 (s, 3H); **¹³C NMR** (125 MHz, CDCl₃) δ 178.12, 159.56, 151.31, 150.83, 138.00, 136.80, 135.32, 128.73, 128.56, 127.70, 127.28, 127.25, 127.08, 112.68, 103.93, 99.40, 58.25, 43.73, 41.02 ppm. **HRMS (ESI)**: calcd. for C₂₃H₂₁N₂O₂ [M+H]⁺: 357.1598, found: 357.1596.

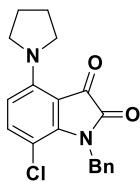
1-benzyl-5-methyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1u)



Flash column chromatography on a silica gel (ethyl acetate: petroleum ether, 1:15) afforded the product (1.4 g, 85% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.31 (s, 5H), 6.98 (d, *J* = 7.3 Hz, 1H), 6.02 (d, *J* = 7.3 Hz, 1H), 4.88 (s, 2H), 3.64 (s, 3H), 2.33 (s, 4H), 2.00 (s, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.97, 160.01, 149.39, 148.28, 139.67, 135.58, 128.74, 127.66, 127.28, 124.89, 107.00, 99.88, 52.88, 43.64, 26.14, 22.49 ppm. **HRMS (ESI)**: calcd. for C₂₀H₂₁N₂O₂ [M+H]⁺: 321.1598, found: 321.1599.

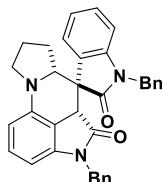
1-benzyl-7-chloro-4-(pyrrolidin-1-yl)indoline-2,3-dione (**1v**)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:15) afforded the product (1.5 g, 87% yield) as a red solid.

¹H NMR (500 MHz, CDCl₃) δ 7.36 – 7.27 (m, 4H), 7.25 – 7.20 (m, 1H), 7.04 (d, *J* = 9.4 Hz, 1H), 6.40 (d, *J* = 9.4 Hz, 1H), 5.36 (s, 2H), 3.54 (s, 4H), 2.00 (s, 4H); **¹³C NMR** (125 MHz, CDCl₃) δ 176.66, 161.08, 147.27, 144.43, 139.82, 136.73, 128.45, 127.20, 126.53, 113.06, 105.14, 103.04, 51.95, 44.81, 25.56 ppm. **HRMS (ESI)**: calcd. for C₁₉H₁₈N₂O₂ [M+H]⁺: 341.1051, found: 341.1055.

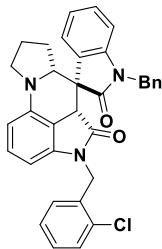
1',4-dibenzyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (**3a**)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:20) afforded the product (47.0 mg, 92% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.42 (d, *J* = 7.6 Hz, 2H), 7.34 (t, *J* = 7.5 Hz, 2H), 7.28 – 7.25 (m, 1H), 7.20 (d, *J* = 6.3 Hz, 1H), 7.14 (t, *J* = 7.7 Hz, 3H), 7.08 (t, *J* = 7.8 Hz, 1H), 6.86 (d, *J* = 7.0 Hz, 2H), 6.71 (d, *J* = 7.8 Hz, 1H), 6.61 (t, *J* = 7.6 Hz, 1H), 6.31 (d, *J* = 8.3 Hz, 1H), 6.05 (d, *J* = 7.7 Hz, 1H), 5.56 (d, *J* = 7.4 Hz, 1H), 5.20 (d, *J* = 15.8 Hz, 1H), 4.97 (d, *J* = 15.8 Hz, 1H), 4.73 (d, *J* = 15.8 Hz, 1H), 4.60 (d, *J* = 15.8 Hz, 1H), 4.29 – 4.25 (m, 1H), 4.25 (s, 1H), 3.61 (t, *J* = 8.3 Hz, 1H), 3.01 (dt, *J* = 16.2, 8.1 Hz, 1H), 2.11 – 1.96 (m, 1H), 1.93 – 1.84 (m, 2H), 0.86 (qd, *J* = 11.9, 7.2 Hz, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.85, 175.13, 144.22, 143.76, 143.02, 135.99, 135.80, 130.47, 128.74, 128.60, 128.52, 128.42, 128.34, 127.50, 127.20, 127.13, 126.91, 125.05, 123.34, 122.53, 109.39, 106.32, 104.05, 98.18, 65.59, 49.13, 47.37, 44.96, 44.29, 43.64, 26.11, 24.68 ppm. **HRMS (ESI)**: calcd. for C₃₄H₃₀N₃O₂ [M+H]⁺: 512.2333, found: 512.2336.

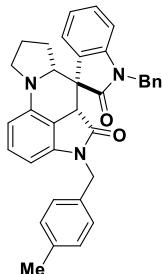
1'-benzyl-4-(2-chlorobenzyl)-4,5a,6a,7,8,9-hexahydro-5*H*-spiro[dipyrrolo[1,2-*a*:4',3',2'-*de*]quinoline-6,3'-indoline]-2',5-dione (3b)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (42.5 mg, 78% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.41 (d, *J* = 7.2 Hz, 2H), 7.36 – 7.31 (m, 2H), 7.30 (dd, *J* = 8.0, 1.0 Hz, 1H), 7.27 (s, 1H), 7.20 – 7.13 (m, 1H), 7.09 (tdd, *J* = 7.9, 4.4, 1.3 Hz, 2H), 6.86 (td, *J* = 7.7, 1.1 Hz, 1H), 6.74 – 6.63 (m, 2H), 6.43 – 6.31 (m, 2H), 6.05 (d, *J* = 7.7 Hz, 1H), 5.69 – 5.60 (m, 1H), 5.20 (d, *J* = 15.8 Hz, 1H), 4.95 (d, *J* = 15.9 Hz, 1H), 4.85 – 4.74 (m, 2H), 4.28 (q, *J* = 5.4 Hz, 2H), 3.63 (t, *J* = 8.3 Hz, 1H), 3.04 (ddd, *J* = 15.3, 9.7, 4.5 Hz, 1H), 2.12 – 1.98 (m, 1H), 1.95 – 1.86 (m, 2H), 0.90 – 0.85 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.80, 175.19, 143.97, 143.84, 143.05, 135.74, 133.08, 132.64, 130.67, 129.27, 128.76, 128.46, 128.28, 127.55, 127.53, 127.19, 126.87, 125.06, 123.37, 122.48, 109.52, 106.21, 104.28, 97.95, 65.58, 49.27, 47.37, 44.93, 44.31, 41.09, 26.13, 24.69 ppm. **HRMS (ESI)**: calcd. for C₃₄H₂₉ClN₃O₂ [M+H]⁺: 546.1943, found: 546.1945.

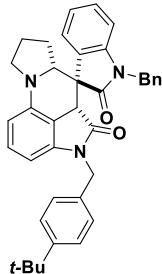
1'-benzyl-4-(4-methylbenzyl)-4,5a,6a,7,8,9-hexahydro-5*H*-spiro[dipyrrolo[1,2-*a*:4',3',2'-*de*]quinoline-6,3'-indoline]-2',5-dione (3c)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (39.9 mg, 76% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.42 (d, *J* = 7.4 Hz, 2H), 7.34 (t, *J* = 7.6 Hz, 2H), 7.28 – 7.26 (m, 1H), 7.18 – 7.03 (m, 2H), 6.93 (d, *J* = 7.9 Hz, 2H), 6.76 (d, *J* = 7.9 Hz, 2H), 6.71 (d, *J* = 7.8 Hz, 1H), 6.61 (t, *J* = 7.6 Hz, 1H), 6.30 (d, *J* = 8.2 Hz, 1H), 6.06 (d, *J* = 7.7 Hz, 1H), 5.56 (d, *J* = 7.4 Hz, 1H), 5.20 (d, *J* = 15.8 Hz, 1H), 4.97 (d, *J* = 15.8 Hz, 1H), 4.67 (d, *J* = 15.7 Hz, 1H), 4.58 (d, *J* = 15.7 Hz, 1H), 4.30 – 4.19 (m, 2H), 3.61 (t, *J* = 8.3 Hz, 1H), 3.05 – 2.94 (m, 1H), 2.25 (s, 3H), 2.11 – 1.98 (m, 1H), 1.94 – 1.85 (m, 2H), 0.92 – 0.77 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.89, 175.12, 144.27, 143.74, 142.97, 136.73, 135.81, 132.94, 130.45, 129.09, 128.74, 128.31, 127.49, 127.19, 126.87, 125.06, 123.34, 122.53, 109.37, 106.34, 104.00, 98.24, 65.59, 49.13, 47.37, 44.97, 44.28, 43.41, 26.11, 24.67, 21.03 ppm. **HRMS (ESI)**: calcd. for C₃₅H₃₂N₃O₂ [M+H]⁺: 526.2489, found: 526.2486.

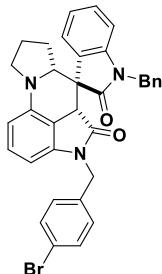
1'-benzyl-4-(4-(tert-butyl)benzyl)-4,5a,6a,7,8,9-hexahydro-5*H*-spiro[dipyrrolo[1,2-*a*:4',3',2'-*de*]quinoline-6,3'-indoline]-2',5-dione (3d)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (40.8 mg, 72% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.42 (d, *J* = 7.1 Hz, 2H), 7.34 (t, *J* = 7.1 Hz, 2H), 7.27 (d, *J* = 8.3 Hz, 1H), 7.16 (t, *J* = 11.0 Hz, 3H), 7.07 (t, *J* = 7.4 Hz, 1H), 6.85 (d, *J* = 7.6 Hz, 2H), 6.70 (d, *J* = 7.6 Hz, 1H), 6.60 (t, *J* = 7.2 Hz, 1H), 6.31 (d, *J* = 8.0 Hz, 1H), 6.11 (d, *J* = 7.5 Hz, 1H), 5.56 (d, *J* = 7.2 Hz, 1H), 5.20 (d, *J* = 15.8 Hz, 1H), 4.96 (d, *J* = 15.8 Hz, 1H), 4.62 (q, *J* = 15.6 Hz, 2H), 4.24 (d, *J* = 9.8 Hz, 2H), 3.61 (t, *J* = 7.9 Hz, 1H), 3.06 – 2.96 (m, 1H), 2.03 (d, *J* = 8.6 Hz, 1H), 1.90 (s, 2H), 1.25 (s, 9H), 0.89 – 0.82 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.89, 175.12, 149.97, 144.40, 143.72, 142.97, 135.81, 133.02, 130.43, 128.74, 128.29, 127.49, 127.19, 126.71, 125.30, 125.07, 123.30, 122.55, 109.36, 106.38, 104.00, 98.17, 65.61, 49.11, 47.37, 44.95, 44.28, 43.30, 34.35, 31.27, 26.10, 24.67 ppm. **HRMS (ESI)**: calcd. for C₃₈H₃₈N₃O₂ [M+H]⁺: 568.2959, found: 568.2961.

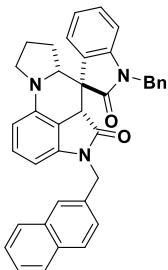
1'-benzyl-4-(4-bromobenzyl)-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-d]quinoline-6,3'-indoline]-2',5-dione (3e)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (46.5 mg, 79% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.41 (d, *J* = 7.2 Hz, 2H), 7.34 (dd, *J* = 10.3, 4.8 Hz, 2H), 7.27 (d, *J* = 7.3 Hz, 1H), 7.23 – 7.19 (m, 2H), 7.18 – 7.05 (m, 2H), 6.69 (dd, *J* = 15.9, 8.1 Hz, 3H), 6.60 (td, *J* = 7.6, 0.9 Hz, 1H), 6.32 (d, *J* = 8.2 Hz, 1H), 6.01 (d, *J* = 7.7 Hz, 1H), 5.52 (dd, *J* = 7.5, 0.6 Hz, 1H), 5.20 (d, *J* = 15.8 Hz, 1H), 4.97 (d, *J* = 15.8 Hz, 1H), 4.75 (d, *J* = 15.9 Hz, 1H), 4.48 (d, *J* = 15.9 Hz, 1H), 4.30 – 4.21 (m, 2H), 3.61 (t, *J* = 8.3 Hz, 1H), 3.01 (ddd, *J* = 10.4, 9.1, 6.4 Hz, 1H), 2.12 – 1.97 (m, 1H), 1.95 – 1.84 (m, 2H), 0.93 – 0.75 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.77, 175.13, 143.85, 143.78, 143.14, 135.73, 135.01, 131.51, 130.54, 128.75, 128.63, 128.41, 127.53, 127.19, 124.95, 123.27, 122.48, 121.01, 109.47, 106.22, 104.23, 97.97, 65.55, 49.09, 47.37, 44.92, 44.30, 43.09, 26.11, 24.67 ppm. **HRMS (ESI)**: calcd. for C₃₄H₂₉BrN₃O₂ [M+H]⁺: 590.1438, found: 590.1440.

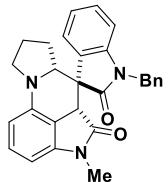
1'-benzyl-4-(naphthalen-2-ylmethyl)-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-d]quinoline-6,3'-indoline]-2',5-dione (3f)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (39.8 mg, 71% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.74 (d, *J* = 3.4 Hz, 1H), 7.65 (d, *J* = 4.4 Hz, 1H), 7.58 (d, *J* = 8.1 Hz, 1H), 7.48 – 7.39 (m, 5H), 7.36 (d, *J* = 6.6 Hz, 2H), 7.27 (d, *J* = 6.7 Hz, 1H), 7.10 (t, *J* = 7.1 Hz, 2H), 6.92 (d, *J* = 8.1 Hz, 1H), 6.73 (d, *J* = 7.3 Hz, 1H), 6.60 (t, *J* = 6.9 Hz, 1H), 6.29 (d, *J* = 7.7 Hz, 1H), 6.08 (d, *J* = 7.2 Hz, 1H), 5.56 (d, *J* = 6.9 Hz, 1H), 5.21 (d, *J* = 15.8 Hz, 1H), 5.00 (d, *J* = 15.7 Hz, 1H), 4.90 (d, *J* = 15.6 Hz, 1H), 4.76 (d, *J* = 15.6 Hz, 1H), 4.28 (d, *J* = 10.8 Hz, 2H), 3.60 (t, *J* = 7.7 Hz, 1H), 3.00 (d, *J* = 8.2 Hz, 1H), 2.03 (d, *J* = 10.8 Hz, 1H), 1.89 (s, 2H), 0.87 (d, *J* = 9.0 Hz, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.89, 175.21, 144.17, 143.75, 142.96, 135.79, 133.68, 133.13, 132.64, 130.47, 128.75, 128.37, 128.34, 127.75, 127.55, 127.51, 127.21, 125.96, 125.80, 125.72, 125.11, 125.08, 123.26, 122.67, 109.41, 106.30, 104.08, 98.28, 65.65, 49.10, 47.34, 44.95, 44.31, 43.95, 26.09, 24.65 ppm. **HRMS (ESI)**: calcd. for C₃₈H₃₂N₃O₂ [M+H]⁺: 562.2489, found: 562.2486.

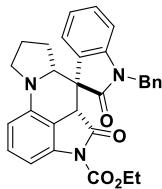
1'-benzyl-4-methyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3g)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (33.9 mg, 78% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.43 (d, *J* = 7.2 Hz, 2H), 7.34 (t, *J* = 7.2 Hz, 2H), 7.31 – 7.26 (m, 2H), 7.02 (t, *J* = 7.6 Hz, 1H), 6.67 (d, *J* = 7.7 Hz, 1H), 6.59 (t, *J* = 7.4 Hz, 1H), 6.35 (d, *J* = 8.1 Hz, 1H), 6.23 (d, *J* = 7.5 Hz, 1H), 5.56 (d, *J* = 7.3 Hz, 1H), 5.06 (dd, *J* = 38.6, 15.7 Hz, 2H), 4.28 – 4.18 (m, 1H), 4.17 (s, 1H), 3.61 (t, *J* = 8.2 Hz, 1H), 3.02 (dd, *J* = 16.7, 8.4 Hz, 1H), 2.96 (s, 3H), 2.01 (dd, *J* = 22.8, 13.4 Hz, 1H), 1.94 – 1.80 (m, 2H), 0.88 – 0.74 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.87, 175.26, 145.25, 143.60, 142.79, 135.75, 130.54, 128.72, 128.31, 127.50, 127.20, 125.12, 122.99, 122.55, 109.27, 106.37, 104.12, 96.95, 65.70, 48.97, 47.29, 44.83, 44.24, 26.23, 26.01, 24.61 ppm. **HRMS (ESI)**: calcd. for C₂₈H₂₆N₃O₂ [M+H]⁺: 436.2020, found: 436.2023.

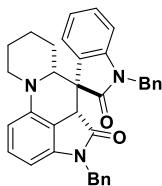
ethyl-1'-benzyl-2',5-dioxo-5,5a,6a,7,8,9-hexahydro-4H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-4-carboxylate (3h)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (28.6 mg, 58% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.40 (d, *J* = 7.0 Hz, 2H), 7.34 (dd, *J* = 13.5, 6.7 Hz, 3H), 7.26 (s, 1H), 7.12 (d, *J* = 7.7 Hz, 1H), 7.05 (t, *J* = 7.4 Hz, 1H), 6.69 (d, *J* = 7.7 Hz, 1H), 6.64 (t, *J* = 7.3 Hz, 1H), 6.44 (d, *J* = 7.9 Hz, 1H), 5.70 (d, *J* = 7.2 Hz, 1H), 5.16 (d, *J* = 15.7 Hz, 1H), 4.93 (d, *J* = 15.6 Hz, 1H), 4.44 – 4.34 (m, 2H), 4.29 (dd, *J* = 15.6, 7.9 Hz, 1H), 4.19 (d, *J* = 7.6 Hz, 1H), 3.62 (t, *J* = 8.1 Hz, 1H), 3.09 – 2.97 (m, 1H), 2.00 (t, *J* = 14.0 Hz, 1H), 1.88 (dd, *J* = 11.7, 6.2 Hz, 2H), 1.36 (t, *J* = 6.8 Hz, 3H), 0.92 – 0.77 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.25, 172.29, 150.68, 143.80, 142.27, 140.13, 135.69, 130.72, 128.76, 128.58, 127.55, 127.21, 124.69, 123.23, 122.83, 109.42, 105.66, 105.58, 103.64, 65.37, 63.03, 49.43, 47.31, 44.42, 44.32, 25.97, 24.44, 14.13 ppm. **HRMS (ESI)**: calcd. for C₃₀H₂₈N₃O₄ [M+H]⁺: 494.2074, found: 494.2076.

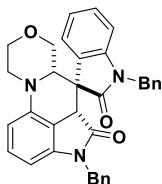
1,4'-dibenzyl-4',5a',6a',7',9',10'-hexahydro-5'H,8'H-spiro[indoline-3,6'-pyrido[1,2-a]pyrrolo[4,3,2-de]quinoline]-2,5'-dione (3i)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (41.0 mg, 78% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.45 (d, *J* = 7.2 Hz, 2H), 7.35 (t, *J* = 7.1 Hz, 2H), 7.26 (s, 1H), 7.19 – 7.05 (m, 5H), 6.83 (d, *J* = 6.4 Hz, 2H), 6.72 (d, *J* = 7.3 Hz, 2H), 6.60 (d, *J* = 8.3 Hz, 1H), 6.04 (s, 2H), 5.17 (d, *J* = 15.8 Hz, 1H), 5.00 (d, *J* = 15.8 Hz, 1H), 4.71 (d, *J* = 15.8 Hz, 1H), 4.58 (d, *J* = 15.8 Hz, 1H), 4.24 (s, 1H), 4.08 (d, *J* = 12.3 Hz, 1H), 3.65 (d, *J* = 11.2 Hz, 1H), 3.02 (t, *J* = 11.7 Hz, 1H), 1.79 – 1.66 (m, 2H), 1.57 (s, 1H), 1.48 – 1.35 (m, 2H), 0.73 (dd, *J* = 23.3, 11.6 Hz, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 176.88, 174.70, 143.83, 143.71, 143.61, 135.80, 129.77, 128.75, 128.44, 127.49, 127.29, 127.15, 126.86, 125.57, 124.25, 122.55, 109.30, 107.58, 107.08, 99.14, 62.08, 50.00, 47.90, 47.61, 44.39, 43.54, 25.92, 25.45, 23.73 ppm. **HRMS (ESI)**: calcd. for C₃₅H₃₂N₃O₂ [M+H]⁺: 526.2489, found: 526.2493.

1,4'-dibenzyl-4',5a',6a',7',9',10'-hexahydro-5'H-spiro[indoline-3,6'-[1,4]oxazino[4,3-a]pyrrolo[4,3,2-de]quinoline]-2,5'-dione (3j)

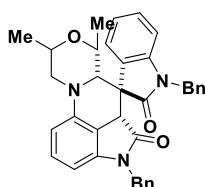


Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product

(32.7 mg, 62% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.43 (d, *J* = 7.3 Hz, 2H), 7.35 (t, *J* = 7.3 Hz, 2H), 7.28 (d, *J* = 7.3 Hz, 1H), 7.13 (dd, *J* = 14.4, 7.2 Hz, 5H), 6.85 (d, *J* = 6.7 Hz, 2H), 6.74 (t, *J* = 8.9 Hz, 2H), 6.56 (d, *J* = 8.4 Hz, 1H), 6.10 (d, *J* = 7.5 Hz, 2H), 5.20 (d, *J* = 15.7 Hz, 1H), 4.96 (d, *J* = 15.7 Hz, 1H), 4.71 (d, *J* = 15.8 Hz, 1H), 4.60 (d, *J* = 15.8 Hz, 1H), 4.27 (s, 1H), 3.92 (d, *J* = 10.4 Hz, 2H), 3.82 (d, *J* = 12.0 Hz, 1H), 3.73 (d, *J* = 10.8 Hz, 1H), 3.42 (t, *J* = 11.5 Hz, 1H), 3.33 (t, *J* = 12.0 Hz, 1H), 2.71 (t, *J* = 10.6 Hz, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 175.86, 174.34, 143.96, 143.34, 142.37, 135.68, 135.59, 130.02, 128.85, 128.79, 128.49, 127.65, 127.30, 127.26, 126.88, 124.68, 124.23, 122.74, 109.57, 107.29, 105.91, 99.87, 66.65, 59.95, 47.85, 46.76, 45.73, 44.47, 43.60 ppm. **HRMS (ESI):** calcd. for C₃₄H₃₀N₃O₃ [M+H]⁺: 528.2282, found: 528.2285.

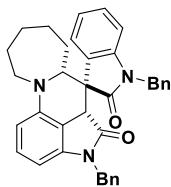
1,4'-dibenzyl-7',9'-dimethyl-4',5a',6a',7',9',10'-hexahydro-5'H-spiro[indoline-3,6'-(1,4)oxazino[4,3-a]pyrrolo[4,3,2-de]quinoline]-2,5'-dione (3k)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (40.0 mg, 72% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.53 (d, *J* = 7.2 Hz, 2H), 7.34 (t, *J* = 7.2 Hz, 2H), 7.28 (d, *J* = 7.2 Hz, 1H), 7.12 (ddd, *J* = 22.7, 15.8, 7.7 Hz, 5H), 6.83 (d, *J* = 7.7 Hz, 1H), 6.71 (t, *J* = 7.4 Hz, 1H), 6.66 (d, *J* = 7.0 Hz, 2H), 6.54 (d, *J* = 8.3 Hz, 1H), 6.14 (d, *J* = 7.2 Hz, 1H), 5.99 (d, *J* = 7.5 Hz, 1H), 5.19 (d, *J* = 15.6 Hz, 1H), 4.95 (d, *J* = 15.5 Hz, 1H), 4.76 (d, *J* = 15.8 Hz, 1H), 4.45 (d, *J* = 15.8 Hz, 1H), 4.07 (s, 1H), 3.93 (d, *J* = 12.7 Hz, 1H), 3.69 (d, *J* = 8.6 Hz, 1H), 3.58 (d, *J* = 1.7 Hz, 1H), 3.02 (t, *J* = 11.3 Hz, 2H), 1.20 (d, *J* = 5.6 Hz, 3H), 0.91 (d, *J* = 5.9 Hz, 3H); **¹³C NMR** (125 MHz, CDCl₃) δ 176.50, 173.96, 143.51, 143.34, 141.99, 135.59, 135.55, 129.97, 128.66, 128.41, 128.07, 127.62, 127.09, 126.64, 124.58, 124.34, 122.44, 109.75, 106.72, 106.27, 98.89, 74.53, 71.56, 64.56, 52.66, 48.49, 48.39, 45.28, 43.52, 18.92, 18.50 ppm. **HRMS (ESI):** calcd. for C₃₆H₃₄N₃O₃ [M+H]⁺: 556.2595, found: 556.2597.

1',4-dibenzyl-4,5a,6a,7,8,9,10,11-octahydro-5H-spiro[azepino[1,2-a]pyrrolo[4,3,2-de]quinoline-6,3'-indoline]-2',5-dione (3l)

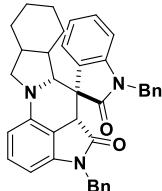


Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (36.1 mg, 67% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.45 (d, *J* = 7.2 Hz, 2H), 7.35 (t, *J* = 7.1 Hz, 2H), 7.28 (s, 1H), 7.18 – 7.03 (m, 5H), 6.96 (s, 2H), 6.66 (dd, *J* = 15.6, 7.7 Hz, 2H), 6.38 (d, *J* = 8.2 Hz, 1H), 6.04 (d, *J* = 7.4 Hz, 1H), 5.97 (d, *J* = 7.3 Hz, 1H), 5.16 – 5.00 (m, 2H), 4.77 (d, *J* = 15.7 Hz, 1H), 4.59 (d, *J* = 15.8 Hz, 1H), 4.40 (s, 1H), 3.91 – 3.84 (m, 1H), 3.28 (d, *J* = 10.7 Hz, 1H), 3.04 – 2.92 (m, 1H), 2.64 (d, *J* = 10.9 Hz, 1H), 2.07 (s, 1H), 1.89 (d, *J* = 10.6 Hz, 1H), 1.86 – 1.72 (m, 2H), 1.63 (dd, *J* = 13.2, 4.2 Hz, 3H); **¹³C NMR**

NMR (125 MHz, CDCl₃) δ 177.28, 174.81, 144.22, 142.76, 142.74, 135.75, 135.24, 131.17, 130.85, 128.82, 128.67, 127.66, 127.18, 127.13, 127.11, 126.56, 126.50, 115.38, 110.77, 105.73, 104.18, 98.50, 65.50, 49.14, 47.34, 45.23, 44.32, 43.72, 26.10, 24.60 ppm. **HRMS (ESI):** calcd. for C₃₆H₃₄N₃O₂ [M+H]⁺: 540.2646, found: 540.2644.

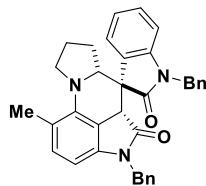
1,4'-dibenzyl-4',5a',6a',6b',7',8',9',10',10a',11'-decahydro-5'H-spiro[indoline-3,6'-isoindolo[2,1-a]pyrrolo[4,3,2-de]quinoline]-2,5'-dione (3m)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (42.4 mg, 75% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.47 (d, *J* = 7.3 Hz, 2H), 7.34 (t, *J* = 7.3 Hz, 2H), 7.26 (s, 1H), 7.11 (dt, *J* = 16.1, 8.0 Hz, 5H), 6.80 (d, *J* = 6.9 Hz, 2H), 6.73 (d, *J* = 7.8 Hz, 1H), 6.61 (t, *J* = 7.4 Hz, 1H), 6.29 (d, *J* = 8.1 Hz, 1H), 6.02 (d, *J* = 7.6 Hz, 1H), 5.59 (d, *J* = 7.3 Hz, 1H), 5.08 (s, 2H), 4.73 (d, *J* = 15.8 Hz, 1H), 4.57 (d, *J* = 15.8 Hz, 1H), 4.36 (d, *J* = 9.4 Hz, 1H), 4.24 (s, 1H), 3.26 (d, *J* = 8.8 Hz, 1H), 3.15 – 3.07 (m, 1H), 1.98 (d, *J* = 5.7 Hz, 1H), 1.69 (t, *J* = 12.0 Hz, 2H), 1.49 (t, *J* = 15.6 Hz, 4H), 1.35 – 1.25 (m, 2H), 1.24 – 1.12 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.86, 175.16, 144.04, 143.94, 143.71, 135.98, 135.61, 130.40, 128.66, 128.40, 128.24, 127.49, 127.47, 127.07, 126.83, 125.38, 123.35, 122.38, 109.51, 106.23, 104.04, 98.04, 64.89, 53.50, 49.64, 44.55, 44.51, 43.59, 38.75, 38.15, 28.28, 25.74, 24.88, 21.26 ppm. **HRMS (ESI):** calcd. for C₃₈H₃₆N₃O₂ [M+H]⁺: 566.2802, found: 566.2807.

1',4-dibenzyl-1-methyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3n)

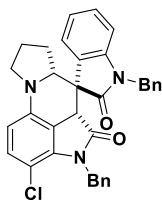


Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (32.0 mg, 61% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.45 (d, *J* = 7.2 Hz, 2H), 7.35 (t, *J* = 7.1 Hz, 2H), 7.30 – 7.24 (m, 1H), 7.16 – 7.07 (m, 4H), 6.90 (d, *J* = 4.4 Hz, 3H), 6.73 (d, *J* = 7.6 Hz, 1H), 6.68 (t, *J* = 7.4 Hz, 1H), 5.96 (dd, *J* = 21.9, 7.4 Hz, 2H), 5.19 (d, *J* = 15.8 Hz, 1H), 4.99 (d, *J* = 15.8 Hz, 1H), 4.71 (d, *J* = 15.7 Hz, 1H), 4.61 (d, *J* = 15.7 Hz, 1H), 4.26 (d, *J* = 12.1 Hz, 2H), 4.05 (t, *J* = 7.8 Hz, 1H), 3.28 (q, *J* = 7.6 Hz, 1H), 2.46 (s, 3H), 1.94 (d, *J* = 4.2 Hz, 1H), 1.86 (dd, *J* = 17.5, 8.6 Hz, 1H), 1.62 – 1.52 (m, 1H), 1.01 (dd, *J* = 17.7, 8.8 Hz, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 178.13, 174.75, 143.87, 142.60, 141.71, 135.99, 135.86, 132.59, 128.74, 128.40, 128.34, 127.49, 127.27, 127.12, 126.91, 125.52, 123.65, 122.40, 115.21, 109.36, 107.78, 98.58, 66.83, 51.15, 49.63, 44.30, 44.17, 43.47, 25.74, 24.76, 21.20 ppm. **HRMS (ESI):** calcd. for C₃₅H₃₂N₃O₂ [M+H]⁺: 526.2488, found: 526.2492.

1',4-dibenzyl-3-chloro-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'

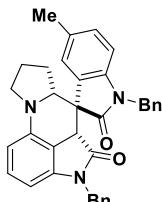
-indoline]-2',5-dione (3o)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (37.6 mg, 69% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.40 (d, *J* = 7.2 Hz, 2H), 7.33 (t, *J* = 7.2 Hz, 2H), 7.27 (s, 1H), 7.17 – 7.03 (m, 5H), 6.73 (t, *J* = 8.5 Hz, 4H), 6.28 (d, *J* = 8.5 Hz, 1H), 5.78 (d, *J* = 7.3 Hz, 1H), 5.21 (d, *J* = 15.8 Hz, 1H), 5.11 (d, *J* = 16.2 Hz, 1H), 5.01 (d, *J* = 16.2 Hz, 1H), 4.94 (d, *J* = 15.9 Hz, 1H), 4.25 (d, *J* = 14.1 Hz, 2H), 3.61 (t, *J* = 8.3 Hz, 1H), 3.04 (dd, *J* = 16.7, 8.4 Hz, 1H), 2.03 (dd, *J* = 18.2, 10.6 Hz, 1H), 1.91 (dd, *J* = 16.8, 10.6 Hz, 2H), 0.97 – 0.81 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.41, 174.91, 143.79, 141.28, 139.22, 137.24, 135.70, 132.22, 128.76, 128.60, 128.23, 127.54, 127.17, 126.69, 126.22, 124.74, 123.46, 122.66, 109.62, 108.16, 105.22, 102.99, 65.46, 49.15, 47.46, 44.50, 44.34, 44.24, 26.13, 24.62 ppm. **HRMS (ESI)**: calcd. for C₃₄H₂₉ClN₃O₂ [M+H]⁺: 546.1943, found: 546.1944.

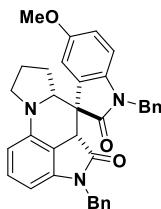
1',4-dibenzyl-5'-methyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3p)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (30.4 mg, 58% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.40 (d, *J* = 7.3 Hz, 2H), 7.33 (t, *J* = 7.2 Hz, 2H), 7.25 (d, *J* = 6.8 Hz, 1H), 7.12 (dt, *J* = 14.3, 7.4 Hz, 4H), 6.86 (d, *J* = 7.8 Hz, 1H), 6.82 (d, *J* = 7.1 Hz, 2H), 6.58 (d, *J* = 7.8 Hz, 1H), 6.31 (d, *J* = 8.1 Hz, 1H), 6.05 (d, *J* = 7.5 Hz, 1H), 5.29 (s, 1H), 5.19 (d, *J* = 15.8 Hz, 1H), 4.93 (d, *J* = 15.8 Hz, 1H), 4.81 (d, *J* = 15.8 Hz, 1H), 4.54 (d, *J* = 15.8 Hz, 1H), 4.29 – 4.22 (m, 1H), 4.21 (s, 1H), 3.60 (t, *J* = 8.2 Hz, 1H), 2.99 (dd, *J* = 16.8, 8.3 Hz, 1H), 2.10 – 1.95 (m, 1H), 1.95 – 1.88 (m, 2H), 1.87 (s, 3H), 0.94 – 0.78 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.73, 175.11, 144.26, 143.23, 141.30, 136.07, 135.91, 131.78, 130.43, 128.67, 128.50, 128.39, 127.40, 127.16, 127.05, 126.77, 125.03, 124.18, 109.03, 106.38, 104.05, 98.09, 65.59, 49.10, 47.45, 45.15, 44.24, 43.65, 26.10, 24.70, 21.05 ppm. **HRMS (ESI)**: calcd. for C₃₅H₃₂N₃O₂ [M+H]⁺: 526.2489, found: 526.2491.

1',4-dibenzyl-5'-methoxy-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3q)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (31.9 mg, 59% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.41 (d, *J* = 7.1 Hz, 2H), 7.34 (t, *J* = 7.0 Hz, 2H), 7.26 (d, *J* = 6.9 Hz, 1H), 7.19 – 7.05 (m, 4H), 6.82 (d, *J* = 7.0 Hz, 2H), 6.65 – 6.52 (m, 2H), 6.31 (d, *J* = 7.9 Hz, 1H), 6.06 (d, *J* = 7.4 Hz, 1H), 5.18 (d, *J* = 15.8 Hz, 1H), 5.08 (s, 1H), 4.94 (d, *J* = 15.8 Hz, 1H), 4.86 (d, *J* = 15.7 Hz, 1H), 4.52 (d, *J* = 15.7 Hz, 1H), 4.31 – 4.23 (m, 1H), 4.23 (s, 1H), 3.62 (t, *J* = 8.1 Hz, 1H), 3.13 (s, 3H), 2.99 (dd, *J* = 16.5, 8.0 Hz, 1H), 2.04 (t, *J* = 14.4 Hz, 1H), 1.97 – 1.87 (m, 2H), 0.97 – 0.75 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.58, 175.19, 155.52, 144.51, 143.47, 137.05, 136.02, 135.92, 130.60, 128.77, 128.50, 127.52, 127.24, 127.22, 126.93, 125.95, 113.98, 110.00, 109.11, 106.37, 104.0, 98.37, 65.70, 54.81, 49.11, 47.65, 45.36, 44.40, 43.76, 26.19, 24.77 ppm. **HRMS (ESI)**: calcd. for C₃₅H₃₂N₃O₃ [M+H]⁺: 542.2438, found: 542.2440.

1',4-dibenzyl-5'-fluoro-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3r)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (45.0 mg, 85% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.40 (d, *J* = 7.3 Hz, 2H), 7.34 (t, *J* = 7.2 Hz, 2H), 7.27 (d, *J* = 7.0 Hz, 1H), 7.16 (s, 4H), 6.91 (s, 2H), 6.77 (t, *J* = 8.7 Hz, 1H), 6.60 (d, *J* = 7.8 Hz, 1H), 6.31 (d, *J* = 8.1 Hz, 1H), 6.08 (d, *J* = 7.6 Hz, 1H), 5.30 (d, *J* = 8.3 Hz, 1H), 5.17 (d, *J* = 15.8 Hz, 1H), 4.96 (d, *J* = 15.8 Hz, 1H), 4.73 (d, *J* = 15.7 Hz, 1H), 4.63 (d, *J* = 15.7 Hz, 1H), 4.25 (d, *J* = 13.7 Hz, 2H), 3.61 (t, *J* = 8.3 Hz, 1H), 3.03 (dd, *J* = 16.6, 8.5 Hz, 1H), 2.02 (dd, *J* = 18.6, 10.8 Hz, 1H), 1.97 – 1.86 (m, 2H), 0.93 – 0.80 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.54, 174.91, 159.78, 157.87, 144.18, 142.68, 139.69, 135.87, 135.43, 130.80, 128.79, 128.46, 127.61, 127.26, 127.14, 126.82, 126.61, 126.55, 114.65, 114.46, 111.59, 111.39, 109.84, 109.77, 105.76, 104.12, 98.43, 65.46, 48.98, 47.27, 45.26, 44.38, 43.66, 26.10, 24.57 ppm. **HRMS (ESI)**: calcd. for C₃₄H₂₉FN₃O₂ [M+H]⁺: 530.2238, found: 530.2240.

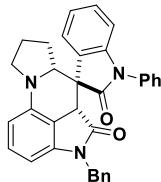
1',4-dibenzyl-5'-bromo-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3s)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:25) afforded the product (45.9 mg, 78% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.38 (d, *J* = 7.2 Hz, 2H), 7.34 (t, *J* = 7.0 Hz, 2H), 7.27 (d, *J* = 6.9 Hz, 1H), 7.18 (t, *J* = 7.9 Hz, 5H), 6.87 (d, *J* = 6.7 Hz, 2H), 6.56 (d, *J* = 8.2 Hz, 1H), 6.33 (d, *J* = 8.0 Hz, 1H), 6.09 (d, *J* = 7.5 Hz, 1H), 5.63 (s, 1H), 5.17 (d, *J* = 15.8 Hz, 1H), 4.94 (d, *J* = 15.8 Hz, 1H), 4.80 (d, *J* = 15.8 Hz, 1H), 4.60 (d, *J* = 15.8 Hz, 1H), 4.28 – 4.20 (m, 2H), 3.62 (t, *J* = 8.2 Hz, 1H), 3.04 (dd, *J* = 16.6, 8.2 Hz, 1H), 2.03 (dd, *J* = 18.0, 10.5 Hz, 1H), 1.98 – 1.86 (m, 2H), 0.92 – 0.80 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.28, 174.81, 144.22, 142.75, 142.74, 135.75, 135.23, 131.17, 130.85, 128.81, 128.67, 127.66, 127.18, 127.13, 127.11, 126.56, 126.50, 115.38, 110.76, 105.73, 104.18, 98.50, 65.49, 49.13, 47.34, 45.23, 44.32, 43.72, 26.09, 24.59 ppm. **HRMS (ESI):** calcd. for C₃₄H₂₉BrN₃O₂ [M+H]⁺: 590.1438, found: 590.1436.

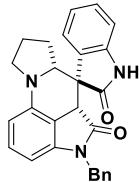
4-benzyl-1'-phenyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3t)



Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:20) afforded the product (41.3 mg, 83% yield) as a yellow solid.

¹H NMR (500 MHz, CDCl₃) δ 7.63 – 7.50 (m, 4H), 7.44 (dd, *J* = 8.4, 4.2 Hz, 1H), 7.21 – 7.06 (m, 5H), 6.79 (dd, *J* = 17.0, 5.8 Hz, 3H), 6.68 (dd, *J* = 8.7, 5.1 Hz, 1H), 6.34 (dt, *J* = 10.6, 5.3 Hz, 1H), 6.05 (dt, *J* = 10.6, 5.3 Hz, 1H), 5.63 (dd, *J* = 8.7, 4.2 Hz, 1H), 4.79 (dd, *J* = 15.6, 6.5 Hz, 1H), 4.65 – 4.50 (m, 1H), 4.35 – 4.17 (m, 2H), 3.64 (d, *J* = 7.1 Hz, 1H), 3.16 – 2.99 (m, 1H), 2.17 – 1.88 (m, 3H), 1.15 – 0.99 (m, 1H); **¹³C NMR** (125 MHz, CDCl₃) δ 177.47, 175.33, 144.94, 144.31, 143.14, 135.91, 134.64, 130.59, 129.73, 128.48, 128.39, 127.31, 127.17, 126.85, 124.78, 123.52, 122.95, 109.57, 106.22, 104.17, 98.29, 65.30, 49.88, 47.48, 45.15, 43.69, 26.20, 24.79 ppm. **HRMS (ESI):** calcd. for C₃₃H₂₈N₃O₂ [M+H]⁺: 498.2176, found: 498.2180.

4-benzyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3u)

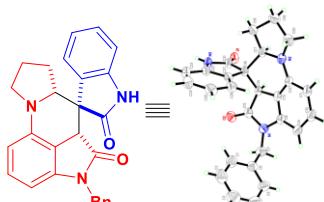


Flash column chromatography on a silica gel (ethyl acetate/petroleum ether, 1:20) afforded the product

(37.1 mg, 88% yield) as a yellow solid.

¹H NMR (500 MHz, DMSO) δ 10.78 (s, 1H), 7.22 – 7.07 (m, 5H), 6.88 (d, *J* = 7.5 Hz, 1H), 6.80 (d, *J* = 6.6 Hz, 2H), 6.60 (t, *J* = 7.3 Hz, 1H), 6.35 (d, *J* = 8.0 Hz, 1H), 6.12 (d, *J* = 7.5 Hz, 1H), 5.43 (d, *J* = 7.1 Hz, 1H), 4.65 (dd, *J* = 36.9, 16.1 Hz, 2H), 4.07 (s, 1H), 3.99 (dd, *J* = 8.8, 6.0 Hz, 1H), 3.58 (t, *J* = 7.8 Hz, 1H), 2.89 (d, *J* = 6.6 Hz, 1H), 1.96 (d, *J* = 9.6 Hz, 1H), 1.81 (dd, *J* = 15.7, 10.1 Hz, 2H), 0.79 – 0.66 (m, 1H); **¹³C NMR** (125 MHz, DMSO) δ 178.94, 175.20, 144.25, 143.48, 143.33, 136.67, 130.80, 128.83, 128.74, 127.40, 126.91, 125.72, 123.35, 121.90, 110.19, 106.68, 104.53, 98.37, 65.49, 48.81, 47.79, 45.05, 43.06, 26.11, 24.63 ppm. **HRMS (ESI):** calcd. for C₂₇H₂₄N₃O₂ [M+H]⁺: 422.1863, found: 422.1865.

5. Crystal Structure and Data



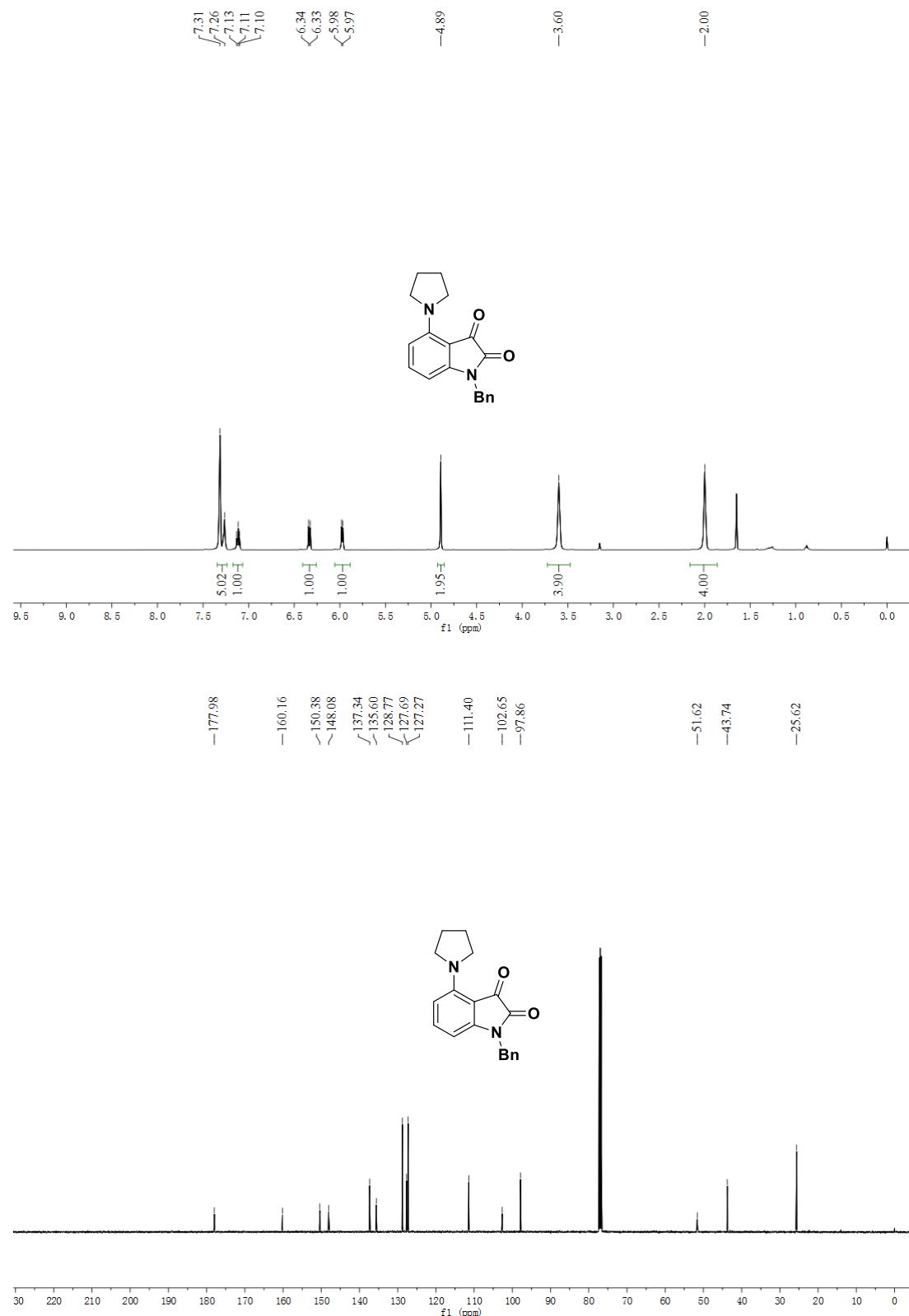
3u (CCDC 1815971)

Table 1. Crystal data and structure refinement for **3u**.

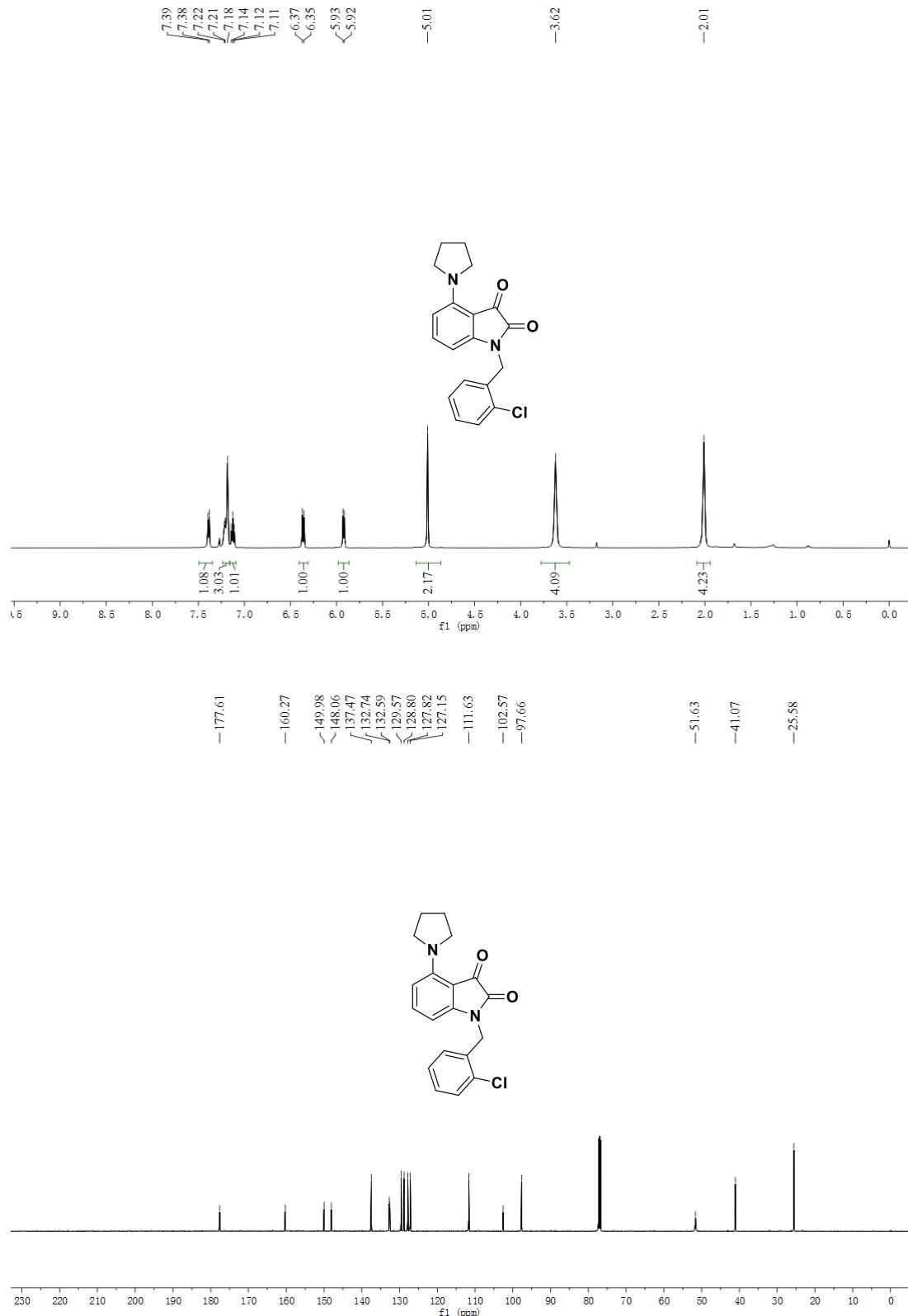
| Identification code | 3u | | |
|-----------------------------------|---|------------------------|--|
| Empirical formula | C ₂₇ H ₂₃ N ₃ O ₂ | | |
| Formula weight | 421.48 | | |
| Temperature | 293(2) K | | |
| Wavelength | 1.54184 Å | | |
| Crystal system, space group | Monoclinic, P21/c | | |
| Unit cell dimensions | a = 12.5436(10) Å | alpha = 90 deg. | |
| | b = 14.5923(11) Å | beta = 105.476(7) deg. | |
| | c = 11.9454(8) Å | gamma = 90 deg. | |
| Volume | 2107.2(3) Å ³ | | |
| Z, Calculated density | 4, 1.329 Mg/m ³ | | |
| Absorption coefficient | 0.678 mm ⁻¹ | | |
| F(000) | 888 | | |
| Crystal size | 0.08 x 0.07 x 0.07 mm | | |
| Theta range for data collection | 3.66 to 67.24 deg. | | |
| Limiting indices | -15<=h<=14, -15<=k<=17, -10<=l<=14 | | |
| Reflections collected / unique | 7289 / 3772 [R(int) = 0.0636] | | |
| Completeness to theta = 67.24 | 99.8 % | | |
| Absorption correction | Semi-empirical from equivalents | | |
| Max. and min. transmission | 0.9541 and 0.9478 | | |
| Refinement method | Full-matrix least-squares on F ² | | |
| Data / restraints / parameters | 3772 / 0 / 290 | | |
| Goodness-of-fit on F ² | 1.097 | | |
| Final R indices [I>2sigma(I)] | R1 = 0.0760, wR2 = 0.2074 | | |
| R indices (all data) | R1 = 0.1384, wR2 = 0.2547 | | |
| Extinction coefficient | 0.0028(4) | | |
| Largest diff. peak and hole | 0.268 and -0.219 e.Å ⁻³ | | |

6. ^1H and ^{13}C -NMR Spectra

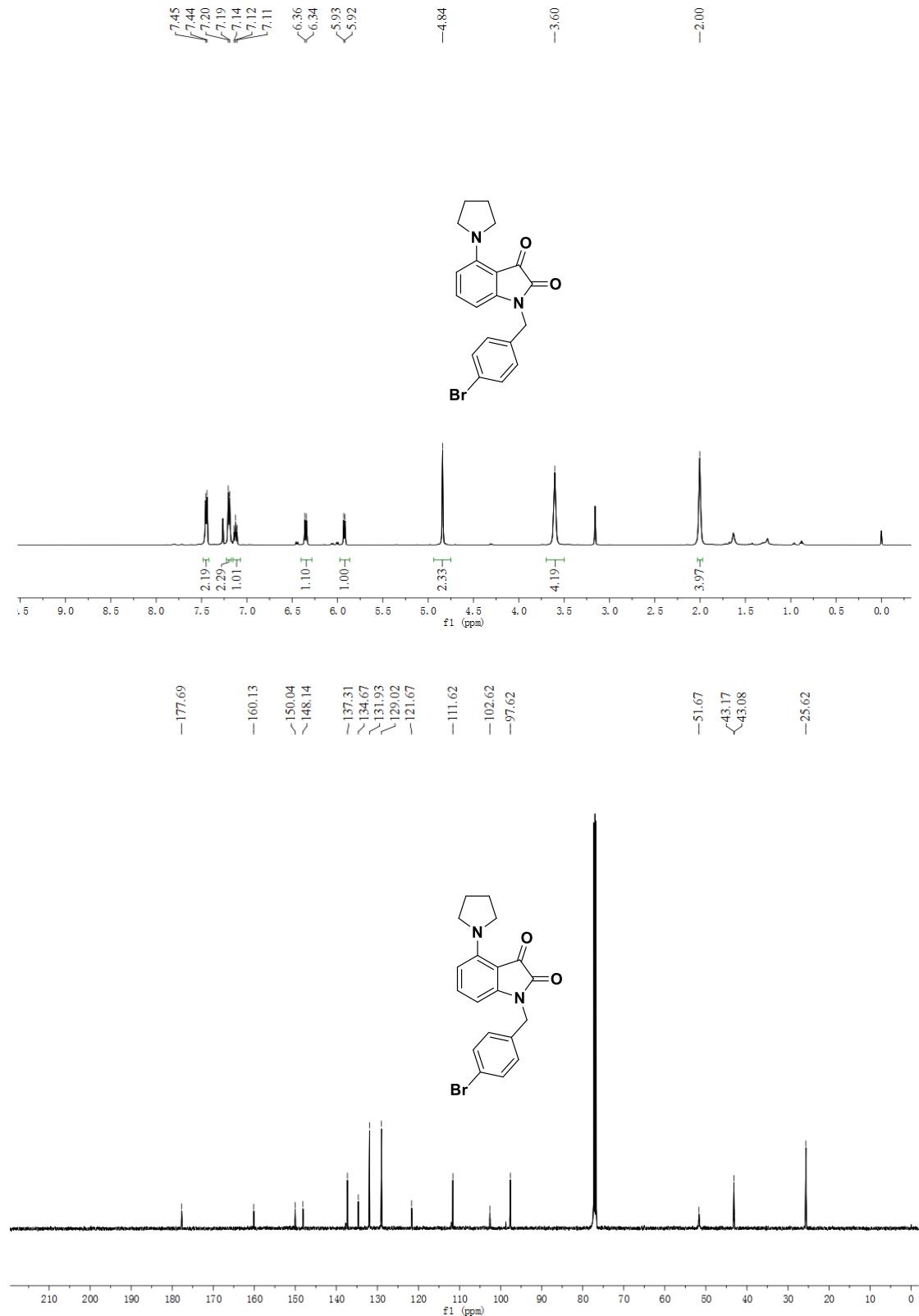
1-benzyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1a)



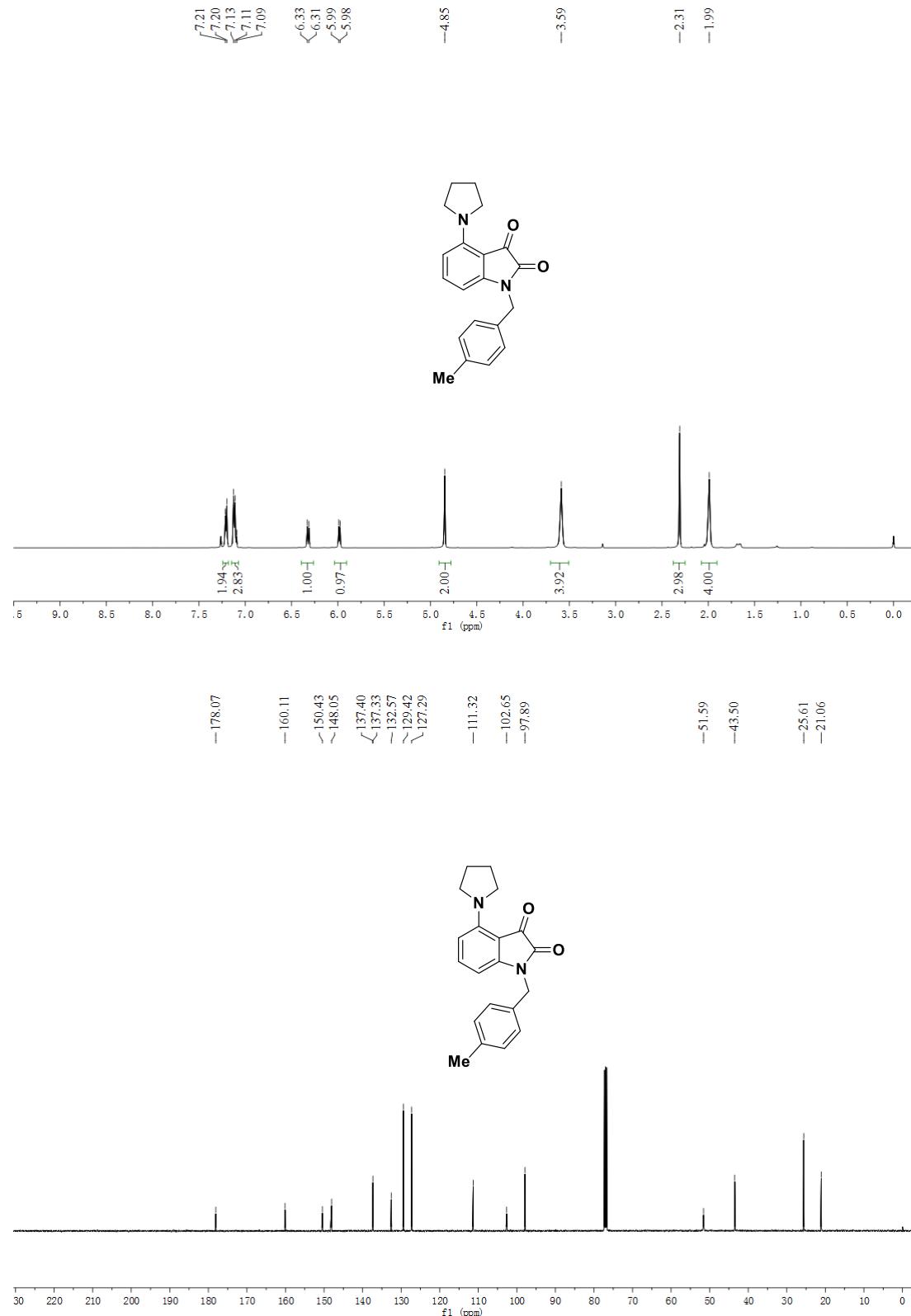
1-(2-chlorobenzyl)-4-(pyrrolidin-1-yl)indoline-2,3-dione (1b)



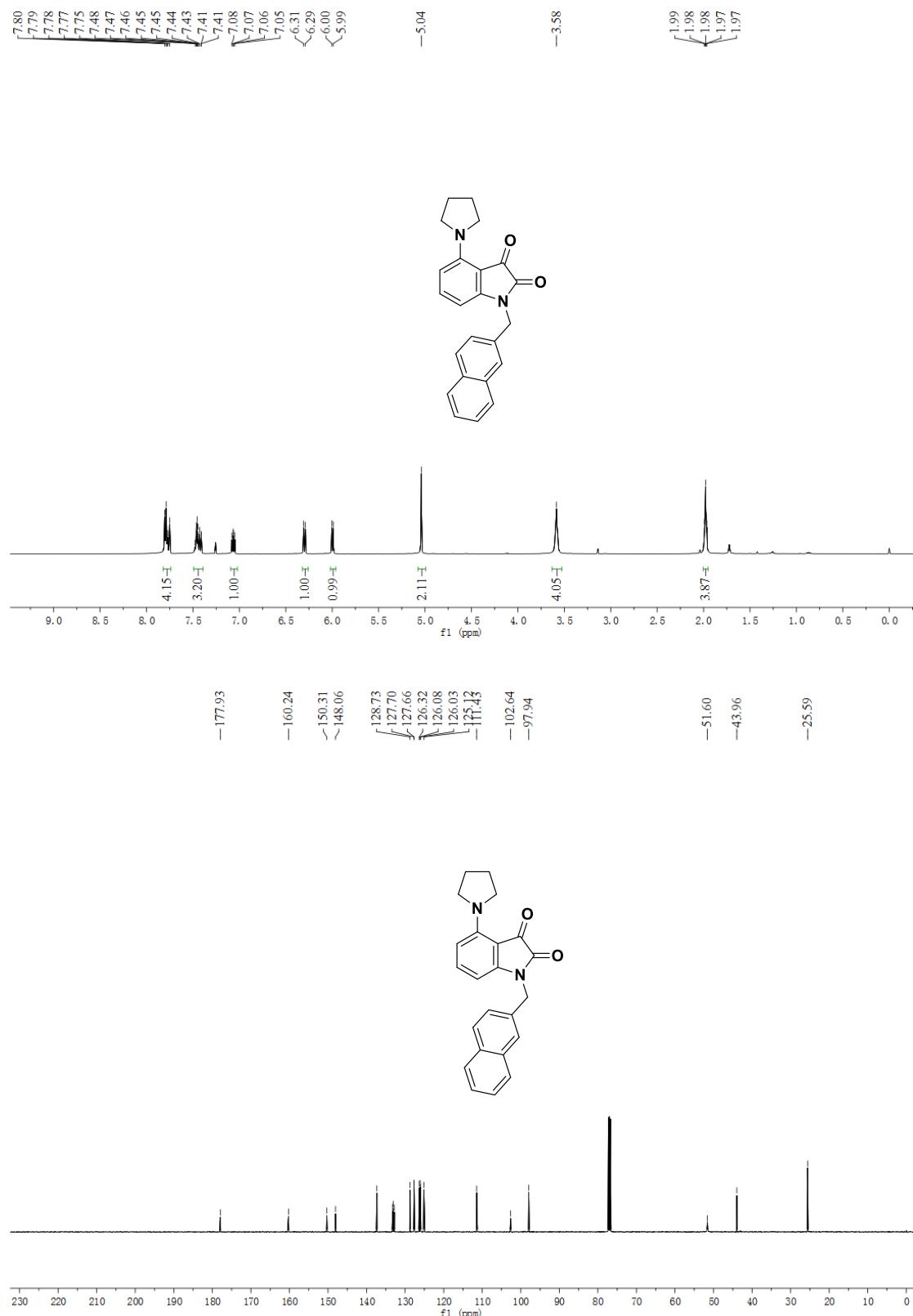
1-(4-bromobenzyl)-4-(pyrrolidin-1-yl)indoline-2,3-dione (1c)



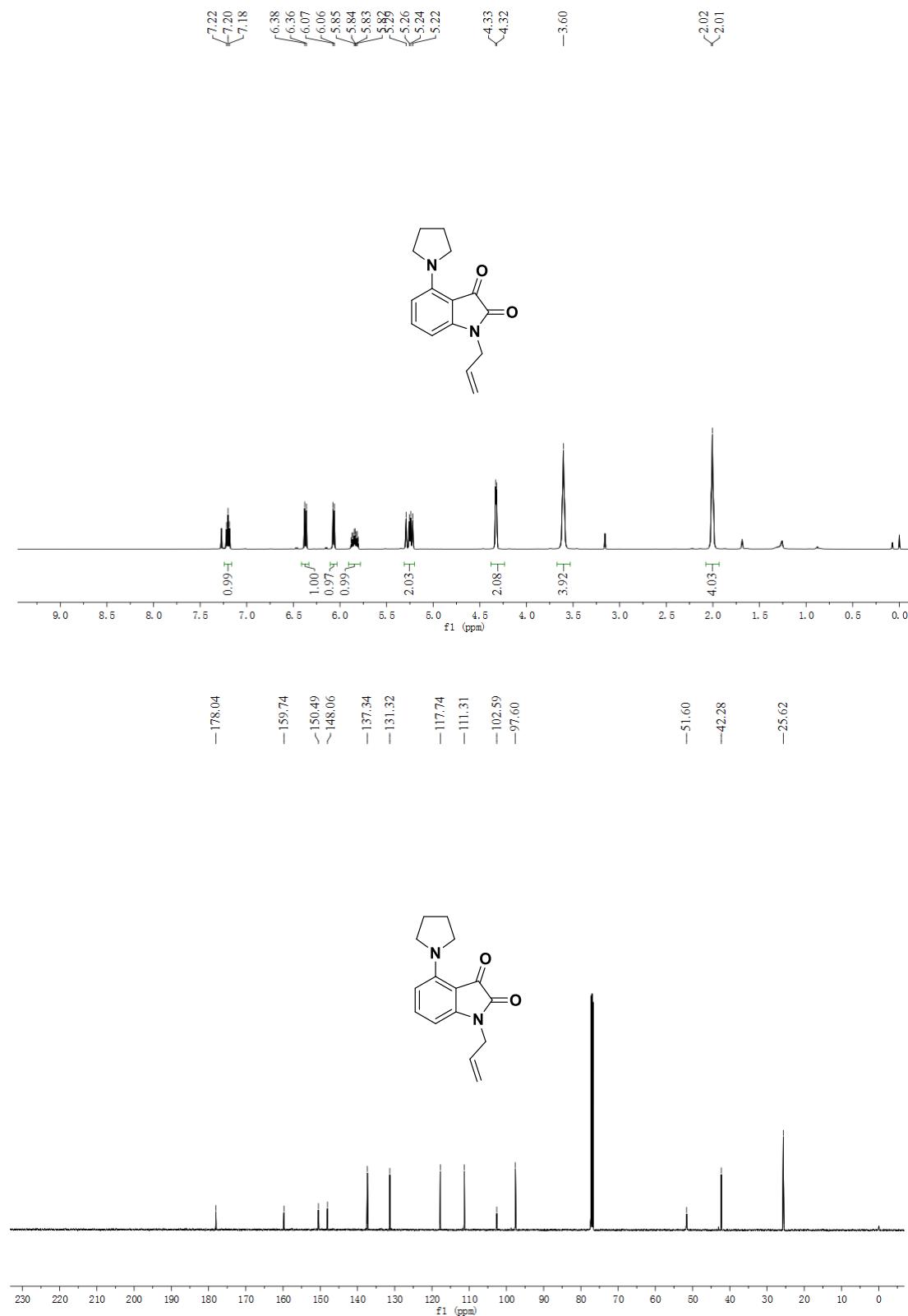
1-(4-methylbenzyl)-4-(pyrrolidin-1-yl)indoline-2,3-dione (1d)



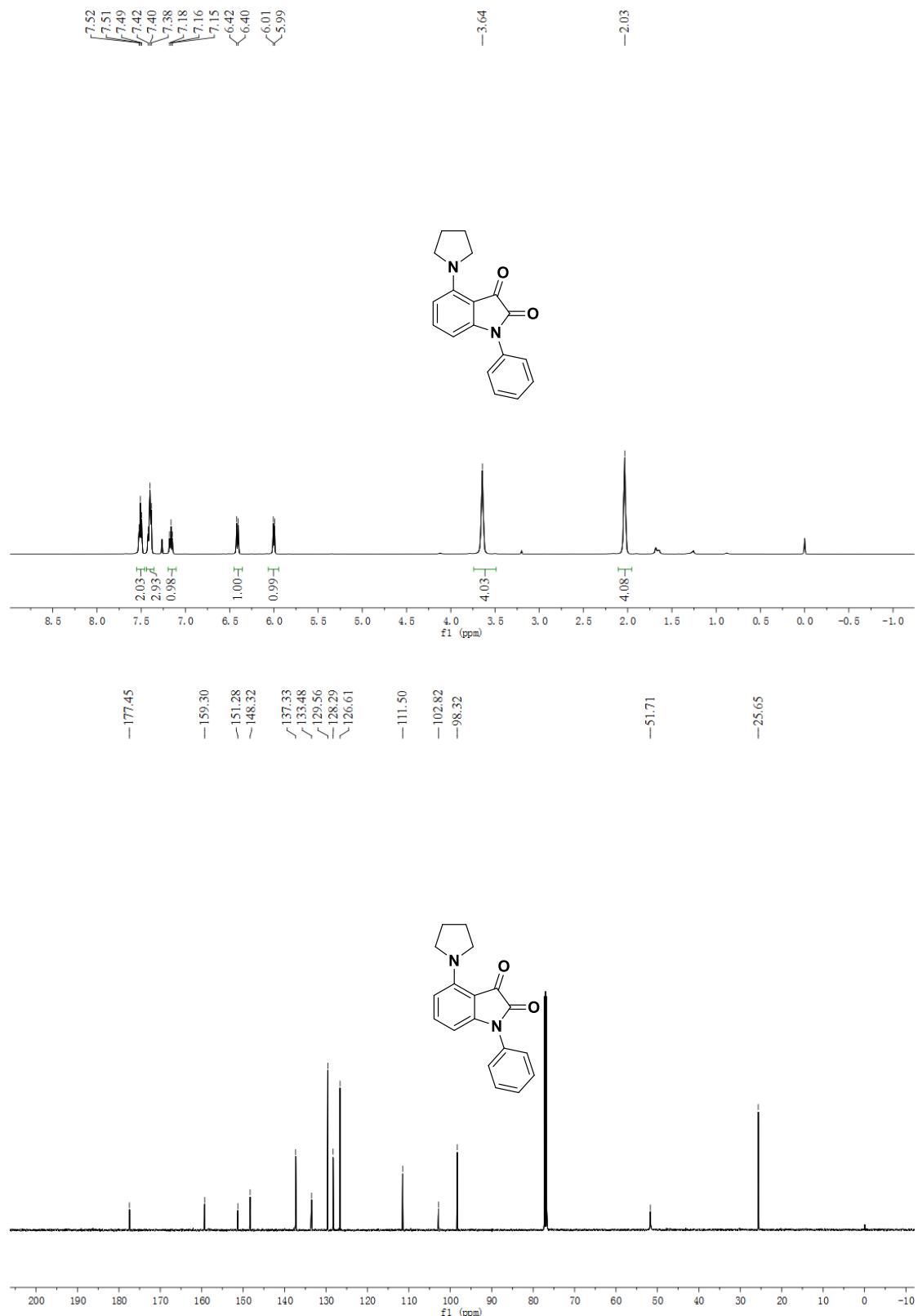
1-(naphthalen-2-ylmethyl)-4-(pyrrolidin-1-yl)indoline-2,3-dione (1e)



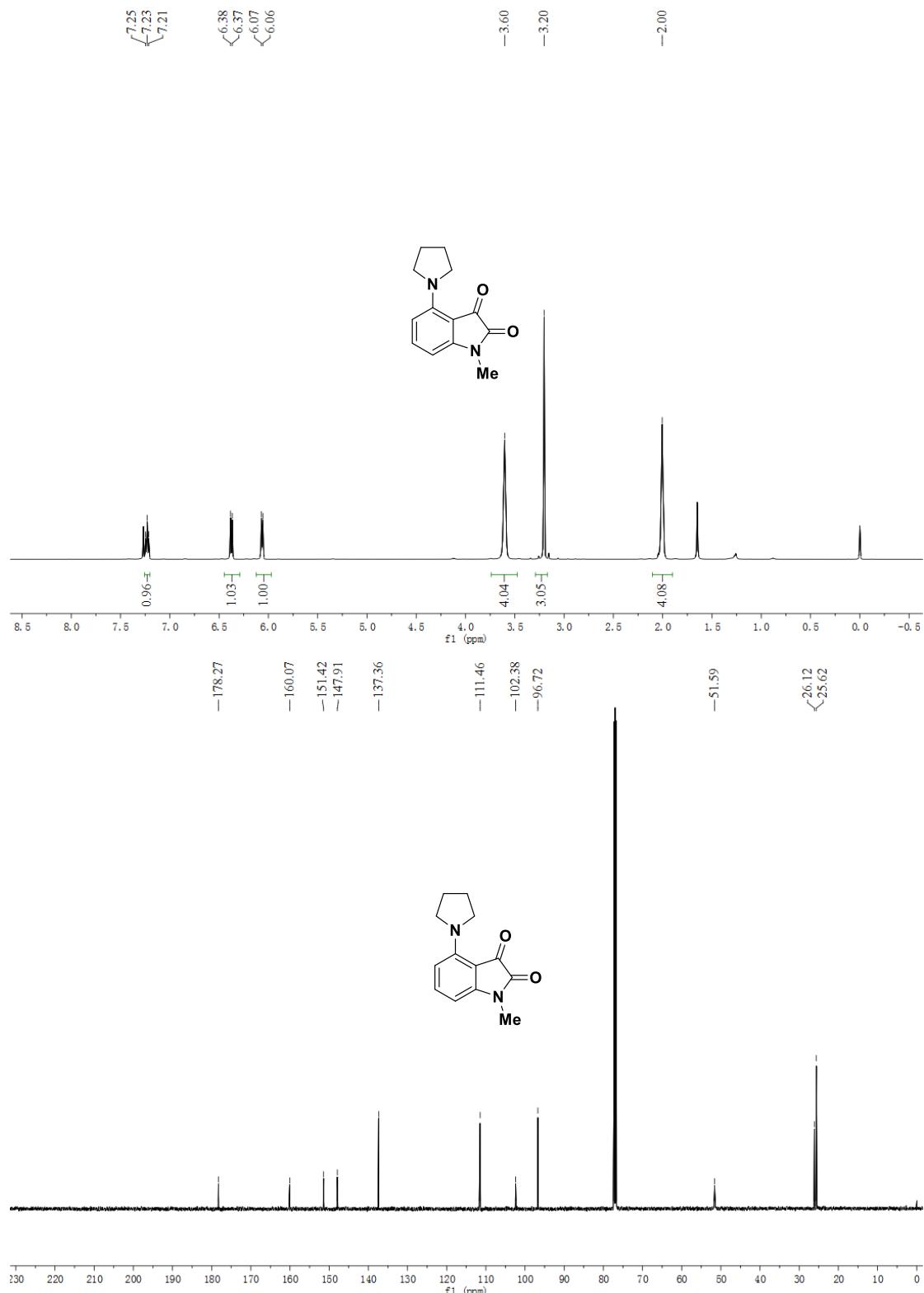
1-allyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1f)



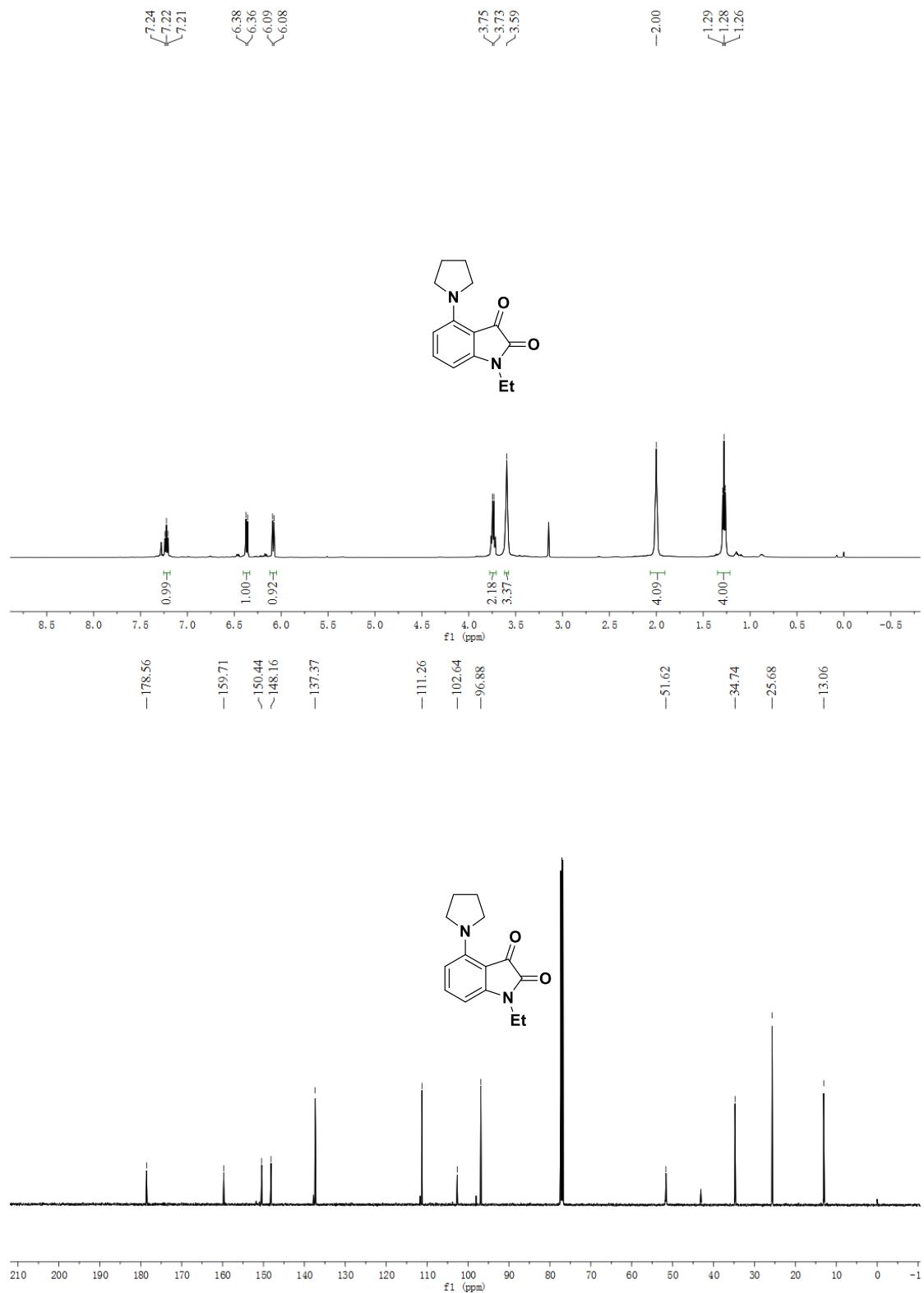
1-phenyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1g)



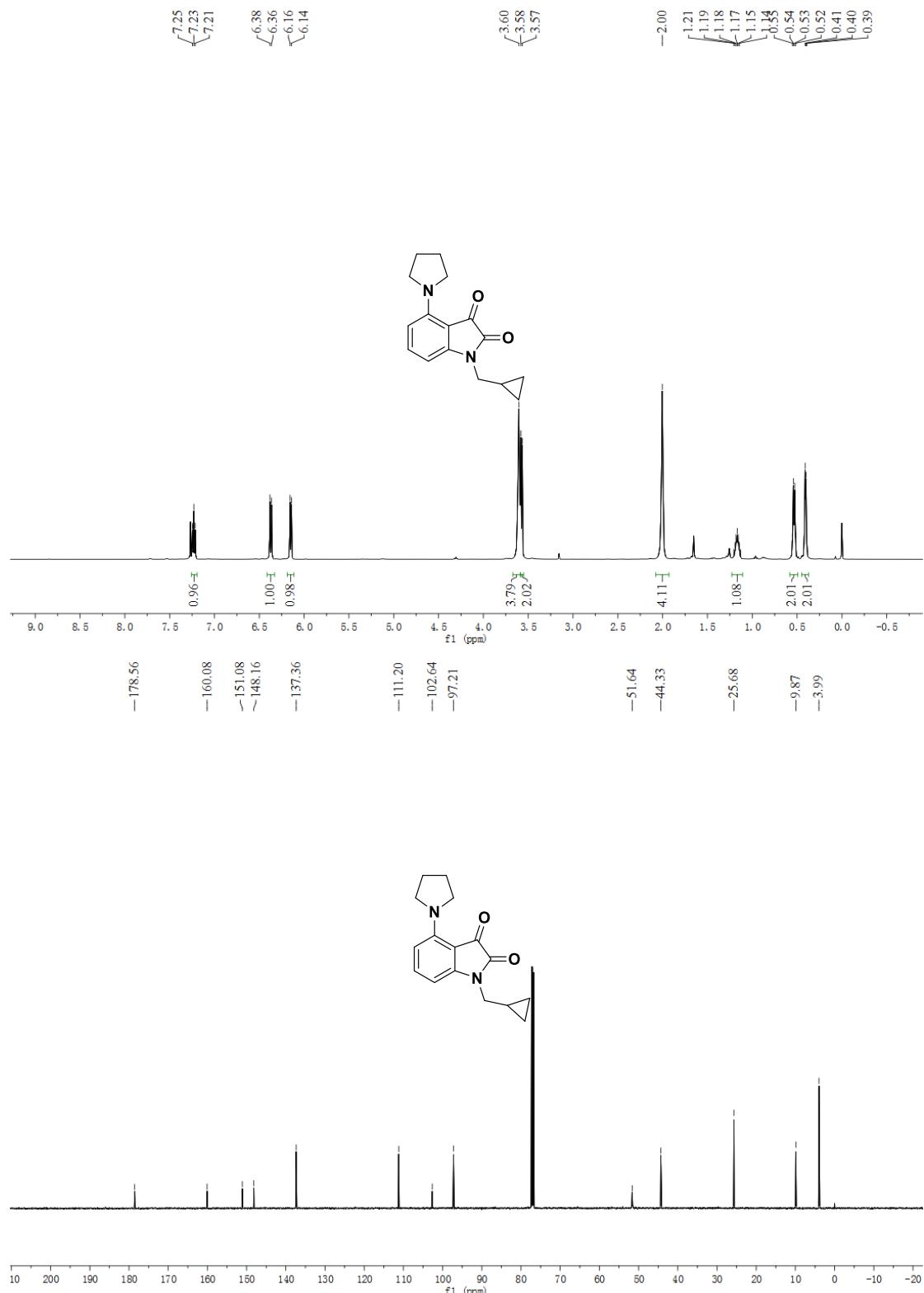
1-methyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1h)



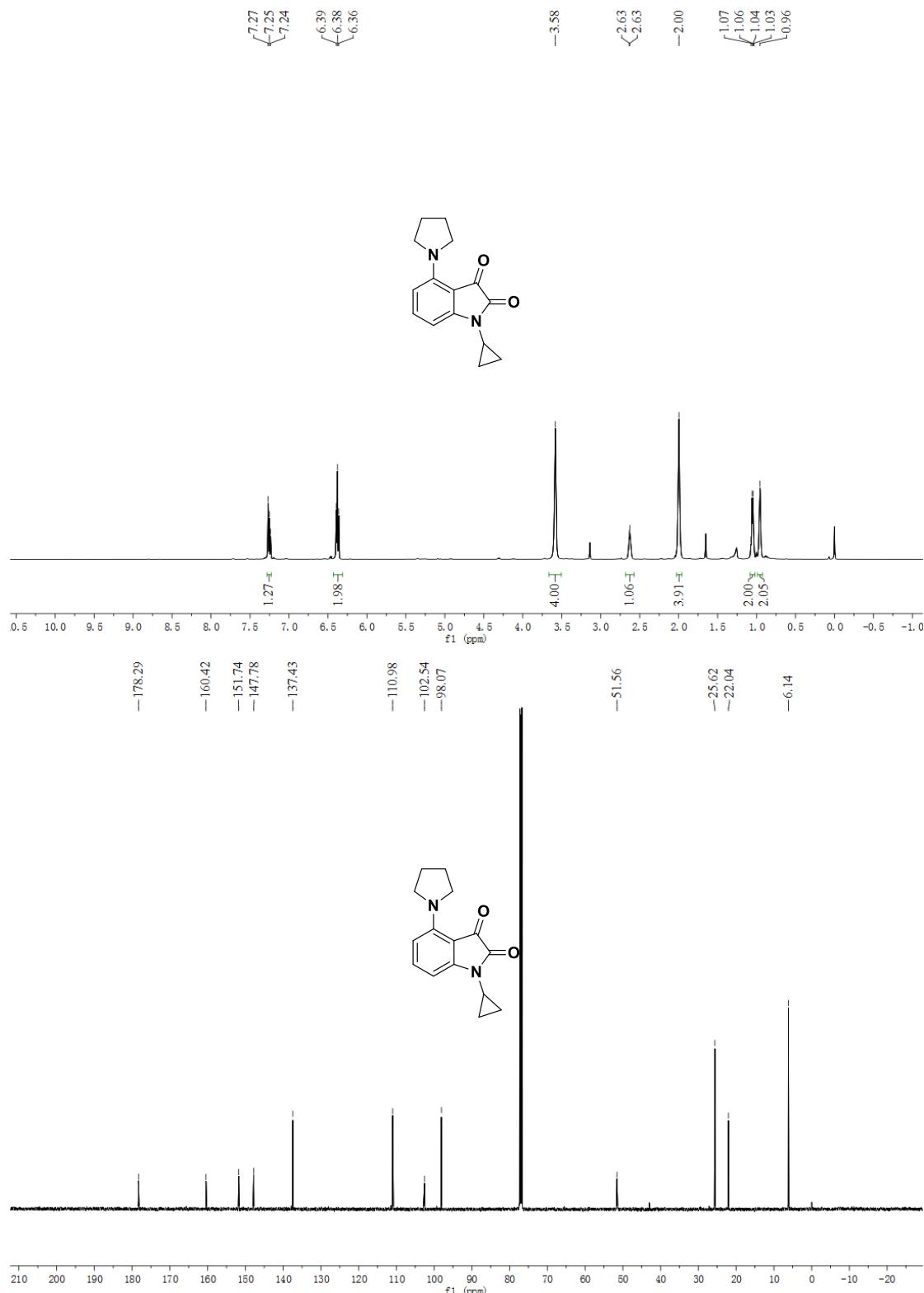
1-ethyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1i)



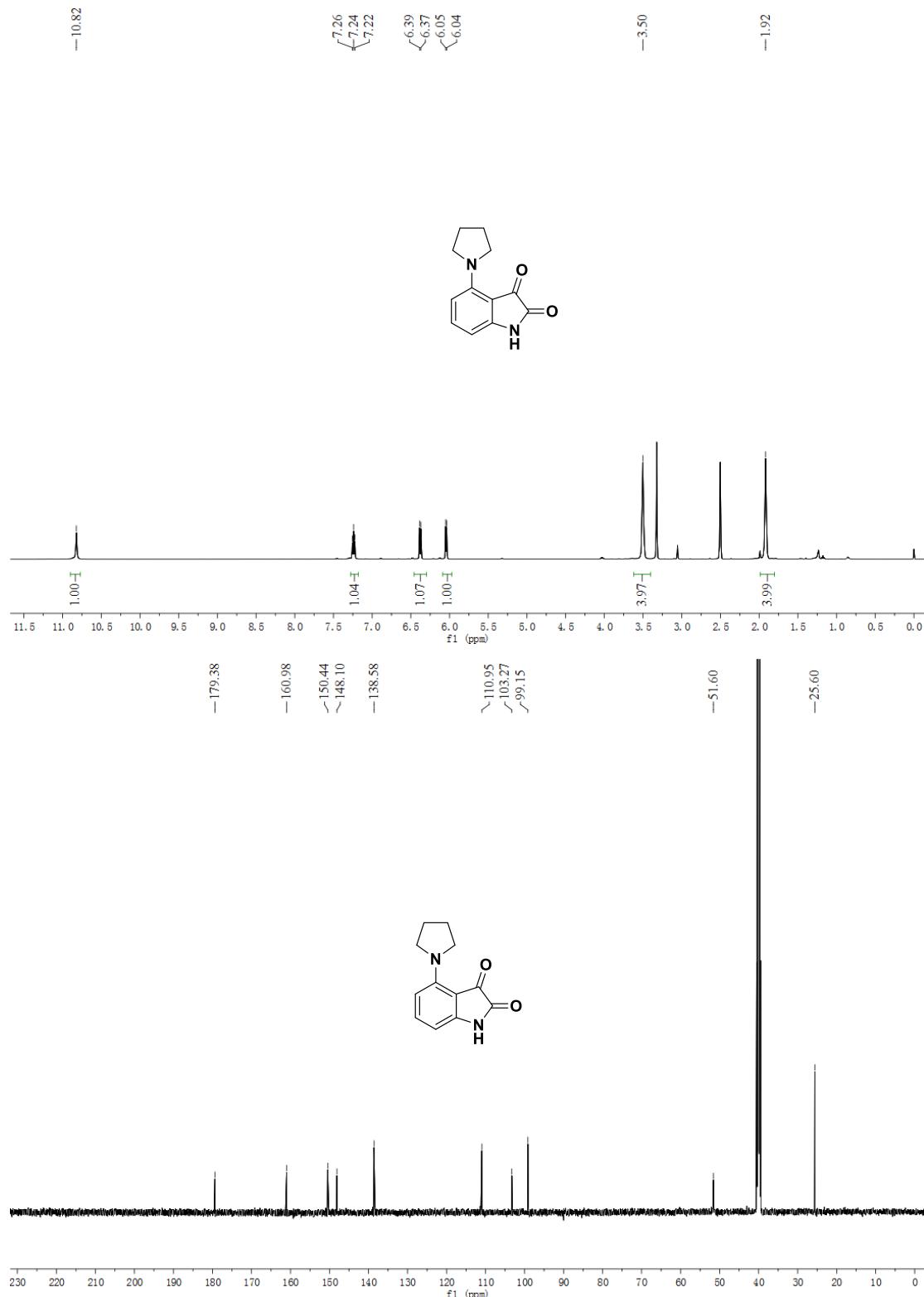
1-(cyclopropylmethyl)-4-(pyrrolidin-1-yl)indoline-2,3-dione (1j)



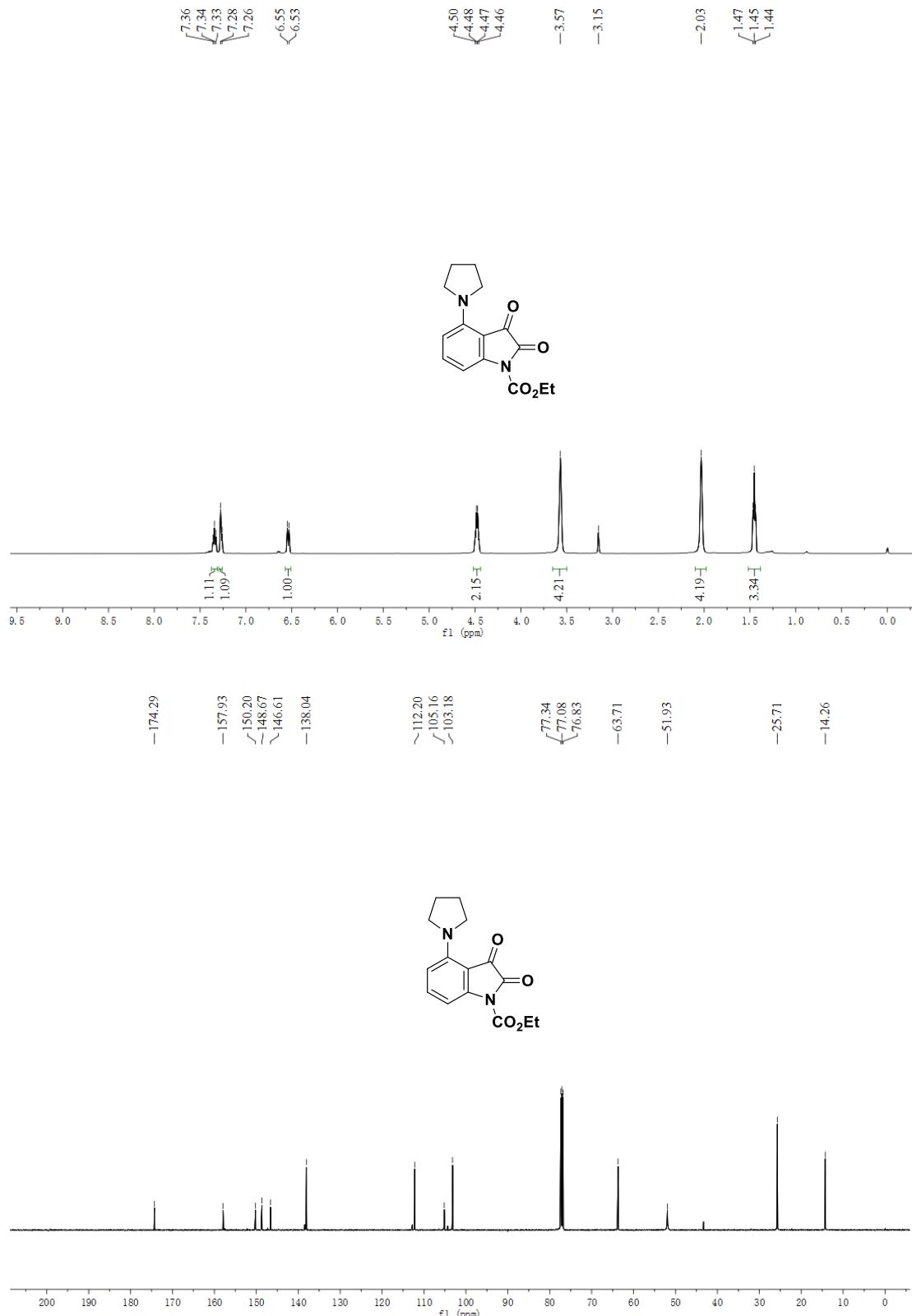
1-cyclopropyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1k)



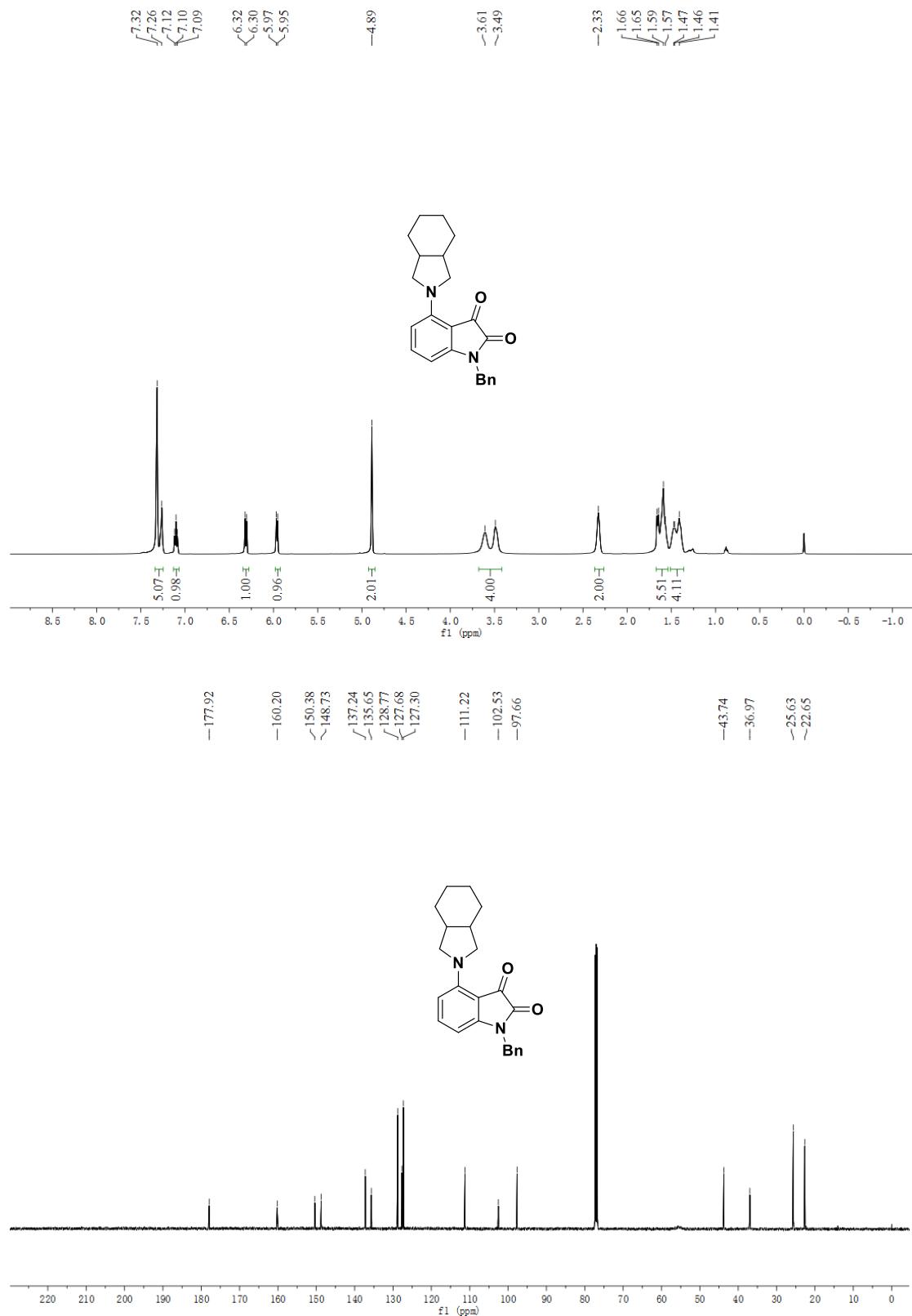
4-(pyrrolidin-1-yl)indoline-2,3-dione (1l)



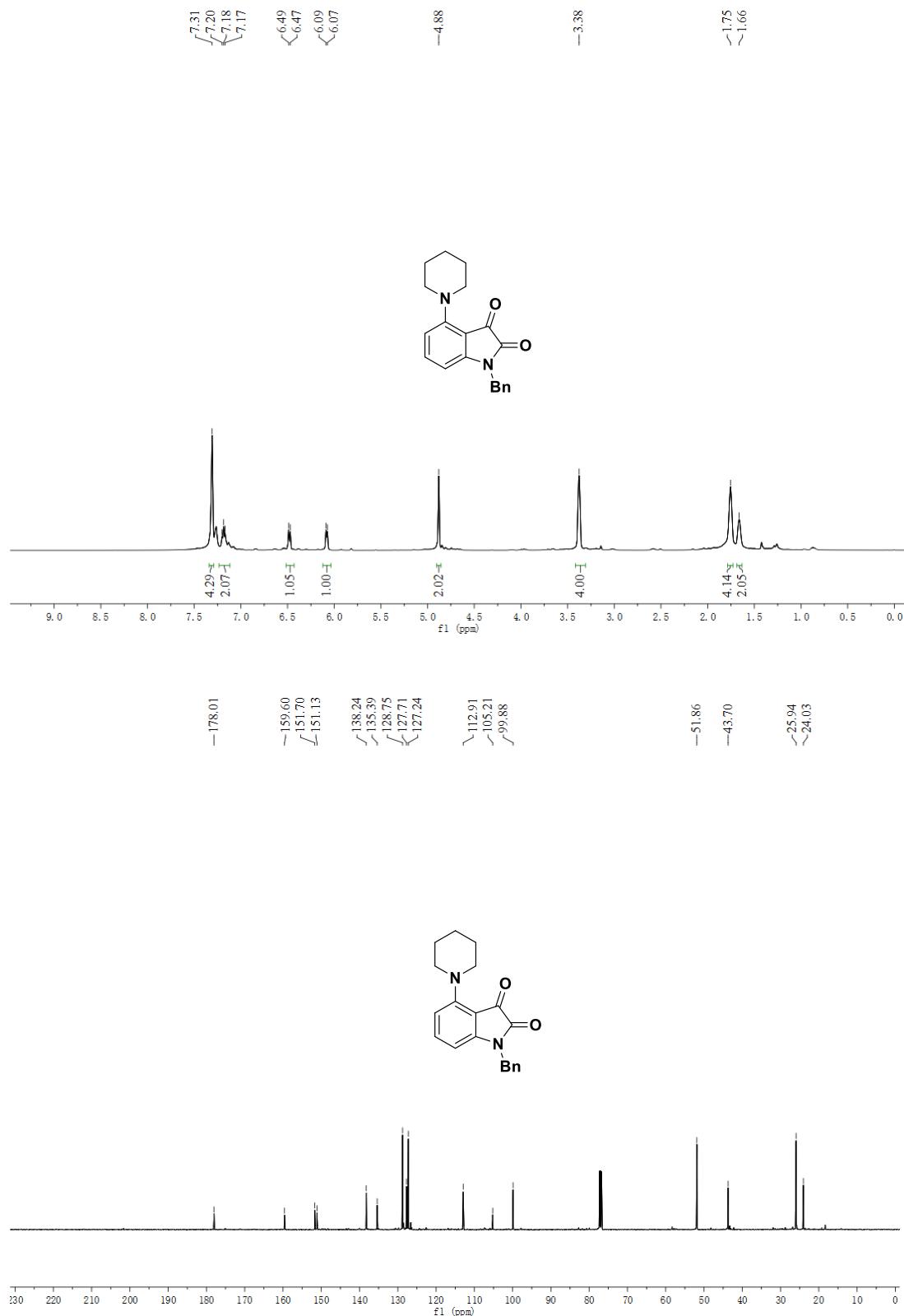
ethyl 2,3-dioxo-4-(pyrrolidin-1-yl)indoline-1-carboxylate (1m)



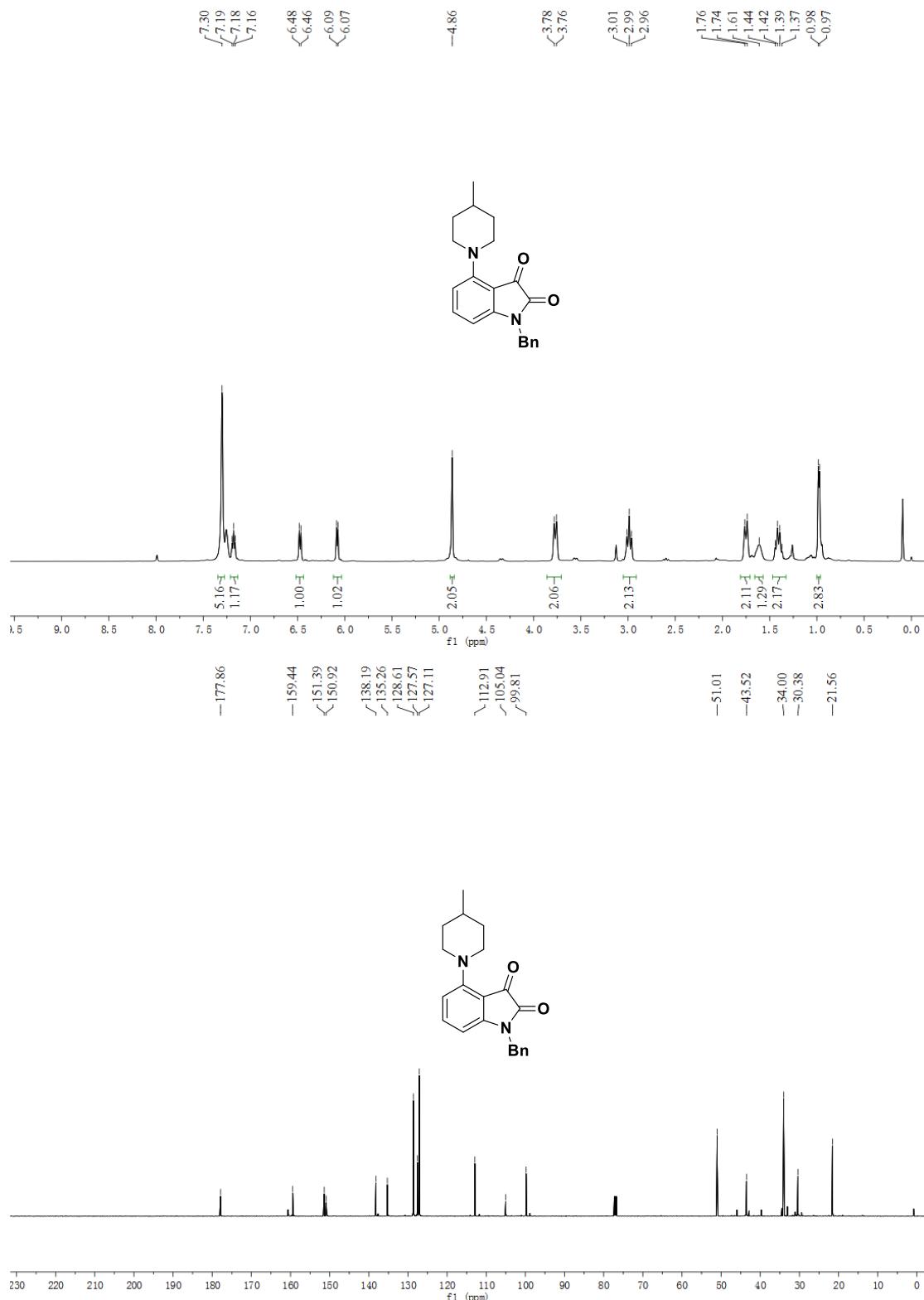
1-benzyl-4-(octahydro-2H-isoindol-2-yl)indoline-2,3-dione (1n)



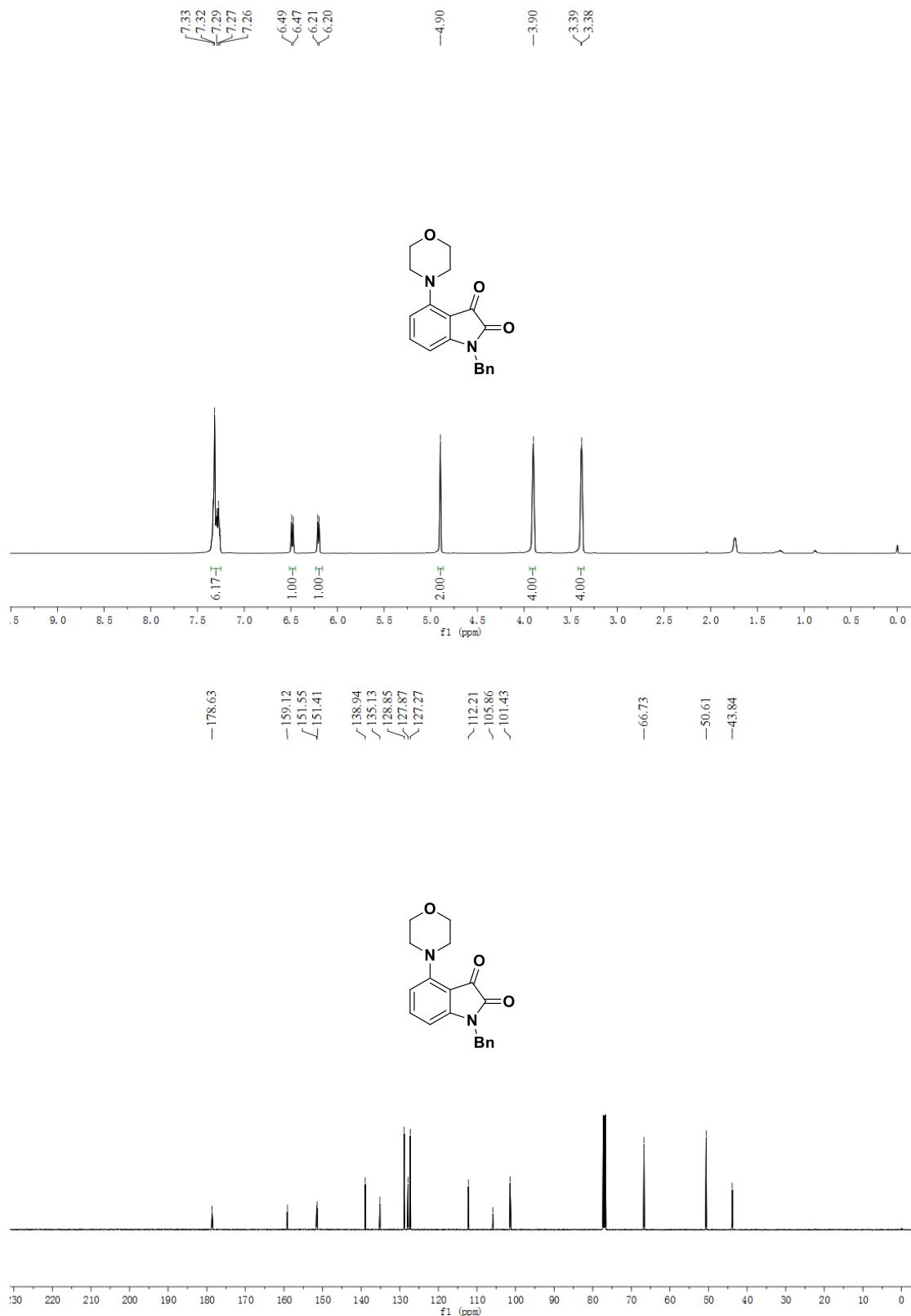
1-benzyl-4-(piperidin-1-yl)indoline-2,3-dione (10)



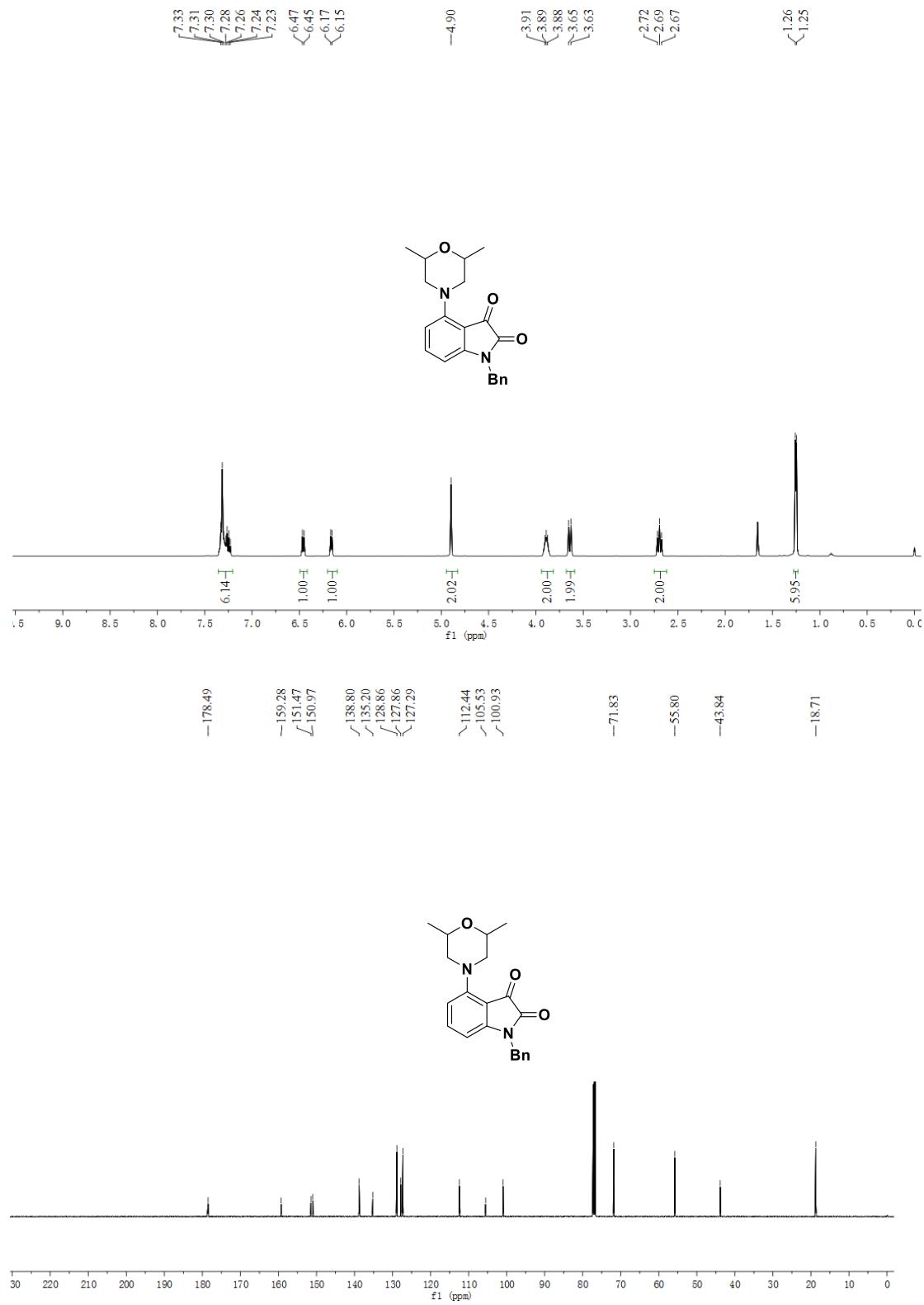
1-benzyl-4-(4-methylpiperidin-1-yl)indoline-2,3-dione (1p)



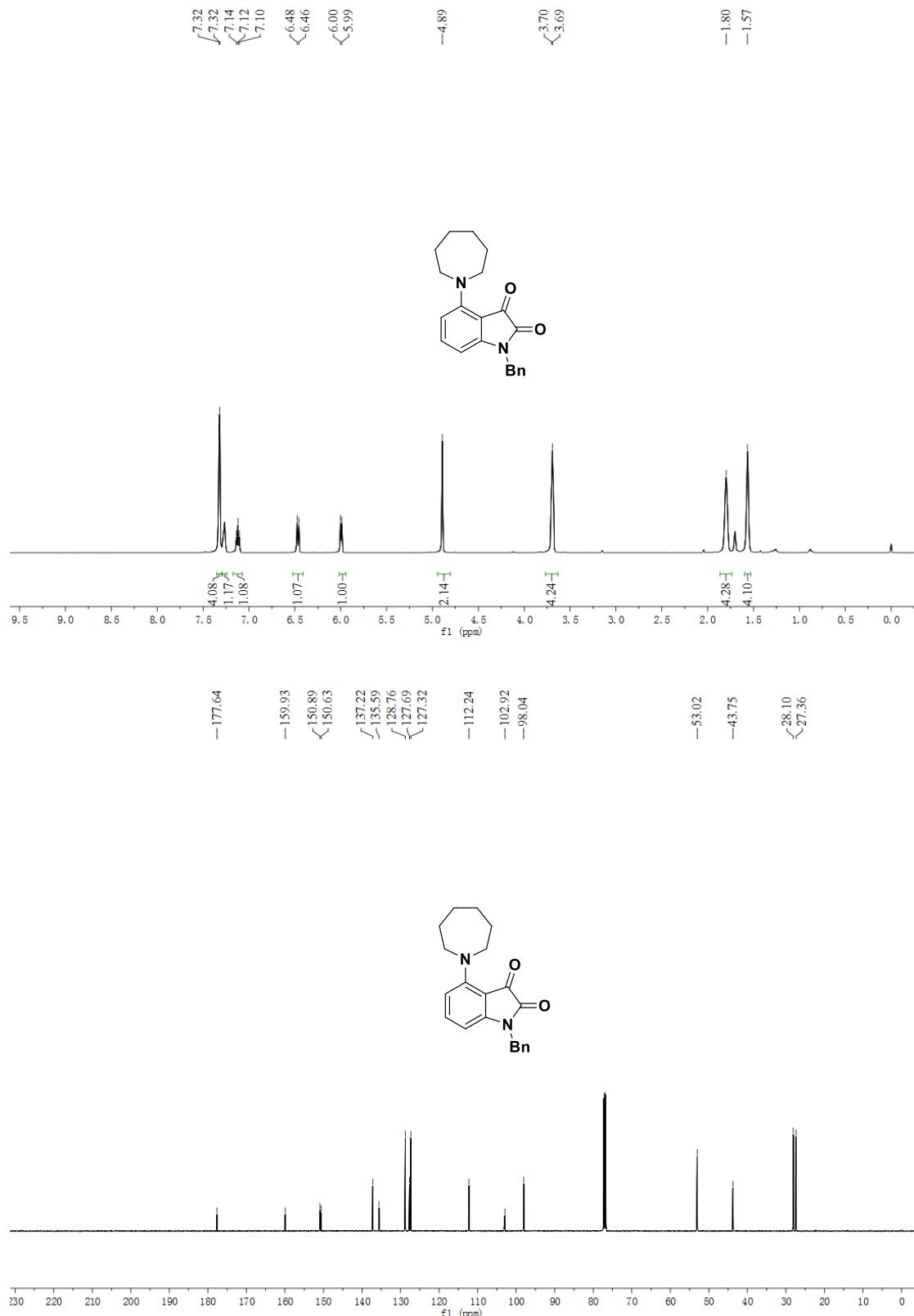
1-benzyl-4-morpholinoindoline-2,3-dione (1q)



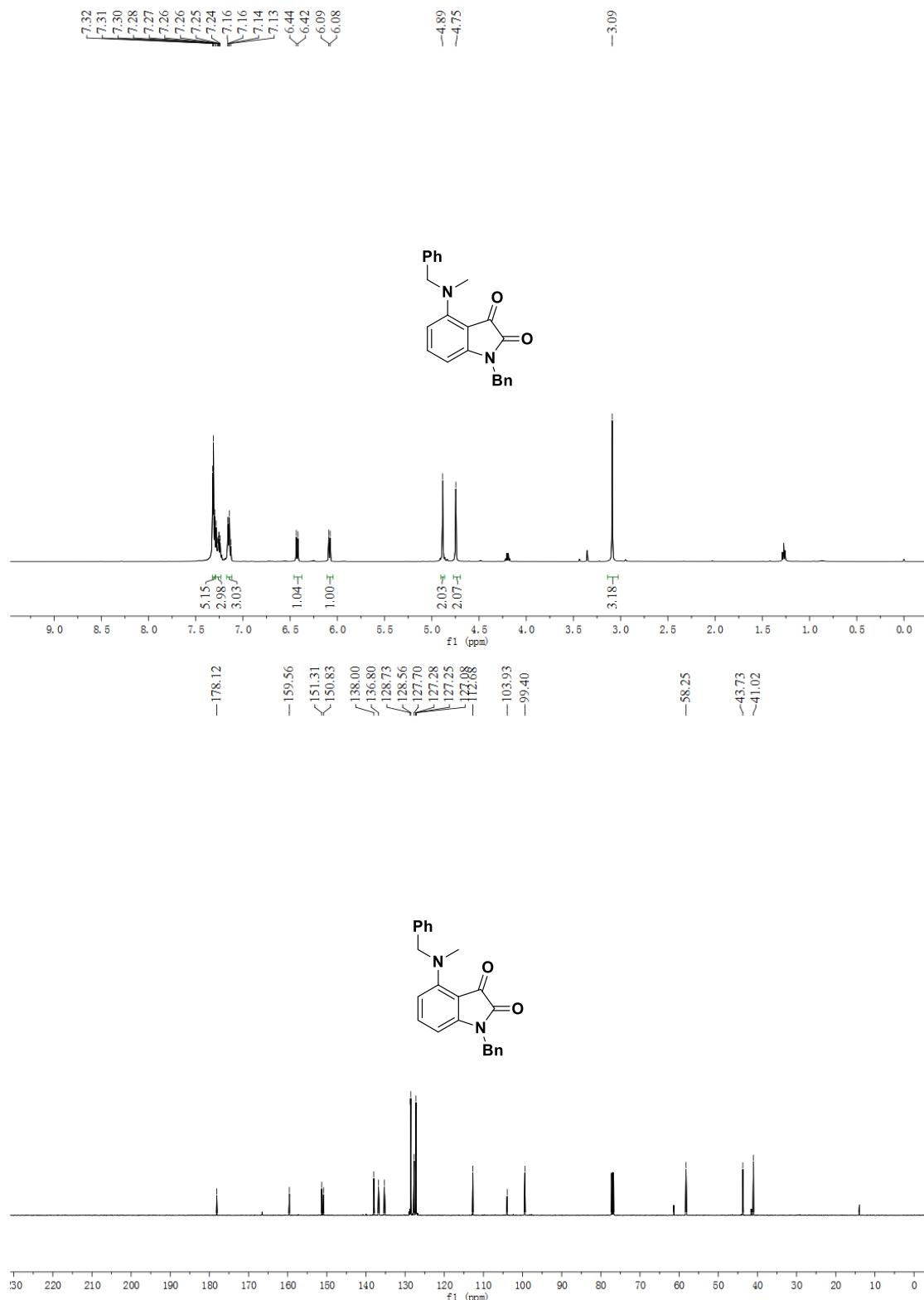
1-benzyl-4-(2,6-dimethylmorpholino)indoline-2,3-dione (1r**)**



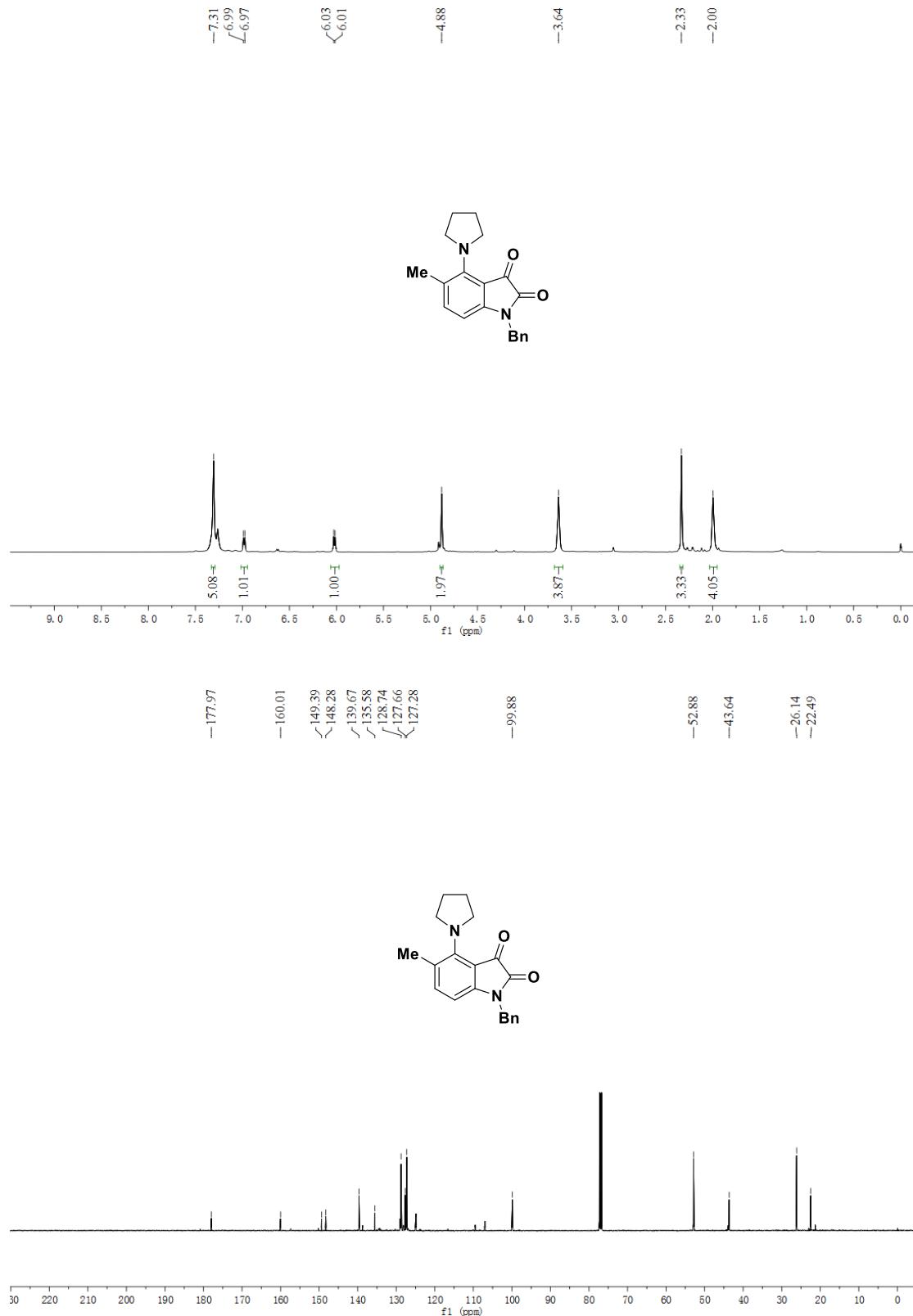
4-(azepan-1-yl)-1-benzylindoline-2,3-dione (1s)



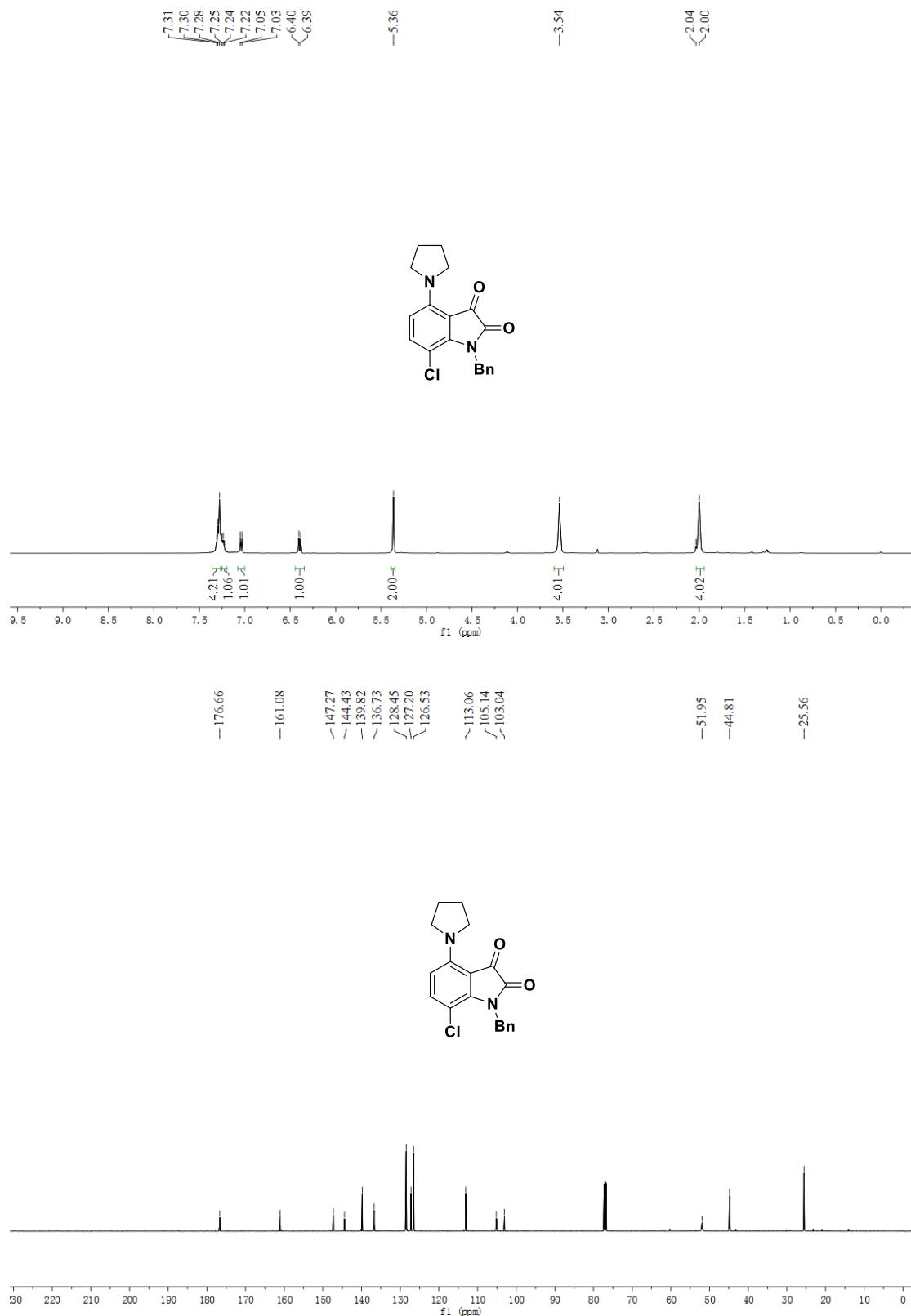
1-benzyl-4-(benzyl(methyl)amino)indoline-2,3-dione (1t)



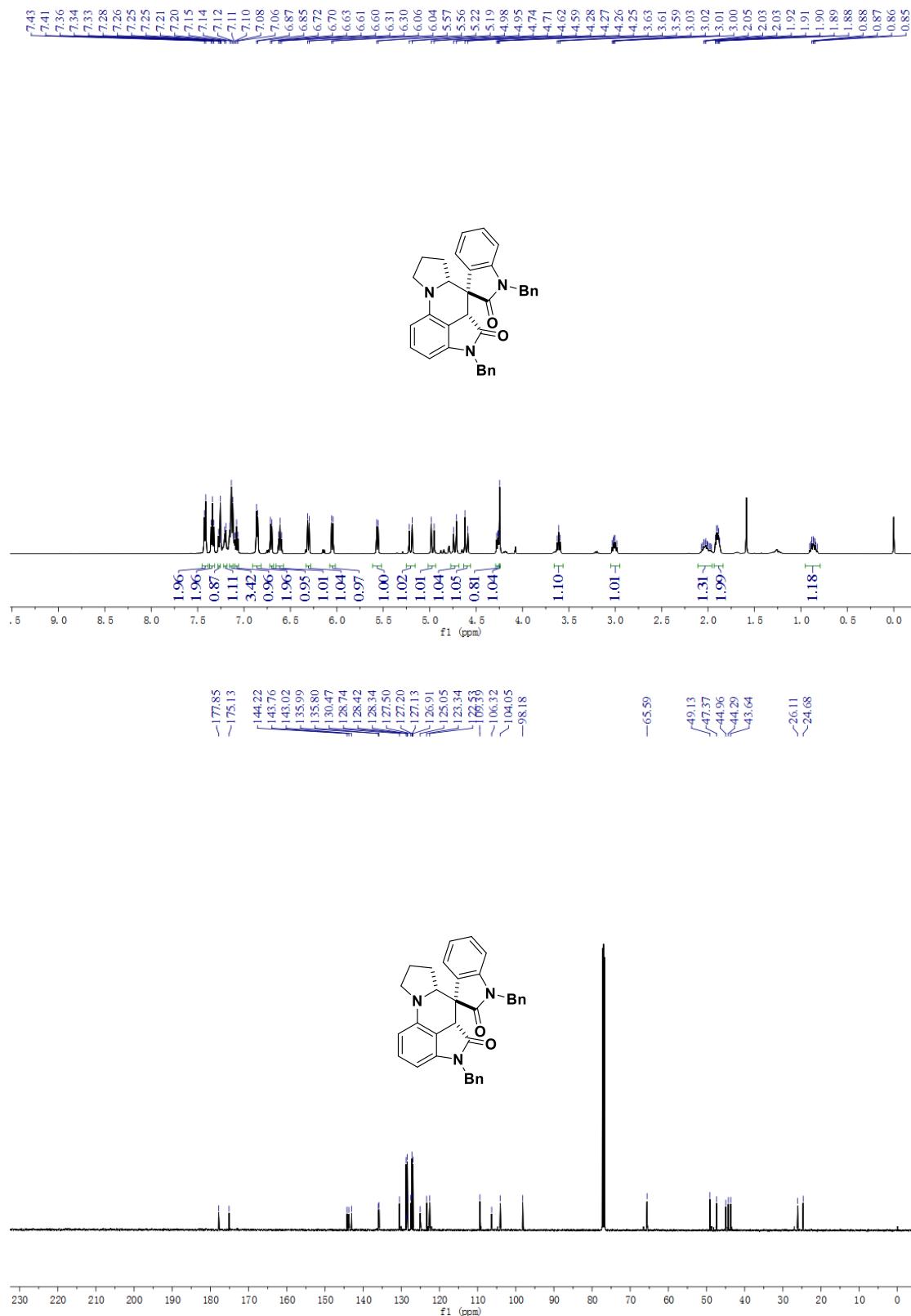
1-benzyl-5-methyl-4-(pyrrolidin-1-yl)indoline-2,3-dione (1u**)**



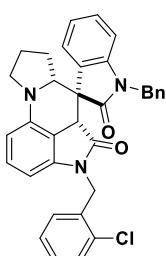
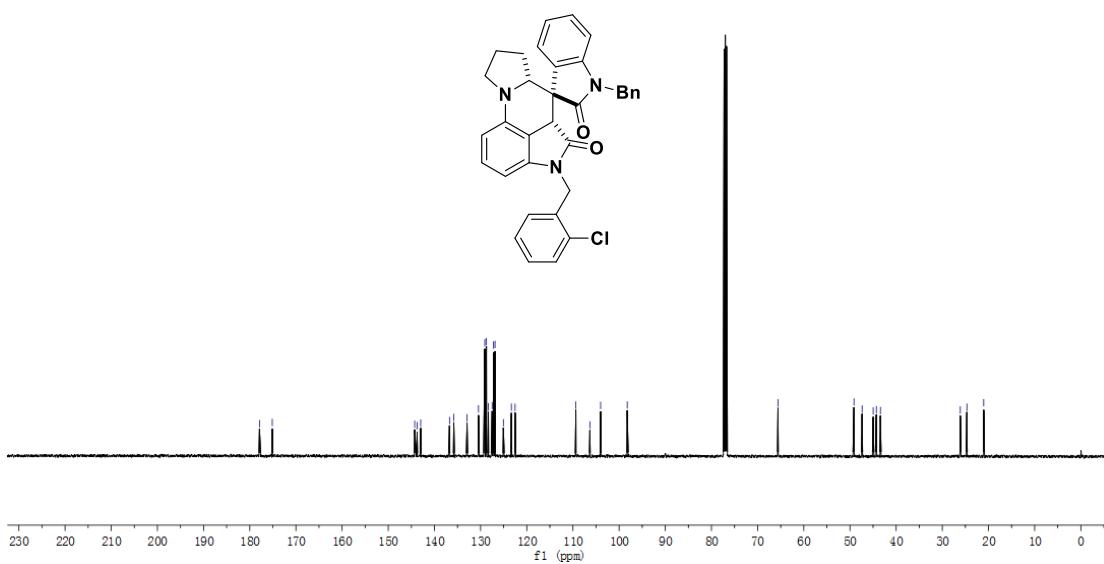
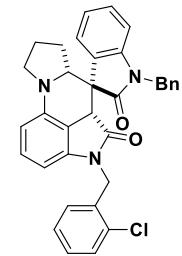
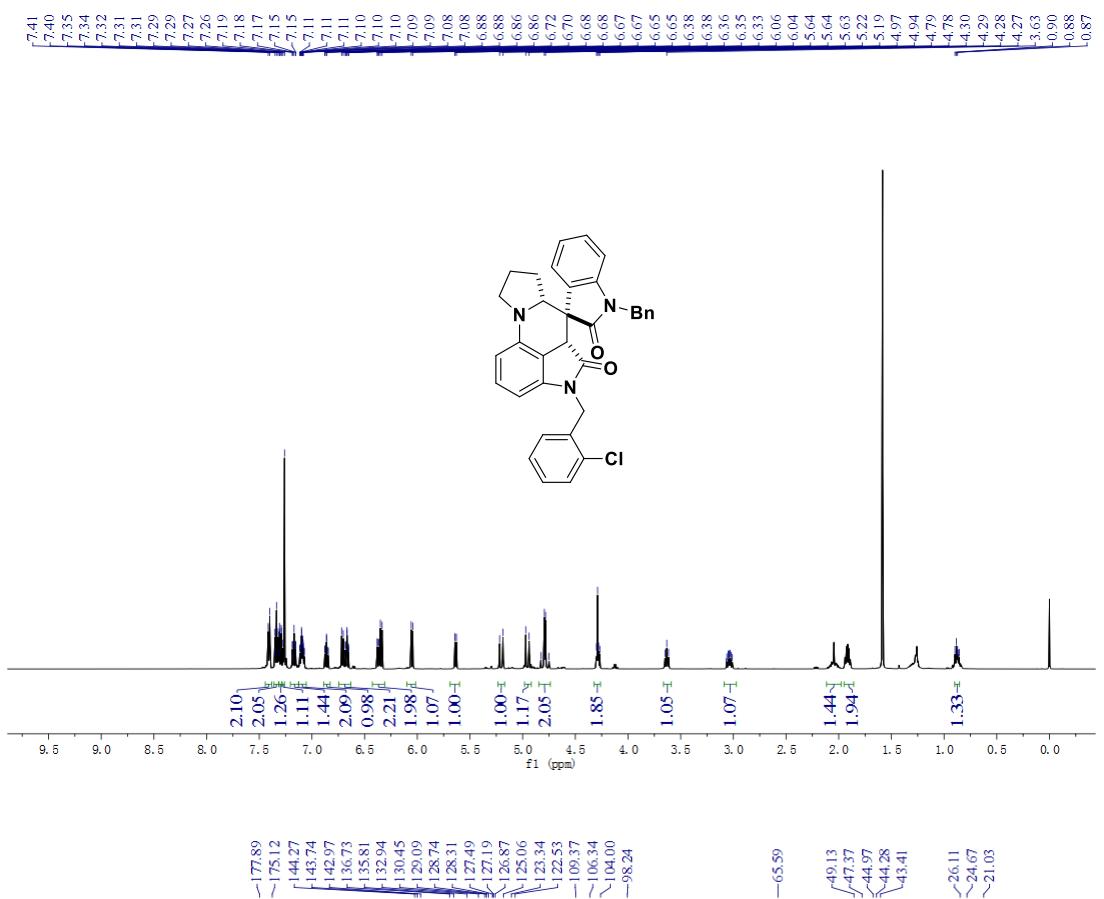
1-benzyl-7-chloro-4-(pyrrolidin-1-yl)indoline-2,3-dione (1v)



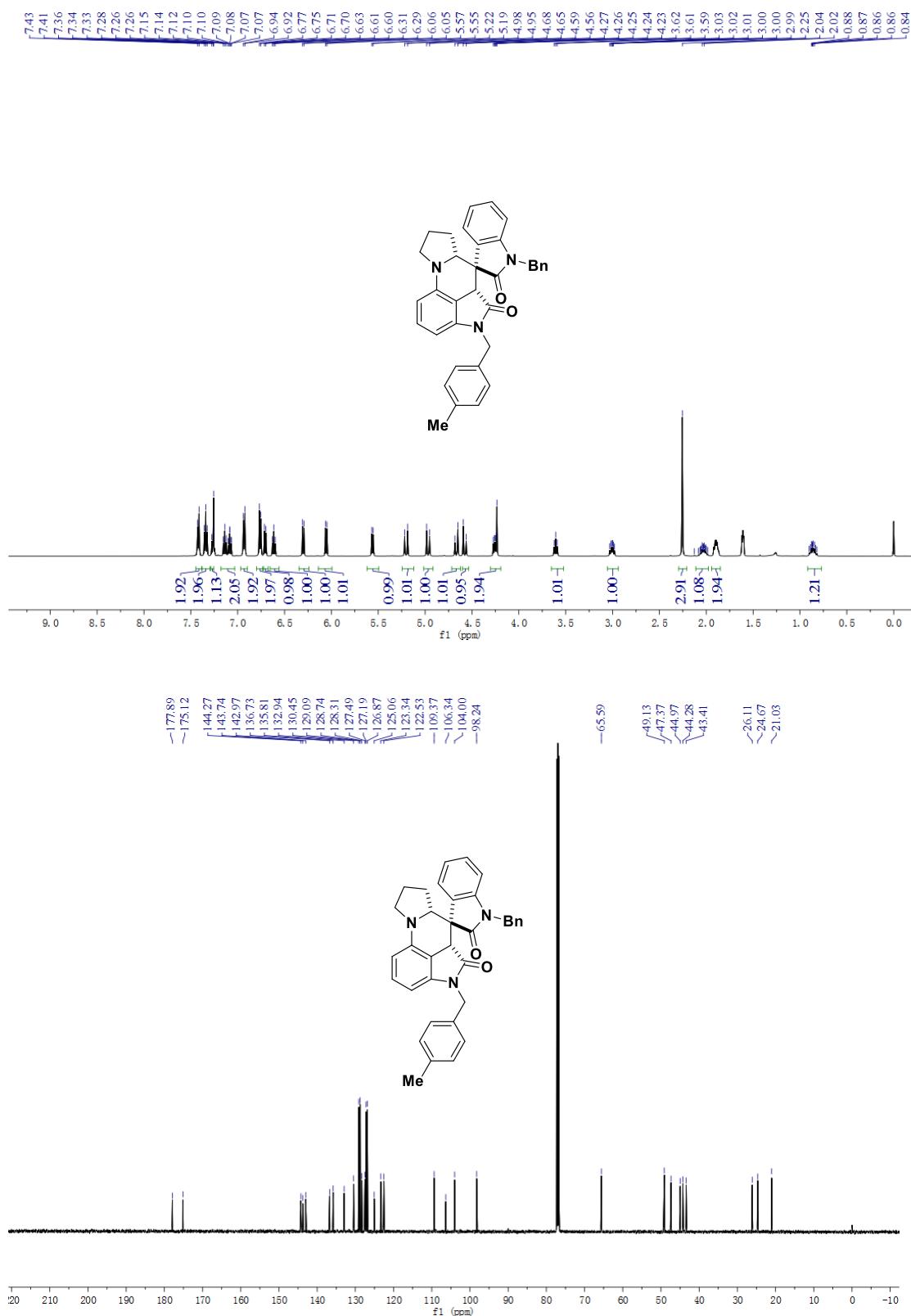
1',4-dibenzyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3a)



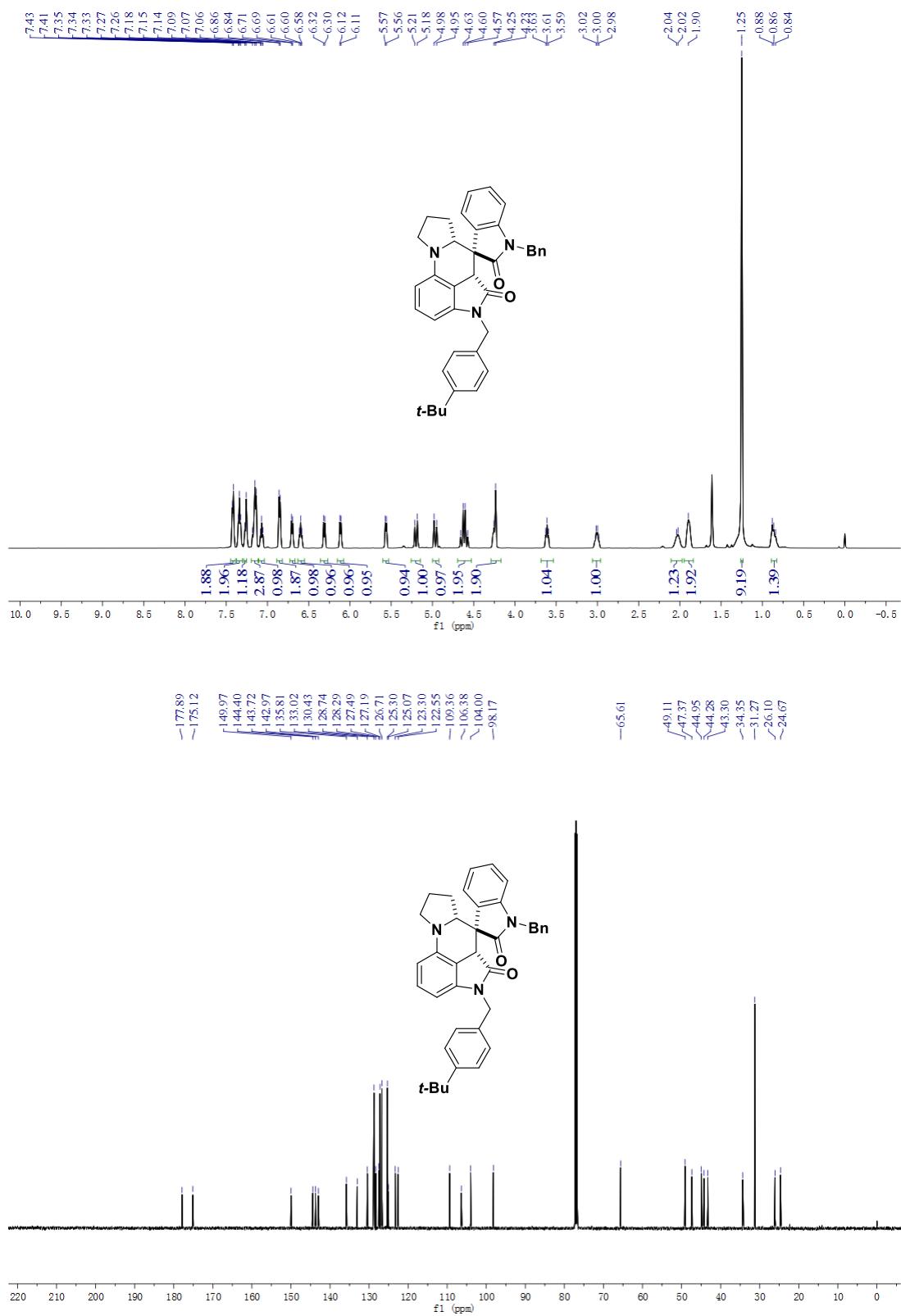
1'-benzyl-4-(2-chlorobenzyl)-4,5a,6a,7,8,9-hexahydro-5*H*-spiro[dipyrrolo[1,2-*a*:4',3',2'-*de*]quinoline-6,3'-indoline]-2',5-dione (3b)



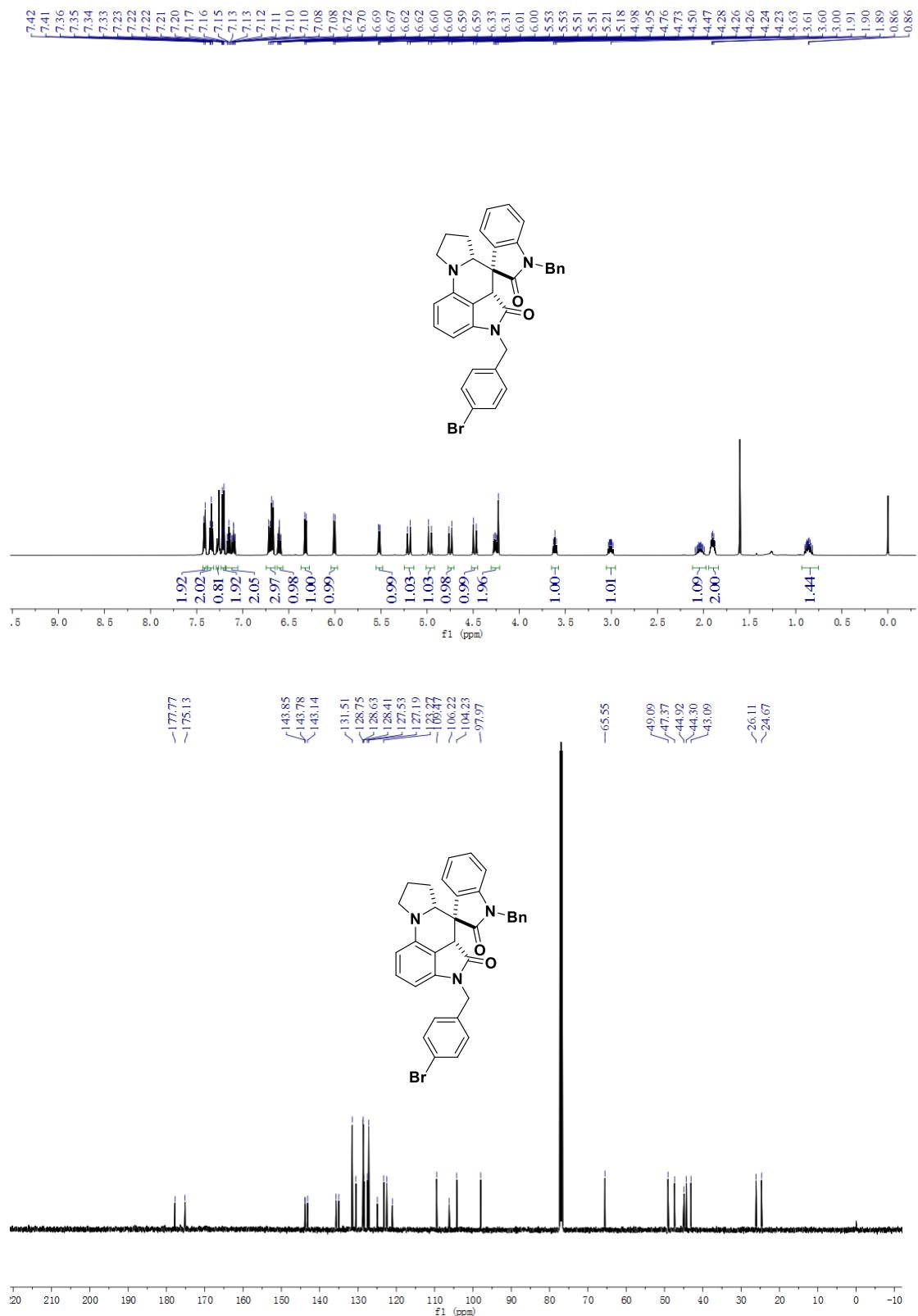
1'-benzyl-4-(4-methylbenzyl)-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrro[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3c)



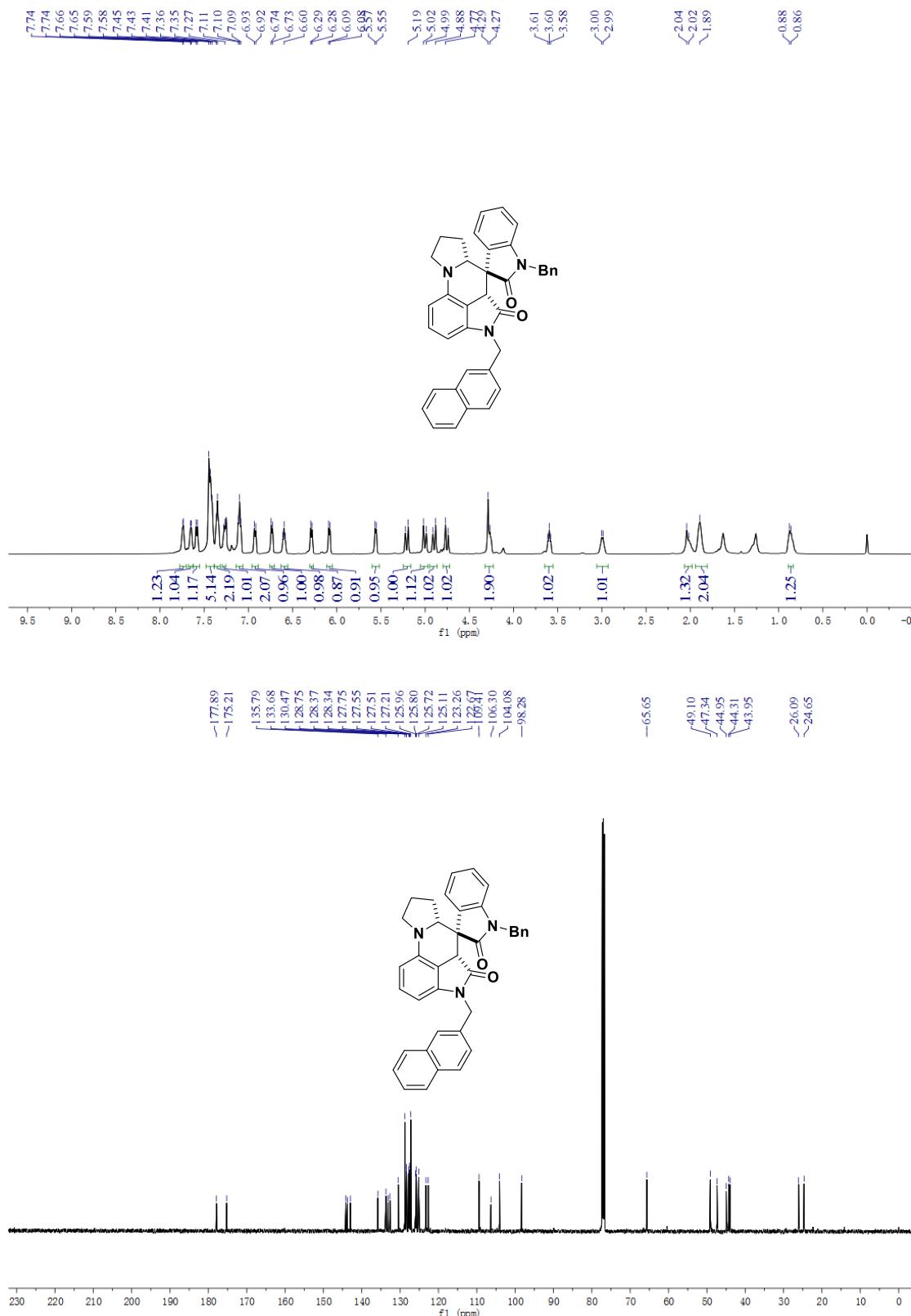
1'-benzyl-4-(4-(tert-butyl)benzyl)-4,5a,6a,7,8,9-hexahydro-5*H*-spiro[dipyrrolo[1,2-*a*:4',3',2'-*d*]quinoline-6,3'-indoline]-2',5-dione (3d)



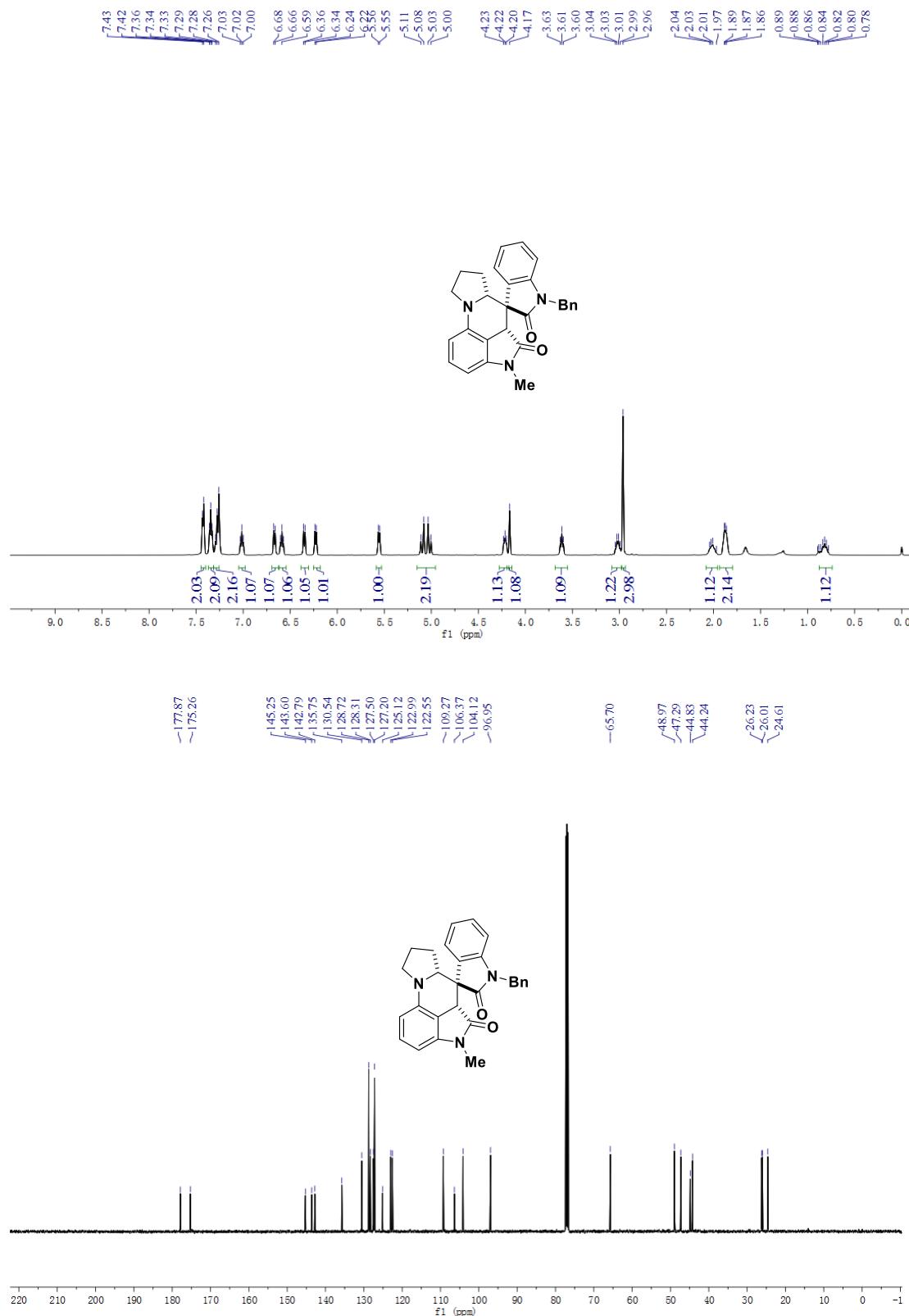
1'-benzyl-4-(4-bromobenzyl)-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrro[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3e)



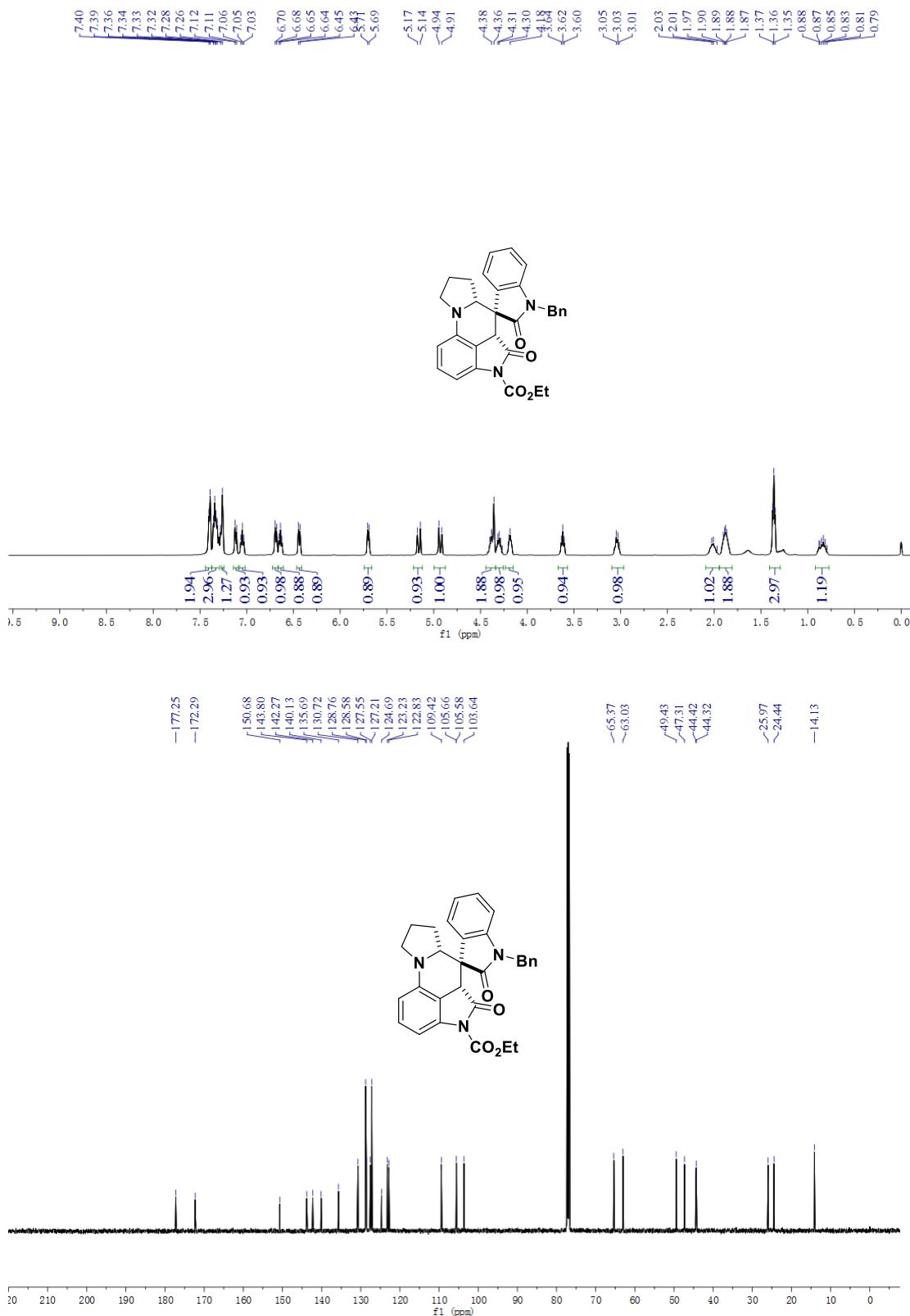
1'-benzyl-4-(naphthalen-2-ylmethyl)-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-d]quinoline-6,3'-indoline]-2',5-dione (3f)



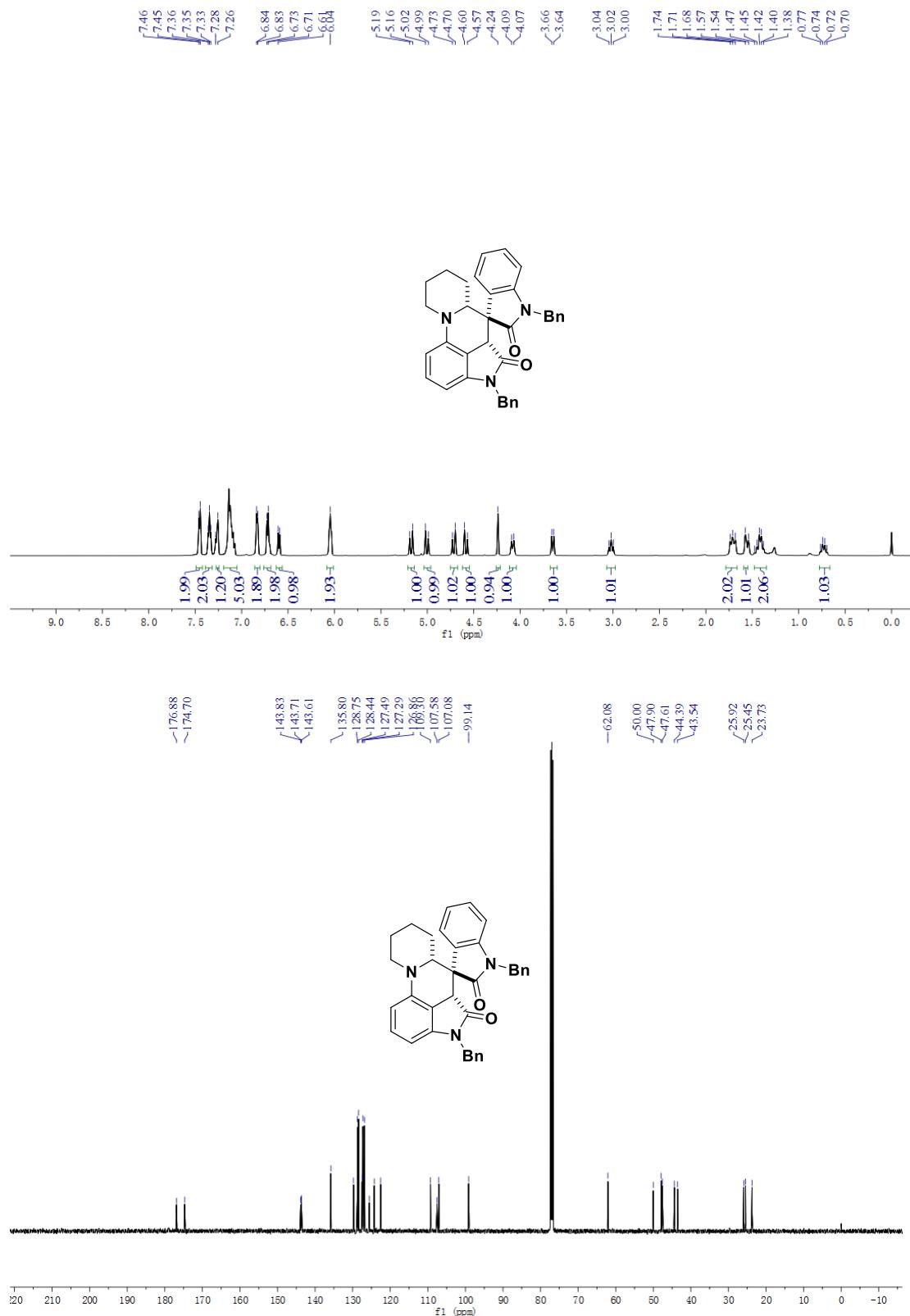
1'-benzyl-4-methyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrro[1,2-*a*:4',3',2'-*de*]quinoline-6,3'-indoline]-2',5-dione (3g)



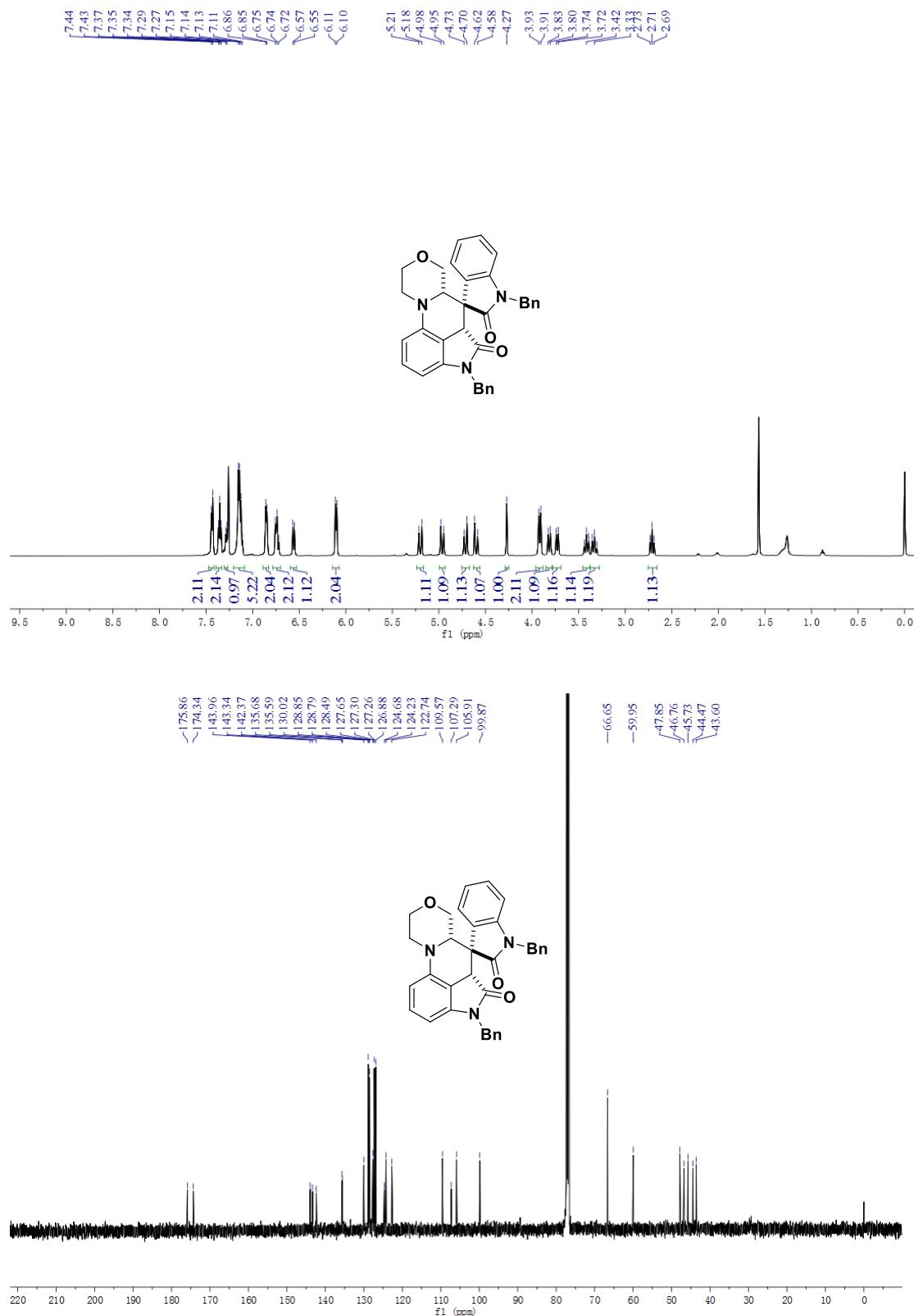
ethyl 1'-benzyl-2',5-dioxo-5,5a,6a,7,8,9-hexahydro-4H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-4-carboxylate (3h)



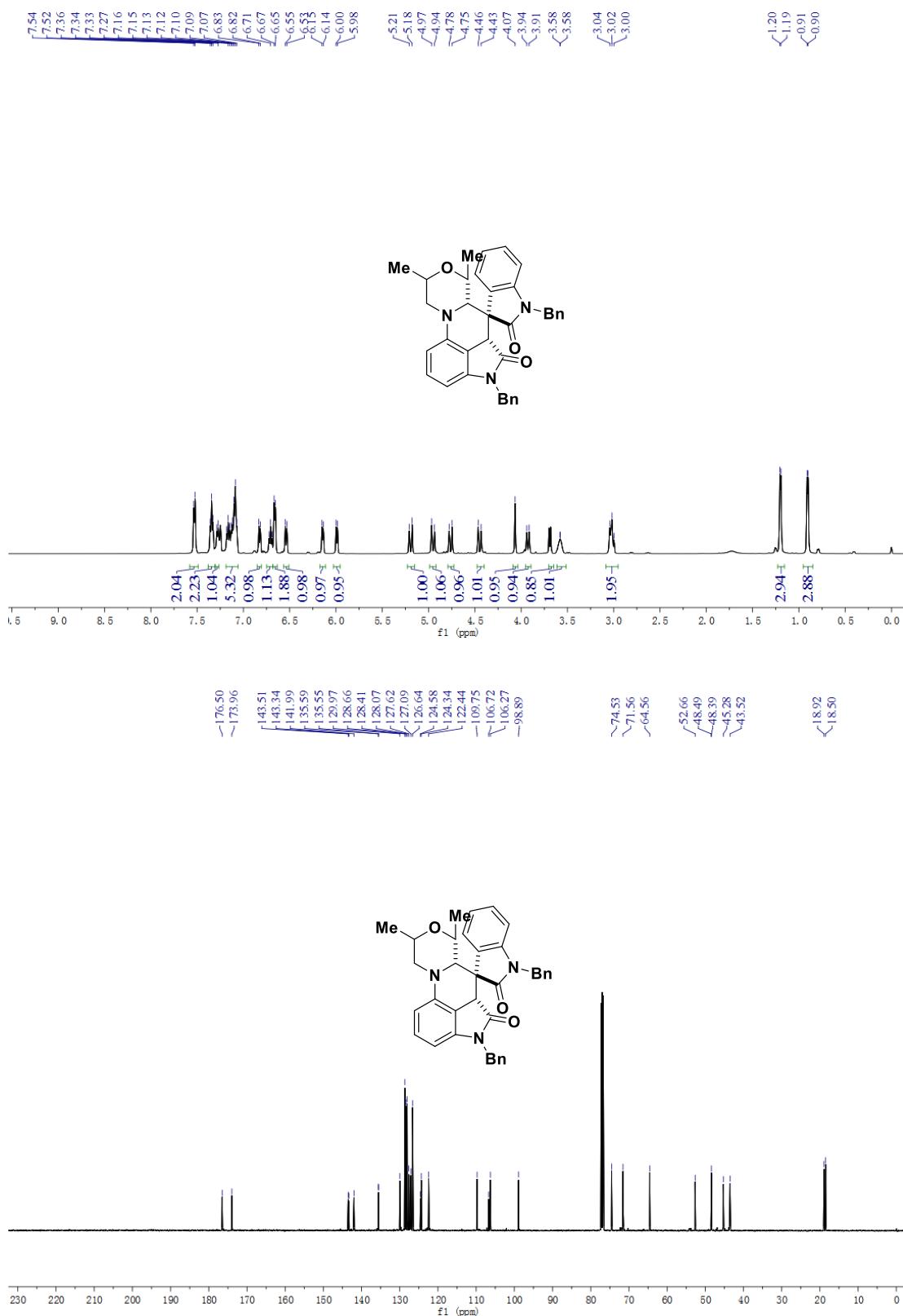
1,4'-dibenzyl-4',5a',6a',7',9',10'-hexahydro-5'H,8'H-spiro[indoline-3,6'-pyrido[1,2-a]pyrrolo[4,3,2-de]quinoline]-2,5'-dione (3i)



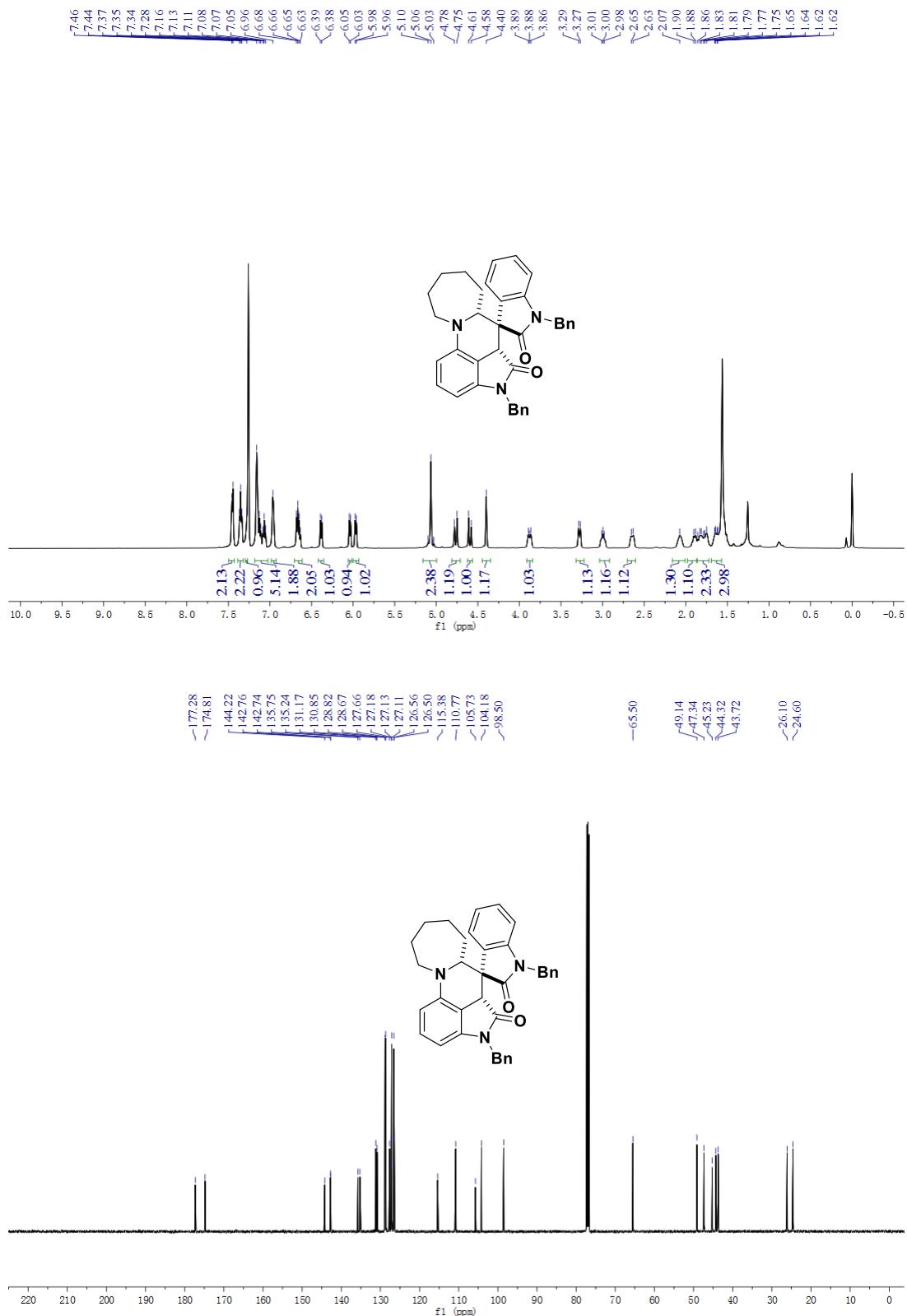
1,4'-dibenzyl-4',5a',6a',7',9',10'-hexahydro-5'H-spiro[indoline-3,6'-[1,4]oxazino[4,3-a]pyrrolo[4,3,2-de]quinoline]-2,5'-dione (3j)



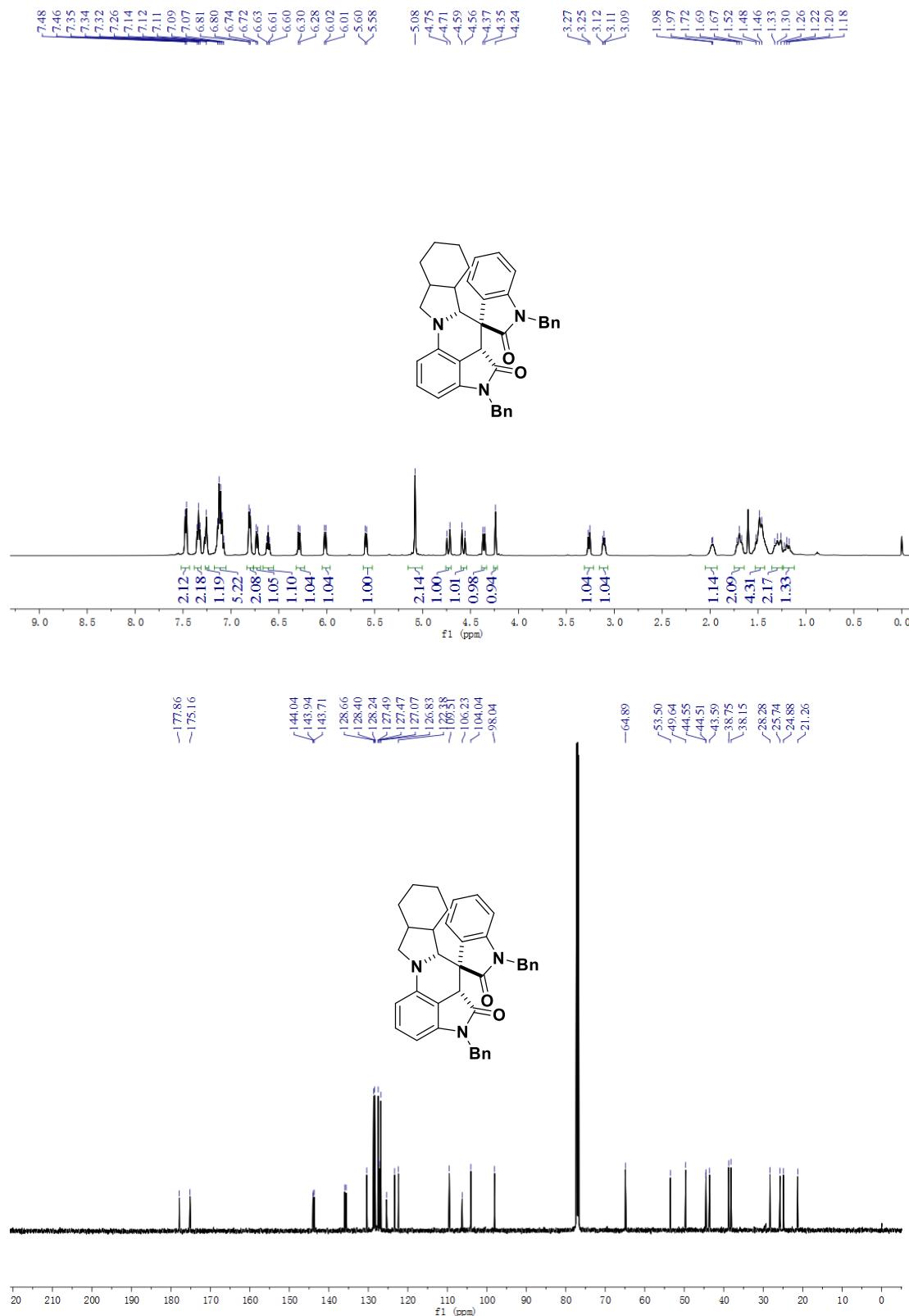
1,4'-dibenzyl-7',9'-dimethyl-4',5a',6a',7',9',10'-hexahydro-5'H-spiro[indoline-3,6'-[1,4]oxazino[4,3]-*a*]pyrrolo[4,3,2-*de*]quinoline]-2,5'-dione (3k)



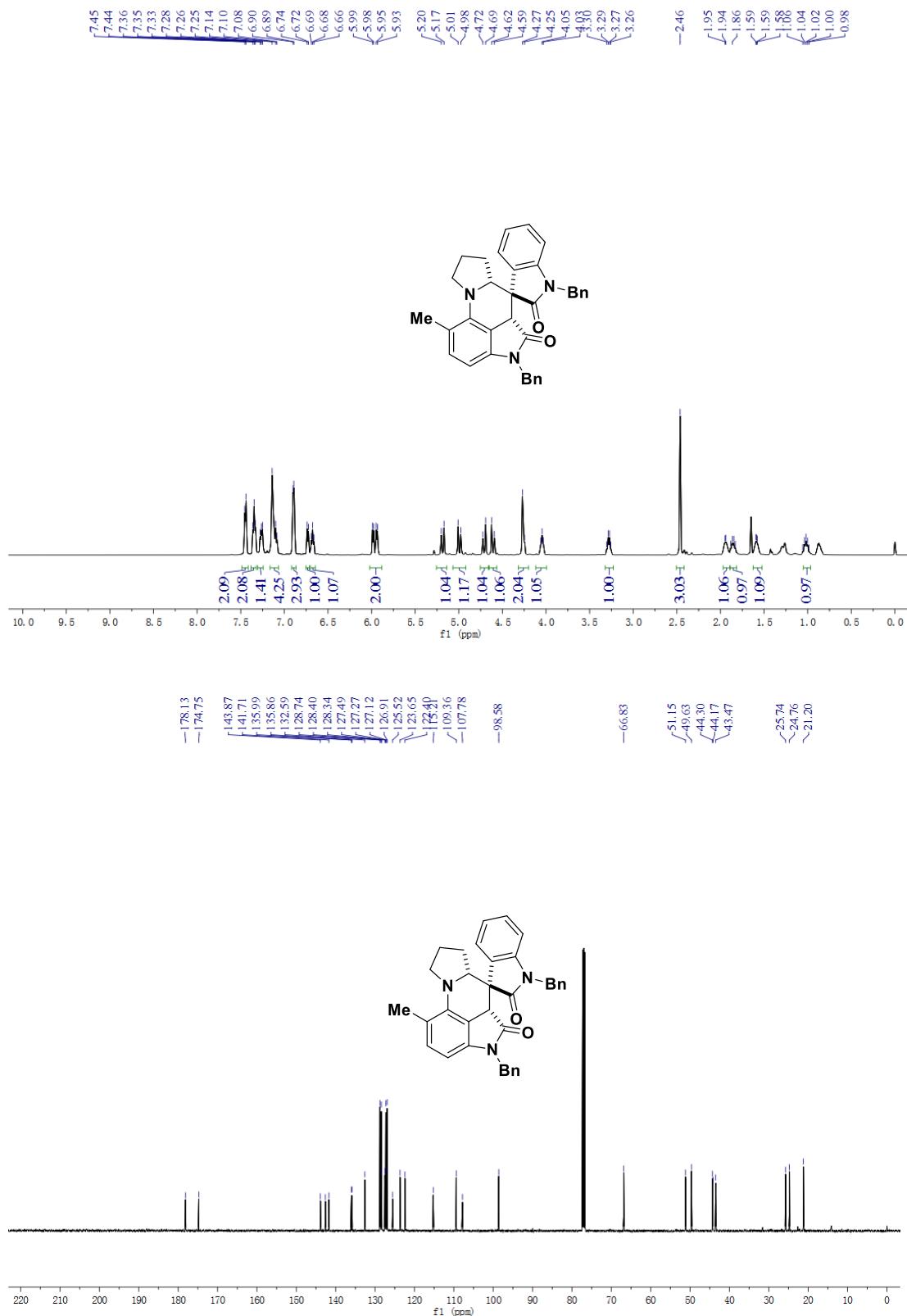
1',4-dibenzyl-4,5a,6a,7,8,9,10,11-octahydro-5*H*-spiro[azepino[1,2-*a*]pyrrolo[4,3,2-*de*]quinoline-6,3'-indoline]-2',5-dione (3l)



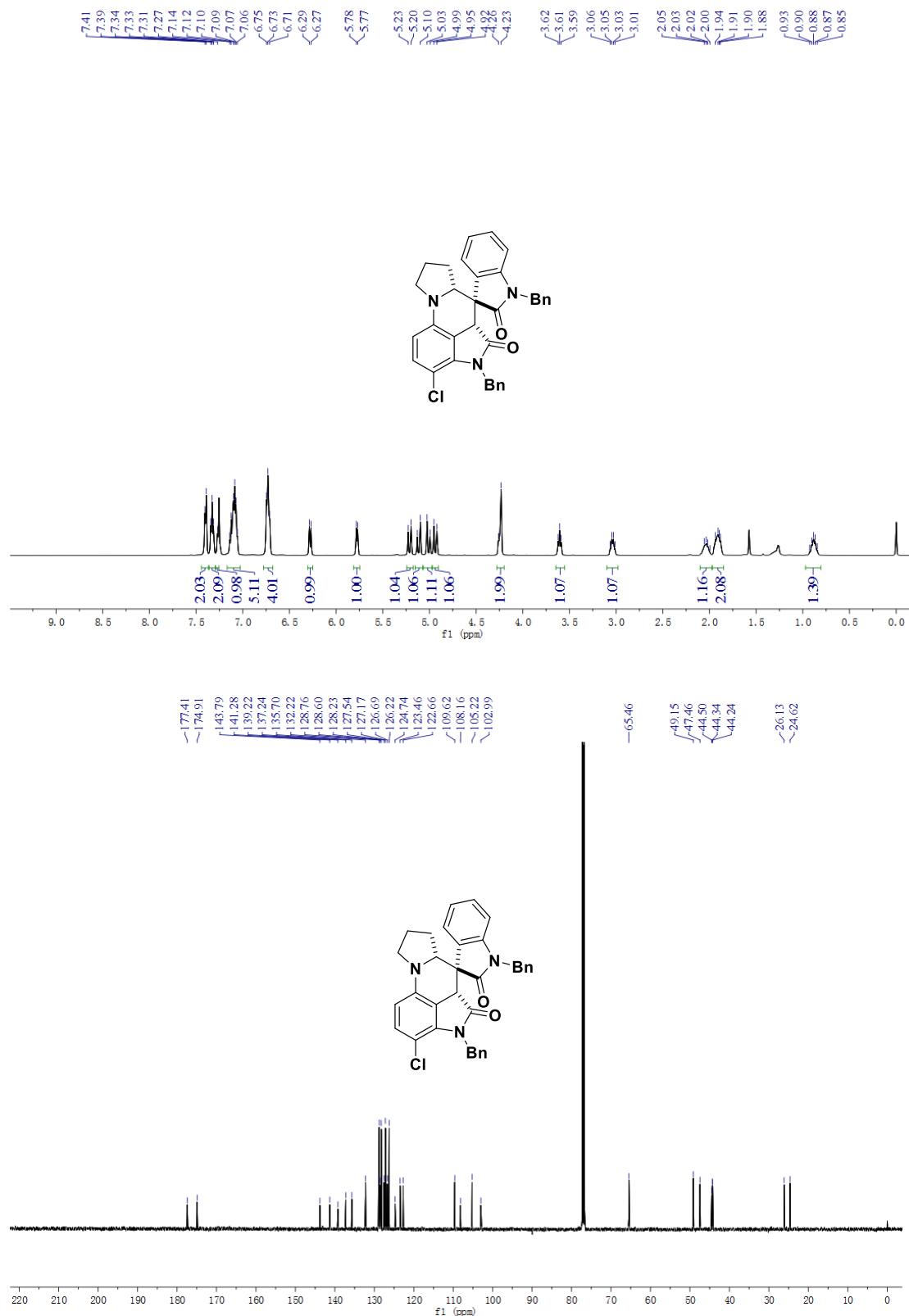
1,4'-dibenzyl-4',5a',6a',6b',7',8',9',10',10a',11'-decahydro-5'H-spiro[indoline-3,6'-isoindolo[2,1-*a*]pyrrolo[4,3,2-*d*]quinoline]-2,5'-dione (3m)



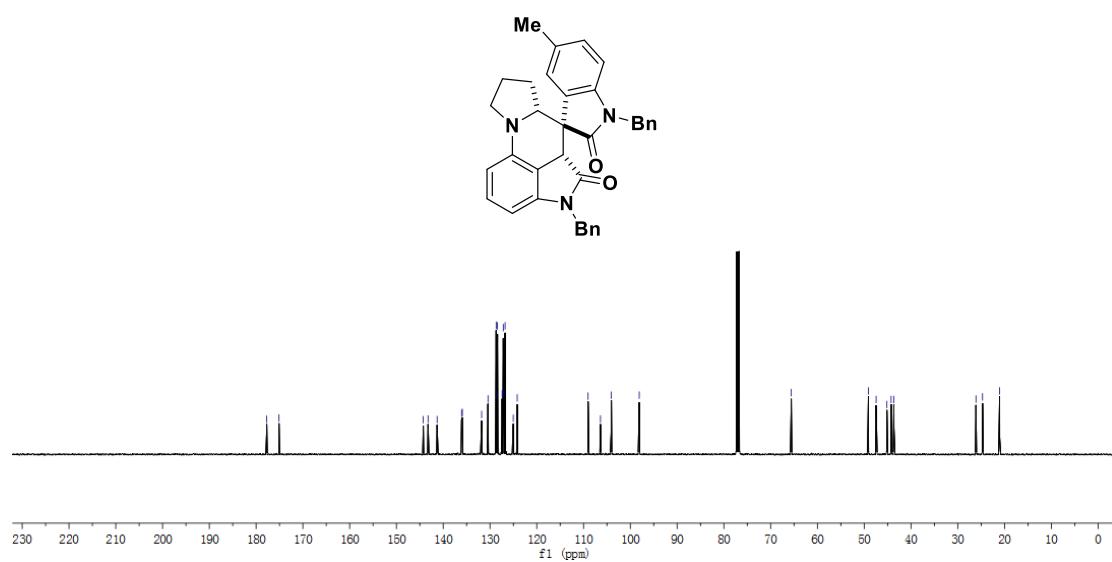
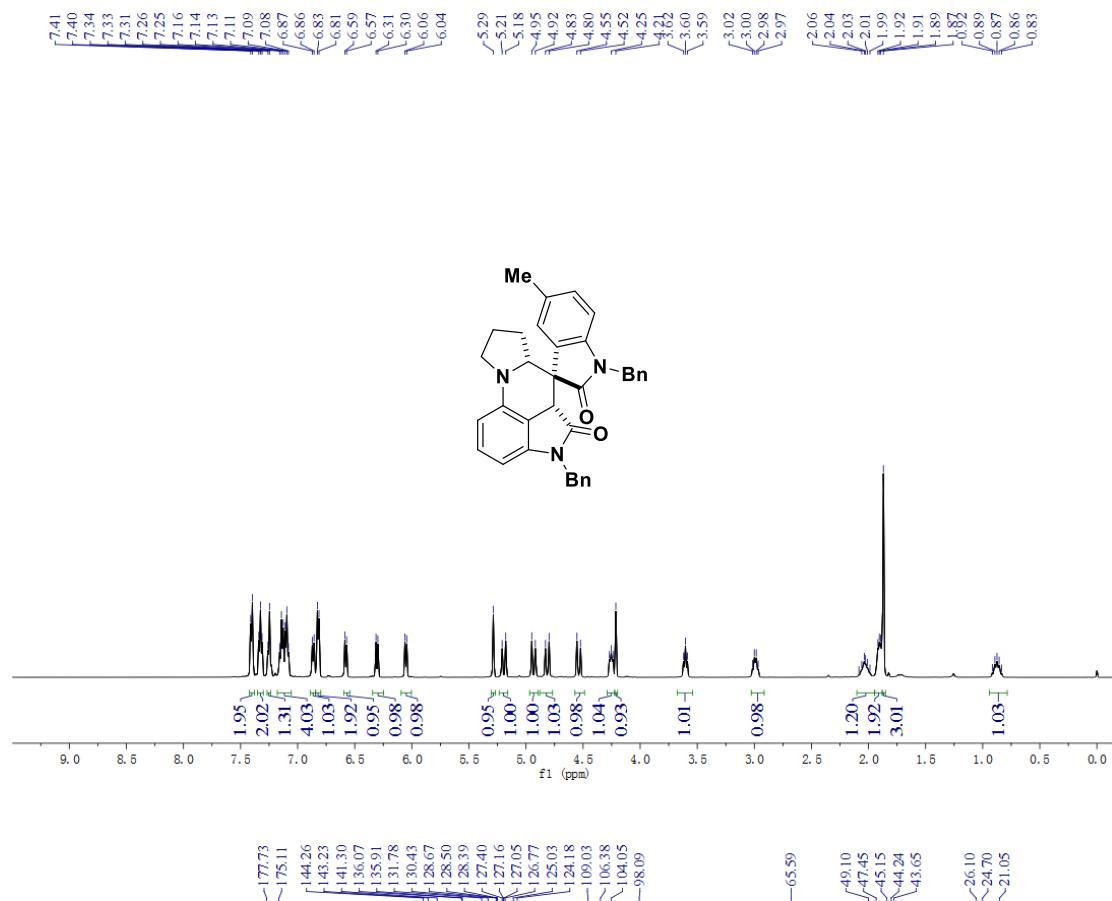
1',4-dibenzyl-1-methyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-*a*:4',3',2'-*d*e]quinoline-6,3'-indoline]-2',5-dione (3n)



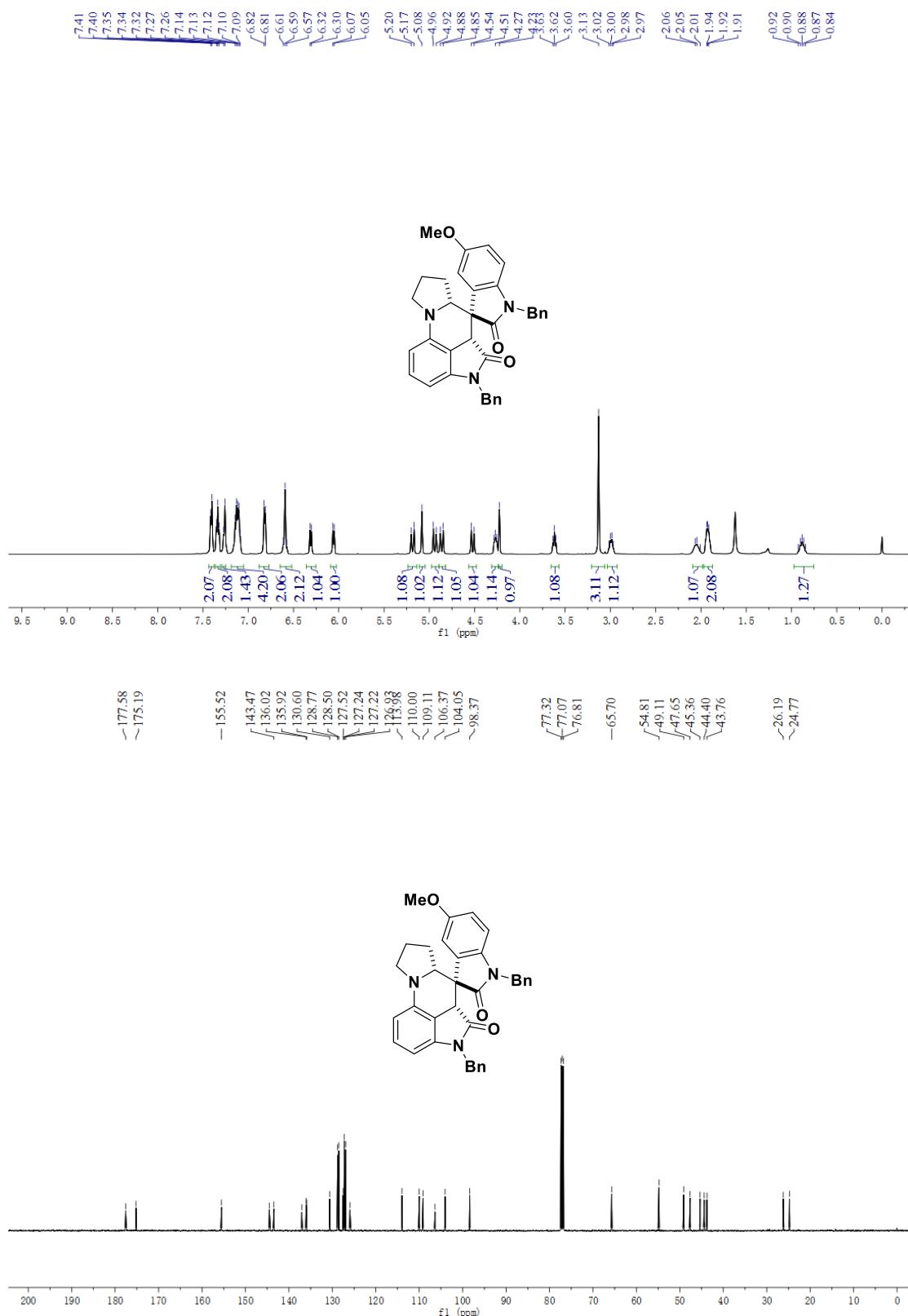
1',4-dibenzyl-3-chloro-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3o)



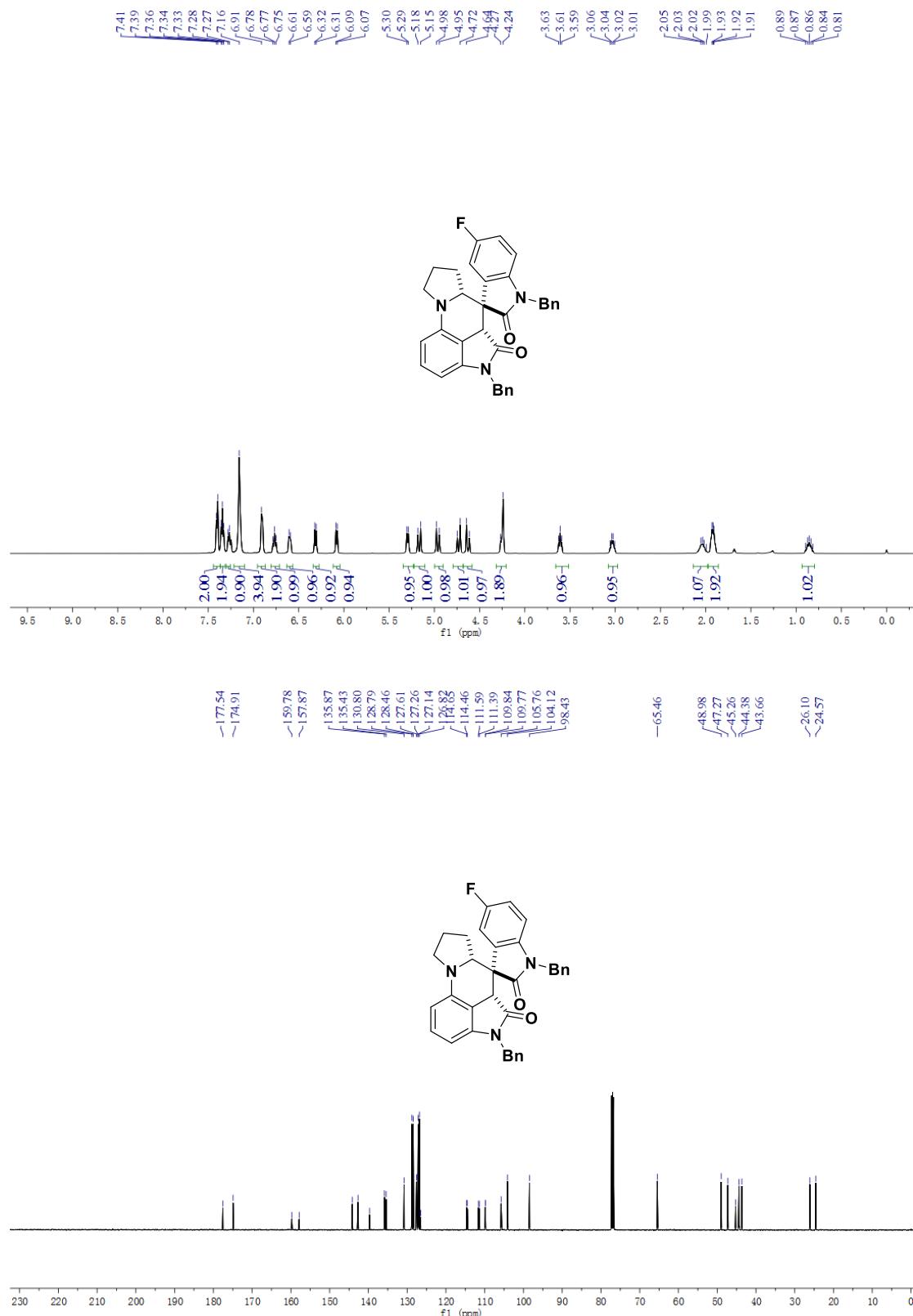
1',4-dibenzyl-5'-methyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3p)



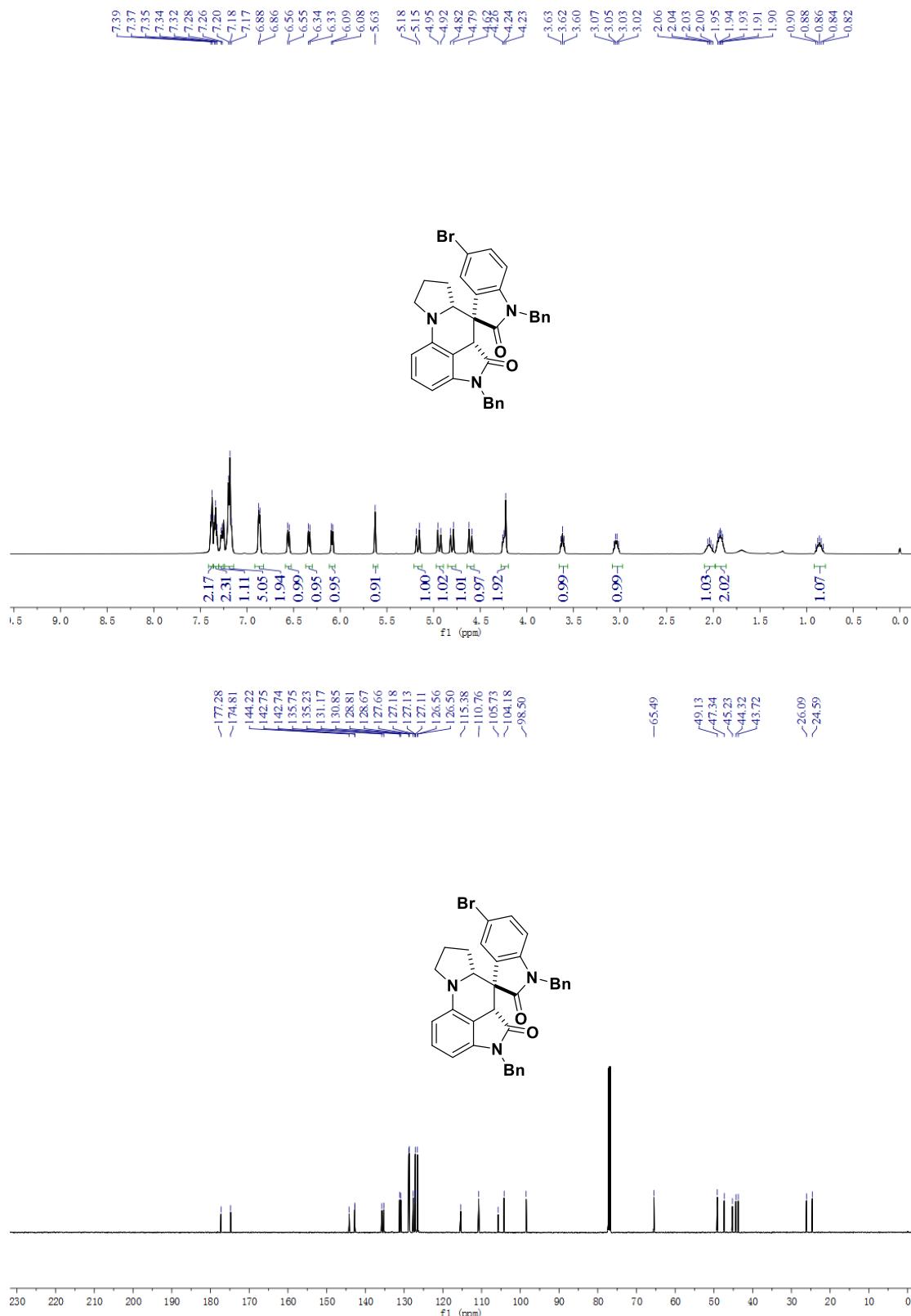
1',4-dibenzyl-5'-methoxy-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3q)



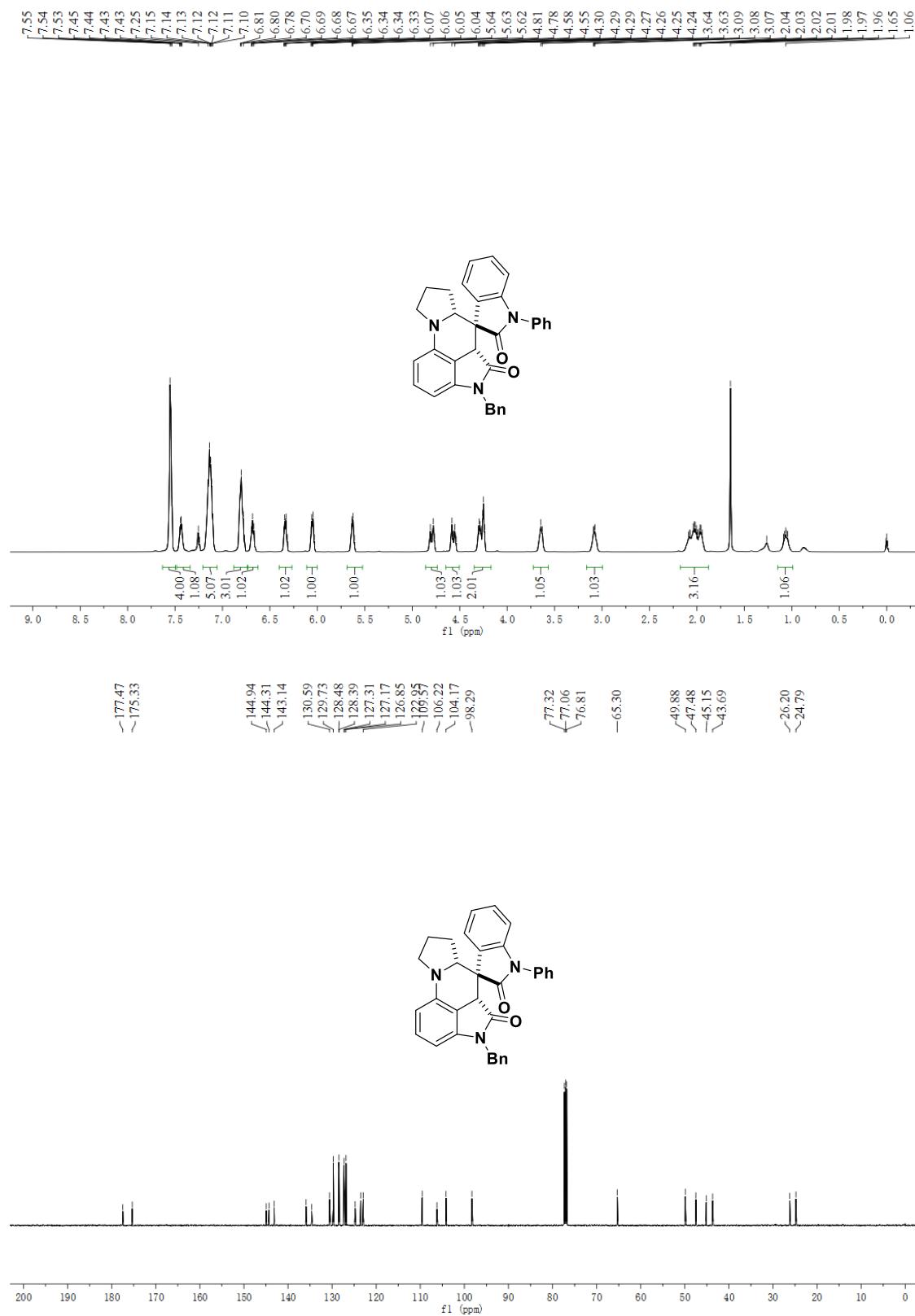
1',4-dibenzyl-5'-fluoro-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3r)



1',4-dibenzyl-5'-bromo-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',2'-*de*]quinoline-6,3'-indoline]-2',5-dione (3s)



4-benzyl-1'-phenyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3t)



4-benzyl-4,5a,6a,7,8,9-hexahydro-5H-spiro[dipyrrolo[1,2-a:4',3',2'-de]quinoline-6,3'-indoline]-2',5-dione (3u)

