

Supporting Information

Synthesis of 3-Azabicyclo[3.1.0]hexane Derivatives *via* Palladium-Catalyzed Cyclopropanation of Maleimides with *N*-Tosylhydrazones: Practical and Facile Access to CP- 866,087

Pengquan Chen,[†] Chuanle Zhu,[†] Rui Zhu, Zhiming Lin, Wanqing Wu,^{*} Huanfeng Jiang^{*}

Key Laboratory of Functional Molecular Engineering of Guangdong Province, School of
Chemistry and Chemical Engineering, South China University of Technology, Guangzhou 510640,
P. R. China

E-mail: cewuwq@scut.edu.cn, jianghf@scut.edu.cn; Fax and Tel.: (+86) 020-87112906

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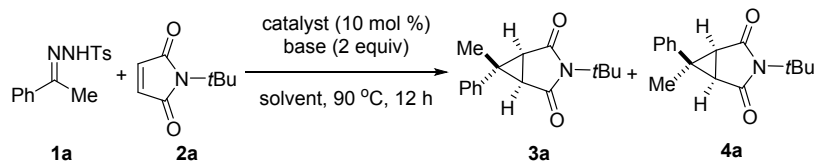
A. General Information

Melting points were measured using a melting point instrument and are uncorrected. Chemical shifts were reported in ppm from the solvent resonance as the internal standard (CDCl_3 $\delta_{\text{H}} = 7.26$ ppm, $\delta_{\text{C}} = 77.16$ ppm). Multiplicity was indicated as follows: s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet). Coupling constants were reported in Hertz (Hz). IR spectra were obtained with an infrared spectrometer on either potassium bromide pellets or liquid films between two potassium bromide pellets. GC-MS data were obtained using electron ionization. HRMS was carried out on a high-resolution mass spectrometer (LCMS-IT-TOF). TLC was performed using commercially available 100–400 mesh silica gel plates (GF₂₅₄). X-ray structural analyses were conducted on an X-ray analysis instrument. The 25 mL Schlenk tube was purchased commercially and used directly to optimize the reaction conditions.

Materials. *N*-Tosylhydrazones were synthesized according to literature procedure. Other commercially available reagents and solvents were purchased and used without further purification. Analytical thin-layer chromatography was performed on 0.20 mm silica gel plates (GF₂₅₄) using UV light as a visualizing agent. Flash column chromatography was carried out using silica gel (200–300 mesh) with the indicated solvent system. All reactions were conducted in oven-dried Schlenk tubes. All the reaction temperatures reported are oil bath temperatures.

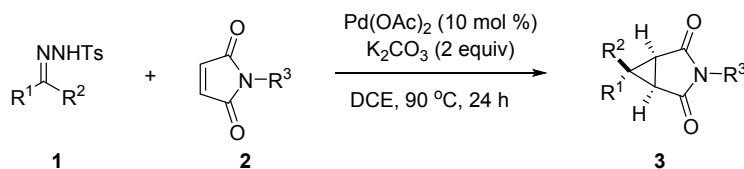
Caution: Normally, *N*-tosylhydrazones are potentially explosive at high temperature. All these grams-scale experiments must be handled carefully. Although no accident happened during our investigation, we strongly recommend all operations involving *N*-tosylhydrazones should carry out in a well-ventilated hood behind a blast shield.

B. General Condition Optimizing Process for the Reaction of Non-Terminal Olefin **2a** and *N*-Tosylhydrazones **1**



A 25 mL round-bottom flask equipped with a magnetic stirring bar, a reflux condenser, **1a** (0.4 mmol), **2** (0.2 mmol), catalyst (10 mol %), base (2 equiv), solvent (2 mL). The mixture was stirred at 90 °C in an oil bath under N₂. After 12 h, the resulting solution was cooled to room temperature, added water (10 mL), and then extracted with EtOAc (3 × 10 mL). The combined organic phases were dried over anhydrous Na₂SO₄, filtered and concentrated *in vacuo*. The ratio of **3a** and **4a** were determined by GC-MS analysis of the obtained crude product. Further purification by flash column chromatography on silica gel (eluting with petroleum ether/ethyl acetate) provided the pure product **3a** and **4a**.

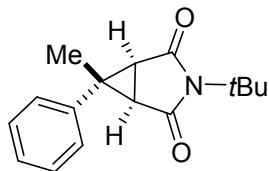
C. General Process for Substrate Scope of *N*-Tosylhydrazones and Maleimides



A 250 mL round-bottom flask equipped with a magnetic stirring bar, a reflux condenser, **1** (20 mmol), **2** (10 mmol), Pd(OAc)₂ (10 mol %), K₂CO₃ (2 equiv), solvent (100 mL). The mixture was stirred at 90 °C in an oil bath under N₂. After 24 h, the resulting solution was cooled to room temperature, added water (100 mL), and then extracted with EtOAc (3 × 100 mL). The combined organic phases were dried over anhydrous Na₂SO₄, filtered and concentrated *in vacuo*. Further purification by flash column chromatography on silica gel (eluting with petroleum ether/ethyl acetate) provided the pure product **3**.

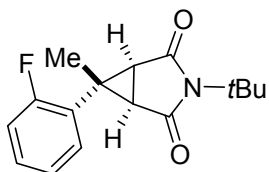
D. Analysis Data for the Products

trans-3-(*tert*-Butyl)-6-Methyl-6-Phenyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3a)



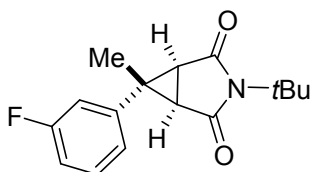
1.82 g, 71% yield; white solid, mp: 149–150 °C ; TLC (petroleum ether/ethyl acetate, 10:1 v/v): $R_f = 0.60$; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.53–7.25 (m, 5H), 2.65 (s, 2H), 1.58 (s, 9H), 1.57 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.6, 143.0, 128.9, 127.6, 127.3, 58.1, 41.2, 32.5, 28.5, 17.0; IR (KBr): 2973, 2931, 1765, 1702, 1531, 1454, 1339, 1263, 1166, 1083, 1010 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{H}]^+$ Calcd. for $\text{C}_{16}\text{H}_{20}\text{NO}_2$, 258.1489; found, 258.1488.

trans-3-(*tert*-Butyl)-6-(2-Fluorophenyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3b)



2.09 g, 76% yield; white solid, mp: 96–97 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.48$; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.31–7.25 (m, 2H), 7.13–7.04 (m, 2H), 2.63 (s, 2H), 1.59 (s, 9H), 1.54 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.2, 160.8 (d, $^1J_{\text{F-C}} = 248.0$ Hz), 130.0 (d, $^2J_{\text{F-C}} = 13.6$ Hz), 129.7 (d, $^3J_{\text{F-C}} = 8.1$ Hz), 129.6 (d, $^4J_{\text{F-C}} = 3.5$ Hz), 124.5 (d, $^3J_{\text{F-C}} = 3.7$ Hz), 116.2 (d, $^2J_{\text{F-C}} = 21.1$ Hz), 58.1, 36.6, 31.7, 28.5, 16.1; $^{19}\text{F NMR}$ (376 MHz, CDCl_3) δ -114.6 – -114.7 (m, 1F); IR (KBr): 3074, 2976, 1768, 1704, 1490, 1455, 1341, 1262, 1216, 1166, 1080, 1012 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{H}]^+$ Calcd. For $\text{C}_{16}\text{H}_{19}\text{FNO}_2$, 276.1394; found, 276.1395.

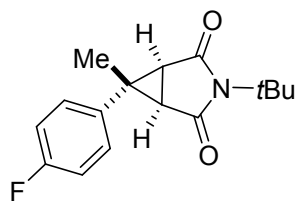
trans-3-(*tert*-Butyl)-6-(3-Fluorophenyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3c)



2.28 g, 83% yield; white solid, mp: 92–93 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f =$

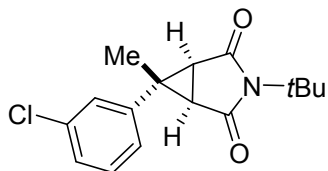
0.50; ^1H NMR (400 MHz, CDCl_3) δ 7.30 (q, $J = 7.2$ Hz, 1H), 7.08 (d, $J = 7.6$ Hz, 1H), 6.98 (m, 2H), 2.63 (s, 2H), 1.58 (s, 9H), 1.57 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.4, 162.9 (d, $^1J_{\text{F-C}} = 245.9$ Hz), 145.2 (d, $^3J_{\text{F-C}} = 7.4$ Hz), 130.5 (d, $^3J_{\text{F-C}} = 8.3$ Hz), 122.8 (d, $^4J_{\text{F-C}} = 2.8$ Hz), 114.7 (d, $^2J_{\text{F-C}} = 16.6$ Hz), 114.5 (d, $^2J_{\text{F-C}} = 17.9$ Hz), 58.2, 40.3, 32.6, 28.5, 16.6; ^{19}F NMR (376 MHz, CDCl_3) δ -111.8 – -111.9 (m, 1F); IR (KBr): 3061, 2971, 2927, 1691, 1584, 1444, 1355, 1261, 1172, 1090, 1021 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{H}]^+$ Calcd. for $\text{C}_{16}\text{H}_{19}\text{FNO}_2$, 276.1394; found, 276.1393.

***trans*-3-(*tert*-Butyl)-6-(4-Fluorophenyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3d)**



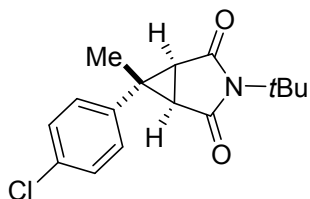
2.42 g, 88% yield; white solid, mp: 95–96 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.48$; ^1H NMR (400 MHz, CDCl_3) δ 7.28 (dd, $J_1 = 7.6$ Hz, $J_2 = 5.2$ Hz, 2H), 7.02 (t, $J = 8.4$ Hz, 2H), 2.61 (s, 2H), 1.58 (s, 9H), 1.55 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.4, 161.9 (d, $^1J_{\text{F-C}} = 245.7$ Hz), 138.8 (d, $^4J_{\text{F-C}} = 3.4$ Hz), 129.1 (d, $^3J_{\text{F-C}} = 8.1$ Hz), 115.8 (d, $^2J_{\text{F-C}} = 21.5$ Hz), 58.1, 40.5, 32.6, 28.5, 17.1; ^{19}F NMR (376 MHz, CDCl_3) δ -114.1 – -114.2 (m, 1F); IR (KBr): 2973, 2930, 2868, 1767, 1703, 1513, 1443, 1343, 1224, 1166, 1085, 1011 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{H}]^+$ Calcd. for $\text{C}_{16}\text{H}_{19}\text{FNO}_2$, 276.1394; found, 276.1399.

***trans*-3-(*tert*-Butyl)-6-(3-Chlorophenyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3e)**



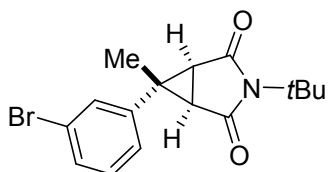
2.36 g, 81% yield; white solid, mp: 102–103 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.37$; ^1H NMR (400 MHz, CDCl_3) δ 7.31 (s, 1H), 7.27–7.18 (m, 3H), 2.63 (s, 2H), 1.58 (s, 9H), 1.56 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.1, 144.7, 134.7, 130.2, 127.9, 125.5, 58.2, 40.4, 32.3, 28.5, 16.8; IR (KBr): 3263, 2974, 2923, 1764, 1691, 1464, 1357, 1260, 1174, 1095, 1022, cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{H}]^+$ Calcd. for $\text{C}_{16}\text{H}_{19}\text{ClNO}_2$, 292.1099; found, 292.1098.

***trans*-3-(*tert*-Butyl)-6-(4-Chlorophenyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3f)**



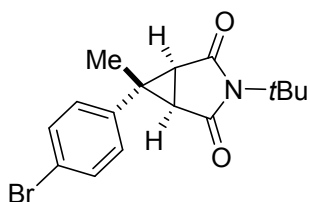
2.56 g, 88% yield; white solid, mp: 102–103 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.33; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.31 (d, J = 8.4 Hz, 2H), 7.25 (d, J = 8.4 Hz, 2H), 2.61 (s, 2H), 1.58 (s, 9H), 1.55 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.2, 141.4, 133.5, 129.1, 128.7, 58.1, 40.3, 32.5, 28.5, 16.9; IR (KBr): 2970, 2933, 2872, 1767, 1702, 1483, 1340, 1165, 1093, 1011 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{16}\text{H}_{18}\text{ClNNaO}_2$, 314.0918; found, 314.0920.

***trans*-6-(3-Bromophenyl)-3-(*tert*-Butyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3g)**



2.68 g, 80% yield; white solid, mp: 108–109 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.44; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.47 (s, 1H), 7.40 (d, J = 7.2 Hz, 1H), 7.27–7.19 (m, 2H), 2.63 (s, 2H), 1.58 (s, 9H), 1.56 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.1, 145.0, 130.8, 130.7, 130.5, 126.0, 122.8, 58.2, 40.4, 32.3, 28.5, 16.9; IR (KBr): 3064, 2972, 2930, 1765, 1698, 1564, 1465, 1260, 1168, 1077, 1007 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{H}]^+$ Calcd. for $\text{C}_{16}\text{H}_{19}\text{BrNO}_2$, 336.0594; found, 336.0594.

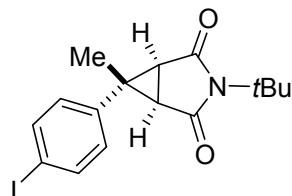
***trans*-6-(4-Bromophenyl)-3-(*tert*-Butyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3h)**



2.78 g, 83% yield; white solid, mp: 94–95 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.35; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.46 (d, J = 8.4 Hz, 2H), 7.19 (d, J = 8.4 Hz, 2H), 2.61 (s, 2H), 1.58 (s, 9H), 1.55 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.2, 141.9, 132.1, 129.1, 121.6,

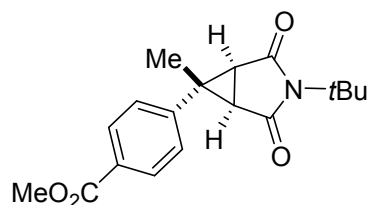
58.2, 40.4, 32.4, 28.5, 16.8; IR (KBr): 3074, 2973, 2930, 1765, 1702, 1485, 1341, 1263, 1166, 1085, 1010 cm^{-1} ; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $\text{C}_{16}\text{H}_{18}\text{BrNNaO}_2$, 358.0413; found, 358.0410.

***trans*-3-(*tert*-Butyl)-6-(4-Iodophenyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3i)**



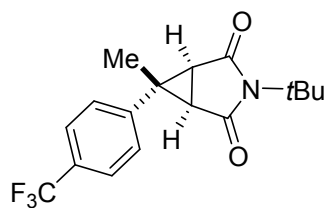
2.07 g, 67% yield; white solid, mp: 123–124 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.47; ^1H NMR (400 MHz, CDCl_3) δ 7.67 (d, J = 8.0 Hz, 2H), 7.06 (d, J = 7.6 Hz, 2H), 2.60 (s, 2H), 1.57 (s, 9H), 1.54 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.2, 142.6, 138.0, 129.3, 93.1, 58.2, 40.5, 32.4, 28.5, 16.8; IR (KBr): 2972, 2928, 2864, 1766, 1701, 1482, 1339, 1264, 1166, 1087, 1007 cm^{-1} ; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $\text{C}_{16}\text{H}_{18}\text{INNaO}_2$, 406.0274; found, 406.0272.

Methyl 4-(*trans*-3-(*tert*-butyl)-6-Methyl-2,4-Dioxo-3-Azabicyclo[3.1.0]hexan-6-yl)benzoate (3j)



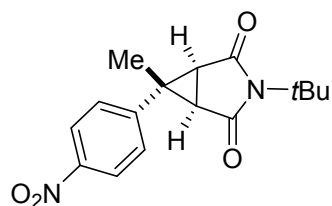
2.43 g, 77% yield; white solid, mp: 137–138 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.22; ^1H NMR (400 MHz, CDCl_3) δ 8.01 (d, J = 8.4 Hz, 2H), 7.38 (d, J = 8.0 Hz, 2H), 3.91 (s, 3H), 2.66 (s, 2H), 1.59 (s, 12H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.1, 166.4, 147.6, 130.2, 129.5, 127.3, 58.2, 52.2, 40.5, 32.5, 28.5, 16.5; IR (KBr): 3069, 2941, 1701, 1610, 1450, 1343, 1278, 1170, 1106, 1012 cm^{-1} ; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $\text{C}_{18}\text{H}_{22}\text{NO}_4$, 316.1543; found, 316.1538.

***trans*-3-(*tert*-Butyl)-6-Methyl-6-(4-(trifluoromethyl)phenyl)-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3k)**



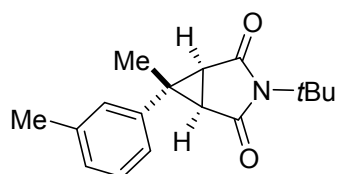
2.60 g, 80% yield; white solid, mp: 177–178 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.30; ^1H NMR (400 MHz, CDCl_3) δ 7.61 (d, J = 8.0 Hz, 2H), 7.44 (d, J = 8.0 Hz, 2H), 2.65 (s, 2H), 1.59 (s, 12H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.1, 146.7, 130.0 (q, $^2J_{\text{F-C}}$ = 32.5 Hz), 127.8, 126.0 (d, $^3J_{\text{F-C}}$ = 3.6 Hz), 123.8, (q, $^1J_{\text{F-C}}$ = 270.1 Hz), 58.3, 30.4, 32.3, 28.5, 16.7; ^{19}F NMR (376 MHz, CDCl_3) δ -62.7 (s, 3F); IR (KBr): 3062, 2980, 2927, 2856, 1689, 1463, 1342, 1263, 1163, 1083, 1027 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{17}\text{H}_{18}\text{F}_3\text{NNaO}_2$, 348.1182; found, 348.1180.

***trans*-3-(*tert*-Butyl)-6-Methyl-6-(4-Nitrophenyl)-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3l)**



2.20 g, 73% yield; white solid, mp: 167–168 °C; TLC (petroleum ether/ethyl acetate, 10:1 v/v): R_f = 0.32; ^1H NMR (400 MHz, CDCl_3) δ 8.21 (d, J = 8.8 Hz, 2H), 7.50 (d, J = 8.4 Hz, 2H), 2.68 (s, 2H), 1.61 (s, 3H), 1.59 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3) δ 173.6, 149.6, 147.2, 128.3, 124.2, 58.4, 39.9, 32.4, 28.5, 16.5; IR (KBr): 3116, 3059, 2978, 2931, 2867, 1764, 1693, 1515, 1354, 1265, 1177, 1087, 1030 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{16}\text{H}_{18}\text{N}_2\text{NaO}_4$, 325.1159; found, 325.1162.

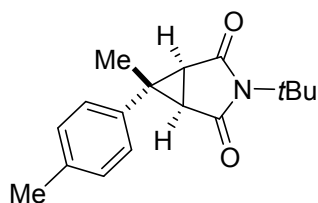
***trans*-3-(*tert*-Butyl)-6-Methyl-6-(*m*-Tolyl)-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3m)**



2.09 g, 77% yield; white solid, mp: 96–97 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f =

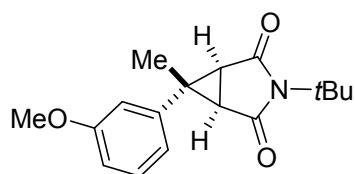
0.56; ^1H NMR (400 MHz, CDCl_3) δ 7.20 (t, $J = 7.2$ Hz, 1H), 7.10 (m, 3H), 2.63 (s, 2H), 2.34 (s, 3H), 1.58 (s, 9H), 1.56 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.7, 143.0, 138.7, 129.8, 128.3, 128.2, 124.4, 58.0, 41.4, 32.5, 28.5, 21.3, 17.1; IR (KBr): 3067, 2971, 2926, 2868, 1763, 1698, 1460, 1335, 1266, 1165, 1082, 1007 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{17}\text{H}_{21}\text{NNaO}_2$, 294.1464; found, 294.1469.

***trans*-3-(*tert*-Butyl)-6-Methyl-6-(*p*-Yolyl)-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3n)**



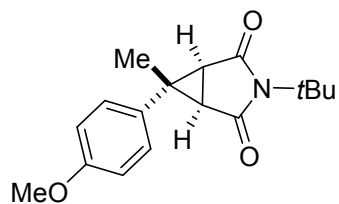
2.01 g, 74% yield; white solid, mp: 93–94 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.55$; ^1H NMR (400 MHz, CDCl_3) δ 7.20–7.14 (m, 4H), 2.62 (s, 2H), 2.32 (s, 3H), 1.58 (s, 9H), 1.56 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.7, 140.1, 137.4, 129.5, 127.2, 58.0, 41.0, 32.7, 28.5, 21.0, 17.0; IR (KBr): 2972, 2926, 2865, 1765, 1703, 1462, 1338, 1264, 1164, 1085, 1009 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{17}\text{H}_{21}\text{NNaO}_2$, 294.1464 found, 294.1468.

***trans*-3-(*tert*-Butyl)-6-(3-Methoxyphenyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3o)**



1.89 g, 66% yield; white solid, mp: 92–93 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.43$; ^1H NMR (400 MHz, CDCl_3) δ 7.24 (t, $J = 8.0$ Hz, 1H), 6.90–6.79 (m, 3H), 3.80 (s, 3H), 2.64 (s, 2H), 1.58 (s, 9H), 1.57 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.6, 159.9, 144.5, 130.0, 119.5, 113.2, 113.1, 58.0, 55.3, 41.2, 32.6, 28.5, 16.9; IR (KBr): 2972, 2928, 2836, 1765, 1702, 1464, 1339, 1270, 1164, 1045, 1008 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{17}\text{H}_{21}\text{NNaO}_3$, 310.1414; found, 310.1415.

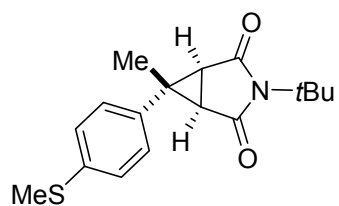
***trans*-3-(*tert*-Butyl)-6-(4-Methoxyphenyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3p)**



1.61 g, 56% yield; white solid, mp: 94–95 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.41; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.22 (d, J = 8.8 Hz, 2H), 6.85 (d, J = 8.8 Hz, 2H), 3.79 (s, 3H), 2.61 (s, 2H), 1.58 (s, 9H), 1.55 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.7, 158.9, 135.1, 128.3, 114.2, 58.0, 55.3, 40.8, 32.8, 28.5, 17.1; IR (KBr): 2970, 2926, 2838, 1763, 1699, 1462, 1340, 1252, 1167, 1084, 1027 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{17}\text{H}_{21}\text{NNaO}_3$, 310.1414; found, 310.1415.

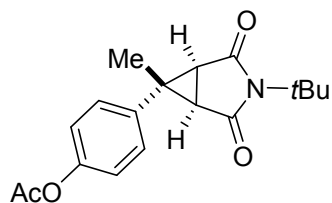
***trans*-3-(*tert*-Butyl)-6-Methyl-6-(4-(Methylthio)phenyl)-3-Azabicyclo[3.1.0]hexane-2,4-Dione**

(3q)



1.76 g, 58% yield; white solid, mp: 116–117 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.30; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.21 (s, 4H), 2.61 (s, 2H), 2.47 (s, 3H), 1.58 (s, 9H), 1.55 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.5, 139.7, 138.2, 127.8, 126.8, 58.1, 40.7, 32.6, 28.5, 16.9, 15.7; IR (KBr): 3061, 2972, 2926, 1762, 1691, 1456, 1351, 1263, 1164, 1086, 1015 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{17}\text{H}_{21}\text{NNaO}_2\text{S}$, 326.1185; found, 326.1183.

4-(*trans*-3-(*tert*-Butyl)-6-Methyl-2,4-Dioxo-3-Azabicyclo[3.1.0]hexan-6-yl)phenyl acetate (3r)

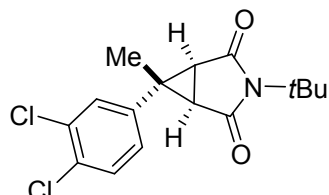


2.24 g, 71% yield; white solid, mp: 151–152 °C; TLC (petroleum ether/ethyl acetate, 10:1 v/v): R_f = 0.30; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.32 (d, J = 8.4 Hz, 2H), 7.05 (d, J = 8.0 Hz, 2H), 2.63 (s, 2H), 2.29 (s, 3H), 1.58 (s, 9H), 1.56 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.4, 169.3, 149.9, 140.5, 128.6, 122.1, 58.1, 40.6, 32.5, 28.5, 21.1, 17.1; IR (KBr): 3075, 2975, 2934, 1762, 1699,

1459, 1364, 1264, 1198, 1083, 1011 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{H}]^+$ Calcd. for $\text{C}_{18}\text{H}_{22}\text{NO}_4$, 316.1543; found, 316.1545.

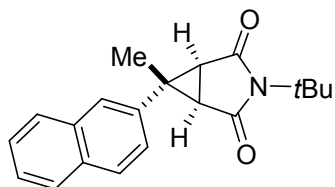
***trans*-3-(*tert*-Butyl)-6-(3,4-Dichlorophenyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione**

(3s)



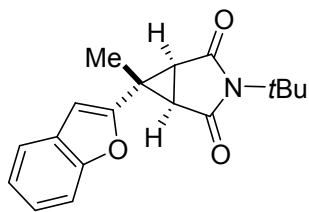
2.41 g, 74% yield; white solid, mp: 158–159 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.40; ^1H NMR (400 MHz, CDCl_3) δ 7.42–7.39 (m, 2H), 7.15 (d, J = 8.4 Hz, 1H), 2.61 (s, 2H), 1.58 (s, 9H), 1.55 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 173.9, 142.9, 133.0, 130.9, 129.5, 126.7, 58.3, 39.6, 32.3, 28.4, 16.7; IR (KBr): 3070, 2975, 2935, 1767, 1702, 1470, 1340, 1265, 1168, 1087, 1020 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{H}]^+$ Calcd. for $\text{C}_{16}\text{H}_{18}\text{Cl}_2\text{NO}_2$, 326.0709; found, 326.0704.

***trans*-3-(*tert*-Butyl)-6-Methyl-6-(Naphthalen-2-yl)-3-Azabicyclo[3.1.0]hexane-2,4-Dione(3t)**



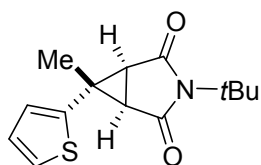
2.21 g, 72% yield; white solid, mp: 161–162 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.56; ^1H NMR (400 MHz, CDCl_3) δ 7.8 (t, J = 8.0 Hz, 3H), 7.76 (s, 1H), 7.51–7.46 (m, 2H), 7.42 (d, J = 8.4 Hz, 1H), 2.75 (s, 2H), 1.66 (s, 3H), 1.61 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.6, 140.2, 133.2, 132.6, 128.9, 127.8, 127.6, 126.6, 126.4, 126.1, 125.4, 58.1, 41.4, 32.6, 28.5, 17.0; IR (KBr): 2976, 2921, 2853, 1761, 1698, 1467, 1337, 1268, 1161 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{20}\text{H}_{21}\text{NNaO}_2$, 330.1464; found, 330.1467.

***trans*-6-(Benzofuran-2-yl)-3-(*tert*-Butyl)-6-Methyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3u)**



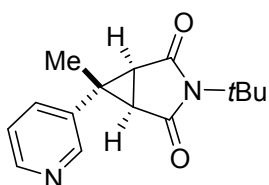
1.90 g, 64% yield; white solid, mp: 133–134 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.48$; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.50 (d, $J = 7.2$ Hz 1H), 7.37 ((d, $J = 8.0$ Hz 1H), 7.27–7.19 (m, 2H), 6.59 (s, 1H), 2.96 (s, 2H), 1.69 (s, 3H), 1.59 (s, 9H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 173.5, 156.4, 154.3, 128.1, 124.5, 123.1, 120.9, 111.0, 103.3, 58.3, 33.6, 32.6, 28.5, 11.8; IR (KBr): 3108, 2976, 2928, 1764, 1702, 1459, 1349, 1265, 1163, 1083, 1014 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{18}\text{H}_{19}\text{NNaO}_3$, 320.1257; found, 320.1260.

***trans*-3-(*tert*-Butyl)-6-Methyl-6-(thiophen-2-yl)-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3v)**



1.32 g, 50% yield; white solid, mp: 74–75 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.57$; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.17 (d, $J = 4.8$ Hz, 1H), 6.91 (t, $J = 4.0$ Hz, 1H), 6.86 (d, $J = 3.6$ Hz, 1H), 2.71 (s, 2H), 1.68 (s, 3H), 1.57 (s, 9H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 173.5, 146.9, 126.9, 124.3, 123.8, 58.2, 35.9, 35.2, 28.5, 15.9; IR (KBr): 2973, 2929, 1766, 1702, 1463, 1338, 1264, 1165, 1075, 1007 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{14}\text{H}_{17}\text{NNaO}_2\text{S}$, 286.0872; found, 286.0872.

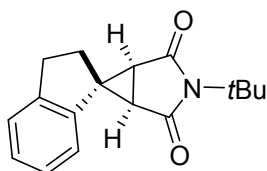
***trans*-3-(*tert*-Butyl)-6-Methyl-6-(Pyridin-3-yl)-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3w)**



1.47 g, 57% yield; orange solid, mp: 150–151 °C; TLC (petroleum ether/ethyl acetate, 1:1 v/v): $R_f = 0.45$; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.57 (d, $J = 27.6$ Hz, 2H), 7.62 (s, 1H), 7.27 (s, 1H), 2.66 (s, 2H), 1.59 (s, 9H), 1.58 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 173.9, 156.9, 148.9, 138.4, 135.0,

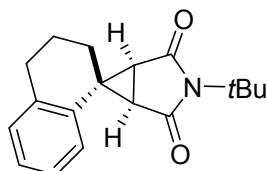
123.6, 58.3, 38.4, 31.9, 28.5, 16.7; IR (KBr): 3042, 2981, 2937, 1762, 1700, 1467, 1364, 1262, 1171, 1083, 1022 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{H}]^+$ Calcd. for $\text{C}_{15}\text{H}_{19}\text{N}_2\text{O}_2$, 259.1441; found, 259.1443.

***trans*-3-(*tert*-Butyl)-2',3'-Dihydro-3-Azaspiro[bicyclo[3.1.0]hexane-6,1'-indene]-2,4-Dione (3x)**



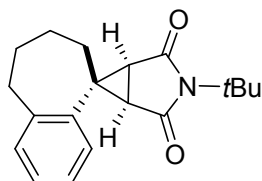
0.81 g, 30% yield; white solid, mp: 119–120 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.50; ^1H NMR (400 MHz, CDCl_3) δ 7.22–7.14 (m, 3H), 6.67 (d, J = 7.2 Hz, 1H), 3.12 (t, J = 7.6 Hz, 2H), 2.64 (s, 2H), 2.28 (t, J = 7.6 Hz, 2H), 1.57 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.3, 143.7, 141.9, 128.1, 127.1, 124.9, 119.1, 57.9, 46.5, 34.2, 29.9, 28.5, 26.2; IR (KBr): 2970, 2928, 2855, 1764, 1701, 1464, 1344, 1265, 1163, 1008 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{17}\text{H}_{19}\text{NNaO}_2$, 292.1308; found, 292.1309.

***trans*-3-(*tert*-Butyl)-3',4'-Dihydro-2'*H*-3-Azaspiro[bicyclo[3.1.0]hexane-6,1'-naphthalene]-2,4-Dione (3y)**



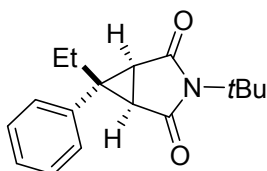
1.13 g, 40% yield; white solid, mp: 72–73 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.58; ^1H NMR (400 MHz, CDCl_3) δ 7.16–7.09 (m, 3H), 6.65 (d, J = 6.8 Hz, 1H), 2.88 (t, J = 5.2 Hz, 2H), 2.69 (s, 2H), 1.96–1.91 (m, 4H), 1.58 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3) δ 173.9, 137.9, 136.6, 129.3, 126.9, 126.6, 121.8, 58.1, 38.2, 36.4, 30.2, 28.5, 24.2, 21.9; IR (KBr): 2932, 2865, 1763, 1700, 1458, 1343, 1263, 1166, 1009 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{18}\text{H}_{21}\text{NNaO}_2$, 306.1464; found, 306.1466.

***trans*-3'-(*tert*-Butyl)-6,7,8,9-Tetrahydro-3'-Azaspiro[benzo[7]annulene-5,6'-bicyclo[3.1.0]hexane]-2',4'-Dione (3z)**



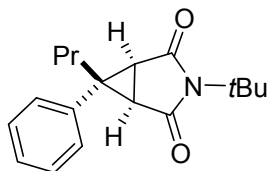
0.92 g, 31% yield; white solid, mp: 134–135 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.61$; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.19–7.15 (m, 4H), 2.98 (d, $J = 10.4$ Hz, 2H), 2.65 (s, 2H), 1.87–1.80 (m, 4H), 1.68 (s, 2H), 1.58 (s, 9H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 175.0, 143.4, 141.7, 129.7, 127.9, 126.4, 126.2, 57.9, 45.0, 34.9, 32.8, 28.5, 28.4, 28.3, 27.3; IR (KBr): 2930, 2857, 1765, 1701, 1454, 1341, 1266, 1209, 1165, 1015 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{19}\text{H}_{23}\text{NNaO}_2$, 320.1621; found, 320.1620.

***trans*-3-(*tert*-Butyl)-6-Ethyl-6-Phenyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3aa)**



1.71 g, 63% yield; white solid, mp: 75–76 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.40$; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.32 (s, 5H), 2.64 (s, 2H), 1.86 (d, $J = 7.2$ Hz, 2H), 1.58 (s, 9H), 0.91 (t, $J = 7.2$ Hz, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.6, 141.3, 128.8, 128.7, 127.7, 57.9, 47.6, 32.2, 28.5, 24.0, 10.6; IR (KBr): 3069, 2973, 2877, 1766, 1689, 1458, 1340, 1265, 1166, 1077, 1016 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{17}\text{H}_{21}\text{NNaO}_2$, 294.1464; found, 294.1467.

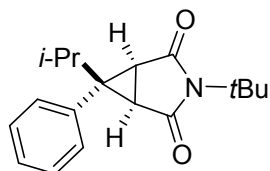
***trans*-3-(*tert*-Butyl)-6-Phenyl-6-Propyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3ab)**



1.91 g, 67% yield; white solid, mp: 73–74 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.47$; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.31 (s, 5H), 2.63 (s, 2H), 1.80 (t, $J = 8.4$ Hz, 2H), 1.59 (s, 9H), 1.39–1.28 (m, 2H), 0.82 (t, $J = 7.2$ Hz, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.6, 141.6, 128.7, 128.6, 127.6, 57.9, 46.6, 33.0, 32.2, 28.5, 19.7, 13.9; IR (KBr): 2964, 2872, 1766, 1703,

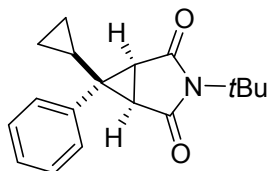
1457, 1339, 1264, 1166, 1014 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{18}\text{H}_{23}\text{NNaO}_2$, 308.1621; found, 308.1624.

***trans*-3-(*tert*-Butyl)-6-Isopropyl-6-Phenyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3ac)**



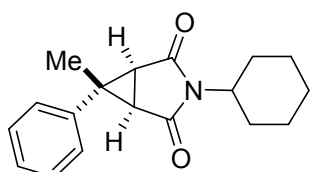
1.37 g, 48% yield; white solid, mp: 142–143 $^{\circ}\text{C}$; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.40; ^1H NMR (400 MHz, CDCl_3) δ 7.30 (s, 5H), 2.64 (s, 2H), 1.95–1.88 (m, 1H), 1.58 (s, 9H), 0.93 (d, J = 6.8 Hz, 6H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.5, 138.2, 130.8, 128.1, 127.8, 58.0, 52.0, 33.2, 28.5, 27.4, 20.0; IR (KBr): 3072, 2967, 2927, 1759, 1698, 1454, 1370, 1259, 1172, 1079, 1017 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{18}\text{H}_{23}\text{NNaO}_2$, 308.1621; found, 308.1624.

***trans*-3-(*tert*-Butyl)-6-Cyclopropyl-6-Phenyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3ad)**



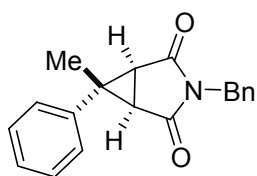
0.99 g, 35% yield; white solid, mp: 90–91 $^{\circ}\text{C}$; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.43; ^1H NMR (400 MHz, CDCl_3) δ 7.31–7.21 (m, 5H), 2.68 (s, 2H), 1.59 (s, 9H), 1.15–1.12 (m, 1H), 0.50 (d, J = 8.0 Hz, 2H), 0.22 (d, J = 5.2 Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.7, 140.2, 129.2, 128.5, 127.7, 57.9, 46.3, 32.3, 28.4, 11.3, 4.9; IR (KBr): 2974, 2929, 1766, 1702, 1458, 1344, 1266, 1210, 1166, 1017 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{18}\text{H}_{21}\text{NNaO}_2$, 306.1464; found, 306.1469.

***trans*-3-Cyclohexyl-6-Methyl-6-Phenyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3ae)**



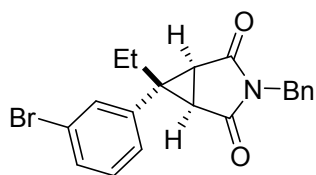
1.90 g, 67% yield; white solid, mp: 94–95 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.56$; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.32 (s, 5H), 3.93 (t, $J = 12.0$ Hz, 1H), 2.20–2.11 (m, 2H), 1.83 (d, $J = 12.4$ Hz, 2H), 1.67–1.60 (m, 3H), 1.53 (s, 3H), 1.36–1.21 (m, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 173.6, 142.9, 128.9, 127.7, 127.3, 51.5, 42.0, 32.4, 29.0, 25.9, 25.0, 17.2; IR (KBr): 3076, 2930, 2857, 1765, 1698, 1449, 1371, 1266, 1188, 1052 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{18}\text{H}_{21}\text{NNaO}_2$, 306.1464; found, 306.1467.

***trans*-3-Benzyl-6-Methyl-6-Phenyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3af)**



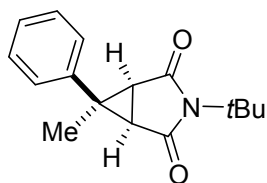
1.78 g, 61% yield; white solid, mp: 151–152 °C; TLC (petroleum ether/ethyl acetate, 10:1 v/v): $R_f = 0.43$; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.43 (d, $J = 7.2$ Hz, 2H), 7.34–7.25 (m, 8H), 4.61 (s, 2H), 2.76 (s, 2H), 1.27 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 173.2, 142.8, 135.7, 129.3, 129.0, 128.6, 128.1, 127.7, 127.2, 42.8, 42.1, 32.5, 17.0; IR (KBr): 3077, 2967, 2858, 1760, 1695, 1440, 1392, 1336, 1167, 1058, 1000 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{19}\text{H}_{17}\text{NNaO}_2$, 314.1151; found, 314.1152.

***trans*-3-Benzyl-6-(3-Bromophenyl)-6-Ethyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (3ag)**



2.80 g, 73% yield; white solid, mp: 126–127 °C; TLC (petroleum ether/ethyl acetate, 15:1 v/v): $R_f = 0.25$; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.45–7.40 (m, 4H), 7.33–7.17 (m, 5H), 4.61 (s, 2H), 2.73 (s, 2H), 1.43 (q, $J = 7.6$ Hz 2H), 0.70 (t, $J = 7.6$ Hz 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 172.8, 143.2, 135.7, 131.8, 131.1, 130.3, 129.3, 128.6, 128.1, 127.4, 122.7, 48.3, 42.2, 31.9, 23.9, 10.3; IR (KBr): 3066, 2926, 2858, 1768, 1703, 1567, 1394, 1342, 1164, 1064, 1002 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{20}\text{H}_{18}\text{NNaO}_2$, 406.0413; found, 406.0404.

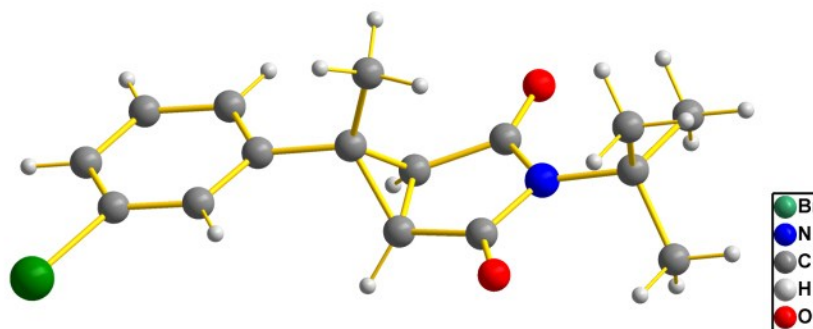
***cis*-3-(*tert*-Butyl)-6-Methyl-6-Phenyl-3-Azabicyclo[3.1.0]hexane-2,4-Dione (4a)**



0.44 g, 16% yield; white solid, mp: 120–121 °C; TLC (petroleum ether/ethyl acetate, 10:1 v/v): R_f = 0.30; $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.36–7.27 (m, 5H), 2.55 (s, 2H), 1.44 (s, 3H), 0.98 (s, 9H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.4, 138.1, 129.0, 128.9, 127.9, 56.9, 42.7, 33.2, 27.6, 27.5; IR (KBr): 3059, 3019, 2968, 1766, 1701, 1451, 1358, 1266, 1170, 1071, 1005 cm^{-1} ; HRMS (ESI, m/z): $[\text{M}+\text{Na}]^+$ Calcd. for $\text{C}_{16}\text{H}_{19}\text{NNaO}_2$, 280.1308; found, 280.1308.

E. X-ray Crystallographic Data for 3g

The X-ray crystallographic structures for **3g**. ORTEP representation with 50% probability thermal ellipsoids. Solvent and hydrogen are omitted for clarity. Crystal data have been deposited to CCDC, number 1489545.

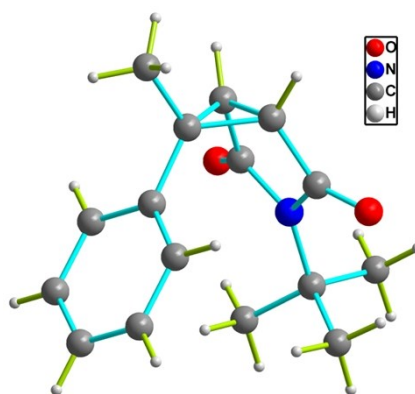


Empirical formula	$\text{C}_{16}\text{H}_{18}\text{BrNO}_2$
Formula weight	336.22
Temperature	293(2) K
Wavelength	0.71073 Å
Crystal system, space group	MONOCLINIC, P2(1)/c
Unit cell dimensions	$a = 6.9645(14)$ Å $\alpha = 90$ deg. $b = 14.893(3)$ Å $\beta = 101.19(3)$ deg. $c = 14.570(3)$ Å $\gamma = 90$ deg.

Volume	1482.5(5) Å ³
Z, Calculated density	4, 1.506 Mg/m ³
Absorption coefficient	2.774 mm ⁻¹
F(000)	688
Crystal size	0.10×0.10×0.10 mm
Theta range for data collection	5.50 to 73.85 deg.
Limiting indices	-8 ≤ h ≤ 8, -17 ≤ k ≤ 17, -17 ≤ l ≤ 15
Reflections collected / unique	10300 / 3491 [R(int) = 0.0420]
Completeness to theta = 25.00	99.8%
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	2607 / 0 / 182
Goodness-of-fit on F ²	1.153
Final R indices [I>2sigma(I)]	R1 = 0.0396, wR2 = 0.0774
R indices (all data)	R1 = 0.0845, wR2 = 0.1299
Extinction coefficient	0.0032(9)

F. X-ray Crystallographic Data for 4a

The X-ray crystallographic structures for **4a**. ORTEP representation with 50% probability thermal ellipsoids. Solvent and hydrogen are omitted for clarity. Crystal data have been deposited to CCDC, number 1489546.

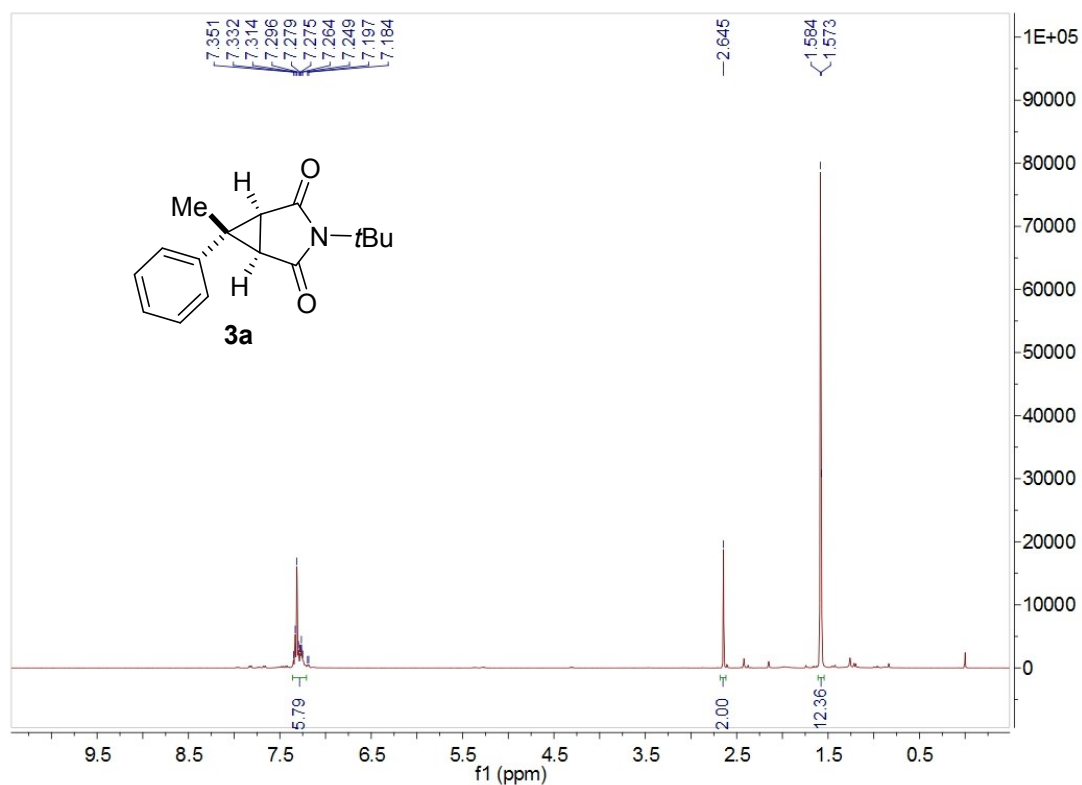


Empirical formula	C ₁₆ H ₁₉ NO ₂
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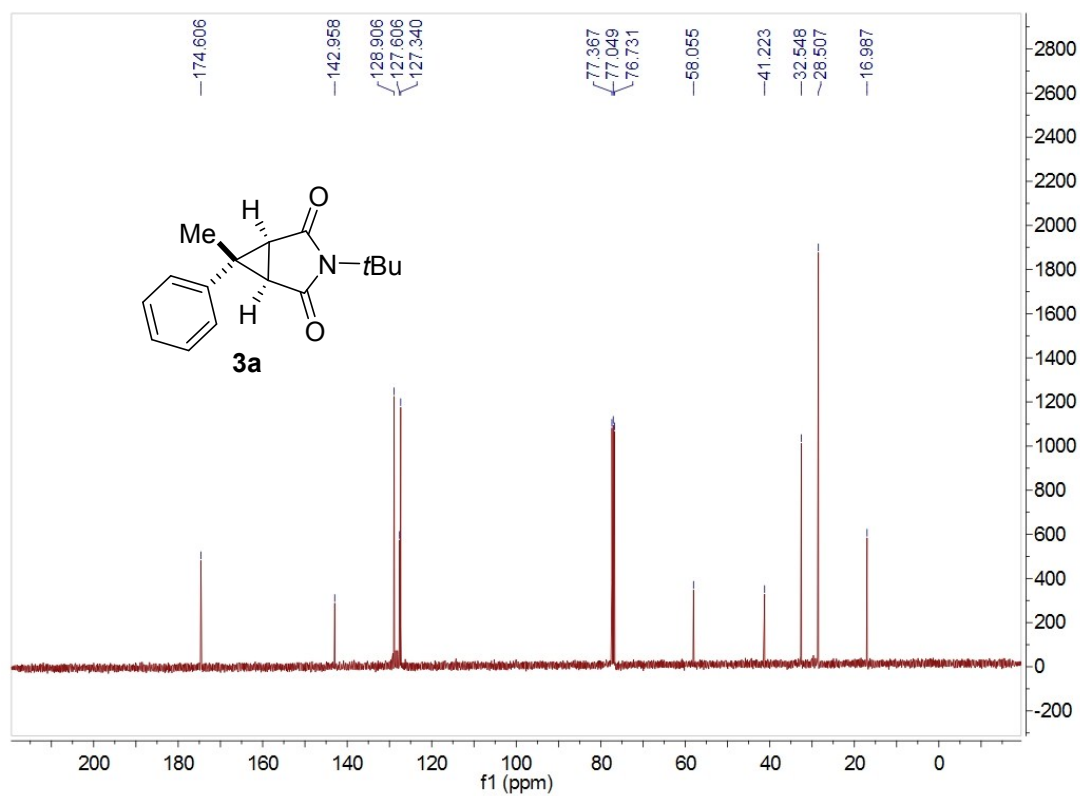
Formula weight	257.32
Temperature	293(2) K
Wavelength	0.71073 Å
Crystal system, space group	MONOCLINIC, P2(1)/c
Unit cell dimensions	a = 8.8657(18) Å alpha = 90 deg. b = 11.708(2) Å beta = 90 deg. c = 13.548(3) Å gamma = 90 deg.
Volume	1406.3(5) Å ³
Z, Calculated density	4, 1.215 Mg/m ³
Absorption coefficient	0.080 mm ⁻¹
F(000)	552
Crystal size	0.10×0.10×0.10 mm
Theta range for data collection	3.01 to 27.48 deg.
Limiting indices	-10 ≤ h ≤ 11, -15 ≤ k ≤ 15, -17 ≤ l ≤ 17
Reflections collected / unique	13757 / 3199 [R(int) = 0.0962]
Completeness to theta = 25.00	99.7%
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	3199 / 0 / 173
Goodness-of-fit on F ²	1.040
Final R indices [I > 2sigma(I)]	R1 = 0.0585, wR2 = 0.1521
R indices (all data)	R1 = 0.0972, wR2 = 0.2084
Extinction coefficient	0.31(3)

G. NMR Spectra of New Compounds

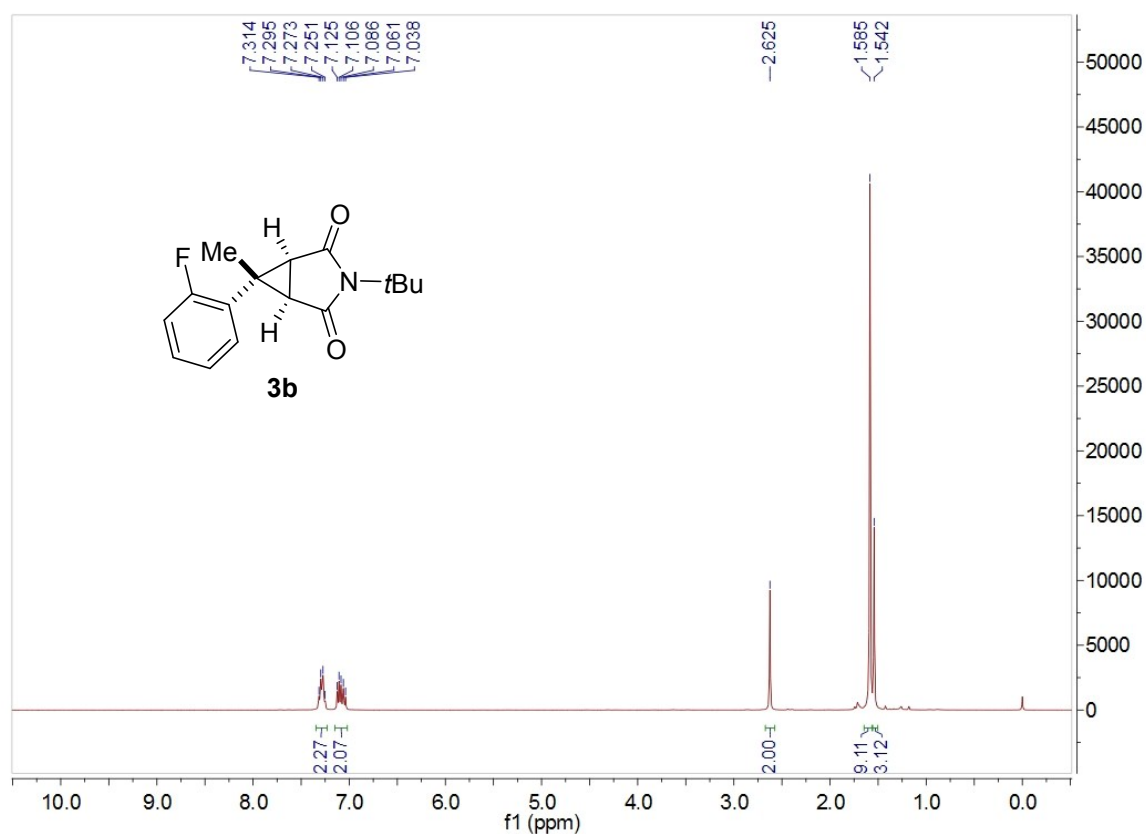
^1H NMR (400 MHz, CDCl_3) spectrum for **3a**



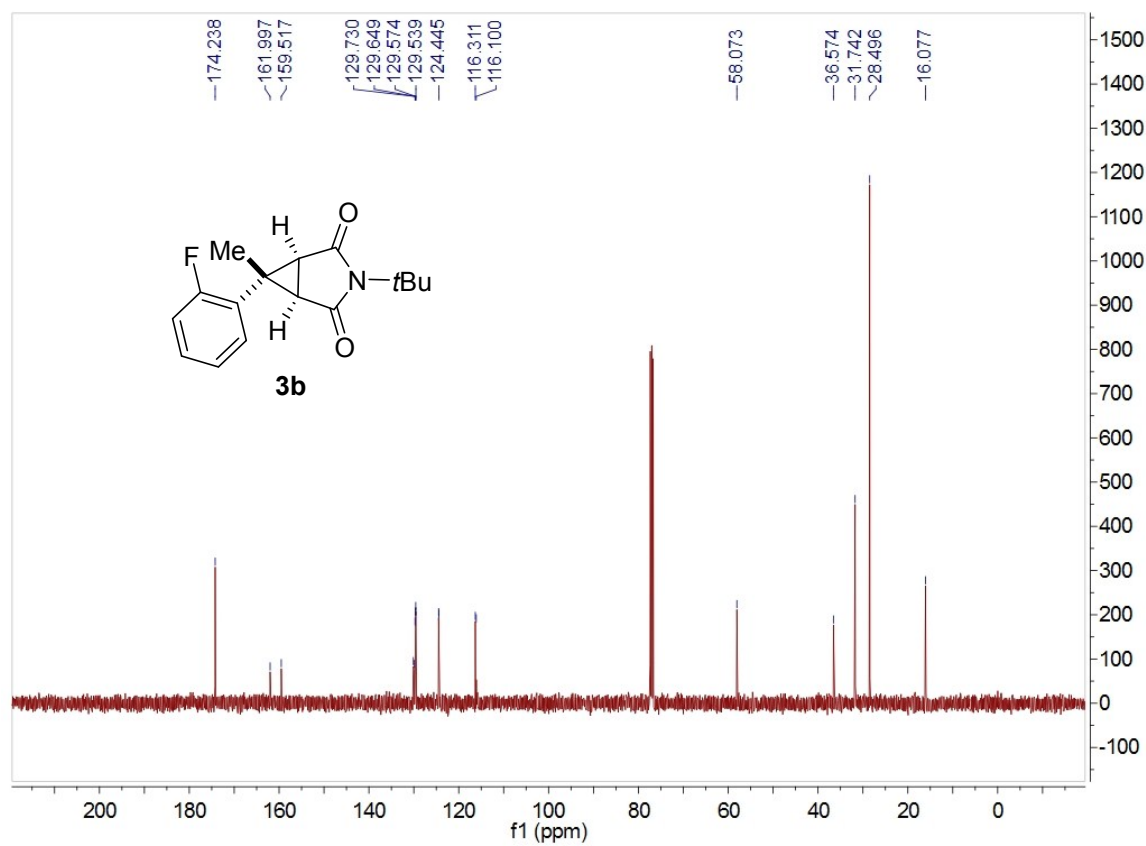
^{13}C NMR (100 MHz, CDCl_3) spectrum for **3a**



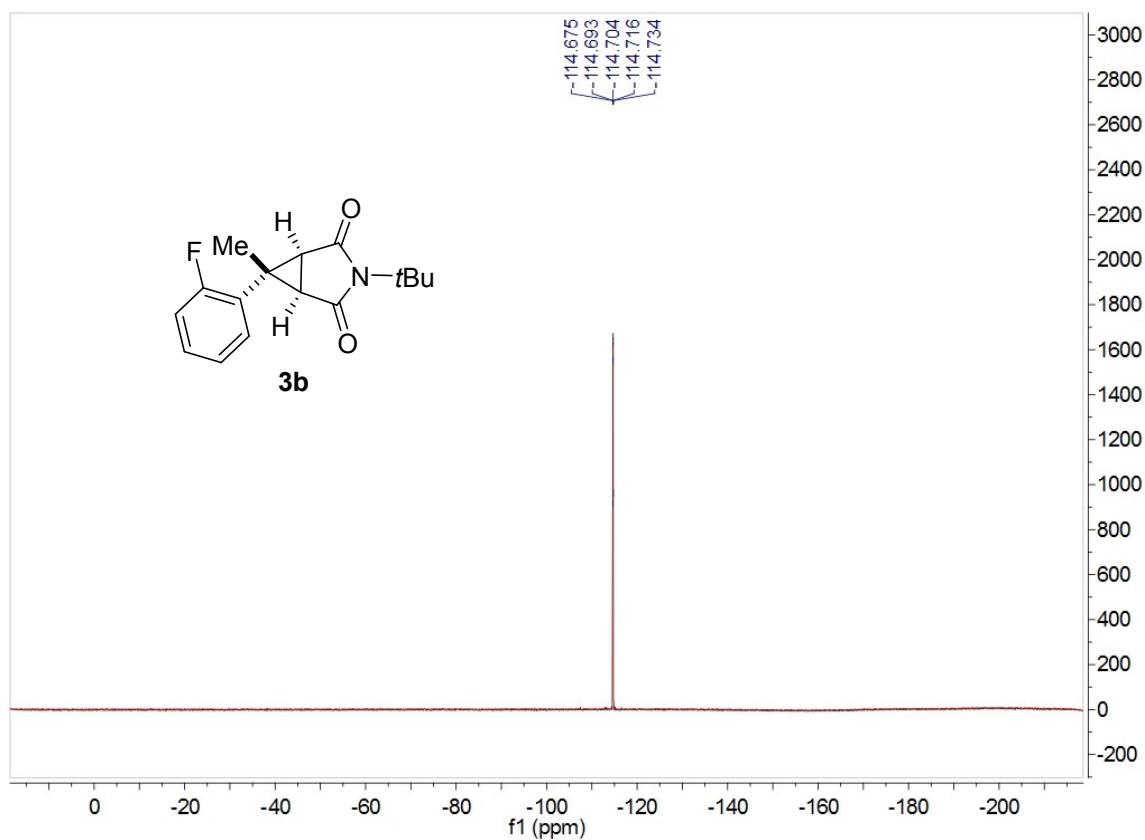
¹H NMR (400 MHz, CDCl₃) spectrum for 3b



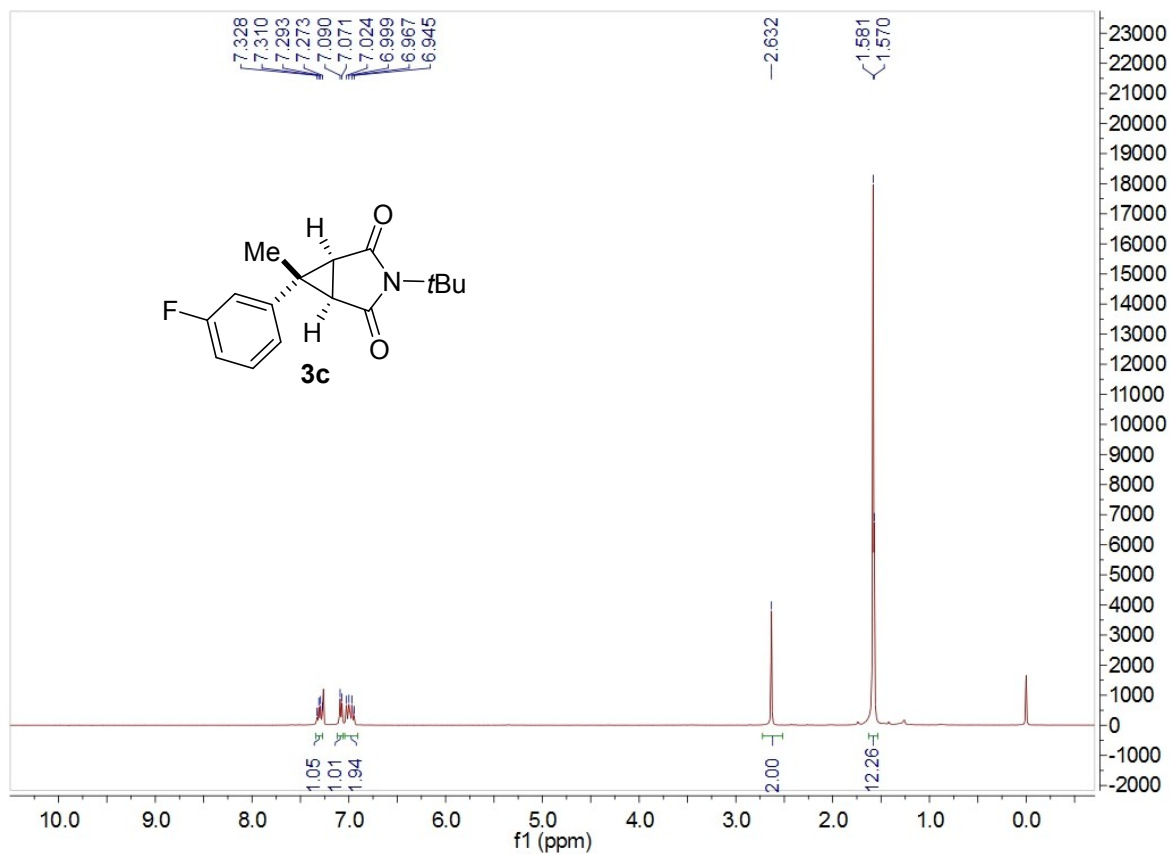
¹³C NMR (100 MHz, CDCl₃) spectrum for 3b



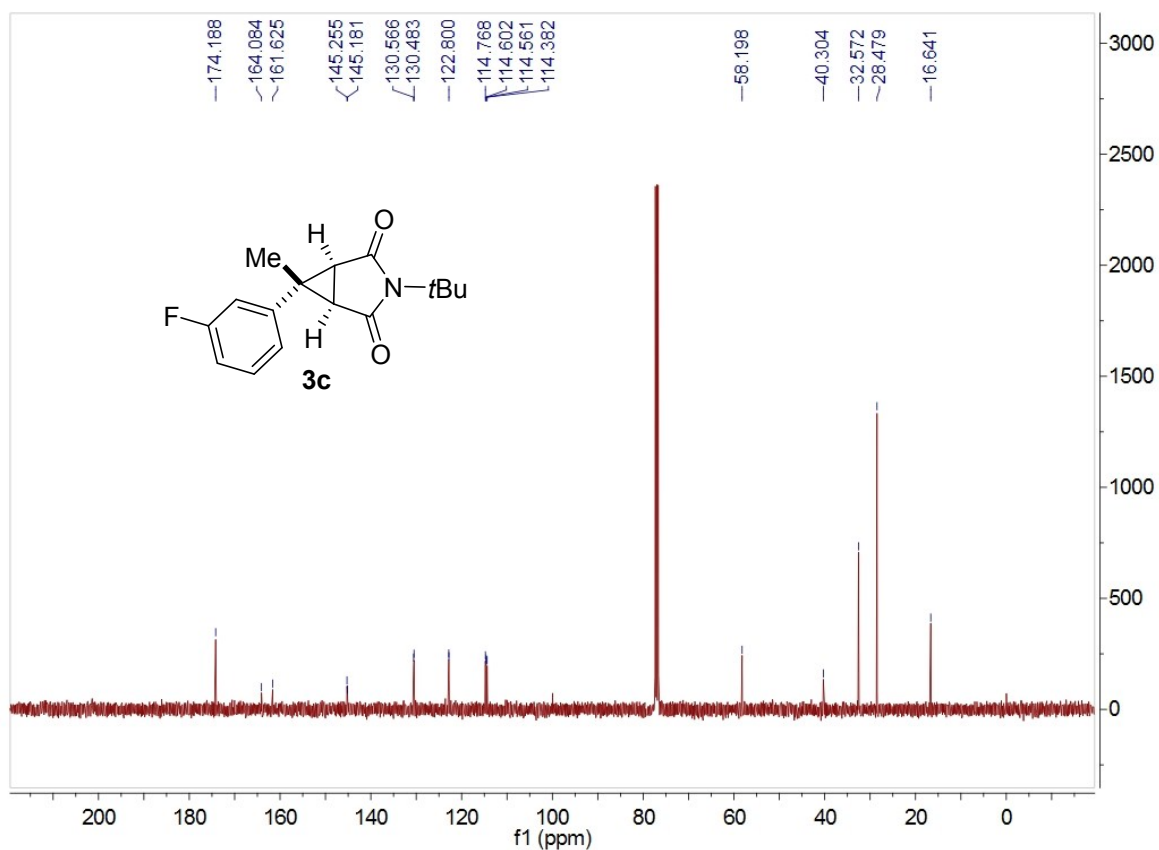
¹⁹F NMR (376 MHz, CDCl₃) spectrum for 3b



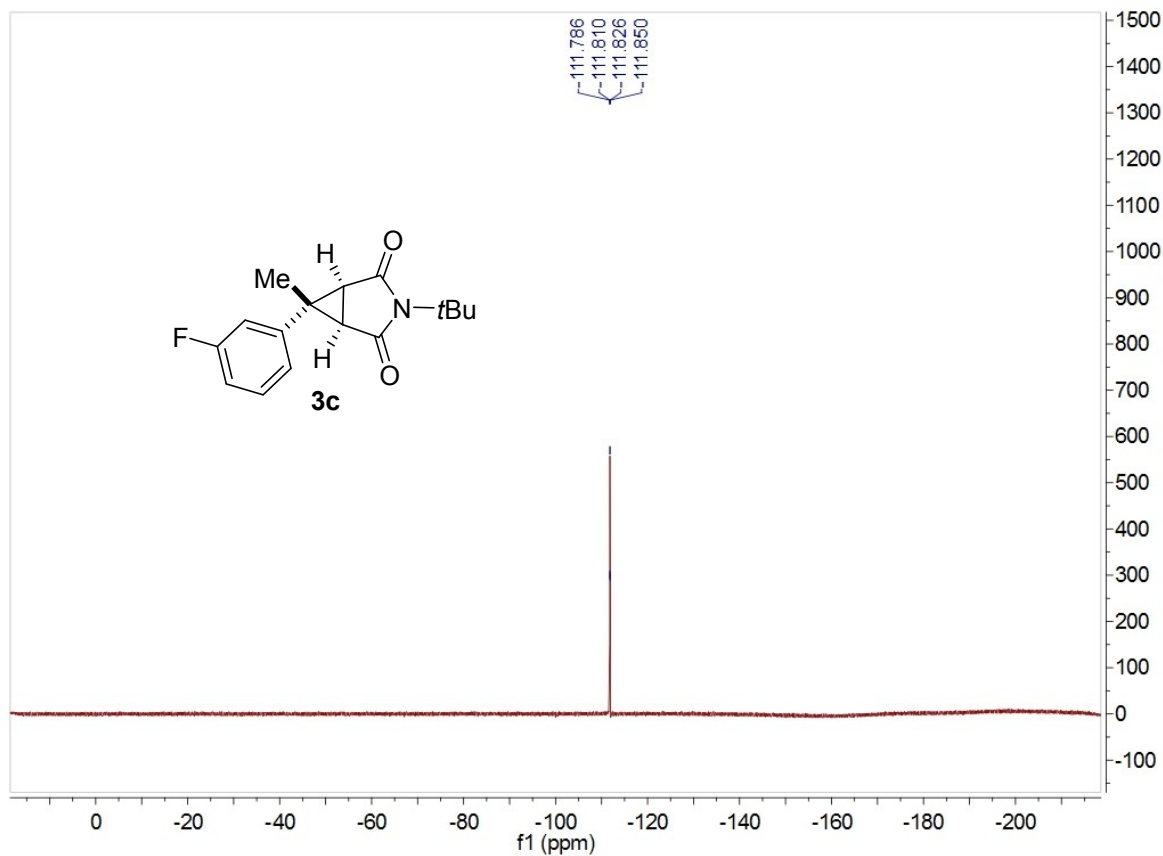
¹H NMR (400 MHz, CDCl₃) spectrum for 3c



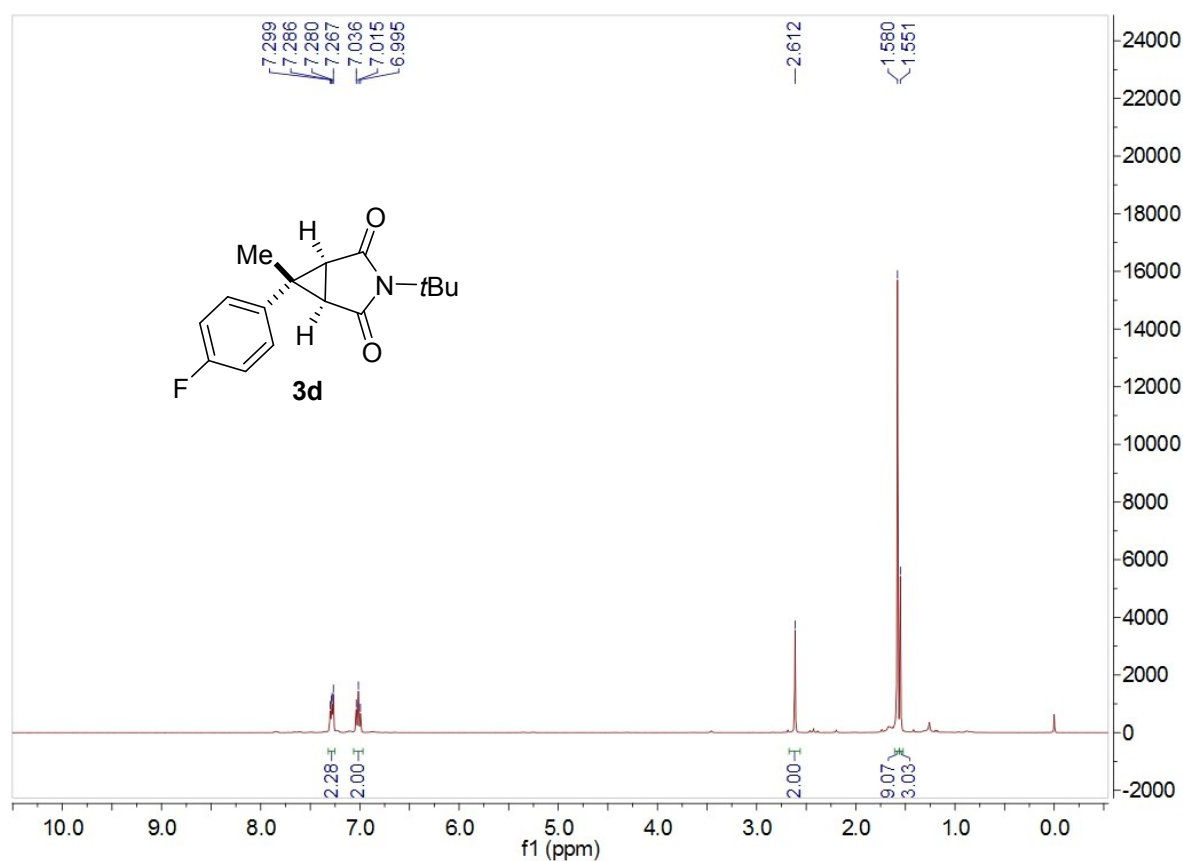
¹³C NMR (100 MHz, CDCl₃) spectrum for 3c



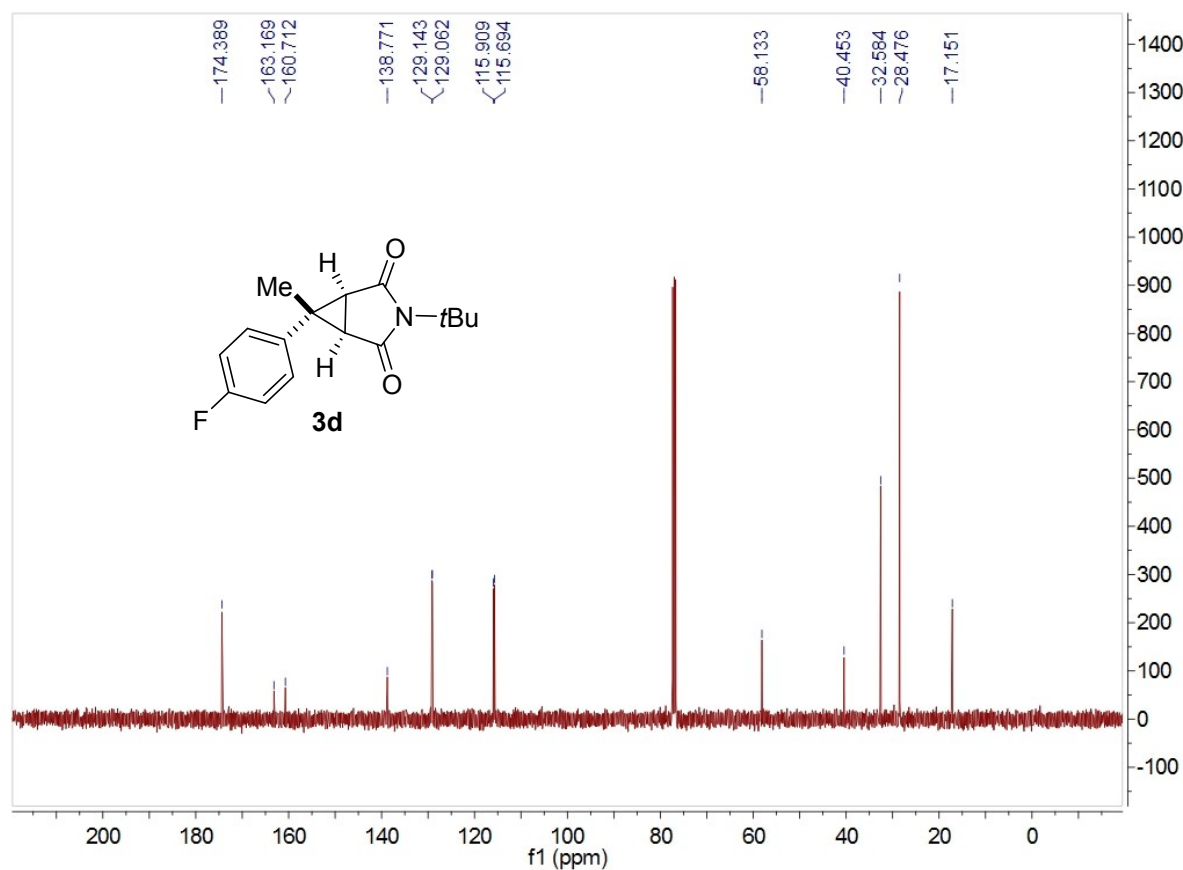
¹⁹F NMR (376 MHz, CDCl₃) spectrum for 3c



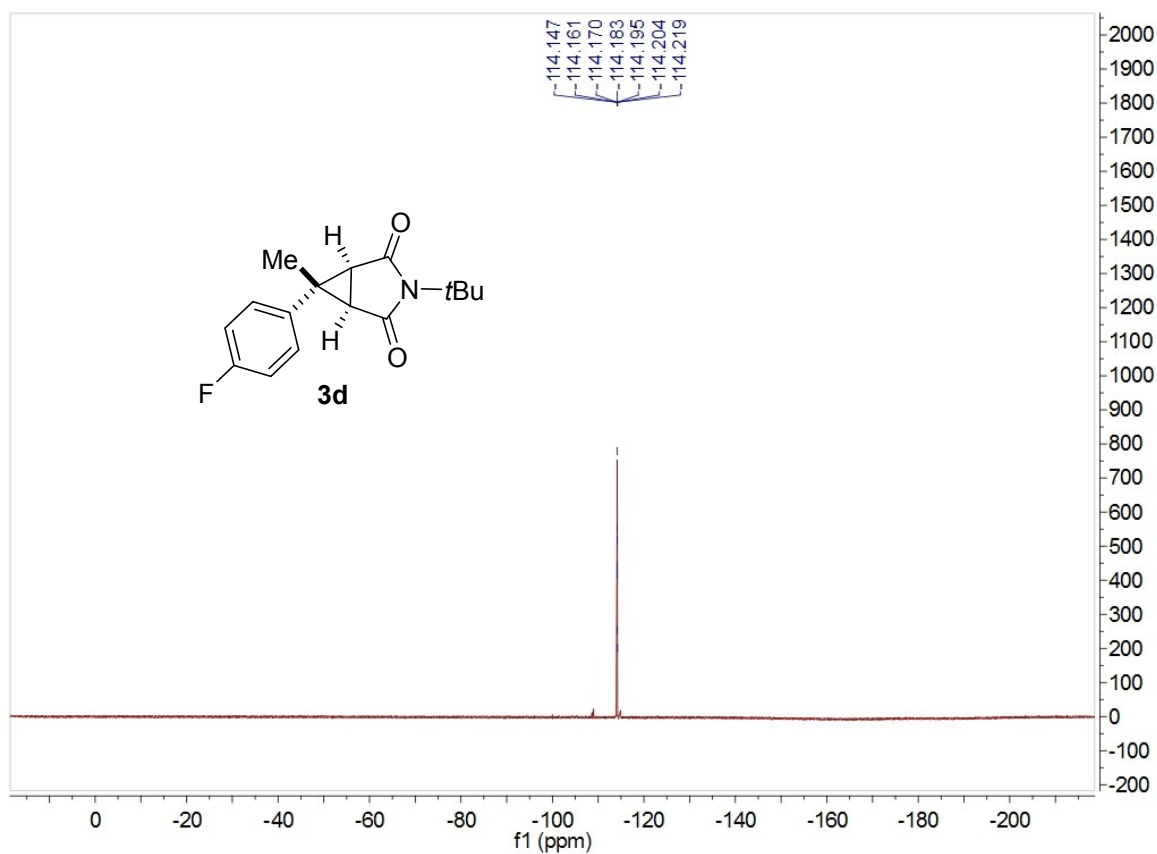
¹H NMR (400 MHz, CDCl₃) spectrum for 3d



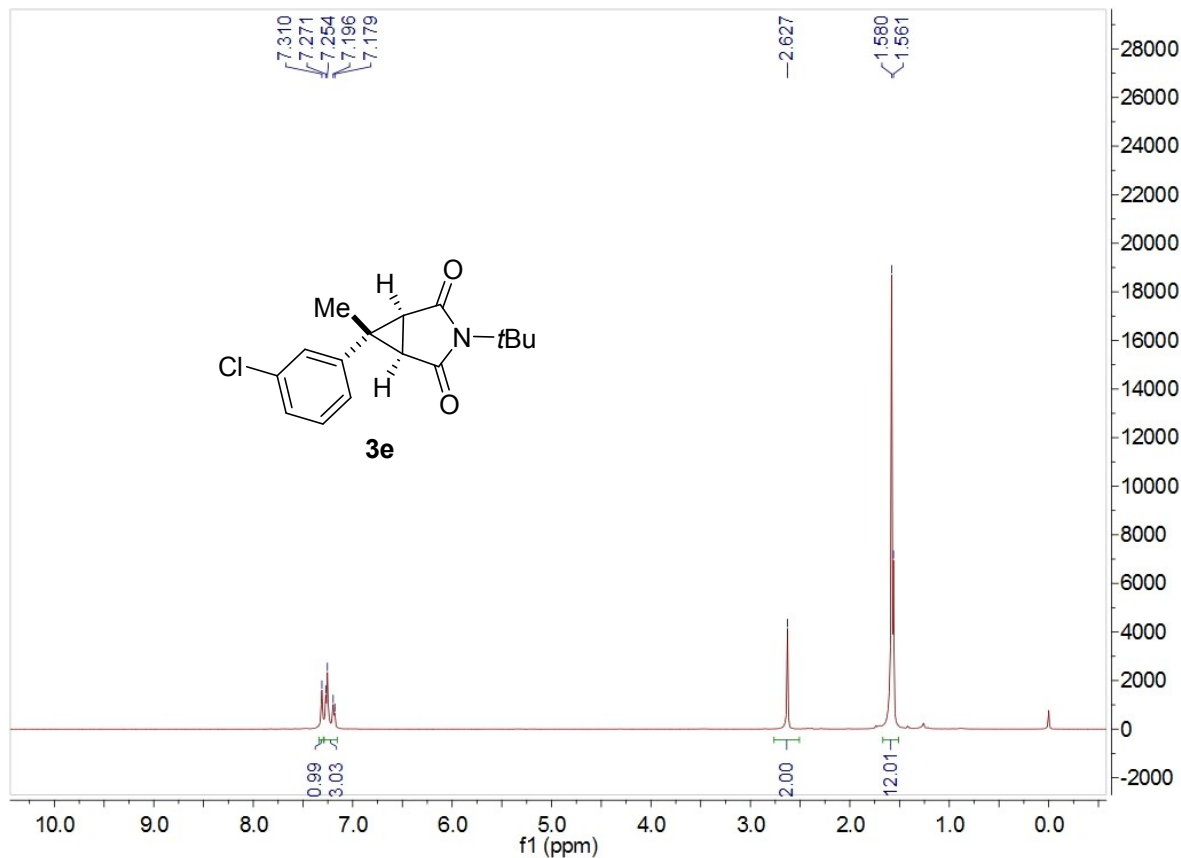
¹³C NMR (100 MHz, CDCl₃) spectrum for 3d



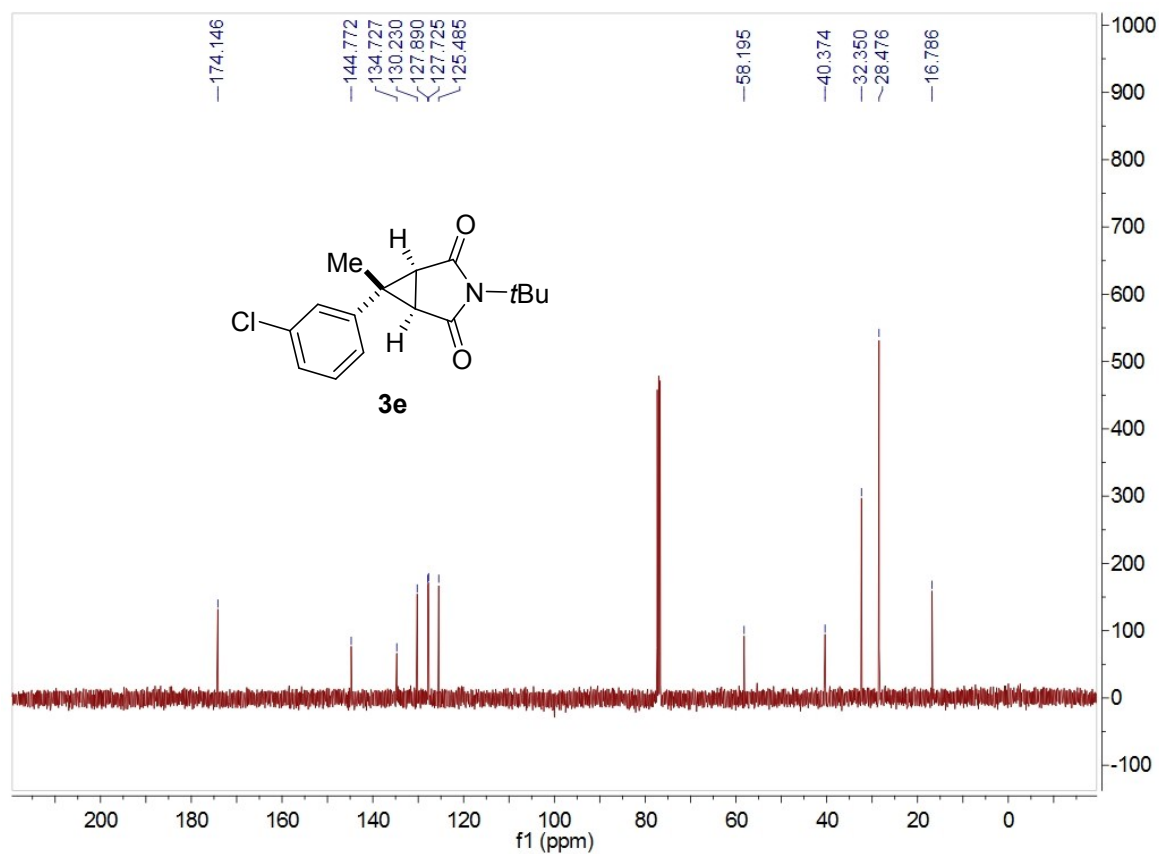
¹⁹F NMR (376 MHz, CDCl₃) spectrum for 3d



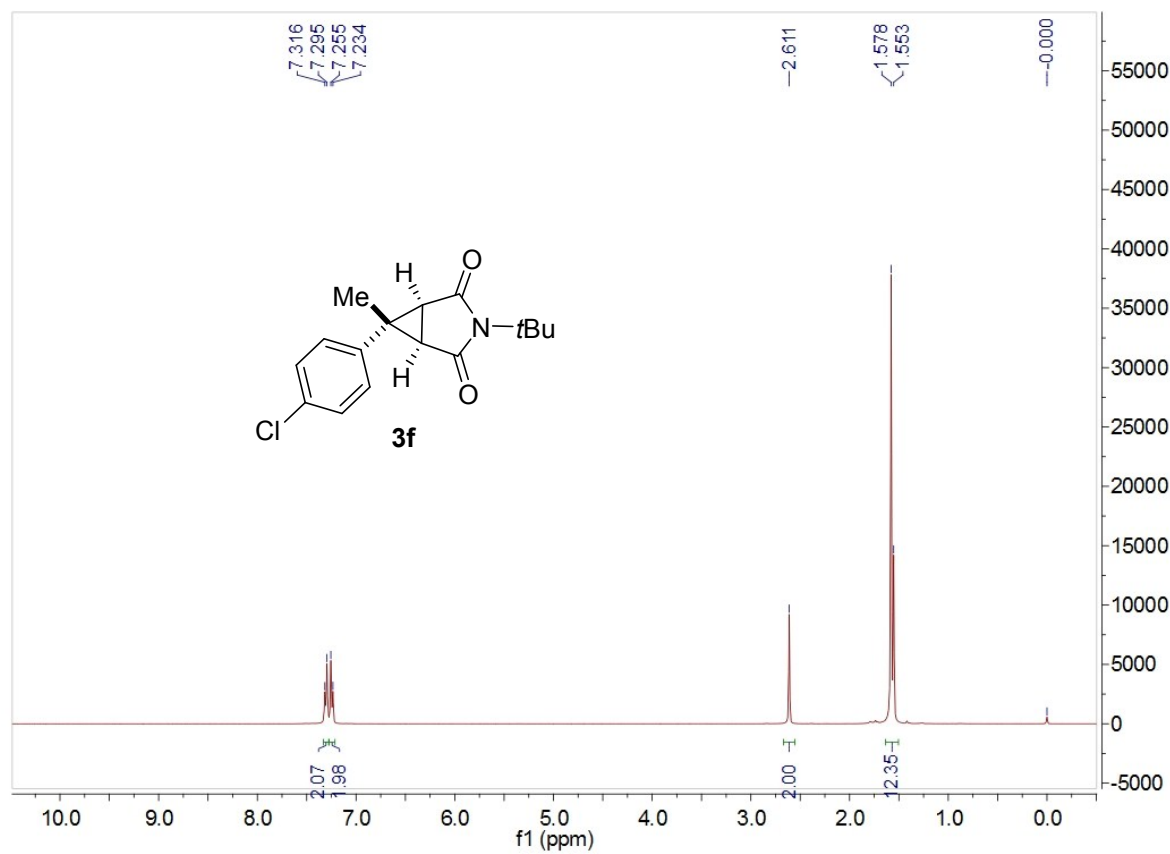
¹H NMR (400 MHz, CDCl₃) spectrum for 3e



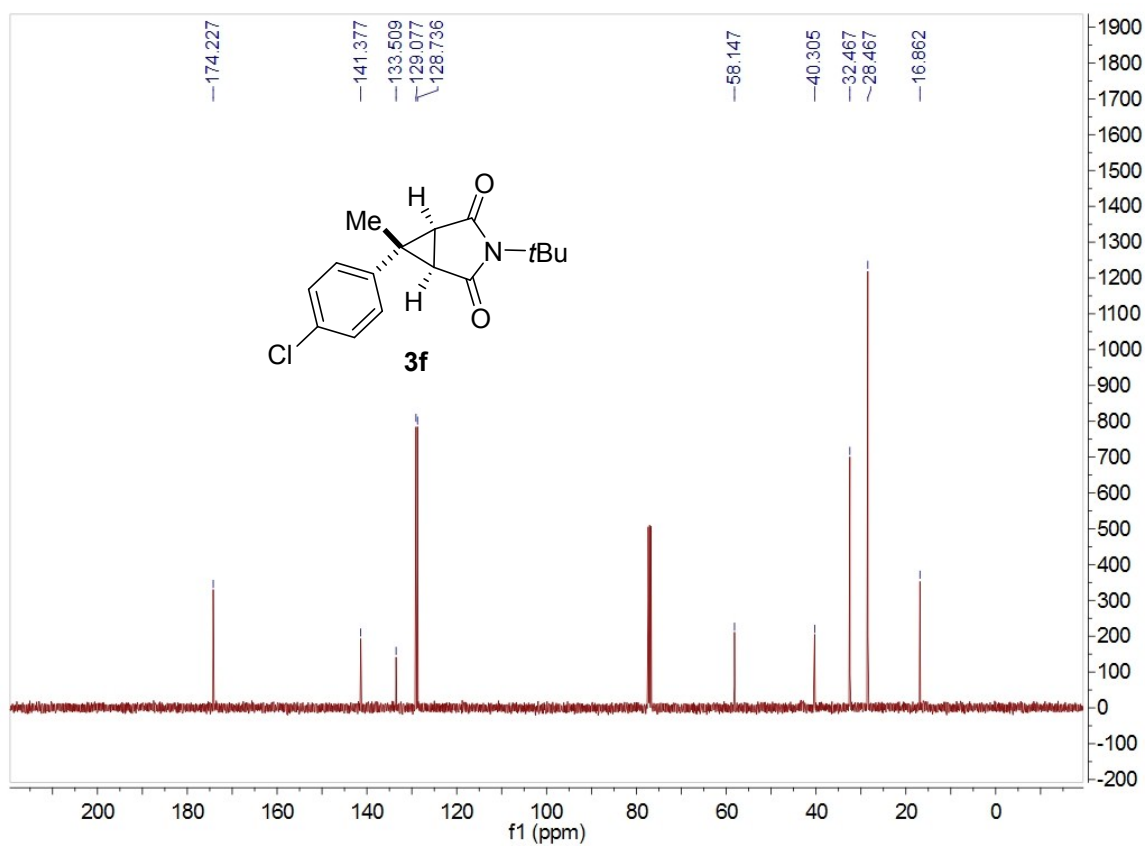
¹³C NMR (100 MHz, CDCl₃) spectrum for 3e



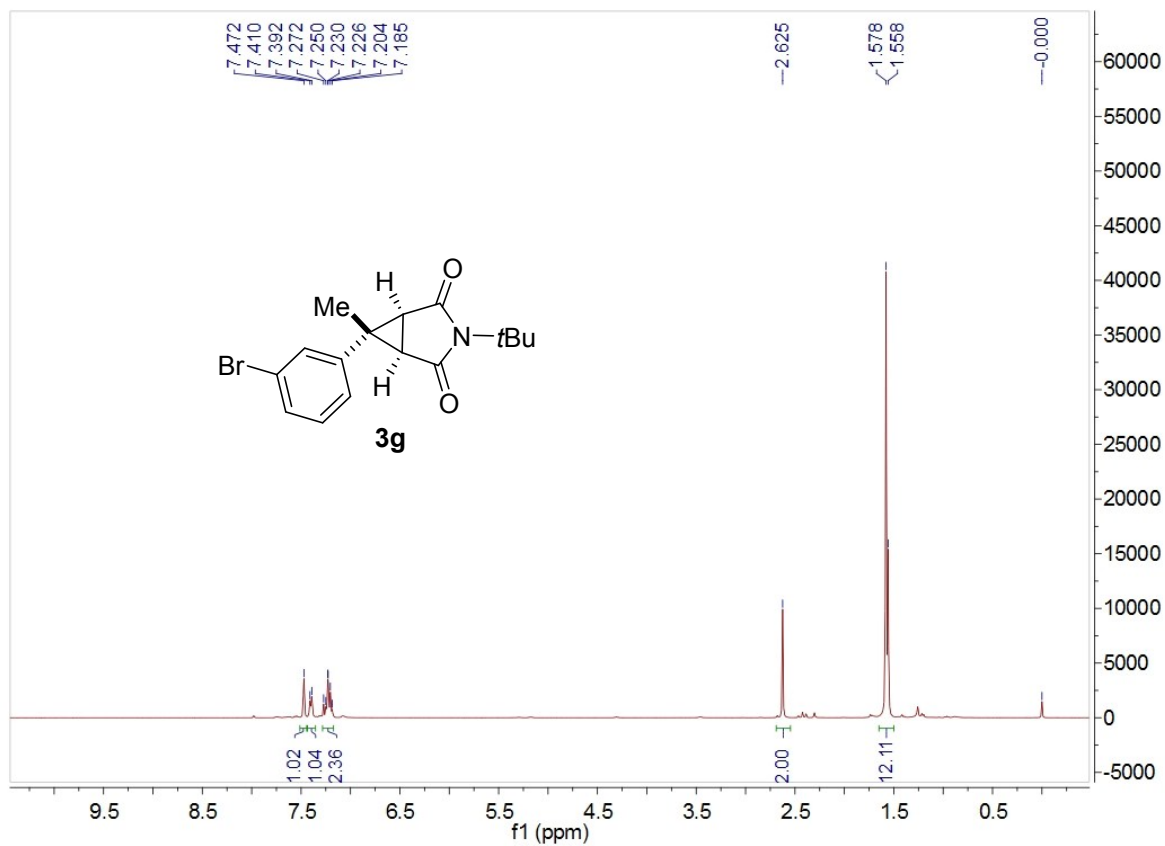
¹H NMR (400 MHz, CDCl₃) spectrum for 3f



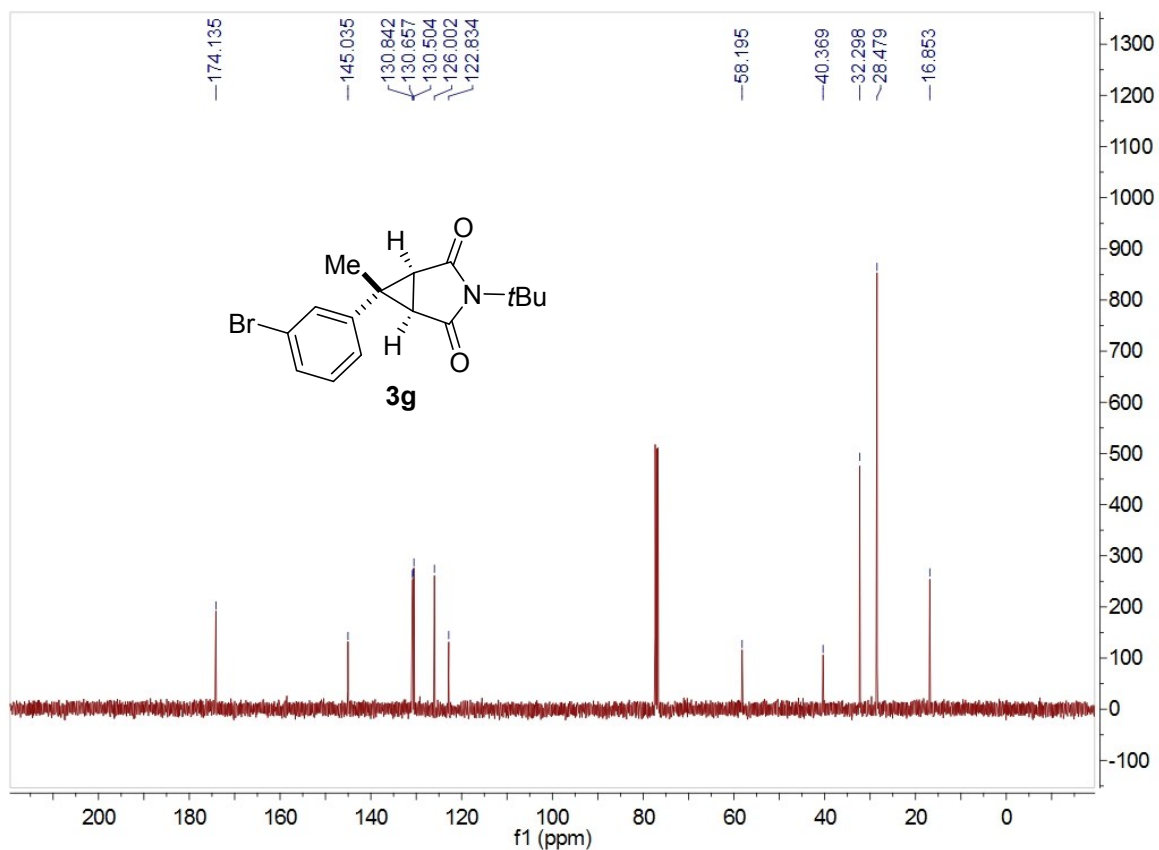
¹³C NMR (100 MHz, CDCl₃) spectrum for 3f



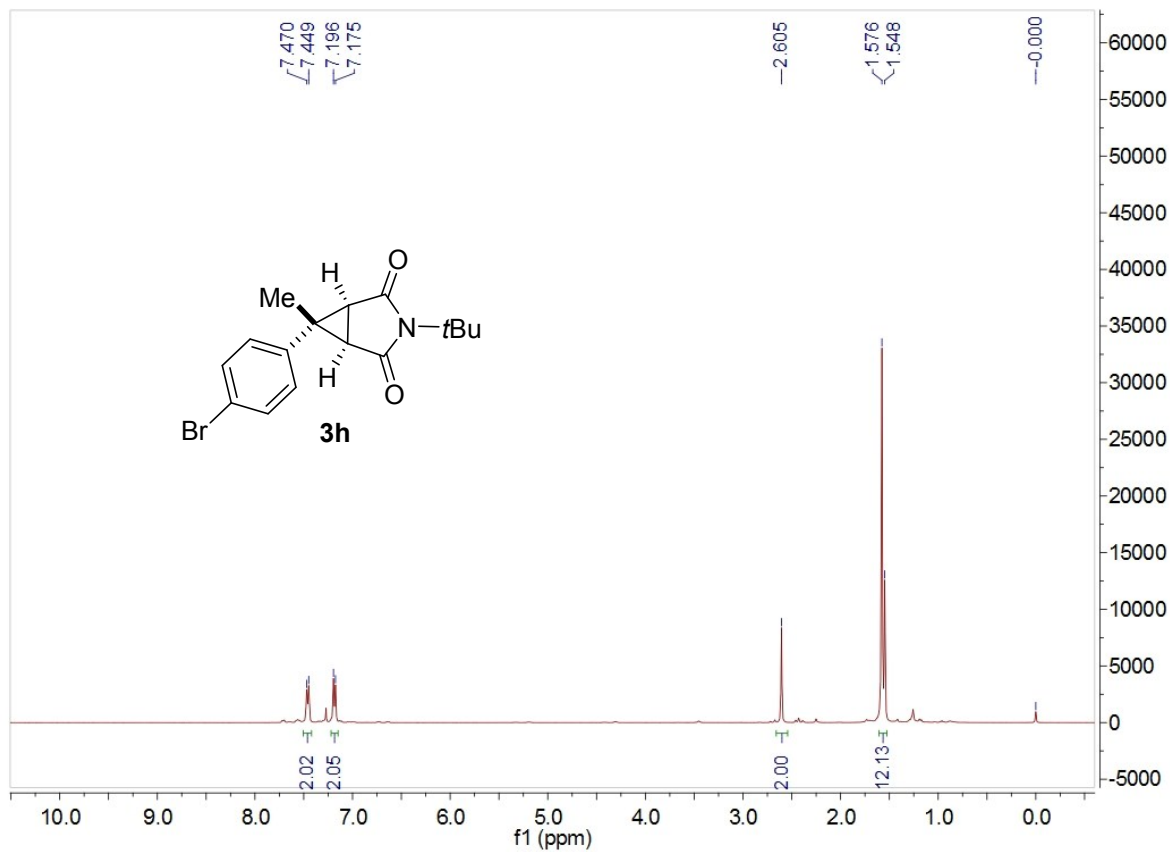
¹H NMR (400 MHz, CDCl₃) spectrum for 3g



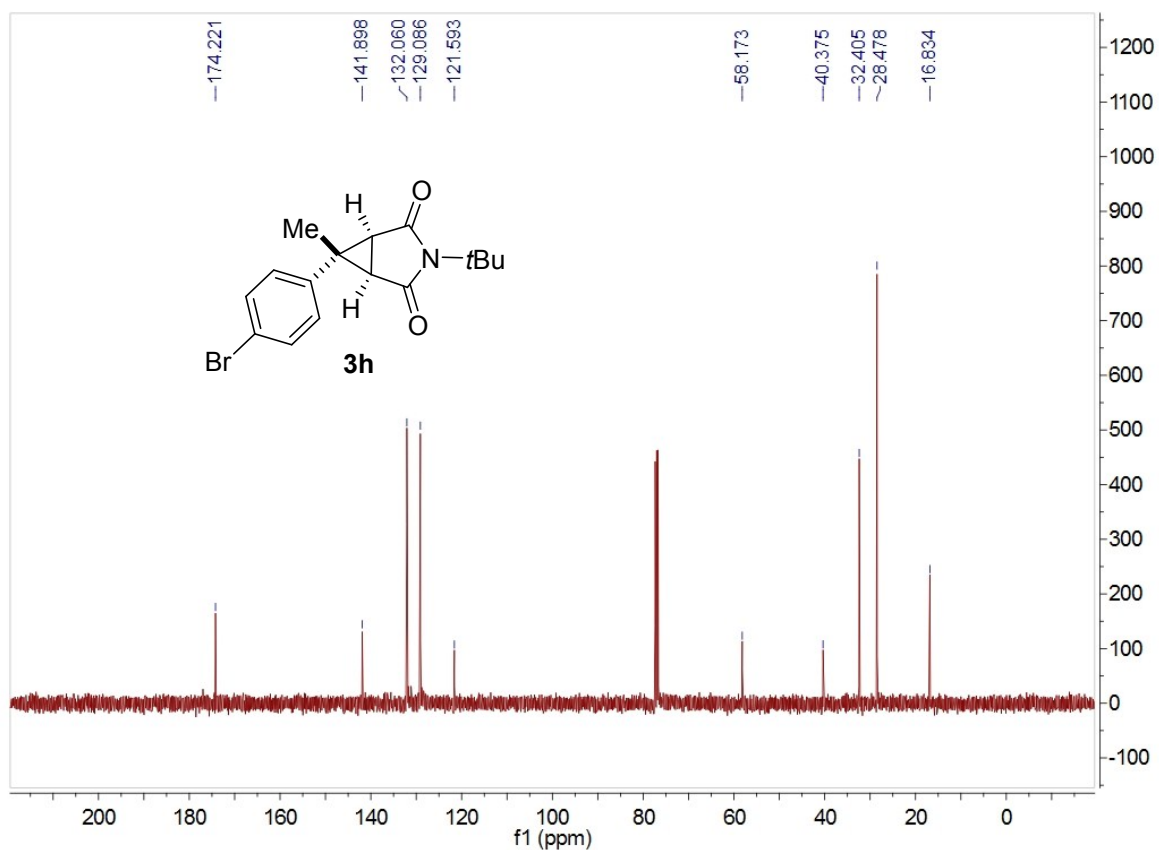
¹³C NMR (100 MHz, CDCl₃) spectrum for 3g



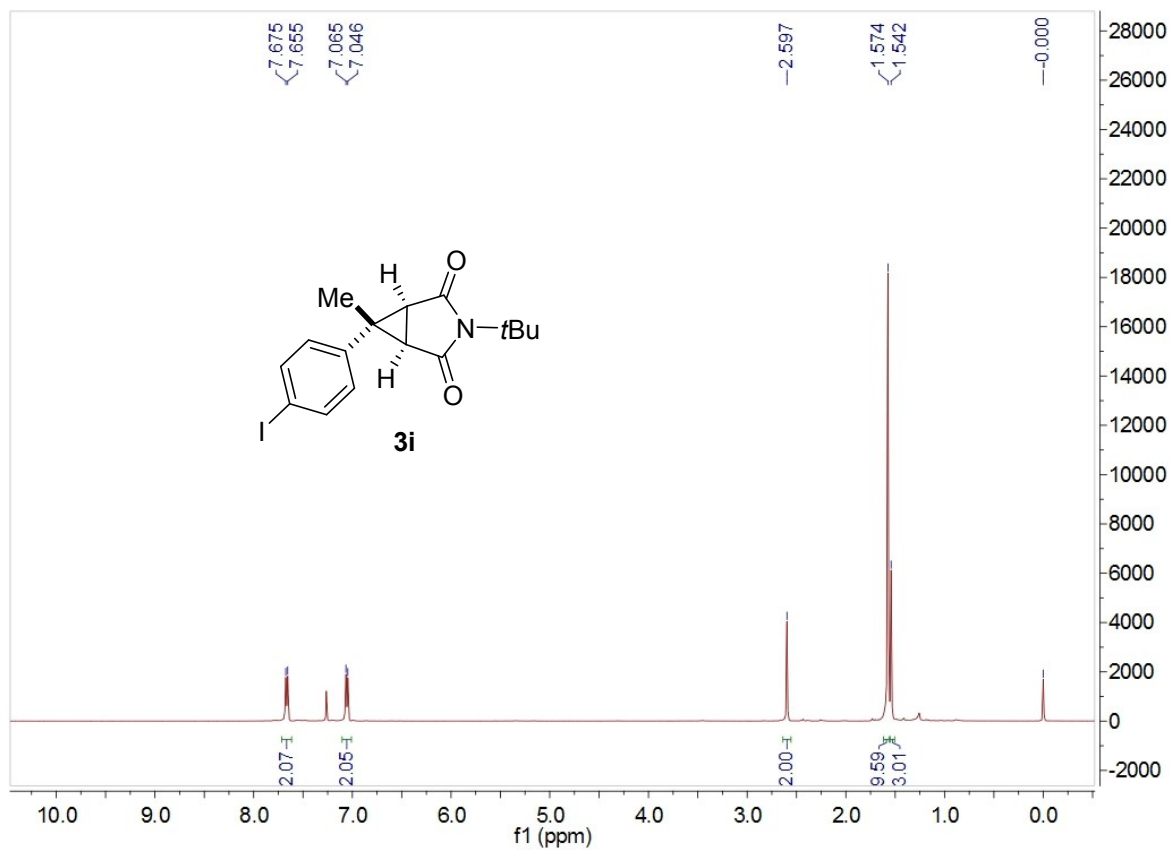
¹H NMR (400 MHz, CDCl₃) spectrum for 3h



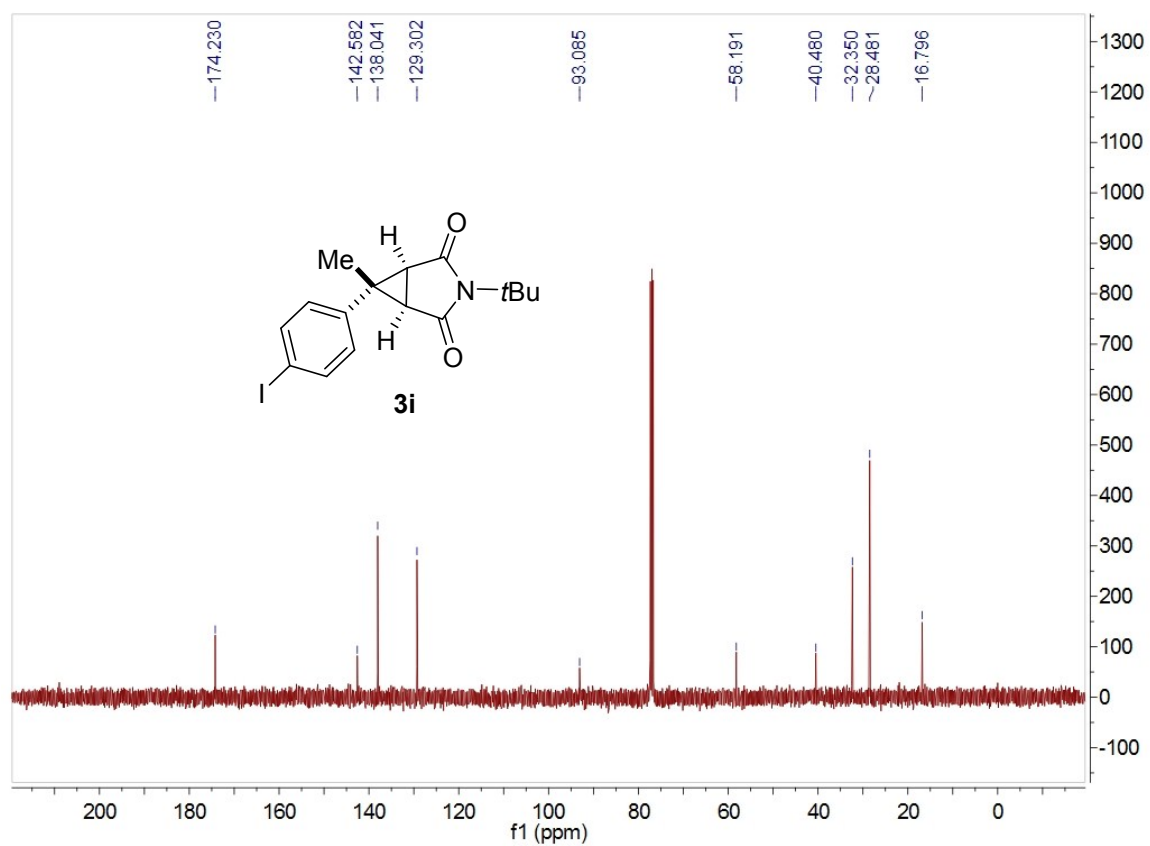
¹³C NMR (100 MHz, CDCl₃) spectrum for 3h



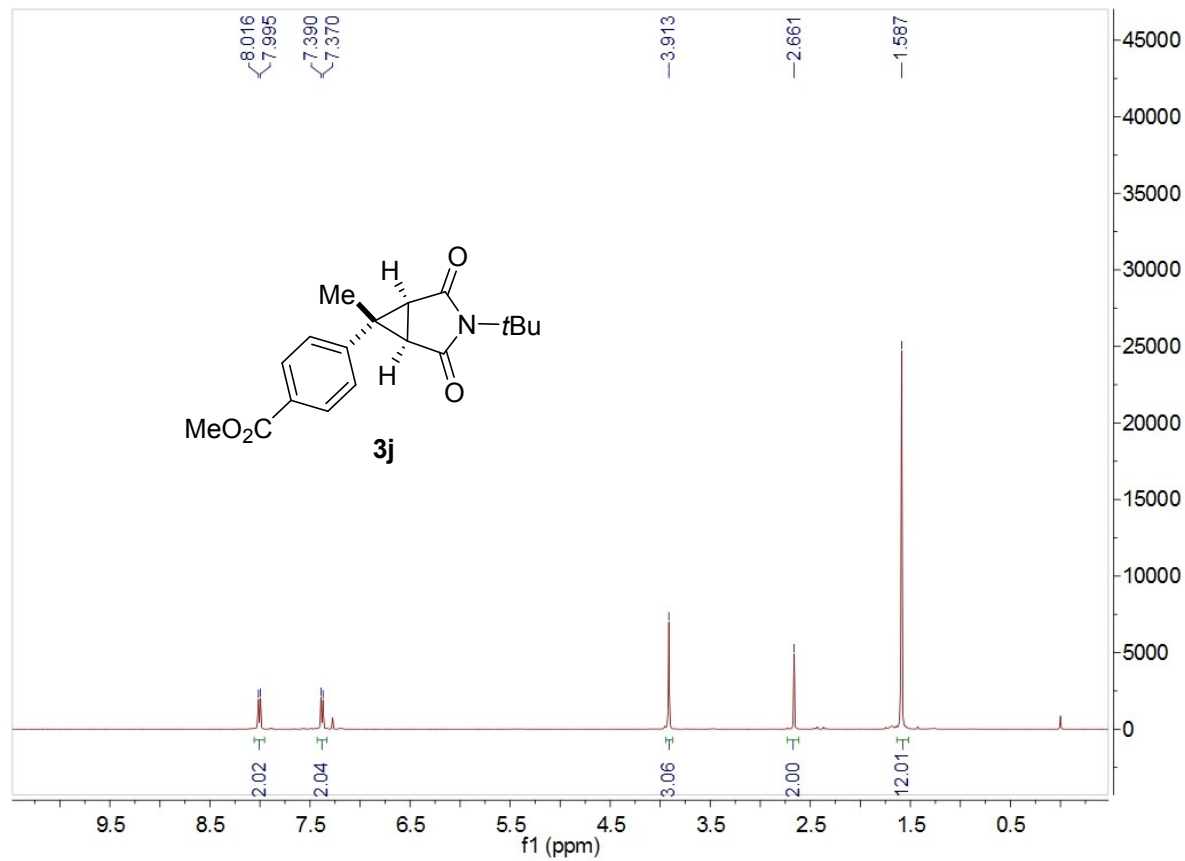
¹H NMR (400 MHz, CDCl₃) spectrum for 3i



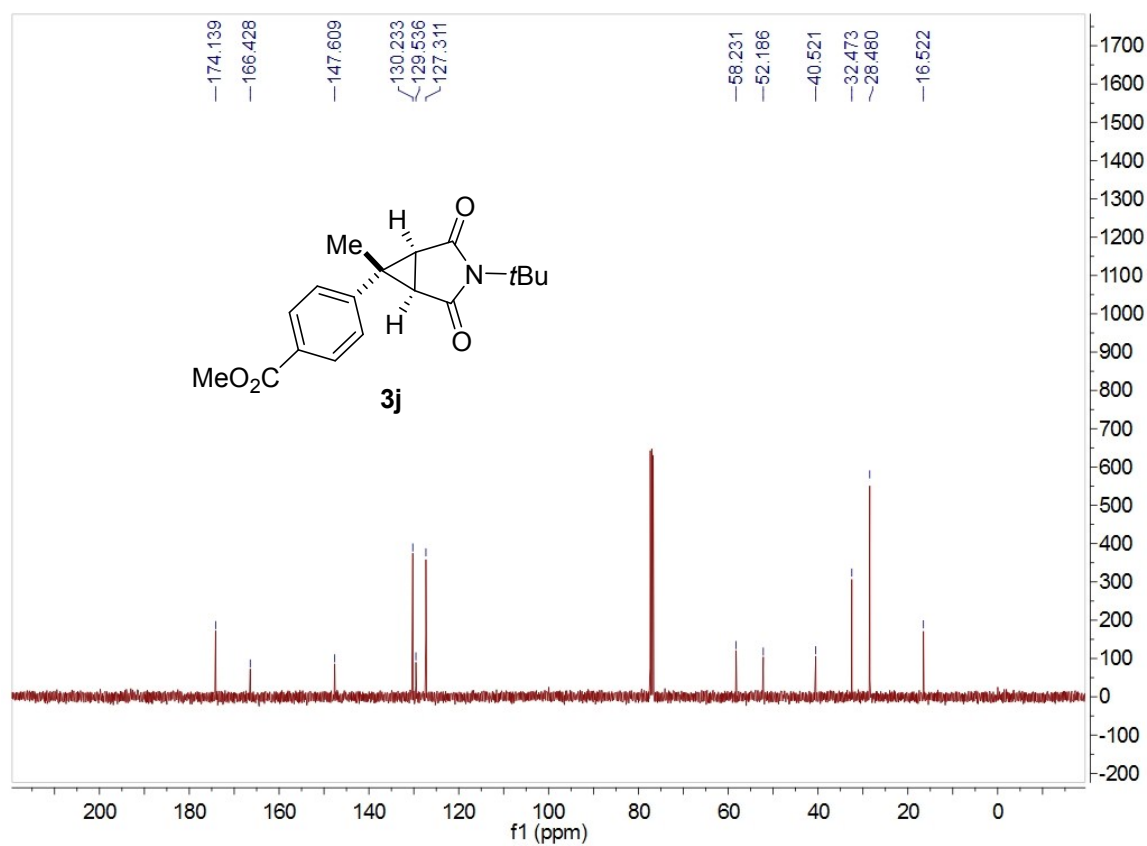
¹³C NMR (100 MHz, CDCl₃) spectrum for 3i



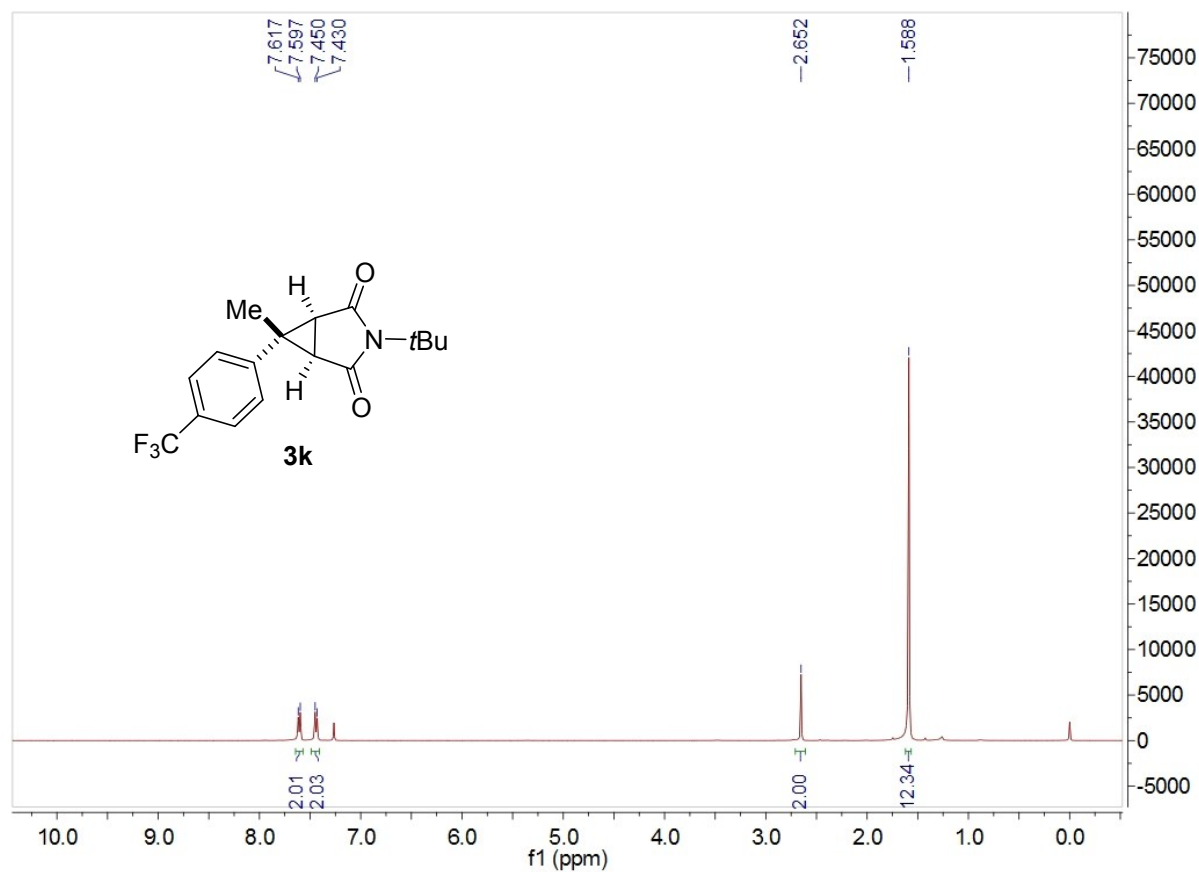
¹H NMR (400 MHz, CDCl₃) spectrum for 3j



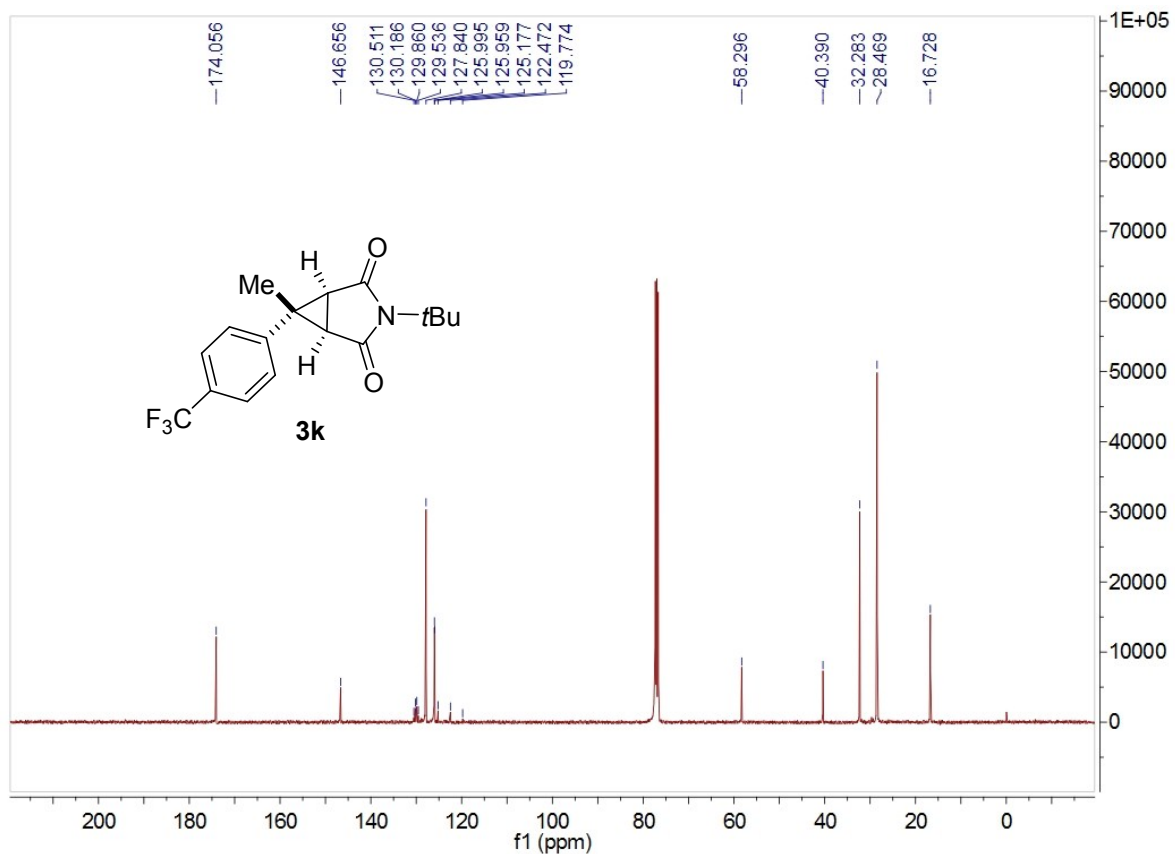
¹³C NMR (100 MHz, CDCl₃) spectrum for 3j



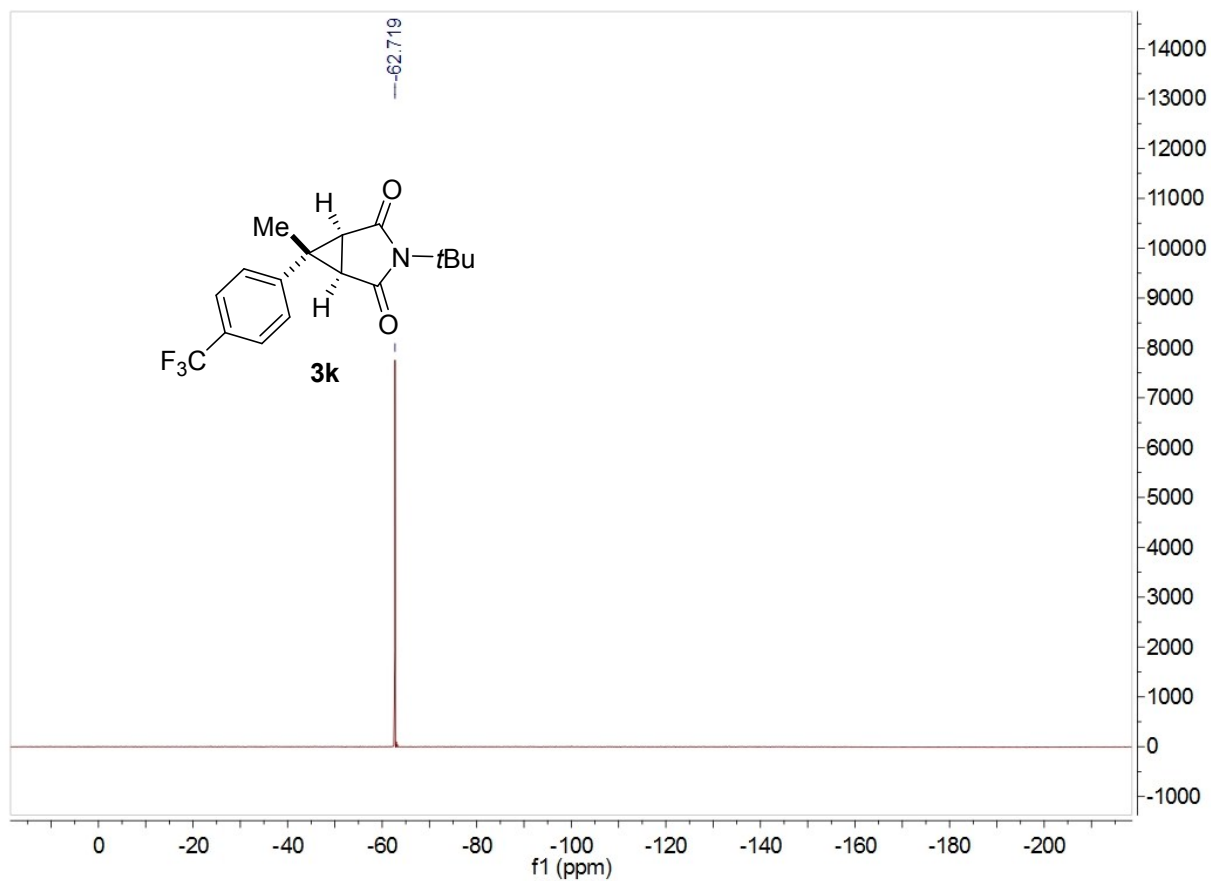
¹H NMR (400 MHz, CDCl₃) spectrum for 3k



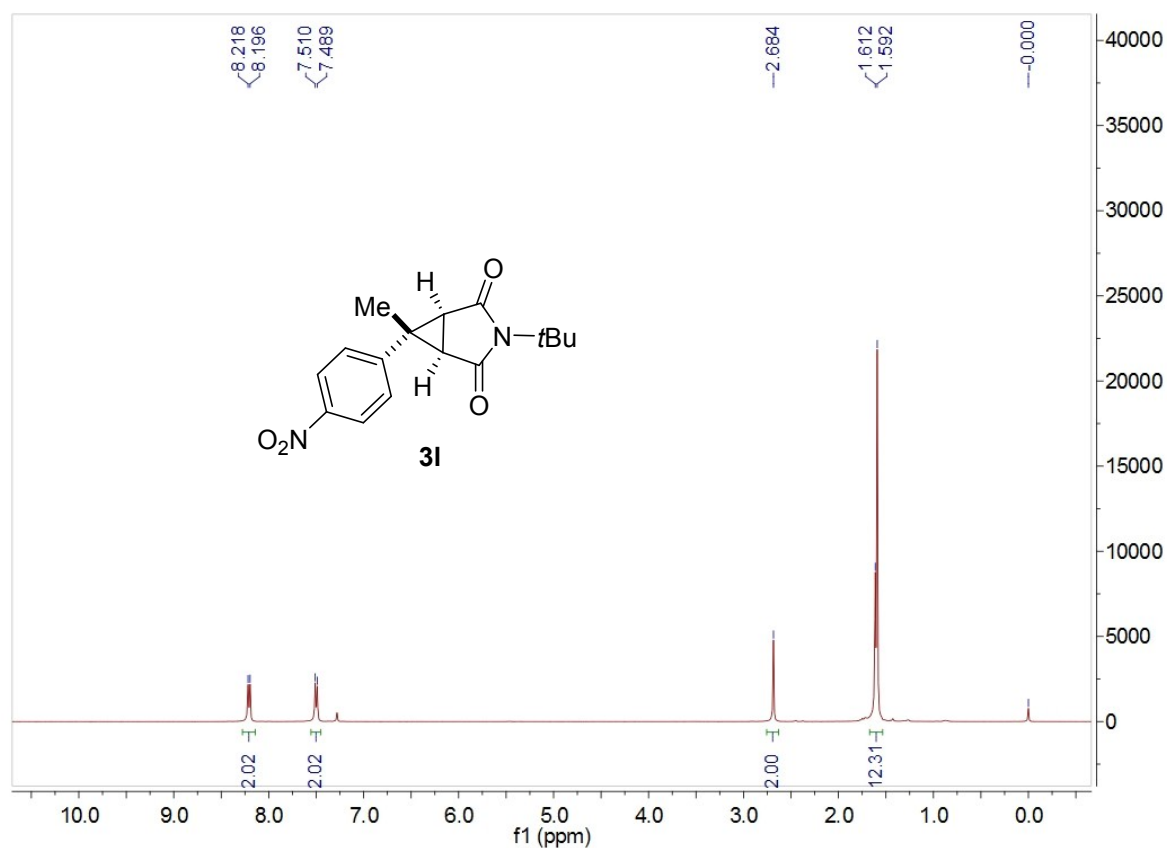
¹³C NMR (100 MHz, CDCl₃) spectrum for 3k



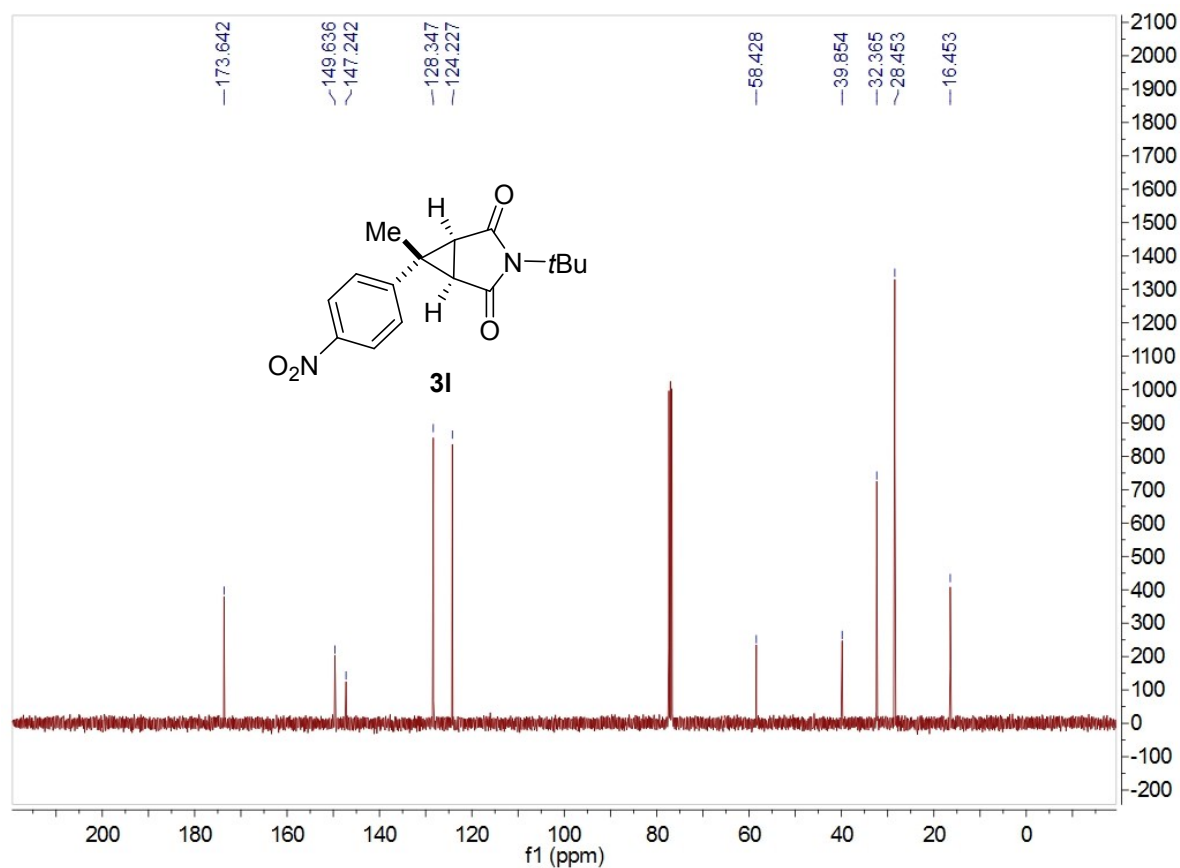
¹⁹F NMR (376 MHz, CDCl₃) spectrum for 3k



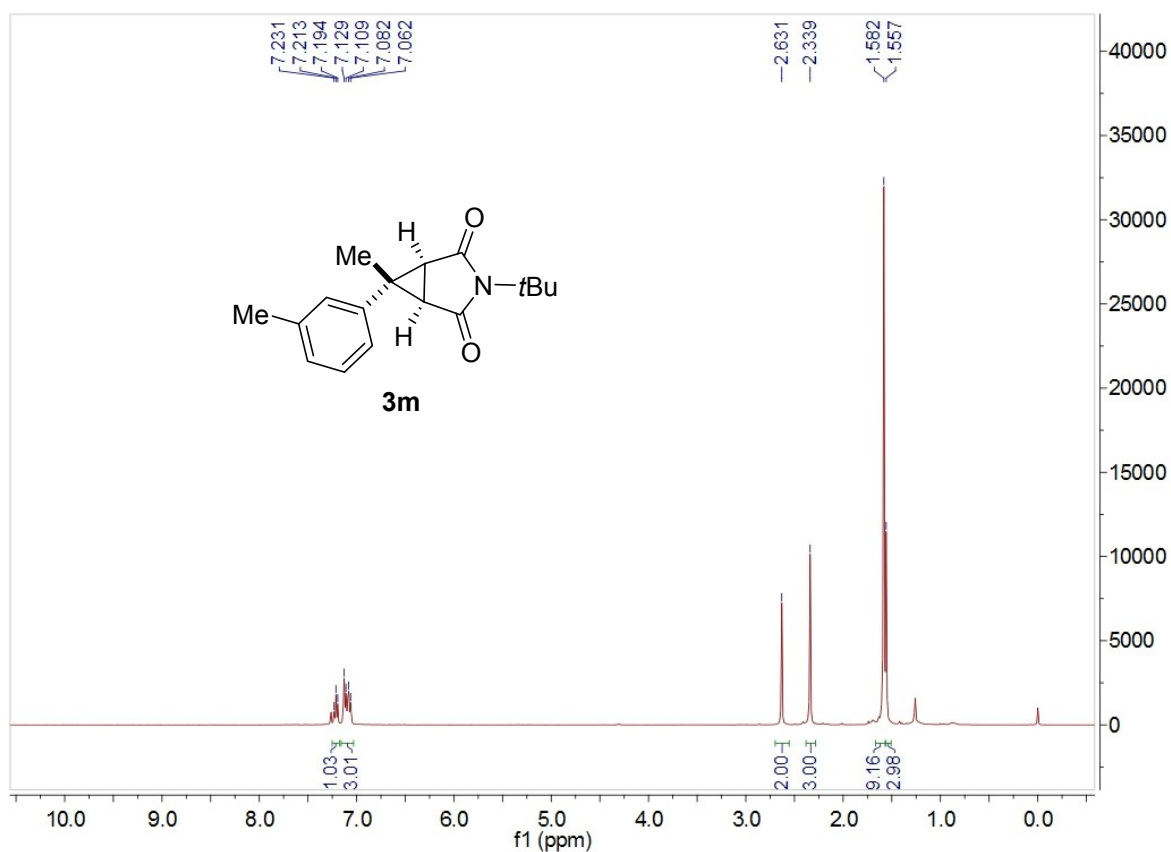
¹H NMR (400 MHz, CDCl₃) spectrum for 3I



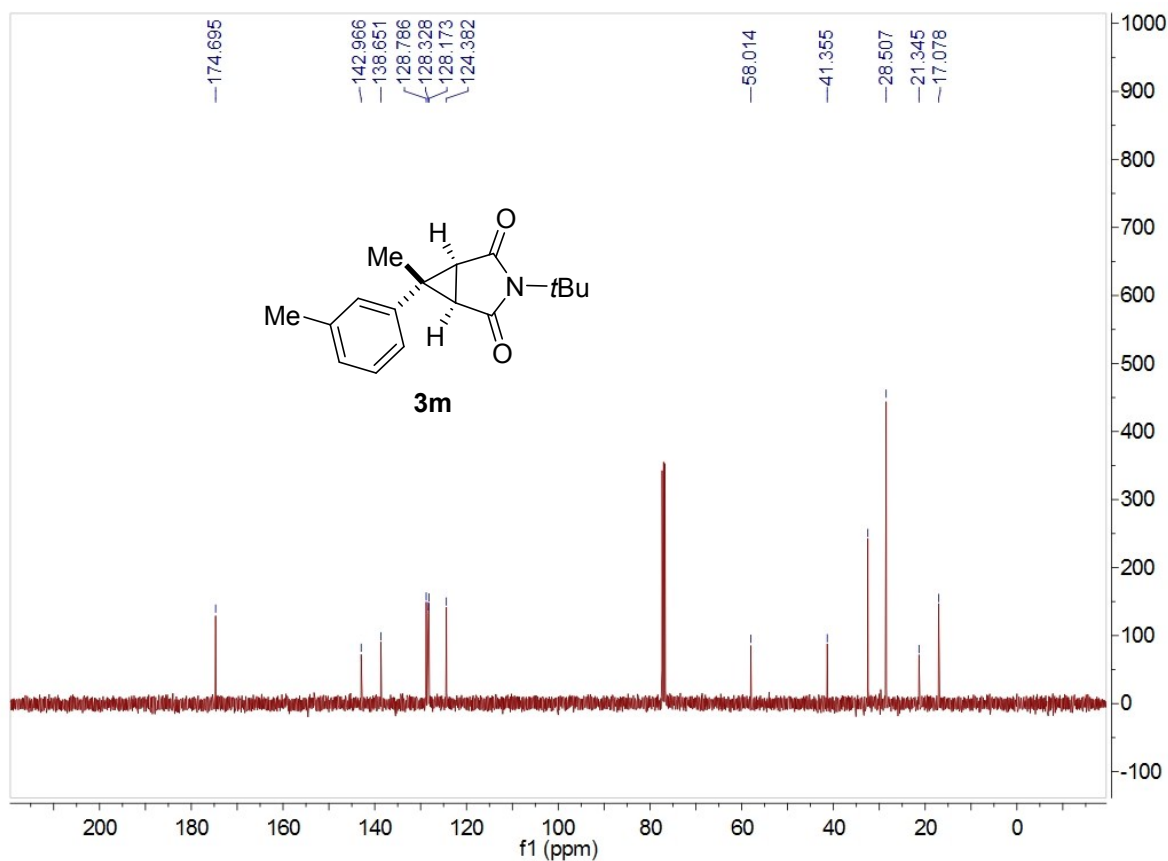
¹³C NMR (100 MHz, CDCl₃) spectrum for 3I



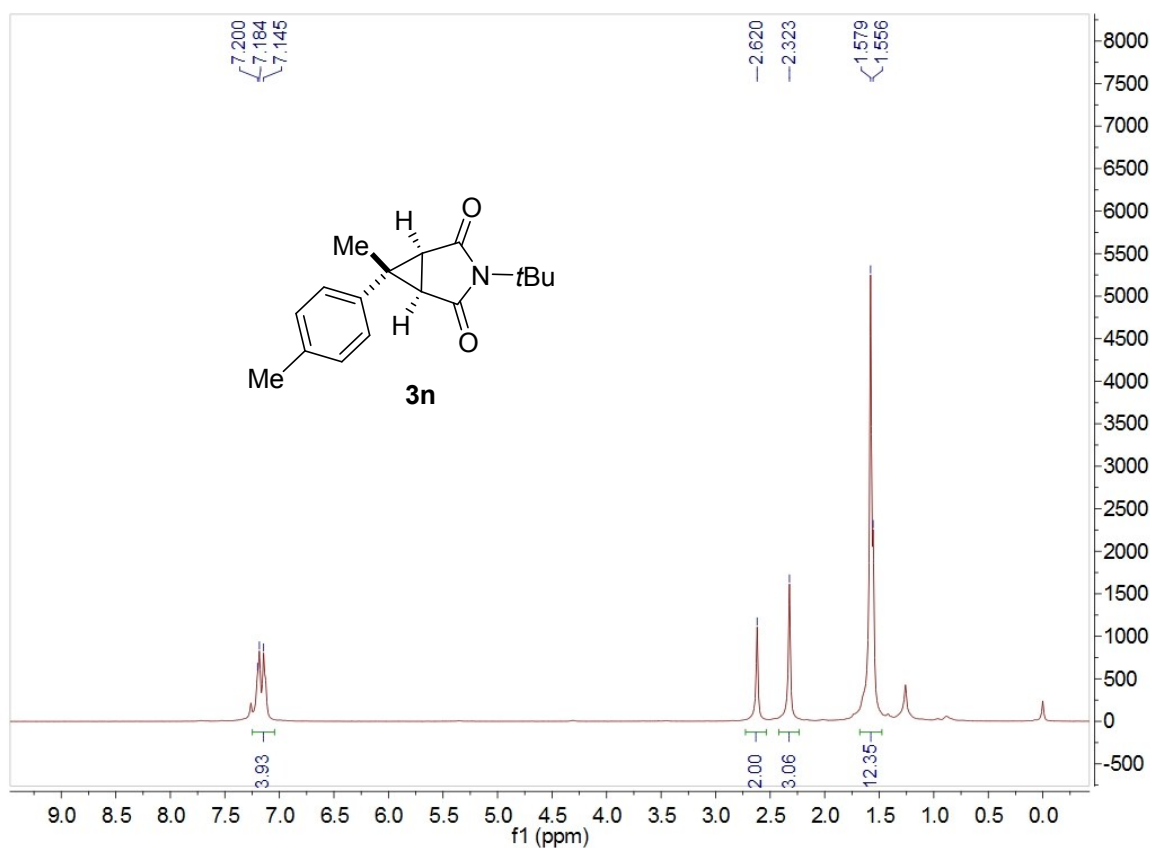
¹H NMR (400 MHz, CDCl₃) spectrum for 3m



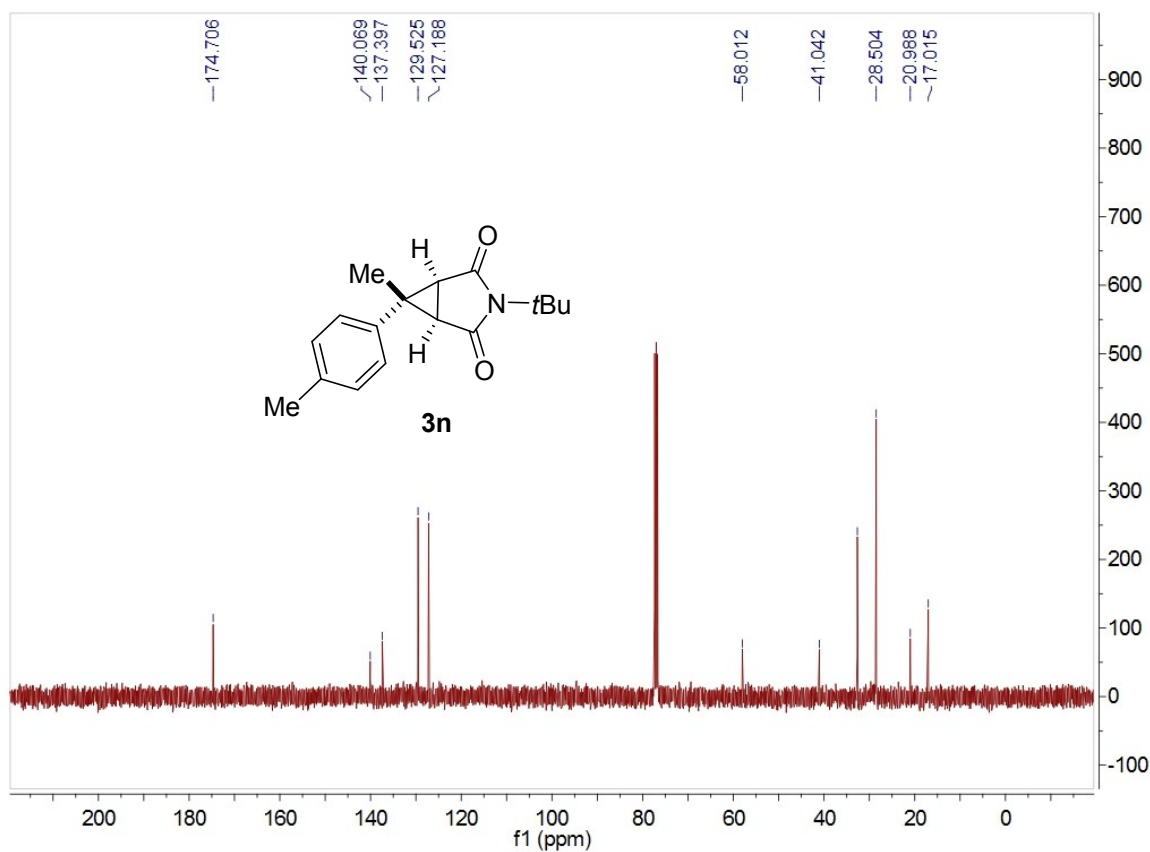
¹³C NMR (100 MHz, CDCl₃) spectrum for 3m



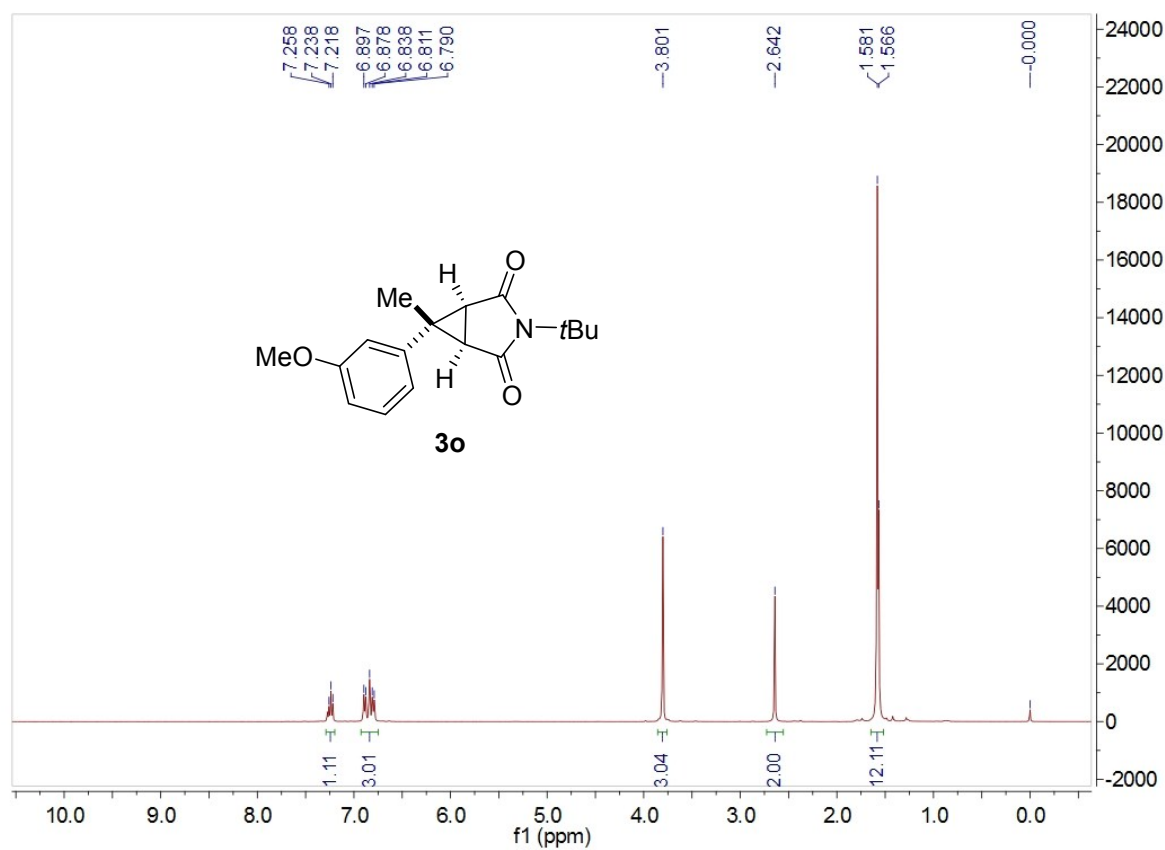
¹H NMR (400 MHz, CDCl₃) spectrum for 3n



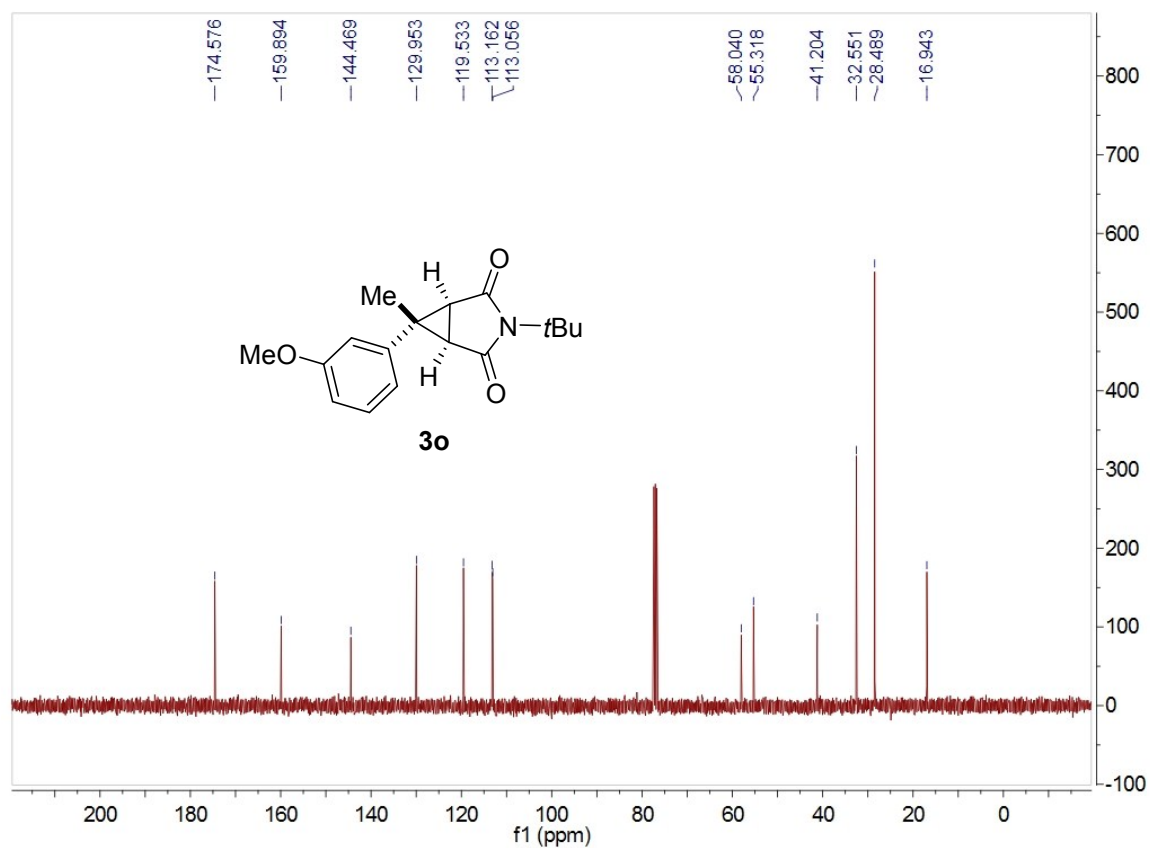
¹³C NMR (100 MHz, CDCl₃) spectrum for 3n



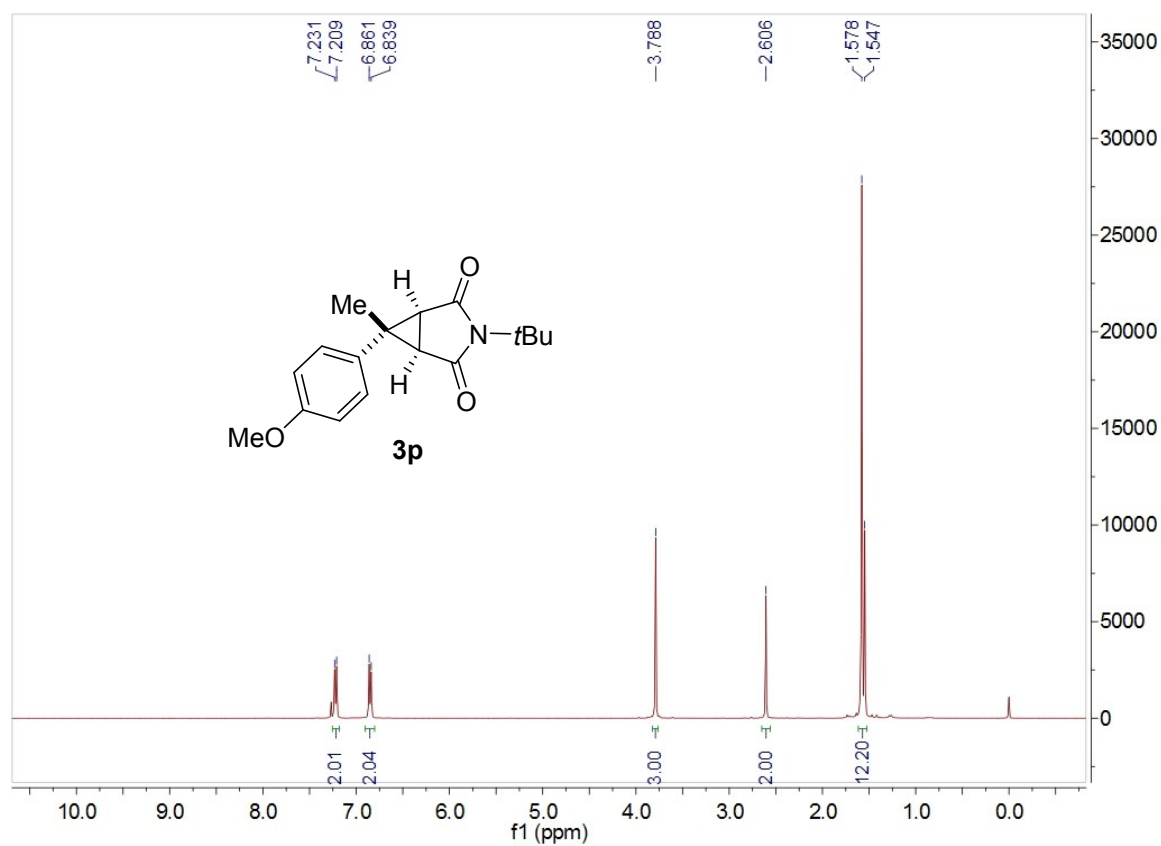
¹H NMR (400 MHz, CDCl₃) spectrum for 3o



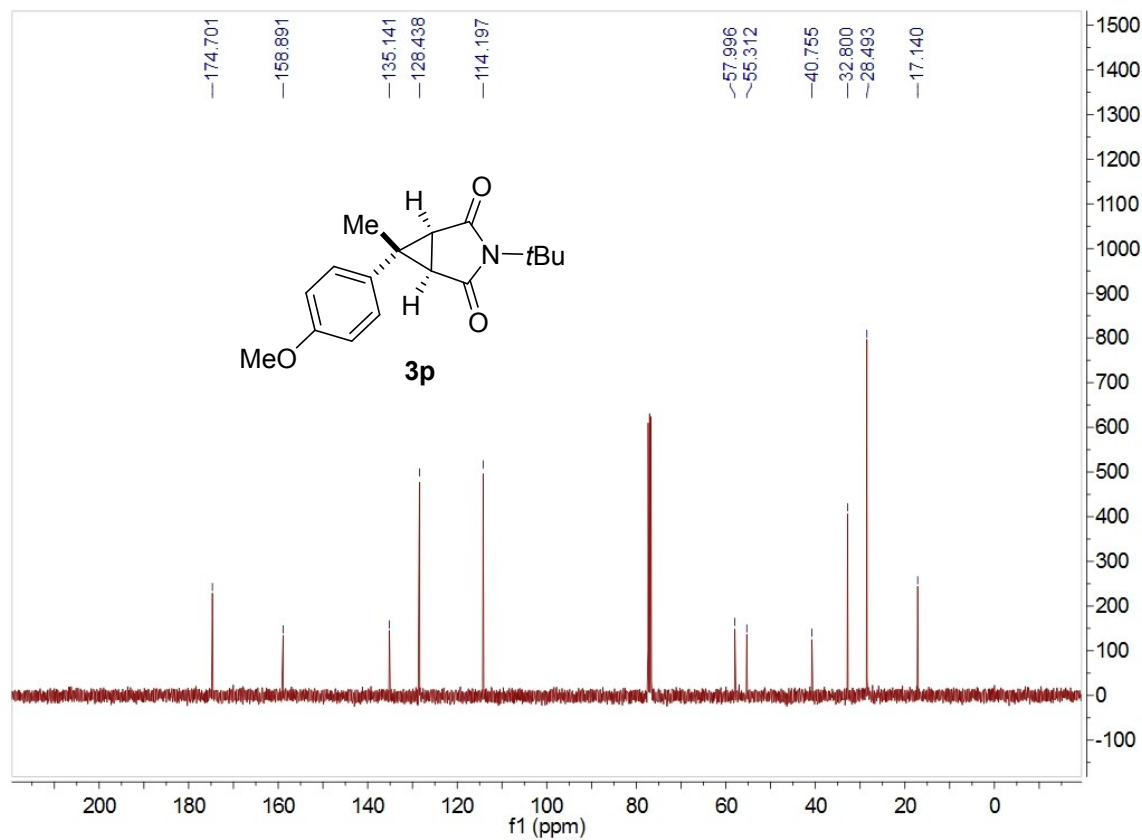
¹³C NMR (100 MHz, CDCl₃) spectrum for 3o



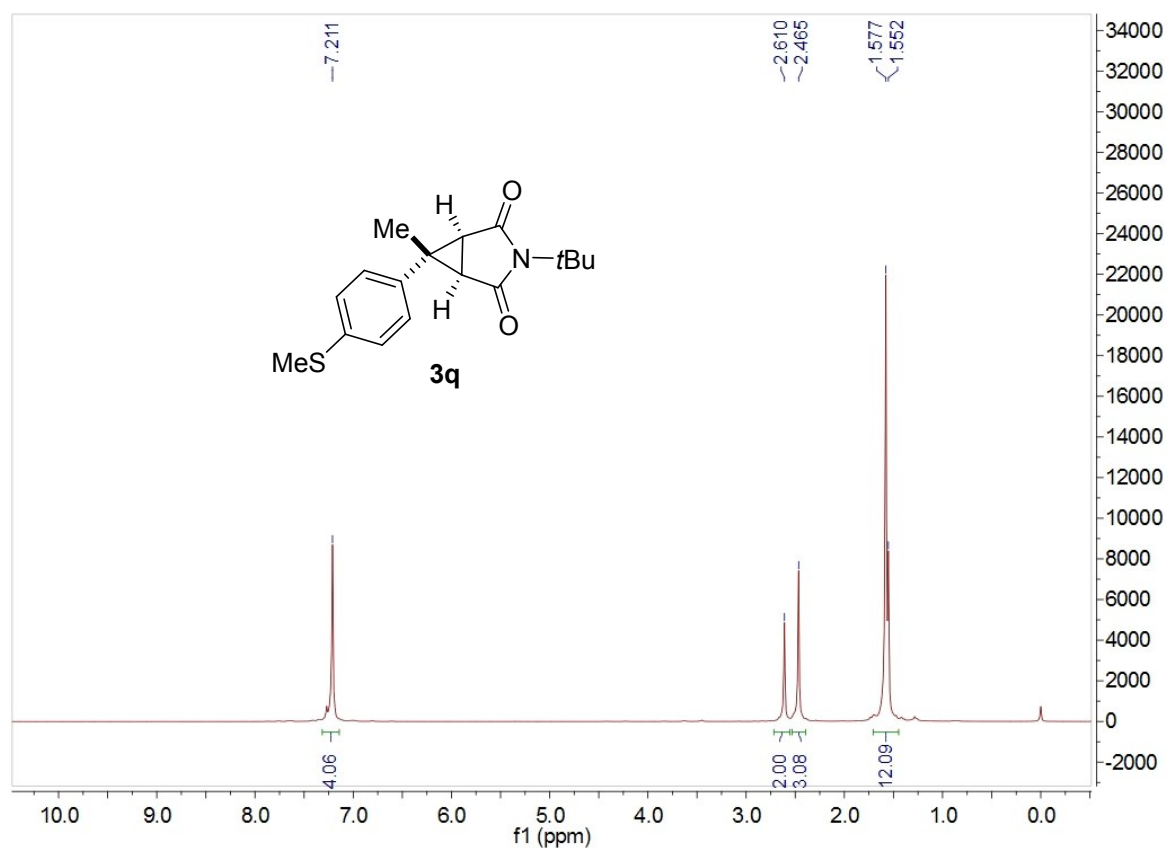
¹H NMR (400 MHz, CDCl₃) spectrum for 3p



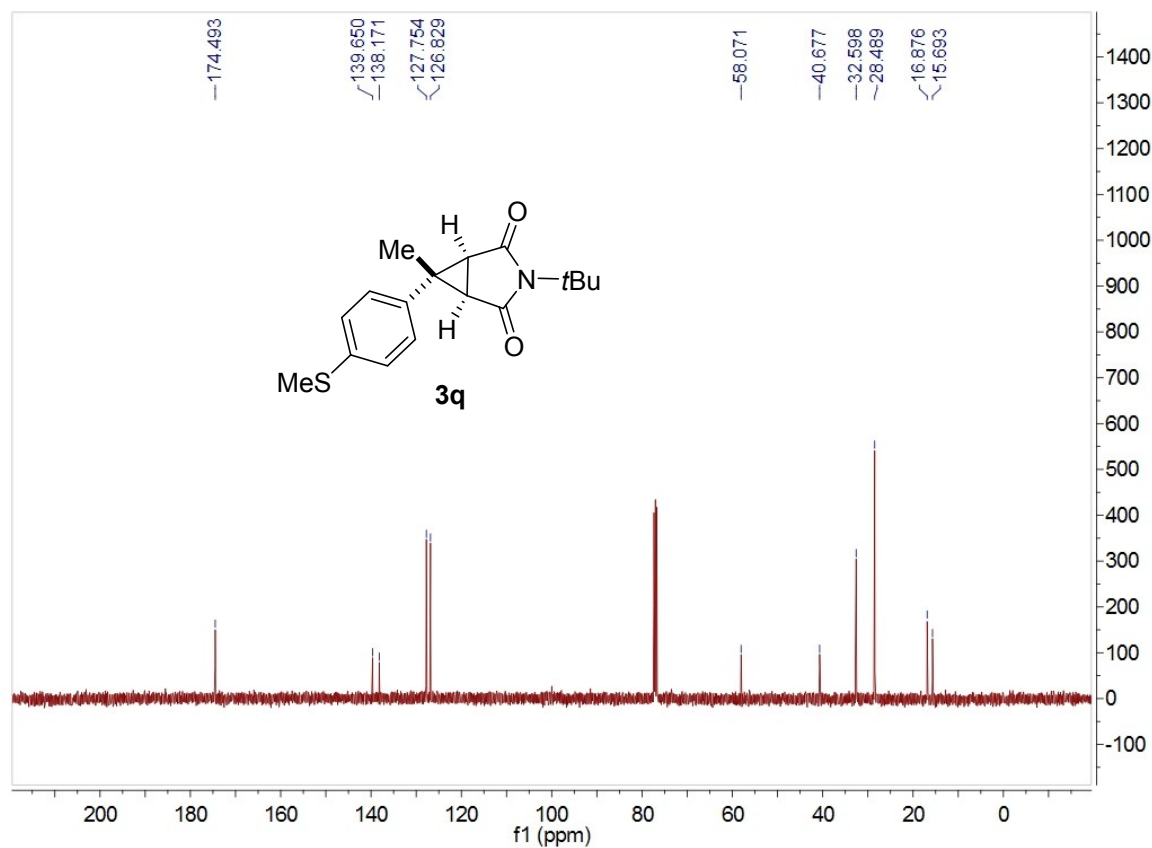
¹³C NMR (100 MHz, CDCl₃) spectrum for 3p



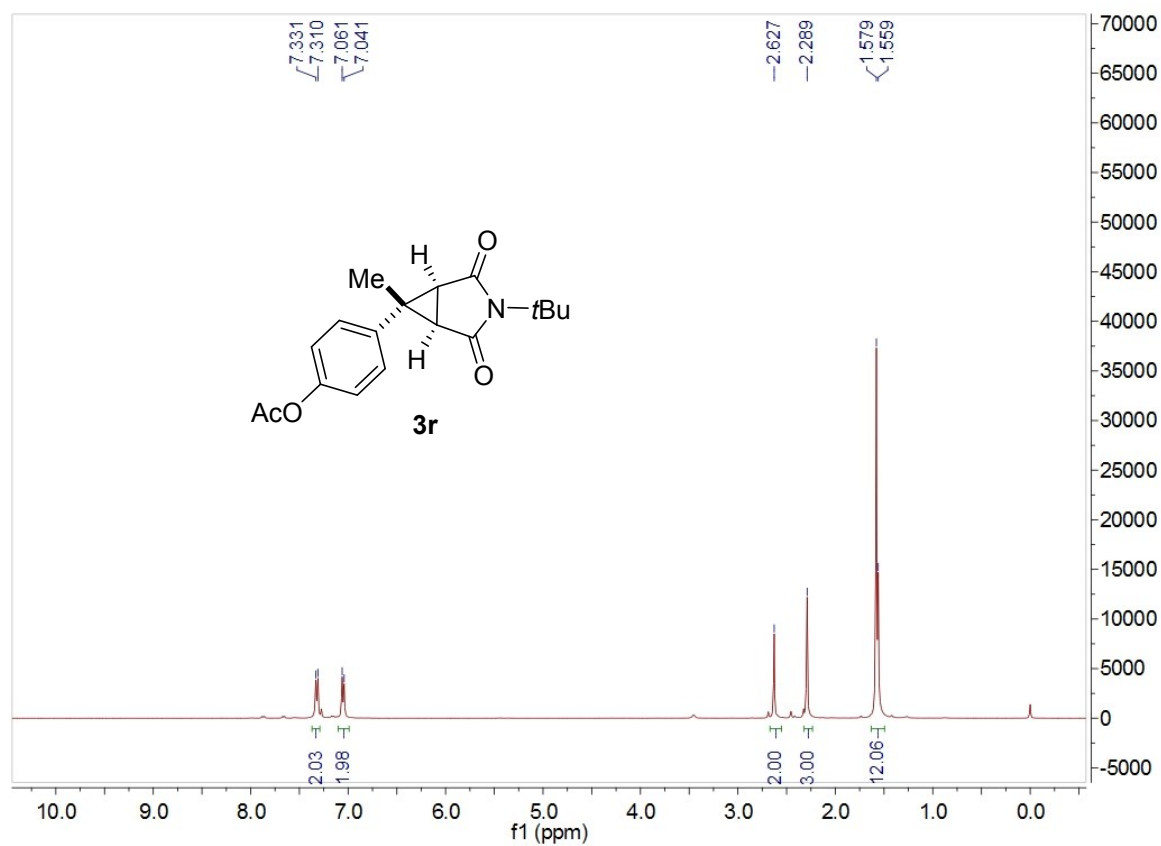
¹H NMR (400 MHz, CDCl₃) spectrum for 3q



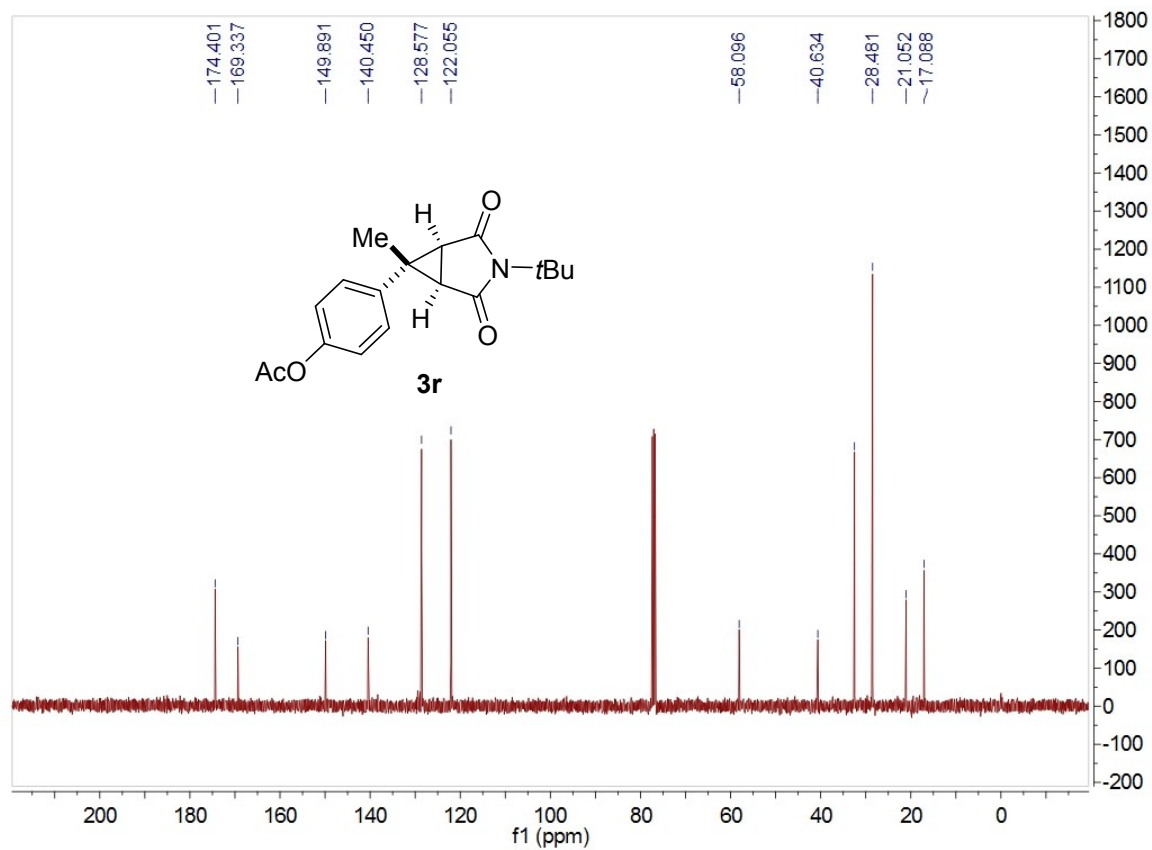
¹³C NMR (100 MHz, CDCl₃) spectrum for 3q



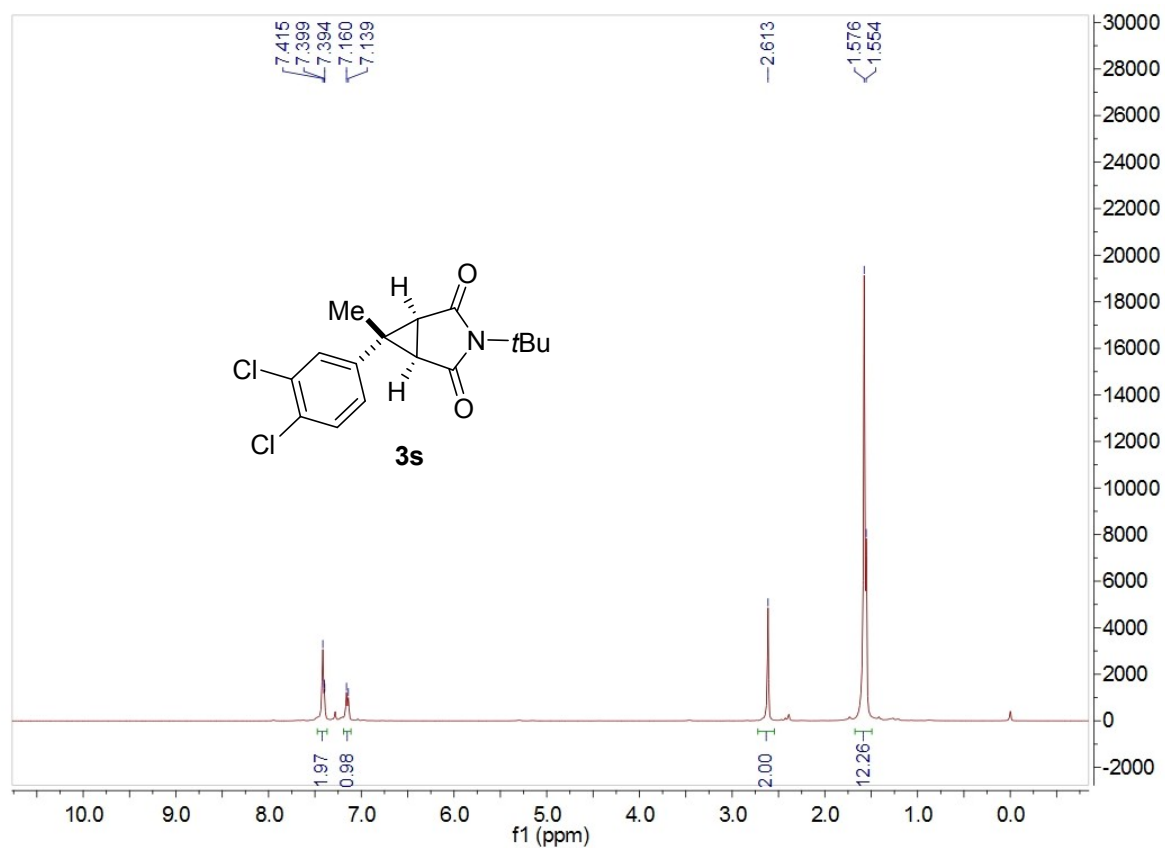
¹H NMR (400 MHz, CDCl₃) spectrum for 3r



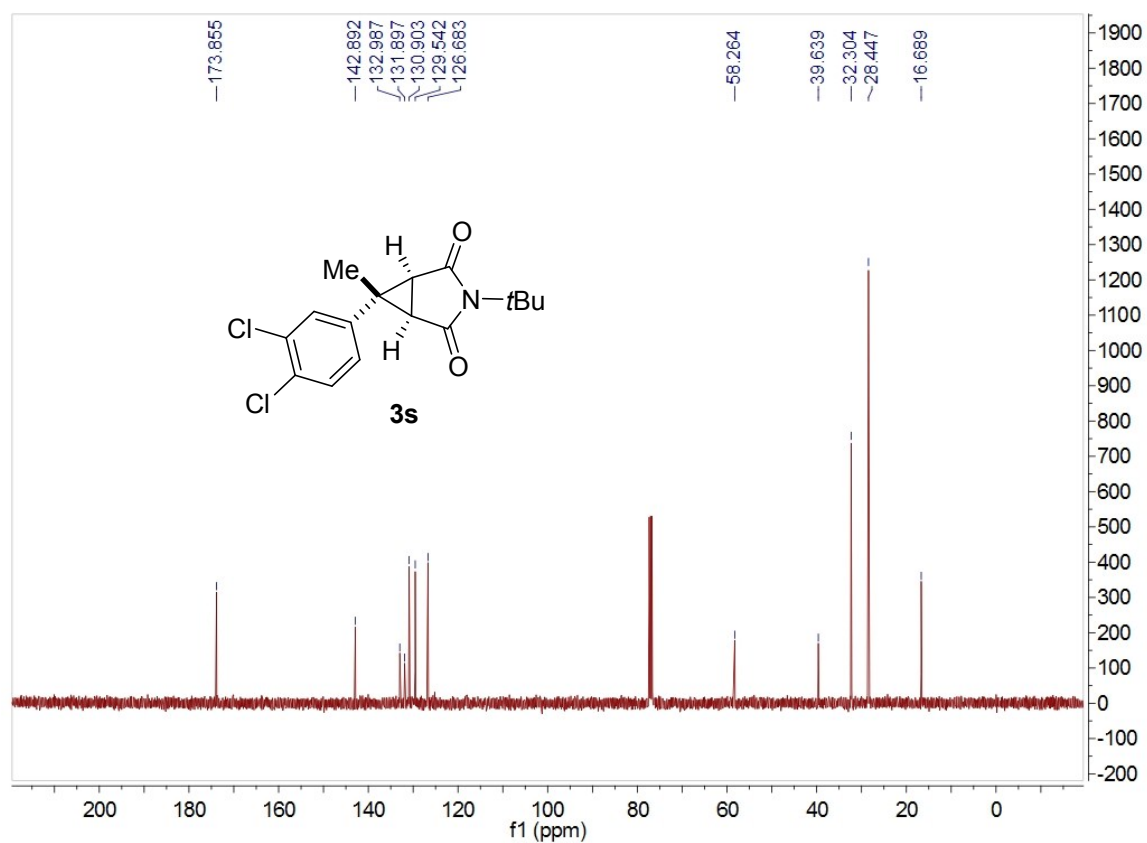
¹³C NMR (100 MHz, CDCl₃) spectrum for 3r



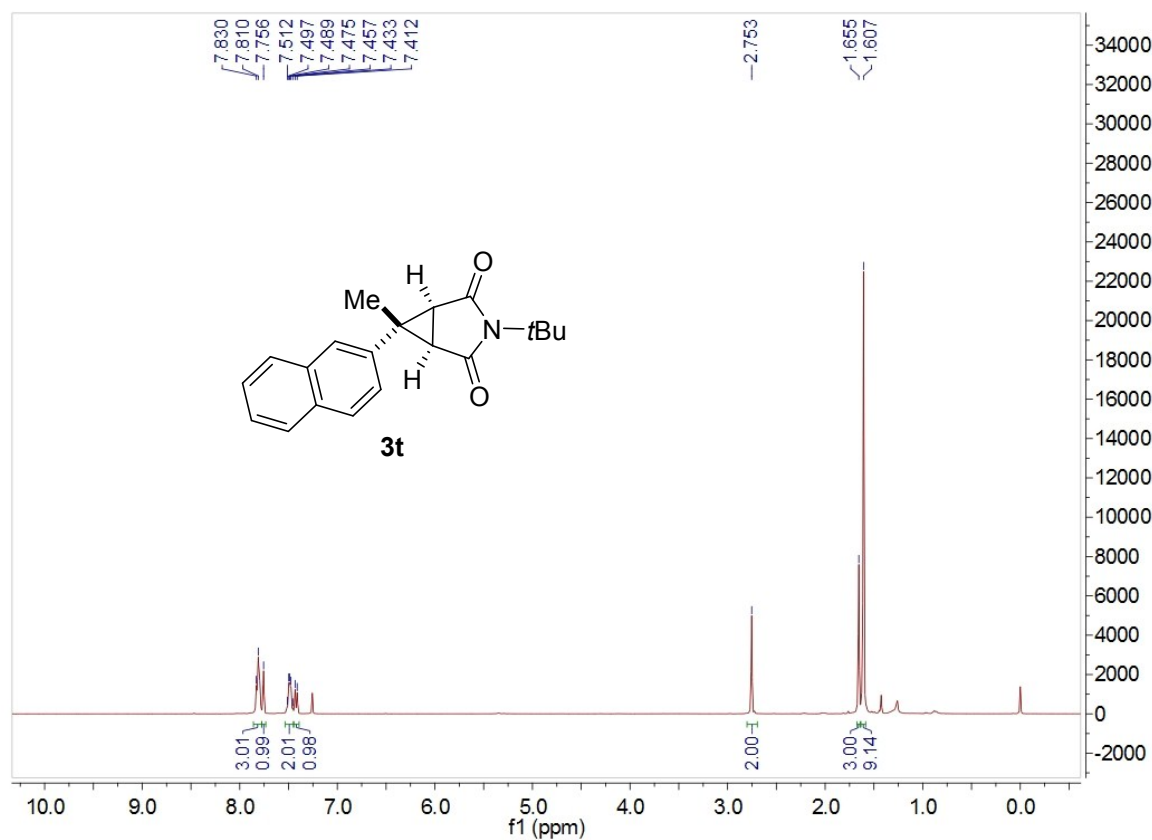
¹H NMR (400 MHz, CDCl₃) spectrum for 3s



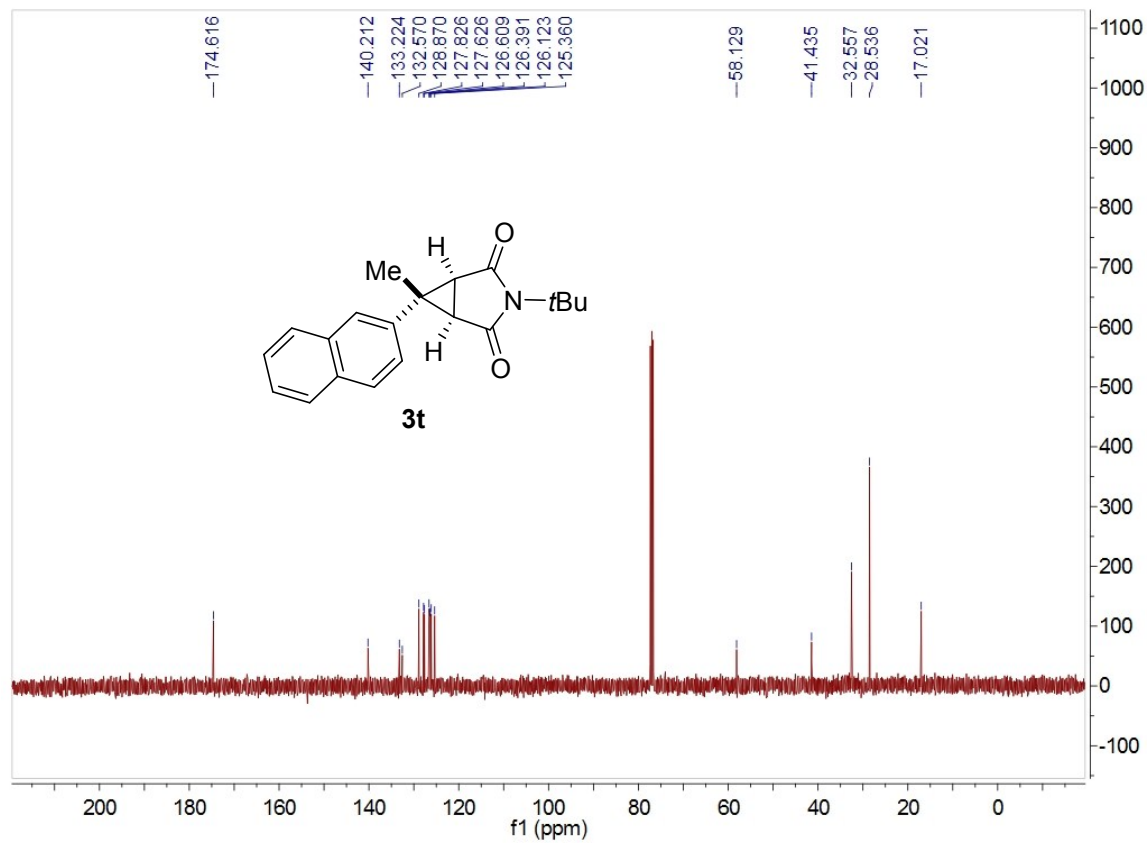
¹³C NMR (100 MHz, CDCl₃) spectrum for 3s



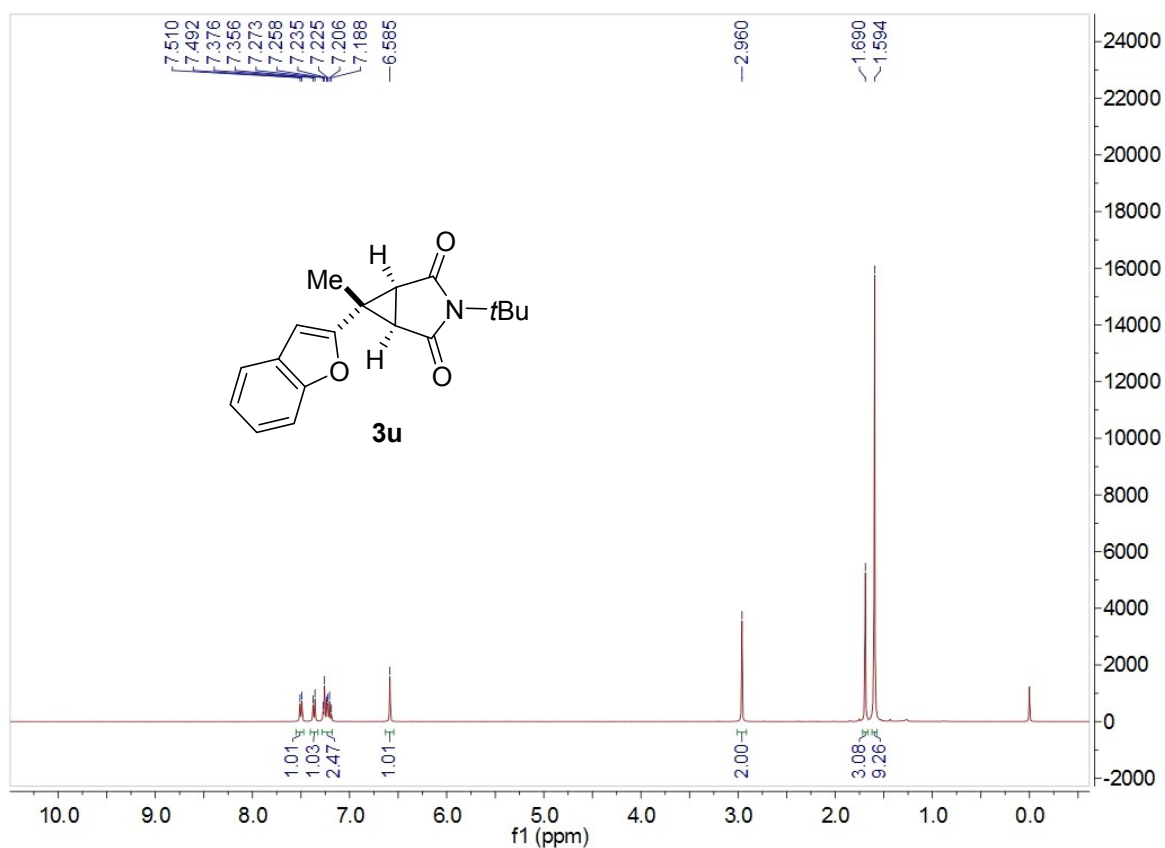
¹H NMR (400 MHz, CDCl₃) spectrum for 3t



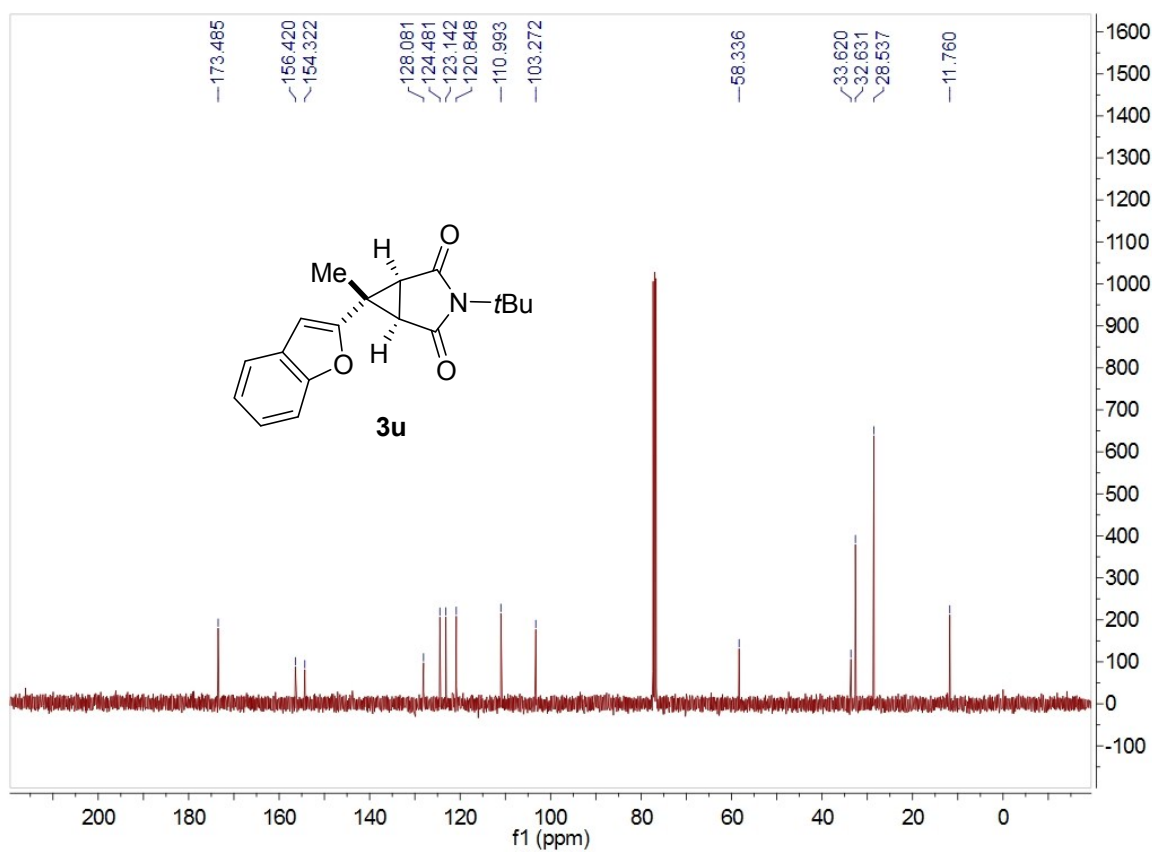
¹³C NMR (100 MHz, CDCl₃) spectrum for 3t



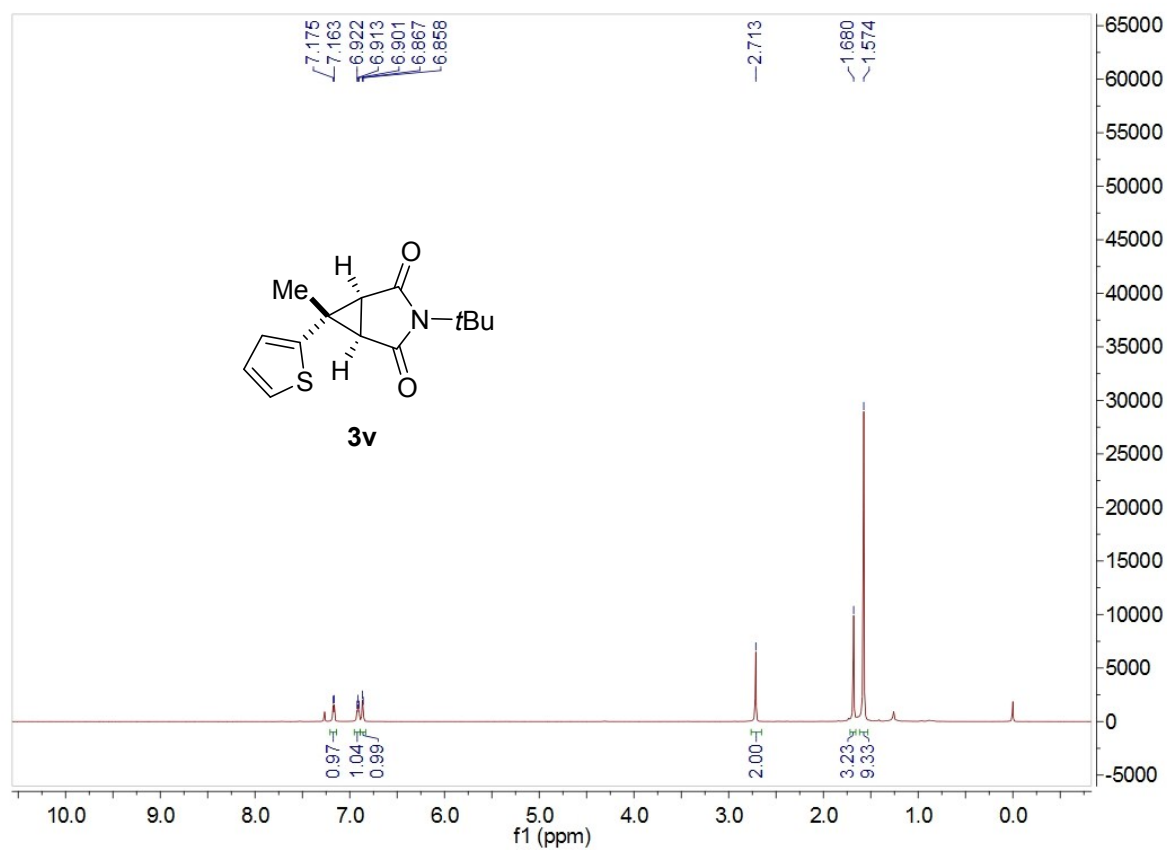
¹H NMR (400 MHz, CDCl₃) spectrum for 3u



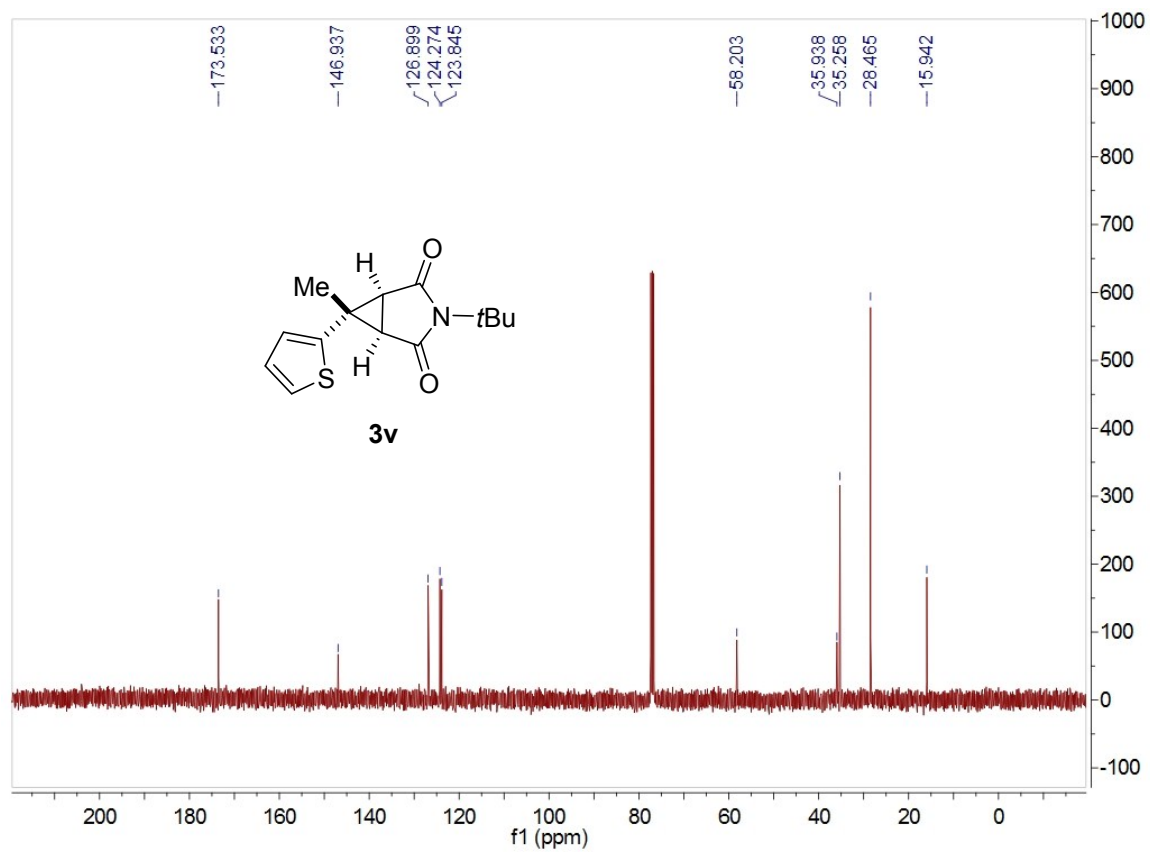
¹³C NMR (100 MHz, CDCl₃) spectrum for 3u



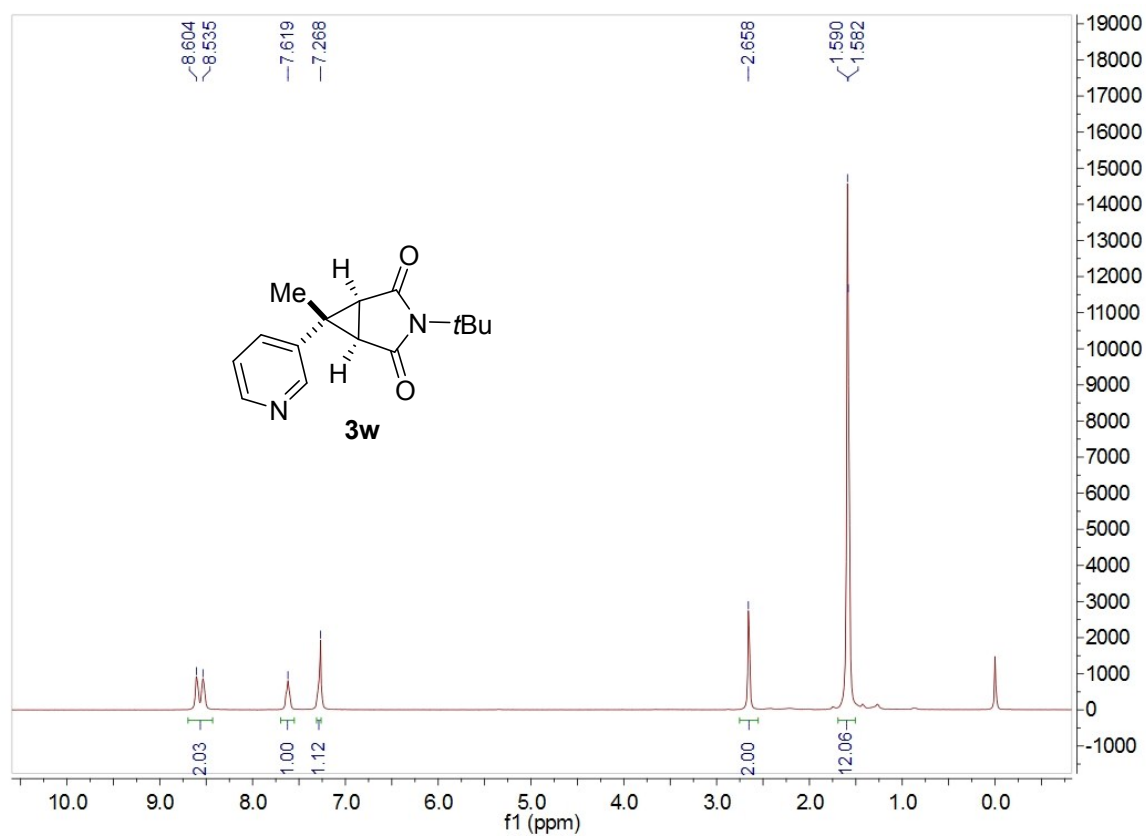
¹H NMR (400 MHz, CDCl₃) spectrum for 3v



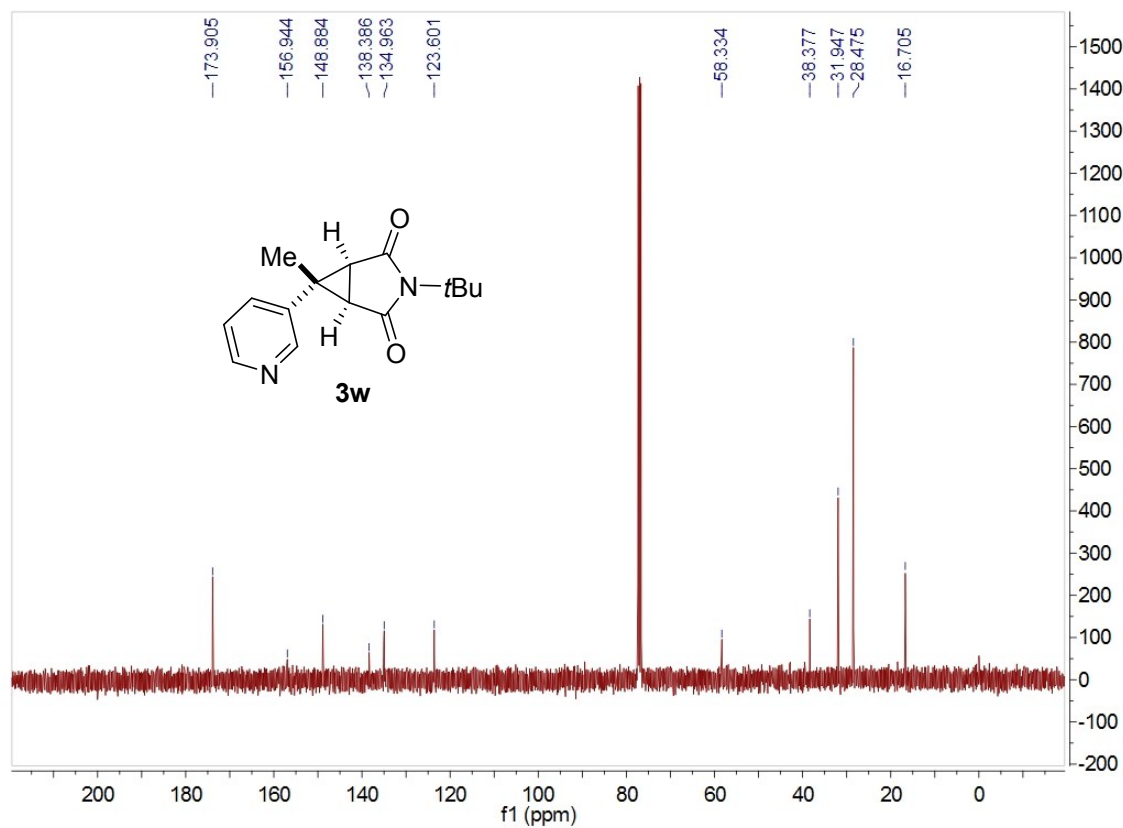
¹³C NMR (100 MHz, CDCl₃) spectrum for 3v



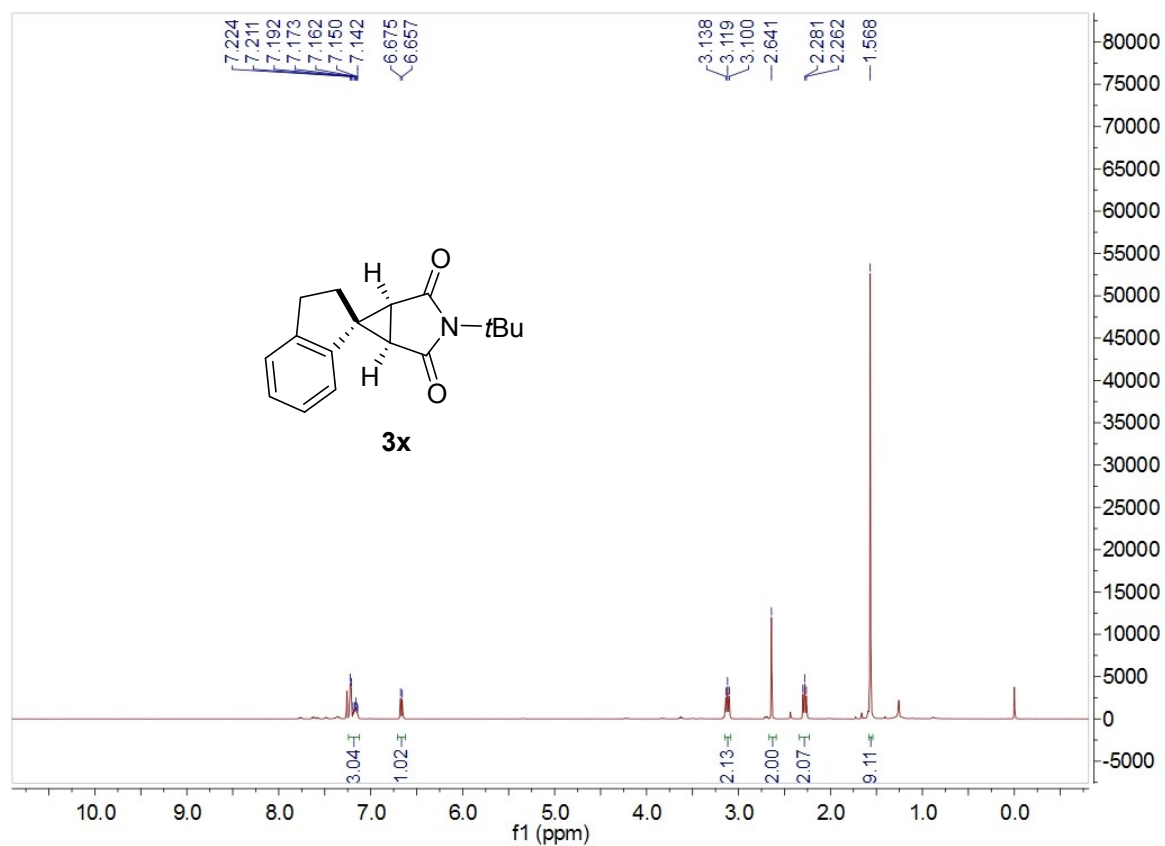
¹H NMR (400 MHz, CDCl₃) spectrum for 3w



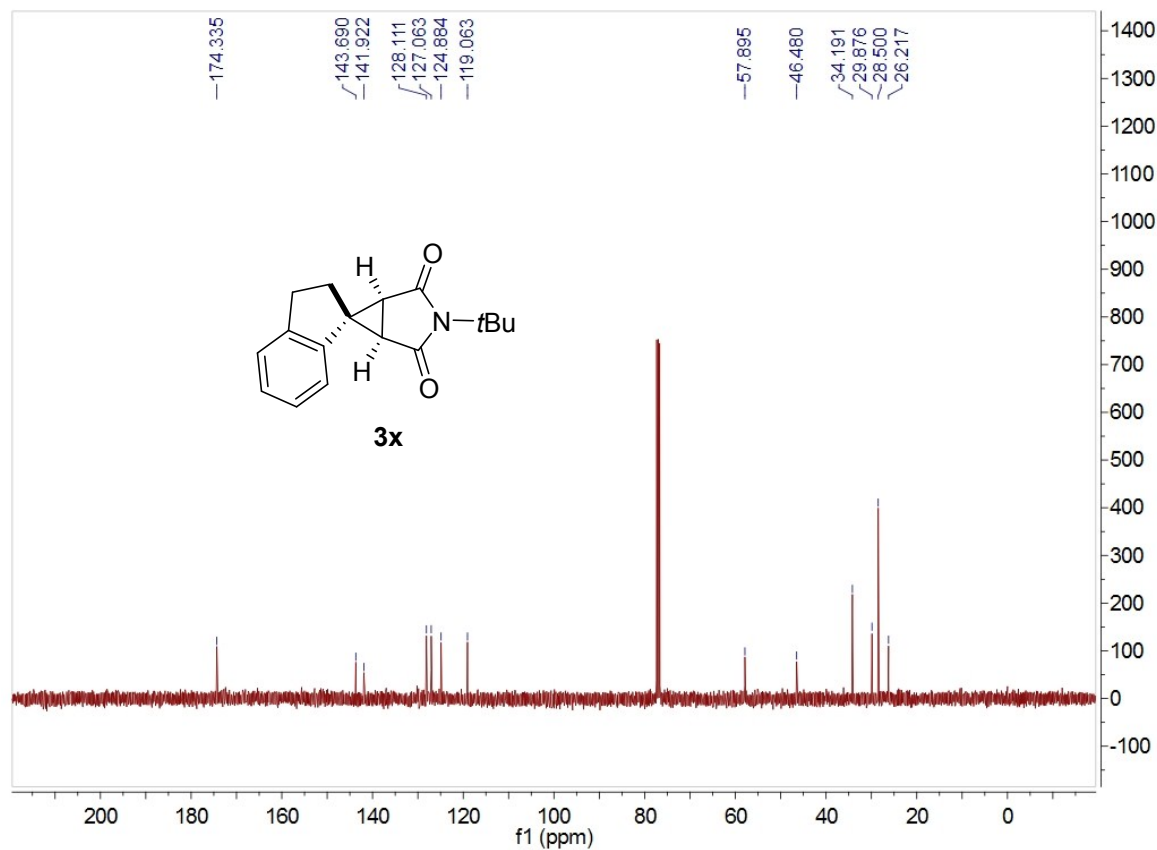
¹³C NMR (100 MHz, CDCl₃) spectrum for 3w



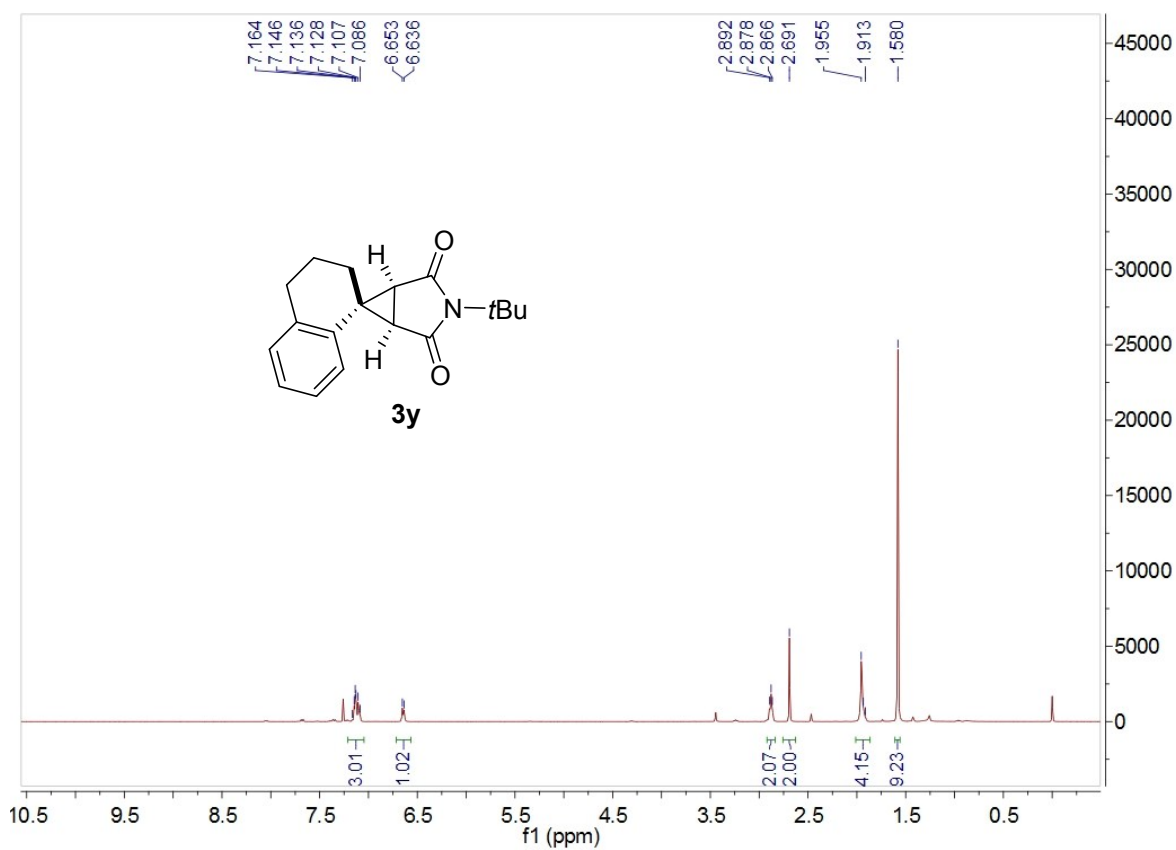
¹H NMR (400 MHz, CDCl₃) spectrum for 3x



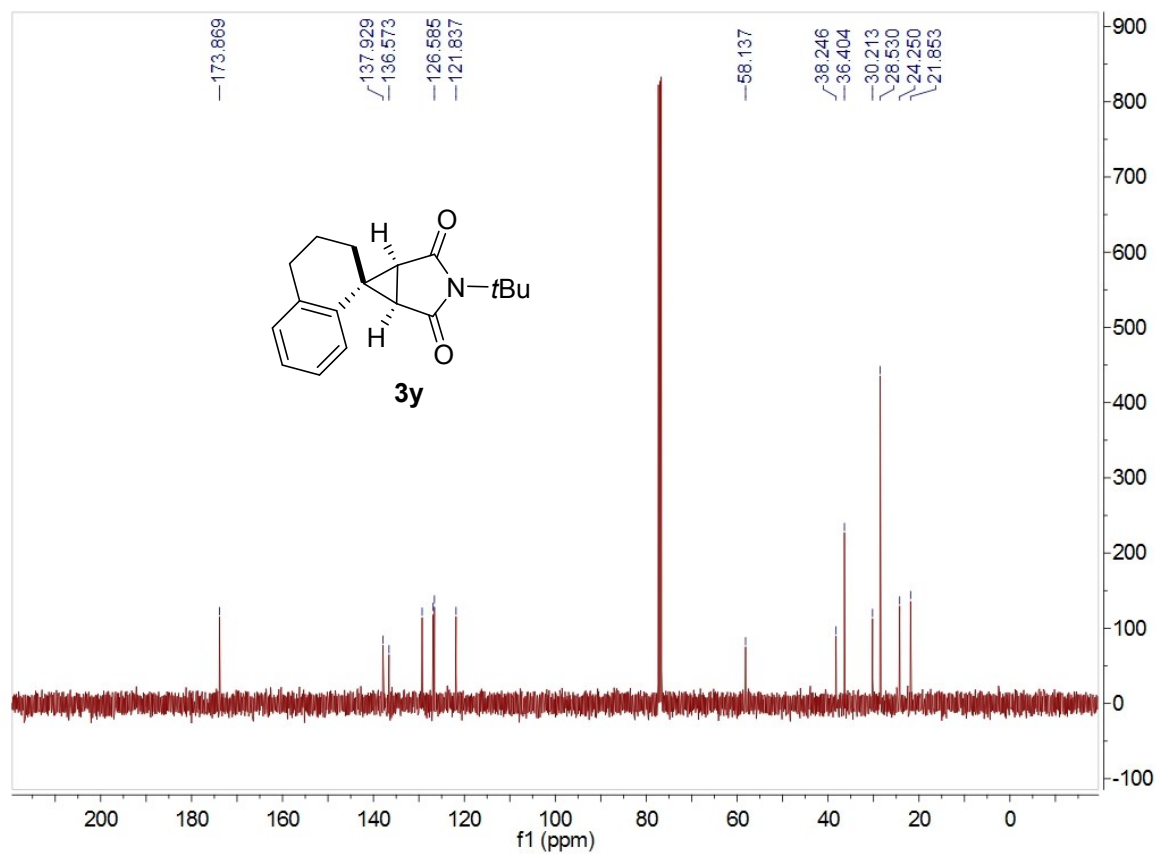
¹³C NMR (100 MHz, CDCl₃) spectrum for 3x



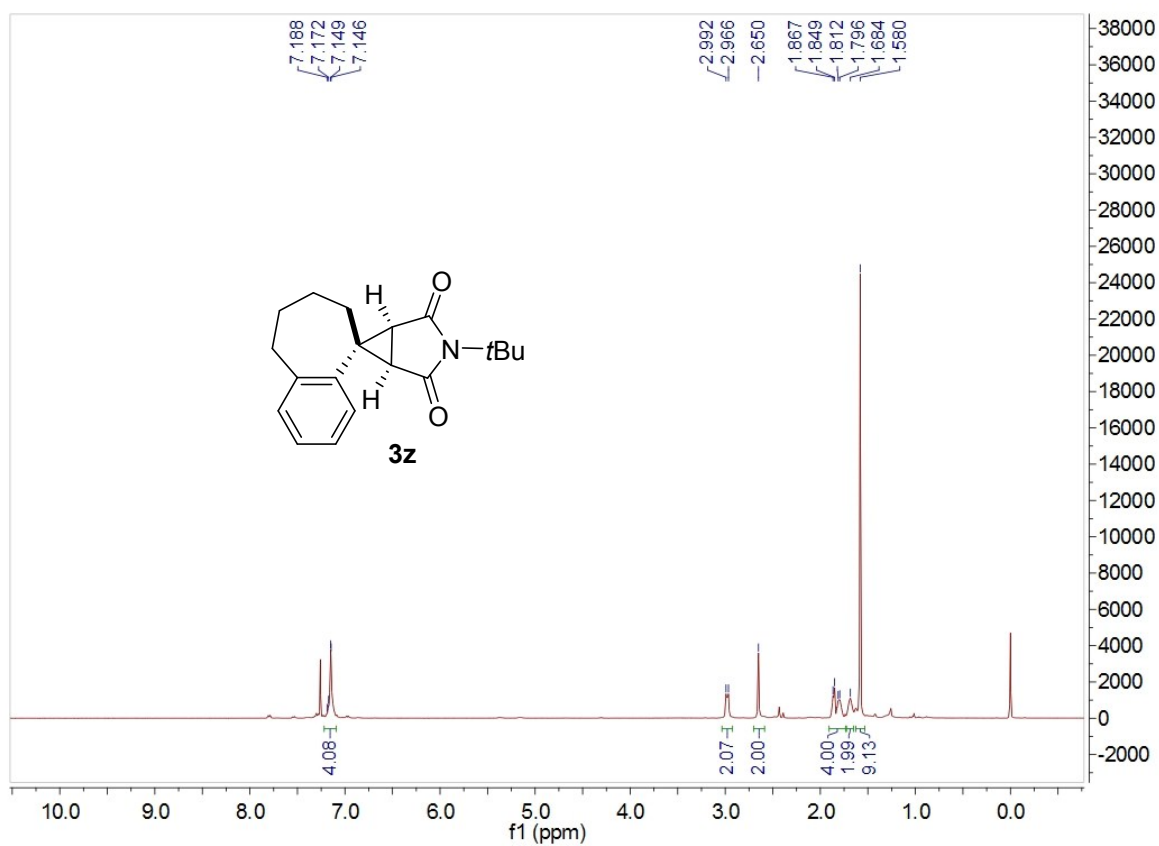
¹H NMR (400 MHz, CDCl₃) spectrum for 3y



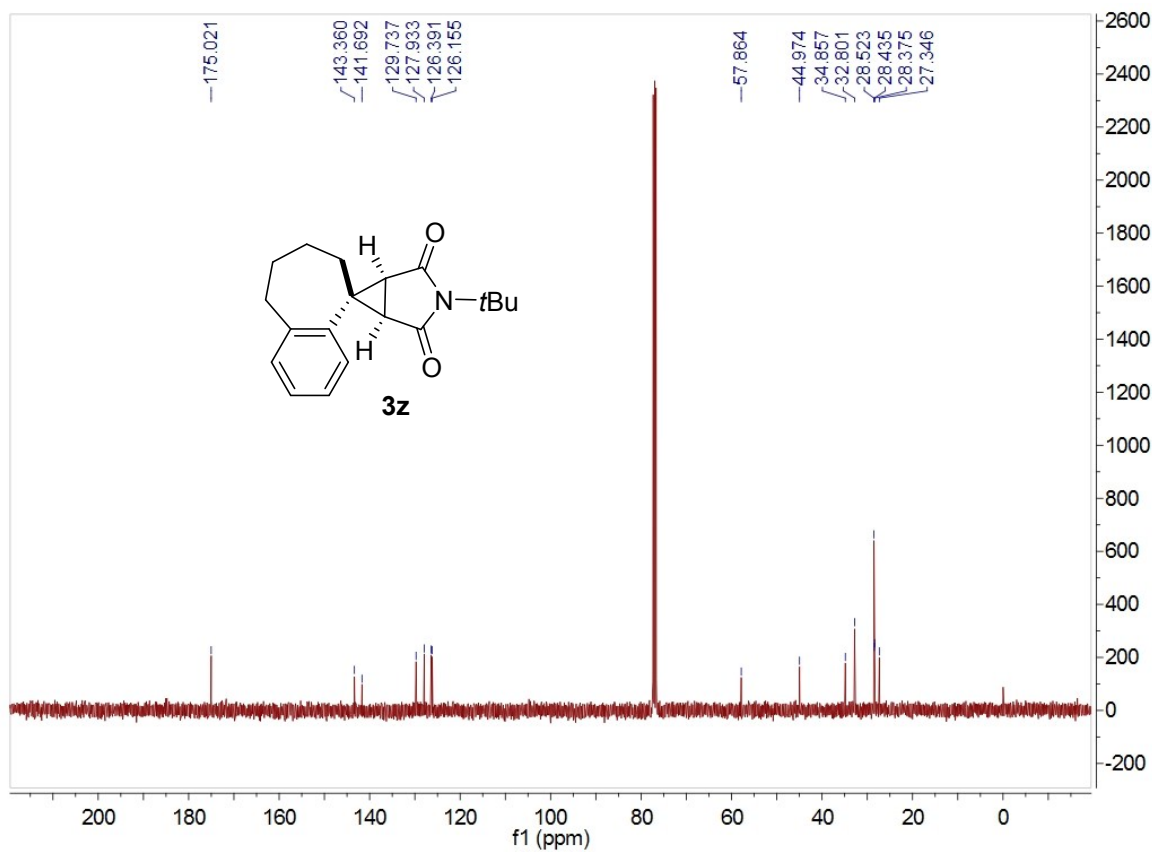
¹³C NMR (100 MHz, CDCl₃) spectrum for 3y



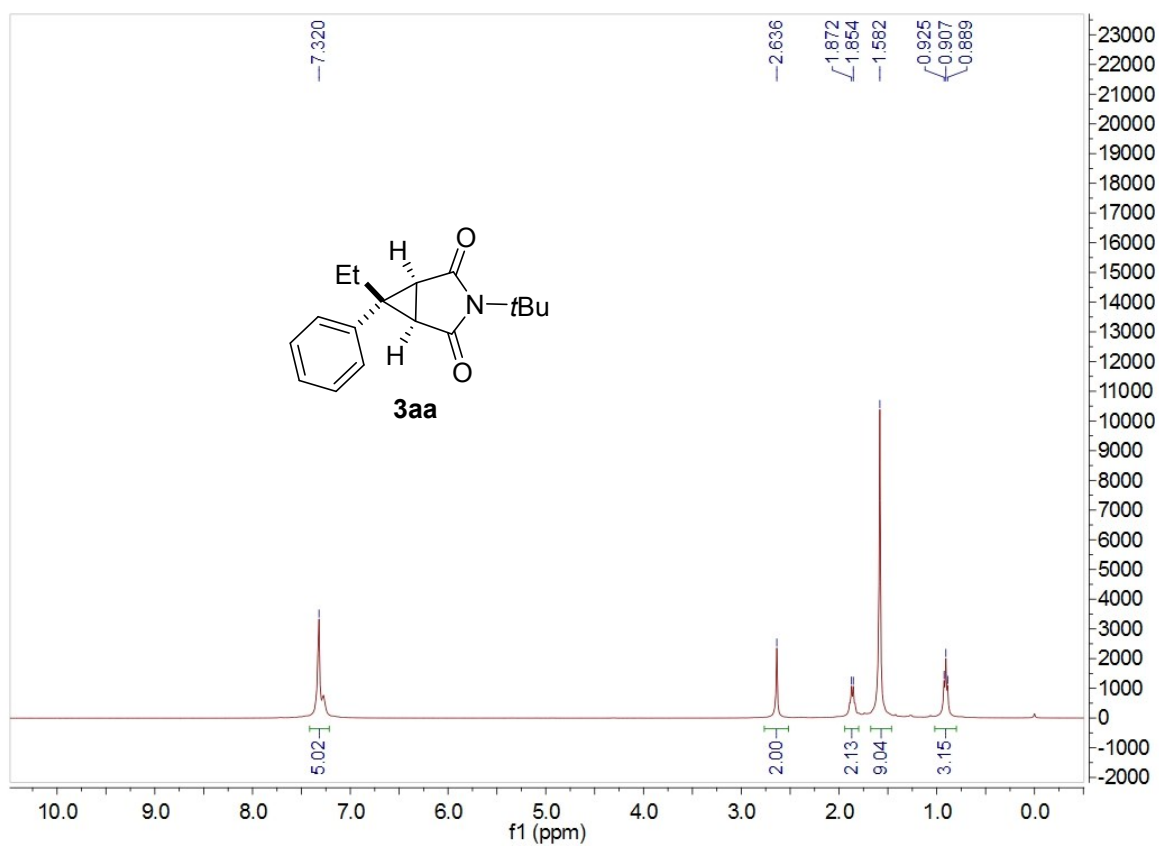
¹H NMR (400 MHz, CDCl₃) spectrum for 3z



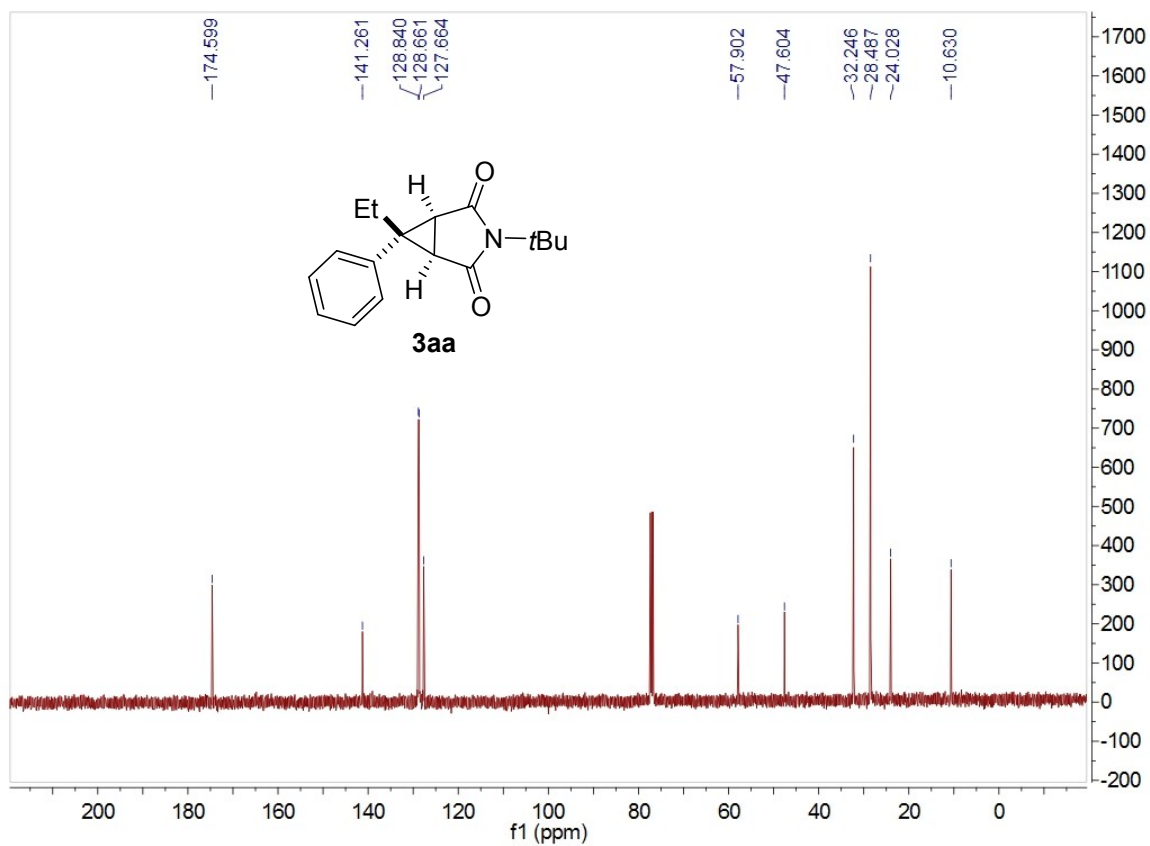
¹³C NMR (100 MHz, CDCl₃) spectrum for 3z



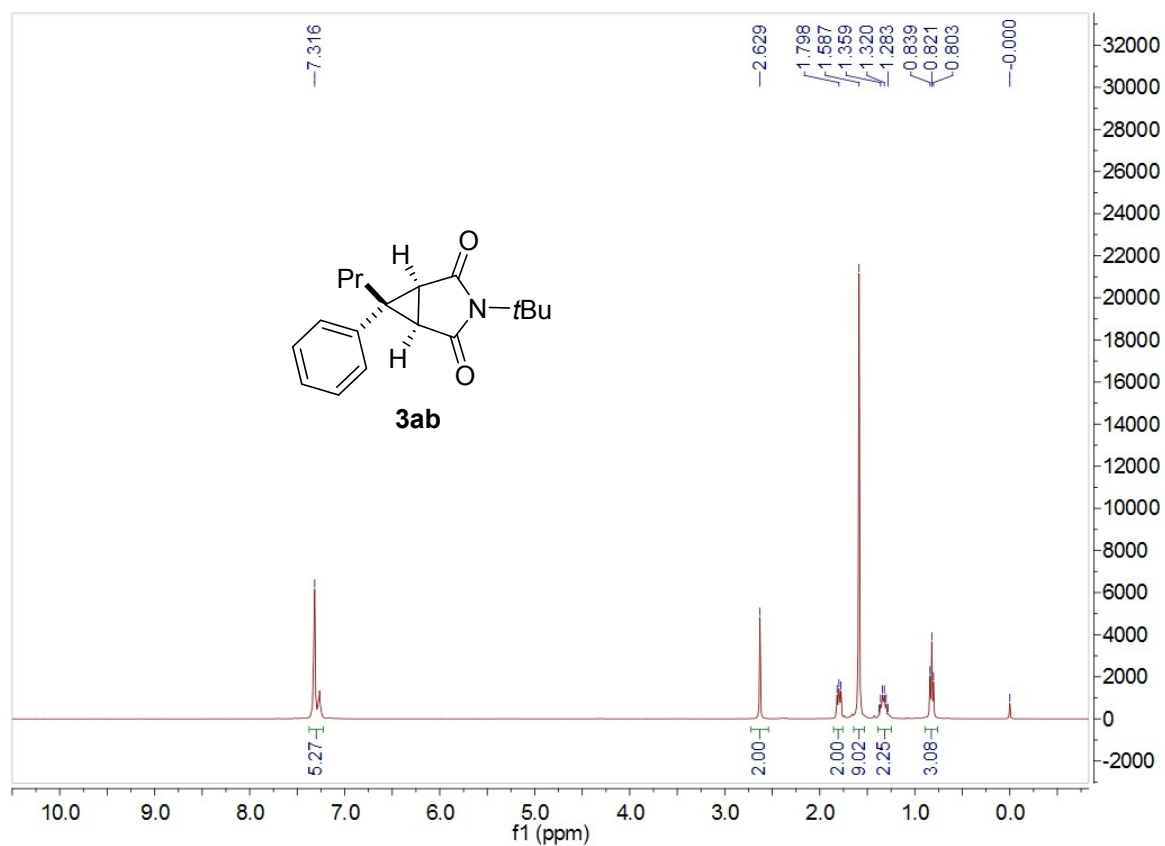
¹H NMR (400 MHz, CDCl₃) spectrum for 3aa



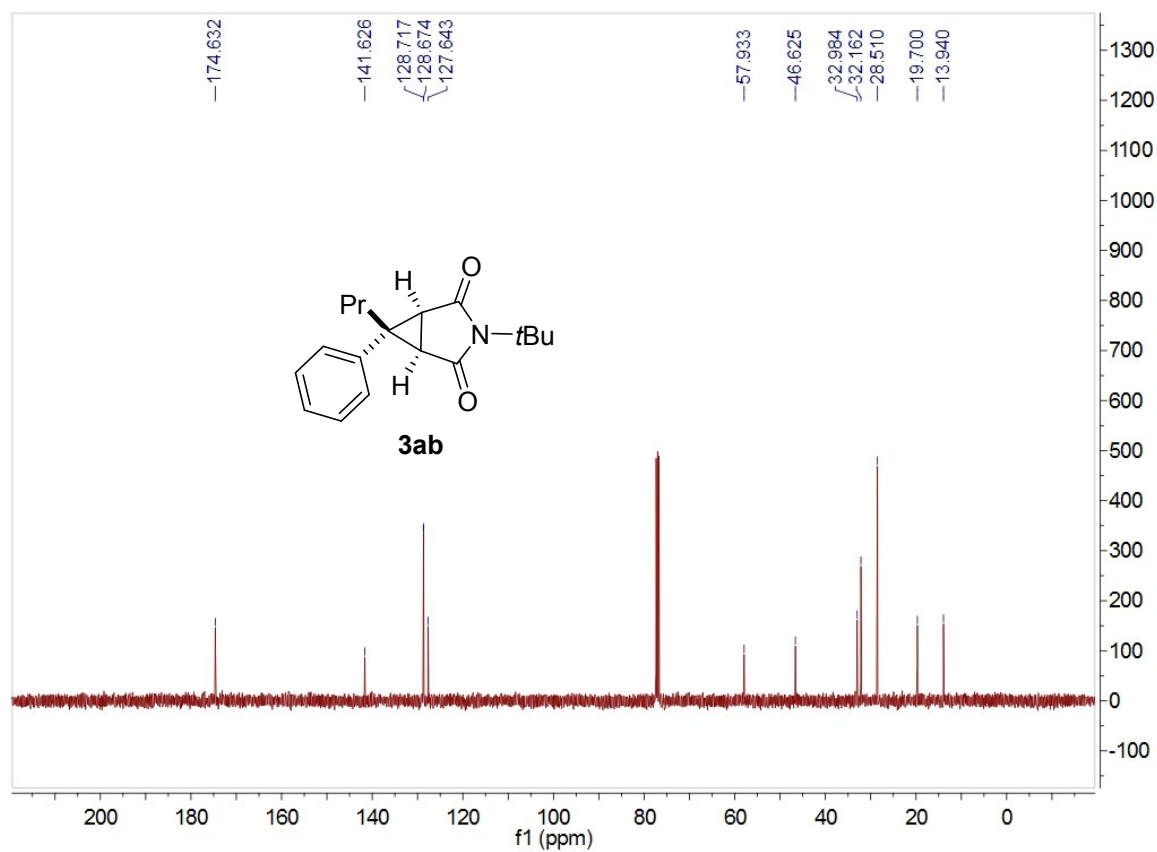
¹³C NMR (100 MHz, CDCl₃) spectrum for 3aa



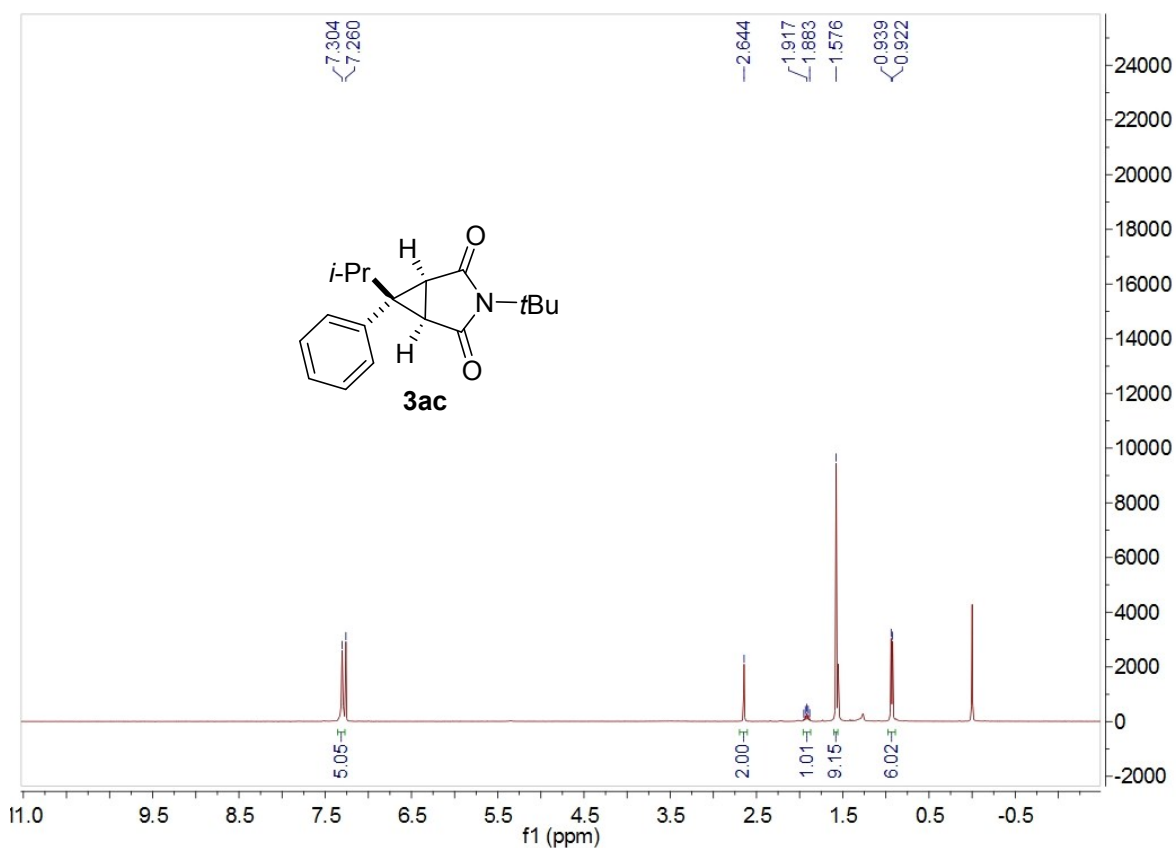
¹H NMR (400 MHz, CDCl₃) spectrum for 3ab



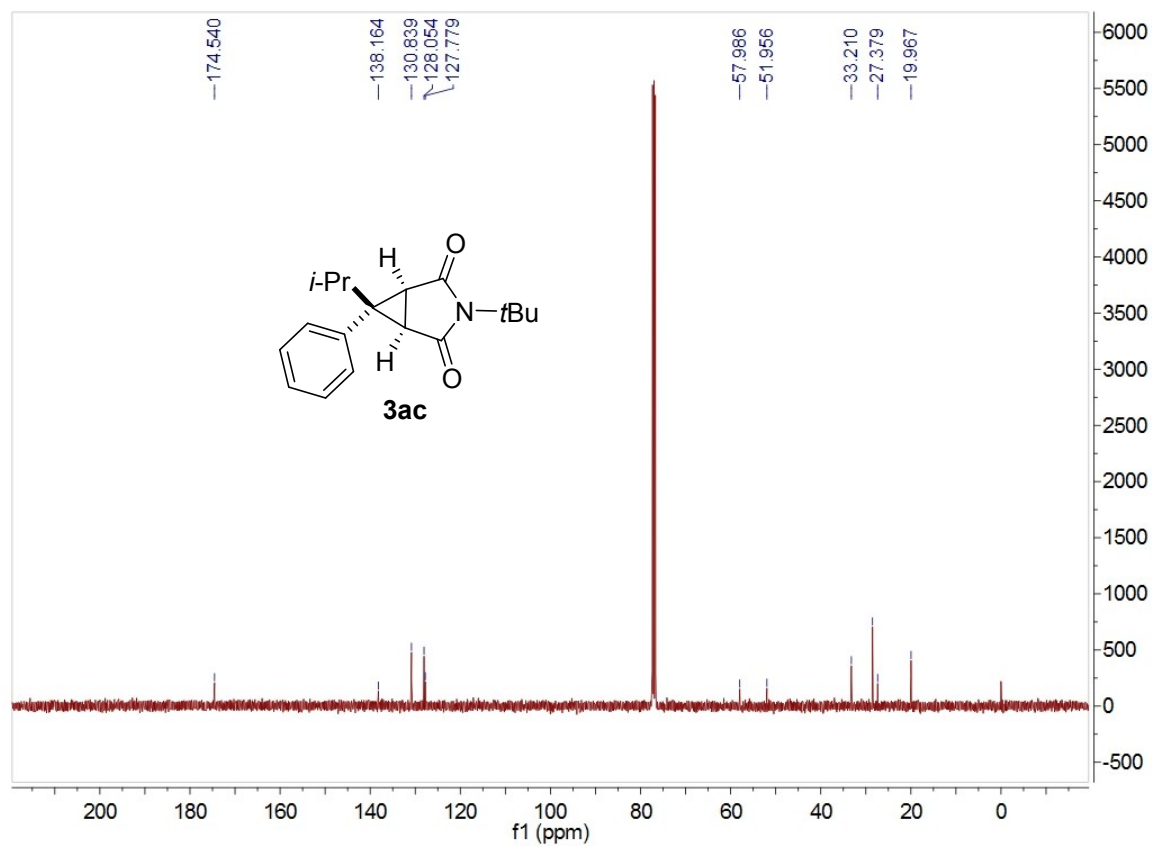
¹³C NMR (100 MHz, CDCl₃) spectrum for 3ab



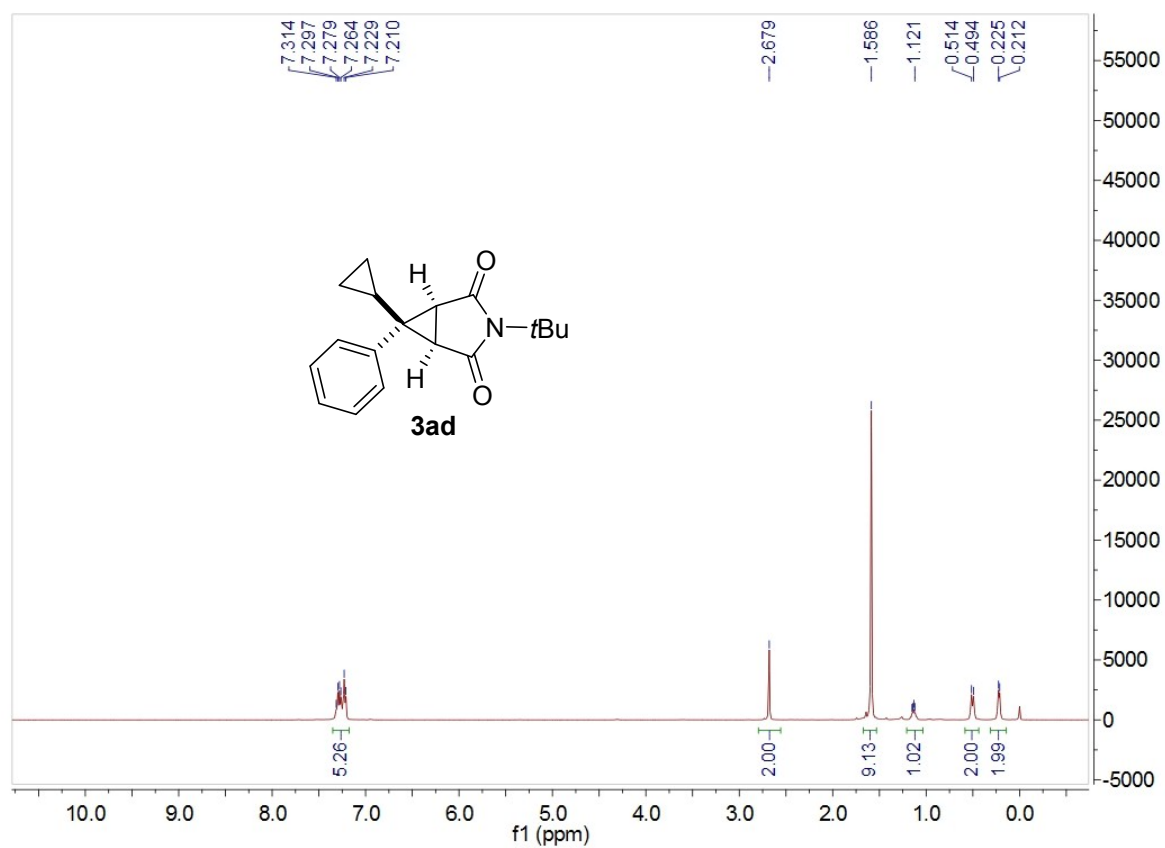
¹H NMR (400 MHz, CDCl₃) spectrum for 3ac



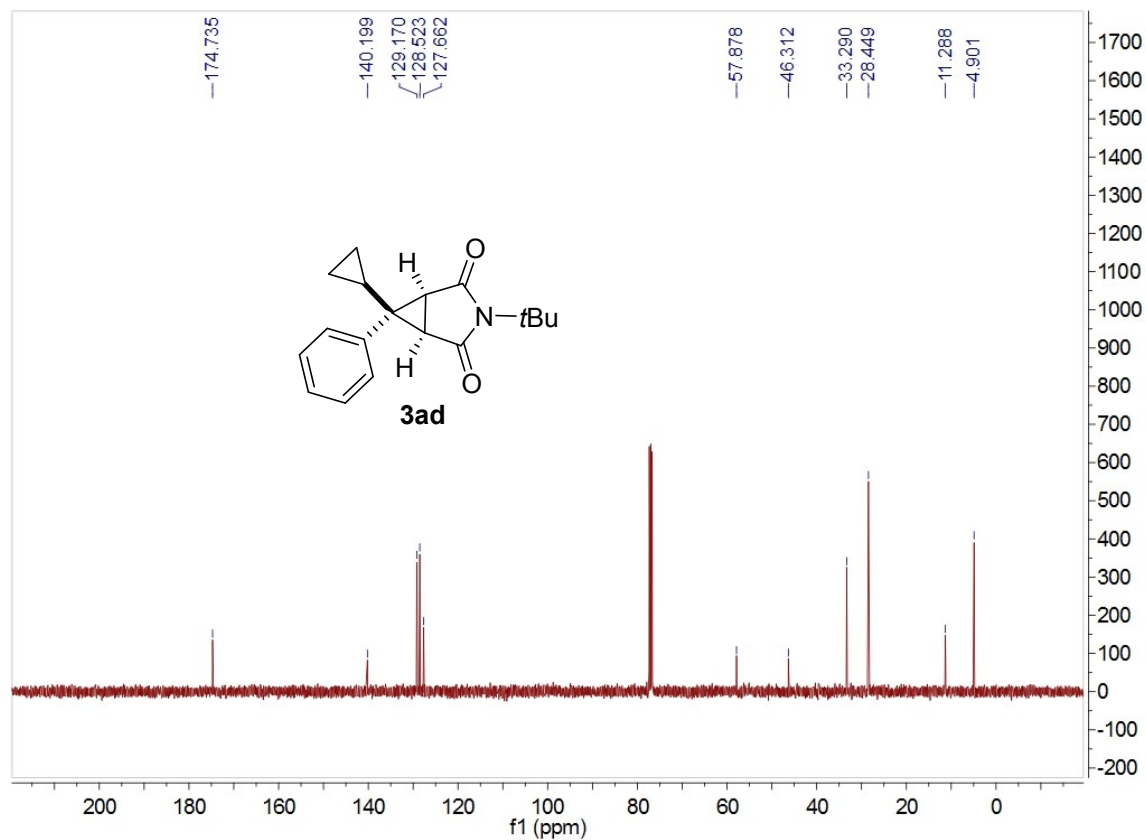
¹³C NMR (100 MHz, CDCl₃) spectrum for 3ac



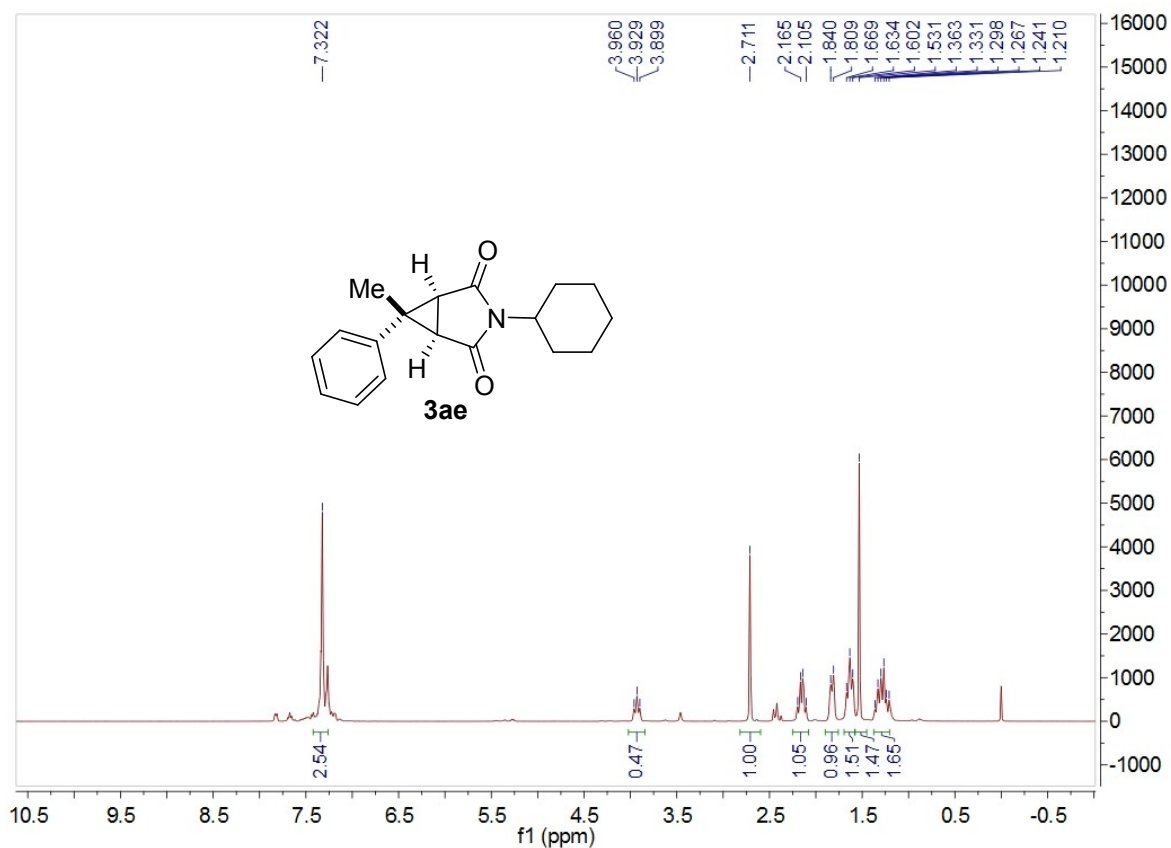
¹H NMR (400 MHz, CDCl₃) spectrum for 3ad



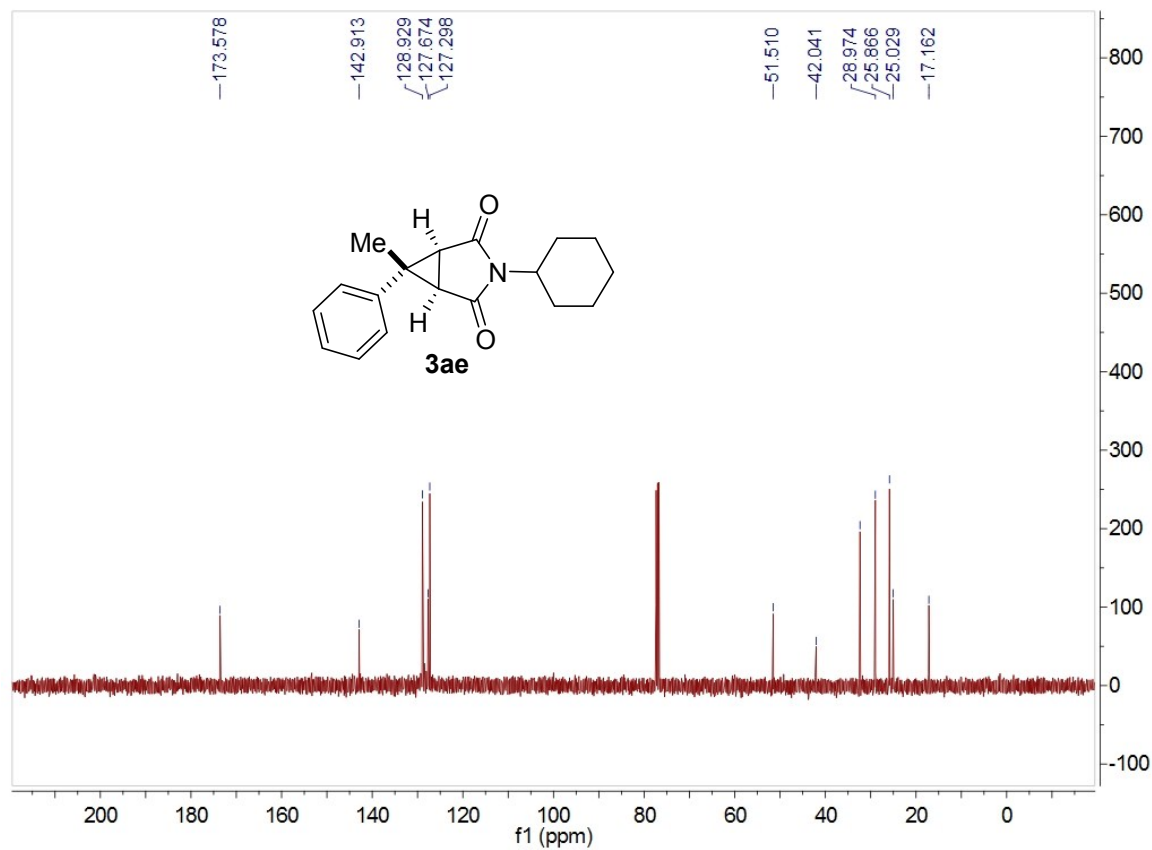
¹³C NMR (100 MHz, CDCl₃) spectrum for 3ad



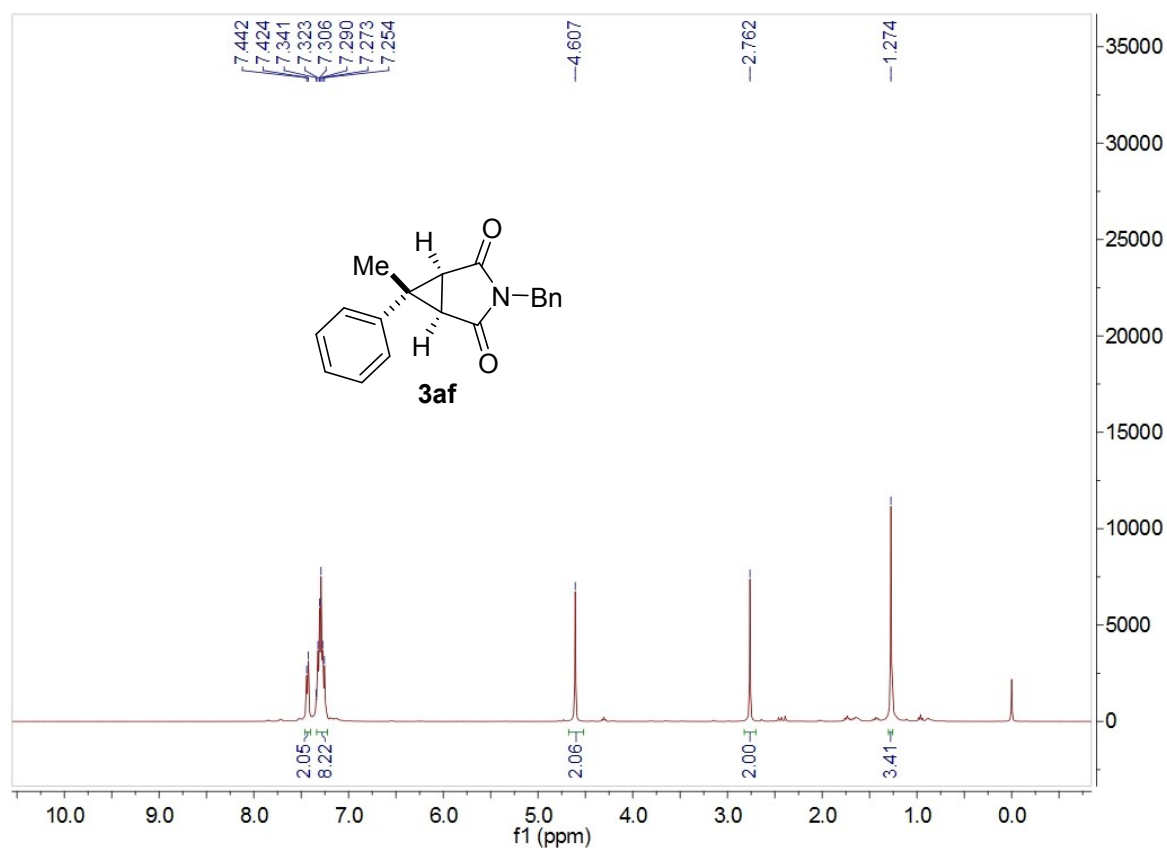
¹H NMR (400 MHz, CDCl₃) spectrum for 3ae



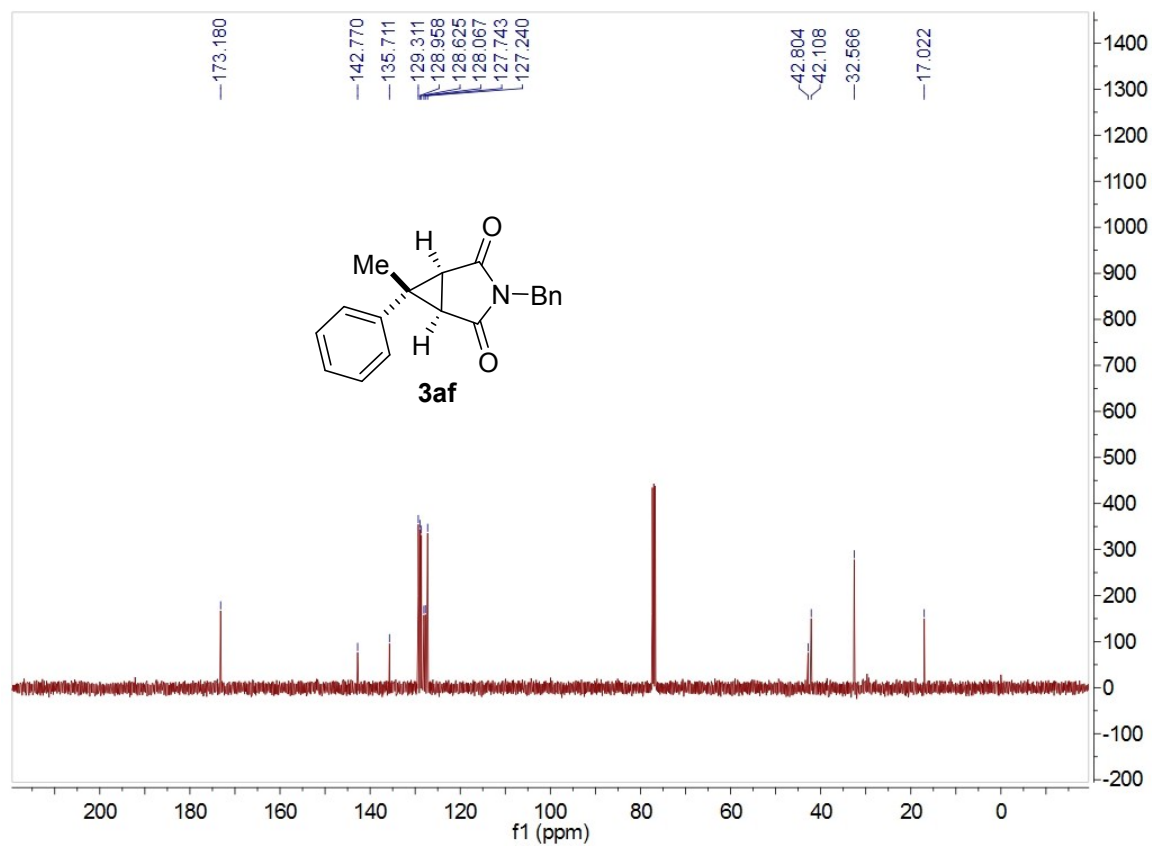
¹³C NMR (100 MHz, CDCl₃) spectrum for 3ae



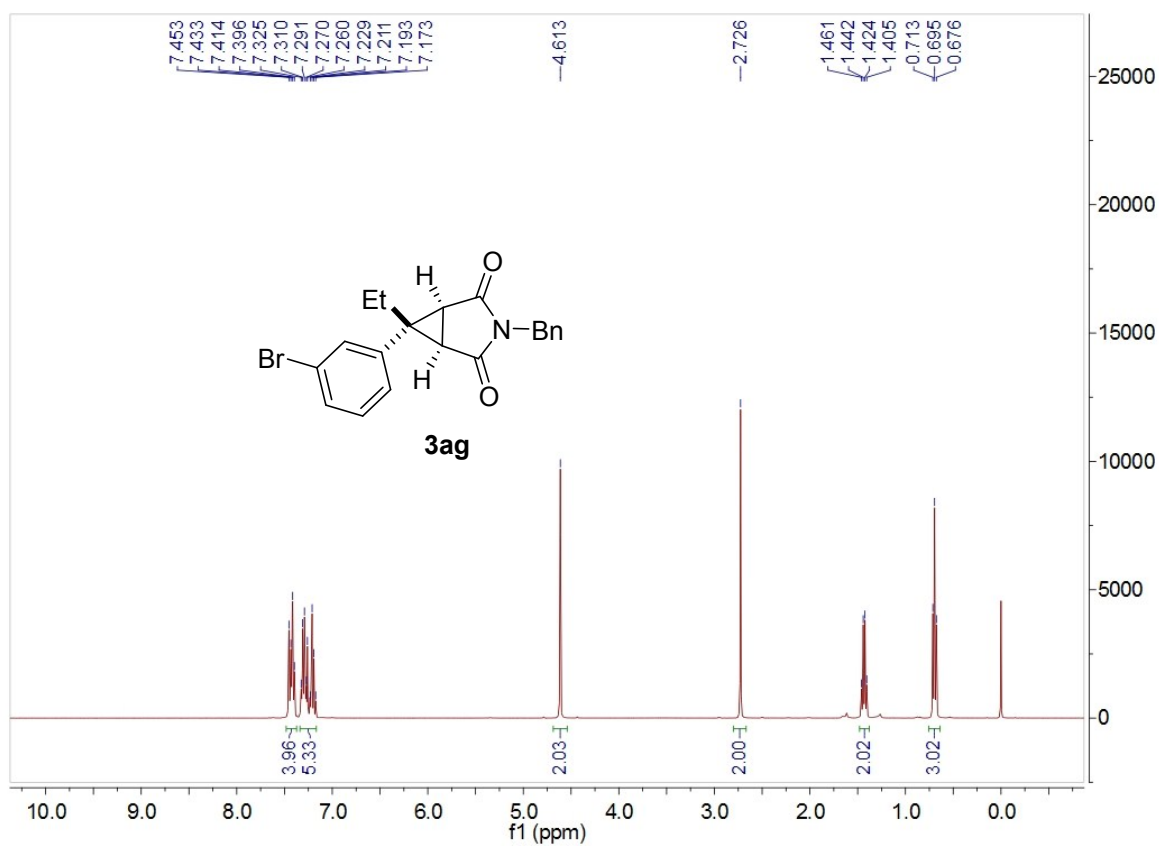
¹H NMR (400 MHz, CDCl₃) spectrum for 3af



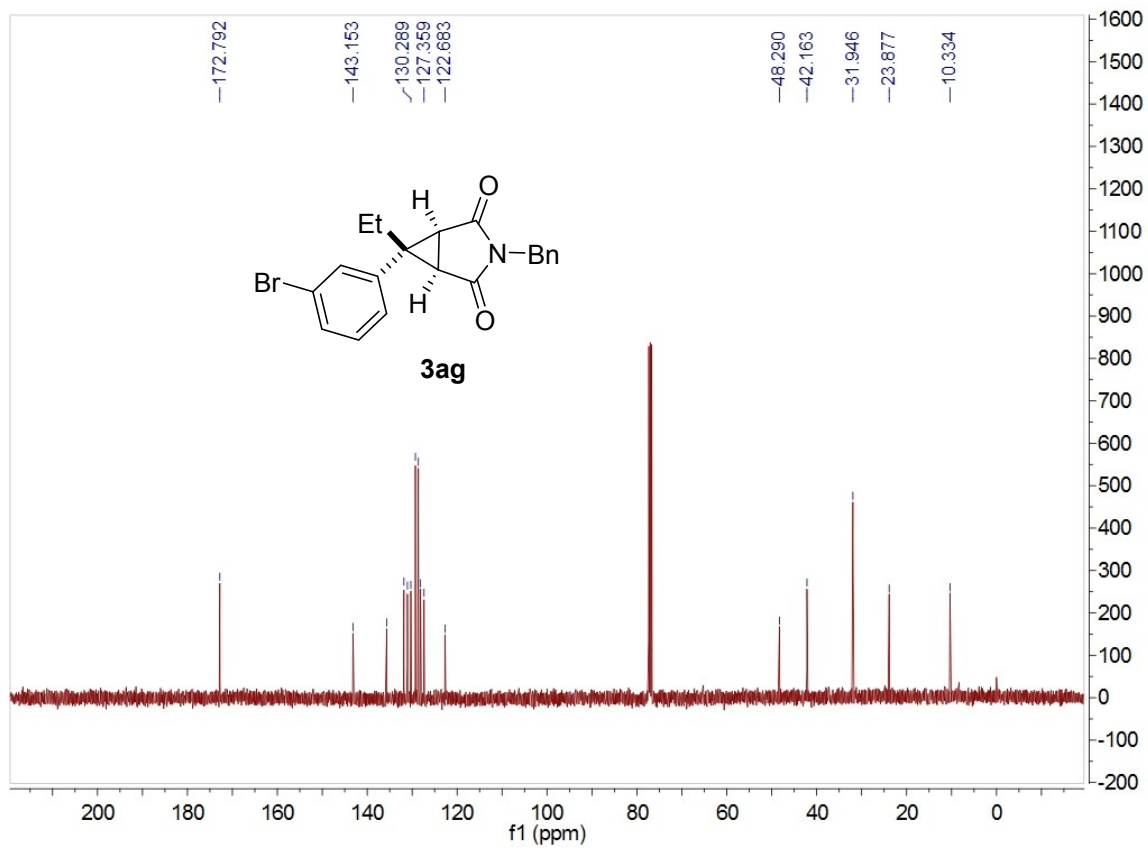
¹³C NMR (100 MHz, CDCl₃) spectrum for 3af



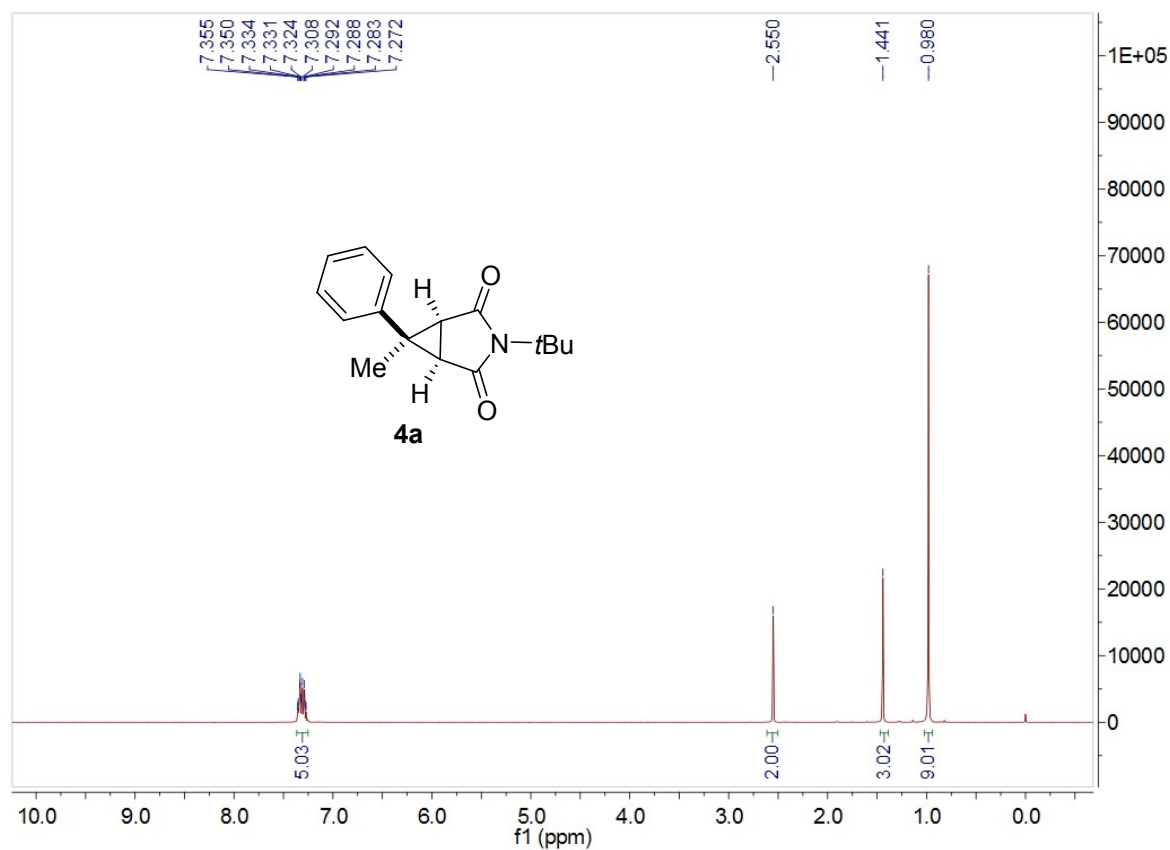
¹H NMR (400 MHz, CDCl₃) spectrum for **3ag**



¹³C NMR (100 MHz, CDCl₃) spectrum for **3ag**



¹H NMR (400 MHz, CDCl₃) spectrum for 4a



¹³C NMR (100 MHz, CDCl₃) spectrum for 4a

