

**Regiocontrolled Coupling of Aromatic and Vinylic Amides with
 α -Allenols To Form γ -Lactams via Rhodium(III)-Catalyzed**

C-H Activation

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Supporting Information

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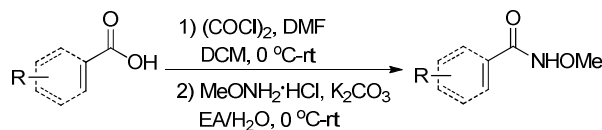
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I. General

NMR spectra were recorded on a Varian Mercury Vx400 spectrometer in solvents as indicated. Chemical shifts (δ) are given in ppm relative to TMS. The residual solvent signals were used as references and the chemical shifts converted to the TMS scale (CDCl_3 : $\delta_{\text{H}} = 7.26$ ppm, $\delta_{\text{C}} = 77.16$ ppm; CD_3OD : $\delta_{\text{H}} = 3.31$ ppm, $\delta_{\text{C}} = 49.00$ ppm; d_6 -DMSO: $\delta_{\text{H}} = 2.50$ ppm, $\delta_{\text{C}} = 39.52$ ppm). Infrared spectra were obtained on a Bio-Rad FTS-185 instrument. Mass spectra were provided on Agilent 5973 or Agilent 1100 instruments. All melting points were uncorrected. $[\text{Cp}^*\text{RhCl}_2]_2$ was purchased from Strem. All other reagents were from commercial sources. No attempts were made to optimize yields for substrate synthesis.

II. Synthesis of *N*-Methoxy Amides **1**

General Procedure:

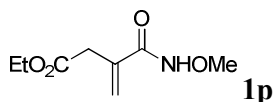


The *N*-methoxy amides **1** were prepared following a published procedure¹: In a reaction flask, drops of DMF were added to the solution of acid (1 equiv) in DCM (0.25 M). The resulting solution was cooled to 0 °C followed by dropwise addition of oxalyl chloride (1.2 equiv). The reaction was allowed to warm to room temperature and stirred for 12 h. Afterwards, the solvent was removed under reduce pressure to afford the corresponding acyl chloride.

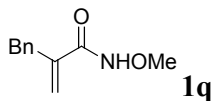
In a reaction flask, a mixture of MeONH₂·HCl (1.5 equiv) and K₂CO₃ (2 equiv) in a 2:1 mixture of EtOAc:H₂O (0.3 M) was stirred at 0 °C, followed by dropwise addition of the acyl chloride obtained above. The reaction was stirred at room temperature until completion. Afterwards, the reaction was quenched with aqueous NaHCO₃ solution and extracted with EtOAc (x3). The organic phase was washed with brine, dried over MgSO₄, filtered and evaporated under reduced pressure. The crude product was purified by flash column chromatography on silica gel or recrystallization from EtOAc/PE to give the desired *N*-methoxy amides **1**.

Characterization of *N*-methoxy amides **1**:

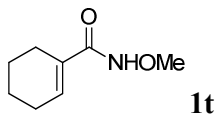
1a-1m, 1n, 1o, 1r, 1s are known compounds and all data were in agreement with those reported.¹



Yield 50% (0.467 g) from 4-ethoxy-2-methylene-4-oxobutanoic acid (0.796 g, 5 mmol, 1 equiv); colorless liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 9.12 (brs, 1H), 5.84 (s, 1H), 5.50 (s, 1H), 4.16 (q, *J* = 7.2 Hz, 2H), 3.81 (s, 3H), 3.37 (s, 2H), 1.27 (t, *J* = 7.2 Hz, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 171.3, 166.7, 135.8, 123.4, 64.4, 61.5, 38.3, 14.2; **IR (neat, cm⁻¹)**: ν 3326, 3038, 1764, 1698, 1645, 1578, 1542, 1234, 1126, 986, 883, 839; **MS (m/z, ESI)**: 188, 141, 113; **HRMS** calculated for C₈H₁₄NO₄ (M+H)⁺: 188.0917; Found: 188.0918; **R_f** = 0.3 (PE: EtOAc, 1:1).

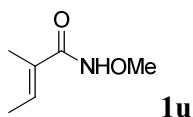


Yield 92% (0.880 g) from 2-benzylacrylic acid (0.811 g, 5 mmol, 1 equiv); yellow liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 8.96 (s, 1H), 7.31-7.26 (m, 2H), 7.23-7.17 (m, 3H), 5.71 (s, 1H), 5.24 (s, 1H), 3.68 (s, 3H), 3.63 (s, 2H); **¹³C NMR (100 MHz, CDCl₃)**: δ 166.9, 141.9, 137.9, 129.1, 128.7, 126.7, 120.6, 64.3, 38.5; **IR (neat, cm⁻¹)**: ν 3193, 2980, 1658, 1617, 1495, 1436, 1050, 939, 746, 700; **MS (m/z, ESI)**: 192; **HRMS** calculated for C₁₁H₁₄NO₂ (M+H)⁺: 192.1019; Found: 192.1022; **R_f** = 0.2 (PE: EtOAc, 2:1).

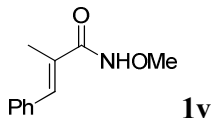


Yield 91% (0.709 g) from cyclohex-1-enecarboxylic acid (0.631 g, 5 mmol, 1 equiv); light yellow liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 8.56 (s, 1H), 6.62-6.60 (m, 1H), 3.79 (s, 3H), 2.23-2.12 (m, 4H), 1.70-1.57 (m, 4H); **¹³C NMR (100 MHz, CDCl₃)**: δ

167.6, 134.7, 131.2, 64.4, 25.4, 24.0, 22.0, 21.5; **IR (neat, cm⁻¹):** ν 3205, 2934, 1662, 1629, 1499, 1438, 1289, 1120, 1028, 944, 825, 802; **MS (m/z, ESI):** 156; **HRMS** calculated for C₈H₁₄NO₂ (M+H)⁺: 156.1019; Found: 156.1022; **R_f** = 0.3 (PE: EtOAc, 1:1).



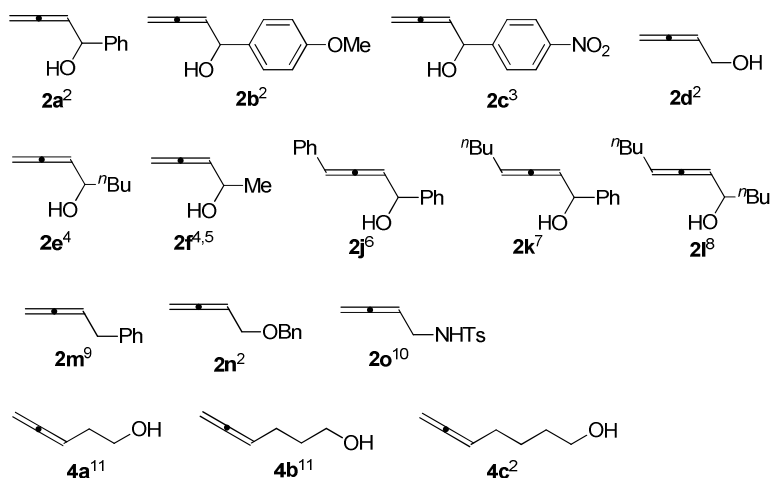
Yield 54% (0.348 g) from 2-methylbut-2-enoic acid (0.501 g, 5 mmol, 1 equiv); light yellow liquid; **¹H NMR (400 MHz, DMSO-*d*₆):** δ 9.31 (s, 1H), 6.41 (q, *J* = 6.8 Hz, 1H), 3.78 (s, 3H), 1.83 (s, 3H), 1.74 (d, *J* = 6.8 Hz, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 168.4, 131.9, 129.5, 64.2, 13.9, 12.1; **IR (neat, cm⁻¹):** ν 3205, 2979, 2937, 1666, 1629, 1498, 1292, 1059, 942, 853; **MS (m/z, ESI):** 130; **HRMS** calculated for C₆H₁₂NO₂ (M+H)⁺: 130.0863; Found: 130.0863; **R_f** = 0.3 (PE: EtOAc, 1:1).



Yield 87% (0.831 g) from 2-methyl-3-phenylacrylic acid (0.811 g, 5 mmol, 1 equiv); white solid; m.p. 92-94 °C; **¹H NMR (400 MHz, DMSO-*d*₆):** δ 9.40 (s, 1H), 7.38-7.27 (m, 6H), 3.83 (s, 3H), 2.07 (d, *J* = 1.2 Hz, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 168.7, 135.7, 134.8, 129.7, 129.4, 128.4, 128.1, 64.3, 14.1; **IR (neat, cm⁻¹):** ν 3205, 2979, 2937, 1666, 1629, 1498, 1441, 1292, 1059, 942, 853; **MS (m/z, ESI):** 192; **HRMS** calculated for C₁₁H₁₄NO₂ (M+H)⁺: 192.1019; Found: 192.1020; **R_f** = 0.3 (DCM: EtOAc, 8:1).

III. Synthesis of Allenes

Compounds list:



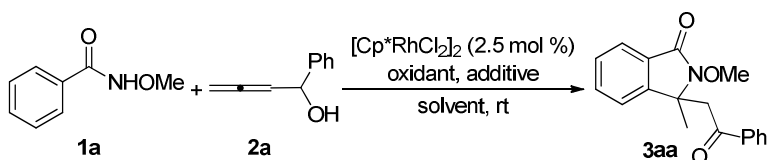
All the allene starting materials are known compounds and were prepared following literature procedure.^{2,12,13}

IV. Rhodium(III)-Catalyzed Coupling of *N*-methoxy amides with α -Allenols

Optimization Studies (Table S1)

Without any particular precautions to extrude oxygen or moisture, the *N*-methoxybenzamide **1a** (0.1 mmol, 1 equiv), 1-phenylbuta-2,3-dien-1-ol **2a** (0.14 mmol, 1.4 equiv), [Cp*RhCl₂]₂ (1.6 mg, 0.0025 mmol, 2.5 mol %), oxidant and additives were weighted in a 10 mL vial equipped with a stir bar. Solvent (0.2 M) was then added. The reaction was stirred at room temperature for 24 hours under air. Afterwards, the reaction mixture was diluted with EtOAc and transferred to a round bottom flask. The solvent was removed under reduced pressure and the crude ¹H NMR was taken using trimethoxybenzene (5.6 mg) as the internal standard.

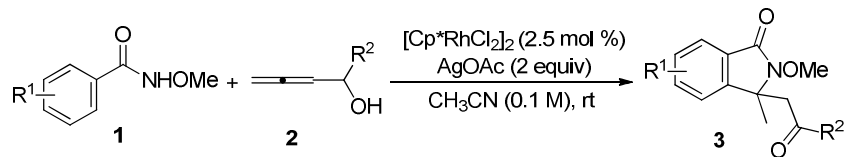
Table S1 Optimization Studies^a



entry	oxidant (equiv)	solvent	yield ^b (%)
1	/	CH ₃ CN	<5
2	AgOAc (1)	CH ₃ CN	48
3	AgOAc (1)	DCM	35
4	AgOAc (1)	MeOH	31
5	AgOAc (1)	THF	48
6	AgOAc (1)	DMF	<5
7 ^c	AgOAc (1)	CH ₃ CN	42
8 ^d	AgOAc (1)	CH ₃ CN	53
9 ^e	AgOAc (1)	CH ₃ CN	50
10 ^{d,f}	AgOAc (2)	CH ₃ CN	65
11 ^{d,g}	AgOAc (2)	CH ₃ CN	73
12 ^{d,g}	Cu(OAc) ₂ (2)	CH ₃ CN	13
13 ^{d,g}	Ag ₂ CO ₃ (2)	CH ₃ CN	44
14 ^{d,g,h}	(PhCO ₂) ₂ (2)	CH ₃ CN	52
15 ^{d,g}	PhI(OAc) ₂ (2)	CH ₃ CN	49
16 ^{d,g,h}	BQ (2)	CH ₃ CN	44
17 ^{d,g,i}	AgOAc (2)	CH ₃ CN	65
18 ^{d,g,j}	AgOAc (2)	CH ₃ CN	57
19 ^k	AgOAc (1)	CH ₃ CN	NR
20 ^l	AgOAc (1)	CH ₃ CN	NR
21 ^m	AgOAc (1)	CH ₃ CN	NR

^a Reaction conditions: **1a** (0.1 mmol), **2a** (0.14 mmol), [Cp*RhCl₂]₂ (2.5 mol %) and oxidant in solvent (0.2 M) at room temperature for 24 h under air. ^b ¹H NMR yield. ^c CH₃CN (0.4 M). ^d CH₃CN (0.1 M). ^e CH₃CN (0.05 M). ^f **2a** (0.2 mmol). ^g **2a** (0.3 mmol). ^h CsOAc (0.5 equiv) was added. ⁱ K₂CO₃ (1 equiv) was added. ^j HOAc (1 equiv) was added. ^k No [Cp*RhCl₂]₂ was used. ^l [Ru(p-cymene)Cl₂]₂ (2.5 mol %) was used as the catalyst ^m Pd(OAc)₂ (5 mol %) was used as the catalyst.

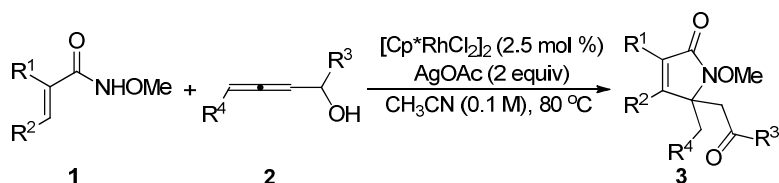
General Procedure 1:



Without any particular precautions to extrude oxygen or moisture, *N*-methoxybenzamide **1** (0.2 mmol, 1 equiv), α -allenol **2** (0.6 mmol, 3 equiv),

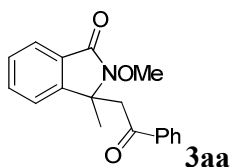
[Cp*RhCl₂]₂ (3.2 mg, 0.005 mmol, 2.5 mol %) and AgOAc (66.8 mg, 0.4 mmol, 2 equiv) were weighted in a 10 mL vial equipped with a stir bar. CH₃CN (0.1 M) was then added. The reaction was stirred at room temperature and monitored by TLC until completion. Afterwards, the reaction mixture was diluted with EtOAc and transferred to a round bottom flask. Silica gel was added to the flask and volatiles were evaporated under reduced pressure. The purification was performed by flash column chromatography on silica gel (see below for specific eluents).

General Procedure 2:



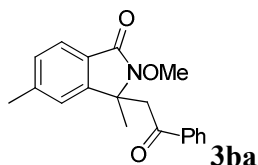
Without any particular precautions to extrude oxygen or moisture, *N*-methoxy amide **1** (0.2 mmol, 1 equiv), α -allenol **2** (0.3 mmol, 1.5 equiv), [Cp*RhCl₂]₂ (3.2 mg, 0.005 mmol, 2.5 mol %) and AgOAc (66.8 mg, 0.4 mmol, 2 equiv) were weighted in a 10 mL sealed tube equipped with a stir bar. CH₃CN (0.1 M) was then added. The reaction was stirred at 80 °C and monitored by TLC until completion. Afterwards, the reaction mixture was diluted with EtOAc and transferred to a round bottom flask. Silica gel was added to the flask and volatiles were evaporated under reduced pressure. The purification was performed by flash column chromatography on silica gel (see below for specific eluents).

Characterization of products:

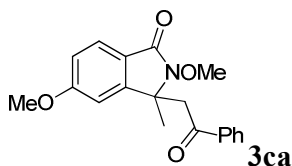


Yield 71% (42 mg); light yellow solid; m.p. 78-80 °C; ¹H NMR (400 MHz, CDCl₃): δ 7.85-7.79 (m, 3H), 7.54-7.49 (m, 3H), 7.43-7.37 (m, 3H), 4.07 (s, 3H), 3.72 (d, *J* = 17.2 Hz, 1H), 3.38 (d, *J* = 16.8 Hz, 1H), 1.82 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ 196.2, 164.9, 146.6, 137.0, 133.4, 132.3, 129.1, 128.6, 128.5, 128.0, 123.7, 122.5,

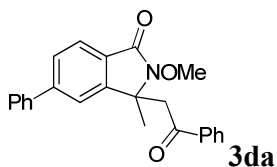
65.3, 64.7, 44.4, 24.1; **IR (neat, cm⁻¹):** ν 3055, 2931, 2854, 1702, 1596, 1362, 928, 750, 689; **MS (m/z, ESI):** 296, 242, 176; **HRMS** calculated for C₁₈H₁₈NO₃ (M+H)⁺: 296.1281; Found: 296.1287; **R_f** = 0.3 (PE: EtOAc, 2:1).



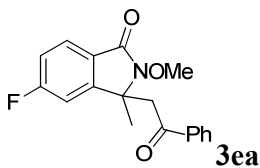
Yield 65% (40 mg); yellow solid; m.p. 98-100 °C; **¹H NMR (400 MHz, CDCl₃):** δ 7.80 (d, J = 7.6 Hz, 2H), 7.71 (d, J = 8.0 Hz, 1H), 7.52 (t, J = 7.2 Hz, 1H), 7.40 (d, J = 7.6 Hz, 2H), 7.31 (s, 1H), 7.22 (d, J = 7.6 Hz, 1H), 4.05 (s, 3H), 3.69 (d, J = 16.4 Hz, 1H), 3.37 (d, J = 17.2 Hz, 1H), 2.38 (s, 3H), 1.80 (s, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 196.4, 165.3, 146.9, 143.1, 137.2, 133.3, 129.5, 128.6, 128.0, 126.3, 123.6, 123.1, 65.4, 64.7, 44.6, 24.1, 22.2; **IR (neat, cm⁻¹):** ν 3058, 2935, 1693, 1619, 1361, 1213, 1011, 759, 726, 689; **MS (m/z, ESI):** 310, 190; **HRMS** calculated for C₁₉H₂₀NO₃ (M+H)⁺: 310.1438; Found: 310.1439; **R_f** = 0.5 (DCM: EtOAc, 10:1).



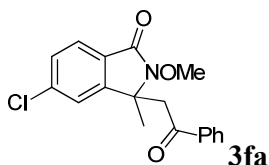
Yield 66% (43 mg); yellow solid; m.p. 97-99 °C; **¹H NMR (400 MHz, CDCl₃):** δ 7.81 (d, J = 7.6 Hz, 2H), 7.75 (d, J = 8.0 Hz, 1H), 7.53 (t, J = 7.6 Hz, 1H), 7.40 (t, J = 7.6 Hz, 2H), 7.04 (d, J = 1.6 Hz, 1H), 6.93 (dd, J = 8.8, 2.0 Hz, 1H), 4.04 (s, 3H), 3.80 (s, 3H), 3.70 (d, J = 16.8 Hz, 1H), 3.35 (d, J = 16.8 Hz, 1H), 1.81 (s, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 196.4, 165.5, 163.3, 149.0, 137.2, 133.4, 128.7, 128.1, 125.4, 121.2, 115.0, 107.9, 65.5, 64.7, 55.7, 44.7, 24.0; **IR (neat, cm⁻¹):** ν 3058, 2964, 1694, 1261, 1093, 1020, 799, 689; **MS (m/z, ESI):** 326, 206; **HRMS** calculated for C₁₉H₂₀NO₄ (M+H)⁺: 326.1387; Found: 326.1390; **R_f** = 0.5 (DCM: EtOAc, 6:1).



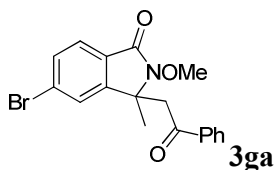
Yield 57% (42 mg); light yellow solid; m.p. 99-101 °C; **¹H NMR (400 MHz, CDCl₃):** δ 7.90 (d, *J* = 8.0 Hz, 1H), 7.81 (d, *J* = 7.2 Hz, 2H), 7.71 (d, *J* = 0.8 Hz, 1H), 7.63 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.52-7.48 (m, 3H), 7.45-7.34 (m, 5H), 4.09 (s, 3H), 3.76 (d, *J* = 16.8 Hz, 1H), 3.42 (d, *J* = 16.4 Hz, 1H), 1.86 (s, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 196.4, 164.9, 147.2, 145.6, 140.4, 137.2, 133.4, 129.0, 128.7, 128.2, 128.1, 127.9, 127.8, 127.5, 124.2, 121.5, 65.5, 65.0, 44.6, 24.0; **IR (neat, cm⁻¹):** ν 3063, 2934, 1692, 1618, 1359, 1211, 956, 757, 691; **MS (m/z, ESI):** 372, 252; **HRMS** calculated for C₂₄H₂₂NO₃ (M+H)⁺: 372.1594; Found: 372.1594; **R_f** = 0.4 (DCM: EtOAc, 10:1).



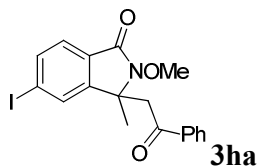
Yield 64% (40 mg); yellow solid; m.p. 106-108 °C; **¹H NMR (400 MHz, CDCl₃):** δ 7.85-7.81 (m, 3H), 7.55 (t, *J* = 6.8 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.32 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.12 (td, *J* = 8.4, 2.0 Hz, 1H), 4.06 (s, 3H), 3.75 (d, *J* = 17.2 Hz, 1H), 3.38 (d, *J* = 17.2 Hz, 1H), 1.81 (s, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 196.0, 165.5 (d, *J*_{C-F} = 250.9 Hz), 164.2, 149.1 (d, *J*_{C-F} = 9.5 Hz), 136.9, 133.6, 128.8, 128.0, 126.0 (d, *J*_{C-F} = 9.5 Hz), 125.1, 116.2 (d, *J*_{C-F} = 23.5 Hz), 110.6 (d, *J*_{C-F} = 24.6 Hz), 65.5, 64.6 (d, *J*_{C-F} = 2.2 Hz), 44.4, 24.0; **¹⁹F NMR (396 MHz, CDCl₃):** δ -105.2; **IR (neat, cm⁻¹):** ν 3057, 2934, 1693, 1599, 1361, 1217, 991, 759, 689; **MS (m/z, ESI):** 314, 194; **HRMS** calculated for C₁₈H₁₇FO₃ (M+H)⁺: 314.1187; Found: 314.1188; **R_f** = 0.3 (PE: EtOAc, 2:1).



Yield 62% (41 mg); light yellow solid; m.p. 139-141 °C; **¹H NMR (400 MHz, CDCl₃)**: δ 7.83 (d, *J* = 7.2 Hz, 2H), 7.77 (d, *J* = 8.4 Hz, 1H), 7.58 (s, 1H), 7.54 (t, *J* = 7.2 Hz, 1H), 7.44-7.39 (m, 3H), 4.05 (s, 3H), 3.74 (d, *J* = 17.6 Hz, 1H), 3.41 (d, *J* = 17.2 Hz, 1H), 1.79 (s, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 195.8, 164.1, 148.2, 138.6, 136.8, 133.6, 129.1, 128.7, 128.0, 127.7, 125.1, 123.3, 65.4, 64.5, 44.2, 24.0; **IR (neat, cm⁻¹)**: ν 3058, 2928, 2853, 1692, 1612, 1361, 1612, 1068, 992, 756, 689; **MS (m/z, ESI)**: 332, 330, 210; **HRMS** calculated for C₁₈H₁₇ClNO₃ (M+H)⁺: 330.0891; Found: 330.0893; **R_f** = 0.6 (DCM: EtOAc, 10:1).

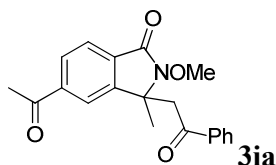


Yield 62% (46 mg); yellow solid; m.p. 154-156 °C; **¹H NMR (400 MHz, CDCl₃)**: δ 7.83 (d, *J* = 7.6 Hz, 2H), 7.74 (s, 1H), 7.70 (d, *J* = 8.0 Hz, 1H), 7.58-7.52 (m, 2H), 7.42 (t, *J* = 7.6 Hz, 2H), 4.05 (s, 3H), 3.73 (d, *J* = 17.2 Hz, 1H), 3.41 (d, *J* = 17.2 Hz, 1H), 1.79 (s, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 195.8, 164.1, 148.3, 136.8, 133.6, 132.0, 128.7, 128.2, 128.0, 127.0, 126.1, 125.2, 65.4, 64.4, 44.1, 24.1; **IR (neat, cm⁻¹)**: ν 3053, 2989, 2940, 1700, 1607, 1362, 1215, 989, 755, 735, 688; **MS (m/z, ESI)**: 376, 374, 336, 253; **HRMS** calculated for C₁₈H₁₇BrNO₃ (M+H)⁺: 374.0386; Found: 374.0385; **R_f** = 0.5 (DCM: EtOAc, 8:1).

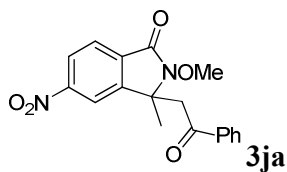


Yield 58% (49 mg); yellow solid; m.p. 126-128 °C; **¹H NMR (400 MHz, CDCl₃)**: δ 7.93 (s, 1H), 7.83-7.77 (m, 3H), 7.57-7.52 (m, 2H), 7.42 (t, *J* = 7.6 Hz, 2H), 4.05 (s, 3H), 3.71 (d, *J* = 17.2 Hz, 1H), 3.40 (d, *J* = 17.2 Hz, 1H), 1.78 (s, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 195.8, 164.3, 148.2, 137.9, 136.9, 133.6, 131.9, 128.8, 128.7, 128.0, 125.2, 99.2, 65.4, 64.2, 44.1, 24.1; **IR (neat, cm⁻¹)**: ν 3057, 2924, 2853, 1703, 1686,

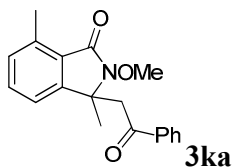
1598, 1580, 1447, 1360, 1211, 989, 753, 687; **MS (m/z, ESI):** 422, 336; **HRMS** calculated for $C_{18}H_{17}INO_3$ ($M+H$)⁺: 422.0248; Found: 422.0247; **R_f** = 0.6 (DCM: EtOAc, 10:1).



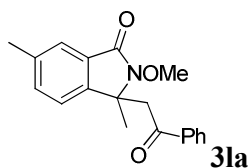
Yield 62% (42 mg); yellow solid; m.p. 68-70 °C; **¹H NMR (400 MHz, CDCl₃):** δ 8.09 (s, 1H), 8.02 (d, *J* = 7.6 Hz, 1H), 7.94 (d, *J* = 8.0 Hz, 1H), 7.81 (d, *J* = 8.4 Hz, 2H), 7.53 (t, *J* = 8.0 Hz, 1H), 7.40 (t, *J* = 7.6 Hz, 2H), 4.07 (s, 3H), 3.74 (d, *J* = 17.2 Hz, 1H), 3.53 (d, *J* = 17.2 Hz, 1H), 2.61 (s, 3H), 1.81 (s, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 197.5, 195.7, 163.8, 146.8, 140.0, 136.8, 133.6, 133.5, 128.9, 128.7, 128.0, 124.0, 121.9, 65.4, 64.6, 43.6, 27.0, 24.5; **IR (neat, cm⁻¹):** ν 3065, 2963, 1688, 1261, 1095, 1020, 800, 690; **MS (m/z, ESI):** 338, 218; **HRMS** calculated for $C_{20}H_{20}NO_4$ ($M+H$)⁺: 338.1387; Found: 338.1388; **R_f** = 0.5 (DCM: EtOAc, 8:1).



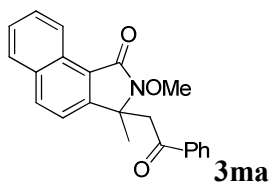
Yield 53% (36 mg); yellow solid; m.p. 121-123 °C; **¹H NMR (400 MHz, CDCl₃):** δ 8.42 (d, *J* = 1.2 Hz, 1H), 8.31 (dd, *J* = 8.0, 2.0 Hz, 1H), 8.02 (d, *J* = 8.4 Hz, 1H), 7.84 (d, *J* = 7.2 Hz, 2H), 7.55 (t, *J* = 7.2 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 4.08 (s, 3H), 3.81 (d, *J* = 17.6 Hz, 1H), 3.58 (d, *J* = 17.6 Hz, 1H), 1.84 (s, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 195.3, 162.5, 150.4, 147.6, 136.5, 135.3, 133.8, 128.8, 128.0, 124.8, 124.2, 118.1, 65.5, 64.6, 43.4, 24.4; **IR (neat, cm⁻¹):** ν 3044, 2941, 1697, 1527, 1340, 1213, 956, 749, 686, 664; **MS (m/z, ESI):** 358, 276, 221; **HRMS** calculated for $C_{18}H_{20}N_3O_5$ ($M+NH_4$)⁺: 358.1397; Found: 358.1398; **R_f** = 0.7 (DCM: EtOAc, 10:1).



Yield 68% (42 mg); light yellow solid; m.p. 102-104 °C; **¹H NMR (400 MHz, CDCl₃)**: δ 7.78 (dd, *J* = 8.4, 0.8 Hz, 2H), 7.51 (td, *J* = 7.6, 1.2 Hz, 1H), 7.41-7.26 (m, 4H), 7.15 (dd, *J* = 7.2, 0.4 Hz, 1H), 4.03 (s, 3H), 3.66 (d, *J* = 16.8 Hz, 1H), 3.37 (d, *J* = 16.8 Hz, 1H), 2.71 (s, 3H), 1.78 (s, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 196.5, 166.4, 147.3, 137.9, 137.3, 133.3, 131.8, 130.5, 128.6, 128.0, 126.1, 119.8, 65.3, 63.9, 44.6, 24.4, 17.5; **IR (neat, cm⁻¹)**: ν 3062, 2974, 2906, 1685, 1387, 1356, 1215, 1187, 1059, 794, 753, 693; **MS (m/z, ESI)**: 310, 190; **HRMS** calculated for C₁₉H₂₀NO₃ (M+H)⁺: 310.1438; Found: 310.1440; **R_f** = 0.4 (PE: EtOAc, 2:1).

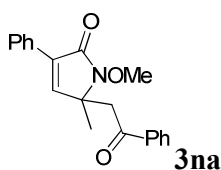


Yield 63% (39 mg); yellow liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 7.80 (d, *J* = 8.0 Hz, 2H), 7.64 (s, 1H), 7.52 (t, *J* = 7.2 Hz, 1H), 7.43-7.37 (m, 3H), 7.30 (d, *J* = 7.6 Hz, 1H), 4.05 (s, 3H), 3.69 (d, *J* = 16.8 Hz, 1H), 3.36 (d, *J* = 17.2 Hz, 1H), 2.39 (s, 3H), 1.79 (s, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 196.4, 165.2, 143.9, 138.6, 137.2, 133.3, 133.2, 129.1, 128.6, 128.0, 124.0, 122.4, 65.3, 64.7, 44.5, 24.1, 21.4; **IR (neat, cm⁻¹)**: ν 3060, 2931, 1691, 1597, 1448, 1358, 1214, 1067, 1004, 830, 759, 692; **MS (m/z, ESI)**: 310, 190; **HRMS** calculated for C₁₉H₂₀NO₃ (M+H)⁺: 310.1438; Found: 310.1440; **R_f** = 0.6 (DCM: EtOAc, 10:1).

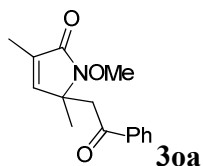


Yield 74% (51 mg); light yellow solid; m.p. 130-132 °C; **¹H NMR (400 MHz, CDCl₃)**: δ 9.16 (d, *J* = 8.4 Hz, 1H), 7.97 (d, *J* = 8.4 Hz, 1H), 7.86 (d, *J* = 8.0 Hz, 1H),

7.80 (d, $J = 8.0$ Hz, 2H), 7.67-7.60 (m, 2H), 7.57-7.47 (m, 2H), 7.37 (t, $J = 7.6$ Hz, 2H), 4.10 (s, 3H), 3.76 (d, $J = 16.8$ Hz, 1H), 3.43 (d, $J = 16.8$ Hz, 1H), 1.86 (s, 3H); **^{13}C NMR (100 MHz, CDCl_3)**: δ 196.5, 166.9, 147.3, 137.2, 133.4, 133.2, 133.1, 129.3, 128.7, 128.3, 128.2, 128.1, 126.9, 124.3, 123.0, 120.0, 65.5, 64.5, 44.5, 23.8; **IR (neat, cm^{-1})**: ν 3069, 2934, 1704, 1683, 1594, 1451, 1214, 1070, 827, 755, 690; **MS (m/z, ESI)**: 346, 226; **HRMS** calculated for $\text{C}_{22}\text{H}_{20}\text{NO}_3$ ($\text{M}+\text{H}$) $^+$: 346.1438; Found: 346.1439; **R_f** = 0.4 (PE: EtOAc, 3:1).

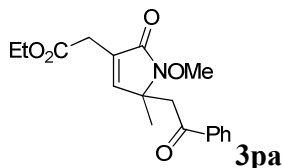


Yield 95% (61 mg); yellow liquid; **^1H NMR (400 MHz, CDCl_3)**: δ 7.92 (d, $J = 7.2$ Hz, 2H), 7.84 (dd, $J = 7.6, 1.2$ Hz, 2H), 7.58 (t, $J = 7.2$ Hz, 1H), 7.54 (s, 1H), 7.46 (t, $J = 7.6$ Hz, 2H), 7.39-7.30 (m, 3H), 4.04 (s, 3H), 3.83 (d, $J = 17.2$ Hz, 1H), 3.08 (d, $J = 17.2$ Hz, 1H), 1.64 (s, 3H); **^{13}C NMR (100 MHz, CDCl_3)**: δ 196.8, 167.2, 143.2, 136.8, 133.7, 133.2, 131.0, 128.9, 128.8, 128.5, 128.1, 126.9, 65.2, 64.0, 45.7, 21.9; **IR (neat, cm^{-1})**: ν 3061, 2979, 2938, 1702, 1684, 1447, 1349, 1216, 1068, 785, 752, 691; **MS (m/z, ESI)**: 322, 202; **HRMS** calculated for $\text{C}_{20}\text{H}_{20}\text{NO}_3$ ($\text{M}+\text{H}$) $^+$: 322.1438; Found: 322.1439; **R_f** = 0.4 (PE: EtOAc, 2:1).

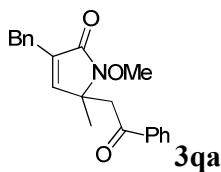


Yield 81% (42 mg); yellow liquid; **^1H NMR (400 MHz, CDCl_3)**: δ 7.91 (d, $J = 8.4$ Hz, 2H), 7.59 (t, $J = 7.6$ Hz, 1H), 7.47 (t, $J = 7.6$ Hz, 2H), 6.99 (d, $J = 1.2$ Hz, 1H), 3.99 (s, 3H), 3.73 (d, $J = 16.8$ Hz, 1H), 2.98 (d, $J = 17.2$ Hz, 1H), 1.86 (d, $J = 1.2$ Hz, 3H), 1.55 (s, 3H); **^{13}C NMR (100 MHz, CDCl_3)**: δ 196.9, 168.8, 144.1, 136.9, 133.6, 132.2, 128.8, 128.1, 65.1, 64.5, 45.6, 21.8, 11.3; **IR (neat, cm^{-1})**: ν 3062, 2980, 2938, 1707, 1683, 1448, 1344, 1182, 994, 753, 690; **MS (m/z, ESI)**: 260, 140; **HRMS**

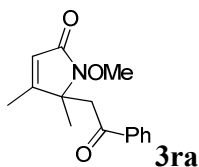
calculated for $C_{15}H_{18}NO_3$ ($M+H$)⁺: 260.1281; Found: 260.1284; **R_f** = 0.4 (DCM: EtOAc, 8:1).



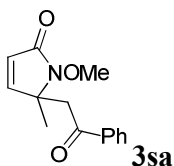
Yield 74% (49 mg); red liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 7.91 (dd, *J* = 8.4, 1.2 Hz, 2H), 7.59 (tt, *J* = 8.4, 1.2 Hz, 1H), 7.47 (t, *J* = 8.0 Hz, 2H), 7.28-7.27 (m, 1H), 4.16 (q, *J* = 7.2 Hz, 2H), 3.99 (s, 3H), 3.76 (d, *J* = 16.8 Hz, 1H), 3.30-3.28 (m, 2H), 3.04 (d, *J* = 16.8 Hz, 1H), 1.59 (s, 3H), 1.25 (t, *J* = 7.2 Hz, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 196.6, 169.8, 167.4, 146.5, 136.8, 133.6, 129.3, 128.8, 128.1, 65.2, 64.9, 61.1, 45.3, 31.0, 21.7, 14.2; **IR (neat, cm⁻¹)**: ν 2980, 2939, 1710, 1685, 1449, 1260, 1207, 1009, 799, 756, 691; **MS (m/z, ESI)**: 332, 302, 260, 212, 121; **HRMS** calculated for $C_{18}H_{22}NO_5$ ($M+H$)⁺: 332.1492; Found: 332.1494; **R_f** = 0.3 (PE: EtOAc, 2:1).



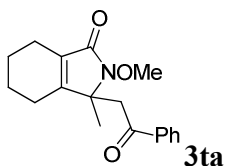
Yield 78% (52 mg); yellow liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 7.86 (d, *J* = 7.6 Hz, 2H), 7.57 (t, *J* = 7.6 Hz, 1H), 7.44 (t, *J* = 7.6 Hz, 2H), 7.28-7.14 (m, 5H), 6.72 (s, 1H), 3.99 (s, 3H), 3.66 (d, *J* = 16.4 Hz, 1H), 3.54 (s, 2H), 3.01 (d, *J* = 16.8 Hz, 1H), 1.51 (s, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 196.6, 168.0, 144.1, 137.5, 136.8, 136.3, 133.5, 129.1, 128.8, 128.6, 128.1, 126.565.1, 64.7, 45.1, 32.1, 22.0; **IR (neat, cm⁻¹)**: ν 3061, 2937, 2904, 1706, 1682, 1598, 1450, 1352, 1206, 1071, 1001, 752, 693; **MS (m/z, ESI)**: 336, 216; **HRMS** calculated for $C_{21}H_{22}NO_3$ ($M+H$)⁺: 336.1594; Found: 336.1595; **R_f** = 0.3 (PE: EtOAc, 2:1).



Yield 23% (12 mg); yellow liquid; **¹H NMR (400 MHz, CDCl₃):** δ 7.90 (d, *J* = 7.2 Hz, 2H), 7.58 (t, *J* = 7.6 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 2H), 5.82 (s, 1H), 3.79 (s, 3H), 3.57 (d, *J* = 16.4 Hz, 1H), 3.10 (d, *J* = 15.6 Hz, 1H), 2.00 (s, 3H), 1.51 (s, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 196.1, 169.8, 162.2, 137.2, 133.6, 128.8, 128.2, 120.3, 67.8, 65.1, 41.7, 23.3, 14.2; **IR (neat, cm⁻¹):** ν 3063, 2979, 2937, 1688, 1446, 1358, 1220, 1099, 984, 840, 751, 691; **MS (m/z, ESI):** 260, 140; **HRMS** calculated for C₁₅H₁₈NO₃ (M+H)⁺: 260.1281; Found: 260.1284; **R_f** = 0.5 (DCM: EtOAc, 6:1).

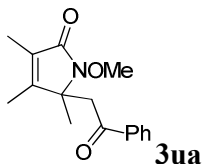


Yield 24% (12 mg); yellow solid; m.p. 112-114 °C; **¹H NMR (400 MHz, CDCl₃):** δ 7.92 (d, *J* = 7.2 Hz, 2H), 7.60 (t, *J* = 7.2 Hz, 1H), 7.48 (t, *J* = 7.2 Hz, 2H), 7.41 (d, *J* = 6.4 Hz, 1H), 6.07 (d, *J* = 6.4 Hz, 1H), 3.99 (s, 3H), 3.77 (d, *J* = 16.8 Hz, 1H), 3.04 (d, *J* = 17.2 Hz, 1H), 1.59 (s, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 196.7, 168.1, 151.4, 136.8, 133.8, 128.9, 128.1, 124.3, 66.3, 65.3, 45.4, 21.6; **IR (neat, cm⁻¹):** ν 3086, 2950, 1699, 1684, 1447, 1339, 1185, 967, 803, 760, 691; **MS (m/z, ESI):** 246, 164, 126; **HRMS** calculated for C₁₃H₁₆NO₃ (M+H)⁺: 246.1125; Found: 246.1128; **R_f** = 0.6 (DCM: EtOAc, 6:1).

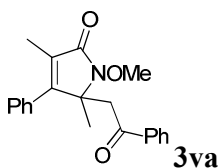


Yield 80% (48 mg); yellow liquid; **¹H NMR (400 MHz, CDCl₃):** δ 7.86 (d, *J* = 7.2 Hz, 2H), 7.55 (t, *J* = 7.6 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 2H), 3.83 (s, 3H), 3.45 (d, *J* = 15.2 Hz, 1H), 3.14 (d, *J* = 15.6 Hz, 1H), 2.19-2.14 (m, 4H), 1.68-1.64 (m, 4H), 1.49 (s,

3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 196.7, 169.8, 156.6, 137.5, 133.3, 129.1, 128.7, 128.1, 66.4, 65.1, 42.4, 23.0, 22.3, 22.0, 21.7, 19.9; **IR (neat, cm⁻¹)**: ν 3061, 2934, 2856, 1695, 1448, 1213, 1096, 1009, 803, 754, 693; **MS (m/z, ESI)**: 300, 180; **HRMS** calculated for C₁₈H₂₂NO₃ (M+H)⁺: 300.1594; Found: 300.1597; **R_f** = 0.3 (PE: EtOAc, 1:1).

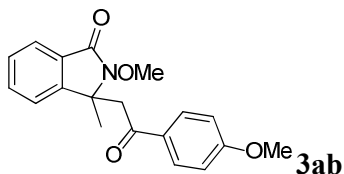


Yield 60% (33 mg); brown liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 7.87 (d, *J* = 7.2 Hz, 2H), 7.56 (t, *J* = 7.6 Hz, 1H), 7.45 (d, *J* = 7.6 Hz, 2H), 3.80 (s, 3H), 3.50 (d, *J* = 15.6 Hz, 1H), 3.09 (d, *J* = 15.6 Hz, 1H), 1.88 (s, 3H), 1.79 (s, 3H), 1.47 (s, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 196.5, 170.5, 152.8, 137.5, 133.3, 128.7, 128.1, 126.5, 66.6, 65.0, 41.8, 23.2, 11.2, 8.6; **IR (neat, cm⁻¹)**: ν 3062, 2978, 2936, 1694, 1448, 1357, 1258, 1216, 1098, 1062, 1014, 802, 754, 694; **MS (m/z, ESI)**: 274, 154; **HRMS** calculated for C₁₆H₂₀NO₃ (M+H)⁺: 274.1438; Found: 274.1440; **R_f** = 0.3 (DCM: EtOAc, 8:1).

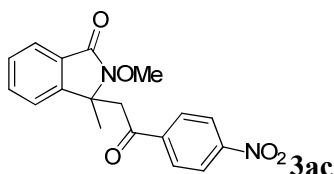


Yield 33% (22 mg); yellow solid; m.p. 104-106 °C; **¹H NMR (400 MHz, CDCl₃)**: δ 7.85 (d, *J* = 7.2 Hz, 2H), 7.55 (t, *J* = 7.2 Hz, 1H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.39-7.35 (m, 3H), 7.20 (dd, *J* = 7.6, 2.0 Hz, 2H), 3.85 (s, 3H), 3.52 (d, *J* = 16.8 Hz, 1H), 3.08 (d, *J* = 16.8 Hz, 1H), 1.82 (s, 3H), 1.56 (s, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 195.9, 170.3, 154.4, 137.4, 133.3, 133.0, 129.4, 128.73, 128.67, 128.65, 128.0, 66.5, 65.0, 40.8, 24.1, 9.7 (one signal missing due to overlap); **IR (neat, cm⁻¹)**: ν 3060, 2932, 1686, 1447, 1360, 1213, 997, 750, 693; **MS (m/z, ESI)**: 336, 216; **HRMS** calculated

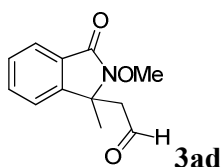
for $C_{21}H_{22}NO_3$ ($M+H$)⁺: 336.1594; Found: 336.1596; R_f = 0.4 (DCM: EtOAc, 8:1).



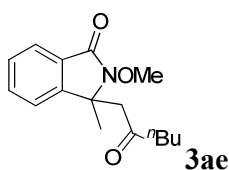
Yield 66% (43 mg); yellow liquid; 1H NMR (400 MHz, $CDCl_3$): δ 7.83 (d, J = 7.6 Hz, 1H), 7.79 (d, J = 9.2 Hz, 2H), 7.55-7.47 (m, 2H), 7.42 (t, J = 7.2 Hz, 1H), 6.86 (d, J = 8.8 Hz, 2H), 4.06 (s, 3H), 3.83 (s, 3H), 3.65 (d, J = 16.4 Hz, 1H), 3.33 (d, J = 16.8 Hz, 1H), 1.81 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 194.7, 164.9, 163.7, 146.7, 132.2, 130.4, 130.2, 129.0, 128.5, 123.7, 122.7, 113.8, 65.3, 64.9, 55.5, 44.1, 24.0; IR (neat, cm^{-1}): ν 3053, 2973, 2937, 1703, 1683, 1599, 1358, 1256, 1172, 1027, 837, 694; MS (m/z , ESI): 326, 176; HRMS calculated for $C_{19}H_{20}NO_4$ ($M+H$)⁺: 326.1387; Found: 326.1389; R_f = 0.6 (DCM: EtOAc, 5:1).



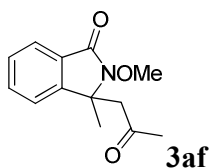
Yield 51% (35 mg); yellow solid; m.p. 175-177 °C; 1H NMR (400 MHz, $CDCl_3$): δ 8.23 (d, J = 8.4 Hz, 2H), 7.93 (d, J = 8.8 Hz, 2H), 7.83 (d, J = 7.2 Hz, 1H), 7.55-7.43 (m, 3H), 4.07 (s, 3H), 3.68 (d, J = 16.8 Hz, 1H), 3.49 (d, J = 16.8 Hz, 1H), 1.84 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 195.0, 164.9, 150.4, 146.0, 141.4, 132.5, 129.2, 129.1, 128.9, 123.92, 123.90, 122.2, 65.5, 64.6, 45.0, 24.3; IR (neat, cm^{-1}): ν 3105, 3075, 2936, 1700, 1518, 1344, 1209, 992, 752, 715, 688; MS (m/z , ESI): 341, 276, 176; HRMS calculated for $C_{18}H_{17}N_2O_5$ ($M+H$)⁺: 341.1132; Found: 341.1133; R_f = 0.7 (DCM: EtOAc, 6:1).



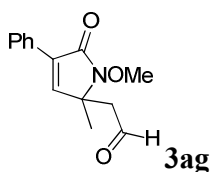
Yield 53% (23 mg); light yellow liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 9.41 (s, 1H), 7.86 (d, *J* = 7.6 Hz, 1H), 7.62 (td, *J* = 7.6, 0.8 Hz, 1H), 7.50 (td, *J* = 7.6, 0.8 Hz, 1H), 7.45 (d, *J* = 7.2 Hz, 1H), 4.07 (s, 3H), 2.96 (d, *J* = 2.0 Hz, 2H), 1.68 (s, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 199.0, 164.9, 145.9, 133.1, 129.2, 128.7, 124.3, 121.6, 65.4, 64.1, 49.6, 24.5; **IR (neat, cm⁻¹)**: ν 2981, 2942, 1703, 1469, 1346, 1074, 988, 908, 763, 728, 691; **MS (m/z, ESI)**: 220, 170; **HRMS** calculated for C₁₂H₁₄NO₃ (M+H)⁺: 220.0968; Found: 220.0970; **R_f** = 0.5 (DCM: EtOAc, 5:1).



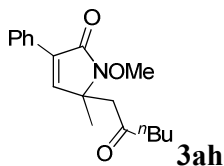
Yield 53% (29 mg); yellow liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 7.83 (d, *J* = 7.6 Hz, 1H), 7.56 (td, *J* = 7.6, 1.2 Hz, 1H), 7.50-7.43 (m, 2H), 4.07 (s, 3H), 3.07 (d, *J* = 16.0 Hz, 1H), 2.84 (d, *J* = 16.4 Hz, 1H), 2.28-2.22 (m, 2H), 1.72 (s, 3H), 1.44-1.36 (m, 2H), 1.22-1.12 (m, 2H), 0.82 (t, *J* = 7.2 Hz, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 207.3, 164.7, 146.5, 132.4, 129.0, 128.7, 123.9, 122.2, 65.4, 64.6, 48.7, 43.9, 25.5, 24.0, 22.2, 13.9; **IR (neat, cm⁻¹)**: ν 3055, 2931, 2854, 1702, 1596, 1362, 928, 750, 689; **MS (m/z, ESI)**: 276, 176; **HRMS** calculated for C₁₆H₂₂NO₃ (M+H)⁺: 276.1594; Found: 276.1597; **R_f** = 0.4 (PE: EtOAc, 2:1).



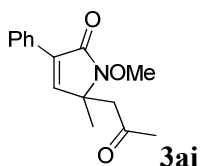
Yield 60% (28 mg); yellow liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 7.83 (d, *J* = 7.6 Hz, 1H), 7.57 (t, *J* = 7.6 Hz, 1H), 7.51-7.44 (m, 2H), 4.07 (s, 3H), 3.10 (d, *J* = 16.0 Hz, 1H), 2.90 (d, *J* = 16.4 Hz, 1H), 1.99 (s, 3H), 1.71 (s, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 204.9, 164.7, 146.4, 132.5, 129.0, 128.7, 123.9, 122.2, 65.3, 64.5, 49.5, 31.4, 24.0; **IR (neat, cm⁻¹)**: ν 2979, 2939, 1706, 1468, 1357, 1169, 1098, 1074, 992, 765, 694; **MS (m/z, ESI)**: 234, 176; **HRMS** calculated for C₁₃H₁₆NO₃ (M+H)⁺: 234.1125; Found: 234.1128; **R_f** = 0.3 (DCM: EtOAc, 10:1).



Yield 65% (32 mg); yellow liquid; **¹H NMR (400 MHz, CDCl₃):** δ 9.67 (s, 1H), 7.87-7.84 (m, 2H), 7.42-7.35 (m, 3H), 7.24 (s, 1H), 4.01 (s, 3H), 2.97 (d, *J* = 16.4 Hz, 1H), 2.77 (d, *J* = 16.4 Hz, 1H), 1.57 (s, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 198.9, 167.5, 141.8, 134.2, 130.6, 129.3, 128.7, 127.0, 65.3, 63.3, 49.7, 22.7; **IR (neat, cm⁻¹):** ν 2932, 2851, 1701, 1448, 1079, 1048, 979, 786, 694; **MS (m/z, ESI):** 246, 202, 121; **HRMS** calculated for C₁₄H₁₆NO₃ (M+H)⁺: 246.1125; Found: 246.1132; **R_f** = 0.3 (PE: EtOAc, 2:1).

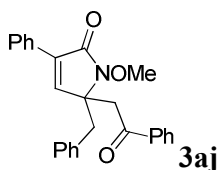


Yield 81% (50 mg); yellow liquid; **¹H NMR (400 MHz, CDCl₃):** δ 7.87-7.83 (m, 2H), 7.43 (s, 1H), 7.40-7.31 (m, 3H), 4.01 (s, 3H), 3.18 (d, *J* = 16.8 Hz, 1H), 2.59 (d, *J* = 16.8 Hz, 1H), 2.42 (t, *J* = 7.2 Hz, 2H), 1.57-1.49 (m, 5H), 1.34-1.24 (m, 2H), 0.89 (t, *J* = 7.2 Hz, 3H); **¹³C NMR (100 MHz, CDCl₃):** δ 207.9, 167.2, 142.9, 133.1, 131.0, 128.9, 128.6, 126.9, 65.2, 63.6, 49.4, 43.7, 25.7, 22.3, 21.8, 13.9; **IR (neat, cm⁻¹):** ν 2958, 2934, 2872, 1702, 1449, 1367, 1050, 786, 695; **MS (m/z, ESI):** 302, 260, 202; **HRMS** calculated for C₁₈H₂₄NO₃ (M+H)⁺: 302.1751; Found: 302.1754; **R_f** = 0.7 (PE: EtOAc, 2:1).

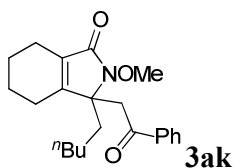


Yield 83% (43 mg); yellow liquid; **¹H NMR (400 MHz, CDCl₃):** δ 7.87-7.84 (m, 2H), 7.41-7.32 (m, 4H), 4.01 (s, 3H), 3.20 (d, *J* = 17.2 Hz, 1H), 2.65 (d, *J* = 16.8 Hz, 1H),

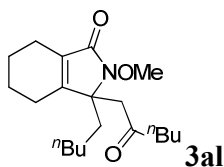
2.17 (s, 3H), 1.55 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 205.4, 167.2, 142.7, 133.3, 130.9, 129.0, 128.6, 126.9, 65.2, 63.5, 50.2, 31.2, 21.9; IR (neat, cm^{-1}): ν 2963, 2931, 1700, 1260, 1075, 1016, 788; MS (m/z, ESI): 260, 202, 121; HRMS calculated for $\text{C}_{15}\text{H}_{18}\text{NO}_3$ ($\text{M}+\text{H}$) $^+$: 260.1281; Found: 260.1283; R_f = 0.4 (PE: EtOAc, 2:1).



Yield 45% (36 mg); yellow liquid; ^1H NMR (400 MHz, CDCl_3): δ 7.95-7.92 (m, 2H), 7.60 (t, J = 7.2 Hz, 1H), 7.55-7.52 (m, 2H), 7.49 (t, J = 7.6 Hz, 2H), 7.36 (s, 1H), 7.31-7.26 (m, 3H), 7.23-7.22 (m, 4H), 7.21-7.13 (m, 1H), 4.11 (s, 3H), 3.85 (d, J = 16.4 Hz, 1H), 3.49 (d, J = 13.2 Hz, 1H), 3.32 (d, J = 16.8 Hz, 1H), 3.23 (d, J = 13.6 Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ 196.8, 167.9, 141.4, 137.1, 135.1, 134.4, 133.8, 131.1, 130.4, 128.9, 128.8, 128.4, 128.3, 128.2, 127.2, 127.0, 67.7, 65.1, 44.1, 41.0; IR (neat, cm^{-1}): ν 2927, 2854, 1695, 1449, 1261, 1180, 1049, 755, 697; MS (m/z, ESI): 398, 121; HRMS calculated for $\text{C}_{26}\text{H}_{24}\text{NO}_3$ ($\text{M}+\text{H}$) $^+$: 398.1751; Found: 398.1752; R_f = 0.4 (PE: EtOAc, 3:1).

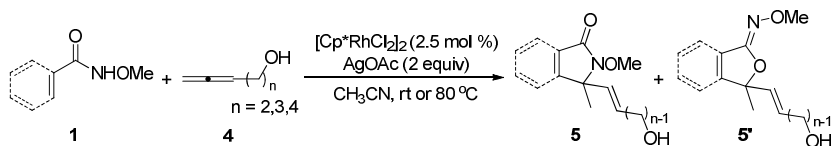


Yield 51% (36 mg); yellow liquid; ^1H NMR (400 MHz, CD_3OD): δ 7.88 (d, J = 7.2 Hz, 2H), 7.56 (t, J = 7.2 Hz, 1H), 7.45 (d, J = 7.6 Hz, 2H), 3.75 (s, 3H), 3.60 (d, J = 16.0 Hz, 1H), 3.31 (d, J = 16.4 Hz, 1H), 2.12-1.93 (m, 6H), 1.79-1.71 (m, 1H), 1.66-1.55 (m, 4H), 1.30-1.20 (m, 5H), 0.86 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 196.7, 170.6, 154.2, 137.8, 133.3, 130.7, 128.7, 128.1, 69.4, 64.7, 42.5, 34.8, 31.7, 22.6, 22.5, 22.4, 22.0, 21.7, 19.9, 14.1; IR (neat, cm^{-1}): ν 3062, 2932, 2860, 1701, 1448, 1227, 1019, 752, 691; MS (m/z, ESI): 356, 236; HRMS calculated for $\text{C}_{22}\text{H}_{30}\text{NO}_3$ ($\text{M}+\text{H}$) $^+$: 356.2220; Found: 356.2222; R_f = 0.5 (PE: EtOAc, 3:1).

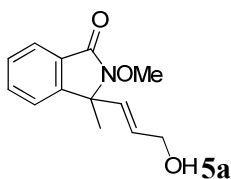


Yield 64% (43 mg); yellow liquid; **¹H NMR (400 MHz, CD₃OD):** δ 3.88 (s, 3H), 3.06 (d, *J* = 15.6 Hz, 1H), 2.73 (d, *J* = 15.6 Hz, 1H), 2.40 (t, *J* = 7.2 Hz, 2H), 2.24-2.04 (m, 4H), 1.92-1.61 (m, 7H), 1.47-1.39 (m, 2H), 1.29-1.21 (m, 7H), 0.88 (t, *J* = 7.2 Hz, 6H); **¹³C NMR (100 MHz, CD₃OD):** δ 209.7, 173.3, 157.8, 131.7, 71.6, 66.2, 47.7, 45.2, 36.6, 33.5, 27.4, 24.4, 24.1, 24.0, 23.9, 23.8, 23.6, 21.6, 15.2, 15.1; **IR (neat, cm⁻¹):** ν 2932, 2865, 1703, 1442, 1376, 1077, 1022, 748; **MS (m/z, ESI):** 336; **HRMS** calculated for C₂₀H₃₄NO₃ (M+H)⁺: 336.2533; Found: 336.2535; **R_f** = 0.3 (PE: EtOAc, 5:1).

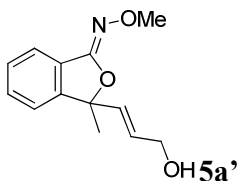
V. Further Investigation on the Effect of Hydroxy Group in the Allenes



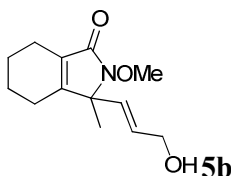
Without any particular precautions to extrude oxygen or moisture, *N*-methoxy amide **1** (0.2 mmol, 1 equiv), the allene derivative **4** (0.4 mmol, 2 equiv), [Cp^{*}RhCl₂]₂ (3.2 mg, 0.005 mmol, 2.5 mol %) and AgOAc (66.8 mg, 0.4 mmol, 2 equiv) were weighted in a 10 mL sealed tube equipped with a stir bar. CH₃CN (0.1 M) was then added. The reaction was stirred at room temperature or 80 °C and monitored by TLC until completion. Afterwards, the reaction mixture was diluted with EtOAc and transferred to a round bottom flask. Silica gel was added to the flask and volatiles were evaporated under reduced pressure. The purification was performed by flash column chromatography on silica gel (see below for specific eluents).



Yield 47% (22 mg); light yellow liquid; **¹H NMR (400 MHz, DMSO-*d*₆)**: δ 7.70 (d, *J* = 7.6 Hz, 1H), 7.65 (td, *J* = 7.6, 1.2 Hz, 1H), 7.53-7.46 (m, 2H), 5.89 (dt, *J* = 15.6, 4.8 Hz, 1H), 5.65 (dt, *J* = 16.0, 1.6 Hz, 1H), 4.84 (t, *J* = 5.2 Hz, 1H), 3.98-3.95 (m, 2H), 3.90 (s, 3H), 1.64 (s, 3H); **¹³C NMR (100 MHz, DMSO-*d*₆)**: δ 164.4, 147.0, 132.5, 132.1, 130.4, 128.6, 128.5, 123.9, 122.0, 66.3, 65.4, 62.5, 21.9; **IR (neat, cm⁻¹)**: ν 3411, 2982, 2939, 1690, 1615, 1466, 1346, 1095, 1064, 984, 763, 690; **MS (m/z, ESI)**: 234; **HRMS** calculated for C₁₃H₁₆NO₃ (M+H)⁺: 234.1125; Found: 234.1127; **R_f** = 0.3 (PE: EtOAc, 1:2).

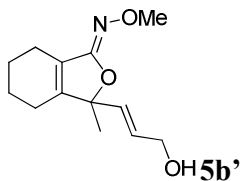


Yield 11% (5 mg); light yellow liquid; **¹H NMR (400 MHz, DMSO-*d*₆)**: δ 7.57-7.53 (m, 2H), 7.49-7.42 (m, 2H), 5.90 (dt, *J* = 15.6, 1.2 Hz, 1H), 5.76 (dt, *J* = 15.2, 4.4 Hz, 1H), 4.83 (t, *J* = 5.6 Hz, 1H), 3.95-3.92 (m, 2H), 3.77 (s, 3H), 1.67 (s, 3H); **¹³C NMR (100 MHz, DMSO-*d*₆)**: δ 155.2, 147.3, 131.5, 131.0, 130.4, 129.0, 127.9, 122.0, 121.7, 91.0, 62.9, 62.7, 26.2; **IR (neat, cm⁻¹)**: ν 3437, 2963, 1763, 1658, 1260, 1090, 1034, 797; **MS (m/z, ESI)**: 234; **HRMS** calculated for C₁₃H₁₆NO₃ (M+H)⁺: 234.1125; Found: 234.1127; **R_f** = 0.5 (PE: EtOAc, 1:2).

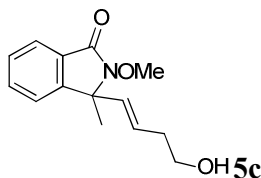


Yield 34% (16 mg); yellow liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 5.88 (dt, *J* = 15.6, 5.2 Hz, 1H), 5.50 (dt, *J* = 15.6, 1.2 Hz, 1H), 4.20 (dd, *J* = 5.2, 1.2 Hz, 2H), 3.88 (s, 3H), 2.22-2.19 (m, 2H), 2.06-2.02 (m, 2H), 1.89 (br, 1H), 1.74-1.63 (m, 4H), 1.46 (s,

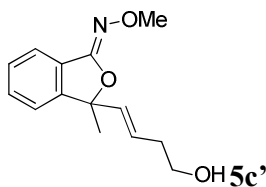
3H); ^{13}C NMR (100 MHz, CDCl_3): δ 169.2, 156.3, 132.1, 130.9, 128.8, 67.8, 65.4, 62.9, 22.1, 21.9, 21.4, 20.0, 19.4; IR (neat, cm^{-1}): ν 3401, 2934, 2858, 1689, 1447, 1437, 1396, 1096, 992, 749; MS (m/z, ESI): 238; HRMS calculated for $\text{C}_{13}\text{H}_{20}\text{NO}_3$ (M+H) $^+$: 238.1438; Found: 238.1440; R_f = 0.2 (PE: EtOAc, 1:2).



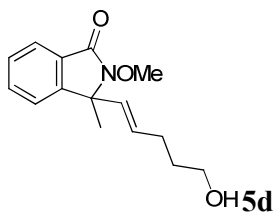
Yield 29% (13 mg); yellow liquid; ^1H NMR (400 MHz, CDCl_3): δ 5.89 (dt, J = 15.6, 5.2 Hz, 1H), 5.71 (d, J = 15.6 Hz, 1H), 4.16 (dd, J = 4.8, 1.6 Hz, 2H), 3.85 (s, 3H), 2.18-2.15 (m, 2H), 2.10-2.06 (m, 2H), 1.75-1.65 (m, 5H), 1.53 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 159.4, 152.5, 130.8, 130.5, 125.0, 92.2, 62.8, 62.4, 22.9, 22.1, 21.9, 21.7, 20.1; IR (neat, cm^{-1}): ν 3396, 2934, 2859, 1668, 1647, 1448, 1437, 1407, 1311, 1088, 1046, 967, 883, 844; MS (m/z, ESI): 238; HRMS calculated for $\text{C}_{13}\text{H}_{20}\text{NO}_3$ (M+H) $^+$: 238.1438; Found: 238.1441; R_f = 0.4 (PE: EtOAc, 1:2).



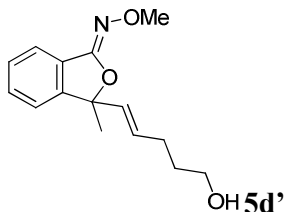
Yield 26% (13 mg); colorless liquid; ^1H NMR (400 MHz, CDCl_3): δ 7.84 (d, J = 7.6 Hz, 1H), 7.56 (td, J = 7.2, 0.8 Hz, 1H), 7.45 (td, J = 7.6, 0.8 Hz, 1H), 7.27 (d, J = 7.6 Hz, 1H), 5.86 (dt, J = 16.0, 6.8 Hz, 1H), 5.58 (dt, J = 16.0, 1.6 Hz, 1H), 4.01 (s, 3H), 3.70 (t, J = 6.4 Hz, 2H), 2.39-2.33 (m, 2H), 1.68 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 164.4, 147.3, 132.8, 132.5, 129.4, 128.7, 128.6, 124.0, 121.9, 66.5, 65.4, 61.8, 35.8, 21.9; IR (neat, cm^{-1}): ν 3437, 2938, 1696, 1468, 1347, 1063, 988, 798, 764, 693; MS (m/z, ESI): 248; HRMS calculated for $\text{C}_{14}\text{H}_{18}\text{NO}_3$ (M+H) $^+$: 248.1281; Found: 248.1284; R_f = 0.3 (PE: EtOAc, 1:2).



Yield 8% (4 mg); colorless liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 7.66 (d, *J* = 7.6 Hz, 1H), 7.46 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.39 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.22 (d, *J* = 7.6 Hz, 1H), 5.83 (d, *J* = 15.6 Hz, 1H), 5.74 (dt, *J* = 15.2, 6.4 Hz, 1H), 3.96 (s, 3H), 3.66 (t, *J* = 6.4 Hz, 2H), 2.31 (q, *J* = 6.4 Hz, 2H), 1.75 (s, 3H); **¹³C NMR (100 MHz, CDCl₃)**: δ 155.2, 147.6, 133.8, 131.0, 128.9, 128.0, 122.0, 121.7, 91.3, 62.9, 61.8, 35.7, 26.3; **IR (neat, cm⁻¹)**: ν 3419, 2932, 1733, 1656, 1468, 1374, 1126, 1040, 971, 887, 767; **MS (m/z, ESI)**: 248; **HRMS** calculated for C₁₄H₁₈NO₃ (M+H)⁺: 248.1281; Found: 248.1284; **R_f** = 0.6 (PE: EtOAc, 1:2).



Yield 33% (17 mg); colorless liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 7.83 (d, *J* = 7.6 Hz, 1H), 7.55 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.44 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.25 (d, *J* = 7.6 Hz, 1H), 5.86 (dt, *J* = 15.6, 6.8 Hz, 1H), 5.50 (d, *J* = 15.6 Hz, 1H), 4.00 (s, 3H), 3.65 (t, *J* = 6.4 Hz, 2H), 2.19 (q, *J* = 6.8 Hz, 2H), 1.71-1.65 (m, 5H); **¹³C NMR (100 MHz, CDCl₃)**: δ 164.3, 147.4, 132.8, 132.5, 130.4, 128.6, 128.5, 123.9, 121.9, 66.5, 65.4, 62.2, 31.9, 28.8, 21.9; **IR (neat, cm⁻¹)**: ν 3428, 2980, 2937, 1699, 1615, 1469, 1345, 1065, 988, 764, 692; **MS (m/z, ESI)**: 262; **HRMS** calculated for C₁₅H₂₀NO₃ (M+H)⁺: 262.1438; Found: 262.1441; **R_f** = 0.2 (PE: EtOAc, 1:1).



Yield 25% (13 mg); colorless liquid; **¹H NMR (400 MHz, CDCl₃)**: δ 7.66 (d, *J* = 7.6 Hz, 1H), 7.46 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.39 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.20 (d, *J* = 7.6 Hz, 1H), 5.75-5.72 (m, 2H), 3.96 (s, 3H), 3.62 (t, *J* = 6.4 Hz, 2H), 2.15-2.10 (m, 2H), 1.74 (s, 3H), 1.67-1.60 (m, 2H); **¹³C NMR (100 MHz, CDCl₃)**: δ 155.3, 147.7, 131.5, 131.4, 130.9, 128.8, 127.9, 121.9, 121.7, 91.5, 62.8, 62.3, 31.8, 28.5, 26.2; **IR (neat, cm⁻¹)**: ν 3419, 2934, 2816, 1716, 1656, 1468, 1446, 1348, 1305, 1126, 1041, 971, 887, 767; **MS (m/z, ESI)**: 262; **HRMS** calculated for C₁₅H₂₀NO₃ (M+H)⁺: 262.1438; Found: 262.1440; **R_f** = 0.4 (PE: EtOAc, 1:1).

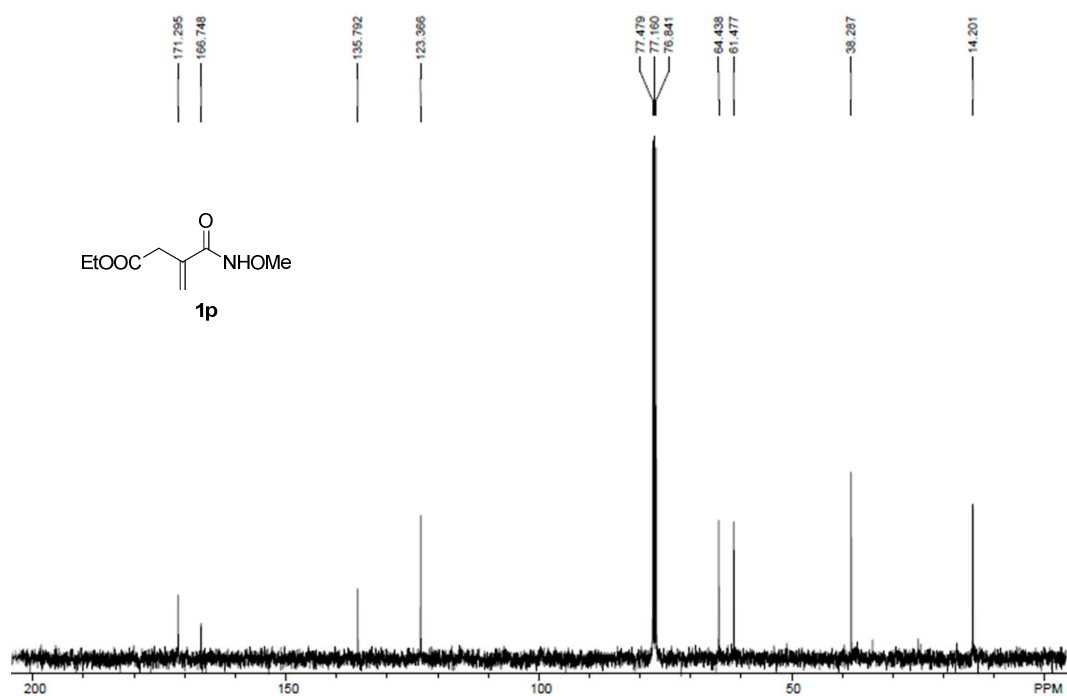
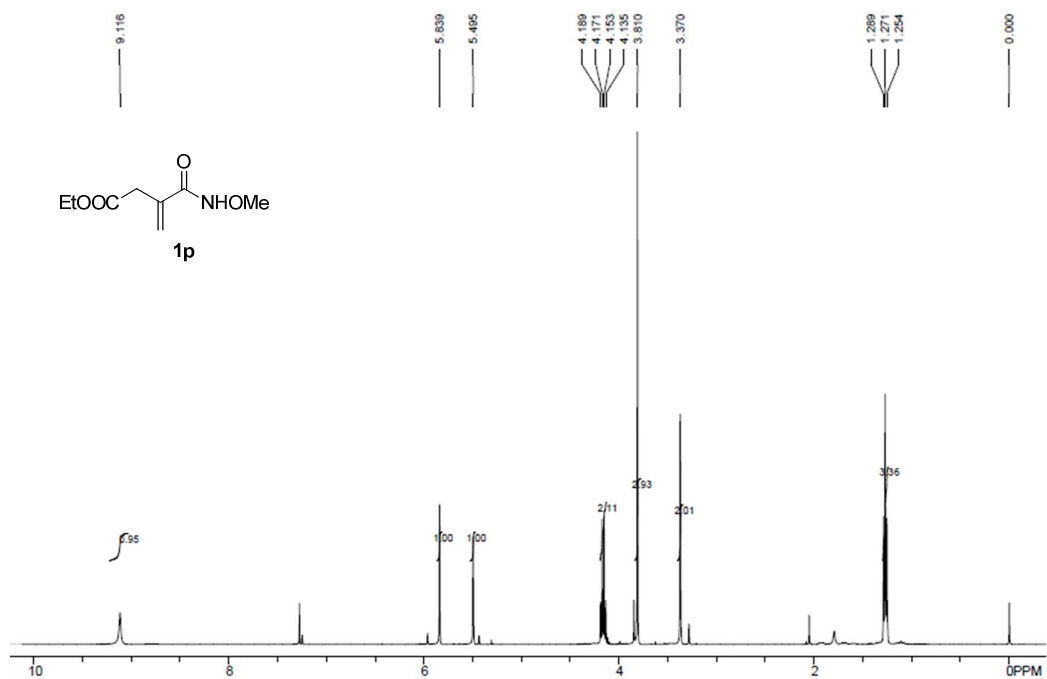
VI References

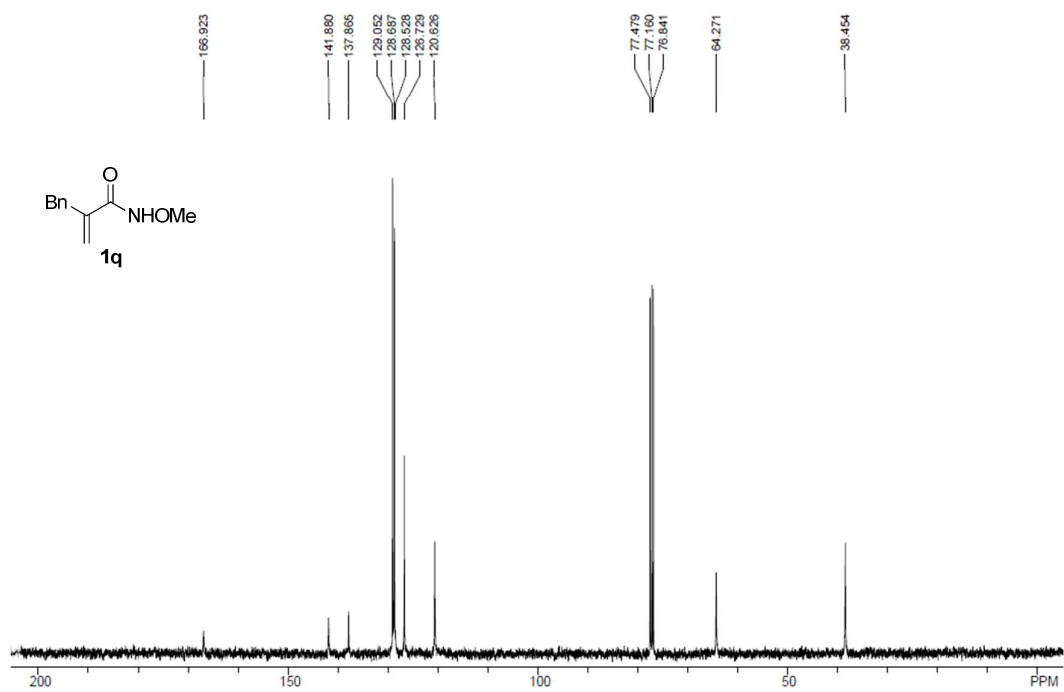
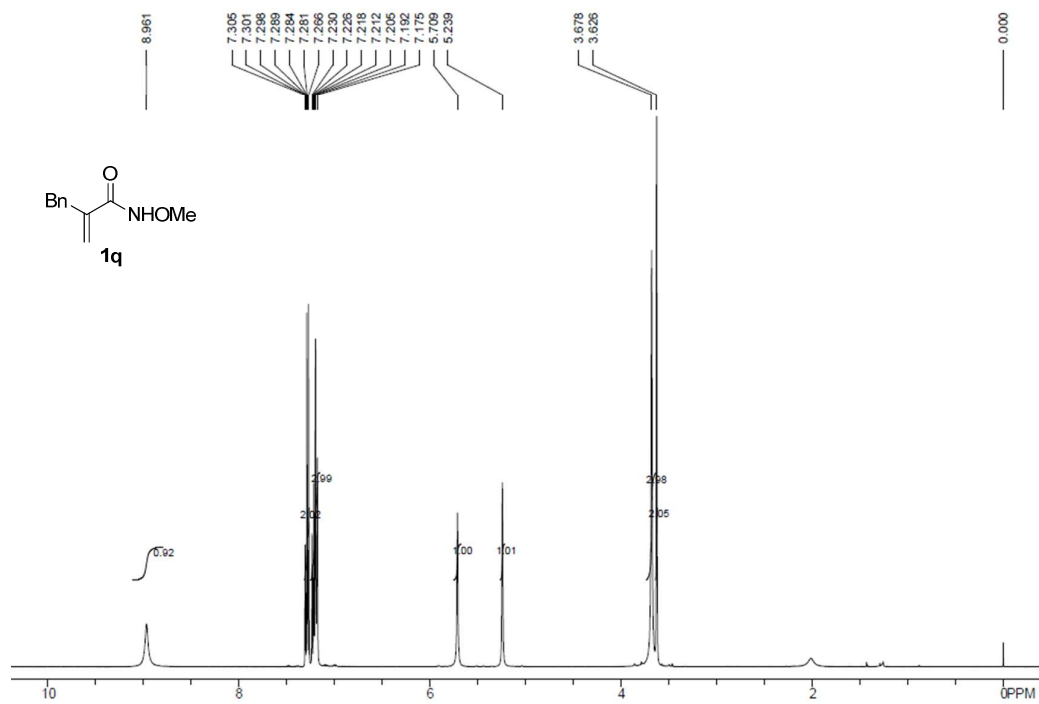
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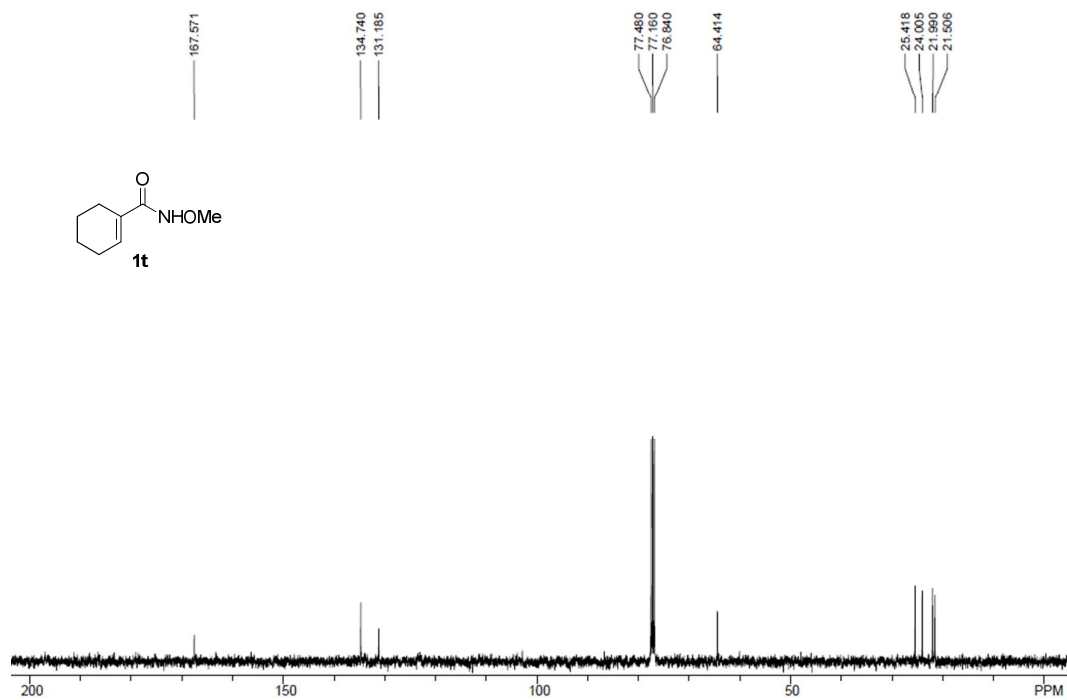
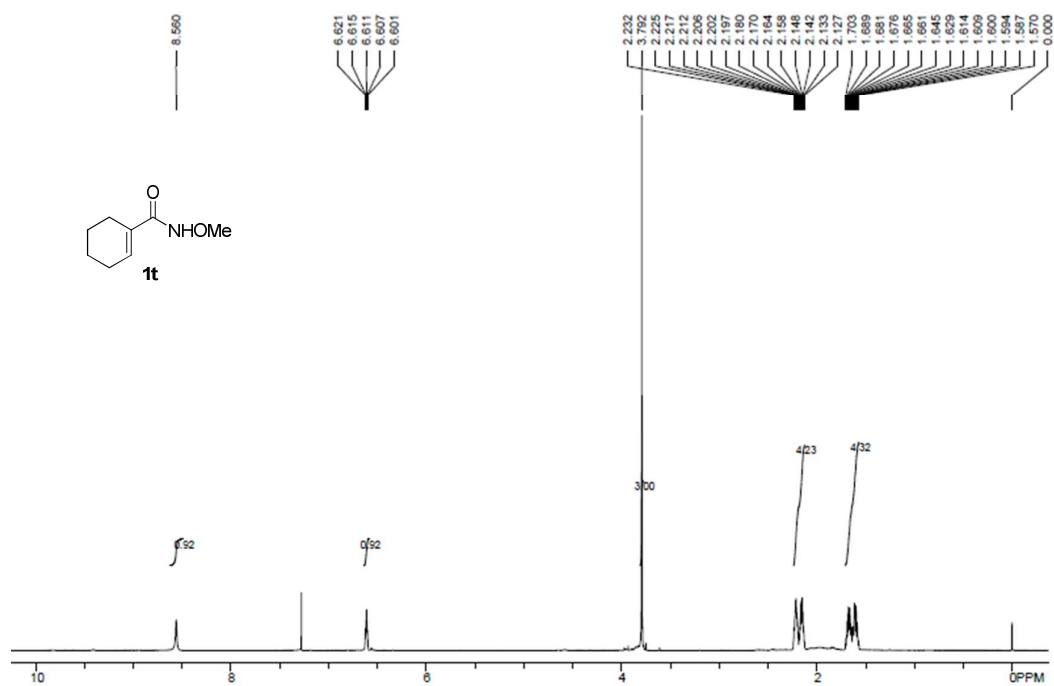
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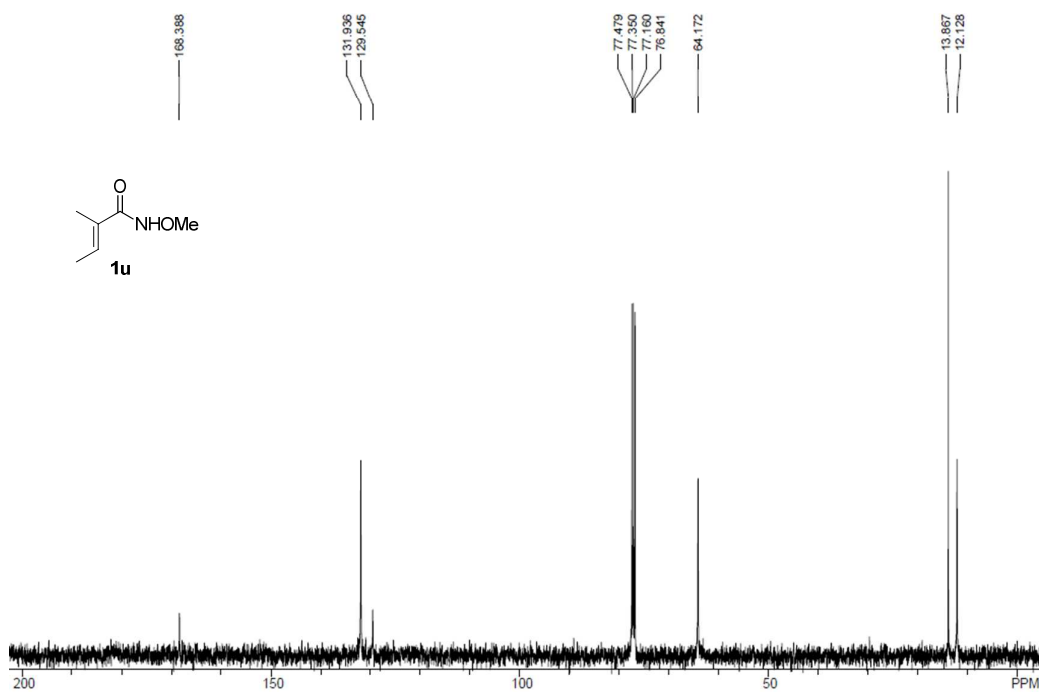
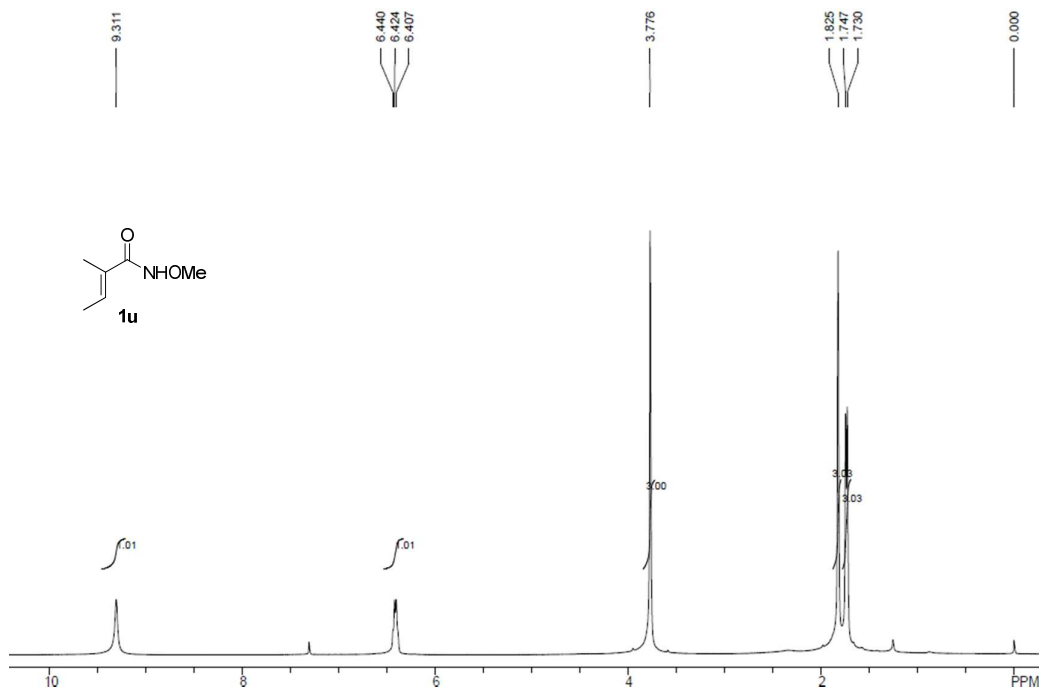
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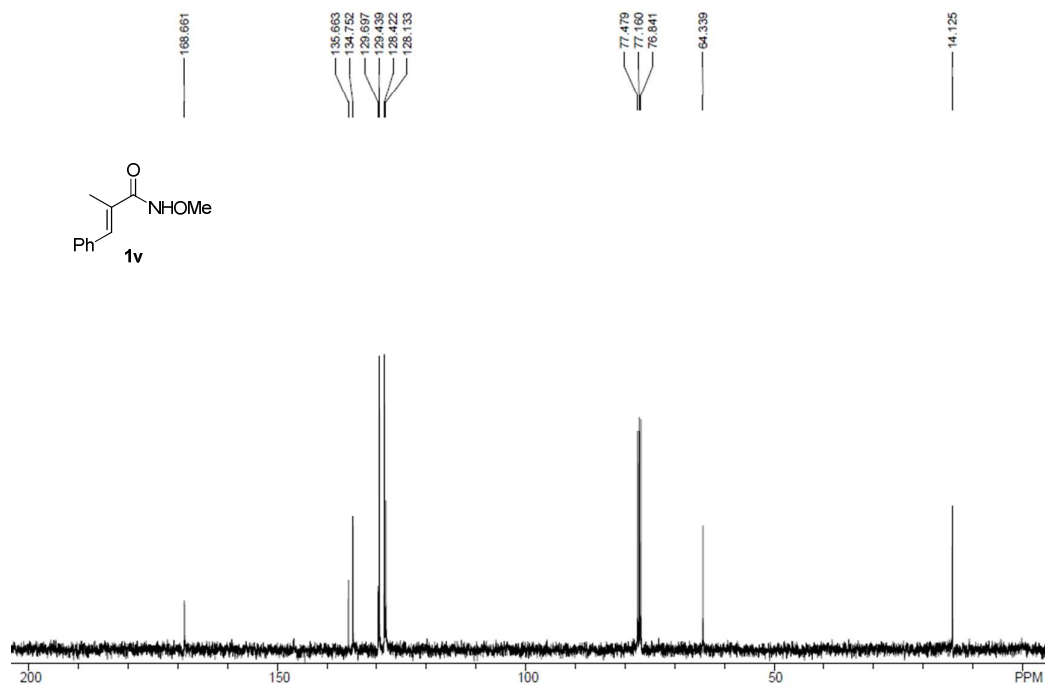
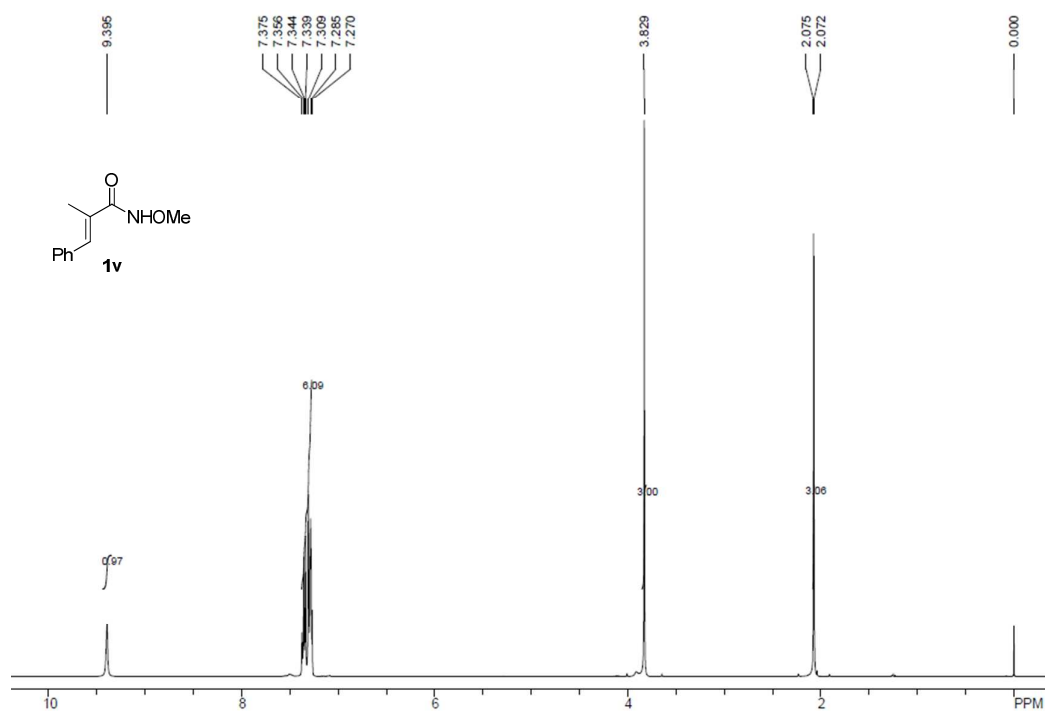
VII Copies of ^1H , ^{13}C NMR and NOESY spectra

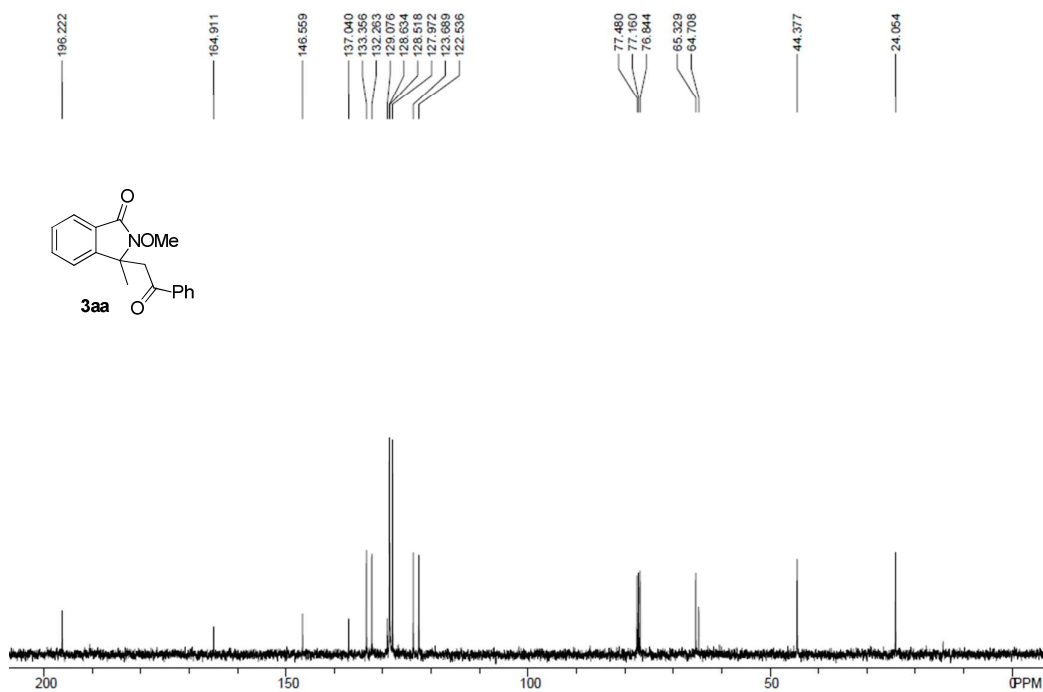
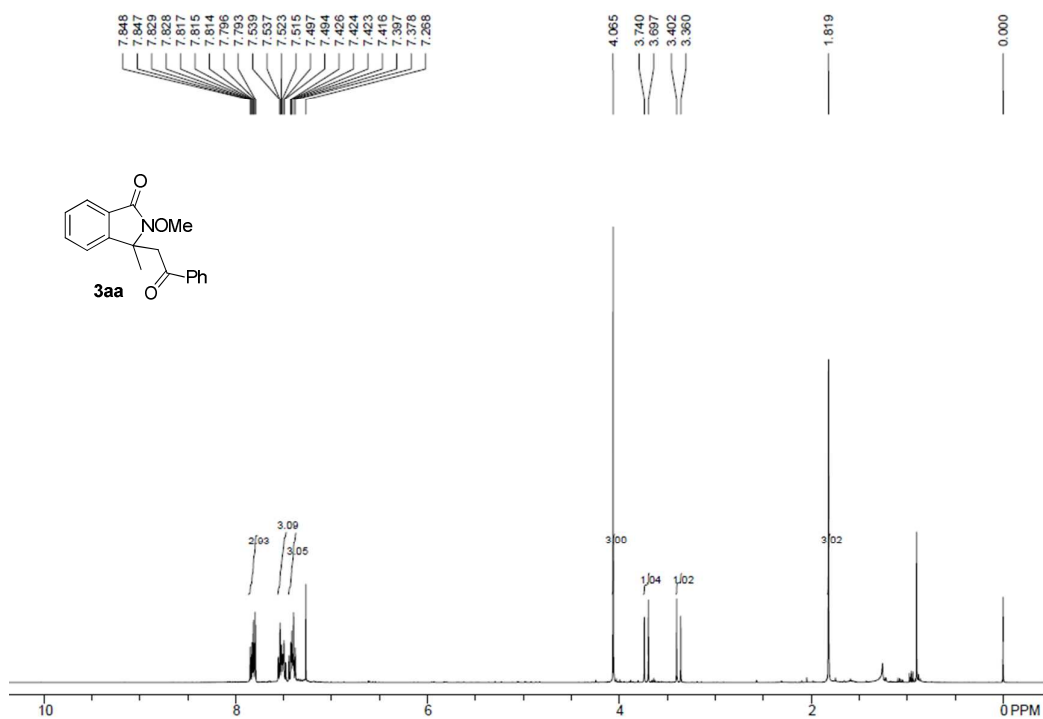


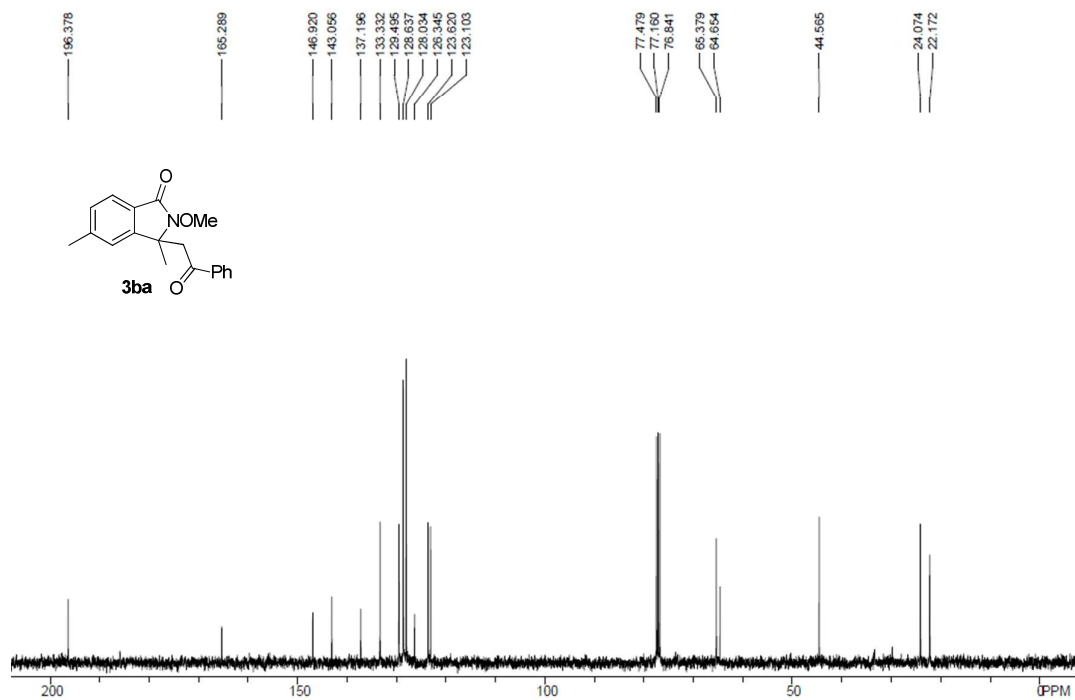
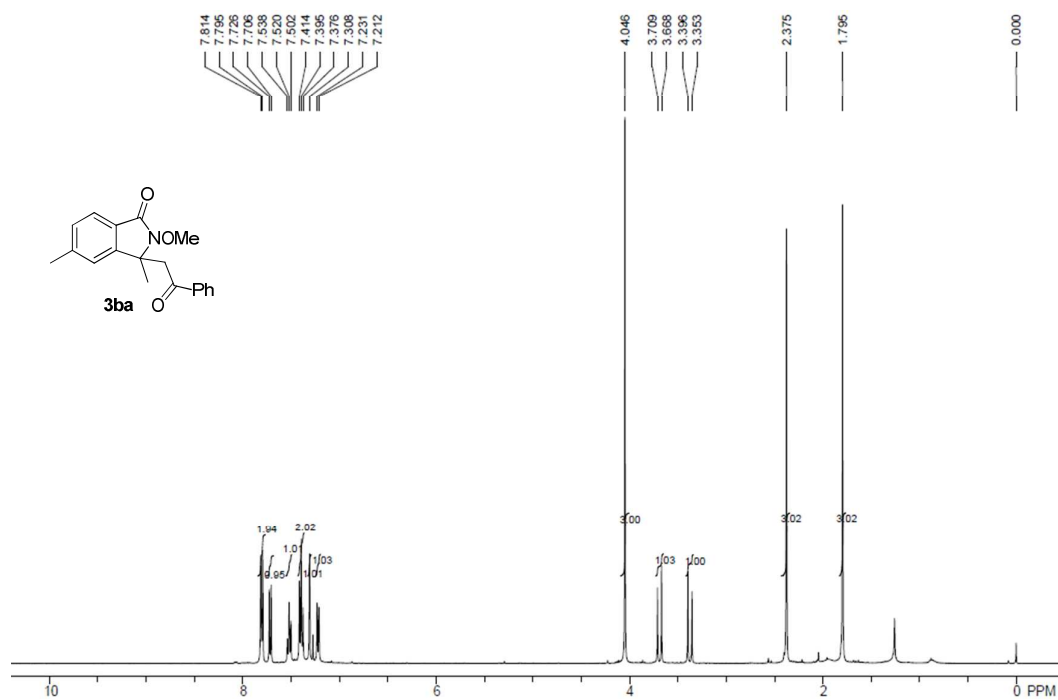


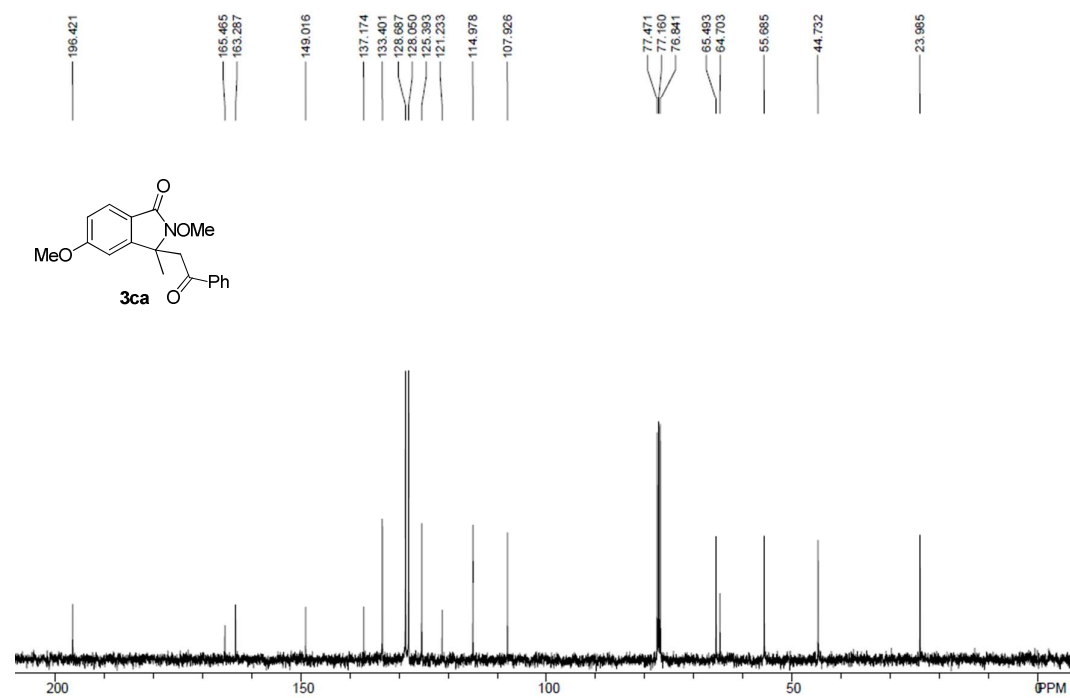
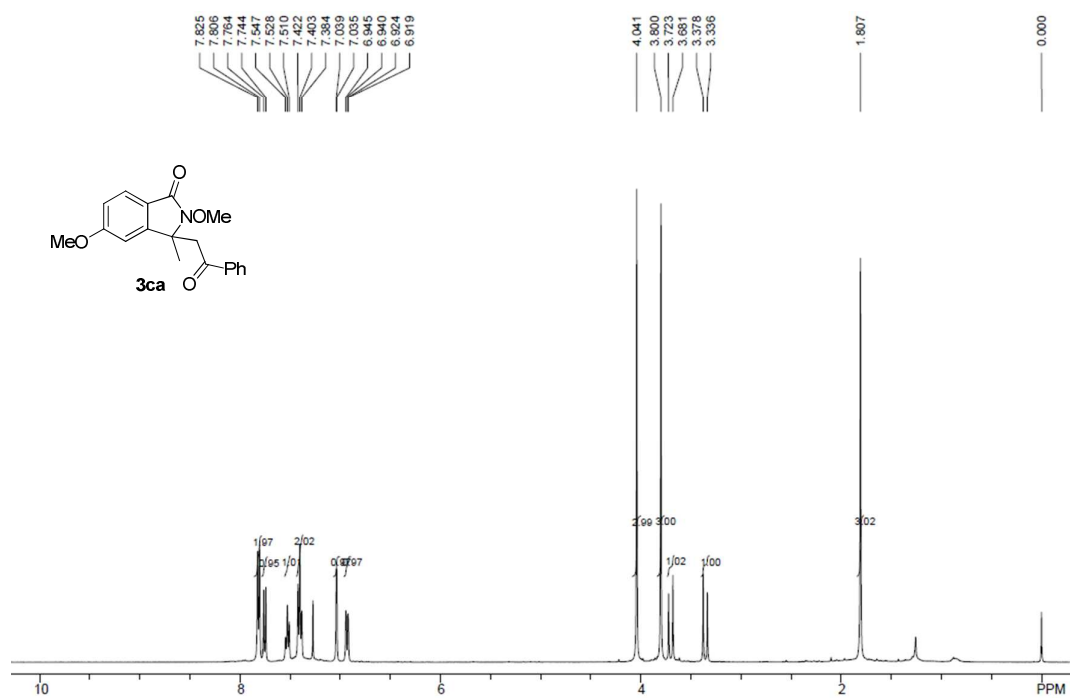


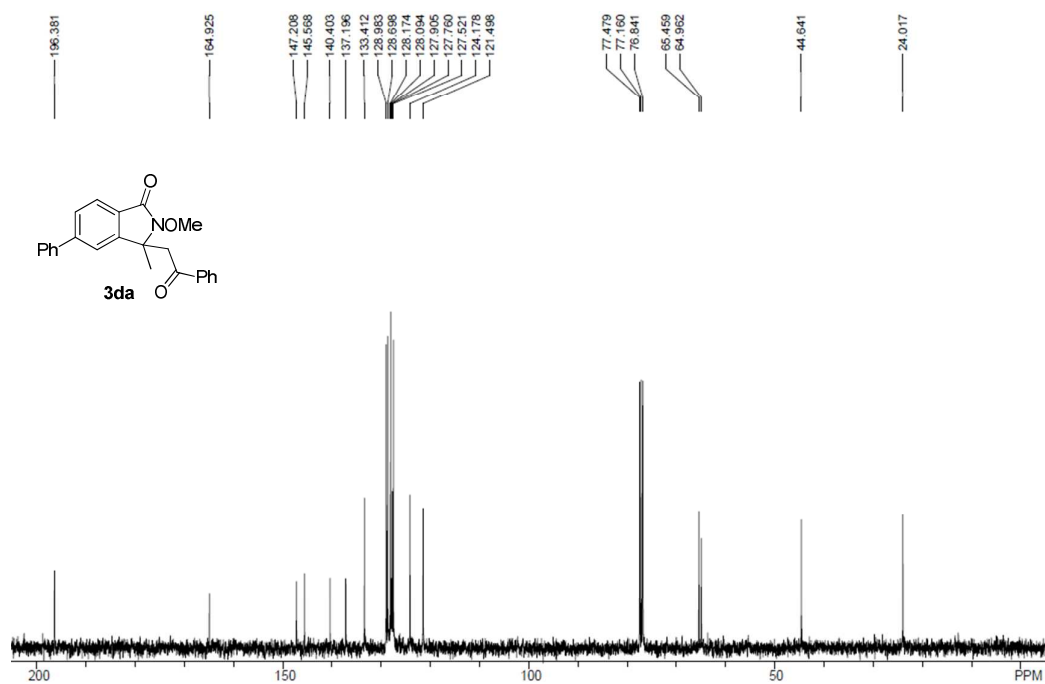
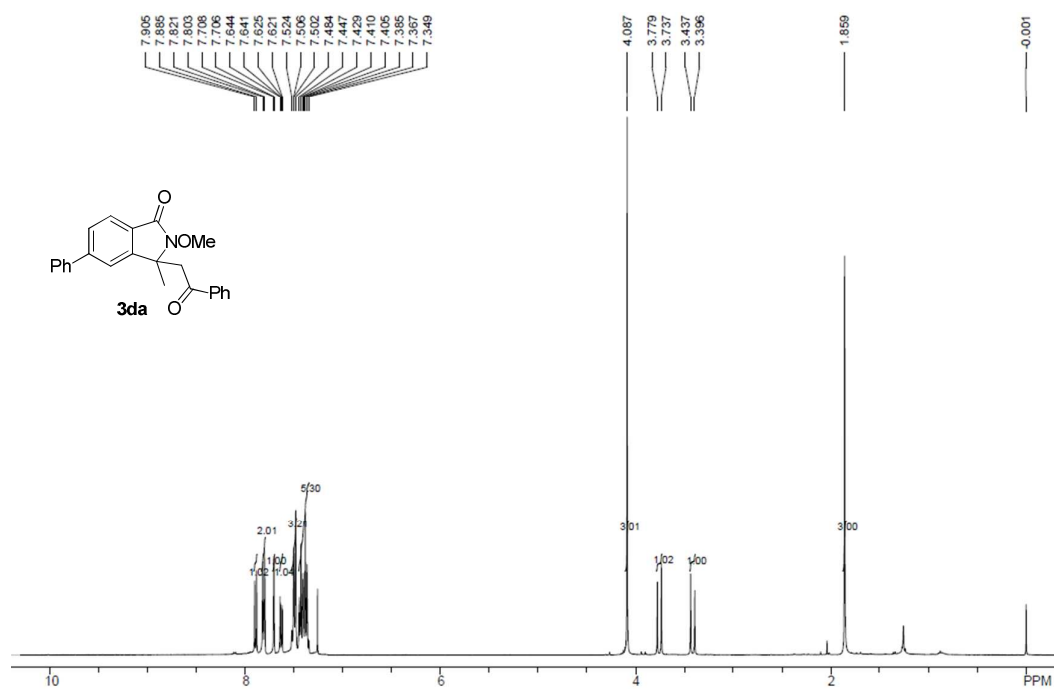


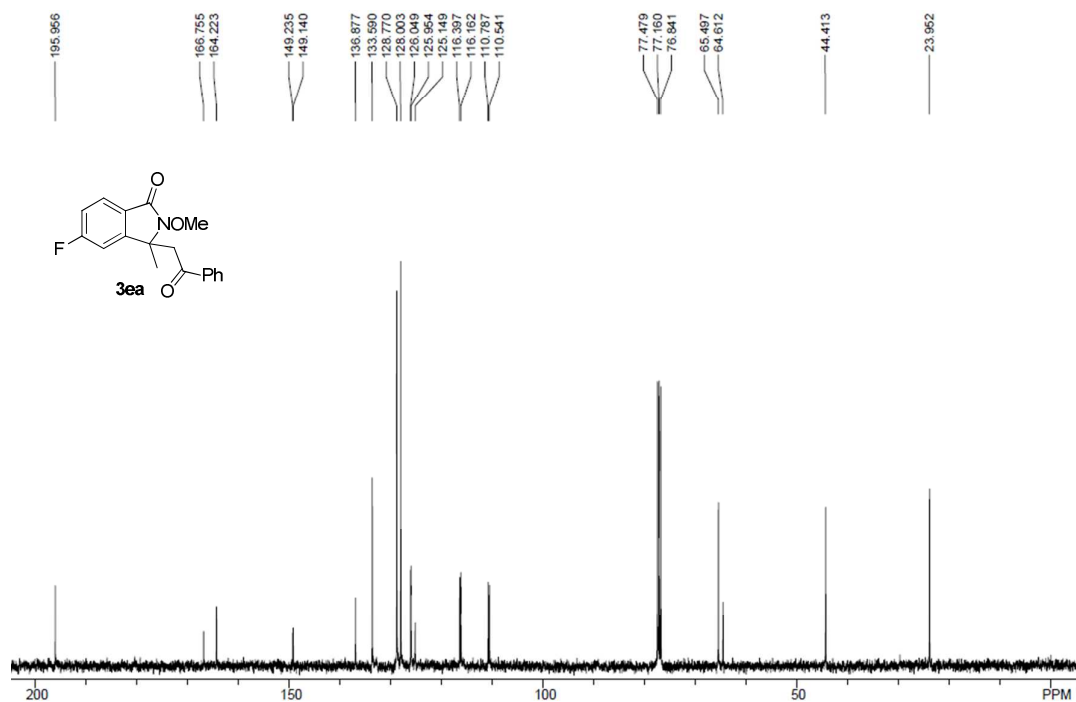
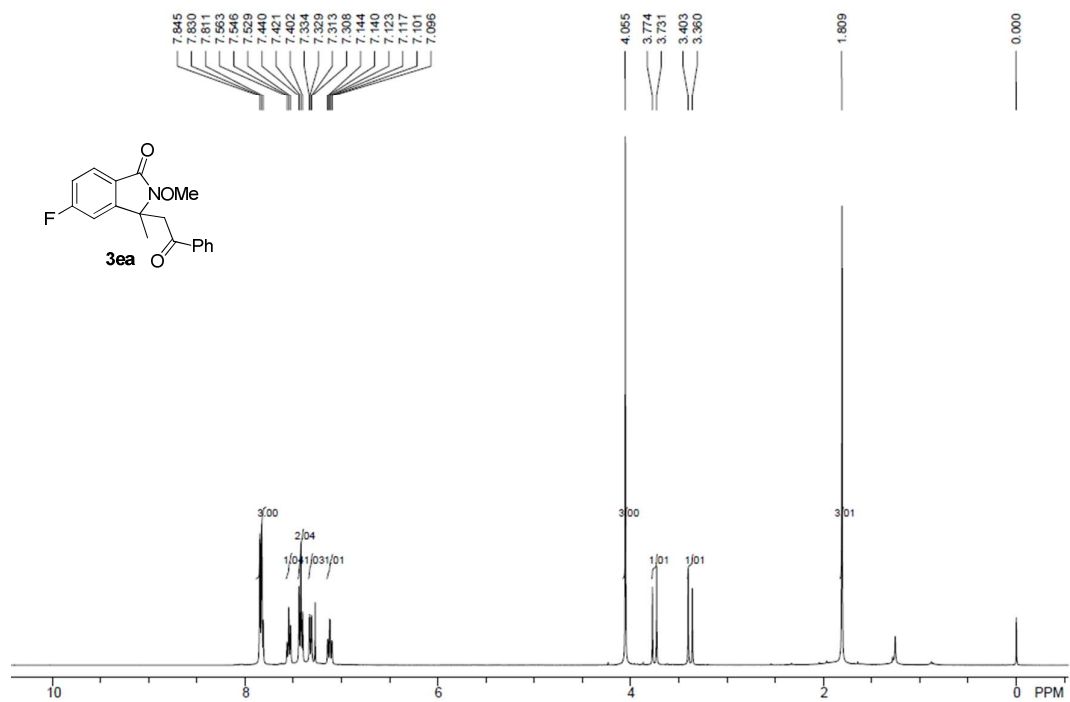












^{19}F Spectra of **3ea**

