Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

NHC-Catalyzed Oxindole Synthesis via Single Electron Transfer

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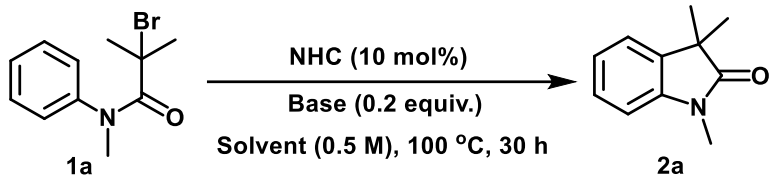
General Methods and Materials:

Unless specified, all reactions were carried out under a nitrogen atmosphere (balloon) with dry solvents under anhydrous conditions. α-bromoamide starting materials were synthesized according to a previous literature.[1] Cs_2CO_3 (purity: 98%) was purchased from Alfa Aesar; 1, 4-dioxane (super dry, 99.8%) was purchased from *J&K*; all other reagents were purchased and used without further purification unless specified otherwise. Solvents for chromatography were technical grade and distilled prior to use. Flash chromatography was performed using 200-300 mesh silica gel with the indicated solvent system according to standard techniques. Analytical thin-layer chromatography (TLC) was performed on pre-coated, glass-backed silica gel plates. Visualization of the developed chromatogram was performed by UV absorbance (254 nm). ^{1}H NMR and ^{13}C NMR data were recorded on Bruker 300 M nuclear resonance spectrometers unless otherwise specified, respectively. Chemical shifts (δ) in ppm are reported as quoted relative to the residual signals of chloroform (^{1}H 7.26 ppm or ^{13}C 77.16 ppm). Multiplicities are described as: s (singlet), bs (broad singlet), d (doublet), t (triplet), q (quartet), m (multiplet); and coupling constants (*J*) are reported in Hertz (Hz). ^{13}C NMR spectra were recorded with total proton decoupling. HRMS (ESI) analysis was performed by The Analytical Instrumentation Center at College of Chemistry and Materials Science, Jinan University, and (HRMS) datas were reported with ion mass/charge (m/z) ratios as values in atomic mass units.

Conditions screening [a]



Entry	Solvent	Catalysis	Base	Isolated yield
1	THF	NHC A	Cs_2CO_3	28%
2	1, 4-dioxane	NHC A	Cs_2CO_3	33%
3	MeCN	NHC A	Cs_2CO_3	13%
4	Toluene	NHC A	Cs_2CO_3	21%
5	DCE	NHC A	Cs_2CO_3	11%
6	DMF	NHC A	Cs_2CO_3	<5%
7	MTBE	NHC A	Cs_2CO_3	12%
8[b]	1, 4-dioxane	NHC A	Cs_2CO_3	37%
9[c]	1, 4-dioxane	NHC A	Cs_2CO_3	33%
10	1, 4-dioxane (0.15 M)	NHC A	Cs_2CO_3	33%
11	1, 4-dioxane (0.2 M)	NHC A	Cs_2CO_3	32%
12	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3	39%
13	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (0.1 equiv)	9%
14	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (0.2 equiv)	39%
15	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (0.3 equiv)	44%
16	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (0.5 equiv)	77%
17	**1, 4-dioxane (0.3 M)**	**NHC A**	**Cs_2CO_3 (0.8 equiv)**	**88%**
18	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (1.0 equiv)	71%
19	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (1.2 equiv)	53%
20	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (1.5 equiv)	50%
21	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (2.0 equiv)	45%
22[d]	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (0.8 equiv)	77%
23[d]	1, 4-dioxane (0.3 M)	NHC A (5 mol%)	Cs_2CO_3 (0.8 equiv)	43%
24[c]	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (0.8 equiv)	83%
25[e]	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (0.8 equiv)	35%
26[f]	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (0.8 equiv)	16%
27	1, 4-dioxane (0.3 M)	–	Cs_2CO_3 (0.8 equiv)	0%
28	1, 4-dioxane (0.3 M)	–	K_2CO_3 (0.8 equiv)	0%
29	1, 4-dioxane (0.3 M)	–	$NaHCO_3$ (0.8 equiv)	0%
30	1, 4-dioxane (0.3 M)	–	*t*-BuONa (0.8 equiv)	0%
31	1, 4-dioxane (0.3 M)	–	KOAc (0.8 equiv)	0%
32	1, 4-dioxane (0.3 M)	–	NaOH (0.8 equiv)	trace
33	1, 4-dioxane (0.3 M)	–	Na_2CO_3 (0.8 equiv)	0%
34	1, 4-dioxane (0.3 M)	–	DBU (0.8 equiv)	0%
35	1, 4-dioxane (0.3 M)	–	Et_3N (0.8 equiv)	0%

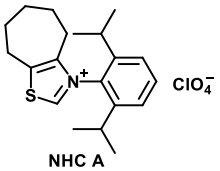
36	1, 4-dioxane (0.3 M)	–	DIPEA (0.8 equiv)	trace
37	1, 4-dioxane (0.3 M)	–	TMP (0.8 equiv)	0%
38	1, 4-dioxane (0.3 M)	–	K_3PO_4 (0.8 equiv)	0%
39	1, 4-dioxane (0.3 M)	–	–	0%
40	1, 4-dioxane (0.3 M)	NHC A	–	0%
41	1, 4-dioxane (0.3 M)	NHC A	*t*-BuONa (0.8 equiv)	14%
42	1, 4-dioxane (0.3 M)	NHC A	DIPEA (0.8 equiv)	10%
43	1, 4-dioxane (0.3 M)	NHC A	DBU (0.8 equiv)	6%
44	1, 4-dioxane (0.3 M)	NHC A	NaOH (0.8 equiv)	33%
45	1, 4-dioxane (0.3 M)	NHC A	K_2CO_3 (0.8 equiv)	51%
46	1, 4-dioxane (0.3 M)	NHC B	Cs_2CO_3 (0.8 equiv)	<5%
47	1, 4-dioxane (0.3 M)	MHC C	Cs_2CO_3 (0.8 equiv)	<5%
48	1, 4-dioxane (0.3 M)	NHC D	Cs_2CO_3 (0.8 equiv)	0%
49	1, 4-dioxane (0.3 M)	NHC E	Cs_2CO_3 (0.8 equiv)	22%
50	1, 4-dioxane (0.3 M)	NHC F	Cs_2CO_3 (0.8 equiv)	10%
51	1, 4-dioxane (0.3 M)	NHC G	Cs_2CO_3 (0.8 equiv)	trace
52	1, 4-dioxane (0.3 M)	NHC H	Cs_2CO_3 (0.8 equiv)	30%
53	1, 4-dioxane (0.3 M)	NHC I	Cs_2CO_3 (0.8 equiv)	45%
54	1, 4-dioxane (0.3 M)	NHC J	Cs_2CO_3 (0.8 equiv)	79%
55	1, 4-dioxane (0.3 M)	NHC K	Cs_2CO_3 (0.8 equiv)	13%
56	1, 4-dioxane (0.3 M)	NHC L	Cs_2CO_3 (0.8 equiv)	0%
57	1, 4-dioxane (0.3 M)	NHC M	Cs_2CO_3 (0.8 equiv)	41%
58	1, 4-dioxane (0.3 M)	NHC N	Cs_2CO_3 (0.8 equiv)	63%
59	1, 4-dioxane (0.3 M)	NHC O	Cs_2CO_3 (0.8 equiv)	10%
60[g]	1, 4-dioxane (0.3 M)	NHC A	Cs_2CO_3 (0.8 equiv)	0%

[a.] Reaction on a 0.3 mmol scale, under N_2, isolated yield; [b.] react at 120 °C; [c.] react at 80 °C; [d.] react for 22 h; [e.] react at 60 °C; [f.] react at 40 °C; [g.] react at rt.

Note:

DCE = 1, 2-dichloroethane; MTBE = *tert*-Butyl methyl ether; DIPEA = N, N-diisopropylethylamine; DBU = 1, 8-Diazabicyclo[5, 4, 0]undec-7-ene; TMP = 2, 2, 6, 6-tetramethylpiperidine.

The structure of NHC catalysts:



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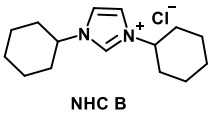
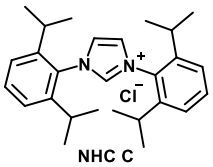
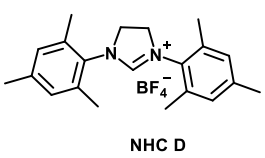


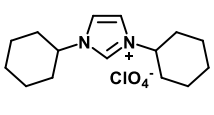
NHC B



NHC C



NHC D



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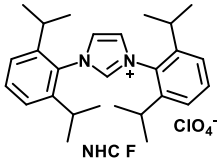
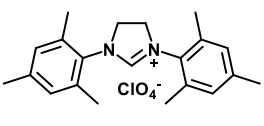
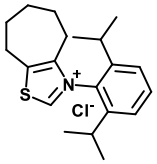


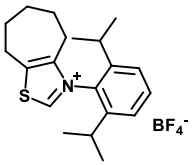
NHC F



NHC G



NHC H



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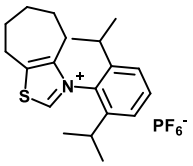

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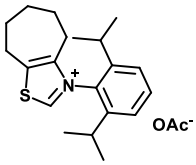
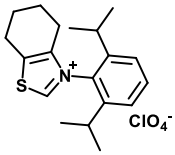
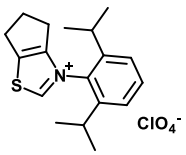


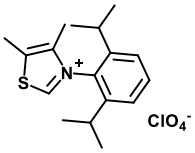
NHC K



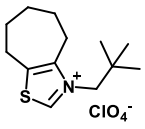
NHC L



NHC M

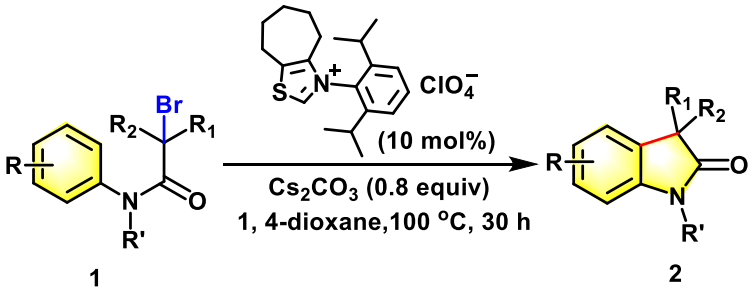


NHC N



NHC O

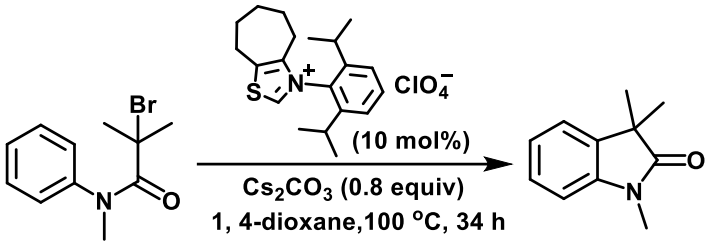
General Procedure for NHC-Catalyzed Oxindole Synthesis



1 2

α-bromoamide **1** (0.3 mmol, 1.0 equiv.), NHC **A** (10 mol%) and Cs_2CO_3 (0.24 mmol, 0.8 equiv.) were weighed into a Schlenk tube. The reaction vessel was capped and subjected to three vacuum-purge/nitrogen-flush cycles. Then 1, 4-dioxane (1.0 mL) was added through the side-arm by syringe *(if α-bromoamide **1** is a liquid, it was first dissolved in 1, 4-dioxane, then added to the reaction tube)*. The reaction was stirred under nitrogen at 100 °C for 30 h. Upon complete consumption of α-bromoamide **1** compound, the reaction was cooled to room temperature. Volatile solvent and reagents were removed by rotary evaporation and the residue was purified by silica gel flash chromatography using petroleum ether/EtOAc (50:1 to 30:1) to afford the desired product **2**.

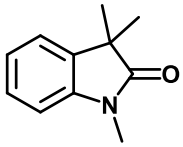
General Procedure for Scalable Reaction (5.0 mmol scale)



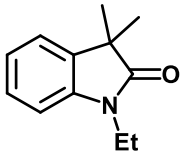
1a 2a

α-bromoamide **1a** (5 mmol, 1.28 g), NHC **A** (0.5 mol, 207 mg) and Cs_2CO_3 (4 mmol, 1.30 g) were weighed into a 100 mL Schlenk tube. The reaction vessel was capped and subjected to three vacuum-purge/nitrogen-flush cycles. Then 1, 4-dioxane (20 mL) was added through the side-arm by syringe. The reaction was stirred under nitrogen at 100 °C for 34 h. Upon complete consumption of α-bromoamide **1a** compound, the reaction was cooled to room temperature. Volatile solvent and reagents were removed by rotary evaporation and the residue was purified by silica gel flash chromatography using petroleum ether/EtOAc (50:1 to 30:1) to afford the desired product **2a** as a yellow oil, got: 767 mg, yield: 88%.

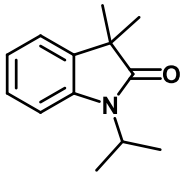
Characterization of Oxindole Products



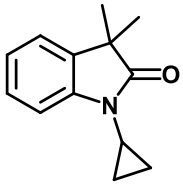
1, 3, 3-trimethylindolin-2-one (2a).[2] yield: 88%, yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.25 (t, *J* = 7.8 Hz, 1H), 7.20 (d, *J* = 7.3 Hz, 1H), 7.05 (t, *J* = 7.5 Hz, 1H), 6.84 (d, *J* = 7.7 Hz, 1H), 3.21 (s, 3H), 1.37 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.3, 142.6, 135.8, 127.7, 122.5, 122.2, 108.0, 44.1, 26.2, 24.4.



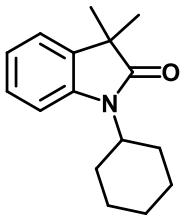
1-ethyl-3, 3-dimethylindolin-2-one (2b).[2] yield: 61%, yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.28-7.20 (m, 2H), 7.05 (t, *J* = 7.5 Hz, 1H), 6.87 (d, *J* = 7.7 Hz, 1H), 3.77 (q, *J* = 7.2 Hz, 2H), 1.37 (s, 6H), 1.26 (t, *J* = 7.1 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.1, 141.8, 136.2, 127.7, 122.5, 122.3, 108.3, 44.2, 34.6, 24.5, 12.8.



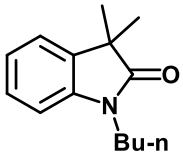
1-isopropyl-3, 3-dimethylindolin-2-one (2c).[2] yield: 75%, yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.26-7.19 (m, 2H), 7.05-7.01 (m, 2H), 4.65 (hept, *J* = 7.1 Hz, 1H), 1.48 (d, *J* = 7.1 Hz, 6H), 1.35 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.1, 141.8, 136.2, 127.7, 122.5, 122.3, 108.3, 44.2, 34.6, 24.5, 12.8.



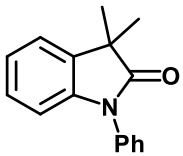
1-cyclopropyl-3, 3-dimethylindolin-2-one (2d). yield: 74%, yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.26 (t, *J* = 6.6 Hz, 1H), 7.18 (d, *J* = 7.2 Hz, 1H), 7.11 (d, *J* = 7.7 Hz, 1H), 7.05 (t, *J* = 7.5 Hz, 1H), 2.68-2.61 (m, 1H), 1.34 (s, 6H), 1.09-1.03 (m, 2H), 0.93-0.87 (m, 2H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 182.2, 143.1, 135.6, 127.7, 122.5, 122.2, 109.5, 44.2, 24.6, 22.2, 6.1. IR (ATR): 2967, 1716, 1611, 1488, 1385, 1126, 821, 743, 754, 694. HRMS (ESI): found: 202.1234, calcd. for $C_{13}H_{16}NO$ $[M+H]^+$: 202.1226.



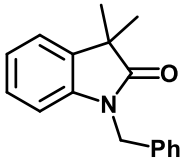
1-cyclohexyl-3, 3-dimethylindolin-2-one (2e). yield: 80%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.26-7.19 (m, 2H), 7.08-6.99 (m, 2H), 4.23-4.08 (m, 1H), 2.22-2.08 (m, 2H), 1.91-1.87 (m, 2H), 1.77-1.73 (m, 2H), 1.49-1.19 (m, 4H), 1.34 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.3, 141.7, 136.4, 127.3, 122.6, 121.9, 110.2, 51.9, 43.8, 29.3, 26.1, 25.5, 24.6. IR (ATR): 2930, 2858, 1705, 1610, 1457, 1360, 1183, 755, 741. HRMS (ESI): found: 244.1700, calcd. for $C_{16}H_{22}NO$ $[M+H]^+$: 244.1696.



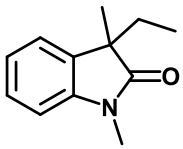
1-butyl-3, 3-dimethylindolin-2-one (2f).[2] yield: 72%, yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.27-7.19 (m, 2H), 7.04 (t, *J* = 7.4 Hz, 1H), 6.86 (d, *J* = 7.7 Hz, 1H), 3.71 (t, *J* = 7.2 Hz, 2H), 1.71-1.61 (m, 2H), 1.44-1.26 (m, 2H), 1.36 (s, 6H), 0.95 (t, *J* = 7.3 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.4, 142.1, 136.1, 127.6, 122.5, 122.3, 108.4, 44.2, 39.6, 29.6, 24.5, 20.2, 13.9.



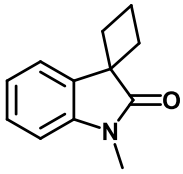
3, 3-dimethyl-1-phenylindolin-2-one (2g).[2] yield: 84%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.54-7.49 (m, 2H), 7.43-7.37 (m, 3H), 7.27 (d, *J* = 7.3 Hz, 1H), 7.19 (td, *J* = 7.7, 1.1 Hz, 1H), 7.09 (t, *J* = 7.2 Hz, 1H), 6.85 (d, *J* = 7.7 Hz, 1H), 1.49 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 180.8, 142.6, 135.8, 134.8, 129.7, 128.0, 127.7, 126.7, 123.1, 122.7, 109.5, 44.4, 24.9.



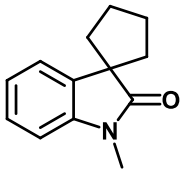
1-benzyl-3, 3-dimethylindolin-2-one (2h).[2] yield: 61%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.33-7.22 (m, 6H), 7.13 (t, *J* = 7.6 Hz, 1H), 7.02 (t, *J* = 7.4 Hz, 1H), 6.72 (d, *J* = 7.7 Hz, 1H), 4.91 (s, 2H), 1.44 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.6, 141.8, 136.2, 135.9, 128.9, 127.7, 127.6, 127.3, 122.6, 122.4, 109.2, 44.3, 43.6, 24.6.



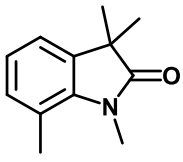
3-ethyl-1, 3-dimethylindolin-2-one (2i).[2] yield: 85%, yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.26 (t, *J* = 7.6 Hz, 1H), 7.17 (d, *J* = 7.1 Hz, 1H), 7.06 (t, *J* = 7.4 Hz, 1H), 6.84 (d, *J* = 7.7 Hz, 1H), 3.21 (s, 3H), 1.99-1.87 (m, 1H), 1.83-1.71 (m, 1H), 1.35 (s, 3H), 0.59 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 180.8, 143.6, 134.0, 127.7, 122.6, 122.5, 107.9, 49.0, 31.5, 26.1, 23.4, 8.9.



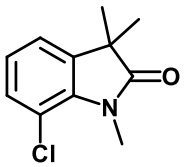
1'-methylspiro[cyclobutane-1, 3'-indolin]-2'-one (2j).[3] yield: 63%, yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.51 (d, *J* = 7.2 Hz, 1H), 7.25 (td, *J* = 7.6, 0.8 Hz, 1H), 7.09 (t, *J* = 7.3 Hz, 1H), 6.78 (d, *J* = 7.7 Hz, 1H), 3.18 (s, 3H), 2.71-2.62 (m, 2H), 2.40-2.20 (m, 4H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 180.3, 143.0, 134.5, 127.9, 122.6, 122.3, 107.7, 48.2, 31.4, 26.2, 16.9.



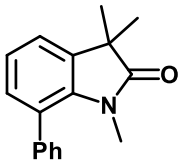
1'-methylspiro[cyclopentane-1, 3'-indolin]-2'-one (2k).[3] yield: 83%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.26-7.18 (m, 2H), 7.04 (t, *J* = 7.4 Hz, 1H), 6.82 (d, *J* = 7.7 Hz, 1H), 3.20 (s, 3H), 2.17-1.81 (m, 8H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 182.0, 143.0, 137.0, 127.4, 122.6, 122.3, 107.8, 54.0, 38.4, 26.7, 26.3.



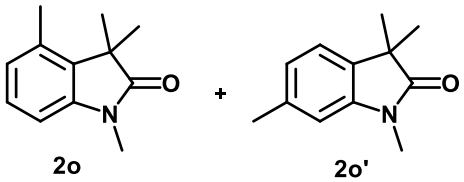
1, 3, 3, 7-tetramethylindolin-2-one (2l).[2] yield: 77%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.05-6.91 (m, 3H), 3.50 (s, 3H), 2.59 (s, 3H), 1.35 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 182.2, 140.5, 136.6, 131.5, 122.5, 120.3, 119.8, 43.6, 29.6, 24.8, 19.2.



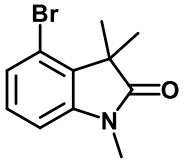
7-chloro-1, 3, 3-trimethylindolin-2-one (2m).[1] yield: 82%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.18 (d, *J* = 8.1 Hz, 1H), 7.08 (d, *J* = 7.2 Hz, 1H), 6.96 (t, *J* = 7.8 Hz, 1H), 3.59 (s, 3H), 1.36 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.6, 138.7, 138.6, 130.1, 123.4, 120.9, 115.6, 44.1, 29.7, 24.8.



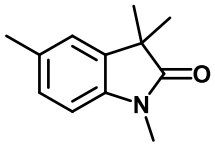
1, 3, 3-trimethyl-7-phenylindolin-2-one (2n).[2] yield: 63%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.40-7.34 (m, 5H), 7.22-7.19 (m, 1H), 7.09-7.03 (m, 2H), 2.74 (s, 3H), 1.41 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 182.5, 139.6, 139.2, 136.9, 130.8, 130.0, 127.9, 127.7, 125.5, 121.9, 121.4, 43.6, 30.2, 24.9.



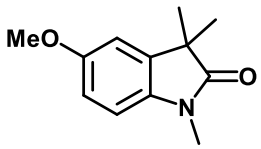
1, 3, 3, 4-tetramethylindolin-2-one (2o) and 1, 3, 3, 6-tetramethylindolin-2-one (2o').[4] **2o** : **2o'** = 1.8 : 1, total yield: 84%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.16 (t, *J* = 7.8 Hz, 1H), 7.09 (d, *J* = 7.4 Hz, 0.6H), 6.88 (d, *J* = 7.6 Hz, 0.6H), 6.83 (d, *J* = 7.8 Hz, 1H), 6.71-6.68 (m, 1.5H), 3.20 (s, 4.7H), 2.40 (s, 3H), 2.39 (s, 1.6H), 1.45 (s, 6H), 1.35 (s, 3.3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.8, 181.4, 143.0, 142.8, 137.8, 134.1, 133.0, 132.6, 127.5, 125.1, 123.0, 122.0, 109.1, 105.8, 45.0, 44.0, 26.4, 26.2, 24.5, 22.4, 21.8, 18.2.



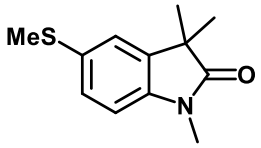
4-bromo-1, 3, 3-trimethylindolin-2-one (2p). yield: 58%, colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.18-7.10 (m, 2H), 6.79 (dd, *J* = 7.2, 1.1 Hz, 1H), 3.21 (s, 3H), 1.52 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 180.9, 144.8, 133.4, 129.2, 126.9, 118.9, 107.2, 46.6, 26.5, 21.5.



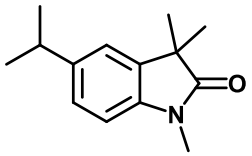
1, 3, 3, 5-tetramethylindolin-2-one (2q).[2] yield: 81%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.06-7.02 (m, 2H), 6.73 (d, *J* = 7.8 Hz, 1H), 3.19 (s, 3H), 2.34 (s, 3H), 1.35 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.4, 140.3, 136.0, 132.1, 127.9, 123.2, 107.8, 44.3, 26.3, 24.5, 21.2.



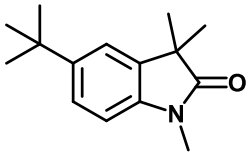
5-methoxy-1, 3, 3-trimethylindolin-2-one (2r).[2] yield: 75%, colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 6.82 (d, *J* = 1.9 Hz, 1H), 6.77-6.72 (m, 2H), 3.80 (s, 3H), 3.19 (s, 3H), 1.36 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.2, 156.2, 137.4, 136.3, 111.7, 110.2, 108.3, 56.0, 44.8, 26.4, 24.5.



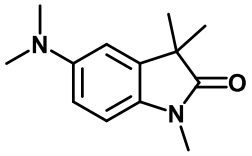
1, 3, 3-trimethyl-5-(methylthio)indolin-2-one (2s). yield: 73%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.25-7.20 (m, 2H), 6.79 (d, *J* = 8.0 Hz, 1H), 3.20 (s, 3H), 2.48 (s, 3H), 1.37 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.1, 141.1, 136.8, 131.4, 128.0, 123.2, 108.6, 44.4, 26.4, 24.4, 18.1. IR (ATR): 2967, 1705, 1608, 1489, 1344, 1243, 1128, 806, 544. HRMS (ESI): found: 222.0952, calcd. for $C_{12}H_{16}NOS$ $[M+H]^+$: 222.0947.



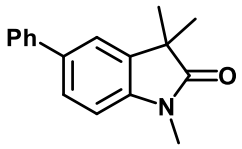
5-isopropyl-1, 3, 3-trimethylindolin-2-one (2t).[2] yield: 58%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.12 (d, *J* = 8.0 Hz, 1H), 7.08 (s, 1H), 6.77 (d, *J* = 7.9 Hz, 1H), 3.20 (s, 3H), 2.91 (hept, *J* = 6.8 Hz, 1H), 1.37 (s, 6H), 1.26 (d, *J* = 6.9 Hz, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.6, 143.5, 140.7, 136.0, 125.3, 120.6, 107.8, 44.4, 34.1, 26.3, 24.5, 24.4.



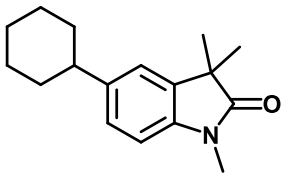
5-(*tert*-butyl)-1, 3, 3-trimethylindolin-2-one (2u).[2] yield: 63%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.29 (dd, *J* = 8.1, 1.8 Hz, 1H), 7.24 (d, *J* = 1.6 Hz, 1H), 6.78 (d, *J* = 8.1 Hz, 1H), 3.20 (s, 3H), 1.38 (s, 6H), 1.33 (s, 9H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.7, 145.9, 140.4, 135.7, 124.3, 119.5, 107.5, 44.5, 34.7, 31.8, 26.3, 24.6.



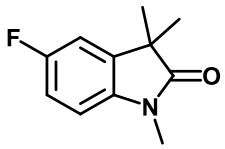
5-(dimethylamino)-1, 3, 3-trimethylindolin-2-one (2v).[4] yield: 88%, yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 6.75-6.72 (m, 2H), 6.64 (dd, *J* = 8.5, 2.3 Hz, 1H), 3.18 (s, 3H), 2.91 (s, 6H), 1.37 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.0, 147.8, 137.0, 133.8, 111.9, 109.2, 108.4, 44.7, 41.8, 26.3, 24.6.



1, 3, 3-trimethyl-5-phenylindolin-2-one (2w).[2] yield: 91%, yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.56 (d, *J* = 7.4 Hz, 2H), 7.50-7.40 (m, 4H), 7.31 (t, *J* = 7.2 Hz, 1H), 6.90 (d, *J* = 8.0 Hz, 1H), 3.23 (s, 3H), 1.42 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.4, 142.1, 141.1, 136.5, 136.1, 128.9, 127.0, 126.9, 126.6, 121.3, 108.3, 44.4, 26.4, 24.5.

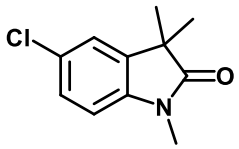


5-cyclohexyl-1, 3, 3-trimethylindolin-2-one (2x). yield: 74%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.10 (d, *J* = 8.0 Hz, 1H), 7.07 (s, 1H), 6.77 (d, *J* = 7.9 Hz, 1H), 3.19 (s, 3H), 2.52-2.45 (m, 1H), 1.88-1.77 (m, 6H), 1.48-1.15 (m, 4H), 1.36 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.6, 142.8, 140.7, 135.9, 125.7, 121.0, 107.8, 44.5, 44.4, 35.0, 27.0, 26.3, 26.2, 24.6. IR (ATR): 2923, 2850, 1709, 1620, 1494, 1350, 1247, 1064, 810, 731. HRMS (ESI): found: 258.1862, calcd. for $C_{17}H_{24}NO$ $[M+H]^+$: 258.1852.

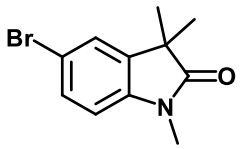


5-fluoro-1, 3, 3-trimethylindolin-2-one (2y).[2] yield: 62%, yellow solid. ^{1}H NMR ($CDCl_3$, 300

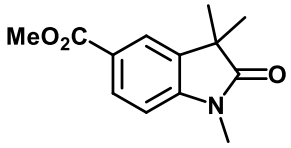
MHz): δ 6.99-6.94 (m, 2H), 6.78-6.74 (m, 1H), 3.21 (s, 3H), 1.37 (s, 6H); ^{19}F NMR ($CDCl_3$, 282 MHz): δ -120.9 (m, 1F); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.1, 159.53 (d, J_{1F} = 238.8), 138.6, 137.6 (d, J_{3F} = 7.8), 113.8 (d, J_{2F} = 23.3), 110.7 (d, J_{2F} = 24.4), 108.6 (d, J_{3F} = 8.1), 44.8, 26.5, 24.4.



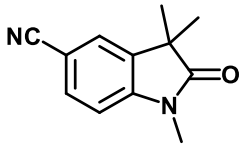
5-chloro-1, 3, 3-trimethylindolin-2-one (2z).[3] yield: 87%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.23 (dd, *J* = 8.2, 2.0 Hz, 1H), 7.18 (d, *J* = 1.9 Hz, 1H), 6.77 (d, *J* = 8.2 Hz, 1H), 3.21 (s, 3H), 1.37 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 180.9, 141.3, 137.5, 127.9, 127.6, 123.0, 109.0, 44.5, 26.4, 24.3.



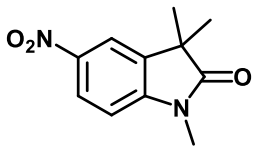
5-bromo-1, 3, 3-trimethylindolin-2-one (2ab).[3] yield: 52%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.38 (dd, *J* = 8.2, 1.8 Hz, 1H), 7.31 (d, *J* = 1.5 Hz, 1H), 6.72 (d, *J* = 8.2 Hz, 1H), 3.20 (s, 3H), 1.36 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 180.8, 141.8, 138.0, 130.6, 125.8, 115.3, 109.6, 44.6, 26.4, 24.4.



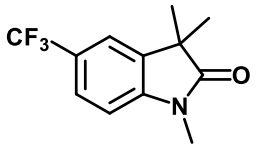
methyl 1, 3, 3-trimethyl-2-oxoindoline-5-carboxylate (2ac).[3] yield: 73%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 8.02 (dd, *J* = 8.2, 1.2 Hz, 1H), 7.89 (s, 1H), 6.89 (d, *J* = 8.2 Hz, 1H), 3.92 (s, 3H), 3.26 (s, 3H), 1.40 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.7, 167.0, 146.9, 135.8, 130.6, 124.5, 123.7, 107.6, 52.1, 44.1, 26.5, 24.3.



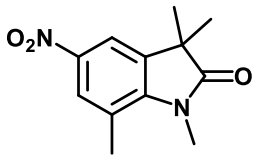
1, 3, 3-trimethyl-2-oxoindoline-5-carbonitrile (2ad).[3] yield: 84%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.61 (dd, *J* = 8.1, 1.3 Hz, 1H), 7.46 (s, 1H), 6.93 (d, *J* = 8.1 Hz, 1H), 3.26 (s, 3H), 1.40 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.0, 146.6, 136.8, 133.2, 125.8, 119.3, 108.6, 105.6, 44.1, 26.5, 24.2.



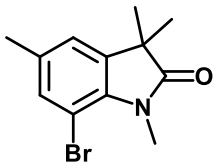
1, 3, 3-trimethyl-5-nitroindolin-2-one (2ae).[4] yield: 68%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 8.26 (dd, *J* = 8.6, 2.2 Hz, 1H), 8.11 (d, *J* = 2.1 Hz, 1H), 6.95 (d, *J* = 8.6 Hz, 1H), 3.30 (s, 3H), 1.44 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.3, 148.5, 143.6, 136.6, 125.3, 118.4, 107.7, 44.3, 26.7, 24.2.



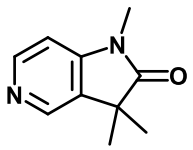
1, 3, 3-trimethyl-5-(trifluoromethyl)indolin-2-one (2af).[3] yield: 68%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.56 (d, *J* = 8.1 Hz, 1H), 7.44 (s, 1H), 6.93 (d, *J* = 8.2 Hz, 1H), 3.26 (s, 3H), 1.40 (s, 6H); ^{19}F NMR ($CDCl_3$, 282 MHz): δ -61.4 (m, 1F); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.3, 145.8, 136.4, 125.7 (q, J_{3F} = 4.0), 124.9 (q, J_{2F} = 32.3), 124.6 (q, J_{3F} = 269.8), 119.5 (q, J_{3F} = 3.6), 107.9, 44.3, 26.5, 24.3.



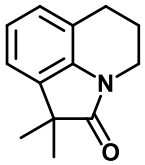
1, 3, 3, 7-tetramethyl-5-nitroindolin-2-one (2ag). yield: 49%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.98 (s, 1H), 7.92 (s, 1H), 3.56 (s, 3H), 2.69 (s, 3H), 1.40 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 182.2, 146.5, 143.0, 137.3, 127.9, 120.2, 116.2, 43.6, 29.7, 24.6, 19.3.



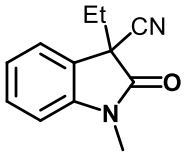
7-bromo-1, 3, 3, 5-tetramethylindolin-2-one (2ah). yield: 84%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.17 (s, 1H), 6.93 (s, 1H), 3.57 (s, 3H), 2.30 (s, 3H), 1.34 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.7, 138.9, 137.6, 133.7, 133.3, 122.5, 102.0, 44.1, 29.8, 24.8, 20.6. IR (ATR): 2969, 1717, 1570, 1468, 1336, 1252, 1066, 853, 789, 743. HRMS (ESI): found: 268.0334, calcd. for $C_{12}H_{15}BrNO$ (M^+): 268.0332.



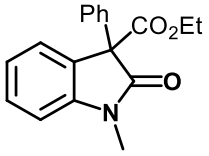
1, 3, 3-trimethyl-1,3-dihydro-2H-pyrrolo[3, 2-c]pyridin-2-one (2ai).[5] yield: 51%, colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 8.47 (d, *J* = 5.3 Hz, 1H), 8.34 (s, 1H), 6.82 (d, *J* = 5.3 Hz, 1H), 3.23 (s, 3H), 1.43 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.2, 150.1, 149.7, 142.8, 131.3, 103.9, 43.1, 26.4, 24.3.



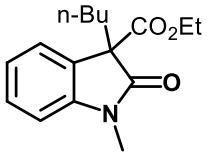
1, 1-dimethyl-5, 6-dihydro-4H-pyrrolo[3, 2, 1-ij]quinolin-2(1H)-one (2aj).[2] yield: 81%, yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.05-6.92 (m, 3H), 3.72 (t, *J* = 5.8 Hz, 2H), 2.79 (t, *J* = 6.0 Hz, 2H), 2.01 (quint, *J* = 5.9 Hz, 2H), 1.38 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 180.4, 138.5, 134.5, 126.5, 122.0, 120.2, 120.1, 45.6, 38.9, 24.7, 24.3, 21.3.



3-ethyl-1-methyl-2-oxoindoline-3-carbonitrile (2ak).[6] yield: 58%, colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.43-7.38 (m, 2H), 7.17 (t, *J* = 7.5 Hz, 1H), 6.90 (d, *J* = 8.0 Hz, 1H), 3.26 (s, 3H), 2.31-2.07 (m, 2H), 0.99 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 170.7, 143.3, 130.4, 125.4, 124.3, 123.8, 117.2, 109.1, 47.2, 31.0, 27.0, 8.5.



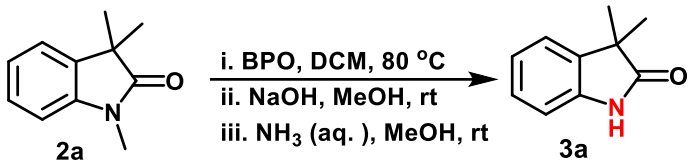
ethyl 1-methyl-2-oxo-3-phenylindoline-3-carboxylate (2al).[7] yield: 40%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.46 (d, *J* = 7.6 Hz, 1H), 7.40 (t, *J* = 7.8 Hz, 1H), 7.32 (s, 5H), 7.16 (t, *J* = 7.5 Hz, 1H), 6.93 (d, *J* = 7.9 Hz, 1H), 4.30-4.14 (m, 2H), 3.23 (s, 3H), 1.20 (t, *J* = 7.1 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 172.9, 169.3, 144.5, 136.1, 129.7, 128.6, 128.3, 128.0, 127.2, 126.1, 123.0, 108.8, 64.2, 62.4, 26.9, 14.1.



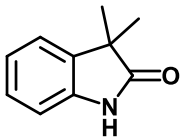
ethyl 3-butyl-1-methyl-2-oxoindoline-3-carboxylate (2am). yield: 34%, colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.32 (t, *J* = 7.7 Hz, 1H), 7.26-7.24 (m, 1H), 7.07 (t, *J* = 7.5 Hz, 1H), 6.85 (d, *J* = 7.8 Hz, 1H), 4.18-4.07 (m, 2H), 3.25 (s, 3H), 2.31-2.13 (m, 2H), 1.25-1.22 (m, 4H), 1.16 (t, *J* = 7.1 Hz, 3H), 7.32 (t, *J* = 7.3 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 174.5, 169.7, 144.3, 129.0, 128.5, 123.5, 122.9, 108.3, 61.9, 59.7, 34.1, 26.6, 25.8, 22.8, 14.1, 13.9. IR (ATR): 2926, 1717, 1611, 1493, 1348, 1226, 1080, 964, 749. HRMS (ESI): found: 276.1600, calcd. for $C_{16}H_{22}NO_3$ $[M+H]^+$: 276.1594.

Diversity of the products

(a) Demethylation [8]

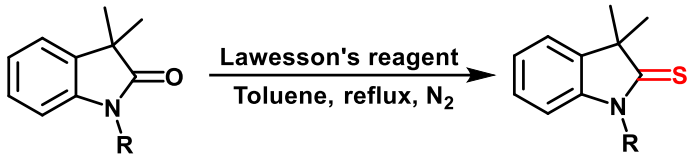


A solution of oxindole **2a** (1 mmol, 175 mg) and benzoyl peroxide (2.0 equiv.) in dry DCM (2 mL) in a sealed tube was heated slowly to 80 °C. After stirring for 18 h, the reaction mixture was cooled to rt and the solvent was evaporated. The residue was dissolved in MeOH (4 mL), NaOH (3.65 mmol, 146 mg) was added and the reaction mixture was stirred at rt for 18 h. Then the slurry was poured into saturated aqueous NH_4Cl (10 mL) and extracted with DCM (3*6 mL). The combined organic layers were dried by anhydrous Na_2SO_4 and concentrated. The residue was dissolved in a methanolic NH_3 solution (5 mL, 7M) and stirred for 19 h at rt. After reaction, the mixture was extracted by EtOAc (3*10 mL) and dried by anhydrous Na_2SO_4 and concentrated, purified by silica gel flash chromatography using Petroleum ether/EtOAc (30:1 to 2:1) to afford the desired product **3a** as a white solid.

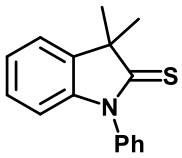


3, 3-dimethylindolin-2-one (3a).[8] yield: 70%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 9.71 (s, 1H), 7.21-7.16 (m, 2H), 7.05-6.97 (m, 2H), 1.41 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 184.9, 140.2, 136.4, 127.7, 122.6, 122.5, 110.2, 44.9, 24.4.

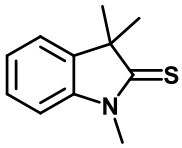
(b) Synthesis of the indoline-2-thione [9]



Oxindoles (**2a** or **2g**, 1 mmol) and Lawesson's reagent (0.51 equiv.) were added into a test tube under N_2. Then dry toluene (2 mL) was added by syringe. It was sealed and refluxed for 1.5-2 h. After cooling down, the mixture was poured into water. The organic layer was separated and the aqueous layer was extracted with ether. The organic layers were combined, washed with brine, dried over Na_2SO_4, concentrated in vacuo and finally purified by silica gel chromatography eluting with EtOAc/PE (1:40) to afford the product **3b-c**.

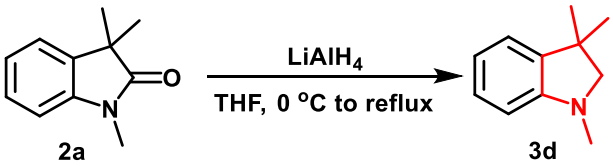


3, 3-dimethyl-1-phenylindoline-2-thione (3b).[9] yield: 96%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.61-7.48 (m, 3H), 7.40-7.36 (m, 3H), 7.21-7.19 (m, 2H), 6.71-6.68 (m, 1H), 1.57 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 213.8, 145.1, 140.3, 137.1, 130.0, 129.2, 127.8, 127.7, 124.4, 123.0, 110.7, 55.4, 28.7.

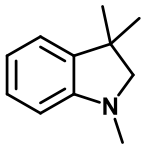


1, 3, 3-trimethylindoline-2-thione (3c).[10] yield: 50%, colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.35-7.30 (m, 2H), 7.19 (t, *J* = 7.5 Hz, 1H), 7.05 (d, *J* = 7.9 Hz, 1H), 3.65 (s, 3H), 1.44 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 211.9, 143.9, 140.3, 127.8, 124.2, 122.7, 109.6, 54.9, 31.5, 28.0.

(c) Reduction of amide [11]

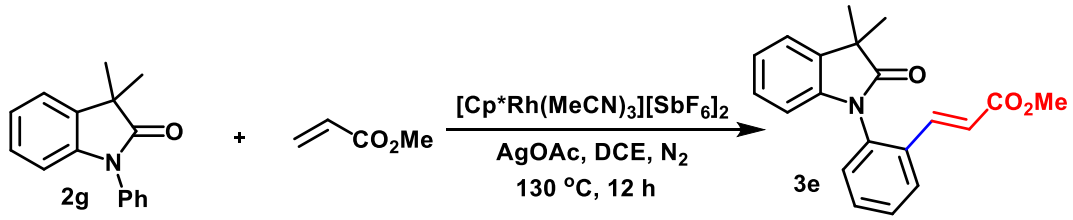


In a flame-dried Schlenktube, oxindole **2a** was dissolved in anhydrous THF (5 mL), $LiAlH_4$ (1 mmol, 175 mg) was then added slowly at 0 °C under N_2. The reaction was then heated to reflux overnight. After cooling to room temperature, the reaction was quenched with a saturated solution of NH_4Cl. The reaction was then extracted with ether three times. The combined organic extracts were washed with brine, dried with $MgSO_4$, filtrated and concentrated *in vacuo*. The product was purified by flash column chromatography (20:1, PE/Et_2O) to yield **3d** as a colorless oil.

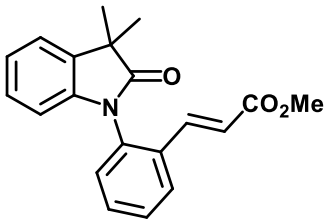


1, 3, 3-trimethylindoline (3d).[11] yield: 98%, volatile colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.09 (t, *J* = 7.5 Hz, 1H), 7.01 (d, *J* = 7.2 Hz, 1H), 6.70 (t, *J* = 7.3 Hz, 1H), 6.49 (d, *J* = 7.8 Hz, 1H), 3.06 (s, 2H), 2.75 (s, 3H), 1.30 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 151.9, 139.0, 127.4, 121.4, 117.9. 107.2, 70.2, 40.1, 35.8, 27.3.

(d) C–H alkenylation [12]

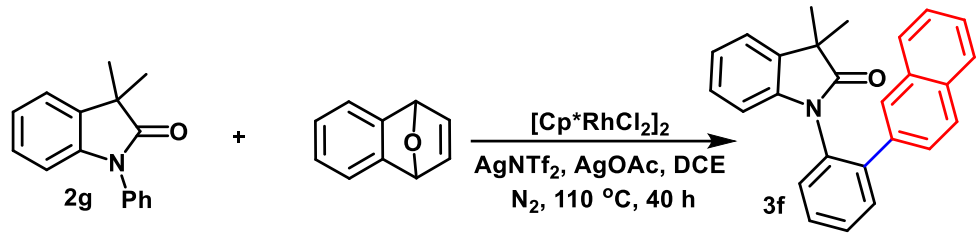


Oxindole **2g** (0.3 mmol, 71.2 mg), methyl acrylate (81.6 µL, 2.5 equiv.), $[Cp^*Rh(MeCN)_3][SbF_6]_2$ (12.6 mg, 5 mol %), AgOAc (50.4 mg, 1 equiv.) were stirred in DCE (2.0 mL) at 130 °C for 12 h. After completion, the reaction mixture was purified by flash chromatography eluting with ethyl acetate and petroleum ether (1:40 to 1:10) to give the product **3e** as a white solid.

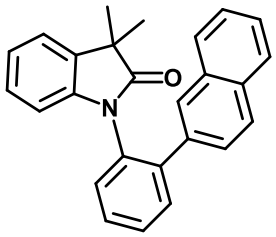


methyl (*E*)-3-(2-(3, 3-dimethyl-2-oxoindolin-1-yl)phenyl)acrylate (3e).[12] yield: 86%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.80 (d, *J* = 7.2 Hz, 1H), 7.56-7.45 (m, 3H), 7.35-7.29 (m, 2H), 7.18-7.07 (m, 2H), 6.50 (d, *J* = 7.2 Hz, 1H), 6.43 (d, *J* = 16.0 Hz, 1H), 3.69 (s, 3H), 1.57 (s, 3H), 1.52 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.0, 166.8, 142.8, 139.3, 135.6, 134.1, 133.0, 131.4, 129.3, 128.9, 127.8, 127.8, 123.3, 122.8, 120.3, 109.4, 51.7, 44.6, 25.5, 24.1.

(e) C–H arylation [13]

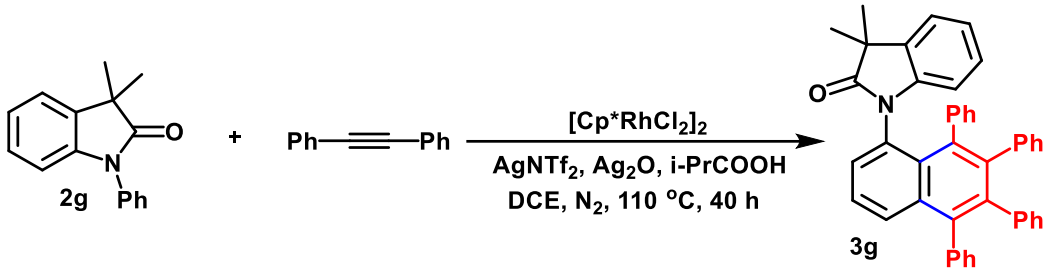


Under N_2 atmosphere, to a 15 mL oven-dried screw-top pressure reaction tube equipped with a magnetic stirring bar were added oxindole **2g** (1.2 equiv, 57.0 mg), 1, 4-dihydro-1, 4-epoxynaphthalene (0.2 mmol, 28.8 mg), $[Cp^*RhCl_2]_2$ (5 mol %, 6.2 mg), $AgNTf_2$ (40 mol %, 31.0 mg), AgOAc (0.9 equiv, 30.0 mg) and anhydrous DCE (2.0 mL). The reaction tube was sealed with a screw teflon cap. After stirring at 110 °C for 40 h, the reaction mixture was diluted with EtOAc, dried with $MgSO_4$, filtered, and concentrated. The residue was purified by flash chromatography on silica gel (petroleum ether/EtOAc = 40:1 to 20:1 as eluent) to afford the desired product **3f** as a colorless oil.

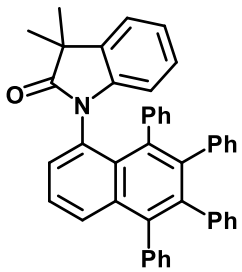


3, 3-dimethyl-1-(2-(naphthalen-2-yl)phenyl)indolin-2-one (3f).[13] yield: 46%, colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): 7.74-7.53 (m, 7H), 7.41-7.38 (m, 4H), 7.09-7.03 (m, 2H), 6.94 (t, *J* = 7.2 Hz, 1H), 6.53 (d, *J* = 7.6 Hz, 1H), 1.39 (s, 3H), 1.00 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.1, 143.2, 141.7, 136.3, 135.5, 133.2, 132.6, 132.5, 131.7, 129.4, 129.3, 129.1, 128.2, 127.9, 127.7, 127.6, 127.4, 126.7, 126.2, 126.1, 122.7, 122.4, 109.4, 44.3, 24.7, 24.1.

(f) C–H activation and cascade cyclization [9]

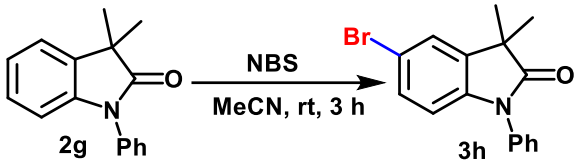


Under N_2 atmosphere, to a 15 mL tube were added oxindole **2g** (0.2 mmol, 47.5 mg), diphenylacetylene (2.2 equiv, 78.4 mg), $[Cp^*RhCl_2]_2$ (5 mol %, 6.2 mg), $AgNTf_2$ (40 mol %, 31.0 mg), Ag_2O (1.1 equiv, 51.0 mg) and DCE (anhydrous, 1.5 mL). Then *i*-PrCOOH (2.2 equiv, 41.0 μL) was added at room temperature. After stirring at 100 °C for 40 h, the reaction mixture was diluted with EtOAc, dried with $MgSO_4$, filtered, and concentrated. The residue was purified by flash chromatography on silica gel (petroleum ether/EtOAc = 40:1 to 20:1 as the eluent) to afford the desired product **3g** as a white solid.

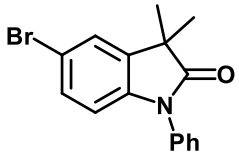


3, 3-dimethyl-1-(5, 6, 7, 8-tetraphenylnaphthalen-1-yl)indolin-2-one (3g).[9] yield: 59%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): 7.79 (d, *J* = 8.3 Hz, 1H), 7.46 (t, *J* = 7.5 Hz, 1H), 7.36-7.20 (m, 6H), 7.11-7.06 (m, 2H), 6.96-6.59 (m, 15H), 6.49 (d, *J* = 7.7 Hz, 1H), 6.36 (t, *J* = 7.4 Hz, 1H), 1.26 (s, 3H), 0.88 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.0, 144.3, 142.2, 140.5, 140.3, 140.0, 139.8, 139.3, 135.9, 135.7, 134.5, 133.1, 131.5, 131.3, 131.1, 130.4, 130.2, 129.3, 129.0, 127.8, 127.7, 126.9, 126.7, 126.6, 126.4, 126.2, 126.1, 125.9, 125.5, 125.1, 122.4, 121.7, 110.7, 44.0, 27.4, 23.2.

(g) Bromination [9]

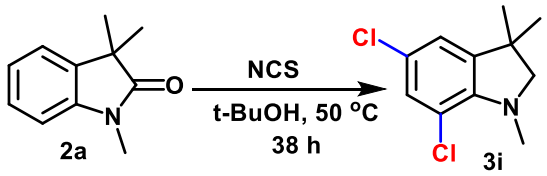


To a Schlenktube were added 3,3-dimethyl-1-phenylindolin-2-one (1 mmol, 237.3mg), *N*-Bromosuccinimide (NBS) (1.1 equiv, 195.8 mg) and CH_3CN (10 mL). The reaction mixture was stirred at room temperature for 3 h. Concentration of the reaction mixture in vacuo followed by silica gel chromatography eluting with EtOAc/PE (1:20) afforded the *N*-phenyl oxindole **3h** as a white solid.

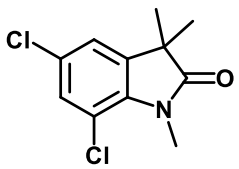


5-bromo-3, 3-dimethyl-1-phenylindolin-2-one (3h).[9] yield: 99%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.52 (t, *J* = 7.4 Hz, 2H), 7.43-7.38 (m, 4H), 7.30 (dd, *J* = 8.3, 1.9 Hz, 1H), 6.73 (d, *J* = 8.3 Hz, 1H), 1.48 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 180.1, 141.7, 137.8, 134.4, 130.6, 129.8, 128.3, 126.5, 126.1, 115.7, 111.0, 44.6, 24.8.

(h) Dichlorination [14]

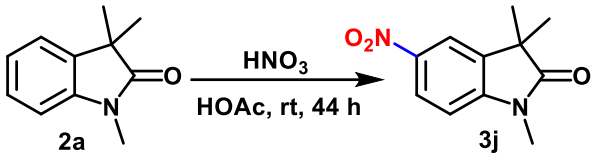


Oxindole **2a** (1.0 mmol, 175 mg) was dissolved in 80% *t*-BuOH (2.0 mL), and NCS (1.6 equiv., 214 mg) was added to this solution. The mixture was stirred for 38 h at 50 °C. Then allowed to cool to room temperature, diluted with water and extracted with ether, dried with $MgSO_4$, filtered and concentrated. The residue was purified by flash chromatography on silica gel (petroleum ether/EtOAc = 40:1 to 20:1 as the eluent) to afford the desired product **3i** as a white solid.

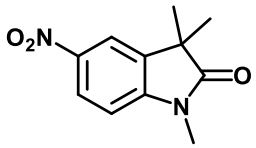


5, 7-dichloro-1, 3, 3-trimethylindolin-2-one (3i).[14] yield: 59%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.20 (d, *J* = 1.8 Hz, 1H), 7.06 (d, *J* = 1.8 Hz, 1H), 3.56 (s, 3H), 1.36 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.1, 139.9, 137.5, 129.5, 128.1, 121.7, 115.9, 44.4, 29.6, 24.6.

(i) Nitration [15]

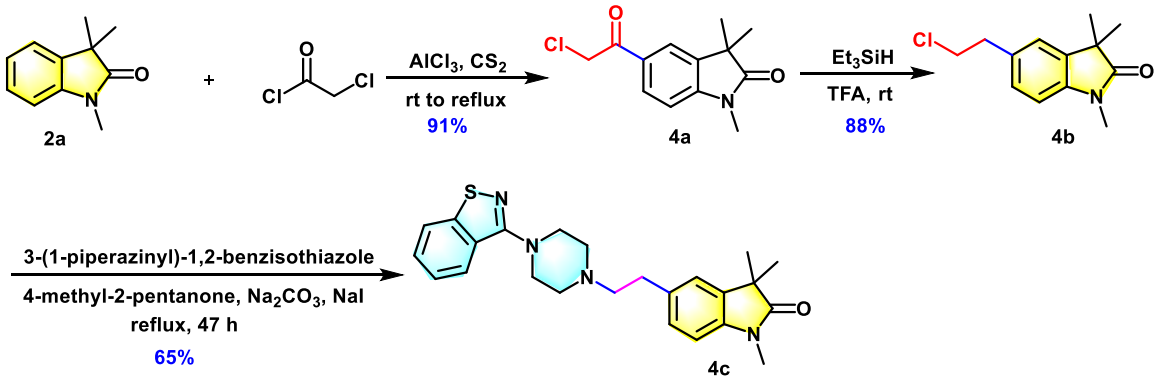


Nitric acid (65%; 329 µL, 1.1 equiv) was added dropwise to oxindole **2a** (526 mg, 3.0 mmol) in acetic acid (5.1 mL) at room temperature. After 44 h, diluted with water and extracted with EtOAc, dried with $MgSO_4$, filtered and concentrated. The residue was purified by flash chromatography on silica gel (petroleum ether/EtOAc = 20:1 to 4:1 as the eluent) to afford the desired product **3j** as a yellow solid.



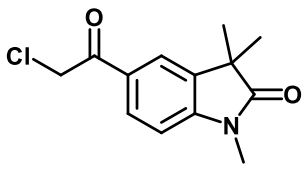
1, 3, 3-trimethyl-5-nitroindolin-2-one (3j).[15] yield: 80%, yellow solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 8.26 (dd, *J* = 8.6, 1.8 Hz, 1H), 8.10 (d, *J* = 1.8 Hz, 1H), 6.95 (d, *J* = 8.6 Hz, 1H), 3.30 (s, 3H), 1.44 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.4, 148.5, 143.6, 136.6, 125.3, 118.4, 107.7, 44.3, 26.7, 24.2.

(j) Synthesis of analogue of *anti*-anxiety treatment drug *Ziprasidone* [16]



Step I

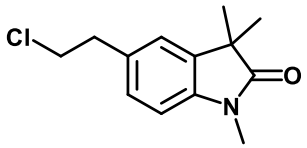
To a 50 mL round bottom flask was added anhydrous $AlCl_3$ (6.2 equiv., 4.13 g), CS_2 (20 mL) and chloroacetyl chloride (1.3 equiv., 517 µL). To the stirring mixture was added oxindole **2a** (5 mmol, 1.0 equiv., 876 mg) portionwise over 15 min. The reaction mixture was stirred further 10 min, then refluxed for 5.5 h. The reaction mixture was allowed to cool, added to ice, stirred thoroughly, the beige precipitate was filtered, washed with water and dried to afford the product **4a** as a beige solid.



5-(2-chloroacetyl)-1, 3, 3-trimethylindolin-2-one (4a).[16] yield: 91%, beige solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.94 (dd, *J* = 8.2, 1.5 Hz, 1H), 7.86 (s, 1H), 6.94 (d, *J* = 8.2 Hz, 1H), 4.69 (s, 2H), 3.27 (s, 3H), 1.41 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 190.1, 181.6, 148.0, 136.5, 130.2, 129.0, 122.7, 107.8, 45.6, 44.1, 26.6, 24.3.

Step II

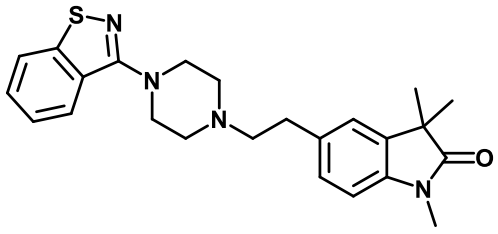
Oxindole **4a** (1.0 equiv., 3 mmol, 755 mg) was added to a Schlenktube followed by addition of TFA (2.5 mL) under N_2. To this solution was added Et_3SiH (2.3 equiv., 1.1 mL) while cooling to prevent exotherm. The reaction was stirred for 19 h at rt. After reaction, it was diluted with water and extracted with EtOAc, dried with $MgSO_4$, filtered and concentrated. The residue was purified by flash chromatography on silica gel (petroleum ether/EtOAc = 20:1 to 3:1 as the eluent) to afford the desired product **4b** as a white solid.



5-(2-chloroethyl)-1, 3, 3-trimethylindolin-2-one (4b).[16] yield: 88%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.12 (d, *J* = 7.9 Hz, 1H), 7.07 (s, 1H), 6.80 (d, *J* = 7.9 Hz, 1H), 3.70 (t, *J* = 7.4 Hz, 2H), 3.21 (s, 3H), 3.06 (t, *J* = 7.4 Hz, 2H), 1.37 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.5, 141.7, 136.3, 132.5, 128.1, 123.0, 108.1, 45.4, 44.4, 39.0, 26.4, 24.5.

Step III

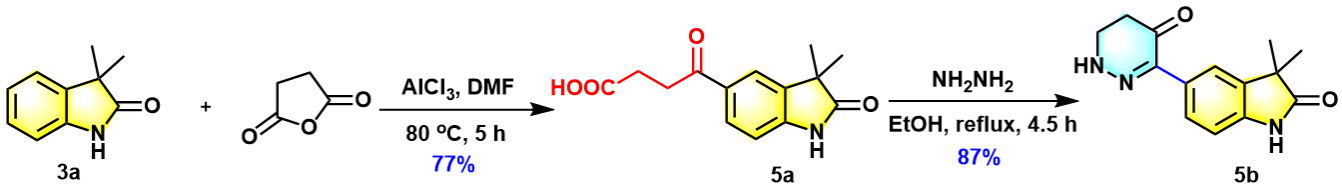
To a 100 ml round-bottom flask equipped with nitrogen inlet and condenser were added oxindole **4b** (1.0 equiv., 2.57 mmol, 610 mg), N-(3-benzisothiazolyl)-piperazine (1.5 equiv., 845 mg), sodium carbonate (2.0 equiv., 544 mg), sodium iodide (6 mg), and methylisobutyl ketone (30 mL). The reaction was refluxed 47 hours, cooled, filtered, and evaporated. The residue was chromatographed on silica gel (petroleum ether/EtOAc = 3:1 to 1:1 as the eluent) to afford the desired product **4c** as a beige solid.



5-(2-(4-(benzo[d]isothiazol-3-yl)piperazin-1-yl)ethyl)-1, 3, 3-trimethylindolin-2-one (4c).[16] yield: 65%, beige solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.89 (d, *J* = 8.1 Hz, 1H), 7.77 (d, *J* = 8.1 Hz, 1H), 7.42 (t, *J* = 7.2 Hz, 1H), 7.32 (t, *J* = 7.6 Hz, 1H), 7.10 (d, *J* = 8.0 Hz, 1H), 7.07 (s, 1H), 6.75 (d, *J* = 7.8 Hz, 1H), 3.58 (t, *J* = 4.4 Hz, 4H), 3.17 (s, 3H), 2.86-2.81 (m, 2H), 2.74 (t, *J* = 4.5 Hz, 4H), 2.69-2.64 (m, 2H), 1.35 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 181.3, 163.9, 152.7, 140.9, 136.0, 134.5, 128.0, 127.7, 127.5, 123.9, 122.8, 120.6, 107.9, 60.8, 53.0, 50.1, 44.2, 33.3, 26.2,

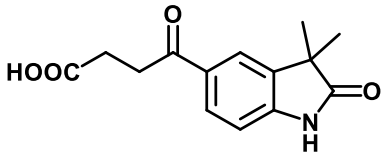
24.4. IR (ATR): 2980, 2968, 1703, 1619, 1491, 1382, 1350, 1255, 1128, 1003, 821, 773, 731. HRMS (ESI): found: 421.2065, calcd. for $C_{24}H_{31}N_4OS$ $[M+H]^+$: 421.2057.

(k) Synthesis of potent oral *inotropes* [17]



Step I

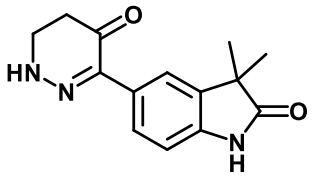
Dimethylformamide (1.1 mL, 2.8 equiv.) was added in a dropwise fashion to anhydrous $AlCl_3$ (6.67 g, 10.0 equiv.), and the exothermic reaction mixture was then allowed to cool to room temperature. An intimate mixture of succinic anhydride (500 mg, 5 mmol, 1.0 equiv.) and oxindole **3a** (806 mg, 1.0 equiv.) was slowly added to the $AlCl_3$/DMF melt. The reaction mixture was then stirred 5 h at 80 °C. The reaction mixture was slowly poured onto ice, and the product **5a** was isolated by filtration as a beige solid.



4-(3, 3-dimethyl-2-oxoindolin-5-yl)-4-oxobutanoic acid (5a).[17] yield: 77%, beige solid. ^{1}H NMR (d_6-DMSO, 300 MHz): δ 12.14 (s, 1H), 10.76 (s, 1H), 7.97 (s, 1H), 7.93 (d, *J* = 8.2 Hz, 1H), 6.99 (d, *J* = 8.1 Hz, 1H), 3.24 (t, *J* = 5.9 Hz, 2H), 2.60 (t, *J* = 6.1 Hz, 2H), 1.33 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 197.9, 183.5, 174.9, 146.6, 137.2, 131.5, 130.0, 123.4, 110.0, 44.6, 33.7, 28.9, 24.8.

Step II

A mixture of **5a** (784 mg, 3.0 mmol) and 50% hydrazine hydrate (661 mg, 2.2 equiv.) in 10 mL of absolute ethanol was refluxed for 4.5 h and then cooled slowly to room temperature. The precipitate was filtered and dried to afford 630 mg of product **5b** as a light-tan solid.

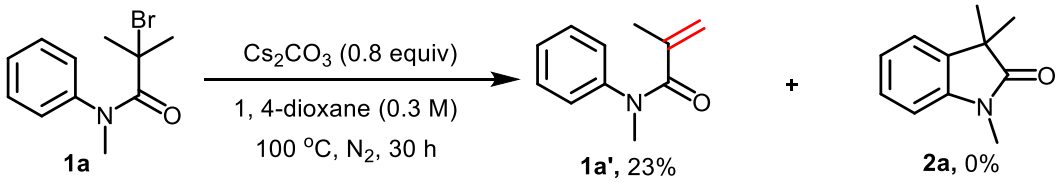


3, 3-dimethyl-5-(4-oxo-1, 4, 5, 6-tetrahydropyridazin-3-yl)indolin-2-one (5b).[17] yield: 87%, light-tan solid. ^{1}H NMR (d_6-DMSO, 300 MHz): δ 10.84 (s, 1H), 10.53 (s, 1H), 7.74 (s, 1H), 7.60 (d, *J* = 8.1 Hz, 1H), 6.92 (d, *J* = 8.1 Hz, 1H), 2.96 (t, *J* = 8.0 Hz, 2H), 2.46 (t, *J* = 8.1 Hz, 2H), 1.30 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 183.2, 168.0, 150.6, 143.1, 137.3, 130.6, 126.7, 121.0,

110.1, 44.7, 27.0, 24.9, 22.9. IR (ATR): 3198, 1709, 1652, 1617, 1499, 1355, 1209, 970, 808, 698. HRMS (ESI): found: 258.1238, calcd. for $C_{14}H_{16}N_3O_2$ $[M+H]^+$: 258.1237.

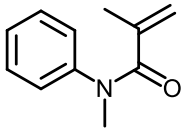
Mechanism study

Scheme 1 Control experiment



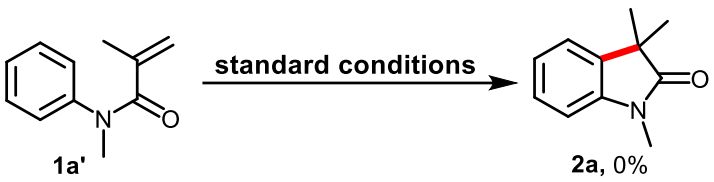
Procedures:

α-bromoamide **1a** (0.3 mmol, 76.8 mg, 1.0 equiv.) and Cs_2CO_3 (0.24 mmol, 78.2 mg, 0.8 equiv.) were weighed into a Schlenk tube. The reaction vessel was capped and subjected to three vacuum-purge/nitrogen-flush cycles. Then 1, 4-dioxane (1.0 mL) was added through the side-arm by syringe. The reaction was stirred under argon at 100 °C for 30 h. After reaction, the residue was purified by flash chromatography on silica gel (petroleum ether/EtOAc = 50:1 to 15:1 as the eluent) to afford **1a'** as a white solid.



N-methyl-N-phenylmethacrylamide (1a').[18] yield: 23%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.33 (t, *J* = 7.1 Hz, 2H), 7.22 (d, *J* = 7.4 Hz, 1H), 7.12 (d, *J* = 7.2 Hz, 1H), 5.02 (s, 1H), 4.97 (s, 1H), 3.33 (s, 3H), 1.75 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 171.7, 144.4, 140.5, 129.1, 126.7, 126.3, 119.1, 37.4, 20.1.

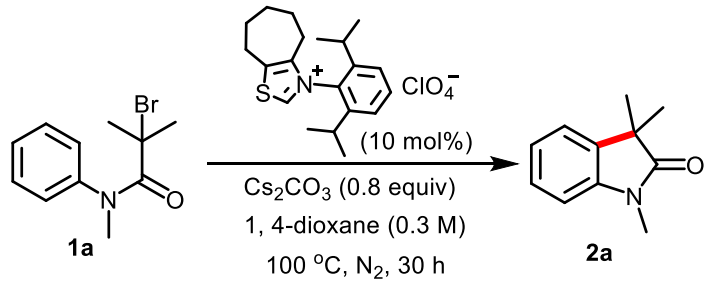
Scheme 2 Heck-type cyclization reaction



Procedures:

α-bromoamide **1a'** (0.30 mmol, 1.0 equiv.), NHC **A** (12.4 mg, 10 mol%) and Cs_2CO_3 (0.24 mmol, 78.2 mg, 0.8 equiv.) were weighed into a Schlenk tube. The reaction vessel was capped and subjected to three vacuum-purge/nitrogen-flush cycles. Then 1, 4-dioxane (1.0 mL) was added through the side-arm by syringe. The reaction was stirred under N_2 at 100 °C for 30 h. After reaction, the mixture was detected by GC-MS and showed no desired product produced.

Scheme 3 Radical trapping experiments



Radical scavenger:

TEMPO (1.0 equiv)	<5% yield
O_2	trace

Procedures:

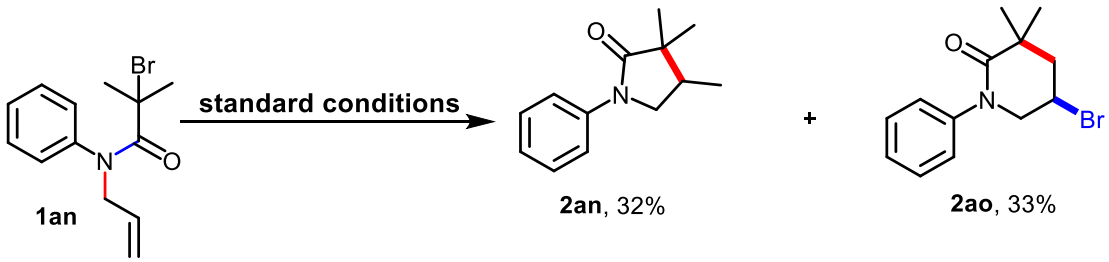
(a) TEMPO

α-bromoamide **1a** (0.3 mmol, 76.8 mg, 1.0 equiv.), NHC **A** (12.4 mg, 10 mol%), TEMPO (66.1 mg, 1.0 equiv.) and Cs_2CO_3 (0.24 mmol, 78.2 mg, 0.8 equiv.) were weighed into a Schlenk tube. The reaction vessel was capped and subjected to three vacuum-purge/nitrogen-flush cycles. Then 1, 4-dioxane (1.0 mL) was added through the side-arm by syringe. The reaction was stirred under argon at 100 °C for 30 h. Only little product **2a** (<5%) was detected by GC-MS.

(b) Under O_2

α-bromoamide **1a** (0.3 mmol, 76.8 mg, 1.0 equiv.), NHC **A** (12.4 mg, 10 mol%) and Cs_2CO_3 (0.24 mmol, 78.2 mg, 0.8 equiv.) were weighed into a Schlenk tube. The reaction vessel was capped and subjected to O_2 (via O_2 balloon). Then 1, 4-dioxane (1.0 mL) was added through the side-arm by syringe. The reaction was stirred under argon at 100 °C for 30 h. Only trace product **2a** was detected by GC-MS.

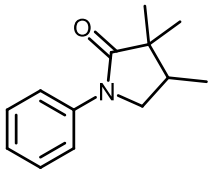
(c) *N*–allyl substrate for radical cyclization



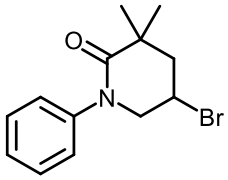
Procedures:

α-bromoamide **1an** (0.30 mmol, 1.0 equiv.), NHC **A** (12.4 mg, 10 mol%) and Cs_2CO_3 (0.24 mmol, 78.2 mg, 0.8 equiv.) were weighed into a Schlenk tube. The reaction vessel was capped and subjected to three vacuum-purge/nitrogen-flush cycles. Then 1, 4-dioxane (1.0 mL) was added through the side-arm by syringe. The reaction was stirred

under N_2 at 100 °C for 30 h. After reaction, the residue was purified by flash chromatography on silica gel (petroleum ether/EtOAc = 50:1 to 30:1 as the eluent) to afford the products **2an** and **2ao**.

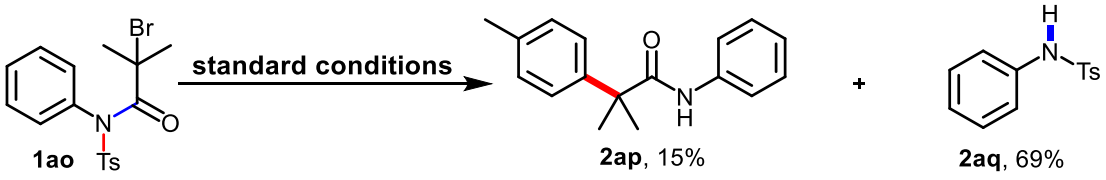


N-methyl-N-phenylmethacrylamide (2an).[19] yield: 32%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.65 (d, *J* = 7.9 Hz, 2H), 7.36 (t, *J* = 7.7 Hz, 2H), 7.12 (t, *J* = 7.4 Hz, 1H), 3.78 (dd, *J* = 9.4, 7.7 Hz, 1H), 3.38 (t, *J* = 9.3 Hz, 1H), 2.27-2.14 (m, 1H), 1.22 (s, 3H), 1.08 (d, *J* = 6.9 Hz, 3H), 1.03 (s, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ 179.4, 139.9, 128.9, 124.3, 119.7, 52.4, 44.8, 37.8, 23.8, 18.5, 12.5.



N-methyl-N-phenylmethacrylamide (2ao). yield: 33%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.65 (d, *J* = 7.9 Hz, 2H), 7.38 (t, *J* = 7.6 Hz, 2H), 7.15 (t, *J* = 7.4 Hz, 1H), 4.00 (dd, *J* = 9.9, 7.6 Hz, 1H), 3.62-3.53 (m, 2H), 3.40 (t, *J* = 10.3 Hz, 1H), 2.64-2.54 (m, 1H), 1.32 (s, 3H), 1.10 (s, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ 177.8, 139.4, 129.0, 124.8, 119.9, 50.7, 45.6, 45.4, 31.3, 24.5, 18.7. IR (ATR): 2967, 1691, 1595, 1499, 1394, 1298, 1101, 896, 798, 757. HRMS (ESI): found: 282.0489, calcd. for $C_{13}H_{17}BrNO$ $[M+H]^+$: 282.0488.

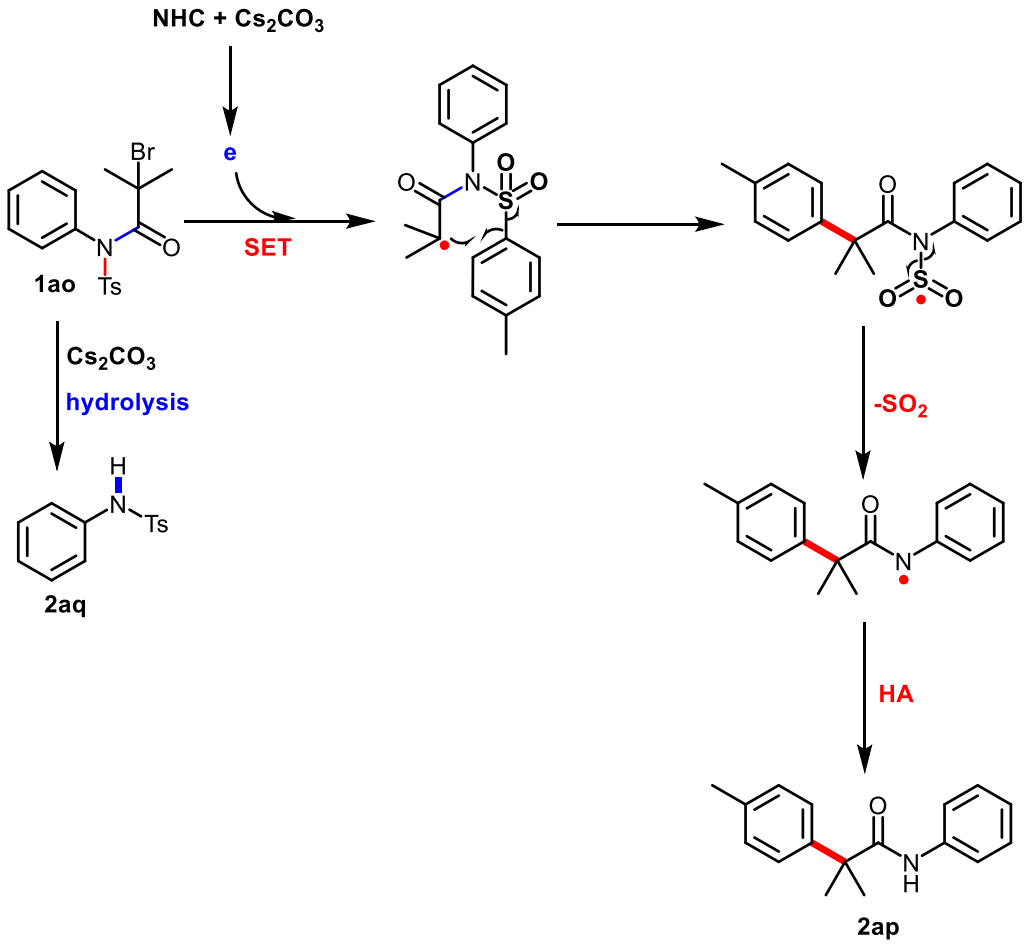
Scheme 4 Radical rearrangement experiments

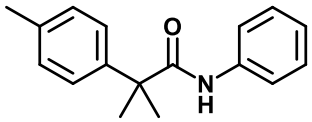


Procedures:

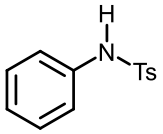
α-bromoamide **1ao** (0.30 mmol, 1.0 equiv.), NHC **A** (12.4 mg, 10 mol%) and Cs_2CO_3 (0.24 mmol, 78.2 mg, 0.8 equiv.) were weighed into a Schlenk tube. The reaction vessel was capped and subjected to three vacuum-purge/nitrogen-flush cycles. Then 1, 4-dioxane (1.0 mL) was added through the side-arm by syringe. The reaction was stirred under N_2 at 100 °C for 30 h. After reaction, the residue was purified by flash chromatography on silica gel (petroleum ether/EtOAc = 40:1 to 10:1 as the eluent) to afford the products **2ap** and **2aq**.

Proposed mechanism:



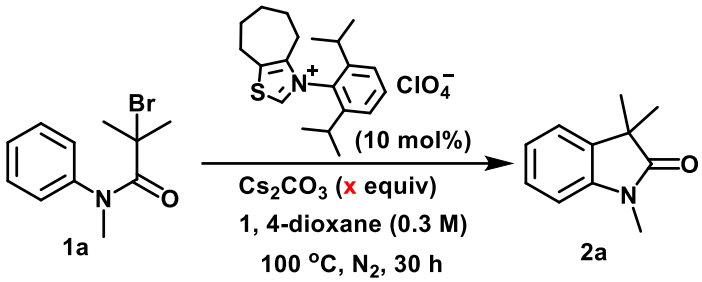


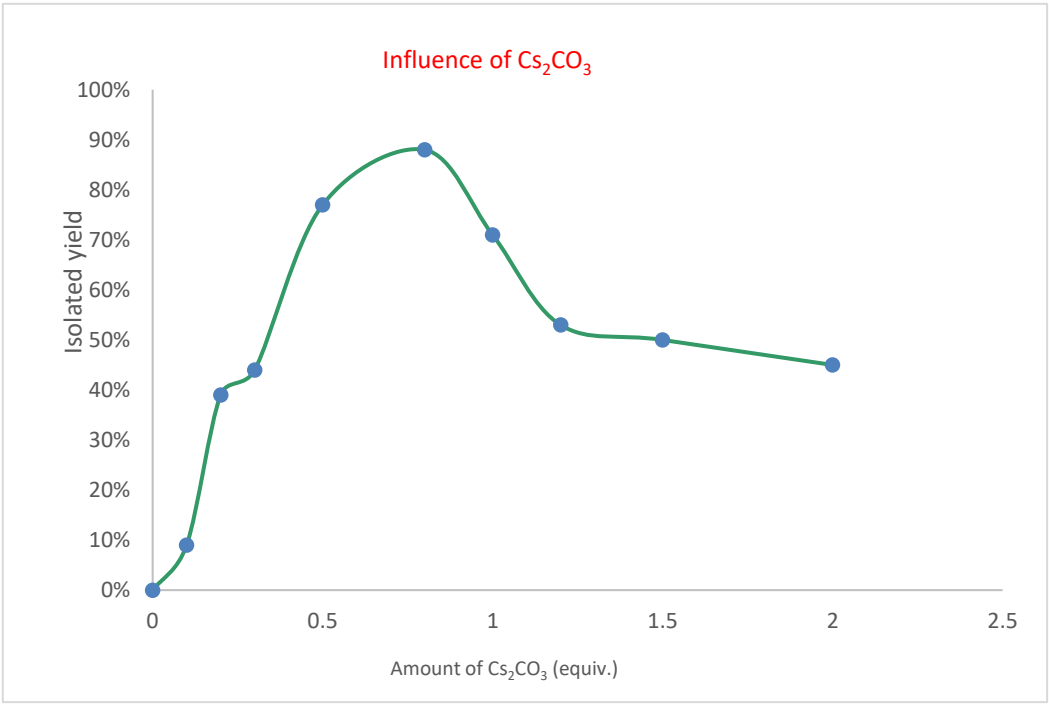
2-methyl-N-phenyl-2-(*p*-tolyl)propanamide (2ap).[20] yield: 15%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.37-7.32 (m, 4H), 7.27 (d, *J* = 6.6 Hz, 2H), 7.21 (d, *J* = 8.4 Hz, 2H), 7.05 (t, *J* = 7.2 Hz, 1H), 6.82 (s, 1H), 2.37 (s, 3H), 1.65 (s, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 176.0, 141.7, 138.2, 137.2, 129.8, 129.0, 126.6, 124.2, 119.7, 47.9, 27.2, 21.1.



4-methyl-N-phenylbenzenesulfonamide (2aq).[21] yield: 69%, white solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ 7.69 (d, *J* = 7.3 Hz, 2H), 7.37 (s, 1H), 7.25-7.19 (m, 4H), 7.10-7.05 (m, 3H), 2.35 (s, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz): δ 144.0, 136.7, 136.1, 129.7, 129.4, 127.4, 125.3, 121.5, 21.6.

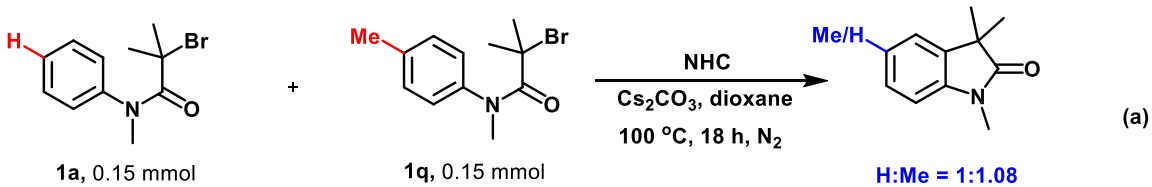
Scheme 5 Influences of the amount of base

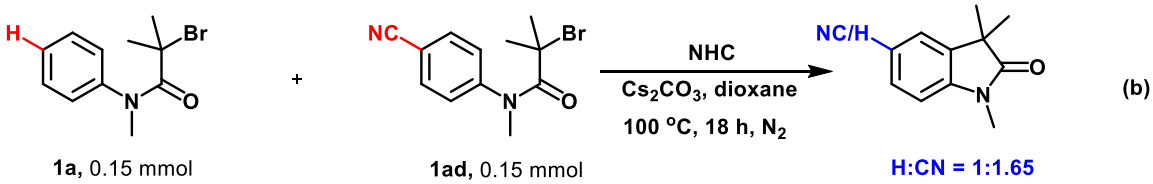




Procedure: Following the **General Procedure for NHC-Catalyzed Oxindole Synthesis**.

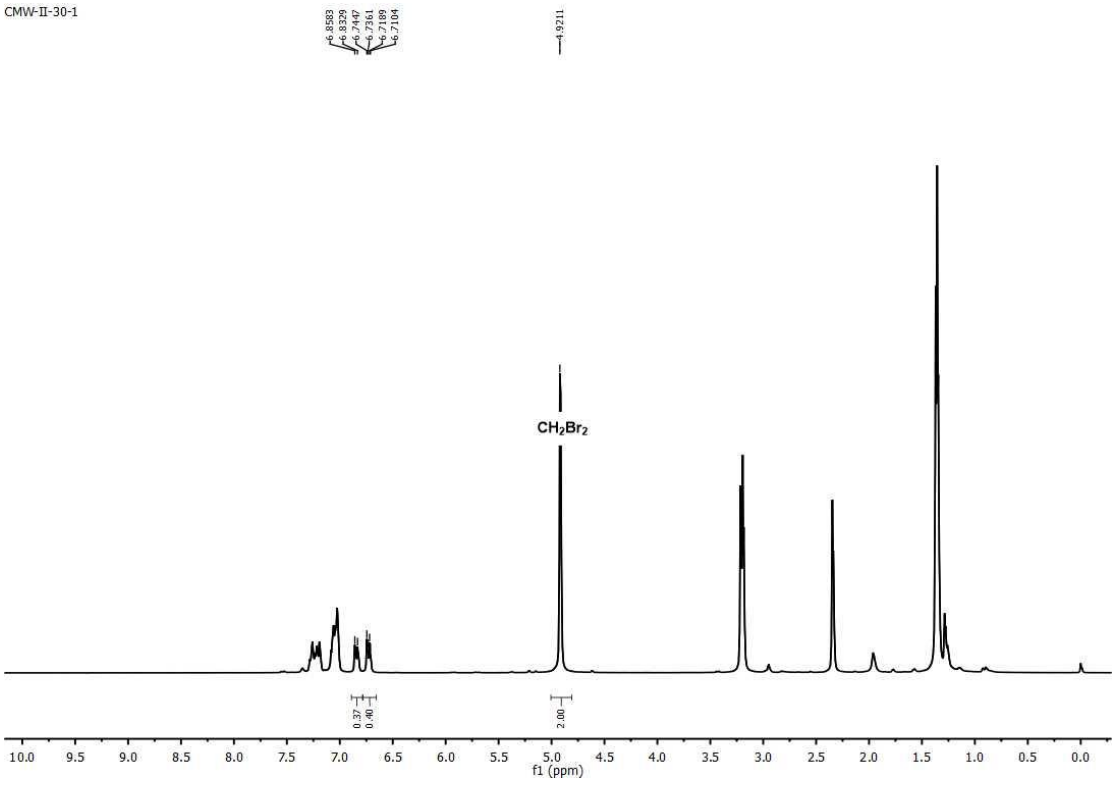
Scheme 6 Competitive experiments





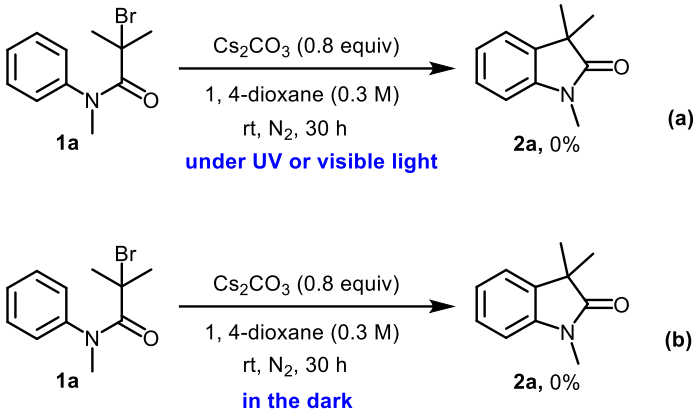
Procedures:

(a) α-bromoamides **1a/1q** (0.15 mmol, 1.0 equiv.), NHC **A** (12.4 mg, 10 mol%) and Cs_2CO_3 (0.24 mmol, 78.2 mg, 0.8 equiv.) were weighed into a Schlenk tube. The reaction vessel was capped and subjected to three vacuum-purge/nitrogen-flush cycles. Then 1, 4-dioxane (1.0 mL) was added through the side-arm by syringe. The reaction was stirred under N_2 at 100 °C for 18 h. After reaction, the residue was purified by flash chromatography on silica gel (petroleum ether/EtOAc = 50:1 to 30:1 as the eluent) to afford the products mixture as an oil, then CH_2Br_2 (0.15 mmol) was added and the mixture was subjected to ^{1}H NMR, the ratios of the products were determined by ^{1} H NMR.



(b) α-bromoamides **1a/1ad** (0.15 mmol, 1.0 equiv.), NHC **A** (12.4 mg, 10 mol%) and Cs_2CO_3 (0.24 mmol, 78.2 mg, 0.8 equiv.) were weighed into a Schlenk tube. The reaction vessel was capped and subjected to three vacuum-purge/nitrogen-flush cycles. Then 1, 4-dioxane (1.0 mL) was added through the side-arm by syringe. The reaction was stirred under N_2 at 100 °C for 18 h. After reaction, the residue was purified by flash chromatography on silica gel (petroleum ether/EtOAc = 50:1 to 30:1 as the eluent) to afford the product **3a** (15.9 mg, 60% yield), **3q** (28.0 mg, 99% yield).

Scheme 7 Reaction under light or in the dark



Procedures:

(a) α-bromoamides **1a** (0.3 mmol, 1.0 equiv.) and Cs_2CO_3 (0.24 mmol, 78.2 mg, 0.8 equiv.) were weighed into a Schlenk tube. The reaction vessel was capped and subjected to three vacuum-purge/nitrogen-flush cycles. Then 1, 4-dioxane (1.0 mL) was added through the side-arm by syringe. The reaction was stirred *under UV or visible light* at rt for 30 h. After reaction, only starting material **1a** was detected.

(b) α-bromoamides **1a** (0.3 mmol, 1.0 equiv.) and Cs_2CO_3 (0.24 mmol, 78.2 mg, 0.8 equiv.) were weighed into a Schlenk tube. The reaction vessel was capped and subjected to three vacuum-purge/nitrogen-flush cycles. Then 1, 4-dioxane (1.0 mL) was added through the side-arm by syringe. The reaction was stirred *in the dark* at rt for 30 h. After reaction, only starting material **1a** was detected.

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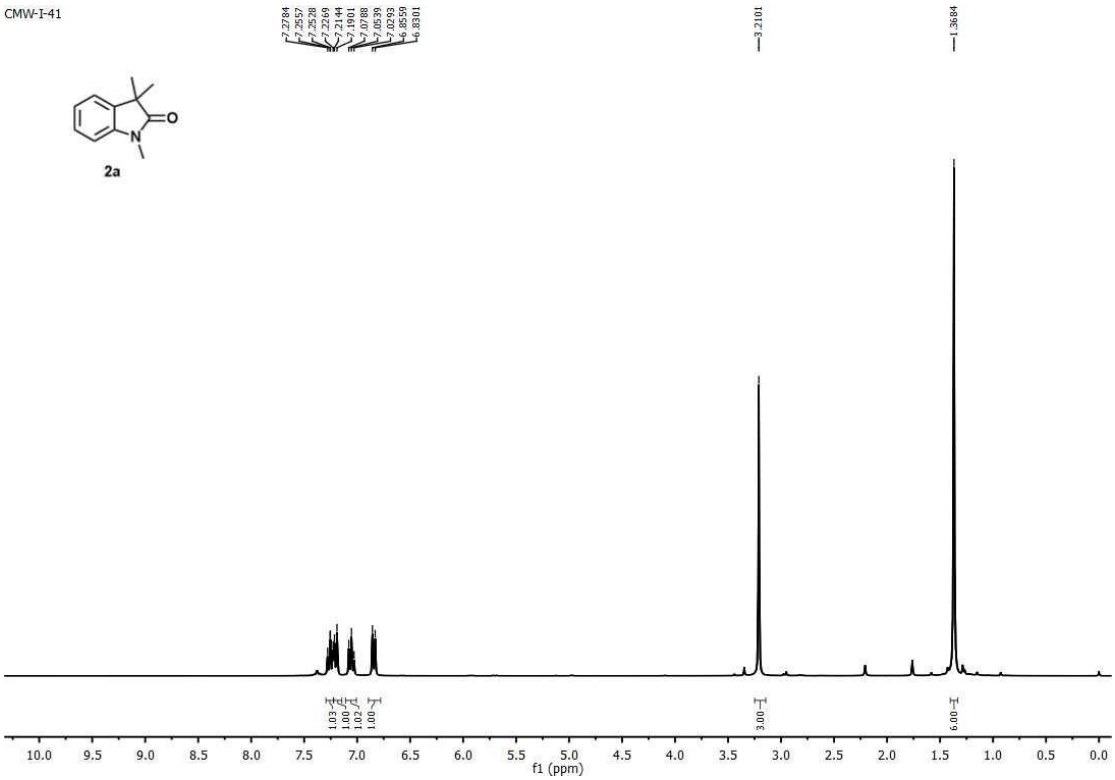
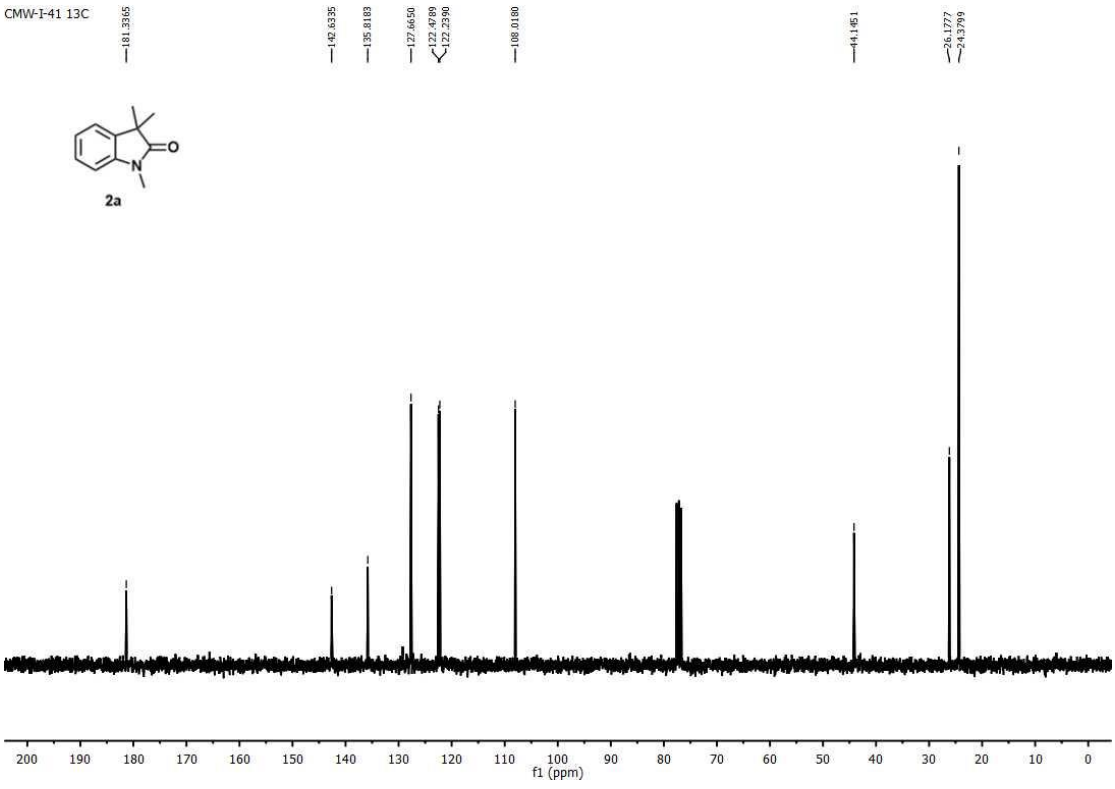
NMR Spectra Images of Products





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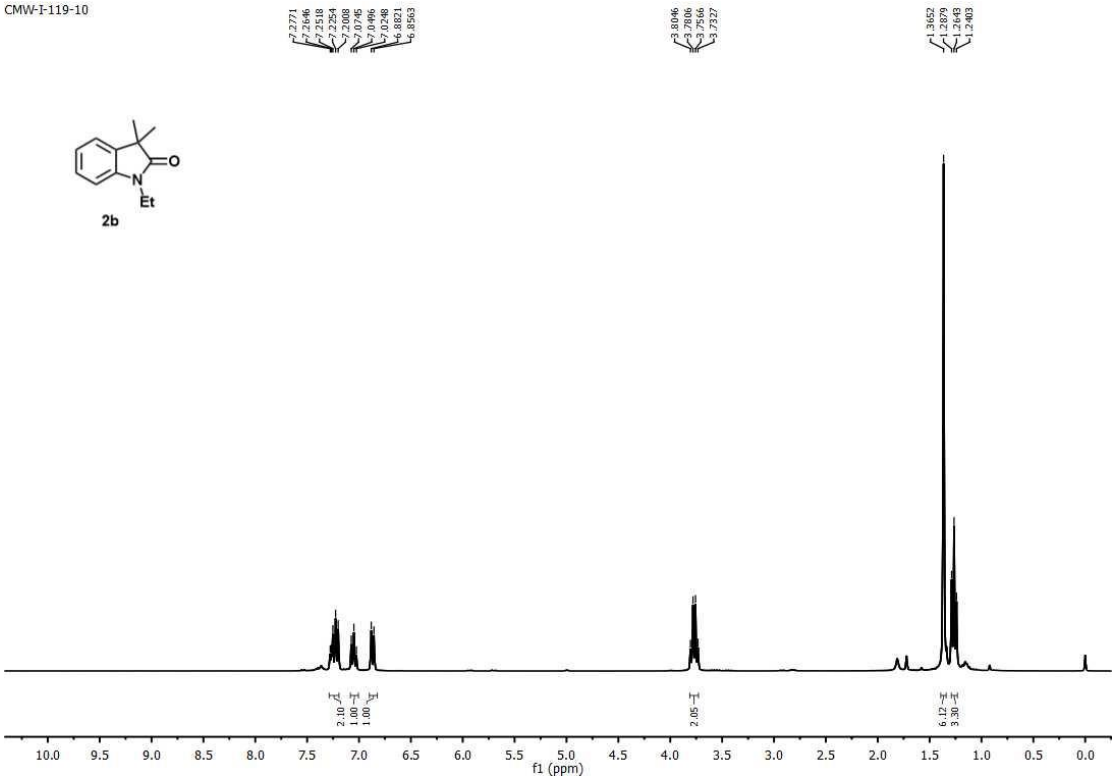

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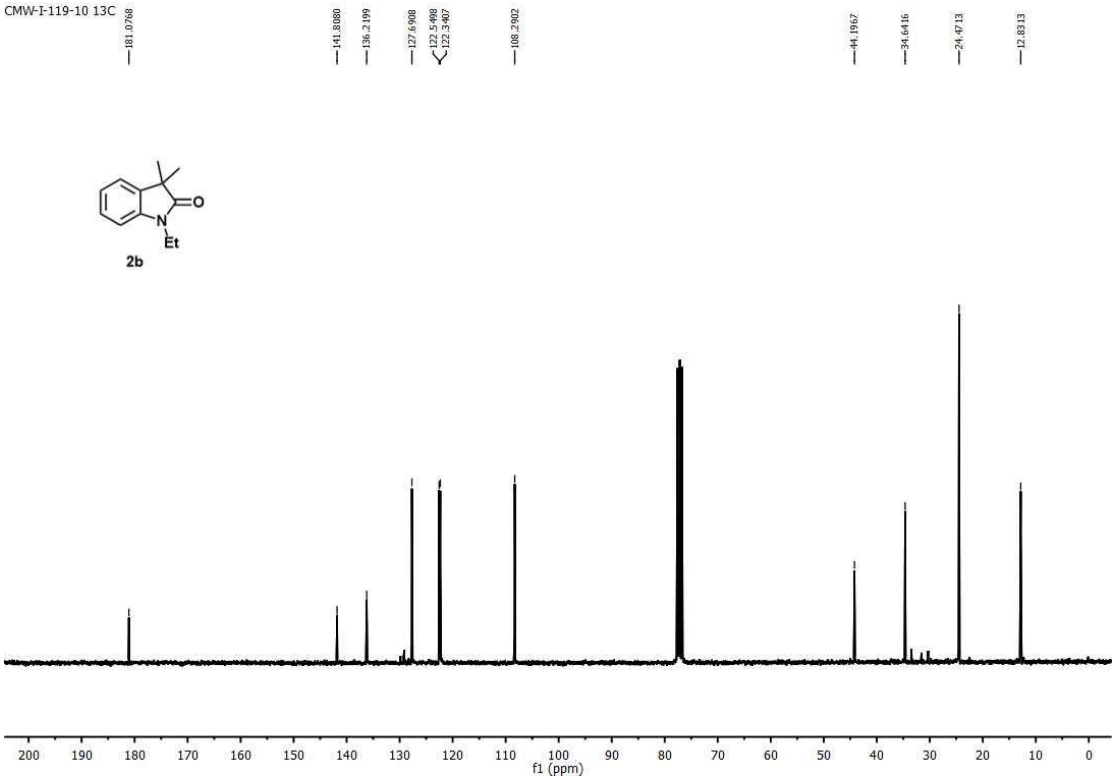

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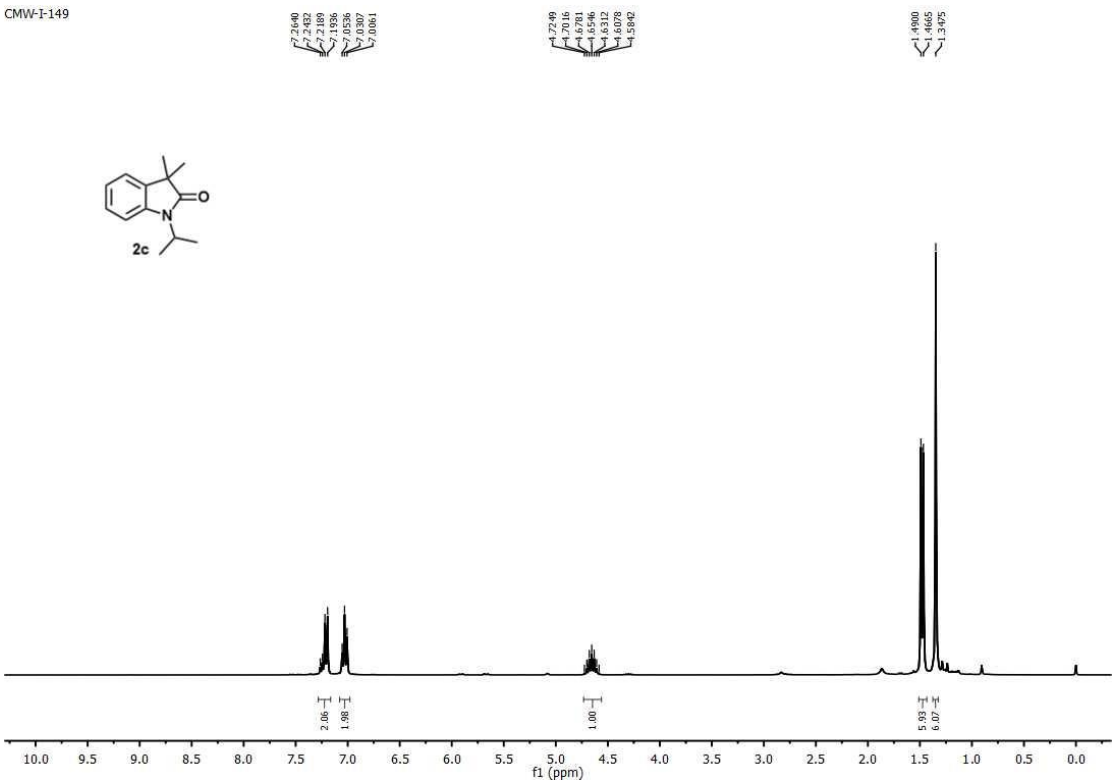

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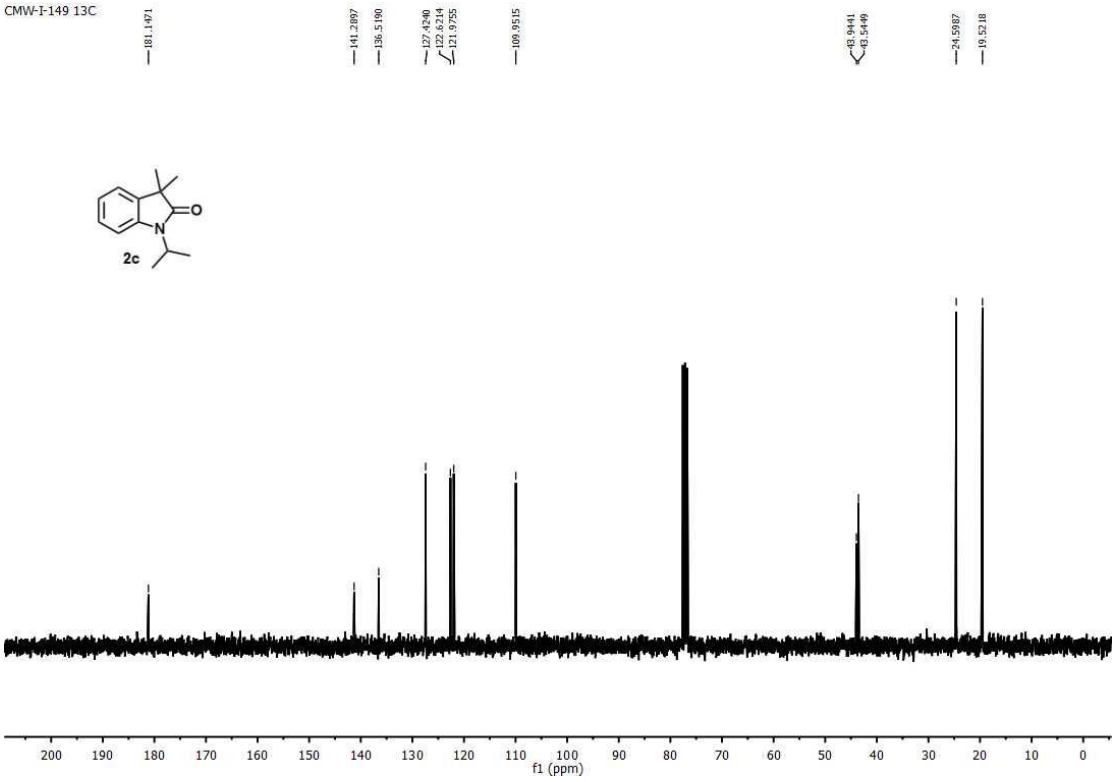

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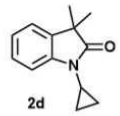

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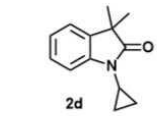

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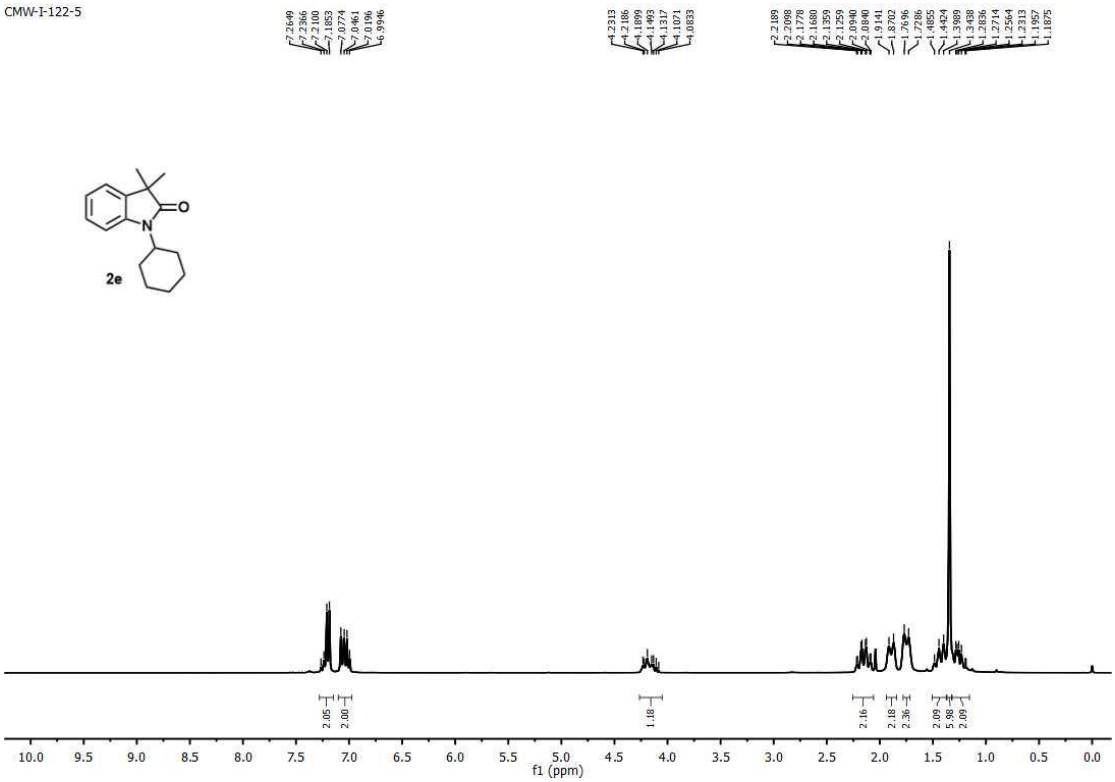

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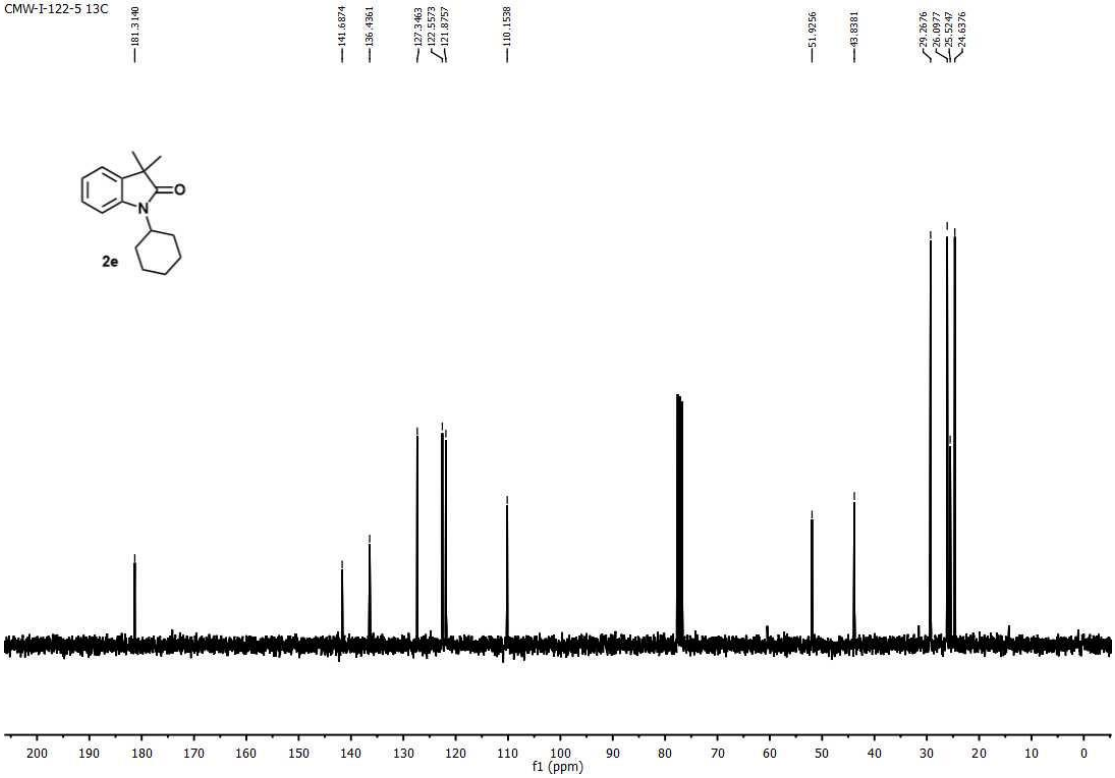

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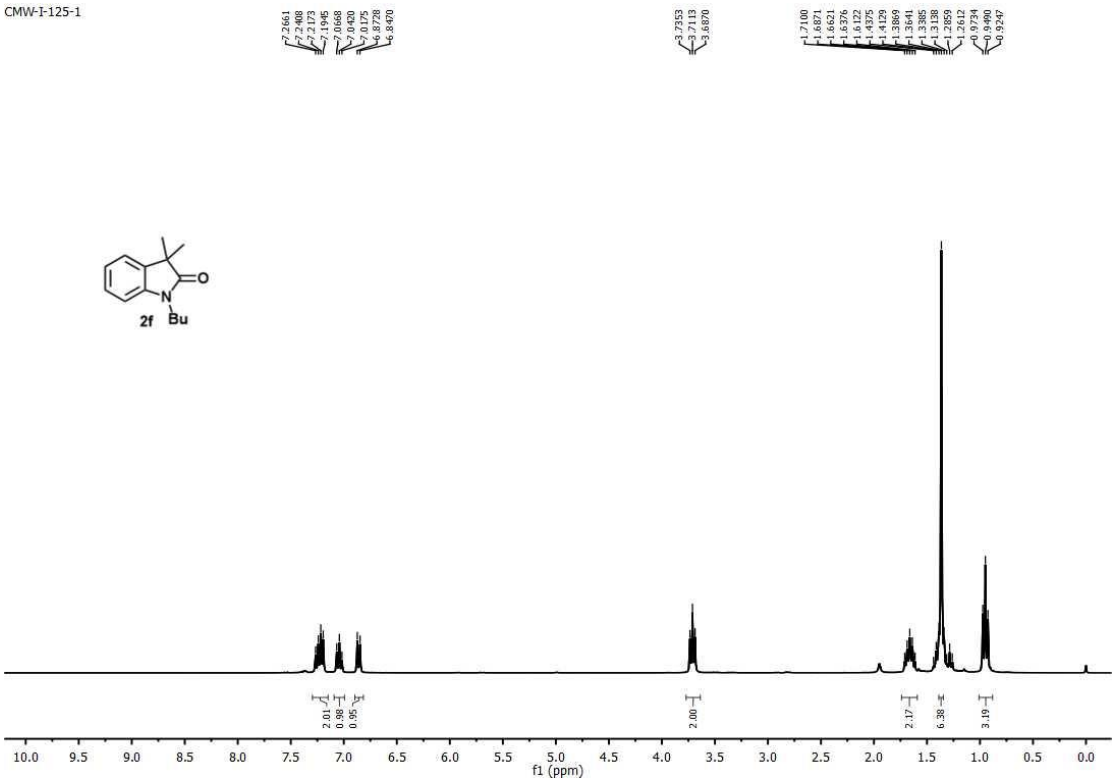

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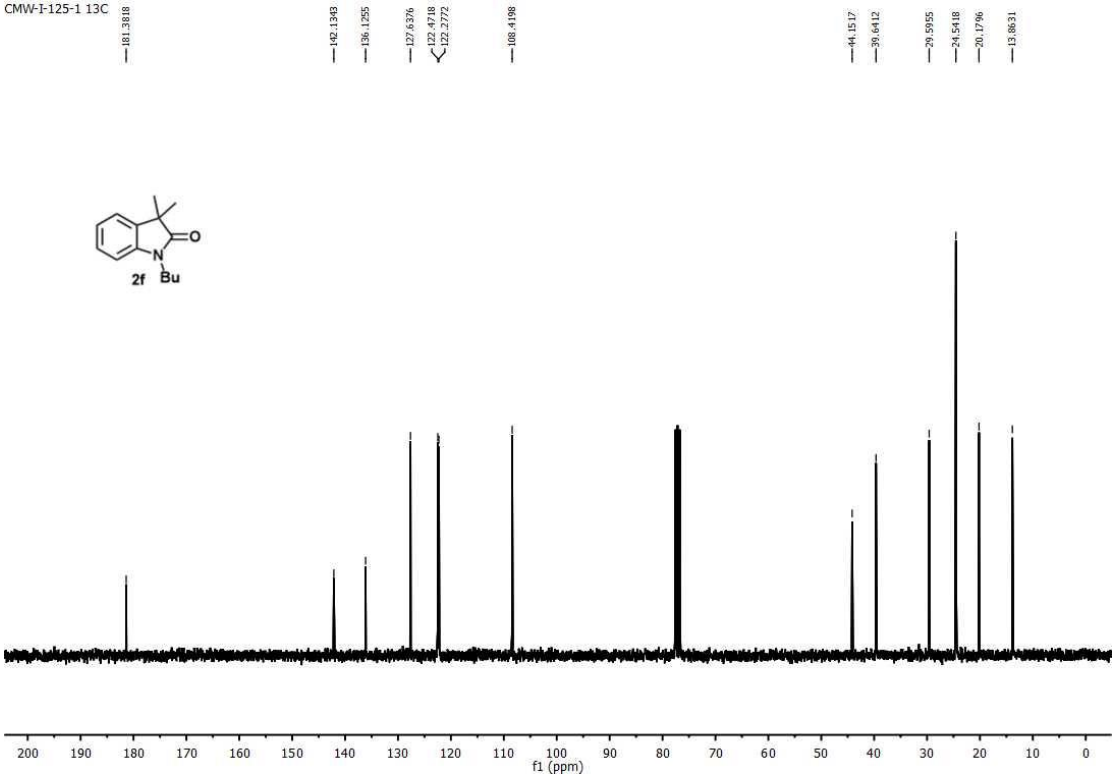

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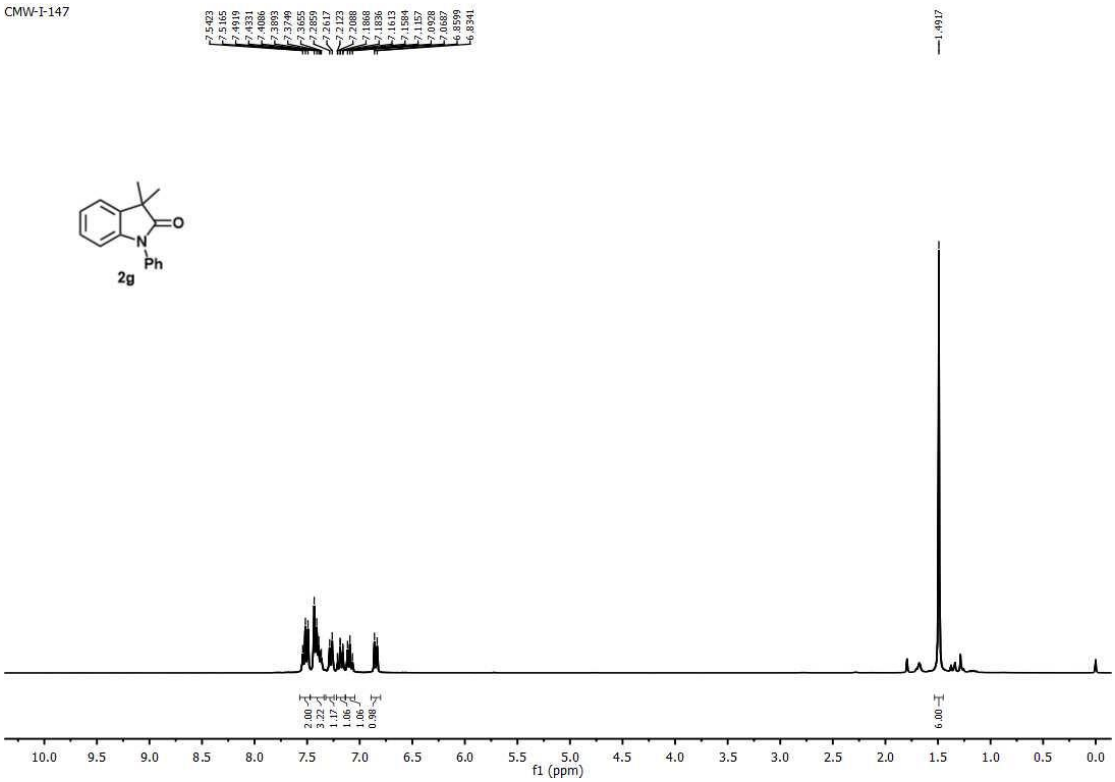

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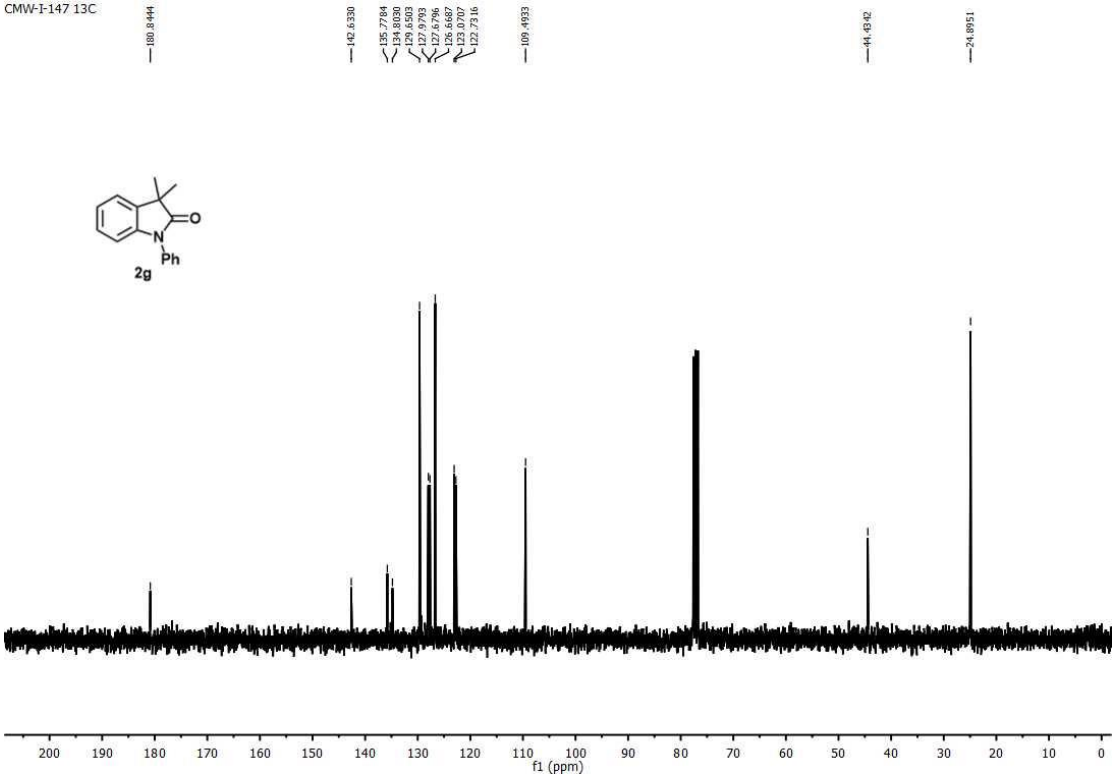

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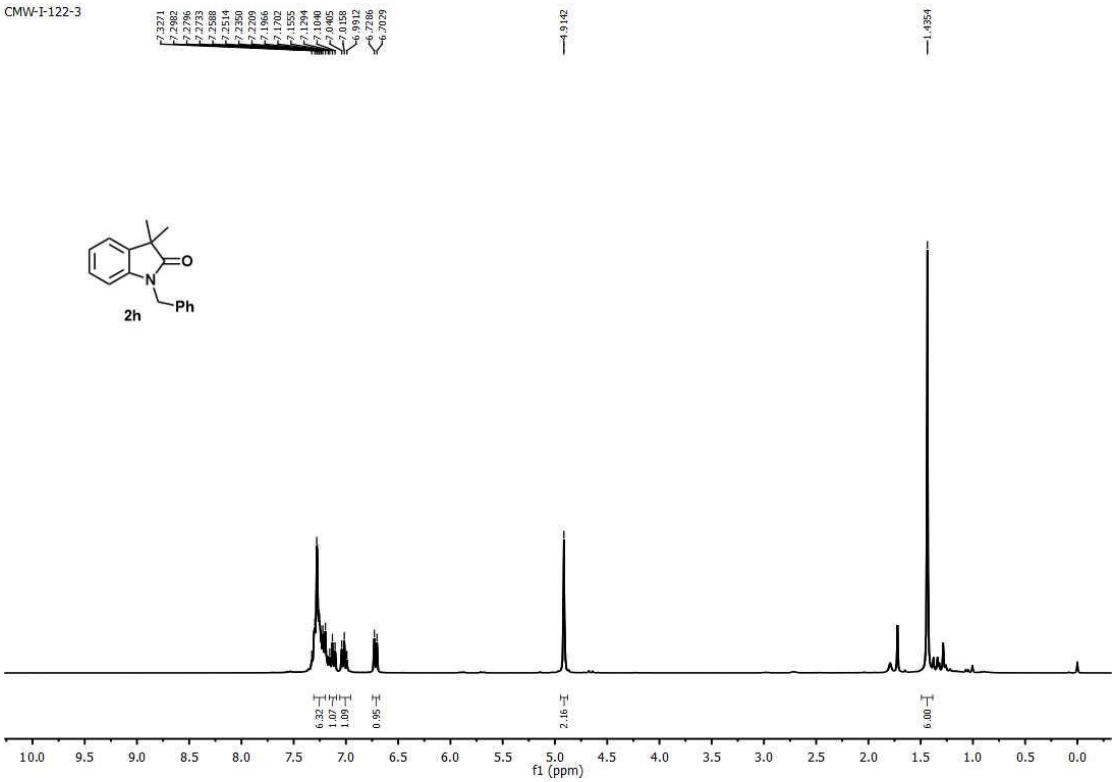

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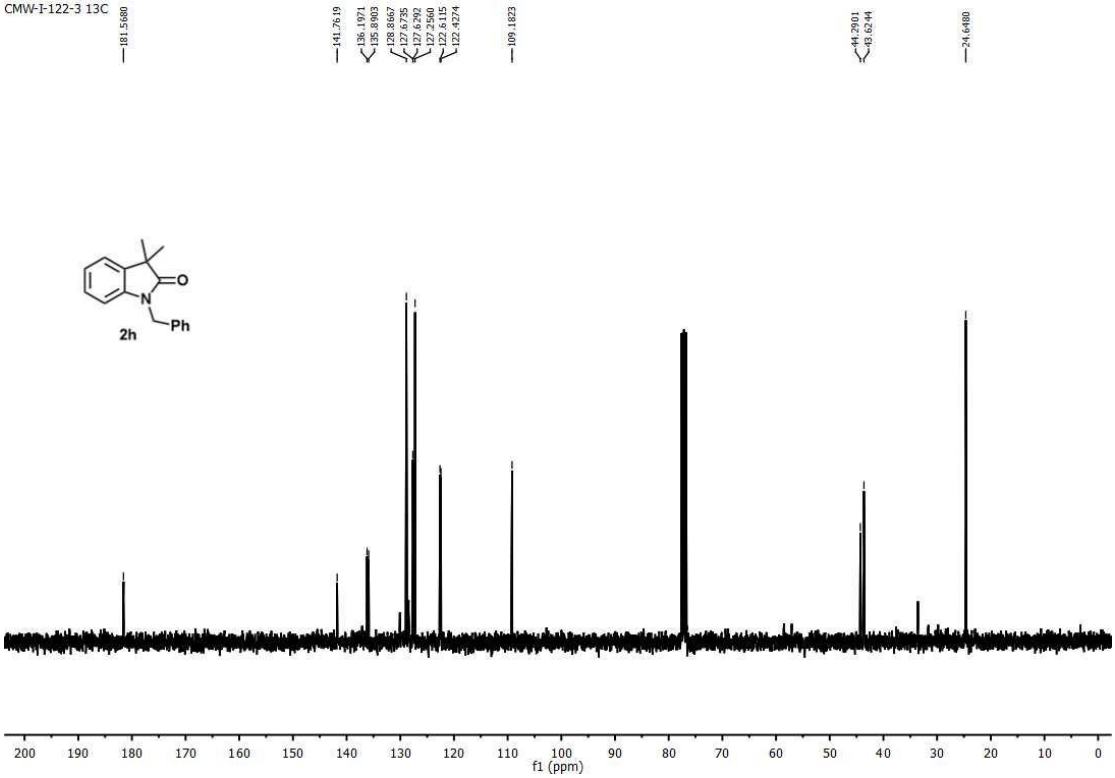

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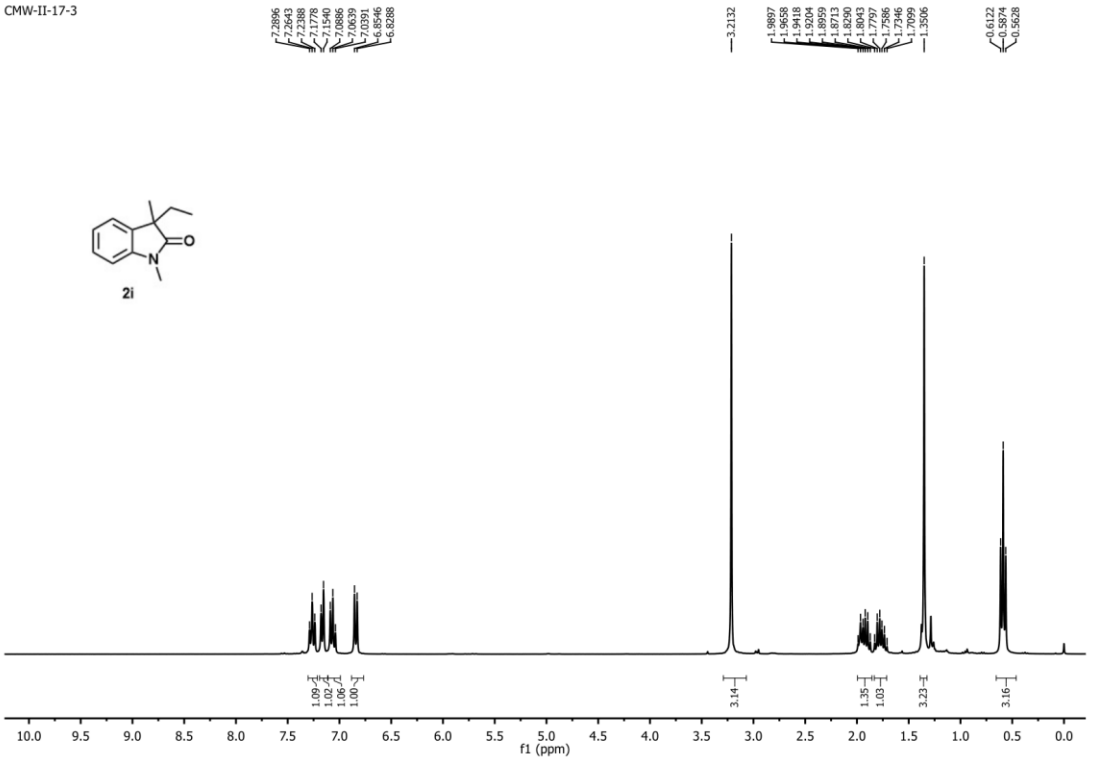
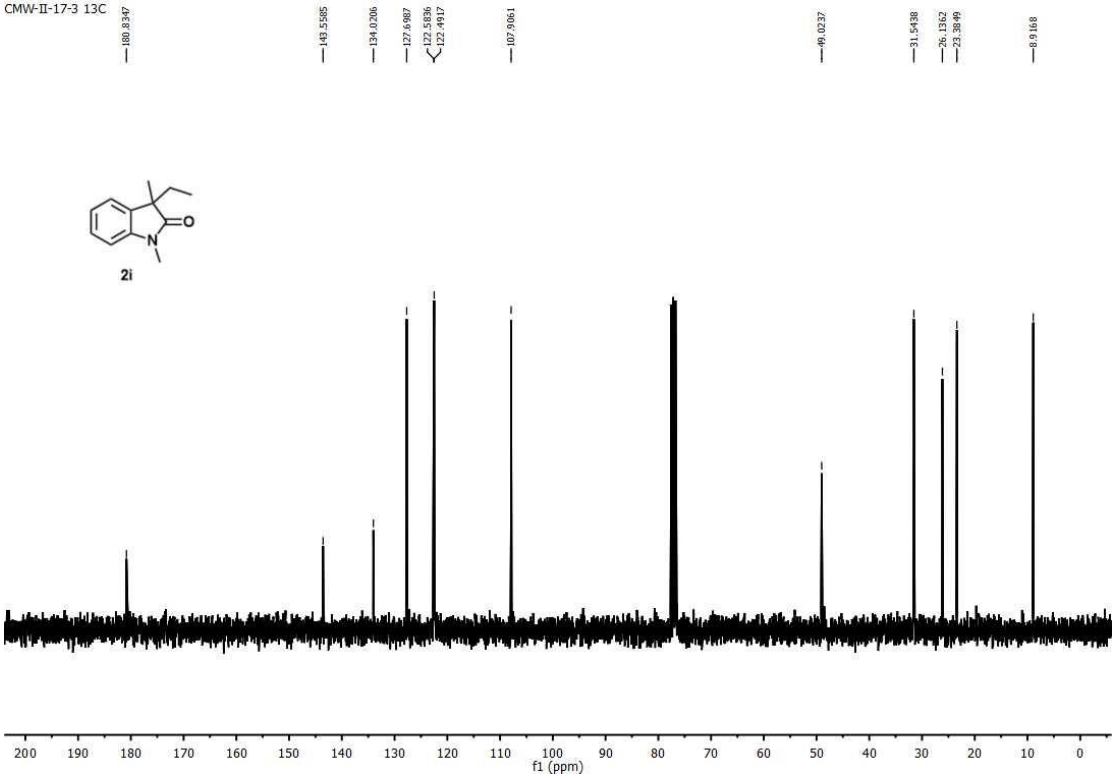


2i

CMW-II-17-3 13C



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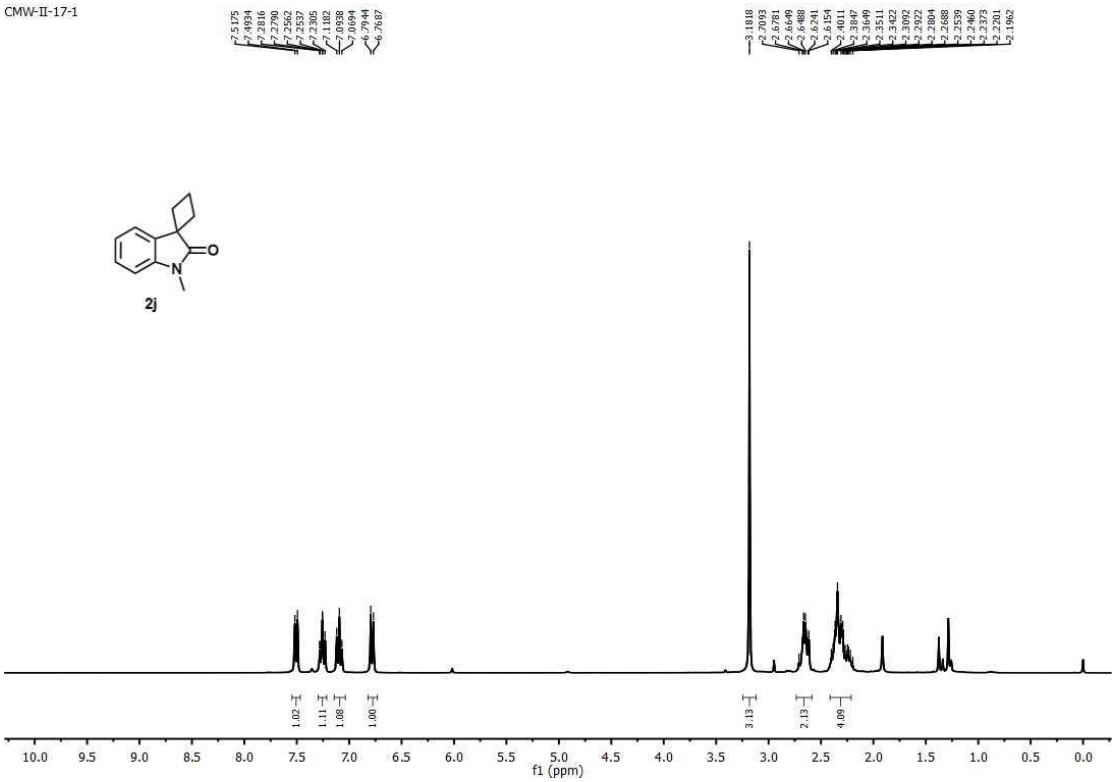

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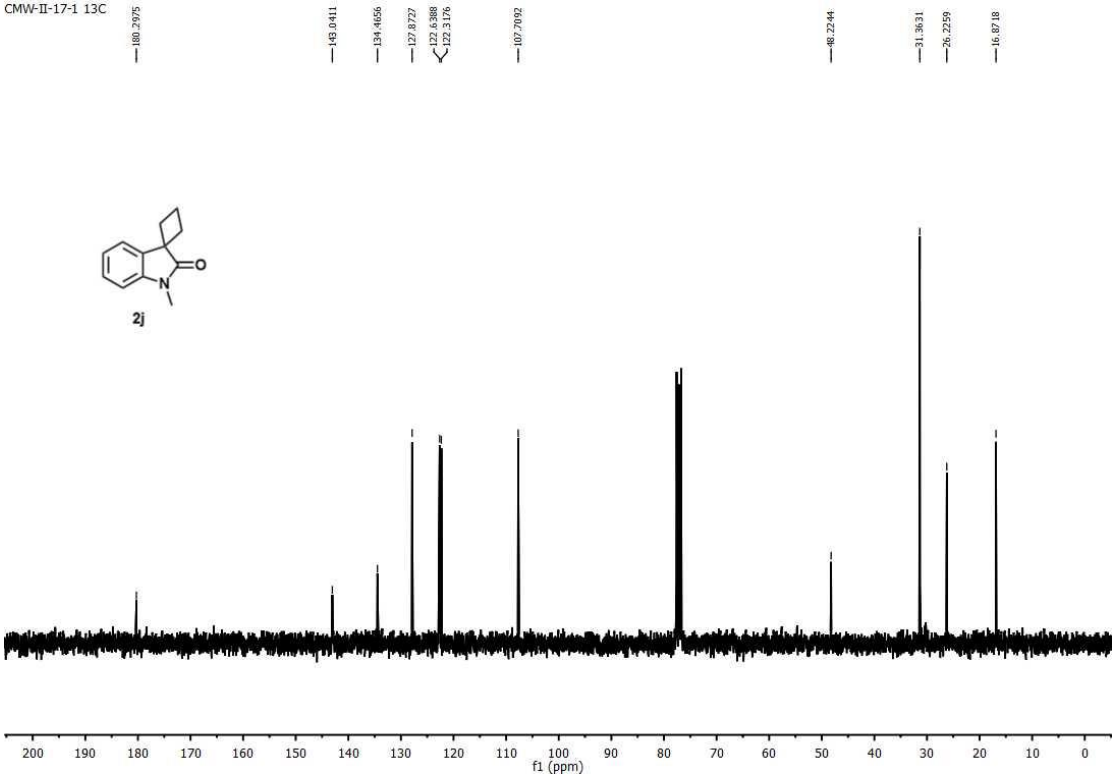

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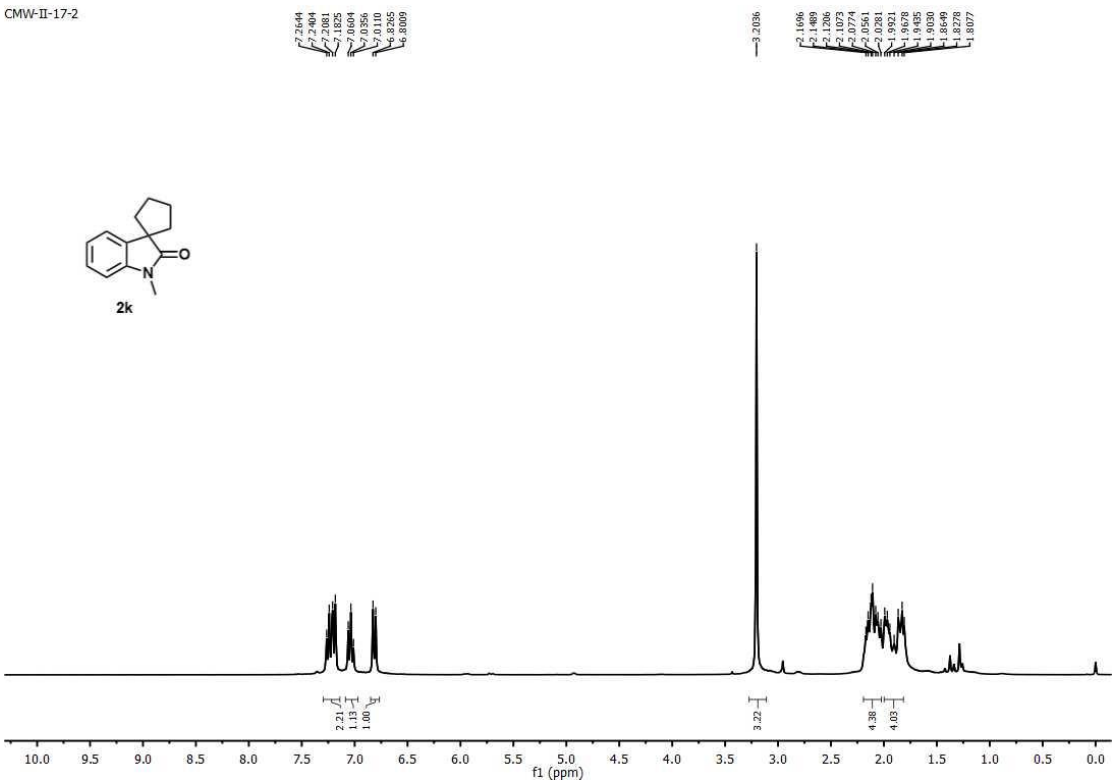

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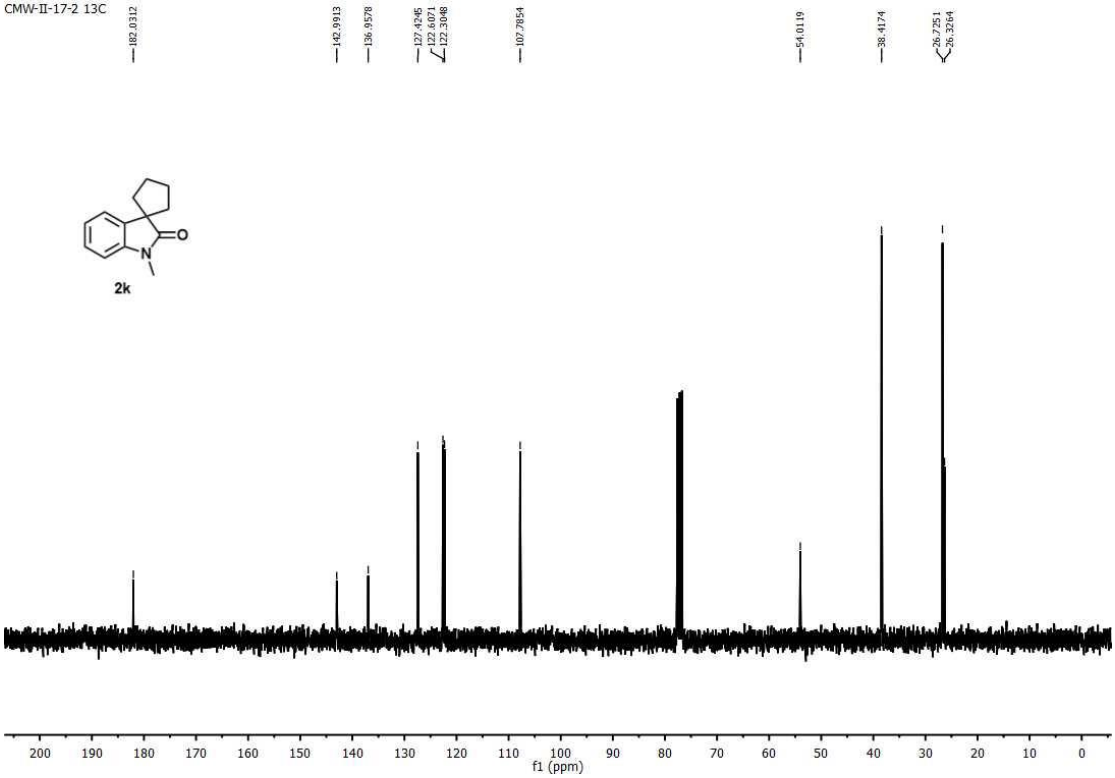

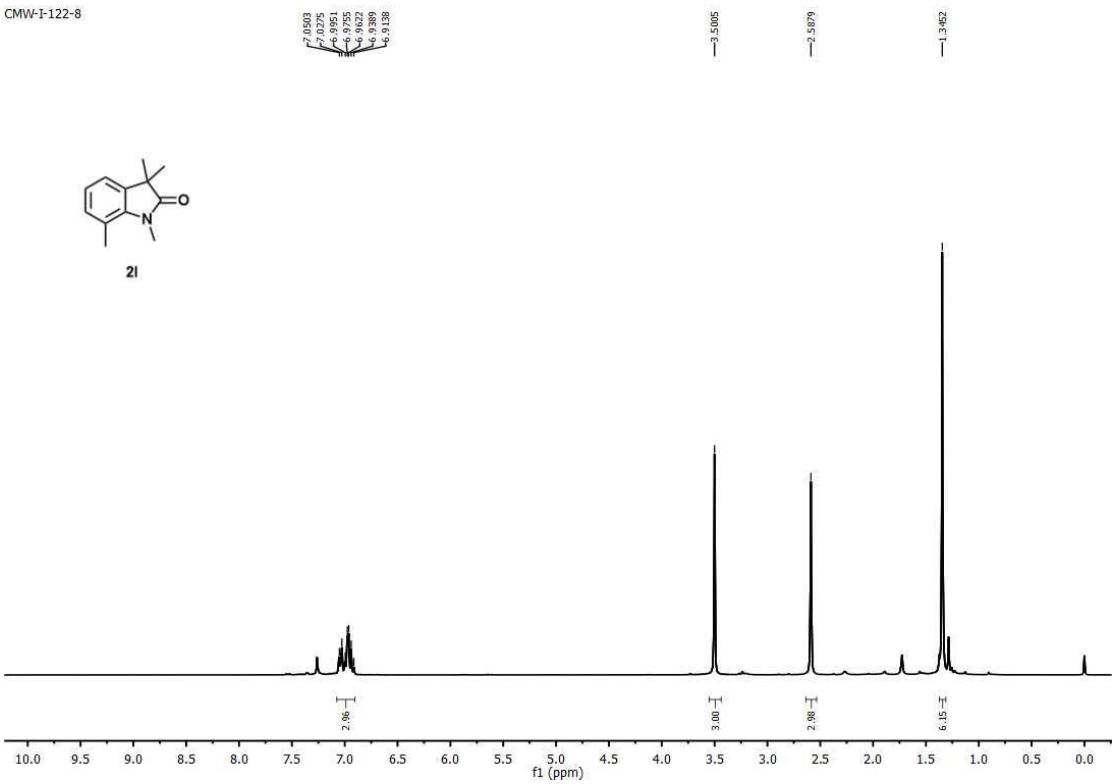
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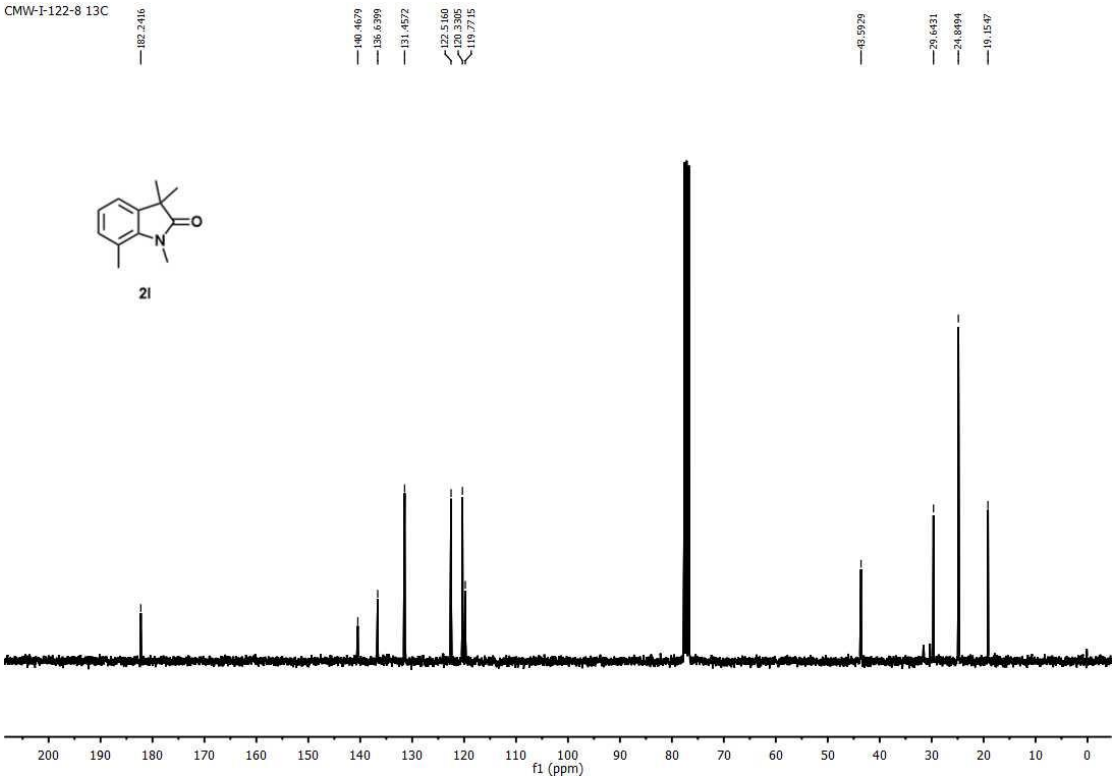
7.0275
6.9951
6.9755
6.9622
6.9389
6.9138
3.5005
2.5879
1.3452
2l
2.96
3.00
2.98
6.15
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


CMW-I-122-8 13C
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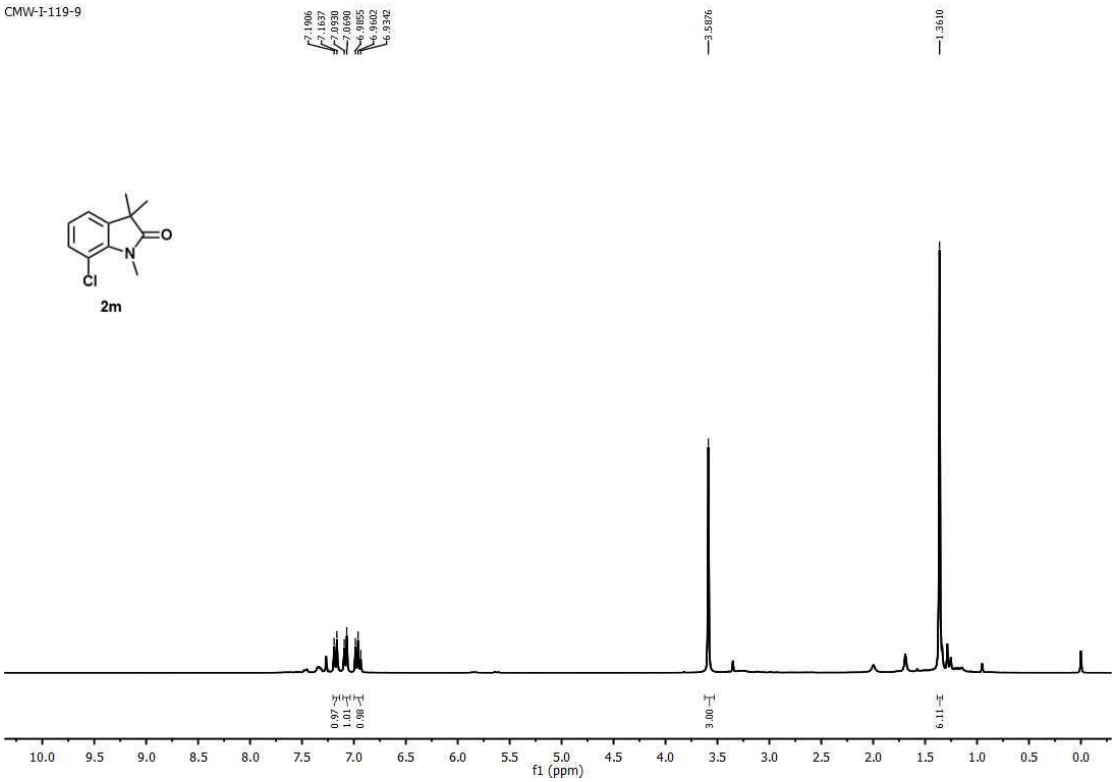
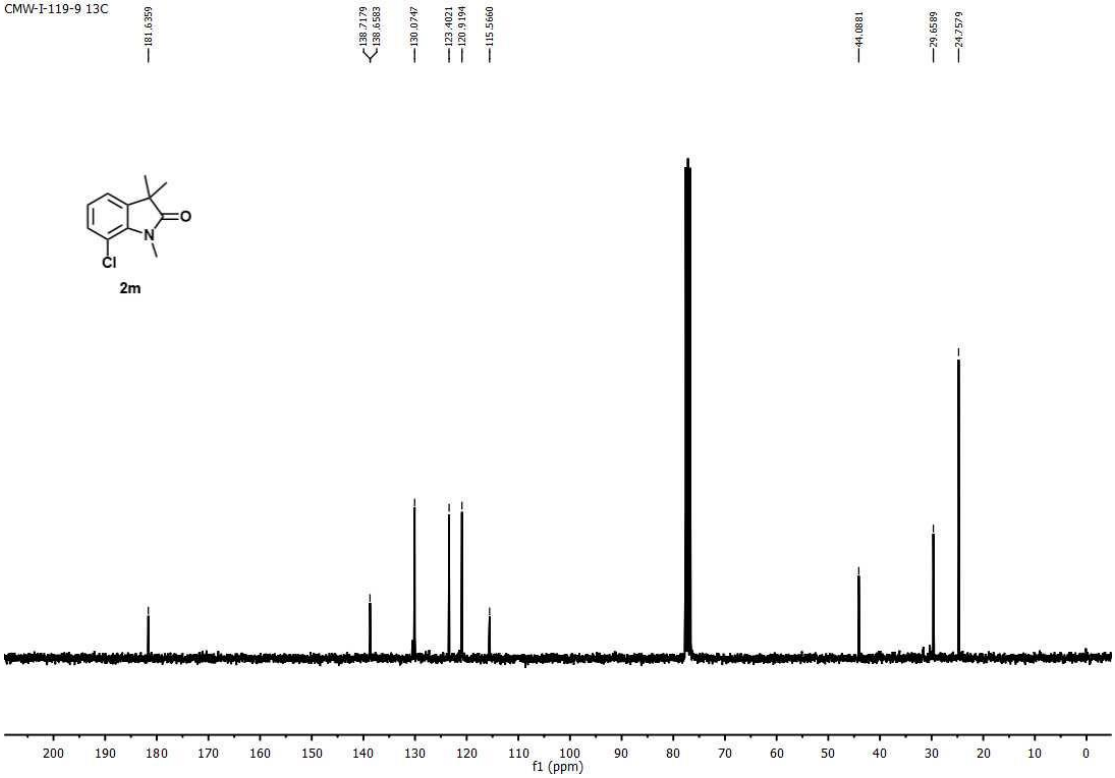
140.4679
136.6399
131.4572
122.5160
120.3305
119.7715
43.5929
29.6431
24.8494
19.1547
2l
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

CMW-I-119-9



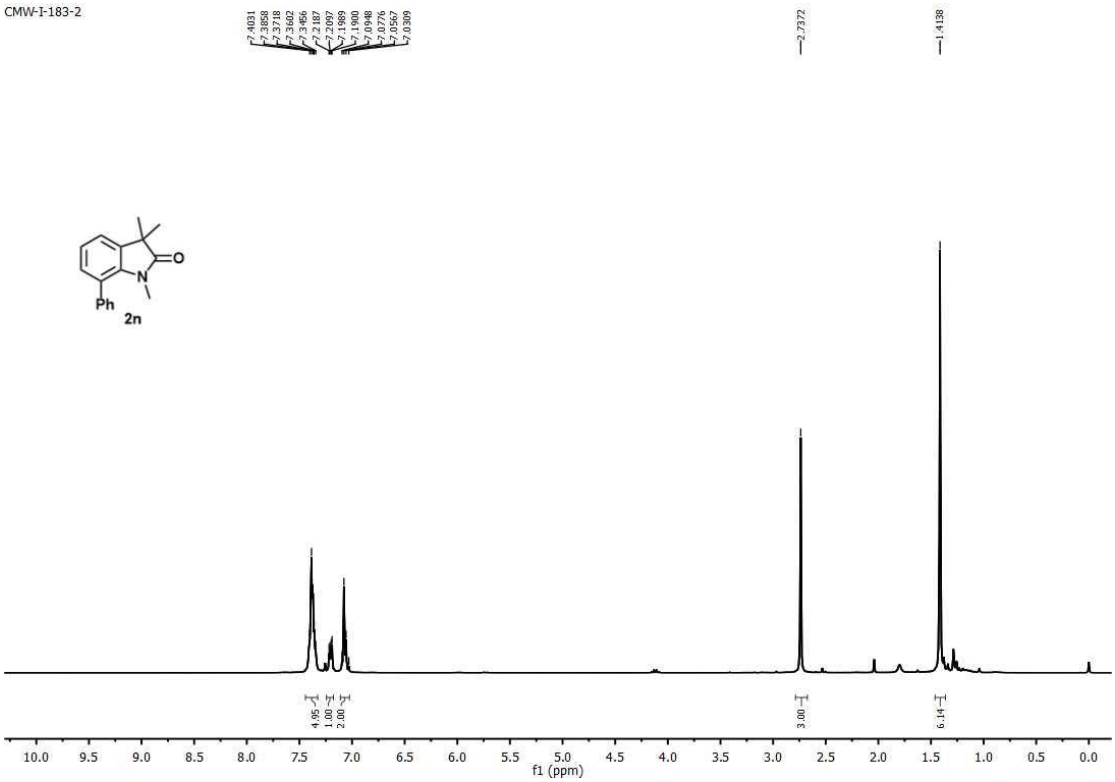
2m

CMW-I-119-9 13C

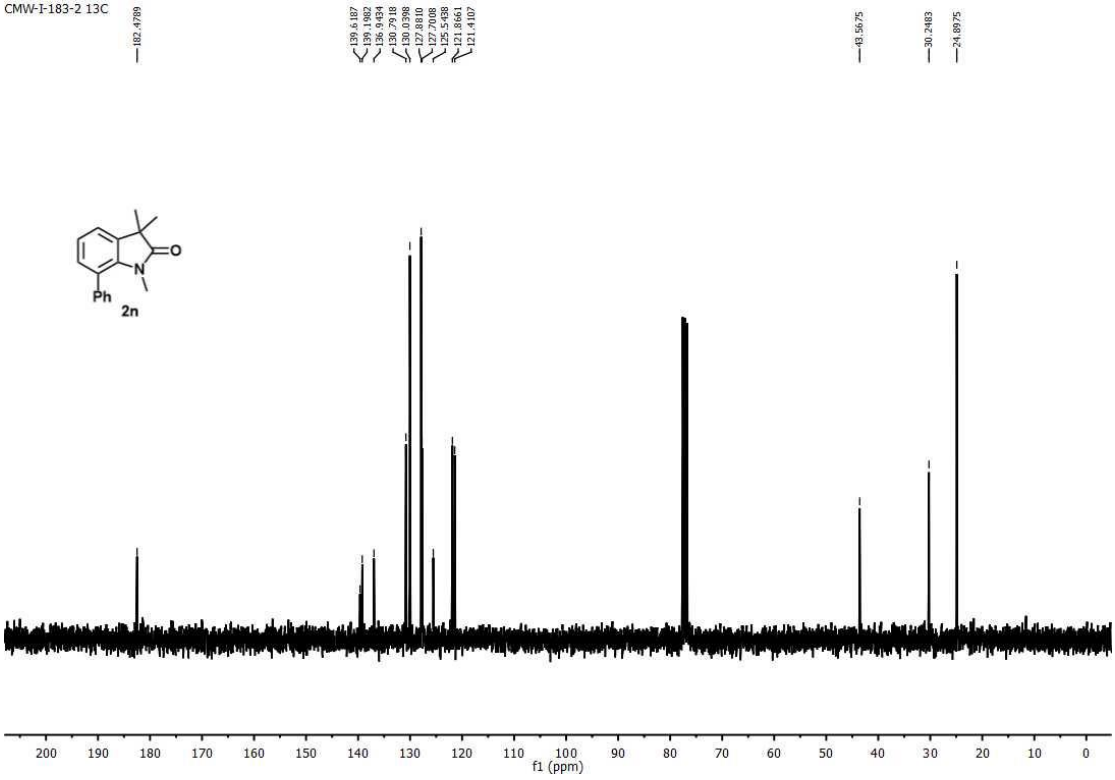


2m

CMW-I-183-2



CMW-I-183-2 13C



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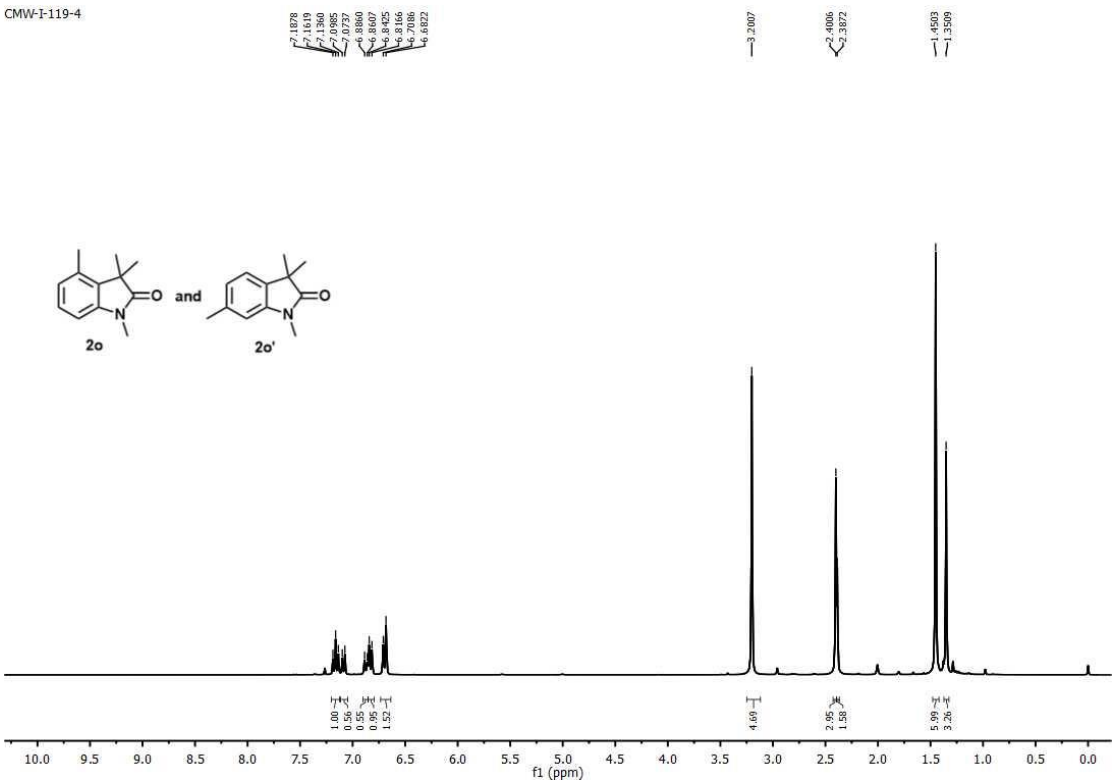

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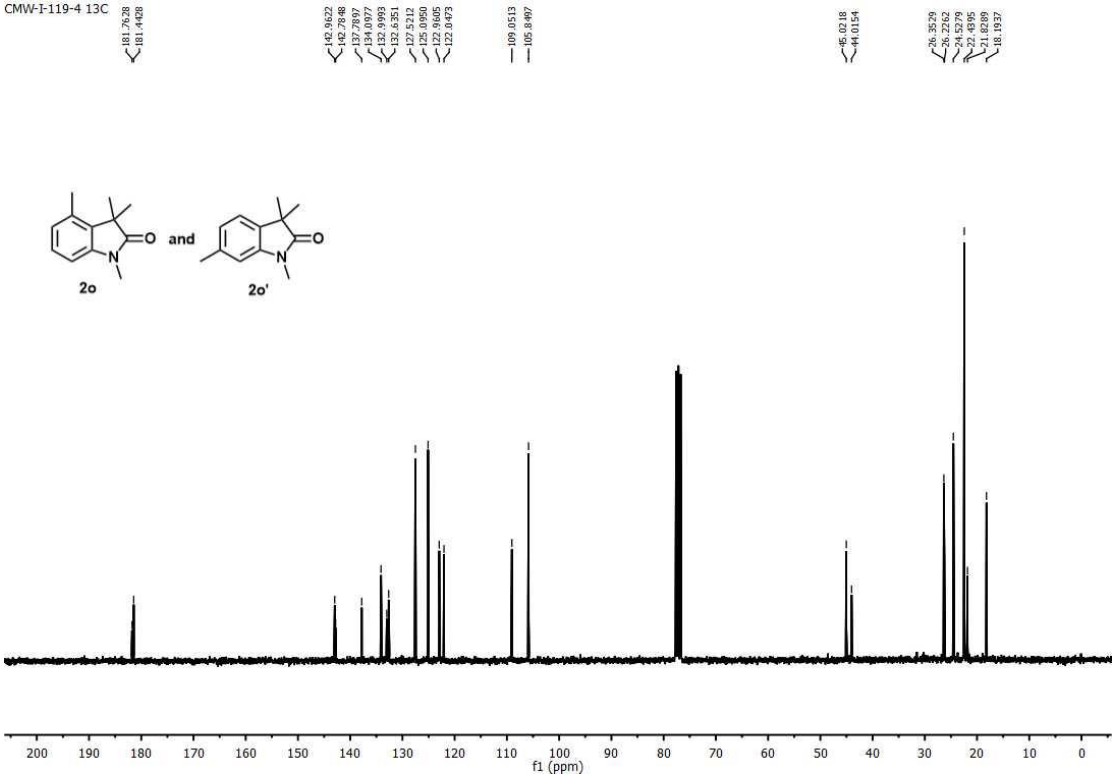

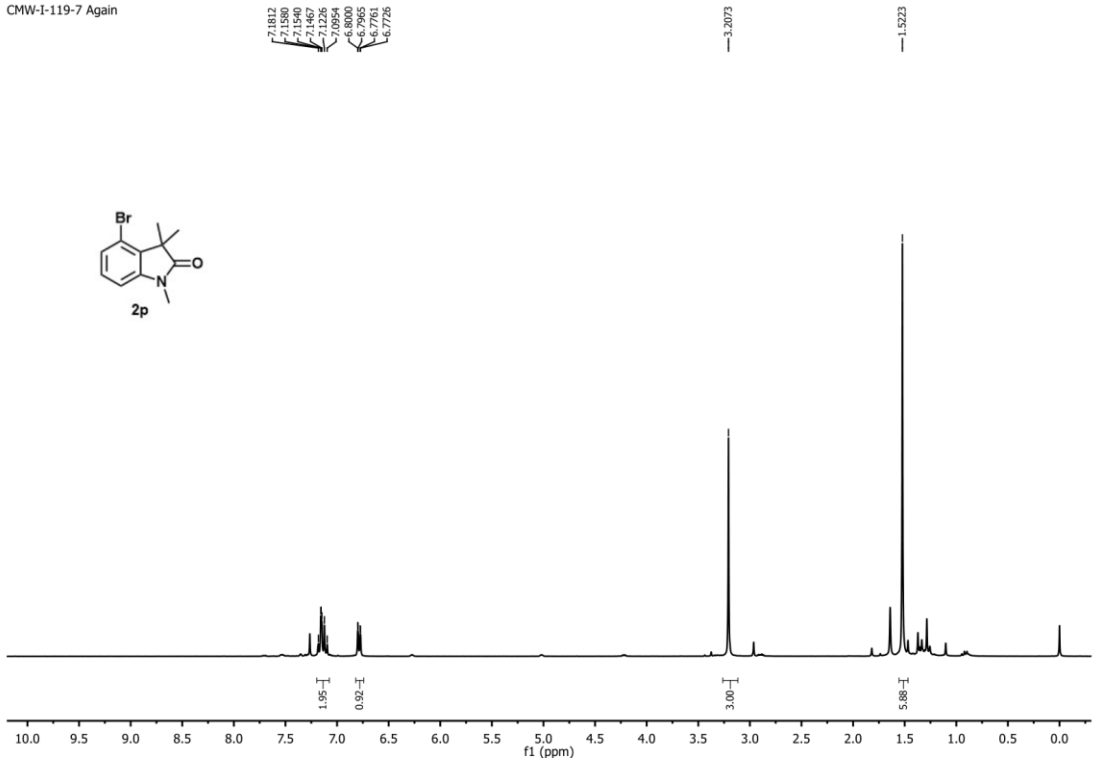
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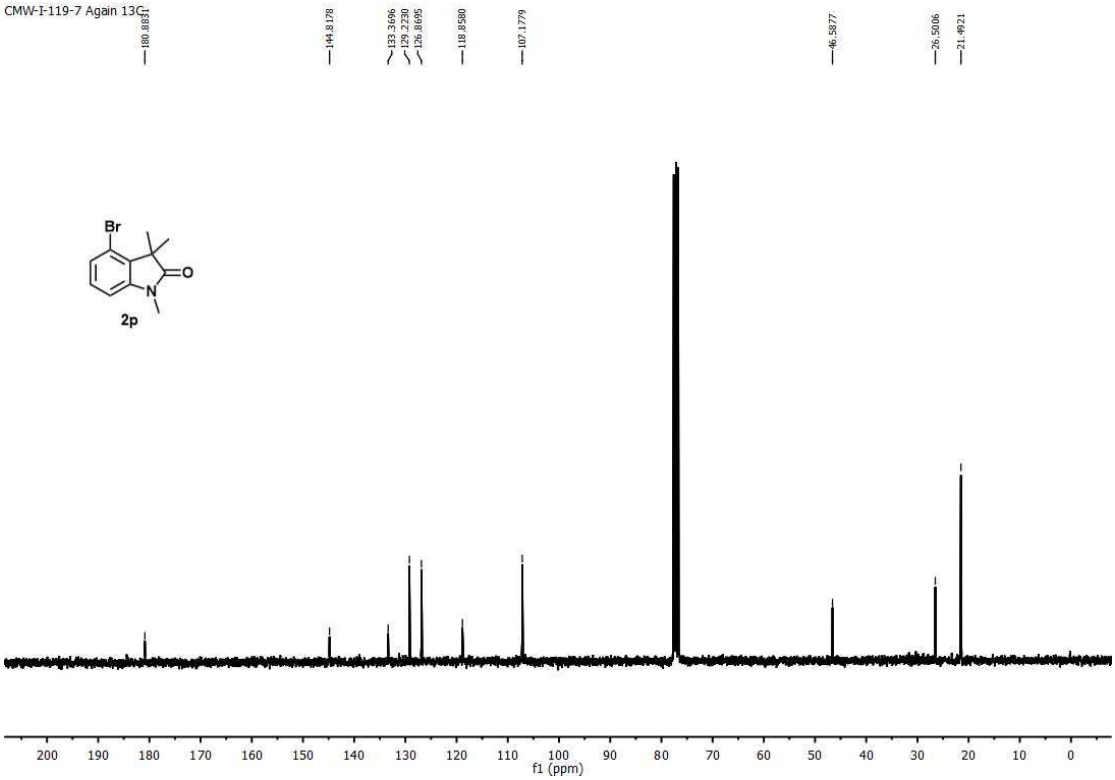
7.1580
7.1540
7.1467
7.1226
7.0954
6.8000
6.7965
6.7761
6.7726
3.2073
1.5223
Br
O
N
2p
1.95
0.92
3.00
5.88
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


CMW-I-119-7 Again 13C
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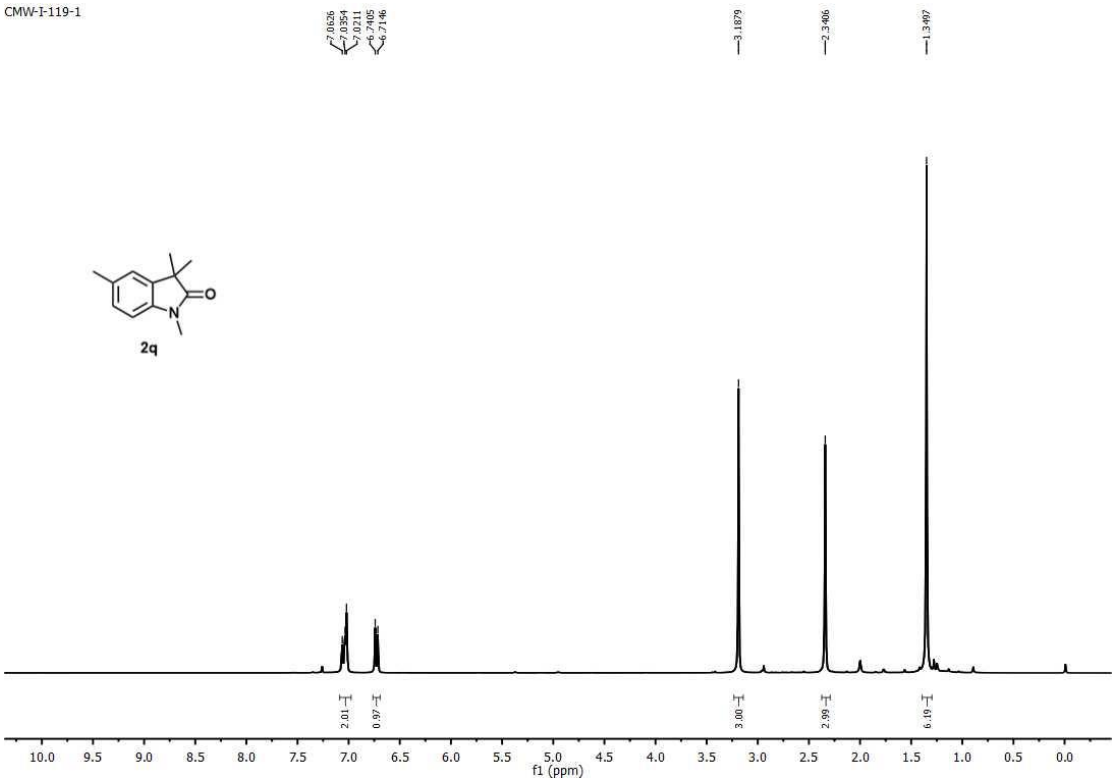
118.8580
107.1779
46.5877
26.5006
21.4921
Br
O
N
2p
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

CMW-I-119-1



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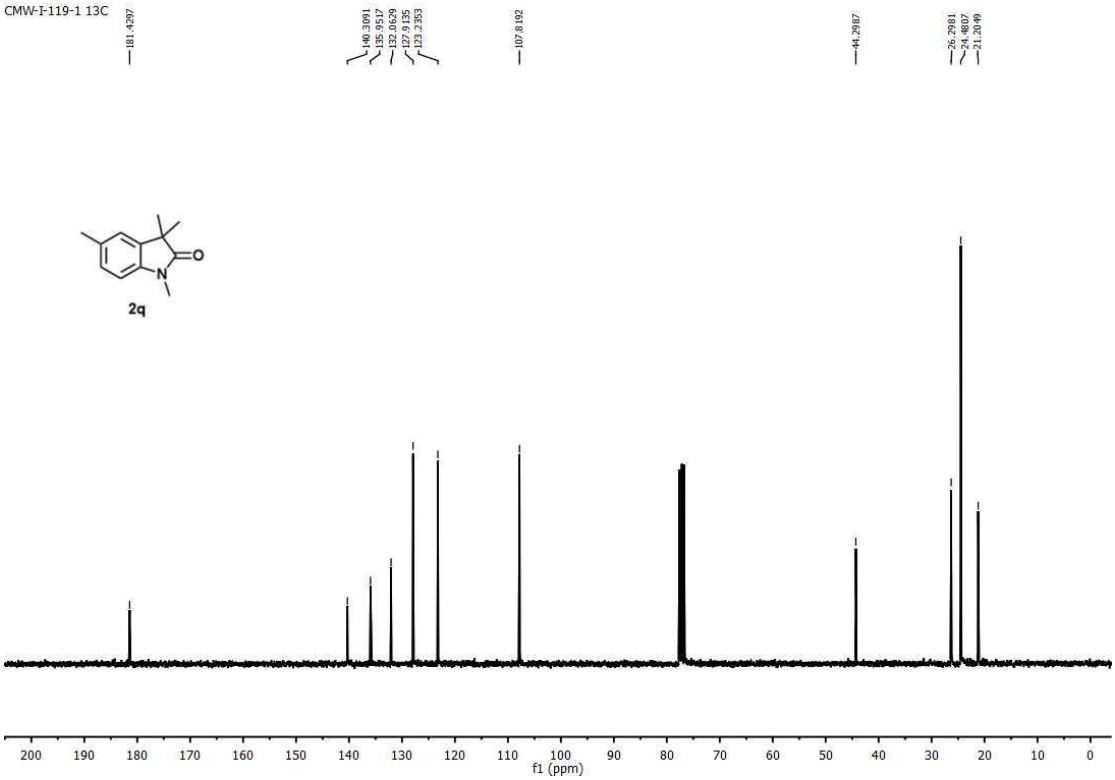

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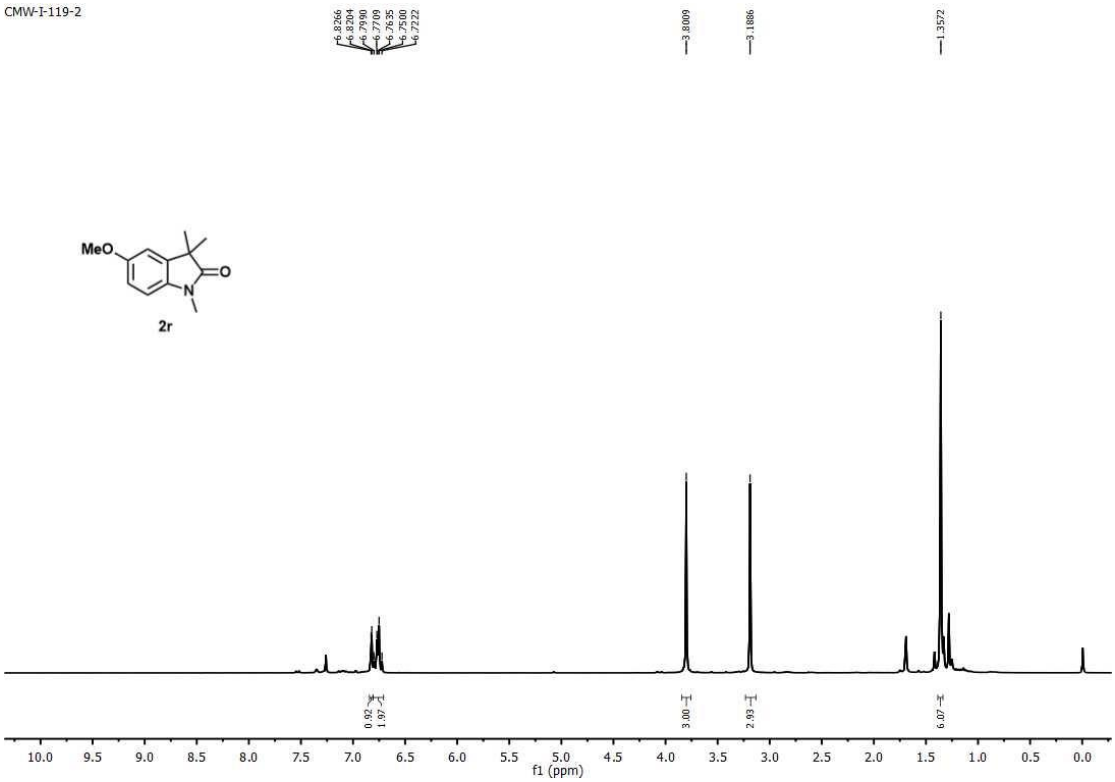

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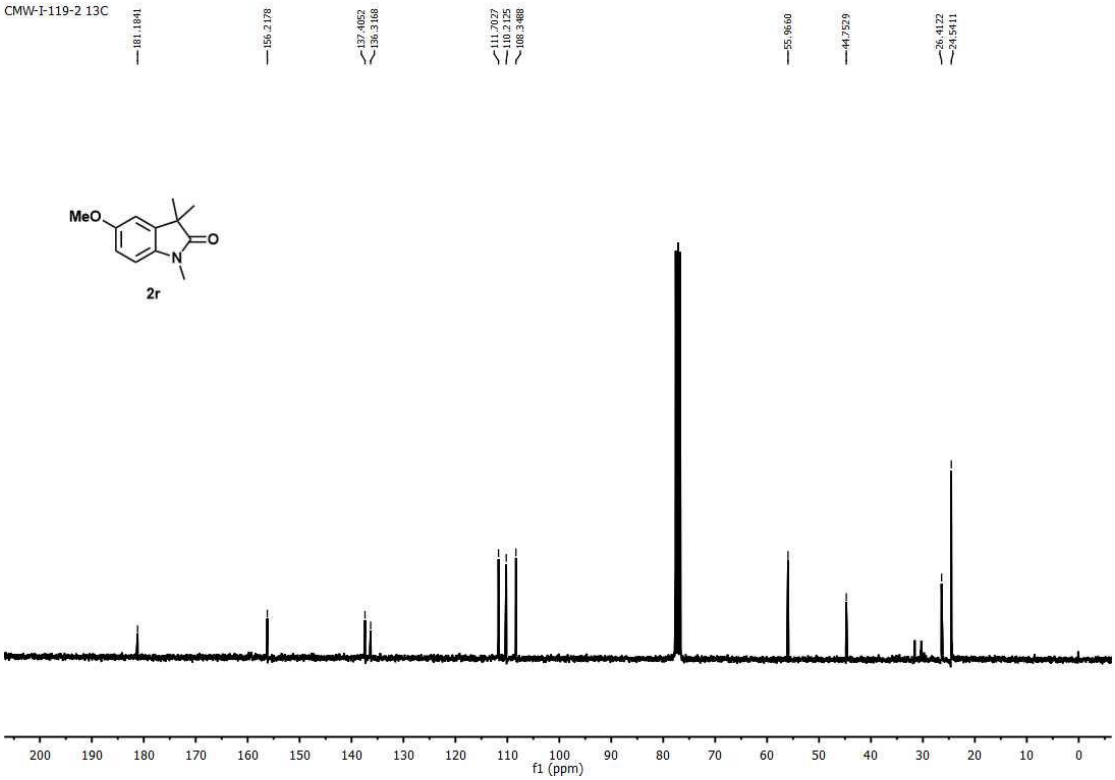

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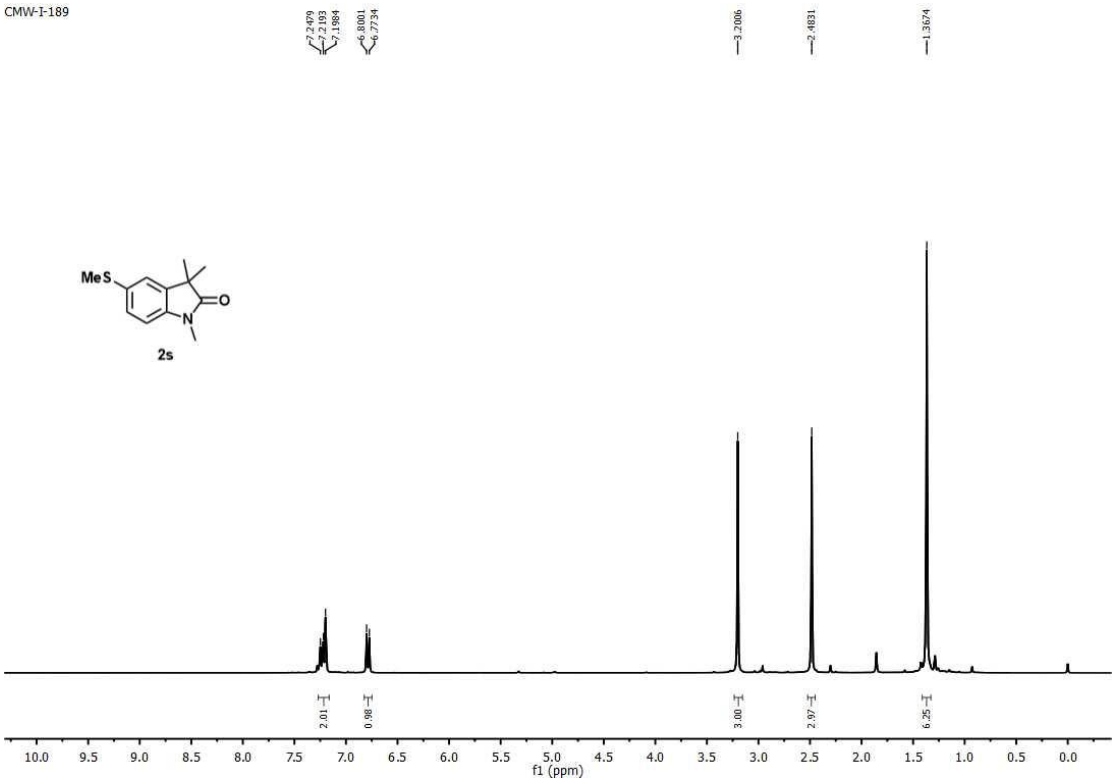

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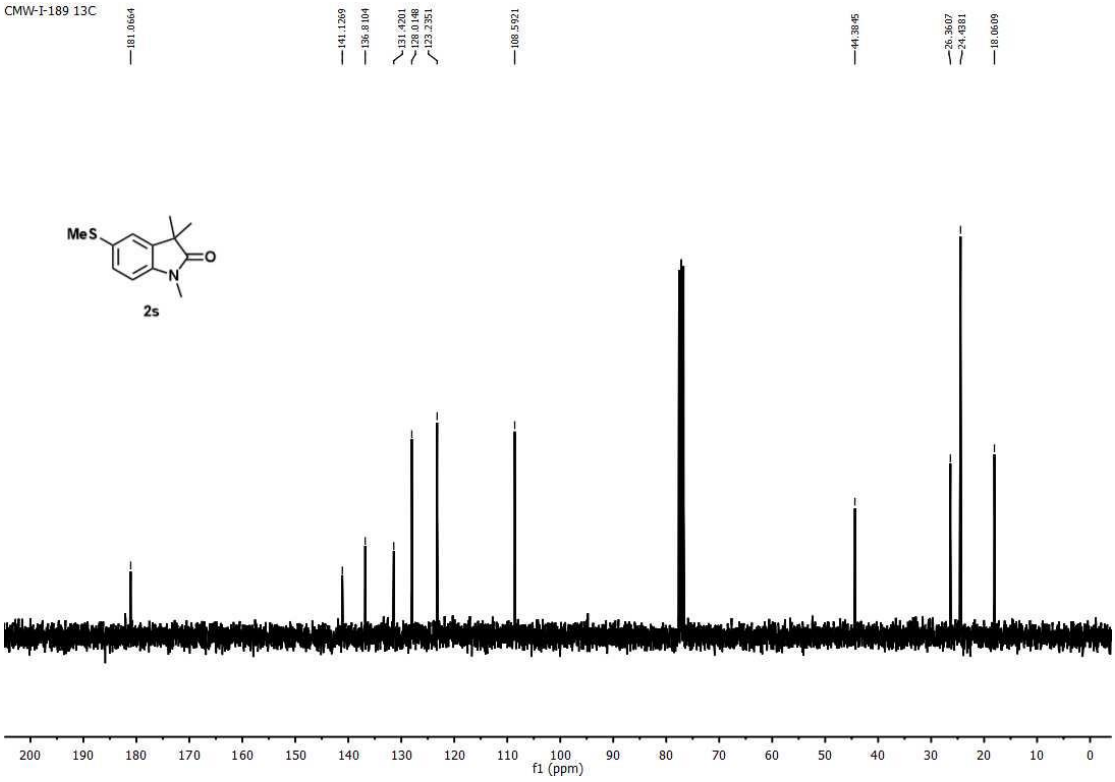
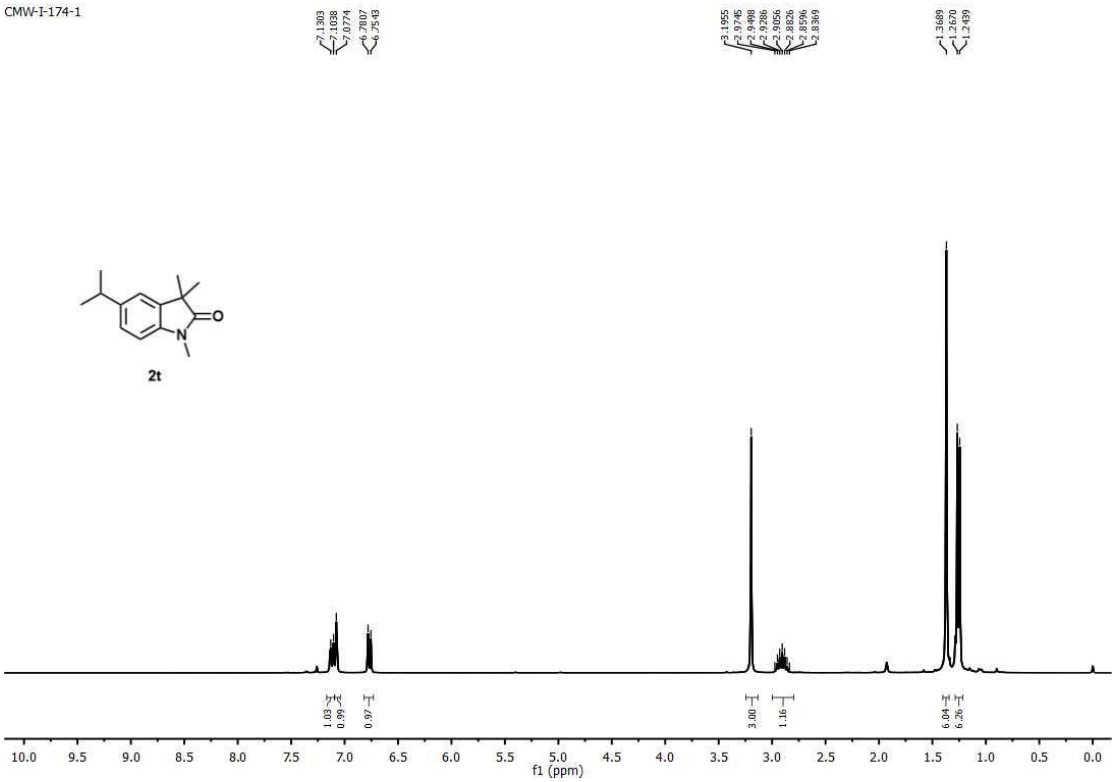
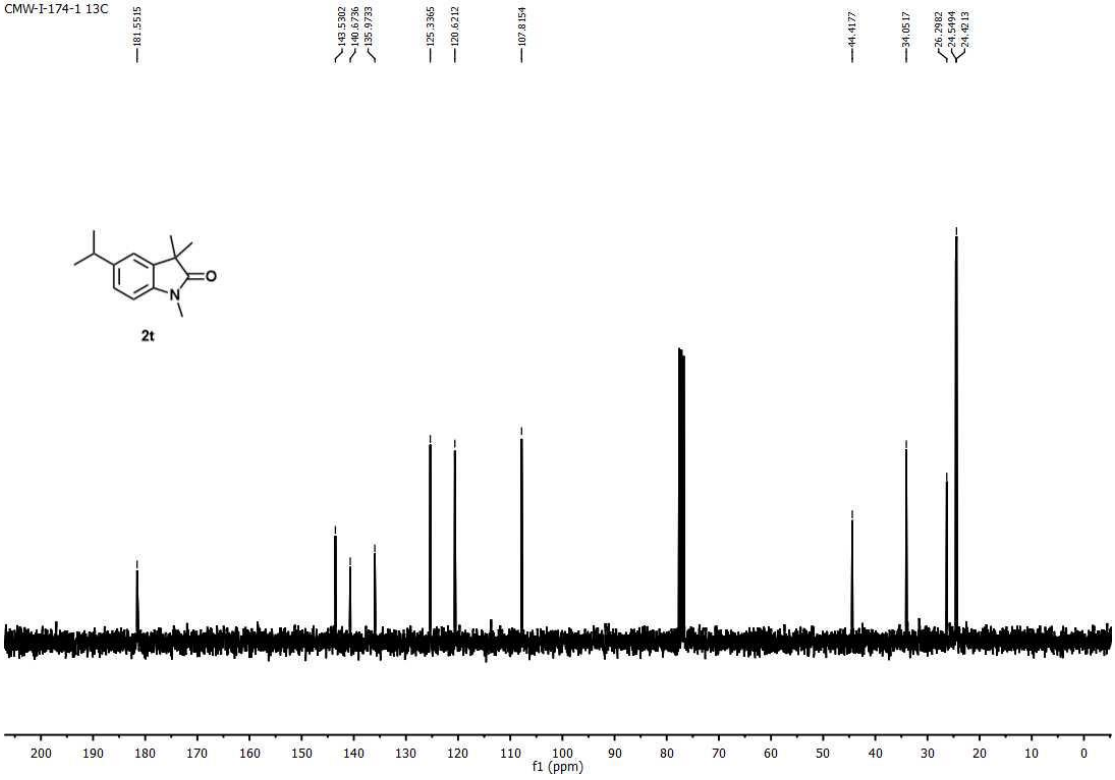


CMW-I-174-1



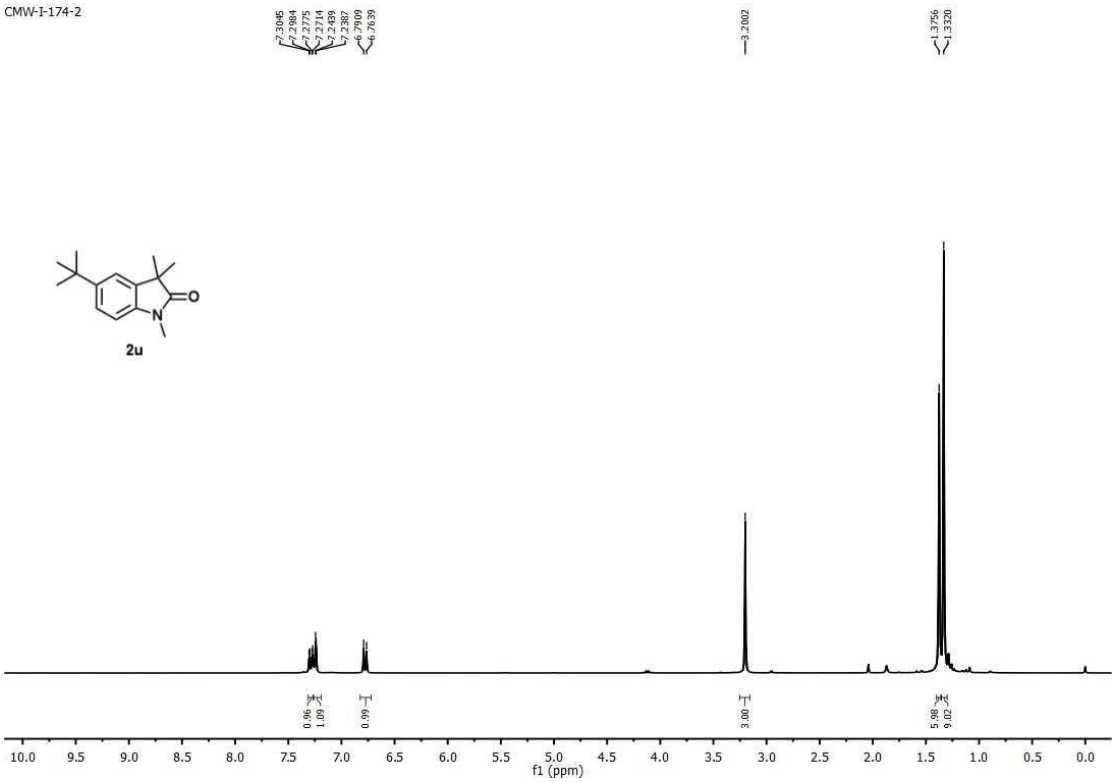
2t

CMW-I-174-1 13C

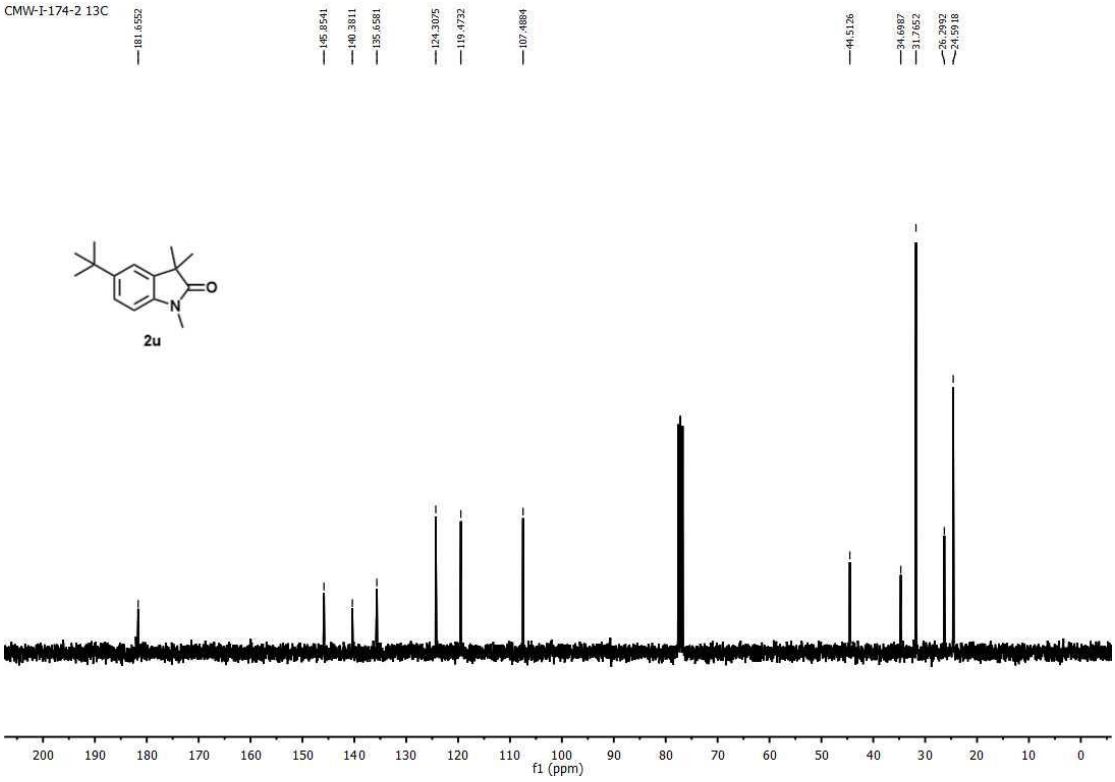


2t

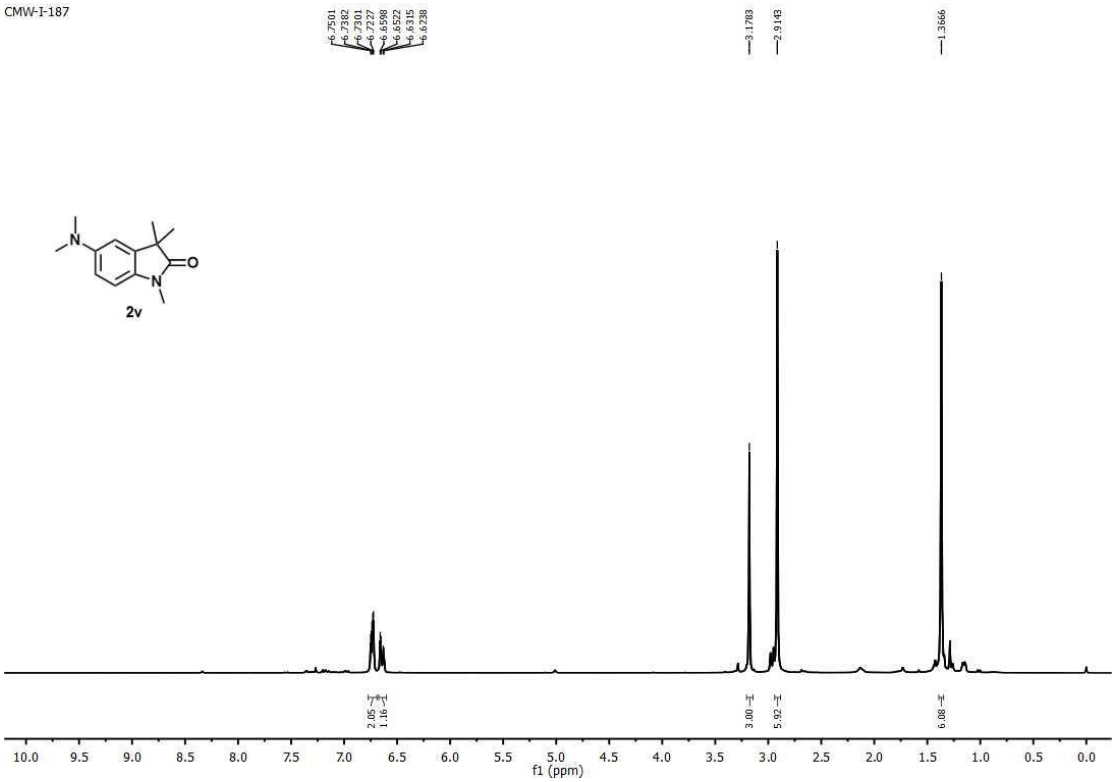
CMW-I-174-2



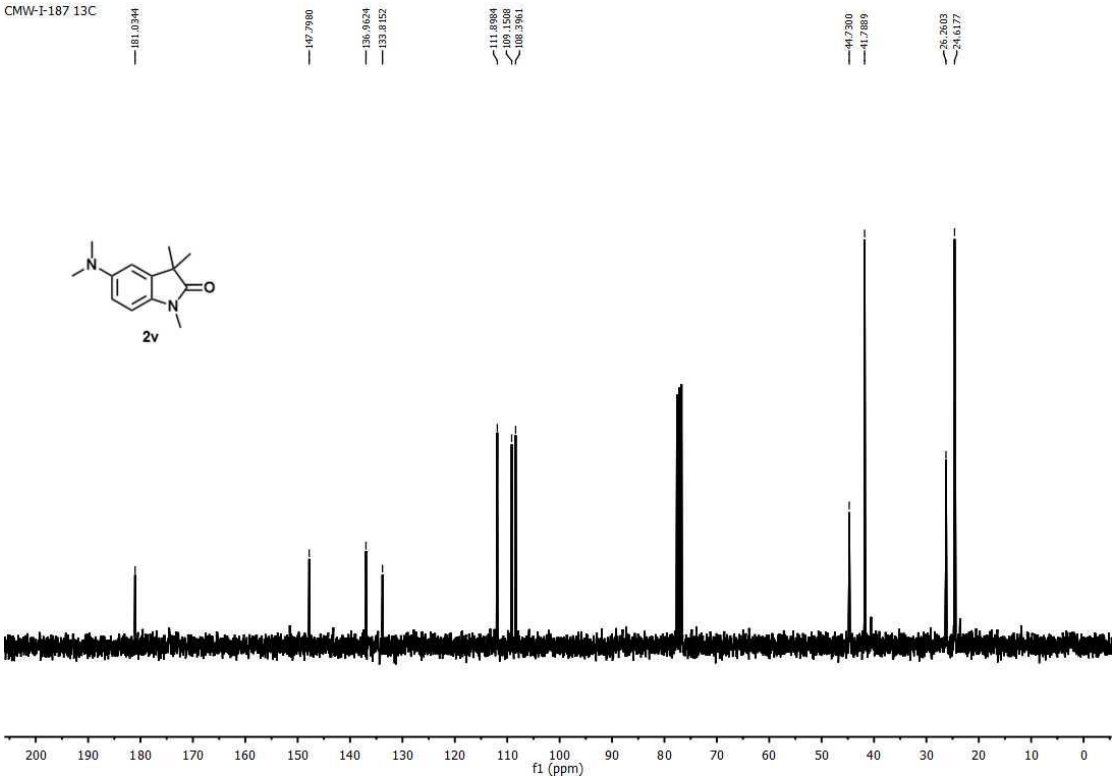
CMW-I-174-2 13C

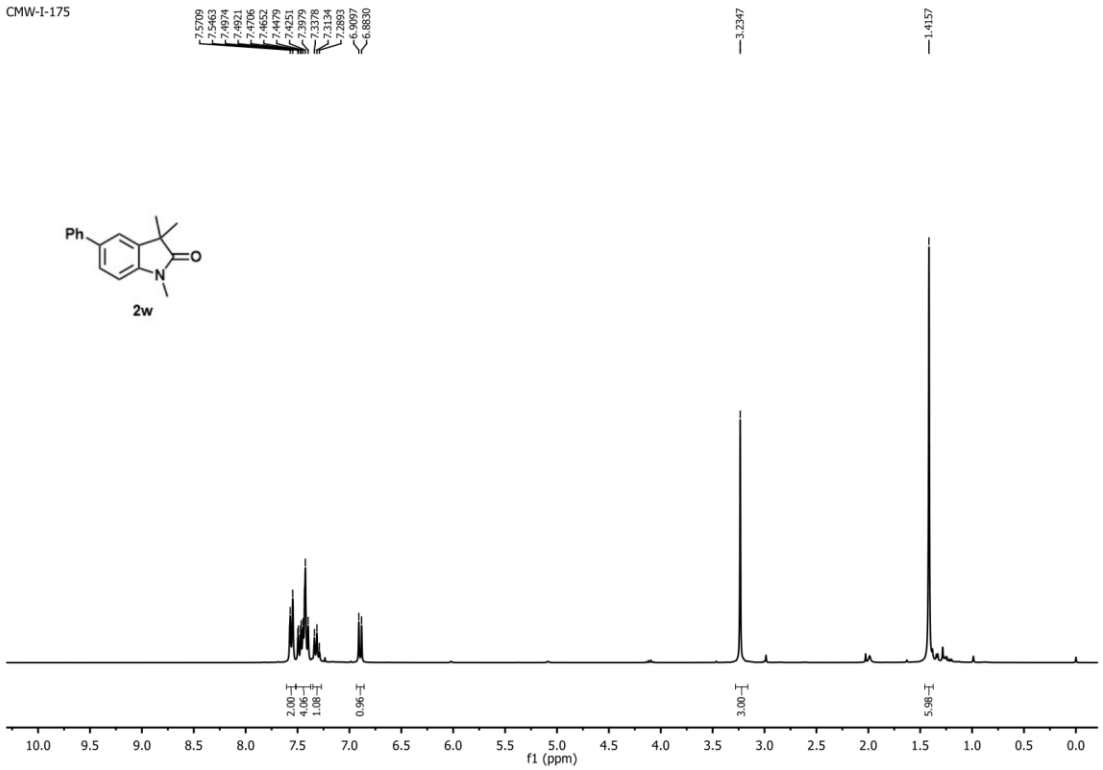


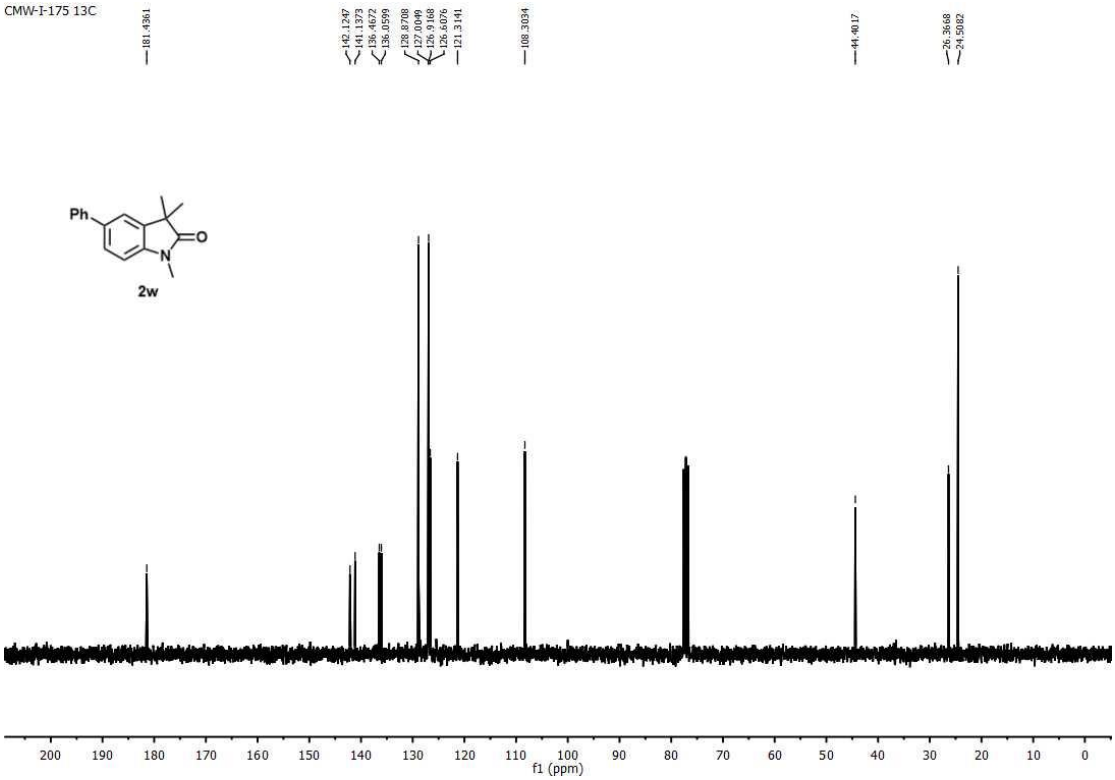
CMW-I-187



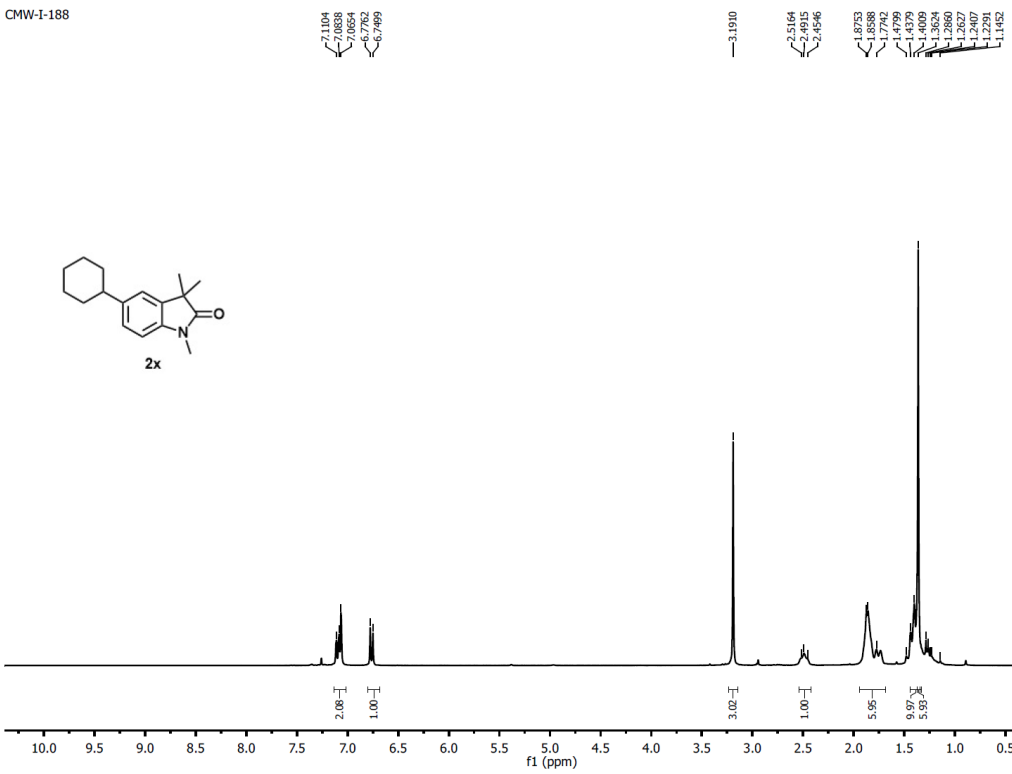
CMW-I-187 13C



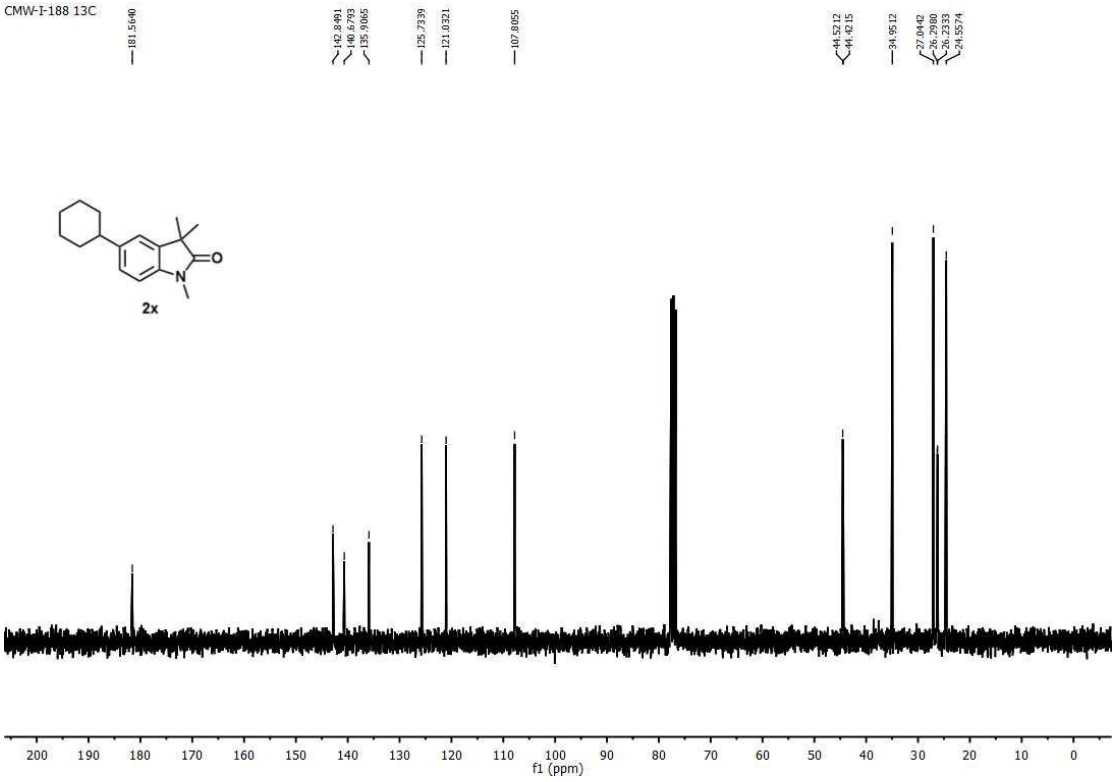

CMW-I-175
7.5709
7.5463
7.4974
7.4921
7.4706
7.4652
7.4479
7.4251
7.3979
7.3378
7.3134
7.2893
6.9097
6.8830
3.2347
1.4157
Ph
O
N
2w
2.00
4.06
1.08
0.96
3.00
5.98
f1 (ppm)


CMW-I-175 13C
181.4361
142.1247
141.1373
136.4672
136.0599
128.8708
127.0049
126.9168
126.6076
121.3141
108.3034
44.4017
26.3668
24.5082
Ph
O
N
2w
f1 (ppm)

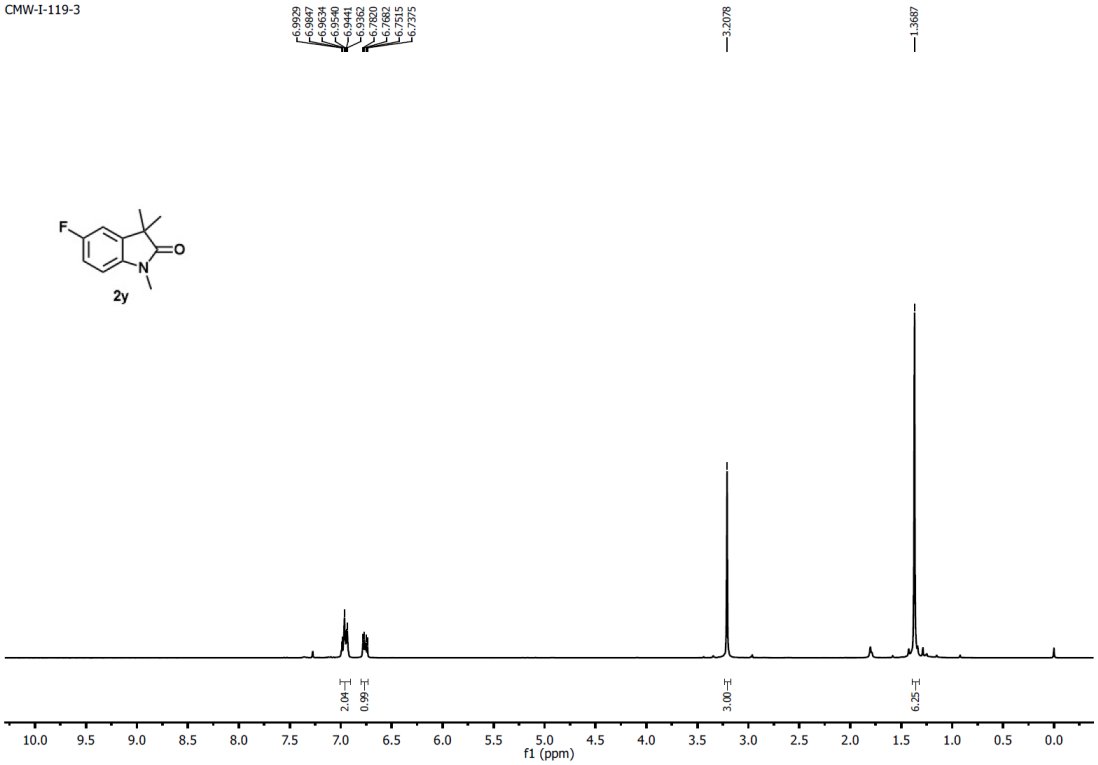
CMW-I-188



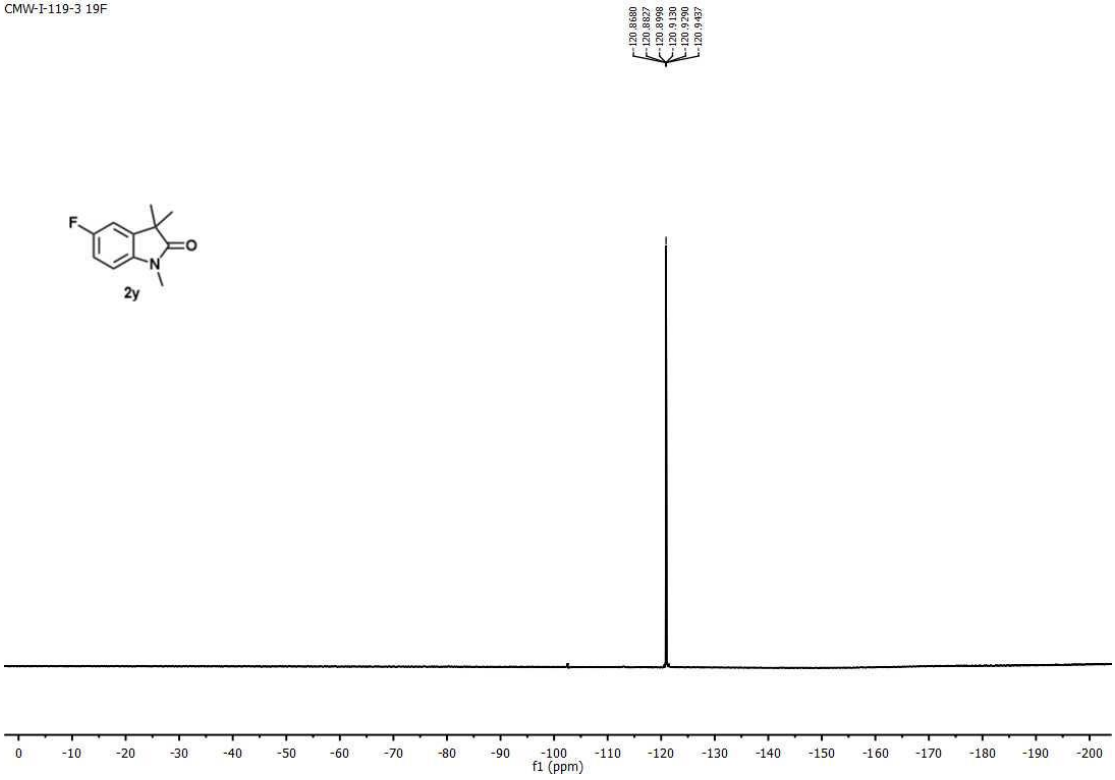
CMW-I-188 13C



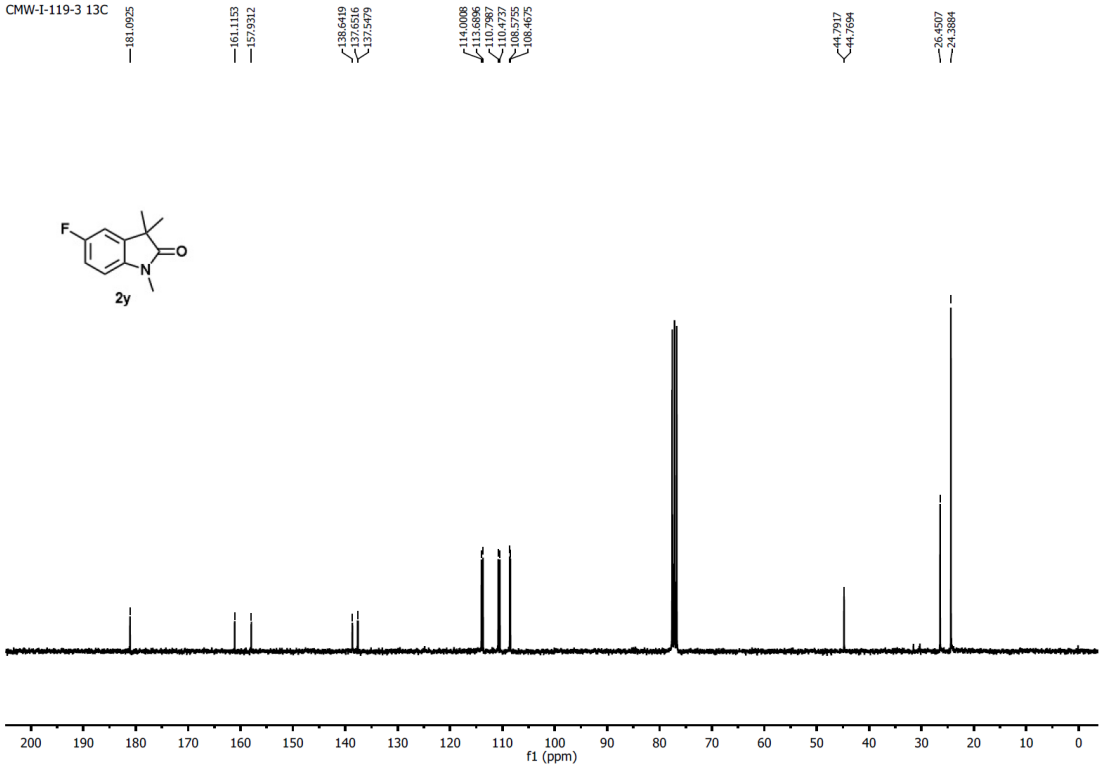
CMW-I-119-3



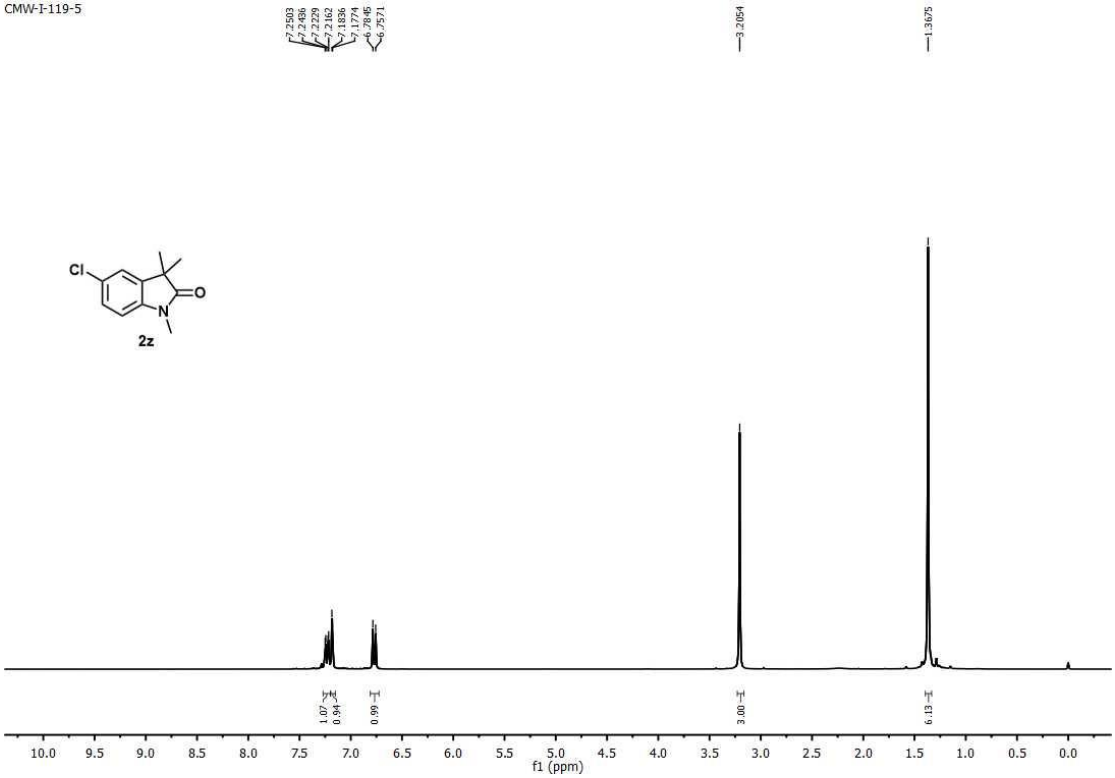
CMW-I-119-3 19F

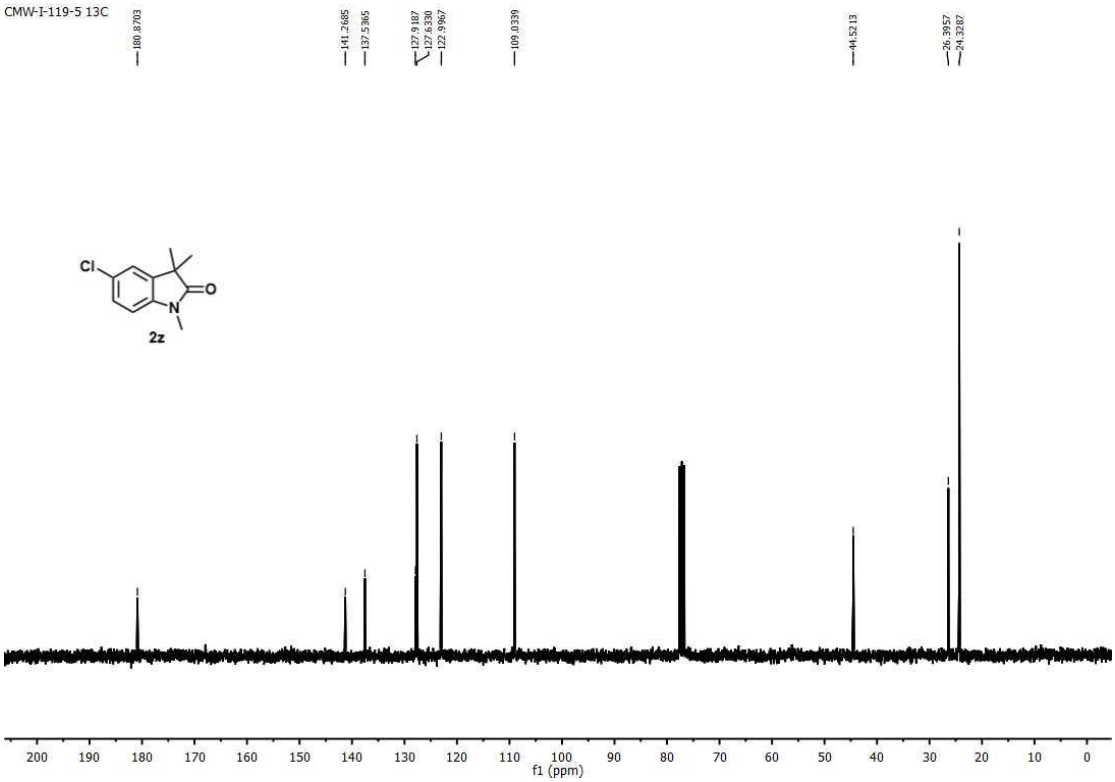


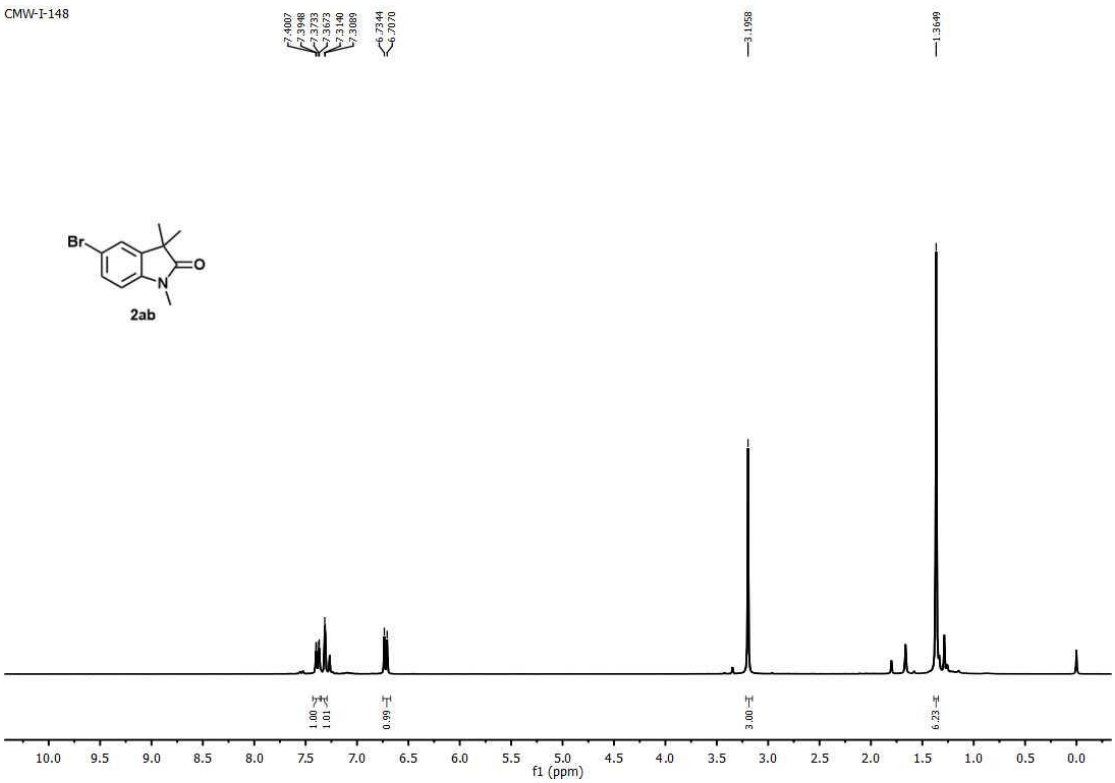
CMW-I-119-3 13C



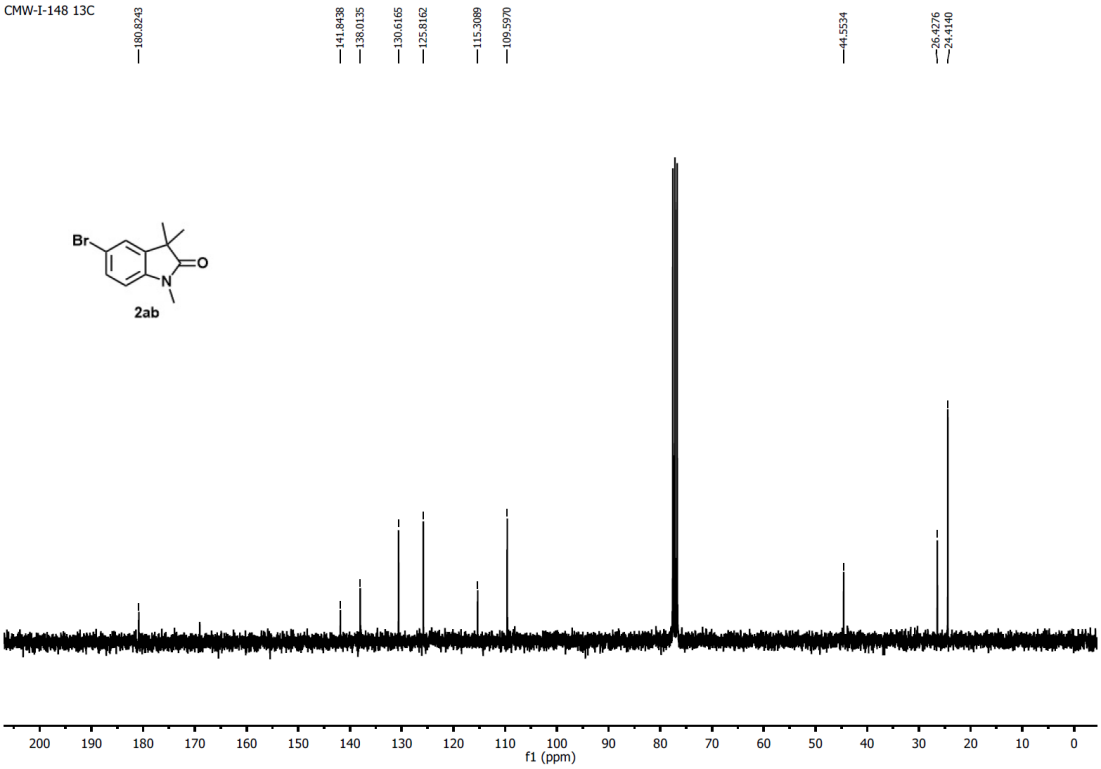
CMW-I-119-5



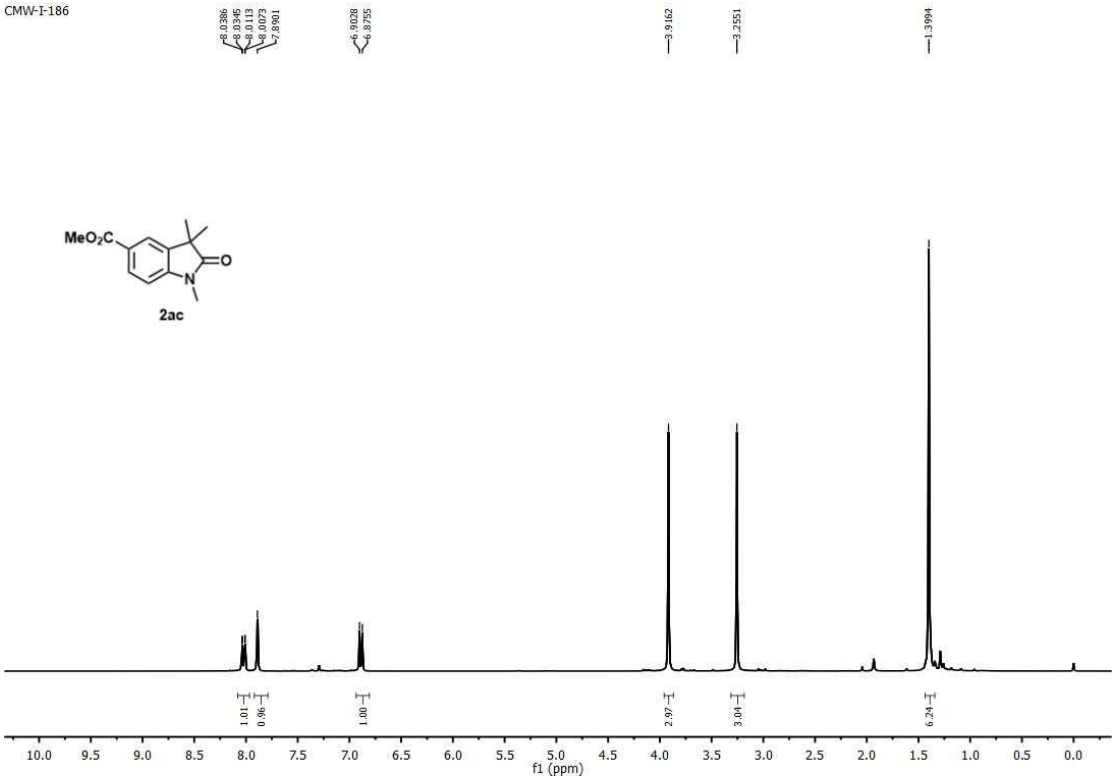

CMW-I-119-5 13C
180.8703
141.2685
137.5365
127.9187
127.6330
122.9967
109.0339
44.5213
26.3957
24.3287
Cl
O
N
2z
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


CMW-I-148
7.4007
7.3998
7.3733
7.3673
7.3140
7.3089
6.7344
6.7070
3.1958
1.3649
Br
O
N
2ab
1.00
1.01
0.99
3.00
6.23
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

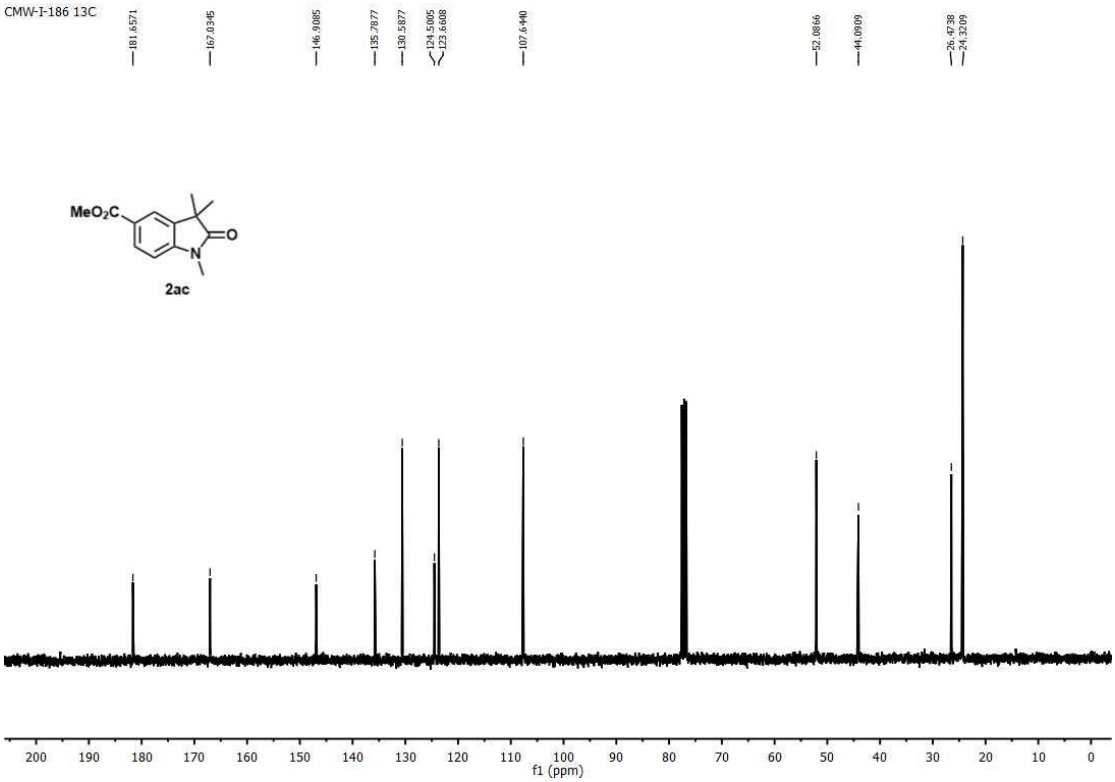
CMW-I-148 13C



CMW-I-186

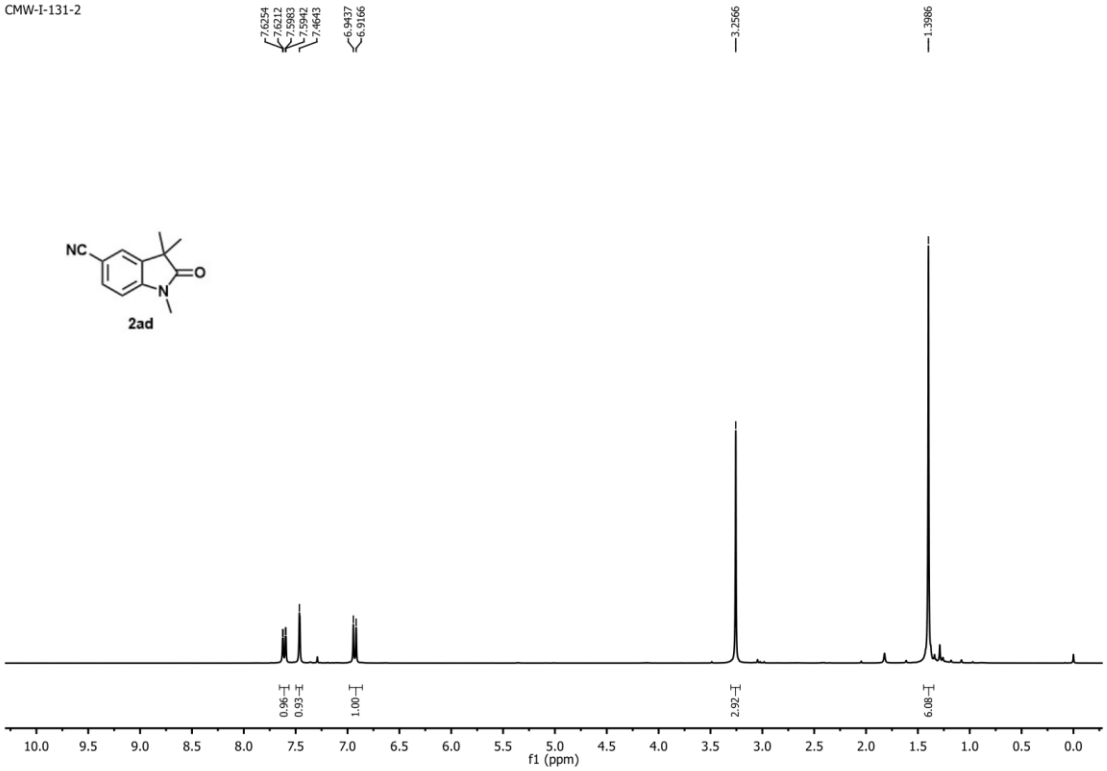


CMW-I-186 13C

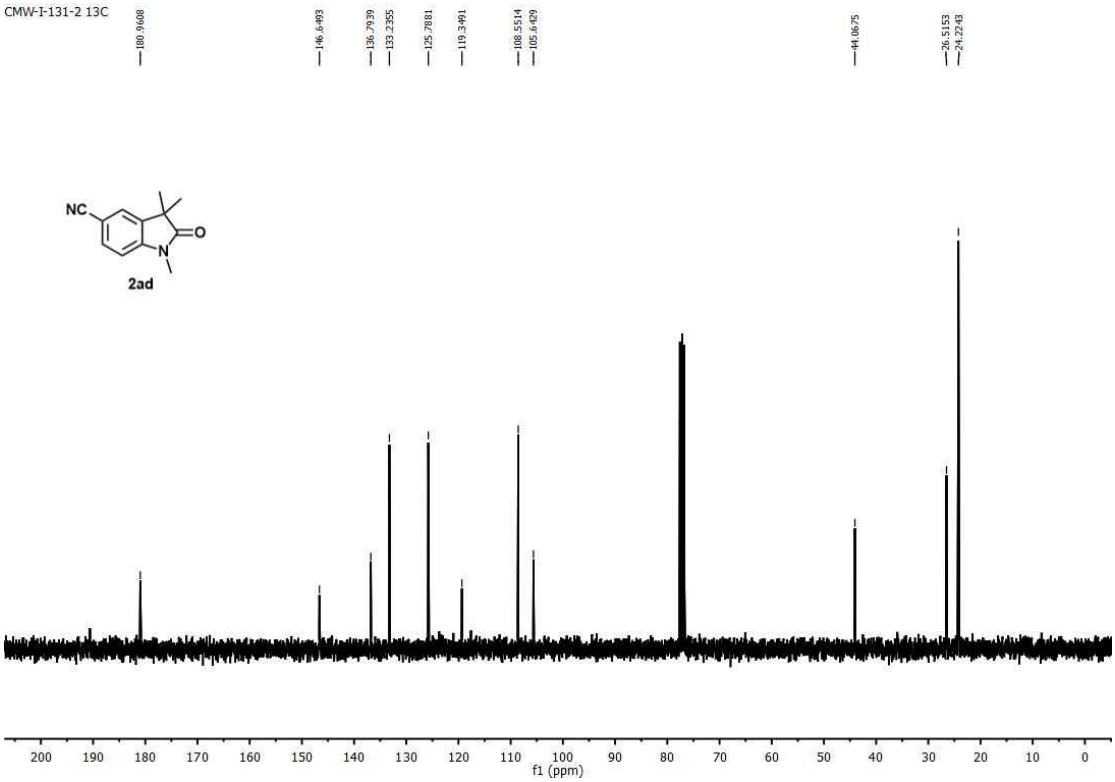


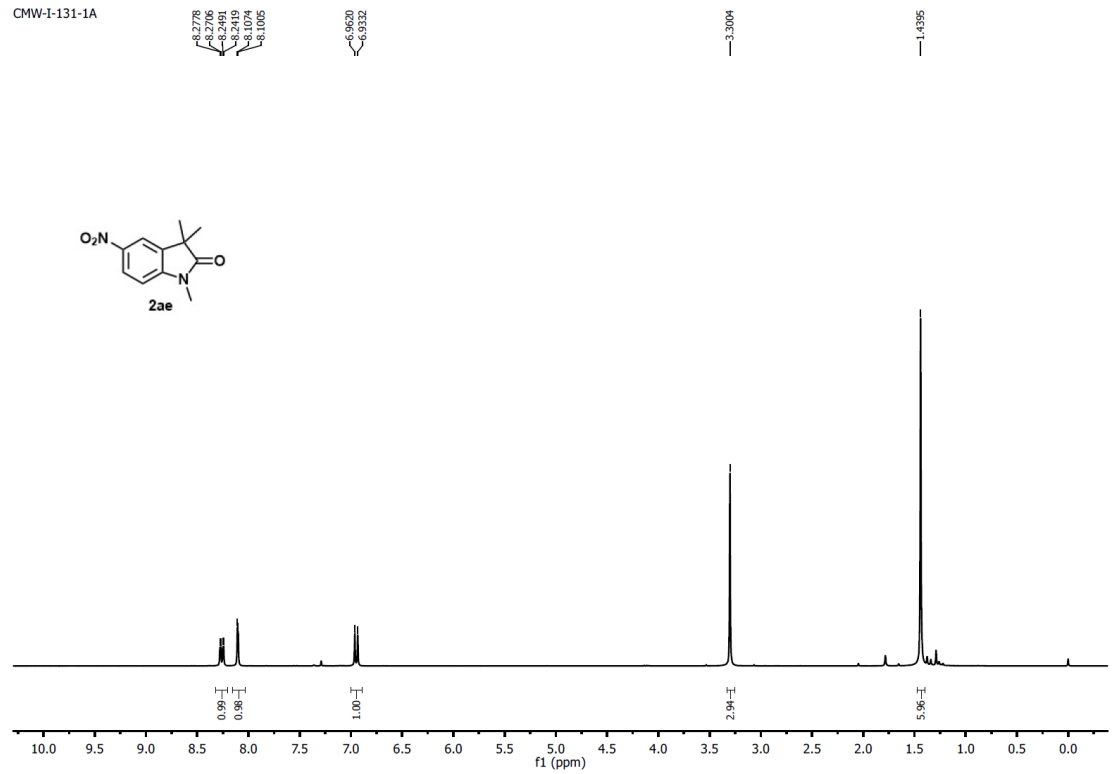
2ac

CMW-I-131-2

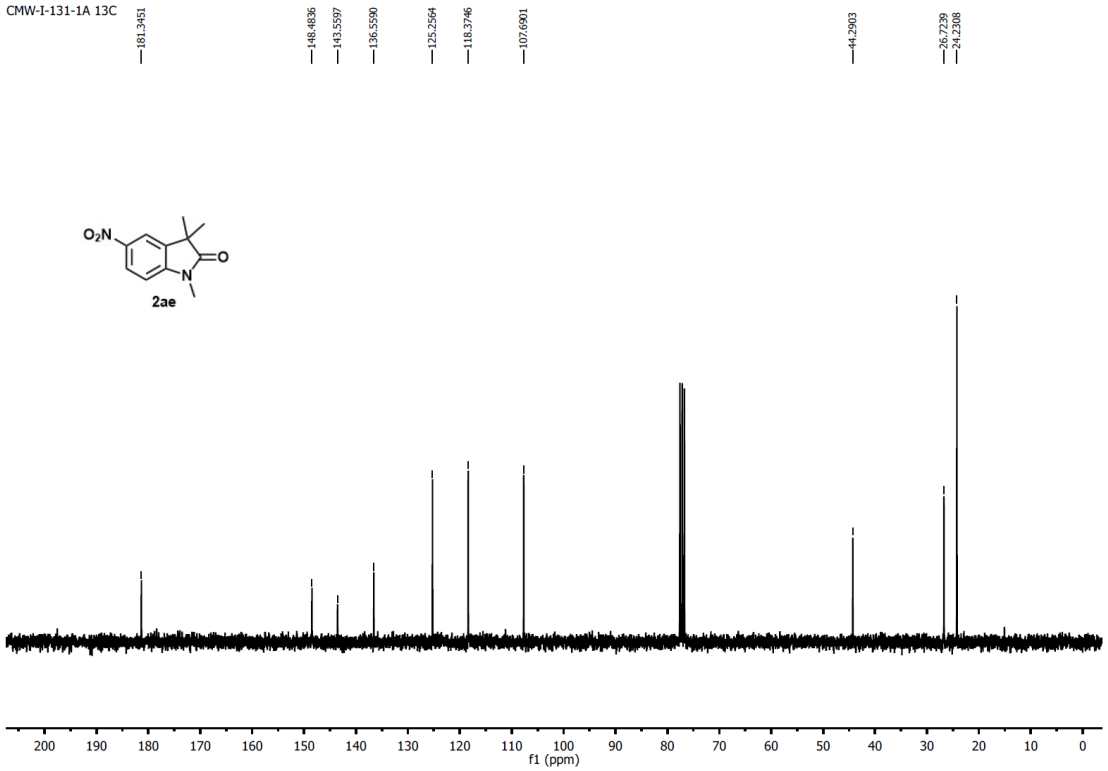


2ad

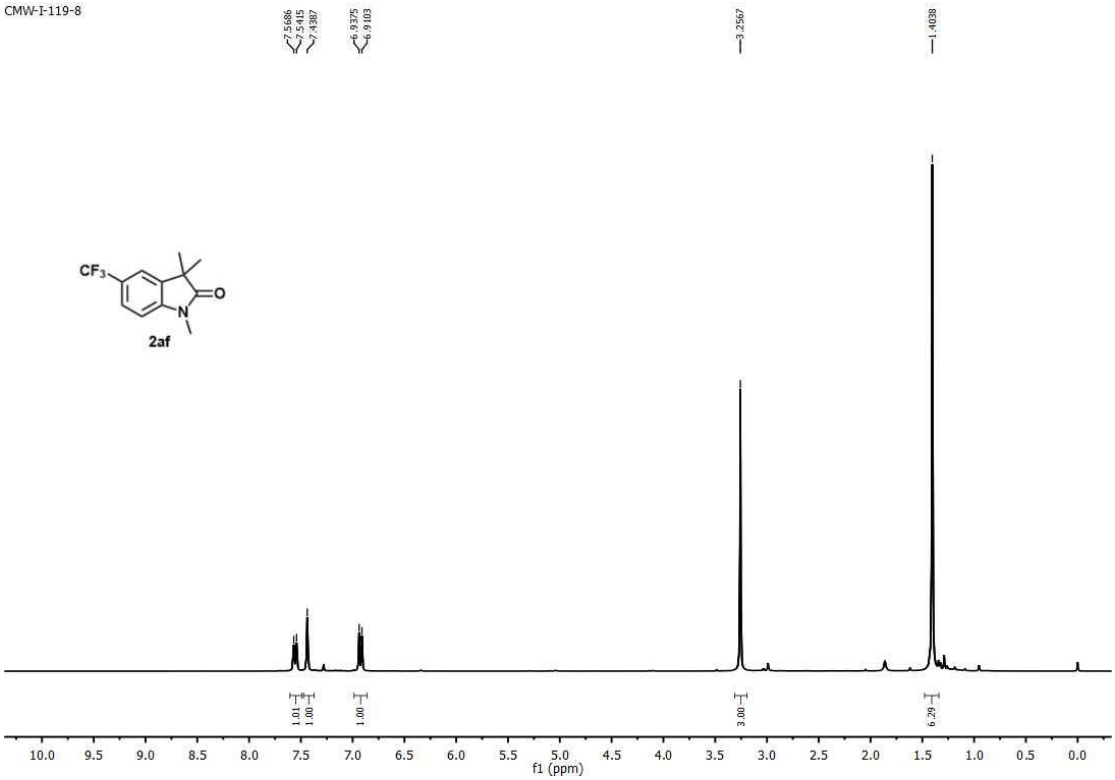

CMW-I-131-2 13C
180.9608
146.6493
136.7939
133.2355
125.7881
119.3491
108.5514
105.6429
44.0675
26.5153
24.2243
NC
O
N
2ad
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


CMW-I-131-1A
8.2778
8.2706
8.2491
8.2419
8.1074
8.1005
6.9620
6.9332
3.3004
1.4395
O2N
O
N
2ae
0.99
0.98
1.00
2.94
5.96
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

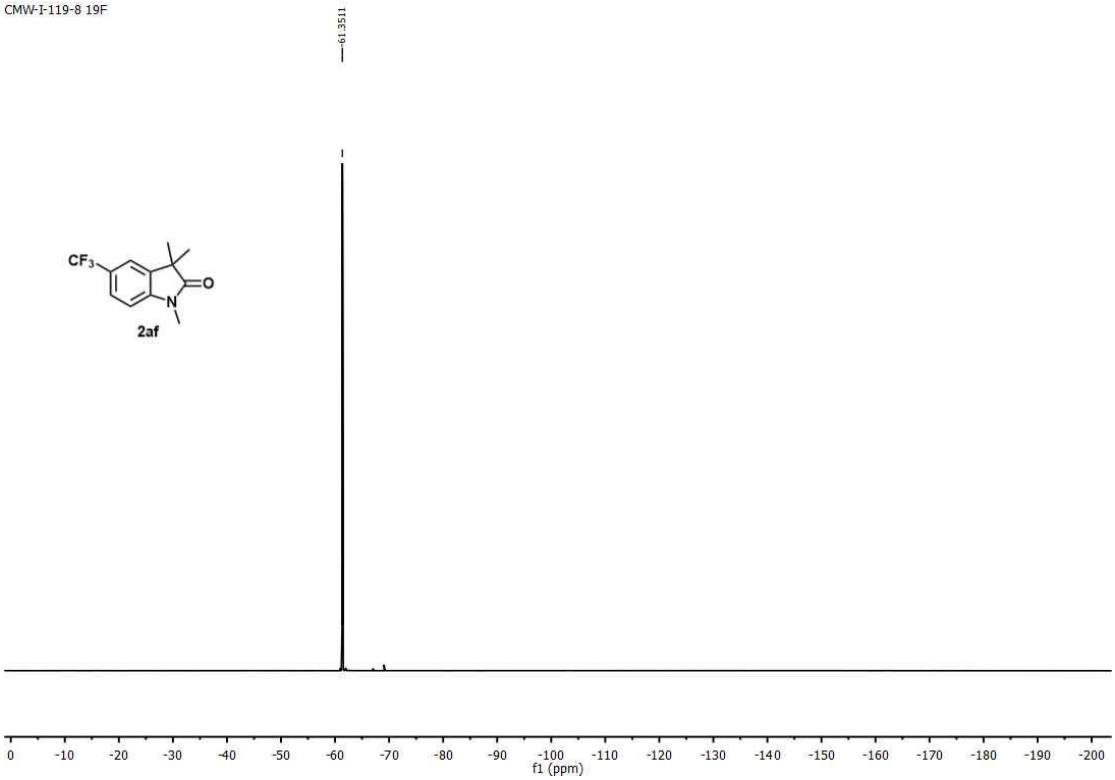
CMW-I-131-1A 13C



CMW-I-119-8

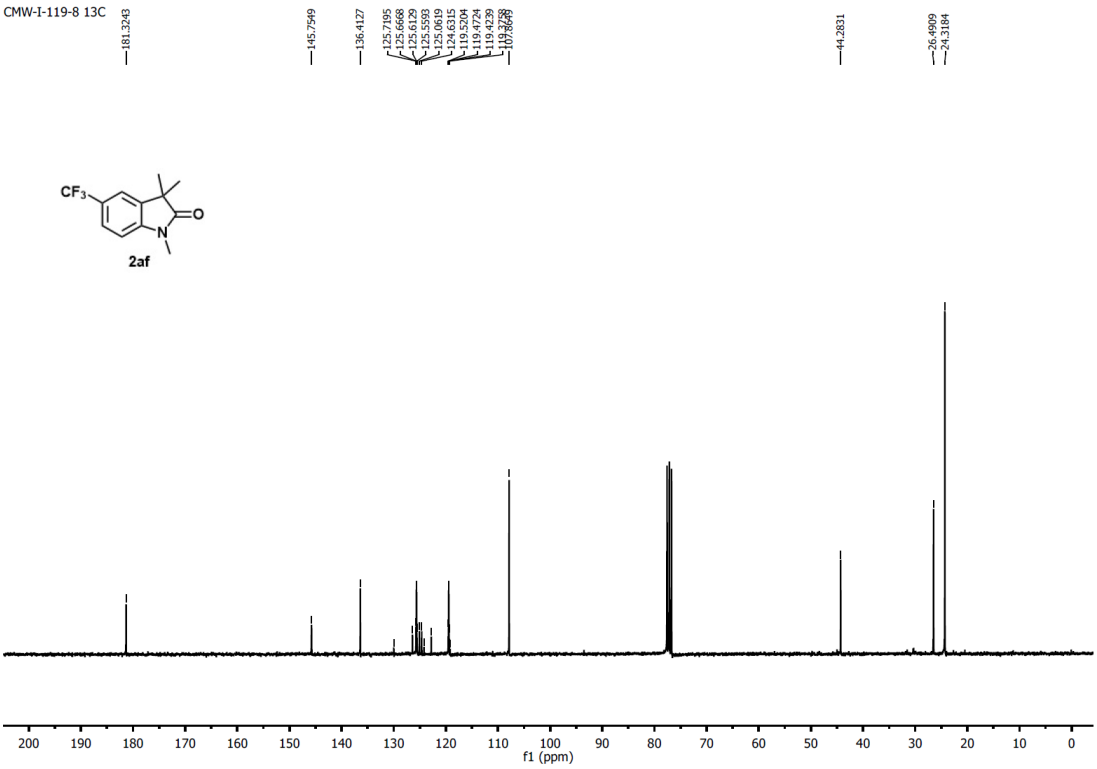


CMW-I-119-8 19F

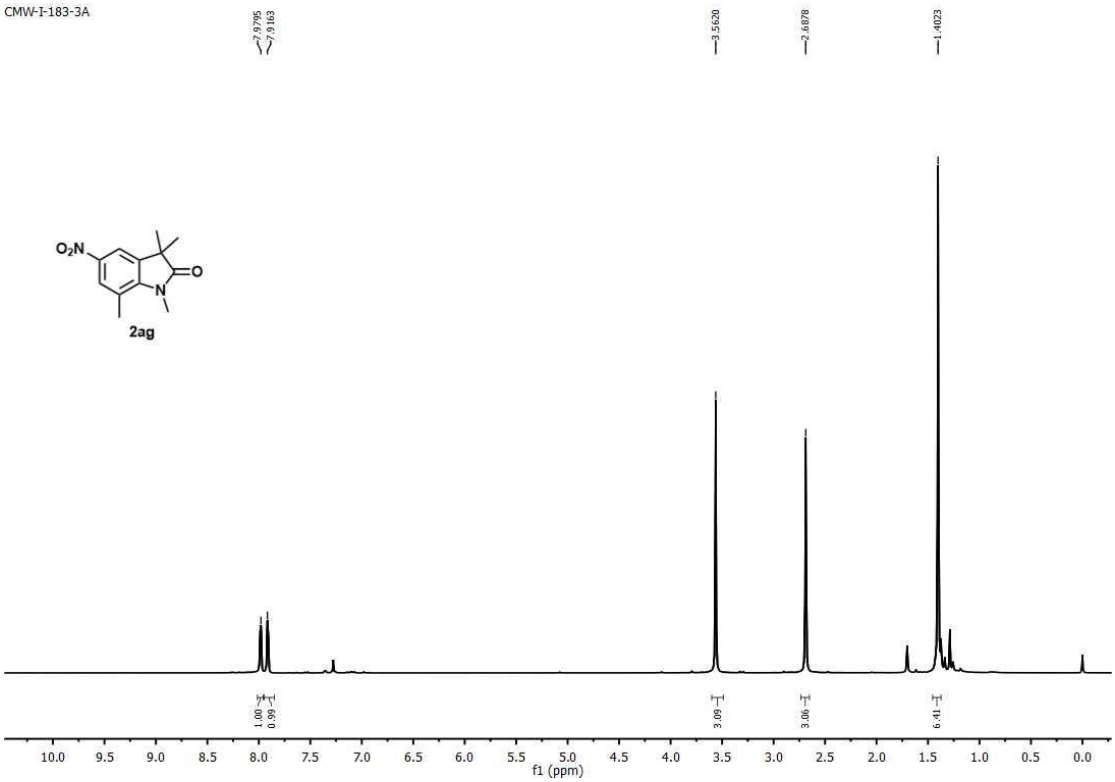


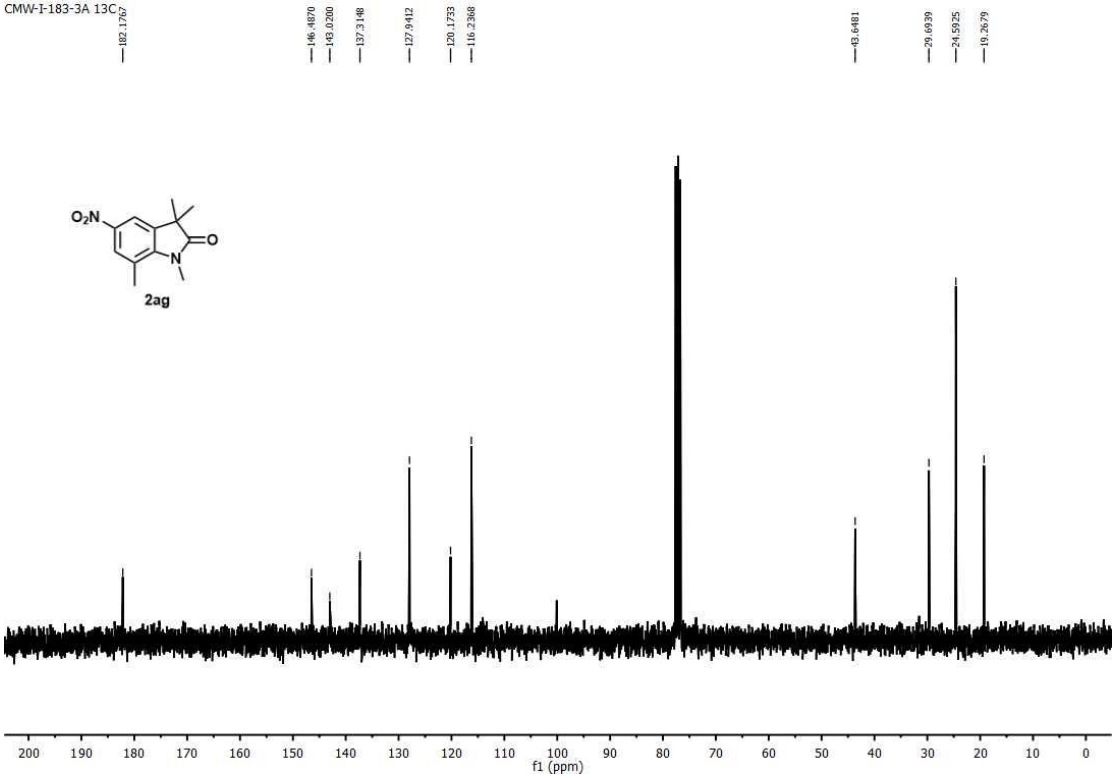
2af

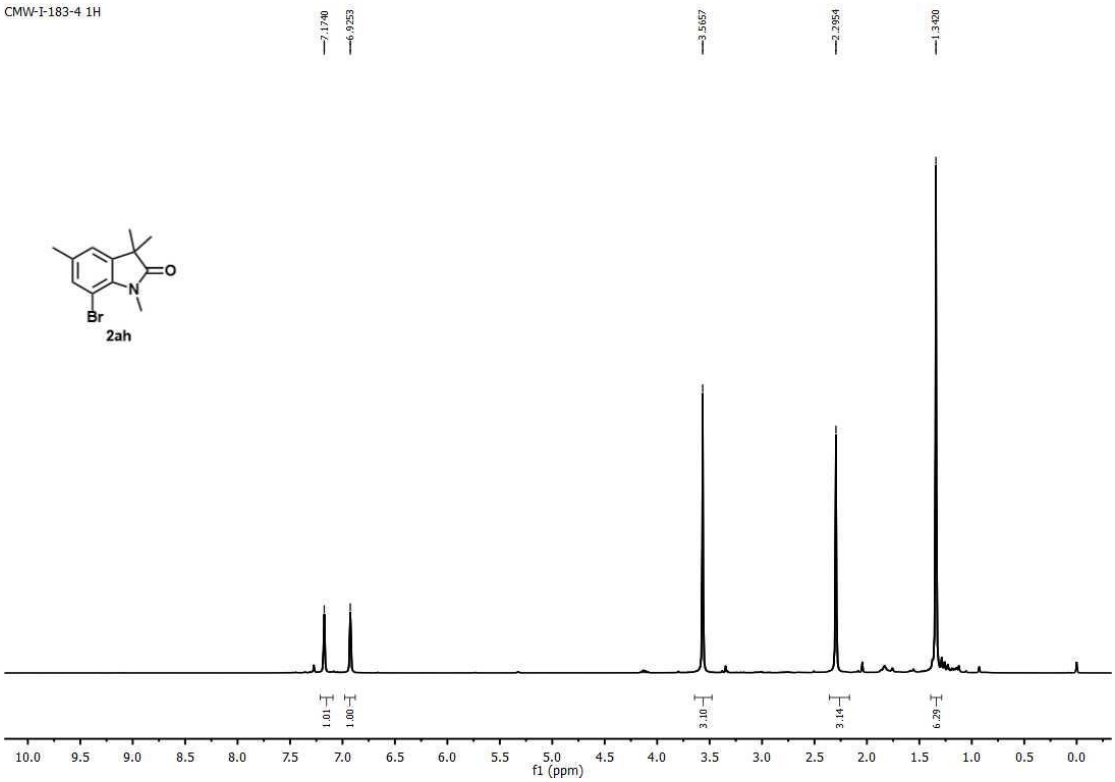
CMW-I-119-8 13C

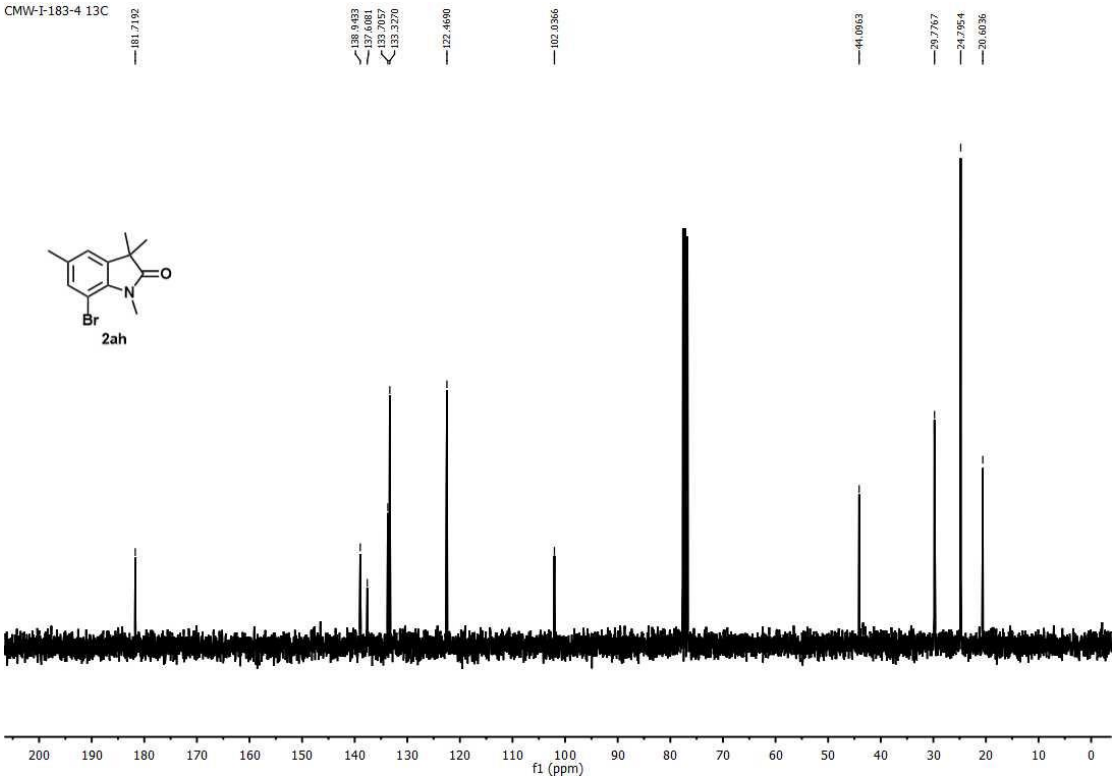


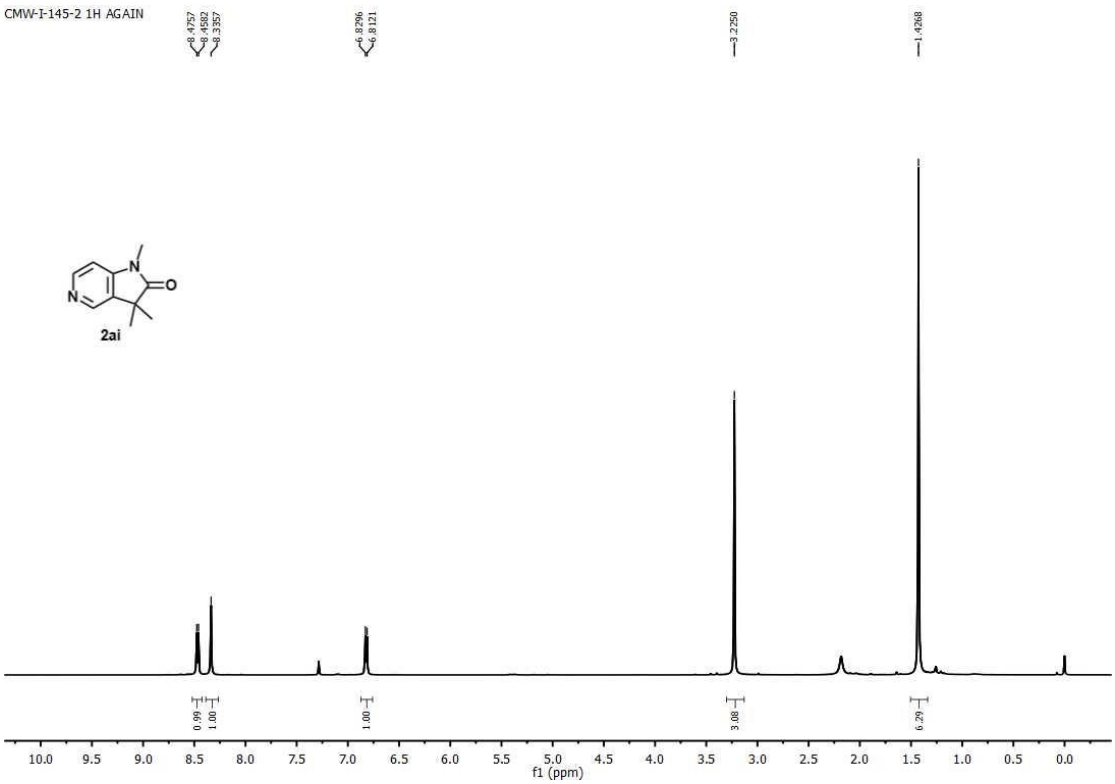
2af

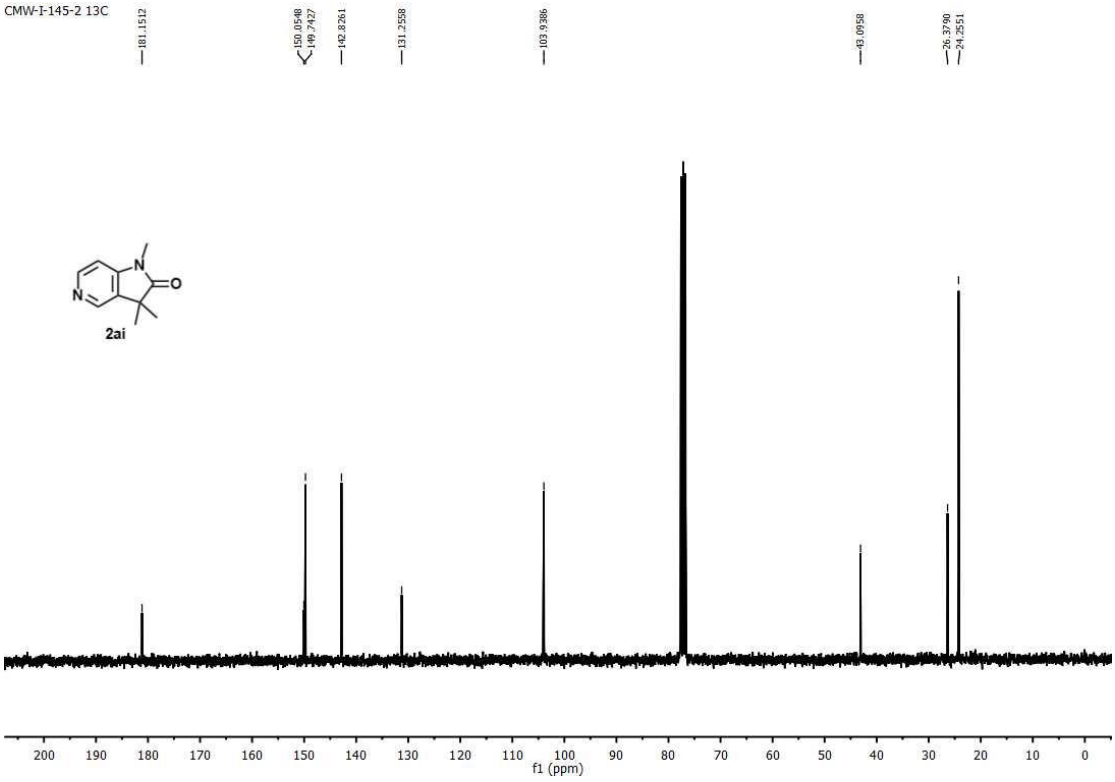

CMW-I-183-3A
7.9795
7.9163
3.5620
2.6878
1.4023
O2N
O
N
2ag
1.00
0.99
3.09
3.06
6.41
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


CMW-I-183-3A 13C
182.1767
146.4870
143.0200
137.3148
127.9412
120.1733
116.2368
43.6481
29.6939
24.5925
19.2679
O2N
O
N
2ag
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

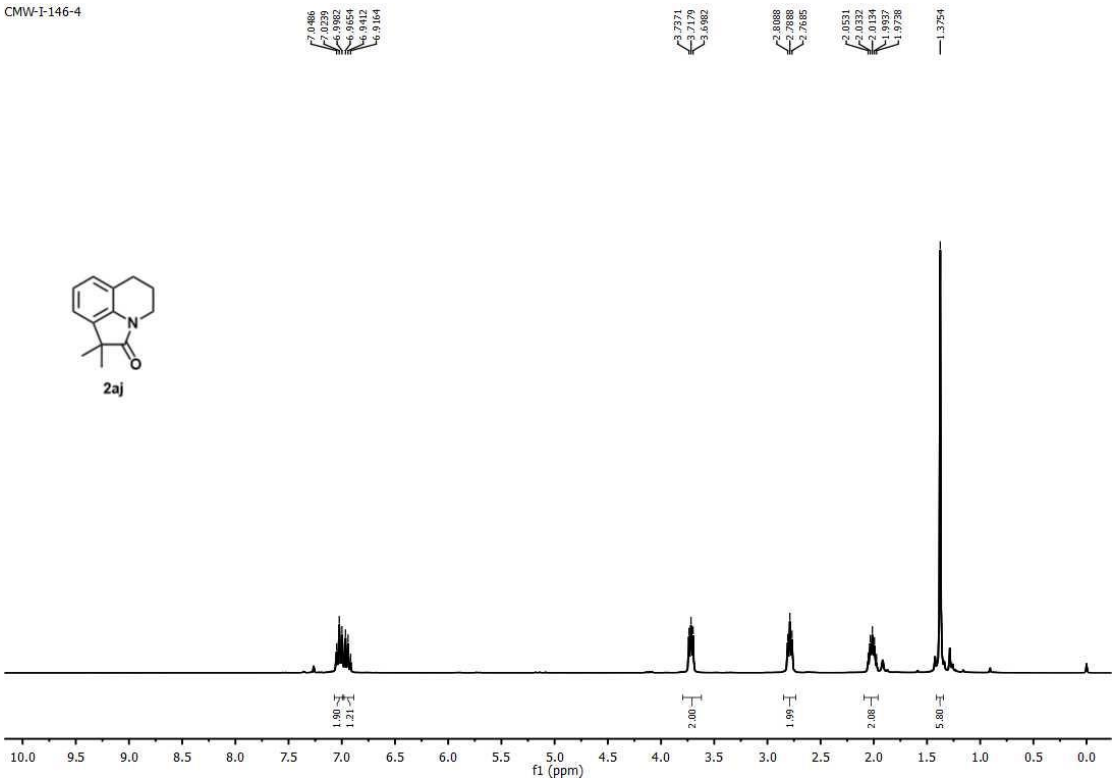

CMW-I-183-4 1H
7.1740
6.9253
3.5657
2.2954
1.3420
O
N
Br
2ah
1.01
1.00
3.10
3.14
6.29
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


CMW-I-183-4 13C
181.7192
138.9433
137.6081
133.7057
133.3270
122.4690
102.0366
44.0963
29.7767
24.7954
20.6036
O
N
Br
2ah
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


CMW-I-145-2 1H AGAIN
8.4757
8.4582
8.3357
6.8296
6.8121
3.2250
1.4268
2ai
0.99
1.00
1.00
3.08
6.29
f1 (ppm)

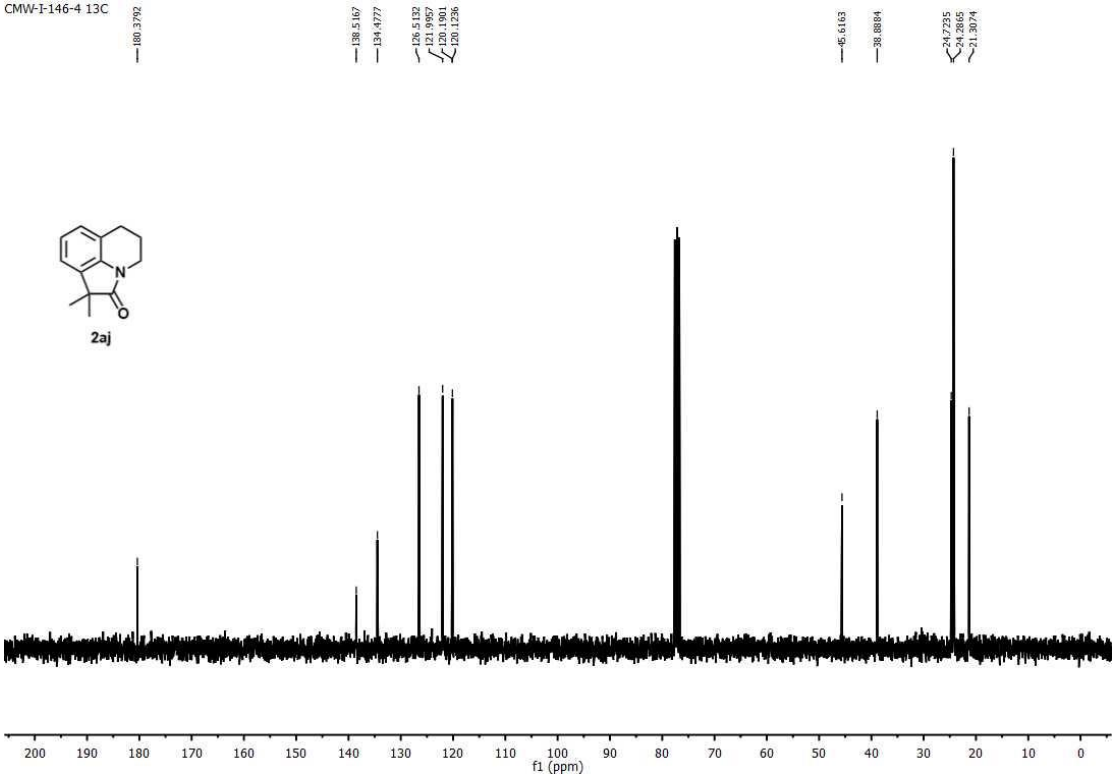

CMW-I-145-2 13C
181.1512
150.0548
149.7427
142.8261
131.2558
103.9386
43.0958
26.3790
24.2551
2ai
f1 (ppm)

CMW-I-146-4



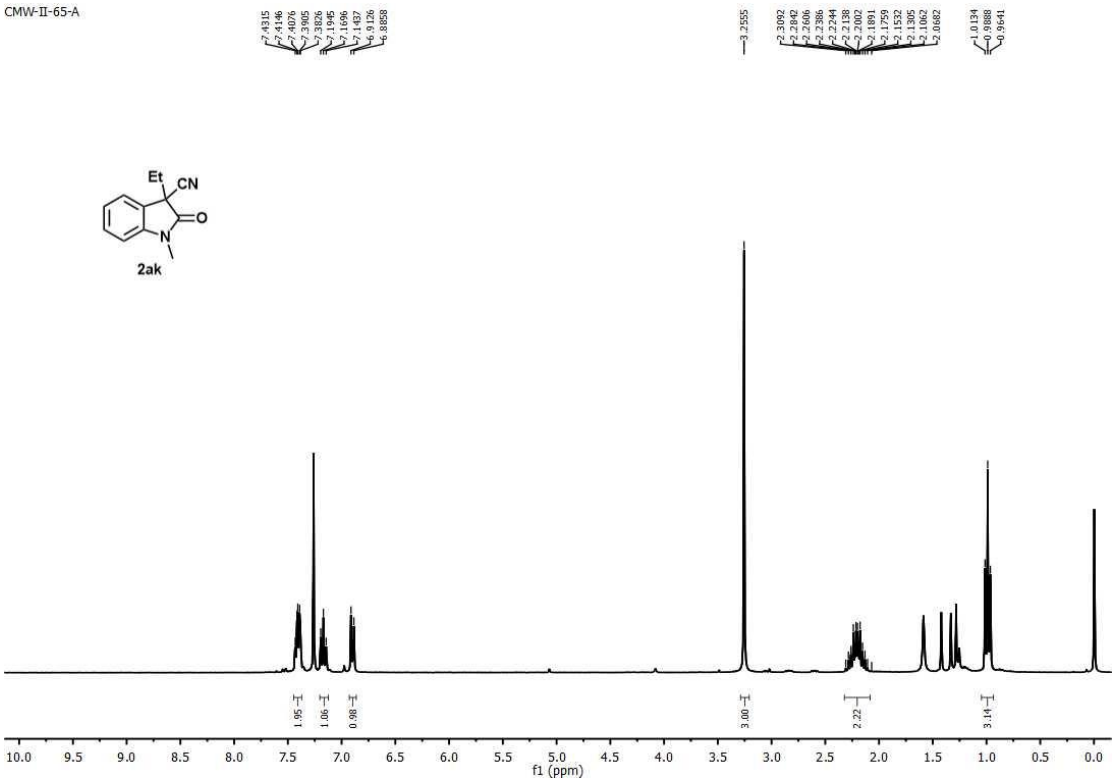
2aj

CMW-I-146-4 13C

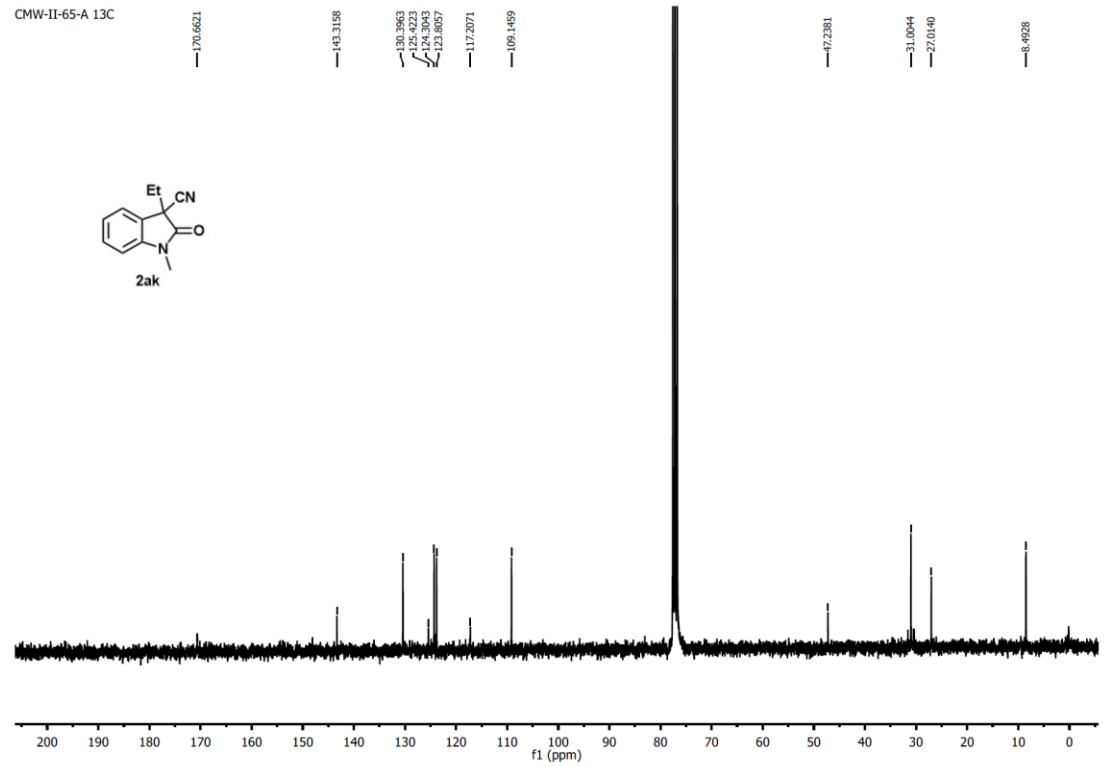


2aj

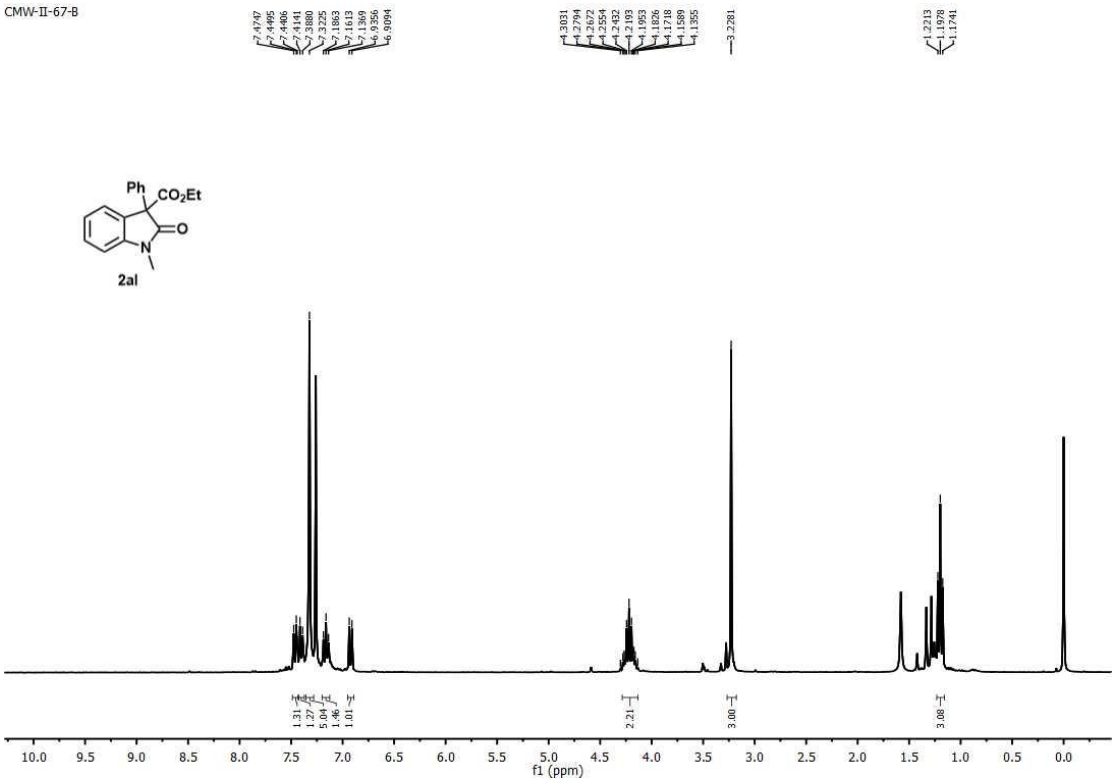
CMW-II-65-A



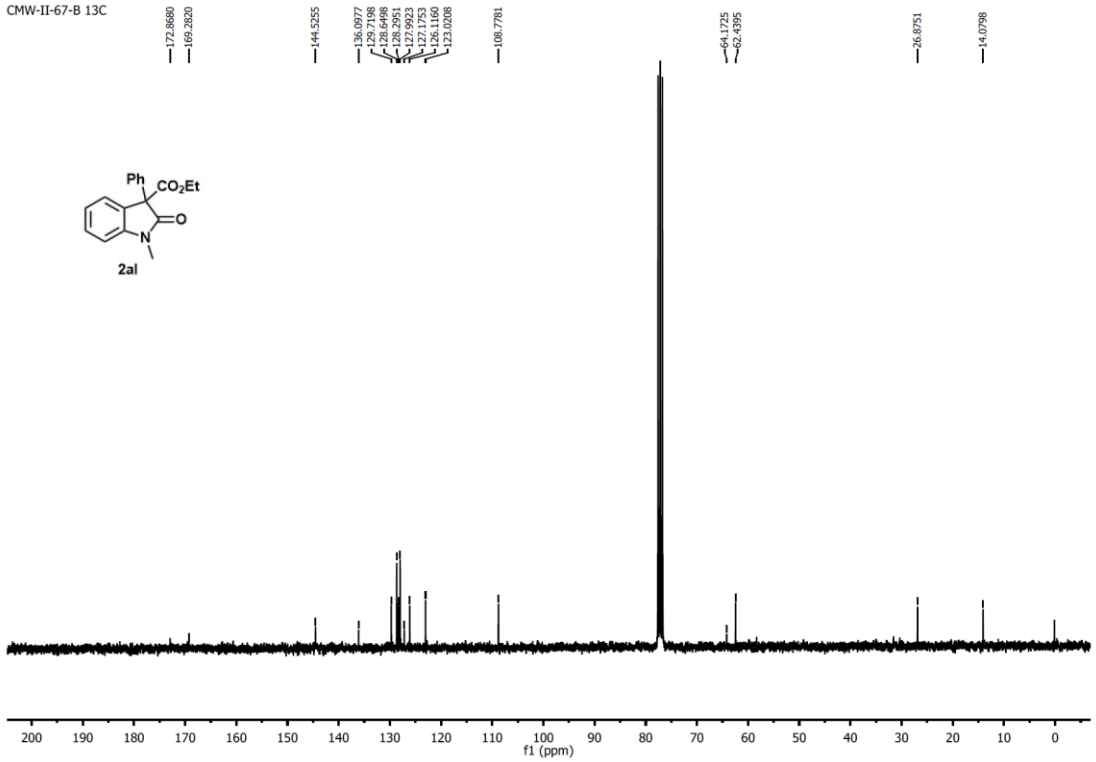
CMW-II-65-A 13C



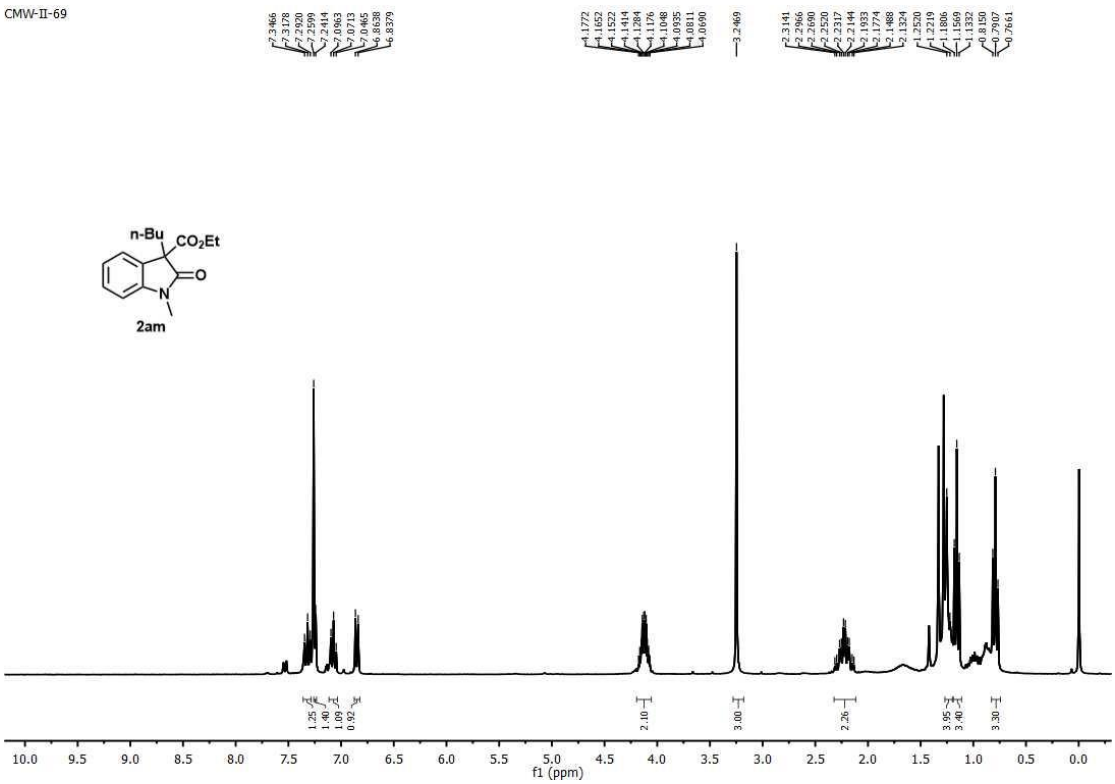
CMW-II-67-B



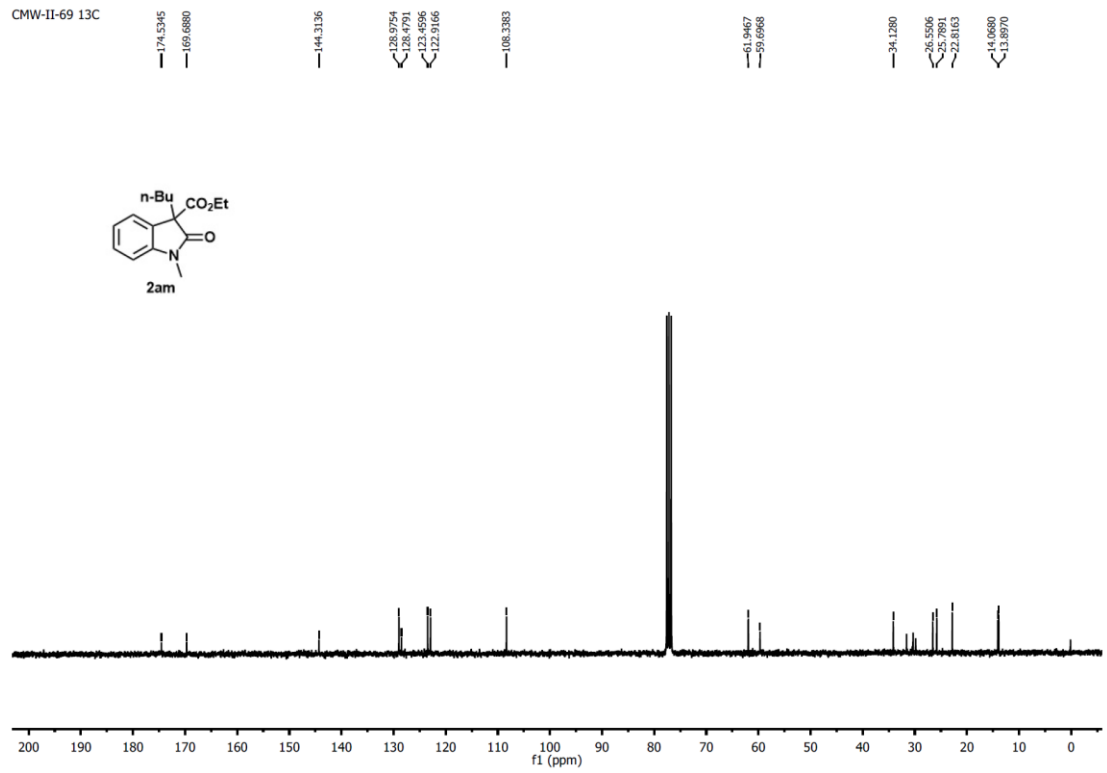
CMW-II-67-B 13C



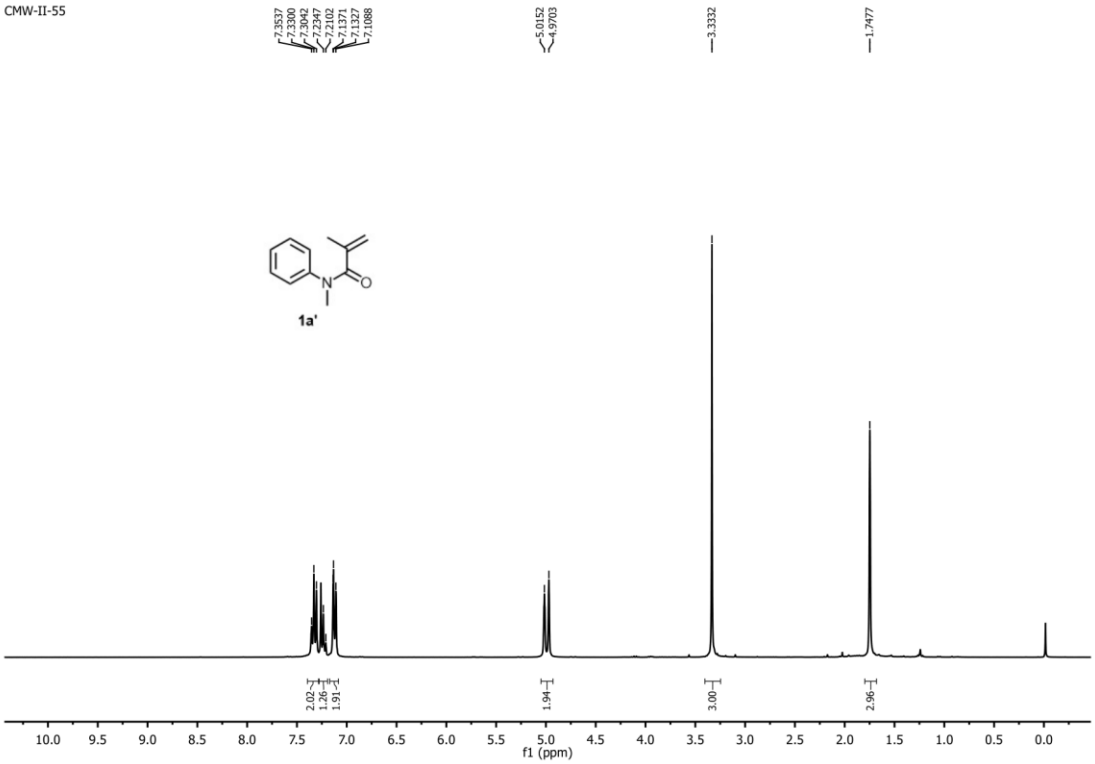
CMW-II-69



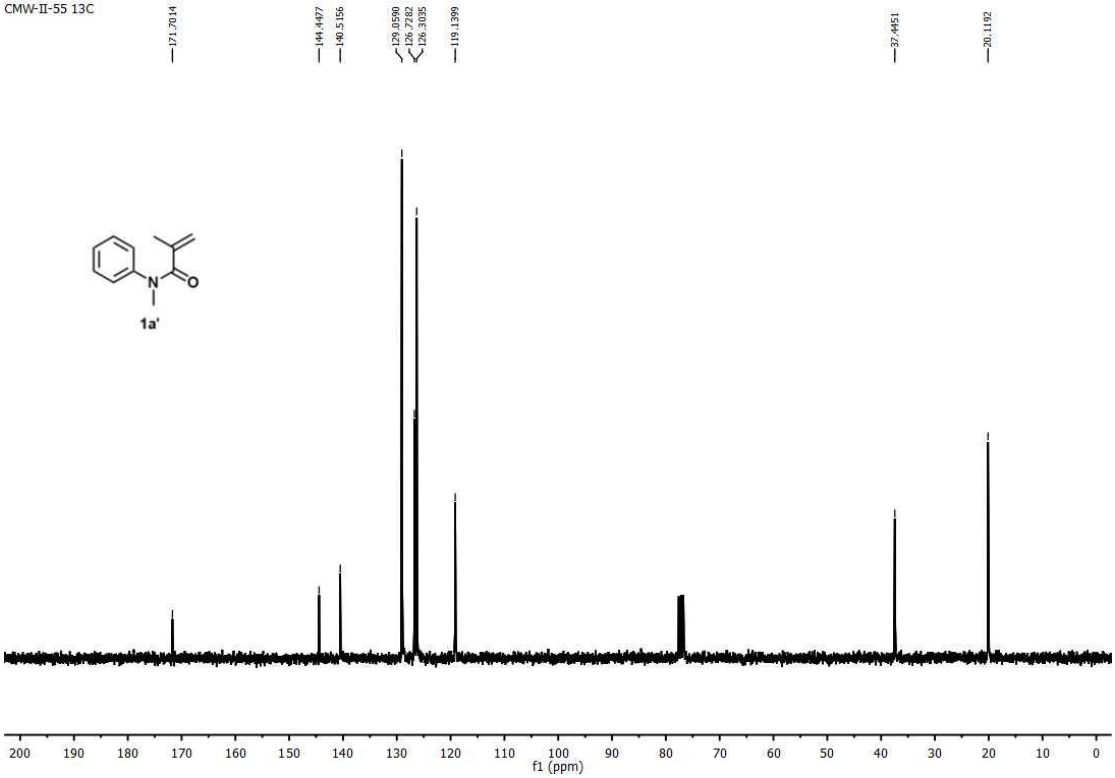
CMW-II-69 13C



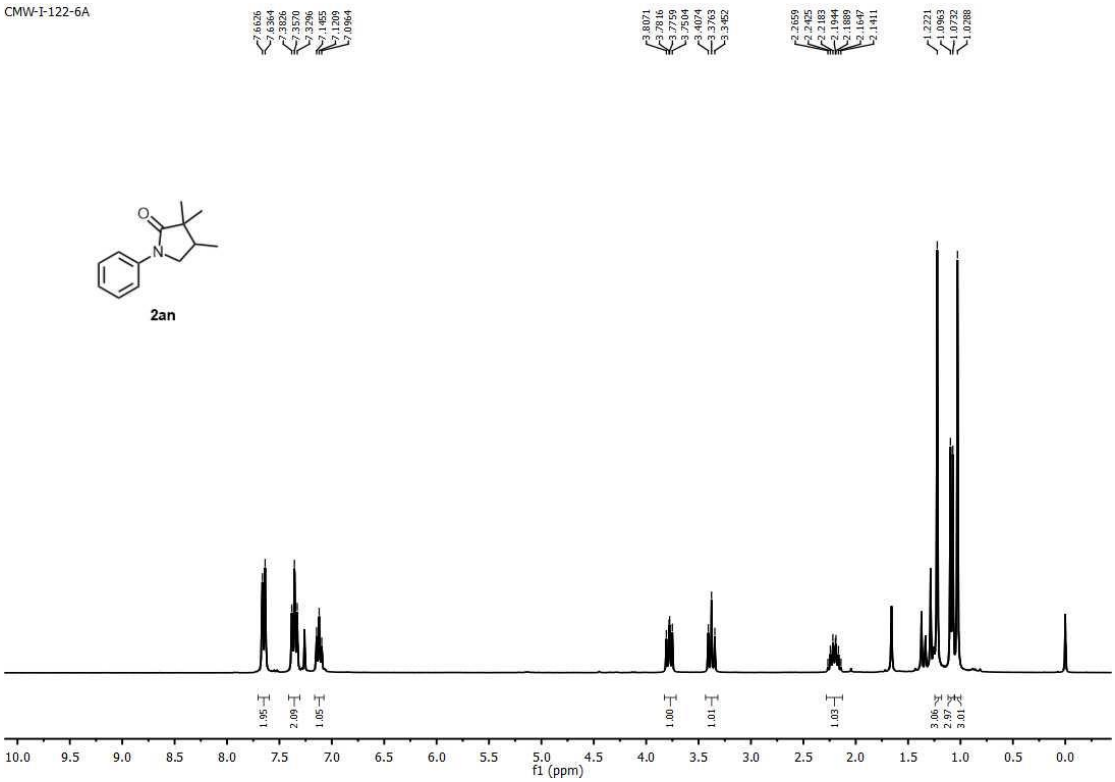
CMW-II-55



CMW-II-55 13C

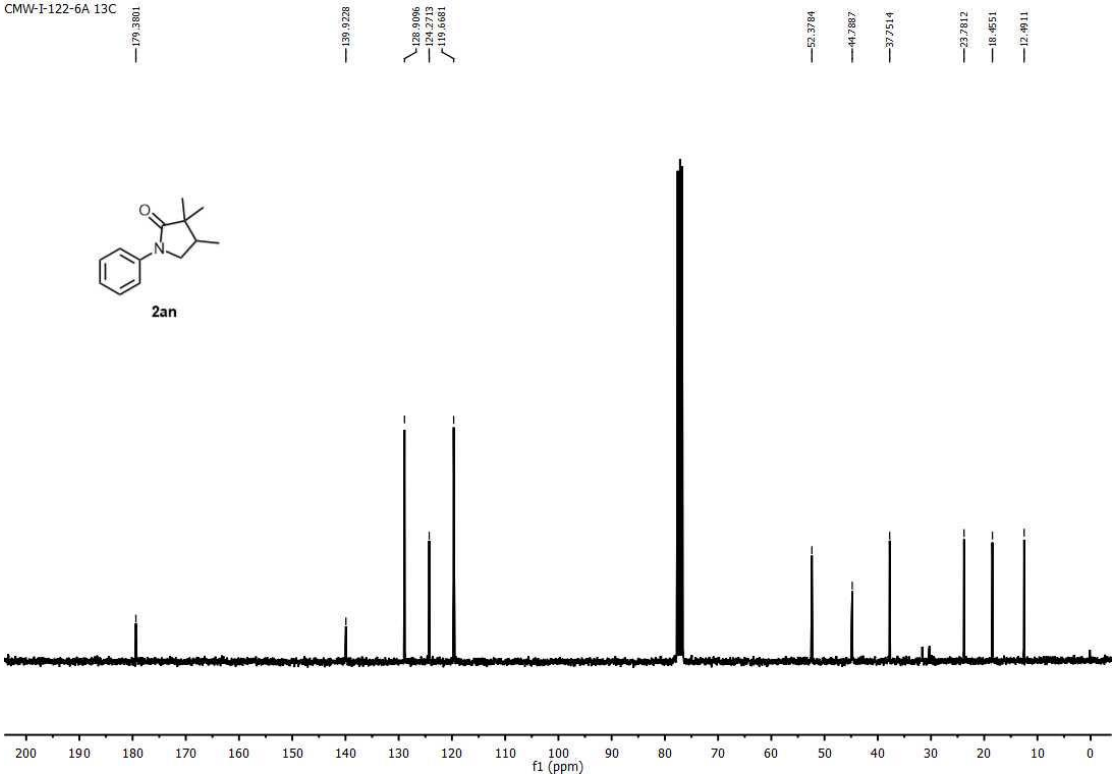


CMW-I-122-6A



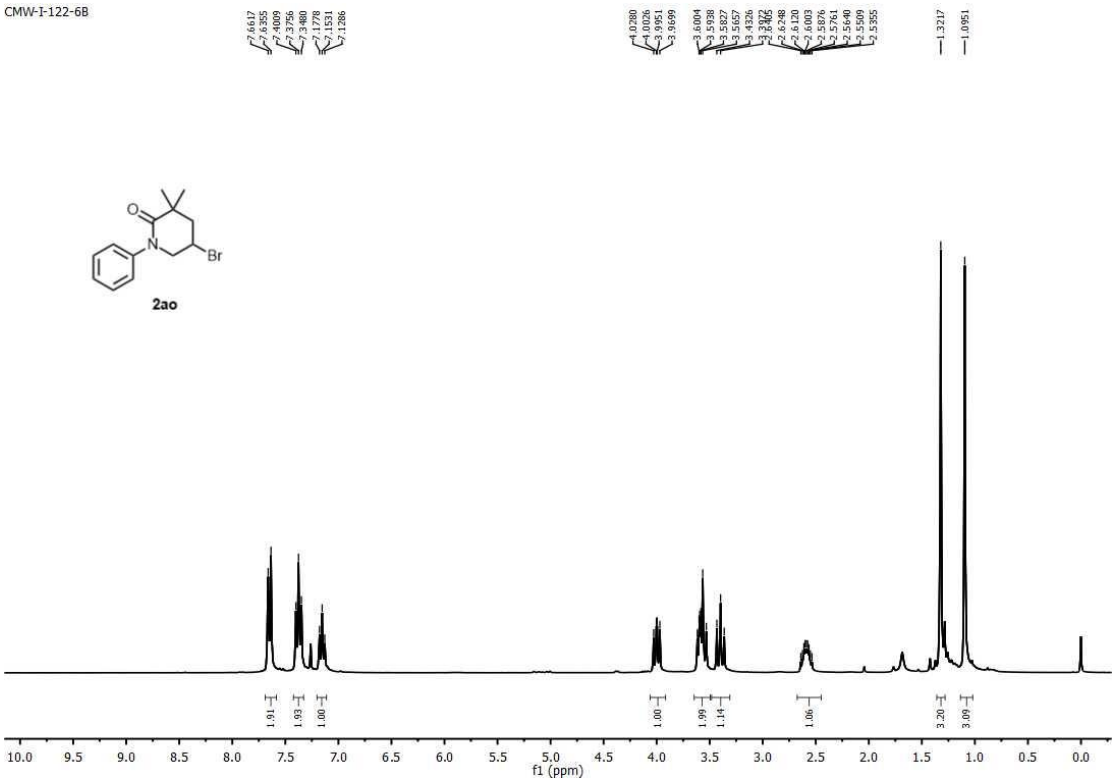
2an

CMW-I-122-6A 13C

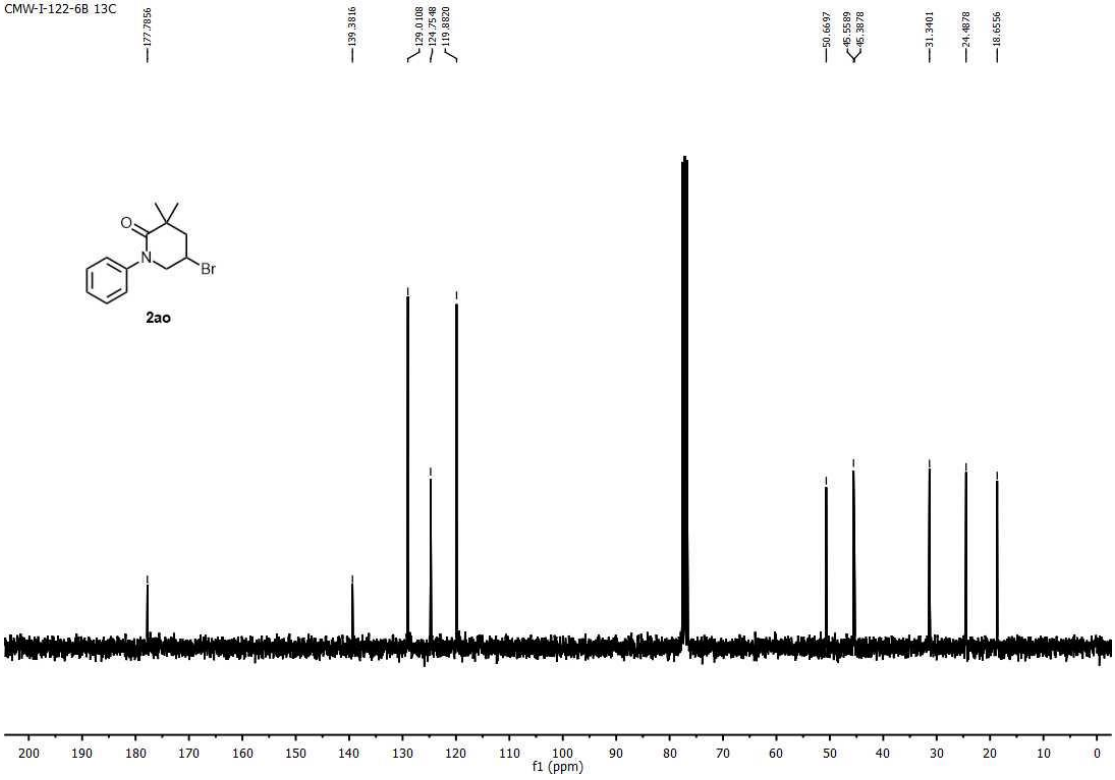


2an

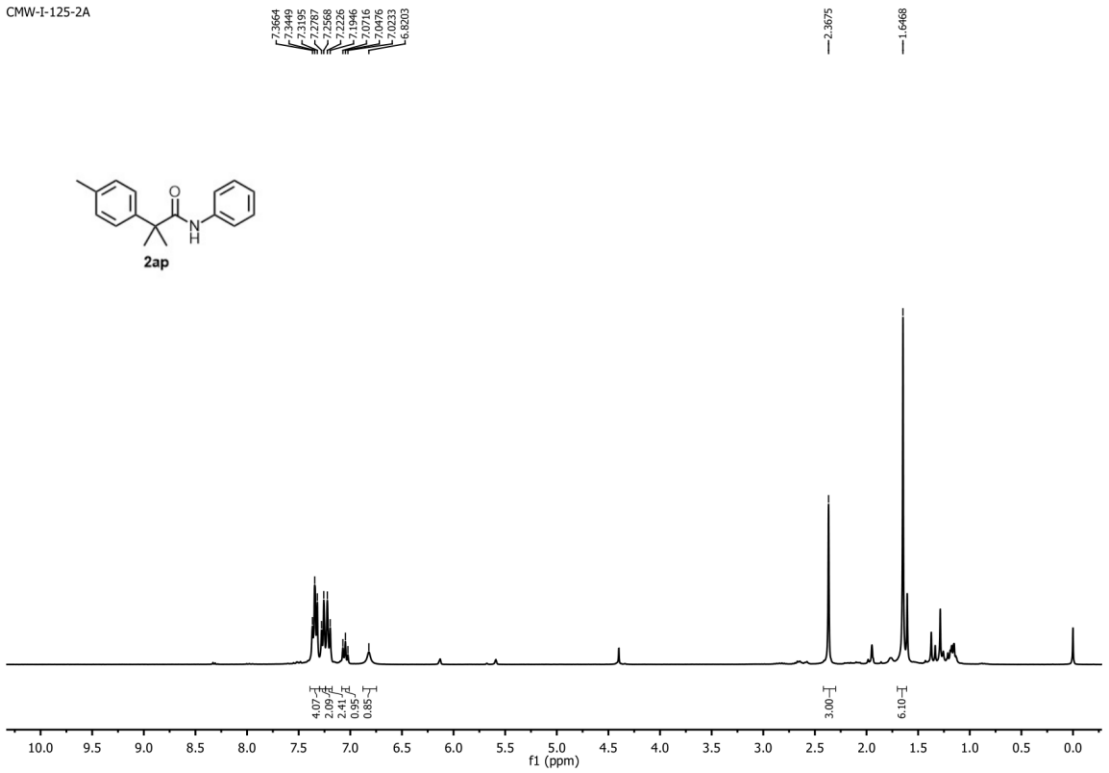
CMW-I-122-6B



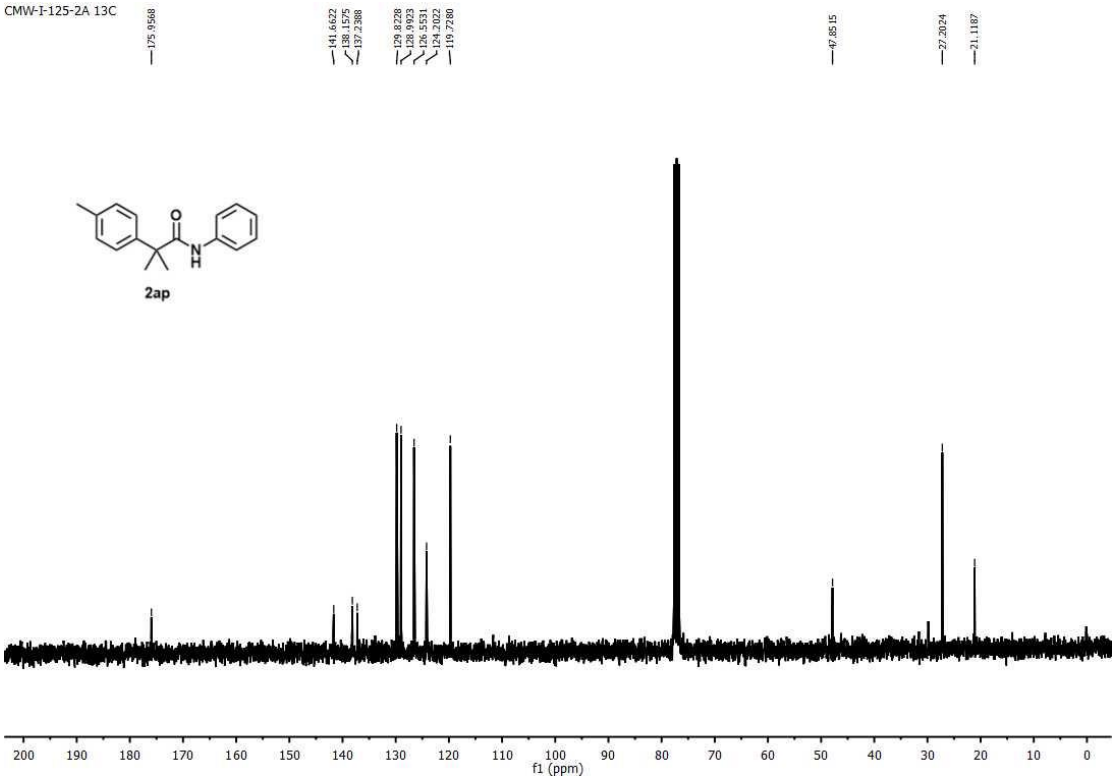
CMW-I-122-6B 13C



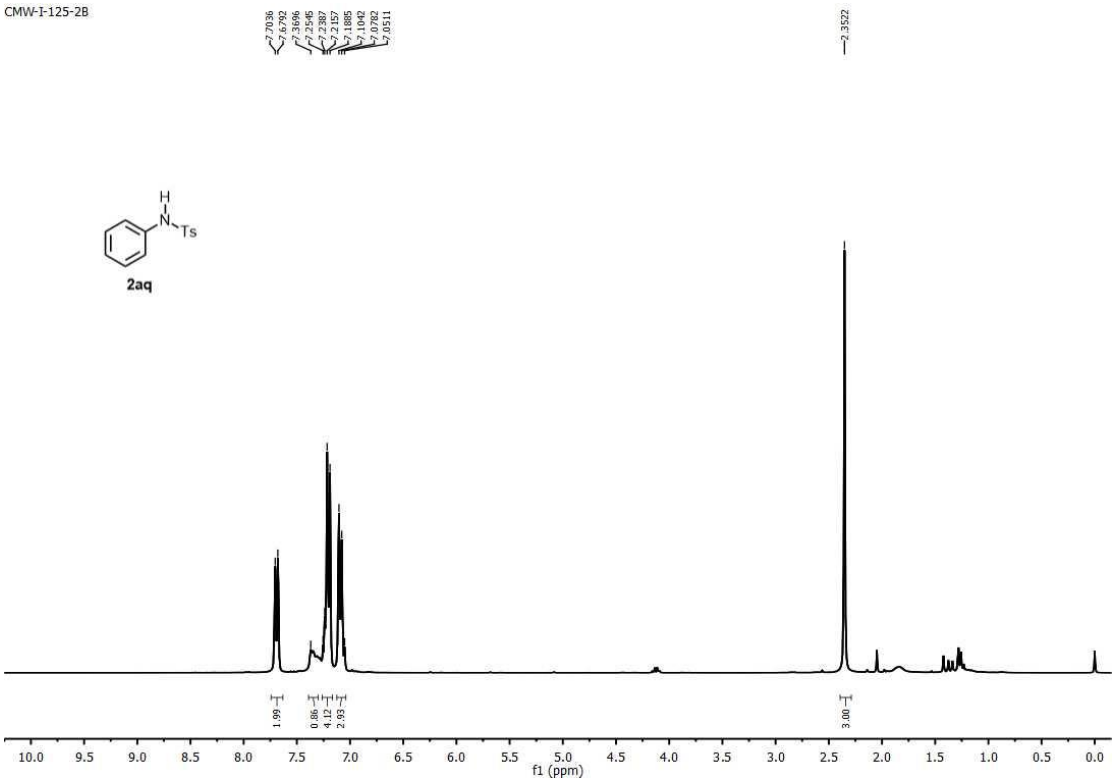
CMW-I-125-2A



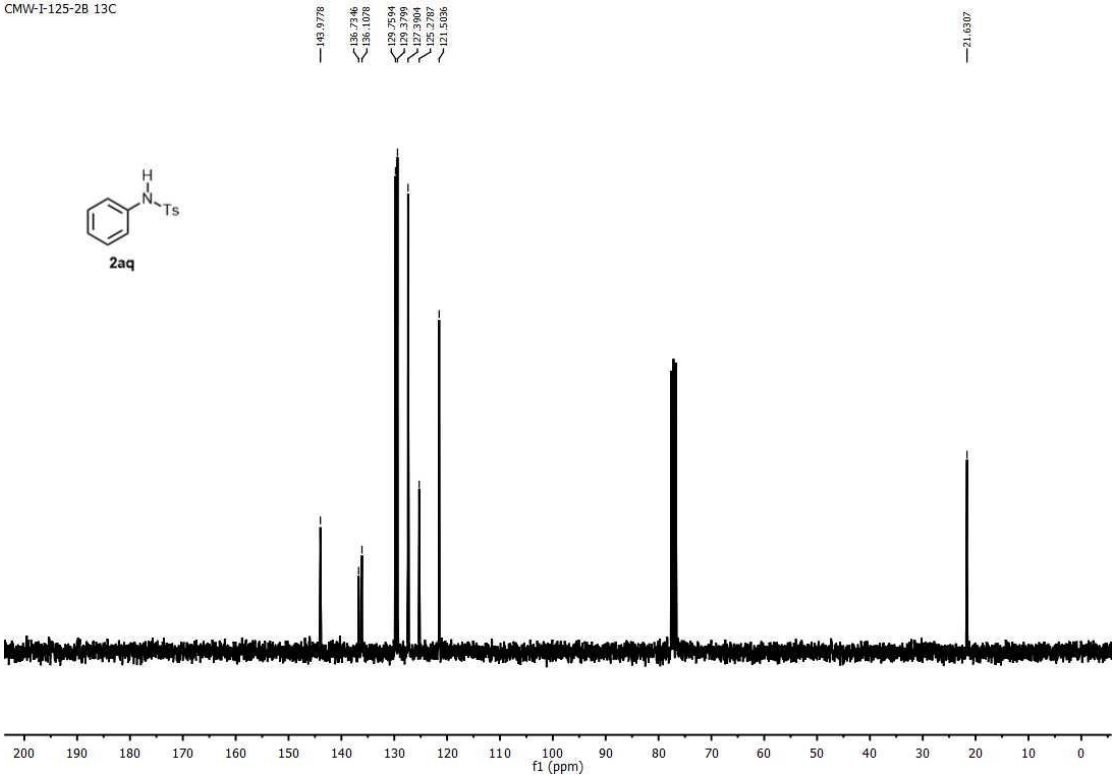
CMW-I-125-2A 13C

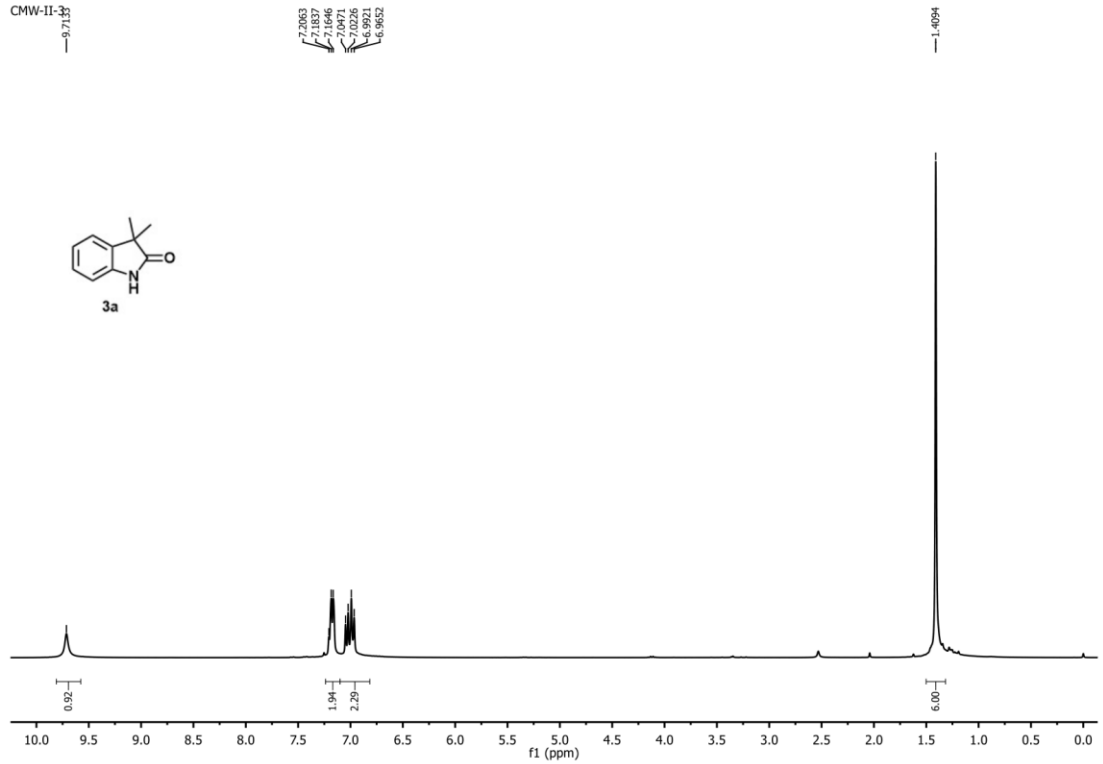


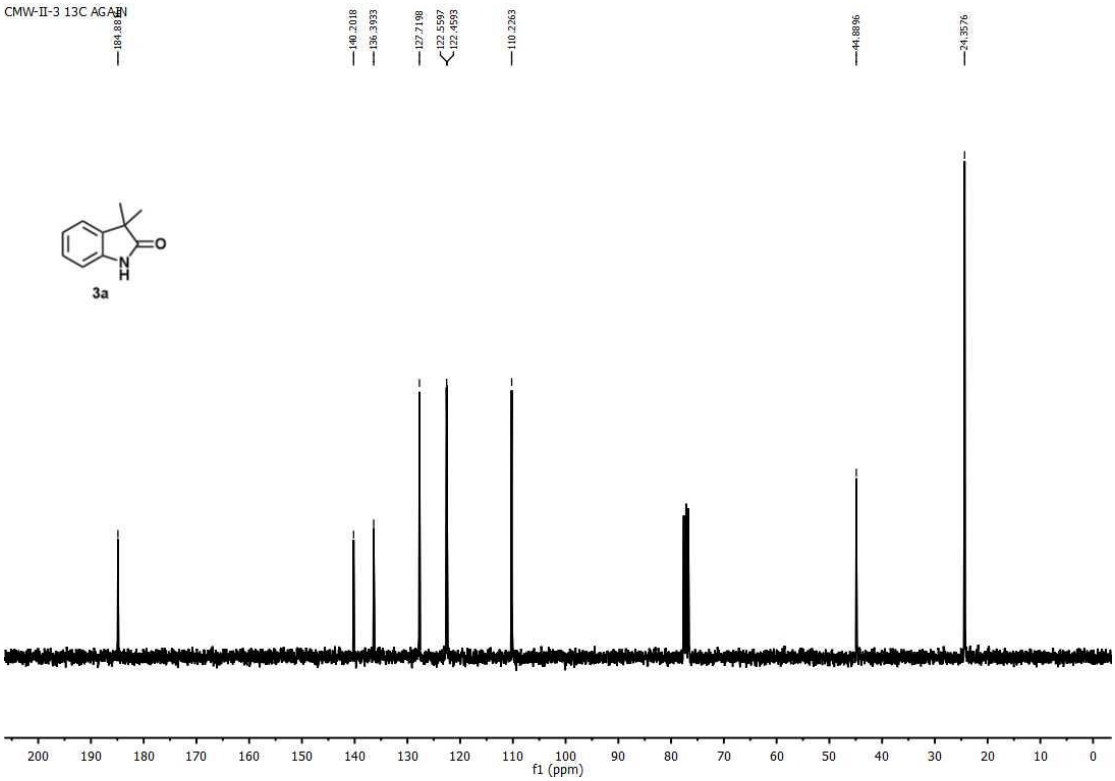
CMW-I-125-2B



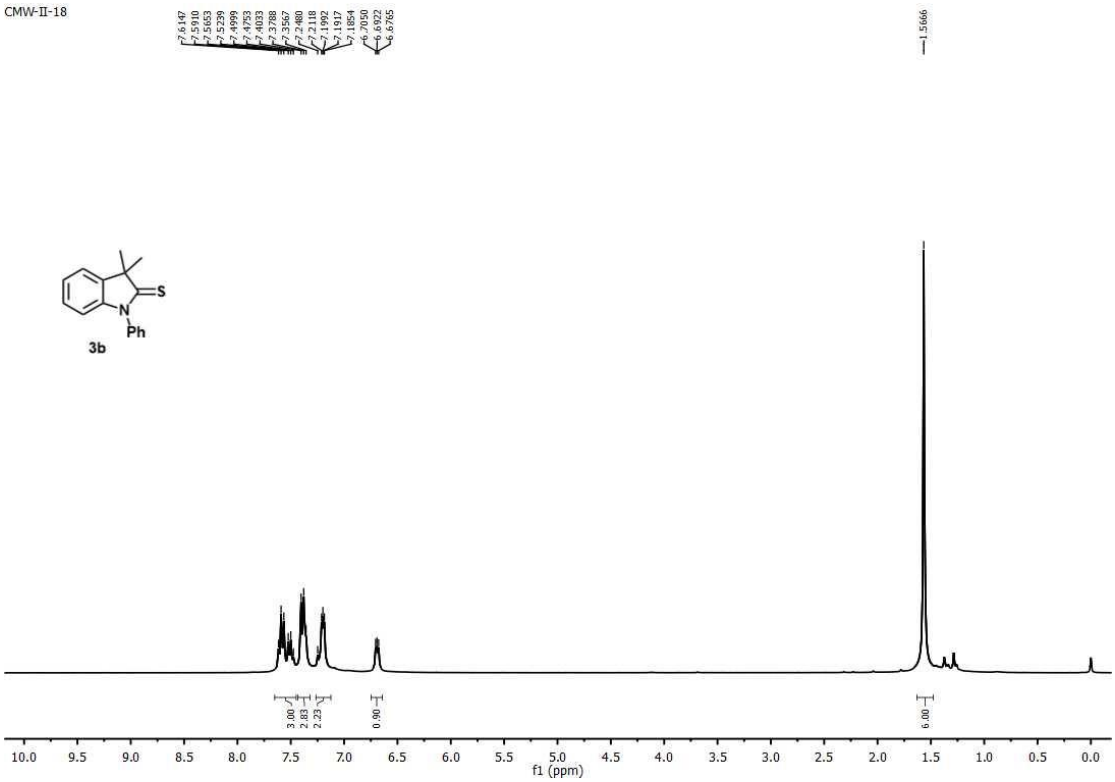
CMW-I-125-2B 13C



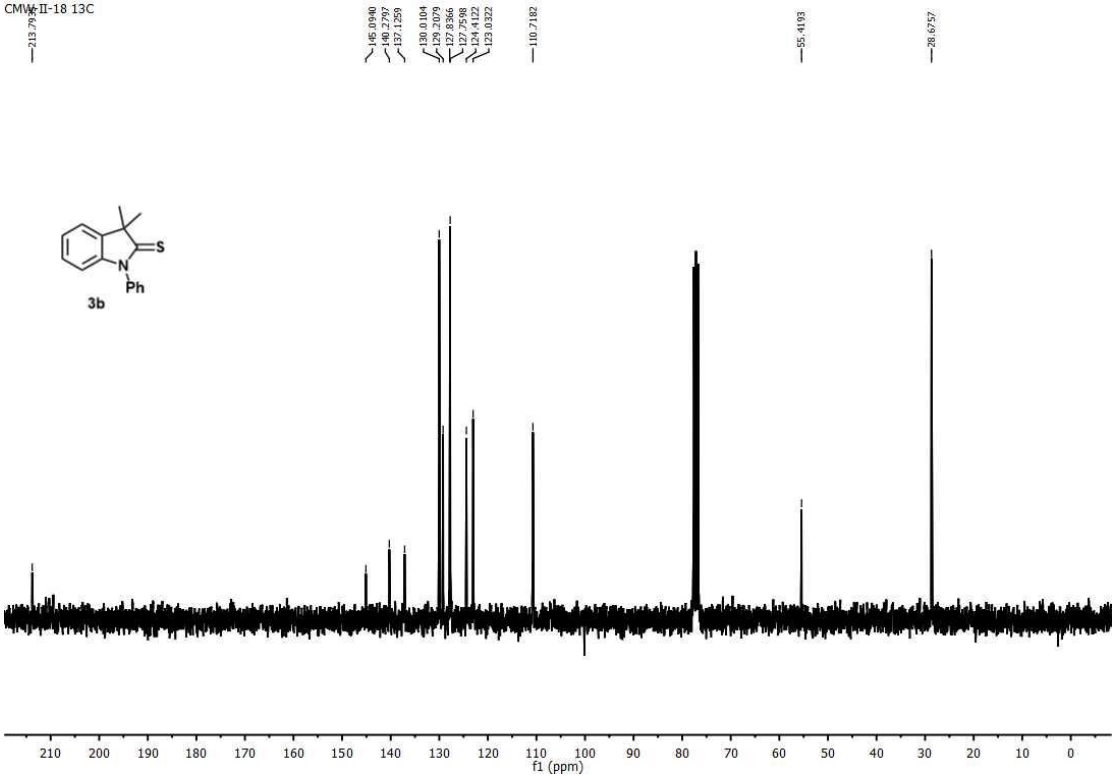

CMW-II-3
9.7133
7.2063
7.1837
7.1646
7.0471
7.0226
6.9921
6.9652
1.4094
3a
0.92
1.94
2.29
6.00
f1 (ppm)

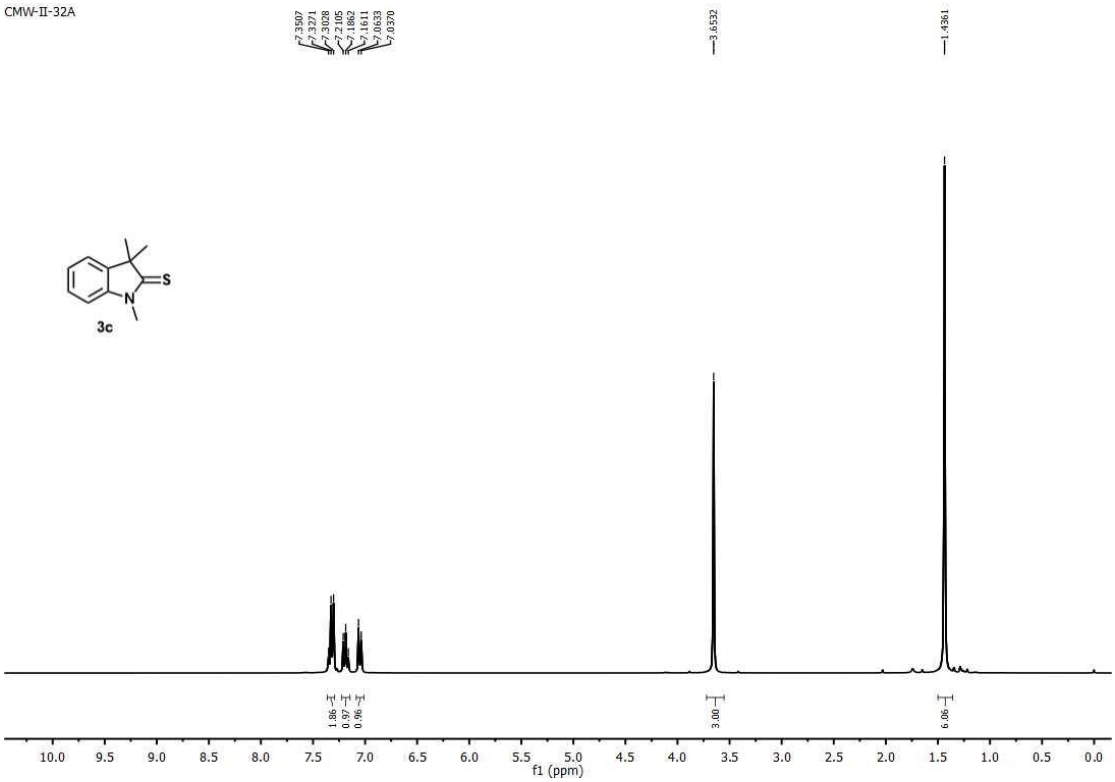

CMW-II-3 13C AGAIN
184.8818
140.2018
136.3933
127.7198
122.5597
122.4593
110.2363
44.8896
24.3576
3a
f1 (ppm)

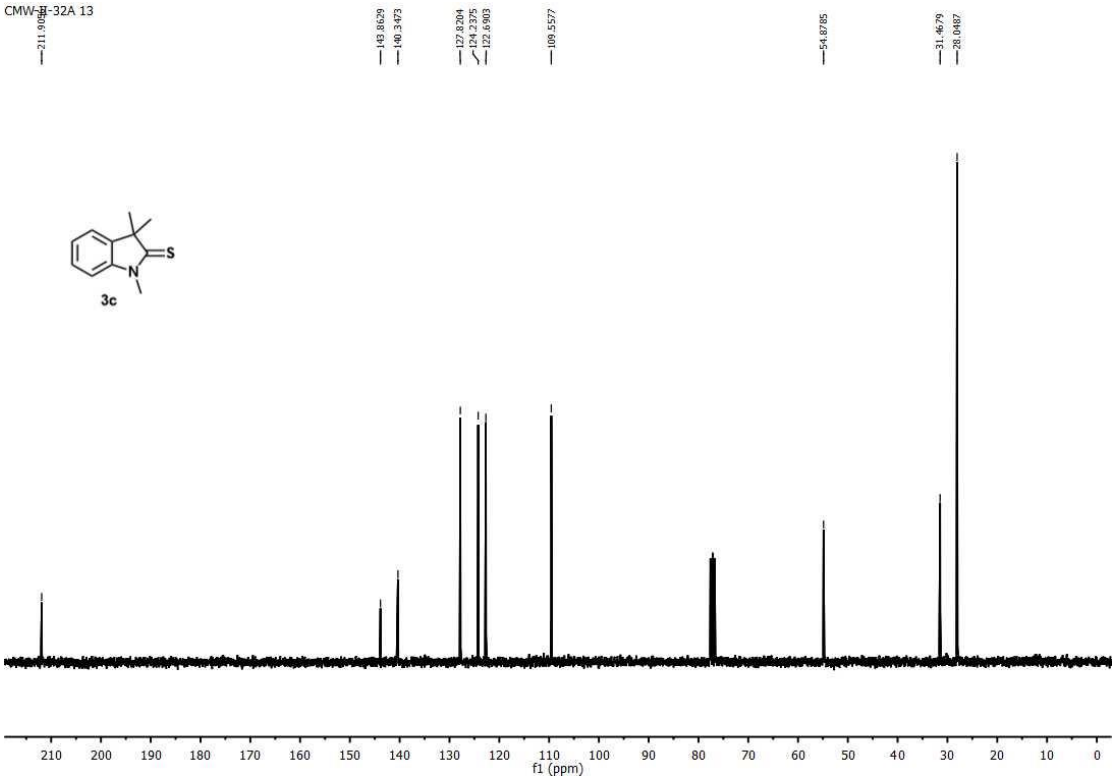
CMW-II-18

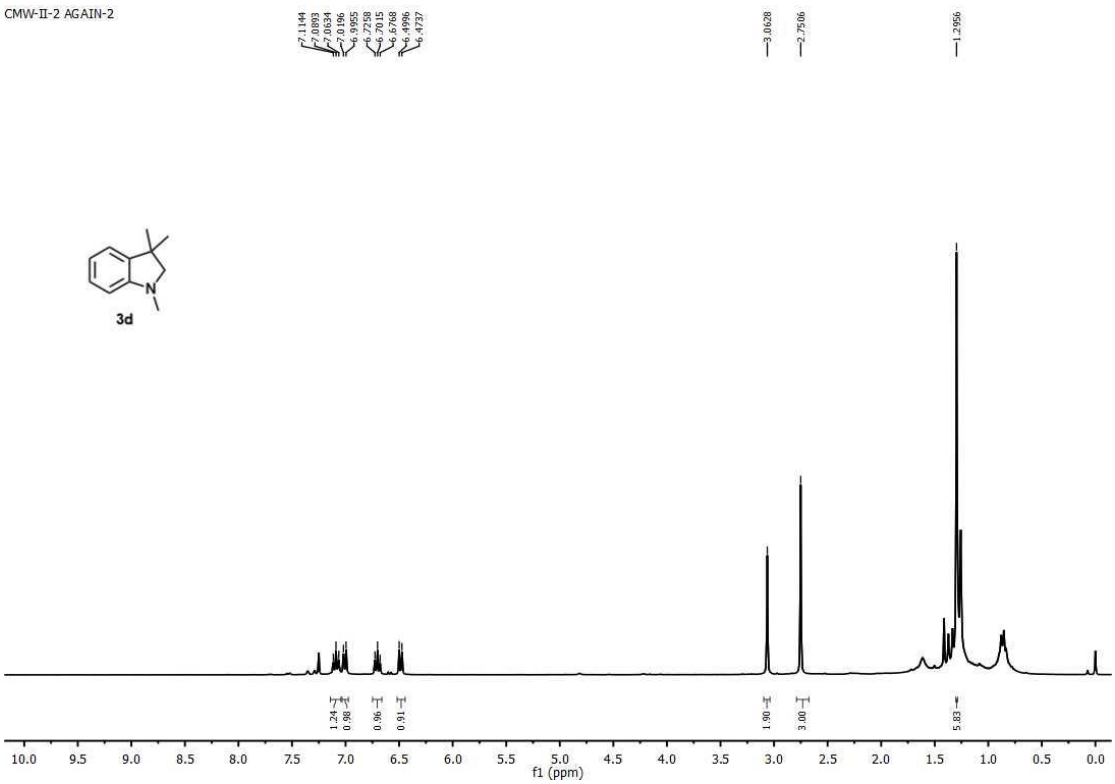


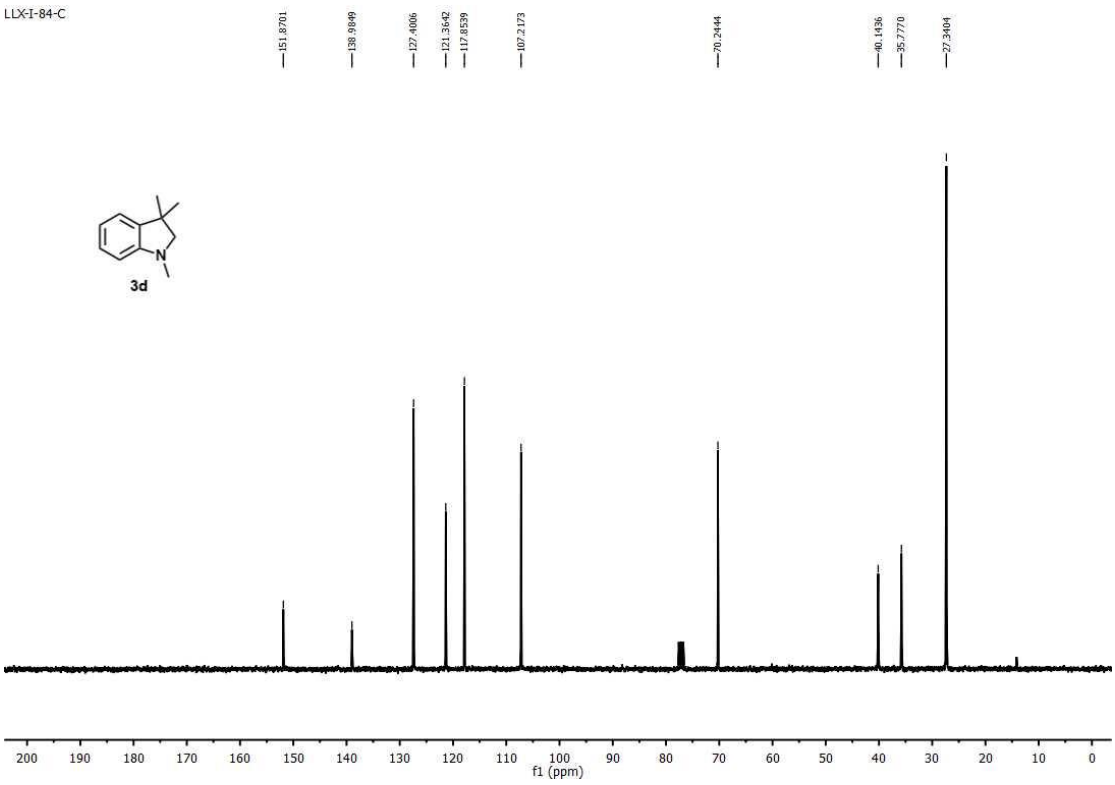
CMW-II-18 13C

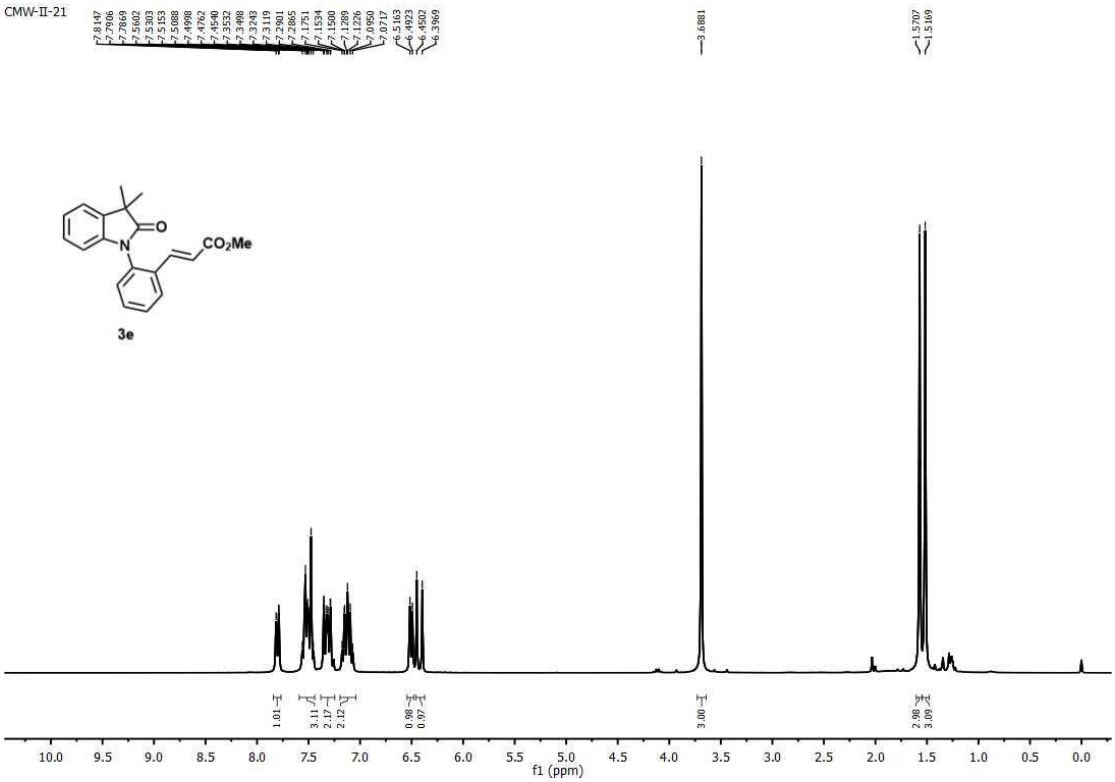


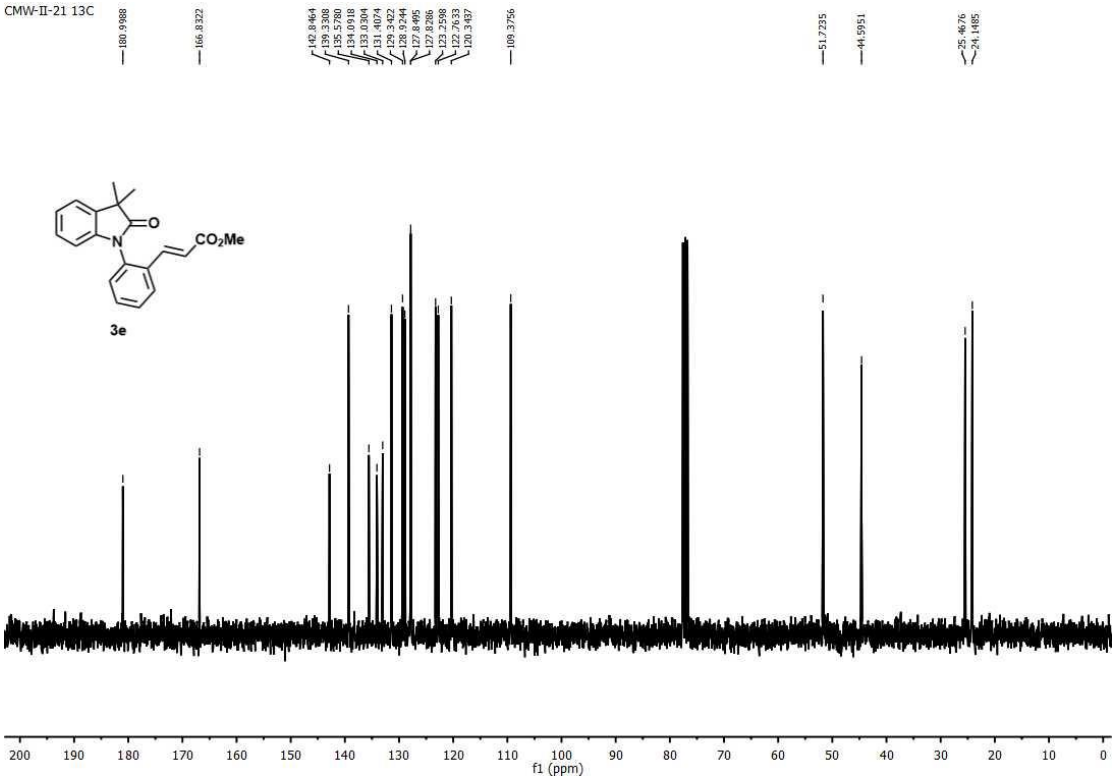

CMW-II-32A
7.3507
7.3271
7.3028
7.2805
7.1862
7.1611
7.0633
7.0370
3.6532
1.4361
3c
1.86
0.97
0.96
3.00
6.06
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


CMW-II-32A 13
211.9048
143.8629
140.3473
127.8204
124.2375
122.6903
109.5577
54.8785
31.4679
28.1487
3c
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

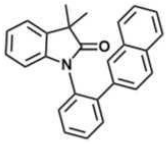

CMW-II-2 AGAIN-2
7.1144
7.0893
7.0634
7.0196
6.9955
6.7258
6.7015
6.6768
6.4996
6.4737
3.0628
2.7506
1.2956
3d
1.24
0.98
0.96
0.91
1.90
3.00
5.83
f1 (ppm)


LLX-I-84-C
151.8701
138.9849
127.4006
121.3642
117.8539
107.2173
70.2444
40.1436
35.7770
27.3404
3d
f1 (ppm)


CMW-II-21
7.8147
7.7906
7.7869
7.5602
7.5303
7.5153
7.5088
7.4998
7.4762
7.4540
7.3552
7.3490
7.3249
7.3119
7.2901
7.2865
7.1751
7.1534
7.1500
7.1289
7.1226
7.0950
7.0717
6.5163
6.4923
6.4902
6.3969
3.6881
1.5707
1.5169
CO2Me
3e
1.01
3.11
2.17
2.12
0.98
0.97
3.00
2.98
3.09
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

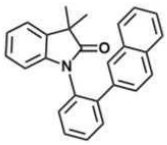

CMW-II-21 13C
180.9988
166.8322
142.8464
139.3308
135.5780
134.0918
133.0304
131.4074
129.3422
128.9244
127.8495
127.8286
123.2598
122.7633
120.3437
109.3756
51.7235
44.5951
25.4676
24.1485
CO2Me
3e
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

CMW-II-22 1H AGAIN-2

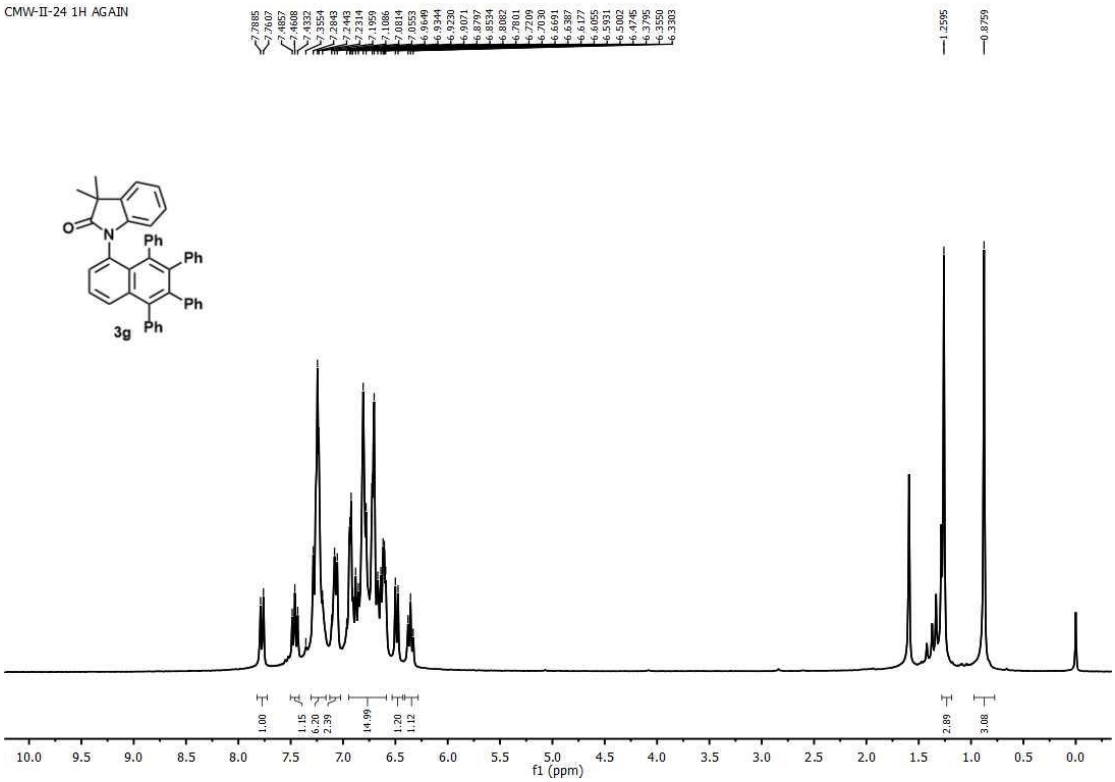


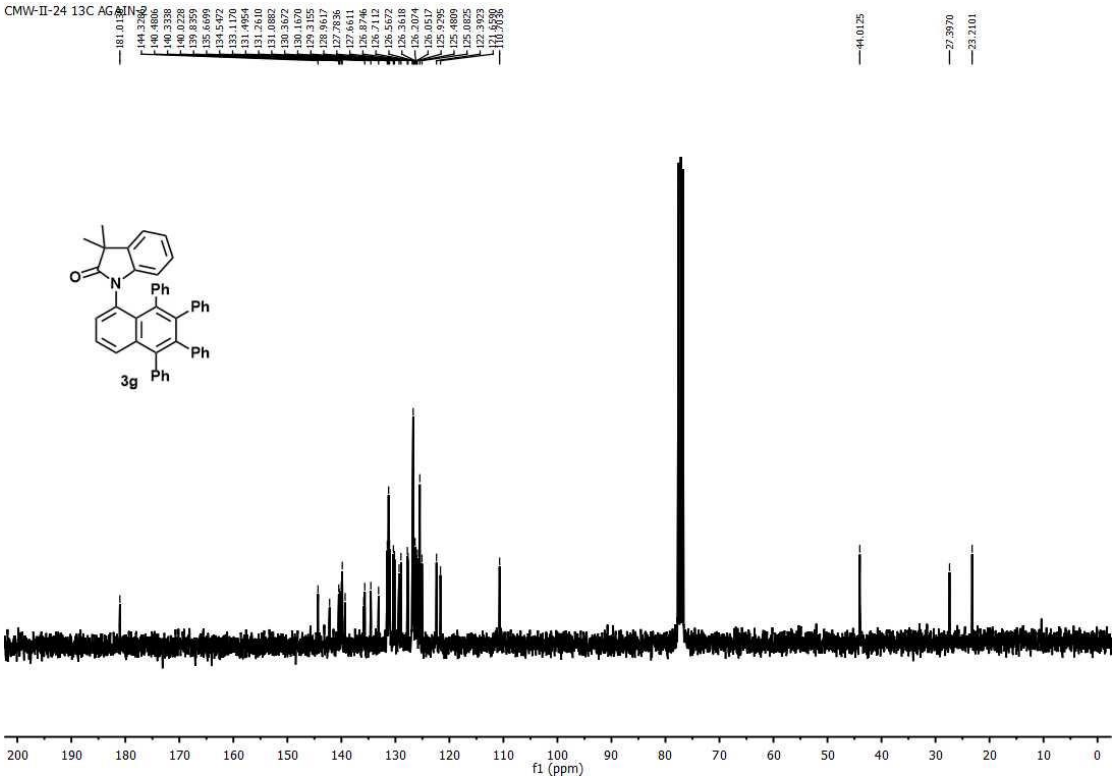
3f

CMW-II-22 13C

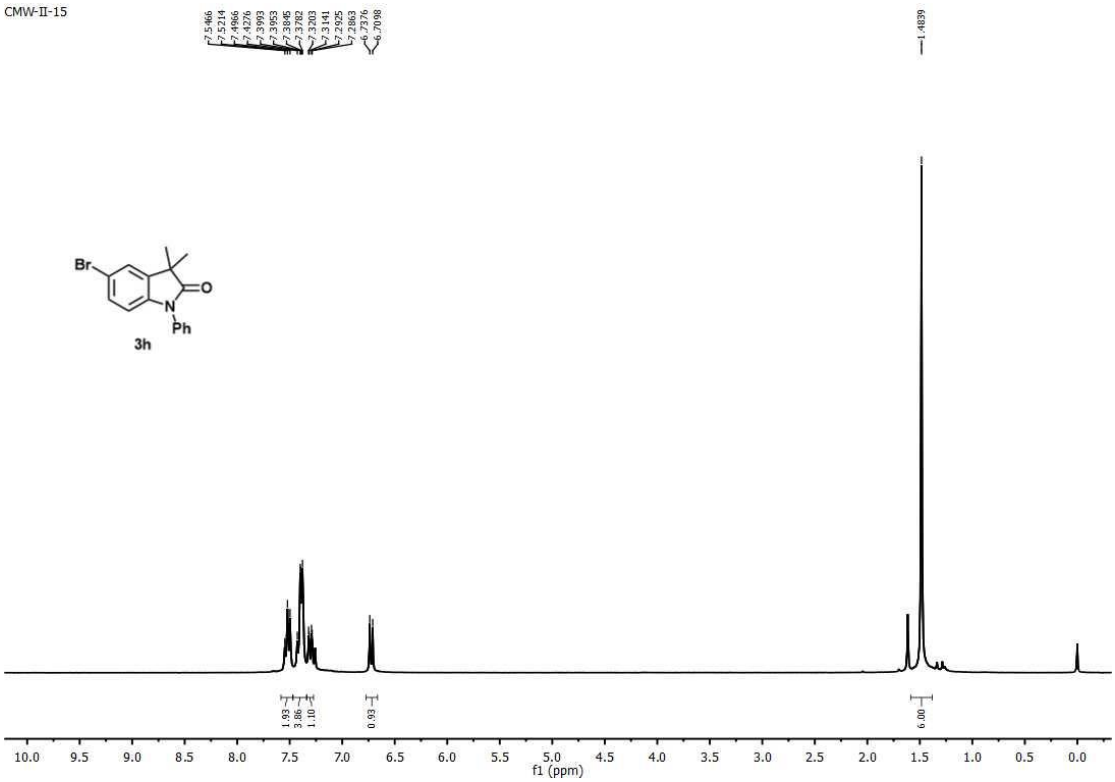


3f

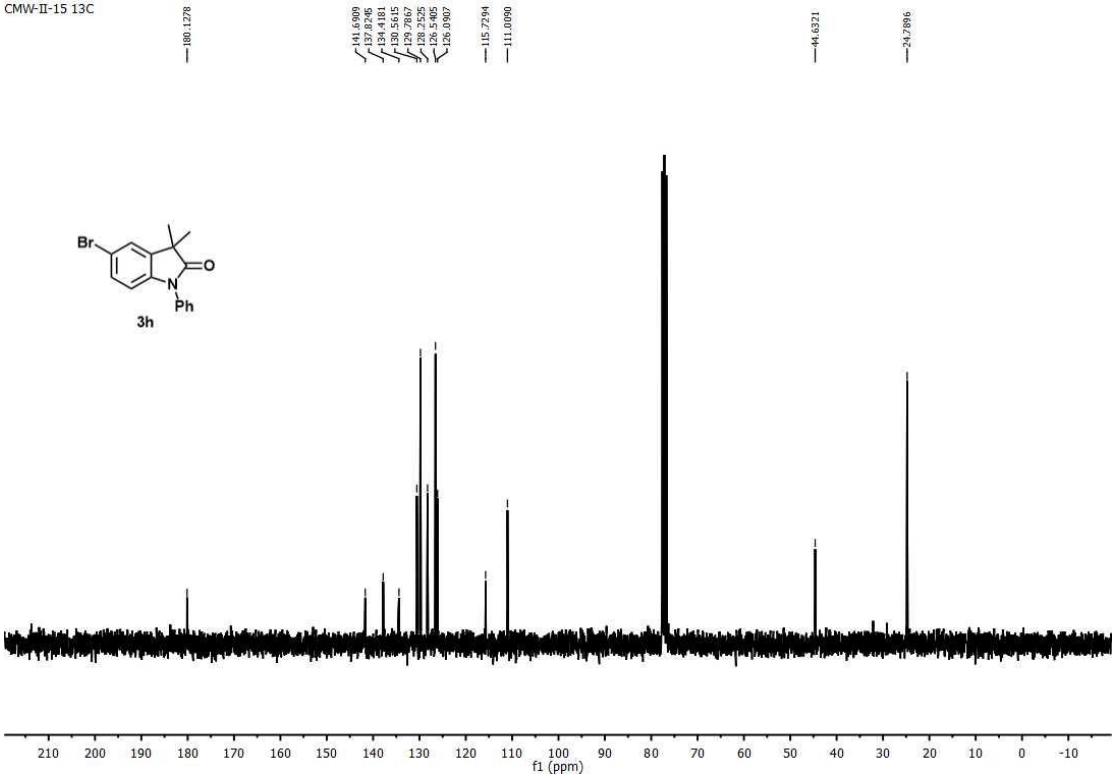

CMW-II-24 1H AGAIN
3g
f1 (ppm)


CMW-II-24 13C AGAIN
3g
f1 (ppm)

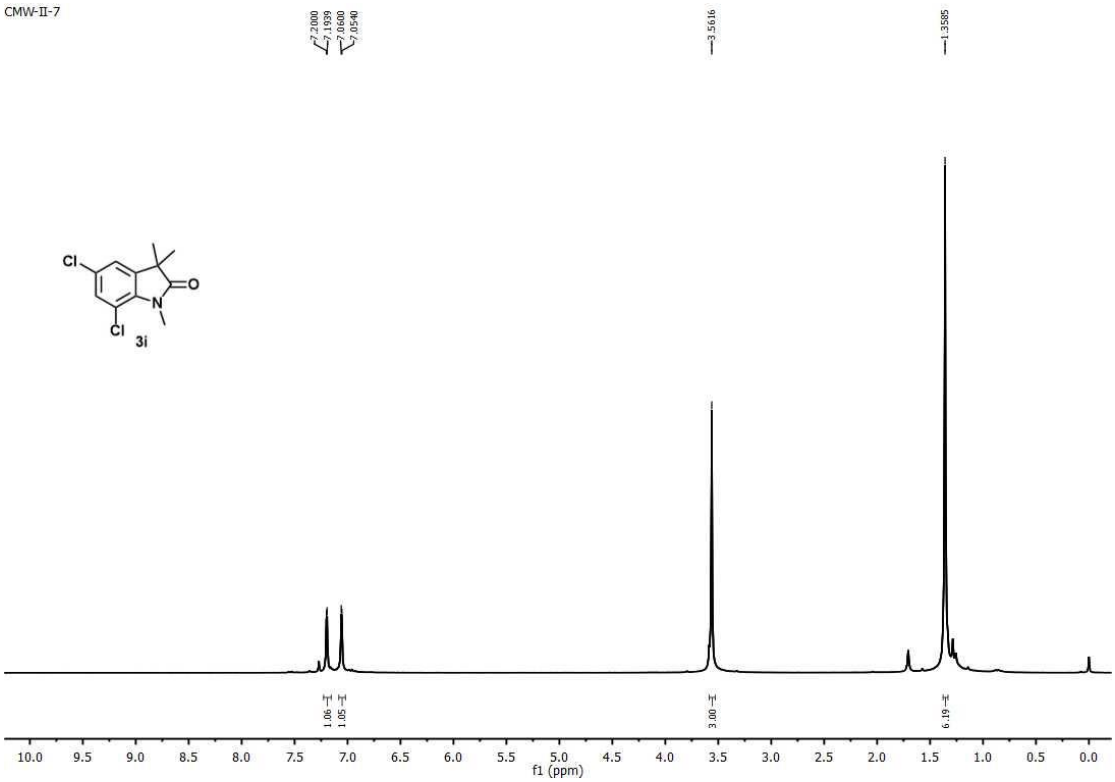
CMW-II-15



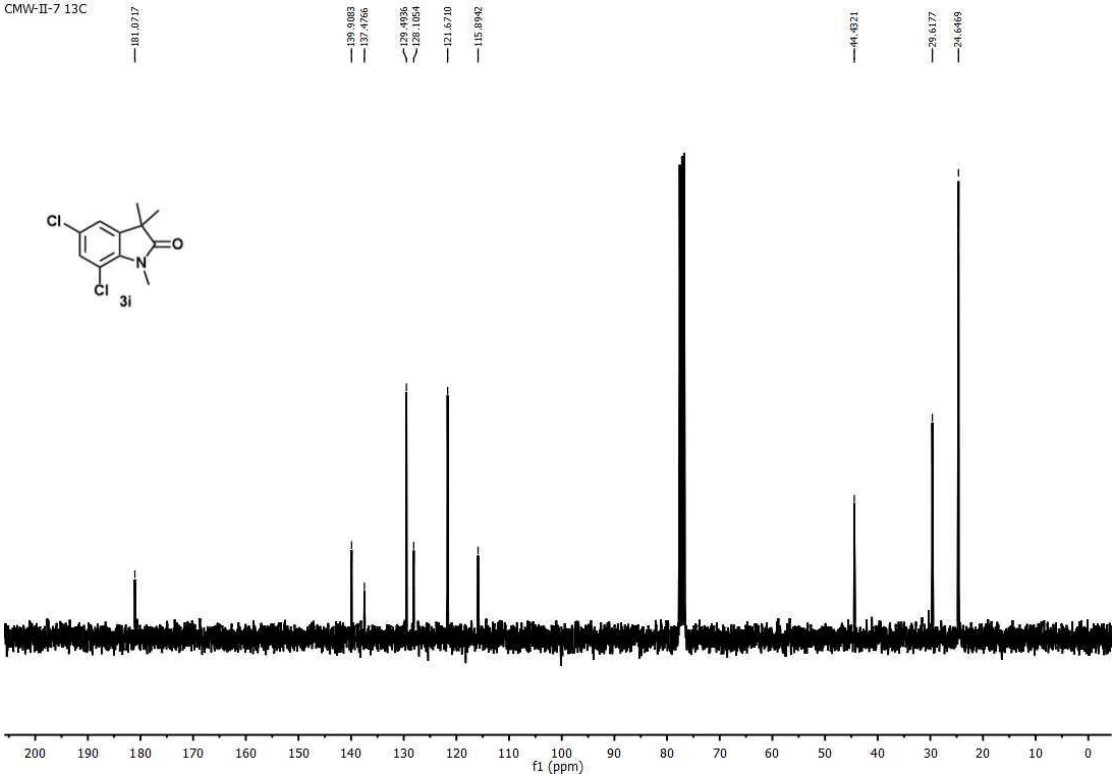
CMW-II-15 13C

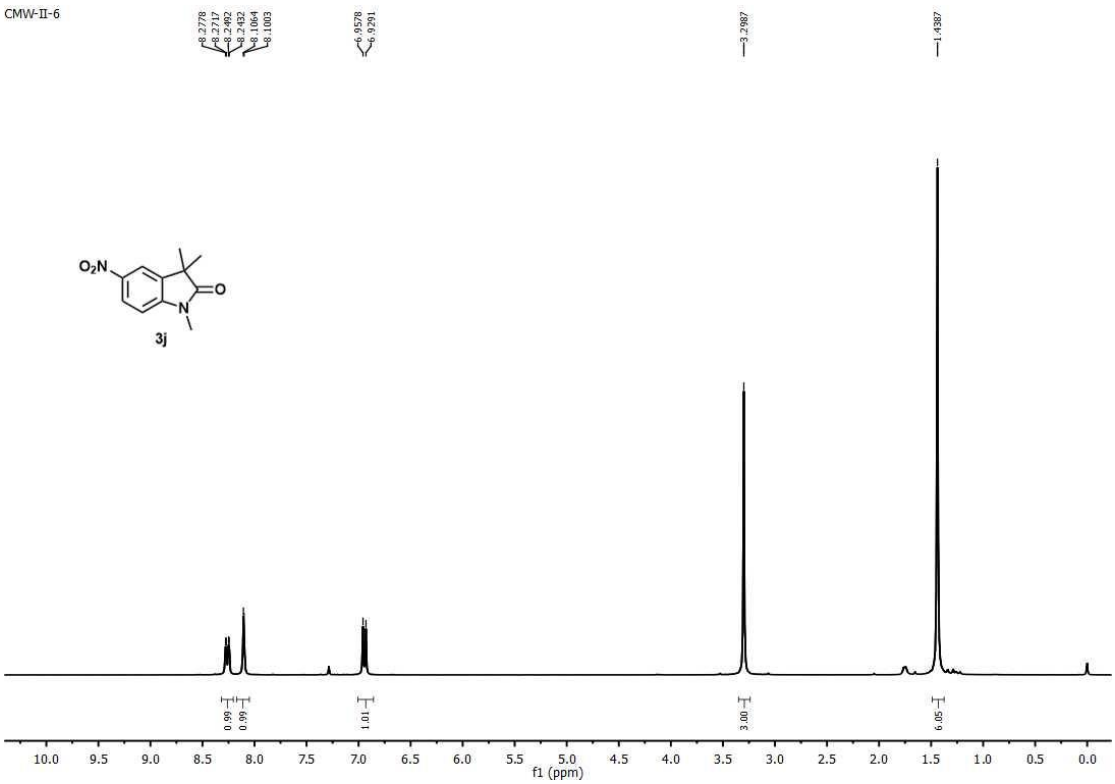


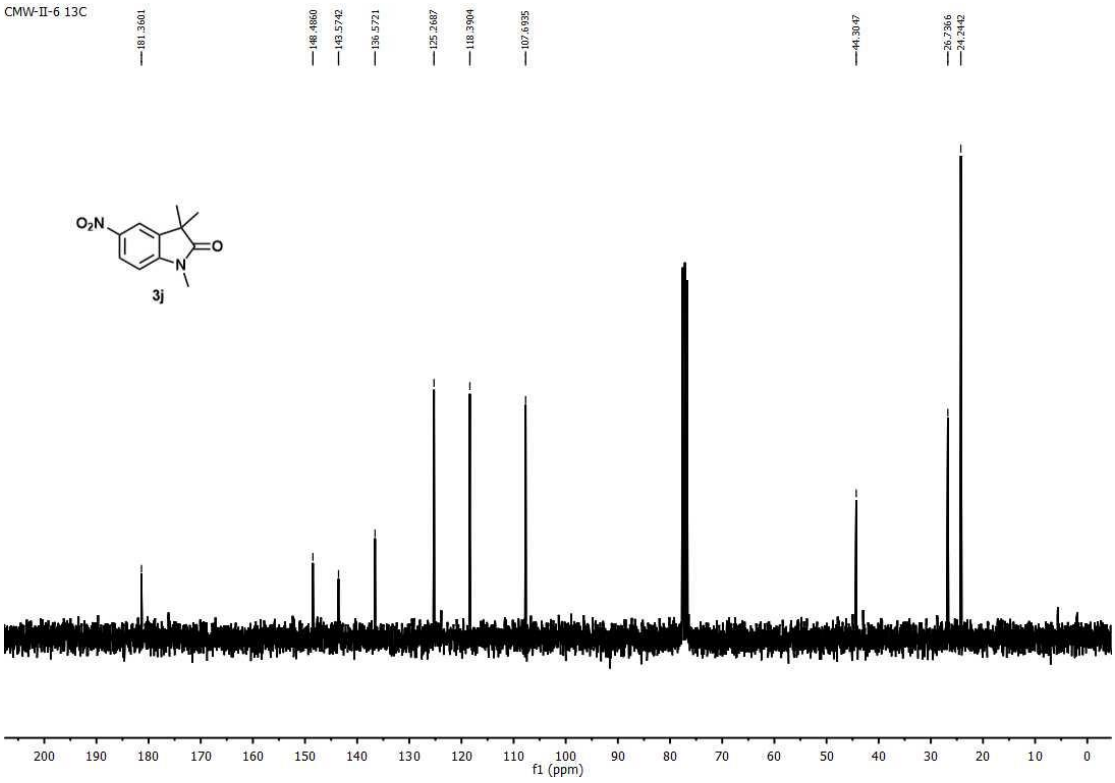
CMW-II-7

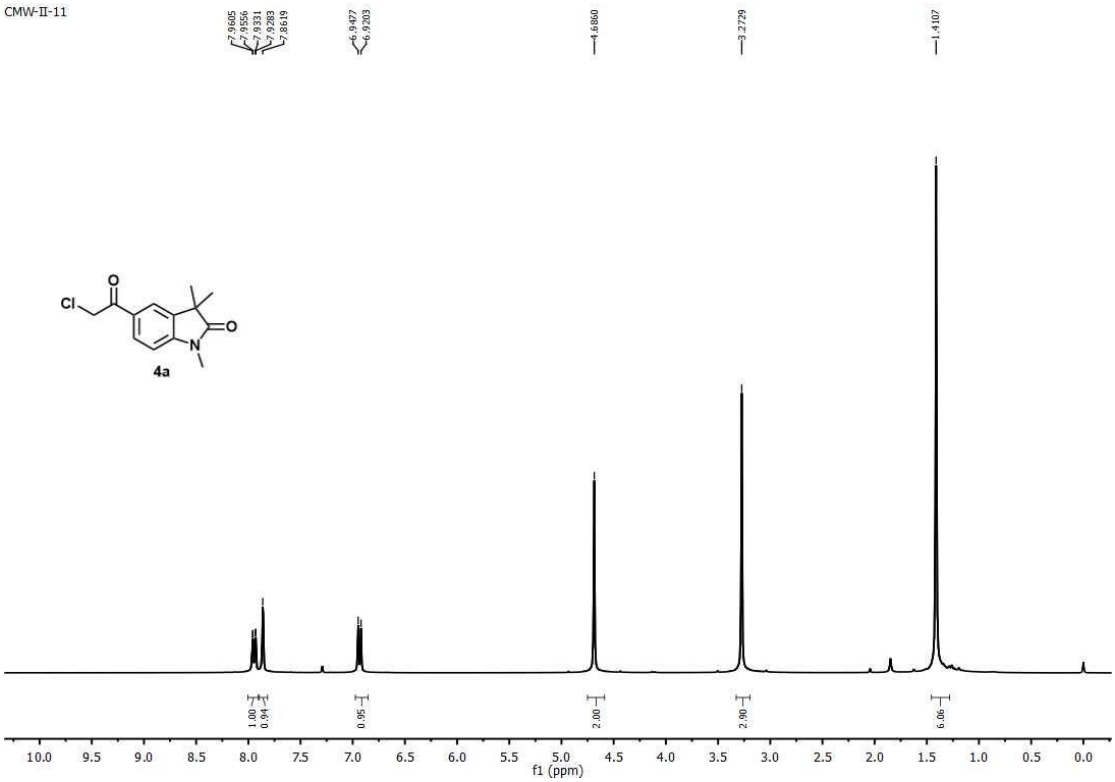


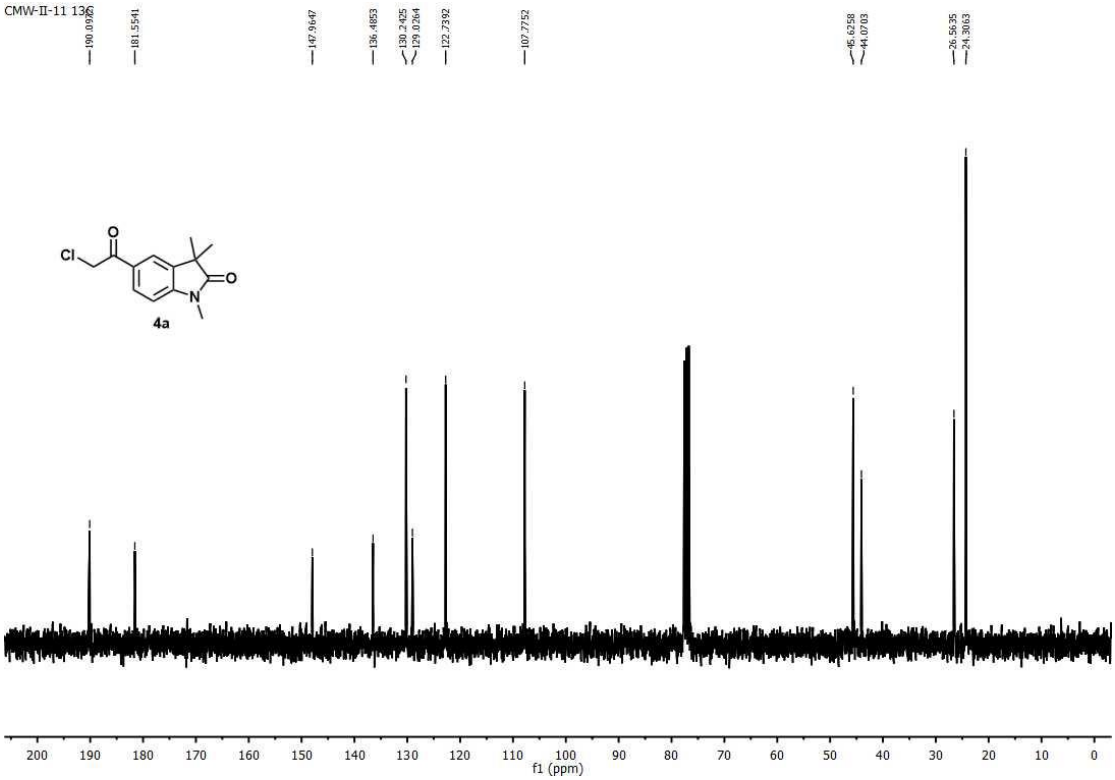
CMW-II-7 13C



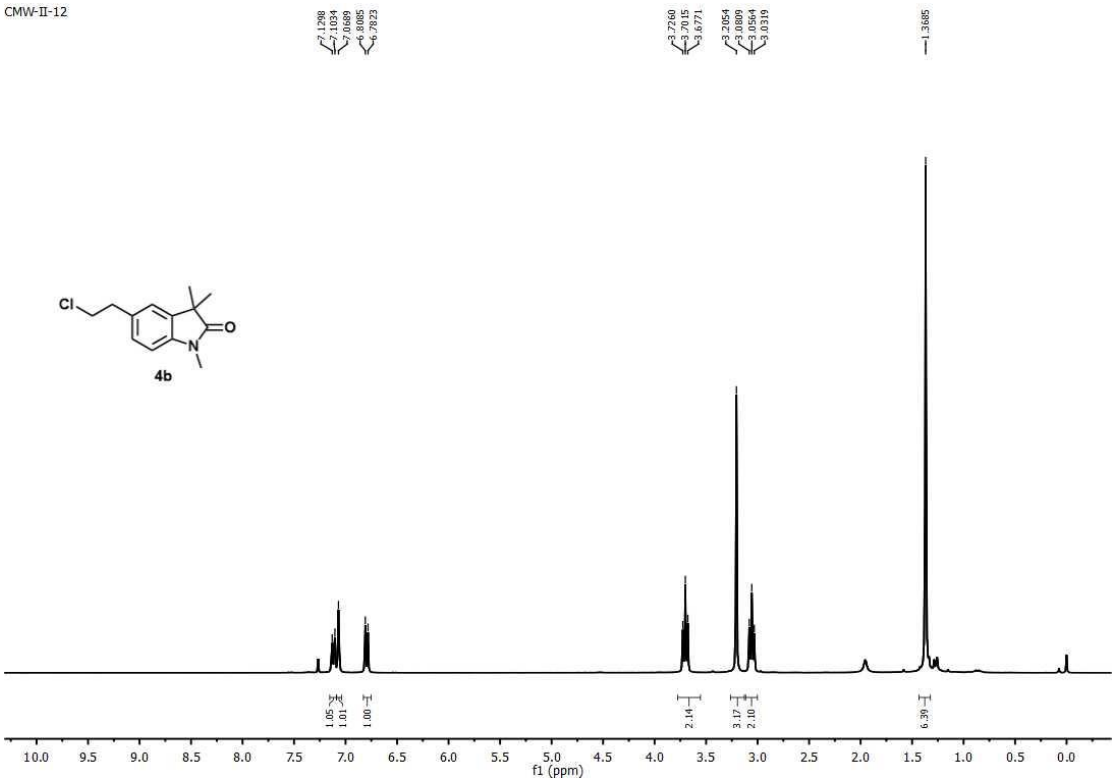

CMW-II-6
8.2778
8.2717
8.2492
8.2432
8.1064
8.1003
6.9578
6.9291
3.2987
1.4387
O2N
O
N
3j
0.99
0.99
1.01
3.00
6.05
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


CMW-II-6 13C
181.3601
148.4860
143.5742
136.5721
125.2687
118.3904
107.6935
44.3047
26.7366
24.2442
O2N
O
N
3j
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

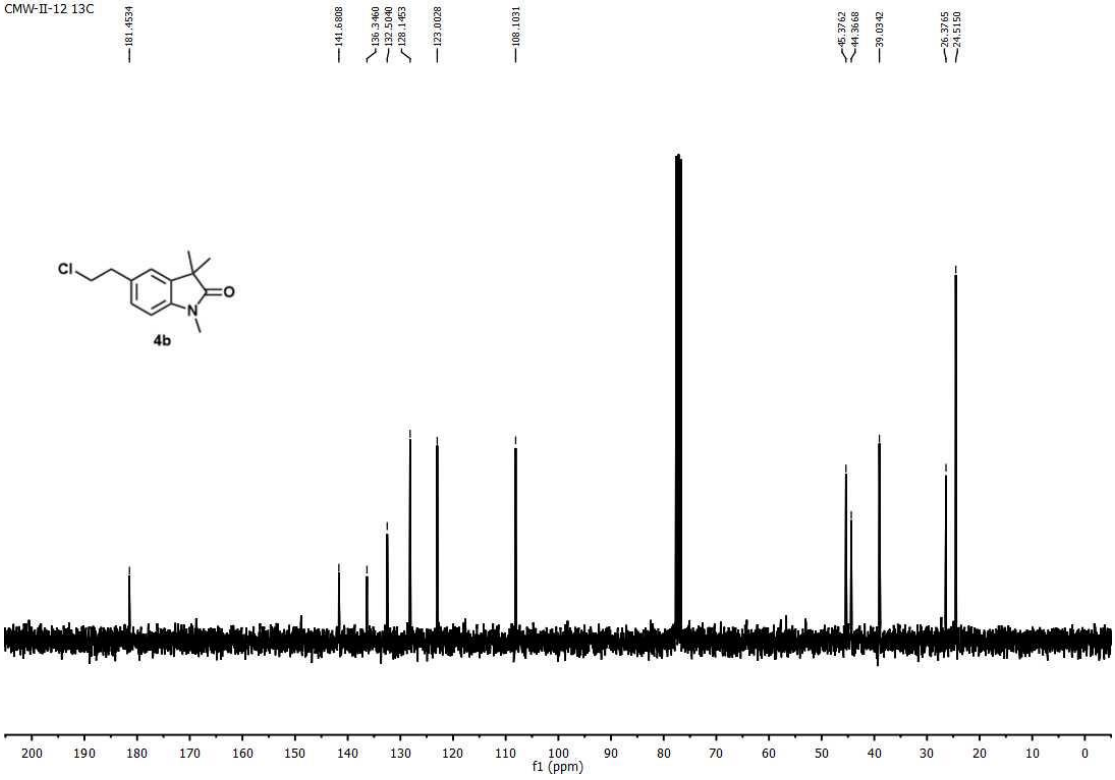

CMW-II-11
7.9605
7.9556
7.9331
7.9283
7.8619
6.9477
6.9203
4.6860
3.2729
1.4107
Cl
O
O
N
4a
1.00
0.94
0.95
2.00
2.90
6.08
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

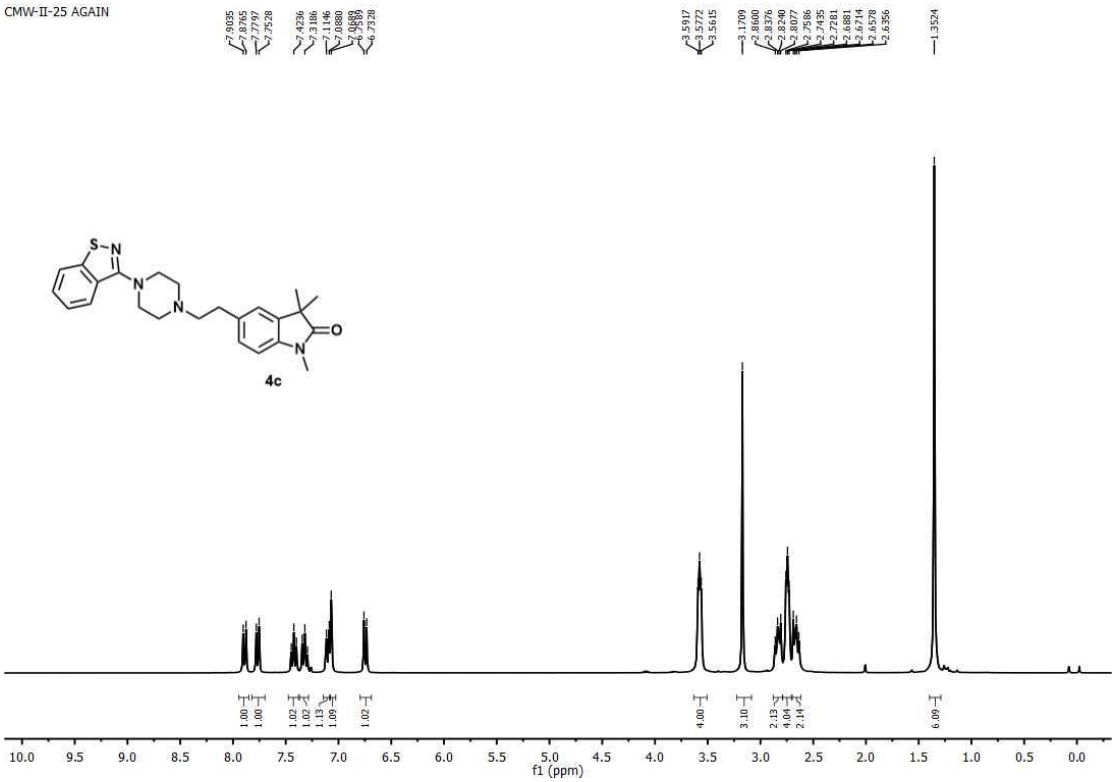

CMW-II-11 13C
190.0925
181.5541
147.9647
136.4853
130.2425
129.0264
122.7392
107.7752
45.6258
44.0703
26.5635
24.3063
Cl
O
O
N
4a
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

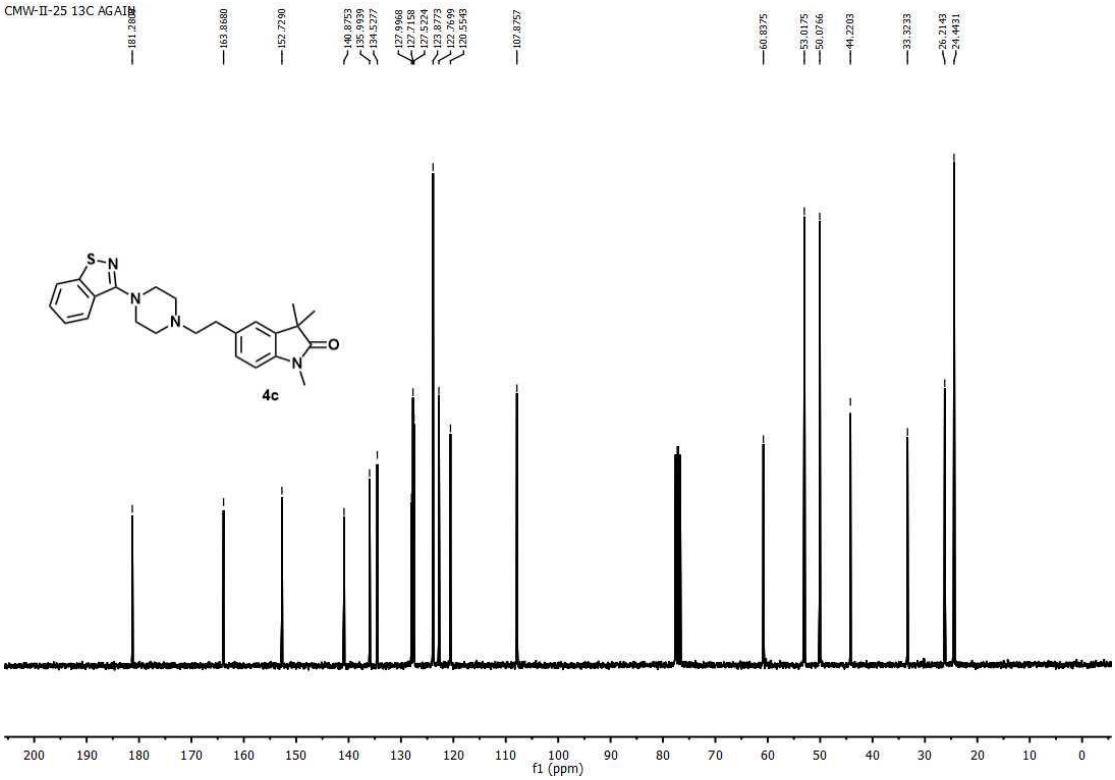
CMW-II-12

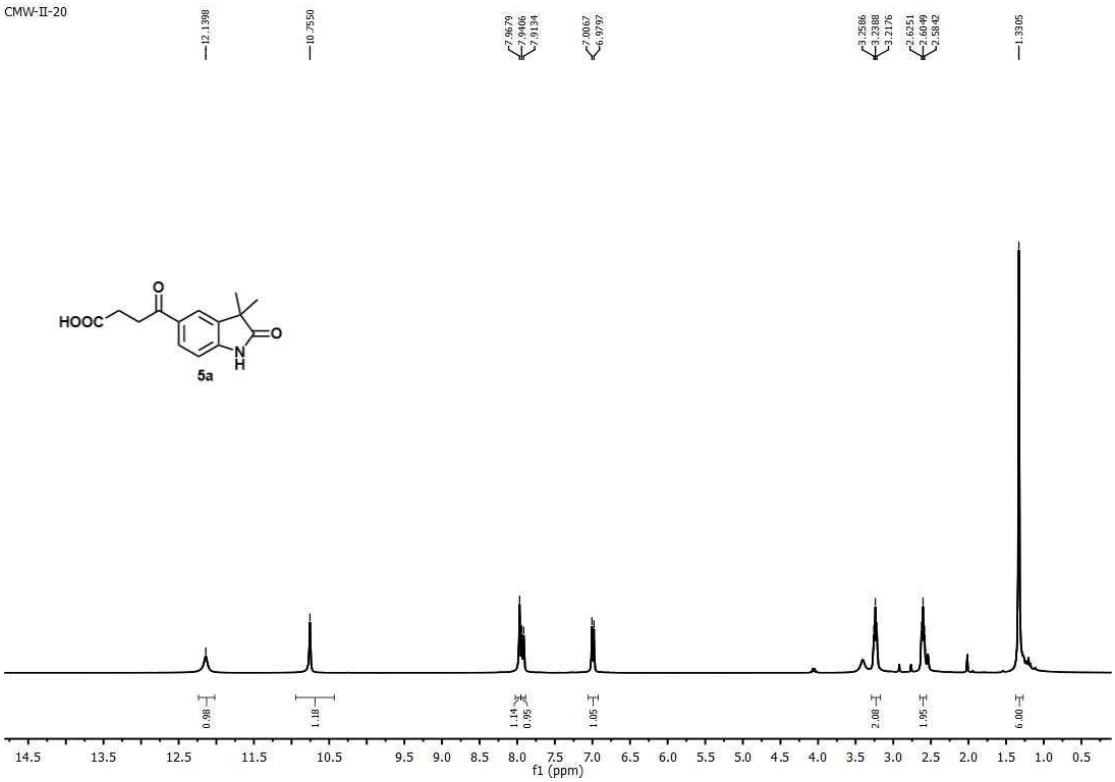


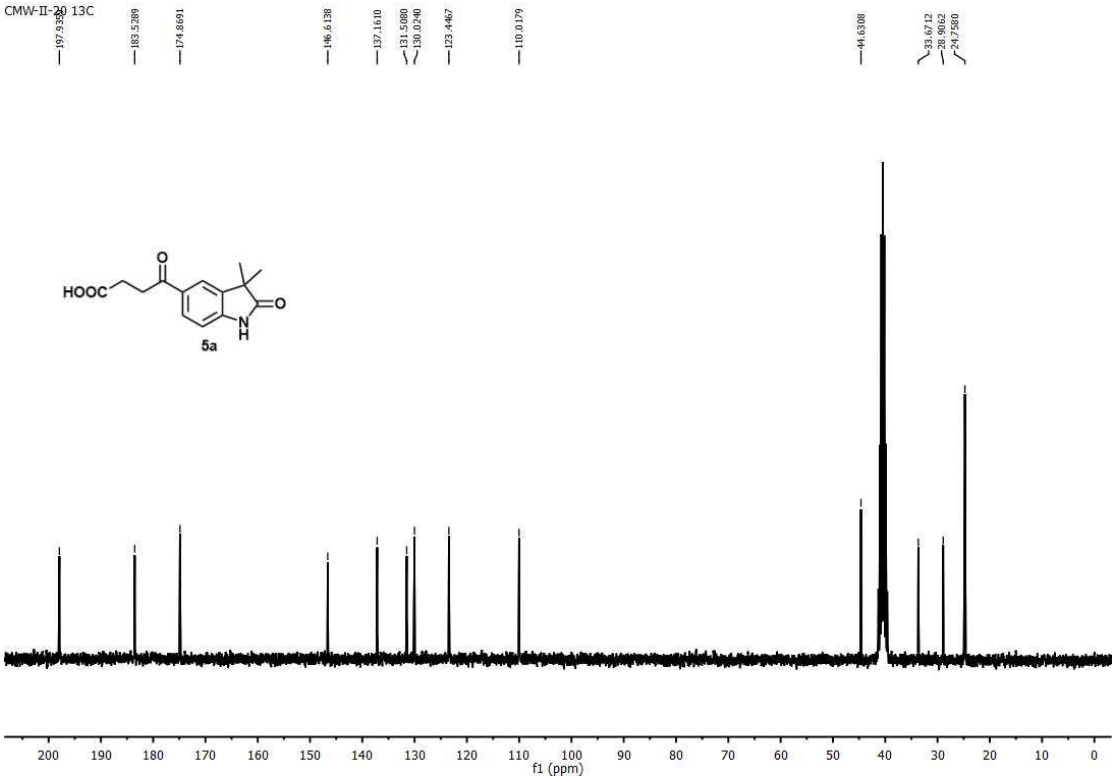
CMW-II-12 13C

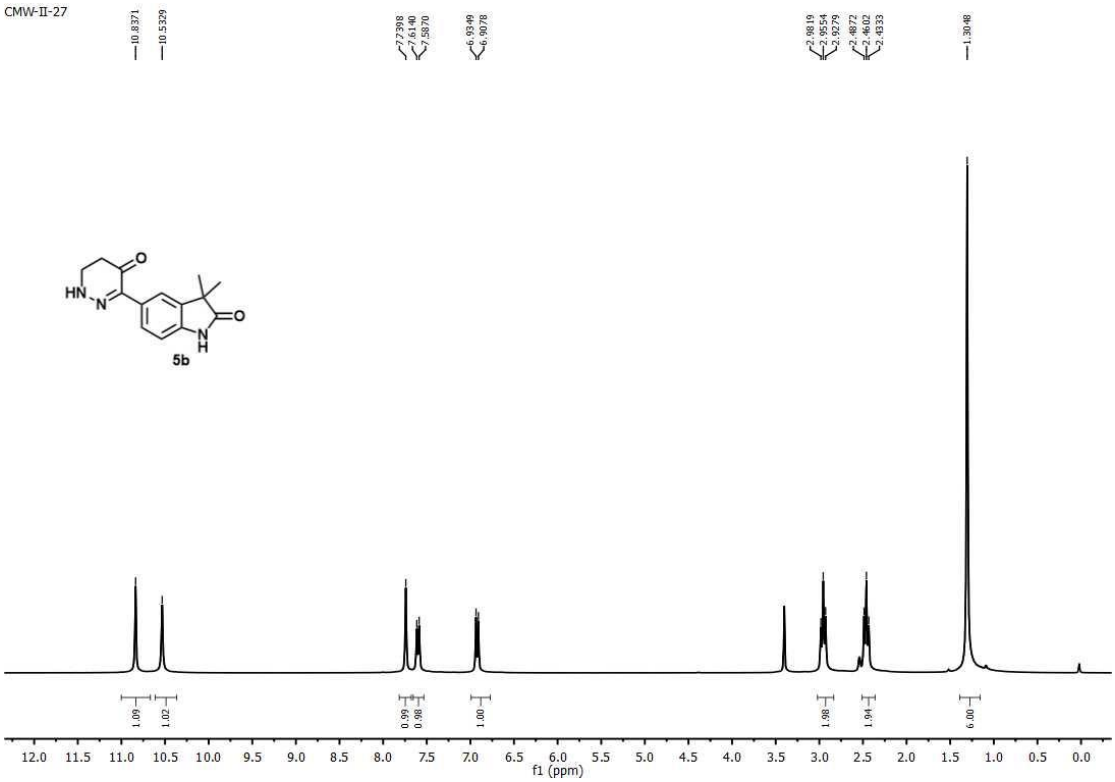


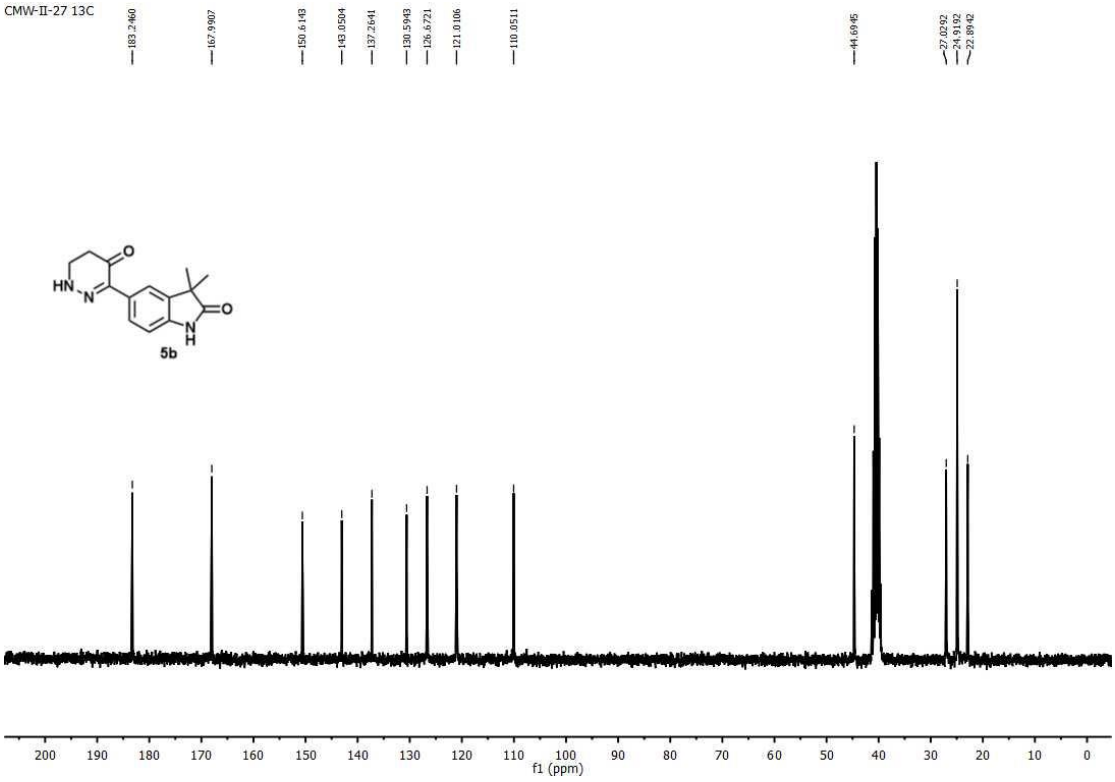

CMW-II-25 AGAIN
4c
f1 (ppm)


CMW-II-25 13C AGAIN
4c
f1 (ppm)


CMW-II-20
12.1398
10.7550
7.9679
7.9406
7.9134
7.0067
6.9797
3.2586
3.2388
3.2176
2.6251
2.6049
2.5842
1.3305
HOOC
O
O
N
H
5a
0.98
1.18
1.14
0.95
1.05
2.08
1.95
6.00
14.5 13.5 12.5 11.5 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


CMW-II-20 13C
197.9380
183.5289
174.8691
146.6138
137.1610
131.5080
130.0240
123.4467
110.0179
44.6308
33.6712
28.9062
24.7580
HOOC
O
O
N
H
5a
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


CMW-II-27
10.8371
10.5329
7.7398
7.6140
7.5870
6.9349
6.9078
2.9819
2.9554
2.9279
2.4872
2.4602
2.4333
1.3048
5b
1.09
1.02
0.99
0.98
1.00
1.98
1.94
6.00
f1 (ppm)


CMW-II-27 13C
183.2460
167.9907
150.6143
143.0504
137.2641
130.5943
126.6721
121.0106
110.0511
44.6945
27.0292
24.9192
22.8942
5b
f1 (ppm)