Palladium-Catalyzed Benzo[*d*]isoxazole Synthesis by C-H Activation/[4+1]Annulation

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Supporting Information

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1. General Informations

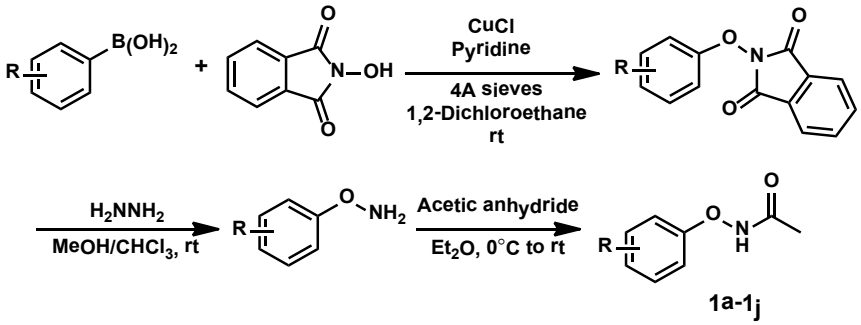
All reactions were carried out under an atmosphere of nitrogen unless otherwise noted. Reaction temperatures were reported as those of the oil bath. The dry solvents used were purified by distillation and were transferred under nitrogen.

Commercially available reagents were purchased from Adamas-beta, Sigma-Aldrich, Alfa Aesar, TCI, Accela, J&K and Aladdin and used as received unless otherwise stated. Palladium (II) trifluoroacetate was purchased from Sinocompound Technology Co., Ltd.

Reactions were monitored with analytical thin-layer chromatography (TLC) on silica. ^{1}H NMR and ^{13}C NMR data were recorded on Bruker nuclear resonance (400 MHz and 500MHz) spectrometers, respectively. Chemical shifts (δ) are given in ppm relative to TMS. The residual solvent signals were used as references and the chemical shifts converted to the TMS scale ($CDCl_3$: δ_H=7.26 ppm, δ_c=77.16 ppm; DMSO-d_6: δ_H = 2.50 ppm, δ_C = 39.52 ppm; MeOD-d_4: δ_H=3.31 ppm, δ_c=49.00 ppm; Acetone-d_6: δ_H = 2.05 ppm, δ_C = 29.84 ppm, 206.26 ppm). HRMS (ESI and APCI) analysis were performed by the Analytical Instrumentation Center at Peking University, Shenzhen Graduate School and (HRMS) data were reported with ion mass/charge (m/z) ratios as values in atomic mass units. All melting points were uncorrected.

2. Synthesis and Characterization of Starting Materials

General procedure for preparation of substrates 1a-1j



1a-1j

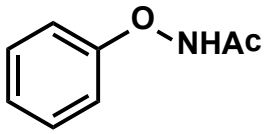
Following a literature report,[1] in a 50 mL round-bottom flask, N-hydroxyphthalimide (1.0 eq), cooper (I) chloride (1.0 eq), freshly activated 4 Å molecular sieves (250mg/mmol), and phenylboronic acid (2.0 eq) were combined in 1,2-dichloroethane (0.2 M). The pyridine (1.1 eq) was then added to the suspension. The reaction mixture was open to the atmosphere and stirred at room temperature over 24-48h. Upon completion, silica gel was added to the flask and the solvent was removed under vacuum. The desired N-aryloxyphthalimides were obtained by flash column chromatography on silica gel.

Hydrazine monohydrate (3.0 eq) was added to the solution of N-aryloxyphthalimide (1.0 eq) in 10% MeOH in $CHCl_3$ (0.1 M). The reaction was allowed to stir at room temperature overnight. Upon completion, the reaction mixture was filtered off and washed with CH_2Cl_2. The filtrate was concentrated under reduced pressure, and purified by flash silica gel column chromatography to

give the corresponding N-aryloxyamine.

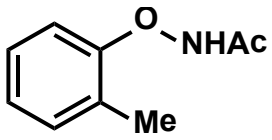
In a 20 mL round-bottom flask, N-aryloxyamine (1.0 eq) was dissolved in ether (0.2 M).The flask was cooled in an ice bath, to which acetic anhydride (2.0 eq) was slowly added. The ice bath was allowed to warm to room temperature and the mixture was stirred for 3 h at room temperature. The reaction mixture was concentrated under reduced pressure and purified by flash silica gel column chromatography to give the corresponding N-aryloxyacetamide.

Characterization of Substrates 1



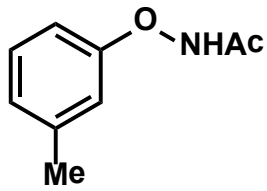
1a, white solid, yield: 60%

^{1}H NMR (400 MHz, DMSO-d$_6$): δ 11.67 (s, 1H), 7.32 (t, J = 7.9 Hz, 2H), 7.01 (t, J = 7.6 Hz, 3H), 1.92 (s, 3H); **^{13}C NMR (101 MHz, DMSO-d$_6$):** δ 167.22, 159.55, 129.45, 122.25, 112.86, 19.43. **IR (cm^{-1}):** 3107, 2907, 1645, 1539, 1506, 743, 689. **HRMS (ESI)** calculated for $C_8H_9NO_2Na$ (+): 174.0633; Found: 174.0527. **Melting Point:** 154-156 °C.



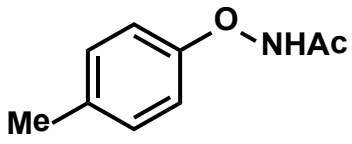
1b, white solid, yield: 56%

^{1}H NMR (400 MHz, DMSO-d$_6$): δ 11.62 (s, 1H), 7.15 (t, *J* = 7.7 Hz, 2H), 6.99 (d, *J* = 8.0 Hz, 1H), 6.92 (t, *J* = 7.3 Hz, 1H), 2.21 (s, 3H), 1.92 (s, 3H); **^{13}C NMR (101MHz, DMSO-d$_6$):** δ 167.09, 157.46, 130.69, 126.87, 123.50, 121.99, 111.54, 19.44, 15.48. **IR (cm^{-1}):** 3177，2984，2808，1653, 1506, 1456, 1119, 991, 750. **HRMS (ESI)** calculated for $C_9H_{11}NO_2Na$ (+): 188.0790; Found: 188.0682. **Melting Point:** 122-125 ℃.



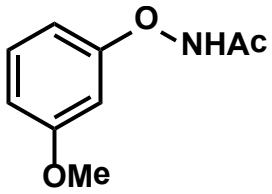
1c, white solid, yield: 50%

^{1}H NMR (400 MHz, Acetone-d$_6$): δ 10.75 (s, 1H), 7.16 (t, *J* = 7.0 Hz, 1H), 6.85 (d, *J* = 14.0 Hz, 3H), 2.29 (s, 3H), 1.97 (s, 3H); **^{13}C NMR (101 MHz, Acetone-d$_6$):** δ 167.75, 160.08, 139.21, 129.01, 122.99, 113.51, 109.98, 20.54, 18.75. **HRMS (ESI)** calculated for $C_9H_{11}NO_2Na$ (+): 188.0790; Found: 188.0682.



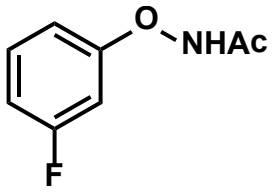
1d, white solid, yield: 45%

^{1}H NMR (400 MHz, DMSO-d$_6$): δ 11.61 (s, 1H), 7.10 (d, *J* = 8.0 Hz, 2H), 6.90 (d, *J* = 7.9 Hz, 2H), 2.24 (s, 3H), 1.90 (s, 3H); **^{13}C NMR (101 MHz, DMSO-d$_6$):** δ 167.58, 158.00, 131.51, 130.14, 113.28, 20.52, 19.84; **HRMS (ESI)** calculated for $C_9H_{11}NO_2Na$ (+): 188.0790; Found: 188.0682. **Melting Point:** 141-143 ℃.



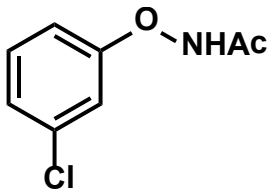
1e, brick-red solid, yield: 50%

^{1}H NMR (400 MHz, DMSO-d$_6$): δ 11.62 (s, 1H), 7.20 (t, *J* = 8.1 Hz, 1H), 6.75 – 6.48 (m, 3H), 3.73 (s, 3H), 1.90 (s, 3H); **^{13}C NMR (101 MHz, DMSO-d$_6$):** δ 167.61, 161.30, 160.88, 130.47, 108.23, 105.50, 99.59, 55.68, 19.83; **IR (cm^{-1}):** 3177, 2957, 1684, 1607, 1489, 1134, 685; **HRMS (ESI)** calculated for $C_9H_{11}NO_3Na$(+): 204.0739 ; Found: 204.0631. **Melting Point:** 98-100 ℃.



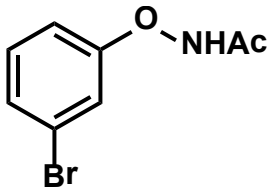
1f, white solid, yield: 35%

^{1}H NMR (400 MHz, DMSO-d$_6$): δ 11.76 (s, 1H), 7.34 (dd, *J* = 15.4, 8.0 Hz, 1H), 6.85 (dd, *J* = 15.3, 9.9 Hz, 3H), 1.92 (s, 3H); **^{13}C NMR (101MHz, DMSO-d$_6$):** δ 167.92, 163.27 (J_{1F} = 244.5), 161.52 (J_{3F} = 10.6), 131.28 (J_{3F} = 10.2), 109.56, 109.34 (J_{2F} = 21.4), 101.12 (J_{2F} = 26.7), 19.85. **HRMS (ESI)** calculated for $C_8H_8NO_2FNa$(+): 192.0539; Found: 192.0430. **Melting Point:** 149-151℃.



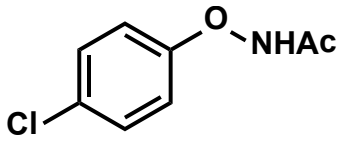
1g, white solid, yield: 40%

^{1}H NMR (400 MHz, DMSO-d$_6$): δ 11.77 (s, 1H), 7.33 (t, *J* = 8.3 Hz, 1H), 7.08 (m, 2H), 6.99 (d, *J* = 8.1 Hz, 1H), 1.92 (s, 3H); **^{13}C NMR (101 MHz, DMSO-d$_6$):** δ 168.01, 160.94, 134.19, 131.43, 122.72, 113.44, 112.42, 19.89. **HRMS (ESI)** calculated for $C_8H_8NO_2NaCl$(+):208.0244 ; Found: 208.0135. **Melting Point:** 124-126℃.



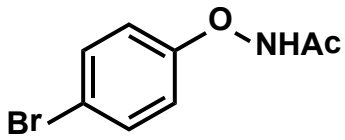
1h, white solid, yield: 30%

1H NMR (400 MHz, DMSO-d6): δ 11.76 (s, 1H), 7.27 (t, J = 8.2 Hz, 1H), 7.21 (d, J = 5.4 Hz, 2H), 7.03 (d, J = 8.1 Hz, 1H), 1.92 (s, 3H); **^{13}C NMR (101 MHz, DMSO-d6)**:δ167.91, 160.93, 131.72, 125.63, 122.43, 116.24, 112.84, 19.84. **IR (cm^{-1})**: 3102, 2911, 1653, 1506, 991, 779. **HRMS (ESI)** calculated for $C_8H_8NO_2NaBr(+)$: 251.9738; Found: 251.9631. **Melting Point:** 129-131 °C.



1i, white solid, yield: 45%

^{1}H NMR (400 MHz, DMSO-d$_6$): δ 11.74 (s, 1H), 7.35 (d, *J* = 8.8 Hz, 2H), 7.03 (d, *J* = 8.6 Hz, 2H), 1.91 (s, 3H); **^{13}C NMR (101 MHz, DMSO-d$_6$):** δ 167.88, 158.89, 129.68, 126.34, 115.22, 19.87. **IR (cm^{-1}):** 3109, 2911, 1663, 1506, 989, 824. **HRMS (ESI)** calculated for $C_8H_8NO_2NaCl(+)$: 208.0244; Found: 208.0137. **Melting Point:** 151-153℃.



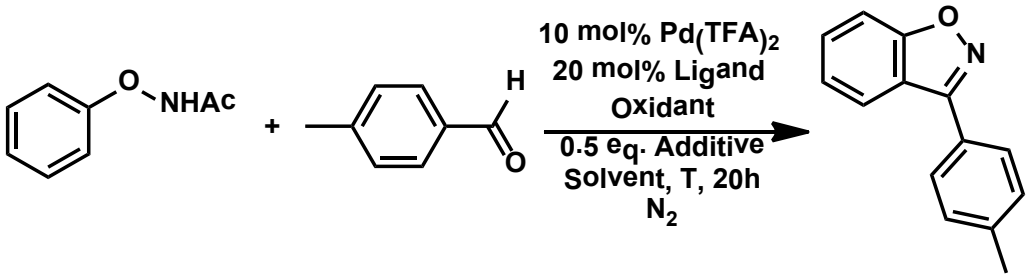
1j, white solid, yield: 35%

^{1}H NMR (400 MHz, DMSO-d$_6$): δ 11.74 (s, 1H), 7.47 (d, *J* = 8.7 Hz, 2H), 6.98 (d, *J* = 8.5 Hz, 2H), 1.91 (s, 3H); **^{13}C NMR (101 MHz, DMSO-d$_6$):** δ 167.88, 159.37, 132.58, 115.71, 114.05, 19.86. **HRMS (ESI)** calculated for $C_8H_8NO_2NaBr(+)$: 251.9738; Found: 251.9630. **Melting Point:** 163-165℃.

3. Condition Sreening

Initial screening quickly identified $Pd(TFA)_2$ was a good catalyst and this reaction required oxidants.

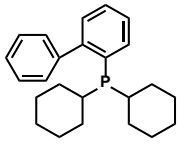
Table S1. Condition Screening[a,b]



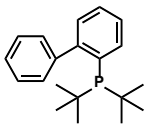
Entry	Solvent	Ligand	Oxidant	Additive	Temperature	Yield
1	toluene	pyridine	4 eq TBHP	-	80℃	N.R.
2	toluene	bpy	4 eq TBHP	-	80℃	N.R.
3	toluene	Cyclohexyl JohnPhos	4 eq TBHP	-	80℃	62%
4	toluene	JohnPhos	4 eq TBHP	-	80℃	40%
5	toluene	DavePhos	4 eq TBHP	-	80℃	44%
6	toluene	-	4 eq Ag_2CO_3	-	80℃	N.R.
7	toluene	-	4 eq AgOAc	-	80℃	N.R.
8	toluene	-	4 eq Ag_2O	-	80℃	N.R.
9	toluene	-	4 eq $K_2S_2O_8$	-	80℃	N.R.
10	toluene	-	4 eq $Cu(OAc)_2$	-	80℃	N.R.
11	DCE	-	4 eq TBHP	-	80℃	30%
12	THF	-	4 eq TBHP	-	80℃	31%
13	1,4-dioxane	-	4 eq TBHP	-	80℃	46%
14	MeOH	-	4 eq TBHP	-	80℃	15%
15	CH_3CN	-	4 eq TBHP	-	80℃	9%
16	DMSO	-	4 eq TBHP	-	80℃	59%
17	xylene		4 eq TBHP		80℃	37%
18	*t*-AmOH	-	4 eq TBHP	-	80℃	75%
19	*t*-BuOH	-	4 eq TBHP	-	80℃	46%
20	PhCl	-	4 eq TBHP	-	80℃	N.R.
21	*t*-AmOH	Cyclohexyl JohnPhos	4 eq TBHP		80℃	48%
22	*t*-AmOH	-	4 eq TBHP	PivOH	80℃	26%
23	*t*-AmOH	-	4 eq TBHP	Cs_2CO_3	80℃	N.R.
24	*t*-AmOH	-	4 eq TBHP	CsOAc	80℃	N.R.
25	*t*-AmOH	-	4 eq TBHP	K_2CO_3	80℃	N.R.
26	*t*-AmOH	-	4 eq TBHP	-	r.t	42%
27	*t*-AmOH	-	4 eq TBHP	-	50℃	70%
28	*t*-AmOH	-	4 eq TBHP	-	60℃	85%
29	*t*-AmOH	-	4 eq TBHP	-	70℃	86%

30	*t*-AmOH	-	4 eq TBHP	-	80℃	74%
31[c]	*t*-AmOH	-	4 eq TBHP	-	80℃	73%
32	*t*-AmOH	-	4 eq TBHP	-	90℃	63%
33	*t*-AmOH	-	4 eq TBHP	-	100℃	53%
34	*t*-AmOH	-	4 eq TBHP	-	120℃	29%
35[d]	*t*-AmOH	-	4 eq TBHP	-	60℃	41%
36[e]	*t*-AmOH	-	4 eq TBHP	-	60℃	67%
37[f]	*t*-AmOH	-	4 eq TBHP	-	60℃	58%
38[g]	*t*-AmOH	-	4 eq TBHP	-	60℃	73%
39	*t*-AmOH	-	-	-	60℃	N.R.
40	*t*-AmOH	-	1 eq TBHP	-	60℃	75%
41	*t*-AmOH	-	1.5 eq TBHP	-	60℃	81%
42	*t*-AmOH	-	2 eq TBHP	-	60℃	78%
43	*t*-AmOH	-	2.5 eq TBHP	-	60℃	88%
44	*t*-AmOH	-	3 eq TBHP	-	60℃	80%
45	*t*-AmOH	-	3.5 eq TBHP	-	60℃	80%
46	*t*-AmOH	-	2.5 eq DTBP	-	60℃	N.R.
47	*t*-AmOH	Ph_3P	2.5 eq TBHP	-	60℃	51%
48	*t*-AmOH	Ph_3P=O	2.5 eq TBHP	-	60℃	57%

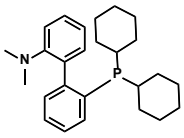
[a]GC yield using mesitylene as an internal standard. [b]All reactions were kept in dark place. [c]solated yield. [d]reaction under air. [e]reaction was not kept in dark place. [f]$Pd(OAc)_2$ instead of $Pd(TFA)_2$.. [g] 5%$Pd(TFA)_2$. Note: Di-*tert*-butyl peroxide (DTBP).



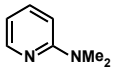
Cyclohexyl JohnPhos



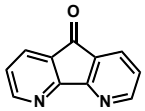
JohnPhos



DavePhos

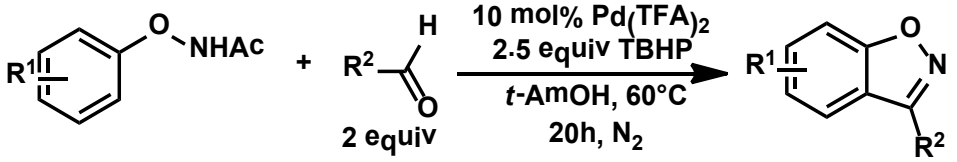


L1



L2

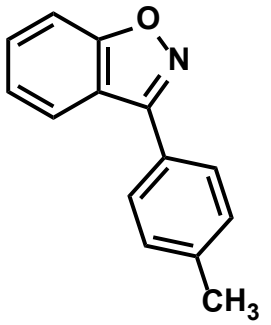
4. Experimental Procedure and Characterization of Products



N-Phenoxyacetamides substrates (**1**) (0.5 mmol) and $Pd(TFA)_2$ (10 mol%) were weighed into a 25ml pressure tube, to which was added *tert*-Amyl alcohol (2 ml) and aldehydes (**2**) (1 mmol) and TBHP (1.25 mmol) in a glove box. The reaction vessel was stirred at 60℃ for 20 h. Then the reaction mixture was cooled and diluted with ethyl acetate, and added with saturated $NaHSO_3$. The aqueous phase was extracted with ethyl acetate. Then the organic phase was washed with saturated NaCl and dried

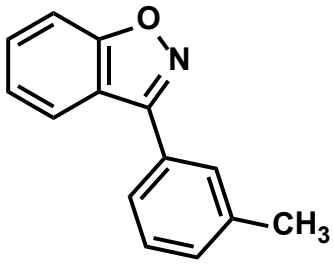
with anhydrous Na_2SO_4. The solvent was evaporated and the residue was purified by column chromatography on silica gel (petroleum ether/EtOAc =100:1) to give the desired product.

Characterization Data



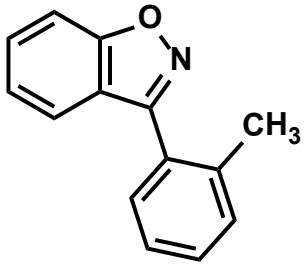
3aa, white solid, yield: 78%

^{1}H NMR (400 MHz, CDCl3): δ 7.93 (d, J = 8.0 Hz, 1H), 7.88 (d, J = 8.0 Hz, 2H), 7.64 (d, J = 8.4 Hz, 1H), 7.59 (t, J = 7.6 Hz, 1H), 7.37 (dd, J=7.2, 4.4, 3H), 2.46 (s, 3H); **^{13}C NMR (101 MHz, CDCl3):** δ 163.81, 157.22, 140.46, 129.86, 129.72, 127.96, 126.06, 123.79, 122.30, 120.60, 110.13, 21.50. **IR (cm-1):** 3080, 2945, 1611, 1491, 1429, 1236, 824, 741. **HRMS (APCI)** calculated for C14H12NO(+): 210.0841; Found: 210.0917. **Melting Point:** 77-79 ℃.



3ab, white solid, yield: 70%

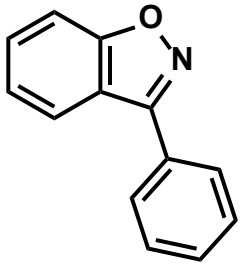
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.94 (d, *J* = 8.0 Hz, 1H), 7.80 (s, 1H), 7.77 (d, *J* = 7.7 Hz, 1H), 7.65 (d, *J* = 8.4 Hz, 1H), 7.63 – 7.57 (m, 1H), 7.46 (t, *J* = 7.6 Hz, 1H), 7.41 – 7.34 (m, 2H), 2.48 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 163.84, 157.40, 138.97, 131.05, 129.76, 129.03, 128.83, 128.69, 125.21, 123.83, 122.32, 120.58, 110.15, 21.49. **HRMS (APCI)** calculated for $C_{14}H_{12}NO(+)$: 210.0841; Found: 210.0914.



3ac, white solid, yield: 56%

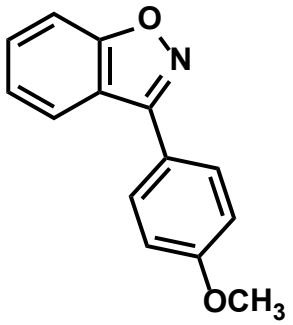
^{1}H NMR (400 MHz, $CDCl_3$): δ7.69 – 7.65 (m, 1H), 7.64 – 7.57 (m, 2H), 7.54 (d, J=7.5, 1H), 7.46 – 7.39 (m, 2H), 7.39 – 7.32 (m, 2H), 2.44 (s, 3H); **^{13}C NMR (101**

MHz, $CDCl_3$): δ 163.16, 158.11, 137.56, 131.10, 130.04, 129.82, 129.81, 127.74, 126.03, 123.72, 122.33, 121.95, 110.03, 20.46. **IR (cm^{-1}):** 2924, 2860, 1508, 1456, 750, 669. **HRMS (APCI)** calculated for $C_{14}H_{12}NO(+)$: 210.0841; Found: 210.0914.



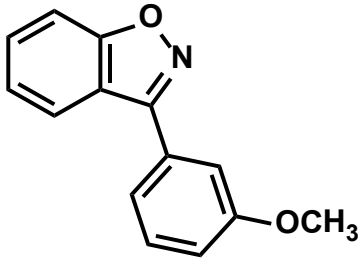
3ad, pale yellow oil, yield: 82%

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.01 – 7.96 (m, 2H), 7.94 (d, *J* = 8.0 Hz, 1H), 7.66 (d, *J* = 8.4 Hz, 1H), 7.63 – 7.60 (m, 1H), 7.59 – 7.54 (m, 3H), 7.41 – 7.37 (m, 1H); **^{13}C NMR (126 MHz, $CDCl_3$):** δ 163.91, 157.26, 130.20, 129.73, 129.11, 129.02, 128.09, 123.84, 122.20, 120.54, 110.15. **IR (cm^{-1}):** 3063, 2926, 2855, 1612, 1597, 1491, 1373, 897, 876, 750, 696. **HRMS (APCI)** calculated for $C_{13}H_{10}NO(+)$: 196.0684; Found: 196.0755.



3ae, white solid, yield: 90%

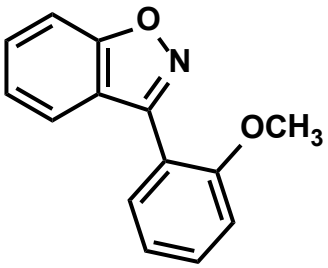
^{1}H NMR (400 MHz, $CDCl_3$): δ7.93 (d, J=8.8, 3H), 7.65 (d, J = 8.4 Hz, 1H), 7.62 – 7.56 (m, 1H), 7.41 – 7.35 (m, 1H), 7.12-7.07 (m, 2H), 3.91 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 163.78, 161.22, 156.87, 129.67, 129.44, 123.72, 122.26, 121.36, 120.61,114.61,110.16,55.43. **HRMS (APCI)** calculated for $C_{14}H_{12}NO_2(+)$: 226.0790; Found: 226.0866.



3af, yellow solid, yield: 66%

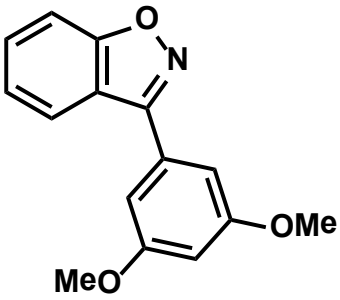
^{1}H NMR (400 MHz, $CDCl_3$):δ7.95 (d, J=8.0, 1H), 7.66 (d, J=8.4, 1H), 7.64 – 7.58 (m, 1H), 7.56 (d, J=7.5, 1H), 7.49 (dd, J=14.8, 6.6, 2H), 7.39 (t, J=7.4, 1H), 7.14 – 7.05 (m, 1H), 3.91 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 163.90, 160.11, 157.21, 130.20, 130.15, 129.81, 123.90, 122.26, 120.50, 120.48, 116.31, 113.20, 110.19,

55.47. **IR (cm^{-1}):** 3262, 2922, 2849, 1585, 1506, 1489, 1456, 1196, 1036, 758,696. HRMS **(APCI)** calculated for $C_{14}H_{12}NO_2$(+): 226.0790; Found: 226.0861.



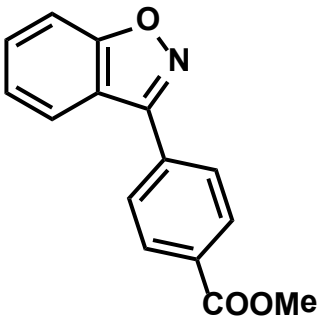
3ag, pale yellow oil, yield: 56%

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.70 (d, J=8.0, 1H), 7.67 (dd, J=7.5, 1.7, 1H), 7.63 (d, J=8.4, 1H), 7.59 – 7.49 (m, 2H), 7.34 – 7.28 (m, 1H), 7.12 (m, 2H), 3.87 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 163.27, 157.51, 156.51, 131.65, 131.34, 129.51, 123.55, 123.21, 121.94, 120.99, 117.71, 111.43, 109.83, 55.53. **HRMS (APCI)** calculated for $C_{14}H_{12}NO_2$(+): 226.0790; Found: 226.0863



3ah, white solid, yield: 53%

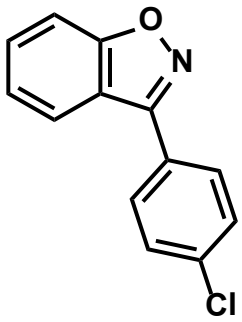
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.95 (d, *J* = 8.0 Hz, 1H), 7.66 (d, *J* = 8.4 Hz, 1H), 7.64 – 7.57 (m, 1H), 7.42 – 7.36 (m, 1H), 7.12 (d, *J* = 2.3 Hz, 2H), 6.64 (t, *J* = 2.3 Hz, 1H), 3.89 (s, 6H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 163.90, 161.29, 157.26, 130.58, 129.85, 123.92, 122.27, 120.46, 110.20, 106.12, 102.44, 55.60; **HRMS (APCI)** calculated for $C_{15}H_{14}NO_3$(+): 256.0895; Found: 256.0968.



3ai, white solid, yield: 76%

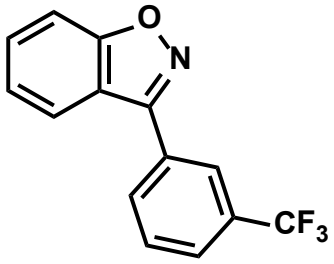
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.22 (d, *J* = 8.4 Hz, 2H), 8.05 (d, *J* = 8.4 Hz, 2H), 7.93 (d, *J* = 8.0 Hz, 1H), 7.67 (d, *J* = 8.4 Hz, 1H), 7.65 – 7.58 (m, 1H), 7.48 – 7.36 (m, 1H), 3.97 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 166.47, 164.03, 156.46, 133.25, 131.64, 130.32, 130.04, 128.02, 124.23, 121.98, 120.17, 110.32, 52.39. **IR (cm^{-1}):** 3040, 2960, 1726, 1611, 1491, 1285, 1125, 1109, 739, 700. **HRMS (APCI)** calculated for $C_{15}H_{12}NO_3$(+):254.0739; Found: 254.0810. **Melting Point:**

139-141°C.



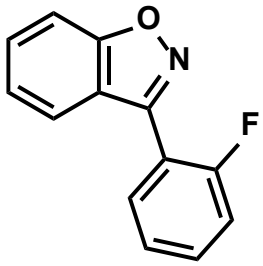
3aj, white solid, yield: 73%

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.91 (m, 3H), 7.67 (d, *J* = 8.4 Hz, 1H), 7.64 – 7.59 (m, 1H), 7.57 – 7.52 (m, 2H), 7.43 – 7.37 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 163.95, 156.31, 136.45, 129.97, 129.47, 129.30, 127.45, 124.09, 121.93, 120.19, 110.30. **HRMS (APCI)** calculated for $C_{13}H_9NOCl(+)$: 230.0294; Found: 230.0364. **Melting Point:** 108-111°C.



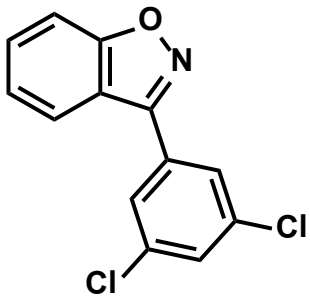
3ak, pale yellow solid, yield: 64%

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.25 (s, 1H), 8.18 (d, J = 7.7 Hz, 1H), 7.93 (d, J = 8.0 Hz, 1H), 7.82 (d, J = 7.9 Hz, 1H), 7.75 – 7.71 (m, 1H), 7.71 – 7.68 (m, 1H), 7.68 – 7.62 (m, 1H), 7.44 (m,1H); **^{13}C NMR (101 MHz, $CDCl_3$)**: δ 164.08, 156.11, 131.72 (J=33.0), 131.24, 130.12, 129.92, 129.74, 126. 88(J=3.3), 124.88(J=3.3), 124.30, 123.81(J=273.7), 121.74, 120.00, 110.38. **HRMS (APCI)** calculated for $C_{14}H_9NOF_3(+)$: 264.0558; Found: 264.0630. **Melting Point:** 57-60°C.



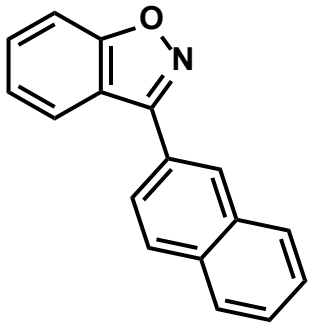
3al, yellow solid, yield: 47%

^{1}H NMR (400 MHz, $CDCl_3$): δ7.87 – 7.79 (m, 2H), 7.67 (d, J=8.5,1H), 7.64 – 7.58 (m, 1H), 7.58 – 7.52 (m, 1H), 7.40 – 7.34 (m, 2H), 7.34 – 7.29 (m, 1H). **^{13}C NMR (101 MHz, $CDCl_3$):** δ 163.63, 160.24 (J_{1F} = 253.1), 158.98, 154.15, 132.12 (J_{3F} = 8.4), 131.10 (J_{4F} = 3.1), 129.97, 124.77 (J_{4F} = 3.7), 123.82, 122.88 (J_{3F} = 7.1), 121.03, 116.81, 116.49 (J_{2F} = 21.6), 109.98. **HRMS (APCI)** calculated for $C_{13}H_9NOF(+)$: 214.0590; Found: 214.0661.



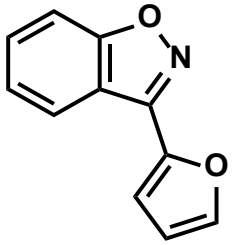
3am, white solid, yield: 48%

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.92 (d, *J* = 8.0 Hz, 1H), 7.88 (d, *J* = 1.9 Hz, 2H), 7.69 (d, *J* = 8.4 Hz, 1H), 7.67 – 7.62 (m, 1H), 7.54 (t, *J* = 1.9 Hz, 1H), 7.44 (m, 1H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 164.11, 155.16, 135.90, 131.81, 130.26, 130.22, 126.38, 124.44, 121.63, 119.73, 110.45. **IR (cm^{-1}):** 3080, 2924, 1558, 1506, 1362, 750, 683. **HRMS (APCI)** calculated for $C_{13}H_8NOCl_2$(+): 263.9905; Found: 263.9974.



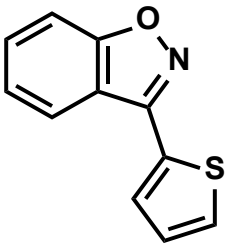
3an, yellow solid, yield: 75%

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.48 (s, 1H), 8.10 (dd, J=8.5, 1.6, 1H), 8.07 (d, J=8.0, 1H), 8.03 (d, J=8.5, 1H), 7.99 (dd, J=4.9, 4.3, 1H), 7.96 – 7.90 (m, 1H), 7.69 (d, J=8.5, 1H), 7.63 (m, 1H), 7.59 (dt, J=6.8, 3.0, 2H), 7.46 – 7.40 (m, 1H); **^{13}C NMR (126 MHz, $CDCl_3$):** δ 164.02, 157.22, 134.10, 133.32, 129.77, 128.98, 128.55, 127.91, 127.89, 127.22, 126.77, 126.48, 125.06, 123.92, 122.29, 120.67, 110.22. **IR (cm^{-1}):** 3055, 2924, 2855, 1609, 1506, 1387, 1236, 835,820, 745, 675. **HRMS (APCI)** calculated for $C_{17}H_{12}NO$(+): 246.0841; Found: 246.0916. **Melting Point:** 84-86^{o}C.



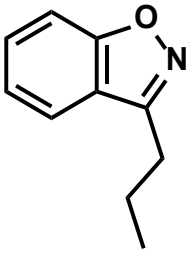
3ao, yellow oil, yield: 63%

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.11 (dt, J = 8.0, 0.9 Hz, 1H), 7.71 (dd, J = 1.8, 0.6 Hz, 1H), 7.66 – 7.56 (m, 2H), 7.40 (m, 1H), 7.20 (dd, J = 3.5, 0.6 Hz, 1H), 6.64 (dd, J = 3.5, 1.8 Hz, 1H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 163.38, 149.39, 144.47, 144.43, 130.11, 124.04, 122.76, 119.52, 111.90, 111.40, 109.93. **HRMS (APCI)** calculated for $C_{11}H_8NO_2$(+):186.0477; Found: 186.0548



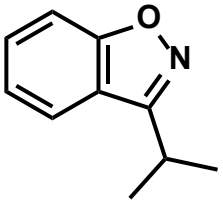
3ap, yellow solid, yield: 55%

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.01 (d, J = 8.0 Hz, 1H), 7.83 (dd, J = 3.7, 1.1 Hz, 1H), 7.67 – 7.63 (m, 1H), 7.63 – 7.58 (m, 1H), 7.56 (dd, J = 5.1, 1.1 Hz, 1H), 7.41 (m, 1H), 7.25 (dd, J = 5.1, 3.7 Hz, 1H); **^{13}C NMR (101 MHz, $CDCl_3$)**: δ 163.78, 152.31, 130.06, 129.97, 128.19, 127.97, 127.92, 124.04, 121.97, 120.00, 110.24. **IR (cm^{-1}):** 2924, 2855, 1611, 1543, 1508, 1489, 1456, 1443, 1236, 891, 847, 746, 700. **HRMS (APCI)** calculated for $C_{11}H_8NOS(+)$:202.0248; Found: 202.0324



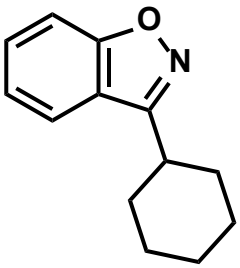
3aq, pale yellow oil, yield:63%

^{1}H NMR (500 MHz, $CDCl_3$): δ7.72 – 7.63 (m, 1H), 7.61 – 7.49 (m, 2H), 7.29 (m, 1H), 3.02 – 2.93 (m, 2H), 1.90 (dd, J=15.0, 7.4, 2H), 1.05 (t, J=7.4, 3H); **^{13}C NMR (126 MHz, $CDCl_3$):** δ 162.97, 158.42, 129.57, 123.02, 121.78, 121.26, 109.87, 27.22, 21.11, 13.89. **IR (cm^{-1}):** 2963, 2928, 2874, 1612, 1522, 1439, 1379, 1238, 748. **HRMS (APCI)** calculated for $C_{10}H_{12}NO(+)$: 162.0841; Found: 162.0914.



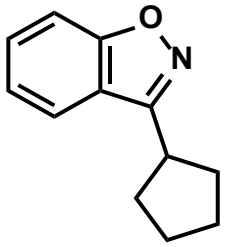
3ar, pale yellow oil, yield: 40%

^{1}H NMR (500 MHz, $CDCl_3$): δ7.72 (d, J=7.9, 1H), 7.60 – 7.47 (m, 2H), 7.33 – 7.26 (m, 1H), 3.43 (dt, J=14.0, 7.0, 1H), 1.54 – 1.48 (m, 6H); **^{13}C NMR (126 MHz, $CDCl_3$):** δ 163.21, 163.07, 129.47, 122.90, 121.60, 120.86, 109.99, 26.88, 21.08. **HRMS (APCI)** calculated for $C_{10}H_{12}NO(+)$:162.0841; Found: 162.0915.



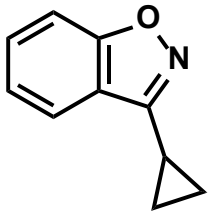
3as, white solid, yield: 41%

^{1}H NMR (500 MHz, $CDCl_3$): δ7.71 (d, J=7.9, 1H), 7.61 – 7.44 (m, 2H), 7.36 – 7.21 (m, 1H), 3.09 (m, 1H), 2.17 – 2.07 (m, 2H), 1.90 (d, J=13.0, 2H), 1.83 – 1.71 (m, 3H), 1.46 (dd, J=25.3, 12.5, 2H), 1.41 – 1.33 (m, 1H). **^{13}C NMR (126 MHz, $CDCl_3$):** δ 163.09, 162.24, 129.42, 122.82, 121.67, 121.02, 109.91, 36.40, 31.41, 26.19, 26.00. **IR (cm^{-1}):** 2936, 2857, 1558, 1508, 1236, 754. **HRMS (APCI)** calculated for $C_{13}H_{16}NO(+)$: 202.1154; Found: 202.1225. **Melting Point:** 66-68°C.



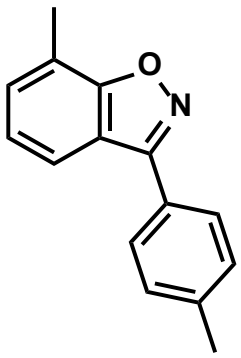
3at, yellow solid, yield: 64%

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.67 (d, *J* = 7.8 Hz, 1H), 7.52 (t, *J* = 9.0 Hz, 2H), 7.26 (dd, *J* = 10.5, 3.8 Hz, 1H), 3.56 – 3.41 (m, 1H), 2.26 – 2.12 (m, 2H), 2.01 (dd, *J* = 12.2, 7.4 Hz, 2H), 1.88 (s, 2H), 1.82 – 1.69 (m, 2H); **^{13}C NMR (126 MHz, $CDCl_3$):** δ 163.21, 161.80, 129.48, 122.88, 121.65, 121.34, 109.91, 36.92, 31.34, 25.62. **HRMS (APCI)** calculated for $C_{12}H_{14}NO(+)$:188.0997; Found: 188.1070.



3au, pale yellow oil, yield: 51%

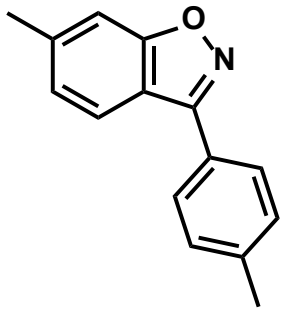
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.68 (d, *J* = 7.9 Hz, 1H), 7.54 (d, *J* = 2.7 Hz, 2H), 7.32 – 7.28 (m, 1H), 2.28 – 2.17 (m, 1H), 1.25 (dd, *J* = 6.4, 4.3 Hz, 2H), 1.20 – 1.12 (m, 2H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 163.13, 160.27, 129.66, 123.05, 121.64, 121.13, 109.99, 7.63, 6.90. **HRMS (APCI)** calculated for $C_{10}H_{10}NO(+)$: 160.0684; Found: 160.0759.



3ba, yellow solid, yield: 50%

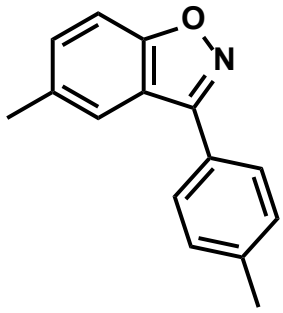
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.88 (d, J = 8.1 Hz, 2H), 7.74 (d, J = 7.9 Hz, 1H), 7.41 – 7.34 (m, 3H), 7.27 (dd, J = 8.2, 6.9 Hz, 1H), 2.63 (s, 3H), 2.46 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 163.16, 157.49, 140.31, 130.10, 129.80, 127.95, 126.36, 124.06, 120.89, 120.06, 119.57, 21.48, 15.24. **IR (cm^{-1}):** 2957, 1940, 1506,

1406, 1111, 824, 743. **HRMS (APCI)** calculated for $C_{15}H_{14}NO(+)$: 224.0997; Found: 224.1071. **Melting Point:** 67-70°C.



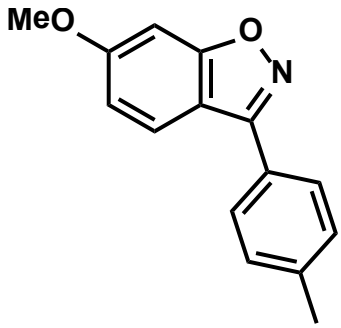
3ca, white solid, yield: 57%

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.86 (d, J = 8.1 Hz, 2H), 7.79 (d, J = 8.2 Hz, 1H), 7.43 (s, 1H), 7.37 (d, J = 7.9 Hz, 2H), 7.20 (d, J = 8.1 Hz, 1H), 2.55 (s, 3H), 2.46 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 164.48, 156.96, 140.73, 140.32, 129.79, 127.90, 126.24, 125.60, 121.65, 118.37, 110.01, 21.91, 21.49. **IR (cm^{-1}):** 2922, 2853, 1917, 1626, 1609, 1485, 1412, 1260, 1128, 1113, 824, 754, 662. **HRMS (APCI)** calculated for $C_{15}H_{14}NO(+)$: 224.0997; Found: 224.1070. **Melting Point:** 70-73°C.



3da, yellow solid, yield: 50%

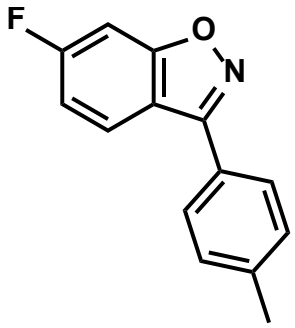
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.86 (d, J = 8.1 Hz, 2H), 7.69 (s, 1H), 7.53 (d, J = 8.6 Hz, 1H), 7.41 (dd, J=8.8, 1.2, 1H), 7.37 (d, J = 7.9 Hz, 2H), 2.51 (s, 3H), 2.46 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 162.52, 156.93, 140.28, 133.47, 131.30, 129.79, 127.95, 126.26, 121.50, 120.80, 109.64, 21.48, 21.24. **HRMS (APCI)** calculated for $C_{15}H_{14}NO(+)$: 224.0997; Found: 224.1073.



3ea, white solid, yield: 60%

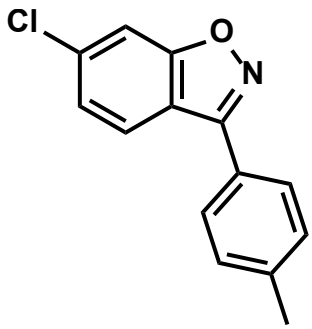
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84 (d, *J* = 8.1 Hz, 2H), 7.75 (d, *J* = 8.8 Hz, 1H), 7.36 (d, *J* = 7.9 Hz, 2H), 7.06 (d, *J* = 2.0 Hz, 1H), 6.98 (dd, *J* = 8.8, 2.1 Hz, 1H), 3.91 (s, 3H), 2.45 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 165.72, 162.05, 156.92, 140.32, 129.78, 127.87, 126.16, 122.48, 114.60, 113.98, 92.73, 55.78, 21.47. **HRMS**

(APCI) calculated for $C_{15}H_{14}NO_2$(+): 240.0946; Found: 240.1018. **Melting Point:** 104-107°C.



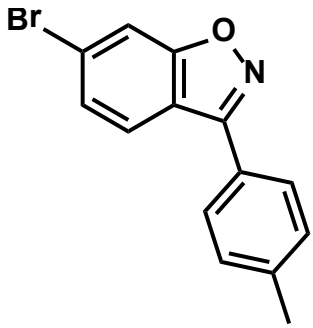
3fa, white solid, yield: 55%

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.89 – 7.85 (m, 1H), 7.85 – 7.80 (m, 2H), 7.37 (d, J = 8.0 Hz, 2H), 7.32 (dd, J = 8.5, 2.0 Hz, 1H), 7.14 (td, J = 8.9, 2.1 Hz, 1H), 2.46 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 164.45 (J_{3F} = 13.7), 164.15 (J_{1F} = 252.0), 157.09, 140.73, 129.90, 127.92, 125.51, 123.29 (J_{3F} = 11.0), 117.20, 113.04 (J_{2F} = 25.5), 97.47 (J_{2F}=26.9), 21.48. **HRMS (APCI)** calculated for $C_{14}H_{11}NOF$(+): 228.0746; Found: 228.0817. **Melting Point:** 90-93°C.



3ga, pale yellow solid, yield: 64%

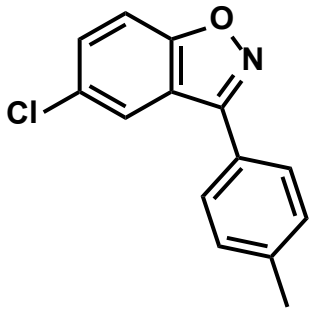
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.82 (d, J = 8.0 Hz, 3H), 7.64 (d, J = 1.3 Hz, 1H), 7.38 – 7.32 (m, 3H), 2.46 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 164.03, 157.06, 140.79, 136.43, 129.92, 127.89, 125.43, 124.84, 122.88, 119.41, 110.54, 21.50. **HRMS (APCI)** calculated for $C_{14}H_{11}NOCl$(+): 244.0451; Found: 244.0520. **Melting Point:** 103-106°C.



3ha, white solid, yield: 76%

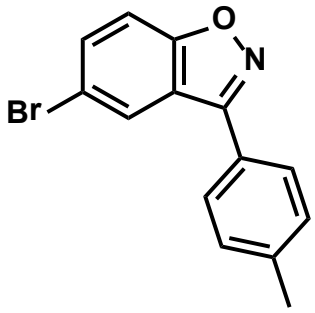
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.82 (d, J = 7.7 Hz, 3H), 7.77 (d, J = 8.5 Hz, 1H), 7.49 (dd, J = 8.5, 1.4 Hz, 1H), 7.37 (d, J = 7.9 Hz, 2H), 2.46 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 164.20, 157.16, 140.82, 129.93, 127.90, 127.49, 125.39, 124.35, 123.14, 119.81, 113.59, 21.51. **IR (cm^{-1}):** 2920, 2849, 1595, 1485, 1402, 826, 754.

HRMS (APCI) calculated for $C_{14}H_{11}NOBr(+)$: 287.9946; Found: 288.0019. **Melting Point:** 111-114°C.



3ia, white solid, yield: 40%

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.88 (d, J = 1.3 Hz, 1H), 7.81 (d, J = 8.1 Hz, 2H), 7.60 – 7.48 (m, 2H), 7.37 (d, J = 7.9 Hz, 2H), 2.46 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 162.34, 156.84, 140.80, 130.19, 129.96, 129.44, 127.85, 125.39, 121.95, 121.69, 111.18, 21.50. **IR (cm^{-1}):** 2922, 2855, 1491, 1425, 1358, 1265, 812, 758; **HRMS (APCI)** calculated for $C_{14}H_{11}NOCl(+)$: 244.0451; Found: 244.0521. **Melting Point:** 112-115°C.



3ja, white solid, yield: 48%

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.06 (d, *J* = 1.7 Hz, 1H), 7.82 (d, *J* = 8.1 Hz, 2H), 7.68 (dd, *J* = 8.8, 1.9 Hz, 1H), 7.54 (d, *J* = 8.8 Hz, 1H), 7.38 (d, *J* = 7.9 Hz, 2H), 2.47 (s, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ162.69, 156.74, 140.84, 132.81, 129.97, 127.89, 125.35, 124.87, 122.64, 116.68, 111.61, 21.51. **HRMS (APCI)** calculated for $C_{14}H_{11}NOBr(+)$: 287.9946; Found: 288.0015.

5. X-ray Crystallographic Data for 3-(*p*-tolyl)benzo[*d*]isoxazole

Figure S1. 3-(*p*-tolyl)benzo[*d*]isoxazole (3aa)

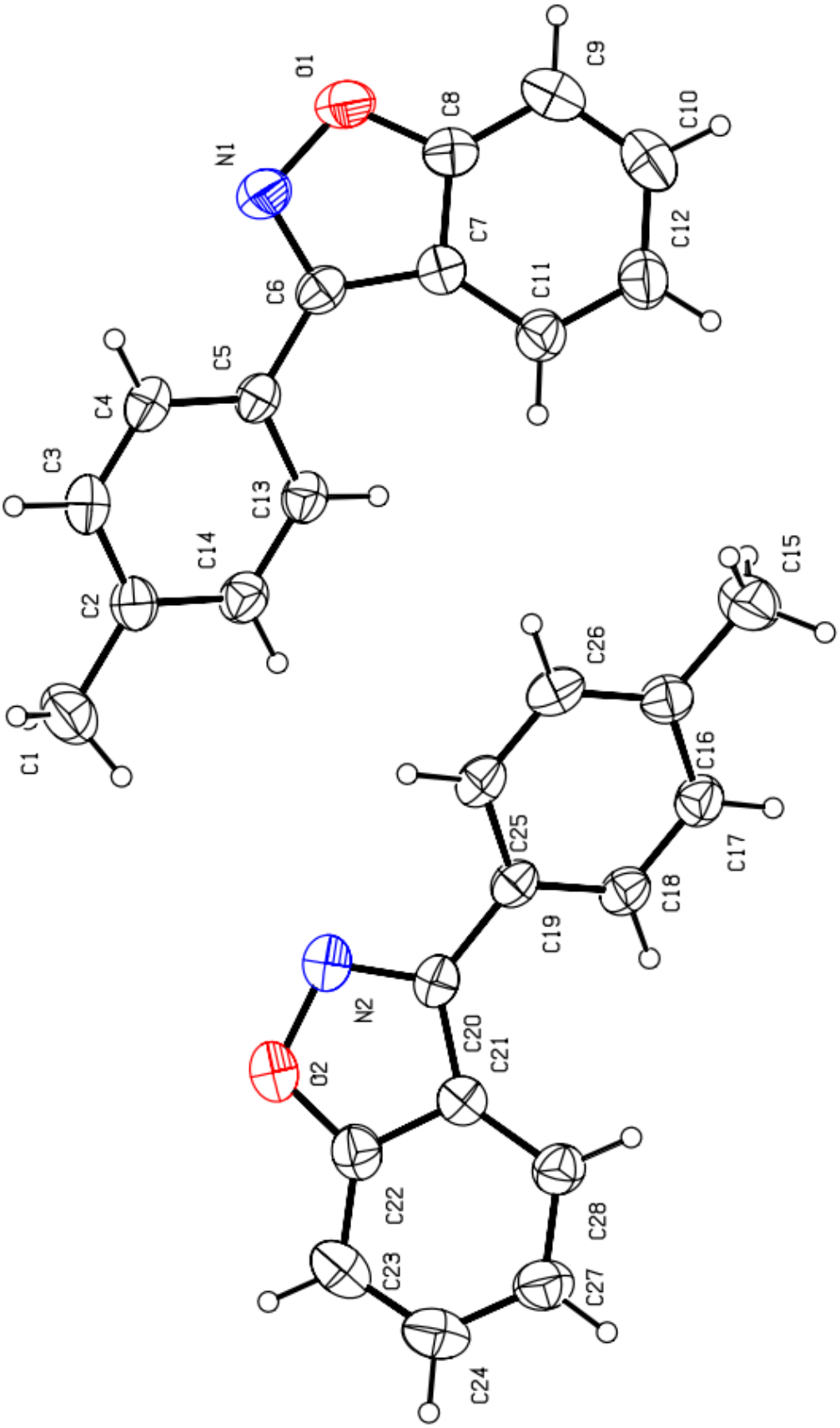


Table S2. Crystal data and structure refinement for a.

Identification code	a	
Empirical formula	C14 H11 N O	
Formula weight	209.24	
Temperature	295(2) K	
Wavelength	1.54178 Å	
Crystal system	Monoclinic	
Space group	P 21/c	
Unit cell dimensions	a = 25.1525(18) Å	□= 90°.
	b = 11.4250(4) Å	□= 94.475(7)°.
	c = 7.5575(3) Å	□ = 90°.
Volume	2165.16(19) $Å^3$	
Z	8	
Density (calculated)	1.284 Mg/m^3	
Absorption coefficient	0.644 mm^{-1}	
F(000)	880	
Crystal size	0.30 x 0.10 x 0.05 mm^3	
Theta range for data collection	6.56 to 68.35°.	
Index ranges	-24<=h<=30, -12<=k<=13, -9<=l<=8	
Reflections collected	15741	
Independent reflections	3881 [R(int) = 0.0440]	
Completeness to theta = 68.35°	97.7 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.968 and 0.803	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	3881 / 0 / 291	
Goodness-of-fit on F^2	1.023	
Final R indices [I>2sigma(I)]	R1 = 0.0491, wR2 = 0.1300	
R indices (all data)	R1 = 0.0701, wR2 = 0.1466	
Largest diff. peak and hole	0.259 and -0.197 $e.Å^{-3}$	

Table S3 Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$x 10^3) for a. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
O(1)	4411(1)	9719(1)	4035(2)	84(1)
O(2)	577(1)	4791(1)	6083(2)	92(1)
N(1)	3875(1)	9898(1)	4427(2)	76(1)
N(2)	1121(1)	4960(1)	5772(2)	81(1)
C(1)	1428(1)	8582(2)	5887(3)	89(1)
C(2)	2008(1)	8656(1)	5559(2)	60(1)
C(3)	2324(1)	9600(1)	6157(2)	65(1)
C(4)	2853(1)	9660(1)	5847(2)	60(1)
C(5)	3093(1)	8780(1)	4909(2)	51(1)
C(6)	3656(1)	8861(1)	4525(2)	55(1)
C(7)	4028(1)	7953(1)	4195(2)	53(1)
C(8)	4490(1)	8547(2)	3896(2)	64(1)
C(9)	4959(1)	8004(2)	3510(2)	80(1)
C(10)	4947(1)	6812(2)	3436(2)	81(1)
C(11)	4030(1)	6729(2)	4149(2)	63(1)
C(12)	4492(1)	6181(2)	3764(2)	76(1)
C(13)	2779(1)	7836(1)	4325(2)	58(1)
C(14)	2250(1)	7782(1)	4657(2)	61(1)
C(15)	3581(1)	3404(2)	4758(3)	90(1)
C(16)	2996(1)	3561(1)	4961(2)	60(1)
C(17)	2632(1)	2729(1)	4327(2)	62(1)
C(18)	2096(1)	2848(1)	4545(2)	57(1)
C(19)	1903(1)	3810(1)	5409(2)	51(1)
C(20)	1333(1)	3920(1)	5680(2)	55(1)
C(21)	949(1)	3017(1)	5911(2)	54(1)
C(22)	487(1)	3621(2)	6163(2)	67(1)
C(23)	9(1)	3088(2)	6484(2)	83(1)
C(24)	14(1)	1902(2)	6561(2)	82(1)
C(25)	2269(1)	4656(1)	6055(2)	60(1)
C(26)	2803(1)	4530(1)	5830(2)	65(1)
C(27)	471(1)	1260(2)	6303(2)	78(1)
C(28)	942(1)	1795(2)	5983(2)	66(1)

Table S4. Bond lengths [Å] and angles [°] for a.

O(1)-C(8)	1.359(2)
O(1)-N(1)	1.4170(17)
O(2)-C(22)	1.359(2)
O(2)-N(2)	1.4188(18)
N(1)-C(6)	1.3105(18)
N(2)-C(20)	1.3069(18)
C(1)-C(2)	1.502(2)
C(1)-H(1A)	0.9600
C(1)-H(1B)	0.9600
C(1)-H(1C)	0.9600
C(2)-C(14)	1.377(2)
C(2)-C(3)	1.393(2)
C(3)-C(4)	1.372(2)
C(3)-H(3)	0.9300
C(4)-C(5)	1.3942(19)
C(4)-H(4)	0.9300
C(5)-C(13)	1.389(2)
C(5)-C(6)	1.4721(19)
C(6)-C(7)	1.431(2)
C(7)-C(8)	1.380(2)
C(7)-C(11)	1.399(2)
C(8)-C(9)	1.384(2)
C(9)-C(10)	1.362(3)
C(9)-H(9)	0.9300
C(10)-C(12)	1.391(3)
C(10)-H(10)	0.9300
C(11)-C(12)	1.371(2)
C(11)-H(11)	0.9300
C(12)-H(12)	0.9300
C(13)-C(14)	1.375(2)
C(13)-H(13)	0.9300
C(14)-H(14)	0.9300
C(15)-C(16)	1.502(2)
C(15)-H(15A)	0.9600
C(15)-H(15B)	0.9600
C(15)-H(15C)	0.9600

C(16)-C(17)	1.380(2)
C(16)-C(26)	1.393(2)
C(17)-C(18)	1.377(2)
C(17)-H(17)	0.9300
C(18)-C(19)	1.3857(19)
C(18)-H(18)	0.9300
C(19)-C(25)	1.396(2)
C(19)-C(20)	1.4693(19)
C(20)-C(21)	1.433(2)
C(21)-C(22)	1.378(2)
C(21)-C(28)	1.397(2)
C(22)-C(23)	1.386(2)
C(23)-C(24)	1.357(3)
C(23)-H(23)	0.9300
C(24)-C(27)	1.389(3)
C(24)-H(24)	0.9300
C(25)-C(26)	1.375(2)
C(25)-H(25)	0.9300
C(26)-H(26)	0.9300
C(27)-C(28)	1.370(2)
C(27)-H(27)	0.9300
C(28)-H(28)	0.9300

C(8)-O(1)-N(1)	107.85(11)
C(22)-O(2)-N(2)	107.96(11)
C(6)-N(1)-O(1)	106.92(12)
C(20)-N(2)-O(2)	106.71(13)
C(2)-C(1)-H(1A)	109.5
C(2)-C(1)-H(1B)	109.5
H(1A)-C(1)-H(1B)	109.5
C(2)-C(1)-H(1C)	109.5
H(1A)-C(1)-H(1C)	109.5
H(1B)-C(1)-H(1C)	109.5
C(14)-C(2)-C(3)	117.43(14)
C(14)-C(2)-C(1)	120.83(15)
C(3)-C(2)-C(1)	121.74(15)
C(4)-C(3)-C(2)	121.25(14)
C(4)-C(3)-H(3)	119.4

C(2)-C(3)-H(3)	119.4
C(3)-C(4)-C(5)	121.01(14)
C(3)-C(4)-H(4)	119.5
C(5)-C(4)-H(4)	119.5
C(13)-C(5)-C(4)	117.67(13)
C(13)-C(5)-C(6)	121.24(13)
C(4)-C(5)-C(6)	121.09(13)
N(1)-C(6)-C(7)	111.28(13)
N(1)-C(6)-C(5)	118.87(13)
C(7)-C(6)-C(5)	129.85(13)
C(8)-C(7)-C(11)	118.84(14)
C(8)-C(7)-C(6)	104.02(14)
C(11)-C(7)-C(6)	137.13(13)
O(1)-C(8)-C(7)	109.93(14)
O(1)-C(8)-C(9)	126.19(16)
C(7)-C(8)-C(9)	123.88(18)
C(10)-C(9)-C(8)	116.06(16)
C(10)-C(9)-H(9)	122.0
C(8)-C(9)-H(9)	122.0
C(9)-C(10)-C(12)	121.81(16)
C(9)-C(10)-H(10)	119.1
C(12)-C(10)-H(10)	119.1
C(12)-C(11)-C(7)	117.80(15)
C(12)-C(11)-H(11)	121.1
C(7)-C(11)-H(11)	121.1
C(11)-C(12)-C(10)	121.59(18)
C(11)-C(12)-H(12)	119.2
C(10)-C(12)-H(12)	119.2
C(14)-C(13)-C(5)	120.74(14)
C(14)-C(13)-H(13)	119.6
C(5)-C(13)-H(13)	119.6
C(13)-C(14)-C(2)	121.90(14)
C(13)-C(14)-H(14)	119.1
C(2)-C(14)-H(14)	119.1
C(16)-C(15)-H(15A)	109.5
C(16)-C(15)-H(15B)	109.5
H(15A)-C(15)-H(15B)	109.5
C(16)-C(15)-H(15C)	109.5

H(15A)-C(15)-H(15C)	109.5
H(15B)-C(15)-H(15C)	109.5
C(17)-C(16)-C(26)	117.65(14)
C(17)-C(16)-C(15)	120.77(16)
C(26)-C(16)-C(15)	121.56(15)
C(18)-C(17)-C(16)	121.37(14)
C(18)-C(17)-H(17)	119.3
C(16)-C(17)-H(17)	119.3
C(17)-C(18)-C(19)	121.11(13)
C(17)-C(18)-H(18)	119.4
C(19)-C(18)-H(18)	119.4
C(18)-C(19)-C(25)	117.91(13)
C(18)-C(19)-C(20)	121.01(12)
C(25)-C(19)-C(20)	121.06(13)
N(2)-C(20)-C(21)	111.52(13)
N(2)-C(20)-C(19)	119.44(13)
C(21)-C(20)-C(19)	129.03(13)
C(22)-C(21)-C(28)	118.73(14)
C(22)-C(21)-C(20)	103.89(15)
C(28)-C(21)-C(20)	137.35(13)
O(2)-C(22)-C(21)	109.92(14)
O(2)-C(22)-C(23)	126.21(16)
C(21)-C(22)-C(23)	123.85(18)
C(24)-C(23)-C(22)	116.11(16)
C(24)-C(23)-H(23)	121.9
C(22)-C(23)-H(23)	121.9
C(23)-C(24)-C(27)	121.80(16)
C(23)-C(24)-H(24)	119.1
C(27)-C(24)-H(24)	119.1
C(26)-C(25)-C(19)	120.54(14)
C(26)-C(25)-H(25)	119.7
C(19)-C(25)-H(25)	119.7
C(25)-C(26)-C(16)	121.43(14)
C(25)-C(26)-H(26)	119.3
C(16)-C(26)-H(26)	119.3
C(28)-C(27)-C(24)	121.63(19)
C(28)-C(27)-H(27)	119.2
C(24)-C(27)-H(27)	119.2

C(27)-C(28)-C(21)	117.86(15)
C(27)-C(28)-H(28)	121.1
C(21)-C(28)-H(28)	121.1

Symmetry transformations used to generate equivalent atoms:

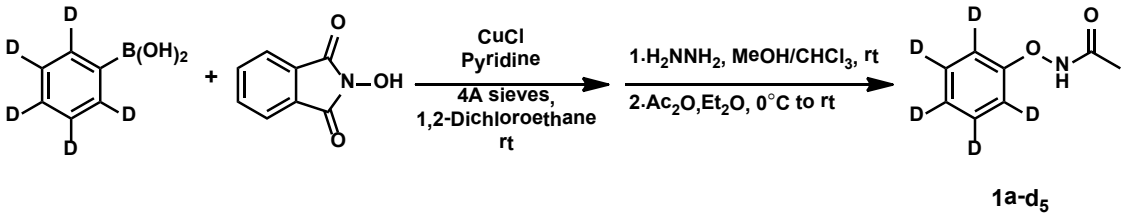
Table S5. Anisotropic displacement parameters ($Å^2 x\ 10^3$)for a. The anisotropic displacement factor exponent takes the form: $-2\pi^2[\ h^2a^{*2}U^{11} + ... + 2\ h\ k\ a^*\ b^*\ U^{12}\ ]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
O(1)	67(1)	69(1)	118(1)	15(1)	8(1)	-13(1)
O(2)	74(1)	72(1)	132(1)	-5(1)	21(1)	16(1)
N(1)	68(1)	58(1)	102(1)	10(1)	3(1)	-6(1)
N(2)	75(1)	59(1)	112(1)	-2(1)	15(1)	8(1)
C(1)	64(1)	100(2)	104(2)	2(1)	9(1)	14(1)
C(2)	61(1)	59(1)	60(1)	4(1)	0(1)	9(1)
C(3)	75(1)	57(1)	63(1)	-7(1)	4(1)	15(1)
C(4)	74(1)	46(1)	59(1)	-4(1)	-4(1)	3(1)
C(5)	61(1)	45(1)	46(1)	1(1)	-1(1)	2(1)
C(6)	64(1)	49(1)	50(1)	4(1)	-2(1)	-5(1)
C(7)	57(1)	58(1)	44(1)	0(1)	2(1)	1(1)
C(8)	64(1)	67(1)	61(1)	4(1)	4(1)	-7(1)
C(9)	57(1)	106(2)	78(1)	3(1)	10(1)	-6(1)
C(10)	63(1)	105(2)	75(1)	-14(1)	7(1)	14(1)
C(11)	64(1)	61(1)	65(1)	-6(1)	4(1)	0(1)
C(12)	71(1)	71(1)	86(1)	-15(1)	3(1)	11(1)
C(13)	65(1)	50(1)	59(1)	-8(1)	4(1)	2(1)
C(14)	65(1)	53(1)	65(1)	-6(1)	-1(1)	-2(1)
C(15)	65(1)	97(2)	109(2)	7(1)	6(1)	-1(1)
C(16)	63(1)	60(1)	57(1)	6(1)	4(1)	-5(1)
C(17)	71(1)	54(1)	61(1)	-4(1)	11(1)	0(1)
C(18)	67(1)	51(1)	53(1)	-6(1)	4(1)	-8(1)
C(19)	63(1)	46(1)	45(1)	3(1)	2(1)	-3(1)
C(20)	67(1)	48(1)	51(1)	0(1)	4(1)	5(1)
C(21)	57(1)	60(1)	45(1)	4(1)	2(1)	1(1)
C(22)	68(1)	68(1)	66(1)	4(1)	9(1)	9(1)
C(23)	60(1)	110(2)	81(1)	8(1)	13(1)	9(1)
C(24)	65(1)	105(2)	78(1)	18(1)	5(1)	-14(1)
C(25)	78(1)	48(1)	54(1)	-3(1)	6(1)	-5(1)
C(26)	76(1)	59(1)	58(1)	-1(1)	-1(1)	-17(1)
C(27)	70(1)	74(1)	89(1)	16(1)	2(1)	-10(1)
C(28)	65(1)	61(1)	70(1)	11(1)	1(1)	-1(1)

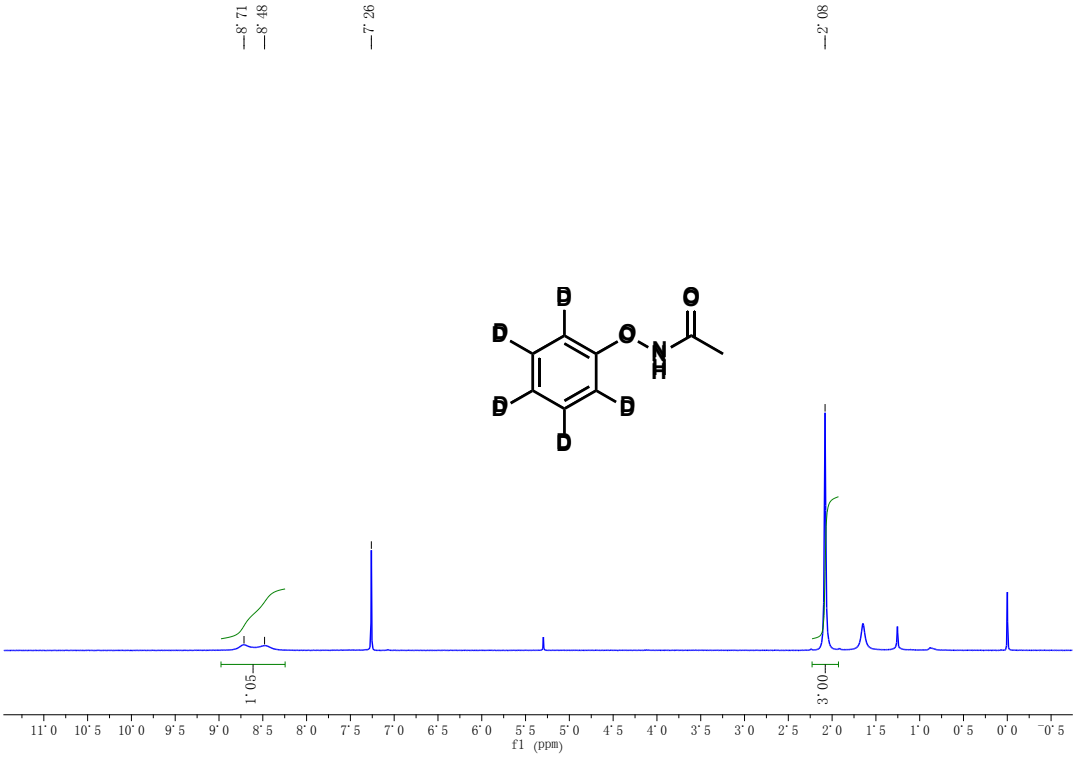
6. Mechanistic Studies

6.1 KIE Experiment

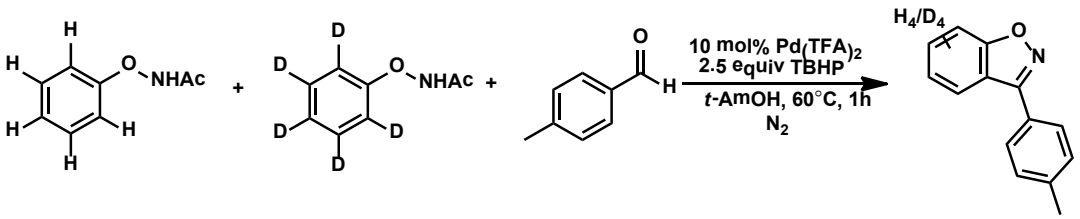
Synthesis of deuterated substrate 1a-d_5



Following the general procedure for the synthesis of substrate **1**[1], deuterated substrate **1a-d_5** was obtained from (d_5-phenyl)boronic acid.

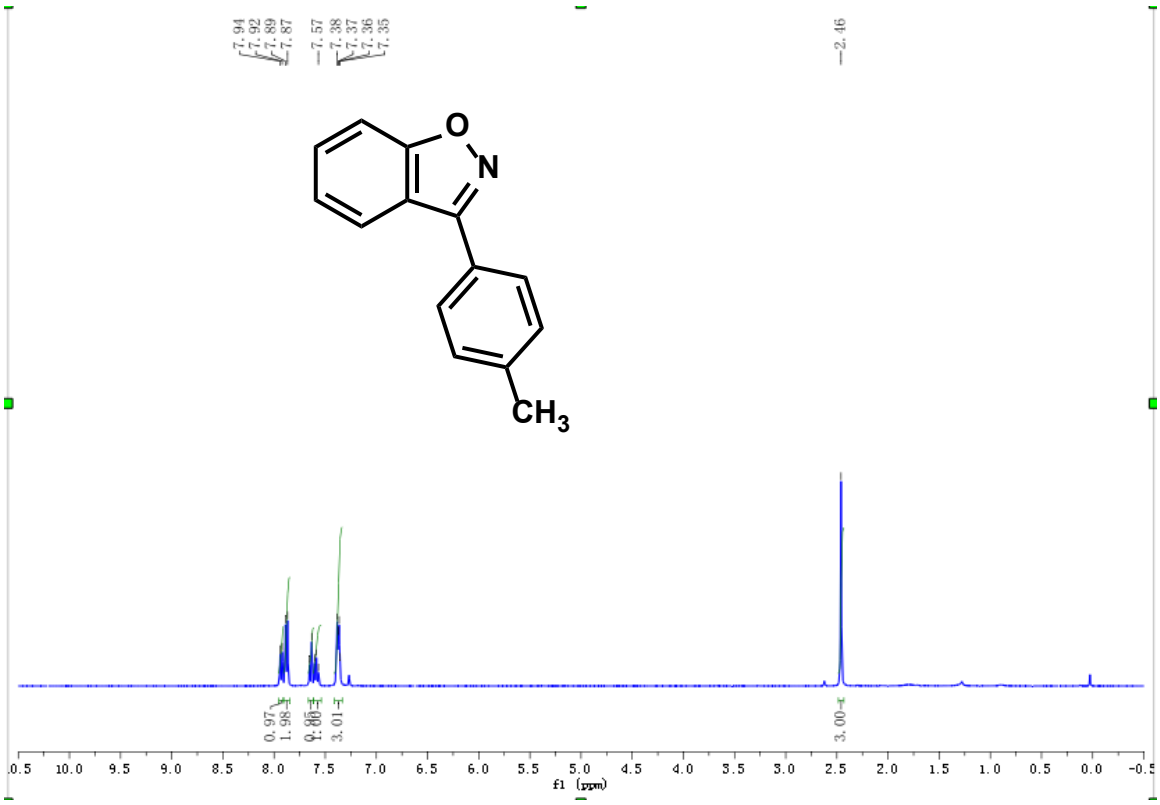


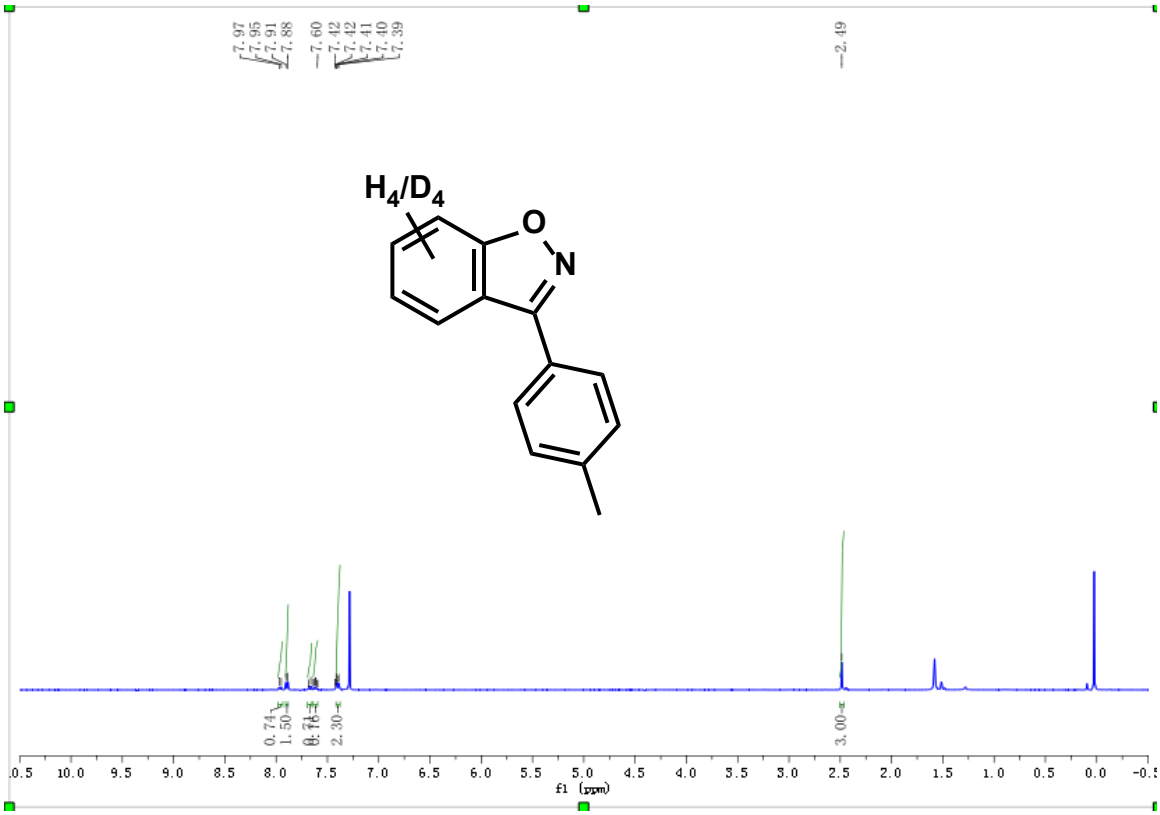
Intermolecular Kinetic Isotope Effect



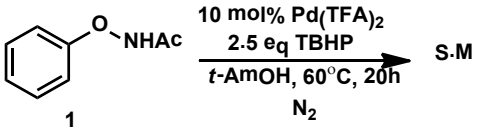
A mixture of **1a-d_5** (31.2 mg, 0.2 mmol), **1a** (30.2 mg, 0.2 mmol), $Pd(TFA)_2$ (6.6mg, 10 mol%), *p*-tolualdehyde (23.6μl, 0.2 mmol) and TBHP (0.06 ml, 0.5 mmol) in *tert*-Amyl alcohol (1ml) was stirred at 60℃ for 1h under N_2 atmosphere. The solvent was evaporated to dryness in vacuo. The residual was separated on a silica gel column to get the products.

The intermolecular KIE was determined by ^{1}HNMR: $\mathbf{K_H/K_D=3.2}$





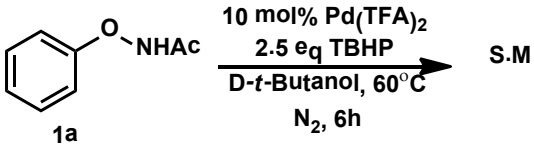
6.2



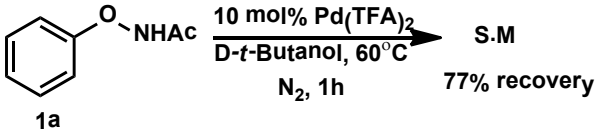
N-Phenoxyacetamides substrates (**1**) (0.4 mmol) and $Pd(TFA)_2$ (10 mol%) were weighed into a 25ml pressure tube, to which was added *tert*-Amyl alcohol (1 ml) and TBHP (1 mmol) in a glove box. The reaction vessel was stirred at 60℃ for 20 h. The solvent was evaporated and the residue was purified by column chromatography on silica gel.

We only obtained the starting material 1. No phenyl acetate was observed, which ruled out the possibility of nitrogen radical initiation.

6.3

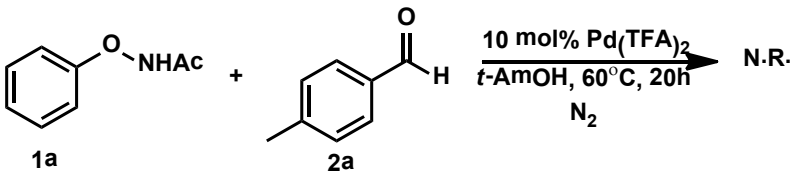


N-Phenoxyacetamides substrates (**1**) (0.4 mmol) and $Pd(TFA)_2$ (10 mol%) were weighed into a 25mL pressure tube, to which was added D-*tert*-Butanol (1 ml) and TBHP (1 mmol) in a glove box. The reaction vessel was stirred at 60℃ for 6 h. The solvent was evaporated and the residue was purified by column chromatography on silica gel. We only recovered the starting material without any D-compound.



Then we carried the experiment without TBHP and reducing the reaction time to 1h, the result was consisted with that above mentioned. So we concluded that the C-H activation was irreversible.

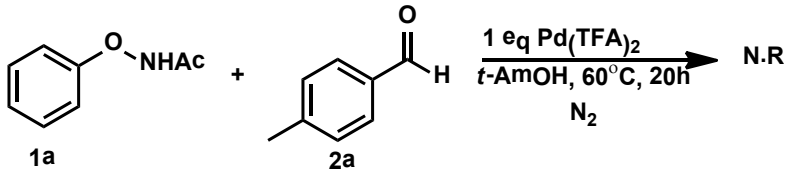
6.4



N-Phenoxyacetamides substrates (**1**) (0.4 mmol) and $Pd(TFA)_2$ (10 mol%) were weighed into a 25mL pressure tube, to which was added *t*ert-Amyl alcohol (1 ml) and aldehyde (0.8 mmol) in a glove box. The reaction vessel was stirred at 60℃ for 20 h. The solvent was evaporated and the residue was purified by column chromatography on silica gel.

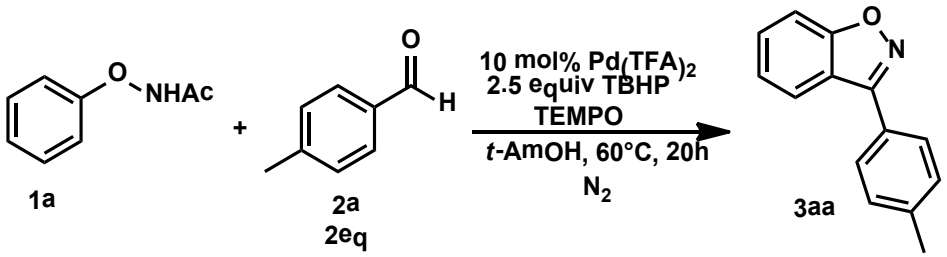
No product was obtained and the aldehyde was recovered which demonstrated that

aldehyde could be only transformed when TBHP was present.



When the loading of catalyst was increased to 1equivalent, we failed to obtain the desired product, which rejected a catalytic cycle involving Pd(II)/Pd(0)/Pd(II) process.

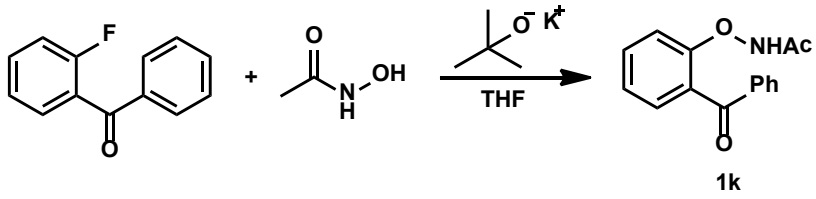
6.5 Effect of radical scavenger[a,b]



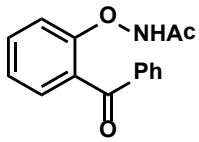
Entry	TEMPO (mol%)	Yield(GC)
1	10	60%
2	50	21%
3	100	N.R.
4	200	N.R.

[a]The reactions were carried out in a 0.1 mmol-scale of 1a.
[b]Yield was determined by GC using mesitylene as internal standard.

6.6

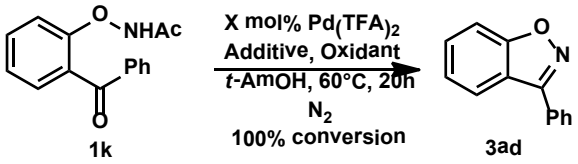


Potassium *tert*-butoxide (1.24g, 11mmol) was added to a solution of acetohydroxamic acid (0.83g, 11 mmol) in dry THF (15 ml). After stirring for 1 h, 2-fluorobenzophenone (1.7ml, 10 mmol) in THF (15 ml) was added, and the reaction was brought to reflux. After refluxing for overnight, the reaction mixture was cooled and distributed between ether and saturated aqueous ammonium chloride solution, after which the organic layer was separated, dried ($MgSO_4$), and evaporated, then purified by flash silica gel column chromatography to give the corresponding product (**1k**).[2]



1k, white solid, 5%

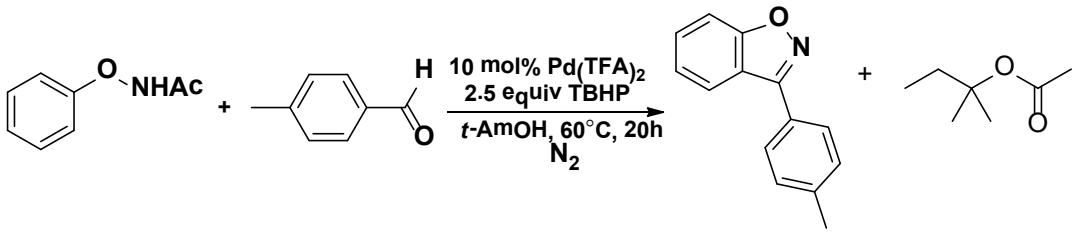
^{1}H NMR (500 MHz, DMSO): δ11.66 (s, 1H), 7.78 (d, J=7.4, 2H), 7.65 (t, J=7.2, 1H), 7.51 (t, J=7.4, 3H), 7.35 (d, J=7.0, 1H), 7.25 – 7.13 (m, 2H), 1.82 (s, 3H); **^{13}C NMR (126 MHz, DMSO):** δ195.07, 167.90, 157.15, 137.23, 134.01, 132.32, 129.99, 129.40, 129.12, 126.60, 122.79, 112.99, 19.74. **IR (cm^{-1}):** 3117, 2928, 1653, 1508, 928, 756. **HRMS (ESI)** calculated for $C_{15}H_{13}NO_3Na(+)$: 278.0895; Found: 278.0786.



Entry	X	Additive	Oxidant	Yield(GC)
1	10 mol% $Pd(TFA)_2$	-	-	86%
2	10 mol% $Pd(TFA)_2$	1 eq TFA	-	73%
3	10 mol% $Pd(TFA)_2$	-	2.5 eq TBHP	19%

The starting materials were all exclusively converted to the product by GC detection, which indicated that the starting material **1k** was the intermediate in the process of the reaction.

6.7

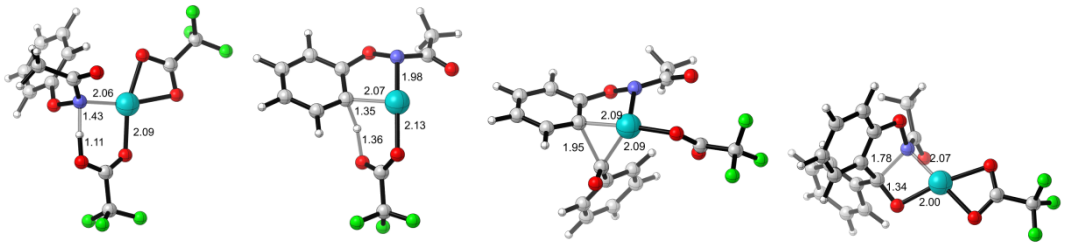


We observed the generation of *tert*-pentyl acetate under our standard reaction conditions by GC-MS.

7. DFT Calculations

All the calculations were carried out with the Gaussian 09 package.[3] Geometry optimization and energy calculations were performed with the B3LYP method.[4] The 6-31G (d) basis set was used for all atoms except Pd, for which a LANL2DZ basis set with ECP was used. Single point energy calculations were then carried out on the above-obtained geometries at the M06[5]/SDD[6]-6-311++G (d, p) level and solvent effect (solvent = ^{t}BuOH) was calculated using the SMD[7]

solvation model. Computed structures were illustrated using CYLVIEW[8] drawings.



TS1_A **TS2_A** **TS3_A** **TS4_A**

Figure S2. The structures of four transition states.

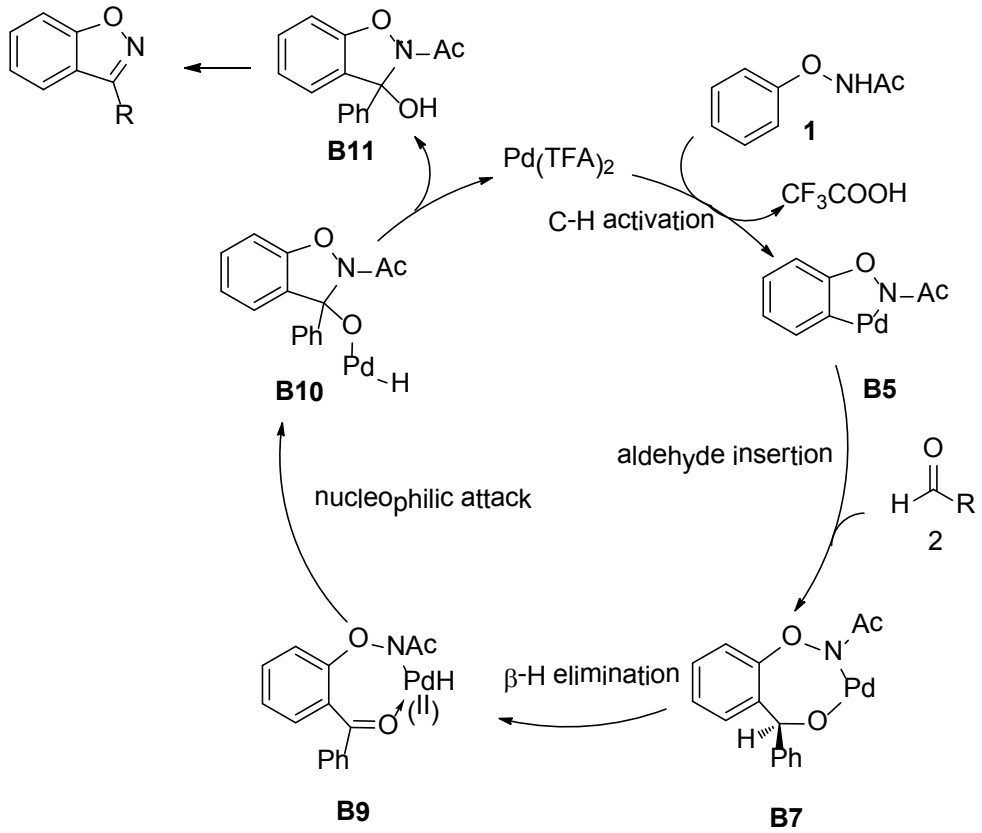


Figure S3. A catalytic cycle involving direct aldehyde insertion.

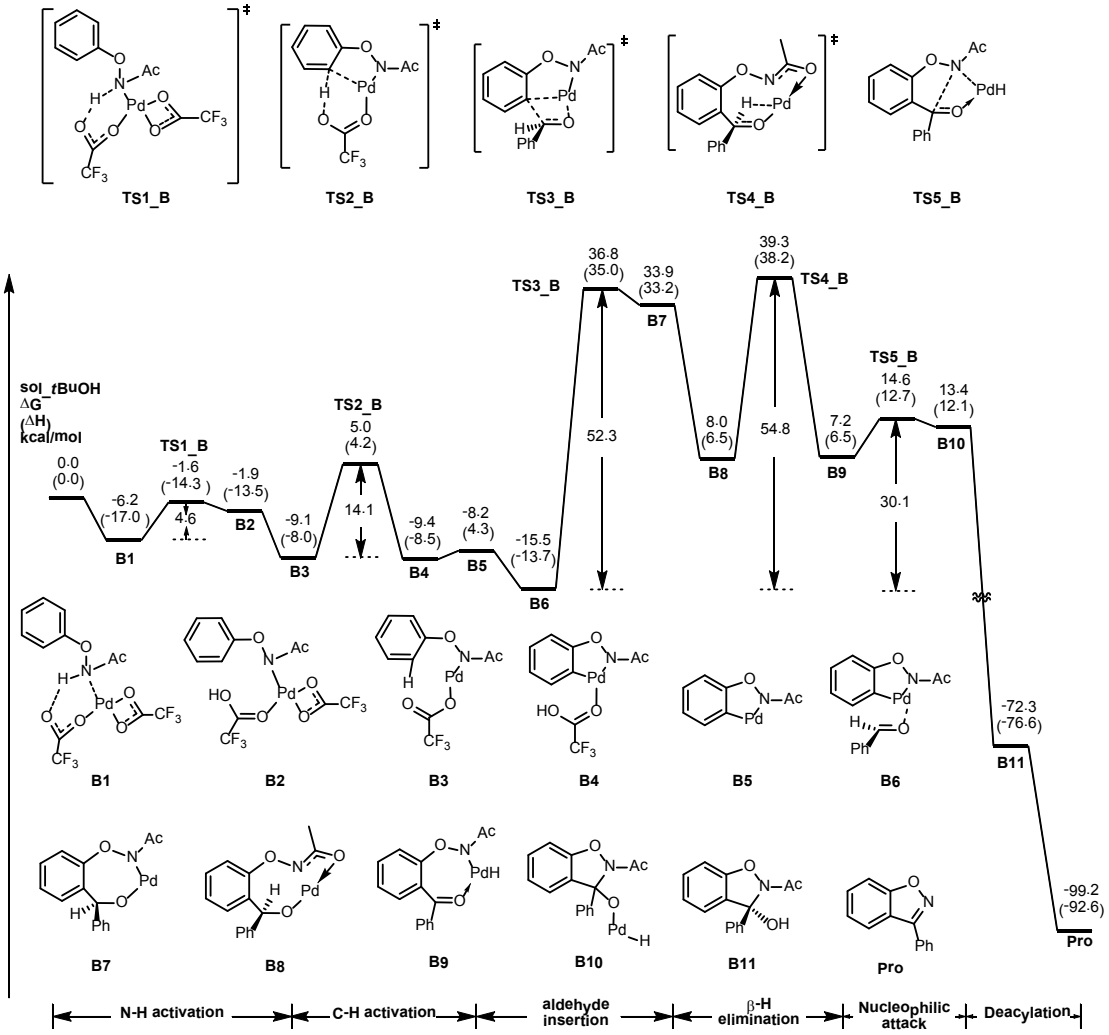


Figure S4. Gibbs free energy profile for the mechanism in Figure S3.

The C-H activation step gave palladcycle intermediate **B5**. In the main text, radical addition of acyl radical generated from aldehyde by TBHP gave intermediate **A6**. Alternatively, the benzaldehyde could coordinate to intermediate **B5** and the direct aldehyde insertion led to the intermediate **B7**. β-Hydrogen elimination of **B7** could form intermediate **B9** which was similar to **A8** in the radical mechanism shown in the main text. The calculation results showed that the aldehyde insertion was the rate-determining step with very high activation energy of 52.3kcal/mol. Therefore, this mechanism was not reasonable in our case.

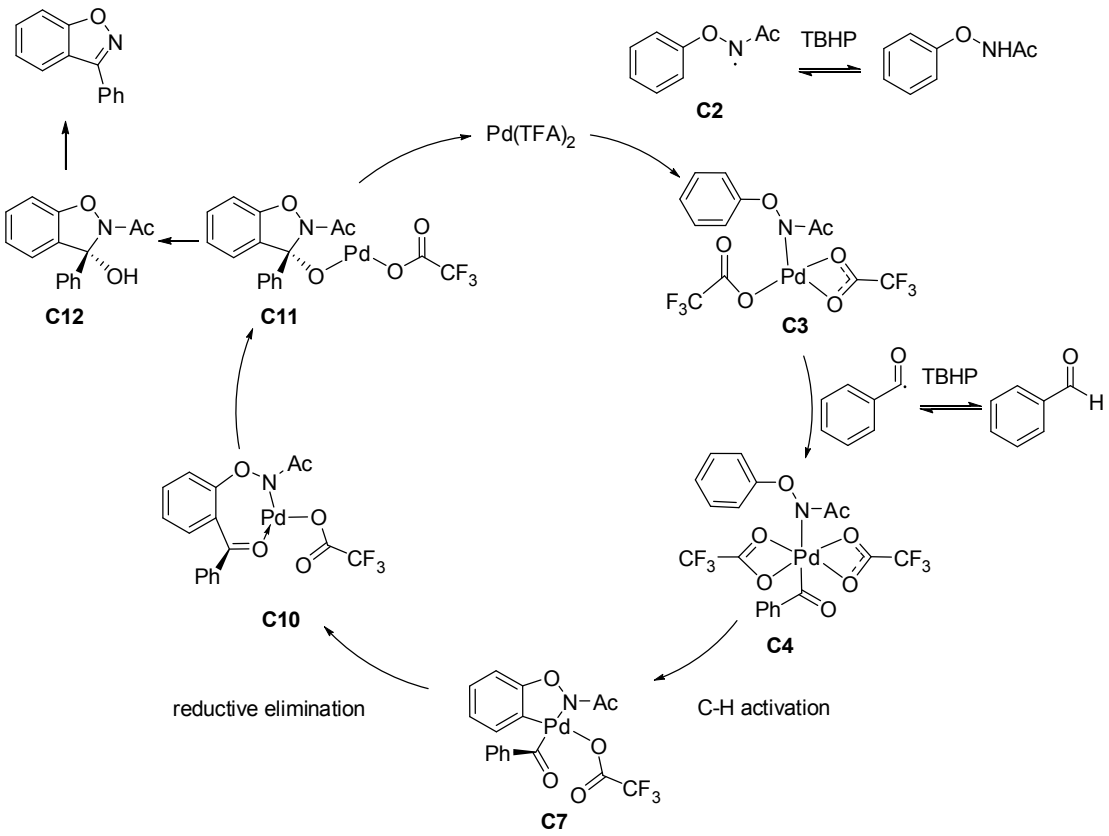


Figure S5. A mechanism proposed involving nitrogen radical initiation.

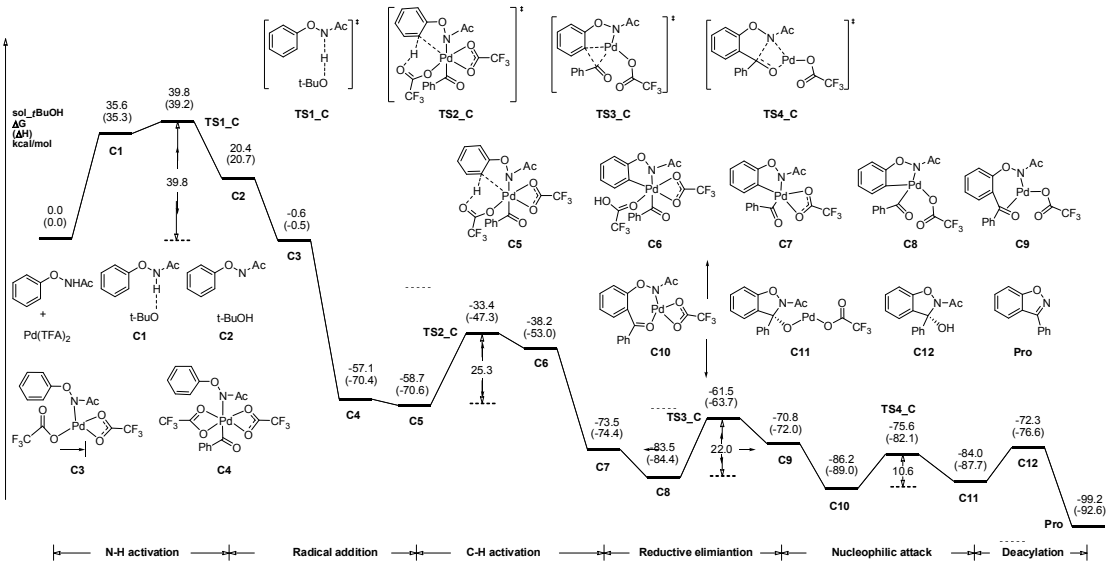


Figure S6. Gibbs free energy profile for the mechanism in Figure S5.

As shown in Figure S5, a mechanism involving nitrogen radical initiation was proposed which was similar to the mechanism reported by Kang Zhao and coworkers.[9] The radical activation of N-phenoxyacetamides gave the amide nitrogen radical that underwent radical addition to form a Pd^{III} radical intermediate **C3.** This step costed activation energy of 39.8 kcal/mol (Figure S6) and is the

rate-determining step. Therefore, we excluded this mechanism in our case. The following steps, C-H activation, reductive elimination, nucleophilic attack and deacylation were similar to the steps in the mechanism proposed in the main text.

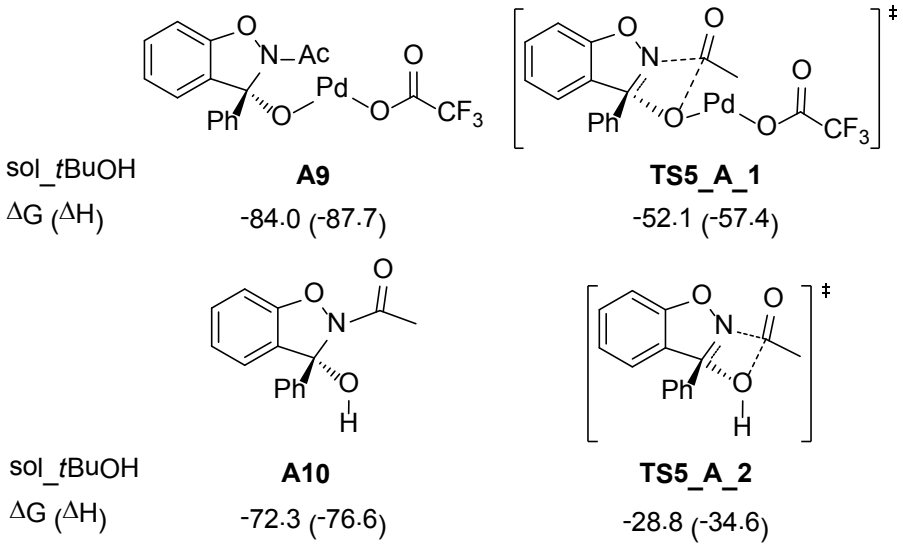


Figure S7. Gibbs free energy for elimination reaction.

In our computational study, we considered the pathway from **A9** to **TS5_A_1**, in which the attack of the Ac group took place before hydrolysis. This pathway had a very high barrier. We further calculated the pathway of intramolecular N to O acetyl transfer. The calculation suggested that this pathway also had a very high barrier (43.5kcal/mol) and was unlikely to occur.

Table S6. Energies of structures on pathway A (single point energy were calculated at the M06/SDD，6-311++G(d,p) level of theory in solvent).

Structure	E	H	G	ΔE	ΔH	ΔG
$PdTFA_2$	-1180.20762	-1180.135581	-1180.194879	0.0	0.0	0.0
Sub	-515.229752	-515.059459	-515.108106	0.0	0.0	0.0
PhCHO	-345.42276	-345.305264	-345.343008	---	---	---
***t*BuOH**	-233.588721	-233.444878	-233.481574	---	---	---
***t*BuOOH**	-308.707438	-308.558983	-308.598826	---	---	---
TFA	-526.760288	-526.713979	-526.752715	---	---	---
***t*AmOH**	-272.879249	-272.705224	-272.745127	---	---	---
***t*AmylOAc**	-425.490055	-425.274283	-425.322893	---	---	---
H_2O	-76.430296	-76.405377	-76.426822	---	---	---
A1	-1695.466999	-1695.222146	-1695.312811	-18.6	-17.0	-6.2
TS1_A	-1695.45871	-1695.217815	-1695.305585	-13.4	-14.3	-1.6
A2	-1695.45883	-1695.216476	-1695.306073	-13.5	-13.5	-1.9
A3	-1168.689146	-1168.493761	-1168.564754	-7.6	-8.0	-9.1
TS2_A	-1168.66446	-1168.474363	-1168.542345	7.9	4.2	5.0

A4	-1168.690799	-1168.494632	-1168.565234	-8.6	-8.5	-9.4
A5	-641.907893	-641.760182	-641.810589	5.6	4.3	-8.2
A6	-1512.905929	-1512.613631	-1512.700786	-73.8	-74.4	-73.5
TS3_A	-1512.887083	-1512.596567	-1512.681668	-62.0	-63.7	-61.5
A7	-1512.901832	-1512.609766	-1512.696529	-71.3	-72.0	-70.8
A8	-1512.930839	-1512.636938	-1512.721055	-89.5	-89.0	-86.2
TS4_A	-1512.917	-1512.625873	-1512.704163	-80.8	-82.1	-75.6
A9	-1512.928973	-1512.634814	-1512.717638	-88.3	-87.7	-84.0
A10	-859.462627	-859.195512	-859.256766	-76.4	-76.6	-72.3
Pro	-630.444771	-630.246519	-630.295086	-91.0	-92.6	-99.2

Table S7. Energies of structures on pathway B (single point energy were calculated at the M06/SDD，6-311++G(d,p) level of theory in solvent).

Structure	E	H	G	ΔE	ΔH	ΔG
B1(A1)	-1695.466999	-1695.222146	-1695.312811	-18.6	-17.0	-6.2
TS1_B(TS1_A)	-1695.45806	-1695.217165	-1695.304935	-13.4	-14.3	-1.6
B2(A2)	-1695.45883	-1695.216476	-1695.306073	-13.5	-13.5	-1.9
B3(A3)	-1168.689146	-1168.493761	-1168.564754	-7.6	-8.0	-9.1
TS2_B(TS2_A)	-1168.66446	-1168.474363	-1168.542345	7.9	4.2	5.0
B4(A4)	-1168.690799	-1168.494632	-1168.565234	-8.6	-8.5	-9.4
B5(A5)	-641.907893	-641.760182	-641.810589	5.6	4.3	-8.2
B6	-987.362193	-987.094196	-987.165291	-14.2	-13.7	-15.5
TS3_B	-987.282708	-987.01655	-987.081859	35.7	35.0	36.8
B7	-987.286962	-987.019475	-987.086486	33.0	33.2	33.9
B8	-987.330762	-987.062046	-987.127892	5.5	6.5	8.0
TS4_B	-987.273407	-987.011537	-987.077872	41.5	38.2	39.3
B9	-987.327416	-987.062022	-987.129096	7.6	6.5	7.2
TS5_B	-987.315809	-987.052085	-987.117348	14.9	12.7	14.6
B10	-987.317828	-987.053012	-987.119255	13.6	12.1	13.4
B11(A10)	-859.462627	-859.195512	-859.256766	-76.4	-76.6	-72.3
Pro	-630.444771	-630.246519	-630.295086	-91.0	-92.6	-99.2

Table S8. Energies of structures on pathway C (single point energy were calculated at the M06/SDD，6-311++G(d,p) level of theory in solvent).

Structure	E	H	G	ΔE	ΔH	ΔG
C1	-748.147349	-747.845061	-747.912885	38.4	35.3	35.6
TS1_C	-748.135933	-747.838773	-747.906078	45.5	39.2	39.8
C2	-748.171957	-747.868272	-747.937107	22.9	20.7	20.4
C3	-1694.824926	-1694.592854	-1694.683868	1.5	-0.5	-0.6
C4	-2039.661408	-2039.3213	-2039.427358	-70.8	-70.4	-57.1
C5	-2039.661532	-2039.321544	-2039.429966	-70.9	-70.6	-58.7
TS2_C	-2039.618919	-2039.284471	-2039.389697	-44.2	-47.3	-33.4

C6	-2039.633446	-2039.293511	-2039.397244	-53.3	-53.0	-38.2
C7(A6)	-1512.905929	-1512.613631	-1512.700786	-73.8	-74.4	-73.5
C8	-1512.92294	-1512.629631	-1512.71672	-84.5	-84.4	-83.5
TS3_C(TS3_A)	-1512.887083	-1512.596567	-1512.681668	-62.0	-63.7	-61.5
C9(A7)	-1512.901832	-1512.609766	-1512.696529	-71.3	-72.0	-70.8
C10(A8)	-1512.930839	-1512.636938	-1512.721055	-89.5	-89.0	-86.2
TS4_C(TS4_A)	-1512.917	-1512.625873	-1512.704163	-80.8	-82.1	-75.6
C11(A9)	-1512.928973	-1512.634814	-1512.717638	-88.3	-87.7	-84.0
C12(A10)	-859.462627	-859.195512	-859.256766	-76.4	-76.6	-72.3
Pro	-630.444771	-630.246519	-630.295086	-91.0	-92.6	-99.2

Cartesian coordinates (in Å) of related structures which were calculated at the B3LYP/Lanl2dz + 6-31G(d) level of theory.

TS1_A

Cartesian coordinates

ATOM	X	Y	Z
H	-2.036334	0.508439	1.071182
C	2.274792	-1.692125	-0.100031
O	1.293520	-2.253461	-0.658687
O	2.113494	-0.614440	0.558902
C	3.689691	-2.272048	-0.248615
O	-1.825252	-1.162503	-0.602053
C	-2.893679	-0.774976	-0.091133
O	-3.035742	0.087074	0.840954
C	-4.209961	-1.352949	-0.657923
C	2.062879	4.227909	-1.754739
C	0.706289	4.495719	-1.964742
C	-0.268491	3.777483	-1.277704
C	0.122061	2.788683	-0.368651
C	1.469125	2.506933	-0.143154
C	2.433516	3.235329	-0.849077
H	2.820971	4.785639	-2.296234
H	0.403290	5.263943	-2.670592
H	-1.326475	3.966615	-1.429445
H	1.779800	1.732388	0.546357
H	3.483520	3.013924	-0.680123
O	-0.946290	2.169889	0.276295
N	-0.693655	1.011864	1.053440
C	-0.237565	1.241494	2.386106
C	-0.301086	2.656876	2.914155
H	0.440934	3.288742	2.415516

TS2_A

Cartesian coordinates

ATOM	X	Y	Z
N	-2.360417	-0.807169	-0.268261
O	1.701609	-0.709260	-0.785686
O	1.603994	0.555243	1.091532
C	2.201815	-0.133318	0.214781
C	3.738919	-0.219034	0.365497
C	-2.031563	1.345935	0.385623
C	-0.688939	1.227865	-0.096736
C	-2.639216	2.594496	0.559597
C	-0.088582	2.407413	-0.616654
H	0.331789	0.764422	0.665739
C	-1.960943	3.732559	0.140798
H	-3.650560	2.646619	0.948717
C	-0.698559	3.643303	-0.472852
H	0.906477	2.340114	-1.046323
H	-2.435404	4.703343	0.254961
H	-0.197769	4.542333	-0.818462
O	-2.760775	0.239287	0.641647
C	-2.578891	-2.074081	0.235956
C	-3.638788	-2.323778	1.273569
H	-3.340104	-1.876922	2.228519
H	-4.586075	-1.861510	0.978656
H	-3.765881	-3.400444	1.397878
O	-1.864675	-2.953346	-0.265920
Pd	-0.421946	-0.746627	-0.675264
F	4.092741	-0.278864	1.655624

H	-1.284525	3.100233	2.731124	F	4.234619	-1.289200	-0.264061
H	-0.092371	2.625541	3.984363	F	4.287885	0.887341	-0.175983
O	0.094914	0.275051	3.041657				
Pd	0.068236	-0.648419	0.106986				
F	3.640586	-3.596620	-0.419308				
F	4.430260	-1.995405	0.831075				
F	4.279110	-1.720220	-1.325693				
F	-3.995351	-2.526912	-1.253176				
F	-5.108519	-1.513924	0.319212				
F	-4.703270	-0.489594	-1.562230				

TS3_A

Cartesian coordinates

ATOM	X	Y	Z
N	-0.132606	-1.488437	1.172596
C	-2.330244	-1.241224	0.621343
C	-1.909608	-1.023430	-0.711042
C	-3.634670	-1.640708	0.924060
C	-2.795028	-1.362772	-1.754483
C	-4.503923	-1.910093	-0.127802
H	-3.925905	-1.790579	1.958371
C	-4.081414	-1.798155	-1.464223
H	-2.482884	-1.208607	-2.783007
H	-5.516616	-2.236578	0.090716
H	-4.770524	-2.027493	-2.271272
O	-1.431493	-1.089002	1.619156
C	0.815872	-1.330105	2.213944
C	0.287930	-1.003595	3.598496
H	-0.190948	-0.019232	3.609194
H	-0.459402	-1.734959	3.920616
H	1.137601	-1.011541	4.282145
O	1.983249	-1.558791	1.977571
O	2.201789	-0.626530	-0.910098
O	2.254422	1.096890	0.562091
C	2.769577	0.305834	-0.215860
C	4.293787	0.371014	-0.488863
F	4.876973	-0.824938	-0.294092
F	4.518875	0.738495	-1.770208
F	4.896855	1.264426	0.307219
Pd	0.176640	-0.858529	-0.725489
C	-1.128875	0.683460	-1.248862
O	-0.922045	0.714390	-2.440758
C	-1.522248	1.802765	-0.366768
C	-0.878291	2.054937	0.851560

TS4_A

Cartesian coordinates

ATOM	X	Y	Z
N	0.684857	-0.022802	1.006720
C	1.402695	2.109670	0.757717
C	1.816392	1.540933	-0.438851
C	1.533890	3.465590	1.035580
C	2.397610	2.351606	-1.413800
C	2.120522	4.265157	0.051907
H	1.188787	3.874281	1.979370
C	2.547505	3.717689	-1.164140
H	2.721599	1.918562	-2.355579
H	2.239315	5.328957	0.236215
H	2.992668	4.358419	-1.919073
O	0.837163	1.235993	1.666798
C	0.993315	-1.128832	1.888434
C	1.595006	-0.789500	3.228457
H	2.521898	-0.220701	3.101076
H	0.910083	-0.169265	3.814800
H	1.796353	-1.724919	3.752170
O	0.766486	-2.245922	1.488929
O	-2.923927	-0.118611	0.899404
O	-2.800975	-0.340844	-1.290992
C	-3.485165	-0.253450	-0.227600
C	-5.018464	-0.332678	-0.288715
F	-5.433922	-1.479250	0.277894
F	-5.561147	0.693558	0.386039
F	-5.454388	-0.296596	-1.551636
Pd	-1.039242	-0.180255	-0.129719
C	1.539955	0.058692	-0.551109
O	0.535811	-0.314373	-1.354740
C	2.739037	-0.848318	-0.585945
C	2.613401	-2.121523	-1.160278

C	-2.545716	2.648720	-0.828589	C	3.973874	-0.450001	-0.049480
C	-1.273200	3.156738	1.610470	C	3.710899	-2.978923	-1.205192
H	-0.027584	1.452455	1.150063	H	1.653766	-2.416426	-1.567560
C	-2.944796	3.729426	-0.048270	C	5.066493	-1.315046	-0.087065
H	-3.019445	2.448679	-1.784693	H	4.082932	0.539054	0.385651
C	-2.310289	3.982570	1.172142	C	4.936964	-2.579427	-0.667694
H	-0.758218	3.375381	2.541140	H	3.608039	-3.962052	-1.655666
H	-3.741314	4.380538	-0.396506	H	6.019766	-0.999632	0.327922
H	-2.616857	4.833513	1.774057	H	5.790614	-3.251061	-0.701699

A1

Cartesian coordinates

ATOM	X	Y	Z
H	-1.642941	0.457747	1.531935
C	2.457106	-1.308999	-0.162076
O	1.506276	-1.905732	-0.739370
O	2.223941	-0.323051	0.608850
C	3.911172	-1.729128	-0.423969
O	-1.604797	-1.138450	-0.531894
C	-2.723184	-1.029975	0.090905
O	-2.972576	-0.447350	1.149129
C	-3.872781	-1.742630	-0.670513
C	0.877366	3.845203	-2.445115
C	-0.513879	3.919844	-2.335614
C	-1.168004	3.329610	-1.255409
C	-0.415270	2.678551	-0.276880
C	0.975881	2.602878	-0.361063
C	1.613442	3.184330	-1.461535
H	1.383071	4.295634	-3.293825
H	-1.096354	4.426345	-3.099683
H	-2.248085	3.361904	-1.156620
H	1.564500	2.095258	0.394250
H	2.695028	3.120566	-1.538065
O	-1.162429	2.199515	0.800834
N	-0.726301	0.977257	1.396315
C	-0.084171	1.159887	2.713191
C	0.109059	2.572165	3.189417
H	0.724373	3.143662	2.487700
H	-0.856621	3.083317	3.258953
H	0.590390	2.537675	4.167407
O	0.200524	0.155438	3.310883
Pd	0.171167	-0.522387	0.204990
F	3.977693	-3.016961	-0.770950
F	4.661216	-1.527120	0.665956

A2

Cartesian coordinates

ATOM	X	Y	Z
H	-2.061479	0.505265	1.073292
C	2.271040	-1.700640	-0.101594
O	1.287742	-2.262234	-0.656034
O	2.113539	-0.620511	0.554429
C	3.684799	-2.283043	-0.251670
O	-1.833262	-1.160913	-0.596179
C	-2.901407	-0.771924	-0.090683
O	-3.045533	0.093757	0.841420
C	-4.219562	-1.346231	-0.656262
C	2.071000	4.236457	-1.750600
C	0.714328	4.506577	-1.957110
C	-0.260027	3.785059	-1.272919
C	0.130958	2.790389	-0.370451
C	1.478086	2.505967	-0.148817
C	2.442033	3.238073	-0.851468
H	2.828812	4.796877	-2.289711
H	0.410959	5.279473	-2.657696
H	-1.318069	3.976224	-1.421795
H	1.788772	1.726859	0.535528
H	3.492105	3.014789	-0.685371
O	-0.937071	2.166910	0.270777
N	-0.682810	1.013080	1.052482
C	-0.224708	1.245256	2.381178
C	-0.289861	2.661683	2.907754
H	0.455913	3.291926	2.412607
H	-1.271543	3.106638	2.719576
H	-0.086310	2.630951	3.978990
O	0.111972	0.281168	3.039227
Pd	0.067272	-0.650432	0.109554
F	3.633386	-3.608024	-0.418845
F	4.428291	-2.004807	0.825615

F	4.407441	-0.983724	-1.429304	F	4.272798	-1.734955	-1.331481
F	-3.573588	-3.035894	-0.874181	F	-4.006258	-2.517423	-1.256705
F	-5.017791	-1.673968	0.015216	F	-5.115282	-1.510786	0.322840
F	-4.058403	-1.156384	-1.867990	F	-4.714399	-0.478650	-1.555375

A3

Cartesian coordinates

ATOM	X	Y	Z
N	-2.304774	-0.918172	-0.405421
O	1.688844	-0.563030	-0.621832
O	2.023049	0.397832	1.402497
C	2.403918	-0.099968	0.349007
C	3.920347	-0.185640	0.038213
C	-2.353191	1.289600	0.136184
C	-0.984735	1.232778	0.554378
C	-2.932520	2.491157	-0.277120
C	-0.197557	2.414748	0.455412
H	-0.725016	0.545309	1.379942
C	-2.133514	3.627583	-0.337275
H	-3.970209	2.504710	-0.591942
C	-0.765126	3.590866	0.004439
H	0.834761	2.358784	0.782418
H	-2.571387	4.559810	-0.683389
H	-0.168782	4.494822	-0.066580
O	-3.095186	0.159596	0.120937
C	-2.662275	-2.151020	0.136755
C	-4.005105	-2.333500	0.793721
H	-4.052032	-1.762097	1.727349
H	-4.806914	-1.964907	0.145887
H	-4.149913	-3.393933	1.005336
O	-1.826525	-3.041372	-0.009277
Pd	-0.321385	-0.659112	-0.376518
F	4.655143	0.068533	1.128969
F	4.261558	-1.401985	-0.423876
F	4.245932	0.724566	-0.905332

A4

Cartesian coordinates

ATOM	X	Y	Z
N	-2.377048	-0.908616	-0.321486
O	1.747368	-0.612826	-0.694240
O	1.915651	0.585645	1.221834
C	2.393133	-0.100768	0.213075
C	3.932749	-0.194332	0.241164
C	-2.288089	1.307636	0.164942
C	-0.935650	1.196515	-0.234810
C	-2.866368	2.559775	0.390783
C	-0.201187	2.360286	-0.476109
H	0.930638	0.674367	1.112160
C	-2.094802	3.706800	0.203170
H	-3.908034	2.620991	0.689444
C	-0.771984	3.616578	-0.236357
H	0.819071	2.300340	-0.846671
H	-2.541259	4.680944	0.382198
H	-0.184095	4.515472	-0.397490
O	-3.038400	0.190007	0.337462
C	-2.605933	-2.137279	0.236760
C	-3.829503	-2.367513	1.087139
H	-3.742167	-1.813334	2.028388
H	-4.729487	-2.005789	0.579977
H	-3.917729	-3.435080	1.295846
O	-1.780317	-3.019558	-0.049822
Pd	-0.426784	-0.702885	-0.553017
F	4.347500	-0.600593	1.447180
F	4.360269	-1.050056	-0.683707
F	4.447327	1.019849	-0.009594

A5

Cartesian coordinates

ATOM	X	Y	Z
N	-1.079960	0.595651	-0.512695
C	1.111078	1.010520	-0.069832
C	1.205544	-0.390856	0.042448
C	2.262993	1.800406	-0.069800

A6

Cartesian coordinates

ATOM	X	Y	Z
N	1.819317	-1.838157	-0.148624
C	2.700851	-0.215200	1.158598
C	1.359590	0.143602	1.353766
C	3.705917	0.371071	1.936500

C	2.451504	-1.004563	0.105968
C	3.506439	1.176041	0.043660
H	2.177082	2.878016	-0.167048
C	3.609212	-0.215003	0.127940
H	2.531592	-2.088084	0.164123
H	4.405745	1.785563	0.050979
H	4.582854	-0.688436	0.215723
O	-0.115856	1.598771	-0.148049
C	-2.348170	0.818262	-0.025224
C	-2.776628	2.223046	0.317429
H	-2.237966	2.569369	1.206374
H	-2.537269	2.913736	-0.497094
H	-3.850381	2.225117	0.512027
O	-3.087007	-0.173167	0.040685
Pd	-0.565671	-1.253843	0.002764
C	0.992803	1.039197	2.352715
C	3.340573	1.296841	2.910791
H	4.740888	0.083766	1.781190
C	1.996370	1.624805	3.130351
H	-0.052525	1.274821	2.523655
H	4.113423	1.755430	3.521058
H	1.727733	2.335422	3.906448
O	3.009869	-1.123801	0.205204
C	1.979384	-2.610486	-1.293648
C	3.387377	-2.872889	-1.786790
H	3.840826	-1.948602	-2.161081
H	4.026678	-3.246206	-0.980951
H	3.329586	-3.606793	-2.592069
O	0.975159	-3.077564	-1.810956
O	-1.733859	-0.086140	0.969162
O	-2.102120	-1.652894	-0.563924
C	-2.510341	-0.845051	0.280318
C	-4.015545	-0.681869	0.568563
F	-4.275611	-0.957803	1.859782
F	-4.390478	0.592027	0.330179
F	-4.753687	-1.489757	-0.196347
Pd	0.102218	-0.847000	0.190179
C	0.167413	0.389830	-1.518043
O	0.323855	-0.254961	-2.499220
C	0.060776	1.857311	-1.393603
C	-0.630524	2.501571	-0.358952
C	0.669641	2.603984	-2.422585
C	-0.708888	3.892936	-0.356288
H	-1.133913	1.915028	0.399574
C	0.604830	3.992408	-2.391941
H	1.187458	2.087021	-3.223583
C	-0.084917	4.637286	-1.359987
H	-1.259281	4.396086	0.432934
H	1.084880	4.571546	-3.175231
H	-0.140124	5.722198	-1.343047

A7

Cartesian coordinates

ATOM	X	Y	Z
N	-0.309257	-1.147264	1.473535
C	-2.456008	-0.875068	0.702706
C	-2.209474	-0.690945	-0.690030
C	-3.550938	-1.614958	1.148646
C	-3.020157	-1.420379	-1.603342

A8

Cartesian coordinates

ATOM	X	Y	Z
N	0.118390	0.915584	1.304320
C	1.277866	2.084407	-0.362485
C	2.042638	0.960916	-0.775405
C	1.428591	3.318962	-1.015853
C	2.951152	1.166048	-1.847259

C	-4.362344	-2.260771	0.219572	C	2.318223	3.471675	-2.066699
H	-3.701092	-1.735001	2.216304	H	0.823521	4.147739	-0.663346
C	-4.077326	-2.193122	-1.155503	C	3.087935	2.383622	-2.493917
H	-2.817711	-1.301939	-2.662989	H	3.534136	0.318989	-2.191434
H	-5.198221	-2.860692	0.568111	H	2.410863	4.437935	-2.554142
H	-4.700062	-2.728096	-1.865583	H	3.781070	2.483900	-3.322898
O	-1.561098	-0.410092	1.625773	O	0.389360	2.154212	0.664570
C	0.655882	-0.583894	2.375177	C	-0.343686	1.106467	2.608940
C	0.296778	0.654001	3.162697	C	-0.064212	2.442386	3.271414
H	0.125630	1.490364	2.477836	H	0.984553	2.735017	3.163099
H	-0.615445	0.505949	3.747811	H	-0.672647	3.227918	2.809883
H	1.133452	0.881800	3.824366	H	-0.323170	2.353772	4.327573
O	1.697726	-1.192731	2.491474	O	-0.891158	0.175299	3.178931
O	2.129909	-1.141209	-0.510472	O	-2.985607	0.335156	0.353919
O	2.185620	1.034083	0.132641	O	-2.519223	-1.321177	-1.028718
C	2.701561	-0.018457	-0.215684	C	-3.354575	-0.567465	-0.460439
C	4.242026	-0.110539	-0.386619	C	-4.857030	-0.767836	-0.715860
F	4.746675	-1.193561	0.225848	F	-5.333100	-1.706366	0.122992
F	4.550588	-0.191273	-1.699931	F	-5.536574	0.368247	-0.511565
F	4.848368	0.974755	0.113343	F	-5.071153	-1.177347	-1.974238
Pd	0.089493	-1.100908	-0.501396	Pd	-0.979082	-0.269948	0.122827
C	-1.439556	0.483828	-1.313395	C	1.944172	-0.457071	-0.327616
O	-0.890963	0.289264	-2.410215	O	0.873237	-1.096191	-0.215167
C	-1.497281	1.837578	-0.703370	C	3.190067	-1.239838	-0.120304
C	-0.463038	2.737065	-1.015691	C	3.137818	-2.642603	-0.221584
C	-2.563215	2.258094	0.108009	C	4.394263	-0.619860	0.258361
C	-0.488941	4.030811	-0.504477	C	4.274604	-3.404553	0.024749
H	0.363735	2.396940	-1.627717	H	2.201552	-3.115002	-0.497896
C	-2.594084	3.561203	0.599772	C	5.525177	-1.390149	0.522452
H	-3.379500	1.579840	0.335335	H	4.435535	0.458571	0.366401
C	-1.554618	4.445643	0.299786	C	5.469483	-2.780123	0.398560
H	0.324348	4.714282	-0.728986	H	4.230863	-4.485691	-0.068640
H	-3.427843	3.886537	1.215221	H	6.448037	-0.905584	0.827494
H	-1.574989	5.458307	0.693266	H	6.354377	-3.378146	0.598297

A9

Cartesian coordinates

ATOM	X	Y	Z
N	2.003585	-1.050259	-0.793467
C	3.840337	-0.747636	0.414789
C	2.890321	0.066143	1.013036
C	5.124993	-0.910964	0.912505
C	3.205154	0.753137	2.179267
C	5.434875	-0.211078	2.083547

A10

Cartesian coordinates

ATOM	X	Y	Z
C	1.156599	-0.762555	0.279158
C	2.152511	0.032637	-0.276268
C	3.408206	-0.462534	-0.615481
C	3.634928	-1.819725	-0.371388
C	2.643502	-2.640092	0.185900
C	1.392951	-2.112716	0.519622

H	5.843997	-1.555935	0.418981	C	-0.038370	0.108173	0.622488
C	4.489203	0.607040	2.713739	H	4.166848	0.178751	-1.051130
H	2.464683	1.384769	2.659914	H	4.601184	-2.245930	-0.626445
H	6.428317	-0.312569	2.510775	H	2.849433	-3.692209	0.357507
H	4.755395	1.132300	3.625846	H	0.616161	-2.737384	0.950940
O	3.385054	-1.372867	-0.738221	O	1.766480	1.334344	-0.438328
C	1.208580	-1.914250	-1.421830	N	0.352966	1.333686	-0.126571
C	1.835226	-3.040871	-2.199907	C	-1.381669	-0.424534	0.132990
H	2.558480	-2.660716	-2.927282	C	-2.379605	-0.794628	1.038241
H	2.373098	-3.707839	-1.517879	C	-1.599063	-0.597071	-1.239328
H	1.042535	-3.590717	-2.707809	C	-3.584718	-1.325662	0.572669
O	-0.049107	-1.797019	-1.411243	H	-2.214119	-0.654371	2.099234
O	-3.181152	-0.872625	-0.687214	C	-2.802359	-1.126452	-1.701227
O	-2.620834	0.252651	1.124179	H	-0.826631	-0.307631	-1.946001
C	-3.501532	-0.180664	0.319440	C	-3.800505	-1.493617	-0.795007
C	-4.981383	0.110203	0.612623	H	-4.357185	-1.603597	1.284837
F	-5.718712	0.014312	-0.499837	H	-2.961072	-1.250818	-2.769124
F	-5.443305	-0.781400	1.509471	H	-4.739831	-1.905381	-1.154513
F	-5.129175	1.340418	1.125088	O	-0.131241	0.322195	2.019206
Pd	-1.128736	-0.698816	-0.042888	C	-0.231621	2.588805	-0.003132
C	1.592885	0.051390	0.213301	O	-1.362888	2.690452	0.435097
O	0.545817	-0.354758	0.973085	C	0.600485	3.754922	-0.498653
C	1.360686	1.370484	-0.539811	H	1.495842	3.882181	0.119468
C	0.466874	2.303125	0.001052	H	0.937690	3.593637	-1.527423
C	2.068808	1.693351	-1.703519	H	-0.017023	4.652388	-0.442706
C	0.273337	3.535853	-0.625311	H	0.771510	0.428931	2.360050
H	-0.077535	2.054796	0.906058				
C	1.871012	2.924418	-2.329281				
H	2.773911	0.983152	-2.126733				
C	0.971808	3.848743	-1.792483				
H	-0.427699	4.248946	-0.200120				
H	2.419481	3.160937	-3.237138				
H	0.817487	4.806663	-2.281626				

Pro

Cartesian coordinates

ATOM	X	Y	Z
C	1.153730	0.167155	0.017555
C	2.172495	-0.785266	-0.103864
C	3.530728	-0.471255	-0.040846
C	3.841285	0.868888	0.164126
C	2.835410	1.848181	0.309606
C	1.488582	1.512739	0.242851
C	-0.052368	-0.622943	-0.100889

Pd(TFA)2

Cartesian coordinates

ATOM	X	Y	Z
Pd	-0.003519	0.000152	0.001809
C	0.005784	2.424277	0.001260
O	-0.318118	1.781622	1.046114
O	0.315010	1.777943	-1.046190
C	-0.013355	-2.423959	0.001633
O	0.311142	-1.780936	-1.042826
O	-0.322509	-1.777995	1.049325

H	4.293385	-1.235709	-0.141673
H	4.883999	1.168464	0.221564
H	3.122923	2.881115	0.482204
H	0.722175	2.269081	0.375423
O	1.635766	-2.017709	-0.272090
N	0.235463	-1.894056	-0.269202
C	-1.460832	-0.191711	-0.043375
C	-1.842920	1.080641	-0.496242
C	-2.445034	-1.062871	0.452843
C	-3.179510	1.476811	-0.445423
H	-1.099255	1.750195	-0.917012
C	-3.778767	-0.664479	0.499158
H	-2.149029	-2.046668	0.802137
C	-4.150379	0.607373	0.054265
H	-3.461966	2.462999	-0.803714
H	-4.530105	-1.346372	0.888079
H	-5.191012	0.917385	0.095546
C	-0.070681	-3.958154	-0.004101
C	0.062477	3.958500	0.006045
F	-0.448003	4.438472	-1.133510
F	-0.624160	4.448455	1.040349
F	1.342968	4.349526	0.105810
F	-1.351178	-4.348536	-0.106361
F	0.437583	-4.439051	1.136040
F	0.617530	-4.447807	-1.037512

Sub

Cartesian coordinates

ATOM	X	Y	Z
C	-3.294551	0.608911	0.270823
C	-3.064488	-0.767859	0.190597
C	-1.790052	-1.256635	-0.086103
C	-0.739546	-0.356522	-0.283906
C	-0.947759	1.018846	-0.206786
C	-2.233303	1.491683	0.072053
H	-4.289210	0.986825	0.488446
H	-3.880595	-1.468292	0.346261
H	-1.590546	-2.321786	-0.147804
H	-0.122075	1.703181	-0.358320
H	-2.398111	2.564137	0.134950
O	0.481324	-0.955811	-0.567481
N	1.538846	-0.057977	-0.748998
H	1.883857	-0.144642	-1.700202
C	2.486166	-0.031261	0.278538
C	3.802588	0.599360	-0.151056
H	4.571314	-0.180067	-0.197977
H	3.750391	1.103818	-1.121156
H	4.107634	1.320467	0.611242
O	2.253813	-0.418807	1.402804

B6

Cartesian coordinates

ATOM	X	Y	Z
N	-2.669514	-0.994643	-0.257404
C	-2.743545	1.254996	0.061497
C	-1.359604	1.186537	-0.206219
C	-3.381737	2.492502	0.194705
C	-0.637499	2.364305	-0.381588
C	-2.632854	3.661720	0.058410
H	-4.448421	2.524078	0.394106
C	-1.268204	3.606985	-0.234414

TS3_B

Cartesian coordinates

ATOM	X	Y	Z
N	-2.686085	0.129503	-0.000086
C	-0.720269	1.416545	0.263903
C	0.473240	0.800863	-0.212717
C	-0.986827	2.768000	0.035696
C	1.280706	1.591449	-1.059864
C	-0.133159	3.524794	-0.759387
H	-1.902366	3.186347	0.440486
C	0.992776	2.922250	-1.332479

H	0.417659	2.328458	-0.640623	H	2.181331	1.142990	-1.465716
H	-3.126886	4.623646	0.166292	H	-0.361373	4.568032	-0.957881
H	-0.695413	4.522390	-0.355237	H	1.652868	3.496900	-1.975511
O	-3.468532	0.116992	0.200996	O	-1.722187	0.709286	0.954908
C	-2.938191	-2.187730	0.341867	C	-3.788045	-0.376513	0.693814
C	-4.248671	-2.382018	1.069899	C	-4.111229	0.162359	2.071354
H	-5.092853	-2.058132	0.453155	H	-4.111604	1.256510	2.078725
H	-4.352711	-3.437855	1.326425	H	-5.090769	-0.217547	2.366094
H	-4.264509	-1.777868	1.984005	H	-3.358260	-0.165435	2.796323
O	-2.085725	-3.081663	0.209552	O	-4.470644	-1.212372	0.115045
Pd	-0.720305	-0.676518	-0.370817	Pd	-1.216632	-1.063652	-0.690637
C	2.153678	0.195824	0.198609	C	1.053410	-0.626823	0.203629
O	1.396108	-0.503106	-0.485777	O	0.715098	-1.594017	-0.751841
C	3.603988	0.050288	0.194111	C	2.568314	-0.559112	0.405728
C	4.234141	-0.924608	-0.602680	C	3.433635	-1.181664	-0.498425
C	4.373391	0.902264	1.005404	C	3.096909	0.108451	1.517448
C	5.618472	-1.038916	-0.582552	C	4.815512	-1.124645	-0.297197
H	3.623766	-1.574128	-1.221846	H	3.010859	-1.715156	-1.342613
C	5.760489	0.783012	1.021345	C	4.475831	0.166731	1.715363
H	3.879069	1.651595	1.619157	H	2.426283	0.585261	2.229634
C	6.380327	-0.186492	0.227861	C	5.340194	-0.450189	0.806069
H	6.110649	-1.788995	-1.194392	H	5.481603	-1.614246	-1.003061
H	6.357190	1.439524	1.647325	H	4.875702	0.687374	2.581627
H	7.462715	-0.280503	0.239688	H	6.414904	-0.409887	0.962345
H	1.730480	0.980297	0.845654	H	0.624374	-0.857828	1.196959

B7

Cartesian coordinates

ATOM	X	Y	Z
N	-2.860325	0.140160	-0.245896
C	-0.739414	1.357174	0.114922
C	0.621350	0.998976	-0.002135
C	-1.232681	2.620825	-0.177461
C	1.472944	2.017271	-0.450041
C	-0.347184	3.602363	-0.625565
H	-2.295242	2.812006	-0.076719
C	1.004890	3.297438	-0.760930
H	2.529068	1.798479	-0.558347
H	-0.720731	4.592112	-0.870982
H	1.702739	4.051217	-1.113603
O	-1.656365	0.381864	0.601995
C	-3.933718	-0.215487	0.588438
C	-3.841204	0.001693	2.088572
H	-3.595378	1.041721	2.326134

B8

Cartesian coordinates

ATOM	X	Y	Z
N	-2.237278	0.312037	0.087701
C	-0.534824	1.844499	0.259100
C	0.679154	1.248092	-0.114561
C	-0.838751	3.172411	-0.021746
C	1.591223	2.054716	-0.806409
C	0.094273	3.955541	-0.701178
H	-1.795509	3.574802	0.296395
C	1.306766	3.389658	-1.098981
H	2.544142	1.629454	-1.104919
H	-0.127325	4.996219	-0.920059
H	2.037880	3.990285	-1.633085
O	-1.484741	1.094869	0.980061
C	-3.367642	-0.238846	0.604592
C	-4.146776	0.371966	1.727381
H	-4.244974	1.452216	1.587190

H	-4.807264	-0.259162	2.523597	H	-5.130796	-0.097505	1.780395
H	-3.059461	-0.625250	2.530636	H	-3.617432	0.210307	2.673848
O	-4.930229	-0.654016	0.036115	O	-3.681917	-1.317161	0.022307
Pd	-1.265071	-1.244393	-0.622531	Pd	-1.510319	-1.440354	-0.570714
C	1.154507	-0.422788	0.375929	C	0.954666	-0.230432	0.203862
O	0.679706	-1.459979	-0.459621	O	0.388158	-1.075667	-0.777037
C	2.680100	-0.487680	0.378858	C	2.441357	-0.547235	0.337455
C	3.380348	-0.849285	-0.778694	C	3.150763	-1.140089	-0.713066
C	3.395399	-0.186463	1.543342	C	3.116305	-0.236194	1.524787
C	4.775268	-0.896965	-0.770934	C	4.513935	-1.413906	-0.577247
H	2.822022	-1.104822	-1.672985	H	2.622324	-1.394195	-1.625751
C	4.790696	-0.229950	1.550049	C	4.477983	-0.506811	1.659813
H	2.858130	0.084415	2.449738	H	2.571374	0.221297	2.348105
C	5.484639	-0.584934	0.391350	C	5.181769	-1.097450	0.607044
H	5.308951	-1.182242	-1.673870	H	5.053701	-1.878225	-1.398762
H	5.333854	0.006751	2.461222	H	4.987850	-0.262591	2.588259
H	6.570678	-0.624260	0.395943	H	6.241804	-1.313208	0.712112
H	0.827656	-0.606065	1.414822	H	0.499360	-0.428689	1.187480

TS4_B

Cartesian coordinates

ATOM	X	Y	Z
N	-2.136749	0.544156	0.417786
C	-0.484943	2.121159	0.355968
C	0.427234	1.434238	-0.485613
C	-0.439685	3.520456	0.430777
C	1.310286	2.215310	-1.257282
C	0.469677	4.260885	-0.314721
H	-1.162759	4.003990	1.079687
C	1.342182	3.604213	-1.183118
H	2.004570	1.704641	-1.919034
H	0.477208	5.344498	-0.236842
H	2.044763	4.162351	-1.794612
O	-1.440827	1.553312	1.170327
C	-2.658894	-0.408946	1.142045
C	-2.999762	-0.346230	2.602683
H	-2.903099	0.669571	2.990409
H	-4.026073	-0.701385	2.743888
H	-2.342387	-1.015558	3.169661
O	-2.844558	-1.545484	0.502535
Pd	-1.317537	-1.375621	-0.920039
C	0.725814	-0.060778	-0.685899
O	0.405536	-0.603096	-1.825470
C	1.923854	-0.603616	0.053163

B9

Cartesian coordinates

ATOM	X	Y	Z
N	-2.138755	0.533036	0.266551
C	-0.308176	1.885838	0.284879
C	0.751732	1.244754	-0.396189
C	-0.470590	3.268407	0.190640
C	1.612826	2.046716	-1.171025
C	0.387737	4.038557	-0.590876
H	-1.292869	3.717771	0.737596
C	1.427212	3.421862	-1.287826
H	2.436671	1.573086	-1.696545
H	0.239943	5.112526	-0.659916
H	2.098768	4.006150	-1.909607
O	-1.185279	1.210525	1.110796
C	-3.139310	-0.050947	0.930107
C	-3.566648	0.277737	2.330291
H	-3.364187	1.324638	2.568200
H	-4.631367	0.057947	2.440655
H	-3.012899	-0.346685	3.041449
O	-3.692279	-0.997814	0.255763
Pd	-1.761888	-1.330309	-0.690788
C	1.093314	-0.220686	-0.362465
O	0.340420	-1.134728	-0.742637
C	2.460321	-0.610716	0.077702

C	2.604735	-1.714701	-0.469443	C	2.921285	-1.906414	-0.225341
C	2.366000	-0.020342	1.250799	C	3.275218	0.248749	0.836238
C	3.717412	-2.225299	0.191891	C	4.176662	-2.322016	0.203264
H	2.252576	-2.156724	-1.395347	H	2.280944	-2.567558	-0.798950
C	3.473652	-0.543896	1.915706	C	4.527080	-0.178561	1.275996
H	1.844244	0.840721	1.656125	H	2.922209	1.240643	1.095612
C	4.152569	-1.644785	1.388364	C	4.981751	-1.459260	0.955538
H	4.247794	-3.077633	-0.223652	H	4.529668	-3.319040	-0.043914
H	3.808841	-0.088860	2.843454	H	5.145613	0.487573	1.870490
H	5.018493	-2.048727	1.905644	H	5.960375	-1.788114	1.294554
H	-0.242229	-0.931275	0.186854	H	-1.780115	-2.763944	-1.326190

TS5_B

Cartesian coordinates

ATOM	X	Y	Z
N	-0.405266	-0.651553	0.920039
C	-1.332649	1.414777	0.832205
C	-0.688265	1.371454	-0.399660
C	-2.185994	2.455541	1.190931
C	-0.894072	2.403998	-1.315457
C	-2.378956	3.483738	0.266368
H	-2.680123	2.452395	2.157003
C	-1.743313	3.461081	-0.980908
H	-0.397554	2.373672	-2.281096
H	-3.039971	4.307562	0.520790
H	-1.914809	4.263476	-1.691999
O	-1.085531	0.366391	1.682191
C	0.581742	-1.308301	1.702077
C	0.900538	-0.752181	3.071605
H	0.013311	-0.734068	3.711814
H	1.673412	-1.378408	3.519674
H	1.258099	0.279713	2.985129
O	1.135609	-2.276195	1.215537
Pd	-1.561689	-1.809457	-0.582955
C	0.191048	0.165996	-0.629582
O	-0.177025	-0.702995	-1.562853
C	1.677129	0.385045	-0.552437
C	2.539547	-0.570356	-1.111417
C	2.218178	1.517489	0.077390
C	3.919747	-0.389052	-1.048037
H	2.111511	-1.441544	-1.592000
C	3.600040	1.691096	0.143921
H	1.558483	2.265725	0.505682
C	4.453104	0.739305	-0.420463

B10

Cartesian coordinates

ATOM	X	Y	Z
N	-0.401453	-0.574730	0.871109
C	-1.226806	1.529813	0.829907
C	-0.549813	1.426970	-0.375402
C	-2.004721	2.631916	1.168917
C	-0.637004	2.459857	-1.304819
C	-2.080648	3.665506	0.231085
H	-2.527354	2.677018	2.118666
C	-1.408958	3.583299	-0.995382
H	-0.114833	2.382762	-2.253866
H	-2.678419	4.543347	0.459883
H	-1.492185	4.395398	-1.711295
O	-1.067919	0.444163	1.659913
C	0.461968	-1.375747	1.690658
C	0.513860	-1.056217	3.165744
H	-0.481925	-1.099359	3.617354
H	1.175281	-1.781003	3.642460
H	0.893113	-0.040547	3.320422
O	1.076795	-2.276237	1.163070
Pd	-1.698506	-1.698144	-0.643002
C	0.204925	0.116710	-0.498469
O	-0.198417	-0.699871	-1.513886
C	1.720377	0.258815	-0.461446
C	2.519691	-0.665587	-1.145140
C	2.329842	1.300657	0.252588
C	3.908628	-0.543448	-1.120321
H	2.037803	-1.467726	-1.690461
C	3.719955	1.413289	0.284784
H	1.719507	2.031453	0.775297
C	4.512337	0.492979	-0.404854

H	4.580480	-1.132203	-1.485627	H	4.520774	-1.262705	-1.657597
H	4.009975	2.572129	0.630214	H	4.182166	2.224895	0.840429
H	5.529968	0.877398	-0.371043	H	5.595141	0.584645	-0.385587
H	-2.159593	-2.425324	-1.871116	H	-2.273076	-2.227771	-1.975238

C1

Cartesian coordinates

ATOM	X	Y	Z
C	-3.953596	-1.706106	-0.489764
C	-3.462557	-1.808621	0.815370
C	-2.335938	-1.088698	1.205353
C	-1.695401	-0.260568	0.278698
C	-2.170683	-0.144727	-1.026810
C	-3.303657	-0.872937	-1.400287
H	-4.834574	-2.265992	-0.789879
H	-3.961342	-2.449042	1.537986
H	-1.946221	-1.147910	2.216840
H	-1.666145	0.506501	-1.729831
H	-3.677699	-0.781022	-2.416704
O	-0.569312	0.386911	0.765209
N	0.019093	1.293976	-0.132535
H	0.980554	0.994689	-0.314460
C	-0.228240	2.636038	0.137018
C	0.727017	3.563488	-0.601159
H	1.243521	4.187666	0.135075
H	1.470492	3.035742	-1.205719
H	0.144750	4.227831	-1.246592
O	-1.145592	3.024891	0.831357
C	4.504211	-1.392931	-0.366104
C	3.034453	-1.024578	-0.095657
H	4.730332	-1.285312	-1.432536
H	5.171723	-0.731292	0.194546
H	4.709192	-2.429361	-0.076687
C	2.722284	-1.114172	1.438668
C	2.053781	-1.922387	-0.877319
H	1.682530	-0.841116	1.633911
H	2.892726	-2.150554	1.749538
H	3.386838	-0.456122	2.004439
H	2.212942	-2.975540	-0.621304
H	1.017244	-1.659482	-0.647616
H	2.213796	-1.805847	-1.954602
O	2.808109	0.311388	-0.373654

TS1_C

Cartesian coordinates

ATOM	X	Y	Z
C	4.130738	-0.825360	0.428124
C	3.783699	-0.629552	-0.912524
C	2.578306	-0.018000	-1.244808
C	1.721867	0.402425	-0.220253
C	2.051926	0.219677	1.124991
C	3.262993	-0.399234	1.436592
H	5.071088	-1.304430	0.684089
H	4.453130	-0.955053	-1.703622
H	2.286088	0.147332	-2.276754
H	1.378673	0.561334	1.901320
H	3.529231	-0.543975	2.479882
O	0.562174	1.009151	-0.659266
N	-0.371812	1.252851	0.324710
H	-0.904472	0.290613	0.670359
C	-1.201422	2.343721	-0.011608
C	-2.374560	2.489519	0.937779
H	-3.168020	3.034810	0.422327
H	-2.737987	1.519687	1.285100
H	-2.063743	3.079594	1.808179
O	-0.934463	3.123300	-0.904058
C	-3.171532	-2.503167	0.551846
C	-2.054198	-1.623524	-0.066996
H	-2.817395	-2.970945	1.475598
H	-4.050061	-1.893907	0.783947
H	-3.459137	-3.290229	-0.154545
C	-2.588702	-0.934314	-1.341163
C	-0.817021	-2.484178	-0.378631
H	-1.819663	-0.290730	-1.782449
H	-2.879345	-1.678281	-2.091742
H	-3.462812	-0.319412	-1.103459
H	-1.056415	-3.287521	-1.085390
H	-0.019730	-1.875891	-0.819309
H	-0.431267	-2.935420	0.541561
O	-1.774968	-0.668153	0.922306

C2

C3

	Cartesian coordinates				Cartesian coordinates		
ATOM	X	Y	Z	ATOM	X	Y	Z
C	-3.497297	-2.222438	-0.150645	N	-0.304837	1.683387	-1.118005
C	-4.088450	-1.107068	0.450066	C	-1.514620	2.218230	0.819179
C	-3.390910	0.095422	0.529616	C	-2.428597	1.167523	0.797364
C	-2.096936	0.164410	0.005515	C	-1.245397	2.967041	1.962130
C	-1.488208	-0.932557	-0.608710	C	-3.071448	0.834806	1.989114
C	-2.205289	-2.127541	-0.675646	H	-2.627736	0.625635	-0.118464
H	-4.042545	-3.159533	-0.214311	C	-1.905155	2.622446	3.141194
H	-5.093271	-1.171686	0.857051	H	-0.530058	3.781643	1.922432
H	-3.821777	0.979108	0.988761	C	-2.811334	1.556951	3.156531
H	-0.490323	-0.858421	-1.023053	H	-3.772115	0.006456	1.991874
H	-1.747549	-2.990102	-1.151385	H	-1.704340	3.182492	4.049326
O	-1.512115	1.416513	0.119164	H	-3.315932	1.290799	4.080321
N	-0.188934	1.481852	-0.123103	O	-0.880565	2.641702	-0.362514
H	1.312229	0.043411	-0.328957	C	0.014278	2.165695	-2.425883
C	0.200410	2.846389	-0.119467	C	-0.459272	3.541763	-2.818987
C	1.691413	3.003147	-0.335305	H	-1.547623	3.619953	-2.731039
H	2.181377	3.146312	0.636069	H	-0.022185	4.302313	-2.163732
H	2.134307	2.127960	-0.816803	H	-0.153901	3.720775	-3.850354
H	1.869512	3.901136	-0.932035	O	0.647862	1.409513	-3.133565
O	-0.570866	3.776362	0.042274	O	-1.089727	-1.092692	-0.986809
C	3.858478	-1.906428	-0.687854	O	-1.037753	-2.153122	1.024708
C	2.760225	-1.235663	0.142374	C	-1.513508	-1.916592	-0.068158
H	3.413494	-2.534460	-1.466926	C	-2.868241	-2.548658	-0.482976
H	4.480315	-1.149133	-1.176832	F	-3.856309	-1.641841	-0.232332
H	4.500112	-2.532860	-0.058509	F	-2.926320	-2.860437	-1.785055
C	3.371963	-0.308798	1.205401	F	-3.132636	-3.645867	0.230719
C	1.857416	-2.290988	0.801515	O	2.450128	0.658696	0.093326
H	2.584844	0.199354	1.777394	O	2.014233	-1.495413	0.171762
H	3.990527	-0.868566	1.916636	C	2.816736	-0.536745	0.336067
H	3.997889	0.454507	0.730721	C	4.260294	-0.794459	0.793734
H	2.421405	-2.918811	1.501653	F	5.079518	-0.741749	-0.271450
H	1.042774	-1.814376	1.360587	F	4.642712	0.144599	1.671028
H	1.412140	-2.939321	0.039107	F	4.371967	-1.996293	1.364026
O	2.000505	-0.462225	-0.801265	Pd	0.559164	-0.066456	-0.473867

C4

	Cartesian coordinates				Cartesian coordinates		
ATOM	X	Y	Z	ATOM	X	Y	Z
N	0.401265	-0.195328	1.587204	N	0.543006	-1.537687	1.166942
C	2.123734	1.380448	1.441009	C	1.971914	-2.475338	-0.438050
C	3.094813	0.387934	1.319480	C	0.916698	-2.942647	-1.222069
C	2.443302	2.736436	1.355411	C	3.308733	-2.620842	-0.821485

C5

C	4.416206	0.777292	1.097030	C	1.230176	-3.577822	-2.425150
H	2.827231	-0.658109	1.390001	H	-0.115412	-2.806024	-0.923555
C	3.770433	3.105025	1.143252	C	3.596092	-3.265553	-2.021234
H	1.656682	3.475955	1.457249	H	4.092040	-2.230430	-0.179877
C	4.760738	2.128117	1.010157	C	2.558070	-3.744913	-2.826717
H	5.178957	0.011199	0.992437	H	0.420088	-3.942551	-3.049653
H	4.028370	4.158406	1.079529	H	4.630309	-3.387237	-2.329305
H	5.793568	2.417417	0.839948	H	2.783775	-4.242237	-3.765433
O	0.780032	1.120037	1.728024	O	1.812528	-1.834075	0.785854
C	-0.310796	-0.676959	2.688171	C	0.514234	-1.326700	2.595347
C	-0.029392	-0.081241	4.043900	C	1.654936	-1.901479	3.400896
H	1.045828	0.003482	4.226898	H	1.857236	-2.942956	3.134760
H	-0.453684	0.927878	4.094181	H	2.557622	-1.316366	3.198501
H	-0.494078	-0.713146	4.802149	H	1.390798	-1.824541	4.456394
O	-1.085655	-1.611224	2.488919	O	-0.451961	-0.773186	3.071360
O	0.548636	-2.242139	-0.350760	O	-2.211311	-0.468910	0.552122
O	1.909515	-0.816564	-1.476105	O	-2.128185	-1.823106	-1.262261
C	1.627071	-1.892894	-0.967363	C	-2.695677	-1.292979	-0.316917
C	2.687366	-3.025374	-0.947740	C	-4.198239	-1.565052	-0.045390
F	3.327466	-2.989410	0.246817	F	-4.734420	-2.347440	-0.987710
F	2.145595	-4.241090	-1.092862	F	-4.372882	-2.157168	1.148136
F	3.600076	-2.848634	-1.909956	F	-4.886404	-0.396422	-0.033519
O	-2.506368	0.372662	0.521916	O	1.513324	0.968337	-0.382575
O	-3.061943	-1.320406	-0.801006	O	2.513869	0.868384	1.660616
C	-3.373081	-0.333459	-0.118309	C	2.455132	1.184058	0.486204
C	-4.837950	0.121876	0.020274	C	3.597231	2.013638	-0.159442
F	-5.248817	-0.036477	1.289902	F	4.042323	1.449478	-1.295626
F	-4.942629	1.426315	-0.297776	F	3.134077	3.253164	-0.467581
F	-5.640553	-0.579936	-0.782238	F	4.632112	2.158365	0.672653
Pd	-0.853321	-0.831883	0.058724	Pd	-0.268869	0.109622	0.148837
C	-0.445561	0.225458	-1.707599	C	-0.726389	1.849683	1.127447
O	-0.742092	-0.449374	-2.627882	O	-0.495120	2.031567	2.259173
C	-0.004708	1.628360	-1.602767	C	-1.330110	2.578074	-0.010478
C	-0.681138	2.554101	-0.797760	C	-0.509328	3.404999	-0.803043
C	1.044458	2.026996	-2.450320	C	-2.712356	2.458327	-0.254770
C	-0.321172	3.899725	-0.871703	C	-1.099372	4.151143	-1.818301
H	-1.488378	2.226646	-0.153400	H	0.560134	3.443250	-0.631394
C	1.404061	3.369617	-2.491238	C	-3.275021	3.216626	-1.276865
H	1.568673	1.284485	-3.040190	H	-3.311969	1.770104	0.328919
C	0.717801	4.306477	-1.711094	C	-2.475260	4.061376	-2.053075
H	-0.856665	4.628988	-0.270953	H	-0.480717	4.798214	-2.432284
H	2.216915	3.686553	-3.137729	H	-4.340013	3.139218	-1.472353
H	0.996116	5.355677	-1.758415	H	-2.924159	4.643306	-2.852792

TS2_C

Cartesian coordinates

ATOM	X	Y	Z
N	1.150467	-1.994065	0.105195
C	0.368480	-1.386451	2.150871
C	0.404226	-0.033257	1.664158
C	-0.158055	-1.688950	3.424024
C	-0.239405	0.966034	2.448974
H	1.724571	0.306184	1.446587
C	-0.694014	-0.667904	4.180474
H	-0.164573	-2.720303	3.760450
C	-0.729209	0.666654	3.702407
H	-0.257909	1.989413	2.088821
H	-1.108864	-0.893714	5.158771
H	-1.128614	1.454483	4.333883
O	0.904972	-2.371763	1.449248
C	2.145637	-2.750227	-0.477169
C	2.731387	-3.927428	0.283303
H	3.263100	-3.588286	1.179092
H	1.948335	-4.619917	0.608833
H	3.428045	-4.441409	-0.380479
O	2.511469	-2.429996	-1.603595
O	2.000000	0.850582	-0.893446
O	2.883028	0.648827	1.177394
C	2.928629	0.919697	-0.060841
C	4.299824	1.431435	-0.568277
F	5.267221	0.577432	-0.206652
F	4.314834	1.571903	-1.892335
F	4.552118	2.627486	-0.003162
O	-1.673157	-0.974497	-0.077716
O	-1.545684	-1.264832	-2.304441
C	-2.083951	-1.437923	-1.222394
C	-3.398696	-2.240125	-1.081782
F	-3.256380	-3.238860	-0.190761
F	-4.383281	-1.427159	-0.641039
F	-3.774730	-2.763389	-2.250024
Pd	0.140182	-0.089848	-0.443382
C	-0.745374	1.615759	-1.167513
O	-0.260451	1.839704	-2.237573
C	-1.778752	2.434076	-0.489238
C	-2.662164	1.915318	0.468474
C	-1.866392	3.785324	-0.877745
C	-3.629384	2.748040	1.030455
H	-2.610273	0.867014	0.735717

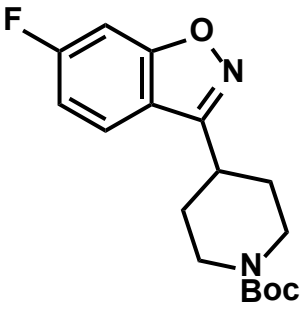
C6

Cartesian coordinates

ATOM	X	Y	Z
N	-1.374587	1.516030	0.666057
C	-0.559685	0.504289	2.536266
C	-0.166737	-0.533014	1.662253
C	-0.449464	0.291752	3.919808
C	0.278728	-1.762699	2.140584
H	-2.296626	-0.979523	1.276153
C	0.004454	-0.933670	4.398310
H	-0.740854	1.092938	4.591787
C	0.348198	-1.969244	3.522785
H	0.574987	-2.551502	1.457834
H	0.073000	-1.089444	5.471176
H	0.676418	-2.931256	3.904095
O	-1.070301	1.663784	2.083532
C	-2.649134	1.858181	0.365534
C	-3.466540	2.670276	1.353897
H	-3.836405	2.020116	2.155814
H	-2.879930	3.467767	1.817163
H	-4.322060	3.087227	0.819300
O	-3.121393	1.488294	-0.725814
O	-1.717097	-1.059461	-0.997528
O	-3.138872	-1.044868	0.764983
C	-2.850489	-1.006343	-0.514326
C	-4.080920	-1.169452	-1.427066
F	-5.172691	-0.635383	-0.881813
F	-3.858243	-0.640385	-2.621739
F	-4.286217	-2.499135	-1.573674
O	1.597556	1.244160	0.205757
O	1.023408	1.663775	-1.907488
C	1.697067	1.901571	-0.905166
C	2.753603	3.025968	-0.877221
F	2.441411	3.935750	0.060560
F	3.962787	2.510899	-0.579115
F	2.831834	3.637847	-2.060364
Pd	-0.022236	0.058214	-0.260545
C	1.190886	-1.334321	-1.236632
O	0.692193	-1.629340	-2.282818
C	2.479598	-1.861588	-0.719437
C	3.118586	-1.373449	0.429893
C	3.065514	-2.908892	-1.460120
C	4.332661	-1.929197	0.831766
H	2.683659	-0.554149	0.985921

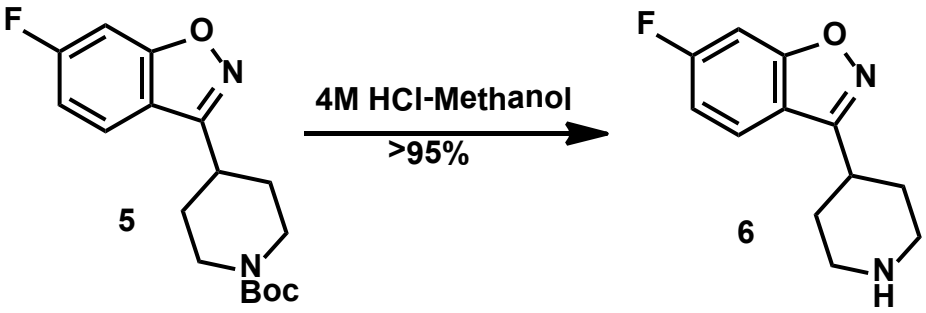
C	-2.820103	4.611311	-0.292577	C	4.271998	-3.460692	-1.045986
H	-1.184552	4.165582	-1.631374	H	2.561347	-3.268851	-2.350692
C	-3.703768	4.092689	0.659972	C	4.907198	-2.970728	0.100548
H	-4.327744	2.343562	1.757227	H	4.830953	-1.543964	1.716333
H	-2.881896	5.655813	-0.583891	H	4.720841	-4.268668	-1.616499
H	-4.454202	4.737650	1.108871	H	5.852613	-3.400322	0.420443

8. The Synthesis and Characterization of key intermediate 6

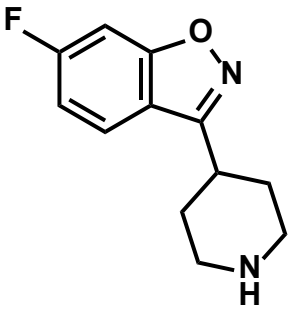


5, white solid, 30%

^{1}H NMR (400 MHz, MeOD-d_4): δ 7.87 (dd, *J* = 8.8, 5.1 Hz, 1H), 7.38 (dd, *J* = 8.8, 2.0 Hz, 1H), 7.16 (td, J = 9.0, 2.2 Hz, 1H), 4.18 (dt, J=13.4, 2.8, 2H), 3.36 (m, 1H), 3.04 (s, 2H), 2.15 – 2.04 (m, 2H), 1.89 – 1.73 (m, 2H), 1.48 (s, 9H); **^{13}C NMR (101 MHz, MeOD-d_4):** δ 164.40 (J_{1F} = 250.3), 163.74 (J_{3F} = 13.9), 160.91, 155.07, 122.87(J_{3F} = 11.1), 117.14, 112.18 (J_{2F} = 25.76), 96.62 (J_{2F} = 27.37), 79.81, 43.25，33.72, 29.99, 27.31. **HRMS (ESI)** calculated for $C_{17}H_{21}N_2O_3FNa(+)$: 343.1536; Found: 343.1429.



Compound 5 (24 mg, 0.07 mmol) was dissolved in 4M HCl-MeOH (1 ml) at 0°C, the reaction mixture was stirred at 0°C to r.t overnight. The reaction was quenched by saturated aqueous solution of $NaHCO_3$ at 0°C. Concentrated and the aqueous phase was extracted with EtOAc. The combined organics were washed with brine, dried over anhydrous Na_2SO_4, filtered and concentrated in vacuo.[10]



6，pale yellow solid, >95%

^{1}H NMR (400 MHz, MeOD-d$_4$): δ 7.93 (dd, J=8.7, 5.1, 1H), 7.43 (dd, J=8.7, 1.8, 1H), 7.27 – 7.14 (m, 1H), 3.65 – 3.45 (m, 3H), 3.22 (t, J=11.3, 2H), 2.35 (d, J=12.9, 2H), 2.22 – 2.06 (m, 2H); **^{13}C NMR (101 MHz, MeOD-d$_4$):** δ 164.43(J_{1F} = 250.5), 163.81 (J_{3F} = 13.9), 160.61, 122.91 (J_{3F} = 11.2), 116.97, 112.26(J_{2F} = 25.9), 96.67(J_{2F} = 27.4), 44.23, 32.62, 28.67. **IR (cm^{-1}):** 2934, 1717, 1684, 1653, 1558, 1506, 1456, 1339, 669. **HRMS (ESI)** calculated for $C_{12}H_{14}N_2OF(+)$: 221.1012; Found: 221.1081.

9. References

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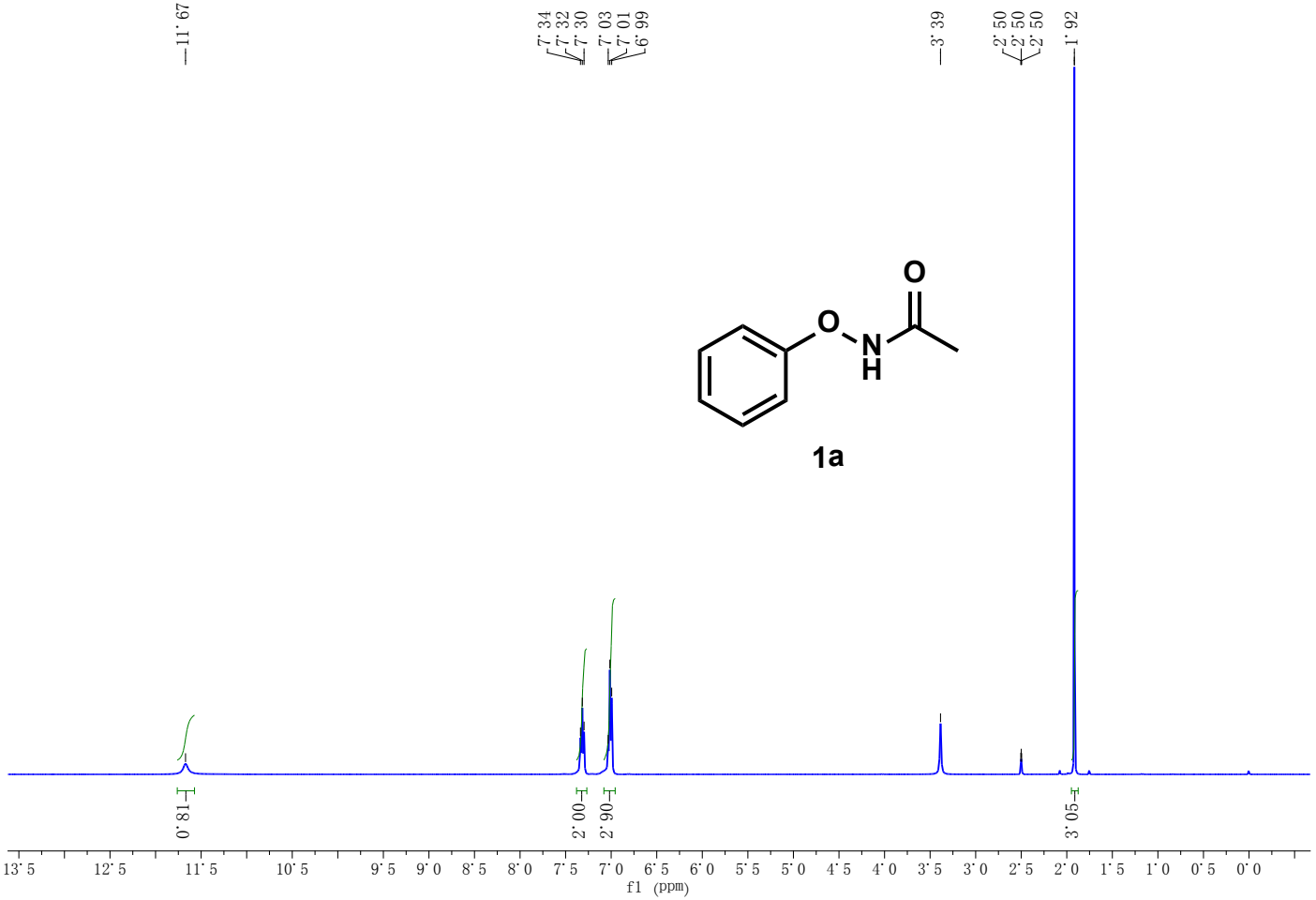
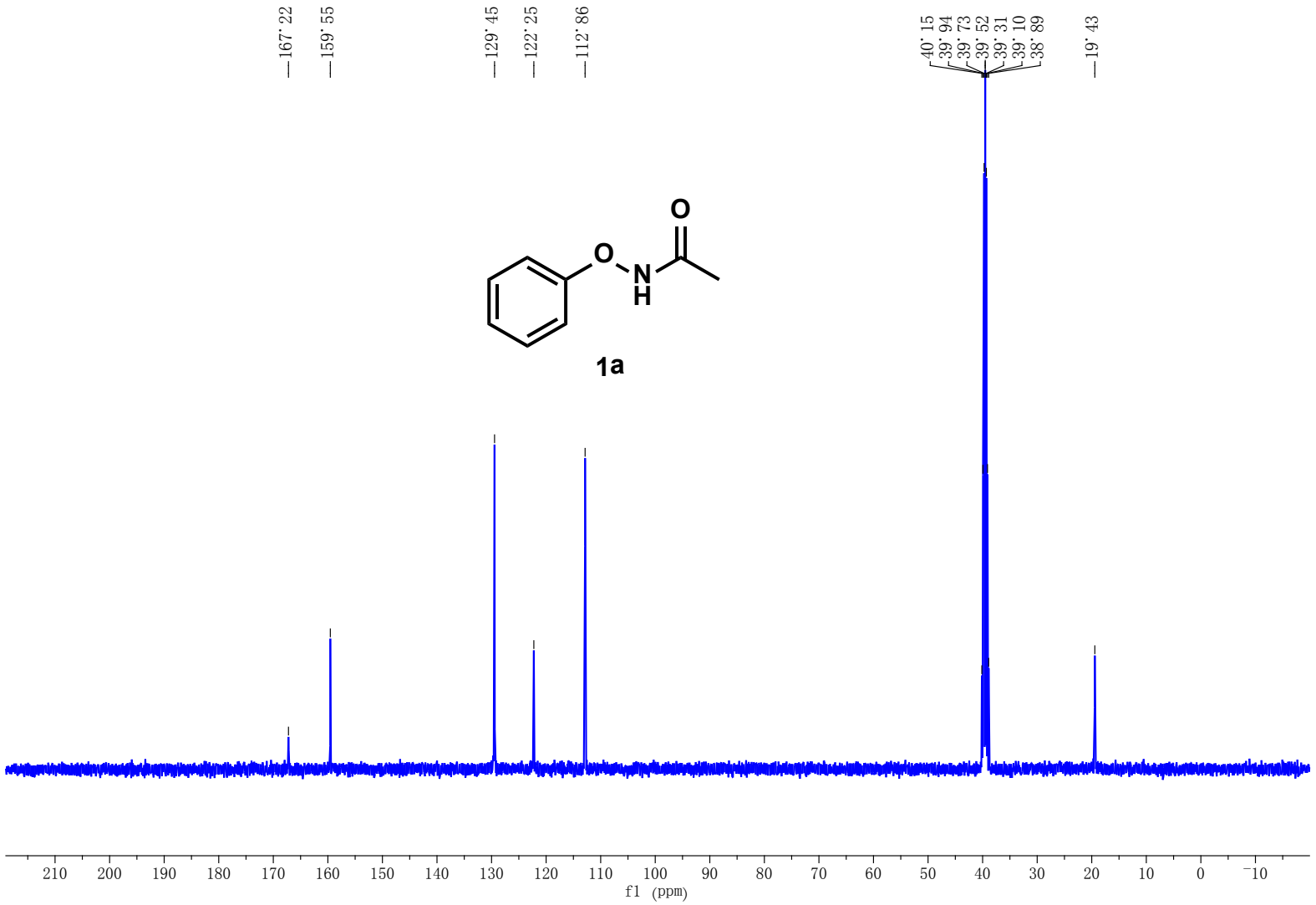
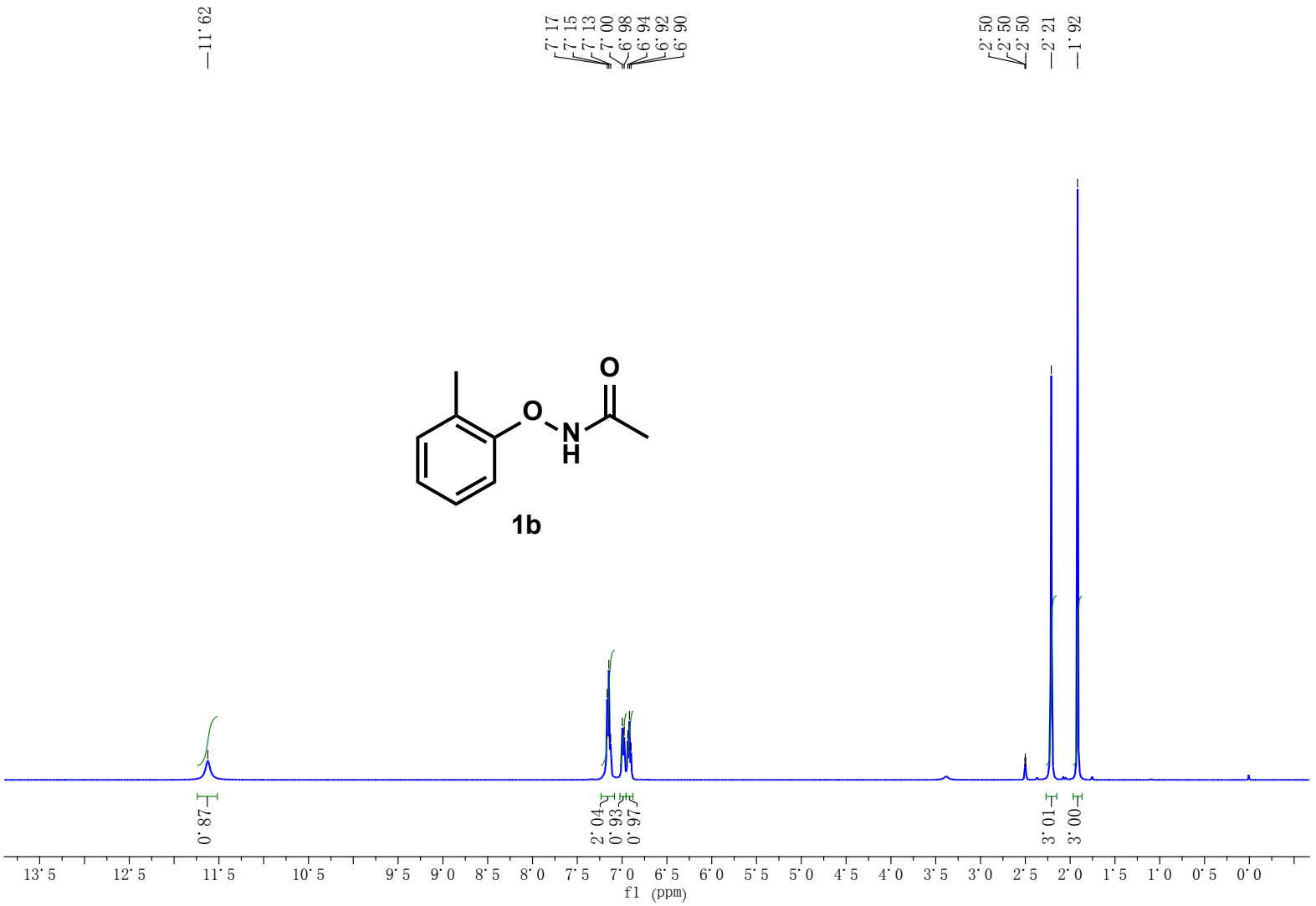
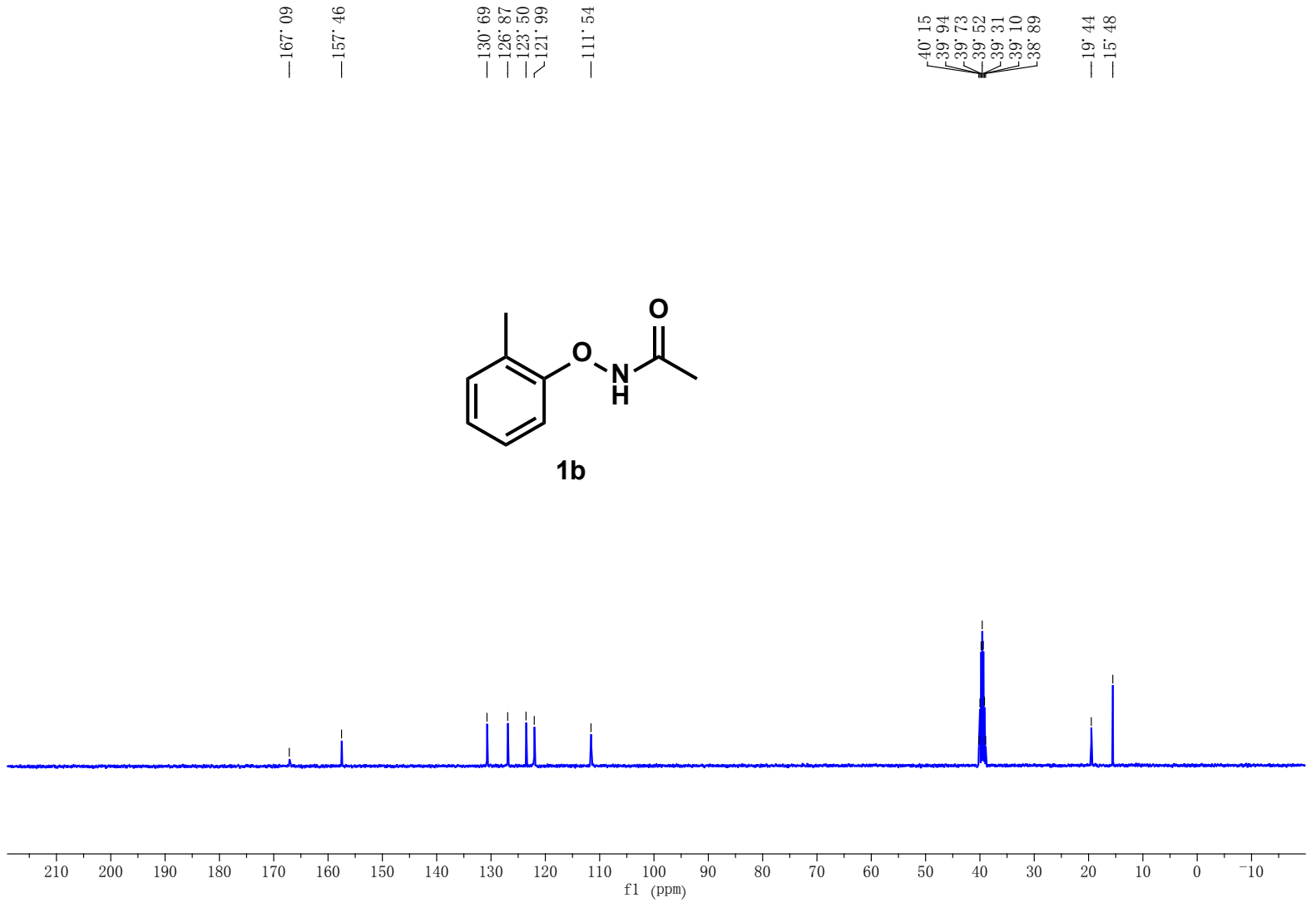
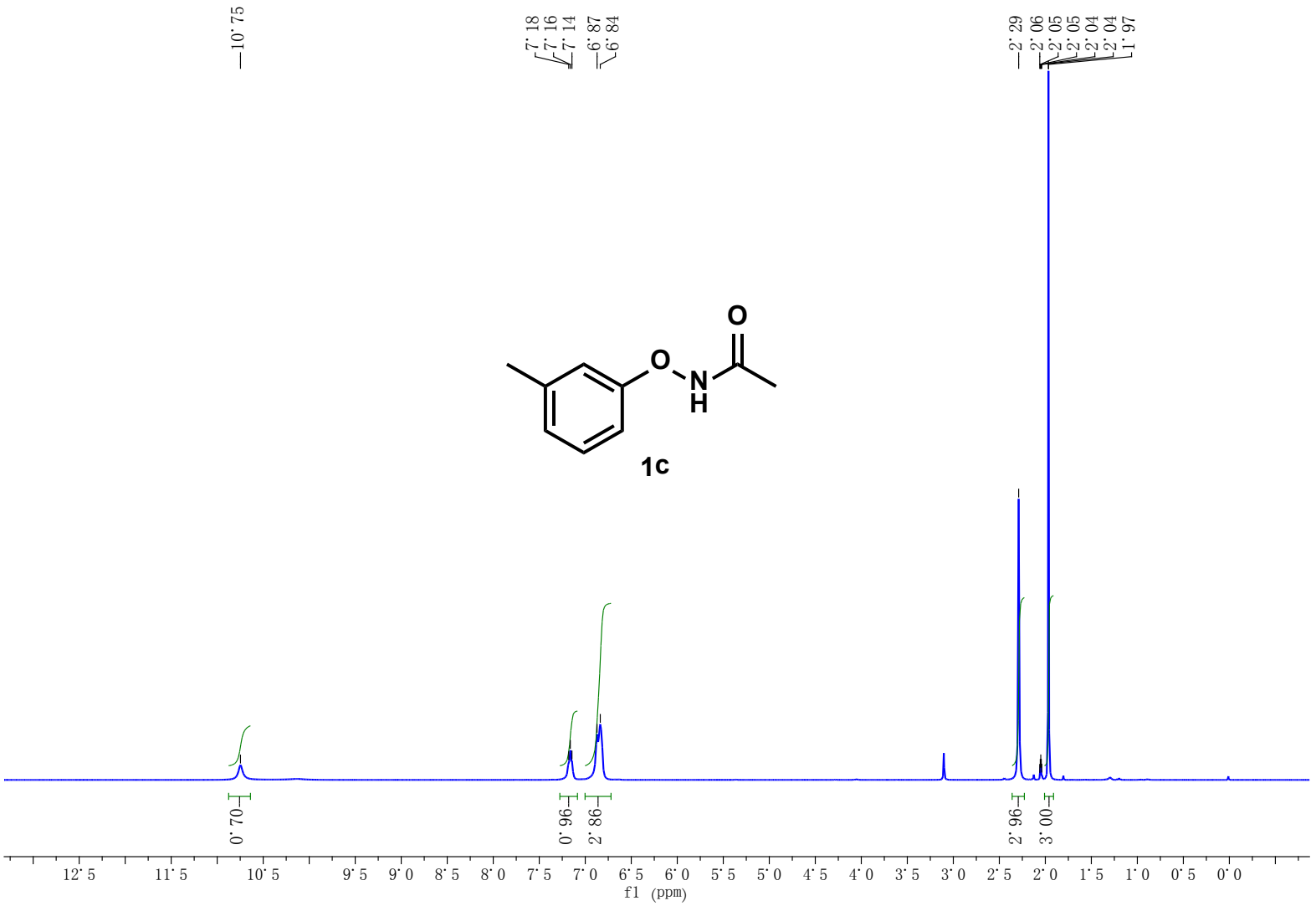
^{1}H and ^{13}C NMR Spectra of Substrates and Products

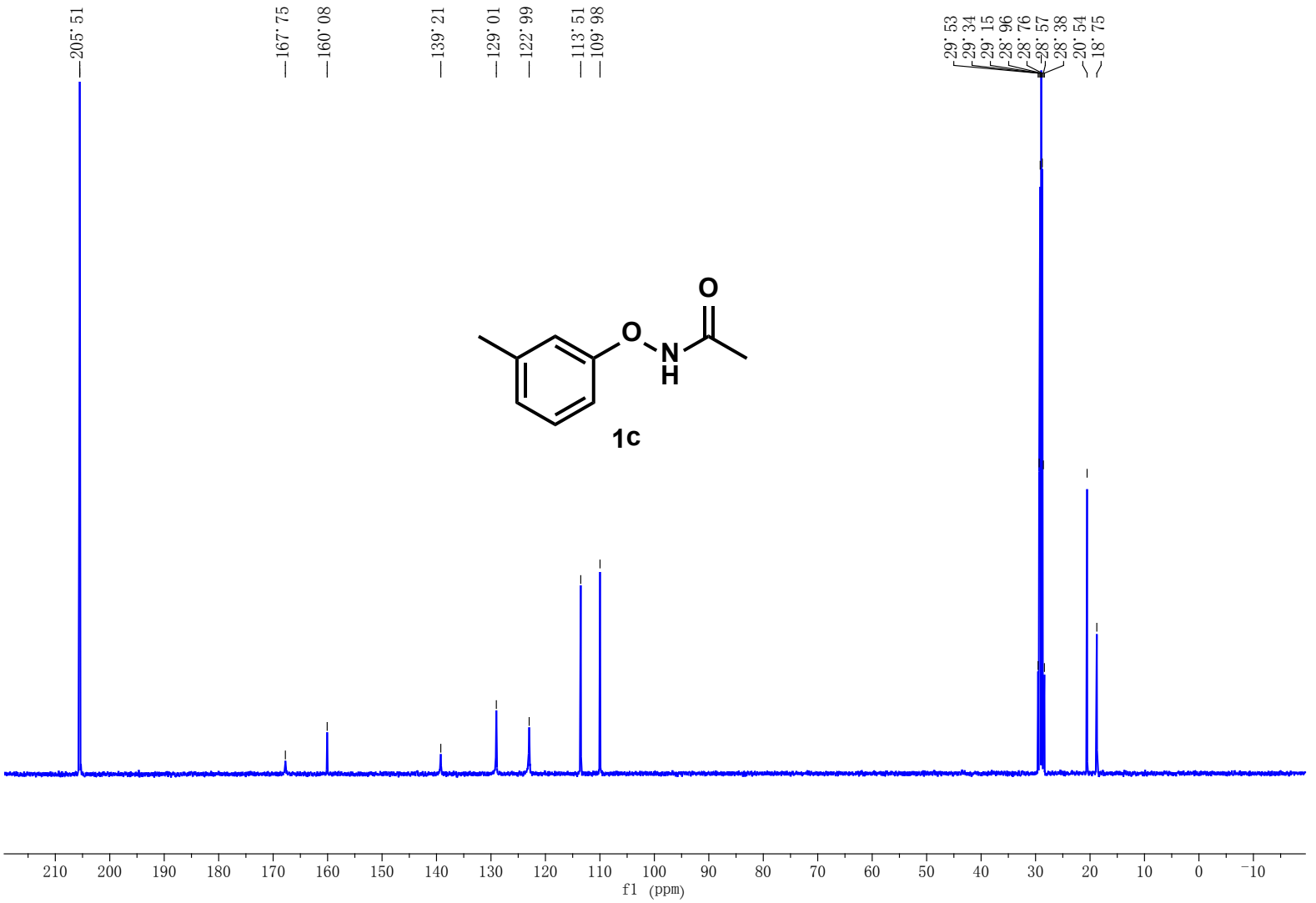


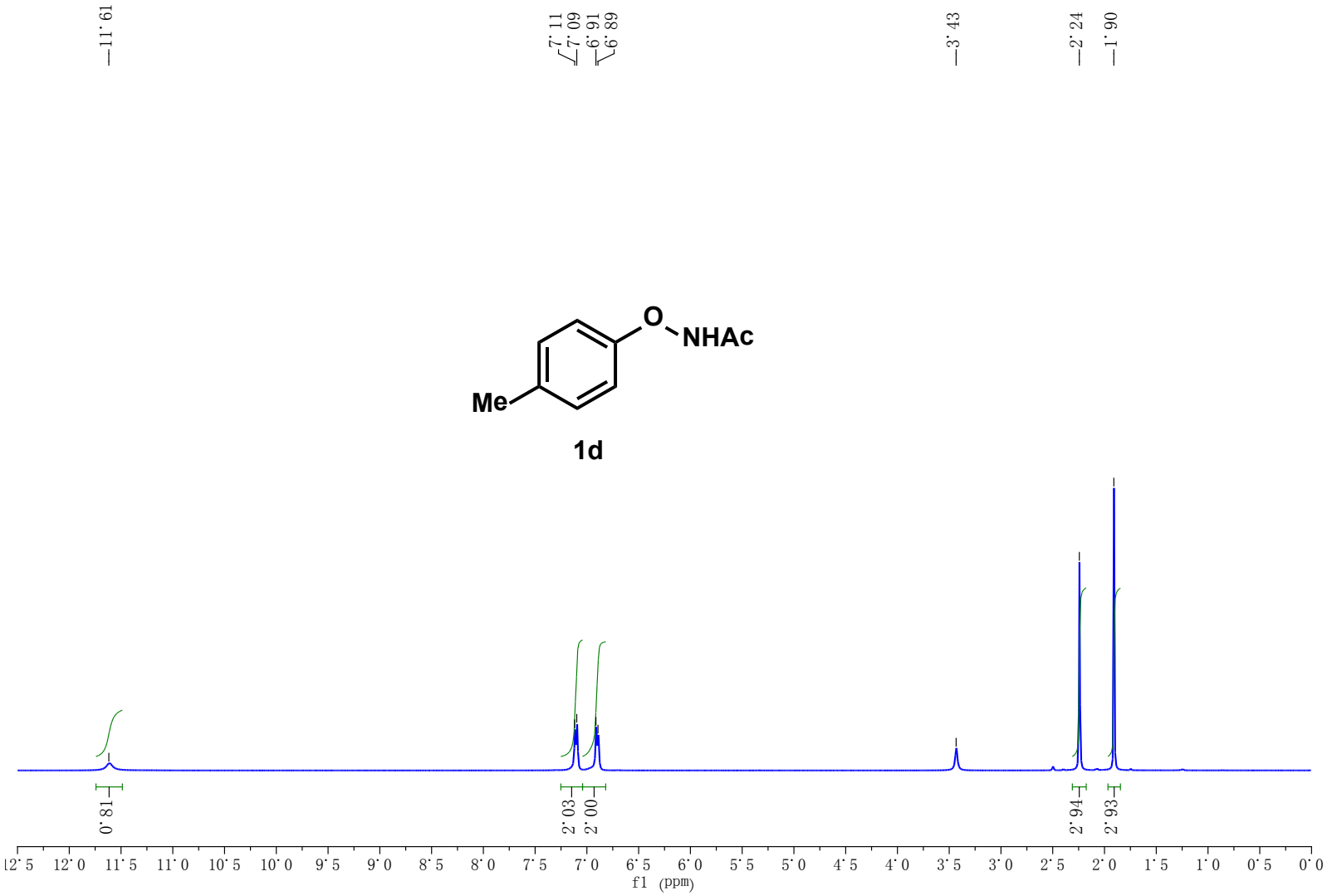


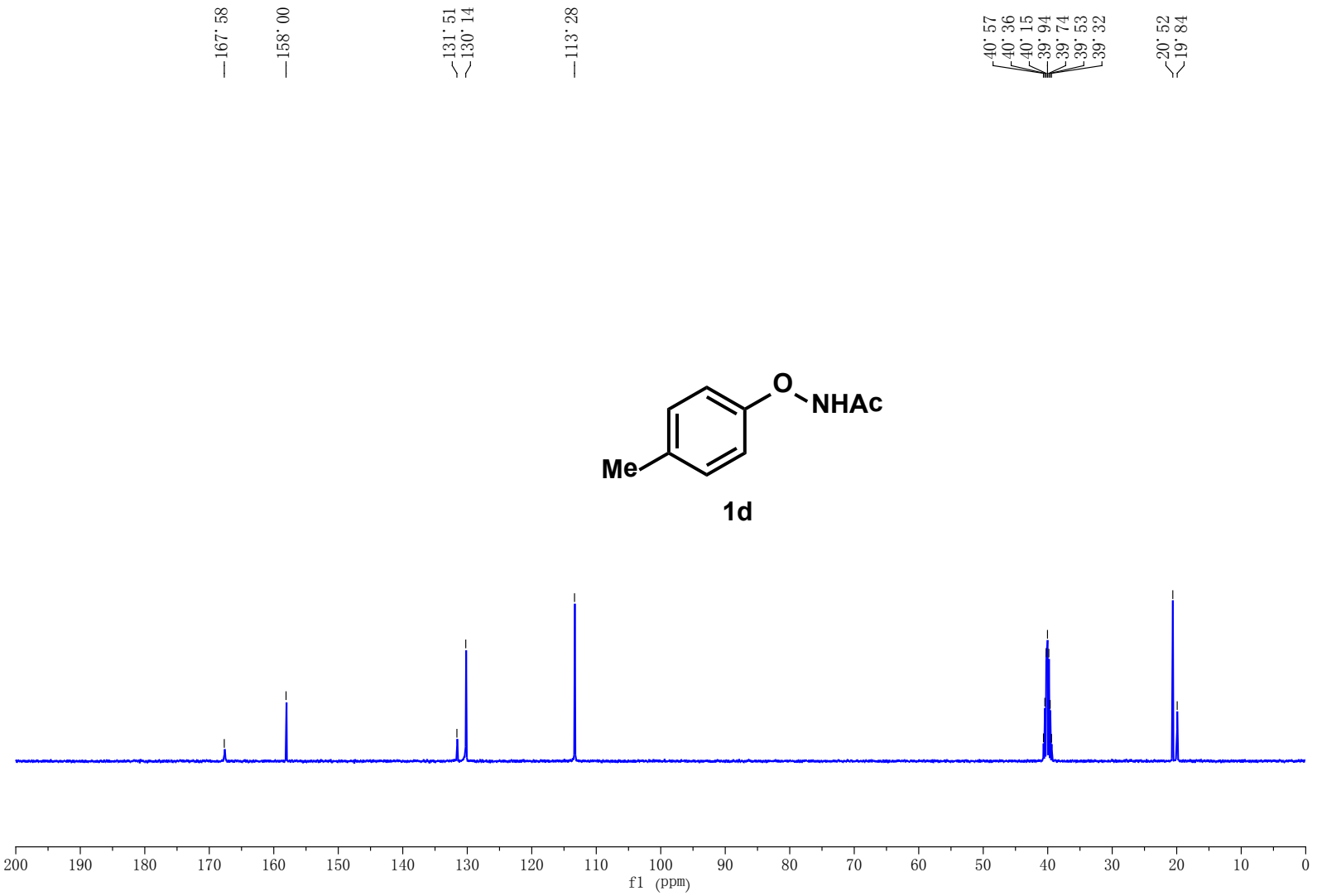


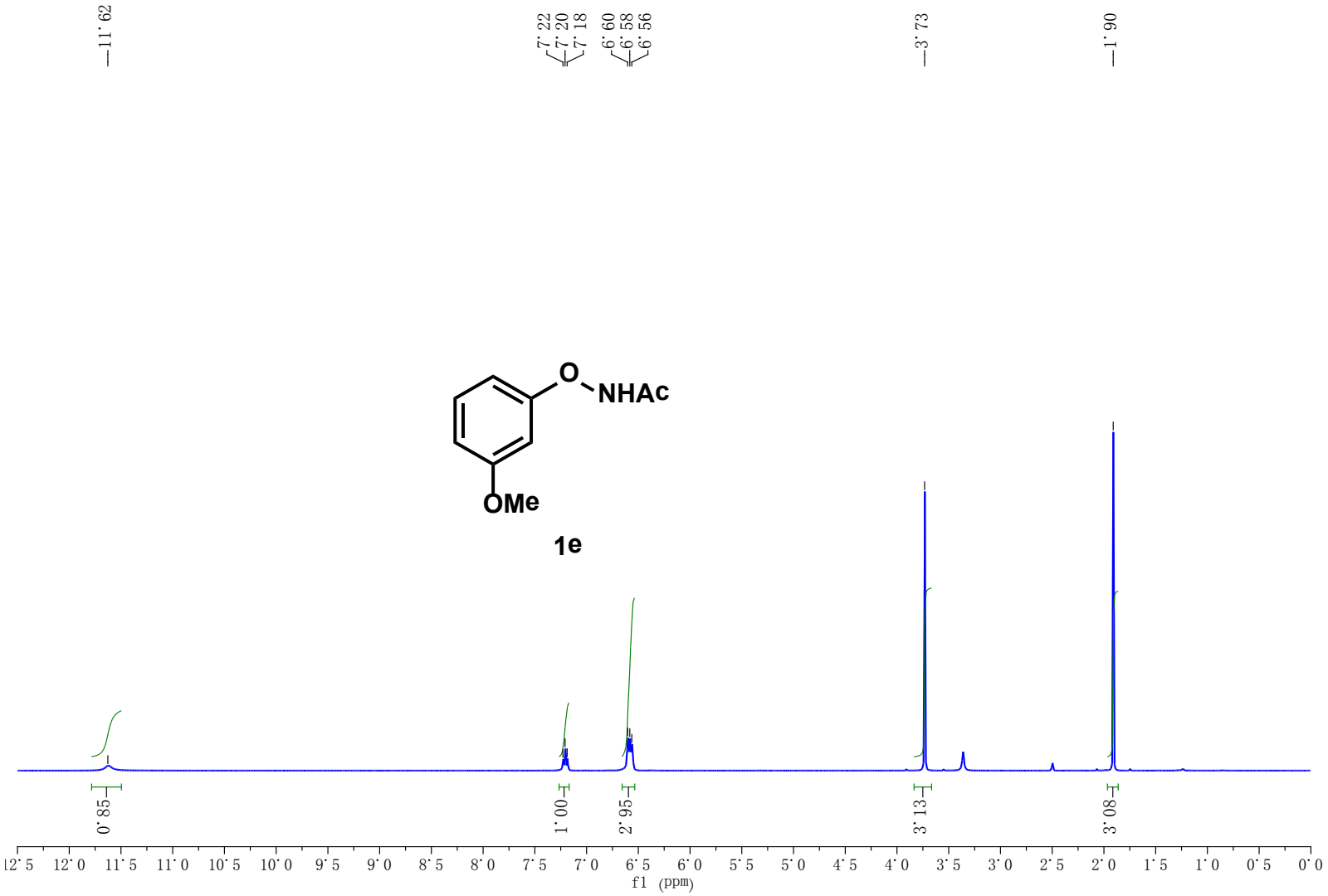


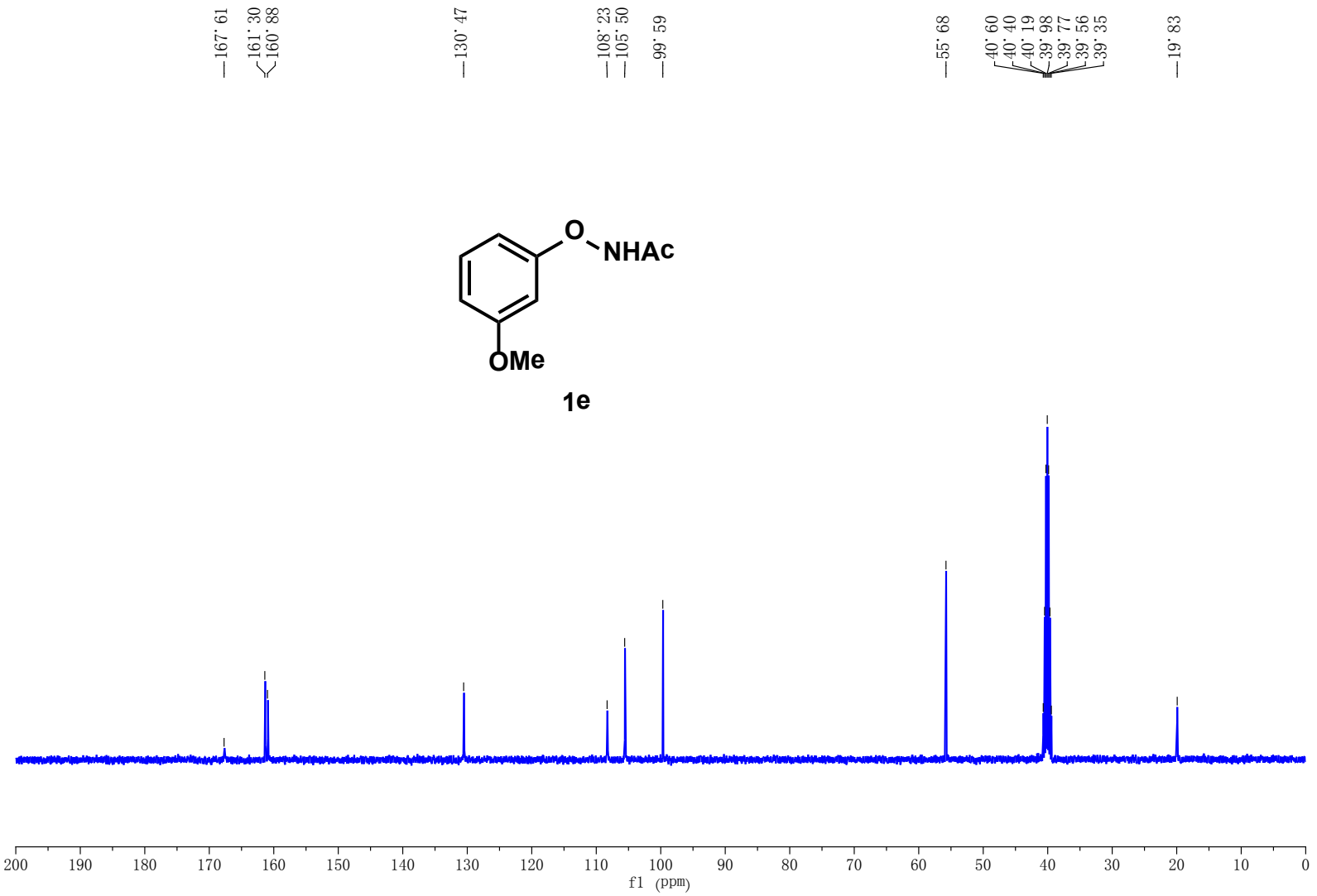


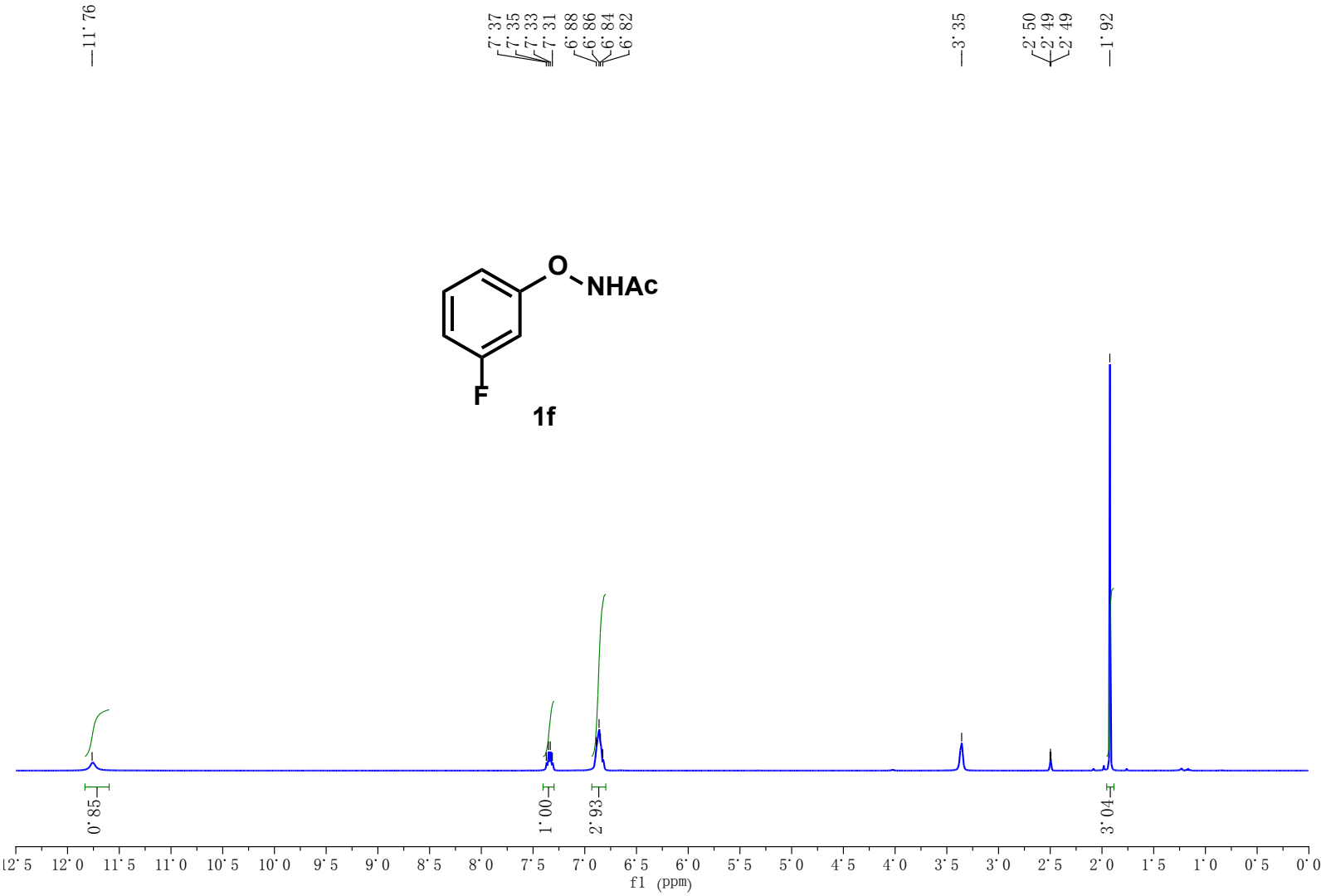


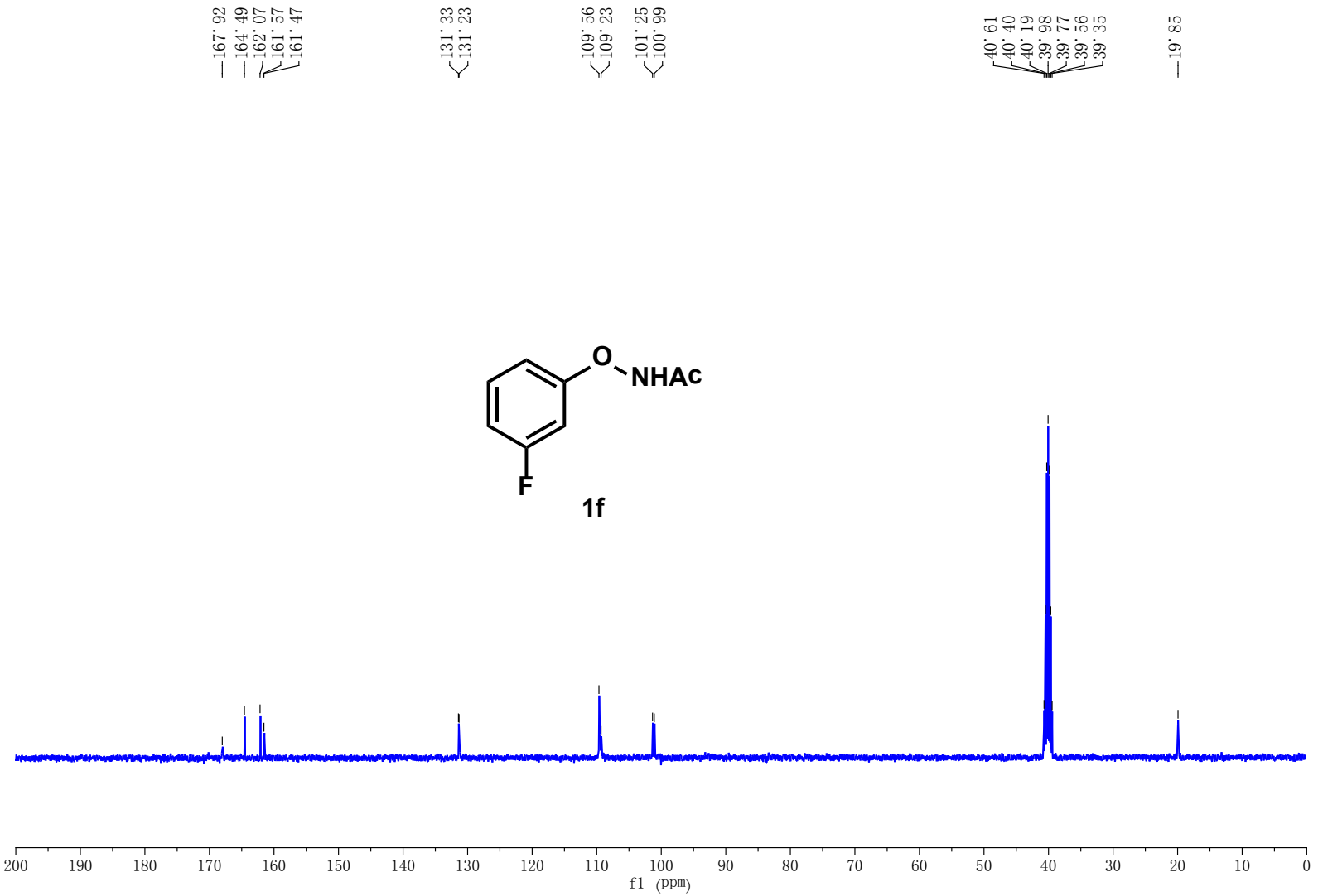


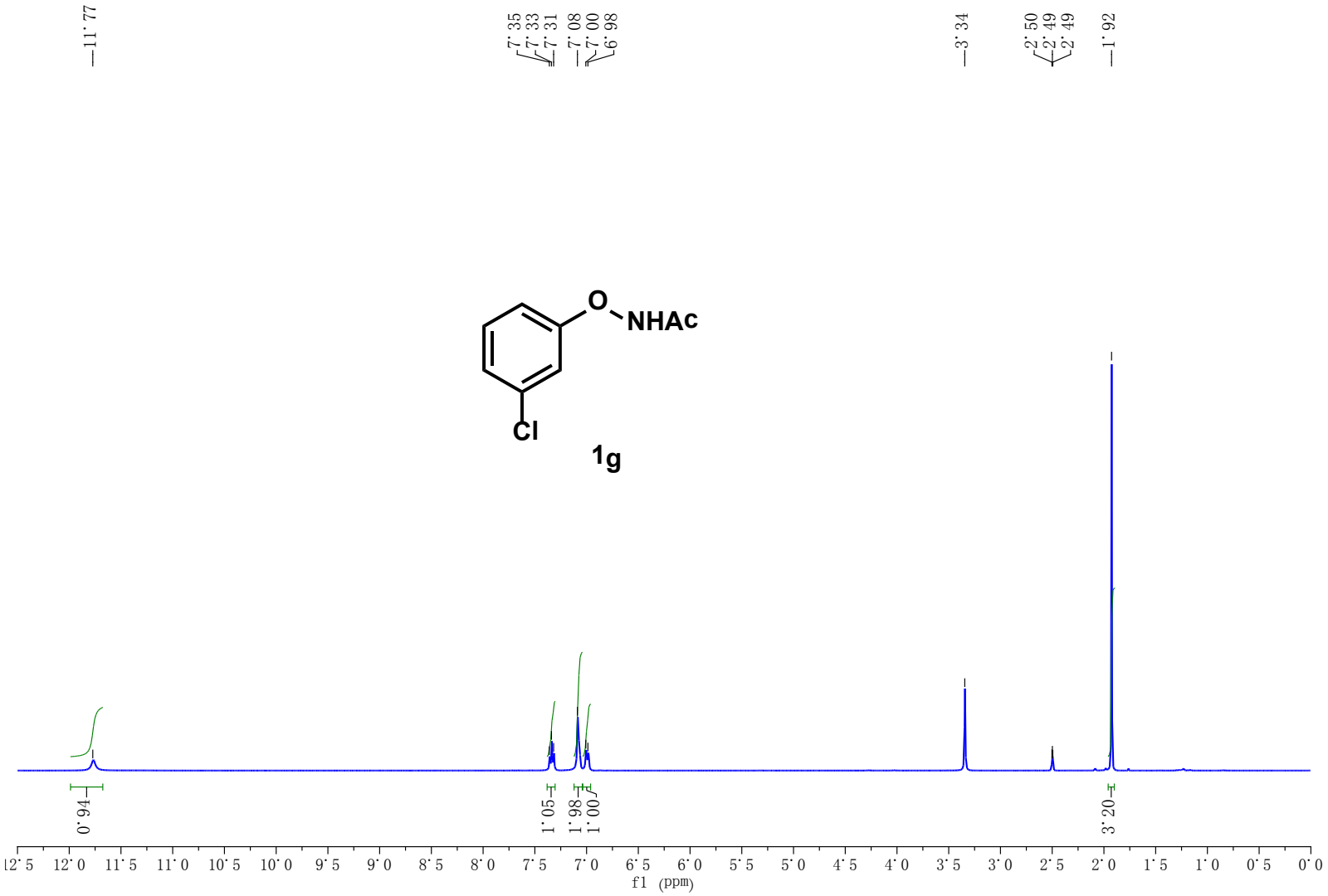


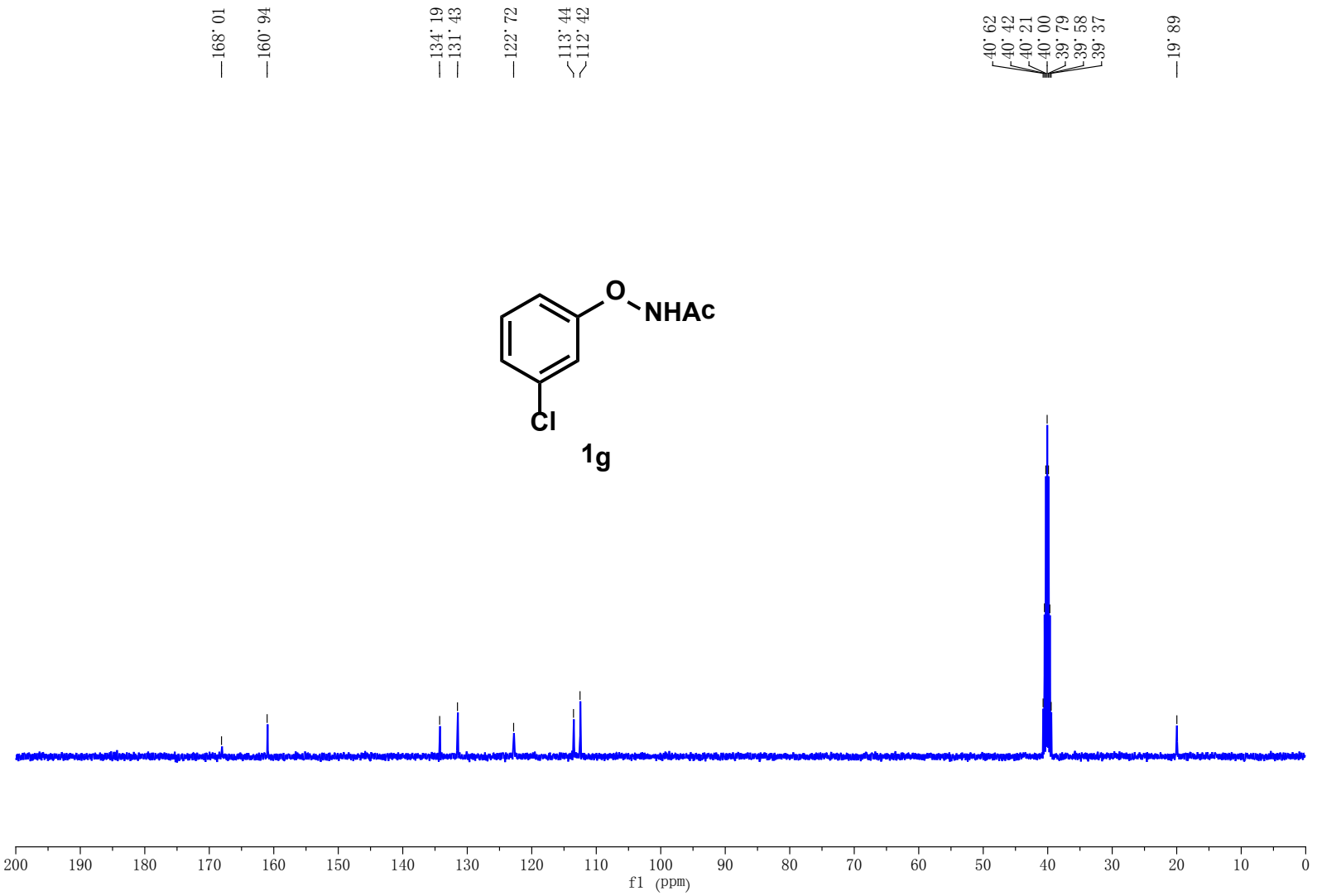


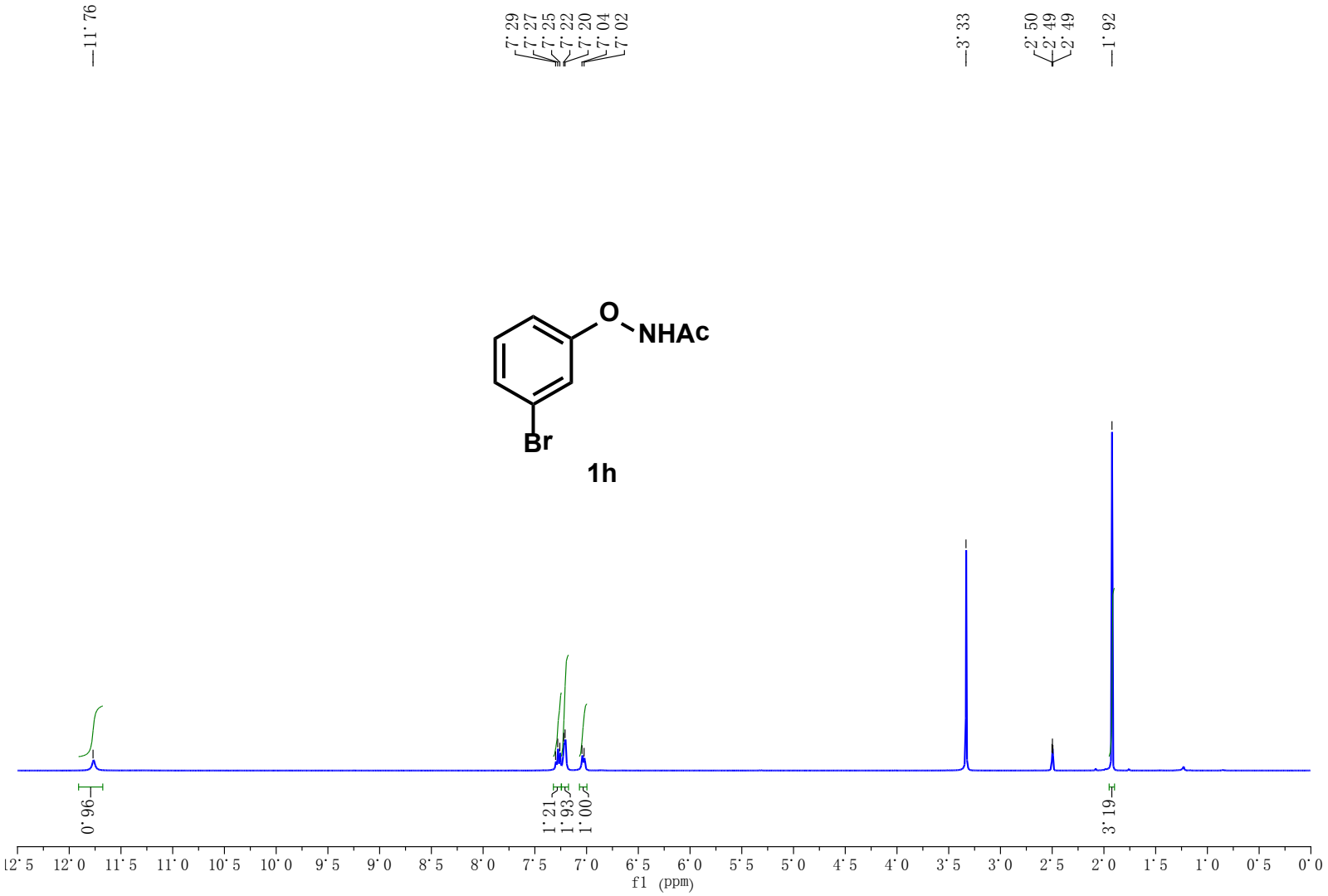


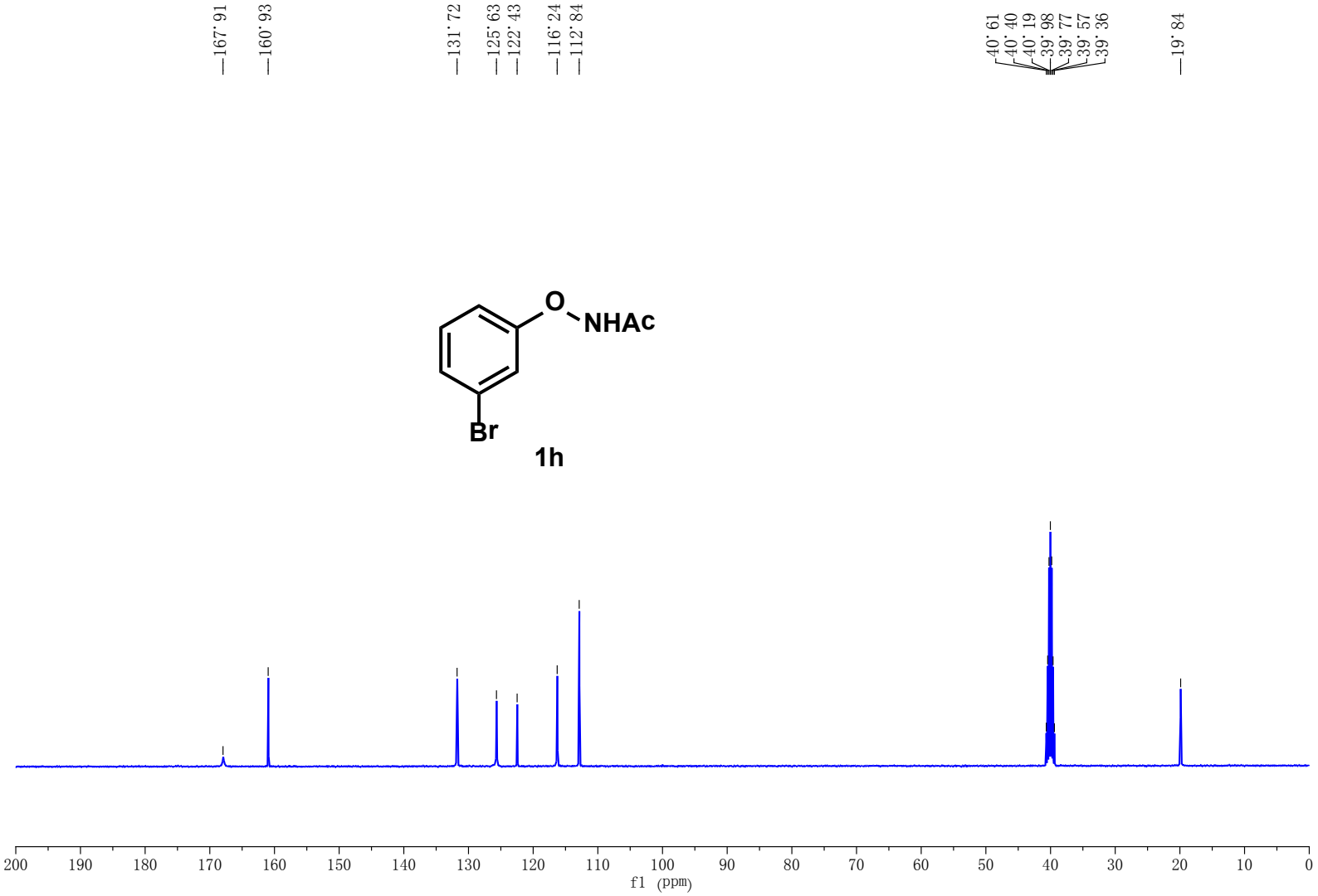


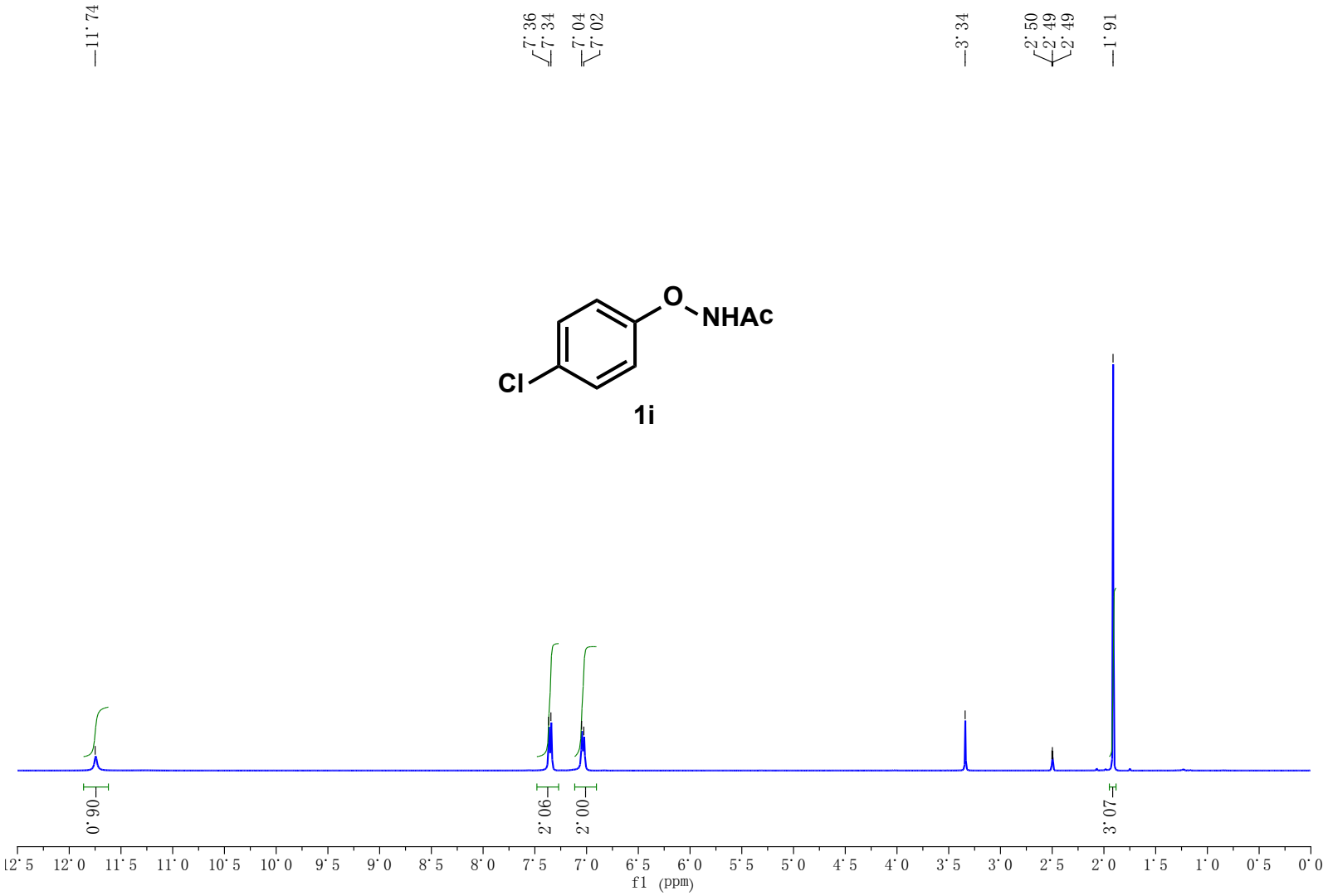


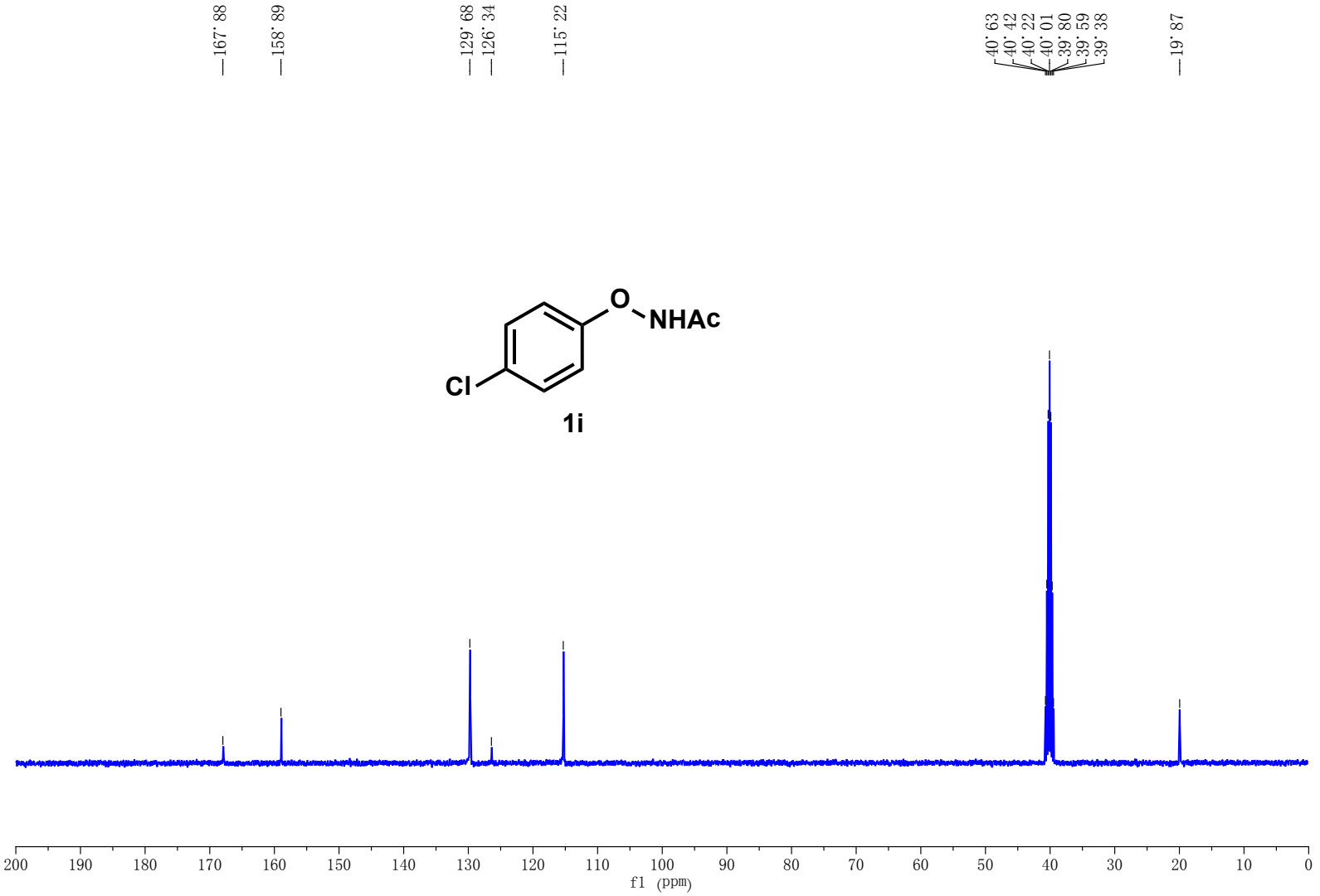


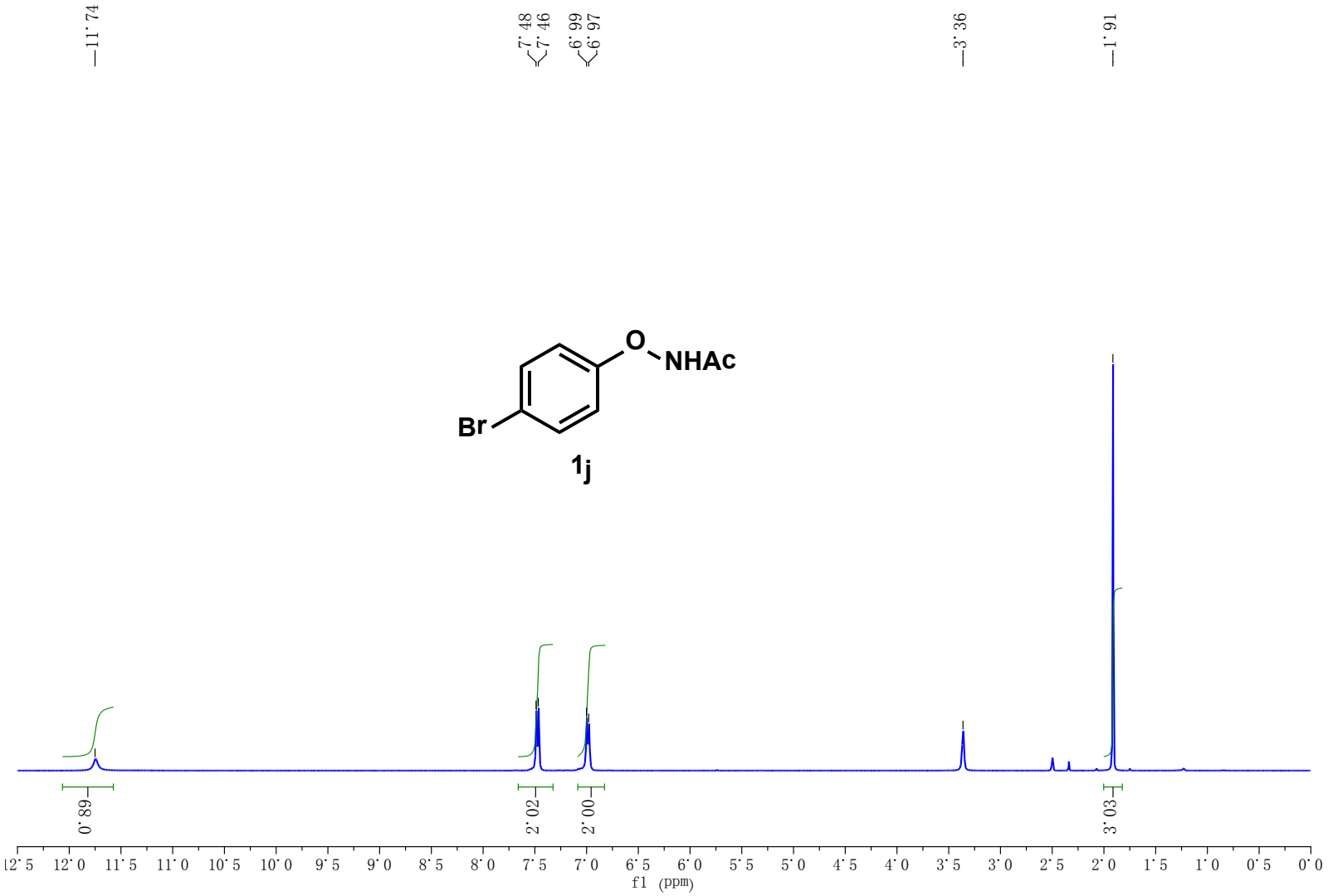


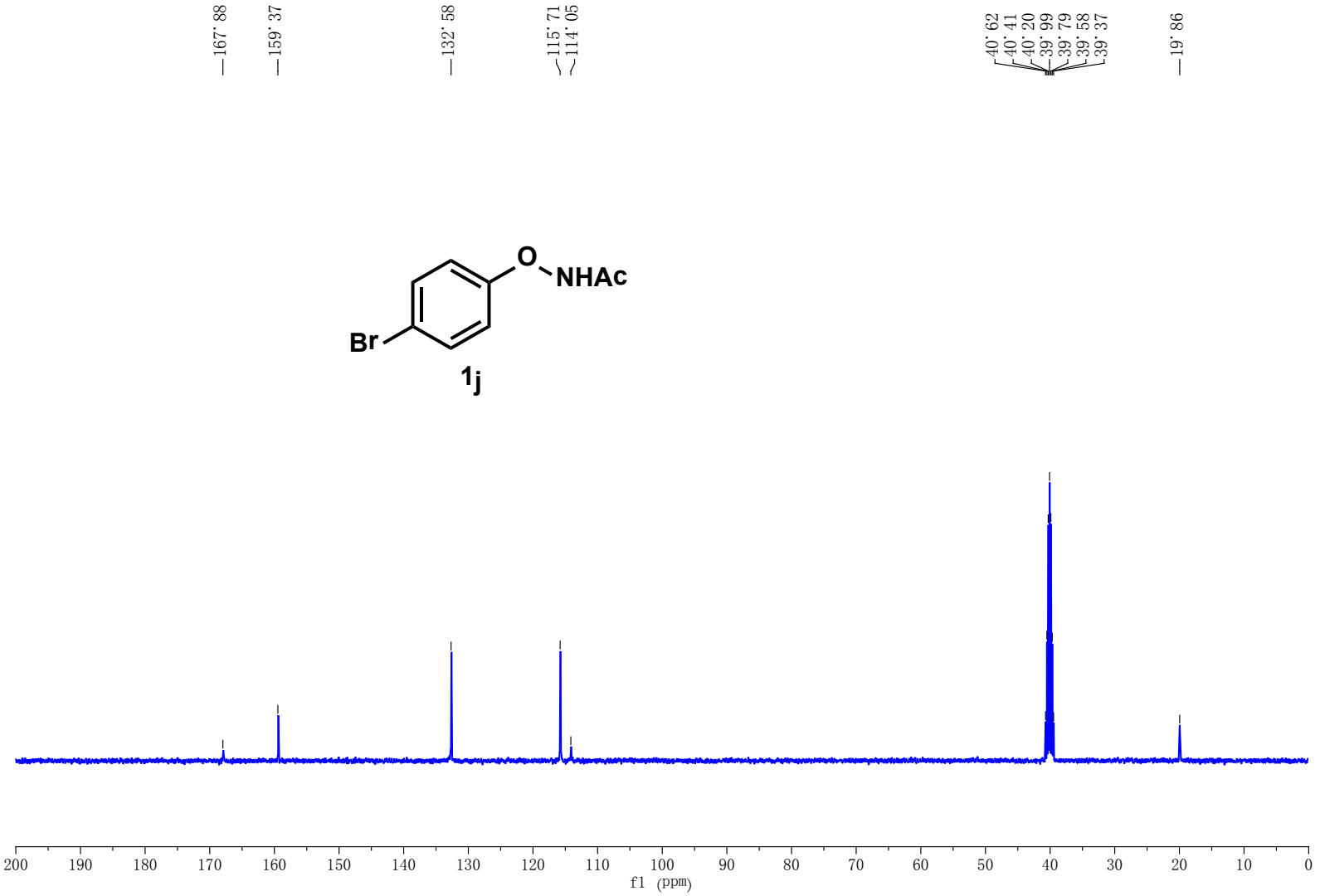


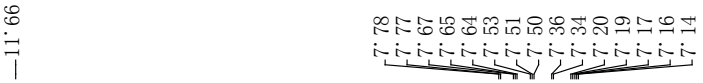


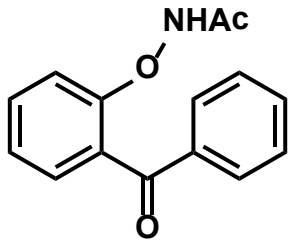












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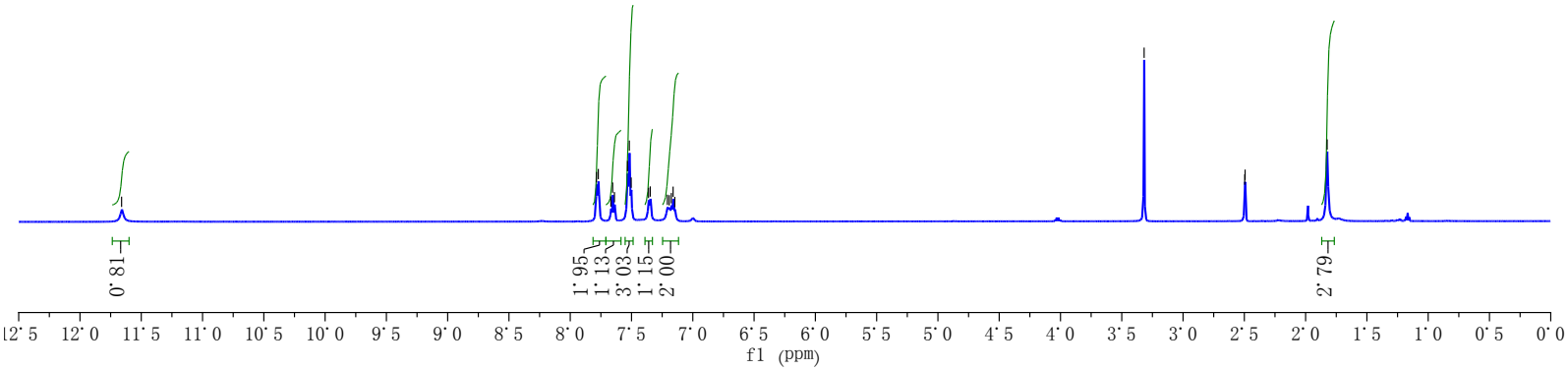

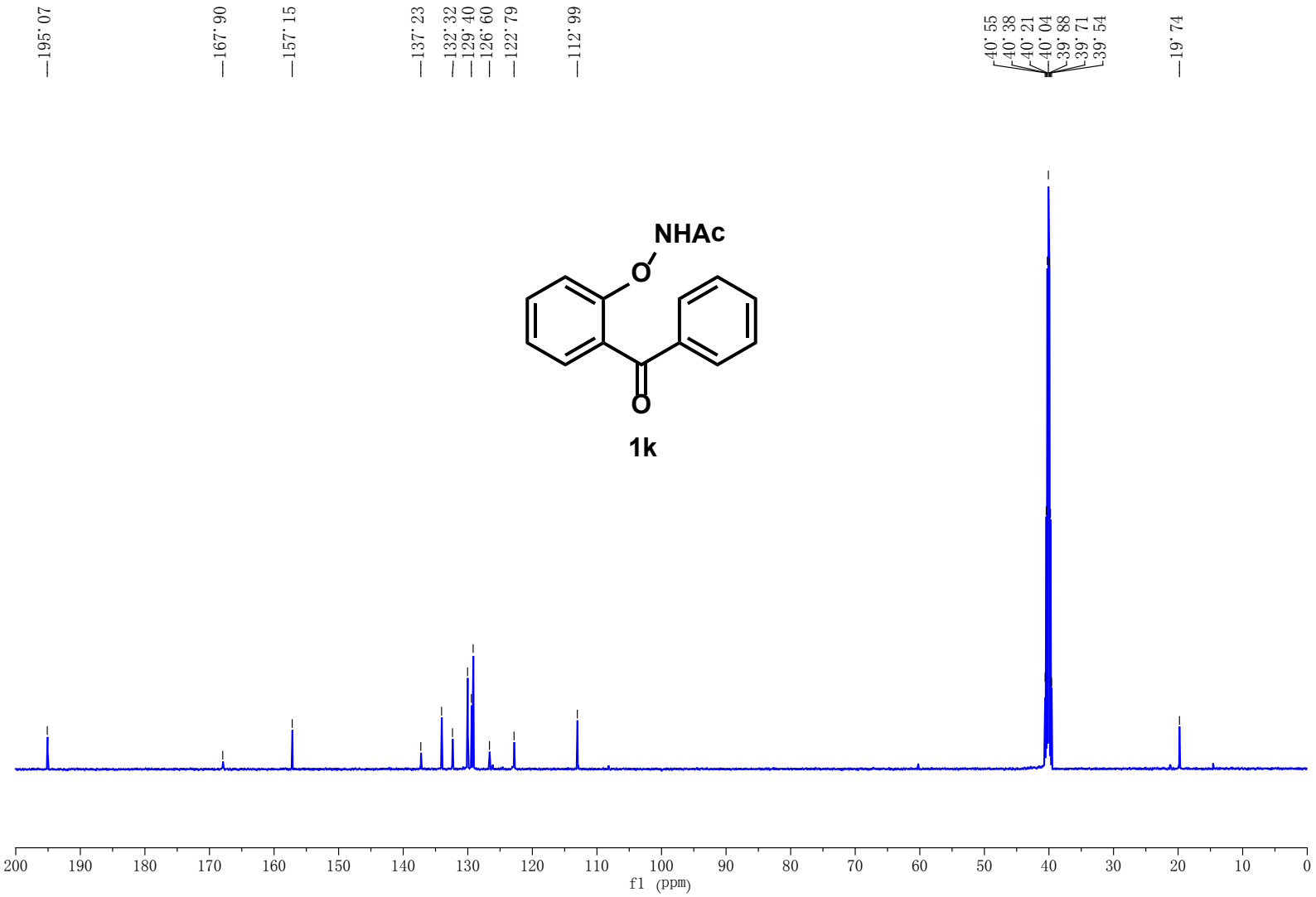

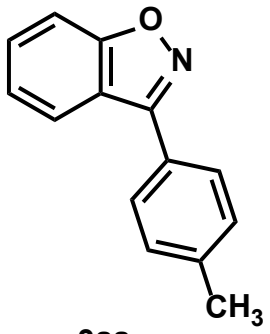

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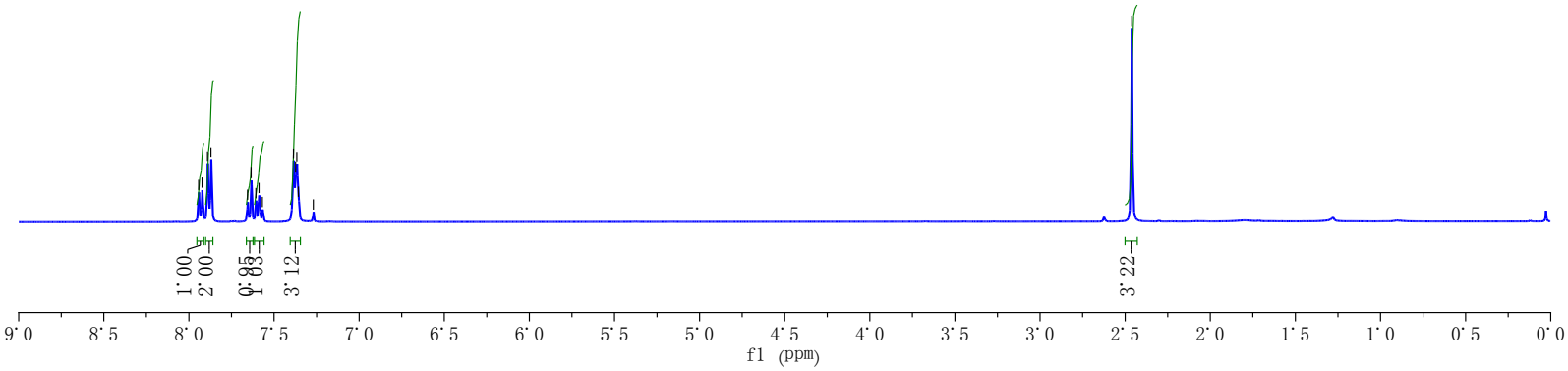

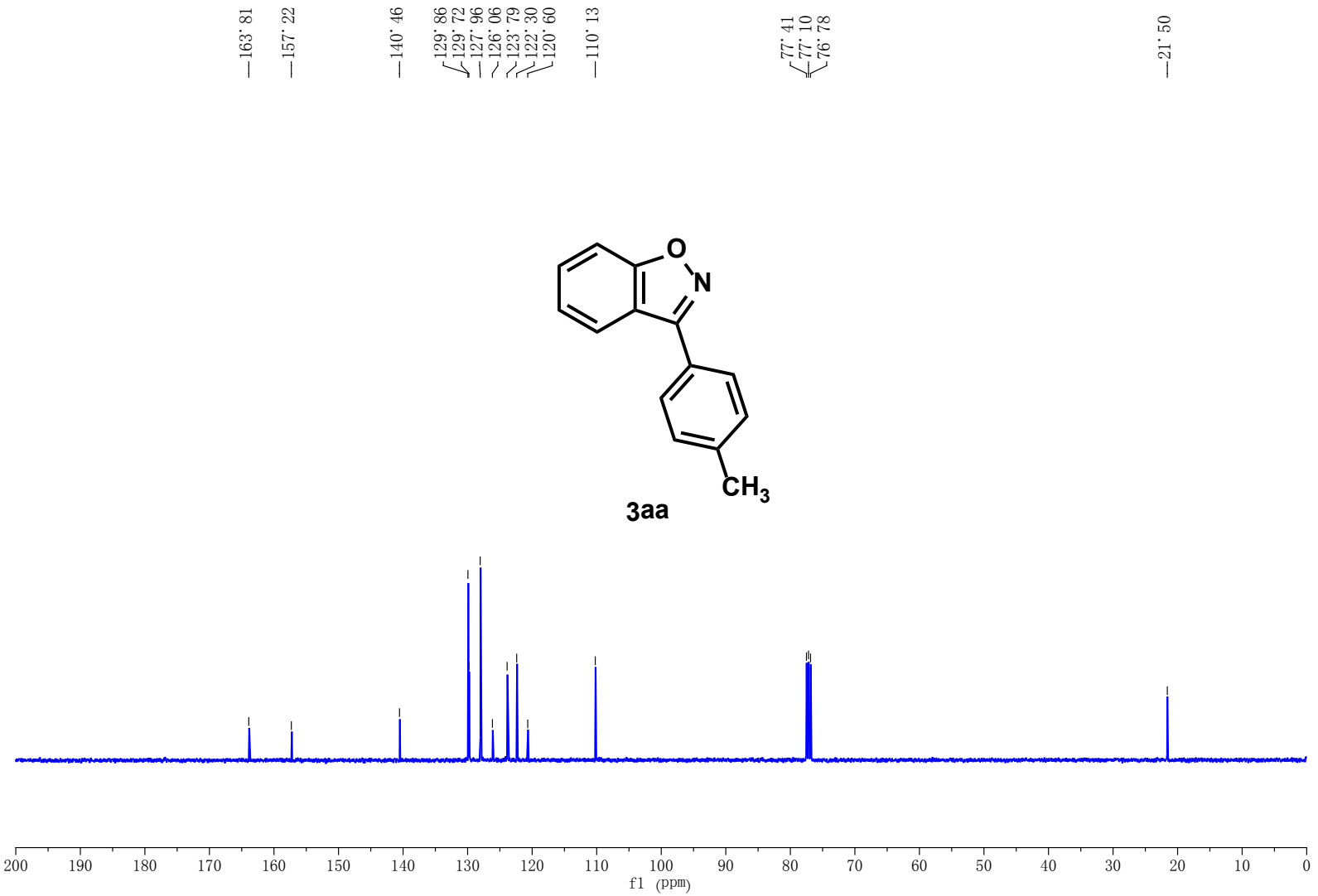

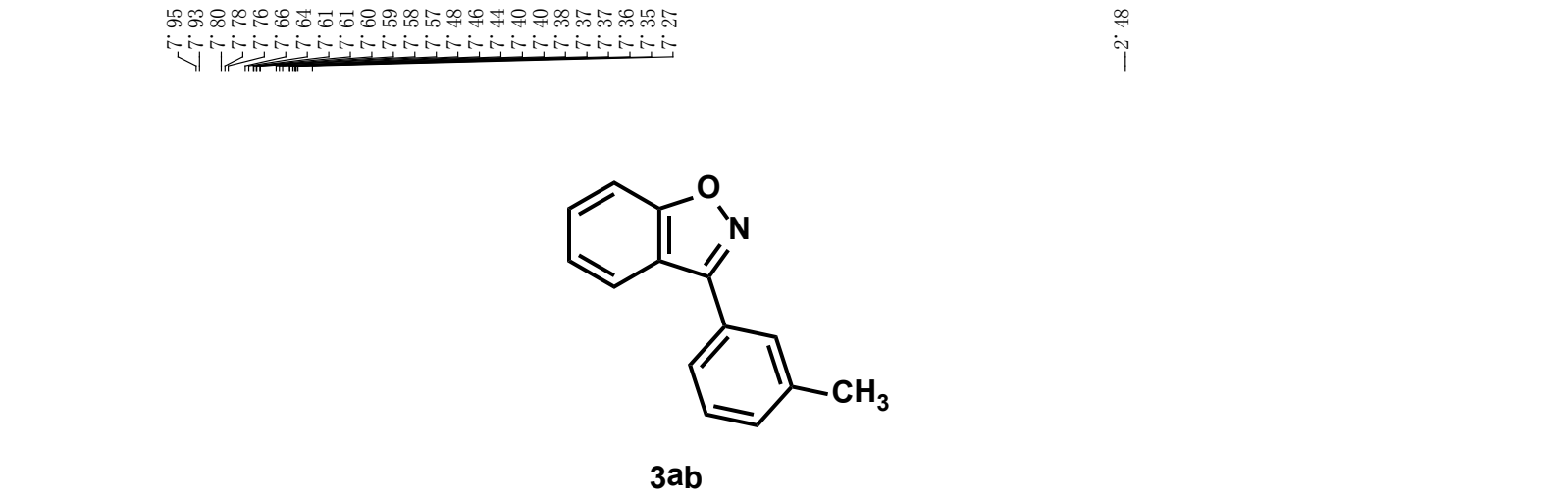

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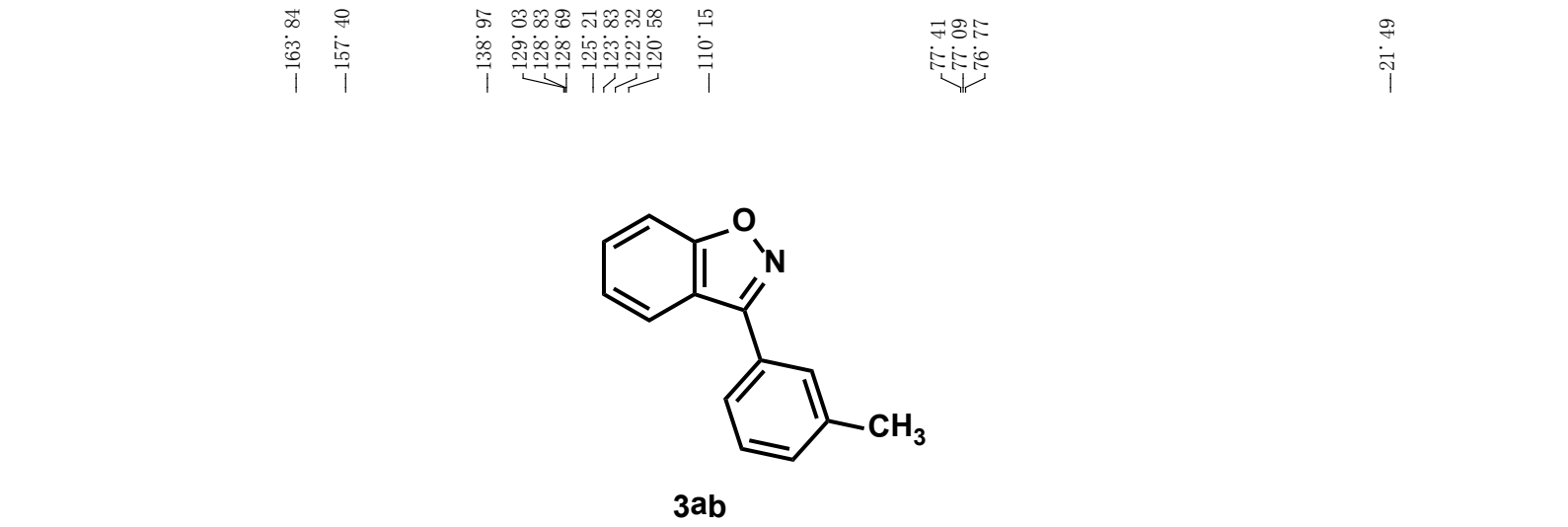

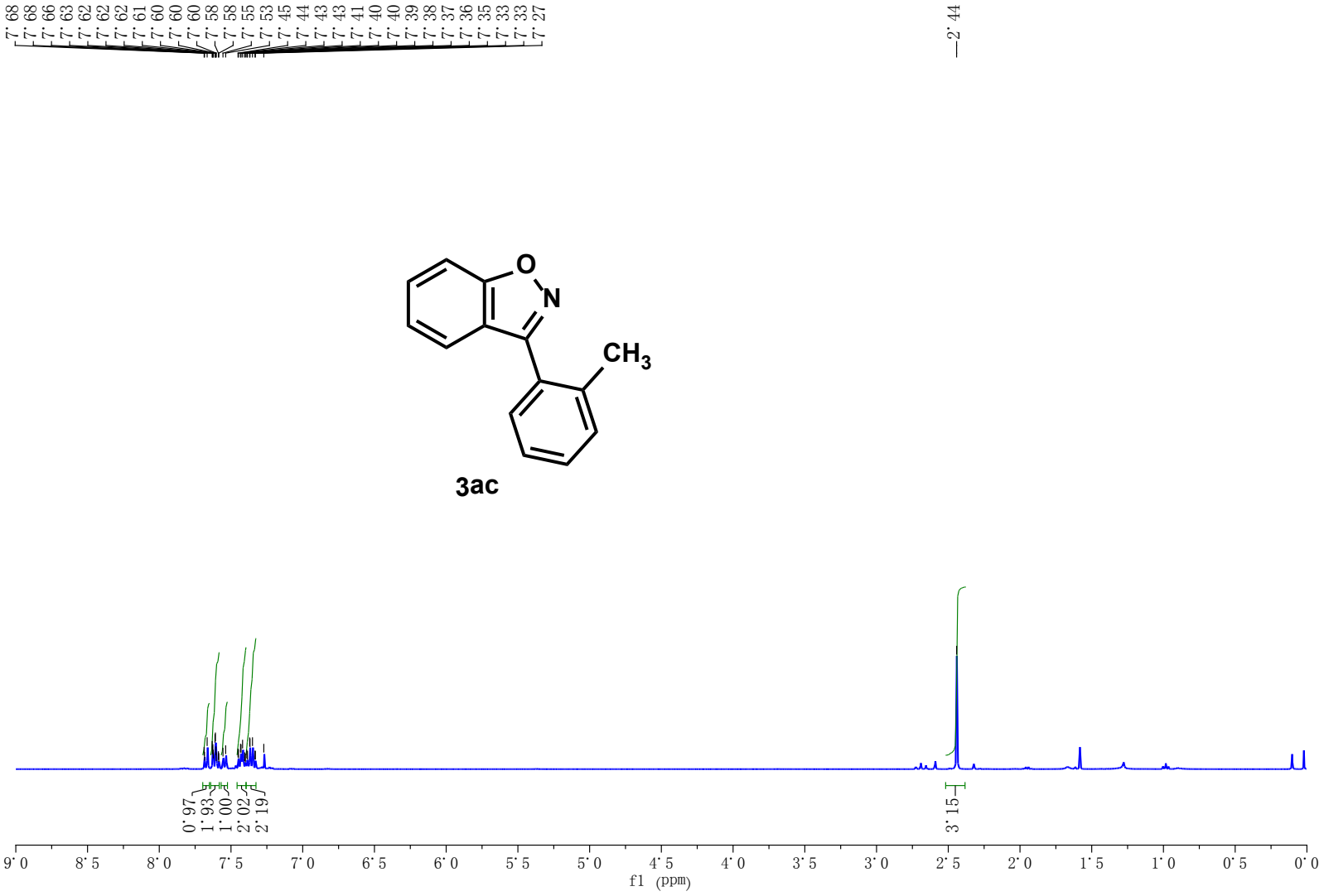

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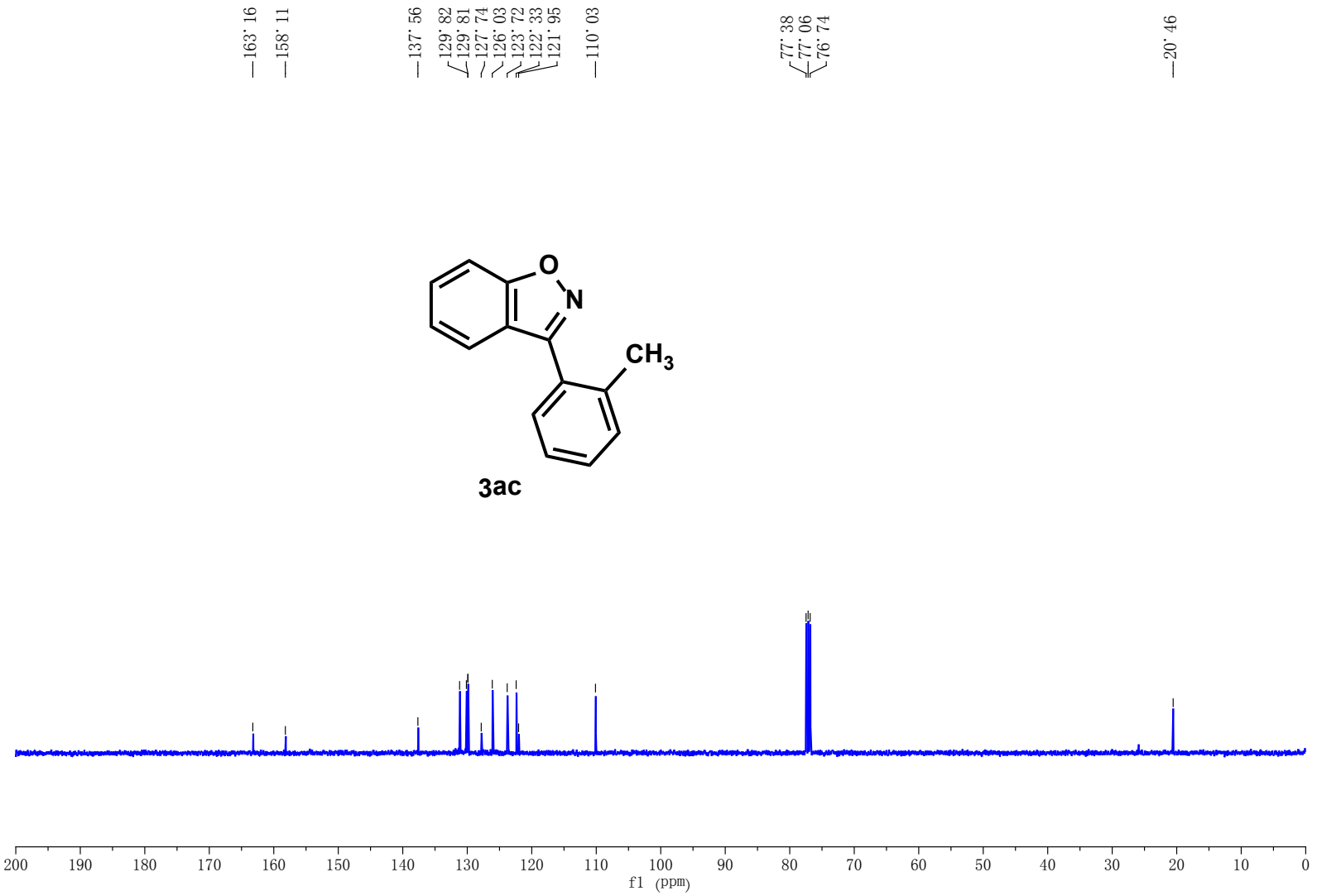

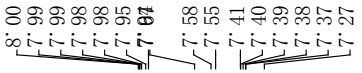

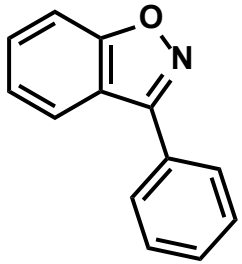

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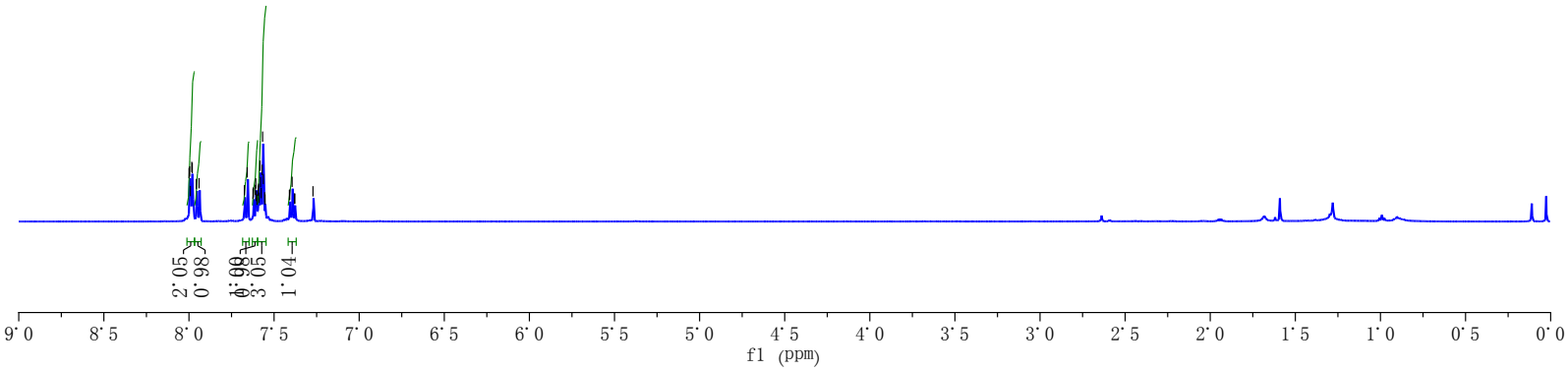

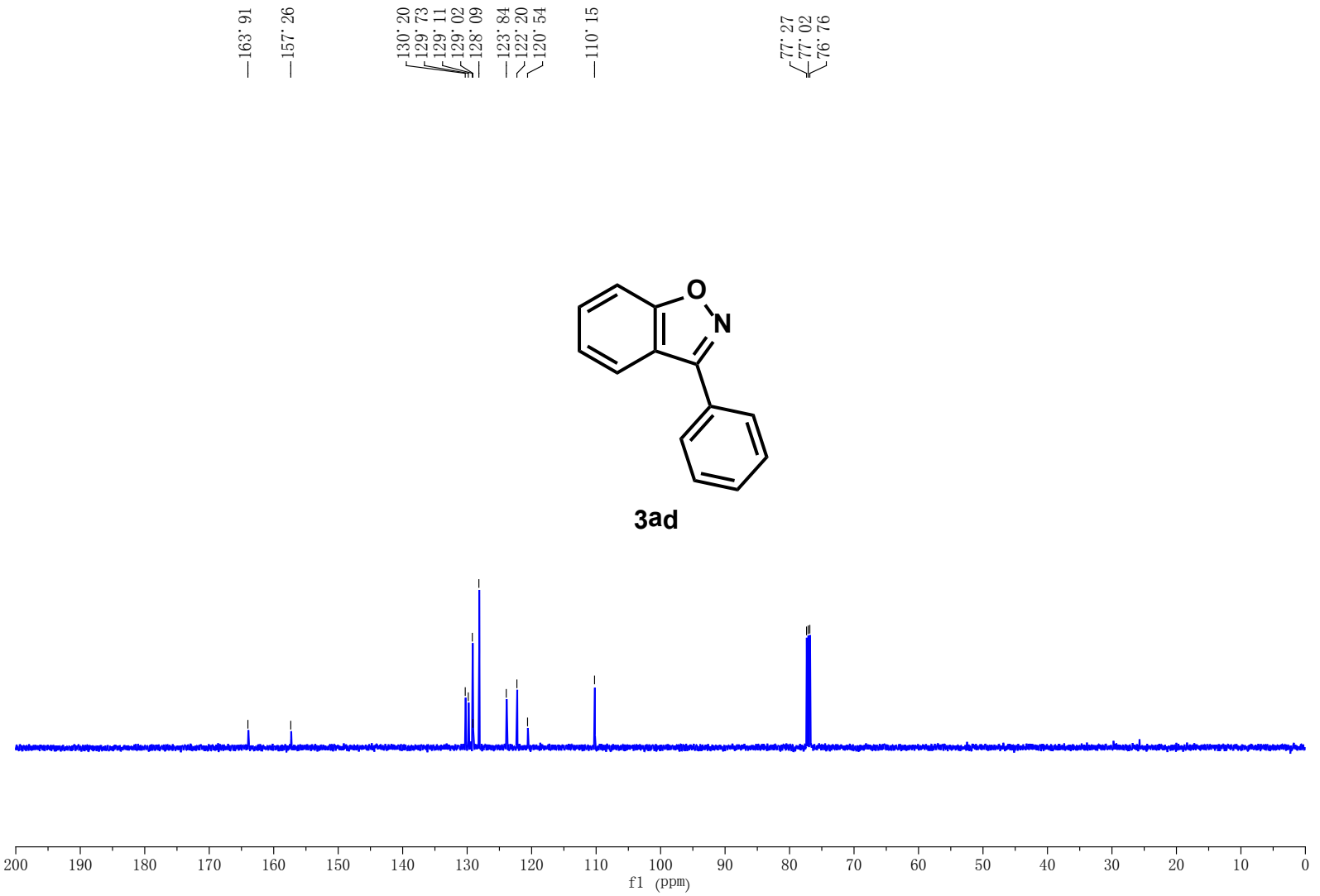

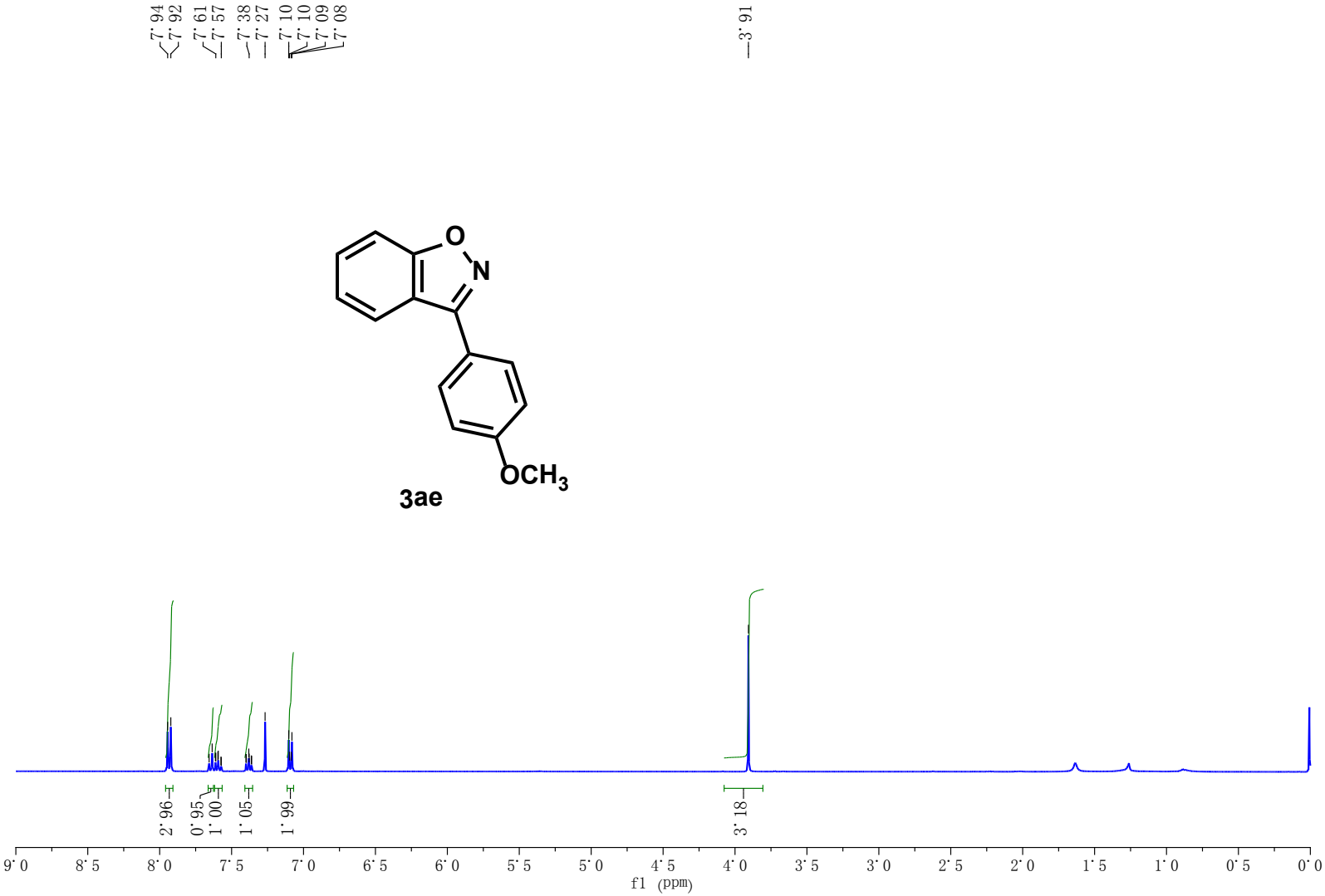

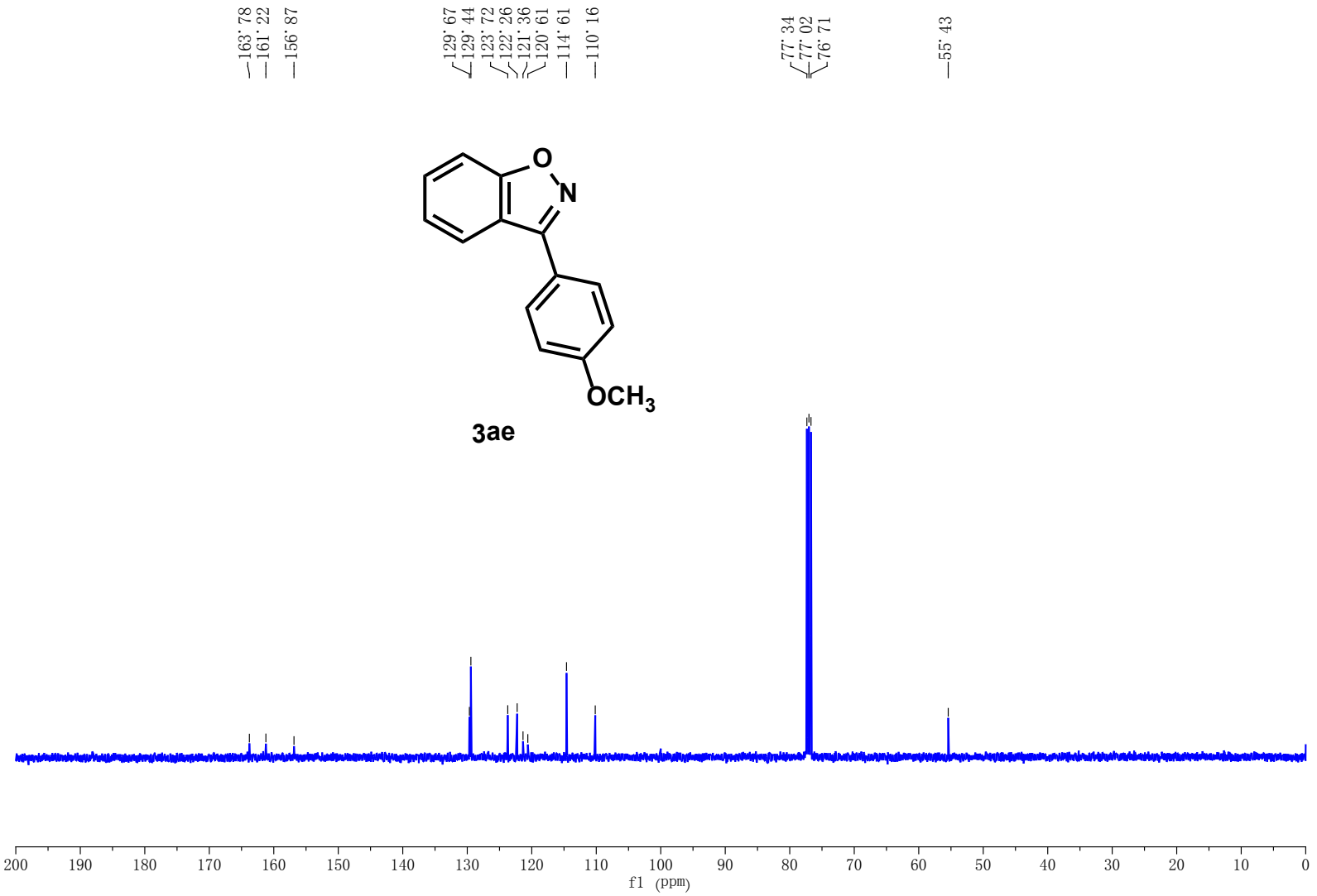

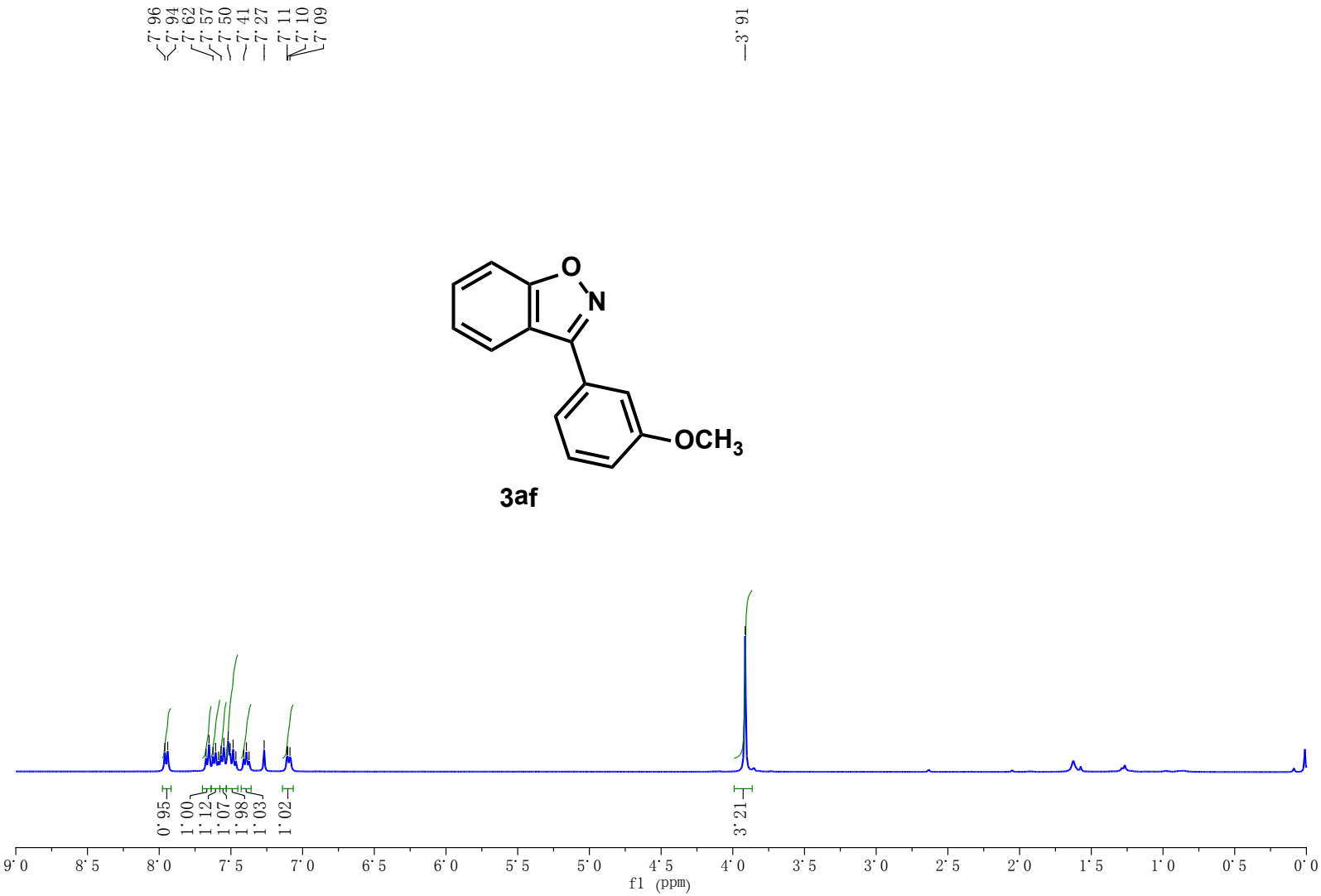

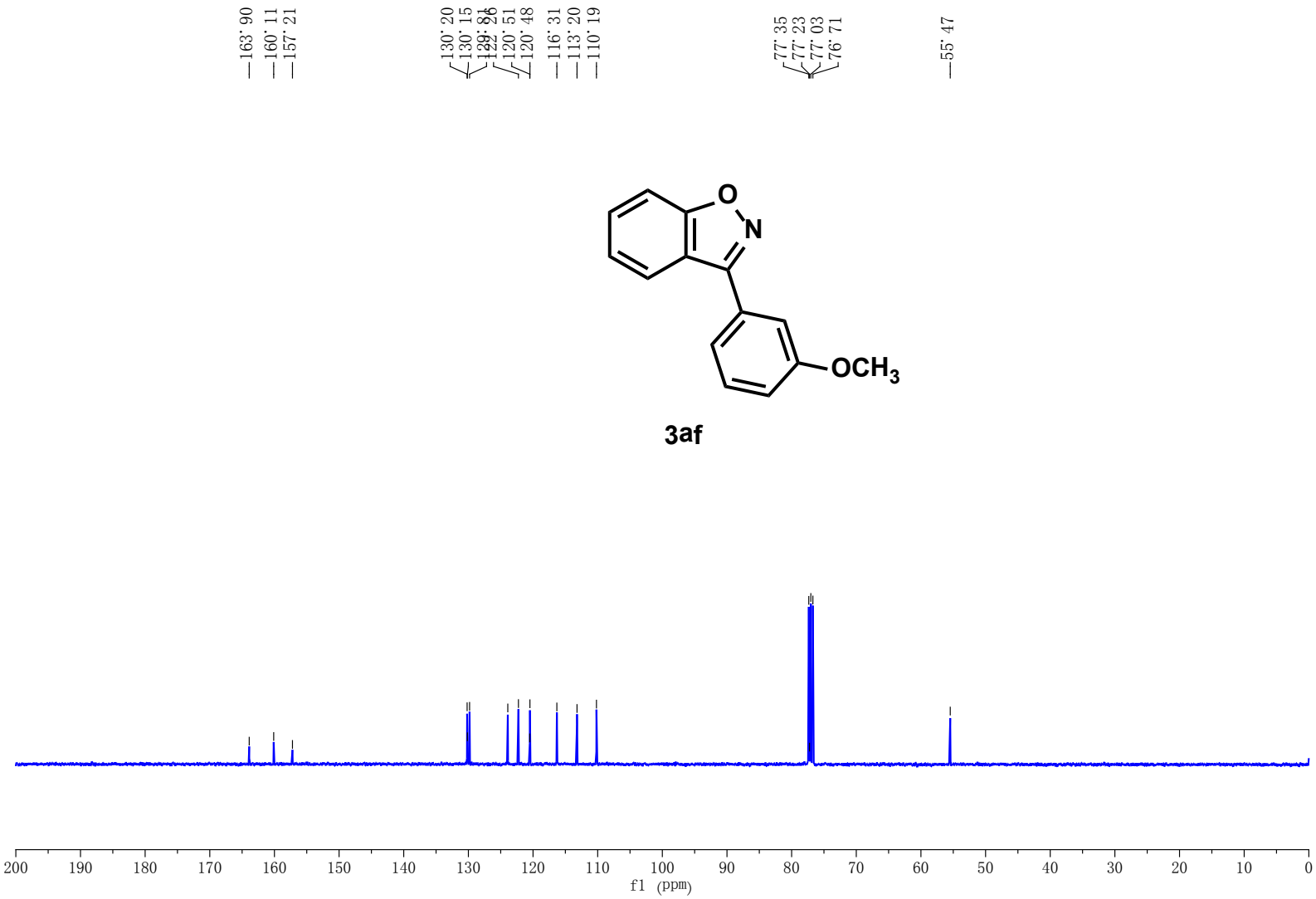

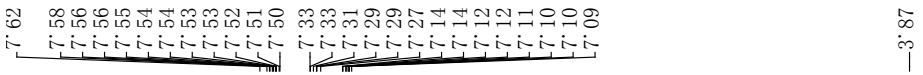

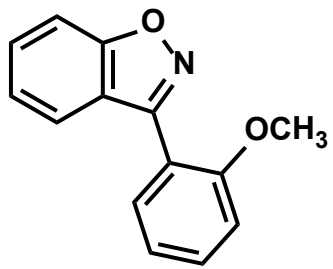

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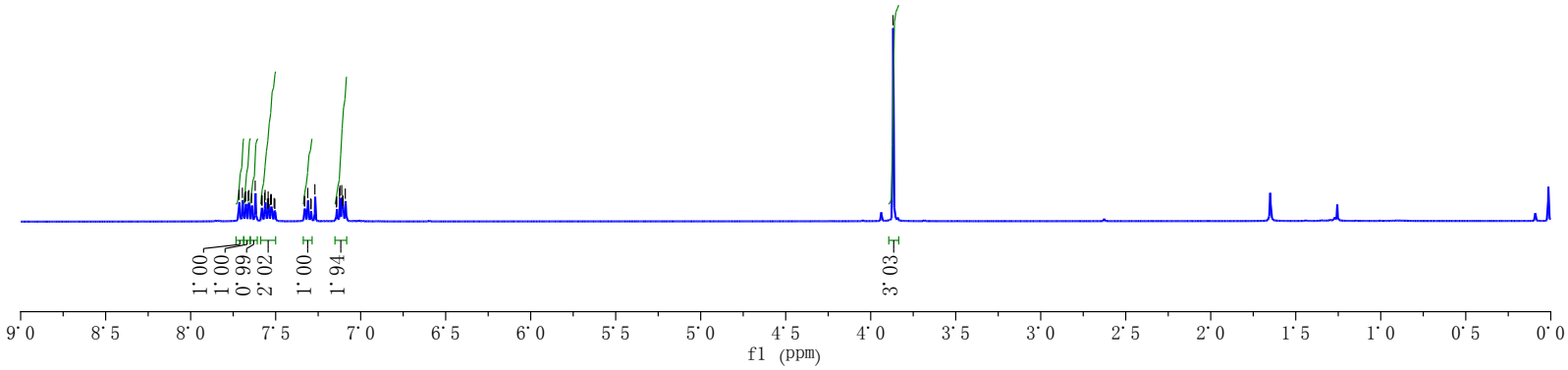

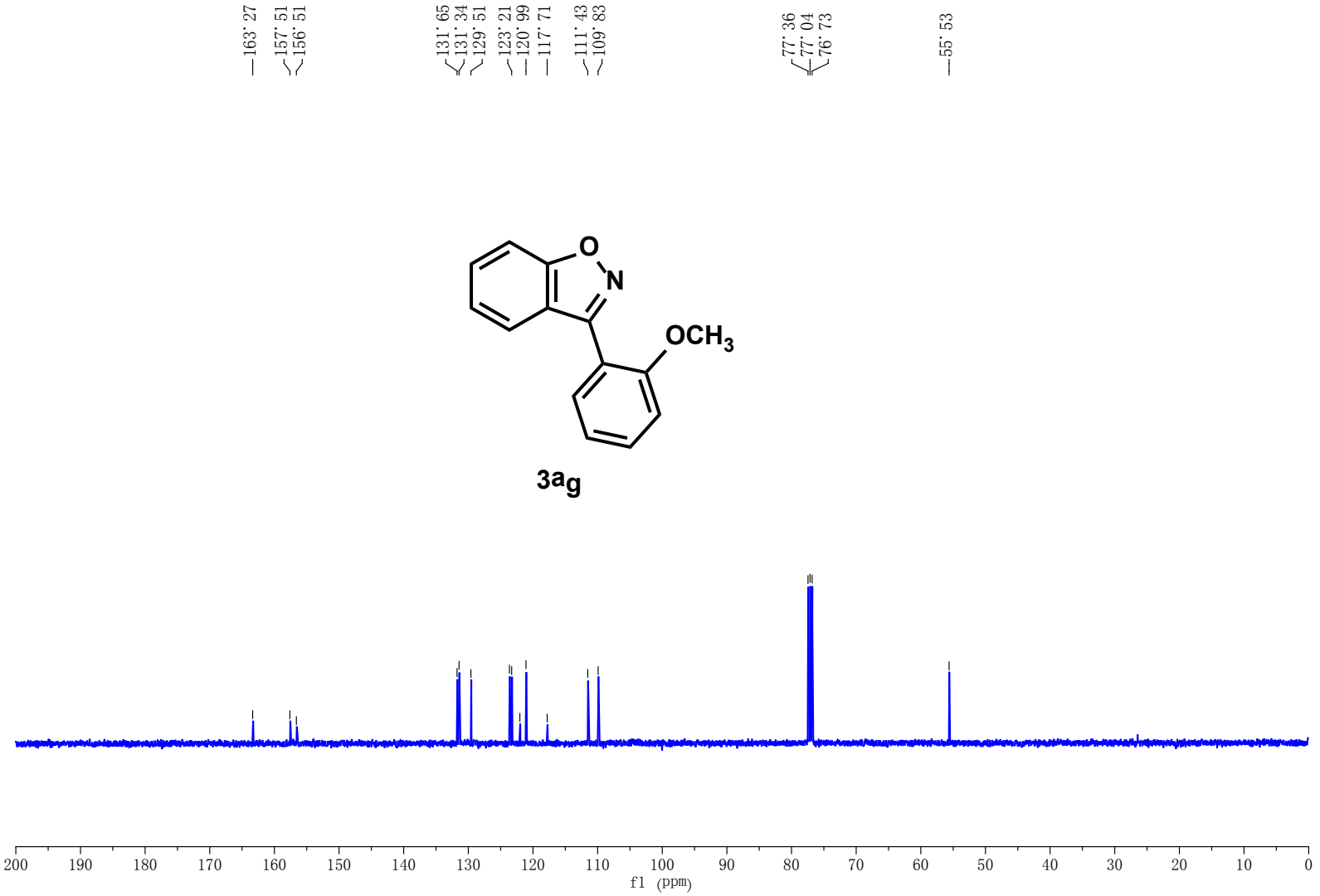

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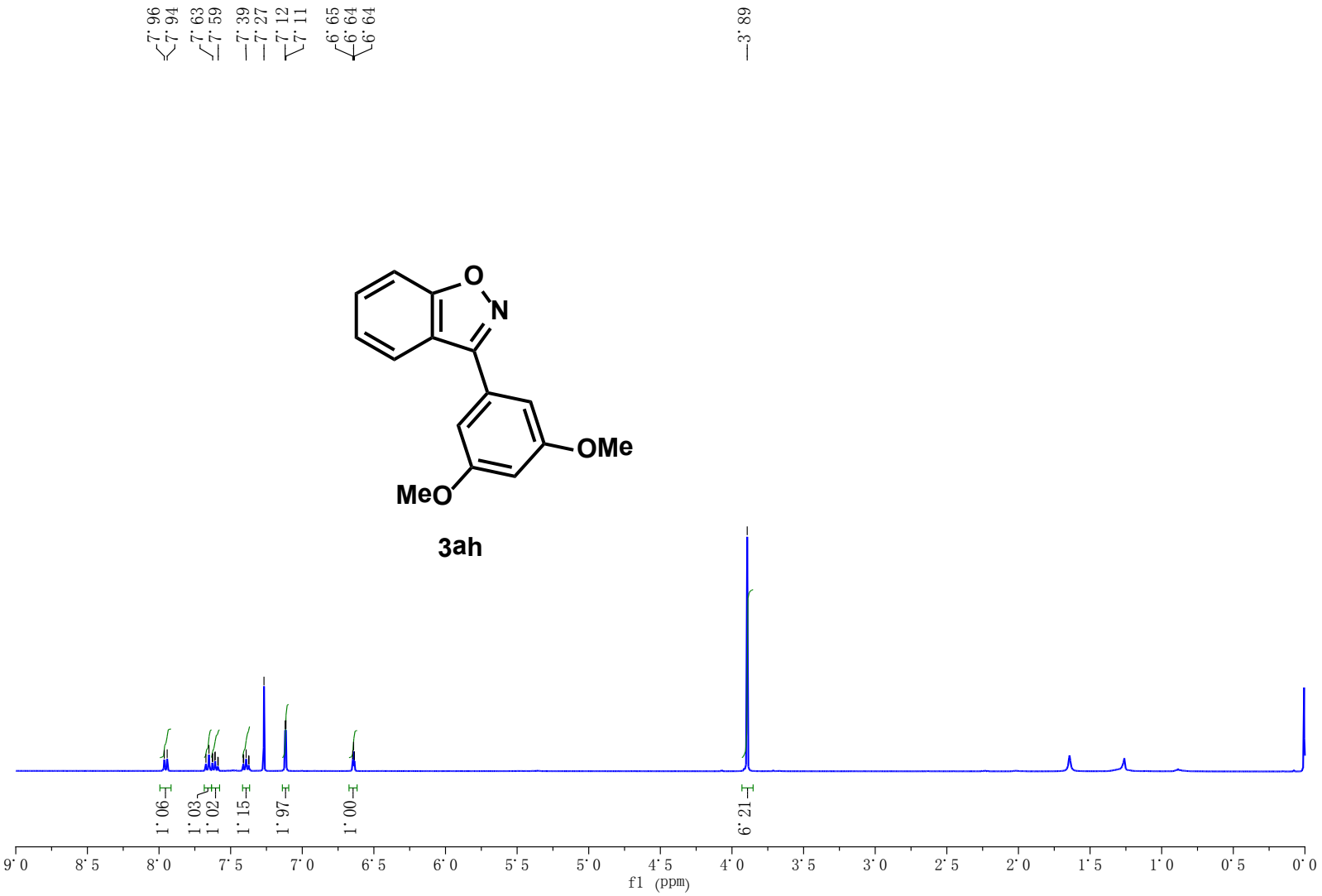

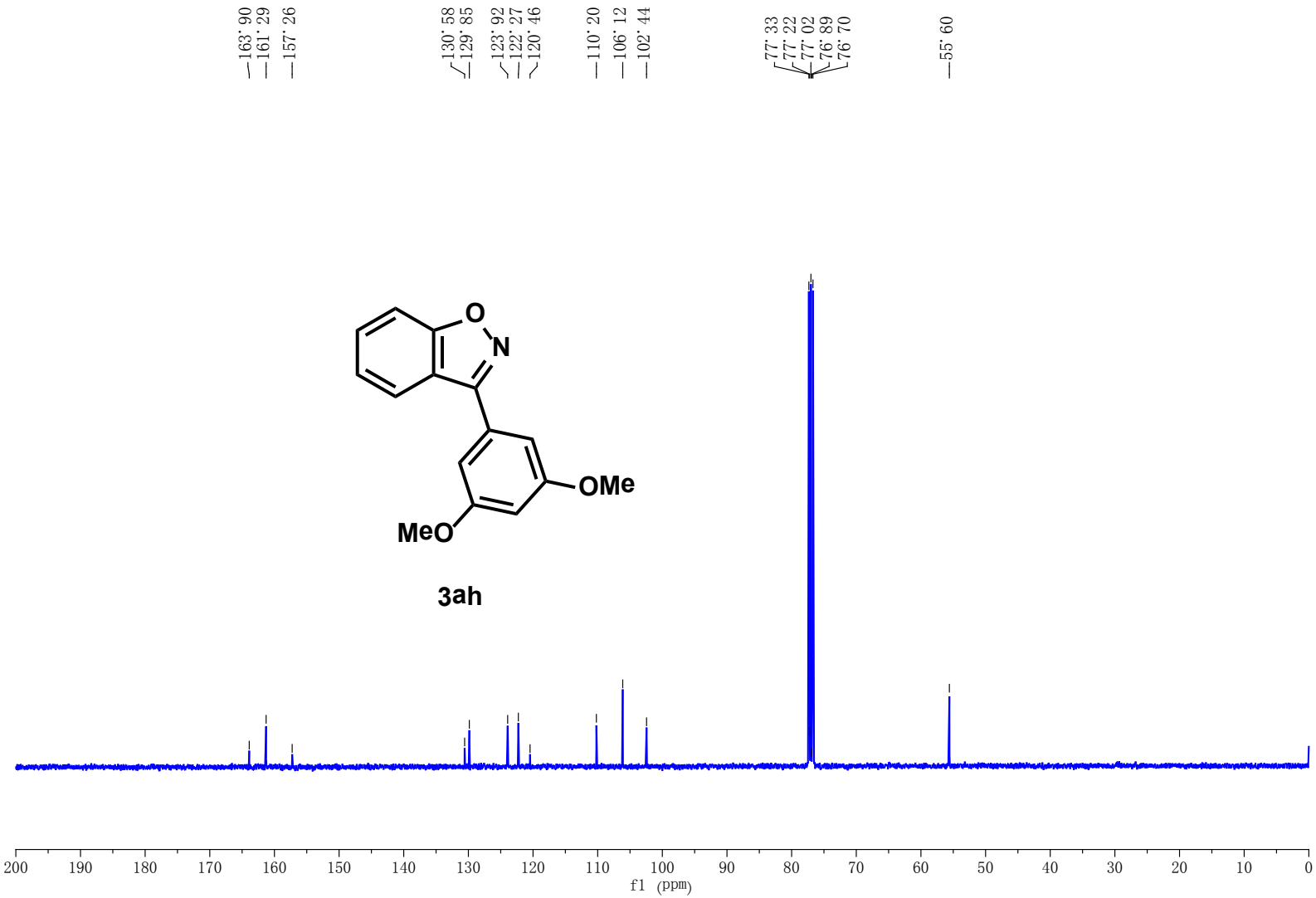

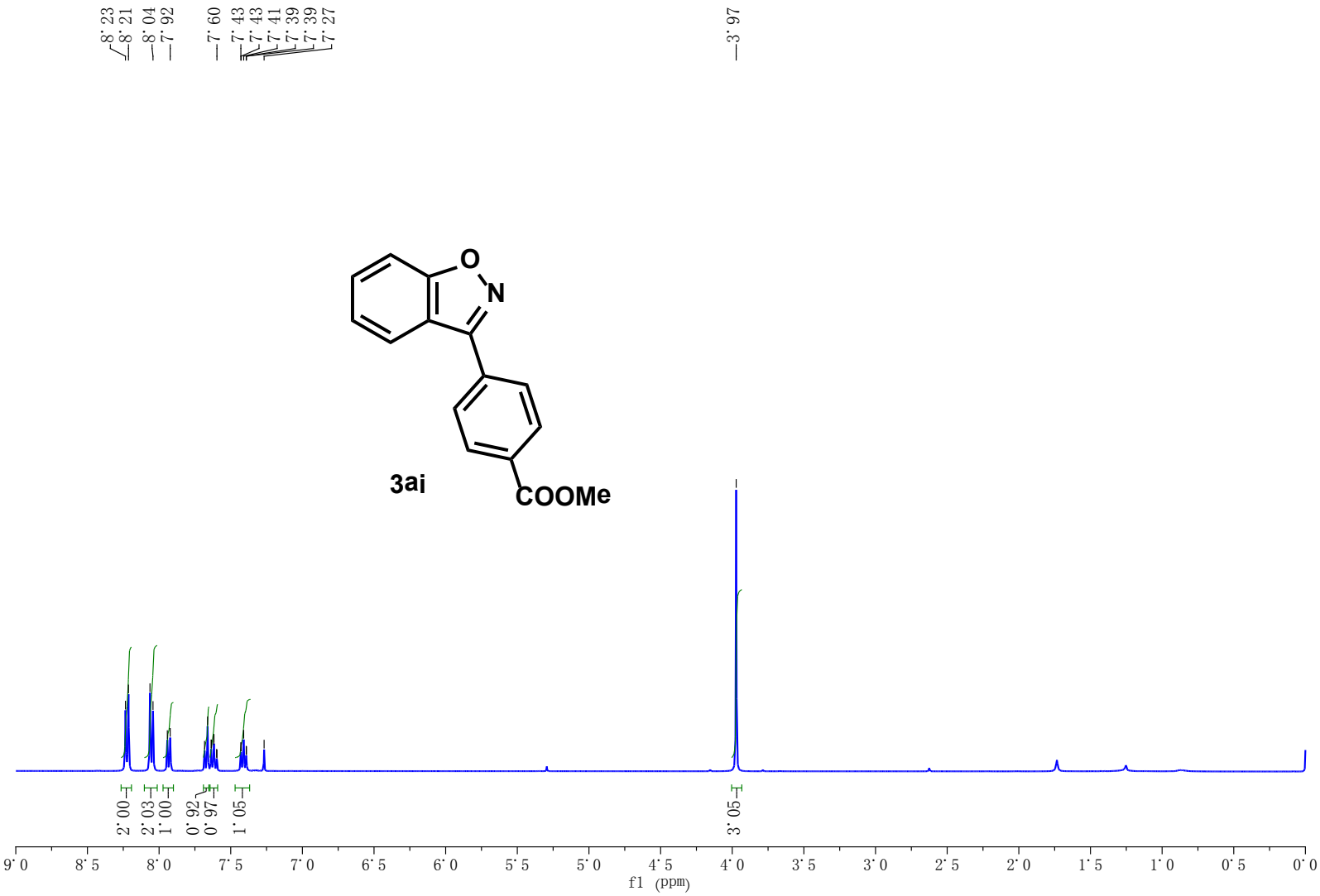

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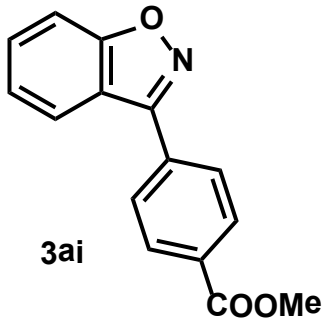

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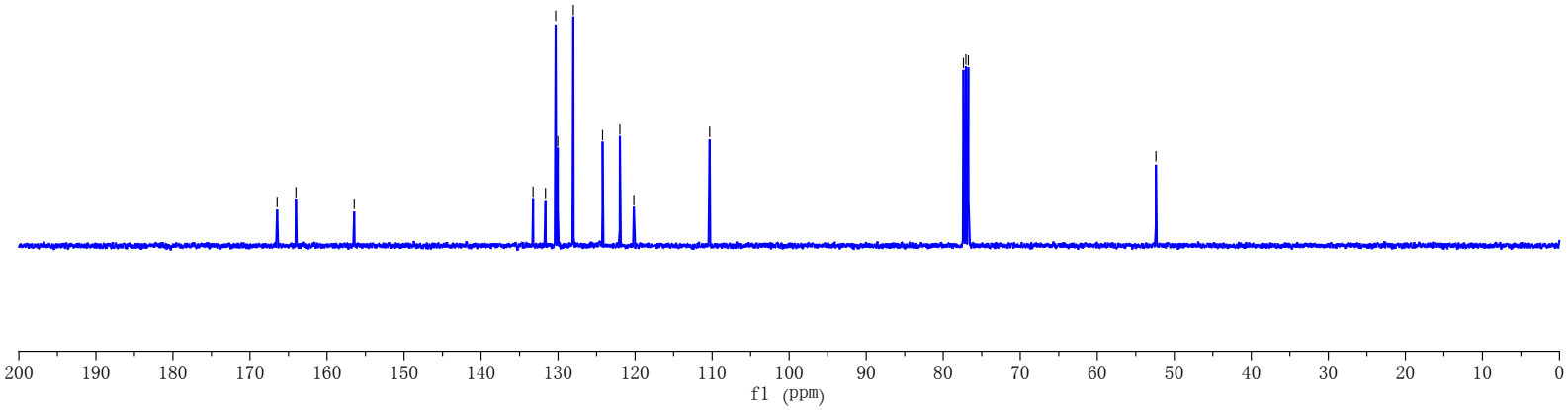

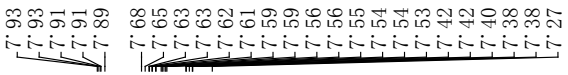
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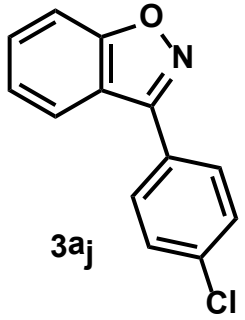
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Cl

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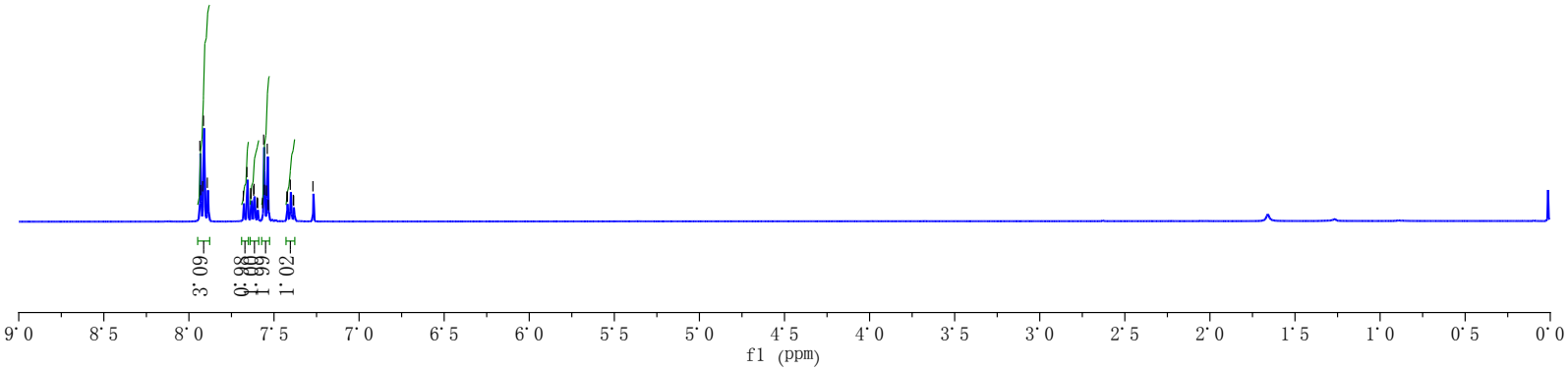
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1.0
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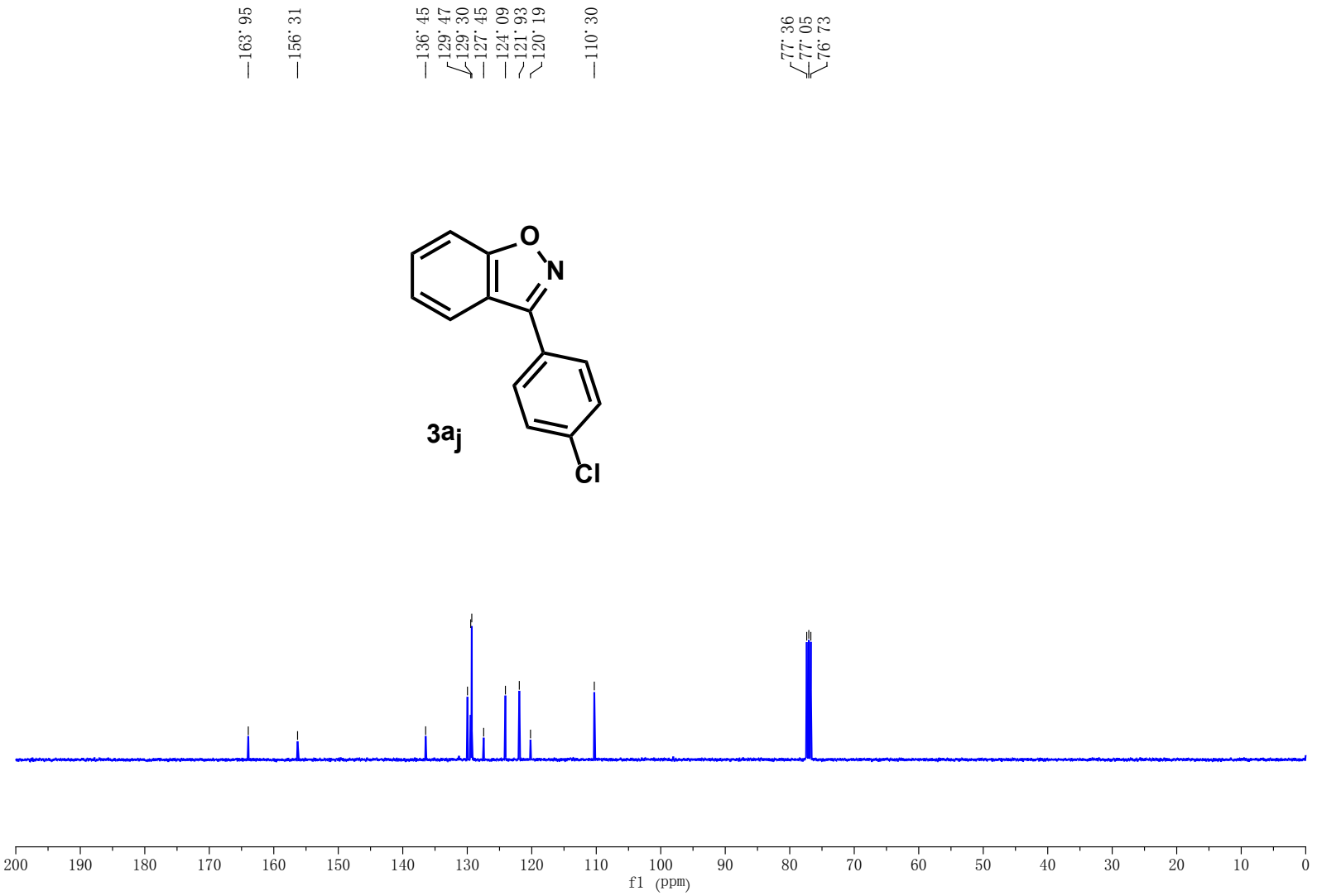
0.0
f1 (ppm)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121.93
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110.30
77.36
77.05
76.73
O
N
Cl
3aj
200
190
180
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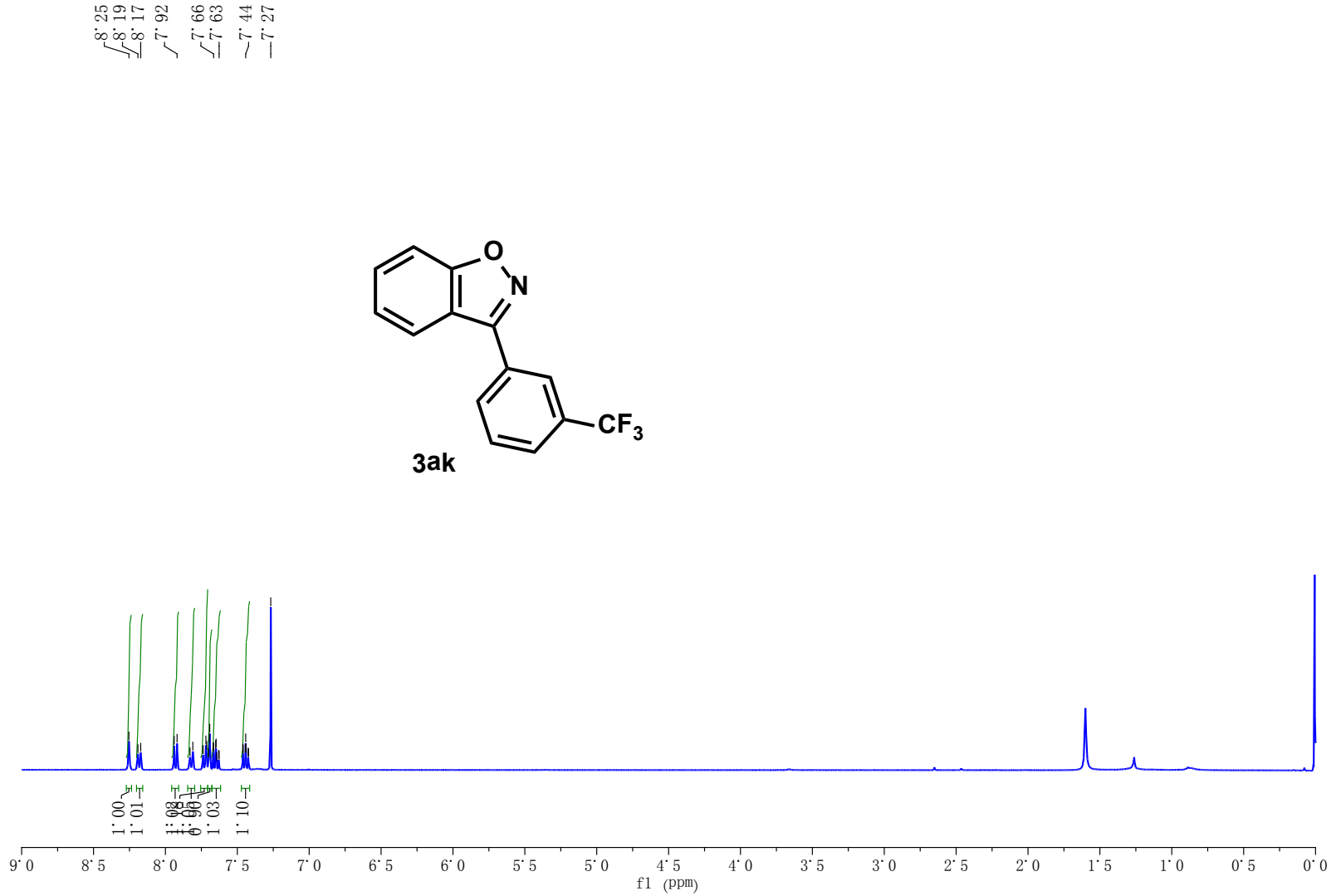
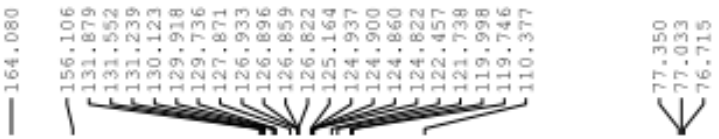
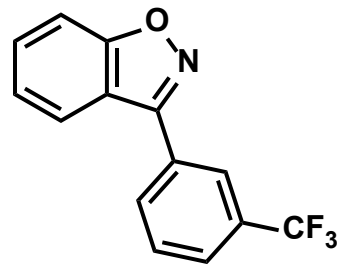
f1 (ppm)







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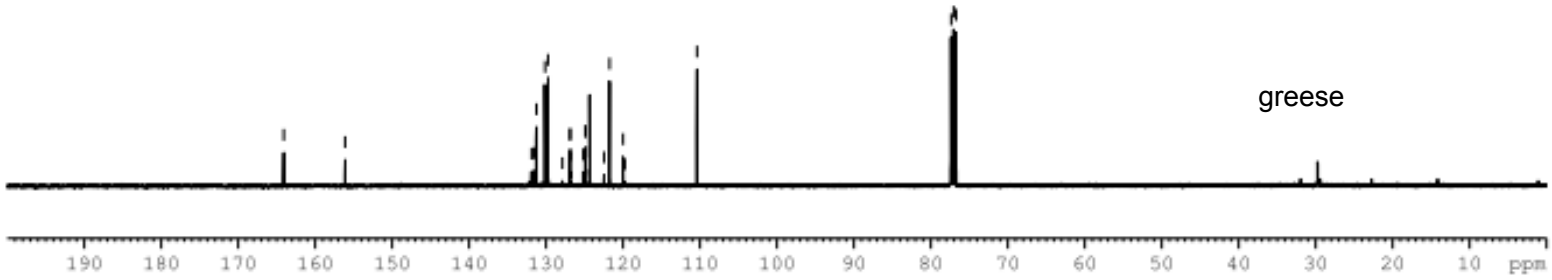

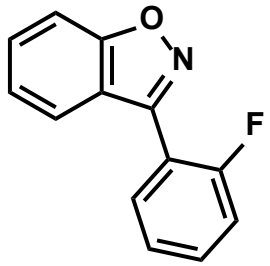

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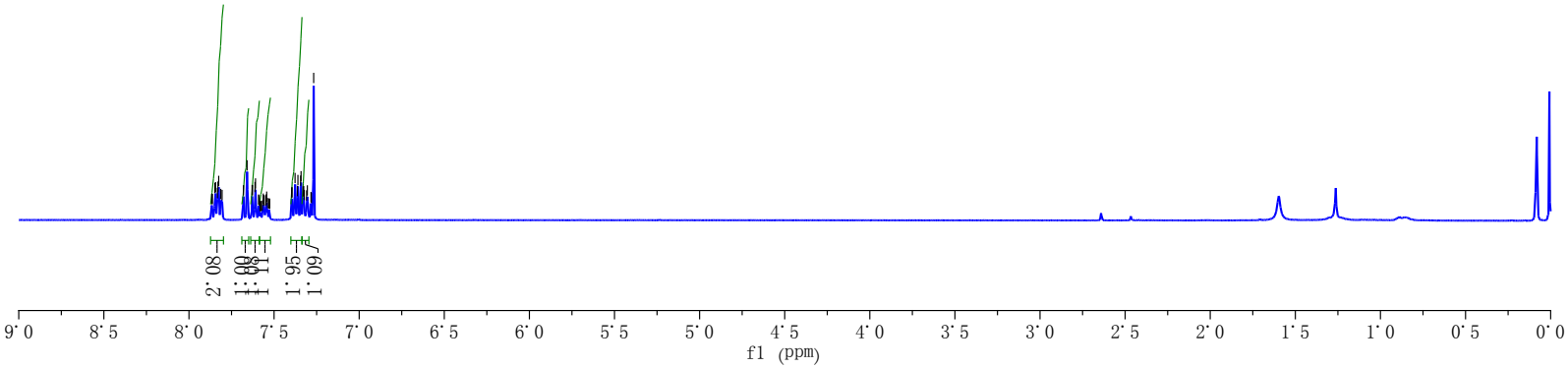

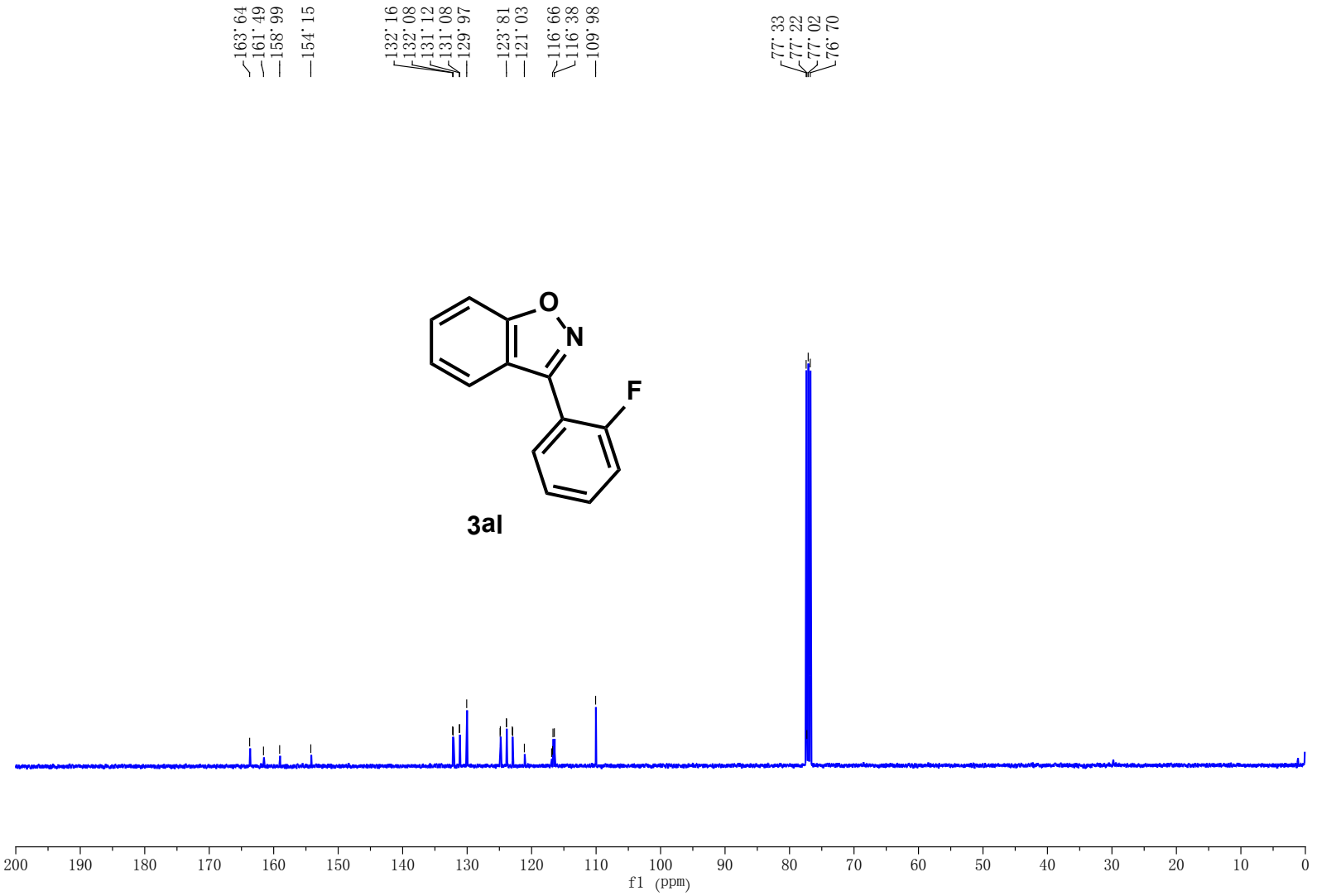

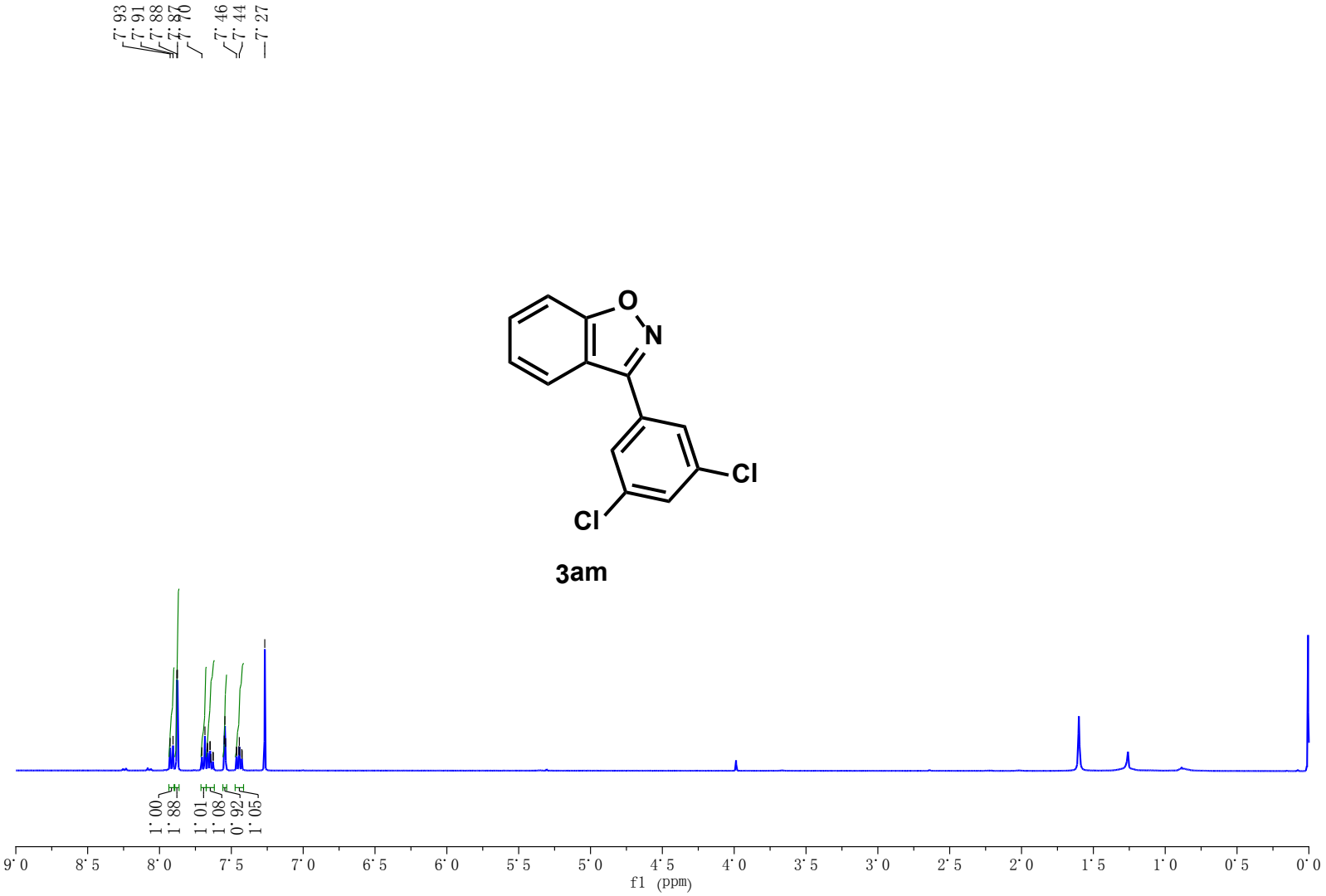

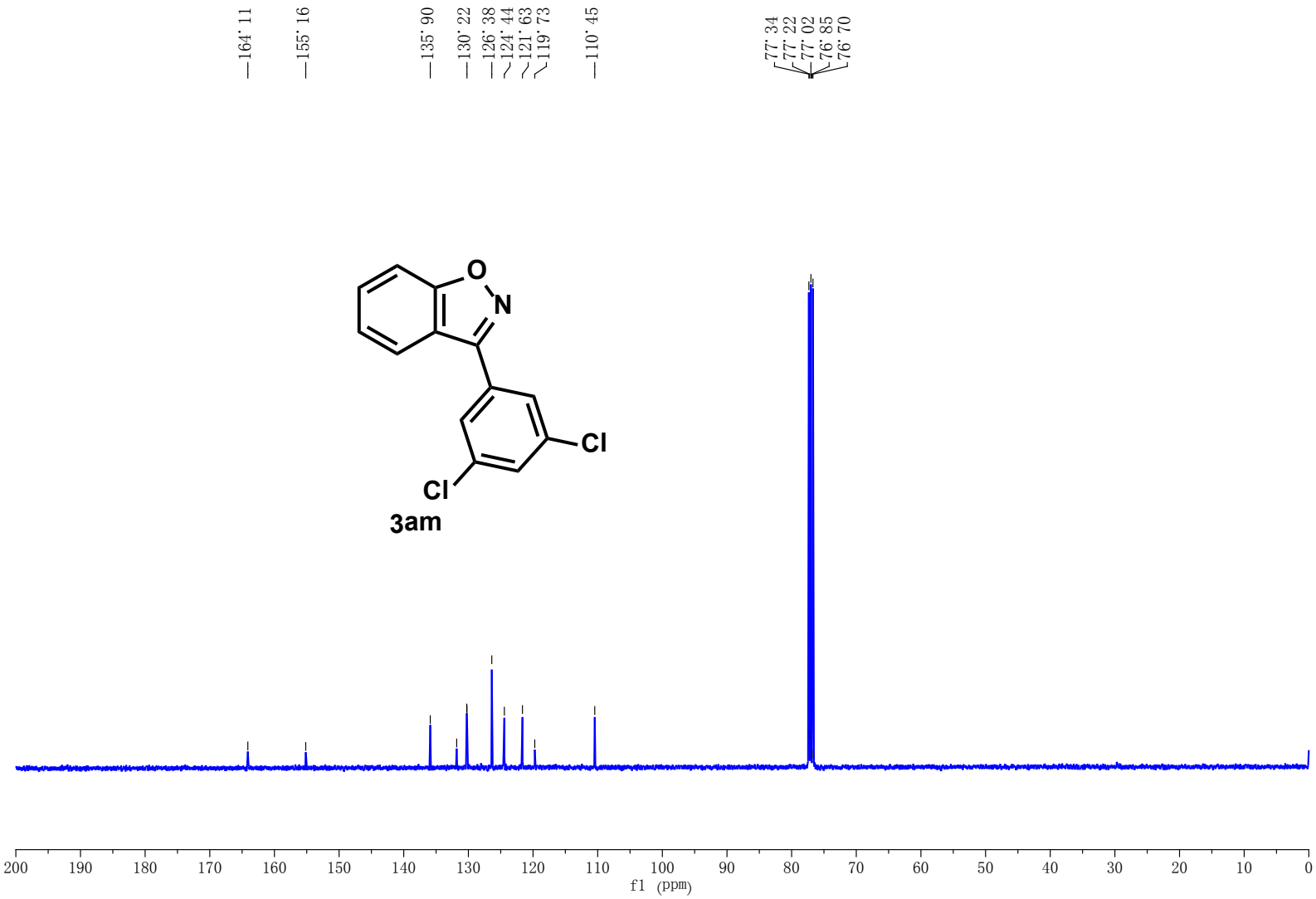
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77.34
77.22
77.02
76.85
76.70
O
N
Cl
Cl
3am
200
190
180
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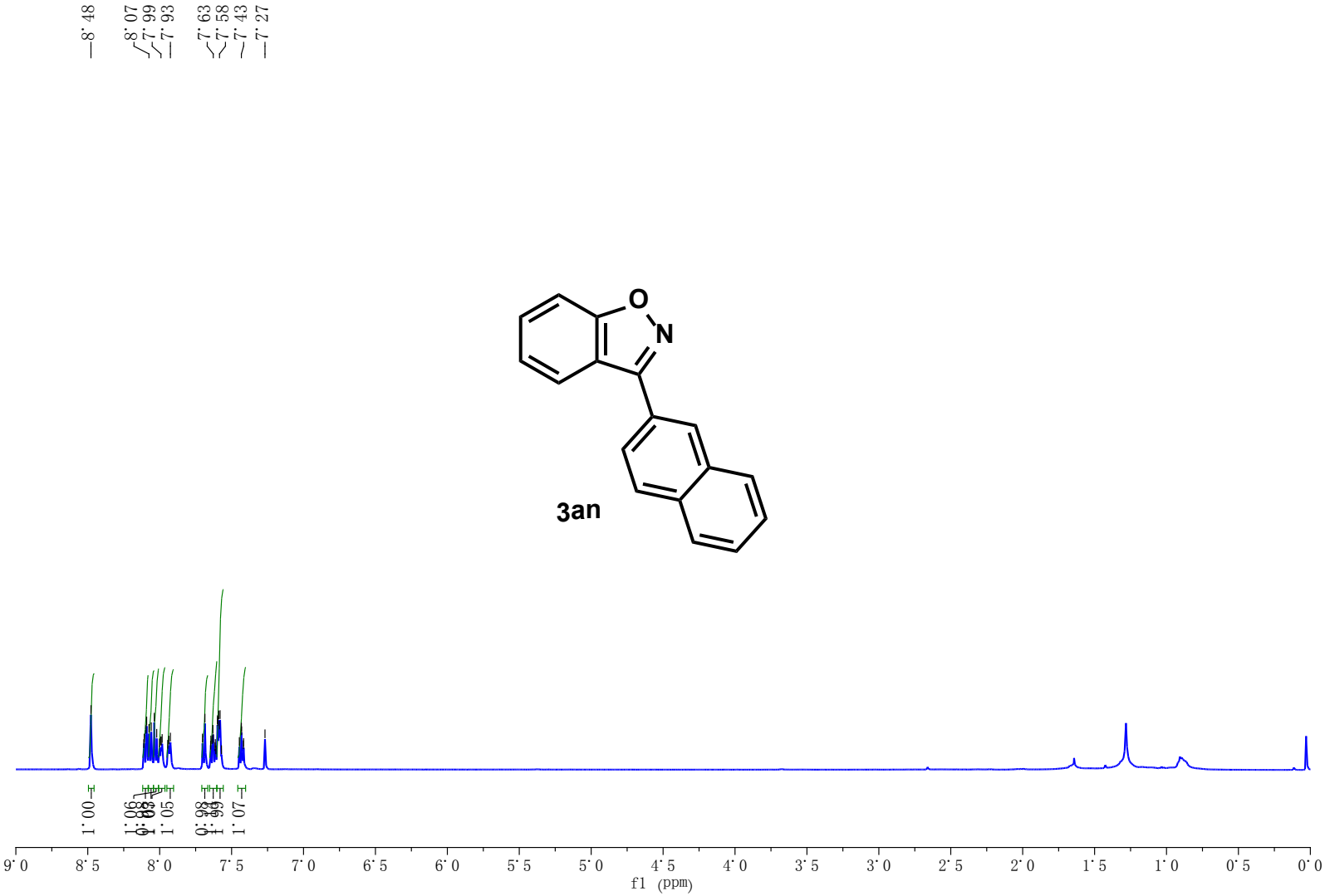
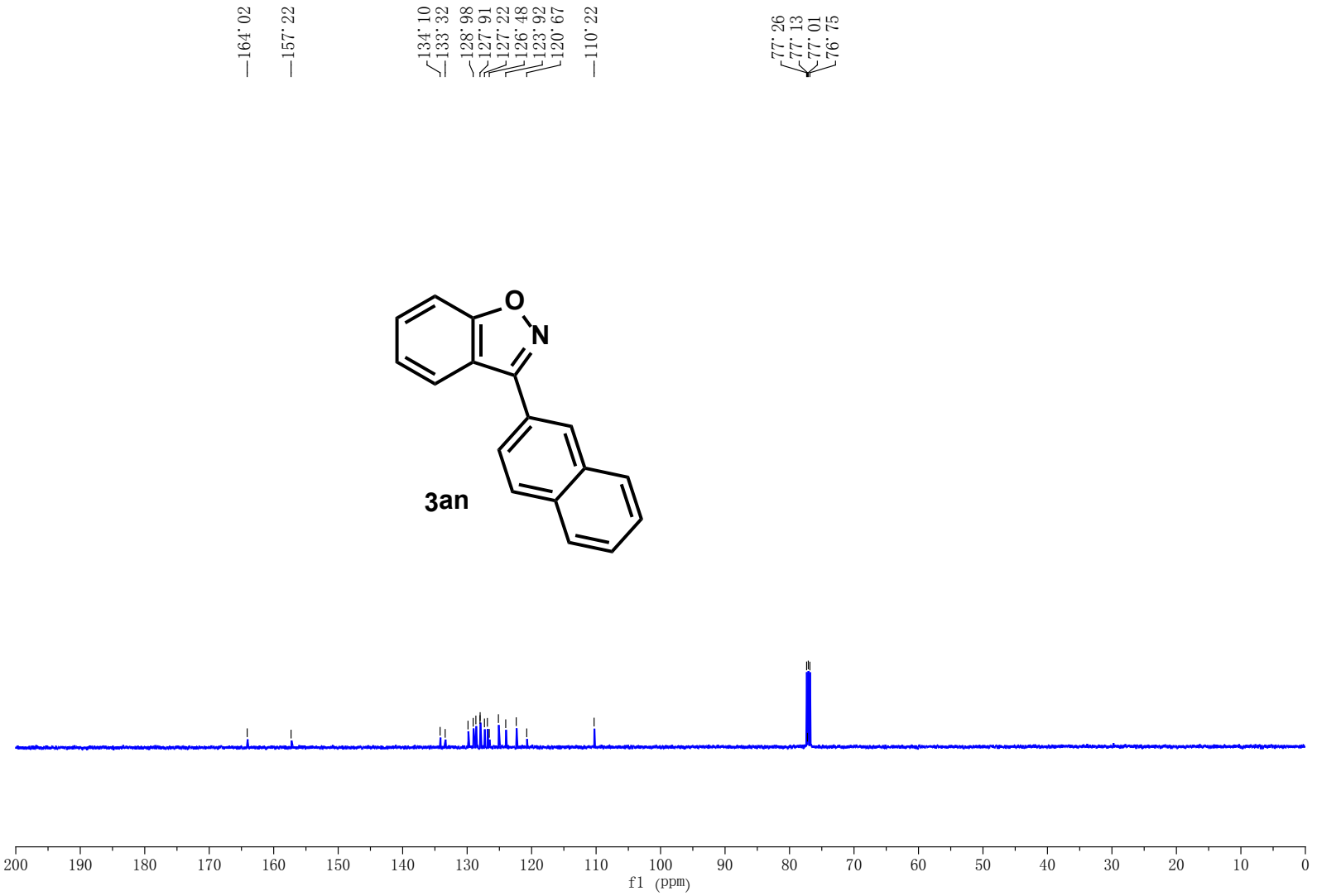
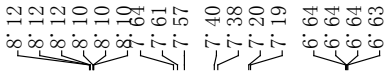
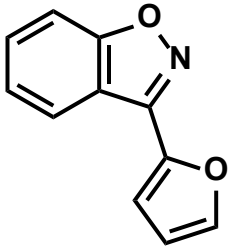
f1 (ppm)









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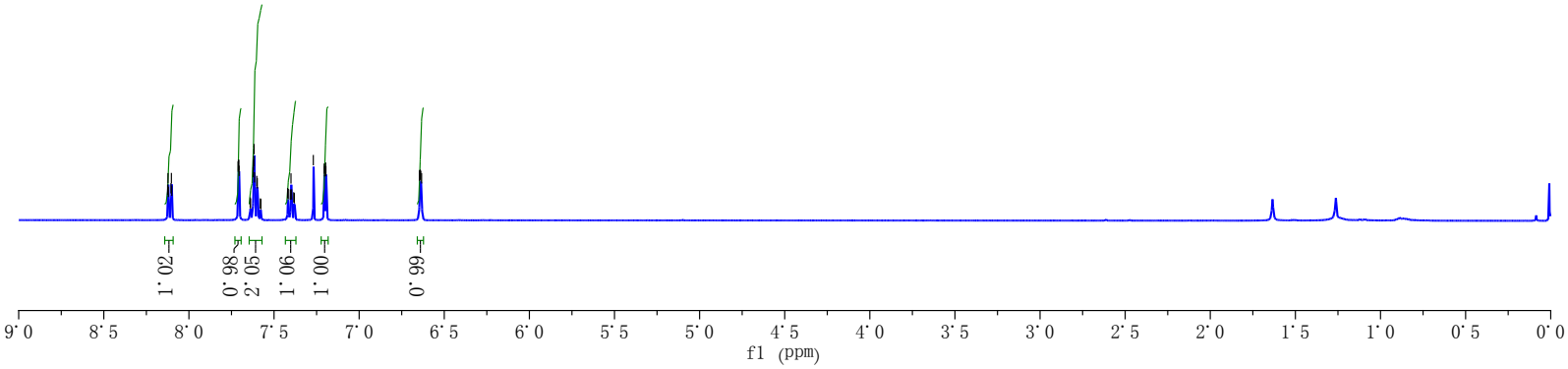

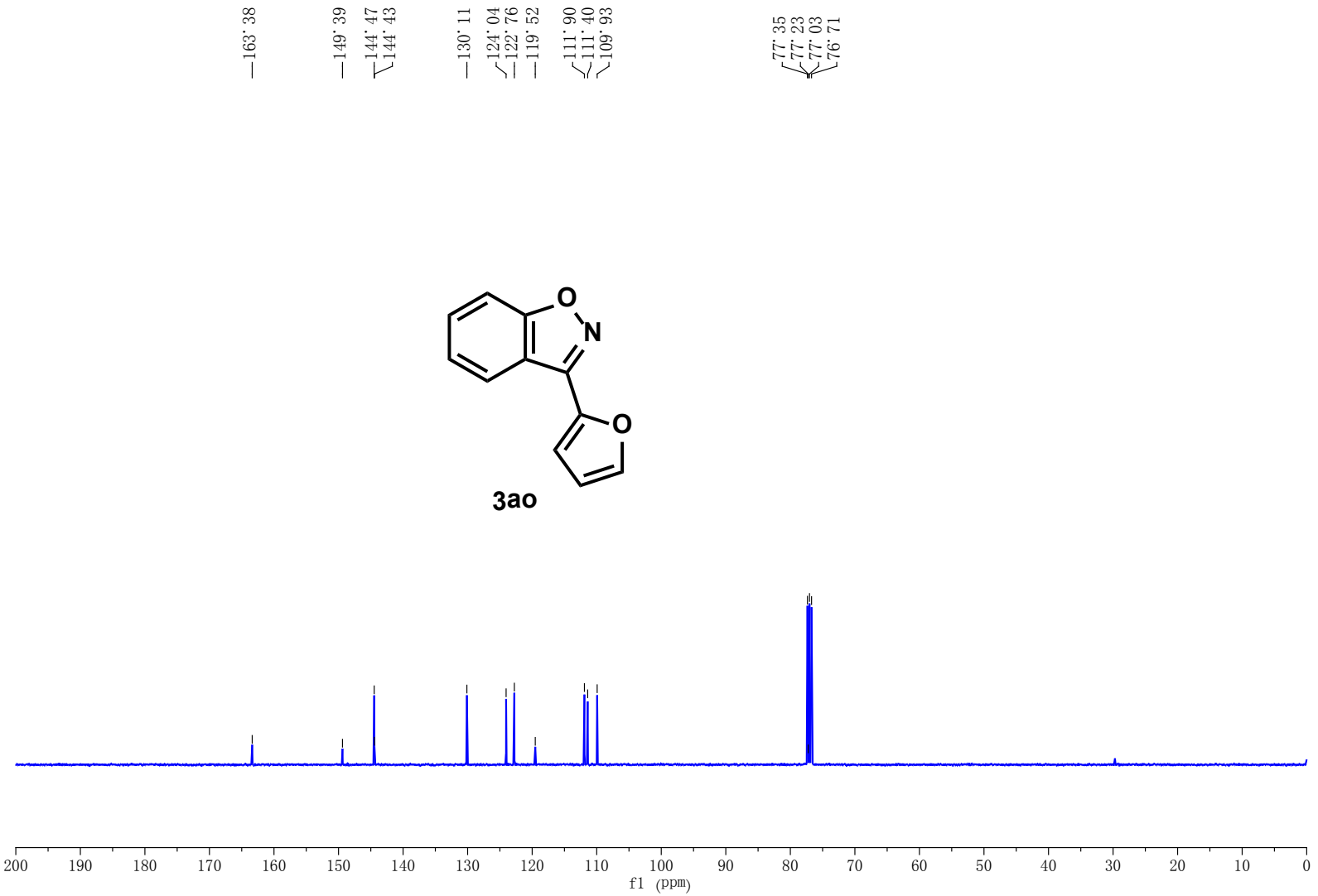

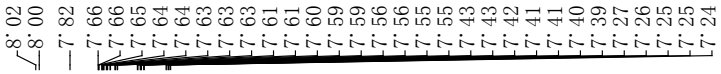
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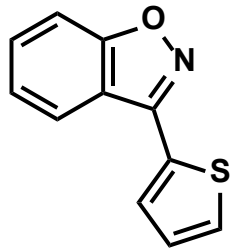
7.24


O
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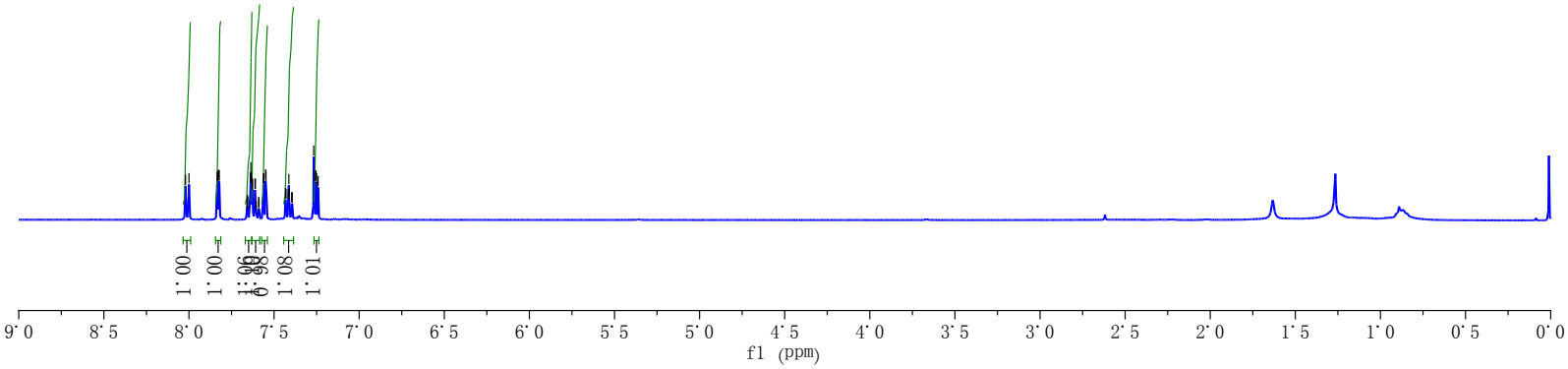
S

3ap


1.00
1.00
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1.01
9.0
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8.0
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7.0
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1.0
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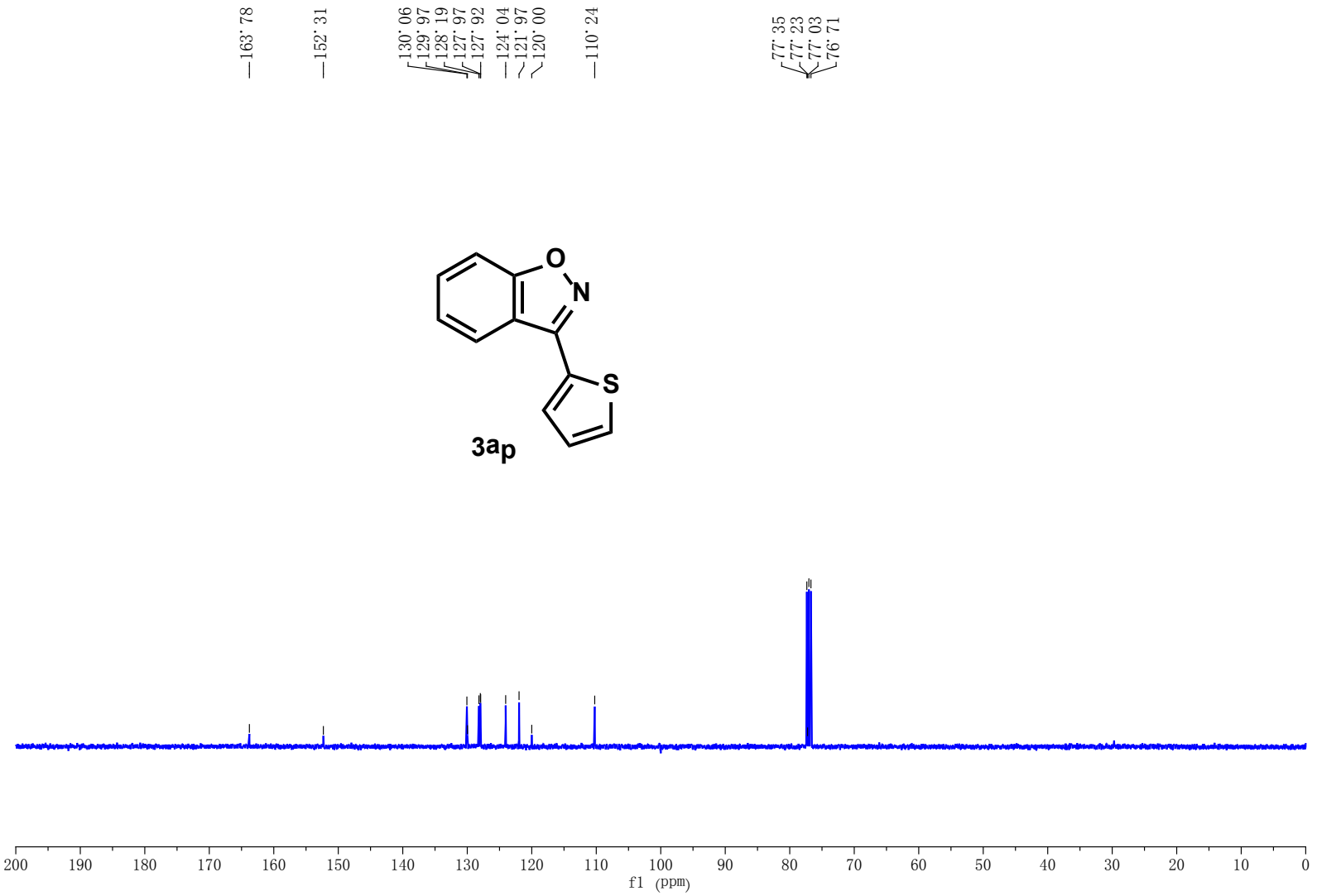
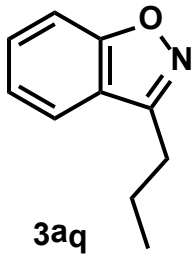
0.0
f1 (ppm)





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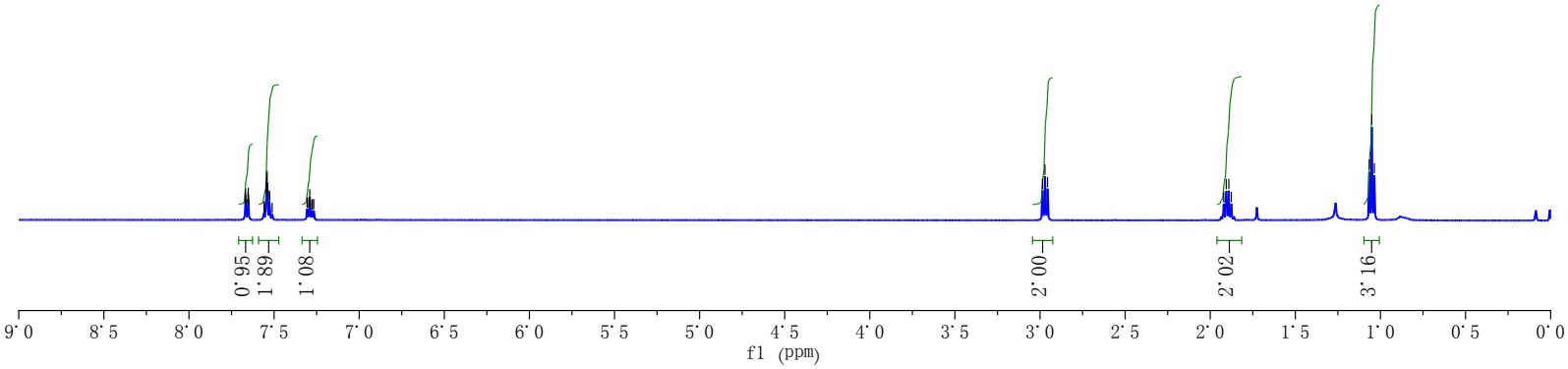

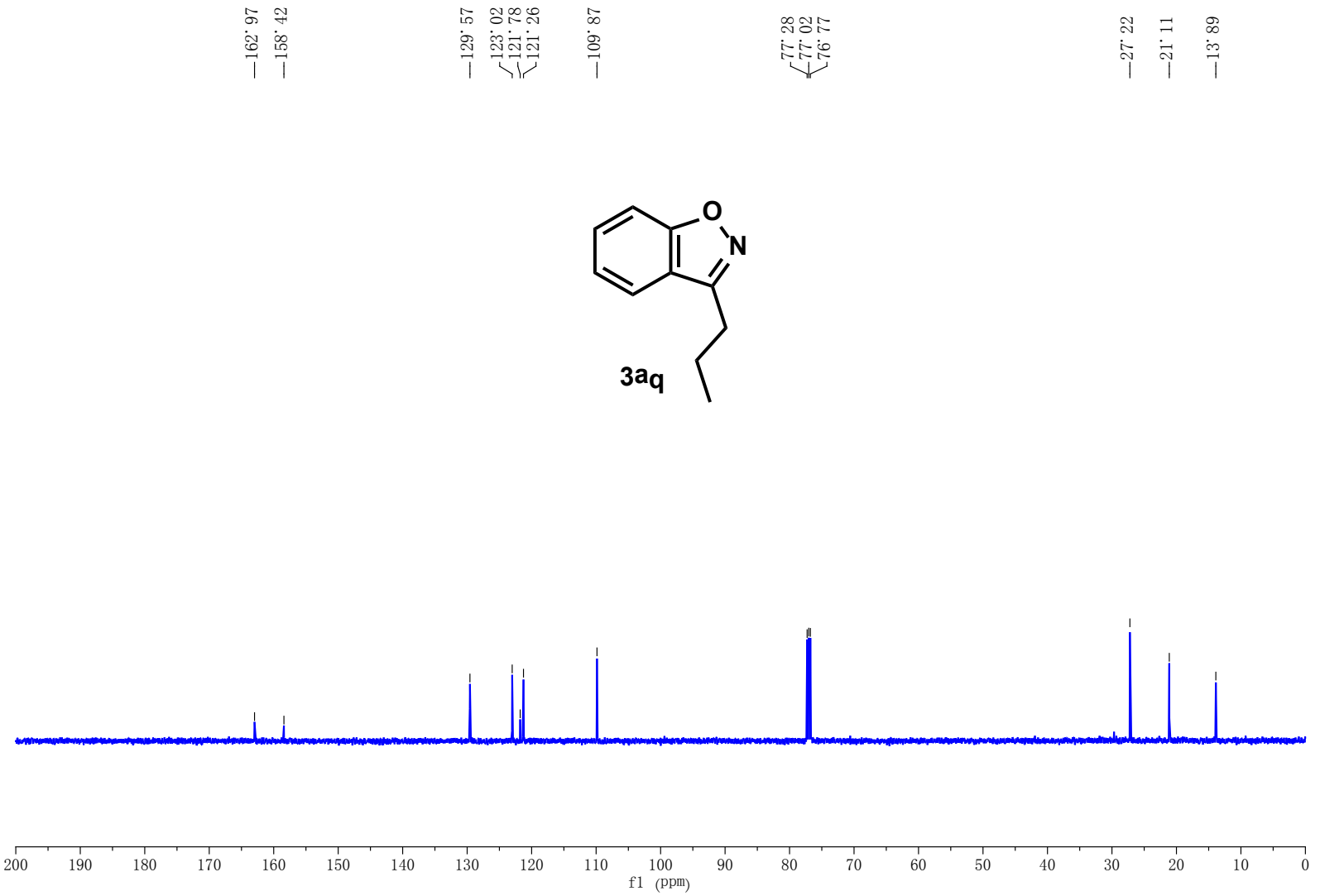

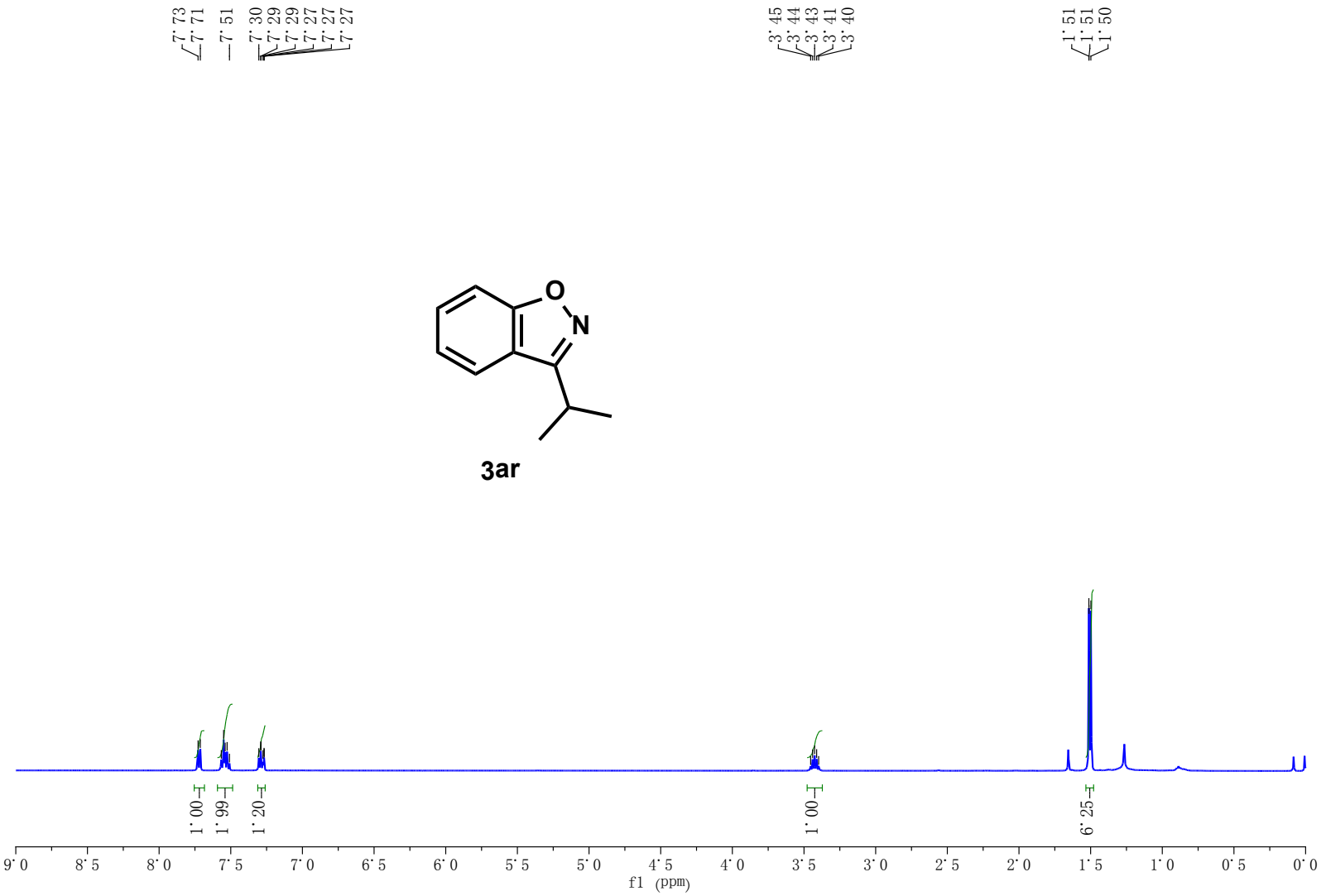

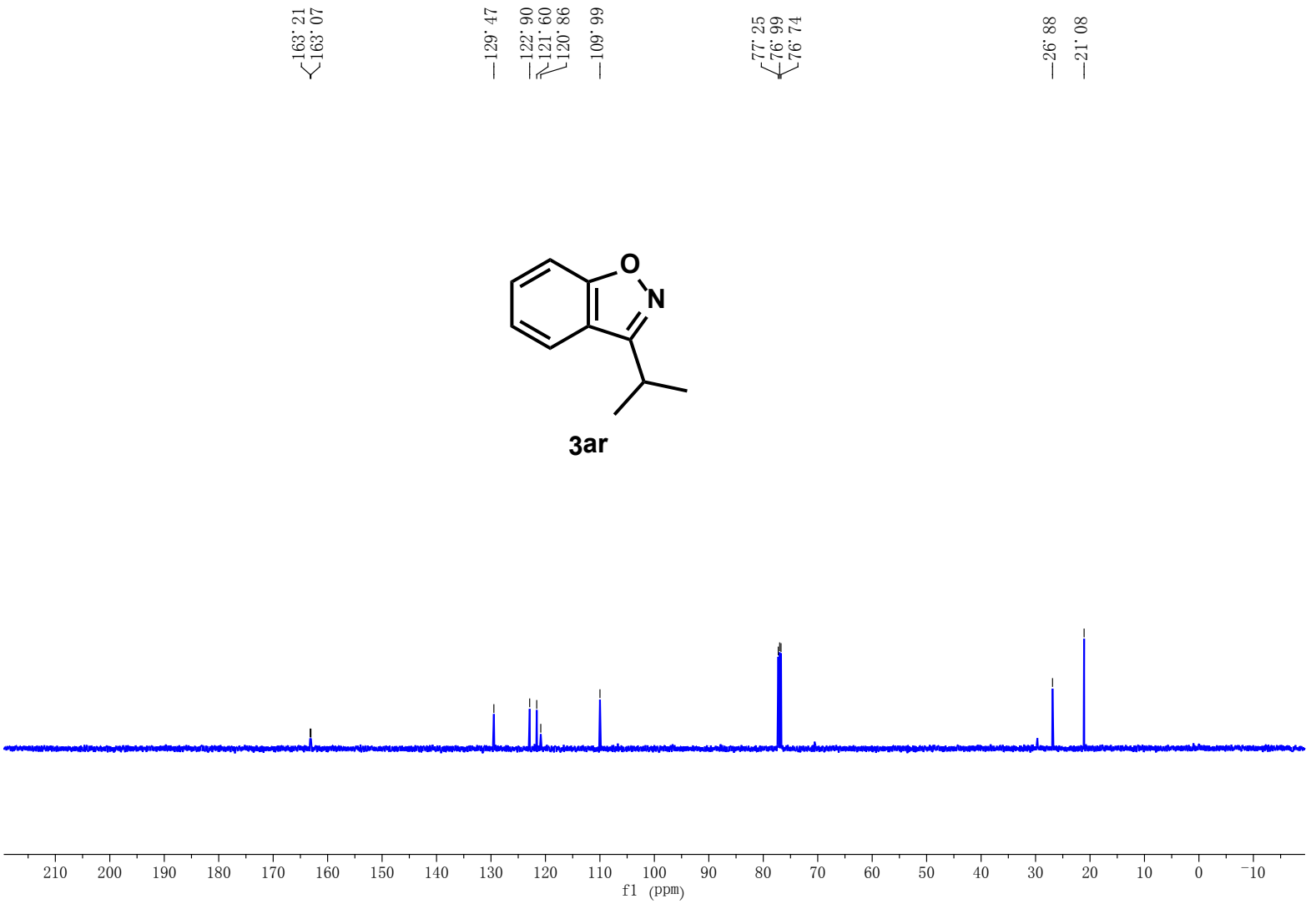

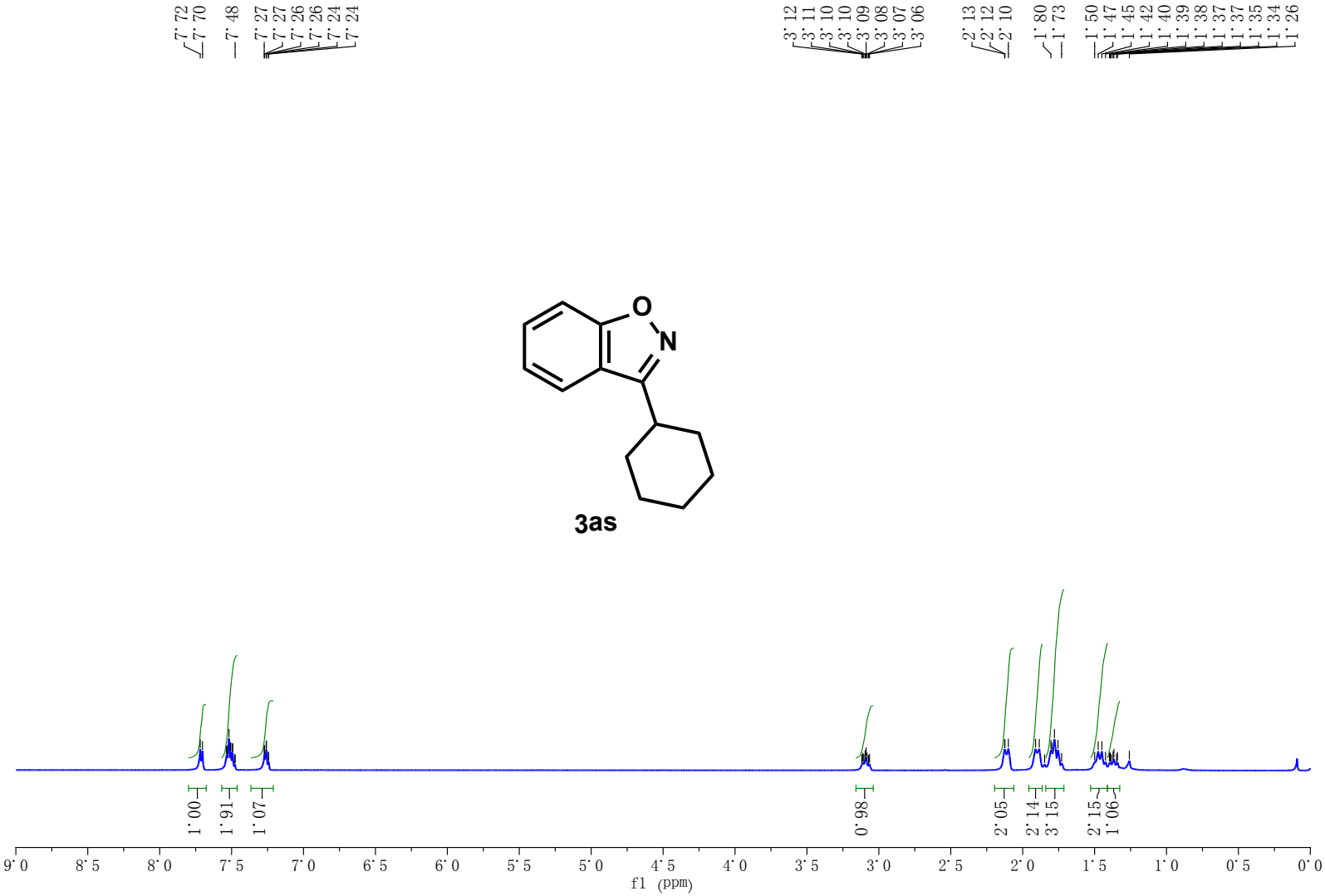

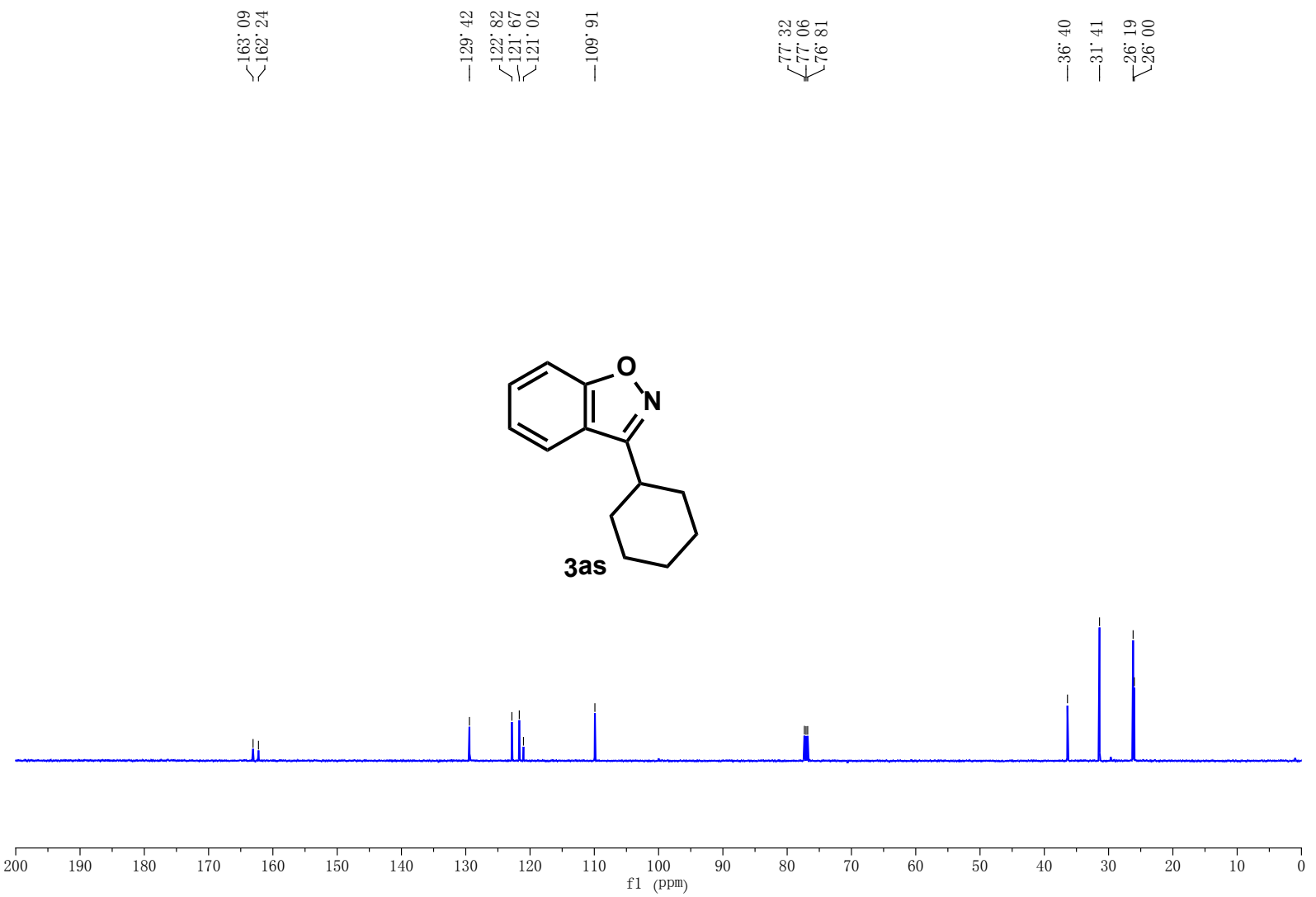

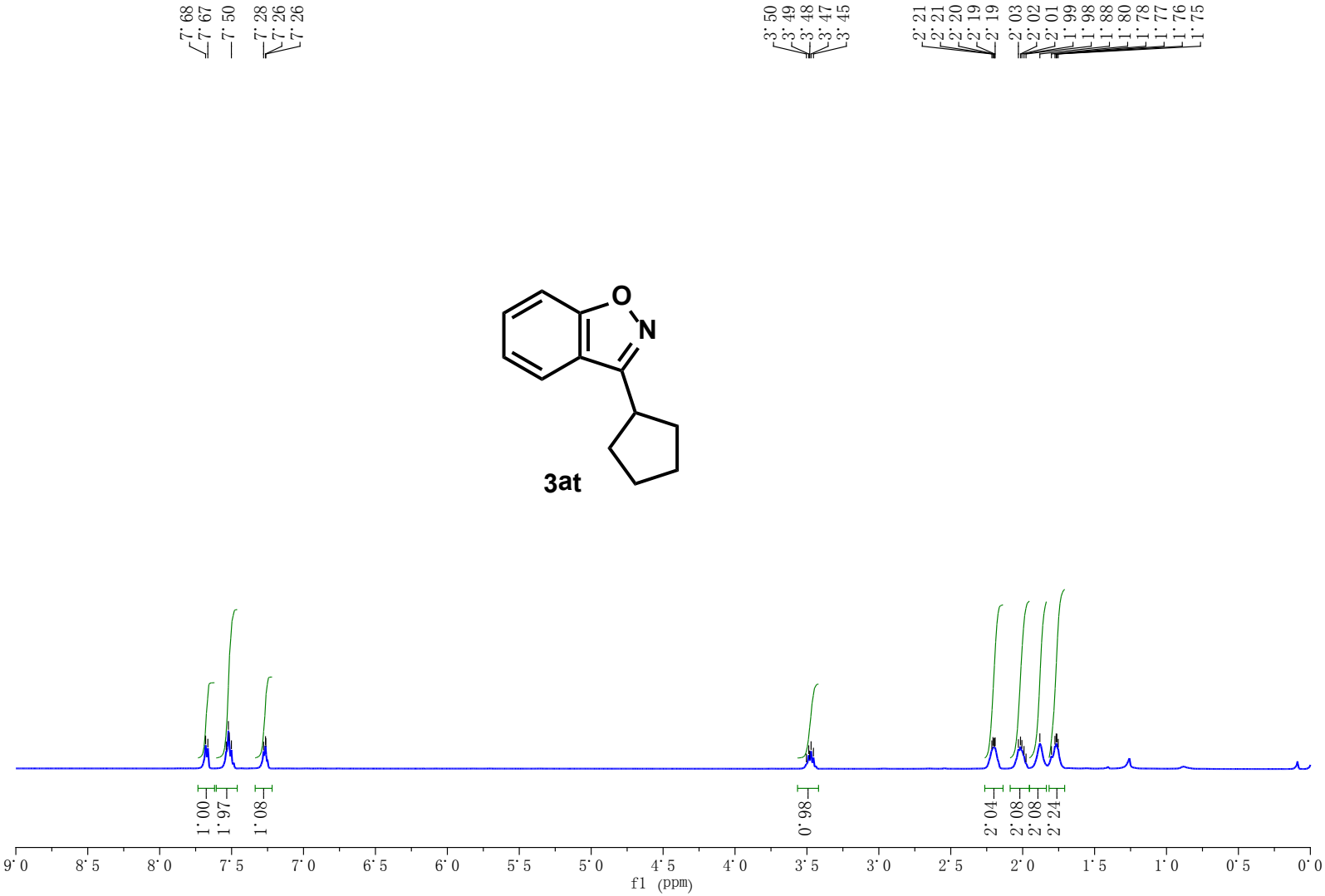

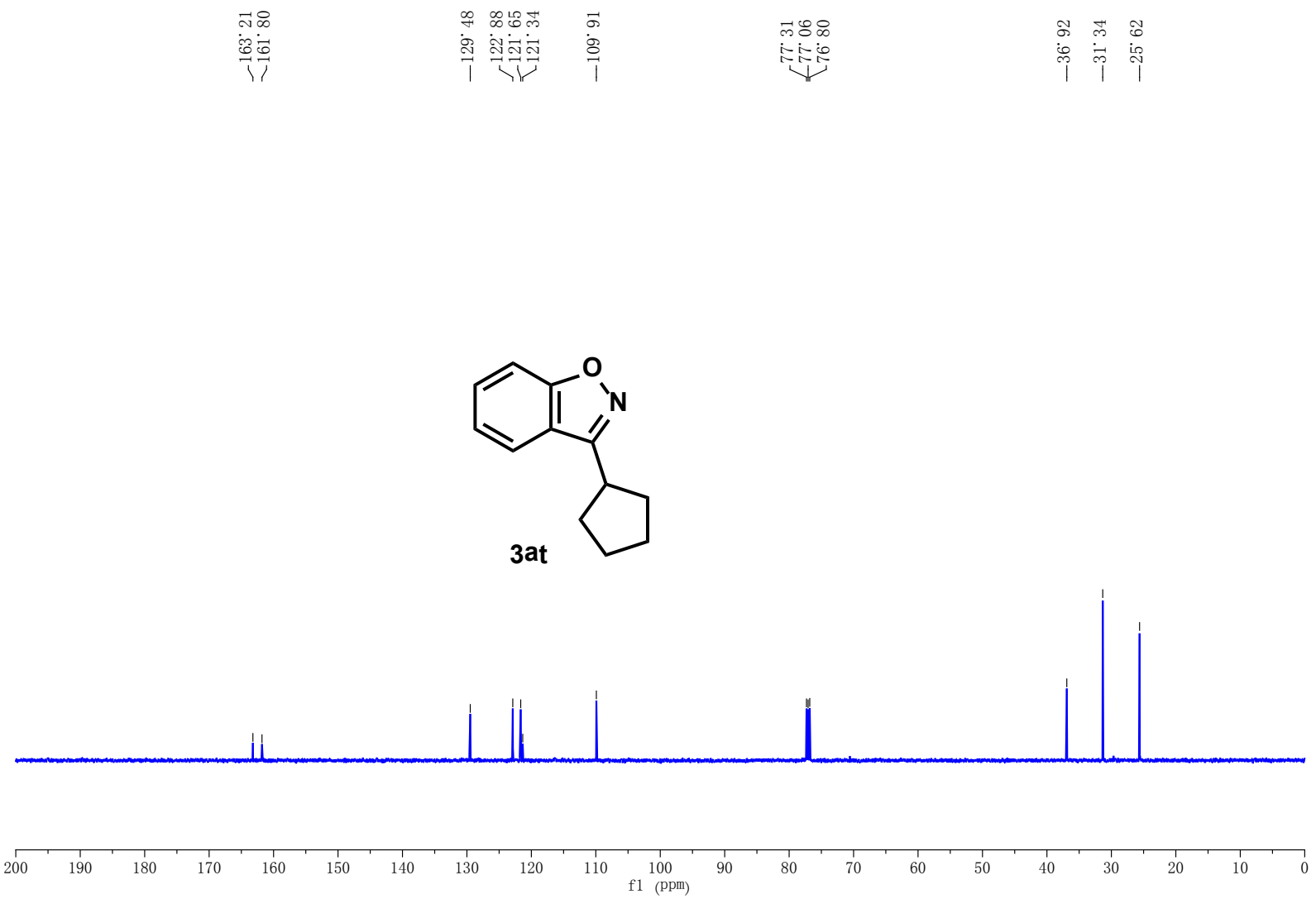

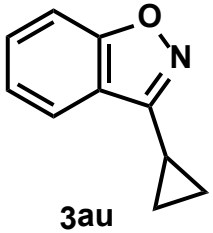

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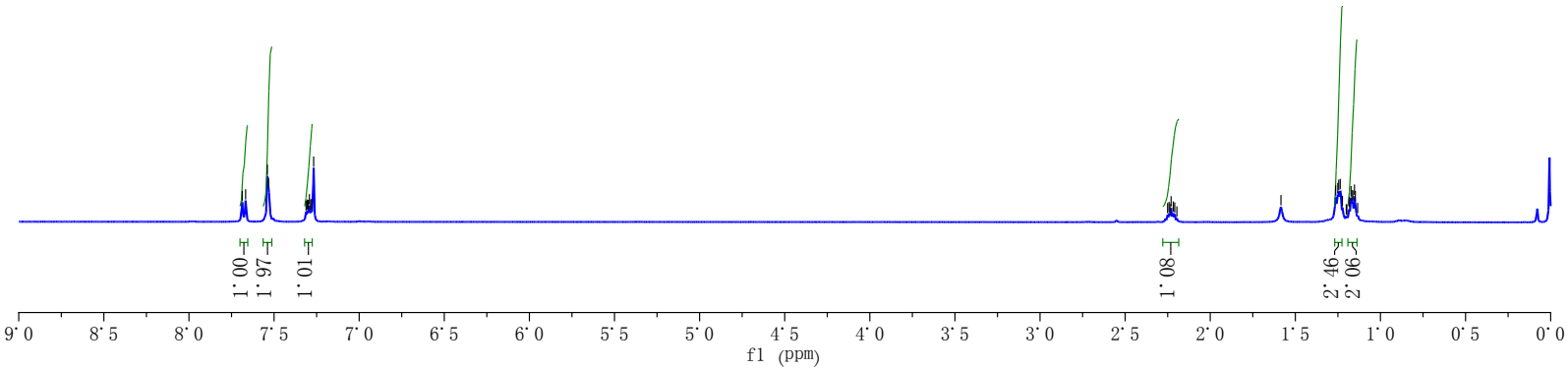

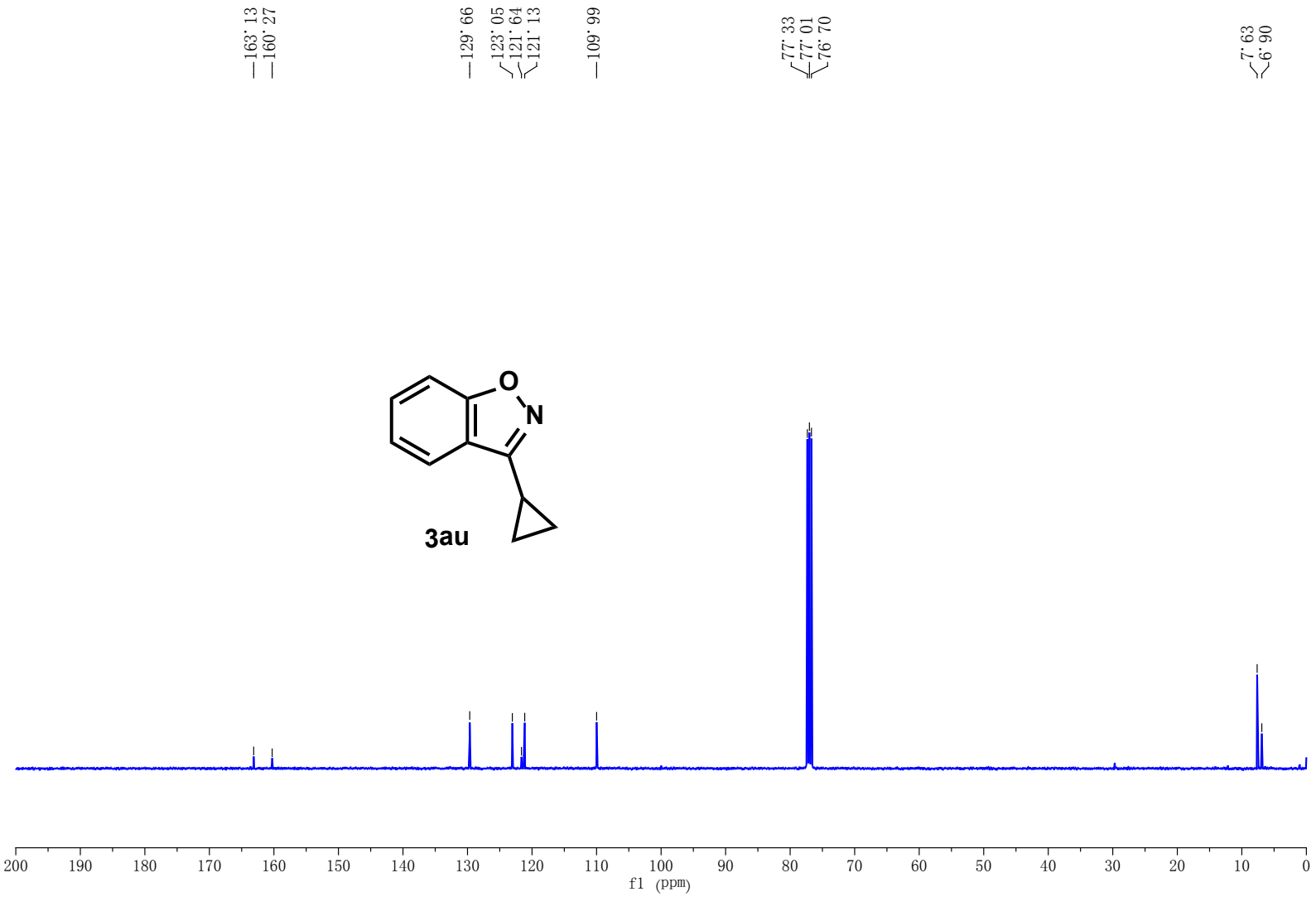

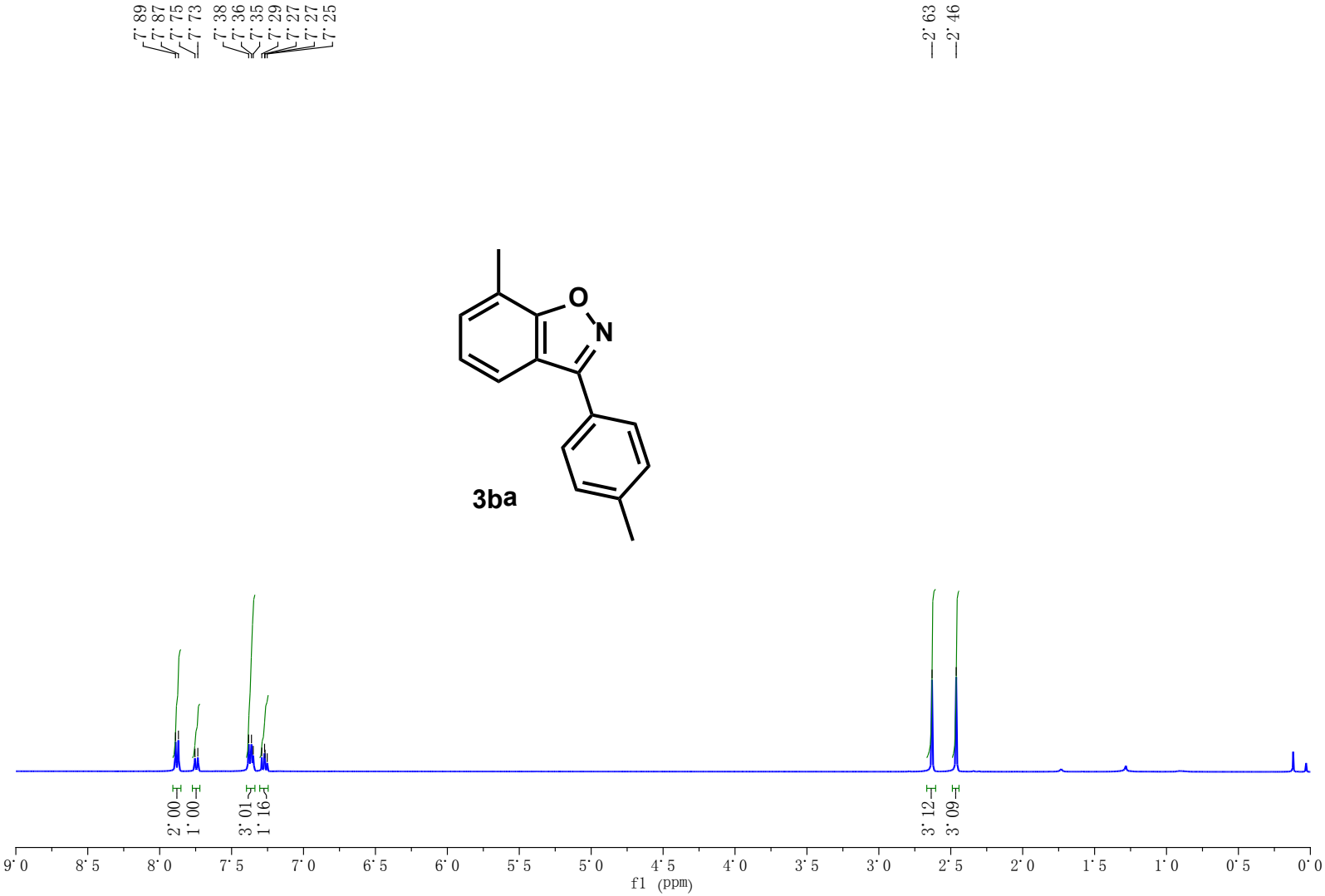

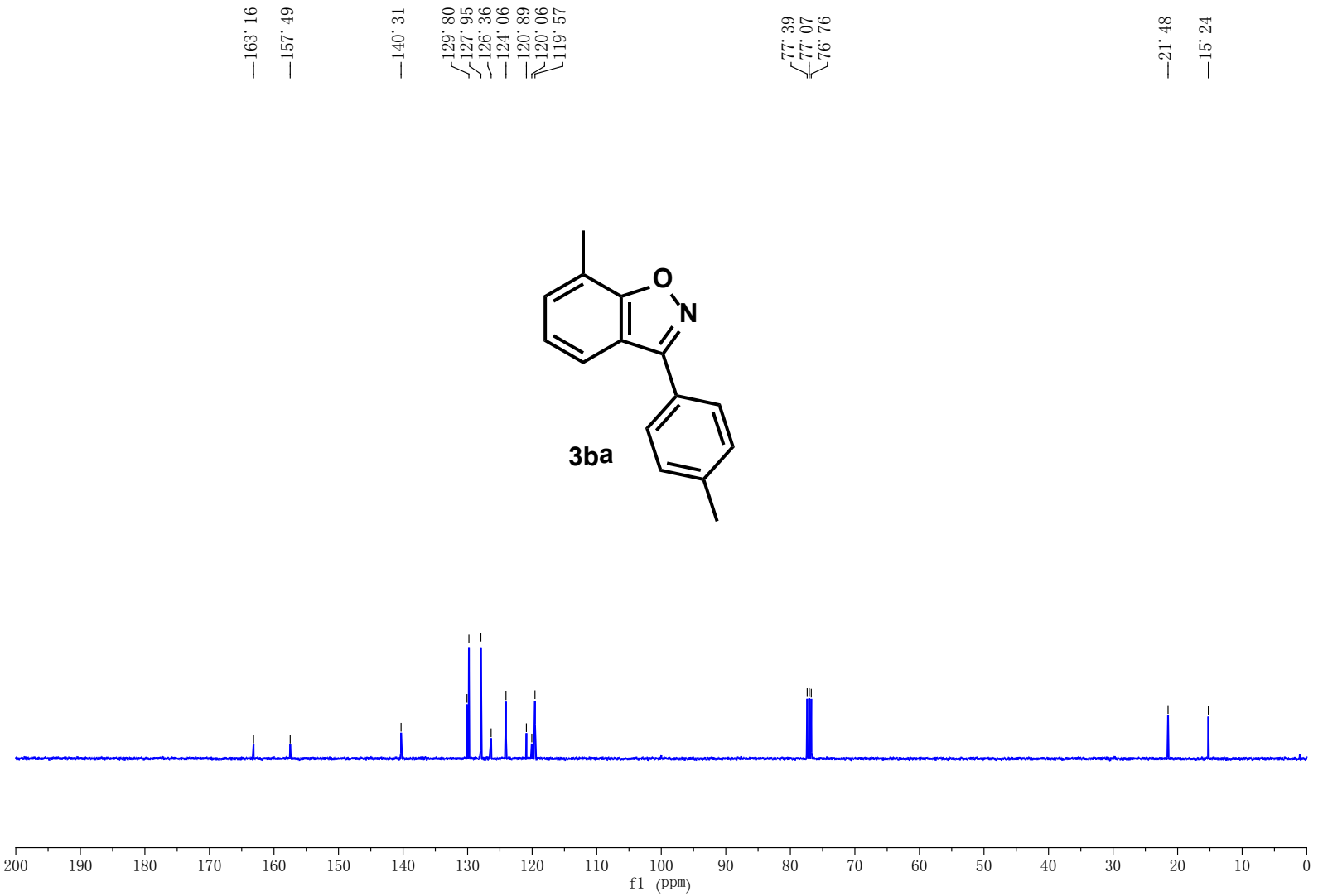

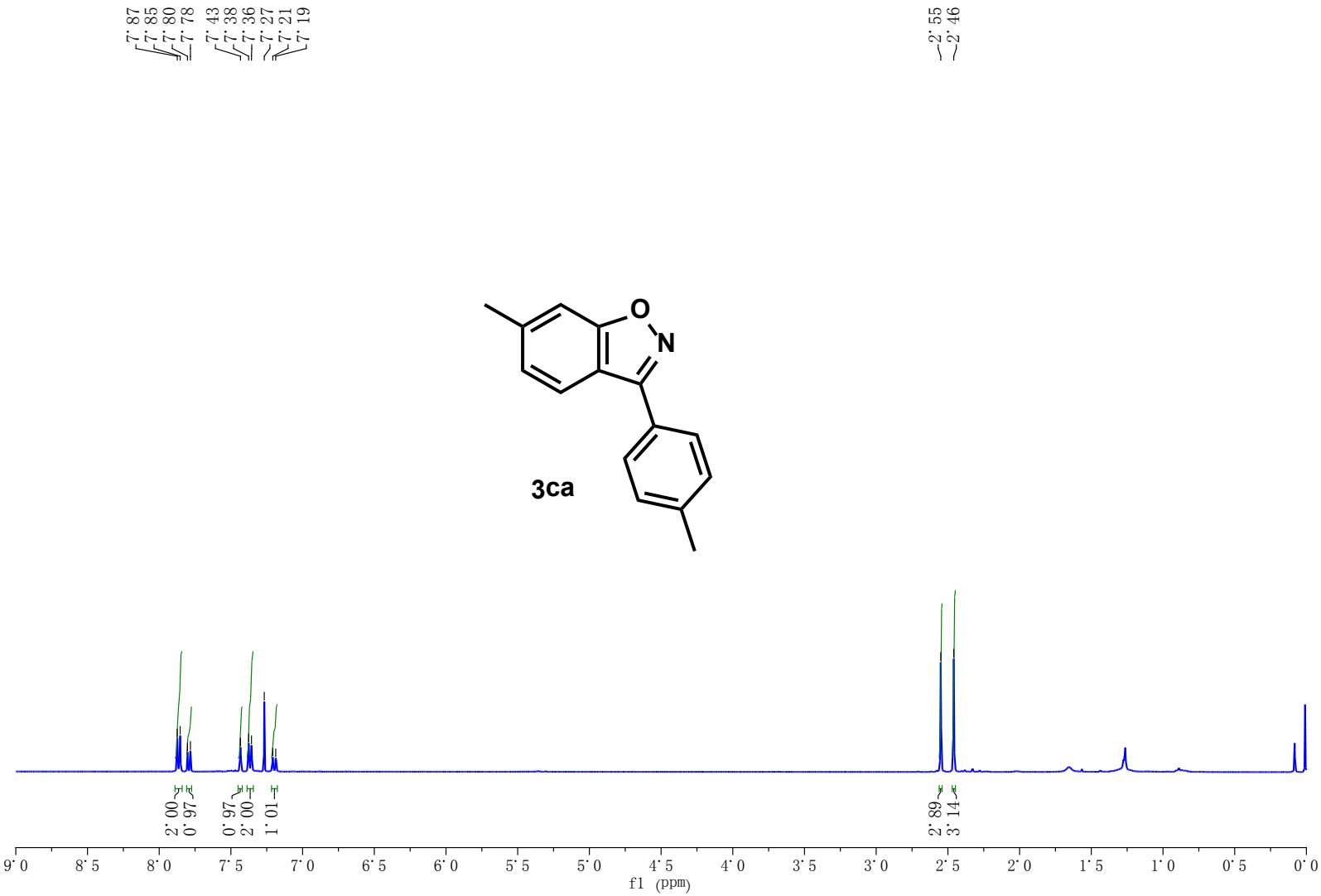

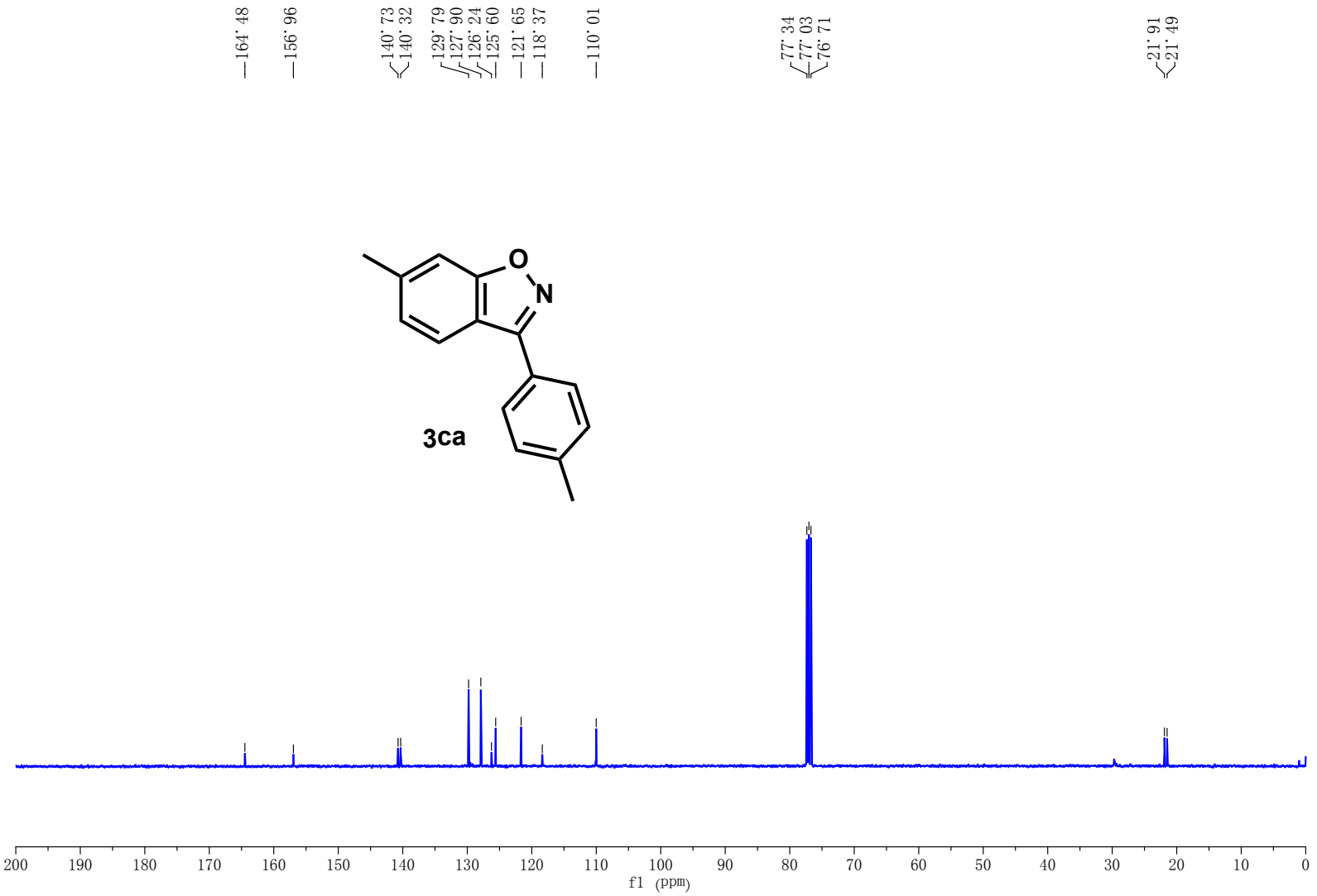

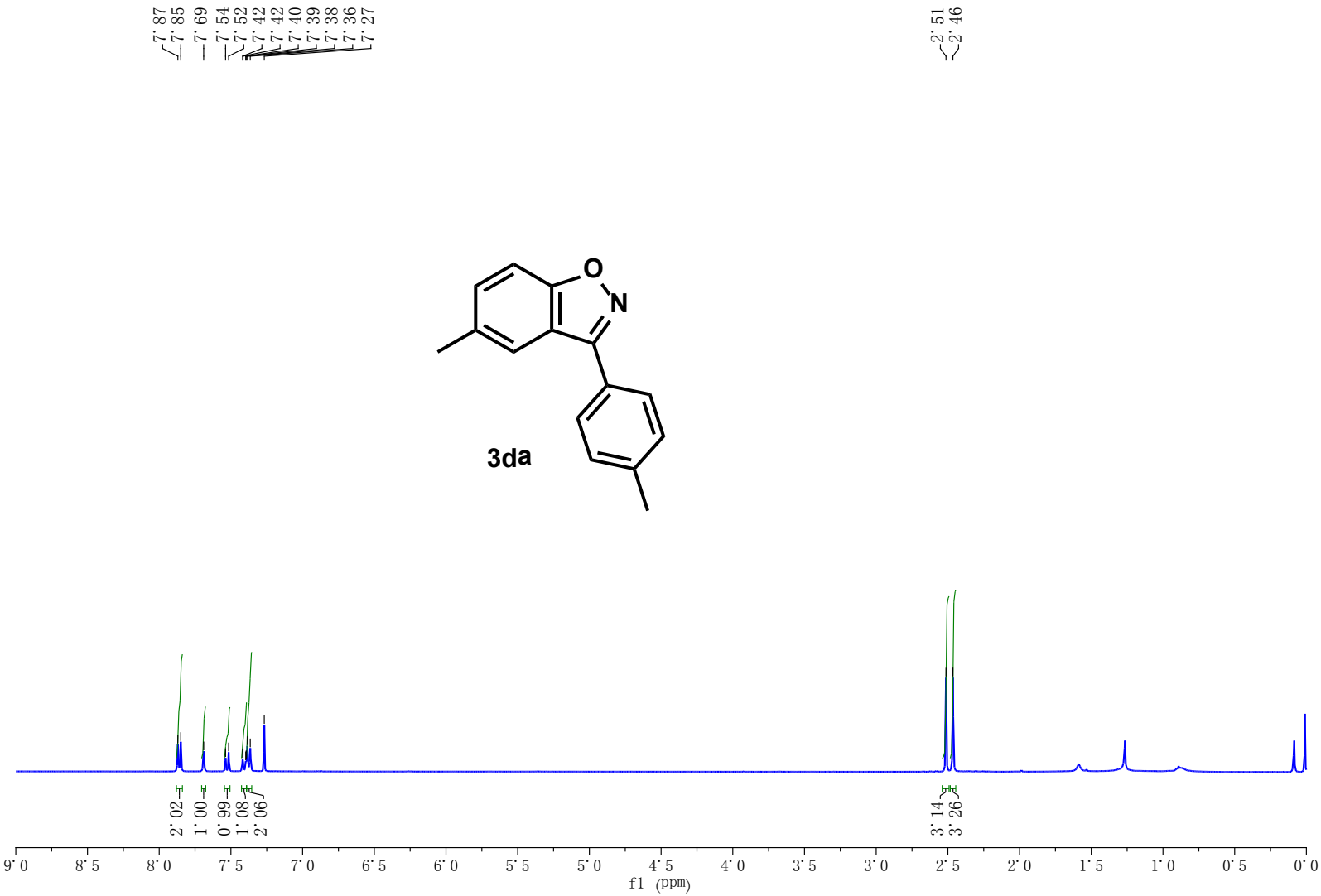

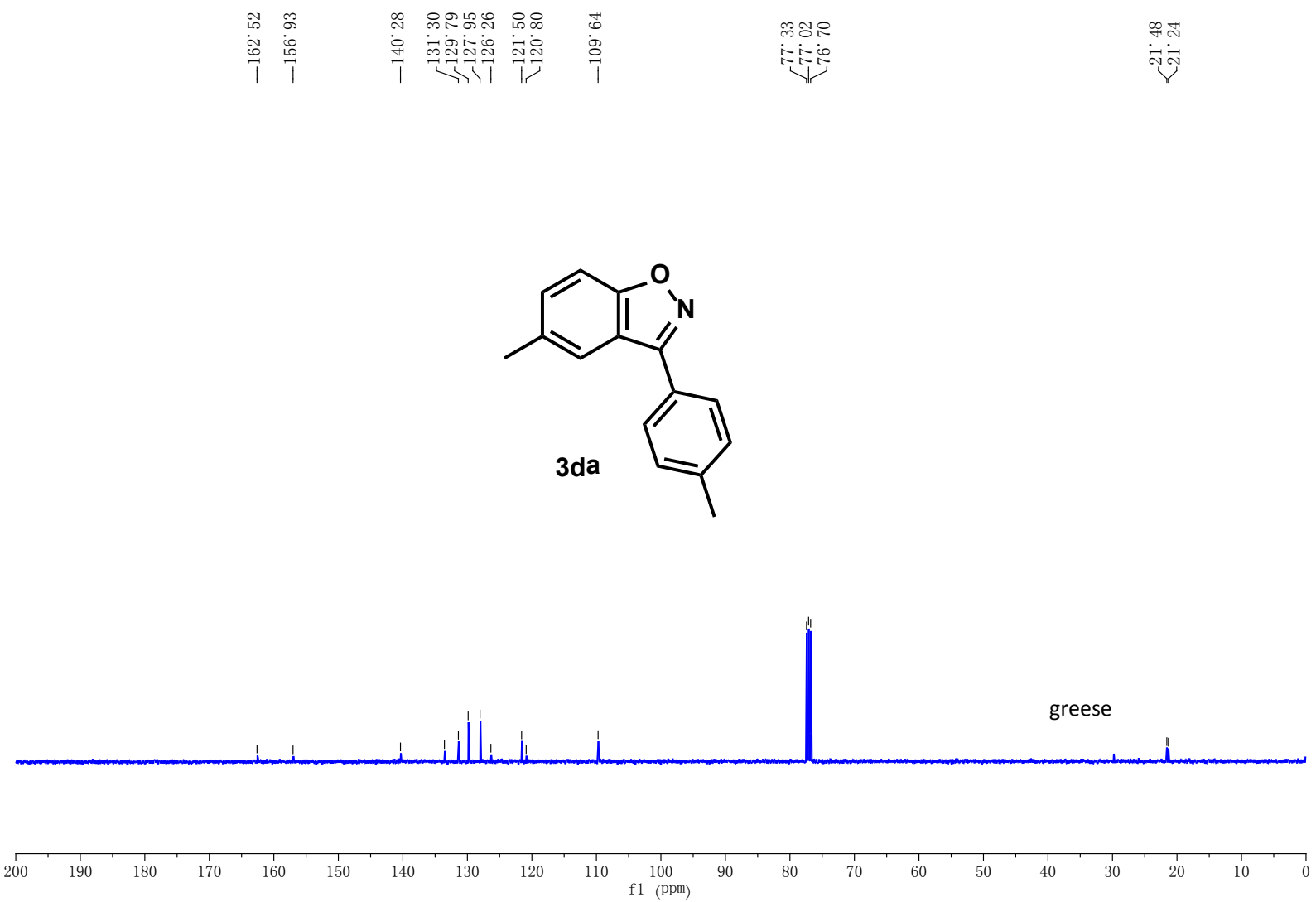

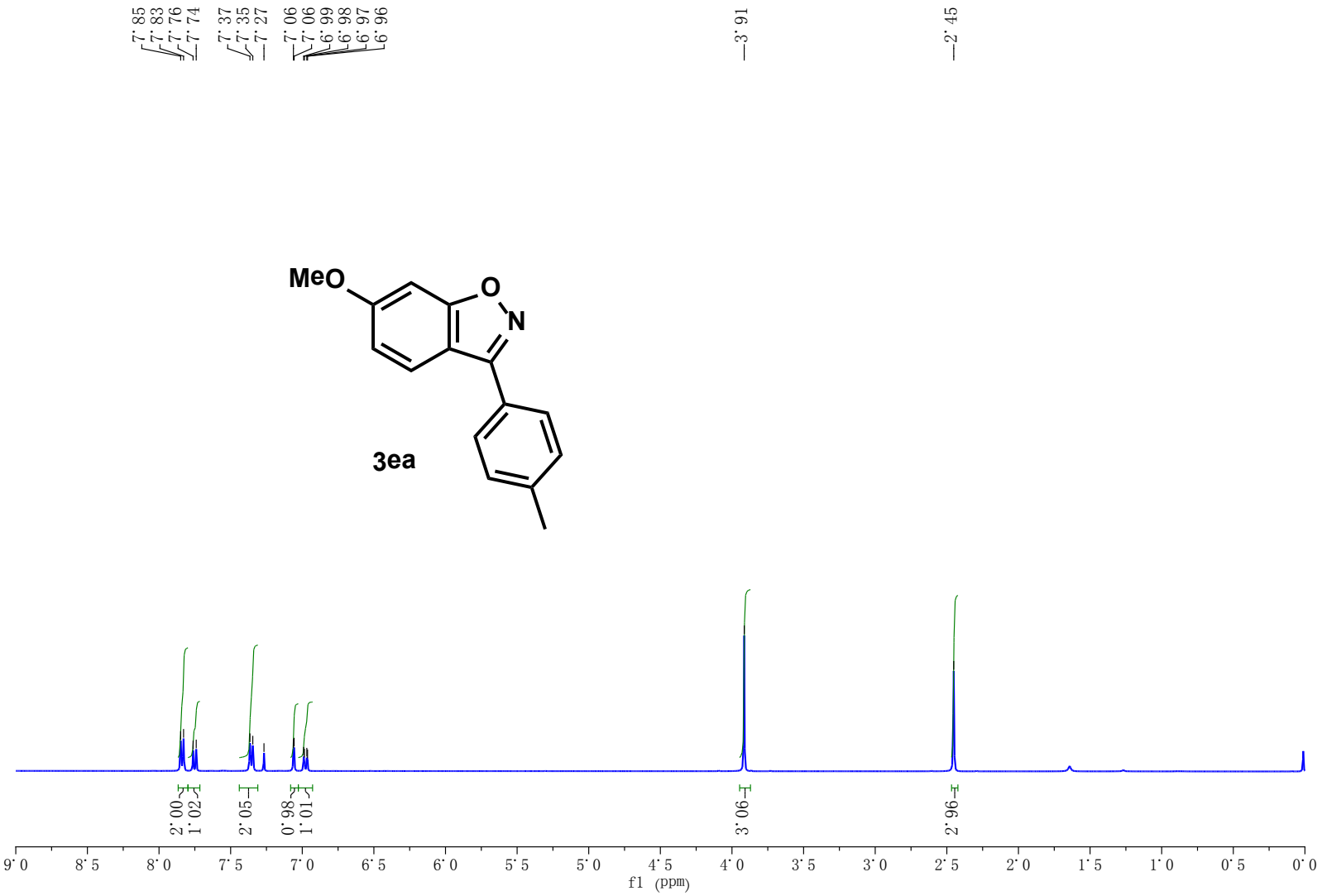

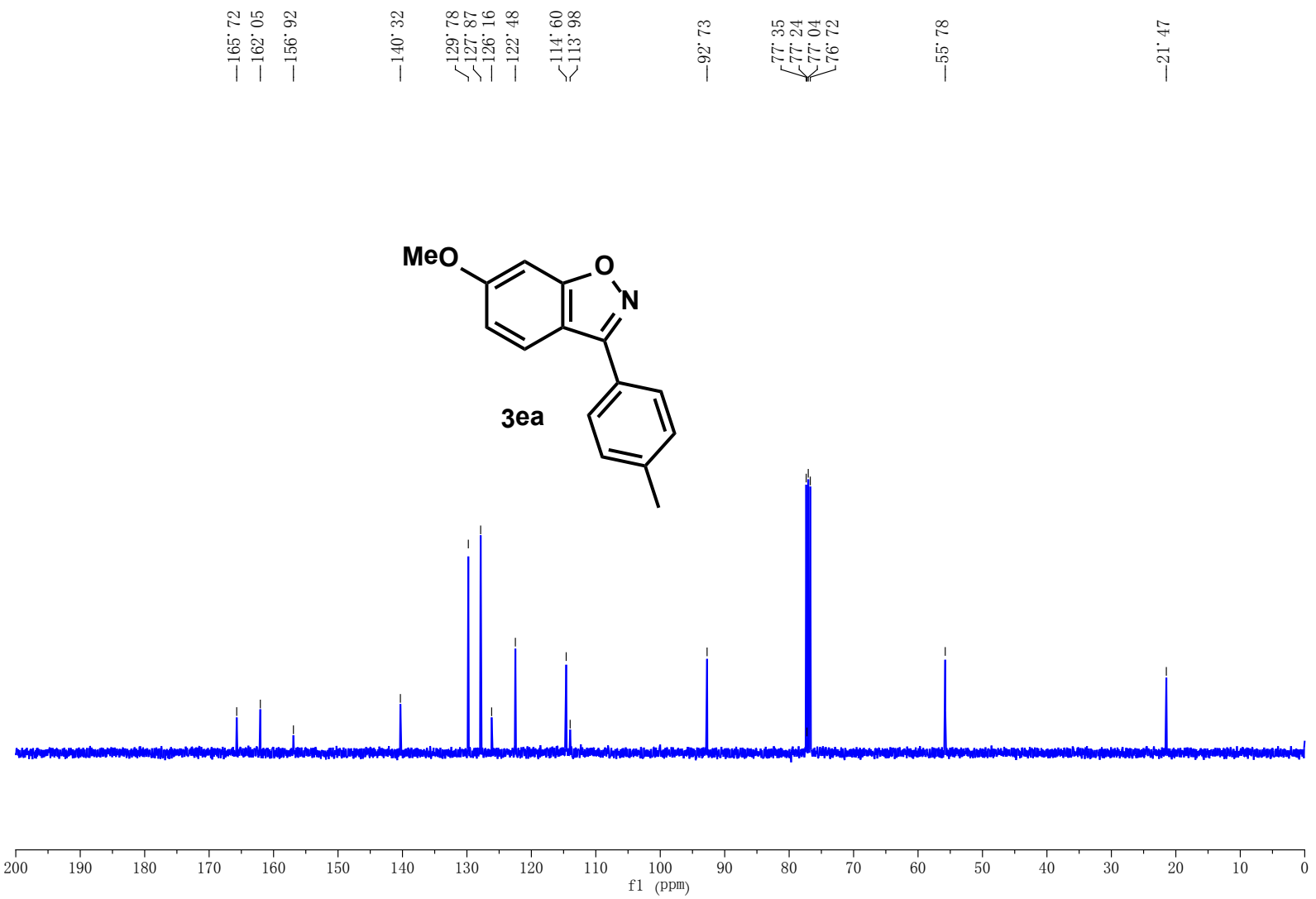

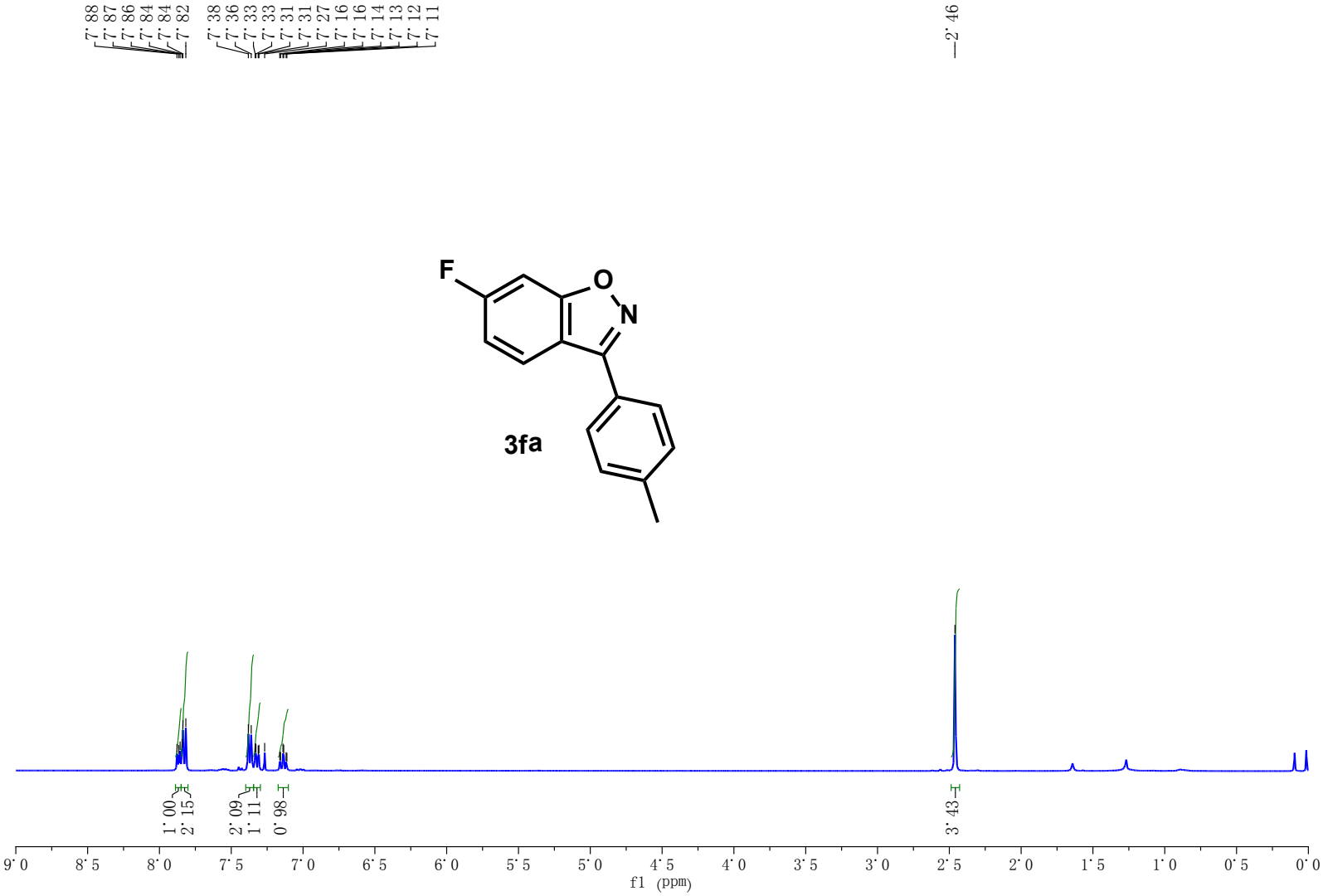

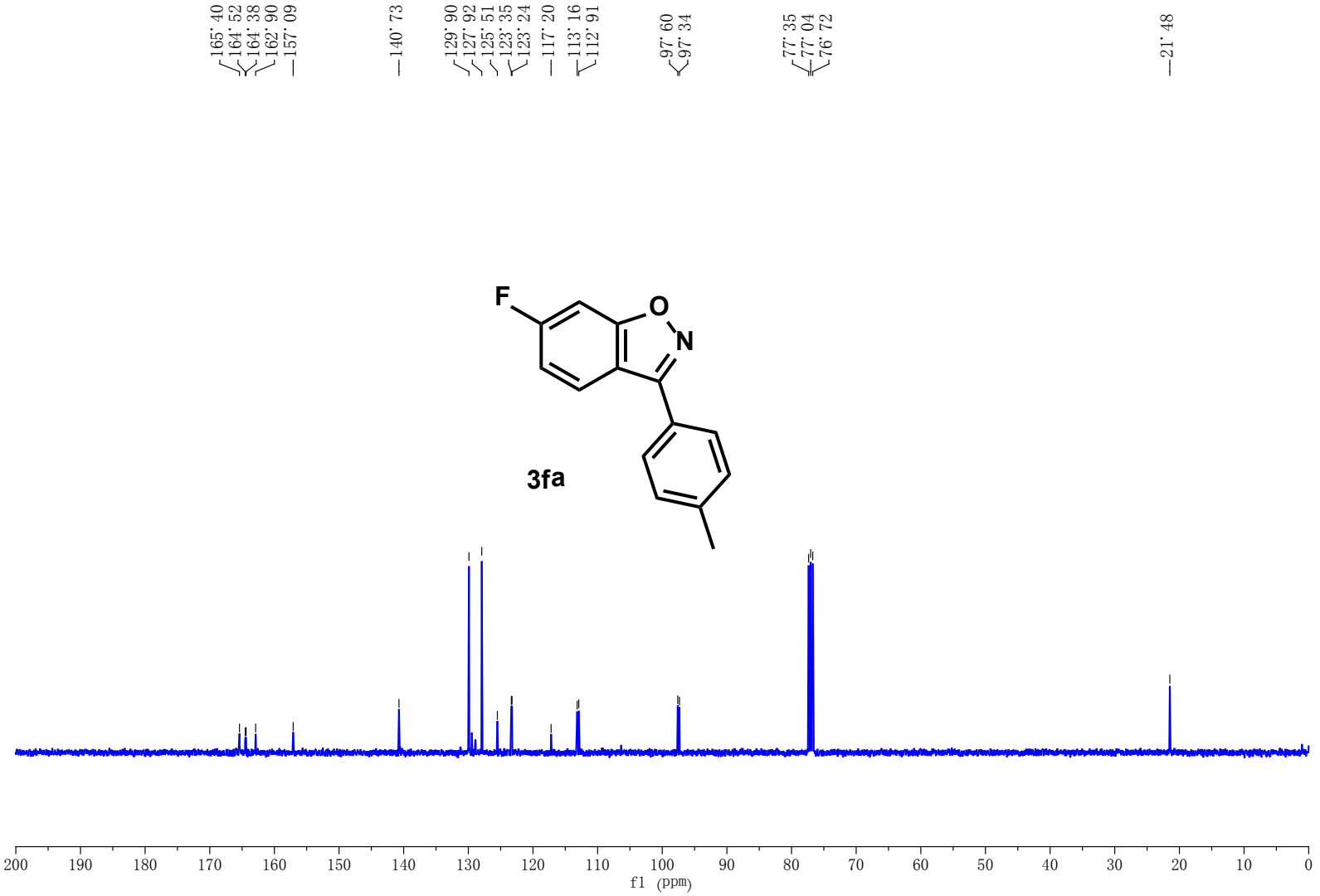

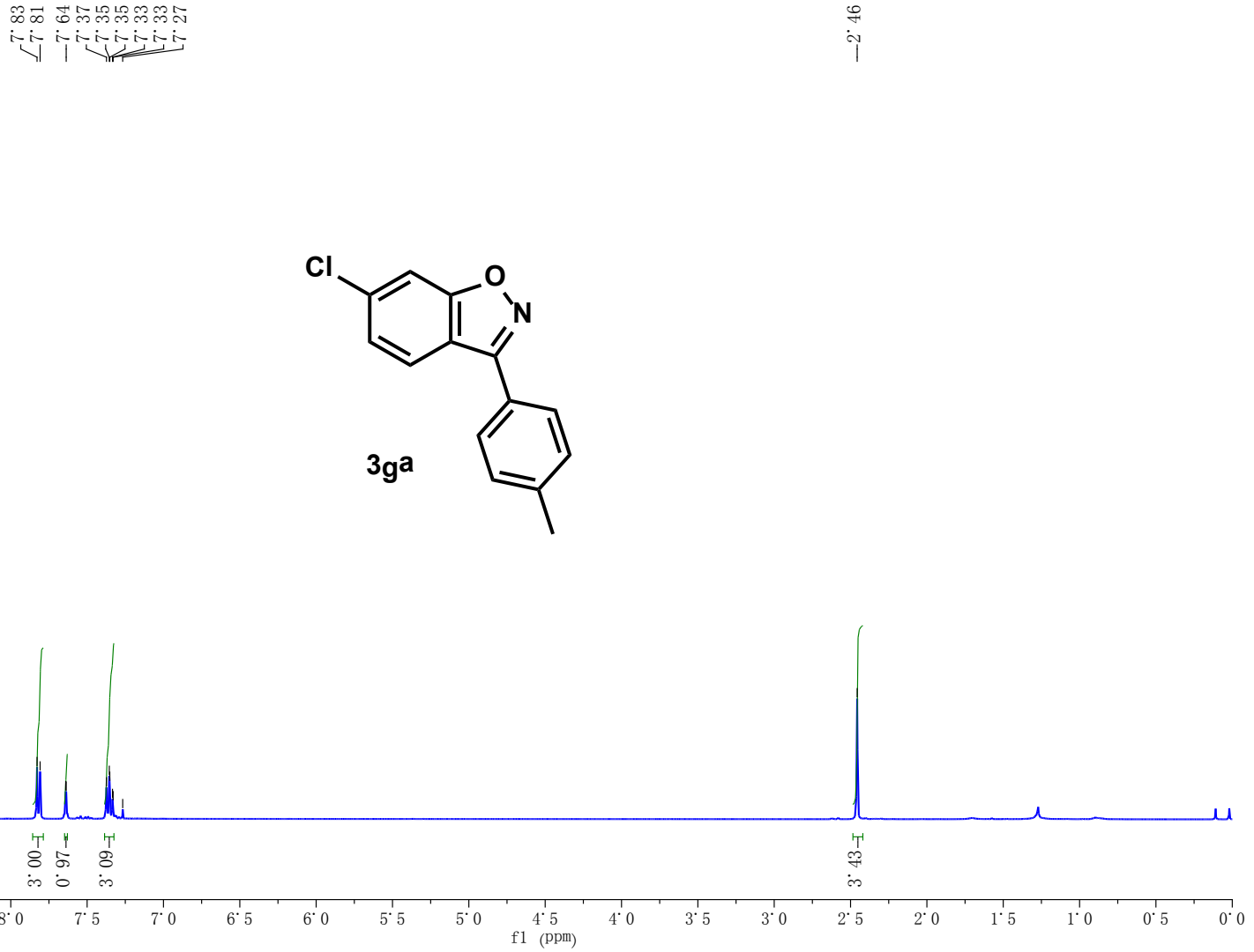

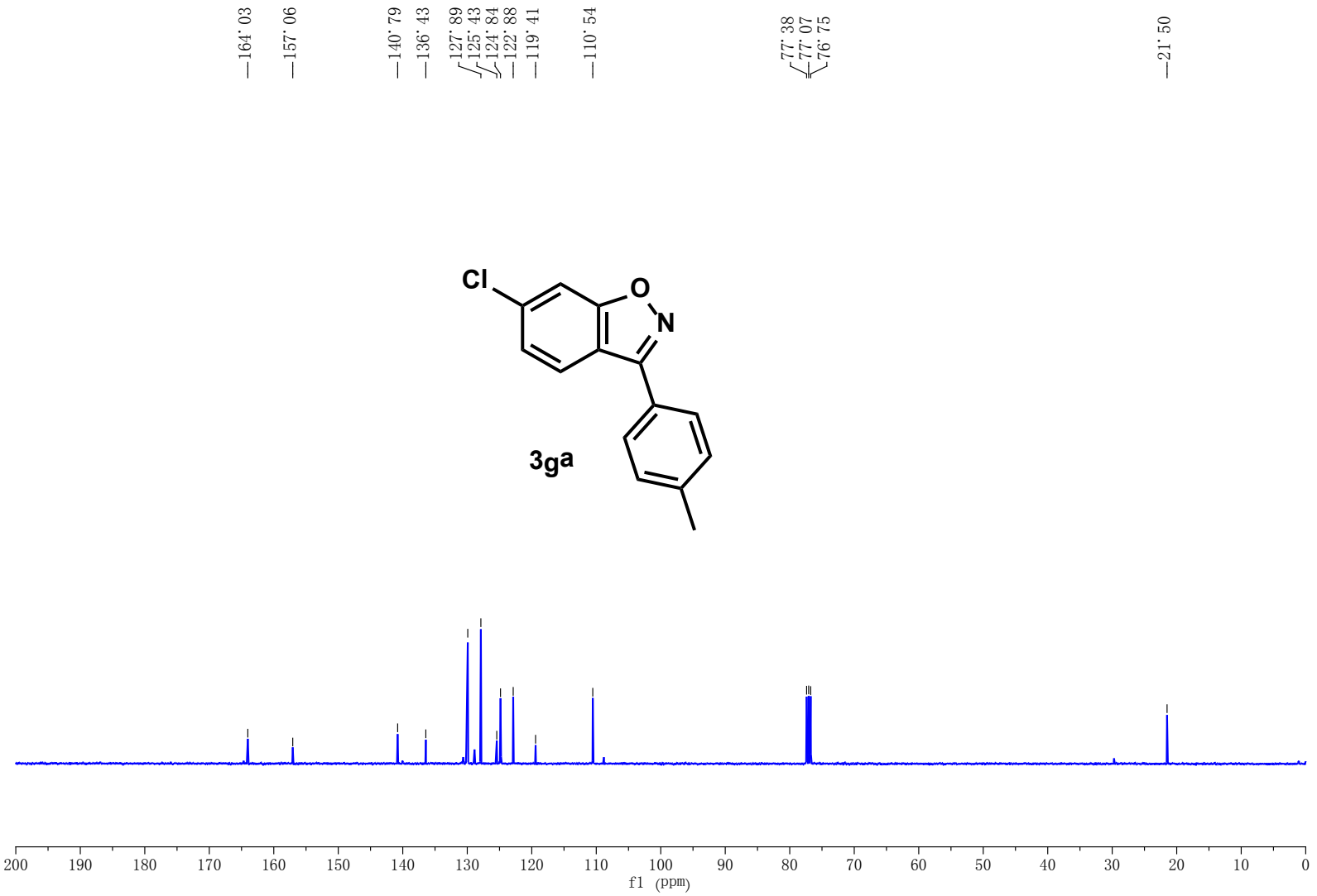

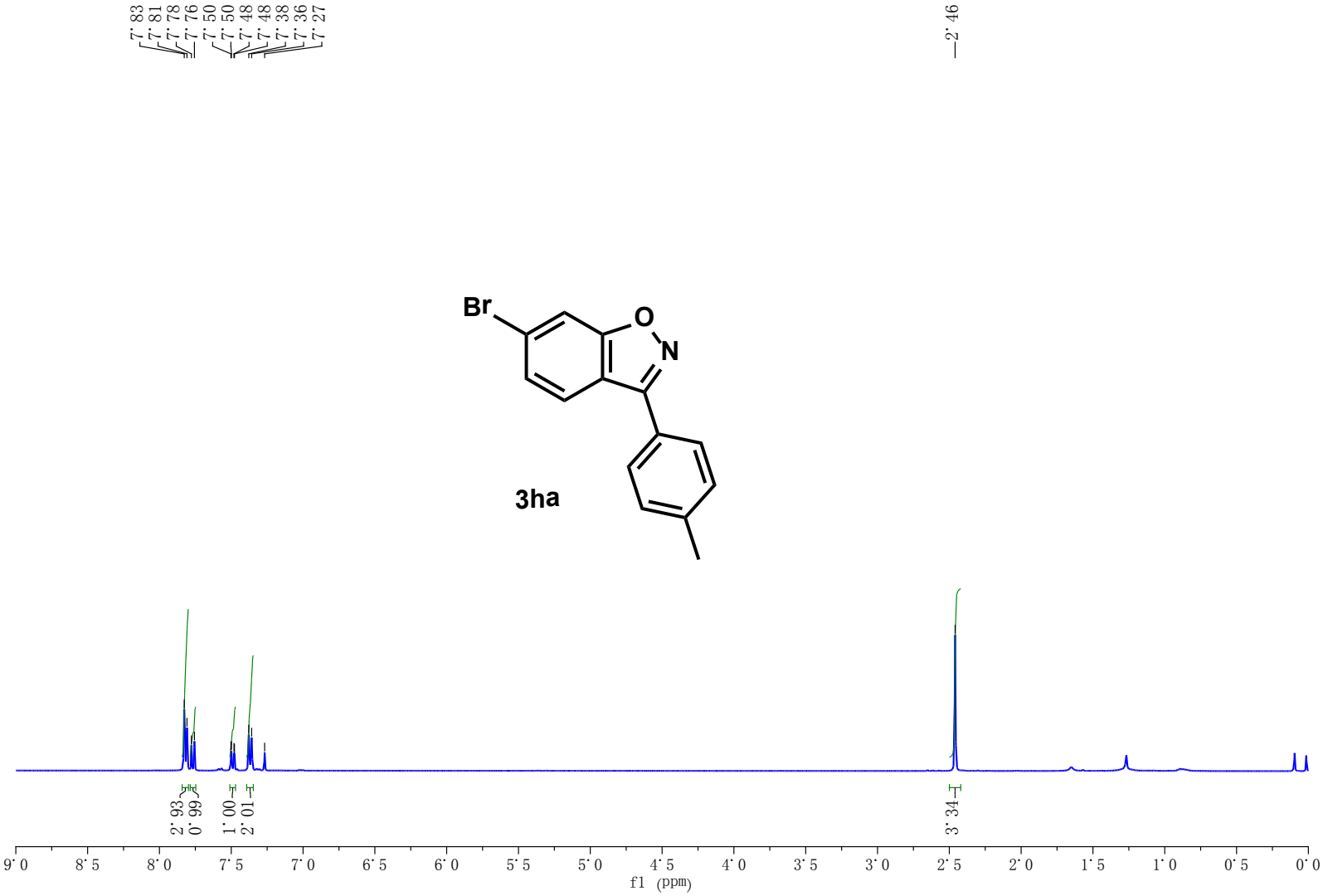

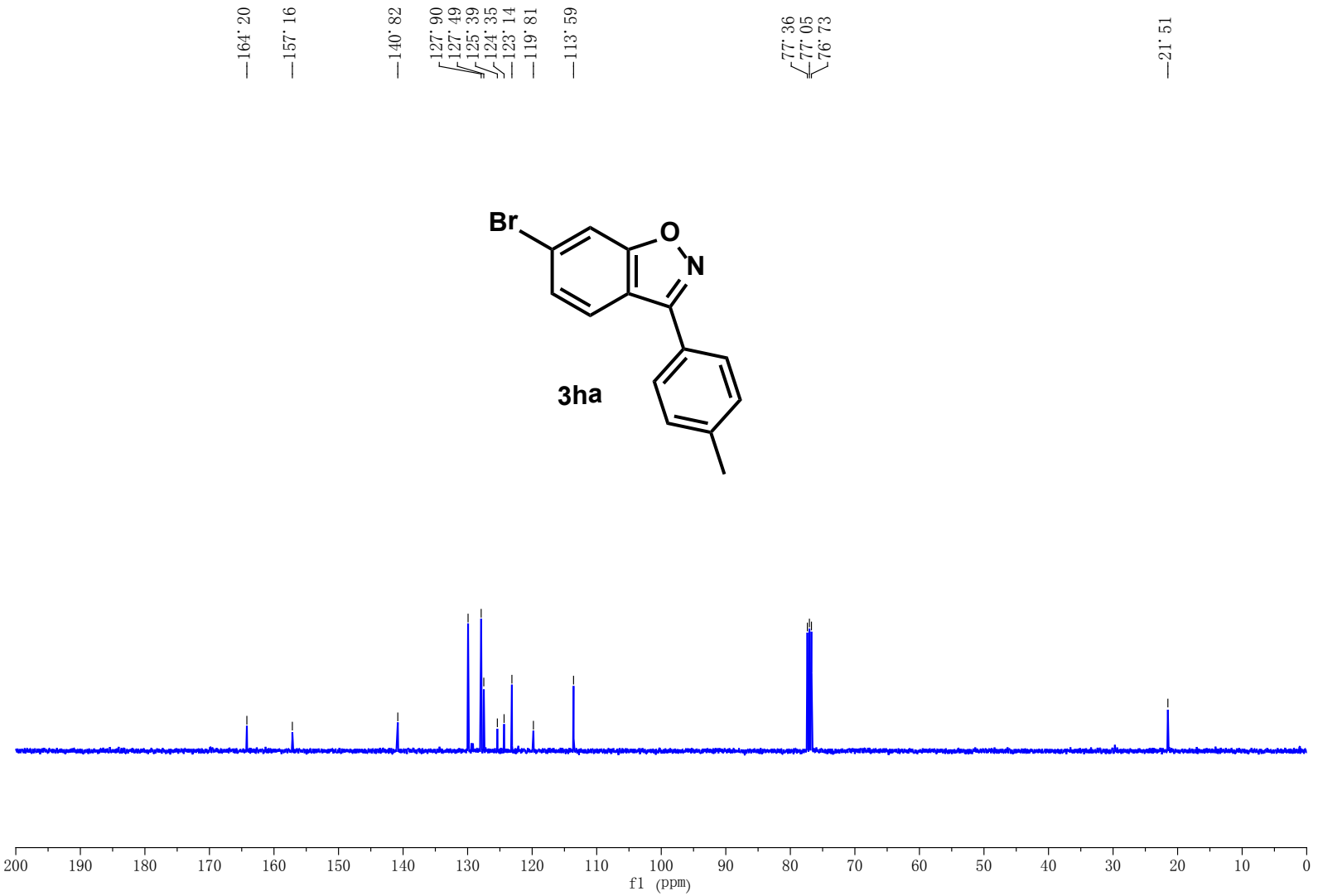

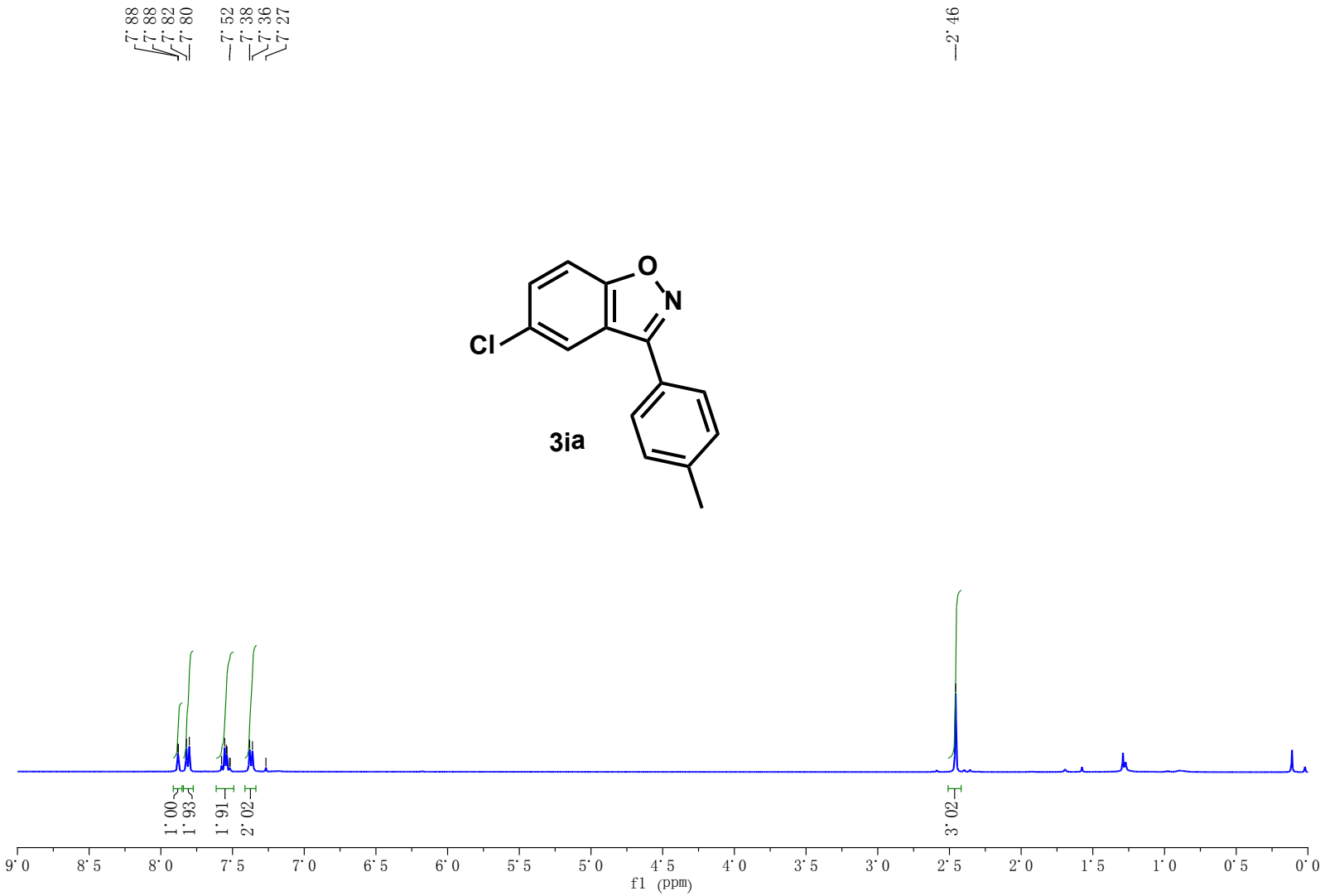

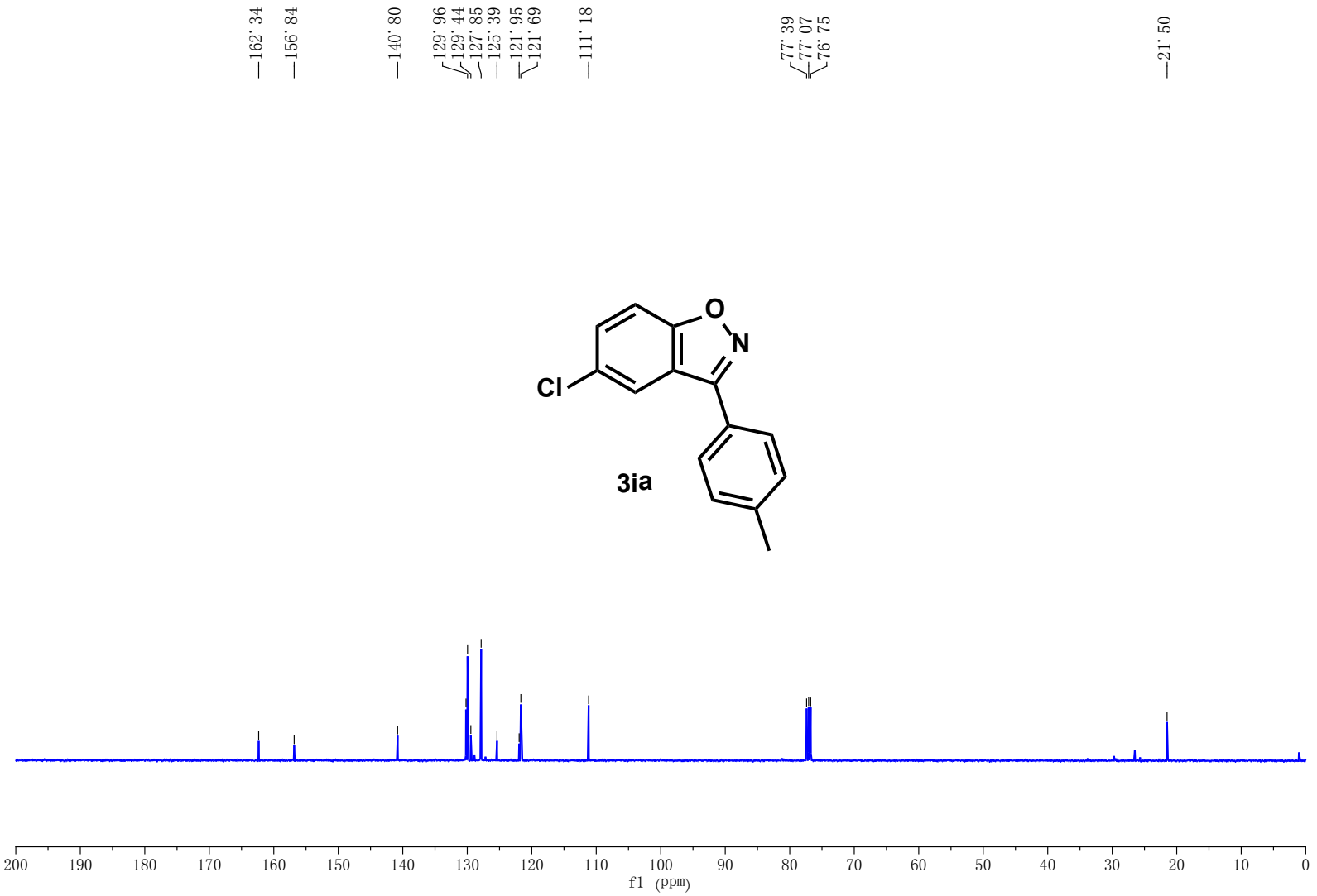

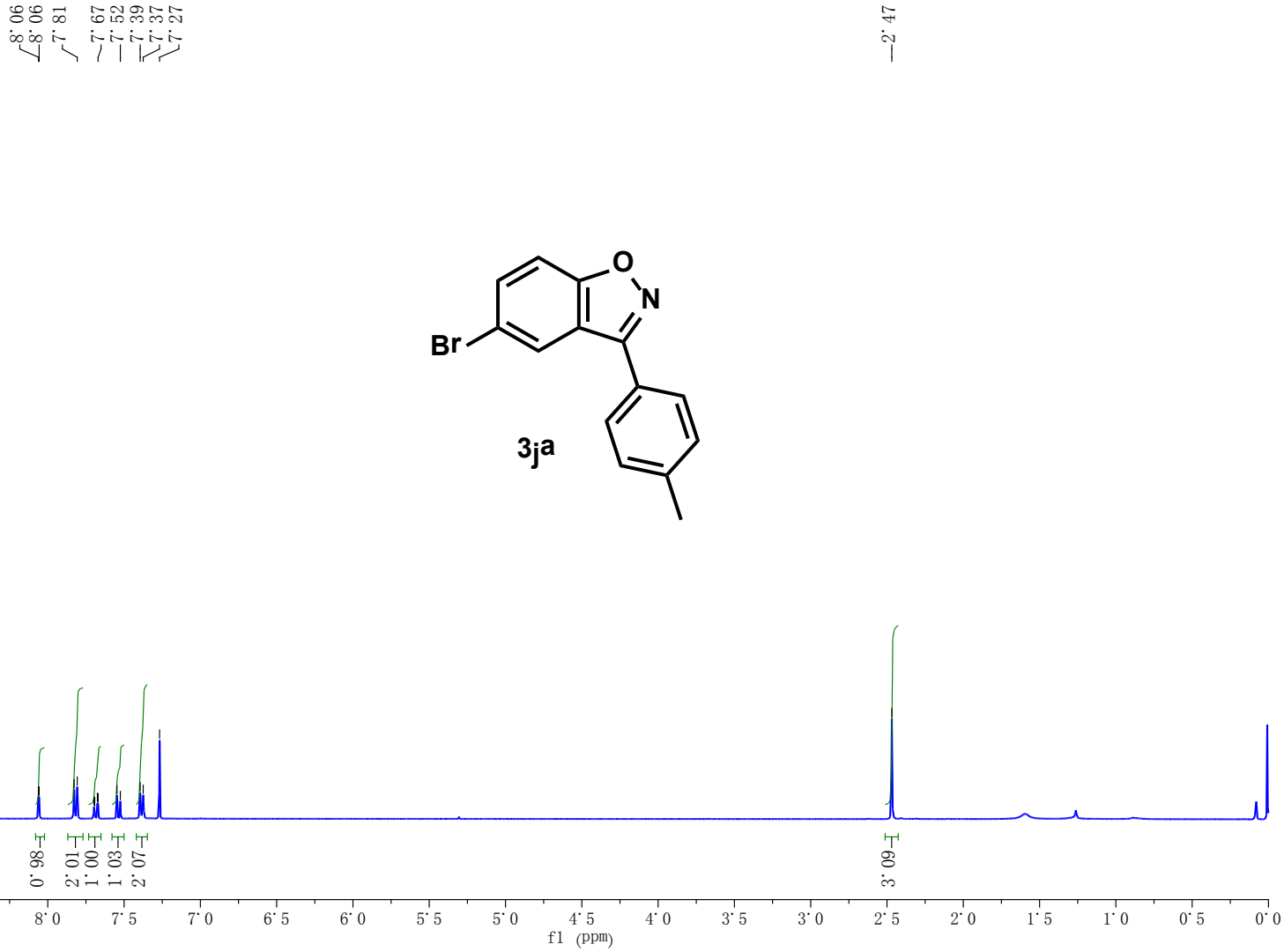
8.06
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7.52
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7.27
2.47
O
N
Br
3ja
0.98
2.01
1.00
1.03
2.07
3.09
f1 (ppm)