Supplementary Information

Highly Efficient Synthesis of *Tert*-butyl Ester Using $(Boc)_2O$ under Solvent/Base-free Electromagnetic Mill: A New Reaction Model

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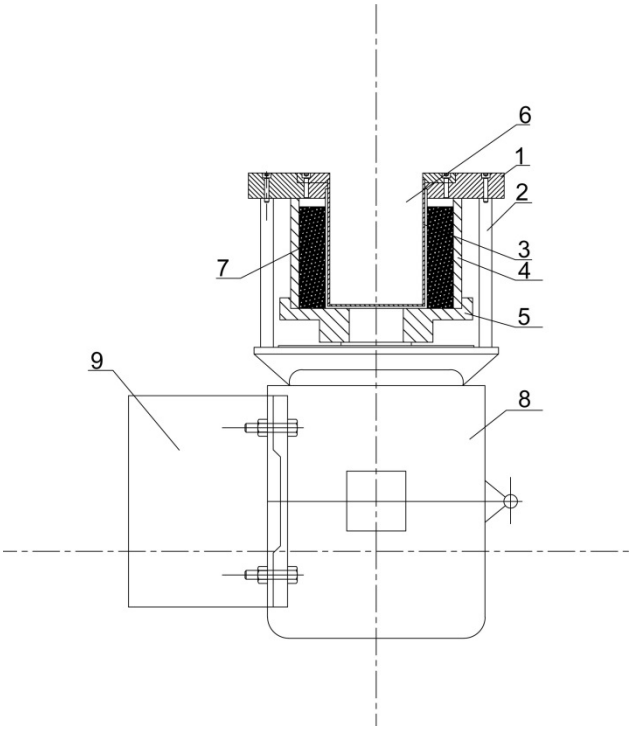
1. General Information

The starting materials were obtained from commercial suppliers and used as received. The ferromagnetic rod used is SUS304 stainless steel, which is purchased from Donghuan Feiada Metal Materials Co., Ltd. and then processed by ourselves. Solvents were purchased from commercial suppliers. Purifications of reactions products were carried out by flash chromatography using Merck silica gel (40-63 μm). All mechanochemical reactions were carried out using grinding vessels in a magnetic grinding machine. The reaction bottle used is a customized 10ml high-temperature pressure resistant tube (2.60 * 4.00 cm) or customized reaction jar. The grinding medium is customized ferromagnetic rods (0.3 * 5.0 mm). ^{1}H NMR (400 MHz), ^{13}C NMR (100 MHz) were measured on a Brucker Avance 400 MHz spectrometer. Chemical shifts are reported in parts per million (ppm, δ) downfield from residual solvents peaks and coupling constants are reported as Hertz (Hz). Splitting patterns are designated as singlet (s), doublet (d), triplet (t)……Splitting patterns that could not be interpreted or easily visualized are designated as multiplet (m). Electrospray mass spectra were obtained using an ESI/TOF Mariner Mass Spectrometer. Unless otherwise noted, all other commercially available reagents and solvents were used without further purification.

About the magnetic grinding used: the magnetic grinding machine (Fig. S1) is self-developed and has not yet been put into commercial use, and the instrument consists of two parts, the working room (left blue part of the picture) and the console (right part of the picture). The left cavity is the main working part. The four square magnets rotate around the cavity to form a rotating magnetic field, which drives the ferromagnetic rod to move. At present, there are two types of equipment with magnetic field strength of 0.1 T and 0.2 T.

Fig. S1. Magnetic Ginding equipment



1 Fixed disc

2 Support shaft

3 Jacket

4 Rotating body

5 Rotating seat

6 Grinding space

7 Magnet

8 Frequency conversion motor

9 Bearing bracket

Fig. S2. Plan view of Magnetic Ginding equipment (left blue part)

2. General Procedure for Green Synthesis of *Tert*-butyl Ester Under Solvent-Free Electromagnetic Mill Conditions

1) Procedure l: Green Synthesis of *Tert*-butyl Ester Under Solvent-Free Electromagnetic Mill Conditions

Aryl halide **1a** (0.1521 g, 1.0 mmol, 1.0 equiv.), **2a** (0.2184 g, 2.0 mmol, 2.0 equiv.), ferromagnetic rods 5.0 g were placed in a high temperature and pressure resistant pipe, then the high temperature and pressure resistant pipe was put in magnetic grinder. After 2 h, the mixture was dissolved in ethyl acetate, then ferromagnetic rods were filtered. After washing with water and extracting with ethyl acetate, the organic phase was combined, dried over Na_2SO_4, evaporated and purified by flash chromatography [petrol ether : ethyl acetate = 30:1 (PE: EA = 30:1)] to give compound **3a**.

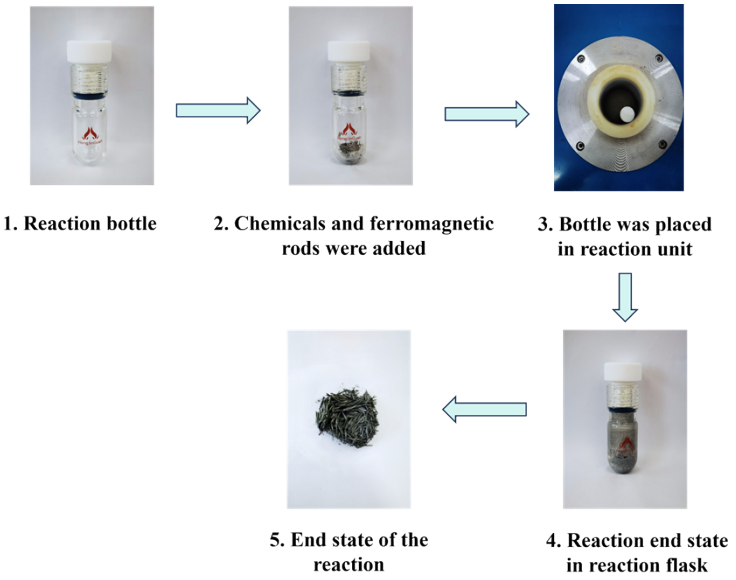


Fig. S3. Set-up procedure for the Green Synthesis of *Tert*-butyl Ester Under Solvent Free Electromagnetic Mill Conditions

3. Ferromagnetic rods of different specifications

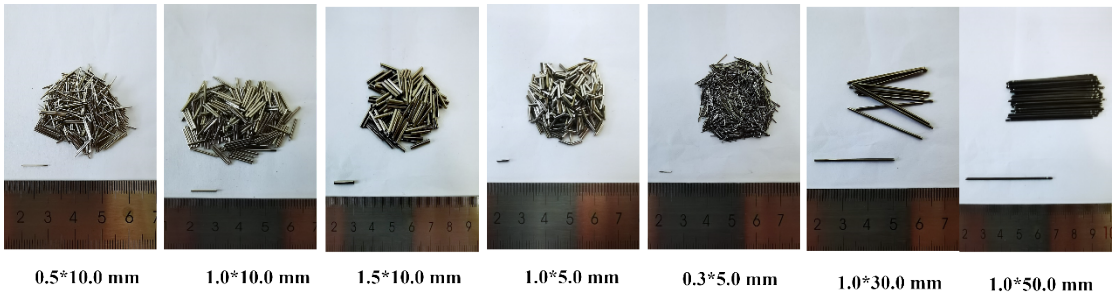


Fig. S4. Ferromagnetic rods of different sizes used in experiments

4. SEM-EDS data analysis of ferromagnetic rod (0.3*5.0 mm)

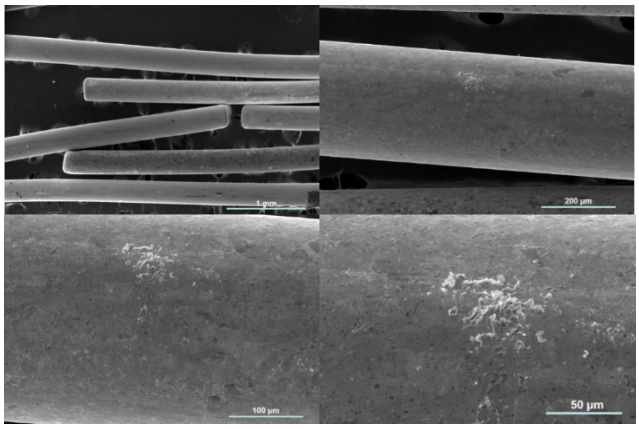
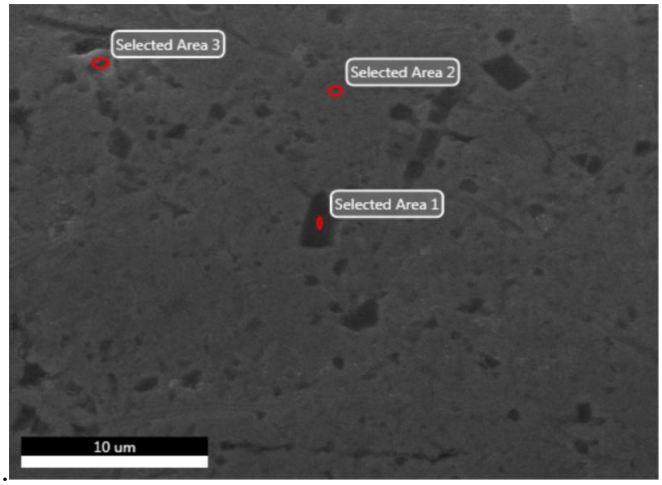
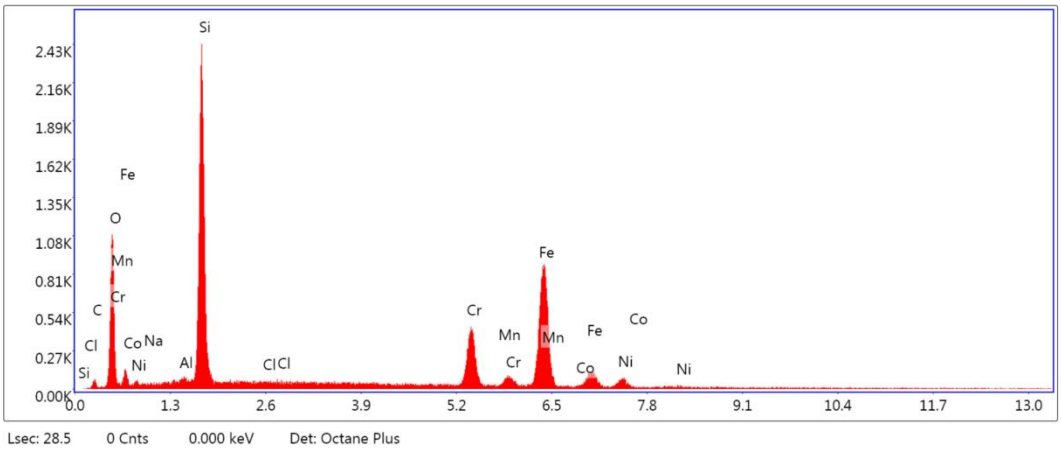


Fig. S5. Morphology of ferromagnetic rod under scanning electron microscope



Selected Area 1



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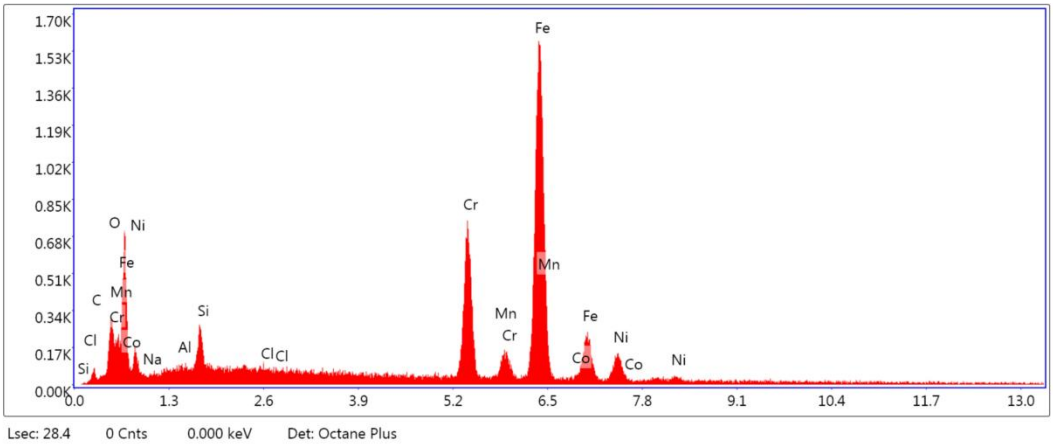

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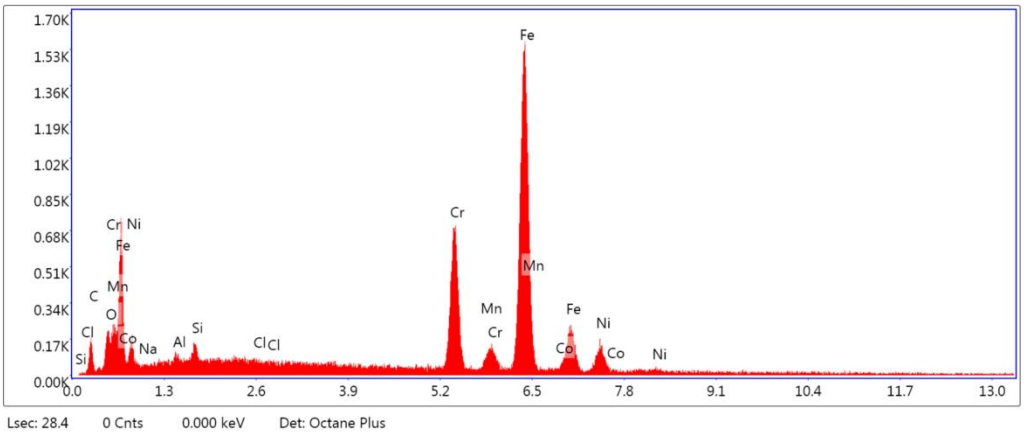
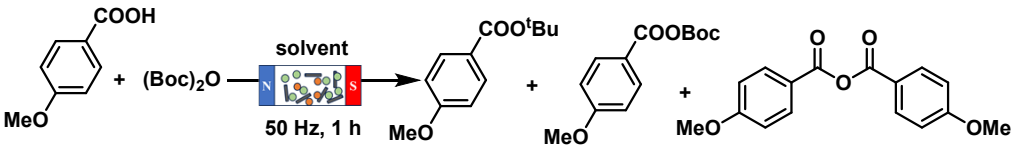


Fig. S6. EDS data analysis of ferromagnetic rod

5 The influence of different specifications of ferromagnetic rods on reaction yield



1a 2a 3a 5a 6a

Entry	SFR (mm)	Solvent	3a%	5a%	6a%	1a% (Recovered)
1	0.3*5.0	-	76	0	0	0
2	1.0*5.0	-	69	5	6	0
3	0.5*10.0	-	71	4	4	0
4	1.0*10.0	-	70	6	4	0
5	1.5*10.0	-	72	5	5	0
6	1.0*30.0	-	0	32	21	40
7	1.0*30.0	MeCN	0	35	34	25
8	1.0*50.0	-	0	31	36	28
9	1.0*50.0	MeCN	0	33	31	31

Fig. S7. The influence of different specifications of ferromagnetic rods on reaction yield

6 GCMS of 3ag

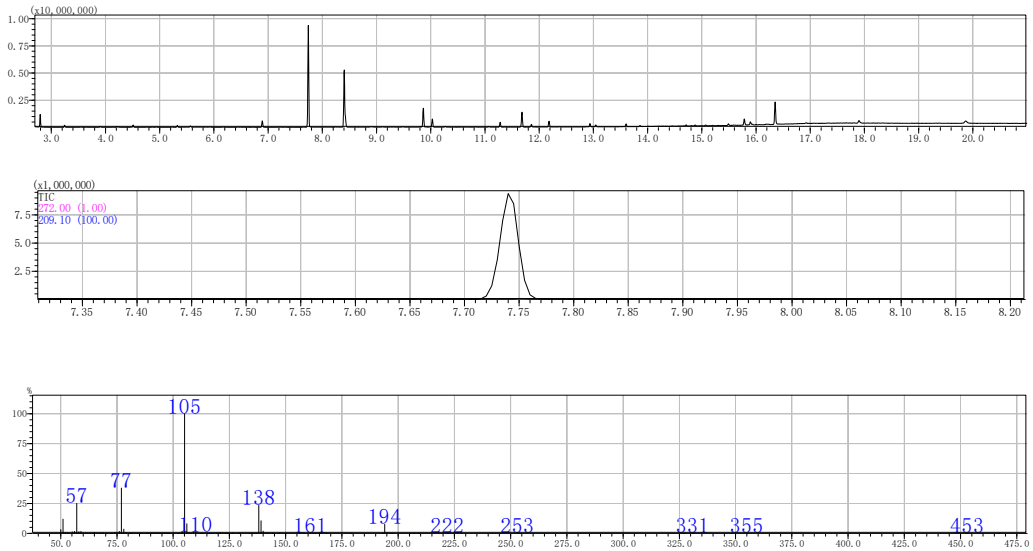
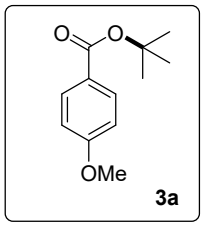


Fig. S8. GCMS of 3ag

7 Analytical Data of Substrates



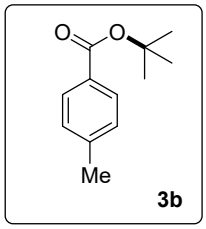
***tert*-butyl 4-methoxybenzoate**[1]

$C_{12}H_{16}O_3$ **MW**: 208.26 g·mol^{-1}

Light yellow oil **Yield**: 189.51 mg, 91%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.94 (d, *J* = 8.8 Hz, 2H), 6.89 (d, *J* = 8.8 Hz, 2H), 3.84 (s, 3H), 1.58 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 165.6, 162.9, 131.3, 124.5, 113.3, 80.5, 55.4, 28.2.



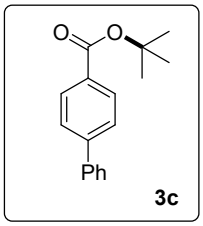
***tert*-butyl 4-methylbenzoate**[1]

$C_{12}H_{16}O_2$ **MW**: 192.26 g·mol^{-1}

Colorless oil **Yield**: 111.51 mg, 58%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.89 (d, *J* = 8.0 Hz, 2H), 7.21 (d, *J* = 8.0 Hz, 2H), 2.39 (s, 3H), 1.59 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 165.8, 142.9, 129.4, 129.2, 128.8, 80.6, 28.1, 21.5.



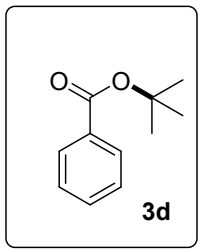
***tert*-butyl [1,1'-biphenyl]-4-carboxylate**[2]

$C_{17}H_{18}O_2$ **MW**: 254.33 g·mol^{-1}

Light yellow oil **Yield**: 198.38 mg, 78%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 8.06(d, *J* = 8.4 Hz, 2H), 7.62 (t, *J* = 8.0 Hz, 4H), 7.55 (t, *J* = 7.6 Hz, 2H), 7.38 (t, *J* = 7.6 Hz, 1H), 1.61 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 165.7, 145.2, 140.2, 130.8, 130.0, 128.9, 128.1, 127.3, 126.9, 81.0, 28.3.



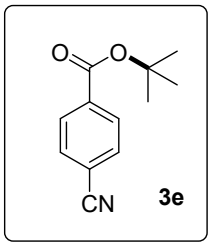
***tert*-butyl benzoate**[1]

$C_{11}H_{14}O_2$ **MW**: 178.23 g·mol^{-1}

Light yellow oil **Yield**: 128.33 mg, 72%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.99 (d, *J* = 6.8 Hz, 2H), 7.52 (t, *J* = 8.0 Hz, 1H), 7.41 (t, *J* = 7.6 Hz, 2H), 1.60 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 165.7, 132.4, 131.9, 129.3, 128.1, 80.9, 28.1.



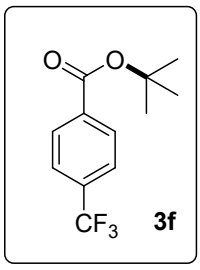
***tert*-butyl 4-cyanobenzoate**[3]

$C_{12}H_{13}NO_2$ **MW**: 203.24 g·mol^{-1}

Light yellow oil **Yield**: 101.62 mg, 50%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 8.07 (d, *J* = 8.4 Hz, 2H), 7.71 (d, *J* = 8.4 Hz, 2H), 1.59 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 163.9, 135.8, 132.0, 129.9, 118.1, 115.8, 82.3, 28.0.



***tert*-butyl 4-(trifluoromethyl)benzoate**[4]

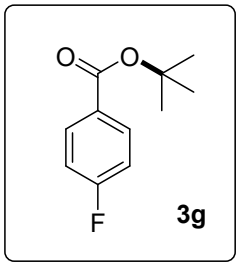
$C_{12}H_{13}F_3O_2$ **MW**: 246.23 g·mol^{-1}

Colorless oil **Yield**: 147.74 mg, 60%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 8.01 (d, *J* = 8.4 Hz, 2H), 7.58 (d, *J* = 8.4 Hz, 2H), 1.52 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 164.4, 135.20, 135.19, 134.4, 134.1, 133.7, 133.4, 129.8, 125.21, 125.18, 125.14, 125.10, 125.07, 122.4, 81.9, 28.0.

^{19}F NMR (376 MHz, $CDCl_3$, δ ppm): -63.02



***tert*-butyl 4-fluorobenzoate**[3]

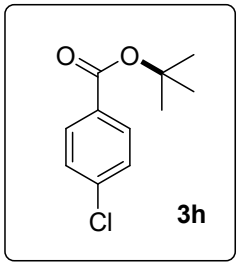
$C_{11}H_{13}FO_2$ **MW**: 196.22 g·mol^{-1}

Light yellow oil **Yield**: 121.66 mg, 62%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 8.01-7.98 (m, 2H), 7.07 (t, *J* = 8.4 Hz, 2H), 1.59 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 166.7, 164.7, 164.1, 131.9, 131.8, 128.1, 128.1, 115.2, 115.0, 81.1, 28.1.

^{19}F NMR (376 MHz, $CDCl_3$, δ ppm): -106.86.



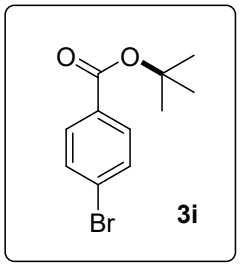
***tert*-butyl 4-chlorobenzoate**[1]

$C_{11}H_{13}ClO_2$ **MW**: 212.67 g·mol^{-1}

Light yellow oil **Yield**: 159.50 mg, 75%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.91 (d, *J* = 8.4 Hz, 2H), 7.36 (d, *J* = 8.8 Hz, 2H), 1.58 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 164.8, 138.7, 130.8, 130.4, 128.4, 81.4, 28.1.



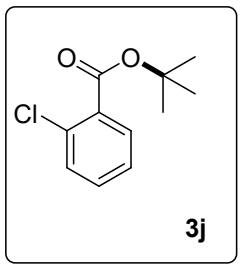
***tert*-butyl 4-bromobenzoate**[5]

$C_{11}H_{13}BrO_2$ **MW**: 257.13 g·mol^{-1}

Light yellow oil **Yield**: 125.99 mg, 49%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.84 (d, *J* = 8.4 Hz, 2H), 7.54 (d, *J* = 8.4 Hz, 2H), 1.58 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 165.0, 131.4, 131.0, 130.9, 127.4, 81.5, 28.1.



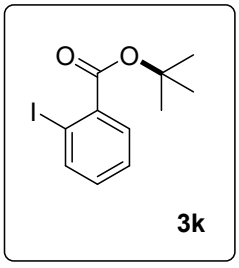
***tert*-butyl 3-chlorobenzoate**[3]

$C_{11}H_{13}ClO_2$ **MW**: 212.67 g·mol^{-1}

Colorless oil **Yield**: 85.07 mg, 40%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.30 (dd, *J* = 8.0, 2.0 Hz, 1H), 7.42-7.34 (m, 2H), 7.28 (td, *J* = 7.4, 1.6 Hz, 1H), 1.61 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 165.2, 133.0, 132.2, 131.8, 130.9, 130.8, 126.5, 82.4, 28.1.



***tert*-butyl 3-iodobenzoate**[6]

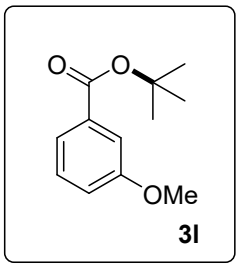
$C_{11}H_{13}IO_2$ **MW**: 304.13 g·mol^{-1}

Colorless oil **Yield**: 76.03 mg, 25%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.94 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.68 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.37 (td, *J* = 7.6, 0.8 Hz, 1H), 7.10 (td, *J* = 7.6, 1.6 Hz, 1H), 1.62 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 166.1, 140.8, 137.3, 131.9,

130.4, 127.8, 93.4, 82.6, 28.1.



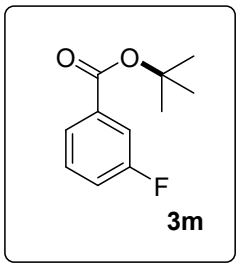
***tert*-butyl 3-methoxybenzoate**[6]

$C_{12}H_{16}O_3$ **MW**: 208.26 g·mol^{-1}

Light yellow oil **Yield**: 147.86 mg, 71%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.59 (dt, *J* = 7.6, 1.6 Hz, 1H), 7.53-7.52 (m, 1H), 7.31 (t, *J* = 8.0 Hz, 1H), 7.08-7.05 (m, 1H), 3.84 (s, 3H), 1.59 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 165.5, 159.4, 133.2, 129.1, 121.7, 118.7, 113.9, 81.0, 55.2, 28.1.



***tert*-butyl 3-fluorobenzoate**[3]

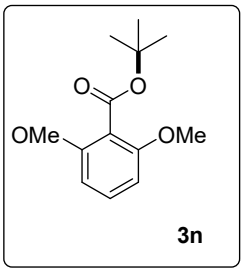
$C_{11}H_{13}FO_2$ **MW**: 196.22 g·mol^{-1}

Light yellow oil **Yield**: 102.03 mg, 52%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.78 (d, *J* = 8.0 Hz, 1H), 7.66 (d, *J* = 9.6 Hz, 1H), 7.41-7.35 (m, 1H), 7.22 (t, *J* = 8.4 Hz, 1H), 1.58 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 164.5, 164.5, 163.7, 161.2, 134.2, 134.1, 129.74, 129.66, 125.08, 125.05, 119.5, 119.3, 116.4, 116.1, 81.5, 28.0.

^{19}F NMR (376 MHz, $CDCl_3$, δ ppm): -112.9



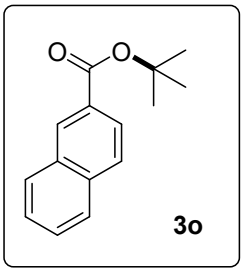
***tert*-butyl 2,3,4,5,6-pentafluorobenzoate**[7]

$C_{11}H_9F_5O_2$ **MW**: 268.18 g·mol^{-1}

Light yellow oil **Yield**: 96.54 mg, 36%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.23 (t, *J* = 8.4 Hz, 1H), 6.53 (d, *J* = 8.4 Hz, 2H), 3.81 (s, 6H), 1.58 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 165.8, 157.0, 130.3, 114.9, 104.0, 81.7, 56.0, 28.2.



***tert*-butyl 2-naphthoate**[4]

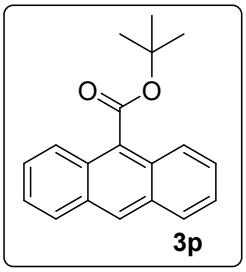
$C_{15}H_{16}O_2$ **MW**: 228.29 g·mol^{-1}

White Solid **Yield**: 189.48 mg, 83%

m.p. : 88.7-89.3 °C

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 8.54 (s, 1H), 8.02 (dd, *J* = 8.6, 1.6 Hz, 1H), 7.92 (d, *J* = 8.0 Hz, 1H), 7.83 (d, *J* = 8.4 Hz, 2H), 7.55-7.47 (m, 2H), 1.64 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 165.9, 135.3, 132.5, 130.6, 129.2, 127.87, 127.85, 127.7, 126.4, 125.3, 81.1, 28.2.



***tert*-butyl 2-naphthoate**[8]

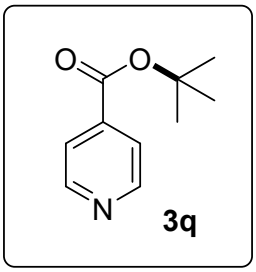
$C_{15}H_{16}O_2$ **MW**: 228.29 g·mol^{-1}

Yellow Solid **Yield**: 75.34 mg, 33%

m.p. : 156.7-157.7 °C

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 8.49 (s, 1H), 8.08 (d, *J* = 8.8 Hz, 2H), 8.01 (d, *J* = 9.2 Hz, 2H), 7.57-7.47 (m, 4H), 1.80 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 169.1, 131.0, 129.6, 128.54, 128.48, 127.9, 126.7, 125.4, 124.9, 82.9, 28.4.



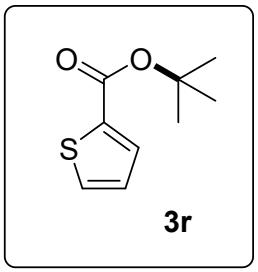
***tert*-butyl isonicotinate**[1]

$C_{10}H_{13}NO_2$ **MW**: 179.22 g·mol^{-1}

Yellow oil **Yield**: 80.65 mg, 45%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 8.75 (dd, *J* = 4.4, 1.6 Hz, 2H), 7.80 (dd, *J* = 4.4, 1.6 Hz, 2H), 1.61 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 164.1, 150.4, 139.1, 122.7, 82.3, 28.0.



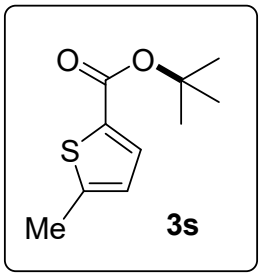
***tert*-butyl thiophene-2-carboxylate**[4]

$C_9H_{12}O_2S$ **MW**: 184.25 g·mol^{-1}

Yellow oil **Yield**: 95.81 mg, 52%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.64 (d, *J* = 4.8 Hz, 1H), 7.41 (d, *J* = 6.4 Hz, 1H), 6.98 (t, *J* = 4.2 Hz, 1H), 1.50 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 161.5, 135.9, 132.6, 131.6, 127.5, 81.7, 28.2.



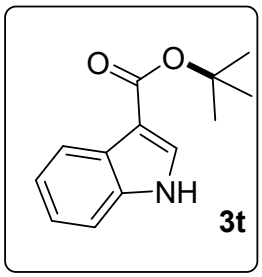
***tert*-butyl 2-methylthiazole-5-carboxylate**[9]

$C_9H_{13}NO_2S$ **MW**: 199.27 g·mol^{-1}

Light yellow oil **Yield**: 157.42 mg, 79%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.31 (d, *J* = 4.8 Hz, 1H), 6.86 (d, *J* = 4.8 Hz, 1H), 2.52 (s, 3H), 1.57 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 162.1, 144.8, 131.6, 129.1, 128.6, 81.2, 28.2, 15.8.



***tert*-butyl 1H-indole-3-carboxylate**[10]

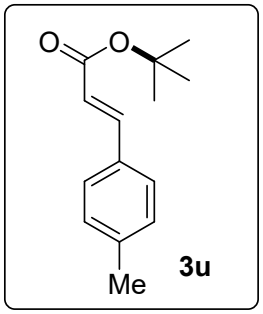
$C_{13}H_{15}NO_2$ **MW**: 217.27 g·mol^{-1}

Yellow Solid **Yield**: 91.25 mg, 42%

m.p. :79.6-82.6 °C

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 9.00 (s, 1H), 8.17-8.14 (m, 1H), 7.83 (d, *J* = 3.2 Hz, 1H), 7.39-7.37 (m, 1H), 7.27-7.22 (m, 2H), 1.65 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 165.2, 136.2, 131.1, 125.7, 122.9, 121.8, 121.4, 111.6, 110.3, 80.2, 28.5.



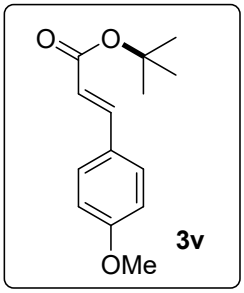
***tert*-butyl (E)-3-(p-tolyl)acrylate**[11]

$C_{14}H_{18}O_2$ **MW**: 218.30 g·mol^{-1}

Light yellow oil **Yield**: 192.10 mg, 88%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.56 (d, *J* = 16.0 Hz, 1H), 7.39 (d, *J* =8.0 Hz, 2H), 7.16 (d, *J* =8.0 Hz, 2H), 6.32 (d, *J* = 15.6 Hz, 1H), 2.34 (s, 3H), 1.53 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 166.4, 143.5, 140.2, 131.8, 129.5, 127.8, 119.0, 80.2, 28.1, 21.3.



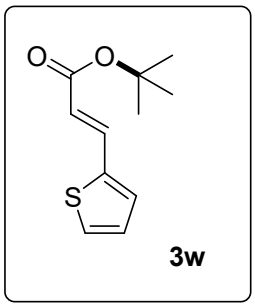
***tert*-butyl (E)-3-(4-methoxyphenyl)acrylate**[12]

$C_{14}H_{18}O_3$ **MW**: 234.30 g·mol^{-1}

Light yellow oil **Yield**: 185.10 mg, 79%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.54 (d, *J* = 16.0 Hz, 1H), 7.45 (d, *J* =8.8 Hz, 2H), 6.88 (d, *J* =8.8 Hz, 2H), 6.24 (d, *J* = 16.0 Hz, 1H), 3.81 (s, 3H), 1.53 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 166.6, 161.0, 143.1, 129.5, 127.4, 117.6, 114.2, 80.1, 55.2, 28.1.



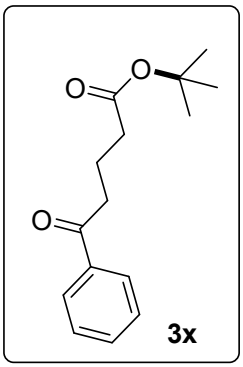
***tert*-butyl (E)-3-(thiophen-2-yl)acrylate**[13]

$C_{11}H_{14}O_2S$ **MW**: 210.29 g·mol^{-1}

Brown oil **Yield**: 136.69 mg, 65%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.68 (d, *J* = 16.0 Hz, 1H), 7.33 (d, *J* = 5.2 Hz, 1H), 7.21 (d, *J* = 4.0 Hz, 1H), 7.02 (t, *J* = 3.4 Hz, 1H), 6.17 (d, *J* = 15.6 Hz, 1H), 1.52 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 166.0, 139.7, 136.0, 130.4, 127.9, 118.9, 80.4, 28.1.



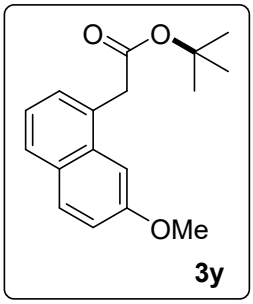
***tert*-butyl 5-oxo-5-phenylpentanoate**[14]

$C_{15}H_{20}O_3$ **MW**: 248.32 g·mol^{-1}

Yellow oil **Yield**: 129.13 mg, 52%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.96 (d, *J* = 6.8 Hz, 2H), 7.55 (t, *J* = 7.2 Hz, 1H), 7.46 (t, *J* = 8.0 Hz, 2H), 3.04 (t, *J* = 7.6 Hz, 2H), 2.34 (t, *J* = 7.2 Hz, 2H), 2.07-2.00 (m, 2H), 1.45 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 199.5, 172.5, 136.7, 132.9, 128.5, 127.9, 80.2, 37.4, 34.6, 28.0, 19.5.



***tert*-butyl 2-(7-methoxynaphthalen-1-yl)acetate**

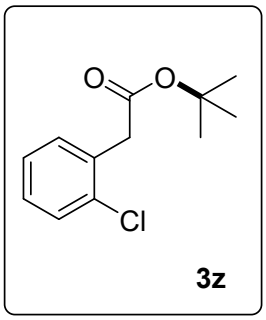
$C_{17}H_{20}O_3$ **MW**: 272.34 g·mol^{-1}

Yellow oil **Yield**: 223.32 mg, 82%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.72 (d, *J* = 8.8 Hz, 1H), 7.67 (d, *J* = 8.0 Hz, 1H), 7.34 (d, *J* = 5.6 Hz, 1H), 7.28-7.24 (m, 2H), 7.13 (dd, *J* = 8.8, 2.4 Hz, 1H), 3.90 (s, 5H), 1.40 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 170.9, 157.8, 133.208, 130.1, 129.9, 129.1, 128.3, 127.4, 123.1, 118.2, 102.3, 80.8, 55.1, 40.9, 27.9.

HRMS (ESI): calculated for $C_{17}H_{20}NaO_3$ ($[M+Na]^+$): 295.1310; found 295.1305.



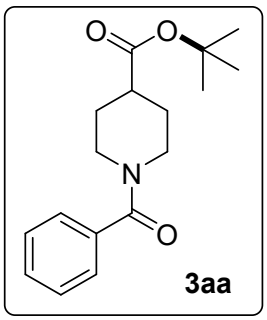
***tert*-butyl 2-(2-chlorophenyl)acetate**[15]

$C_{12}H_{15}ClO_2$ **MW**: 226.70 g·mol^{-1}

Light yellow oil **Yield**: 163.22 mg, 72%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.29-7.26 (m, 1H), 7.19-7.16 (m, 1H), 7.15-7.01 (m, 2H), 3.59 (s, 2H), 1.36 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 169.8, 134.4, 133.0, 131.3, 129.3, 128.3, 126.7, 81.0, 40.3, 27.9.



***tert*-butyl 1-benzoylpiperidine-4-carboxylate**

$C_{17}H_{23}NO_3$ **MW**: 289.38 g·mol^{-1}

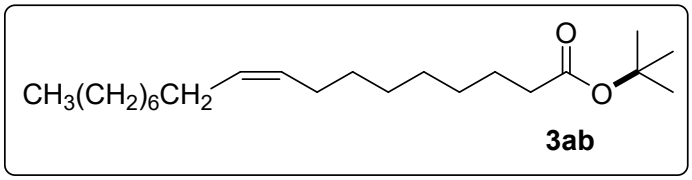
White Solid **Yield**: 251.76 mg, 87%

m.p. :63.3-65.7 °C

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.37 (s, 5H), 4.89 (s, 1H), 3.70 (s, 1H), 3.01 (s, 2H), 2.48-2.43 (m, 1H), 2.00-1.96 (m, 1H), 1.77-1.58 (m, 3H), 1.43 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 173.3, 170.2, 135.9, 129.4, 128.3, 126.6, 80.4, 41.7, 27.9.

HRMS (ESI): calculated for $C_{17}H_{23}NNaO_3$ ($[M+Na]^+$): 312.1576; found 312.1570.



***tert*-butyl oleate**

$C_{22}H_{42}O_2$

MW: 338.58 g·mol^{-1}

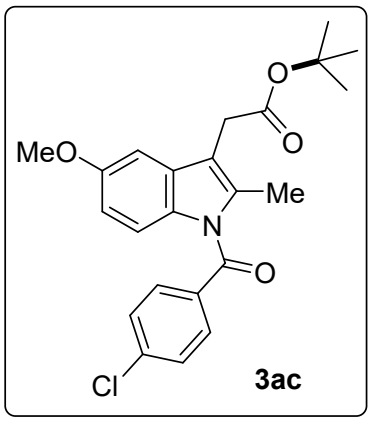
Light yellow oil

Yield: 287.79 mg, 85%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 5.38-5.30 (m, 2H), 2.20 (t, J = 7.6 Hz, 2H), 2.03-1.99 (m, 4H), 1.61-1.54 (m, 2H), 1.44 (s, 9H), 1.35-1.27 (m, 20H), 0.90-0.86 (m, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 173.2, 129.9, 129.7, 79.7, 35.5, 31.9, 29.7, 29.6, 29.5, 29.3, 29.2, 29.1, 29.0, 28.0, 27.2, 27.1, 25.0, 22.6, 14.0.

HRMS (ESI): calculated for $C_{22}H_{42}NaO_2$ ($[M+Na]^+$): 361.3083; found 361.3077.



***tert*-butyl 2-(1-(4-chlorobenzoyl)-5-methoxy-2-methyl-1H-indol-3-yl)acetate**[21]

$C_{23}H_{24}ClNO_4$ **MW**: 413.90 g·mol^{-1}

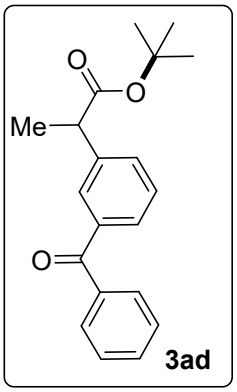
White Solid **Yield**: 310.43 mg, 75%

m.p. :107.0-107.6 °C

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.65 (d, J = 8.4 Hz, 2H), 7.46 (d, J = 8.4 Hz, 2H), 6.70 (d, J = 2.8 Hz, 1H), 6.89 (d, J = 5.2 Hz, 1H), 6.66 (dd, J = 8.8, 2.8 Hz, 1H), 3.83 (s, 3H), 3.57 (s, 2H), 2.37 (s, 3H), 1.45 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 170.1, 168.2, 155.9,

139.1, 135.6, 133.9, 131.1, 130.7, 130.7, 129.0, 114.9, 113.3, 111.5, 101.2, 81.1, 55.6, 31.6, 28.0, 13.3.



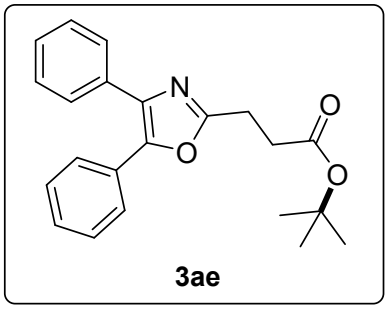
***tert*-butyl 2-(3-benzoylphenyl)propanoate**[22]

$C_{20}H_{22}O_3$ **MW**: 310.39 g·mol^{-1}

Light yellow oil **Yield**: 203.19 mg, 86%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.78 (d, *J* = 6.8 Hz, 2H), 7.73 (s, 1H), 7.66 (d, *J* = 7.6 Hz, 1H), 7.58-7.52 (m, 2H), 7.48-7.40 (m, 3H), 3.71-3.65 (m, 1H), 1.46 (d, *J* = 7.2 Hz, 2H), 1.39 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 196.5, 173.2, 141.3, 137.6, 137.4, 132.3, 131.4, 129.9, 129.1, 128.6, 128.3, 128.2, 80.7, 46.2, 27.8, 18.4



***tert*-butyl 3-(4,5-diphenyloxazol-2-yl)propanoate**[24]

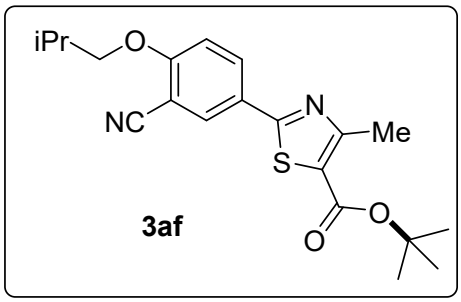
$C_{22}H_{23}NO_3$ **MW**: 349.43 g·mol^{-1}

White Solid **Yield**: 304.00 mg, 87%

m.p. :113.7-113.9 °C

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.53 (d, *J* = 6.8 Hz, 2H), 7.46 (d, *J* = 6.4 Hz, 2H), 7.26-7.14 (m, 6H), 3.03 (t, *J* = 6.0 Hz, 2H), 2.71 (t, *J* = 7.6 Hz, 2H), 1.35 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 171.0, 161.9, 145.1, 134.9, 132.4, 128.9, 128.5, 128.4, 128.2, 127.9, 127.7, 126.3, 80.6, 32.2, 27.9, 23.5.



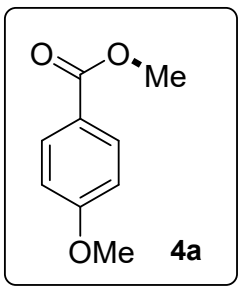
***tert*-butyl 2-(3-ethynyl-4-isobutoxyphenyl)-4-methylthiazole-5-carboxylate**[23]

$C_{21}H_{25}NO_3S$ **MW**: 371.50 g·mol^{-1}

Yellow oil **Yield**: 252.62 mg, 68%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 8.10 (d, *J* = 2.0 Hz, 1H), 8.04 (dd, *J* = 8.8, 2.0 Hz, 1H), 6.97 (d, *J* = 8.8 Hz, 1H), 3.86 (d, *J* = 6.4 Hz, 2H), 2.69 (s, 3H), 2.21-2.11 (m, 1H), 1.56 (s, 9H), 1.05 (d, *J* = 6.4 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 166.3, 162.2, 161.2, 160.0, 132.4, 131.8, 126.0, 123.5, 115.3, 112.5, 102.7, 82.4, 75.5, 28.1, 28.0, 18.9, 17.3.



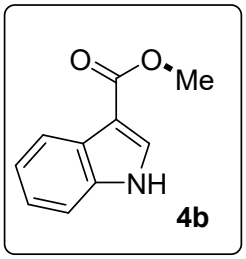
methyl 4-methoxybenzoate[16]

$C_9H_{10}O_3$ **MW**: 166.18 g·mol^{-1}

Colorless oil **Yield**: 96.38 mg, 58%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.99 (d, *J* = 8.8 Hz, 2H), 6.91 (d, *J* = 8.8 Hz, 2H), 3.88 (s, 3H), 3.85 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 166.8, 163.2, 131.5, 122.5, 113.5, 55.3, 51.8.



methyl 1H-indole-3-carboxylate[17]

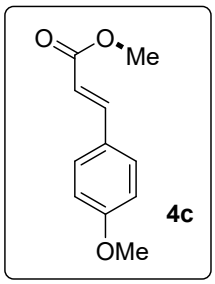
$C_{10}H_9NO_2$ **MW**: 175.19 g·mol^{-1}

White Solid **Yield**: 168.18 mg, 96%

m.p. :150.7-150.9 °C

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 8.96 (s, 1H), 8.21-8.17 (m, 1H), 7.90 (d, *J* = 3.2 Hz, 1H), 7.43-7.39 (m, 1H), 7.30-7.24 (m, 2H), 3.93 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 165.9, 136.1, 131.2, 125.7, 123.2, 122.0, 121.4, 111.6, 108.5, 51.1.



methyl (E)-3-(4-methoxyphenyl)acrylate[18]

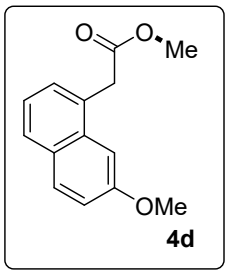
$C_{11}H_{12}O_3$ **MW**: 192.21 g·mol^{-1}

White Solid **Yield**: 76.88 mg, 40%

m.p. :89.1-89.9 °C

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.65 (d, *J* = 16.0 Hz, 1H), 7.47 (d, *J* =8.8 Hz, 2H), 6.90 (d, *J* =8.8 Hz, 2H), 6.31 (d, *J* = 16.0 Hz, 1H), 3.83 (s, 3H), 3.79 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 167.7, 161.3, 144.5, 129.7, 127.0, 115.2, 114.2, 55.3, 51.5.



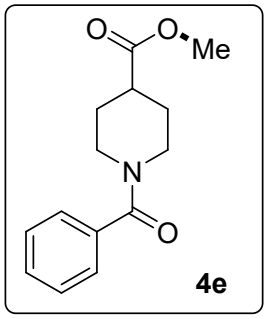
methyl 2-(7-methoxynaphthalen-1-yl)acetate[19]

$C_{14}H_{14}O_3$ **MW**: 230.26 g·mol^{-1}

Yellow oil **Yield**: 168.09 mg, 73%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.73 (d, *J* = 8.8 Hz, 1H), 7.69 (d, *J* = 8.0 Hz, 1H), 7.36 (d, *J* = 6.4 Hz, 1H), 7.29-7.26 (m, 2H), 7.14 (dd, *J* = 8.8, 2.4 Hz, 1H), 4.00 (s, 2H), 3.90 (s, 3H), 3.65 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 172.0, 157.9, 133.1, 130.1, 129.1, 129.1, 128.5, 127.7, 123.1, 118.2, 102.3, 55.2, 52.0, 39.4.



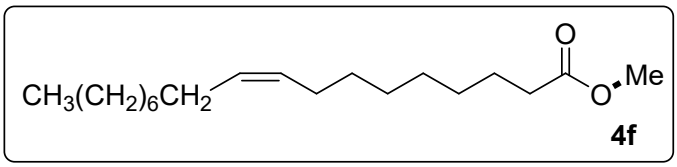
methyl 1-benzoylpiperidine-4-carboxylate[20]

$C_{14}H_{17}NO_3$ **MW**: 247.29 g·mol^{-1}

Light yellow oil **Yield**: 165.68 mg, 67%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.42-7.31 (m, 5H), 4.54 (s, 1H), 3.76-3.70 (m, 4H), 3.04 (s, 2H), 2.63-2.56 (m, 1H), 2.03-1.72 (m, 4H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 174.4, 170.2, 135.8, 129.4, 128.3, 126.6, 51.7, 40.7.



methyl oleate

$C_{19}H_{36}O_2$

MW: 296.50 g·mol^{-1}

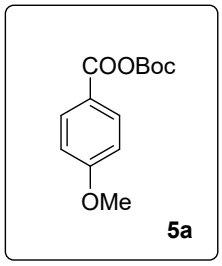
Colorless oil

Yield: 254.99 mg, 86%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 5.38-5.31 (m, 2H), 3.66 (s, 3H), 2.30 (t, *J* = 7.6 Hz, 2H), 2.03-1.99 (m, 4H), 1.66-1.58 (m, 2H), 1.35-1.27 (m, 20H), 0.90-0.86 (m, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 174.1, 129.9, 129.6, 51.3, 34.0, 31.8, 29.7, 29.6, 29.5, 29.27, 29.25, 29.09, 29.05, 29.01, 27.13, 27.07, 24.9, 22.6, 14.0.

HRMS (ESI): calculated for $C_{19}H_{36}KO_2$ ($[M+K]^+$): 335.2352; found 335.2347.



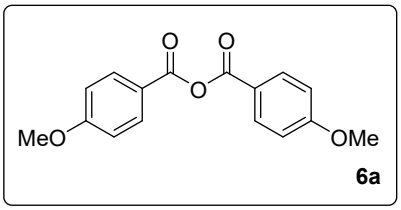
(*tert*-butyl carbonic) 4-methoxybenzoic anhydride[25]

$C_{13}H_{16}O_5$ **MW**: 252.27 g·mol^{-1}

Colorless oil

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 8.01 (d, *J* = 9.2 Hz, 2H), 6.94 (d, *J* = 8.8 Hz, 2H), 3.87 (s, 3H), 1.59 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm):164.4, 161.5, 147.5, 132.7, 120.2, 113.9, 85.3, 55.5, 27.5.



4-methoxybenzoic anhydride[26]

$C_{16}H_{14}O_5$ **MW**:286.28 g·mol^{-1}

White Solid m.p. :94.2-95.1 °C

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm):8.10 (d, *J* = 8.8 Hz, 4H), 6.99 (d, *J* = 8.8 Hz, 4H), 3.90 (s, 6H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm):164.5, 162.3, 132.8, 121.2, 114.1, 55.6.

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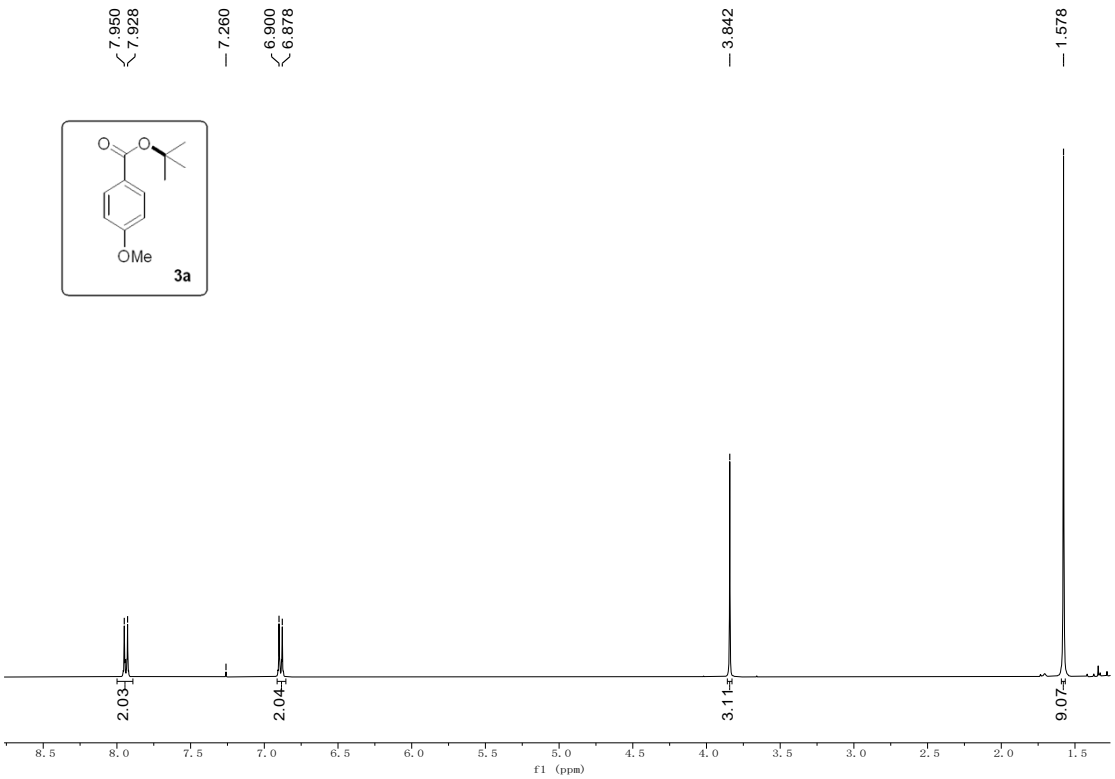
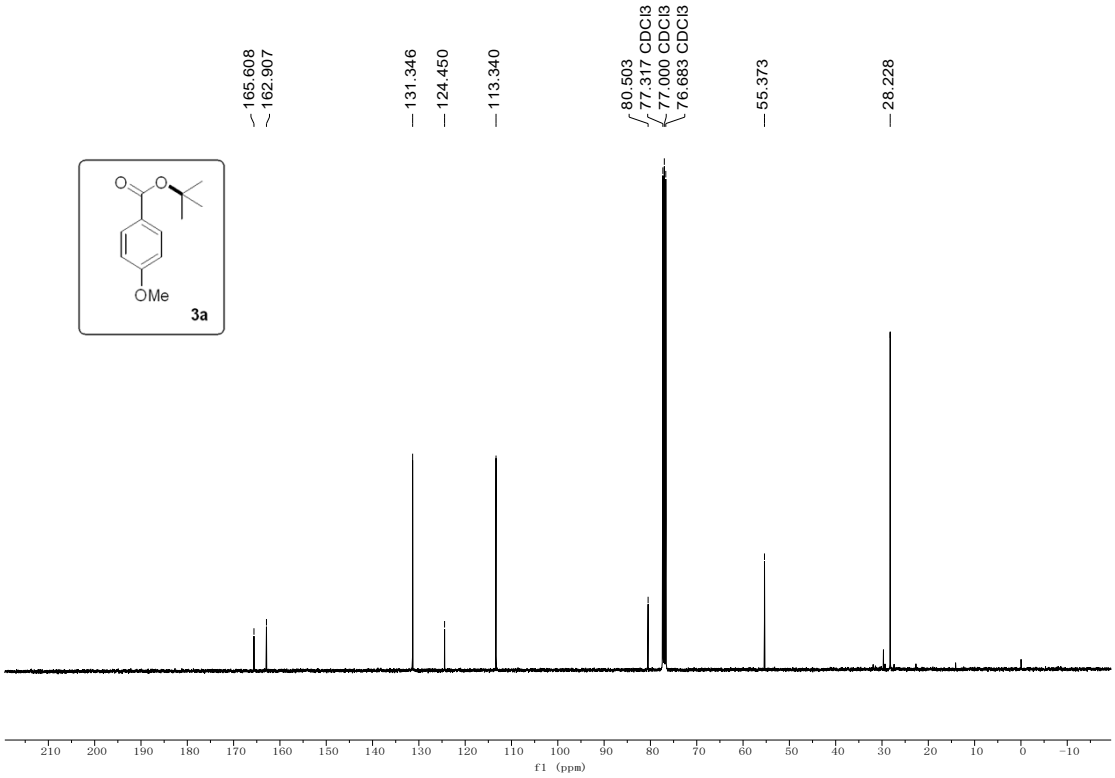
9 Copies of the 1H NMR, 13C NMR



^{1}H NMR (400 MHz, $CDCl_3$) of product **3a**



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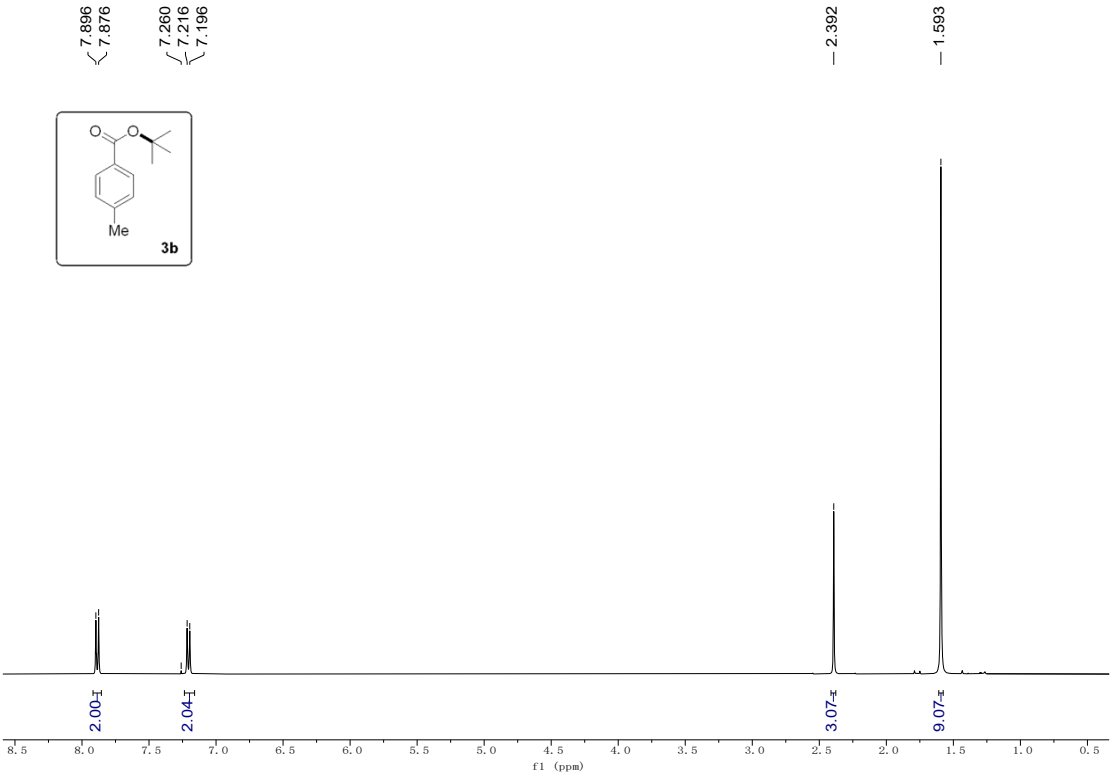
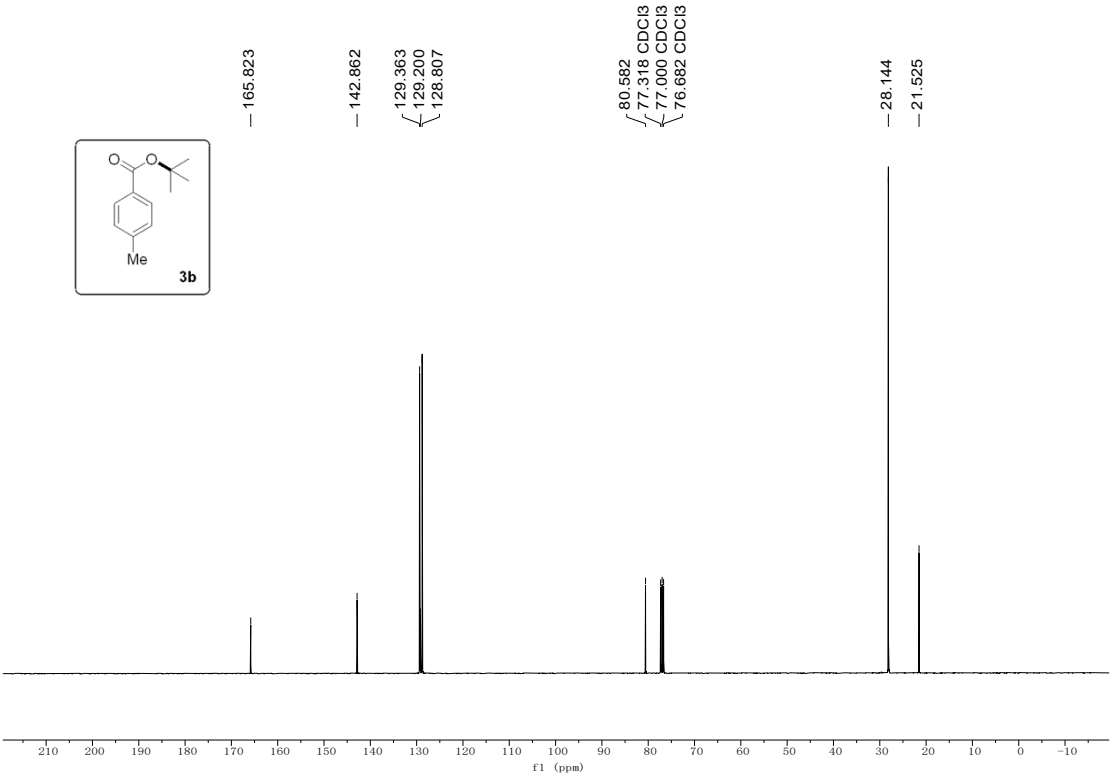


^{1}H NMR (400 MHz, $CDCl_3$) of product **3b**



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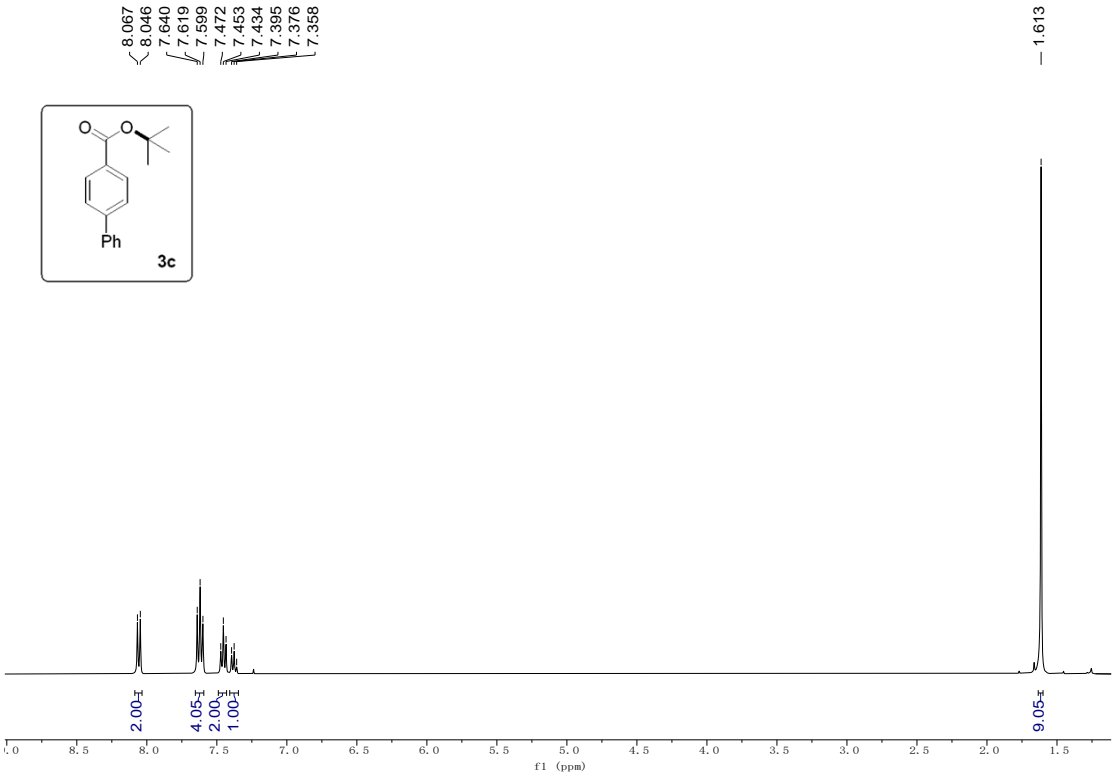
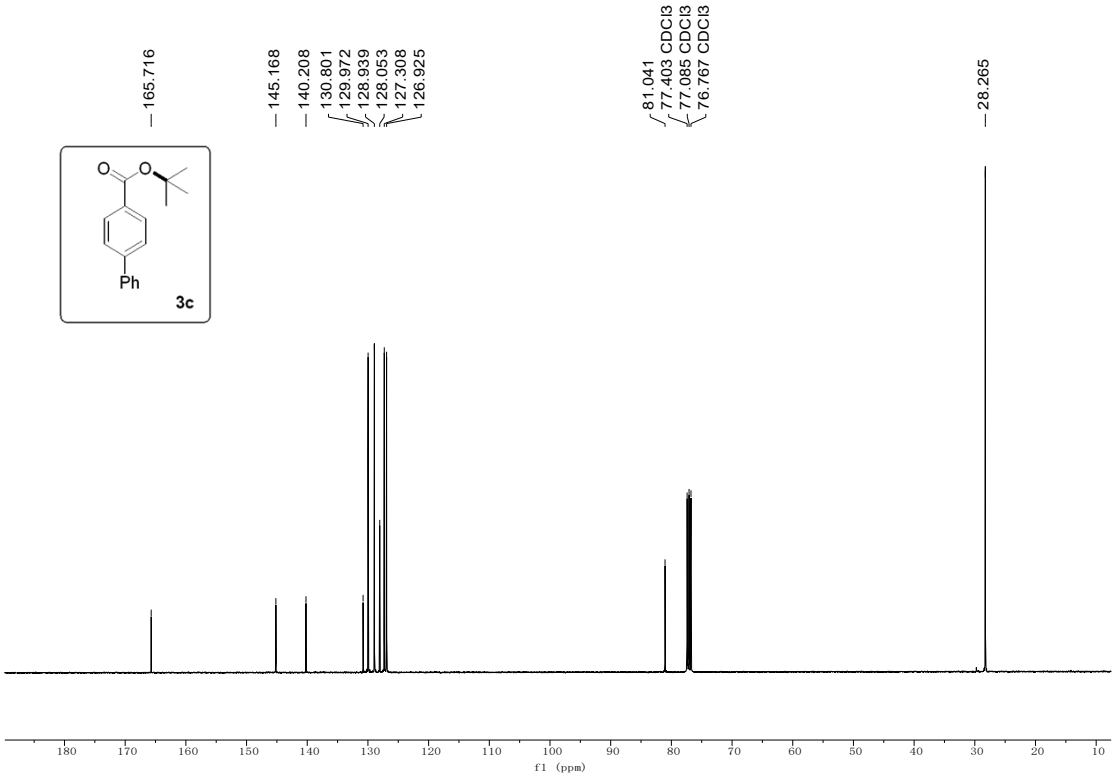


^{1}H NMR (400 MHz, $CDCl_3$) of product **3c**



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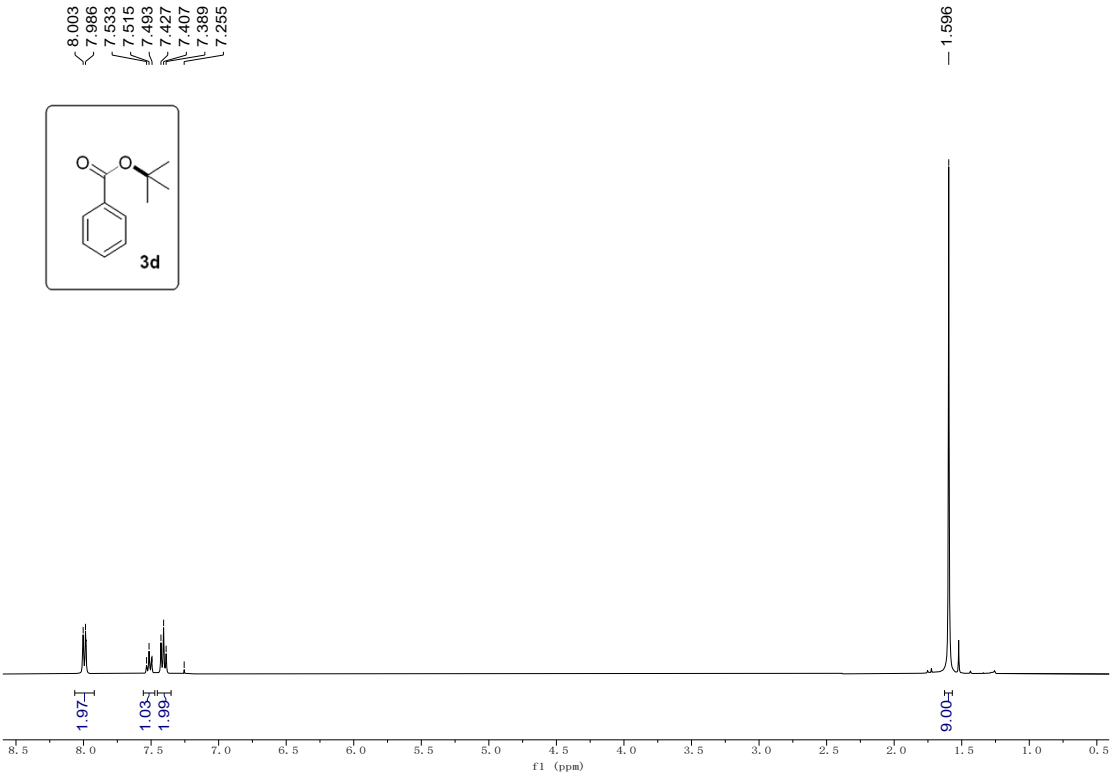
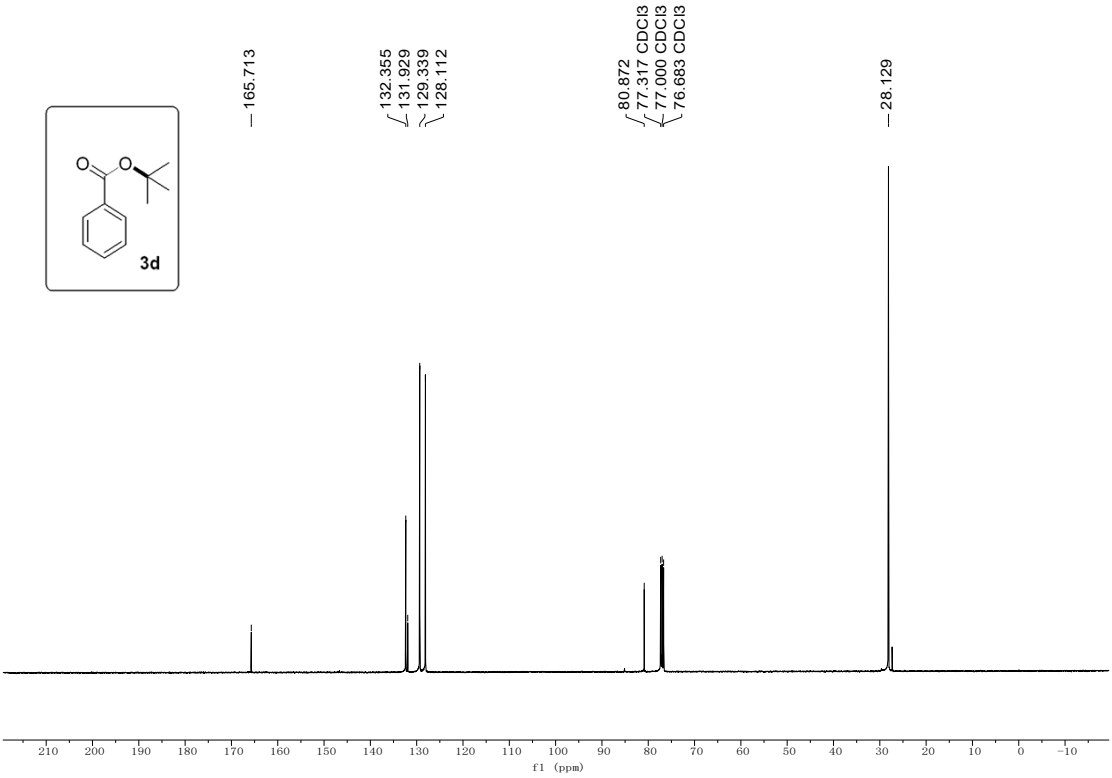


^{1}H NMR (400 MHz, $CDCl_3$) of product **3d**



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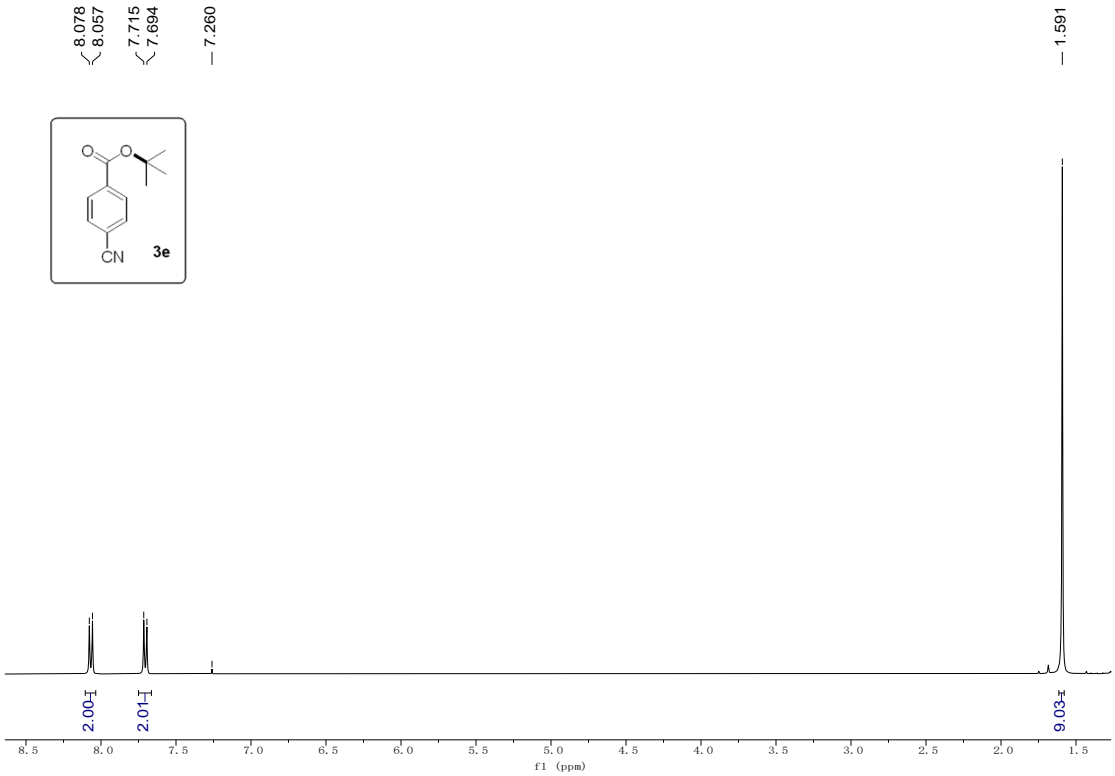

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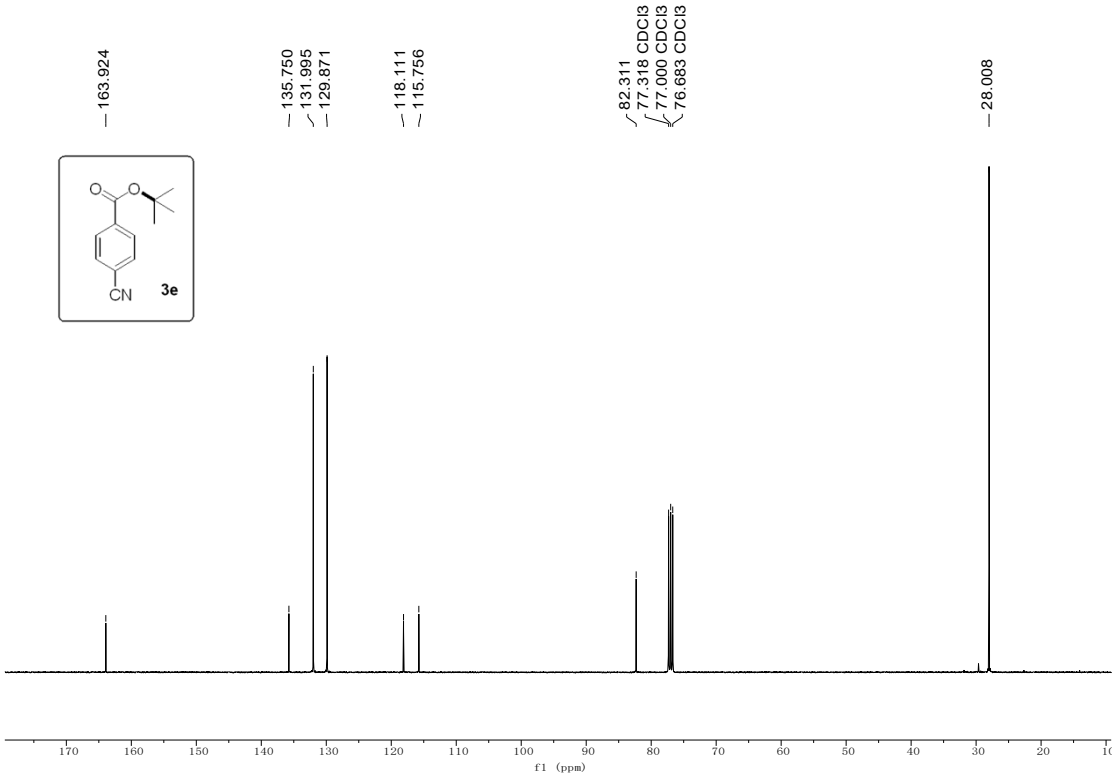

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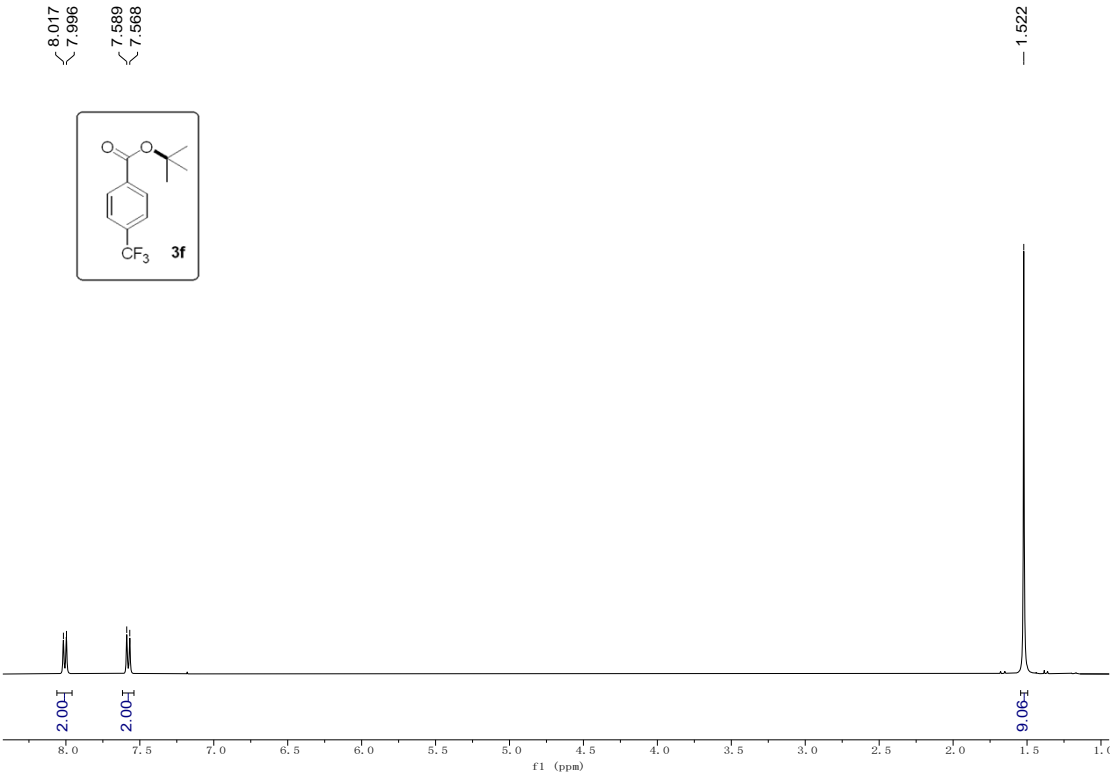

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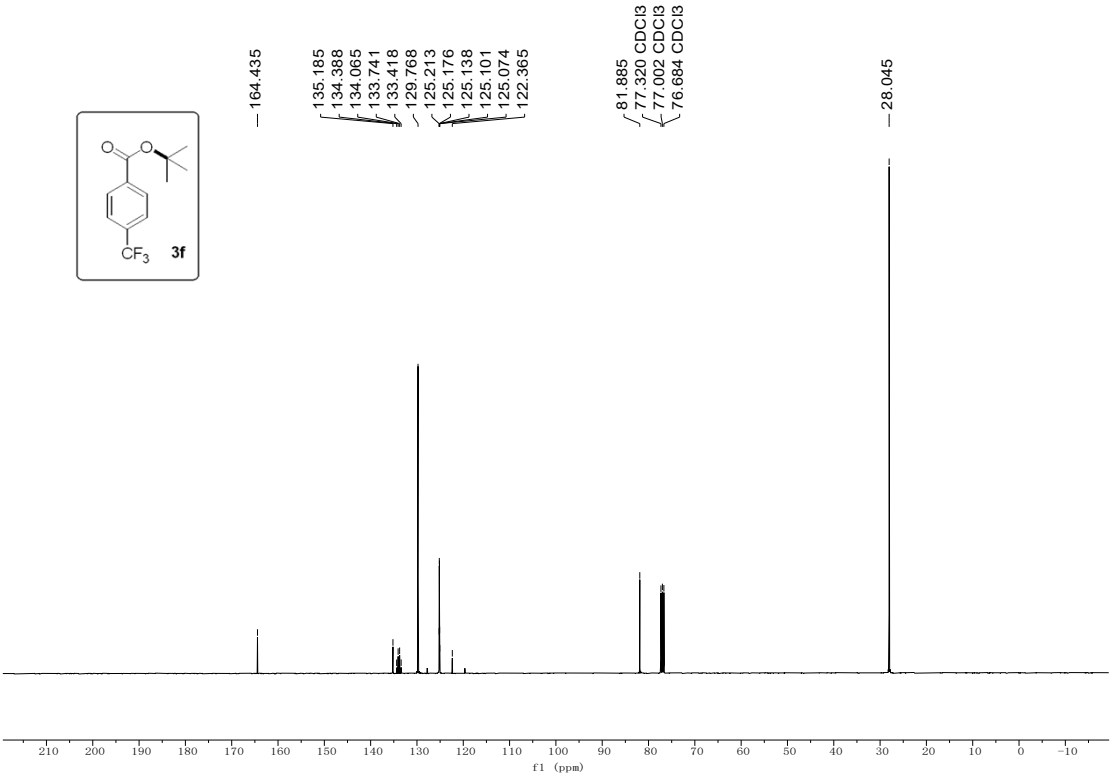

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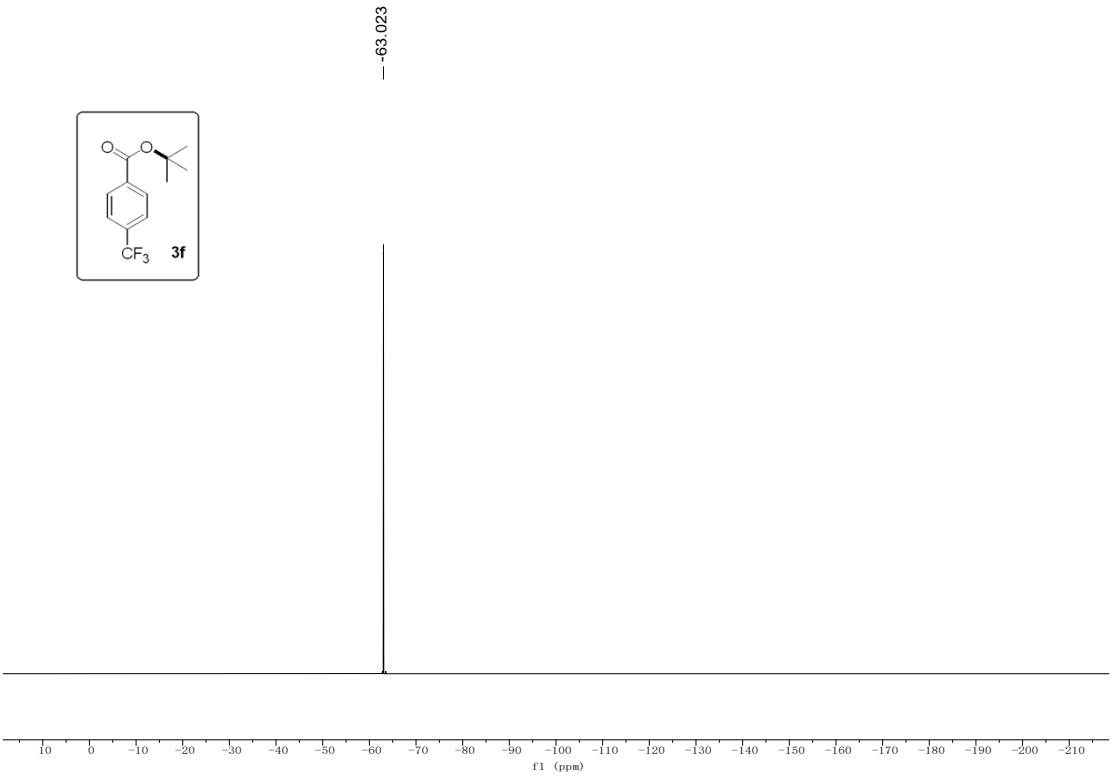
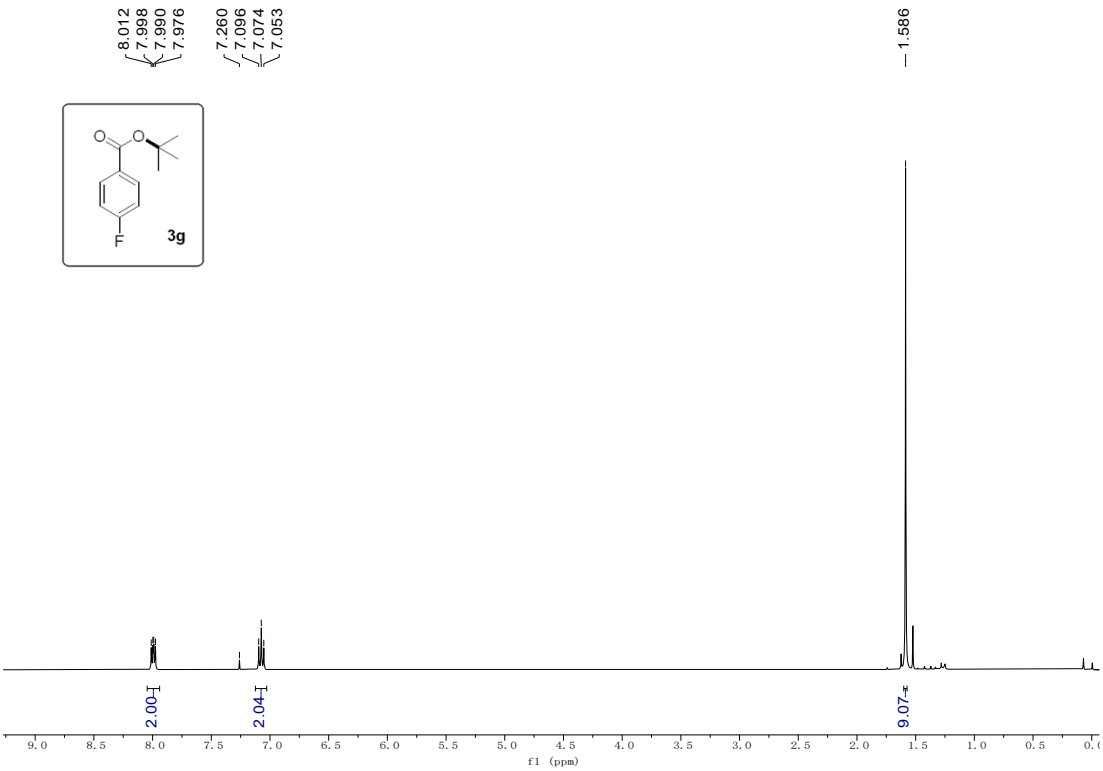
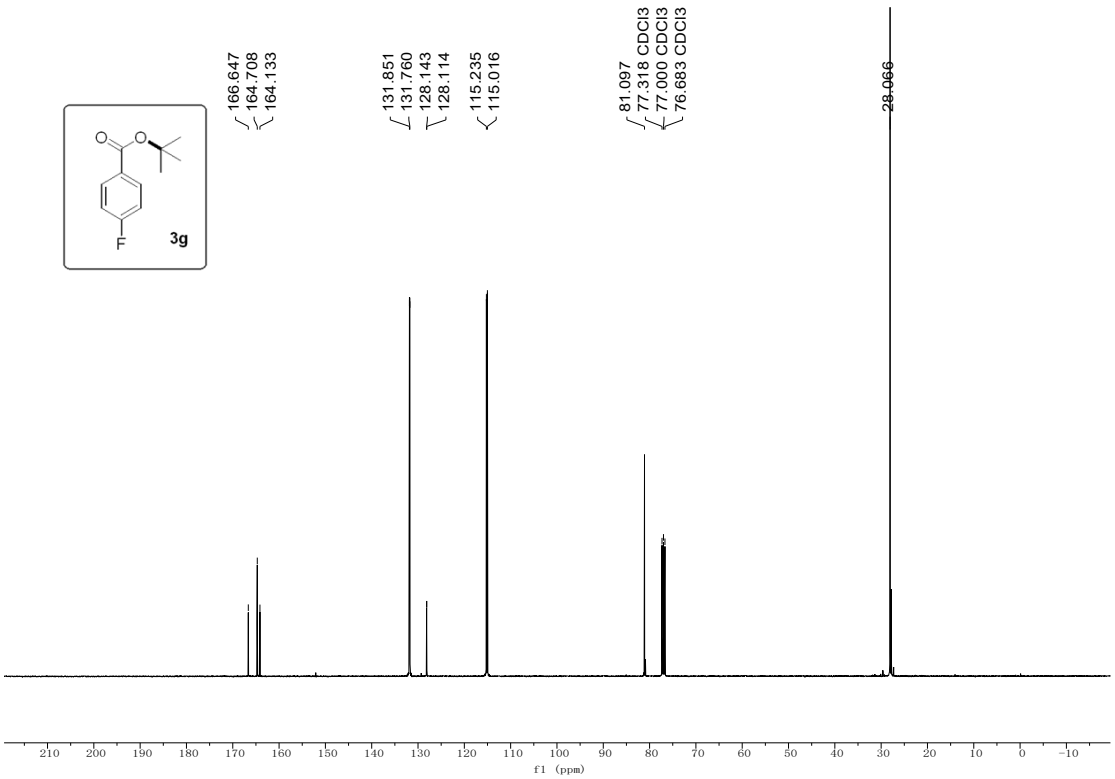


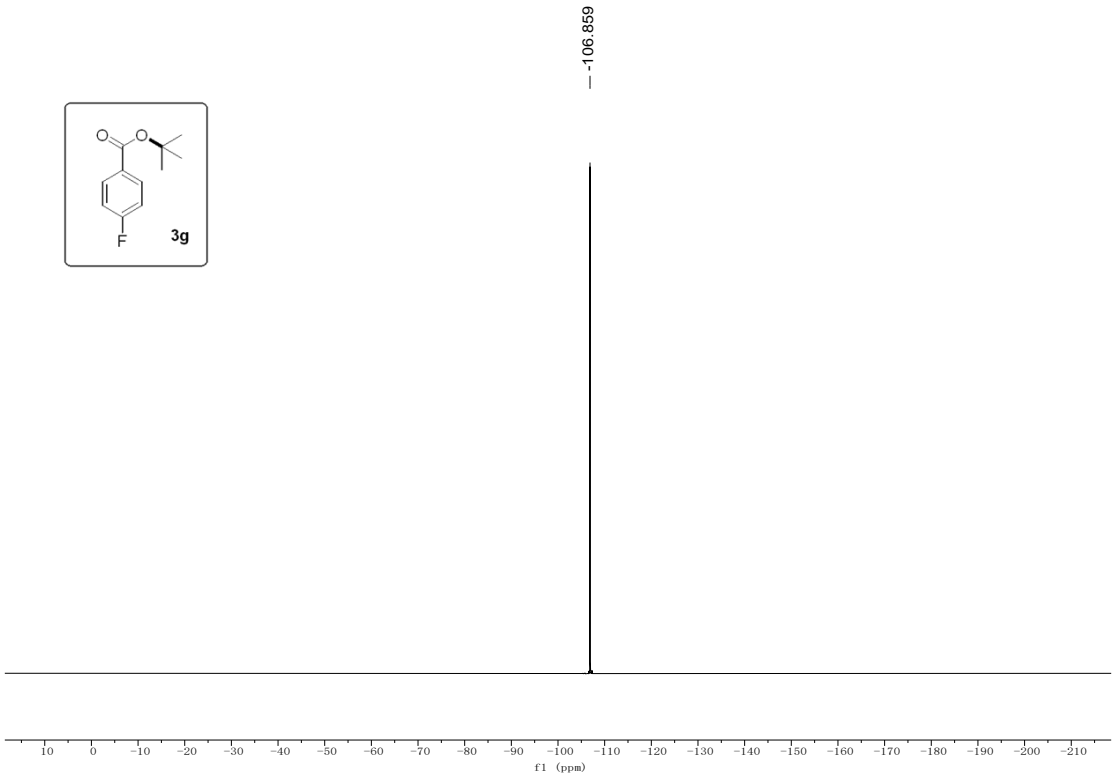
^{19}F NMR (376 MHz, $CDCl_3$) of product **3f**



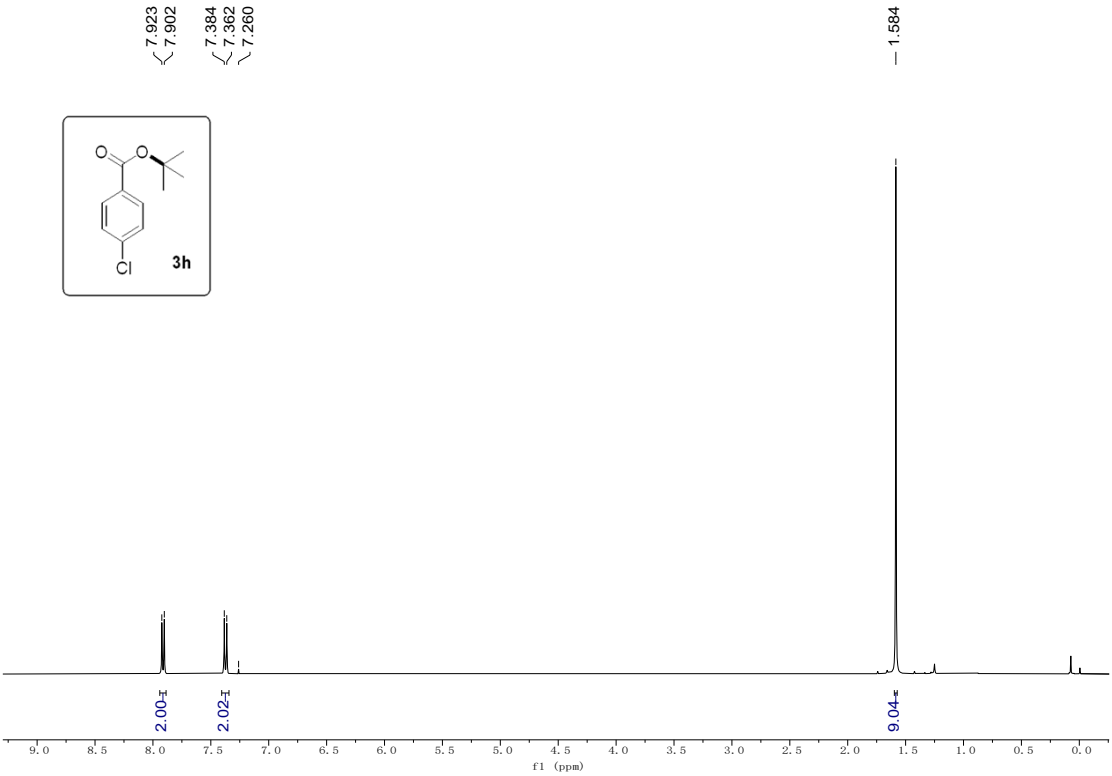
^{1}H NMR (400 MHz, $CDCl_3$) of product **3g**



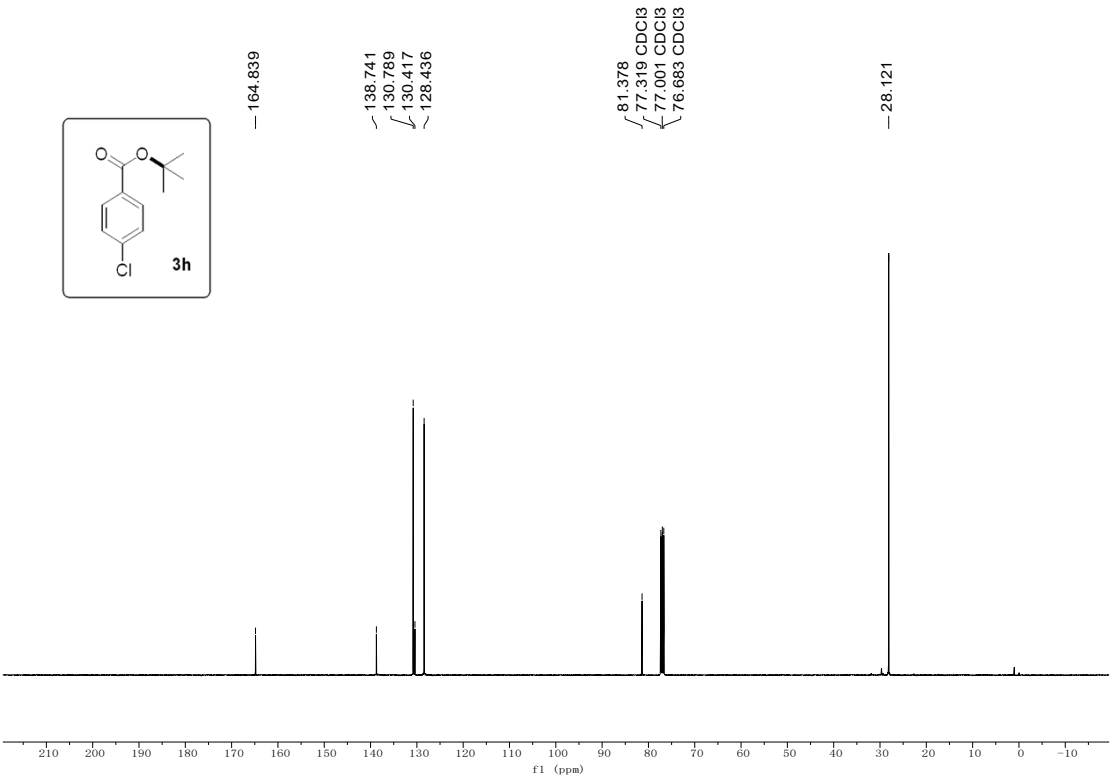
^{13}C NMR (100 MHz, $CDCl_3$) of product **3g**



^{19}F NMR (376 MHz, $CDCl_3$) of product **3g**



^{1}H NMR (400 MHz, $CDCl_3$) of product **3h**



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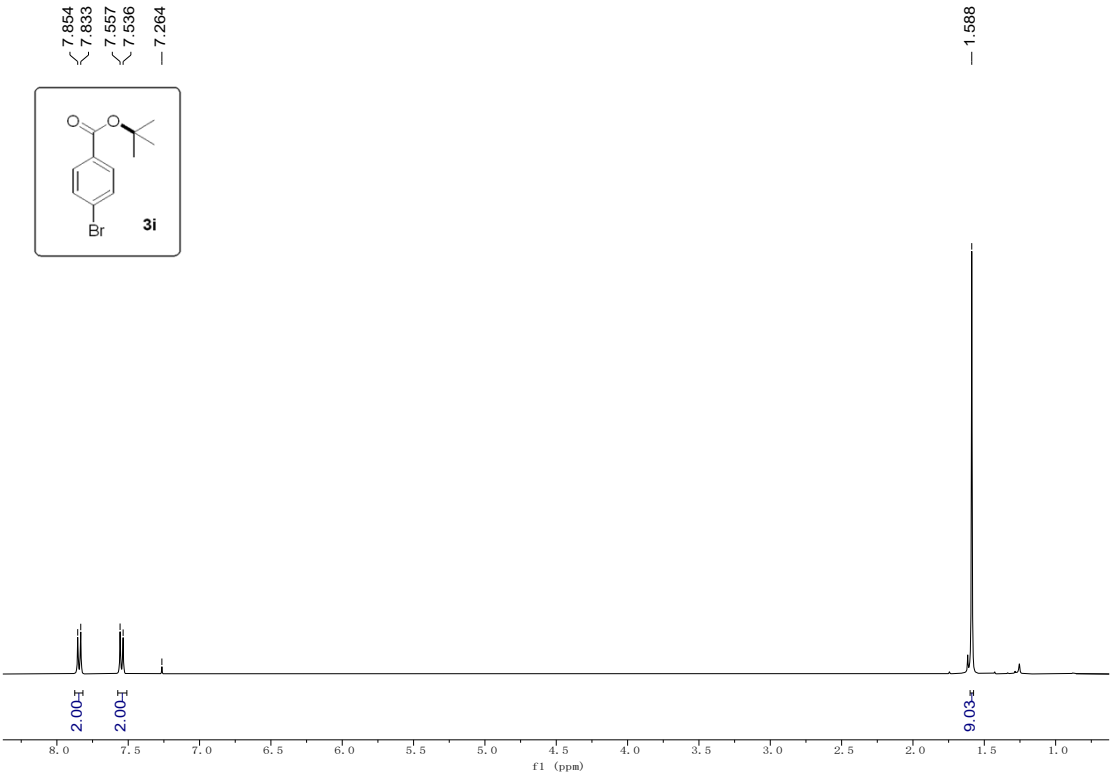
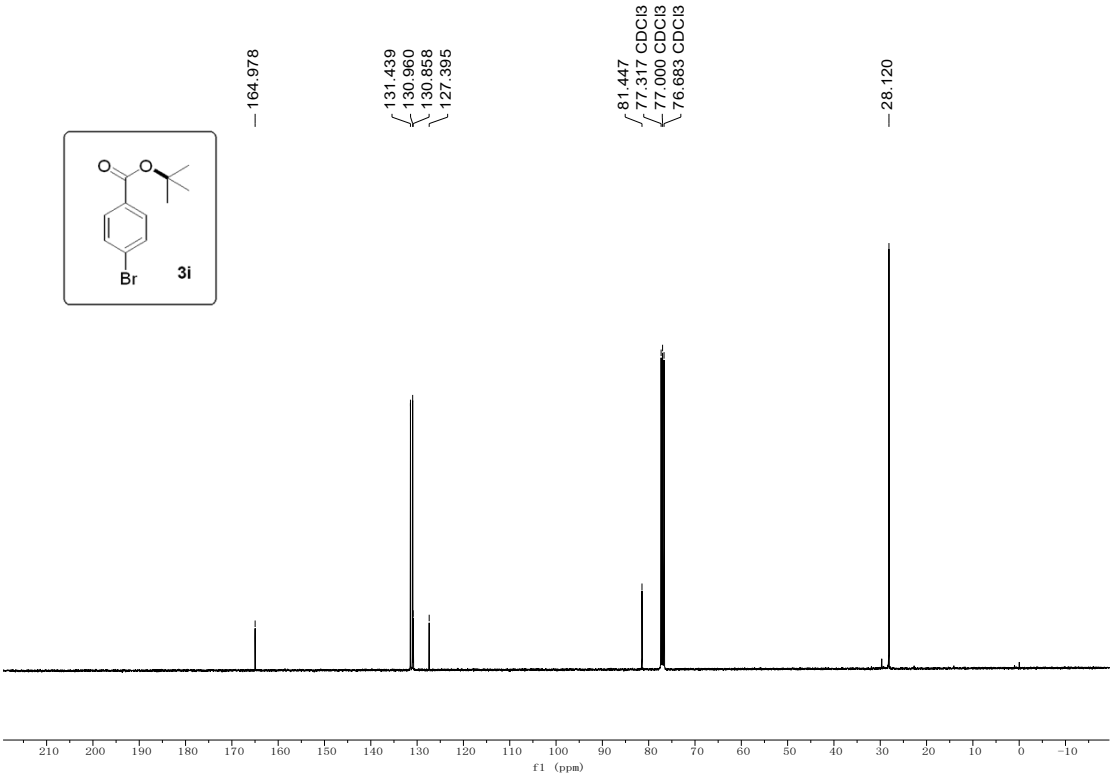


^{1}H NMR (400 MHz, $CDCl_3$) of product **3i**



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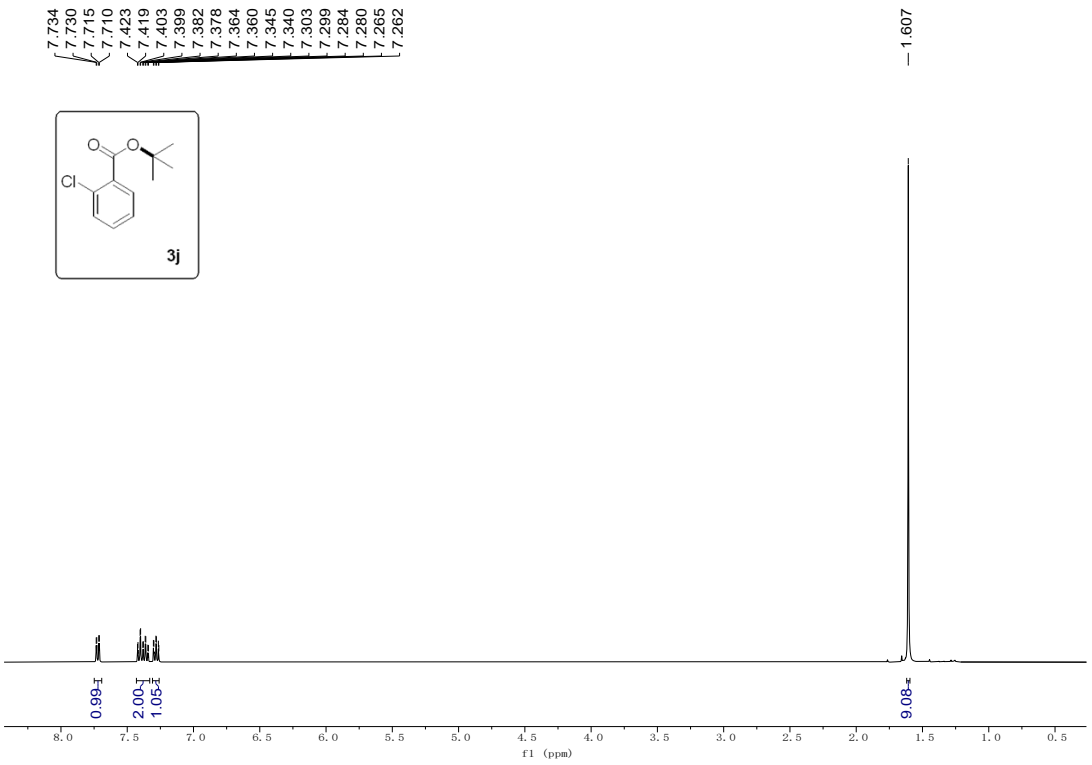

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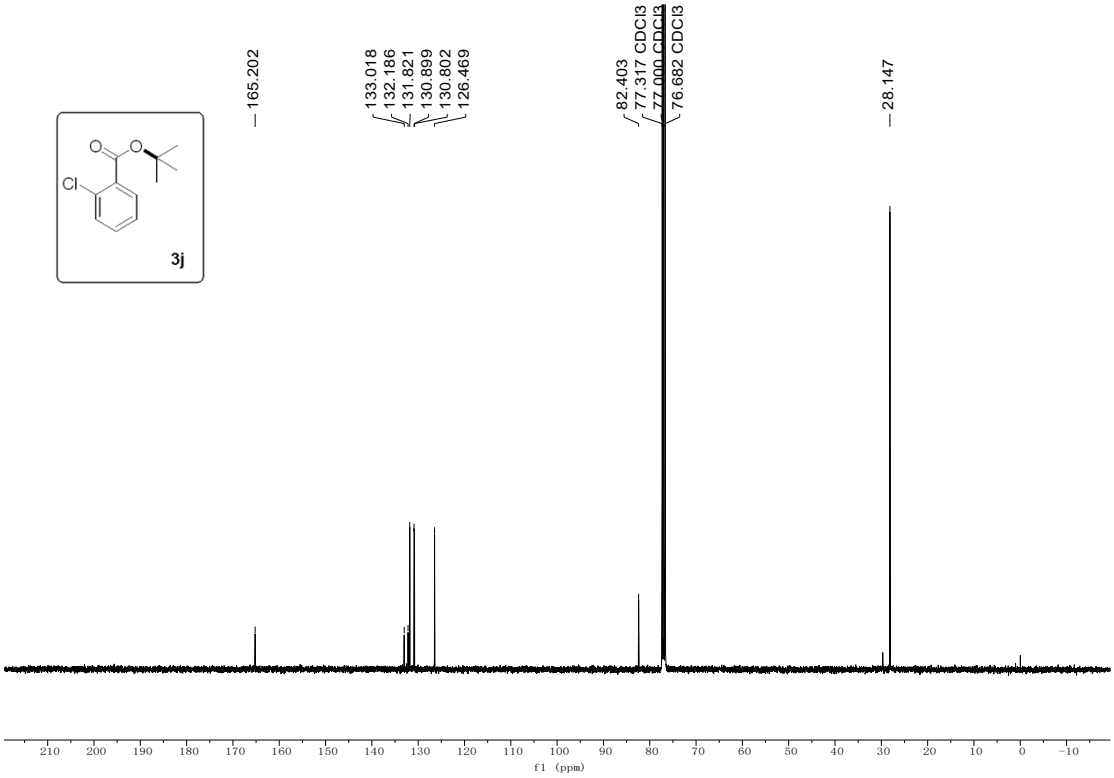

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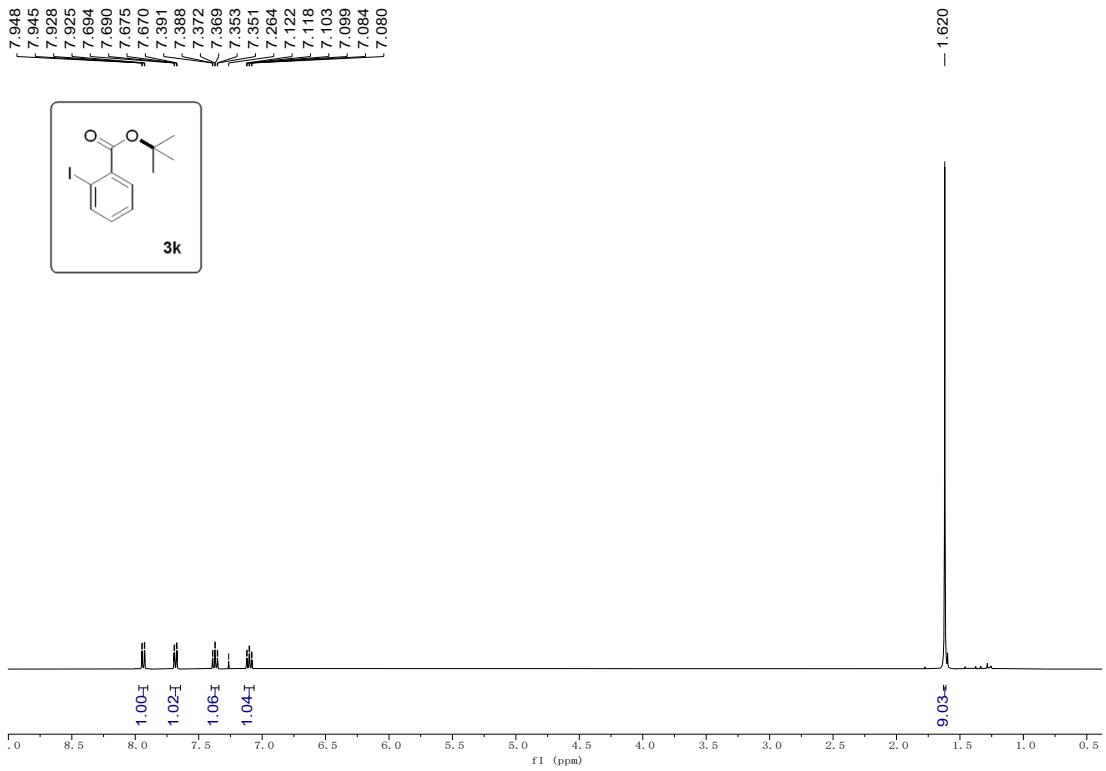

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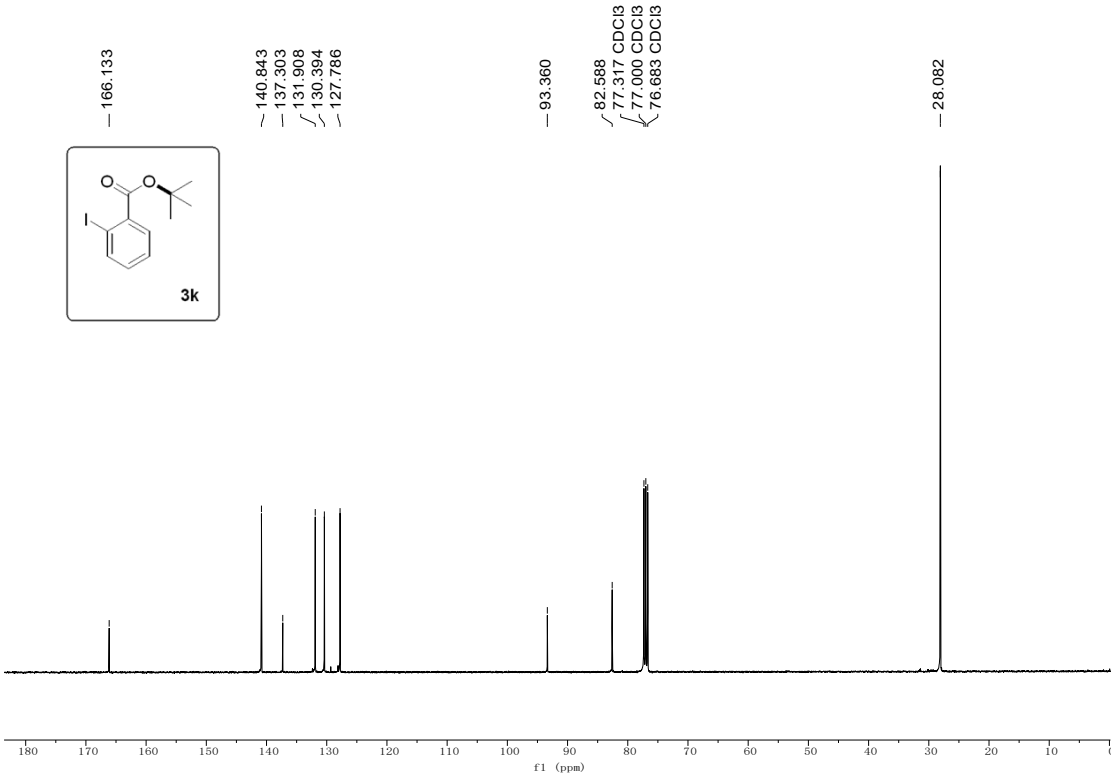

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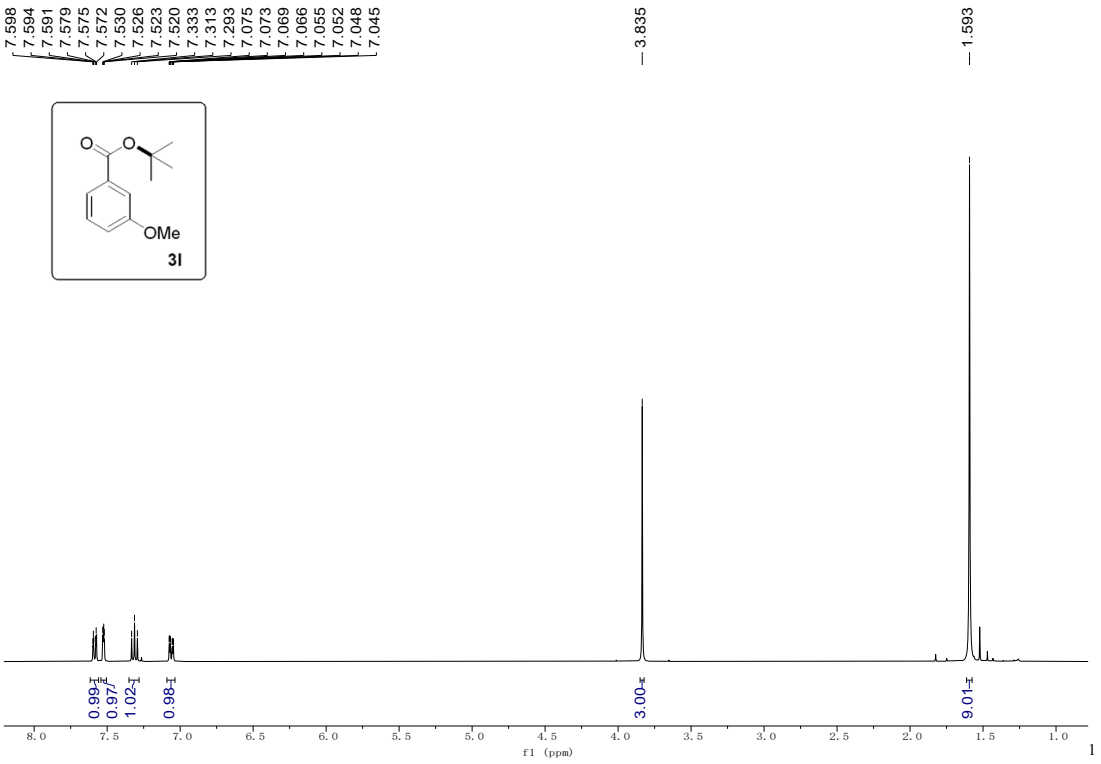
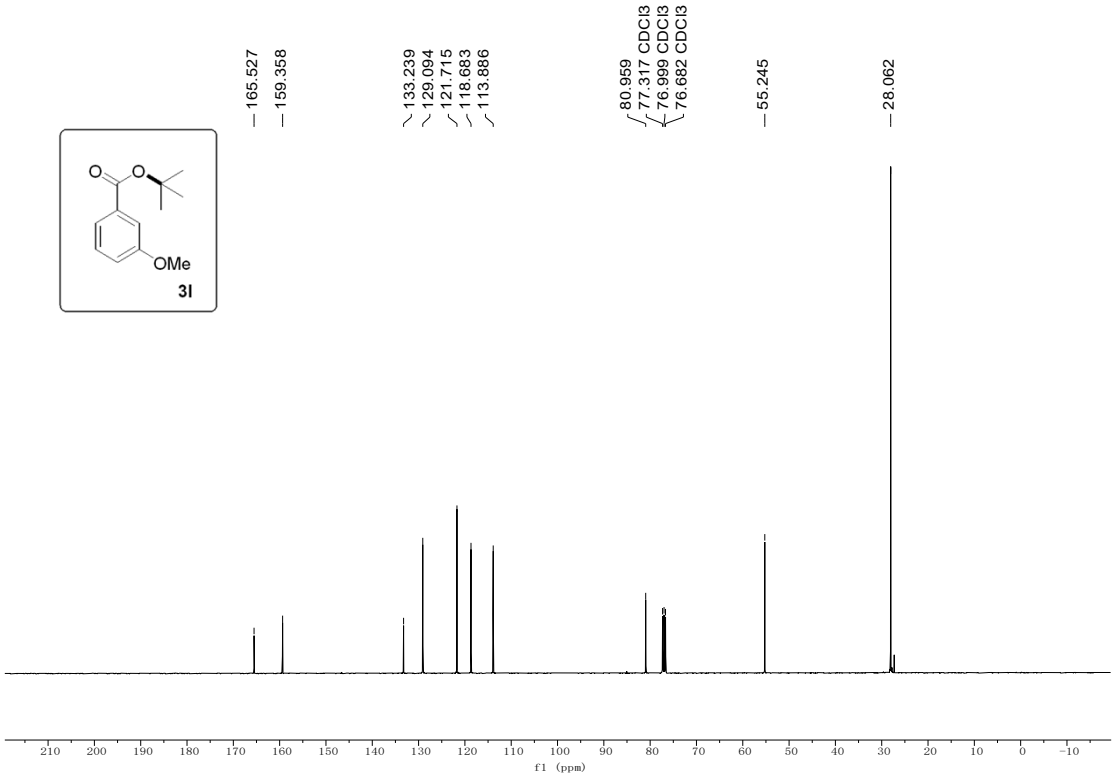
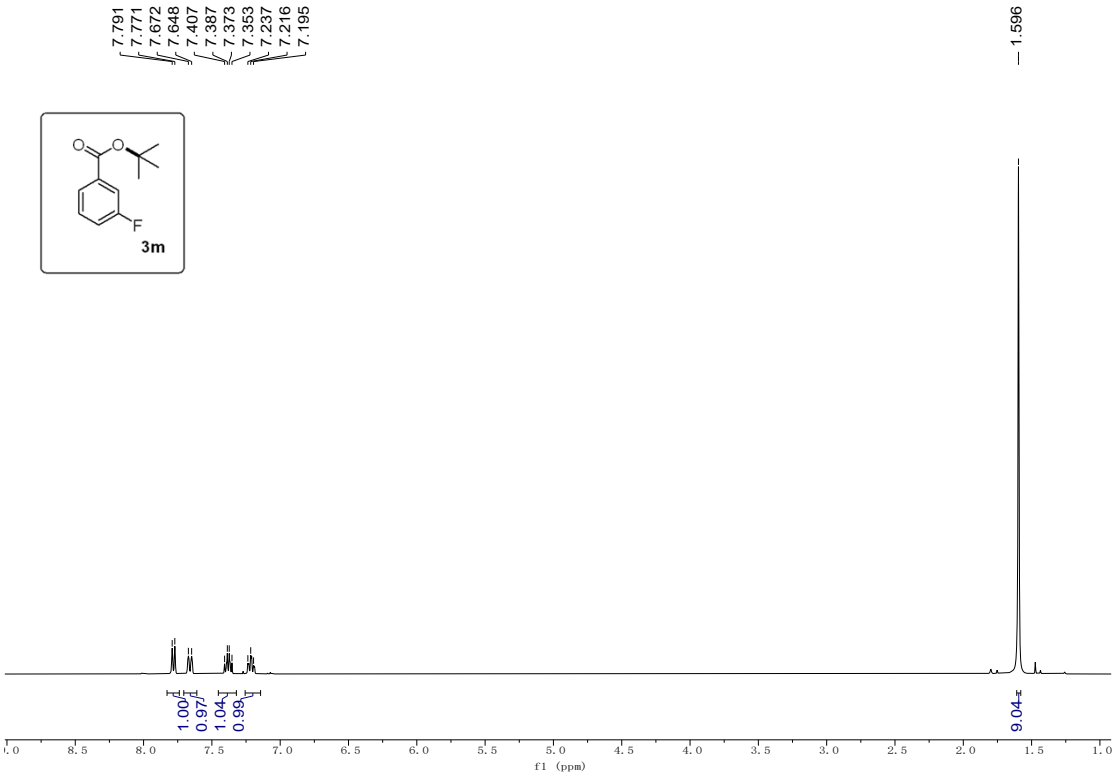


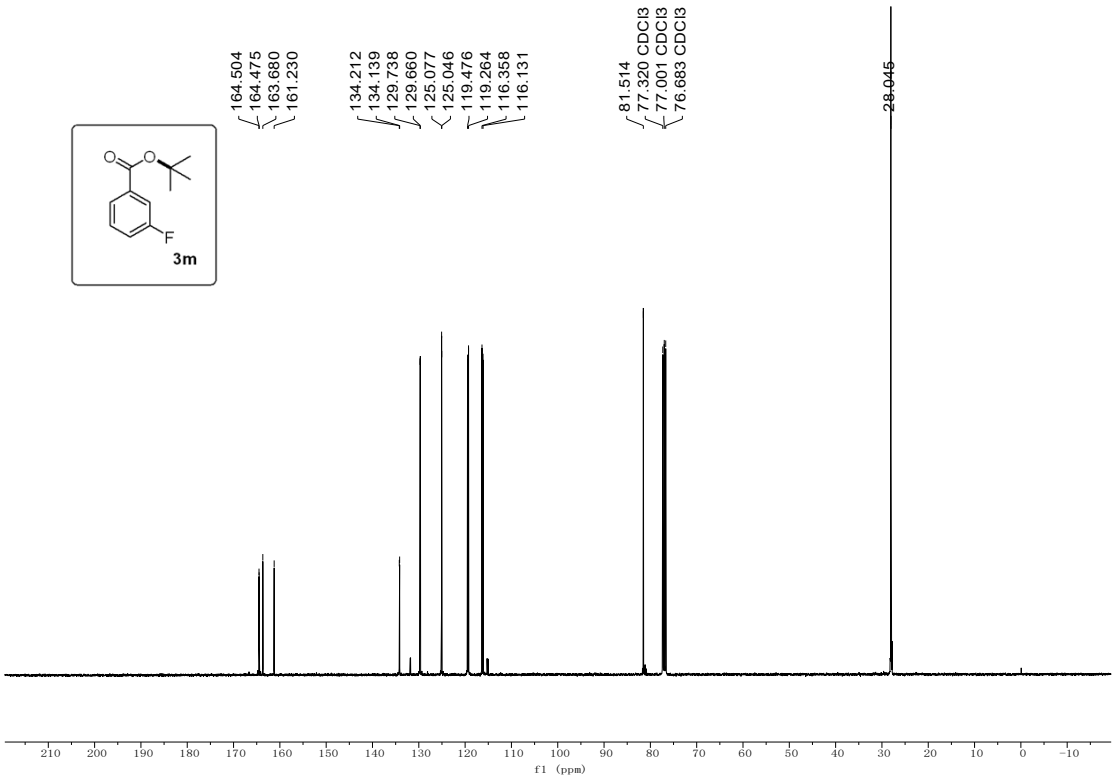
H NMR (400 MHz, $CDCl_3$) of product **3l**



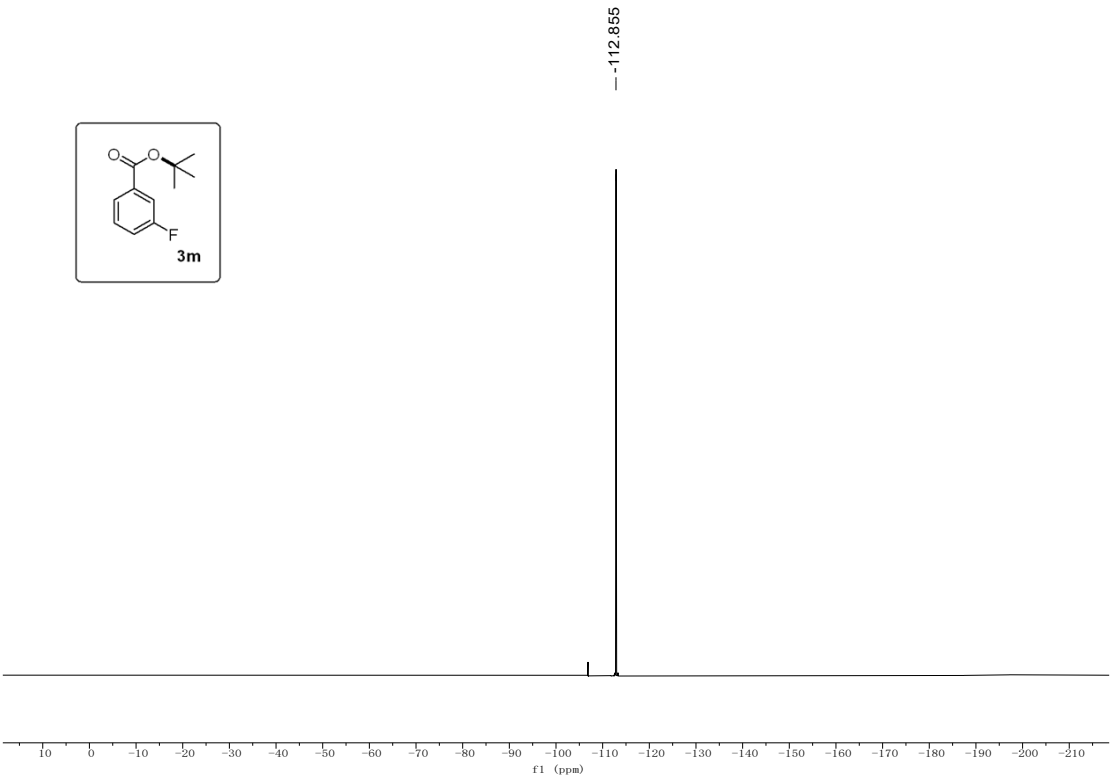
^{13}C NMR (100 MHz, $CDCl_3$) of product **3l**



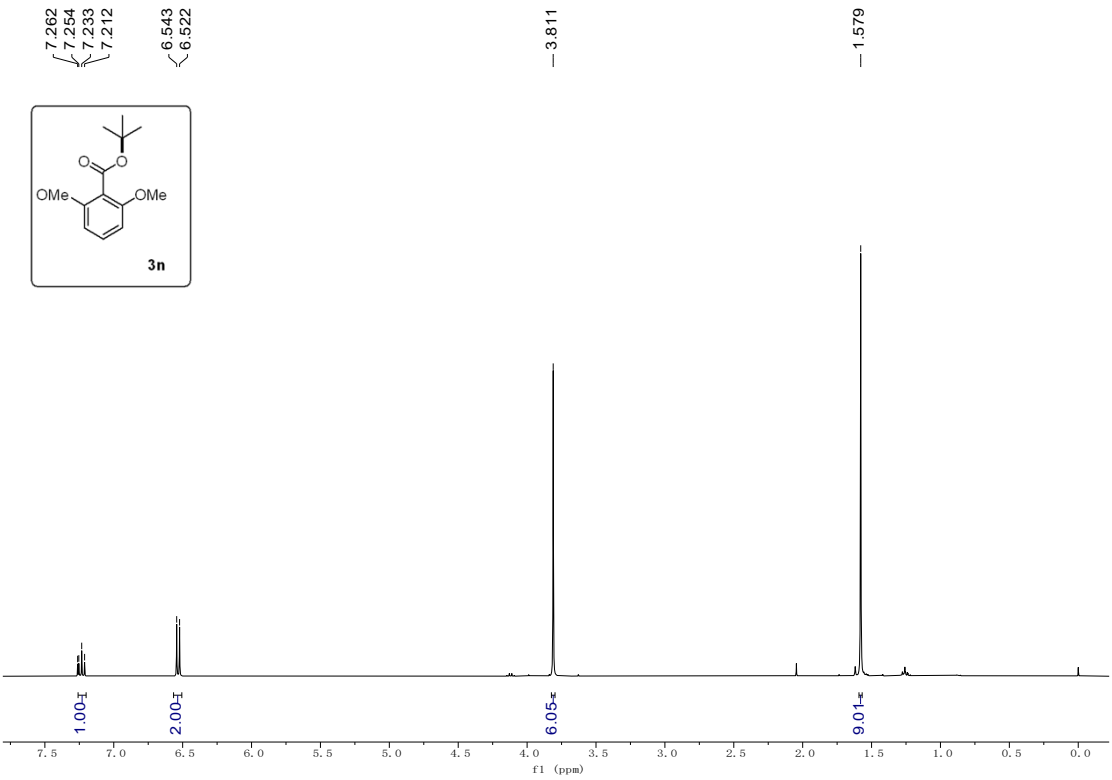
^{1}H NMR (400 MHz, $CDCl_3$) of product **3m**



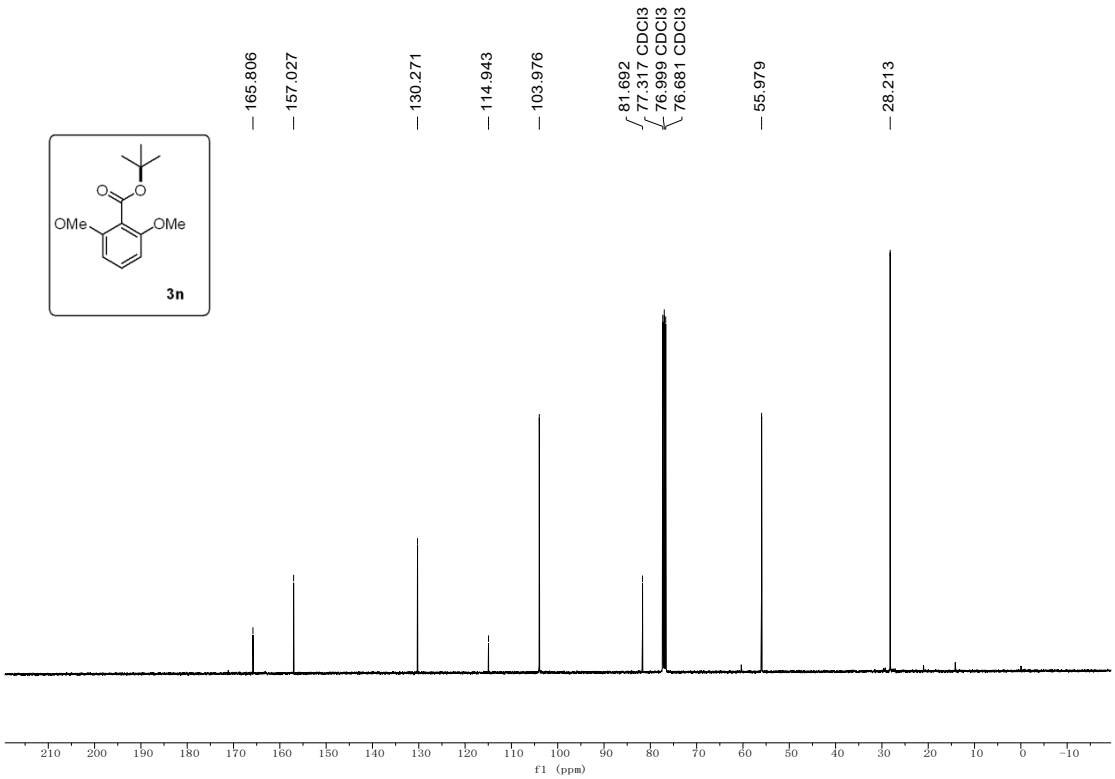
^{13}C NMR (100 MHz, $CDCl_3$) of product **3m**



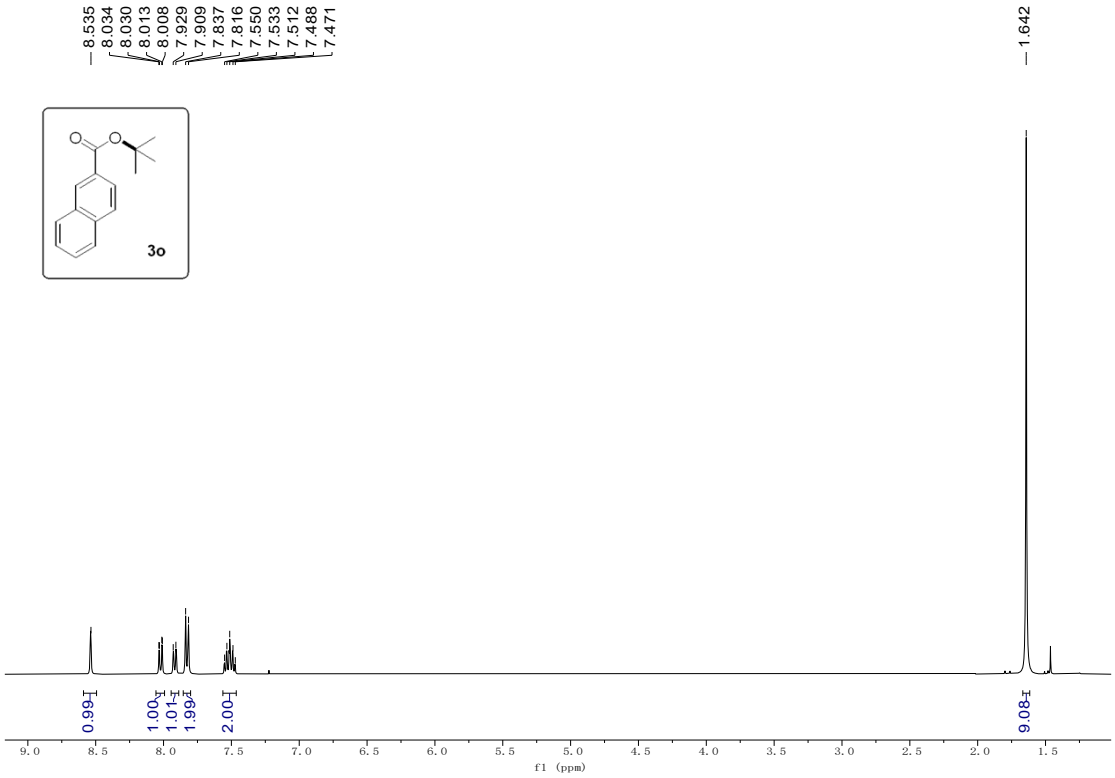
^{19}F NMR (376 MHz, $CDCl_3$) of product **3m**



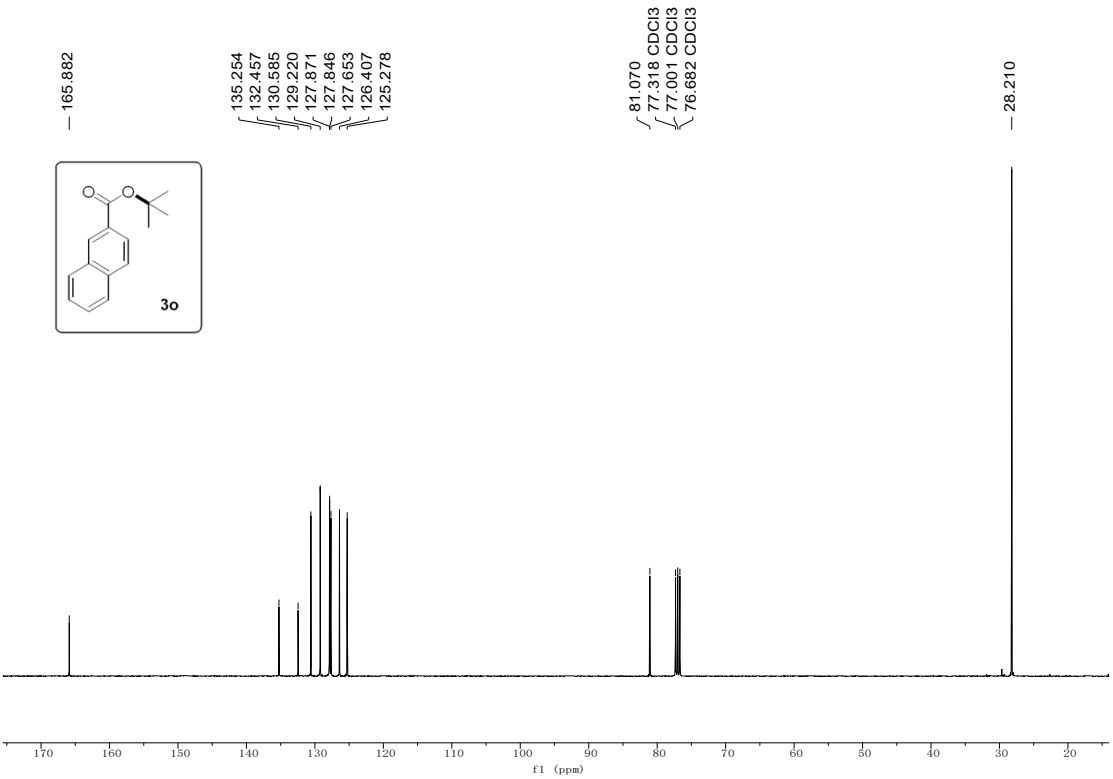
^{1}H NMR (400 MHz, $CDCl_3$) of product **3n**



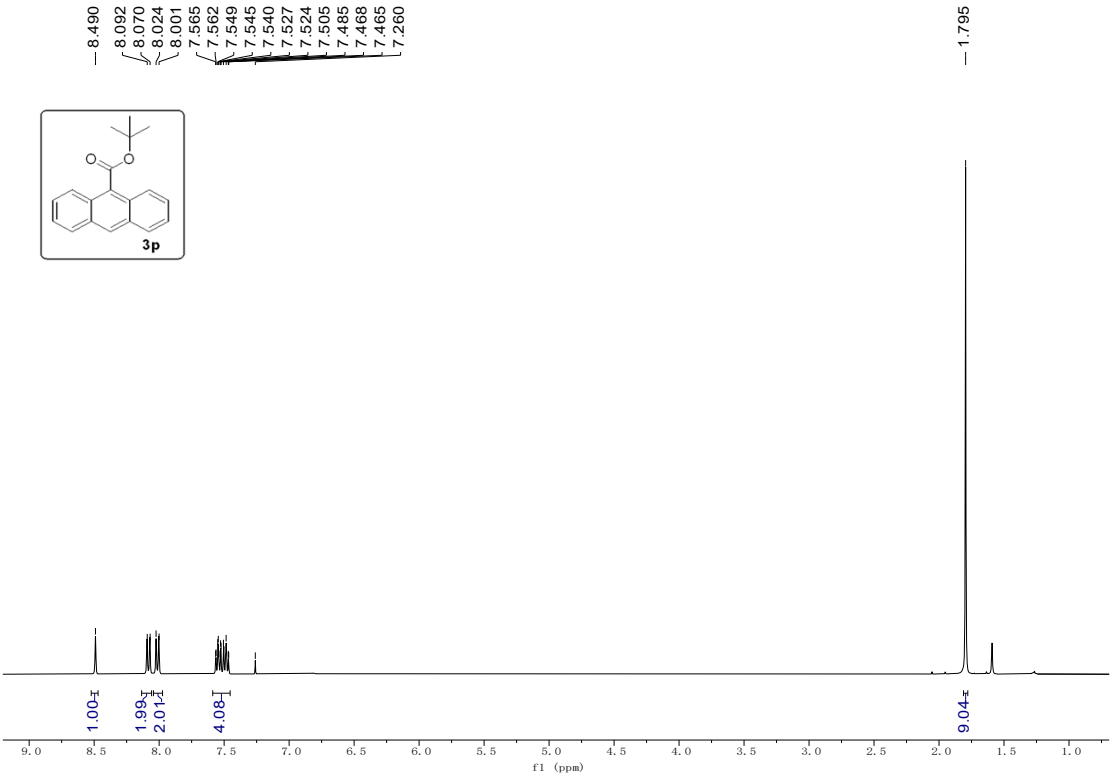
^{13}C NMR (100 MHz, $CDCl_3$) of product **3n**



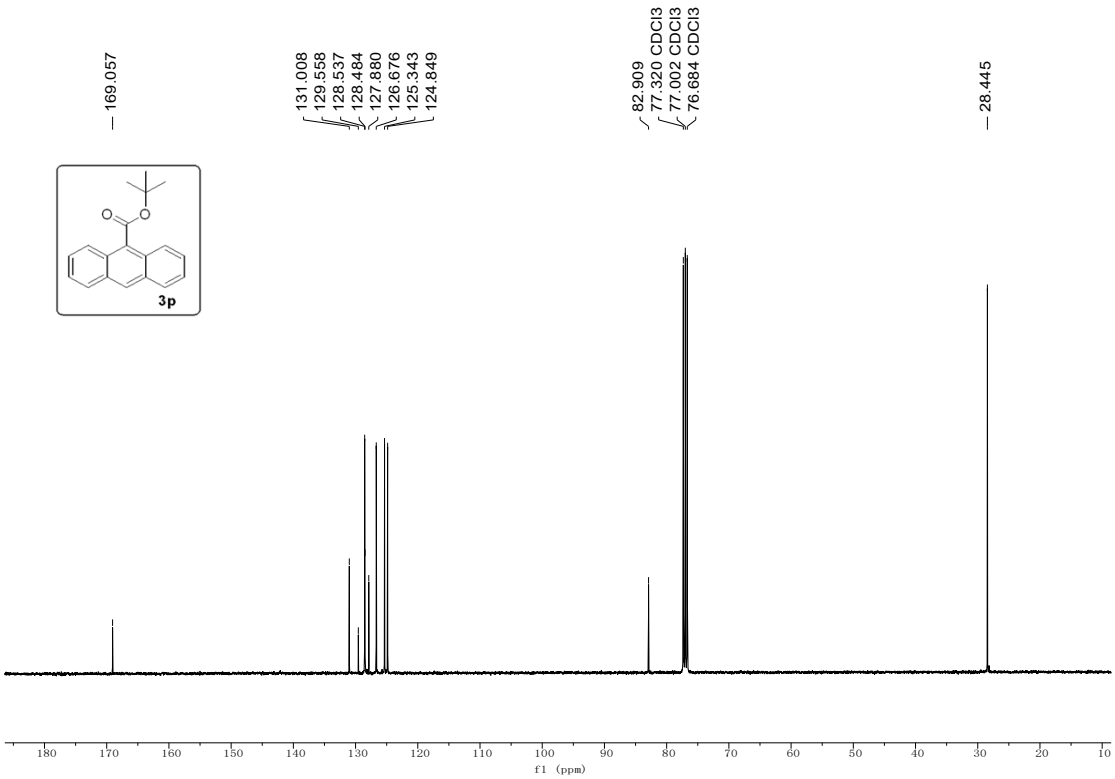
^{1}H NMR (400 MHz, $CDCl_3$) of product **3o**



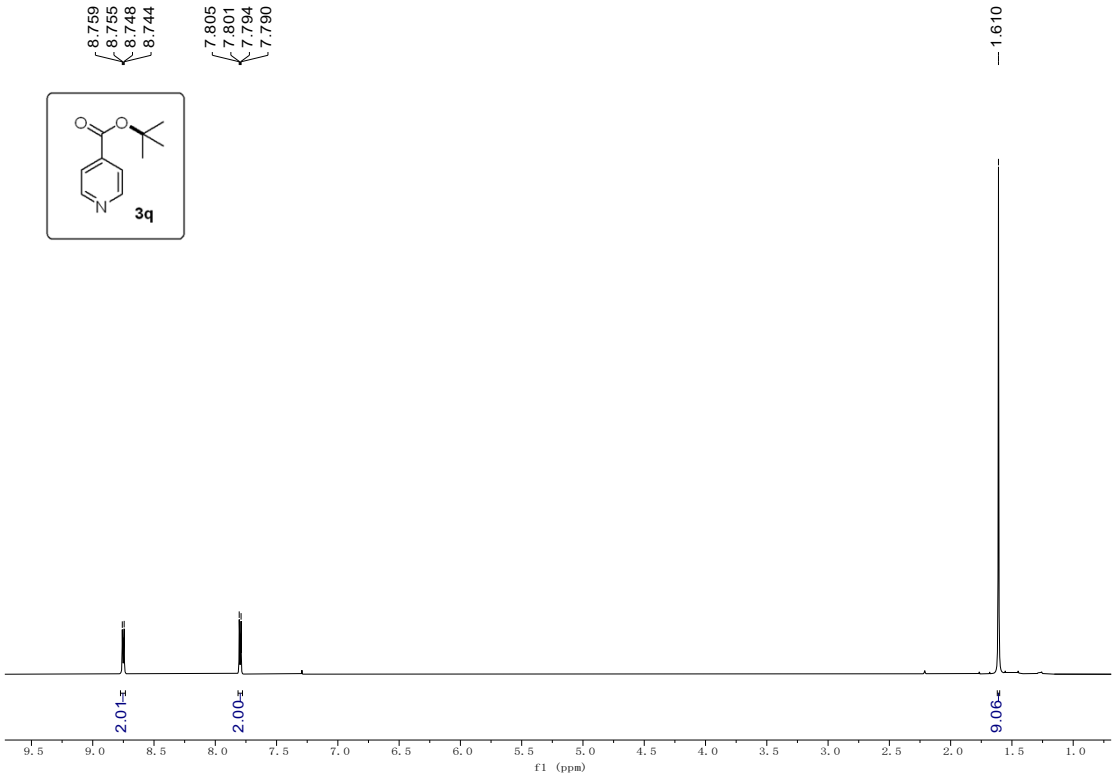
^{13}C NMR (100 MHz, $CDCl_3$) of product **3o**



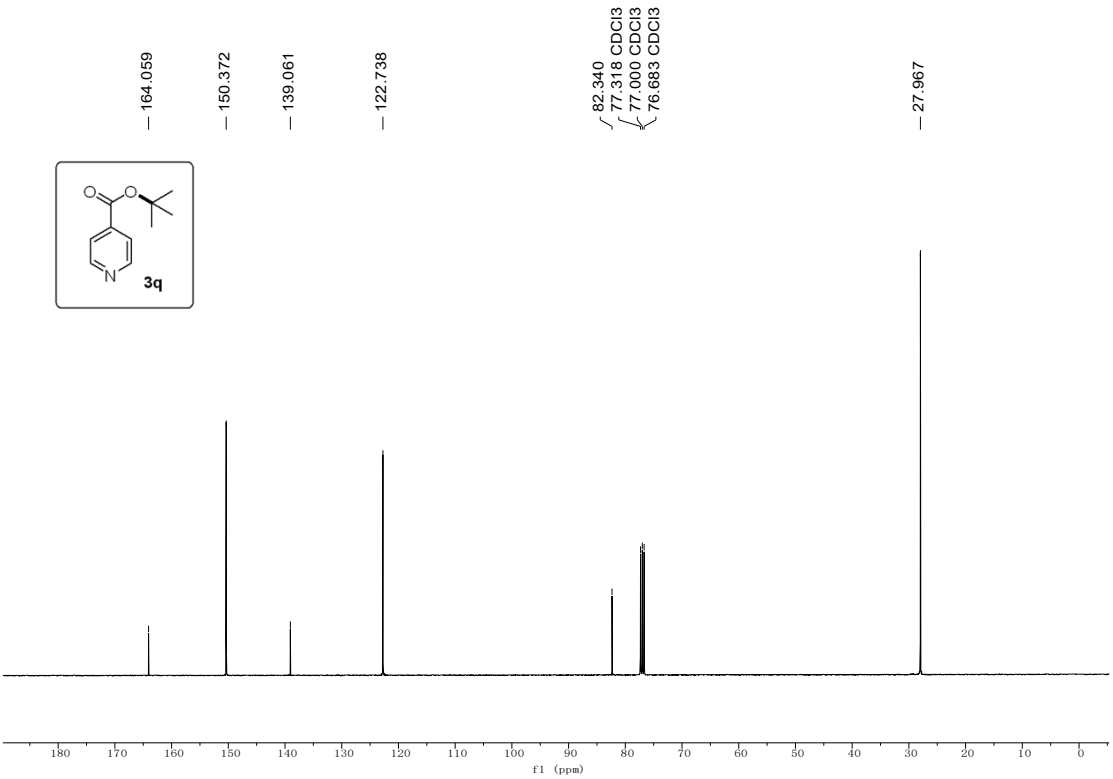
^{1}H NMR (400 MHz, $CDCl_3$) of product **3p**



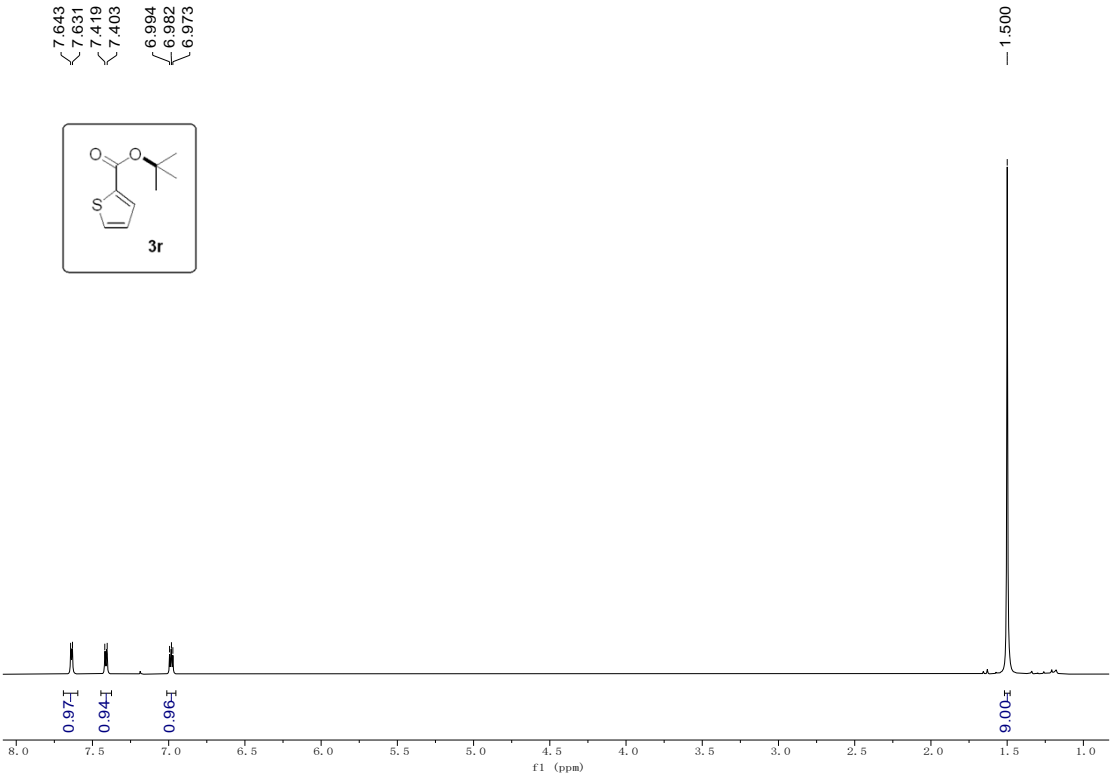
^{13}C NMR (100 MHz, $CDCl_3$) of product **3p**



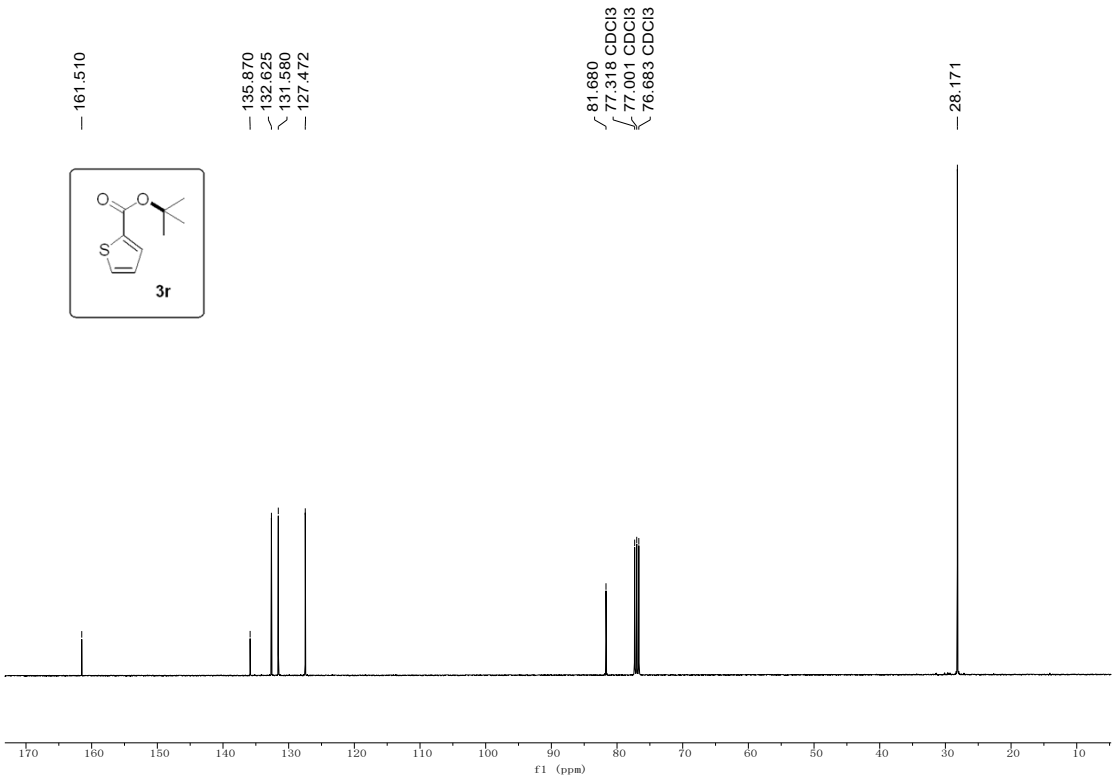
^{1}H NMR (400 MHz, $CDCl_3$) of product **3q**



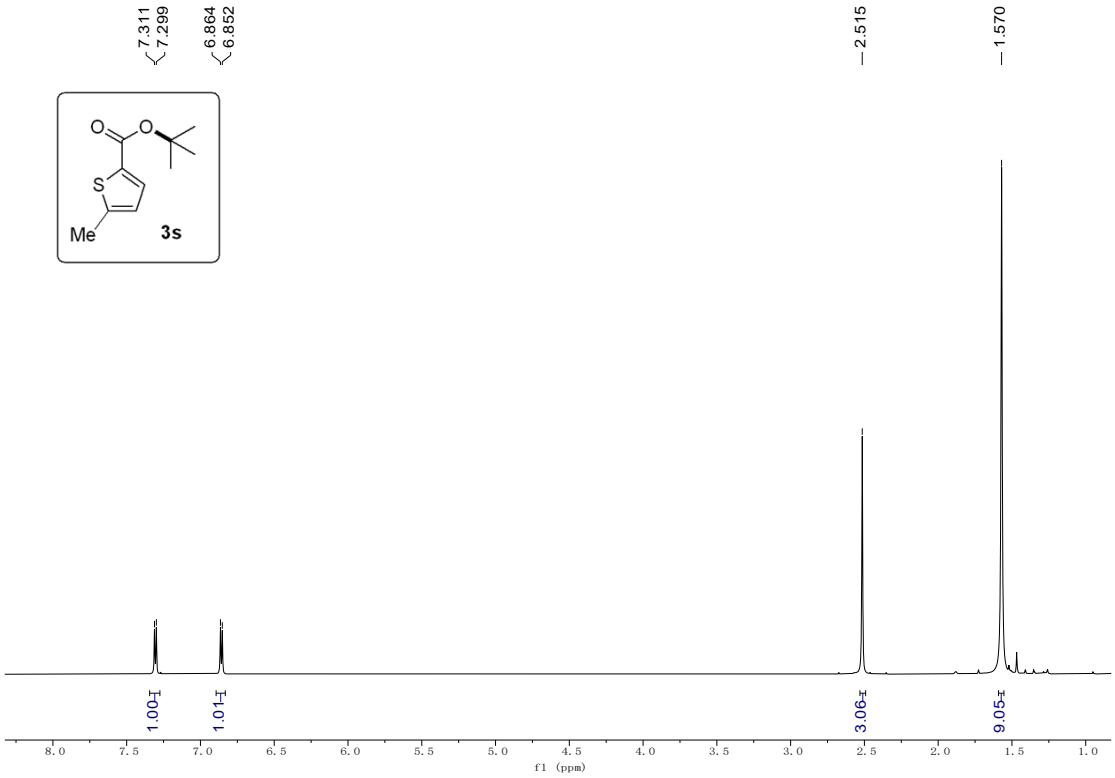
^{13}C NMR (100 MHz, $CDCl_3$) of product **3q**



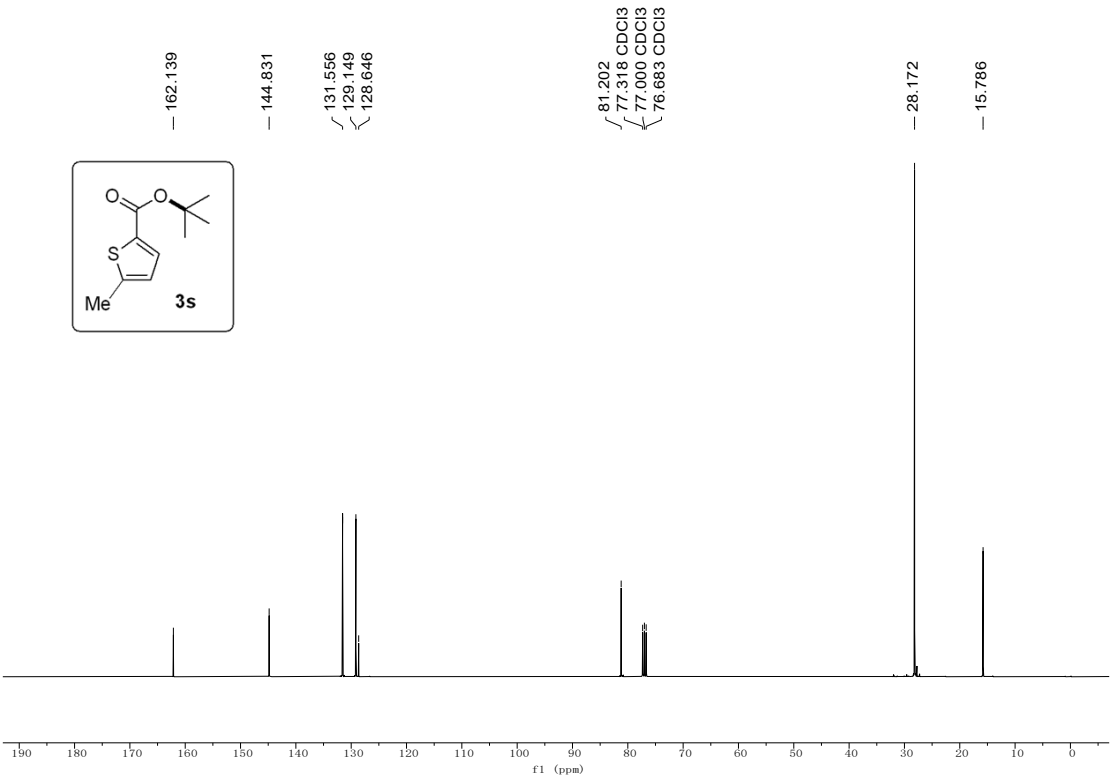
^{1}H NMR (400 MHz, $CDCl_3$) of product **3r**



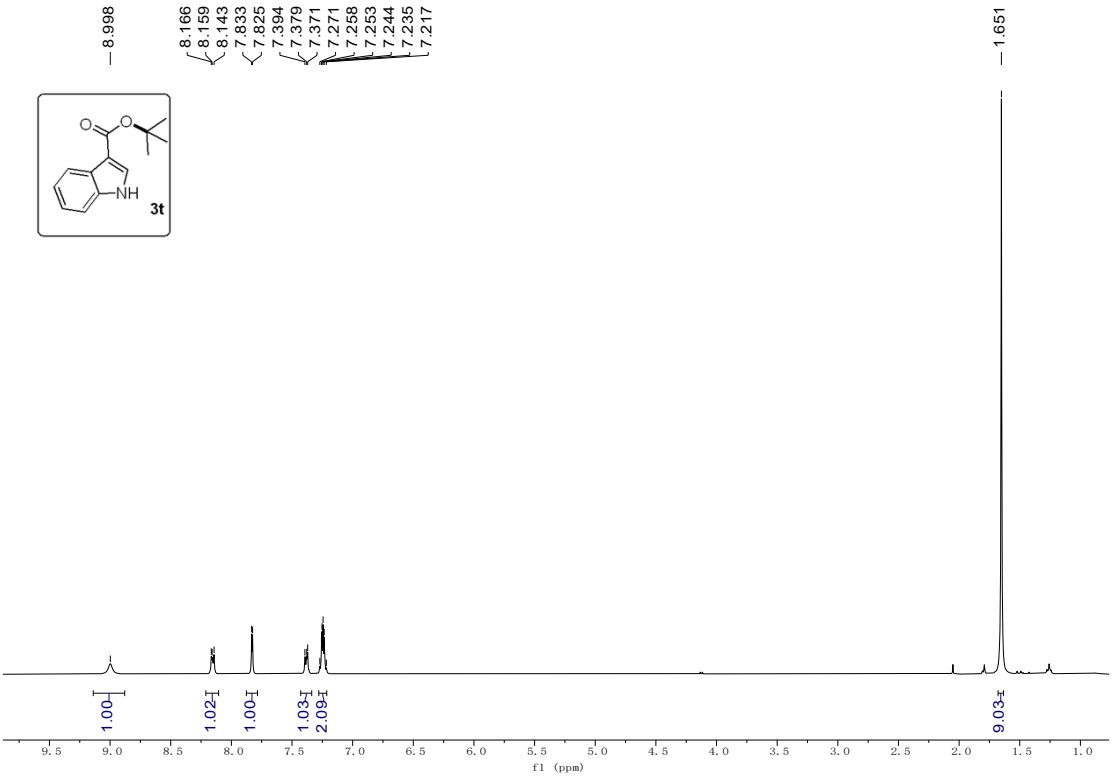
^{13}C NMR (100 MHz, $CDCl_3$) of product **3r**



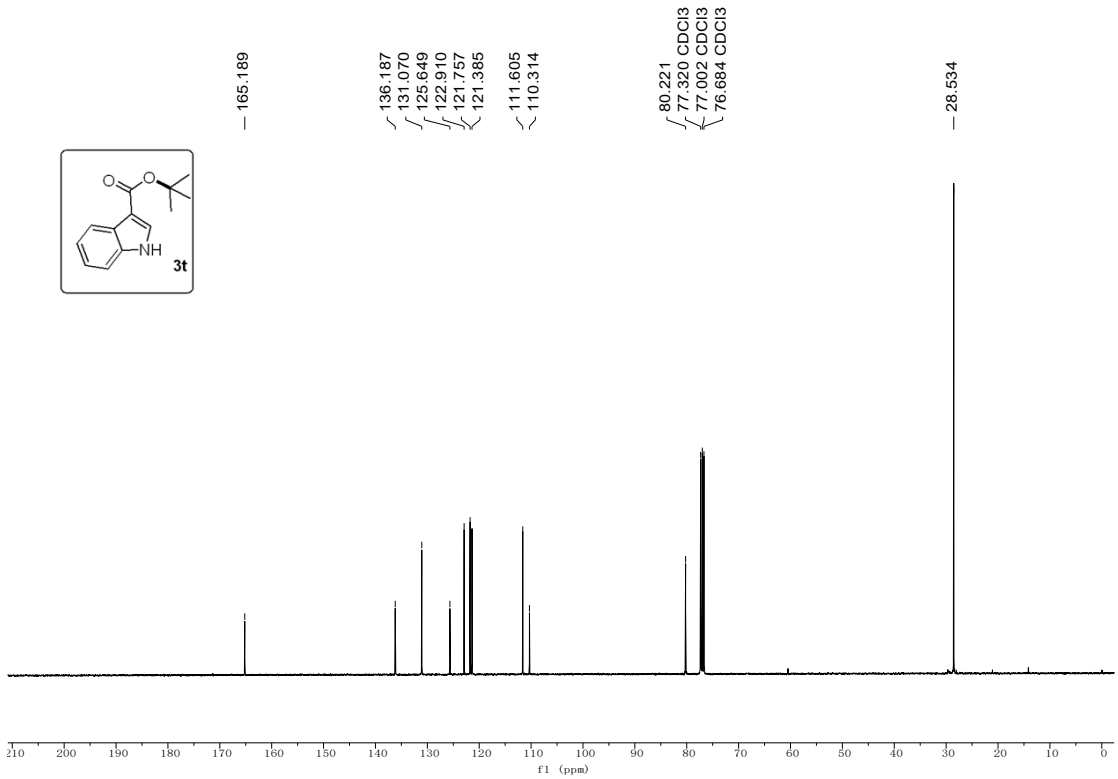
^{1}H NMR (400 MHz, $CDCl_3$) of product **3s**



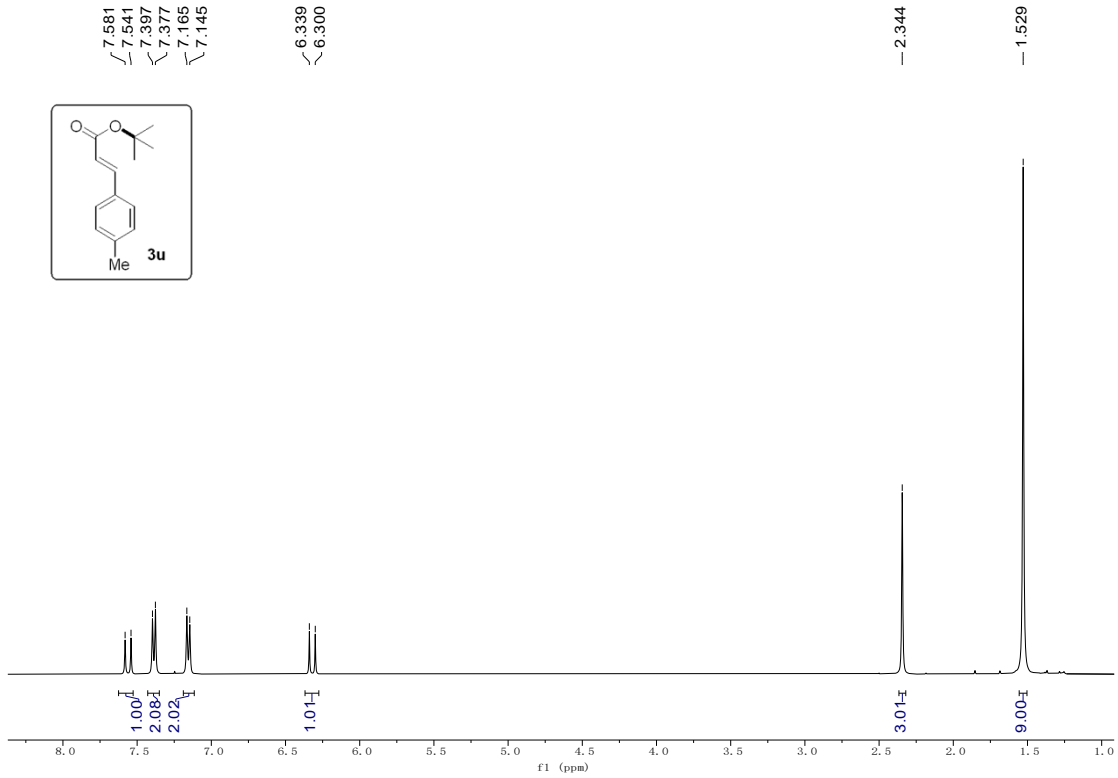
^{13}C NMR (100 MHz, $CDCl_3$) of product **3s**



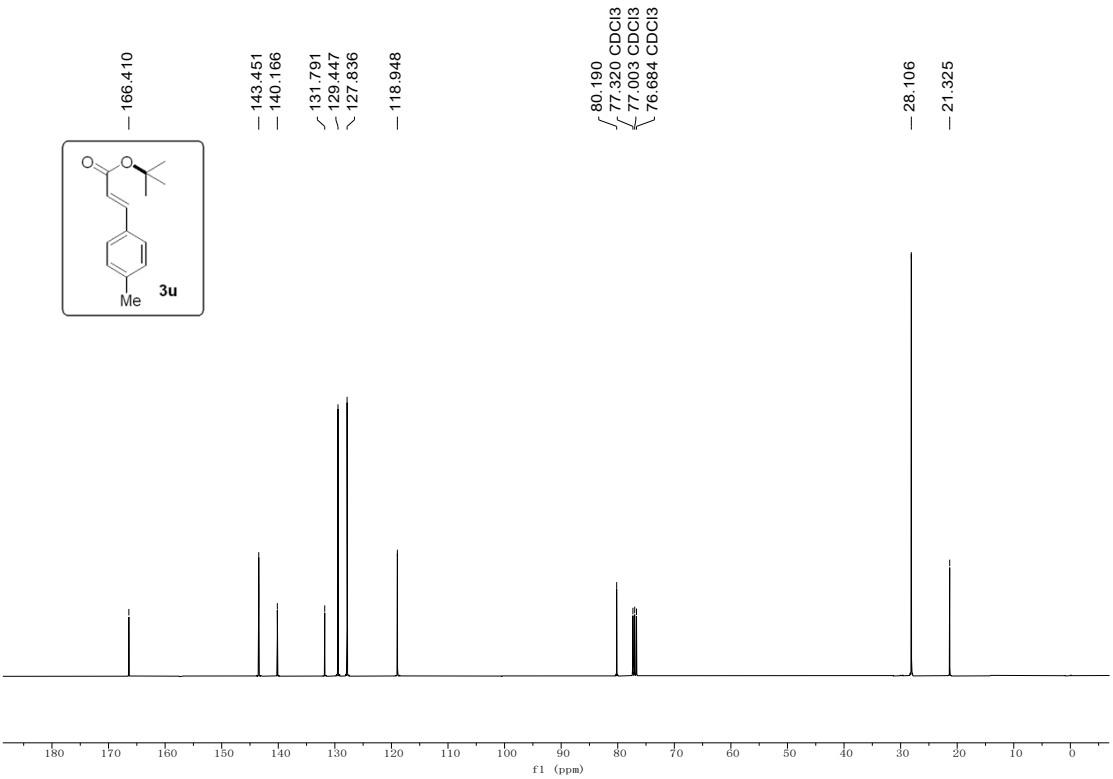
^{1}H NMR (400 MHz, $CDCl_3$) of product **3t**



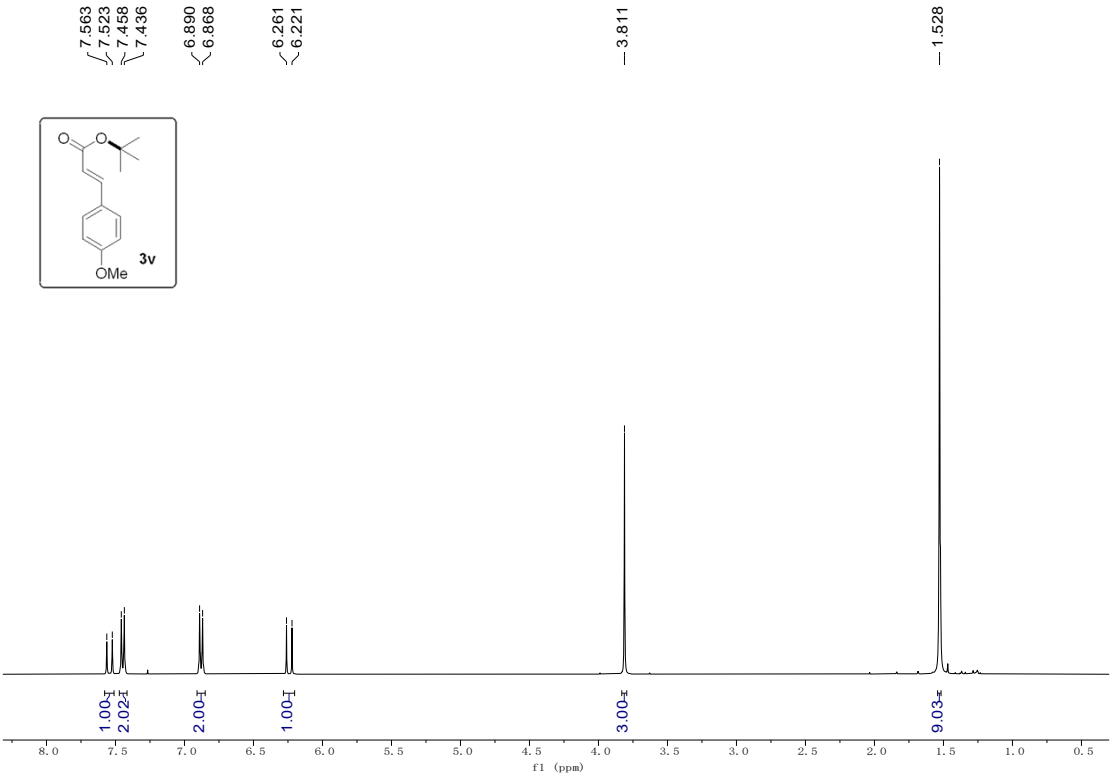
^{13}C NMR (100 MHz, $CDCl_3$) of product **3t**



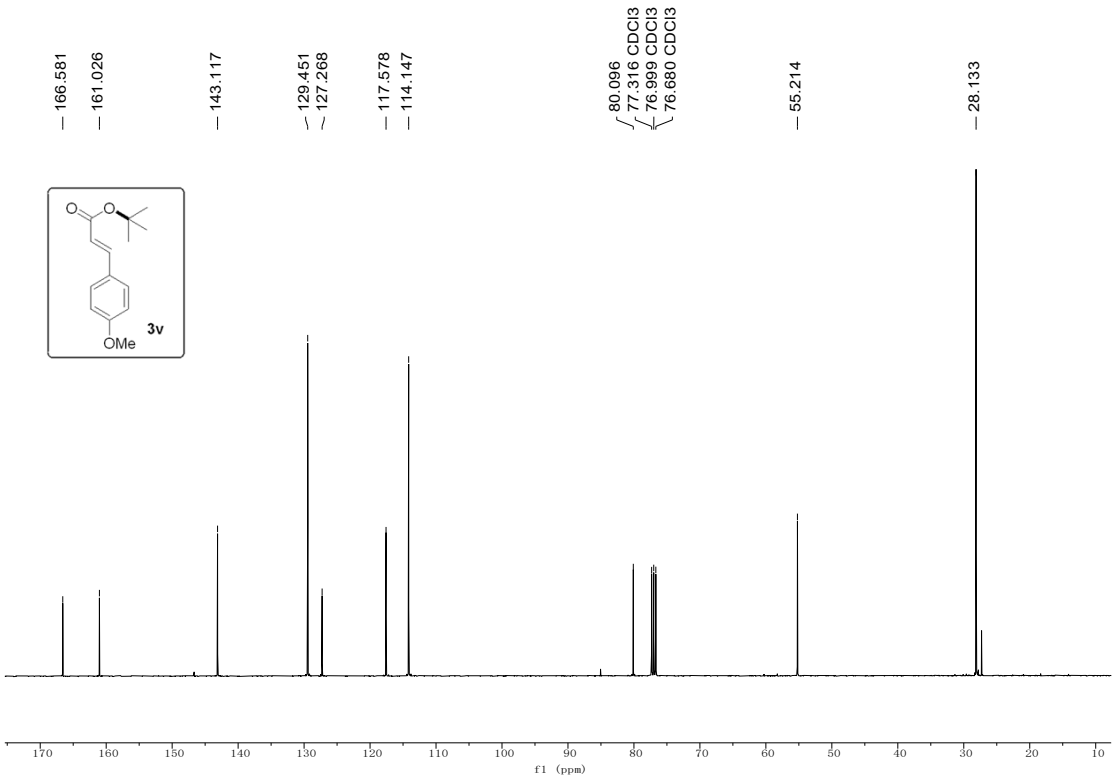
^{1}H NMR (400 MHz, $CDCl_3$) of product **3u**



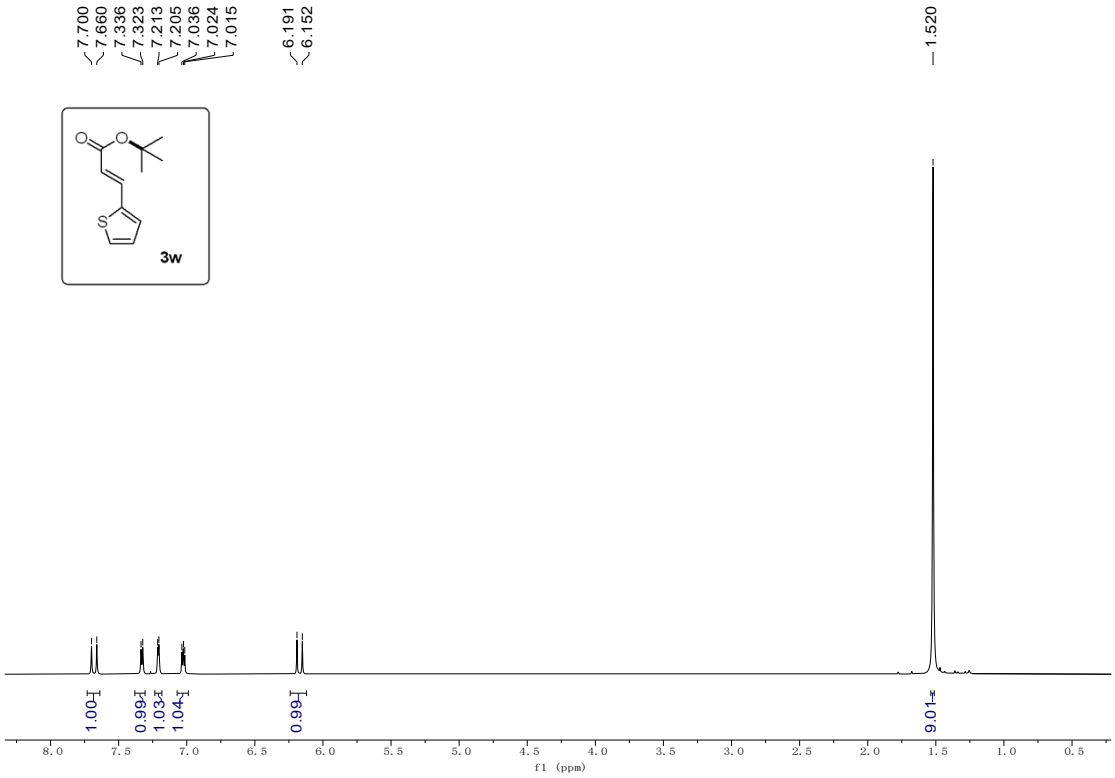
^{13}C NMR (100 MHz, $CDCl_3$) of product **3u**



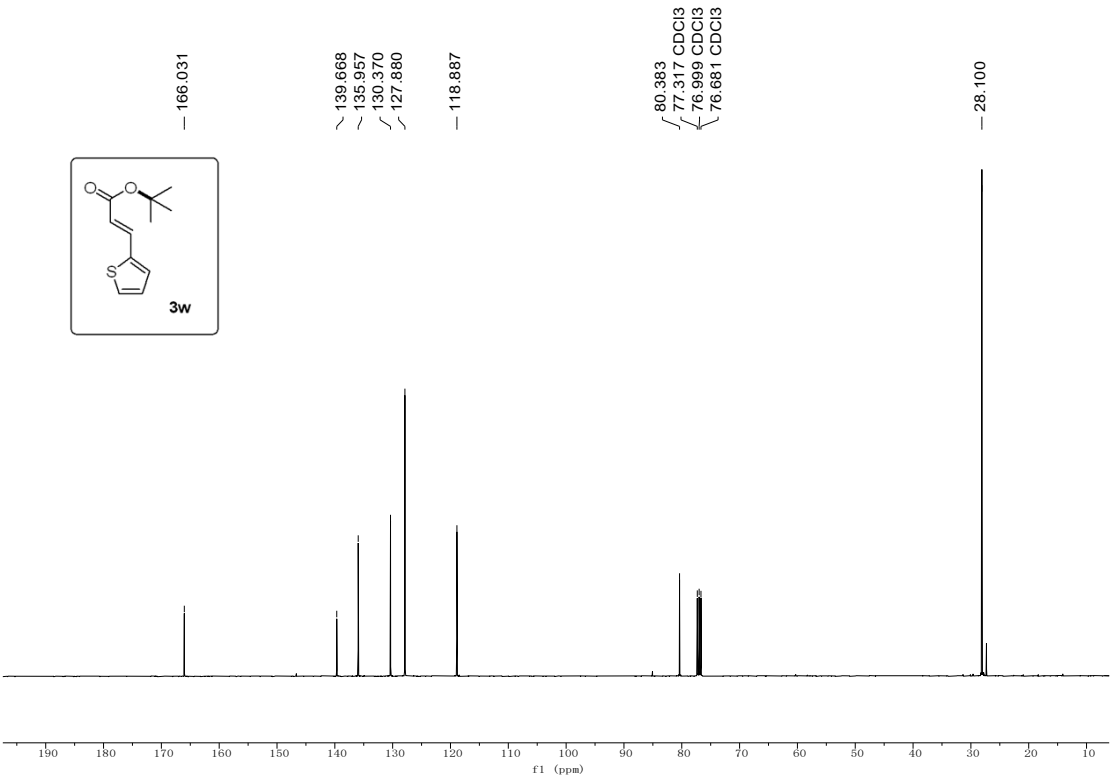
^{1}H NMR (400 MHz, $CDCl_3$) of product **3v**



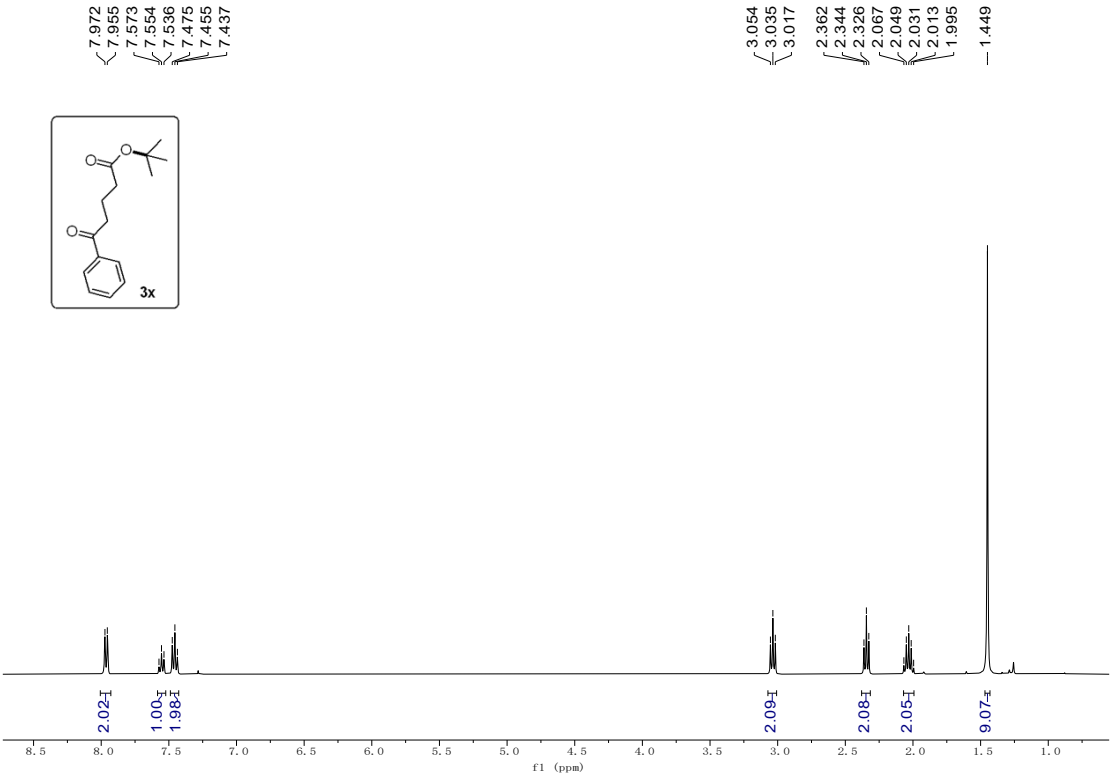
^{13}C NMR (100 MHz, $CDCl_3$) of product **3v**



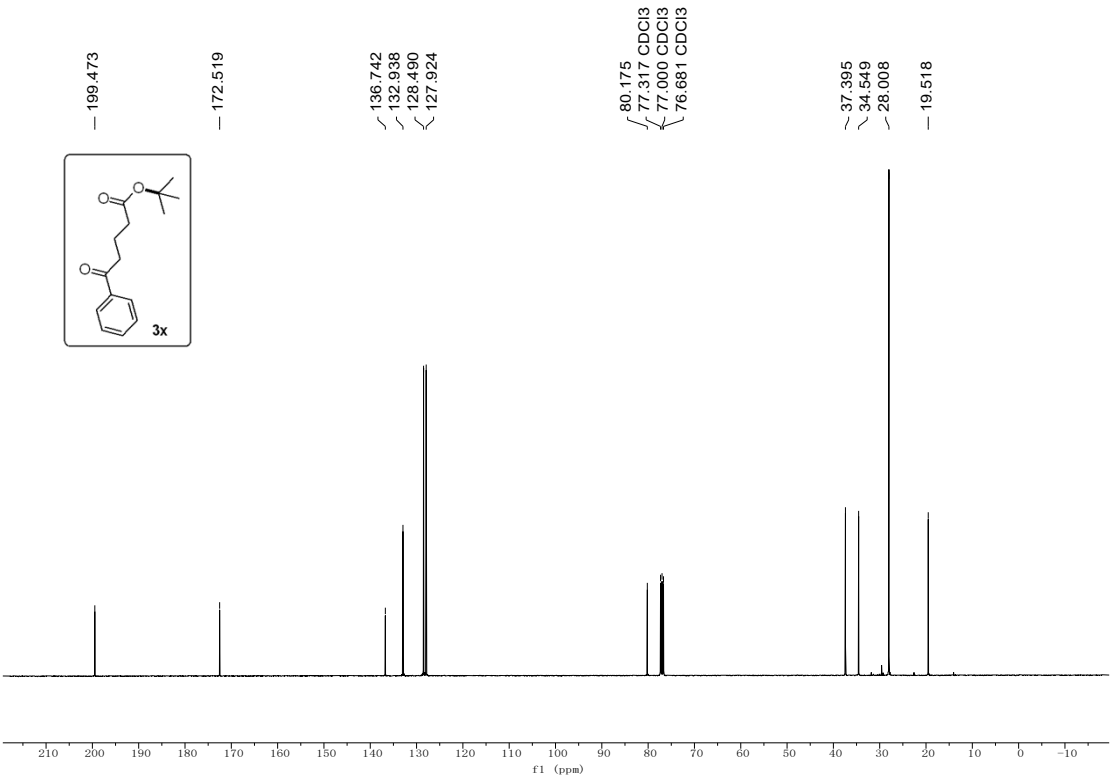
^{1}H NMR (400 MHz, $CDCl_3$) of product **3w**



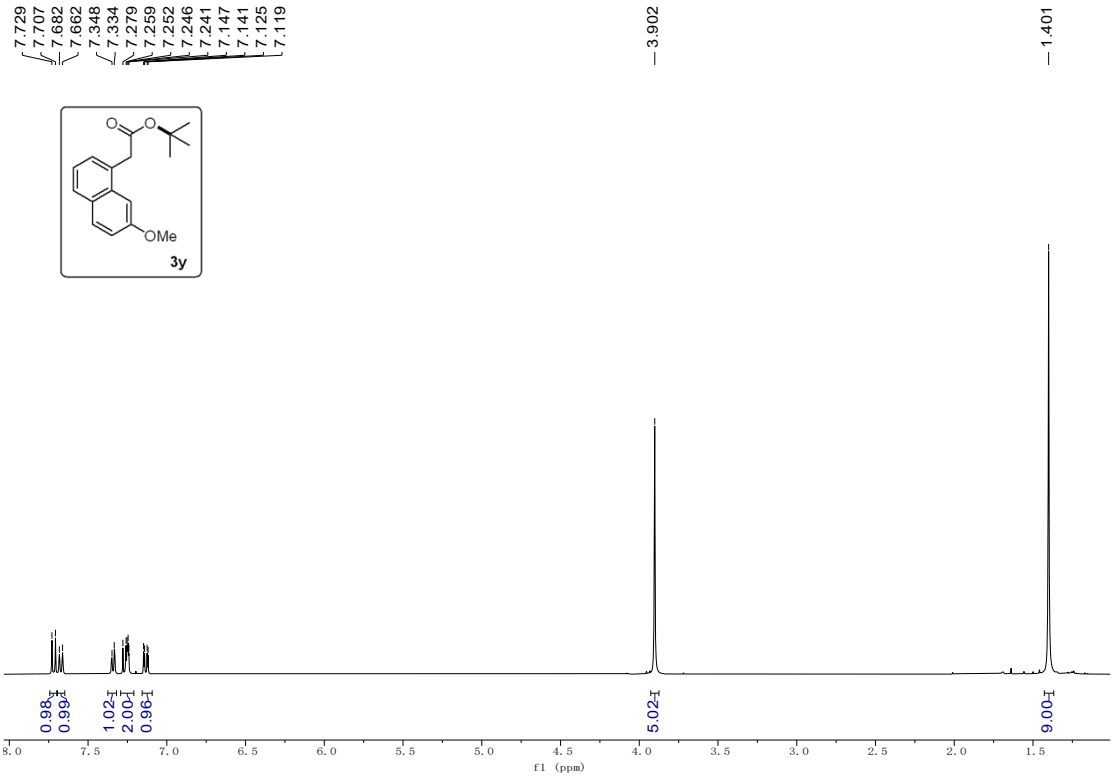
^{13}C NMR (100 MHz, $CDCl_3$) of product **3w**



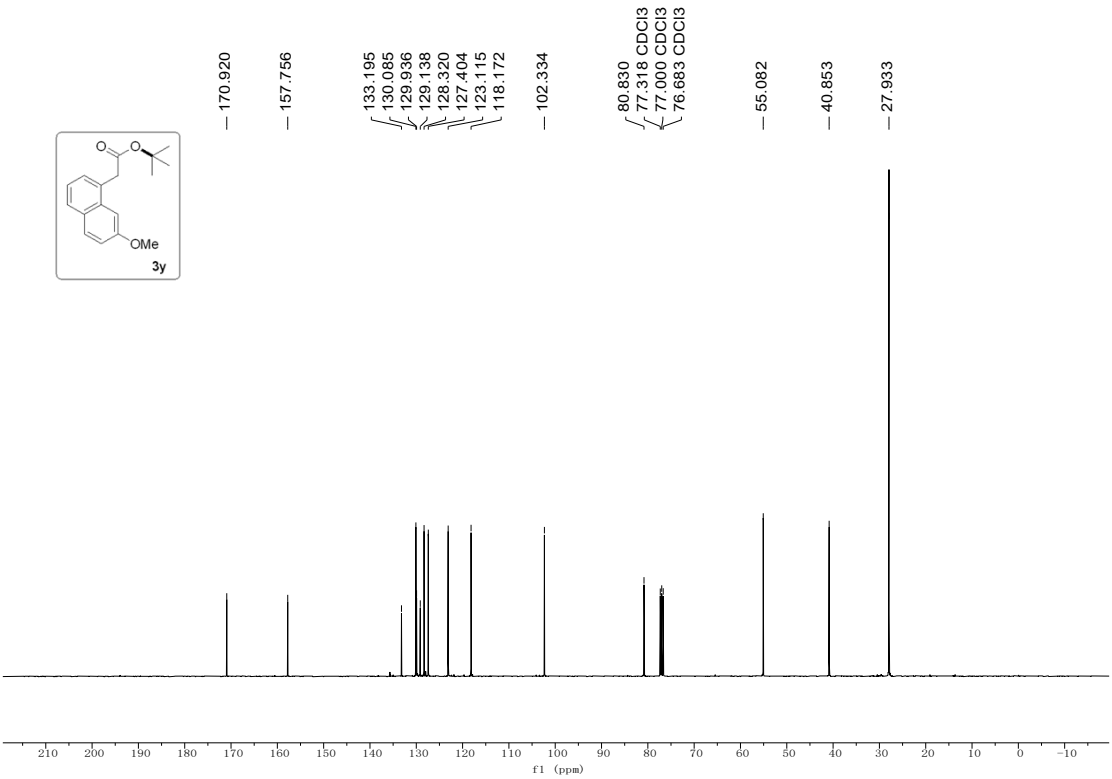
^{1}H NMR (400 MHz, $CDCl_3$) of product **3x**



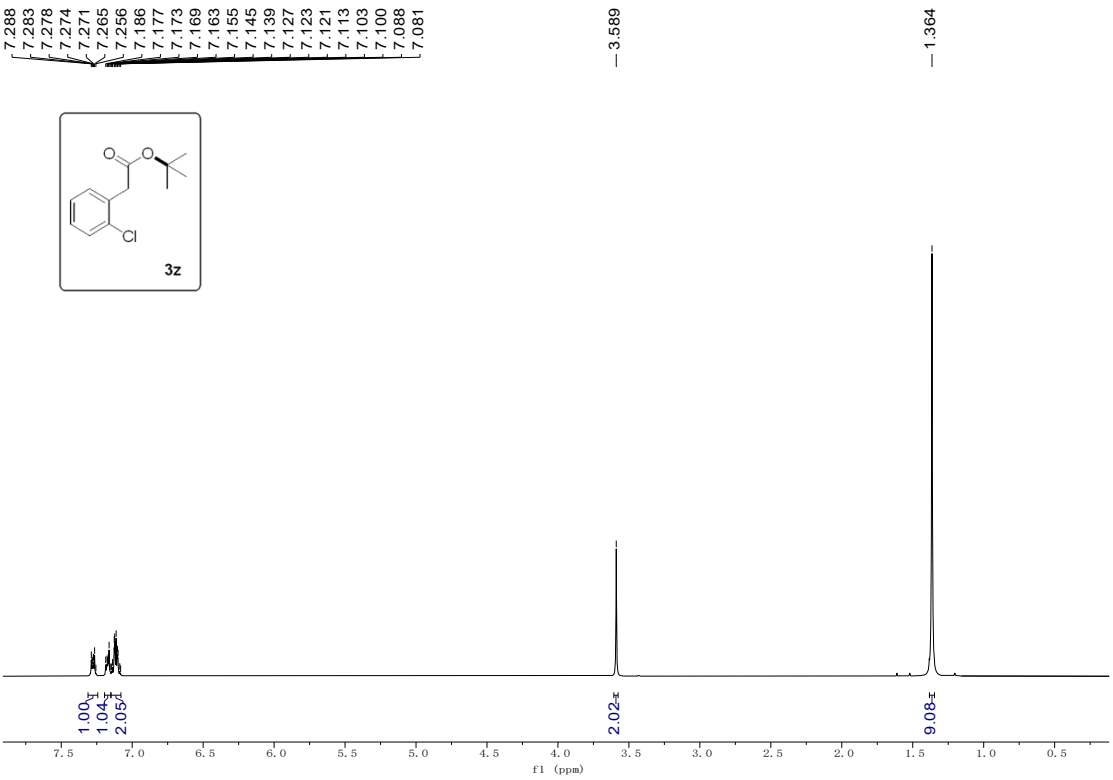
^{13}C NMR (100 MHz, $CDCl_3$) of product **3x**



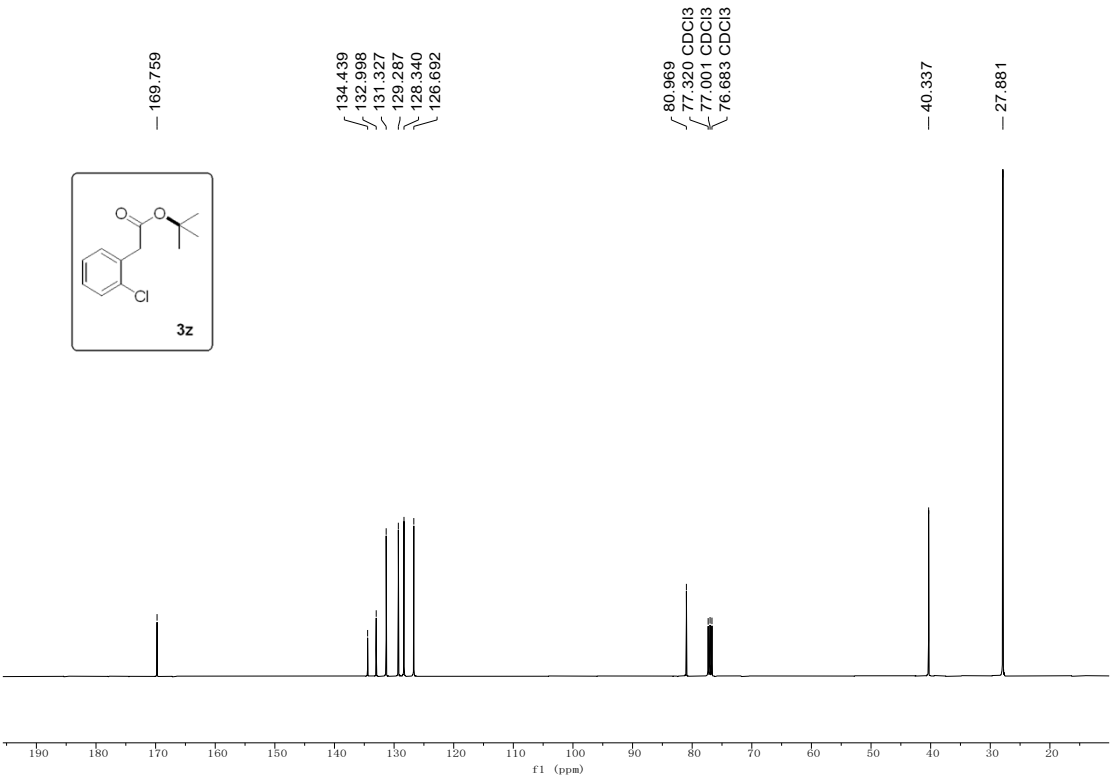
^{1}H NMR (400 MHz, $CDCl_3$) of product **3y**



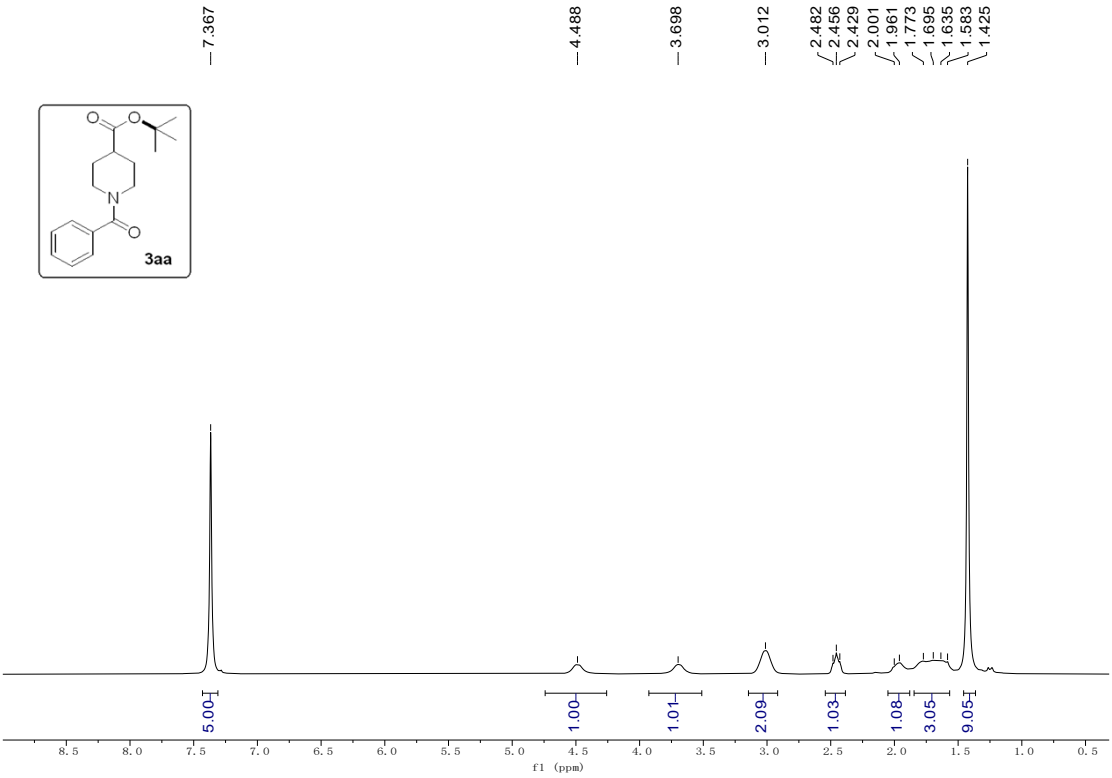
^{13}C NMR (100 MHz, $CDCl_3$) of product **3y**



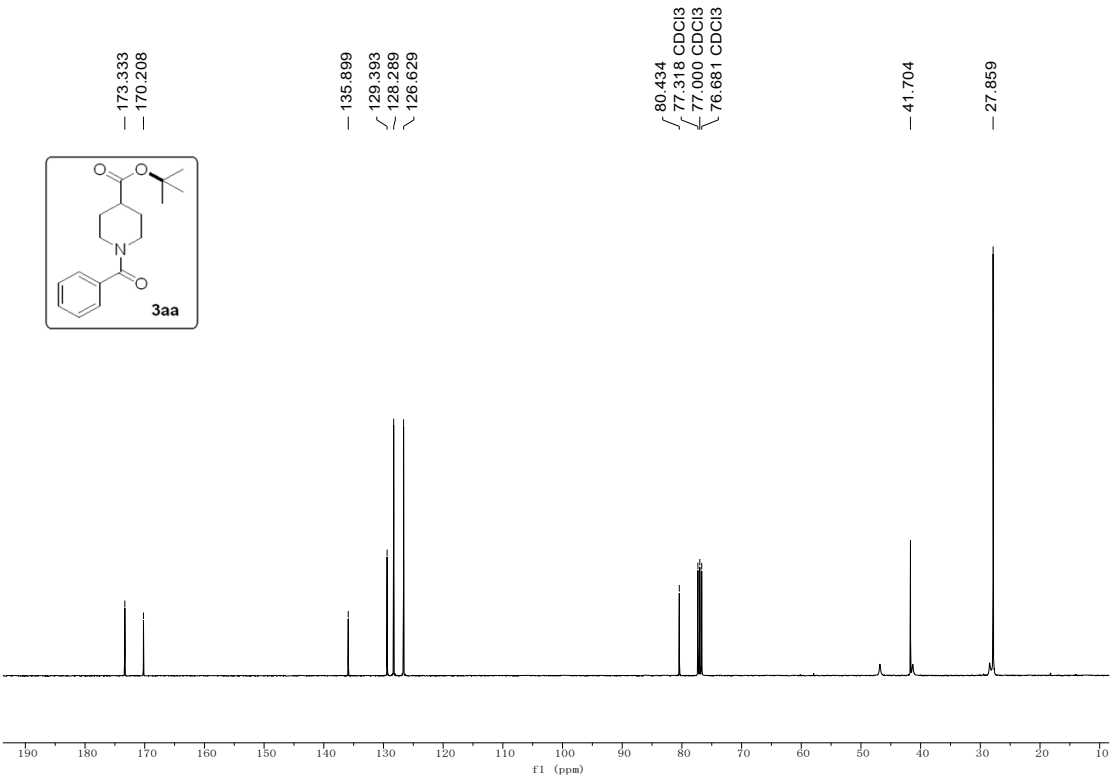
^{1}H NMR (400 MHz, $CDCl_3$) of product **3z**



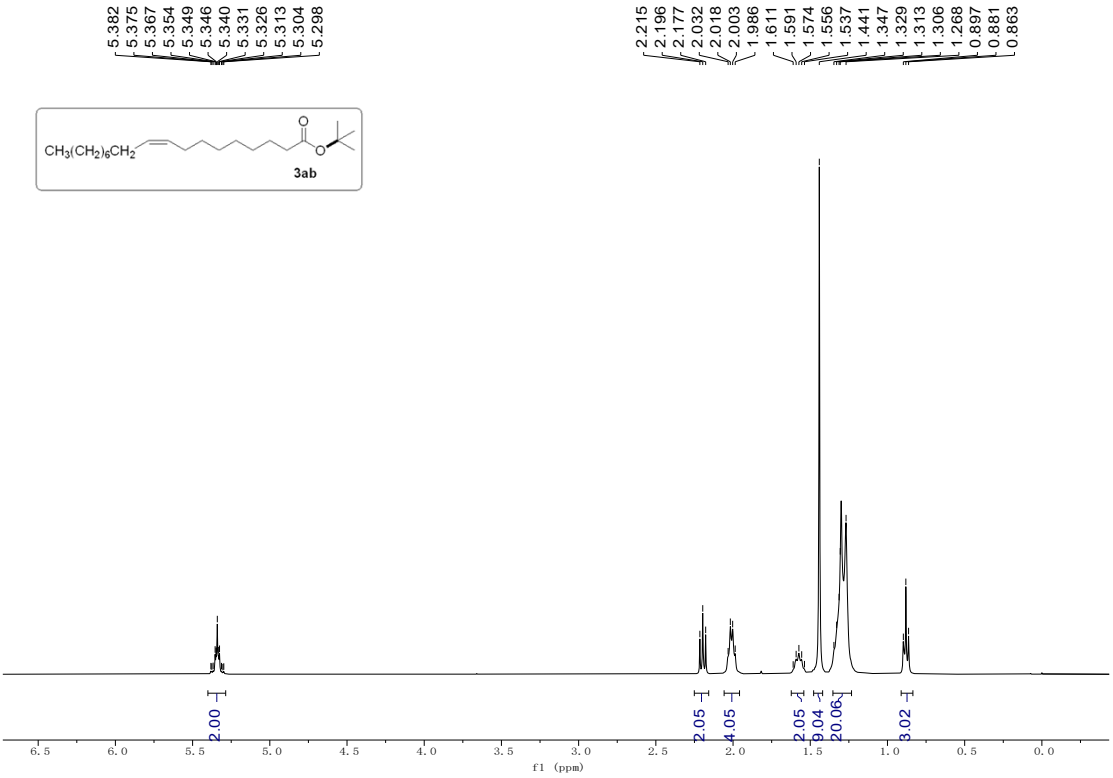
^{13}C NMR (100 MHz, $CDCl_3$) of product **3z**



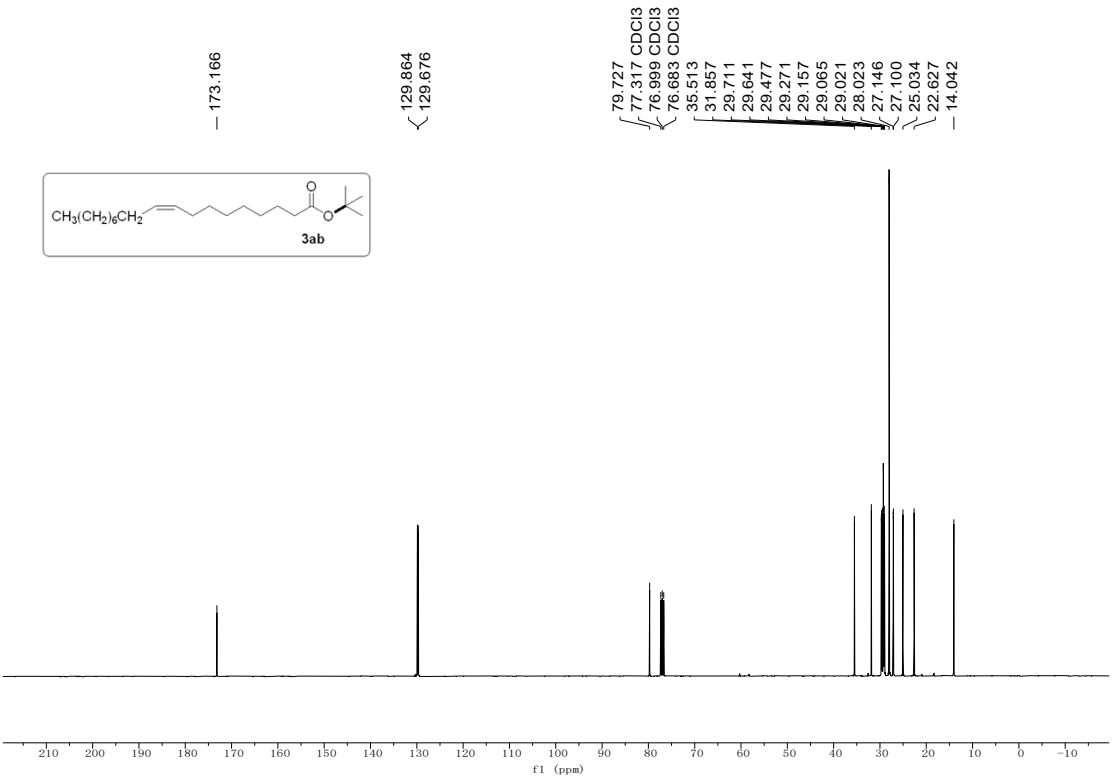
^{1}H NMR (400 MHz, $CDCl_3$) of product **3aa**



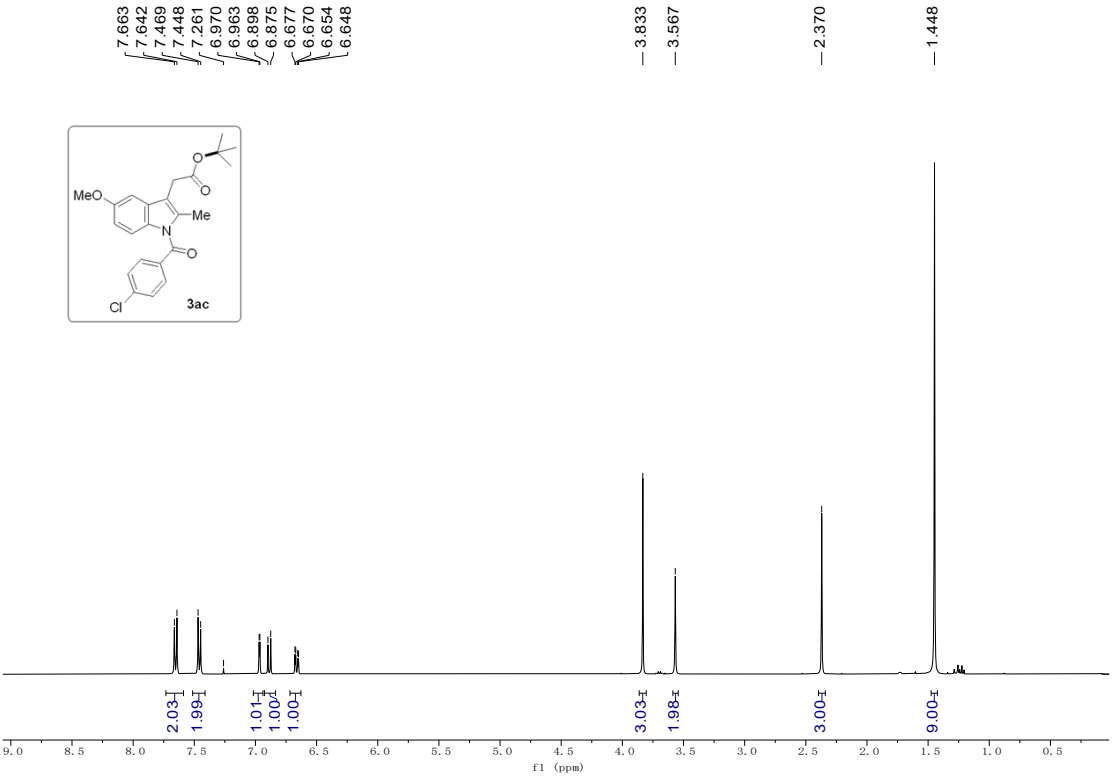
^{13}C NMR (100 MHz, $CDCl_3$) of product **3aa**



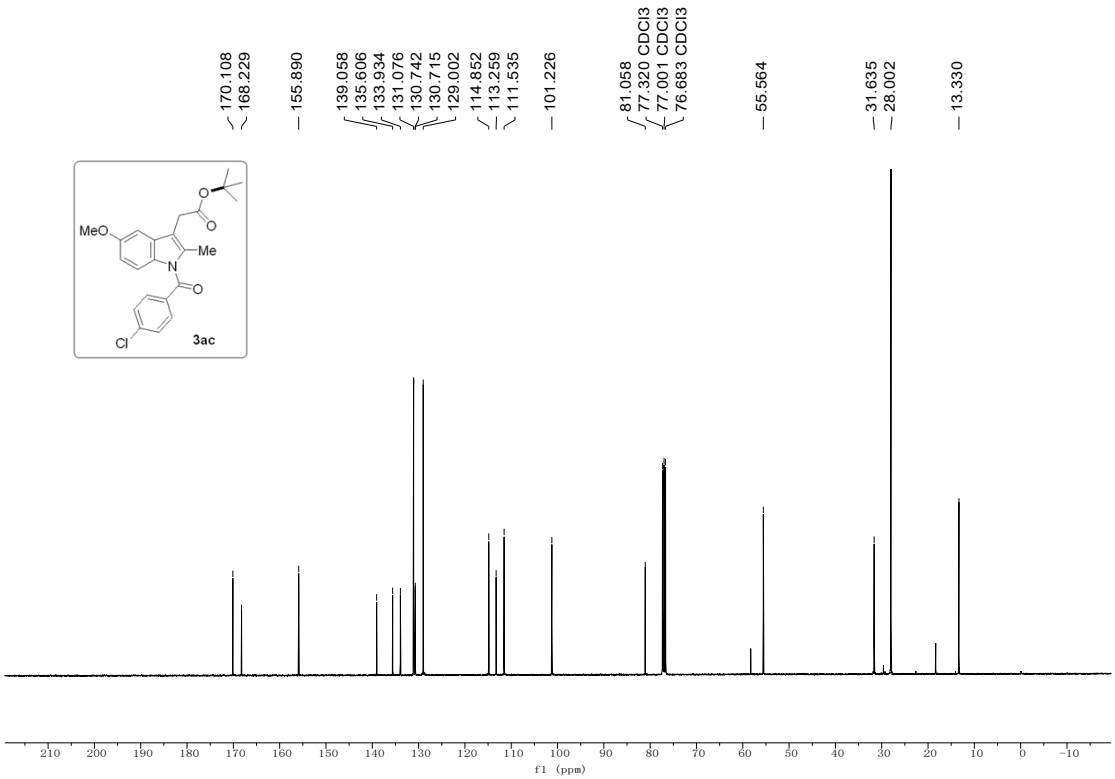
^{1}H NMR (400 MHz, $CDCl_3$) of product **3ab**



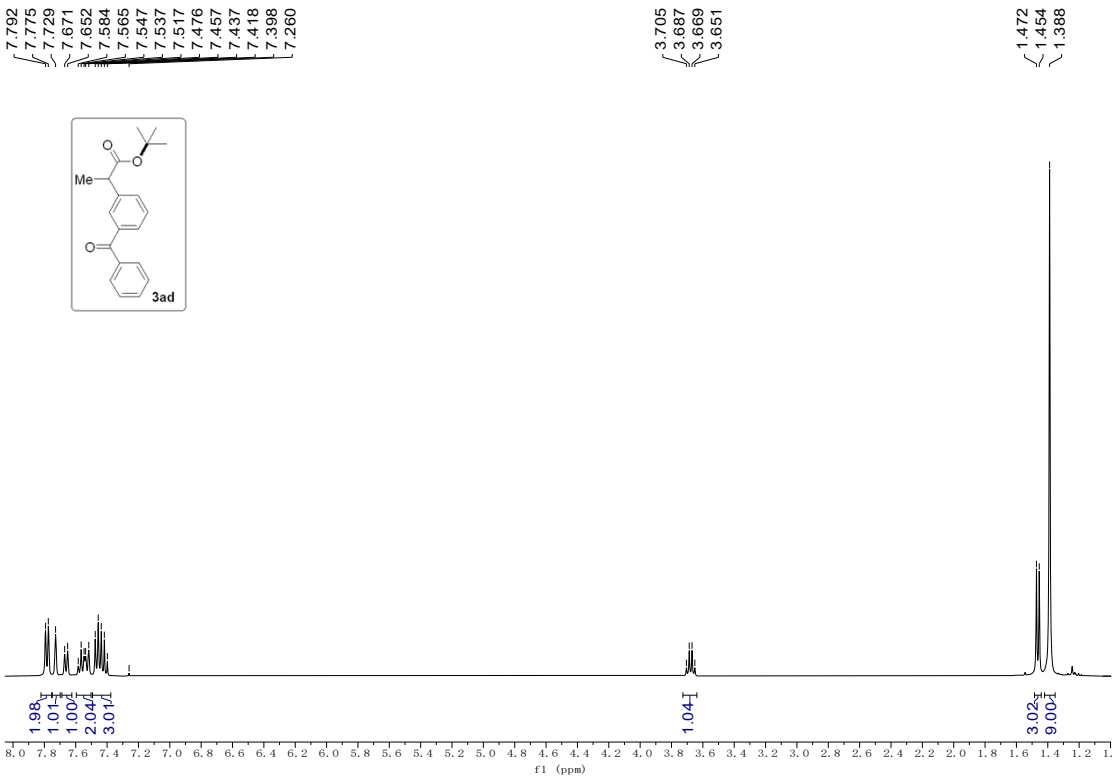
^{13}C NMR (100 MHz, $CDCl_3$) of product **3ab**



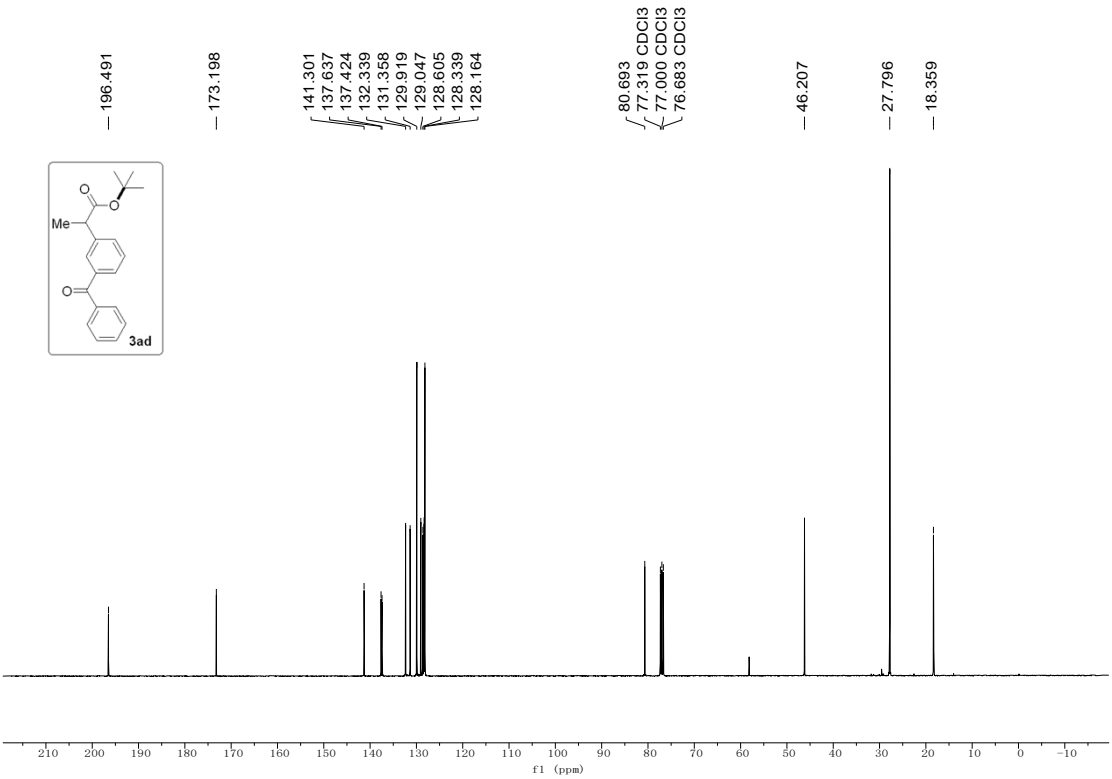
^{1}H NMR (400 MHz, $CDCl_3$) of product **3ac**



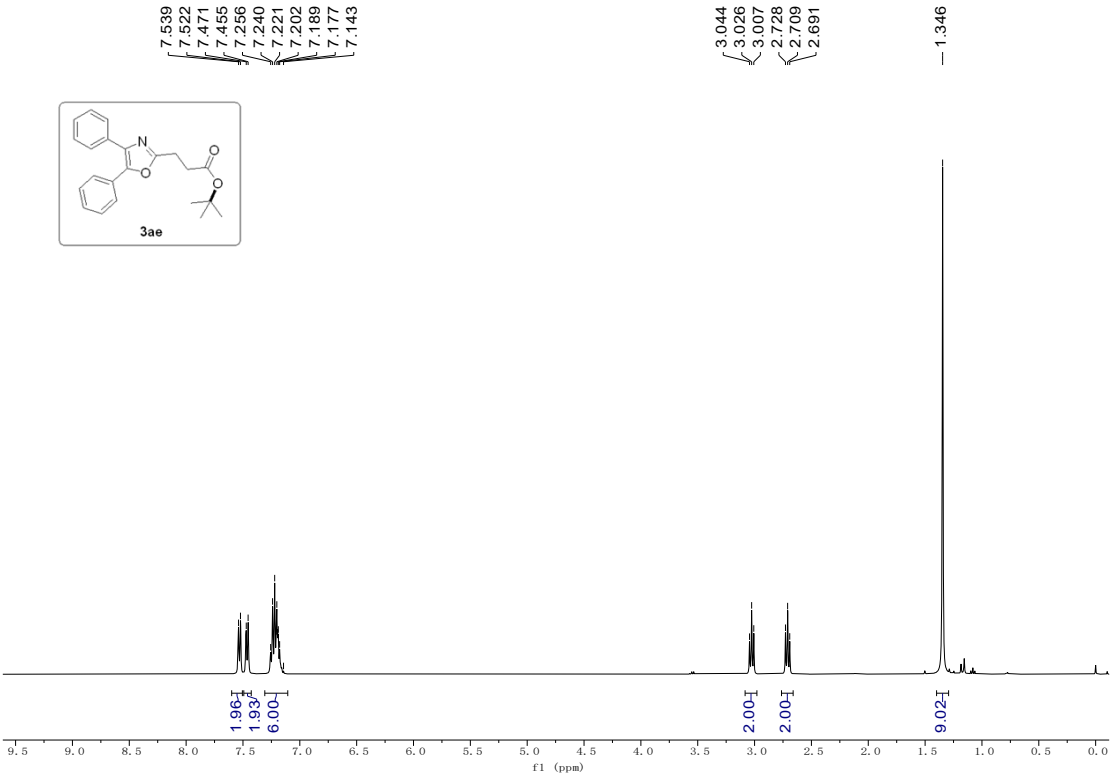
^{13}C NMR (100 MHz, $CDCl_3$) of product **3ac**



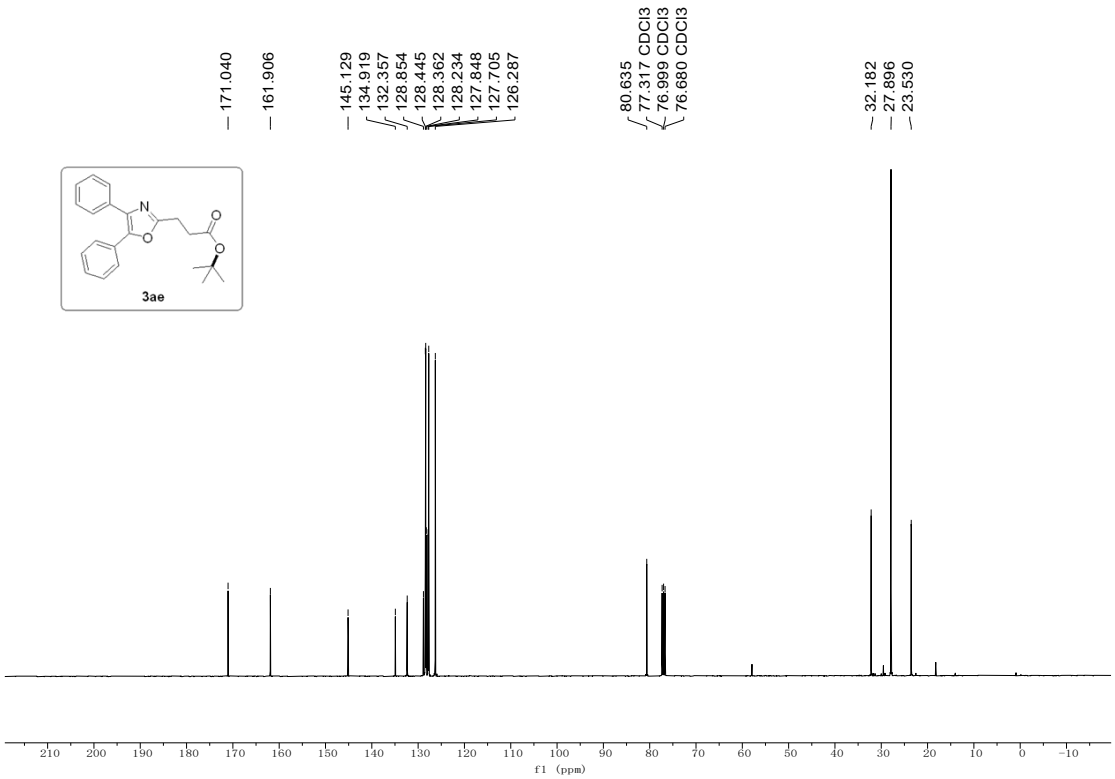
^{1}H NMR (400 MHz, $CDCl_3$) of product **3ad**



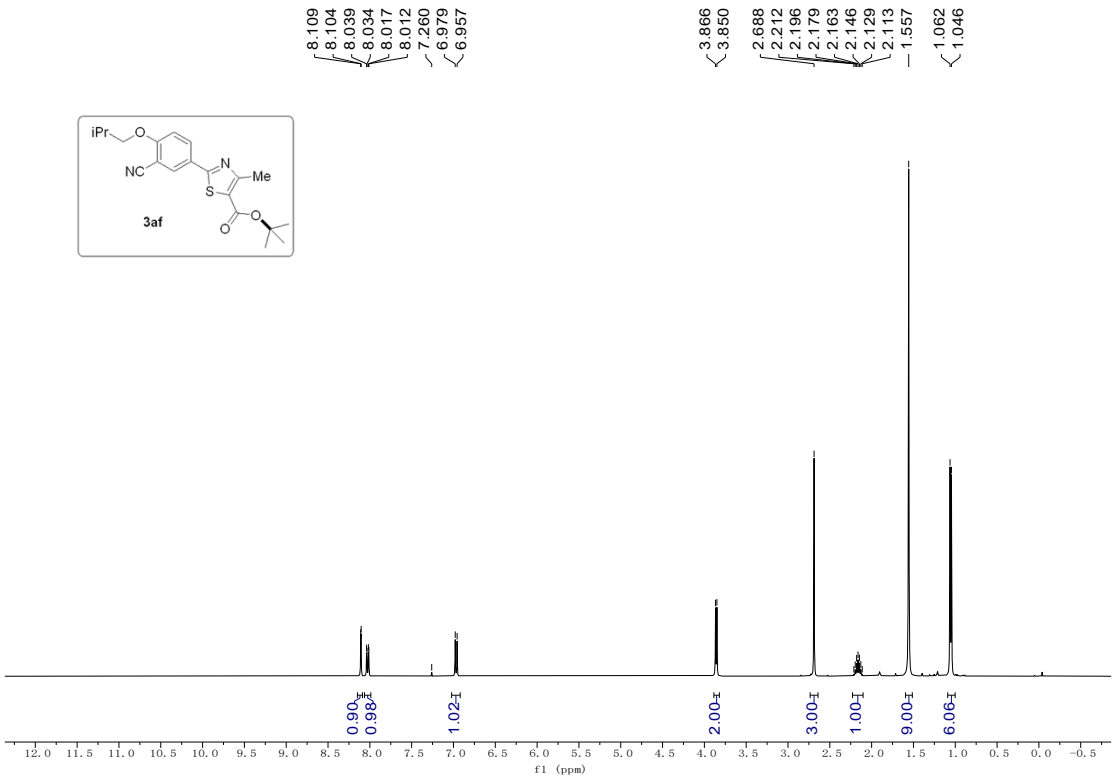
^{13}C NMR (100 MHz, $CDCl_3$) of product **3ad**



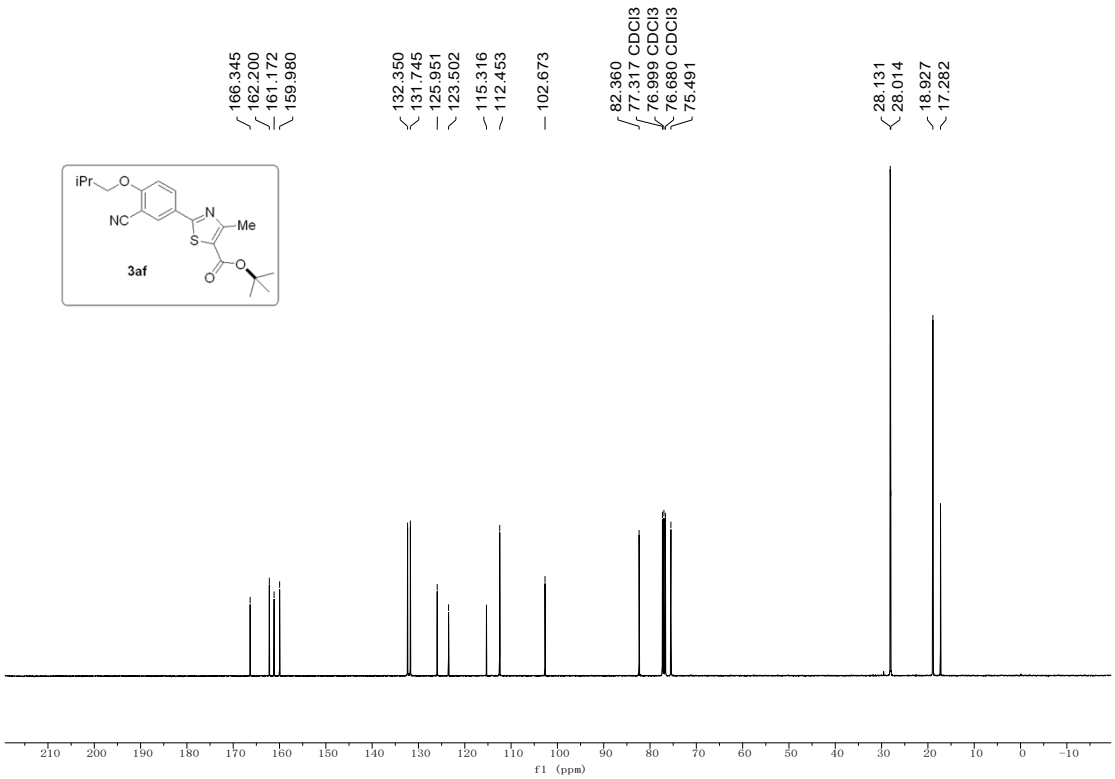
^{1}H NMR (400 MHz, $CDCl_3$) of product **3ae**



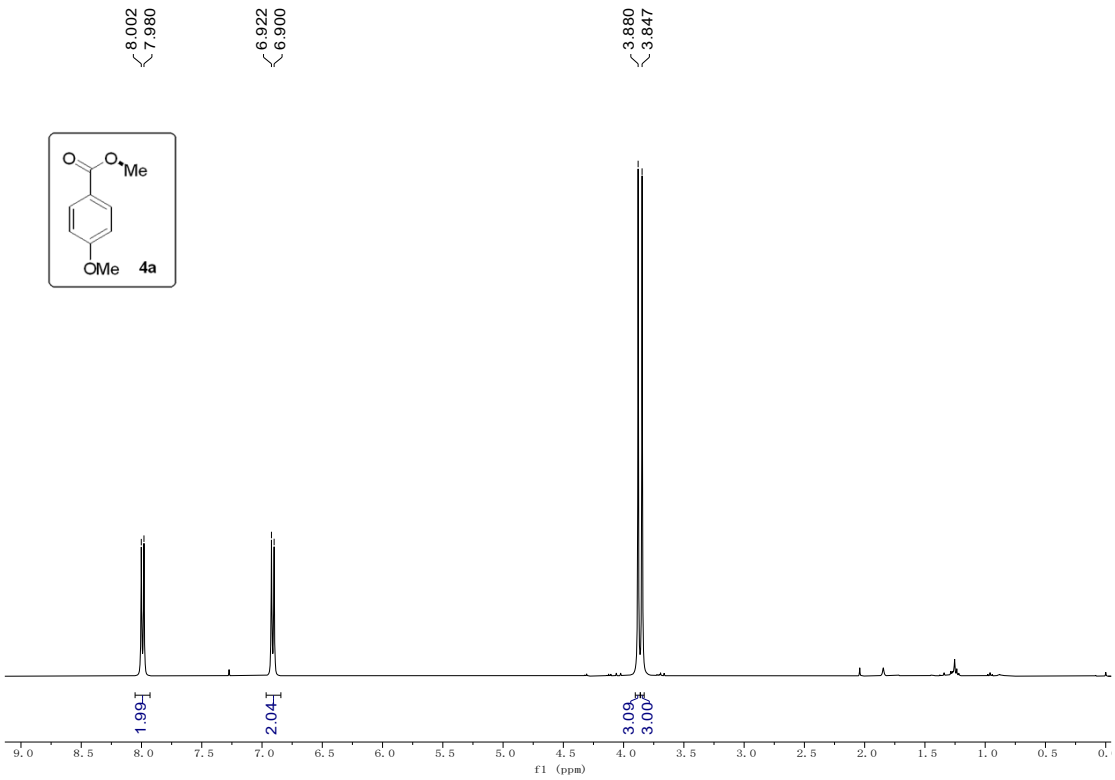
^{13}C NMR (100 MHz, $CDCl_3$) of product **3ae**



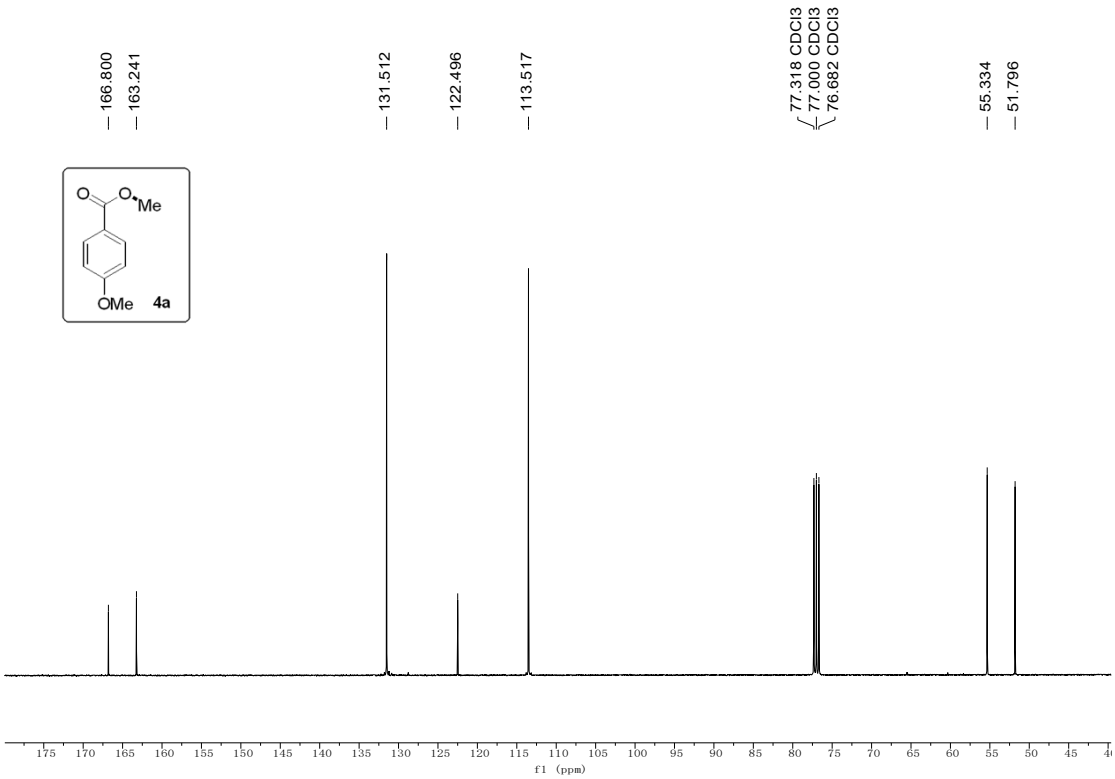
^{1}H NMR (400 MHz, $CDCl_3$) of product **3af**



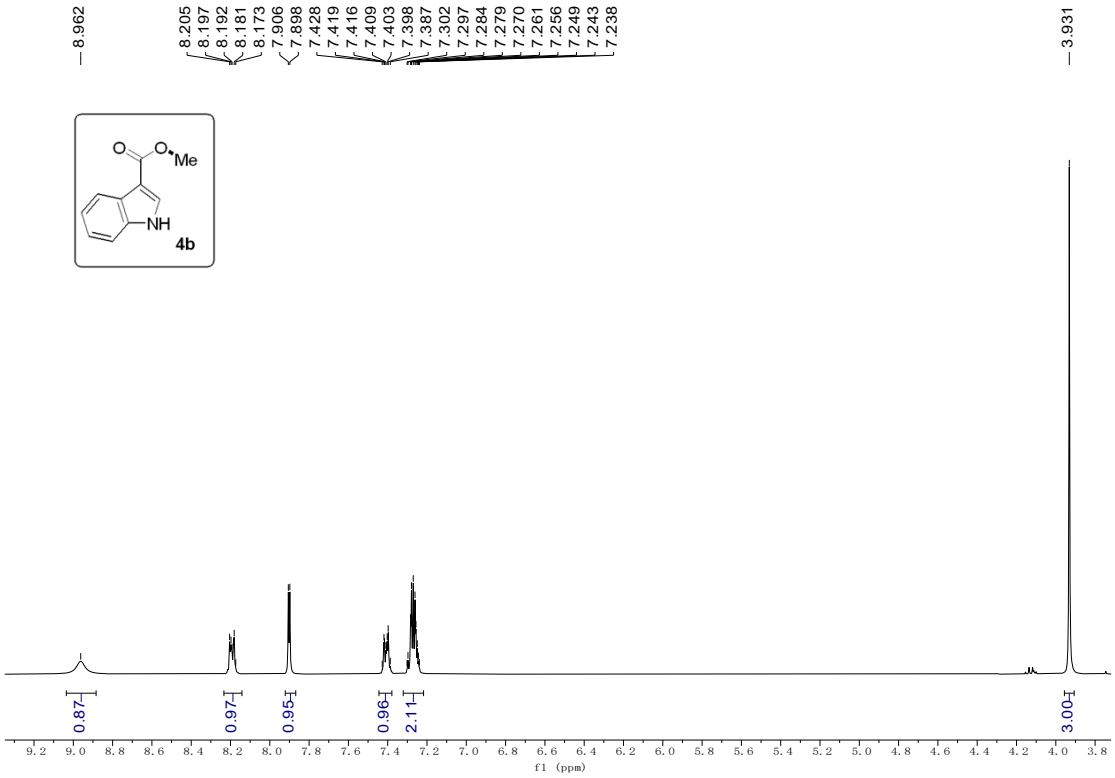
^{13}C NMR (100 MHz, $CDCl_3$) of product **3af**



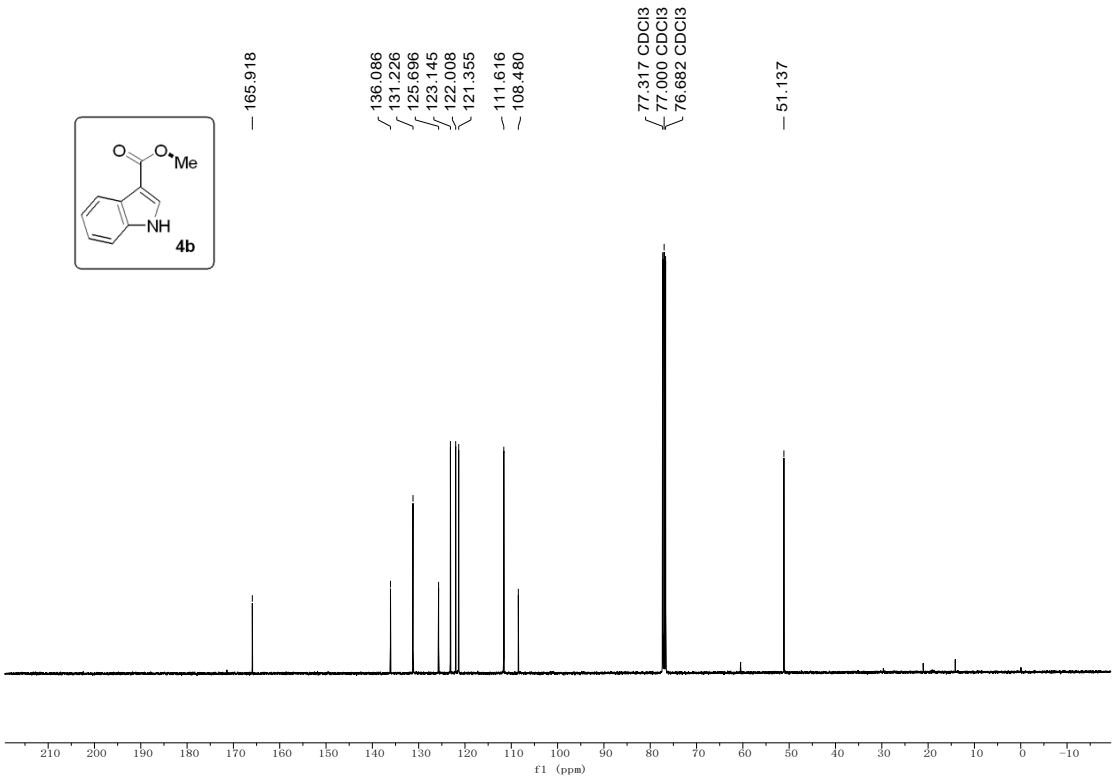
^{1}H NMR (400 MHz, $CDCl_3$) of product **4a**



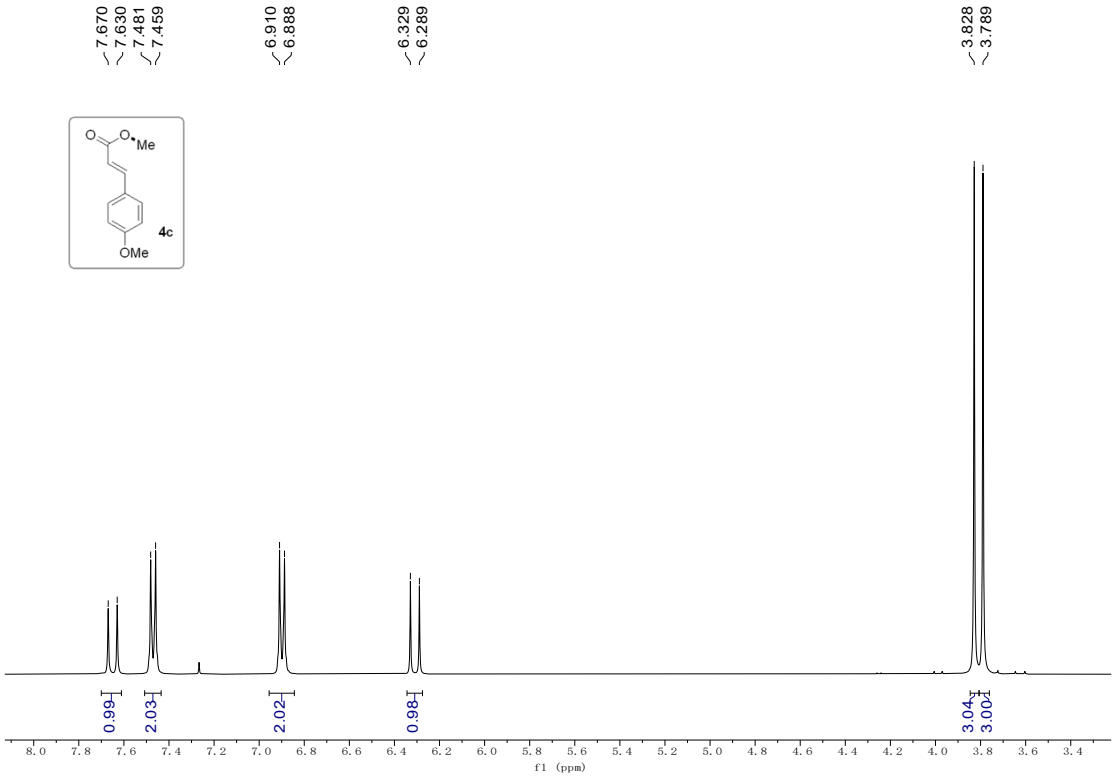
^{13}C NMR (100 MHz, $CDCl_3$) of product **4a**



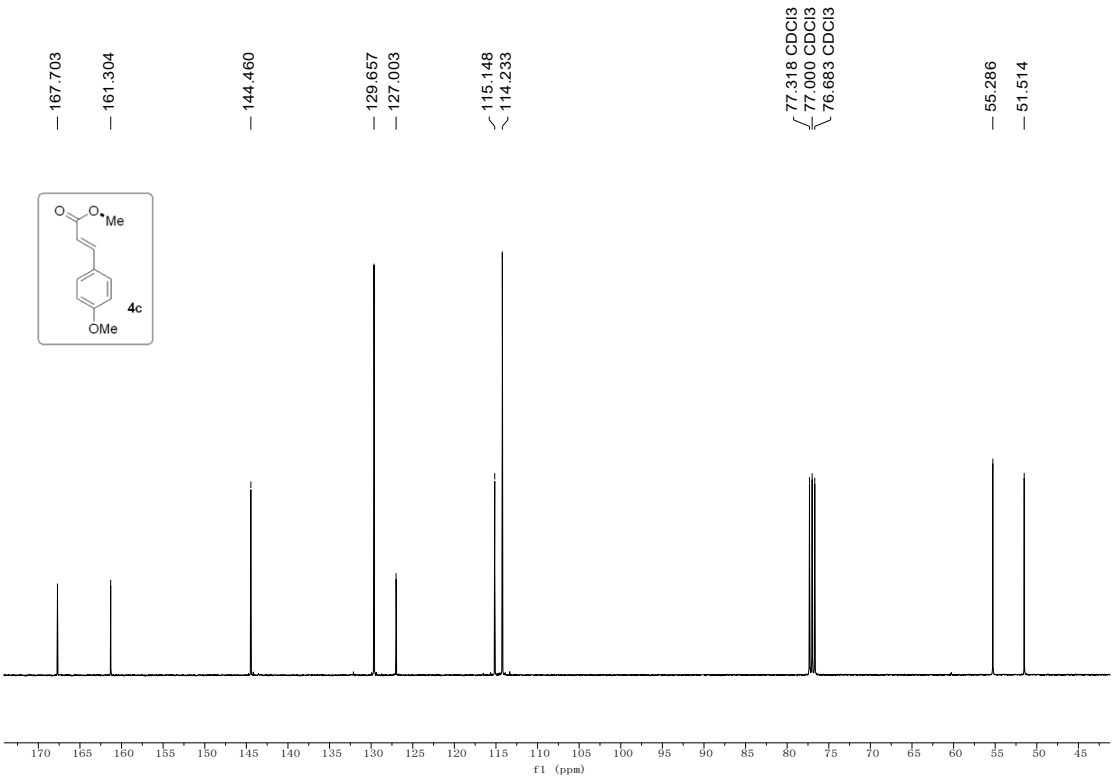
^{1}H NMR (400 MHz, $CDCl_3$) of product **4b**



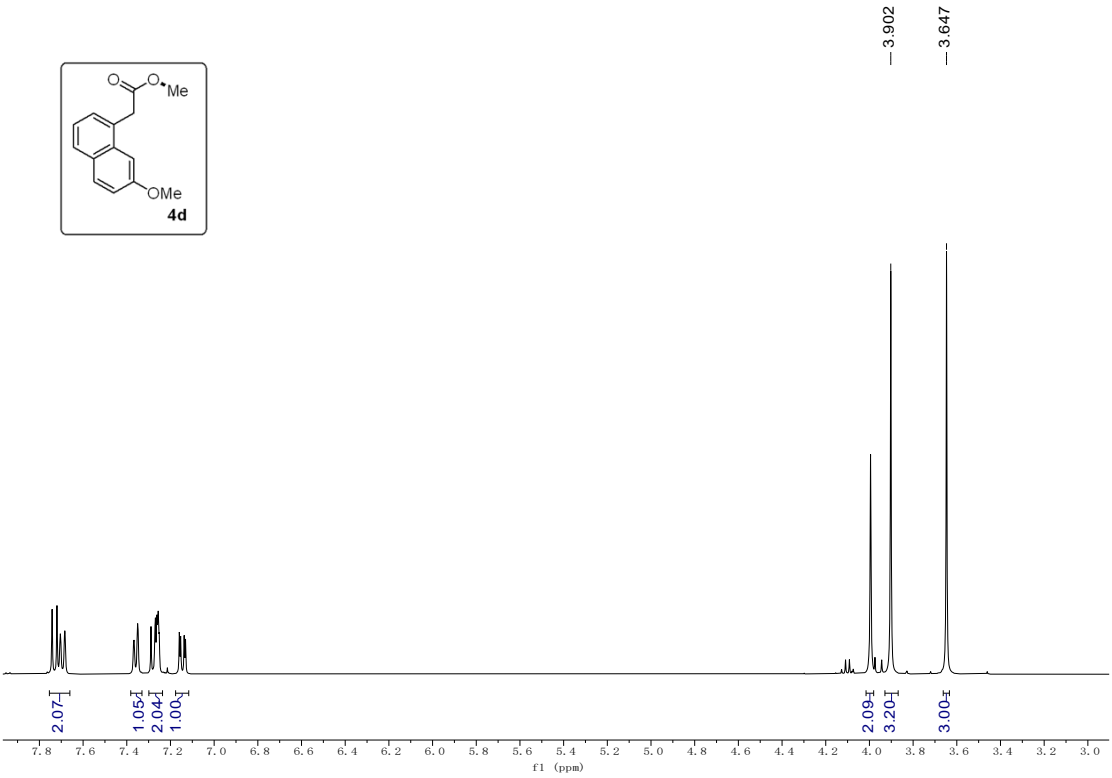
^{13}C NMR (100 MHz, $CDCl_3$) of product **4b**



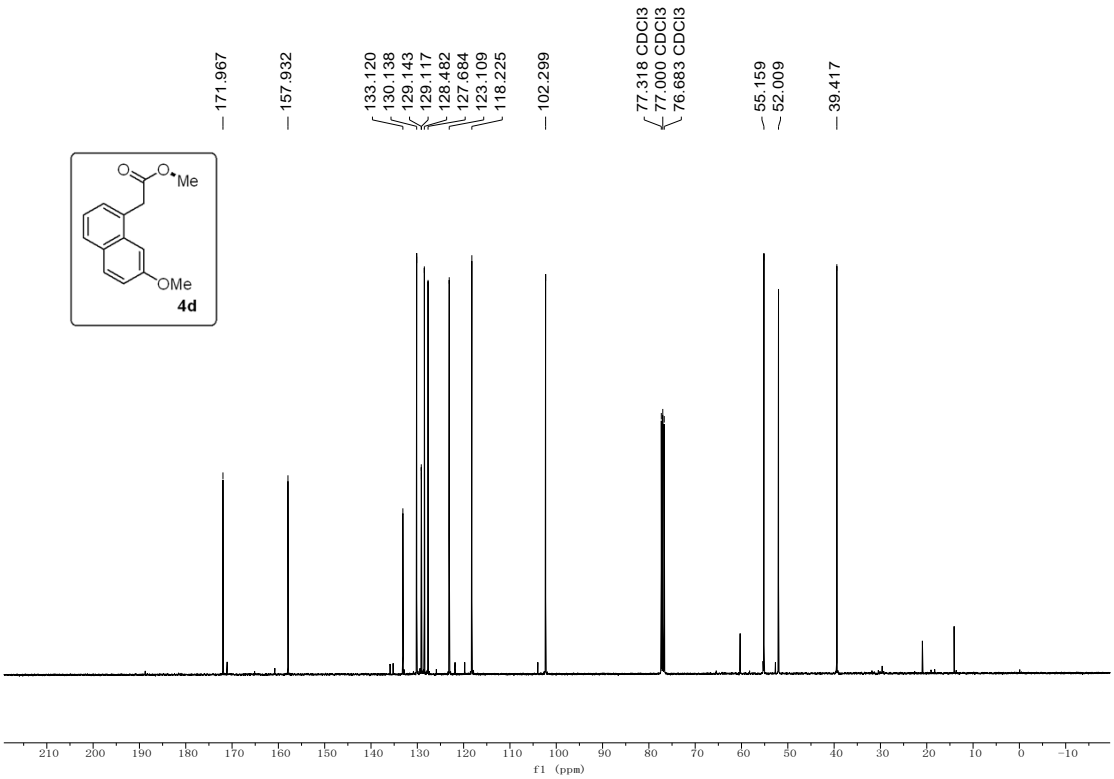
^{1}H NMR (400 MHz, $CDCl_3$) of product **4c**



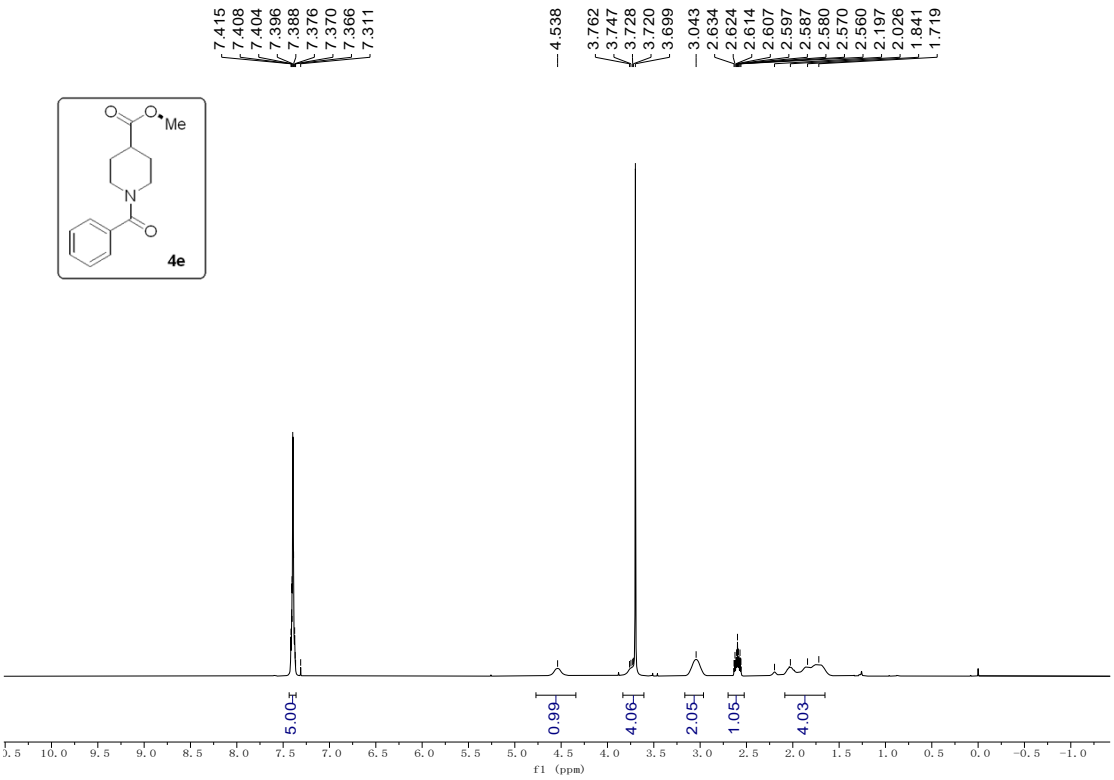
^{13}C NMR (100 MHz, $CDCl_3$) of product **4c**



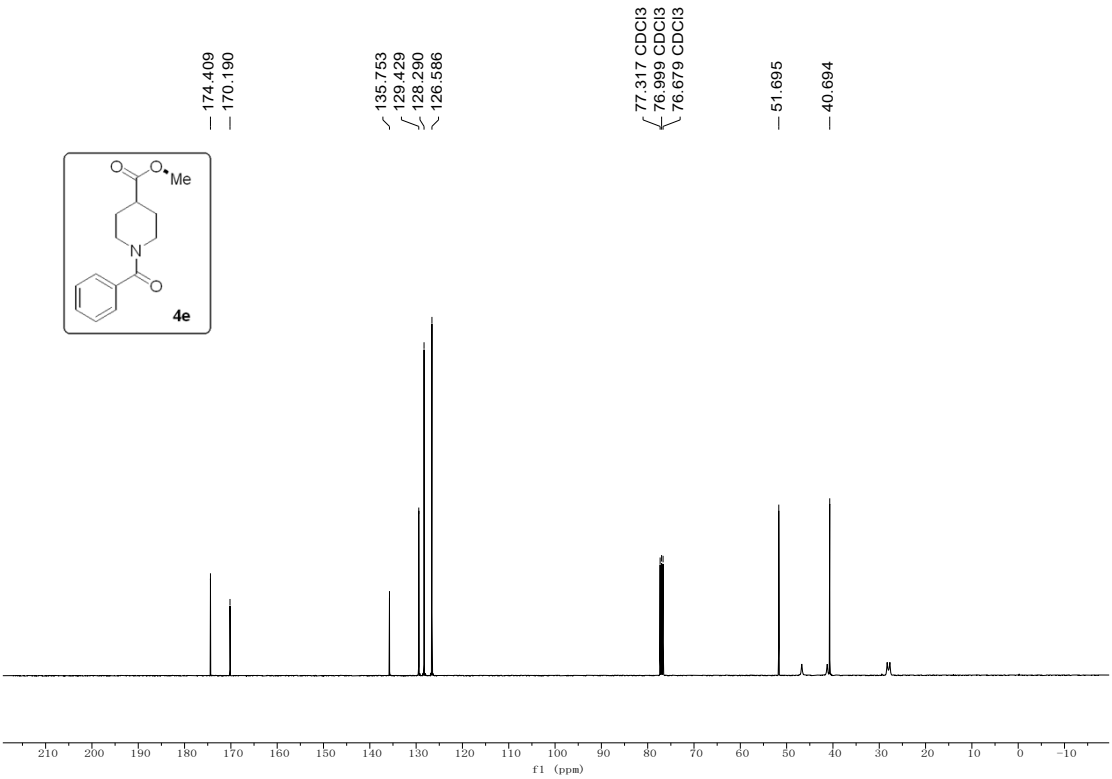
^{1}H NMR (400 MHz, $CDCl_3$) of product **4d**



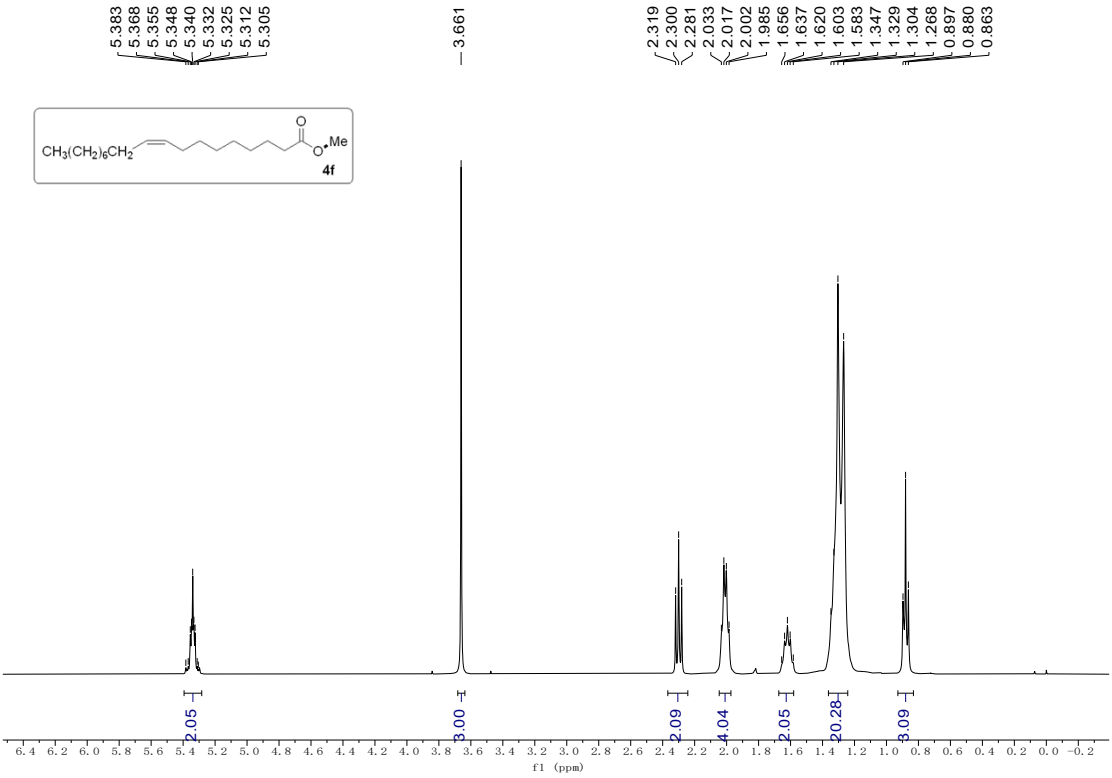
^{13}C NMR (100 MHz, $CDCl_3$) of product **4d**



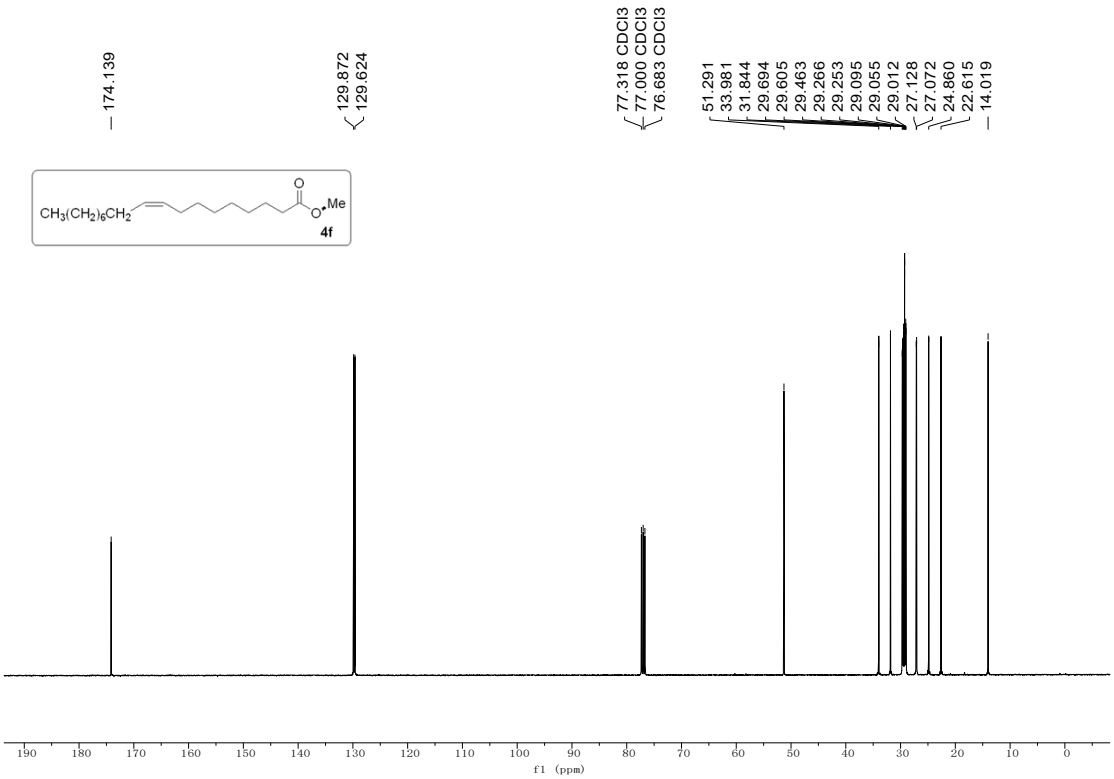
^{1}H NMR (400 MHz, $CDCl_3$) of product **4e**



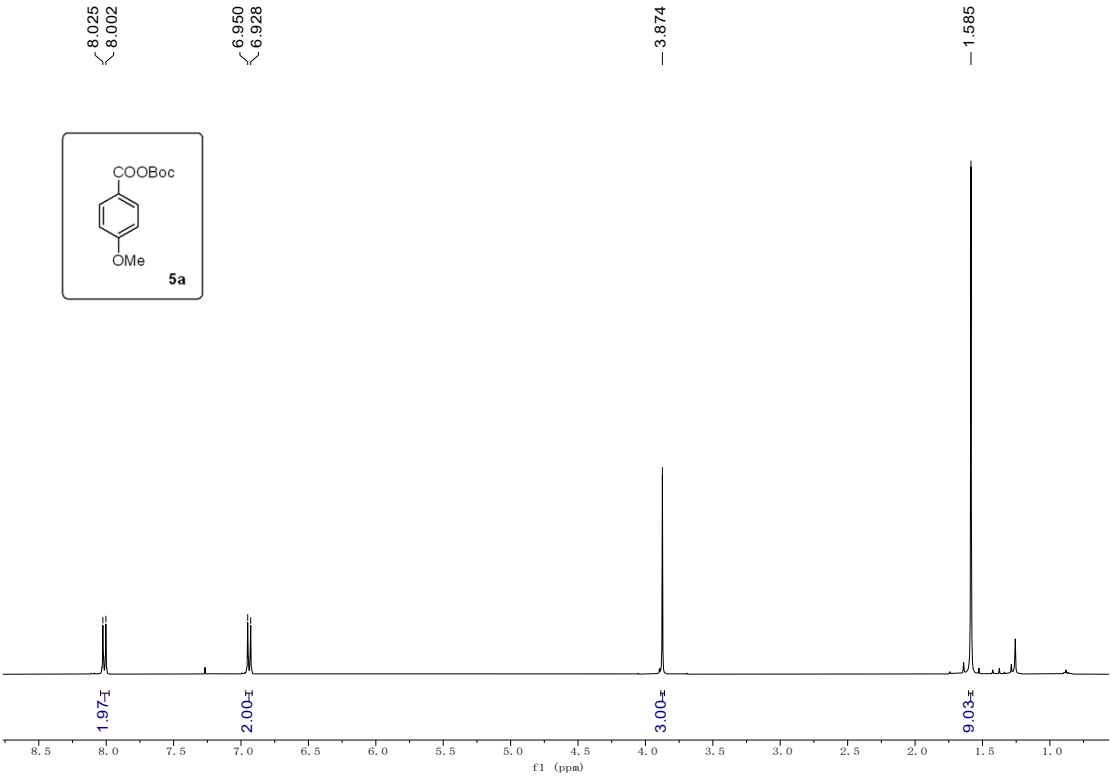
^{13}C NMR (100 MHz, $CDCl_3$) of product **4e**



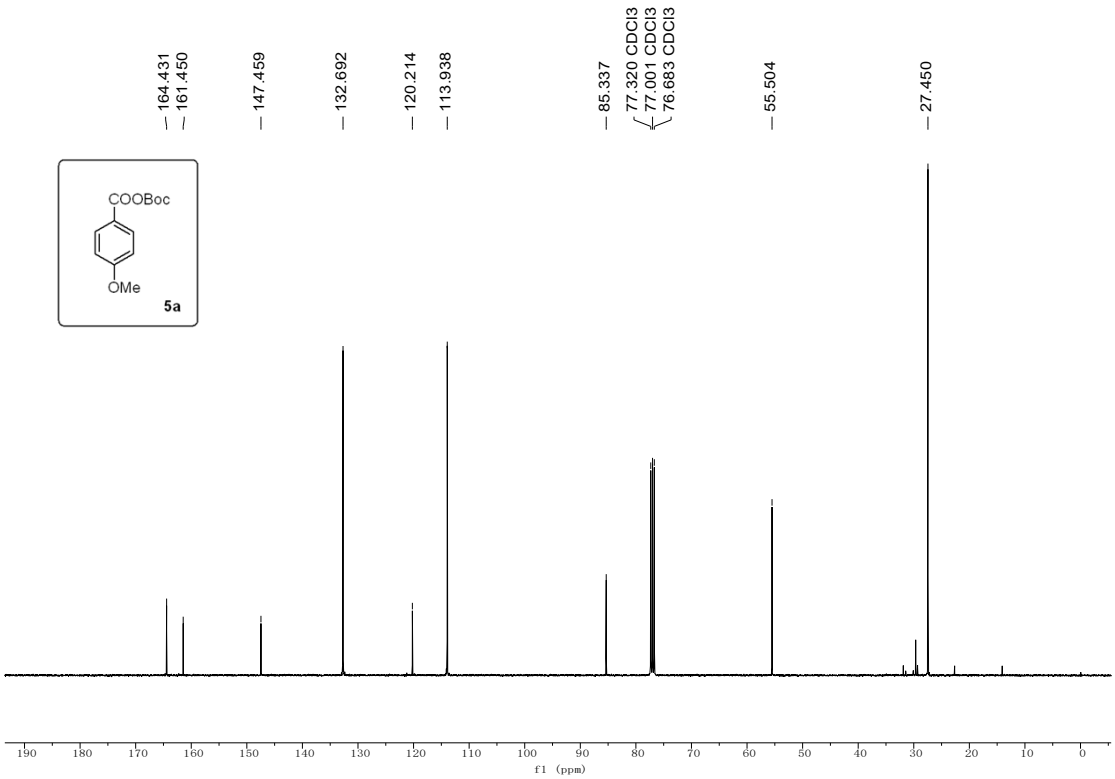
^{1}H NMR (400 MHz, $CDCl_3$) of product **4f**



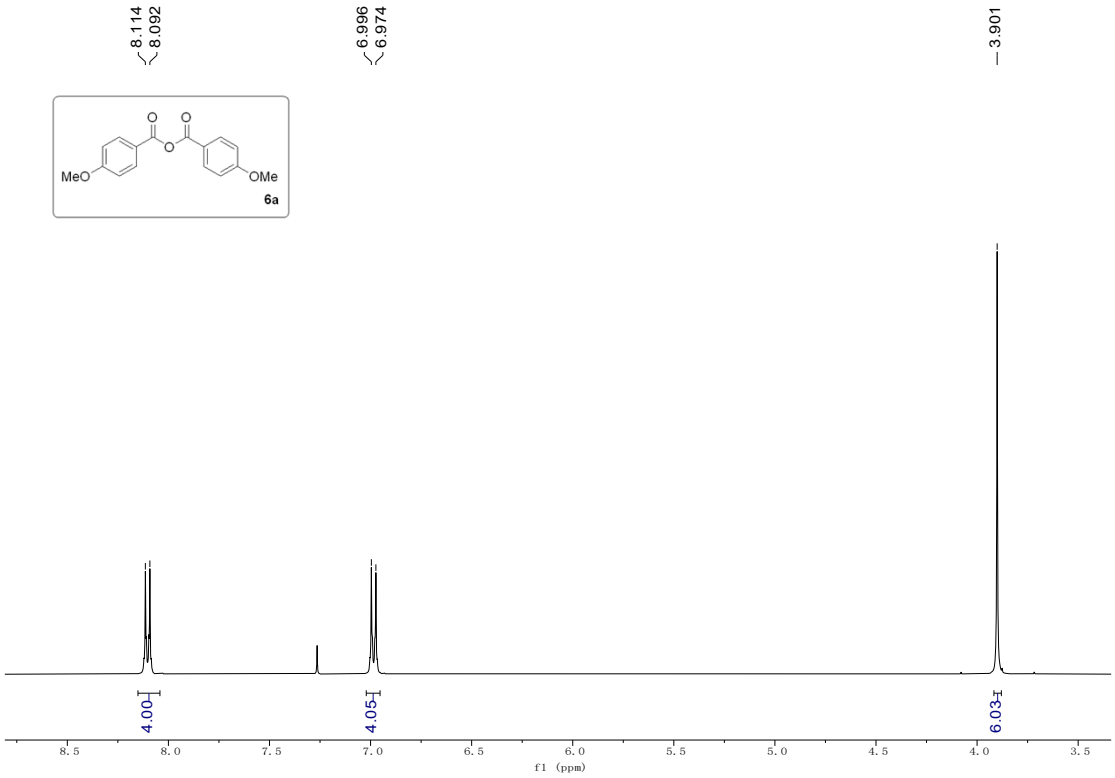
^{13}C NMR (100 MHz, $CDCl_3$) of product **4f**



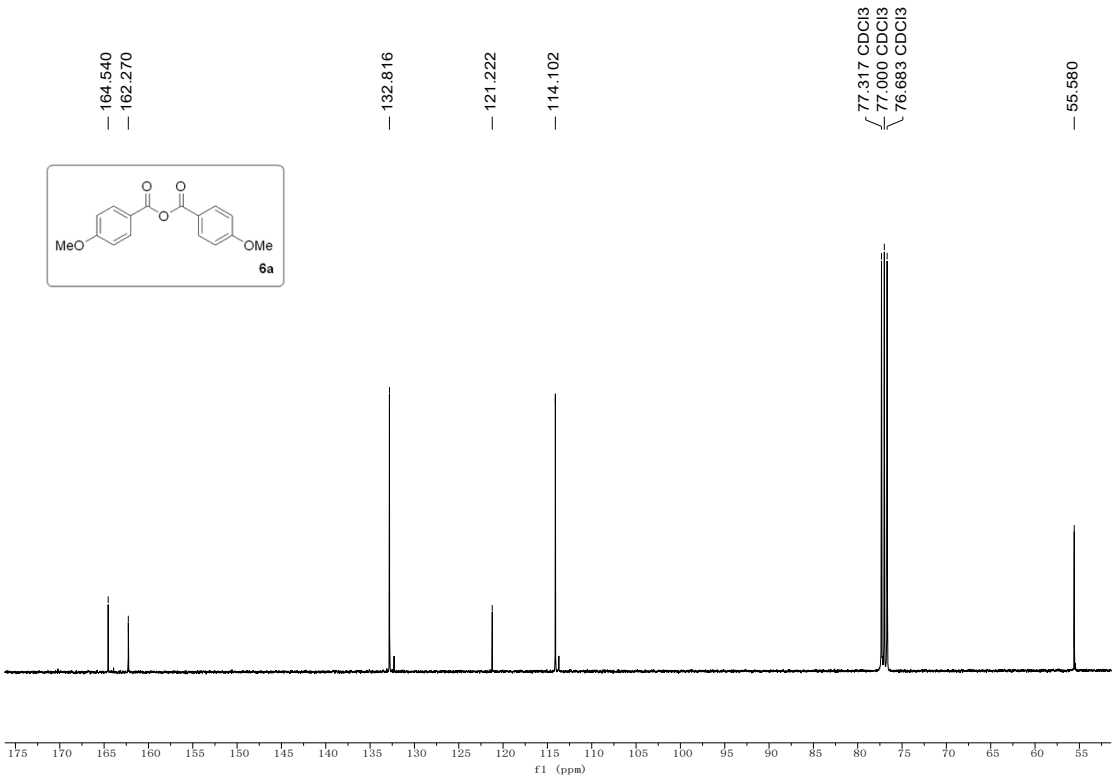
^{1}H NMR (400 MHz, $CDCl_3$) of product **5a**



^{13}C NMR (100 MHz, $CDCl_3$) of product **5a**



^{1}H NMR (400 MHz, $CDCl_3$) of product **6a**



^{13}C NMR (100 MHz, $CDCl_3$) of product **6a**