

Supporting Information

Palladium/copper-catalyzed oxidative coupling of arylboronic acids with isocyanides: Selective routes to amides and diaryl ketones

Fangling Lu,^a Ziyue Chen,^a Zhen Li,^a Xiaoyan Wang,^a Xinyue Peng,^a Cong Li,^a Lingtong Fang,^a
Dong Liu,^b Meng Gao^{*a} and Aiwen Lei^{*ab}

^aNational Research Center for Carbohydrate Synthesis, Jiangxi Normal University, Nanchang, Jiangxi 330022, P. R. China

^bCollege of Chemistry and Molecular Sciences, the Institute for Advanced Studies (IAS), Wuhan University, Wuhan, Hubei 430072, P. R. China.

E-mail: aiwenlei@whu.edu.cn

General information.....	S2
General procedure.....	S3
Gram-Scale Experiments	S4
¹⁸ O-Labeling Experiments	S4
Effect of different amount of H ₂ O on this reaction.....	S6
Detailed descriptions for products.....	S6

General Information

Unless otherwise noted, all the reagents were purchased and used without further purification. O¹⁸ labeled water was purchased from Aladdin (O¹⁸ purity: 97 atom%). Thin layer chromatography (TLC) employed glass 0.25 mm silica gel plates. Flash chromatography columns were packed with 200-300 mesh silica gel in petroleum (boiling point is between 60-90 °C). NMR spectra were recorded on a Bruker spectrometer at 400 MHz (¹H NMR), 100 MHz (¹³C NMR). Tetramethylsilane was used as an internal standard. All ¹H NMR spectra were reported in delta (δ) units, parts per million (ppm) downfield from the internal standard. Coupling constants are reported in Hertz (Hz). Selective ratios were recorded with a Varian GC 2000 gas chromatography instrument with a FID detector. GC-MS spectra were recorded on a Varian GC-MS 3900-2100T and Shimadzu GCMS-QP2010SE.

General Procedures

N-tert-butyl-1-naphthamide (3a).

PdCl₂ (0.03 mmol, 5.4 mg), Cu(OH)₂ (0.12 mmol, 11.7 mg) and Phenylboronic Acid (0.3 mmol, 36.6 mg) were added into an oven-dried Schlenk tube equipped with a magnetic stirred bar. And toluene (1 mL), t-BuNC (0.36 mmol, 29.9 mg) (*Note: isocyanides are quite toxic reagents and stinking, please handle them with caution*) were injected in Schlenk tube. The Schlenk tube was then heated up to 100 °C and kept stirring for 16 hours. After completion of the reaction, as indicated by TLC and GC-MS, The pure product (yield 75%, 39.8 mg) was obtained by flash column chromatography on silica gel (petroleumether : ethyl acetate = 70 : 1).

N-tert-butyl-1-naphthamide (4a).

PdCl₂ (0.03 mmol, 5.4 mg), Cu(OH)₂ (0.12 mmol, 11.7 mg) , NH₄Cl (0.6 mmol, 32.4 mg) and Phenylboronic Acid (1.5 mmol, 183 mg) were added into an oven-dried Schlenk tube equipped with a magnetic stirred bar. And Tol (3 mL), t-BuNC (0.3 mmol, 24.9 mg) were injected in the Schlenk tube through a syringe in turn. The Schlenk tube was then heated up to 100 °C and kept stirring for 16 hours. After completion of the reaction, as indicated by TLC and GC-MS, The pure product (yield 85%, 46.7 mg) was obtained by flash column chromatography on silica gel.

Note: toluene was purchased and used without further purification, which means that it contains small amount of moisture. We believe that the residual moisture in toluene accounts for the formation of final products. Therefore, treatment of additional water after heating is unnecessary.

Gram-Scale Experiments

Synthesis of 3a (460.2 mg): PdCl₂ (0.5 mmol, 88.7 mg), Cu(OH)₂ (2 mmol, 195 mg) and Phenylboronic Acid (5 mmol, 609.7 mg) were added into an oven-dried sealed tube equipped with a magnetic stirred bar. And Tol (10 mL), t-BuNC (6 mmol, 498.8 mg) were injected in the tube through a syringe in turn, which was then put into the sealed tube. The sealed tube was then heated up to 100 °C and kept stirring for 16 hours. After completion of the reaction, the mixture was cooled to room temperature. The solvent was removed under vacuum. The crude product was purified by flash column chromatography (eluting with petroleum ether/ethyl acetate = 70/1) on silica gel to afford product **3a** (460.2 mg, 55% yield).

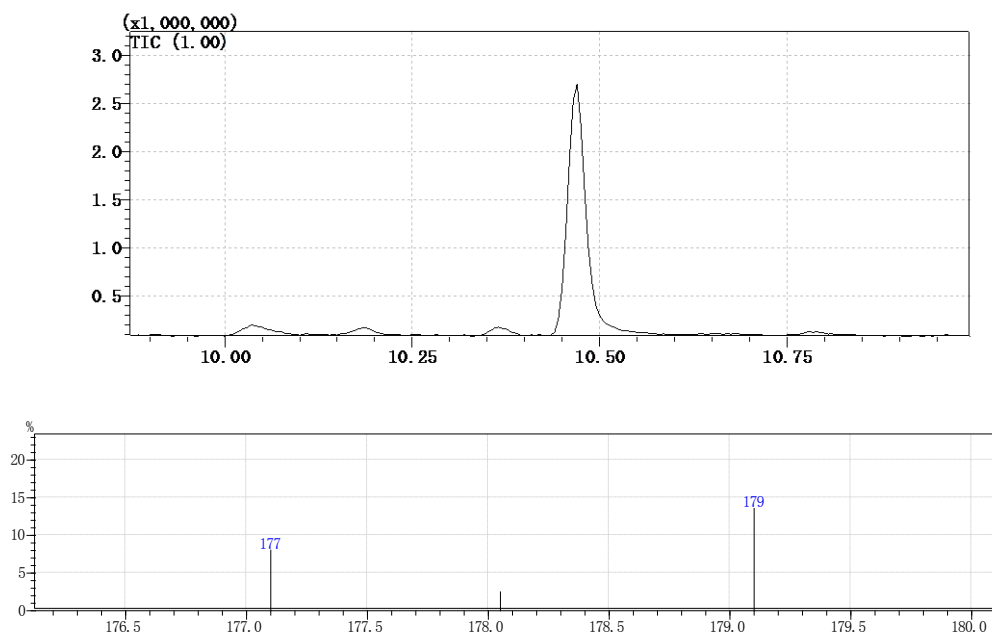
¹⁸O-Labeling Experiments

¹⁸O-Labeling Experiments of 3a: PdCl₂ (0.03 mmol, 5.4 mg), Cu(OH)₂ (0.12 mmol, 11.7 mg) and Phenylboronic Acid (0.3 mmol, 36.6 mg) were added into an oven-dried sealed tube equipped with a magnetic stirred bar. And anhydrous Tol (1 mL), t-BuNC (0.36 mmol, 29.9 mg), H₂¹⁸O (0.9 mmol, 18 mg) were injected in sealed tube. The sealed tube was then heated up to 100 °C and kept stirring for 16 hours. After completion of the reaction, then the mixture was detected by GC-MS. The ¹⁸O/¹⁶O ratio was 67:33.

¹⁸O-Labeling Experiments of 4a: PdCl₂ (0.03 mmol, 5.4 mg), Cu(OH)₂ (0.12 mmol, 11.7 mg), NH₄Cl (0.6 mmol, 32.4 mg) and Phenylboronic Acid (1.5 mmol, 183 mg) were added into an oven-dried sealed tube equipped with a magnetic stirred bar. And anhydrous Tol (3 mL), t-BuNC (0.3 mmol, 24.9 mg), H₂¹⁸O (0.9 mmol, 18

mg) were injected in the sealed tube through a syringe in turn. The sealed tube was then heated up to 100 °C and kept stirring for 16 hours. Then the mixture was detected by GC-MS. The $^{18}\text{O}/^{16}\text{O}$ ratio was 75:25.

^{18}O -Labeling Experiments of 3a

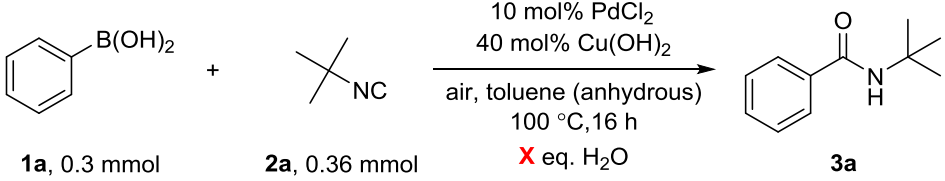


^{18}O -Labeling Experiments of 4a



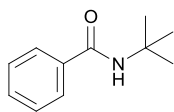
Effect of different amount of H₂O on this reaction

PdCl₂ (0.03 mmol, 5.4 mg), Cu(OH)₂ (0.12 mmol, 11.7 mg) and Phenylboronic Acid (0.3 mmol, 36.6 mg) were added into an oven-dried sealed tube equipped with a magnetic stirred bar. And anhydrous Tol (1 mL), t-BuNC (0.36 mmol, 29.9 mg), H₂O (X equiv) were injected in sealed tube. The Schlenk tube was then heated up to 100 °C and kept stirring for 16 hours. After completion of the reaction, the mixture was cooled to room temperature. The solvent was removed under vacuum. The crude product was purified by flash column chromatography (eluting with petroleum ether/ethyl acetate = 70/1) on silica gel to afford product **3a**.

		
1a , 0.3 mmol	2a , 0.36 mmol	3a
Entry	X	Yield/ %
1	1	50
2	3	73
3	5	74
4	7	70
5	9	60
6	15	trace
7	0	trace

1.0 mL anhydrous toluene was used in each reaction. Isolated yield.

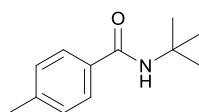
Detailed descriptions for products



***N*-tert-butylbenzamide (3a).¹**

(Isolated yield: 75%, white solid, 39.8 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.71 (d, *J* = 8.0 Hz, 2H), 7.43-7.46 (m, 1H), 7.38 (t, *J* = 8.0 Hz, 2H), 6.03 (s, 1H), 1.47 (s, 9H);

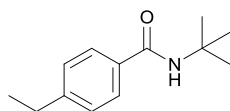
¹³C NMR (100 MHz, CDCl₃): δ 167.0, 136.0, 131.0, 128.4, 126.7, 51.6, 28.9.



***N*-tert-butyl-4-methylbenzamide (3b).¹**

(Isolated yield: 71%, white solid, 40.7 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.61 (d, *J* = 8.0 Hz, 2H), 7.20 (d, *J* = 8.0 Hz, 2H), 5.93 (s, 1H), 2.38 (s, 3H), 1.46 (s, 9H); ¹³C

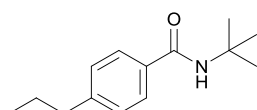
NMR (100 MHz, CDCl₃): δ 166.9, 141.4, 133.1, 129.1, 126.7, 51.5, 28.9, 21.4.



***N*-tert-butyl-4-ethylbenzamide (3c).¹**

(Isolated yield: 68%, white solid, 41.8 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.64 (d, *J* = 8.0 Hz, 2H), 7.22 (d, *J* = 8.0 Hz, 2H), 5.94 (s, 1H), 2.65-2.30 (m, 2H), 1.46 (s, 9H),

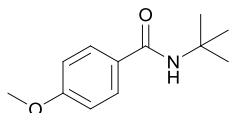
1.22 (d, *J* = 8.0 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃): δ 166.9, 147.7, 133.3, 127.9, 126.8, 51.5, 28.9, 28.7, 15.4.



***N*-(tert-butyl)-4-propylbenzamide (3d).**

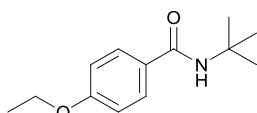
(Isolated yield: 62%, white solid, 40.8 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.63 (d, *J*

= 8.0 Hz, 2H), 7.20 (d, J = 8.0 Hz, 2H), 5.96 (s, 1H), 2.61 (t, J = 8.0 Hz, 2H), 1.64 (d, J = 8.0 Hz, 2H), 1.46 (s, 9H), 0.92 (t, J = 8.0 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 167.0, 146.1, 133.3, 128.6, 126.7, 51.5, 37.8, 28.9, 24.3, 13.7.



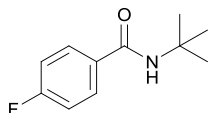
***N*-(*tert*-butyl)-4-methoxybenzamide (3e).¹**

(Isolated yield: 62%, white solid, 43.5 mg); ^1H NMR (400 MHz, CDCl_3): δ 7.68 (d, J = 8.0 Hz, 2H), 6.88 (d, J = 8.0 Hz, 2H), 5.93 (s, 1H), 3.82 (d, J = 8.0 Hz, 3H), 1.46 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 166.4, 161.9, 128.5, 128.3, 113.6, 55.4, 51.4, 28.9.



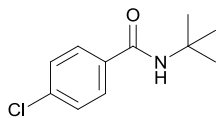
***N*-*tert*-butyl-4-ethoxybenzamide. (3f).¹**

(Isolated yield: 52%, white solid, 34.5 mg); ^1H NMR (400 MHz, CDCl_3): δ 7.67 (d, J = 8.0 Hz, 2H), 6.86 (d, J = 8.0 Hz, 2H), 4.02-4.07 (m, 2H), 1.46 (s, 9H), 1.41 (d, J = 8.0 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 166.5, 161.2, 128.4, 128.0, 114.1, 63.6, 51.4, 28.9, 14.7.



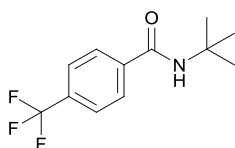
***N*-*tert*-butyl-4-fluorobenzamide (3g).¹**

(Isolated yield: 45%, white solid, 26.3 mg); ^1H NMR (400 MHz, CDCl_3): δ 7.70-7.74 (m, 2H), 7.02-7.07 (m, 2H), 6.03 (s, 1H), 1.46 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 165.9, 165.7, 163.2, 132.2, 132.1, 129.1, 129.0, 115.4, 115.2, 51.7, 28.8.



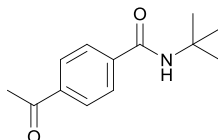
***N*-tert-butyl-4-chlorobenzamide (3h).¹**

(Isolated yield: 65%, white soild, 41.2 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.65 (d, J = 8.0 Hz, 2H), 7.36 (d, J = 8.0Hz, 2H), 5.99 (s, 1H), 1.46 (s, 9H); ¹³C NMR (100 MHz, CDCl₃): δ 165.8, 137.2, 134.3, 128.6, 128.2, 51.8, 28.8.



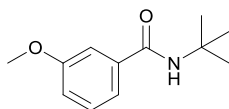
***N*-tert-butyl-4-(trifluoromethyl)benzamide (3i).¹**

(Isolated yield: 52%, white soild, 38.3 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.82 (d, J = 8.0 Hz, 2H), 7.66 (d, J = 8.0 Hz, 2H), 6.00 (s, 1H), 1.48 (s, 9H); ¹³C NMR (100 MHz, CDCl₃): δ 165.7, 139.3, 133.0, 132.7, 127.2, 125.1, 125.6, 122.4, 52.0, 28.8.



4-acetyl-N-tert-butylbenzamide(3j).¹

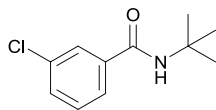
(Isolated yield: 46%, white soild, 30.2 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.99 (d, J = 8.0 Hz, 2H), 7.80 (d, J = 8.0 Hz, 2H), 6.0 (s, 1H), 2.63 (s, 3 H), 1.49 (s, 9H); ¹³C NMR (100 MHz, CDCl₃): δ 197.5, 165.9, 139.9, 138.9, 128.5, 127.0, 52.0, 28.9, 26.7.



***N*-tert-butyl-3-methoxybenzamide (3k).²**

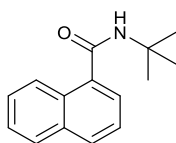
(Isolated yield: 65%, white soild, 40.4 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.33 (s, 1H), 7.28 (t, J= 8.0 Hz, 1H), 7.22 (s, 1H), 6.99 (d, J= 8.0 Hz, 1H), 6.02 (s, 1H), 3.82

(s, 3H), 1.46 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 166.7, 159.8, 137.4, 129.4, 118.4, 117.3, 112.2, 55.4, 51.6, 28.8.



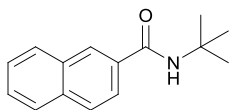
***N*-tert-butyl-3-chlorobenzamide (3l).²**

(Isolated yield: 45%, white solid, 28.6 mg); ^1H NMR (400 MHz, CDCl_3): δ 7.69 (s, 1H), 7.58 (d, J = 8.0 Hz, 1H), 7.43 (d, J = 8.0 Hz, 1H), 7.33 (t, J = 8.0 Hz, 1H), 5.95 (s, 1H), 1.47 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 165.6, 137.8, 134.6, 131.1, 129.8, 127.1, 124.9, 51.9, 28.8.



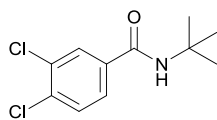
***N*-tert-butyl-1-naphthamide (3m).²**

(Isolated yield: 71%, white solid, 48.4 mg); ^1H NMR (400 MHz, CDCl_3): δ 8.25 (d, J = 8.0 Hz, 1H), 7.83 (t, J = 8.0 Hz, 2H), 7.46-7.54 (m, 3H), 7.39 (t, J = 8.0 Hz, 1H), 5.84 (s, 1H), 1.51 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 169.2, 136.0, 133.7, 130.1, 130.0, 128.3, 126.9, 126.3, 125.4, 124.8, 124.4, 52.0, 28.9.



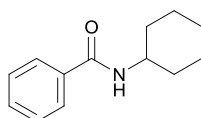
***N*-tert-butyl-2-naphthamide (3n).¹**

(Isolated yield: 68%, white solid, 46.4 mg); ^1H NMR (400 MHz, CDCl_3): δ 8.21 (s, 1H), 7.84-7.91 (m, 3H), 7.77-7.80 (m, 1H), 7.49-7.56 (m, 2H), 6.11 (s, 1H), 1.52 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 167.0, 134.6, 133.2, 132.7, 128.8, 128.3, 127.7, 127.4, 126.9, 126.7, 123.6, 51.8, 29.0.



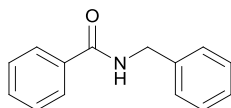
***N*-tert-butyl-3,4-dichlorobenzamide (3o).**

(Isolated yield: 51%, white solid, 37.6 mg); ^1H NMR (400 MHz, CDCl_3): δ 7.77 (s, 1H), 7.49-7.52 (m, 1H), 7.41-7.44 (m, 1H), 6.12 (s, 1H), 1.46 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 164.7, 135.8, 135.3, 132.8, 130.4, 129.0, 126.0, 52.0, 28.8.



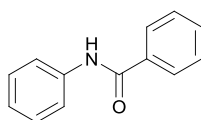
***N*-cyclohexylbenzamide (3p).³**

(Isolated yield: 65%, white solid, 39.6 mg); ^1H NMR (400 MHz, CDCl_3): δ 7.78 (d, J = 8.0 Hz, 2H), 7.43 (t, J = 8.0 Hz, 1H), 7.34 (t, J = 8.0 Hz, 2H), 6.62 (d, J = 8.0 Hz, 1H), 3.89-3.97 (m, 1H), 1.95-1.98 (m, 2H), 1.70-1.74 (m, 2H), 1.59-1.62 (m, 1H), 1.12-1.35 (m, 5H); ^{13}C NMR (100 MHz, CDCl_3): δ 166.8, 135.1, 131.1, 128.4, 127.0, 48.8, 33.1, 25.5, 25.0.



***N*-benzylbenzamide (3q).³**

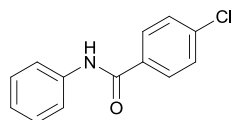
(Isolated yield: 50%, white solid, 31.7 mg); ^1H NMR (400 MHz, CDCl_3): δ 7.79 (d, J = 8.0 Hz, 2H), 7.49 (d, J = 8.0 Hz, 1H), 7.40-7.43 (m, 2H), 7.32-7.35 (m, 4H), 7.27-7.31 (m, 1H), 6.47 (s, 1H), 4.63 (d, J = 8.0 Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 167.4, 138.2, 134.4, 131.6, 128.8, 128.6, 127.9, 127.6, 127.0, 44.2.



***N*-phenylbenzamide (3r).⁴**

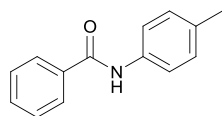
(Isolated yield: 50%, white solid, 29.6 mg); ^1H NMR (400 MHz, $\text{d}^6\text{-DMSO}$): δ 10.30

(s, 1H), 8.02 (d, $J = 8.0$ Hz, 2H), 7.77 (d, $J = 8.0$ Hz, 2H), 7.51-7.58 (m, 3H), 7.38 (t, $J = 8.0$ Hz, 2H), 7.12 (t, $J = 8.0$ Hz, 1H); ^{13}C NMR (100 MHz, $\text{d}^6\text{-DMSO}$): δ 166.1, 139.7, 135.6, 132.0, 129.1, 128.8, 128.2, 124.1, 121.0.



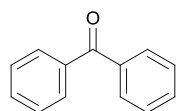
4-chloro-N-phenylbenzamide (3s).⁴

(Isolated yield: 45%, white solid, 31.3 mg); ^1H NMR (400 MHz, $\text{d}^6\text{-DMSO}$): δ 10.43 (s, 1H), 8.01 (d, $J = 8.0$ Hz, 2H), 7.90 (d, $J = 8.0$ Hz, 2H), 7.51-7.59 (m, 3H), 7.41 (d, $J = 8.0$ Hz, 2H). ^{13}C NMR (100 MHz, $\text{d}^6\text{-DMSO}$): δ 166.2, 138.7, 135.3, 132.1, 128.9, 128.8, 128.2, 127.9, 122.4.



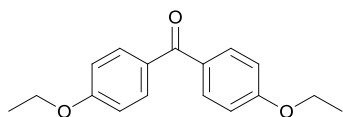
N-p-tolylbenzamide (3t).⁴

(Isolated yield: 45%, white solid, 28.5 mg); ^1H NMR (400 MHz, CDCl_3): δ 7.86 (t, $J = 8.0$ Hz, 2H), 7.52 (d, $J = 8.0$ Hz, 2H), 7.52 (t, $J = 8.0$ Hz, 2H), 7.46 (t, $J = 8.0$ Hz, 2H), 7.16 (d, $J = 8.0$ Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3): δ 166.2, 138.7, 135.3, 132.1, 128.9, 128.8, 128.2, 127.9, 122.4.



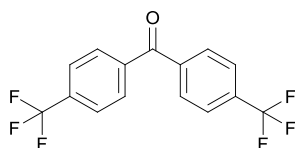
benzophenone (4a).⁵

(Isolated yield: 85%, white solid, 46.4 mg); ^1H NMR (400 MHz, CDCl_3): δ 7.81-7.79 (m, $J = 8.0$ Hz, 2H), 7.58 (t, $J = 8.0$ Hz, 1H), 7.48 (t, $J = 8.0$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 196.8, 137.6, 132.5, 130.1, 128.3.



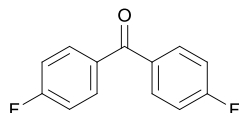
bis(4-ethoxyphenyl)methanone (4b).⁶

(Isolated yield: 63%, white solid, 51.1 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.77 (d, *J* = 8.0 Hz, 4H), 6.93 (d, *J* = 8.0 Hz, 4H), 4.10 (d, *J* = 8.0 Hz, 4H), 1.44 (t, *J* = 8.0 Hz, 4H); ¹³C NMR (100 MHz, CDCl₃): δ 194.4, 162.3, 132.2, 130.6, 113.9, 63.7, 14.7.



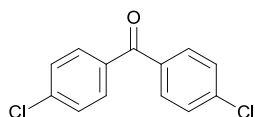
bis(4-(trifluoromethyl)phenyl)methanone (4c).⁵

(Isolated yield: 45%, white solid, 43.0 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.91 (d, *J* = 8.0 Hz, 4H), 7.78 (d, *J* = 8.0 Hz, 4H); ¹³C NMR (100 MHz, CDCl₃): δ 194.3, 139.8, 134.4 (q, *J* = 32.5 Hz), 130.2, 125.6 (q, *J* = 4.0 Hz), 123.6 (q, *J* = 27.1 Hz).



bis(4-fluorophenyl)methanone (4d).⁵

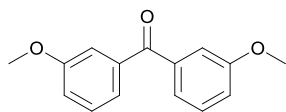
(Isolated yield: 85%, white solid, 55.6 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.80-7.84 (m, 4H), 7.17 (d, *J* = 8.0 Hz, 4H); ¹³C NMR (100 MHz, CDCl₃): δ 193.8, 166.7, 164.1, 133.7, 133.7, 132.6, 132.5, 115.7, 115.5.



bis(4-chlorophenyl)methanone (4e).⁵

(Isolated yield: 82%, white solid, 61.7 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.71 (d, *J* = 8.0 Hz, 4H), 7.46 (d, *J* = 8.0 Hz, 4H); ¹³C NMR (100 MHz, CDCl₃): δ 194.1, 139.1,

135.5, 131.3, 128.8.

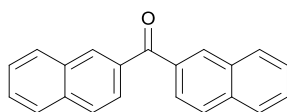


bis(3-methoxyphenyl)methanone (4f).⁶

(Isolated yield: 81%, white solid, 58.9 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.32-7.37

(m, 6H), 7.09-7.12 (m, 4H), 3.82 (s, 6H); ¹³C NMR (100 MHz, CDCl₃): δ 196.1,

159.6, 138.9, 129.2, 122.8, 118.8, 114.4, 55.4.



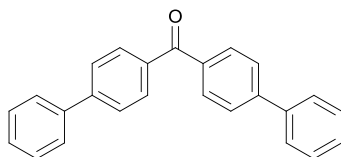
dinaphthalen-2-ylmethanone (4g).⁷

(Isolated yield: 85%, white solid, 72.0 mg); ¹H NMR (400 MHz, CDCl₃): δ 8.32 (s,

2H), 8.01-7.95 (m, 4H), 7.92 (t, *J* = 8.0 Hz, 4H), 7.62 (t, *J* = 8.0 Hz, 2H), 7.55 (t, *J* =

8.0 Hz, 2H); ¹³C NMR (100 MHz, CDCl₃): δ 196.8, 135.3, 135.2, 132.3, 131.9, 129.5,

128.4, 128.7, 127.9, 126.9, 125.9.



dibiphenyl-4-ylmethanone (4h).⁸

(Isolated yield: 40%, white solid, 40.1 mg); ¹H NMR (400 MHz, CDCl₃): δ 7.93 (d, *J*

= 8.0 Hz, 4H), 7.72 (d, *J* = 8.0 Hz, 4H), 7.66 (d, *J* = 8.0 Hz, 4H), 7.49 (t, *J* = 8.0

Hz, 4H), 7.41 (t, *J* = 8.0 Hz, 2H); ¹³C NMR (100 MHz, CDCl₃): δ 196.0, 145.2, 140.0,

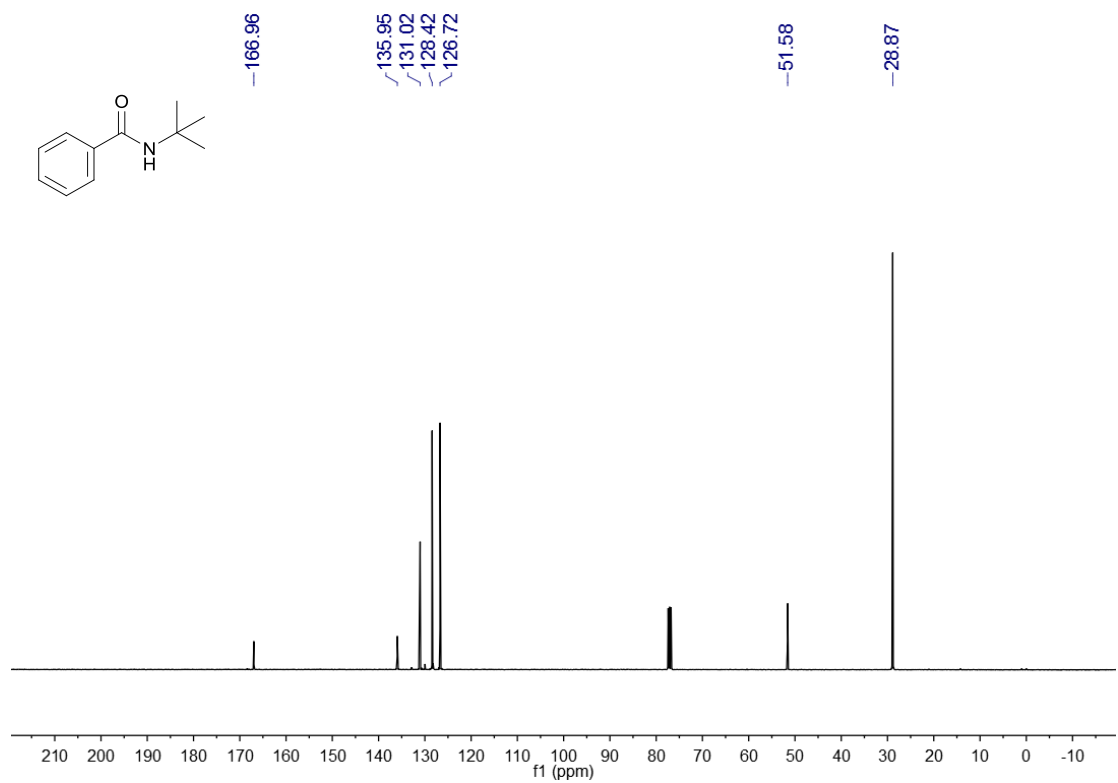
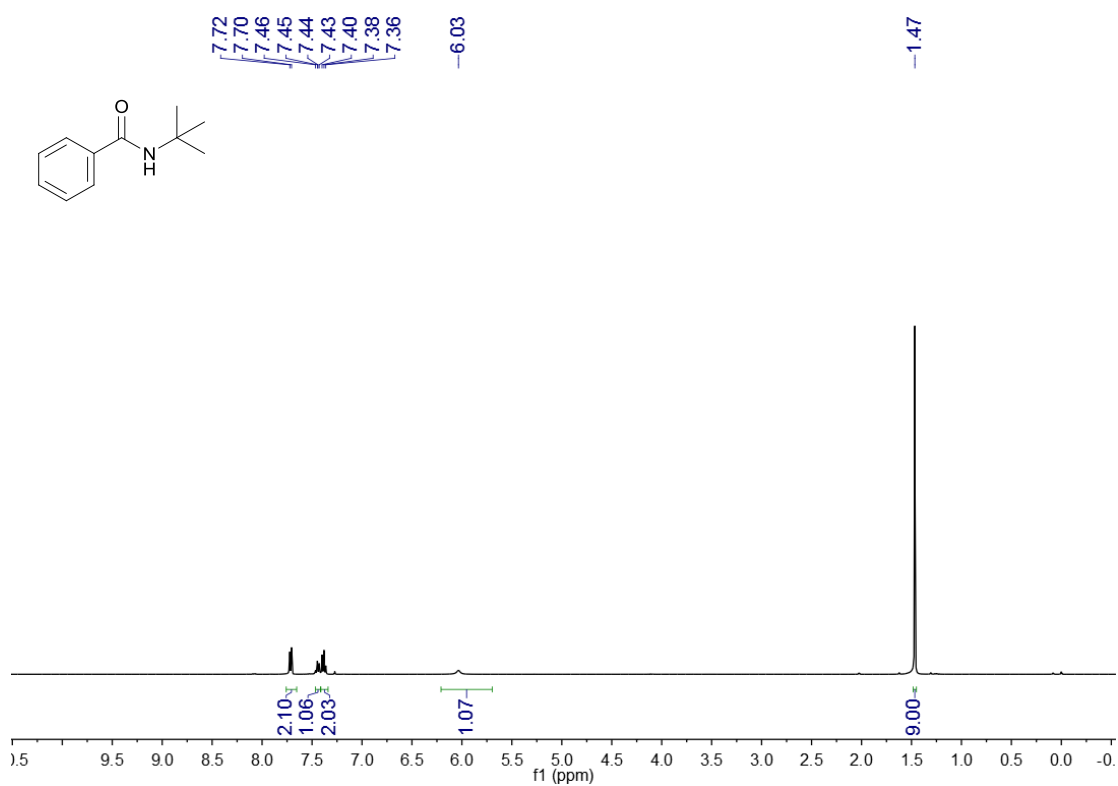
136.4, 130.7, 129.0, 128.2, 127.3, 127.0.

Reference

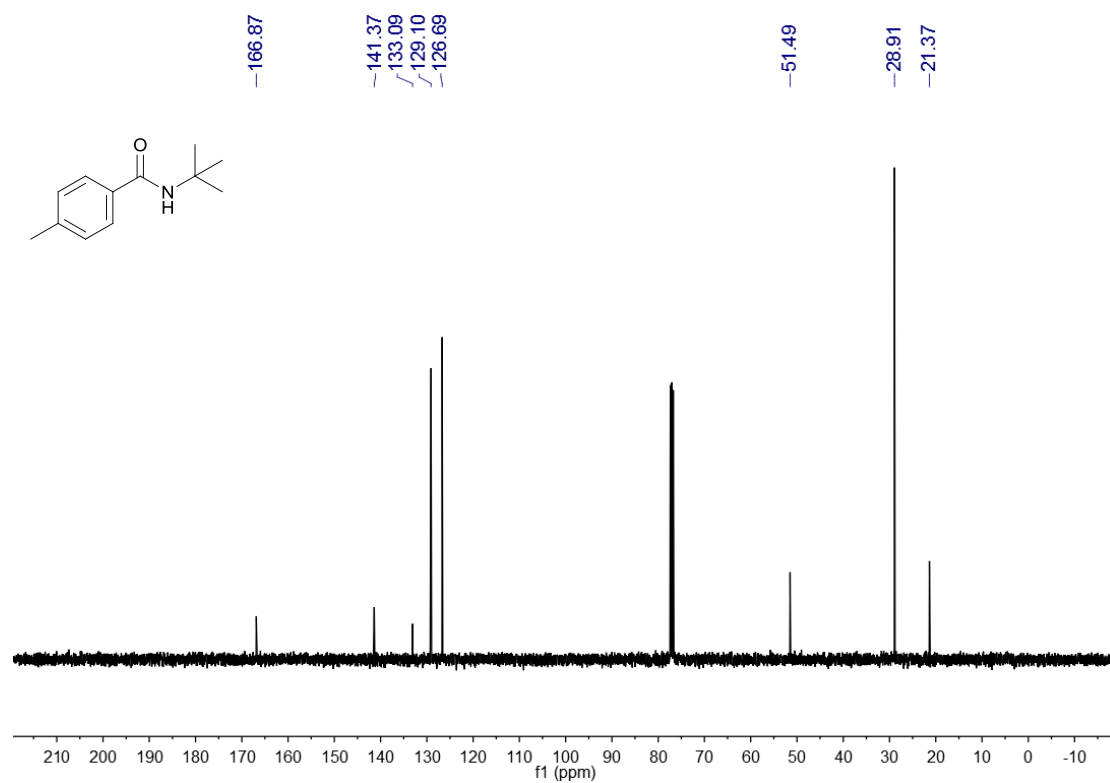
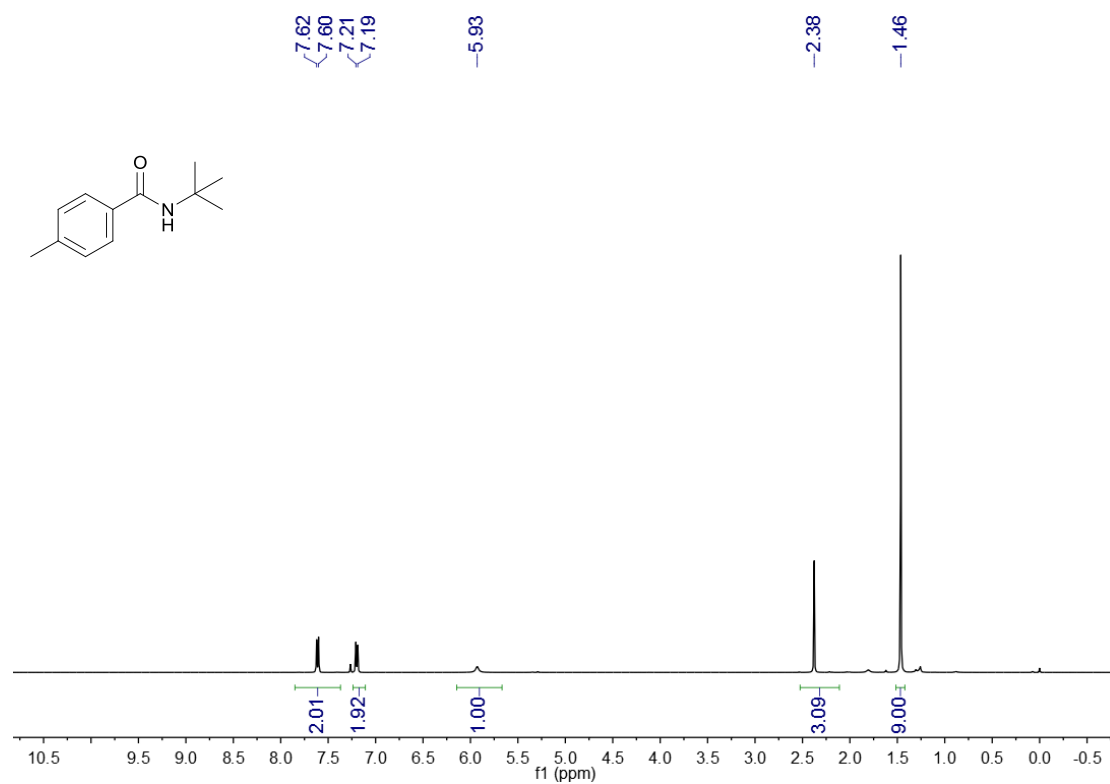
1. Jiang, H.; Liu, B.; Li, Y.; Wang, A.; Huang, H., Synthesis of Amides via Palladium-Catalyzed Amidation of Aryl Halides. *Organic Letters*, **2011**, *13*, 1028-1031.
2. Katkar, K. V.; Chaudhari, P. S.; Akamanchi, K. G., Sulfated tungstate: an efficient catalyst for the Ritter reaction. *Green Chemistry*, **2011**, *13*, 835-838.
3. Liu, Z.; Zhang, X.; Li, J.; Li, F.; Li, C.; Jia, X.; Li, J., Exploiting the Reactivity of Isocyanide: Coupling Reaction between Isocyanide and Toluene Derivatives Using the Isocyano Group as an N1 Synthon. *Organic Letters*, **2016**, *18*, 4052-4055.
4. Rovira, M.; Soler, M.; Güell, I.; Wang, M.-Z.; Gómez, L.; Ribas, X., Orthogonal Discrimination among Functional Groups in Ullmann-Type C–O and C–N Couplings. *The Journal of Organic Chemistry*, **2016**, *81*, 7315-7325.
5. Wang, X.; Liu, F.-D.; Tu, H.-Y.; Zhang, A.-D., One-Pot Synthesis of Diarylmethanones through Palladium-Catalyzed Sequential Coupling and Aerobic Oxidation of Aryl Bromides with Acetophenone as a Latent Carbonyl Donor. *The Journal of Organic Chemistry*, **2014**, *79*, 6554-6562.
6. Li, X.-F.; Chi, Z.-G.; Xu, B.-J.; Li, H.-Y.; Zhang, X.-Q.; Zhou, W.; Zhang, Y.; Liu, S.-W.; Xu, J.-R., Synthesis and Characterization of Triphenylethylene Derivatives with Aggregation-Induced Emission Characteristics. *Journal of Fluorescence*, **2011**, *21*, 1969-1977.
7. Rérat, A.; Michon, C.; Agbossou-Niedercorn, F.; Gosmini, C., Synthesis of Symmetrical Diaryl Ketones by Cobalt-Catalyzed Reaction of Arylzinc Reagents with Ethyl Chloroformate. *European Journal of Organic Chemistry*, **2016**, *2016*, 4554-4560.
8. Li, X.-F.; Chi, Z.-G.; Xu, B.-J.; Li, H.-Y.; Zhang, X.-Q.; Zhou, W.; Zhang, Y.; Liu, S.-W.; Xu, J.-R., Synthesis and Characterization of Triphenylethylene Derivatives with Aggregation-Induced Emission Characteristics. *Journal of Fluorescence*, **2011**, *21*, 1969-1977.

Copies of product NMR Spectra

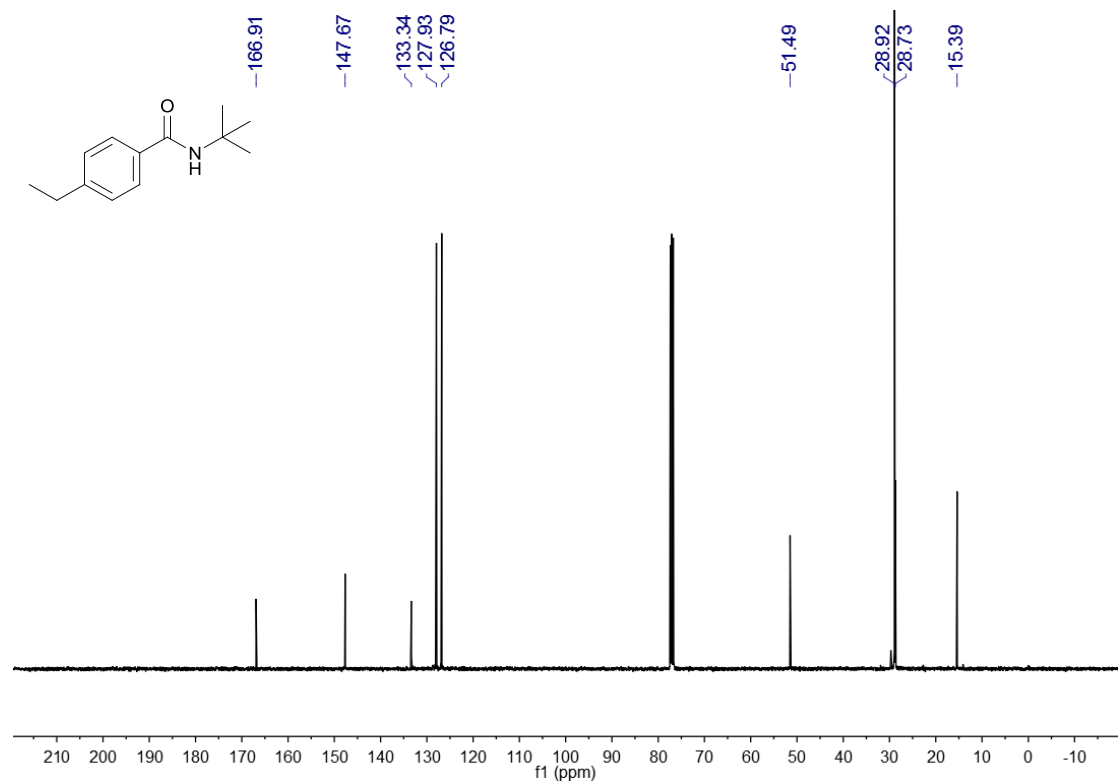
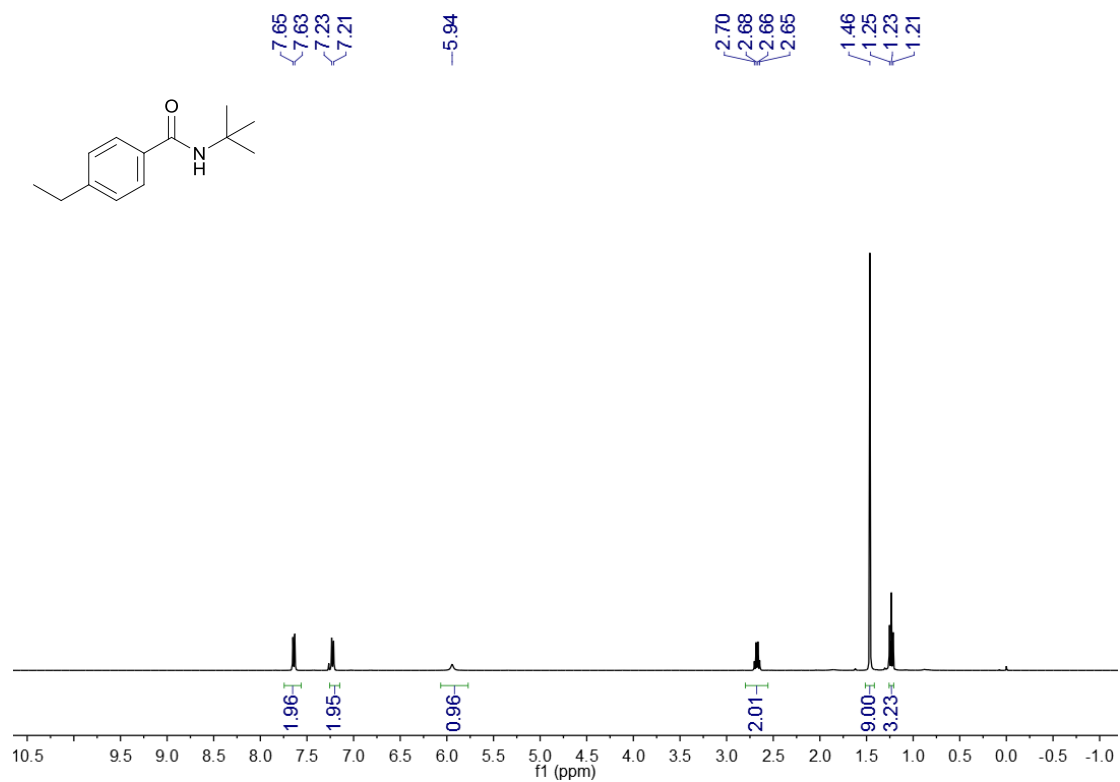
N-tert-butylbenzamide(3a)



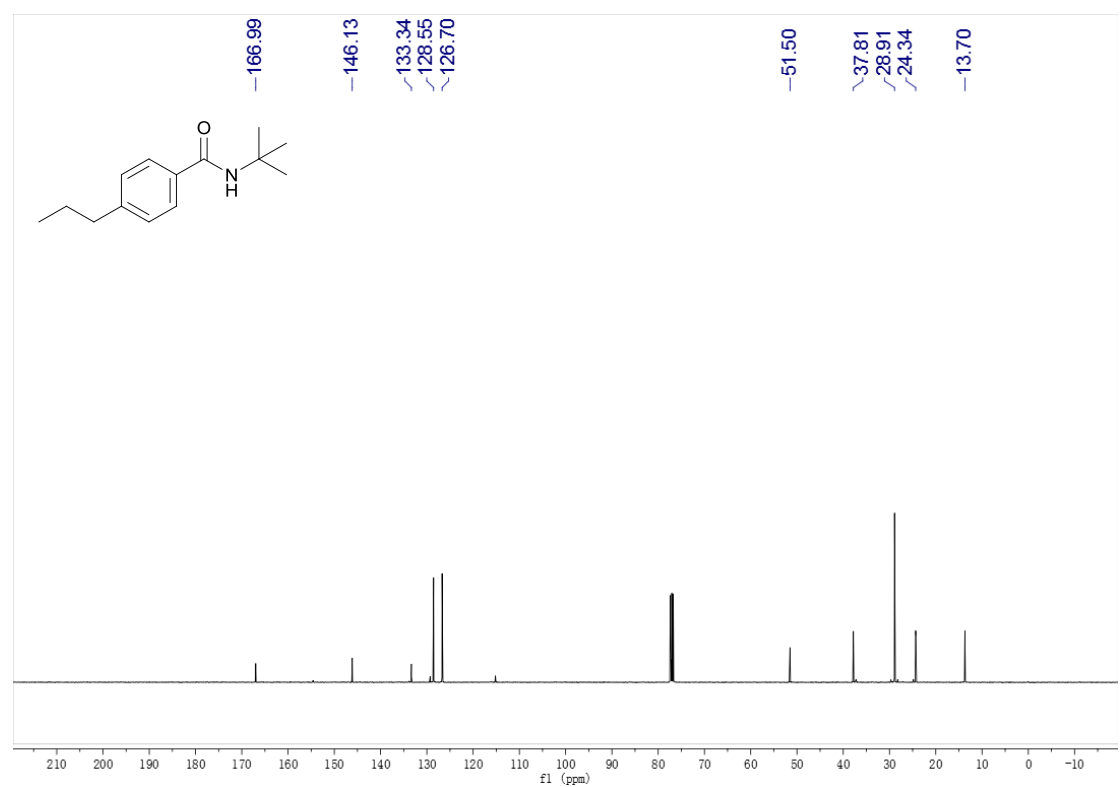
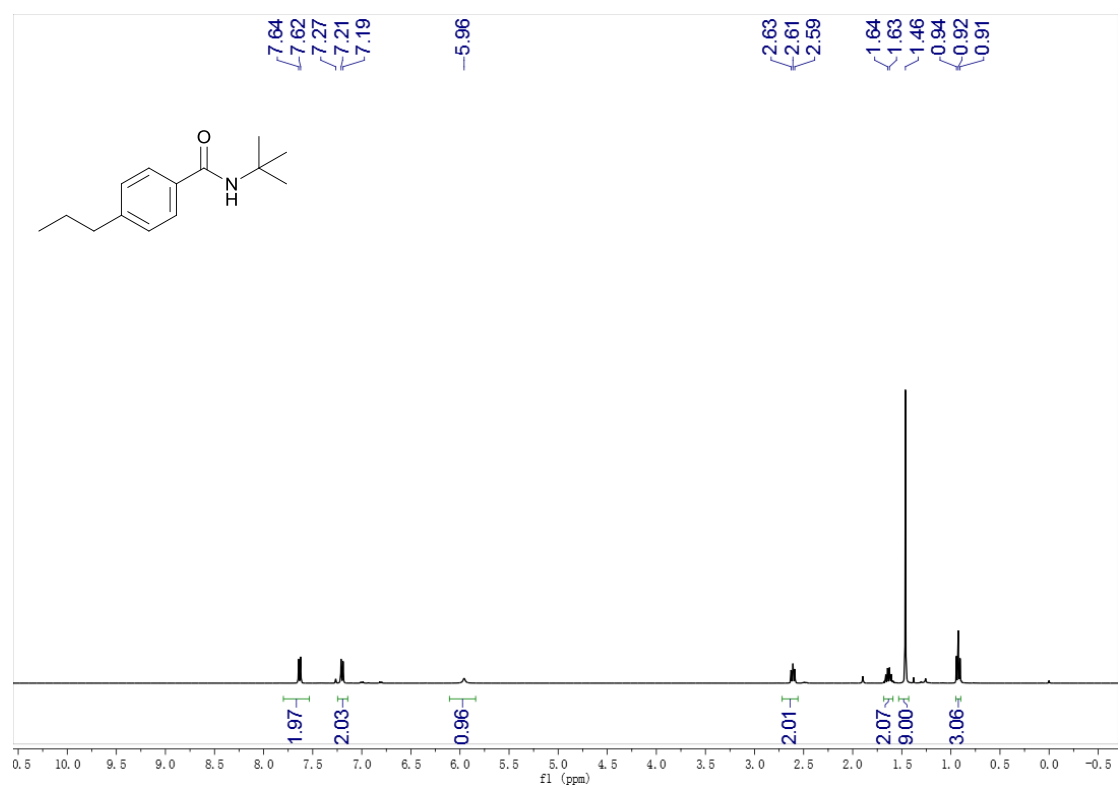
N-tert-butyl-4-methylbenzamide(3b)



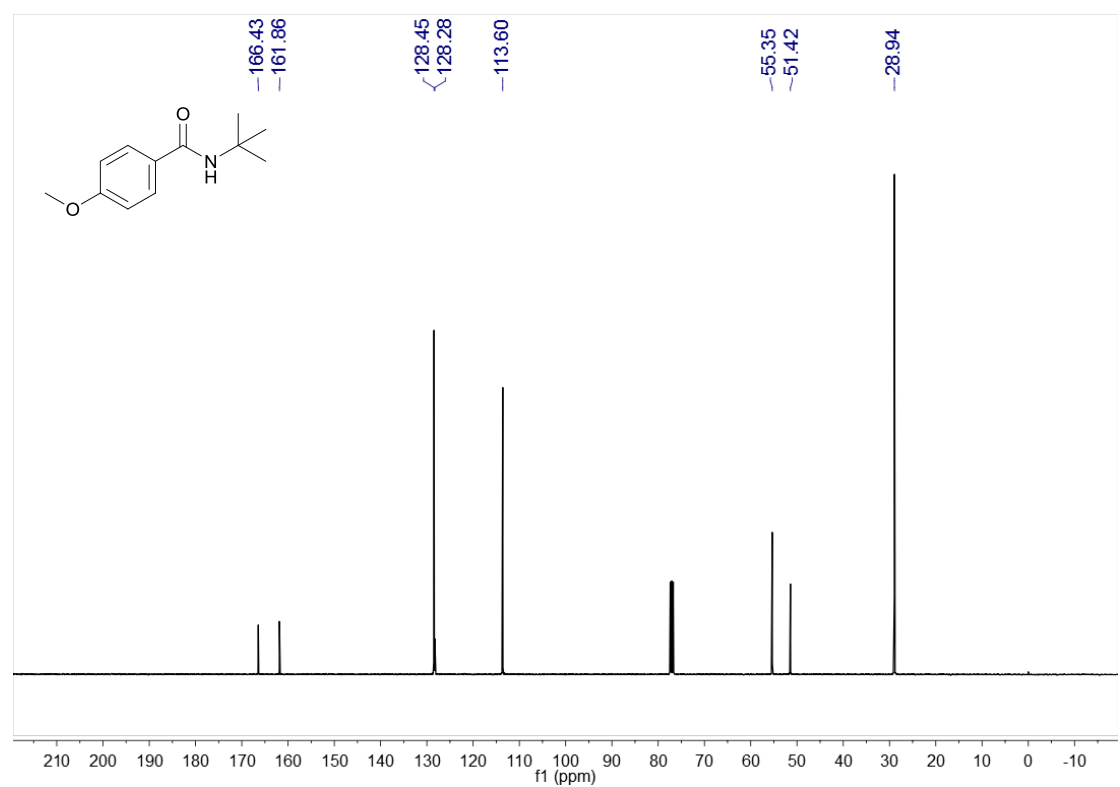
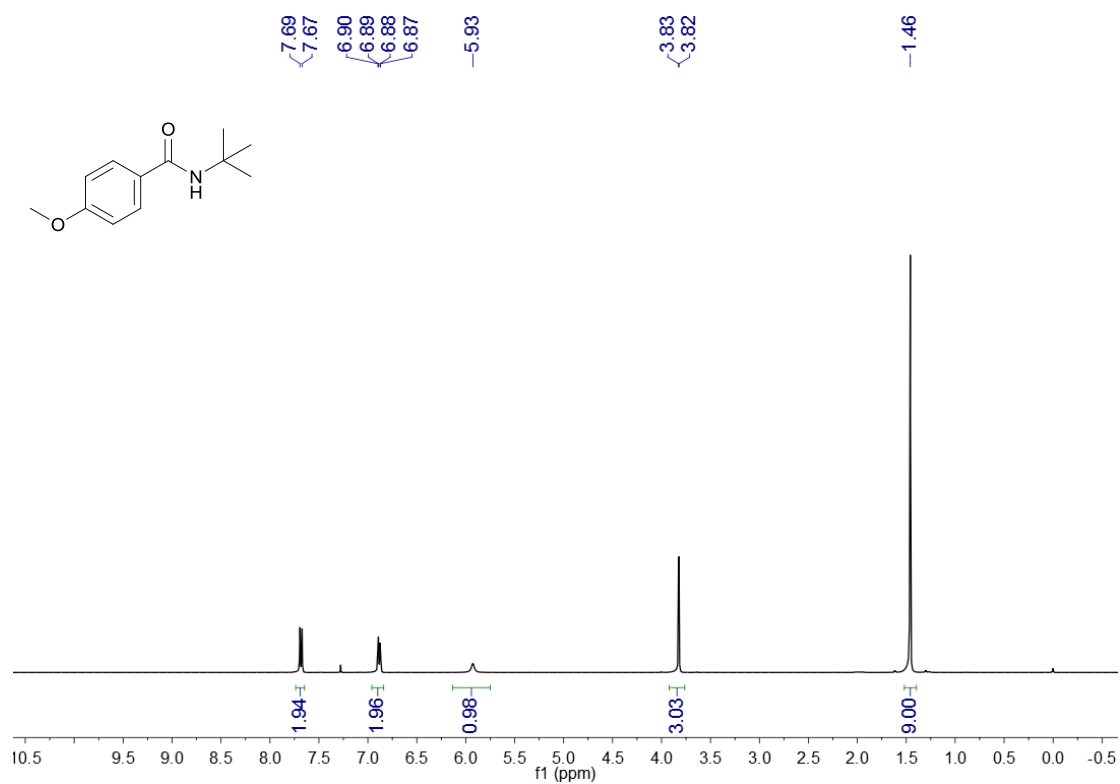
***N*-tert-butyl-4-ethylbenzamide (3c)**



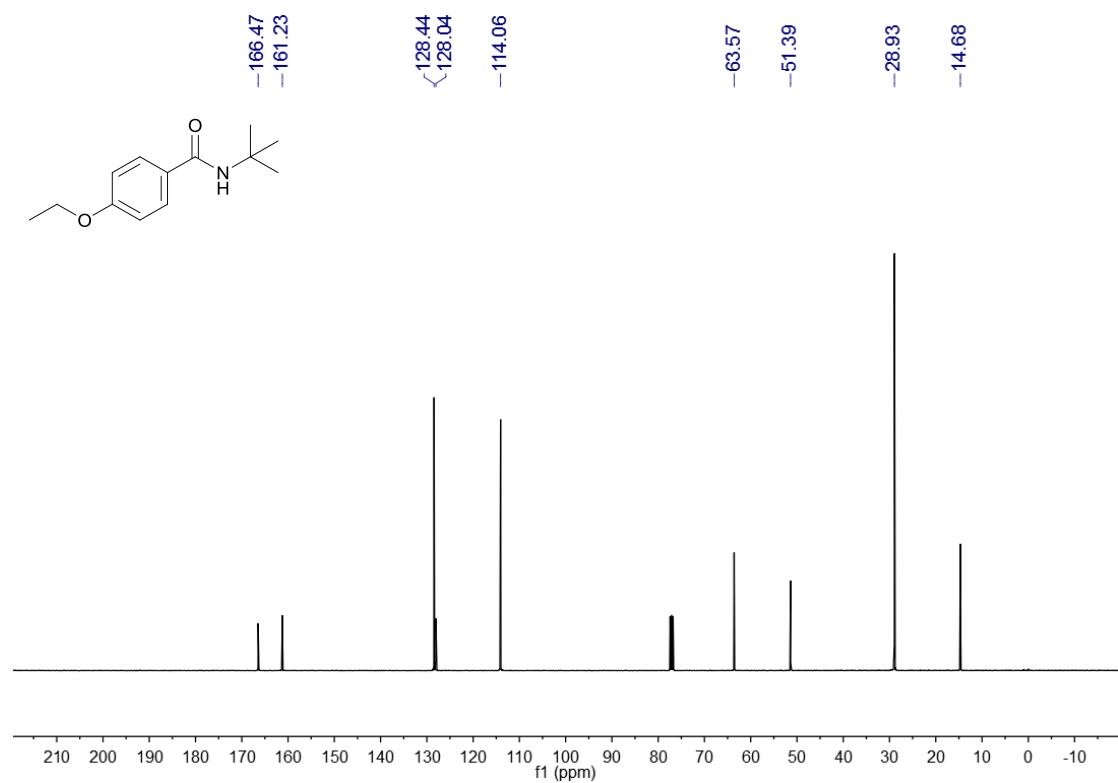
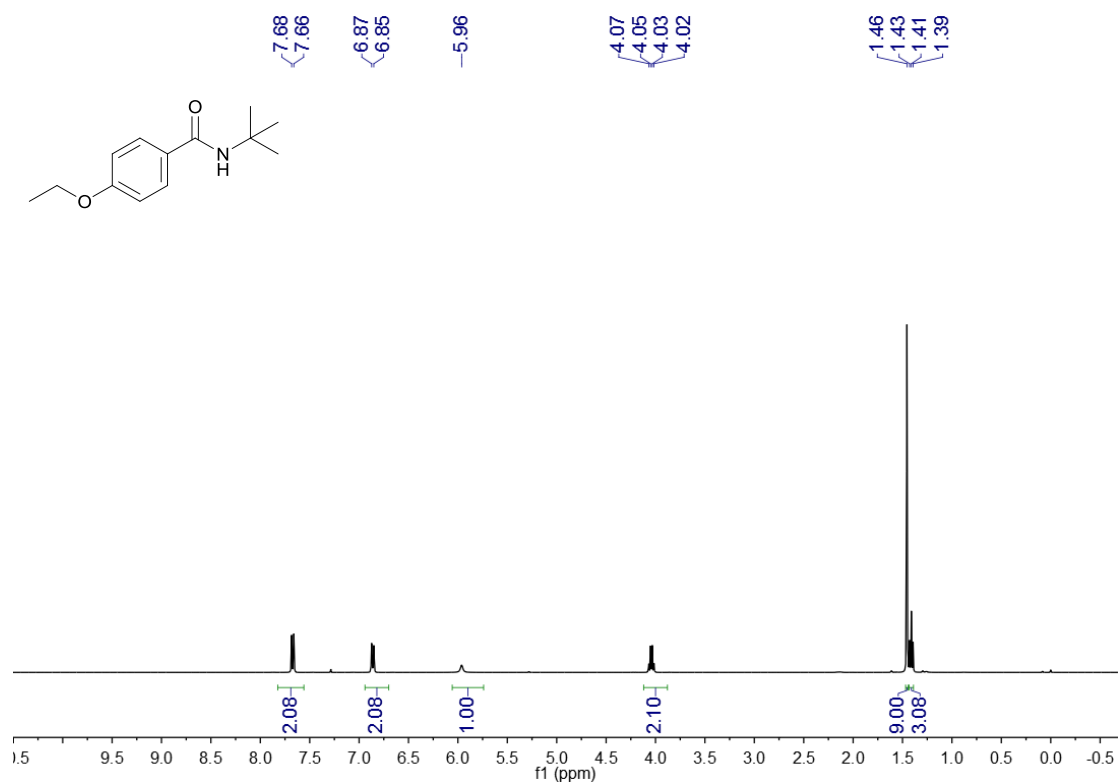
N-(tert-butyl)-4-propylbenzamide(3d)



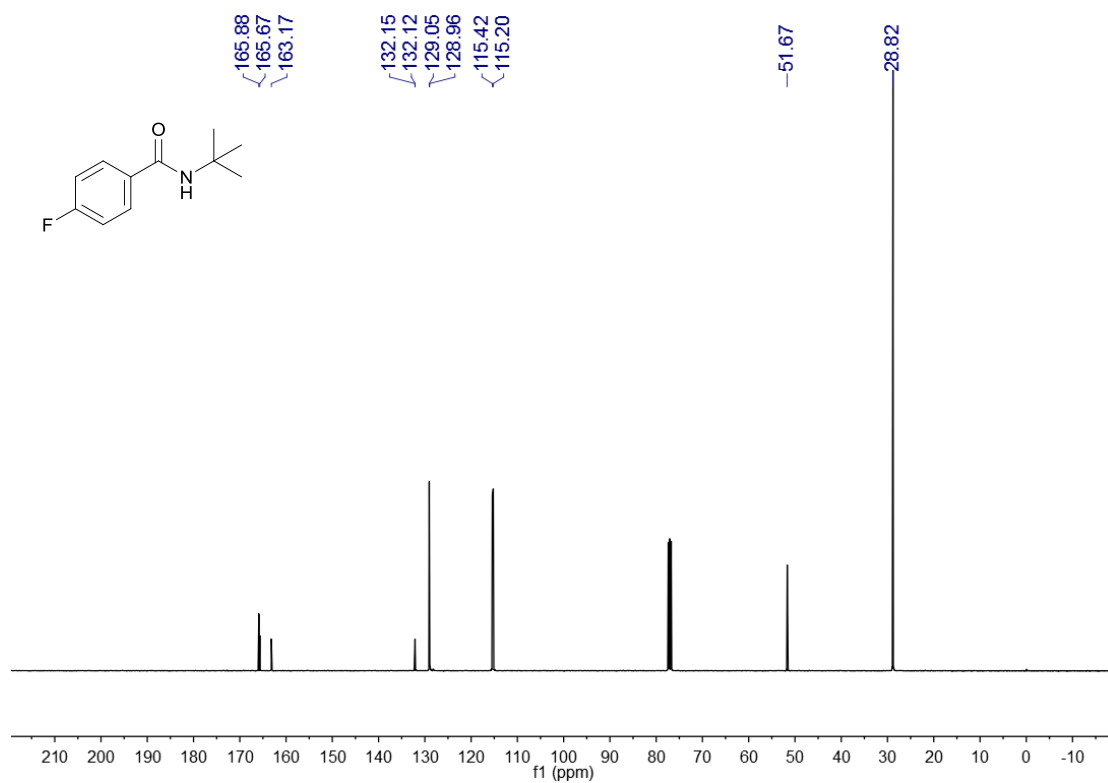
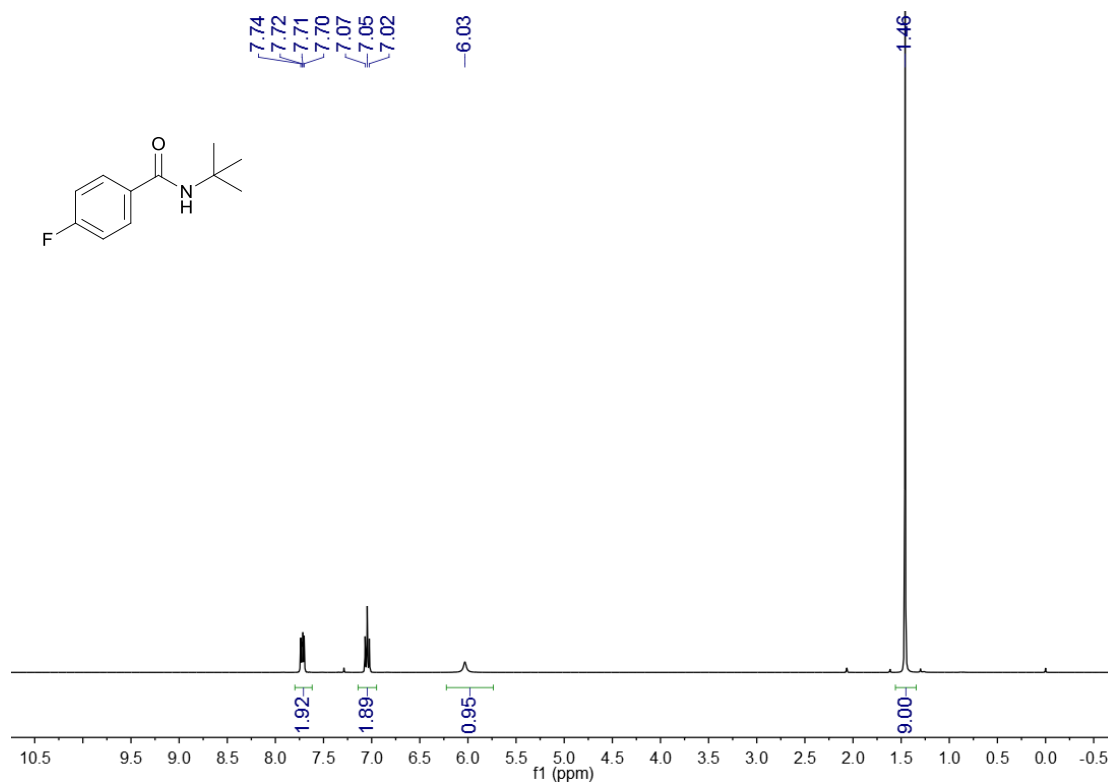
N-(tert-butyl)-4-methoxybenzamide(3e)



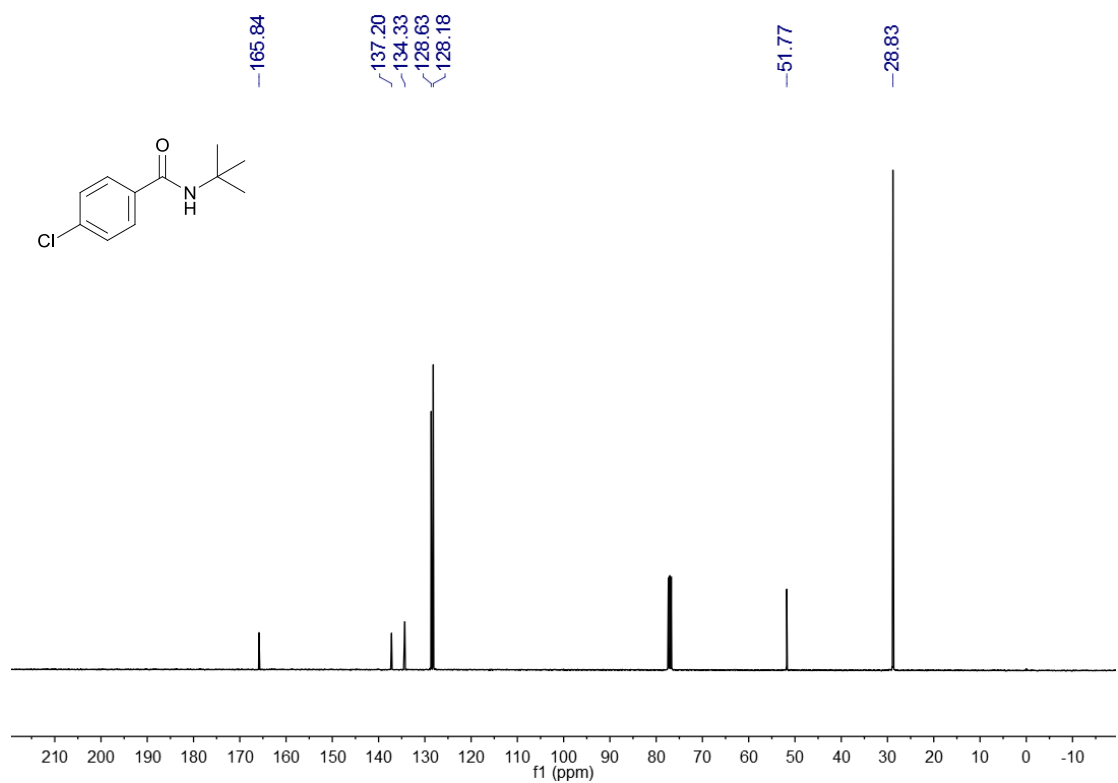
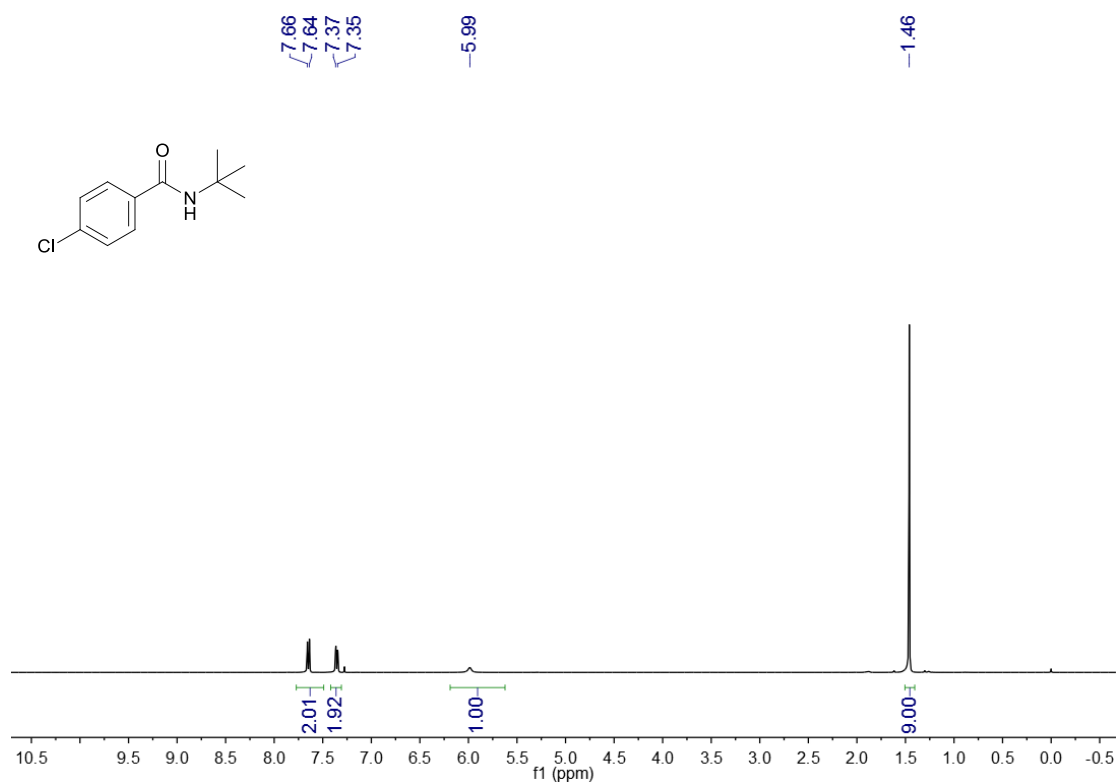
N-tert-butyl-4-ethoxybenzamide. (3f)



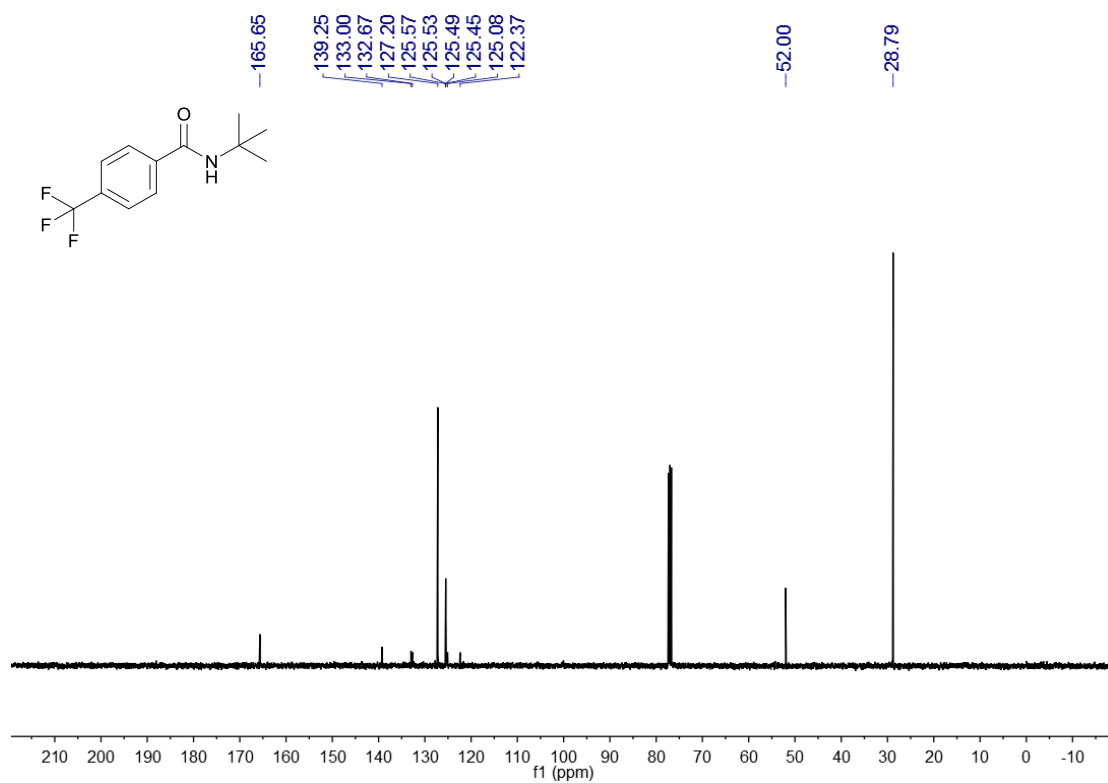
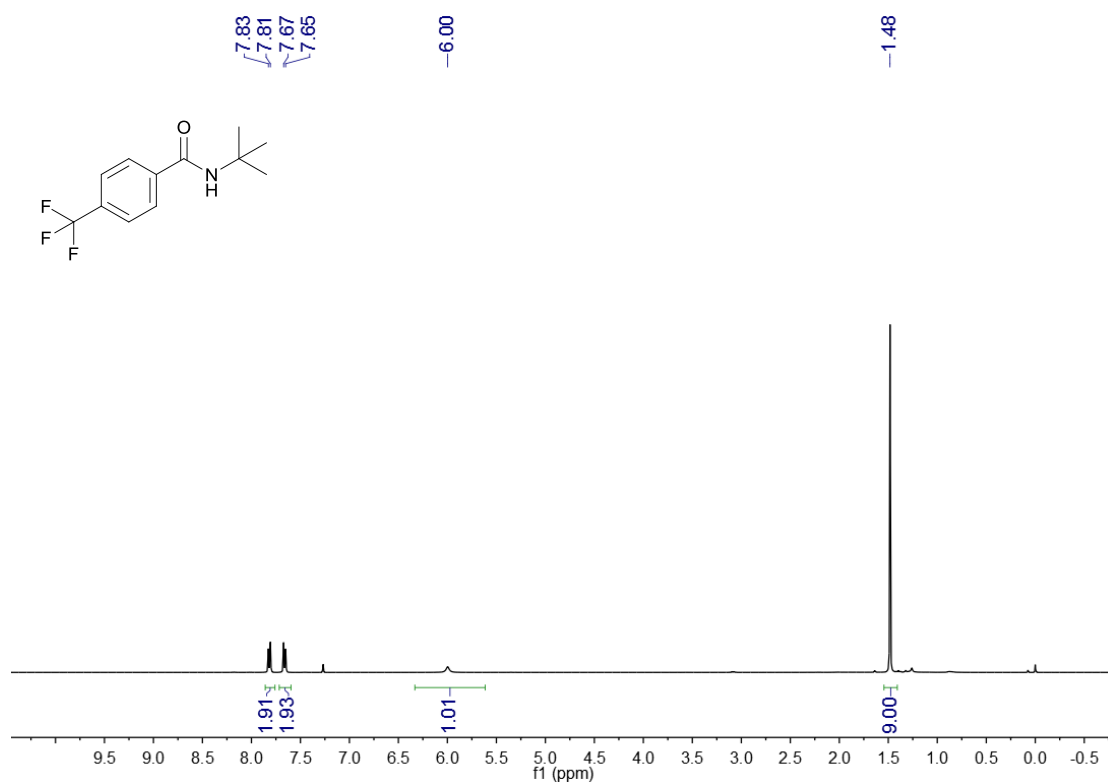
N-tert-butyl-4-fluorobenzamide (3g)



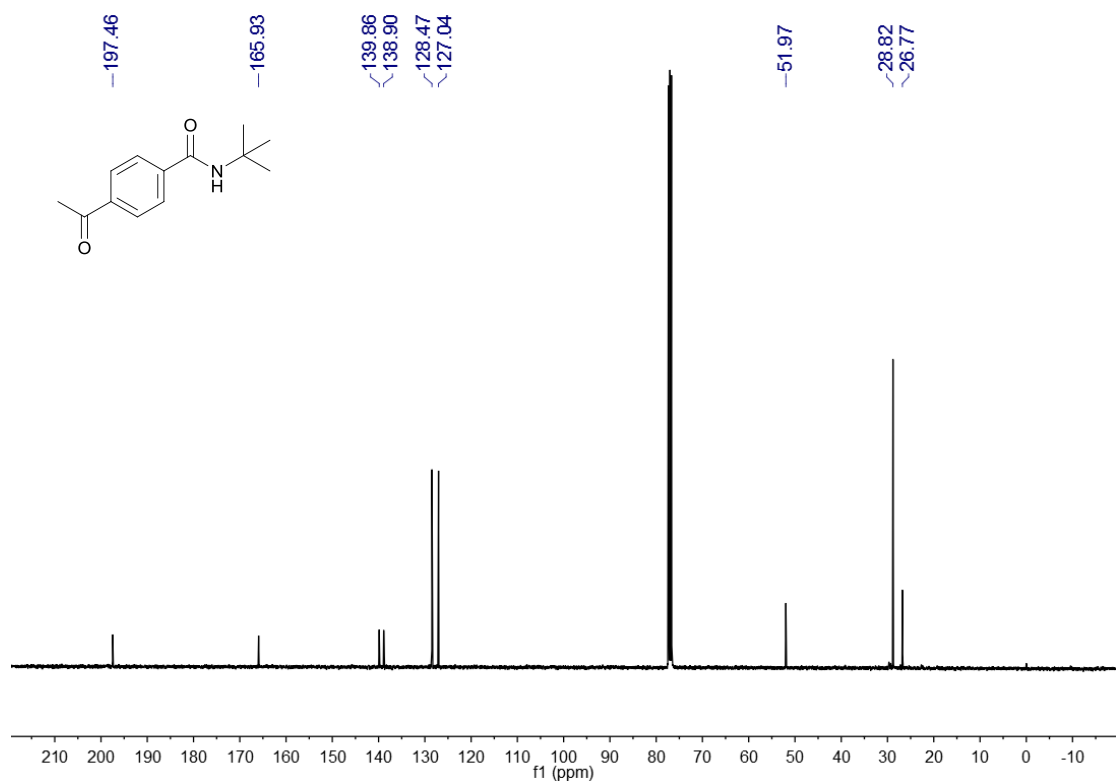
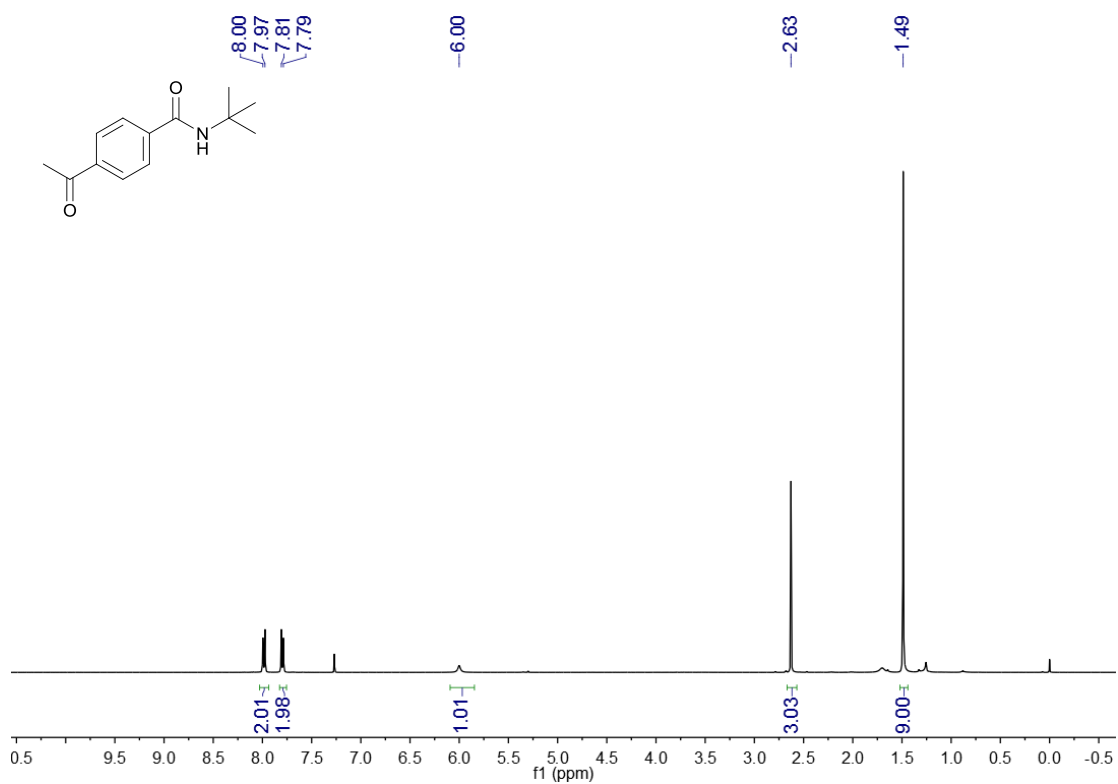
N-tert-butyl-4-chlorobenzamide(3h)



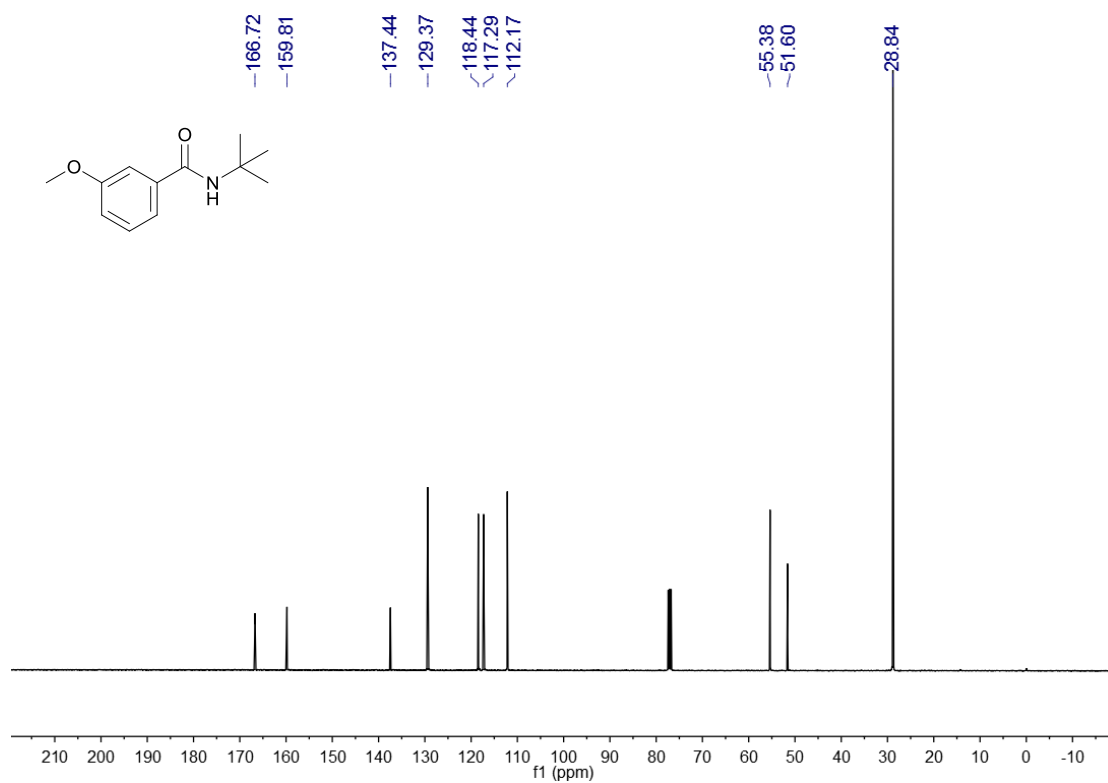
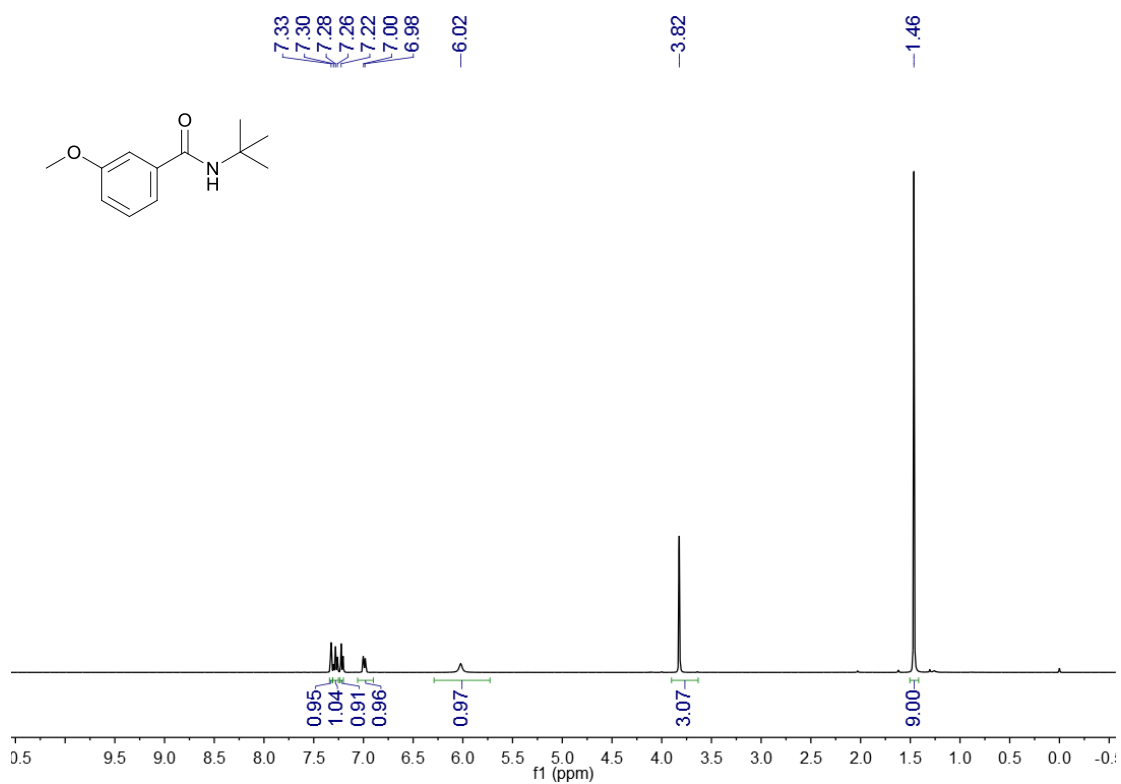
N-tert-butyl-4-(trifluoromethyl)benzamide(3i)



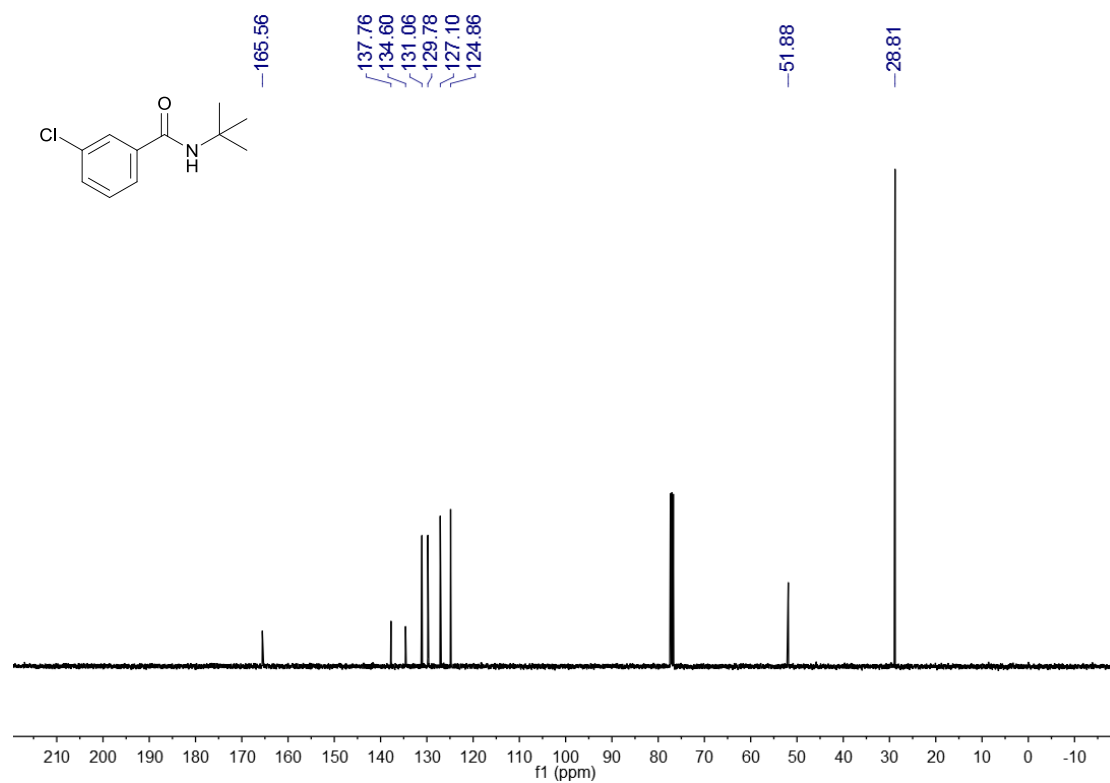
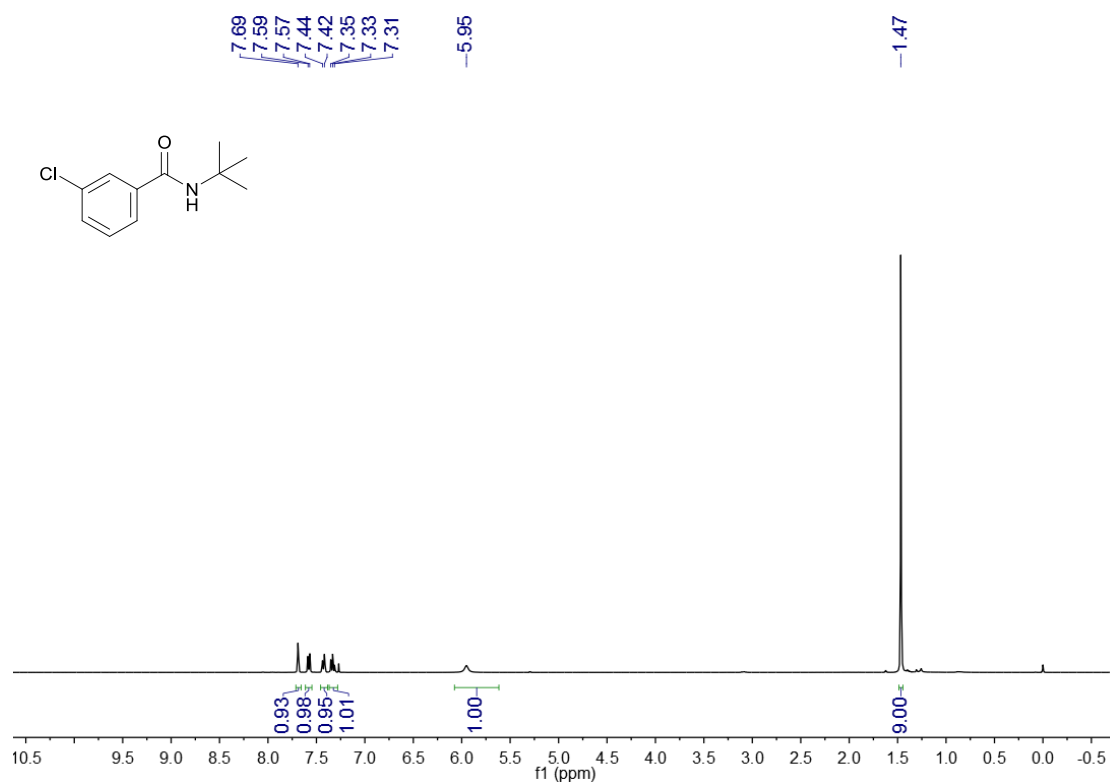
4-acetyl-N-tert-butylbenzamide(3j)



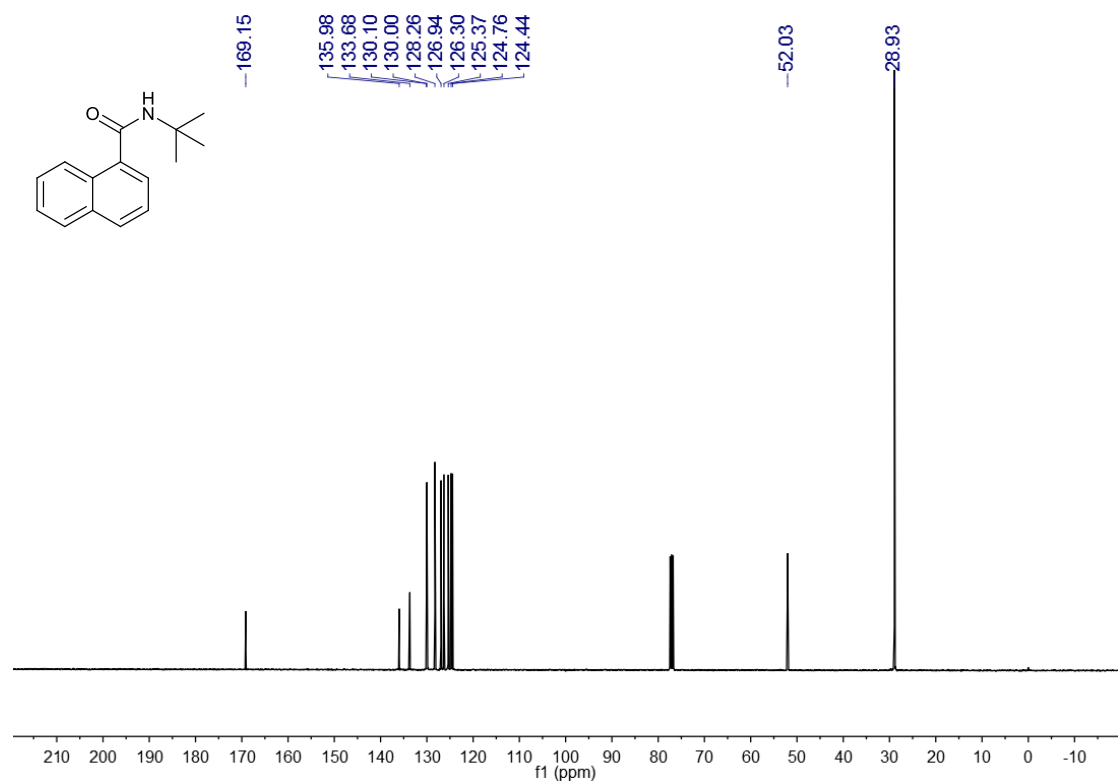
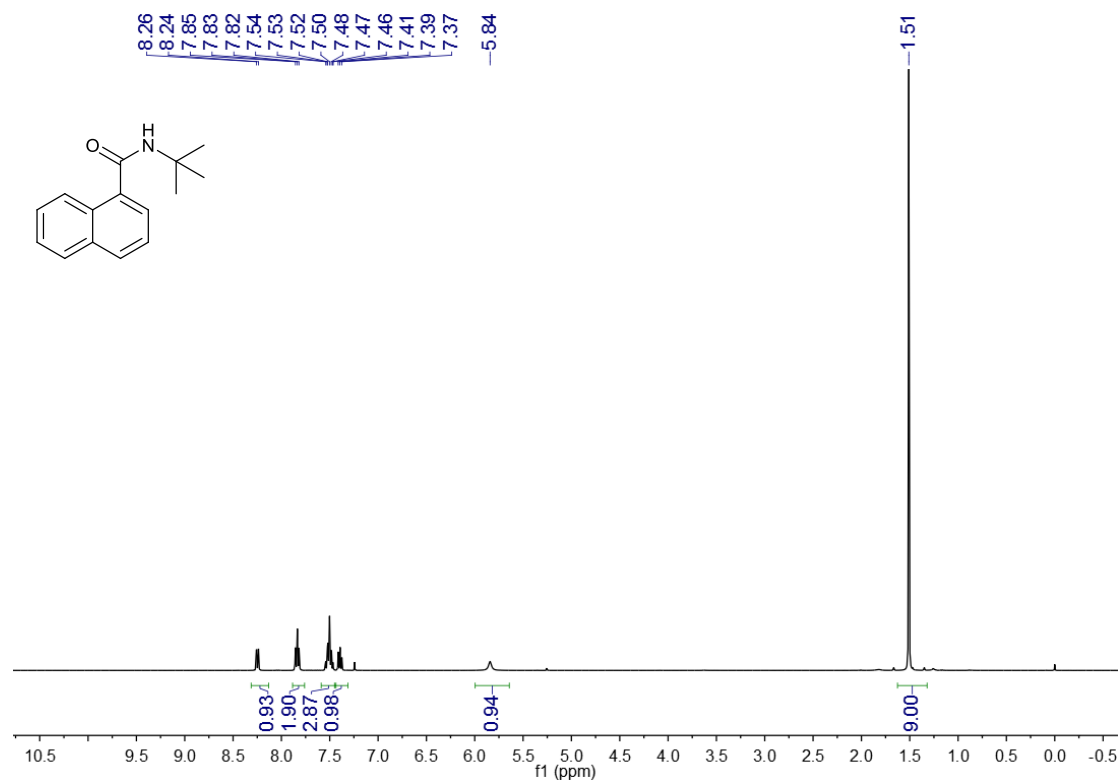
N-tert-butyl-3-methoxybenzamide(3k)



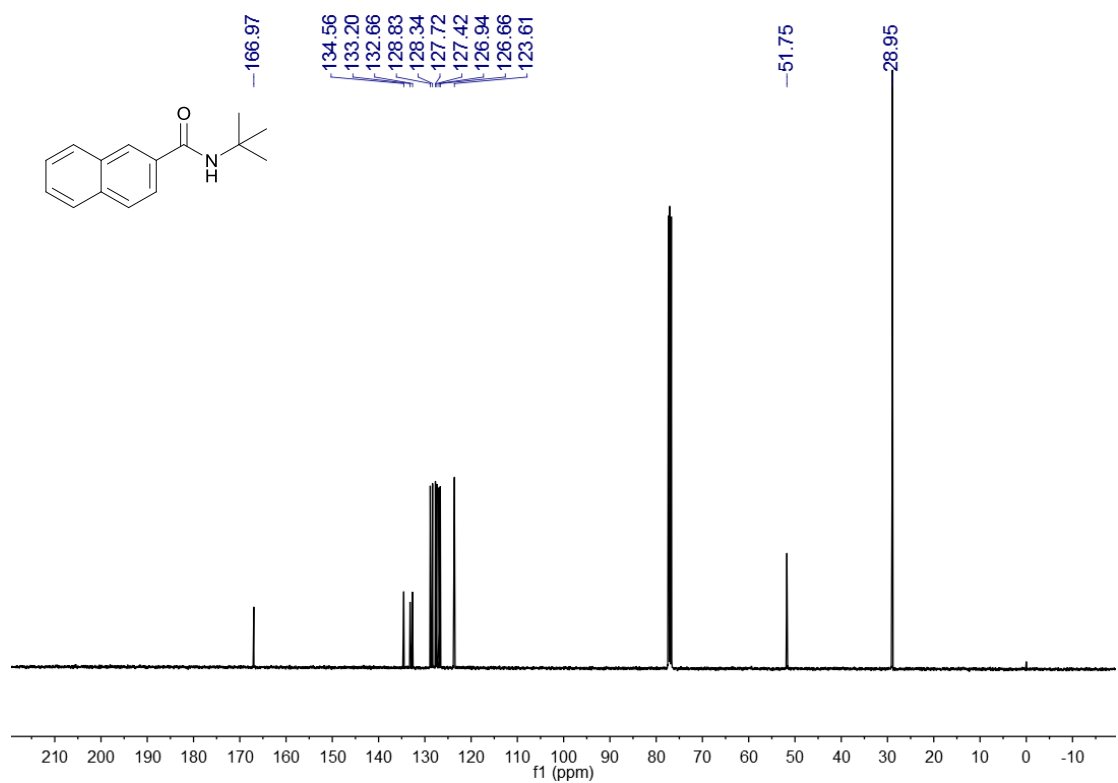
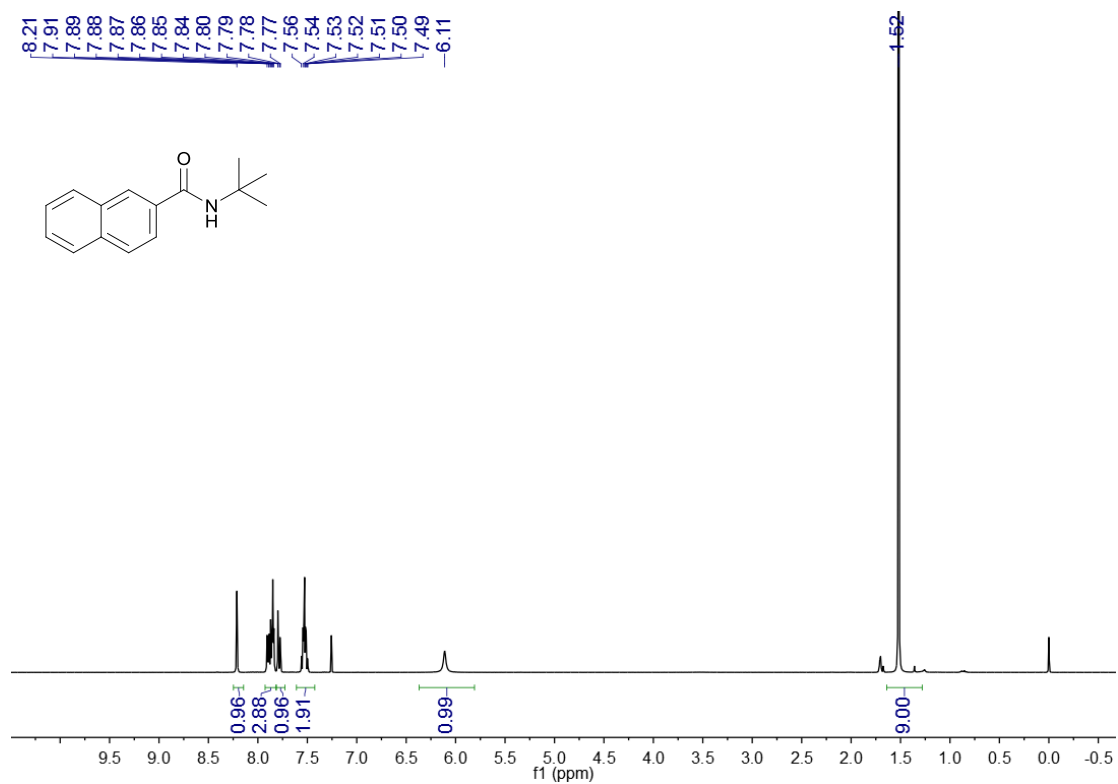
N-tert-butyl-3-chlorobenzamide(3l)



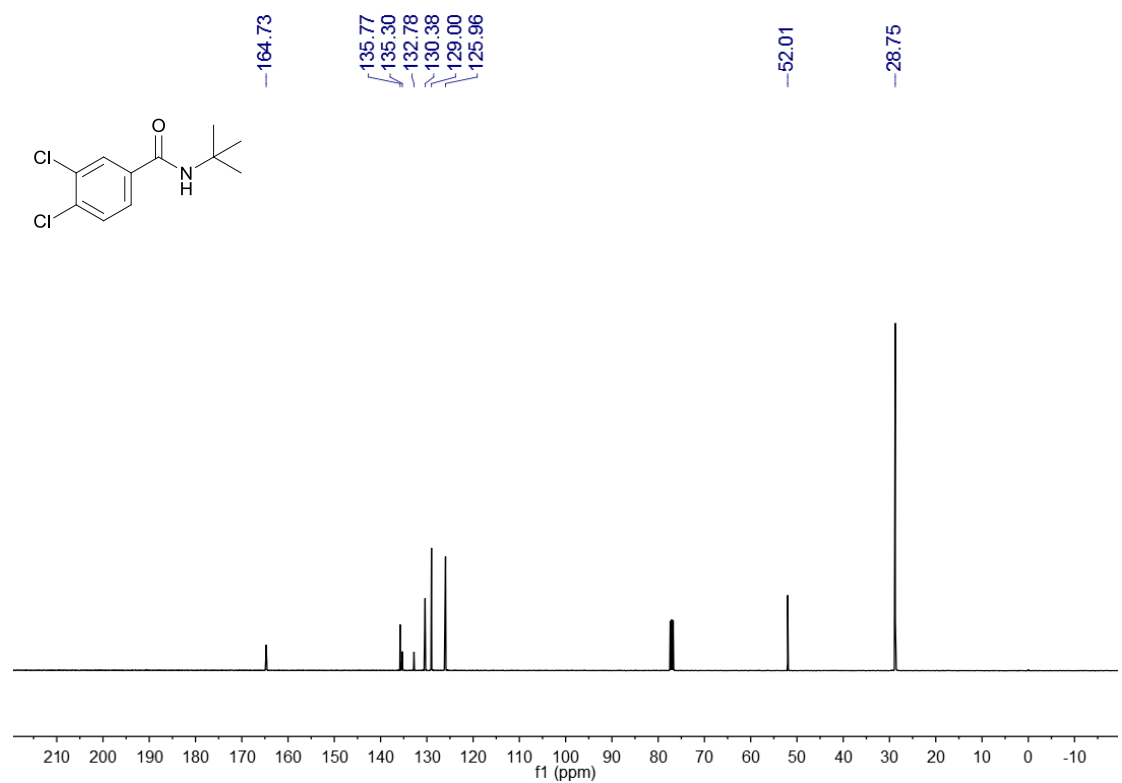
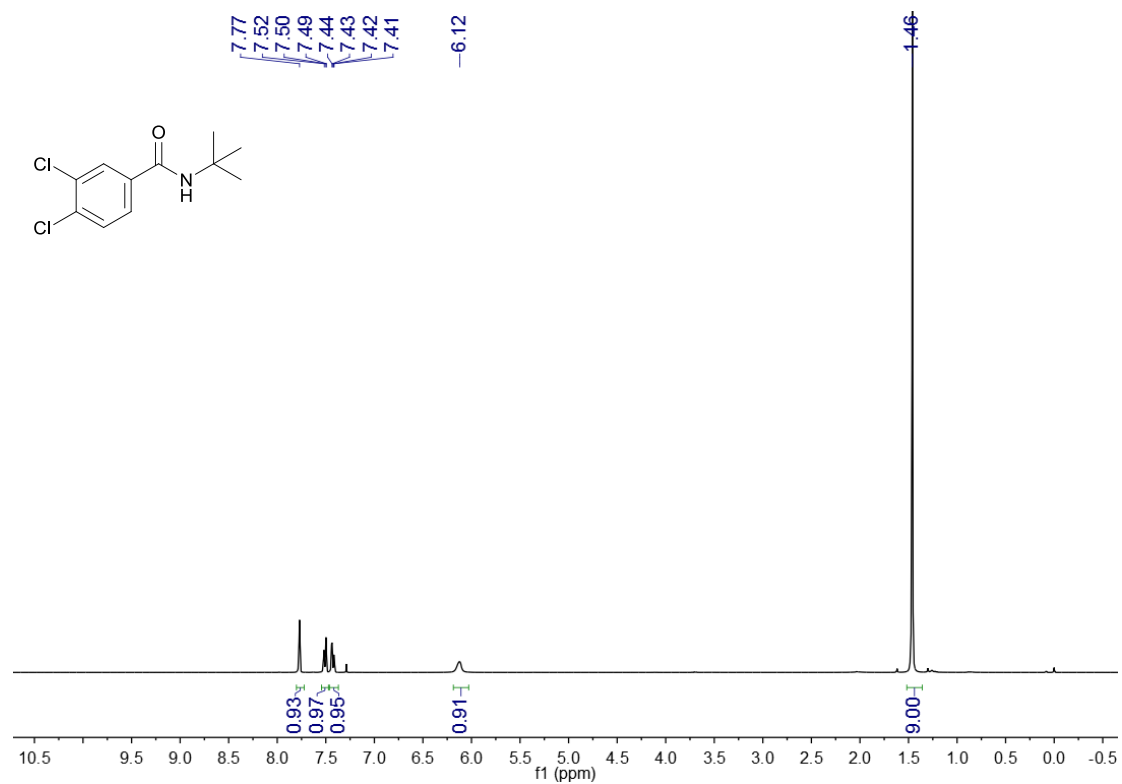
N-tert-butyl-1-naphthamide(3m)



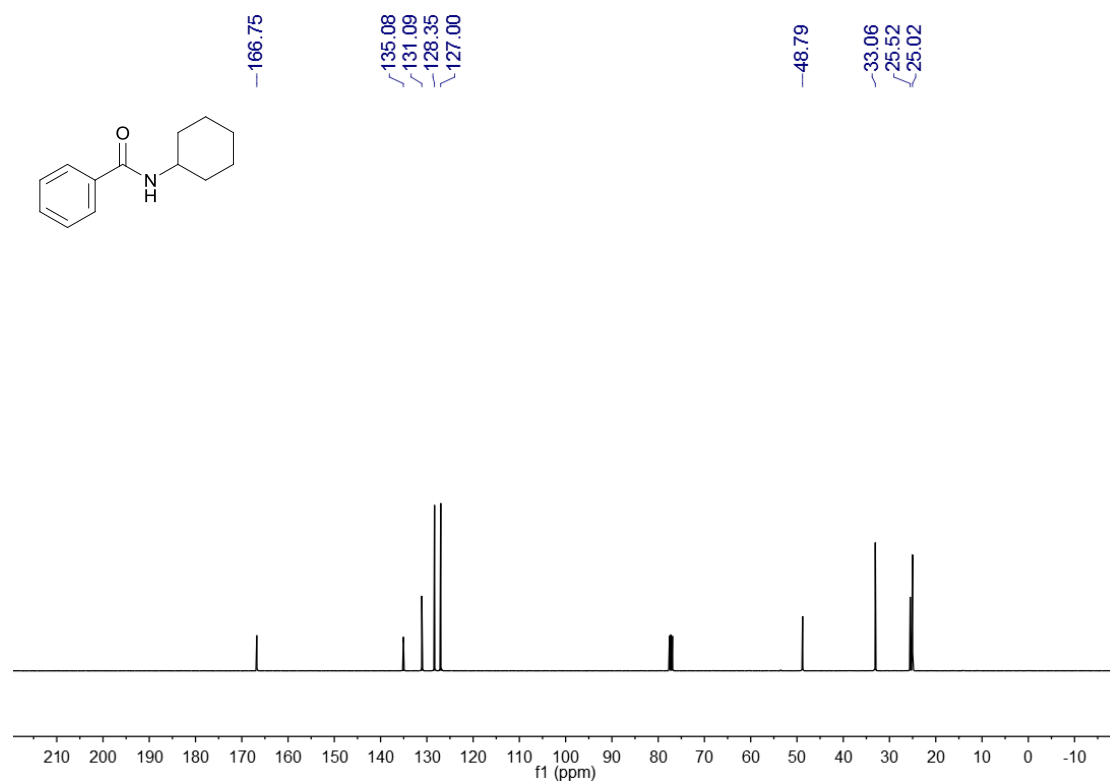
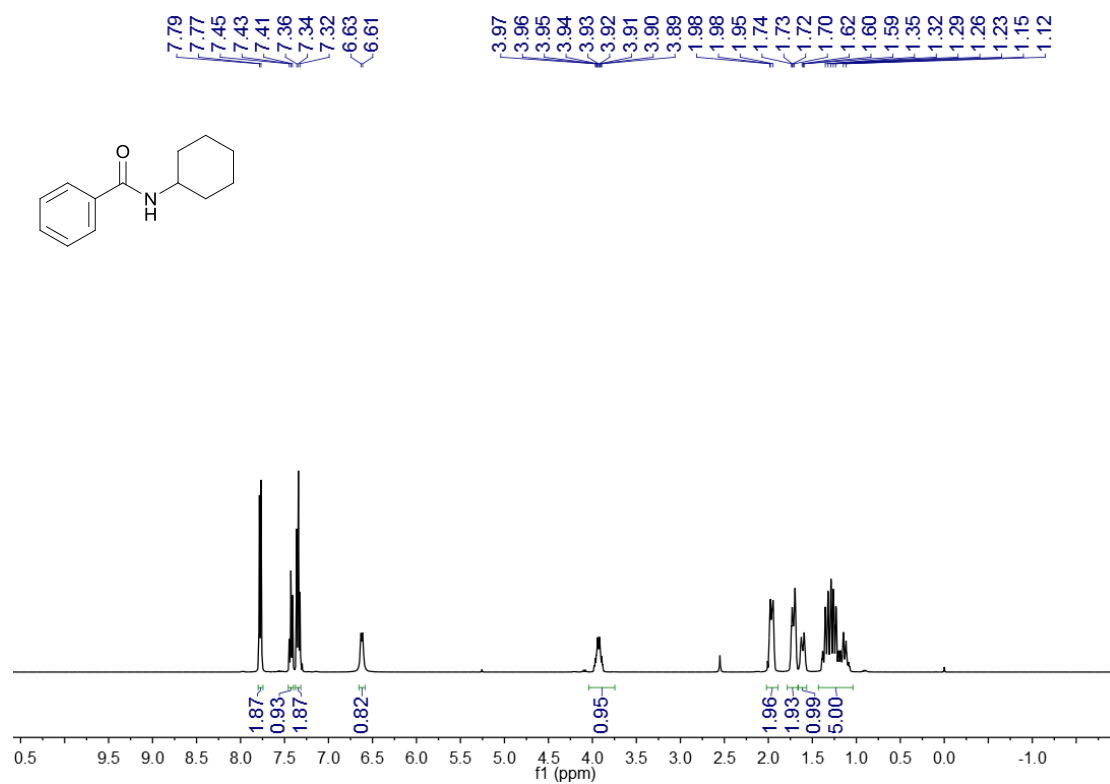
N-tert-butyl-2-naphthamide(3n)



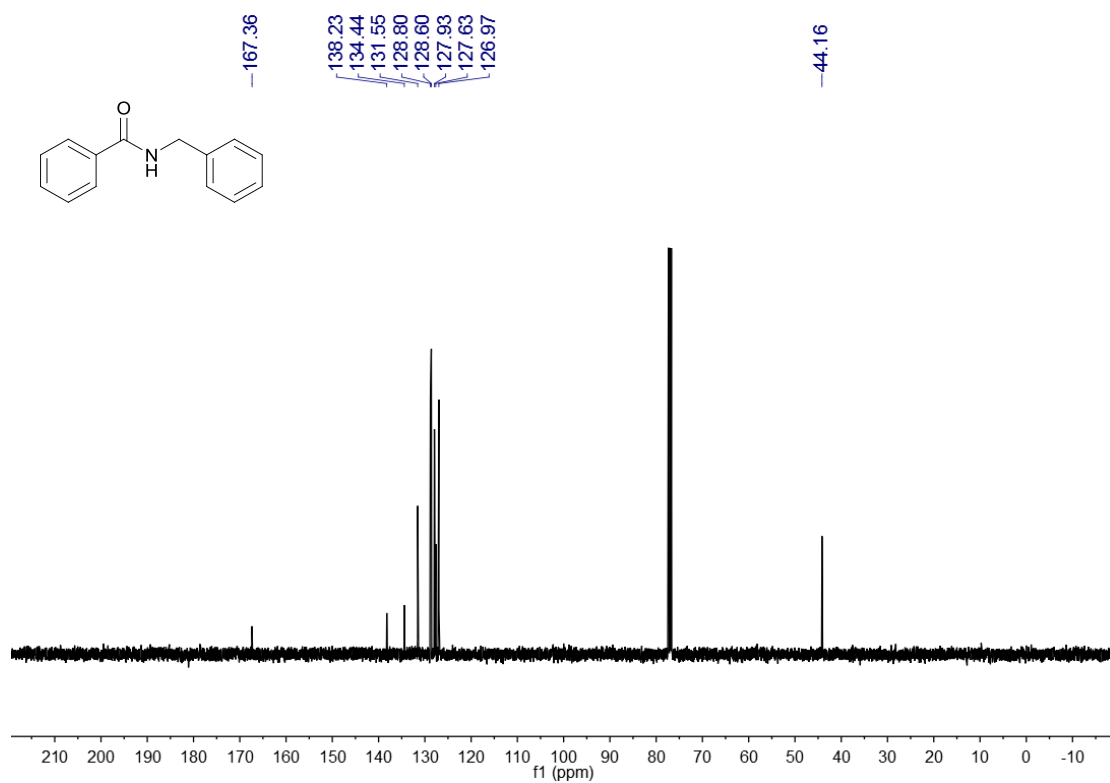
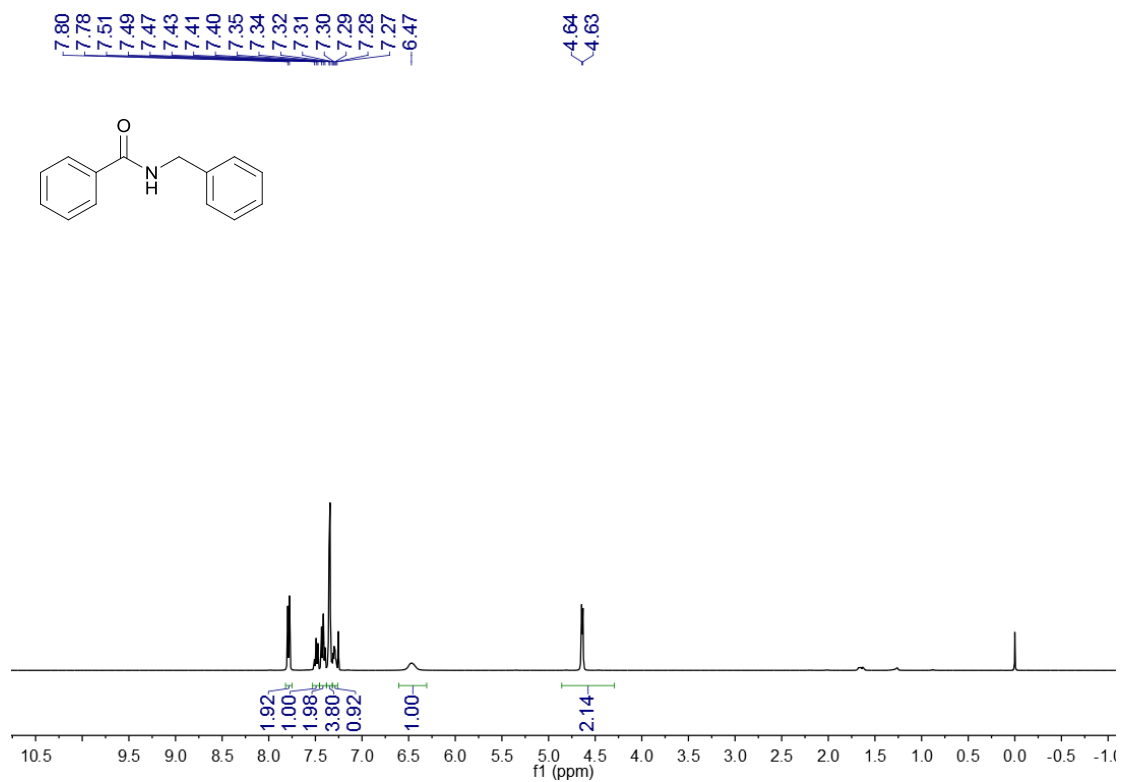
N-tert-butyl-3,4-dichlorobenzamide(3o)



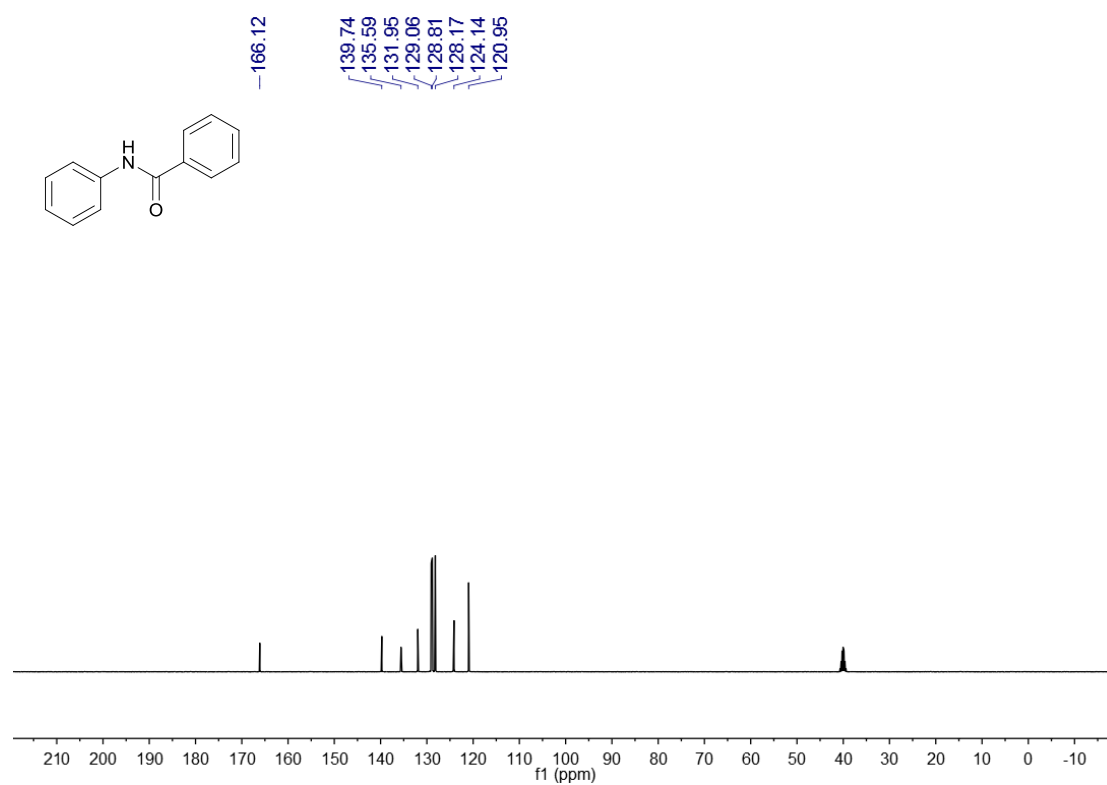
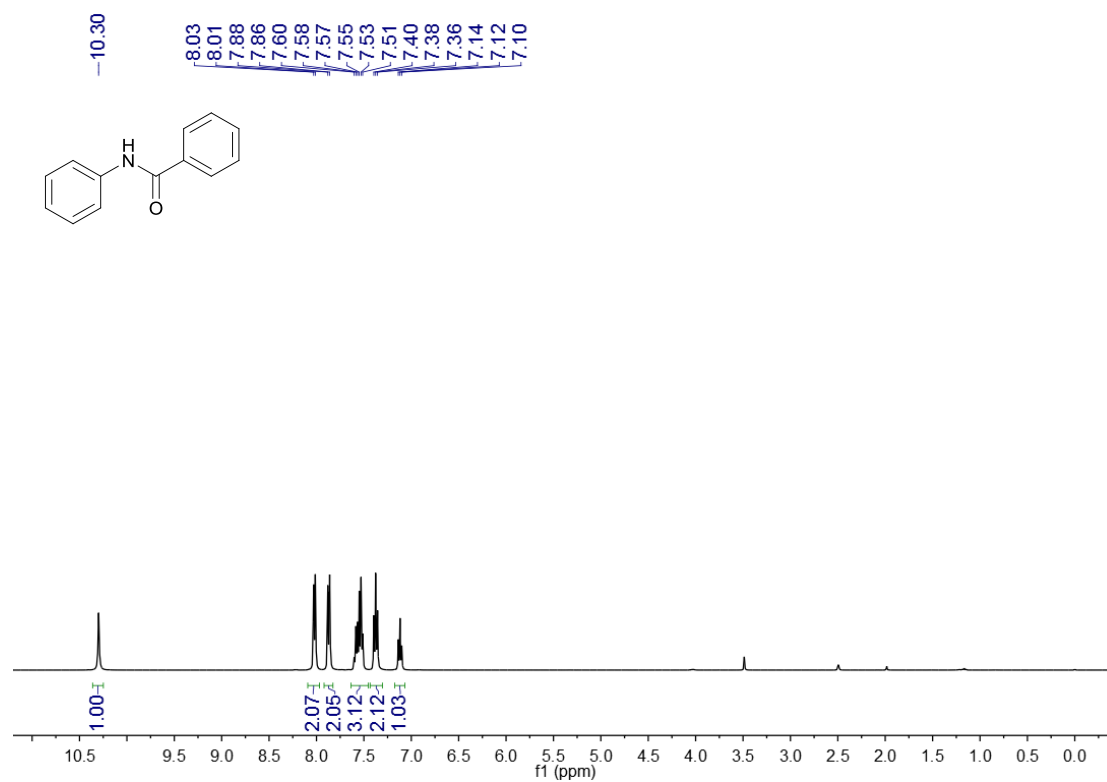
N-cyclohexylbenzamide(3p)



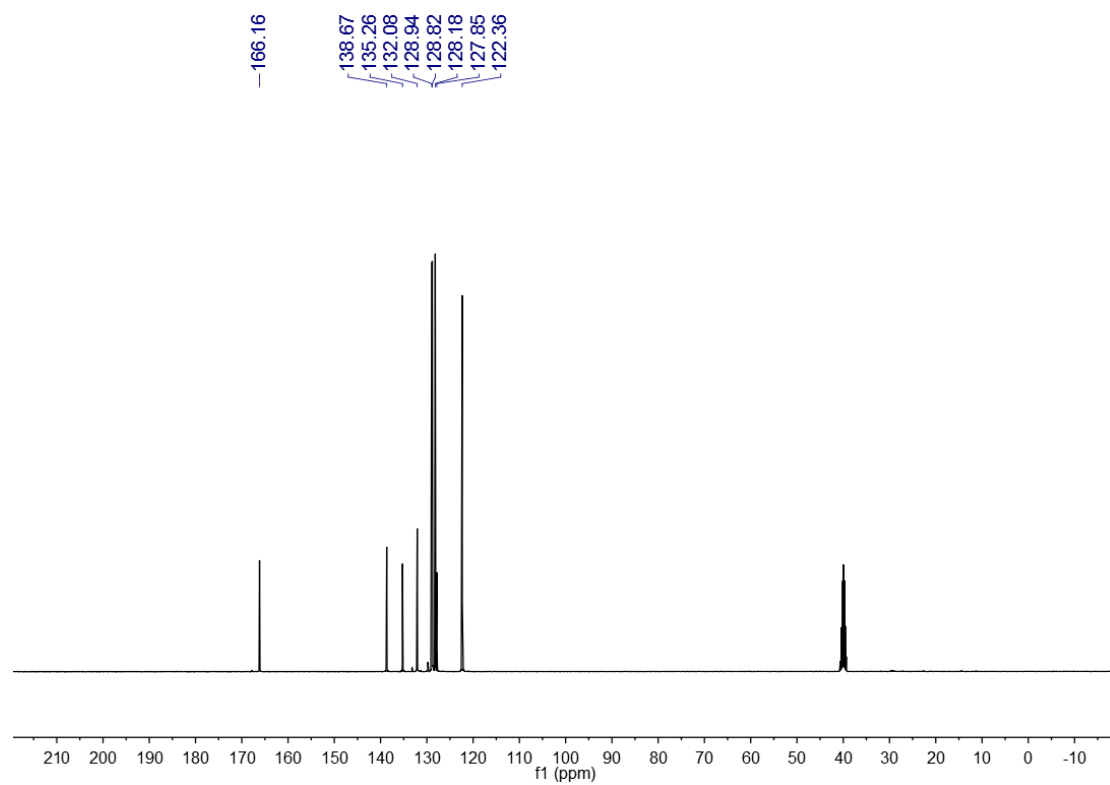
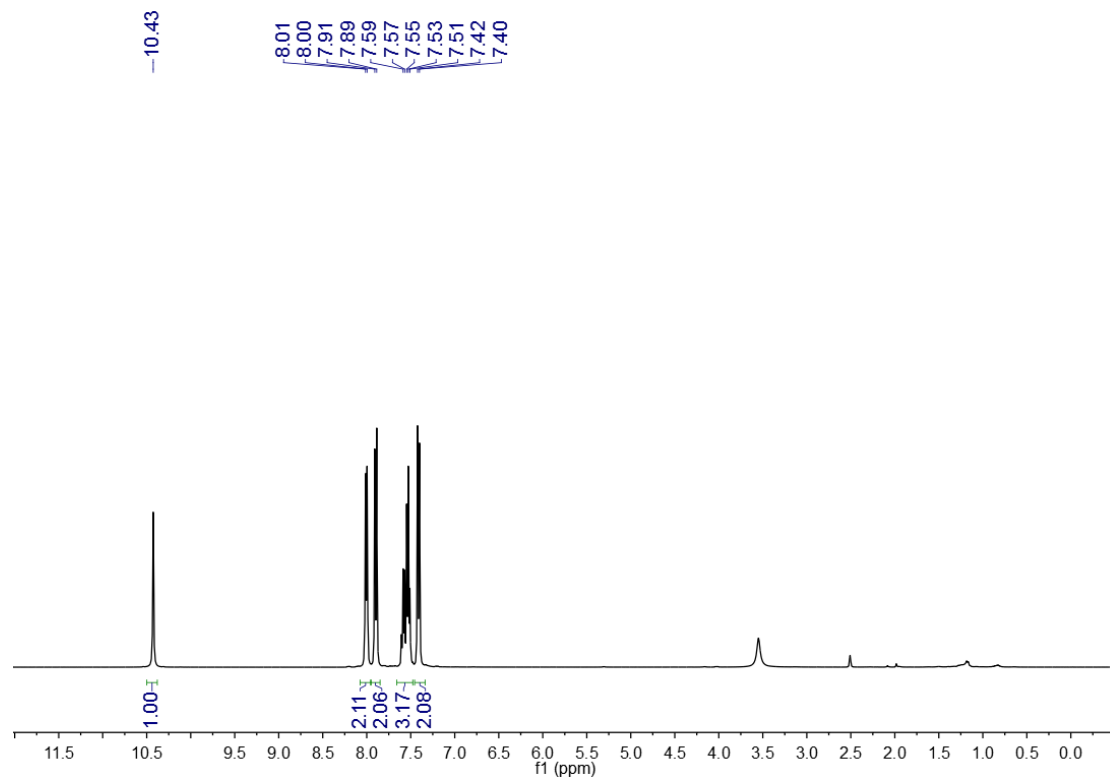
N-benzylbenzamide(3q)



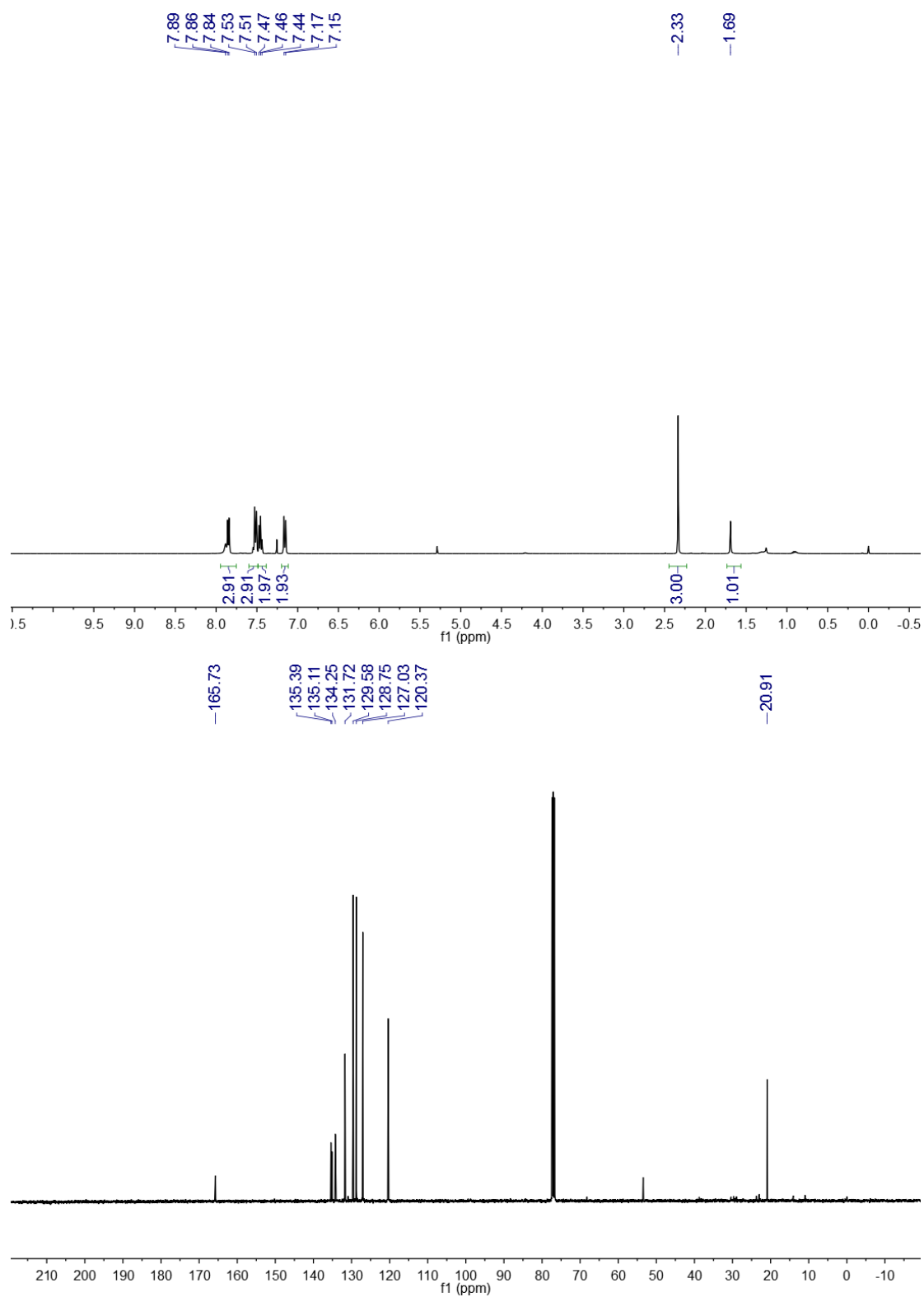
N-phenylbenzamide(3r)



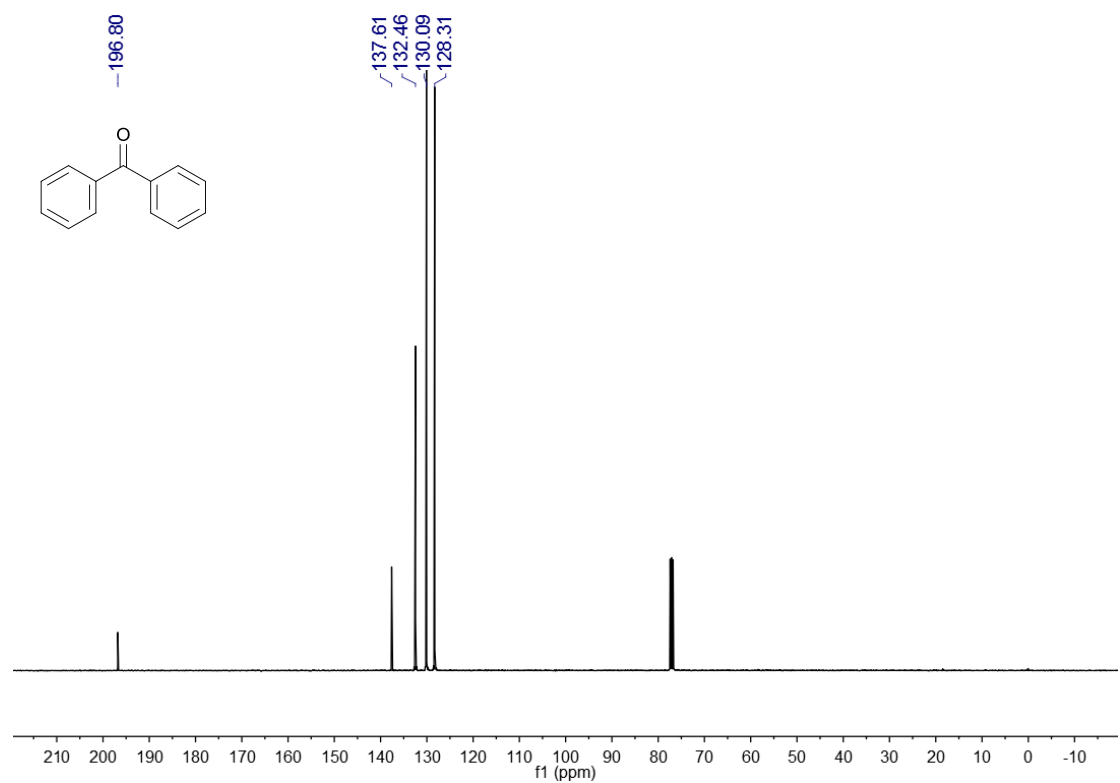
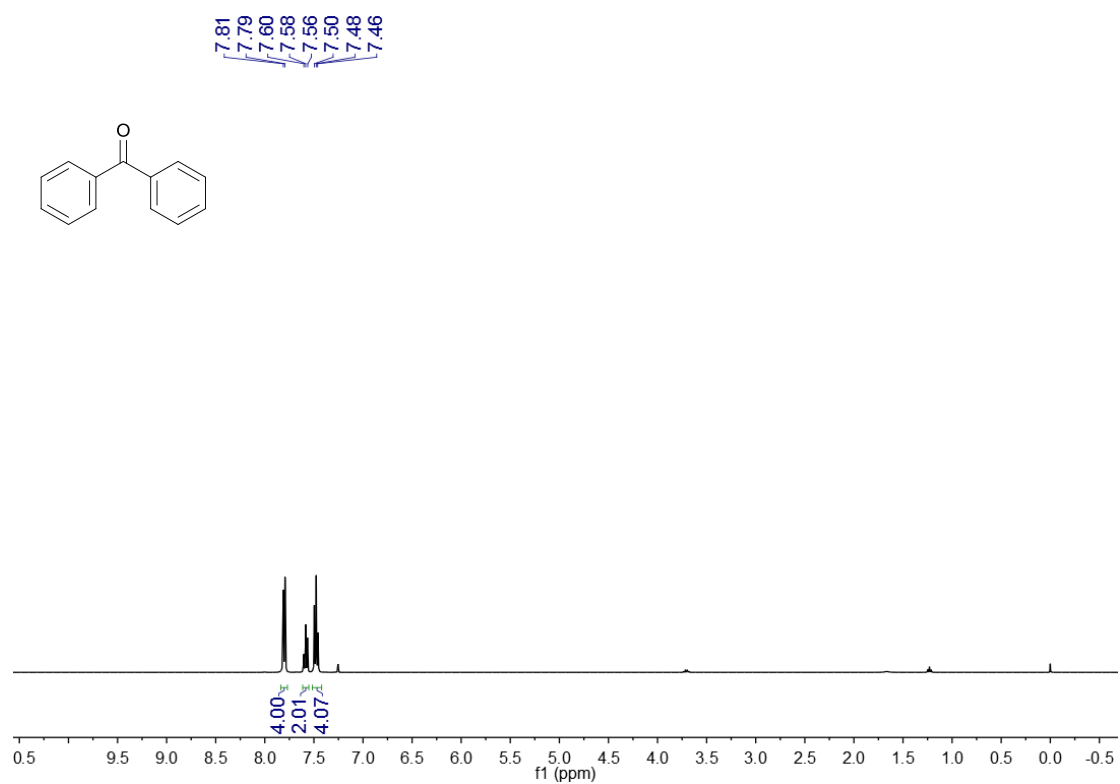
4-chloro-N-phenylbenzamide (3s)



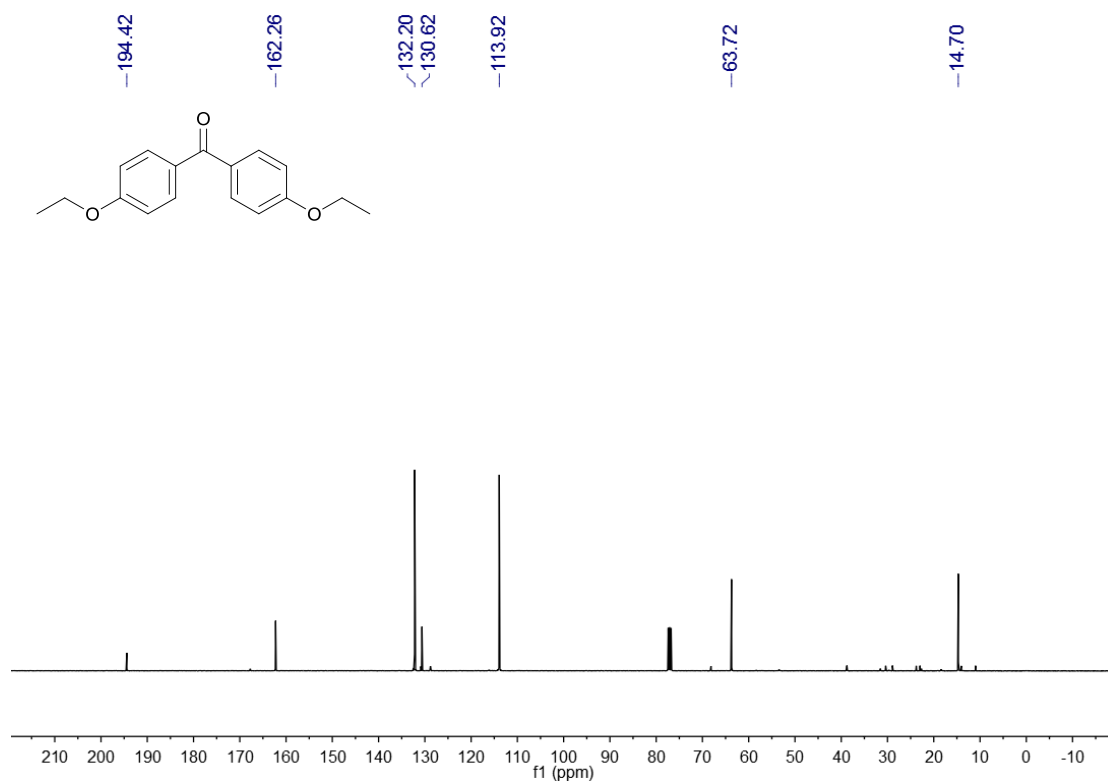
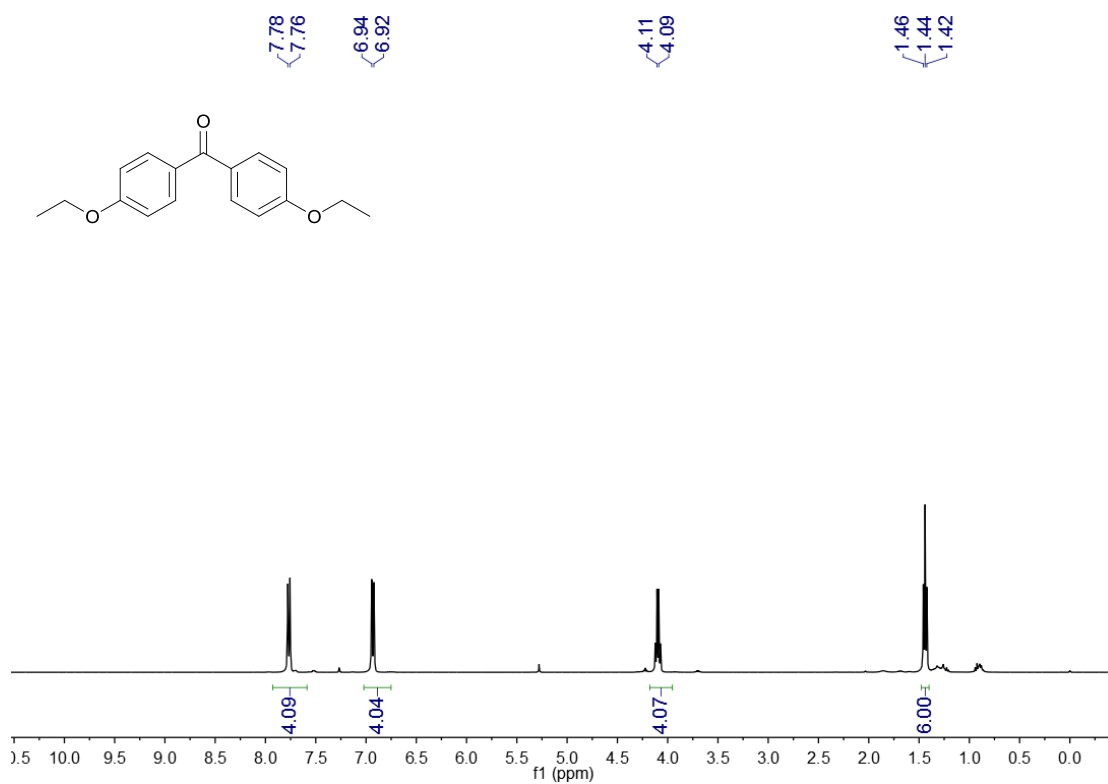
N-p-tolylbenzamide (3t)



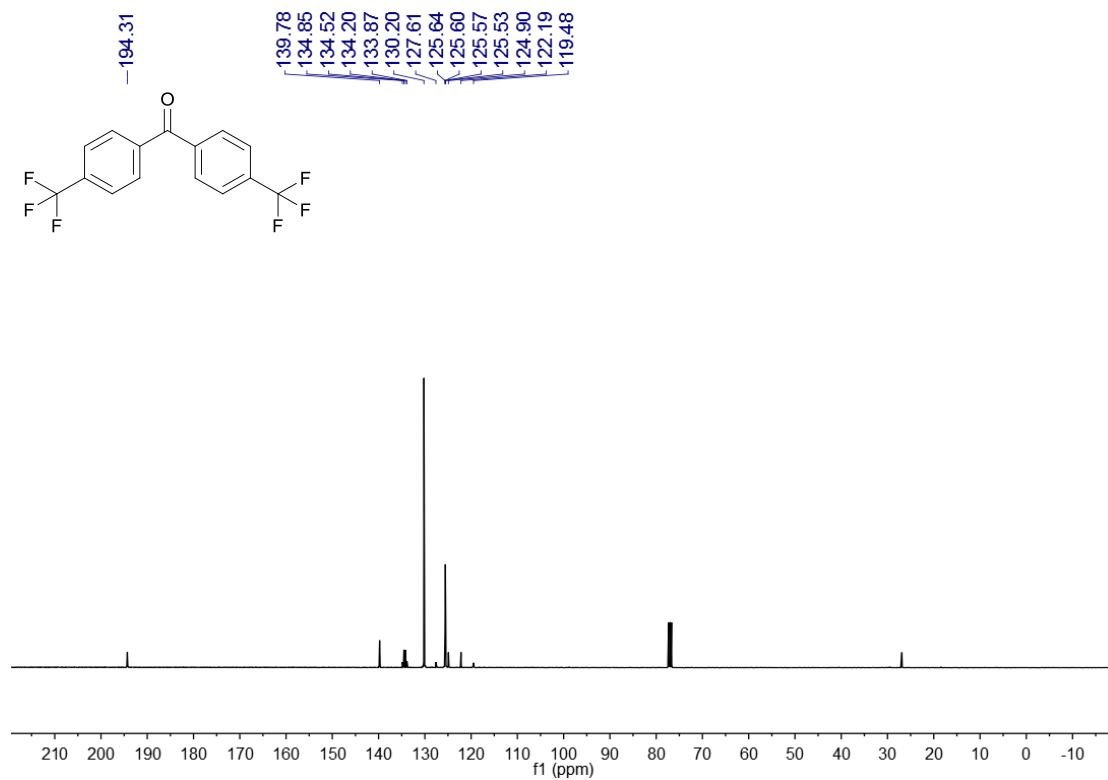
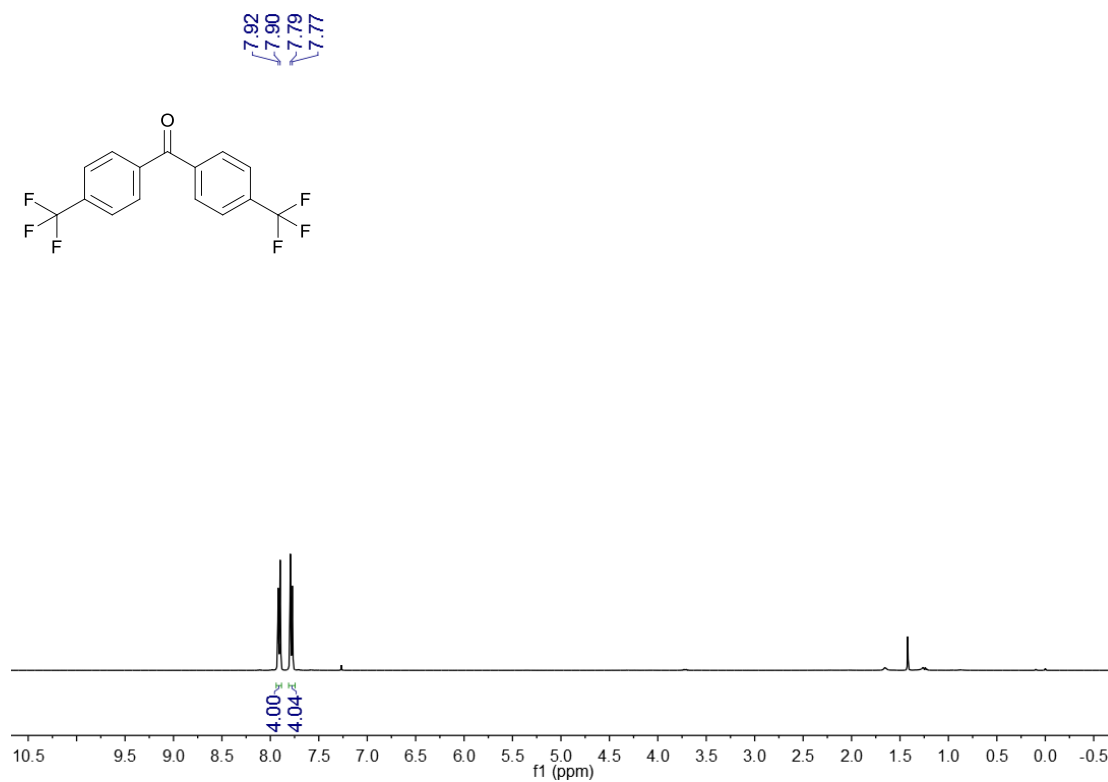
benzophenone(4a)



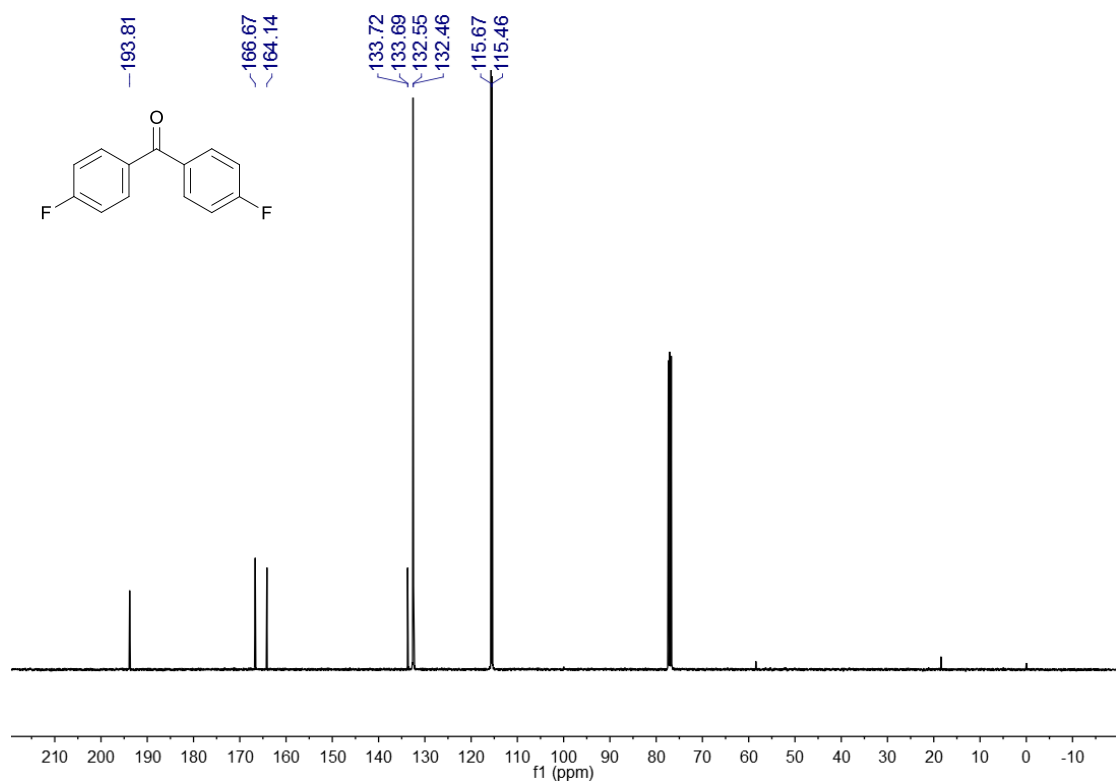
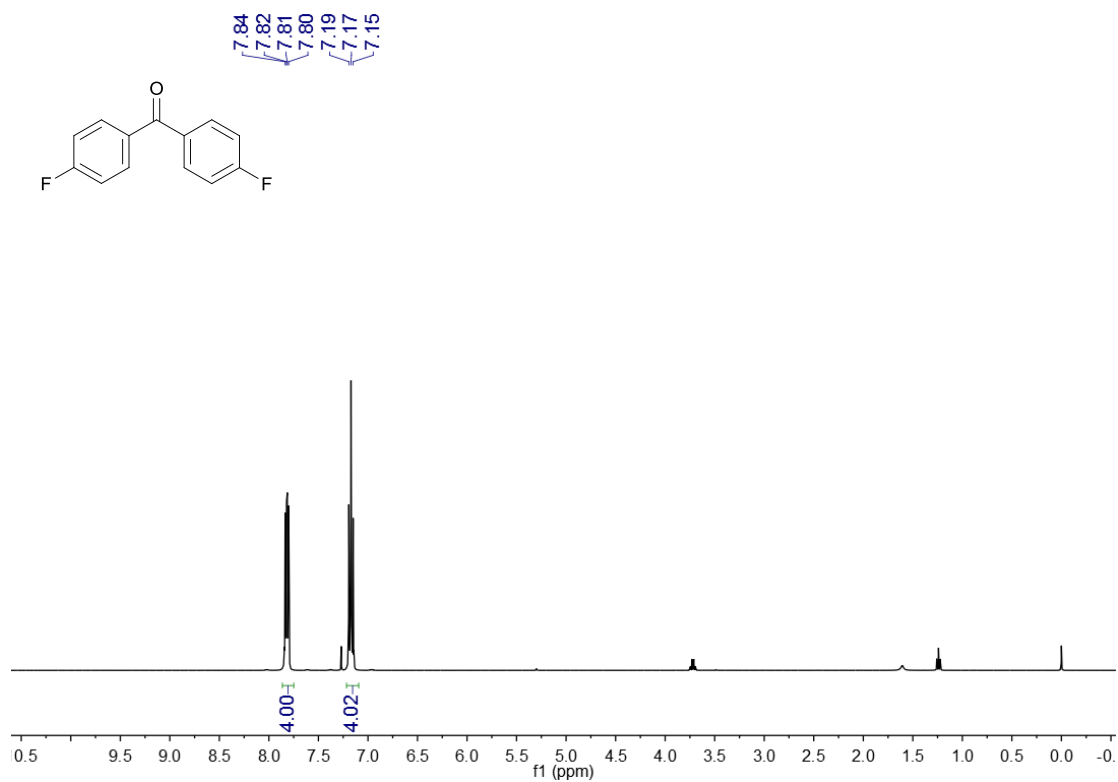
bis(4-ethoxyphenyl)methanone (4b)



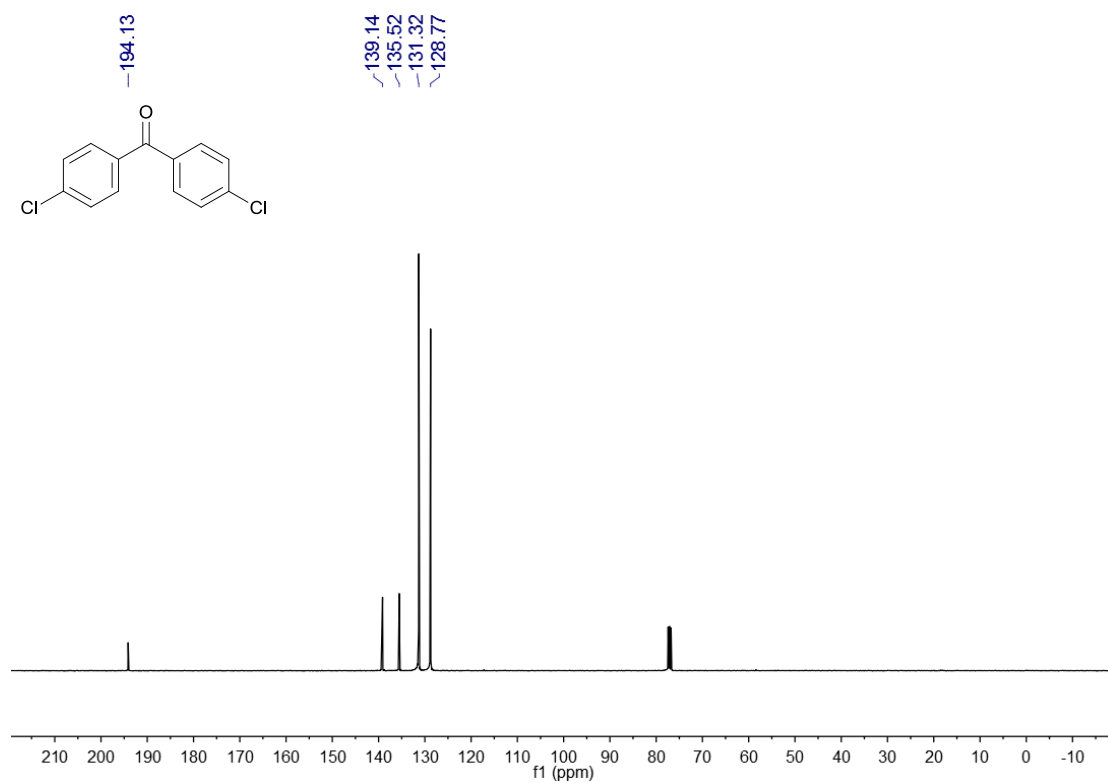
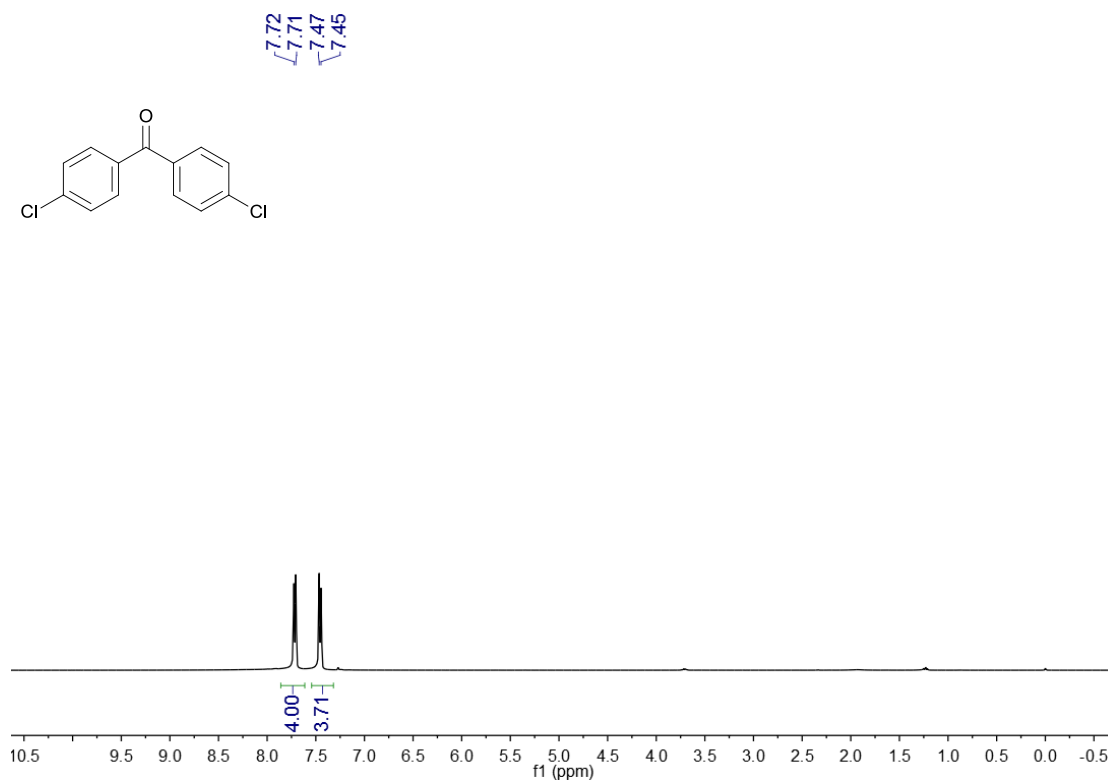
bis(4-(trifluoromethyl)phenyl)methanone (4c)



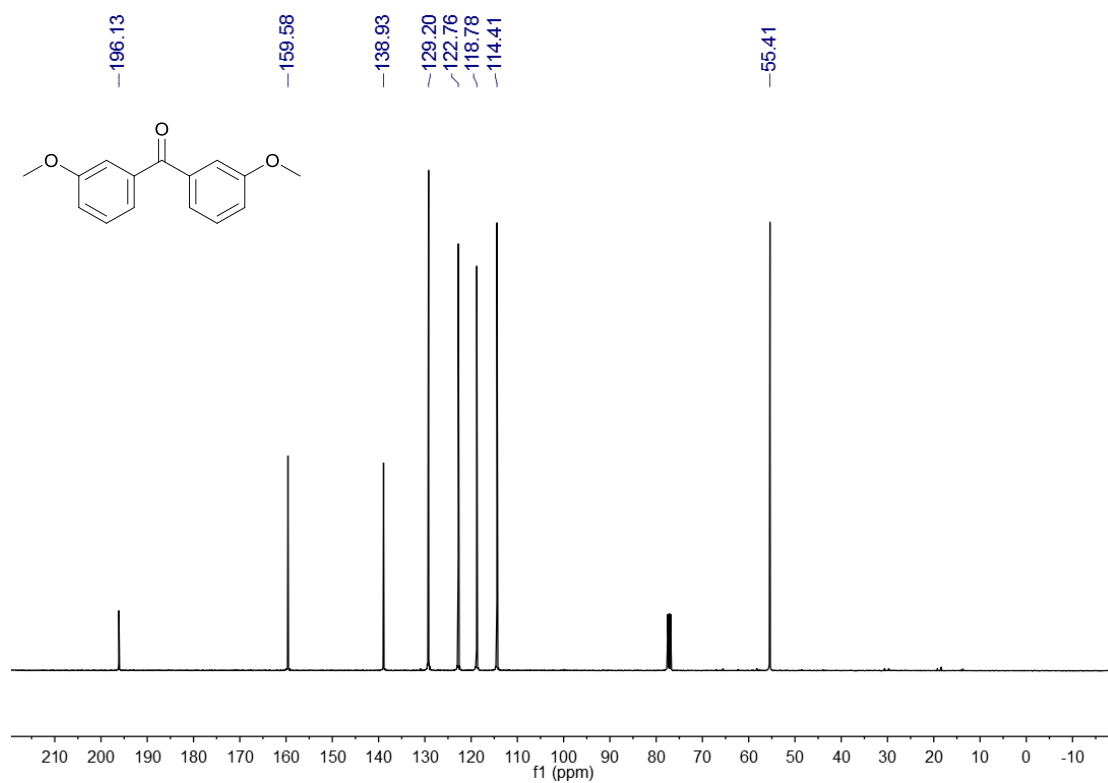
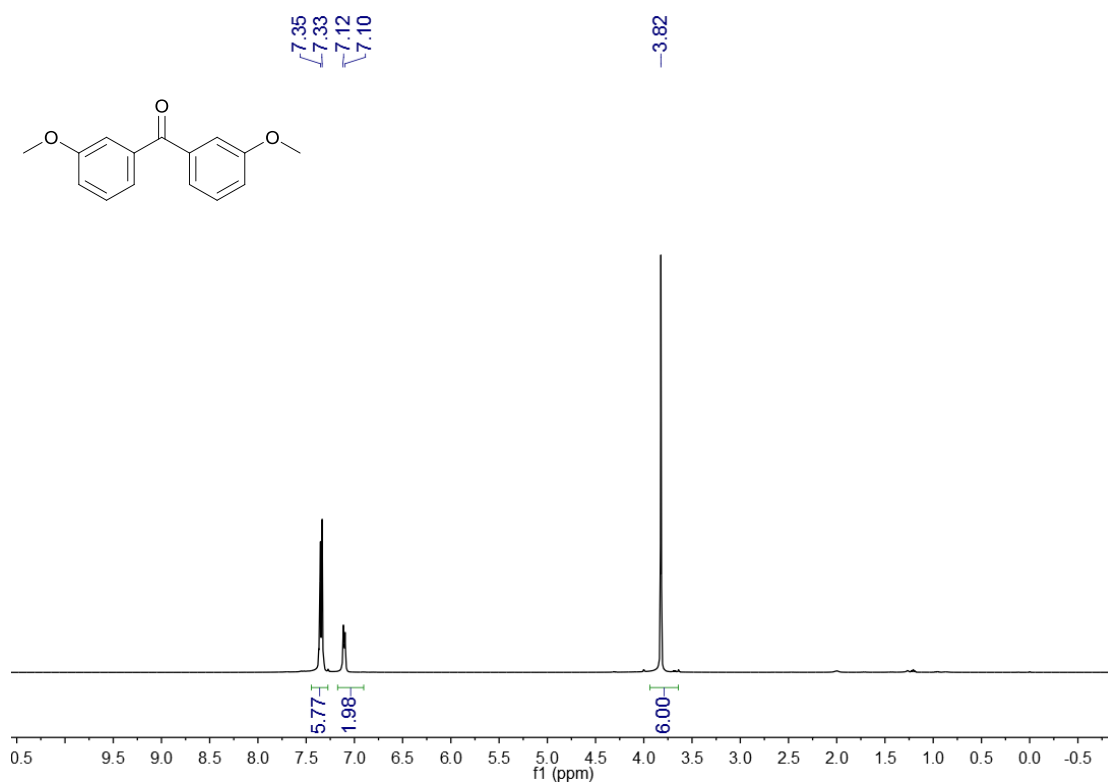
bis(4-fluorophenyl)methanone(4d)



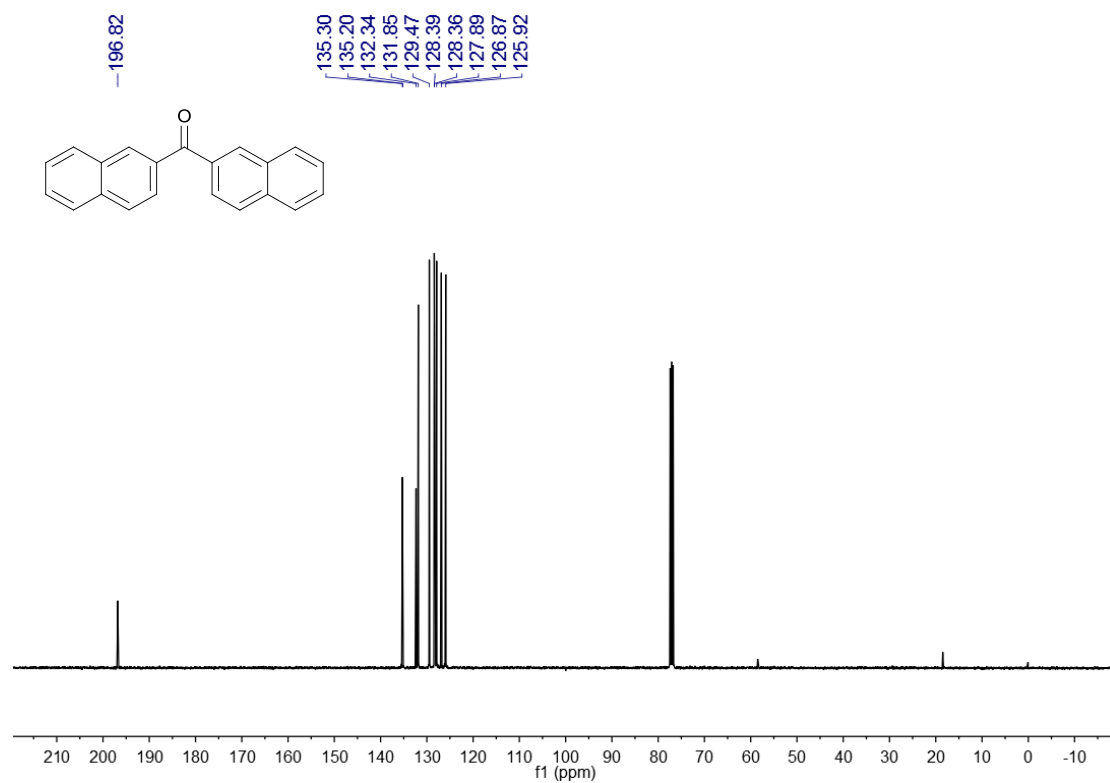
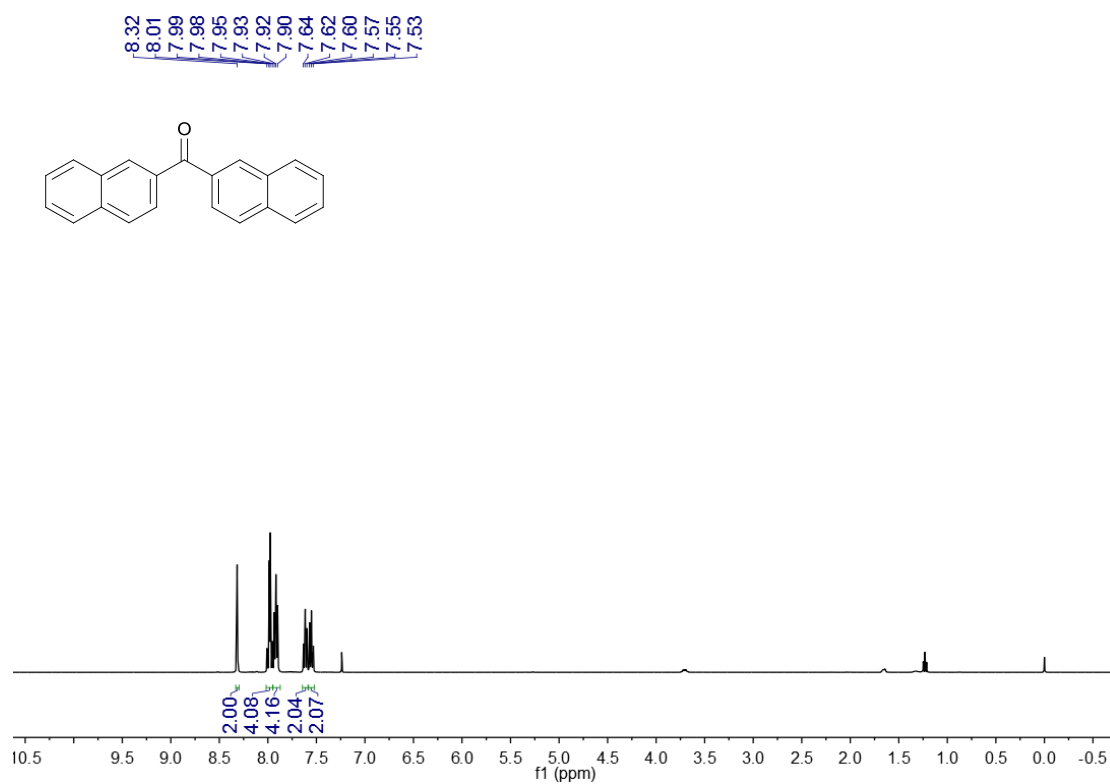
bis(4-chlorophenyl)methanone(4e)



bis(3-methoxyphenyl)methanone(4f)



dinaphthalen-2-ylmethanone (4g)



dibiphenyl-4-ylmethanone(4h)

