Supporting Information

Organic Template-Free Synthesis of Zeolite Y Nanoparticle Assemblies and Their Application in the Catalysis of Ritter Reactions

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1. Figures

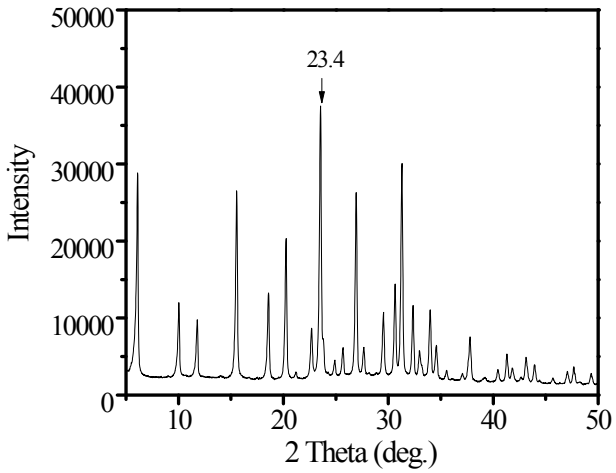


Fig. S1. XRD pattern of the conventional zeolite Y.

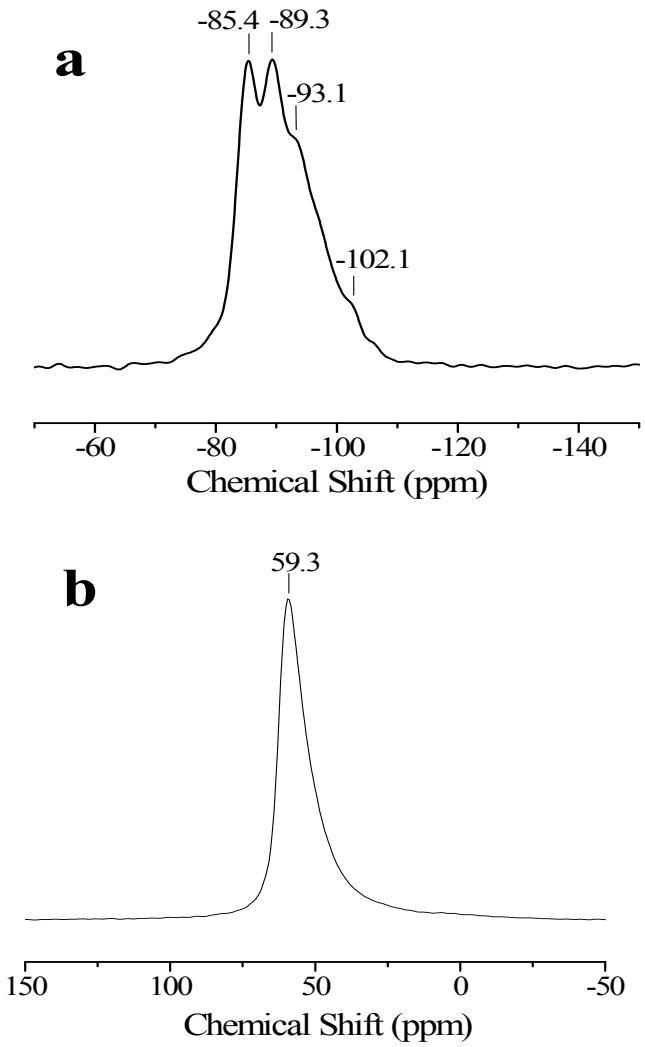


Fig. S2. ^{29}Si MAS NMR and ^{27}Al MAS NMR spectra of the Y-NA sample.

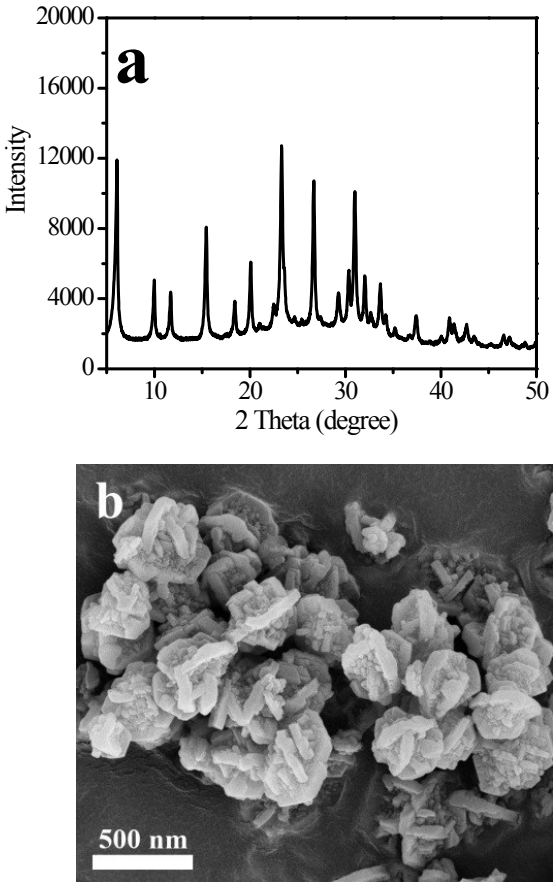


Fig. S3. (a) XRD pattern and (b) SEM image of the Y-NAL sample.

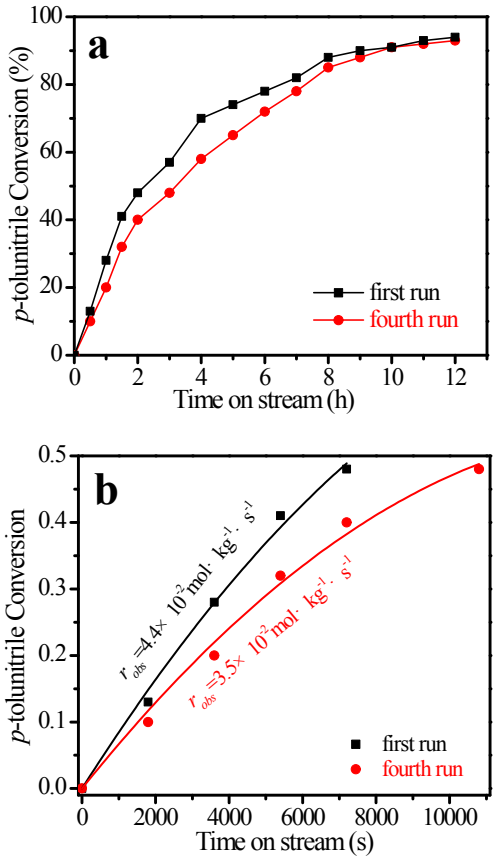


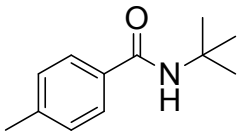
Fig. S4. (a) Time dependence of *p*-tolunitrile conversion over the HY-NA catalyst for the first and fourth runs, and (b) initial apparent reaction rate over the HY-NA catalyst for the first and fourth runs (Reaction conditions: 10 g catalyst, *p*-tolunitrile (50 mmol), *t*-BuOH (100 mL), 120 °C for 12 h, 300 rpm).

The initial apparent reaction rate was calculated according to following equation,

$$r_{obs} = \frac{n}{W} \times \frac{\mathrm{d}x}{\mathrm{d}t}$$

where r_{obs} is initial apparent reaction rate (mol·kg^{-1}·s^{-1}), n is the amount of the *p*-tolunitrile (mol), x is the benzhydrol conversion, W is the catalyst mass (kg), t is the reaction time (s).

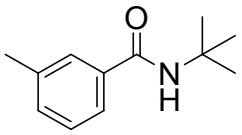
2. Analytical data



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

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (d, *J* = 6.8 Hz, 2H), 7.21 (d, *J* = 6.4 Hz, 2H), 5.92 (s, 1H), 2.37 (s, 3H), 1.46 (s, 9H);

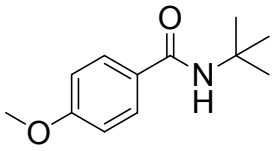
^{13}C NMR (100 MHz, $CDCl_3$) δ166.8, 141.3, 133.0, 129.0, 126.6, 51.4, 28.8, 21.3.



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

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 (s, 1H), 7.43-7.38 (m, 1H), 7.22-7.16 (m, 2H), 5.87 (s, 1H), 2.30 (s, 3H), 1.39 (s, 9H);

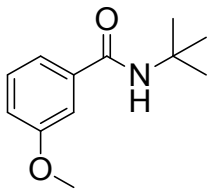
^{13}C NMR (100 MHz, $CDCl_3$) δ 167.0, 138.2, 135.8, 131.7, 128.2, 127.4, 123.5, 51.5, 28.8, 21.3.



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

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 7.2 Hz, 2H), 6.91 (d, *J* = 7.2 Hz, 2H), 5.86 (s, 1H), 3.84 (s, 3H), 1.46 (s, 9H);

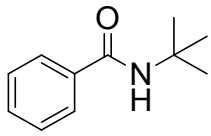
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.4, 161.8, 128.4, 128.2, 113.6, 55.3, 51.4, 28.9.



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

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.25 (m, 2H), 7.20 (d, *J* = 7.6 Hz, 1H), 7.03-6.96 (m, 1H), 6.01 (s, 1H), 3.82 (s, 3H), 1.46 (s, 9H);

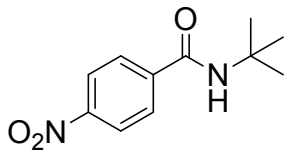
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 159.7, 137.3, 129.3, 118.3, 117.2, 112.0, 55.3, 51.5, 28.7.



N-(tert-butyl)benzamide (3e)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74-7.69 (m, 2H), 7.50-7.37 (m, 3H), 5.93 (s, 1H), 1.47 (s, 9H);

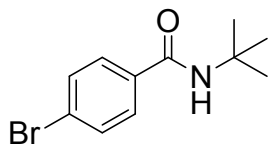
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.8, 135.9, 131.0, 128.4, 126.6, 51.5, 28.8.



N-(tert-butyl)-4-nitrobenzamide (3f)

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (d, *J* = 6.8 Hz, 2H), 7.88 (d, *J* = 6.8 Hz, 2H), 5.98 (s, 1H), 1.49 (s, 9H);

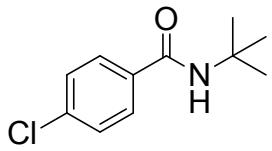
^{13}C NMR (100 MHz, $CDCl_3$) δ 164.8, 149.3, 141.5, 127.9, 123.7, 52.2, 28.7.



4-bromo-N-(tert-butyl)benzamide (3g)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, *J* = 7.2 Hz, 2H), 7.53 (d, *J* = 7.2 Hz, 2H), 5.93 (s, 1H), 1.46 (s, 9H);

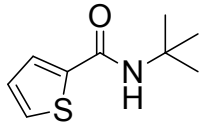
^{13}C NMR (100 MHz, $CDCl_3$) δ 165.8, 134.7, 131.63, 131.6, 128.3, 125.6, 51.7, 28.7.



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

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 6.8 Hz, 2H), 7.36 (d, *J* = 6.8 Hz, 2H), 5.90 (s, 1H), 1.46 (s, 9H);

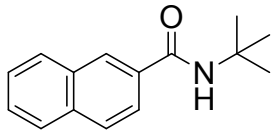
^{13}C NMR (100 MHz, $CDCl_3$) δ 165.8, 137.2, 134.2, 128.6, 128.1, 51.7, 28.8.



N-(tert-butyl)thiophene-2-carboxamide (3i)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44-7.39 (m, 2H), 7.05 (dd, *J* = 3.2, 4.0 Hz, 1H), 5.80 (s, 1H), 1.46 (s, 9H);

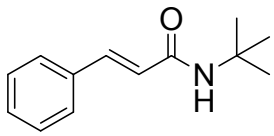
^{13}C NMR (100 MHz, $CDCl_3$) δ 161.2, 140.5, 129.3, 127.4, 127.3, 51.9, 28.9.



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

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 (s, 1H), 7.93-7.82 (m, 3H), 7.80 (dd, *J* = 1.2, 8.4 Hz, 1H), 7.57-7.48 (m, 2H), 6.10 (s, 1H), 1.52 (s, 9H);

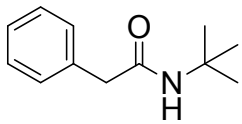
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.9, 134.5, 133.1, 132.6, 128.8, 128.3, 127.6, 127.4, 126.9, 126.6, 123.5, 51.7, 28.9.



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

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, *J* = 15.6 Hz, 1H), 7.49-7.43 (m, 2H), 7.37-7.29 (m, 3H), 6.39 (d, *J* = 15.6 Hz, 1H), 5.70 (s, 1H), 1.43 (s, 9H);

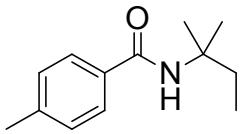
^{13}C NMR (100 MHz, $CDCl_3$) δ 165.2, 140.0, 134.9, 129.3, 128.6, 127.6, 122.0, 51.4, 28.8.



N-(tert-butyl)-2-phenylacetamide (3l)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.31 (m, 2H), 7.30-7.22 (m, 3H), 5.18 (s, 1H), 3.48 (s, 2H), 1.28 (s, 9H);

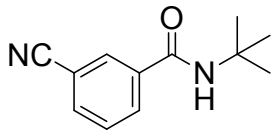
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 135.4, 129.2, 128.8, 127.1, 51.2, 44.8, 28.6.



4-methyl-N-(tert-pentyl)benzamide (3m)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 8.0 Hz, 2H), 7.13 (d, *J* = 8.0 Hz, 2H), 5.75 (s, 1H), 2.30 (s, 3H), 1.77 (q, *J* = 14.8 Hz, 2H), 1.33 (s, 6H), 0.82 (t, *J* = 7.6 Hz, 3H);

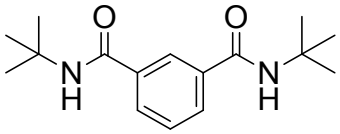
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.7, 141.3, 133.0, 129.0, 126.6, 54.1, 32.7, 26.5, 21.3, 8.3.



N-(tert-butyl)-3-cyanobenzamide (3n)

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (s, 1H), 7.97 (d, *J* = 8.0 Hz, 1H), 7.78-7.70 (m, 1H), 7.58-7.49 (m, 1H), 6.05 (s, 1H), 1.48 (s, 9H);

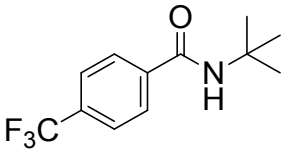
^{13}C NMR (100 MHz, $CDCl_3$) δ 164.6, 137.0, 134.2, 131.1, 130.5, 129.4, 118.0, 112.6, 52.1, 28.7



N1,N3-di-tert-butylisophthalamide (3n")

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (s, 1H), 7.76 (d, *J* = 7.6 Hz, 2H), 7.38 (t, *J* = 7.6 Hz, 1H), 6.04 (s, 2H), 1.40 (s, 18H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 166.0, 135.9, 129.2, 128.6, 124.9, 51.8, 28.7.



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

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 8.0Hz, 2H), 7.68 (d, *J* = 8.0Hz, 2H), 5.94 (s, 1H), 1.48 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 165.6, 139.2, 132.9 (q, *J* = 52.0 Hz), 127.1 (m), 125.4 (q, *J* = 5.8 Hz), 124.7 (q, *J* = 434.0 Hz), 51.9, 28.7.

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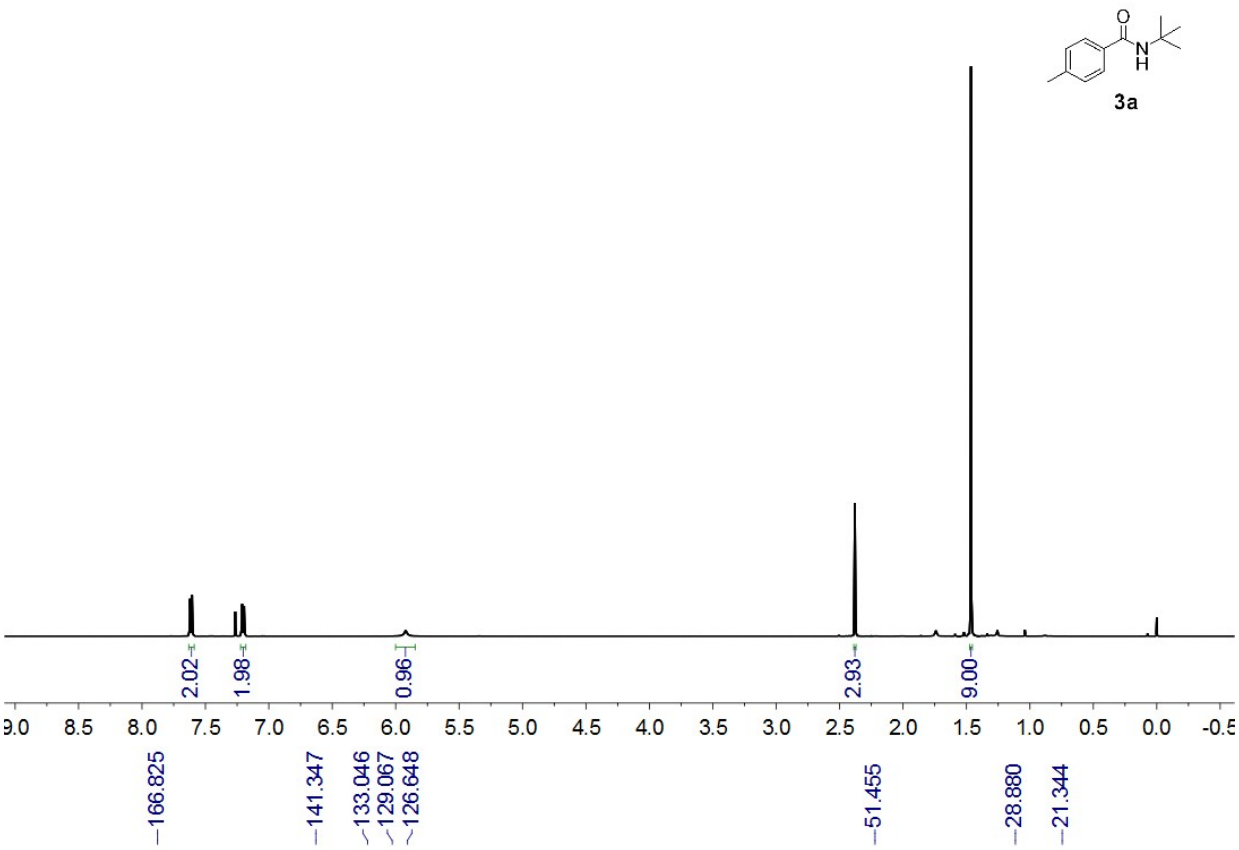
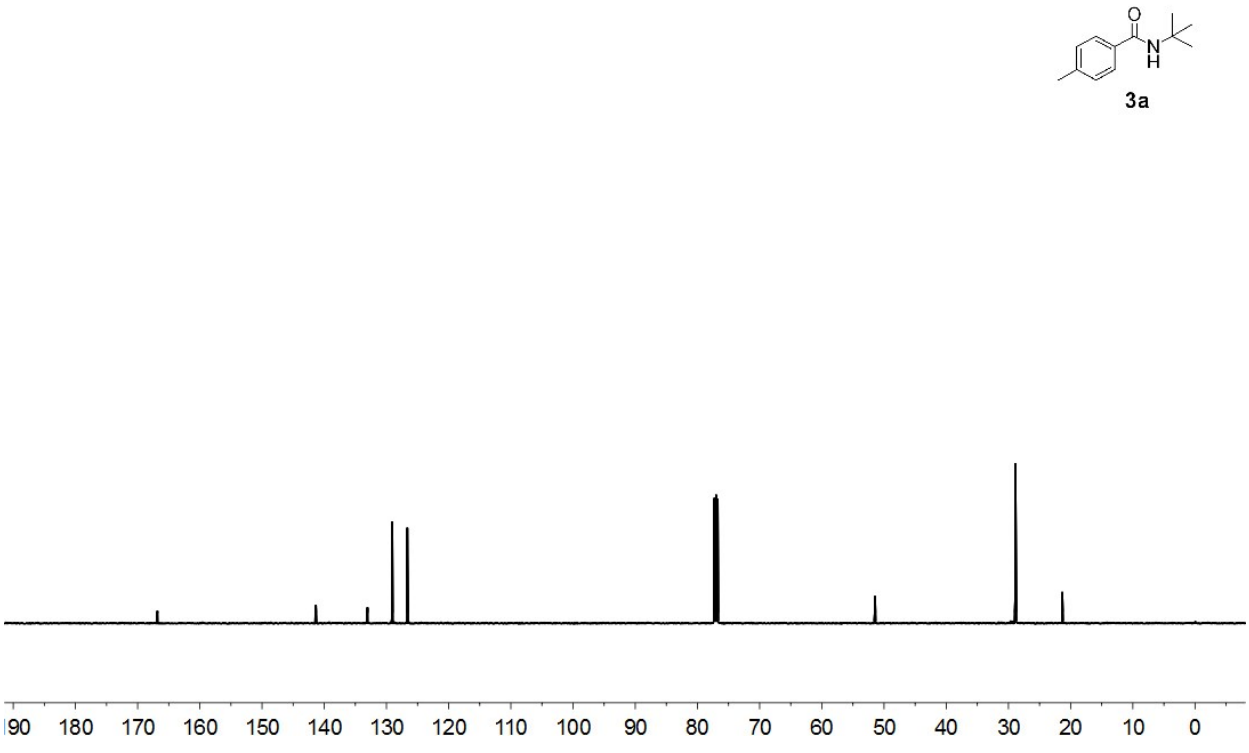
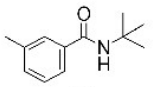
3. Spectra of these compounds







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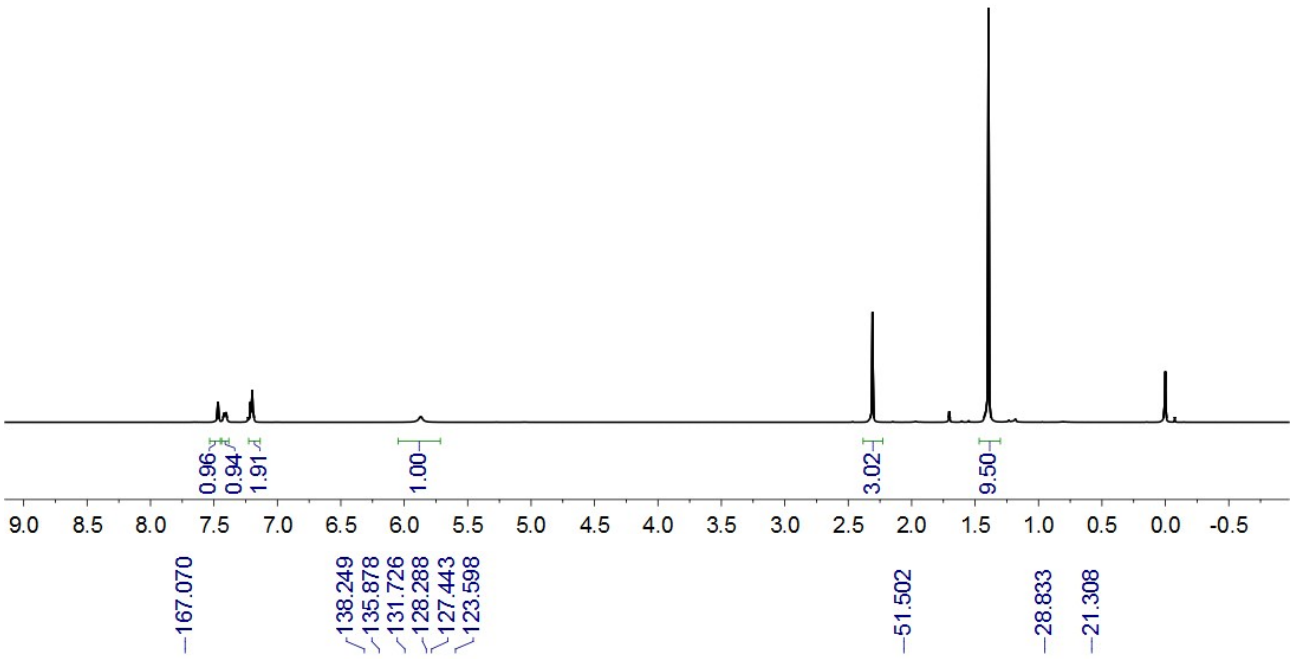
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1.00
3.02
9.50
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
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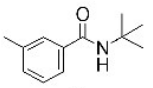

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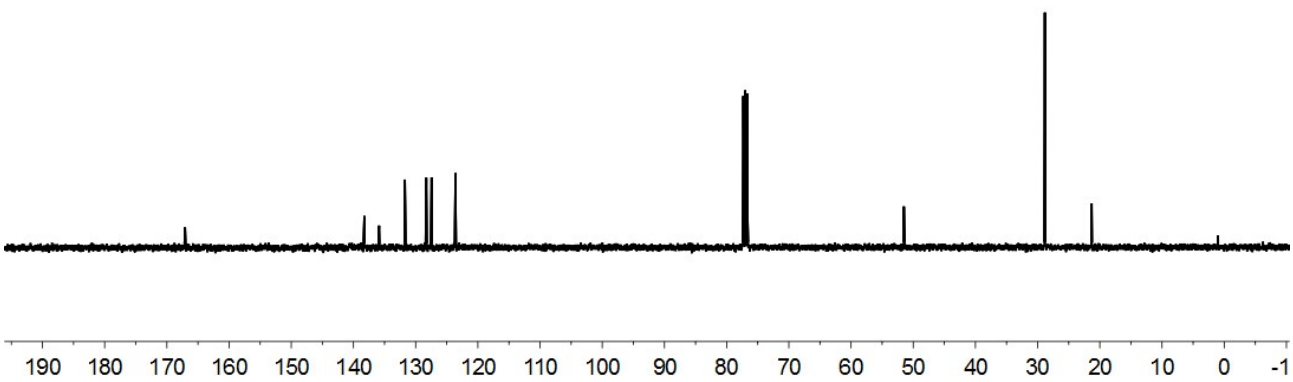
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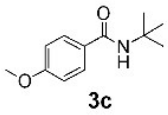
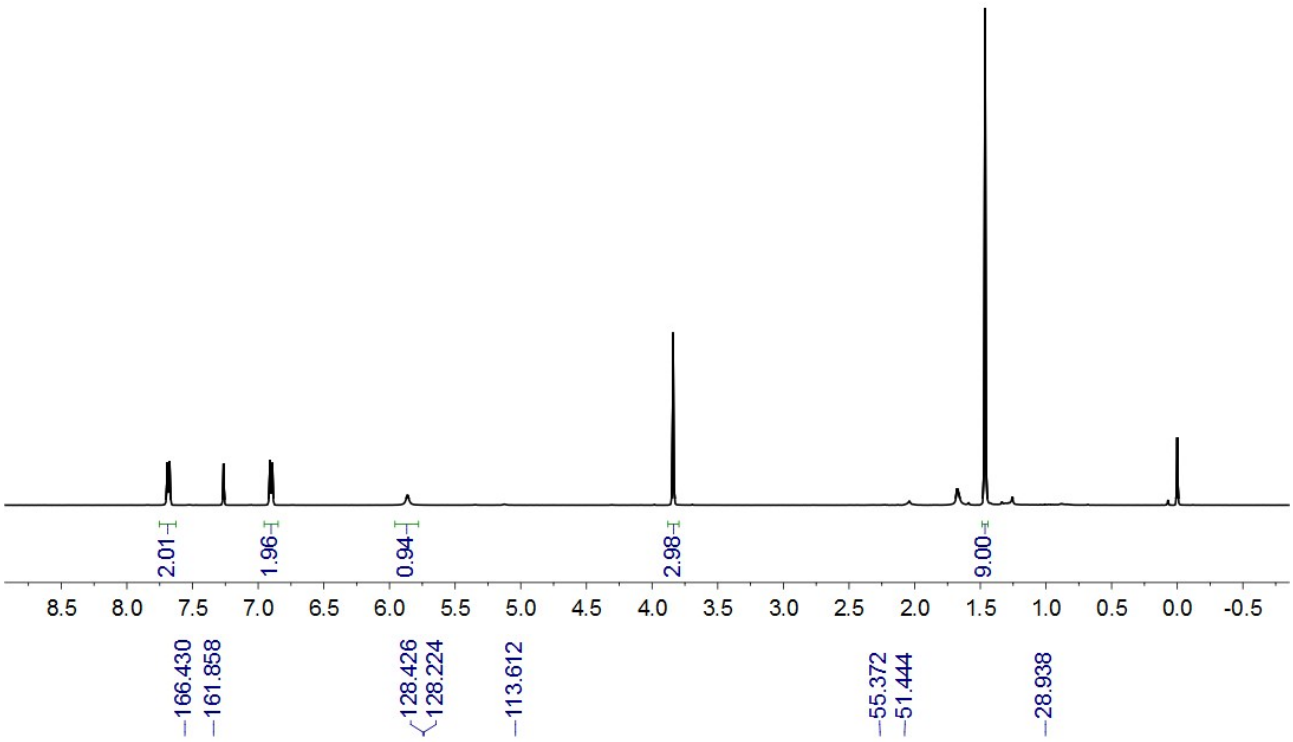


3c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2.98
9.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
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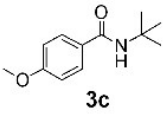

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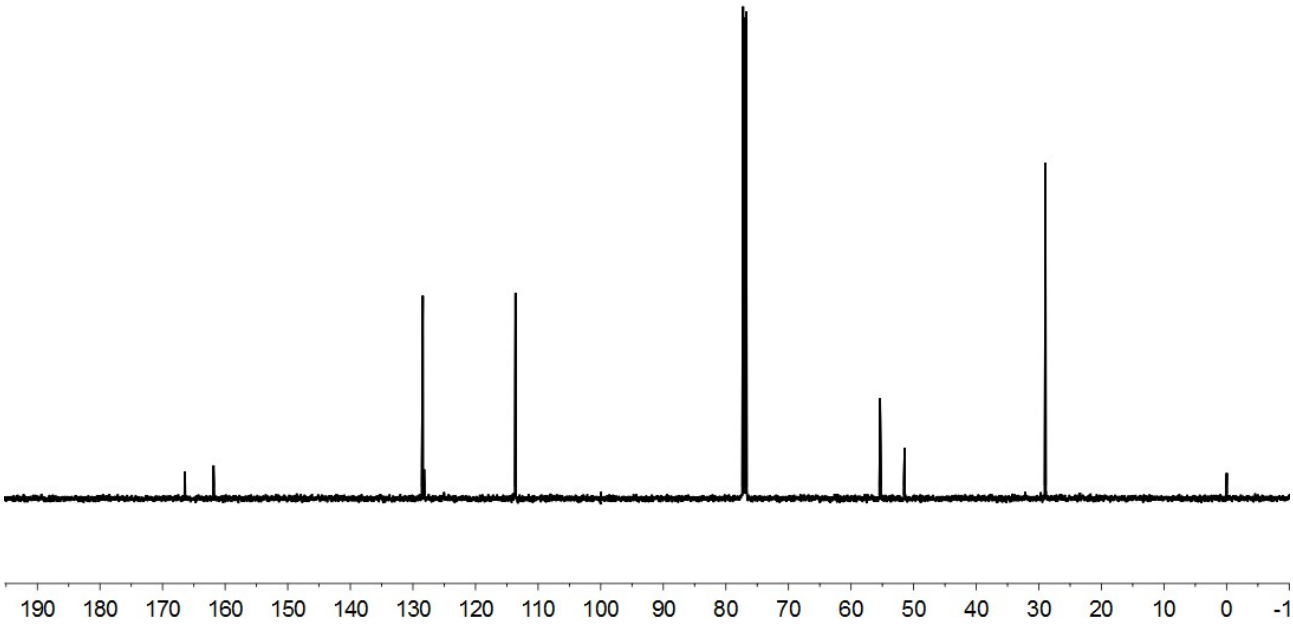
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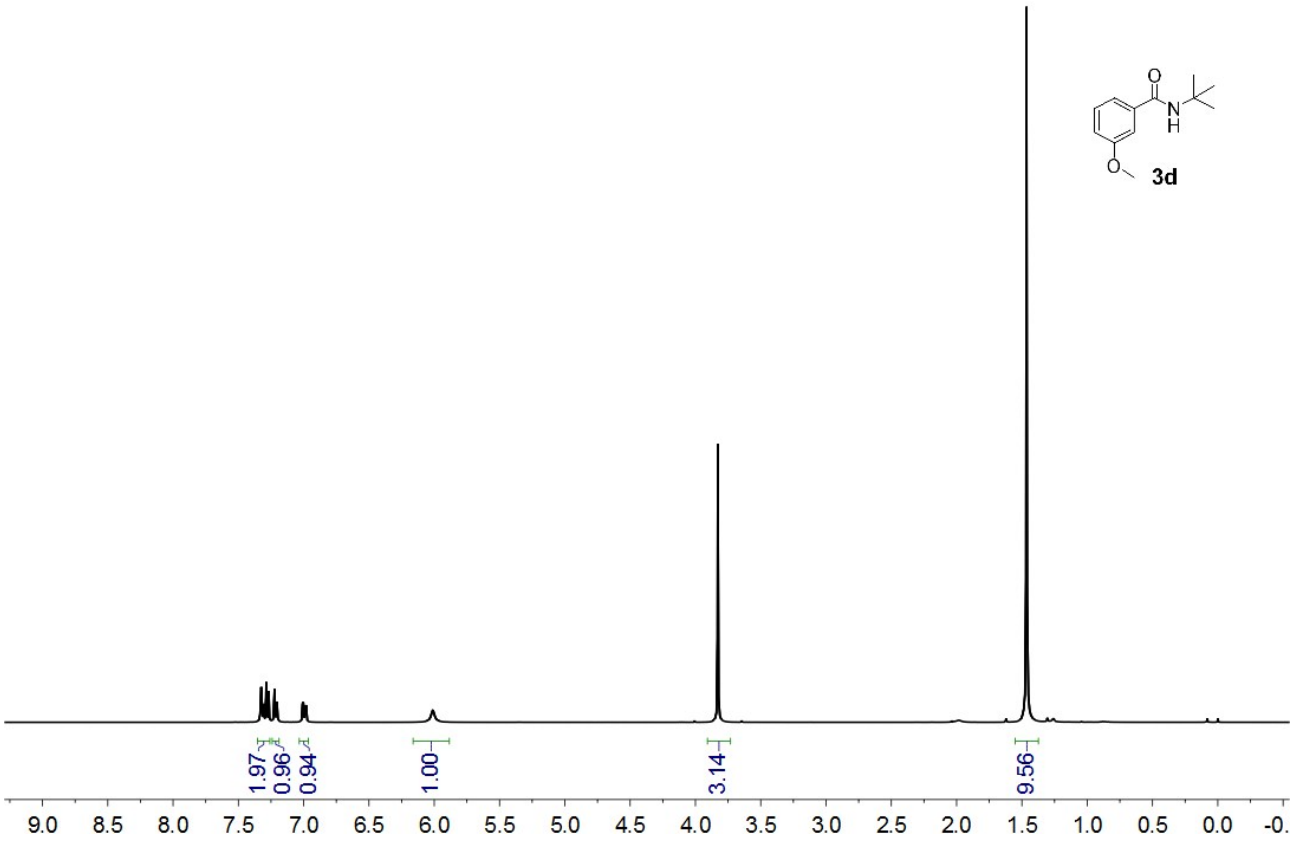
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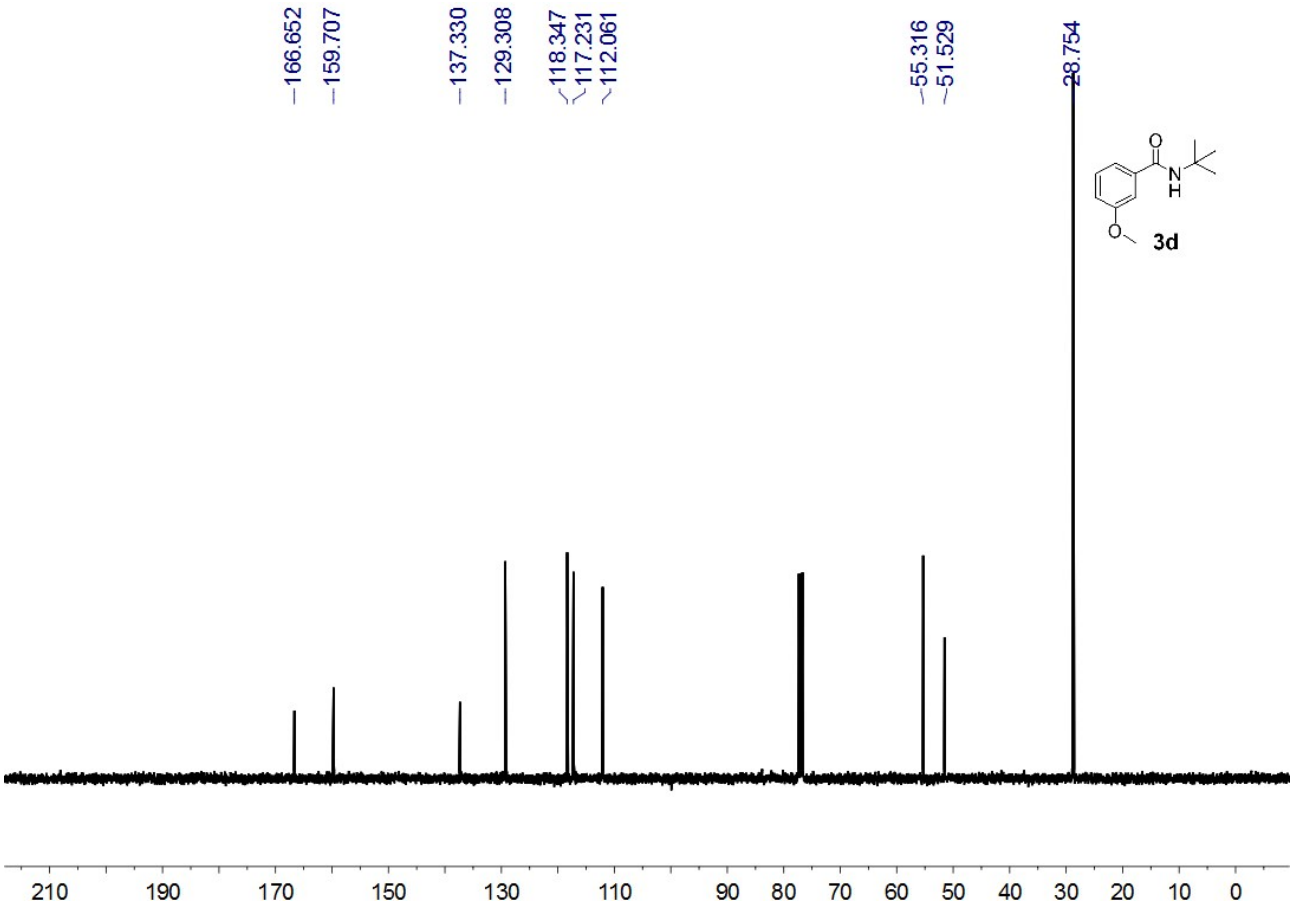
0.94
1.00
3.14
9.56
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.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3d
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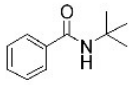
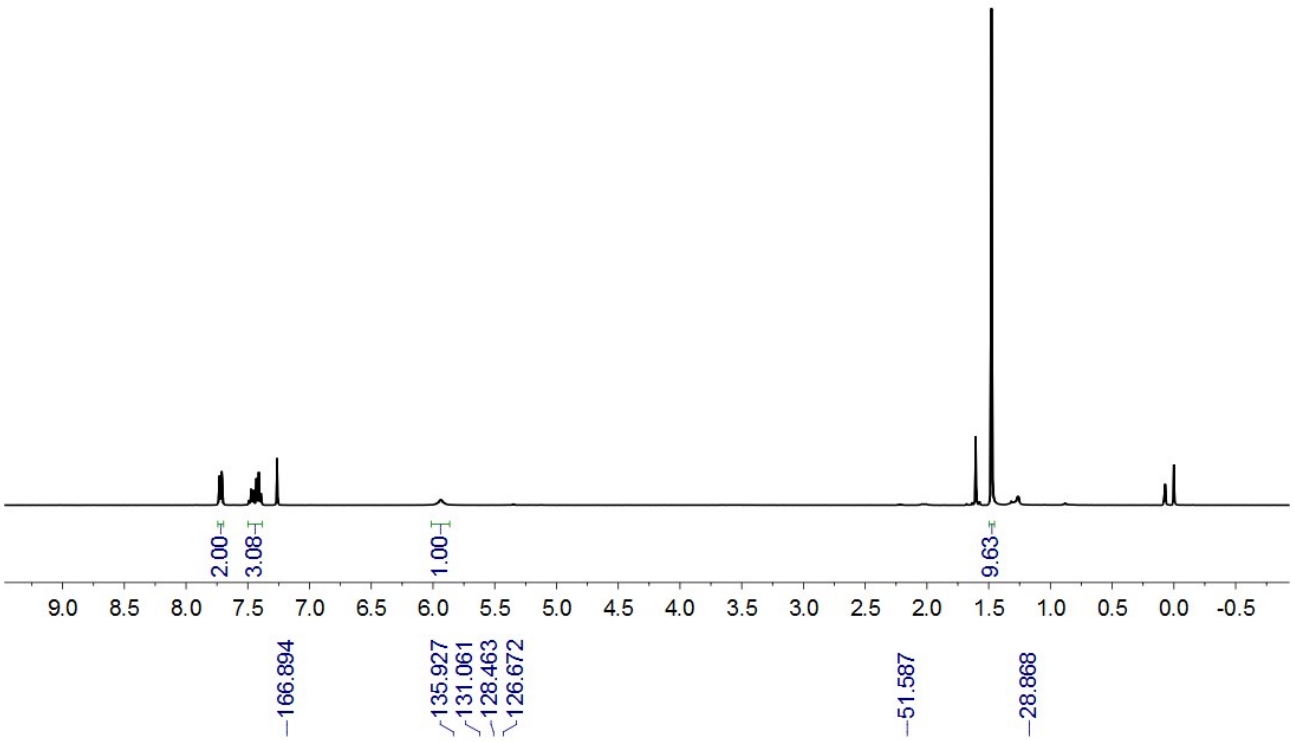


3e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1.00
9.63
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

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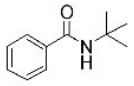
28.868



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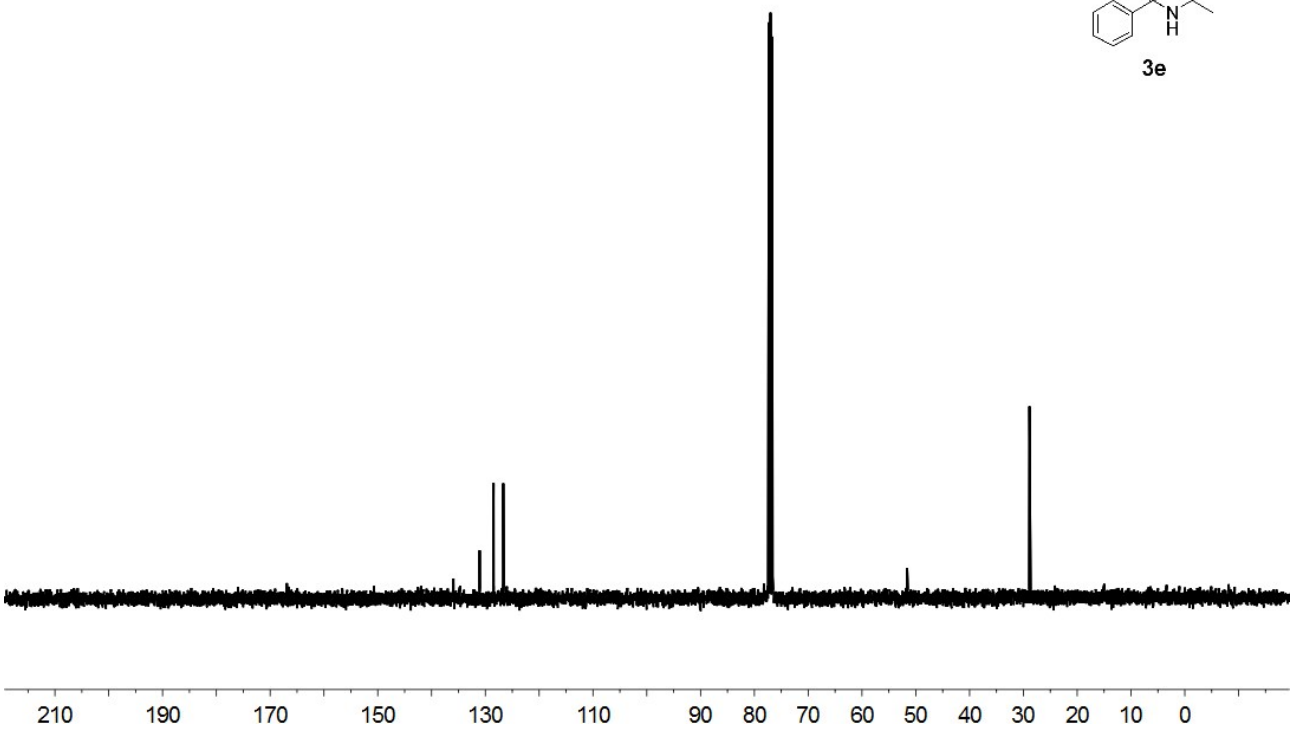
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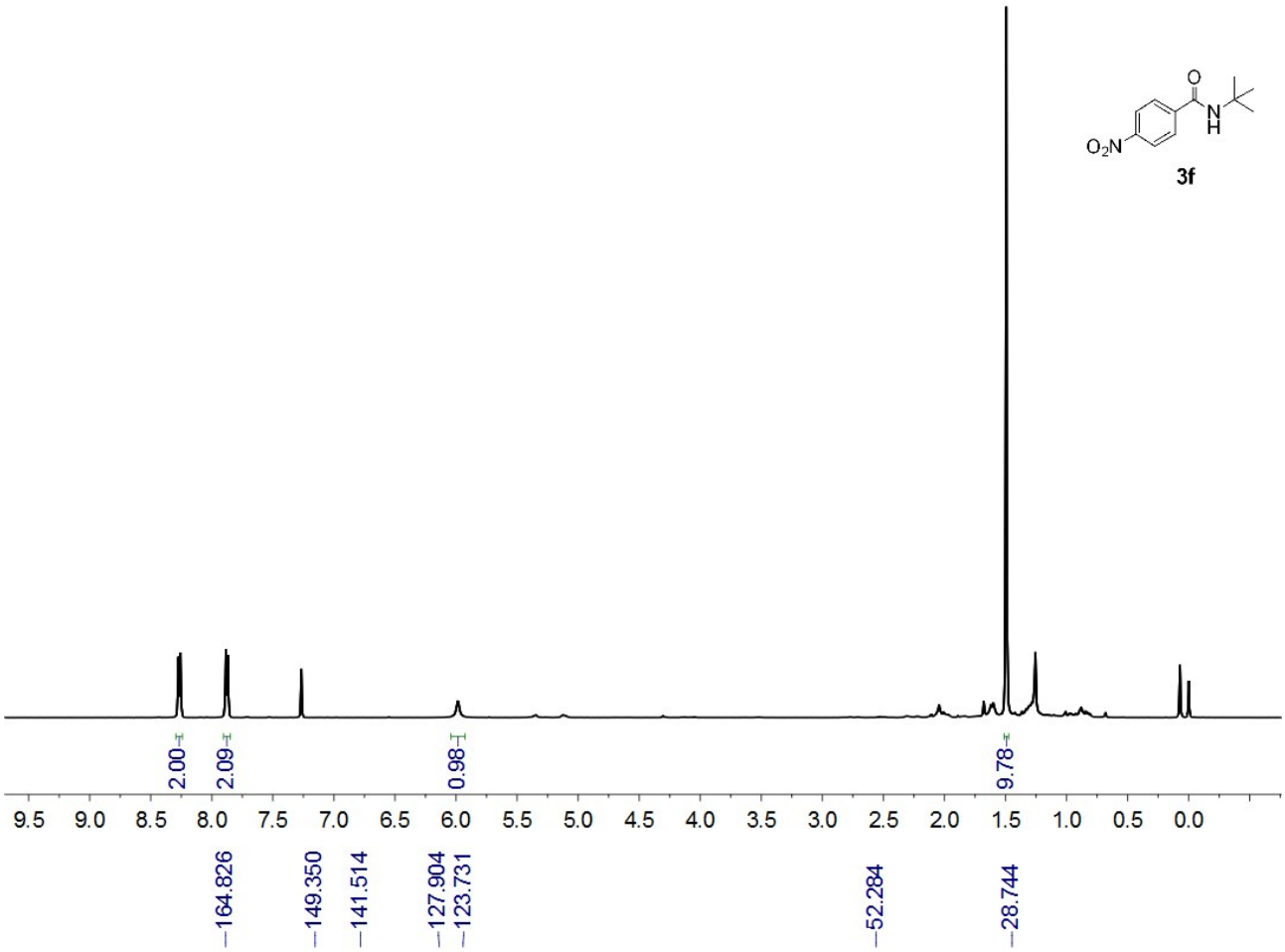
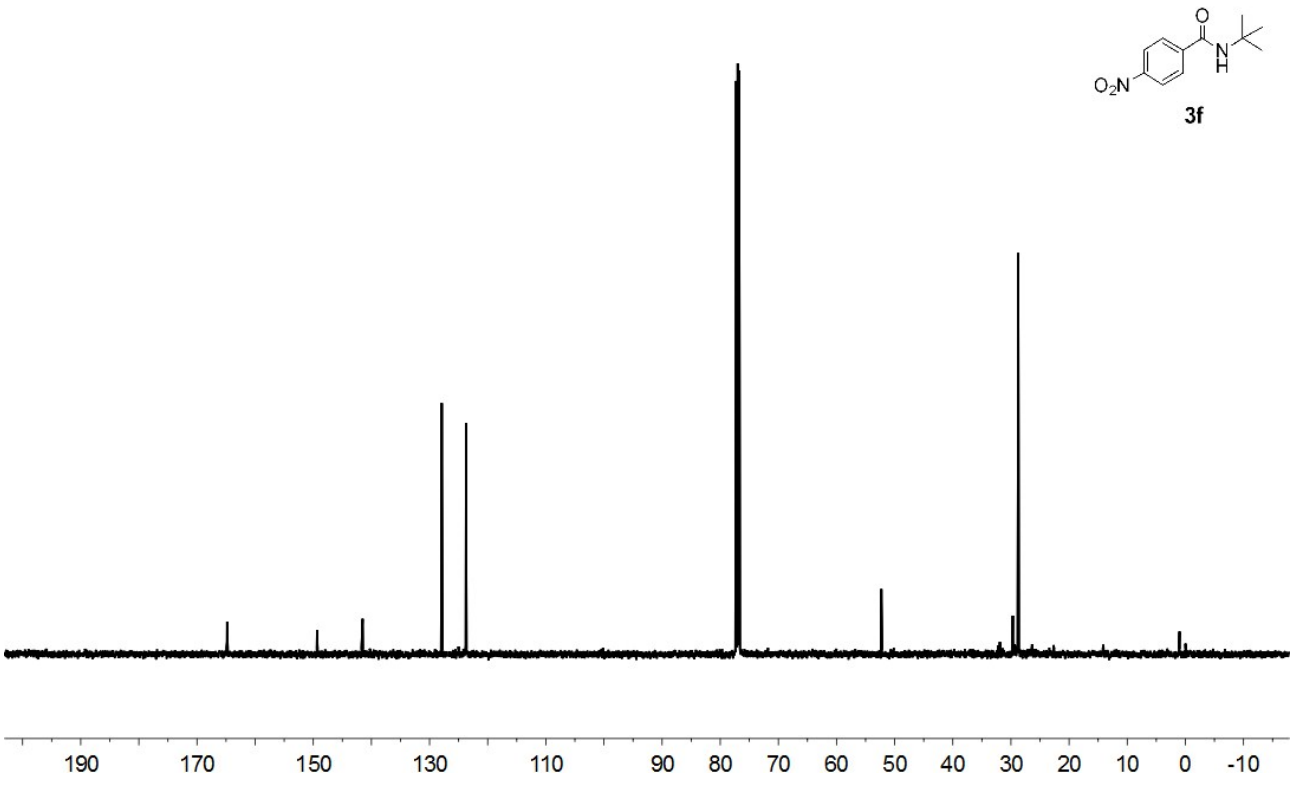

O
N
H
O2N
3f
2.00
2.09
0.98
9.78
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0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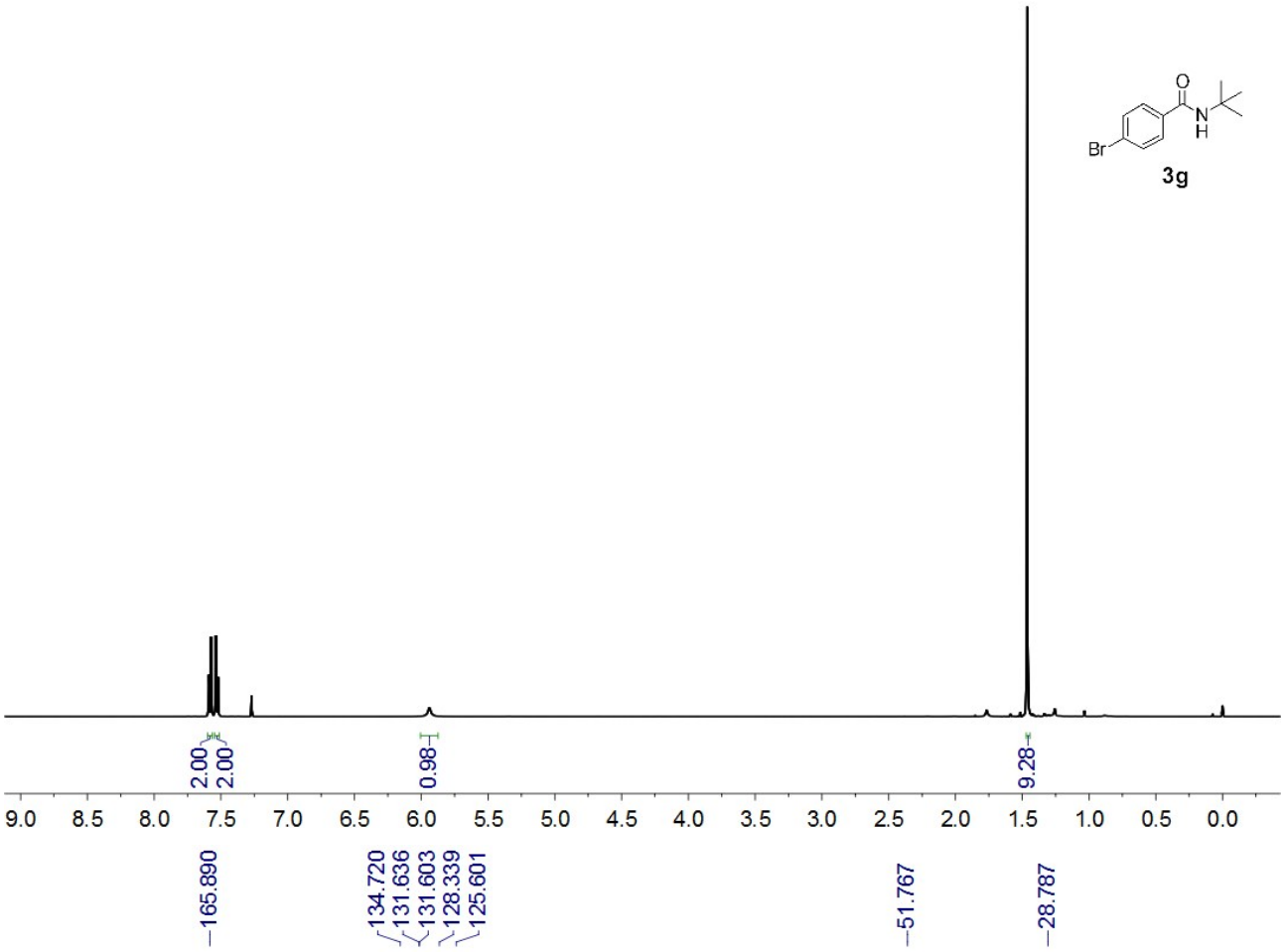
149.350
141.514
127.904
123.731
52.284
28.744
O
N
H
O2N
3f
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10


O
N
H
Br
3g
2.00
2.00
0.98
9.28
9.0
8.5
8.0
7.5
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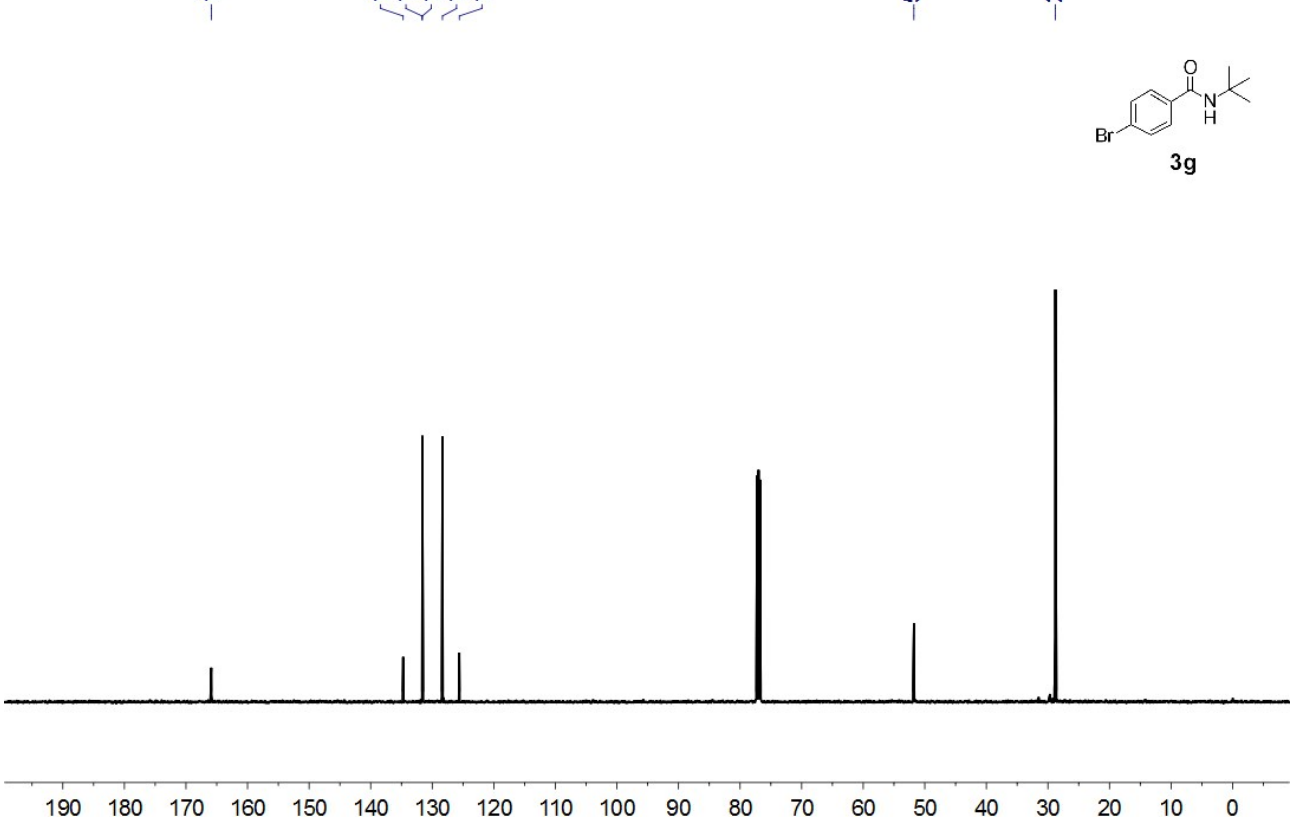
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0


165.890
134.720
131.636
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125.601
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28.787
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N
H
Br
3g
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180
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150
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110
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70
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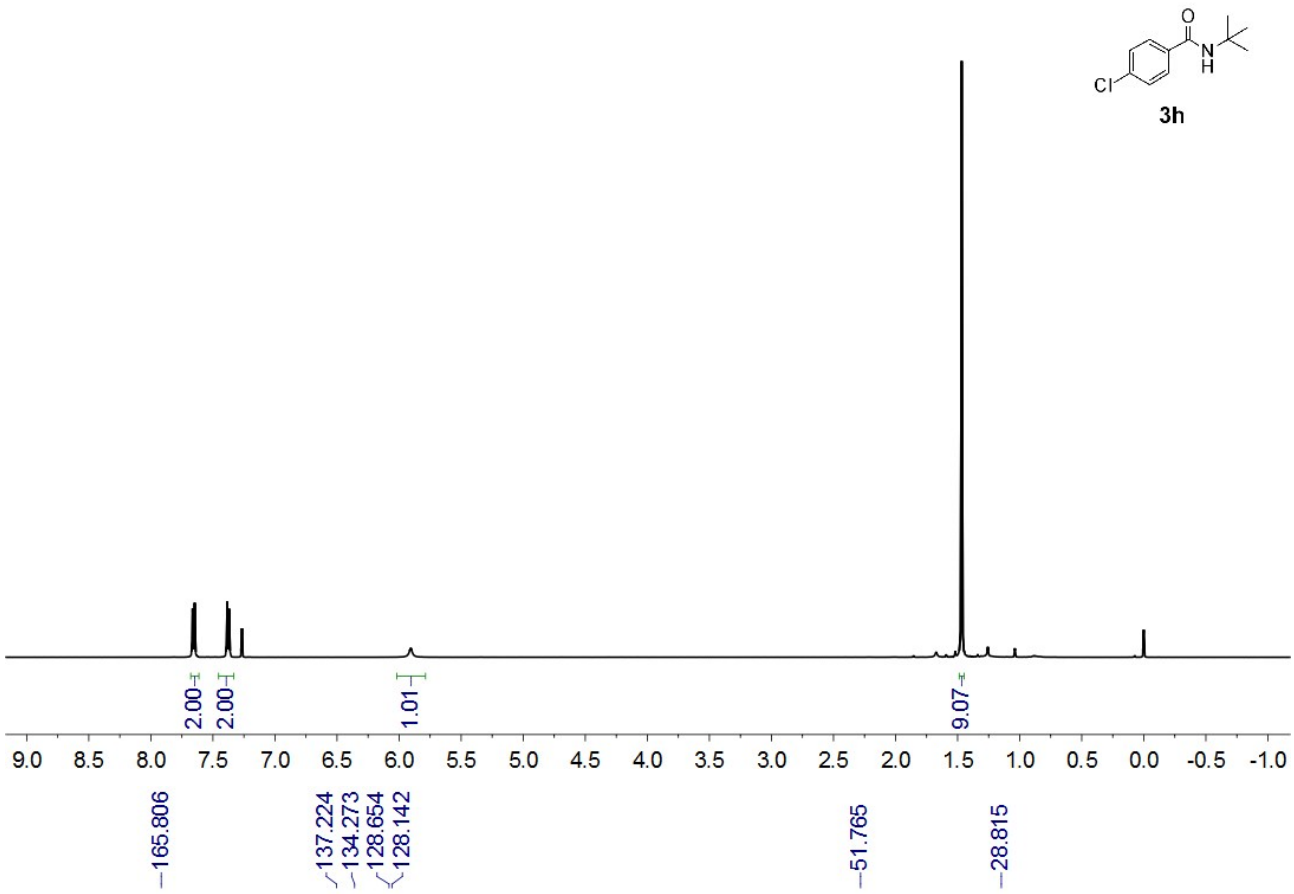
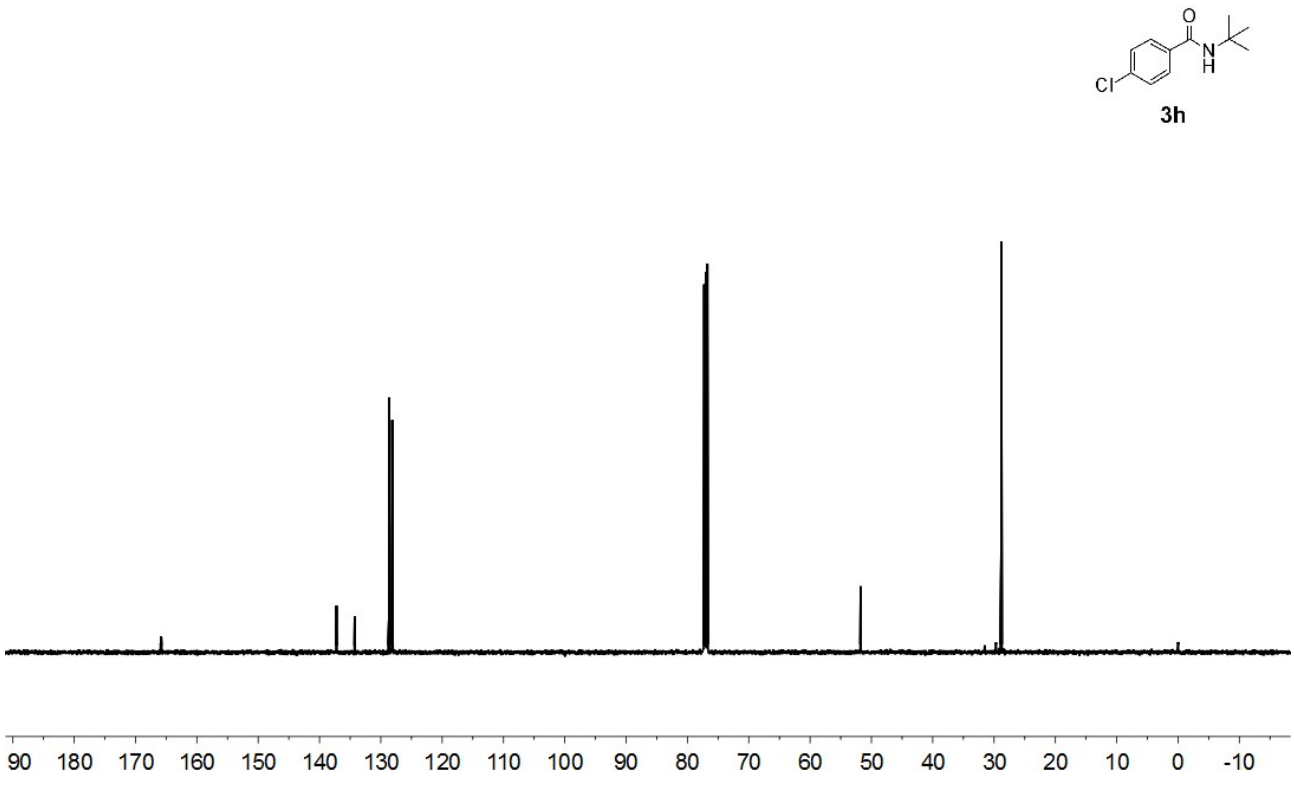
20
10
0


3h
2.00
2.00
1.01
9.07
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0


165.806
137.224
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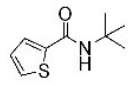
128.654
128.142
51.765
28.815
3h
90 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10



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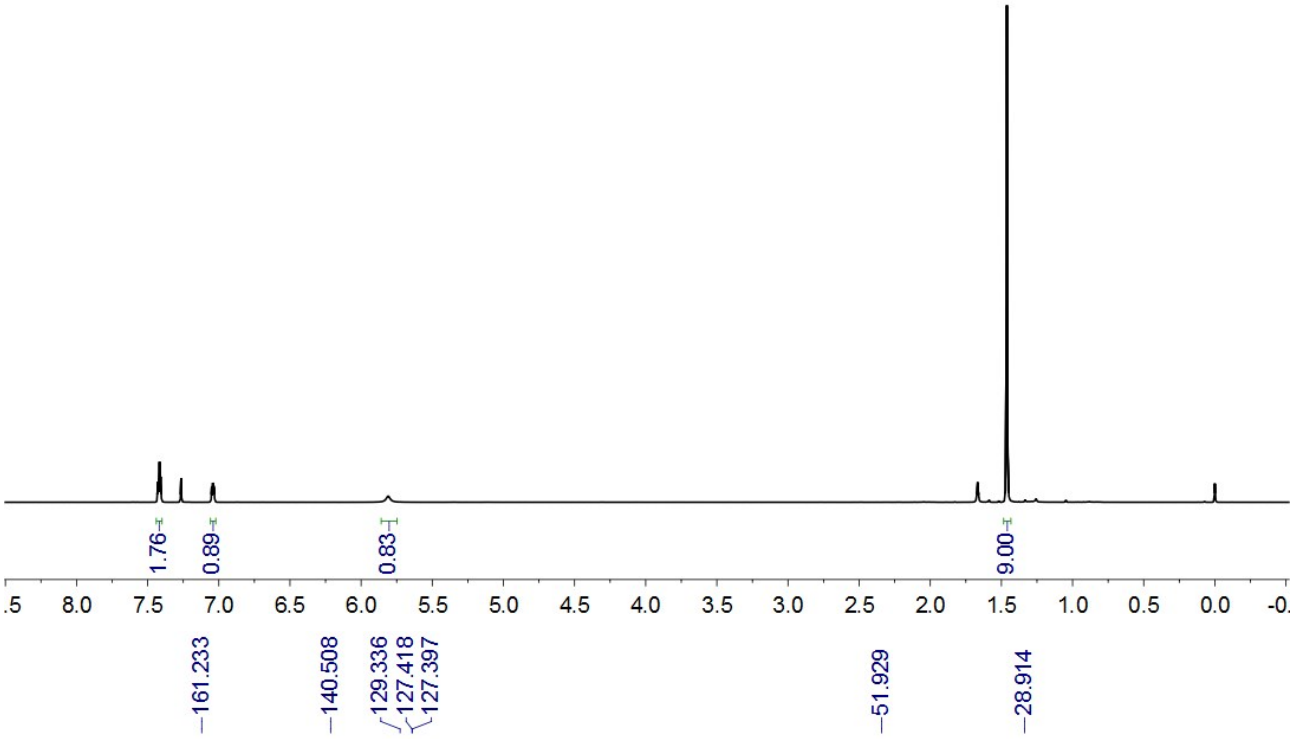
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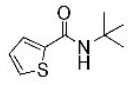
0.83
9.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
161.233
140.508
129.336
127.418
127.397
51.929
28.914



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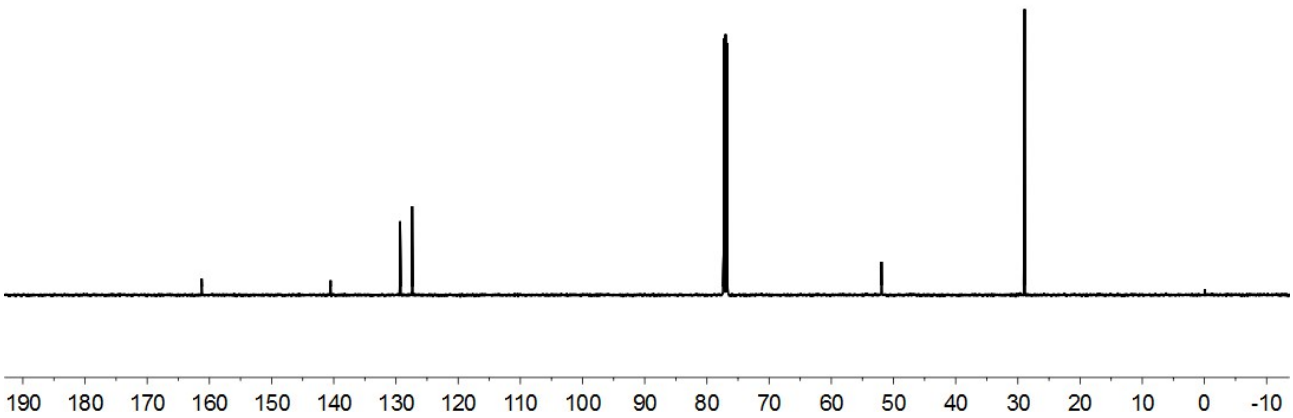
190
180
170
160
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140
130
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100
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80
70
60
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40
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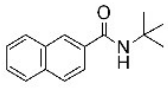
20
10
0
-10



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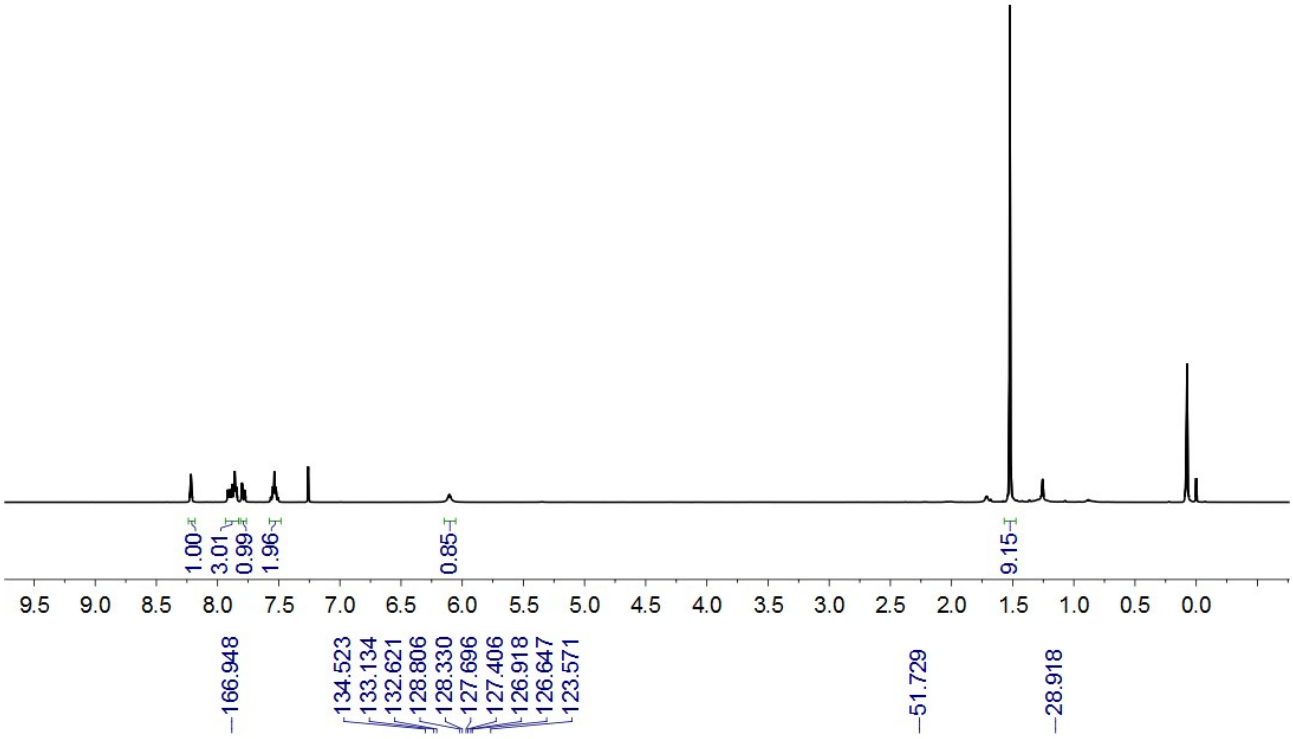
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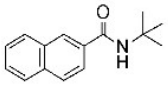
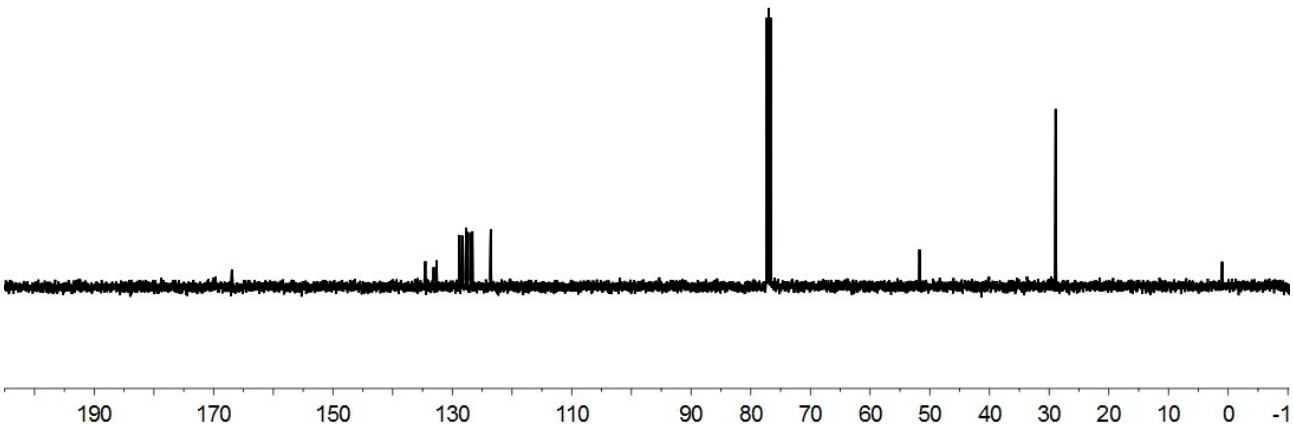
3.01
0.99
1.96
0.85
9.15
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
166.948
134.523
133.134
132.621
128.806
128.330
127.696
127.406
126.918
126.647
123.571
51.729
28.918



3j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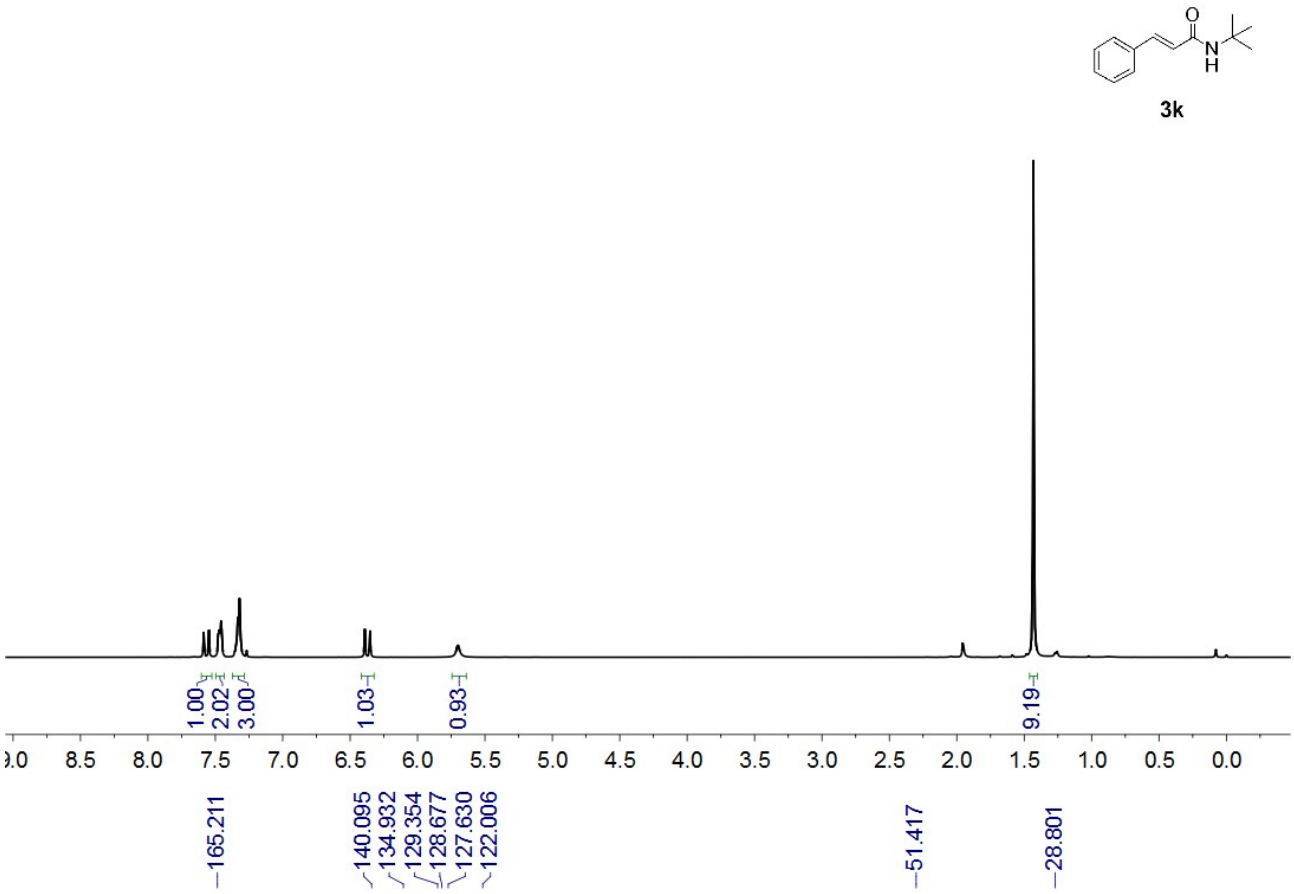
3k
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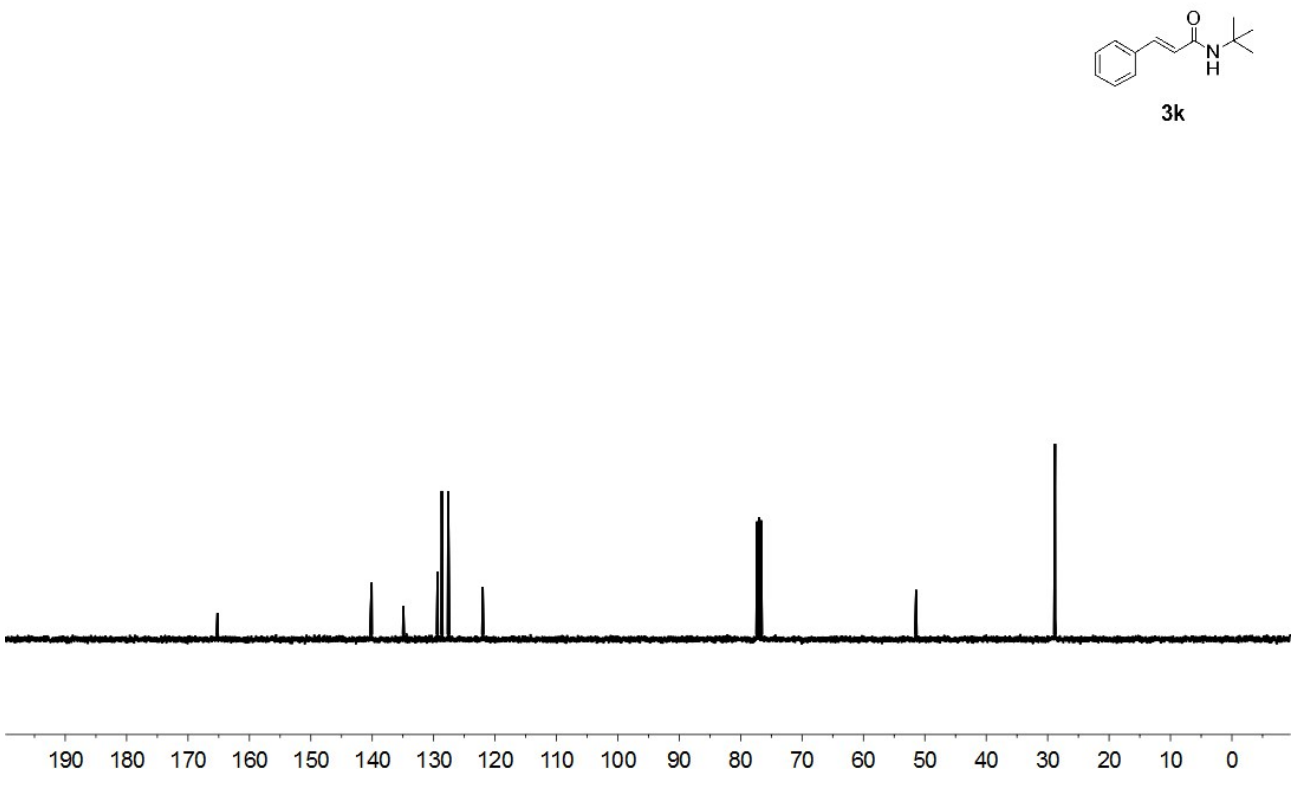
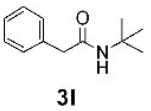
2.02
3.00
1.03
0.93
9.19
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
165.211
140.095
134.932
129.354
128.677
127.630
122.006
51.417
28.801


3k
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0



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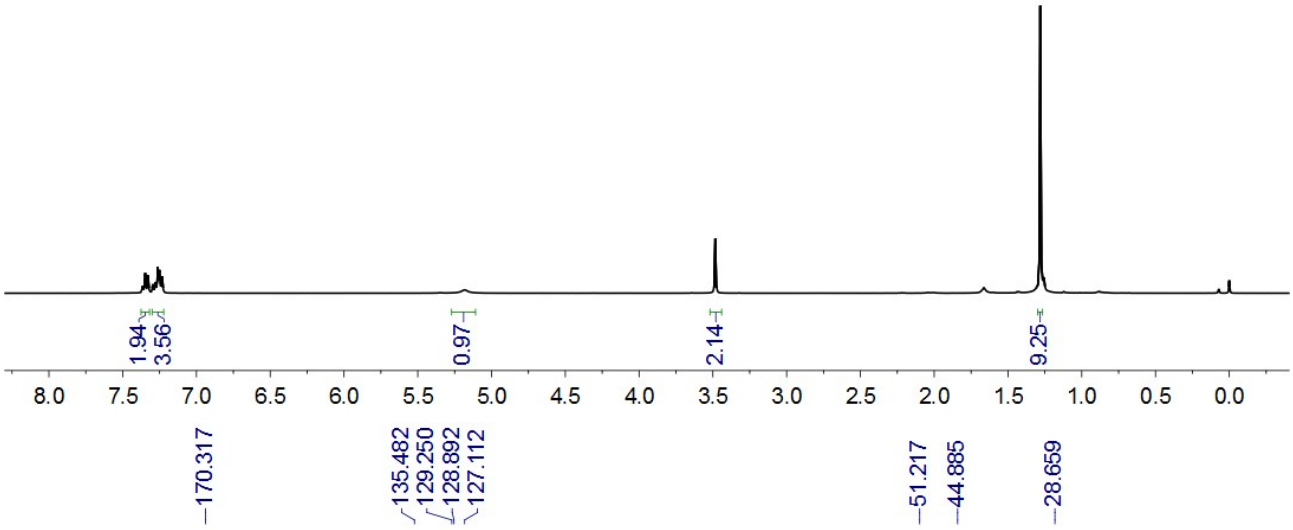
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2.14
9.25
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
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0.5
0.0

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128.892
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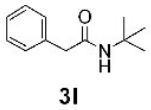
51.217
44.885
28.659



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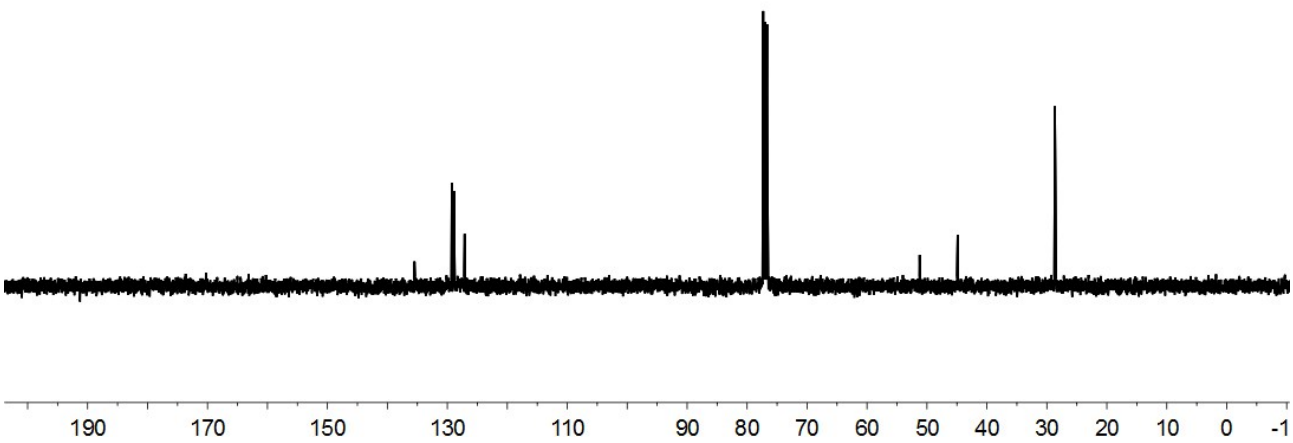
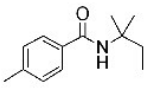
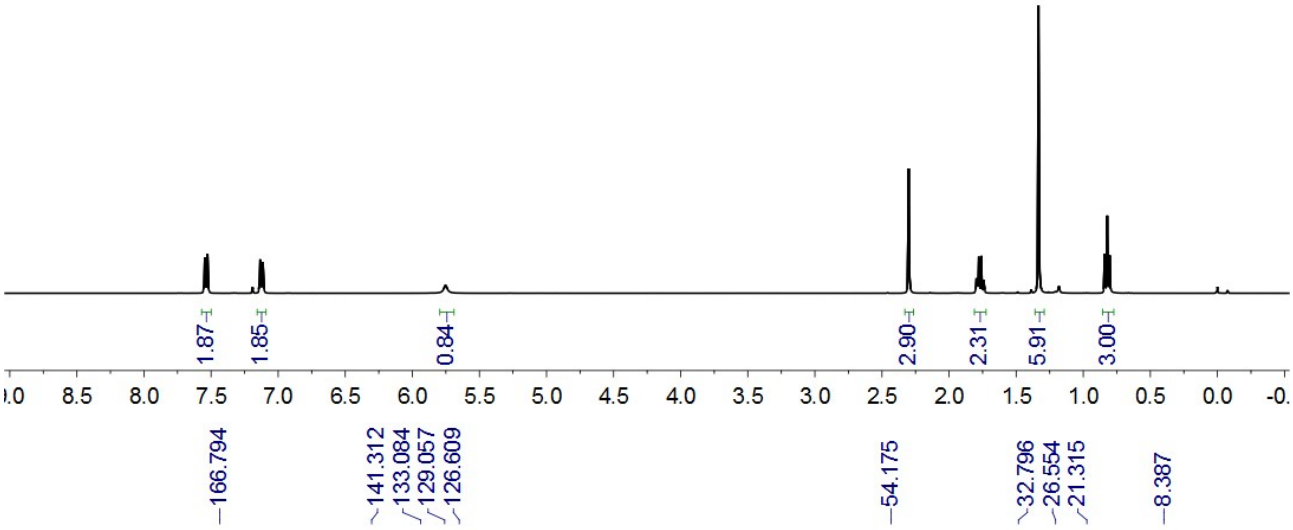

190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-1



3m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2.31
5.91
3.00
8.5
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7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
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54.175
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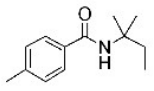
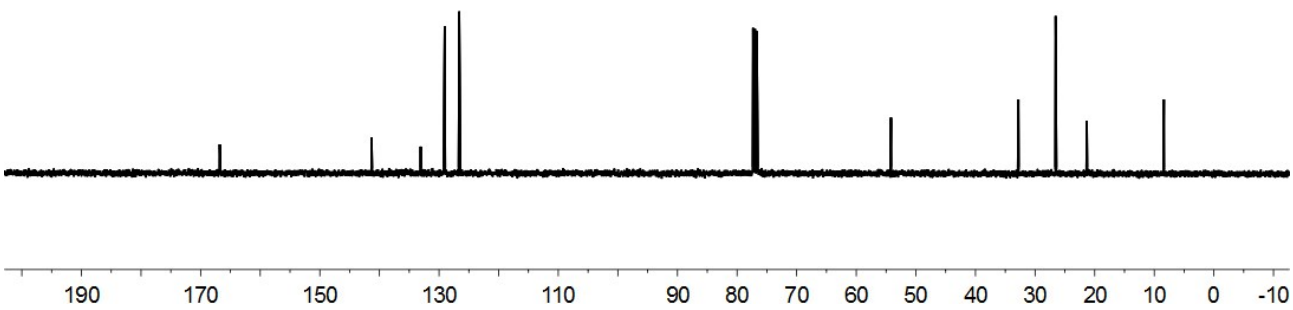
21.315
8.387



3m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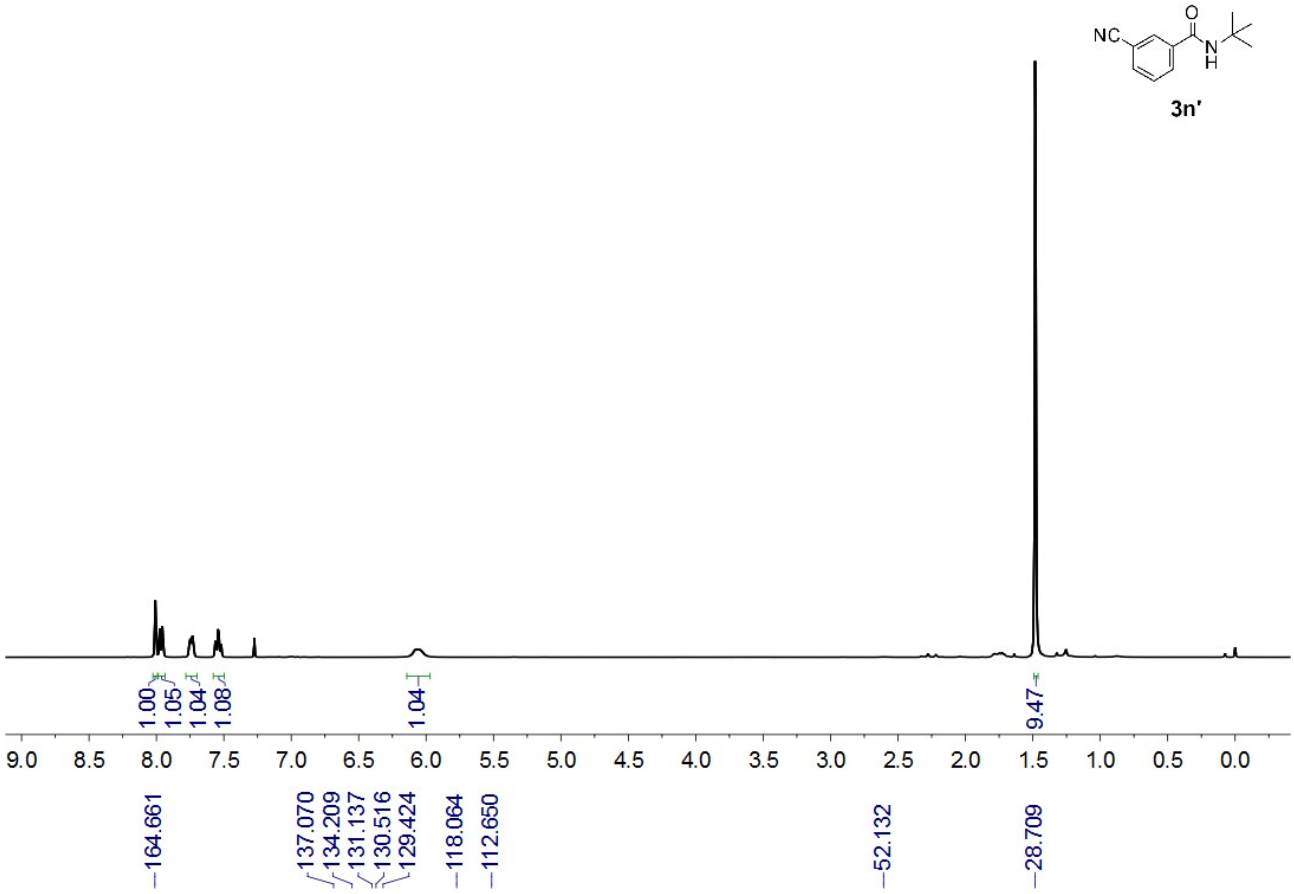
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10


NC
O
N
H
3n'
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1.05
1.04
1.08
1.04
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9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
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0.0
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129.424
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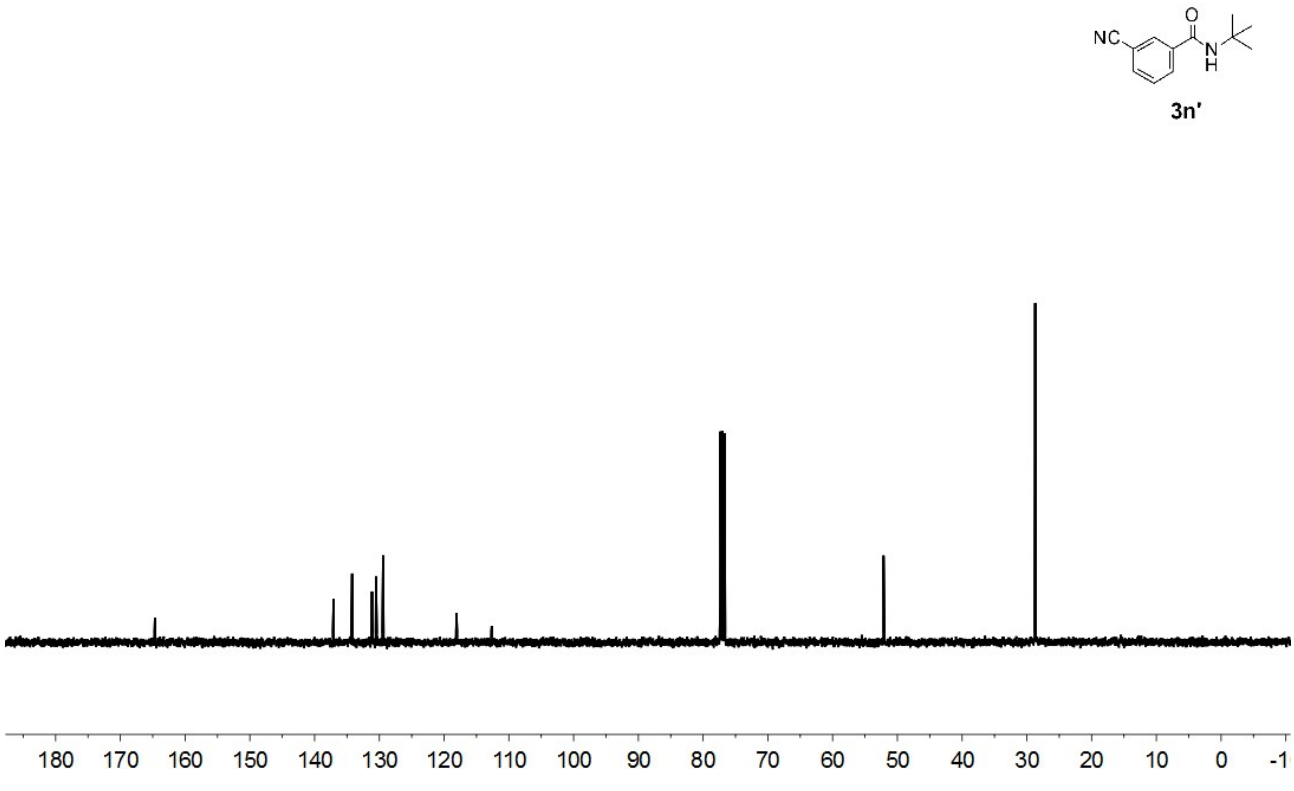
112.650
52.132
28.709


NC
O
N
H
3n'
180
170
160
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140
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120
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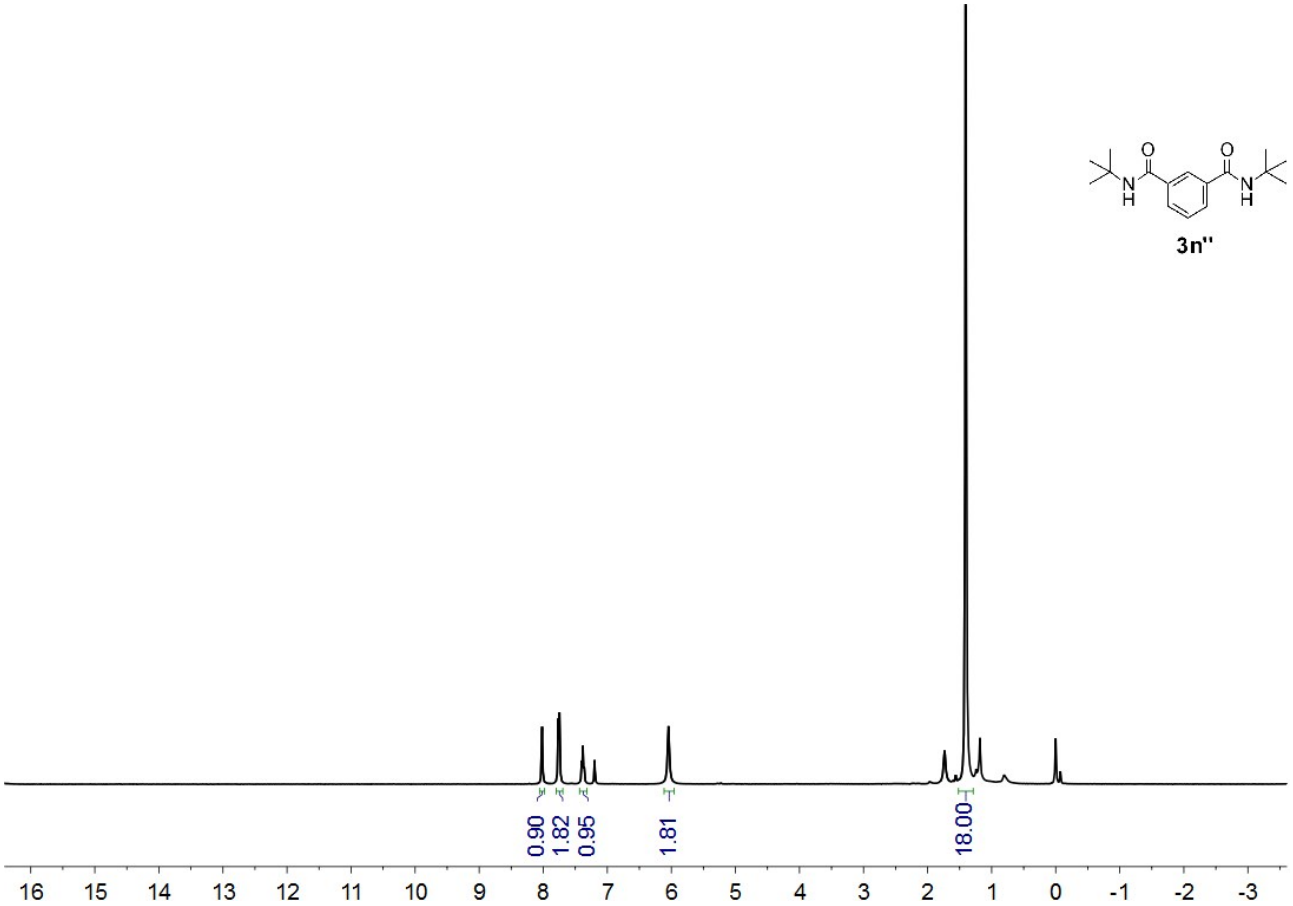
100
90
80
70
60
50
40
30
20
10
0
-1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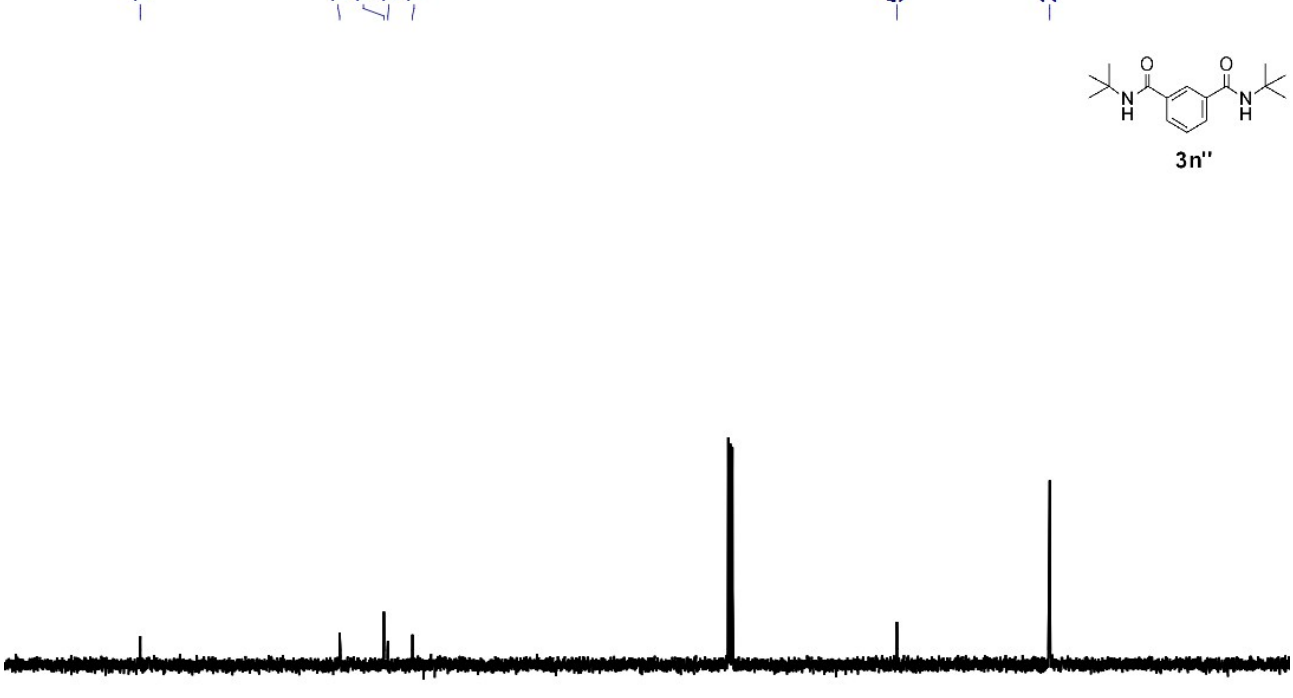
1.82
0.95
1.81
18.00
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3

3n''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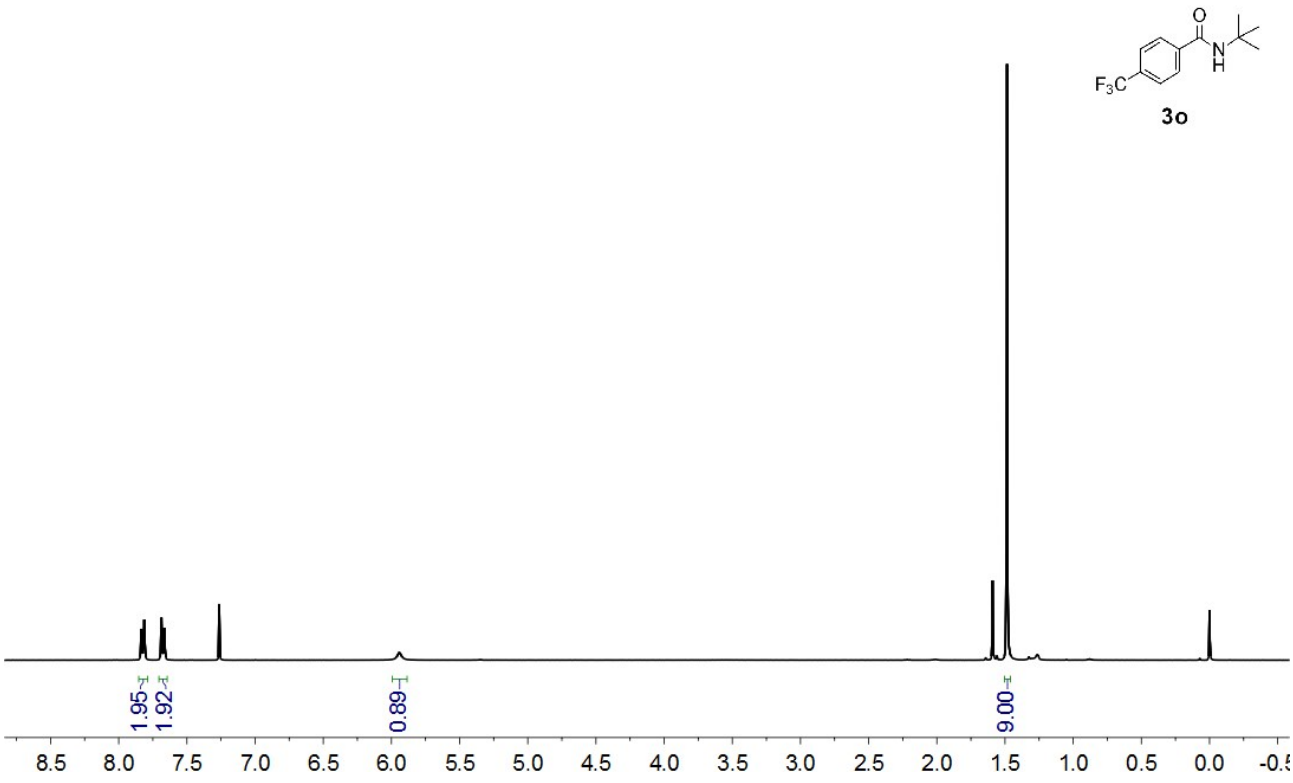
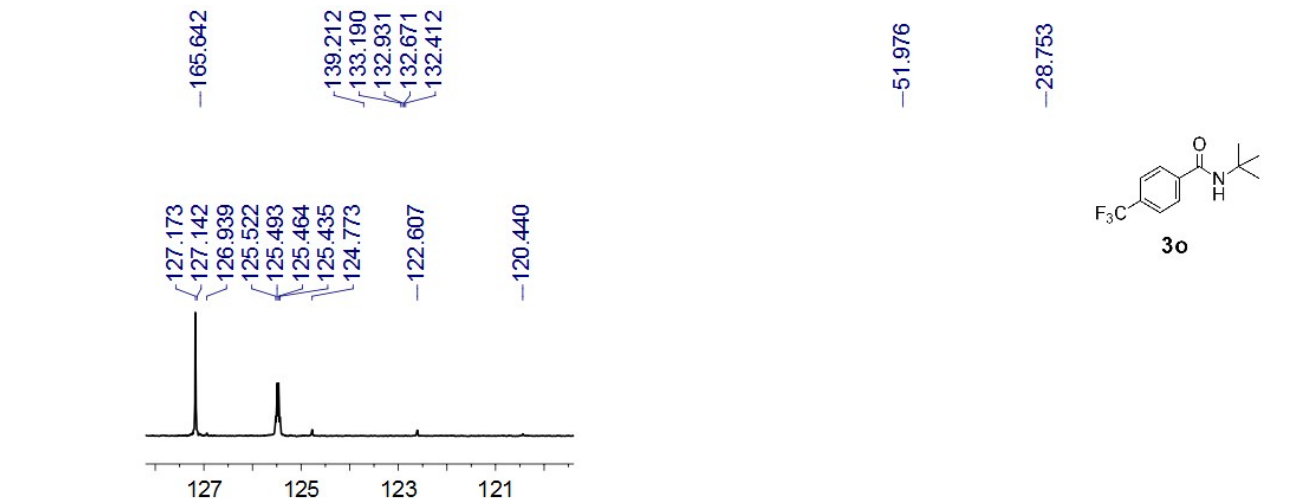
51.857
28.794
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

3n''


3o
1.95
1.92
0.89
9.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0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125.493
125.464
125.435
124.773
122.607
120.440
127 125 123 121
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1