Electronic Supplementary Material (ESI) for Chemical Communications


# Palladium-catalyzed Suzuki cross-coupling of *N*'-tosyl arylhydrazines

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## Supporting Information

## 1. General procedures

The solvents were distilled from standard drying agents. Unless otherwise stated, commercial reagents purchased from Alfa Aesar, Acros and Aldrich chemical companies were used without further purification. Purification of reaction products was carried out by flash chromatography using Qing Dao Sea Chemical Reagent silica gel (200–300 mesh). $^{1}$H NMR spectra were recorded on a Bruker Avance III 400 (400 MHz) spectrometer and referenced internally to the residual proton resonance in $CDCl_3$ ($\delta$ = 7.26 ppm), or with tetramethylsilane (TMS, $\delta$ = 0.00 ppm) as the internal standard. Chemical shifts were reported as parts per million (ppm) in the $\delta$ scale downfield from TMS. Multiplicity is indicated as follows: s (singlet), d (doublet), t (triplet), q (quartet), quint (quintet), m (multiplet), dd (doublet of doublet), bs (broad singlet). $^{13}$C NMR spectra were recorded on Bruker spectrometer with complete proton decoupling, and chemical shifts were reported in ppm from TMS with the solvent as the internal reference ($CDCl_3$, $\delta$ = 77.0 ppm). High resolution mass spectra were recorded on an ESI-ion trap mass spectrometer (Shimadzu, LCMS-IT-TOF). Analytical TLC was performed using EM separations percolated silica gel 0.2 mm layer UV 254 fluorescent sheets.

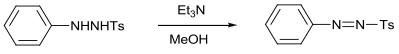
## 2.1 Typical procedure for Pd-catalyzed Suzuki cross-coupling of *N*'-tosyl arylhydrazines with aryl boronic acids

A mixture of *N*'-tosyl arylhydrazine **1** (0.2 mmol), aryl boronic acid **2** (0.24 mmol), $Pd(OAc)_2$ (0.004 mmol, 2 mol %), and $K_2CO_3$ (0.4 mmol, 2 equiv.) was stirred at 60 °C in MeOH (2 mL) for 2-12 h under $N_2$. After completion of the reaction (indicated by TLC), the mixture was quenched with saturated NaCl solution, extracted by EtOAc, and dried over $Na_2SO_4$. The crude product was purified by flash column chromatography to provide the corresponding product **3**.

## 2.2 Typical procedure for Pd-catalyzed Suzuki cross-coupling of *N*'-tosyl arylhydrazines with arylborane and boronic ester

A mixture of *N*'-tosyl arylhydrazine **1** (0.24 mmol), arylborane or boronic ester **2** (0.2 mmol), $Pd(OAc)_2$ (0.004 mmol, 2 mol %), and $K_2CO_3$ (0.4 mmol, 2 equiv.) was stirred at 60 °C in DMSO (1 mL) for 2-6 h under $N_2$. After completion of the reaction (indicated by TLC), the mixture was quenched with saturated NaCl solution, extracted by EtOAc, and dried over $Na_2SO_4$. The crude product was purified by flash column chromatography to provide the corresponding product **3**.

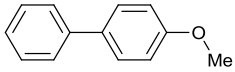
## 2.3 Procedure for the capture of 1-phenyl-2-tosyldiazene




A mixture of *N*'-tosyl phenylhydrazine **1a** (0.2 mmol) and $Et_3N$ (0.4 mmol, 2 equiv.) in MeOH (1.0 mL) was stirred at room temperature for 2 h. The mixture was quenched with saturated $NH_4Cl$ solution, extracted by EtOAc. The combined organic layer was dried over $Na_2SO_4$ and concentrated in vacuo. The residue was purified by column chromatography on silica gel to provide 1-phenyl-2-tosyldiazene **1a'** in 26% yield.

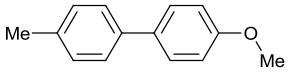
## 3. Characterization of the products

**4-Methoxybiphenyl** [1]



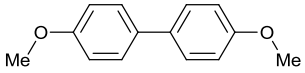
White solid; mp: 90-91 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.56-7.51 (m, 4H), 7.41 (t, $J$ = 7.7 Hz, 2H), 7.30 (t, $J$ = 7.4 Hz, 1H), 6.99-6.96 (m, 2H), 3.85 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 159.19, 140.86, 133.83, 128.69, 128.13, 126.73, 126.63, 114.23, 55.33.

**4-Methoxy-4'-methylbiphenyl** [1]



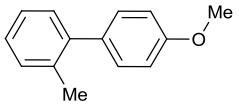
White solid; mp: 107-108 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.54 (d, $J$ = 8.4 Hz, 2H), 7.47 (d, $J$ = 8.0 Hz, 2H), 7.25 (d, $J$ = 8.0 Hz, 2H), 6.99 (d, $J$ = 8.5 Hz, 2H), 3.87 (s, 3H), 2.41 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 158.94, 137.98, 136.35, 133.77, 129.44, 127.95, 126.59, 114.17, 55.34, 21.04.

**4, 4'-Dimethoxybiphenyl** [1]



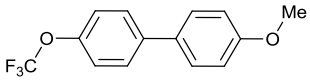
White solid; mp: 169-170 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.47 (d, $J$ = 8.6 Hz, 4H), 6.95 (d, $J$ = 8.6 Hz, 4H), 3.84 (s, 6H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 158.71, 133.50, 127.73, 114.18, 55.34.

**4'-Methoxy-2-methylbiphenyl** [3]



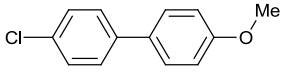
White solid; mp: 52-53 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.26-7.22 (m, 6H), 6.96-6.94 (m, 2H), 3.85 (s, 3H), 2.27 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 158.52, 141.56, 135.48, 134.39, 130.27, 130.24, 129.89, 126.95, 125.73, 113.49, 55.28, 20.52.

**4-Methoxy-4'-(trifluoromethoxy) biphenyl** [12]



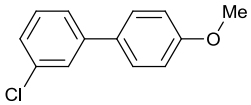
White solid; mp: 95-97 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.56 (d, $J$ = 8.6 Hz, 2H), 7.50 (d, $J$ = 8.6 Hz, 2H), 7.28 (d, $J$ = 3.3 Hz, 2H), 7.00 (d, $J$ = 8.6 Hz, 2H), 3.87 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 159.44, 148.19, 139.63, 132.37, 128.14, 127.95, 121.20, 114.33, 55.35.

**4-Chloro-4'-methoxybiphenyl** [3]



White solid; mp: 110-111 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.50 (dd, $J$ = 10.6, 3.6 Hz, 4H), 7.40-7.38 (m, 2H), 7.00-6.98 (m, 2H), 3.87 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 159.38, 139.28, 132.68, 132.51, 128.83, 128.01, 127.93, 114.32, 55.36.

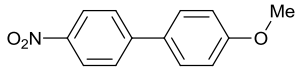
**3-Chloro-4'-methoxybiphenyl** [3]



White solid; mp: 52-53 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.53-7.48 (m, 3H), 7.43-7.40 (m, 1H),

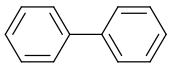
7.33 (t, *J* = 7.8 Hz, 1H), 7.28-7.25 (m, 1H), 6.98-6.96 (m, 2H), 3.85 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 159.59, 142.67, 134.60, 132.30, 129.92, 128.15, 126.82, 126.62, 124.83, 114.33, 55.36.

**4-Methoxy-4'-nitrobiphenyl** [1]



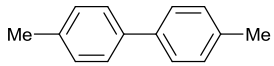

Yellow solid; mp: 104-105 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.27 (d, *J* = 8.8 Hz, 2H), 7.69 (d, *J* = 8.8 Hz, 2H), 7.58 (d, *J* = 8.8 Hz, 2H), 7.02 (d, *J* = 8.8 Hz, 2H), 3.87 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 160.46, 147.21, 146.57, 131.09, 128.56, 127.07, 124.13, 114.62, 55.42.

**Biphenyl** [1]



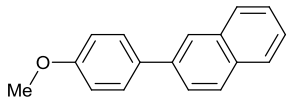
White solid; mp: 68-69 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.62 (d, *J* = 7.4 Hz, 4H), 7.47 (t, *J* = 7.7 Hz, 4H), 7.37 (t, *J* = 7.3 Hz, 2H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 141.25, 128.74, 127.24, 127.16.

**4, 4'-Dimethylbiphenyl** [2]



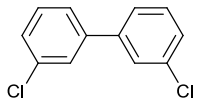

White solid; mp: 119-120 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.51 (d, *J* = 8.0 Hz, 4H), 7.27 (d, *J* = 7.8 Hz, 4H), 2.42 (s, 6H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 138.31, 136.70, 129.44, 126.82, 21.08.

**2-(4-Methoxyphenyl) naphthalene** [4]



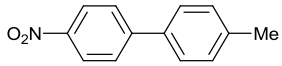

White solid; mp: 130-132 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.00 (s, 1H), 7.89 (dd, *J* = 15.8, 9.4 Hz, 3H), 7.71 (dd, *J* = 20.9, 8.6 Hz, 3H), 7.53-7.45 (m, 2H), 7.05 (d, *J* = 8.6 Hz, 2H), 3.89 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 159.25, 138.16, 133.76, 133.65, 132.32, 128.42, 128.33, 128.04, 127.61, 126.22, 125.64, 125.43, 125.03, 114.32, 55.38.

**3, 3'-Dichlorobiphenyl** [2]



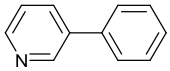

Colorless oil; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.56 (d, *J* = 0.6 Hz, 2H), 7.45 (dd, *J* = 7.0, 0.9 Hz, 2H), 7.41-7.35 (m, 4H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 140.62, 133.82, 129.11, 126.87, 126.26, 124.25.

**4-Methyl-4'-nitrobiphenyl** [1]




Yellow solid; mp: 140-141 °C; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.28 (d, *J* = 8.5 Hz, 2H), 7.71 (d, *J* = 8.6 Hz, 2H), 7.53 (d, *J* = 8.1 Hz, 2H), 7.30 (d, *J* = 8.3 Hz, 2H), 2.42 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 147.58, 146.87, 139.08, 135.86, 129.88, 127.47, 127.21, 124.09, 21.19.

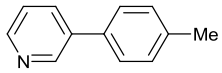
**3-Phenylpyridine**[5]




Colorless oil; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.85 (d, *J* = 2.1 Hz, 1H), 8.60-8.58 (m, 1H), 7.88 (dt,

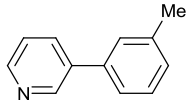
*J* = 7.9, 1.6 Hz, 1H), 7.58 (d, *J* = 7.6 Hz, 2H), 7.48 (t, *J* = 7.6 Hz, 2H), 7.43-7.40 (m, 1H), 7.39-7.35 (m, 1H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 148.31, 148.19, 137.77, 136.73, 134.48, 129.09, 128.14, 127.15, 123.59.

**3-*p*-Tolylpyridine** [5]



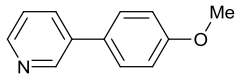

Colorless oil; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.83 (s, 1H), 8.56 (d, *J* = 4.7 Hz, 1H), 7.86-7.84 (m, 1H), 7.48 (d, *J* = 7.3 Hz, 2H), 7.34 (dd, *J* = 7.8, 4.9 Hz, 1H), 7.27 (dd, *J* = 11.1, 4.3 Hz, 2H), 2.41 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 148.18, 148.16, 138.03, 136.58, 134.93, 134.14, 129.80, 126.97, 123.50, 21.13.

**3-*m*-Tolylpyridine** [5]



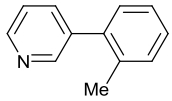

Colorless oil; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.84 (s, 1H), 8.58 (d, *J* = 4.4 Hz, 1H), 7.86 (d, *J* = 7.8 Hz, 1H), 7.39-7.33 (m, 4H), 7.22 (d, *J* = 4.5 Hz, 1H), 2.43 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 148.35, 138.76, 137.82, 136.78, 134.36, 128.98, 128.84, 127.91, 124.25, 123.49, 21.50.

**3-(4-Methoxyphenyl) pyridine** [3]



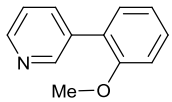

Colorless oil; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.82 (s, 1H), 8.54 (d, *J* = 4.0 Hz, 1H), 7.83 (dd, *J* = 7.9, 1.4 Hz, 1H), 7.52 (d, *J* = 8.7 Hz, 2H), 7.33 (dd, *J* = 7.8, 4.9 Hz, 1H), 7.01 (d, *J* = 8.7 Hz, 2H), 3.86 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 159.78, 147.98, 147.85, 133.86, 130.26, 128.22, 123.50, 114.56, 55.38.

**3-*o*-Tolylpyridine** [14]



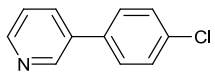

Colorless oil; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.59 (dd, *J* = 4.7, 1.5 Hz, 2H), 7.67-7.64 (m, 1H), 7.36-7.26 (m, 4H), 7.22 (d, *J* = 7.0 Hz, 1H), 2.28 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 149.95, 148.10, 138.09, 137.47, 136.48, 135.59, 130.56, 129.86, 128.11, 126.07, 123.00, 20.38.

**3-(2-Methoxyphenyl)pyridine** [15]




Colorless oil; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.78 (s, 1H), 8.56 (d, *J* = 4.3 Hz, 1H), 7.87 (d, *J* = 7.1 Hz, 1H), 7.40-7.32 (m, 3H), 7.09-7.01 (m, 2H), 3.83 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 156.58, 150.26, 147.90, 136.80, 134.22, 130.65, 129.54, 127.06, 122.87, 121.05, 111.30, 55.52.

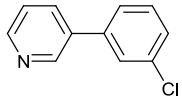
**3-(4-Chlorophenyl)pyridine** [5]




Colorless oil; $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.82 (d, *J* = 2.0 Hz, 1H), 8.61 (d, *J* = 4.8 Hz, 1H), 7.84 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.52 (d, *J* = 8.4 Hz, 2H), 7.46 (d, *J* = 8.5 Hz, 2H), 7.37 (dd, *J* = 7.9, 4.8 Hz, 1H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 148.77, 148.11, 136.28, 135.52, 134.40, 134.20,

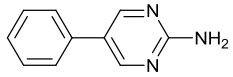
129.29, 128.39, 123.61.

**3-(3-Chlorophenyl)pyridine** [6]



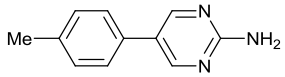

Colorless oil; $^{1}$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.70 (d, $J$ = 2.3 Hz, 1H), 8.50 (dd, $J$ = 4.8, 1.3 Hz, 1H), 7.74-7.71 (m, 1H), 7.45 (t, $J$ = 1.7 Hz, 1H), 7.35-7.14 (m, 4H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 148.04, 147.21, 138.67, 134.36, 134.03, 133.36, 129.32, 127.15, 126.29, 124.30, 122.62.

**5-Phenylpyrimidin-2-amine** [7]



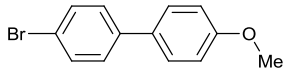

White solid; mp: 161-163 °C; $^{1}$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.54 (s, 2H), 7.48-7.44 (m, 4H), 7.37 (d, $J$ = 6.3 Hz, 1H), 5.13 (s, 2H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 162.23, 156.50, 135.25, 129.15, 127.58, 126.06, 125.03.

**5-*p*-Tolylpyrimidin-2-amine** [7]



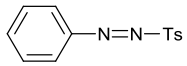

White solid; mp: 192-193 °C; $^{1}$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.51 (s, 2H), 7.37 (d, $J$ = 7.9 Hz, 2H), 7.25 (d, $J$ = 7.5 Hz, 2H), 5.33 (s, 2H), 2.39 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 162.13, 156.31, 137.44, 132.34, 129.85, 125.90, 124.95, 21.10.

**4-Bromo-4'-methoxybiphenyl** [11]




White solid; mp: 143-144 °C; $^{1}$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.50 (dd, $J$ = 17.3, 7.1 Hz, 4H), 7.41 (d, $J$ = 6.9 Hz, 2H), 6.97 (d, $J$ = 7.0 Hz, 2H), 3.85 (s, 3H).

**1-Phenyl-2-tosyldiazene** [10]




Orange solid; mp: 90-91 °C; $^{1}$H NMR (400 MHz, $CDCl_3$): $\delta$ 7.86 (d, $J$ = 8.1 Hz, 2H), 7.81 (d, $J$ = 7.6 Hz, 2H), 7.59 (t, $J$ = 7.3 Hz, 1H), 7.49 (t, $J$ = 7.6 Hz, 2H), 7.39 (d, $J$ = 8.0 Hz, 2H), 2.47 (s, 3H); $^{13}$C NMR (101 MHz, $CDCl_3$): $\delta$ 149.17, 146.01, 134.79, 130.39, 130.00, 129.89, 129.48, 124.50, 21.80.

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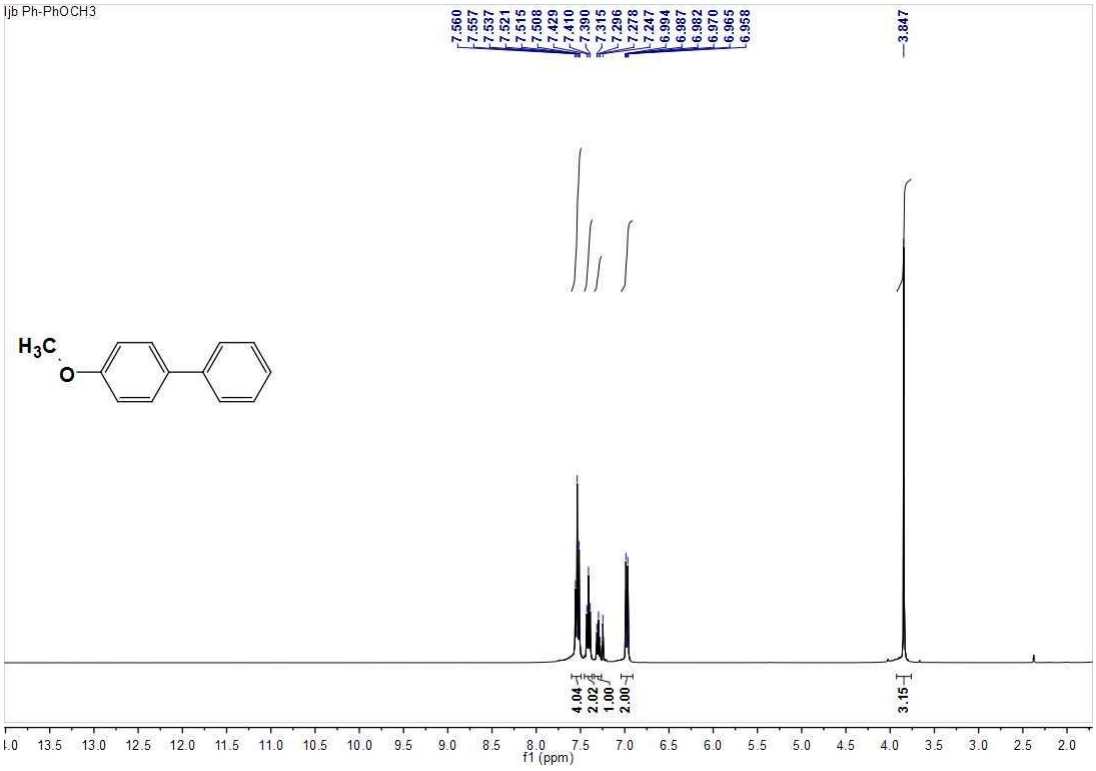
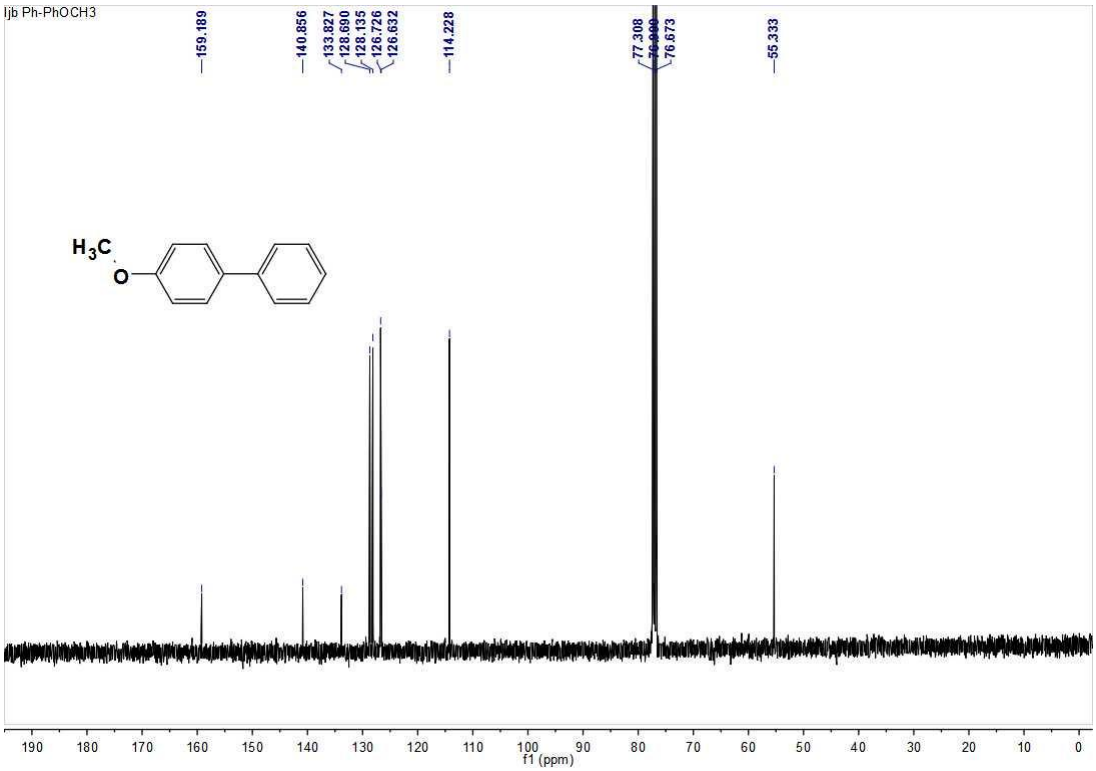
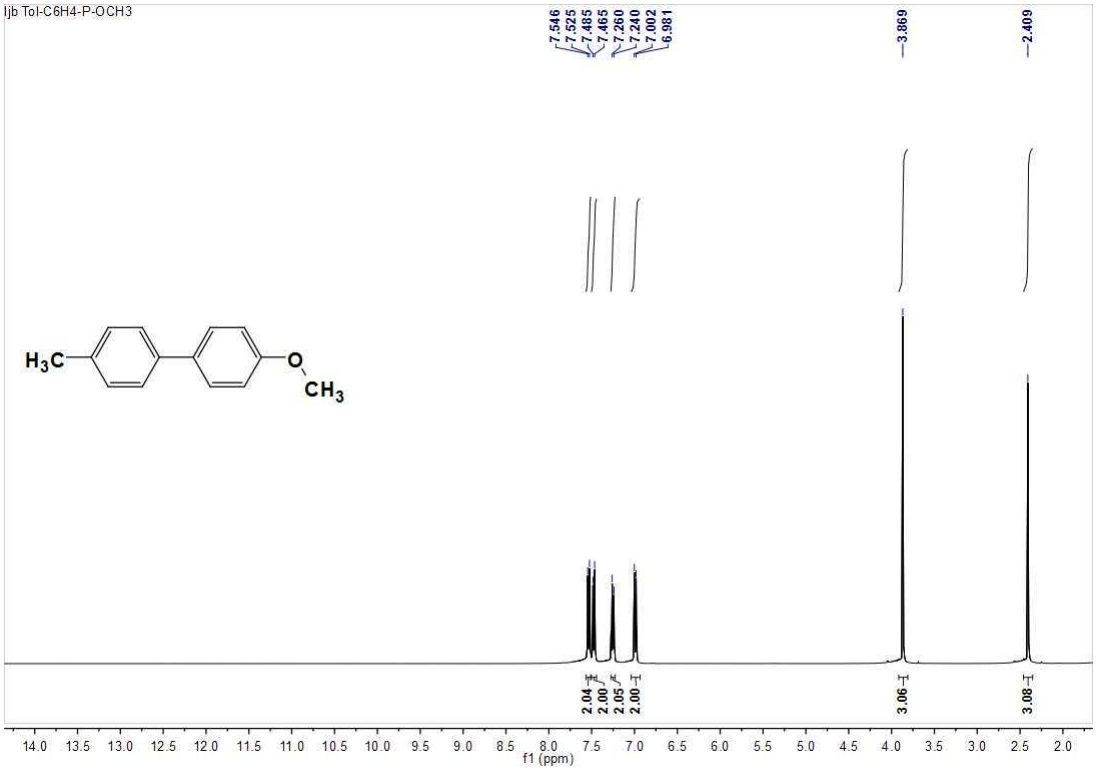
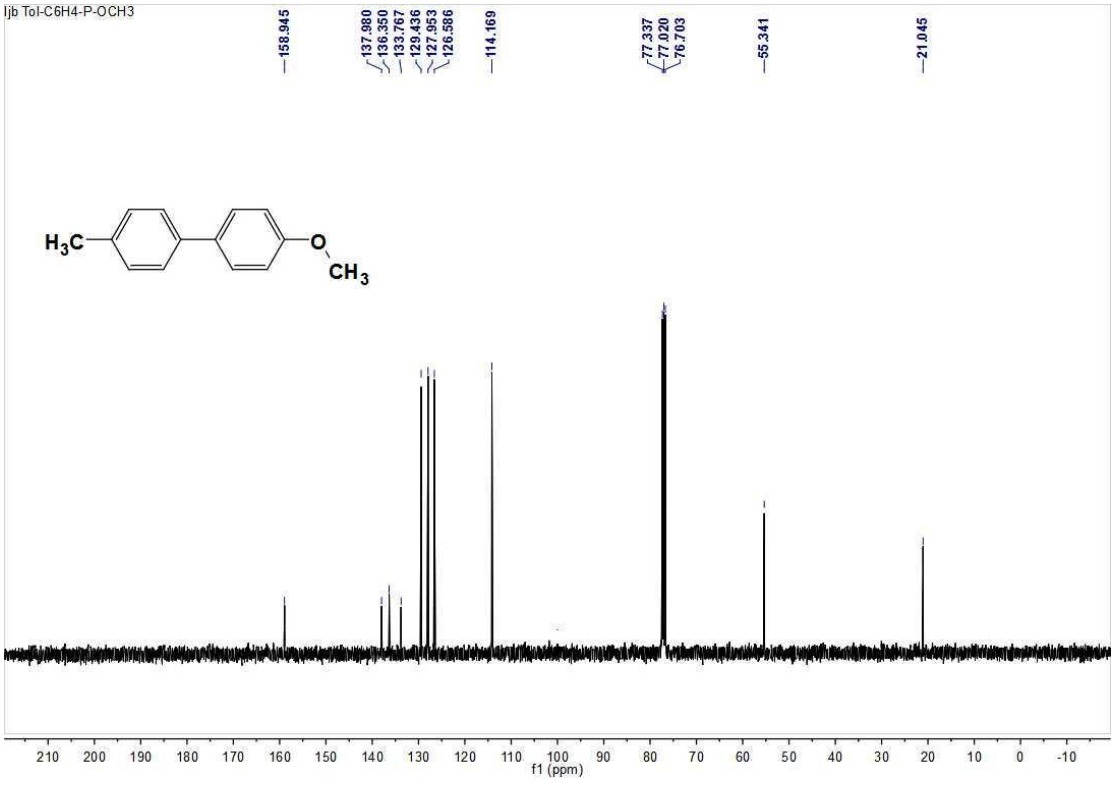
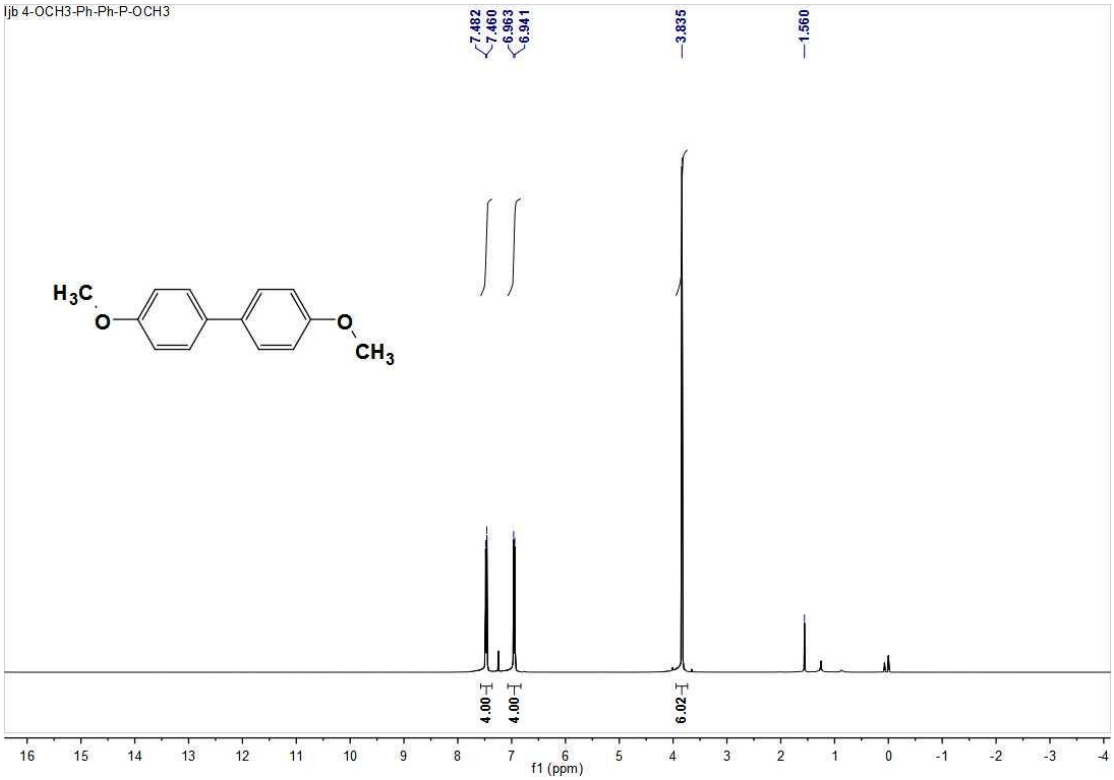
## 4. NMR spectra of the compounds




ljb Tol-C6H4-P-OCH3
7.546
7.525
7.485
7.465
7.260
7.240
7.002
6.981
3.869
2.409
H3C
O
CH3
2.04
2.00
2.05
2.00
3.06
3.08
f1 (ppm)


ljb Tol-C6H4-P-OCH3
158.945
137.980
136.350
133.767
129.436
127.953
126.586
114.169
77.337
77.020
76.703
55.341
21.045
H3C
O
CH3
f1 (ppm)


ljb 4-OCH3-Ph-Ph-P-OCH3
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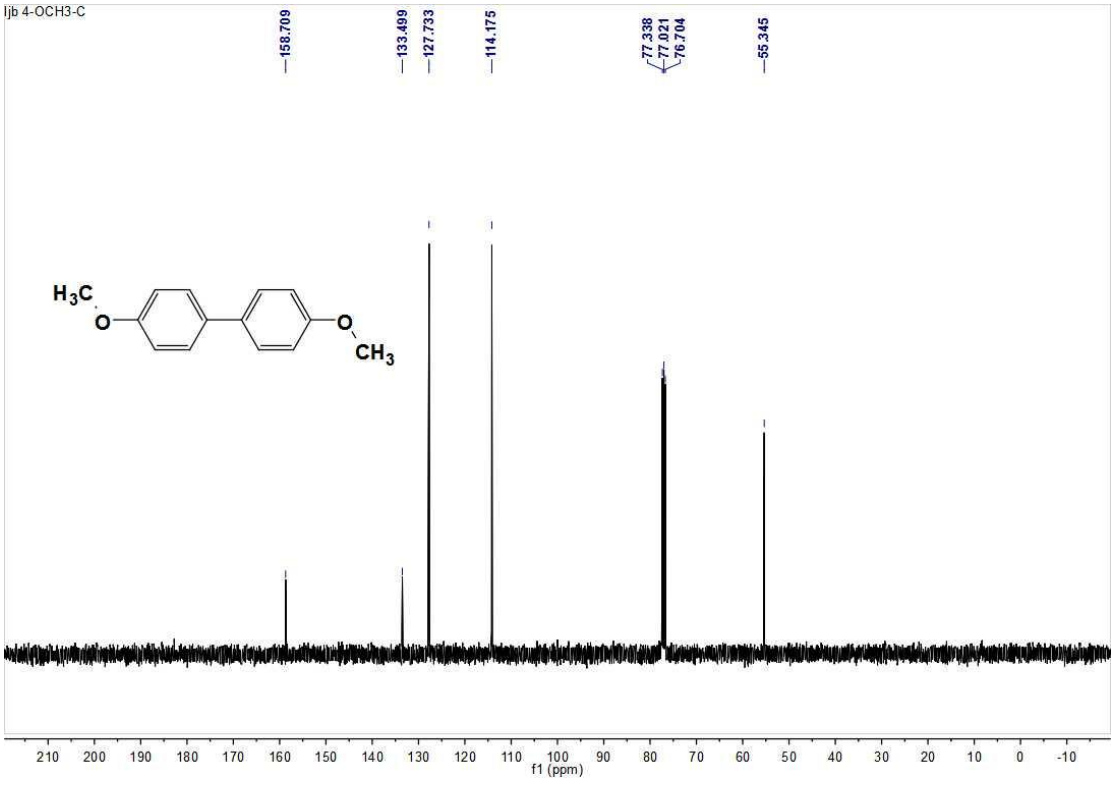
7.460
6.963
6.941
3.835
1.560
4.00
4.00
6.02
f1 (ppm)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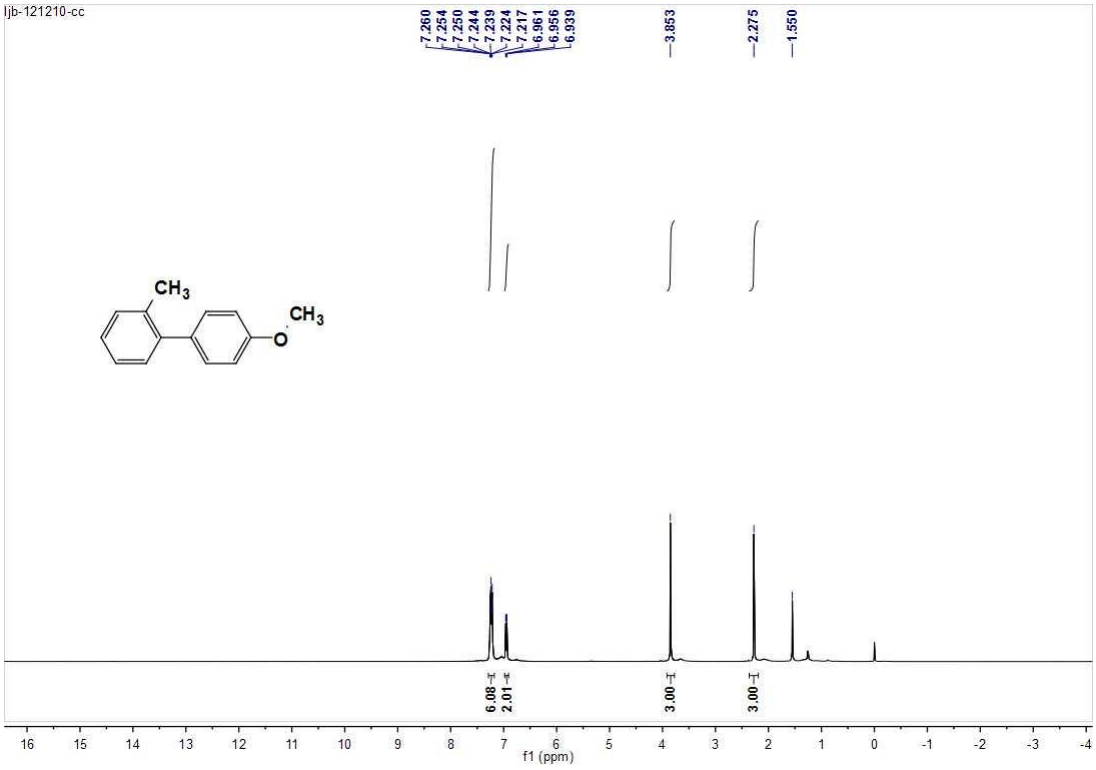
133.499
127.733
114.175
77.338
77.021
76.704
55.345
f1 (ppm)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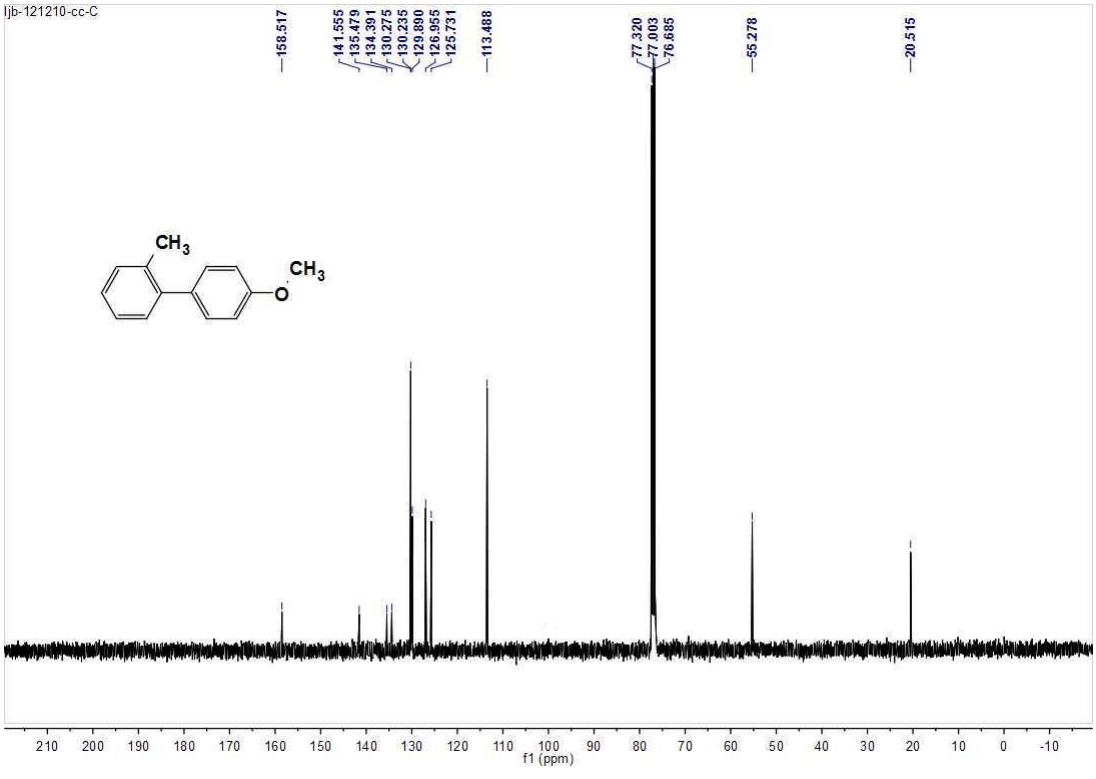
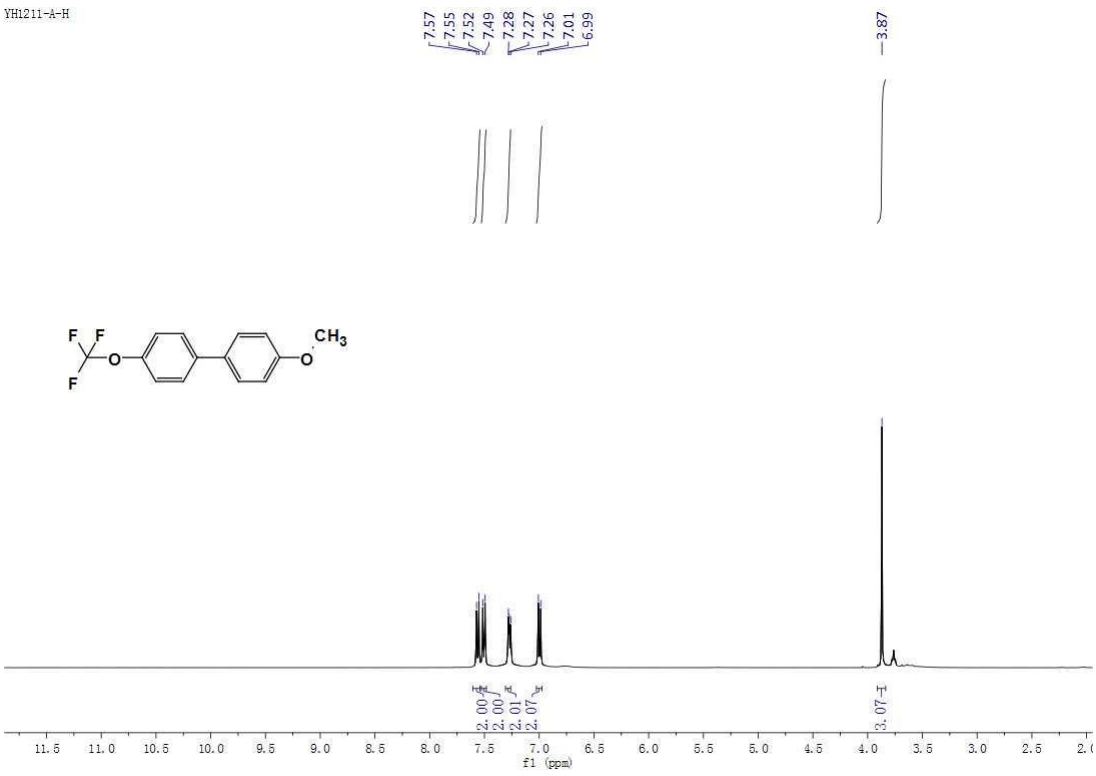
7.254
7.250
7.244
7.239
7.224
7.217
6.961
6.956
6.939
3.853
2.275
1.550
CH3
CH3
O
6.08
2.01
3.00
3.00
f1 (ppm)


ljb-121210-cc-C
158.517
141.555
135.479
134.391
130.275
130.235
129.890
126.955
125.731
113.488
77.320
77.003
76.685
55.278
20.515
CH3
CH3
O
f1 (ppm)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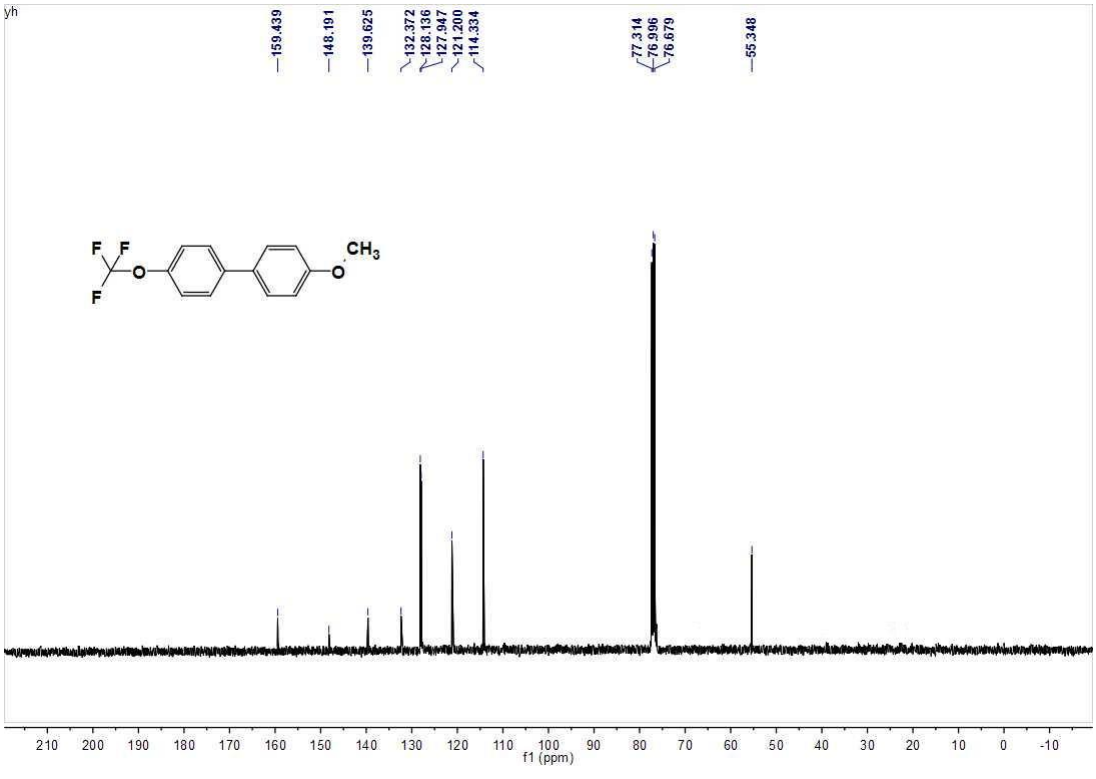
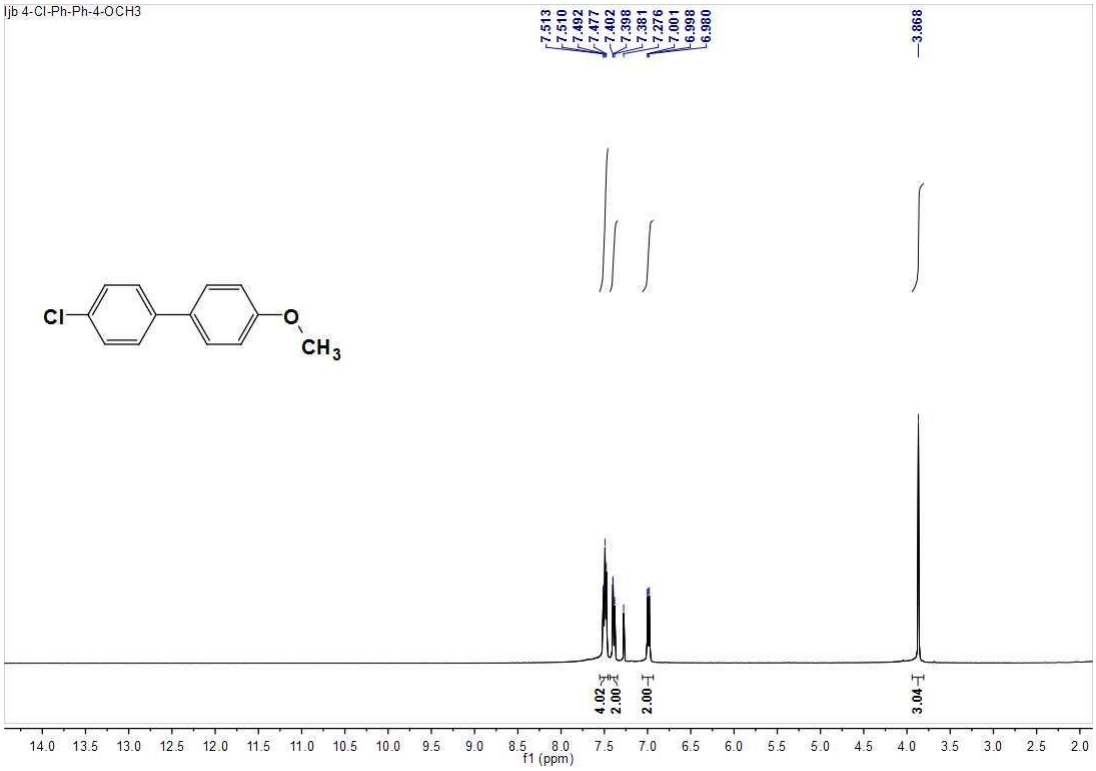
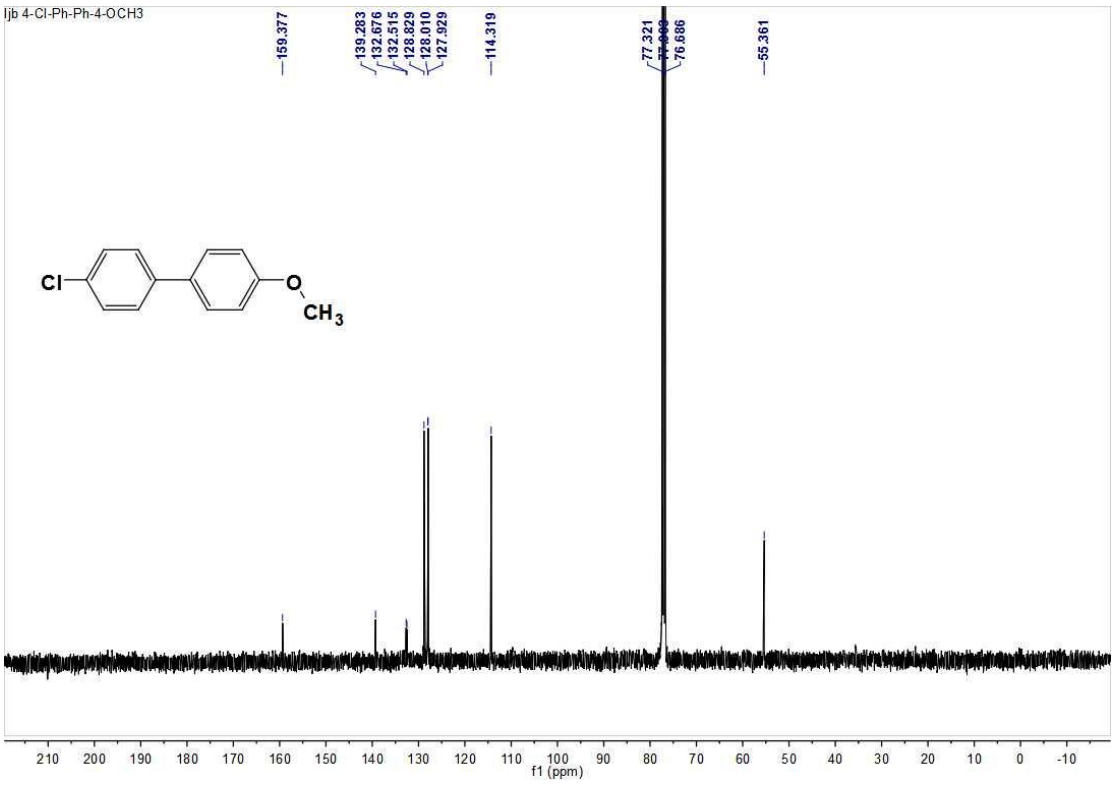
7.57
7.55
7.52
7.49
7.28
7.27
7.26
7.01
6.99
3.87
F
F
F
O
O
CH3
2.00
2.00
2.01
2.07
3.07
f1 (ppm)


yh
159.439
148.191
139.625
132.372
128.136
127.947
121.200
114.334
77.314
76.996
76.679
55.348
F
F
F
O
O
CH3
f1 (ppm)


ljb 4-Cl-Ph-Ph-4-OCH3
7.513
7.510
7.492
7.477
7.402
7.398
7.381
7.276
7.001
6.998
6.980
3.868
Cl
O
CH3
4.02
2.00
2.00
3.04
14.0 13.5 13.0 12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0
f1 (ppm)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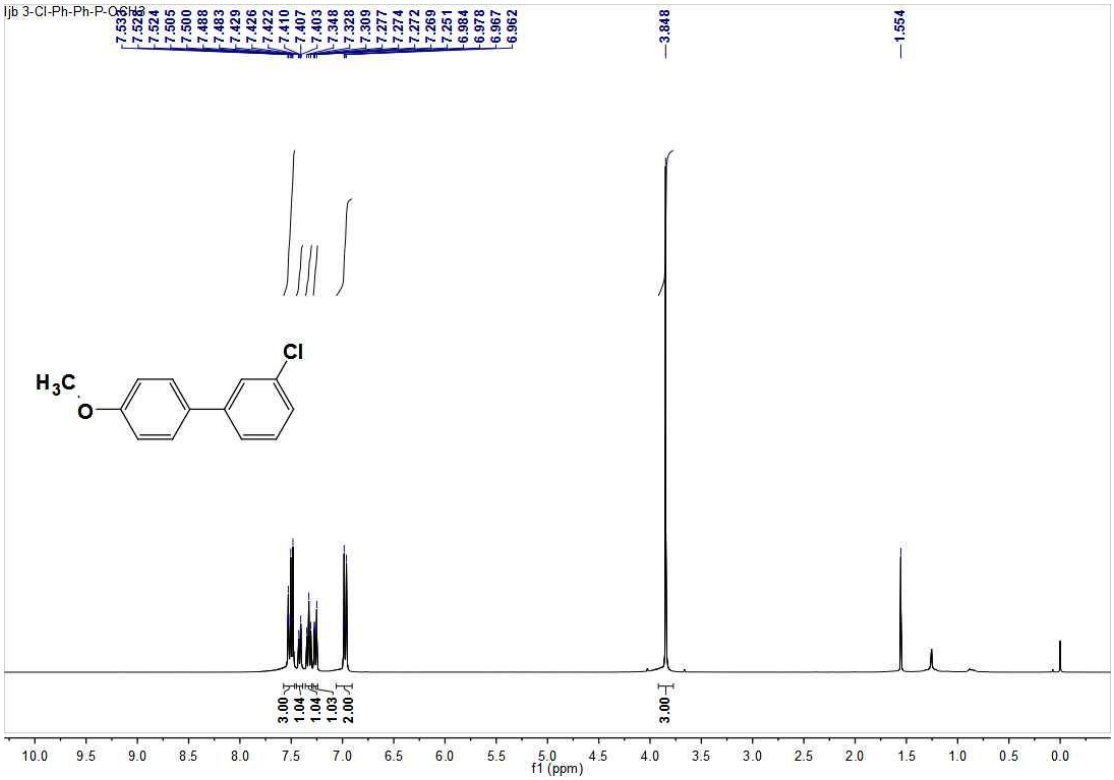
139.283
132.676
132.515
128.829
128.010
127.929
114.319
77.321
76.686
55.361
Cl
O
CH3
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


ljb 3-Cl-Ph-P-OCH3
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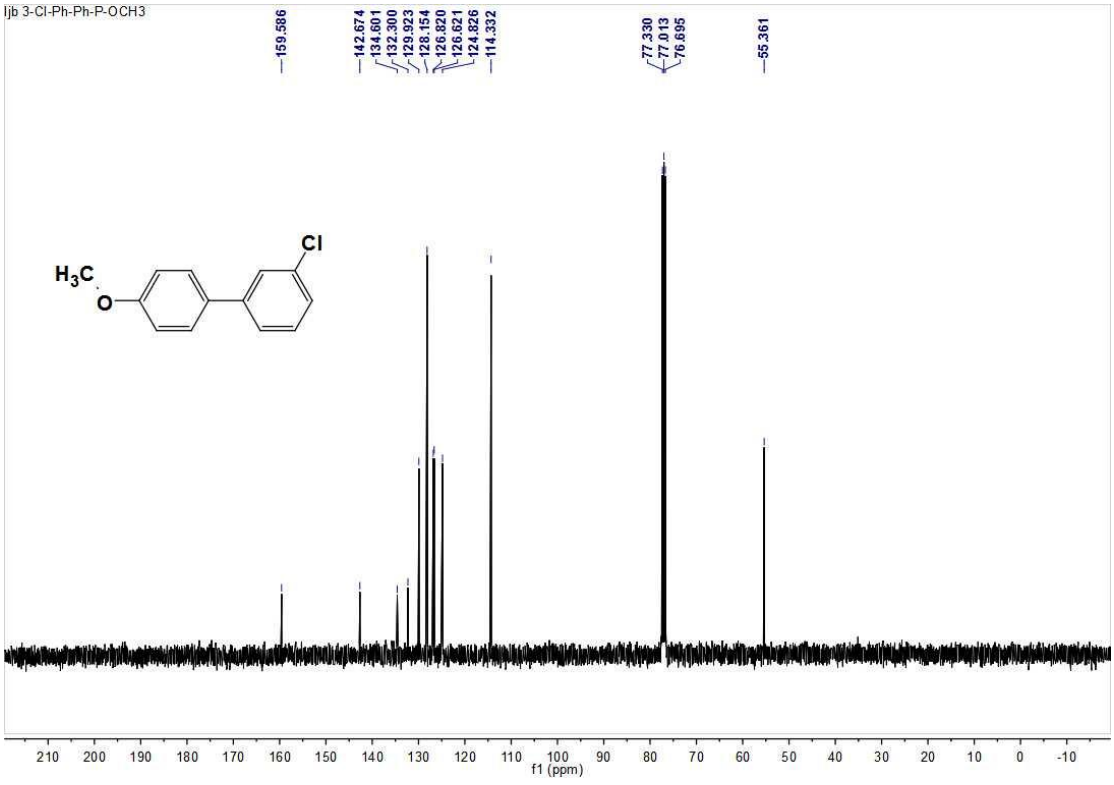
7.528
7.524
7.505
7.500
7.488
7.483
7.429
7.426
7.422
7.410
7.407
7.403
7.348
7.328
7.309
7.277
7.274
7.272
7.269
7.251
6.984
6.978
6.967
6.962
3.848
1.554
Cl
H3C
O
3.00
1.04
1.04
1.03
2.00
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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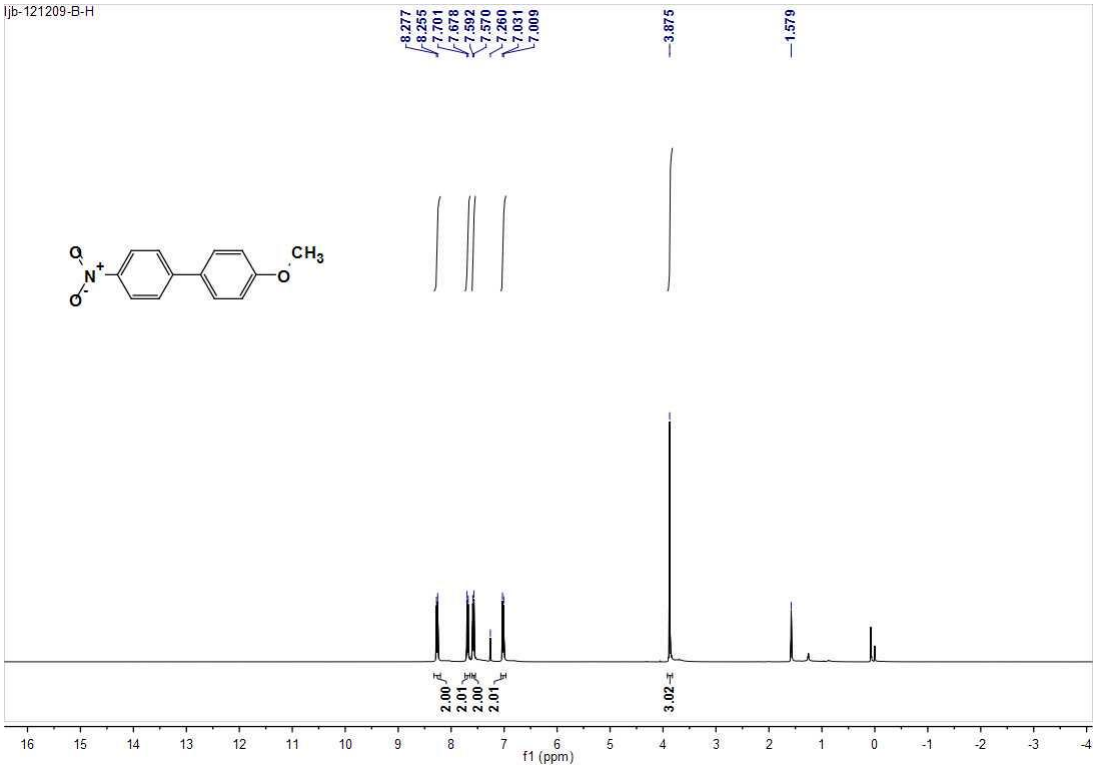
134.601
132.300
129.923
128.154
126.820
126.621
124.826
114.332
77.330
77.013
76.695
55.361
Cl
H3C
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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8.255
7.701
7.678
7.592
7.570
7.260
7.031
7.009
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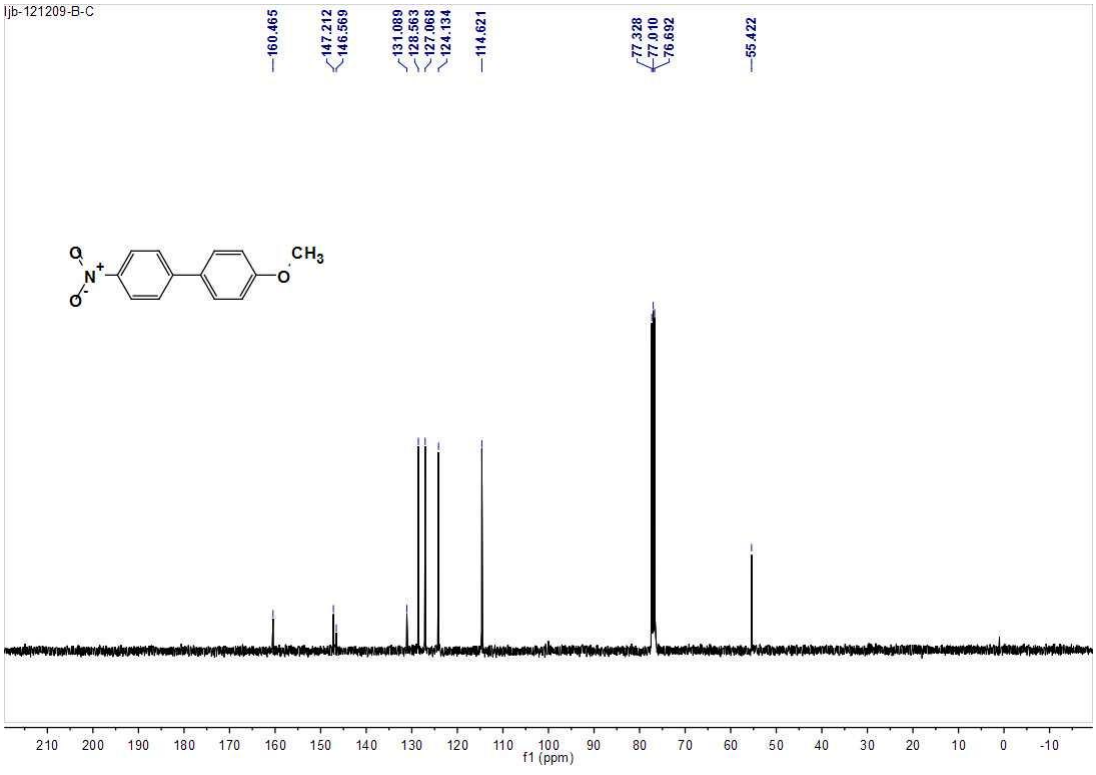
2.01
2.00
2.01
3.02
f1 (ppm)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147.212
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77.010
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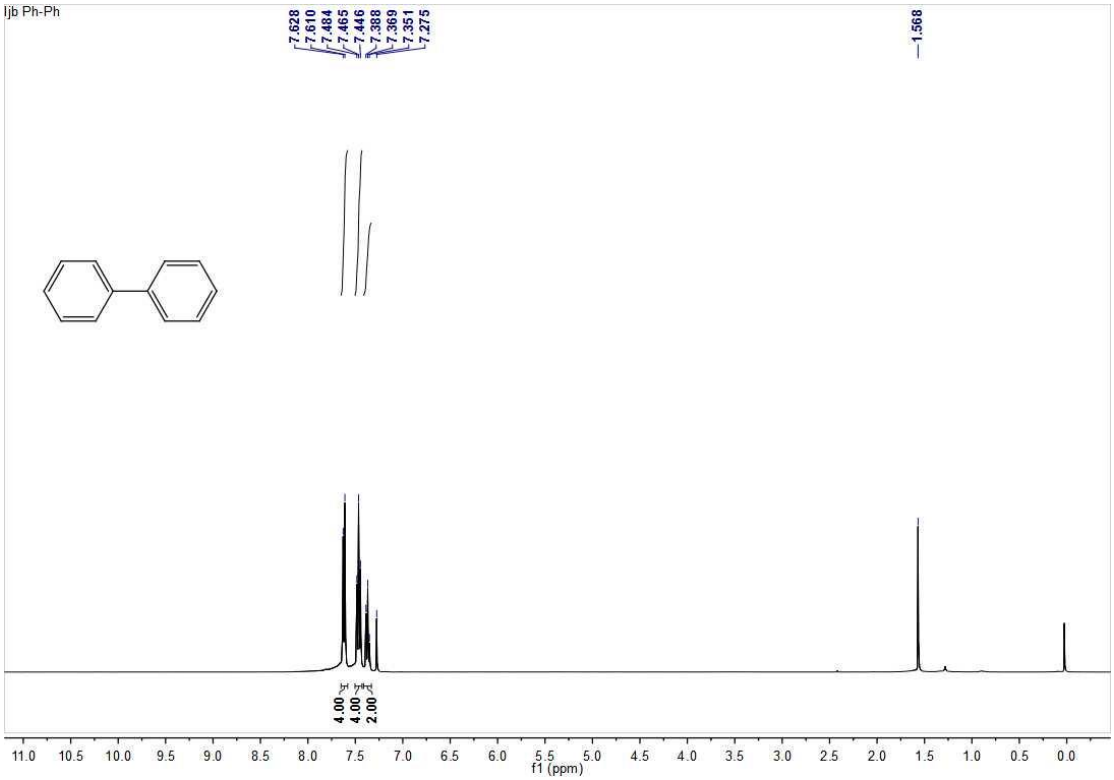
ljb Ph-Ph
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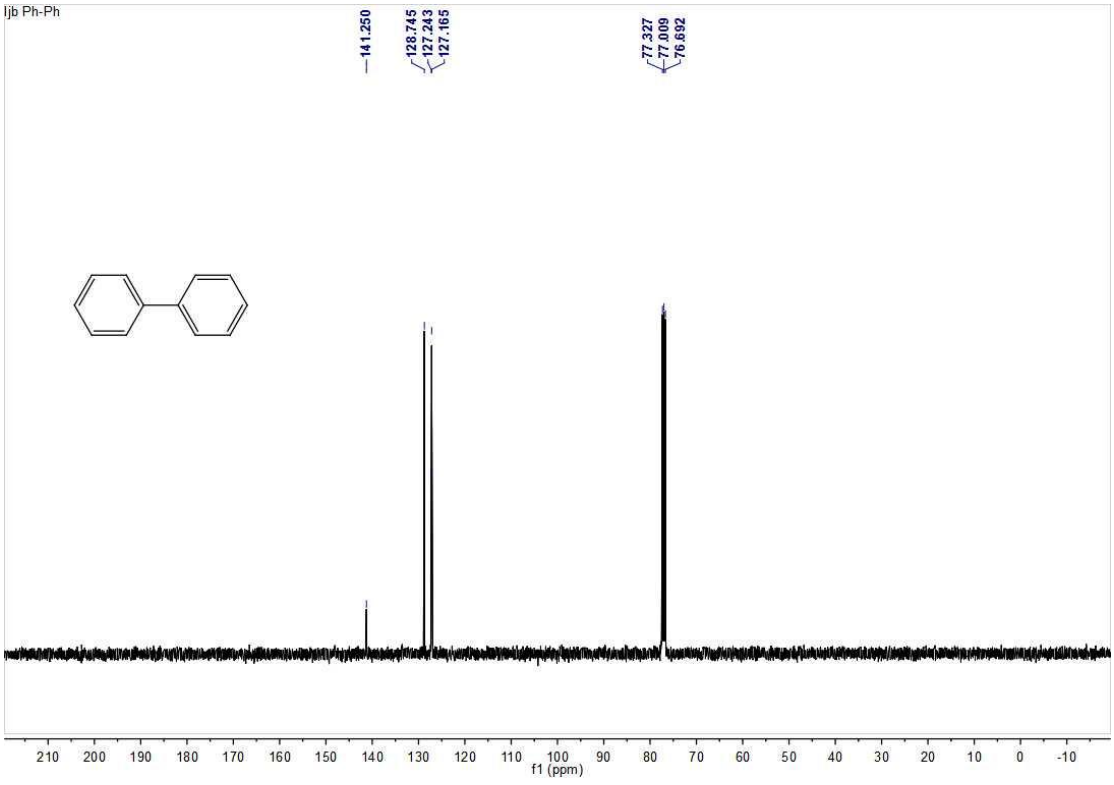
7.351
7.275
1.568
4.00
4.00
2.00
f1 (ppm)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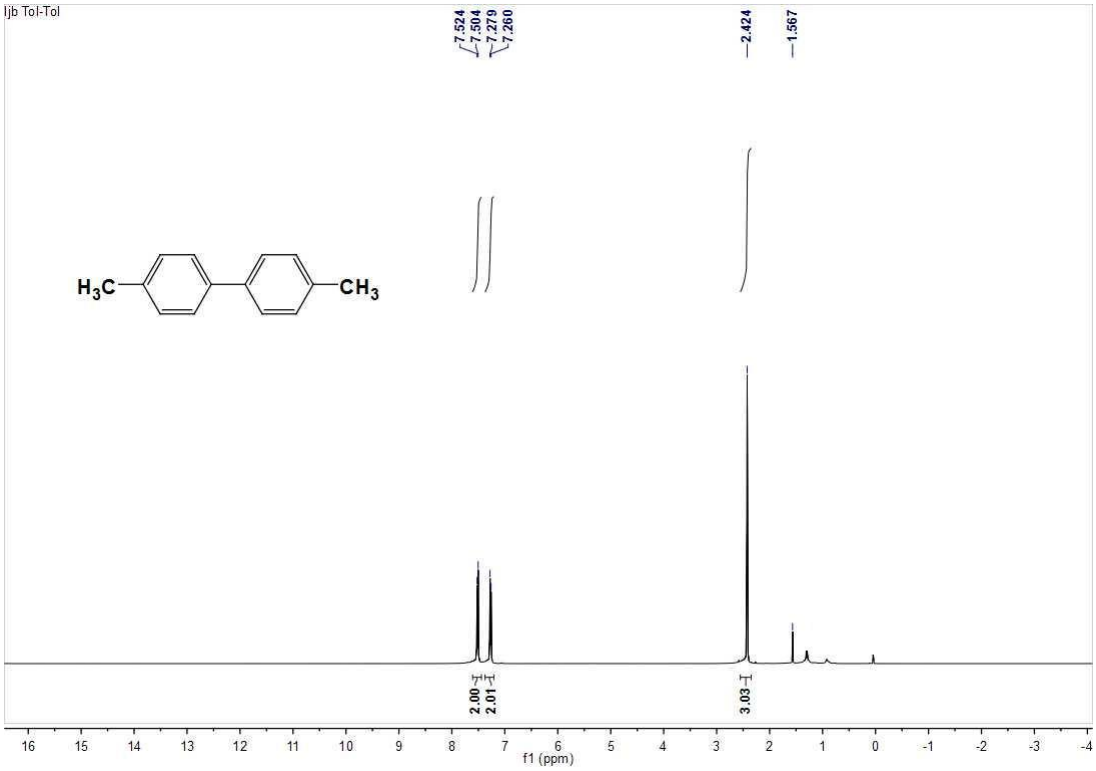
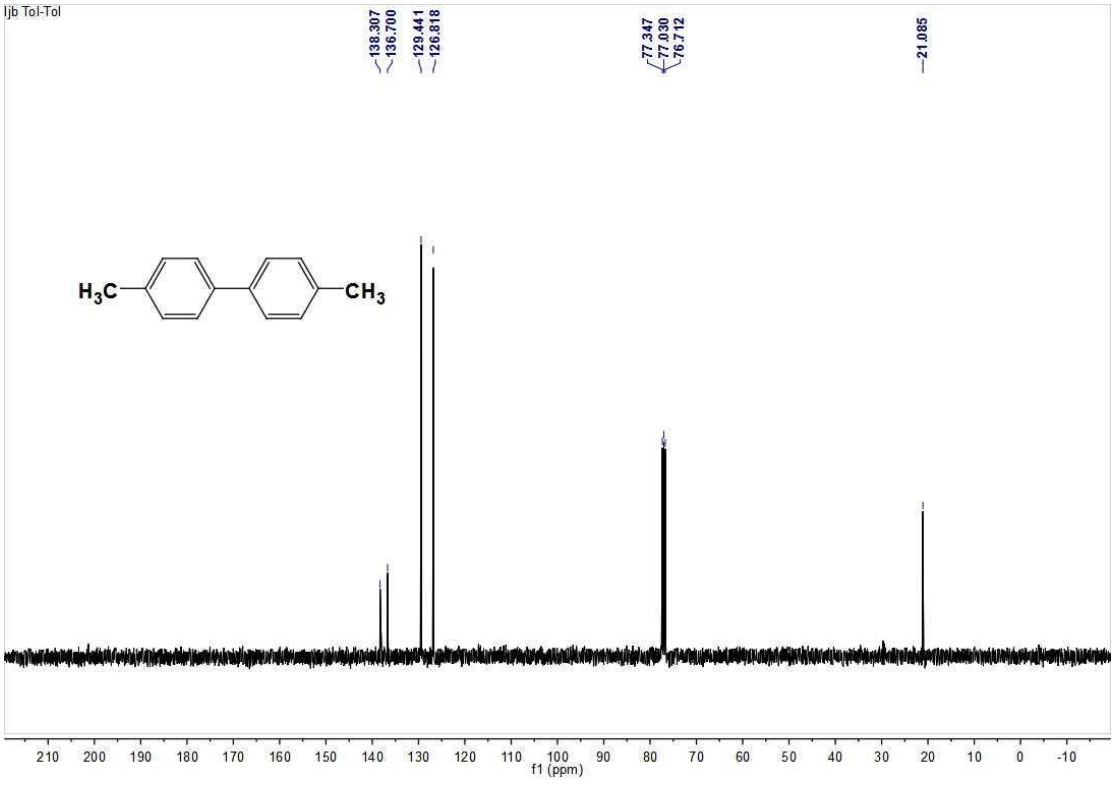
127.165
77.327
77.009
76.692
f1 (ppm)


ljb Tol-Tol
7.524
7.504
7.279
7.260
2.424
1.567
$H_3C$
$CH_3$
2.00
2.01
3.03
f1 (ppm)


ljb Tol-Tol
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136.700
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126.818
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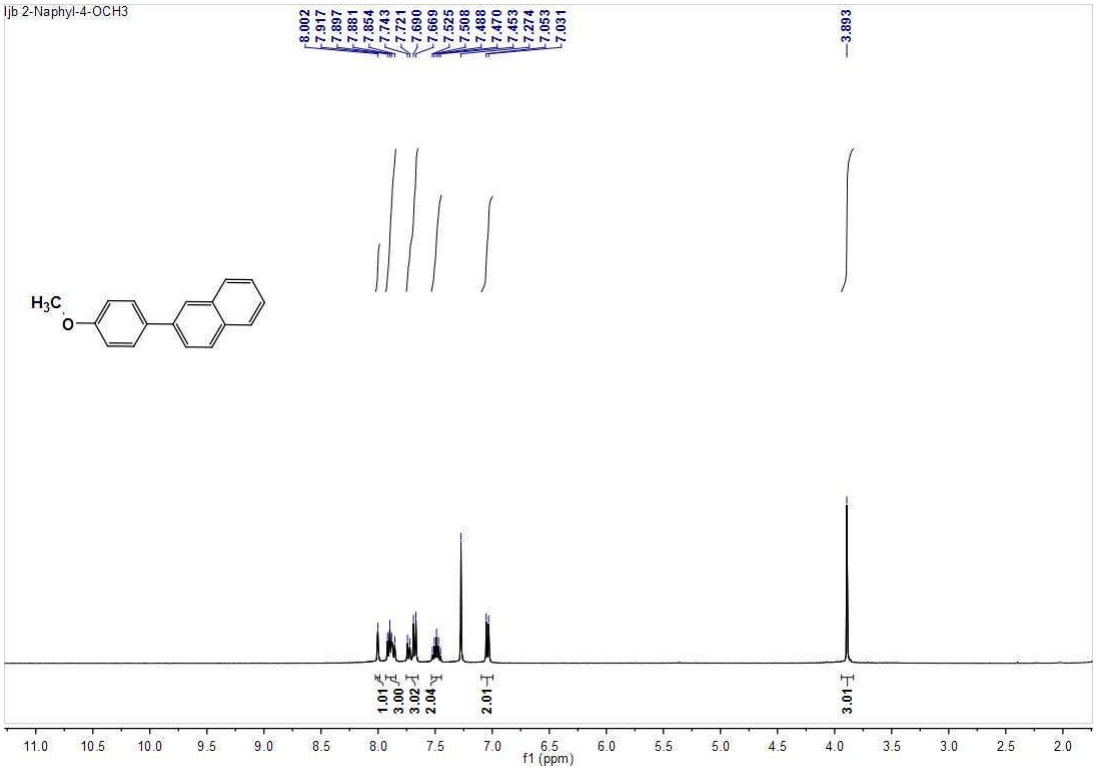
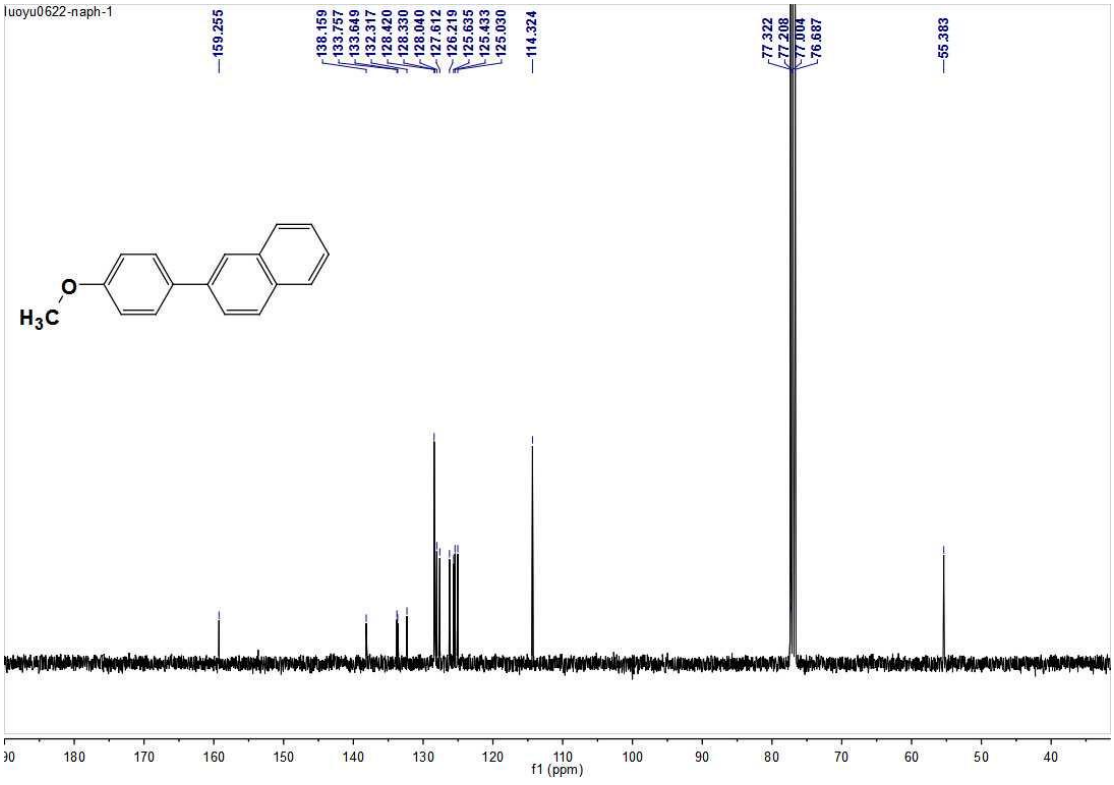
77.030
76.712
21.085
$H_3C$
$CH_3$
f1 (ppm)


ljb 2-Naphyl-4-OCH3
8.002
7.917
7.897
7.881
7.854
7.743
7.721
7.690
7.669
7.525
7.508
7.488
7.470
7.453
7.274
7.053
7.031
3.893
H3C
O
1.01
3.00
3.02
2.04
2.01
3.01
f1 (ppm)


luoyu0622-naph-1
159.255
138.159
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133.649
132.317
128.420
128.330
128.040
127.612
126.219
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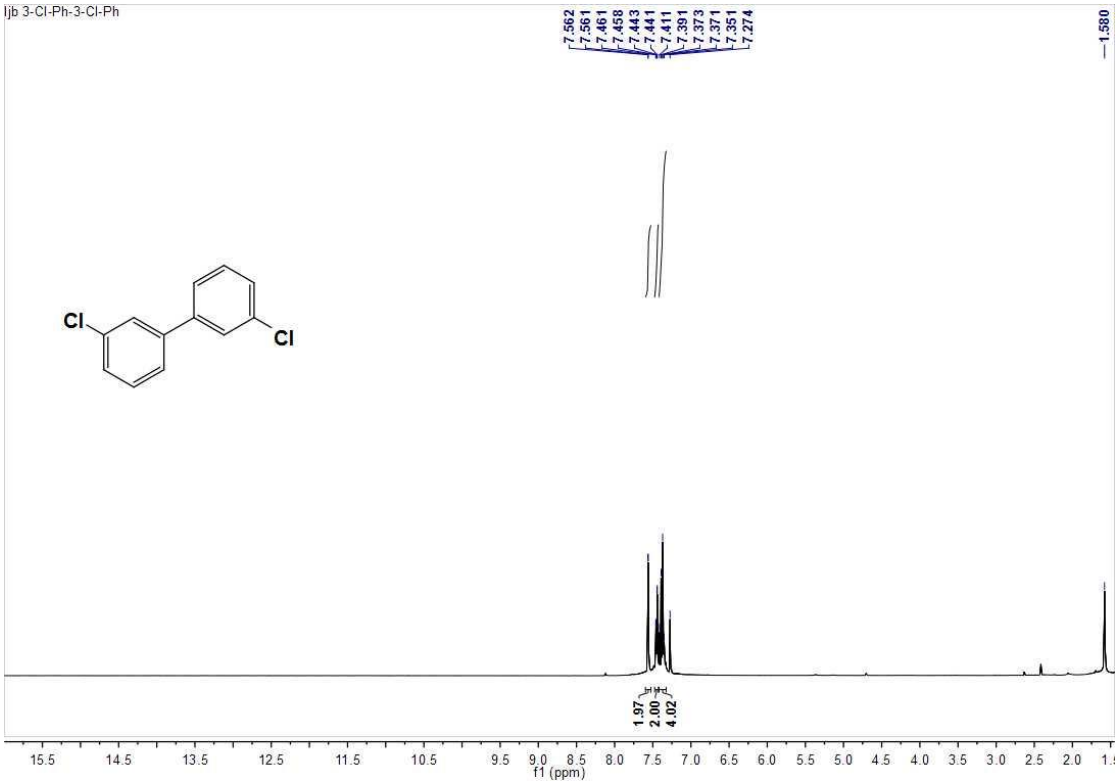
77.004
76.687
55.383
H3C
O
f1 (ppm)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7.561
7.461
7.458
7.443
7.441
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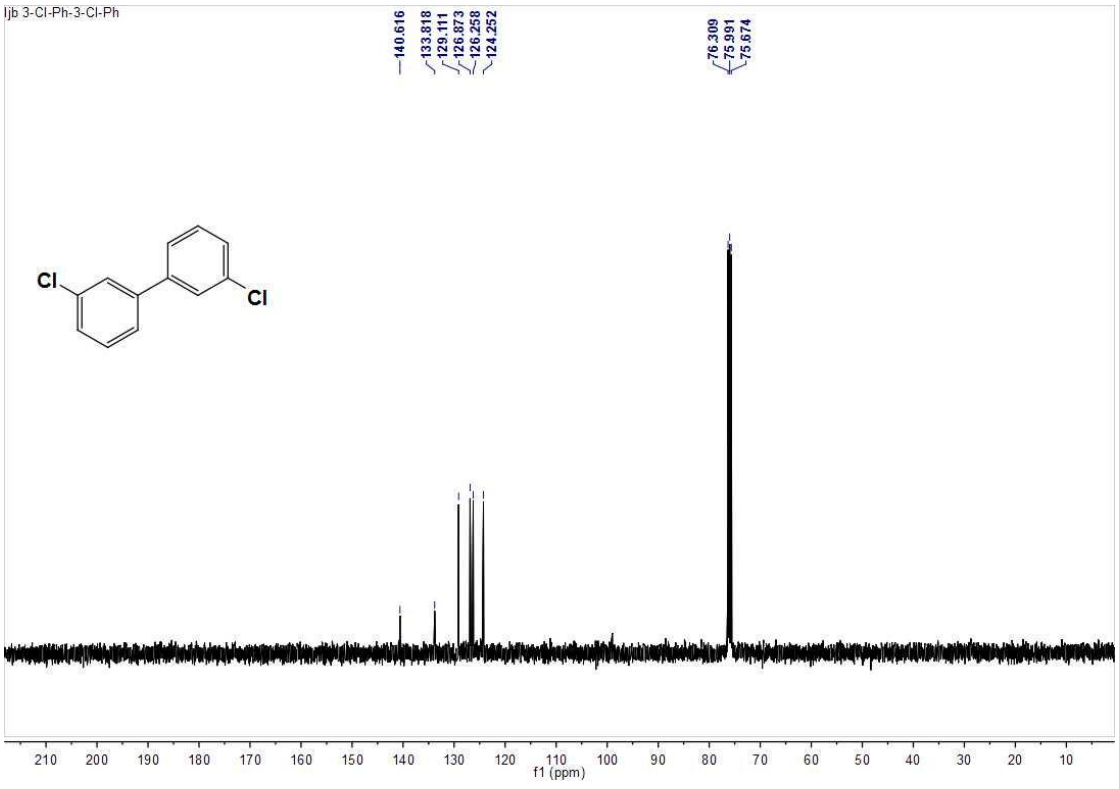
7.371
7.351
7.274
1.580
Cl
Cl
1.97
2.00
4.02
f1 (ppm)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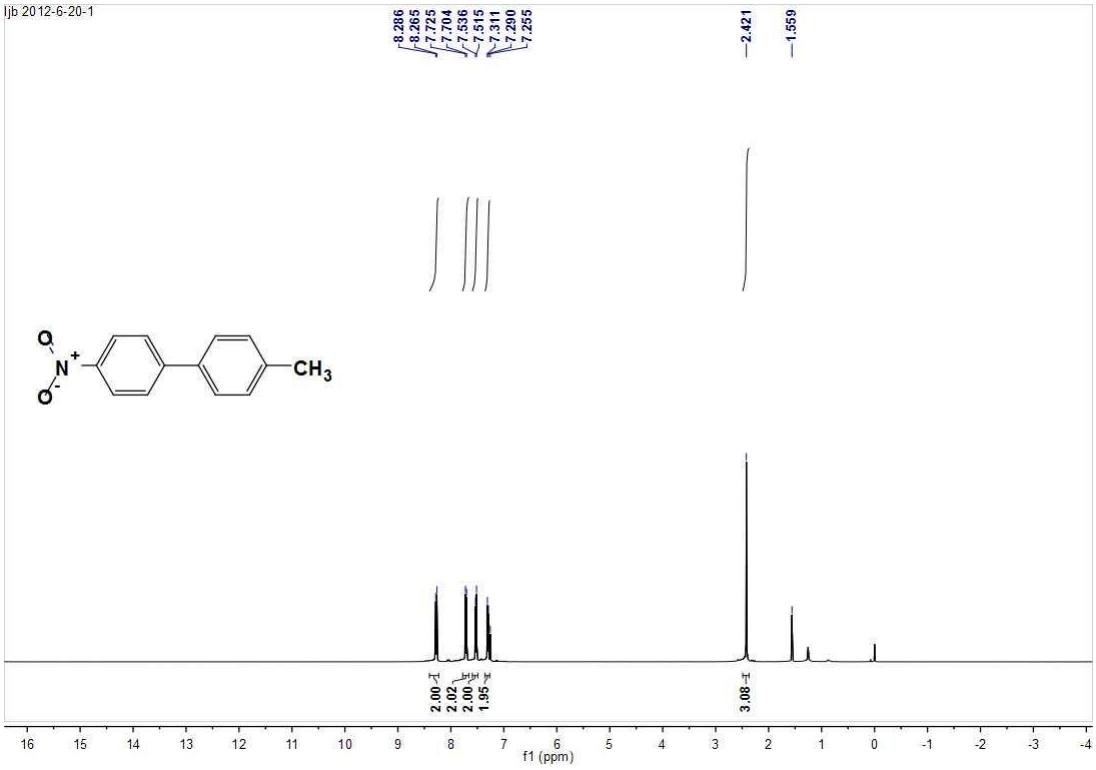
75.991
75.674
Cl
Cl
f1 (ppm)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8.265
7.725
7.704
7.536
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7.290
7.255
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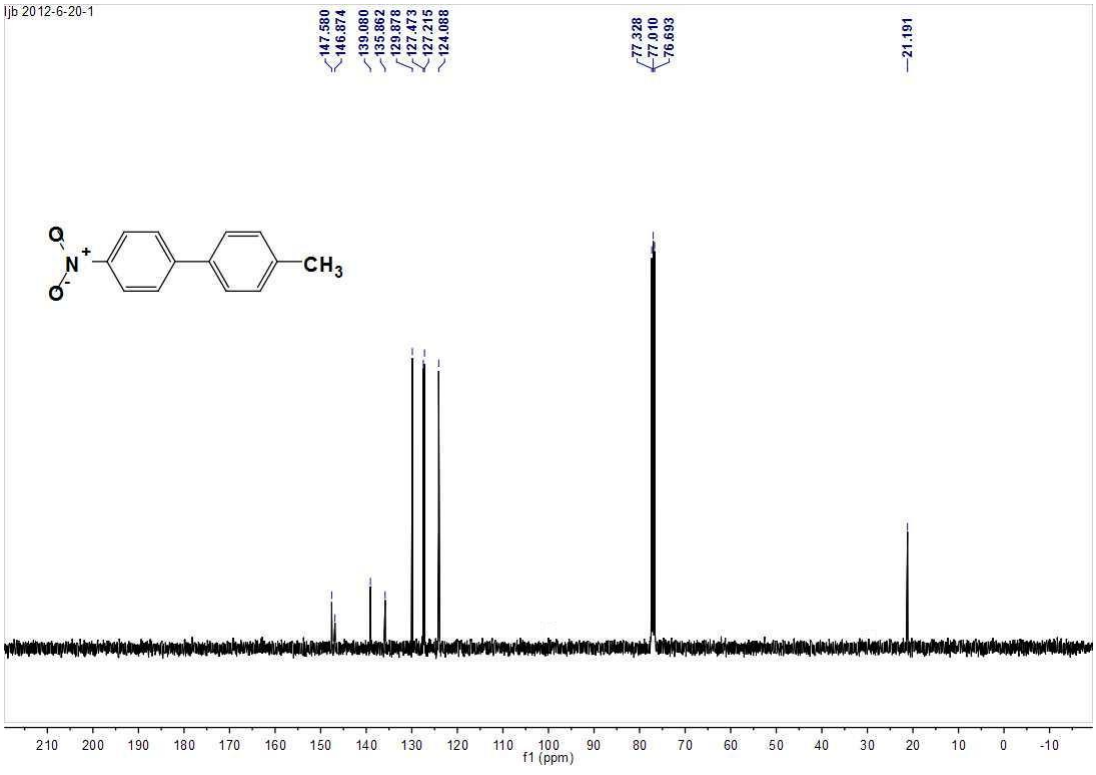
2.02
2.00
1.95
3.08
f1 (ppm)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147.580
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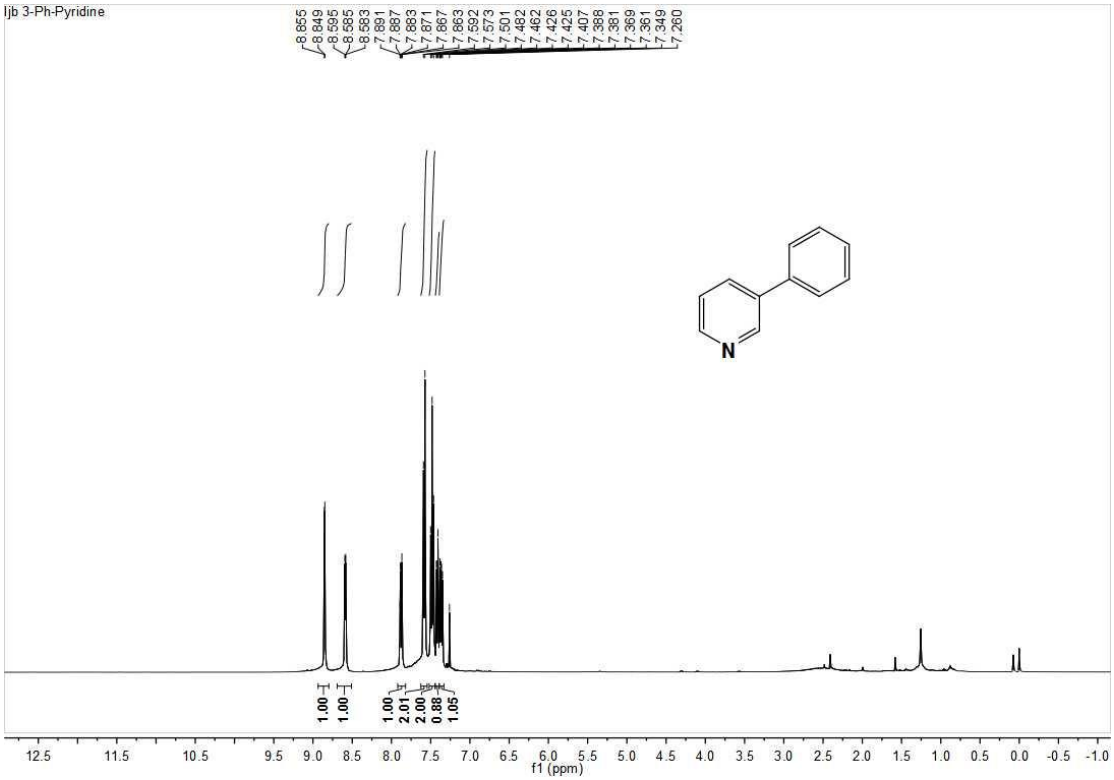
77.328
77.010
76.693
21.191
f1 (ppm)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8.849
8.595
8.585
8.583
7.891
7.887
7.883
7.871
7.867
7.863
7.592
7.573
7.501
7.482
7.462
7.426
7.425
7.407
7.388
7.381
7.369
7.361
7.349
7.260
N
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1.00
1.00
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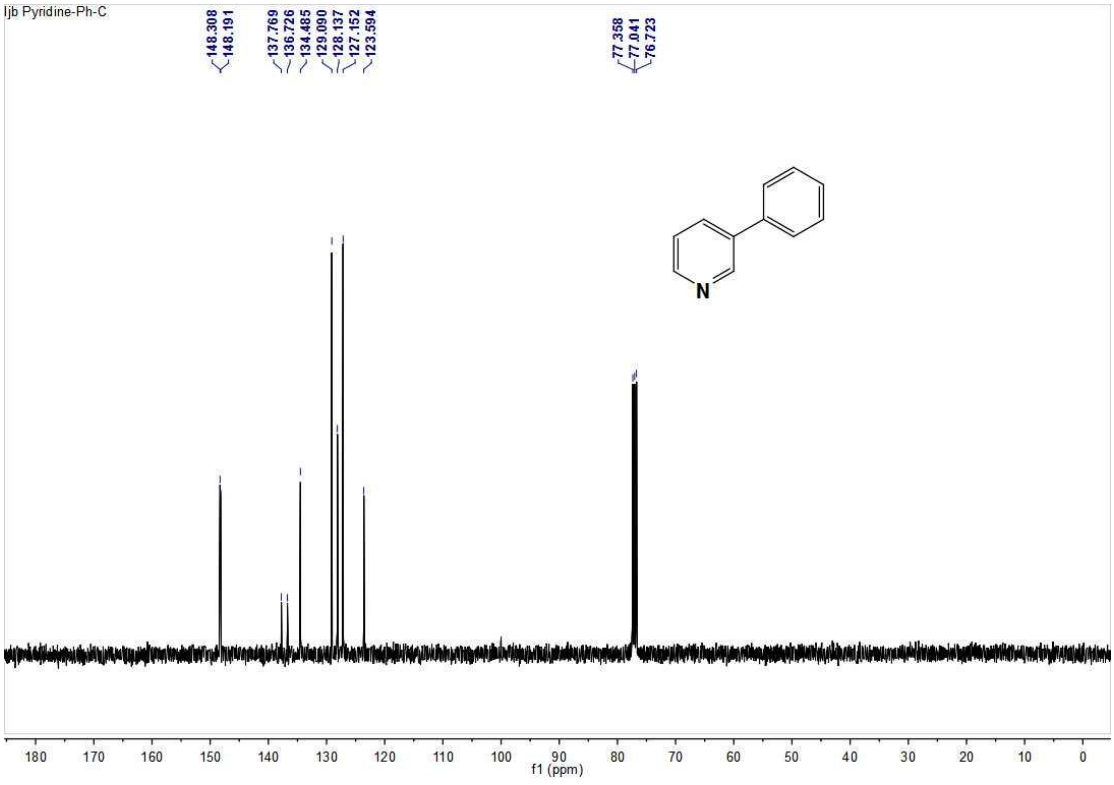
2.00
0.88
1.05
f1 (ppm)


ljb Pyridine-Ph-C
148.308
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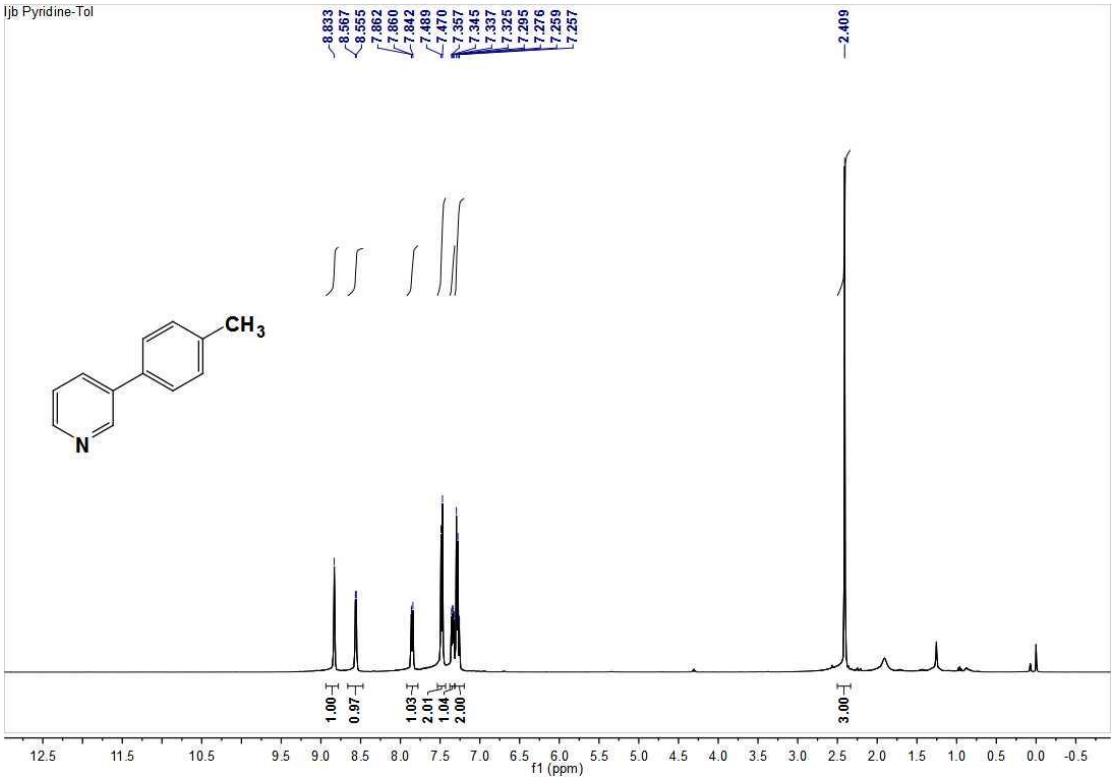
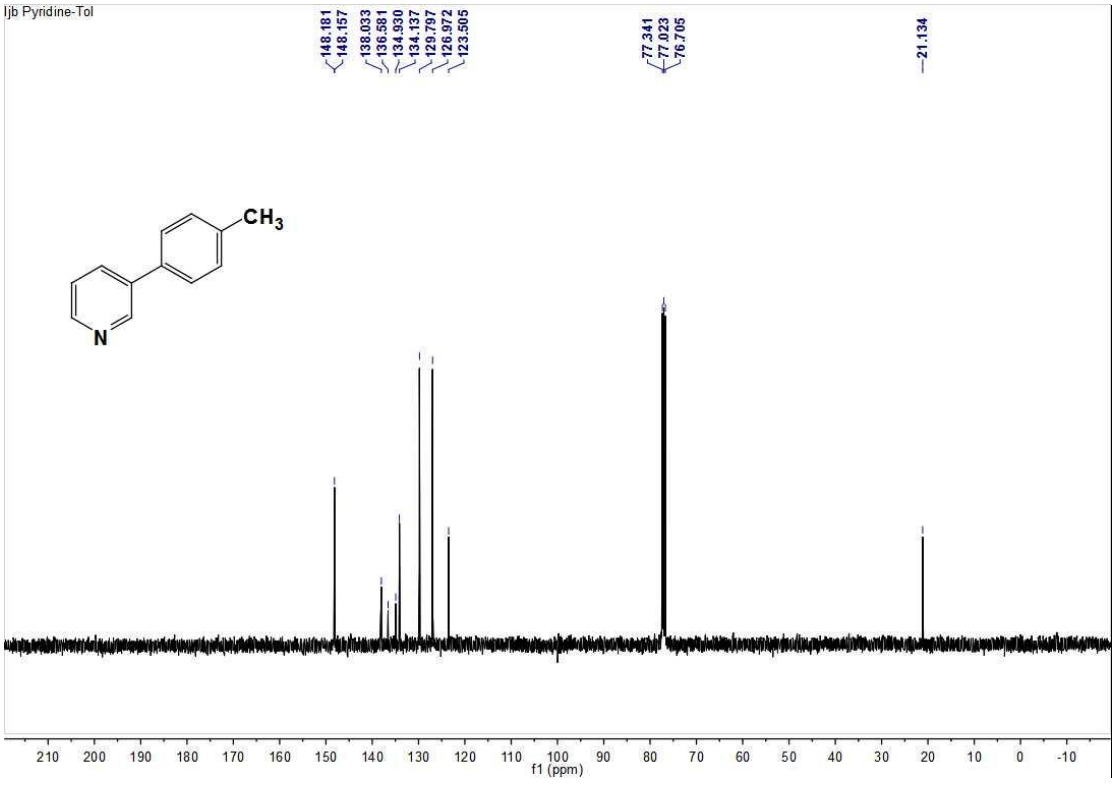
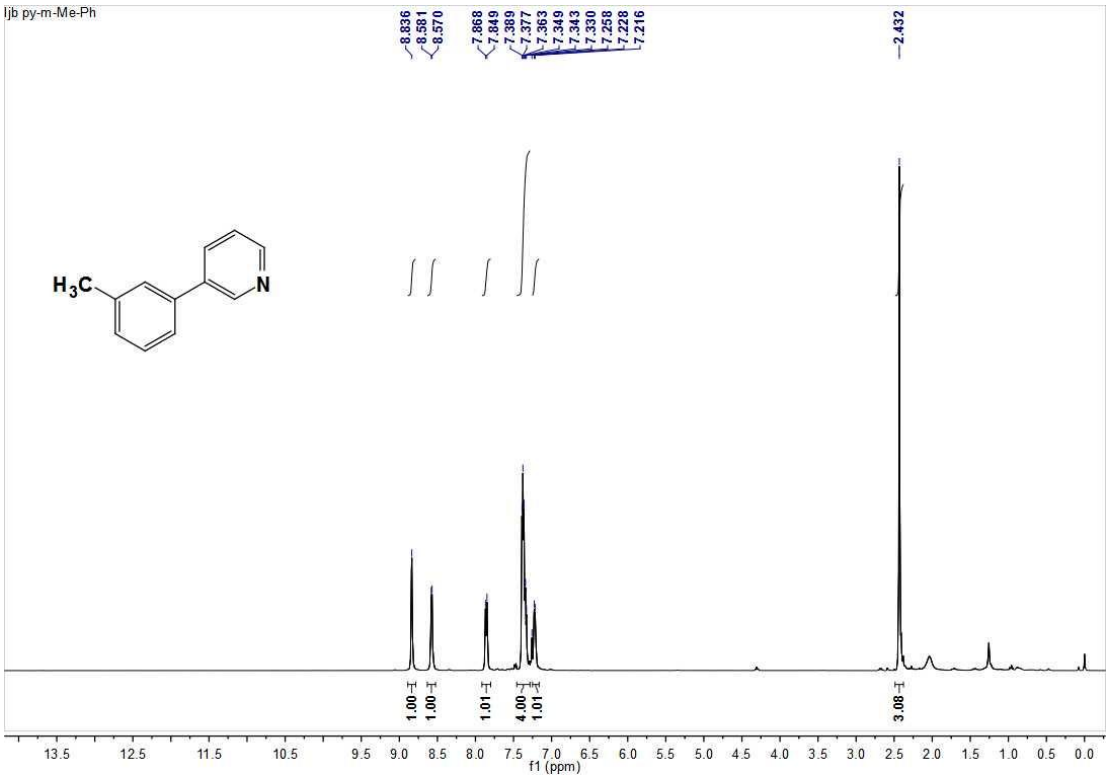
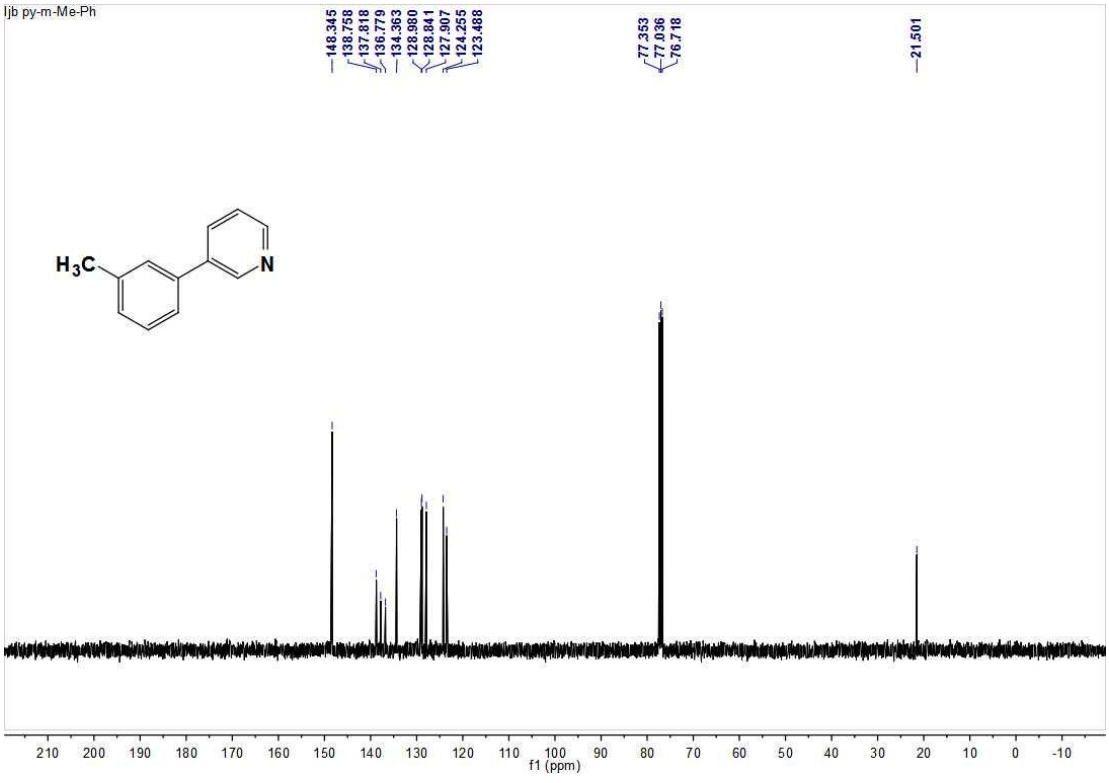
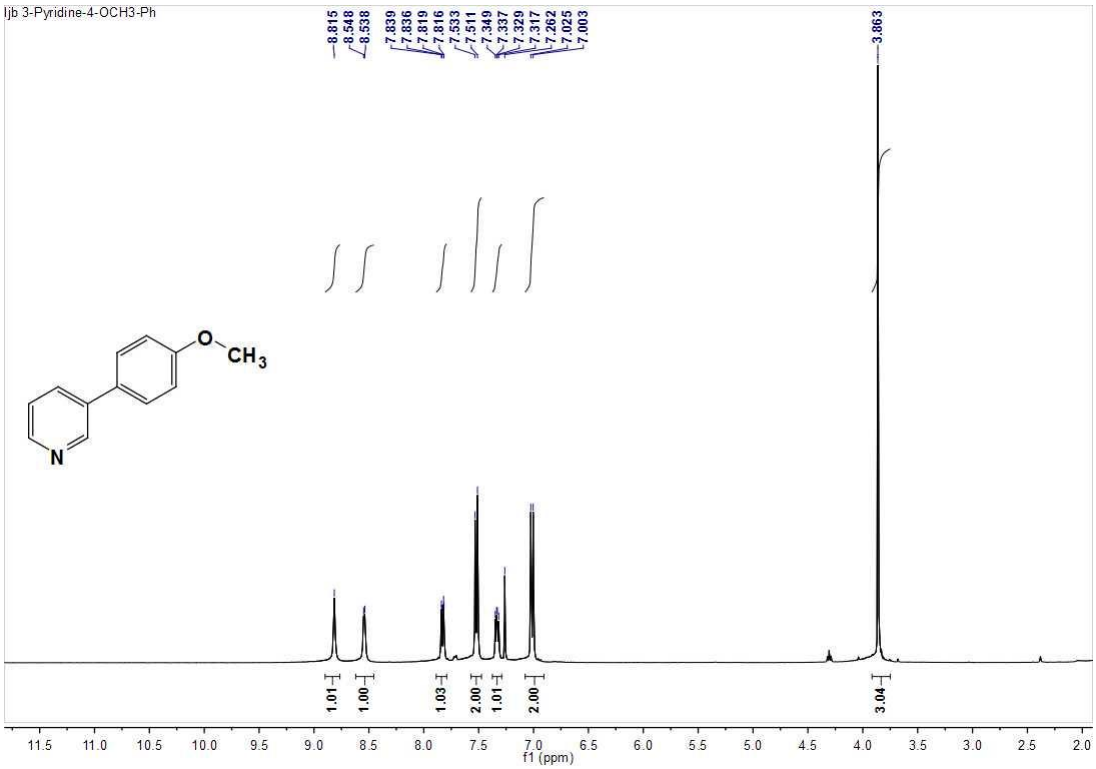
129.090
128.137
127.152
123.594
77.358
77.041
76.723
N
f1 (ppm)

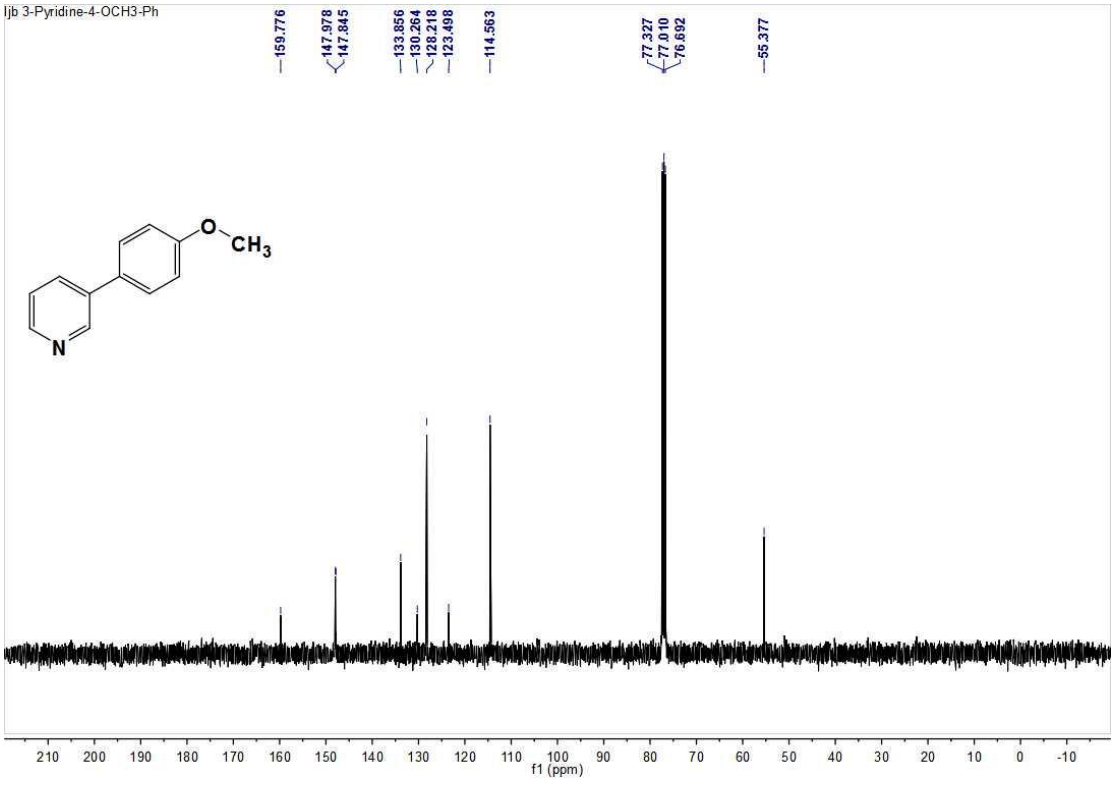

ljb Pyridine-Tol
8.833
8.567
8.555
7.862
7.860
7.842
7.489
7.470
7.357
7.345
7.337
7.325
7.295
7.276
7.259
7.257
2.409
CH3
N
1.00
0.97
1.03
2.01
1.04
2.00
3.00
f1 (ppm)

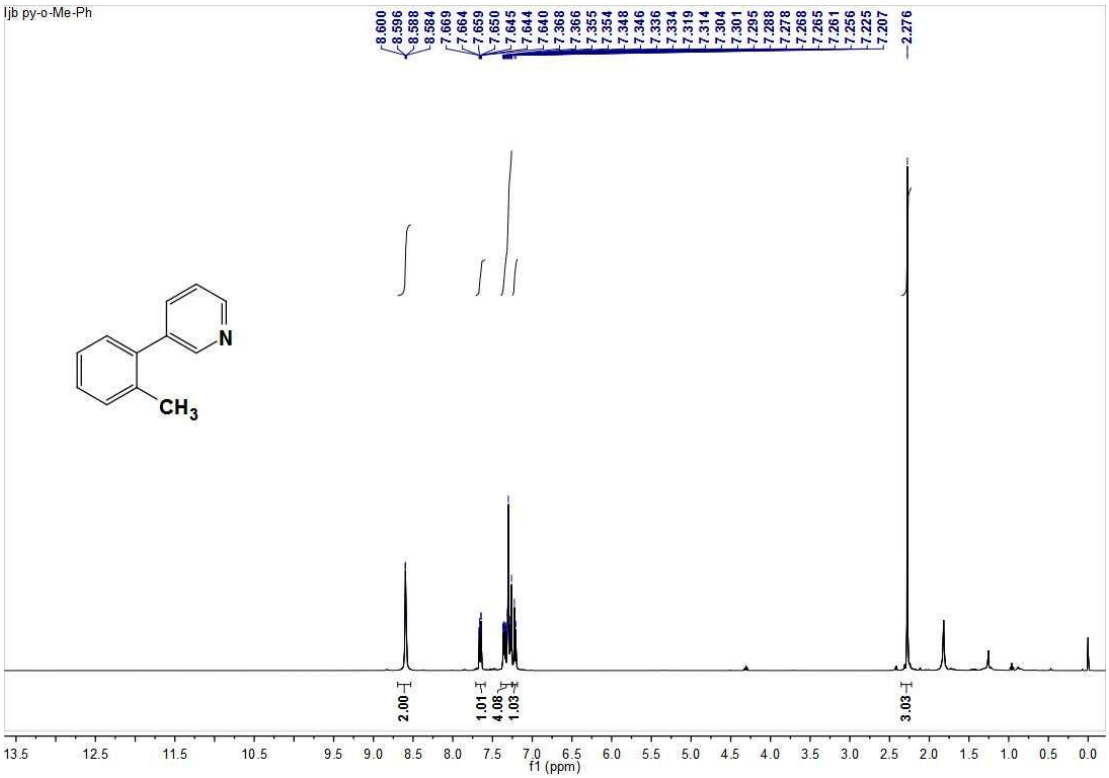

ljb Pyridine-Tol
148.181
148.157
138.033
136.581
134.930
134.137
129.797
126.972
123.505
77.341
77.023
76.705
21.134
CH3
N
f1 (ppm)

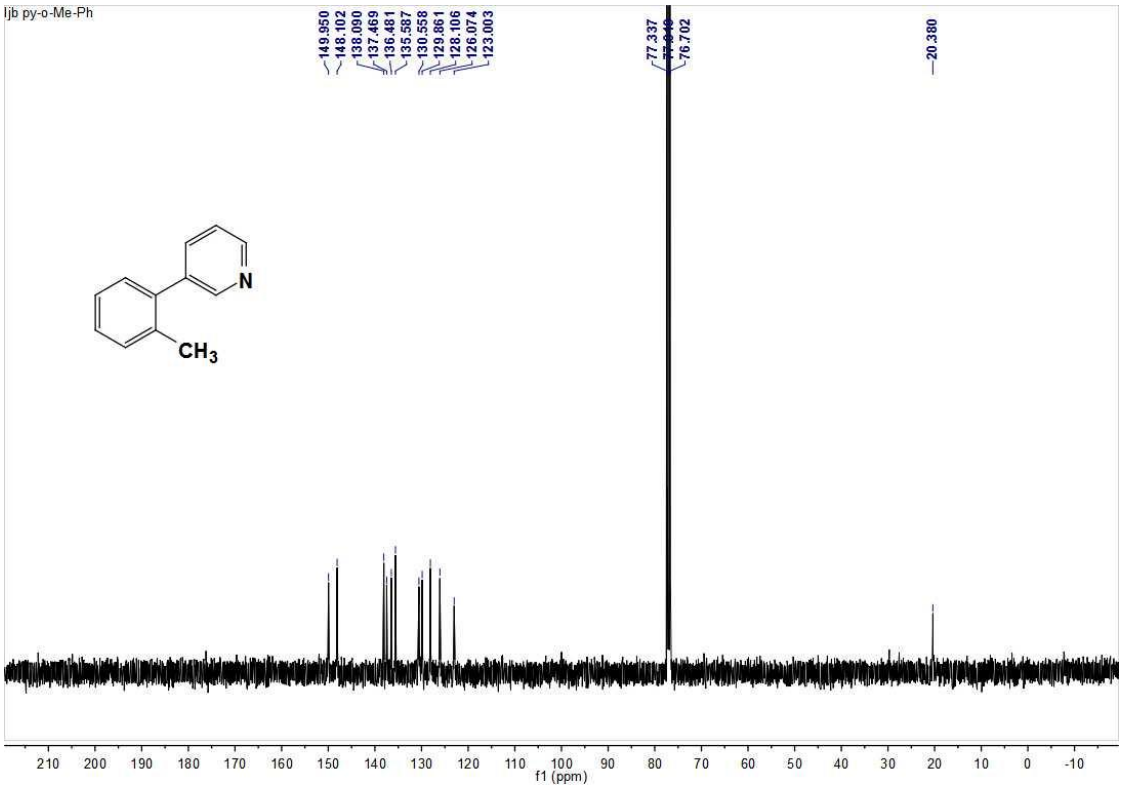

ljb py-m-Me-Ph
8.836
8.581
8.570
7.868
7.849
7.389
7.377
7.363
7.349
7.343
7.330
7.258
7.228
7.216
2.432
H3C
N
1.00
1.00
1.01
4.00
1.01
3.08
f1 (ppm)

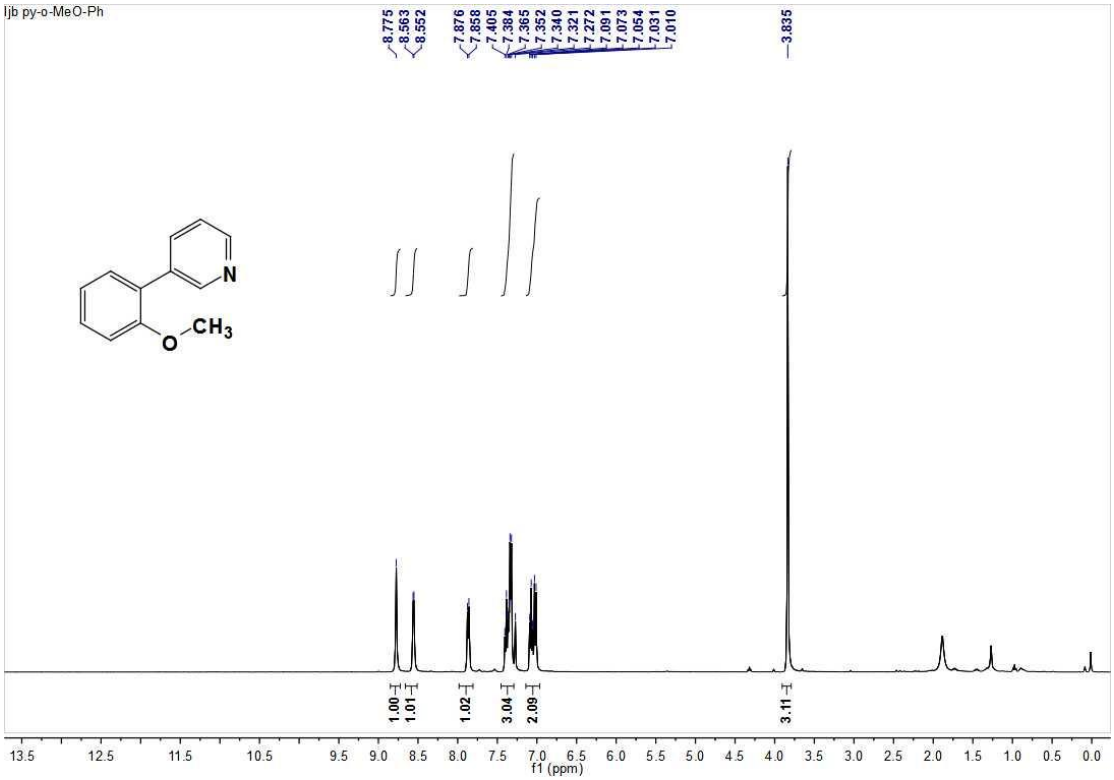

ljb py-m-Me-Ph
148.345
138.758
137.818
136.779
134.363
128.980
128.841
127.907
124.255
123.488
77.353
77.036
76.718
21.501
H3C
N
f1 (ppm)

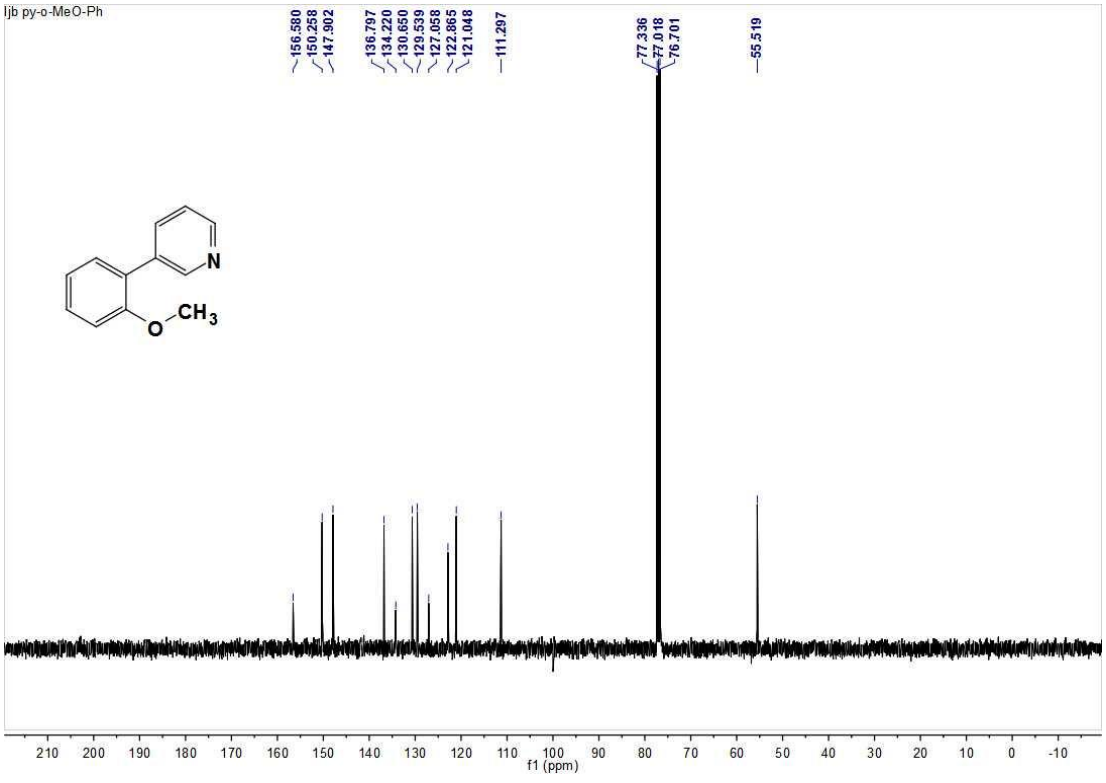

ljb 3-Pyridine-4-OCH3-Ph
8.815
8.548
8.538
7.839
7.836
7.819
7.816
7.533
7.511
7.349
7.337
7.329
7.317
7.262
7.025
7.003
3.863
O
CH3
N
1.01
1.00
1.03
2.00
1.01
2.00
3.04
f1 (ppm)

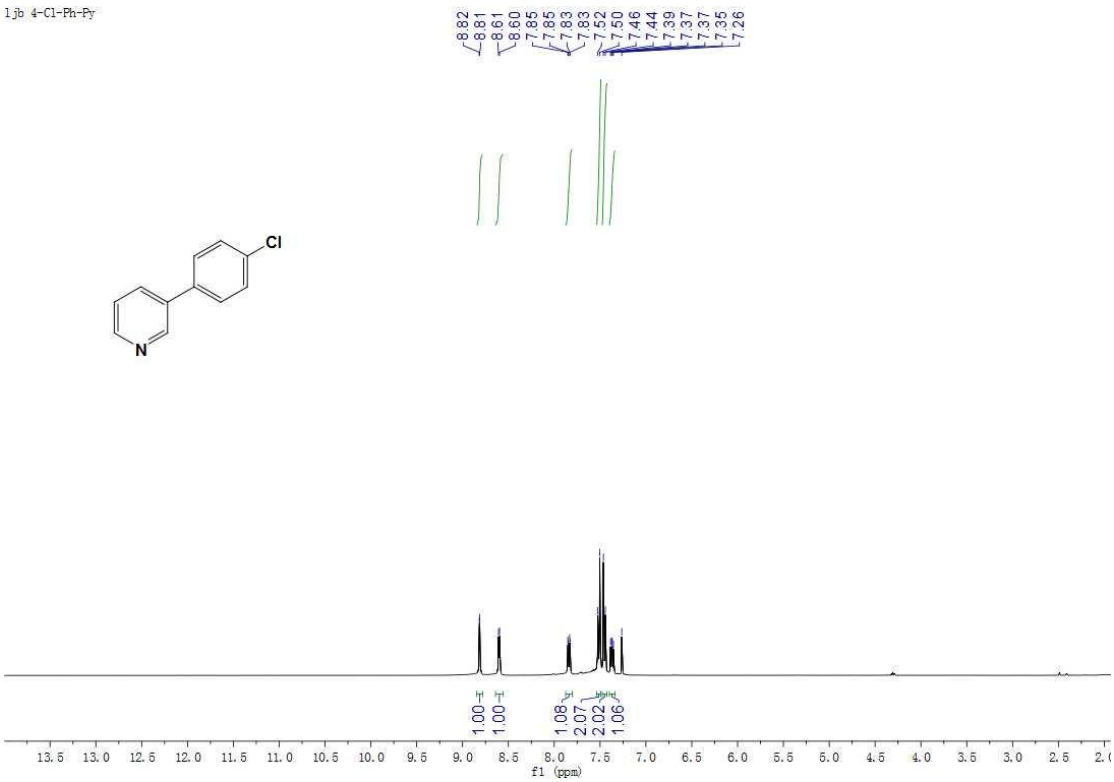

ljb 3-Pyridine-4-OCH3-Ph
159.776
147.978
147.845
133.856
130.264
128.218
123.498
114.563
77.327
77.010
76.692
55.377
O
CH3
N
f1 (ppm)

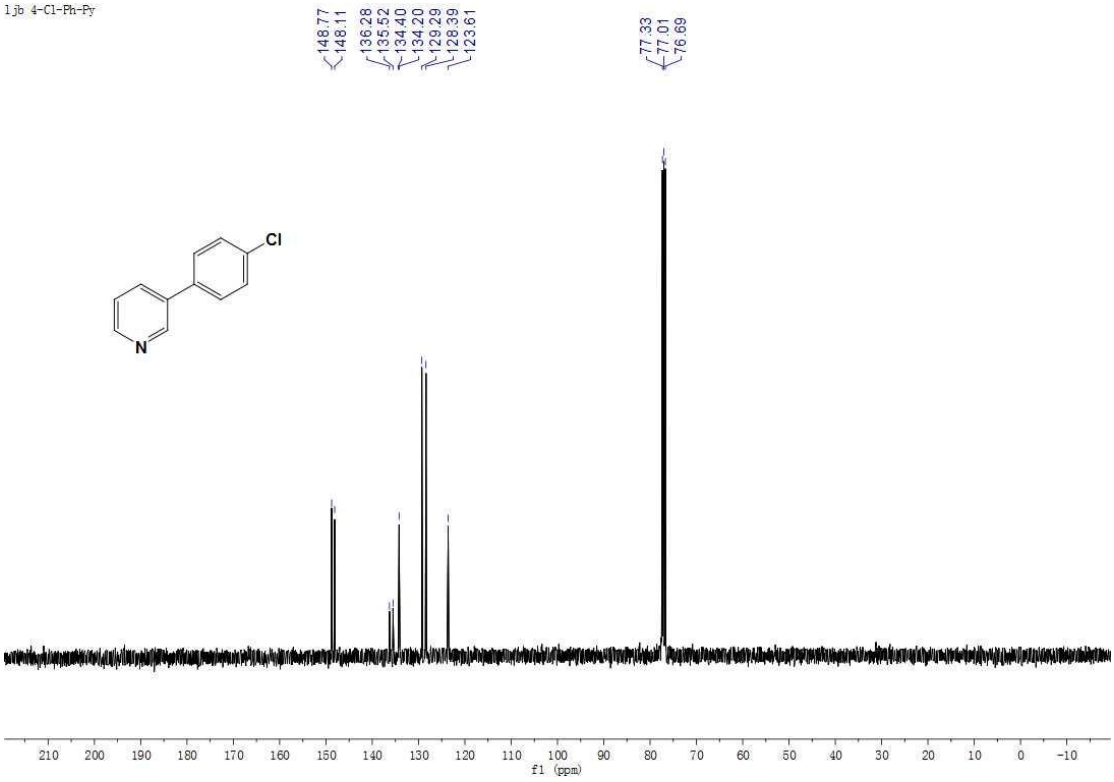

ljb py-o-Me-Ph
8.600
8.596
8.588
8.584
7.669
7.664
7.659
7.650
7.645
7.644
7.640
7.368
7.366
7.355
7.354
7.348
7.346
7.336
7.334
7.319
7.314
7.304
7.301
7.295
7.288
7.278
7.268
7.265
7.261
7.256
7.225
7.207
2.276
N
CH3
2.00
1.01
4.08
1.03
3.03
f1 (ppm)

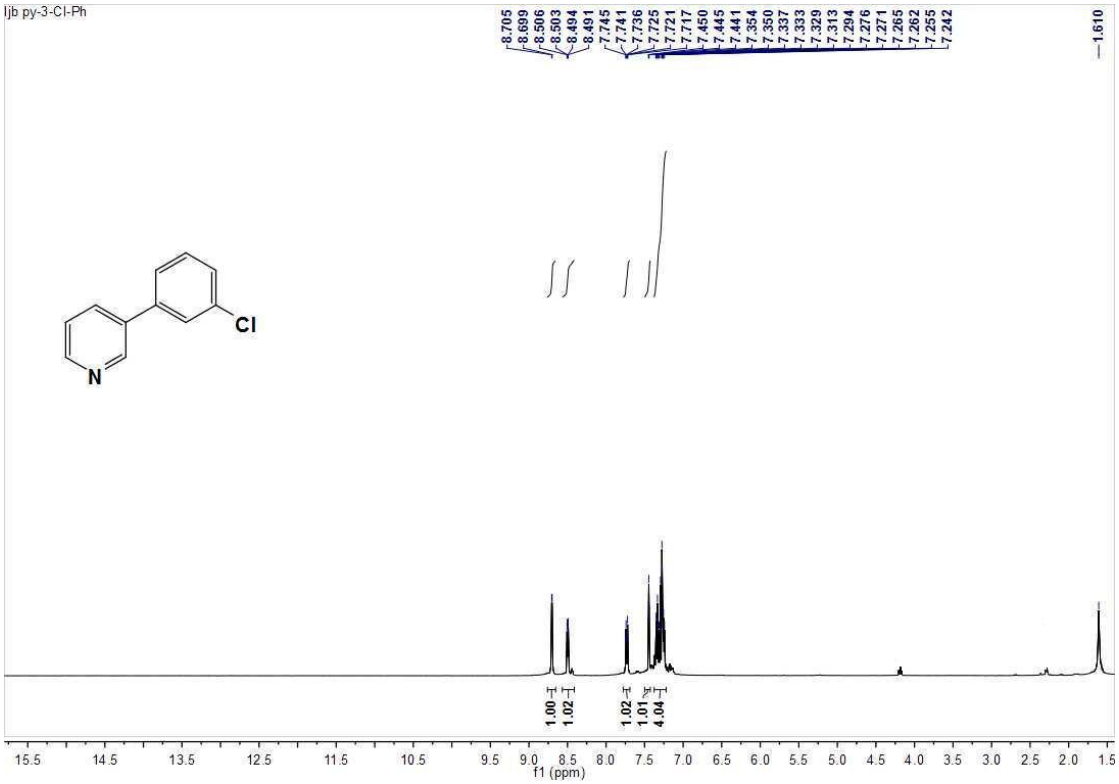

ljb py-o-Me-Ph
149.950
148.102
138.090
137.469
136.481
135.587
130.558
129.861
128.106
126.074
123.003
77.337
77.019
76.702
20.380
N
CH3
f1 (ppm)

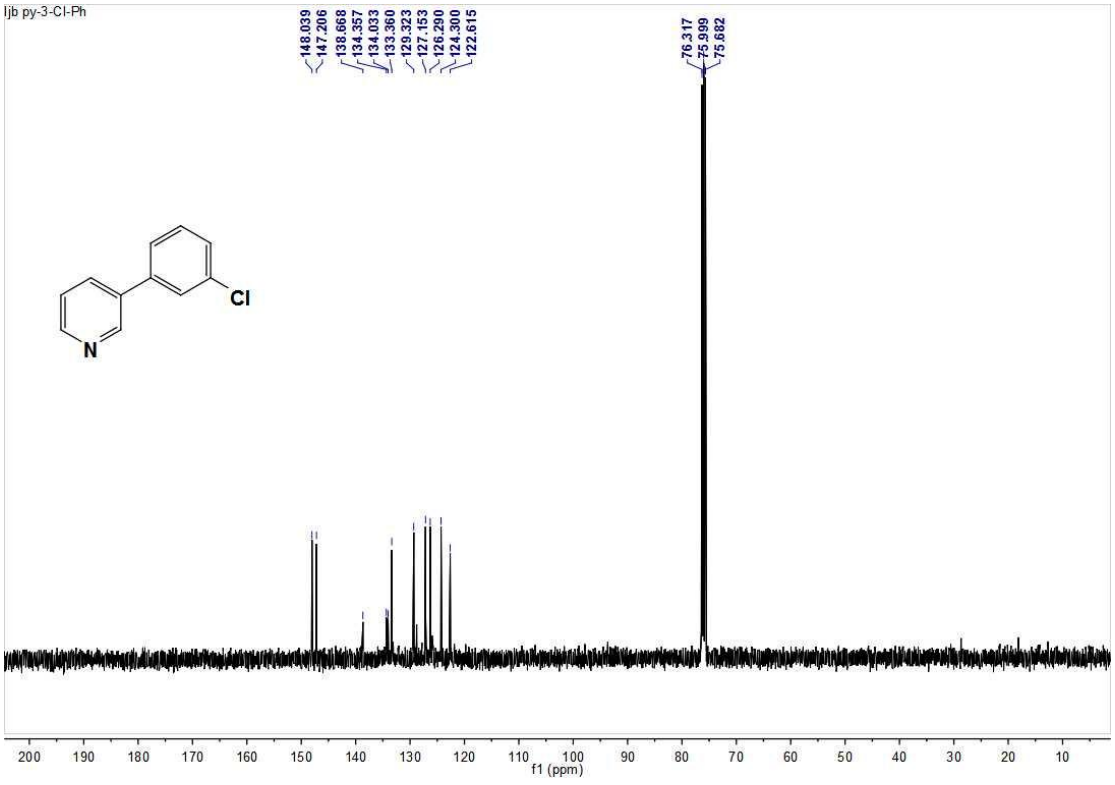

ljb py-o-MeO-Ph
8.775
8.563
8.552
7.876
7.858
7.405
7.384
7.365
7.352
7.340
7.321
7.272
7.091
7.073
7.054
7.031
7.010
3.835
1.00
1.01
1.02
3.04
2.09
3.11
f1 (ppm)

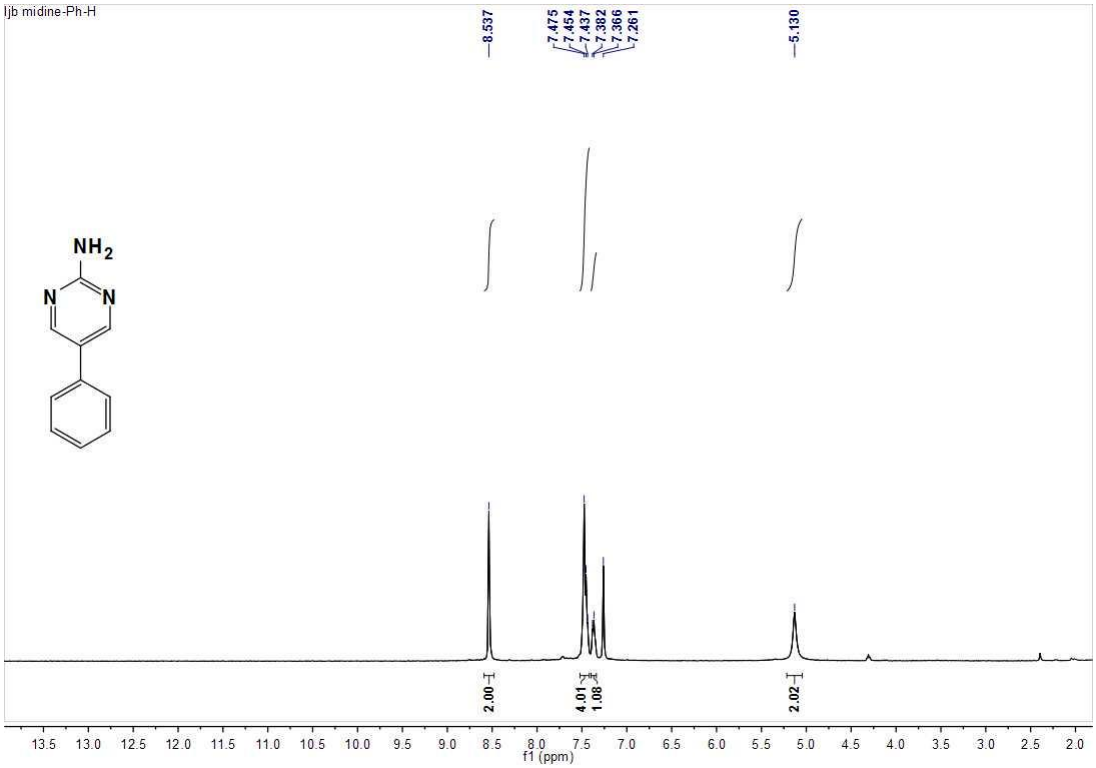

ljb py-o-MeO-Ph
156.580
150.258
147.902
136.797
134.220
130.650
129.539
127.058
122.865
121.048
111.297
77.336
77.018
76.701
55.519
f1 (ppm)

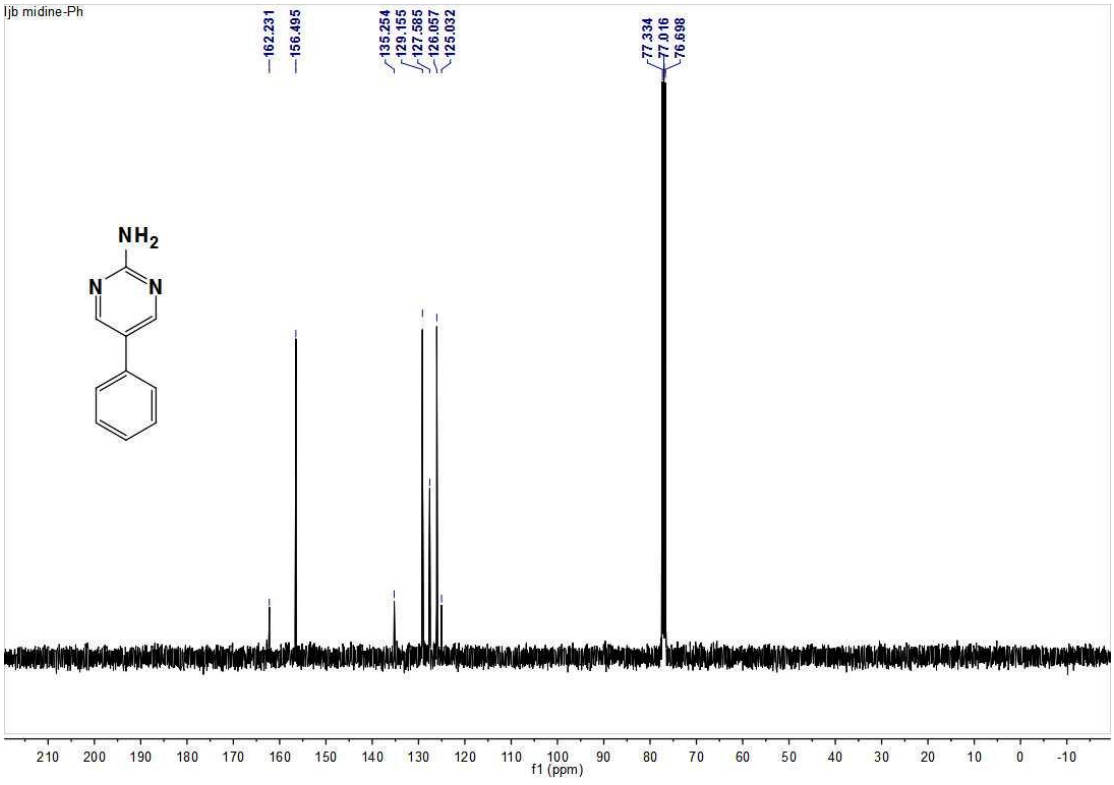

ljb 4-Cl-Ph-Py
8.82
8.81
8.61
8.60
7.85
7.85
7.83
7.83
7.52
7.50
7.46
7.44
7.39
7.37
7.37
7.35
7.26
Cl
N
1.00
1.00
1.08
2.07
2.02
1.06
f1 (ppm)

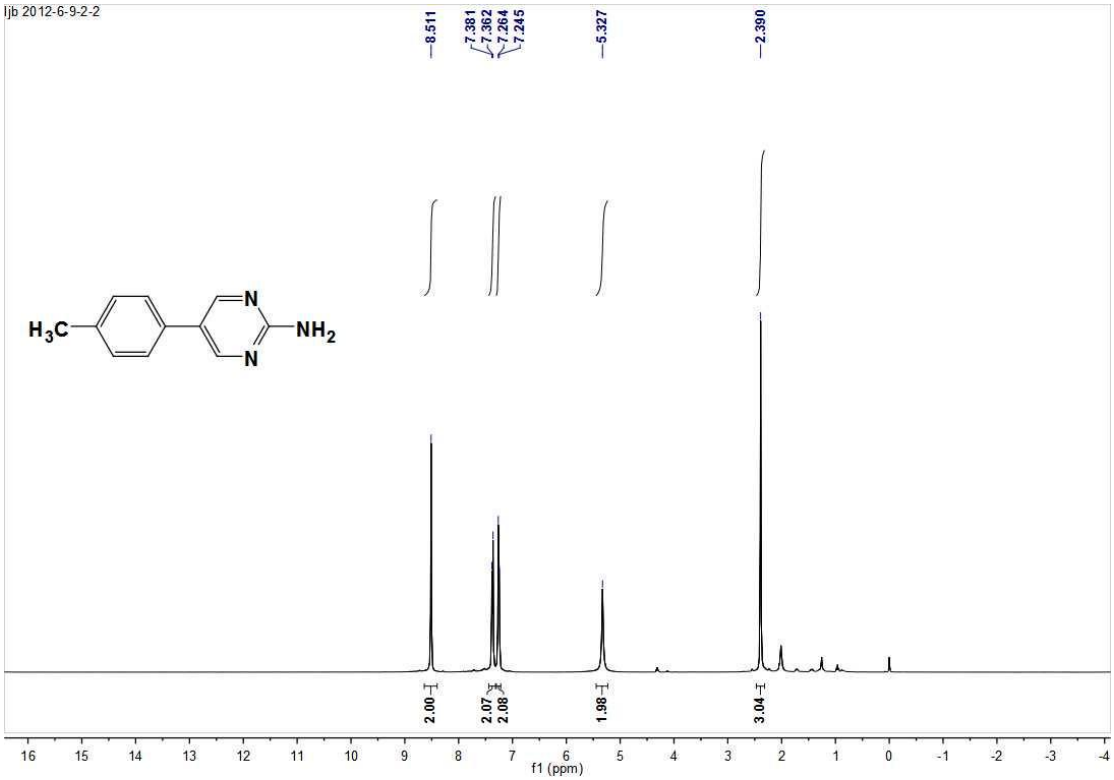

ljb 4-Cl-Ph-Py
148.77
148.11
136.28
135.52
134.40
134.20
129.29
128.39
123.61
77.33
77.01
76.69
Cl
N
f1 (ppm)

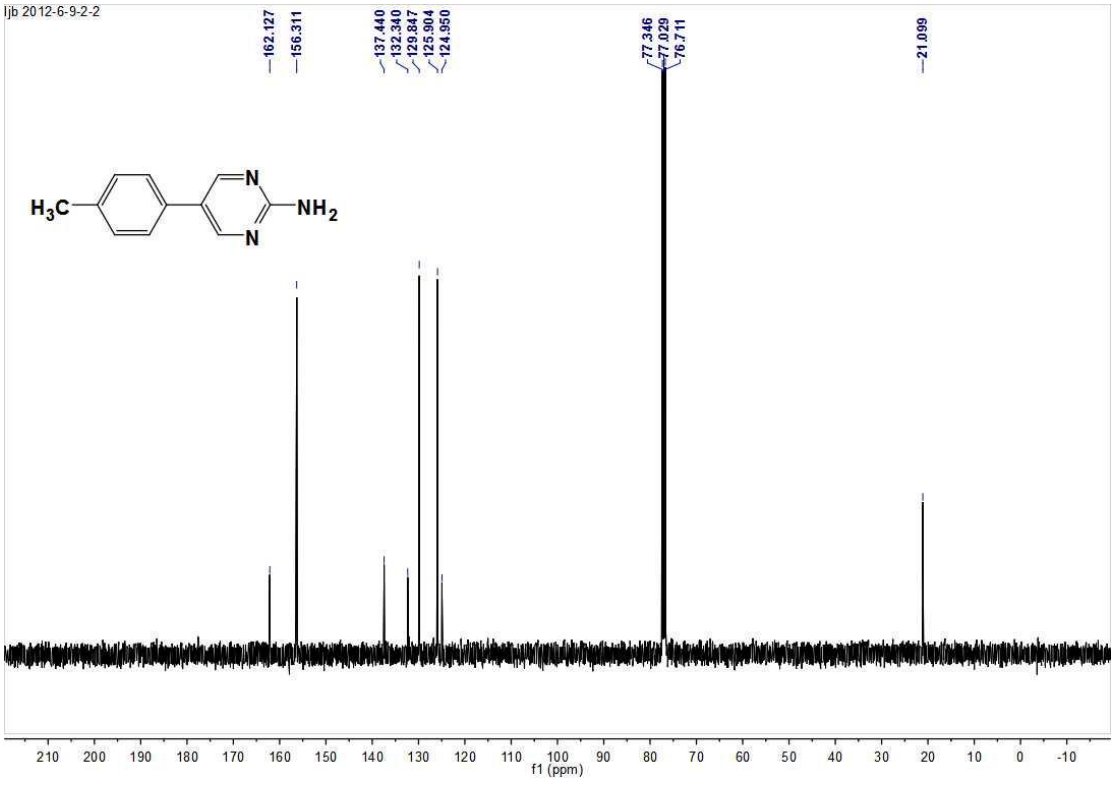

ljb py-3-Cl-Ph
8.705
8.699
8.506
8.503
8.494
8.491
7.745
7.741
7.736
7.725
7.721
7.717
7.450
7.445
7.441
7.354
7.350
7.337
7.333
7.329
7.313
7.294
7.276
7.271
7.265
7.262
7.255
7.242
1.610
Cl
N
1.00
1.02
1.02
1.01
4.04
f1 (ppm)

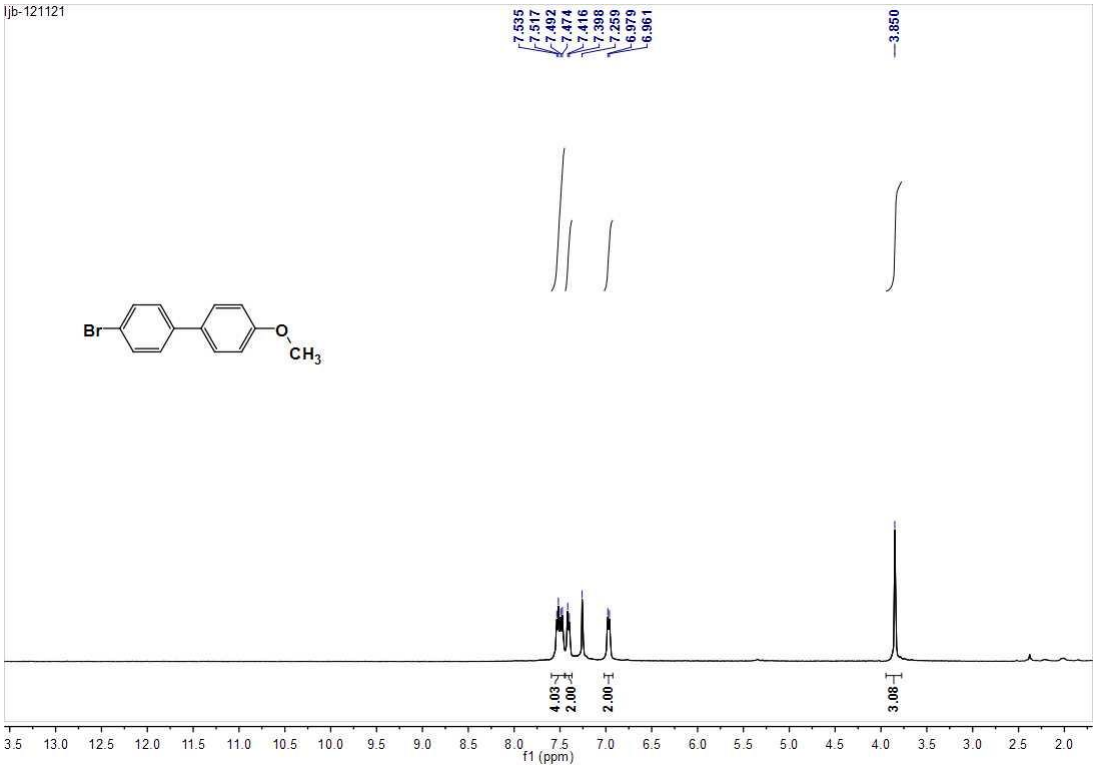

ljb py-3-Cl-Ph
148.039
147.206
138.668
134.357
134.033
133.360
129.323
127.153
126.290
124.300
122.615
76.317
75.999
75.682
Cl
N
f1 (ppm)

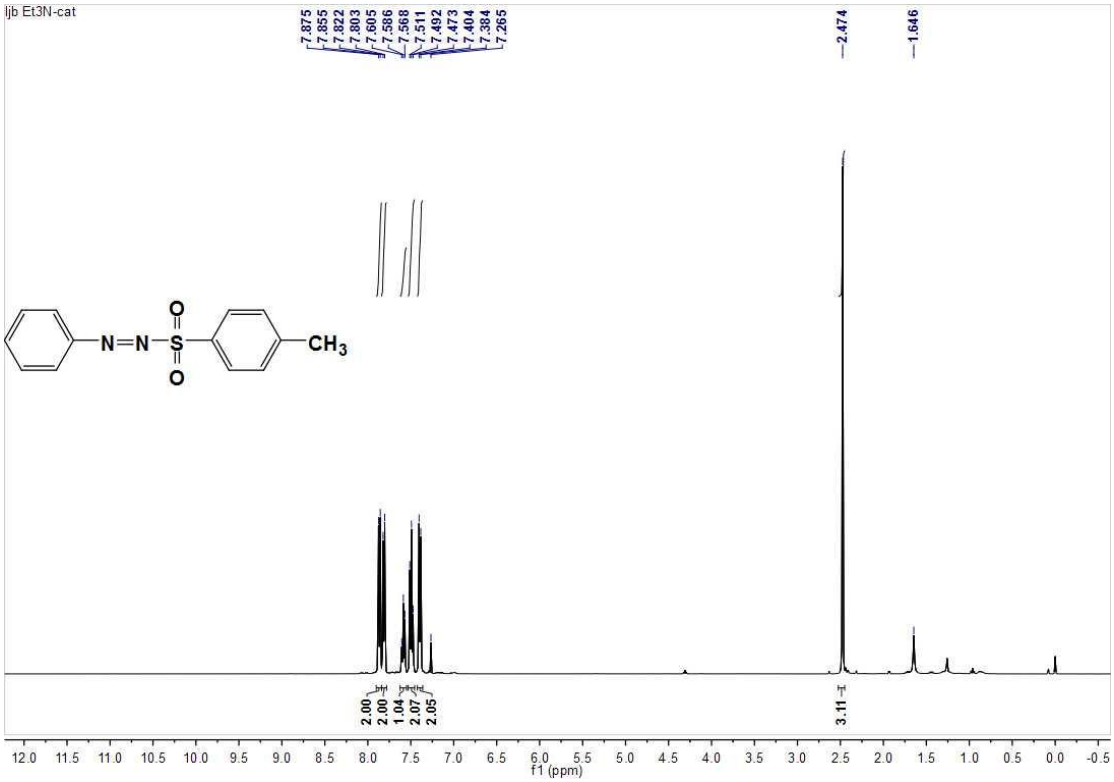

ljb midine-Ph-H
8.537
7.475
7.454
7.437
7.382
7.366
7.261
5.130
NH2
N
N
2.00
4.01
1.08
2.02
f1 (ppm)

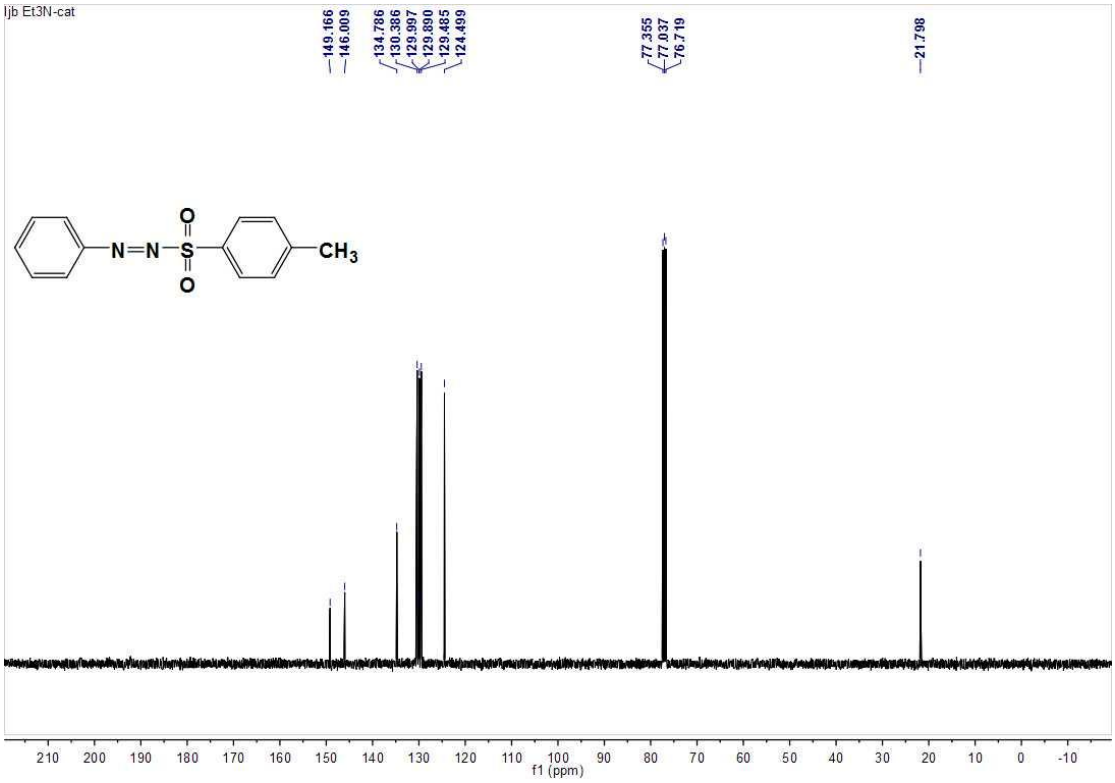

ljb midine-Ph
162.231
156.495
135.254
129.155
127.585
126.057
125.032
77.334
77.016
76.698
NH2
N
N
f1 (ppm)


ljb 2012-6-9-2-2
8.511
7.381
7.362
7.264
7.245
5.327
2.390
2.00
2.07
2.08
1.98
3.04
f1 (ppm)


ljb 2012-6-9-2-2
162.127
156.311
137.440
132.340
129.847
125.904
124.950
77.346
77.029
76.711
21.099
f1 (ppm)


ljb-121121
7.535
7.517
7.492
7.474
7.416
7.398
7.259
6.979
6.961
3.850
Br
O
CH3
4.03
2.00
2.00
3.08
f1 (ppm)


ljb Et3N-cat
7.875
7.855
7.822
7.803
7.605
7.586
7.568
7.511
7.492
7.473
7.404
7.384
7.265
2.474
1.646
N=N
S
O
O
CH3
2.00
2.00
1.04
2.07
2.05
3.11
f1 (ppm)


ljb Et3N-cat
149.166
146.009
134.786
130.386
129.997
129.890
129.485
124.499
77.355
77.037
76.719
21.798
N=N
S
O
O
CH3
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)