Electronic Supplementary Information

Aerobic Oxidative Coupling of Alcohols and Amines over Au-Pd/resin in Water: Au/Pd Molar Ratios Switch the Reaction Pathways to Amides or Imines

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1. General remarks

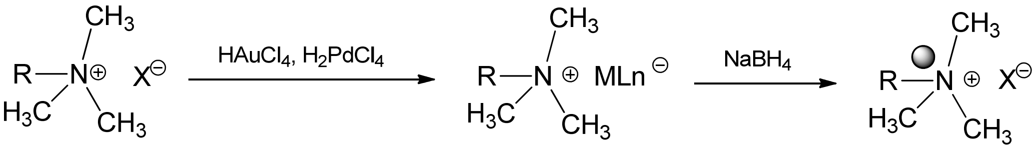
Reactions were carried out using commercially available reagents in over-dried apparatus. Reactions were monitored with analytical thin-layer chromatography (TLC) on silica gel 60 F_{254} plates and visualized under UV (254 nm) and/or by staining with $KMnO_4$. ^1H NMR spectra were recorded on commercial instruments (500 MHz). Chemical shifts were reported in ppm from tetramethylsilane with the solvent resonance as the internal standard ($CDCl_3$, $\delta = 7.26$). Spectra were reported as follows: chemical shift (δ ppm), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constants (Hz), integration and assignment. ^{13}C NMR spectra were collected on commercial instruments (125 MHz) with complete proton decoupling. Chemical shifts are reported in ppm from the tetramethylsilane with the solvent resonance as internal standard ($CDCl_3$, $\delta = 77.0$). The structures of the known compounds were confirmed by comparison with commercially available compounds or data shown in literature.

Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) was tested on an IRIS Intrepid Ⅱ XSP instrument (Thermo Electron Corp.). X-ray power diffraction (XRD) analysis was carried out on a PANalytical X'pert diffractometer using nickel-filtered Cu Kα radiation with a scanning angel (2θ) of 10^o-80^o, operated at 40kV and 40mA. HAADF-STEM was carried out with a Tecnai G2 Spirit (FEI) microscope operating at 200 kV. Prior to observations, powder sample of the catalyst was ultrasonicated in ethanol and dispersed on copper grids covered with a holey carbon film and dried at room temperature. Au and Pd core level spectra usually overlapped to each other in low binding energy region, which is difficult to distinguish them with lab XPS. To solve the problem, hard x-ray photoemission spectroscopy (HAXPES) was used to distinguish Au and Pd core level spectra in high binding energy region, since high excitation energy of several kilo-electronvolt can probe deeper core levels. The HAXPES characterization was performed using a SCIENTA R-4000 hemispherical electron energy analyzer at BL46XU of SPring-8 in Japan. The excitation energy used for HAXPES was monochromatized with Si (111) double crystal and Si (444) channel-cut monochromators. The photon energy and total energy resolution of the HAXPES measurements estimated from the Fermi edge of gold as a standard sample were 7938.95 eV and 235 meV, respectively. The composite samples were placed on a sample holder with a carbon conductive tape in an Ar-filled glove box. The sample holder was introduced into a load-lock chamber using a transfer vessel without air exposure. After reaching the pressure of the load-lock chamber to be $< 10^{-6}$ Torr, the samples were transferred to a measurement chamber. The base pressure of the measurement chamber was mainly kept to $\sim 5.0 \times 10^{-8}$ Torr during the measurements. In order to remove the charging effects on the samples, both an electron flood gun and a beam attenuator were used. The binding energy of cared core levels were calibrated with careful measurement of C 1s spectra.

Aqueous solutions of $HAuCl_4$ with mass concentration of 9.56 mg_{Au}/mL and H_2PdCl_4 with concentration of 12.00 mg_{Pd}/mL were prepared. The water used in this study was deionized by milli-Q Plus system, having 18.2 MΩ electrical resistivity.

Unless otherwise noted, materials obtained from commercial suppliers were used without further purification.

2. Preparation of Au-Pd/resin catalyst



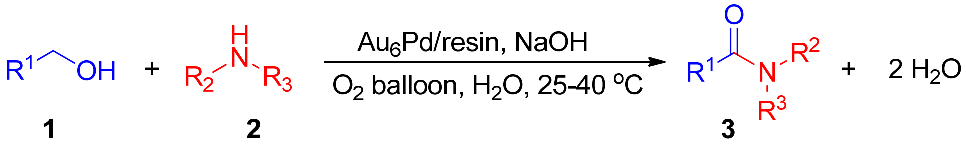
717# anion exchange resin was washed by water several times until the washed water became clean. After dried at 60 °C, the recovered resin was crushed with a ball mill at 250 rpm for 1 h and was sieved, particles between 100 mesh and 180 mesh were used as catalyst support. The support resin was soaked sequentially in 1.0 mol/L NaOH, 1.0 mol/L HNO_3, 1.0 mol/L NaOH for 8 h, and then soaked in 2.0 mol/L K_2CO_3 solution for 24 h. The resin was then filtered and washed with water until the filtrate was neutral and then dried under vacuum at 60 °C for 12 h.

Anion-exchange resin supported Au-Pd nanoparticles were prepared with anion exchange-$NaBH_4$ reduction method. Specifically, 1.92 mL 9.56 mg_{Au}/mL $HAuCl_4$ solution and 0.14 mL 12.00 mg_{Pd}/mL H_2PdCl_4 were added to 200 mL water, followed by addition of 1.0 g support and stirred for 2 h under dark. The mixture was filtered and washed with 300 mL water before re-dispersion in 30.0 mL water, and followed by addition of 15.0 mL $NaBH_4$ (10.0 equiv) solution. The mixture turned immediately from orange to dark brown. After being stirred under dark for another 0.5 h, the catalyst was filtered and washed with plentiful water until no Cl^- was detected and then dried at 60 °C for 8 h under vacuum. The prepared catalyst was denoted as Au_6Pd/resin. Catalysts with different Au/Pd molar ratios were synthesized with the same method except for different volume of precursor solutions. For all the catalysts with different Au/Pd molar ratios, the total metal loading determined by ICP-AES was 2.0 wt%. The ICP-AES results are shown in Table S1.

Table S1. Chemical compositions of the Au-Pd/resin catalysts

Sample	Nominal loading(%)		Actual loading(%)		Au/Pd (molar ratio)
	Au	Pd	Au	Pd	
Au	2.0	—	1.99	—	—
$Au_{10}Pd$	1.89	0.10	1.88	0.10	10.2
Au_6Pd	1.84	0.17	1.82	0.16	6.1
Au_2Pd	1.58	0.43	1.57	0.41	2.1
$AuPd_2$	0.97	1.04	0.96	0.97	1.9
$AuPd_4$	0.63	1.37	0.63	1.29	3.8

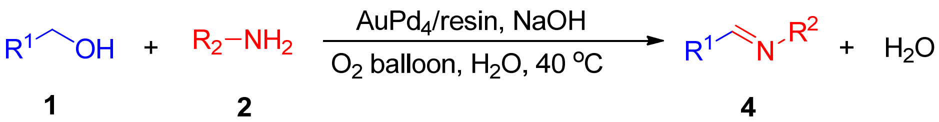
3. General procedure for amidation over Au_6Pd/resin.



Unless otherwise noted, reactions were carried out as following: a mixture of alcohol **1** (1.00 mmol, 2.0 equiv), amine **2** (0.50 mmol, 1.0 equiv), sodium hydroxide (0.55 mmol in 1.0 mL H_2O, 1.1 equiv) and Au_6Pd/resin (90 mg, 2 mol%) were vigorously stirred at 40 °C for 12 h under oxygen balloon. After cooling down to room temperature, the catalyst was separated by filtration and washed with ethyl acetate (15.0 mL). After adding 10.0 mL H_2O, the filtrate was extracted with ethyl acetate (3 x 15.0 mL). The combined organic layer was washed by saturated NaCl solution and dried over anhydrous magnesium sulfate and the solvent was removed under vacuum. The residue was purified by flash chromatography on a short silica gel (eluent: petroleum ether/ethyl acetate = 10:1, 2:1, or 1:1) to afford the corresponding amide **3**.

The amount of Au-Pd/resin catalyst employed in the reaction was calculated based on the total moles of the two metals (Au+Pd). Take Au_6Pd/resin for example, for 1.0 g Au_6Pd/resin catalyst, the total moles of the two metals were calculated as follows: 1 g * 1.82 wt% / 197.0 g/mol + 1 g * 0.16 wt% / 106.4 g/mol = 0.107 mmol. For 0.5 mmol substrate, the weight of Au_6Pd/resin was 0.5 mmol * 2% / 0.107 mmol/g = 0.093 g.

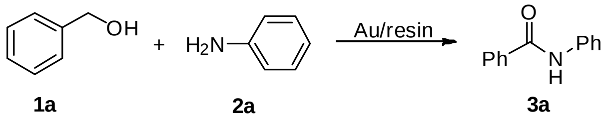
4. General procedure for imination over $AuPd_4$/resin.



Unless otherwise noted, imination reactions were carried out as following: a mixture of alcohol **1** (0.75 mmol), amine **2** (0.50 mmol), sodium hydroxide (0.75 mmol in 1.0 mL H_2O) and $AuPd_4$/resin (93 mg, 3 mol%) were vigorously stirred at 40 °C for 12 h under oxygen balloon. After cooling down to room temperature, the catalyst was separated by filtration and washed with ethyl acetate (15.0 mL). After adding 10.0 mL H_2O, the filtrate was extracted with ethyl acetate (3 x 15.0 mL). The combined organic layer was washed by saturated NaCl solution and dried over anhydrous magnesium sulfate and the solvent was removed under vacuum. The residue was purified by flash chromatography on a short silica gel (eluent: petroleum ether/ethyl acetate/triethylamine = 10:1:0.1) to afford the corresponding imine **4**.

5. Detailed optimization of reaction conditions and catalyst.

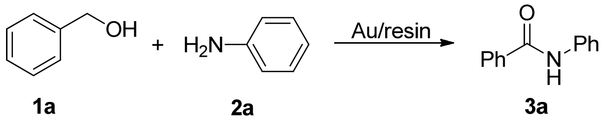
Table S2. Optimization of base for oxidative coupling of benzyl alcohol and aniline over Au/resin.



Entry[a]	**1a** : **2a** (equiv)	Base	T (°C)	t (h)	Yield of **3a** (%)[b]
1	2:1	KOH	25	2	53
2	**2:1**	**NaOH**	**25**	**2**	**53**
3	2:1	K_2CO_3	25	2	6
4	2:1	Na_2CO_3	25	2	7
5	2:1	LiOH	25	2	50
6	2:1	$(NH_4)_2CO_3$	25	2	2

[a] Reaction conditions: **2a** (1.1 mmol), **1a** (2.2 mmol), base (1.2 mmol), Au/resin (46 mg, 0.45 mol%), 2 mL H_2O, O_2 balloon, 25 °C, 2 h. [b] Determined by GC using 1,3,5-trimethylbenzene as an internal standard.

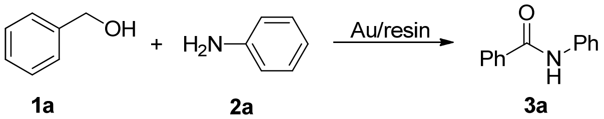
Table S3. Optimization of substrate ratios for oxidative coupling of benzyl alcohol and aniline over Au/resin.



Entry[a]	**1a** : **2a** (equiv)	T (°C)	t (h)	Yield of **3a** (%)[b]
1	**2:1**	**25**	**2**	**53**
2	1.5:1	25	2	51
3	1:1	25	2	48
4	1:1.5	25	2	45
5	1:2	25	2	44

[a] Reaction conditions: **2a**, **1a**, NaOH (2.2 mmol), Au/resin (46 mg, 0.45 mol%), 2 mL H_2O, O_2 balloon, 25 °C, 2 h, 1 equiv = 1.1 mmol. [b] Determined by GC using 1,3,5-trimethylbenzene as an internal standard.

Table S4. Optimization of the amount of NaOH and H_2O for oxidative coupling of benzyl alcohol and aniline over Au/resin.

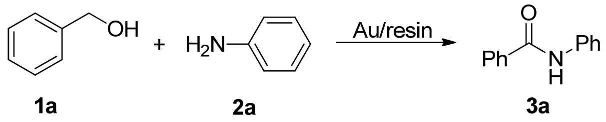


Entry[a]	Base (equiv)	H_2O (mL)	Yield of **3a** (%)[b]
1	NaOH (2.2)	2	46
2	NaOH (0.8)	2	50

3	NaOH (0.55)	2	28
4	NaOH (0)	2	0
5	NaOH (1.1)	1	41
6	**NaOH (1.1)**	**2**	**53**
7	NaOH (1.1)	3	40
8	NaOH (1.1)	5	44

[a] Reaction conditions: **2a** (1.1 mmol), **1a** (2.2 mmol), NaOH, Au/resin (45 mg , 0.45 mol%), H_2O, O_2 balloon, 25 °C, 2 h, 1 equiv=1.1 mmol. [b] Determined by GC using 1,3,5-trimethylbenzene as an internal standard.

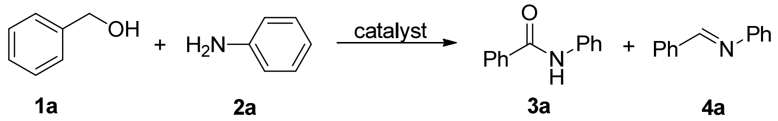
Table S5. Optimization of reaction temperature, and reaction atmosphere for oxidative coupling of benzyl alcohol and aniline over Au/resin.



Entry[a]	T(°C)	Cat. (mol%)	t (h)	Atmosphere	Solvent	Yield of **3a** (%)[b]
1	25	0.45	6	air	H_2O	59
2	25	0.45	2	Ar	H_2O	No reaction
3	**40**	**0.45**	**2**	**O_2**	**H_2O**	**61**
4	50	0.45	2	O_2	H_2O	58

[a] Reaction conditions: **2a** (1.1mmol), **1a** (2.2 mmol), NaOH (1.2 mmol), Au/resin (45 mg, 0.45 mol%), 2 mL H_2O, O_2 balloon. [b] Determined by GC using 1,3,5-trimethylbenzene as an internal standard.

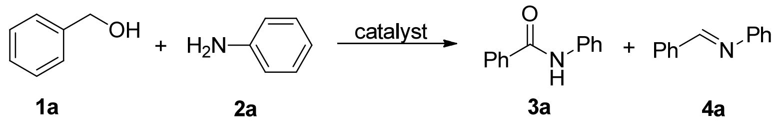
Table S6. Optimization of the catalysts for oxidative coupling of benzyl alcohol and aniline.



Entry[a]	Catalysts	Conversion (%)[c]	Selectivity (%)[c]	
			3a	**4a**
1	Au/resin	47	93	6
2	$Au_{10}Pd$/resin	63	91	8
3	**Au_6Pd/resin**	**77**	**97**	**2**
4	Au_2Pd/resin	51	71	28
5[b]	AuPd/resin	75	77	22
6[b]	$AuPd_2$/resin	60	32	67
7[b]	$AuPd_4$/resin	42	5	94
8[b]	Pd/resin	16	0	99

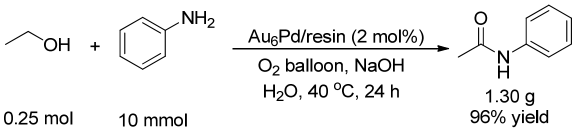
[a] Reaction conditions: **2a** (1.1mmol), **1a** (2.2 mmol), NaOH (1.2 mmol), catalyst (0.45 mol%), 2 mL H_2O, O_2 balloon, 25 °C, 2 h. [b] **1a** (1.0 mmol), **2a** (0.5 mmol), catalyst (2 mol%), 1 mL H_2O, 5 h. [c] Determined by GC using 1,3,5-trimethylbenzene as an internal standard.

Table S7. Optimized reaction conditions for amidation and imination.



Entry	**1a** : **2a** (mmol)	Catalyst	NaOH (mmol)	T (°C)	t (h)	Atmosphere	H_2O (mL)	Isolated yield (%)	
								3a	**4a**
1	1.0:0.5	Au_6Pd/resin (2 mol%)	0.55	40	12	O_2 balloon	1	91	—
2	0.75:0.5	$AuPd_4$/resin (3 mol%)	0.55	40	12	O_2 balloon	1	—	80

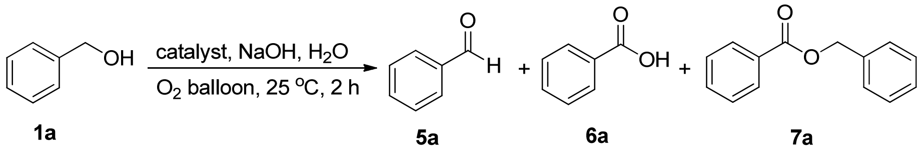
6. Gram-scale experiment.



Scheme S1. Gram-scale experiment of amidation with aniline and ethanol over Au_6Pd/resin.

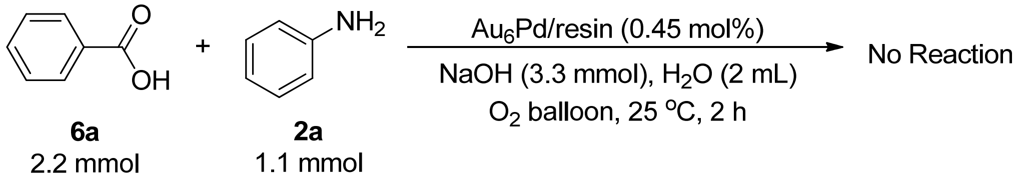
7. Control experiments

Table S8. Oxidation of benzyl alcohol over different catalysts.

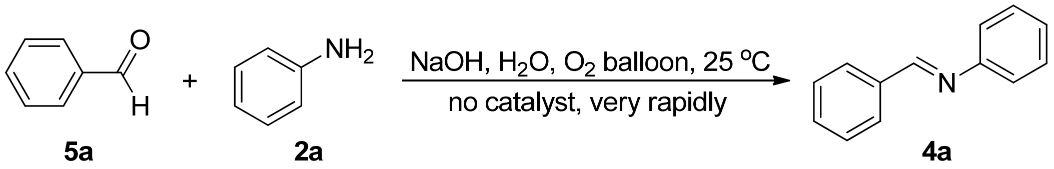


Catalysts	Conversion(%)[b]	Selectivity(%)[b]		
		5a	**6a**	**7a**
Au/resin	95	3	65	32
Au_6Pd/resin	>99	0	60	40
$AuPd_2$/resin	>99	13	68	19
Pd/resin	40	24	74	2

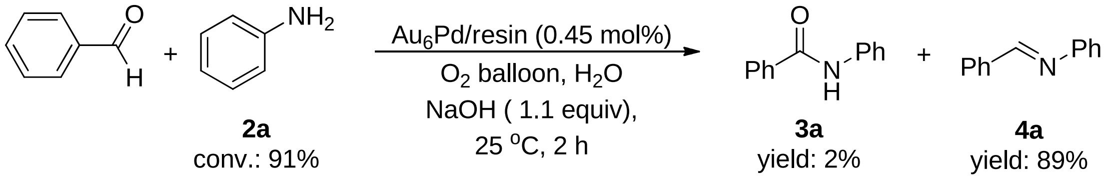
[a] Reaction conditions: **1a** (1.0 mmol), NaOH (1.1 mmol), H_2O (2 mL), O_2 balloon, 25 °C, 2 h. [b] Determined by GC using 1,3,5-trimethylbenzene as an internal standard.



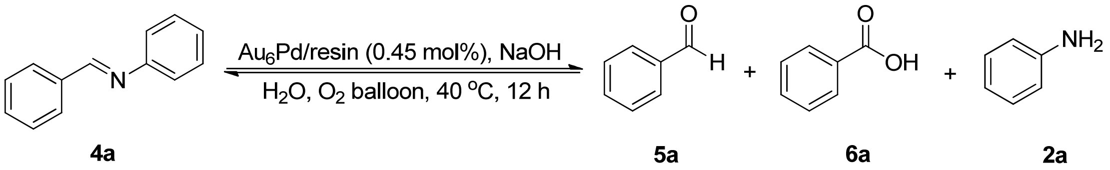
Scheme S2. The reaction from benzoic acid and aniline over Au_6Pd/resin.



Scheme S3. The reaction from benzaldehyde and aniline without Au-Pd/resin.



Scheme S4. The reaction from benzaldehyde and aniline over Au_6Pd/resin.

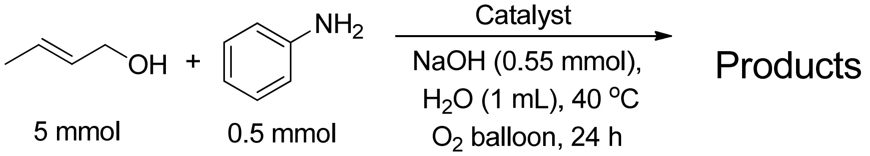


Scheme S5. The reaction of N-benzylideneaniline over Au_6Pd/resin.

The coupling reaction of benzoic acid and aniline did not proceed over Au_6Pd/resin at all. Benzaldehyde condensed rapidly with aniline to yield N-benzylideneaniline without Au_6Pd/resin while accompanied by little of *N*-phenylbenzamide when Au6Pd/resin was added. The condensation reaction of benzaldehyde and aniline is reverse. Using Au6Pd/resin as a catalyst, the *N*-benzylideneaniline **4a** decomposed into benzaldehyde **5a**, benzoic acid **6a**, aniline **2a**, and the amide **3a** was not detected.

8. Control experiments with 2-buten-1-ol and aniline as the substrates.

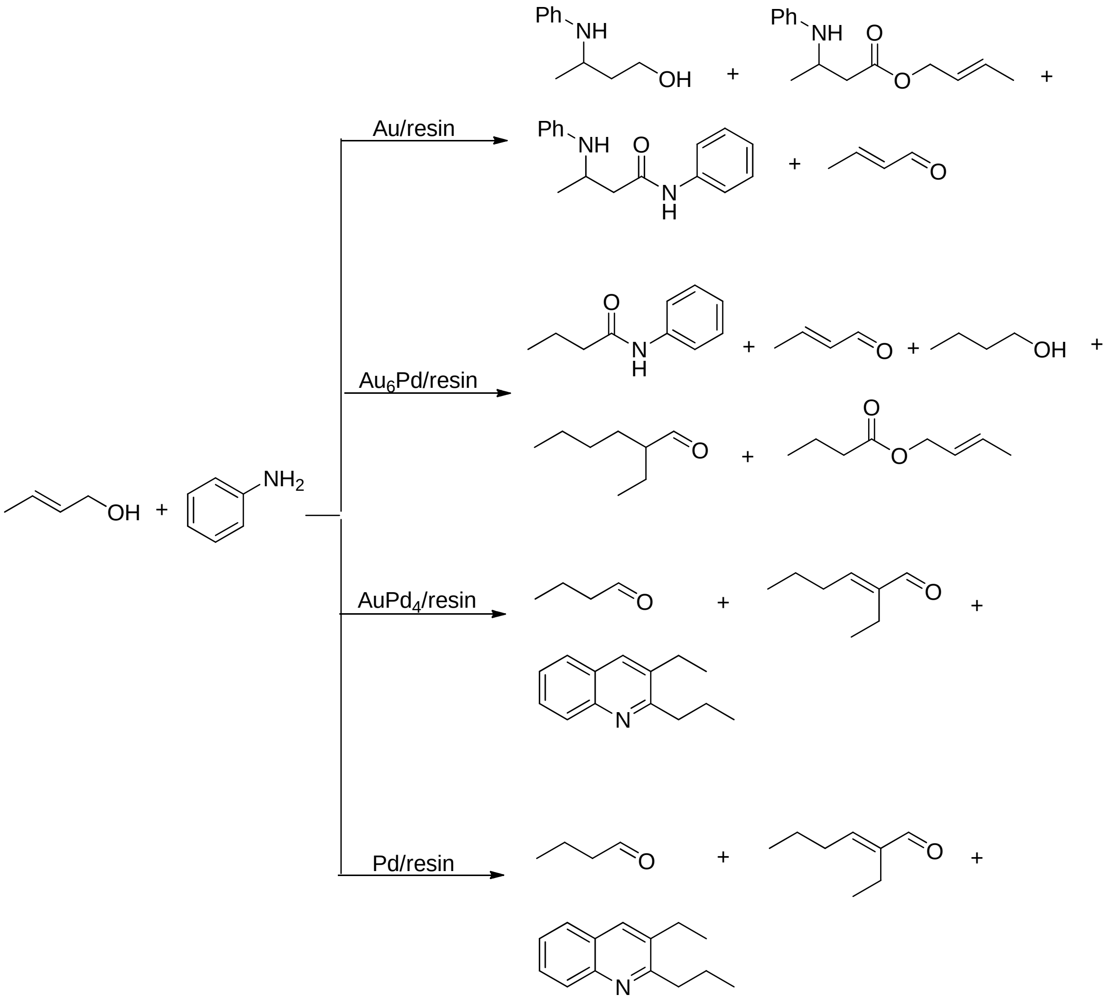
Table S9. Oxidation coupling of 2-buten-1-ol and aniline over different catalysts.



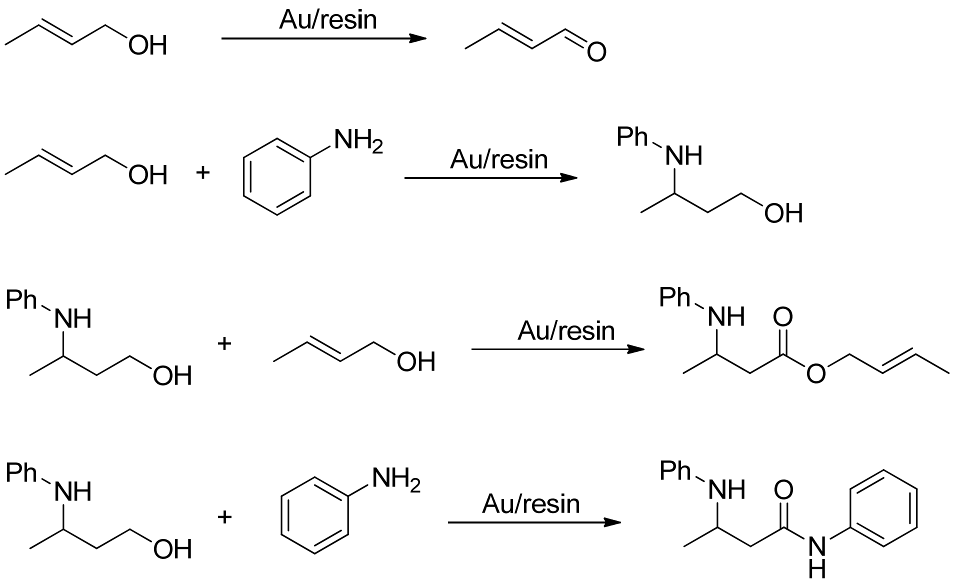
Catalysts	Au/resin	Au_6Pd/resin	$AuPd_4$/resin	Pd/resin
Conversion(%)[a]	>99	>99	89	88

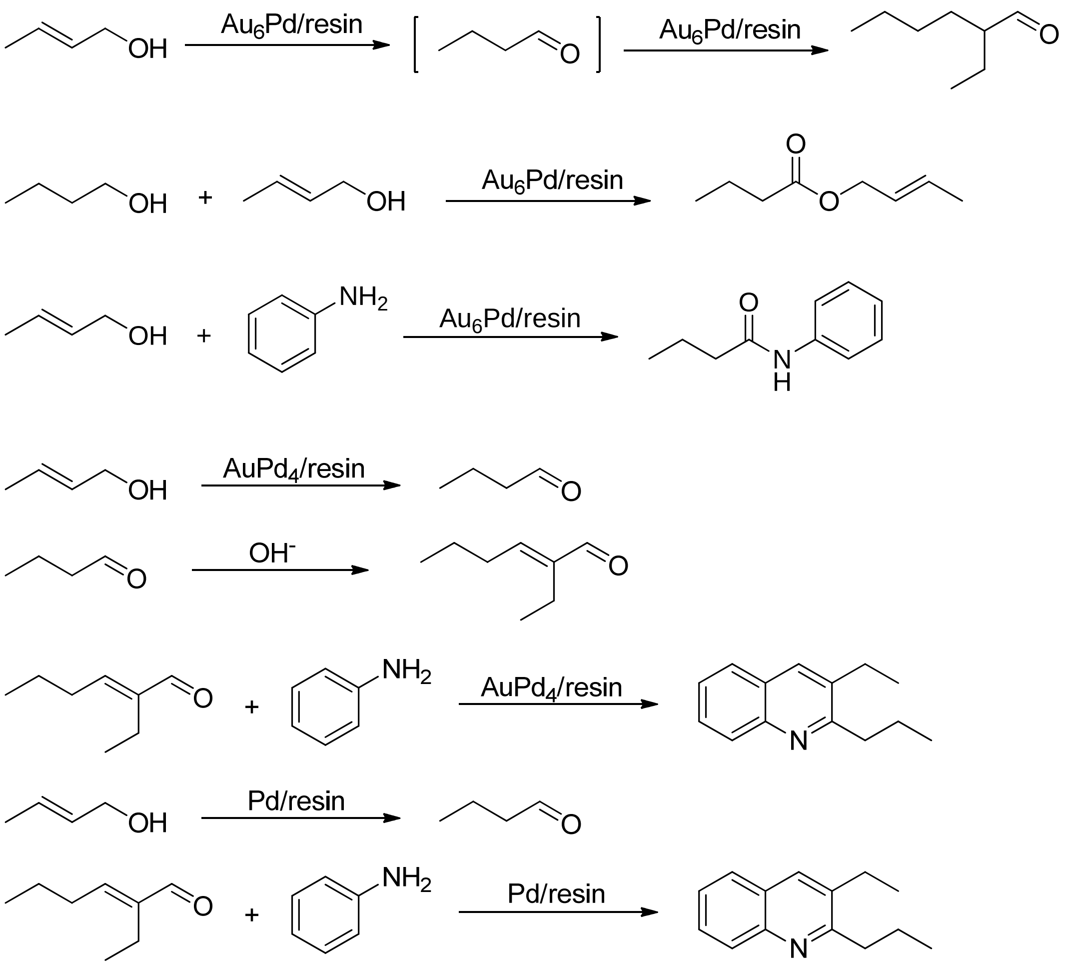
[a] Determined by GC using 1,3,5-trimethylbenzene as an internal standard and calculated based on aniline.

Products of oxidation coupling of 2-buten-1-ol and aniline over different catalyst:



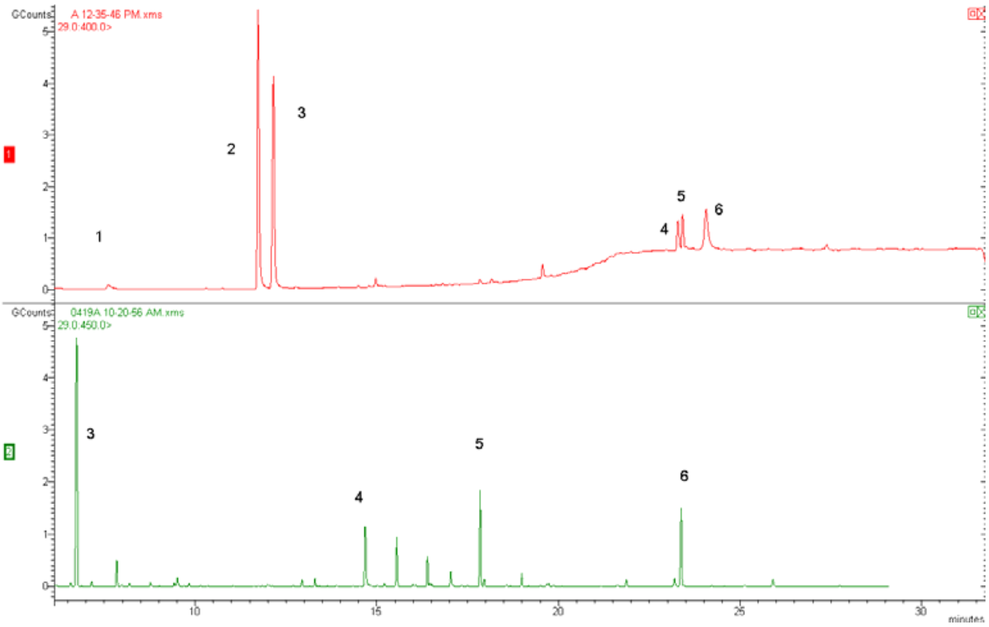
Possible reaction pathways:





GC-MS spectra of the crude reaction mixtures:

(a) Au/resin



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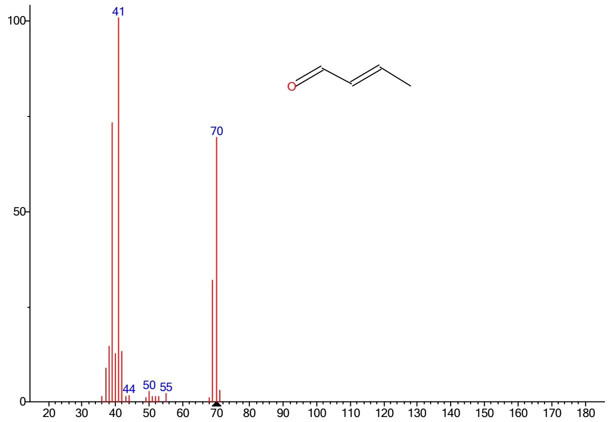
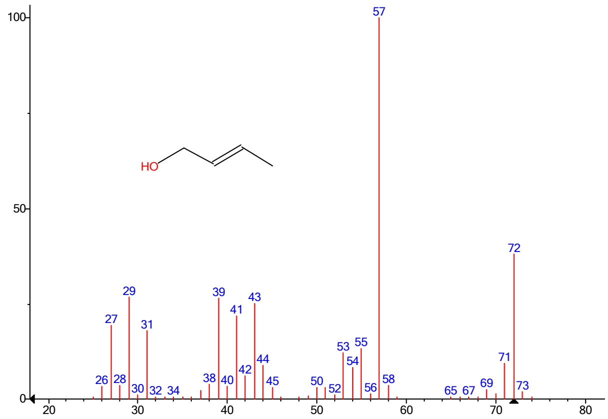


CAS# 123-73-9 (replib) 2-Butenal, (E)-

2



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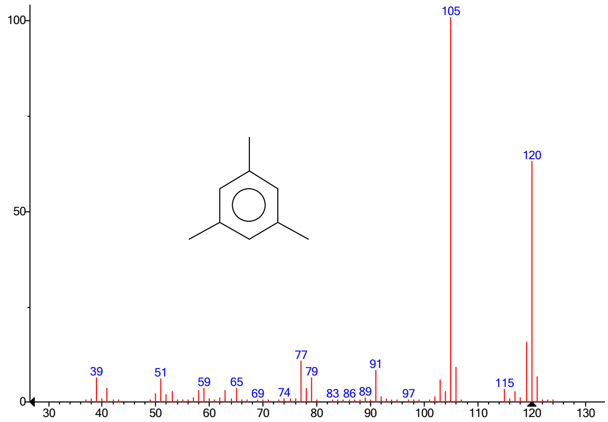

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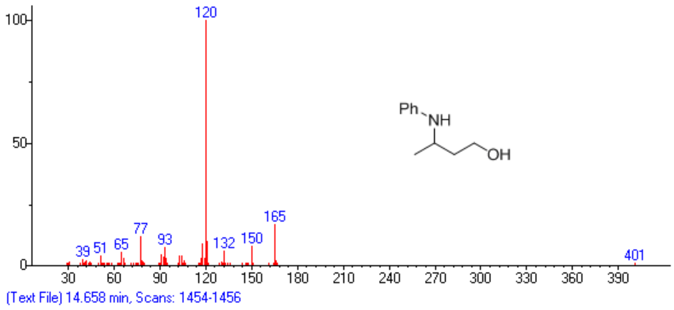
4



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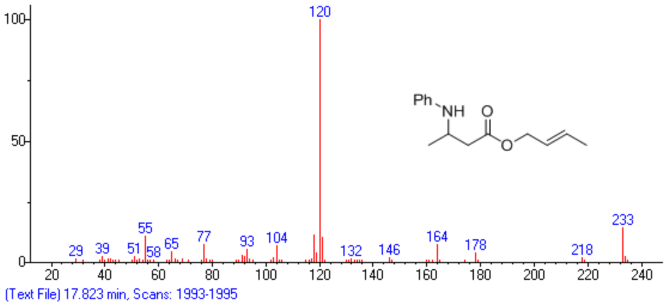

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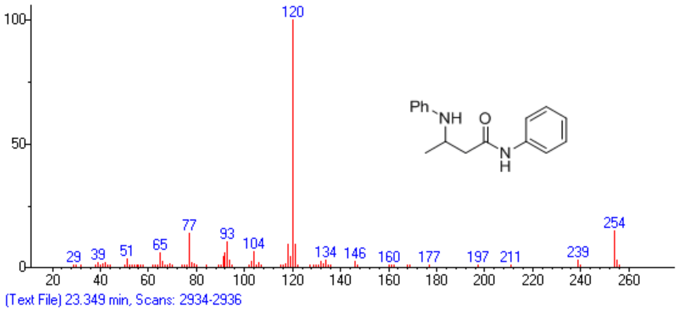
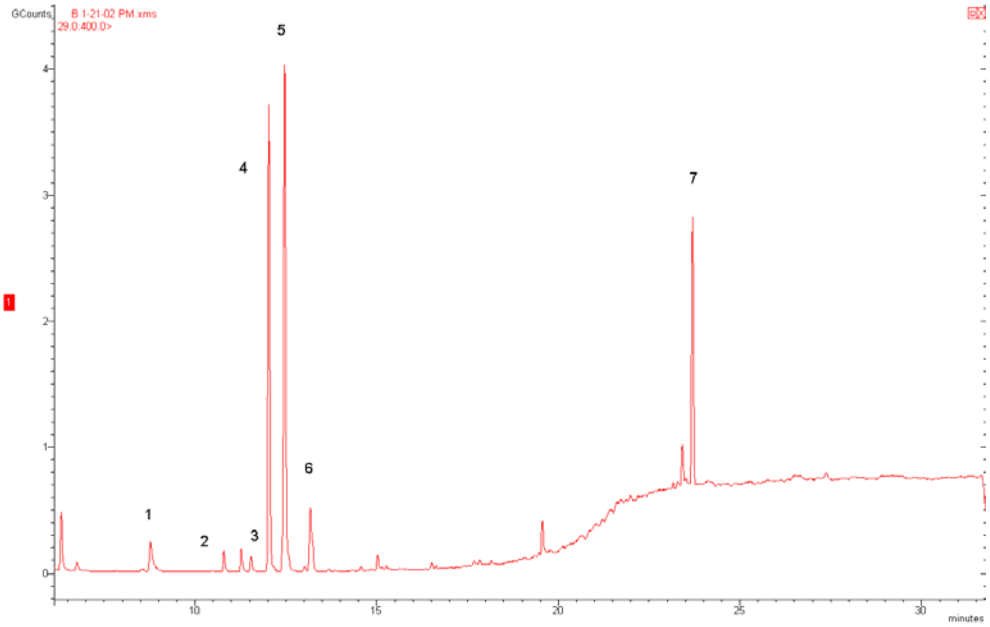


(b) Au_6Pd/resin



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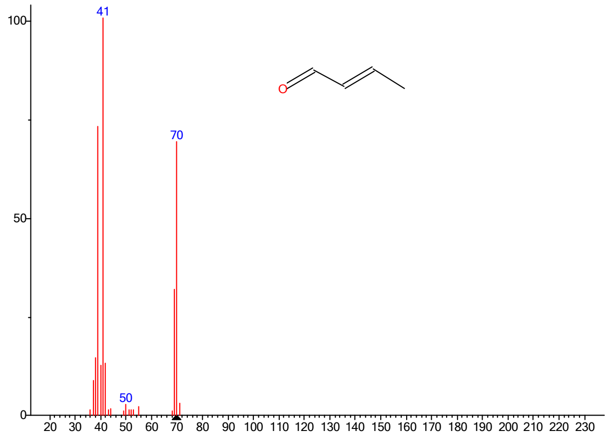

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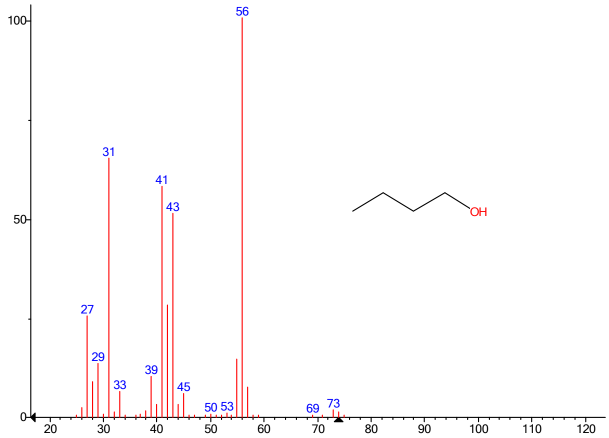

CAS# 71-36-3 (replib) 1-Butanol

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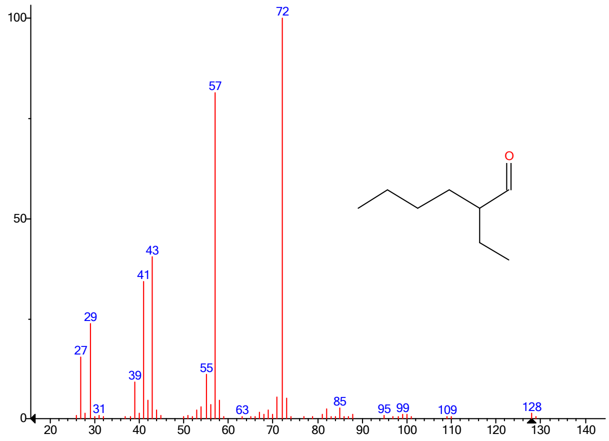

CAS# 123-05-7 (replib) Hexanal, 2-ethyl-

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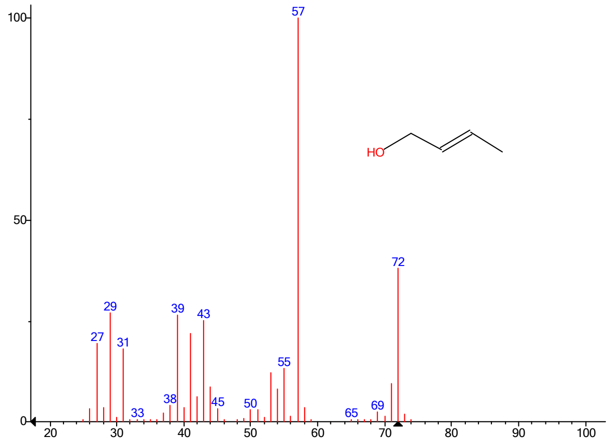

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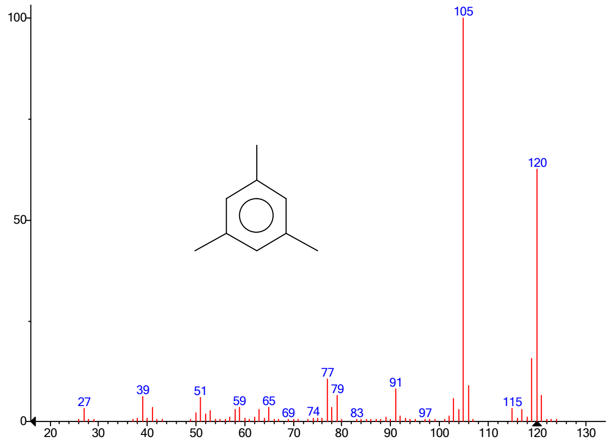
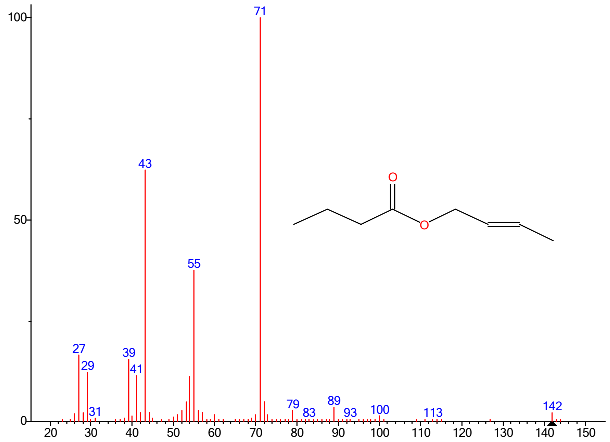
5



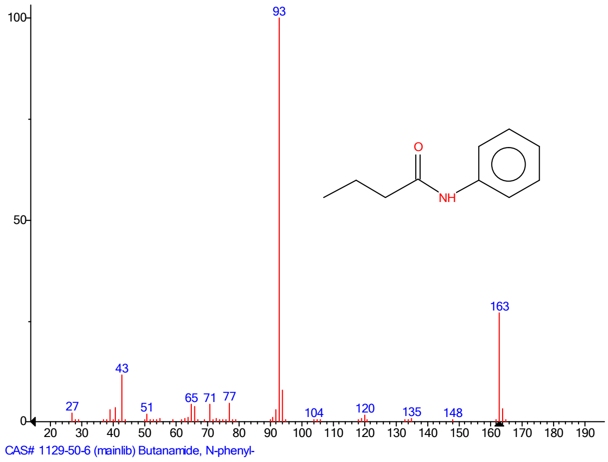
CAS# 108-67-8 (replib) Benzene, 1,3,5-trimethyl-

6

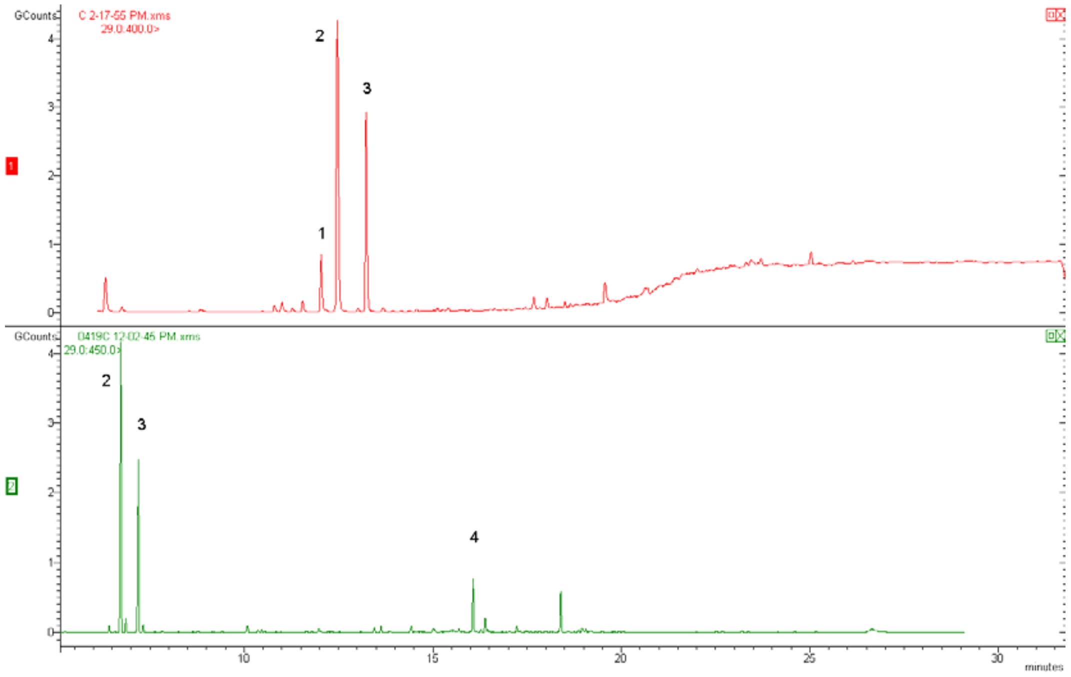


CAS# 20279-26-9 (mainlib) Butyric acid, crotyl ester

7



(c) $AuPd_4$/resin



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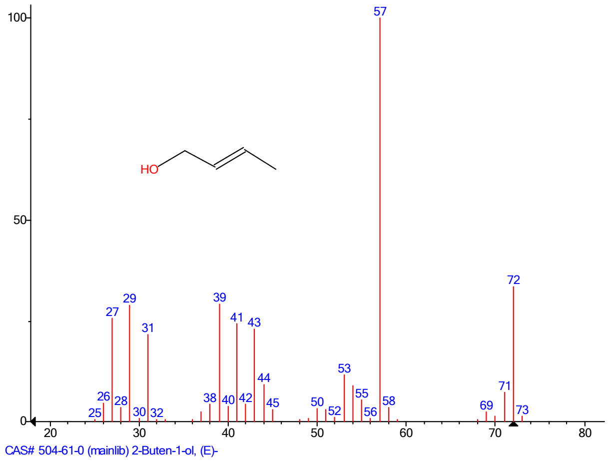

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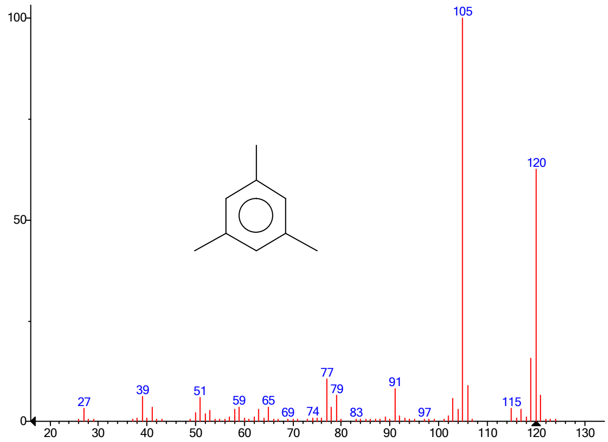
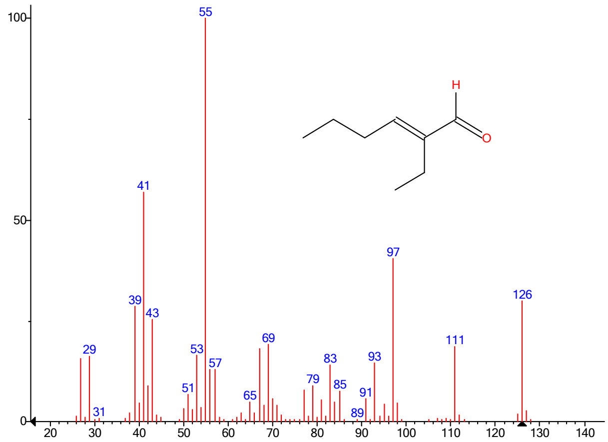


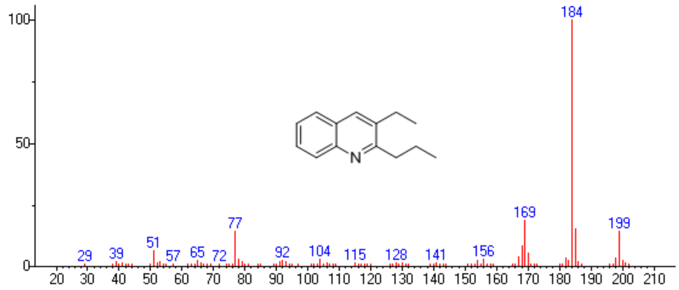
CAS# 108-67-8 (replib) Benzene, 1,3,5-trimethyl-

3



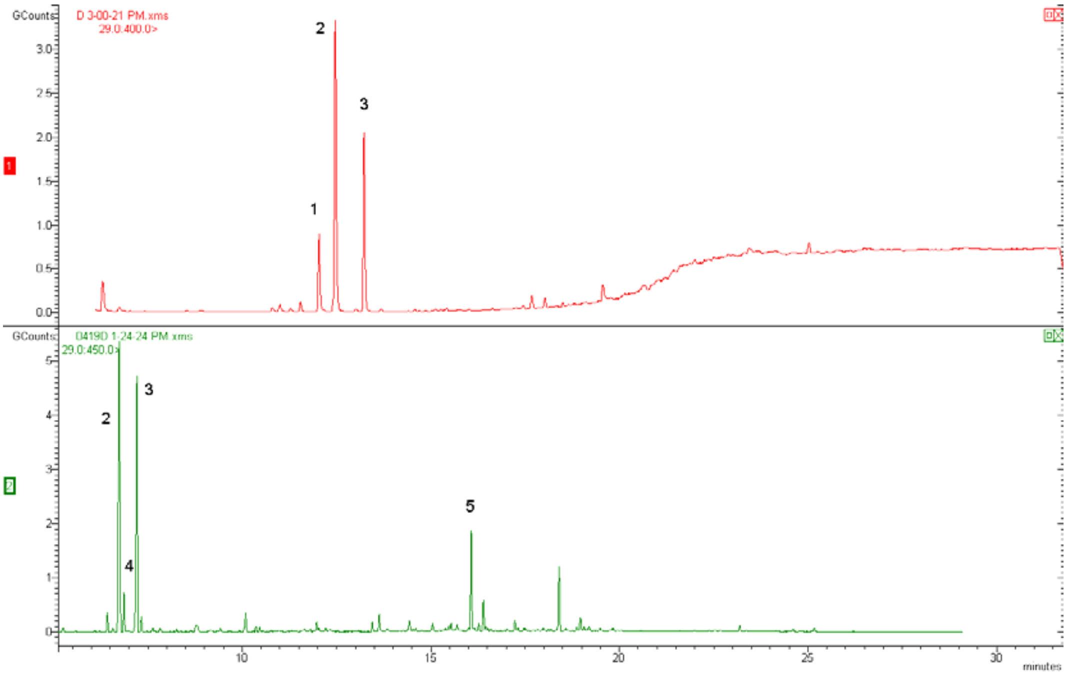
CAS# 26266-68-2 (mainlib) Hexenal, 2-ethyl-

4



(Text File) 16.056 min, Scans: 1863-1865

(d) Pd/resin



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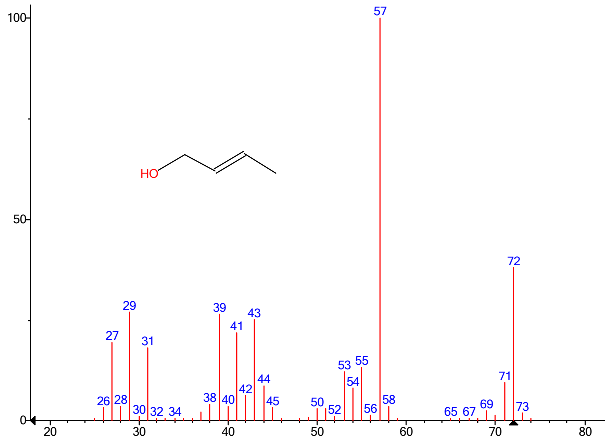
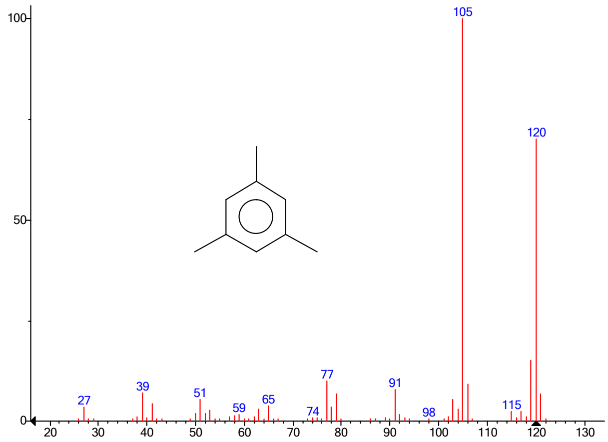


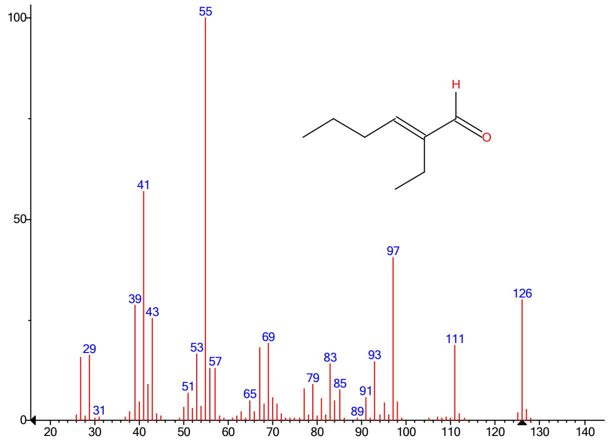
CAS# 6117-91-5 (replib) 2-Buten-1-ol

2



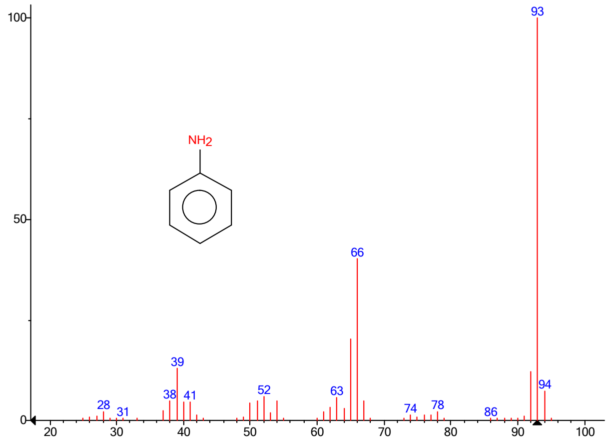
CAS# 108-67-8 (mainlib) Benzene, 1,3,5-trimethyl-

3



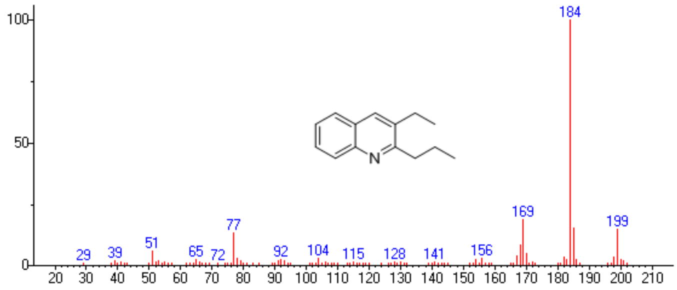
CAS# 26266-68-2 (mainlib) Hexenal, 2-ethyl-

4



CAS# 62-53-3 (mainlib) Aniline

5



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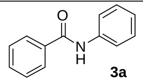
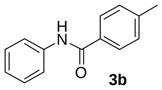
9. Identification of the obtained products by NMR:



3a

Chemical Formula: $C_{13}H_{11}NO$
Exact Mass: 197.0841

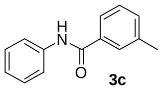
***N*-phenylbenzamide 3a:** The reaction was carried out according to the general procedure with phenylmethanol (108.0 mg, 1.0 mmol, 2.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv). The product was obtained as a white solid (89.5 mg, 91% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.90 (s, 1H), 7.86 (d, *J* = 7.3 Hz, 2H), 7.64 (d, *J* = 7.9 Hz, 2H), 7.54 (t, *J* = 7.4 Hz, 1H), 7.47 (t, *J* = 7.5 Hz, 2H), 7.36 (t, *J* = 7.8 Hz, 2H), 7.15 (t, *J* = 7.4 Hz, 1H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 165.90, 138.07, 135.16, 131.97, 129.23, 128.92, 127.16, 124.71, 120.36 ppm.



3b

Chemical Formula: $C_{14}H_{13}NO$
Exact Mass: 211.0997

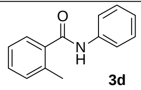
4-methyl-*N*-phenylbenzamide 3b: The reaction was carried out according to the general procedure with *p*-tolylmethanol (122.1 mg, 1.0 mmol, 2.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv). The product was obtained as a white solid (100.8 mg, 96% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.89 (s, 1H), 7.76 (d, *J* = 7.8 Hz, 2H), 7.63 (d, *J* = 8.1 Hz, 2H), 7.35 (t, *J* = 7.7 Hz, 2H), 7.25 (d, *J* = 7.8 Hz, 2H), 7.13 (t, *J* = 7.4 Hz, 1H), 2.41 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 165.85, 142.47, 138.19, 132.24, 129.54, 129.18, 127.17, 124.54, 120.33, 21.61 ppm.



3c

Chemical Formula: $C_{14}H_{13}NO$
Exact Mass: 211.0997

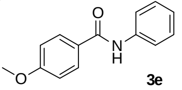
3-methyl-*N*-phenylbenzamide 3c: The reaction was carried out according to the general procedure with *m*-tolylmethanol (268.4 mg, 2.2 mmol, 2.0 equiv) and aniline (102.3 mg, 1.1 mmol, 1.0 equiv) by 1 mol% Au_6Pd/resin catalyst for 8 h. The product was obtained as a white solid (191.7 mg, 83% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.71 – 7.59 (m, 4H), 7.34 (m, 4H), 7.13 (t, J = 7.4 Hz, 1H), 2.40 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 166.14, 138.78, 138.14, 135.11, 132.67, 129.17, 128.73, 127.93, 124.60, 124.10, 120.35, 21.49 ppm.



3d

Chemical Formula: $C_{14}H_{13}NO$
Exact Mass: 211.0997

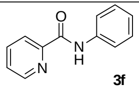
2-methyl-*N*-phenylbenzamide 3d: The reaction was carried out according to the general procedure with *o*-tolylmethanol (122.1 mg, 1.0 mmol, 2.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 24 h. The product was obtained as a white solid (75.3 mg, 71% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.62 (d, *J* = 7.6 Hz, 2H), 7.52 (s, 1H), 7.47 (d, *J* = 7.4 Hz, 1H), 7.36 (t, *J* = 8.0 Hz, 3H), 7.25 (dd, *J* = 11.6, 7.9 Hz, 2H), 7.15 (t, *J* = 7.4 Hz, 1H), 2.50 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 168.19, 138.10, 136.58, 131.41, 130.43, 129.25, 126.72, 126.04, 124.69, 119.98, 19.95 ppm.



3e

Chemical Formula: $C_{14}H_{13}NO_2$
Exact Mass: 227.0946

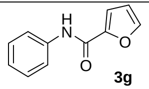
4-methoxy-*N*-phenylbenzamide 3e: The reaction was carried out according to the general procedure with (4-methoxyphenyl)methanol (138.1 mg, 1.0 mmol, 2.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv). The product was obtained as a white solid (107.8 mg, 95% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.6 Hz, 2H), 7.76 (s, 1H), 7.63 (d, *J* = 8.0 Hz, 2H), 7.36 (t, *J* = 7.7 Hz, 2H), 7.14 (t, *J* = 7.4 Hz, 1H), 6.97 (d, *J* = 8.6 Hz, 2H), 3.87 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 165.35, 162.64, 138.25, 129.22, 129.03, 127.32, 124.49, 120.28, 114.14, 55.62 ppm.



3f

Chemical Formula: $C_{12}H_{10}N_2O$
Exact Mass: 198.0793

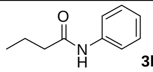
***N*-phenylpicolinamide 3f:** The reaction was carried out according to the general procedure with pyridin-2-ylmethanol (239.8 mg, 2.2 mmol, 2.0 equiv) and aniline (102.3 mg, 1.10 mmol, 1.0 equiv) by 1 mol% Au_6Pd/resin catalyst for 12 h. The product was obtained as a yellow solid (206.4 mg, 95% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 10.03 (s, 1H), 8.61 (d, *J* = 4.7 Hz, 1H), 8.30 (d, *J* = 7.8 Hz, 1H), 7.90 (t, *J* = 7.7 Hz, 1H), 7.79 (t, *J* = 8.3 Hz, 2H), 7.47 (dd, *J* = 7.2, 5.1 Hz, 1H), 7.43 – 7.35 (m, 2H), 7.15 (t, *J* = 7.4 Hz, 1H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 162.11, 149.96, 148.09, 137.88, 137.80, 129.21, 126.56, 124.43, 122.53, 119.81 ppm.



3g

Chemical Formula: $C_{11}H_9NO_2$
Exact Mass: 187.0633

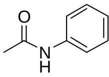
***N*-phenylfuran-2-carboxamide 3g:** The reaction was carried out according to the general procedure with furan-2-ylmethanol (98.0 mg, 1.0 mmol, 2.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 18 h. The product was obtained as a brown solid (62.5 mg, 67% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.10 (s, 1H), 7.65 (d, *J* = 8.2 Hz, 2H), 7.50 (s, 1H), 7.36 (t, *J* = 7.7 Hz, 2H), 7.23 (d, *J* = 3.4 Hz, 1H), 7.14 (t, *J* = 7.4 Hz, 1H), 6.57 – 6.52 (m, 1H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 156.20, 147.96, 144.29, 137.51, 129.23, 124.65, 120.05, 115.38, 112.75 ppm.



3h

Chemical Formula: $C_{10}H_{13}NO$
Exact Mass: 163.0997

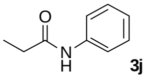
***N*-phenylbutyramide 3h:** The reaction was carried out according to the general procedure with (*E*)-but-2-en-1-ol (540.8 mg, 7.5 mmol, 15.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 24 h. The product was obtained as a white solid (43.5 mg, 53% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.51 (d, *J* = 8.2 Hz, 2H), 7.34 (s, 1H), 7.30 (t, *J* = 7.8 Hz, 2H), 7.08 (t, *J* = 7.5 Hz, 1H), 2.32 (t, *J* = 7.5 Hz, 2H), 1.74 (dt, *J* = 16.5, 8.2 Hz, 2H), 0.99 (t, *J* = 7.4 Hz, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.47, 138.11, 131.07, 129.09, 124.28, 119.93, 39.80, 19.20, 13.88 ppm.



3i

Chemical Formula: C_8H_9NO
Exact Mass: 135.0684

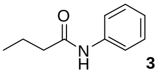
***N*-phenylacetamide 3i:** The reaction was carried out according to the general procedure with ethanol (1.15 g, 25.0 mmol, 50.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 18 h. The product was obtained as a white solid (67.3 mg, 99% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.50 (d, *J* = 8.0 Hz, 3H), 7.30 (t, *J* = 7.6 Hz, 2H), 7.10 (t, *J* = 7.3 Hz, 1H), 2.16 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 168.61, 138.05, 129.09, 124.42, 120.07, 24.68 ppm.



3j

Chemical Formula: $C_9H_{11}NO$
Exact Mass: 149.0841

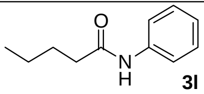
***N*-phenylpropionamide 3j:** The reaction was carried out according to the general procedure with propan-1-ol (751.3 mg, 12.5 mmol, 25.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 24 h. The product was obtained as a white solid (70.2 mg, 94% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.52 (d, *J* = 7.9 Hz, 2H), 7.45 (s, 1H), 7.30 (t, *J* = 7.7 Hz, 2H), 7.09 (t, *J* = 7.3 Hz, 1H), 2.38 (q, *J* = 7.5 Hz, 2H), 1.23 (t, *J* = 7.5 Hz, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 172.30, 138.14, 129.07, 124.26, 119.97, 30.83, 9.81 ppm.



3k

Chemical Formula: $C_{10}H_{13}NO$
Exact Mass: 163.0997

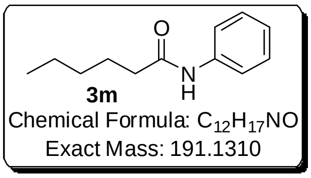
***N*-phenylbutyramide 3k:** The reaction was carried out according to the general procedure with butan-1-ol (926.3 mg, 12.5 mmol, 25.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 24 h. The product was obtained as a white solid (81.0 mg, 99% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.53 (t, *J* = 10.6 Hz, 2H), 7.37 (s, 1H), 7.30 (t, *J* = 7.7 Hz, 2H), 7.09 (t, *J* = 7.3 Hz, 1H), 2.33 (t, *J* = 7.4 Hz, 2H), 1.81 – 1.69 (m, 2H), 1.00 (t, J = 7.3 Hz, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.55, 138.10, 129.09, 124.31, 119.99, 39.80, 19.21, 13.87 ppm.



3l

Chemical Formula: $C_{11}H_{15}NO$
Exact Mass: 177.1154

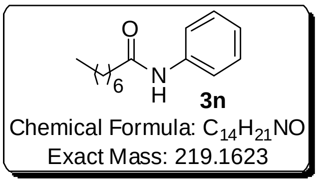
***N*-phenylpentanamide 3l:** The reaction was carried out according to the general procedure with pentan-1-ol (660.8 mg, 7.5 mmol, 15.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 24 h. The product was obtained as a white solid (88.5 mg, 99% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.51 (d, *J* = 7.9 Hz, 2H), 7.41 (s, 1H), 7.29 (t, *J* = 7.8 Hz, 2H), 7.08 (t, *J* = 7.4 Hz, 1H), 2.34 (t, *J* = 7.6 Hz, 2H), 1.70 (dt, *J* = 15.2, 7.6 Hz, 2H), 1.43 – 1.36 (m, 2H), 0.93 (t, *J* = 9.4, 5.3 Hz, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.71, 138.14, 129.07, 124.27, 119.97, 37.65, 27.84, 22.51, 13.93 ppm.



3m

Chemical Formula: $C_{12}H_{17}NO$
Exact Mass: 191.1310

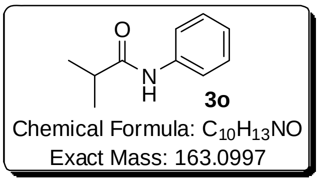
***N*-phenylhexanamide 3m:** The reaction was carried out according to the general procedure with hexan-1-ol (510.5 mg, 5.0 mmol, 10.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 24 h. The product was obtained as a white solid (75.4 mg, 79% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.53 (s, 1H), 7.51 (s, 1H), 7.34 – 7.25 (m, 3H), 7.10 (t, *J* = 7.3 Hz, 1H), 2.35 (t, *J* = 7.6 Hz, 2H), 1.77 – 1.70 (m, 2H), 1.39 – 1.32 (m, *J* = 9.6, 6.2 Hz, 4H), 0.91 (t, *J* = 6.6 Hz, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.63, 138.09, 129.11, 124.30, 119.90, 37.94, 31.55, 25.46, 22.57, 14.07 ppm.



3n

Chemical Formula: $C_{14}H_{21}NO$
Exact Mass: 219.1623

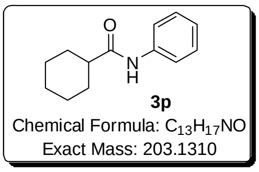
***N*-phenyloctanamide 3n:** The reaction was carried out according to the general procedure with octan-1-ol (650.5 mg, 5.0 mmol, 10.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 24 h. The product was obtained as a white solid (76.2 mg, 70% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.52 (d, *J* = 7.9 Hz, 2H), 7.37 (s, 1H), 7.30 (t, *J* = 7.8 Hz, 2H), 7.09 (t, *J* = 7.4 Hz, 1H), 2.35 (t, *J* = 7.6 Hz, 2H), 1.77 – 1.67 (m, 2H), 1.35 – 1.26 (m, 8H), 0.88 (t, *J* = 6.8 Hz, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.71, 138.11, 129.08, 124.28, 119.93, 37.96, 31.80, 29.36, 29.17, 25.79, 22.73, 14.20 ppm.



3o

Chemical Formula: $C_{10}H_{13}NO$
Exact Mass: 163.0997

***N*-phenyl*iso*butyramide 3o:** The reaction was carried out according to the general procedure with 2-methylpropan-1-ol (555.8 mg, 7.5 mmol, 15.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 24 h. The product was obtained as a white solid (80.5 mg, 99% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.53 (s, 1H), 7.52 (s, 1H), 7.30 (t, *J* = 7.9 Hz, 3H), 7.08 (t, *J* = 7.4 Hz, 1H), 2.51 (dt, *J* = 13.7, 6.9 Hz, 1H), 1.25 (s, 3H), 1.23 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 175.45, 138.19, 129.08, 124.25, 119.93, 36.81, 19.74 ppm.

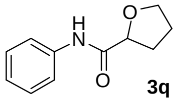


3p

Chemical Formula: $C_{13}H_{17}NO$
Exact Mass: 203.1310

***N*-phenylcyclohexanecarboxamide 3p:** The reaction was carried out according to the general procedure with cyclohexylmethanol (570.5 mg, 5.0 mmol, 10.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 24 h. The product was obtained as a white solid (80.2 mg, 79% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.53 (d, *J* = 8.0 Hz, 2H), 7.30 (t, *J* =

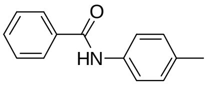
7.8 Hz, 3H), 7.08 (t, *J* = 7.3 Hz, 1H), 2.28 – 2.19 (m, 2H), 1.95 (d, *J* = 12.6 Hz, 1H), 1.83 (d, *J* = 12.0 Hz, 2H), 1.70 (d, *J* = 7.0 Hz, 1H), 1.61 – 1.48 (m, 2H), 1.35 – 1.19 (m, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 174.56, 138.25, 129.07, 124.19, 119.91, 46.67, 29.79, 25.79 ppm.



3q

Chemical Formula: $C_{11}H_{13}NO_2$
Exact Mass: 191.0946

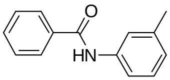
***N*-phenyltetrahydrofuran-2-carboxamide 3q:** The reaction was carried out according to the general procedure with (tetrahydrofuran-2-yl)methanol (765.8 mg, 7.5 mmol, 15.0 equiv) and aniline (46.5 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 24 h. The product was obtained as a white solid (65.5 mg, 69% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.46 (s, 1H), 7.57 (d, *J* = 7.7 Hz, 2H), 7.32 (t, *J* = 7.9 Hz, 2H), 7.14 – 7.07 (m, 1H), 4.46 (dd, *J* = 8.4, 5.9 Hz, 1H), 4.08 – 4.01 (m, 1H), 3.95 (dd, *J* = 15.1, 6.9 Hz, 1H), 2.36 (ddd, *J* = 15.3, 12.6, 7.7 Hz, 1H), 2.23 – 2.14 (m, 1H), 1.99 – 1.90 (m, 2H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.46, 137.38, 129.15, 124.53, 119.74, 78.75, 69.81, 30.32, 25.72 ppm.



3r

Chemical Formula: $C_{14}H_{13}NO$
Exact Mass: 211.0997

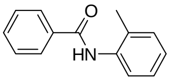
***N*-(*p*-tolyl)benzamide 3r:** The reaction was carried out according to the general procedure with phenylmethanol (108.1 mg, 1.0 mmol, 2.0 equiv) and *p*-toluidine (53.6 mg, 0.50 mmol, 1.0 equiv). The product was obtained as a white solid (96.0 mg, 91% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.90 (s, 1H), 7.85 (d, *J* = 7.5 Hz, 2H), 7.52 (t, *J* = 7.3 Hz, 3H), 7.45 (t, *J* = 7.6 Hz, 2H), 7.15 (d, *J* = 8.2 Hz, 2H), 2.33 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 165.85, 135.48, 135.17, 134.34, 131.83, 129.68, 128.84, 127.13, 120.45, 21.03 ppm.



3s

Chemical Formula: $C_{14}H_{13}NO$
Exact Mass: 211.0997

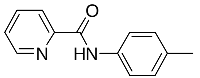
***N*-(*m*-tolyl)benzamide 3s:** The reaction was carried out according to the general procedure with phenylmethanol (108.1 mg, 1.0 mmol, 2.0 equiv) and *m*-toluidine (53.6 mg, 0.50 mmol, 1.0 equiv) for 24 h. The product was obtained as a white solid (85.8 mg, 81% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00 (s, 1H), 7.85 (d, *J* = 7.3 Hz, 2H), 7.55 – 7.48 (m, 2H), 7.47 – 7.39 (m, 3H), 7.23 (dd, *J* = 14.6, 6.8 Hz, 1H), 6.96 (d, *J* = 7.5 Hz, 1H), 2.34 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 165.98, 139.12, 138.01, 135.17, 131.89, 129.00, 128.86, 127.19, 125.50, 121.08, 117.51, 21.64 ppm.



3t

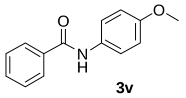
Chemical Formula: $C_{14}H_{13}NO$
Exact Mass: 211.0997

***N*-(*o*-tolyl)benzamide 3t:** The reaction was carried out according to the general procedure with phenylmethanol (108.1 mg, 1.0 mmol, 2.0 equiv) and *o*-toluidine (53.6 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au$_6$Pd/resin catalyst for 24 h. The product was obtained as a white solid (65.1 mg, 62% yield). ^{1}H NMR (500 MHz, CDCl$_3$) δ 7.95 (t, *J* = 11.7 Hz, 1H), 7.89 (d, *J* = 7.3 Hz, 2H), 7.67 (s, 1H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.50 (t, *J* = 7.4 Hz, 2H), 7.30 – 7.21 (m, 2H), 7.12 (dd, *J* = 10.8, 4.1 Hz, 1H), 2.34 (s, 3H) ppm; ^{13}C NMR (126 MHz, CDCl$_3$) δ 165.85, 135.91, 135.12, 131.97, 130.70, 129.64, 128.95, 127.22, 127.00, 125.56, 123.44, 115.16, 17.98ppm.



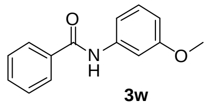
3u
Chemical Formula: $C_{13}H_{12}N_2O$
Exact Mass: 212.0950

***N*-(p-tolyl)picolinamide 3u:** The reaction was carried out according to the general procedure with pyridin-2-ylmethanol (109.1 mg, 1.0 mmol, 2.0 equiv) and *p*-toluidine (53.6 mg, 0.50 mmol, 1.0 equiv). The product was obtained as a yellow solid (101.8 mg, 96% yield). ^{1}H NMR (500 MHz, CDCl$_3$) δ 9.97 (s, 1H), 8.61 (d, *J* = 4.7 Hz, 1H), 8.30 (d, *J* = 7.8 Hz, 1H), 7.90 (t, *J* = 7.7 Hz, 1H), 7.67 (d, *J* = 8.4 Hz, 2H), 7.51 – 7.43 (m, 1H), 7.19 (d, *J* = 8.2 Hz, 2H), 2.34 (s, 3H) ppm; ^{13}C NMR (126 MHz, CDCl$_3$) δ 161.97, 150.04, 148.05, 137.78, 135.33, 134.04, 129.70, 126.48, 122.48, 119.78, 21.06 ppm.



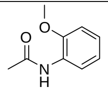
3v
Chemical Formula: $C_{14}H_{13}NO_2$
Exact Mass: 227.0946

***N*-(4-methoxyphenyl)benzamide 3v:** The reaction was carried out according to the general procedure with phenylmethanol (108.1 mg, 1.0 mmol, 2.0 equiv), 4-methoxyaniline (61.6 mg, 0.50 mmol, 1.0 equiv) and *t*-BuOH (370.5 mg, 5.0 mmol) for 24 h. The product was obtained as a white solid (84.8 mg, 75% yield). ^{1}H NMR (500 MHz, CDCl$_3$) δ 7.85 (d, *J* = 7.4 Hz, 2H), 7.81 (s, 1H), 7.53 (t, *J* = 6.5 Hz, 3H), 7.46 (t, *J* = 7.0 Hz, 2H), 6.89 (d, *J* = 7.5 Hz, 2H), 3.80 (s, 3H) pm; ^{13}C NMR (126 MHz, CDCl$_3$) δ 165.77, 156.76, 135.16, 131.82, 131.12, 128.86, 127.11, 122.24, 114.36, 55.63 ppm.



3w
Chemical Formula: $C_{14}H_{13}NO_2$
Exact Mass: 227.0946

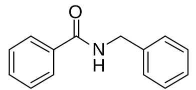
***N*-(3-methoxyphenyl)benzamide 3w:** The reaction was carried out according to the general procedure with phenylmethanol (108.1 mg, 1.0 mmol, 2.0 equiv) and 3-methoxyaniline (61.6 mg, 0.50 mmol, 1.0 equiv) for 24 h. The product was obtained as a white solid (110.1 mg, 97% yield). ^{1}H NMR (500 MHz, CDCl$_3$) δ 8.02 (s, 1H), 7.83 (t, *J* = 10.1 Hz, 2H), 7.49 – 7.41 (m, 4H), 7.23 (dd, *J* = 16.7, 8.6 Hz, 1H), 7.11 (d, *J* = 7.9 Hz, 1H), 6.70 (dd, *J* = 8.2, 1.8 Hz, 1H), 3.80 (s, 3H) ppm;^{13}C NMR (126 MHz, CDCl$_3$) δ 166.04, 160.32, 139.33, 135.06, 131.99, 130.25, 129.87, 128.89, 127.18, 112.49, 110.68, 105.97, 55.45 ppm.



3x
Chemical Formula: $C_9H_{11}NO_2$
Exact Mass: 165.0790

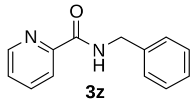
***N*-(2-methoxyphenyl)acetamide 3x**: The reaction was carried out according to the general procedure with ethanol (575.0 mg, 12.5 mmol, 25.0 equiv) and 2-methoxyaniline (61.6 mg, 0.50

mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 24 h. The product was obtained as a white solid (80.8 mg, 98% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 8.34 (dd, *J* = 7.9, 1.0 Hz, 1H), 7.77 (s, 1H), 7.01 (td, *J* = 7.9, 1.3 Hz, 1H), 6.96 – 6.91 (m, 1H), 6.85 (d, *J* = 8.0 Hz, 1H), 3.85 (s, 3H), 2.18 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 168.30, 147.80, 127.83, 123.71, 121.17, 119.90, 109.99, 55.75, 25.03 ppm.



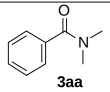
3y
Chemical Formula: $C_{14}H_{13}NO$
Exact Mass: 211.0997

***N*-benzylbenzamide 3y:** The reaction was carried out according to the general procedure with phenylmethanol (108.1 mg, 1.0 mmol, 2.0 equiv) and phenylmethanamine (53.6 mg, 0.50 mmol, 1.0 equiv) by 3 mol% Au_6Pd/resin catalyst for 18 h. The product was obtained as a white solid (87.6 mg, 83% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.79 (d, *J* = 7.8 Hz, 2H), 7.49 (t, *J* = 7.3 Hz, 1H), 7.42 (t, *J* = 7.5 Hz, 2H), 7.35 (d, *J* = 4.2 Hz, 4H), 7.32 – 7.27 (m, 1H), 6.48 (s, 1H), 4.64 (d, *J* = 5.6 Hz, 2H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 167.49, 138.32, 134.52, 131.68, 128.92, 128.73, 128.05, 127.76, 127.09, 44.27 ppm.



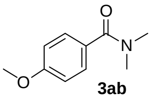
3z
Chemical Formula: $C_{13}H_{12}N_2O$
Exact Mass: 212.0950

***N*-benzylpicolinamide 3z:** The reaction was carried out according to the general procedure with pyridin-2-ylmethanol (109.1 mg, 1.0 mmol, 2.0 equiv) and phenylmethanamine (53.6 mg, 0.50 mmol, 1.0 equiv). The product was obtained as a yellow solid (96.4 mg, 91% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 8.53 (d, *J* = 4.2 Hz, 1H), 8.40 (s, 1H), 8.25 (d, *J* = 7.8 Hz, 1H), 7.86 (td, *J* = 7.7, 1.6 Hz, 1H), 7.45 – 7.40 (m, 1H), 7.36 (dt, *J* = 15.1, 7.3 Hz, 4H), 7.31 – 7.27 (m, 1H), 4.68 (d, *J* = 6.1 Hz, 2H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 164.39, 149.93, 148.21, 138.31, 137.53, 130.31, 129.29, 128.84, 128.00, 127.61, 126.36, 122.53, 43.64 ppm.



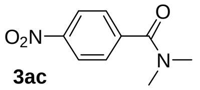
3aa
Chemical Formula: $C_9H_{11}NO$
Exact Mass: 149.0841

***N,N*-dimethylbenzamide 3aa:** The reaction was carried out according to the general procedure with phenylmethanol (54.1 mg, 0.50 mmol, 1.0 equiv) and dimethylamine (40 wt% in H_2O) (1.125 g, 10 mmol, 20.0 equiv) by 3 mol% Au_6Pd/resin catalyst at 25 °C for 24 h. The product was obtained as a colourless oil (67.7 mg, 91% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.41 – 7.36 (m, 5H), 3.09 (s, 3H), 2.96 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.76, 136.46, 129.61, 128.45, 127.15, 39.69, 35.45 ppm.



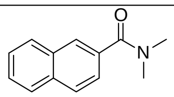
3ab
Chemical Formula: $C_{10}H_{13}NO_2$
Exact Mass: 179.0946

4-methoxy-*N,N*-dimethylbenzamide 3ab: The reaction was carried out according to the general procedure with (4-methoxyphenyl)methanol (69.1 mg, 0.50 mmol, 1.0 equiv) and dimethylamine (40 wt% in H_2O) (1.125 g, 10 mmol, 20.0 equiv) by 3 mol% Au_6Pd/resin catalyst at 25 °C for 24 h. The product was obtained as a colourless oil (84.6 mg, 95% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.42 – 7.35 (m, 2H), 6.91 – 6.85 (m, 2H), 3.80 (s, 3H), 3.03 (s, 6H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.60, 160.71, 129.21, 128.58, 113.66, 55.41, 39.92, 35.62 ppm.



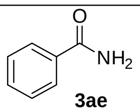
3ac
Chemical Formula: $C_9H_{10}N_2O_3$
Exact Mass: 194.0691

***N,N*-dimethyl-4-nitrobenzamide 3ac:** The reaction was carried out according to the general procedure with (4-nitrophenyl)methanol (76.5 mg, 0.50 mmol, 1.0 equiv), dimethylamine (40 wt% in H_2O) (1.125 g, 10 mmol, 20.0 equiv) by 3 mol% Au_6Pd/resin catalyst at 25 °C for 24 h. The product was obtained as a yellow solid (52.4 mg, 57% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 8.25 (d, *J* = 8.7 Hz, 2H), 7.56 (d, *J* = 8.7 Hz, 2H), 3.11 (s, 3H), 2.94 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 169.37, 148.38, 142.61, 128.18, 123.89, 39.42, 35.46 ppm.



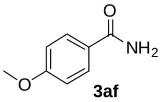
3ad
Chemical Formula: $C_{13}H_{13}NO$
Exact Mass: 199.0997

***N,N*-dimethyl-2-naphthamide 3ad:** The reaction was carried out according to the general procedure with naphthalen-2-ylmethanol (79.1 mg, 0.50 mmol, 1.0 equiv), dimethylamine (40 wt% in H_2O) (1.125 g, 10 mmol, 20.0 equiv) and *t*-BuOH (185.3 mg, 2.5 mmol) by 3 mol% Au_6Pd/resin catalyst at 25 °C for 24 h. The product was obtained as a white solid (94.1 mg, 95% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.90 (s, 1H), 7.87 – 7.82 (m, 3H), 7.53 – 7.49 (m, 3H), 3.13 (s, 3H), 3.02 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 171.76, 133.76, 133.72, 132.79, 128.52, 128.31, 127.91, 127.11, 126.97, 126.75, 124.56, 39.79, 35.54 ppm.



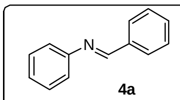
3ae
Chemical Formula: C_7H_7NO
Exact Mass: 121.0528

Benzamide 3ae: The reaction was carried out according to the general procedure with phenylmethanol (54.1 mg, 0.50 mmol, 1.0 equiv), ammonia (30 wt% in H_2O) (1.167 g, 10 mmol, 20.0 equiv) by 3 mol% Au_6Pd/resin catalyst at 25 °C for 24 h. The product was obtained as a white solid (29.4 mg, 49% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.84 – 7.78 (m, 2H), 7.53 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.6 Hz, 2H), 6.13 (s, 1H), 6.06 (s, 1H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 169.66, 133.45, 132.15, 128.76, 127.46 ppm.



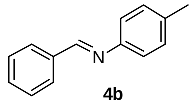
3af
Chemical Formula: $C_8H_9NO_2$
Exact Mass: 151.0633

4-methoxybenzamide 3af: The reaction was carried out according to the general procedure with (4-methoxyphenyl)methanol (69.1 mg, 0.50 mmol, 1.0 equiv), ammonia (30 wt% in H_2O) (1.167 g, 10 mmol, 20.0 equiv) by 3 mol% Au_6Pd/resin catalyst at 25 °C for 24 h. The product was obtained as a white solid (40.4 mg, 54% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.7 Hz, 2H), 6.93 (d, *J* = 8.7 Hz, 2H), 6.04 (s, 1H), 5.81 (s, 1H), 3.85 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 169.11, 162.76, 129.44, 125.53, 113.94, 55.57 ppm.



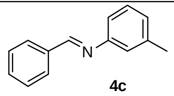
4a
Chemical Formula: $C_{13}H_{11}N$
Exact Mass: 181.0891

(*E*)-N-benzylideneaniline 4a: The reaction was carried out according to the general procedure with benzyl alcohol (108.2 mg, 1.0 mmol, 2.0 equiv) and aniline (46.5 mg, 0.5 mmol, 1.0 equiv) by $AuPd_4$/resin (93 mg, 3 mol%) at 40 °C for 24 h and the product was obtained as a yellow solid (72.4 mg, 80% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 8.46 (s, 1H), 7.94 – 7.87 (m, 2H), 7.51 – 7.45 (m, 3H), 7.40 (t, *J* = 7.6 Hz, 2H), 7.22 (t, *J* = 7.1 Hz, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 160.58, 152.22, 136.34, 131.53, 129.29, 128.95, 128.92, 126.08, 121.00 ppm.



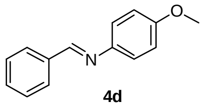
4b
Chemical Formula: $C_{14}H_{13}N$
Exact Mass: 195.1048

(*E*)-N-benzylidene-4-methylaniline 4b: The reaction was carried out according to the general procedure with benzyl alcohol (81.2 mg, 0.75 mmol, 1.5 equiv) and 4-methylaniline (53.6 mg, 0.5 mmol, 1.0 equiv) by $AuPd_4$/resin (93 mg, 3 mol%) at 40 °C for 24 h and the product was obtained as a yellow solid (61.3 mg, 63% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 8.48 (s, 1H), 7.91 (dd, *J* = 6.1, 2.4 Hz, 2H), 7.50 – 7.45 (m, 3H), 7.21 (d, *J* = 8.0 Hz, 2H), 7.15 (d, *J* = 8.2 Hz, 2H), 2.38 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 159.75, 149.59, 136.48, 135.94, 131.34, 129.90, 128.88, 128.85, 120.95, 21.16 ppm.



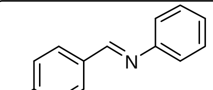
4c
Chemical Formula: $C_{14}H_{13}N$
Exact Mass: 195.1048

(*E*)-N-benzylidene-3-methylaniline 4c: The reaction was carried out according to the general procedure with benzyl alcohol (81.2 mg, 0.75 mmol, 1.5 equiv) and 3-methylaniline (53.6 mg, 0.5 mmol, 1.0 equiv) by $AuPd_4$/resin (93 mg, 3 mol%) at 40 °C for 12 h and the product was obtained as a yellow solid (48.4 mg, 50% yield). ^1H NMR (500 MHz, $CDCl_3$) δ 8.46 (s, 1H), 7.91 (dd, *J* = 6.2, 2.6 Hz, 2H), 7.51 – 7.45 (m, 3H), 7.29 (t, *J* = 7.5 Hz, 1H), 7.09 – 7.00 (m, 3H), 2.41 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 160.30, 152.23, 139.11, 136.43, 131.44, 129.11, 128.91, 128.89, 126.85, 121.77, 117.98, 21.55 ppm.



4d
Chemical Formula: $C_{14}H_{13}NO$
Exact Mass: 211.0997

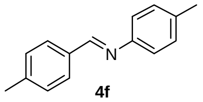
(*E*)-N-benzylidene-4-methoxyaniline 4d: The reaction was carried out according to the general procedure with benzyl alcohol (81.2 mg, 0.75 mmol, 1.5 equiv) and 4-methoxyaniline (61.6 mg, 0.5 mmol, 1.0 equiv) by AuPd$_4$/resin (93 mg, 3 mol%) at 40 ^{o}C for 12 h and the product was obtained as a yellow solid (68.5 mg, 65% yield). ^{1}H NMR (500 MHz, CDCl$_3$) δ 8.48 (s, 1H), 7.92 – 7.86 (m, 2H), 7.48 – 7.43 (m, 3H), 7.24 (d, *J* = 9.0 Hz, 2H), 6.94 (d, *J* = 8.9 Hz, 2H), 3.83 (s, 3H) ppm; ^{13}C NMR (126 MHz, CDCl$_3$) δ 158.54, 158.42, 145.05, 136.59, 131.16, 128.87, 128.72, 122.33, 114.51, 55.62 ppm.



4e

Chemical Formula: $C_{14}H_{13}N$
Exact Mass: 195.1048

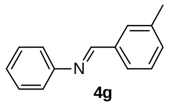
(*E*)-N-(4-methylbenzylidene)aniline 4e: The reaction was carried out according to the general procedure with 4-methylbenzyl alcohol (91.7 mg, 0.75 mmol, 1.5 equiv) and aniline (46.5 mg, 0.5 mmol, 1.0 equiv) by AuPd$_4$/resin (93 mg, 3 mol%) at 40 ^{o}C for 12 h and the product was obtained as a yellow solid (59.4 mg, 61% yield). ^{1}H NMR (500 MHz, CDCl$_3$) δ 8.43 (s, 1H), 7.81 (d, *J* = 7.9 Hz, 2H), 7.40 (t, *J* = 7.7 Hz, 2H), 7.29 (d, *J* = 7.9 Hz, 2H), 7.26 – 7.20 (m, 3H), 2.43 (s, 3H) ppm; ^{13}C NMR (126 MHz, CDCl$_3$) δ 160.49, 152.41, 142.00, 133.83, 129.66, 129.26, 128.96, 125.88, 121.02, 21.77 ppm.



4f

Chemical Formula: $C_{15}H_{15}N$
Exact Mass: 209.1204

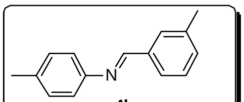
(*E*)-4-methyl-N-(4-methylbenzylidene)aniline 4f: The reaction was carried out according to the general procedure with 4-methylbenzyl alcohol (91.7 mg, 0.75 mmol, 1.5 equiv) and 4-methylaniline (53.6 mg, 0.5 mmol, 1.0 equiv) by AuPd$_4$/resin (93 mg, 3 mol%) at 40 ^{o}C for 12 h and the product was obtained as a yellow solid (43.0 mg, 41% yield). ^{1}H NMR (500 MHz, CDCl$_3$) δ 8.43 (s, 1H), 7.79 (d, *J* = 8.0 Hz, 2H), 7.27 (t, *J* = 6.0 Hz, 2H), 7.19 (d, *J* = 8.0 Hz, 2H), 7.13 (d, *J* = 8.2 Hz, 2H), 2.42 (s, 3H), 2.37 (s, 3H) ppm; ^{13}C NMR (126 MHz, CDCl$_3$) δ 159.71, 149.78, 141.78, 135.69, 133.93, 129.86, 129.61, 128.84, 120.93, 21.74, 21.13 ppm.



4g

Chemical Formula: $C_{14}H_{13}N$
Exact Mass: 195.1048

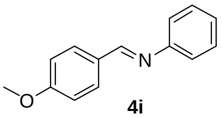
(*E*)-N-(3-methylbenzylidene)aniline 4g: The reaction was carried out according to the general procedure with 3-methylbenzyl alcohol (122.2 mg, 1.0 mmol, 2.0 equiv) and aniline (46.5 mg, 0.5 mmol, 1.0 equiv) by AuPd$_4$/resin (93 mg, 3 mol%) at 40 ^{o}C for 24 h and the product was obtained as a yellow solid (80.9 mg, 83% yield). ^{1}H NMR (500 MHz, CDCl$_3$) δ 8.43 (s, 1H), 7.77 (s, 1H), 7.67 (d, *J* = 7.7 Hz, 1H), 7.42 – 7.35 (m, 3H), 7.31 (d, *J* = 7.5 Hz, 1H), 7.27 – 7.19 (m, 3H), 2.43 (s, 3H) ppm; ^{13}C NMR (126 MHz, CDCl$_3$) δ 160.84, 152.30, 138.69, 136.29, 132.39, 129.27, 129.09, 128.79, 126.57, 126.00, 121.00, 21.44 ppm.



4h

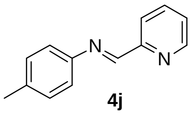
Chemical Formula: $C_{15}H_{15}N$
Exact Mass: 209.1204

(*E*)-4-methyl-N-(3-methylbenzylidene)aniline 4h: The reaction was carried out according to the general procedure with 3-methylbenzyl alcohol (91.7 mg, 0.75 mmol, 1.5 equiv) and 4-methylaniline (53.6 mg, 0.5 mmol, 1.0 equiv) by $AuPd_4$/resin (93 mg, 3 mol%) at 40 ^{o}C for 12 h and the product was obtained as a yellow solid (62.6 mg, 60% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.45 (s, 1H), 7.77 (s, 1H), 7.66 (d, *J* = 7.5 Hz, 1H), 7.36 (t, *J* = 7.5 Hz, 1H), 7.29 (d, *J* = 7.4 Hz, 1H), 7.20 (t, *J* = 8.5 Hz, 2H), 7.15 (d, *J* = 8.1 Hz, 2H), 2.43 (s, 3H), 2.38 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 160.02, 149.68, 138.64, 136.44, 135.85, 132.21, 129.89, 128.99, 128.76, 126.48, 120.94, 21.44, 21.14 ppm.



4i
Chemical Formula: $C_{14}H_{13}NO$
Exact Mass: 211.0997

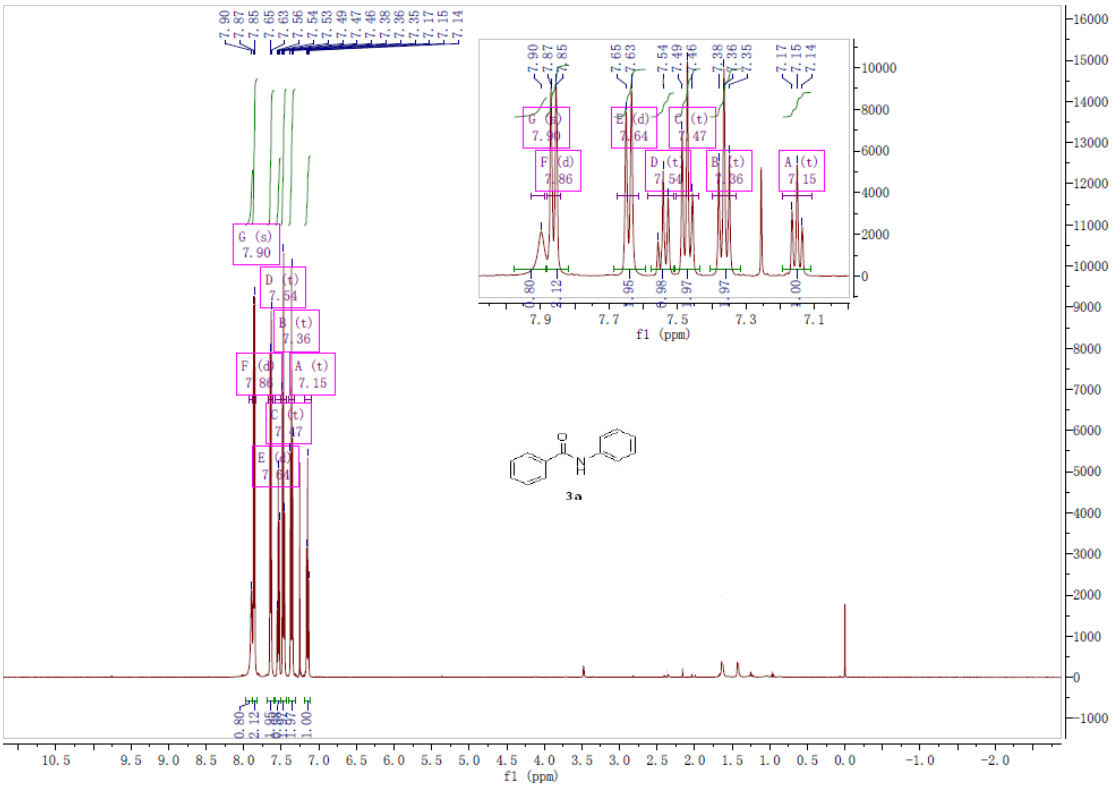
(*E*)-N-(4-methoxybenzylidene)aniline 4i: The reaction was carried out according to the general procedure with 4-methoxybenzyl alcohol (103.6 mg, 0.75 mmol, 1.5 equiv) and aniline (46.5 mg, 0.5 mmol, 1.0 equiv) by $AuPd_4$/resin (93 mg, 3 mol%) at 40 ^{o}C for 12 h and the product was obtained as a yellow solid (55.4 mg, 53% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.39 (s, 1H), 7.86 (d, *J* = 8.6 Hz, 2H), 7.39 (t, *J* = 7.8 Hz, 2H), 7.24 – 7.18 (m, 3H), 7.00 (t, *J* = 8.3 Hz, 2H), 3.87 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 162.39, 159.83, 152.52, 130.65, 129.25, 125.70, 121.02, 114.33, 55.56 ppm.

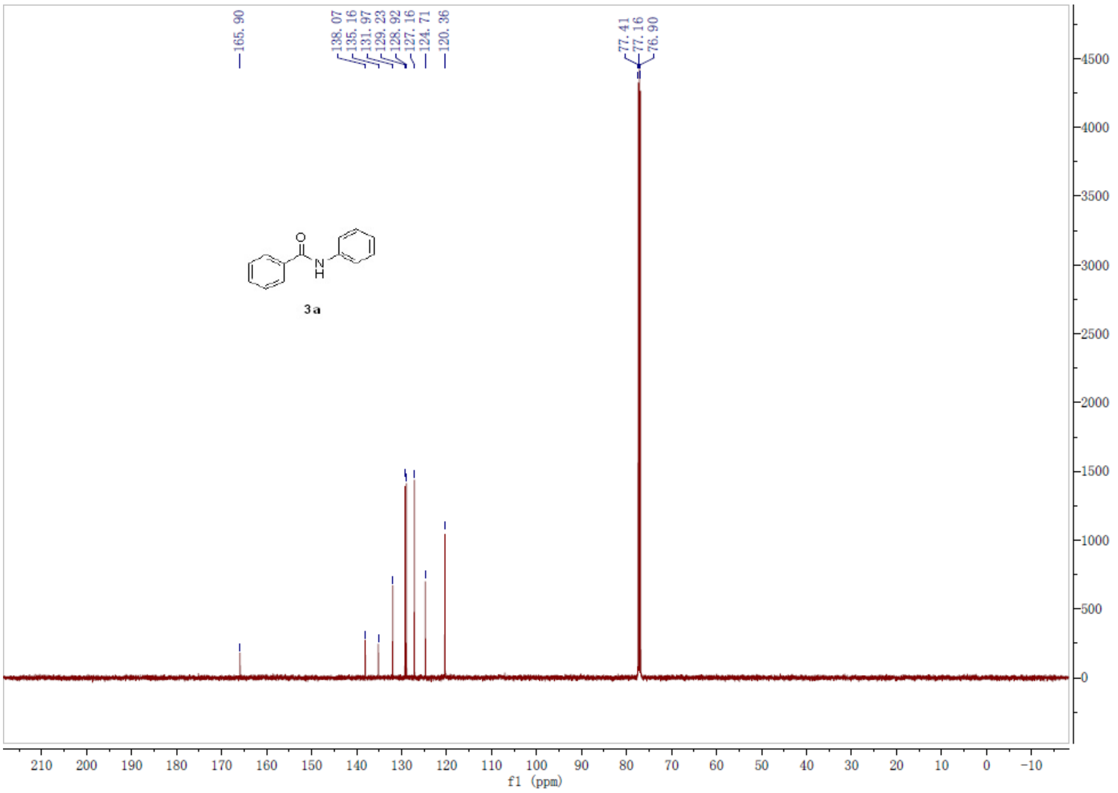


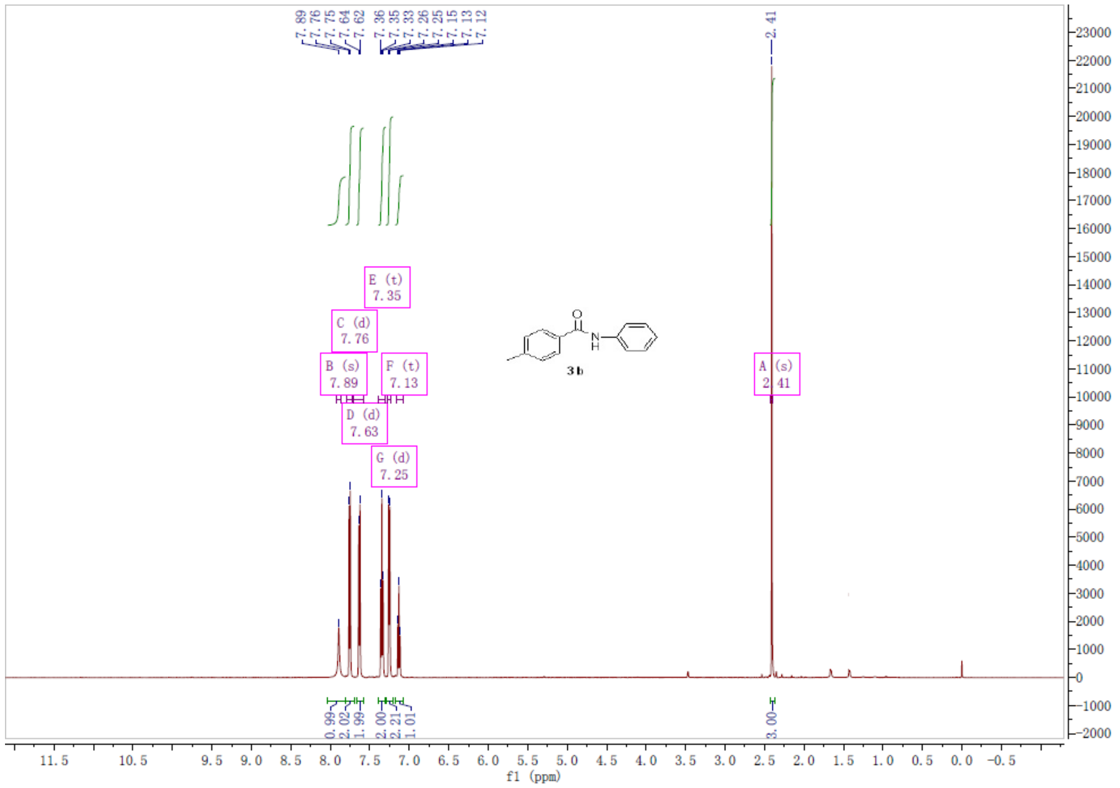
4j
Chemical Formula: $C_{13}H_{12}N_2$
Exact Mass: 196.1000

(*E*)-4-methyl-N-(pyridin-2-ylmethylene)aniline 4j: The reaction was carried out according to the general procedure with pyridin-2-ylmethanol (81.8 mg, 0.75 mmol, 1.5 equiv) and 4-methylaniline (53.6 mg, 0.5 mmol, 1.0 equiv) by $AuPd_4$/resin (93 mg, 3 mol%) at 40 ^{o}C for 24 h and the product was obtained as a yellow solid (52.1 mg, 53% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.70 (d, *J* = 4.4 Hz, 1H), 8.62 (s, 1H), 8.20 (d, *J* = 7.9 Hz, 1H), 7.84 – 7.77 (m, 1H), 7.35 (dd, *J* = 6.7, 5.3 Hz, 1H), 7.22 (s, 4H), 2.38 (s, 3H) ppm; ^{13}C NMR (126 MHz, $CDCl_3$) δ 159.78, 154.83, 149.77, 148.45, 137.78, 136.93, 136.82, 130.00, 129.87, 125.14, 121.94, 121.25, 21.21.ppm.

10. Copy of ^{1}H NMR and ^{13}C NMR spectra for products.



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7.75
7.64
7.62
7.36
7.35
7.33
7.26
7.25
7.15
7.13
7.12
2.41
E (t) 7.35
C (d) 7.76
B (s) 7.89
F (t) 7.13
D (d) 7.63
G (d) 7.25
A (s) 2.41
O
N
H
3b
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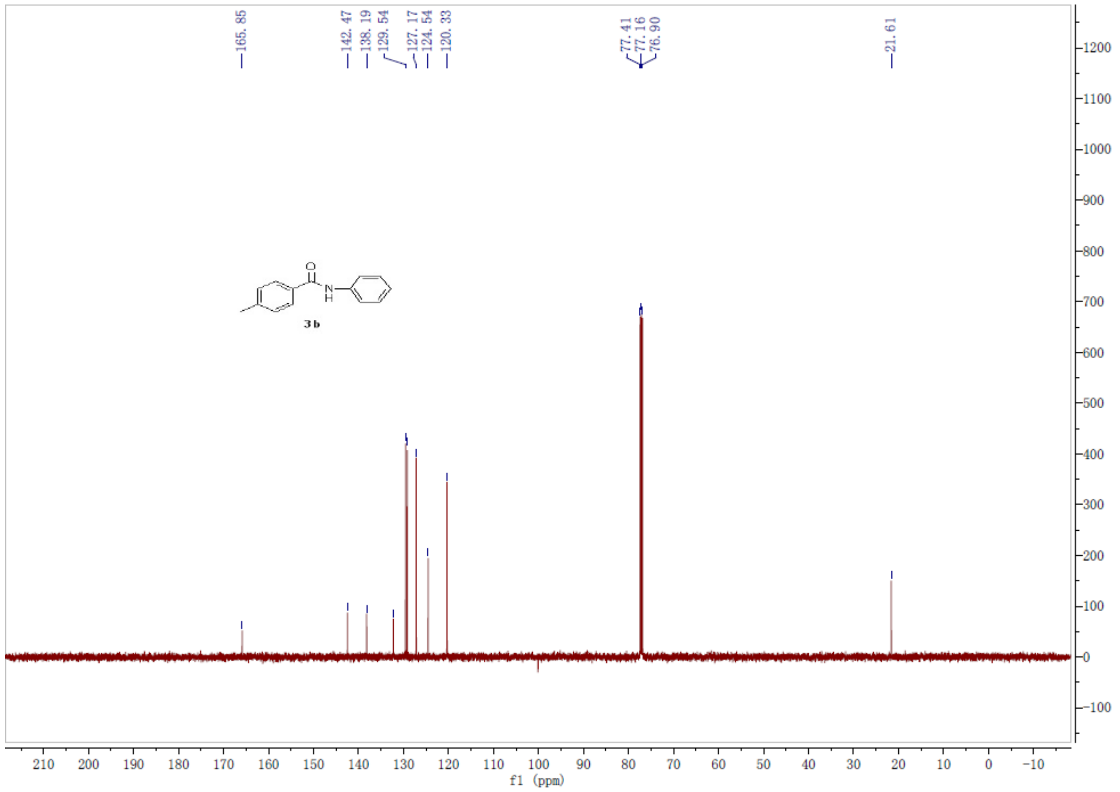
2.02
1.99
2.00
2.21
1.01
3.00
f1 (ppm)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124.54
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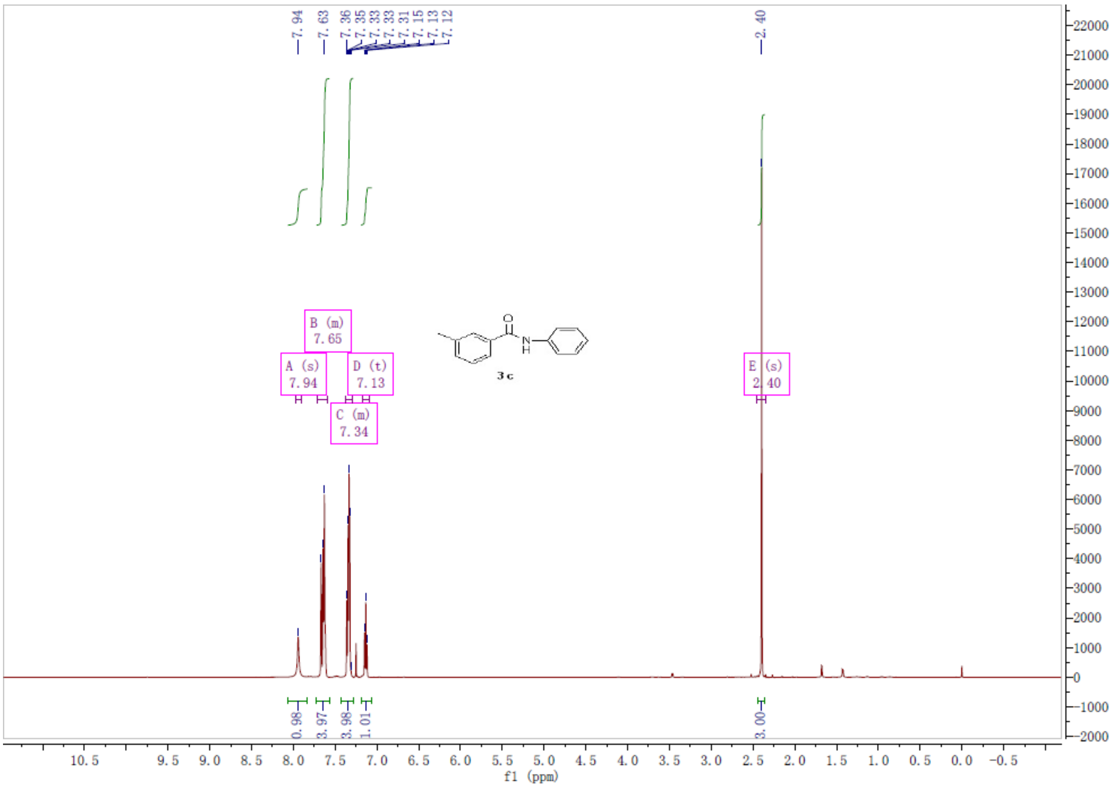
77.16
76.90
21.61
O
N
H
3b
f1 (ppm)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7.33
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7.15
7.13
7.12
2.40
B (m)
7.65
A (s)
7.94
D (t)
7.13
C (m)
7.34
E (s)
2.40
3c
0.98
3.97
3.98
1.01
3.00
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)
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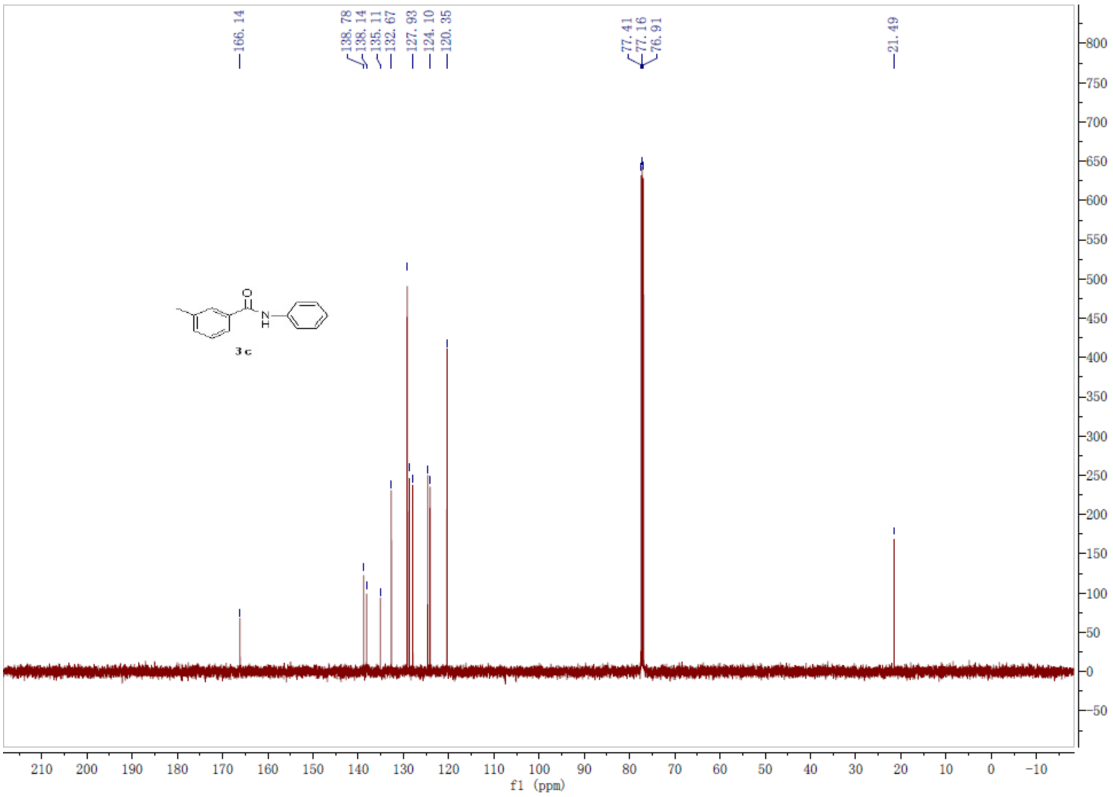
21000
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000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132.67
127.93
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120.35
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77.16
76.91
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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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700
650
600
550
500
450
400
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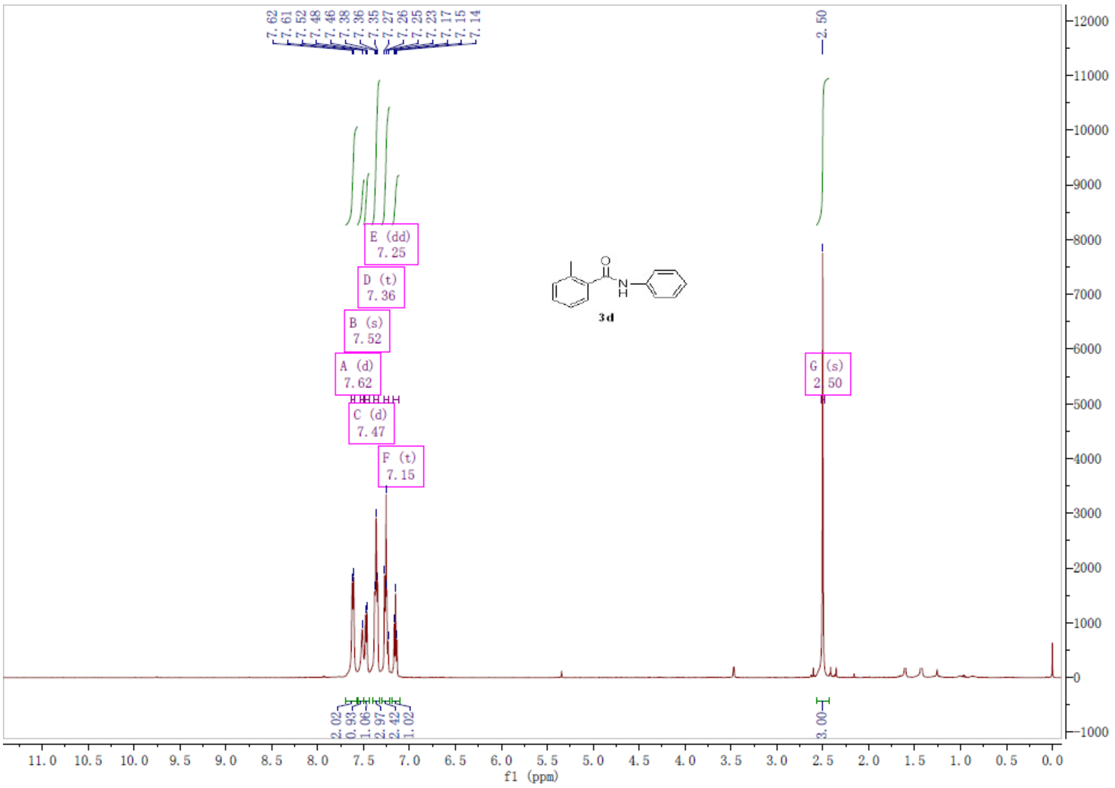
300
250
200
150
100
50
0
-50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7.36
7.35
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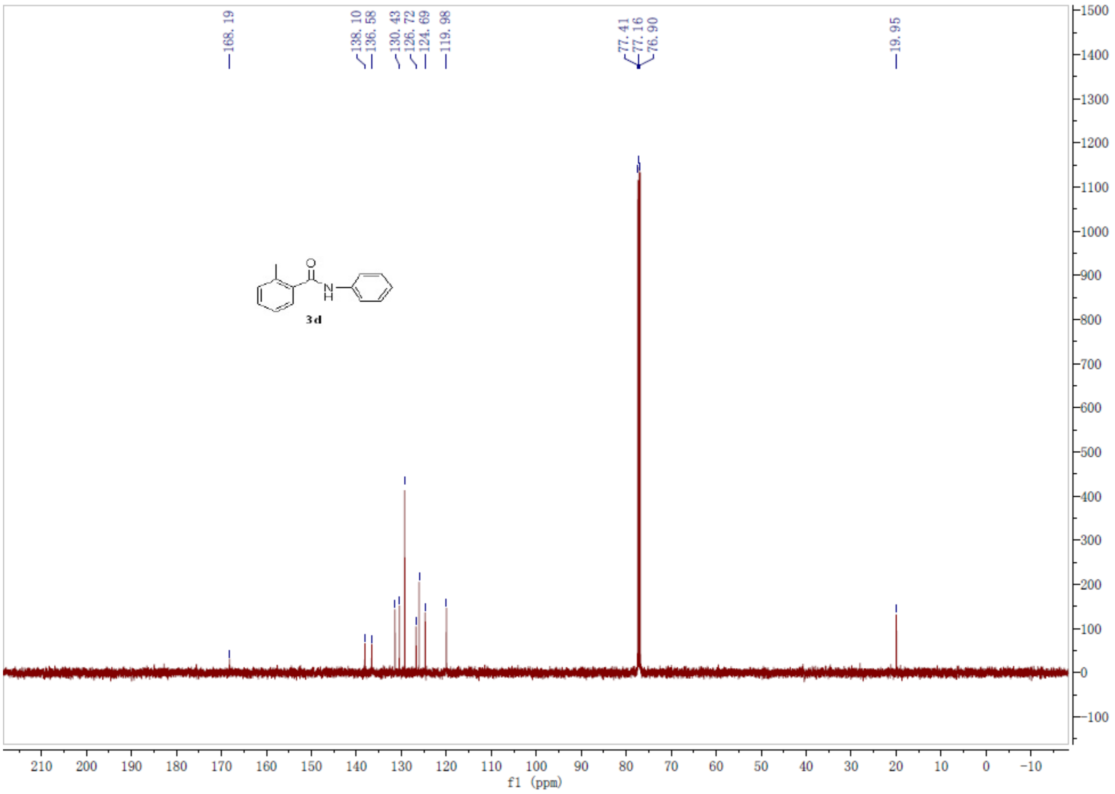
7.26
7.25
7.23
7.17
7.15
7.14
2.50
E (dd) 7.25
D (t) 7.36
B (s) 7.52
A (d) 7.62
C (d) 7.47
F (t) 7.15
G (s) 2.50
3d
O
N
H
2.02
0.93
1.06
1.97
2.42
1.02
3.00
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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76.90
19.95
3d
O
N
H
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
210
200
190
180
170
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100
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40
30
20
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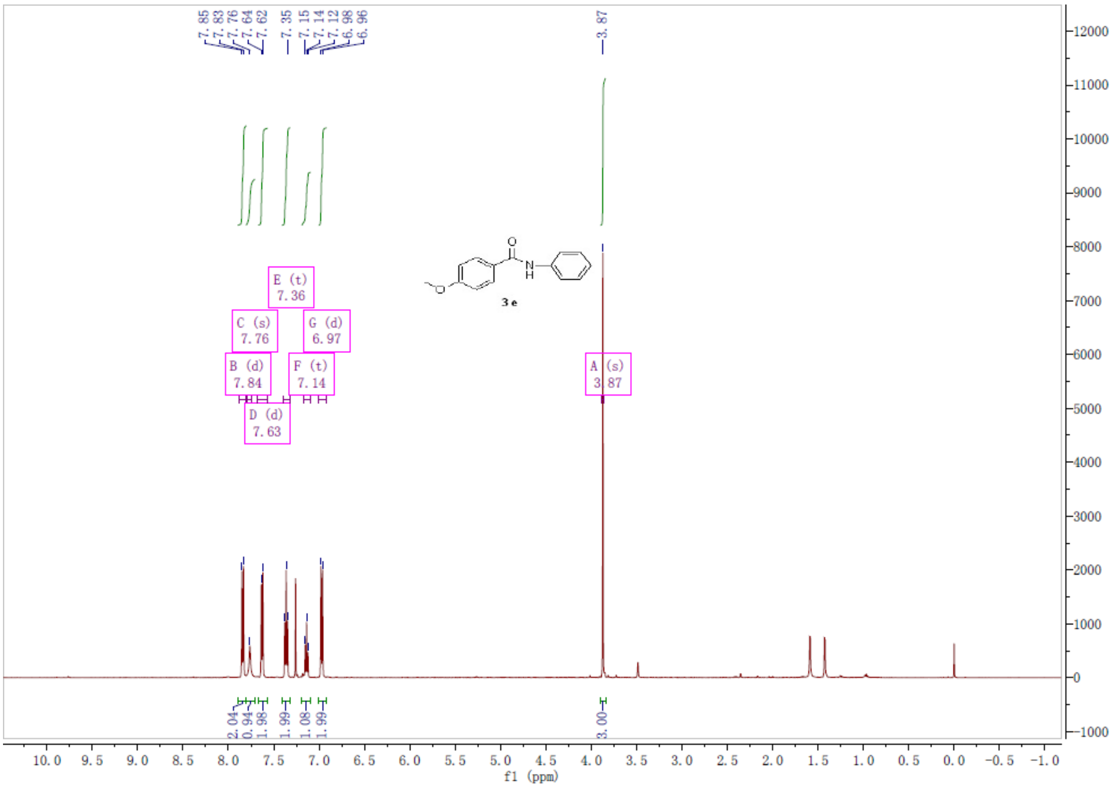
f1 (ppm)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7.62
7.35
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7.12
6.98
6.96
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3e
E (t) 7.36
C (s) 7.76
G (d) 6.97
B (d) 7.84
F (t) 7.14
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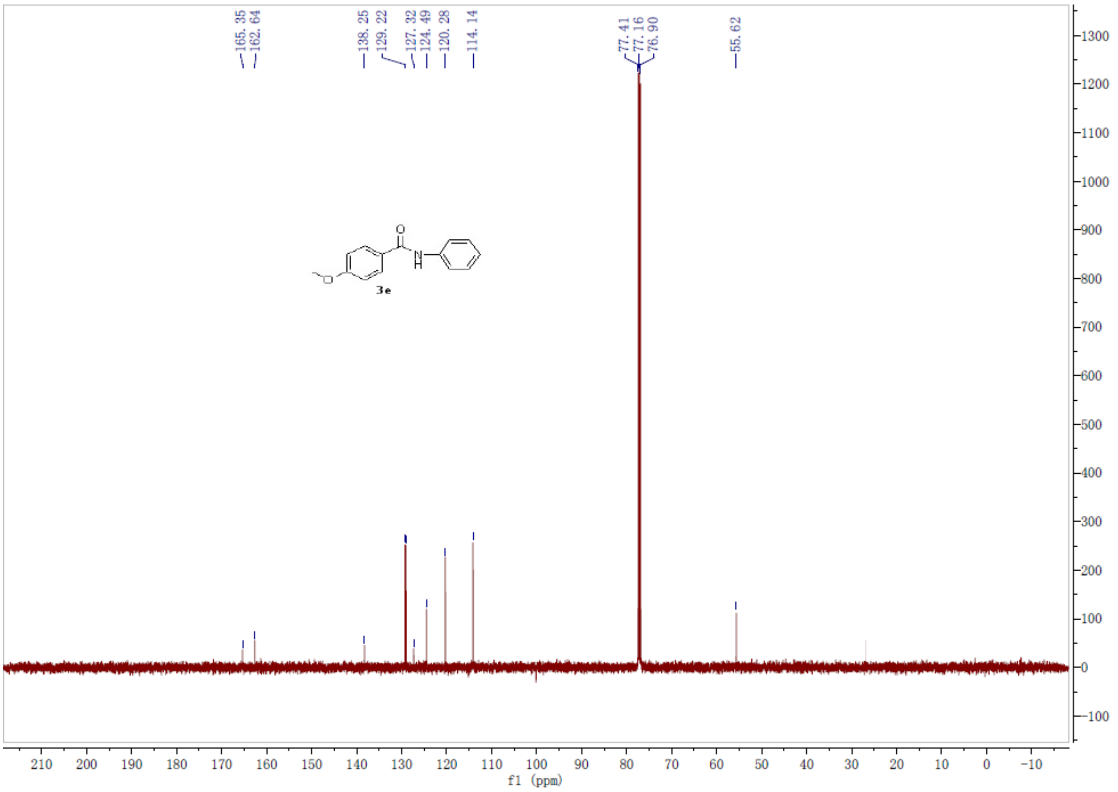
1.08
1.99
3.00
f1 (ppm)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124.49
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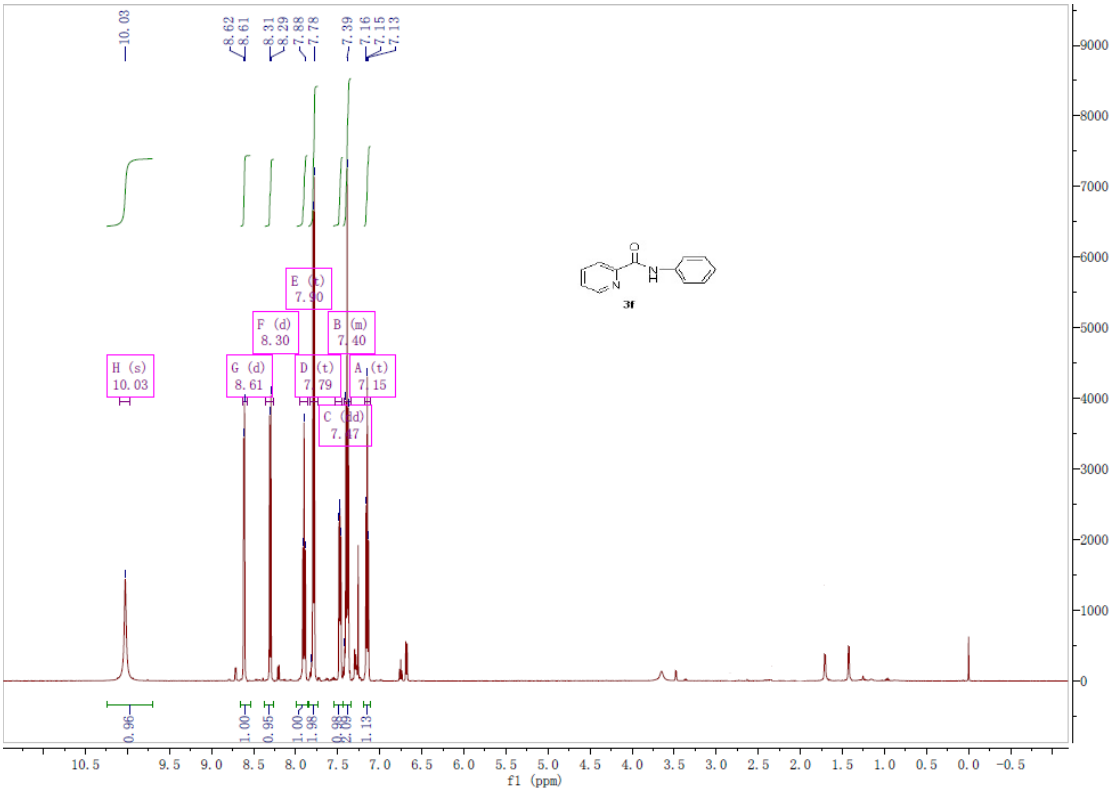
77.16
76.90
55.62
3e
f1 (ppm)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7.39
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7.13
3f
E (t)
7.90
F (d)
8.30
B (m)
7.40
H (s)
10.03
G (d)
8.61
D (t)
7.79
A (t)
7.15
C (dd)
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0.95
1.00
1.98
0.98
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1.13
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9.5
9.0
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8.0
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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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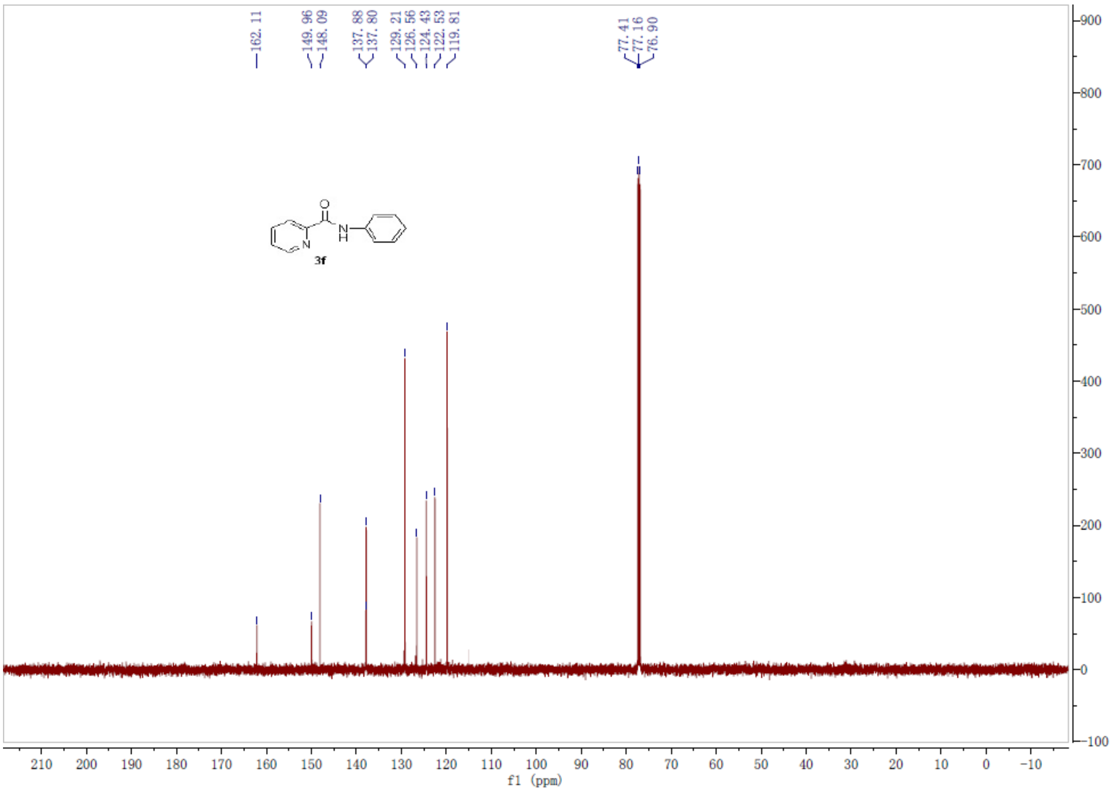
7000
6000
5000
4000
3000
2000
1000
0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77.41
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200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
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0
-10
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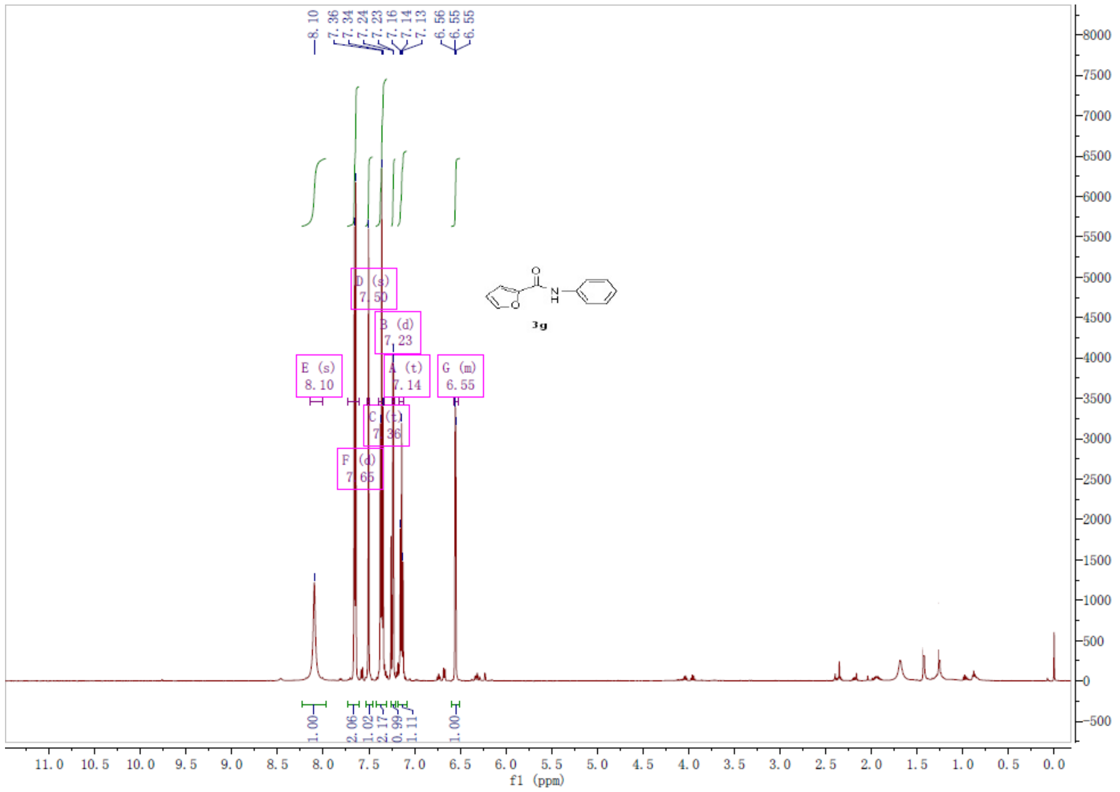
800
700
600
500
400
300
200
100
0
-100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7.13
6.56
6.55
6.55
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B (d) 7.23
E (s) 8.10
A (t) 7.14
G (m) 6.55
C (t) 7.36
F (d) 7.65
3g
1.00
2.06
1.02
2.17
0.99
1.11
1.00
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
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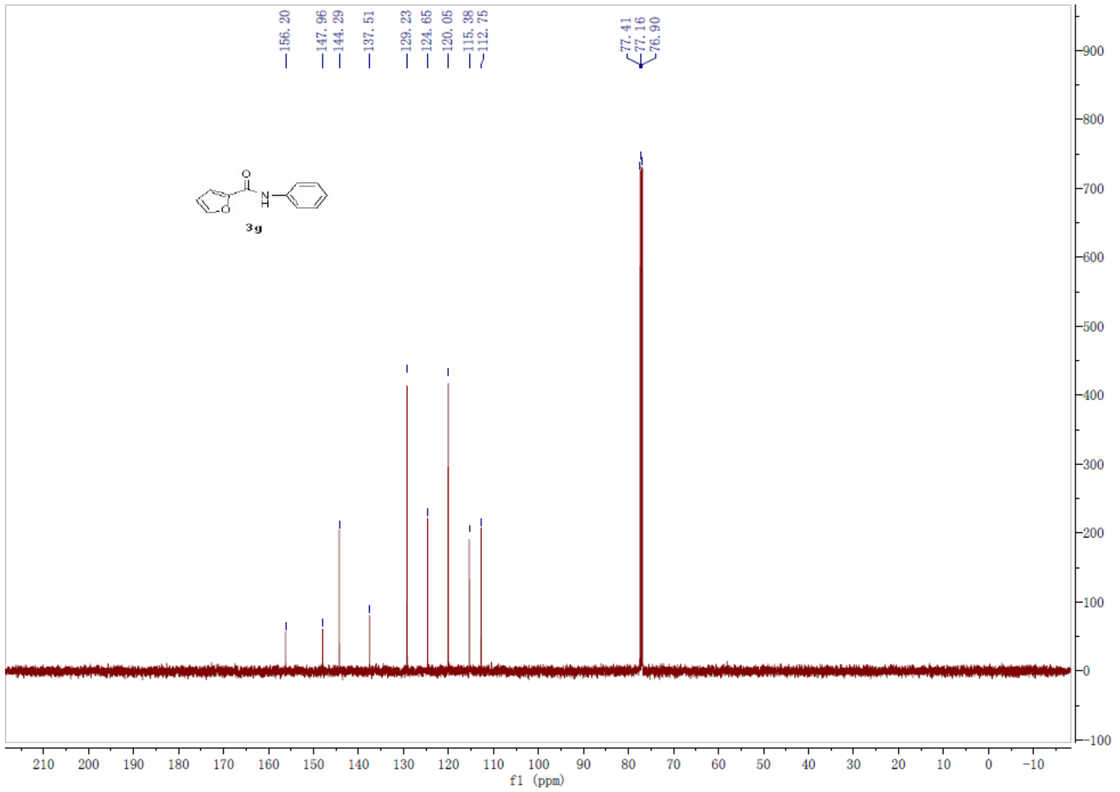
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77.41
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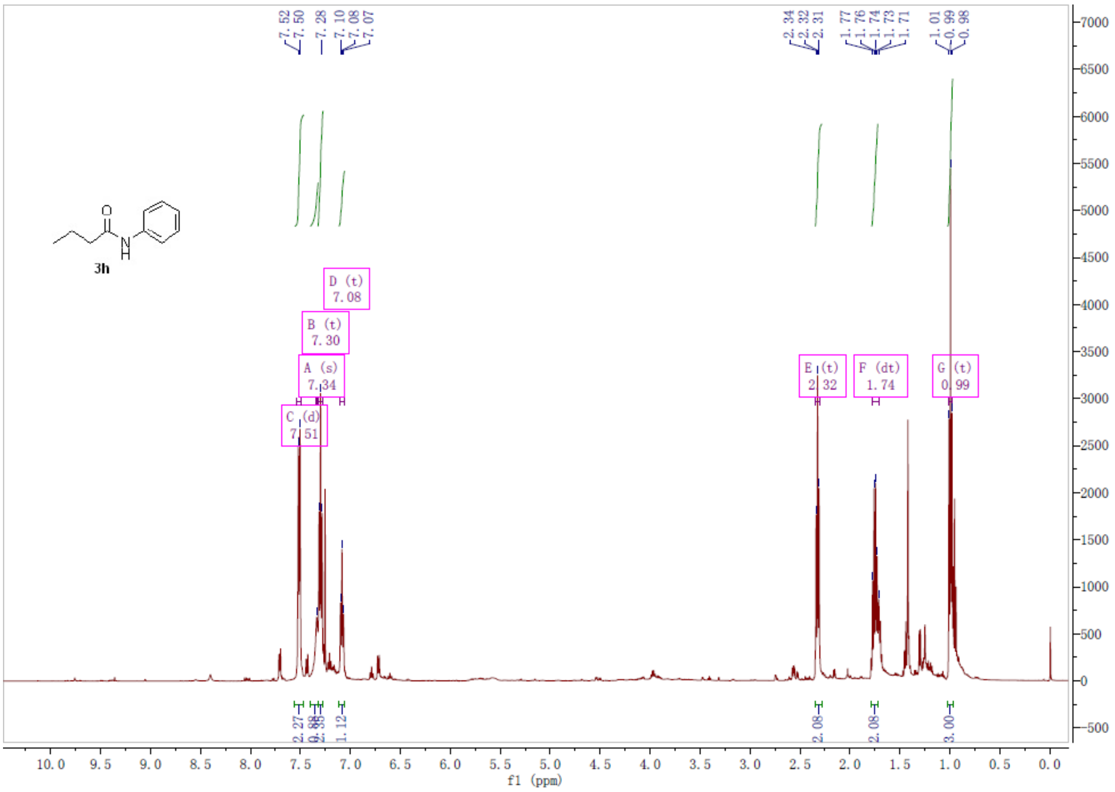
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1.71
1.01
0.99
0.98
3h
D (t)
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B (t)
7.30
A (s)
7.34
C (d)
7.51
E (t)
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G (t)
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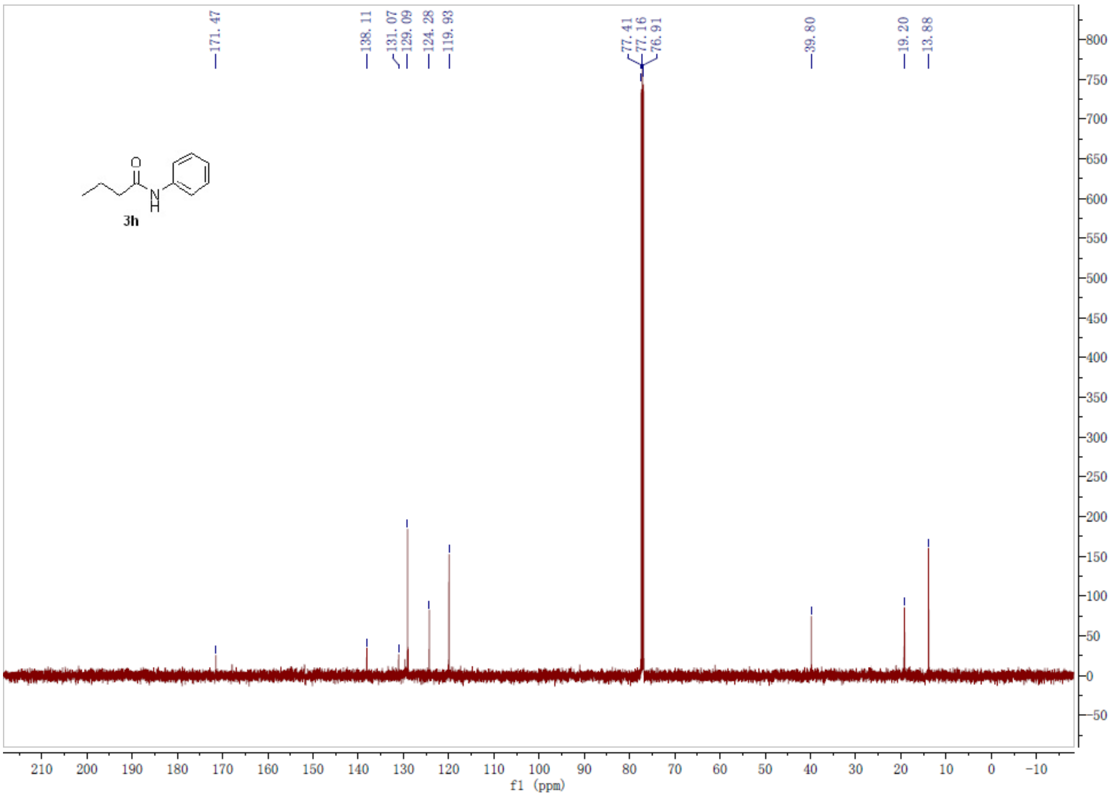
2.08
2.08
3.00
f1 (ppm)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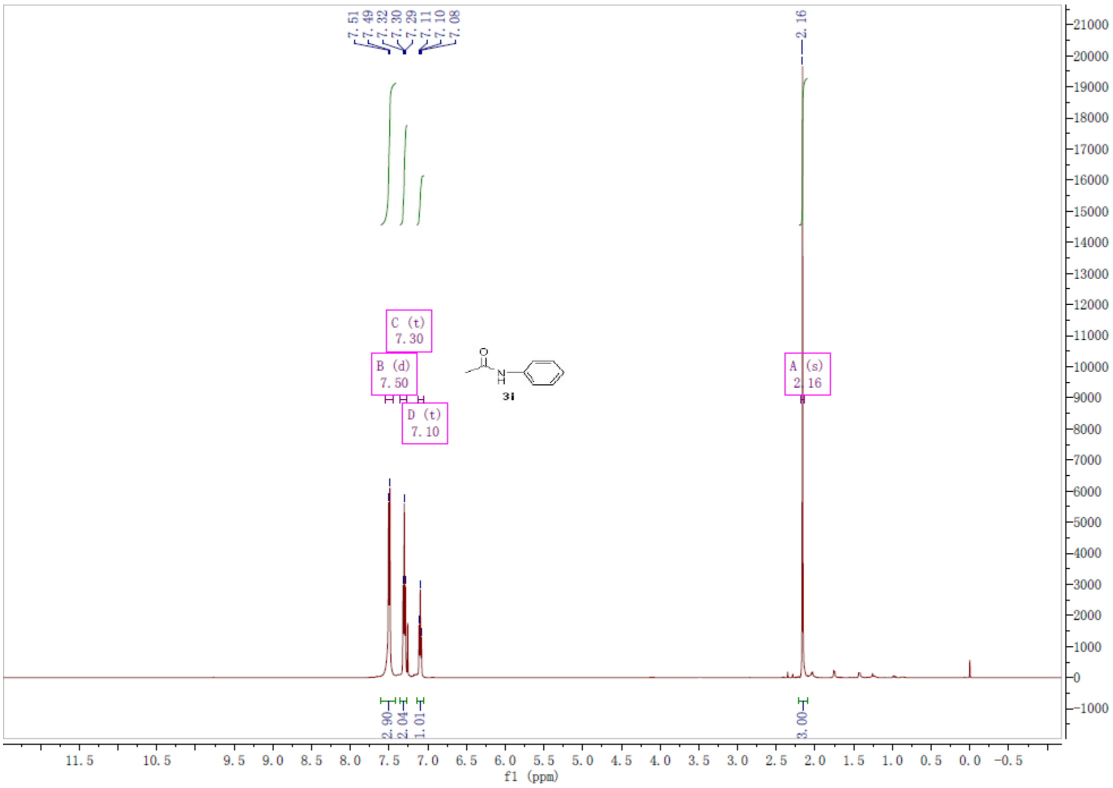
f1 (ppm)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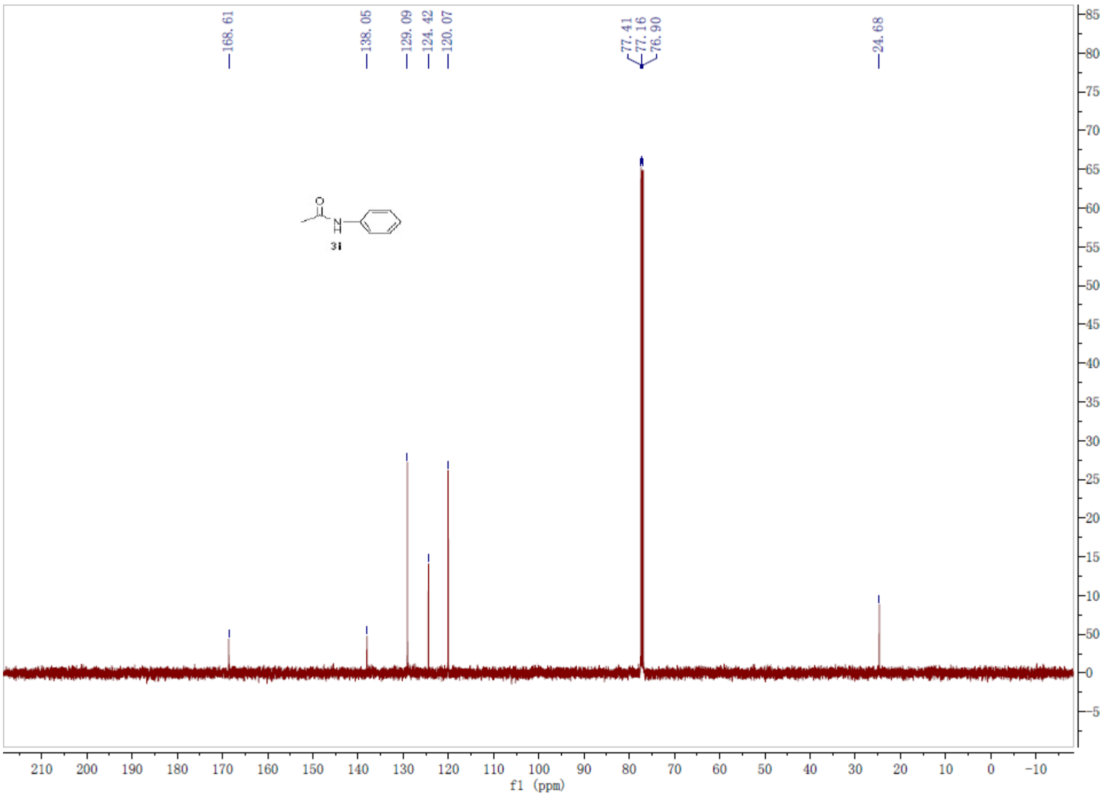
7.08
2.16
C (t)
7.30
B (d)
7.50
D (t)
7.10
A (s)
2.16
3l
2.90
2.04
1.01
3.00
f1 (ppm)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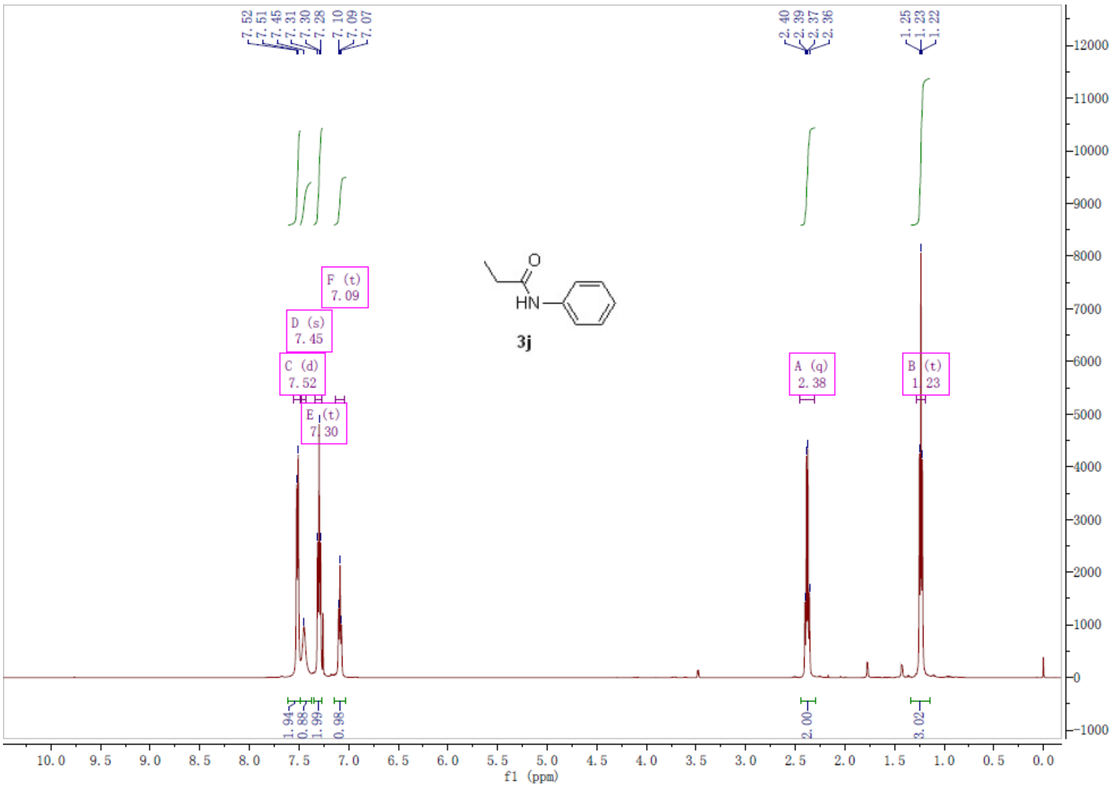
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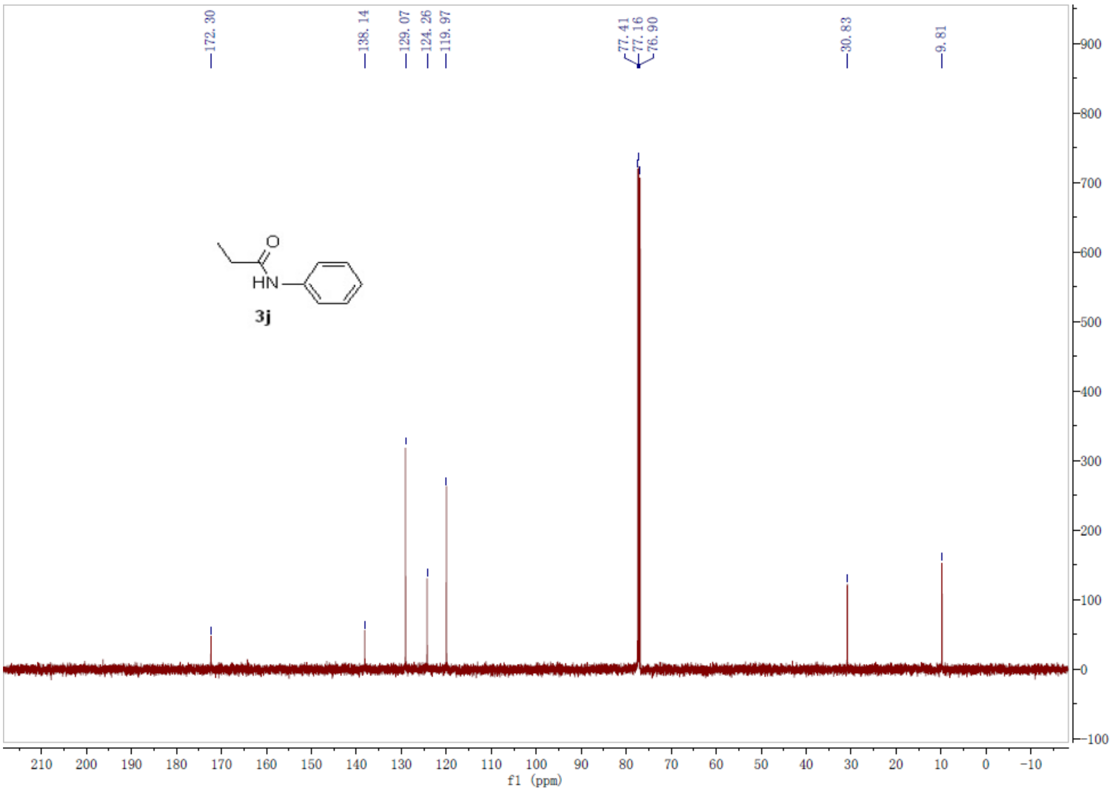
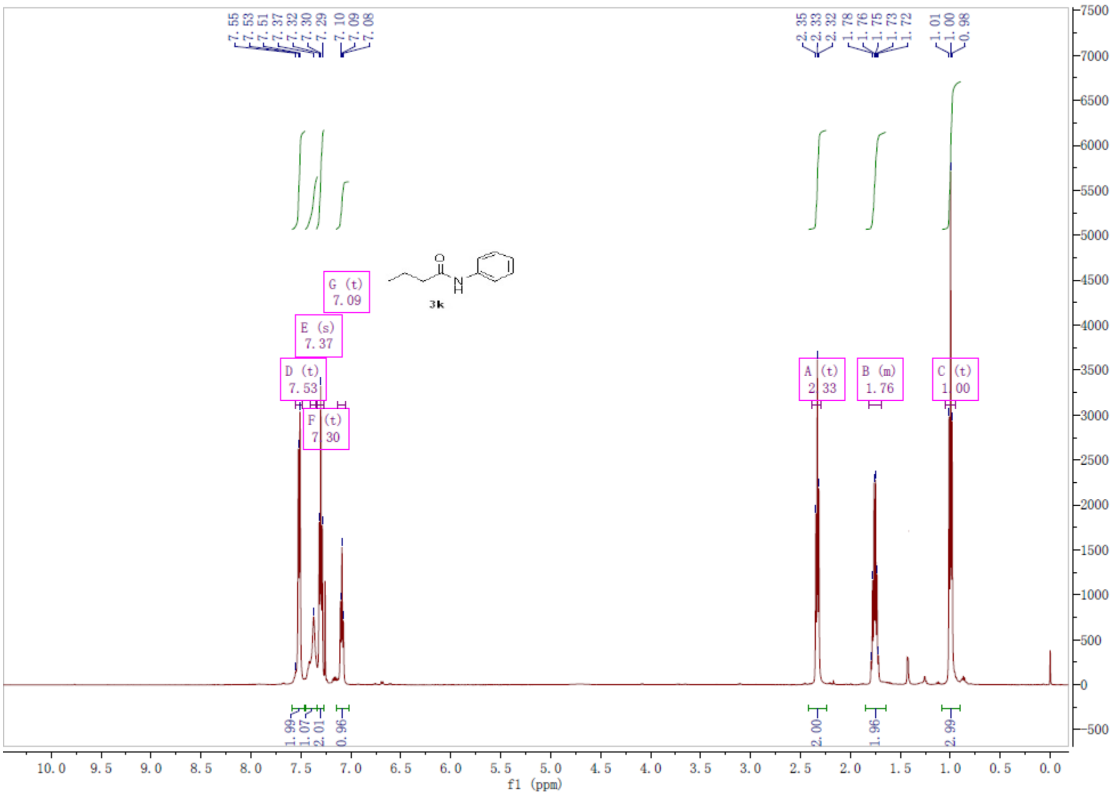
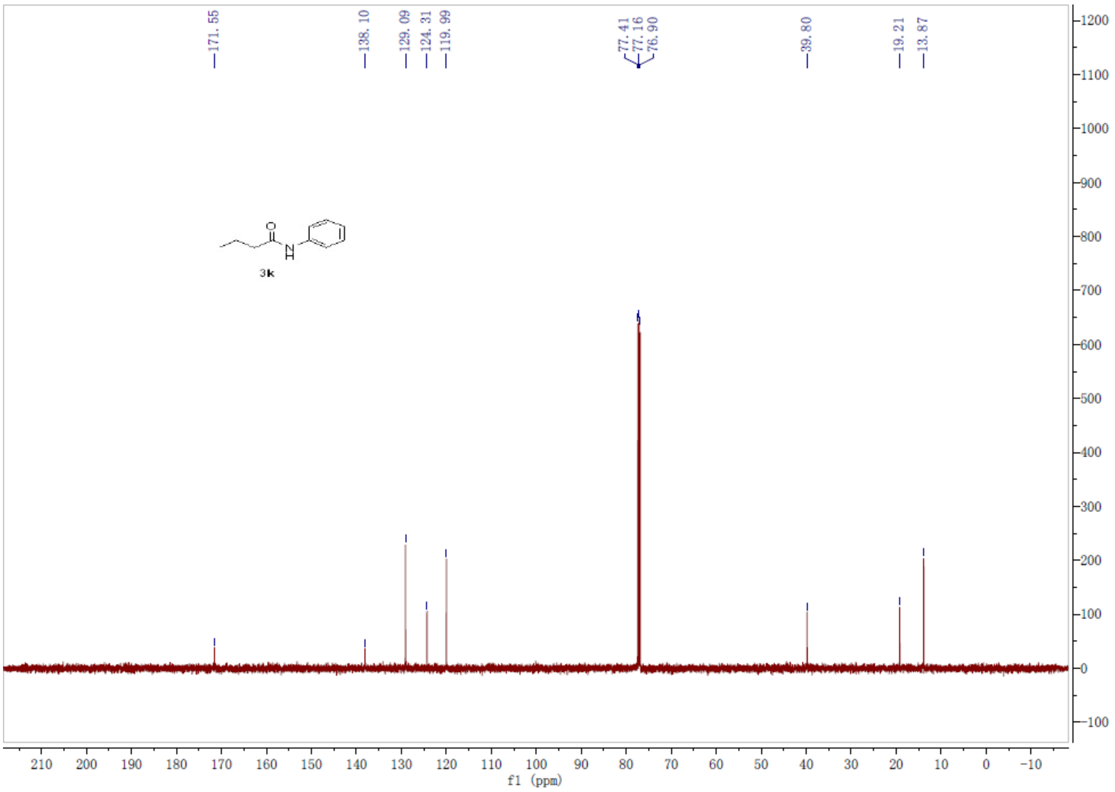
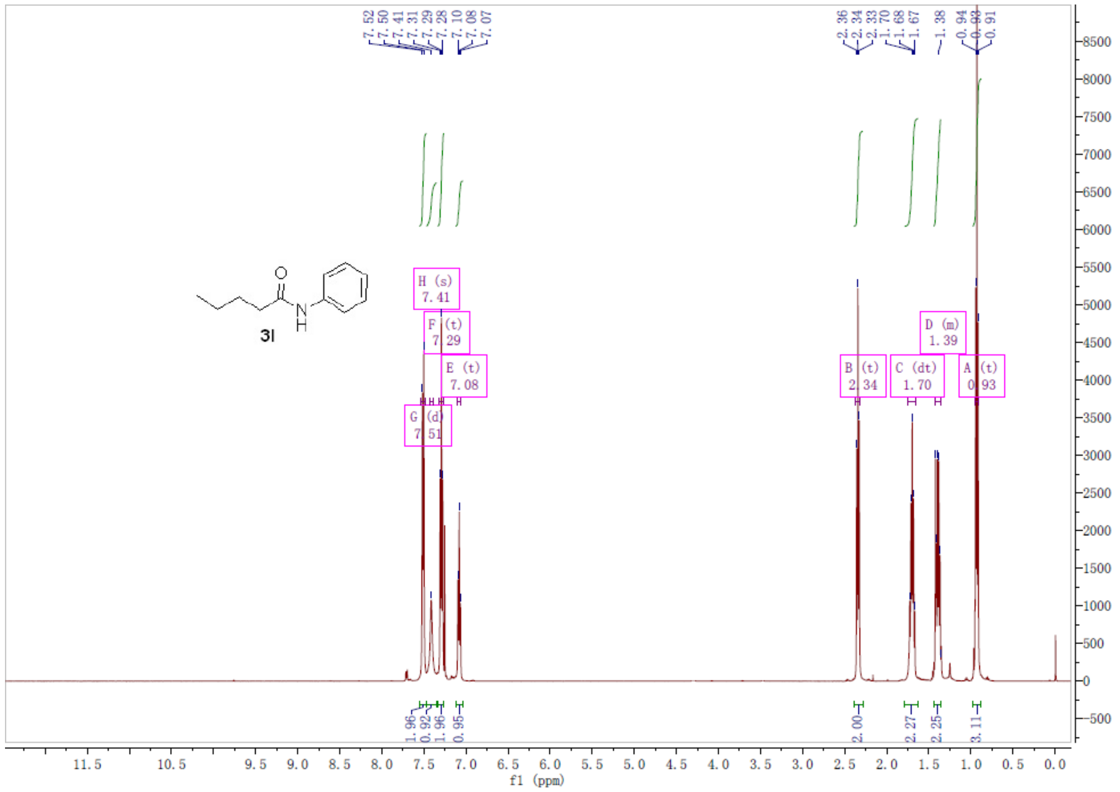
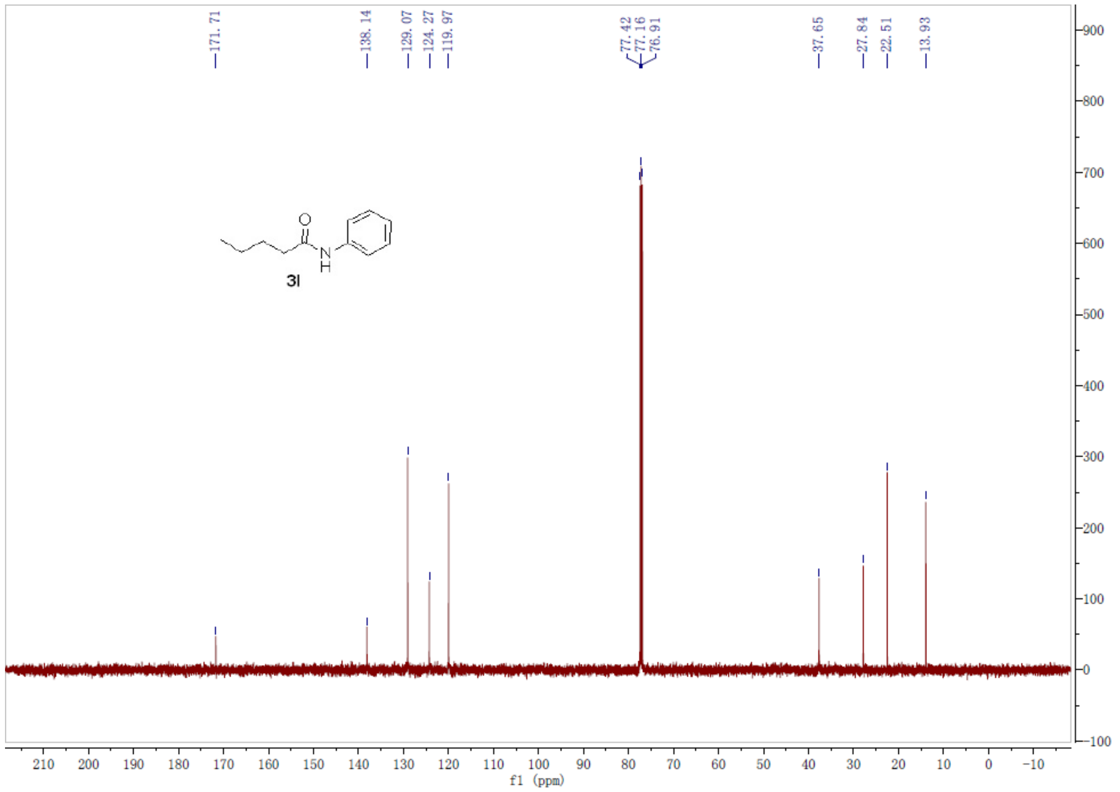
2.36
1.25
1.23
1.22
F (t) 7.09
D (s) 7.45
C (d) 7.52
E (t) 7.30
A (q) 2.38
B (t) 1.23
O
HN
3j
1.94
0.88
1.99
0.98
2.00
3.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
12000 11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0 -1000

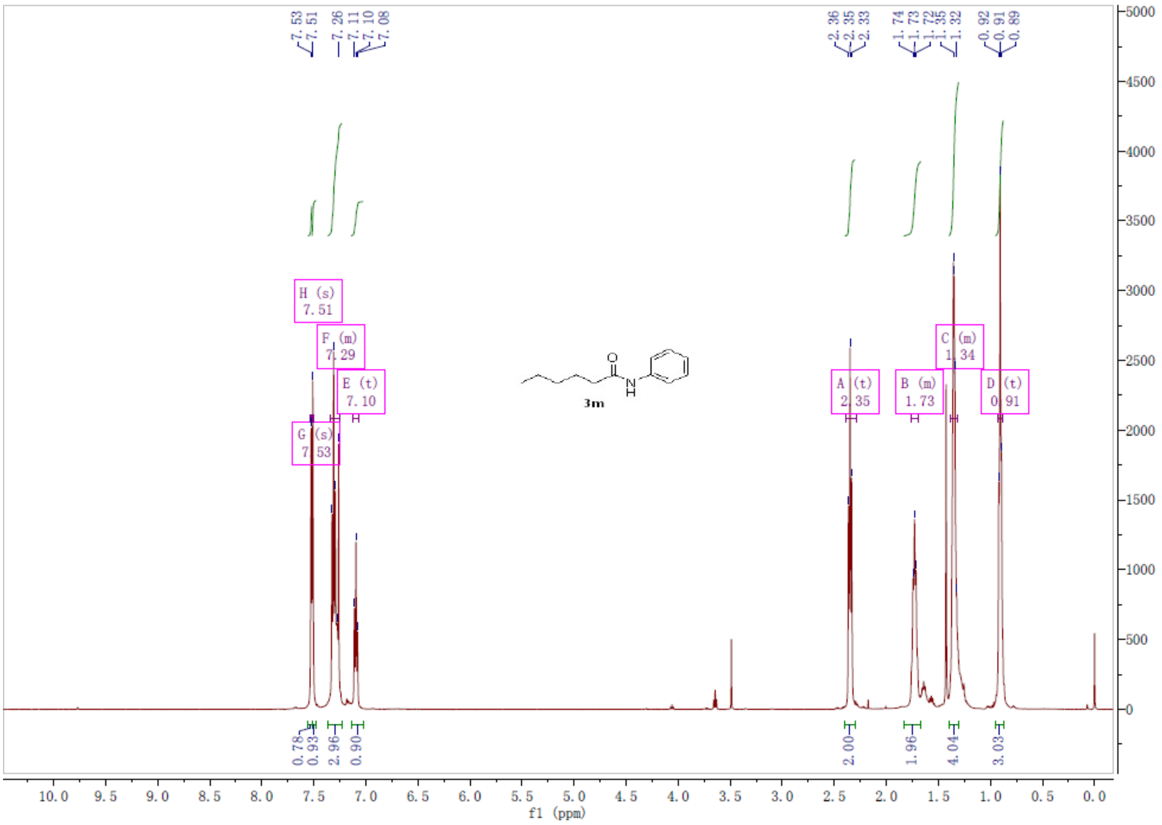

172.30
138.14
129.07
124.26
119.97
77.41
77.16
76.90
30.83
9.81
O
HN
3j
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)
900 800 700 600 500 400 300 200 100 0 -100

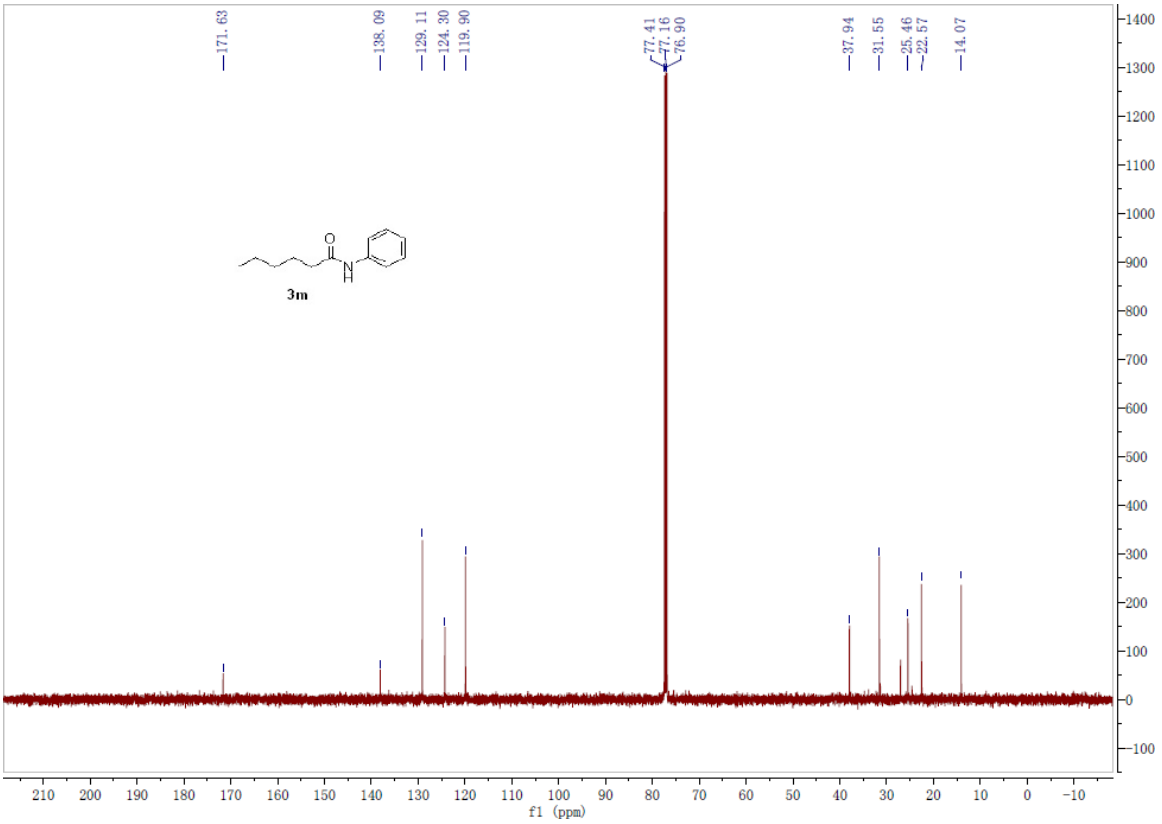

7.55
7.53
7.51
7.37
7.32
7.30
7.29
7.10
7.09
7.08
2.35
2.33
2.32
1.78
1.76
1.75
1.73
1.72
1.01
1.00
0.98
3k
G (t) 7.09
E (s) 7.37
D (t) 7.53
F (t) 7.30
A (t) 2.33
B (m) 1.76
C (t) 1.00
1.99
1.07
2.01
0.96
2.00
1.96
2.99
f1 (ppm)

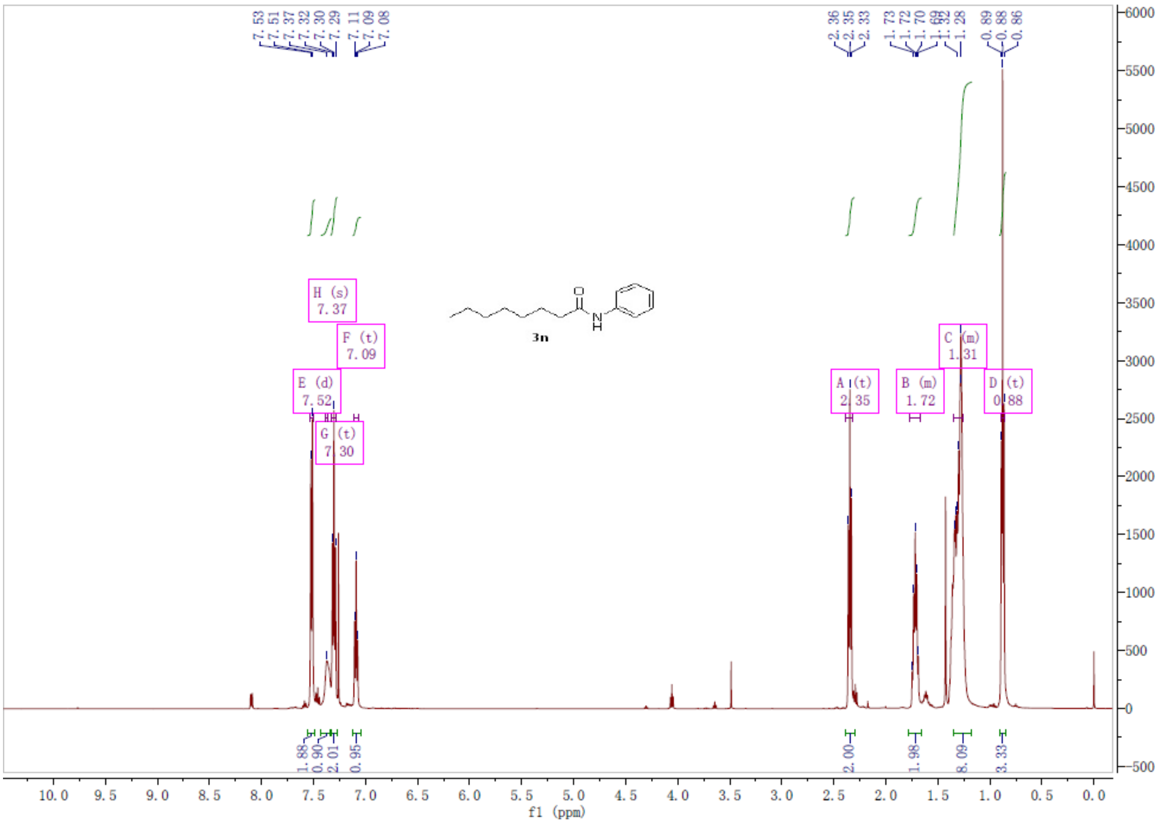

171.55
138.10
129.09
124.31
119.99
77.41
77.16
76.90
39.80
19.21
13.87
3k
f1 (ppm)

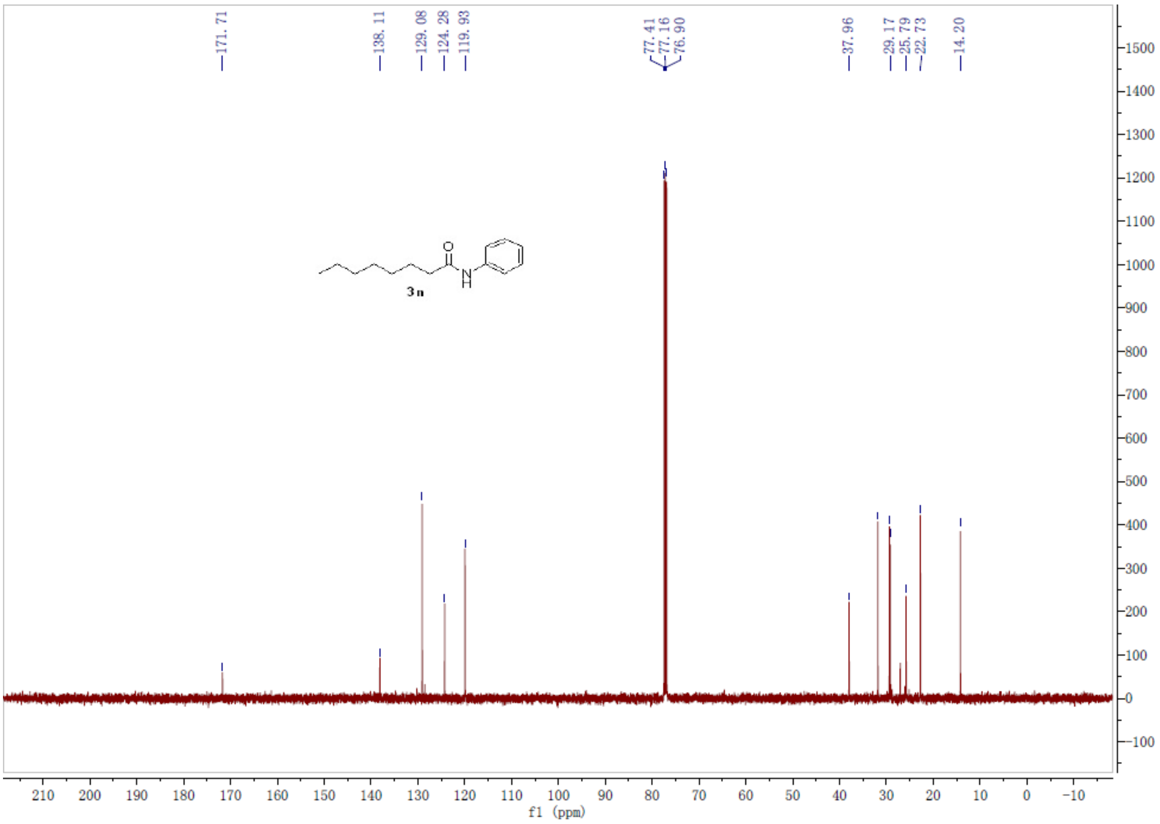

7.52
7.50
7.41
7.31
7.29
7.28
7.10
7.08
7.07
2.36
2.34
2.33
1.70
1.68
1.67
1.38
0.94
0.93
0.91
3l
O
N
H
H (s) 7.41
F (t) 7.29
E (t) 7.08
G (d) 7.51
B (t) 2.34
C (dt) 1.70
D (m) 1.39
A (t) 0.93
1.96
0.92
1.96
0.95
2.00
2.27
2.25
3.11
f1 (ppm)

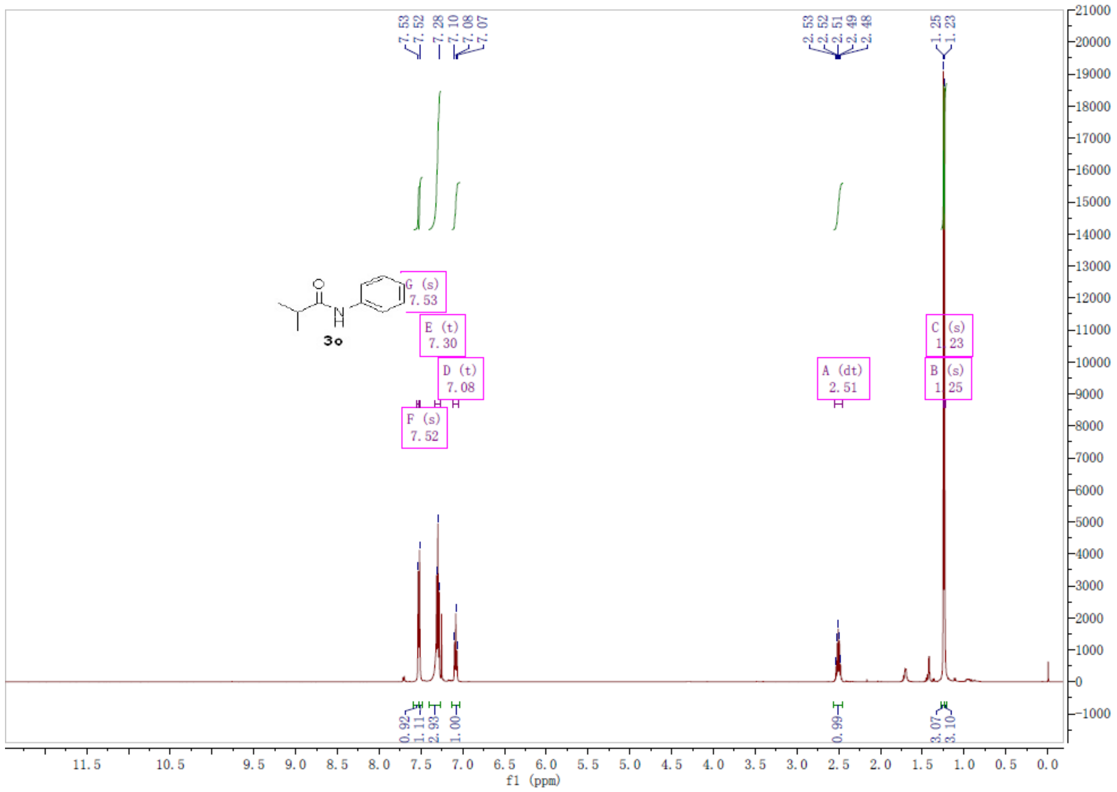

171.71
138.14
129.07
124.27
119.97
77.42
77.16
76.91
37.65
27.84
22.51
13.93
3l
O
N
H
f1 (ppm)

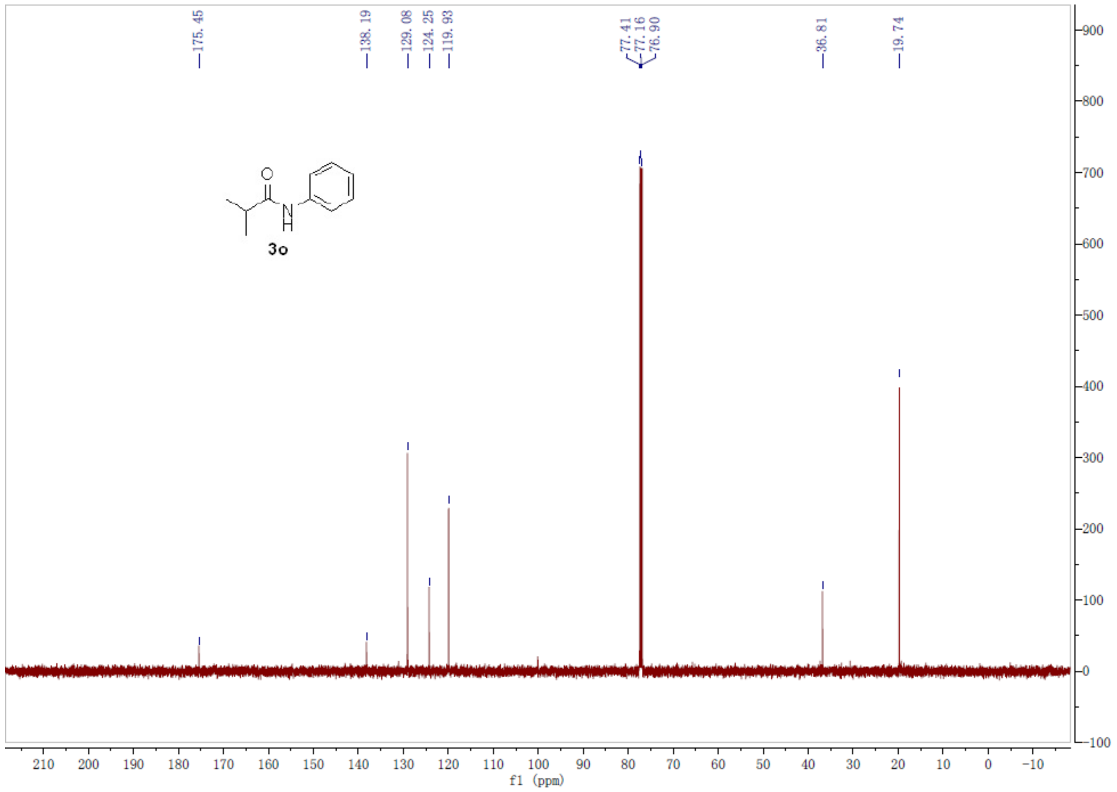

7.53
7.51
7.26
7.11
7.10
7.08
2.36
2.35
2.33
1.74
1.73
1.72
1.35
1.32
0.92
0.91
0.89
H (s) 7.51
F (m) 7.29
E (t) 7.10
G (s) 7.53
A (t) 2.35
B (m) 1.73
C (m) 1.34
D (t) 0.91
O
N
H
3m
0.78
0.93
2.96
0.90
2.00
1.96
4.04
3.03
f1 (ppm)

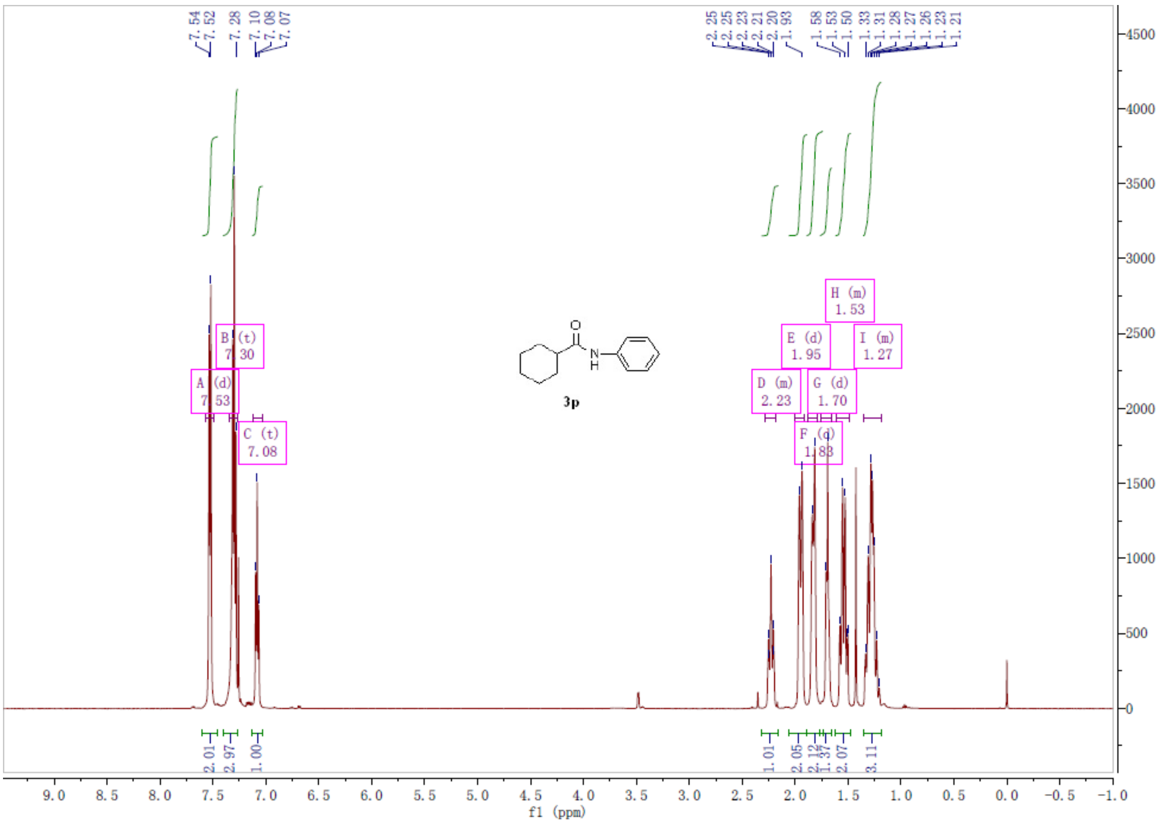

171.63
138.09
129.11
124.30
119.90
77.41
77.16
76.90
37.94
31.55
25.46
22.57
14.07
O
N
H
3m
f1 (ppm)

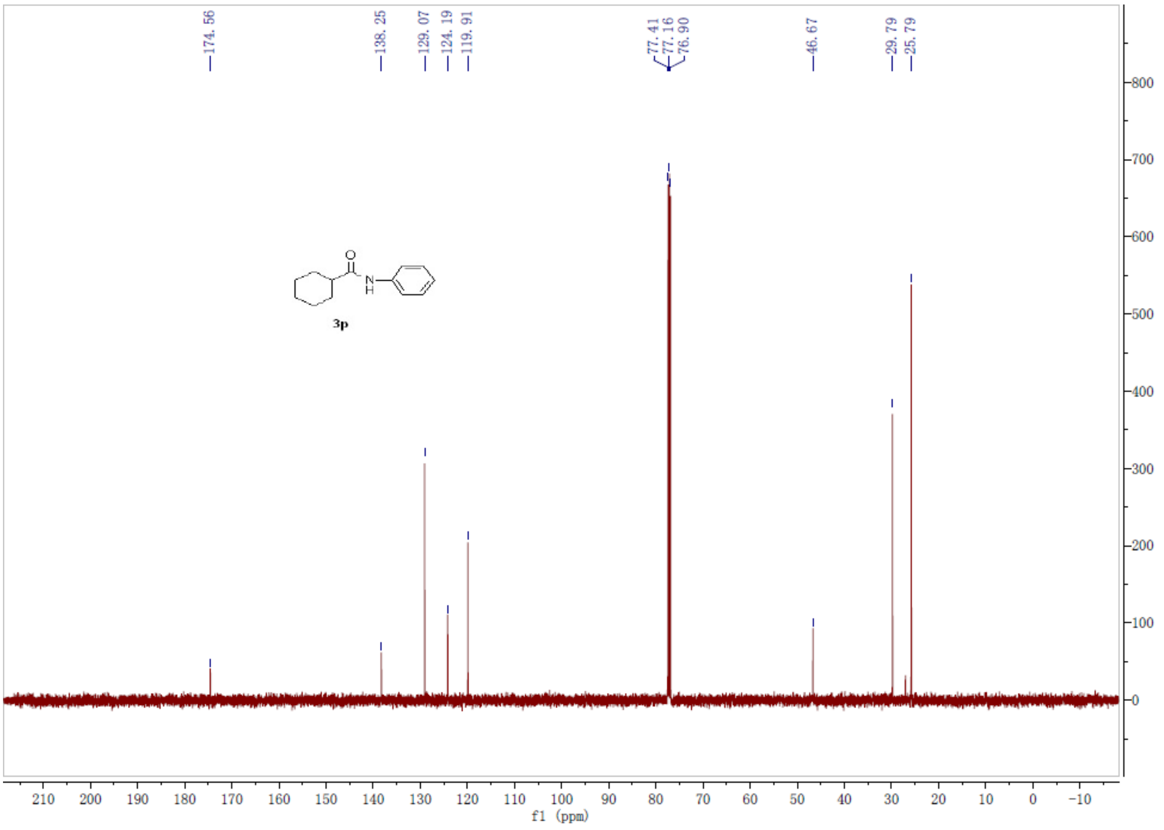

7.53
7.51
7.37
7.32
7.30
7.29
7.11
7.09
7.08
2.36
2.35
2.33
1.73
1.72
1.70
1.69
1.32
1.28
0.89
0.88
0.86
H (s)
7.37
F (t)
7.09
E (d)
7.52
G (t)
7.30
A (t)
2.35
B (m)
1.72
C (m)
1.31
D (t)
0.88
3n
O
N
H
1.88
0.90
2.01
0.95
2.00
1.98
8.09
3.33
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
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)

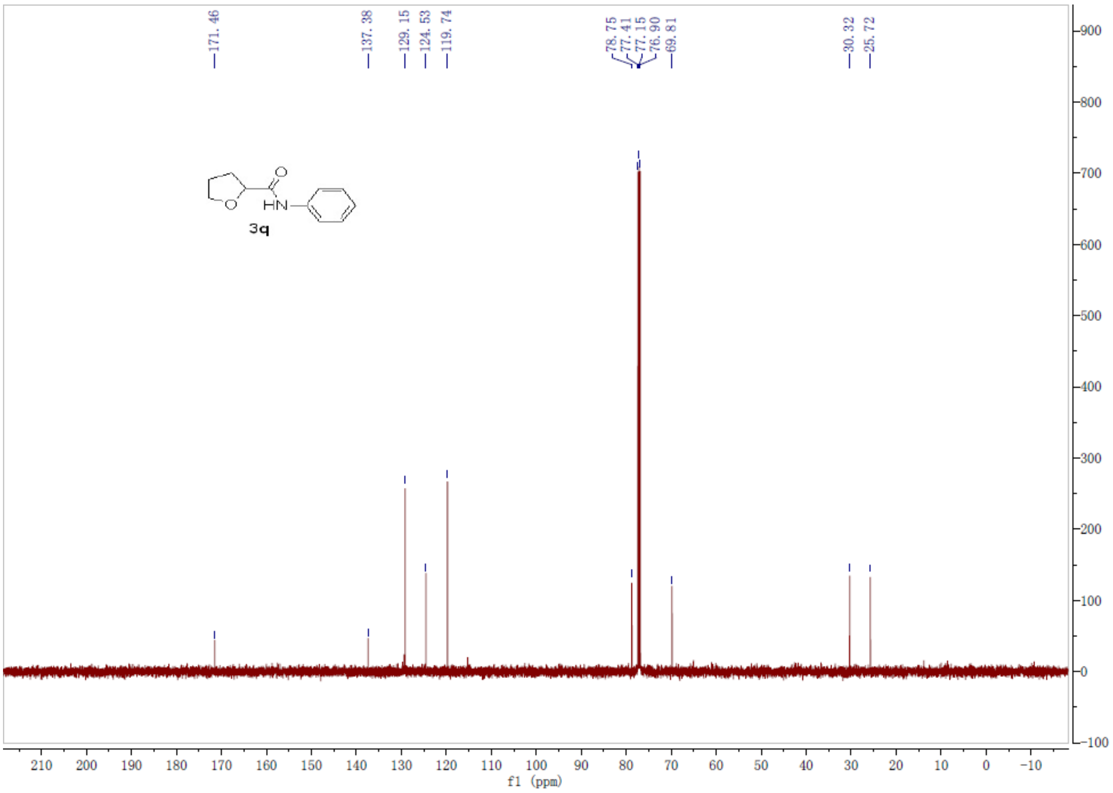

171.71
138.11
129.08
124.28
119.93
77.41
77.16
76.90
37.96
29.17
25.79
22.73
14.20
3n
O
N
H
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

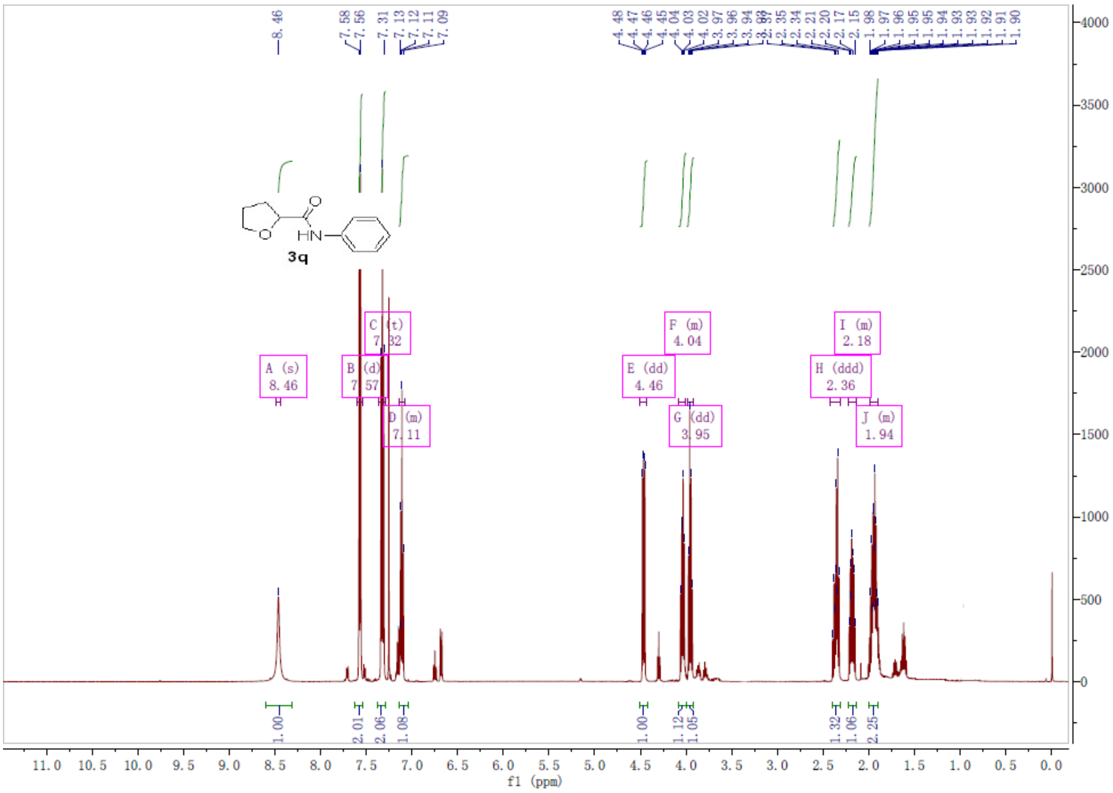

7.53
7.52
7.28
7.10
7.08
7.07
2.53
2.52
2.51
2.49
2.48
1.25
1.23
3o
G (s) 7.53
E (t) 7.30
D (t) 7.08
F (s) 7.52
A (dt) 2.51
C (s) 1.23
B (s) 1.25
0.92
1.11
2.93
1.00
0.99
3.07
3.10
f1 (ppm)

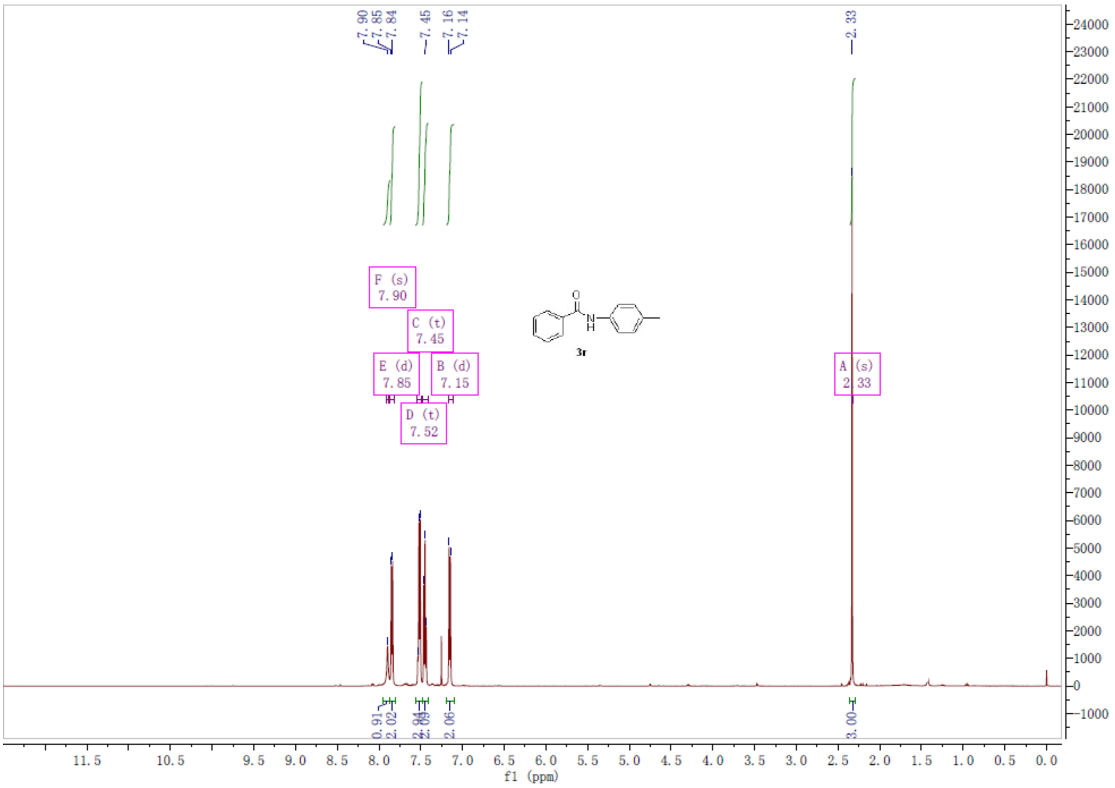

175.45
138.19
129.08
124.25
119.93
77.41
77.16
76.90
36.81
19.74
3o
f1 (ppm)

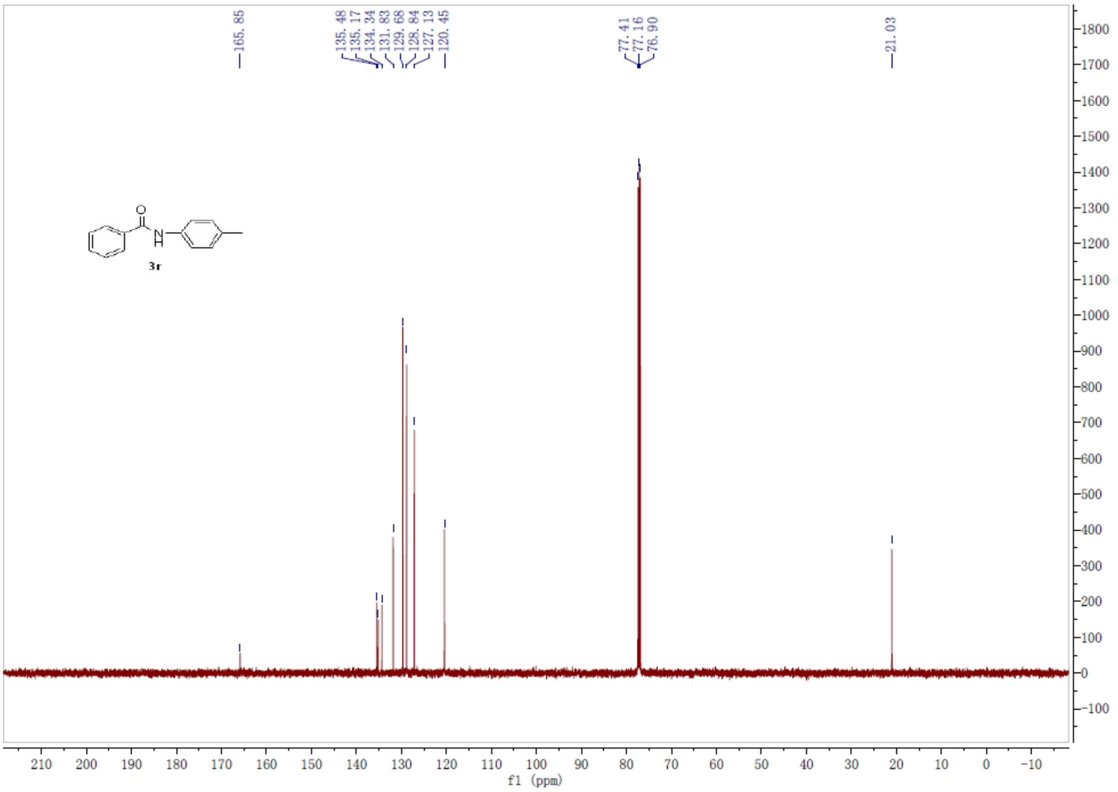

7.54
7.52
7.28
7.10
7.08
7.07
2.25
2.25
2.23
2.21
2.20
1.93
1.58
1.53
1.50
1.33
1.31
1.28
1.27
1.26
1.23
1.21
A (d) 7.53
B (t) 7.30
C (t) 7.08
D (m) 2.23
E (d) 1.95
F (d) 1.83
G (d) 1.70
H (m) 1.53
I (m) 1.27
O
N
H
3p
2.01
2.97
1.00
1.01
2.05
2.12
1.37
2.07
3.11
4500
4000
3500
3000
2500
2000
1500
1000
500
0
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
f1 (ppm)

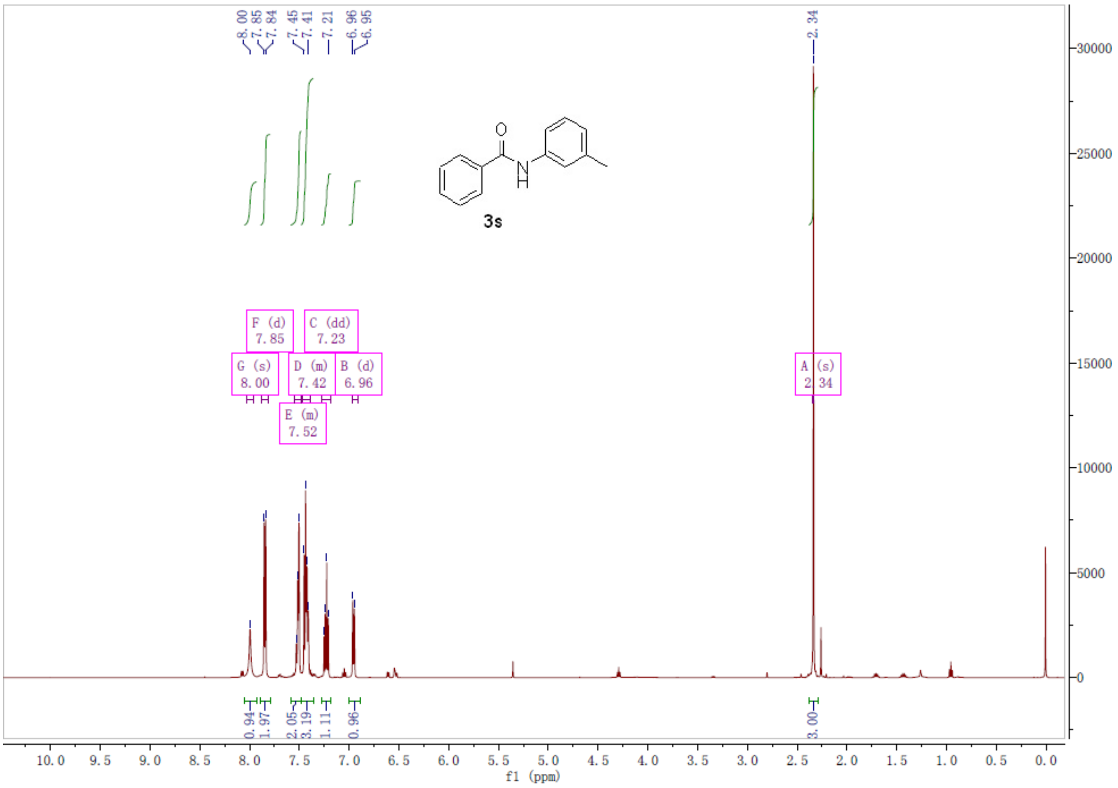

174.56
138.25
129.07
124.19
119.91
77.41
77.16
76.90
46.67
29.79
25.79
O
N
H
3p
800
700
600
500
400
300
200
100
0
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

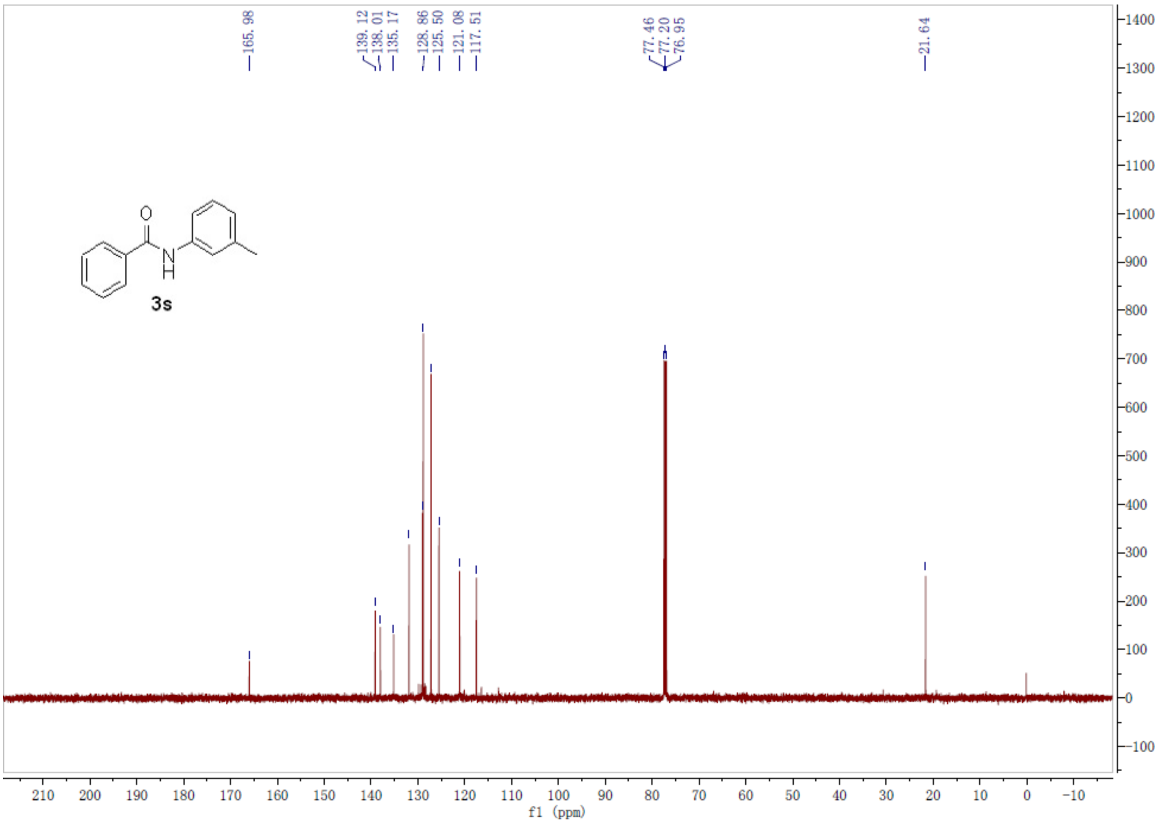

171.46
137.38
129.15
124.53
119.74
78.75
77.41
77.15
76.90
69.81
30.32
25.72
HN
O
3q
900
800
700
600
500
400
300
200
100
0
-100
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

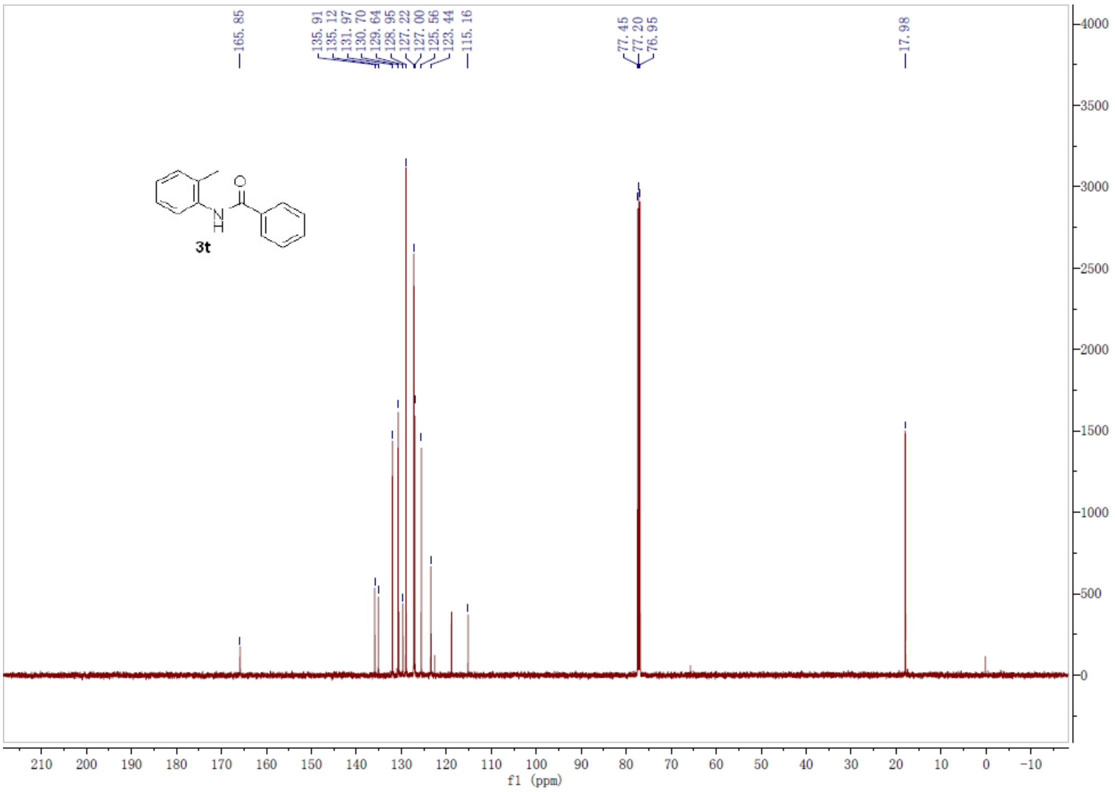

8.46
7.58
7.56
7.31
7.13
7.12
7.11
7.09
4.48
4.47
4.46
4.45
4.04
4.03
4.02
3.97
3.96
3.94
3.93
2.37
2.35
2.34
2.21
2.20
2.17
2.15
1.98
1.97
1.96
1.95
1.95
1.94
1.93
1.93
1.92
1.91
1.90
HN
O
3q
A (s)
8.46
B (d)
7.57
C (t)
7.32
D (m)
7.11
E (dd)
4.46
F (m)
4.04
G (dd)
3.95
H (ddd)
2.36
I (m)
2.18
J (m)
1.94
1.00
2.01
2.06
1.08
1.00
1.12
1.05
1.32
1.06
2.25
4000
3500
3000
2500
2000
1500
1000
500
0
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 1.5 1.0 0.5 0.0
f1 (ppm)

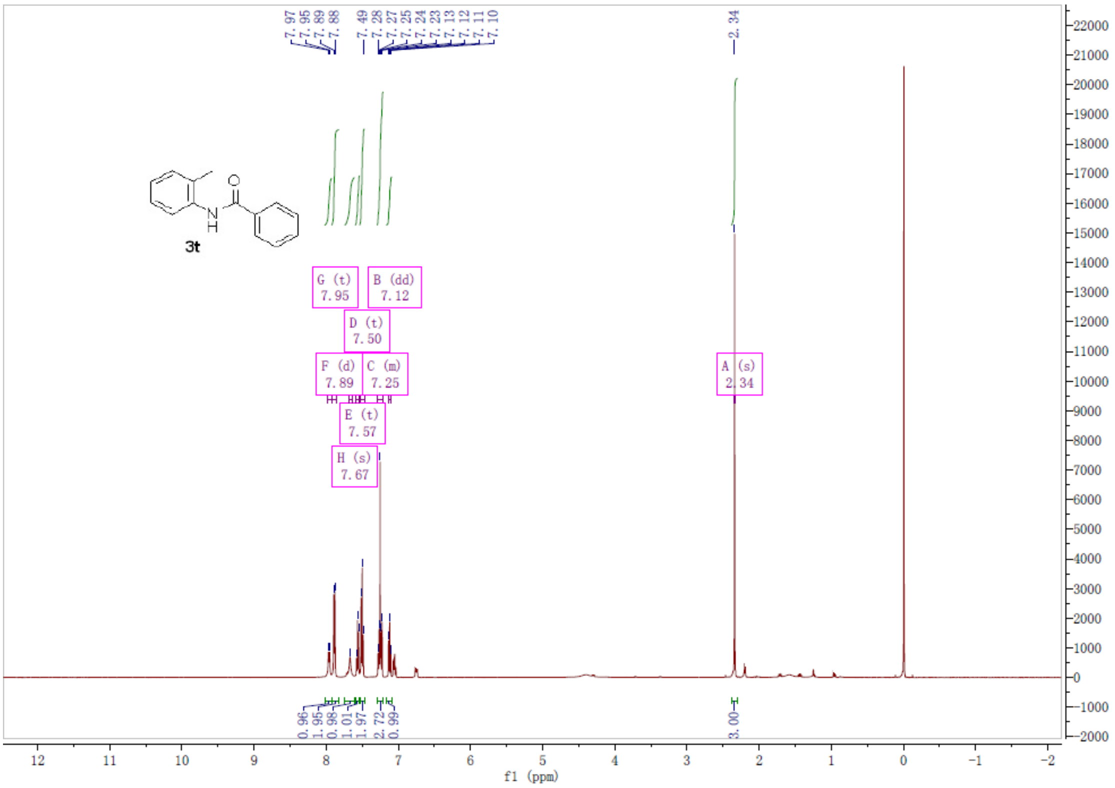

7.90
7.85
7.84
7.45
7.16
7.14
2.33
F (s)
7.90
C (t)
7.45
E (d)
7.85
B (d)
7.15
D (t)
7.52
A (s)
2.33
O
N
H
3r
0.91
2.02
2.04
2.09
2.06
3.00
f1 (ppm)

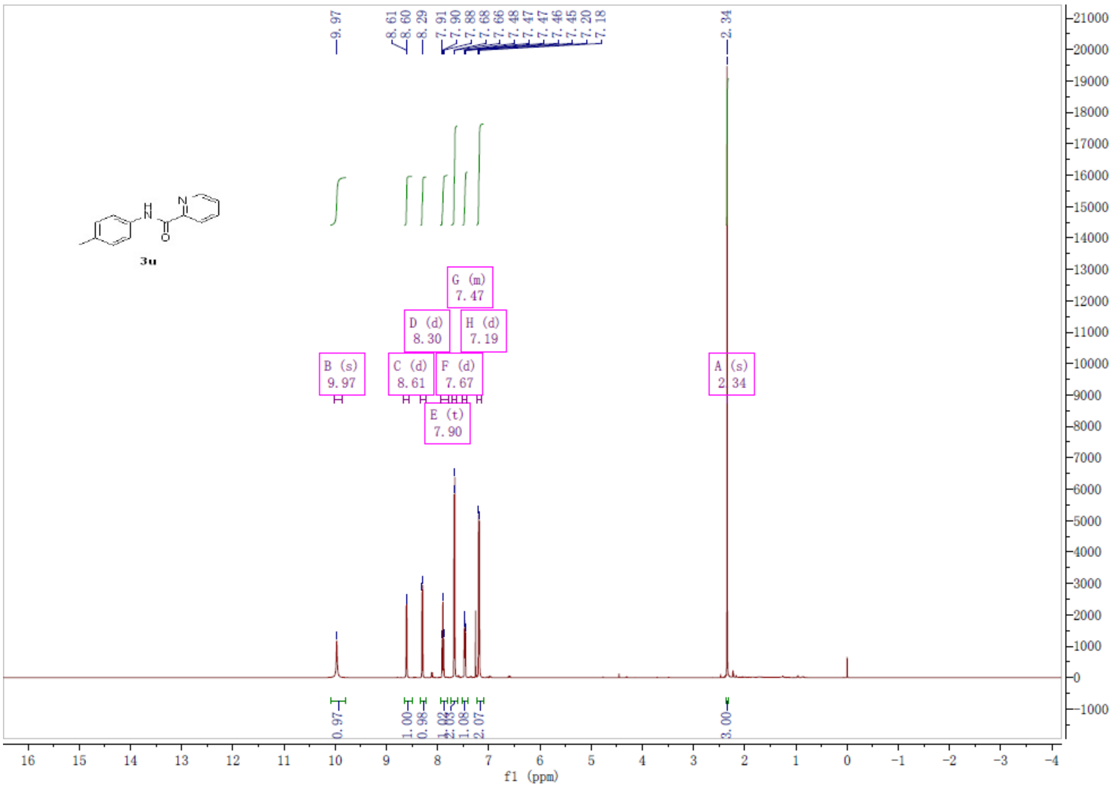

165.85
135.48
135.17
134.34
131.83
129.68
128.84
127.13
120.45
77.41
77.16
76.90
21.03
O
N
H
3r
f1 (ppm)

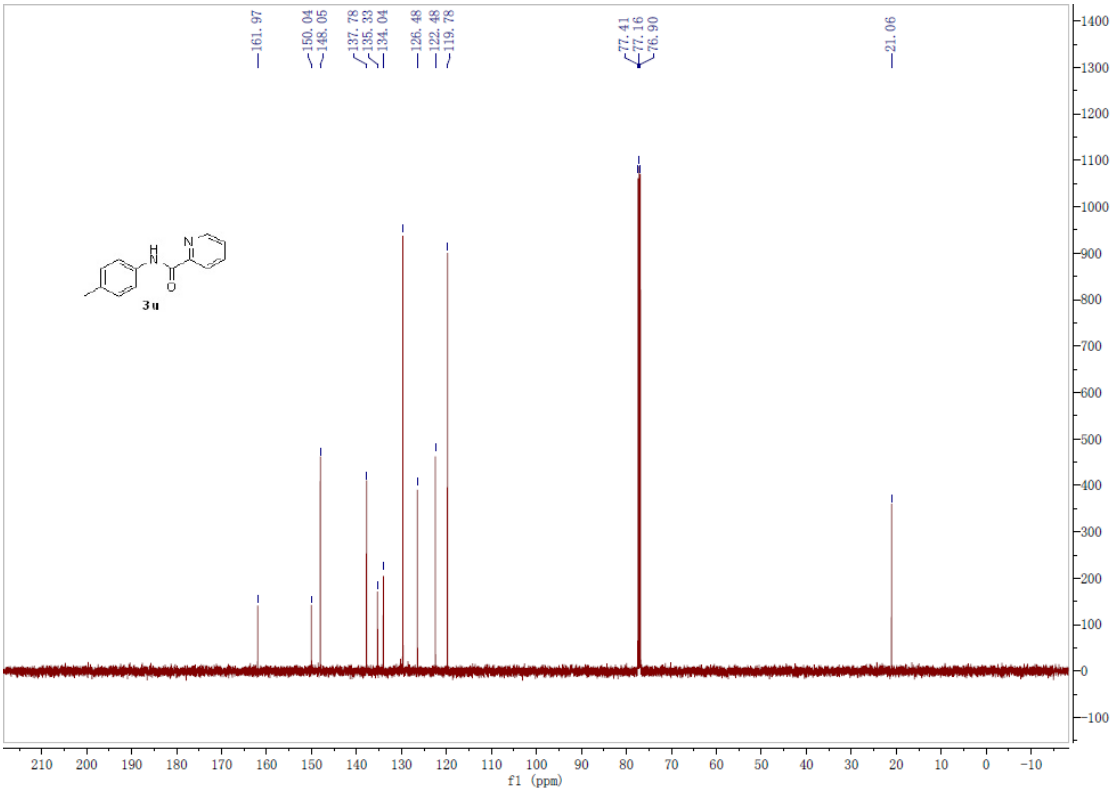

8.00
7.85
7.84
7.45
7.41
7.21
6.96
6.95
2.34
3s
F (d) 7.85
C (dd) 7.23
G (s) 8.00
D (m) 7.42
B (d) 6.96
E (m) 7.52
A (s) 2.34
0.94
1.97
2.05
3.19
1.11
0.96
3.00
30000
25000
20000
15000
10000
5000
0
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

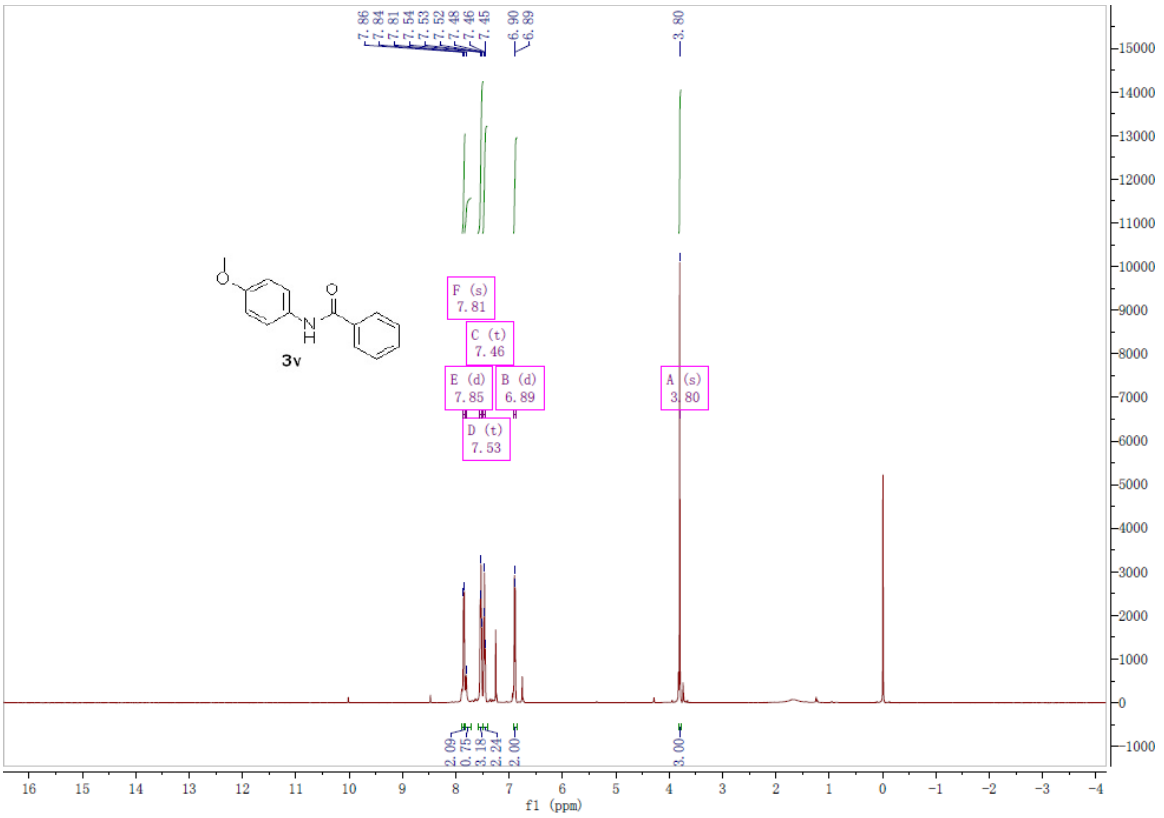

165.98
139.12
138.01
135.17
128.86
125.50
121.08
117.51
77.46
77.20
76.95
21.64
3s
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

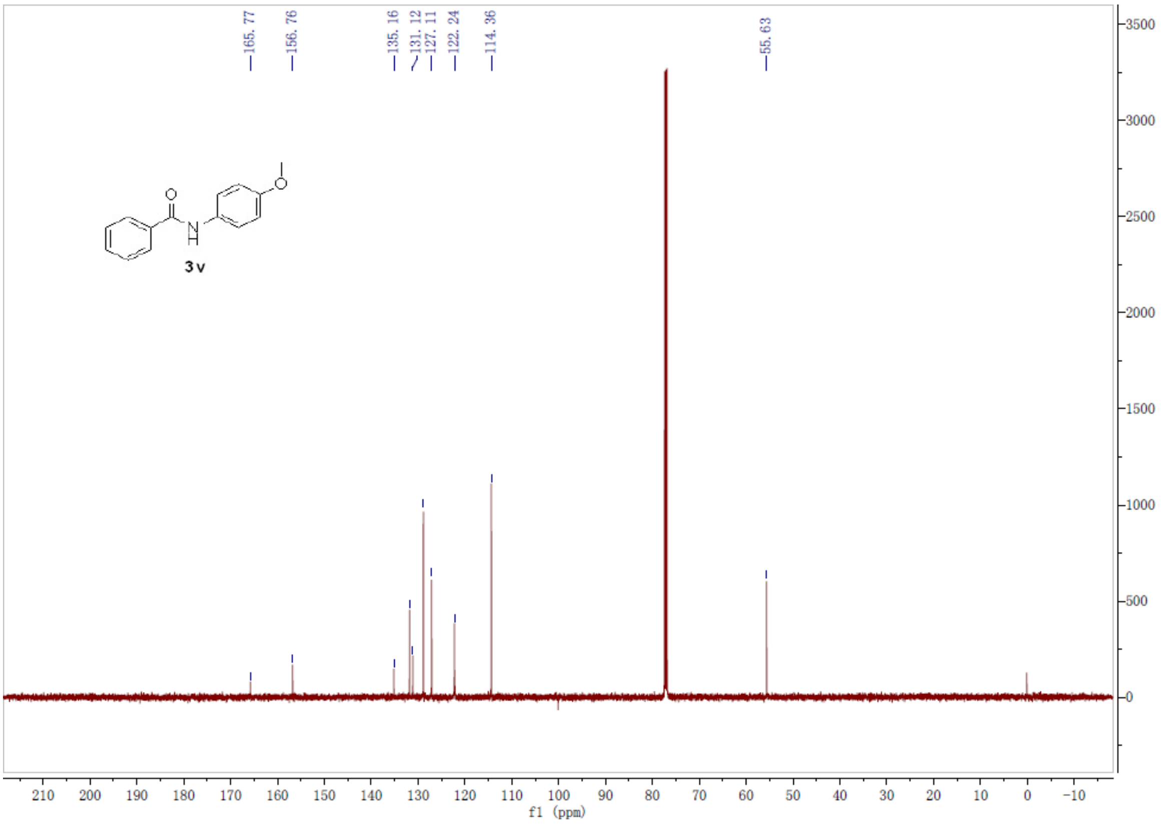

165.85
135.91
135.12
131.97
130.70
129.64
128.95
127.22
127.00
125.56
123.44
115.16
77.45
77.20
76.95
17.98
3t
4000
3500
3000
2500
2000
1500
1000
500
0
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)

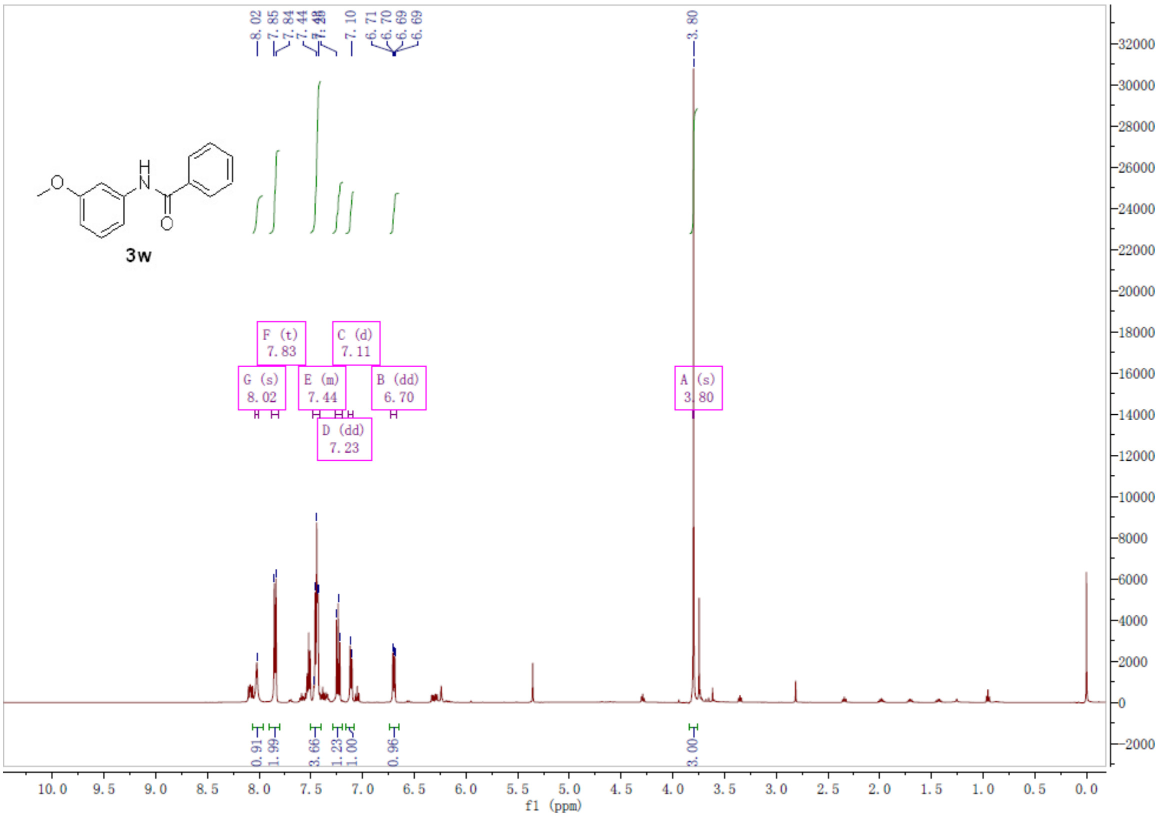

7.97
7.95
7.89
7.88
7.49
7.28
7.27
7.25
7.24
7.23
7.13
7.12
7.11
7.10
2.34
3t
G (t) 7.95
B (dd) 7.12
D (t) 7.50
F (d) 7.89
C (m) 7.25
A (s) 2.34
E (t) 7.57
H (s) 7.67
0.96
1.95
0.98
1.01
1.97
2.72
0.99
3.00
22000
21000
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
−1000
−2000
12 11 10 9 8 7 6 5 4 3 2 1 0 −1 −2
f1 (ppm)

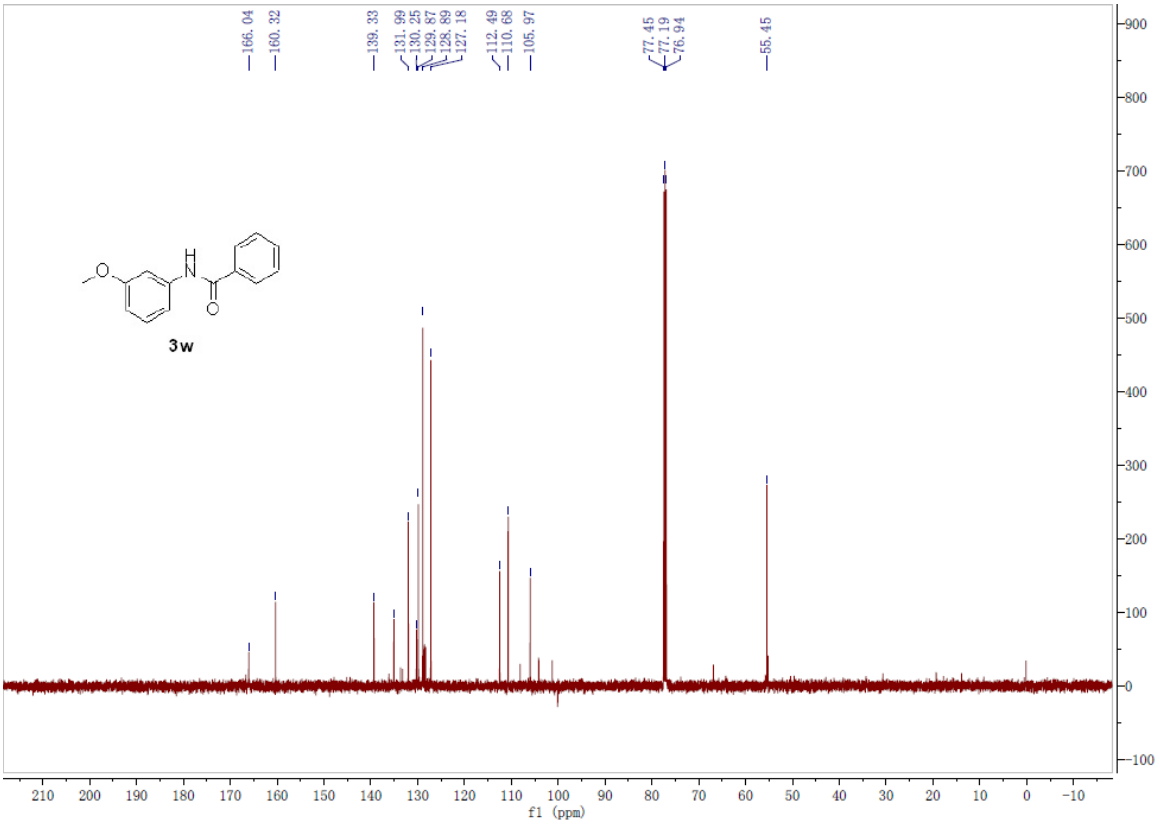

3u
9.97
8.61
8.60
8.29
7.91
7.90
7.88
7.68
7.66
7.48
7.47
7.47
7.46
7.45
7.20
7.18
2.34
G (m) 7.47
D (d) 8.30
H (d) 7.19
B (s) 9.97
C (d) 8.61
F (d) 7.67
E (t) 7.90
A (s) 2.34
0.97
1.00
0.98
1.02
2.03
1.08
2.07
3.00
f1 (ppm)

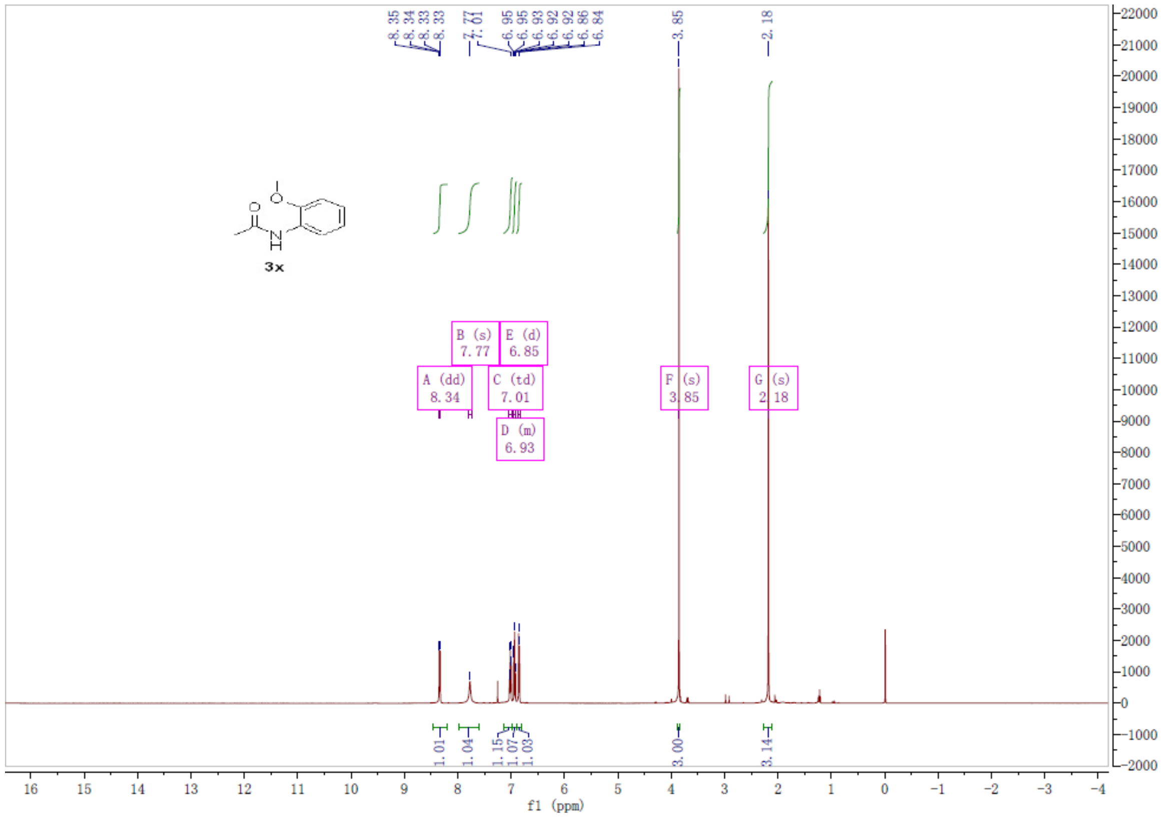

3u
161.97
150.04
148.05
137.78
135.33
134.04
126.48
122.48
119.78
77.41
77.16
76.90
21.06
f1 (ppm)

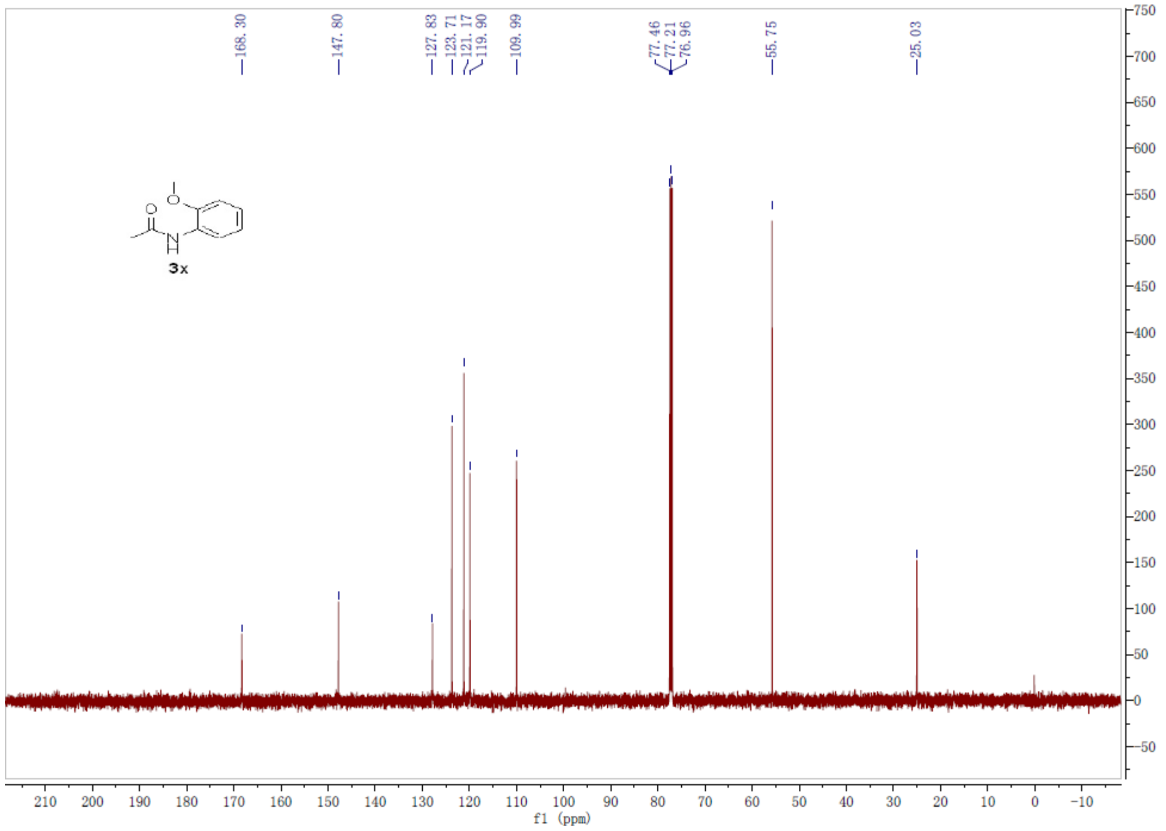

7.86
7.84
7.81
7.54
7.53
7.52
7.48
7.46
7.45
6.90
6.89
3.80
3v
F (s) 7.81
C (t) 7.46
E (d) 7.85
B (d) 6.89
A (s) 3.80
D (t) 7.53
2.09
0.75
3.18
2.24
2.00
3.00
f1 (ppm)

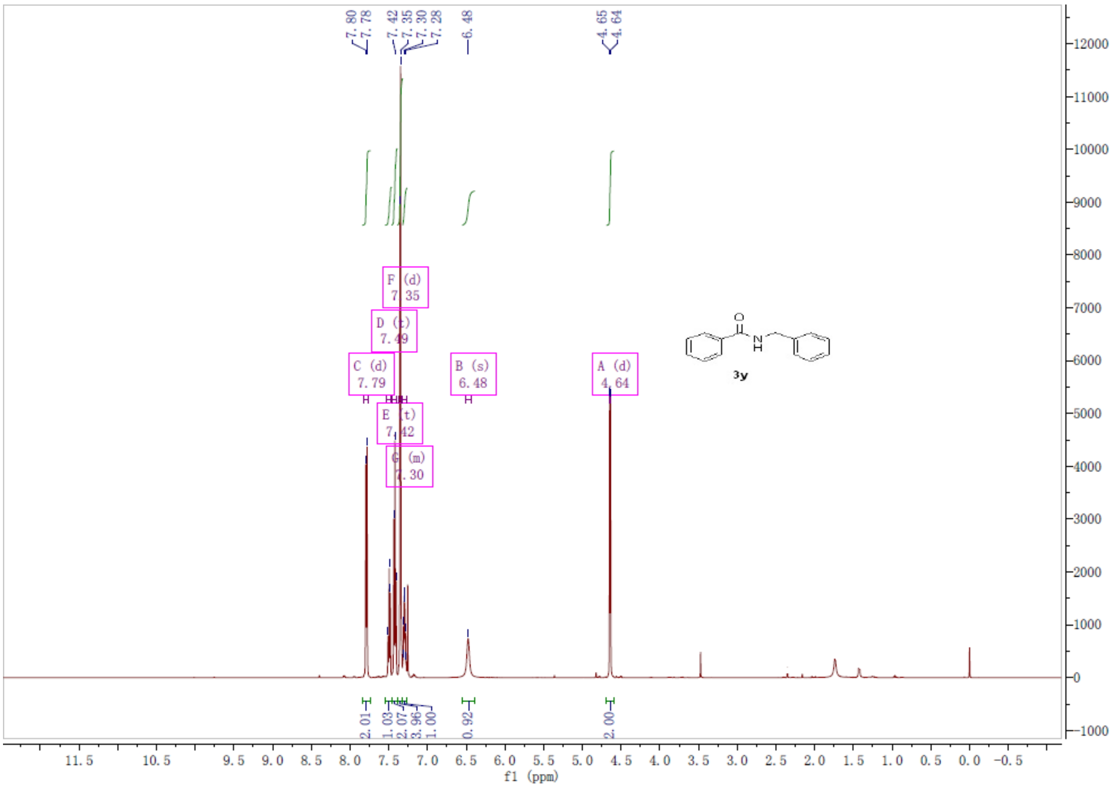

165.77
156.76
135.16
131.12
127.11
122.24
114.36
55.63
3v
f1 (ppm)

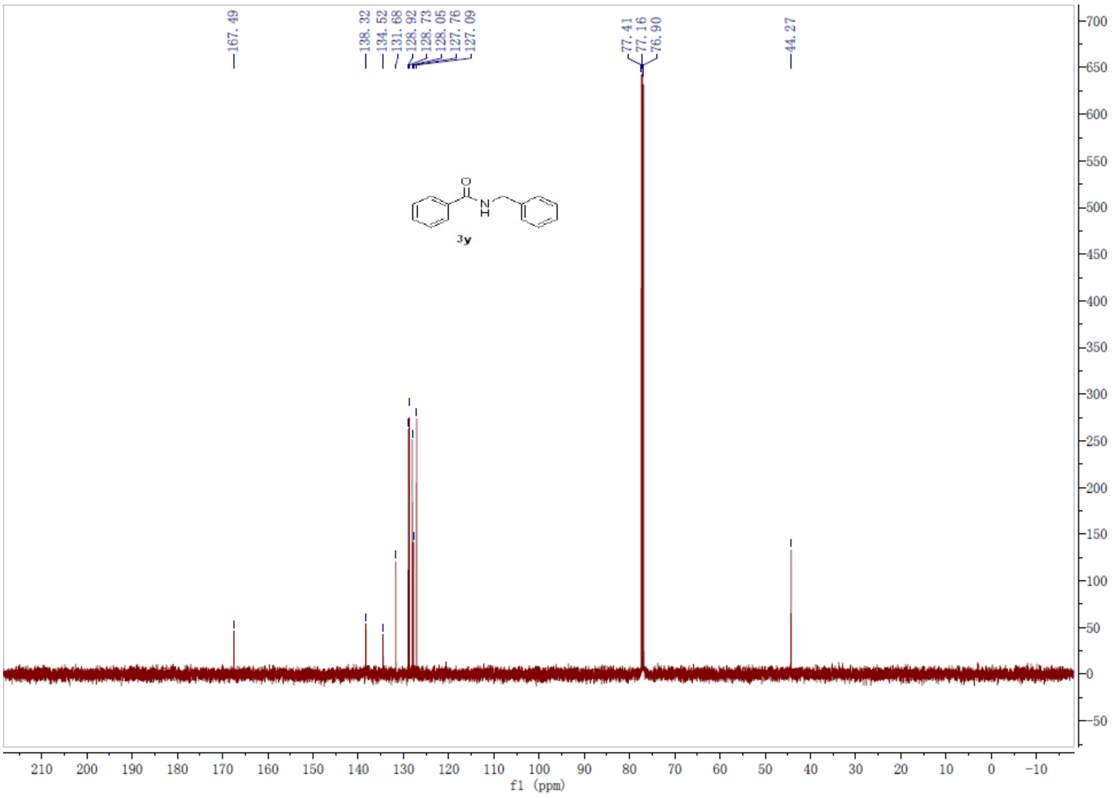

3w
8.02
7.85
7.84
7.44
7.10
6.71
6.70
6.69
6.69
3.80
F (t) 7.83
C (d) 7.11
G (s) 8.02
E (m) 7.44
B (dd) 6.70
A (s) 3.80
D (dd) 7.23
0.91
1.99
3.66
1.23
1.00
0.96
3.00
f1 (ppm)

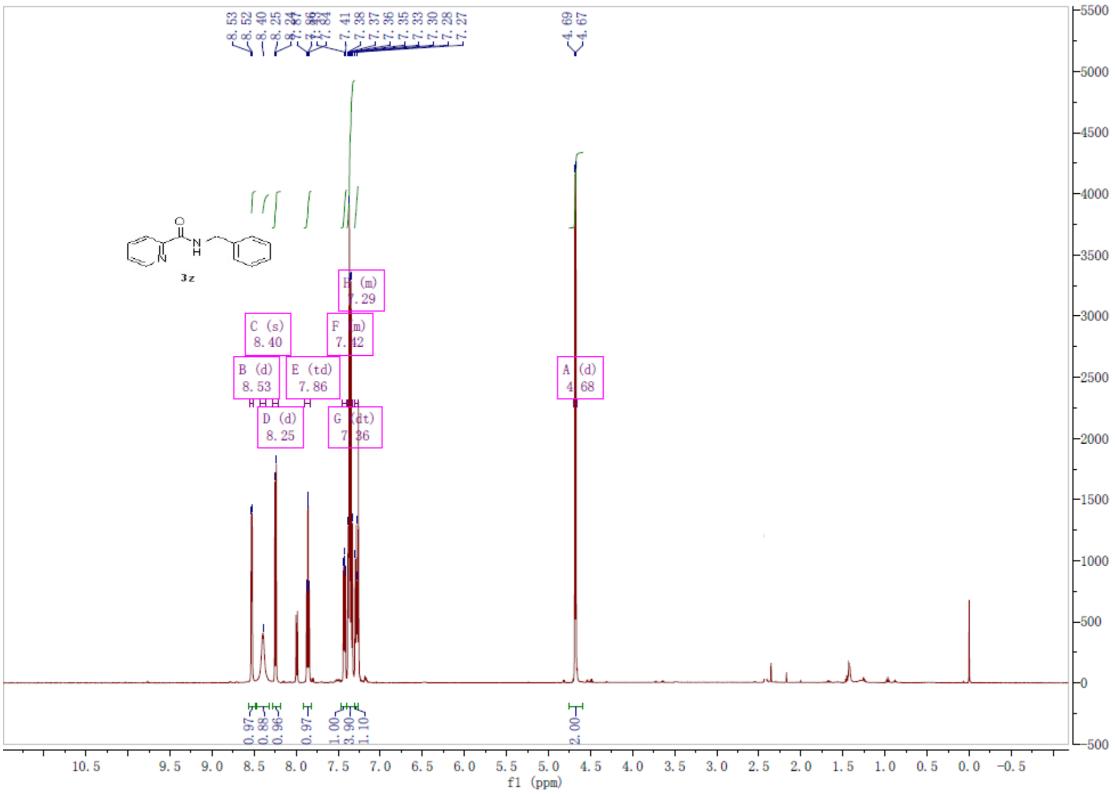

3w
166.04
160.32
139.33
131.99
130.25
129.87
128.89
127.18
112.49
110.68
105.97
77.45
77.19
76.94
55.45
f1 (ppm)

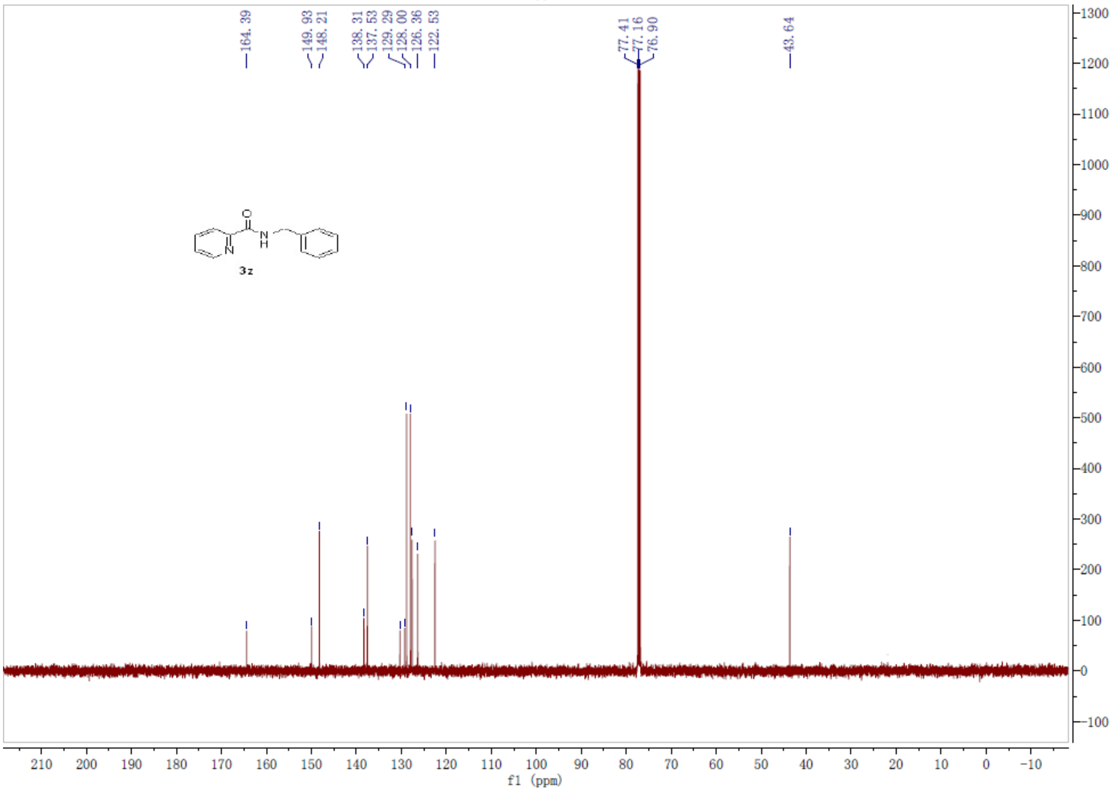

8.35
8.34
8.33
8.33
7.77
7.01
6.95
6.95
6.93
6.92
6.92
6.86
6.84
3.85
2.18
3x
B (s) 7.77
E (d) 6.85
A (dd) 8.34
C (td) 7.01
D (m) 6.93
F (s) 3.85
G (s) 2.18
1.01
1.04
1.15
1.07
1.03
3.00
3.14
f1 (ppm)

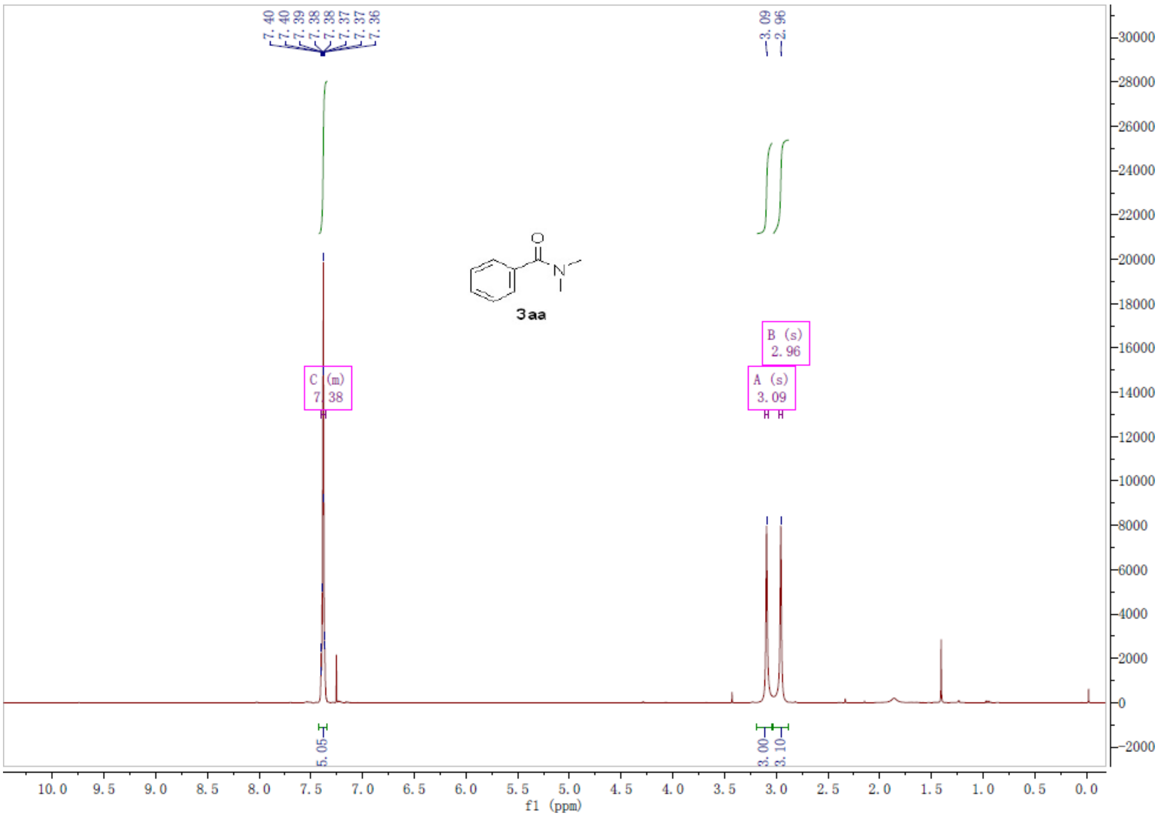

168.30
147.80
127.83
123.71
121.17
119.90
109.99
77.46
77.21
76.96
55.75
25.03
3x
f1 (ppm)

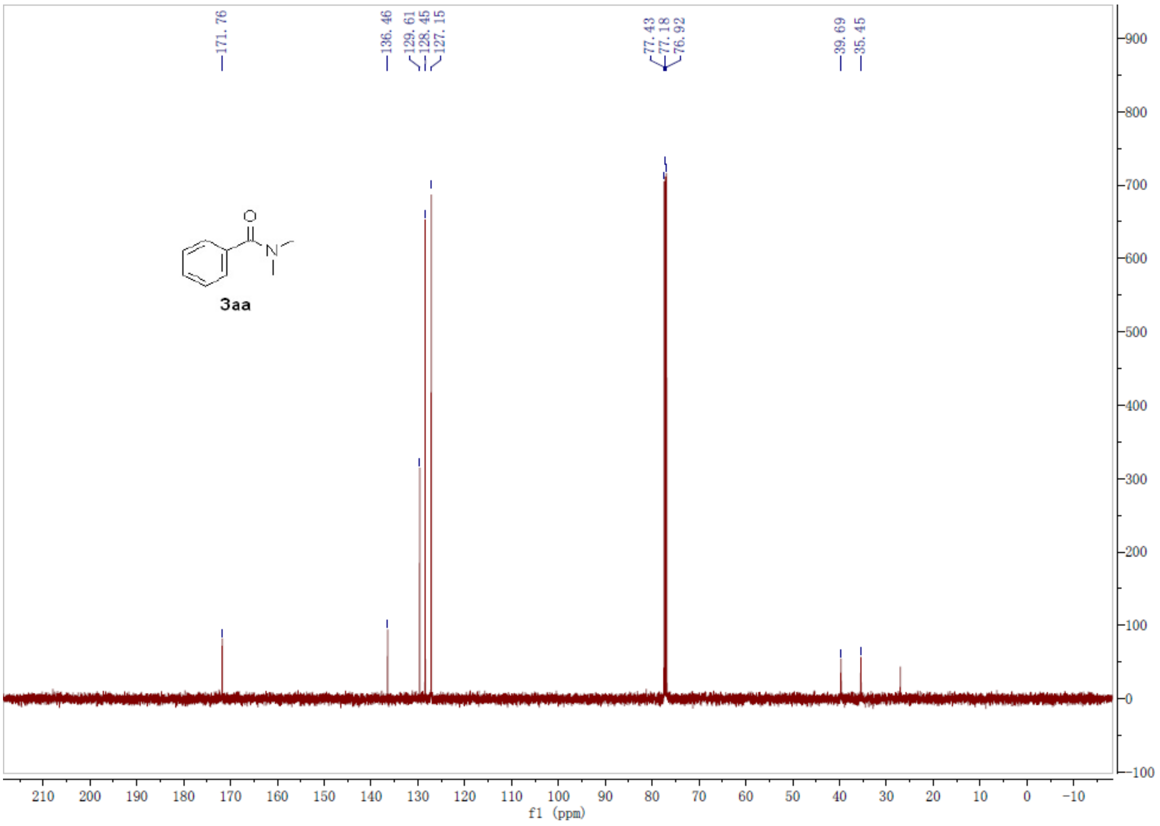

7.80
7.78
7.42
7.35
7.30
7.28
6.48
4.65
4.64
F (d)
7.35
D (t)
7.49
C (d)
7.79
B (s)
6.48
A (d)
4.64
E (t)
7.42
G (m)
7.30
3y
2.01
1.03
2.07
3.96
1.00
0.92
2.00
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

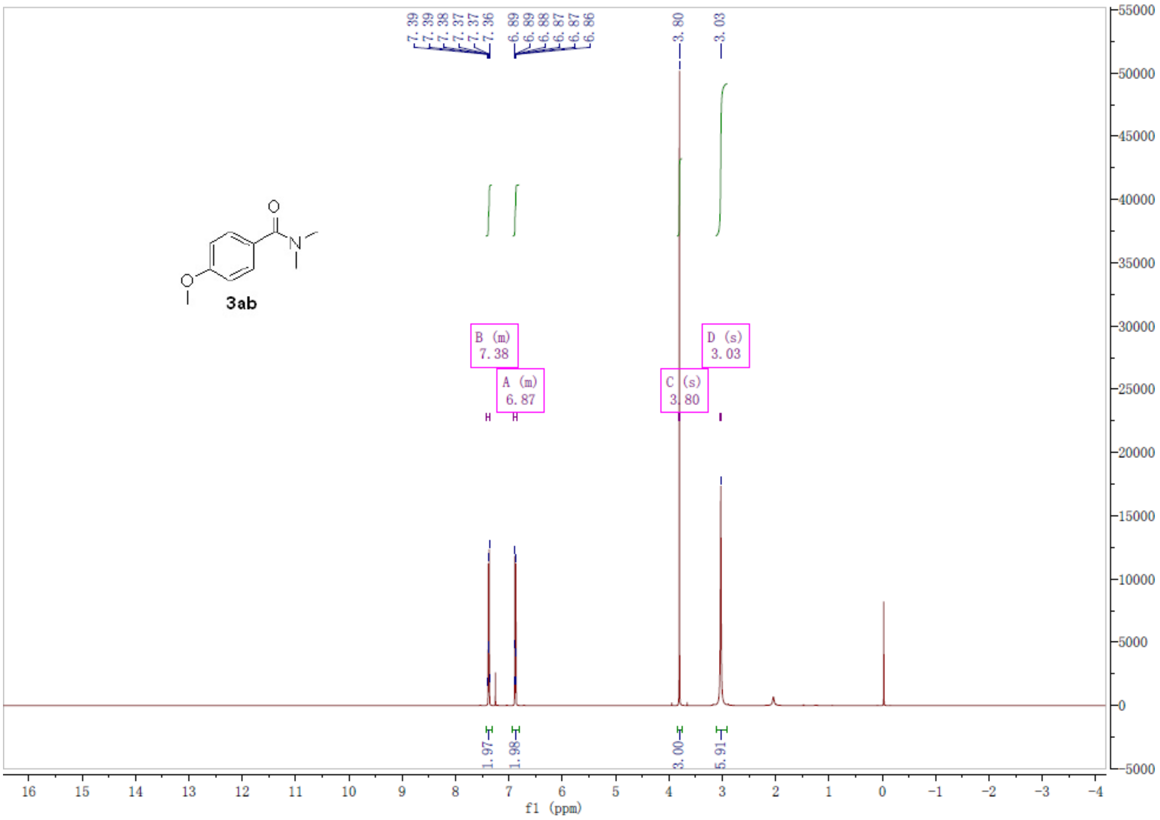

167.49
138.32
134.52
131.68
128.92
128.73
128.05
127.76
127.09
77.41
77.16
76.90
44.27
3y
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

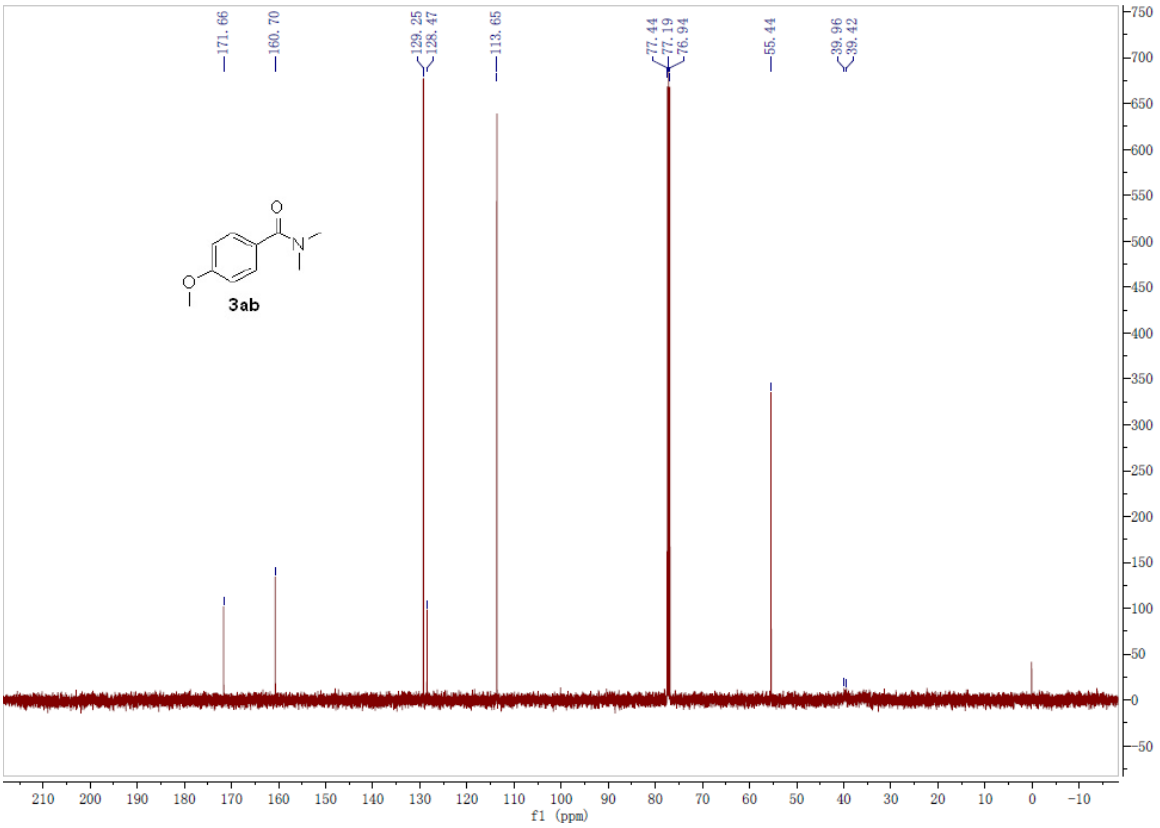

8.53
8.52
8.40
8.25
8.24
7.87
7.86
7.85
7.84
7.41
7.38
7.37
7.36
7.35
7.33
7.30
7.28
7.27
4.69
4.67
3z
H (m)
7.29
C (s)
8.40
F (m)
7.42
B (d)
8.53
E (td)
7.86
A (d)
4.68
D (d)
8.25
G (dt)
7.36
0.97
0.88
0.96
0.97
1.00
3.90
1.10
2.00
f1 (ppm)

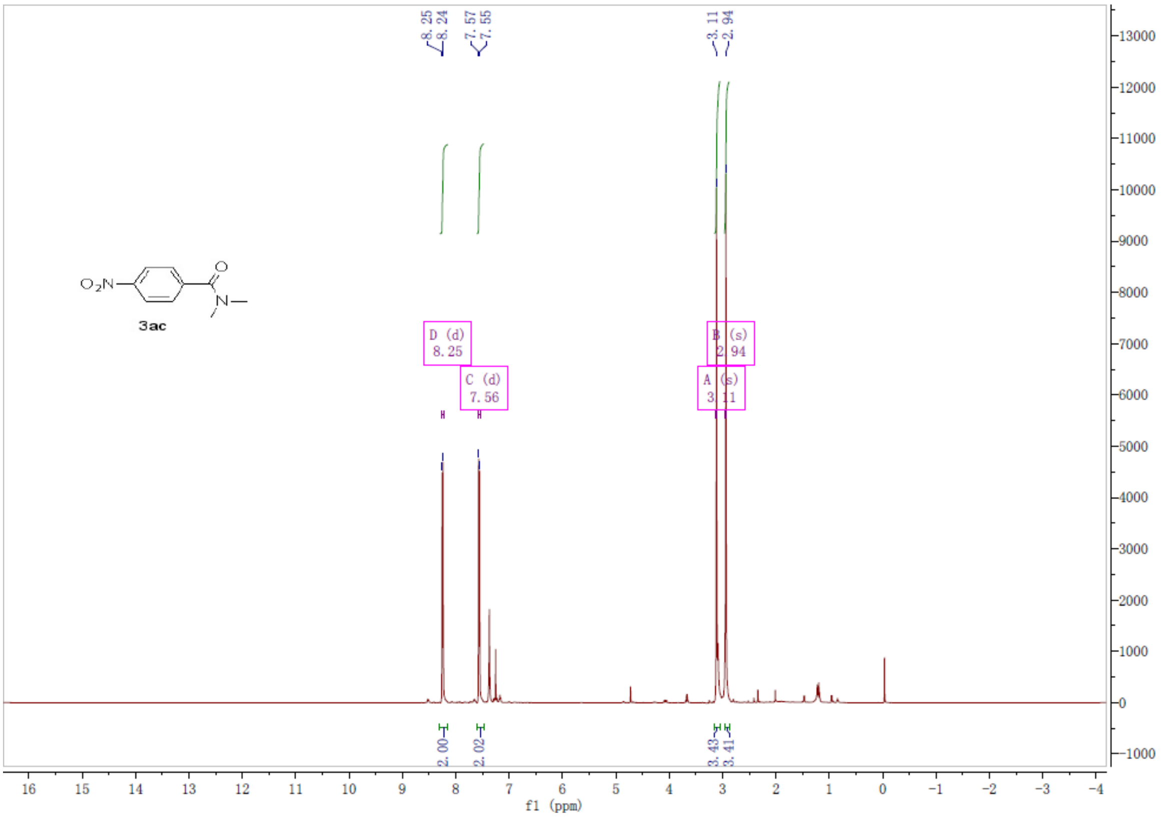

164.39
149.93
148.21
138.31
137.53
129.29
128.00
126.36
122.53
77.41
77.16
76.90
43.64
3z
f1 (ppm)

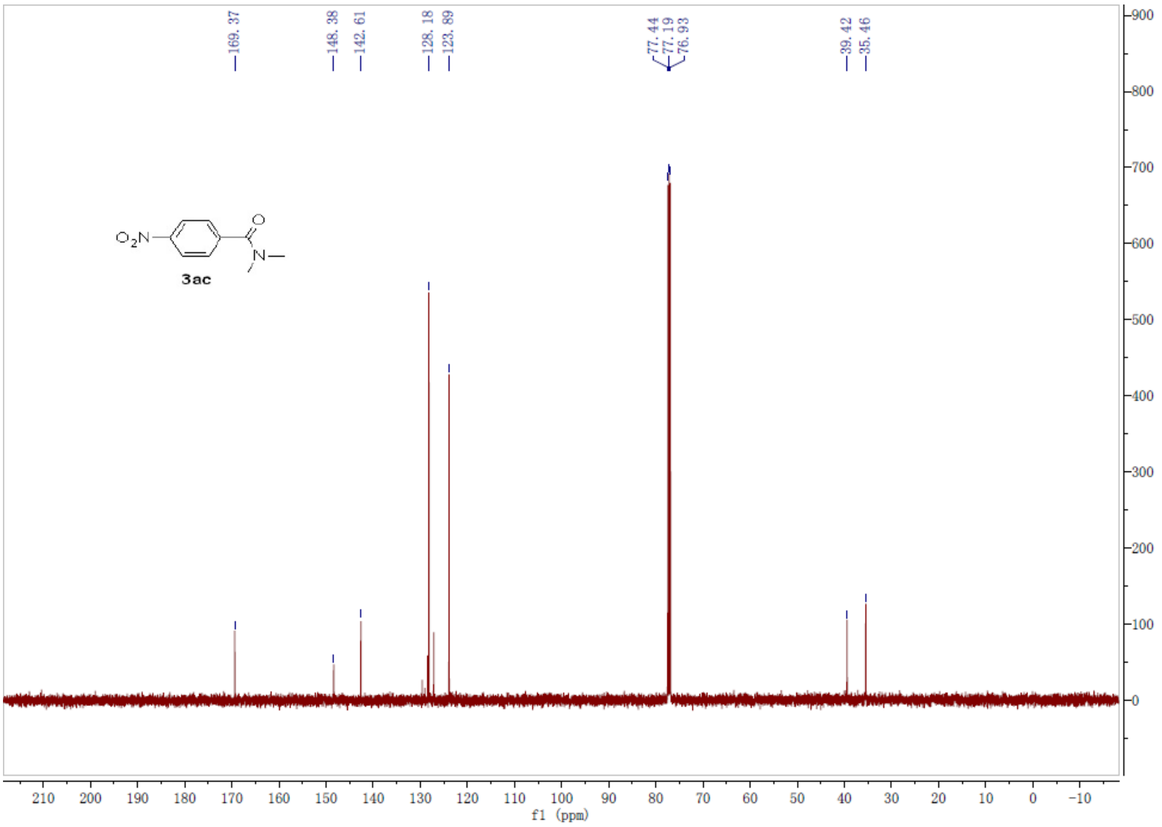

7.40
7.40
7.39
7.38
7.38
7.37
7.37
7.36
3.09
2.96
3aa
O
N
B (s)
2.96
C (m)
7.38
A (s)
3.09
5.05
3.00
3.10
f1 (ppm)

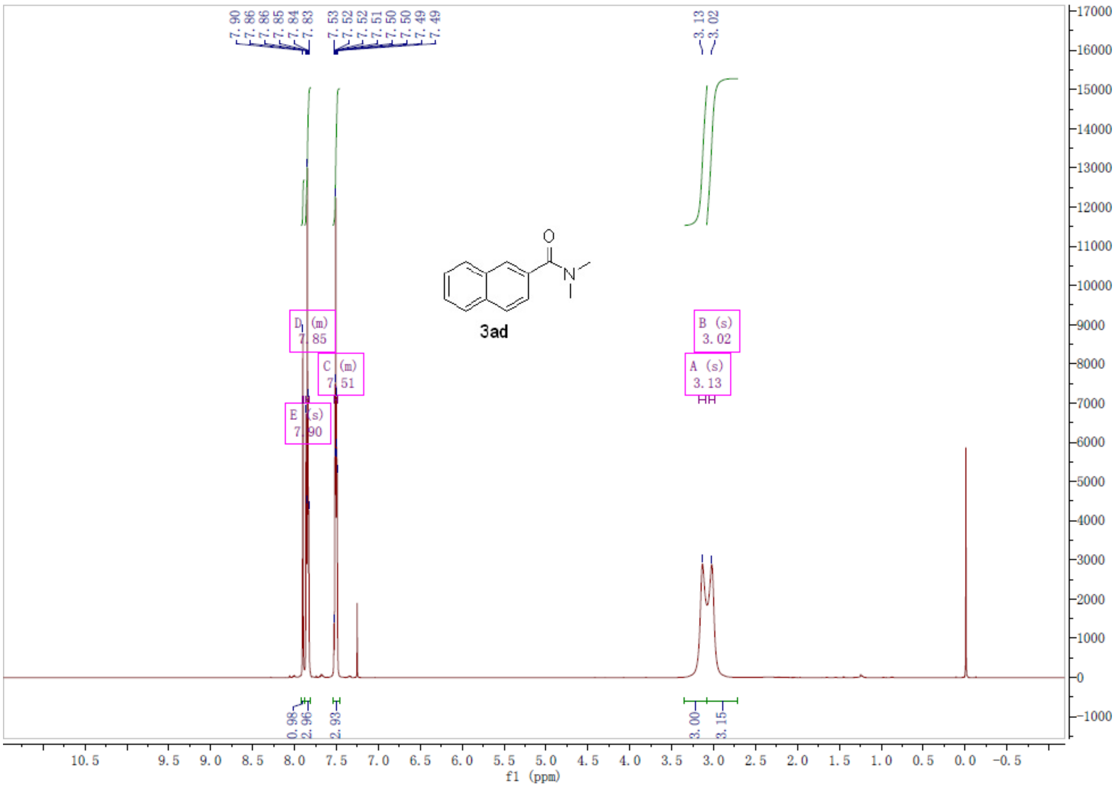

171.76
136.46
129.61
128.45
127.15
77.43
77.18
76.92
39.69
35.45
3aa
O
N
f1 (ppm)

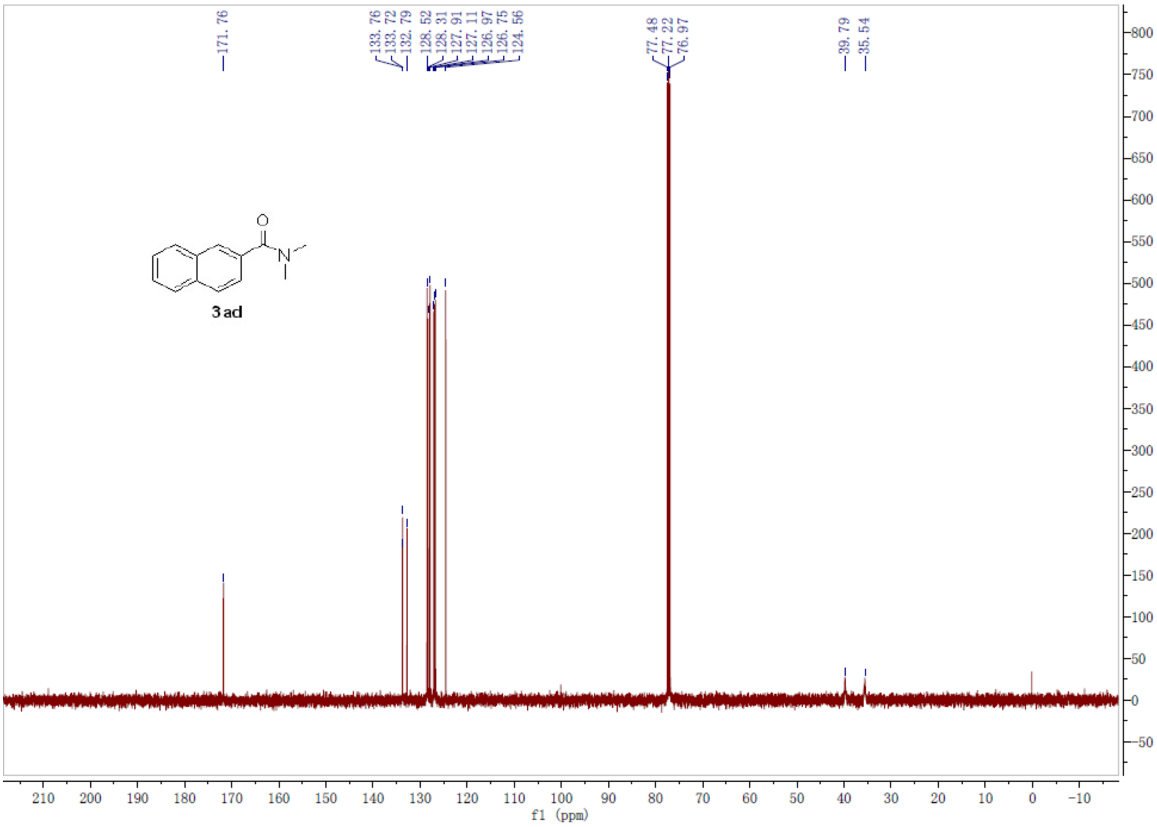

7.39
7.39
7.38
7.37
7.37
7.36
6.89
6.89
6.88
6.87
6.87
6.86
3.80
3.03
3ab
B (m)
7.38
A (m)
6.87
C (s)
3.80
D (s)
3.03
1.97
1.98
3.00
5.91
f1 (ppm)

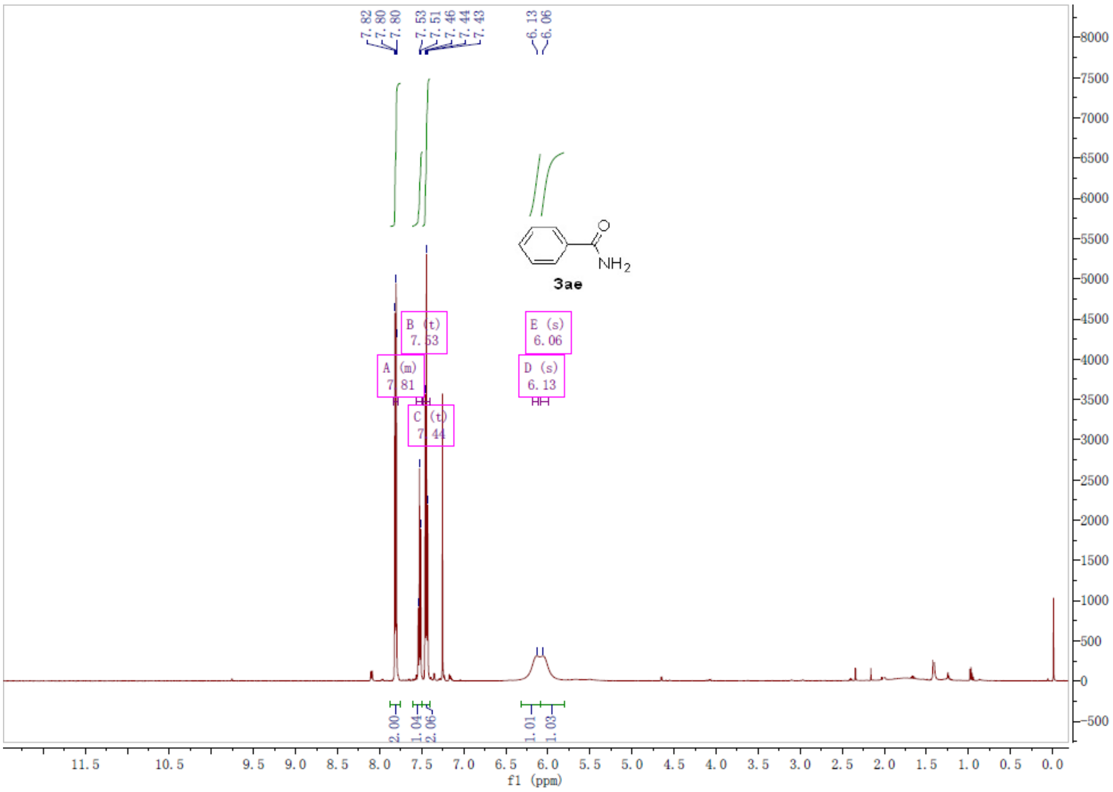

171.66
160.70
129.25
128.47
113.65
77.44
77.19
76.94
55.44
39.96
39.42
3ab
f1 (ppm)

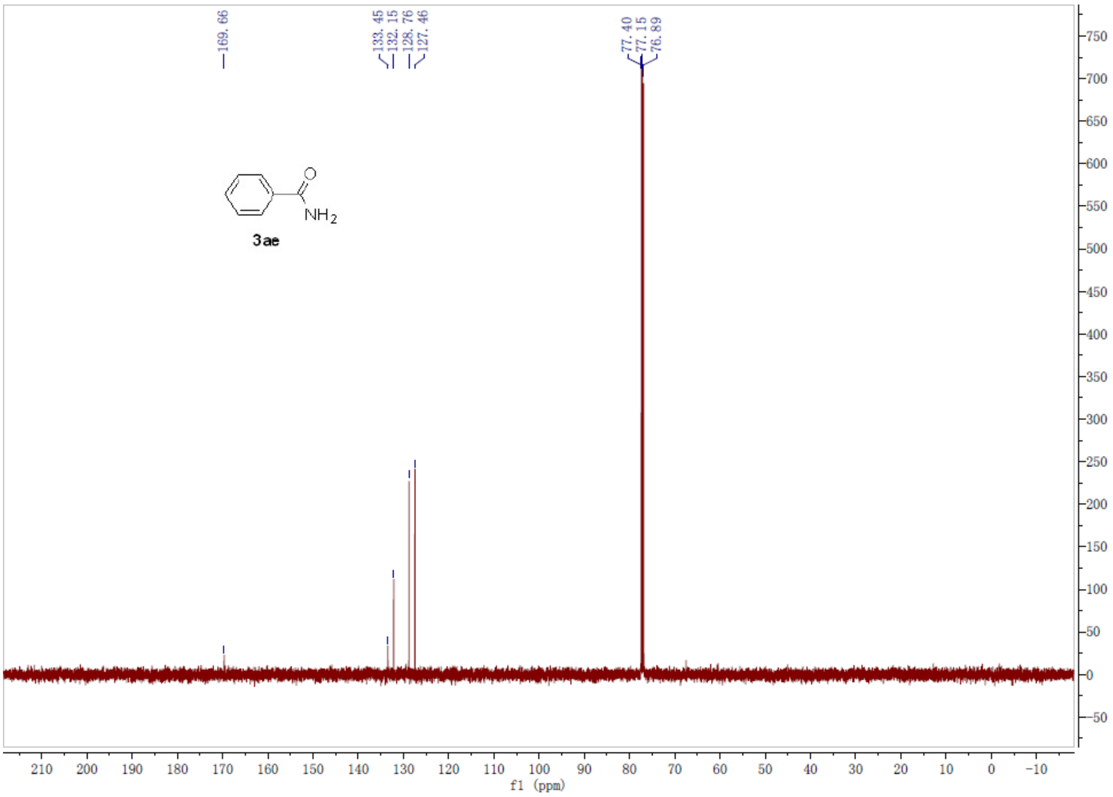

8.25
8.24
7.57
7.55
3.11
2.94
3ac
D (d) 8.25
C (d) 7.56
B (s) 2.94
A (s) 3.11
2.00
2.02
3.43
3.41
f1 (ppm)

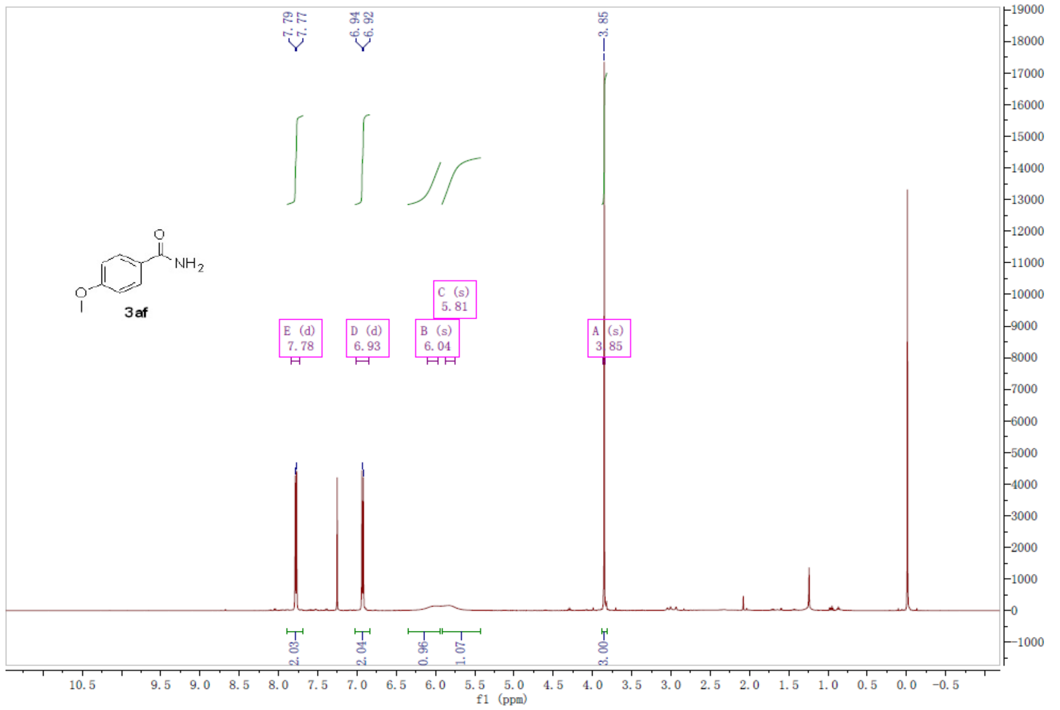

169.37
148.38
142.61
128.18
123.89
77.44
77.19
76.93
39.42
35.46
3ac
f1 (ppm)

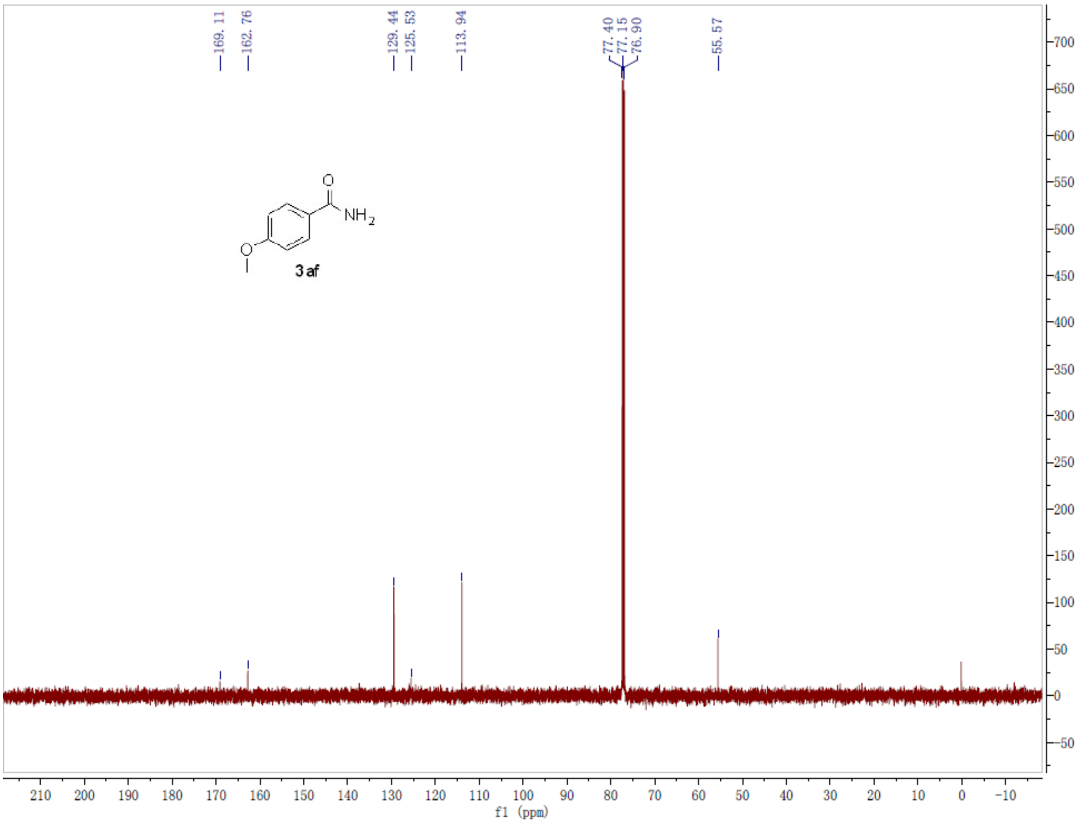

7.90
7.86
7.86
7.85
7.84
7.83
7.53
7.52
7.52
7.51
7.50
7.50
7.49
7.49
3.13
3.02
3ad
D (m)
7.85
C (m)
7.51
E (s)
7.90
B (s)
3.02
A (s)
3.13
0.98
2.96
2.93
3.00
3.15
f1 (ppm)

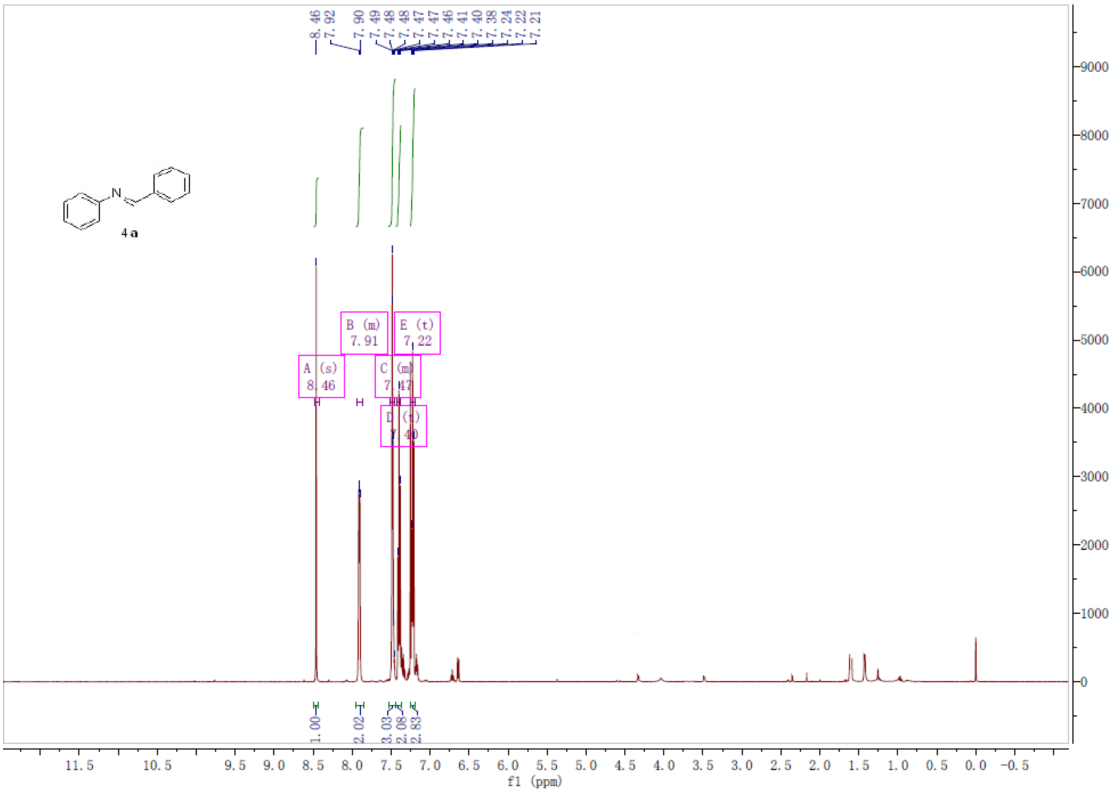

171.76
133.76
133.72
132.79
128.52
128.31
127.91
127.11
126.97
126.75
124.56
77.48
77.22
76.97
39.79
35.54
3ad
f1 (ppm)

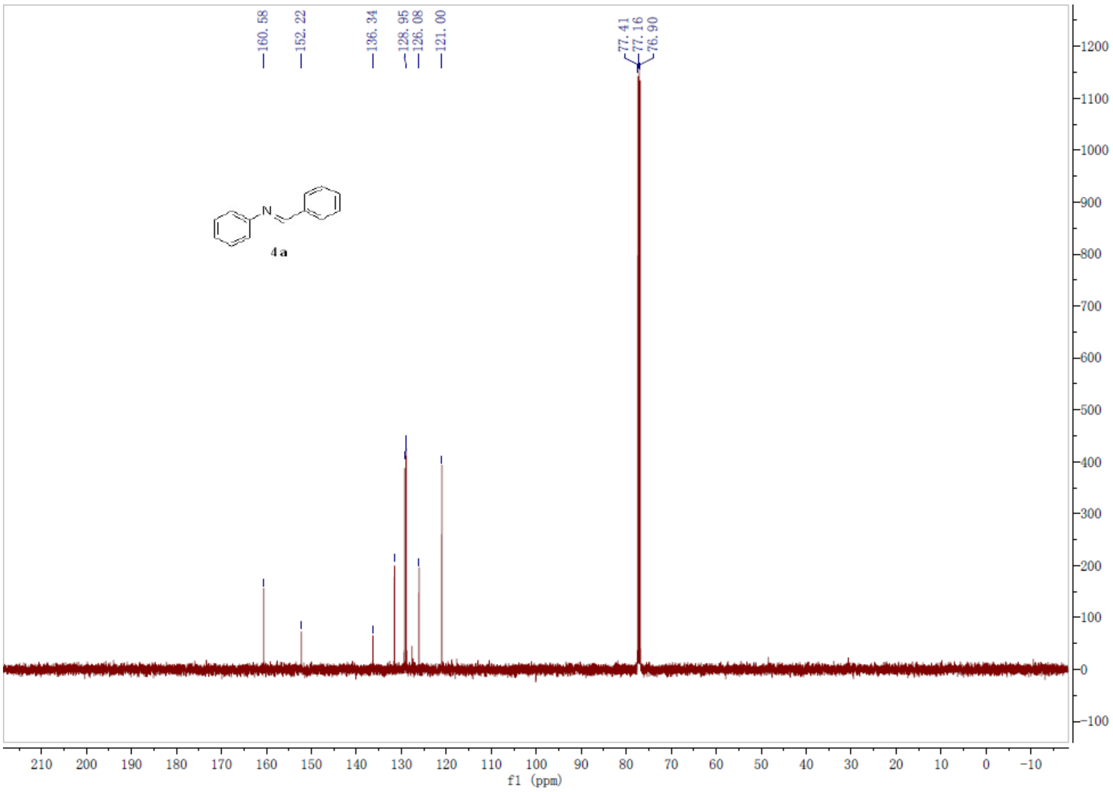

7.82
7.80
7.80
7.53
7.51
7.46
7.44
7.43
6.13
6.06
NH2
3ae
B (t) 7.53
A (m) 7.81
C (t) 7.44
E (s) 6.06
D (s) 6.13
2.00
1.04
2.06
1.01
1.03
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
8000
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500

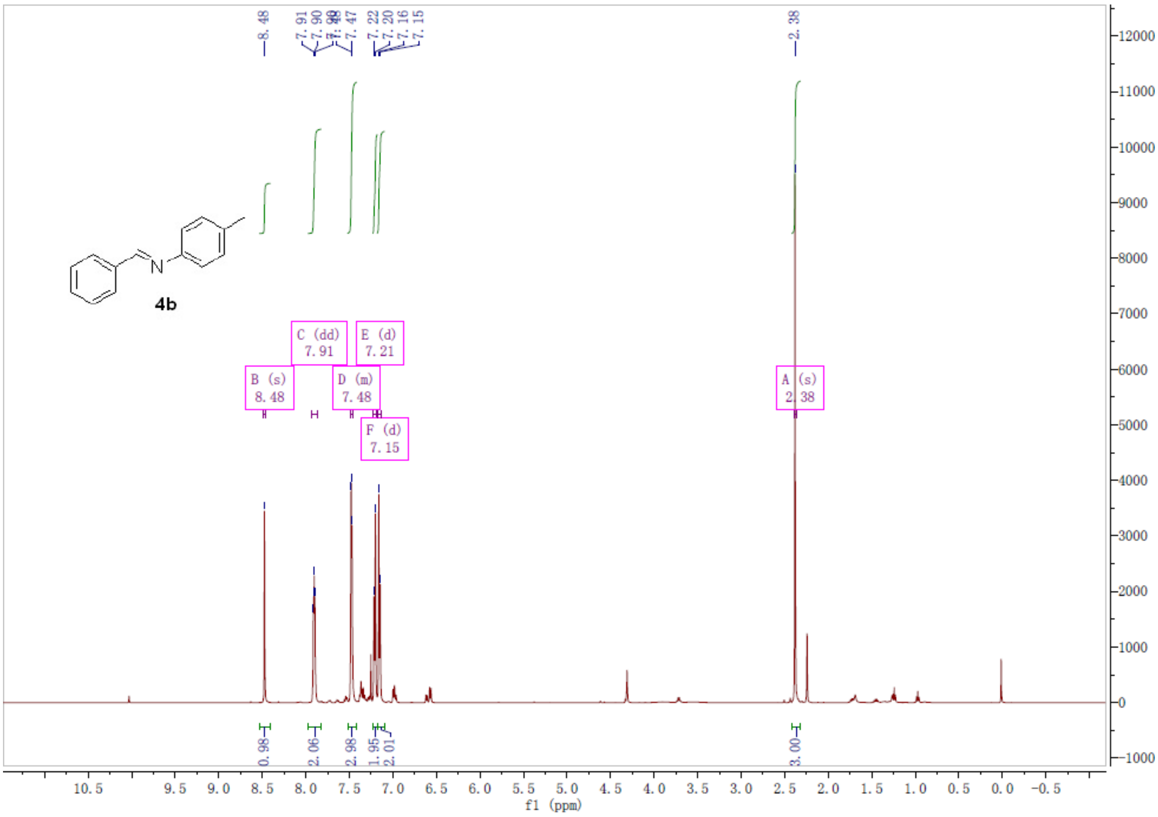

169.66
133.45
132.15
128.76
127.46
77.40
77.15
76.89
NH2
3ae
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50

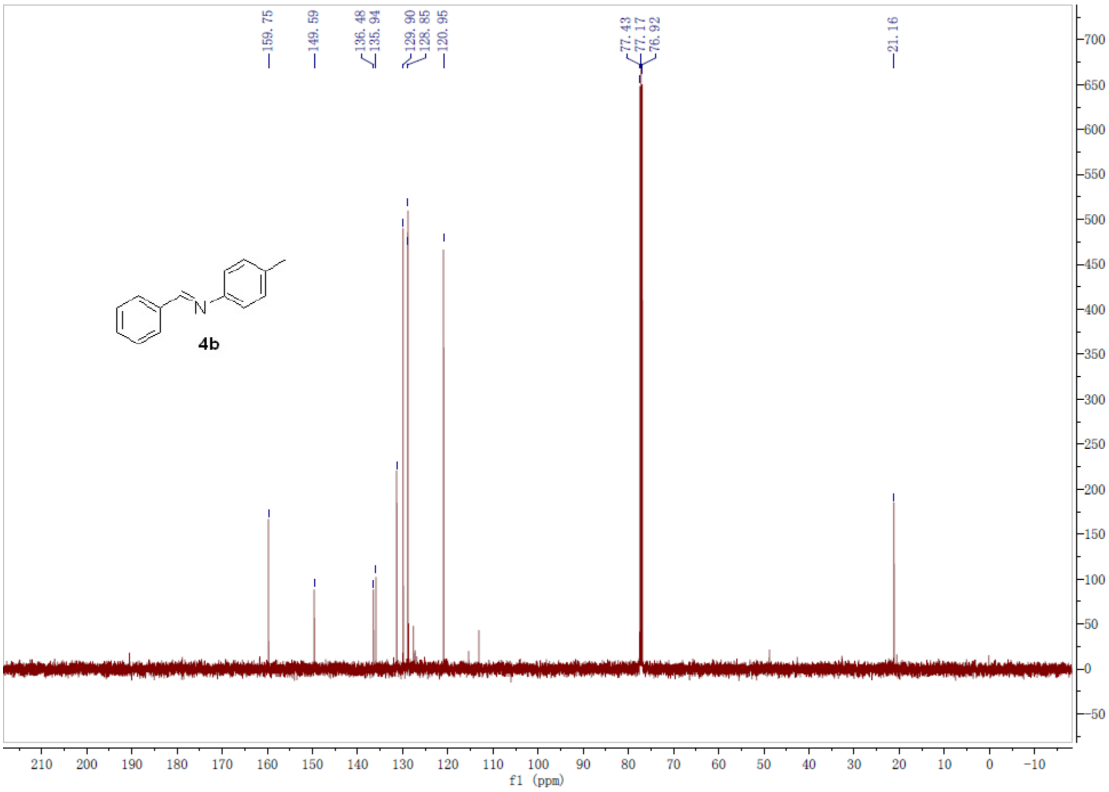

7.79
7.77
6.94
6.92
3.85
NH2
3af
E (d) 7.78
D (d) 6.93
C (s) 5.81
B (s) 6.04
A (s) 3.85
2.03
2.04
0.96
1.07
3.00
f1 (ppm)

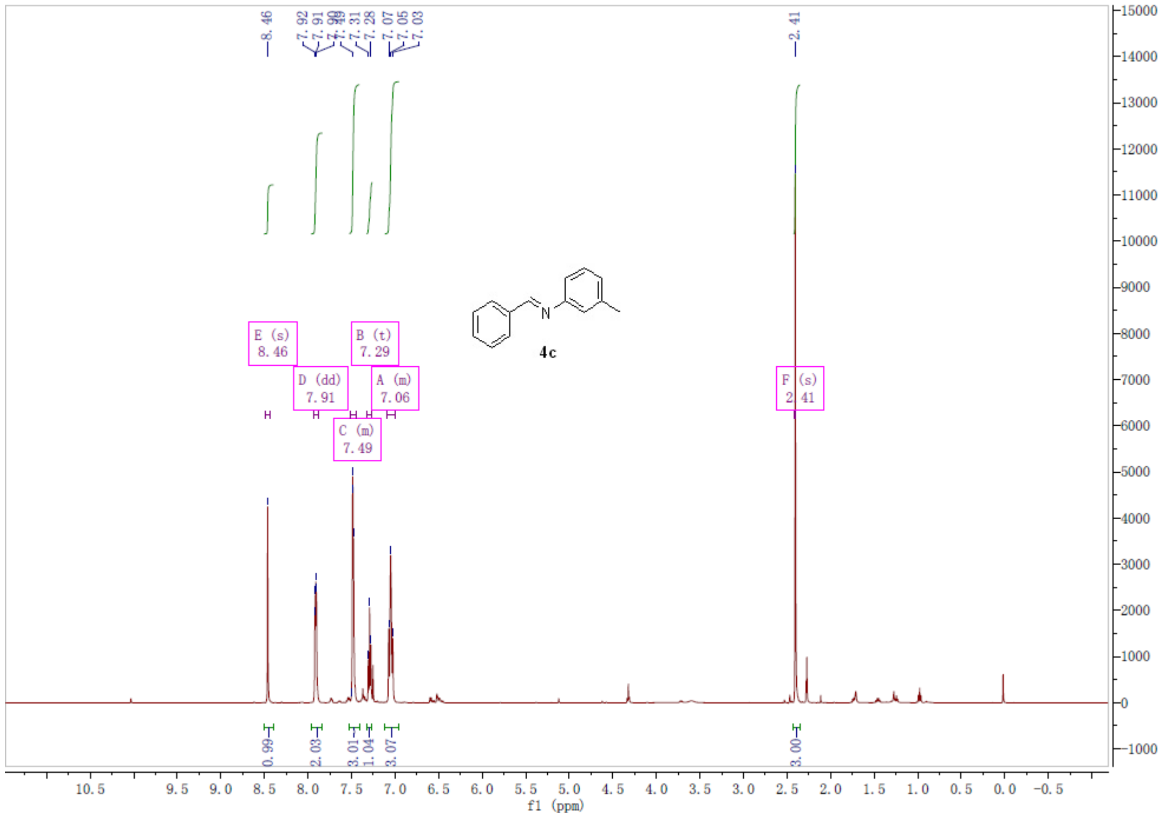

169.11
162.76
129.44
125.53
113.94
77.40
77.15
76.90
55.57
NH2
3af
f1 (ppm)

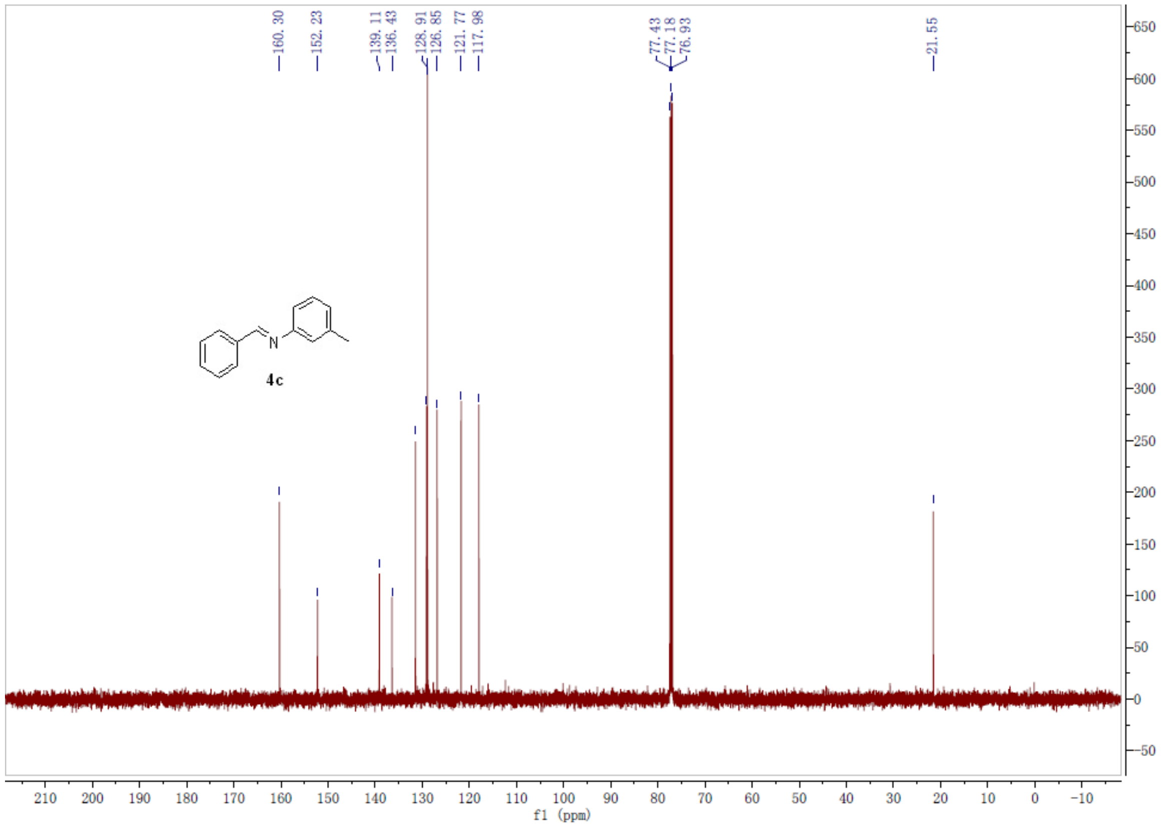

8.46
7.92
7.90
7.49
7.48
7.48
7.47
7.47
7.46
7.41
7.40
7.38
7.24
7.22
7.21
N
4a
A (s)
8.46
B (m)
7.91
C (m)
7.47
D (t)
7.40
E (t)
7.22
1.00
2.02
3.03
2.08
2.83
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

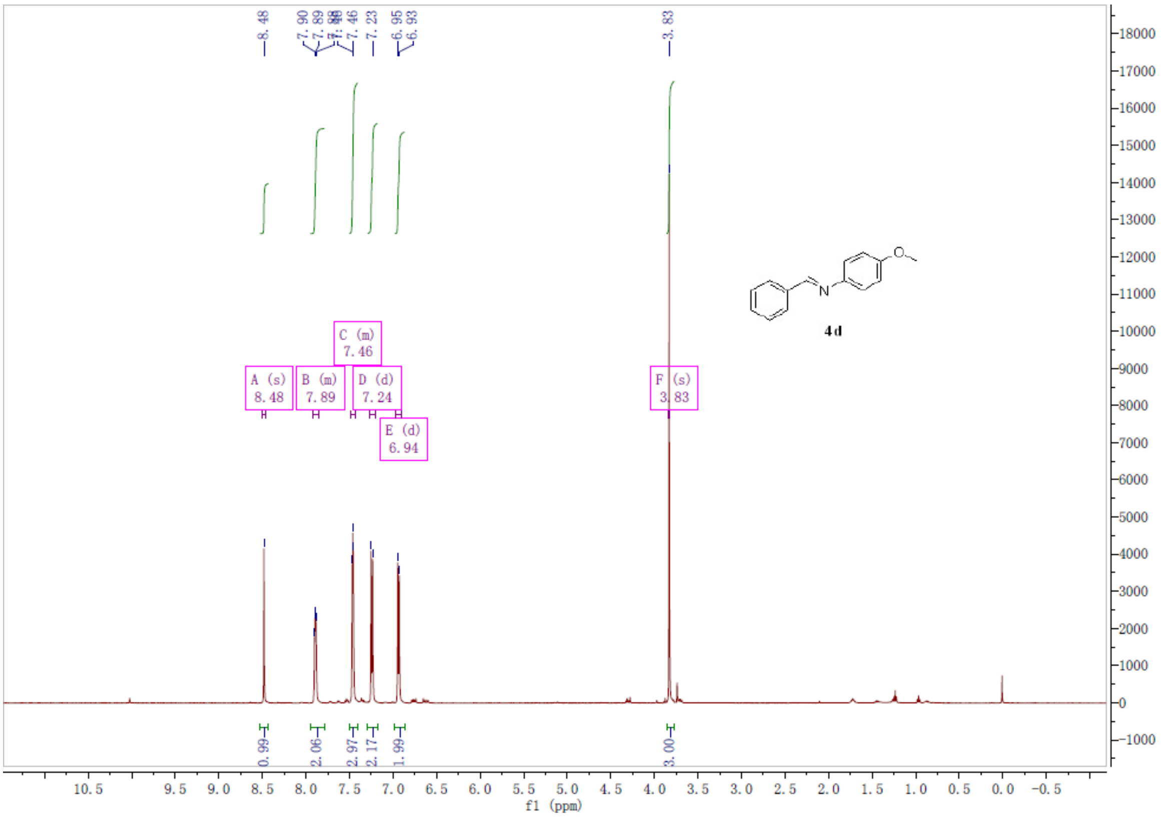

160.58
152.22
136.34
128.95
126.08
121.00
77.41
77.16
76.90
N
4a
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

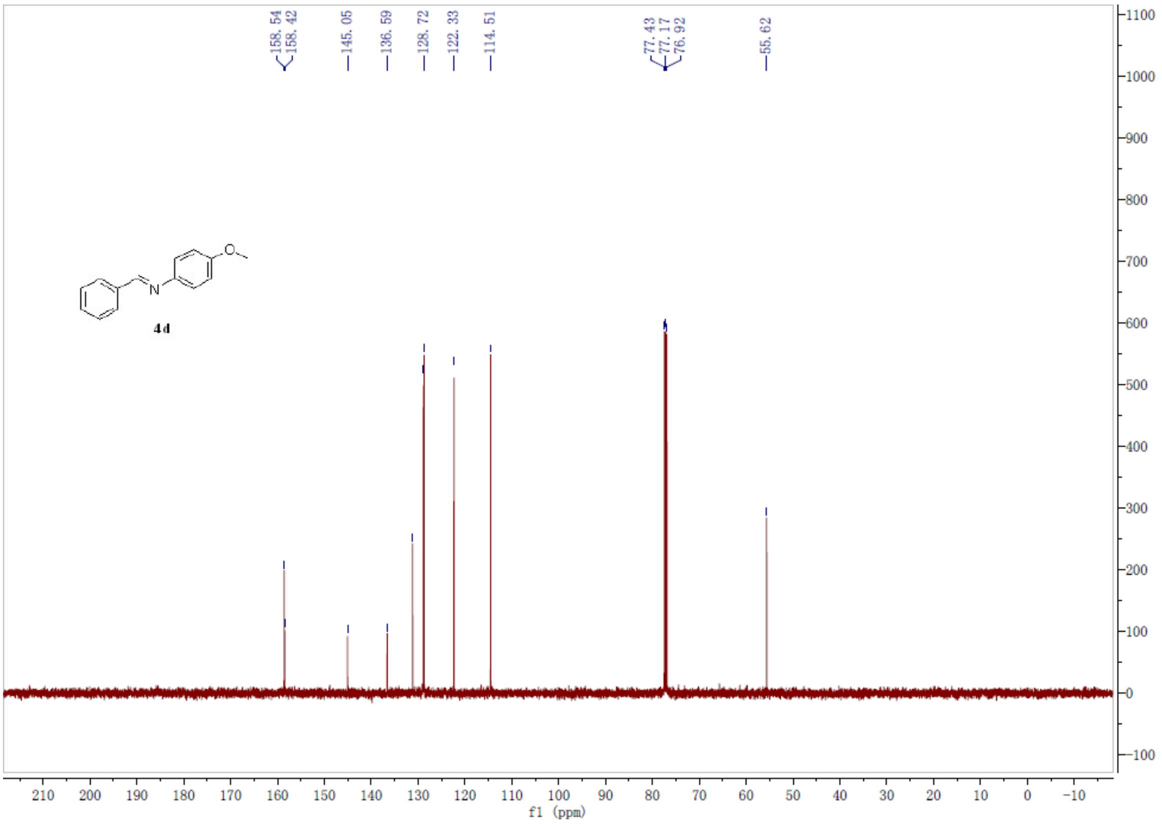

8.48
7.91
7.90
7.89
7.48
7.47
7.22
7.20
7.16
7.15
2.38
4b
C (dd)
7.91
E (d)
7.21
B (s)
8.48
D (m)
7.48
F (d)
7.15
A (s)
2.38
0.98
2.06
2.98
1.95
2.01
3.00
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

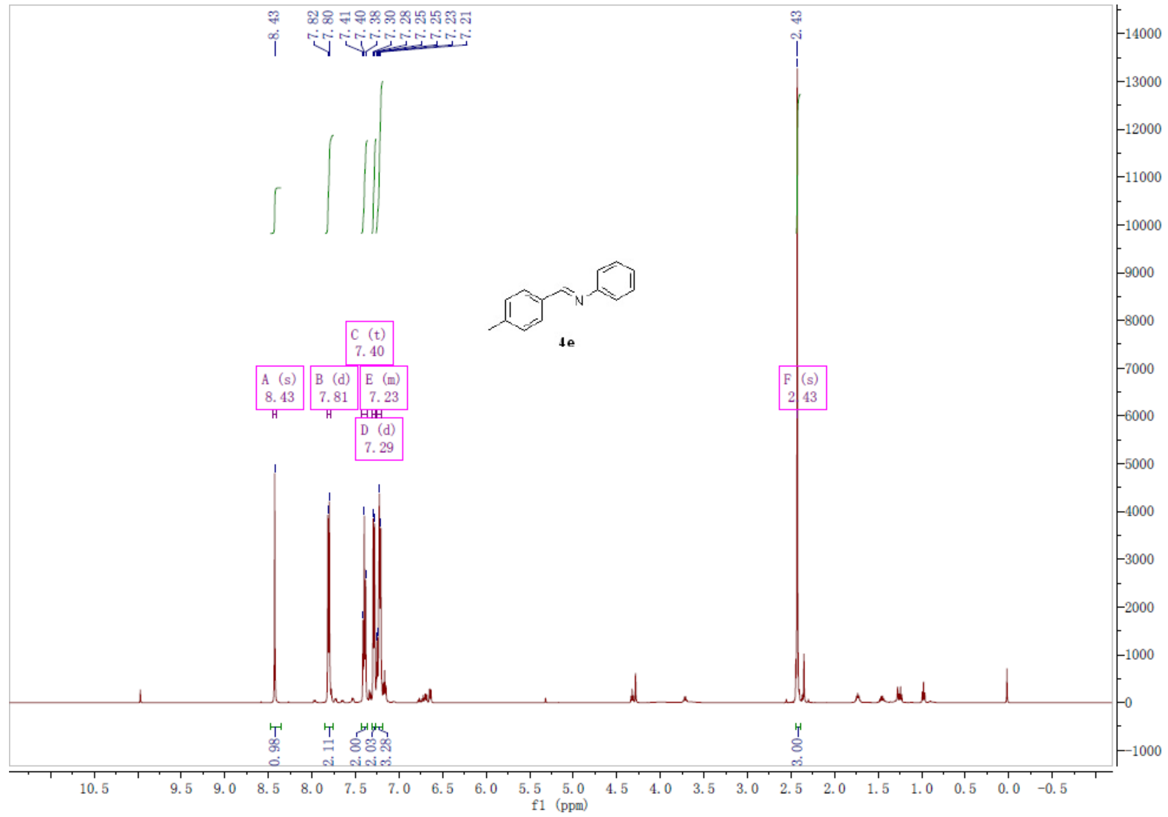

159.75
149.59
136.48
135.94
129.90
128.85
120.95
77.43
77.17
76.92
21.16
4b
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

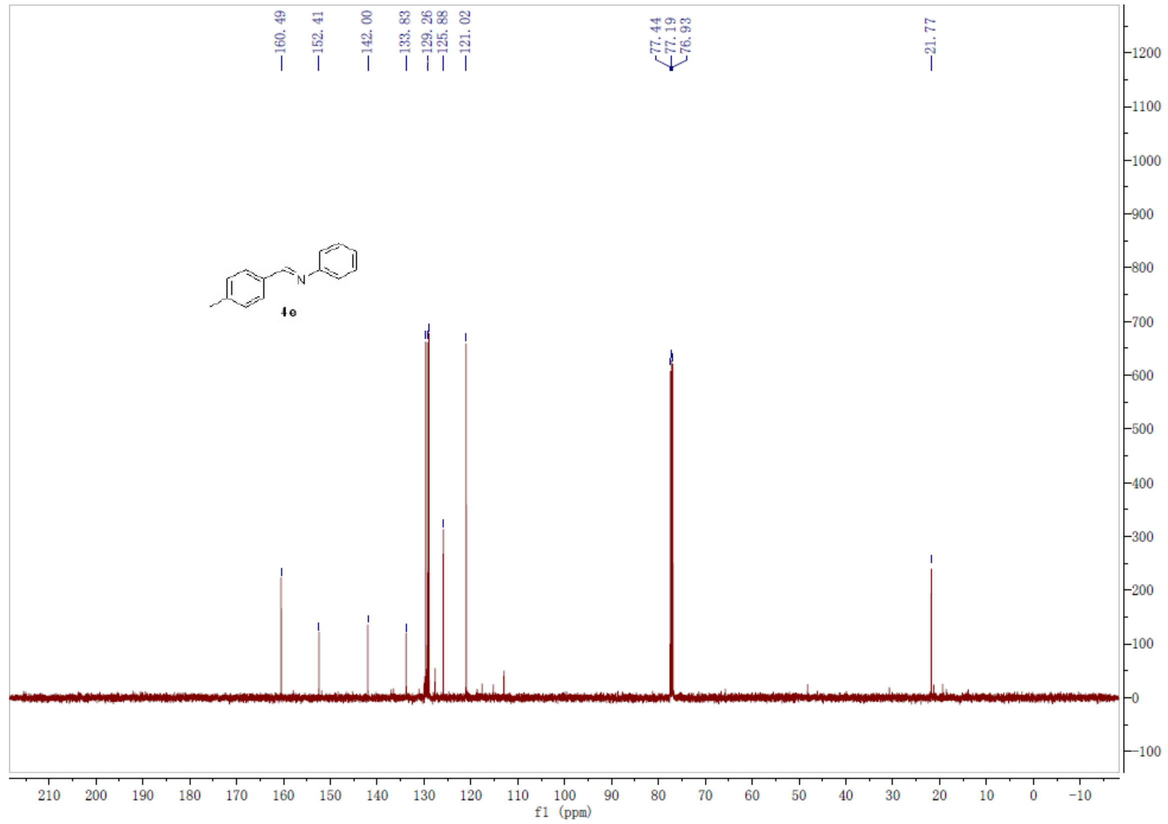

8.46
7.92
7.91
7.90
7.49
7.31
7.28
7.07
7.05
7.03
2.41
E (s) 8.46
B (t) 7.29
D (dd) 7.91
A (m) 7.06
C (m) 7.49
F (s) 2.41
N
4c
0.99
2.03
3.01
1.04
3.07
3.00
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000

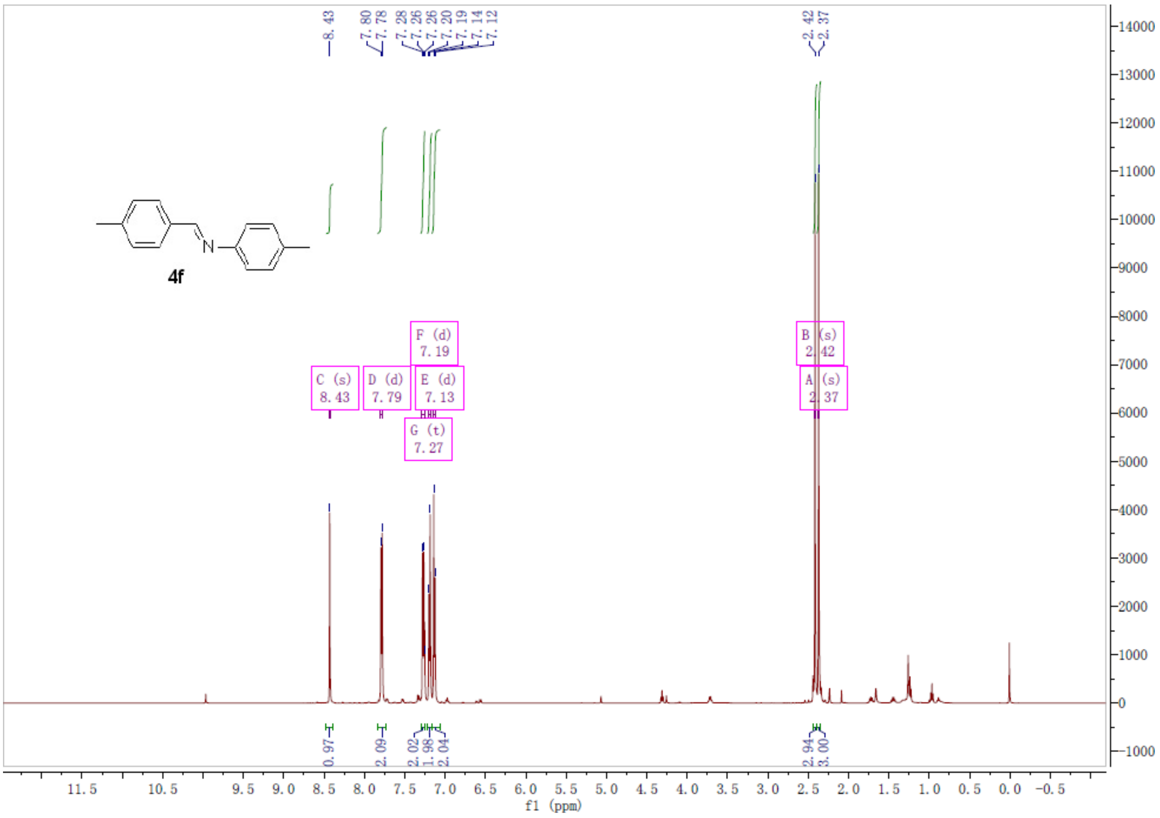

160.30
152.23
139.11
136.43
128.91
126.85
121.77
117.98
77.43
77.18
76.93
21.55
N
4c
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50

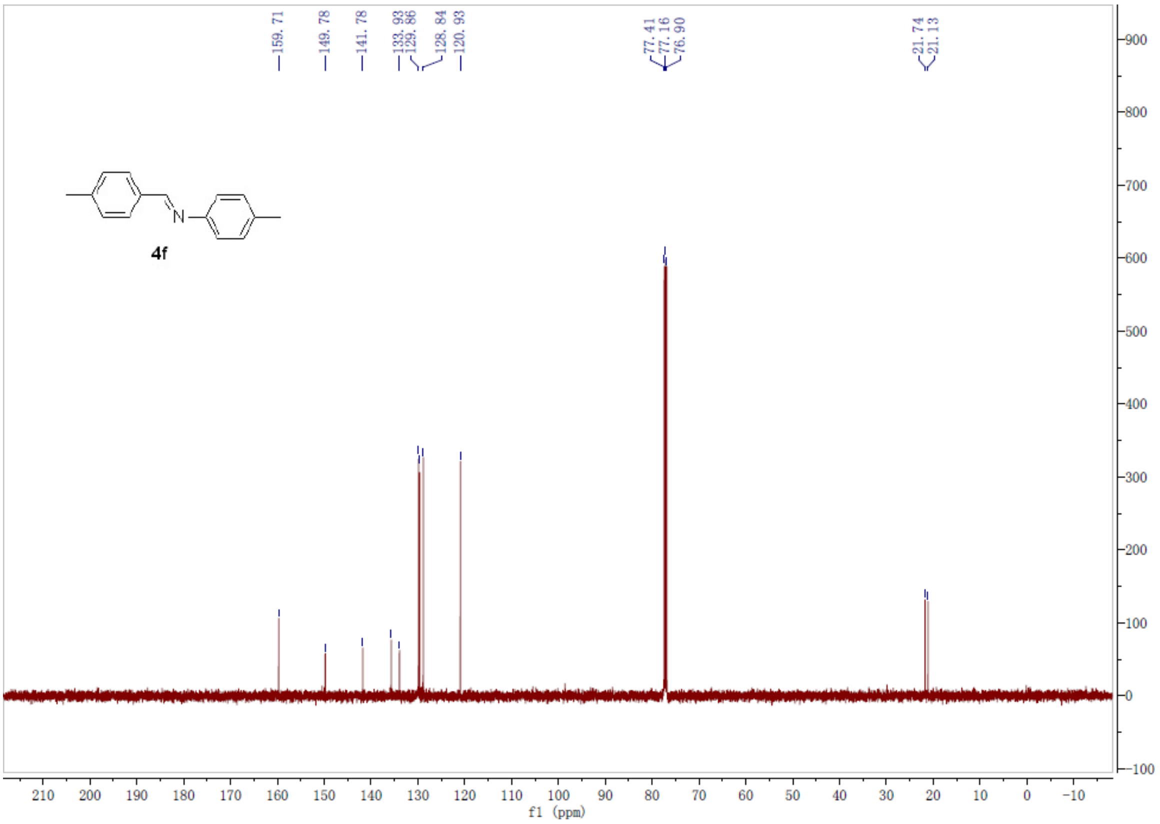

8.48
7.90
7.89
7.46
7.23
6.95
6.93
3.83
A (s) 8.48
B (m) 7.89
C (m) 7.46
D (d) 7.24
E (d) 6.94
F (s) 3.83
0.99
2.06
2.97
2.17
1.99
3.00
N
O
4d
f1 (ppm)

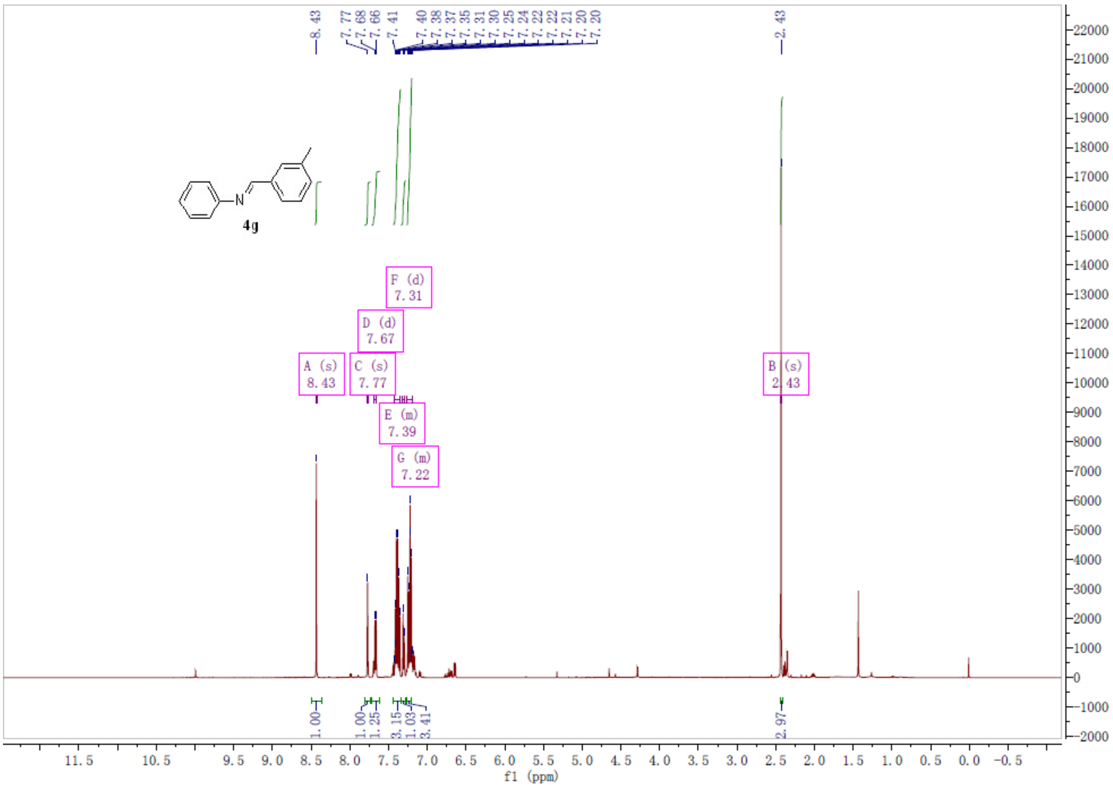

158.54
158.42
145.05
136.59
128.72
122.33
114.51
77.43
77.17
76.92
55.62
N
O
4d
f1 (ppm)

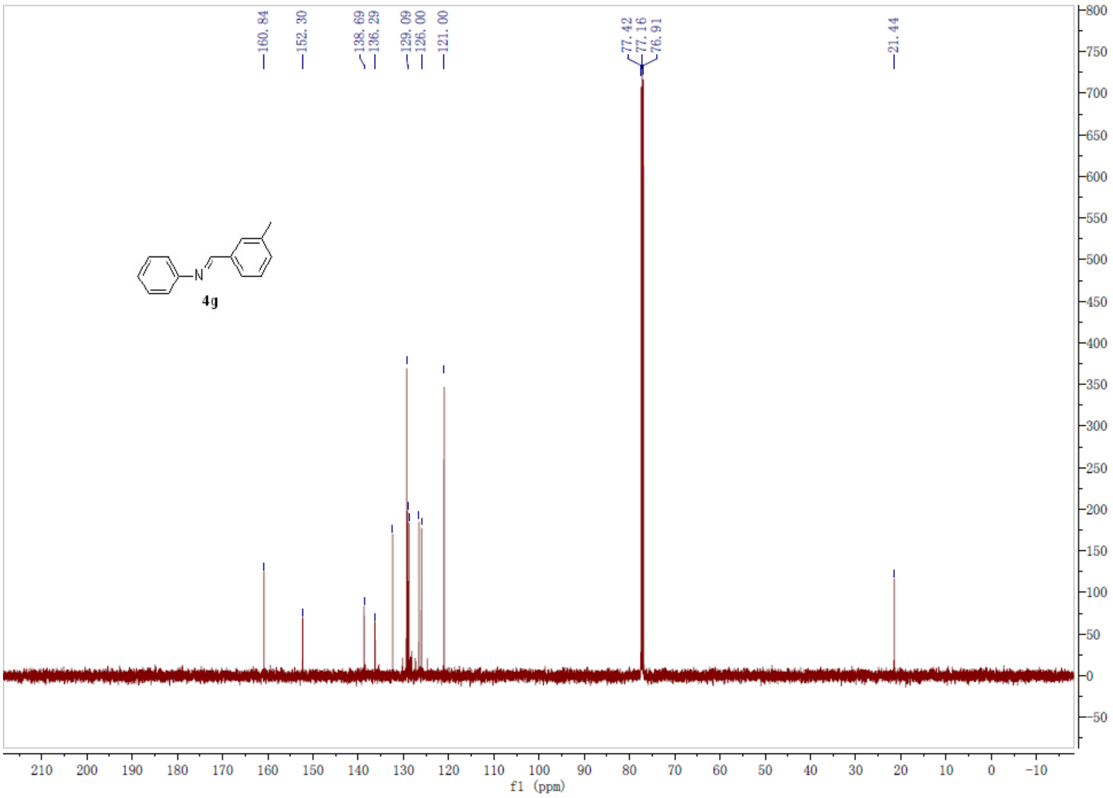

8.43
7.82
7.80
7.41
7.40
7.38
7.30
7.28
7.25
7.25
7.23
7.21
2.43
4e
A (s)
8.43
B (d)
7.81
C (t)
7.40
D (d)
7.29
E (m)
7.23
F (s)
2.43
0.98
2.11
2.00
2.03
3.28
3.00
f1 (ppm)

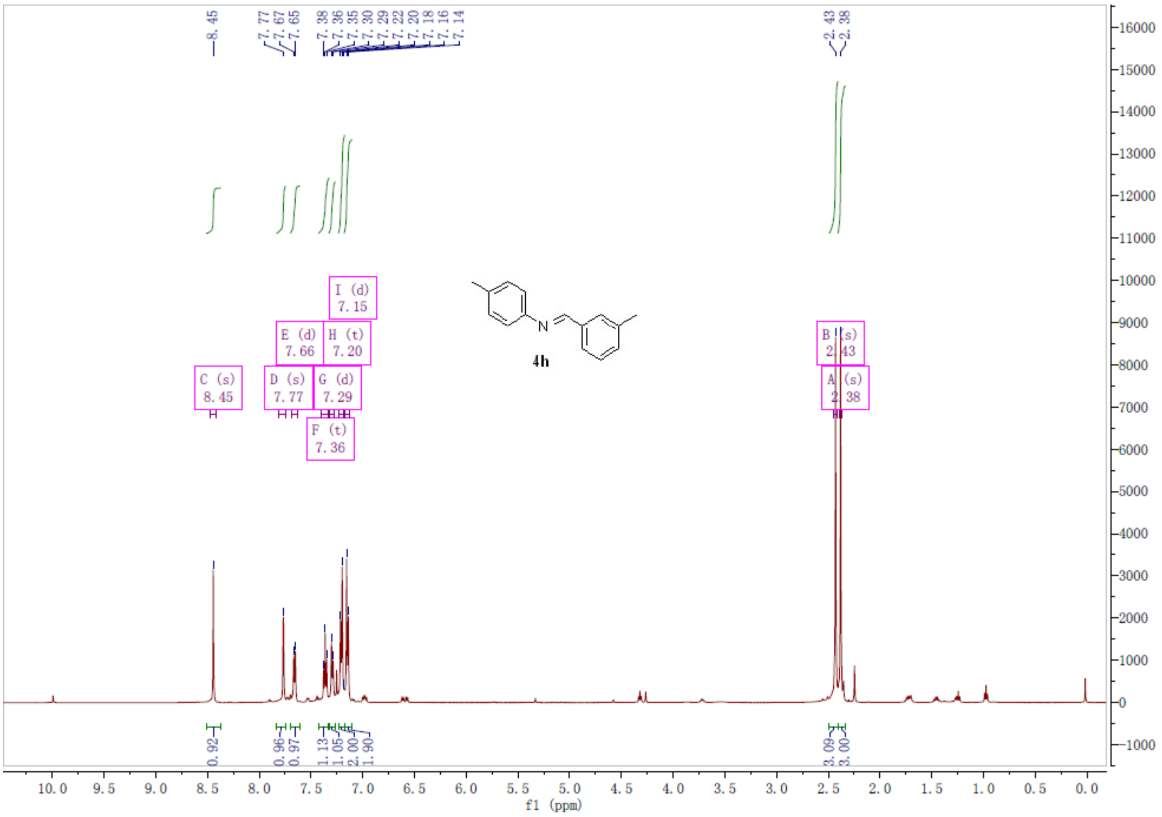

160.49
152.41
142.00
133.83
129.26
125.88
121.02
77.44
77.19
76.93
21.77
4e
f1 (ppm)

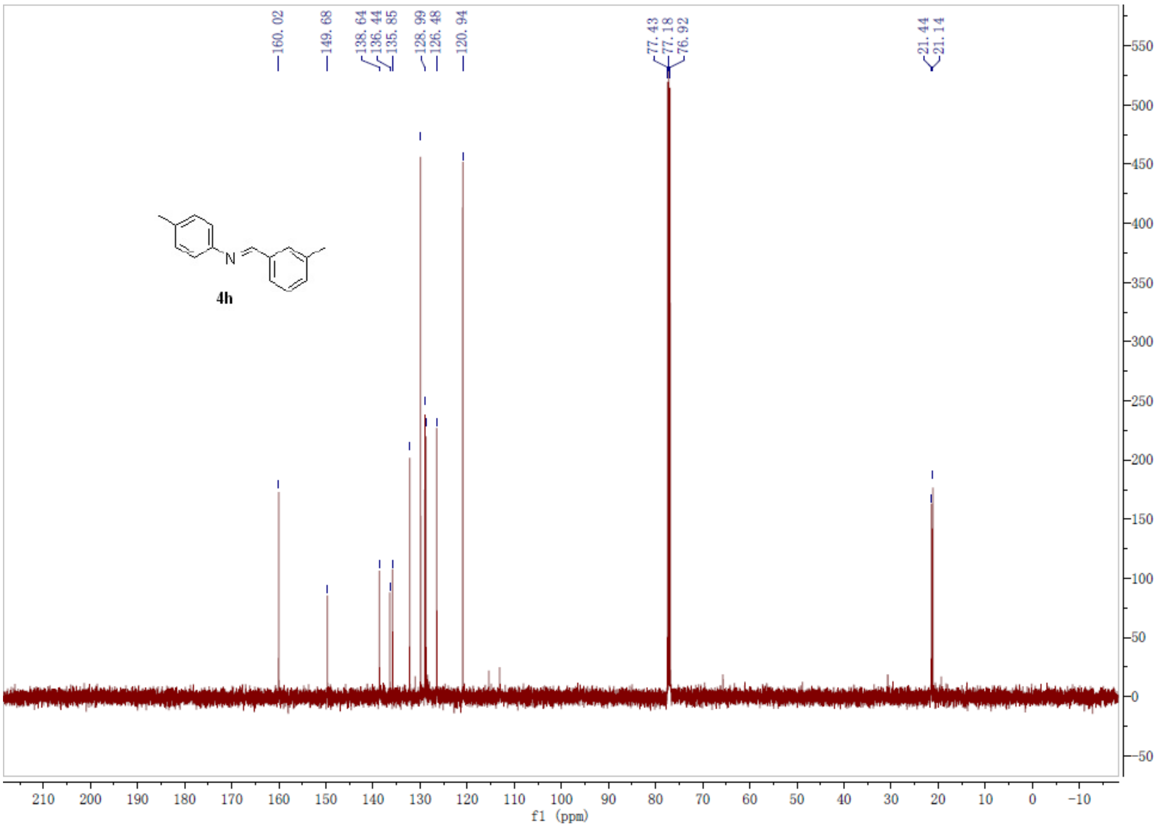

8.43
7.80
7.78
7.28
7.26
7.26
7.26
7.20
7.19
7.14
7.12
2.42
2.37
N
4f
F (d) 7.19
B (s) 2.42
C (s) 8.43
D (d) 7.79
E (d) 7.13
A (s) 2.37
G (t) 7.27
0.97
2.09
2.02
1.98
2.04
2.94
3.00
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
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
-0.5
f1 (ppm)

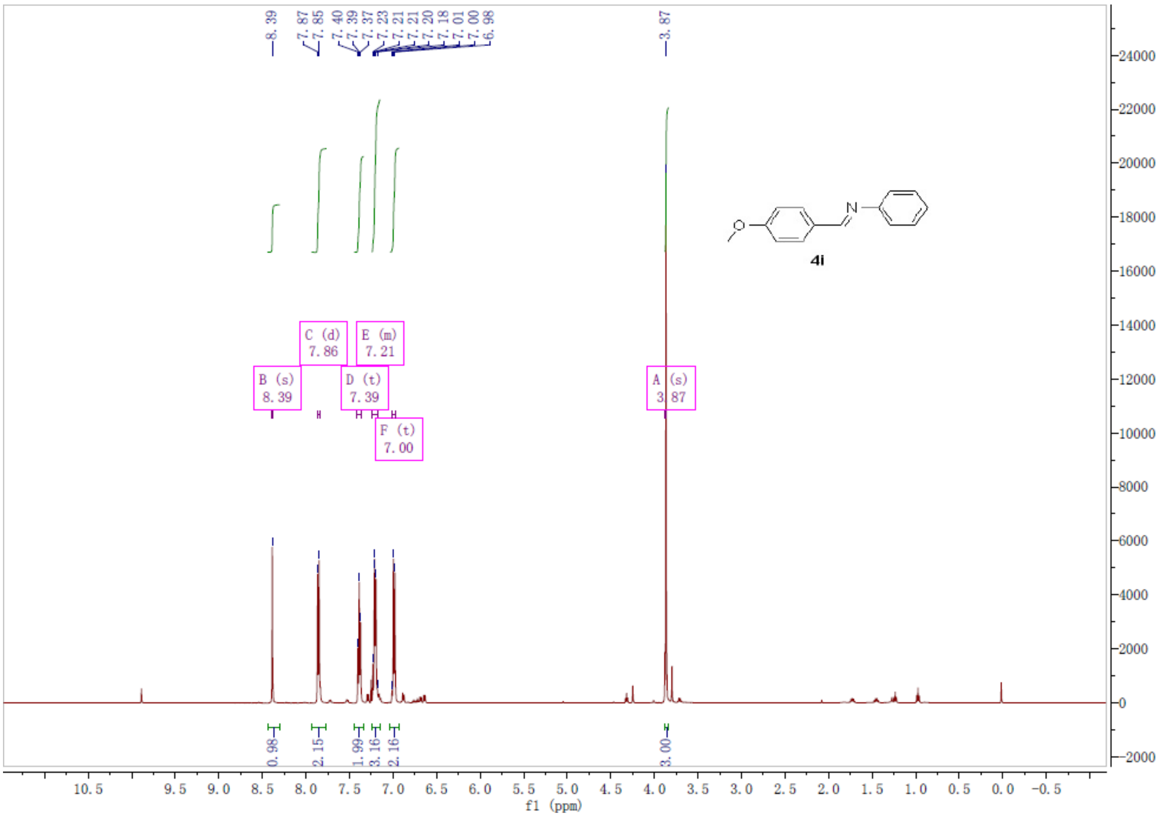

159.71
149.78
141.78
133.93
129.86
128.84
120.93
77.41
77.16
76.90
21.74
21.13
N
4f
900
800
700
600
500
400
300
200
100
0
-100
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

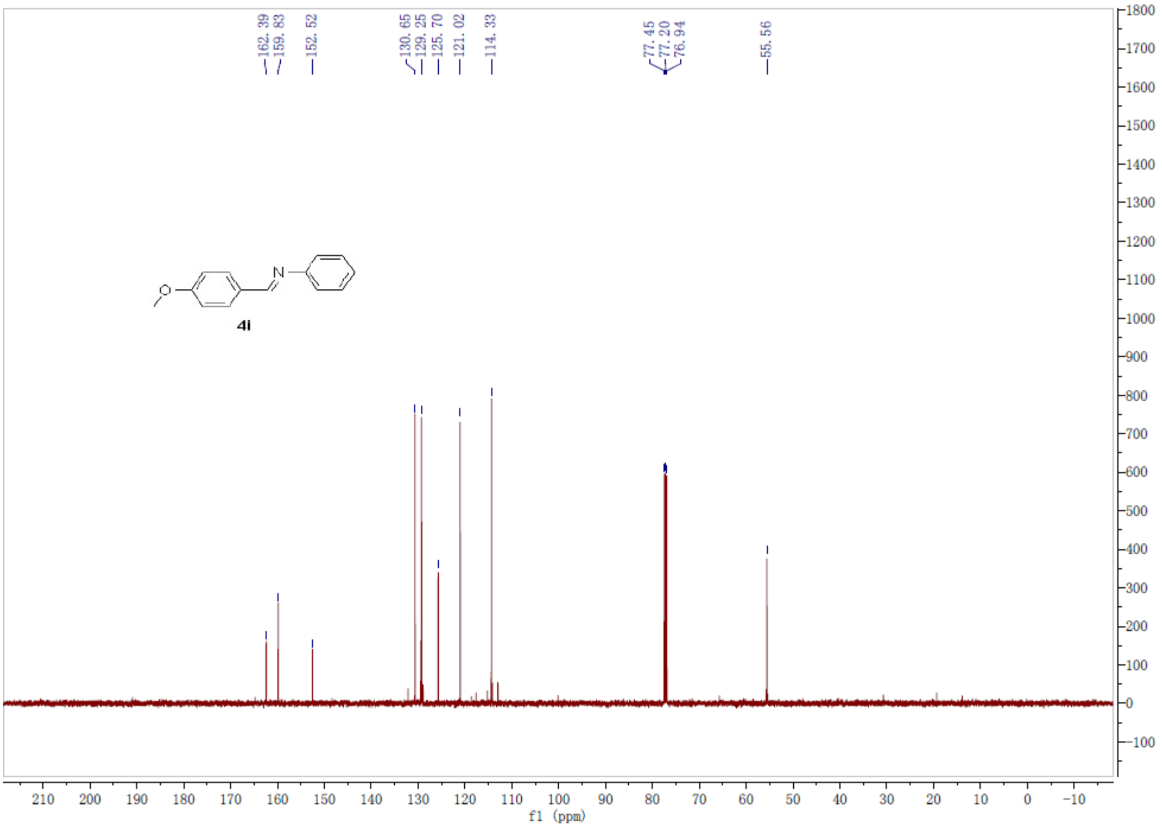

4g
8.43
7.77
7.68
7.66
7.41
7.40
7.38
7.37
7.35
7.31
7.30
7.25
7.24
7.22
7.22
7.21
7.20
7.20
2.43
A (s) 8.43
C (s) 7.77
D (d) 7.67
F (d) 7.31
E (m) 7.39
G (m) 7.22
B (s) 2.43
1.00
1.00
1.25
3.15
1.03
3.41
2.97
f1 (ppm)

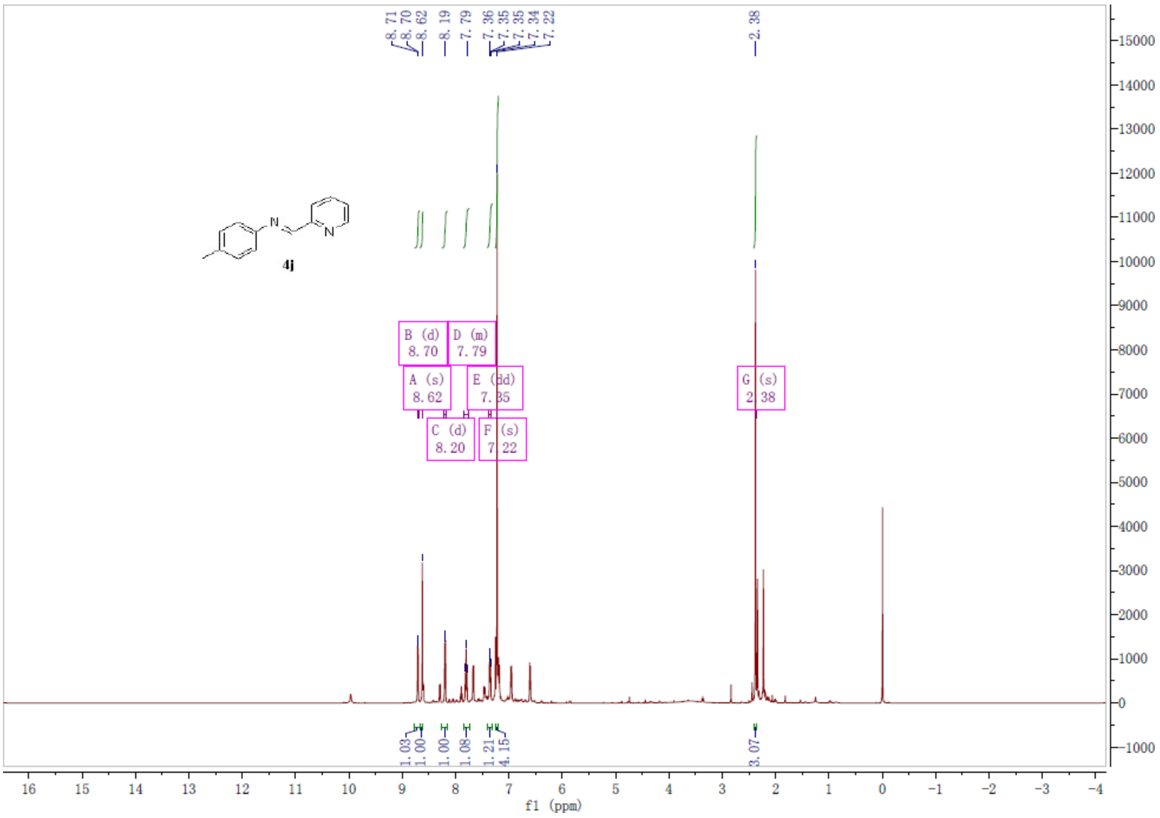

4g
160.84
152.30
138.69
136.29
129.09
126.00
121.00
77.42
77.16
76.91
21.44
f1 (ppm)

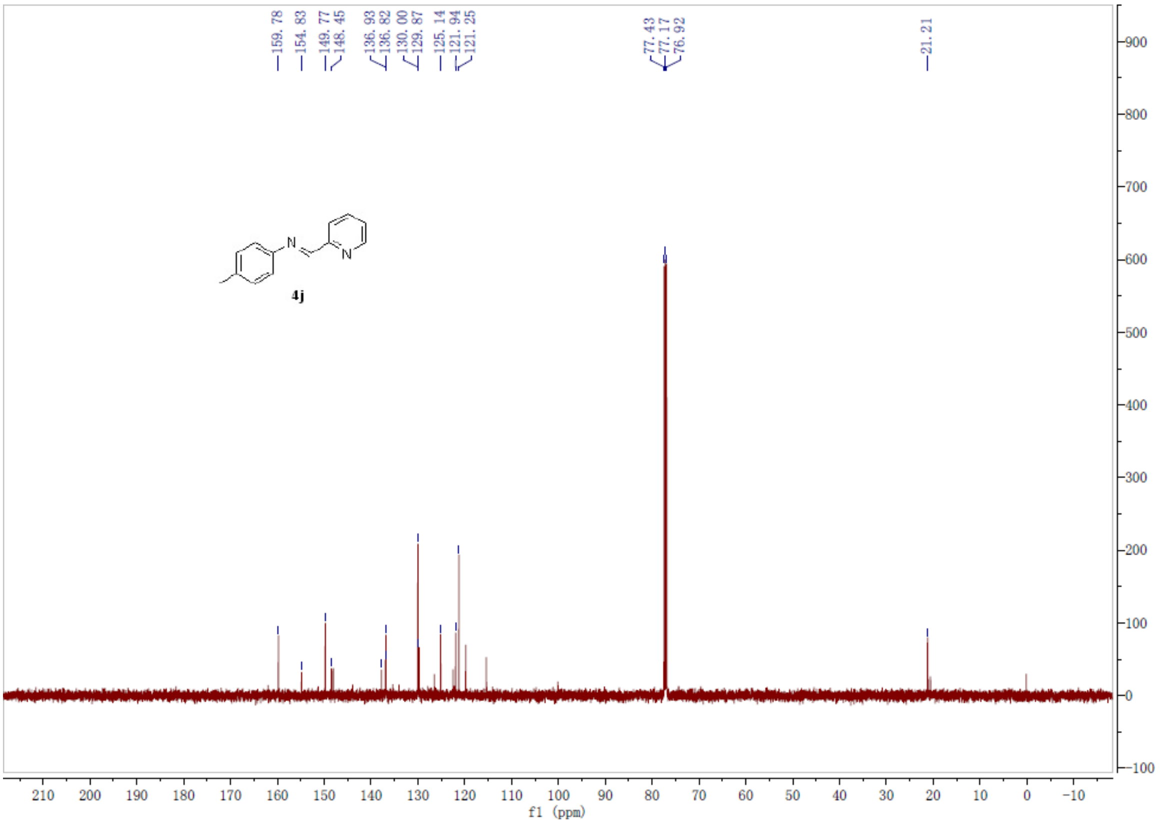

8.45
7.77
7.67
7.65
7.38
7.36
7.35
7.30
7.29
7.22
7.20
7.18
7.16
7.14
2.43
2.38
C (s) 8.45
D (s) 7.77
E (d) 7.66
F (t) 7.36
G (d) 7.29
H (t) 7.20
I (d) 7.15
B (s) 2.43
A (s) 2.38
N
4h
0.92
0.96
0.97
1.13
1.05
2.00
1.90
3.09
3.00
f1 (ppm)


160.02
149.68
138.64
136.44
135.85
128.99
126.48
120.94
77.43
77.18
76.92
21.44
21.14
N
4h
f1 (ppm)


8.39
7.87
7.85
7.40
7.39
7.37
7.23
7.21
7.21
7.20
7.18
7.01
7.00
6.98
3.87
B (s) 8.39
C (d) 7.86
D (t) 7.39
E (m) 7.21
F (t) 7.00
A (s) 3.87
0.98
2.15
1.99
3.16
2.16
3.00
O
N
4i
f1 (ppm)
10.5 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 -0.5
24000 22000 20000 18000 16000 14000 12000 10000 8000 6000 4000 2000 0 -2000


162.39
159.83
152.52
130.65
129.25
125.70
121.02
114.33
77.45
77.20
76.94
55.56
O
N
4i
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
1800 1700 1600 1500 1400 1300 1200 1100 1000 900 800 700 600 500 400 300 200 100 0 -100


8.71
8.70
8.62
8.19
7.79
7.36
7.35
7.35
7.34
7.22
2.38
N
N
4j
B (d) 8.70
D (m) 7.79
A (s) 8.62
E (dd) 7.35
C (d) 8.20
F (s) 7.22
G (s) 2.38
1.03
1.00
1.00
1.08
1.21
4.15
3.07
f1 (ppm)


159.78
154.83
149.77
148.45
136.93
136.82
130.00
129.87
125.14
121.94
121.25
77.43
77.17
76.92
21.21
N
N
4j
f1 (ppm)