

Electronic Supplementary Information

Clean Synthesis of Primary to Tertiary Carboxamides by CsOH-Catalyzed Aminolysis of Nitriles in Water

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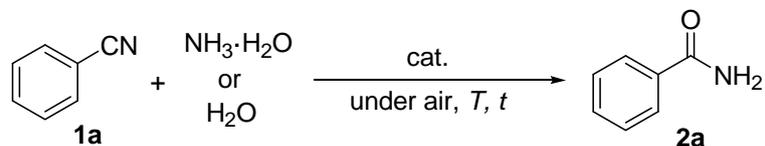
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Table S1. Condition Screening and Optimization for Primary Carboxamide Synthesis by Nitrile Aminolysis with Ammonia.^a

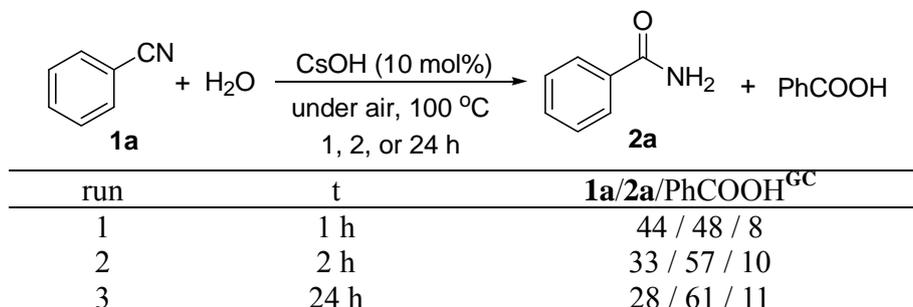


run	cat. (mol%)	reactant	<i>T, t</i>	2a % ^b
1	CsOH·H ₂ O (10)	H ₂ O	100 °C, 24 h	61 ^c
2	CsOH·H ₂ O (10)	H ₂ O	100 °C, 2 h	57 ^d
3	CsOH·H ₂ O (10)	H ₂ O	100 °C, 1 h	48 ^e
4	CsOH·H ₂ O (10)	NH ₃ ·H ₂ O	100 °C, 1 h	>99 (94)
5	KOH (10)	NH ₃ ·H ₂ O	100 °C, 2 h	64
6	KOH (10)	H ₂ O	100 °C, 2 h	41
7	NaOH (10)	NH ₃ ·H ₂ O	100 °C, 2 h	80
8	NaOH (10)	H ₂ O	100 °C, 2 h	11
9	<i>t</i> -BuOK (10)	NH ₃ ·H ₂ O	100 °C, 2 h	60
10	<i>t</i> -BuOK (10)	H ₂ O	100 °C, 2 h	38
11	<i>t</i> -BuONa (10)	NH ₃ ·H ₂ O	100 °C, 2 h	81
12	<i>t</i> -BuONa (10)	H ₂ O	100 °C, 2 h	46
13	Cs ₂ CO ₃ (10)	NH ₃ ·H ₂ O	100 °C, 5 h	0
14	CsF (10)	NH ₃ ·H ₂ O	100 °C, 5 h	0
15	--	NH ₃ ·H ₂ O	100 °C, 24 h	0
16	CsOH·H ₂ O (10)	NH ₃ ·H ₂ O	80 °C, 6 h	96
17	CsOH·H ₂ O (5)	NH ₃ ·H ₂ O	100 °C, 24 h	80

^a The mixture of **1a** (1.0 mmol) and base catalyst in NH₃·H₂O or distilled water (0.5 mL) was directly sealed under air in a Schlenk tube and then heated and monitored by GC-MS/TLC. ^b GC yields (isolated yield in parenthesis) based on **1a**. ^c 28% PhCN and 11% PhCOOH were detected. ^d 33% PhCN and 10% PhCOOH were detected. ^e 44% PhCN and 8% PhCOOH were detected.

Control Reactions

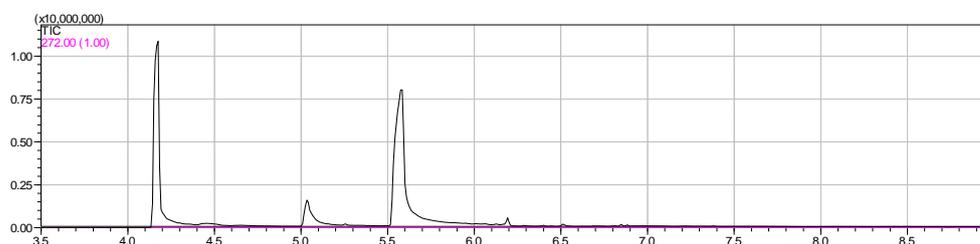
1. Reaction progress monitoring of the hydration reaction (runs 1-3 in Table 1 in the manuscript and also in Table S1 of ESI)



Typical procedure: The mixture of **1a** (0.103 g, 1.0 mmol), CsOH:H₂O (0.018 g, 0.1 mmol, 10 mol%), H₂O (0.5 mL) in a 20 mL Schlenk tube under air and heated at 100 °C for 1 h. The mixture was then quenched with ethyl acetate and carefully acidified with 0.5 mL HCl (1 M). The organic layer was separated and water layer extracted by ethyl acetate. The combined organic layer was then concentrated, and the crude reaction residues were then subjected to GC-MS analysis (data shown in above table, see also Table 1 in the manuscript and Table S1 in ESI, runs 1-3).

To isolate the generated PhCOOH, the crude reaction residue was again dissolved in ethyl acetate and washed with dilute NaOH for several times to convert PhCOOH to PhCOONa. The separated water layer was also extracted with small amounts of ethyl acetate to remove any organic chemicals. The water layer was then neutralized by HCl to convert PhCOONa back into PhCOOH. However, although we tried several times, the generated low yields of PhCOOH could not be successfully isolated. This is very possibly because the reactions are too small in scale and that the tedious workup procedure involved the use of water. Therefore, GC data were adopted for discussion.

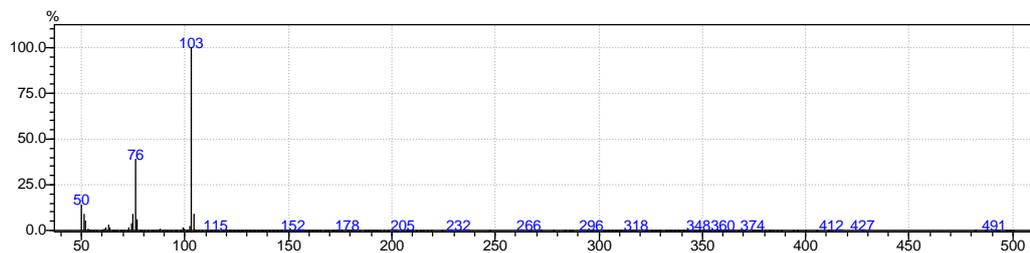
GC spectra of 1 h reaction:



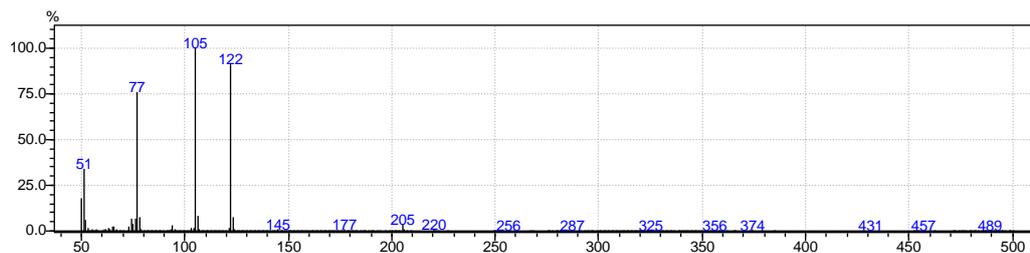
Ret.time	Start TM	End TM	m/z	Area	Area%	Height	Height% A/H	
4.171	4.125	4.833	TIC	30148241	43.55	10859644	53.45	2.78 MI
5.035	4.983	5.258	TIC	5712492	8.25	1534540	7.55	3.72 MI
5.579	5.500	5.767	TIC	33373852	48.20	7925131	39.00	4.21 MI

Mass spectra:

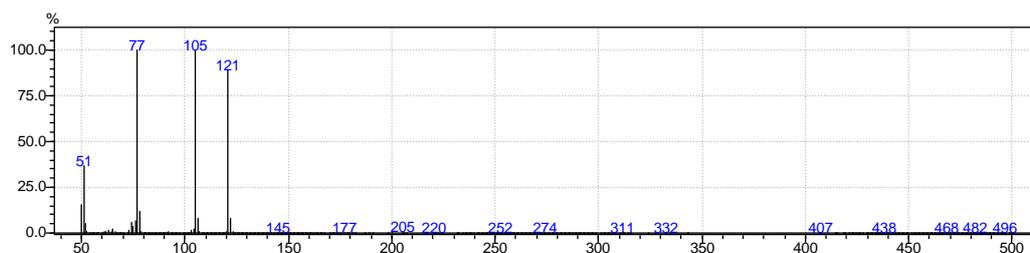
Ret.time: 4.171 min, PhCN (**1a**)



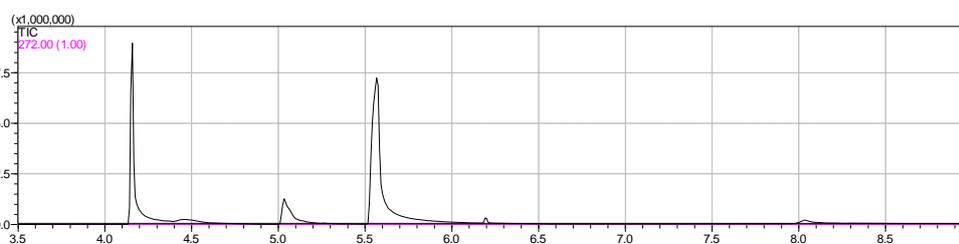
Ret.time: 5.035 min, PhCOOH



Ret.time: 5.579 min, PhCONH₂ (**2a**)



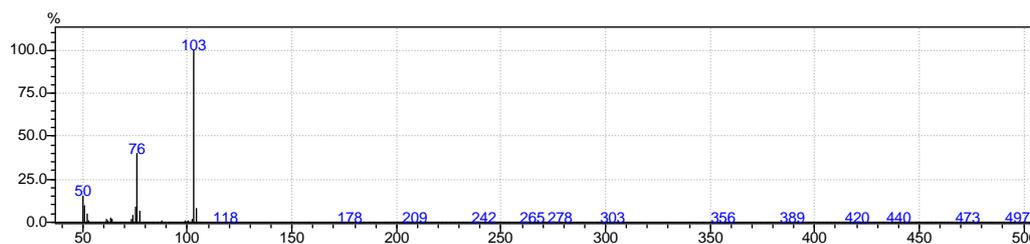
GC spectra of 2 h reaction:



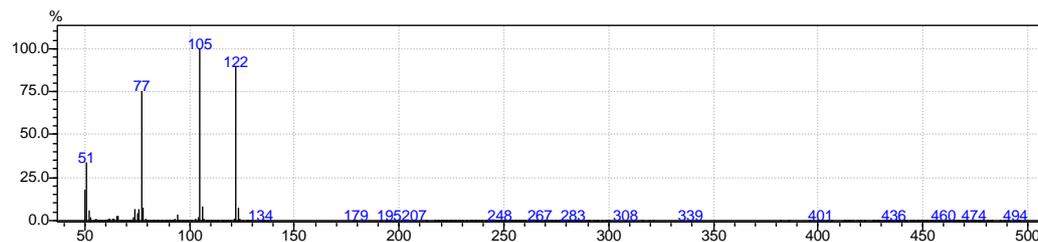
Ret.time	Start TM	End TM	m/z	Area	Area%	Height	Height%	A/H
4.156	4.117	4.642	TIC	17314856	33.31	8955039	51.33	1.93 MI
5.035	4.992	5.325	TIC	5146724	9.90	1263932	7.25	4.07 MI
5.567	5.508	5.967	TIC	29515149	56.79	7225084	41.42	4.09 MI

Mass spectra:

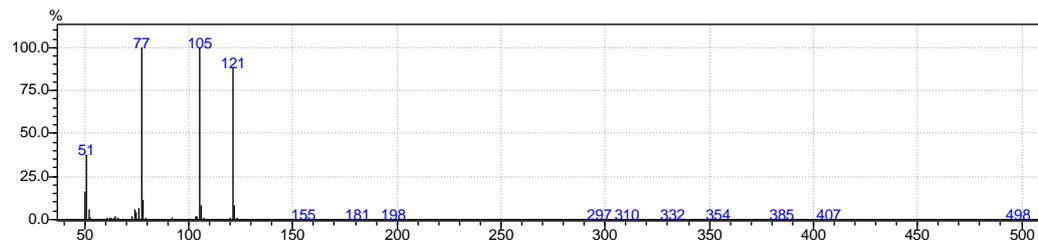
Ret.time: 4.156 min, PhCN (**1a**)



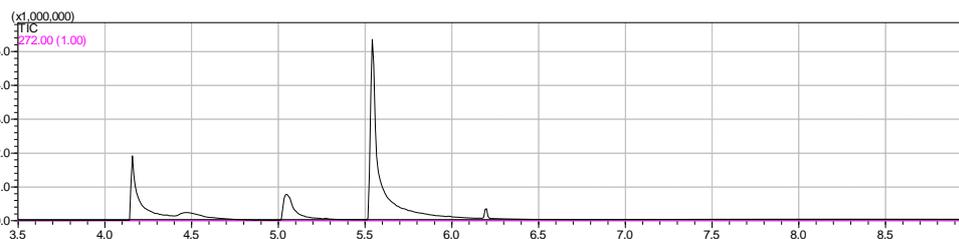
Ret.time: 5.035 min, PhCOOH



Ret.time: 5.567 min, PhCONH₂ (2a)



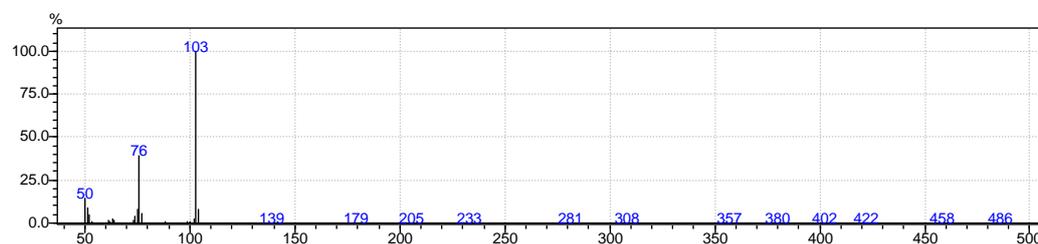
GC spectra of 24 h reaction:



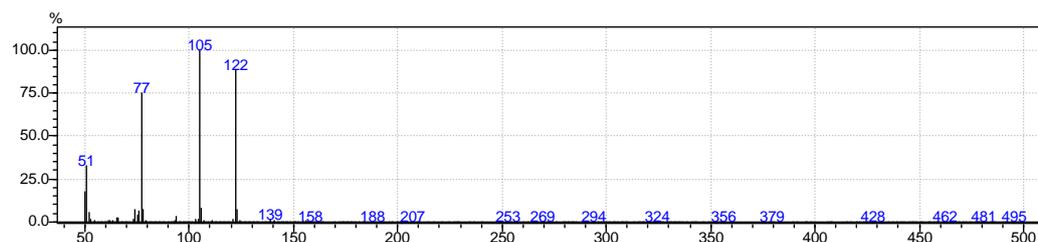
Ret.time	Start TM	End TM	m/z	Area	Area%	Height	Height%	A/H
4.159	4.117	4.700	TIC	8996261	28.28	1905119	23.80	4.72 MI
5.047	4.992	5.200	TIC	3474531	10.92	765860	9.57	4.54 MI
5.543	5.492	6.067	TIC	19340824	60.80	5333476	66.63	3.63 MI

Mass spectra:

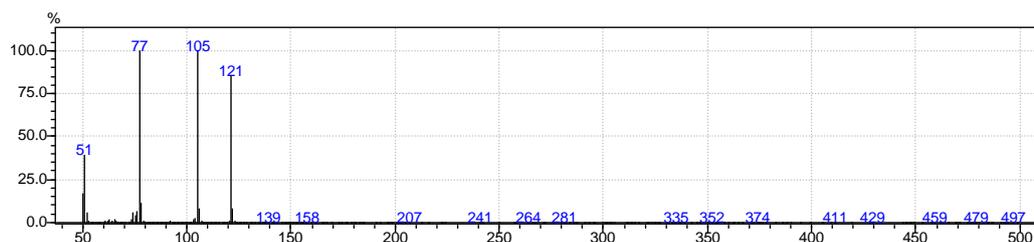
Ret.time: 4.159 min, PhCN (1a)



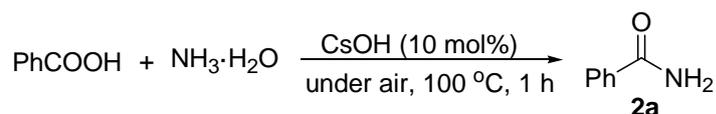
Ret.time: 5.047 min, PhCOOH



Ret.time: 5.543 min, PhCONH₂ (**2a**)



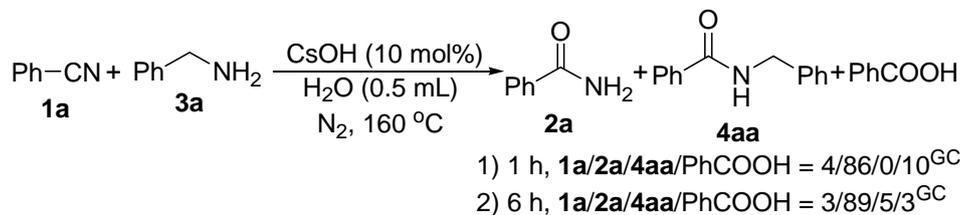
2. Condensation of PhCOOH and ammonia (eq. 1 in the manuscript)



not detected by both TLC and GC

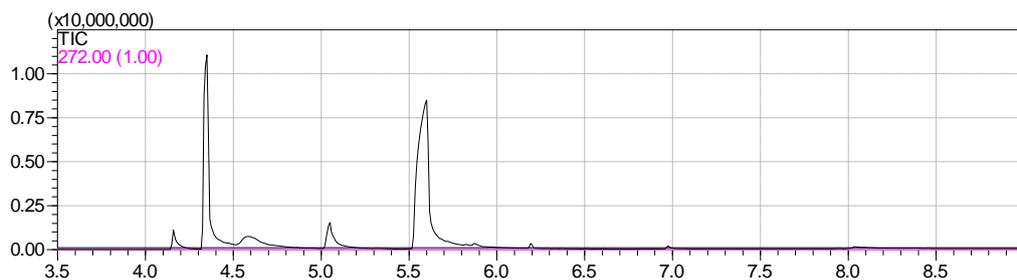
Procedure: The mixture of benzoic acid (0.122 g, 1.0 mmol), NH₃·H₂O (0.5 mL), CsOH·H₂O (0.017 g, 0.1 mmol, 10 mol%) in a 20 mL Schlenk tube was sealed under air and heated at 100 °C for 1 h. The reaction mixture was then quenched with ethyl acetate and monitored by TLC and GC-MS analysis. No **2a** could be detected by TLC analysis by comparison with the authentic sample. No formation of **2a** was also detected by GC-MS analysis.

3. Reaction progress monitoring of the aminolysis reaction with amines (eq. 2 in the manuscript)



Procedure: The mixture of **1a** (0.103 g, 1.0 mmol), **3a** (0.129 g, 1.2 mmol, 1.2 equiv.), CsOH·H₂O (0.017 g, 0.1 mmol, 10 mol%), H₂O (0.5 mL) in a 20 mL Schlenk tube was sealed under N₂ and heated at 160 °C for 1 h or 6 h. The reaction mixture was then quenched with ethyl acetate and carefully acidified with 0.5 mL HCl (1M). The organic layer was separated and water layer extracted by ethyl acetate. The combined organic layer was then concentrated and the residue subjected to GC-MS analysis.

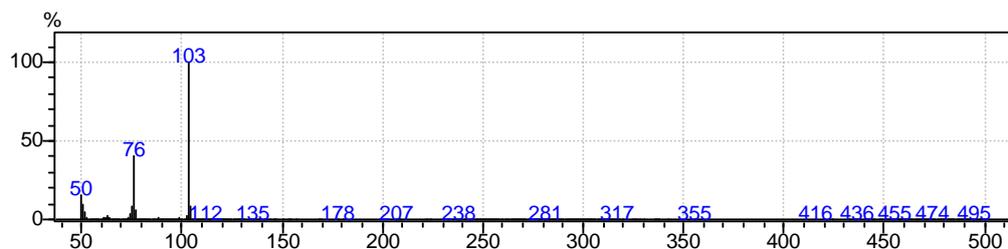
GC spectra of 1 h reaction:



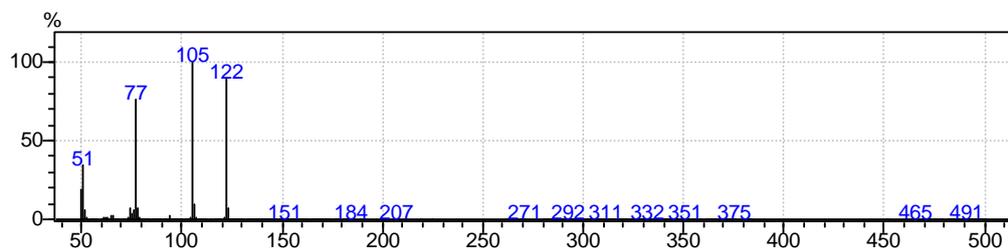
Ret.time	Start TM	End TM	m/z	Area	Area%	Height	Height%	A/H
4.160	4.117	4.275	TIC	2089272	4.27	1106069	9.99	1.89 MI
5.048	4.975	5.300	TIC	4760488	9.73	1493550	13.49	3.19 MI
5.596	5.500	6.075	TIC	42065059	86.00	8469612	76.52	4.97 MI

Mass spectra:

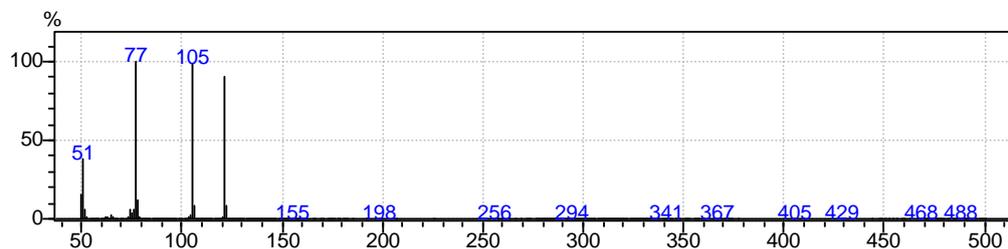
Ret.time: 4.160 min, PhCN (**1a**)



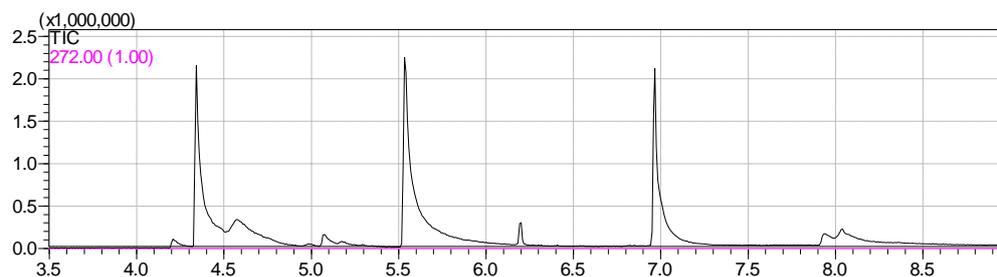
Ret.time: 5.048 min, PhCOOH



Ret.time: 5.596 min, PhCONH₂ (**2a**)



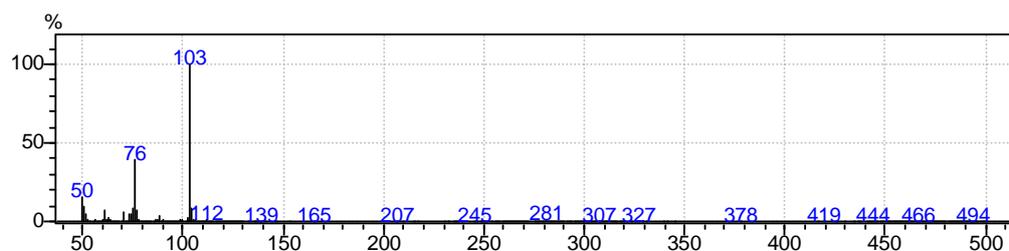
GC spectra of 6 h reaction:



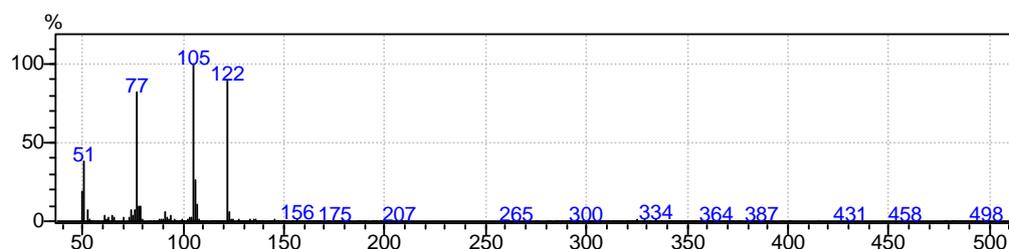
Ret.time	Start TM	End TM	m/z	Area	Area%	Height	Height%	A/H
4.210	4.100	4.300	TIC	319908	2.83	103301	4.00	3.09 MI
5.073	5.017	5.367	TIC	602252	5.33	131869	5.10	4.57 MI
5.537	5.500	6.125	TIC	10038474	88.81	2235666	86.51	4.49 MI
7.940	7.917	7.975	TIC	342722	3.03	113497	4.39	3.05 MI

Mass spectra:

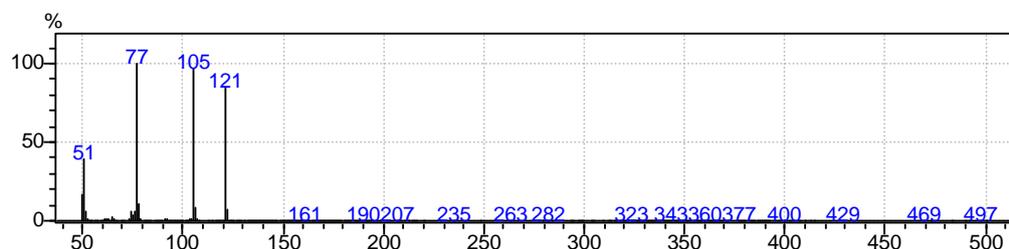
Ret.time: 4.210 min, PhCN (**1a**)



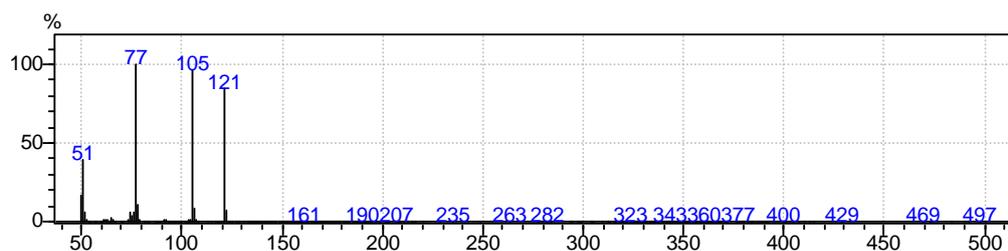
Ret.time: 5.073 min, PhCOOH



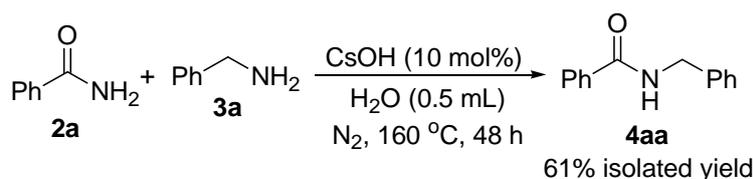
Ret.time: 5.537 min, PhCONH₂ (**2a**)



Ret.time: 7.940 min, PhCONHCH₂Ph (**4aa**)

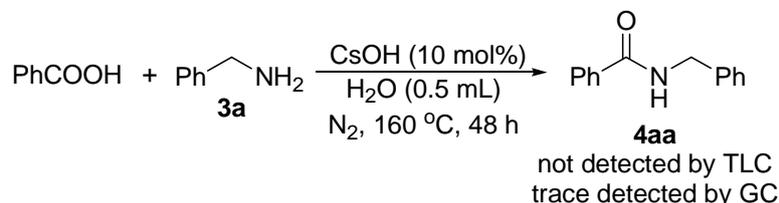


4. Transamidation reaction (eq. 3 in the manuscript)



Procedure: The mixture of **2a** (0.242 g, 2.0 mmol), **3a** (0.259 g, 2.4 mmol, 1.2 equiv.), CsOH·H₂O (0.040 g, 0.2 mmol, 10 mol%), H₂O (0.5 mL) in a 20 mL Schlenk tube was sealed under N₂ and heated at 160 °C for 48 h. The mixture was then quenched with ethyl acetate, solvent evaporated under vacuum, and the residue purified by column chromatography using ethyl acetate and petroleum ether (60-90 °C) (v/v 1/5) as the eluent. 61% Isolated yield (0.254 g) of **4aa** was obtained.

5. Condensation of PhCOOH and benzyl amine (eq. 4 in the manuscript)

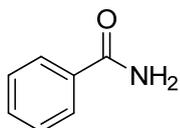


Procedure: The mixture of benzoic acid (0.122 g, 1.0 mmol), **3a** (0.129 g, 1.2 mmol, 1.2 equiv.), CsOH·H₂O (0.017 g, 0.1 mmol, 10 mol%), H₂O (0.5 mL) in a 20 mL Schlenk tube was sealed under N₂ and heated at 160 °C for 48 h. The mixture was then quenched with ethyl acetate and monitored by TLC and GC-MS analysis. No **4aa** could be detected by TLC by comparison with the authentic sample. Only trace amounts of **4aa** was detected by GC-MS analysis.

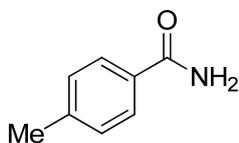
Experimental

General. Substrates and catalysts were all purchased and used as received. Progresses of the reactions were monitored by TLC and/or GC-MS. Products were purified by column chromatography on silica gel using petroleum ether and ethyl acetate as the eluent. ^1H and ^{13}C NMR spectra were recorded on a Bruker Avance-III 500 instrument (500 MHz for ^1H and 125.4 MHz for ^{13}C NMR spectroscopy). Unless otherwise noted, d_6 -DMSO or CDCl_3 was used as the solvent. Chemical shifts for ^1H and ^{13}C NMR were referred to internal Me_4Si (0 ppm). Mass spectra were measured on a Shimadzu GCMS-QP2010 Plus spectrometer (EI).

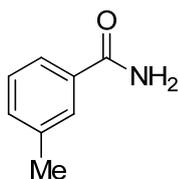
Typical Procedure for CsOH-Catalyzed Nitrile Aminolysis with Ammonia for Preparation of Primary Amides. The mixture of benzonitrile **1a** (0.103g, 1.0 mmol) and $\text{CsOH}\cdot\text{H}_2\text{O}$ (0.017 g, 0.1 mmol, 10 mol%) in $\text{NH}_3\cdot\text{H}_2\text{O}$ (0.5 mL) was directly sealed under air in a Schlenk tube and then heated at $100\text{ }^\circ\text{C}$ for 1 h. After completion of the reaction as monitored by GC-MS and/or TLC, the mixture was directly purified, without any workup, through a silica gel column by using ethyl acetate and petroleum ether as the eluent, affording benzamide **2a** in 94% isolated yield.



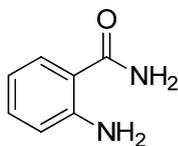
Benzamide (2a). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.97 (b, 1H), 7.89-7.86 (m, 2H), 7.54-7.51 (m, 1H), 7.47-7.44 (m, 2H), 7.36 (b, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 167.9, 134.2, 131.2, 128.2, 127.4. MS (EI): m/z (%) 122 (6), 121 (86), 106 (8), 105 (100), 78 (12), 77 (83), 76 (6), 75 (4), 74 (6), 65 (2), 52 (6), 51 (35), 50 (20), 44 (8), 39 (6), 38 (4), 37 (3), 27 (4). This compound was known: Li, Z.; Wang, L.; Zhou, X. *Adv. Synth. Catal.* **2012**, 354, 584-588.



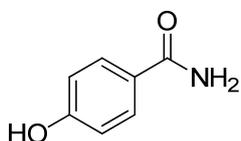
4-Methylbenzamide (2b). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.71 (d, $J = 8.0$ Hz, 2H), 7.25 (d, $J = 8.0$ Hz, 2H), 6.01 (b, 2H), 2.40 (s, 3H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 169.4, 142.5, 130.6, 129.3, 127.4, 21.5. MS (EI): m/z (%) 136 (5), 135 (60), 120 (8), 119 (100), 117 (3), 92 (5), 91 (74), 90 (8), 89 (10), 65 (33), 64 (4), 63 (13), 51 (9), 50 (6), 44 (12), 41 (5), 40 (9), 39 (20), 38 (4). This compound was known: Li, Z.; Wang, L.; Zhou, X. *Adv. Synth. Catal.* **2012**, 354, 584-588.



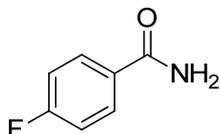
3-Methylbenzamide (2c). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.92 (b, 1H), 7.71 (s, 1H), 7.68-7.66 (m, 1H), 7.33 (d, $J = 5.0$ Hz, 2H), 7.30 (b, 1H), 2.35 (s, 3H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 168.0, 137.4, 134.2, 131.7, 128.0, 124.5, 20.9. MS (EI): m/z (%) 136 (6), 135 (63), 120 (9), 119 (100), 117 (4), 116 (2), 92 (6), 91 (77), 90 (5), 89 (7), 65 (18), 63 (6), 62 (2), 51(4), 44 (3), 39 (6). This compound was known: Li, Z.; Wang, L.; Zhou, X. *Adv. Synth. Catal.* **2012**, 354, 584-588.



2-Aminobenzamide (2d). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.70 (b, 1H), 7.51 (d, $J = 8.0$ Hz, 1H), 7.13-7.10 (m, 1H), 7.03 (b, 1H), 6.66 (d, $J = 8.0$ Hz, 1H), 6.53 (b, 2H), 6.48-6.45 (m, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 171.3, 150.1, 131.8, 128.7, 116.4, 114.4, 113.7. MS (EI): m/z (%) 137(6), 136 (74), 120 (15), 119 (100), 118 (6), 93 (4), 92 (52), 91 (15), 66 (4), 65 (24), 64 (9), 63 (6), 52 (5), 39 (9). This compound was known: Tao, T.; Wang, Z.; Liu, Z.; Feng, X.; Wang, Q. *Green. Chem.* **2012**, 14, 921-924.

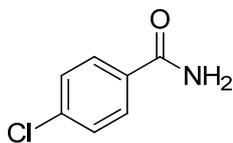


4-Hydroxybenzamide (2e). ^1H NMR (500 MHz, d_6 -DMSO): δ 9.94 (b, 1H), 7.73 (d, $J = 8.5$ Hz, 2H), 7.71 (b, 1H), 7.05 (b, 1H), 6.78 (d, $J = 9.0$ Hz, 2H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 167.6, 160.1, 129.4, 125.0, 114.6. MS (EI): m/z (%) 138 (5), 137 (59), 122 (8), 121 (100), 93 (36), 92 (6), 66 (4), 65 (33), 64 (6), 63 (12), 62 (6), 55 (4), 53 (7), 50 (4), 44 (7), 39 (22), 38 (7), 37 (3). This compound was known: Datta, B.; Pasha, M. A. *Bull. Korean Chem. Soc.* **2012**, 33(7), 2129-2130.

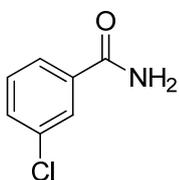


4-Fluorobenzamide (2f). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.98 (b, 1H), 7.96-7.93 (m, 2H), 7.38 (b, 1H), 7.28-7.25 (m, 2H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 166.8, 163.9 (d, $J_{\text{C-F}} = 247.7$ Hz), 130.7, 130.0, 115.0 (d, $J_{\text{C-F}} = 21.7$ Hz). MS (EI): m/z (%) 140 (6), 139 (62), 124 (8), 123 (100), 122 (2), 121 (5), 96 (10), 95 (80), 94 (8), 93 (3), 83 (3), 76 (4), 75 (35), 74 (10), 70 (4), 69 (8), 68 (6), 63

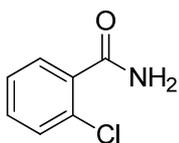
(4), 62 (3), 61 (3), 57 (4), 51 (7), 50 (14), 44 (11), 39 (3), 38 (3), 37 (4), 31 (3). This compound was known: Tao, T.; Wang, Z.; Liu, Z.; Feng, X.; Wang, Q. *Green. Chem.* **2012**, *14*, 921-924.



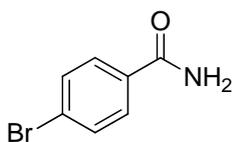
4-Chlorobenzamide (2g). ^1H NMR (500 MHz, d_6 -DMSO): δ 8.04 (b, 1H), 7.89 (d, $J = 8.5$ Hz, 2H), 7.53 (d, $J = 8.5$ Hz, 2H), 7.45 (b, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 166.8, 136.0, 133.0, 129.4, 128.2. MS (EI): m/z (%) 157 (16), 155 (50), 141 (29), 140 (8), 139 (100), 137 (8), 113 (16), 112 (5), 111 (51), 85 (4), 77 (5), 76 (8), 75 (35), 74 (15), 73 (5), 51 (10), 50 (21), 44 (10), 38 (5), 28 (4). This compound was known: Li, Z.; Wang, L.; Zhou, X. *Adv. Synth. Catal.* **2012**, *354*, 584-588.



3-Chlorobenzamide (2h). ^1H NMR (500 MHz, d_6 -DMSO): δ 8.09 (b, 1H), 7.92-7.91 (m, 1H), 7.85-7.83 (m, 1H), 7.61-7.59 (m, 1H), 7.52 (b, 1H), 7.51-7.48 (m, 2H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 166.4, 136.3, 133.1, 131.0, 130.2, 127.3, 126.1. MS (EI): m/z (%) 157 (16), 156 (4), 155 (50), 141 (29), 140 (8), 139 (100), 137 (8), 113 (16), 112 (5), 111 (51), 85 (4), 77 (5), 76 (8), 75 (35), 74 (15), 73 (5), 51 (10), 50 (21), 44 (10), 28 (4). This compound was known: Tao, T.; Wang, Z.; Liu, Z.; Feng, X.; Wang, Q. *Green. Chem.* **2012**, *14*, 921-924.

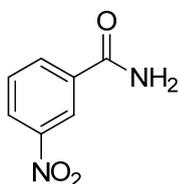


2-Chlorobenzamide (2i). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.88 (b, 1H), 7.58 (b, 1H), 7.49-7.47 (m, 1H), 7.46-7.42 (m, 2H), 7.40-7.38 (m, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 168.2, 137.1, 130.5, 129.60, 129.57, 128.6, 127.0. MS (EI): m/z (%) 157 (18), 156 (4), 155 (58), 142 (2), 141 (32), 140 (8), 139 (100), 113 (12), 112 (6), 111 (38), 85 (3), 77 (9), 76 (8), 75 (26), 74 (8), 51 (9), 50 (16), 44 (11), 38 (4), 37 (3). This compound was known: Li, Z.; Wang, L.; Zhou, X. *Adv. Synth. Catal.* **2012**, *354*, 584-588.

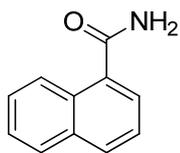


4-Bromobenzamide (2j). ^1H NMR (500 MHz, d_6 -DMSO): δ 8.05 (b, 1H), 7.83-7.81 (m, 2H),

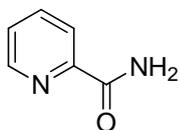
7.67-7.65 (m, 2H), 7.46 (b, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 167.0, 133.4, 131.2, 129.6, 125.0. MS (EI): m/z (%) 201 (51), 199 (53), 185 (94), 184 (7), 183 (100), 157 (37), 155 (38), 77 (20), 76 (46), 75 (45), 74 (26), 73 (6), 65 (6), 51 (22), 50 (67), 49 (6), 44 (25). This compound was known: Tao, T.; Wang, Z.; Liu, Z.; Feng, X.; Wang, Q. *Green. Chem.* **2012**, *14*, 921-924.



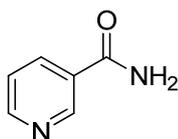
3-Nitrobenzamide (2k). ^1H NMR (500 MHz, d_6 -DMSO): δ 8.69 (s, 1H), 8.39 (b, 1H), 8.36 (d, J = 8.0 Hz, 1H), 8.31 (d, J = 7.5 Hz, 1H), 7.79-7.76 (m, 1H), 7.73 (b, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 165.8, 147.8, 135.7, 133.8, 130.1, 125.9, 122.2. MS (EI): m/z (%) 167 (6), 166 (67), 151 (8), 150 (100), 105 (3), 104 (33), 103 (8), 92 (17), 77 (14), 76 (54), 75 (32), 74 (32), 73 (6), 65 (26), 64 (6), 63 (9), 62 (5), 53 (4), 52 (5), 51 (26), 50 (52), 46 (20), 44 (50), 39 (9), 38 (8), 37 (5), 30 (31). This compound was known: Li, Z.; Wang, L.; Zhou, X. *Adv. Synth. Catal.* **2012**, *354*, 584-588.



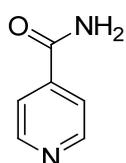
1-Naphthamide (2l). ^1H NMR (500 MHz, d_6 -DMSO): δ 8.31 (d, J = 8.5 Hz, 1H), 8.01-7.96 (m, 3H), 7.64 (d, J = 6.5 Hz, 1H), 7.59-7.52 (m, 4H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 171.4, 135.4, 134.0, 130.53, 130.50, 128.9, 127.4, 126.9, 126.4, 125.9, 125.7. MS (EI): m/z (%) 172 (9), 171 (72), 170 (26), 156 (9), 155 (75), 154 (7), 153 (4), 128 (15), 127 (100), 126 (28), 125.4 (3), 115 (9), 101 (9), 85 (4), 77 (12), 76 (5), 75 (10), 63 (12), 51 (8), 50 (6), 44 (4). This compound was known: Tao, T.; Wang, Z.; Liu, Z.; Feng, X.; Wang, Q. *Green. Chem.* **2012**, *14*, 921-924.



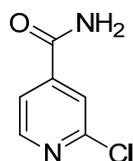
Picolinamide (2m). ^1H NMR (500 MHz, d_6 -DMSO): δ 8.58 (d, J = 4.5 Hz, 1H), 8.22 (d, J = 8.0 Hz, 1H), 7.88-7.85 (m, 2H), 7.47-7.44 (m, 1H), 5.97 (b, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 166.5, 150.8, 149.0, 138.2, 127.0, 122.4. MS (EI): m/z (%) 123 (2), 122 (29), 80 (6), 79 (100), 78 (34), 76 (5), 53 (7), 52 (50), 51 (39), 50 (20), 49 (5), 44 (19), 39 (8), 38 (6), 37 (4), 28 (7), 27 (8), 26 (7), 16 (5). This compound was known: Tamura, M.; Wakasugi, H.; Shimizu, K.; Satsuma, A. *Chem. Eur. J.* **2011**, *17*, 11428-11431.



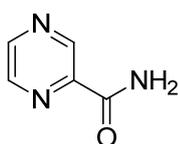
Nicotinamide (2n). ^1H NMR (500 MHz, d_6 -DMSO): δ 9.02 (s, 1H), 8.69 (dd, $J = 1.5$, $J = 5.0$ Hz, 1H), 8.20 (d, $J = 7.5$ Hz, 1H), 8.14 (b, 1H), 7.58 (b, 1H), 7.48 (dd, $J = 8.0$, $J = 5.0$ Hz, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 166.4, 151.8, 148.6, 135.1, 129.7, 123.4. MS (EI): m/z (%) 123 (8), 122 (100), 106 (60), 105 (6), 104 (3), 94 (3), 79 (8), 78 (69), 77 (7), 76 (3), 75 (2), 53 (3), 52 (12), 51 (30), 50 (13), 49 (2), 44 (8), 39 (3), 38 (2). This compound was known: Li, Z.; Wang, L.; Zhou, X. *Adv. Synth. Catal.* **2012**, *354*, 584-588.



Isonicotinamide (2o). ^1H NMR (500 MHz, d_6 -DMSO): δ 8.72 (d, $J = 6.0$ Hz, 2H), 8.24 (b, 1H), 7.77 (d, $J = 5.5$ Hz, 2H), 7.71 (b, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 166.3, 150.2, 141.3, 121.4. MS (EI): m/z (%) 123 (8), 122 (100), 107 (2), 106 (40), 79 (12), 78 (56), 77 (2), 53 (2), 52 (15), 51 (36), 50 (14), 49 (2), 44 (13), 39 (3), 28 (3), 26 (2). This compound was known: Tao, T.; Wang, Z.; Liu, Z.; Feng, X.; Wang, Q. *Green. Chem.* **2012**, *14*, 921-924.

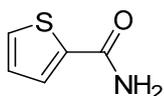


2-Chloroisonicotinamide (2p). ^1H NMR (500 MHz, d_6 -DMSO): δ 8.56 (d, $J = 5.0$ Hz, 1H), 8.33 (b, 1H), 7.87 (b, 2H), 7.78 (dd, $J = 5.0$, $J = 1.5$ Hz, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 164.9, 150.9, 150.7, 144.9, 122.1, 121.0. MS (EI): m/z (%) 158 (25), 157 (7), 156 (78), 142 (32), 141 (8), 140 (100), 114 (16), 112 (48), 85 (14), 78 (8), 76 (19), 75 (4), 51 (10), 50 (16), 44(13), 28 (3). This compound was known: Sahnoun, S.; Messaoudi, S.; Peyrat, J.; Brion, J.; Alami, M. *Tetrahedron Lett.* **2012**, *53*, 2860-2863.

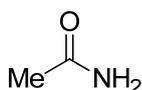


Pyrazine-2-Carboxamide (2q). ^1H NMR (500 MHz, d_6 -DMSO): δ 9.19 (d, $J = 1.5$ Hz, 1H), 8.85 (d, $J = 2.5$ Hz, 1H), 8.71 (dd, $J = 2.5$, $J = 1.5$ Hz, 1H), 8.25 (b, 1H), 7.86 (b, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 170.3, 152.6, 150.3, 148.9, 148.8. MS (EI): m/z (%) 124 (7), 123 (100), 81 (4), 80 (80), 79 (18), 54 (2), 53 (51), 52 (32), 51 (9), 44 (18), 40 (2), 28 (12), 26 (15). This compound was known:

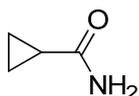
Tamura, M.; Wakasugi, H.; Shimizu, K.; Satsuma, A. *Chem. Eur. J.* **2011**, *17*, 11428-11431.



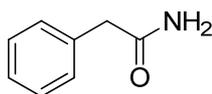
Thiophene-2-Carboxamide (2r). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.99 (b, 1H), 7.78-7.77 (m, 2H), 7.40 (b, 1H), 7.18-7.16 (m, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 168.1, 145.5, 136.2, 133.9, 133.1. MS (EI): m/z (%) 129 (4), 128 (5), 127(75), 113 (6), 112 (7), 111 (100), 83 (13), 82 (8), 81 (7), 58 (13), 57 (18), 54 (4), 53 (4), 50 (5), 45 (19), 44 (18), 39 (60), 38 (10). This compound was known: Rocío, G.-Á.; Josefina, D.; Pascale, C.; Victorio, C. *Organometallics*. **2011**, *30*, 5442–5451.



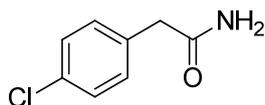
Acetamide (2s). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.30 (b, 1H), 6.68 (b, 1H), 1.77 (s, 3H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 171.6, 22.4. MS (EI): m/z (%) 59 (M^+). This compound was known: Li, Z.; Wang, L.; Zhou, X. *Adv. Synth. Catal.* **2012**, *354*, 584-588.



Cyclopropanecarboxamide (2t). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.49 (b, 1H), 6.72 (b, 1H), 1.52-1.47 (m, 1H), 0.65-0.59 (m, 4H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 175.2, 13.8, 6.7. MS (EI): m/z (%) 85 (8), 84 (61), 69 (25), 68 (8), 54 (5), 44 (100), 43 (8), 42 (41), 41 (72), 40 (16), 39 (90), 38 (20), 37 (12), 28 (26), 27 (20), 26 (12), 16 (10), 15 (7), 14 (6). This compound was known: Jiang, D.; Yuan, F.; Jiang, B.; Li, C. *Chinese Patent Application*, **2011**, CN102249949A (20111123).

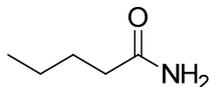


2-Phenylacetamide (2u). ^1H NMR (500 MHz, CDCl_3): δ 7.38-7.35 (m, 2H), 7.32-7.27 (m, 3H), 5.56 (b, 1H), 5.38 (b, 1H), 3.59 (s, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 173.4, 134.9, 129.4, 129.1, 127.5, 43.4. MS (EI): m/z (%) 135 (18), 93 (7), 92 (92), 91 (100), 90 (5), 89 (8), 65 (25), 64 (3), 63 (11), 51 (8), 50 (4), 44 (21), 41 (3), 39 (16), 38 (3). This compound was known: Li, Z.; Wang, L.; Zhou, X. *Adv. Synth. Catal.* **2012**, *354*, 584-588.

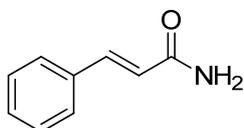


2-(4-Chlorophenyl)acetamide (2v). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.48 (b, 1H), 7.36 (d, J = 8.5 Hz, 2H), 7.28 (d, J = 8.5 Hz, 2H), 6.90 (b, 1H), 3.38 (s, 2H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 171.8, 135.5, 130.96, 130.91, 128.0, 41.3. MS (EI): m/z (%) 158 (14), 156 (41), 128 (15), 127 (24),

126 (46), 125 (63), 112 (4), 99 (6), 92 (8), 91 (100), 90 (7), 89 (16), 77 (5), 65 (5), 63 (9), 51 (6), 39 (7), 31 (17). This compound was known: Khodaei, M. M.; Nazari, E. *Tetrahedron Lett.* **2012**, 53, 2881-2884.

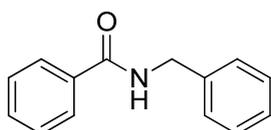


Pentanamide (2w). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.22 (b, 1H), 6.66 (b, 1H), 2.03 (t, $J = 7.5$ Hz, 2H), 1.49-1.43 (m, 2H), 1.29-1.24 (m, 2H), 0.89-0.85 (m, 3H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 174.3, 34.8, 27.2, 21.8, 13.7. MS (EI): m/z (%) 86 (3), 85 (2), 73 (3), 72 (18), 60 (3), 59 (100), 57 (11), 55 (5), 44 (39), 43 (9), 42 (4), 41 (16), 39 (6), 29 (19), 28 (4). This compound was known: Das, R.; Chakraborty, D. *Catal. Commun.* **2012**, 26, 48-53.



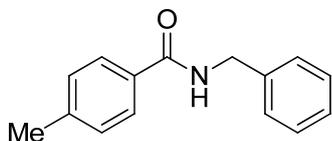
Cinnamamide (2x). ^1H NMR (500 MHz, d_6 -DMSO): δ 7.57-7.54 (m, 3H), 7.44-7.37 (m, 4H), 7.10 (b, 1H), 6.62 (d, $J = 16.0$ Hz, 1H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 166.6, 139.1, 134.9, 129.4, 128.9, 127.5, 122.3. MS (EI): m/z (%) 148 (6), 147 (55), 146 (100), 131 (60), 130 (22), 129 (61), 128 (18), 104 (8), 103 (80), 102 (35), 78 (12), 77 (49), 76 (10), 63 (8), 51 (32), 50 (13), 44 (9), 39 (7). This compound was known: Li, Z.; Wang, L.; Zhou, X. *Adv. Synth. Catal.* **2012**, 354, 584-588.

Typical Procedure for CsOH-Catalyzed Nitrile Aminolysis with Primary and Secondary Amines for Preparation of Secondary and Tertiary Carboxamides. The mixture of benzonitrile **1a** (0.103g, 1.0 mmol), benzylamine **3a** (0.129g, 1.2 mmol, 1.2 equiv.), and CsOH·H₂O (0.017 g, 0.1 mmol, 10 mol%) in distilled H₂O (0.5 mL) was sealed under nitrogen in a Schlenk tube and then heated at 160 °C for 2 days. After completion of the reaction as monitored by GC-MS and/or TLC, the mixture was directly purified, without any workup, through a silica gel column by using ethyl acetate and petroleum ether as the eluent, affording *N*-benzylbenzamide **4aa** in 68% isolated yield.

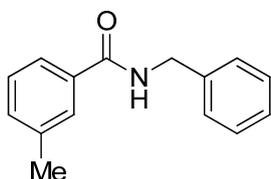


***N*-Benzyl benzamide (4aa).** ^1H NMR (500 MHz, d_6 -DMSO): δ 9.05 (t, $J = 6.0$ Hz, 1H), 7.91 (d, $J = 7.5$ Hz, 2H), 7.56-7.53 (m, 1H), 7.50-7.47 (m, 2H), 7.34-33 (m, 4H), 7.27-7.24 (m, 1H), 4.50 (d, $J = 6.0$ Hz, 2H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 166.2, 139.7, 134.3, 131.2, 128.28, 128.24, 127.20, 127.17, 126.7, 42.6. MS (EI): m/z (%) 212 (13), 211 (82), 210 (25), 107 (3), 106 (9), 105

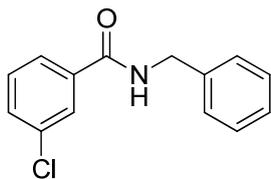
(100), 104 (4), 91 (9), 79 (4), 78 (5), 77 (42), 76 (2), 65 (4), 51 (11), 50 (3). This compound was known: Rattanaburi, P.; Khumraksa, B.; Pattarawarapan, M. *Tetrahedron Lett.* **2012**, 53, 2689-269.



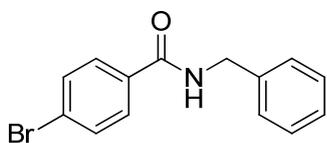
N-Benzyl 4-methylbenzamide (4ba). ^1H NMR (500 MHz, CDCl_3): δ 7.68 (d, $J = 8.0$ Hz, 2H), 7.36-7.34 (m, 4H), 7.31-7.28 (m, 1H), 7.22 (d, $J = 8.0$ Hz, 2H), 6.40 (b, 1H), 4.64 (d, $J = 6.0$ Hz, 2H), 2.39 (s, 3H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 167.3, 142.0, 138.3, 131.6, 129.3, 128.8, 127.9, 127.6, 127.0, 44.1, 21.4. MS (EI): m/z (%) 226 (6), 225 (41), 120 (7), 119 (100), 107 (2), 92 (2), 91 (28), 89 (2), 77 (2), 65 (6). This compound was known: Muthaiah, S.; Ghosh, S. C.; Jee, J.-E.; Chen, C.; Zhang, J.; Hong, S. H. *J. Org. Chem.* **2010**, 75, 3002-3006.



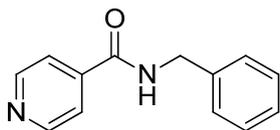
N-Benzyl 3-methylbenzamide (4ca). ^1H NMR (500 MHz, CDCl_3): δ 7.61 (s, 1H), 7.56-7.54 (m, 1H), 7.34-7.33 (m, 4H), 7.29-7.27 (m, 3H), 6.47 (b, 1H), 4.62 (d, $J = 5.5$ Hz, 2H), 2.37 (s, 3H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 167.5, 138.4, 138.2, 134.4, 132.2, 128.7, 128.4, 127.9, 127.7, 127.6, 123.9, 44.1, 21.3. MS (EI): m/z (%) 226 (8), 225 (50), 107 (2), 106 (3), 104 (2), 92 (20), 91 (100), 89 (3), 77 (4), 65 (15), 63 (3), 51 (5), 50 (3), 43 (2), 41 (2). This compound was known: De Sarkar, S.; Studer, A. *Org. Lett.* **2010**, 12, 1992-1995.



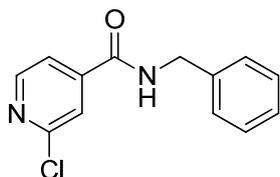
N-Benzyl 3-chlorobenzamide (4ha). ^1H NMR (500 MHz, CDCl_3): δ 7.77 (t, $J = 2.0$ Hz, 1H), 7.65 (d, $J = 7.5$ Hz, 1H), 7.48-7.46 (m, 1H), 7.37-7.33 (m, 5H), 7.32-7.30 (m, 1H), 6.42 (b, 1H), 4.63 (d, $J = 6.0$ Hz, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 166.0, 137.9, 136.2, 134.8, 131.6, 129.9, 128.9, 128.0, 127.8, 127.4, 125.1, 44.3. MS (EI): m/z (%) 248 (2), 247 (12), 246 (6), 245 (37), 210 (4), 142 (2), 141 (34), 140 (7), 139 (100), 113 (6), 111 (17), 107 (2), 77 (3), 75 (4). This compound was known: De Sarkar, S.; Studer, A. *Org. Lett.* **2010**, 12, 1992-1995.



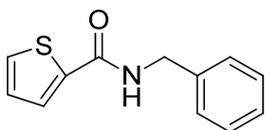
N-Benzyl 4-bromobenzamide (4ja). ^1H NMR (500 MHz, CDCl_3): δ 7.65 (d, $J = 8.5$ Hz, 2H), 7.56 (d, $J = 8.5$ Hz, 2H), 7.38-7.29 (m, 5H), 6.37 (b, 1H), 4.62 (d, $J = 5.5$ Hz, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 166.4, 137.9, 133.2, 131.9, 128.9, 128.6, 128.0, 127.8, 126.3, 44.3. MS (EI): m/z (%) 292 (8), 291 (51), 290 (9), 289 (53), 186 (8), 185 (99), 184 (8), 183 (100), 157 (25), 155 (25), 108 (3), 107 (4), 106 (4), 104 (5), 77 (8), 76 (13), 75 (7), 50 (3). This compound was known: Ren, W.; Yamane, M. *J. Org. Chem.* **2010**, *75*, 8410-8415.



N-Benzyl isonicotinamide (4oa). ^1H NMR (500 MHz, CDCl_3): δ 8.68 (d, $J = 5.0$ Hz, 2H), 7.62-7.61 (m, 2H), 7.37-7.31 (m, 5H), 6.81 (b, 1H), 4.63 (d, $J = 6.0$ Hz, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 165.5, 150.5, 141.5, 137.5, 128.9, 128.0, 127.9, 121.0, 44.3. MS (EI): m/z (%) 213 (15), 212 (100), 211 (23), 183 (2), 168 (2), 155 (3), 107 (6), 106 (54), 104 (7), 91 (10), 79 (10), 78 (22), 77 (6), 65 (3), 51 (8), 50 (2), 28 (3). This compound was known: Kim, B. R.; Lee, H.-G.; Kang, S.-B.; Sung, G. H.; Kim, J.-J.; Park, J. K.; Lee, S.-G.; Yoon, Y.-J. *Synthesis.* **2012**, *44*, 42-50.

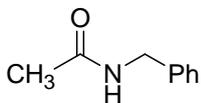


N-Benzyl 2-chloroisonicotinamide (4pa). ^1H NMR (500 MHz, CDCl_3): δ 8.46 (d, $J = 5.0$ Hz, 1H), 7.66 (s, 1H), 7.53 (dd, $J = 5.0$ Hz, $J = 1.0$ Hz, 1H), 7.38-7.31 (m, 5H), 6.66 (b, 1H), 4.61 (d, $J = 5.5$ Hz, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 164.1, 152.5, 150.5, 144.5, 137.2, 129.0, 128.04, 128.00, 122.0, 119.8, 44.4. MS (EI): m/z (%) 249 (5), 248 (28), 247 (21), 246 (100), 245 (27), 211 (42), 210 (12), 182 (7), 169 (7), 139 (10), 135 (11), 111 (11), 107 (27), 106 (8), 85 (9), 80 (12), 79 (7), 69 (19), 53 (9), 52 (9). This compound was known: Ferraccioli, R.; Carezzi, D.; Rombola, O.; Catellani, M. *Org. Lett.* **2004**, *6*, 4759-4762.

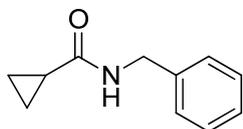


N-Benzyl thiophene-2-carboxamide (4ra). ^1H NMR (500 MHz, CDCl_3): δ 7.51 (dd, $J = 3.5$ Hz, $J = 1.0$ Hz, 1H), 7.47 (dd, $J = 5.0$ Hz, $J = 1.0$ Hz, 1H), 7.35-7.34 (m, 4H), 7.32-7.28 (m, 1H), 7.06 (dd, $J = 4.0$ Hz, $J = 5.0$ Hz, 1H), 6.31 (b, 1H), 4.61 (d, $J = 5.5$ Hz, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 161.8, 138.8, 138.1, 130.0, 128.8, 128.2, 128.0, 127.7, 127.6, 44.0. MS (EI): m/z (%) 219 (4), 218 (11), 217 (72), 216 (4), 113 (8), 112 (13), 111 (100), 106 (42), 105 (12), 104 (7), 91 (20), 84 (10), 83

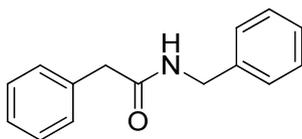
(11), 79 (8), 77 (11), 65 (10), 51 (8), 39 (24). This compound was known: De Sarkar, S.; Studer, A. *Org. Lett.* **2010**, *12*, 1992-1995.



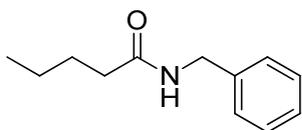
N-Benzyl acetamide (4sa). ^1H NMR (500 MHz, CDCl_3): δ 7.34-7.31 (m, 2H), 7.28-7.26 (m, 3H), 6.03 (b, 1H), 4.40 (d, $J = 5.5$ Hz, 2H), 2.00 (s, 3H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 169.9, 138.2, 128.7, 127.8, 127.5, 43.7, 23.2. MS (EI): m/z (%) 150 (8), 149 (80), 148 (4), 107 (23), 106 (100), 104 (6), 92 (4), 91 (34), 89 (3), 79 (14), 78 (6), 77 (12), 65 (7), 51 (8), 43 (32), 39 (5), 30 (10), 15 (3). This compound was known: Atkinson, B. N.; Chhatwal, A. R.; Lomax, H. V.; Walton, J. W.; Williams, J. M. J. *Chem. Commun.* **2012**, *48*, 11626-11628.



N-Benzyl cyclopropanecarboxamide (4ta). ^1H NMR (500 MHz, CDCl_3): δ 7.35-7.27 (m, 5H), 5.96 (b, 1H), 4.45 (d, $J = 6.0$ Hz, 2H), 1.38-1.33 (m, 1H), 1.02-0.99 (m, 2H), 0.76-0.73 (m, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 173.4, 138.5, 128.7, 127.9, 127.5, 43.9, 14.8, 7.2. MS (EI): m/z (%) 176 (8), 175 (56), 174 (13), 160 (6), 146 (9), 132 (10), 131 (26), 130 (8), 117 (12), 116 (7), 107 (8), 106 (48), 105 (12), 104 (100), 92 (8), 91 (94), 79 (12), 77 (18), 69 (45), 65 (22), 59 (12), 55 (9), 51 (15), 50 (6), 41 (57), 39 (34), 28 (12), 27 (5). This compound was known: Rolfe, A.; Probst, D. A.; Volp, K. A.; Omar, I.; Flynn, D. L.; Hanson, P. R. *J. Org. Chem.* **2008**, *73*, 8785-8790.

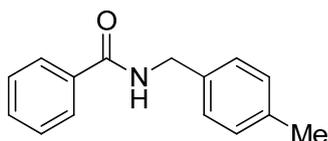


N-Benzyl 2-phenylacetamide (4ua). ^1H NMR (500 MHz, CDCl_3): δ 7.36-7.24 (m, 8H), 7.17 (d, $J = 7.0$ Hz, 2H), 5.73 (b, 1H), 4.41 (d, $J = 6.0$ Hz, 2H), 3.62 (s, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 170.8, 138.1, 134.8, 129.5, 129.1, 128.7, 127.5, 127.44, 127.42, 43.9, 43.6. MS (EI): m/z (%) 226 (8), 225 (50), 107 (2), 106 (3), 104 (2), 92 (20), 91 (100), 89 (3), 77 (4), 65 (15), 63 (3), 51 (5), 50 (2), 43 (2), 41 (2). This compound was known: Muthaiah, S.; Ghosh, S. C.; Jee, J.-E.; Chen, C.; Zhang, J.; Hong, S. H. *J. Org. Chem.* **2010**, *75*, 3002-3006.

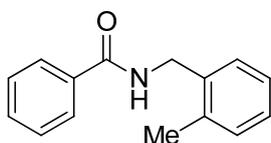


N-Benzyl pentanamide (4wa). ^1H NMR (500 MHz, CDCl_3): δ 7.34-7.26 (m, 5H), 5.82 (b, 1H), 4.42

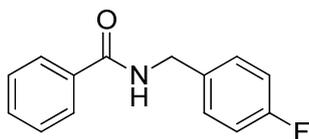
(d, $J = 6.0$ Hz, 2H), 2.21 (t, $J = 7.5$ Hz, 2H), 1.67-1.61 (m, 2H), 1.39-1.33 (m, 2H), 0.92 (t, $J = 7.5$ Hz, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 173.0, 138.5, 128.7, 127.8, 127.5, 43.6, 36.5, 27.9, 22.4, 13.8. MS (EI): m/z (%) 192 (6), 191 (42), 148 (18), 130 (3), 107 (33), 106 (100), 105 (13), 104 (4), 103 (3), 92 (3), 91 (29), 85 (2), 79 (10), 77 (4), 65 (4), 58 (5), 43 (10), 42 (3), 28 (2). This compound was known: Sabot, C.; Kumar, K. A.; Meunier, S.; Mioskowski, C. *Tetrahedron Lett.* **2007**, *48*, 3863-3866.



***N*-(4-Methylbenzyl) benzamide (4ab).** ^1H NMR (500 MHz, CDCl_3): δ 7.78 (d, $J = 7.0$ Hz, 2H), 7.51-7.48 (m, 1H), 7.42-7.40 (m, 2H), 7.26-7.24 (m, 2H), 7.16 (d, $J = 8.0$ Hz, 2H), 6.41 (b, 1H), 4.60 (d, $J = 5.5$ Hz, 2H), 2.35 (s, 3H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 167.3, 137.4, 135.1, 134.5, 131.5, 129.5, 128.6, 128.0, 126.9, 44.0, 21.1. MS (EI): m/z (%) 226 (8), 225 (44), 210 (10), 156 (22), 120 (8), 113 (6), 106 (10), 105 (100), 104 (28), 79 (6), 78 (10), 77 (58), 56 (8), 51 (17), 50 (5), 42 (7). This compound was known: Maki, T.; Ishihara, K.; Yamamoto, H. *Tetrahedron.* **2007**, *63*, 8645-8657.

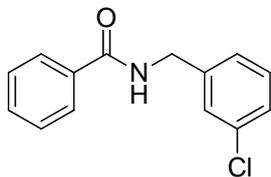


***N*-(2-Methylbenzyl) benzamide (4ac).** ^1H NMR (500 MHz, CDCl_3): δ 7.77 (d, $J = 7.0$ Hz, 2H), 7.48-7.46 (m, 1H), 7.42-7.39 (m, 2H), 7.28 (d, $J = 7.0$ Hz, 1H), 7.22-7.18 (m, 3H), 6.35 (b, 1H), 4.61 (d, $J = 5.5$ Hz, 2H), 2.36 (s, 3H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 167.3, 136.6, 135.8, 134.4, 131.5, 130.6, 128.7, 128.6, 127.9, 127.0, 126.3, 42.3, 19.1. MS (EI): m/z (%) 226 (8), 225 (44), 210 (10), 156 (22), 120 (8), 113 (6), 106 (10), 105 (100), 104 (28), 103 (6), 79 (6), 78 (10), 77 (58), 56 (8), 51 (17), 50 (5), 42(7), 39(4). This compound was known: Molander, G.; Hiebel, M.-A. *Org. Lett.* **2010**, *12*, 4876-4879.

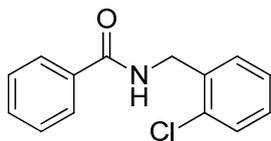


***N*-(4-Fluorobenzyl) benzamide (4ad).** ^1H NMR (500 MHz, CDCl_3): δ 7.78 (d, $J = 7.0$ Hz, 2H), 7.52-7.49 (m, 1H), 7.45-7.42 (m, 2H), 7.34-7.31 (m, 2H), 7.05-7.01 (m, 2H), 6.44 (b, 1H), 4.61 (d, $J = 6.0$ Hz, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 167.4, 162.3 (d, $J_{\text{C-F}} = 245.3$ Hz), 134.3, 134.1 (d, $J_{\text{C-F}} = 3.3$ Hz), 131.7, 129.6 (d, $J_{\text{C-F}} = 8.2$ Hz), 128.6, 126.9, 115.6 (d, $J_{\text{C-F}} = 21.4$ Hz), 43.4. MS (EI):

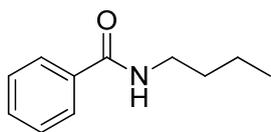
m/z (%) 230 (3), 229 (20), 228 (7), 200 (6), 108 (7), 106 (7), 105 (100), 104 (8), 103 (7), 77 (47), 76 (5), 70 (7), 67 (8), 57 (7), 55 (11), 54 (6), 51 (10), 43 (12), 41 (14), 39 (8). This compound was known: Dube, D.; Scholte, A. A. *Tetrahedron Lett.* **1999**, *40*, 2295-2298.



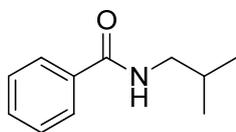
N-(3-Chlorobenzyl) benzamide (4ae). ^1H NMR (500 MHz, CDCl_3): δ 7.79 (d, $J = 7.5$ Hz, 2H), 7.52-7.50 (m, 1H), 7.45-7.42 (m, 2H), 7.33 (s, 1H), 7.27-7.22 (m, 3H), 6.58 (b, 1H), 4.61 (d, $J = 5.5$ Hz, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 167.4, 140.3, 134.6, 134.1, 131.7, 130.0, 128.6, 127.8, 127.7, 126.9, 125.9, 43.4. MS (EI): m/z (%) 247 (5), 246 (2), 245 (14), 211 (10), 210 (63), 106 (8), 105 (100), 78 (4), 77 (46), 76 (2), 51 (8). This compound was known: Julius, V. B.; Kuhn, M.; Weismantel, J. J. *Liebigs. Annalen. der. Chem.* **1926**, *449*, 249-77.



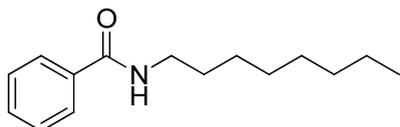
N-(2-Chlorobenzyl) benzamide (4af). ^1H NMR (500 MHz, CDCl_3): δ 7.78 (d, $J = 7.0$ Hz, 2H), 7.51-7.37 (m, 5H), 7.25-7.23 (m, 2H), 6.67 (b, 1H), 4.74-4.72 (m, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 167.4, 135.7, 134.4, 133.8, 131.7, 130.6, 129.7, 129.2, 128.7, 127.3, 127.1, 42.2. MS (EI): m/z (%) 247 (5), 246 (2), 245 (14), 211 (10), 210 (63), 106 (8), 105 (100), 78 (4), 77 (46), 76 (2), 51 (8). This compound was known: Qu, G.-R.; Song, Y.-W.; Niu, H.-Y.; Guo, H.-M.; Fossey, J. S. *RSC. Adv.* **2012**, *2*, 6161-6163.



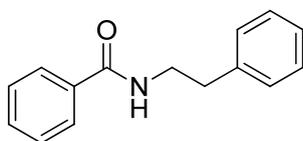
N-Butyl benzamide (4ag). ^1H NMR (500 MHz, d_6 -DMSO): δ 8.44 (b, 1H), 7.85-7.83 (m, 2H), 7.53-7.50 (m, 1H), 7.47-7.44 (m, 2H), 3.29-3.25 (m, 2H), 1.54-1.48 (m, 2H), 1.37-1.29 (m, 2H), 0.91 (t, $J = 7.5$ Hz, 3H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 166.1, 134.7, 130.9, 128.2, 127.1, 38.8, 31.2, 19.6, 13.7. MS (EI): m/z (%) 178 (2), 177 (13), 176 (2), 148 (4), 136 (3), 135 (15), 134 (11), 106 (8), 105 (100), 78 (3), 77 (32), 76 (2), 51 (9), 50 (3). This compound was known: Rattanaburi, P.; Khumraksa, B.; Pattarawarapan, M. *Tetrahedron Lett.* **2012**, *53*, 2689-269.



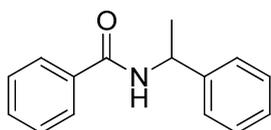
N-Isobutyl benzamide (4ah). ^1H NMR (500 MHz, CDCl_3): δ 7.77 (d, $J = 7.5$ Hz, 2H), 7.48-7.45 (m, 1H), 7.40-7.37 (m, 2H), 6.61 (b, 1H), 3.25 (t, $J = 6.5$ Hz, 2H), 1.92-1.86 (m, 1H), 0.95 (d, $J = 7.0$ Hz, 6H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 167.8, 134.9, 131.3, 128.5, 126.9, 47.4, 28.6, 20.2. MS (EI): m/z (%) 225 (9), 134 (8), 121 (2), 106 (4), 105 (53), 104 (23), 92 (4), 91 (11), 77 (21), 65 (5), 51 (6), 39 (3), 38 (4), 36 (11), 30 (100), 28 (2). This compound was known: Thomas, G. L.; Boehner, C.; Ladlow, M.; Spring, D. R. *Tetrahedron*. **2005**, *61*, 12153-12159.



N-Octyl benzamide (4ai). ^1H NMR (500 MHz, CDCl_3): δ 7.75 (d, $J = 7.0$ Hz, 2H), 7.50-7.46 (m, 1H), 7.43-7.40 (m, 2H), 6.25 (b, 1H), 3.46-3.42 (m, 2H), 1.64-1.58 (m, 2H), 1.31-1.27 (m, 10H), 0.88 (t, $J = 7.0$ Hz, 3H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 167.5, 134.9, 131.3, 128.5, 126.8, 40.1, 31.8, 29.7, 29.3, 29.2, 27.0, 22.6, 14.1. MS (EI): m/z (%) 190 (2), 176 (7), 162 (8), 149 (3), 148 (10), 135 (26), 134 (22), 122 (7), 106 (8), 105 (100), 79 (2), 78 (2), 77 (31), 55 (7), 51 (5), 43 (12), 41 (12). This compound was known: Morcillo, S. P.; Alvarez, L.; Mota, A. J.; Justicia, J.; Robles, R. *J. Org. Chem.* **2011**, *76*, 2277-2281.

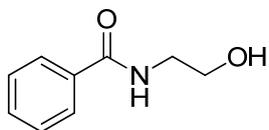


N-(2-Phenethyl) benzamide (4aj). ^1H NMR (500 MHz, d_6 -DMSO): δ 8.55 (t, $J = 5.5$ Hz, 1H), 7.81 (d, $J = 7.0$ Hz, 2H), 7.53-7.50 (m, 1H), 7.47-7.44 (m, 2H), 7.31-7.28 (m, 2H), 7.24 (d, $J = 7.0$ Hz, 2H), 7.22-7.19 (m, 1H), 3.51-3.47 (m, 2H), 2.85 (t, $J = 7.5$ Hz, 2H). ^{13}C NMR (125.4 MHz, d_6 -DMSO): δ 166.2, 139.5, 134.6, 131.0, 128.6, 128.3, 128.2, 127.1, 126.0, 40.8, 35.1. MS (EI): m/z (%) 225 (9), 134 (8), 121 (2), 106 (4), 105 (53), 104 (23), 92 (4), 91 (11), 77 (21), 65 (5), 51 (6), 39 (3), 38 (4), 36 (11), 30 (100), 28 (2). This compound was known: Arora, J. S.; Kaur, N.; Phanstiel, Otto, IV. *J. Org. Chem.* **2008**, *73*, 6182-6186.

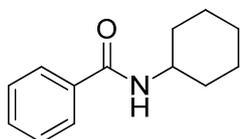


N-(1-Phenylethyl) benzamide (4ak). ^1H NMR (500 MHz, CDCl_3): δ 7.77 (d, $J = 7.0$ Hz, 2H), 7.51-7.48 (m, 1H), 7.44-7.35 (m, 6H), 7.30-7.28 (m, 1H), 6.31 (b, 1H), 5.38-5.32 (m, 1H), 1.61 (d, $J = 7.0$ Hz, 3H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 166.6, 143.1, 134.6, 131.5, 128.8, 128.6, 127.5, 126.9, 126.3, 49.2, 21.7. MS (EI): m/z (%) 225 (9), 134 (8), 121 (2), 106 (4), 105 (53), 104 (23), 92

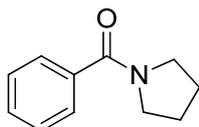
(4), 91 (11), 77 (21), 65 (5), 51 (6), 39 (3), 38 (4), 36 (11), 30 (100), 28 (2). This compound was known: Liu, X.; Zhang, Y.; Wang, L.; Fu, H.; Jiang, Y.; Zhao, Y. *J. Org. Chem.* **2008**, *73*, 6207-6212.



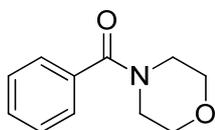
N-(2-Hydroxyethyl) benzamide (4al). ^1H NMR (500 MHz, CDCl_3): δ 7.74 (d, $J = 7.5$ Hz, 2H), 7.45-7.42 (m, 1H), 7.34-7.31 (m, 2H), 4.38 (b, 1H), 3.72 (t, $J = 5.0$ Hz, 2H), 3.53-3.50 (m, 2H), 3.15 (b, 1H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 168.9, 134.0, 131.6, 128.5, 127.0, 61.5, 42.7. MS (EI): m/z (%) 165 (2), 147 (14), 135 (4), 134 (9), 122 (20), 117 (8), 106 (9), 105 (100), 104 (3), 78 (6), 77 (67), 76 (5), 51 (28), 50 (10), 40 (4), 33 (9), 32 (4), 31 (3). This compound was known: Denton, R. M.; An, J.; Adeniran, B.; Blake, A. J.; Lewis, W.; Poulton, A. M. *J. Org. Chem.* **2011**, *76*, 6749-6767.



N-Cyclohexyl benzamide (4am). ^1H NMR (500 MHz, CDCl_3): δ 7.75 (d, $J = 7.5$ Hz, 2H), 7.50-7.40 (m, 3H), 5.99 (b, 1H), 4.01-3.95 (m, 1H), 2.05-2.02 (m, 2H), 1.90-1.74 (m, 2H), 1.67-1.64 (m, 1H), 1.48-1.39 (m, 2H), 1.28-1.20 (m, 3H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 166.6, 135.2, 131.2, 128.5, 126.8, 48.7, 33.2, 25.6, 24.9. MS (EI): m/z (%) 176 (4), 175 (36), 174 (28), 146 (8), 106 (7), 105 (100), 78 (4), 77 (49), 70 (9), 68 (4), 55 (4), 51 (16), 50 (6), 44 (4), 43 (6), 41 (16). This compound was known: Rattanaburi, P.; Khumraksa, B.; Pattarawarapan, M. *Tetrahedron Lett.* **2012**, *53*, 2689-269.

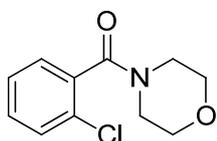


N-Benzoyl pyrrolidine (4an). ^1H NMR (500 MHz, CDCl_3): δ 7.48-7.46 (m, 2H), 7.35-7.34 (m, 3H), 3.60 (t, $J = 7.0$ Hz, 2H), 3.37 (t, $J = 6.5$ Hz, 2H), 1.94-1.88 (m, 2H), 1.85-1.79 (m, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 169.7, 137.2, 129.7, 128.2, 127.0, 49.6, 46.1, 26.3, 24.4. MS (EI): m/z (%) 176 (5), 175 (34), 174 (23), 147 (3), 146 (17), 106 (9), 105 (100), 104 (13), 78 (5), 77 (55), 76 (2), 70 (4), 56 (2), 51 (12), 50 (3). This compound was known: Rolfe, A.; Probst, D. A.; Volp, K. A.; Omar, I.; Flynn, D. L.; Hanson, P. R. *J. Org. Chem.* **2008**, *73*, 8785-8790.

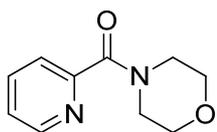


N-Benzoyl morpholine (4ao). ^1H NMR (500 MHz, CDCl_3): δ 7.44-7.41 (m, 5H), 3.79-3.46 (m, 8H).

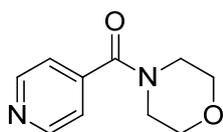
^{13}C NMR (125.4 MHz, CDCl_3): δ 170.5, 135.3, 129.9, 128.6, 127.1, 66.9, 48.2, 42.6. MS (EI): m/z (%) 191 (4), 176 (13), 148 (4), 134 (7), 106 (7), 105 (100), 78 (3), 77 (29), 57 (5), 56 (5), 51 (9), 41 (8), 39 (4), 29 (5), 27 (3). This compound was known: Luo, Q.-L.; Lu, L.; Li, Y.; Tan, J.-P.; Nan, W.; Hui, Q. *Eur. J. Org. Chem.* **2011**, *34*, 6916–6922.



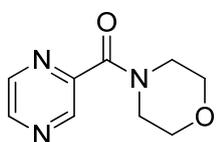
N-(2-Chlorobenzoyl) morpholine (4io). ^1H NMR (500 MHz, CDCl_3): δ 8.15 (dd, $J = 8.0$ Hz, $J = 1.5$ Hz, 1H), 7.51–7.47 (m, 1H), 7.27–7.21 (m, 2H), 3.88 (t, $J = 4.5$ Hz, 4H), 3.04 (t, $J = 4.5$ Hz, 4H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 168.7, 151.2, 132.6, 131.9, 127.5, 124.9, 120.1, 67.4, 53.6. MS (EI): m/z (%) 226 (4), 225 (6), 224 (10), 210 (4), 190 (5), 162 (3), 141 (34), 140 (7), 139 (100), 113 (8), 111 (23), 86 (23), 77 (3), 76 (3), 75 (10), 56 (16), 42 (3). This compound was known: Lysén, M.; Kelleher, S.; Begtrup, M.; Kristensen, J. L. *J. Org. Chem.* **2005**, *70*, 5342–5343.



N-(2-Pyridinoyl) morpholine (4mo). ^1H NMR (500 MHz, CDCl_3): δ 8.57–8.56 (m, 1H), 7.82–7.78 (m, 1H), 7.66 (d, $J = 8.0$ Hz, 1H), 7.36–7.33 (m, 1H), 3.80 (b, 4H), 3.69–3.63 (m, 4H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 167.5, 153.6, 148.3, 137.2, 124.7, 124.2, 67.0, 66.8, 47.8, 42.8. MS (EI): m/z (%) 149 (3), 107 (3), 106 (19), 94 (5), 93 (4), 87 (7), 86 (100), 79 (3), 78 (6), 72 (3), 65 (3), 58 (12), 56 (5), 51 (3), 42 (6), 30 (9), 29 (5), 27 (3). This compound was known: Wang, X.; Wang, D. Z. *Tetrahedron.* **2011**, *67*, 3406–3411.

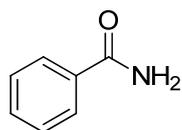


N-(4-Pyridinoyl) morpholine (4oo). ^1H NMR (500 MHz, CDCl_3): δ 8.71 (dd, $J = 4.0$ Hz, $J = 1.5$ Hz, 2H), 7.30 (dd, $J = 4.0$ Hz, $J = 1.5$ Hz, 2H), 3.80 (b, 4H), 3.63 (b, 2H), 3.39 (b, 2H). ^{13}C NMR (125.4 MHz, CDCl_3): δ 167.7, 150.3, 142.9, 121.2, 66.7, 47.8, 42.4. MS (EI): m/z (%) 192 (34), 191 (55), 177 (52), 161 (14), 149 (7), 135 (6), 107 (10), 106 (100), 93 (7), 86 (39), 79 (8), 78 (68), 56 (70), 51 (41), 50 (9), 42 (10), 29 (7), 28 (12). This compound was known: Wang, X.; Wang, D. Z. *Tetrahedron.* **2011**, *67*, 3406–3411.



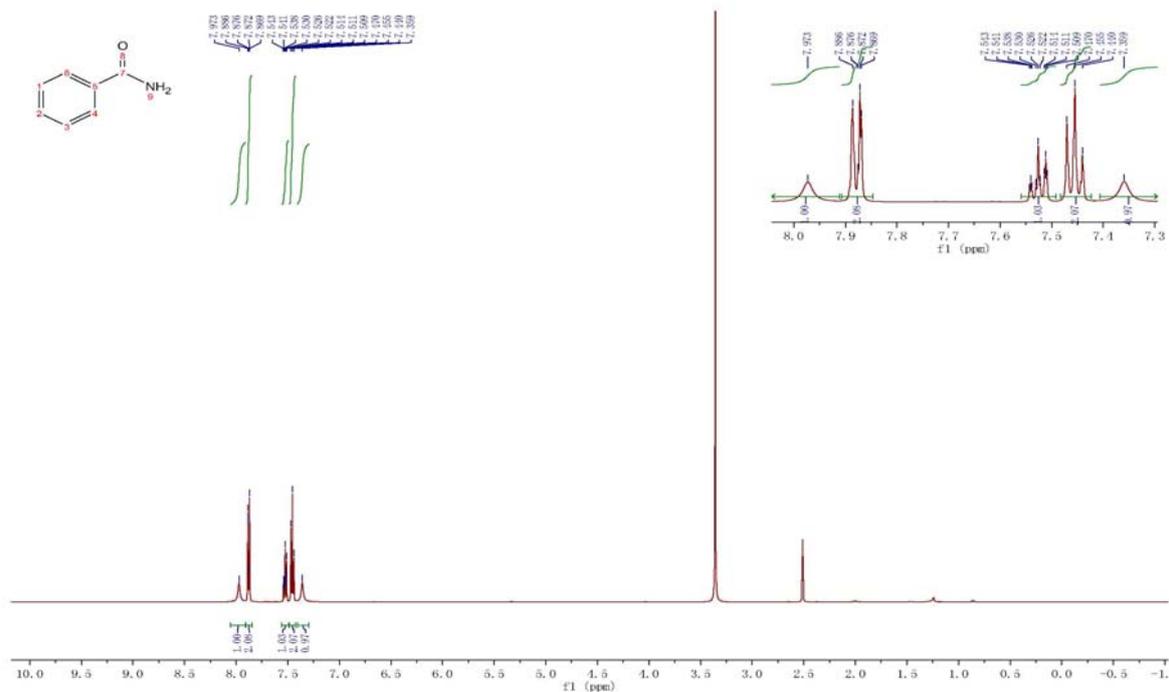
***N*-(2-Pyrazinzoyl) morpholine (4qo)**. ¹H NMR (500 MHz, CDCl₃): δ 8.92 (d, *J* = 1.0 Hz, 1H), 8.60 (d, *J* = 2.5 Hz, 1H), 8.50 (dd, *J* = 2.0 Hz, *J* = 1.5 Hz, 1H), 3.77 (b, 4H), 3.67-3.63 (m, 4H). ¹³C NMR (125.4 MHz, CDCl₃): δ 165.0, 148.8, 145.9, 145.4, 142.4, 66.9, 66.7, 47.6, 42.8. MS (EI): *m/z* (%) 193 (9), 175 (5), 109 (5), 108 (46), 86 (100), 81 (18), 80 (44), 79 (29), 77 (9), 56 (7), 55 (7), 53 (10), 41 (19), 39 (12), 27 (11). This compound was known: Takács, A.; Jakab, B.; Petz, A.; Kollár, L. *Tetrahedron*. **2007**, *63*, 10372-10378.

¹H NMR and ¹³C NMR Spectra of the Products

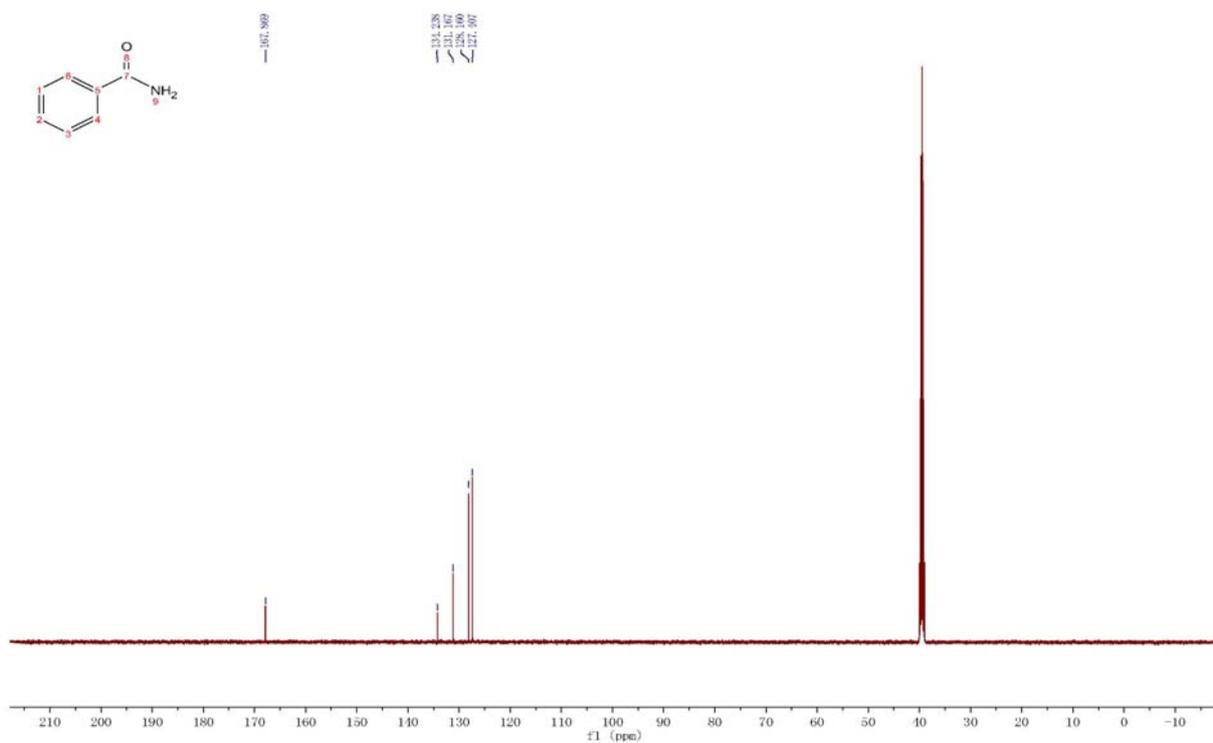


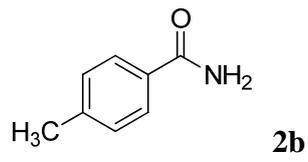
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¹H NMR

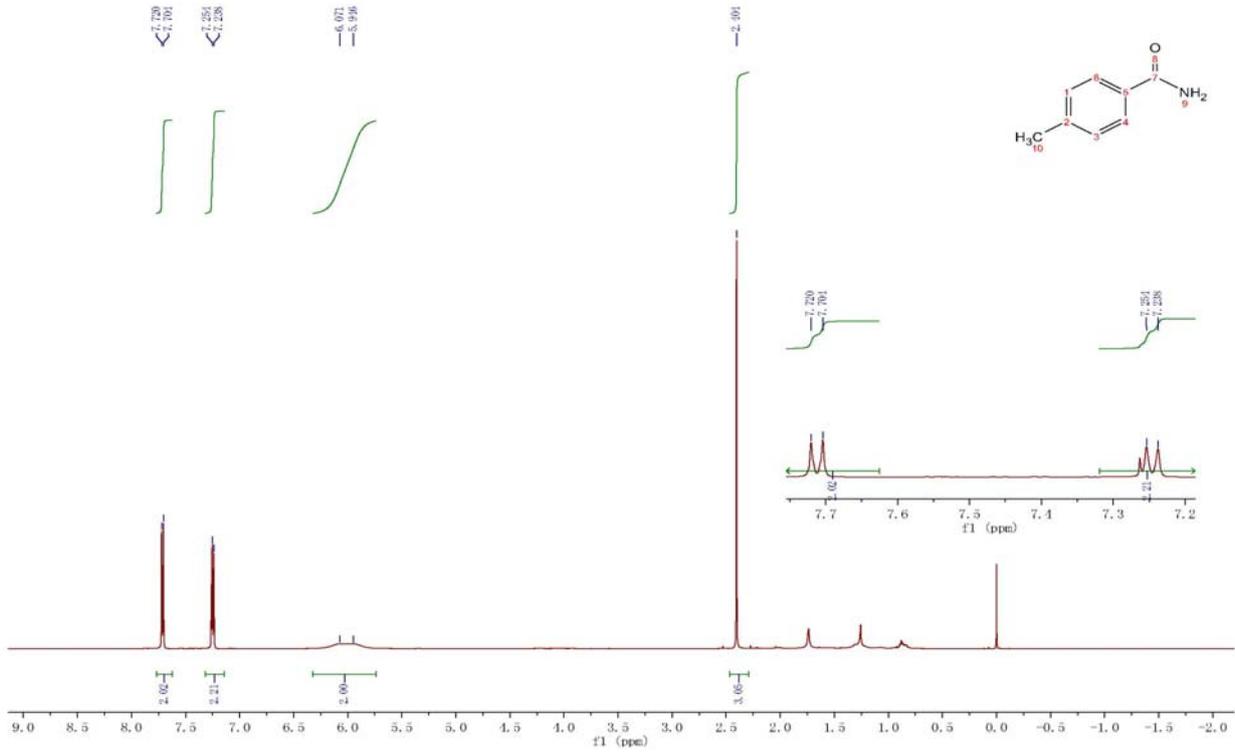


¹³C NMR

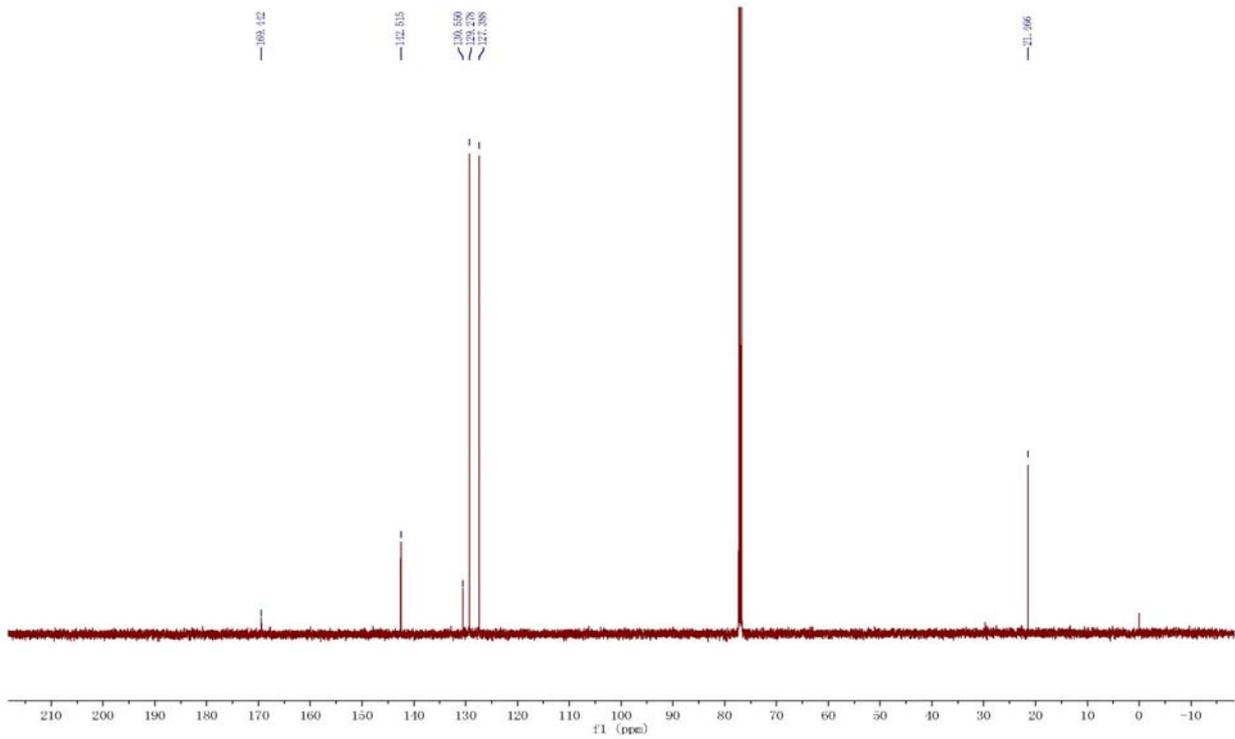


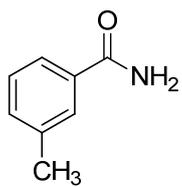


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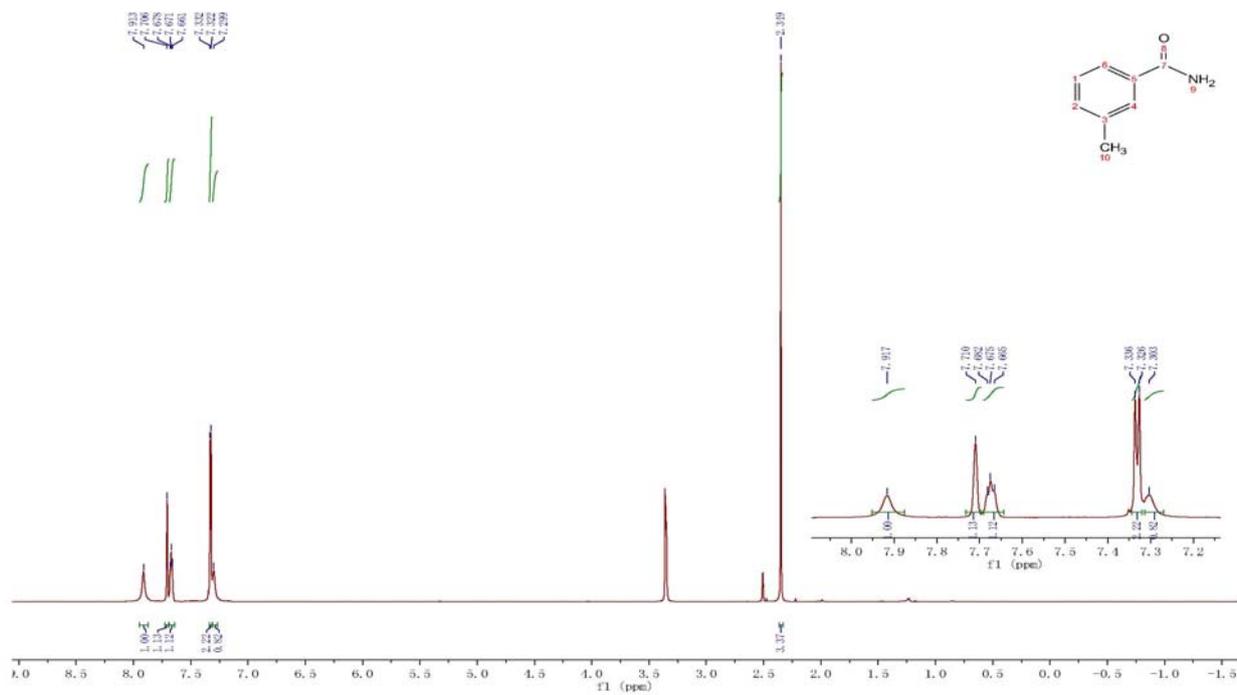


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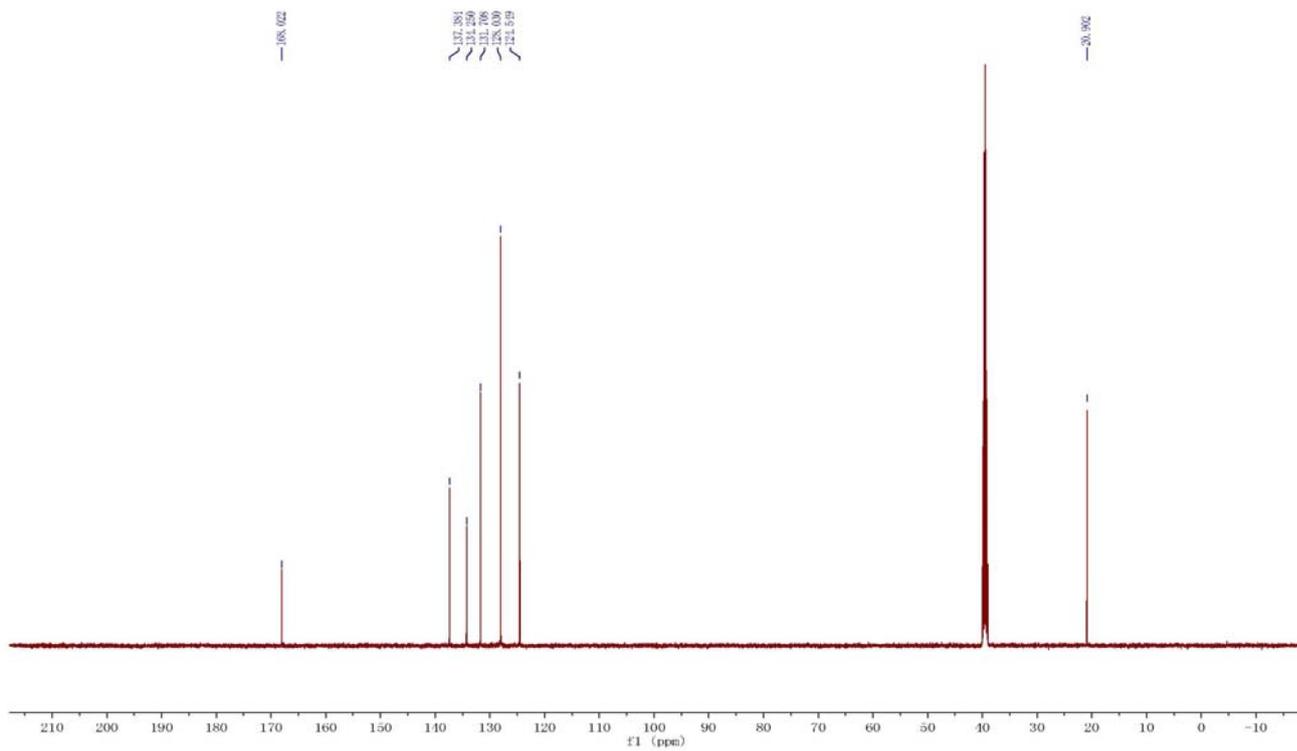


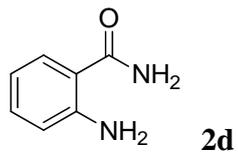


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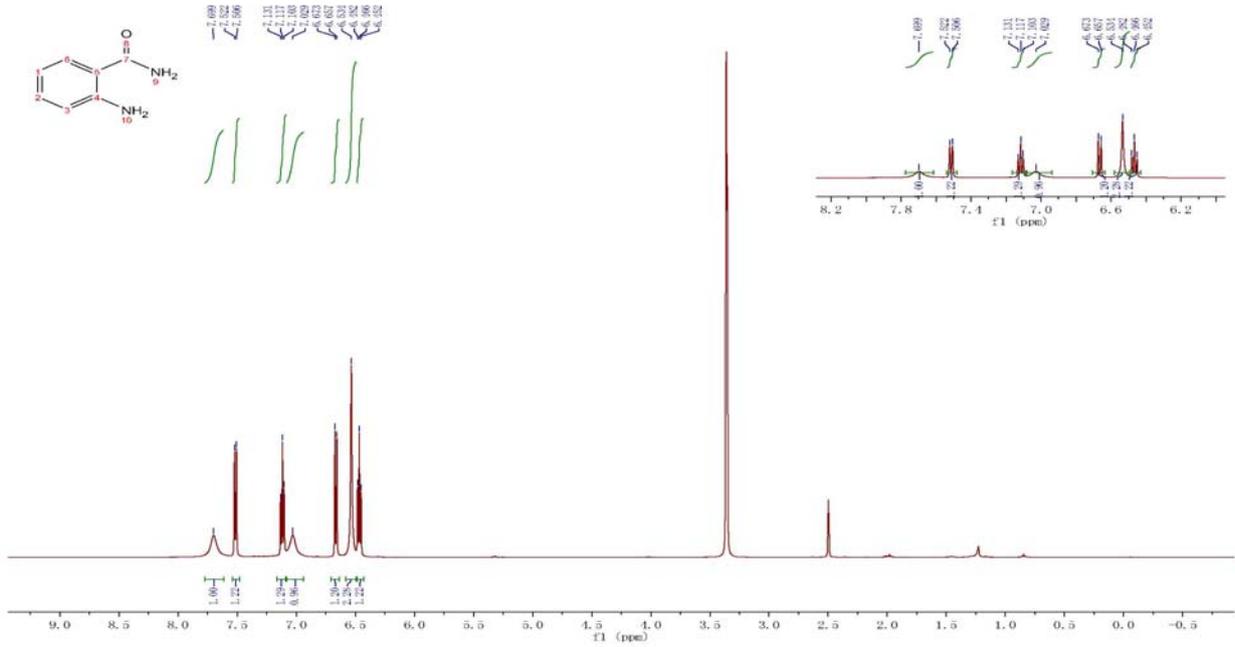


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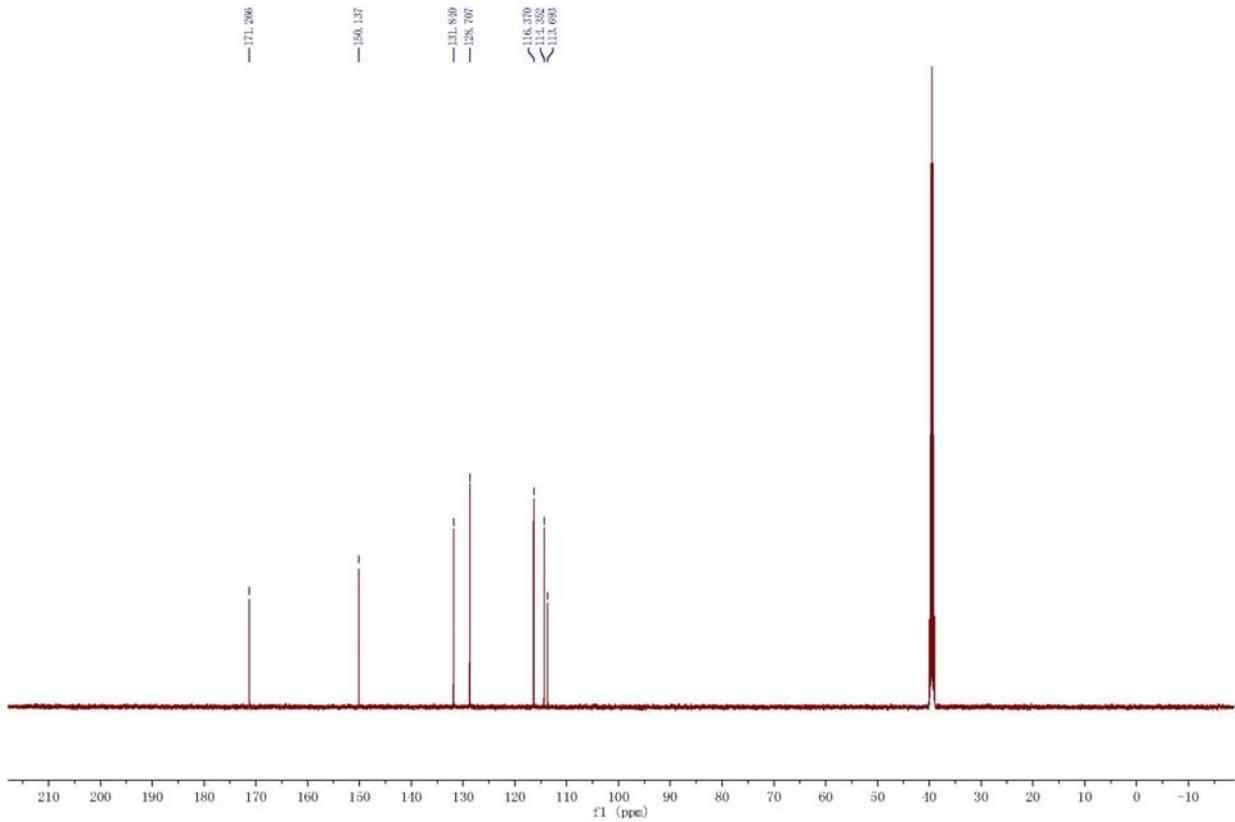




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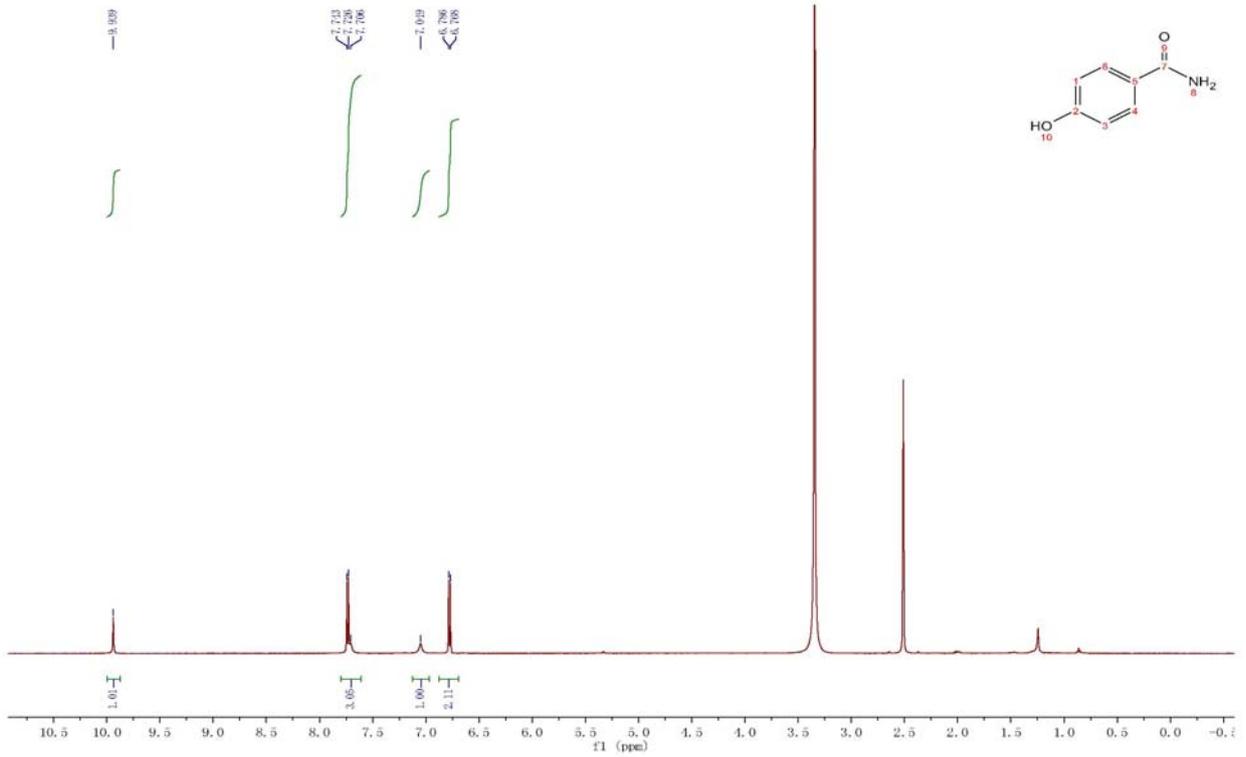


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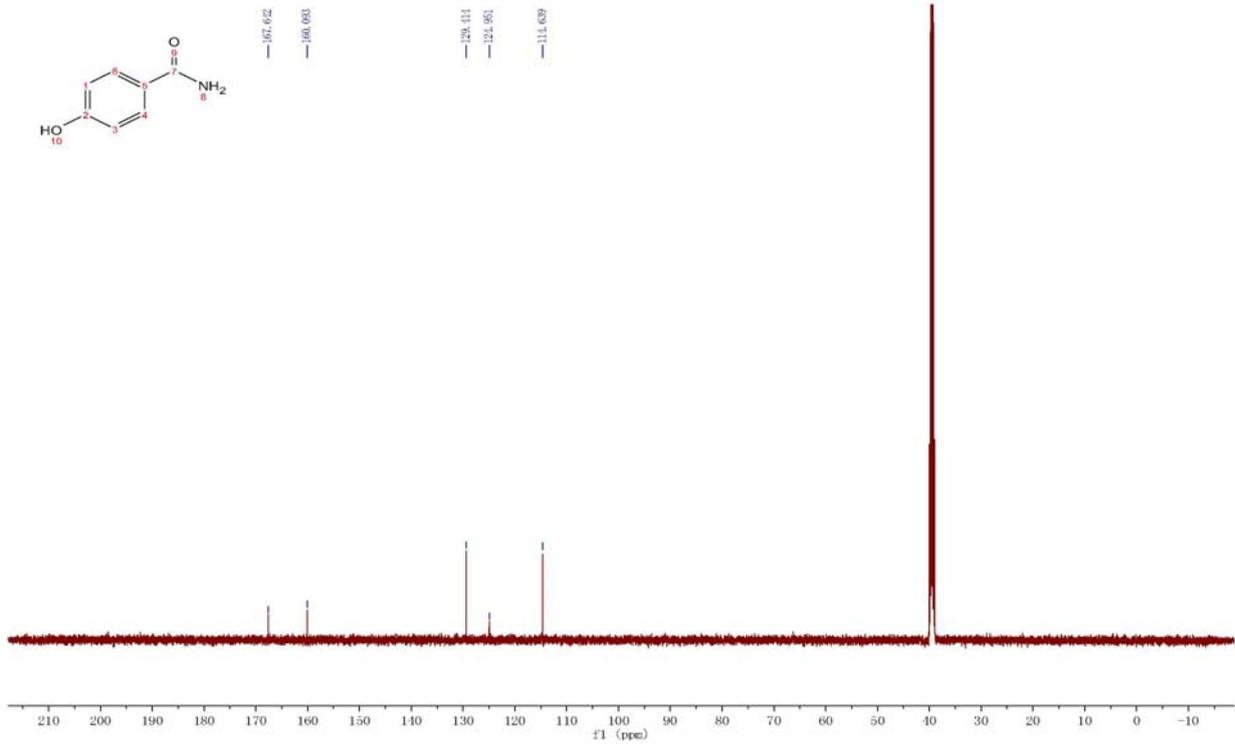




¹H NMR



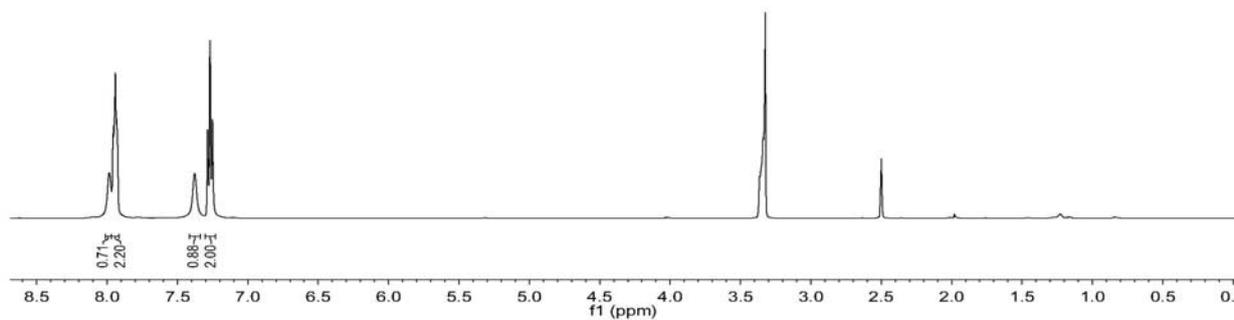
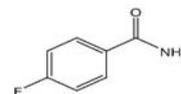
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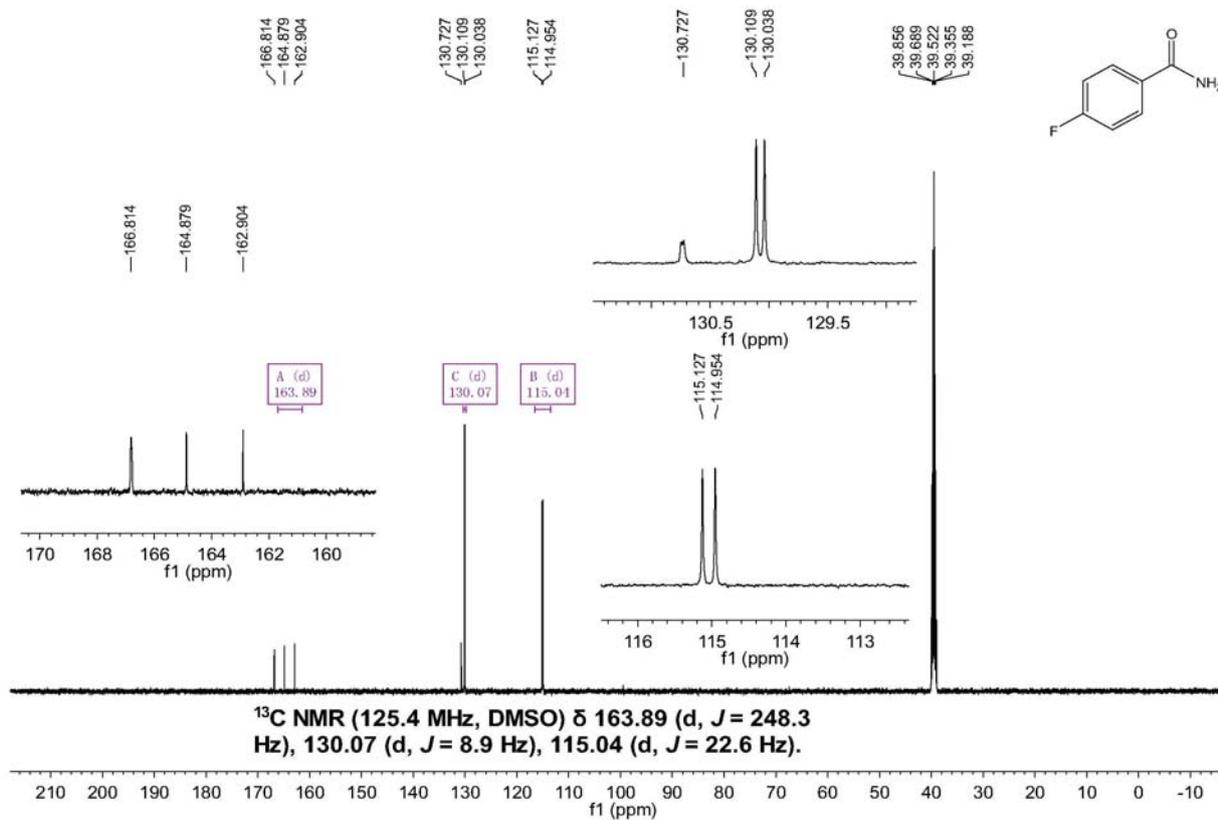


¹H NMR

7.984
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7.950
7.941
7.934
7.930
7.927
7.376
7.285
7.269
7.252

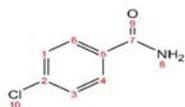
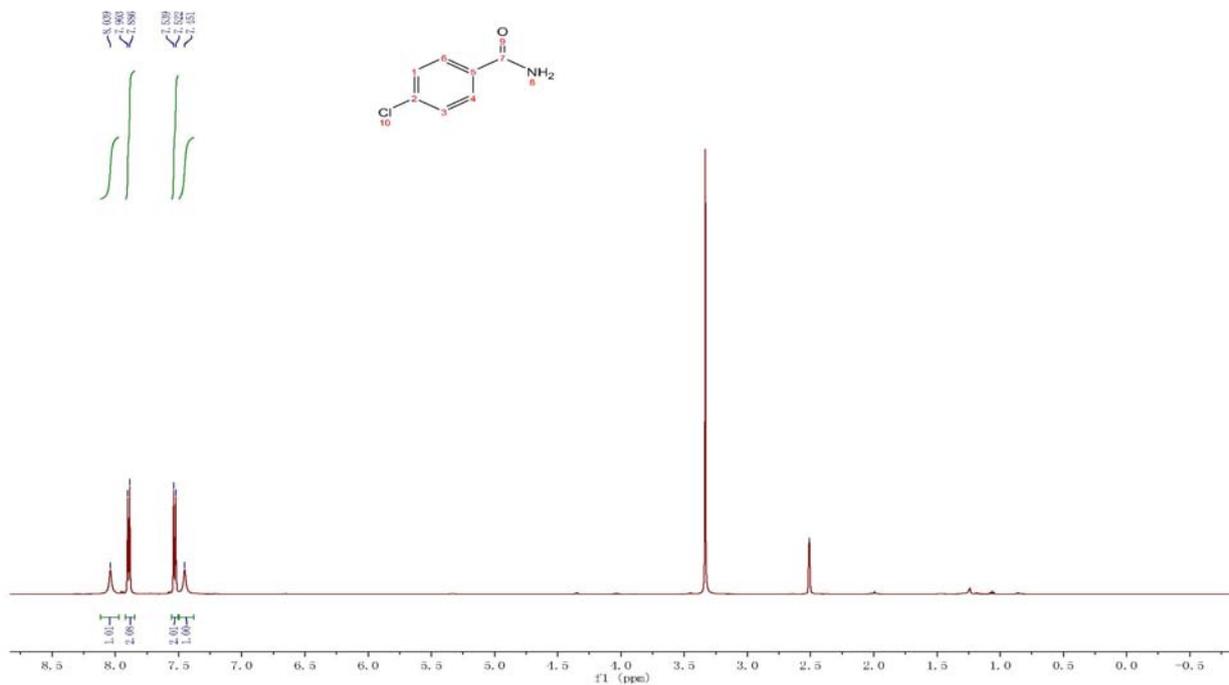


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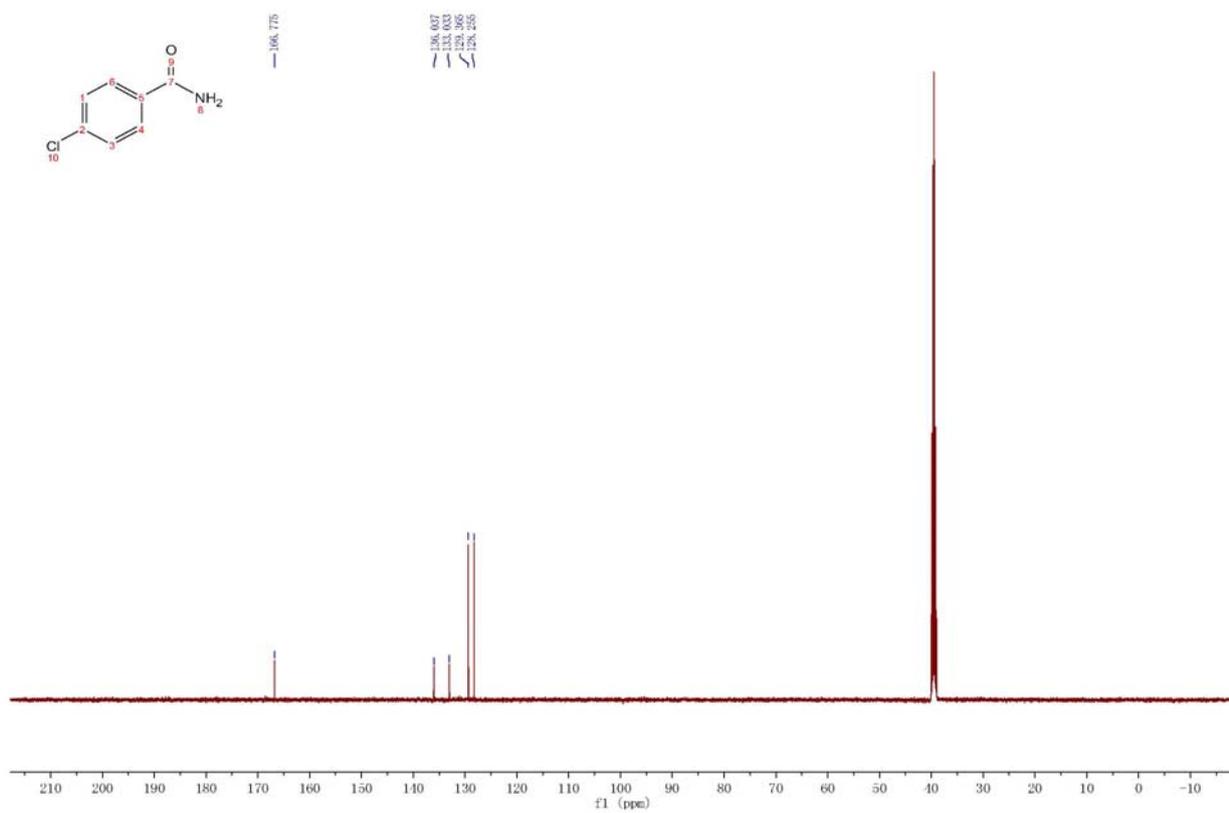


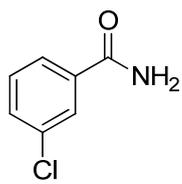


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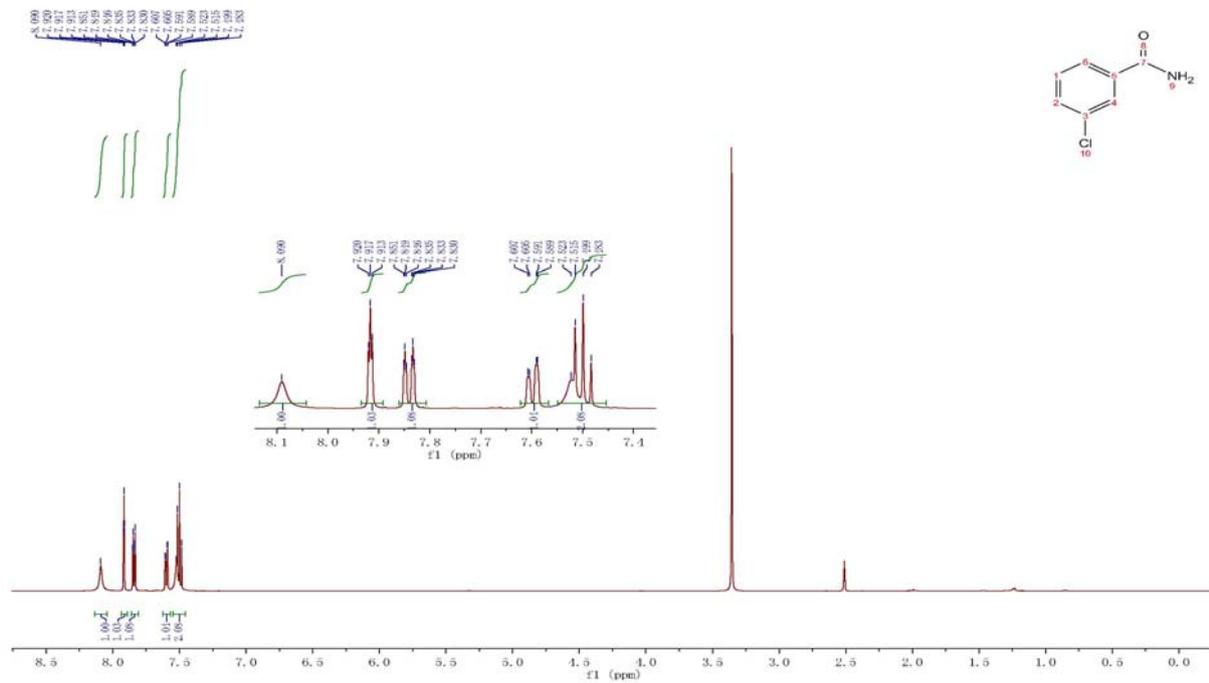
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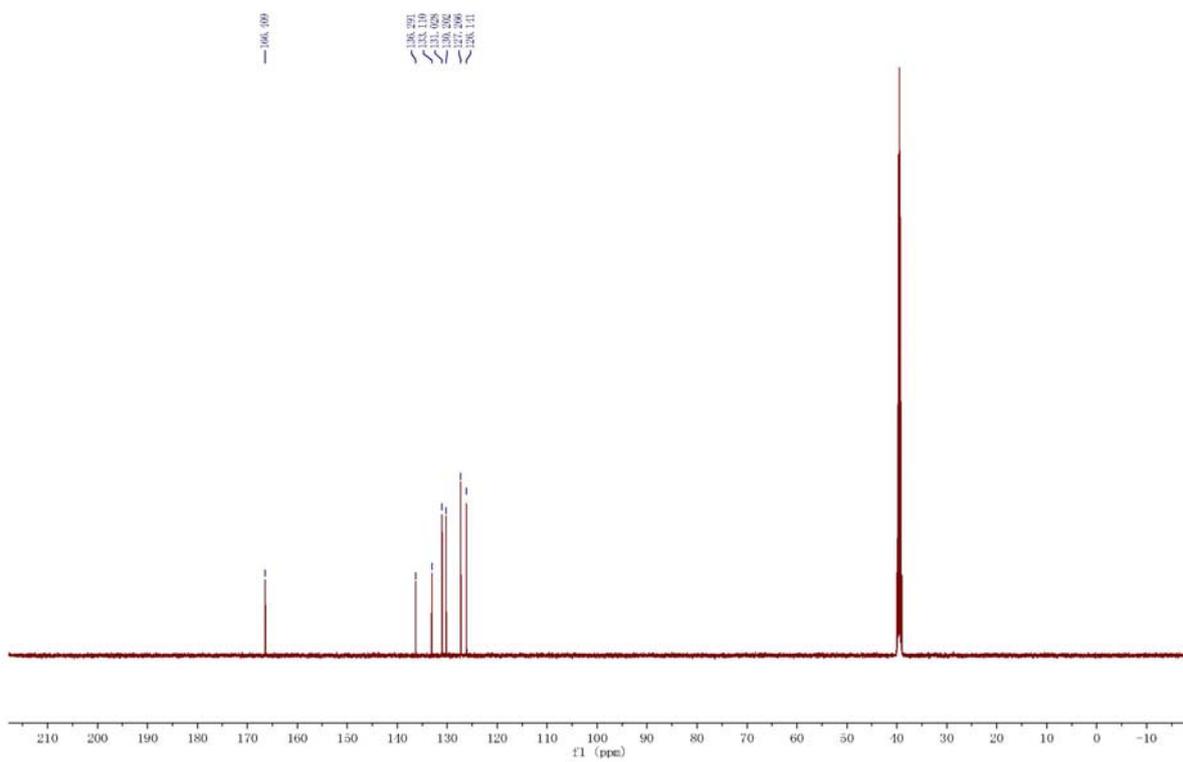


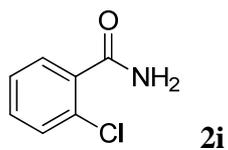
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¹H NMR

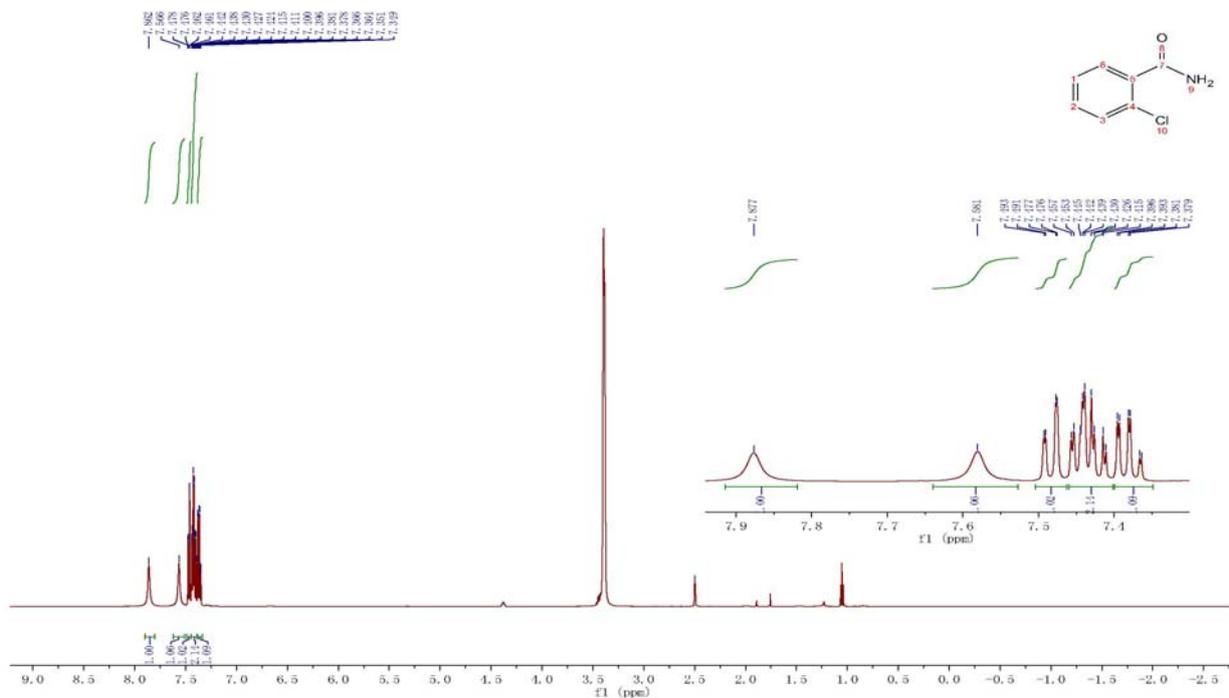


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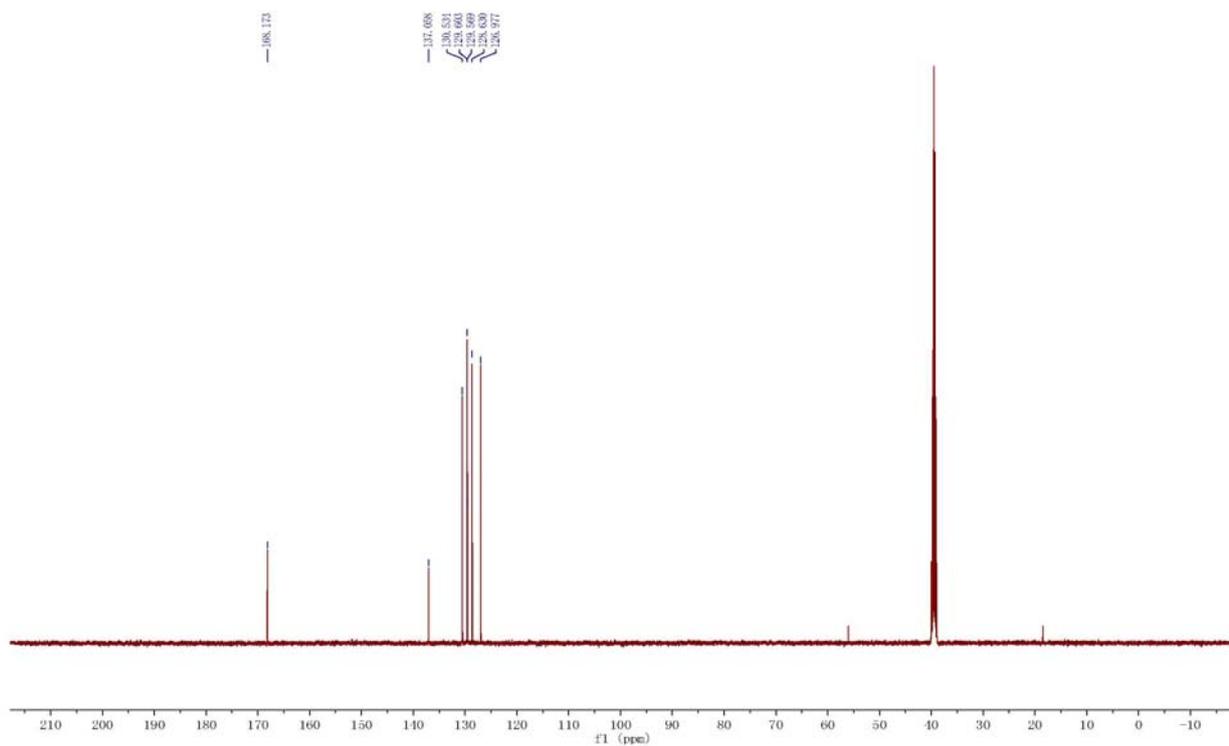


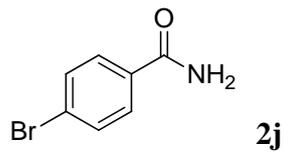


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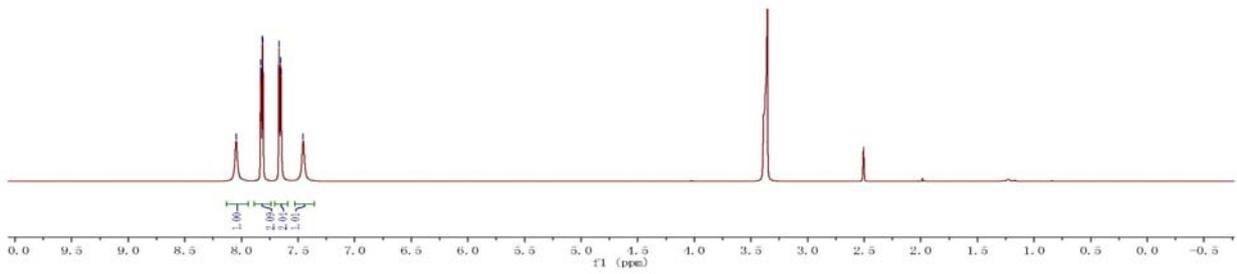
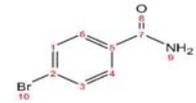
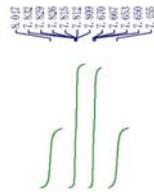


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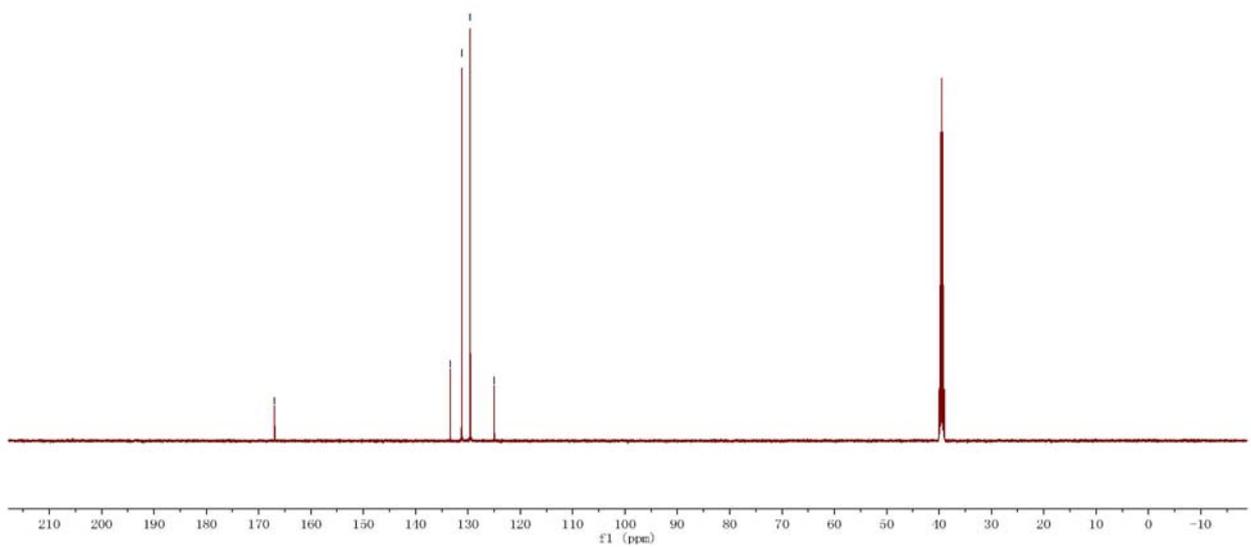


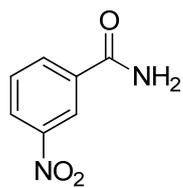


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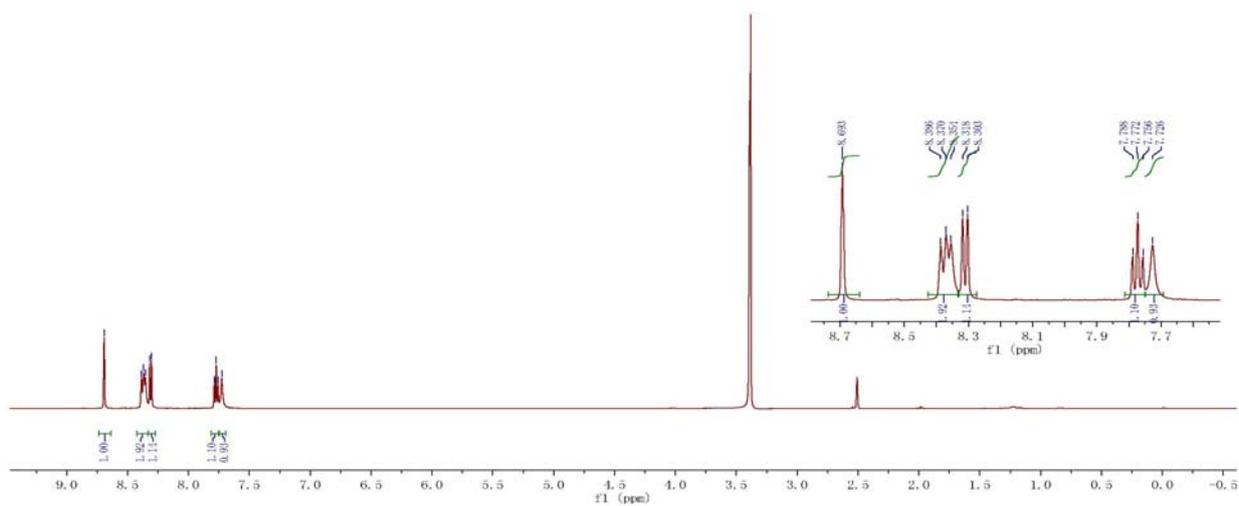
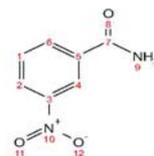
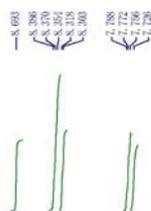
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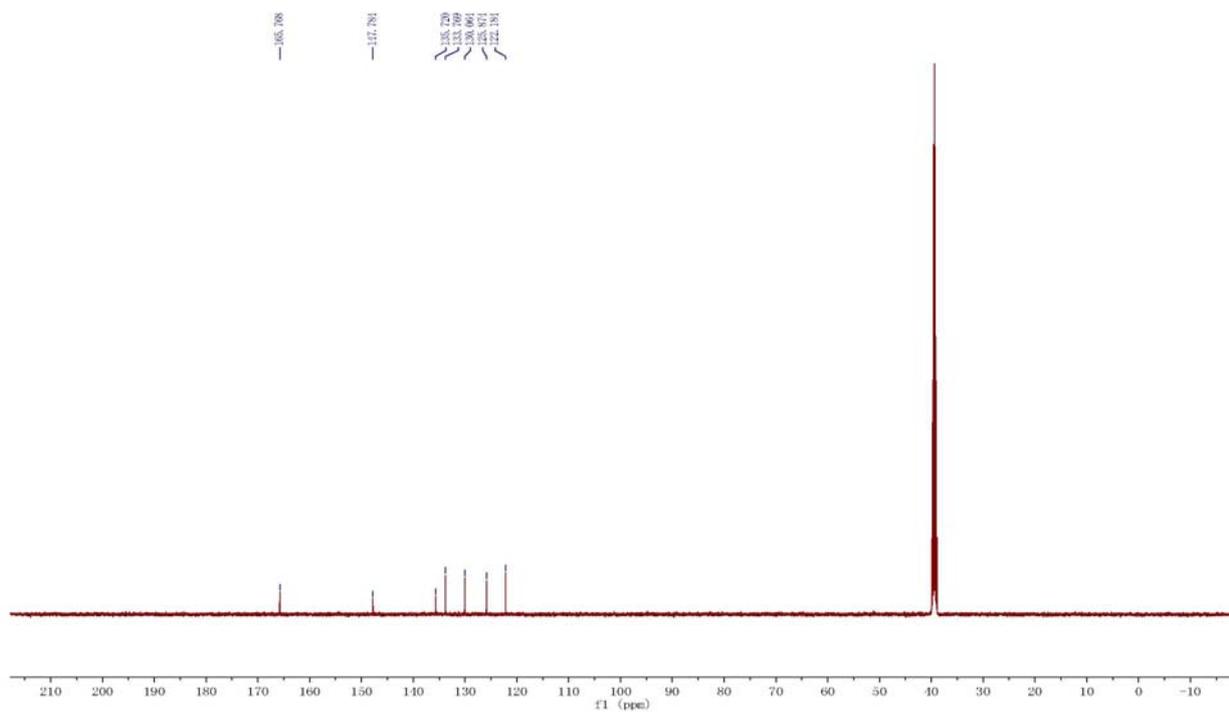


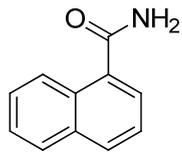
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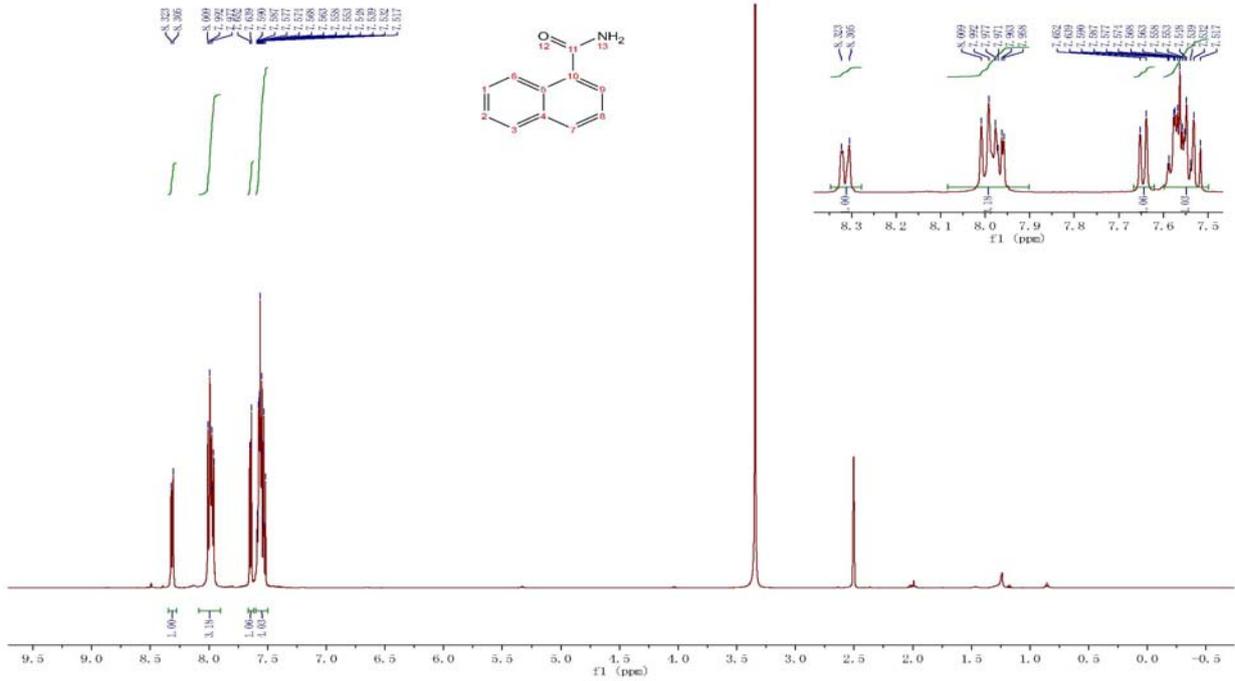
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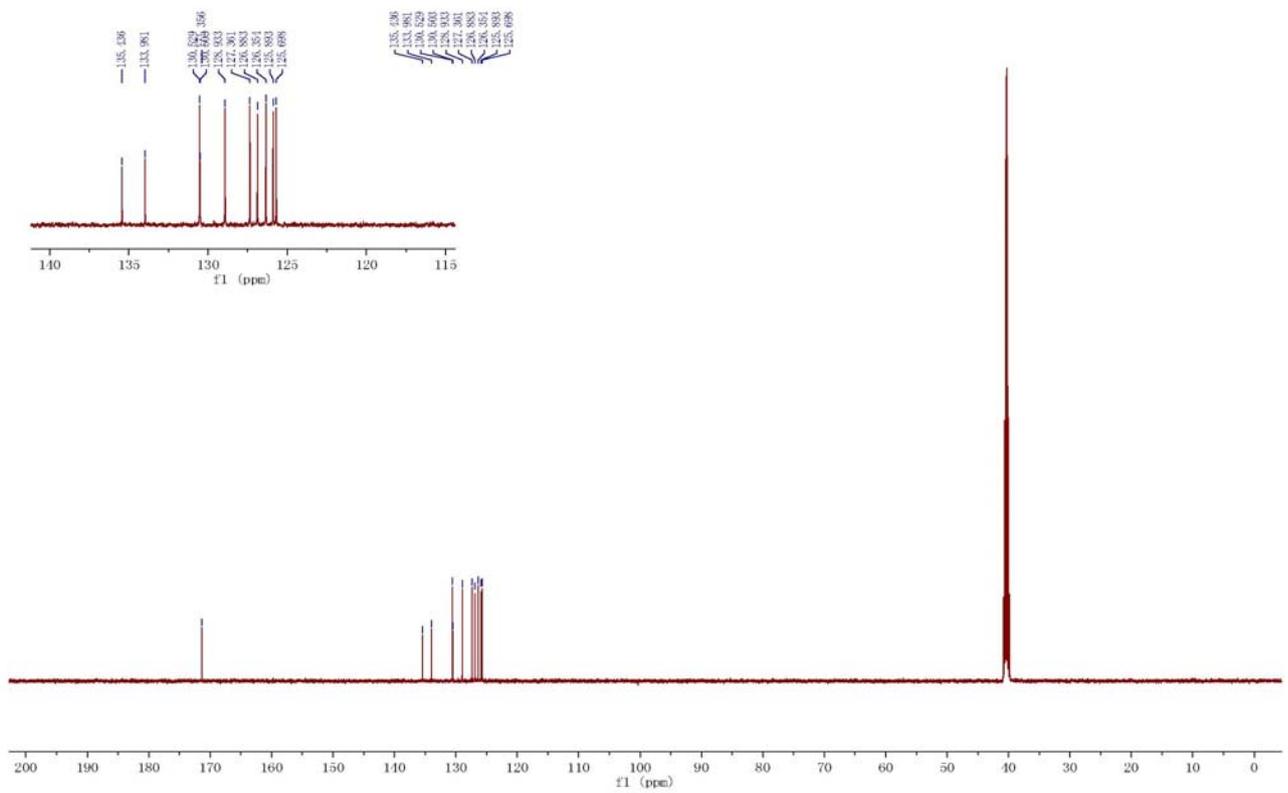


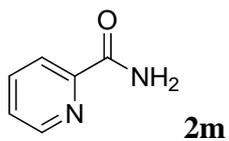
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¹H NMR

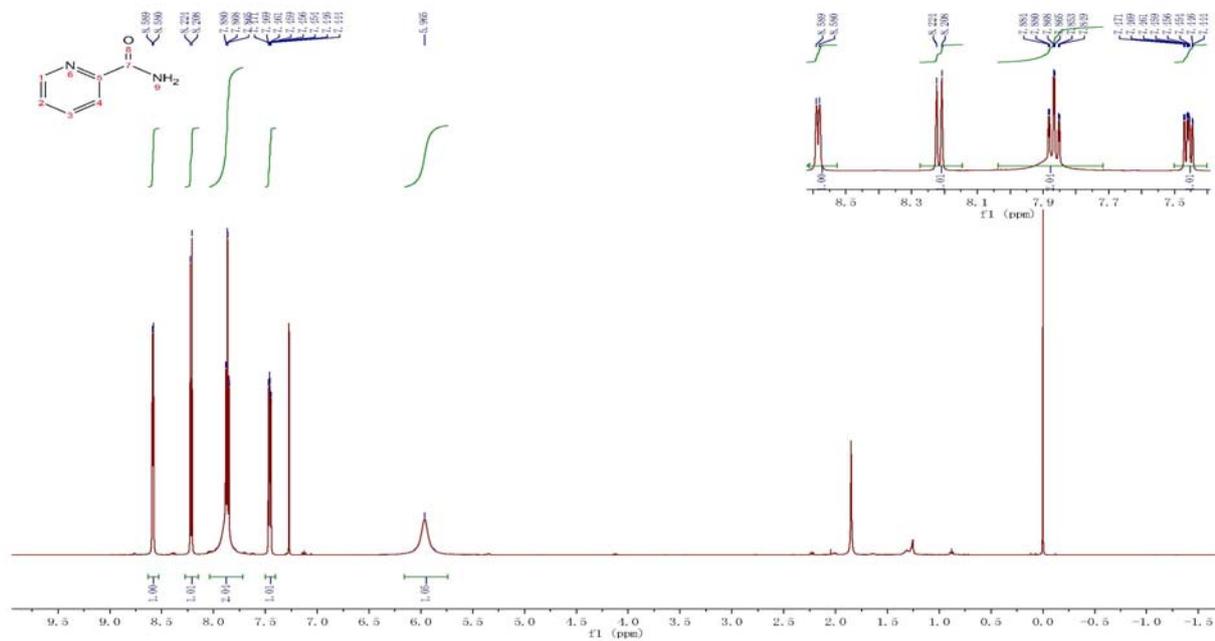


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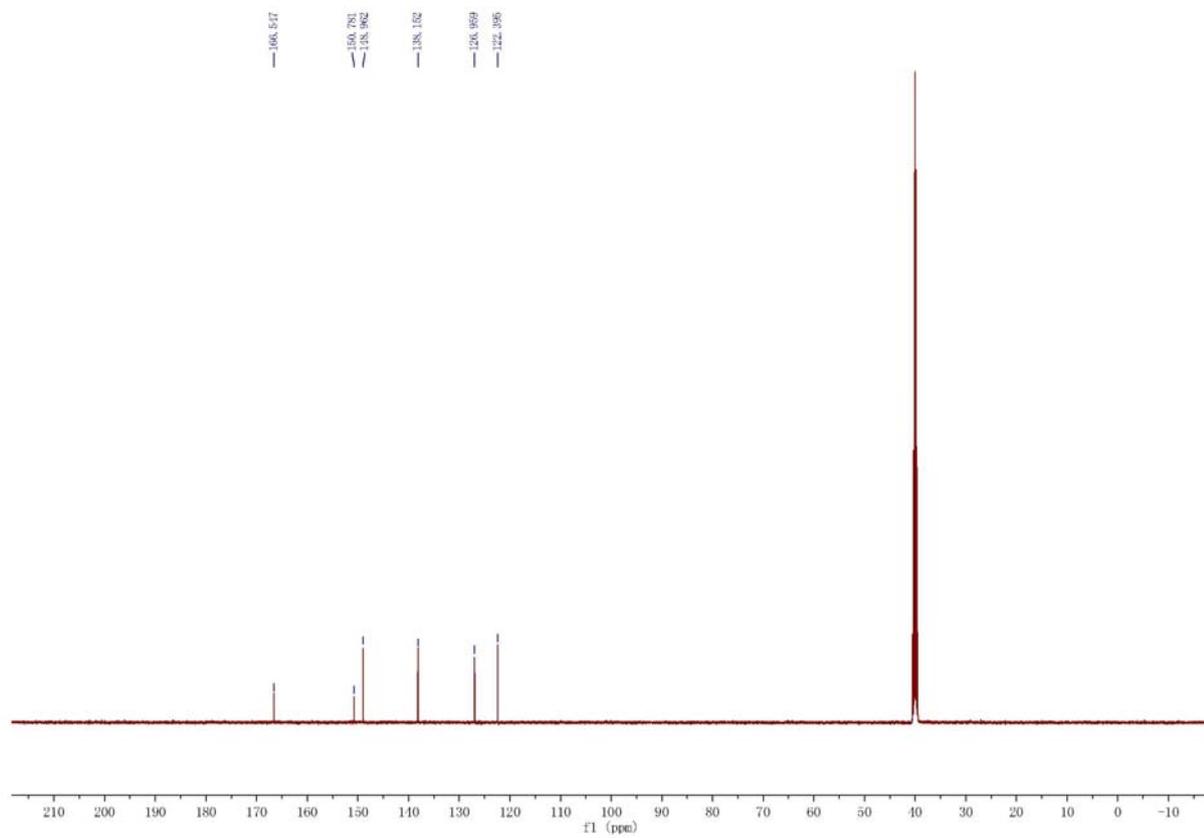


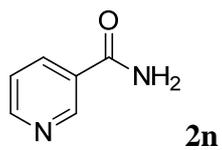


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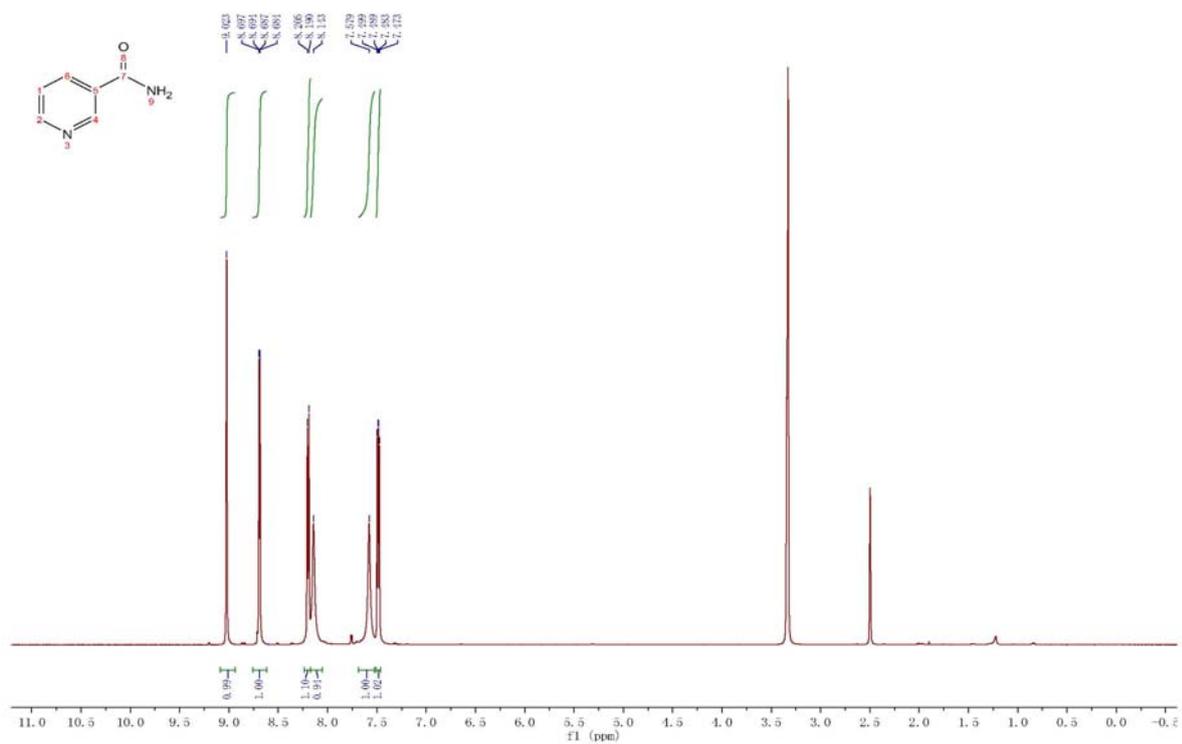


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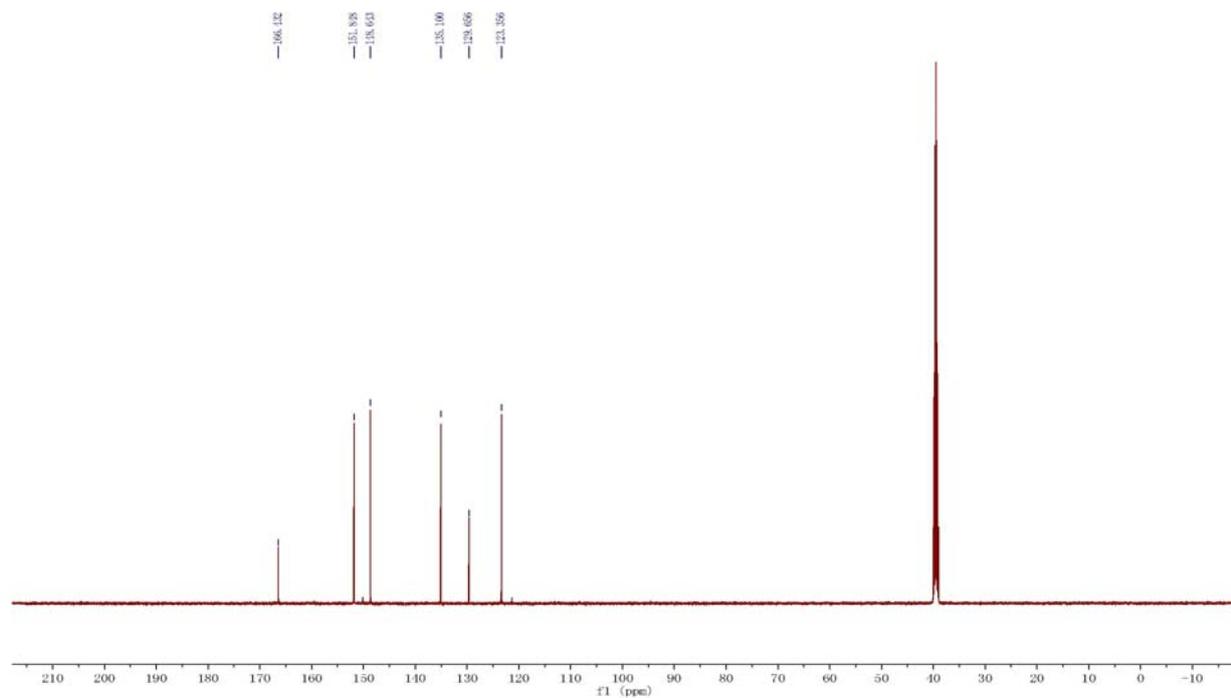


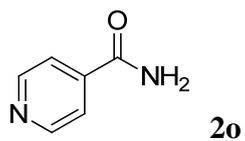


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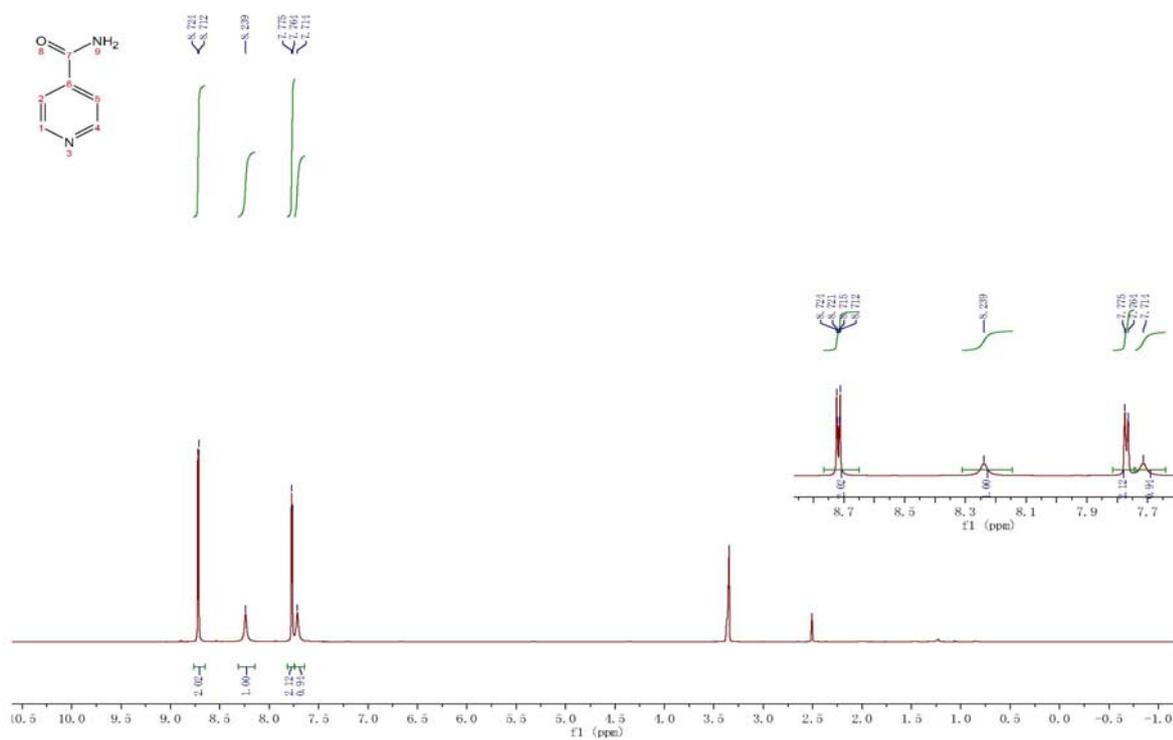


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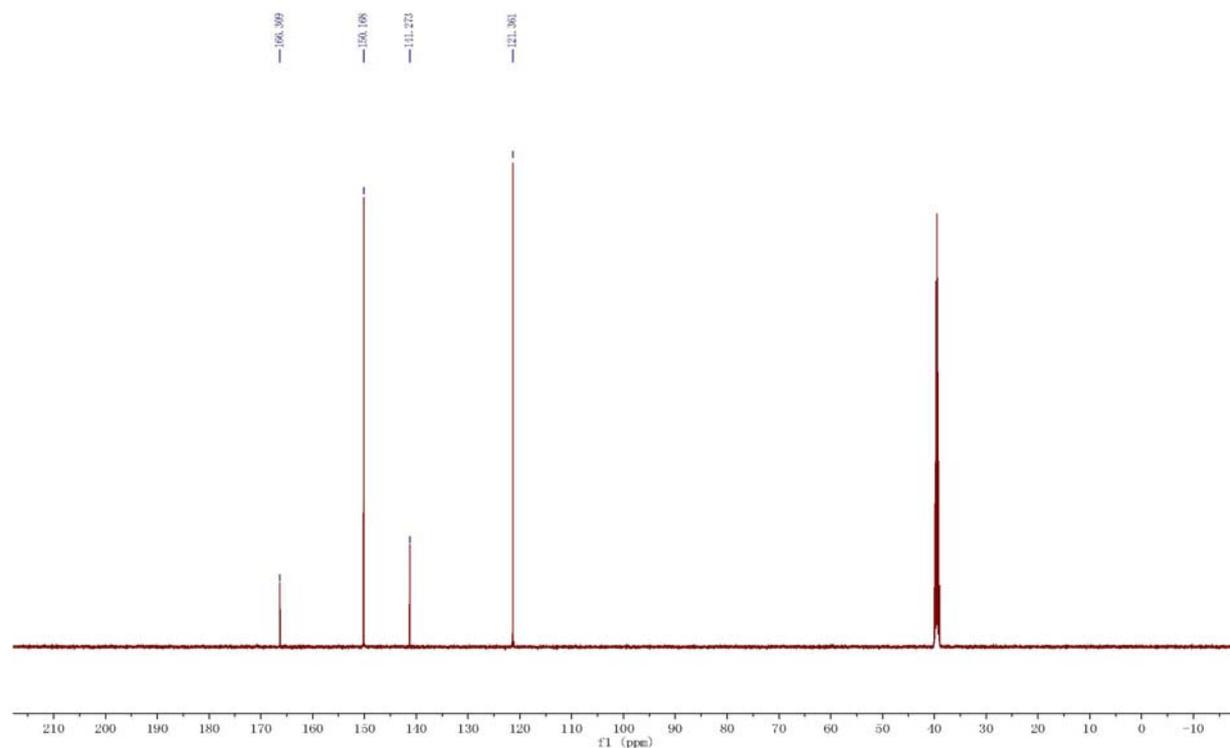




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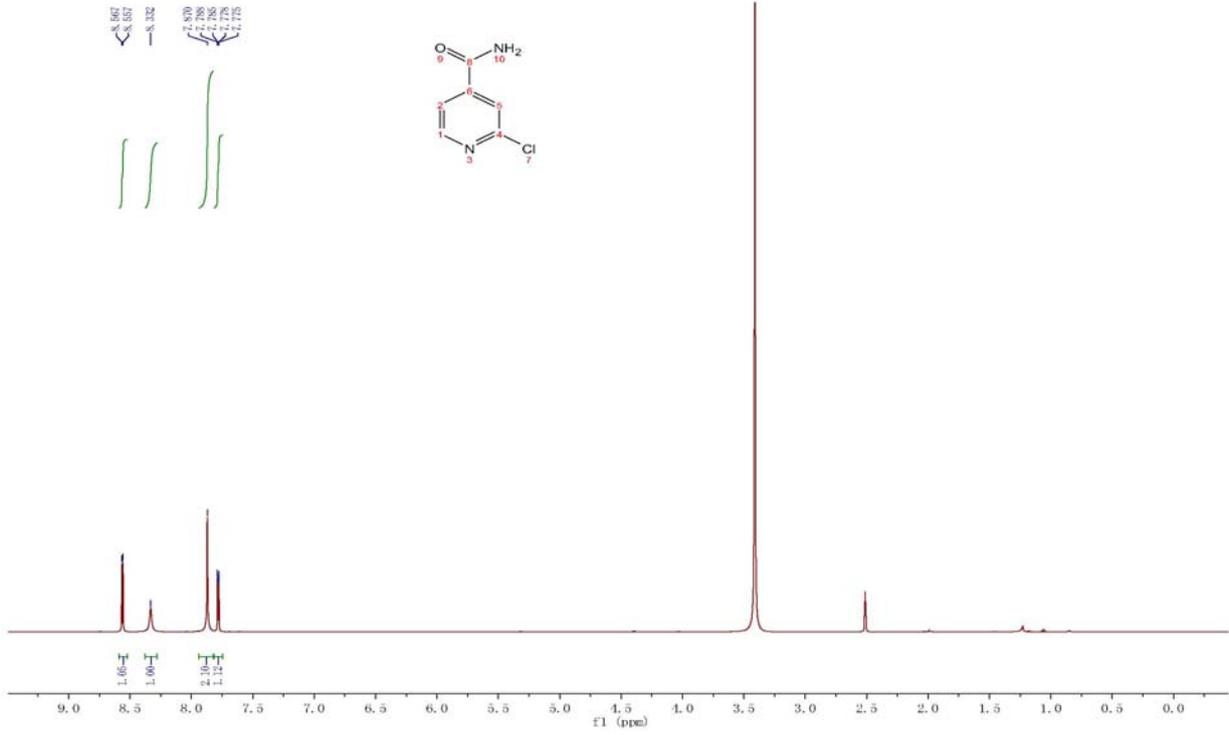


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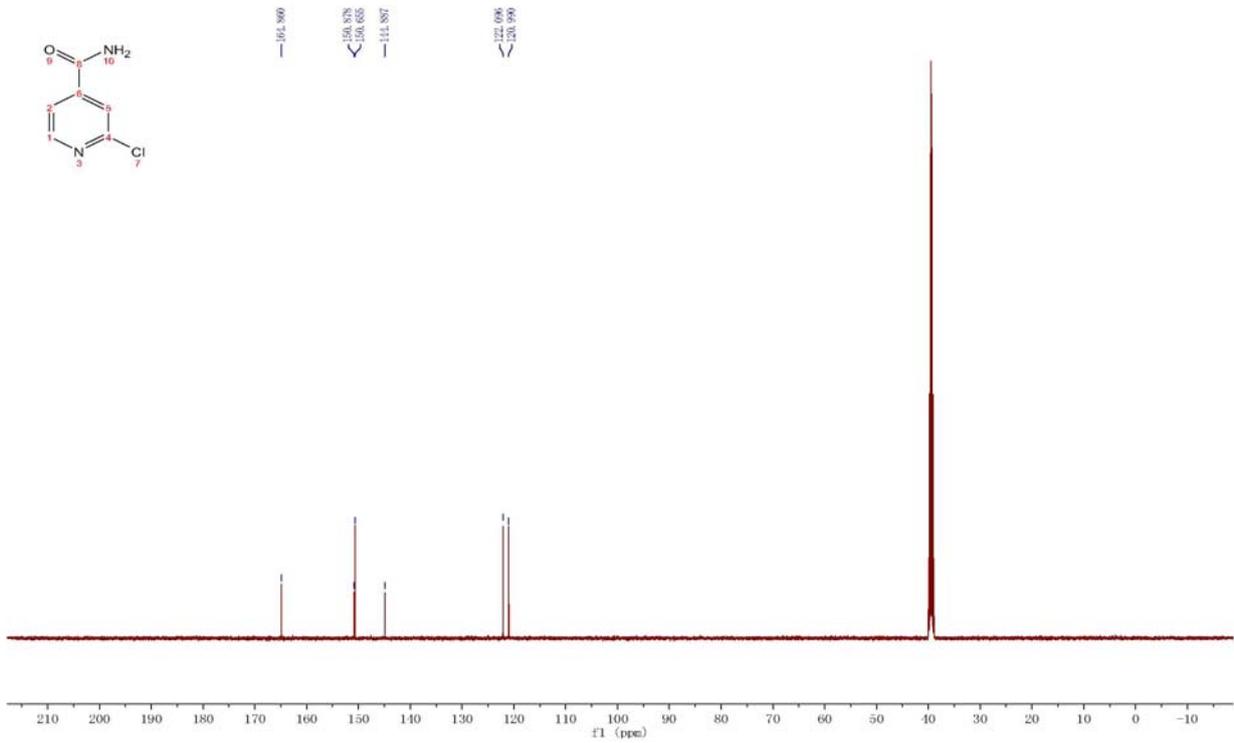


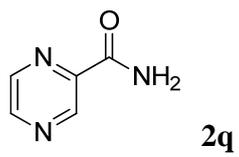


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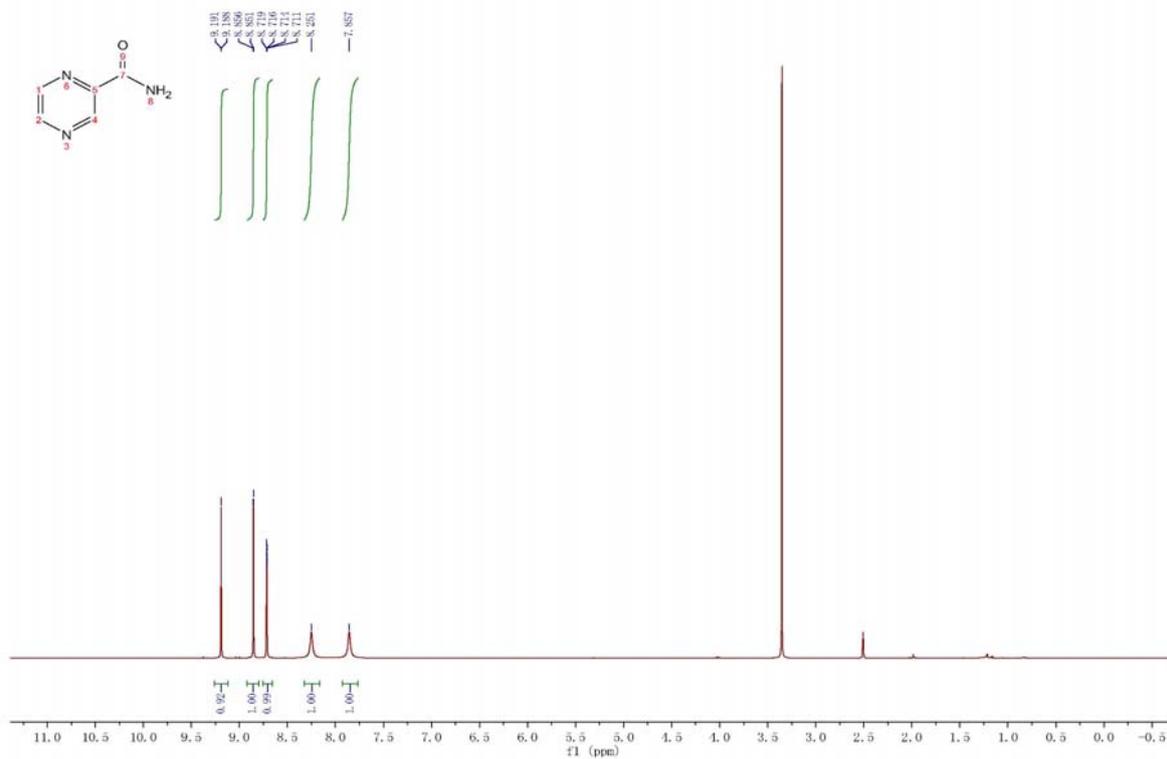


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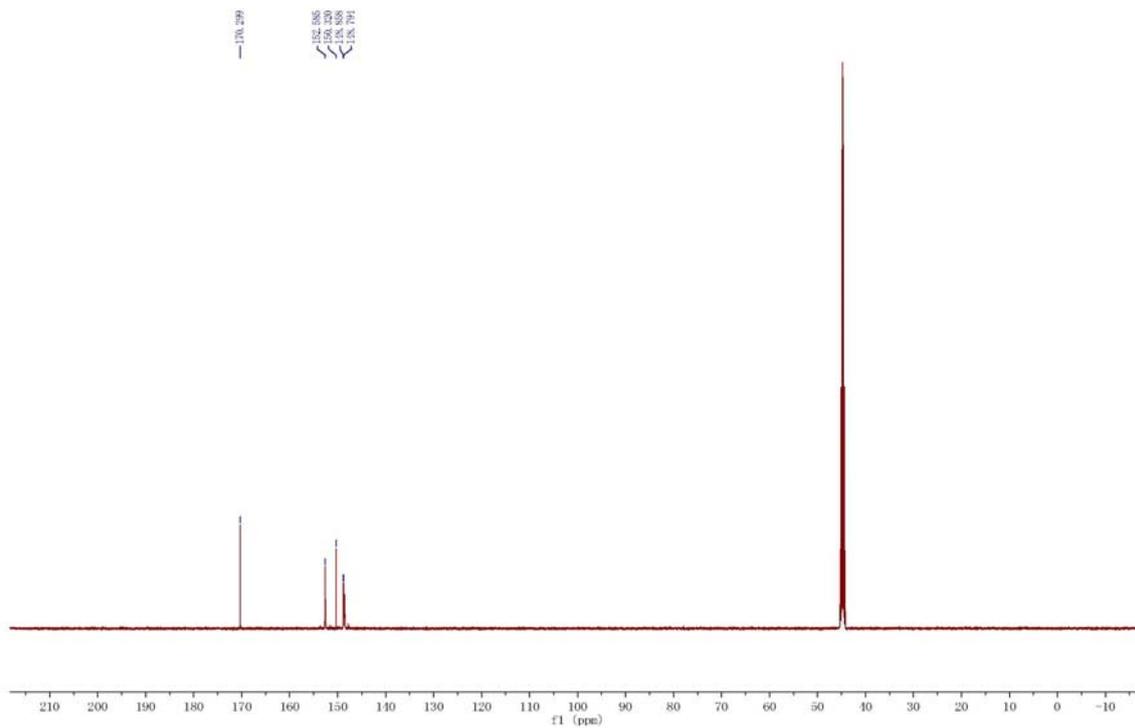


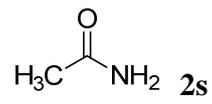


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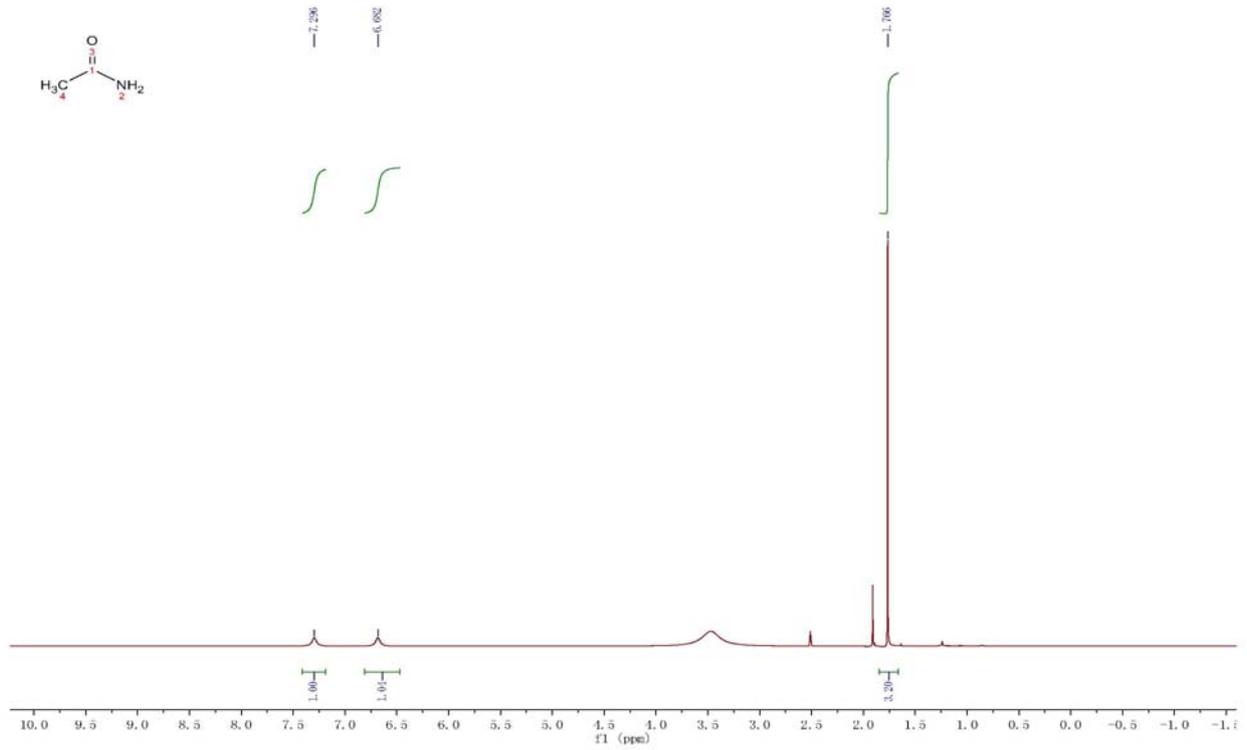


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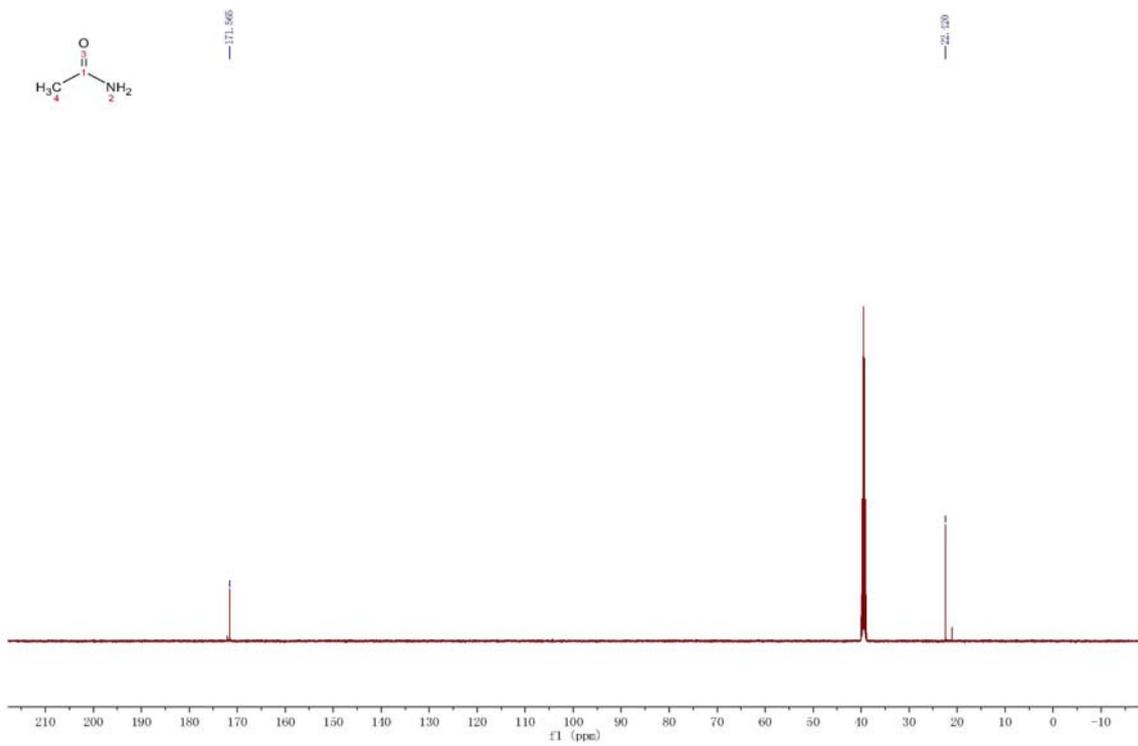


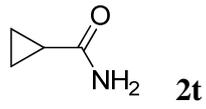


^1H NMR

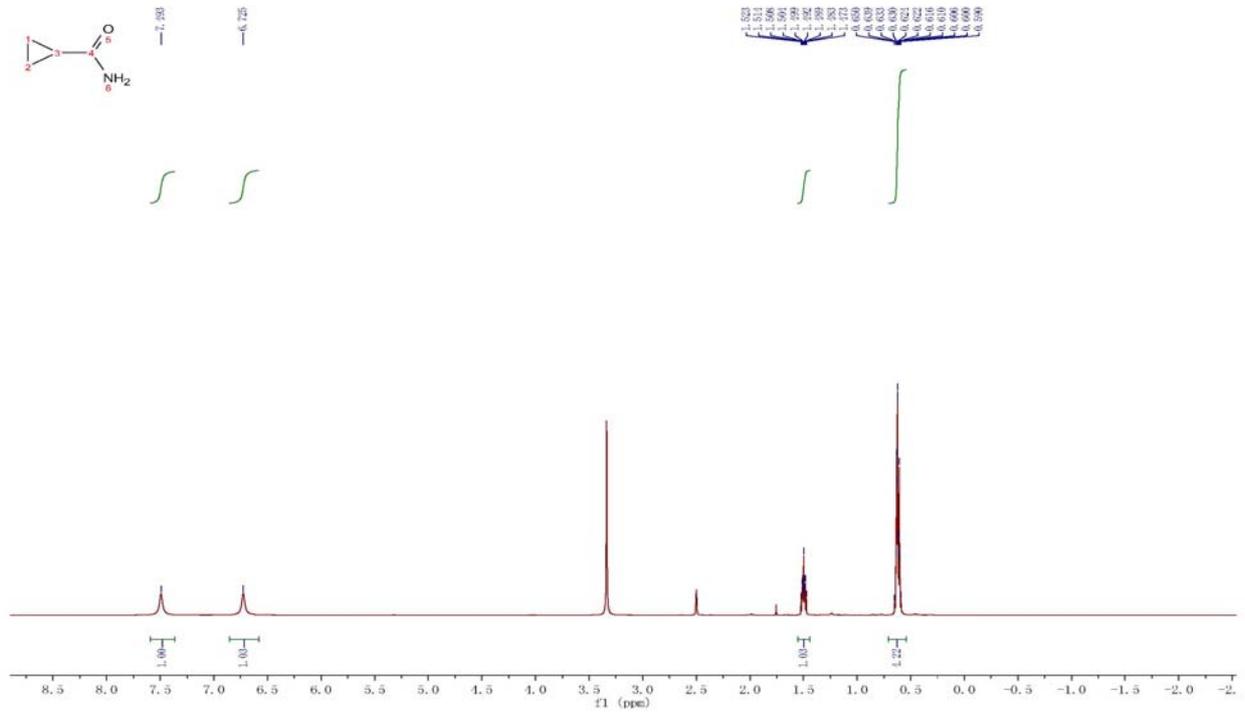


^{13}C NMR

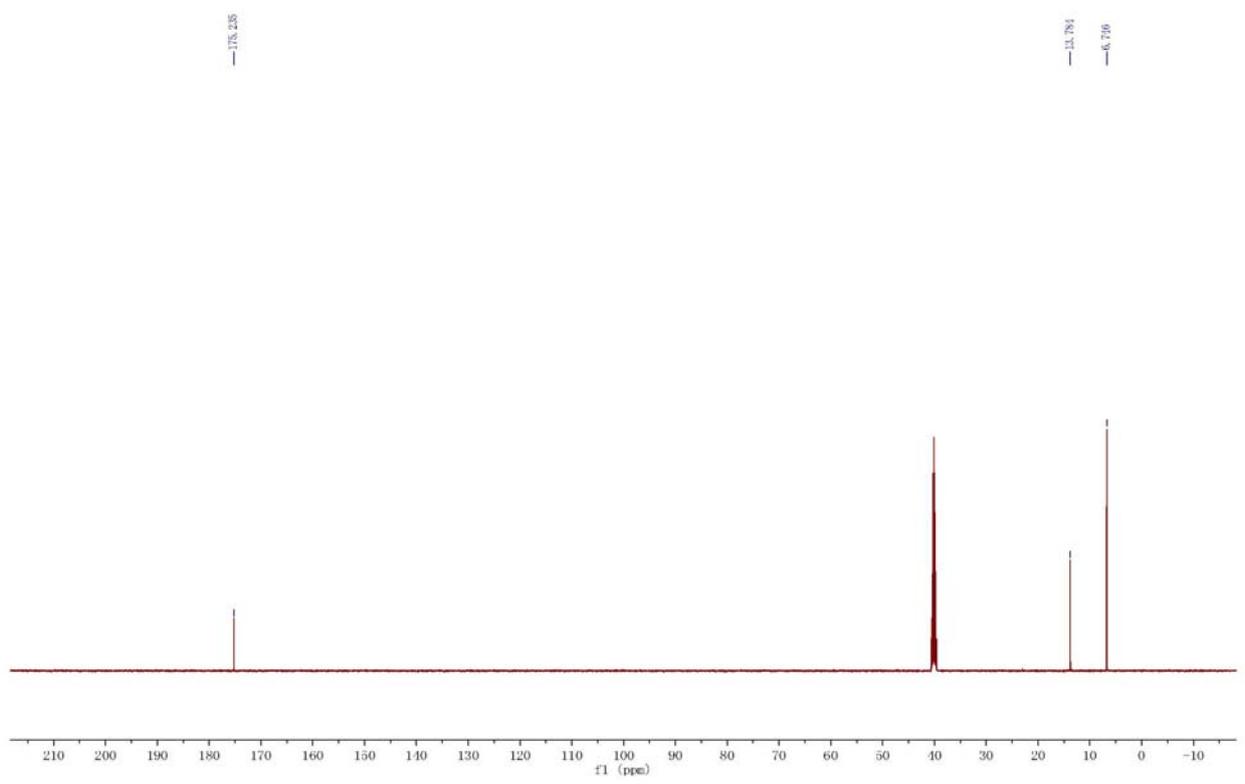


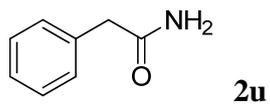


¹H NMR

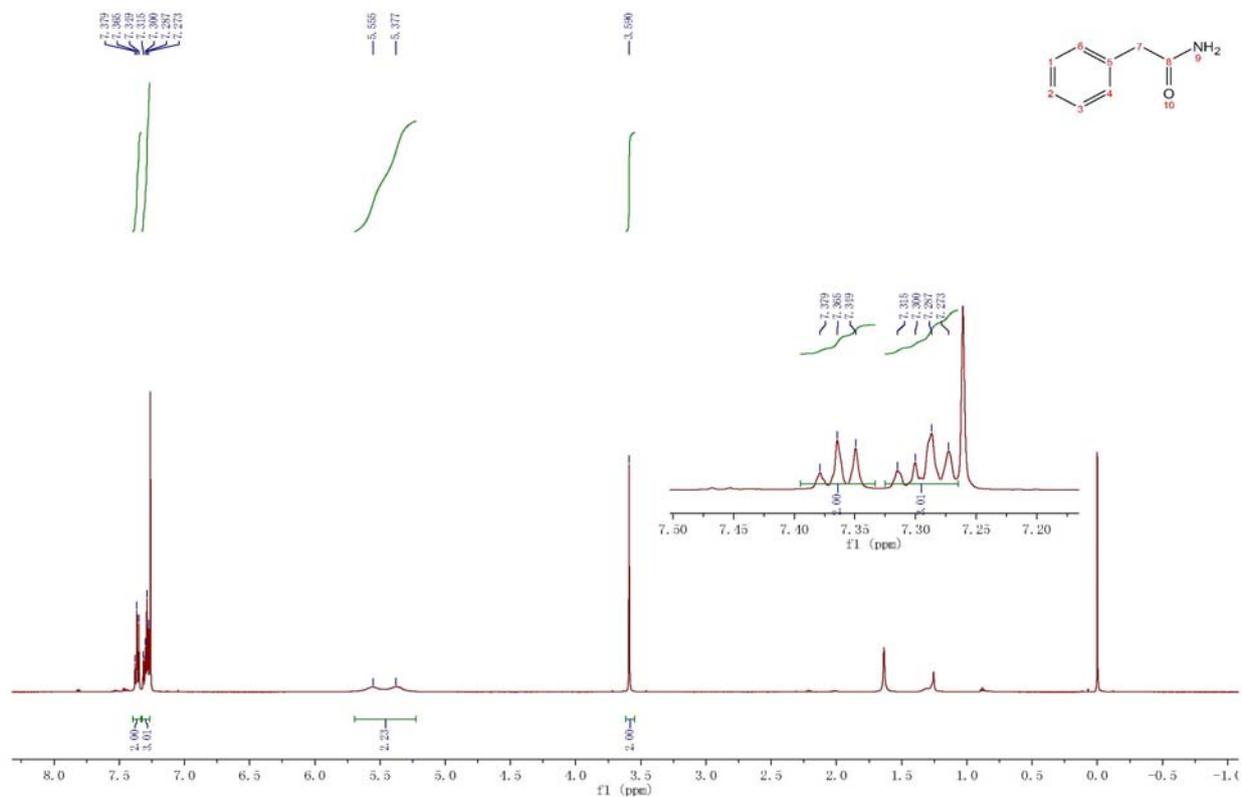


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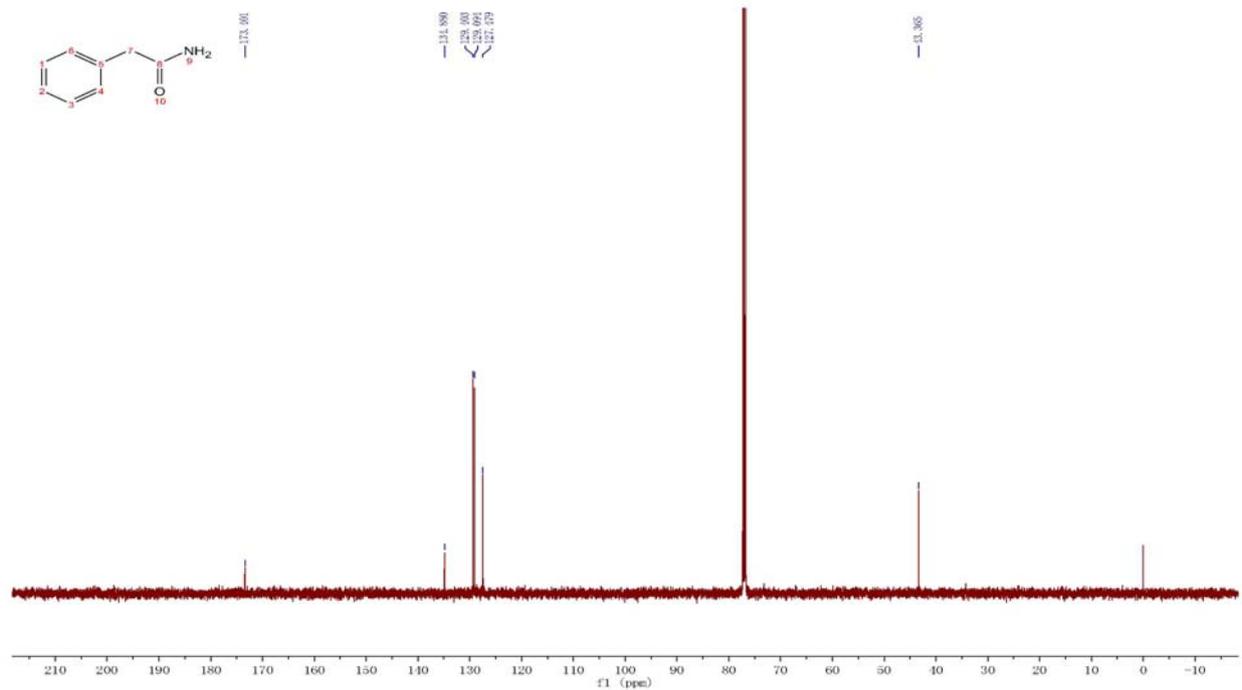


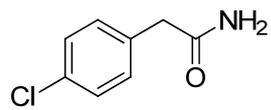


¹H NMR



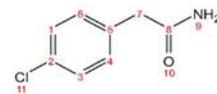
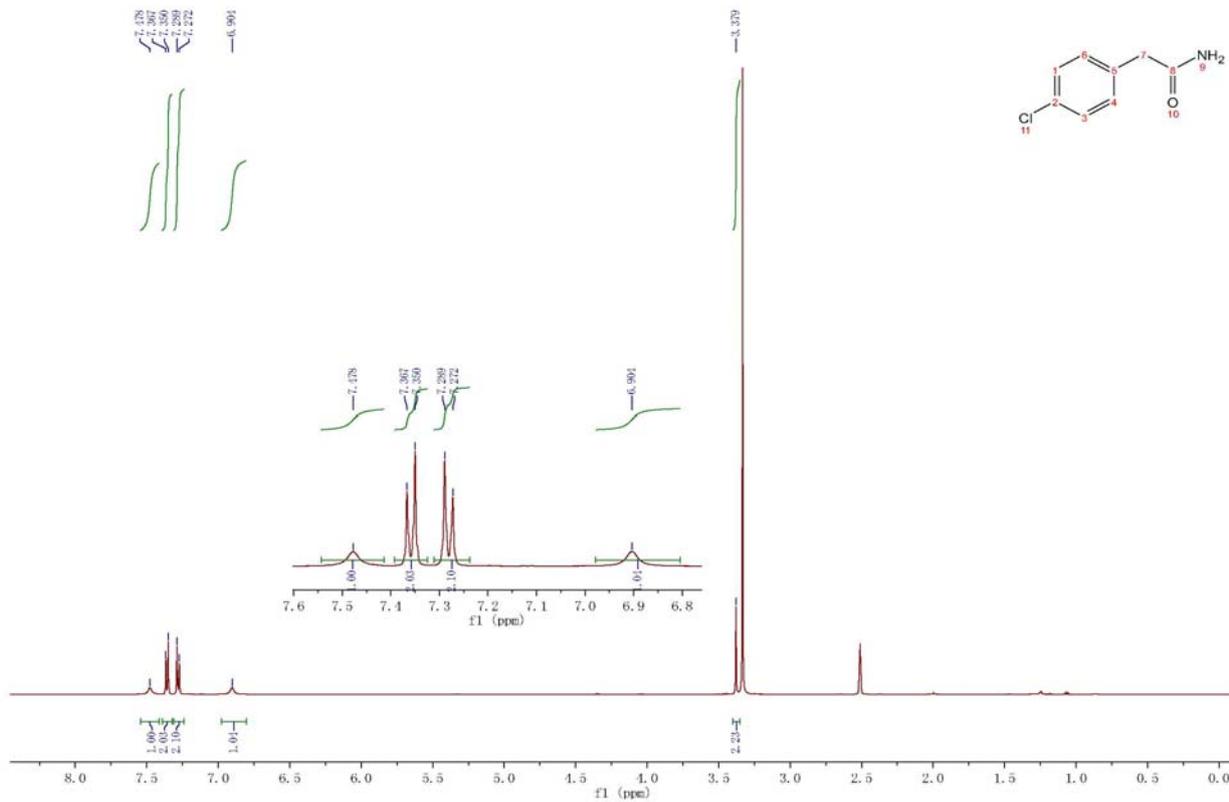
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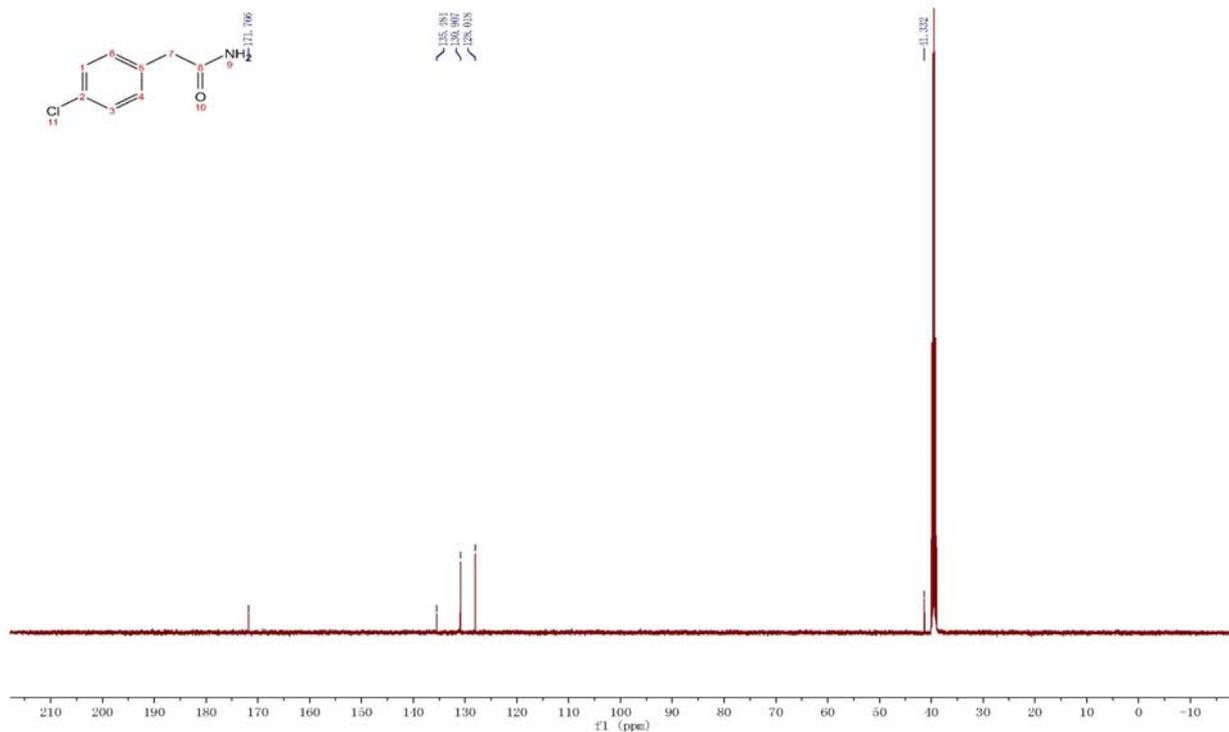


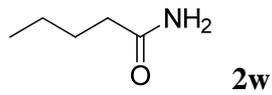
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¹H NMR

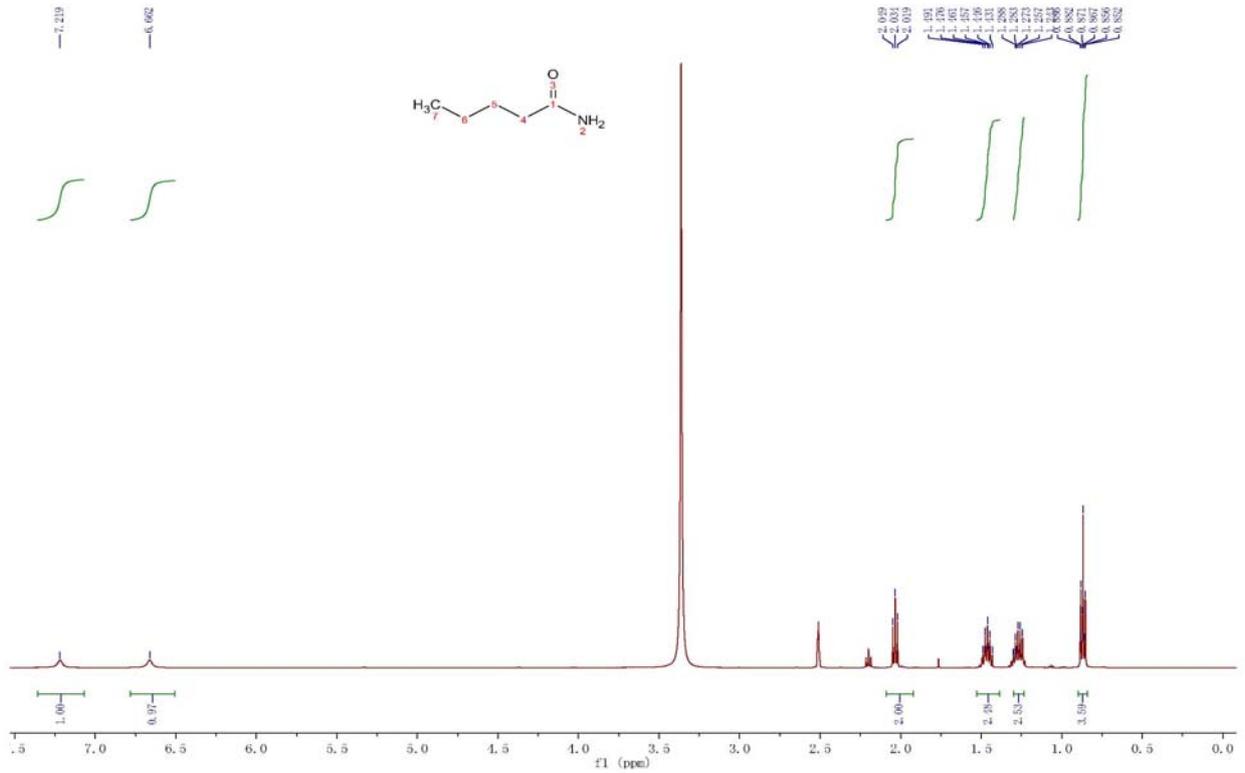


¹³C NMR

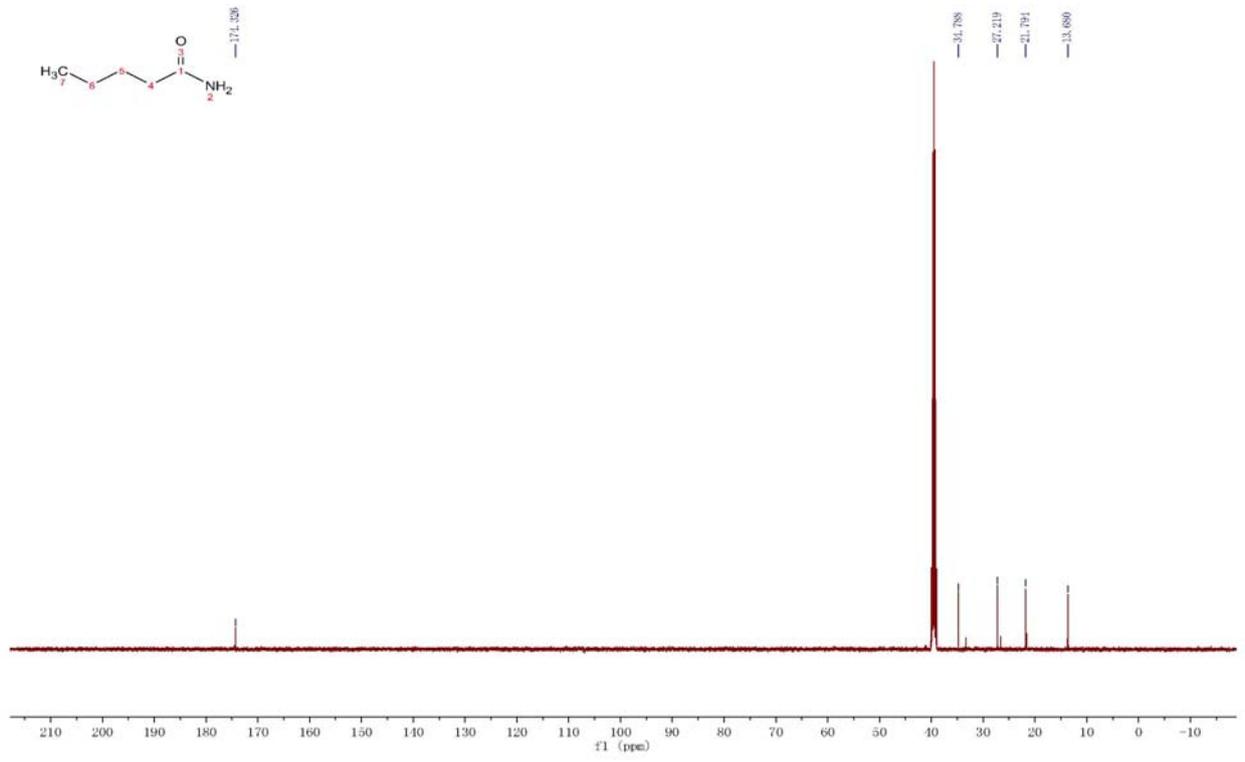


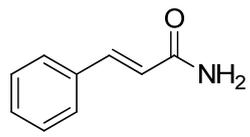


¹H NMR



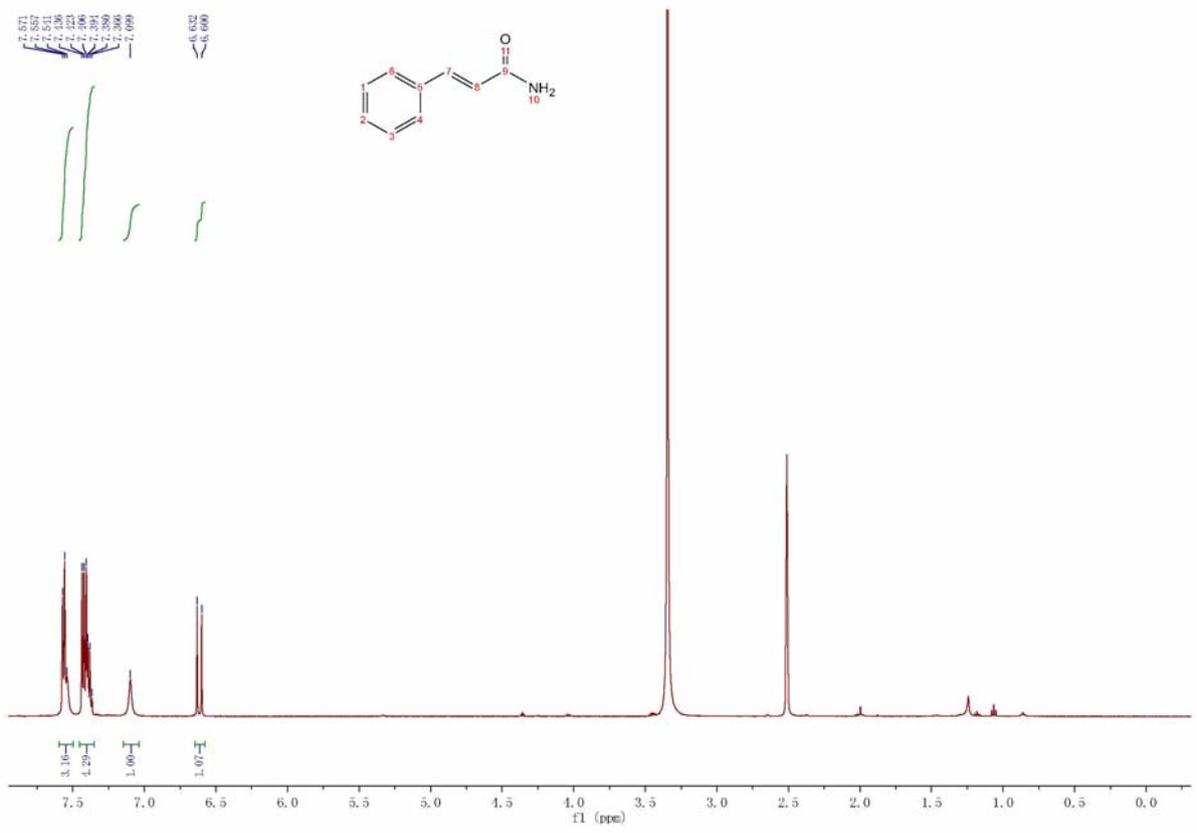
¹³C NMR



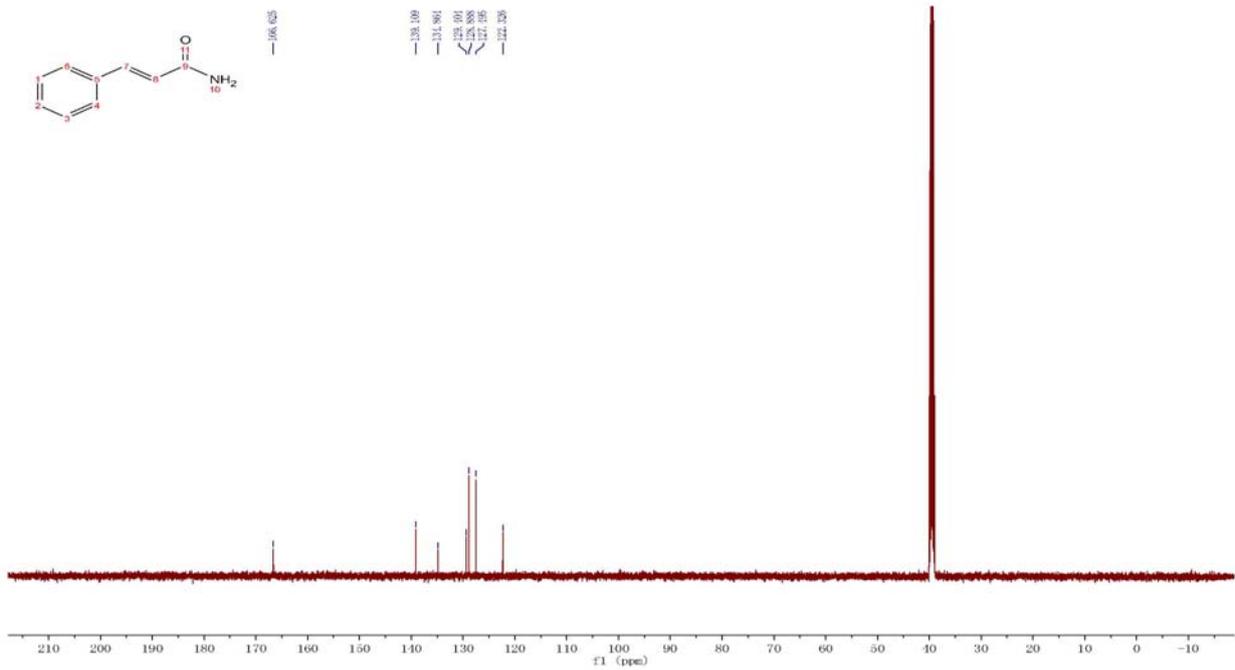


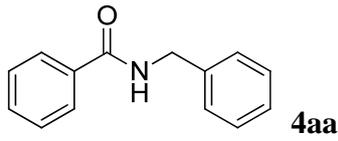
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¹H NMR

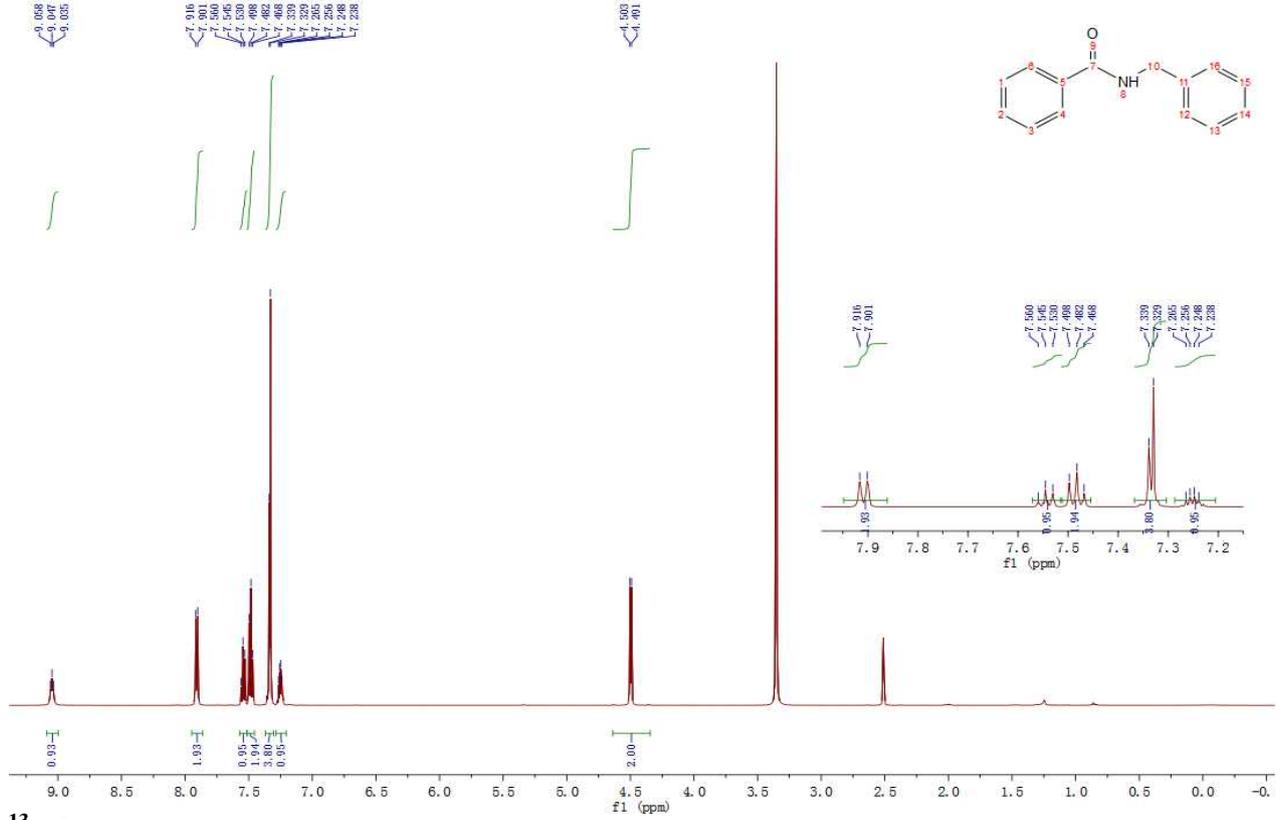


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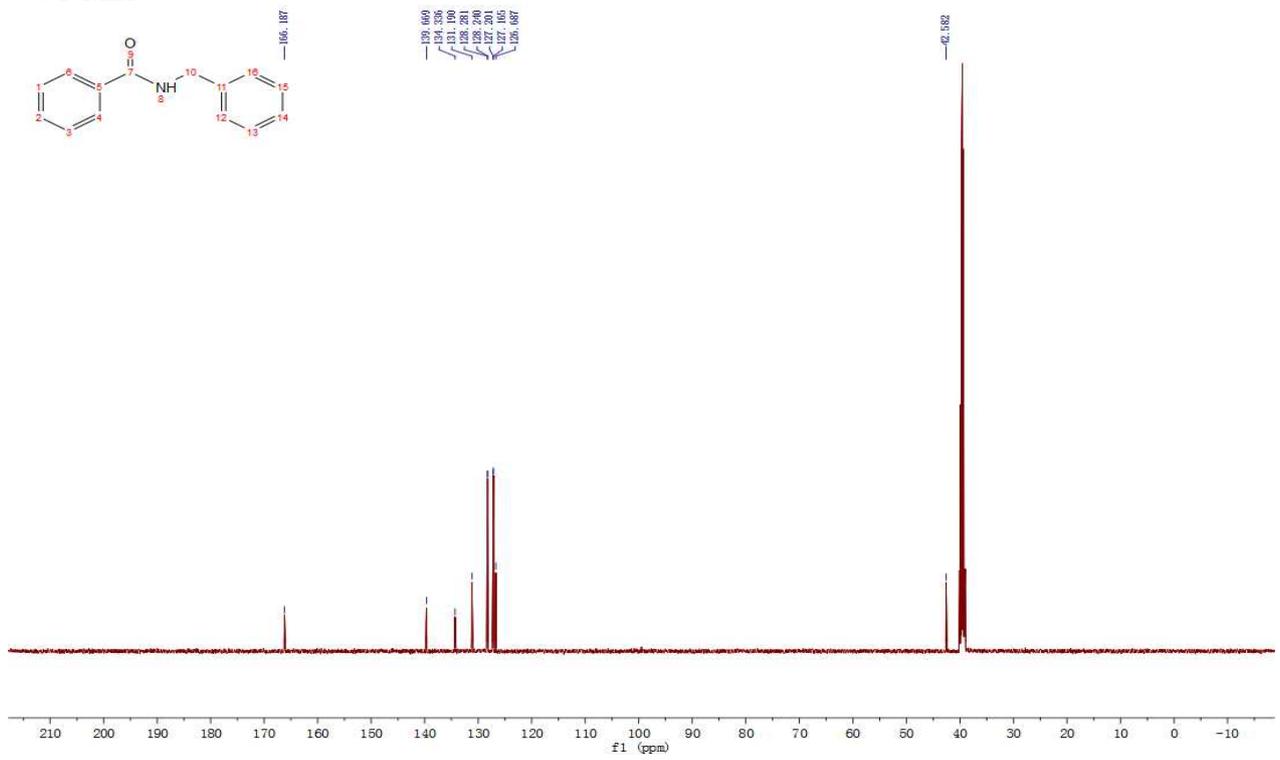




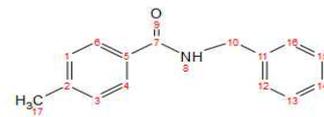
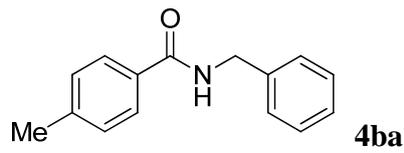
¹H NMR



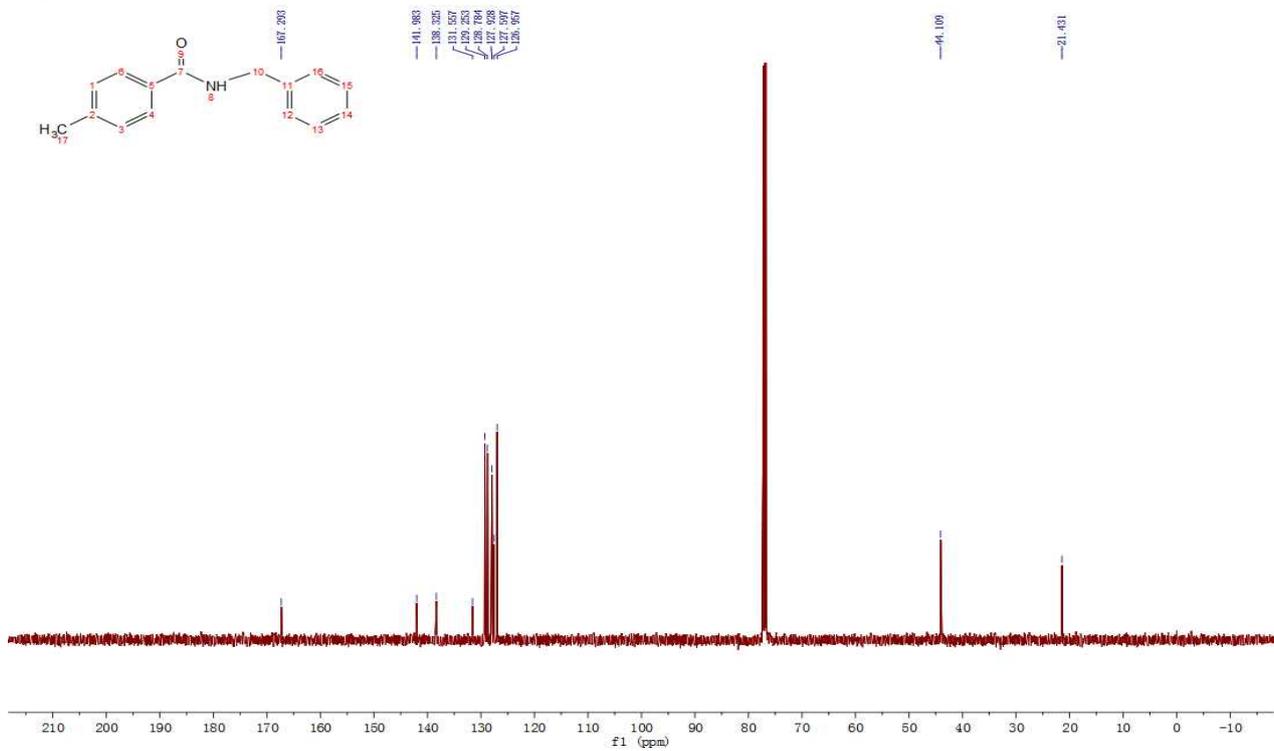
¹³C NMR

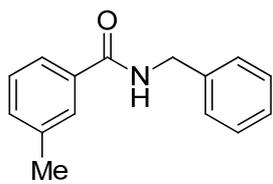


¹H NMR

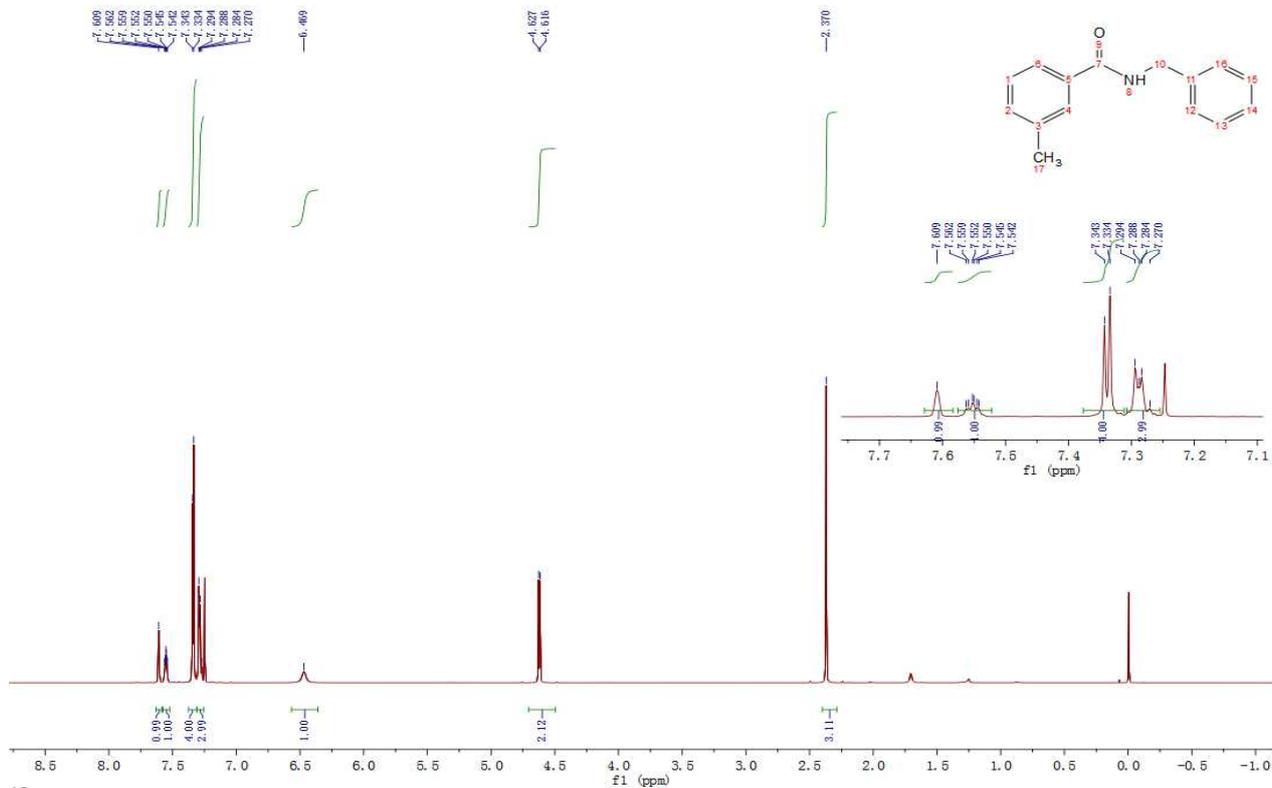


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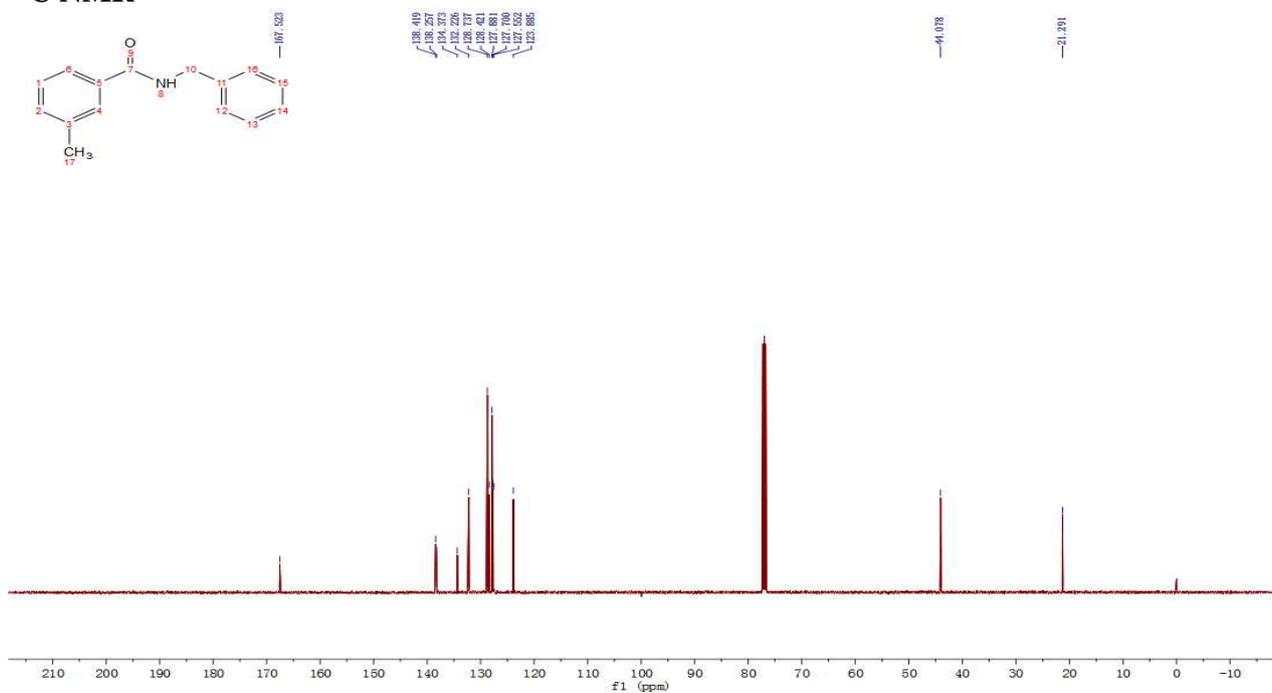


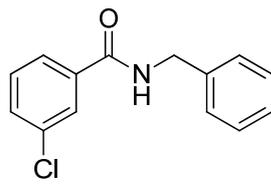


¹H NMR



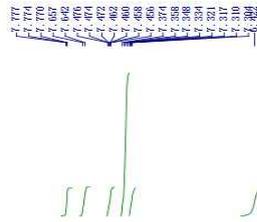
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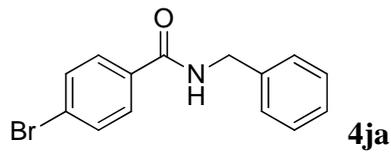


4ha

¹H NMR



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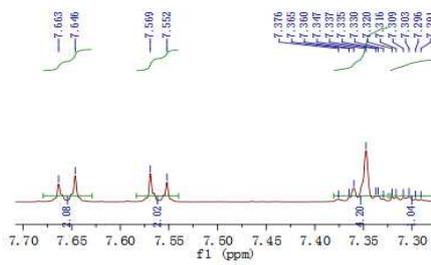
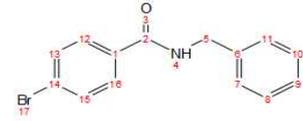
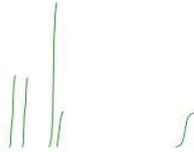


¹H NMR

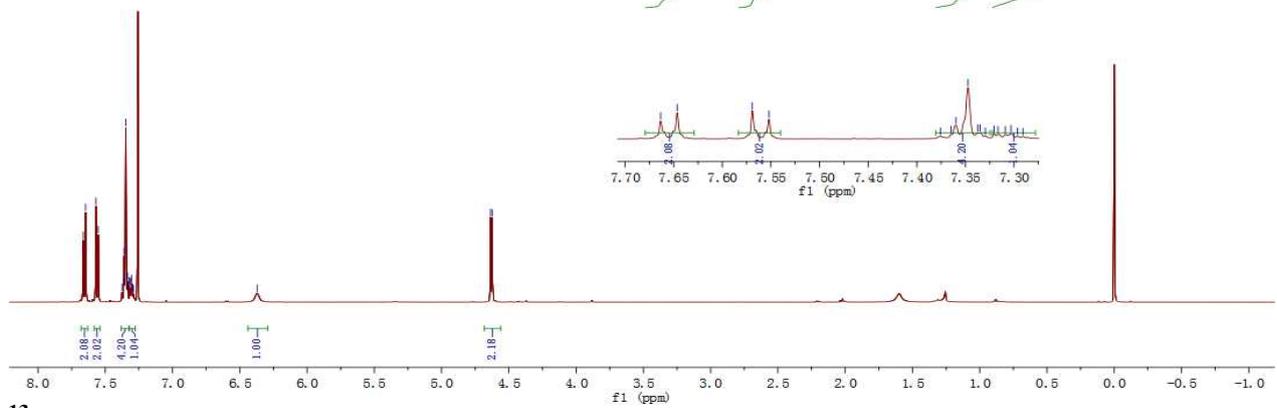
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7.376
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7.316
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7.291

6.371

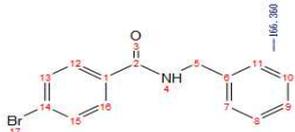
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7.291

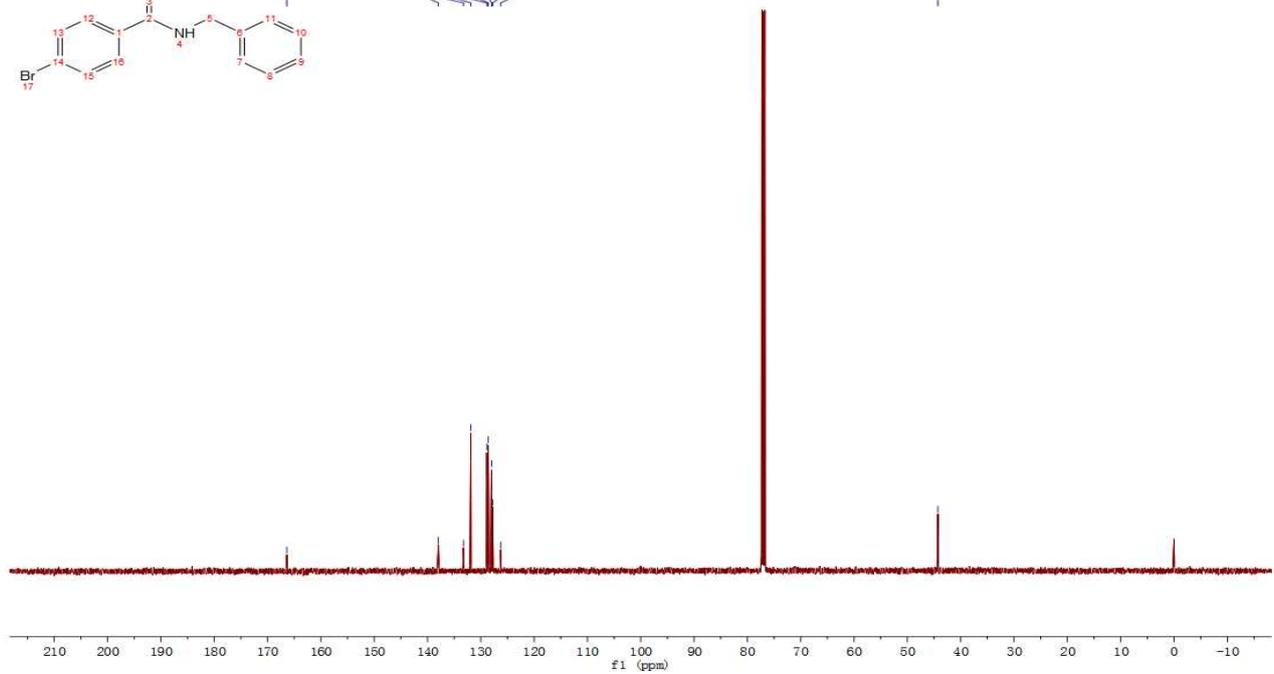


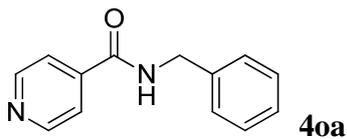
¹³C NMR



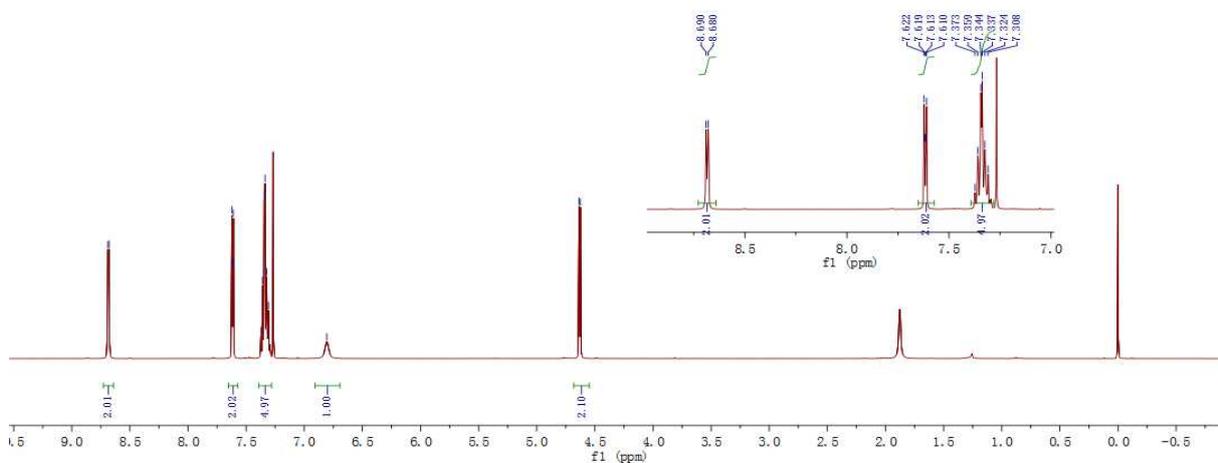
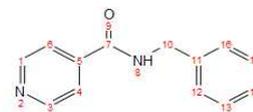
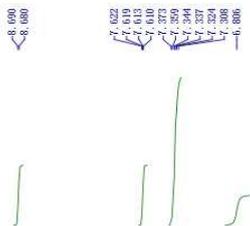
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41.289

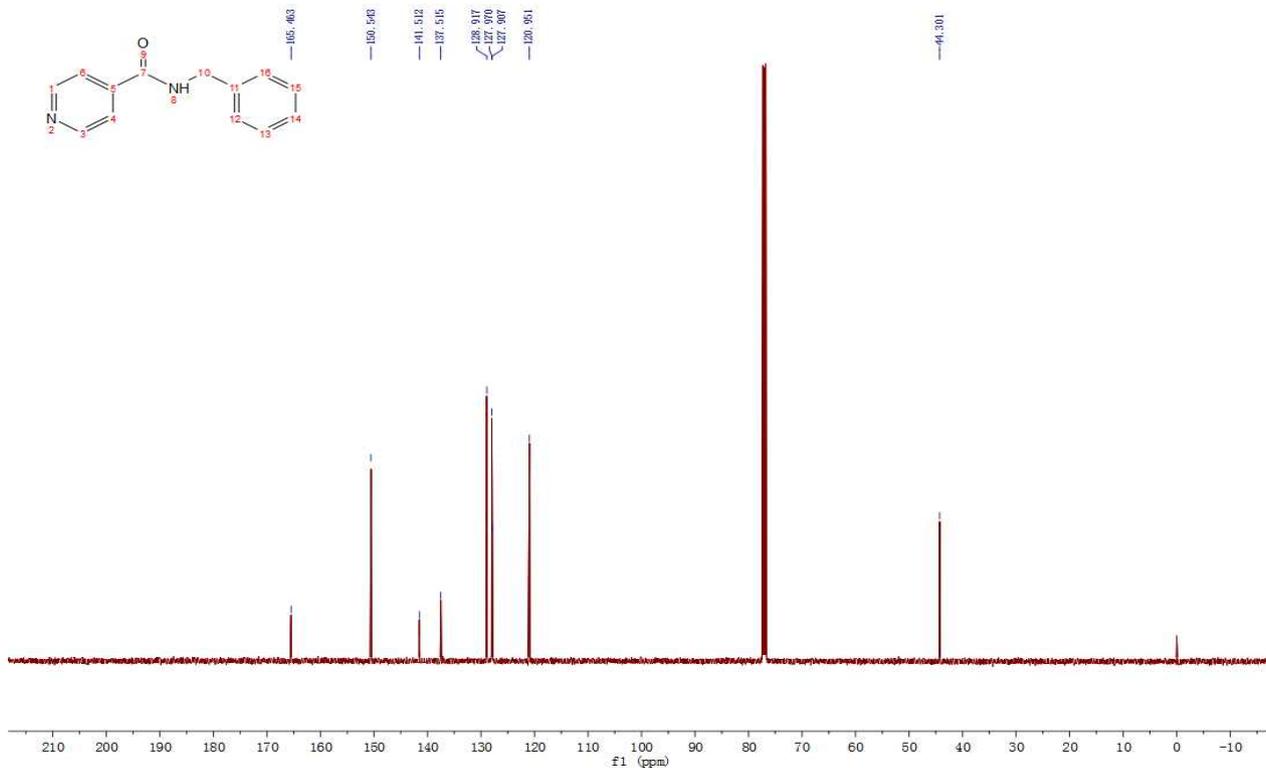
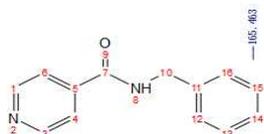


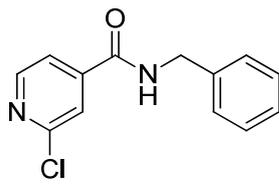


¹H NMR



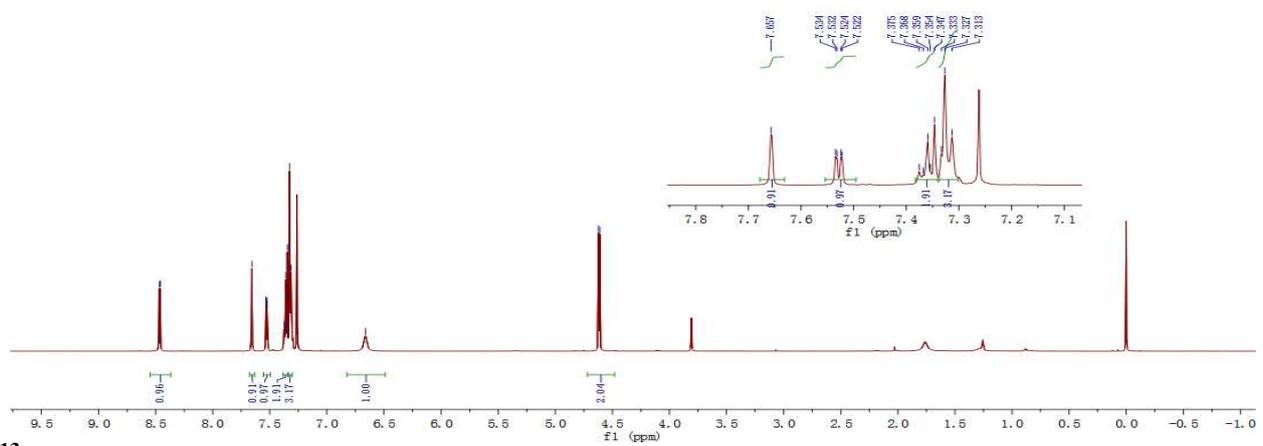
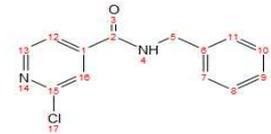
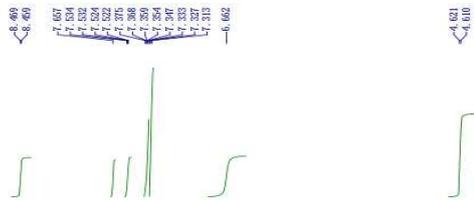
¹³C NMR



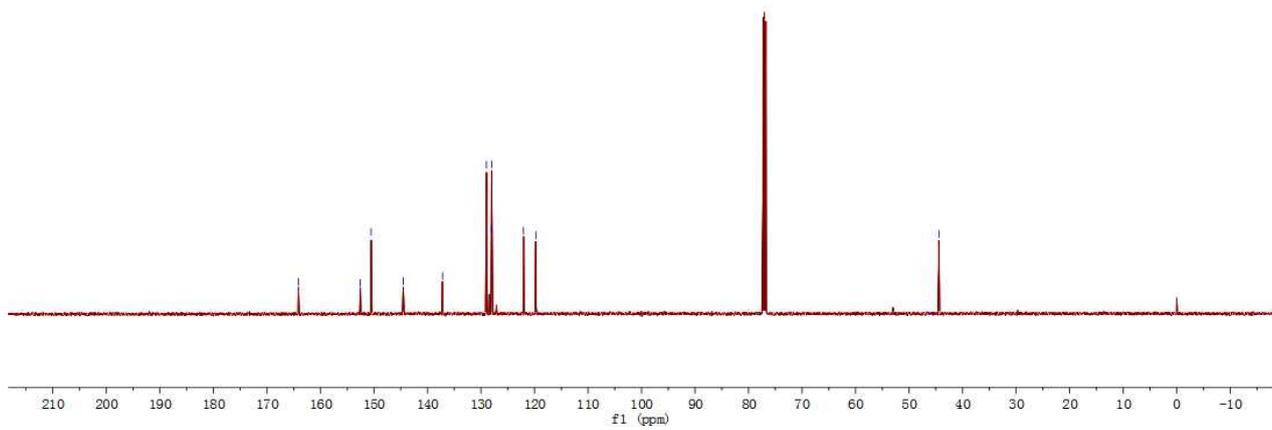
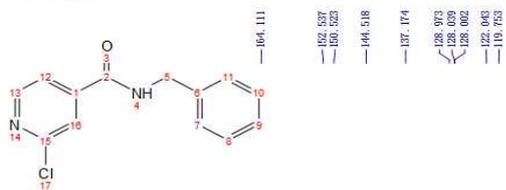


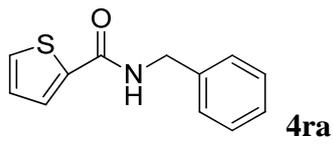
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¹H NMR

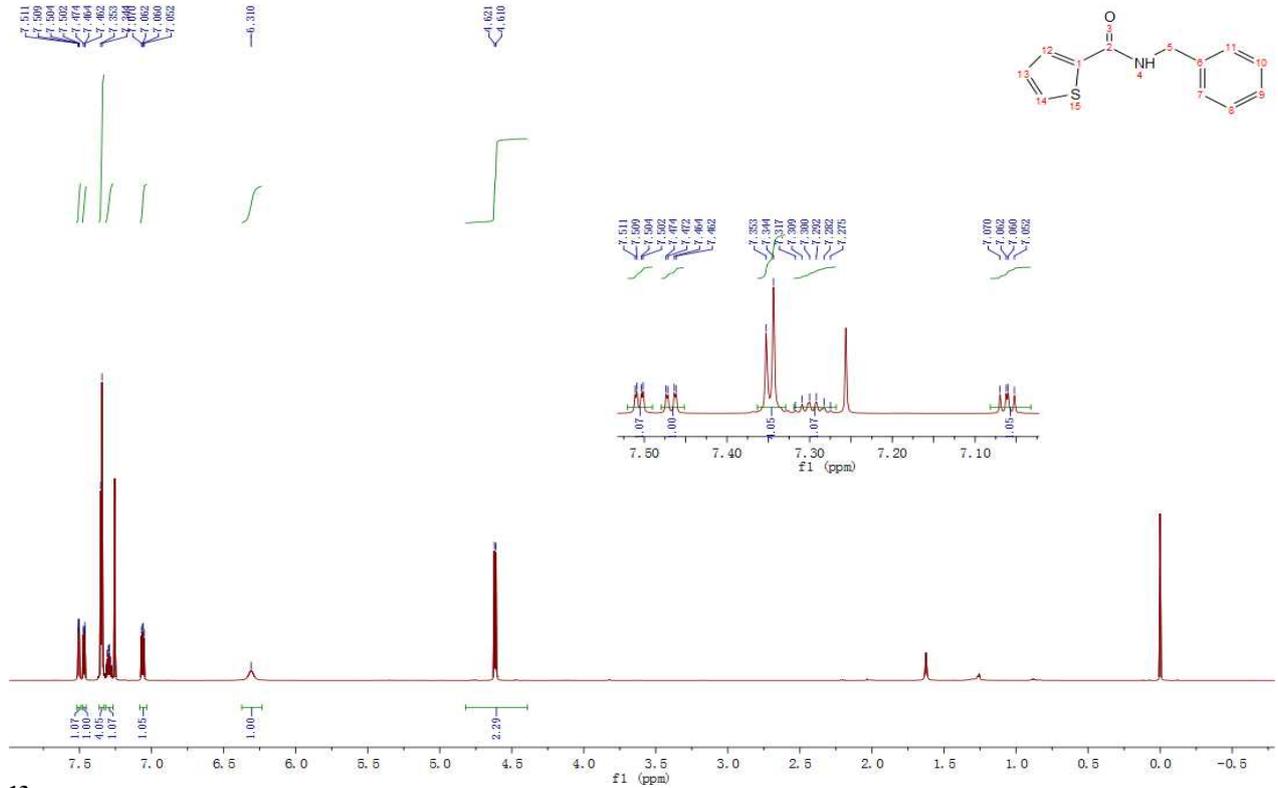


¹³C NMR

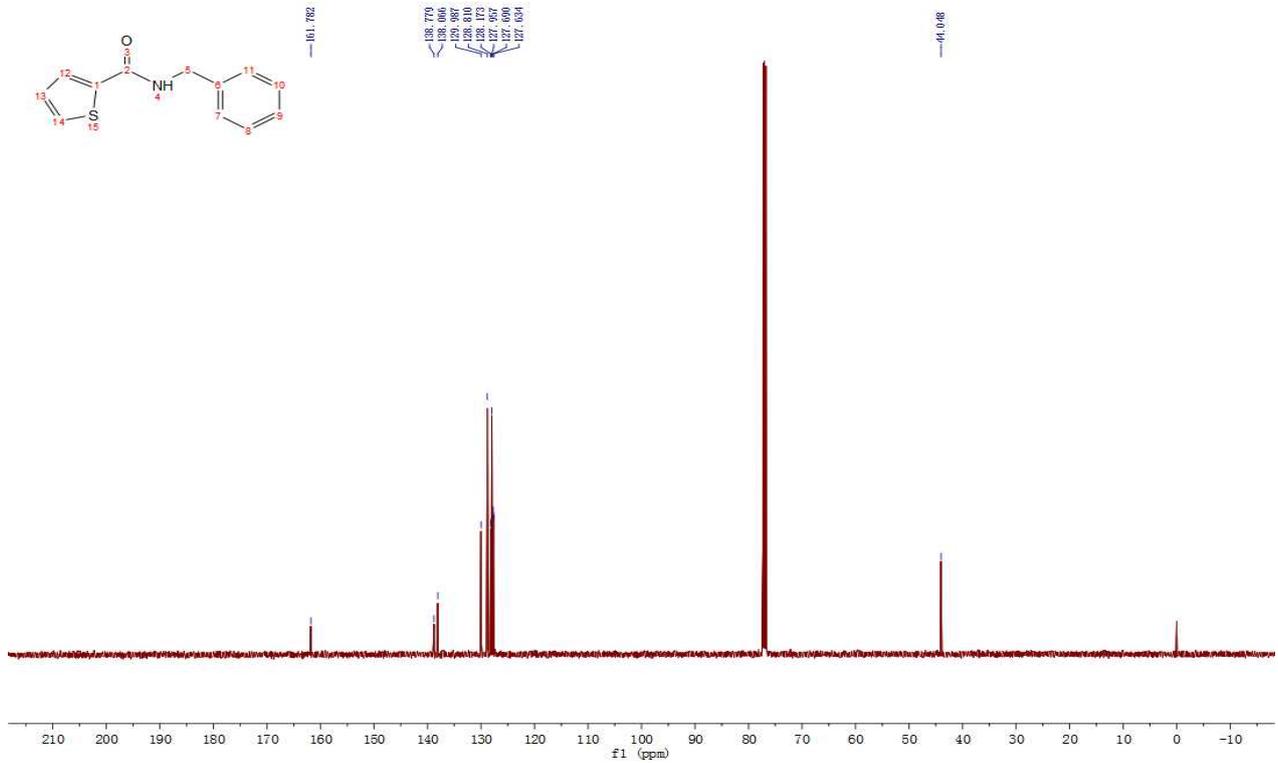


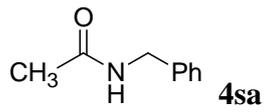


¹H NMR

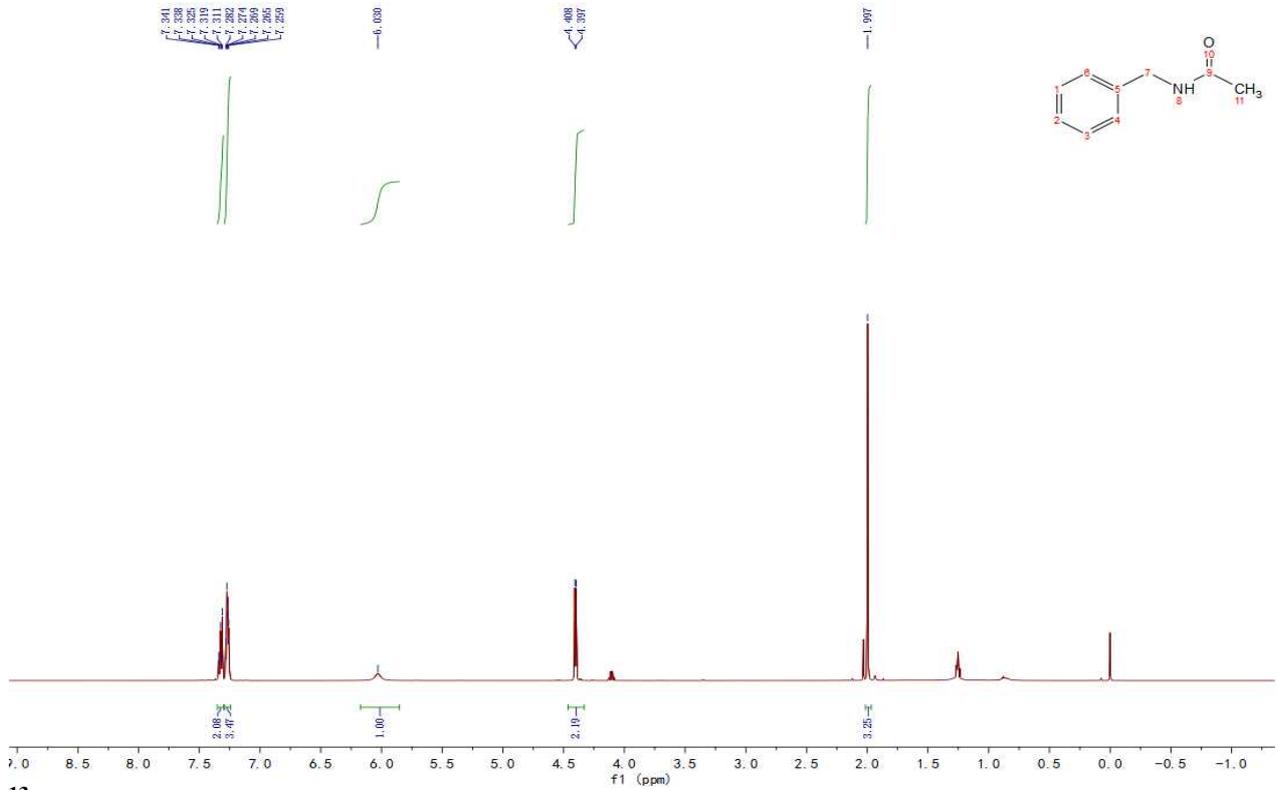


¹³C NMR

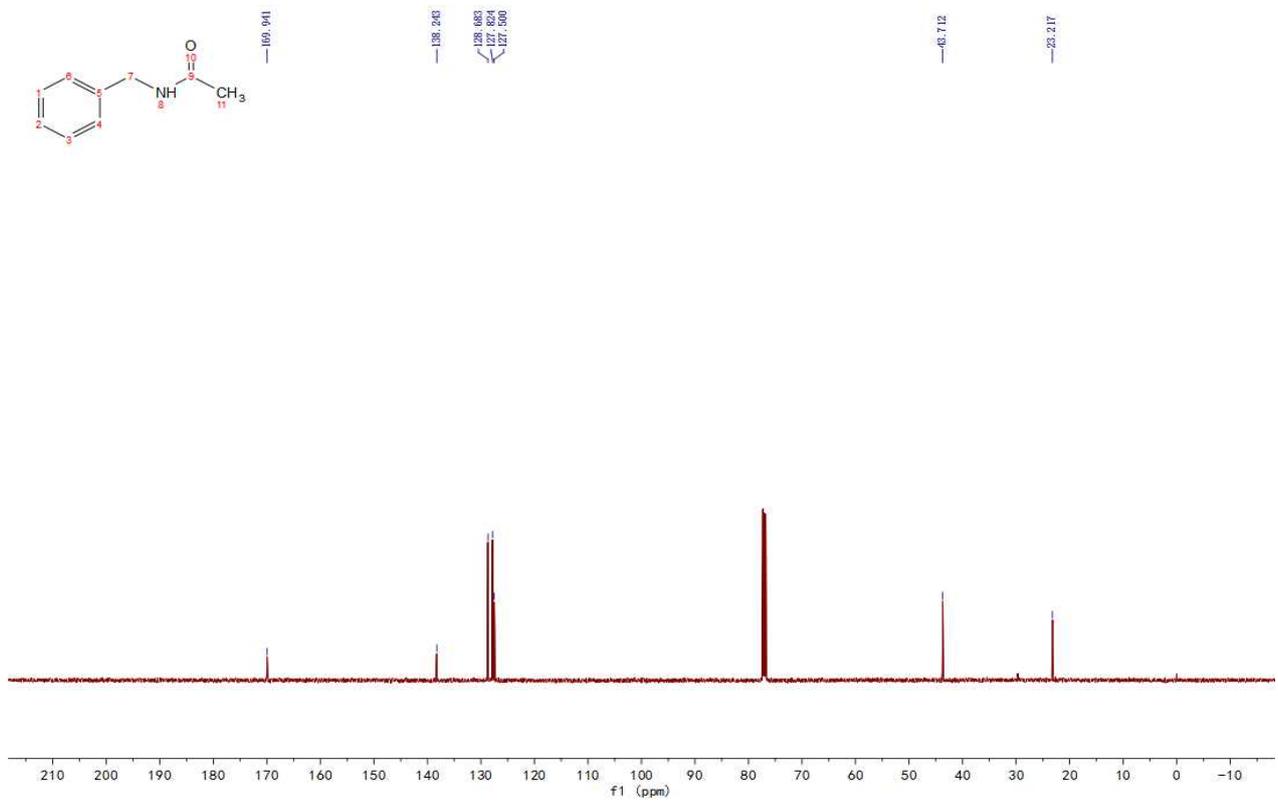


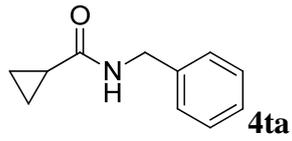


¹H NMR

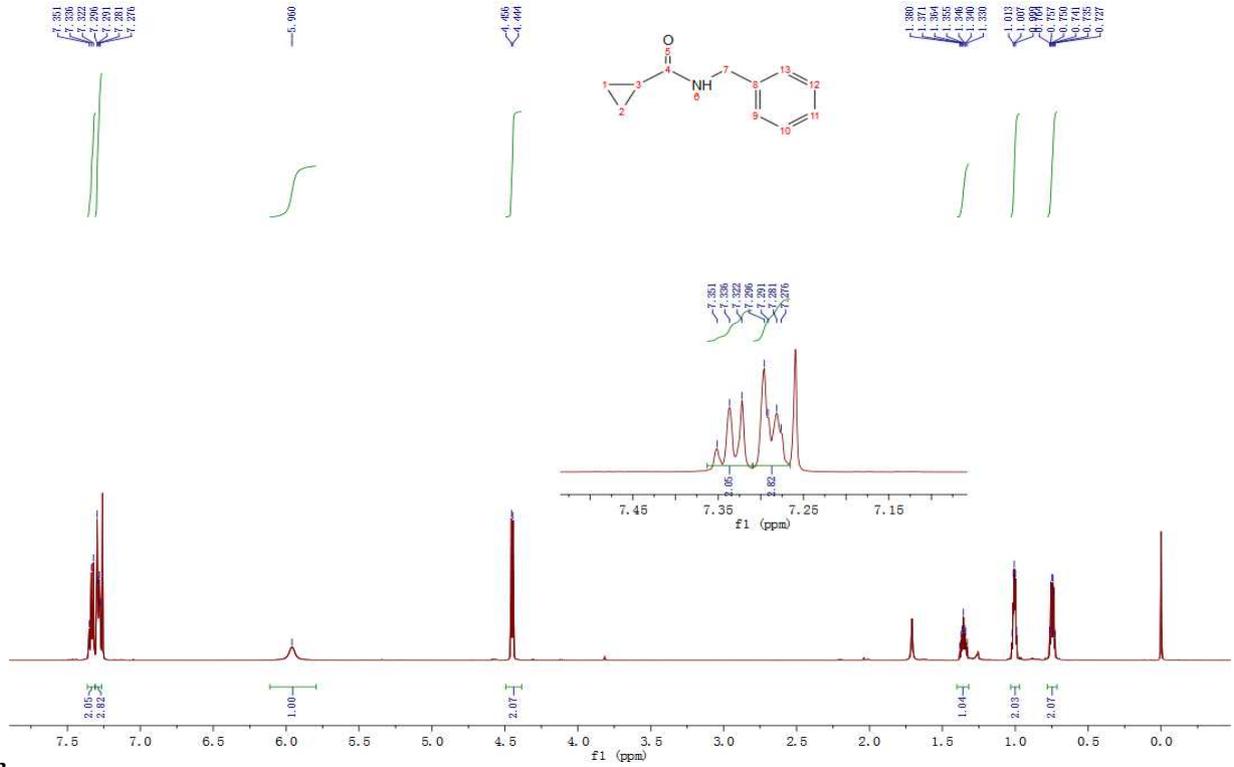


¹³C NMR

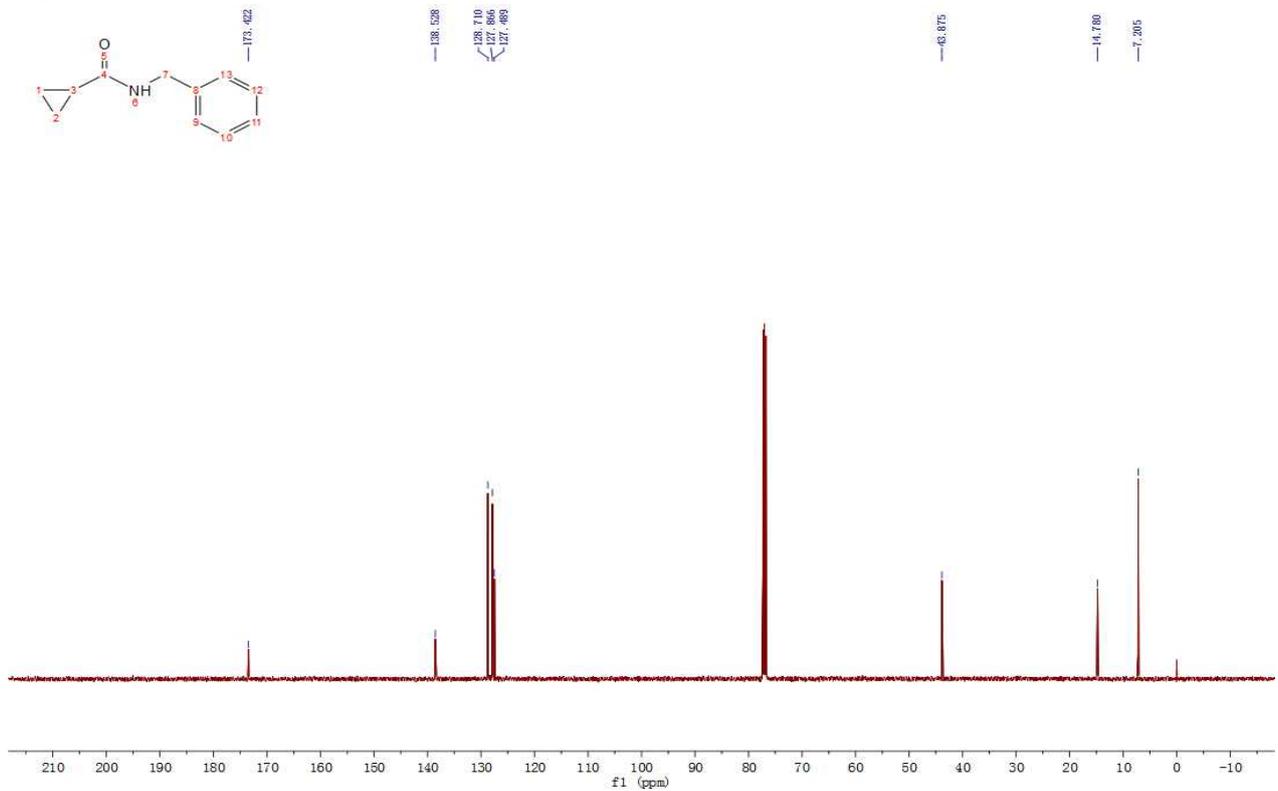


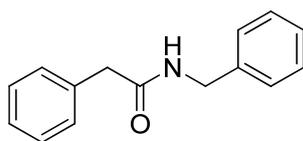


¹H NMR



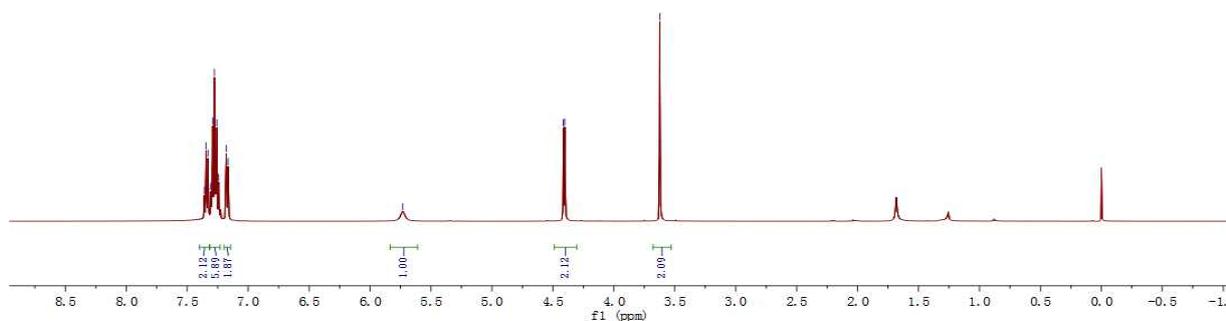
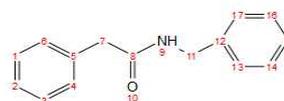
¹³C NMR



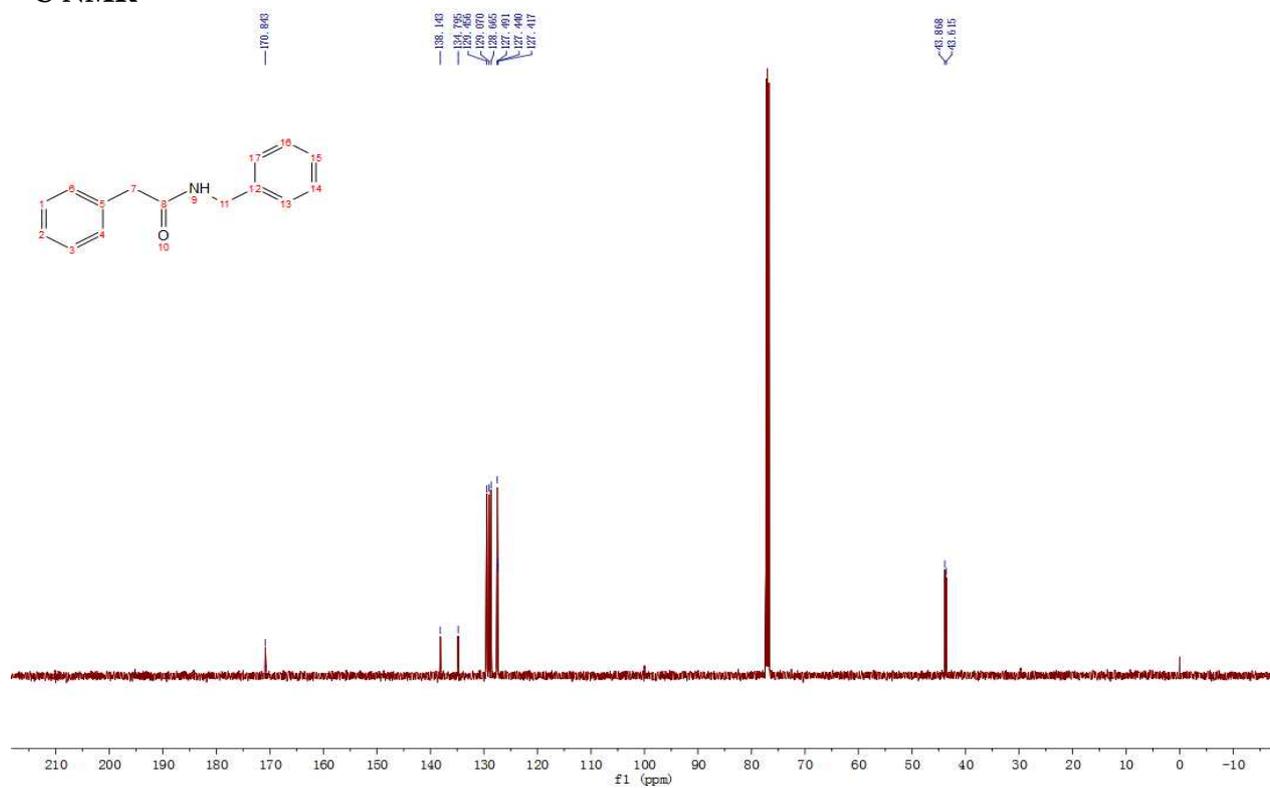
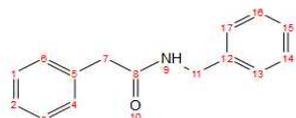


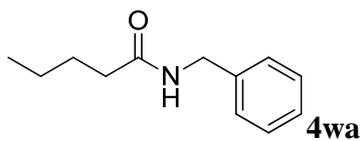
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¹H NMR

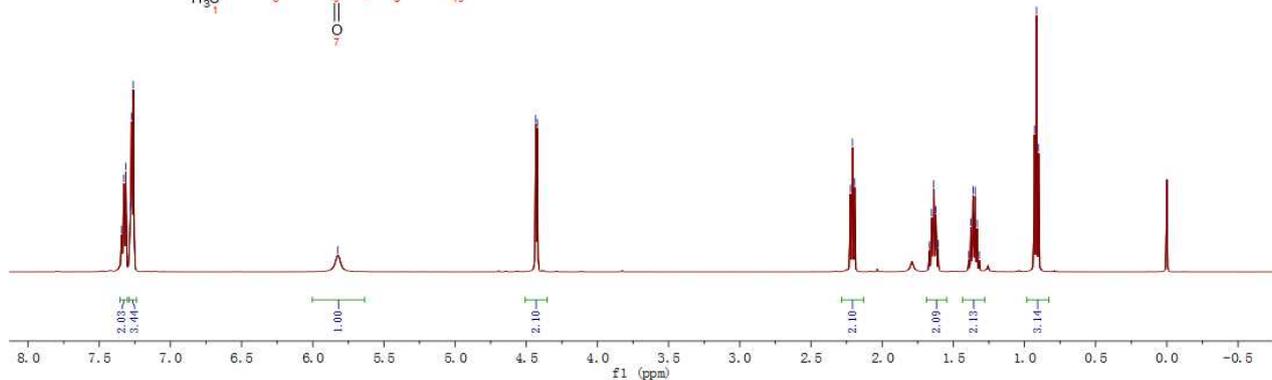
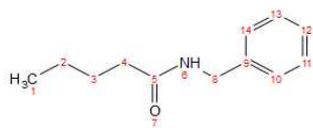
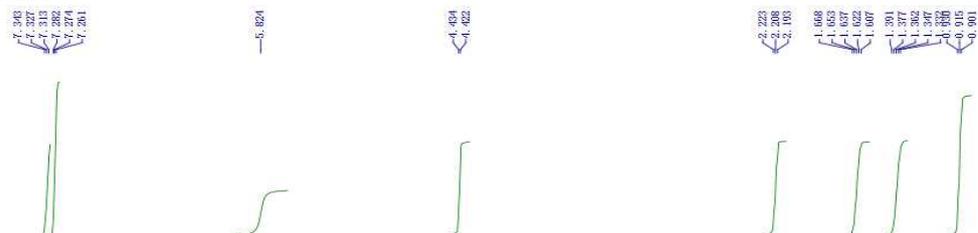


¹³C NMR

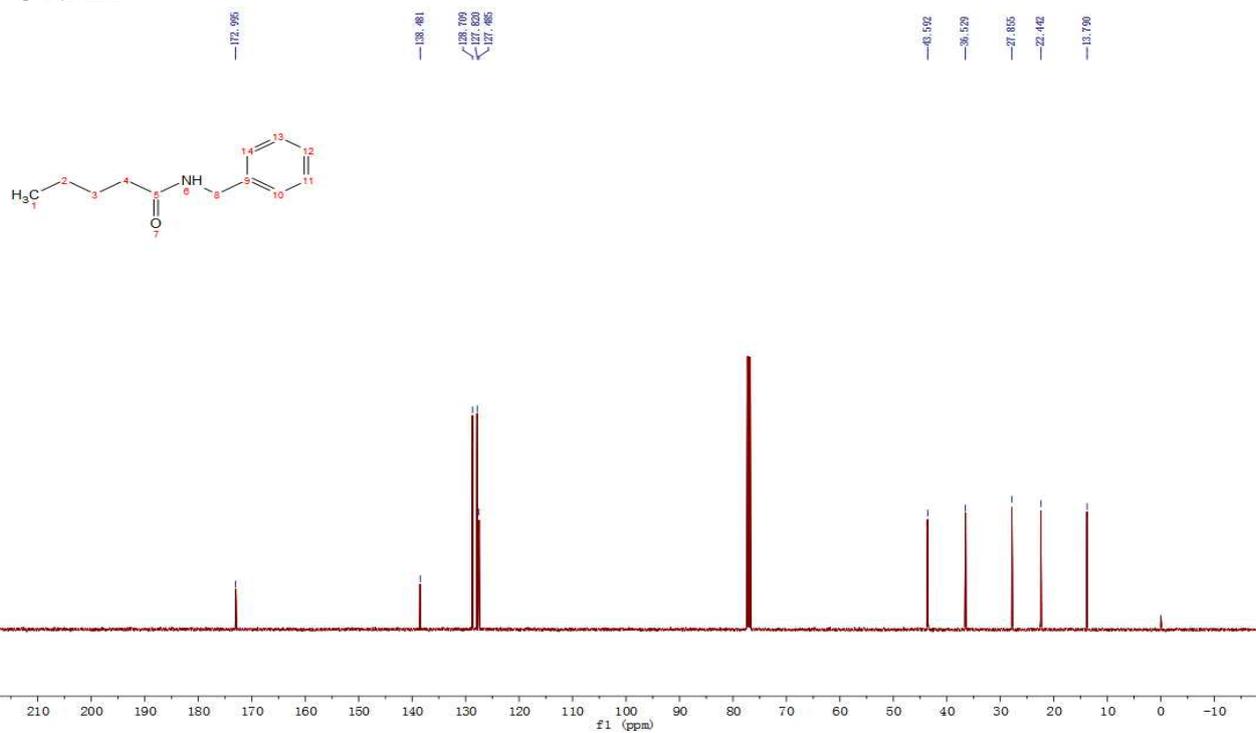


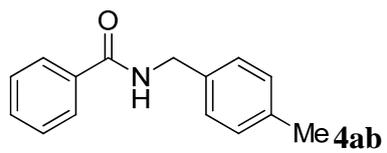


¹H NMR

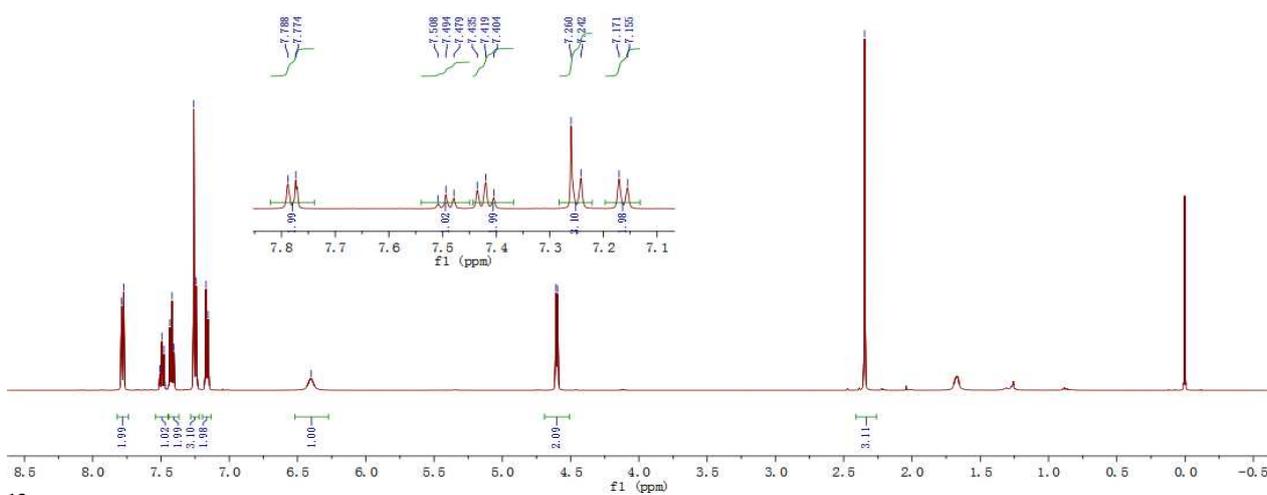
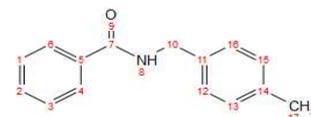
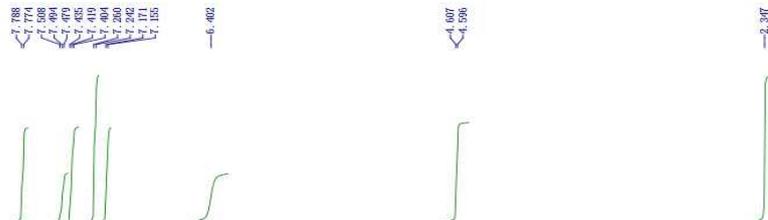


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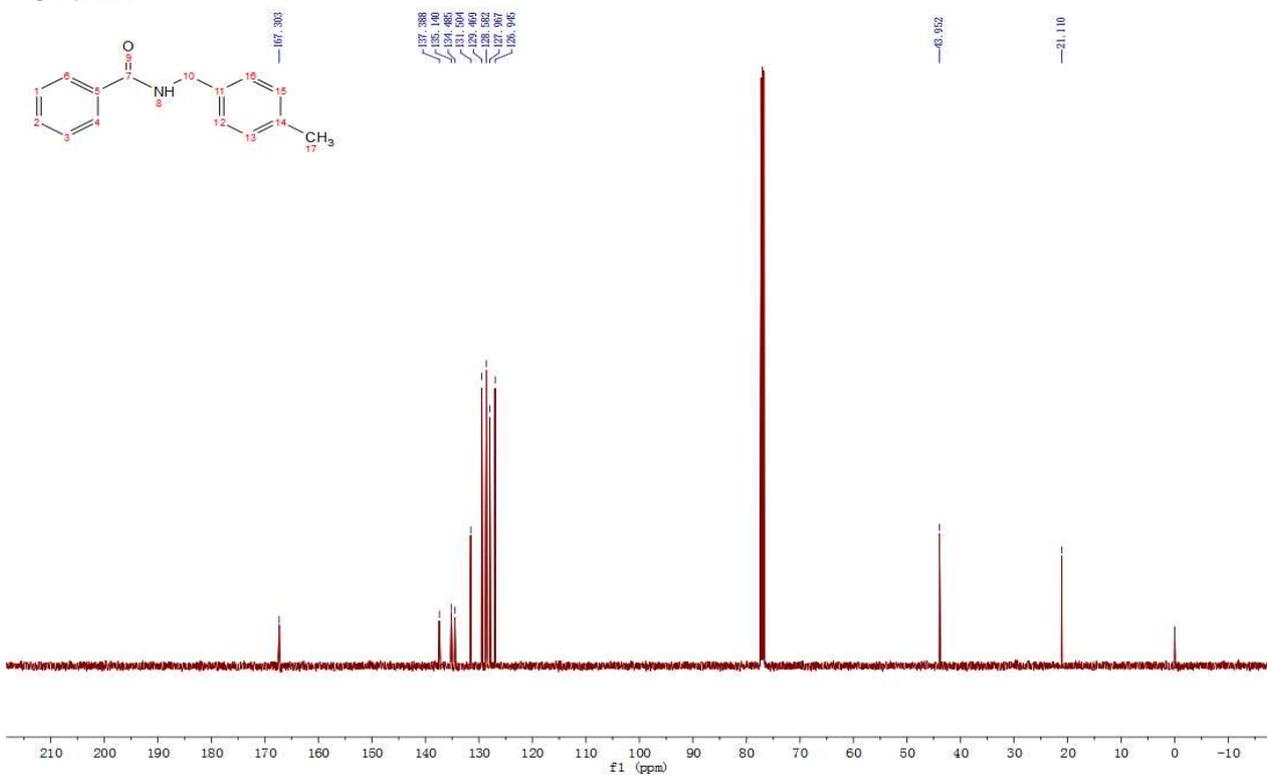
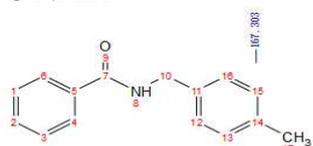


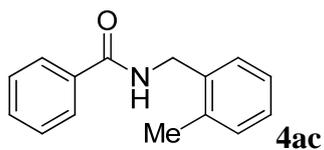


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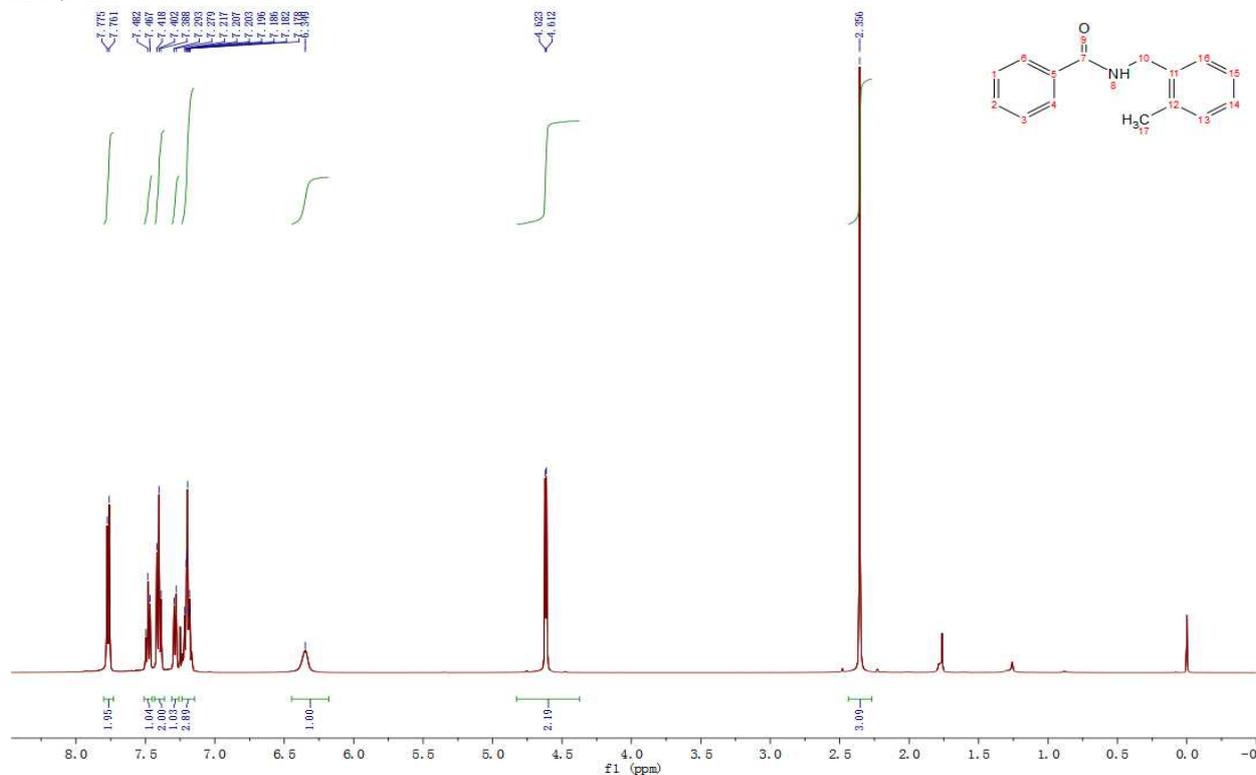


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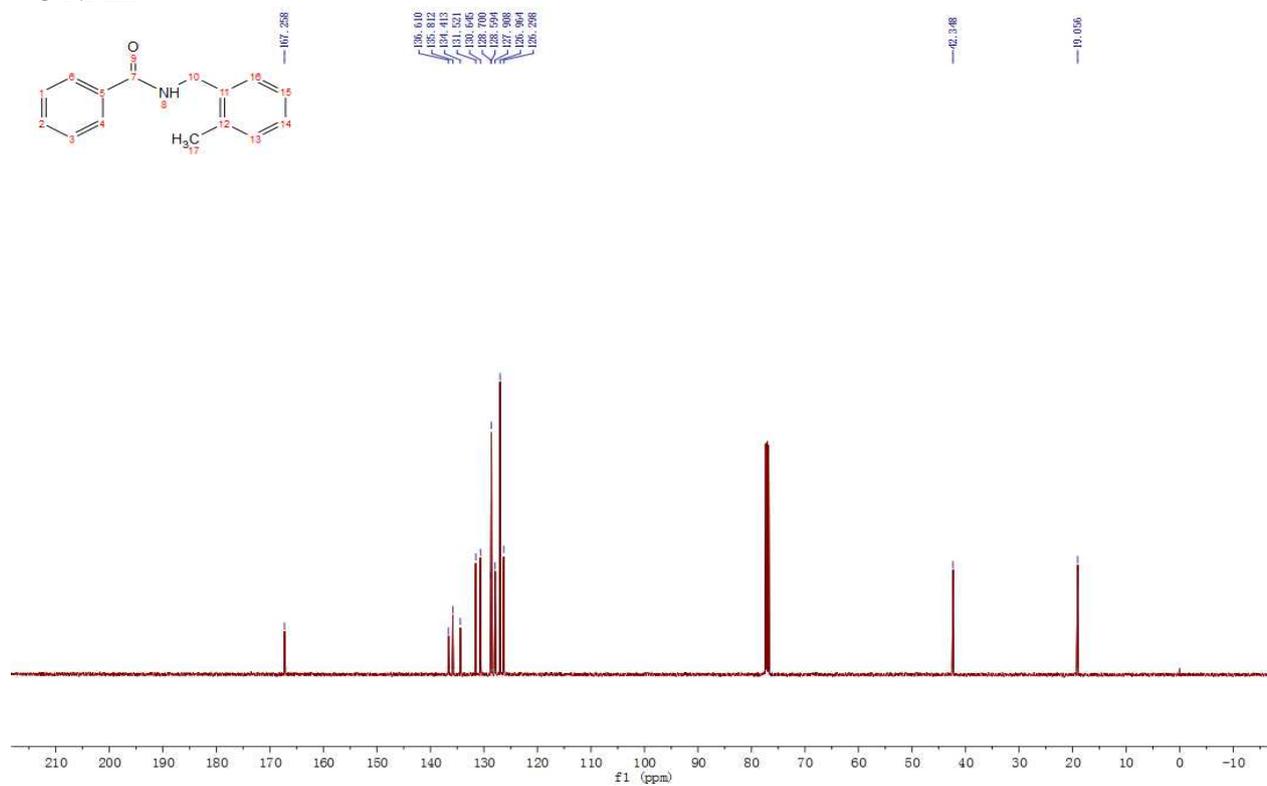


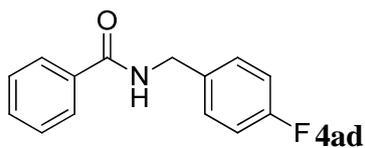


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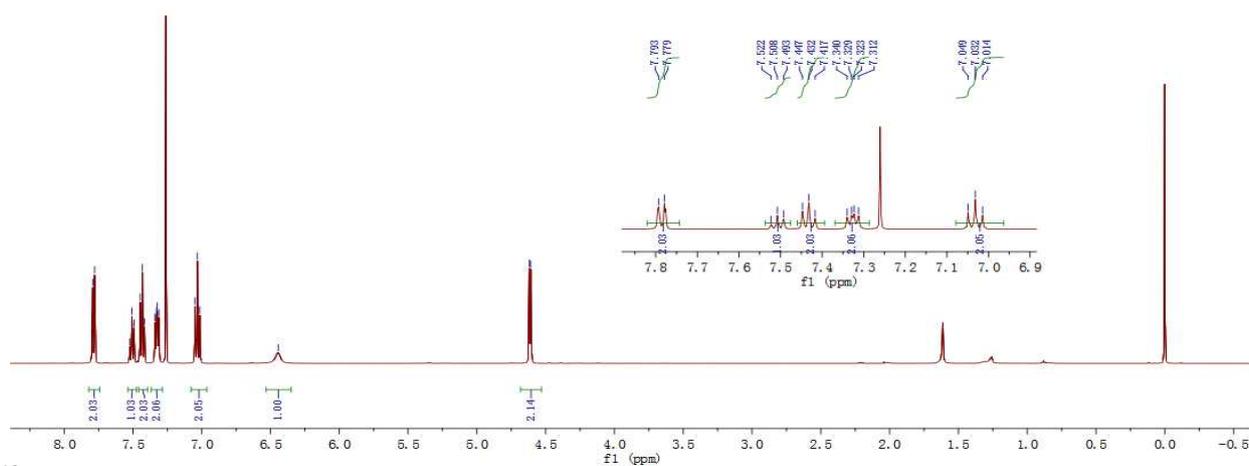
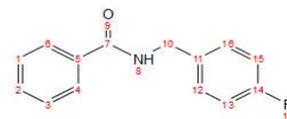
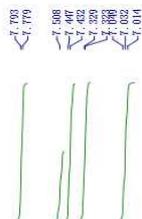


¹³C NMR

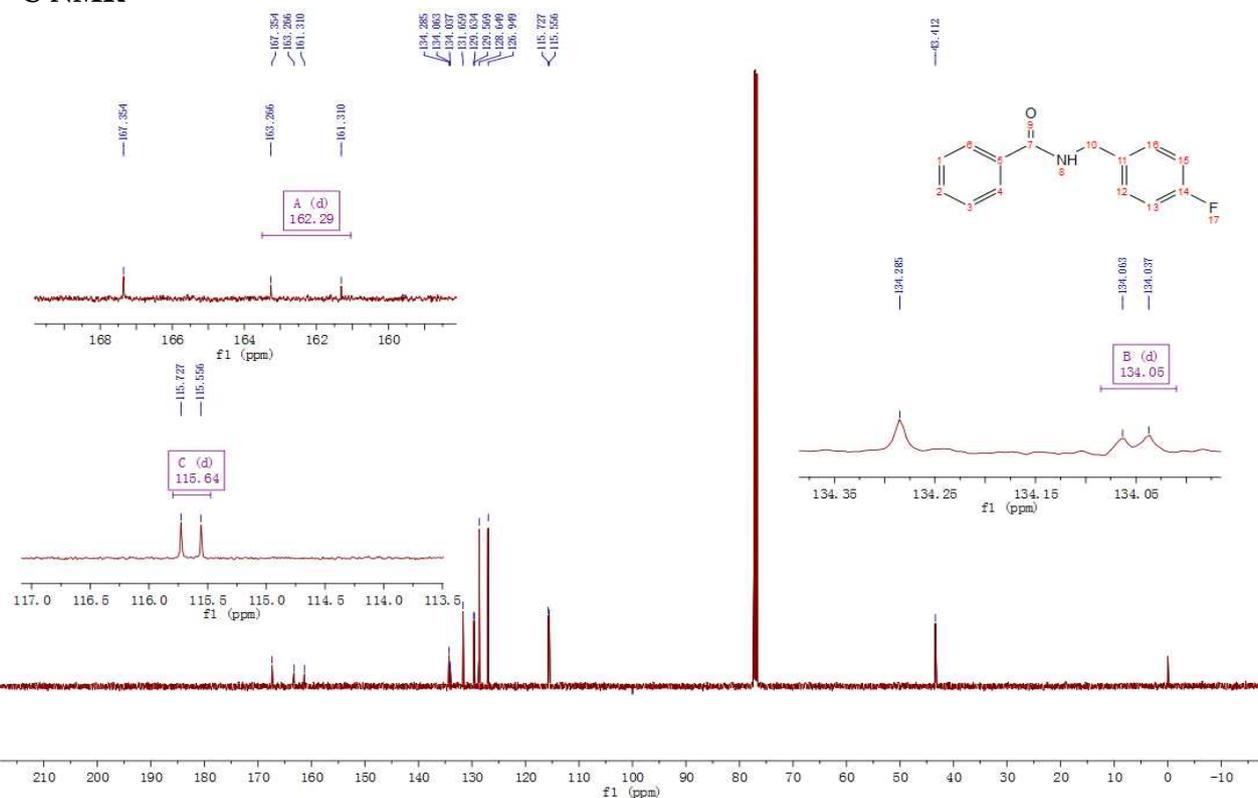


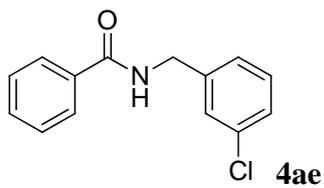


¹H NMR

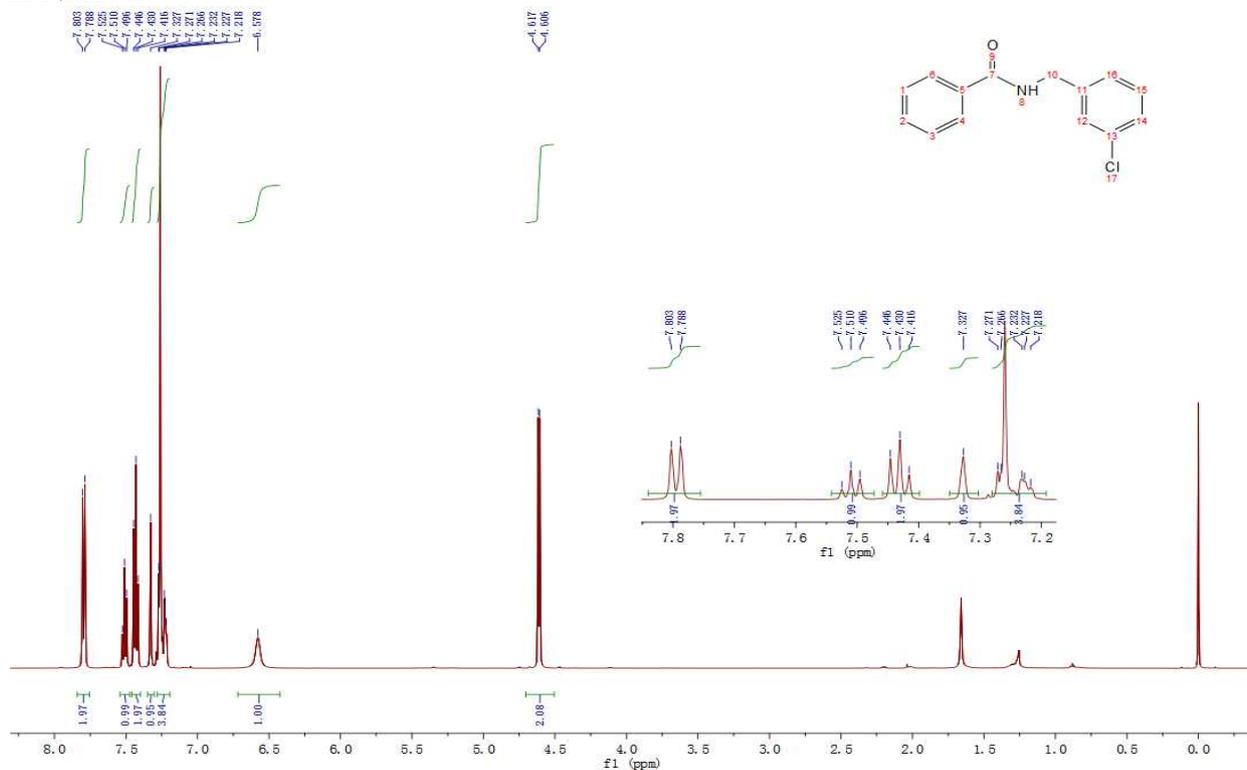


¹³C NMR

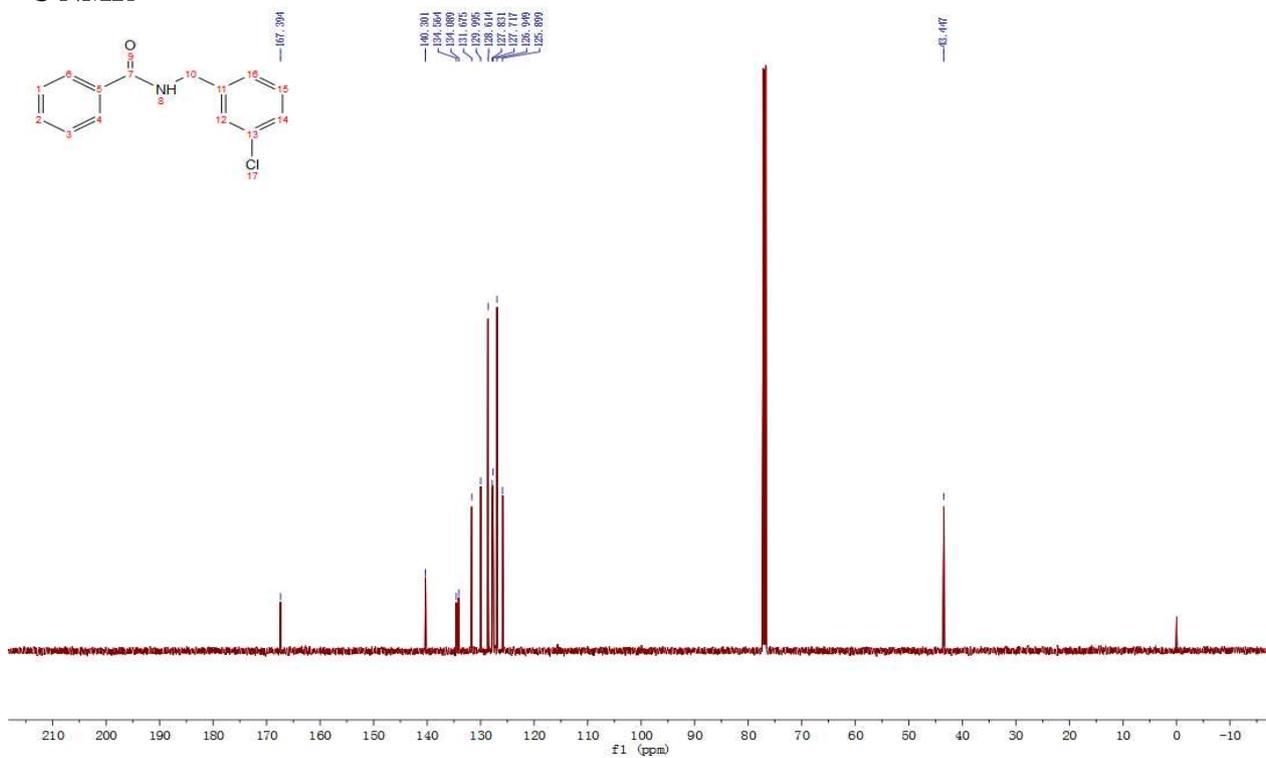


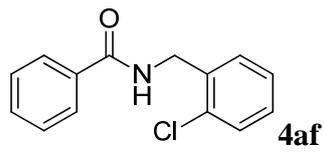


¹H NMR

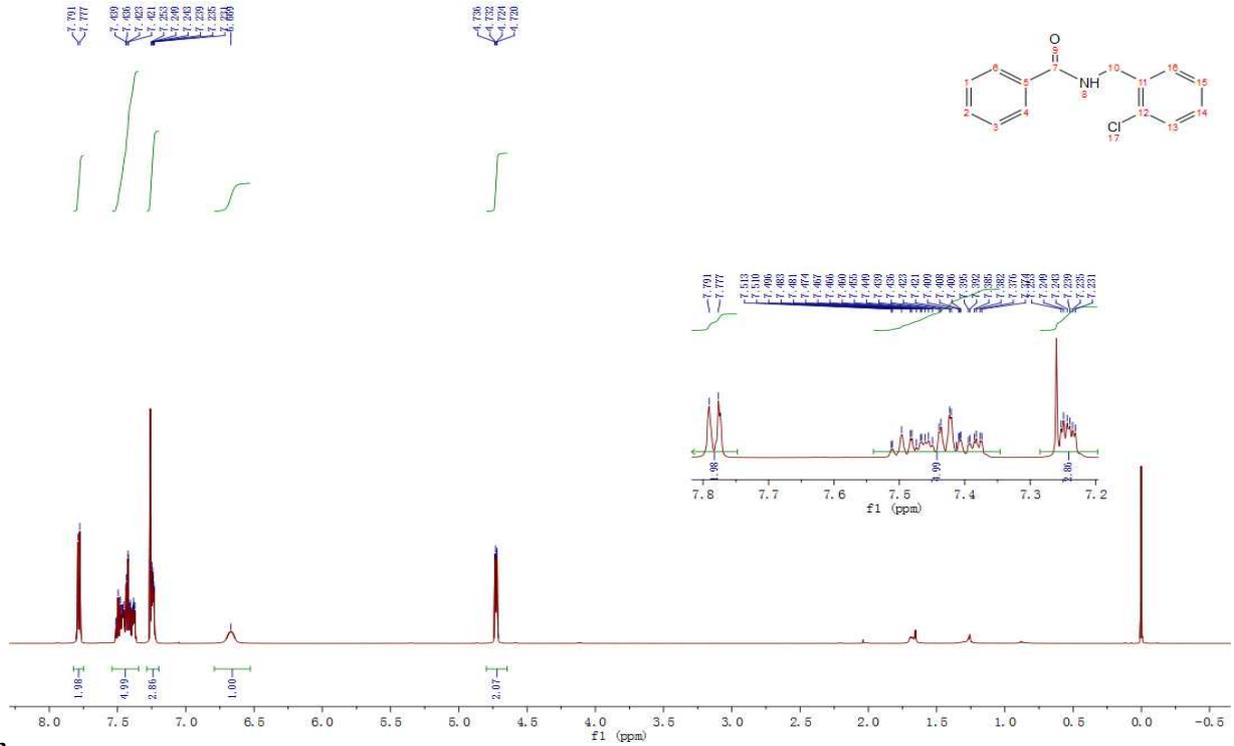


¹³C NMR

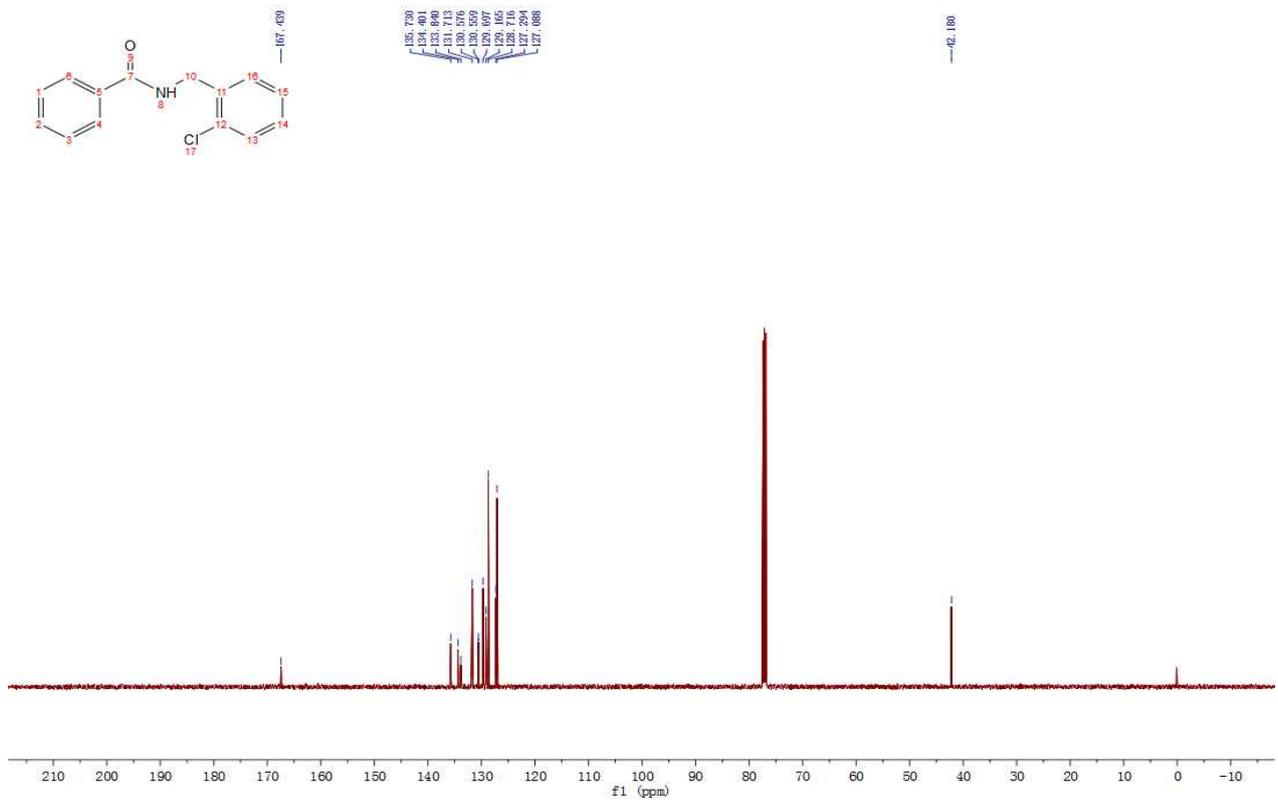


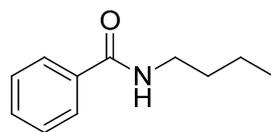


¹H NMR



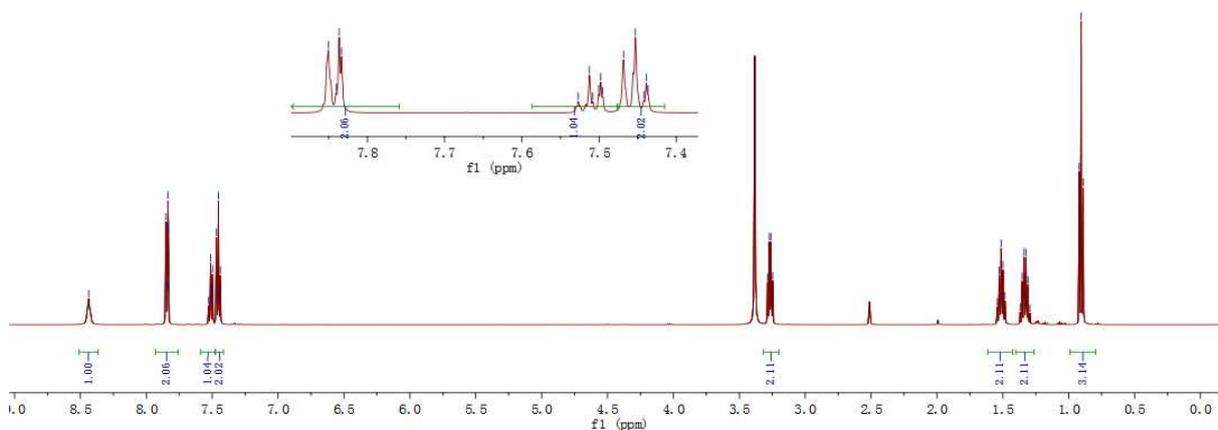
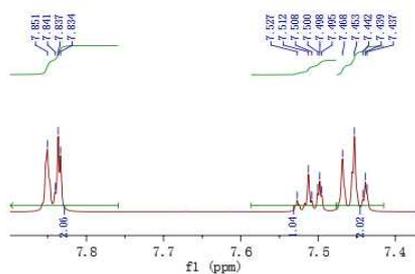
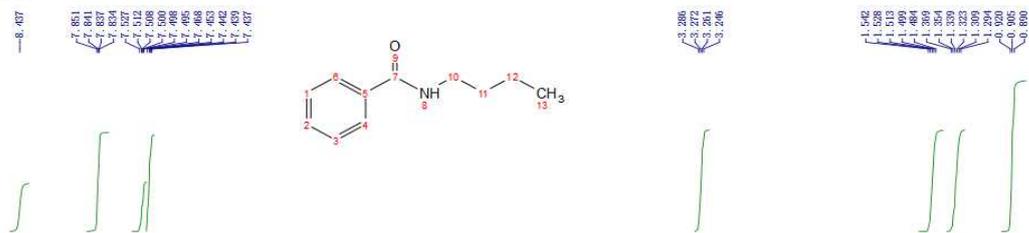
¹³C NMR



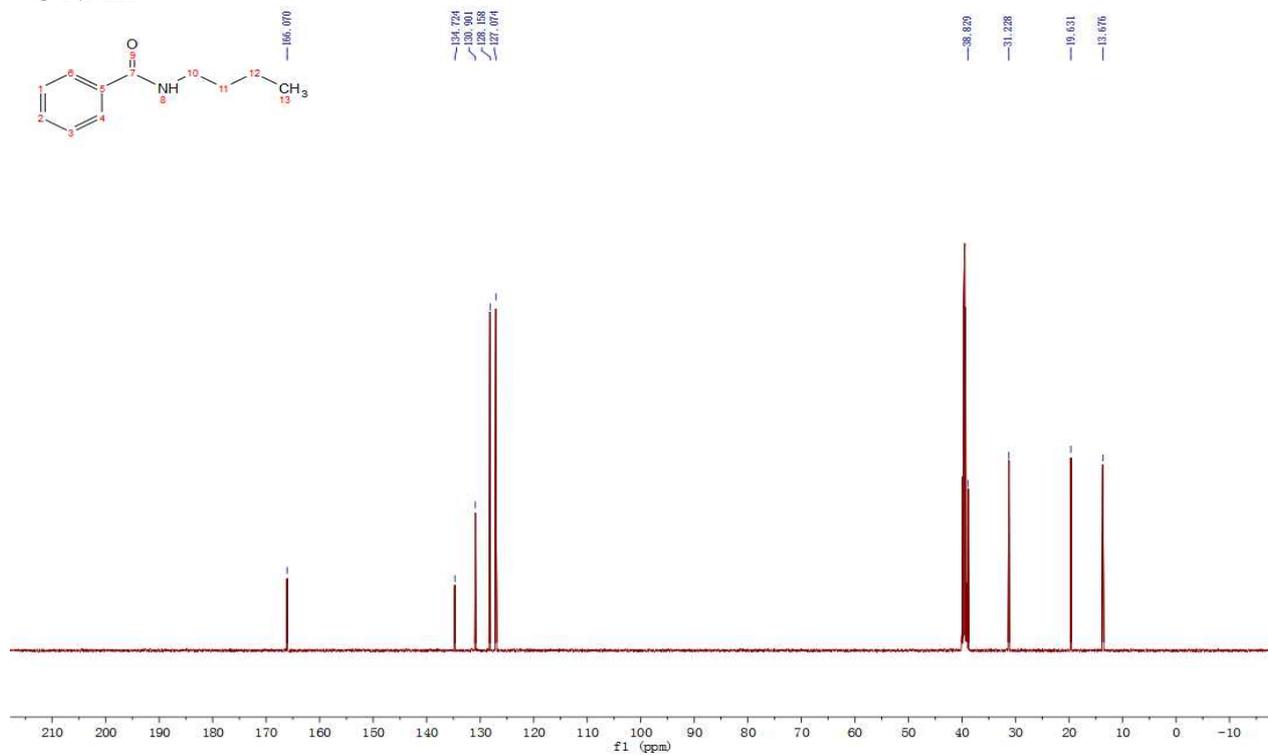


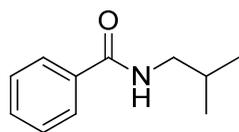
4ag

¹H NMR



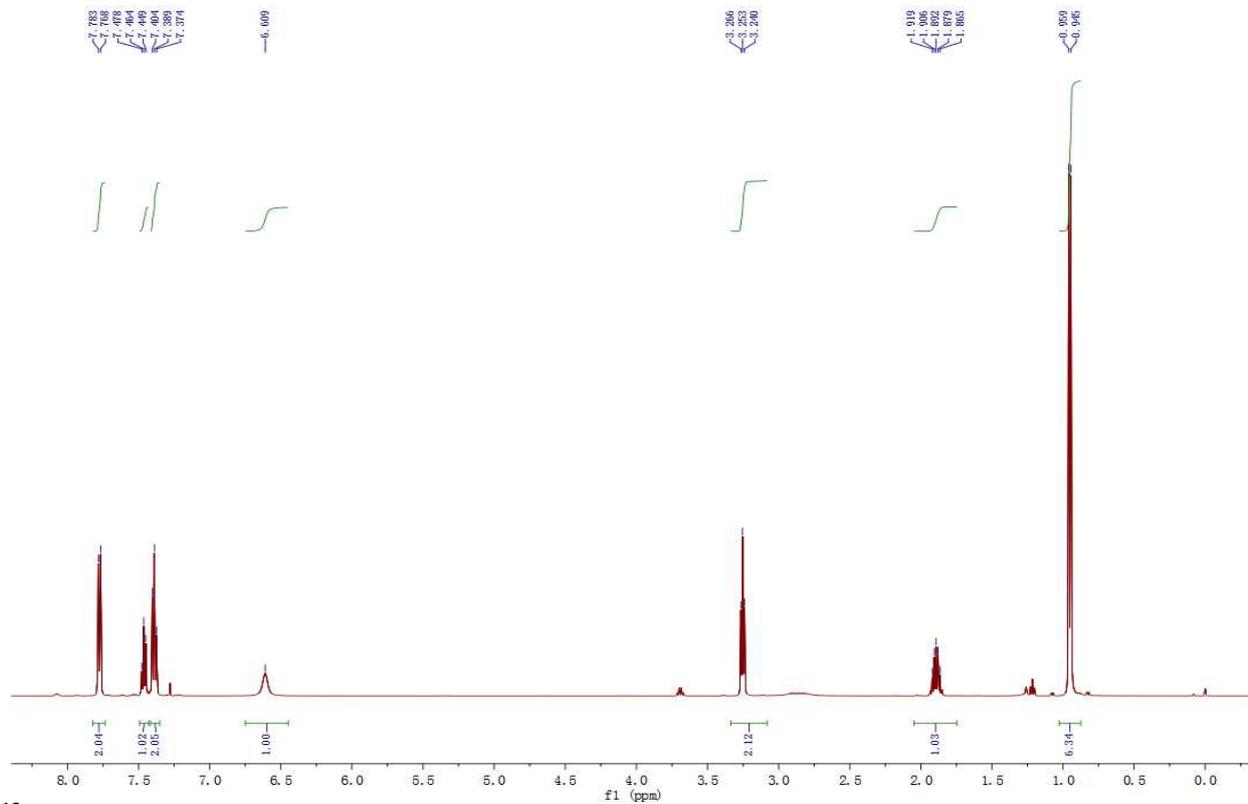
¹³C NMR



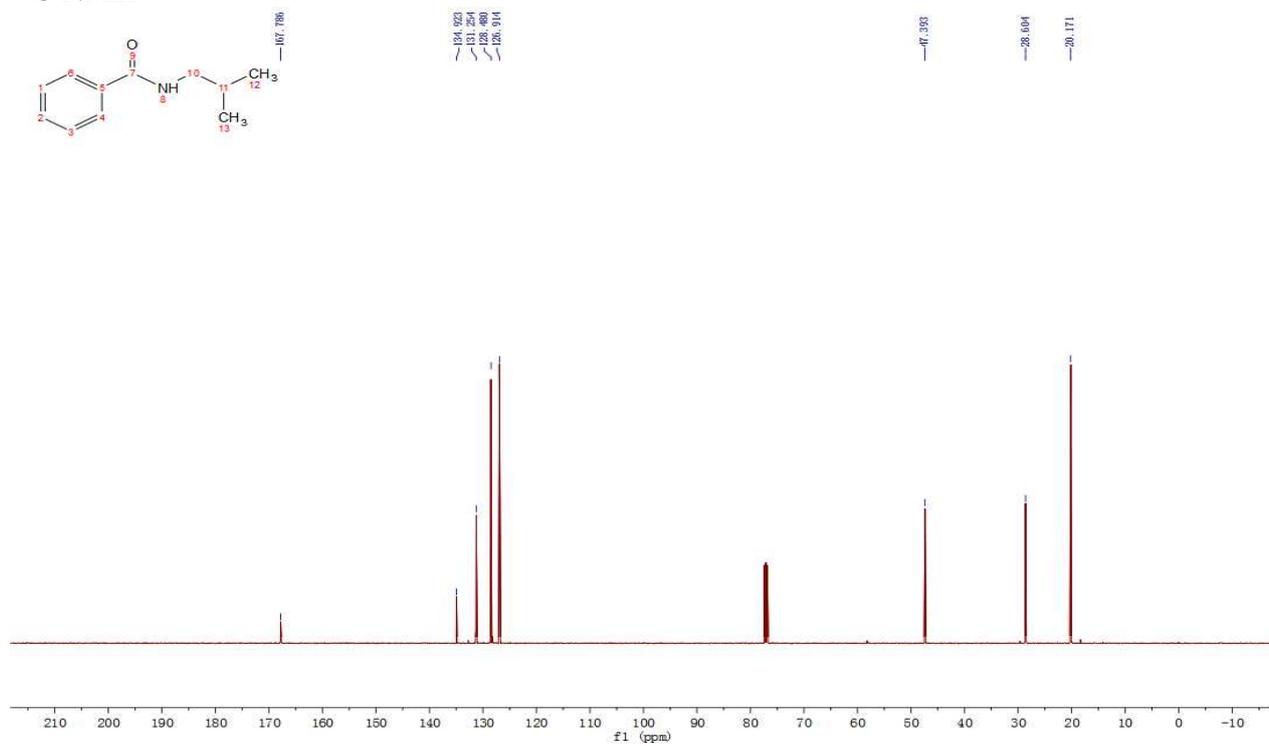


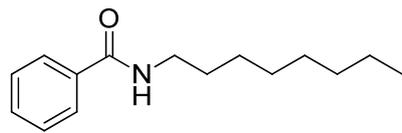
4ah

¹H NMR



¹³C NMR





4ai

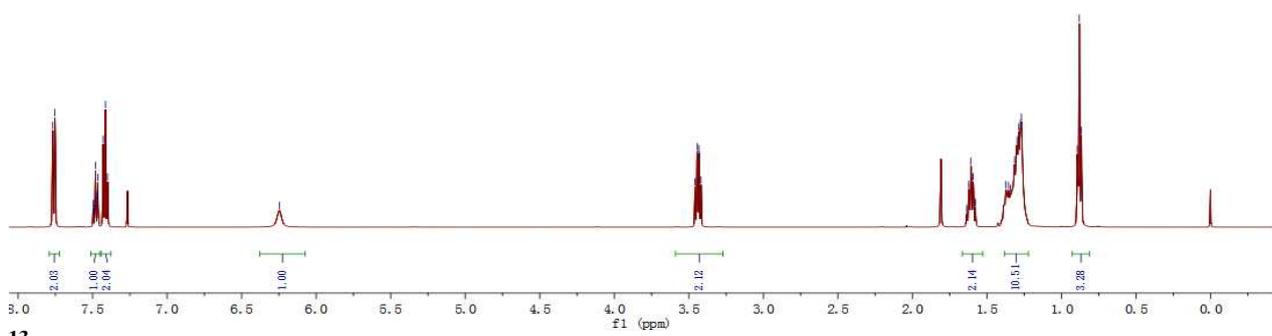
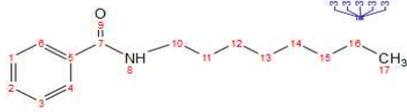
¹H NMR

7.767
7.753
7.498
7.483
7.463
7.481
7.477
7.466
7.464
7.423
7.414
7.399

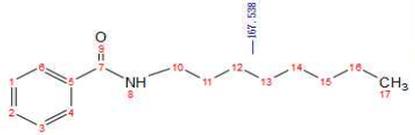
-6.397

3.468
3.444
3.422
3.400
3.418

1.635
1.614
1.604
1.592
1.577
1.314
1.298
1.286
1.275
1.263
1.251
1.239
1.227
1.215
1.203
1.191
1.179
1.167
1.155
1.143
1.131
1.119
1.107
1.095
1.083
1.071
1.059
1.047
1.035
1.023
1.011
0.999
0.987
0.975
0.963
0.951
0.939
0.927
0.915
0.903
0.891
0.879
0.867
0.855
0.843
0.831
0.819
0.807
0.795
0.783
0.771
0.759
0.747
0.735
0.723
0.711
0.699
0.687
0.675
0.663
0.651
0.639
0.627
0.615
0.603
0.591
0.579
0.567
0.555
0.543
0.531
0.519
0.507
0.495
0.483
0.471
0.459
0.447
0.435
0.423
0.411
0.399
0.387
0.375
0.363
0.351
0.339
0.327
0.315
0.303
0.291
0.279
0.267
0.255
0.243
0.231
0.219
0.207
0.195
0.183
0.171
0.159
0.147
0.135
0.123
0.111
0.099
0.087
0.075
0.063
0.051
0.039
0.027
0.015
0.003

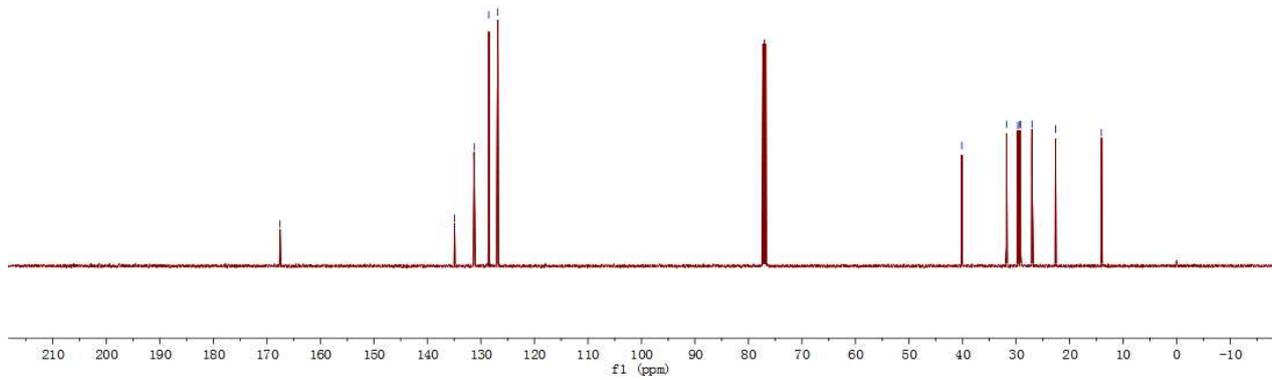


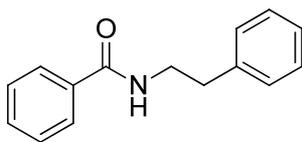
¹³C NMR



134.920
133.568
131.575
128.811

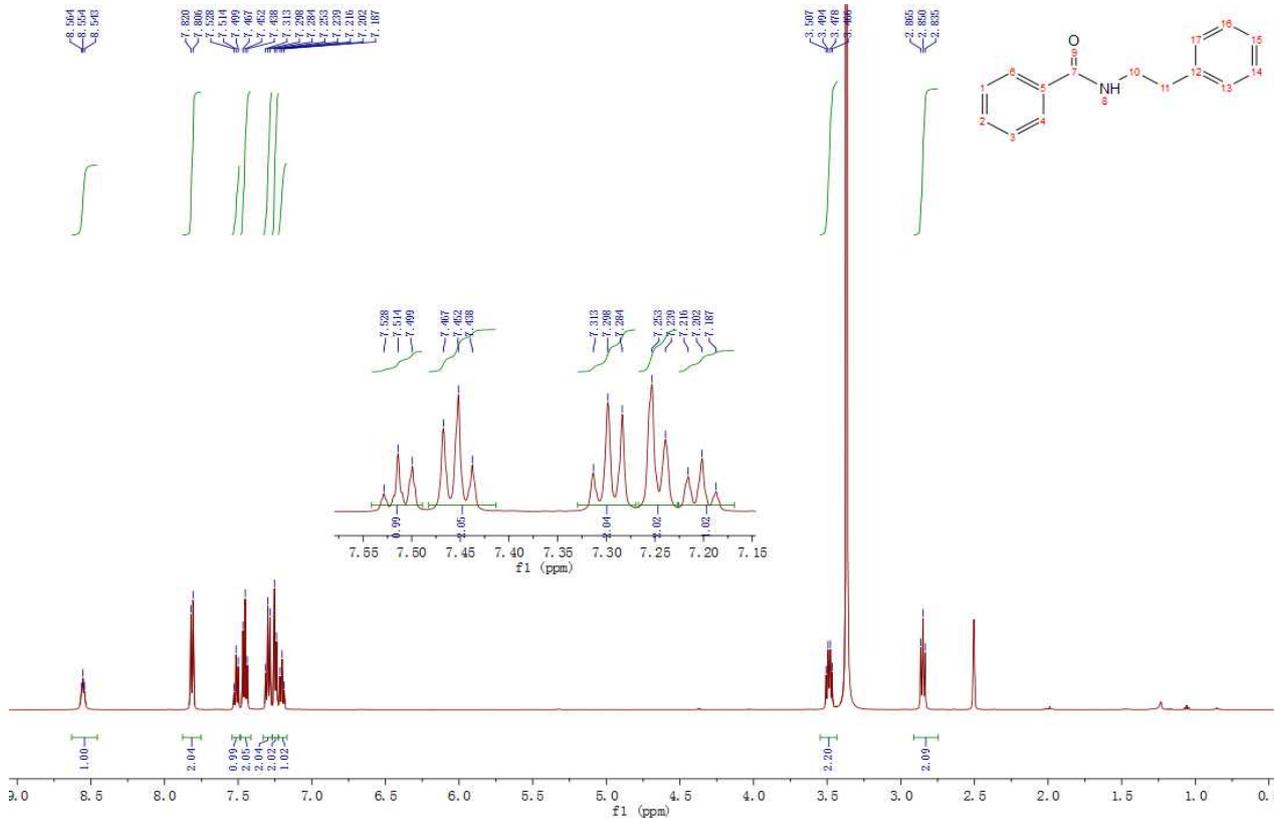
-0.135
-31.794
-29.897
-29.288
-27.019
-22.632
-14.069



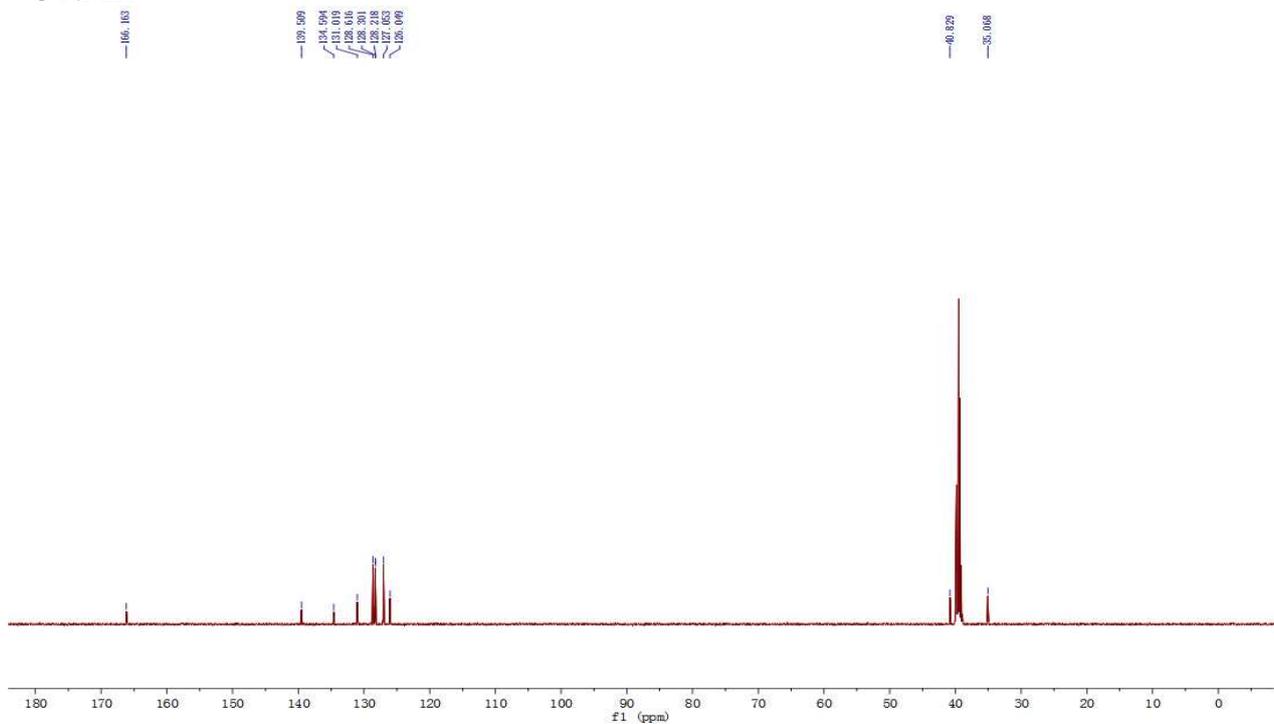


4aj

¹H NMR

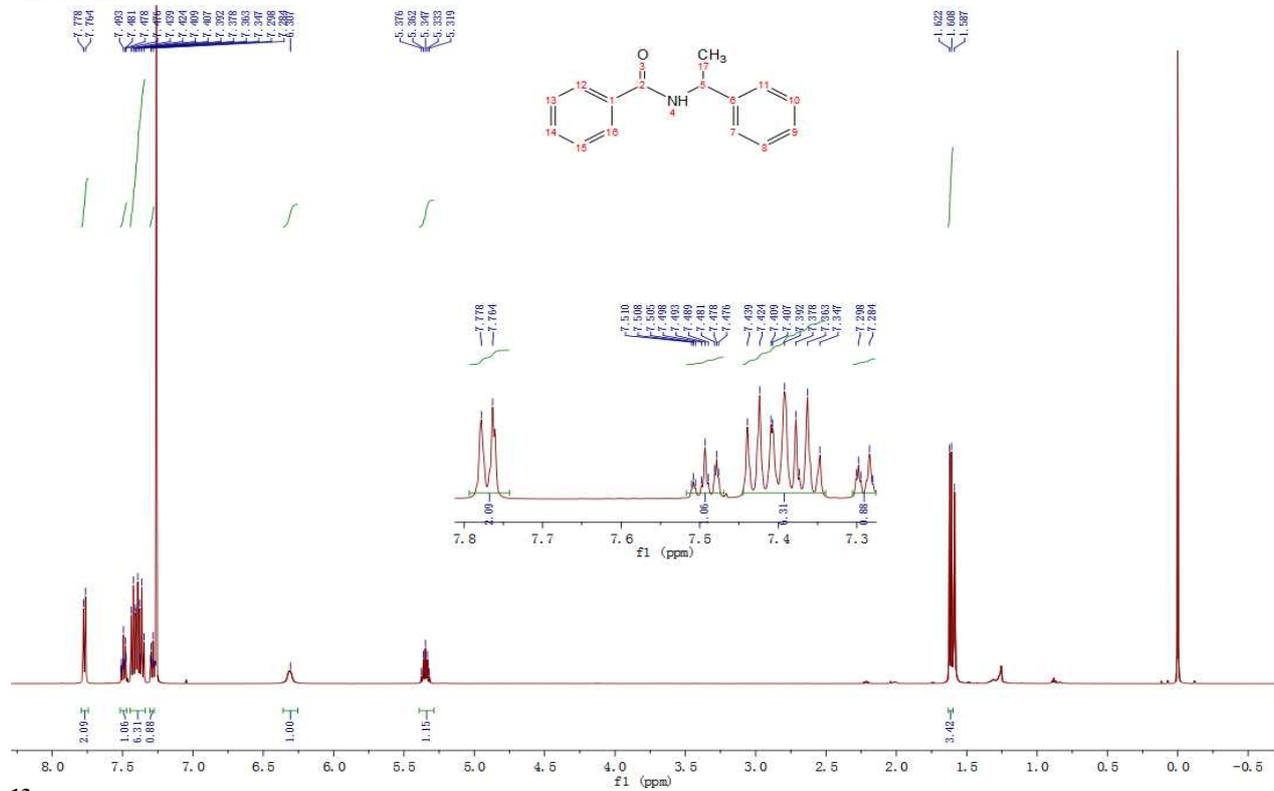


¹³C NMR

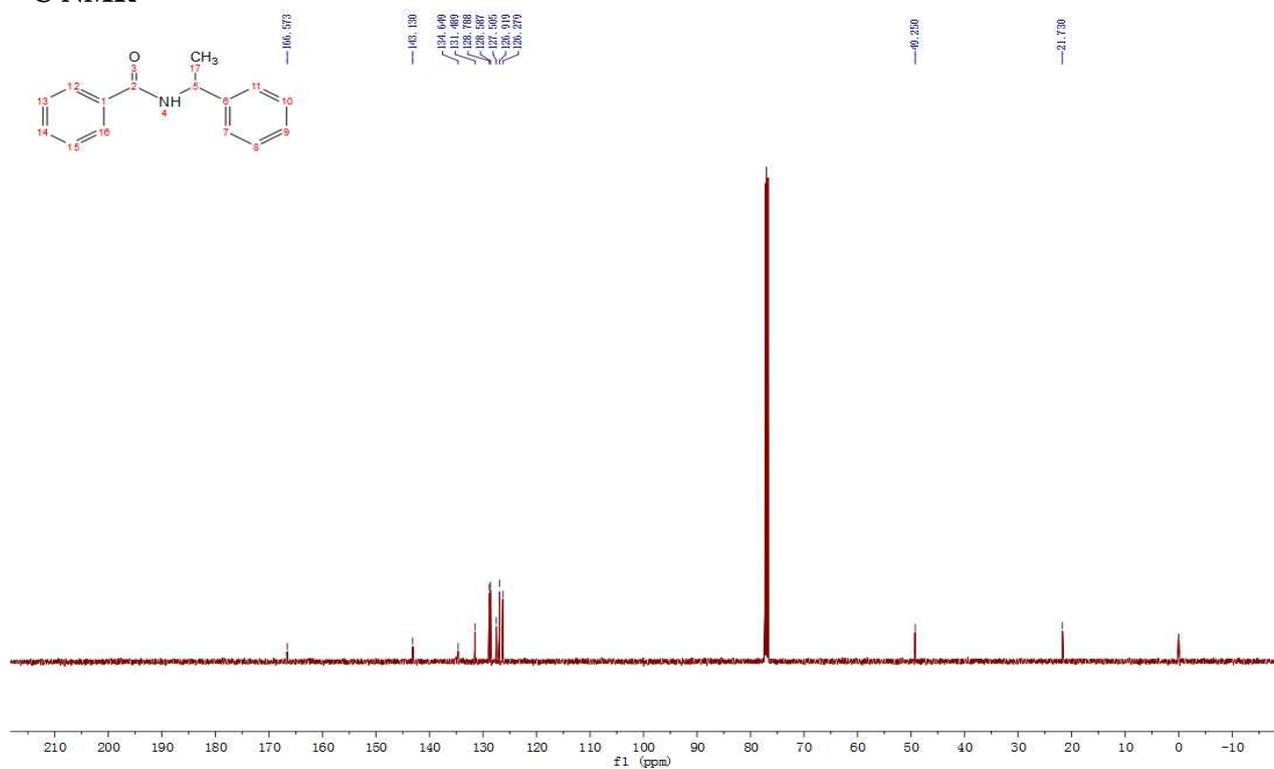


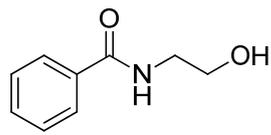


¹H NMR



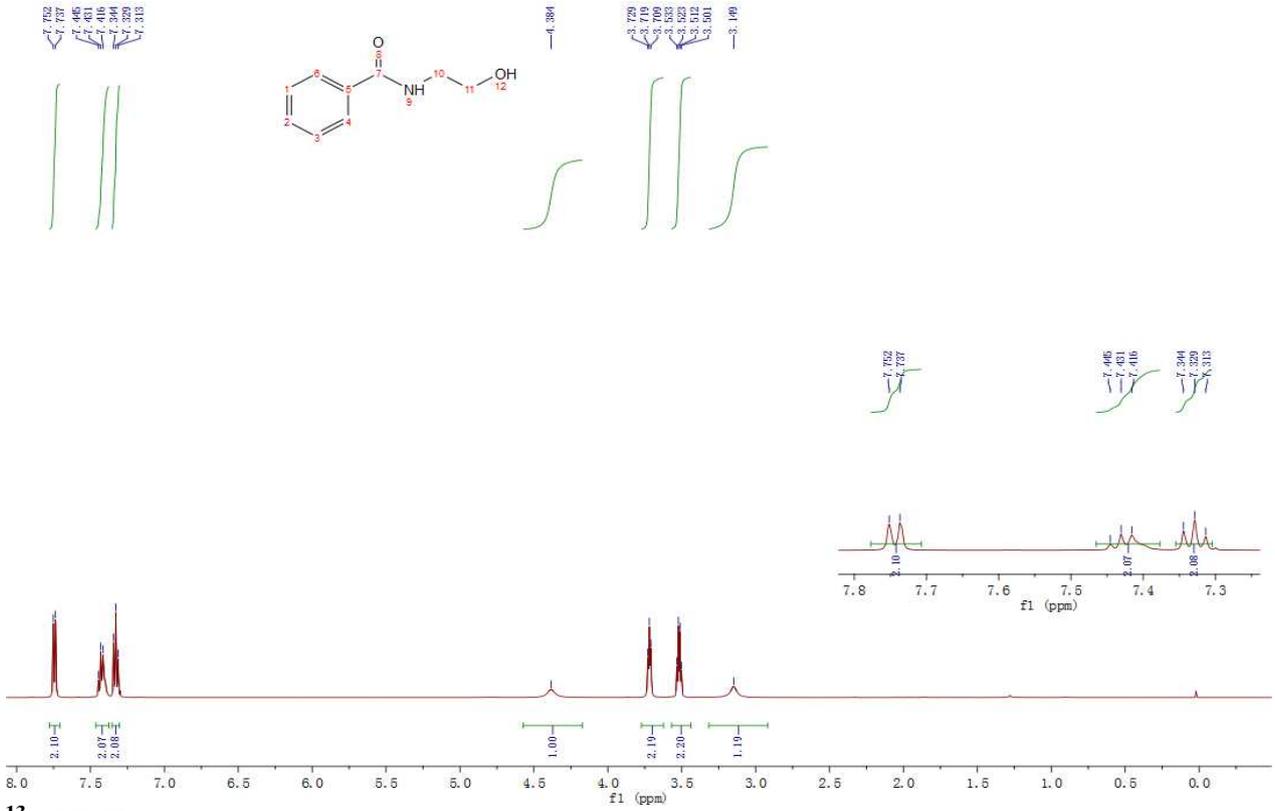
¹³C NMR



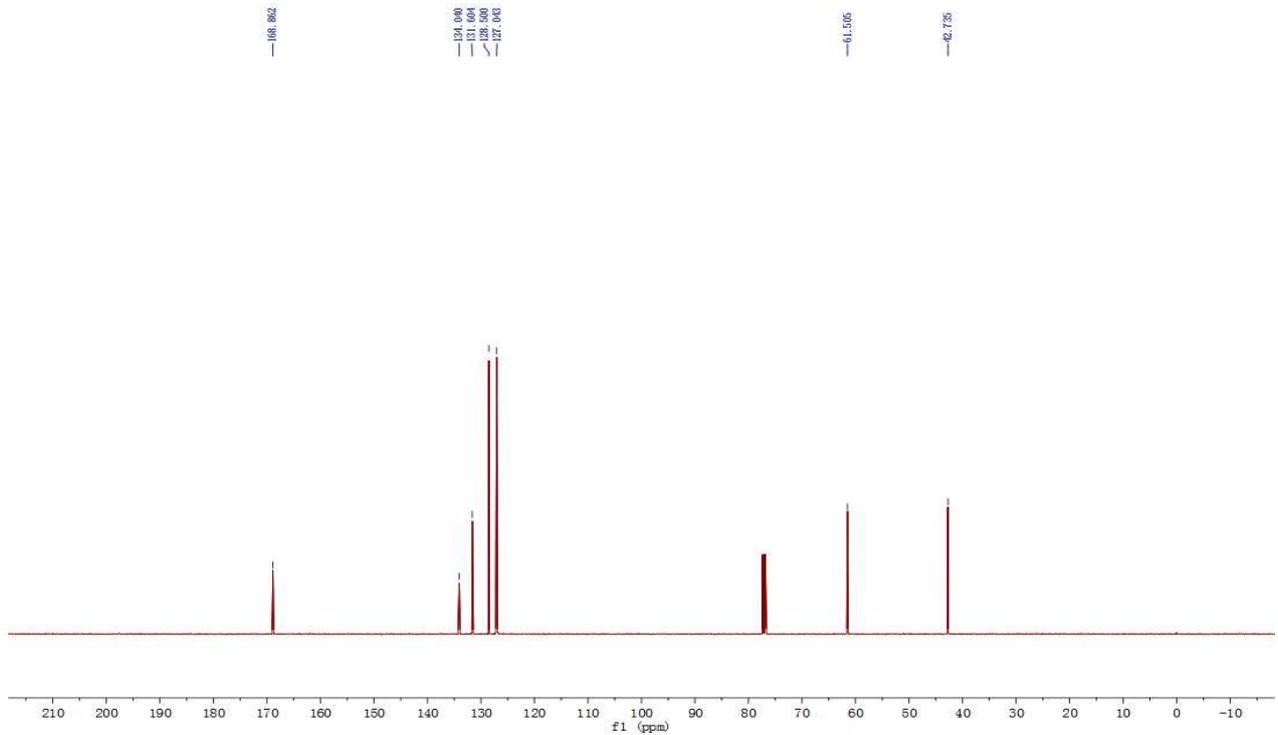


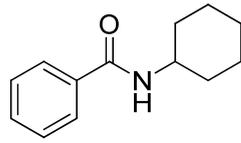
4al

¹H NMR



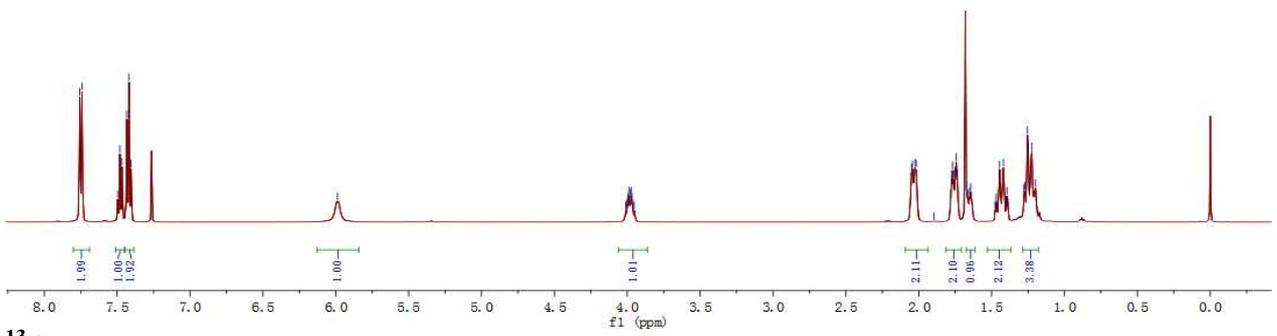
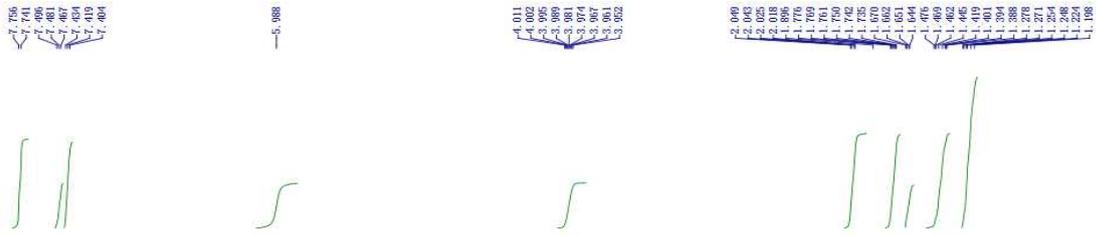
¹³C NMR



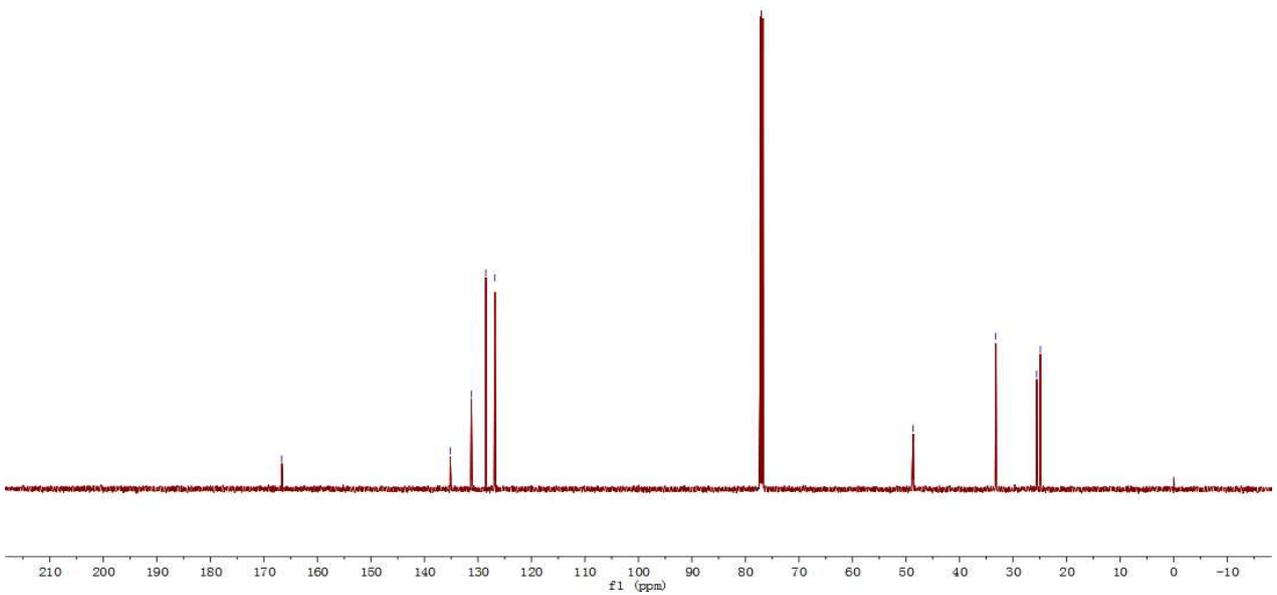
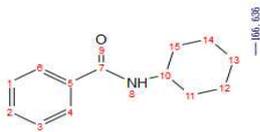


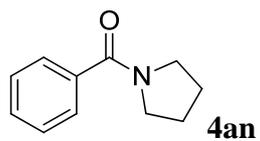
4am

¹H NMR

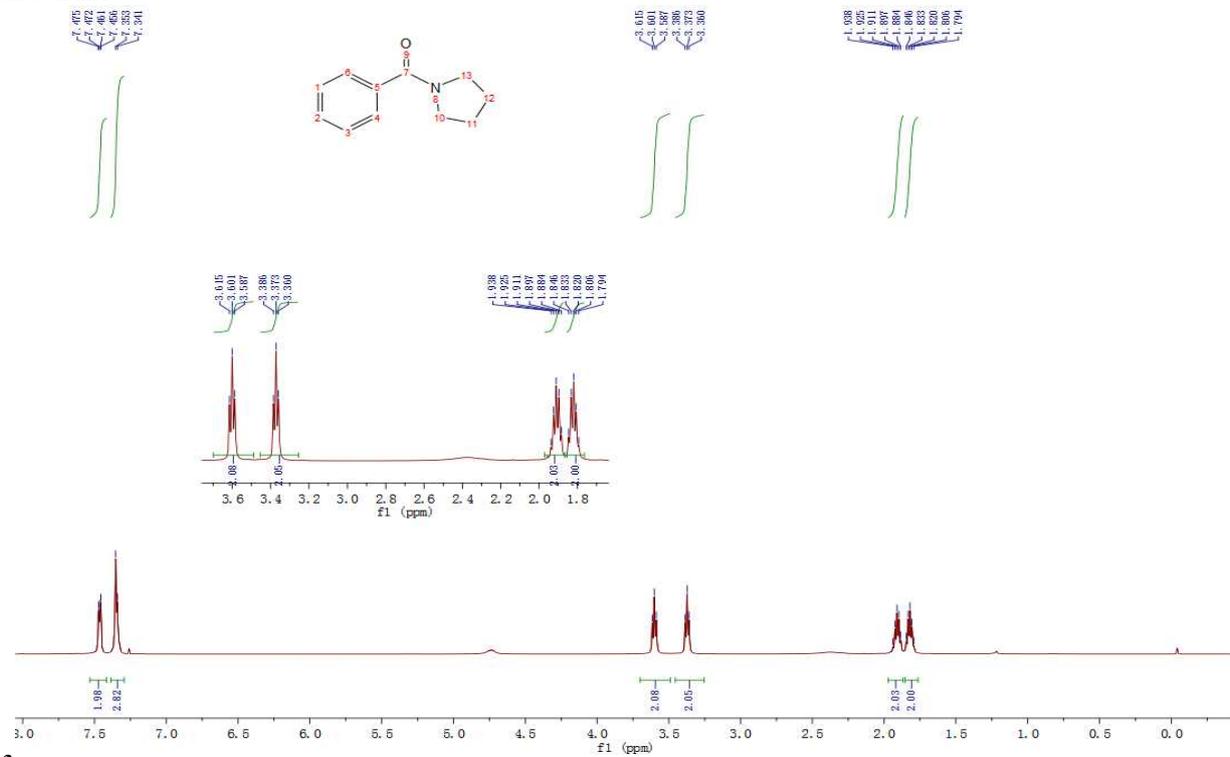


¹³C NMR

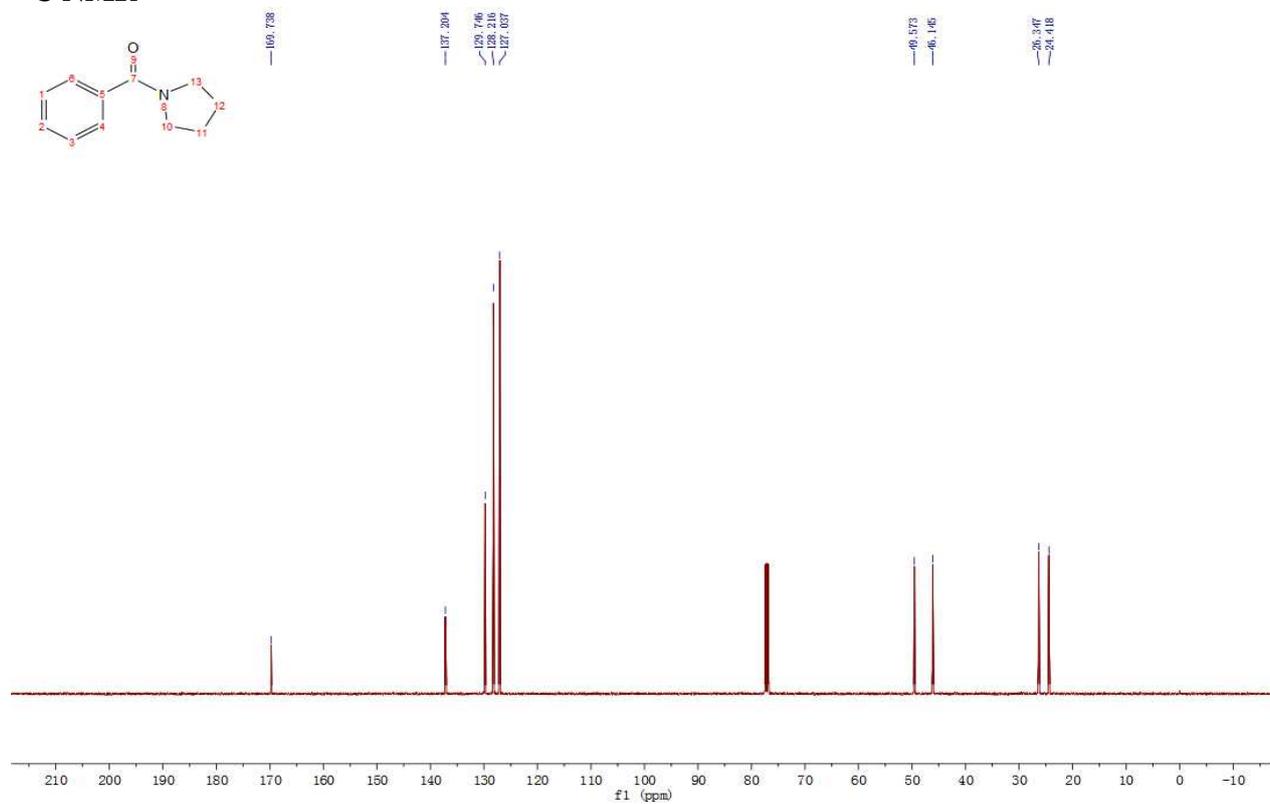




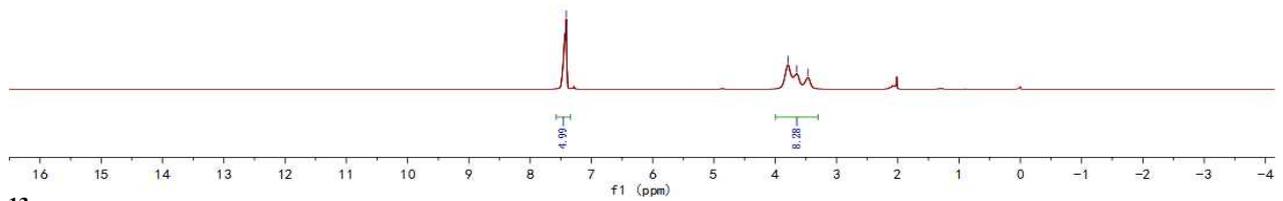
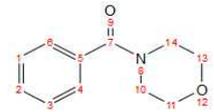
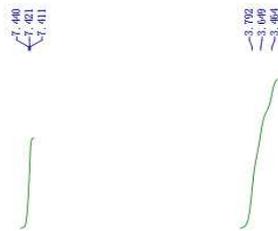
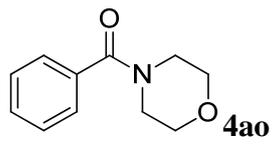
¹H NMR



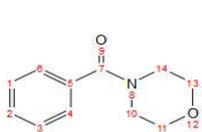
¹³C NMR

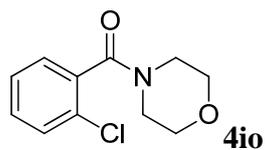


¹H NMR

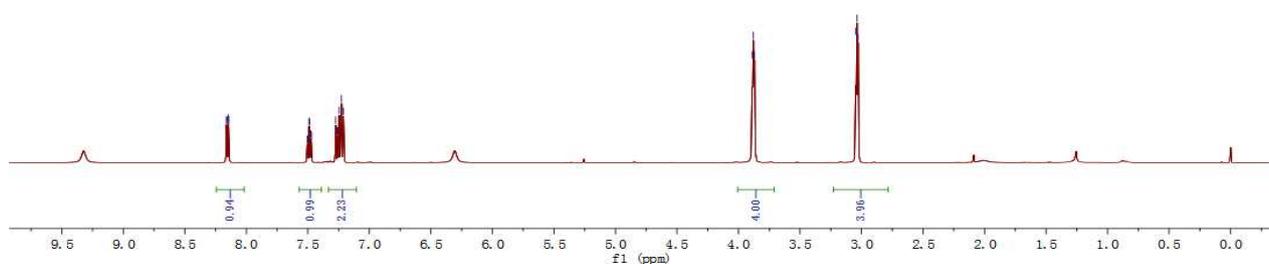
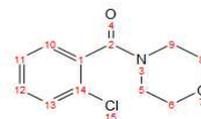
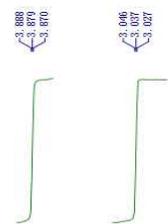
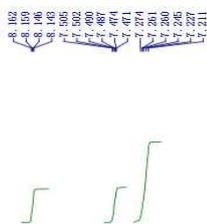


¹³C NMR

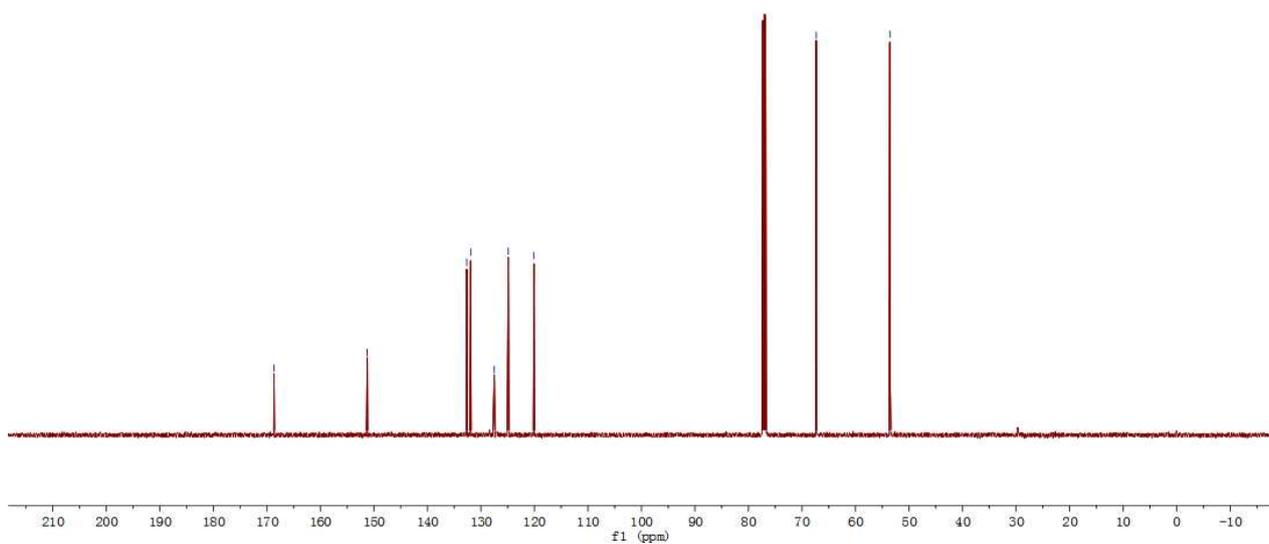


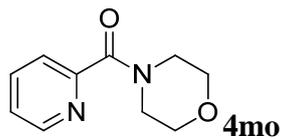


¹H NMR



¹³C NMR



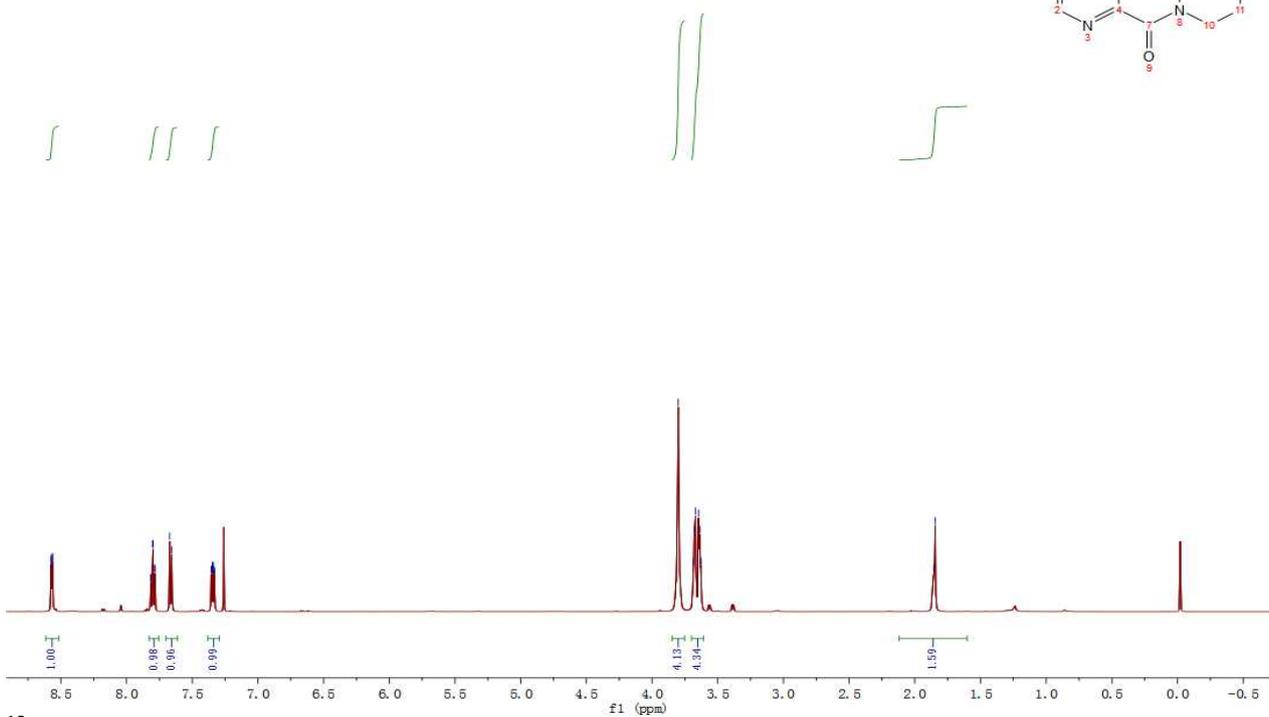


¹H NMR

8.574
8.571
8.571
8.566
8.565
8.565
7.814
7.802
7.799
7.787
7.782
7.656
7.356
7.354
7.347
7.344
7.339
7.331
7.329

3.801
3.686
3.679
3.679
3.646
3.637
3.629

1.864
1.864



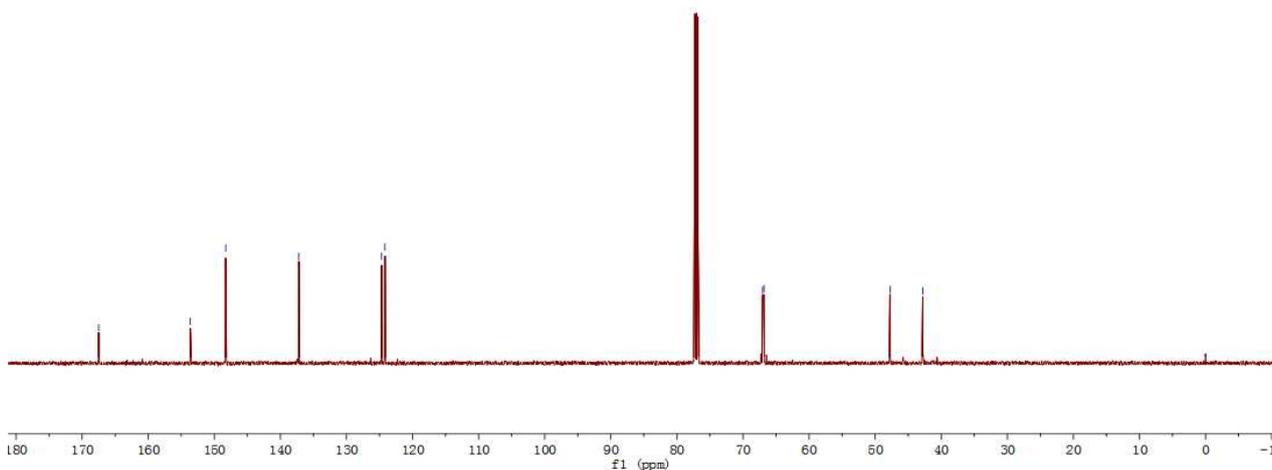
¹³C NMR

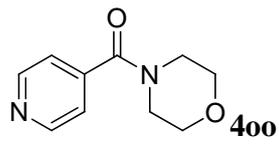
167.406
153.627
148.265
137.206

124.091
124.174

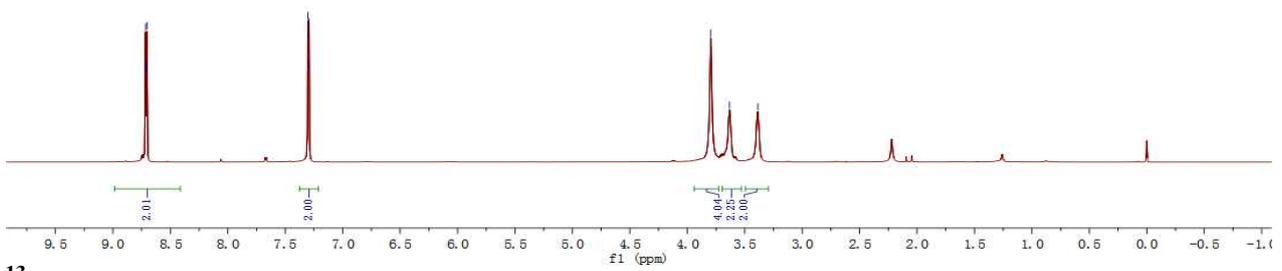
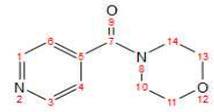
67.037
66.922

47.750
42.798

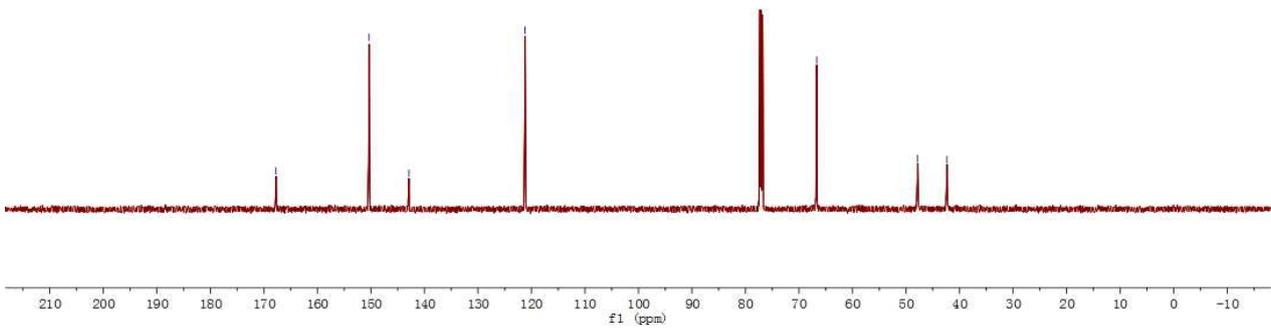
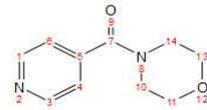




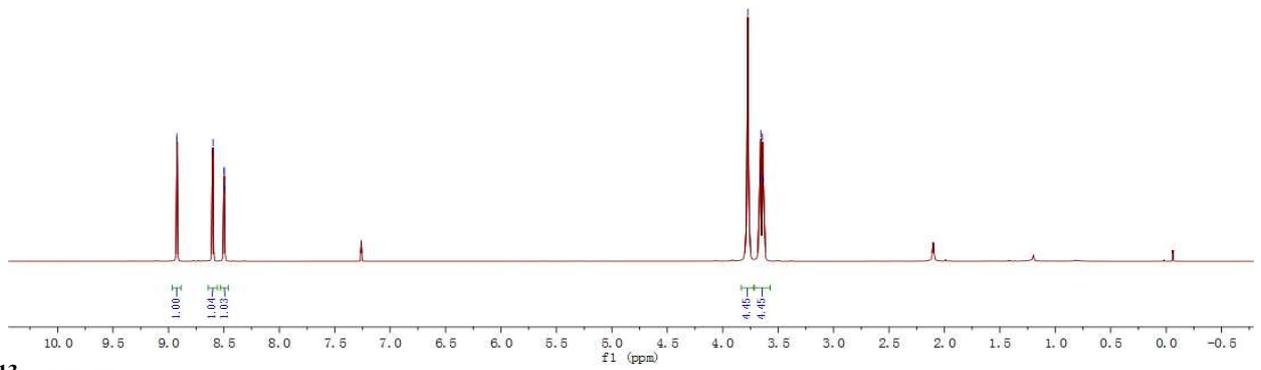
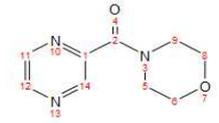
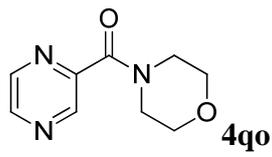
¹H NMR



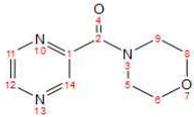
¹³C NMR



¹H NMR



¹³C NMR



165.028

148.841
145.851
145.849
142.499

66.882
66.711

47.638
43.824

