

Supporting Information

Catalyst- and Additive-Free Reduction of Carboxylic Acids and Amides Using Ammonia Borane as Hydrogen Source

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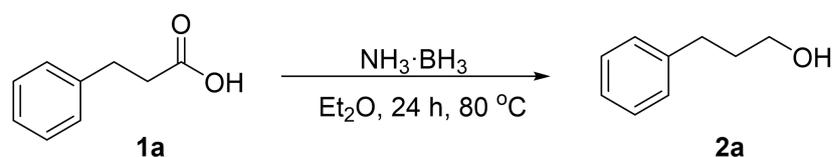
1. Materials and methods

General. All reactions dealing with air or moisture-sensitive compounds were carried out in a dried schlenk tube under atmosphere of nitrogen. Analytical thin-layer chromatography was performed on glass plates coated with 0.25 mm 230–400 mesh silica gel containing a fluorescent indicator (Merck). Flash silica gel column chromatography was performed on silica gel 60N (spherical and neutral, 140–325 mesh) as described by Still. ¹H NMR spectra were measured on a JNM-ECZ400S (JEOL, Japan) spectrometer. ¹H NMR spectra were recorded at 400 MHz in CDCl₃ or DMSO-*d*₆ were referenced internally to tetramethylsilane as a standard, and ¹³C NMR spectra were recorded at 100 MHz and referenced to the solvent resonance. Melting points were determined with a X-5 (Beijing Tech Instrument Co., Ltd).

Materials. Unless otherwise noted, materials were purchased from Tokyo Chemical Industry Co., Aldrich Inc., Titan, Adamas-beta., and other commercial suppliers and used as received. Solvents were dried over sodium (for Toluene, THF and Et₂O) by refluxing for overnight and freshly distilled prior to use.

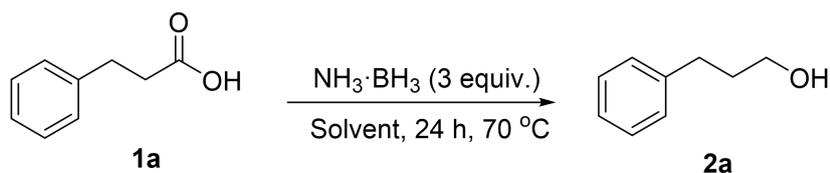
2. Optimizing reaction parameters

Table S1. Investigation of the effect of the amount of NH₃·BH₃ on hydrogenation of 3-phenylpropionic acid.^a



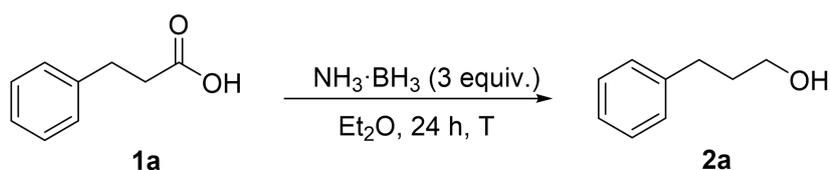
Entry	NH ₃ ·BH ₃	Solvent	Temp./°C	Time/h	Yield/%
1	1.0 equiv.	Et ₂ O	80	24	trace
2	2.0 equiv.	Et ₂ O	80	24	67
3	3.0 equiv.	Et ₂ O	80	24	88
4	4.0 equiv.	Et ₂ O	80	24	85

^aReaction conditions: **1a** (0.2 mmol), NH₃·BH₃, Et₂O (2.5 mL), at 80 °C for 24 h, isolated yield.

Table S2. Investigation of the effect of solvent on hydrogenation of 3-phenylpropionic acid.^a

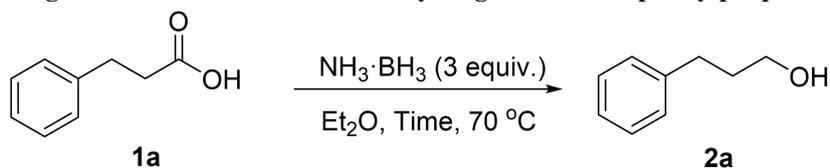
Entry	NH ₃ ·BH ₃	Solvent	Temp./°C	Time/h	Yield/%
1	3.0 equiv.	Toluene	80	24	86
2	3.0 equiv.	EtOH	80	24	nd ^b
3	3.0 equiv.	THF	80	24	24
4	3.0 equiv.	Et ₂ O	80	24	88
5	3.0 equiv.	CH ₃ CN	80	24	36
6	3.0 equiv.	CHCl ₃	80	24	60

^aReaction conditions: **1a** (0.2 mmol), NH₃·BH₃ (3.0 equiv.), solvent (2.5 mL), at 80 °C for 24 h, isolated yield. ^bNot detected.

Table S3. Investigation of the effect of temperature on hydrogenation of 3-phenylpropionic acid.^a

Entry	NH ₃ ·BH ₃	Solvent	Temp./°C	Time/h	Yield/%
1	3.0 equiv.	Et ₂ O	45	24	trace
2	3.0 equiv.	Et ₂ O	50	24	49
3	3.0 equiv.	Et ₂ O	60	24	52
4	3.0 equiv.	Et ₂ O	70	24	88
5	3.0 equiv.	Et ₂ O	80	24	88
6	3.0 equiv.	Et ₂ O	90	24	89

^aReaction conditions: **1a** (0.2 mmol), NH₃·BH₃ (3.0 equiv.), Et₂O (2.5 mL), 24 h, isolated yield.

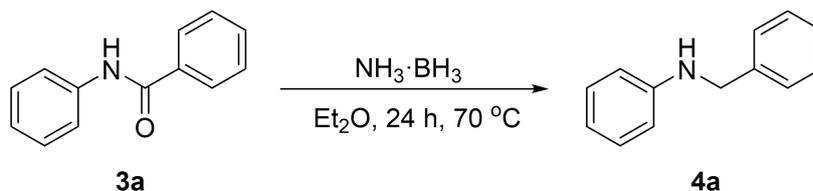
Table S4. Investigation of the effect of time on hydrogenation of 3-phenylpropionic acid.^a

Entry	NH ₃ ·BH ₃	Solvent	Temp./°C	Time/h	Yield/%
1	3.0 equiv.	Et ₂ O	70	6	49

2	3.0 equiv.	Et ₂ O	70	8	50
3	3.0 equiv.	Et ₂ O	70	10	53
4	3.0 equiv.	Et ₂ O	70	12	80
5	3.0 equiv.	Et ₂ O	70	24	88

^aReaction conditions: **1a** (0.2 mmol), NH₃·BH₃ (3.0 equiv.), Et₂O (2.5 mL), 70 °C, isolated yield.

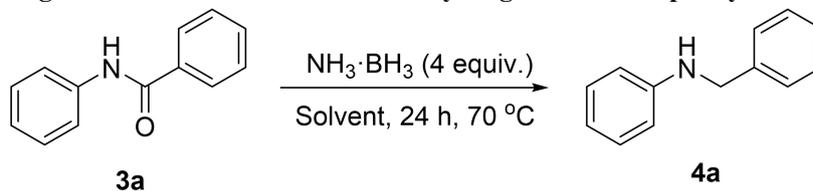
Table S5. Investigation of the effect of the amount of NH₃·BH₃ on hydrogenation of *N*-phenylbenzamide.^a



Entry	NH ₃ ·BH ₃	Solvent	Temp. /°C	Time /h	Yield(%)
1	1.0 equiv.	Et ₂ O	70	24	32
2	2.0 equiv.	Et ₂ O	70	24	47
3	3.0 equiv.	Et ₂ O	70	24	55
4	4.0 equiv.	Et ₂ O	70	24	74
5	5.0 equiv.	Et ₂ O	70	24	65

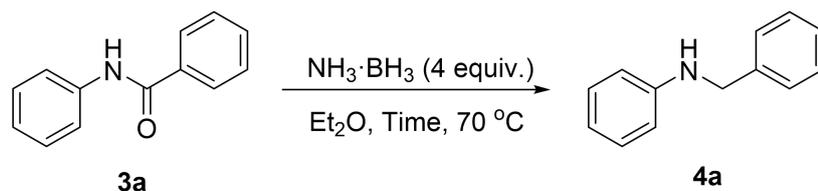
^aReaction conditions: **3a** (0.2 mmol), NH₃·BH₃, Et₂O (2.5 mL), at 70 °C for 24 h, isolated yield.

Table S6. Investigation of the effect of solvent on hydrogenation of *N*-phenylbenzamide.^a



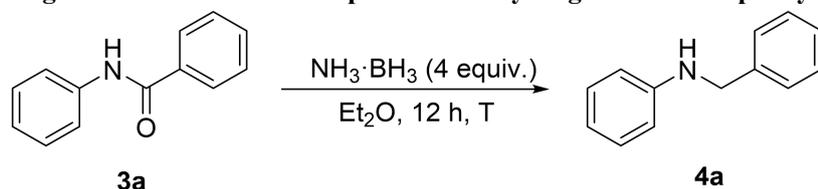
Entry	NH ₃ ·BH ₃	Solvent	Temp./°C	Time/h	Yield/%
1	4.0 equiv.	Toluene	70	24	28
2	4.0 equiv.	EtOH	70	24	nd ^b
3	4.0 equiv.	THF	70	24	trace
4	4.0 equiv.	Et ₂ O	70	24	74
5	4.0 equiv.	CH ₃ CN	70	24	nd ^b
6	4.0 equiv.	CHCl ₃	70	24	26
7	4.0 equiv.	CH ₃ COOH	70	24	nd ^b

^aReaction conditions: **3a** (0.2 mmol), NH₃·BH₃ (4.0 equiv.), solvent (2.5 mL), at 70 °C for 24 h, isolated yield. ^bNot detected.

Table S7. Investigation of the effect of time on hydrogenation of *N*-phenylbenzamide.^a

Entry	NH ₃ ·BH ₃	Solvent	Temp./°C	Time/h	Yield/%
1	4.0 equiv.	Et ₂ O	70	4	46
2	4.0 equiv.	Et ₂ O	70	8	58
3	4.0 equiv.	Et ₂ O	70	12	74
4	4.0 equiv.	Et ₂ O	70	24	74

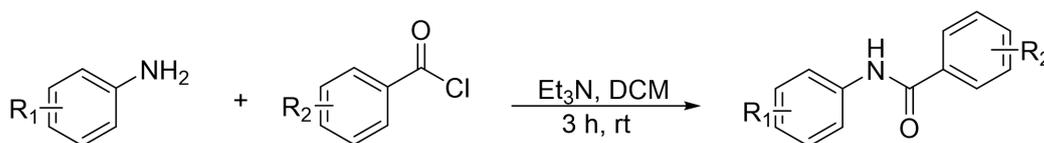
^aReaction conditions: **3a** (0.2 mmol), NH₃·BH₃ (4.0 equiv.), Et₂O (2.5 mL), 70 °C, isolated yield.

Table S8. Investigation of the effect of temperature on hydrogenation of *N*-phenylbenzamide.^a

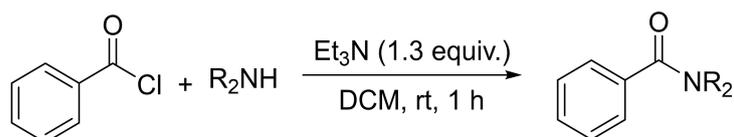
Entry	NH ₃ ·BH ₃	Solvent	Temp. /°C	Time /h	Yield(%)
1	4.0 equiv.	Et ₂ O	25	12	nd ^b
2	4.0 equiv.	Et ₂ O	45	12	trace
3	4.0 equiv.	Et ₂ O	60	12	56
4	4.0 equiv.	Et ₂ O	70	12	74
5	4.0 equiv.	Et ₂ O	80	12	72

^aReaction conditions: **3a** (0.2 mmol), NH₃·BH₃ (4.0 equiv.), Et₂O (2.5 mL), 24 h, isolated yield. ^bNot detected.

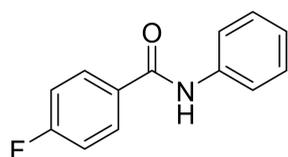
3. Preparation of amides compounds



General procedure A: The acyl chlorides (10 mmol) was slowly dropwisied into the solution of corresponding aniline (1.5 equiv.), Et₃N (2 equiv.) and DCM (2 M) at ice-water bath. Then the mixture was warmed to room temperature and stirred for 3 h. The crude product was then purified by flash chromatography on silica gel to give the corressponing amides compounds. ^[1]



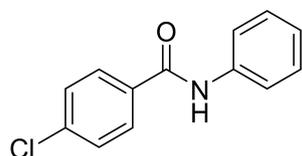
General procedure B: The acyl chloride (10 mmol) was added in one portion to a solution of the amine (11 mmol), Et₃N (12.5 mmol) and DCM (20 mL) at room temperature, resulting rapidly in a boiling solution. The reaction mixture was stirred for 30-60 min. At room temperature and then was diluted with DCM (30 mL). The solution was transferred to a separation funnel and was washed with 1N HCl (50 mL). The organic layer was filtered on silica gel column and washed with ((Petroleum ether/EtOAc=1:1). The combined fractions were concentrated under reduced pressure, after give the desired product.^[2]



4-fluoro-*N*-phenylbenzamide (3b)

The title compound was prepared according the **General procedure A**.

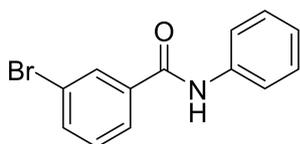
White soild. Yiled: 77%. ¹H NMR (400 MHz, DMSO-*d*₆): δ = 10.21 (s, 1H), 7.99 – 7.94 (m, 2H), 7.70 (d, *J* = 7.5z Hz, 2H), 7.35 – 7.26 (m, 4H), 7.04 (t, *J* = 7.4 Hz, 1H); ¹³C NMR (100 MHz, DMSO-*d*₆): δ = 164.6, 164.2 (d, *J* = 247.7 Hz), 139.2, 131.5, 130.5 (d, *J* = 9.0 Hz), 128.8, 123.9, 120.5, 115.5 (d, *J* = 21.7 Hz); ¹⁹F NMR (376 MHz, DMSO-*d*₆): δ = -108.7. The spectroscopic data are in accordance with those described in the literature.^[3]



4-chloro-*N*-phenylbenzamide (3c)

The title compound was prepared according the **General procedure A**.

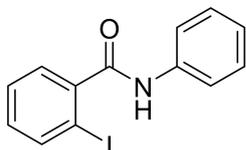
White soild. Yiled: 85%. ^1H NMR (400 MHz, $\text{DMSO-}d_6$): $\delta = 10.29$ (s, 1H), 7.95 (d, $J = 8.6$ Hz, 2H), 7.73 (d, $J = 7.8$ Hz, 2H), 7.57 (d, $J = 8.6$ Hz, 2H), 7.39 – 7.26 (t, $J = 7.8$ Hz, 2H), 7.15 – 7.00 (t, $J = 7.4$ Hz, 1H); ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): $\delta = 164.6, 139.1, 136.5, 133.8, 129.8, 128.8, 128.6, 124.0, 120.5$. The spectroscopic data are in accordance with those described in the literature.^[4]



3-bromo-*N*-phenylbenzamide (3d)

The title compound was prepared according the **General procedure A**.

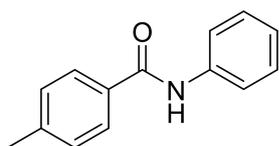
White soild. Yiled: 90%. ^1H NMR (400 MHz, CDCl_3): $\delta = 7.99$ (d, $J = 12.6$ Hz, 2H), 7.76 (d, $J = 7.6$ Hz, 1H), 7.62 (m, 3H), 7.34 (m, $J = 15.6$, 3H), 7.16 (t, $J = 7.6$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 164.4, 137.5, 136.9, 134.7, 130.3, 130.2, 129.1, 125.6, 124.9, 122.9, 120.4$. The spectroscopic data are in accordance with those described in the literature.^[5]



2-iodo-*N*-phenylbenzamide (3e)

The title compound was prepared according the **General procedure A**.

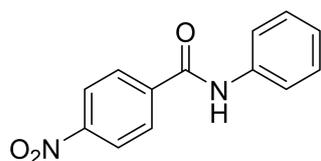
White soild. Yiled: 87%. ^1H NMR (400 MHz, CDCl_3): $\delta = 7.91$ (d, $J = 8.0$ Hz, 1H), 7.64 (d, $J = 7.9$ Hz, 2H), 7.52 (d, $J = 4.7$ Hz, 2H), 7.40 (m, 3H), 7.22 – 7.11 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 167.2, 142.1, 140.0, 137.5, 131.5, 129.1, 128.5, 128.3, 124.9, 120.0, 92.4$. The spectroscopic data are in accordance with those described in the literature.^[6]



4-methyl-*N*-phenylbenzamide (3f)

The title compound was prepared according the **General procedure A**.

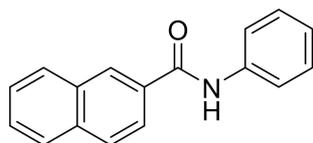
White soild. Yiled: 92%. ^1H NMR (400 MHz, CDCl_3): δ =7.87 (s, 1H), 7.77 (d, J = 8.2 Hz, 2H), 7.64 (d, J = 7.6 Hz, 2H), 7.38 – 7.34 (t, J = 7.6 Hz, 2H), 7.27 (d, J = 9.2 Hz, 2H), 7.14 (t, J = 7.2 Hz, 1H), 2.42 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ =165.7, 142.4, 138.0, 132.0, 129.4, 129.0, 127.0, 124.4, 120.1, 21.5. The spectroscopic data are in accordance with those described in the literature.^[6]



4-nitro-*N*-phenylbenzamide (3g)

The title compound was prepared according the **General procedure A**.

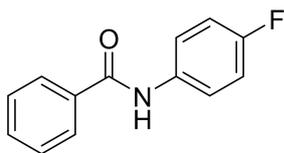
White soild. Yiled: 88%. ^1H NMR (400 MHz, $\text{DMSO}-d_6$): δ = 10.50 (s, 1H), 8.30 (d, J = 8.8 Hz, 2H), 8.11 (d, J = 8.9 Hz, 2H), 7.70 (d, J = 7.5 Hz, 2H), 7.30 (t, J = 8.0 Hz, 2H), 7.06 (t, J = 7.4 Hz, 1H); ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$): δ = 164.0, 149.3, 140.8, 138.8, 129.4, 128.9, 124.3, 123.7, 120.6. The spectroscopic data are in accordance with those described in the literature.^[3]



N-phenyl-2-naphthamide (3h)

The title compound was prepared according the **General procedure A**.

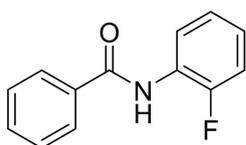
White soild. Yiled: 72%. ^1H NMR (400 MHz, $\text{DMSO}-d_6$): δ =10.37 (s, 1H), 8.51 (s, 1H), 8.05 – 7.90 (m, 4H), 7.76 (d, J = 7.6 Hz, 2H), 7.60 – 7.51 (m, 2H), 7.34 – 7.27 (t, J = 7.6 Hz, 2H), 7.04 (t, J = 7.4 Hz, 1H); ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$): δ = 165.8, 139.4, 134.4, 132.4, 132.2, 129.1, 128.8, 128.2, 128.1, 1280, 127.8, 127.0, 124.6, 123.8, 120.5. The spectroscopic data are in accordance with those described in the literature.^[3]



***N*-(4-fluorophenyl)benzamide (3i)**

The title compound was prepared according the **General procedure A**.

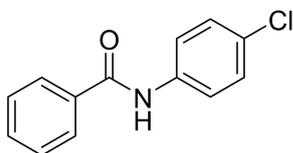
White soild. Yiled: 82%. ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ = 10.25 (s, 1H), 7.88 (d, J = 7.1 Hz, 2H), 7.75 – 7.52 (m, 2H), 7.51 (t, J = 7.0 Hz, 1H), 7.46 (t, J = 7.2 Hz, 2H), 7.12 (t, J = 8.9 Hz, 2H); ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ = 165.6, 158.4 (d, J = 238.9 Hz), 135.7, 134.9, 131.8, 128.6, 127.8, 122.3 (d, J = 7.6 Hz), 115.3 (d, J = 22.1 Hz); ^{19}F NMR (376 MHz, $\text{DMSO-}d_6$): δ = -113.8. The spectroscopic data are in accordance with those described in the literature.^[7]



***N*-(2-fluorophenyl)benzamide (3j)**

The title compound was prepared according the **General procedure A**.

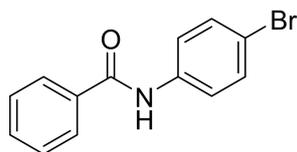
White soild. Yiled: 80%. ^1H NMR (400 MHz, CDCl_3): δ = 8.47 (t, J = 7.3 Hz, 1H), 8.09 (s, 1H), 7.94 – 7.85 (m, 2H), 7.58 (t, J = 7.3 Hz, 1H), 7.51 (t, J = 7.4 Hz, 2H), 7.23 – 7.05 (m, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ = 165.4, 152.6 (d, J = 241.7 Hz), 134.4, 132.1, 128.8, 127.0, 126.4 (d, J = 9.8 Hz), 124.6 (d, J = 3.5 Hz), 124.4 (d, J = 7.7 Hz), 121.7, 114.7 (d, J = 19.1 Hz); ^{19}F NMR (376 MHz, CDCl_3): δ = -131.2. The spectroscopic data are in accordance with those described in the literature.^[8]



***N*-(4-chlorophenyl)benzamide (3k)**

The title compound was prepared according the **General procedure A**.

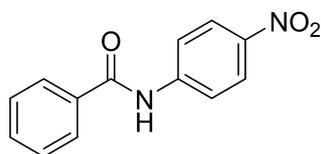
White soild. Yiled: 90%. ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ = 10.40 (s, 1H), 7.95 (d, J = 7.0 Hz, 2H), 7.84 (d, J = 7.3 Hz, 2H), 7.60 (t, J = 7.2 Hz, 1H), 7.53 (t, J = 7.5 Hz, 2H), 7.41 (d, J = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ = 165.8, 138.3, 134.9, 131.9, 128.7, 128.6, 127.8, 127.4, 122.0. The spectroscopic data are in accordance with those described in the literature.^[4]



***N*-(4-bromophenyl)benzamide (3l)**

The title compound was prepared according the **General procedure A**.

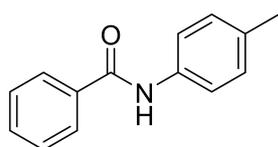
White soild. Yiled: 86%. ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ = 10.32 (s, 1H), 7.88 (d, J = 6.9 Hz, 2H), 7.70 (d, J = 8.9 Hz, 2H), 7.53 (t, J = 7.3 Hz, 1H), 7.49 – 7.44 (m, 4H); ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ = 165.8, 138.7, 134.8, 131.9, 131.6, 128.6, 127.8, 122.3, 115.5. The spectroscopic data are in accordance with those described in the literature.^[5]



***N*-(4-nitrophenyl)benzamide (3m)**

The title compound was prepared according the **General procedure A**.

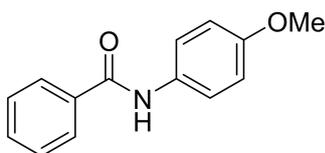
Yellow soild. Yiled: 86%. ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ = 10.76 (s, 1H), 8.20 (d, J = 9.2 Hz, 2H), 8.01 (d, J = 9.2 Hz, 2H), 7.92 (d, J = 7.0 Hz, 2H), 7.57 (t, J = 7.3 Hz, 1H), 7.50 (t, J = 7.4 Hz, 2H); ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ = 166.4, 145.6, 142.6, 134.4, 132.3, 128.7, 128.1, 124.9, 119.9. The spectroscopic data are in accordance with those described in the literature.^[6]



***N*-(*p*-tolyl)benzamide (3n)**

The title compound was prepared according the **General procedure A**.

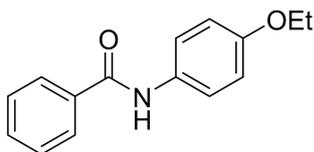
White soild. Yiled: 93%. ¹H NMR (400 MHz, CDCl₃): δ = 7.90 (s, 1H), 7.85 (d, *J* = 6.7 Hz, 2H), 7.52 (d, *J* = 8.6 Hz, 3H), 7.49 – 7.42 (t, *J* = 7.9 Hz, 2H), 7.16 (d, *J* = 8.2 Hz, 2H), 2.34 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 165.7, 135.3, 135.0, 134.2, 131.7, 129.5, 128.7, 127.0, 120.3, 20.9. The spectroscopic data are in accordance with those described in the literature.^[4]



***N*-(4-methoxyphenyl)benzamide (3o)**

The title compound was prepared according the **General procedure A**.

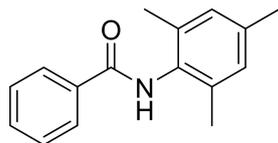
White soild. Yiled: 82%. ¹H NMR (400 MHz, DMSO-*d*₆): δ = 10.06 (s, 1H), 7.86 (d, *J* = 8.0 Hz, 2H), 7.60 (d, *J* = 9.1 Hz, 2H), 7.52 – 7.40 (m, 3H), 6.84 (d, *J* = 9.2 Hz, 2H), 3.65 (s, 3H); ¹³C NMR (100 MHz, DMSO-*d*₆): δ = 165.3, 155.7, 135.2, 132.4, 131.5, 128.5, 127.7, 122.1, 113.9, 54.8. The spectroscopic data are in accordance with those described in the literature.^[6]



***N*-(4-ethoxyphenyl)benzamide (3p)**

The title compound was prepared according the **General procedure A**.

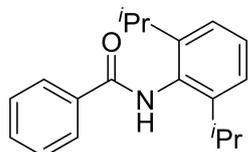
White soild. Yiled: 86%. ¹H NMR (400 MHz, DMSO-*d*₆): δ = 10.14 (s, 1H), 7.95 (d, *J* = 6.8 Hz, 2H), 7.68 (d, *J* = 7.1 Hz, 2H), 7.60 – 7.49 (m, 3H), 6.91 (d, *J* = 9.0 Hz, 2H), 3.99 (q, *J* = 6.9 Hz, 2H), 1.32 (t, *J* = 7.0 Hz, 3H); ¹³C NMR (100 MHz, DMSO-*d*₆): δ = 165.3, 155.0, 135.2, 132.3, 131.5, 128.5, 127.7, 122.1, 114.4, 63.2, 14.8. The spectroscopic data are in accordance with those described in the literature.^[7]



***N*-mesitylbenzamide (3q)**

The title compound was prepared according the **General procedure A**.

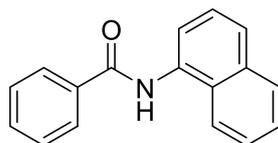
White solid. Yiled: 81%. ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ =9.62 (s, 1H), 7.92 (d, J = 6.9 Hz, 2H), 7.54 – 7.39 (m, 3H), 6.85 (s, 2H), 2.18 (s, 3H), 2.06 (s, 6H); ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ = 165.2, 135.8, 135.4, 134.6, 132.8, 131.6, 128.6, 128.5, 127.6, 20.7, 18.9. The spectroscopic data are in accordance with those described in the literature.^[9]



***N*-(2,6-diisopropylphenyl)benzamide (3r)**

The title compound was prepared according the **General procedure A**.

Pale pink solid. Yiled: 87%. ^1H NMR (400 MHz, CDCl_3): δ = 7.90 (d, J = 8.3 Hz, 2H), 7.55 (d, J = 12.0 Hz, 2H), 7.45 (t, J = 7.28 Hz, 2H), 7.36 (t, J = 7.7 Hz, 1H), 7.23 (d, J = 7.7 Hz, 2H), 3.19 – 3.10 (m, 2H), 1.21 (d, J = 7.0 Hz, 12H); ^{13}C NMR (100 MHz, CDCl_3): δ = 167.0, 146.4, 134.4, 131.7, 131.2, 128.7, 128.4, 127.2, 123.5, 28.8, 23.6. The spectroscopic data are in accordance with those described in the literature.^[4]

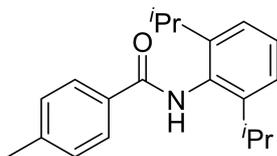


***N*-(naphthalen-1-yl)benzamide (3s)**

The title compound was prepared according the **General procedure A**.

Pale pink solid. Yiled: 73%. ^1H NMR (400 MHz, CDCl_3): δ = 8.34 (s, 1H), 8.03 – 7.83 (m, 5H), 7.73 (d, J = 8.5 Hz, 1H), 7.57 (t, J = 7.4 Hz, 1H), 7.54 – 7.42 (m, 5H); ^{13}C NMR (100 MHz, CDCl_3): δ = 166.3, 134.7, 134.1, 132.3, 131.9, 128.8, 128.7, 127.5,

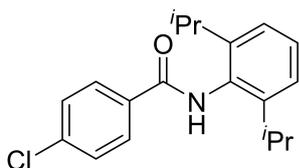
127.2, 126.3, 126.1, 126.0, 125.7, 121.4, 120.8. The spectroscopic data are in accordance with those described in the literature.^[7]



***N*-(2,6-diisopropylphenyl)-4-methylbenzamide (3t)**

The title compound was prepared according the **General procedure A**.

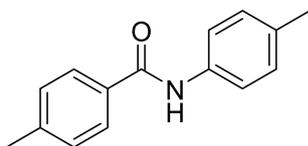
Pale pink soild. Yiled: 86%. ¹H NMR (400 MHz, CDCl₃): δ = 7.81 (d, J = 8.2 Hz, 2H), 7.43 (s, 1H), 7.37 – 7.31 (m, 1H), 7.28 (d, J = 7.9 Hz, 2H), 7.22 (d, J = 7.7 Hz, 2H), 3.14 (p, J = 6.9 Hz, 2H), 2.44 (s, 3H), 1.21 (d, J = 6.9 Hz, 12H); ¹³C NMR (100 MHz, CDCl₃): δ = 163.2, 146.9, 143.3, 132.2, 131.3, 129.4, 128.4, 127.2, 123.5, 28.3, 23.6, 21.5. The spectroscopic data are in accordance with those described in the literature.^[4]



4-chloro-*N*-(2,6-diisopropylphenyl)benzamide (3u)

The title compound was prepared according the **General procedure A**.

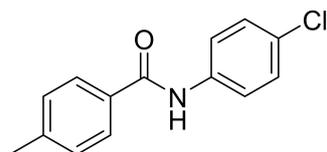
White soild. Yiled: 85%. ¹H NMR (400 MHz, DMSO-*d*₆): δ = 9.76 (s, 1H), 7.94 (d, J = 8.2 Hz, 2H), 7.53 (d, J = 8.3 Hz, 2H), 7.25 – 7.19 (m, 1H), 7.11 (d, J = 7.6 Hz, 2H), 2.98 (m, J = 7.0 Hz, 2H), 1.08 – 1.00 (m, 12H); ¹³C NMR (100 MHz, DMSO-*d*₆): δ = 165.3, 146.2, 133.2, 132.7, 132.5, 129.6, 128.8, 127.9, 123.1, 28.3, 23.7. The spectroscopic data are in accordance with those described in the literature.^[4]



4-methyl-*N*-(p-tolyl)benzamide (3v)

The title compound was prepared according the **General procedure A**.

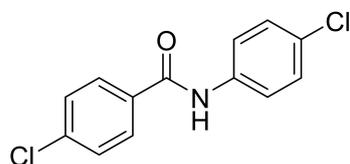
White solid. Yield: 92%. ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ = 10.03 (s, 1H), 7.81 (d, J = 6.3 Hz, 2H), 7.60 (d, J = 8.4 Hz, 2H), 7.27 (d, J = 8.0 Hz, 2H), 7.09 (d, J = 8.2 Hz, 2H), 2.32 (s, 3H), 2.22 (s, 3H); ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ = 165.2, 141.5, 136.8, 132.6, 132.3, 129.1, 129.0, 127.8, 120.5, 21.1, 20.6. The spectroscopic data are in accordance with those described in the literature.^[4]



***N*-(4-chlorophenyl)-4-methylbenzamide (3w)**

The title compound was prepared according the **General procedure A**.

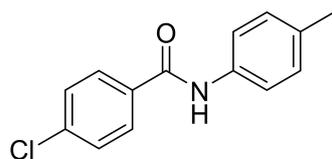
White solid. Yield: 91%. ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ = 10.24 (s, 1H), 7.76 – 7.82 (m, 4H), 7.35 (d, J = 8.8 Hz, 2H), 7.28 (d, J = 8.0 Hz, 2H), 2.33 (s, 3H); ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ = 165.6, 141.9, 138.4, 131.9, 129.1, 128.6, 127.8, 127.2, 121.9, 21.1. The spectroscopic data are in accordance with those described in the literature.^[4]



4-chloro-*N*-(4-chlorophenyl)benzamide (3x)

The title compound was prepared according the **General procedure A**.

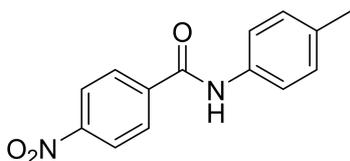
White solid. Yield: 89%. ^1H NMR (400 MHz, $\text{DMSO-}d_6$): δ = 10.44 (s, 1H), 7.97 (d, J = 8.6 Hz, 2H), 7.80 (d, J = 8.8 Hz, 2H), 7.61 (d, J = 8.6 Hz, 2H), 7.41 (d, J = 8.9 Hz, 2H); ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$): δ = 164.7, 138.1, 136.7, 133.5, 129.8, 128.7, 128.7, 127.6, 122.0. The spectroscopic data are in accordance with those described in the literature.^[10]



4-chloro-*N*-(*p*-tolyl)benzamide (3y)

The title compound was prepared according the **General procedure A**.

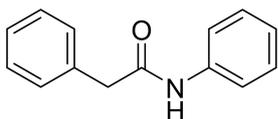
White soild. Yiled: 91%. ¹H NMR (400 MHz, DMSO-*d*₆): δ = 10.24 (s, 1H), 7.81 (d, *J* = 6.3 Hz, 2H), 7.77 (d, *J* = 8.9 Hz, 2H), 7.35 (d, *J* = 8.8 Hz, 2H), 7.28 (d, *J* = 8.0 Hz, 2H), 2.33 (s, 3H); ¹³C NMR (100 MHz, DMSO-*d*₆): δ = 165.6, 141.9, 138.4, 131.9, 129.1, 128.6, 127.8, 127.2, 121.9, 21.1. The spectroscopic data are in accordance with those described in the literature.^[4]



4-nitro-*N*-(*p*-tolyl)benzamide (3z)

The title compound was prepared according the **General procedure A**.

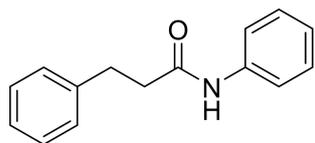
Yellow soild. Yiled: 88%. ¹H NMR (400 MHz, DMSO-*d*₆): δ = 10.42 (s, 1H), 8.29 (d, *J* = 9.1 Hz, 2H), 8.10 (d, *J* = 8.7 Hz, 2H), 7.58 (d, *J* = 8.4 Hz, 2H), 7.10 (d, *J* = 8.2 Hz, 2H), 2.21 (s, 3H); ¹³C NMR (100 MHz, DMSO-*d*₆): δ = 163.8, 149.2, 140.8, 136.3, 133.4, 129.3, 129.3, 123.7, 120.6, 20.7. The spectroscopic data are in accordance with those described in the literature.^[11]



N,2-diphenylacetamide (3aa)

The title compound was prepared according the **General procedure A**.

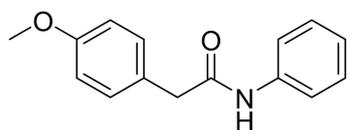
Yellow soild. Yiled: 88%. ¹H NMR (400 MHz, CDCl₃): δ = 7.44 – 7.40 (m, 4H), 7.36 – 7.06 (m, 6H), 7.08 (t, *J* = 7.4 Hz, 1H), 3.73 (s, 2H); ¹³C NMR (100 MHz, CDCl₃): δ = 169.2, 137.6, 134.4, 129.5, 129.2, 128.9, 127.6, 124.4, 119.8, 44.7. The spectroscopic data are in accordance with those described in the literature.^[3]



***N*,3-diphenylpropanamide (3ab)**

The title compound was prepared according the **General procedure A**.

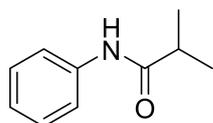
White solid. Yiled: 80%. ^1H NMR (400 MHz, CDCl_3): δ = 7.43 (d, J = 7.4 Hz, 2H), 7.36 – 7.14 (m, 8H), 7.09 (t, J = 7.4 Hz, 1H), 3.05 (t, J = 7.6 Hz, 2H), 2.66 (t, J = 7.6 Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ = 170.4, 141.0, 137.7, 128.9, 128.6, 128.4, 126.4, 124.3, 119.9, 39.4, 31.5. The spectroscopic data are in accordance with those described in the literature.^[6]



2-(4-methoxyphenyl)-*N*-phenylacetamide (3ac)

The title compound was prepared according the **General procedure A**.

Pale yellow solid. Yiled: 79%. ^1H NMR (400 MHz, CDCl_3): δ = 7.42 (d, J = 7.3 Hz, 2H), 7.31 – 7.23 (m, 5H), 7.08 (t, J = 7.4 Hz, 1H), 6.93 (d, J = 8.6 Hz, 2H), 3.83 (s, 3H), 3.68 (s, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ = 169.6, 158.1, 136.1, 130.7, 128.9, 126.3, 124.4, 119.7, 114.0, 56.5, 47.0. The spectroscopic data are in accordance with those described in the literature.^[12]

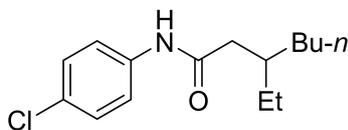


***N*-phenylisobutyramide (3ad)**

The title compound was prepared according the **General procedure A**.

Pale yellow solid. Yiled: 77%. ^1H NMR (400 MHz, CDCl_3): δ = 7.54 (d, J = 7.2 Hz, 2H), 7.45 (s, 1H), 7.35 – 7.27 (m, 2H), 7.09 (t, J = 7.4 Hz, 1H), 2.56 – 2.47 (m, 1H), 1.24 (d, J = 6.9 Hz, 6H); ^{13}C NMR (100 MHz, CDCl_3): δ = 175.4, 139.8, 128.9, 124.7, 120.6,

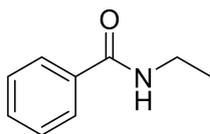
36.0, 18.5. The spectroscopic data are in accordance with those described in the literature.^[13]



3-ethyl-*N*-phenylheptanamide (3af)

The title compound was prepared according the **General procedure A**.

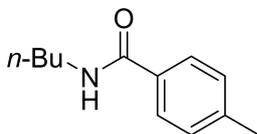
White soild. Yiled: 79%. ¹H NMR (400 MHz, CDCl₃): δ = 7.50 (d, J = 8.9 Hz, 2H), 7.36 (s, 1H), 7.29 – 7.24 (m, 2H), 2.13 – 2.04 (m, 1H), 1.76 – 1.43 (m, 5H), 1.30 (s, 5H), 1.29 – 0.85 (m, 6H); ¹³C NMR (100 MHz, CDCl₃): δ = 174.6, 137.2, 129.1, 128.9, 121.2, 50.7, 33.0, 29.8, 27.3, 22.8, 13.9, 12.6. The spectroscopic data are in accordance with those described in the literature.^[4]



N-ethylbenzamide (3ah)

The title compound was prepared according the **General procedure A**.

White soild. Yiled: 77%. ¹H NMR (400 MHz, CDCl₃): δ = 7.76 (d, J = 6.9 Hz, 2H), 7.50 – 7.37 (m, J = 7.4 Hz, 3H), 6.32 (s, 1H), 3.52 – 3.43 (m, 2H), 1.23 (t, J = 7.3 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 167.4, 134.7, 131.2, 128.5, 126.8, 34.9, 14.8. The spectroscopic data are in accordance with those described in the literature.^[2]

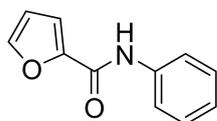


N-butyl-4-methylbenzamide (3ai)

The title compound was prepared according the **General procedure A**.

White soild. Yiled: 72%. ¹H NMR (400 MHz, CDCl₃): δ = 7.65 (d, J = 8.2 Hz, 2H), 7.20 (d, J = 7.9 Hz, 2H), 6.25 (s, 1H), 3.46 – 3.39 (m, 2H), 2.37 (s, 3H), 1.62 – 1.57 (m, 2H), 1.56 – 1.40 (m, 2H), 1.40 – 1.30 (m, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 167.4, 141.6,

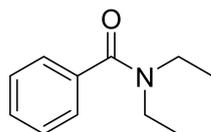
131.9, 129.1, 126.8, 39.7, 31.7, 21.4, 20.1, 13.8. The spectroscopic data are in accordance with those described in the literature.^[14]



***N*-phenylfuran-2-carboxamide (3aj)**

The title compound was prepared according the **General procedure A**.

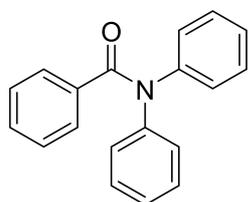
White soild. Yiled: 86%. ¹H NMR (400 MHz, CDCl₃): δ = 8.10 (s, 1H), 7.66 (d, J = 7.4 Hz, 2H), 7.51 (d, J = 1.0 Hz, 1H), 7.40 – 7.33 (m, 2H), 7.24 (d, J = 3.5 Hz, 1H), 7.14 (t, J = 7.4 Hz, 1H), 6.57 – 6.54 (m, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 156.0, 147.8, 144.2, 137.3, 129.1, 124.5, 119.9, 115.2, 112.6. The spectroscopic data are in accordance with those described in the literature.^[6]



***N,N*-diethylbenzamide (3ao)**

The title compound was prepared according the **General procedure B**.

Pale yellow soild. Yiled: 80%. ¹H NMR (400 MHz, CDCl₃): δ = 7.32 (s, 5H), 3.48 (s, 2H), 3.18 (s, 2H), 1.12 (d, J = 60.1 Hz, 6H); ¹³C NMR (100 MHz, CDCl₃): δ = 171.1, 137.0, 128.9, 128.2, 126.0, 43.1, 39.0, 14.0, 12.7. The spectroscopic data are in accordance with those described in the literature.^[15]

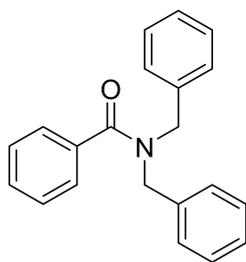


***N,N*-diphenylbenzamide (3ap)**

The title compound was prepared according the **General procedure B**.

White soild. Yiled: 76%. ¹H NMR (400 MHz, CDCl₃): δ = 7.50 – 7.43 (m, 2H), 7.32 – 7.26 (m, 5H), 7.25 – 7.11 (m, 8H); ¹³C NMR (100 MHz, CDCl₃): δ = 170.6, 143.8, 136.0,

130.1, 129.1, 129.1, 127.8, 127.4, 126.3. The spectroscopic data are in accordance with those described in the literature.^[15]



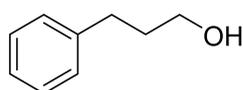
***N,N*-dibenzylbenzamide (3aq)**

The title compound was prepared according to the **General procedure B**.

White solid. Yield: 79%. ¹H NMR (400 MHz, CDCl₃): δ = 7.55 – 7.48 (m, 2H), 7.43 – 7.27 (m, 11H), 7.15 (d, *J* = 7.4 Hz, 2H), 4.72 (s, 2H), 4.41 (s, 2H); ¹³C NMR (100 MHz, CDCl₃): δ = 172.4, 136.3, 129.8, 129.0, 128.8, 128.7, 128.5, 127.8, 127.7, 127.2, 126.8, 51.6, 46.5. The spectroscopic data are in accordance with those described in the literature.^[15]

4. General procedure for hydrogenation of carboxylic acid compound.

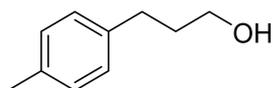
A mixture of carboxylic acid derivatives (0.2 mmol) and NH₃·BH₃ (0.0185 g, 3.0 equiv.) were added to an oven dried schlenk tube under atmosphere of nitrogen. Et₂O (2.5 mL) were added by syringe. The reaction mixture was stirred at 70 °C for 24 h. After quenching with saturated NH₄Cl/H₂O (10 mL), the crude product was extracted with EtOAc (3 × 10 mL). The combined organic phases were dried over anhydrous Na₂SO₄ and concentrated under vacuum, the crude product was purified by column chromatography to afford the desired hydrogenation compound.



3-phenyl-1-propanol (2a)

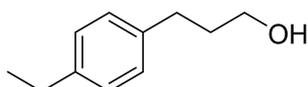
The general procedure was applied to 3-phenylpropionic acid (30.0 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column

chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (23.9 mg, 88% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.34 – 7.27 (m, 2H), 7.25 – 7.17 (m, 3H), 3.68 (t, J = 6.4 Hz, 2H), 2.77 – 2.67 (m, 2H), 1.97 – 1.85 (m, 2H), 1.49 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ = 141.8, 128.4, 128.4, 125.8, 62.2, 34.2, 32.0. The spectroscopic data are in accordance with those described in the literature.^[16]



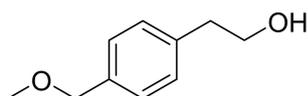
3-(*p*-tolyl)propan-1-ol (2b)

The general procedure was applied to *p*-methylphenylpropionic acid (32.8 mg, 0.2 mmol) under an atmosphere of N_2 at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (20.8 mg, 78% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.11 (s, 4H), 3.67 (t, J = 6.4 Hz, 2H), 2.68 (t, J = 7.7 Hz, 2H), 2.33 (s, 3H), 1.93 – 1.84 (m, 2H), 1.57 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ = 138.7, 135.3, 129.0, 128.3, 62.3, 34.3, 31.6, 20.9. The spectroscopic data are in accordance with those described in the literature.^[29]



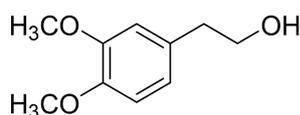
3-(4-ethyl-phenyl)propanol (2c)

The general procedure was applied to 3-(4-ethylphenyl)propionic acid (35.6 mg, 0.2 mmol) under an atmosphere of N_2 at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (18.7 mg, 57% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.13 (s, 4H), 3.68 (t, J = 6.5 Hz, 2H), 2.72 – 2.60 (m, 4H), 1.97 – 1.84 (m, 2H), 1.48 (s, 1H), 1.24 (t, J = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ = 141.7, 138.9, 128.3, 127.8, 62.3, 34.3, 31.6, 28.4, 15.6. The spectroscopic data are in accordance with those described in the literature.^[16]



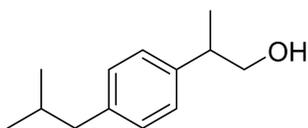
2-(4-(methoxymethyl)phenyl)ethanol (2d)

The general procedure was applied to 2-(4-(methoxymethyl)phenyl)acetic acid (36.0 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale colorless liquid (22.3 mg, 68% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.30 – 7.18 (m, 4H), 4.41 (s, 2H), 3.80 (t, *J* = 6.6 Hz, 2H), 3.37 (s, 3H), 2.84 (t, *J* = 6.6 Hz, 2H), 1.74 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 138.0, 136.2, 129.0, 128.1, 74.4, 63.5, 58.0, 38.8. The spectroscopic data are in accordance with those described in the literature.^[16]



2-(3,4-Dimethoxyphenyl)ethanol (2e)

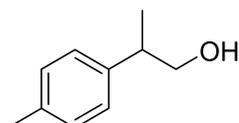
The general procedure was applied to (3,4-dimethoxyphenyl)acetic acid (39.2 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (28.1 mg, 77% yield); ¹H NMR (400 MHz, CDCl₃): δ = 6.84 – 6.74 (m, 3H), 3.89 – 3.82 (m, 8H), 2.82 (t, *J* = 6.4 Hz, 2H), 1.61 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 149.0, 147.7, 130.9, 120.9, 112.1, 111.3, 63.7, 55.9, 55.8, 38.7. The spectroscopic data are in accordance with those described in the literature.^[16]



2-(4-(2-methylpropyl)phenyl)propan-1-ol (2f)

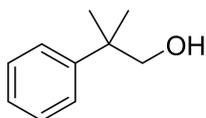
The general procedure was applied to 2-(4-(2-methylpropyl)phenyl)propanoic acid (41.2 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford

the title compound as pale yellow liquid (25.1 mg, 65% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.13 (q, J = 8.2 Hz, 4H), 3.68 (d, J = 6.9 Hz, 2H), 2.92 (q, J = 6.9 Hz, 1H), 2.46 (d, J = 7.2 Hz, 2H), 1.92 – 1.80 (m, 1H), 1.47 (s, 1H), 1.27 (d, J = 7.0 Hz, 3H), 0.91 (d, J = 6.7 Hz, 6H); ^{13}C NMR (100 MHz, CDCl_3): δ = 140.7, 140.0, 129.3, 127.1, 68.7, 44.9, 41.9, 30.2, 22.4, 17.6. The spectroscopic data are in accordance with those described in the literature.^[16]



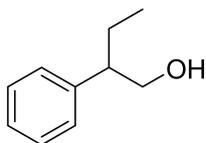
2-(4-methylphenyl)propan-1-ol (2g)

The general procedure was applied to p-methyl isophthalic acid (32.8 mg, 0.2 mmol) under an atmosphere of N_2 at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (27.0 mg, 90% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.15 (s, 4H), 3.68 (d, J = 7.1 Hz, 2H), 2.97 – 2.87 (m, 1H), 2.34 (s, 3H), 1.63 – 1.40 (m, 1H), 1.26 (d, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ = 140.5, 136.2, 129.3, 127.3, 68.7, 42.0, 21.0, 17.6. The spectroscopic data are in accordance with those described in the literature.^[16]



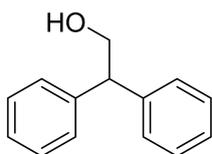
2-methyl-2-phenylpropan-1-ol (2h)

The general procedure was applied to 2-phenylisobutyric acid (32.8 mg, 0.2 mmol) under an atmosphere of N_2 at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (20.4 mg, 67% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.41 – 7.31 (m, 4H), 7.26 – 7.19 (m, 1H), 3.61 (s, 2H), 1.33 (s, 7H); ^{13}C NMR (100 MHz, CDCl_3): δ = 146.2, 128.4, 126.2, 73.1, 40.1, 25.3. The spectroscopic data are in accordance with those described in the literature.^[16]



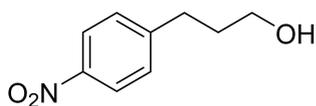
2-phenylbutan-1-ol (2i)

The general procedure was applied to 2-phenylbutyric acid (32.8 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (19.3 mg, 64% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.32 (t, *J* = 7.3 Hz, 2H), 7.26 – 7.17 (m, 3H), 3.79 – 3.69 (m, 2H), 2.73 – 2.61 (m, 1H), 1.81 – 1.68 (m, 1H), 1.63 – 1.52 (m, 1H), 1.41 (s, 1H), 0.83 (t, *J* = 7.4 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 142.2, 128.6, 128.1, 126.7, 67.3, 50.4, 24.9, 11.9. The spectroscopic data are in accordance with those described in the literature.^[16]



2,2-diphenylethanol (2j)

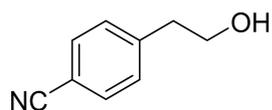
The general procedure was applied to 2,2-diphenylacetic acid (42.4 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (31.0 mg, 78% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.43 – 7.17 (m, 10H), 4.28 – 4.09 (m, 3H), 1.66 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 141.3, 128.7, 128.3, 126.8, 66.0, 53.5. The spectroscopic data are in accordance with those described in the literature.^[16]



3-(4-nitrophenyl)propan-1-ol (2k)

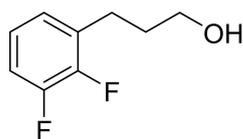
The general procedure was applied to 3-(4-nitrophenyl)propanoic acid (39.0 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by

column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (22.2 mg, 73% yield); ^1H NMR (400 MHz, CDCl_3): δ = 8.15 (d, J = 8.3 Hz, 2H), 7.36 (d, J = 8.3 Hz, 2H), 3.69 (t, J = 6.3 Hz, 2H), 2.96 – 2.72 (m, 2H), 2.00 – 1.84 (m, 2H), 1.52 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ = 149.8, 146.3, 129.2, 123.7, 61.7, 33.6, 31.9. The spectroscopic data are in accordance with those described in the literature.^[16]



4-(2-hydroxyethyl)benzonitrile (2l)

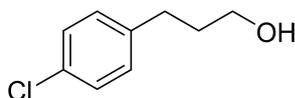
The general procedure was applied to 4-cyanophenylacetic acid (32.2 mg, 0.2 mmol) under an atmosphere of N_2 at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale colorless liquid (13.1 mg, 45% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.59 (d, J = 8.4 Hz, 2H), 7.34 (d, J = 8.4 Hz, 2H), 3.88 (t, J = 6.5 Hz, 2H), 2.92 (t, J = 6.5 Hz, 2H), 1.73 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ = 144.6, 132.2, 129.8, 118.9, 110.2, 62.8, 39.1. The spectroscopic data are in accordance with those described in the literature.^[29]



3-(2,3-difluorophenyl)propan-1-ol (2m)

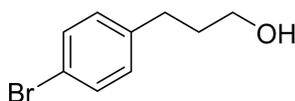
The general procedure was applied to 3-(2,3-difluorophenyl)propionic acid (37.2 mg, 0.2 mmol) under an atmosphere of N_2 at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale colorless liquid (26.8 mg, 78% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.04 – 6.91 (m, 3H), 3.67 (t, J = 6.4 Hz, 2H), 2.80 – 2.74 (m, J = 7.7, 1.4 Hz, 2H), 1.94 – 1.83 (m, 2H), 1.72 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ = 151.0 (dd, J = 157.8, 12.7 Hz), 148.6 (dd, J = 156.1, 12.9 Hz), 131.1 (d, J = 12.7 Hz), 125.2 (t, J = 3.5 Hz),

123.8 (dd, $J = 6.8, 4.7$ Hz), 61.9, 32.7, 25.1; ^{19}F NMR (376 MHz, CDCl_3): $\delta = -138.74, -144.13$. The spectroscopic data are in accordance with those described in the literature.^[16]



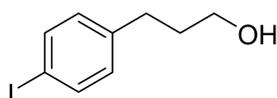
3-(4-Chlorophenyl)propan-1-ol (2n)

The general procedure was applied to 3-(4-chlorophenyl)propanoic acid (36.9 mg, 0.2 mmol) under an atmosphere of N_2 at $70\text{ }^\circ\text{C}$ for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale colorless liquid (24.1 mg, 64% yield); ^1H NMR (400 MHz, CDCl_3): $\delta = 7.25$ (d, $J = 9.0$ Hz, 2H), 7.13 (d, $J = 8.2$ Hz, 2H), 3.66 (t, $J = 6.4$ Hz, 2H), $2.74 - 2.63$ (m, 2H), $1.95 - 1.79$ (m, 2H), 1.56 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 140.2, 131.5, 129.8, 128.4, 62.0, 34.0, 31.3$. The spectroscopic data are in accordance with those described in the literature.^[16]



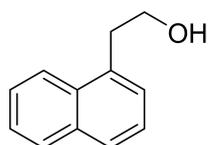
3-(4-bromo-phenyl)-propan-1-ol (2o)

The general procedure was applied to 3-(4-bromophenyl)propionic acid (45.8 mg, 0.2 mmol) under an atmosphere of N_2 at $70\text{ }^\circ\text{C}$ for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale colorless liquid (30.0 mg, 70% yield); ^1H NMR (400 MHz, CDCl_3): $\delta = 7.45 - 7.34$ (m, 2H), $7.13 - 7.02$ (m, 2H), 3.66 (t, $J = 6.4$ Hz, 2H), $2.70 - 2.60$ (m, 2H), $1.92 - 1.80$ (m, 2H), 1.61 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 140.7, 131.4, 130.2, 120.0, 62.0, 34.0, 31.4$. The spectroscopic data are in accordance with those described in the literature.^[16]



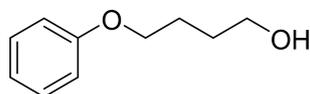
3-(4-iodophenyl)propan-1-ol (2p)

The general procedure was applied to 3-(4-iodophenyl)propionic acid (55.2 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale colorless liquid (51.2 mg, 98% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.59 (d, *J* = 8.3 Hz, 2H), 6.95 (d, *J* = 8.1 Hz, 2H), 3.64 (t, *J* = 6.4 Hz, 2H), 2.70 – 2.61 (m, 2H), 1.89 – 1.80 (m, 2H), 1.75 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 141.4, 137.3, 130.5, 90.8, 62.0, 33.9, 31.5. The spectroscopic data are in accordance with those described in the literature.^[16]



1-Naphthaleneethanol (2q)

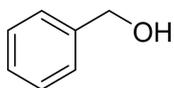
The general procedure was applied to 1-naphthaleneacetic acid (37.2 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale red liquid (21.4 mg, 60% yield); ¹H NMR (400 MHz, CDCl₃): δ = 8.06 (d, *J* = 8.4 Hz, 1H), 7.88 (d, *J* = 7.2 Hz, 1H), 7.77 (d, *J* = 8.0 Hz, 1H), 7.57 – 7.47 (m, 2H), 7.46 – 7.38 (m, 2H), 3.98 (t, *J* = 6.7 Hz, 2H), 3.35 (t, *J* = 6.7 Hz, 2H), 1.62 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 134.3, 133.9, 132.0, 128.8, 127.3, 127.1, 126.0, 125.6, 126.5, 123.6, 62.9, 36.1. The spectroscopic data are in accordance with those described in the literature.^[16]



4-phenoxybutan-1-ol (2r)

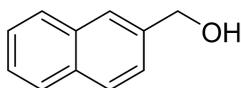
The general procedure was applied to 4-phenoxybutanoic acid (36.0 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (25.3 mg, 76% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.32 – 7.23

(m, 2H), 6.96 – 6.87 (m, 3H), 3.99 (t, $J = 6.1$ Hz, 2H), 3.71 (t, $J = 6.3$ Hz, 2H), 1.95 – 1.66 (m, 5H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 158.8, 129.4, 120.6, 114.4, 67.5, 62.5, 29.4, 25.7$. The spectroscopic data are in accordance with those described in the literature.^[16]



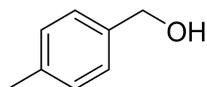
Phenylmethanol (2s)

The general procedure was applied to benzoic acid (24.4 mg, 0.2 mmol) under an atmosphere of N_2 at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (20.9 mg, 97% yield); ^1H NMR (400 MHz, CDCl_3): $\delta = 7.37$ (d, $J = 5.1$ Hz, 4H), 7.34 – 7.27 (m, 1H), 4.70 (s, 2H), 1.74 (d, $J = 13.9$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 140.8, 128.6, 127.7, 127.0, 65.4$. The spectroscopic data are in accordance with those described in the literature.^[16]



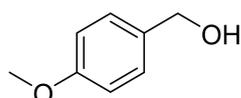
2-Naphthalenemethanol (2t)

The general procedure was applied to 2-naphthoic acid (34.4 mg, 0.2 mmol) under an atmosphere of N_2 at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale white solid (19.7 mg, 62% yield); Melting point: 80.2–81.7 °C; ^1H NMR (400 MHz, CDCl_3): $\delta = 7.88 - 7.79$ (m, 4H), 7.53 – 7.43 (m, 3H), 4.87 (s, 2H), 1.79 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 138.3, 133.3, 132.9, 128.3, 127.9, 127.7, 126.2, 125.9, 125.4, 125.2, 65.5$. The spectroscopic data are in accordance with those described in the literature.^[16]



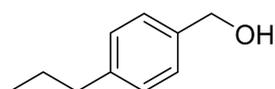
4-Methylbenzyl alcohol (2u)

The general procedure was applied to *p*-toluic acid (27.2 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale white solid (15.7 mg, 65% yield); Melting point: 42.3–44.7 °C; ¹H NMR (400 MHz, CDCl₃): δ = 7.24 (d, *J* = 8.2 Hz, 2H), 7.16 (d, *J* = 7.7 Hz, 2H), 4.63 (s, 2H), 2.35 (s, 3H), 1.79 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 137.8, 137.4, 129.2, 127.1, 65.2, 21.1. The spectroscopic data are in accordance with those described in the literature.^[16]



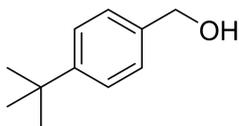
4-Methoxybenzyl alcohol (2v)

The general procedure was applied to 4-methoxybenzoic acid (30.4 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale colorless liquid (23.8 mg, 86% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.29 (d, *J* = 8.4 Hz, 2H), 6.89 (d, *J* = 8.6 Hz, 2H), 4.61 (s, 2H), 3.81 (s, 3H), 1.74 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 159.2, 133.0, 128.7, 113.9, 65.0, 55.3. The spectroscopic data are in accordance with those described in the literature.^[16]



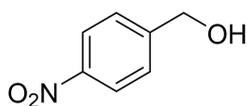
(4-propylphenyl)methanol (2w)

The general procedure was applied to 4-propylbenzoic acid (32.8 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale colorless liquid (22.5 mg, 75% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.27 (d, *J* = 8.0 Hz, 2H), 7.17 (d, *J* = 8.0 Hz, 2H), 4.64 (s, 2H), 2.64 – 2.53 (m, 2H), 1.77 – 1.57 (m, 3H), 0.93 (t, *J* = 7.3 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 142.3, 138.1, 128.7, 127.1, 65.3, 37.7, 24.6, 13.8. The spectroscopic data are in accordance with those described in the literature.^[16]



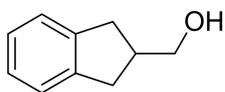
4-*tert*-butylbenzyl alcohol (2x)

The general procedure was applied to 4-*tert*-butylbenzoic acid (35.6 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (22.4 mg, 68% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.40 (d, *J* = 8.3 Hz, 2H), 7.31 (d, *J* = 8.2 Hz, 2H), 4.67 (s, 2H), 1.61 (s, 1H), 1.33 (s, 9H). ¹³C NMR (100 MHz, CDCl₃): δ = 150.7, 137.9, 126.9, 125.5, 65.2, 34.5, 31.3. The spectroscopic data are in accordance with those described in the literature.^[16]



4-Nitrobenzyl alcohol (2y)

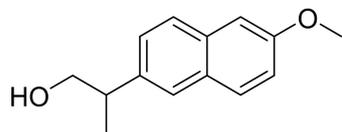
The general procedure was applied to 4-nitrobenzoic acid (33.4 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale white solid (16.2 mg, 53% yield); Melting point: 91.8–93.8 °C; ¹H NMR (400 MHz, CDCl₃): δ = 8.24 – 8.17 (m, 2H), 7.53 (d, *J* = 8.9 Hz, 2H), 4.83 (s, 2H), 2.07 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 148.1, 127.0, 123.7, 64.0. The spectroscopic data are in accordance with those described in the literature.^[16]



2,3-dihydro-1H-inden-2-ylmethanol (2z)

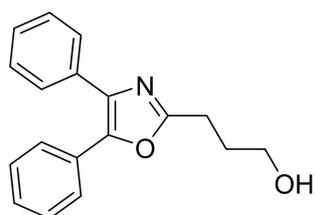
The general procedure was applied to 2,3-dihydro-1H-indene-2-carboxylic acid (32.4 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as pale yellow liquid (18.0 mg, 60% yield); ¹H NMR (400 MHz,

CDCl₃): δ = 7.27 – 7.19 (m, 2H), 7.18 – 7.13 (m, 2H), 3.67 (d, J = 6.6 Hz, 2H), 3.13 – 3.03 (m, 2H), 2.81 – 2.54 (m, 3H), 1.75 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 142.6, 126.2, 124.6, 66.5, 41.4, 35.7. The spectroscopic data are in accordance with those described in the literature.^[16]



2-(6-methoxynaphthalen-2-yl)propan-1-ol (2aa)

The general procedure was applied to 2-(6-methoxynaphthalen-2-yl)propanoic acid (46.1 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as colorless liquid (22.0 mg, 51% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.74 – 7.69 (m, 2H), 7.61 (d, J = 2.1 Hz, 1H), 7.35 (m, J = 8.5, 2.4 Hz, 1H), 7.19 – 7.10 (m, 2H), 3.92 (d, J = 2.9 Hz, 3H), 3.79 – 3.75 (m, 2H), 3.12 – 3.05 (m, 1H), 1.49 (s, 1H), 1.38 – 1.33 (m, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 157.4, 138.6, 133.5, 129.1, 129.0, 127.2, 126.2, 125.9, 118.9, 105.5, 68.6, 55.3, 42.3, 17.6. The spectroscopic data are in accordance with those described in the literature.^[16]



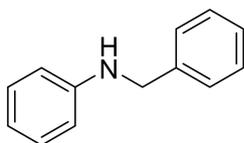
3-(4,5-diphenyl-3,4-dihydro-2H-oxazol-2-yl)propan-1-ol (2ab)

The general procedure was applied to 3-(4,5-diphenyl-3,4-dihydro-2H-oxazol-2-yl)propanoic acid (58.7 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the title compound as colorless liquid (23.4 mg, 42% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.63 (d, J = 7.2 Hz, 2H), 7.57 (d, J = 6.1 Hz, 2H), 7.41 – 7.27 (m, 6H), 4.40 (s, 1H), 3.82 – 3.77 (m, 2H), 3.02 – 2.97 (m, 2H), 2.12 – 2.03 (m, 2H); ¹³C NMR (100

MHz, CDCl₃): δ = 163.6, 145.3, 134.7, 132.1, 128.8, 128.6, 128.5, 128.4, 128.1, 127.8, 126.4, 61.8, 29.4, 25.2.

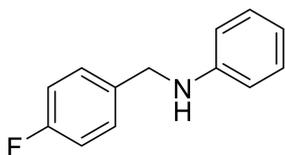
5. General procedure for hydrogenation of amide derivatives.

A mixture of amide derivatives (0.2 mmol) and NH₃·BH₃ (0.0246 g, 4.0 equiv.) were added to an oven dried schlenk tube under atmosphere of nitrogen. Et₂O (2.5 mL) were added by syringe. The reaction mixture was stirred at 70 °C for 12 h. After quenching with saturated NH₄Cl/H₂O (10 mL), the crude product was extracted with EtOAc (3 × 10 mL). The combined organic phases were dried over anhydrous Na₂SO₄ and concentrated under vacuum, the crude product was purified by column chromatography to afford the desired hydrogenation compound.



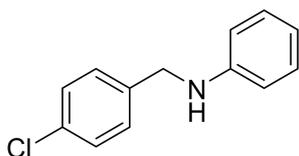
***N*-Benzylaniline (4a)**

The general procedure was applied to 4-chloro-*N*-phenylbenzamide (46.3 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (25.9 mg, 74% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.39 (q, J = 7.9 Hz, 4H), 7.31 (t, J = 6.6 Hz, 1H), 7.21 (t, J = 8.0 Hz, 2H), 6.76 (t, J = 7.3 Hz, 1H), 6.67 (d, J = 8.7 Hz, 2H), 4.36 (s, 2H), 4.05 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 148.1, 139.4, 129.2, 128.6, 127.5, 127.2, 117.5, 112.8, 48.2. The spectroscopic data are in accordance with those described in the literature.^[6]



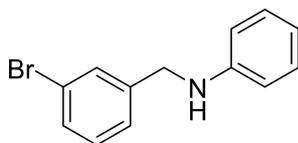
***N*-(4-fluorobenzyl)aniline (4b)**

The general procedure was applied to 4-fluoro-*N*-phenylbenzamide (36.0 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (43.0 mg, 64% yield). ¹H NMR (400 MHz, CDCl₃): δ = 7.32 (s, 4H), 7.23 – 7.16 (m, 2H), 6.75 (t, *J* = 7.3 Hz, 1H), 6.62 (d, *J* = 8.5 Hz, 2H), 4.32 (s, 2H), 4.07 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 162.0 (d, *J* = 243.7 Hz), 147.9, 135.0, 129.3, 129.0 (d, *J* = 7.7 Hz), 117.7, 115.4 (d, *J* = 21.2 Hz), 112.8, 47.6; ¹⁹F NMR (376 MHz, CDCl₃): δ = -115.5. The spectroscopic data are in accordance with those described in the literature.^[17]



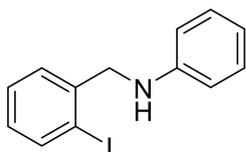
***N*-(4-chlorobenzyl)aniline (4c)**

The general procedure was applied to 4-chloro-*N*-phenylbenzamide (46.3 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (25.9 mg, 70% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.31 (s, 4H), 7.22 – 7.15 (t, *J* = 7.4 Hz, 2H), 6.74 (t, *J* = 7.3 Hz, 1H), 6.62 (d, *J* = 7.6 Hz, 2H), 4.32 (s, 2H), 4.07 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 147.8, 137.9, 132.8, 129.3, 128.7, 128.7, 117.8, 112.8, 47.5. The spectroscopic data are in accordance with those described in the literature.^[6]



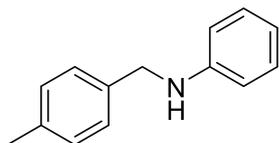
***N*-(3-bromobenzyl)aniline (4d)**

The general procedure was applied to 3-bromo-*N*-phenylbenzamide (55.2 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (36.9 mg, 70% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.54 (s, 1H), 7.41 (d, *J* = 7.9 Hz, 1H), 7.31 (d, *J* = 7.5 Hz, 1H), 7.24 – 7.16 (m, 3H), 6.75 (t, *J* = 7.3 Hz, 1H), 6.62 (d, *J* = 7.5 Hz, 2H), 4.33 (s, 2H), 4.12 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 147.7, 141.9, 130.3, 130.3, 130.2, 129.3, 125.9, 122.7, 117.8, 112.9, 47.7. The spectroscopic data are in accordance with those described in the literature.^[18]



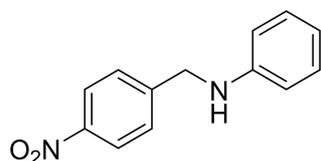
***N*-(2-iodobenzyl)aniline (4e)**

The general procedure was applied to 2-iodo-*N*-phenylbenzamide (64.4 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 48 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (40.4 mg, 65% yield); Melting point: 42.3–44.7 °C; ¹H NMR (400 MHz, CDCl₃): δ = 7.87 (d, *J* = 7.9 Hz, 1H), 7.39 (d, *J* = 6.1 Hz, 1H), 7.31 (t, *J* = 7.5 Hz, 1H), 7.19 (t, *J* = 8.0 Hz, 2H), 6.98 (t, *J* = 7.5 Hz, 1H), 6.74 (t, *J* = 7.3 Hz, 1H), 6.61 (d, *J* = 8.6 Hz, 2H), 4.33 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 147.5, 140.8, 139.4, 129.3, 128.9, 128.7, 128.4, 117.8, 112.9, 98.5, 53.2. The spectroscopic data are in accordance with those described in the literature.^[6]



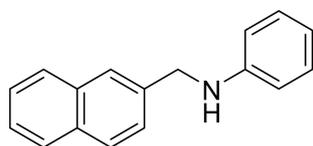
***N*-(4-methylbenzyl)aniline (4f)**

The general procedure was applied to 4-methyl-*N*-phenylbenzamide (42.2 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as red brown liquid (26.4 mg, 67% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.28 (d, *J* = 8.0 Hz, 2H), 7.23 – 7.15 (m, 4H), 6.73 (t, *J* = 6.8 Hz, 1H), 6.65 (d, *J* = 7.8 Hz, 2H), 4.30 (s, 2H), 4.00 (s, 1H), 2.37 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 148.2, 136.9, 136.3, 129.3, 129.2, 127.5, 118.1, 113.5, 54.6, 24.0. The spectroscopic data are in accordance with those described in the literature.^[6]



***N*-(4-nitrobenzyl)aniline (4g)**

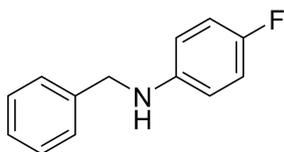
The general procedure was applied to 4-nitro-*N*-phenylbenzamide (48.4 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as orange yellow liquid (33.8 mg, 74% yield); ¹H NMR (400 MHz, CDCl₃): δ = 8.19 (d, *J* = 8.7 Hz, 2H), 7.54 (d, *J* = 8.7 Hz, 2H), 7.18 (t, *J* = 8.7 Hz, 2H), 6.76 (t, *J* = 7.3 Hz, 1H), 6.59 (d, *J* = 8.7 Hz, 2H), 4.48 (s, 2H), 4.29 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 147.5, 147.3, 147.1, 129.3, 127.6, 123.8, 118.1, 112.8, 47.5. The spectroscopic data are in accordance with those described in the literature.^[19]



***N*-(naphthalen-2-ylmethyl)aniline (4h)**

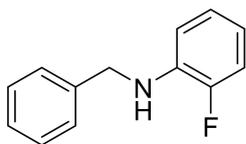
The general procedure was applied to *N*-phenyl-2-naphthamide (49.5 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title

compound as pale yellow liquid (31.1 mg, 67% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.86 (d, J = 9.0 Hz, 4H), 7.57 – 7.45 (m, 3H), 7.22 (t, J = 7.4 Hz, 2H), 6.80 – 6.70 (m, 3H), 4.51 (s, 2H), 4.16 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ = 149.3, 135.2, 133.4, 132.7, 129.3, 128.3, 127.7, 127.7, 126.1, 125.9, 125.7, 117.6, 113.3, 51.5. The spectroscopic data are in accordance with those described in the literature.^[20]



***N*-benzyl-4-fluoroaniline (4i)**

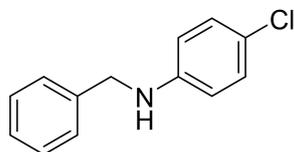
The general procedure was applied to *N*-(4-fluorophenyl)benzamide (43.0 mg, 0.2 mmol) under an atmosphere of N_2 at 85°C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (30.7 mg, 76% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.41 – 7.32 (m, 4H), 7.30 (d, J = 6.3 Hz, 1H), 6.89 (t, J = 8.7 Hz, 2H), 6.60 – 6.57 (m, 2H), 4.30 (s, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ = 155.9 (d, J = 233.8 Hz), 144.4, 139.1, 128.7, 127.5, 127.3, 115.7 (d, J = 22.2 Hz), 113.6 (d, J = 7.4 Hz), 48.9; ^{19}F NMR (376 MHz, CDCl_3): δ = -127.8. The spectroscopic data are in accordance with those described in the literature.^[21]



***N*-benzyl-2-fluoroaniline (4j)**

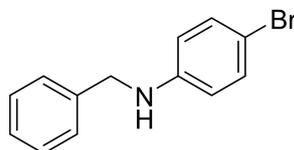
The general procedure was applied to *N*-(2-fluorophenyl)benzamide (43.0 mg, 0.2 mmol) under an atmosphere of N_2 at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale colorless liquid (28.7 mg, 71% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.42 – 7.33 (m, 4H), 7.30 (d, J = 6.9 Hz, 1H), 7.03 – 6.93 (m, 2H), 6.71 – 6.60 (m, 2H), 4.38 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ = 151.5 (d, J = 237.2 Hz), 138.8, 128.7,

127.4, 127.4, 124.6 (d, $J = 3.4$ Hz), 116.8 (d, $J = 7.0$ Hz), 114.5, 114.3, 112.3, 47.8; ^{19}F NMR (376 MHz, CDCl_3): $\delta = -136.3$. The spectroscopic data are in accordance with those described in the literature.^[20]



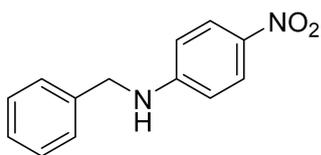
***N*-benzyl-4-chloroaniline (4k)**

The general procedure was applied to *N*-(4-chlorophenyl)benzamide (46.3 mg, 0.2 mmol) under an atmosphere of N_2 at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (31.5 mg, 72% yield); ^1H NMR (400 MHz, CDCl_3): $\delta = 7.37$ (d, $J = 4.5$ Hz, 4H), 7.33 – 7.29 (m, 1H), 7.13 (d, $J = 8.9$ Hz, 2H), 6.56 (d, $J = 8.8$ Hz, 2H), 4.31 (s, 2H), 4.06 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3): $\delta = 147.0, 138.9, 129.5, 128.7, 127.4, 127.3, 122.5, 113.9, 48.3$. The spectroscopic data are in accordance with those described in the literature.^[6]



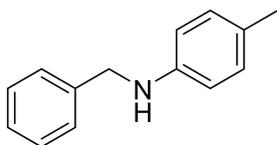
***N*-benzyl-4-bromoaniline (4l)**

The general procedure was applied to *N*-(4-bromophenyl)benzamide (55.2 mg, 0.2 mmol) under an atmosphere of N_2 at 85 °C for 48 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as brown liquid (44.9 mg, 86% yield); ^1H NMR (400 MHz, CDCl_3): $\delta = 7.36$ (d, $J = 4.4$ Hz, 4H), 7.33 – 7.23 (m, 3H), 6.51 (d, $J = 8.8$ Hz, 2H), 4.31 (s, 2H), 4.09 (s, 1H); ^{13}C NMR (100MHz, CDCl_3) $\delta = 147.0, 138.8, 131.9, 128.7, 127.4, 114.9, 109.1, 48.2$. The spectroscopic data are in accordance with those described in the literature.^[22]



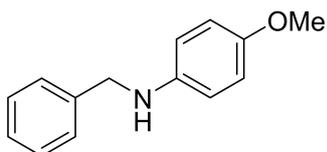
***N*-benzyl-4-nitroaniline (4m)**

The general procedure was applied to *N*-(4-nitrophenyl)benzamide (48.4 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as yellow liquid (33.6 mg, 74% yield); ¹H NMR (400 MHz, DMSO-*d*₆): δ = 7.90 (d, *J* = 9.1 Hz, 2H), 7.77 (t, *J* = 6.0 Hz, 1H), 7.26 (d, *J* = 4.4 Hz, 4H), 7.18 (q, *J* = 4.4 Hz, 1H), 6.59 (d, *J* = 9.0 Hz, 2H), 4.34 (d, *J* = 6.0 Hz, 2H); ¹³C NMR (100 MHz, DMSO-*d*₆): δ = 154.5, 138.6, 136.0, 128.6, 127.4, 127.2, 126.3, 112.5, 46.0. The spectroscopic data are in accordance with those described in the literature.^[22]



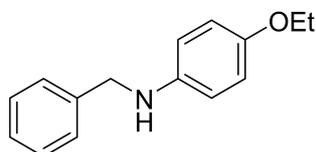
***N*-benzyl-4-methylaniline (4n)**

The general procedure was applied to *N*-(*p*-tolyl)benzamide (42.2 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 48 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (32.9 mg, 84% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.42 – 7.33 (m, 4H), 7.30 (d, *J* = 7.0 Hz, 1H), 7.01 (d, *J* = 8.1 Hz, 2H), 6.59 (d, *J* = 8.4 Hz, 2H), 4.33 (s, 2H), 2.26 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 145.8, 139.6, 129.7, 128.6, 127.5, 127.1, 126.7, 113.0, 48.6, 20.4. The spectroscopic data are in accordance with those described in the literature.^[21]



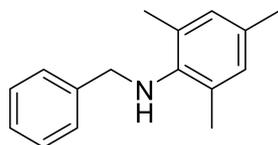
***N*-benzyl-4-methoxyaniline (4o)**

The general procedure was applied to *N*-(4-methoxyphenyl)benzamide (45.4 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (30.7 mg, 72% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.37 (q, *J* = 7.5, 7.0 Hz, 4H), 7.30 (d, *J* = 6.8 Hz, 1H), 6.80 (d, *J* = 9.0 Hz, 2H), 6.62 (d, *J* = 8.9 Hz, 2H), 4.30 (s, 2H), 3.76 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 152.1, 142.3, 139.6, 128.6, 127.5, 127.1, 114.8, 114.1, 55.7, 49.2. The spectroscopic data are in accordance with those described in the literature.^[6]



***N*-benzyl-4-ethoxyaniline (4p)**

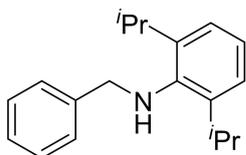
The general procedure was applied to *N*-(4-ethoxyphenyl)benzamide (48.3 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (35.0 mg, 77% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.42 – 7.31 (m, 4H), 7.28 (d, *J* = 6.7 Hz, 1H), 6.78 (d, *J* = 8.9 Hz, 2H), 6.61 (d, *J* = 8.9 Hz, 2H), 4.29 (s, 2H), 3.96 (q, *J* = 7.0 Hz, 2H), 1.37 (t, *J* = 7.0 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 151.5, 142.2, 139.6, 128.6, 127.6, 127.2, 115.7, 114.1, 64.0, 51.3, 15.9. The spectroscopic data are in accordance with those described in the literature.^[18]



***N*-benzyl-2,4,6-trimethylaniline (4q)**

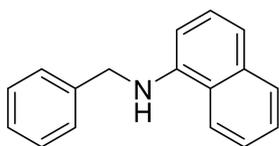
The general procedure was applied to *N*-mesitylbenzamide (47.9 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 48 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title

compound as pale yellow liquid (29.4 mg, 65% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.44 – 7.28 (m, 5H), 6.86 (s, 2H), 4.08 (d, J = 2.2 Hz, 2H), 2.27 (d, J = 3.6 Hz, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ = 143.2, 140.4, 131.7, 130.1, 129.4, 128.5, 128.0, 127.2, 53.1, 20.6, 18.3. The spectroscopic data are in accordance with those described in the literature.^[23]



***N*-benzyl-2,6-diisopropylaniline (4r)**

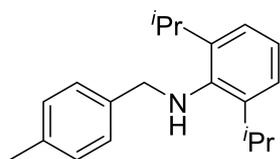
The general procedure was applied to *N*-(2,6-diisopropylphenyl)benzamide (56.3 mg, 0.2 mmol) under an atmosphere of N_2 at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as colorless liquid (32.0 mg, 60% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.45 (s, 2H), 7.40 (s, 2H), 7.33 (s, 1H), 7.14 (s, 3H), 4.06 (s, 2H), 3.33 (d, J = 3.1 Hz, 2H), 1.27 (s, 12H); ^{13}C NMR (100 MHz, CDCl_3): δ = 142.9, 142.8, 140.1, 128.6, 127.9, 127.3, 124.0, 123.6, 56.1, 28.1, 24.3. The spectroscopic data are in accordance with those described in the literature.^[22]



***N*-benzyl-1-naphthylamine (4s)**

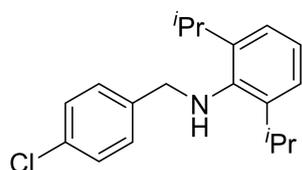
The general procedure was applied to *N*-(naphthalen-1-yl)benzamide (49.5 mg, 0.2 mmol) under an atmosphere of N_2 at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (29.8 mg, 64% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.85 (d, J = 7.7 Hz, 2H), 7.54 – 7.27 (m, 9H), 6.66 (d, J = 7.3 Hz, 1H), 4.72 (s, 1H), 4.52 (s, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ = 143.2, 139.0, 134.2, 128.7, 127.7, 127.4,

126.6, 125.7, 124.7, 123.3, 119.9, 117.6, 104.7, 48.5. The spectroscopic data are in accordance with those described in the literature.^[22]



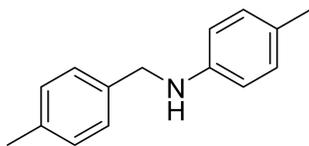
2,6-diisopropyl-*N*-(4-methylbenzyl)aniline (4t)

The general procedure was applied to *N*-(2,6-diisopropylphenyl)-4-methylbenzamide (59.1 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as colorless liquid (33.9 mg, 60% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.37 – 7.31 (m, 2H), 7.20 (d, J = 7.6 Hz, 2H), 7.13 (s, 3H), 4.01 (s, 2H), 3.40 – 3.26 (m, 2H), 2.39 (s, 3H), 1.28 – 1.24 (m, 12H); ¹³C NMR (100 MHz, CDCl₃): δ = 143.0, 142.7, 137.1, 136.9, 129.2, 128.2, 124.0, 123.6, 56.2, 27.7, 24.3, 21.1. The spectroscopic data are in accordance with those described in the literature.^[22]



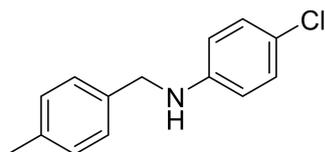
N-(4-chlorobenzyl)-2,6-diisopropylaniline (4u)

The general procedure was applied to 4-chloro-*N*-(2,6-diisopropylphenyl)benzamide (63.3 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 24 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as colorless liquid (41.9 mg, 69% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.39 – 7.32 (m, 4H), 7.17 – 7.08 (m, 3H), 4.01 (s, 2H), 3.31 – 3.23 (m, J = 6.9 Hz, 2H), 1.25 (d, J = 7.7 Hz, 12H); ¹³C NMR (100 MHz, CDCl₃): δ = 142.7, 142.6, 138.6, 133.0, 129.2, 128.6, 124.6, 123.6, 55.3, 28.2, 24.2. The spectroscopic data are in accordance with those described in the literature.^[22]



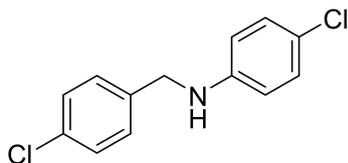
4-methyl-*N*-(4-methylbenzyl)aniline (4v)

The general procedure was applied to 4-methyl-*N*-(*p*-tolyl)benzamide (45.1 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as yellow solid (33.6 mg, 79% yield); Melting point: 53.9–54.2 °C; ¹H NMR (400 MHz, CDCl₃): δ = 7.29 (d, *J* = 8.0 Hz, 2H), 7.18 (d, *J* = 7.8 Hz, 2H), 7.02 (d, *J* = 8.4 Hz, 2H), 6.59 (d, *J* = 8.4 Hz, 2H), 4.29 (s, 2H), 2.38 (s, 3H), 2.27 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 145.9, 136.7, 136.5, 129.7, 129.2, 127.5, 126.6, 113.0, 48.4, 21.1, 20.4. The spectroscopic data are in accordance with those described in the literature.^[6]



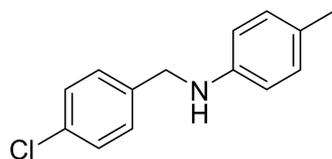
4-chloro-*N*-(4-methylbenzyl)aniline (4w)

The general procedure was applied to *N*-(4-chlorophenyl)-4-methylbenzamide (49.1 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 48 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow solid (34.9 mg, 75% yield); Melting point: 67.4–68.2 °C; ¹H NMR (400 MHz, CDCl₃): δ = 7.24 (s, 2H), 7.17 (d, *J* = 7.9 Hz, 2H), 7.11 (d, *J* = 8.7 Hz, 2H), 6.55 (d, *J* = 8.8 Hz, 2H), 4.26 (s, 2H), 4.07 (s, 1H), 2.36 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 146.6, 137.0, 135.8, 129.3, 129.0, 127.4, 122.0, 113.9, 48.1, 21.1. The spectroscopic data are in accordance with those described in the literature.^[6]



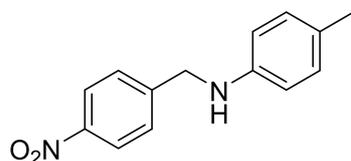
4-chloro-*N*-(4-chlorobenzyl)aniline (4x)

The general procedure was applied to 4-chloro-*N*-(4-chlorophenyl)benzamide (53.2 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow solid (36.7 mg, 73% yield); Melting point: 63.9–68.7 °C; ¹H NMR (400 MHz, CDCl₃): δ = 7.34 – 7.27 (m, 4H), 7.16 – 7.05 (m, 2H), 6.54 – 6.50 (m, 2H), 4.28 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 146.3, 137.5, 133.0, 129.1, 128.9, 128.6, 122.4, 114.0, 44.6. The spectroscopic data are in accordance with those described in the literature.^[6]



N-(4-chlorobenzyl)-4-methylaniline (4y)

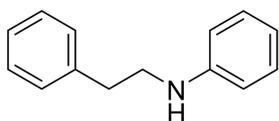
The general procedure was applied to 4-chloro-*N*-(*p*-tolyl)benzamide (49.1 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 48 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (34.1 mg, 74% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.31 (s, 4H), 7.00 (d, *J* = 8.5 Hz, 2H), 6.55 (d, *J* = 8.4 Hz, 2H), 4.30 (s, 2H), 2.25 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 145.5, 138.2, 132.7, 129.8, 128.7, 127.0, 113.0, 47.9, 20.4. The spectroscopic data are in accordance with those described in the literature.^[6]



4-methyl-*N*-(4-nitrobenzyl)aniline (4z)

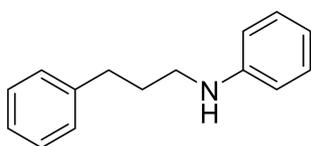
The general procedure was applied to 4-nitro-*N*-(*p*-tolyl)benzamide (51.2 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 48 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as orange yellow solid (39.7 mg, 82% yield); Melting point: 63.1–64.3 °C; ¹H

NMR (400 MHz, CDCl₃): δ = 8.18 (d, J = 8.7 Hz, 2H), 7.53 (d, J = 8.7 Hz, 2H), 6.99 (d, J = 8.5 Hz, 2H), 6.51 (d, J = 8.4 Hz, 2H), 4.46 (s, 2H), 2.24 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 147.7, 147.1, 144.9, 129.8, 127.7, 127.4, 123.8, 113.0, 47.8, 20.0. The spectroscopic data are in accordance with those described in the literature.^[24]



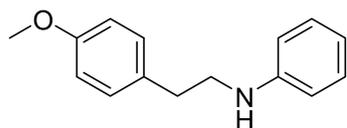
***N*-phenethylamine (4aa)**

The general procedure was applied to *N*,2-diphenylacetamide (42.2 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as red brown liquid (28.8 mg, 73% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.37 – 7.31 (m, 2H), 7.29 – 7.17 (m, 5H), 6.74 (t, J = 7.3 Hz, 1H), 6.64 (d, J = 7.5 Hz, 2H), 3.69 (s, 1H), 3.42 (t, J = 7.0 Hz, 2H), 2.94 (t, J = 7.0 Hz, 2H); ¹³C NMR (100 MHz, CDCl₃): δ = 147.9, 139.3, 129.3, 128.8, 128.6, 126.4, 117.4, 112.9, 45.0, 35.4. The spectroscopic data are in accordance with those described in the literature.^[25]



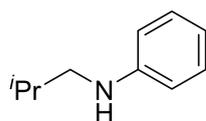
***N*-(3-phenylpropyl)aniline (4ab)**

The general procedure was applied to *N*,3-diphenylpropanamide (51.1 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (36.1 mg, 75% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.35 – 7.13 (m, 7H), 6.91 (s, 3H), 3.19 (d, J = 7.7 Hz, 2H), 2.72 (d, J = 7.8 Hz, 2H), 2.04 (d, J = 7.7 Hz, 2H); ¹³C NMR (100 MHz, CDCl₃): δ = 143.4, 141.6, 129.5, 128.4, 128.3, 124.3, 121.1, 116.1, 46.2, 33.5, 30.2. The spectroscopic data are in accordance with those described in the literature.^[6]



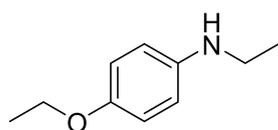
***N*-(4-methoxyphenethyl)aniline (4ac)**

The general procedure was applied to 2-(4-methoxyphenyl)-*N*-phenylacetamide (48.3 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow solid (32.8 mg, 72% yield); Melting point: 93.8–96.4 °C; ¹H NMR (400 MHz, CDCl₃): δ = 7.35 (d, *J* = 5.9 Hz, 4H), 7.22 – 7.15 (m, 1H), 7.06 (d, *J* = 8.6 Hz, 2H), 6.79 (d, *J* = 8.6 Hz, 2H), 3.76 (s, 3H), 3.49 – 3.35 (m, 2H), 3.13–2.99 (m, 2H); ¹³C NMR (100 MHz, CDCl₃): δ = 155.4, 137.6, 129.8, 129.7, 129.0, 125.8, 119.7, 112.2, 55.8, 50.0, 33.7. The spectroscopic data are in accordance with those described in the literature.^[30]



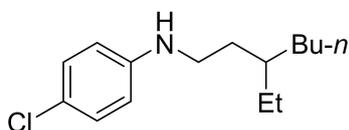
***N*-isobutylaniline (4ad)**

The general procedure was applied to *N*-phenylisobutyramide (32.6 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale colorless liquid (20.6 mg, 69% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.18 (d, *J* = 7.6 Hz, 2H), 6.69 (t, *J* = 7.3 Hz, 1H), 6.61 (d, *J* = 8.7 Hz, 2H), 2.93 (d, *J* = 6.7 Hz, 2H), 1.96 – 1.83 (m, 1H), 0.98 (d, *J* = 6.7 Hz, 6H); ¹³C NMR (100 MHz, CDCl₃): δ = 148.4, 129.2, 117.1, 112.1, 44.8, 27.3, 20.5. The spectroscopic data are in accordance with those described in the literature.^[22]



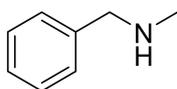
4-ethoxy-*N*-ethylaniline(4ae)

The general procedure was applied to *N*-ethylbenzamide (35.8 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (24.9 mg, 75% yield); ¹H NMR (400 MHz, CDCl₃): δ = 6.79 (d, *J* = 8.9 Hz, 2H), 6.58 (d, *J* = 9.0 Hz, 2H), 3.97 (q, *J* = 7.0 Hz, 2H), 3.12 (q, *J* = 7.1 Hz, 2H), 1.38 (t, *J* = 7.0 Hz, 3H), 1.24 (t, *J* = 7.1 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 151.3, 142.7, 115.8, 114.0, 64.1, 39.4, 29.7, 15.0. The spectroscopic data are in accordance with those described in the literature.^[28]



4-chloro-*N*-(3-ethylheptyl)aniline (4af)

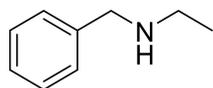
The general procedure was applied to 3-ethyl-*N*-phenylheptanamide (50.7 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (40.0 mg, 84% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.11 (d, *J* = 8.8 Hz, 2H), 6.52 (d, *J* = 8.8 Hz, 2H), 3.67 (s, 1H), 2.98 (d, *J* = 6.2 Hz, 2H), 1.62 – 1.49 (m, 1H), 1.45 – 1.24 (m, 9H), 0.91 (d, *J* = 14.6 Hz, 7H); ¹³C NMR (100 MHz, CDCl₃): δ = 147.2, 129.0, 121.8, 113.6, 47.6, 38.9, 31.7, 29.7, 28.9, 24.9, 23.6, 14.9, 10.4. The spectroscopic data are in accordance with those described in the literature.



N-benzyl-*N*-phenylaniline (4ag)

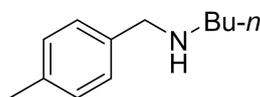
The general procedure was applied to *N*-methylbenzamide (27.0 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale white solid (19.0 mg, 70% yield); Melting point: 75.9 –79.5 °C; ¹H

NMR (400 MHz, CDCl₃): δ = 7.41 – 7.27 (m, 5H), 4.29 (d, J = 16.9 Hz, 1H), 4.00 (s, 1H), 3.53 – 3.45 (m, 1H), 2.41 (d, J = 5.7 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 134.1, 129.4, 129.1, 128.9, 60.9, 40.2. The spectroscopic data are in accordance with those described in the literature.^[25]



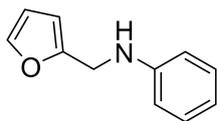
***N*-benzyl-*N*-phenylaniline (4ah)**

The general procedure was applied to *N*-ethylbenzamide (29.8 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (22.8 mg, 84% yield); Melting point: 80.2–81.7 °C; ¹H NMR (400 MHz, CDCl₃): δ = 7.50 – 7.33 (m, 3H), 7.30 (d, J = 6.8 Hz, 2H), 4.19 (t, J = 8.4 Hz, 1H), 3.65 (d, J = 9.6 Hz, 1H), 2.83 (s, 1H), 2.67 (s, 1H), 1.27 – 1.18 (m, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 134.3, 129.3, 129.1, 128.7, 59.2, 47.5, 11.7. The spectroscopic data are in accordance with those described in the literature.^[15]



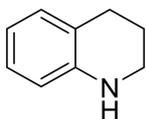
***N*-(4-methylbenzyl)butan-1-amine (4ai)**

The general procedure was applied to *N*-butyl-4-methylbenzamide (38.2 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 48 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (26.4 mg, 75% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.23 – 7.13 (m, 4H), 4.17 (d, J = 13.4 Hz, 1H), 3.63 – 3.54 (m, 1H), 3.41 (s, 1H), 2.65 (d, J = 29.5 Hz, 2H), 2.36 (s, 3H), 1.69 (d, J = 5.5 Hz, 1H), 1.57 (s, 1H), 1.27 – 1.10 (m, J = 28.2, 13.7, 6.9 Hz, 2H), 0.83 (t, J = 7.3 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃): δ = 138.7, 131.4, 129.7, 129.2, 59.6, 52.9, 28.3, 21.2, 19.8, 13.5. The spectroscopic data are in accordance with those described in the literature.^[29]



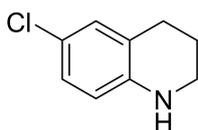
***N*-(furan-2-ylmethyl)aniline (4aj)**

The general procedure was applied to *N*-phenylfuran-2-carboxamide (37.4 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (23.7 mg, 68% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.38 (s, 1H), 7.24 – 7.17 (m, 2H), 6.76 (t, *J* = 7.4 Hz, 1H), 6.69 (d, *J* = 7.4 Hz, 2H), 6.35 – 6.32 (m, 1H), 6.25 (d, *J* = 3.8 Hz, 1H), 4.33 (s, 2H), 4.07 (s, 1H); ¹³C NMR (100 MHz, CDCl₃): δ = 152.7, 147.5, 141.9, 129.2, 118.0, 113.1, 110.3, 107.0, 41.4. The spectroscopic data are in accordance with those described in the literature.^[6]



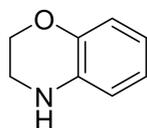
1,2,3,4-tetrahydroquinoline (4ak)

The general procedure was applied to 3,4-dihydroquinolin-2(1H)-one (29.4 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (20.8 mg, 78% yield); ¹H NMR (400 MHz, CDCl₃): δ = 6.96 (d, *J* = 8.0 Hz, 2H), 6.61 (t, *J* = 7.4 Hz, 1H), 6.48 (d, *J* = 7.8 Hz, 1H), 3.34 – 3.27 (m, 2H), 2.78 (t, *J* = 6.4 Hz, 2H), 1.99 – 1.91 (m, 2H); ¹³C NMR (100 MHz, CDCl₃): δ = 144.7, 129.5, 126.7, 121.4, 116.9, 114.1, 41.9, 26.9, 22.1. The spectroscopic data are in accordance with those described in the literature.^[27]



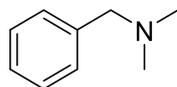
6-chloro-1,2,3,4-tetrahydroquinoline (4al)

The general procedure was applied to 6-chloro-3,4-dihydroquinolin-2(1H)-one (36.3 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (29.7 mg, 81% yield); ¹H NMR (400 MHz, CDCl₃): δ = 6.90 (d, *J* = 8.0 Hz, 2H), 6.38 (d, *J* = 8.6 Hz, 1H), 3.33 – 3.23 (m, 2H), 2.73 (t, *J* = 6.4 Hz, 2H), 1.95 – 1.87 (m, 2H); ¹³C NMR (100 MHz, CDCl₃): δ = 143.2, 129.0, 126.5, 122.8, 121.1, 115.0, 41.8, 26.8, 21.7. The spectroscopic data are in accordance with those described in the literature.^[27]



3,4-dihydro-2H-benzo[b][1,4]oxazine (4am)

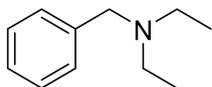
The general procedure was applied to 2H-benzo[b][1,4]oxazin-3(4H)-one (29.8 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (16.1 mg, 60% yield); ¹H NMR (400 MHz, CDCl₃): δ = 6.81 – 6.73 (m, 2H), 6.69 – 6.63 (m, 1H), 6.62 – 6.58 (m, 1H), 4.30 – 4.22 (m, 2H), 3.74 (s, 1H), 3.46 – 3.39 (m, 2H); ¹³C NMR (100 MHz, CDCl₃): δ = 144.1, 133.6, 121.3, 118.8, 116.7, 115.6, 65.2, 40.9. The spectroscopic data are in accordance with those described in the literature.^[27]



N,N-dimethyl-1-phenylmethanamine (4an)

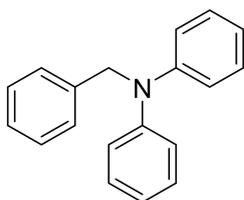
The general procedure was applied to *N,N*-dimethylbenzamide (29.8 mg, 0.2 mmol) under an atmosphere of N₂ at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as colorless oil (19.7 mg, 73% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.41

(s, 3H), 7.34 (s, 2H), 3.99 (s, 2H), 2.51 (s, 6H); ^{13}C NMR (100 MHz, CDCl_3): δ = 132.2, 131.2, 129.1, 128.4, 67.5, 49.6. The spectroscopic data are in accordance with those described in the literature.^[25]



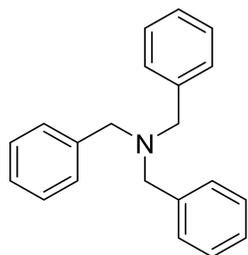
***N*-benzyl-*N*-phenylaniline (4ao)**

The general procedure was applied to *N,N*-diethylbenzamide (35.4 mg, 0.2 mmol) under an atmosphere of N_2 at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (22.8 mg, 70% yield); ^1H NMR (400 MHz, CDCl_3): δ = 7.37 (s, 5H), 3.94 (s, 2H), 2.77 – 2.70 (m, 4H), 1.32 (t, J = 7.3 Hz, 6H); ^{13}C NMR (100 MHz, CDCl_3): δ = 132.3, 131.5, 128.8, 128.2, 62.3, 52.6, 9.3. The spectroscopic data are in accordance with those described in the literature.^[21]



***N*-benzyl-*N*-phenylaniline (4ap)**

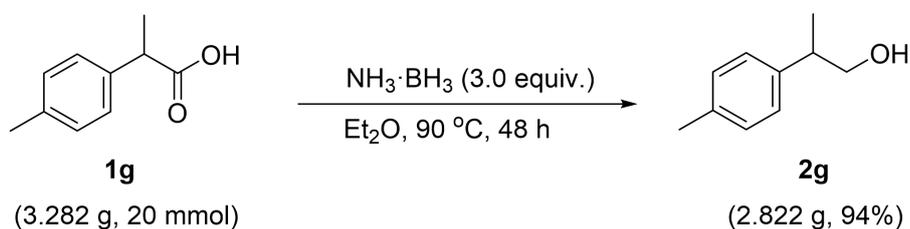
The general procedure was applied to *N,N*-diphenylbenzamide (54.7 mg, 0.2 mmol) under an atmosphere of N_2 at 85 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow solid (31.4 mg, 61% yield); Melting point: 82.4–84.3 °C; ^1H NMR (400 MHz, CDCl_3): δ = 7.37 – 7.28 (m, 4H), 7.27 – 7.21 (m, 5H), 7.08 (d, J = 7.8 Hz, 4H), 6.94 (t, J = 7.3 Hz, 2H), 5.01 (s, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ = 148.0, 139.2, 129.2, 128.5, 126.7, 126.5, 121.3, 120.6, 56.3. The spectroscopic data are in accordance with those described in the literature.^[21]



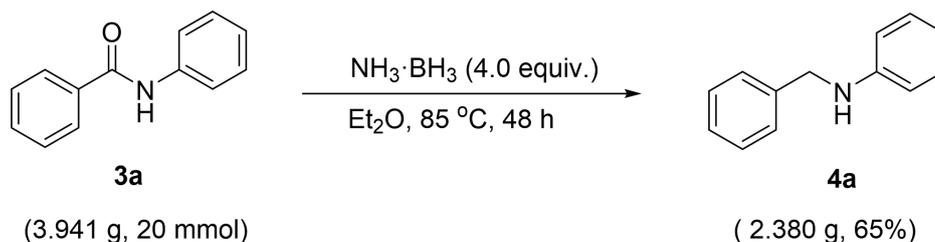
***N*-benzyl-*N*-phenylaniline (4aq)**

The general procedure was applied to *N,N*-dibenzylbenzamide (60.3 mg, 0.2 mmol) under an atmosphere of N₂ at 70 °C for 12 h. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the title compound as pale yellow liquid (35.4 mg, 62% yield); ¹H NMR (400 MHz, CDCl₃): δ = 7.47 (d, *J* = 7.4 Hz, 6H), 7.37 (t, *J* = 7.5 Hz, 6H), 7.28 (t, *J* = 7.4 Hz, 3H), 3.61 (s, 6H); ¹³C NMR (100 MHz, CDCl₃): δ = 139.6, 128.7, 128.0, 126.8, 57.9. The spectroscopic data are in accordance with those described in the literature.^[25]

6. Gram-scale hydrogenation of 1g and 3a

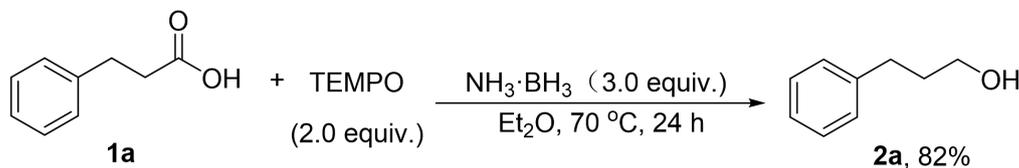
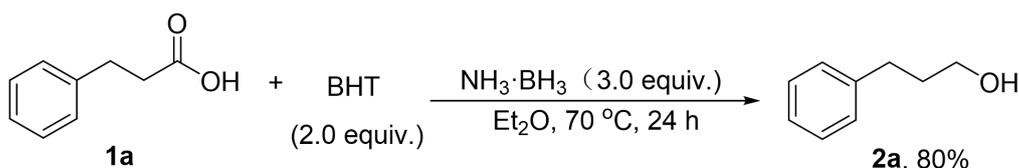


A mix of substrate **1g** (20 mmol, 3.282 g) was added to an oven dried schlenk tube under atmosphere of nitrogen, NH₃·BH₃ (3.0 equiv., 1.852 g) and Et₂O (180 mL) were added by syringe. The reaction mixture was stirred at 90 °C for 48 h. After quenched with NH₄Cl/H₂O (30 mL) and extracted with EtOAc (3×40 mL). The combined organic phases were dried over anhydrous Na₂SO₄ and concentrated under vacuum. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=5:1) to afford the compound **2g**.

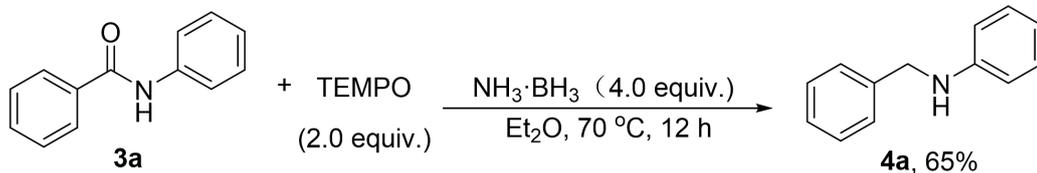
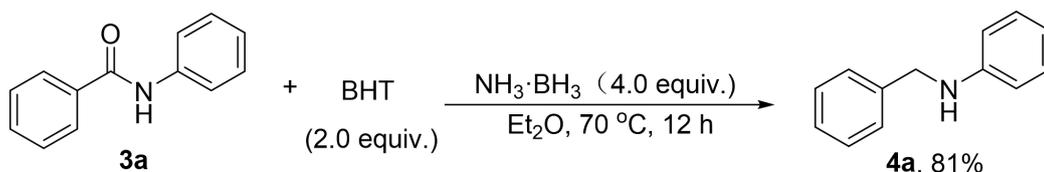


A mix of substrate **3a** (20 mmol, 3.941 g) was added to an oven dried schlenk tube under atmosphere of nitrogen, $\text{NH}_3\cdot\text{BH}_3$ (4.0 equiv., 2.469 g) and Et_2O (180 mL) were added by syringe. The reaction mixture was stirred at 85 °C for 48 h. After quenched with $\text{NH}_4\text{Cl}/\text{H}_2\text{O}$ (30 mL) and extracted with EtOAc (3×40 mL). The combined organic phases were dried over anhydrous Na_2SO_4 and concentrated under vacuum. The crude product was purified by column chromatography on silica gel (Petroleum ether/ EtOAc =15:1) to afford the compound **4a**.

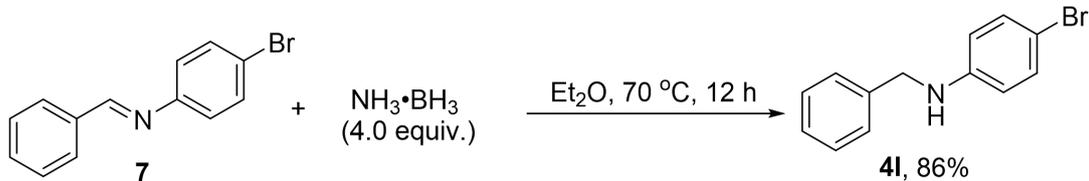
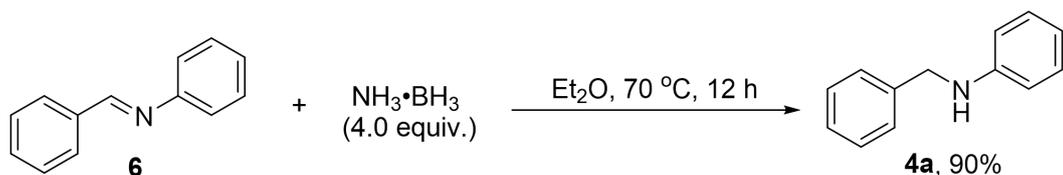
7. Control experiments and Deuteration experiments



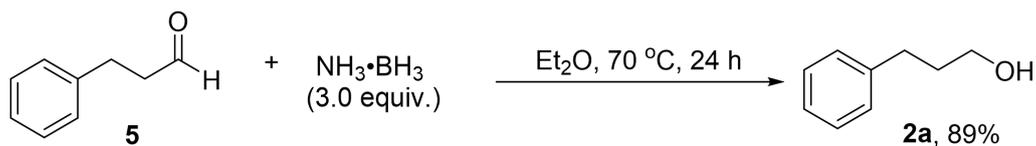
A mix of substrate **1a** (0.2 mmol) and $\text{NH}_3\cdot\text{BH}_3$ (3 equiv.) were added to an oven dried schlenk tube under atmosphere of nitrogen, Et_2O (2.5 mL) were added by syringe. Then 2.0 equiv. of BHT or TEMPO was added. The reaction mixture was stirred at 70 °C for 24 h. After quenched with $\text{NH}_4\text{Cl}/\text{H}_2\text{O}$ (4 mL) and extracted with EtOAc (3×5 mL). The combined organic phases were dried over anhydrous Na_2SO_4 and concentrated under vacuum. The crude product was purified by column chromatography on silica gel (Petroleum ether/ EtOAc =5:1) to afford the compound **2a**.



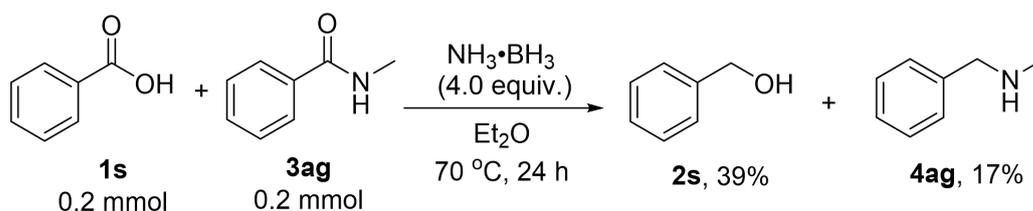
A mix of substrate **3a** (0.2 mmol) and $\text{NH}_3\cdot\text{BH}_3$ (4 equiv.) were added to an oven dried schlenk tube under atmosphere of nitrogen, Et_2O (2.5 mL) were added by syringe. Then 2.0 equiv. of BHT or TEMPO was added. The reaction mixture was stirred at 70 °C for 12 h. After quenched with $\text{NH}_4\text{Cl}/\text{H}_2\text{O}$ (4 mL) and extracted with EtOAc (3×5 mL). The combined organic phases were dried over anhydrous Na_2SO_4 and concentrated under vacuum. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the compound **4a**.



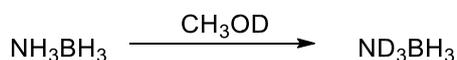
A mix of substrate **6** or **7** (0.2 mmol) and $\text{NH}_3\cdot\text{BH}_3$ (4 equiv.) were added to an oven dried schlenk tube under atmosphere of nitrogen, Et_2O (2.5 mL) were added by syringe. The reaction mixture was stirred at 70 °C for 12 h. After quenched with $\text{NH}_4\text{Cl}/\text{H}_2\text{O}$ (4 mL) and extracted with EtOAc (3×5 mL). The combined organic phases were dried over anhydrous Na_2SO_4 and concentrated under vacuum. The crude product was purified by column chromatography on silica gel (Petroleum ether/EtOAc=15:1) to afford the compound **4a** or **4l**.



A mix of substrate **5** (0.2 mmol) and $\text{NH}_3 \cdot \text{BH}_3$ (3 equiv.) were added to an oven dried schlenk tube under atmosphere of nitrogen, Et_2O (2.5 mL) were added by syringe. The reaction mixture was stirred at 70 °C for 24 h. After quenched with $\text{NH}_4\text{Cl}/\text{H}_2\text{O}$ (4 mL) and extracted with EtOAc (3×5 mL). The combined organic phases were dried over anhydrous Na_2SO_4 and concentrated under vacuum. The crude product was purified by column chromatography on silica gel (Petroleum ether/ EtOAc =5:1) to afford the compound **2a**.



A mix of substrate **1s** (0.2 mmol) and **3ag** (0.2 mmol) were added to an oven dried schlenk tube under atmosphere of nitrogen, Et_2O (2.5 mL) were added by syringe. Then 4.0 equiv. of $\text{NH}_3 \cdot \text{BH}_3$ was added. The reaction mixture was stirred at 70 °C for 24 h. After quenched with $\text{NH}_4\text{Cl}/\text{H}_2\text{O}$ (4 mL) and extracted with EtOAc (3×5 mL). The combined organic phases were dried over anhydrous Na_2SO_4 and concentrated under vacuum. The crude product was purified by column chromatography on silica gel (Petroleum ether/ EtOAc = 5:1 and 15:1) to afford the compound **2s** and **4ag**.



A 25 mL bottle equipped with a magnetic stir bar was charged with $\text{NH}_3 \cdot \text{BH}_3$ (153 mg, 4.96 mmol) and CH_3OD (10 mL). the mixture was reacting under air at 25 °C for 6 h. The mixture was reduced in vacuo to give 128 mg (83.7%) $\text{ND}_3 \cdot \text{BH}_3$ as white solid. ^1H

NMR (400 MHz, Acetonitrile- d_3): $\delta = 3.63 - 3.40$ (m, 0.13H), 1.72 - 0.79 (m, 3H). The spectroscopic data are in accordance with those described in the literature.^[16]

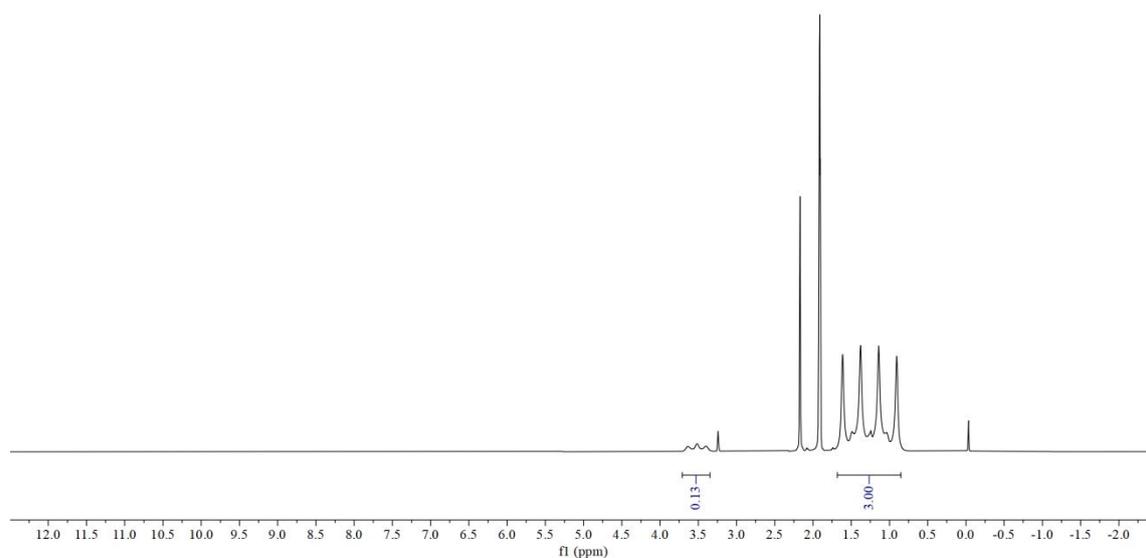
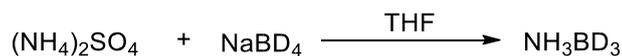


Figure S1. ^1H NMR (400 MHz, Acetonitrile- d_3) spectrum of $\text{BH}_3\cdot\text{ND}_3$



A 500 mL bottle equipped with a magnetic stir bar was charged with NaBD_4 (1.0 g, 23.8 mmol, 1.0 equiv.), $(\text{NH}_4)_2\text{SO}_4$ (3.2 g, 24.2 mmol, 1.02 equiv.) and THF (200 mL). The mixture was reacting under air at 25 °C for 24 h. The mixture was reduced in vacuo and sublimated to give 496 mg (67.6%) $\text{NH}_3\cdot\text{BD}_3$ as white solid. ^1H NMR (400 MHz, Acetonitrile- d_3): $\delta = 3.52$ (t, $J = 47.9$ Hz, 3H), 1.81 - 0.72 (m, 0.68H). The spectroscopic data are in accordance with those described in the literature.^[16]

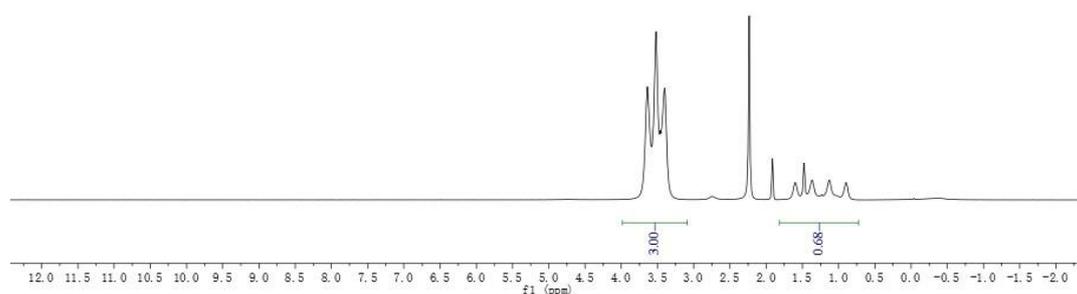
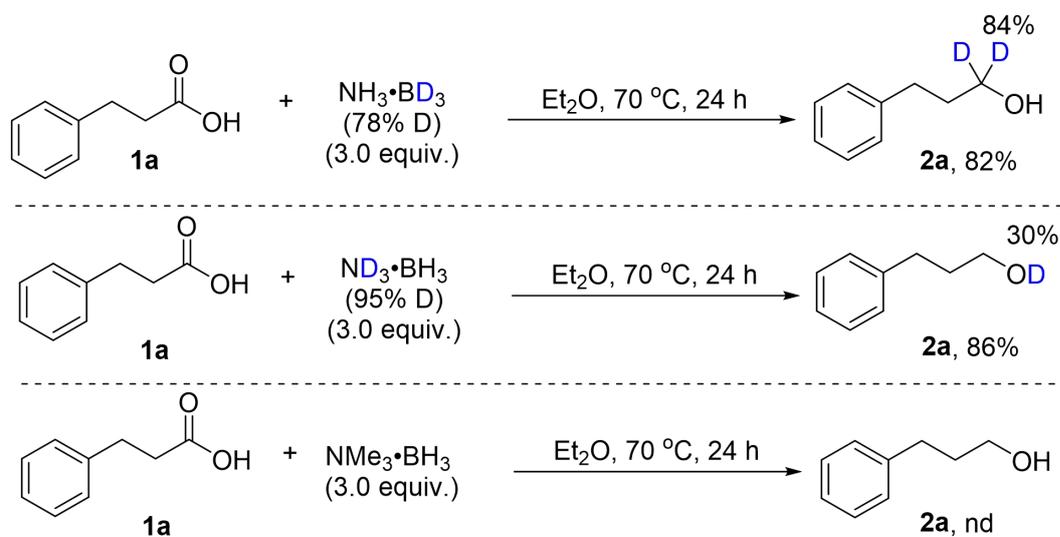


Figure S2. ^1H NMR (400 MHz, Acetonitrile- d_3) spectrum of $\text{NH}_3\cdot\text{BD}_3$



A mixture of **1a** (0.2 mmol), $\text{ND}_3\cdot\text{BH}_3$, $\text{NH}_3\cdot\text{BD}_3$ and $\text{NMe}_3\cdot\text{BH}_3$ (0.0185 g, 3.0 equiv.) were added to an oven dried schlenk tube under atmosphere of nitrogen. Et_2O (2.5 mL) were added by syringe. The reaction mixture was stirred at 70 $^\circ\text{C}$ for 24 h. the crude product was extracted with EtOAc (3×10 mL). The combined organic phases were dried over anhydrous Na_2SO_4 and concentrated under vacuum, the crude product was purified by column chromatography to afford the desired hydrogenation compound.

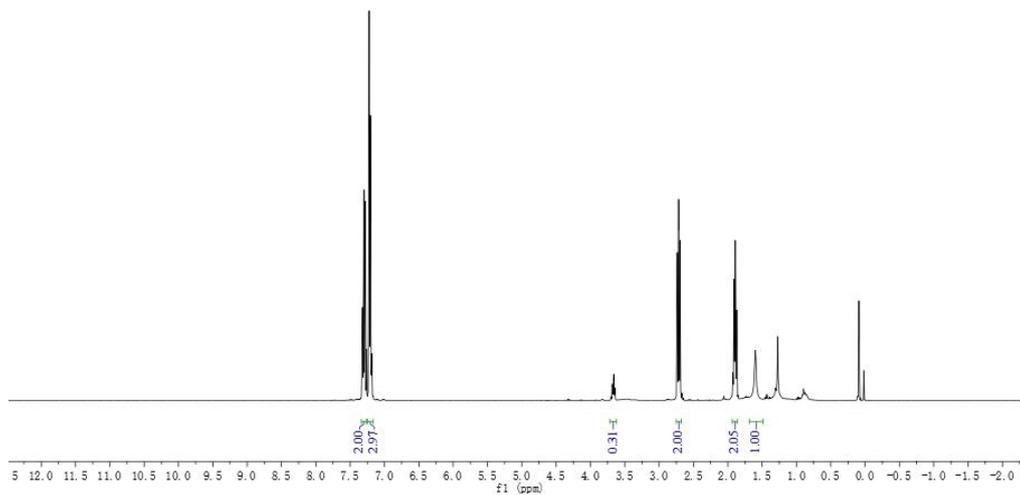


Figure S3. ^1H NMR (400 MHz, CDCl_3) spectrum of **1a** with $\text{NH}_3\cdot\text{BD}_3$

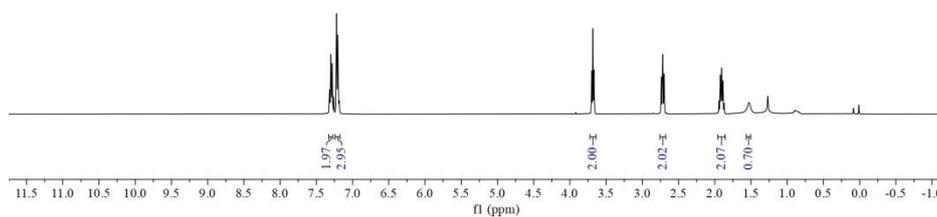
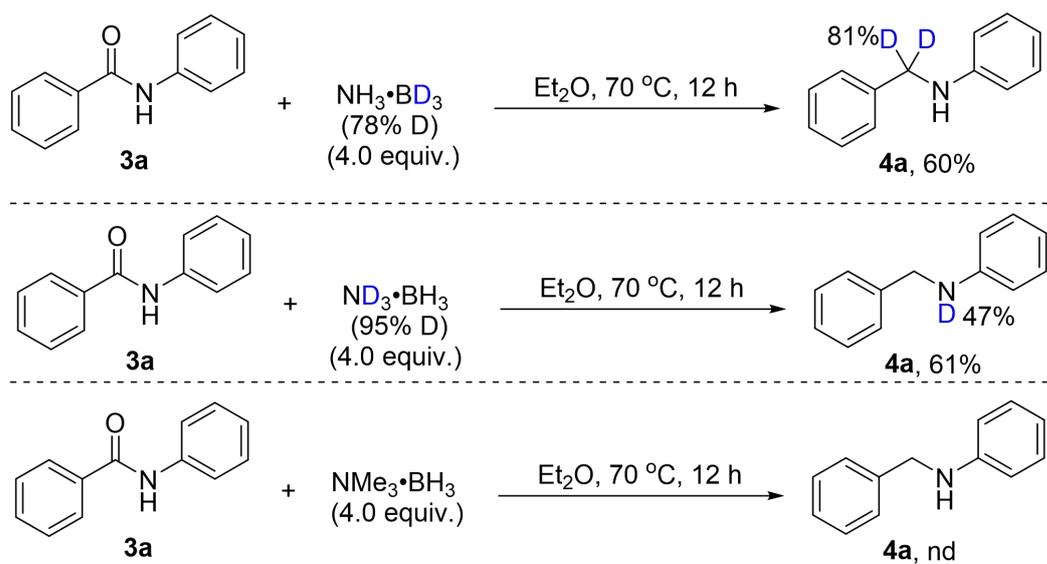


Figure S4. ^1H NMR (400 MHz, CDCl_3) spectrum of **1a** with $\text{ND}_3\cdot\text{BH}_3$



A mixture of **3a** (0.2 mmol), $\text{ND}_3 \cdot \text{BH}_3$, $\text{NH}_3 \cdot \text{BD}_3$ and $\text{NMe}_3 \cdot \text{BH}_3$ (0.0246 g, 4.0 equiv.) were added to an oven dried schlenk tube under atmosphere of nitrogen. Et_2O (2.5 mL) were added by syringe. The reaction mixture was stirred at 70 °C for 12 h. the crude product was extracted with EtOAc (3×10 mL). The combined organic phases were dried over anhydrous Na_2SO_4 and concentrated under vacuum, the crude product was purified by column chromatography to afford the desired hydrogenation compound.

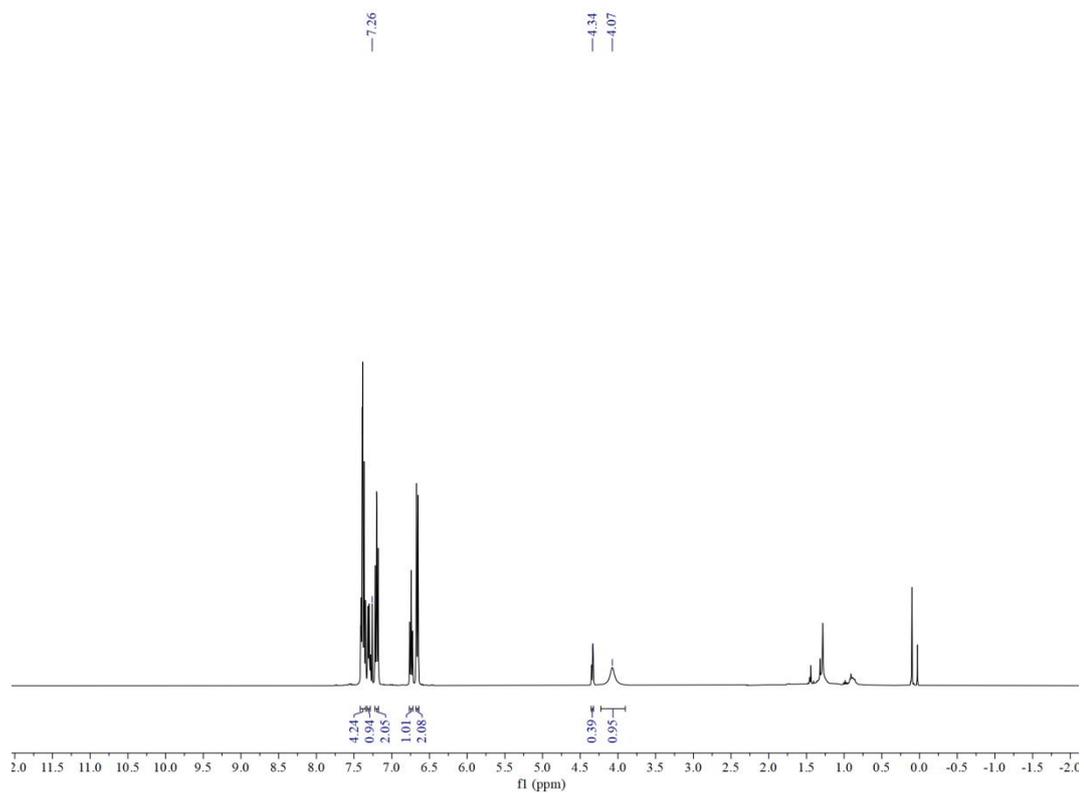


Figure S5. ^1H NMR (400 MHz, CDCl_3) spectrum of **3a** with $\text{NH}_3 \cdot \text{BD}_3$

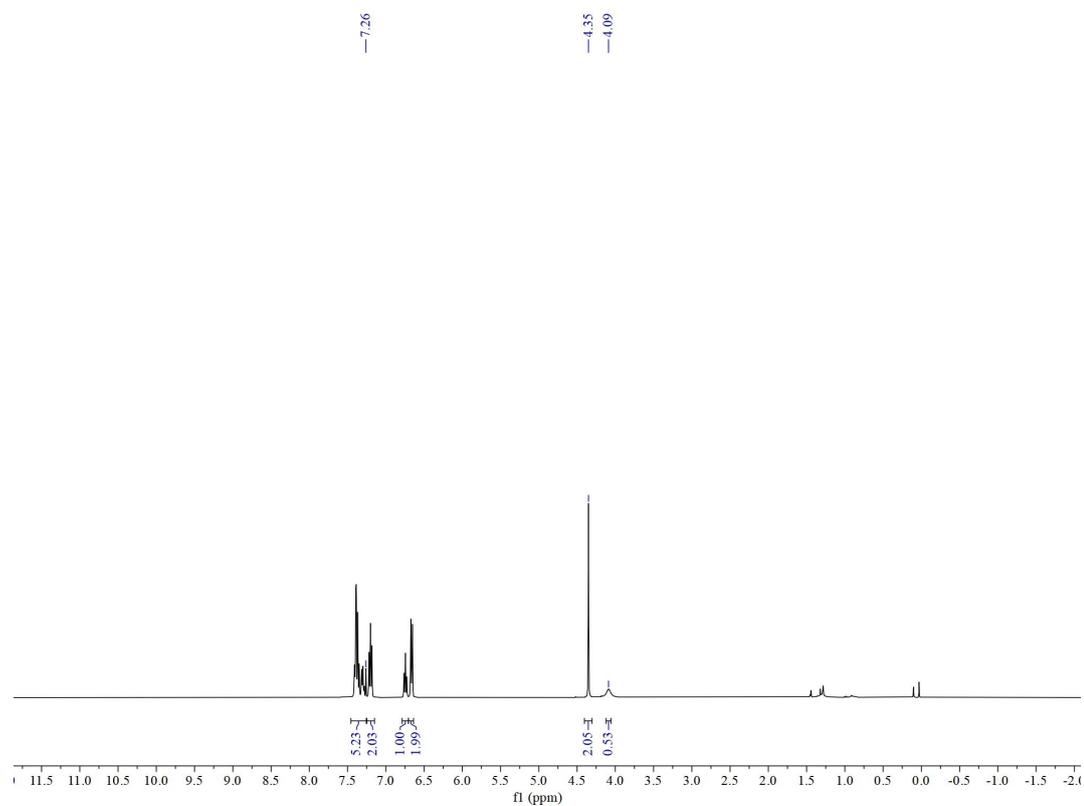


Figure S6. ^1H NMR (400 MHz, CDCl_3) spectrum of **3a** with $\text{ND}_3 \cdot \text{BH}_3$

8. Studying the reaction profile of hydrogenation of 1a and 3a.

Kinetic studies were performed by treating **3a** (0.2 mmol), $\text{NH}_3 \cdot \text{BH}_3$ (4 equiv.) and Et_2O (2.5 mL) at 70 °C. The yield of **4a** and the recovery of **3a** were determined by ^1H NMR analysis using 1,3,5-trimethoxybenzene as an internal standard. The data points for reaction profiles were collected by performing multiple batches of the reaction with different reaction times.

Table S9. Studying the reaction profile of hydrogenation of 3a.

Time (h)	Recovery of 3a (%)	Yield of 4a (%)
0	1	0
1	0.93	0.06
1.333	0.8	0.19
1.667	0.66	0.32
2	0.55	0.44
4	0.46	0.51
8	0.36	0.58
10	0.2	0.65
11	0.1	0.71
12	0	0.74
16	0	0.74

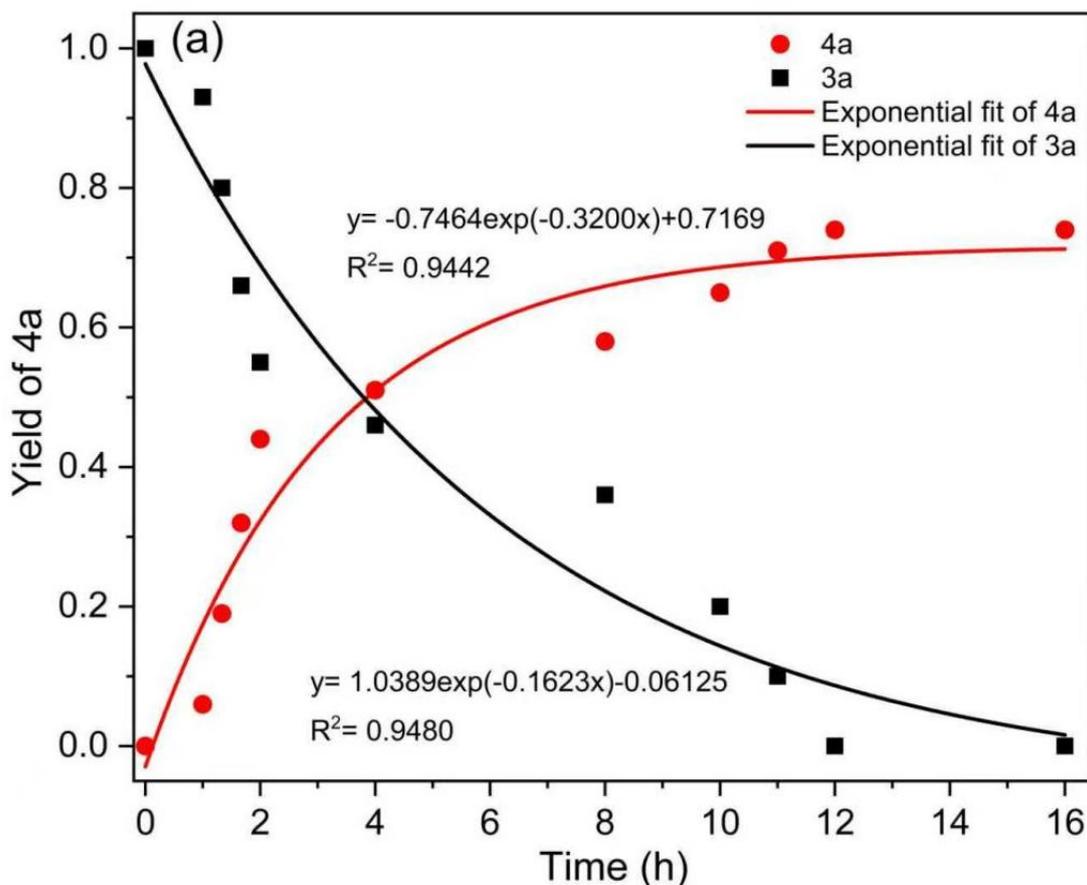


Figure S7. Reaction profile (exponential fit) for catalyst-free hydrogenation of **3a**

Kinetic studies were performed by treating **1a** (0.2 mmol), $\text{NH}_3 \cdot \text{BH}_3$ (3 equiv.) and Et_2O (2.5 mL) at 70 °C. The yield of **2a** and the recovery of **1a** were determined by ^1H NMR analysis using 1,3,5-trimethoxybenzene as an internal standard. The data points for reaction profiles were collected by performing multiple batches of the reaction with different reaction times.

Table S10. Studying the reaction profile of hydrogenation of **1a**.

Time (h)	Recovery of 1a (%)	Yield of 2a (%)
0	1	0
0.333	0.9	0.1
0.667	0.72	0.24
1	0.67	0.32
2	0.55	0.42

4	0.38	0.59
6	0.2	0.78
8	0.14	0.82
12	0.09	0.84
16	0.05	0.88
24	0	0.90

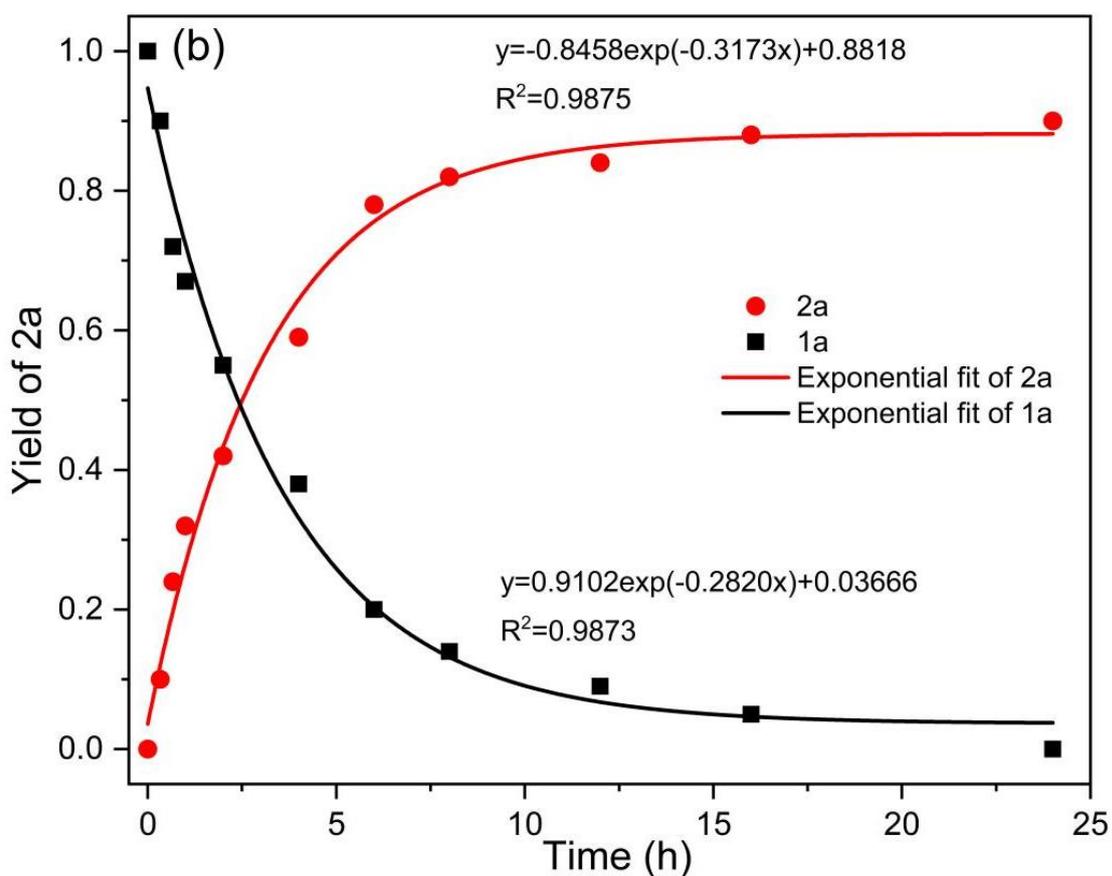


Figure S8. Reaction profile (exponential fit) for catalyst-free hydrogenation of **1a**

9. Kinetic experiments

Procedure for determining the order in $\text{BH}_3 \cdot \text{NH}_3$

Substrate **3a** (0.2 mmol) and $\text{NH}_3 \cdot \text{BH}_3$ (2.0 eq~6.0 eq) were added to an oven dried schlenk tube under atmosphere of nitrogen. Et_2O (2.5 mL) were added by syringe. The reaction mixture was stirred at 70 °C for 75 min. The reaction was quenched and 1,3,5-

trimethoxy benzene was added as an internal standard for ^1H NMR analysis. Plots of the initial rate data for **4a** are shown below. The reaction order is determined by the slope in Eq. of figure S9.

Table S11. Initial rate data obtained by varying the concentration of $\text{BH}_3\cdot\text{NH}_3$

Entry	$\text{NH}_3\cdot\text{BH}_3$	$\text{NH}_3\cdot\text{BH}_3$ [M]	$\text{Log}(\text{NH}_3\cdot\text{BH}_3$ [M])	Initial rate [M/min]	$\text{Log}(\text{Initial rate}$ [M/min])
1	2.0 equiv.	0.00016	-3.7958	0.00000053333	-7.2730
2	3.0 equiv.	0.00024	-3.6197	0.00000014933	-6.8258
3	4.0 equiv.	0.00032	-3.4948	0.00000018133	-6.7415
4	5.0 equiv.	0.0004	-3.3979	0.00000020262	-6.6933
5	6.0 equiv.	0.00048	-3.3187	0.00000026666	-6.5740

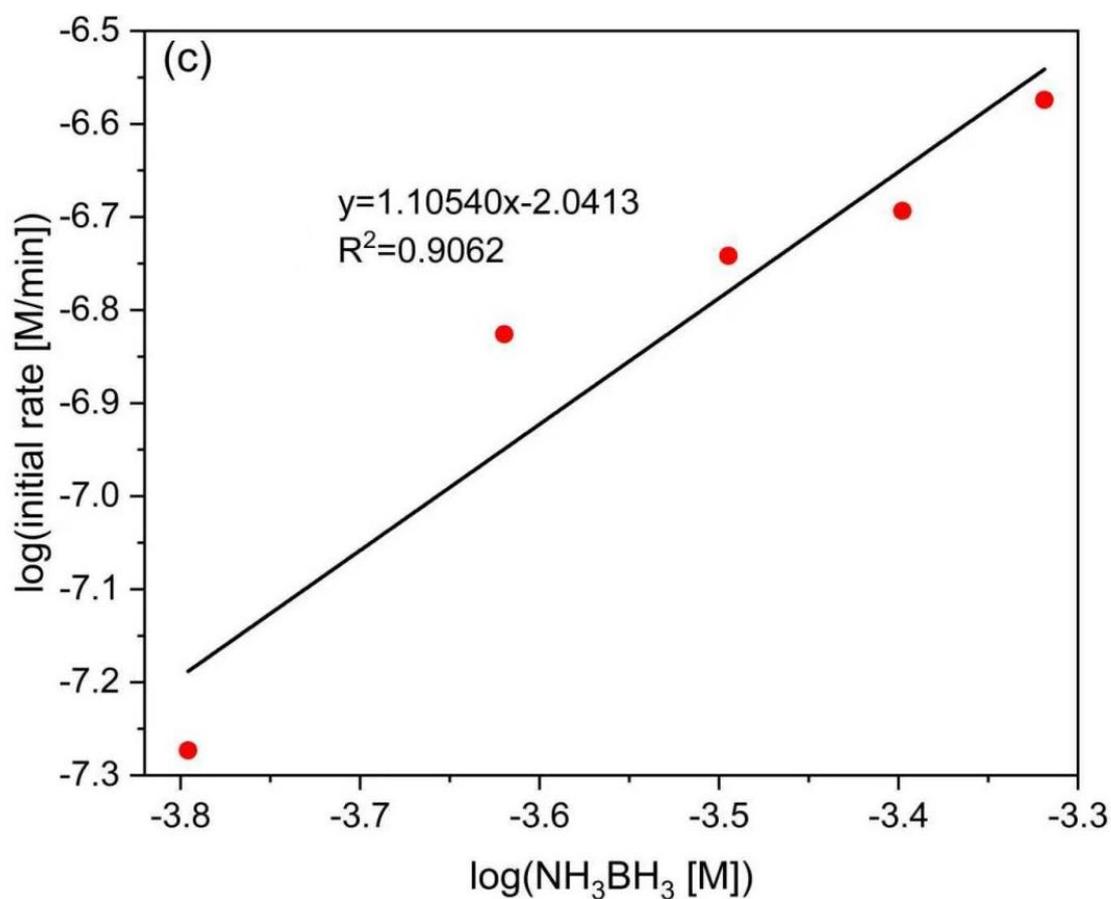


Figure S9. Plot of the initial rate versus the initial concentration of $\text{NH}_3\cdot\text{BH}_3$

Substrate **1a** (0.2 mmol) and $\text{NH}_3\cdot\text{BH}_3$ (2.0 eq~5.0 eq) were added to an oven dried schlenk tube under atmosphere of nitrogen. Et_2O (2.5 mL) were added by syringe. The reaction mixture was stirred at 80 °C for 40 min. The reaction was quenched and 1,3,5-trimethoxy benzene (0.0336, 0.20 mmol) was added as an internal standard for ^1H NMR analysis. Plots of the initial rate data for **2a** are shown below. The reaction order is determined by the slope in Eq. of figure S10.

Table S12. Initial rate data obtained by varying the concentration of $\text{BH}_3\cdot\text{NH}_3$

Entry	$\text{NH}_3\cdot\text{BH}_3$	$\text{NH}_3\cdot\text{BH}_3$ [M]	$\text{Log}(\text{NH}_3\cdot\text{BH}_3$ [M])	Initial rate [M/min]	$\text{Log}(\text{Initial rate}$ [M/min])
1	2.0 equiv.	0.00016	-3.7958	0.000000020003	-7.6989
2	3.0 equiv.	0.00024	-3.6197	0.000000033113	-7.48
3	4.0 equiv.	0.00032	-3.4948	0.000000076085	-7.1187
4	5.0 equiv.	0.00040	-3.3979	0.000000076913	-7.114

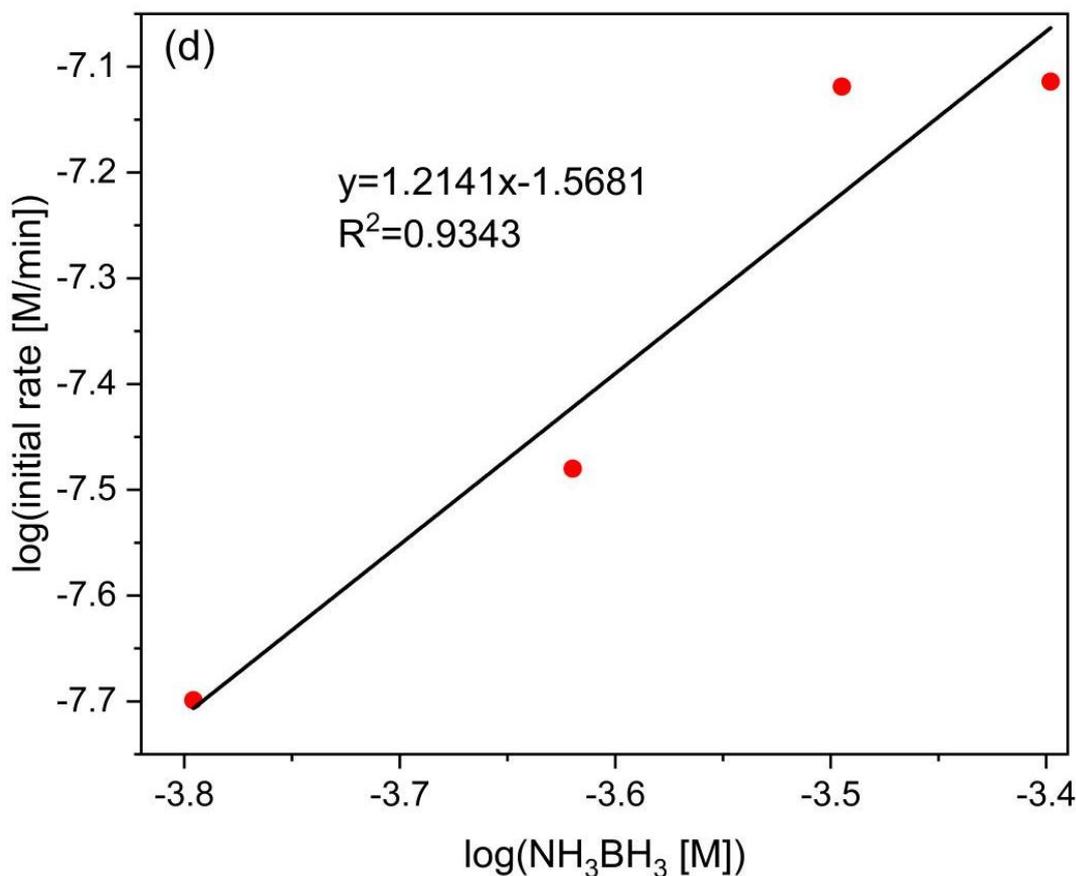


Figure S10. Plot of the initial rate versus the initial concentration of $\text{NH}_3\cdot\text{BH}_3$

10. ^{11}B NMR study on the reaction mixture

After the solvent of the reaction mixture was removed under reduced pressure, the crude residue was dissolved in THF- d_8 (2.0 mL). A ^{11}B NMR spectra is recorded on Bruker AV 400 at room temperature, and the chemical shift is relative to $\text{Et}_2\text{O}\cdot\text{BF}_3$ (0 ppm).

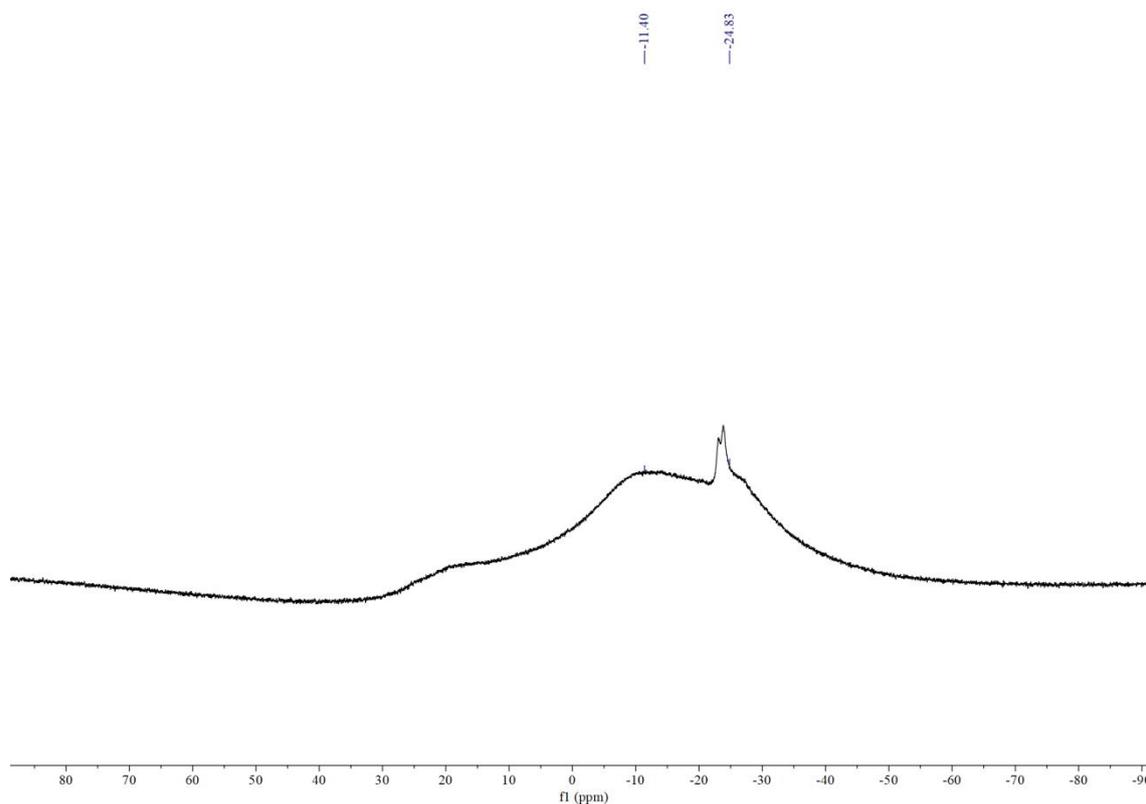
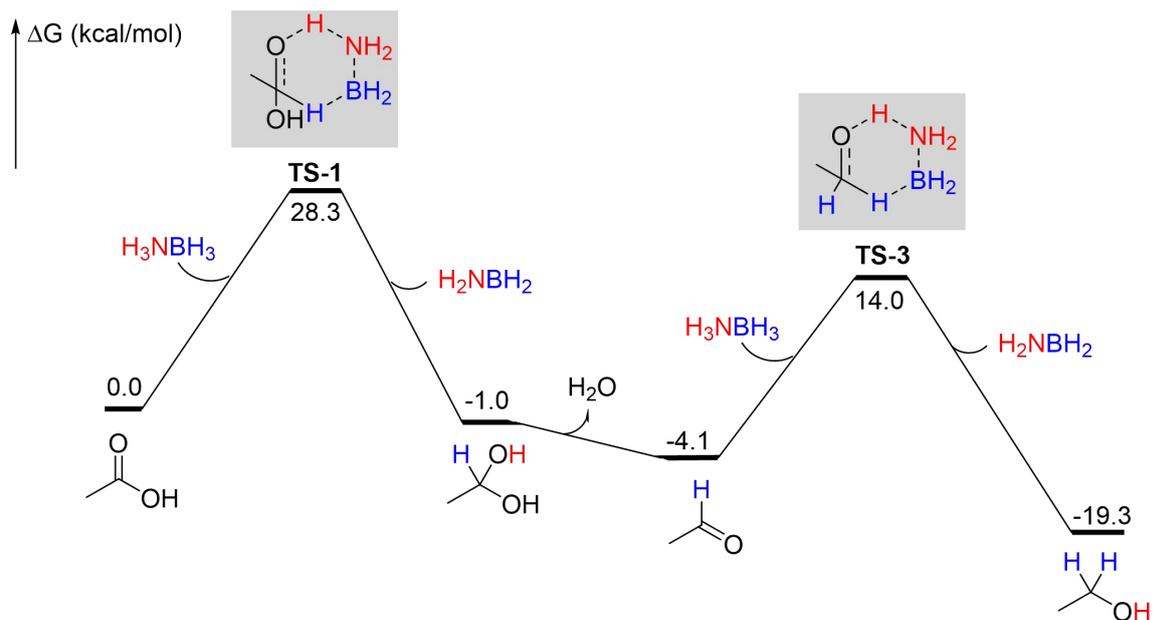


Figure S11. ^{11}B NMR of the reaction in THF- d_8 after 12 hours at 70 °C, chemical shift relative to $\text{Et}_2\text{O}\cdot\text{BF}_3$

11. Computational details

To verify whether our proposed reaction mechanism is feasible, we further Geometry optimizations and frequencies calculations of all the species were performed by using the M06-2X/6-31G(d,p) method. To get more accurate energies, single-point energy calculations were performed with the M06-2X/cc-PVTZ method in conjugation with polarizable continuum model (PCM, in toluene). All calculations were performed with the Gaussian 16 package.^[32]



Method: M06-2X/cc-pvtz/PCM(toluene)//M06-2X/6-31g(d,p)

Figure S12. Computed potential energy surface for the model reductive reaction of acetic acid and ammonia borane at the M06-2X/cc-pvtz/PCM(toluene)//M06-2X/6-31g(d,p) level of theory.

Supplementary references

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12. ^1H , ^{13}C and ^{19}F NMR Spectra

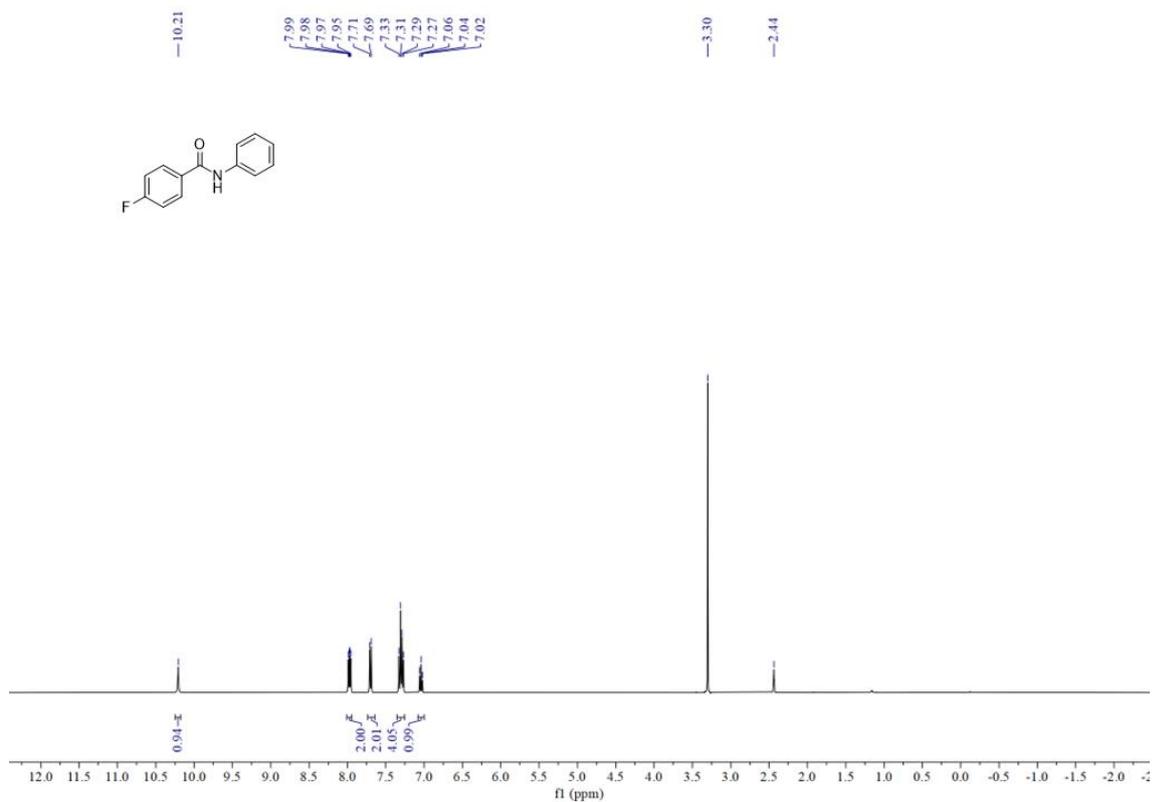


Figure S13. ^1H NMR (400 MHz, $\text{DMSO-}d_6$) spectrum of 3b

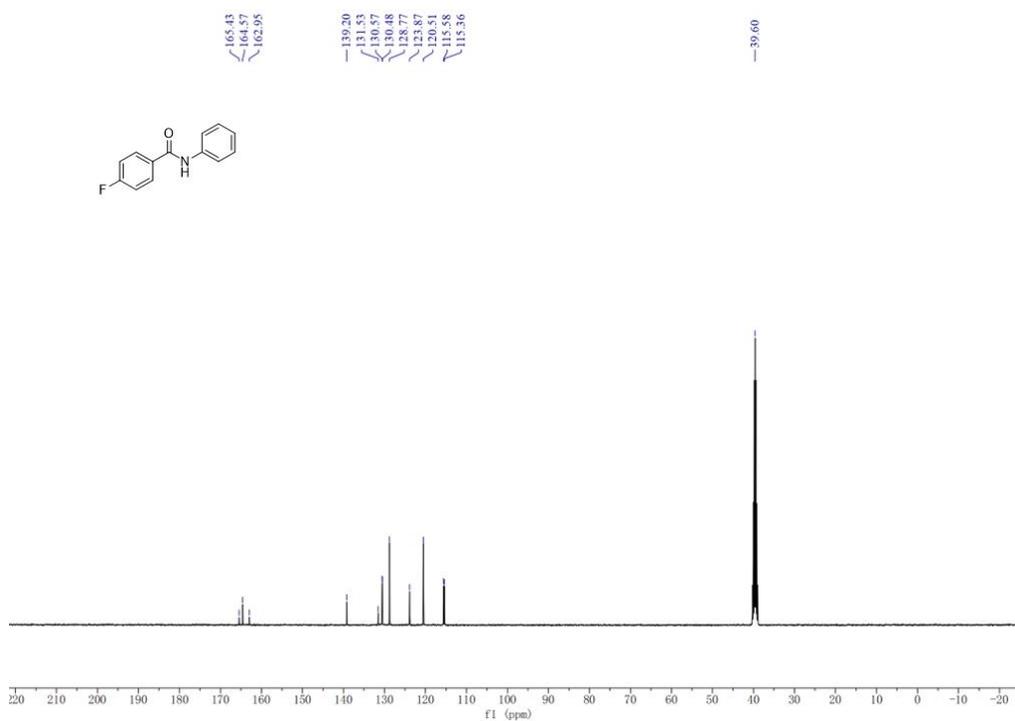


Figure S14. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$) spectrum of 3b

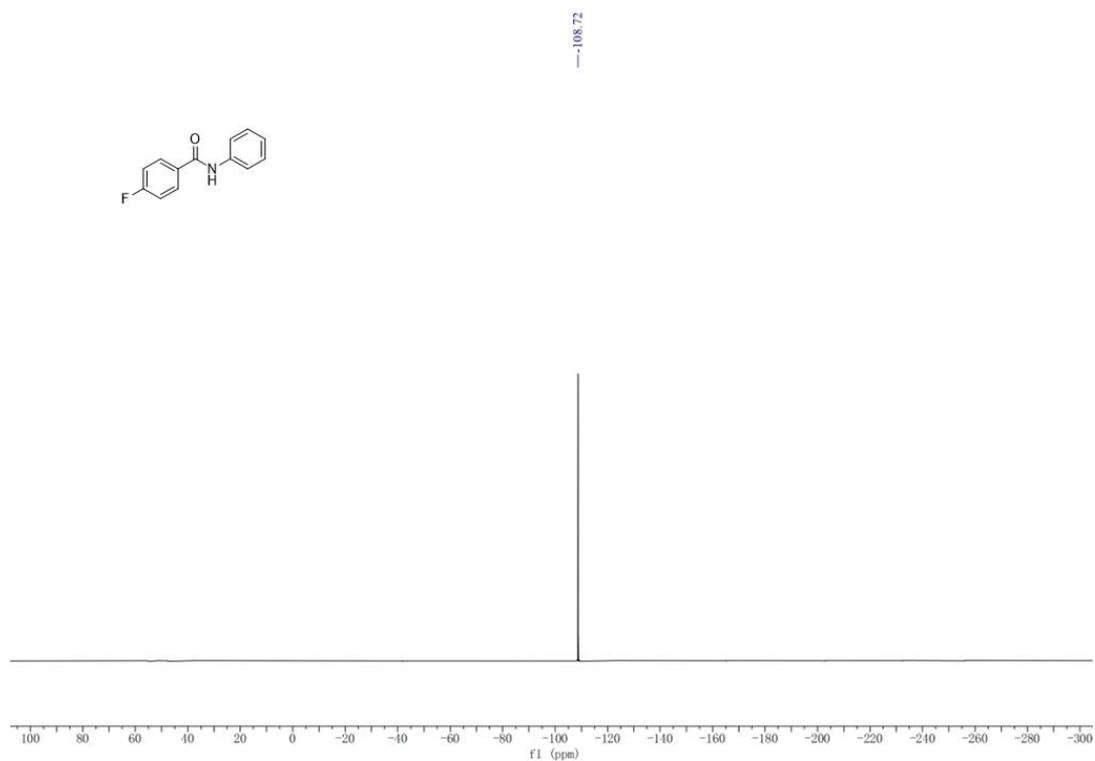


Figure S15. ^{19}F NMR (100 MHz, $\text{DMSO-}d_6$) spectrum of 3b

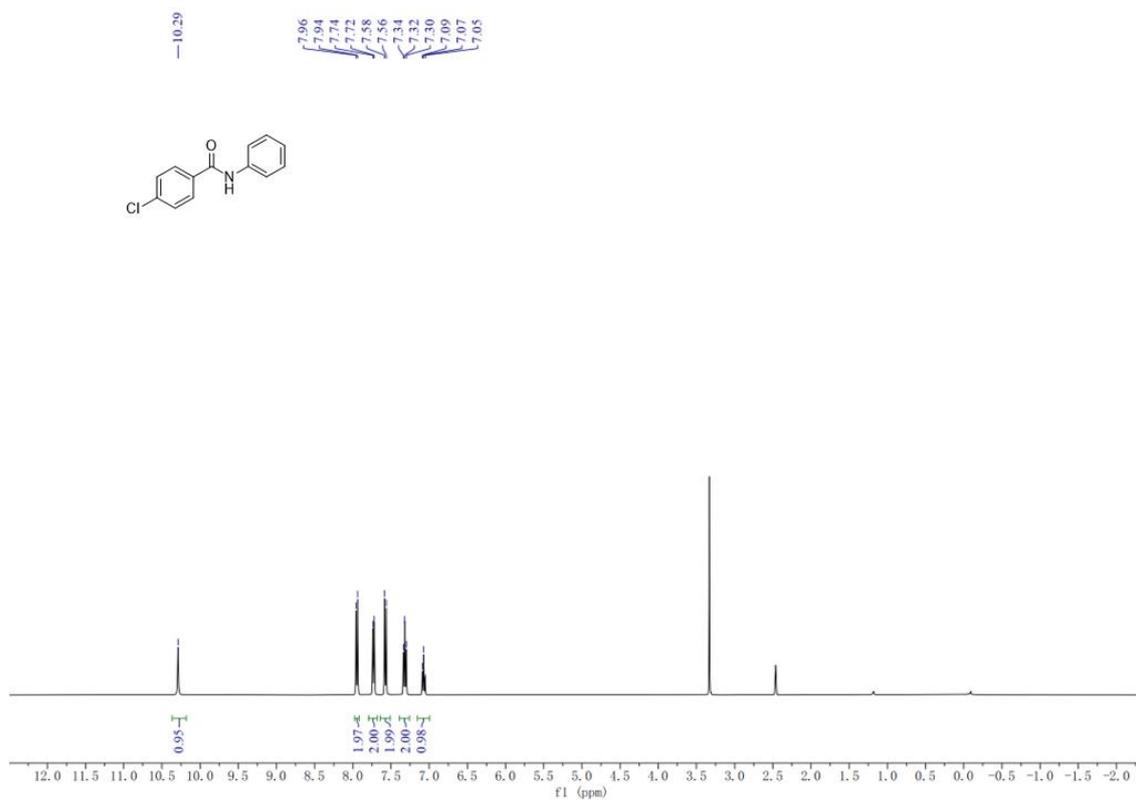


Figure S16. ^1H NMR (400 MHz, $\text{DMSO-}d_6$) spectrum of 3c

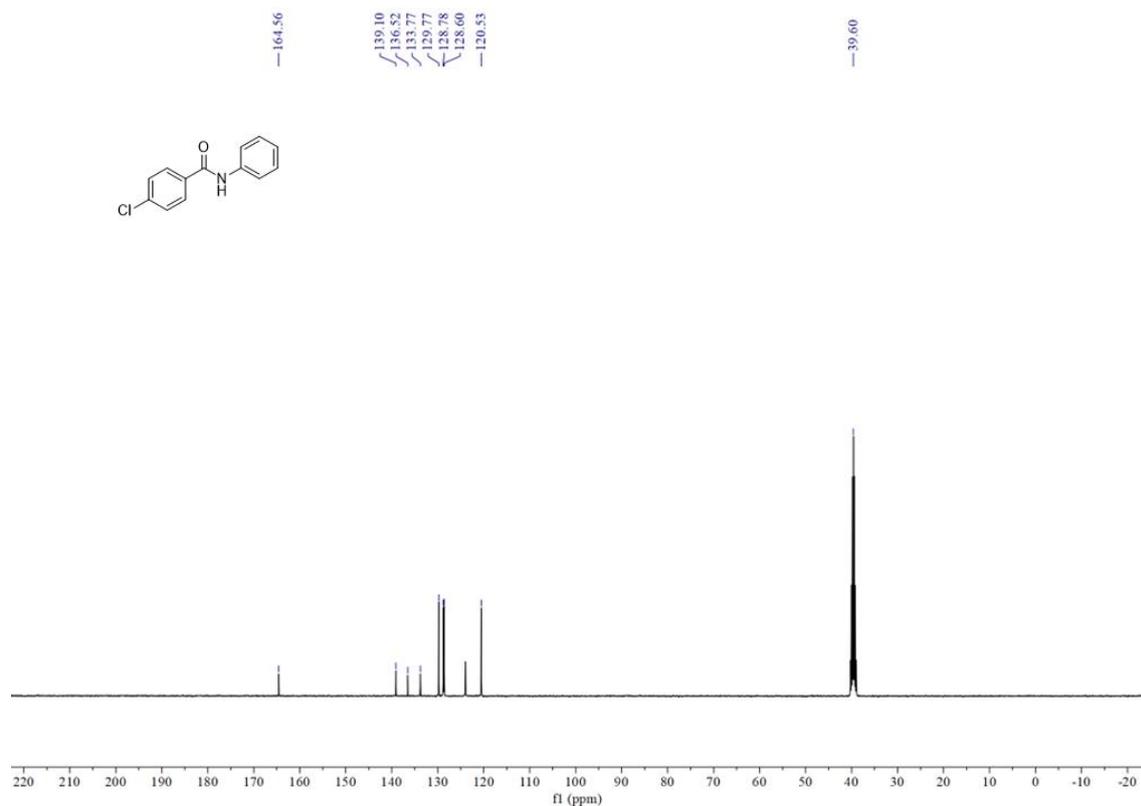


Figure S17. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$) spectrum of 3c

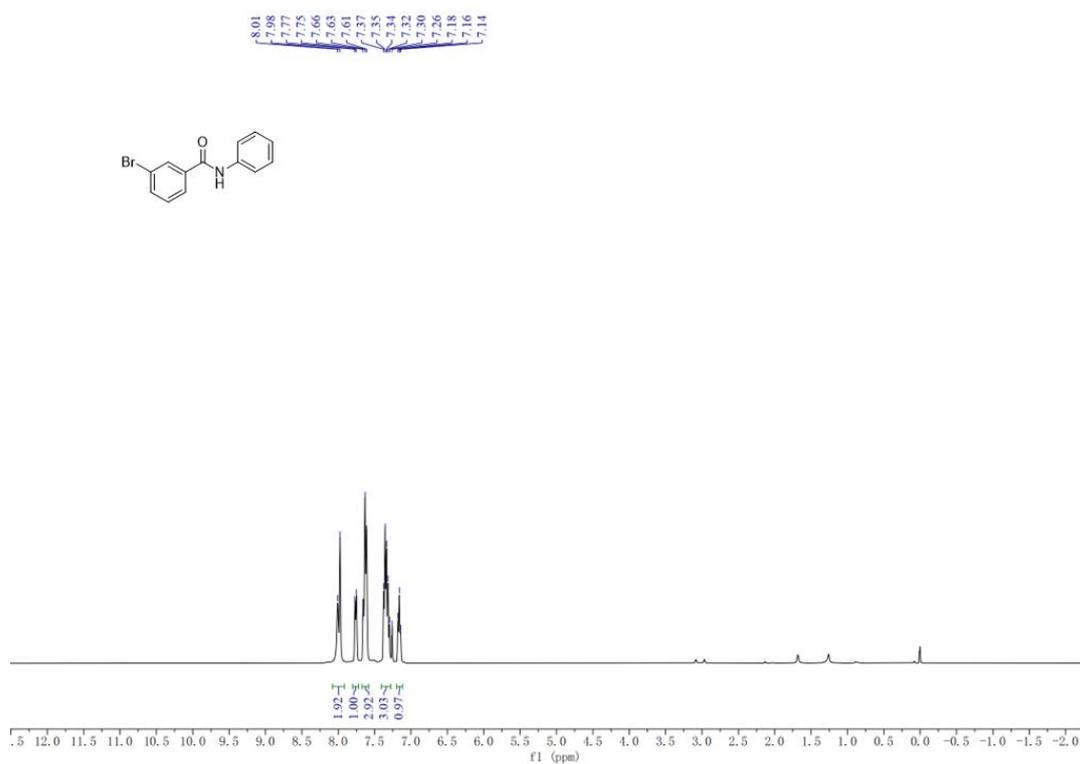


Figure S18. ^1H NMR (400 MHz, CDCl_3) spectrum of 3d

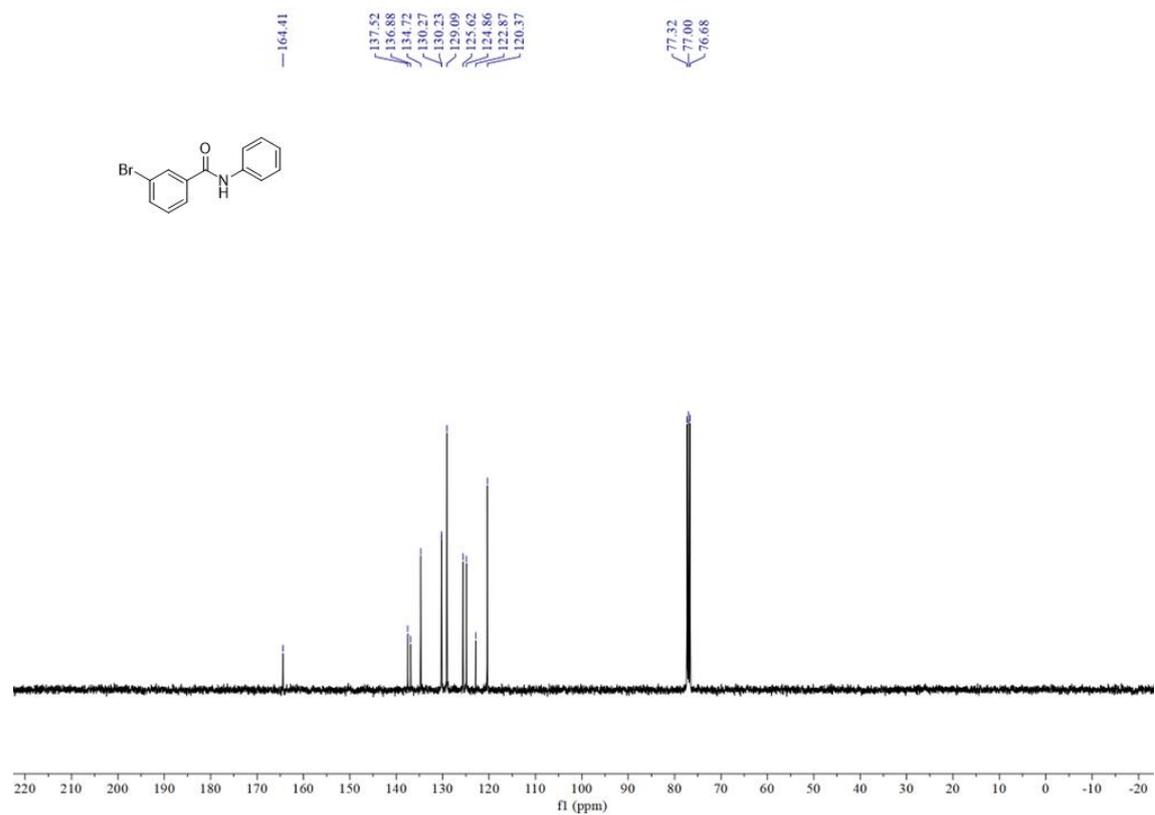


Figure S19. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **3d**

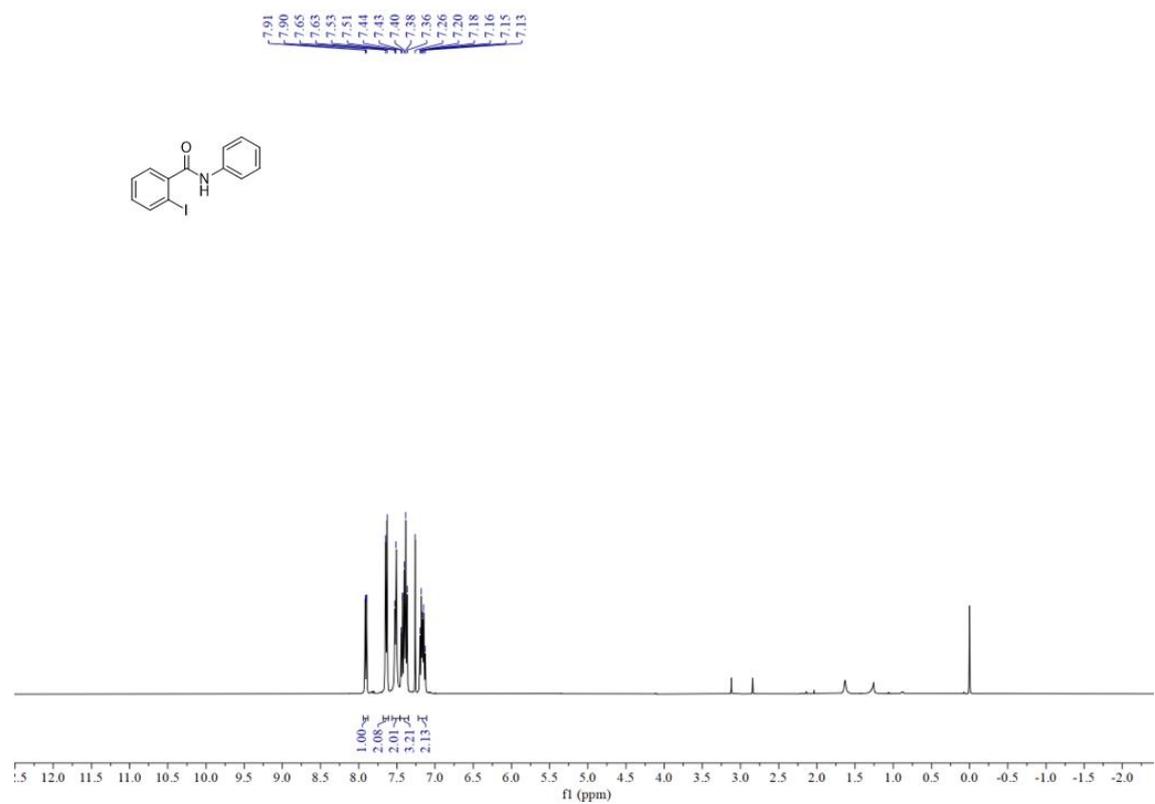


Figure S20. ^1H NMR (400 MHz, CDCl_3) spectrum of **3e**

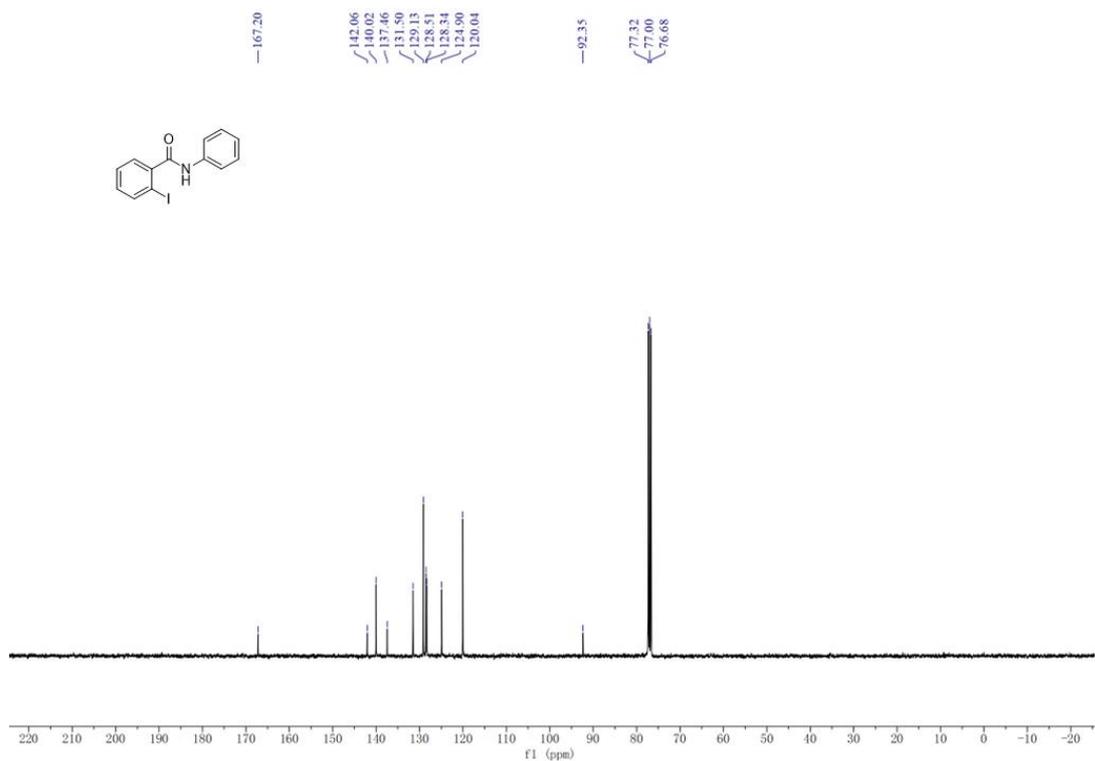


Figure S21. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 3e

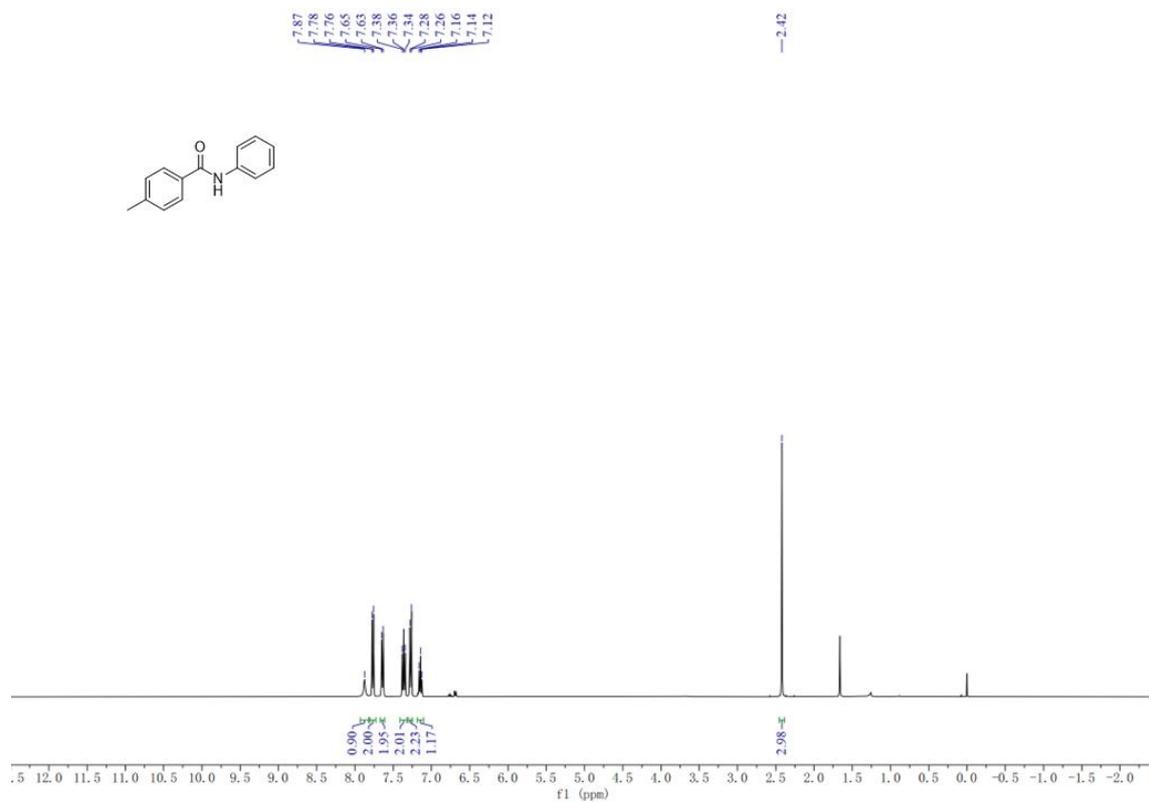


Figure S22. ^1H NMR (400 MHz, CDCl_3) spectrum of 3f

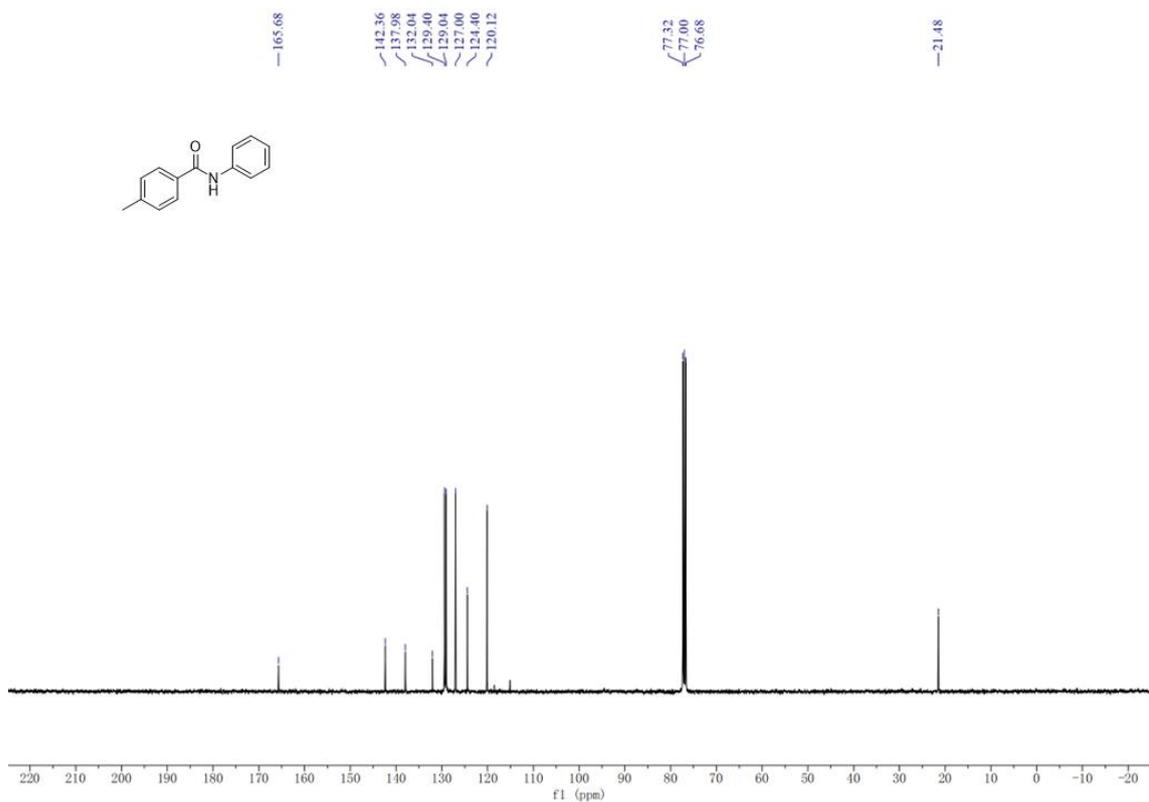


Figure S23. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 3f

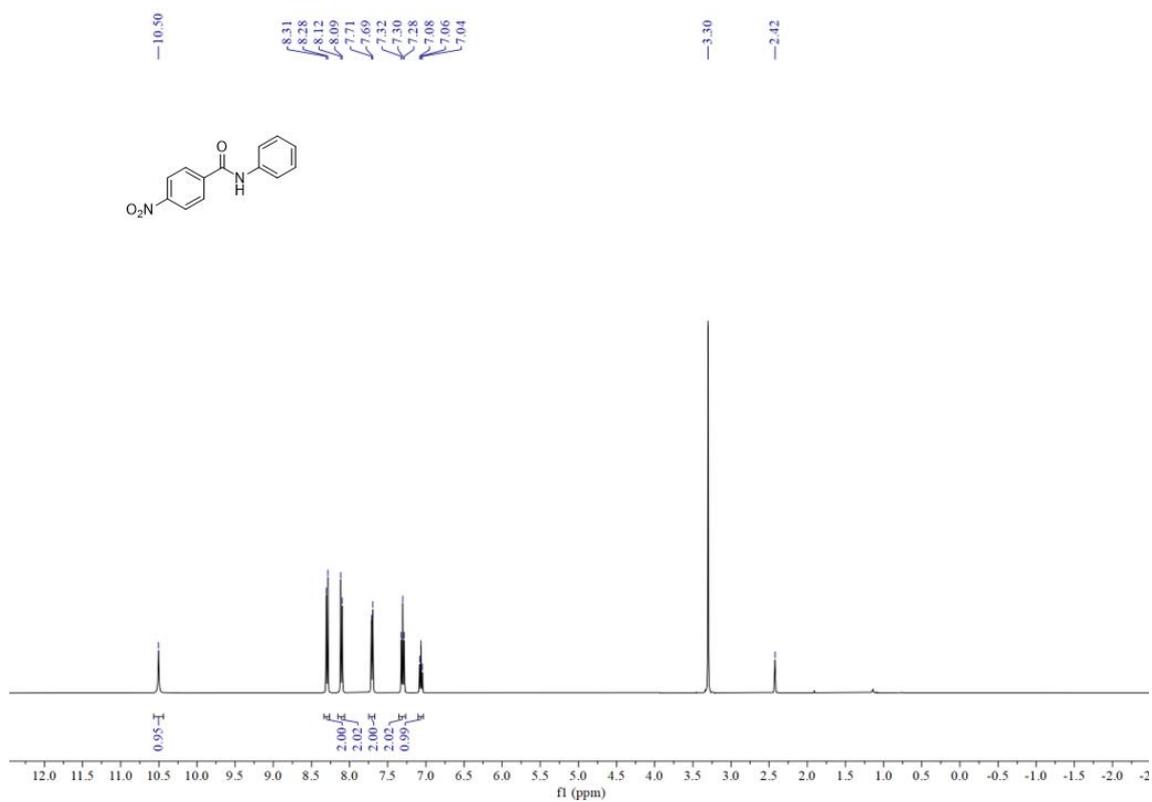


Figure S24. ^1H NMR (400 MHz, $\text{DMSO}-d_6$) spectrum of 3g

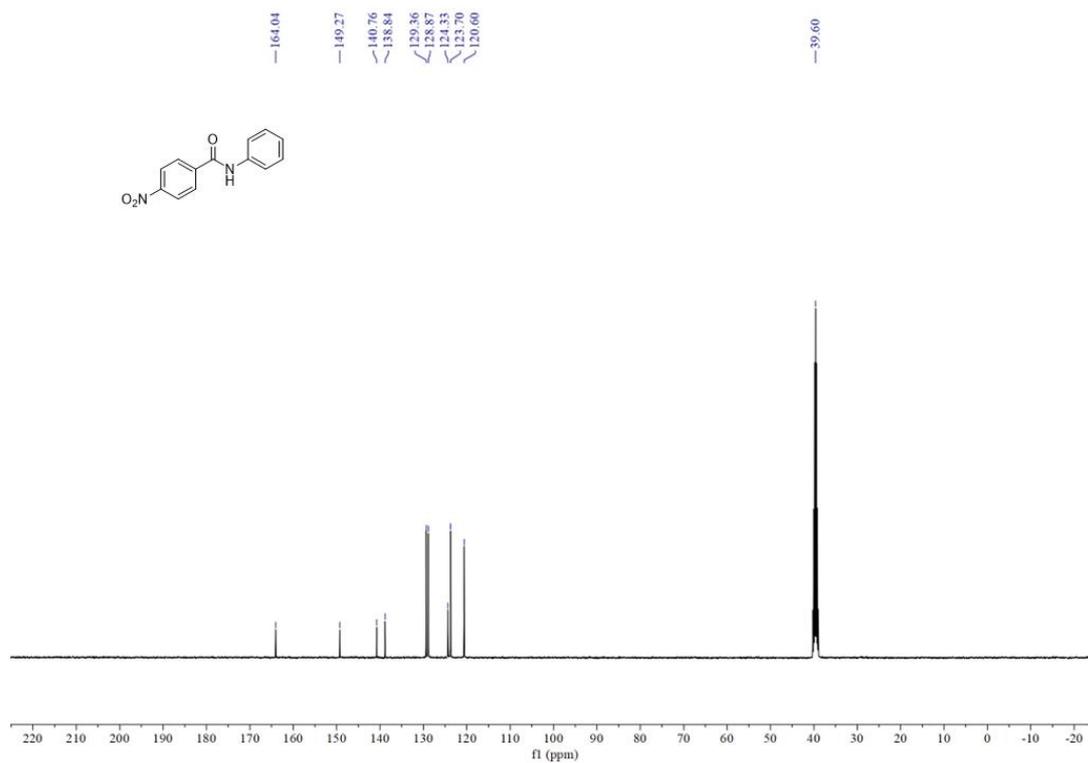


Figure S25. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$) spectrum of 3g

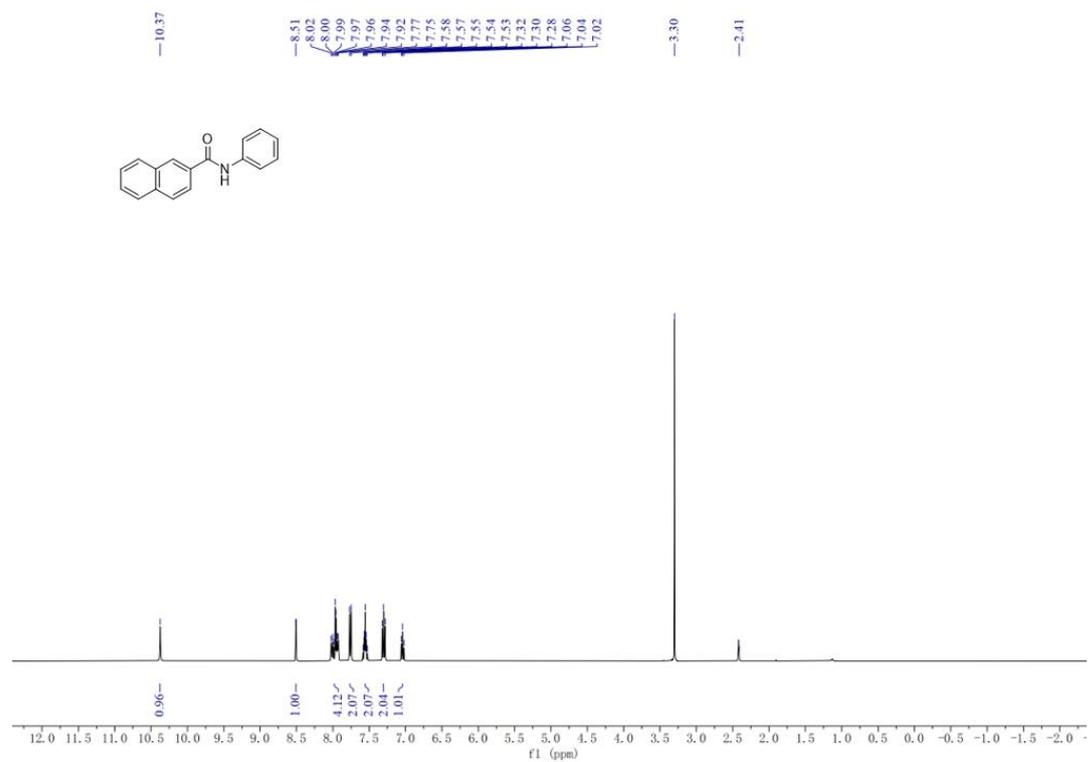


Figure S26. ^1H NMR (400 MHz, $\text{DMSO-}d_6$) spectrum of 3h

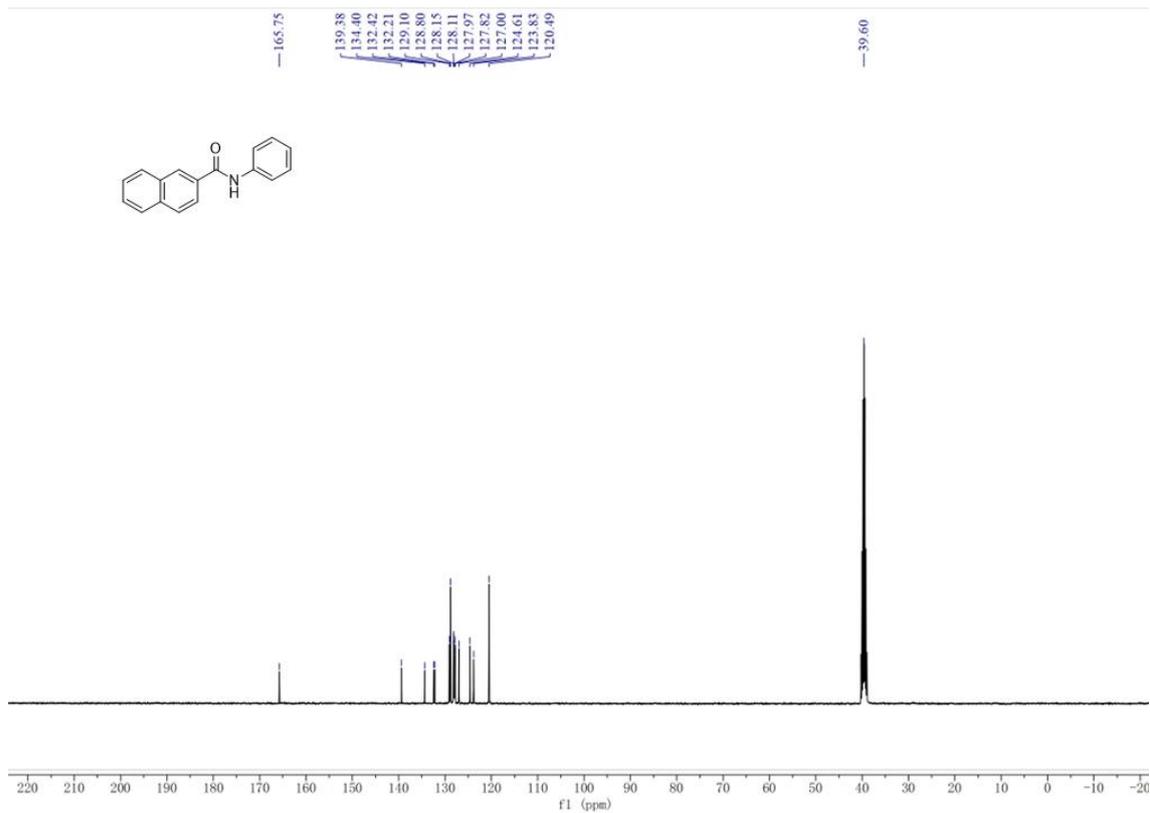


Figure S27. ¹³C NMR (100 MHz, DMSO-*d*₆) spectrum of 3h

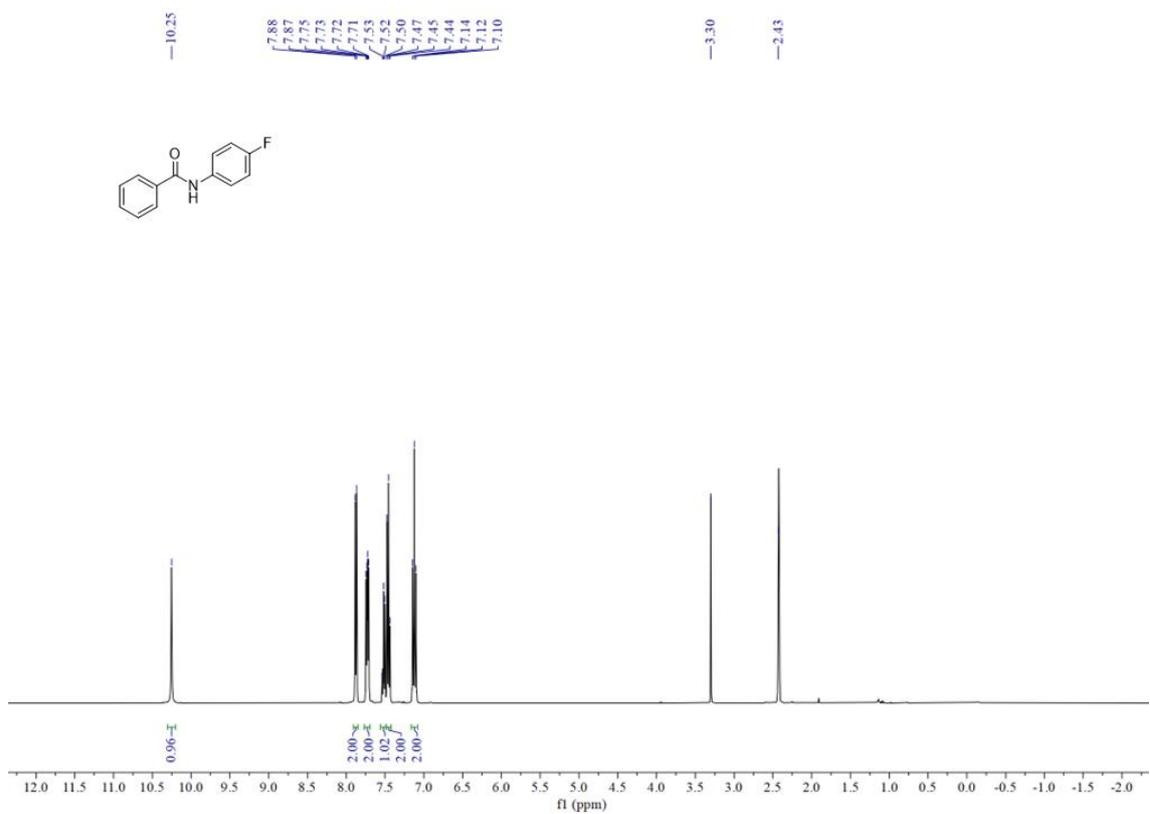


Figure S28. ¹H NMR (400 MHz, DMSO-*d*₆) spectrum of 3i

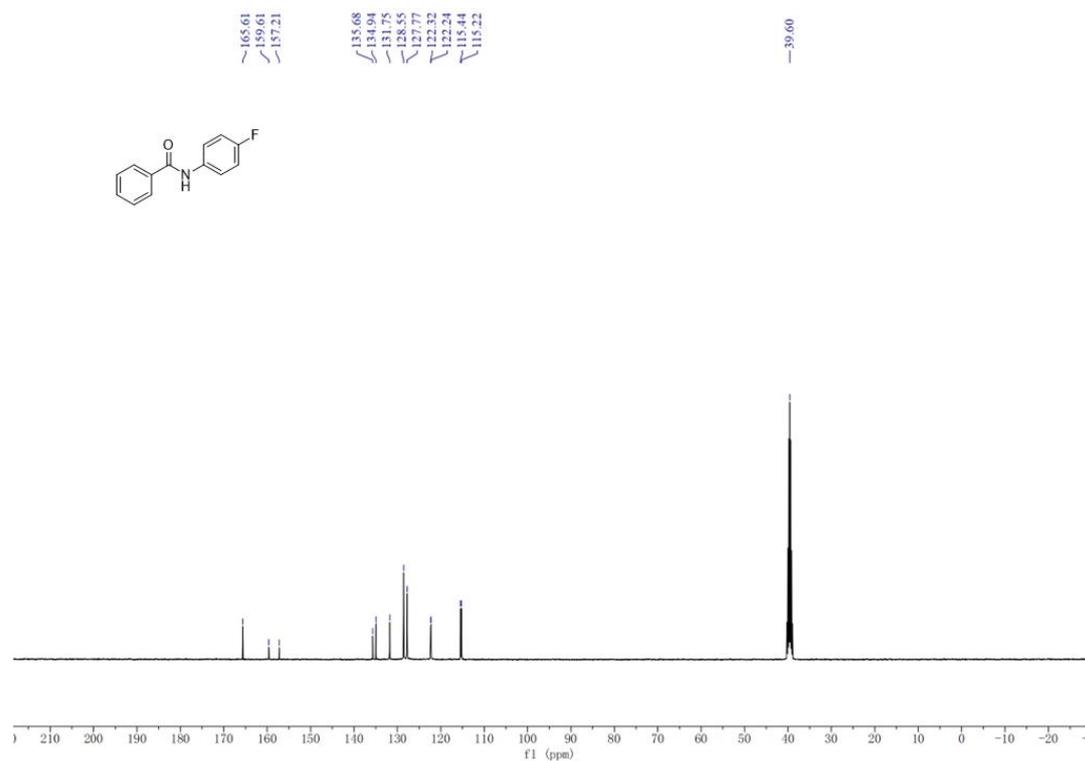


Figure S29. ¹³C NMR (100 MHz, DMSO-*d*₆) spectrum of 3i

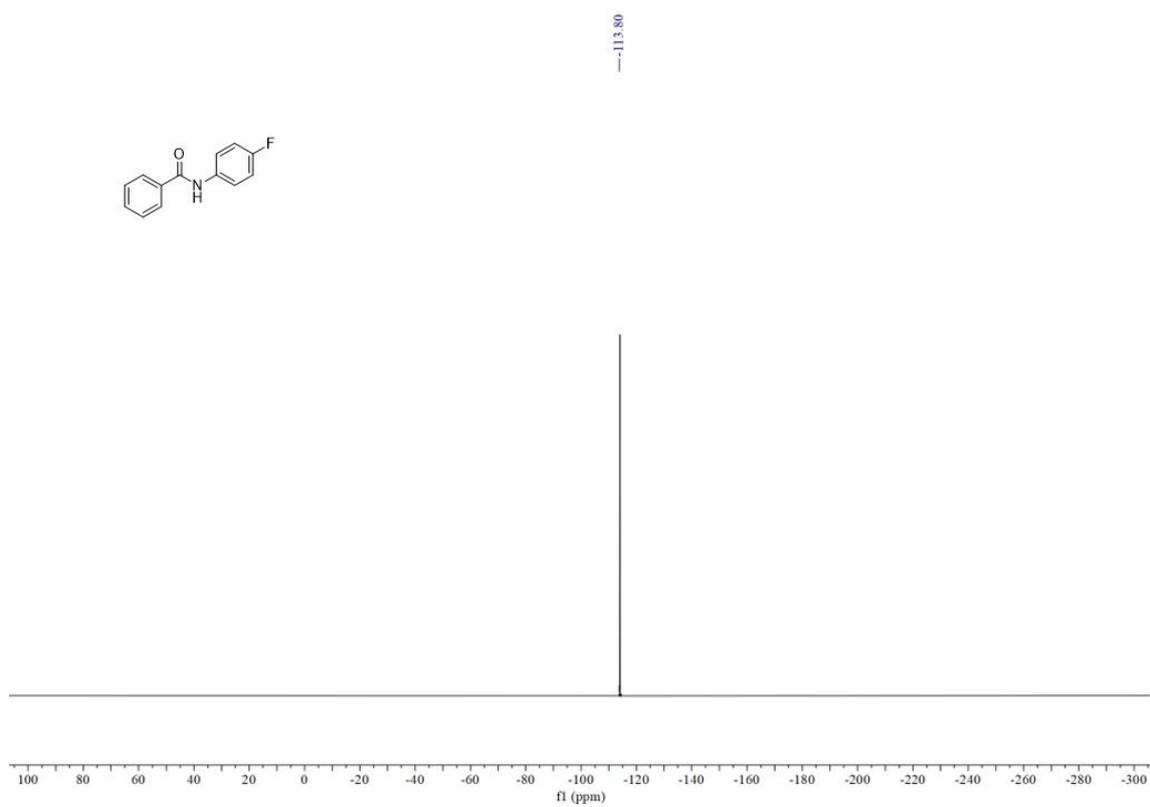


Figure S30. ¹⁹F NMR (100 MHz, DMSO-*d*₆) spectrum of 3i

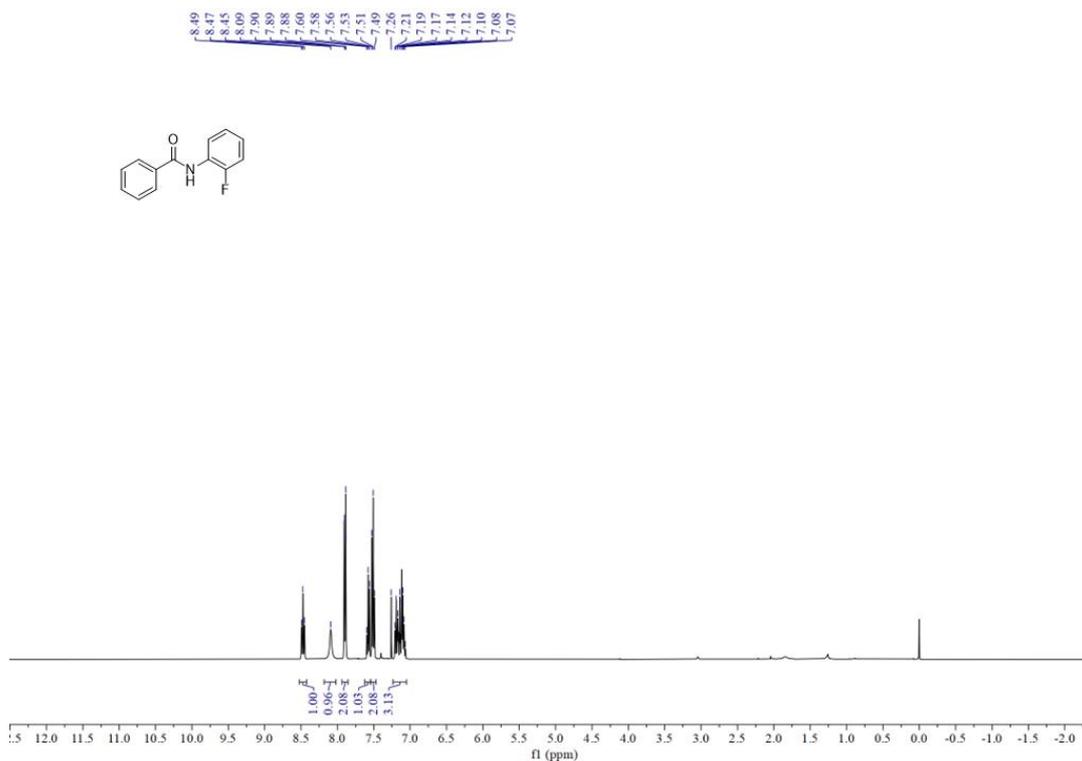


Figure S31. ¹H NMR (376 MHz, CDCl₃) spectrum of **3j**

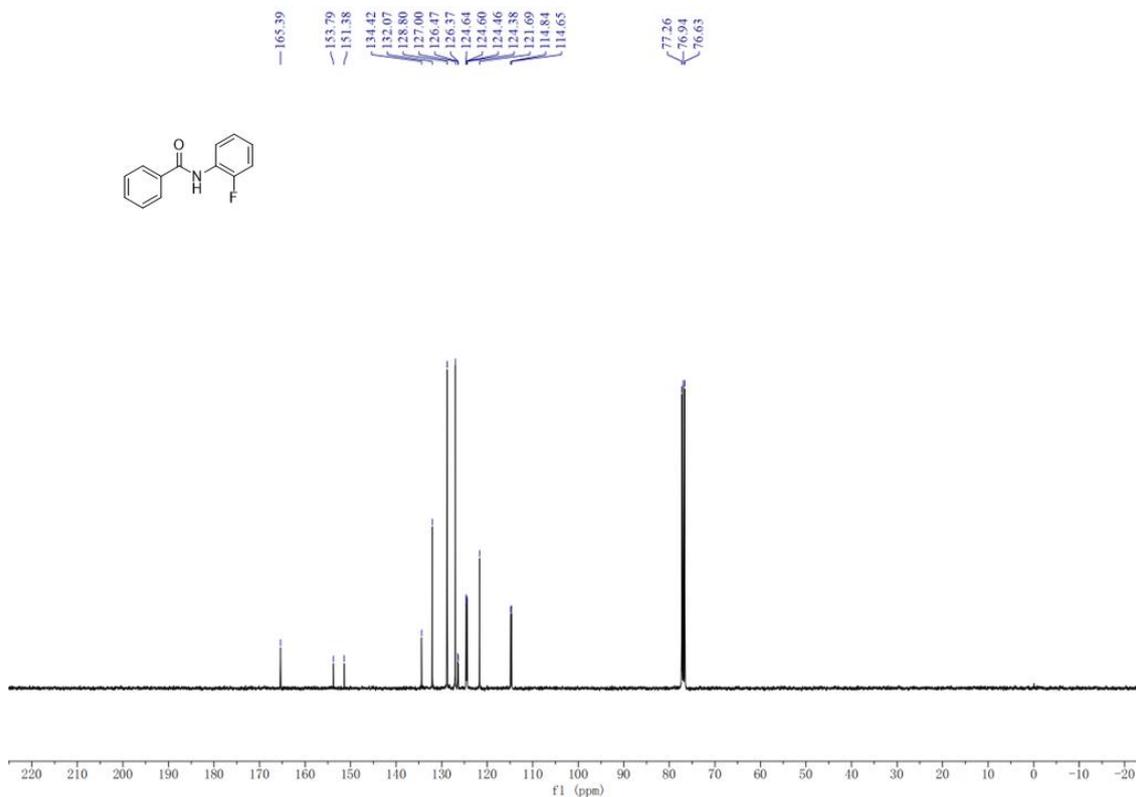


Figure S32. ¹³C NMR (400 MHz, CDCl₃) spectrum of **3j**

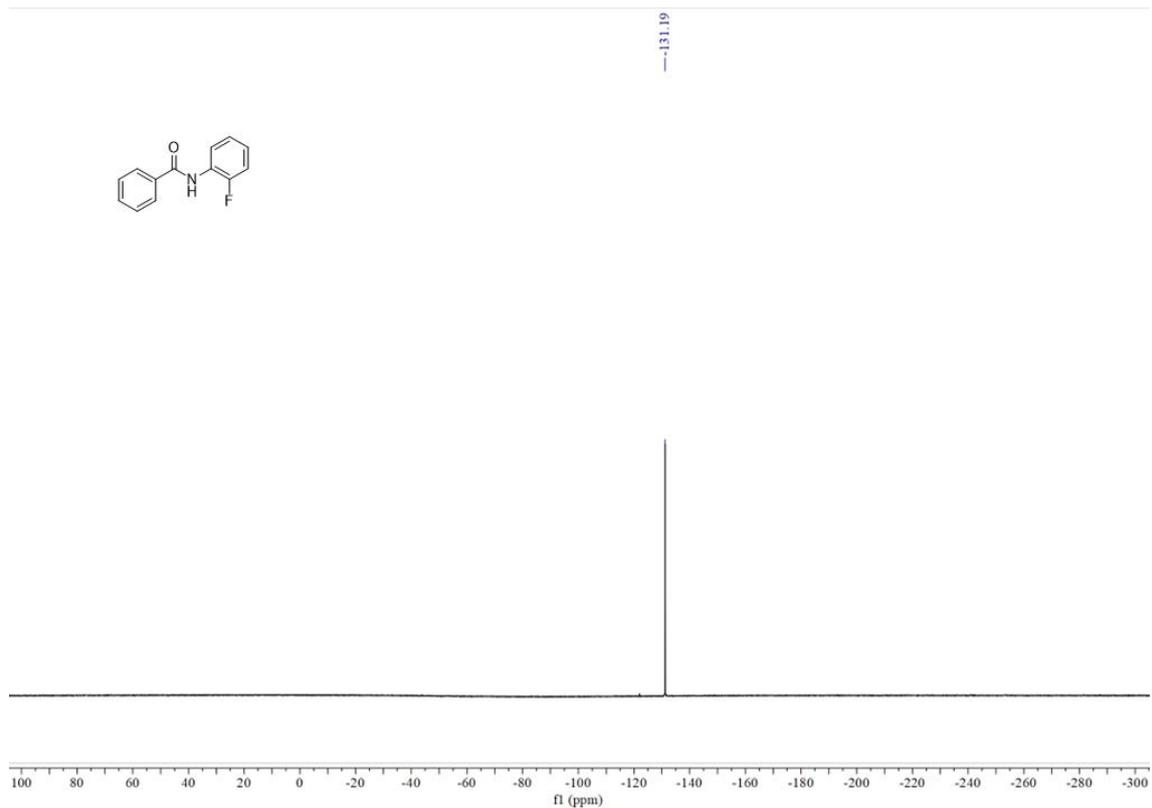


Figure S33. ^{19}F NMR (100 MHz, CDCl_3) spectrum of 3j

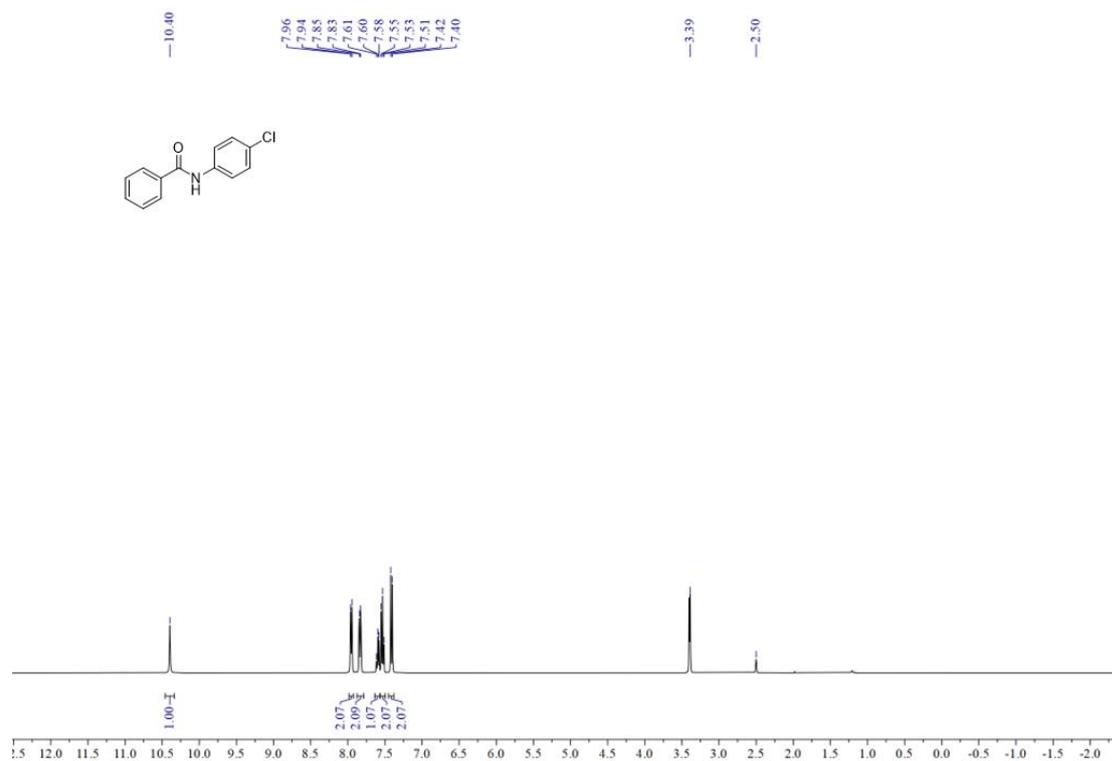


Figure S34. ^1H NMR (100 MHz, $\text{DMSO}-d_6$) spectrum of 3k

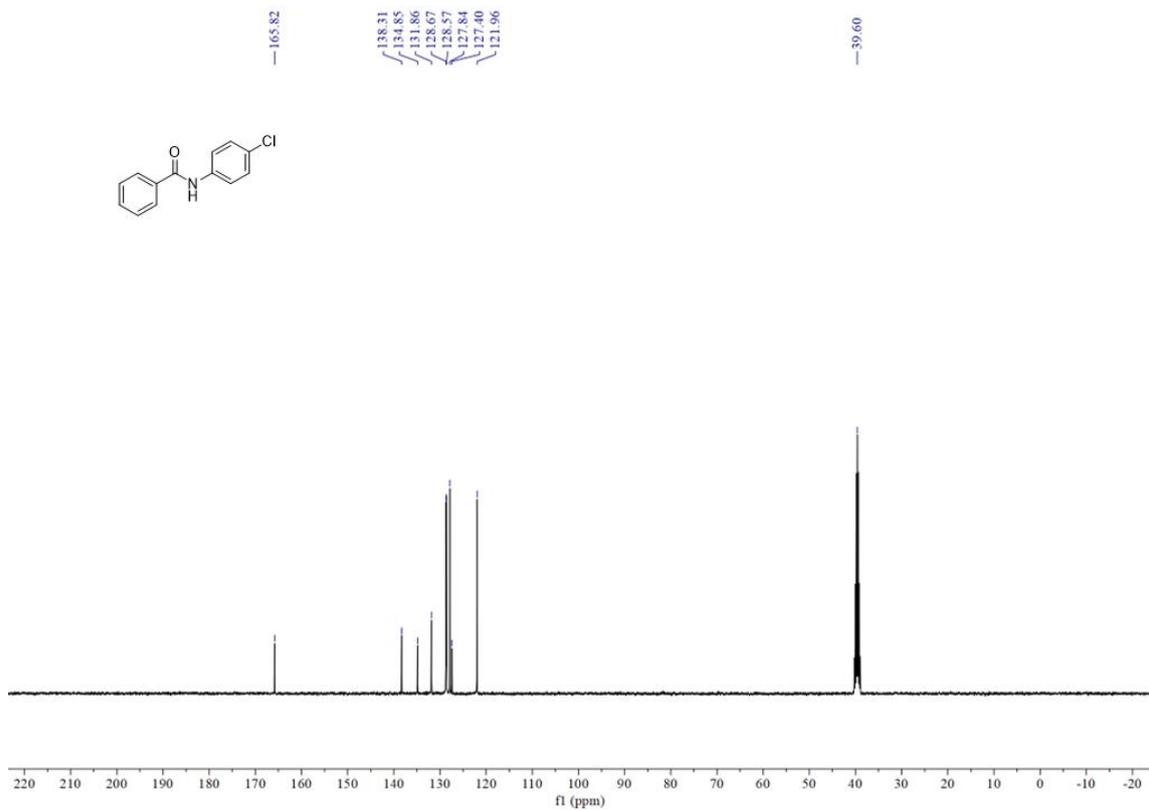


Figure S35. ¹³C NMR (400 MHz, DMSO-*d*₆) spectrum of **3k**

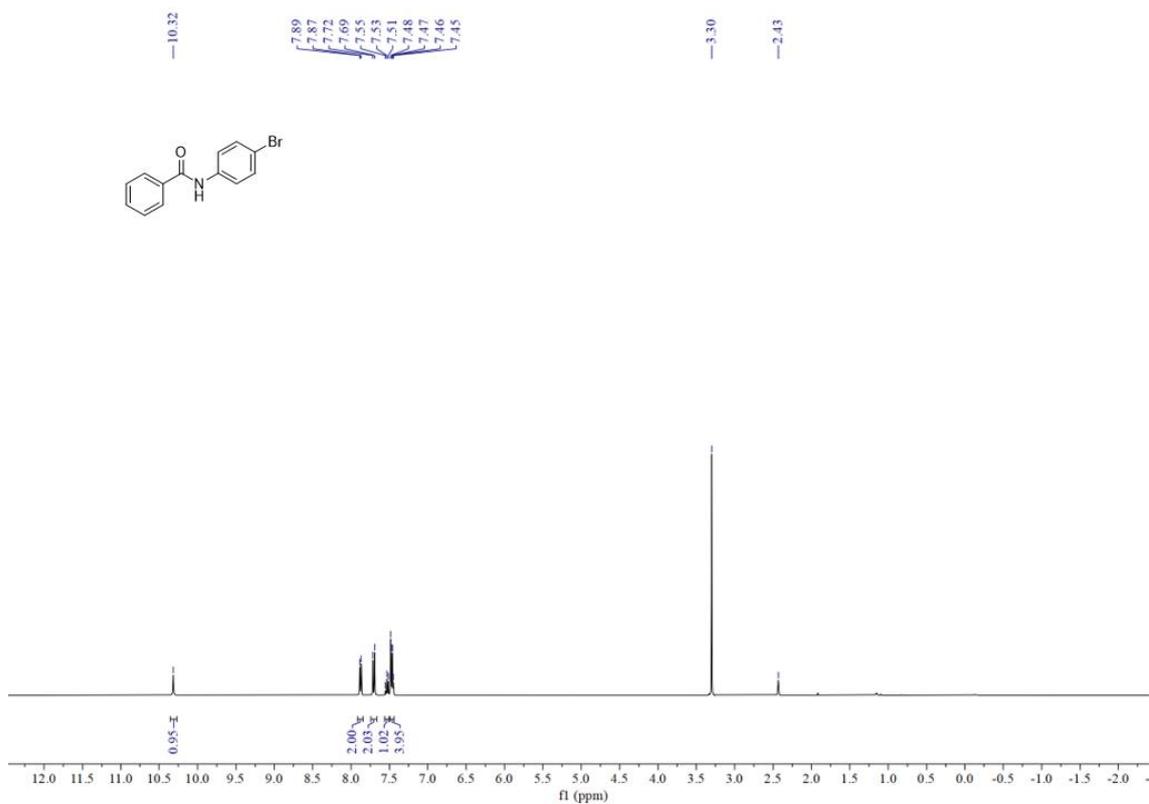


Figure S36. ¹H NMR (100 MHz, DMSO-*d*₆) spectrum of **3l**

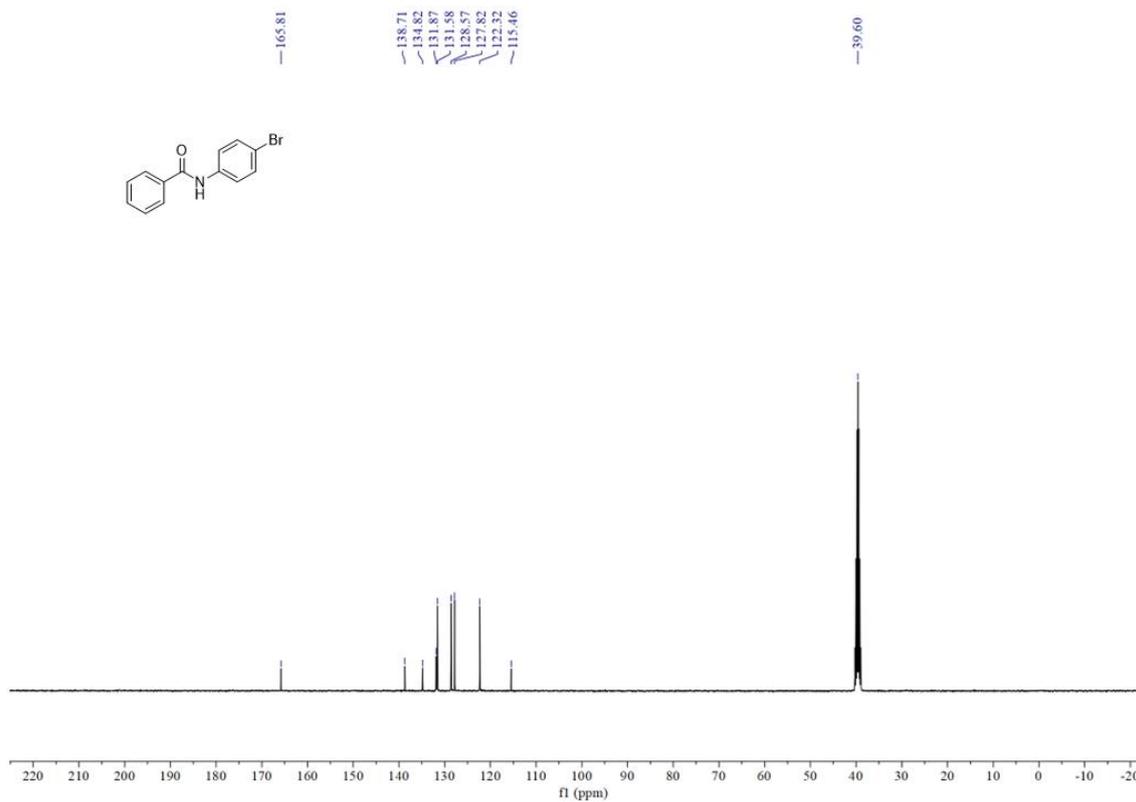


Figure S37. ^{13}C NMR (400 MHz, $\text{DMSO-}d_6$) spectrum of **31**

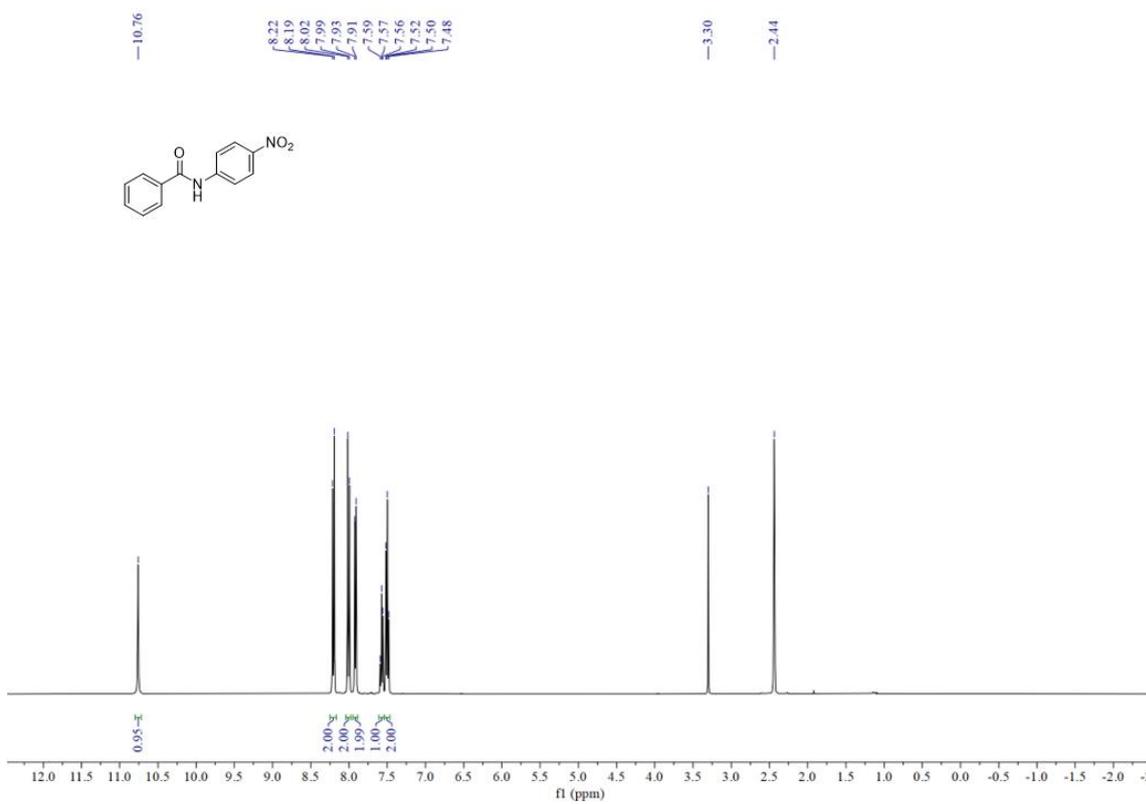


Figure S38. ^1H NMR (400 MHz, $\text{DMSO-}d_6$) spectrum of **3m**

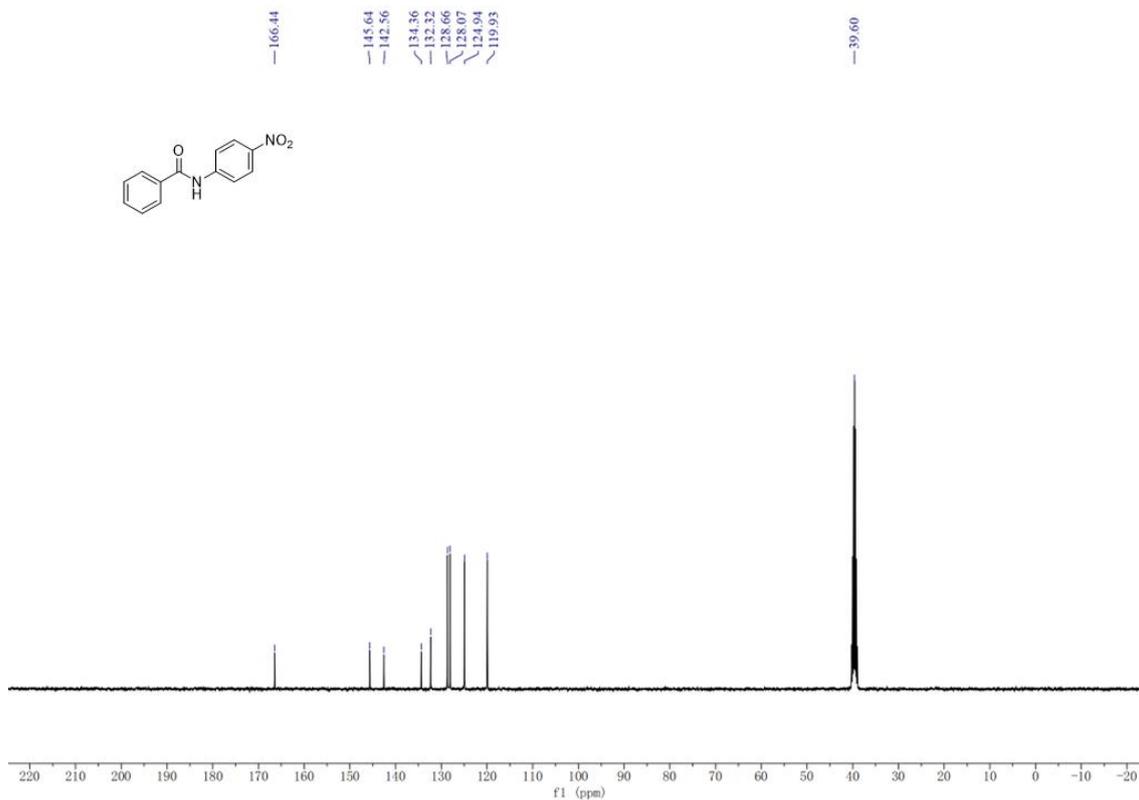


Figure S39. ^{13}C NMR (400 MHz, $\text{DMSO-}d_6$) spectrum of 3m

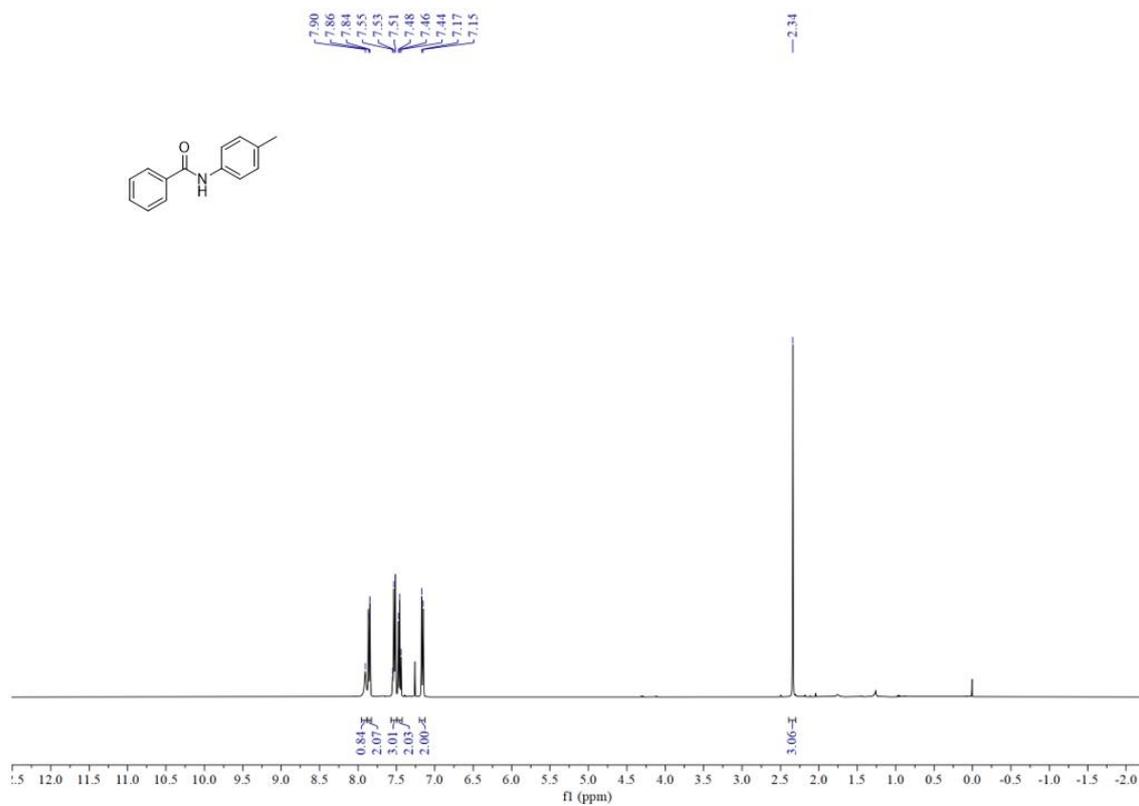


Figure S40. ^1H NMR (400 MHz, CDCl_3) spectrum of 3n

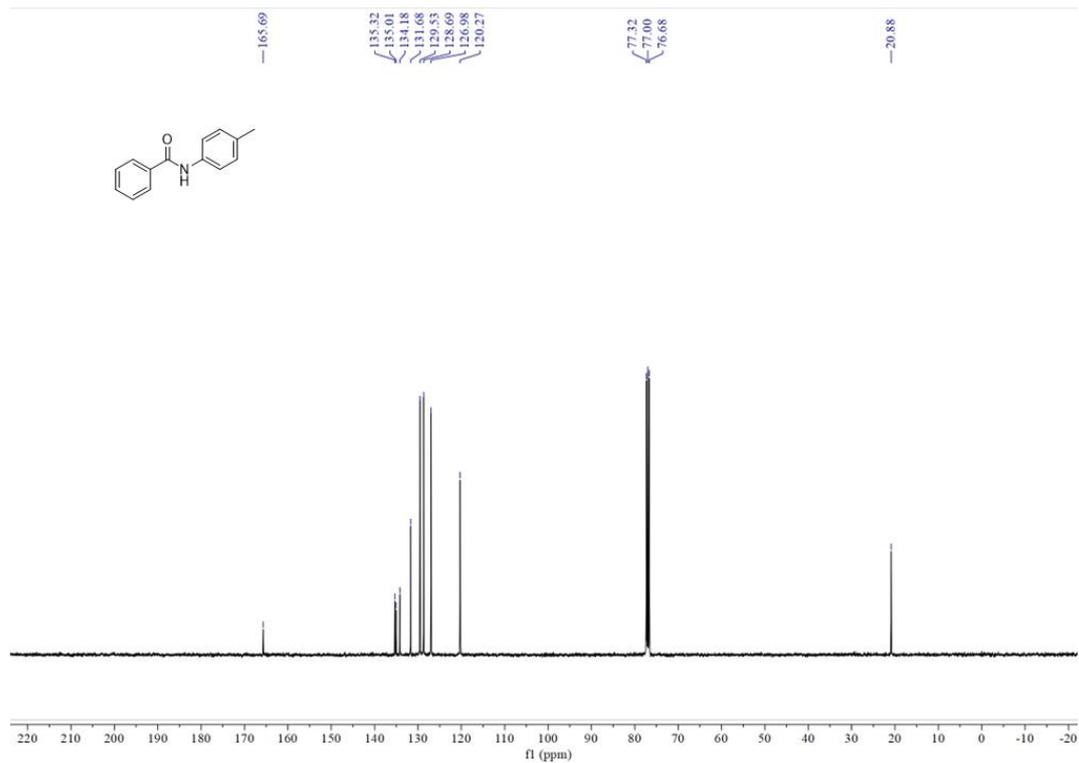


Figure S41. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **3n**

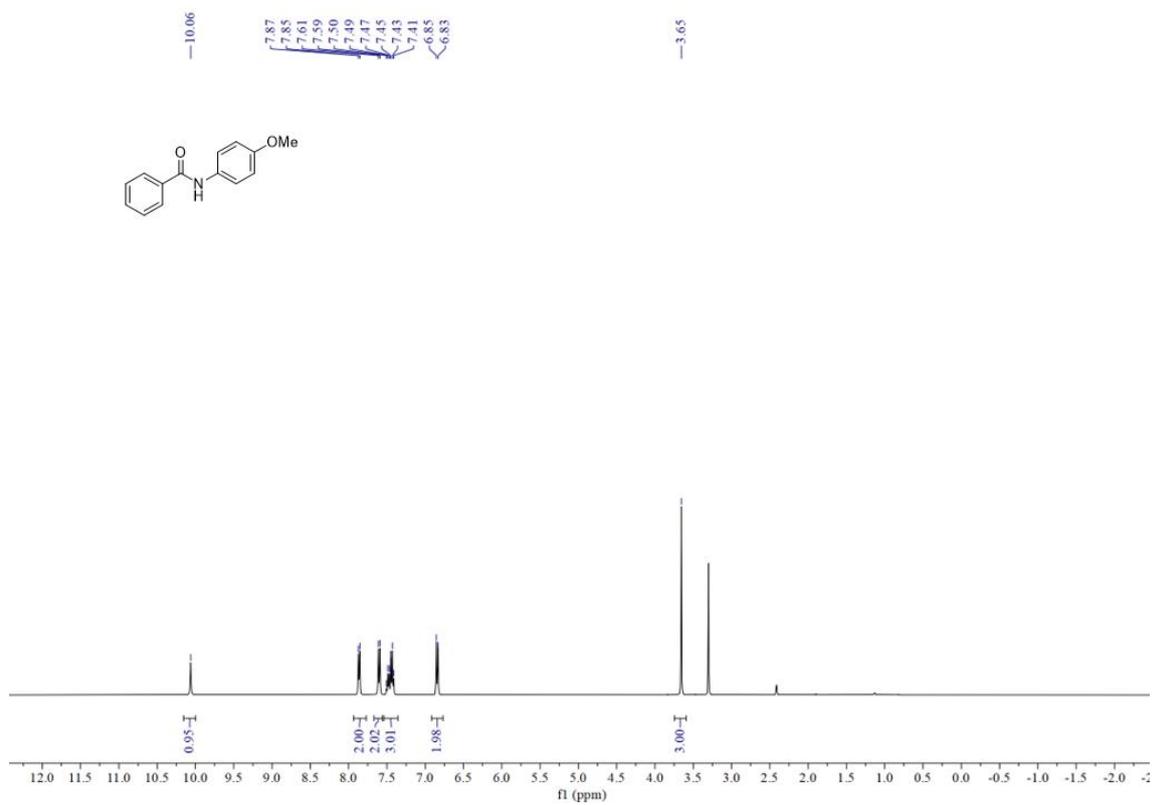


Figure S42. ^1H NMR (400 MHz, $\text{DMSO}-d_6$) spectrum of **3o**

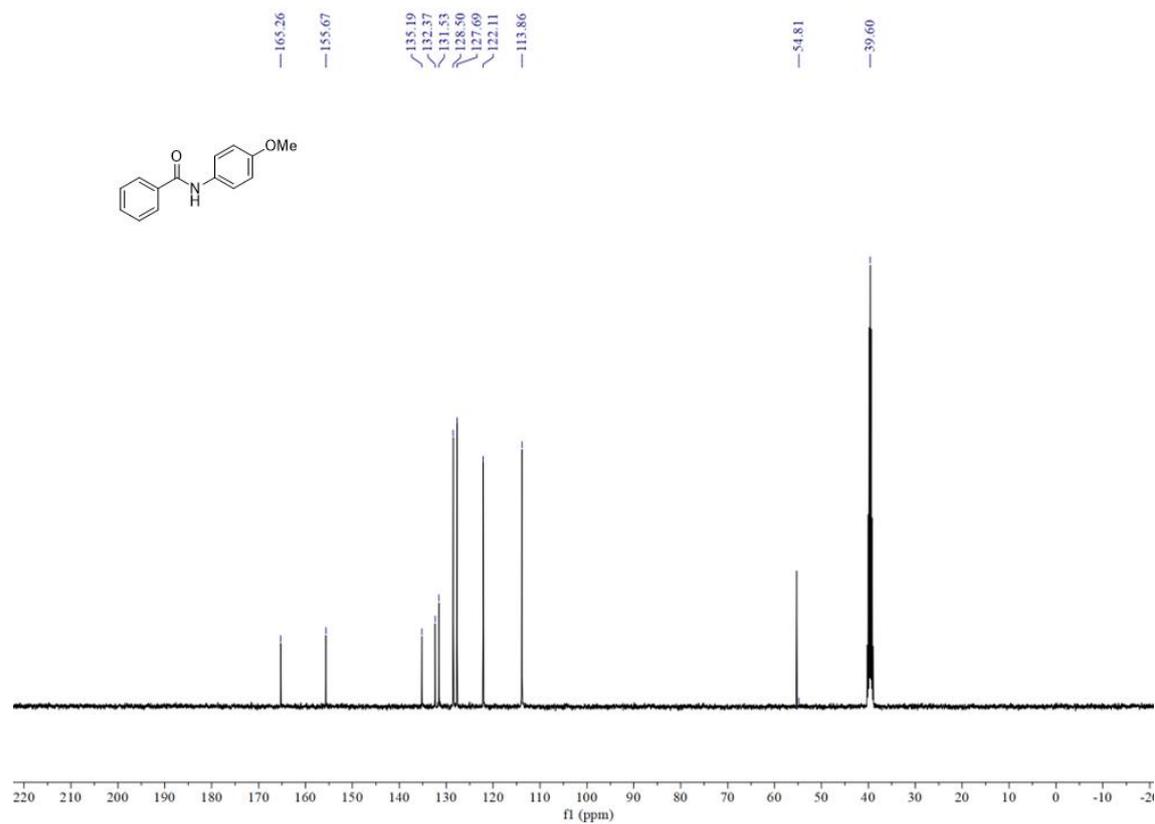


Figure S43. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$) spectrum of **3o**

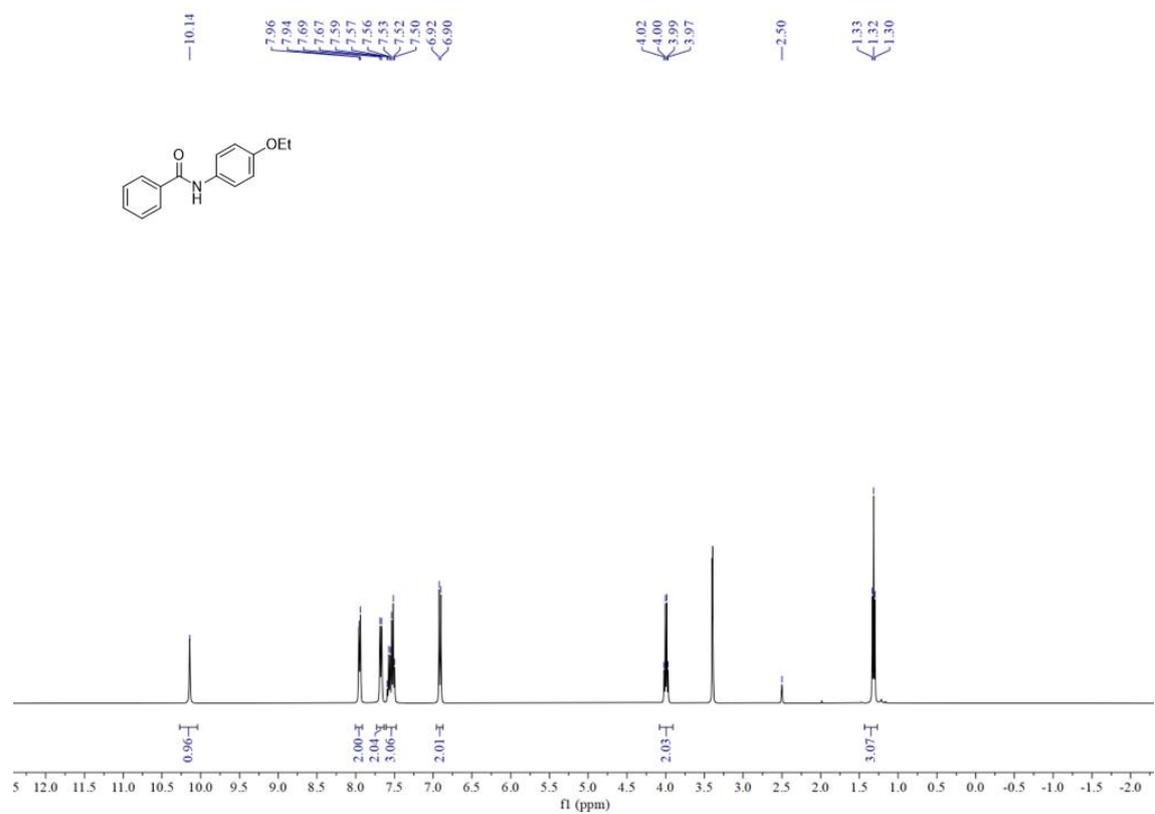


Figure S44. ^1H NMR (400 MHz, $\text{DMSO-}d_6$) spectrum of **3p**

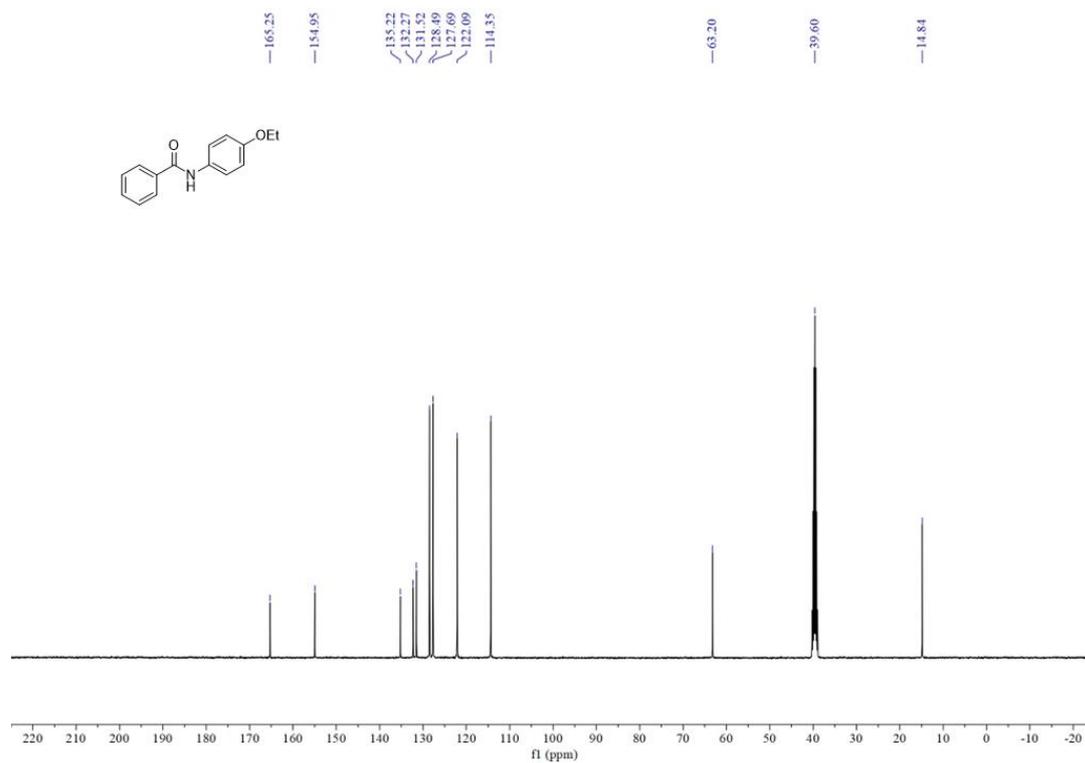


Figure S45. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$) spectrum of **3p**

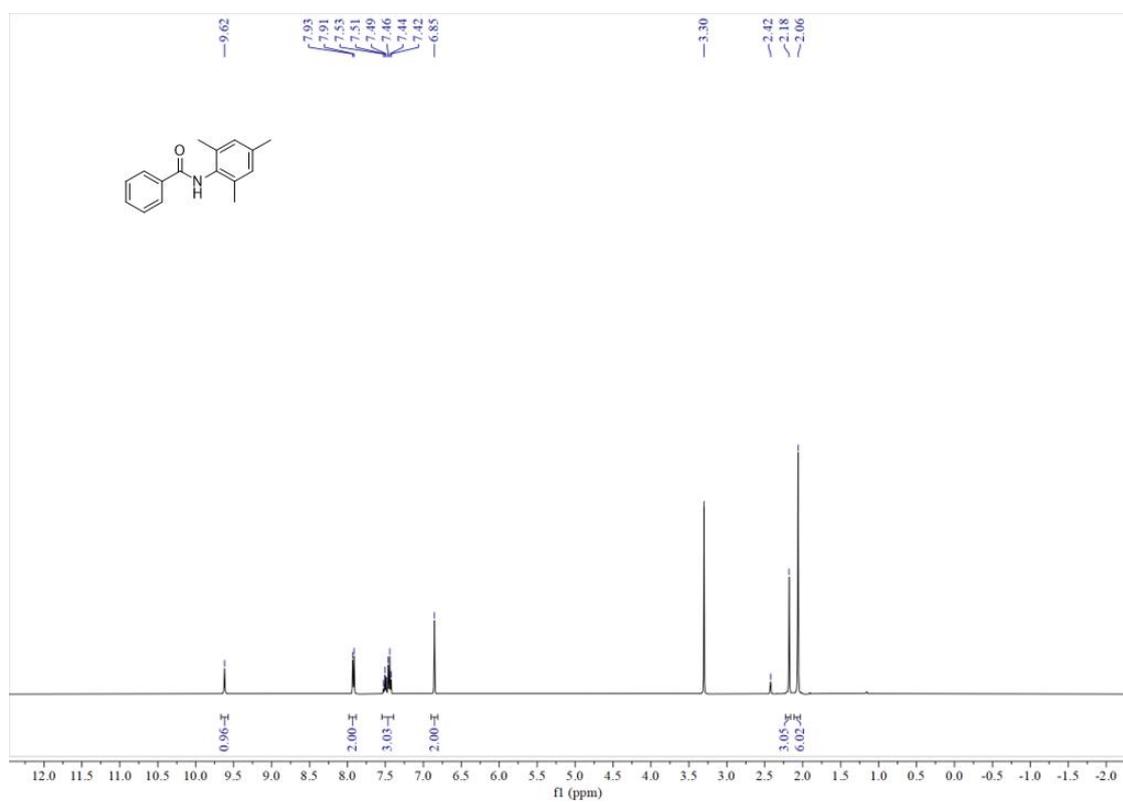


Figure S46. ^1H NMR (400 MHz, $\text{DMSO-}d_6$) spectrum of **3q**

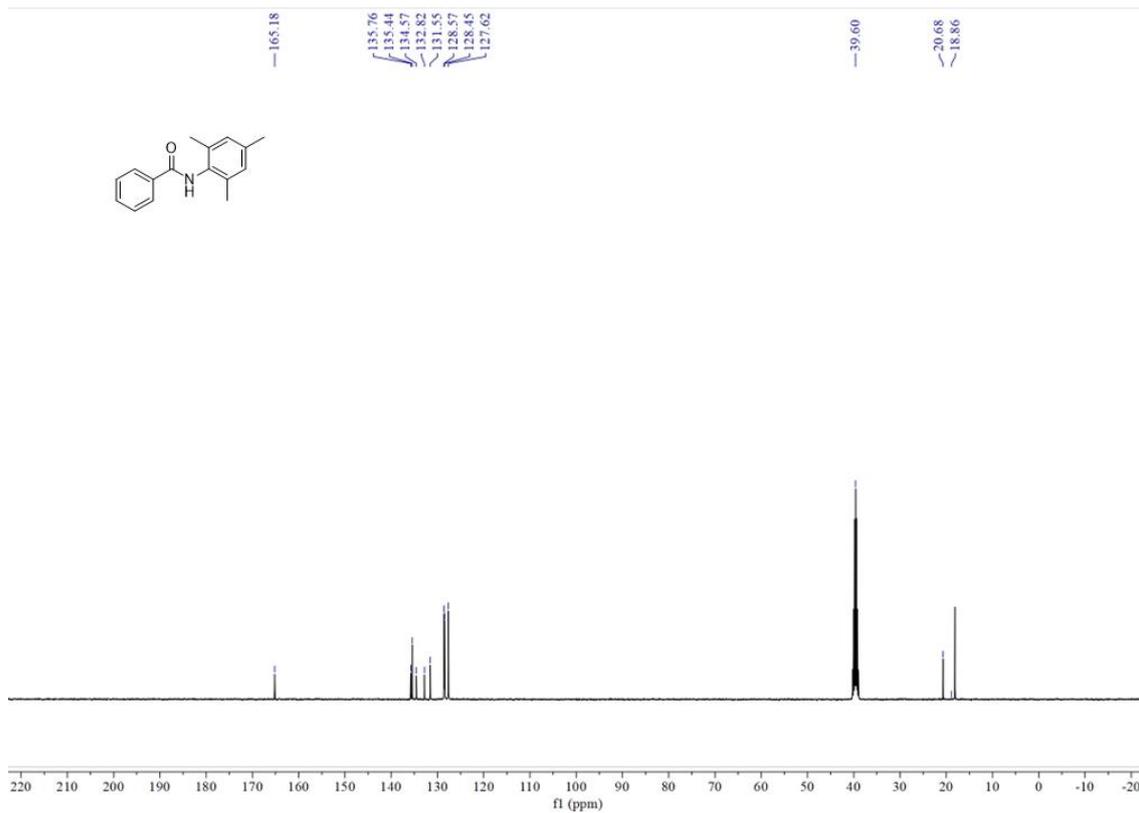


Figure S47. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$) spectrum of 3q

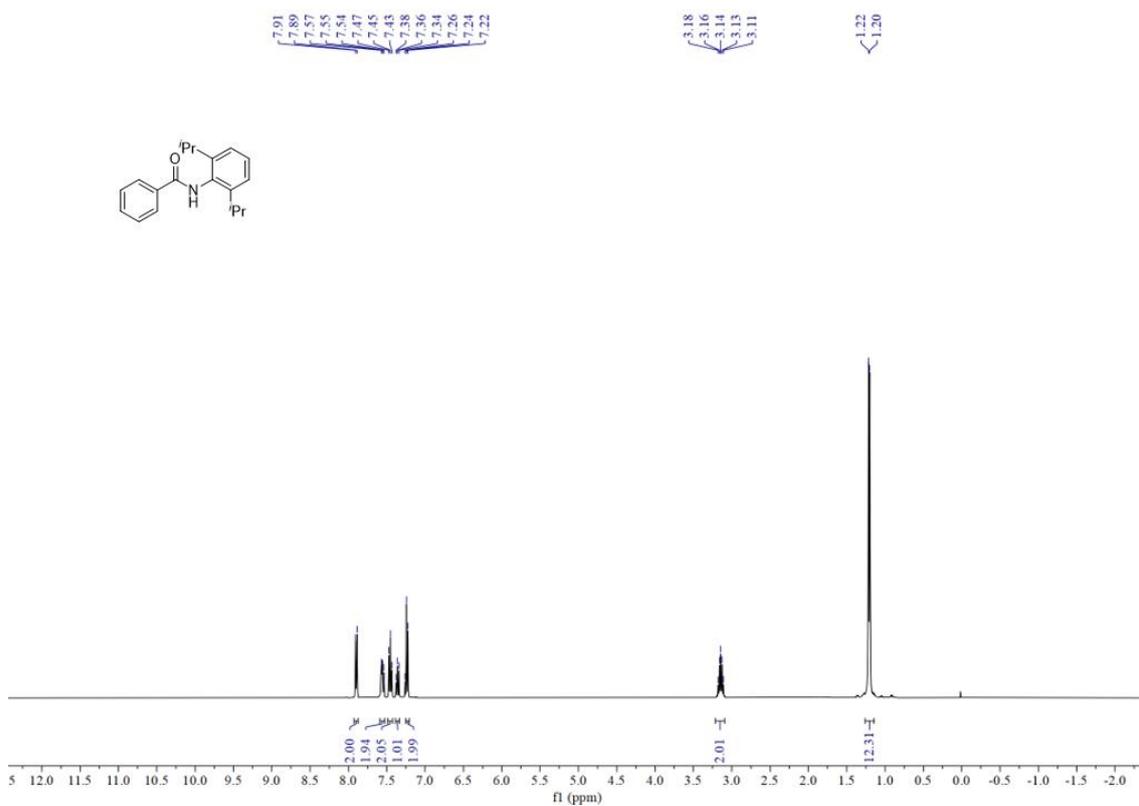


Figure S48. ^1H NMR (400 MHz, CDCl_3) spectrum of 3r

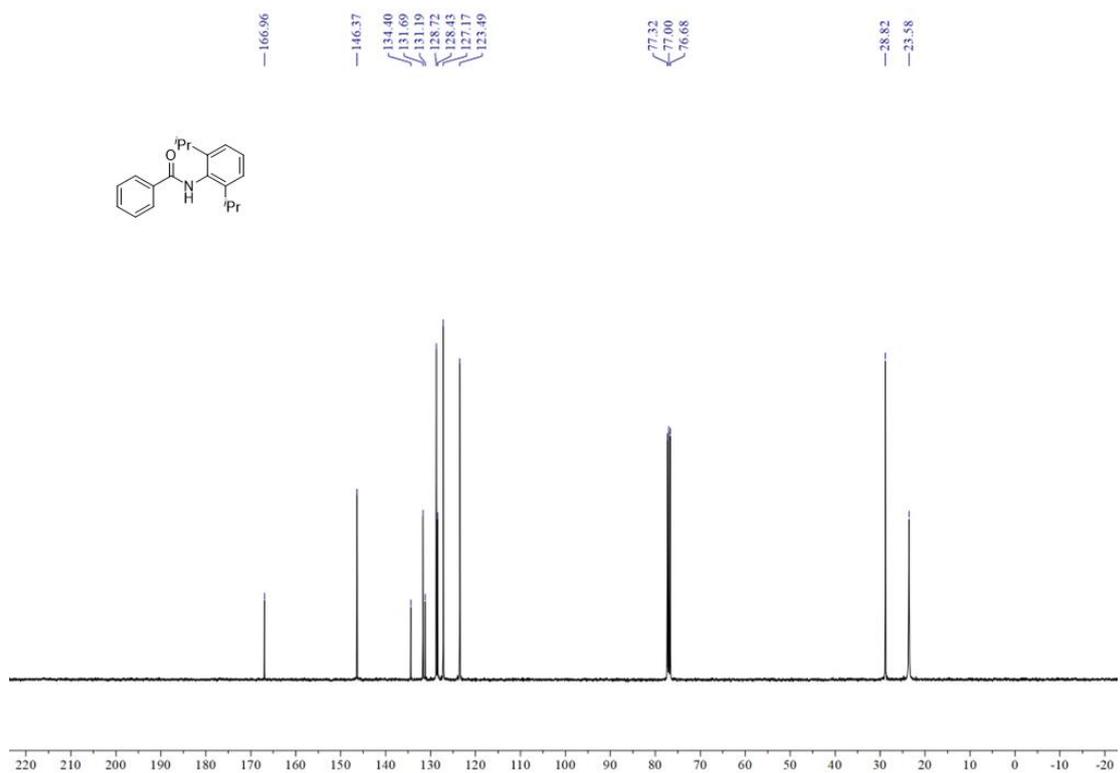


Figure S49. ¹³C NMR (100 MHz, CDCl₃) spectrum of **3r**

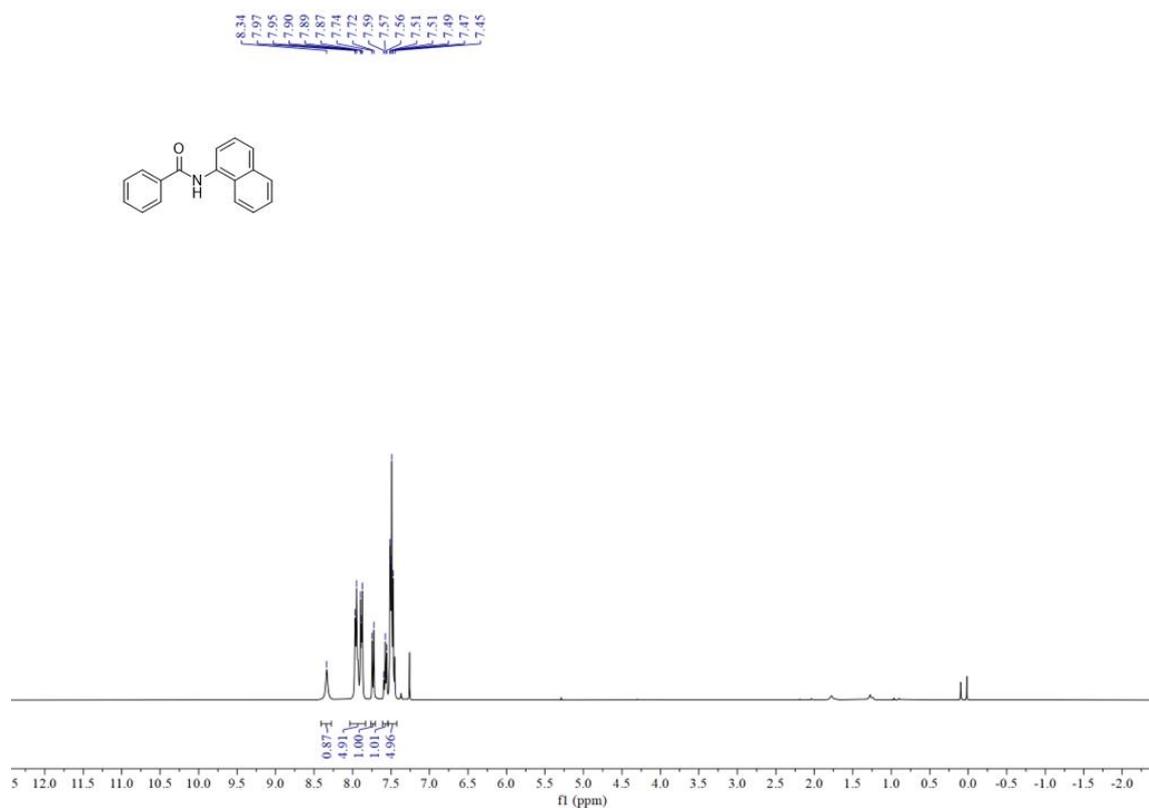


Figure S50. ¹H NMR (400 MHz, CDCl₃) spectrum of **3s**

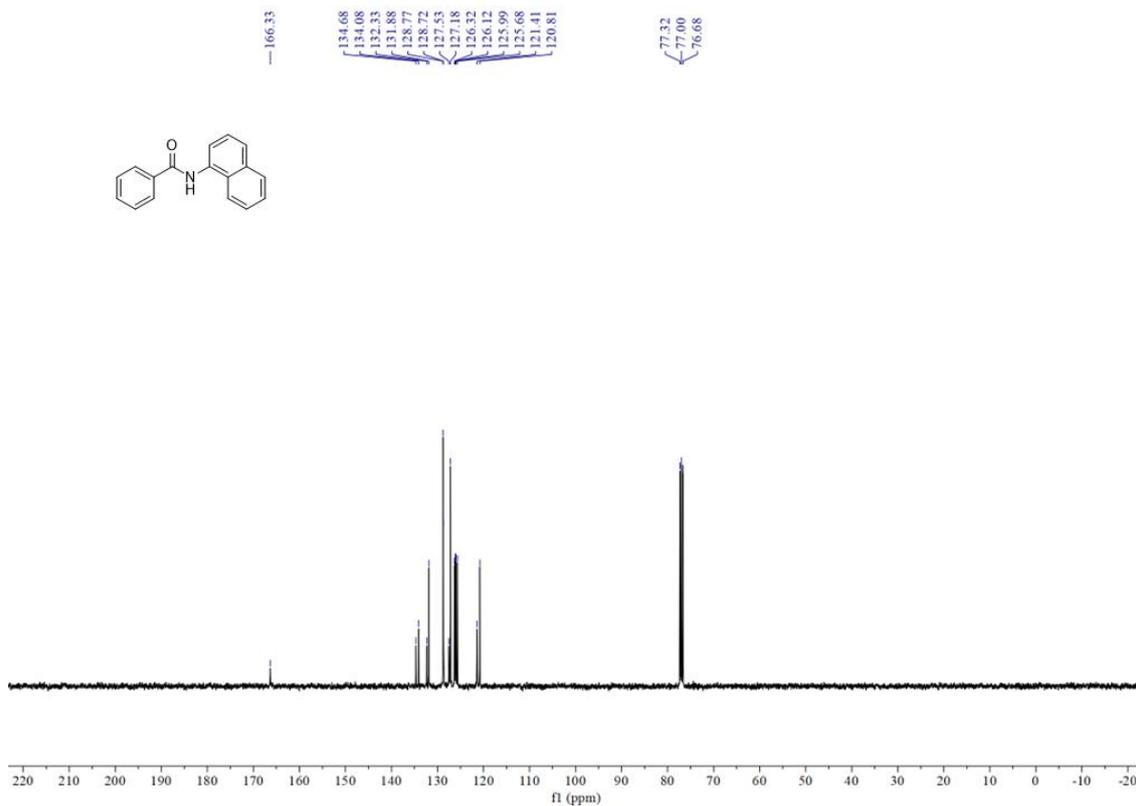


Figure S51. ¹³C NMR (100 MHz, CDCl₃) spectrum of 3s

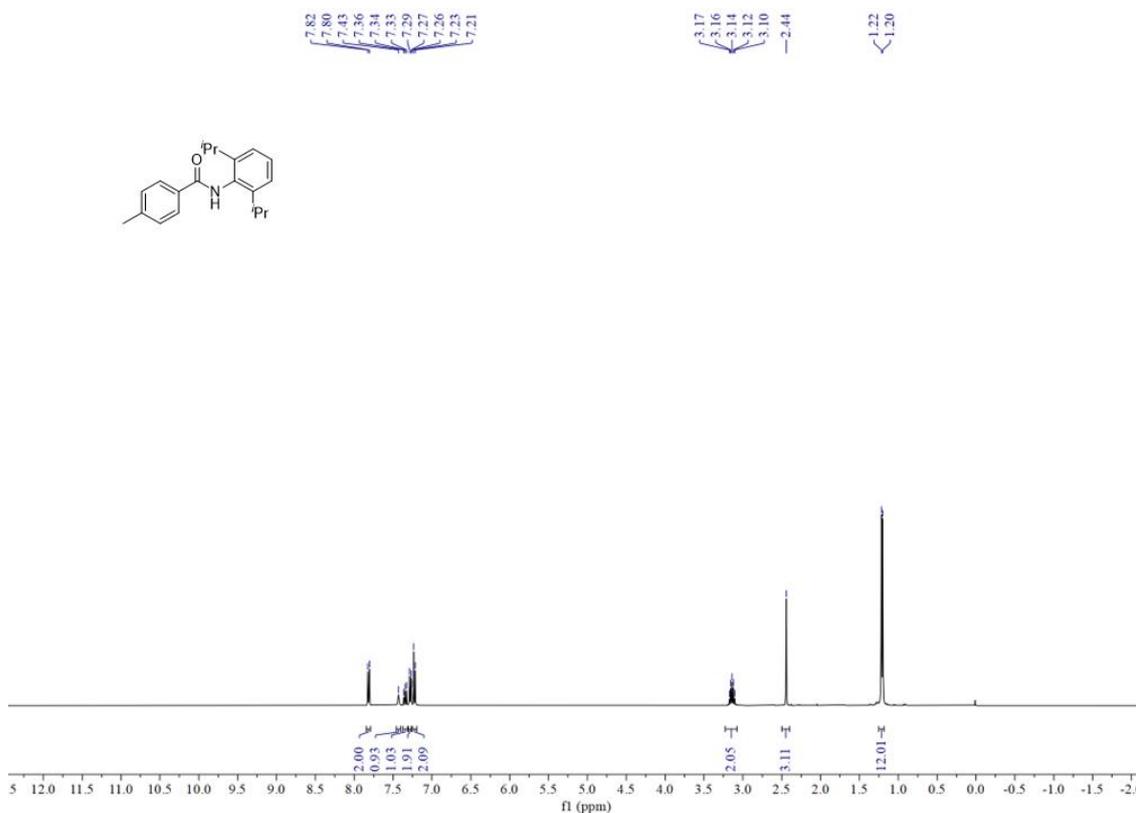


Figure S52. ¹H NMR (400 MHz, CDCl₃) spectrum of 3t

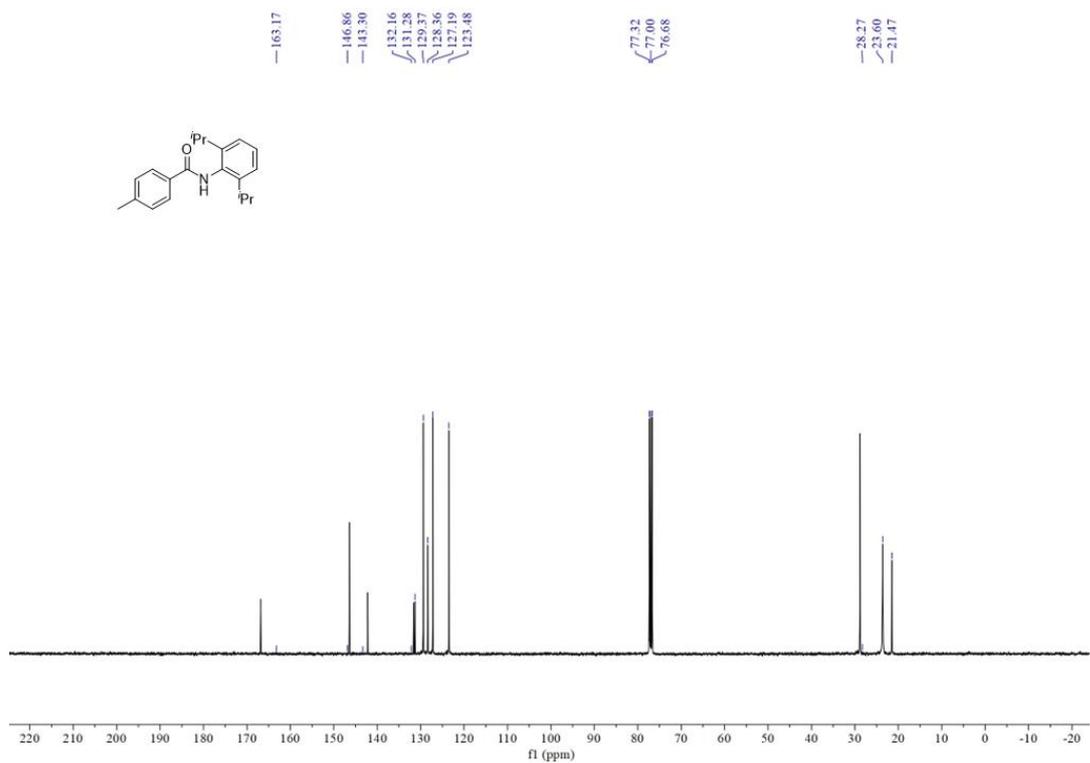


Figure S53. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **3t**

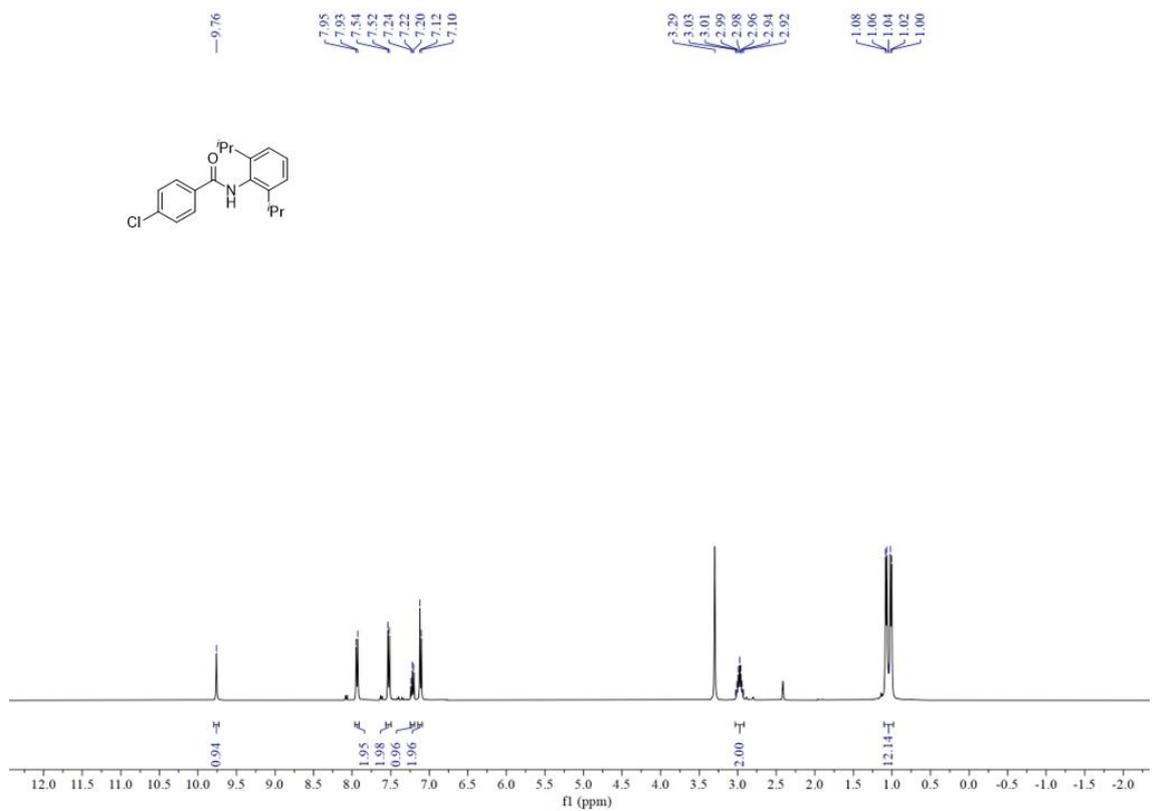


Figure S54. ^1H NMR (400 MHz, $\text{DMSO}-d_6$) spectrum of **3u**

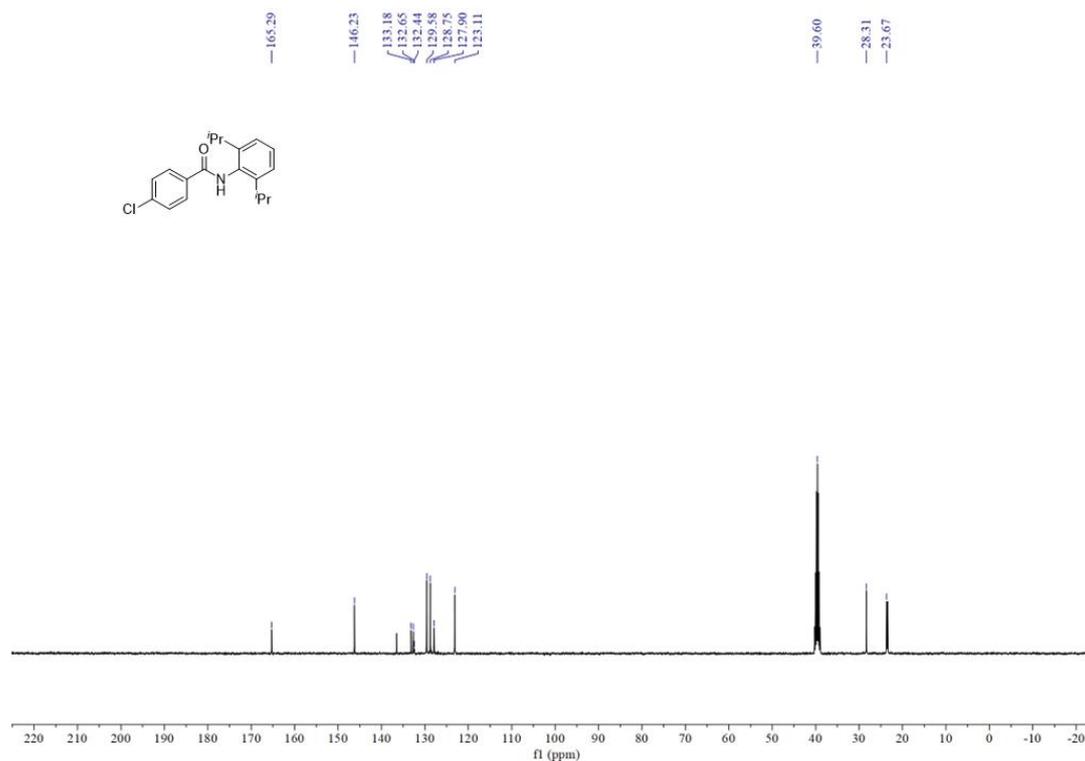


Figure S55. ¹³C NMR (100 MHz, DMSO-*d*₆) spectrum of 3u

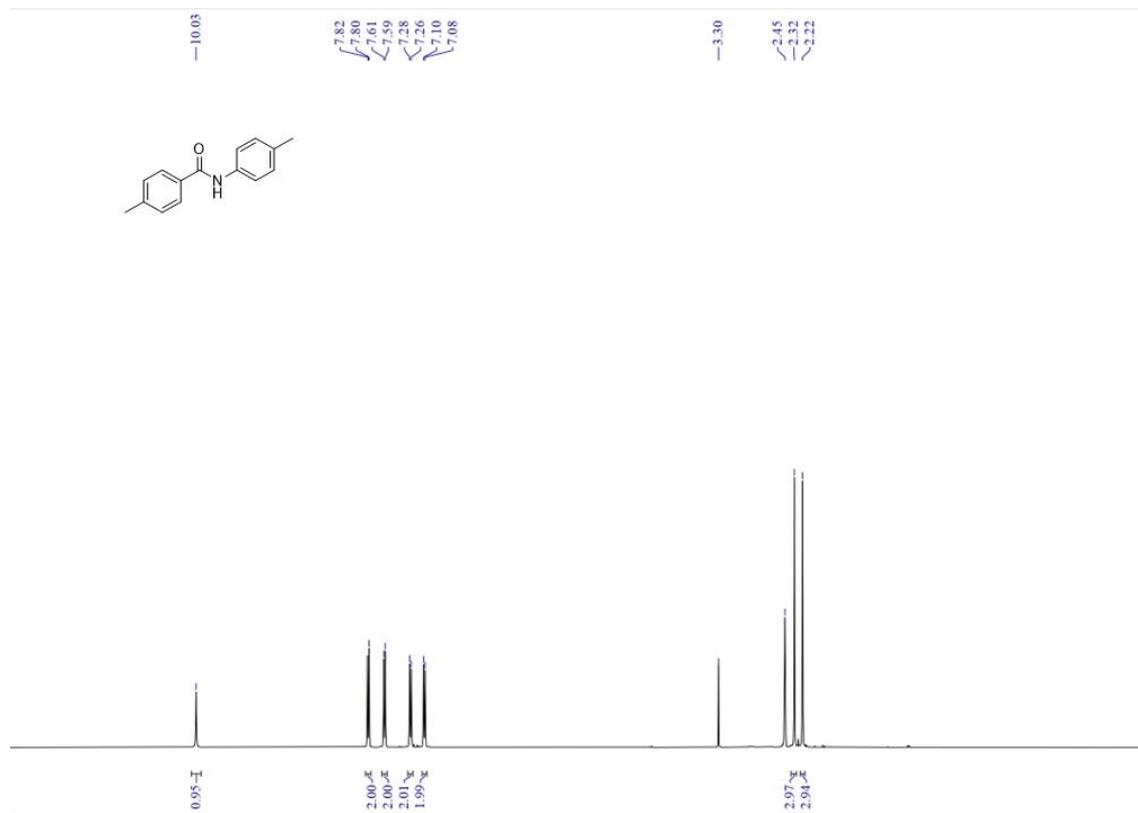


Figure S56. ¹H NMR (400 MHz, DMSO-*d*₆) spectrum of 3v

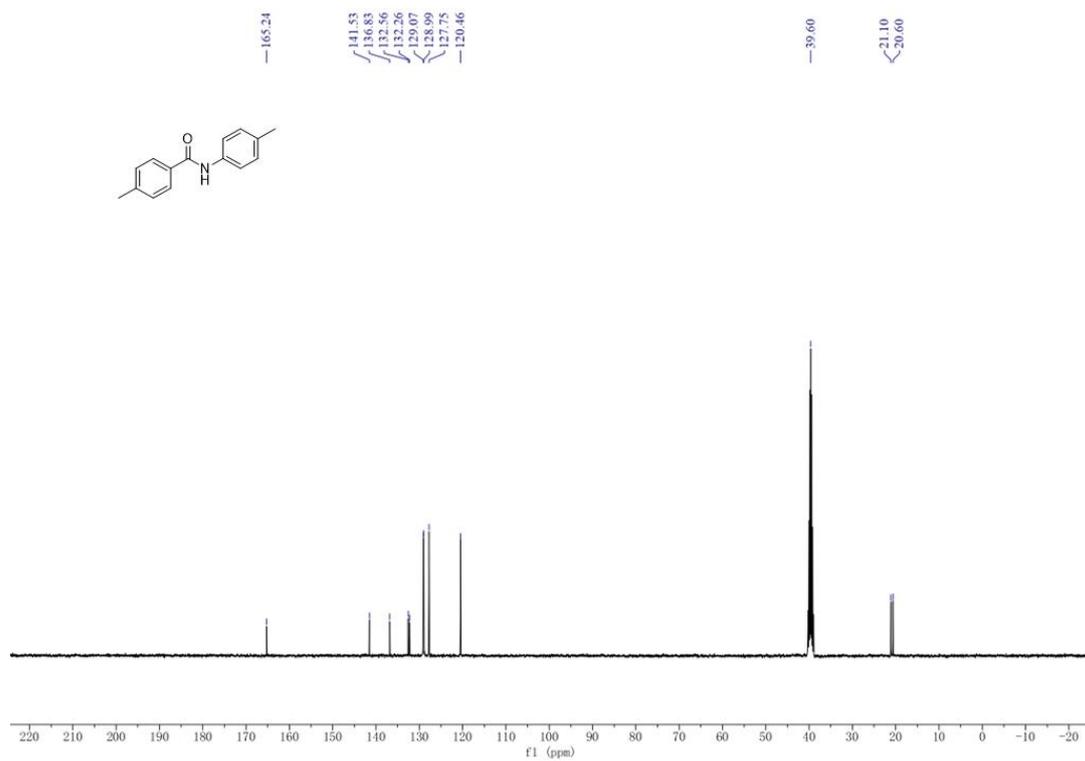


Figure S57. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$) spectrum of **3v**

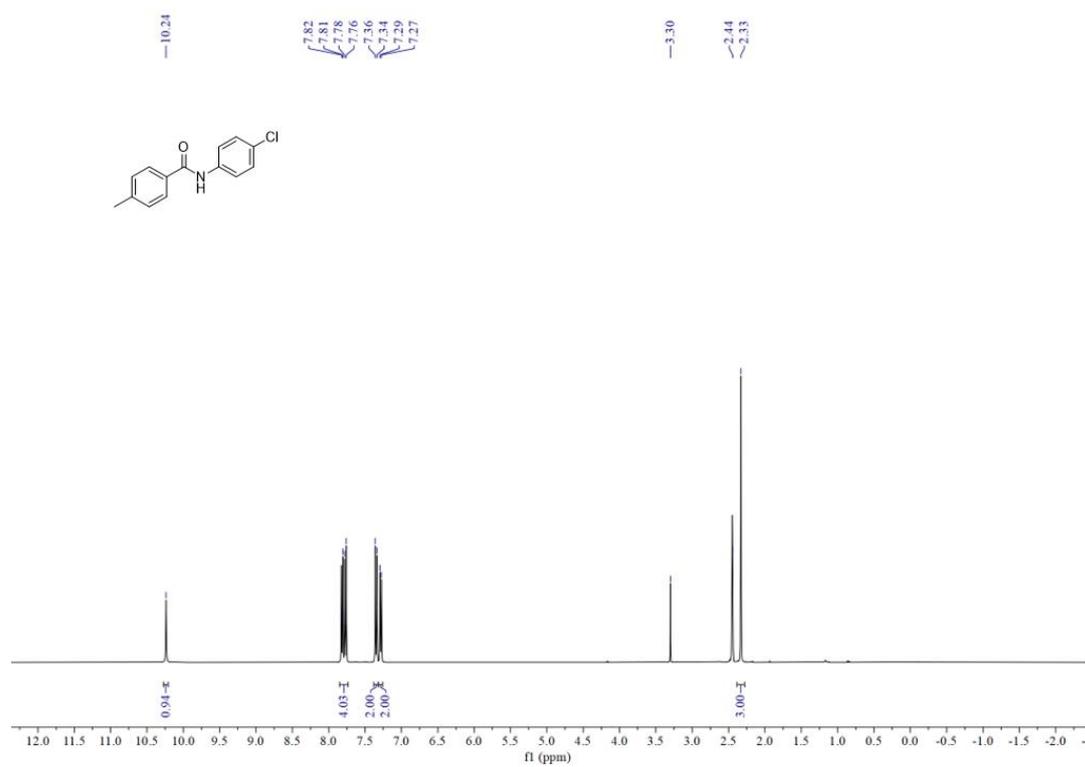


Figure S58. ^1H NMR (400 MHz, $\text{DMSO-}d_6$) spectrum of **3w**

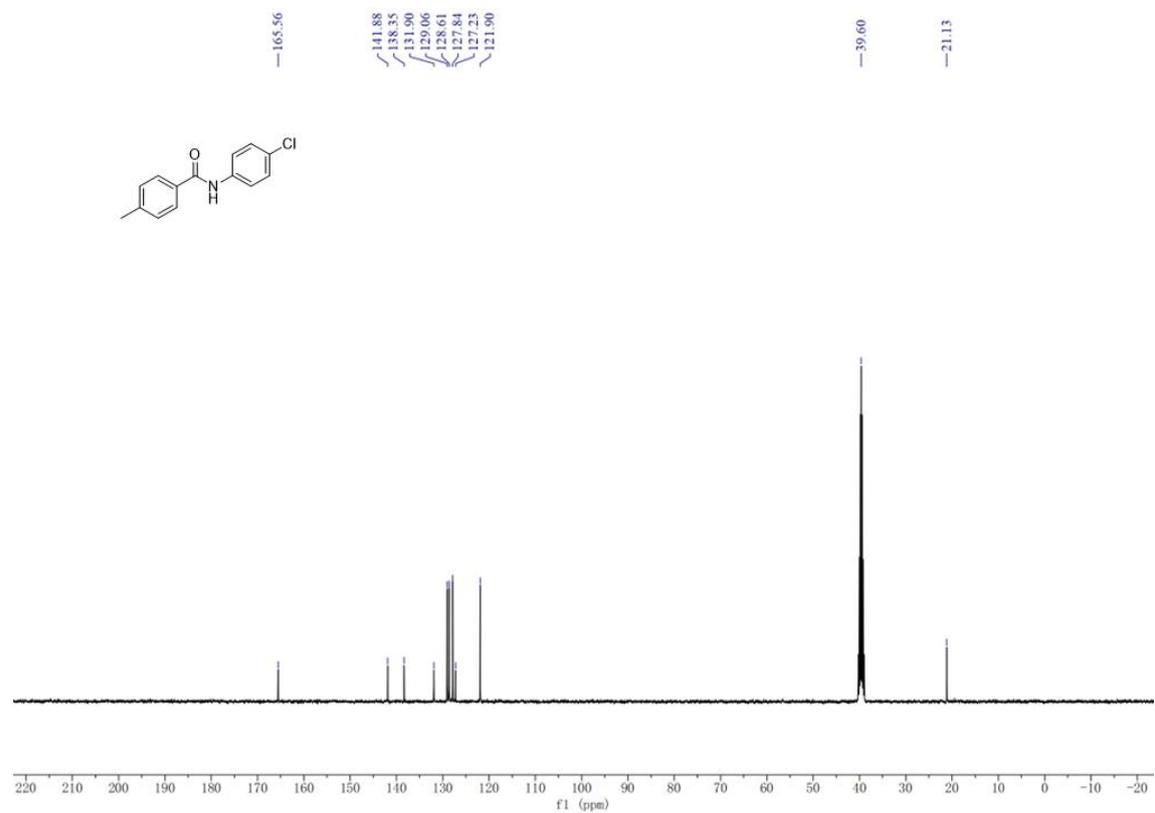


Figure S59. ¹³C NMR (100 MHz, DMSO-*d*₆) spectrum of **3w**

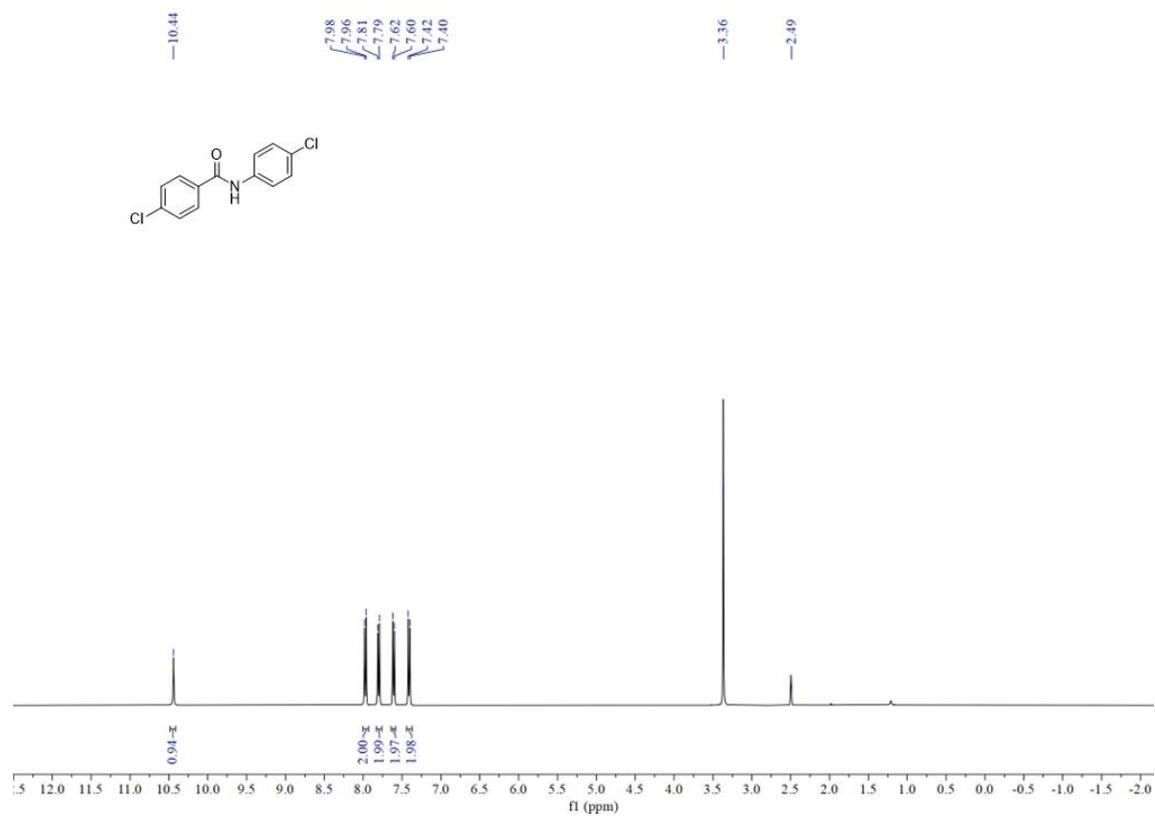


Figure S60. ¹H NMR (400 MHz, DMSO-*d*₆) spectrum of **3x**

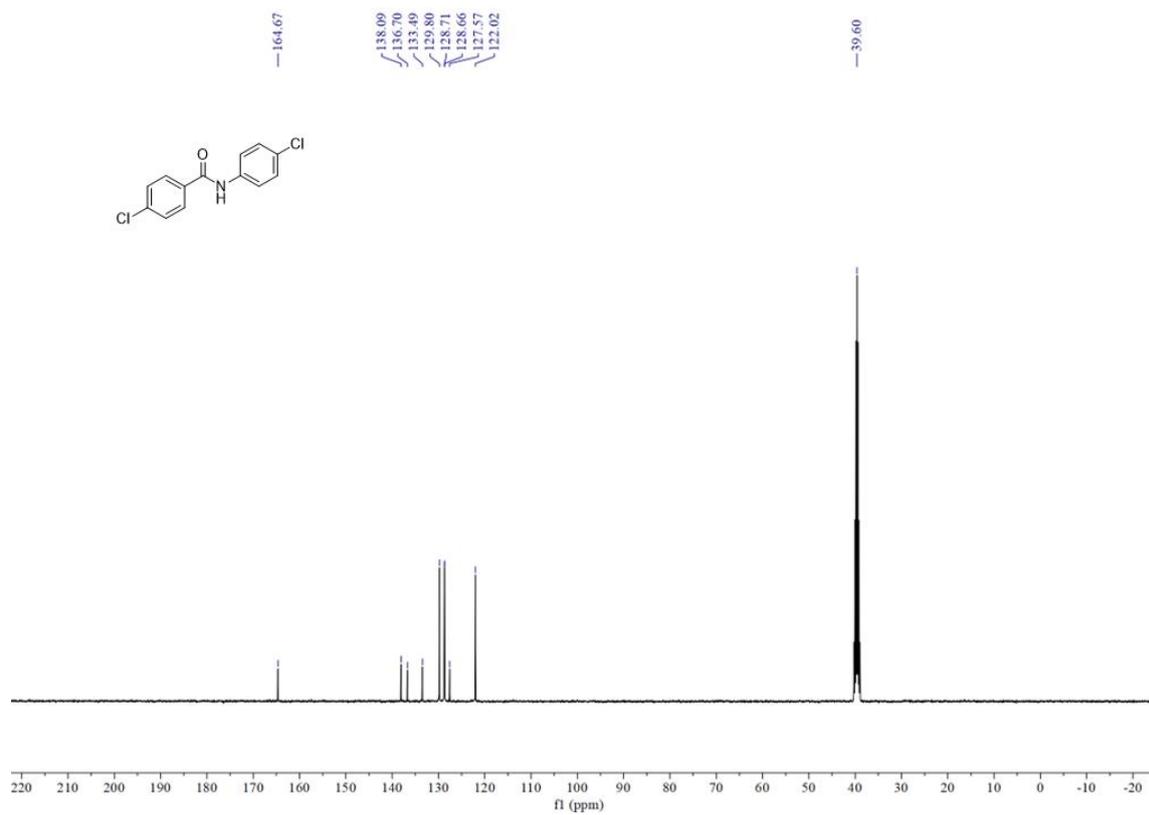


Figure S61. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$) spectrum of 3x

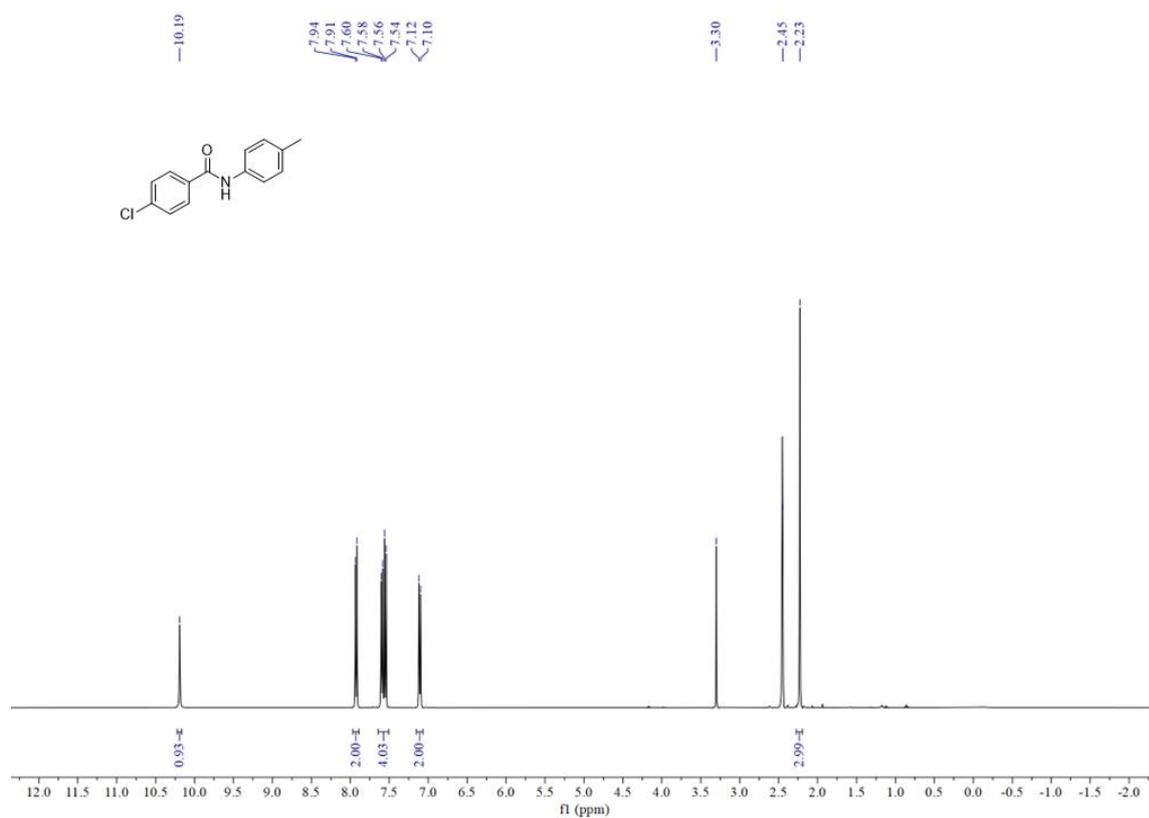


Figure S62. ^1H NMR (400 MHz, $\text{DMSO-}d_6$) spectrum of 3x

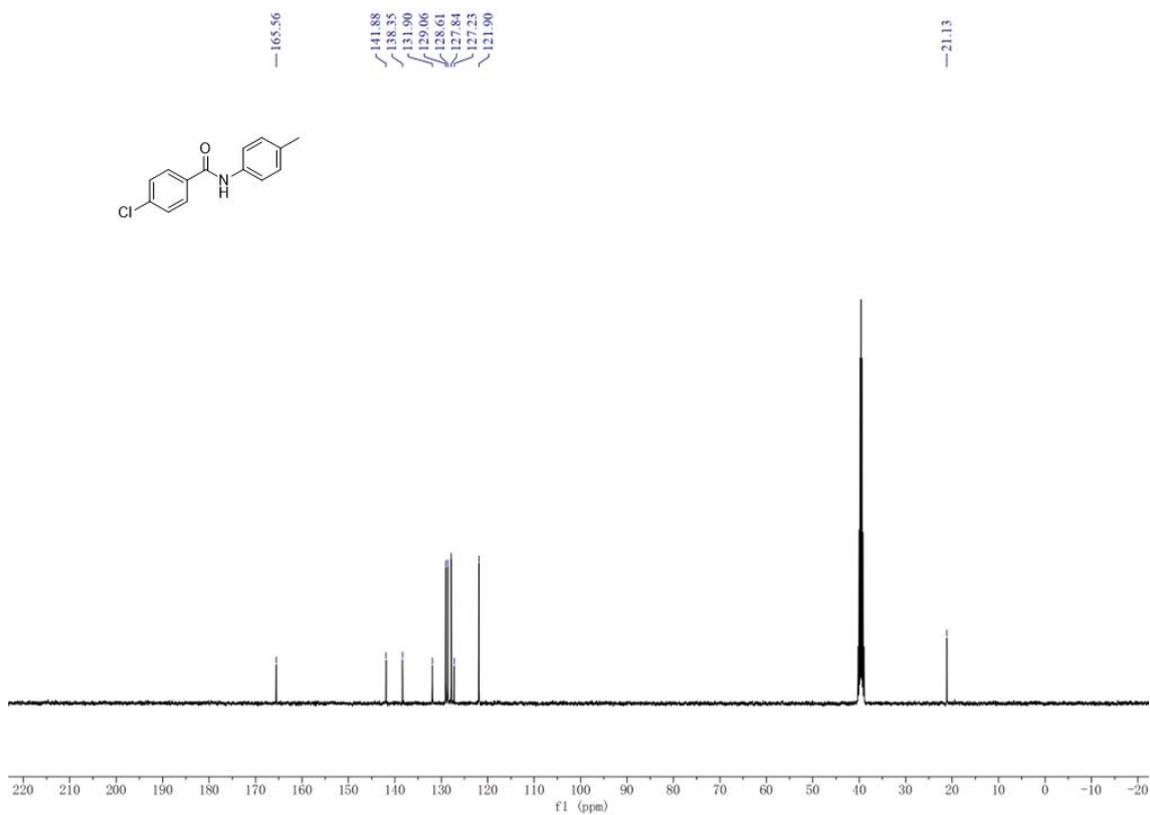


Figure S63. ^{13}C NMR (100 MHz, $\text{DMSO-}d_6$) spectrum of 3y

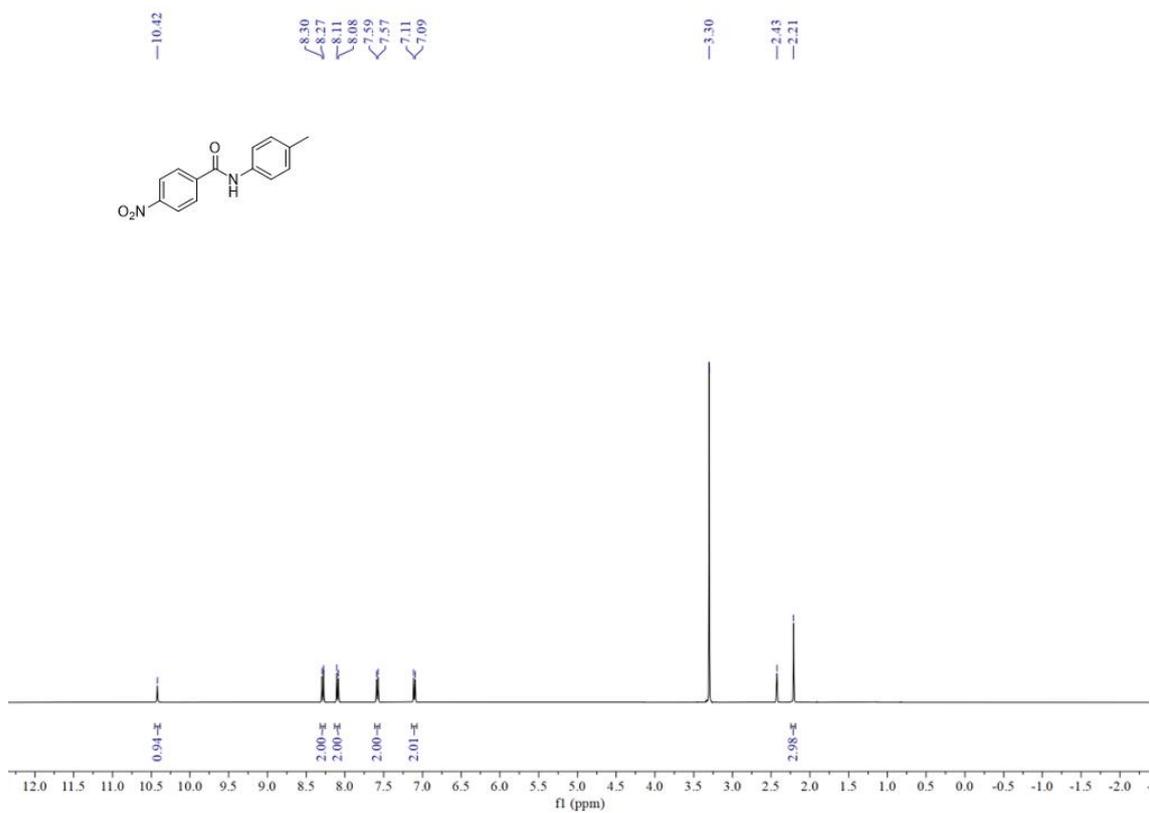


Figure S64. ^1H NMR (400 MHz, $\text{DMSO-}d_6$) spectrum of 3z

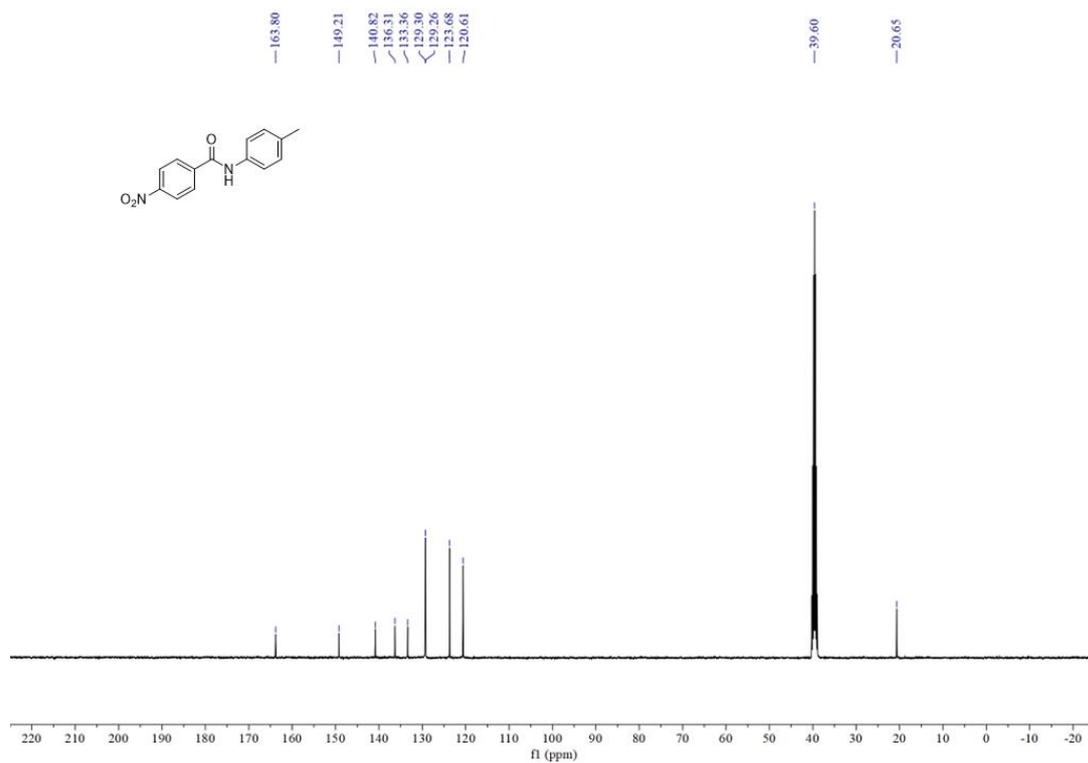


Figure S65. ¹³C NMR (100 MHz, DMSO-*d*₆) spectrum of **3z**

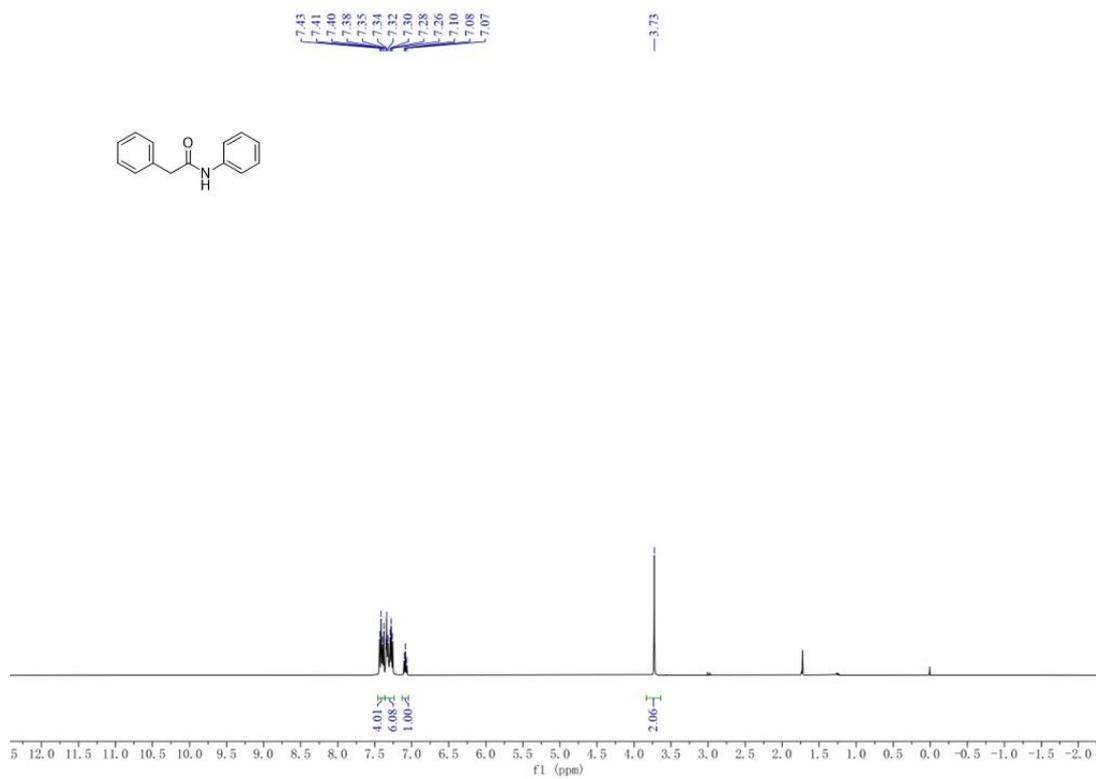


Figure S66. ¹H NMR (400 MHz, CDCl₃) spectrum of **3aa**

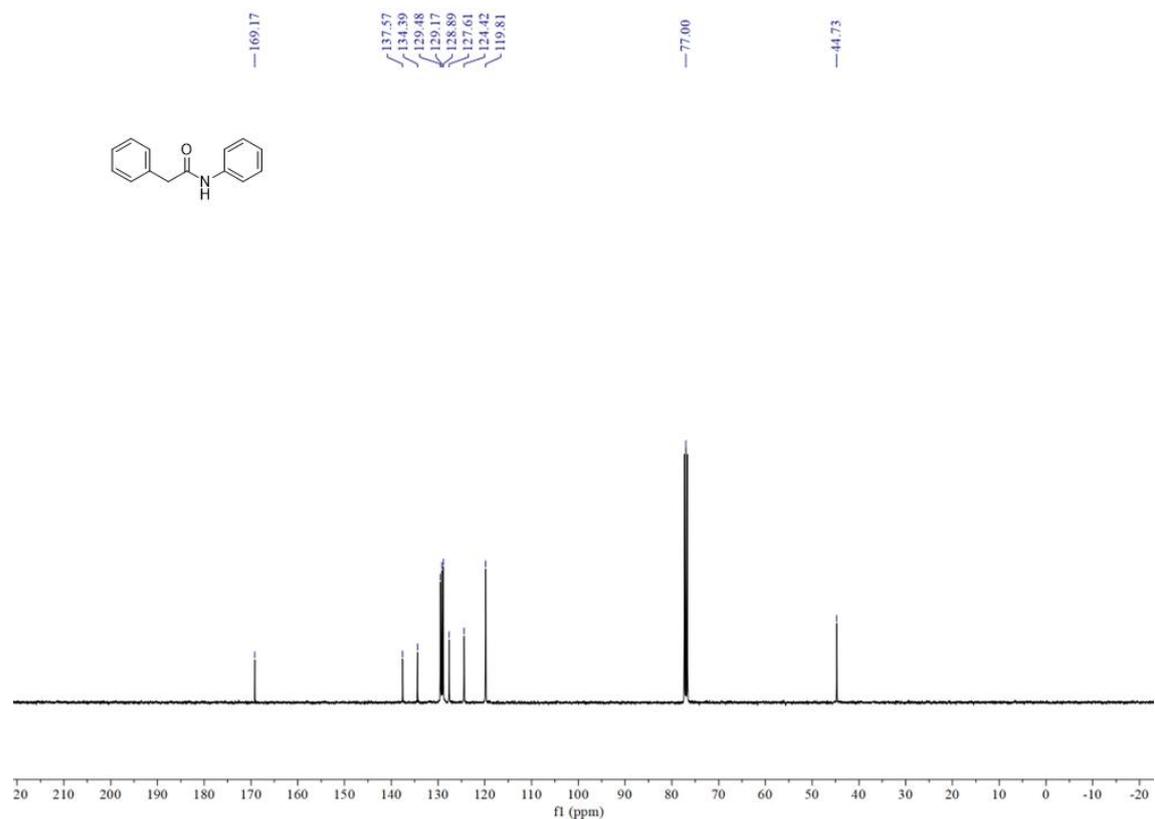


Figure S67. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **3aa**

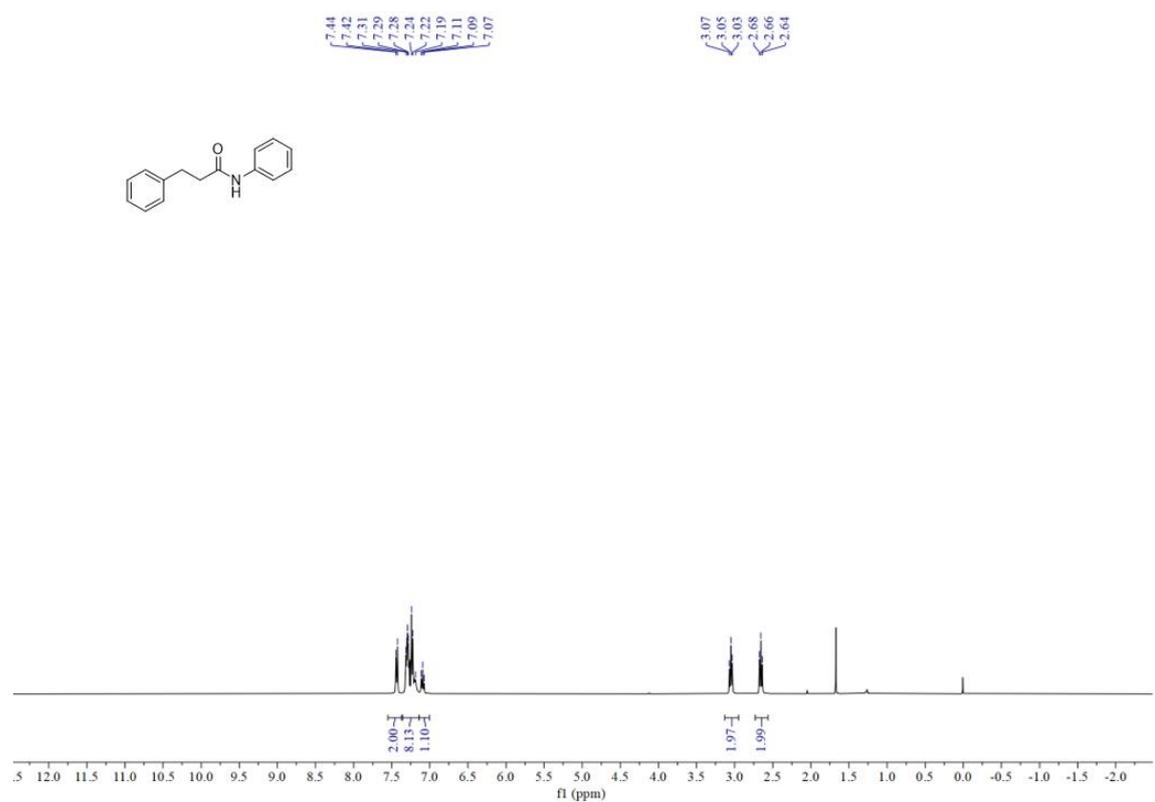


Figure S68. ^1H NMR (400 MHz, CDCl_3) spectrum of **3ab**

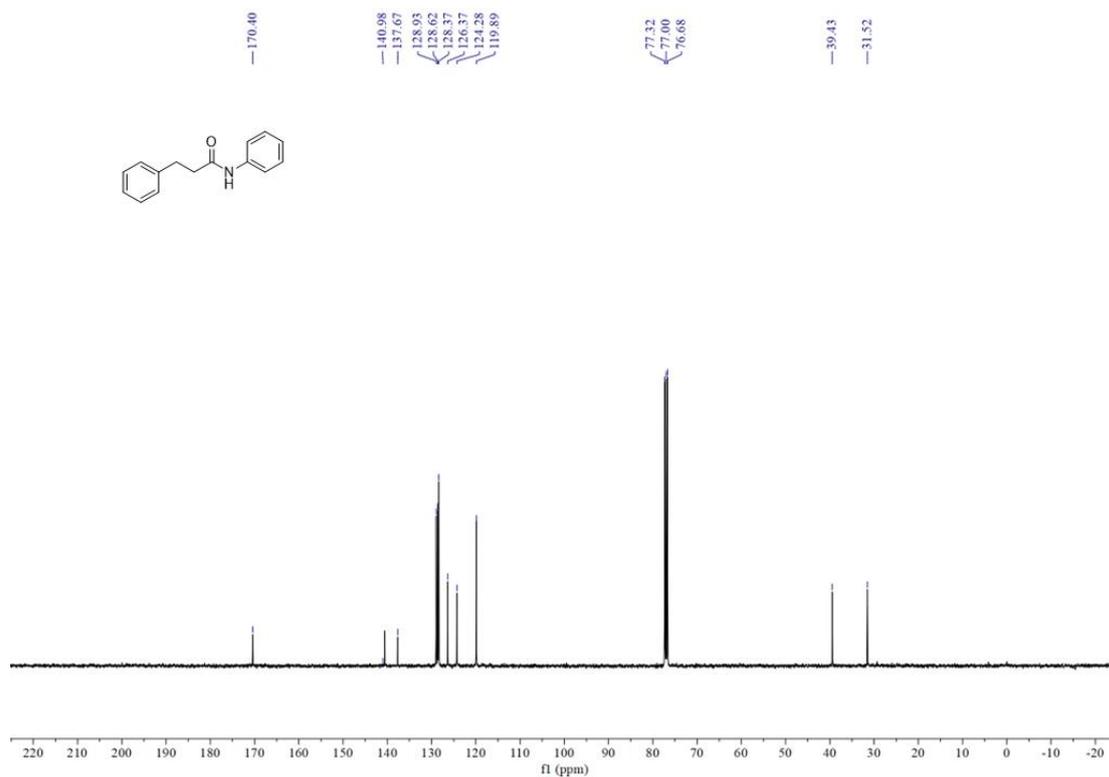


Figure S69. ¹³C NMR (100 MHz, CDCl₃) spectrum of **3ab**

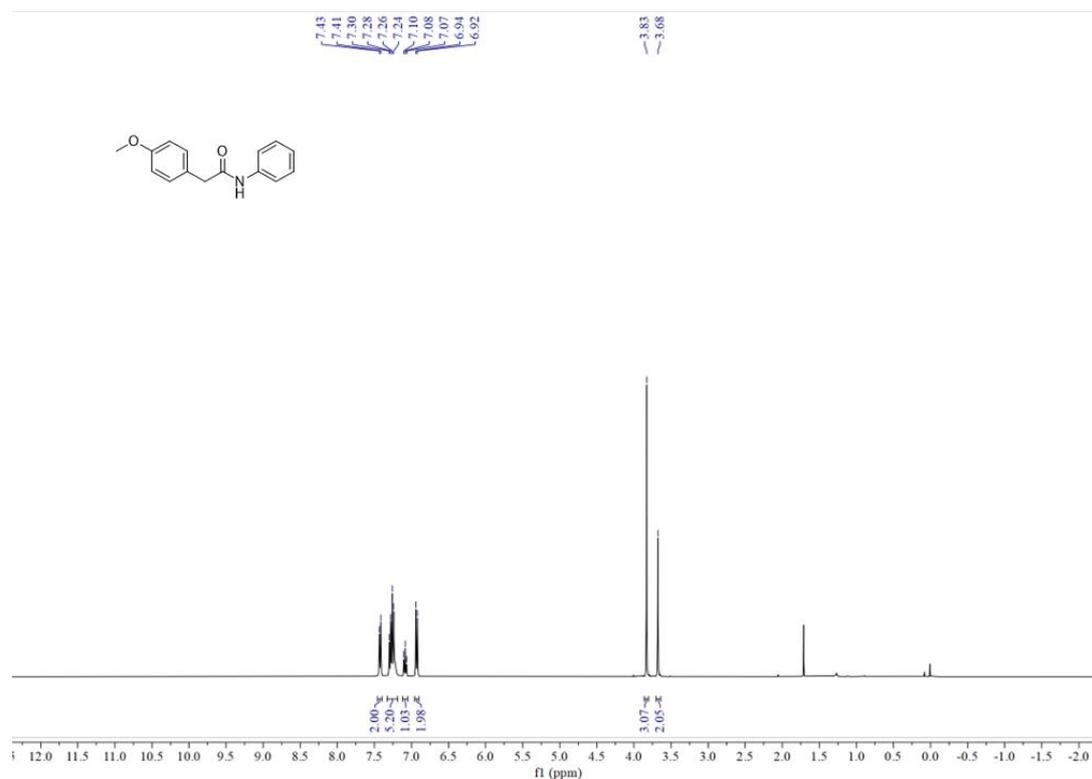


Figure S70. ¹H NMR (400 MHz, CDCl₃) spectrum of **3ac**

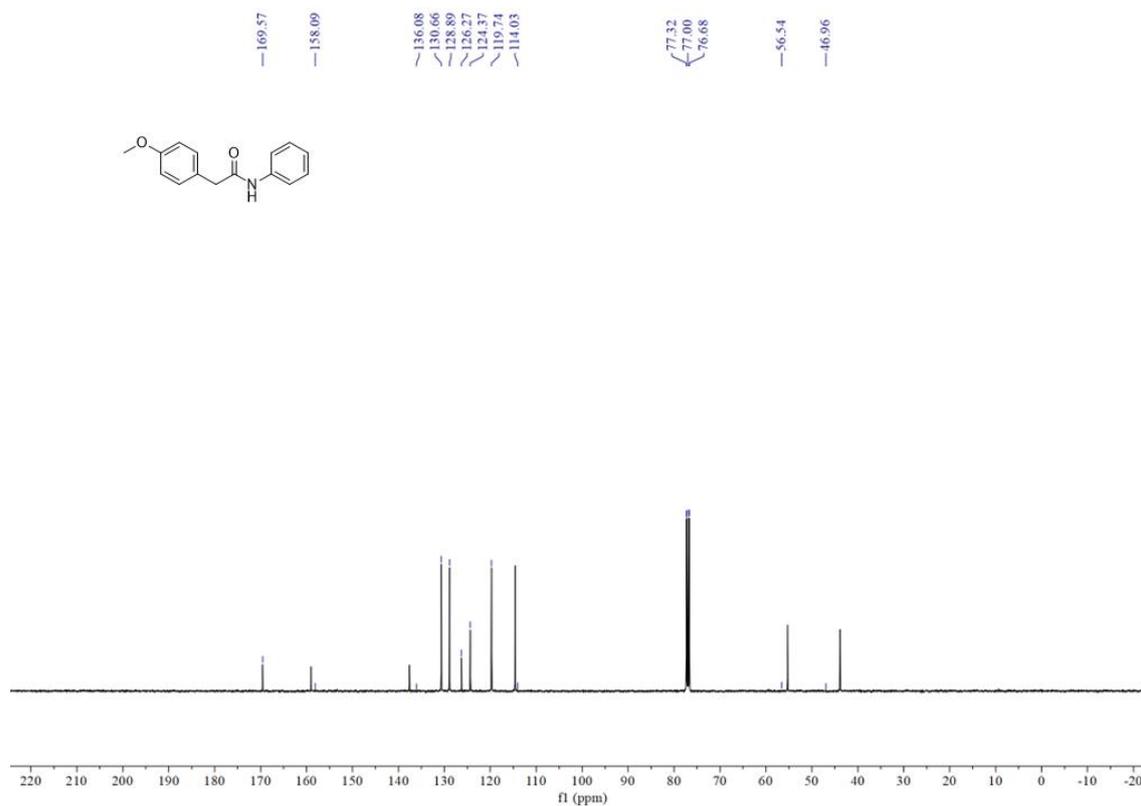


Figure S71. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 3ac

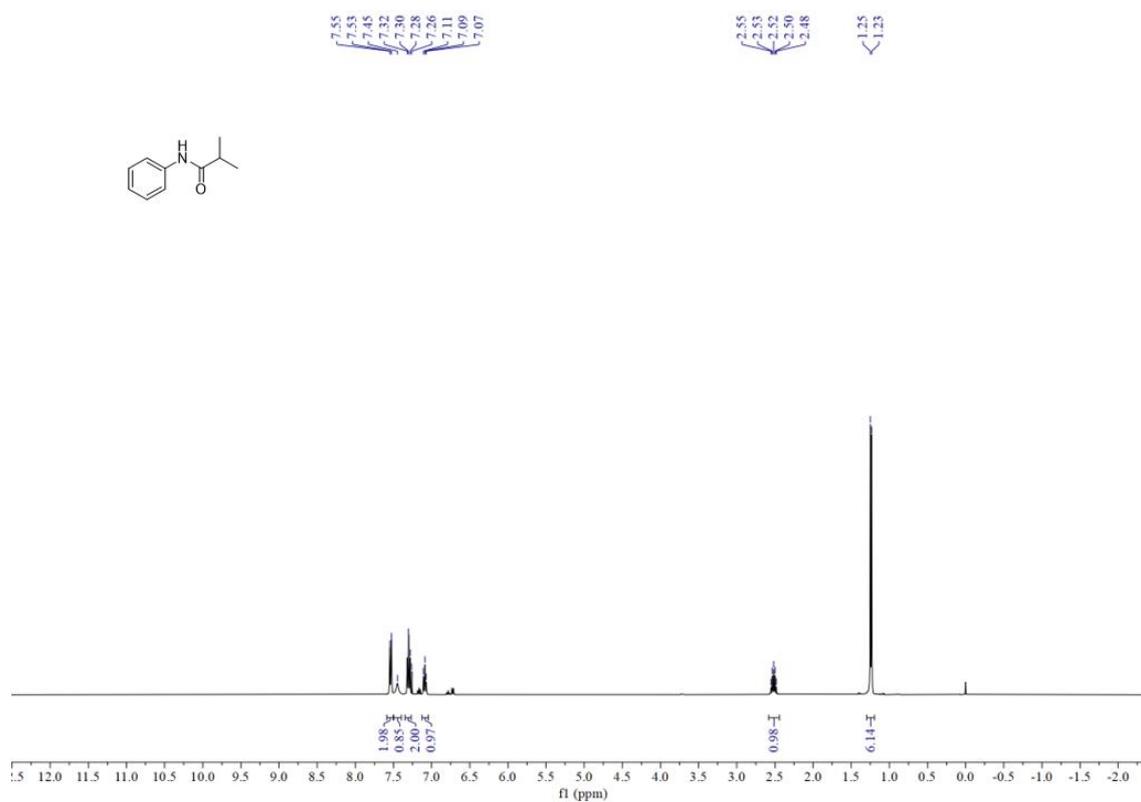


Figure S72. ^1H NMR (400 MHz, CDCl_3) spectrum of 3ad

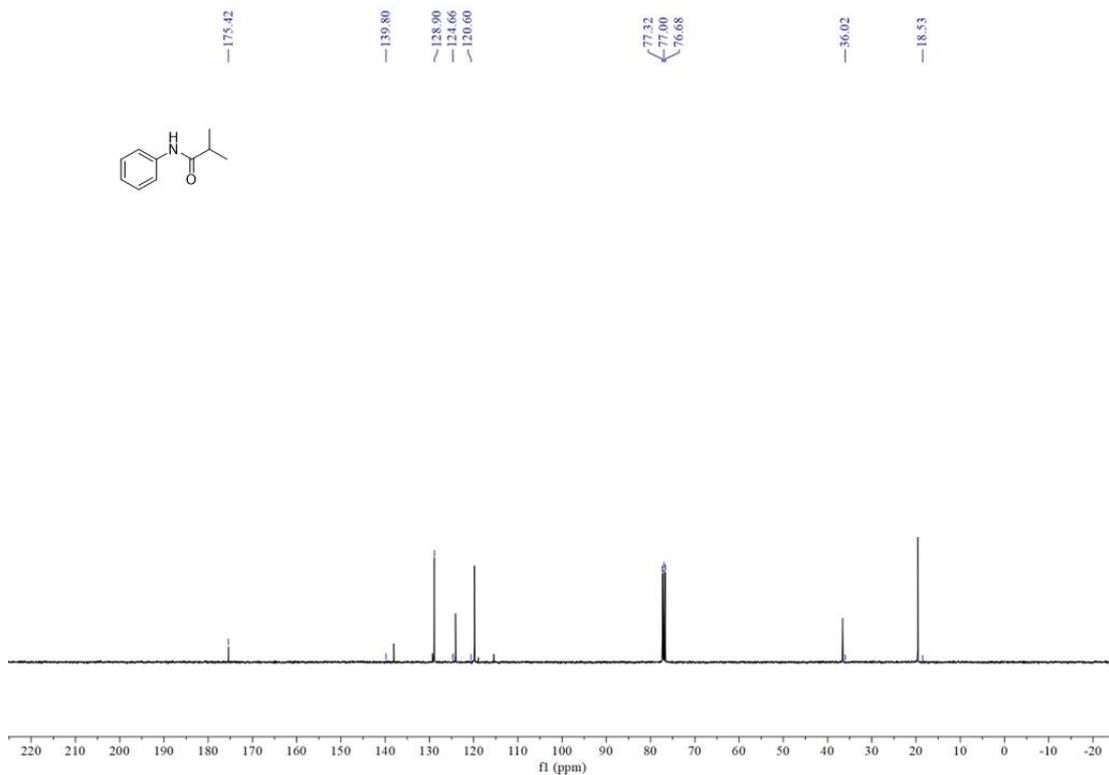


Figure S73. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **3ad**

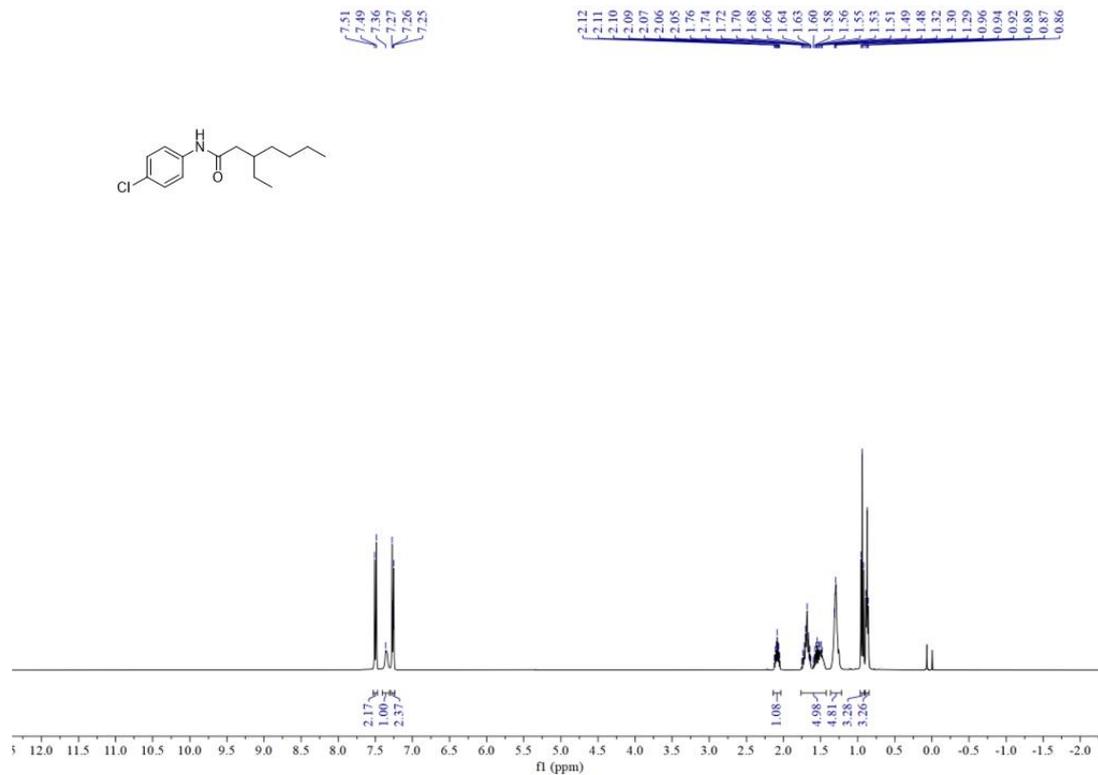


Figure S74. ^1H NMR (400 MHz, CDCl_3) spectrum of **3af**

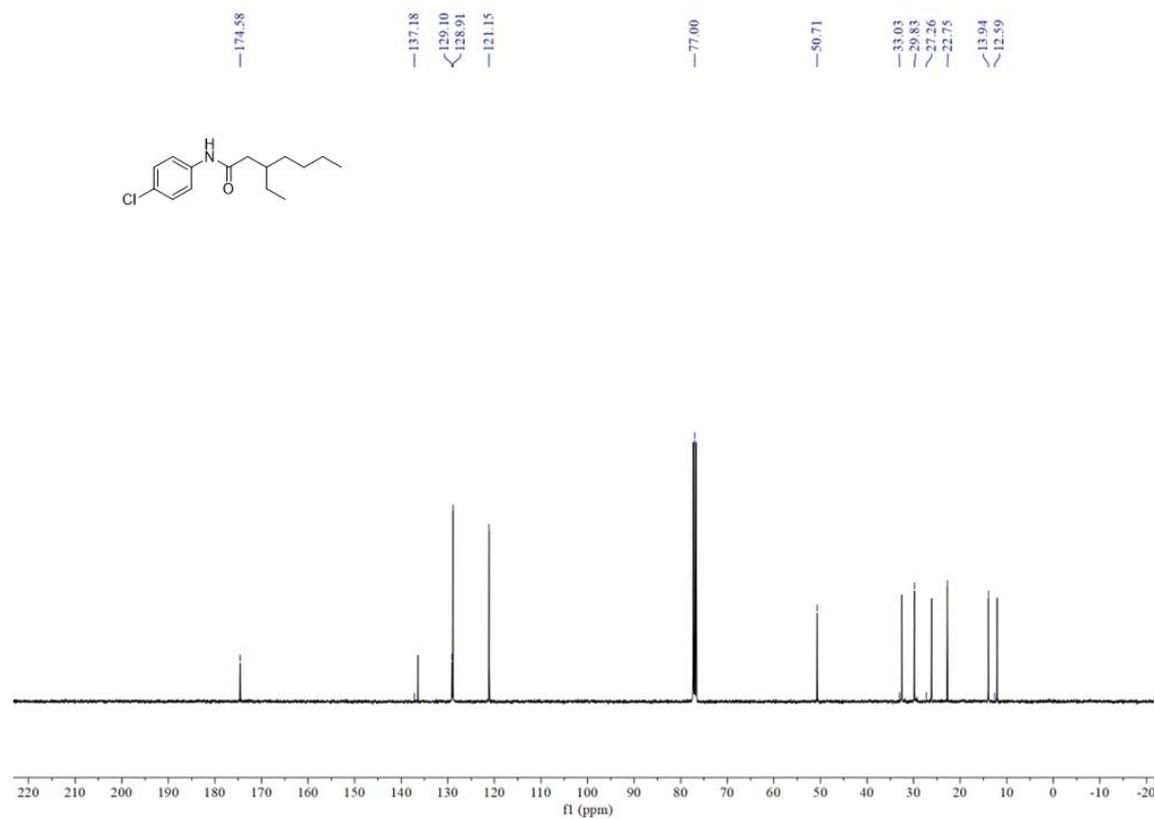


Figure S75. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 3af

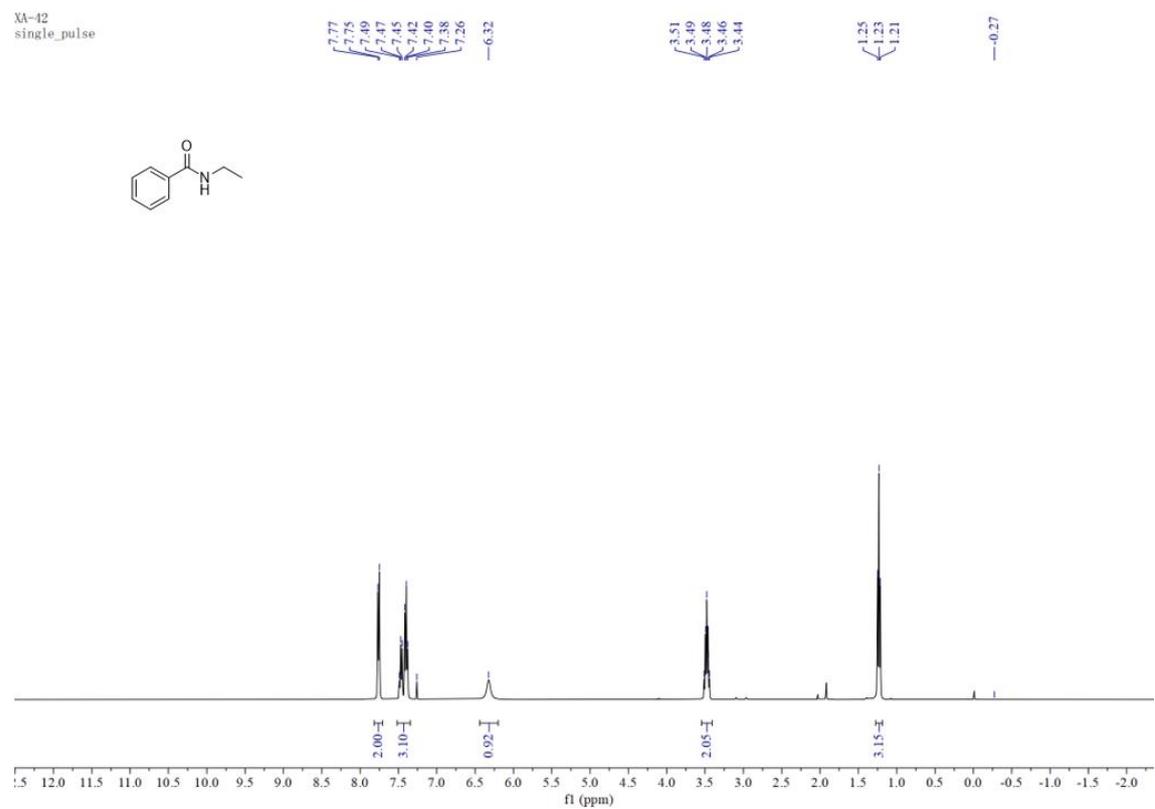


Figure S76. ^1H NMR (400 MHz, CDCl_3) spectrum of 3ah

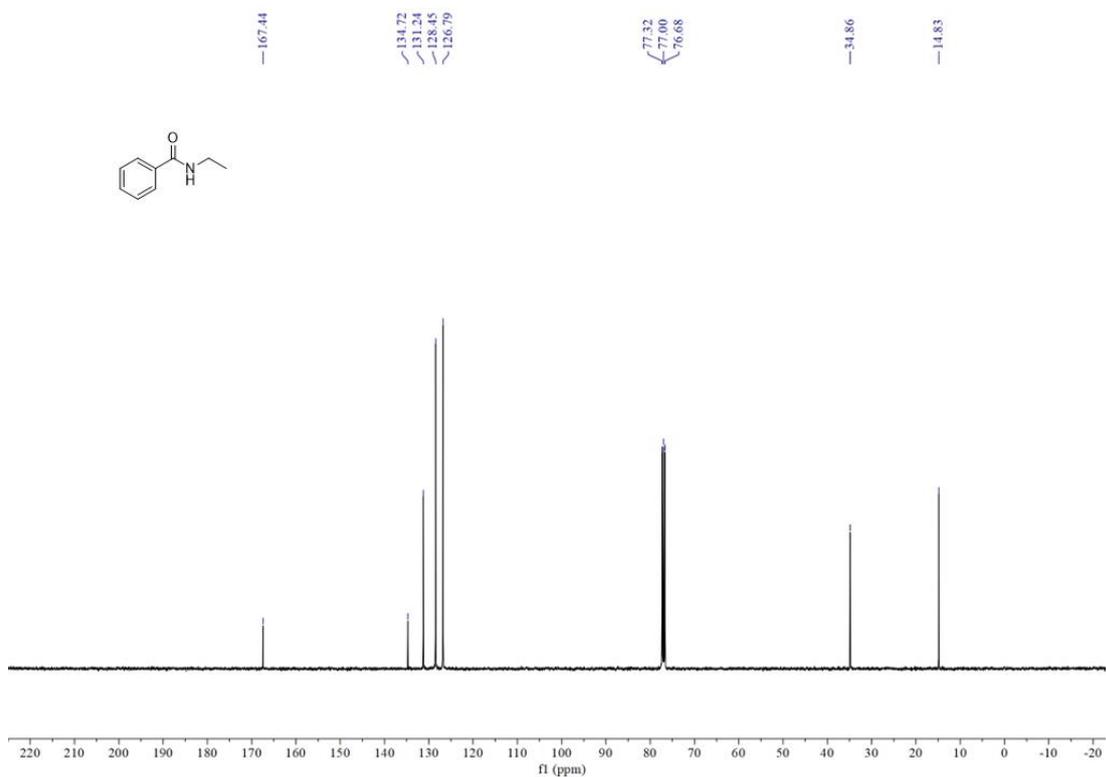


Figure S77. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **3ah**

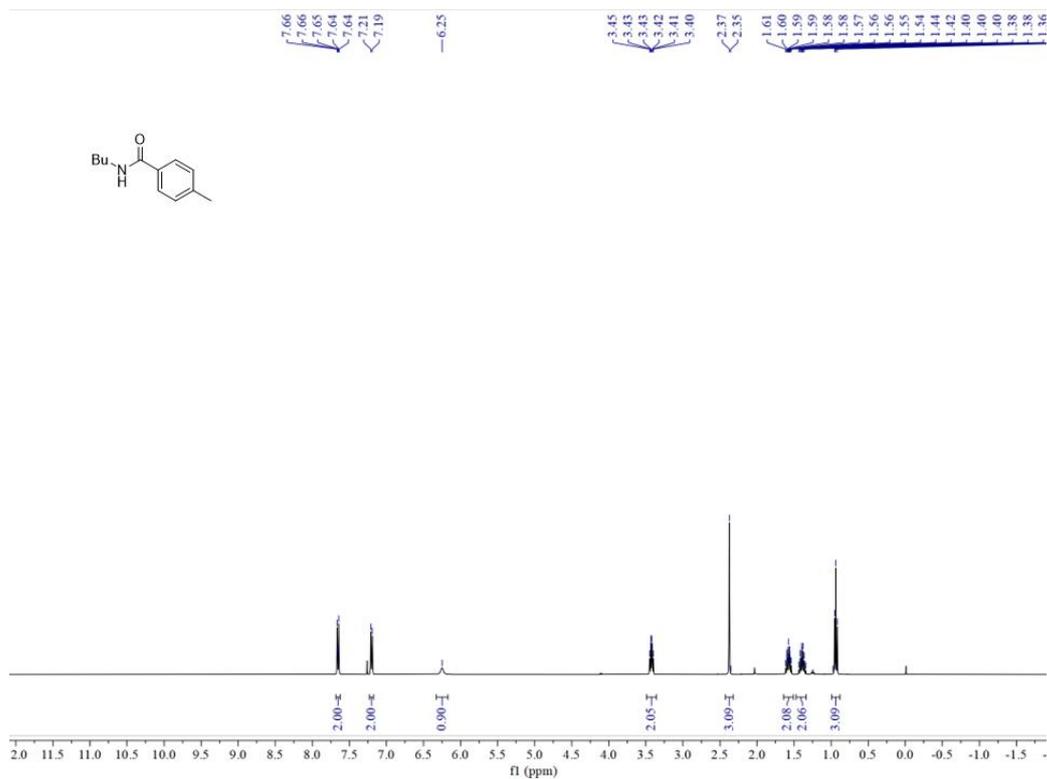


Figure S78. ^1H NMR (400 MHz, CDCl_3) spectrum of **3ai**

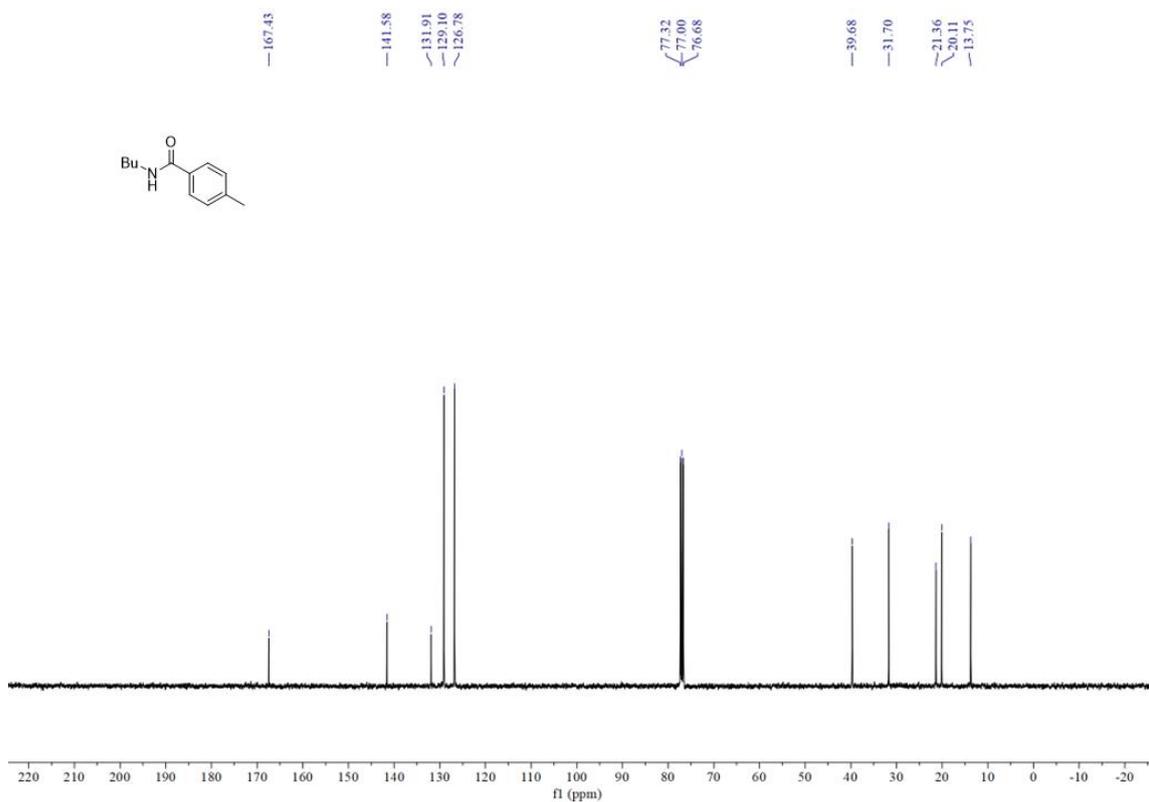


Figure S79. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 3ai

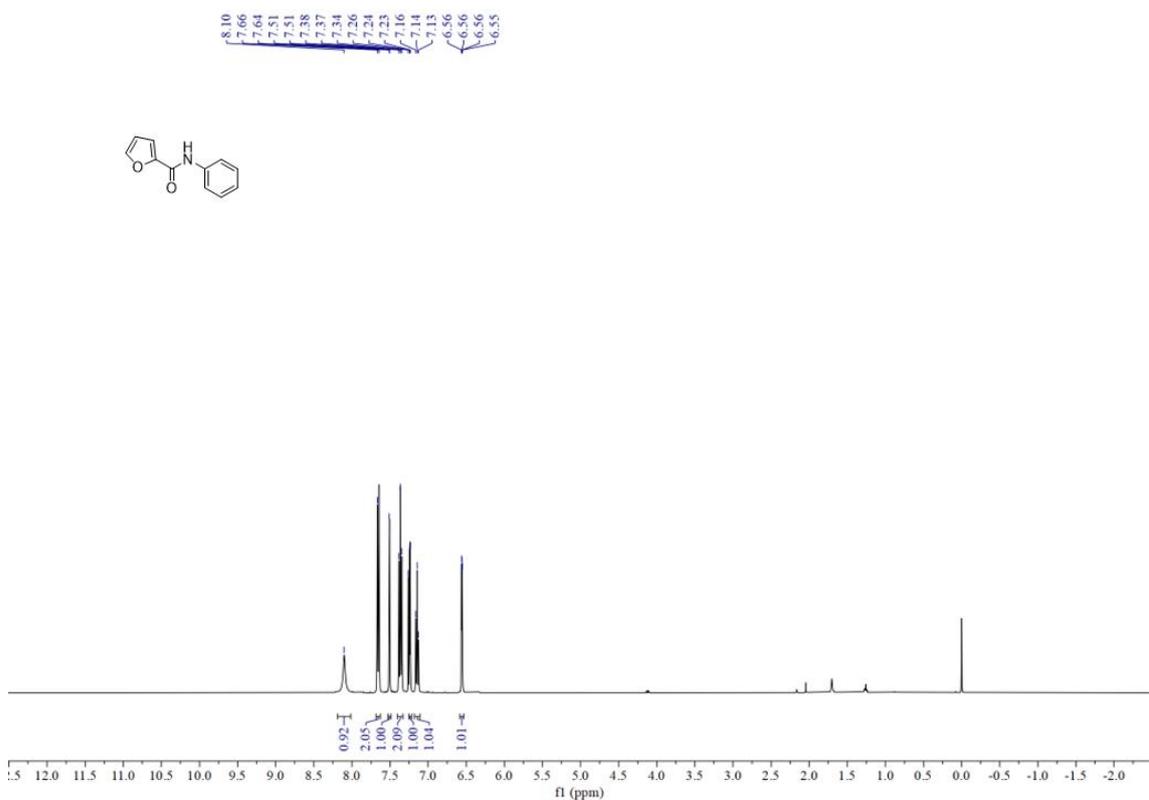


Figure S80. ^1H NMR (400 MHz, CDCl_3) spectrum of 3aj

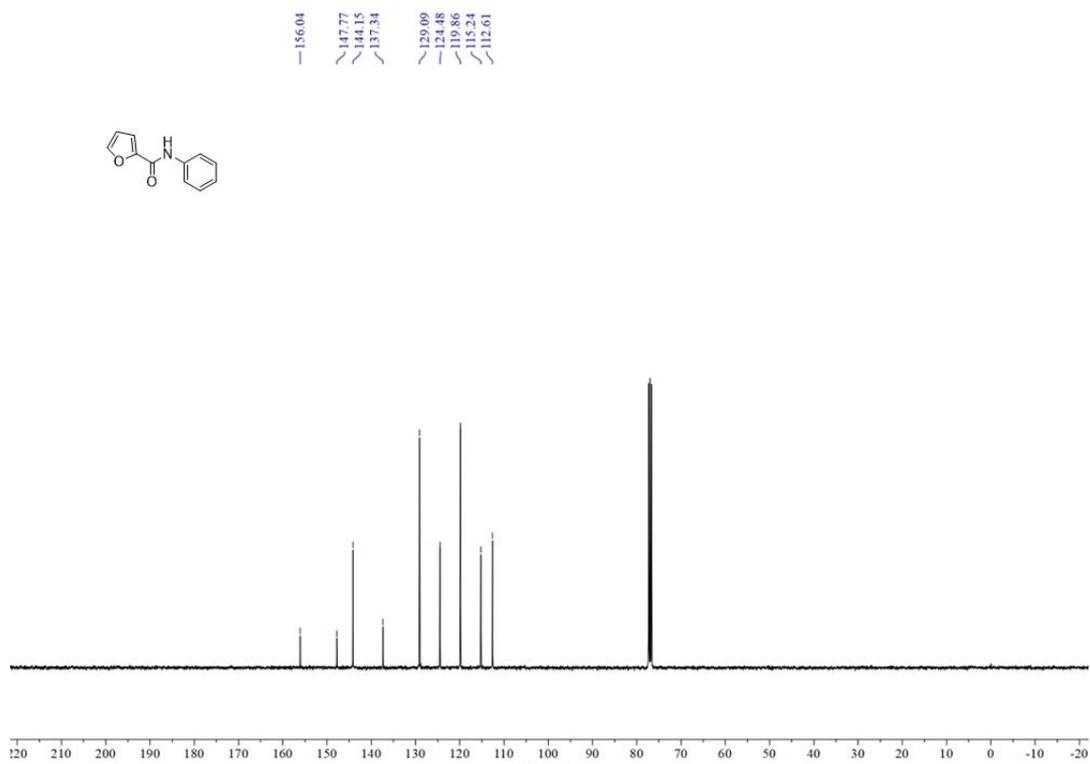


Figure S81. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **3aj**

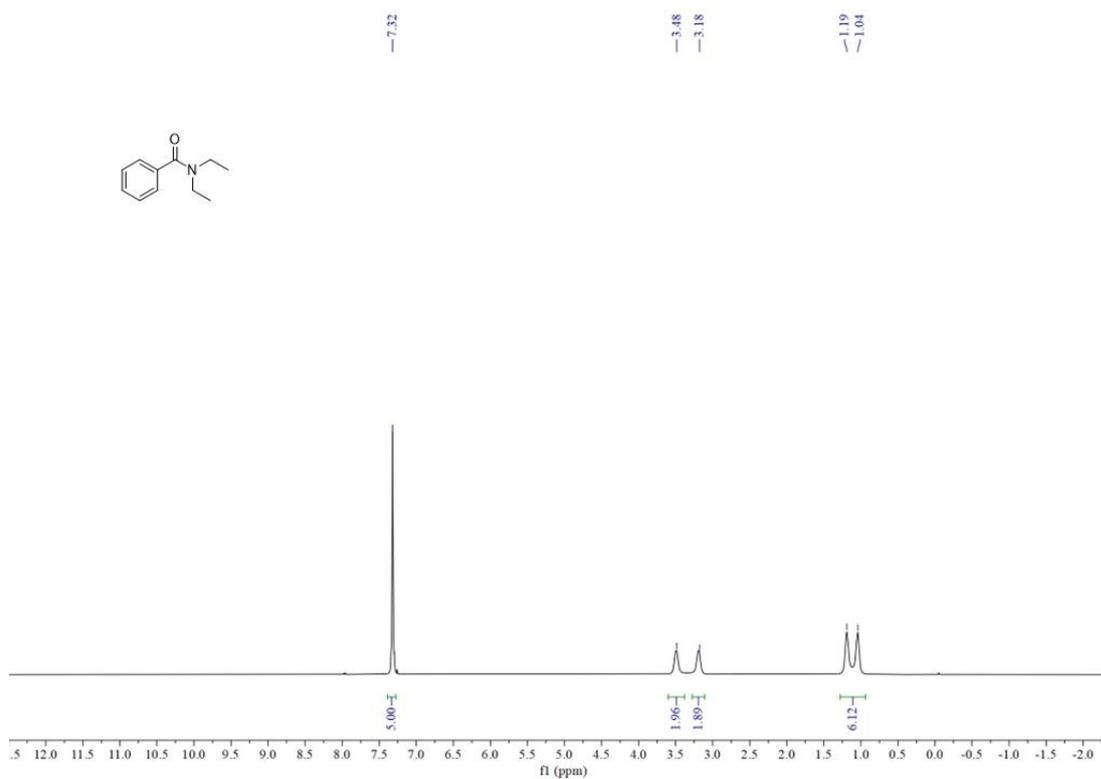


Figure S82. ^1H NMR (400 MHz, CDCl_3) spectrum of **3ao**

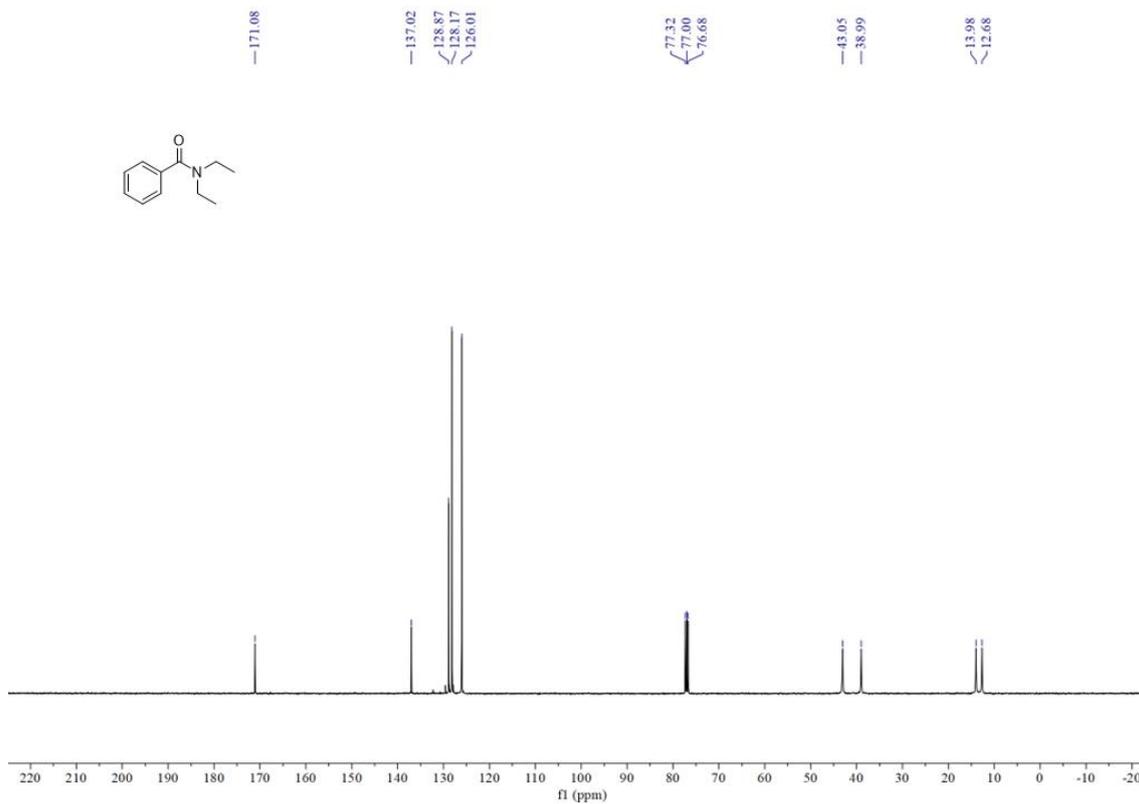


Figure S83. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **3ao**

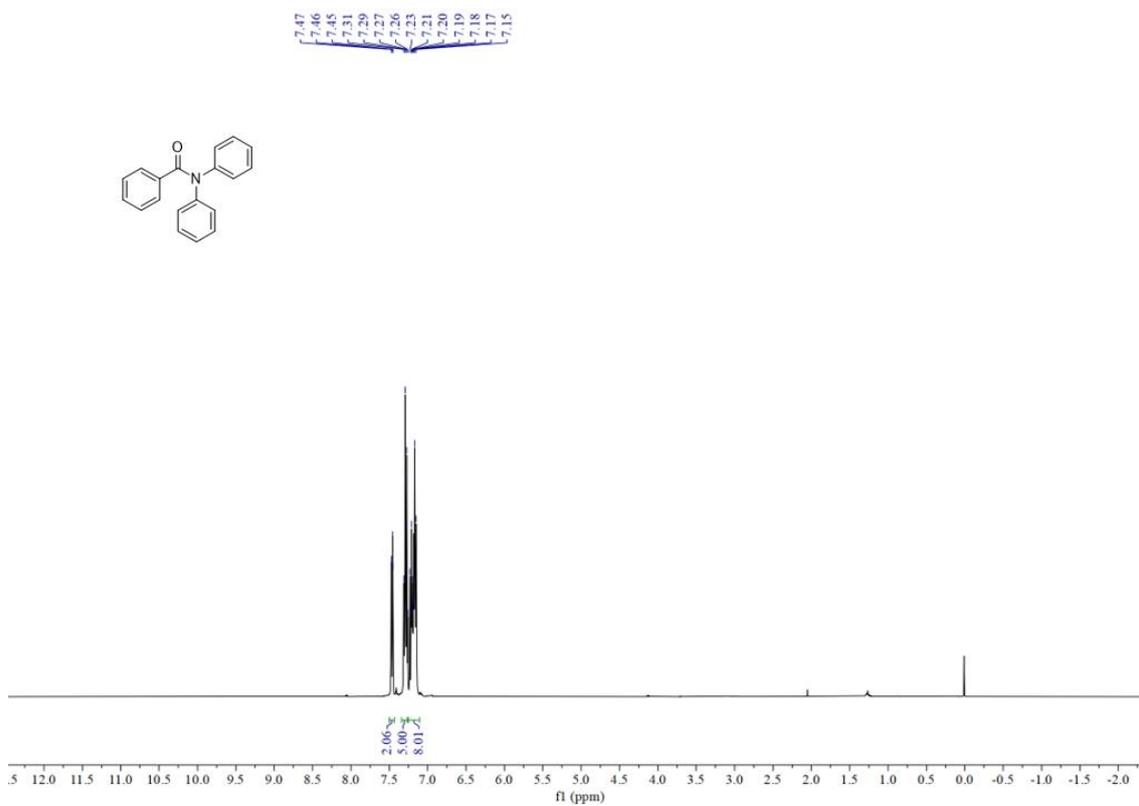


Figure S84. ^1H NMR (400 MHz, CDCl_3) spectrum of **3ap**

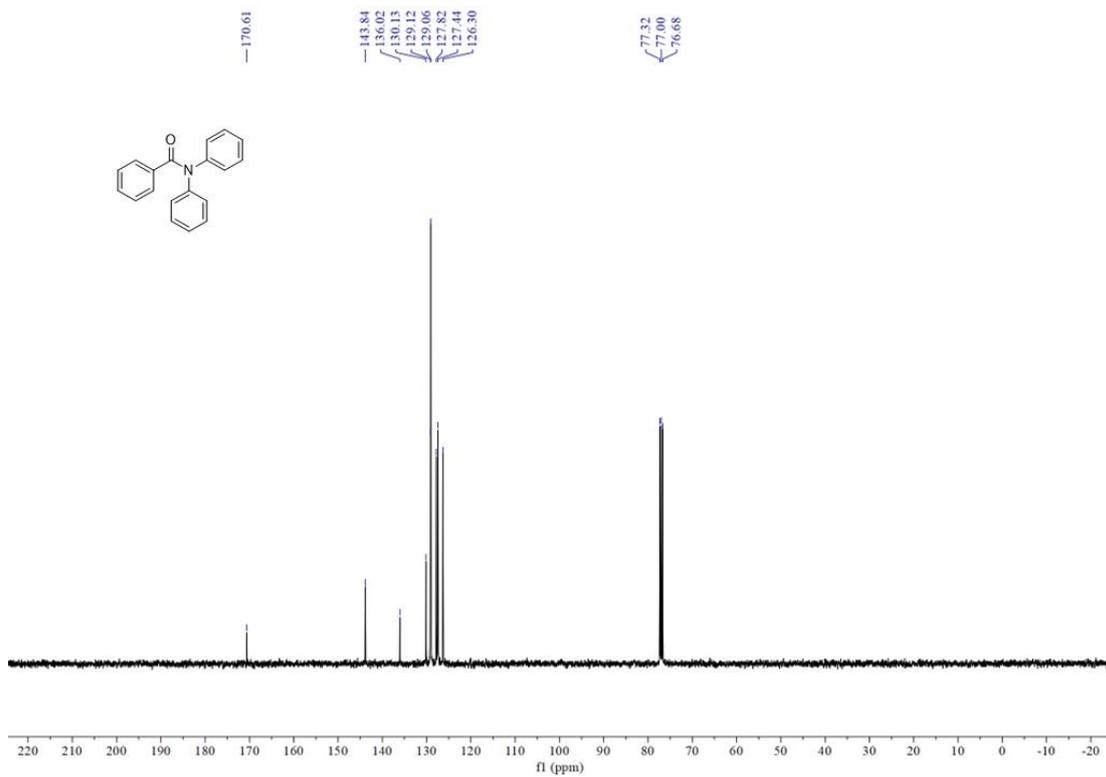


Figure S85. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 3ap

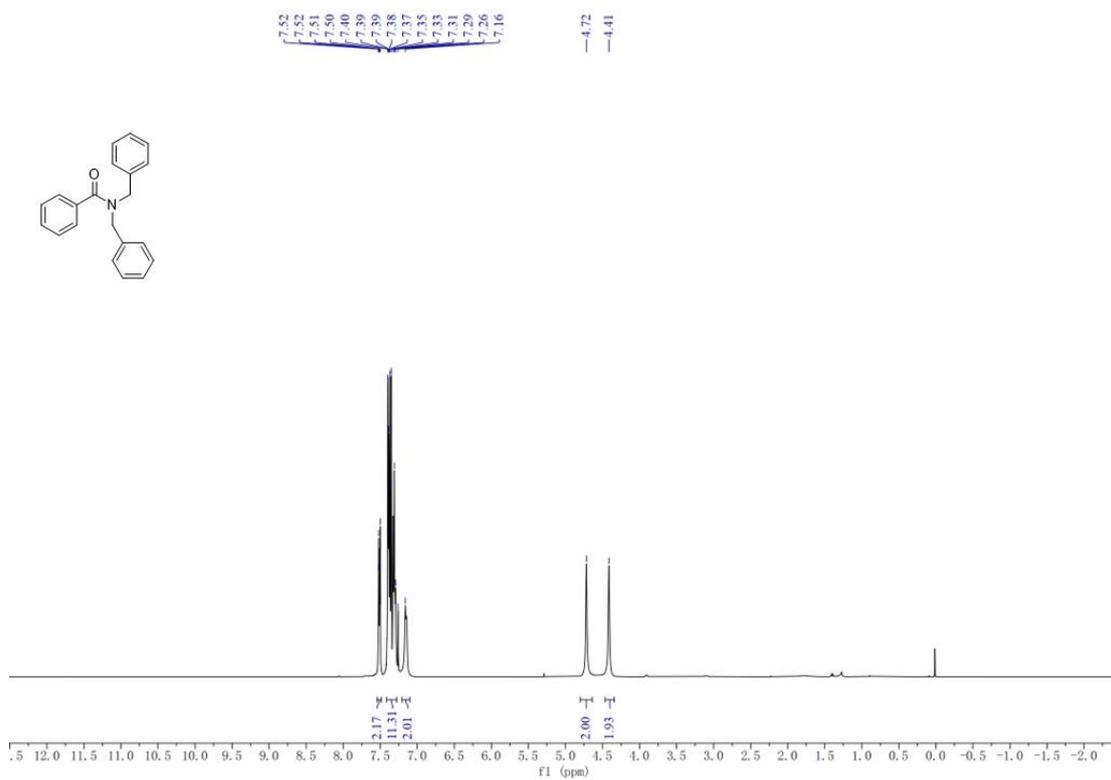


Figure S86. ^1H NMR (400 MHz, CDCl_3) spectrum of 3aq

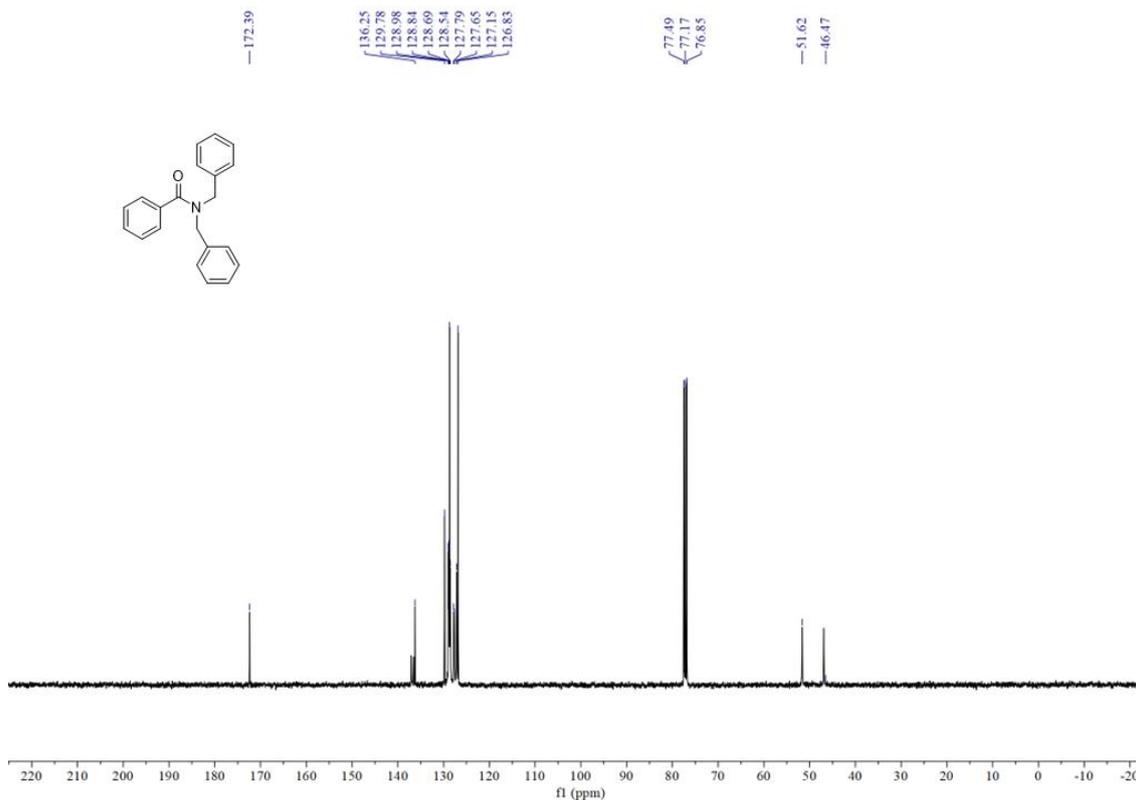


Figure S87. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 3a

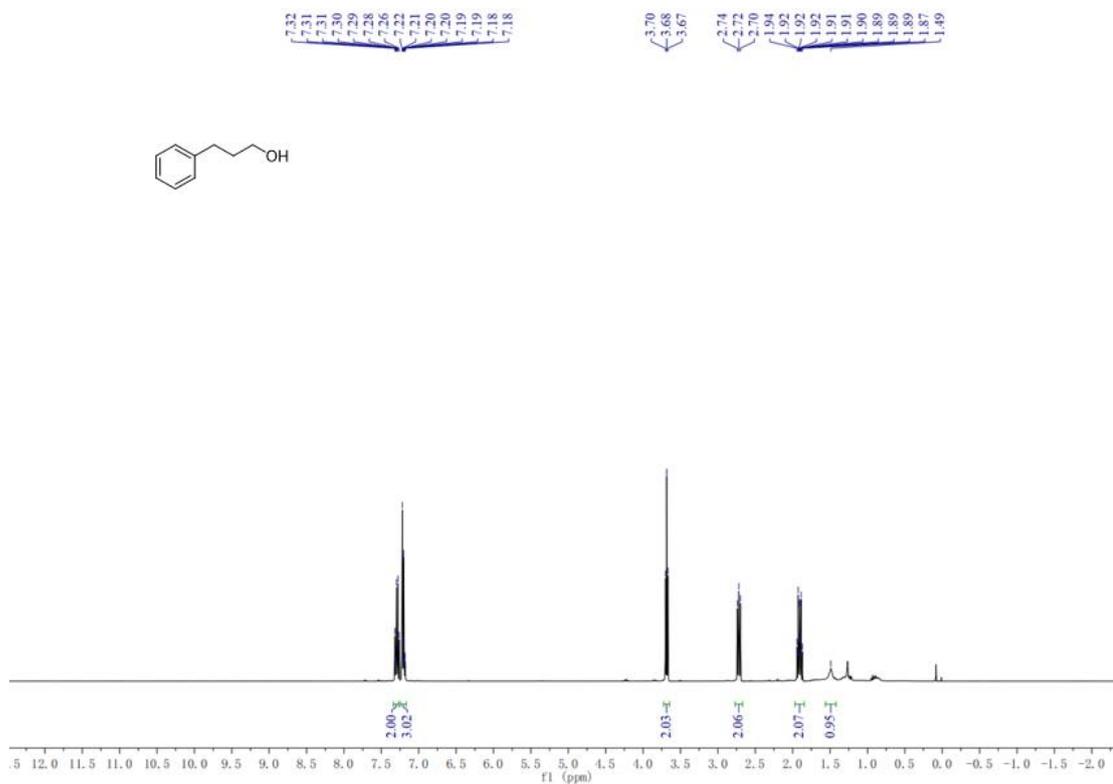


Figure S88. ^1H NMR (400 MHz, CDCl_3) spectrum of 2a

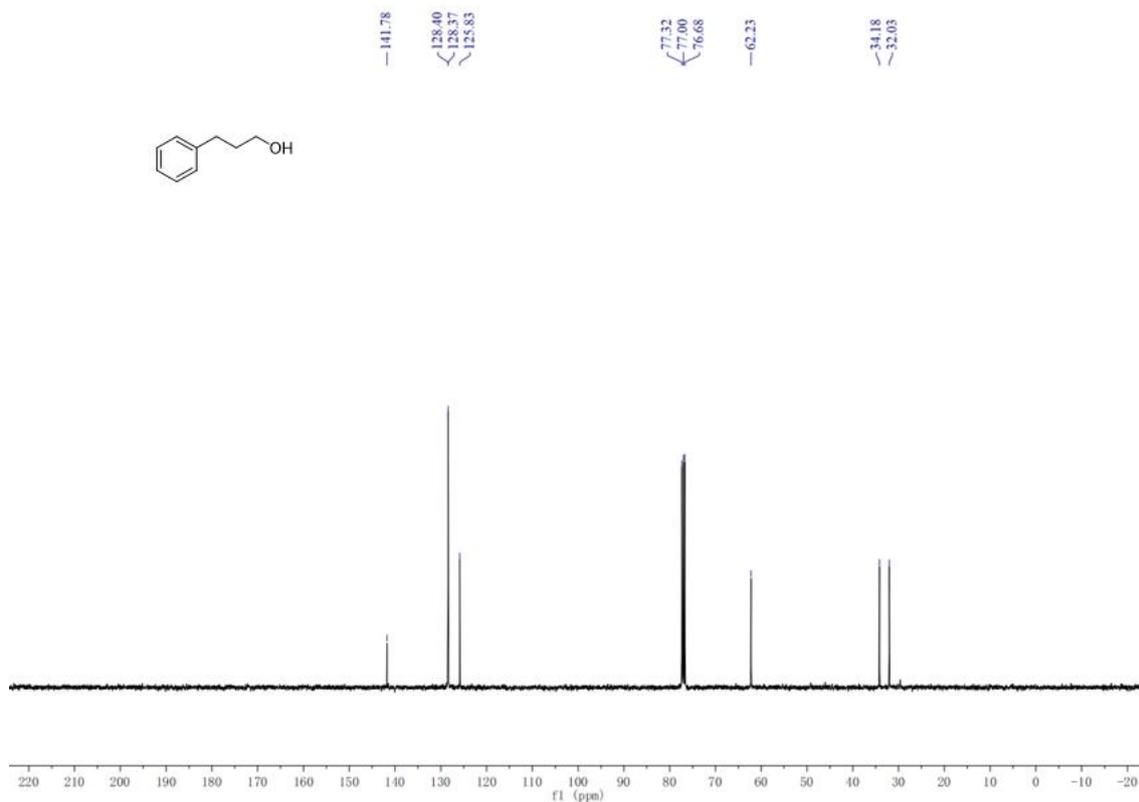


Figure S89. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **2a**

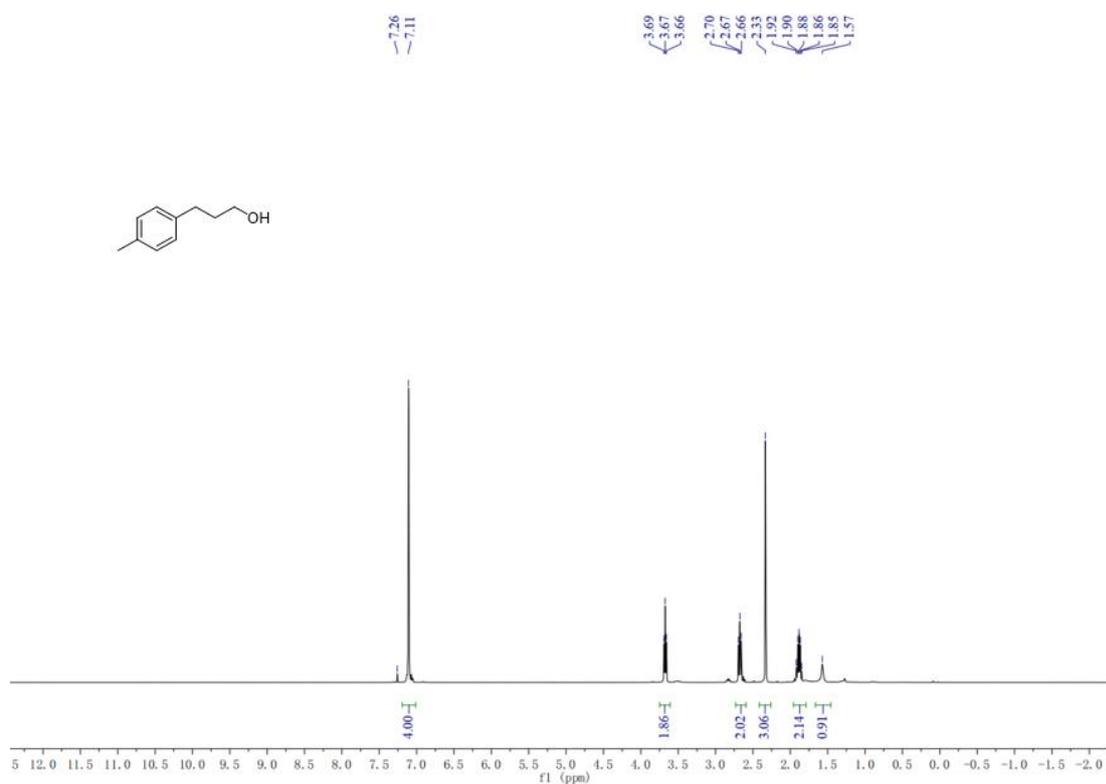


Figure S90. ^1H NMR (400 MHz, CDCl_3) spectrum of **2b**

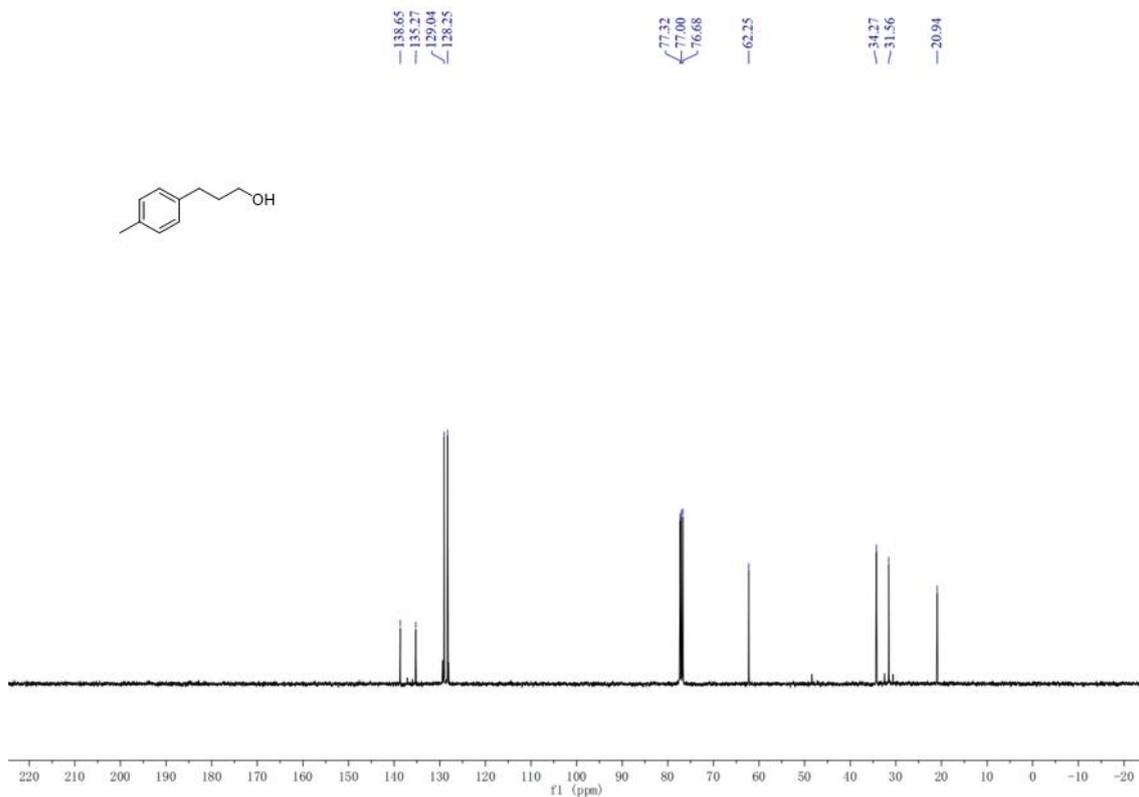


Figure S91. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2b

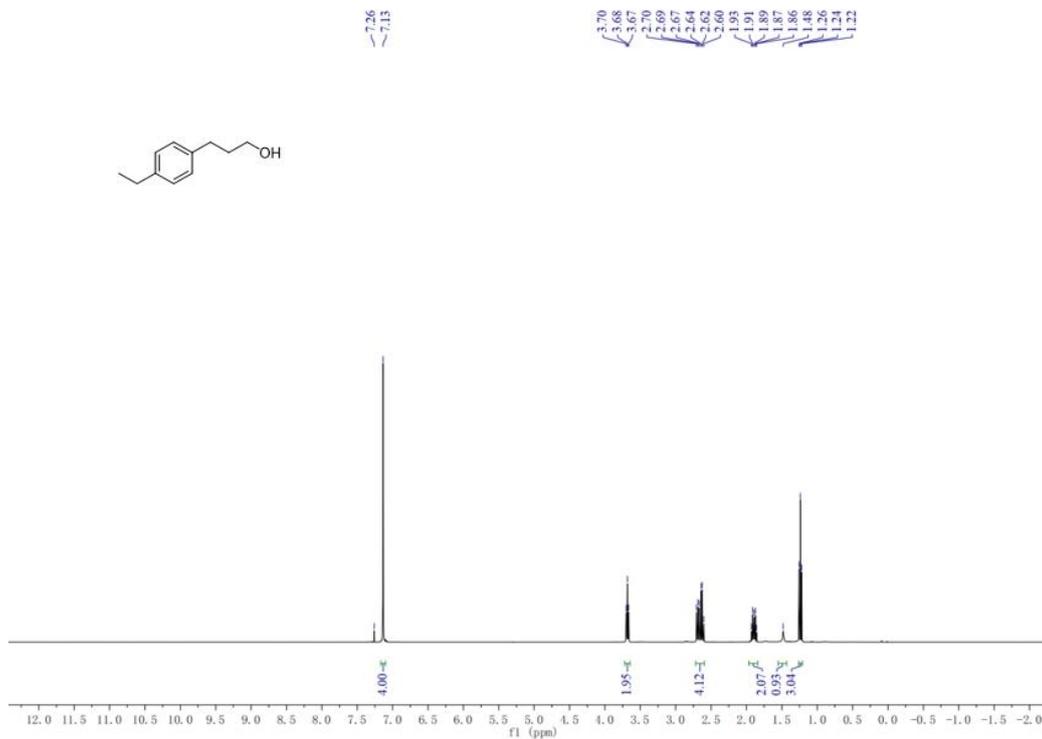


Figure S92. ¹H NMR (400 MHz, CDCl₃) spectrum of 2c

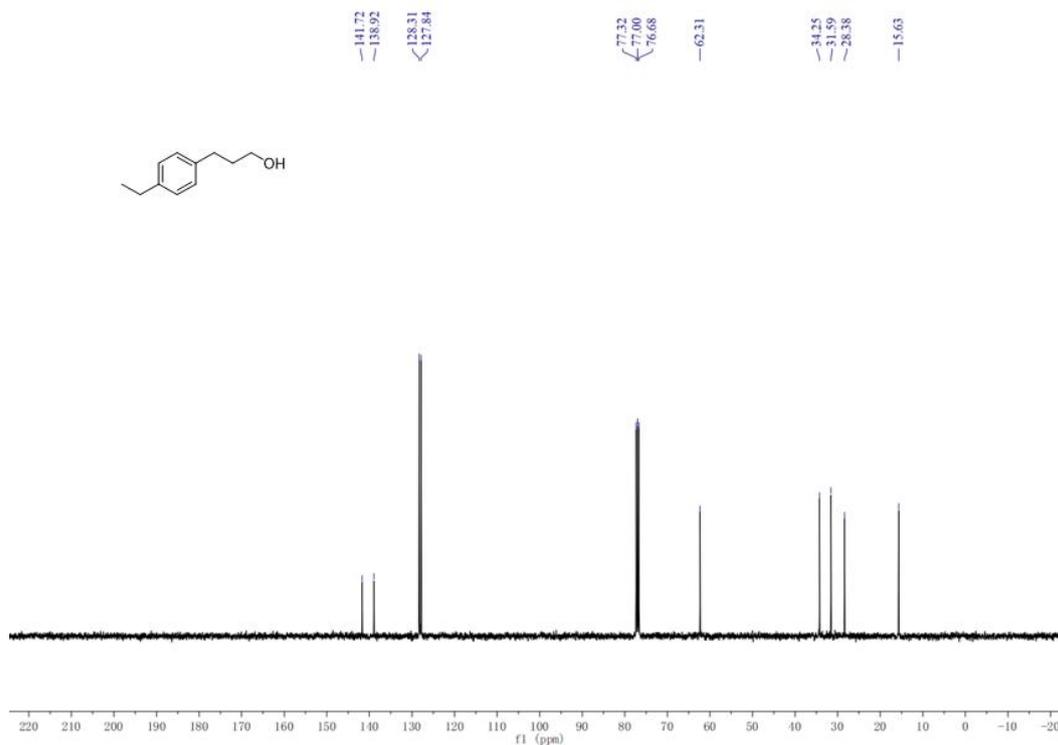


Figure S93. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2c

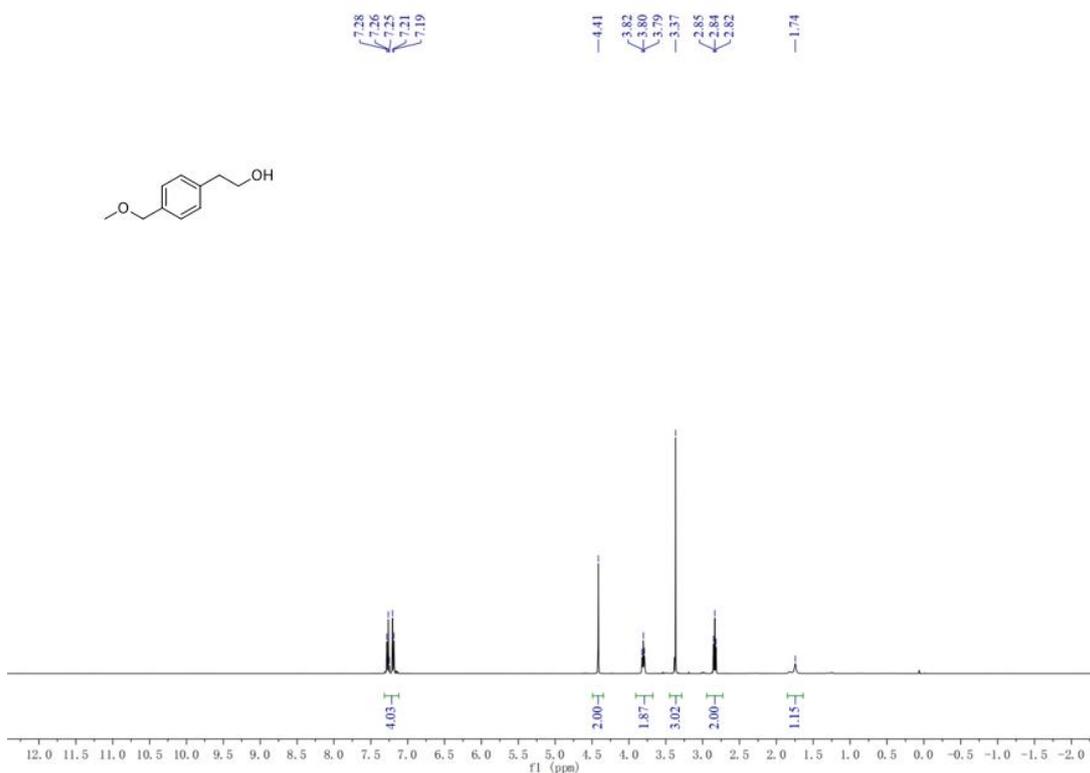


Figure S94. ¹H NMR (400 MHz, CDCl₃) spectrum of 2d

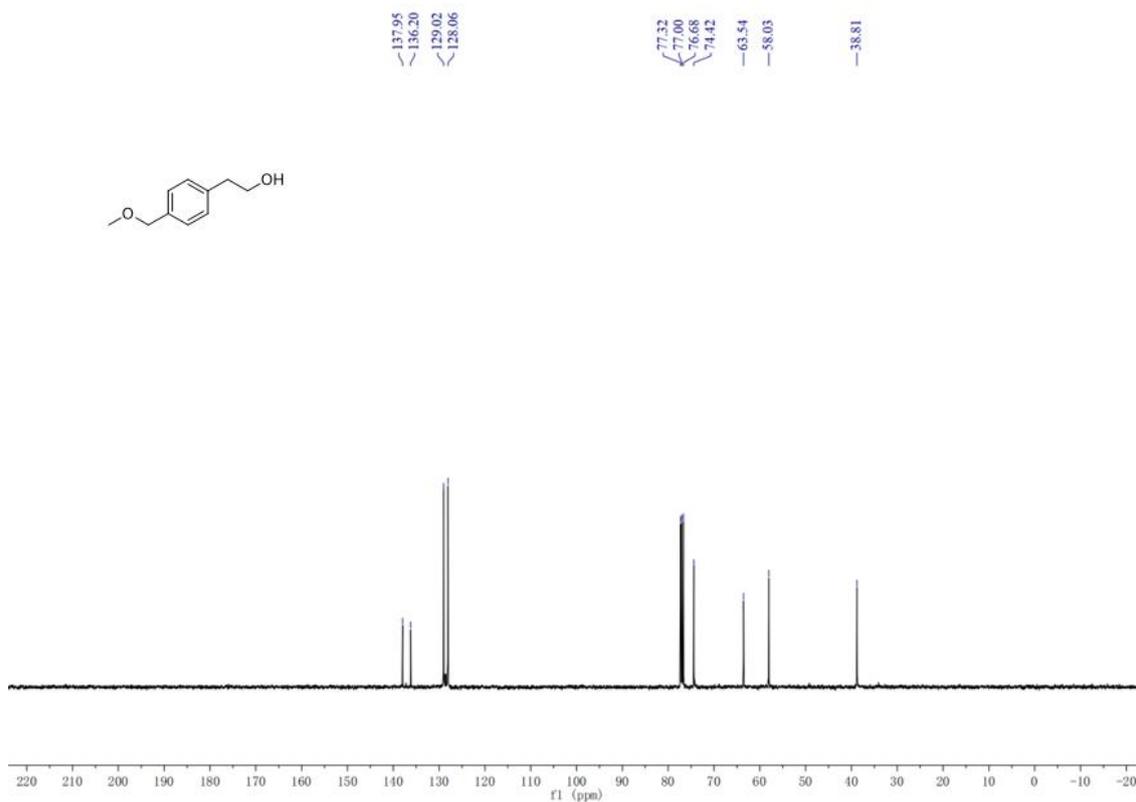


Figure S95. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2d

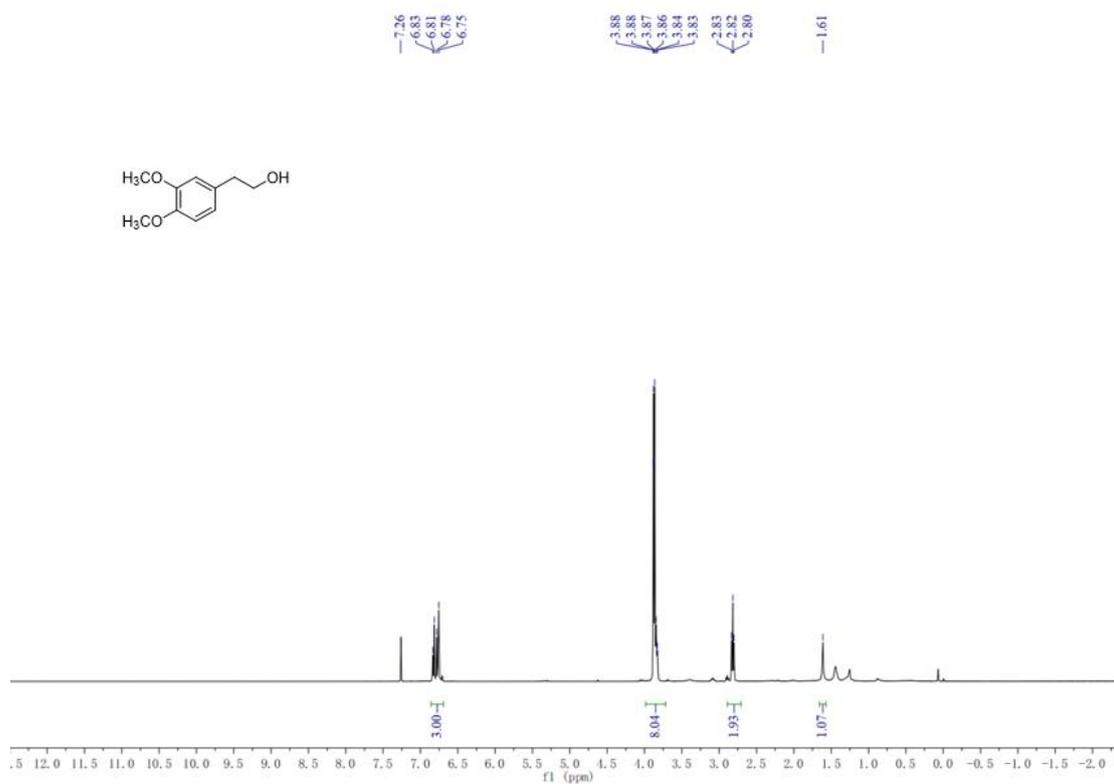


Figure S96. ¹H NMR (400 MHz, CDCl₃) spectrum of 2e

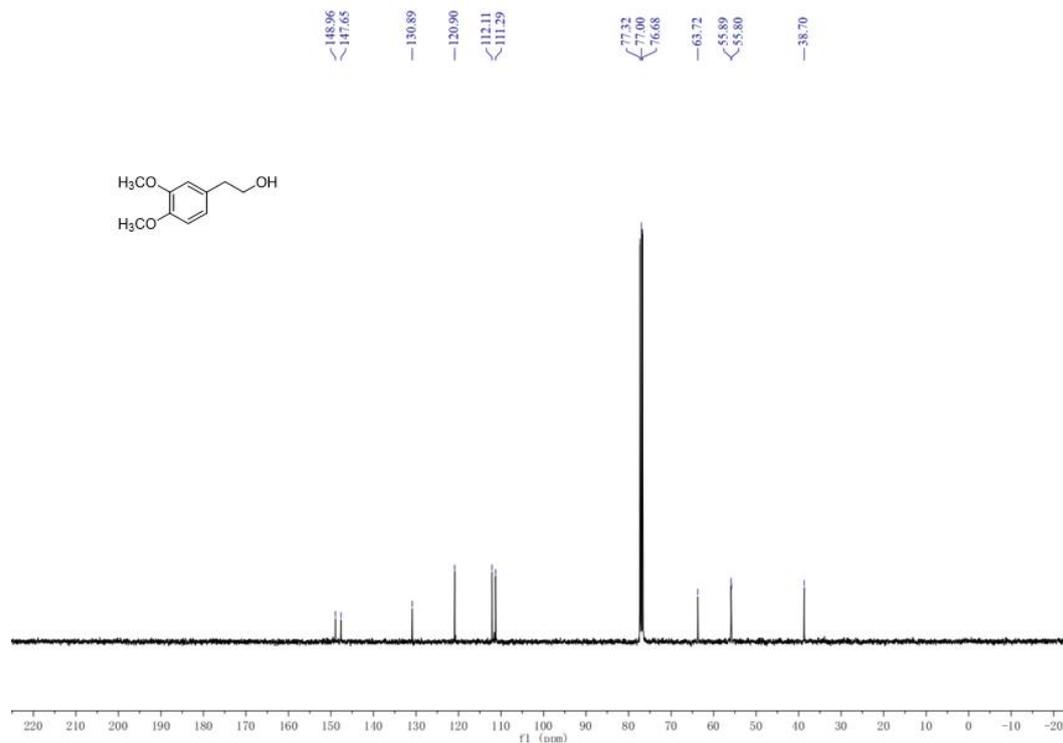


Figure S97. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 2e

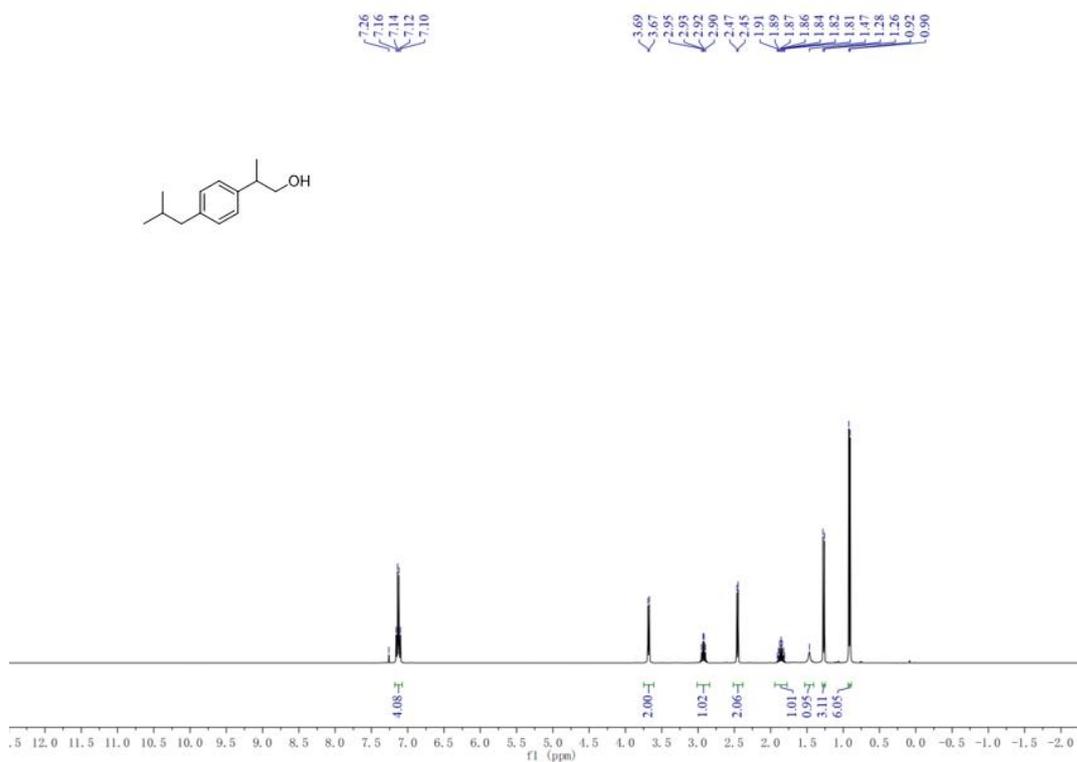


Figure S98. ^1H NMR (400 MHz, CDCl_3) spectrum of 2f

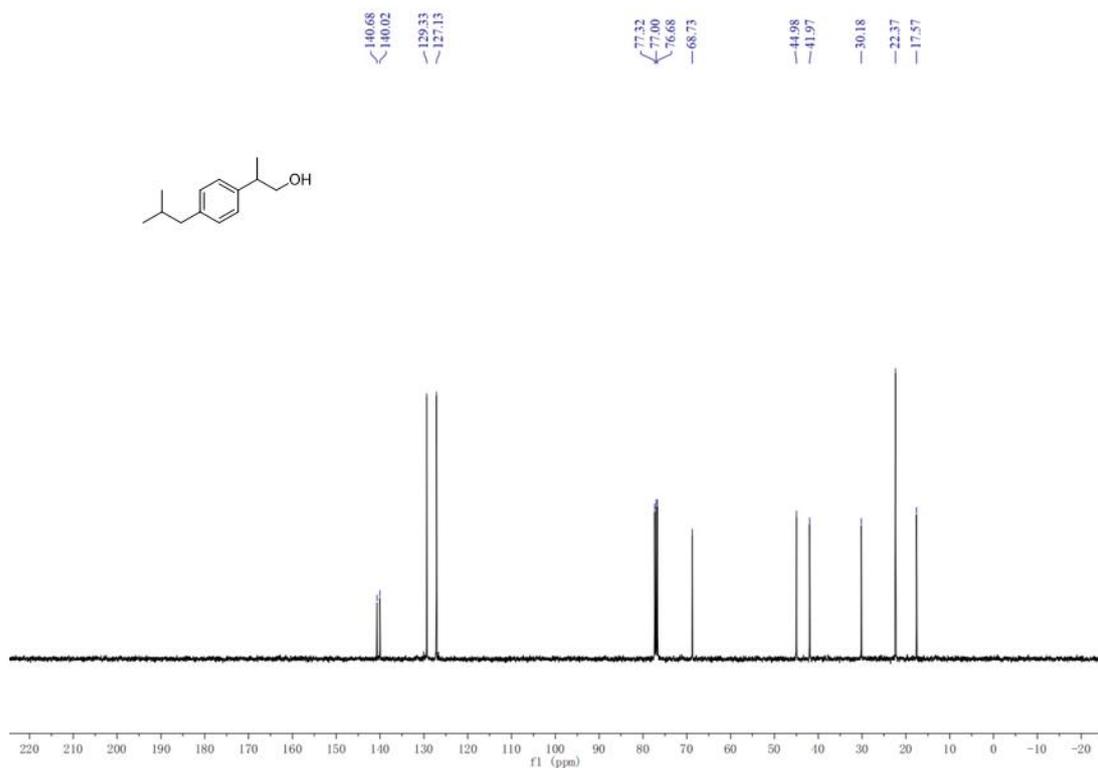


Figure S99. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2f

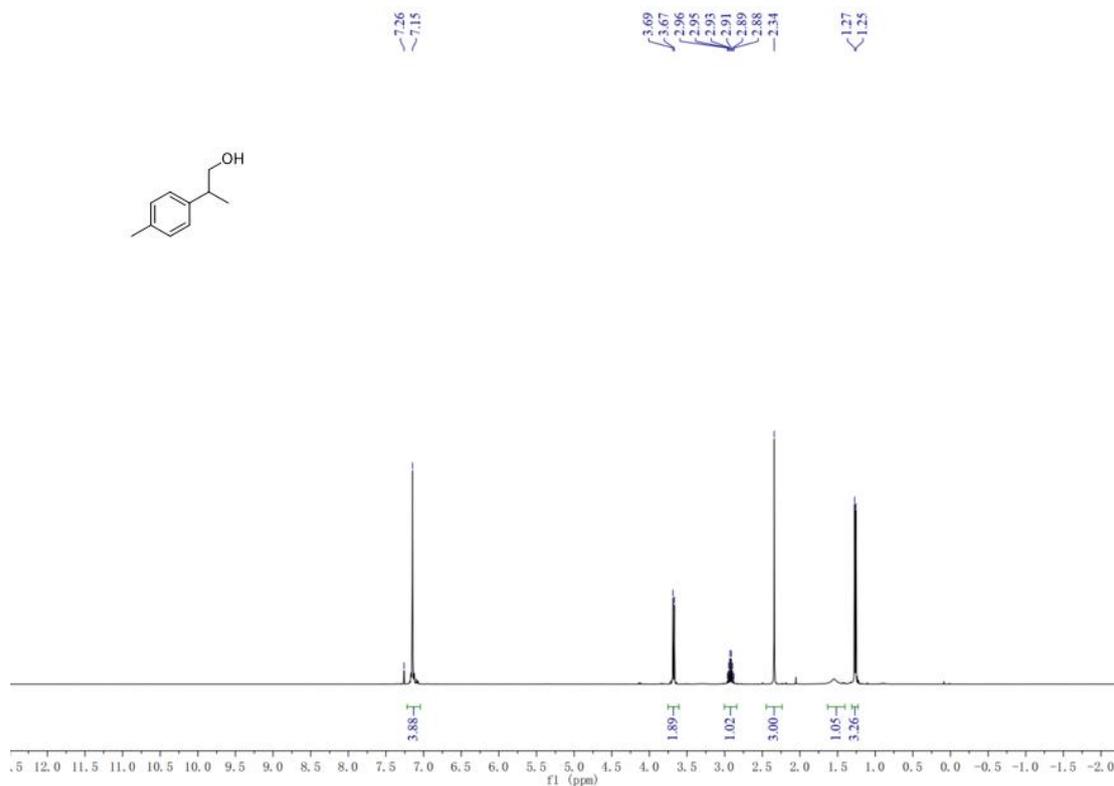


Figure S100. ¹H NMR (400 MHz, CDCl₃) spectrum of 2g

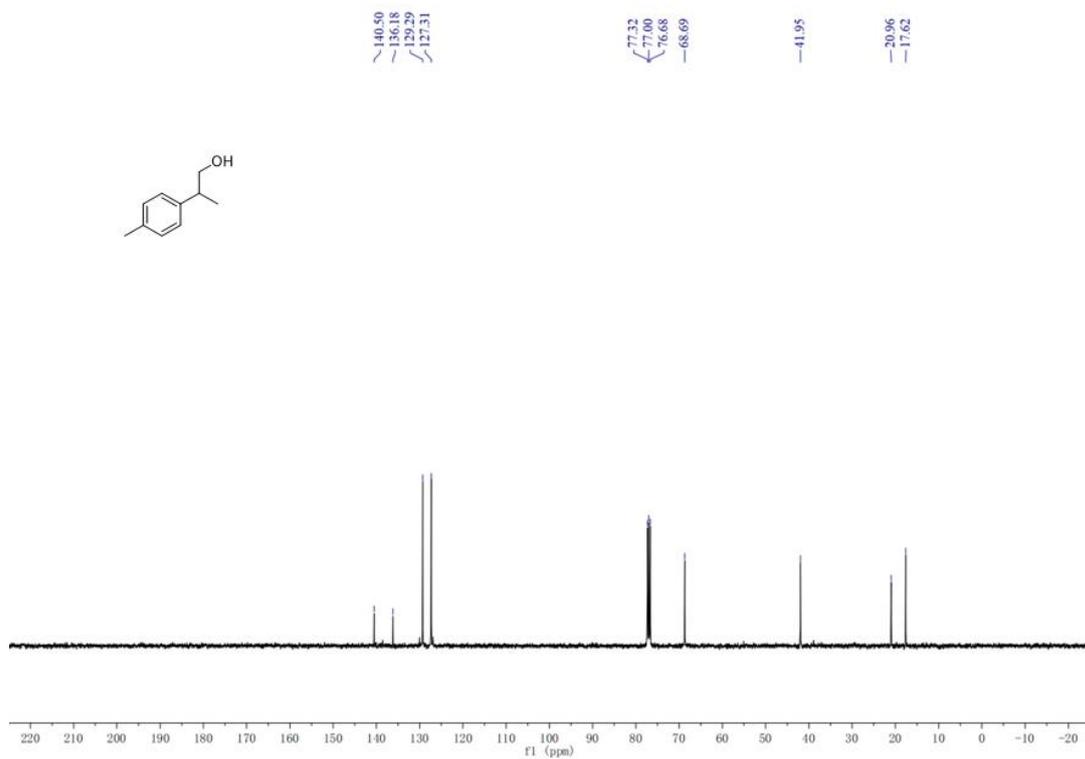


Figure S101. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 2g

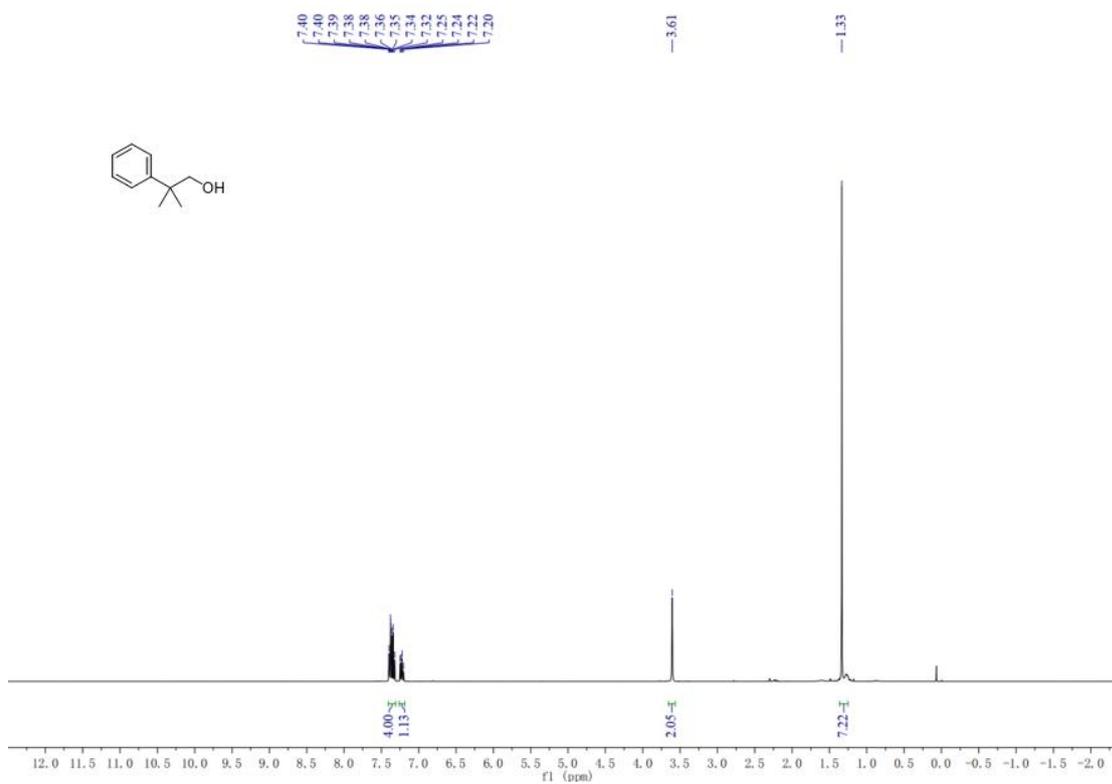


Figure S102. ^1H NMR (400 MHz, CDCl_3) spectrum of 2h

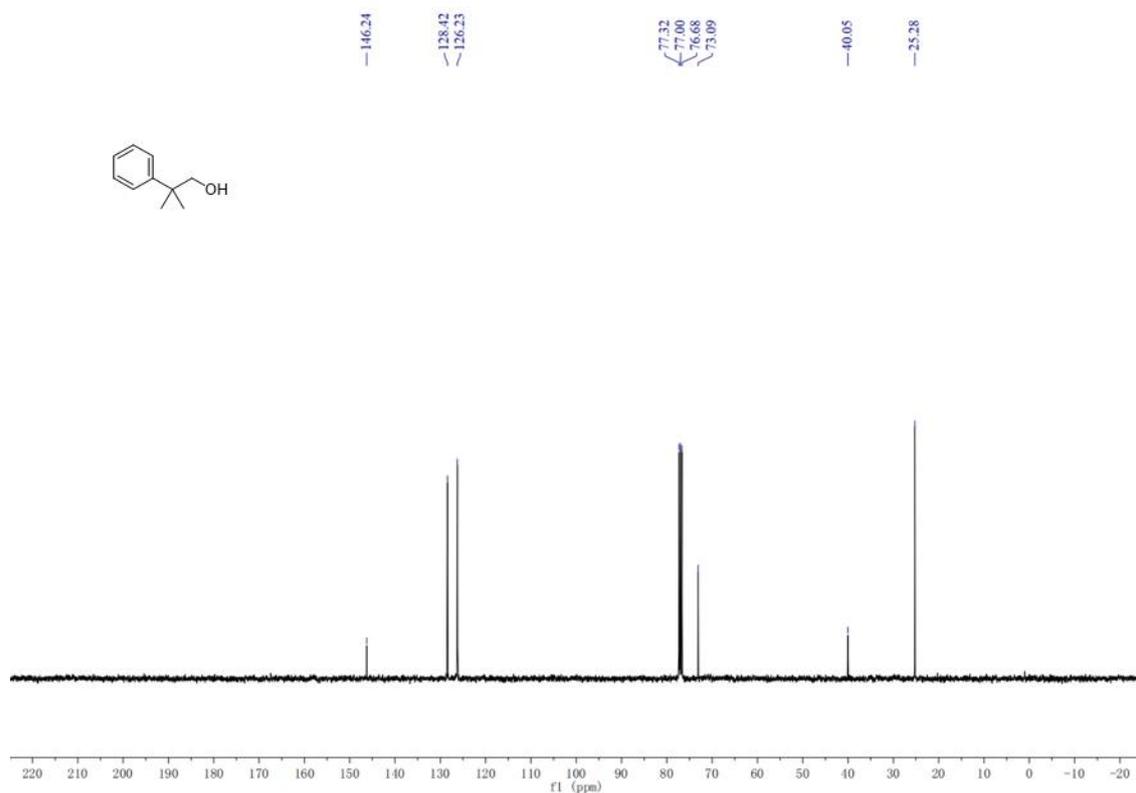


Figure S103. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 2h

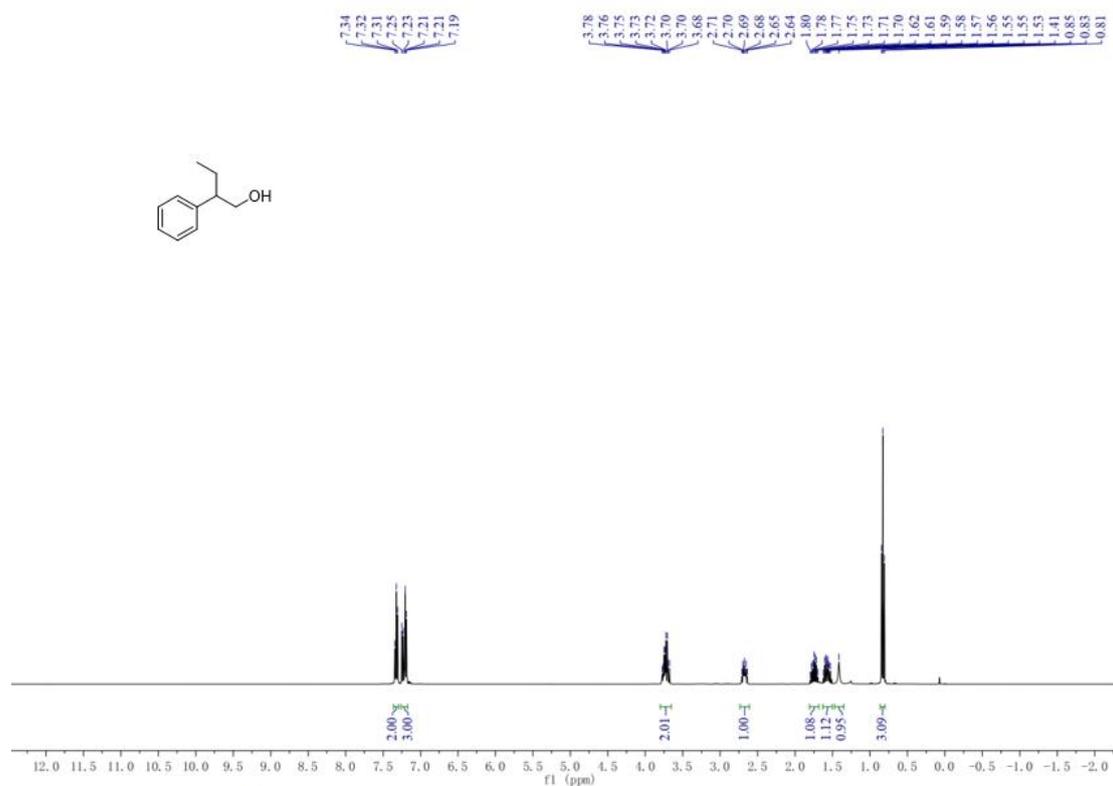


Figure S104. ^1H NMR (400 MHz, CDCl_3) spectrum of 2i

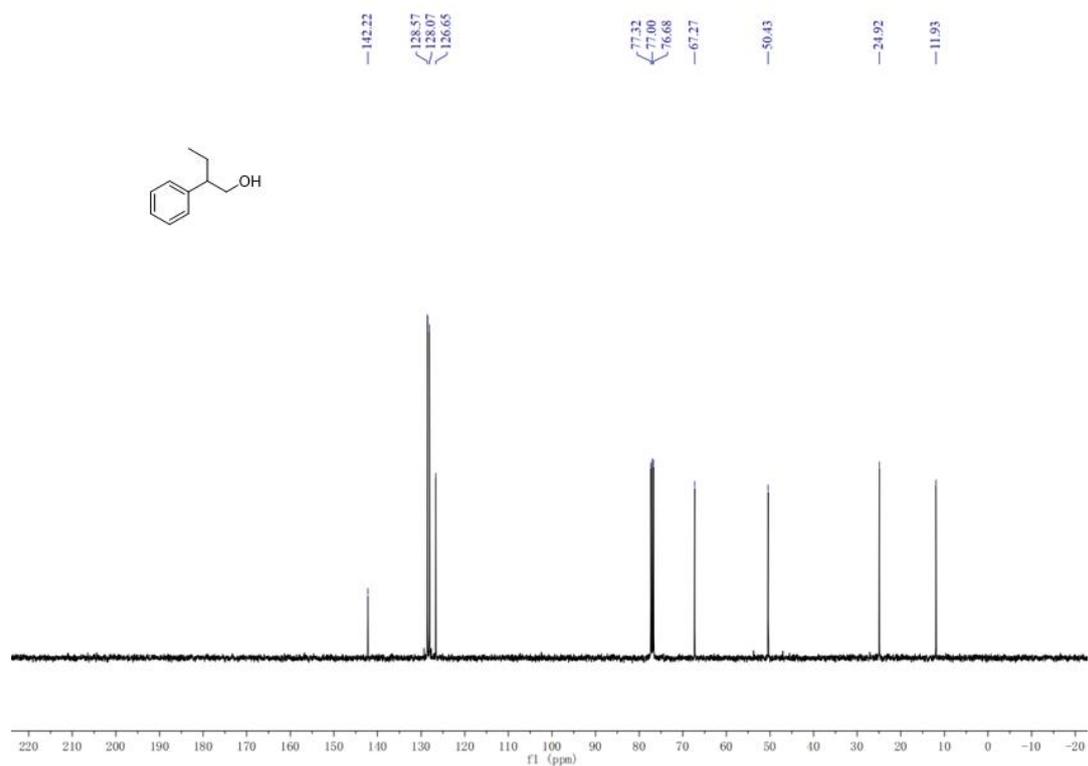


Figure S105. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2i

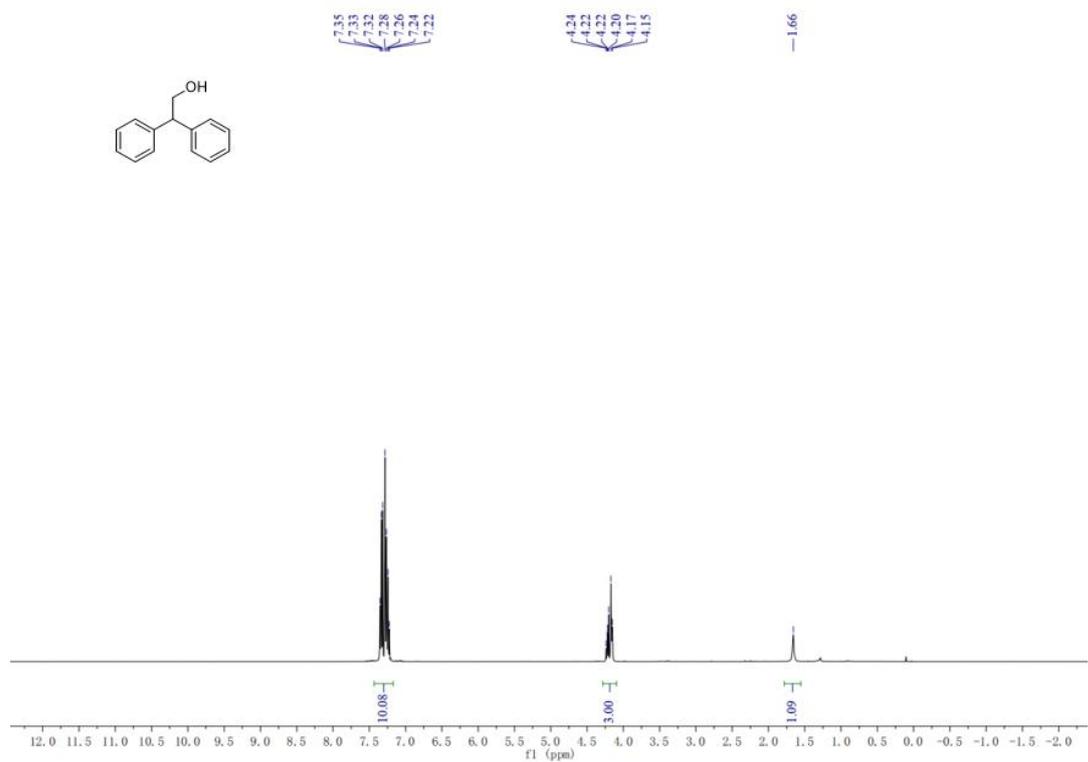


Figure S106. ¹H NMR (400 MHz, CDCl₃) spectrum of 2j

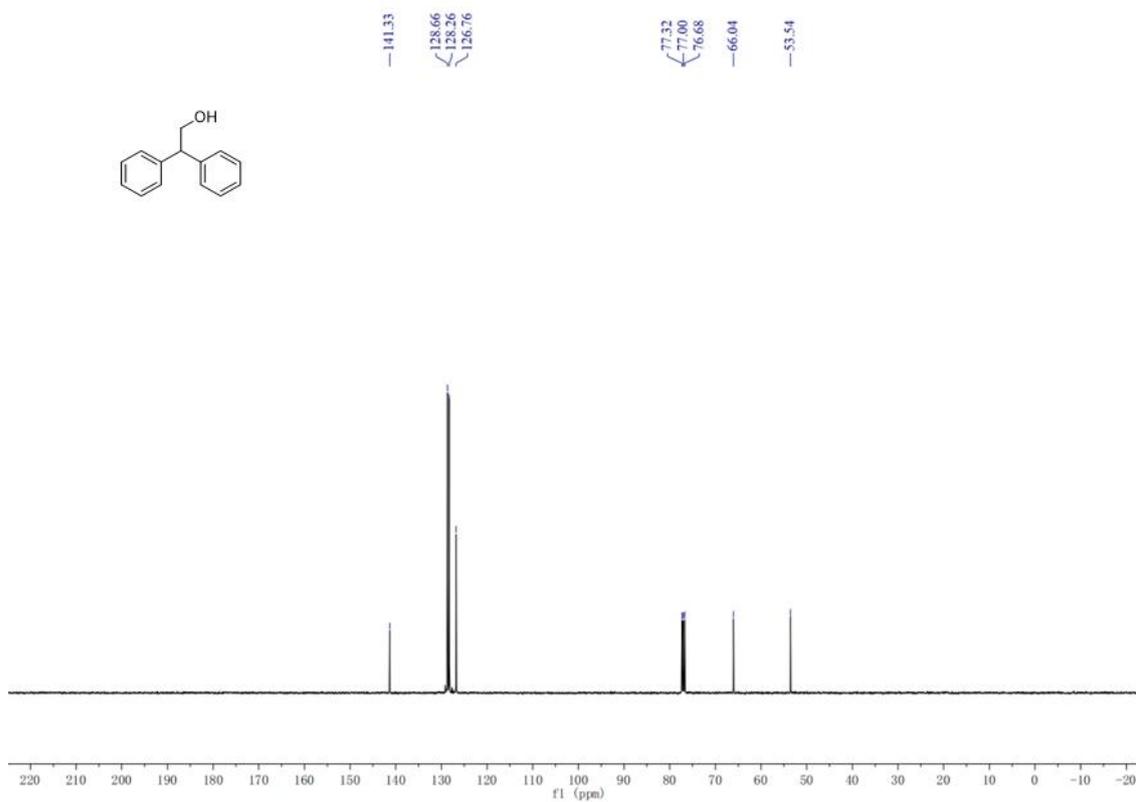


Figure S107. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 2j

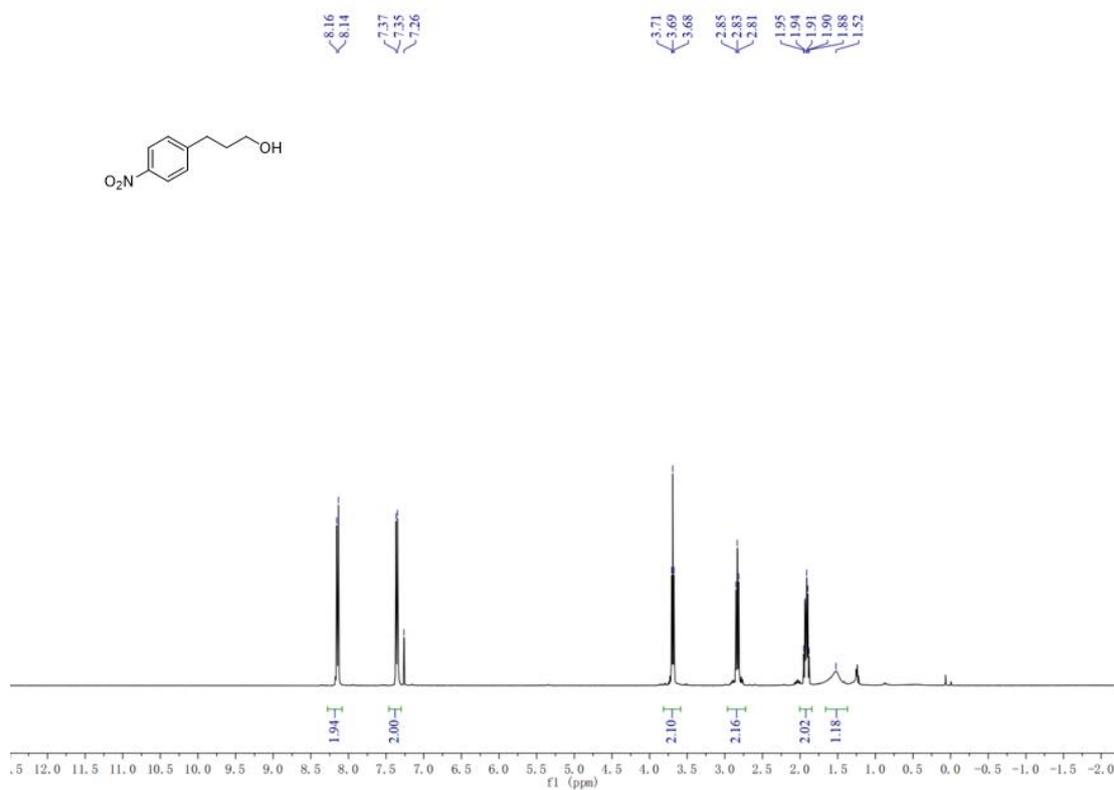


Figure S108. ^1H NMR (400 MHz, CDCl_3) spectrum of 2k

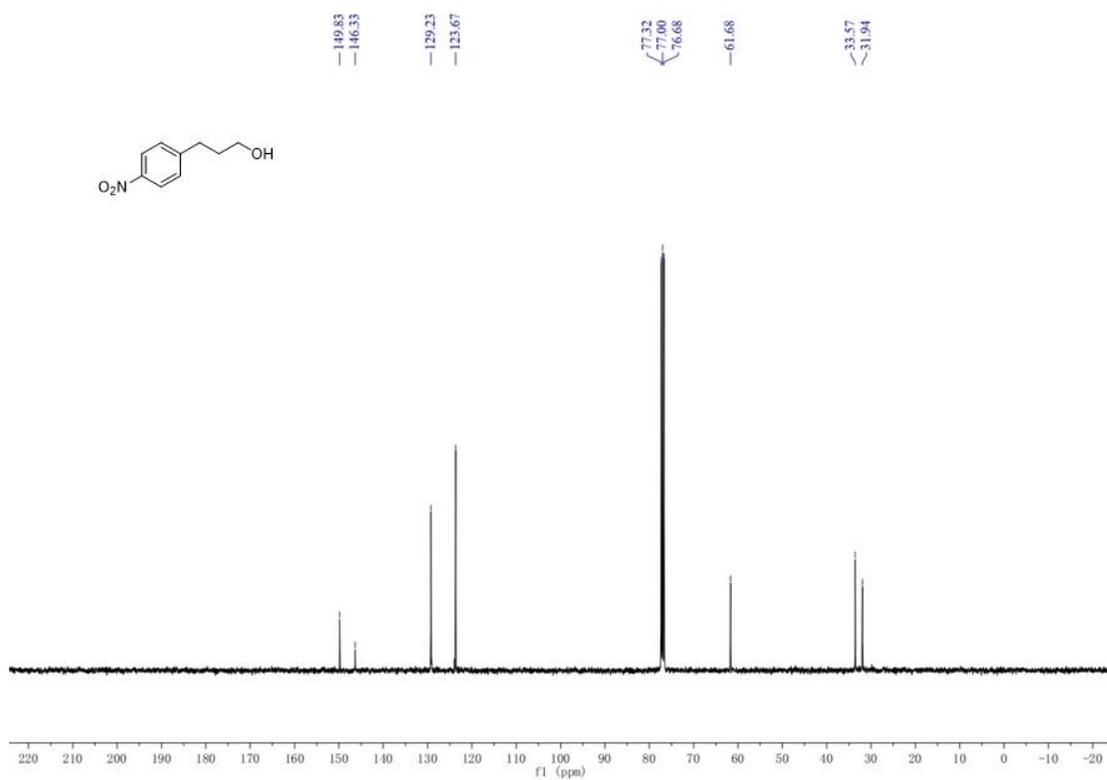


Figure S109. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2k

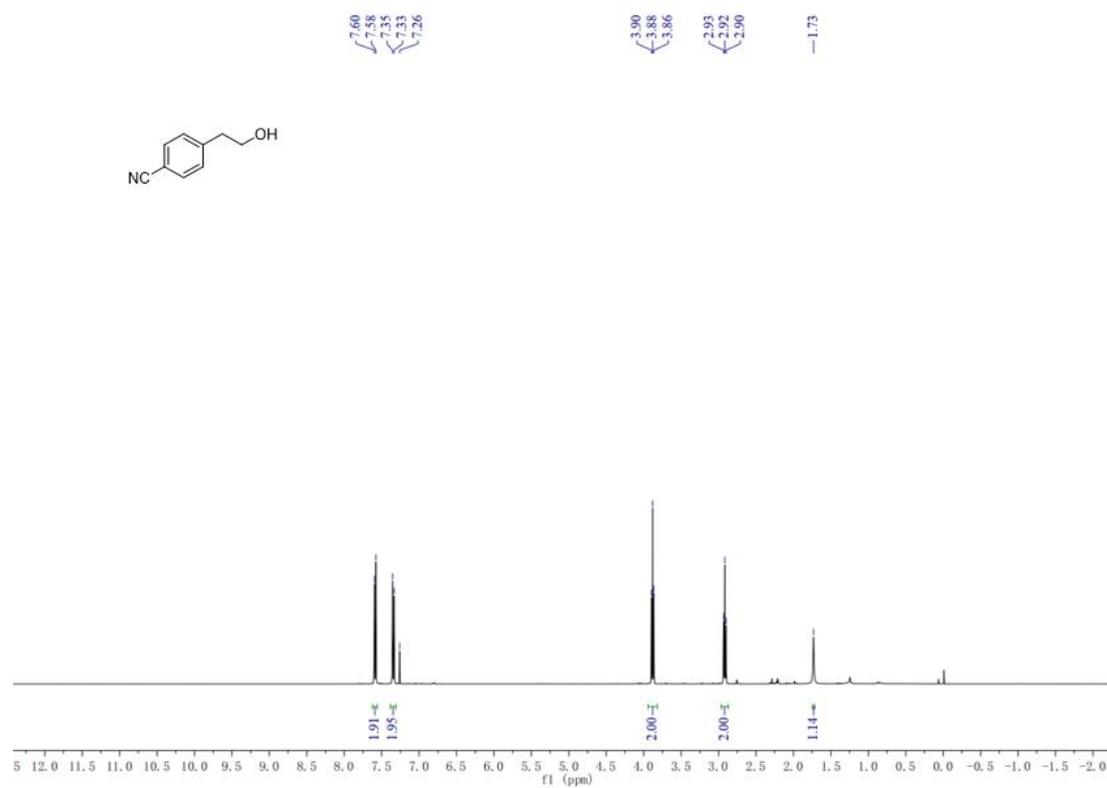


Figure S110. ¹H NMR (400 MHz, CDCl₃) spectrum of 21

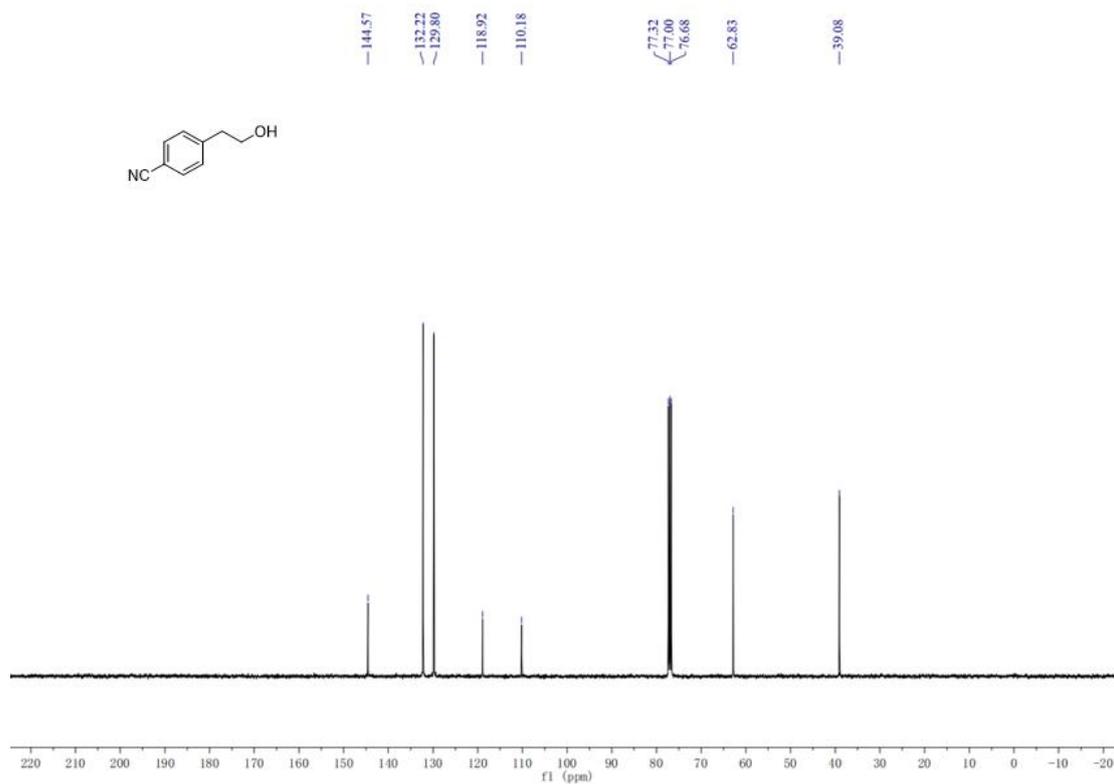


Figure S111. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 2l

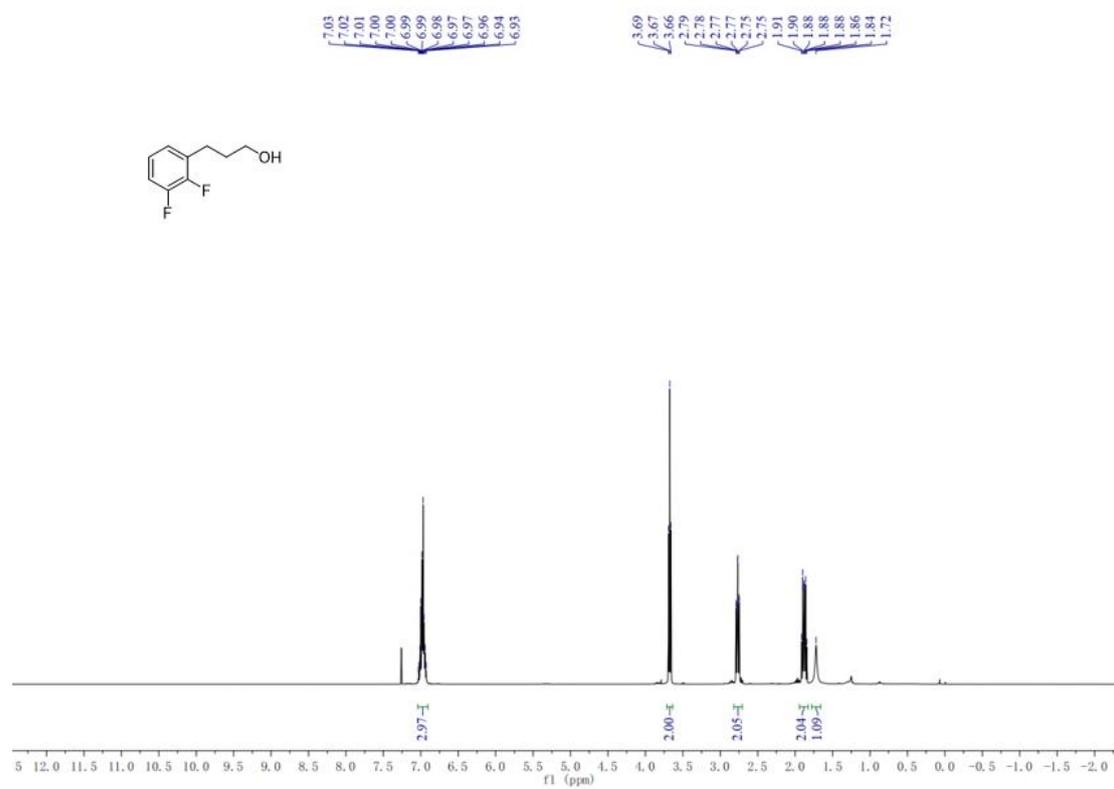


Figure S112. ^1H NMR (400 MHz, CDCl_3) spectrum of 2m

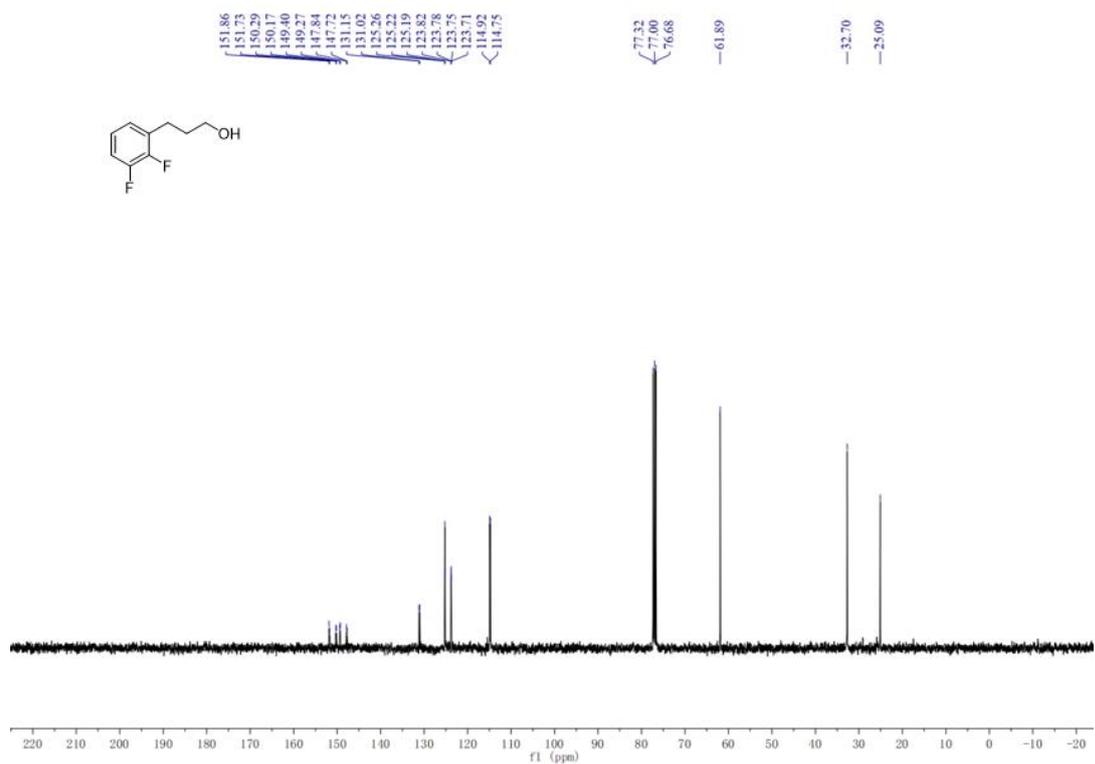


Figure S113. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2m

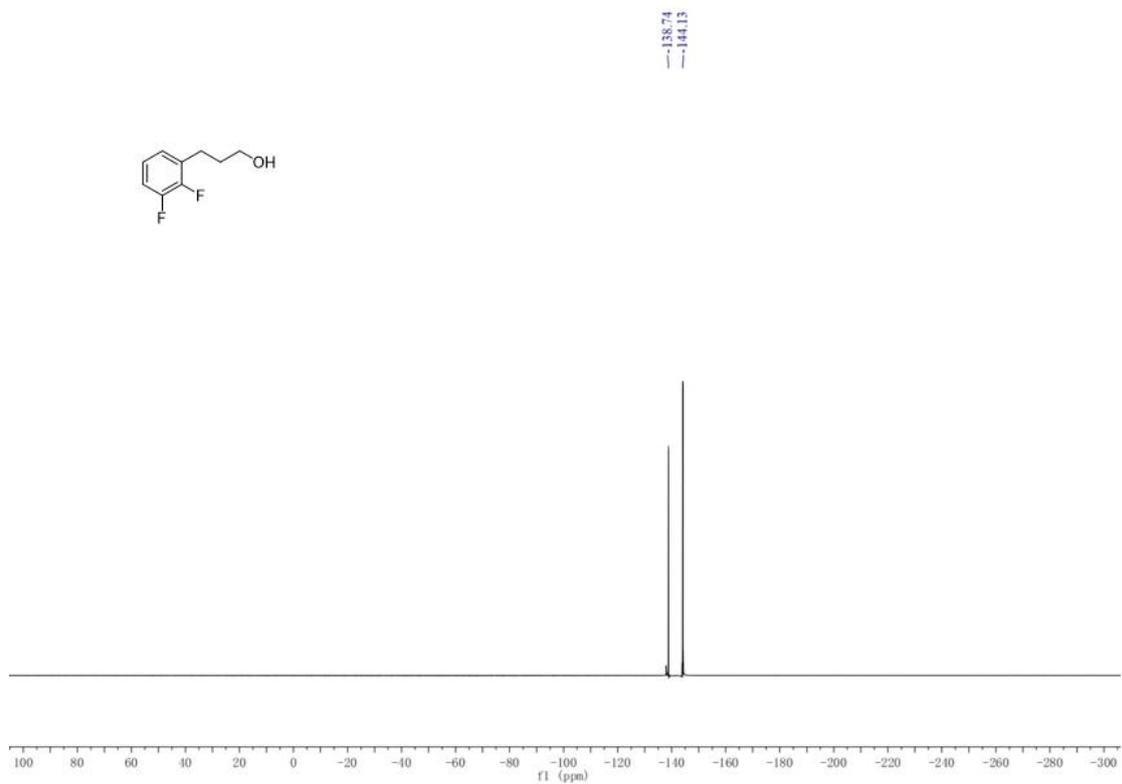


Figure S114. ¹⁹F NMR (100 MHz, CDCl₃) spectrum of 2m

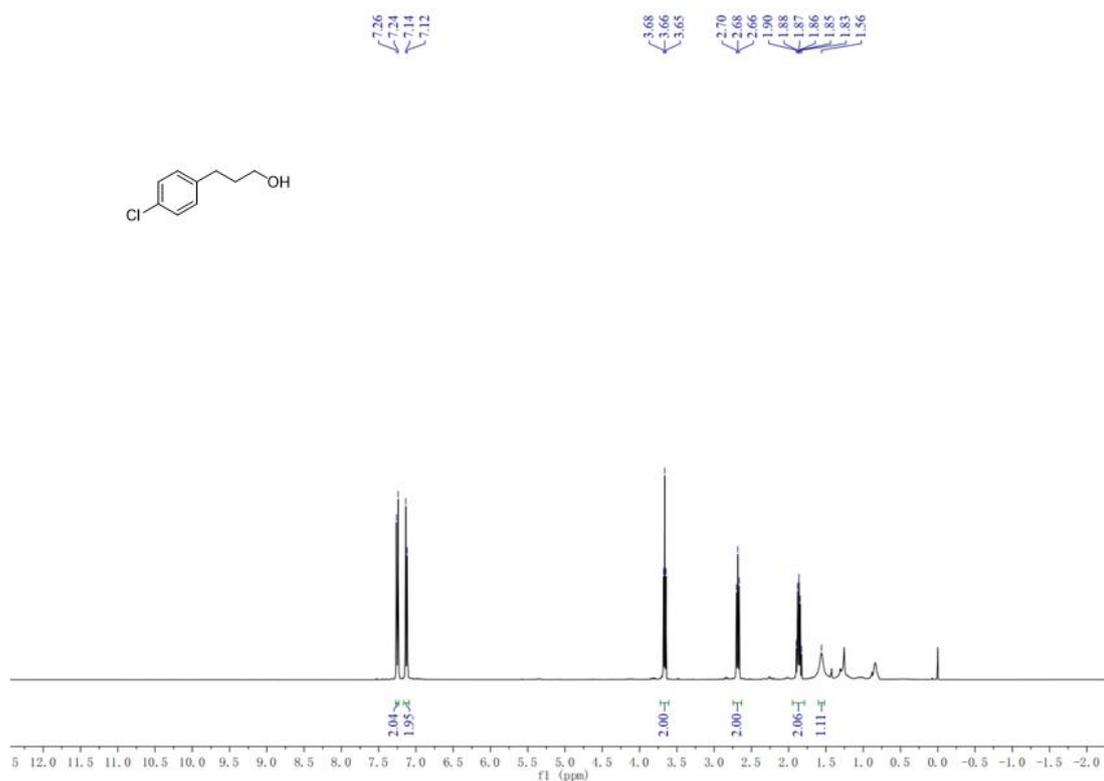


Figure S115. ¹H NMR (400 MHz, CDCl₃) spectrum of 2n

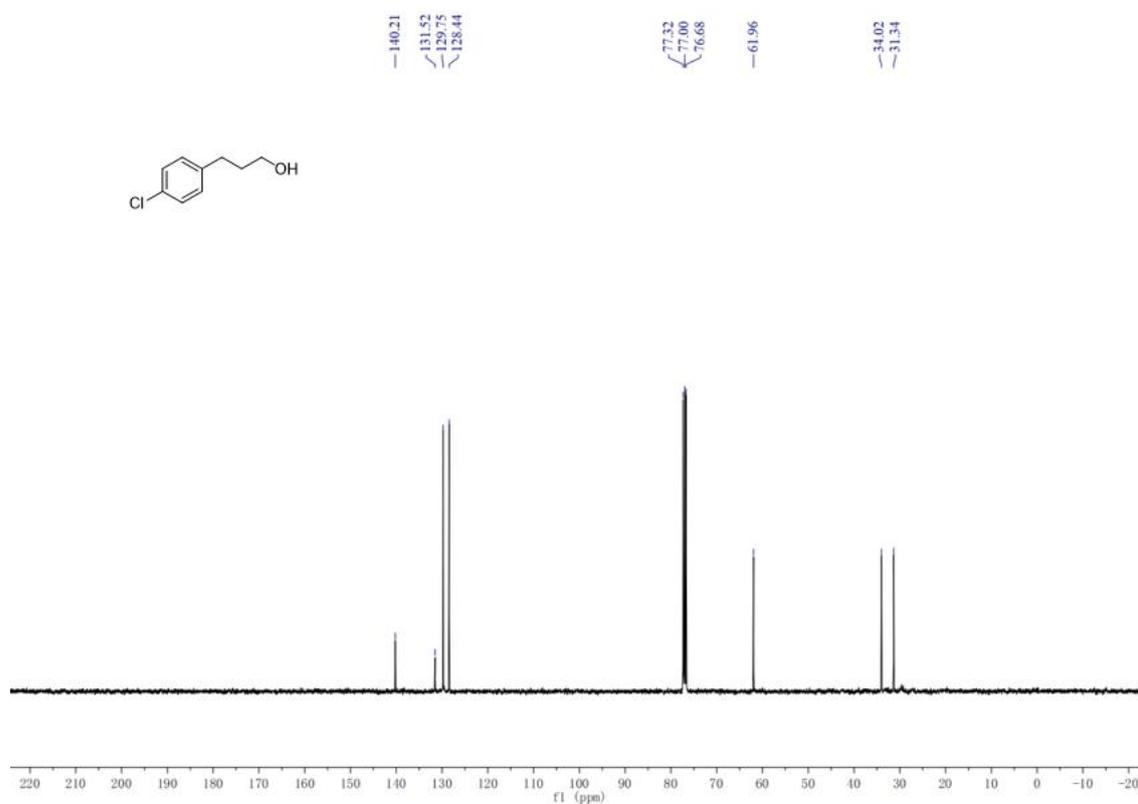


Figure S116. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2n

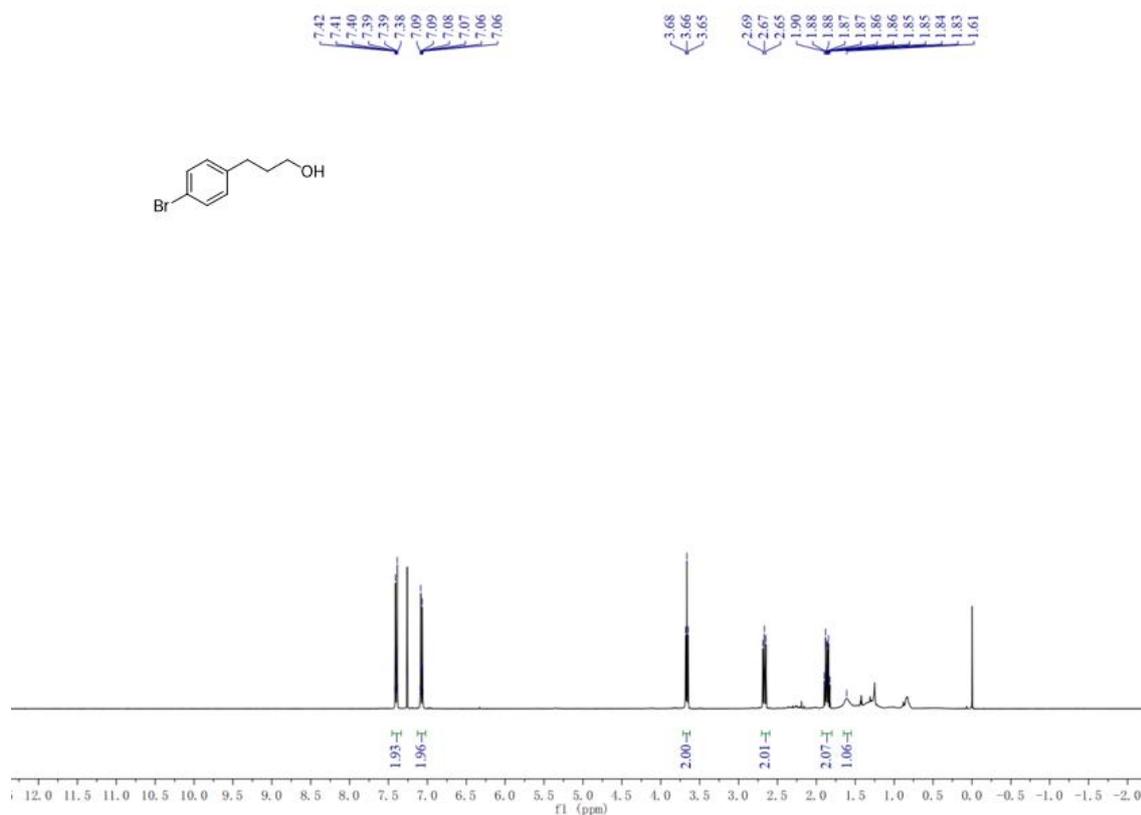


Figure S117. ¹H NMR (400 MHz, CDCl₃) spectrum of 2o

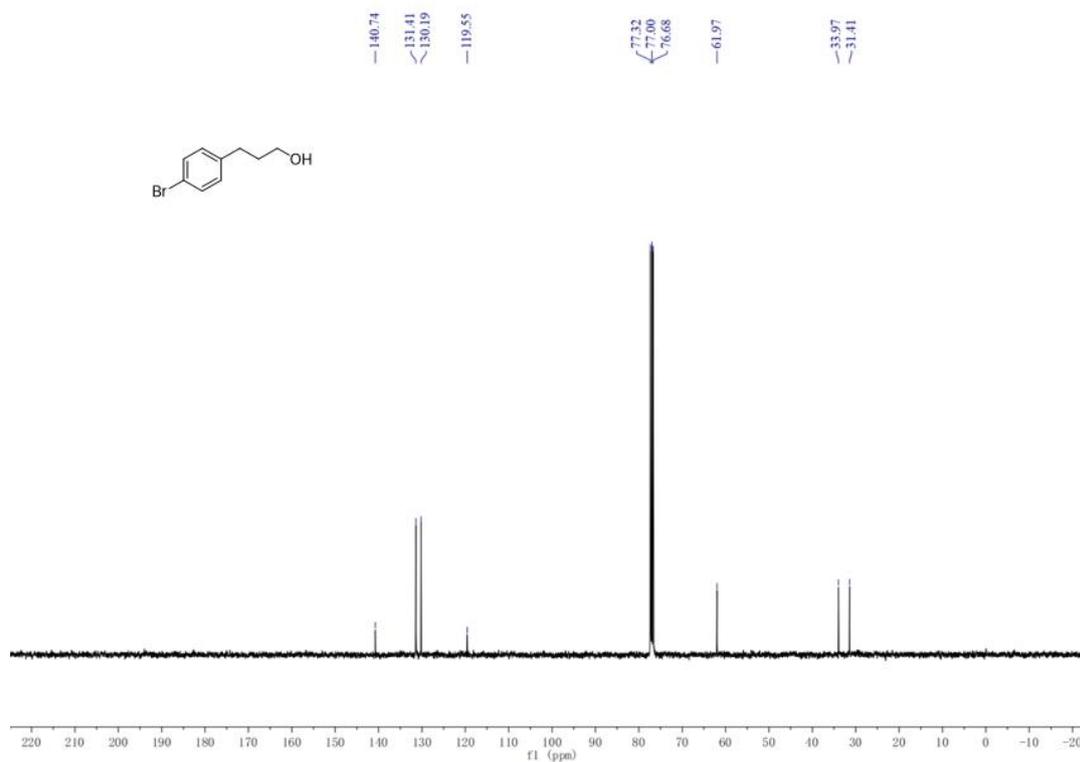


Figure S118. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2o

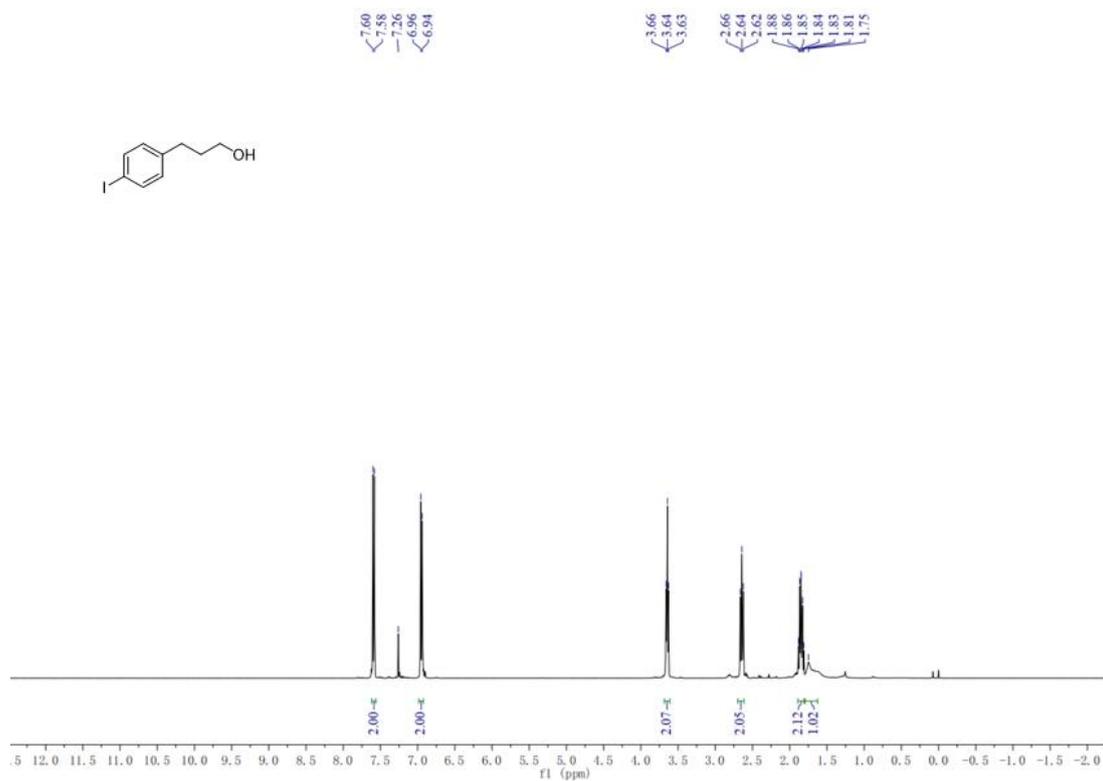


Figure S119. ¹H NMR (400 MHz, CDCl₃) spectrum of 2p

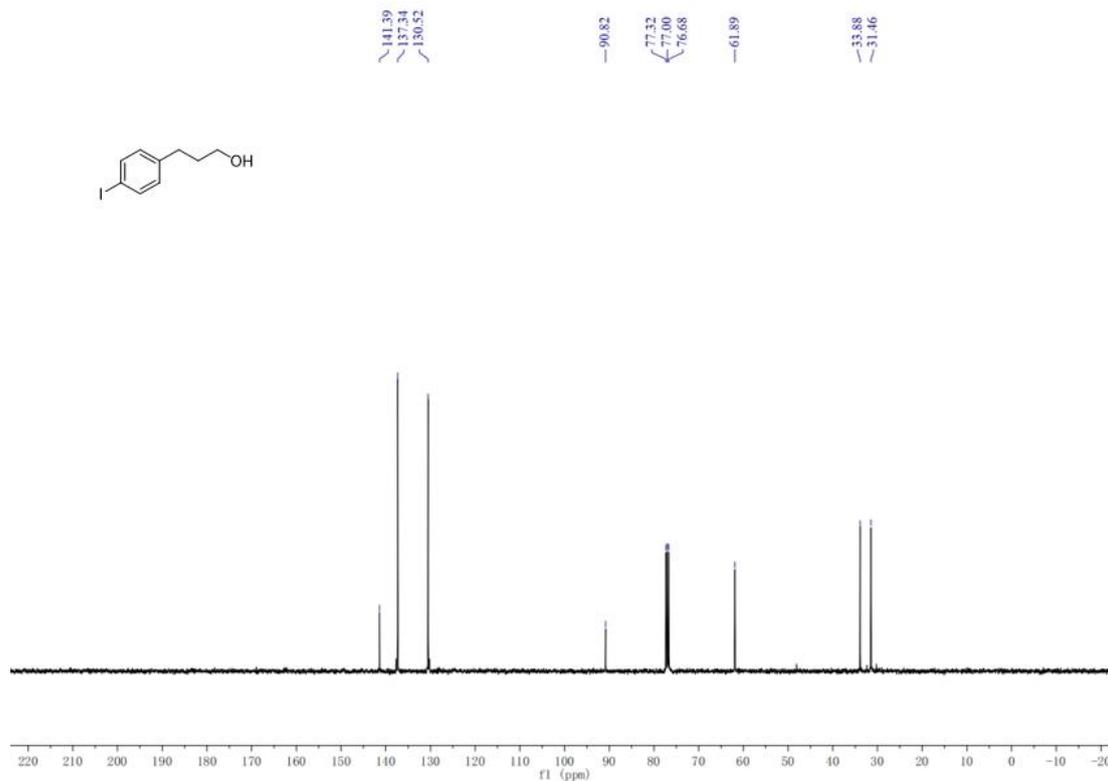


Figure S120. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2p

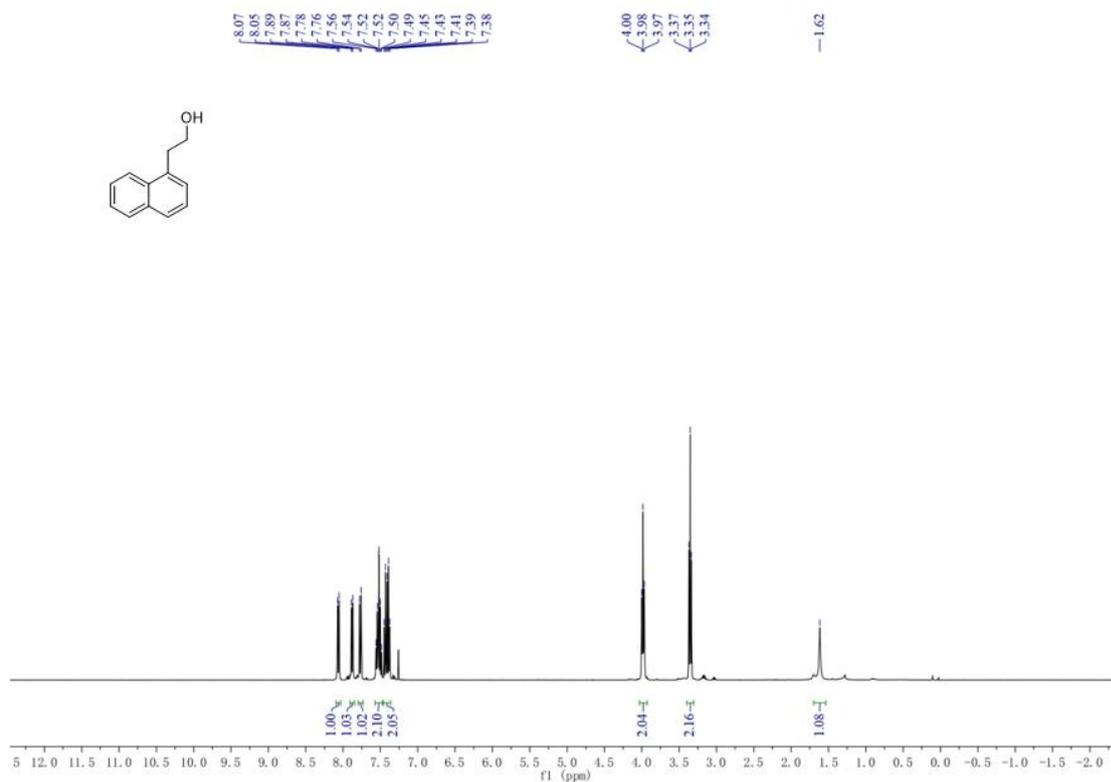


Figure S121. ¹H NMR (400 MHz, CDCl₃) spectrum of 2q

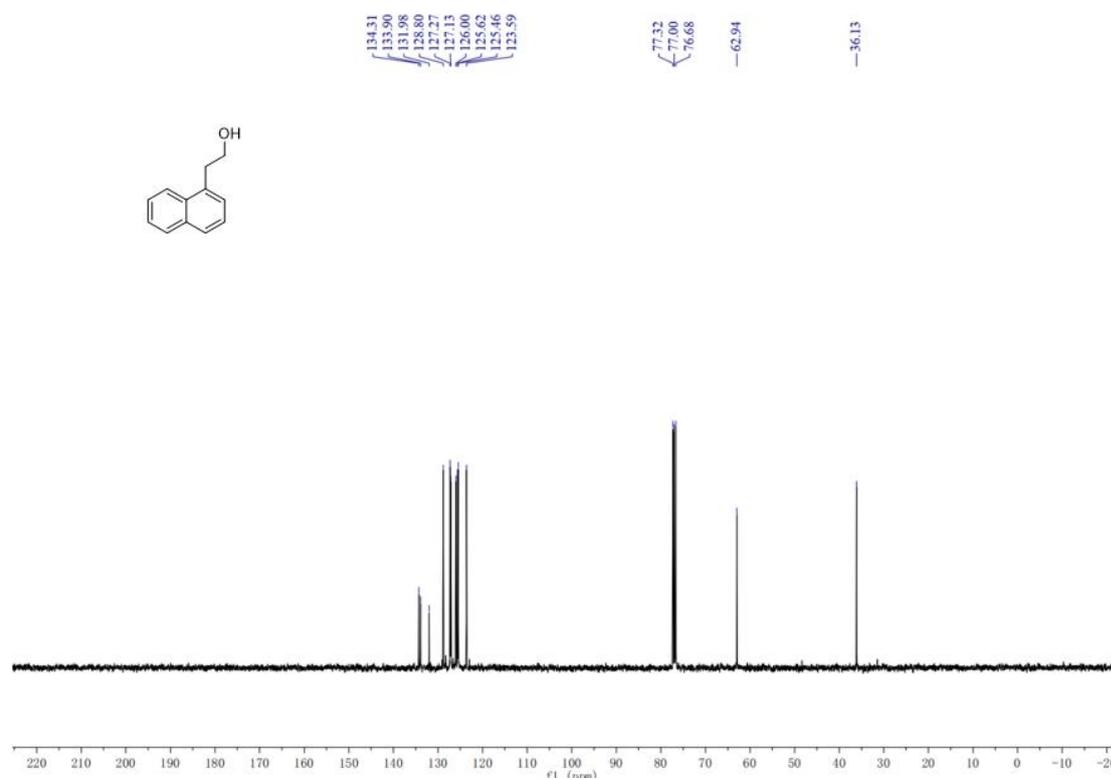


Figure S122. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2q

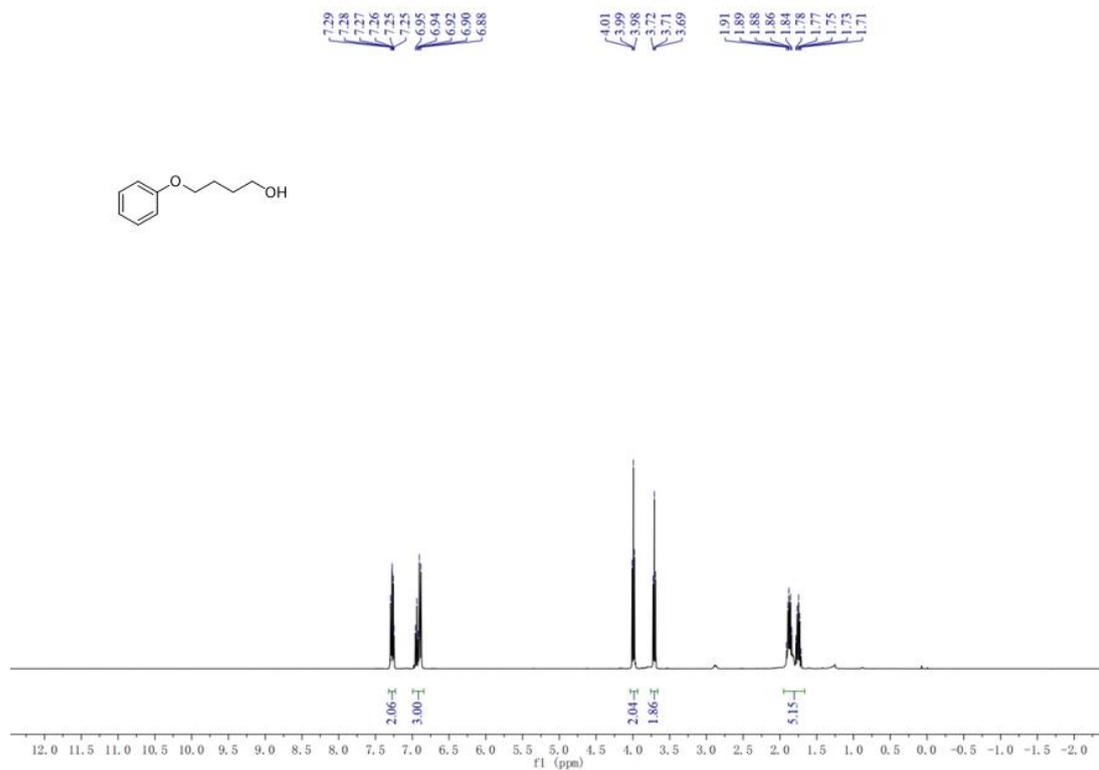


Figure S123. ^1H NMR (400 MHz, CDCl_3) spectrum of **2r**

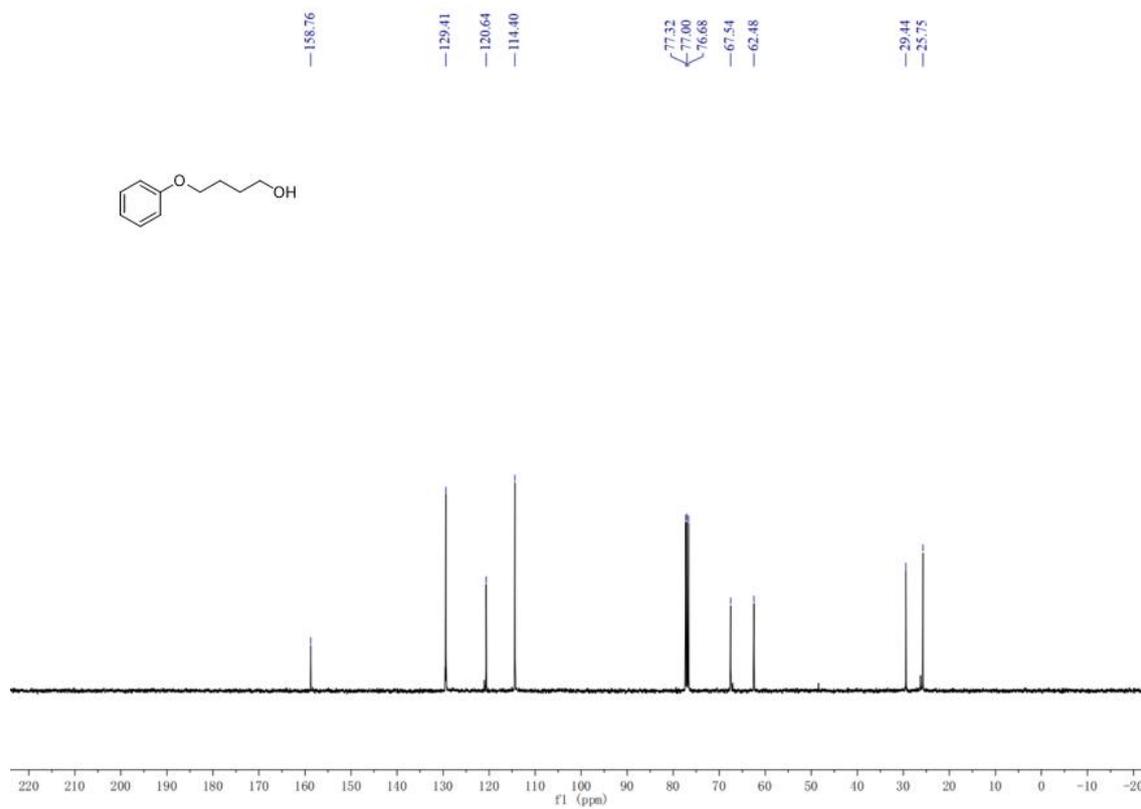


Figure S124. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **2r**

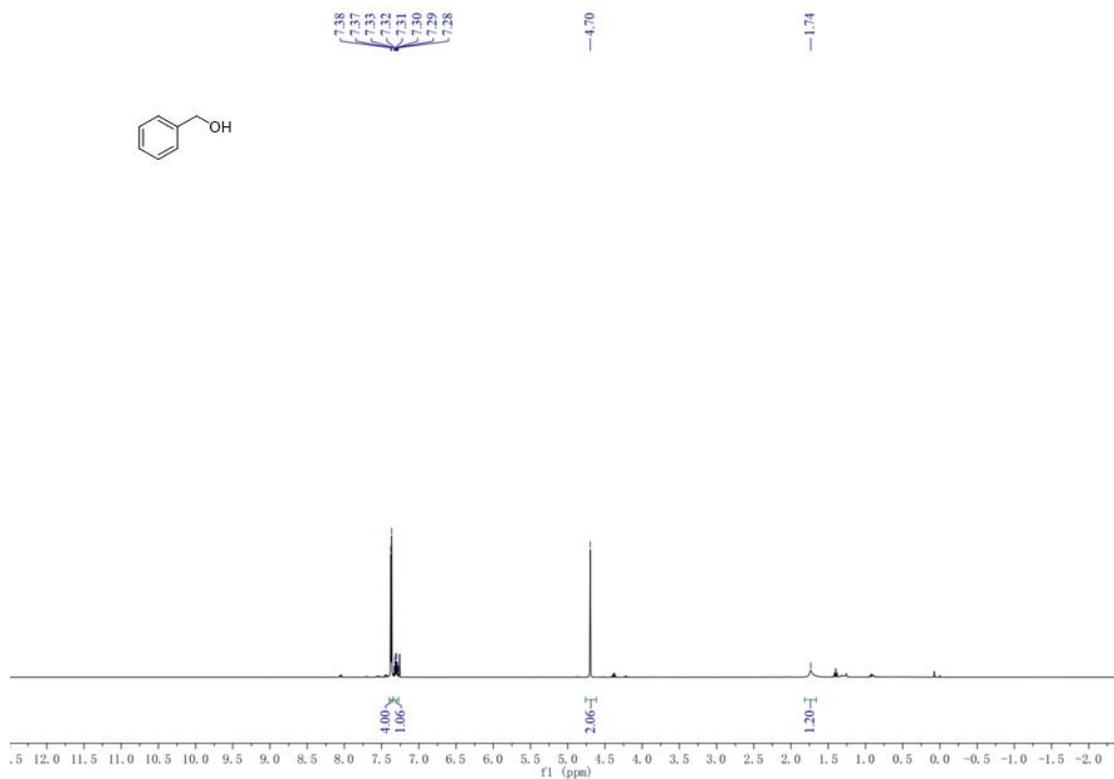


Figure S125. $^1\text{H NMR}$ (400 MHz, CDCl_3) spectrum of **2s**

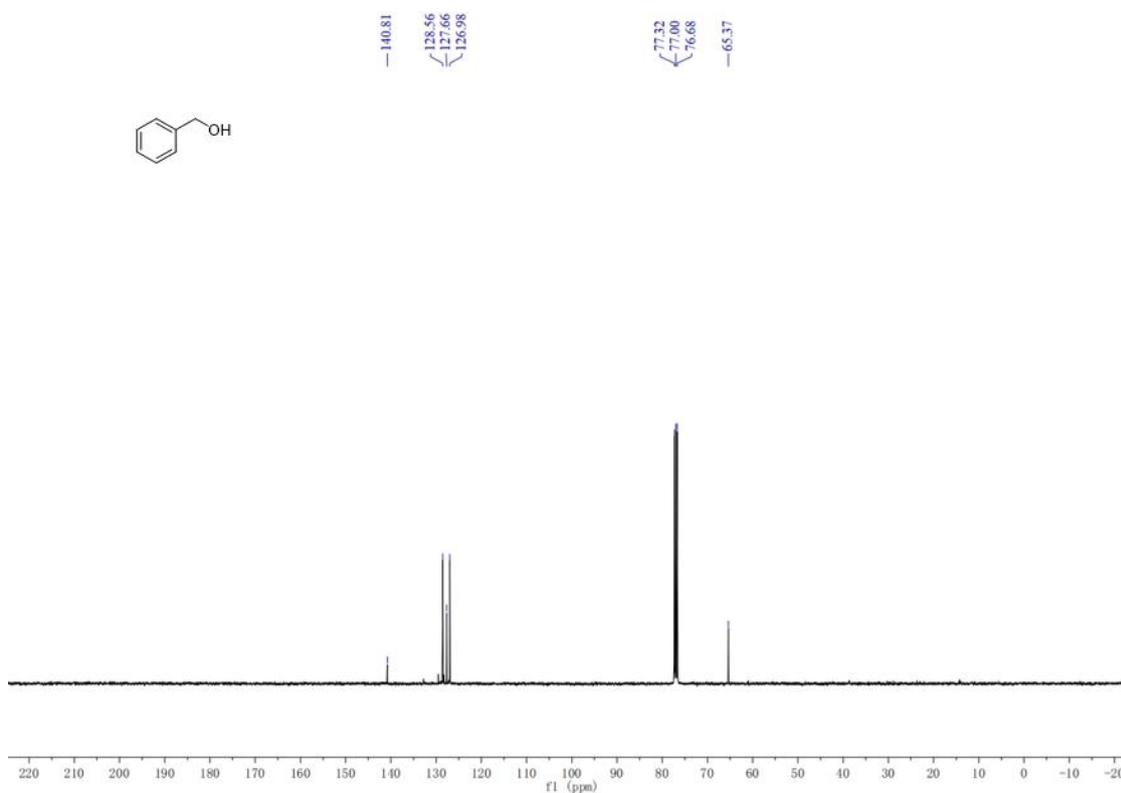


Figure S126. $^{13}\text{C NMR}$ (100 MHz, CDCl_3) spectrum of **2s**

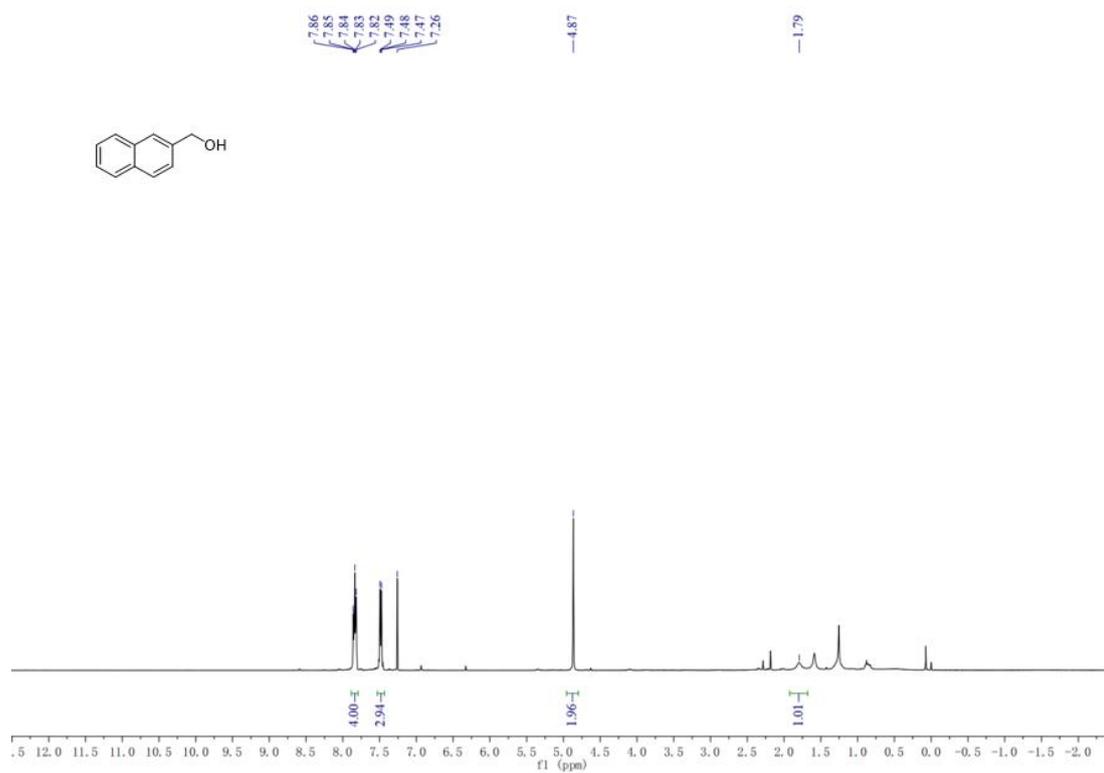


Figure S127. ¹H NMR (400 MHz, CDCl₃) spectrum of **2t**

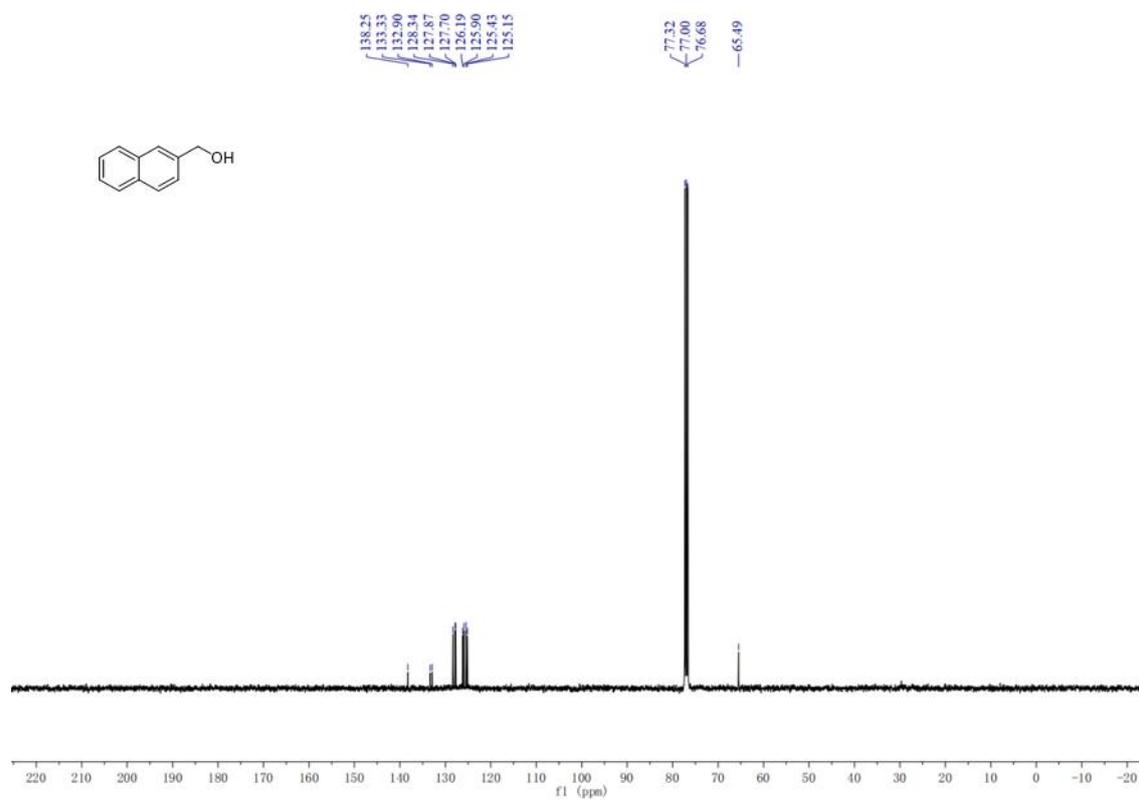


Figure S128. ¹³C NMR (100 MHz, CDCl₃) spectrum of **2t**

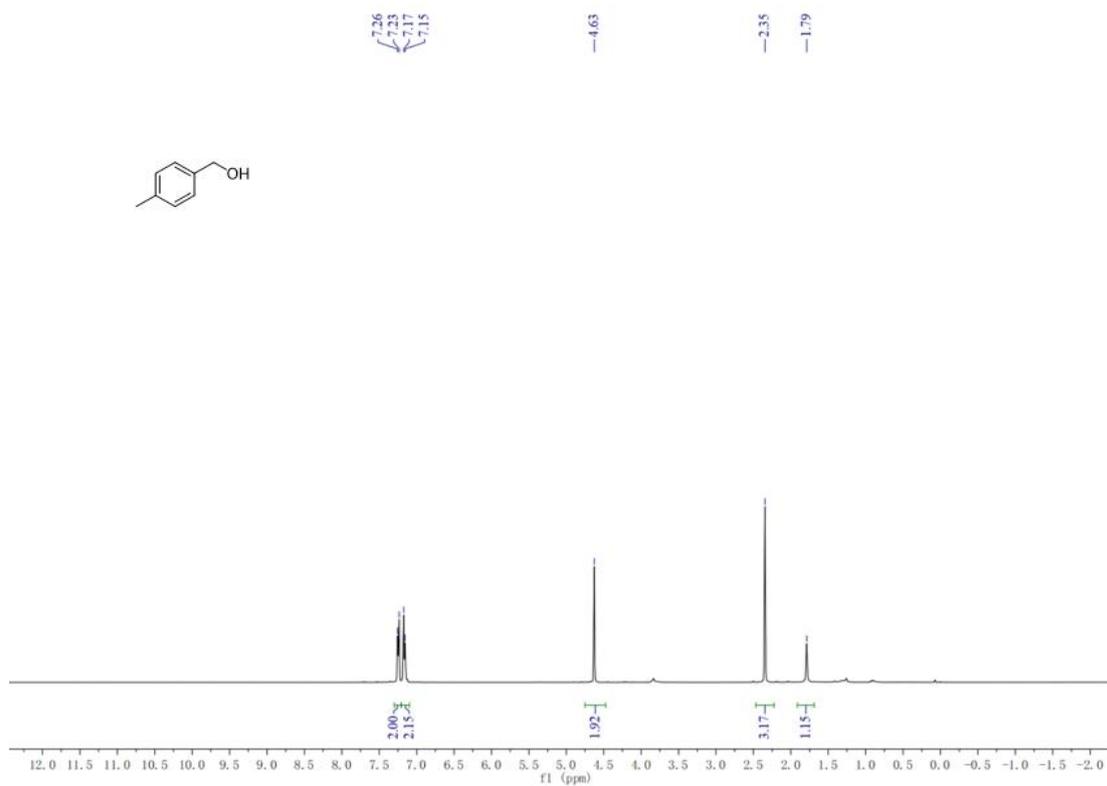


Figure S129. ¹H NMR (400 MHz, CDCl₃) spectrum of **2u**

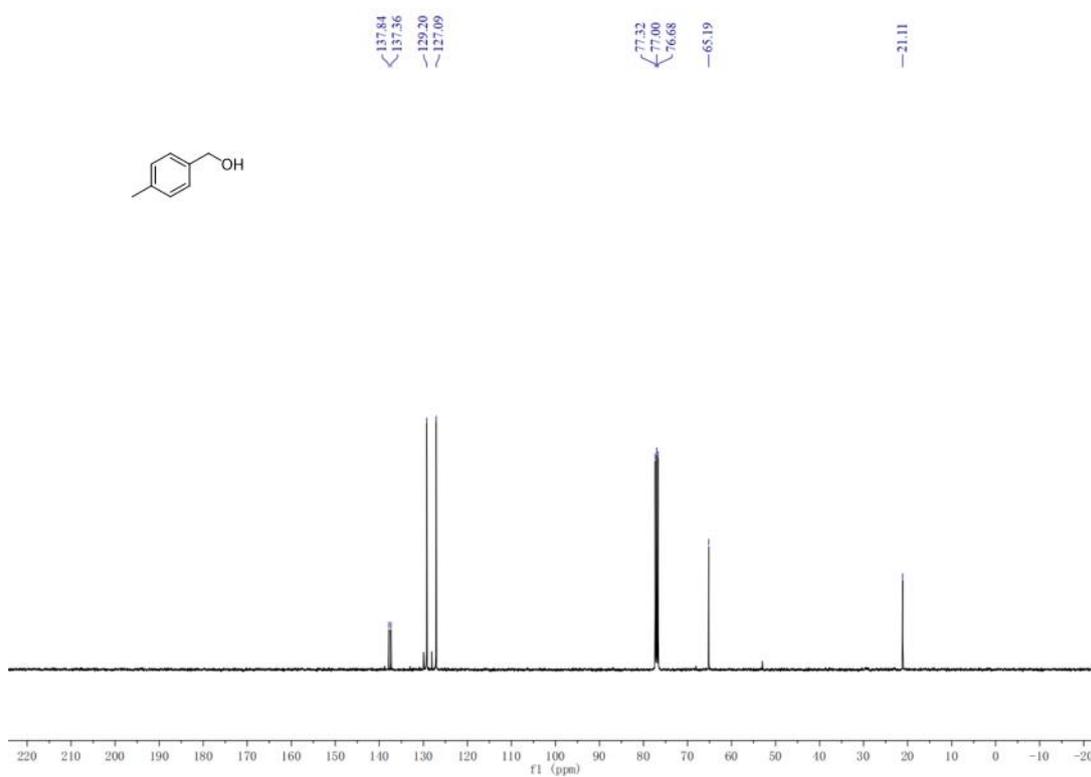


Figure S130. ¹³C NMR (100 MHz, CDCl₃) spectrum of **2u**

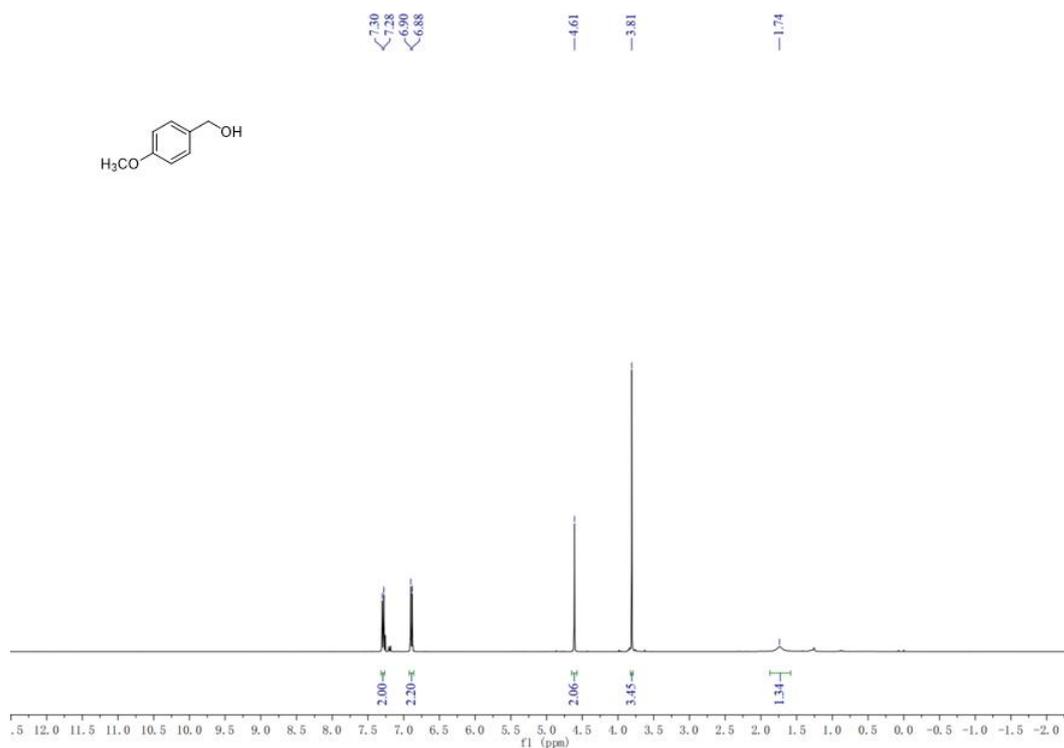


Figure S131. ^1H NMR (400 MHz, CDCl_3) spectrum of **2v**

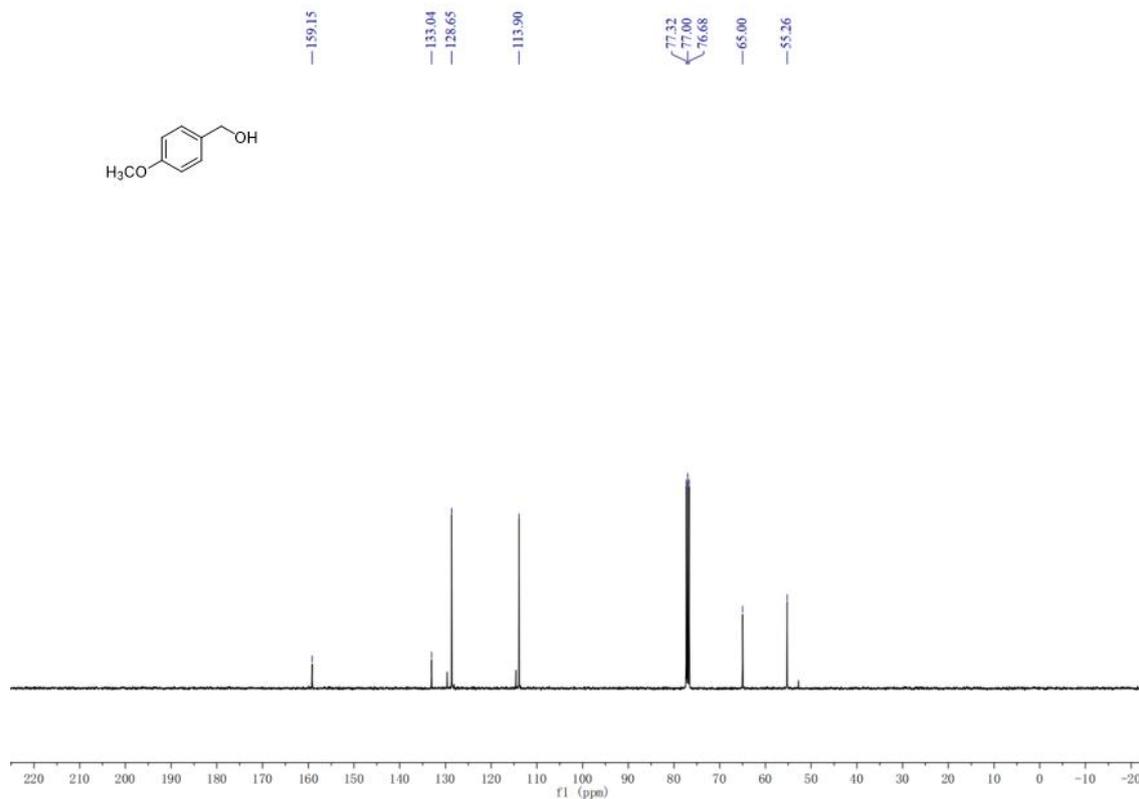


Figure S132. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **2v**

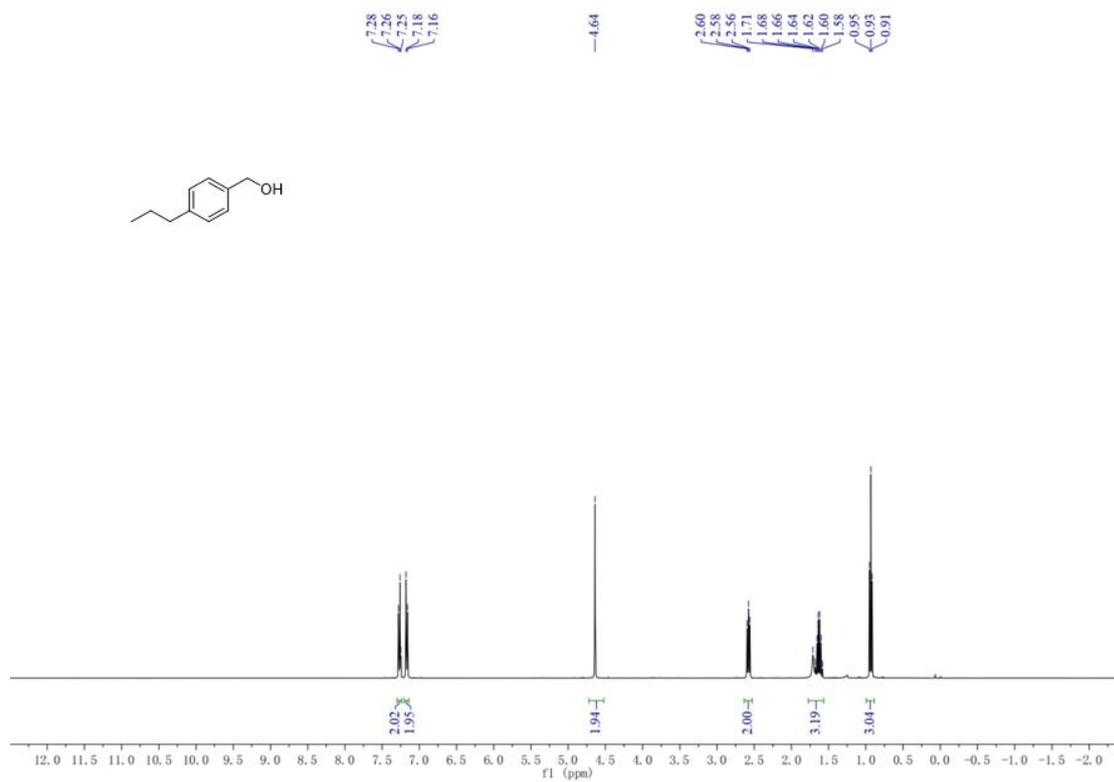


Figure S133. ¹H NMR (400 MHz, CDCl₃) spectrum of 2w

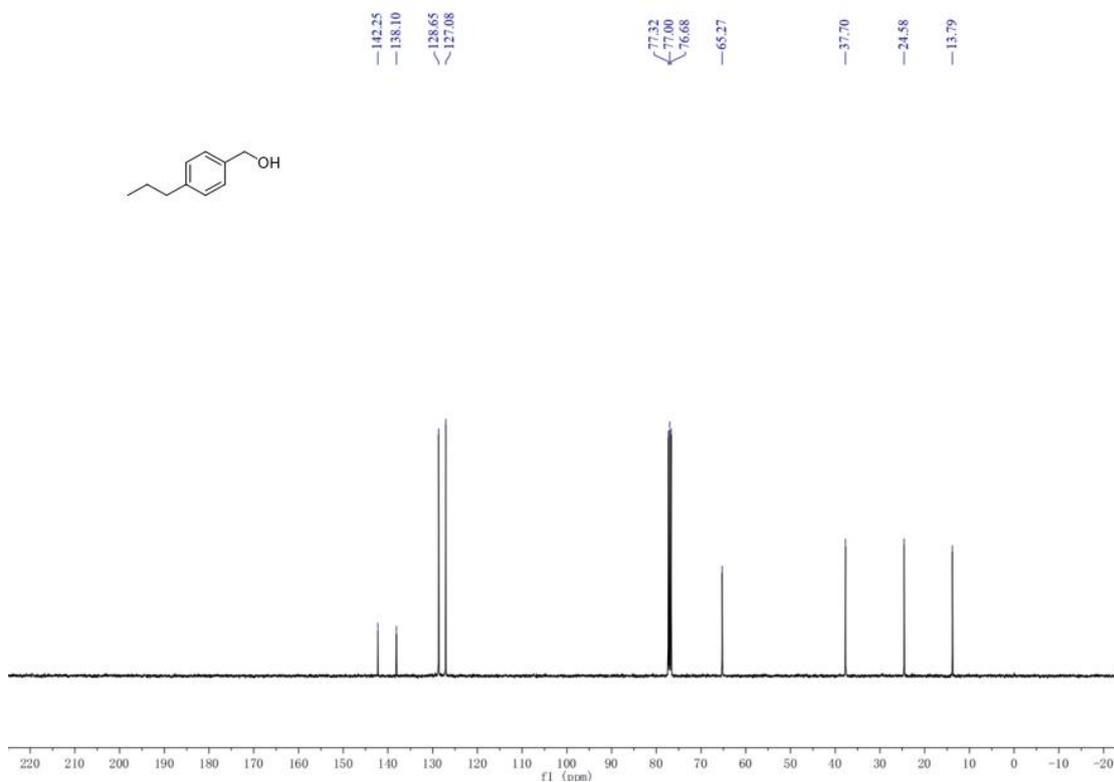


Figure S134. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2w

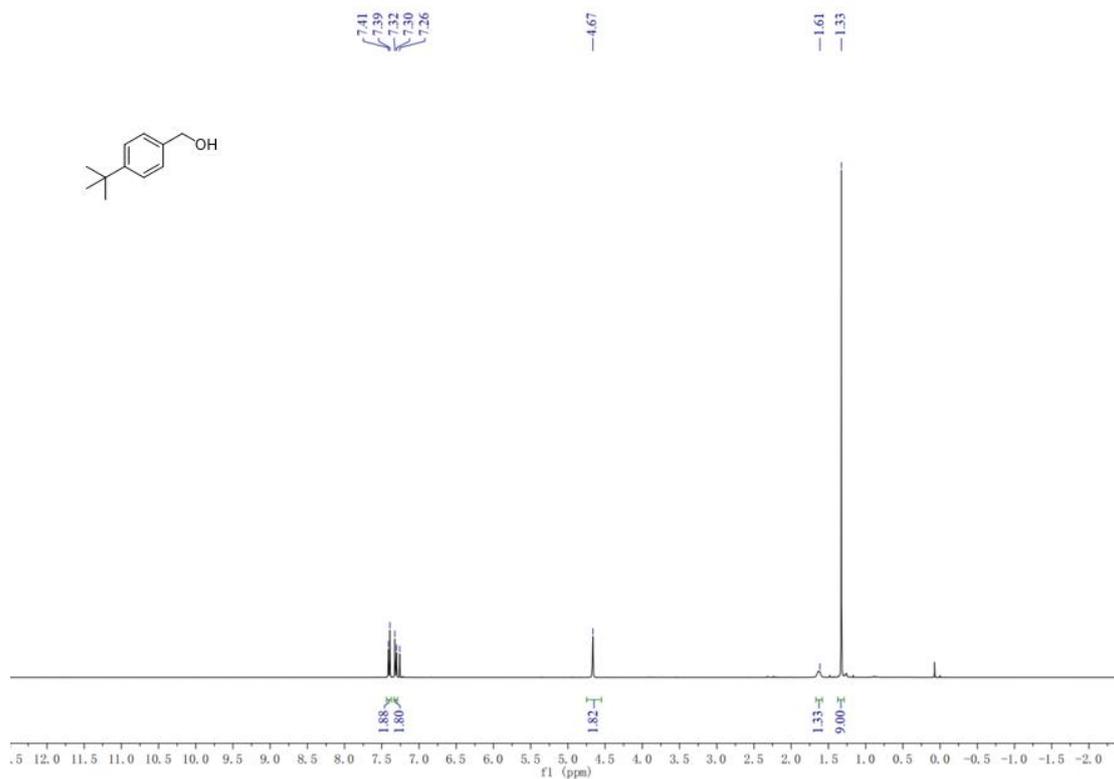


Figure S135. ¹H NMR (400 MHz, CDCl₃) spectrum of 2x

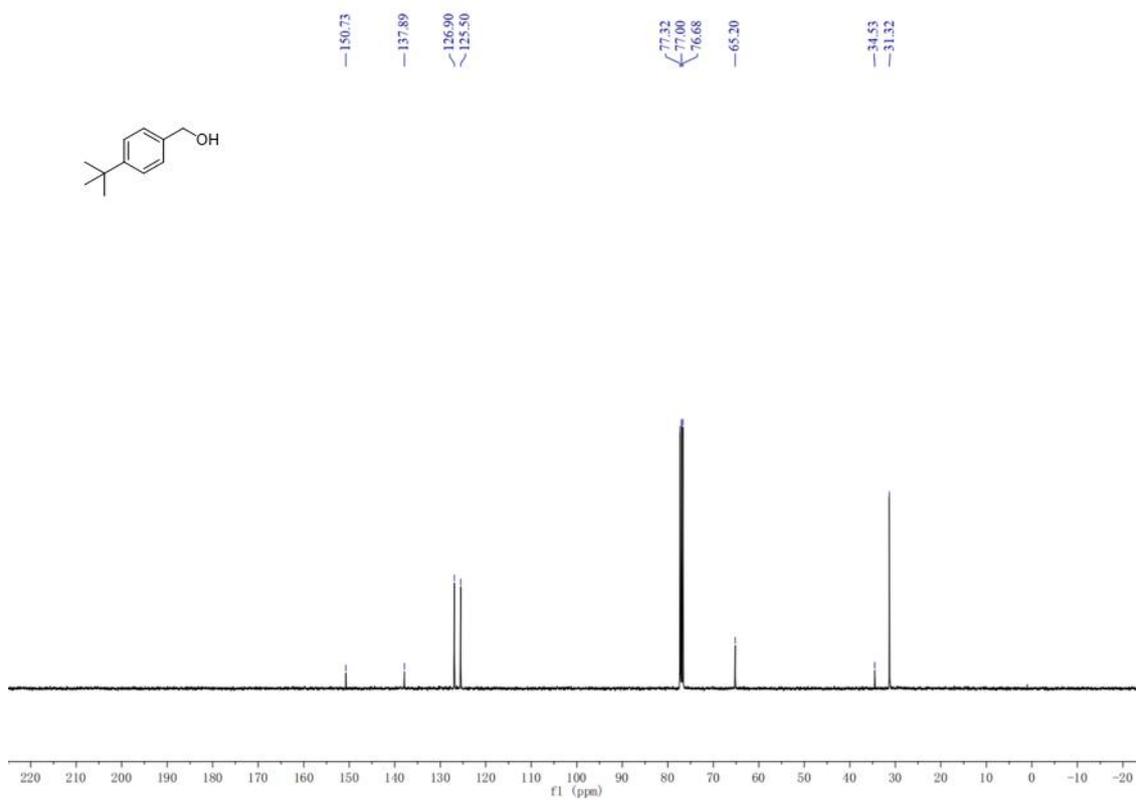


Figure S136. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2x

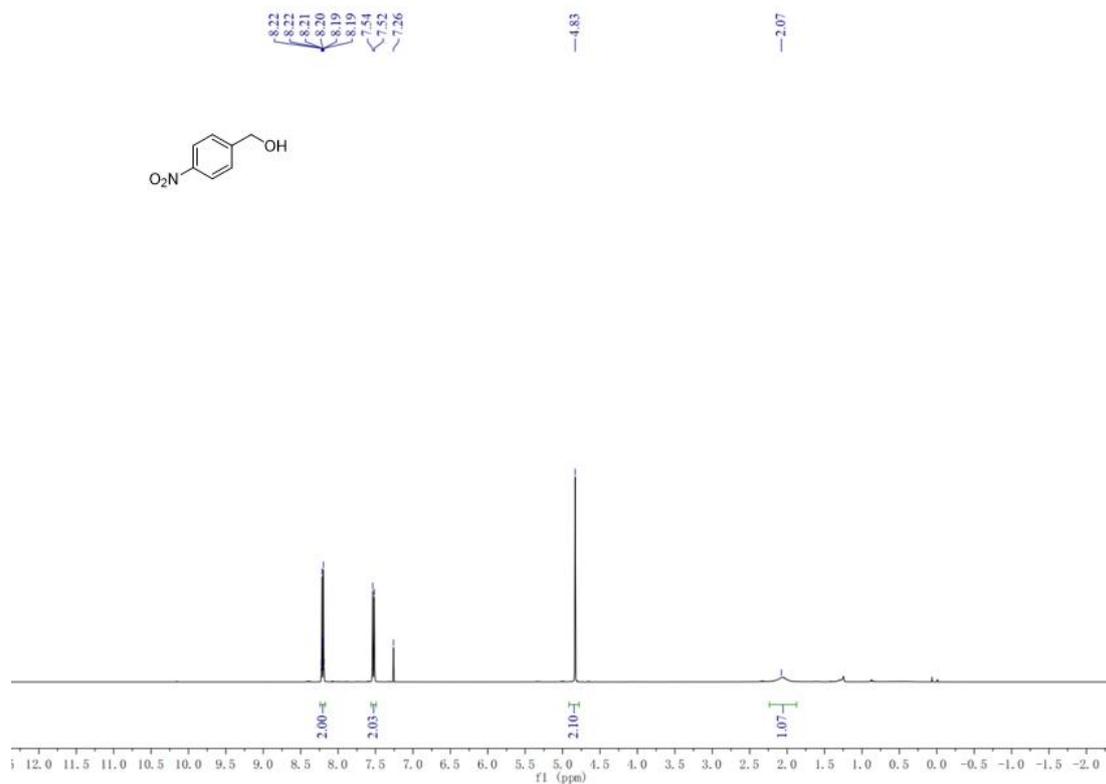


Figure S137. ¹H NMR (400 MHz, CDCl₃) spectrum of 2y

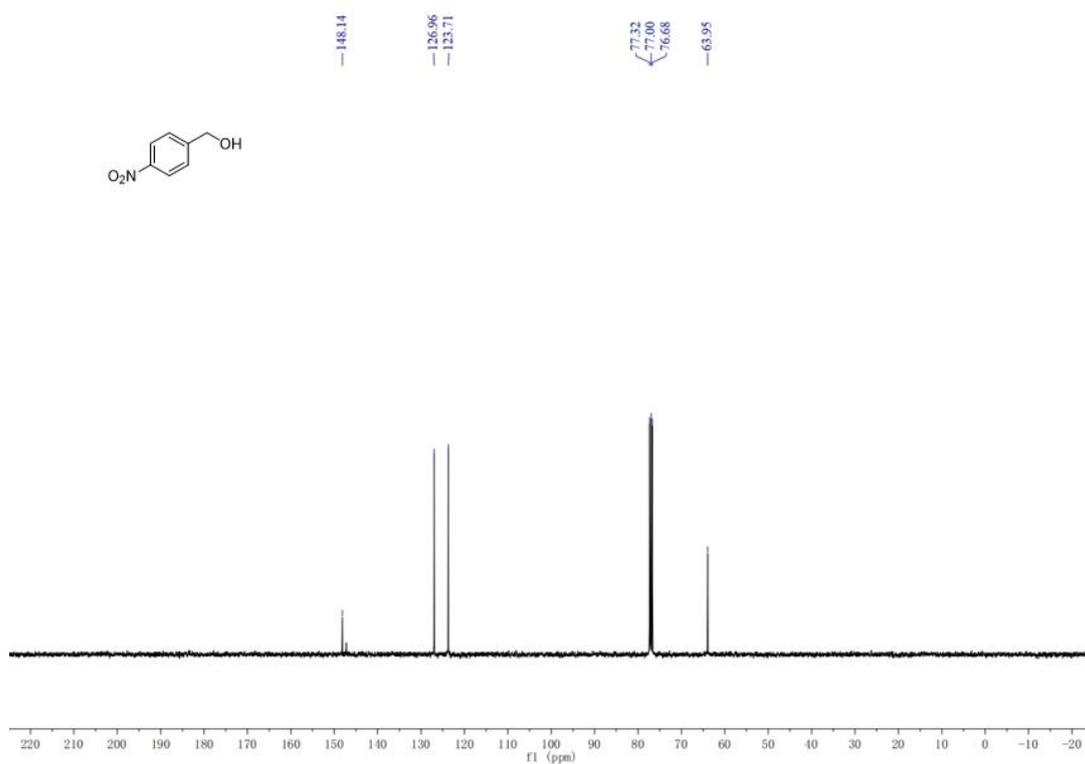


Figure S138. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2y

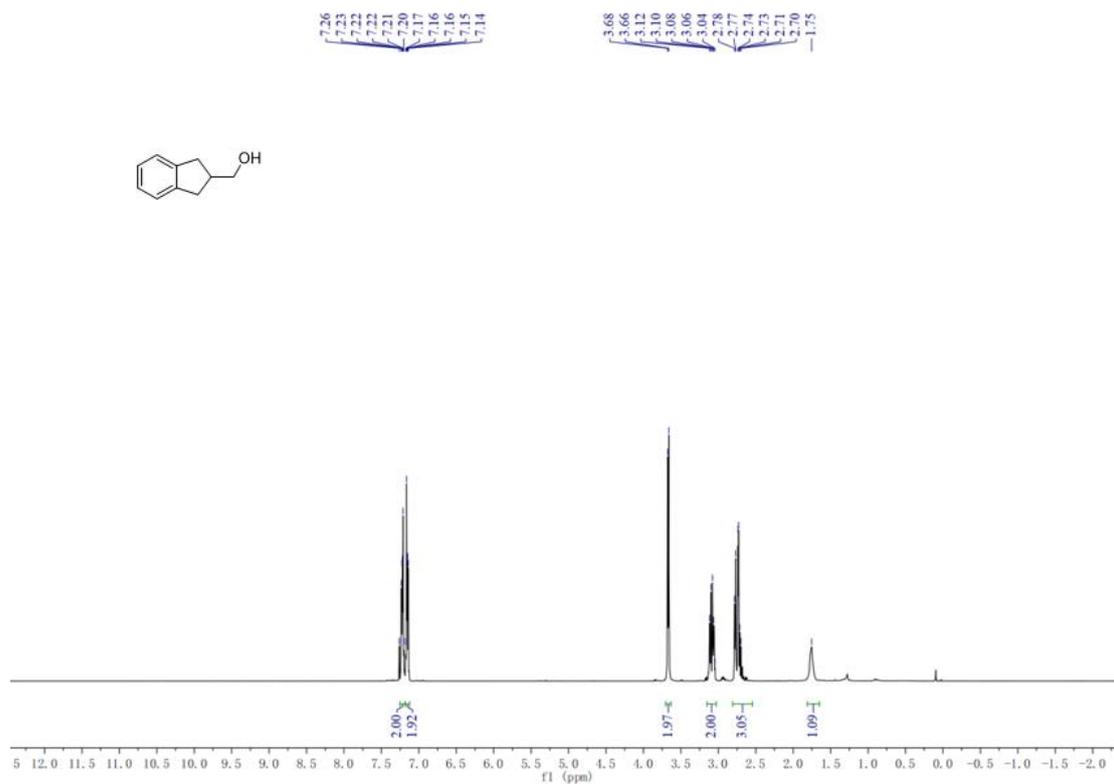


Figure S139. ¹H NMR (400 MHz, CDCl₃) spectrum of 2z

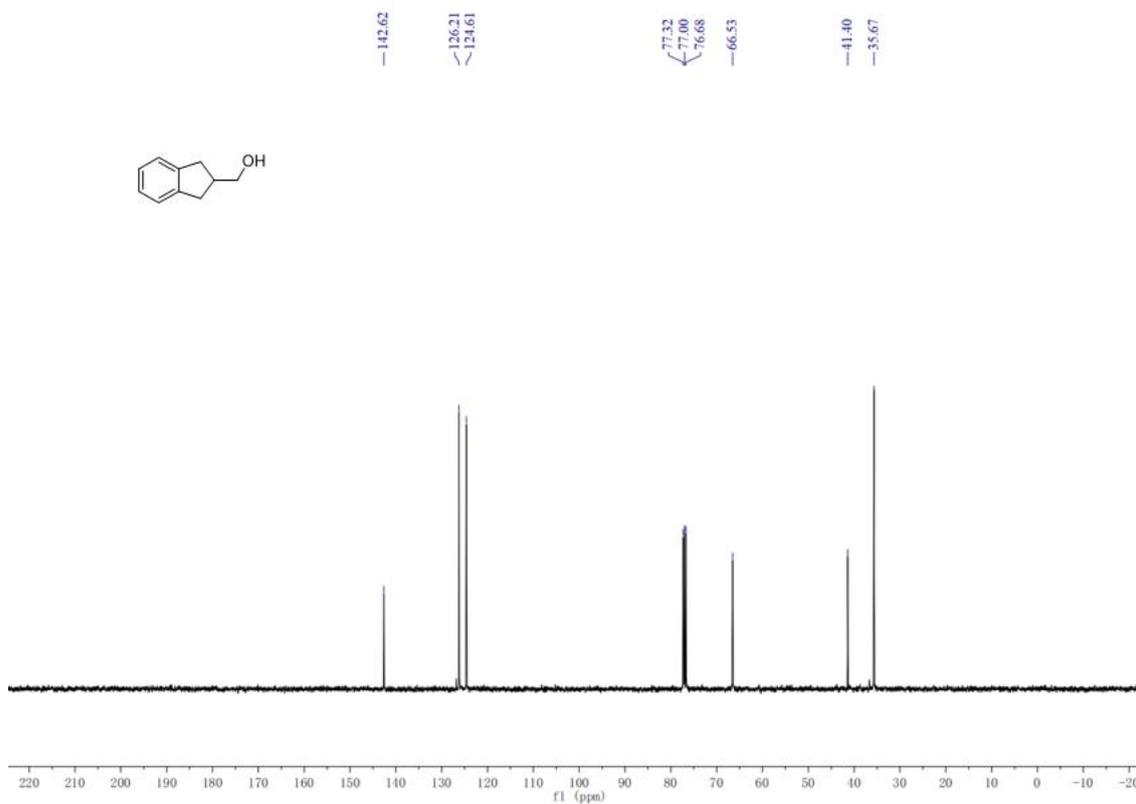


Figure S140. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2z

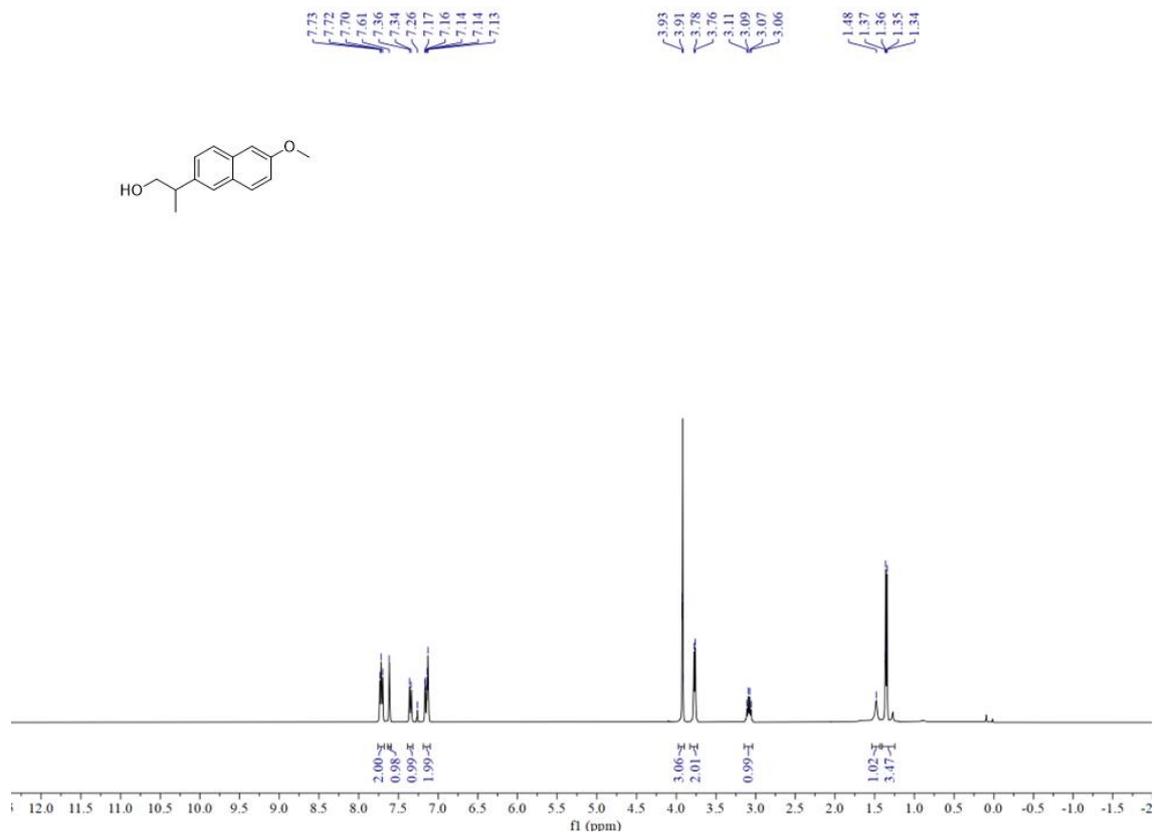


Figure S141. ¹H NMR (400 MHz, CDCl₃) spectrum of 2aa

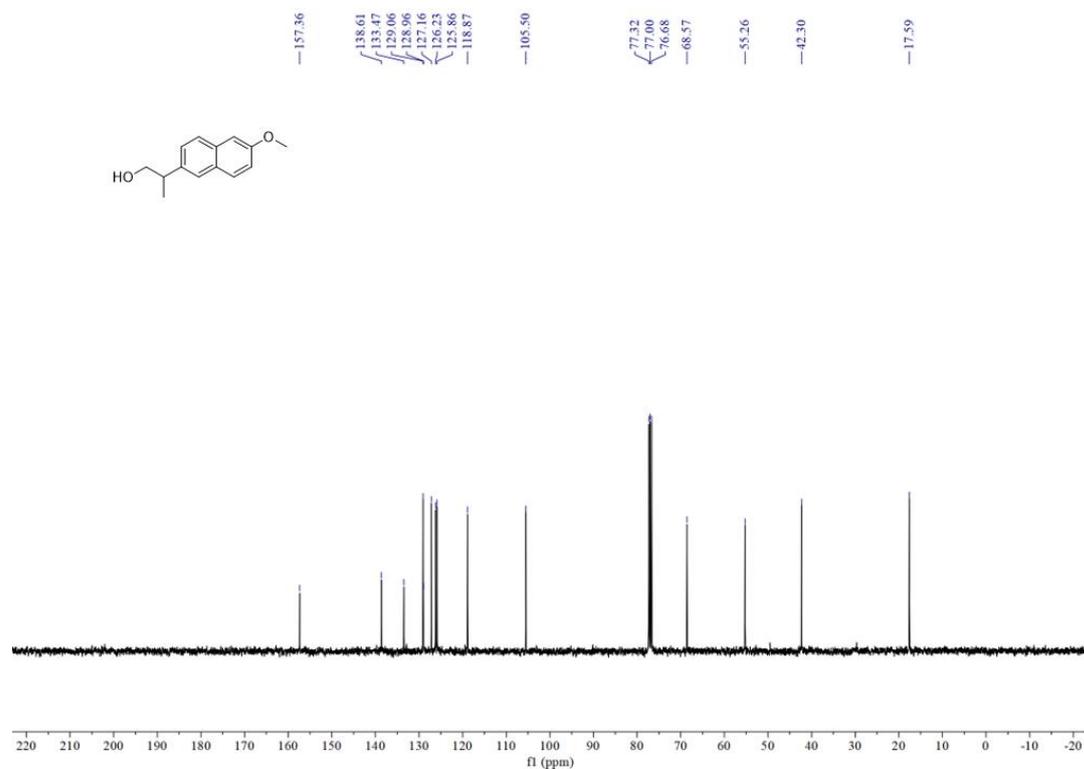


Figure S142. ¹³C NMR (100 MHz, CDCl₃) spectrum of 2aa

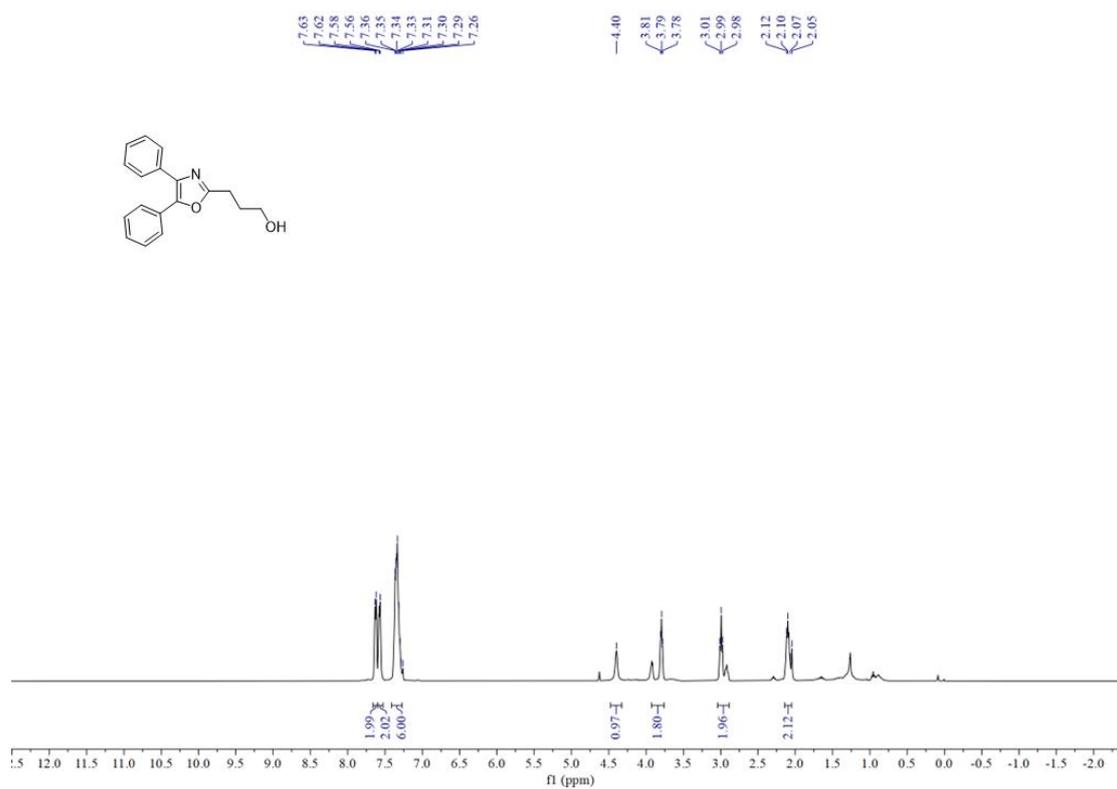


Figure S143. ¹H NMR (400 MHz, CDCl₃) spectrum of **2ab**

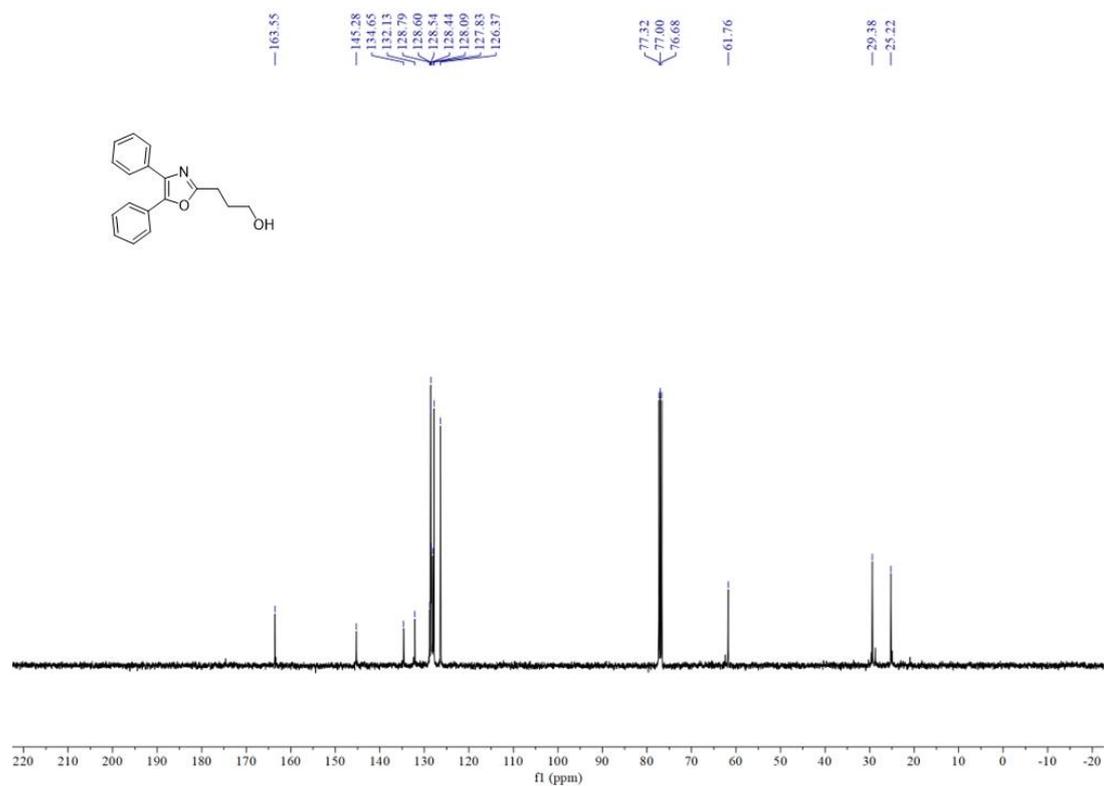


Figure S144. ¹³C NMR (100 MHz, CDCl₃) spectrum of **2ab**

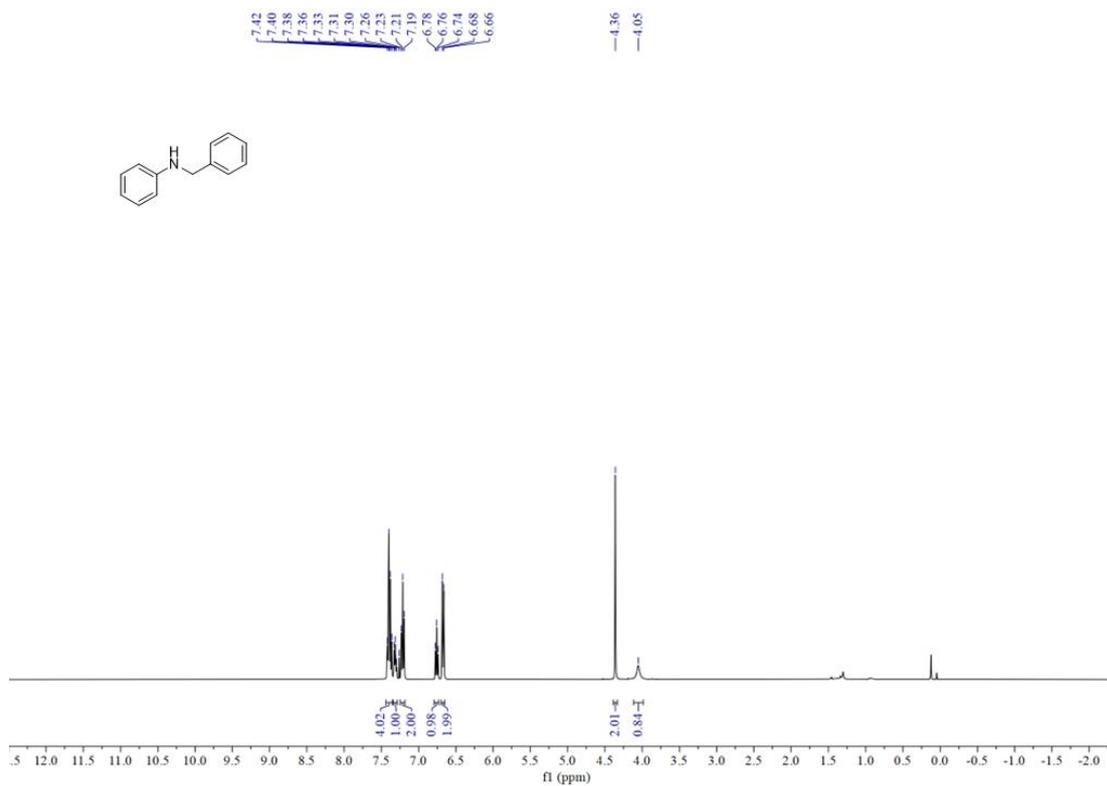


Figure S145. ¹H NMR (400 MHz, CDCl₃) spectrum of **4a**

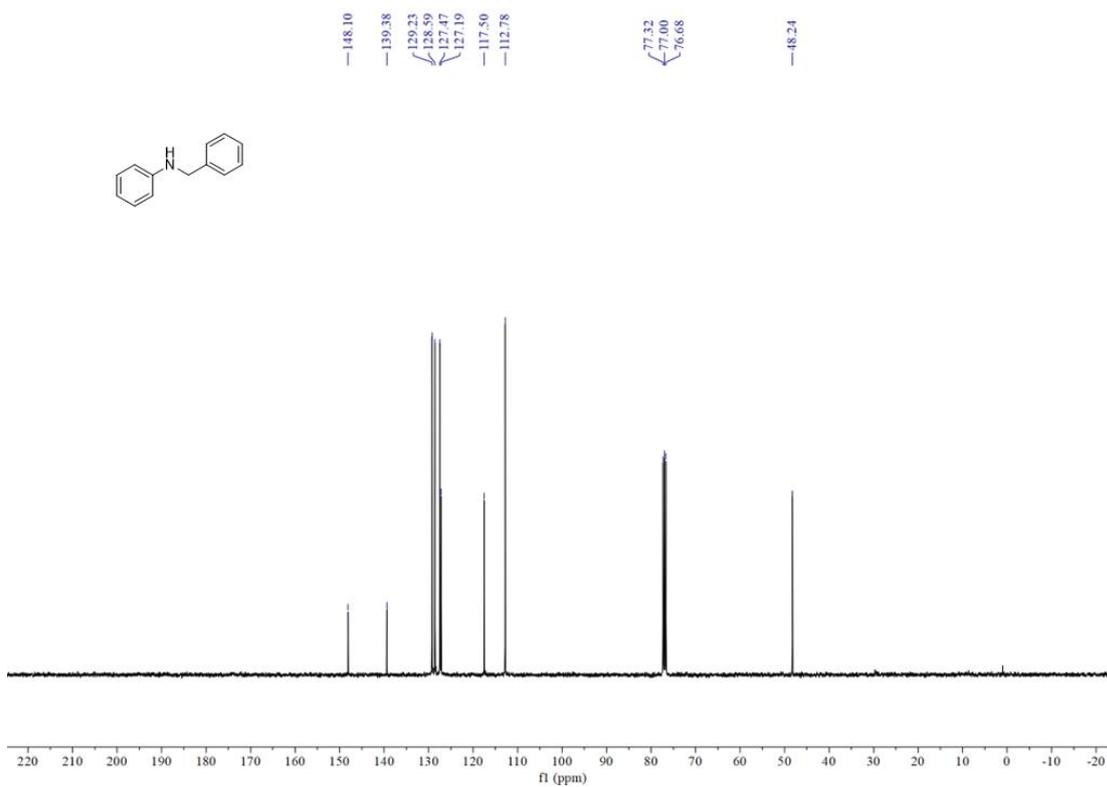


Figure S146. ¹³C NMR (100 MHz, CDCl₃) spectrum of **4a**

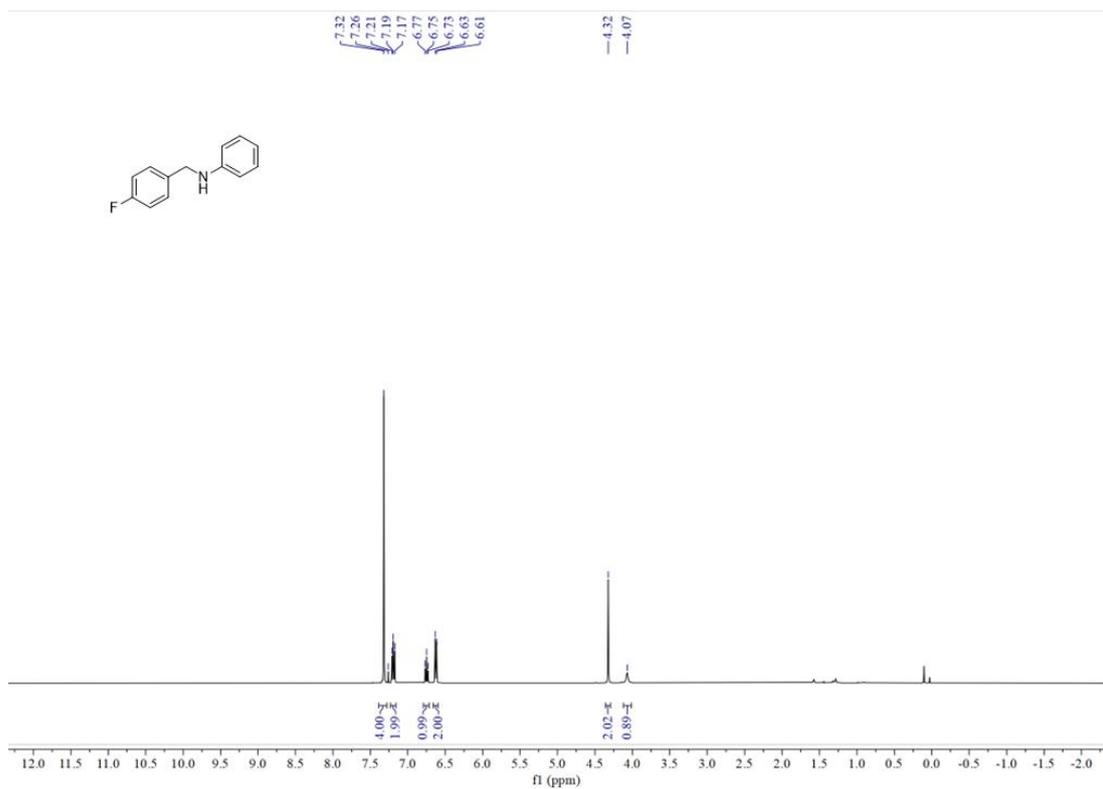


Figure S147. ¹H NMR (400 MHz, CDCl₃) spectrum of 4b

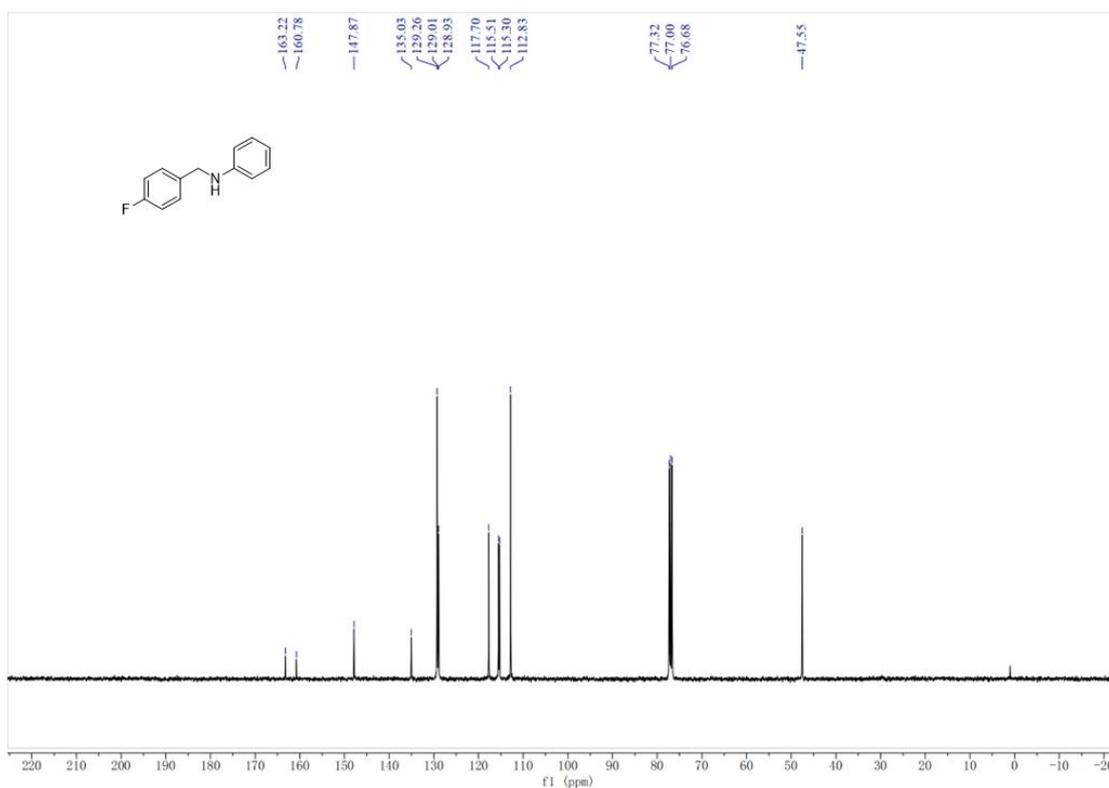


Figure S148. ¹³C NMR (100 MHz, CDCl₃) spectrum of 4b

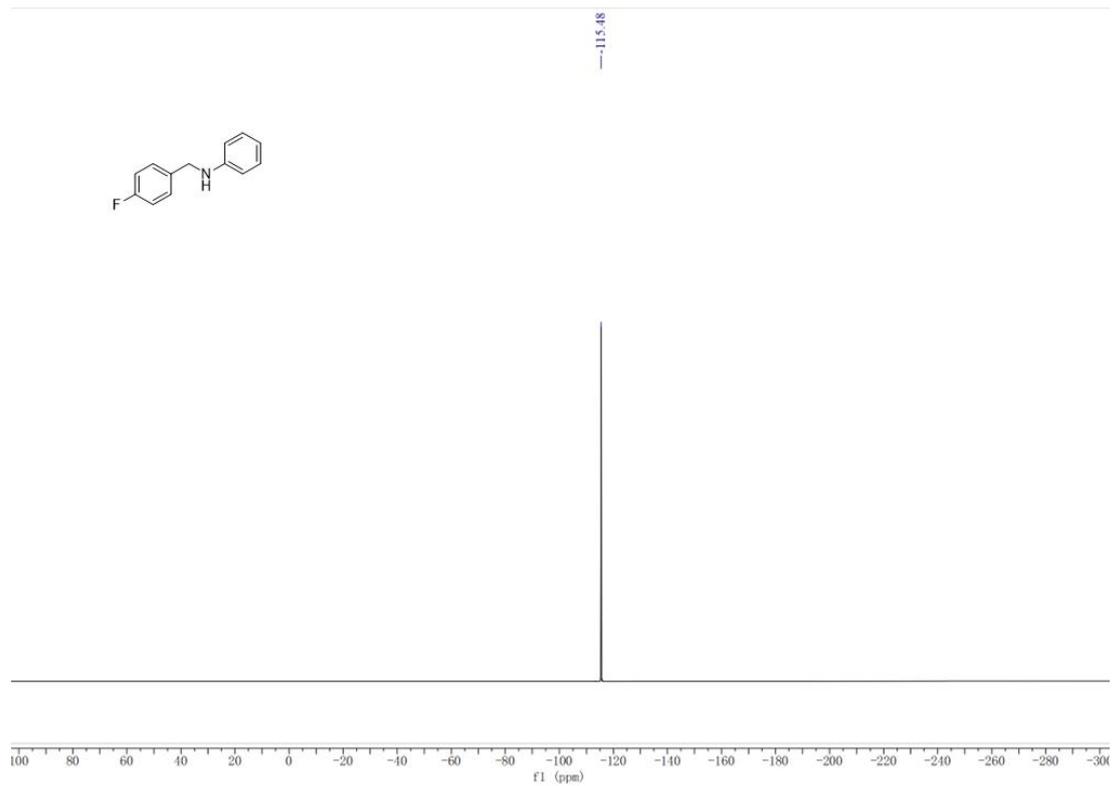


Figure S149. ^{19}F NMR (100 MHz, CDCl_3) spectrum of 4b

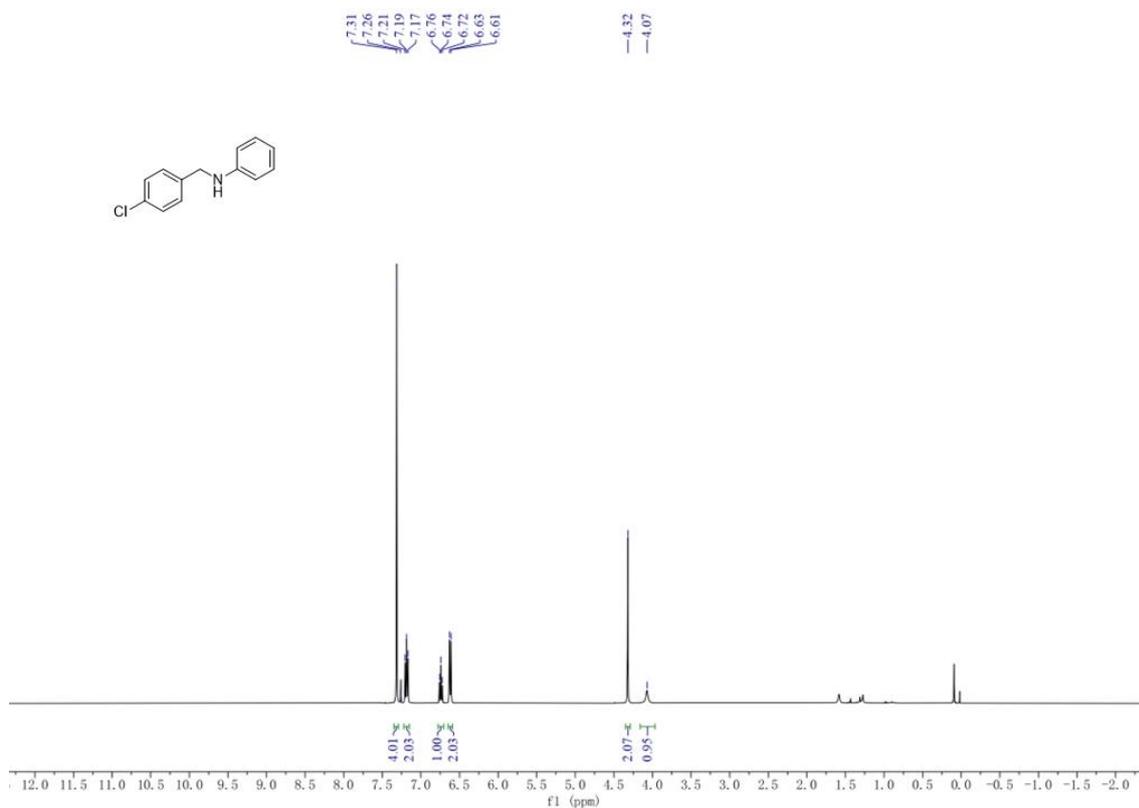


Figure S150. ^1H NMR (400 MHz, CDCl_3) spectrum of 4c

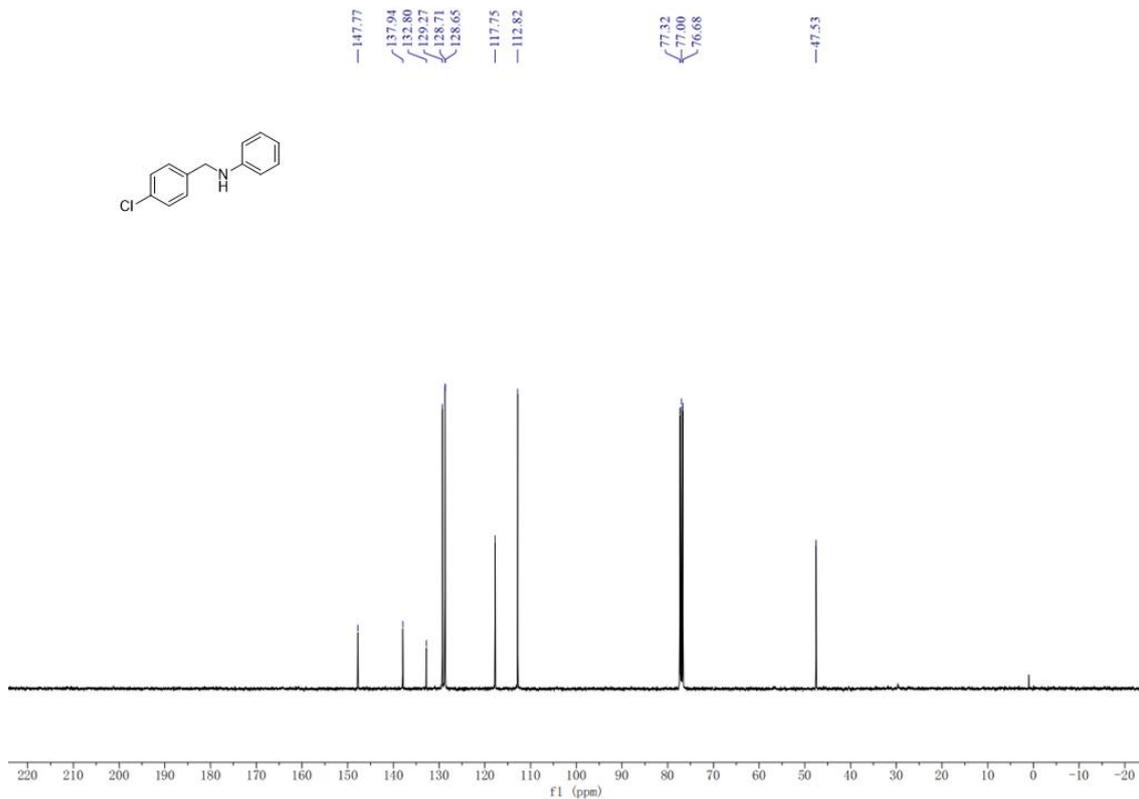


Figure S151. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4c

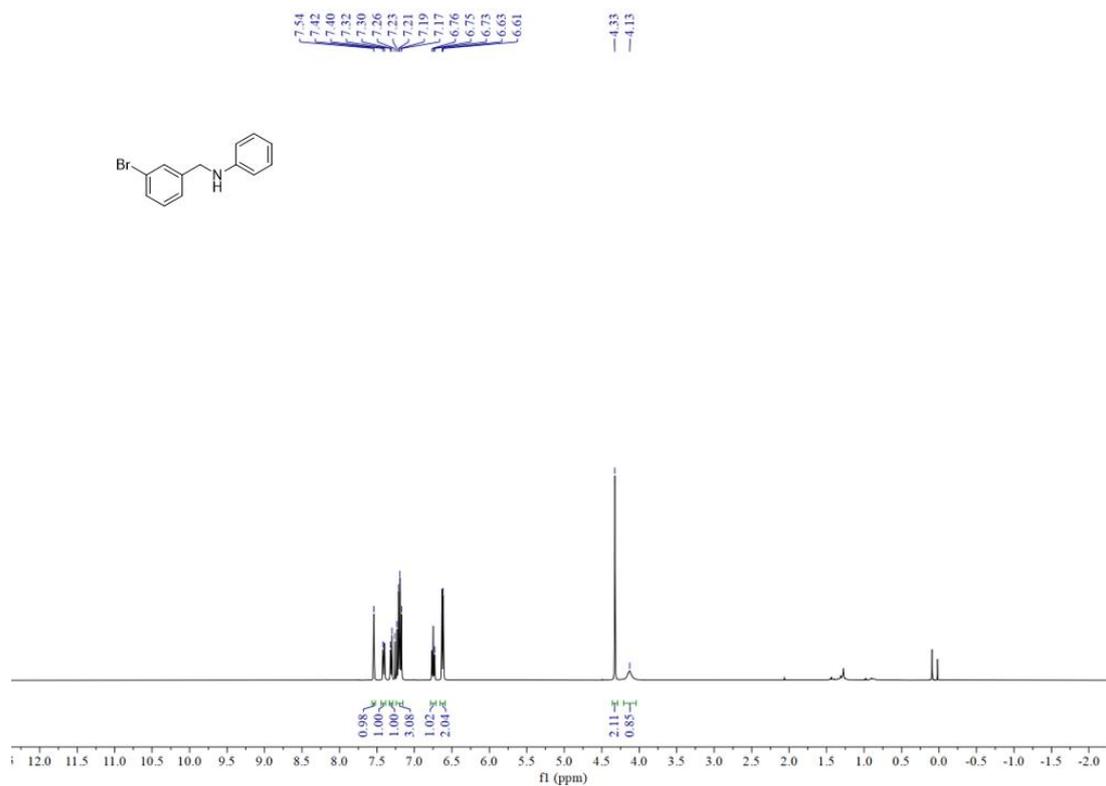


Figure S152. ^1H NMR (400 MHz, CDCl_3) spectrum of 4d

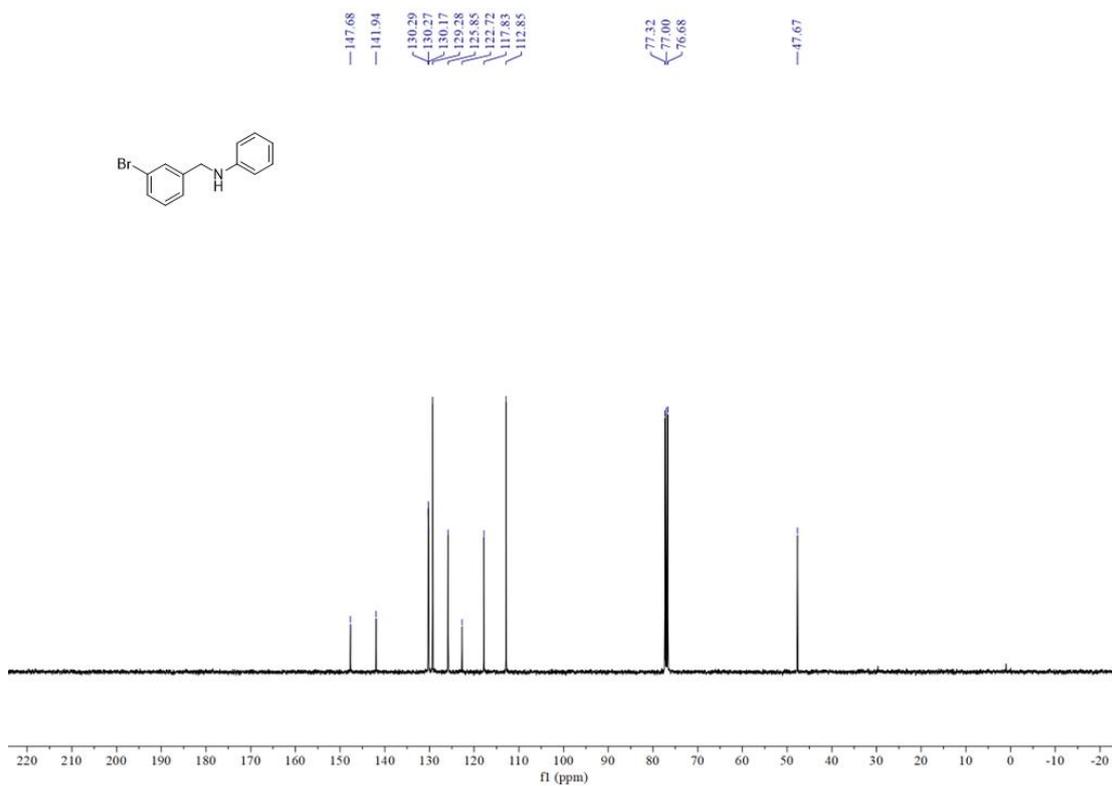


Figure S153. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4d

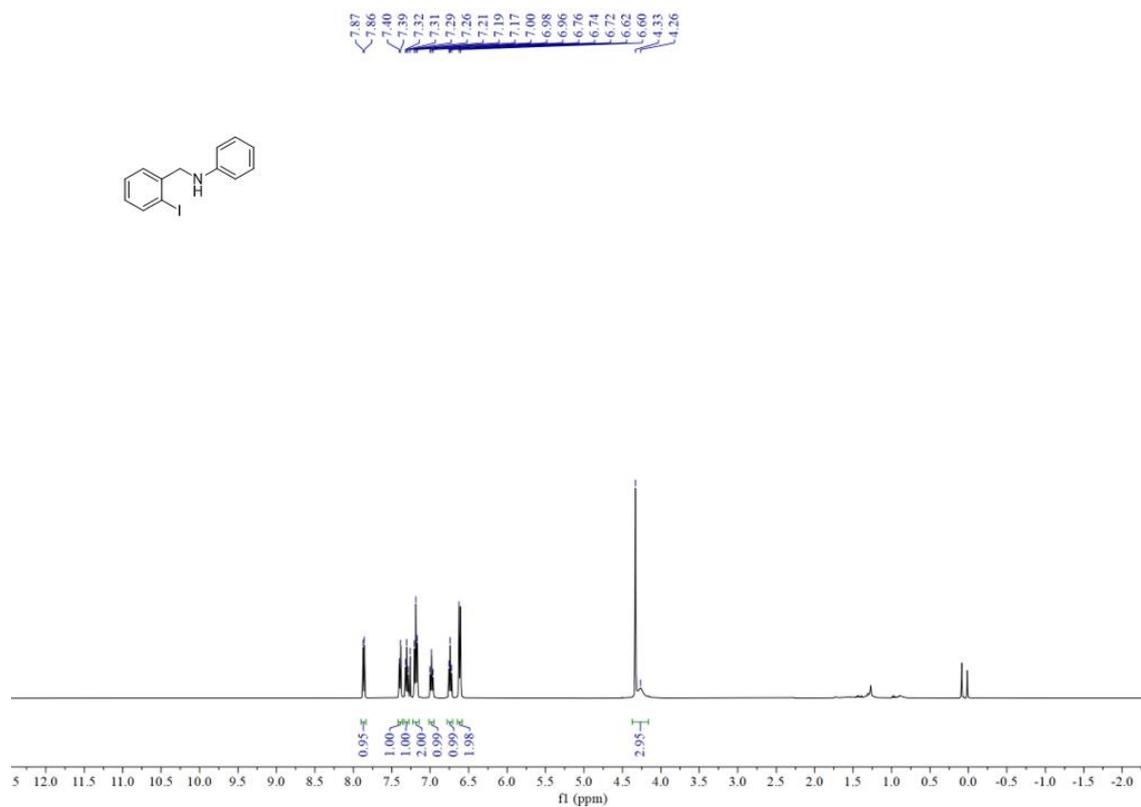


Figure S154. ^1H NMR (400 MHz, CDCl_3) spectrum of 4e

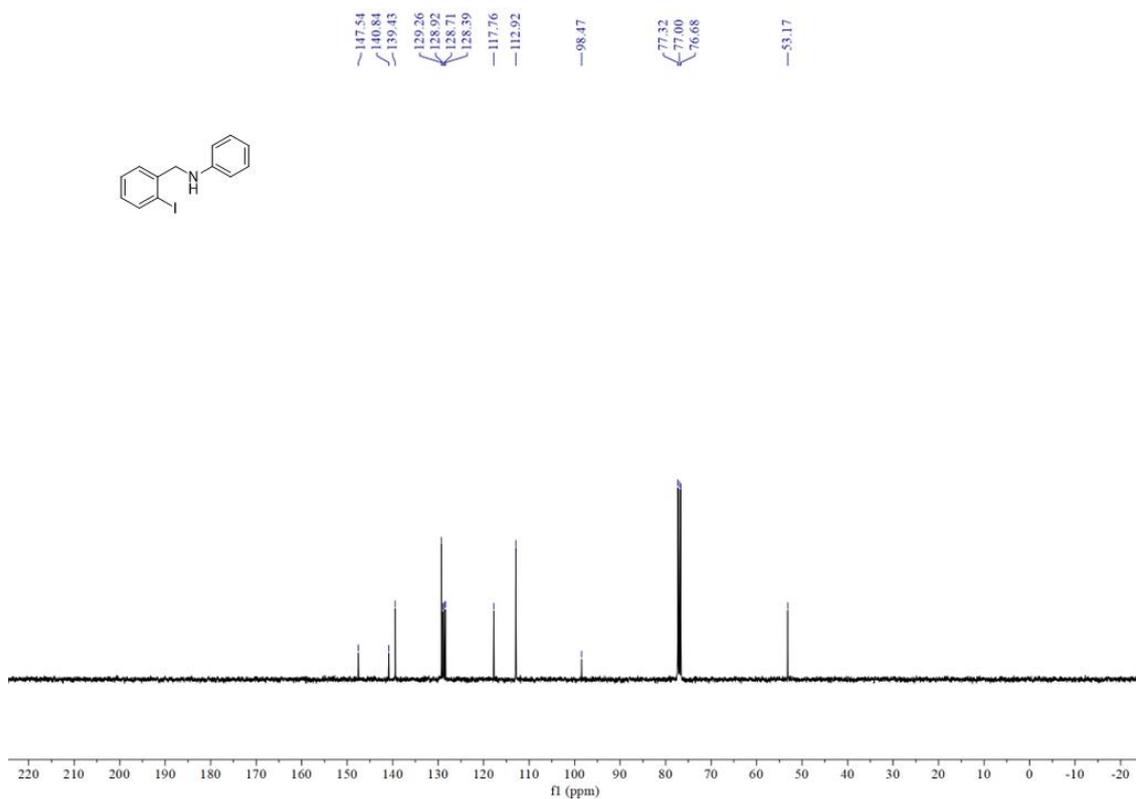


Figure S155. ¹³C NMR (100 MHz, CDCl₃) spectrum of 4e

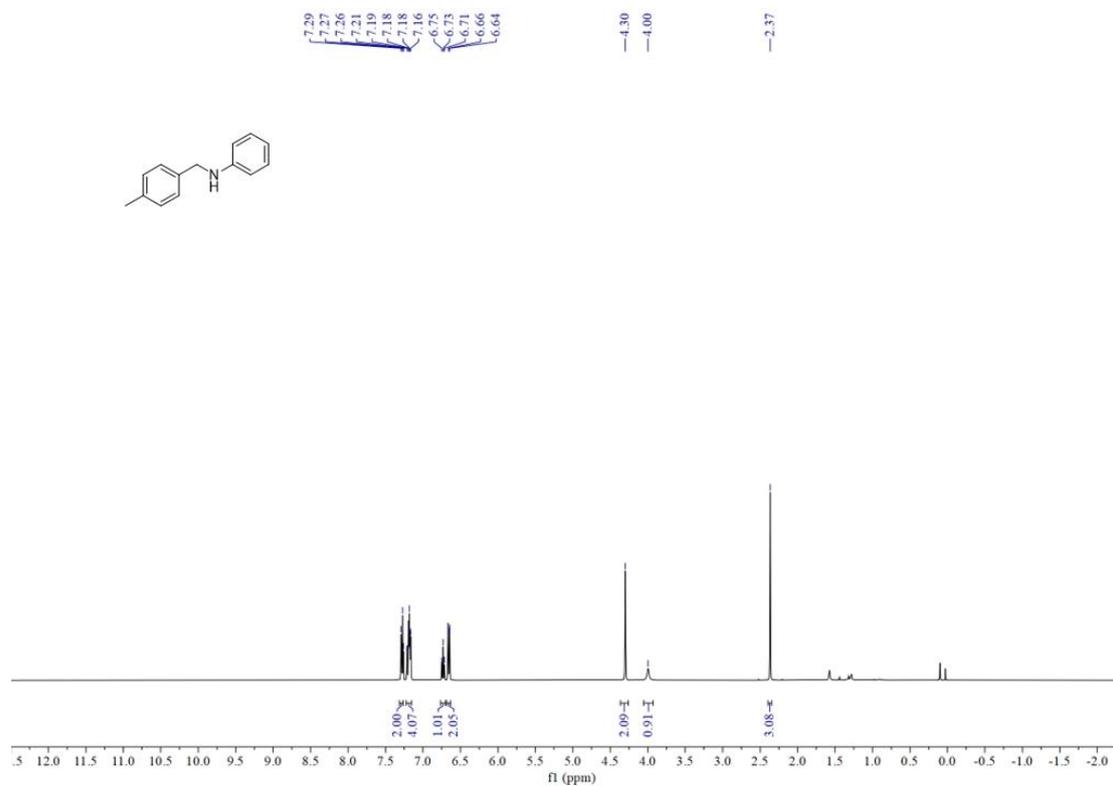


Figure S156. ¹H NMR (400 MHz, CDCl₃) spectrum of 4f

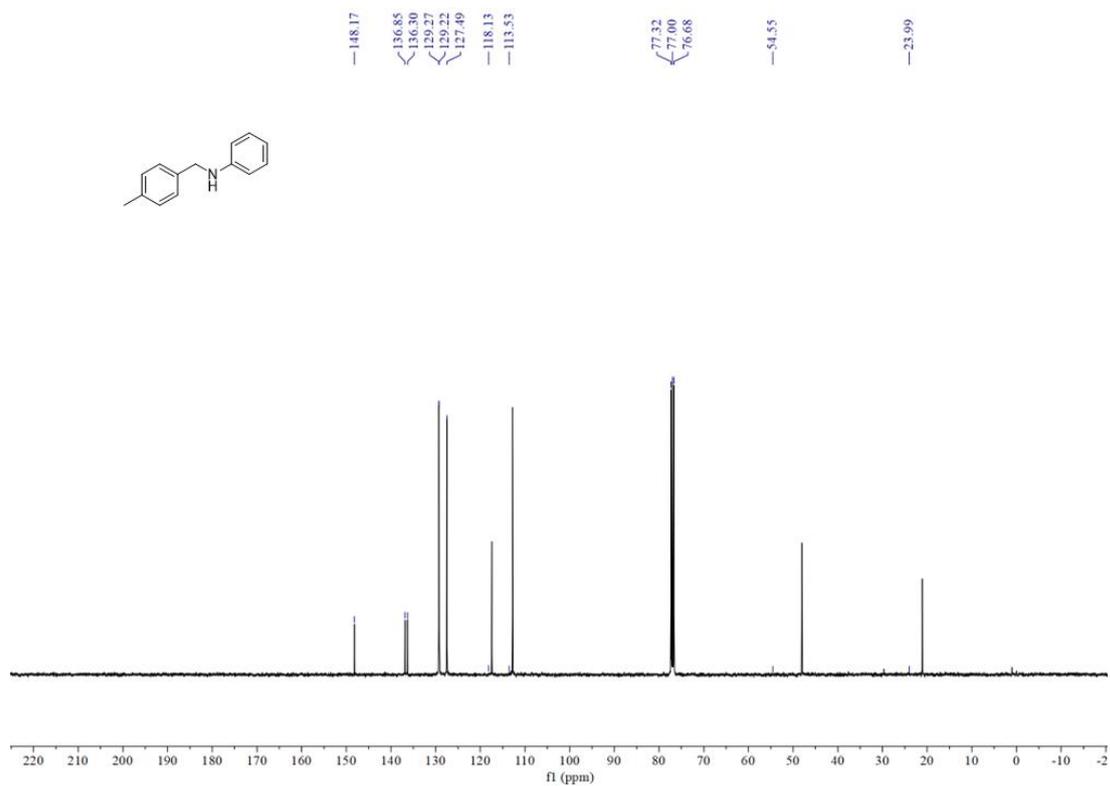


Figure S157. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4f

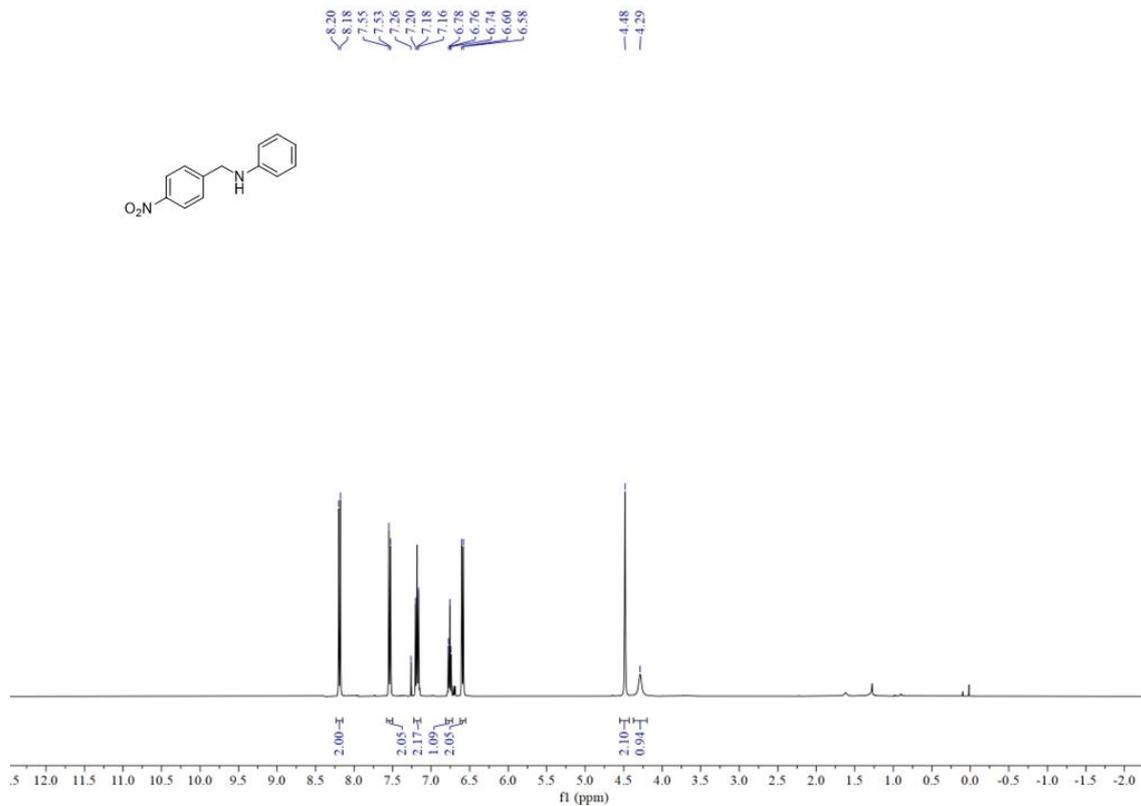


Figure S158. ^1H NMR (400 MHz, CDCl_3) spectrum of 4g

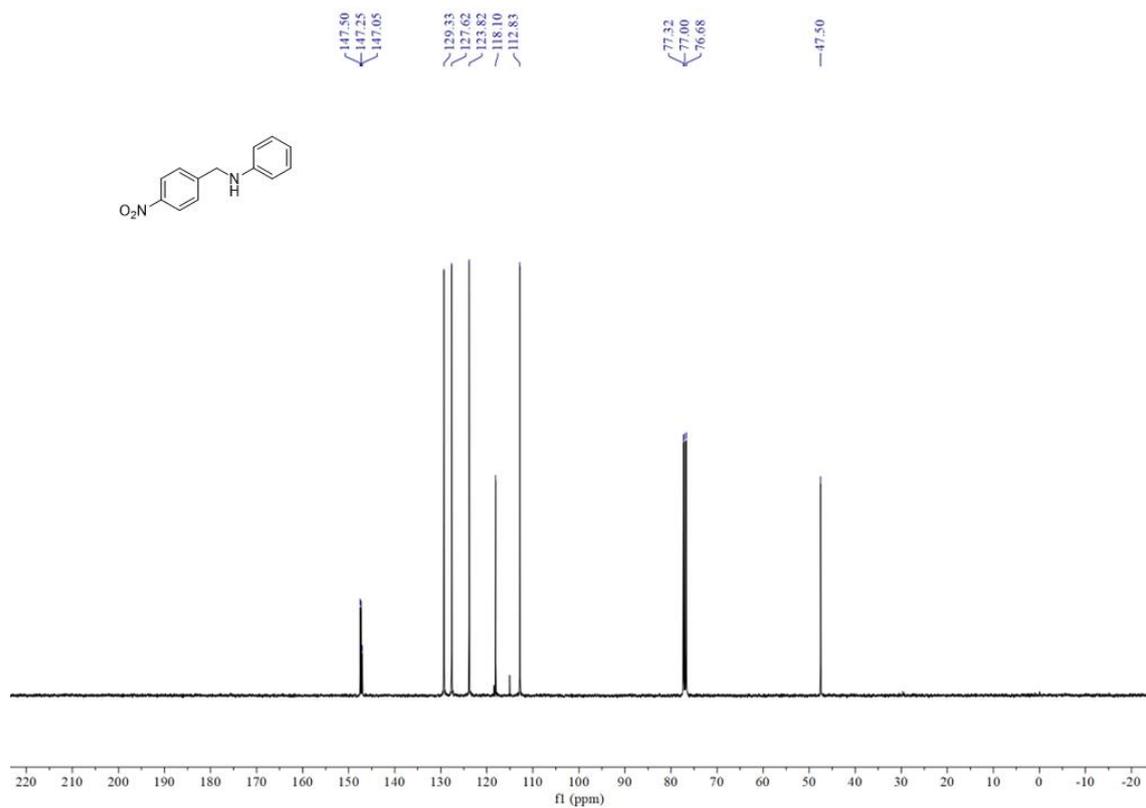


Figure S159. ¹³C NMR (100 MHz, CDCl₃) spectrum of 4g

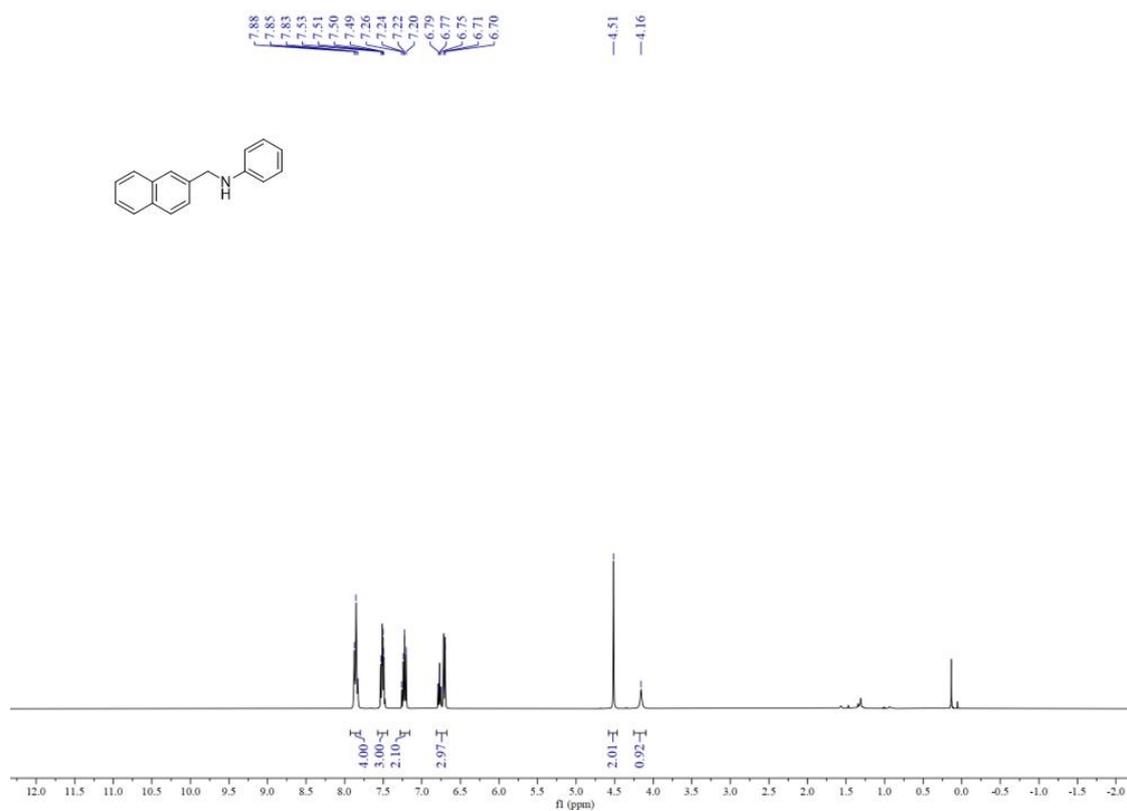


Figure S160. ¹H NMR (400 MHz, CDCl₃) spectrum of 4h

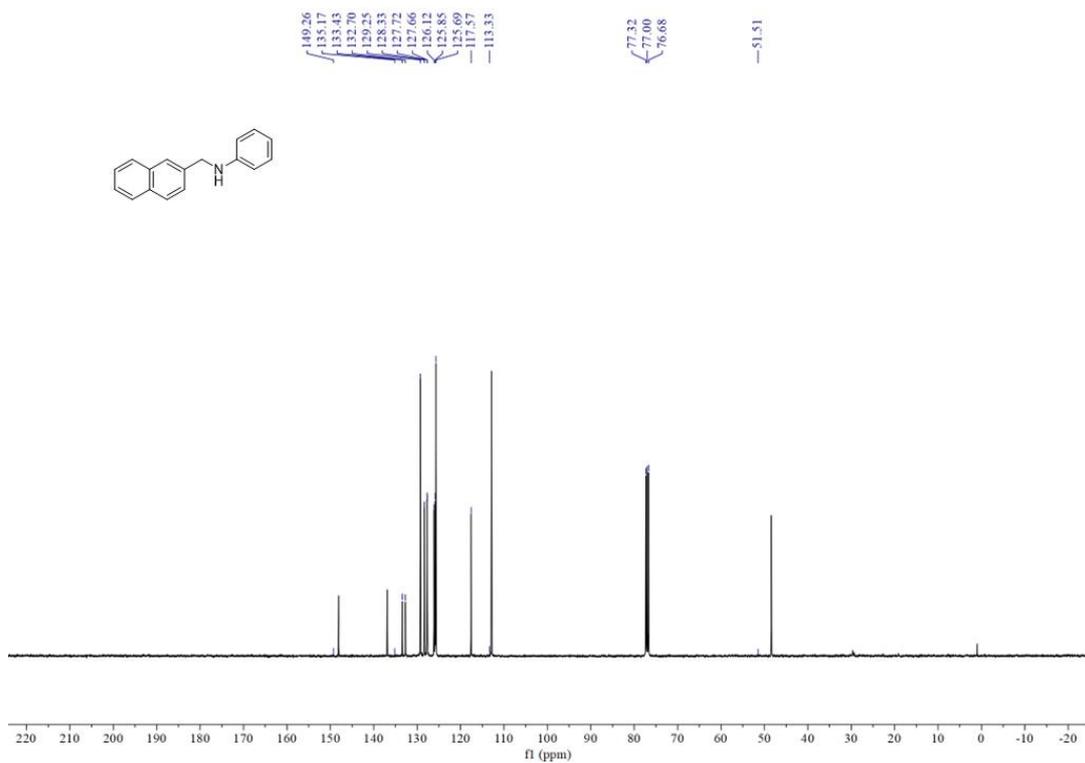


Figure S161. ¹³C NMR (100 MHz, CDCl₃) spectrum of 4h

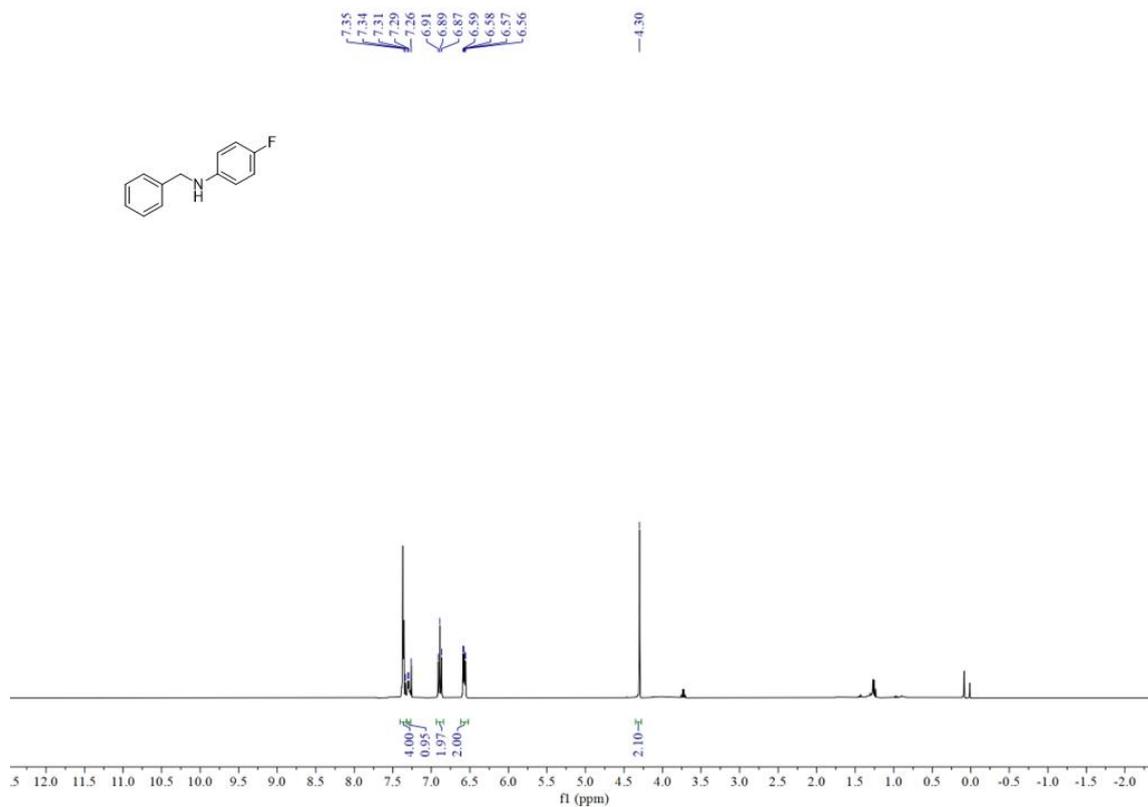


Figure S162. ¹H NMR (400 MHz, CDCl₃) spectrum of 4i

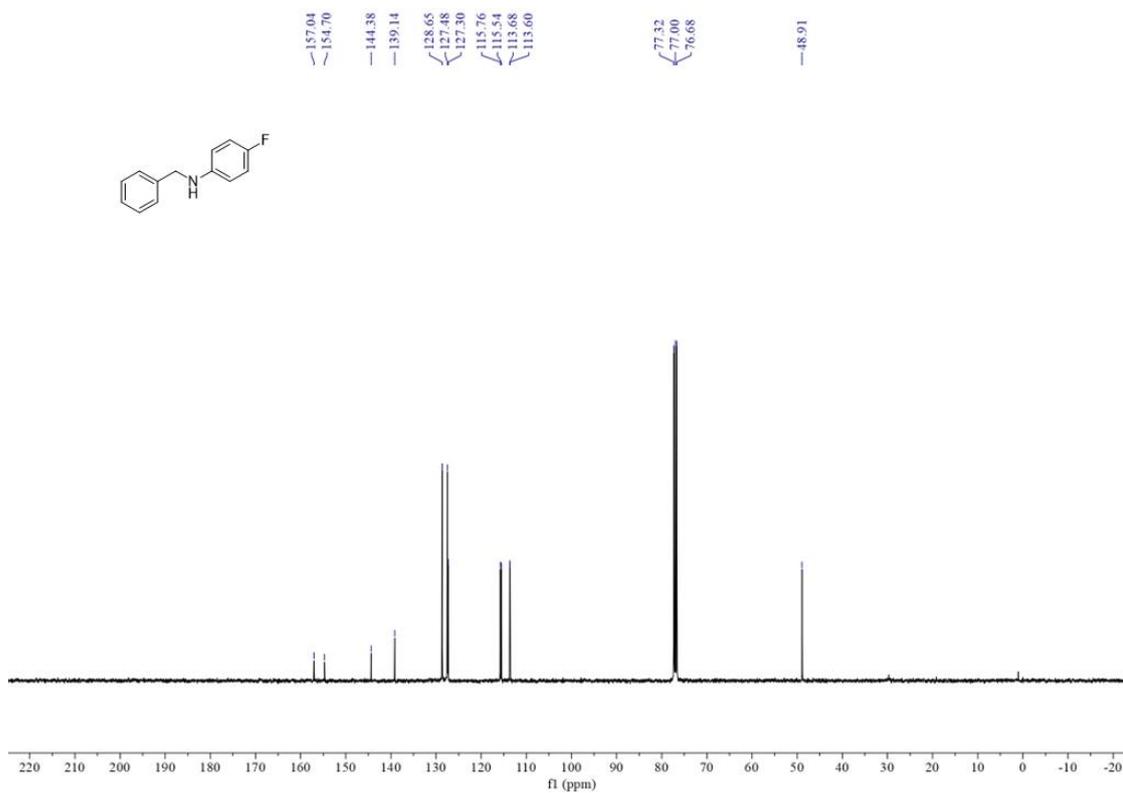


Figure S163. ¹³C NMR (100 MHz, CDCl₃) spectrum of **4i**

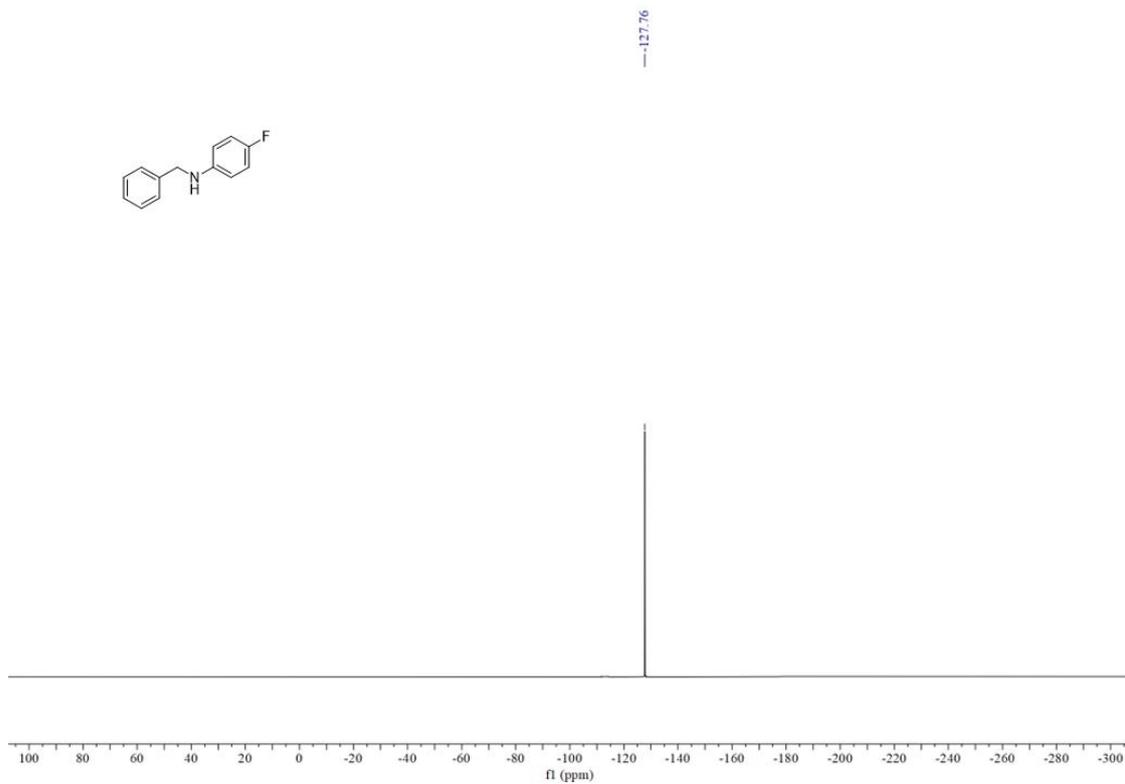


Figure S164. ¹⁹F NMR (100 MHz, CDCl₃) spectrum of **4i**

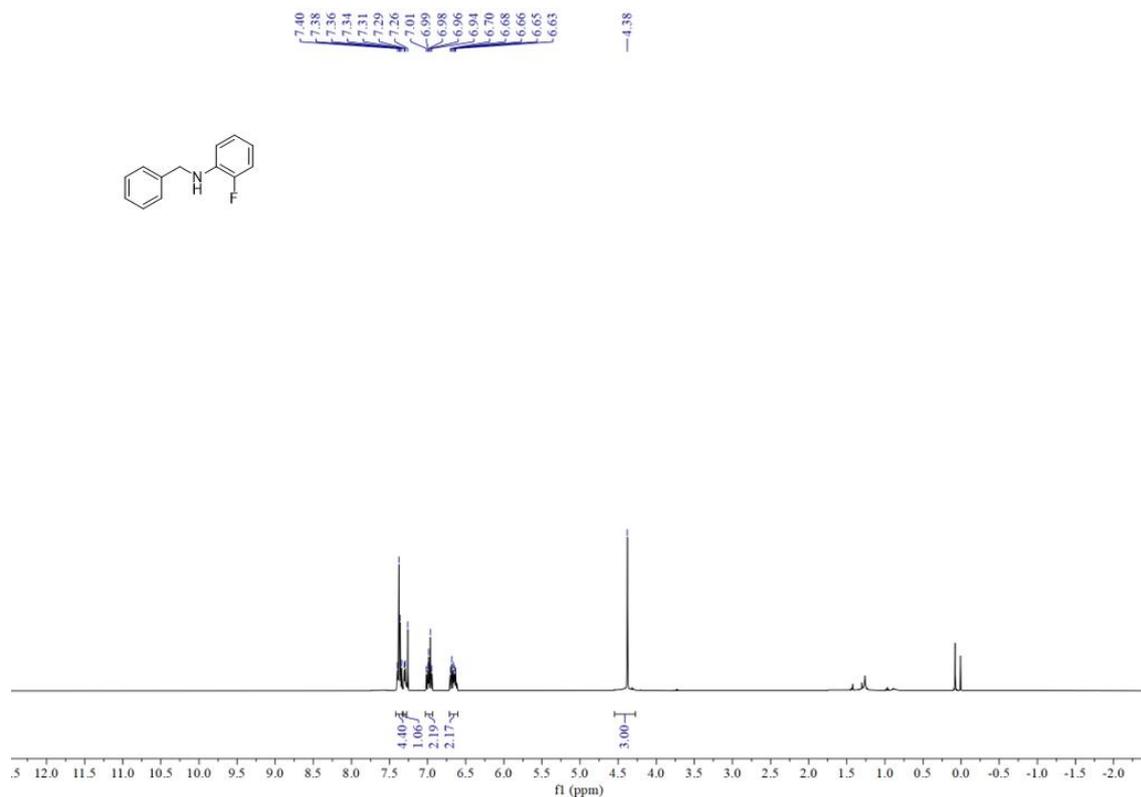


Figure S165. ¹H NMR (400 MHz, CDCl₃) spectrum of 4j

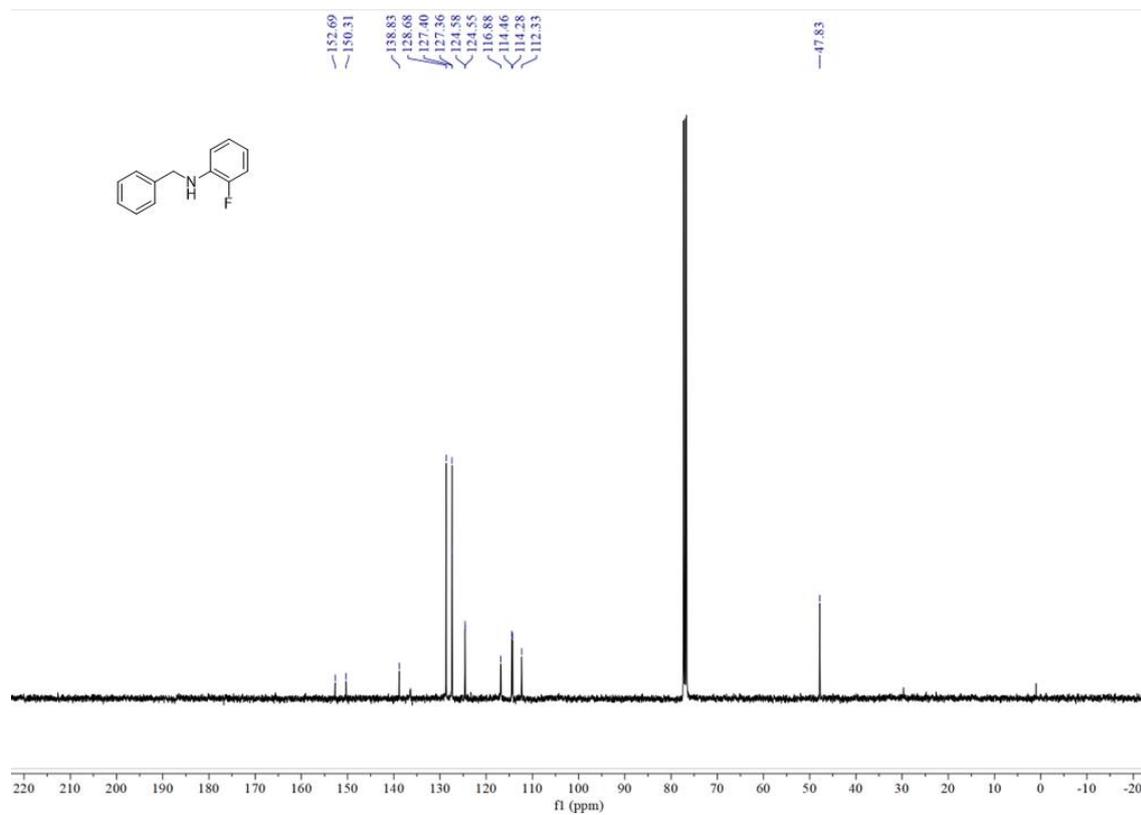


Figure S166. ¹³C NMR (100 MHz, CDCl₃) spectrum of 4j

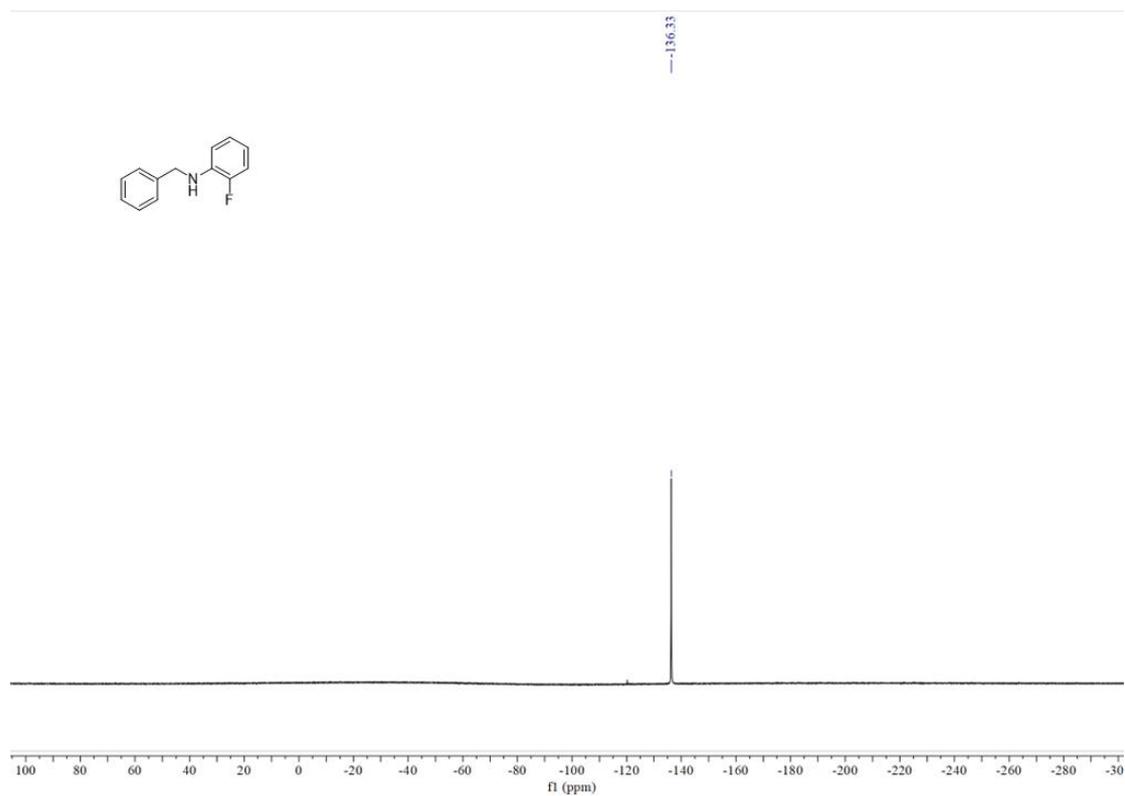


Figure S167. ^{19}F NMR (100 MHz, CDCl_3) spectrum of 4j

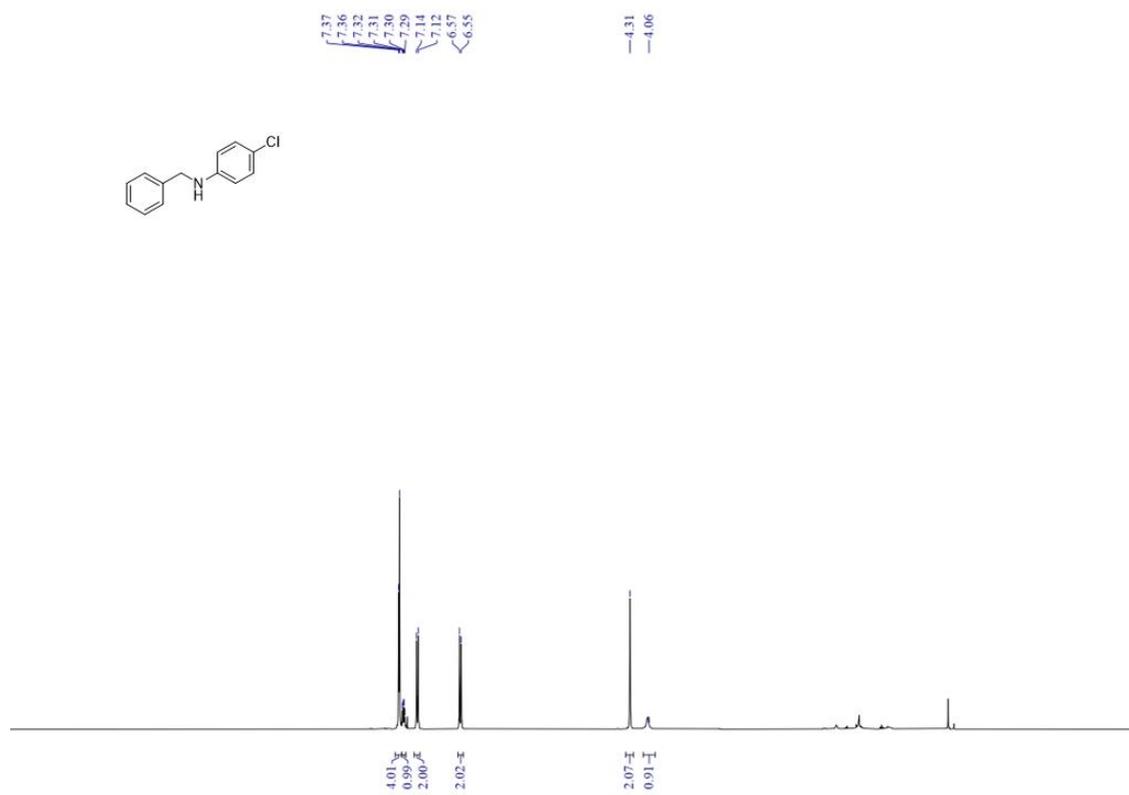


Figure S168. ^1H NMR (400 MHz, CDCl_3) spectrum of 4k

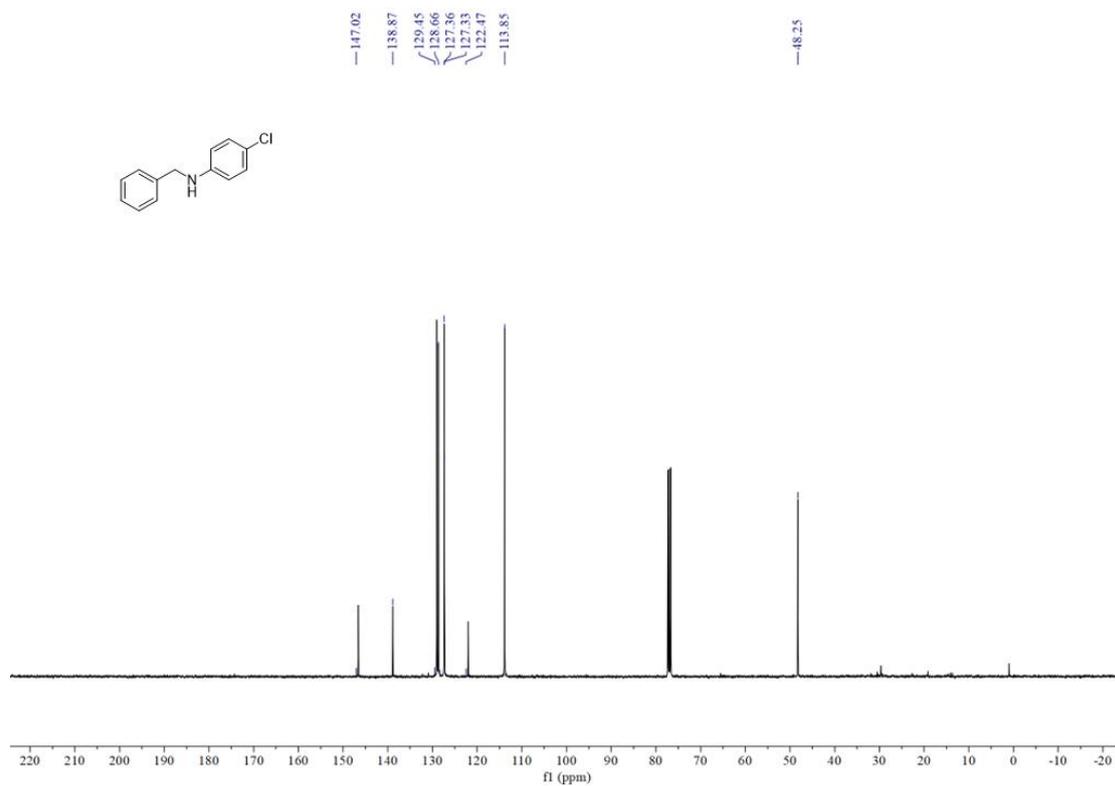


Figure S169. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4k

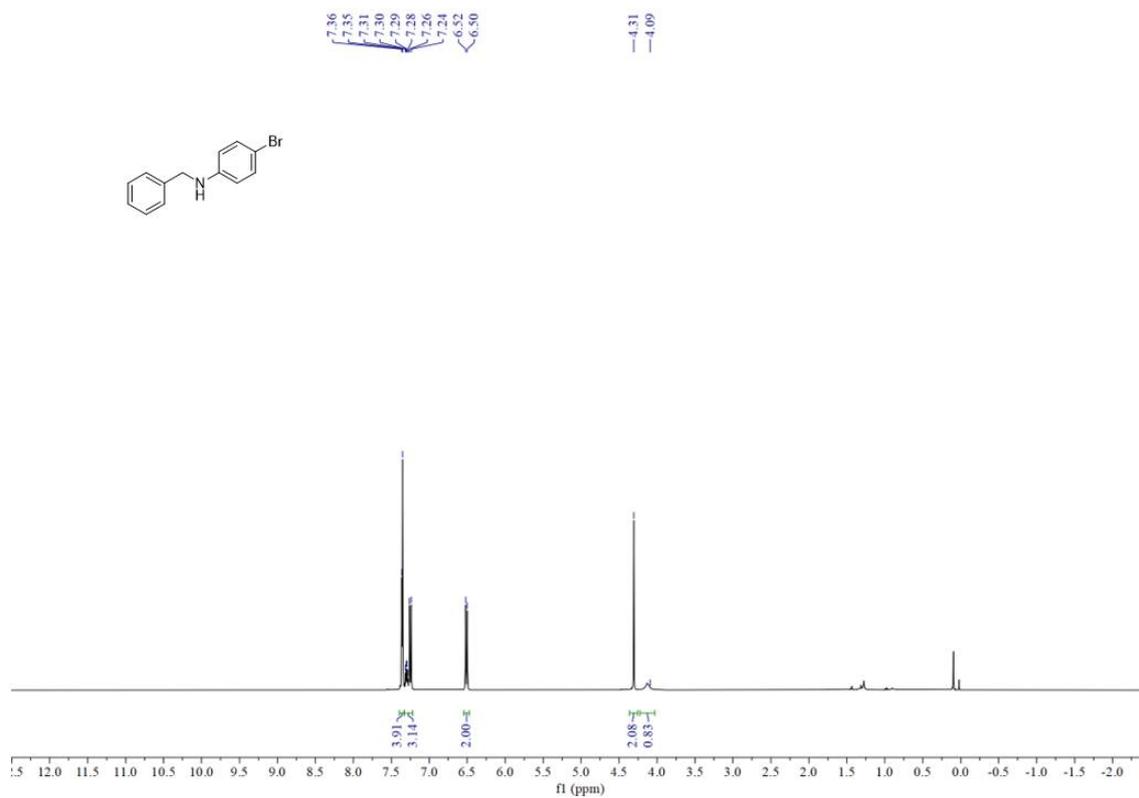


Figure S170. ^1H NMR (400 MHz, CDCl_3) spectrum of 4l

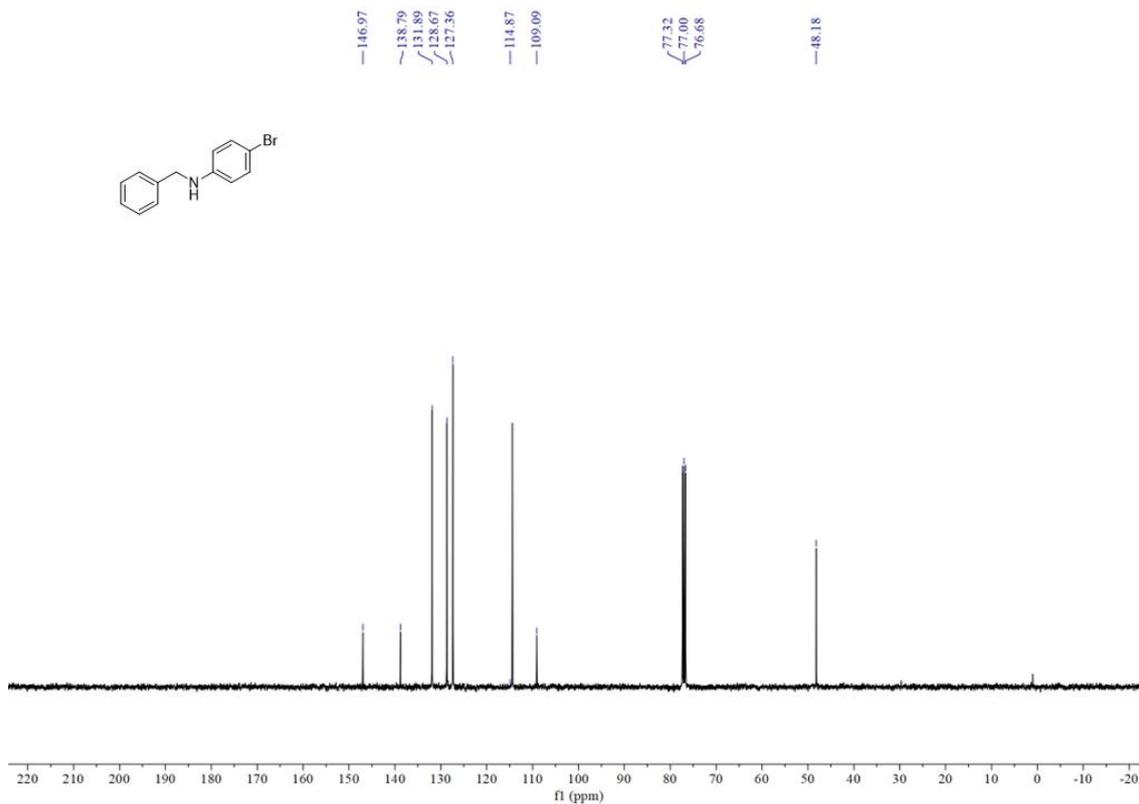


Figure S171. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4l

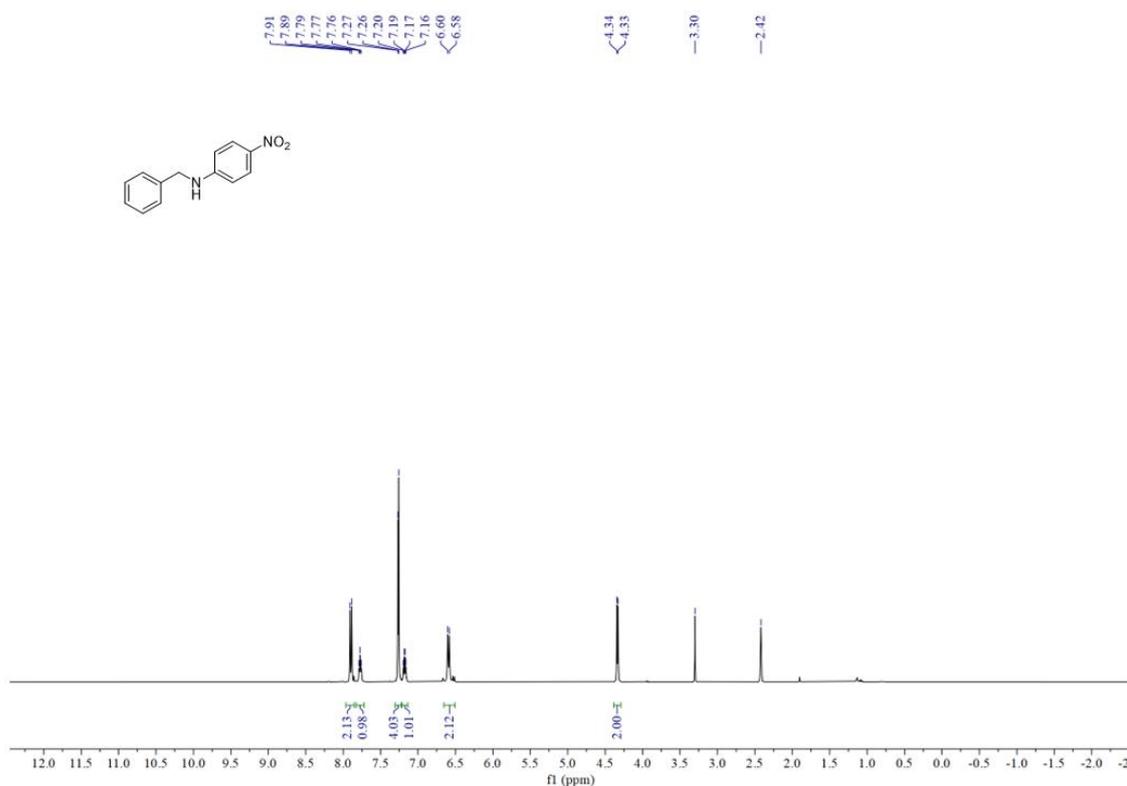


Figure S172. ^1H NMR (400 MHz, $\text{DMSO}-d_6$) spectrum of 4m

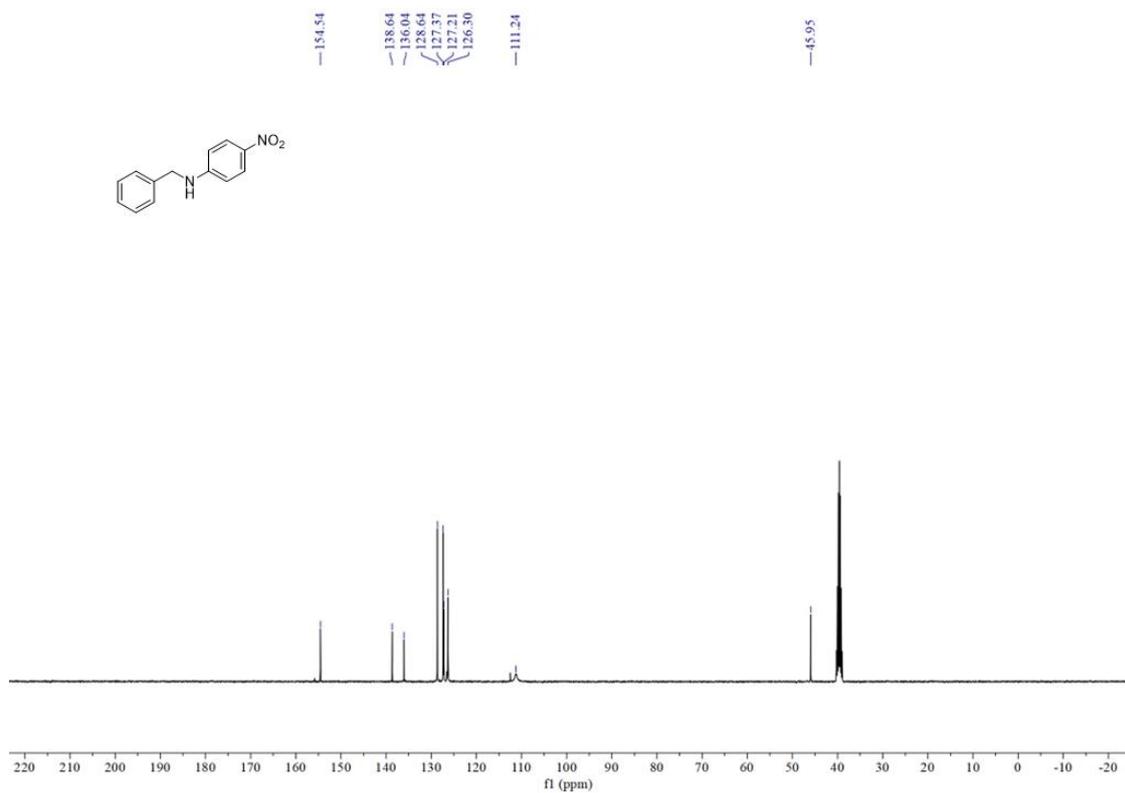


Figure S173. ¹³C NMR (100 MHz, DMSO-*d*₆) spectrum of 4m

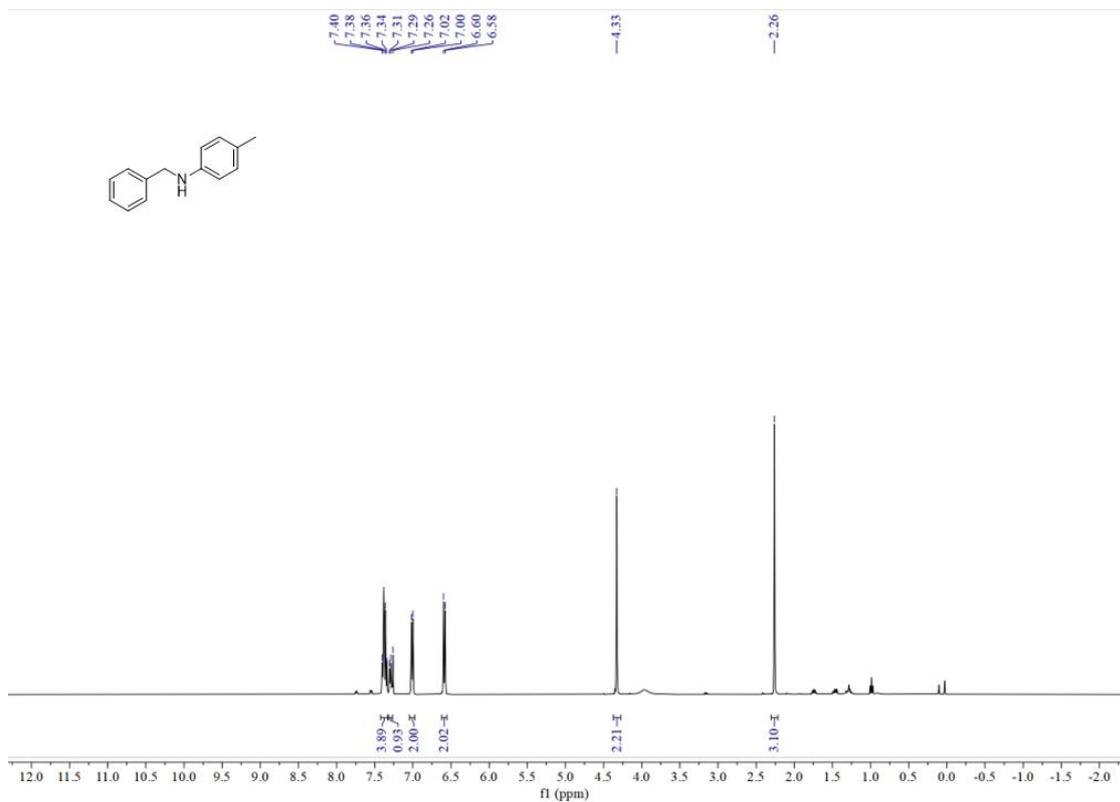


Figure S174. ¹H NMR (400 MHz, CDCl₃) spectrum of 4n

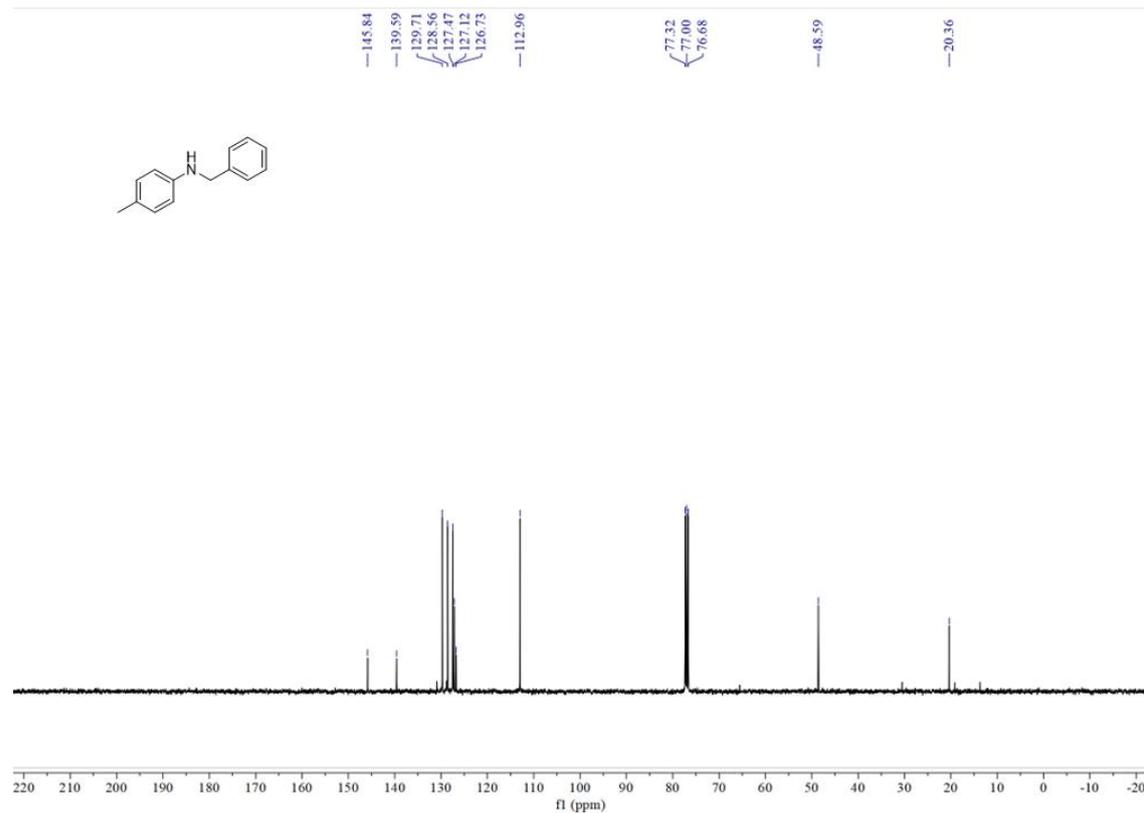


Figure S175. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4n

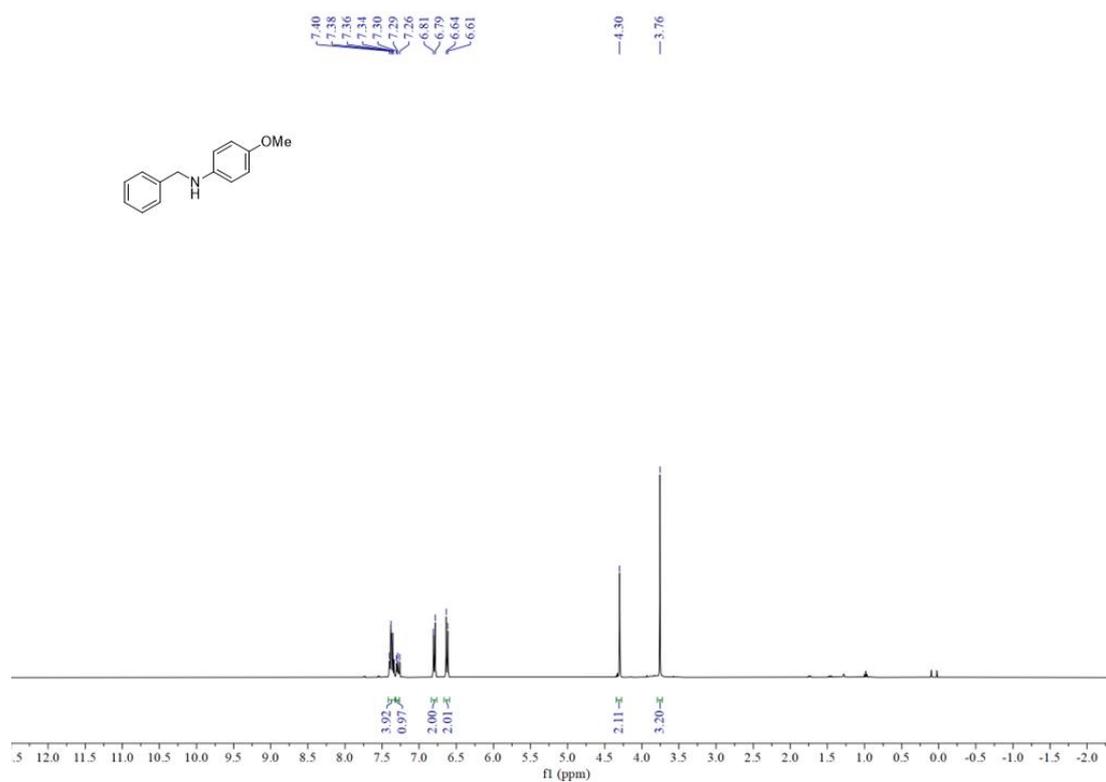


Figure S176. ^1H NMR (400 MHz, CDCl_3) spectrum of 4o

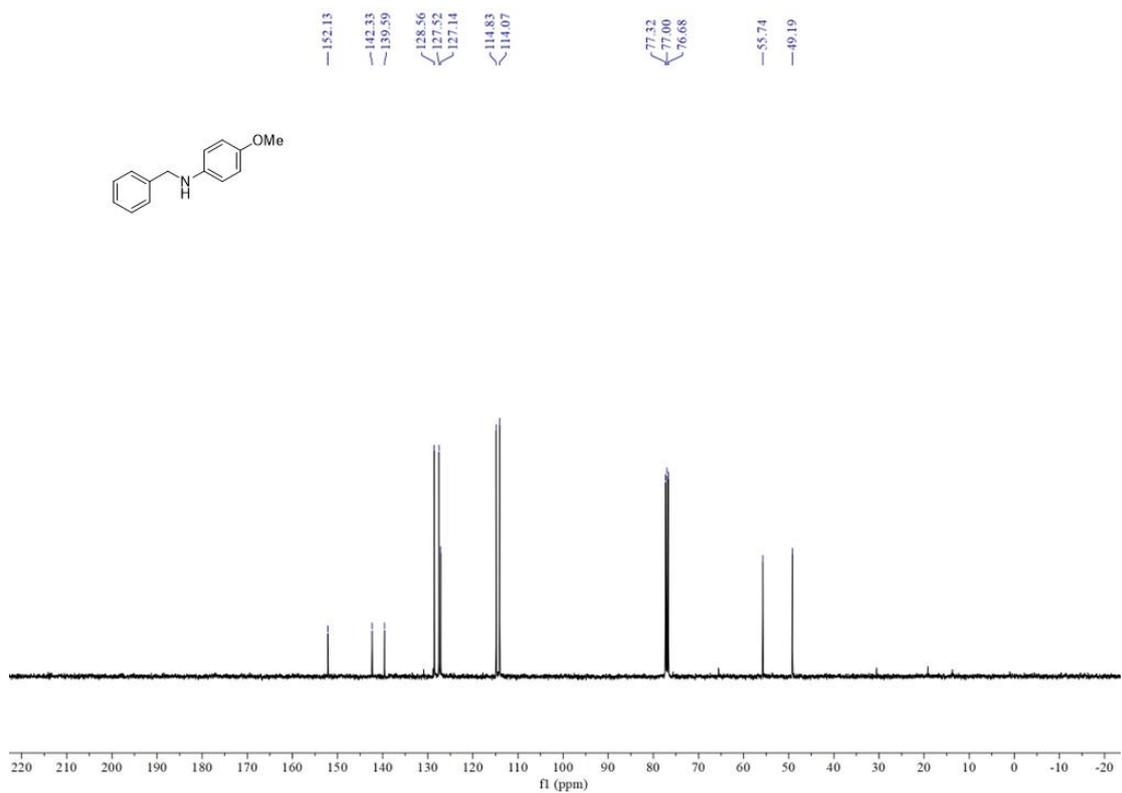


Figure S177. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **4o**

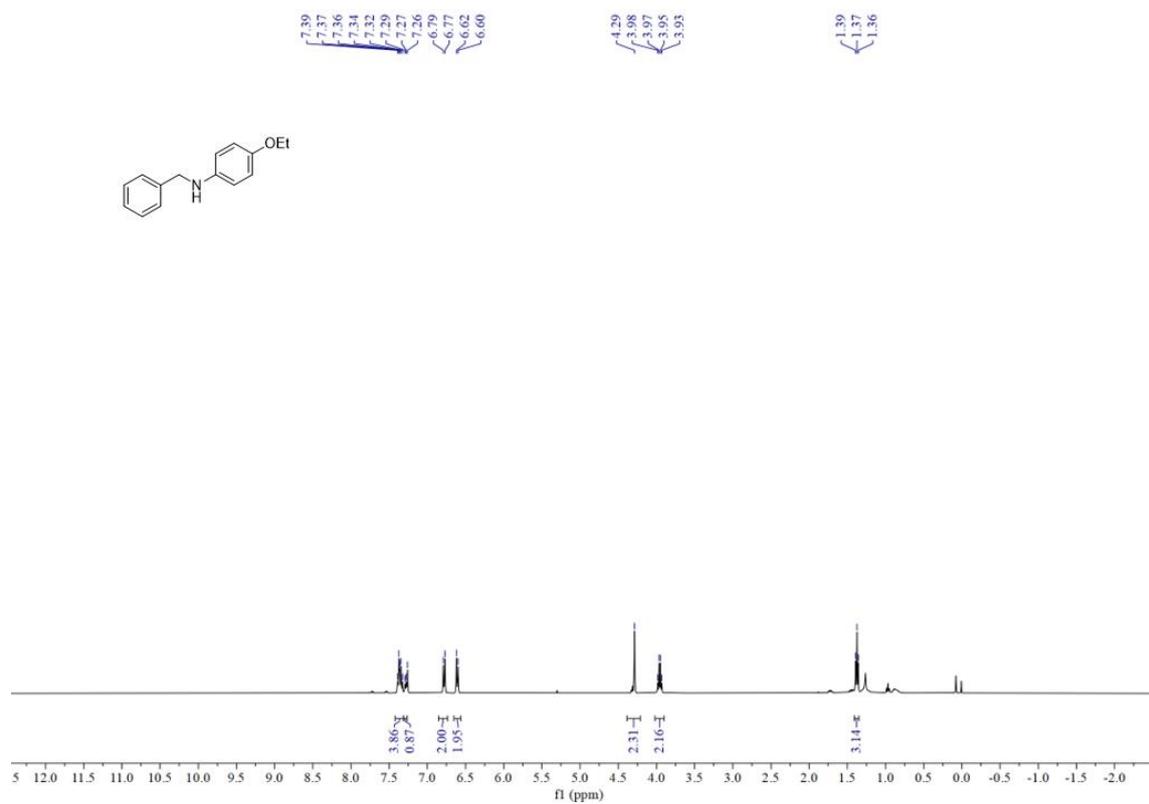


Figure S178. ^1H NMR (400 MHz, CDCl_3) spectrum of **4p**

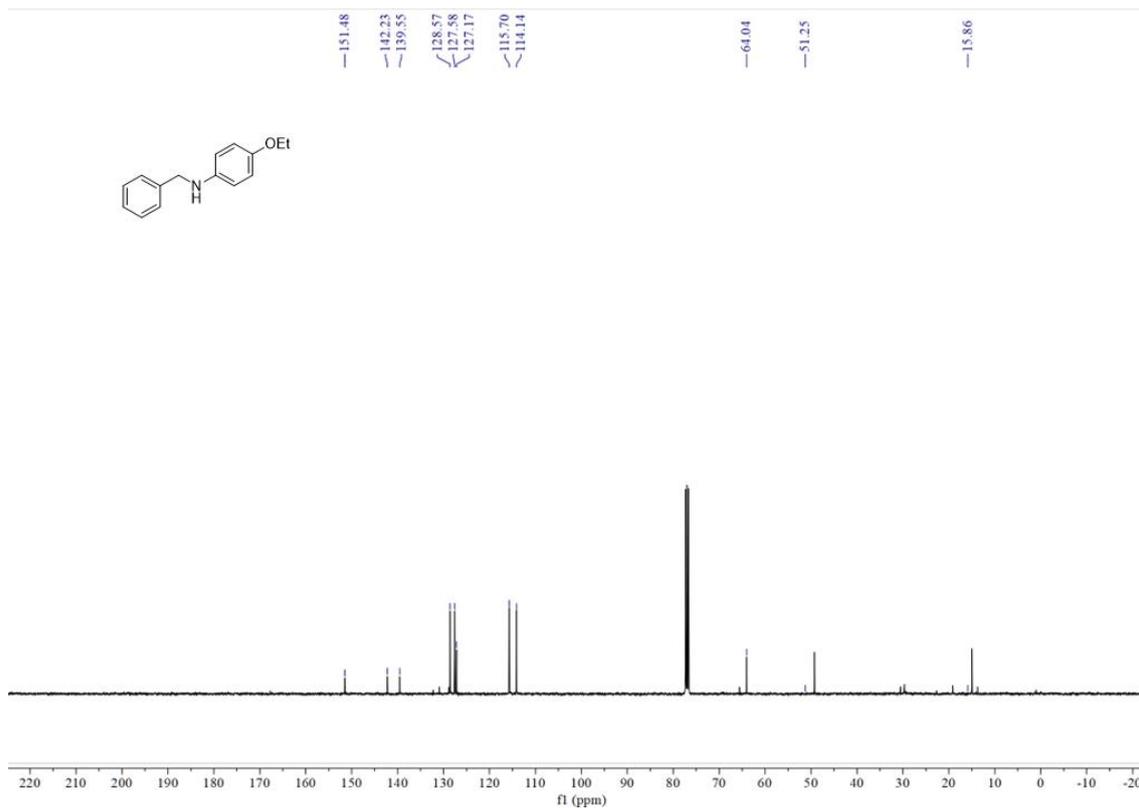


Figure S179. ¹³C NMR (100 MHz, CDCl₃) spectrum of 4p

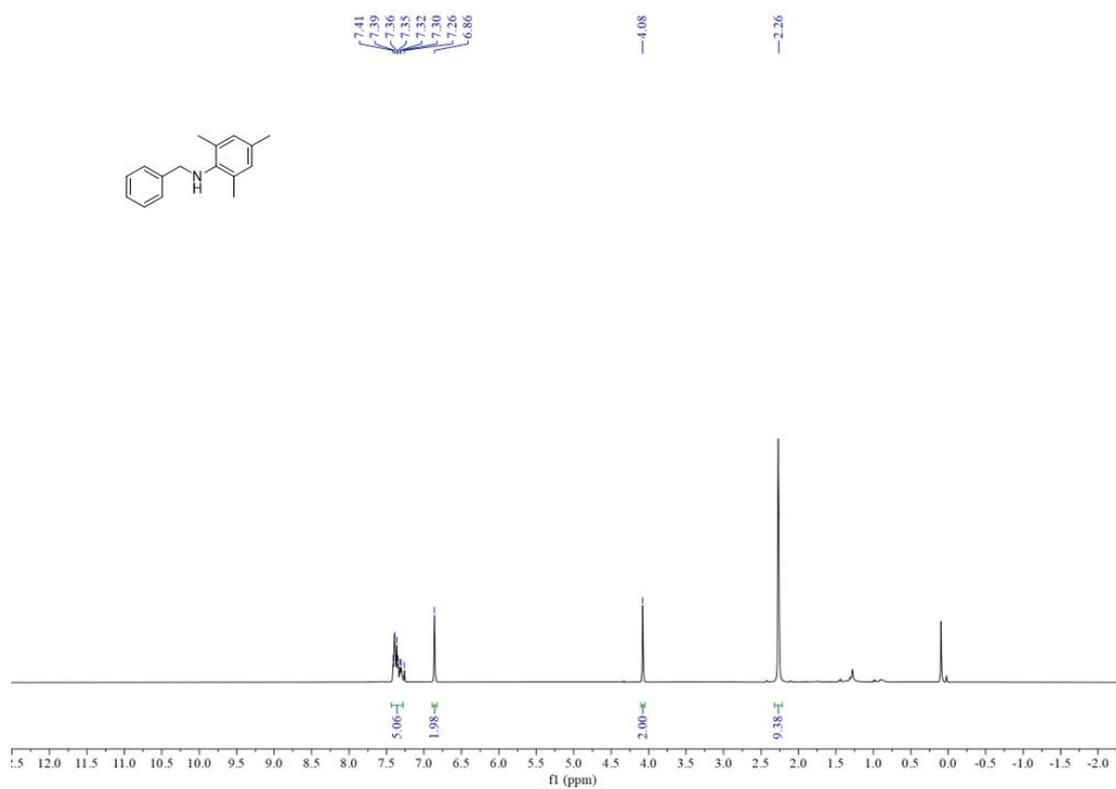


Figure S180. ¹H NMR (400 MHz, CDCl₃) spectrum of 4q

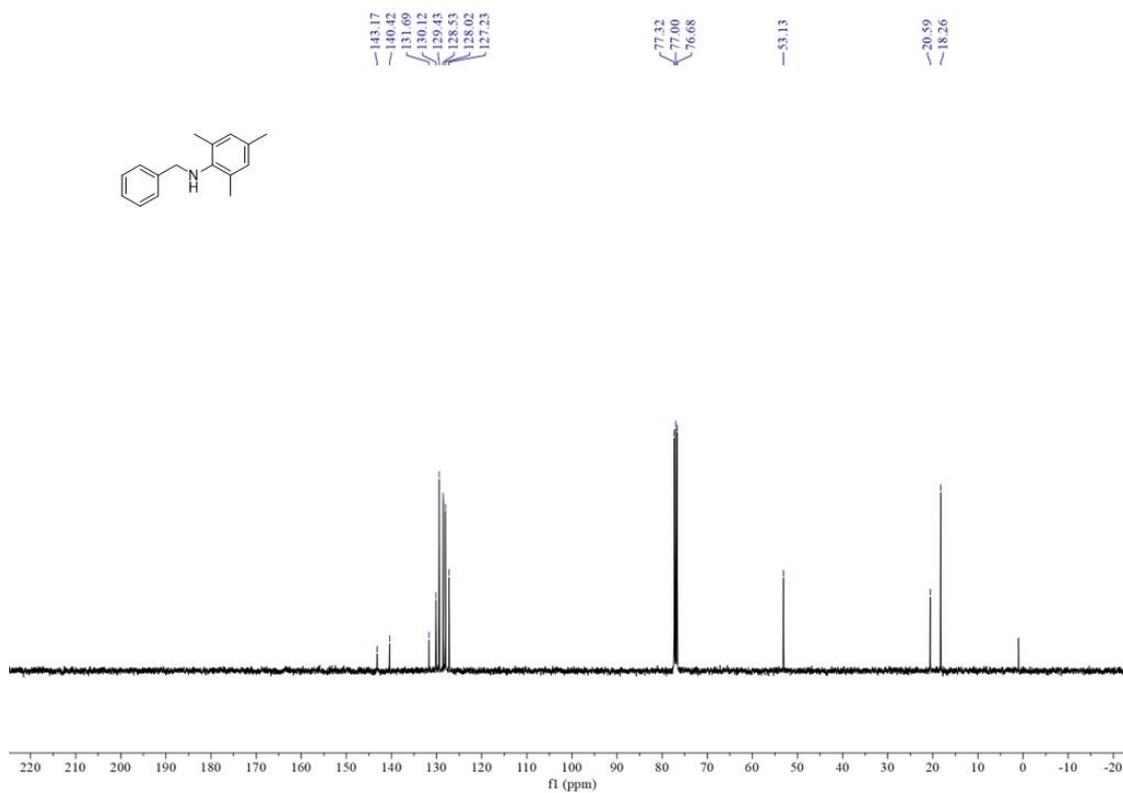


Figure S181. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4q

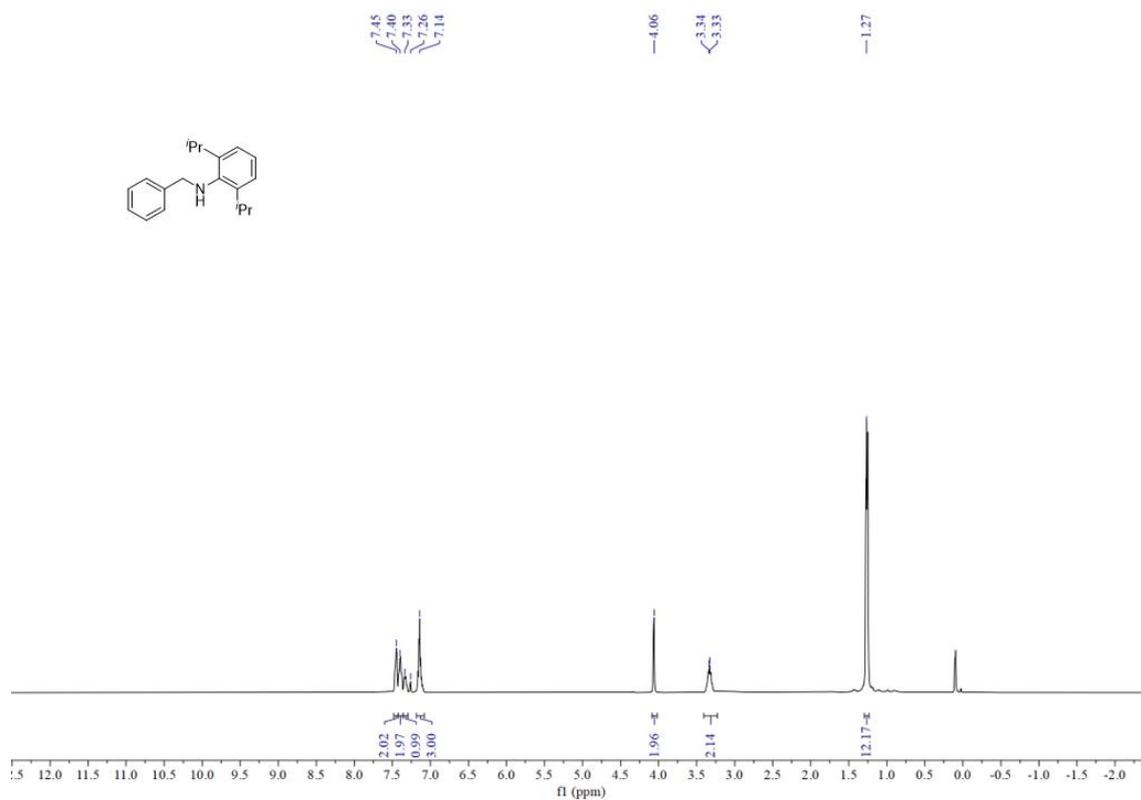


Figure S182. ^1H NMR (400 MHz, CDCl_3) spectrum of 4r

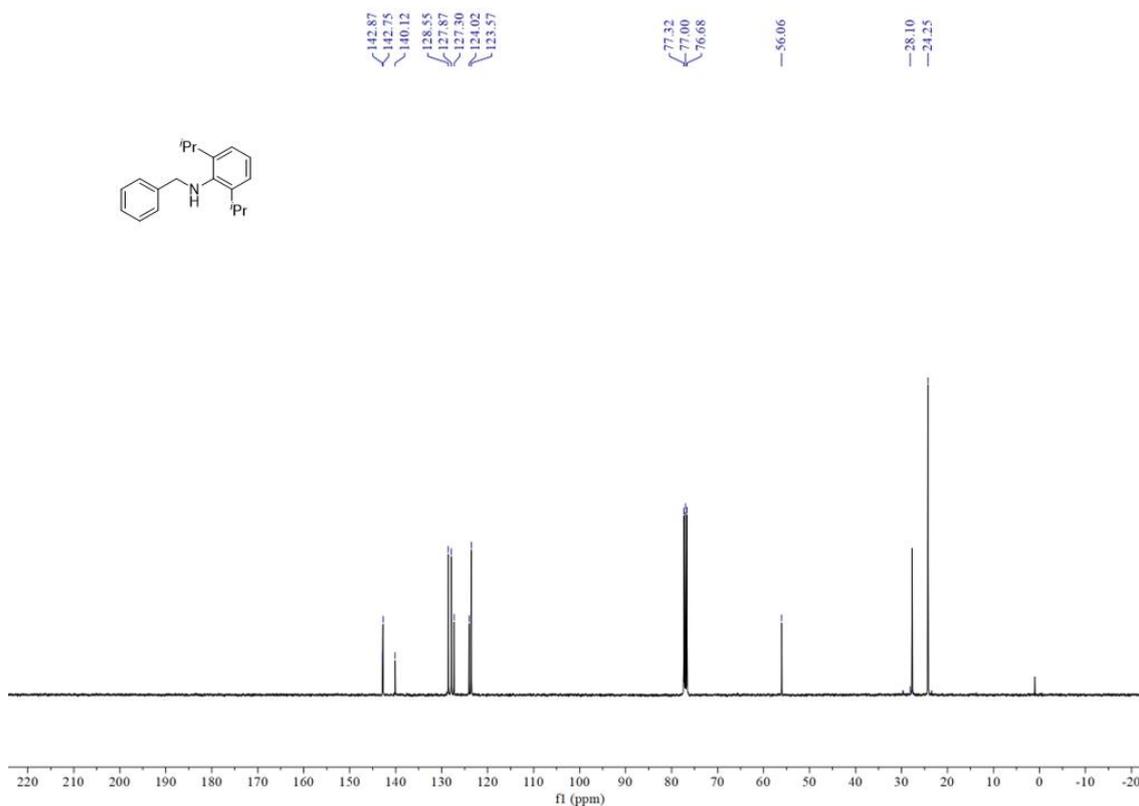


Figure S183. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4r

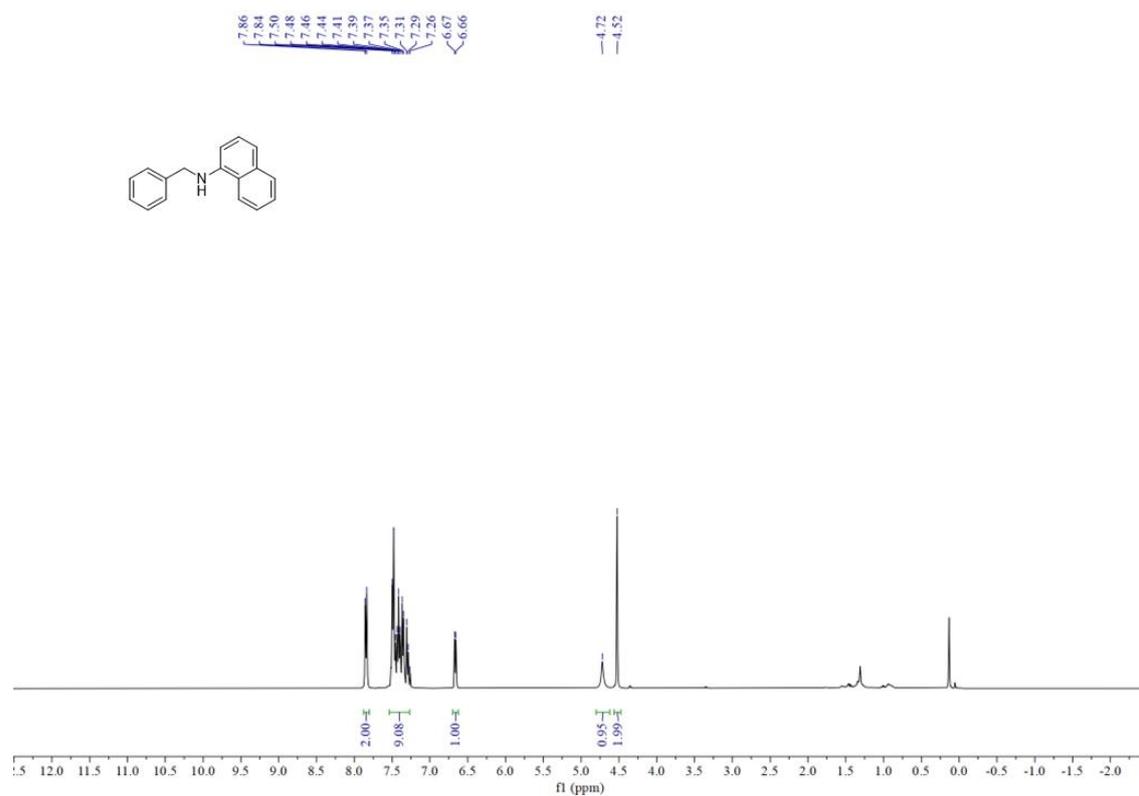


Figure S184. ^1H NMR (400 MHz, CDCl_3) spectrum of 4s

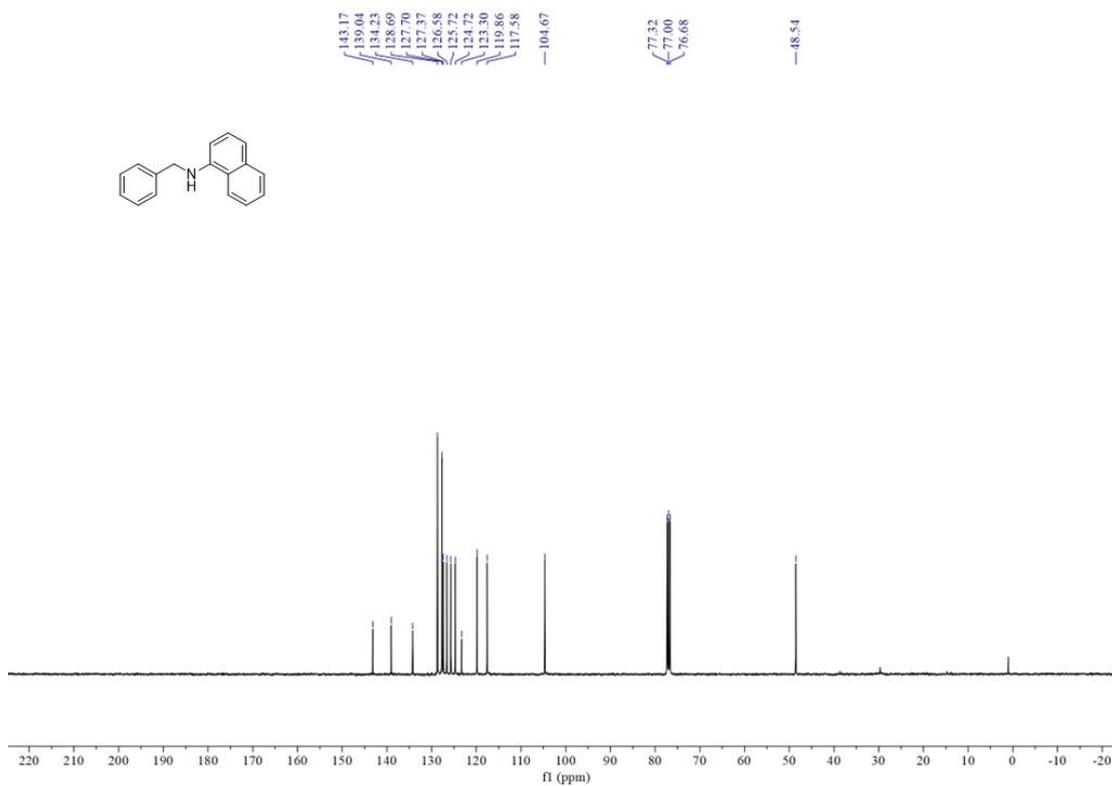


Figure S185. ¹³C NMR (100 MHz, CDCl₃) spectrum of 4s

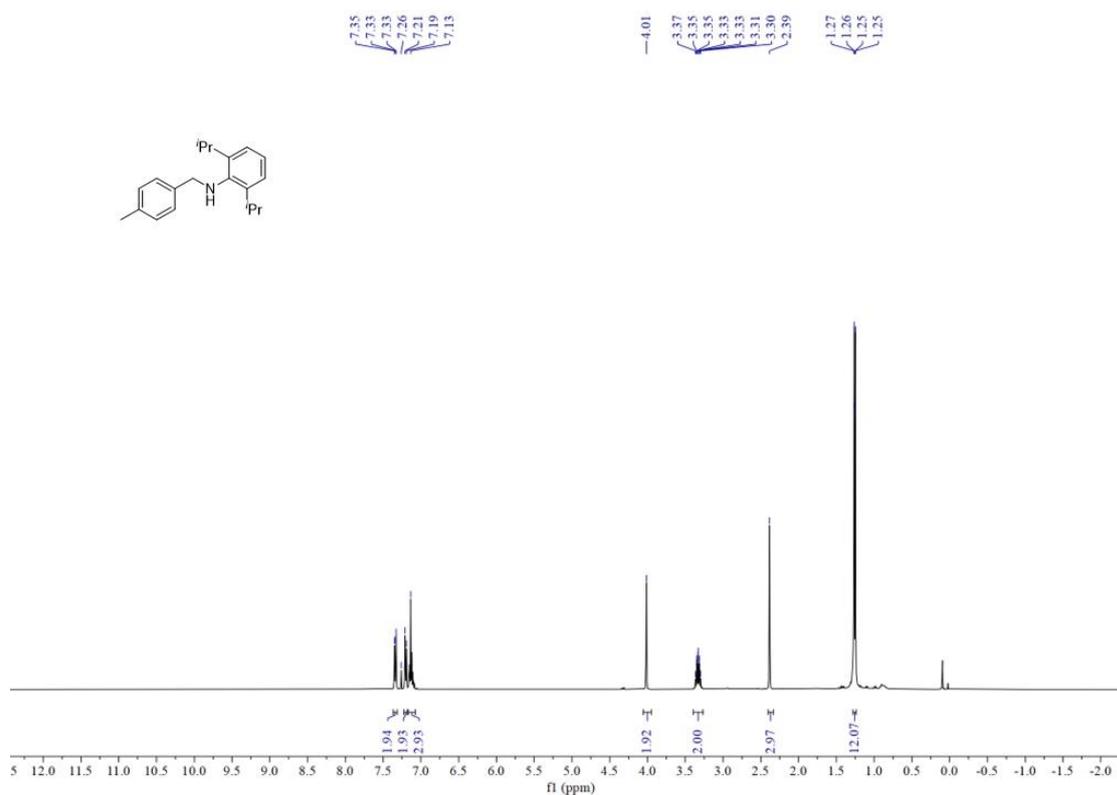


Figure S186. ¹H NMR (400 MHz, CDCl₃) spectrum of 4t

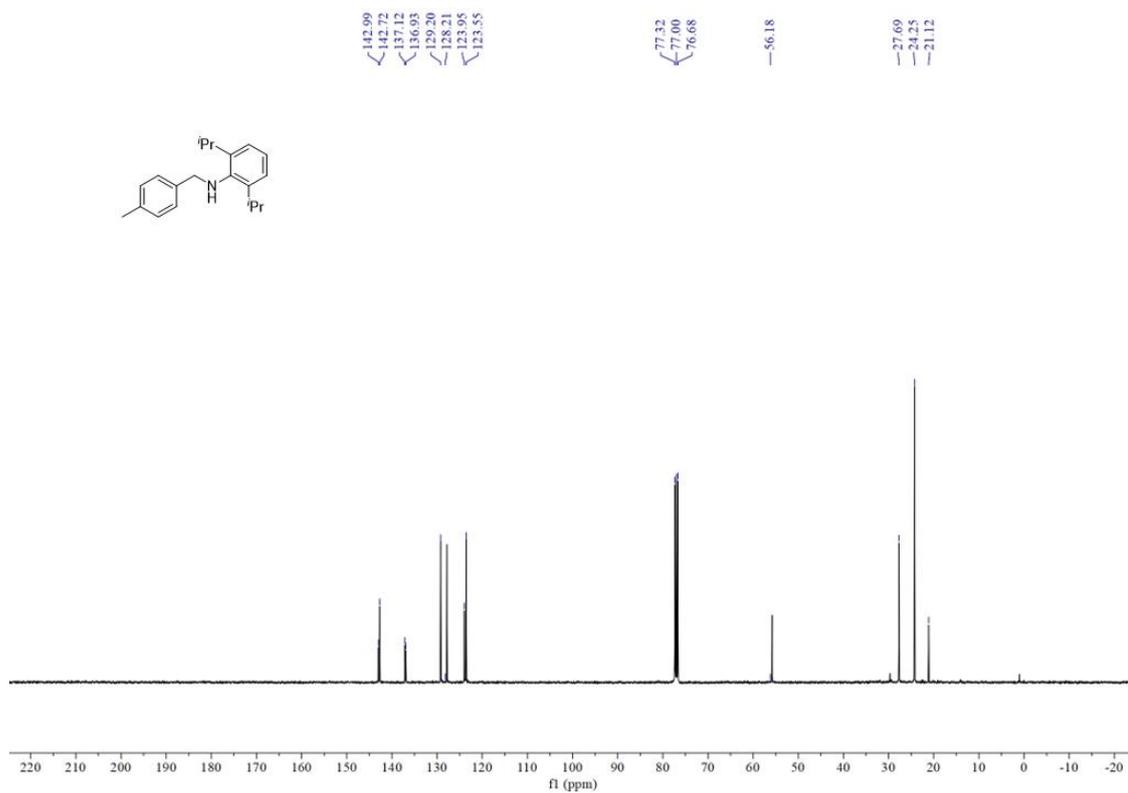


Figure S187. ¹³C NMR (100 MHz, CDCl₃) spectrum of **4t**

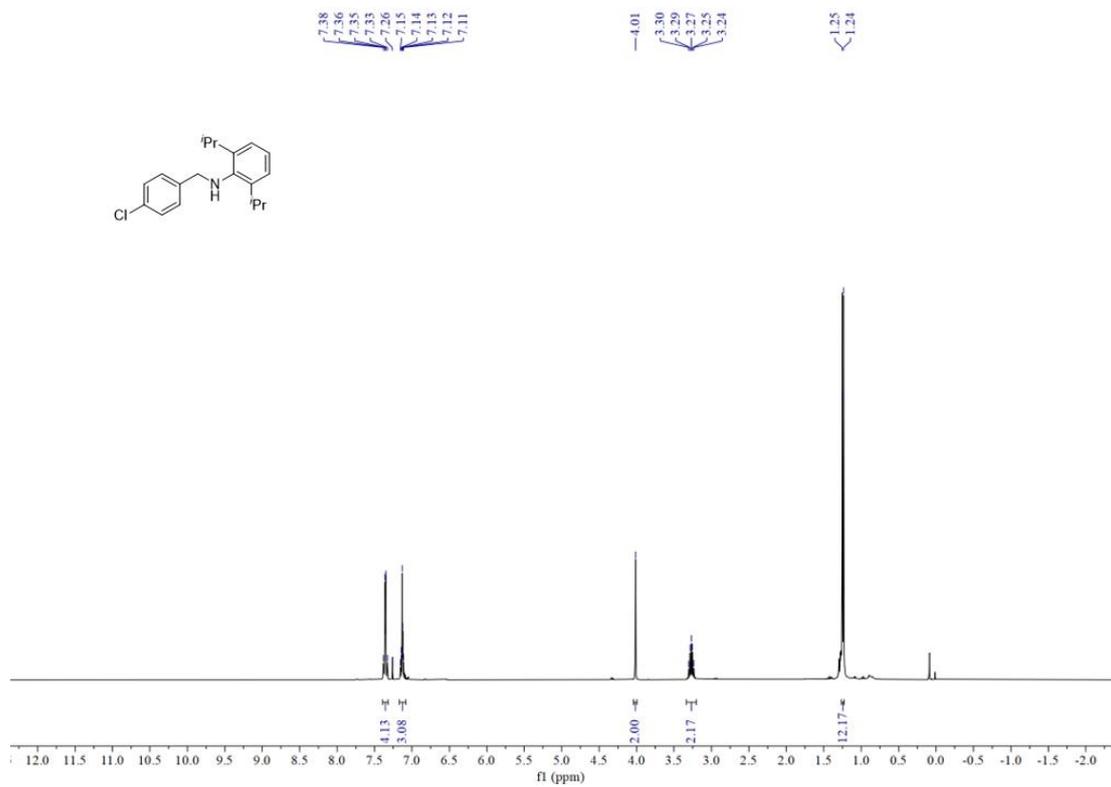


Figure S188. ¹H NMR (400 MHz, CDCl₃) spectrum of **4u**

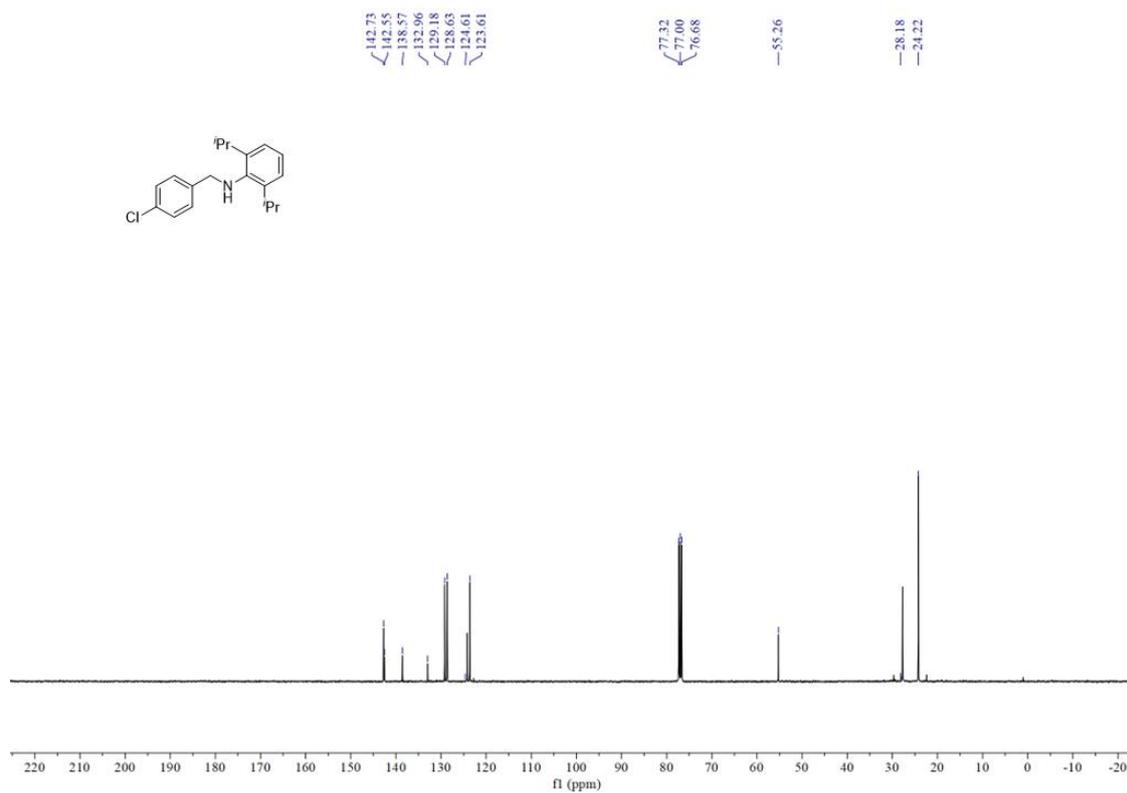


Figure S189. ¹³C NMR (100 MHz, CDCl₃) spectrum of **4u**

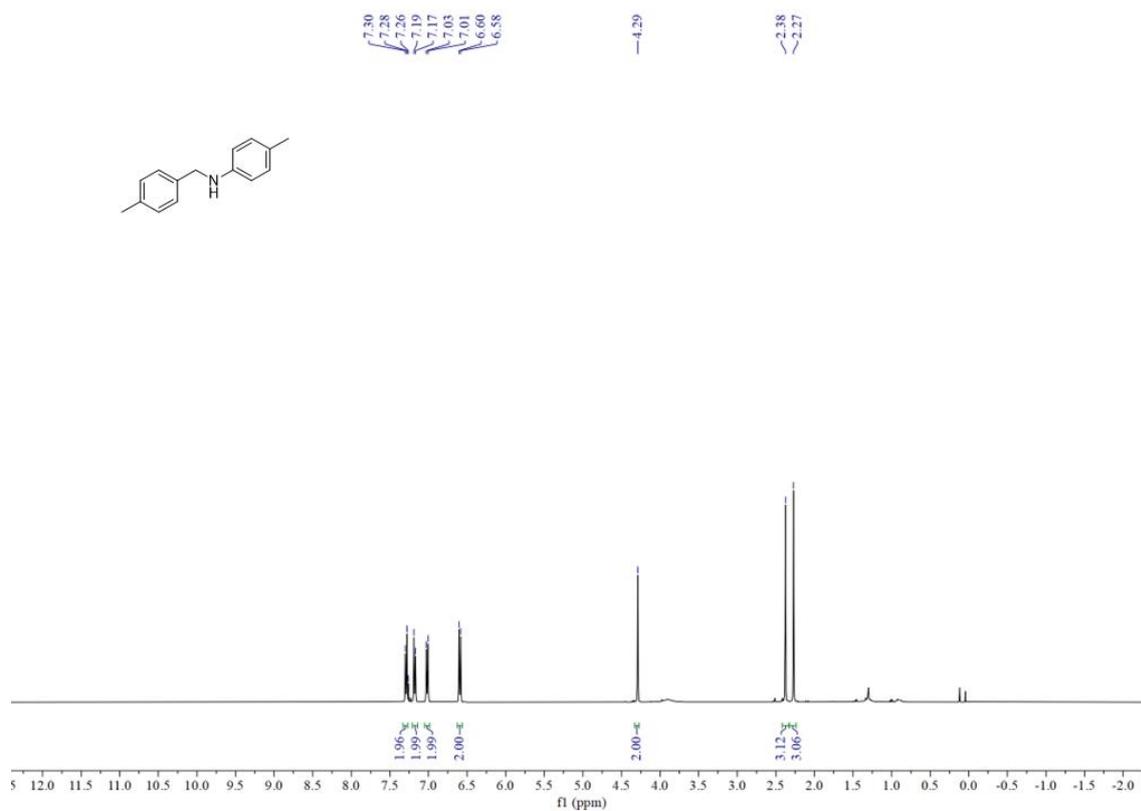


Figure S190. ¹H NMR (400 MHz, CDCl₃) spectrum of **4v**

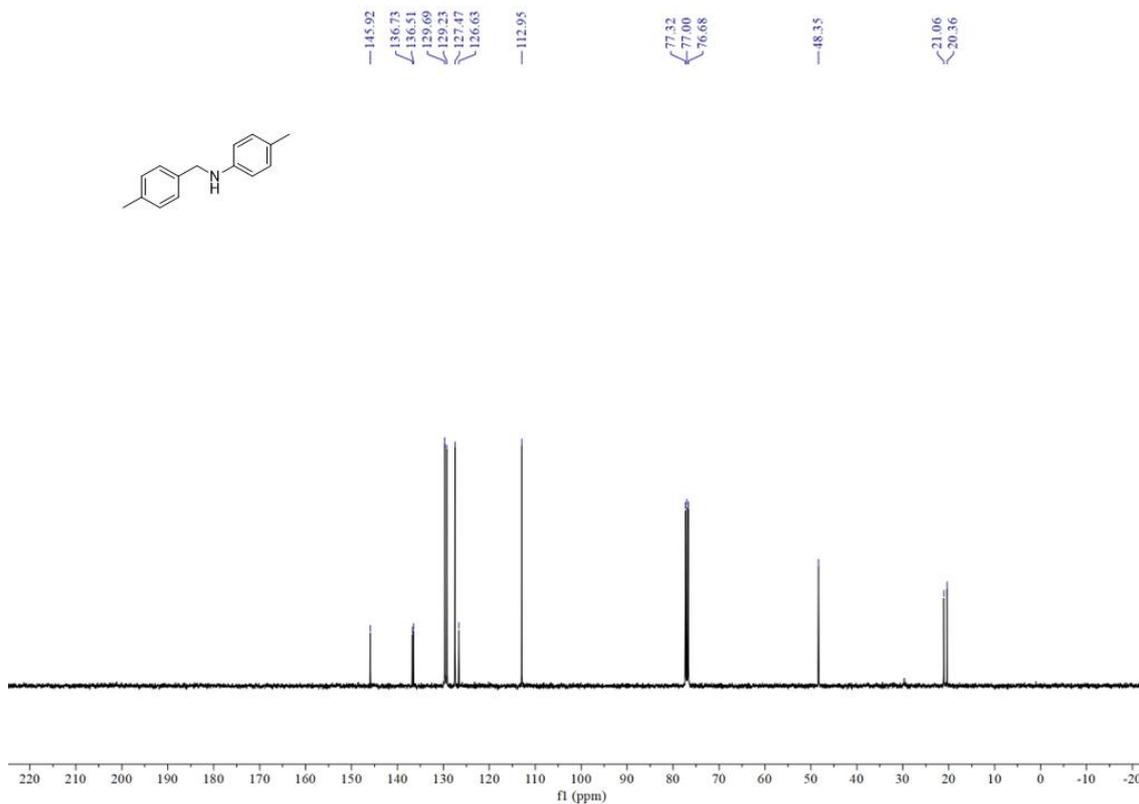


Figure S191. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4v



Figure S192. ^1H NMR (400 MHz, CDCl_3) spectrum of 4w

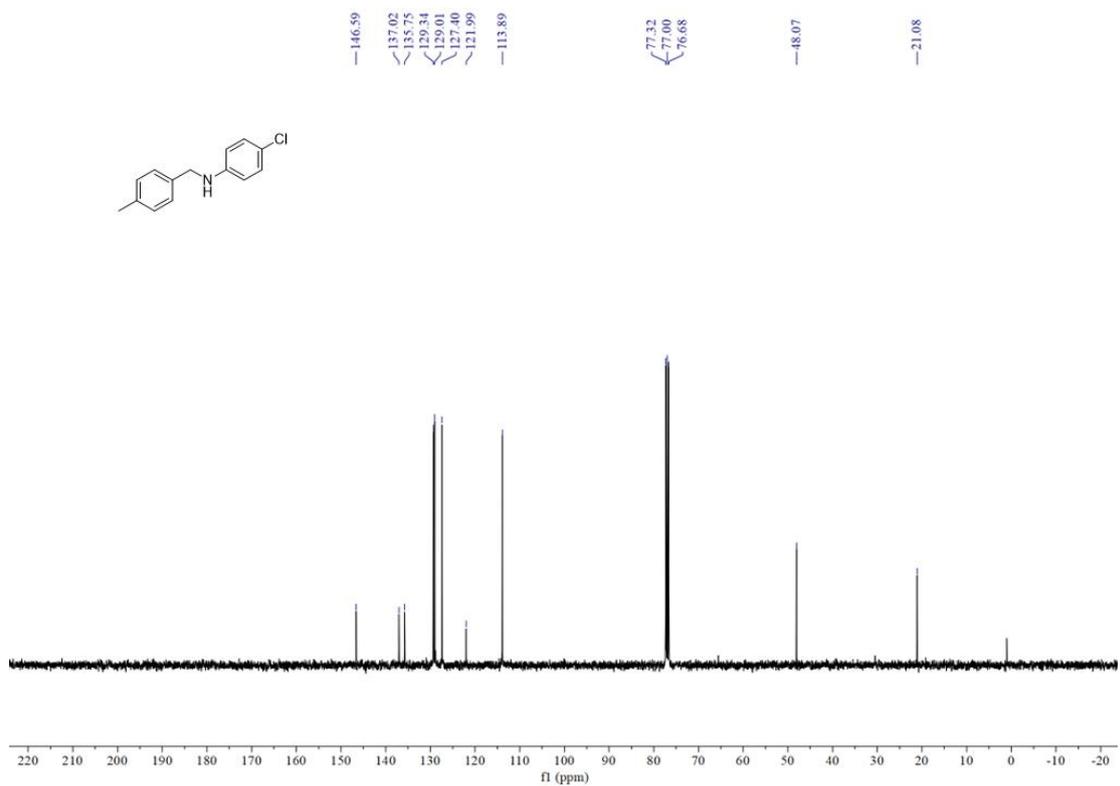


Figure S193. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4w

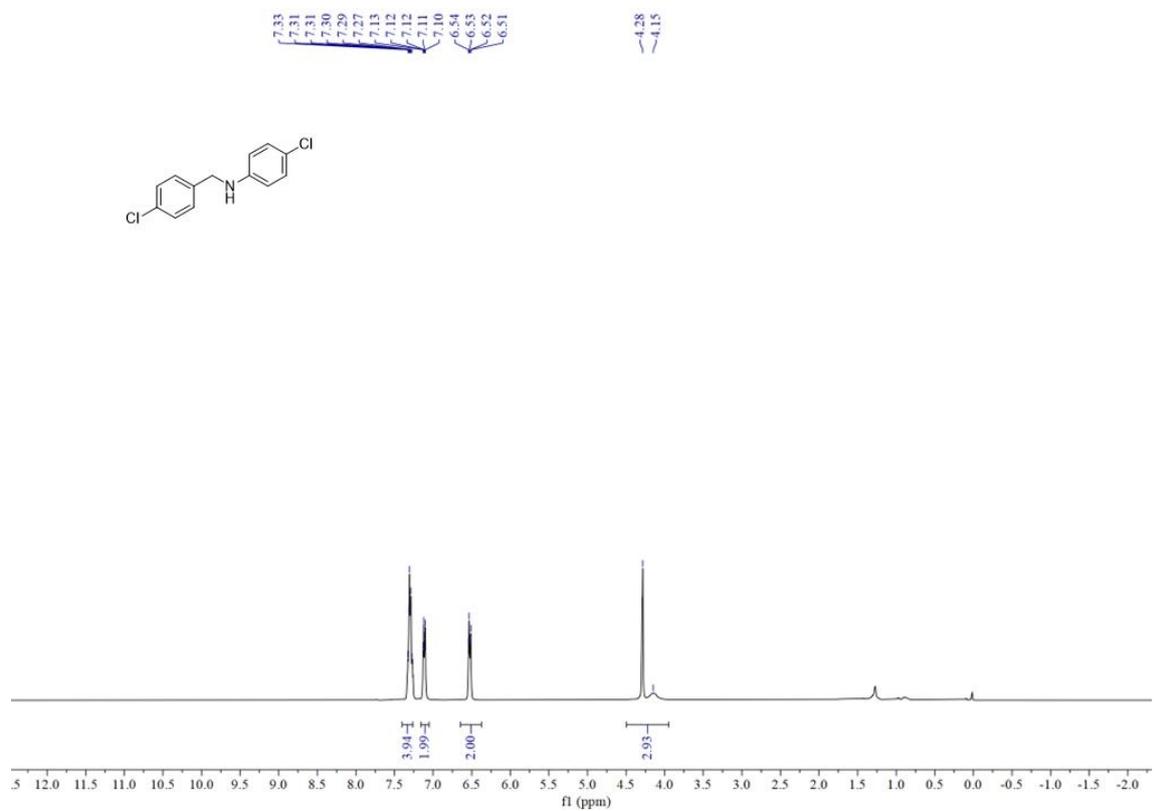


Figure S194. ^1H NMR (400 MHz, CDCl_3) spectrum of 4x

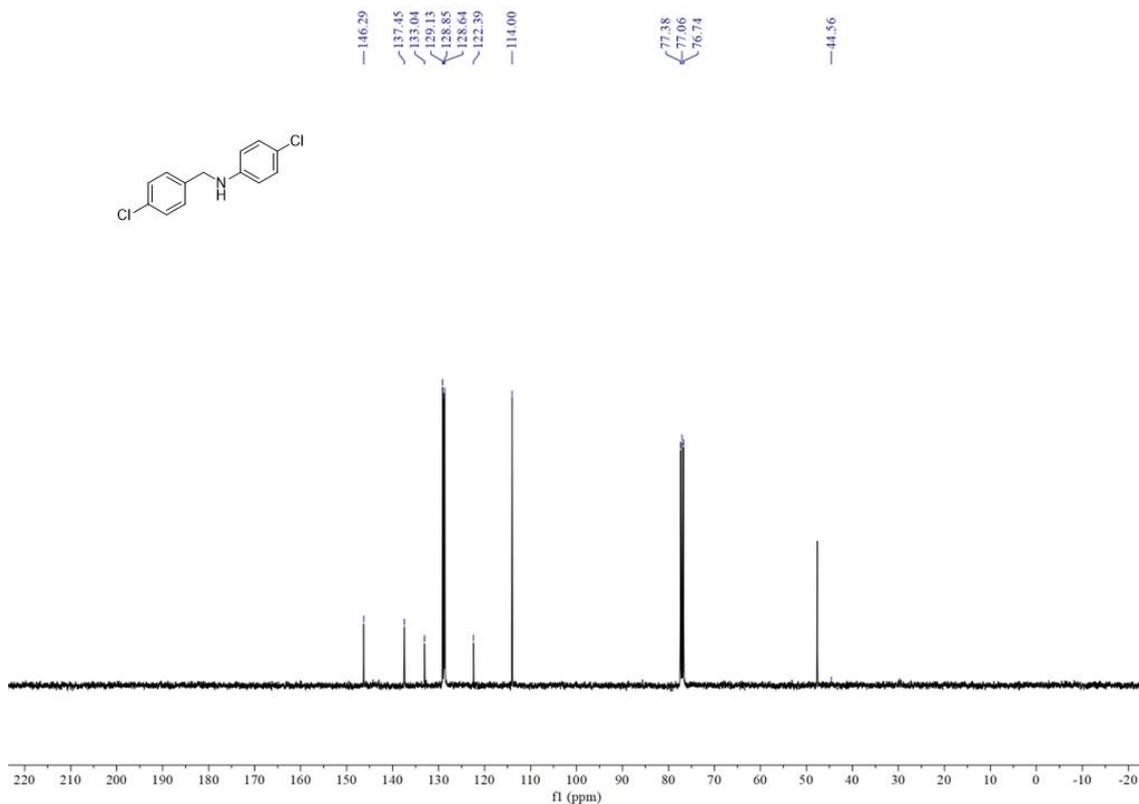


Figure S195. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4x

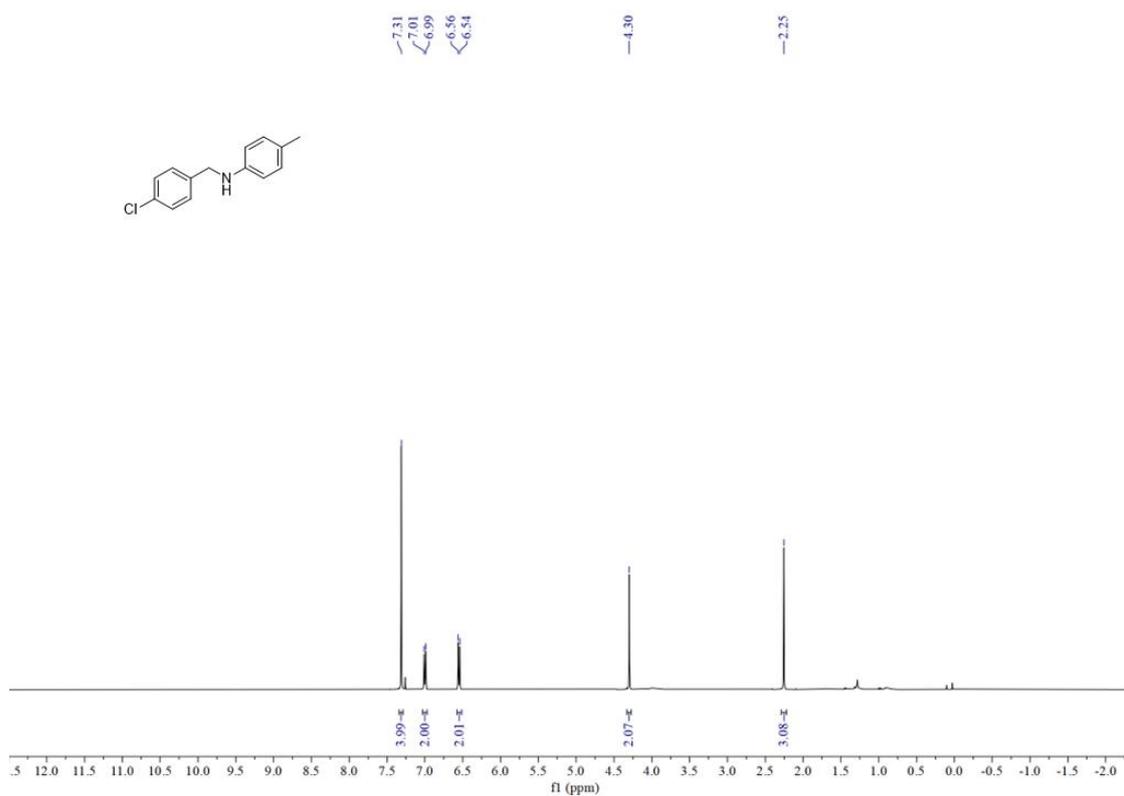


Figure S196. ^1H NMR (400 MHz, CDCl_3) spectrum of 4y

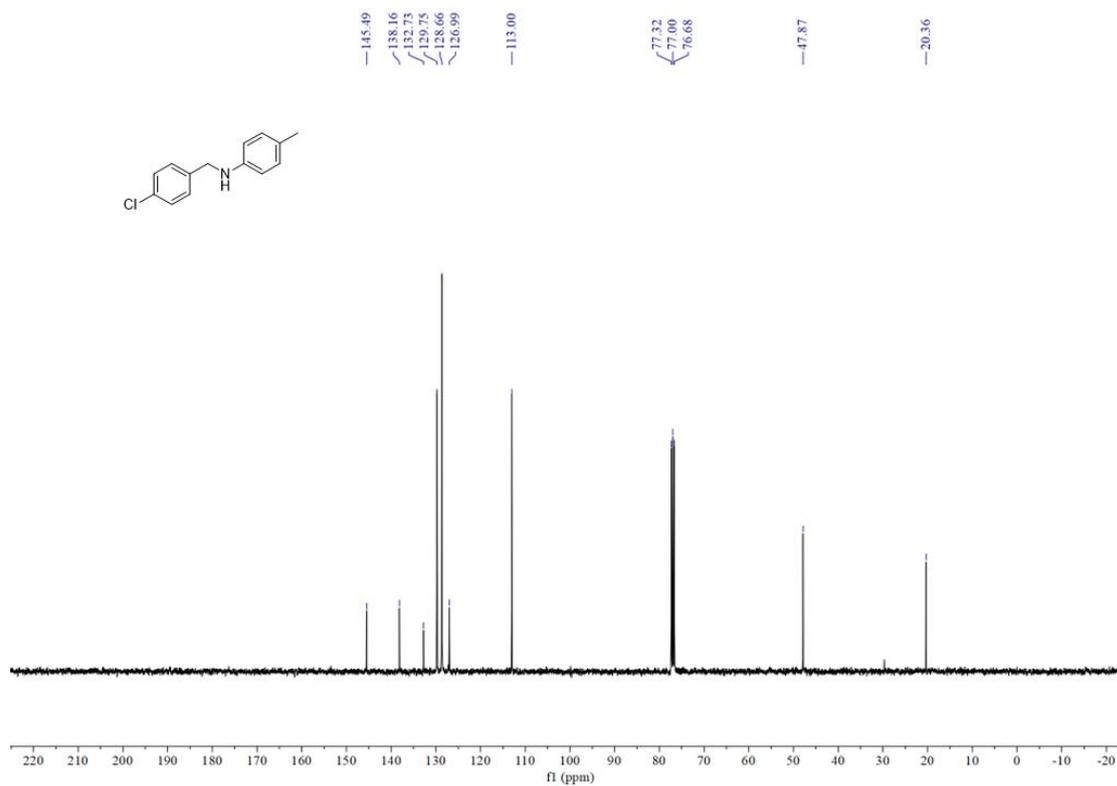


Figure S197. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4y

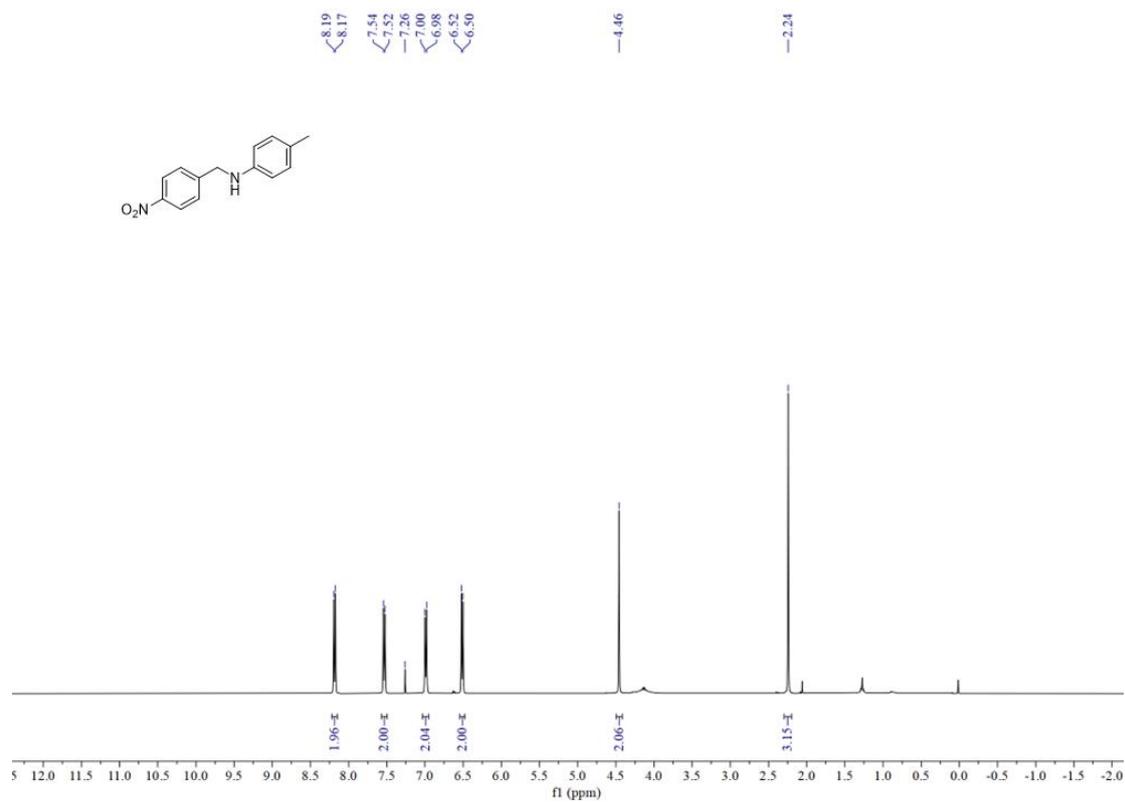


Figure S198. ^1H NMR (400 MHz, CDCl_3) spectrum of 4z

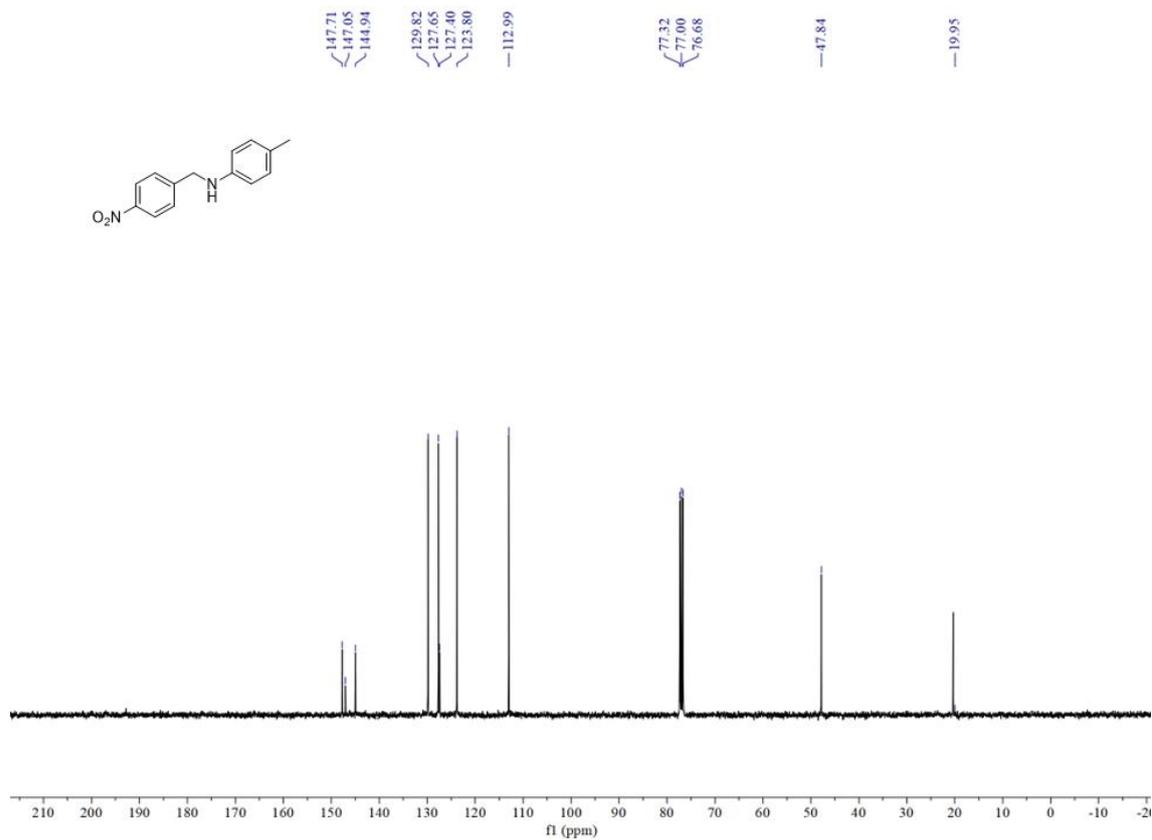


Figure S199. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4z

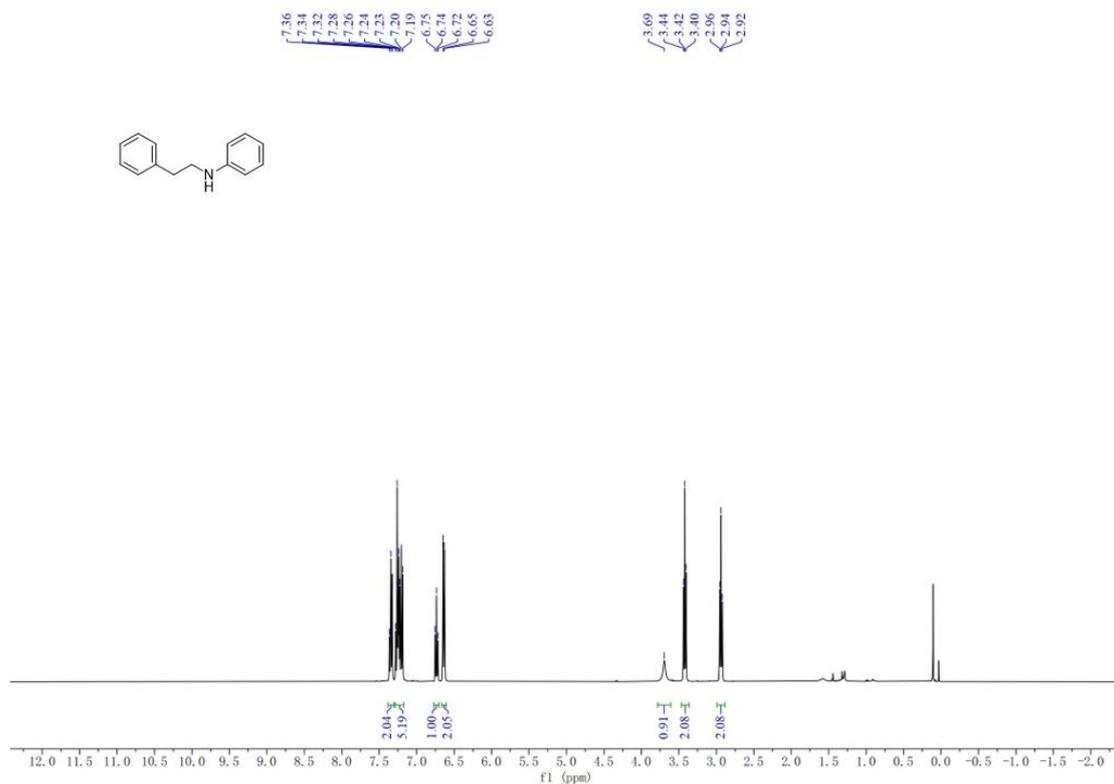


Figure S200. ^1H NMR (400 MHz, CDCl_3) spectrum of 4aa

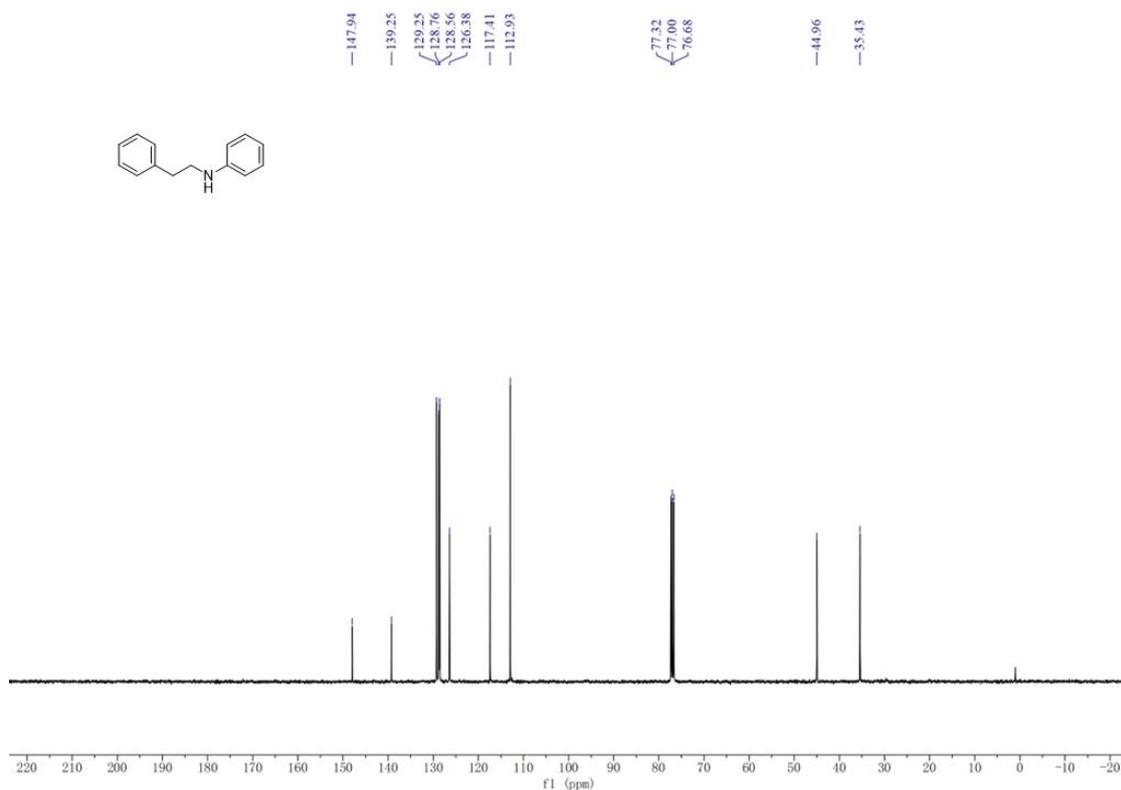


Figure S201. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **4aa**

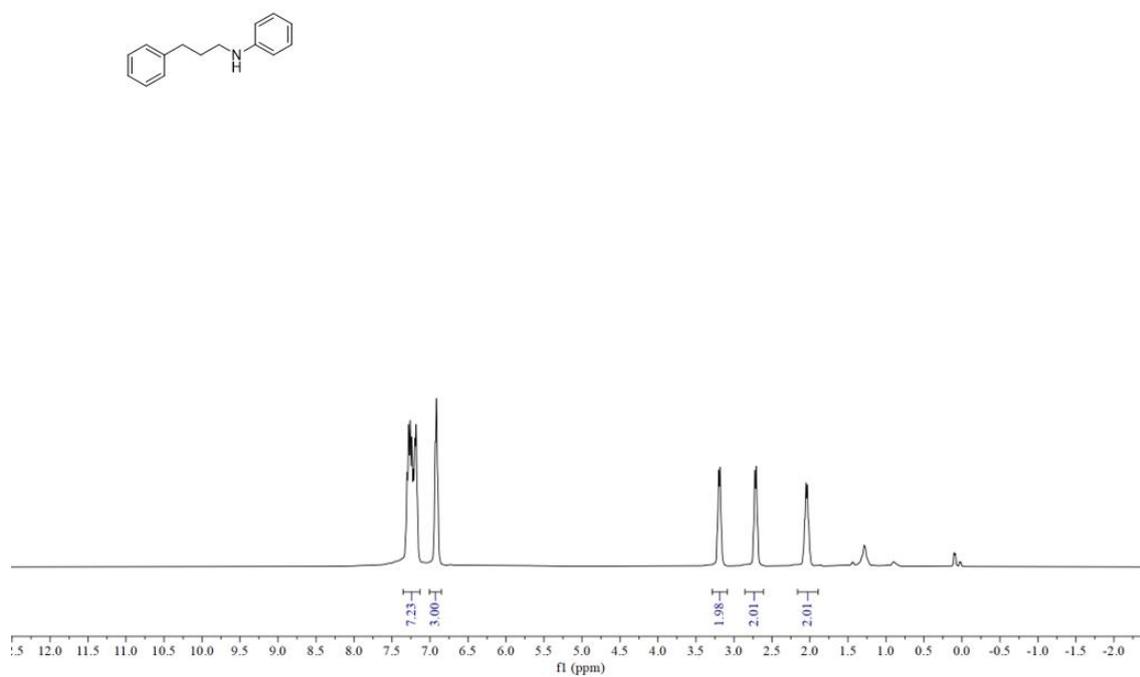


Figure S202. ^1H NMR (400 MHz, CDCl_3) spectrum of **4ab**

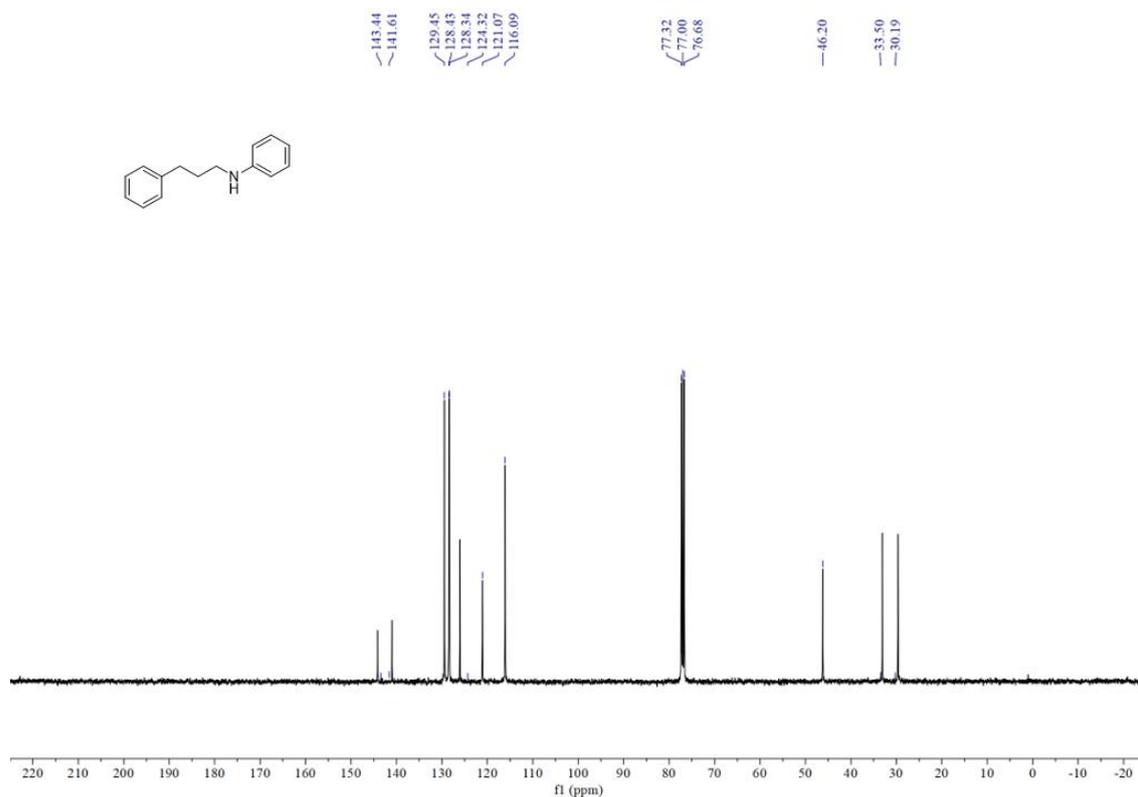


Figure S203. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4ab

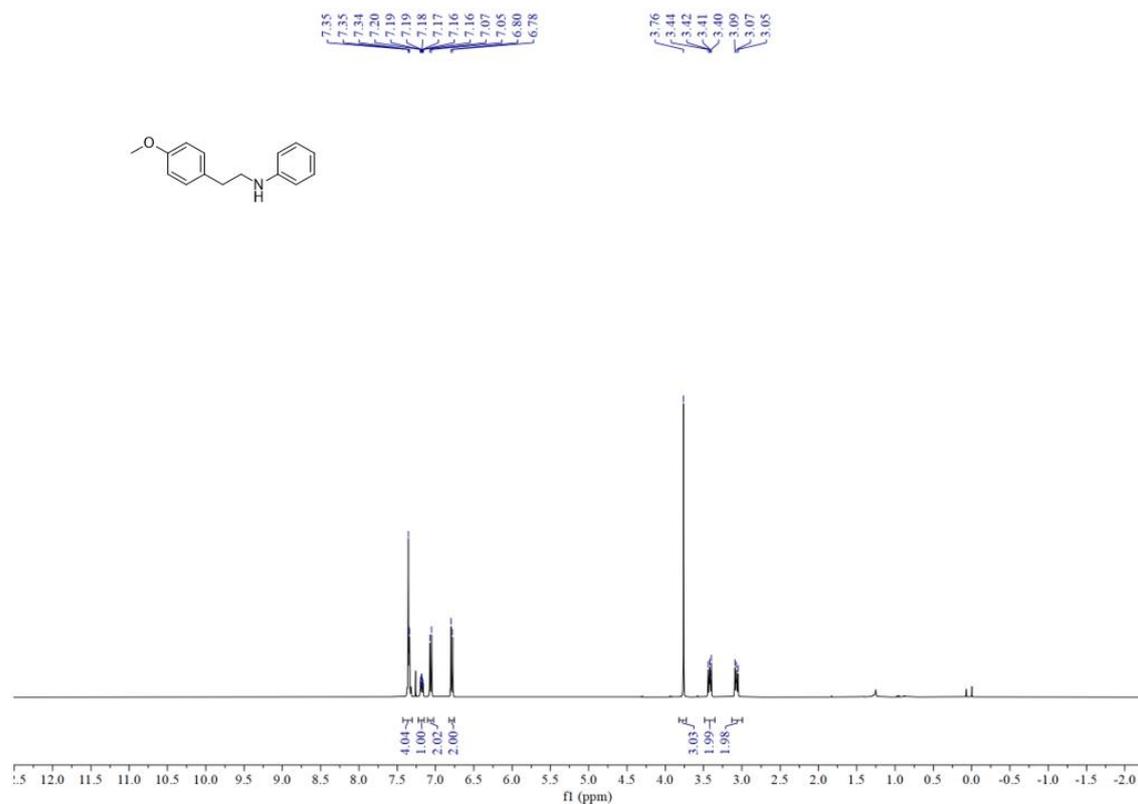


Figure S204. ^1H NMR (400 MHz, CDCl_3) spectrum of 4ac

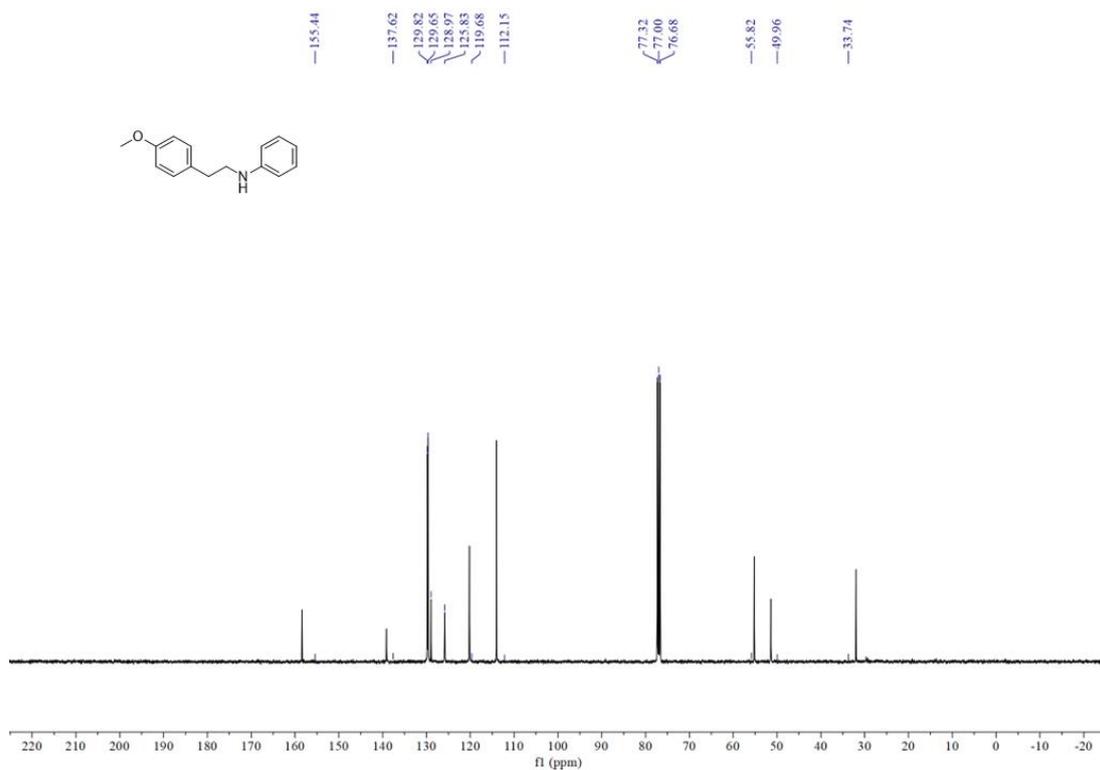


Figure S205. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4ac

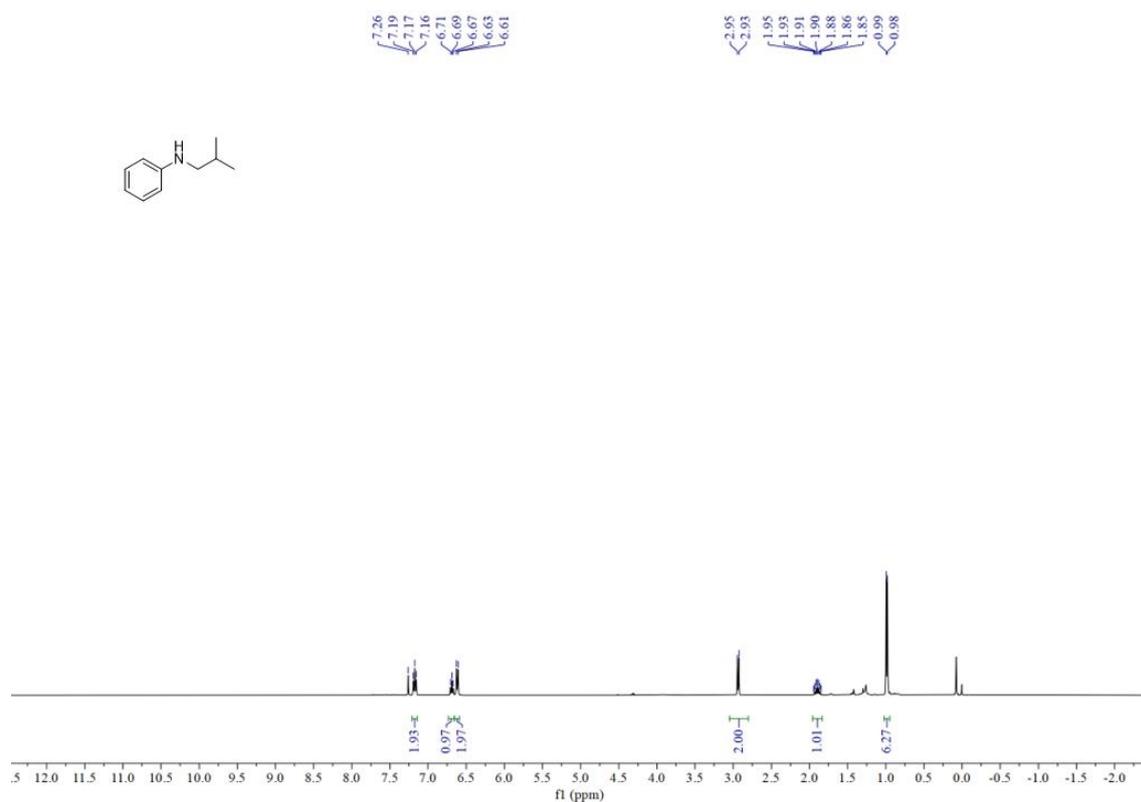


Figure S206. ^1H NMR (400 MHz, CDCl_3) spectrum of 4ad

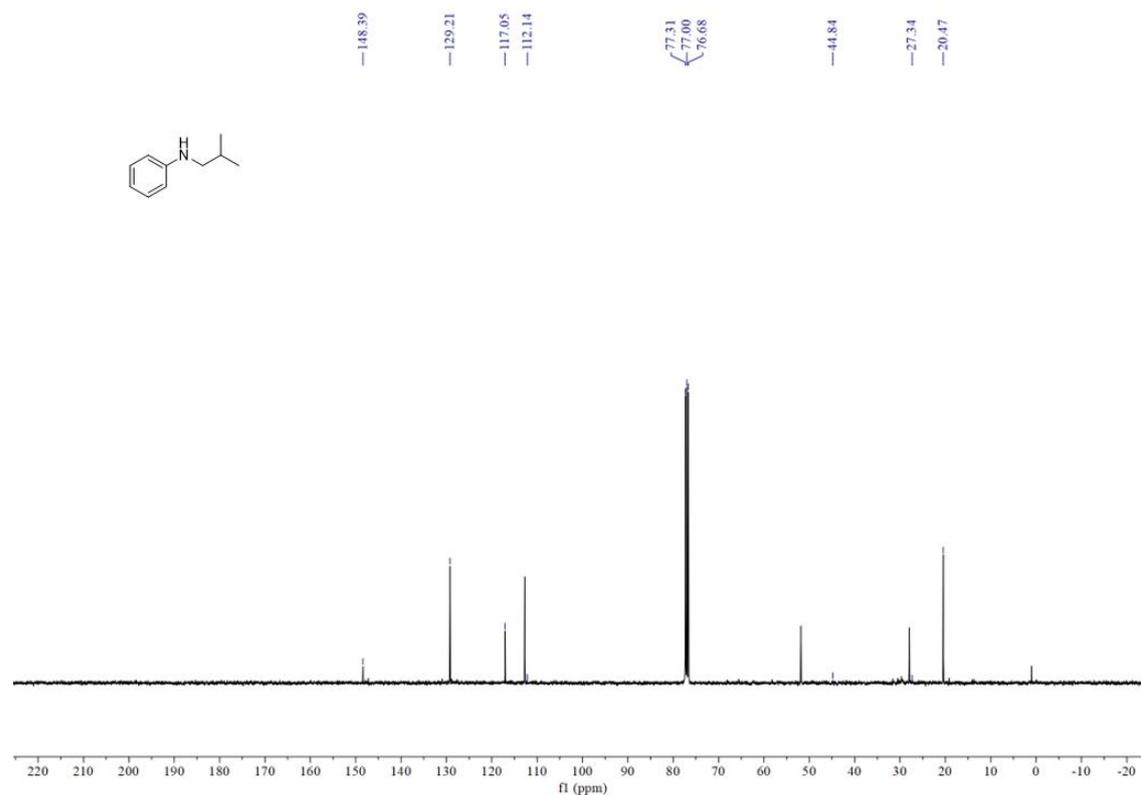


Figure S207. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **4ad**

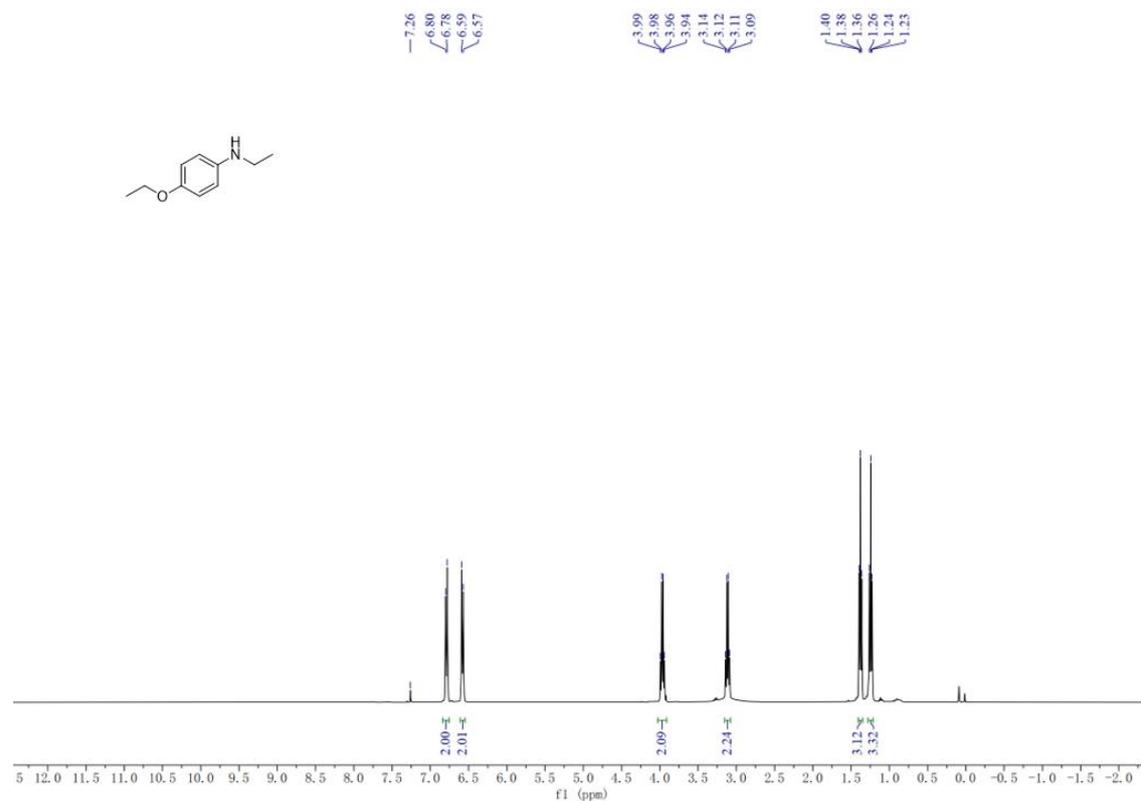


Figure S208. ^1H NMR (400 MHz, CDCl_3) spectrum of **4ae**

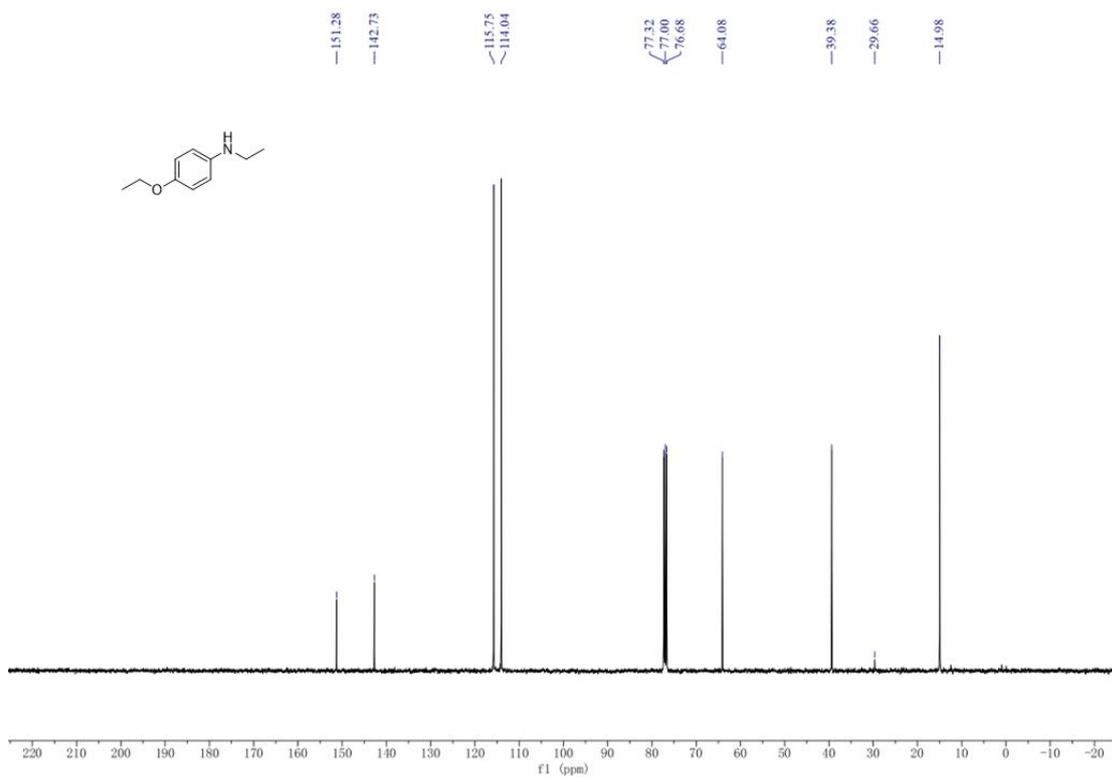


Figure S209. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4ae

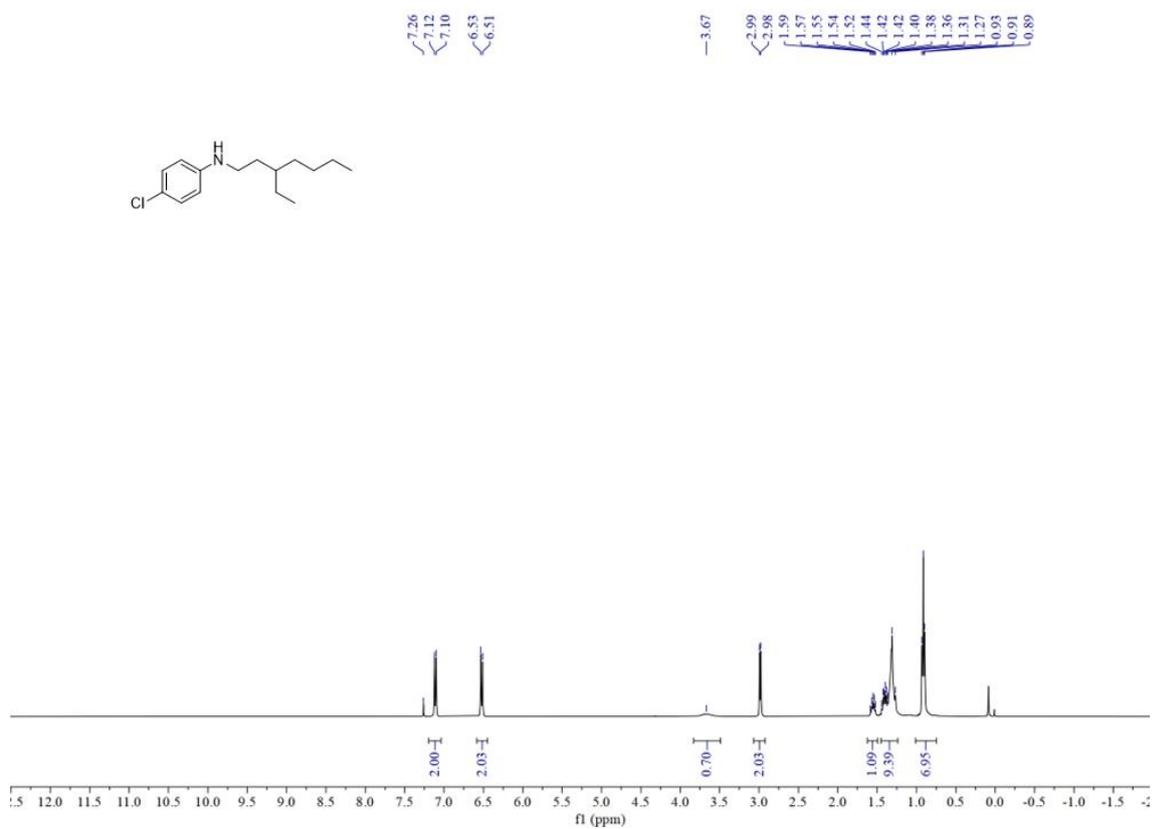


Figure S210. ^1H NMR (400 MHz, CDCl_3) spectrum of 4af

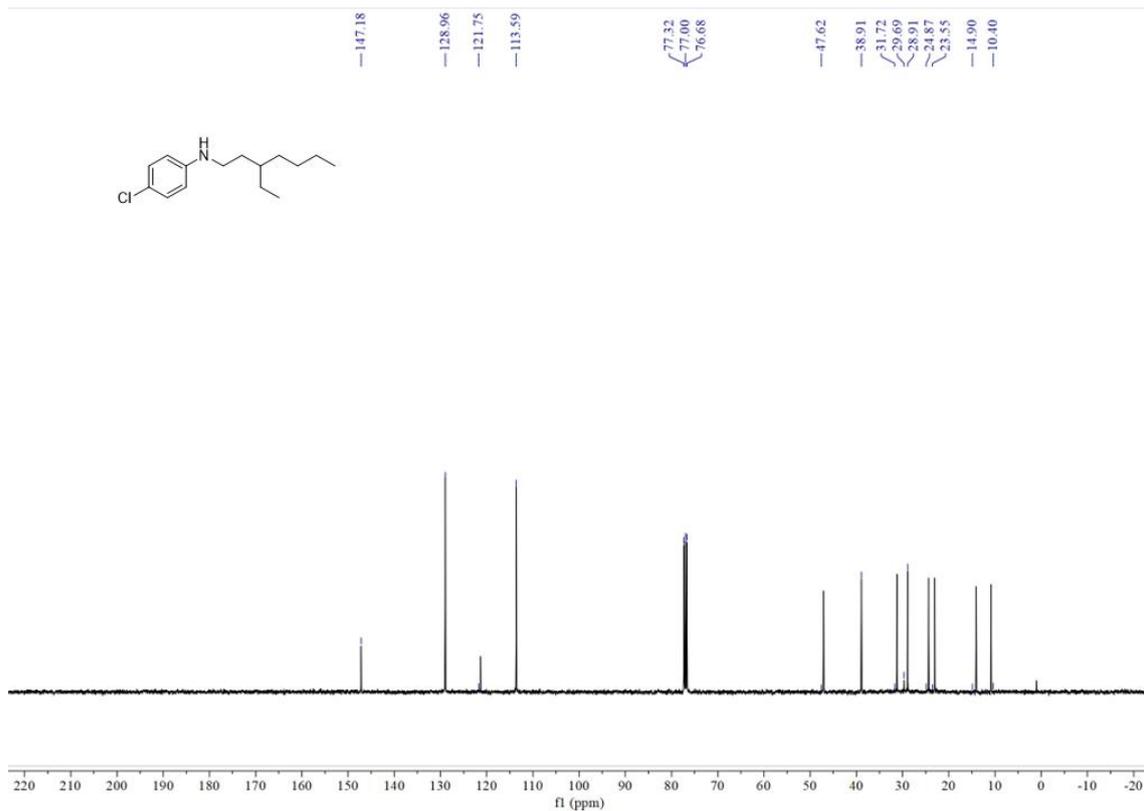


Figure S211. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4af

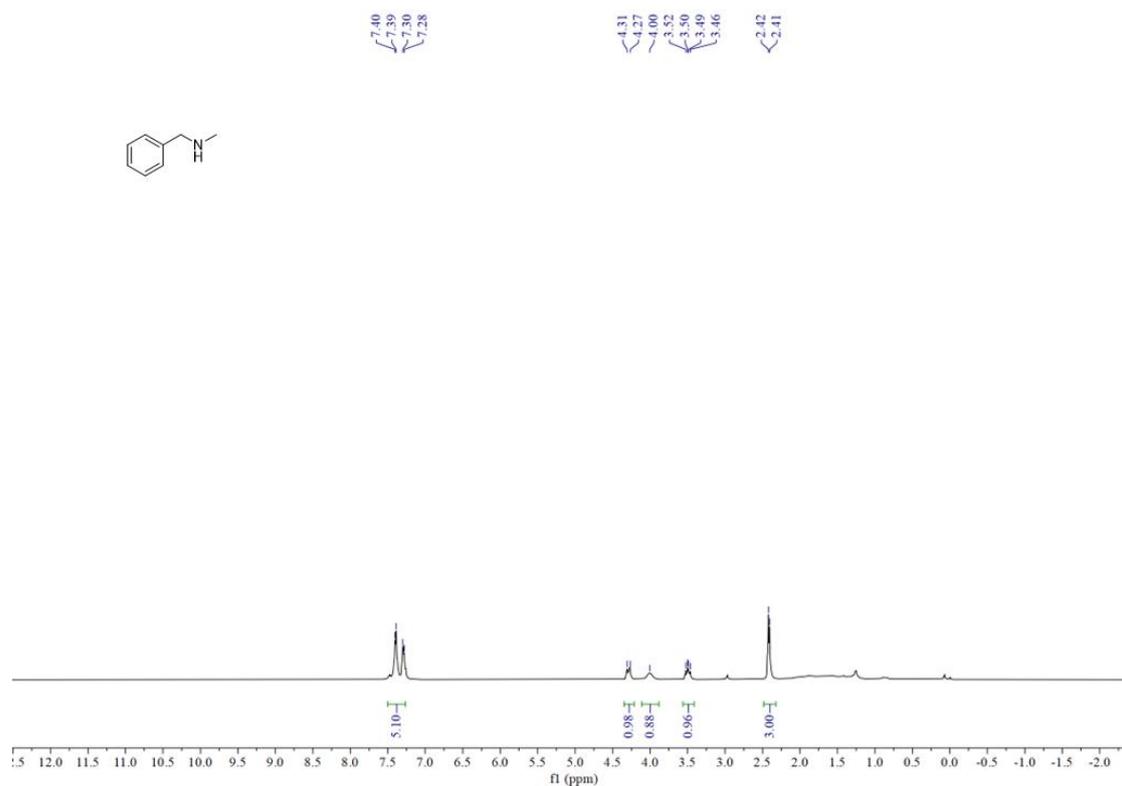


Figure S212. ^1H NMR (400 MHz, CDCl_3) spectrum of 4ag

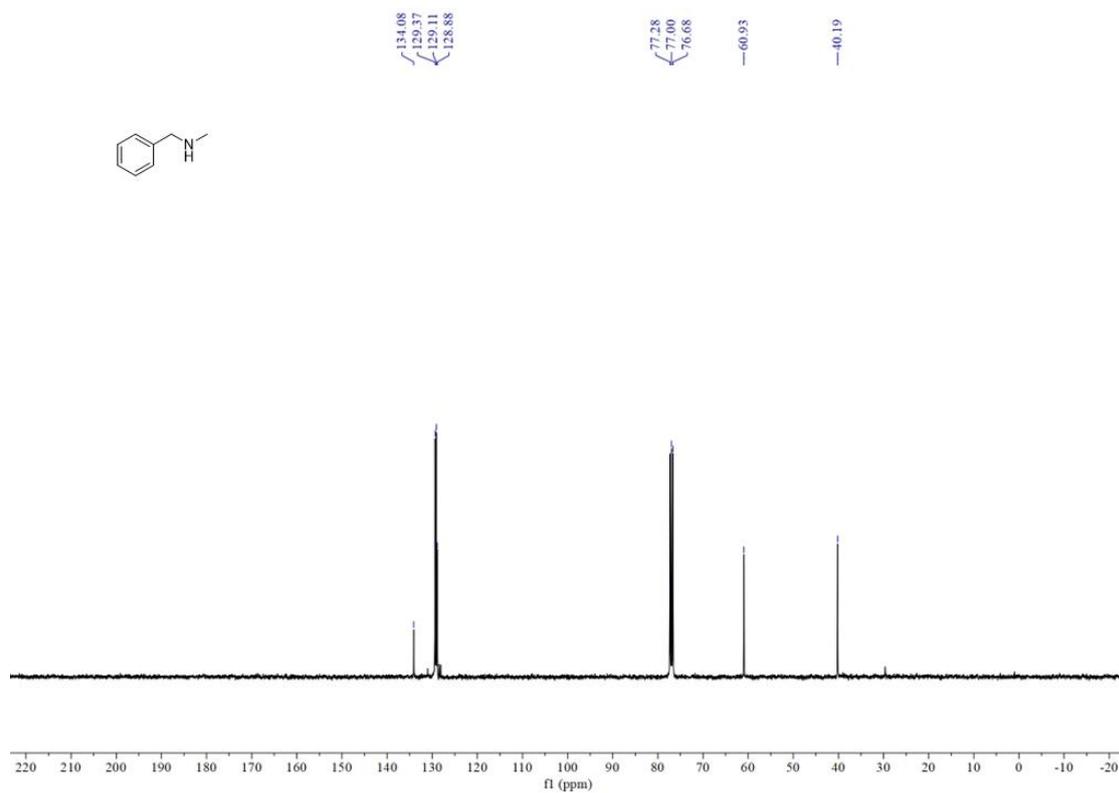


Figure S213. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **4ag**

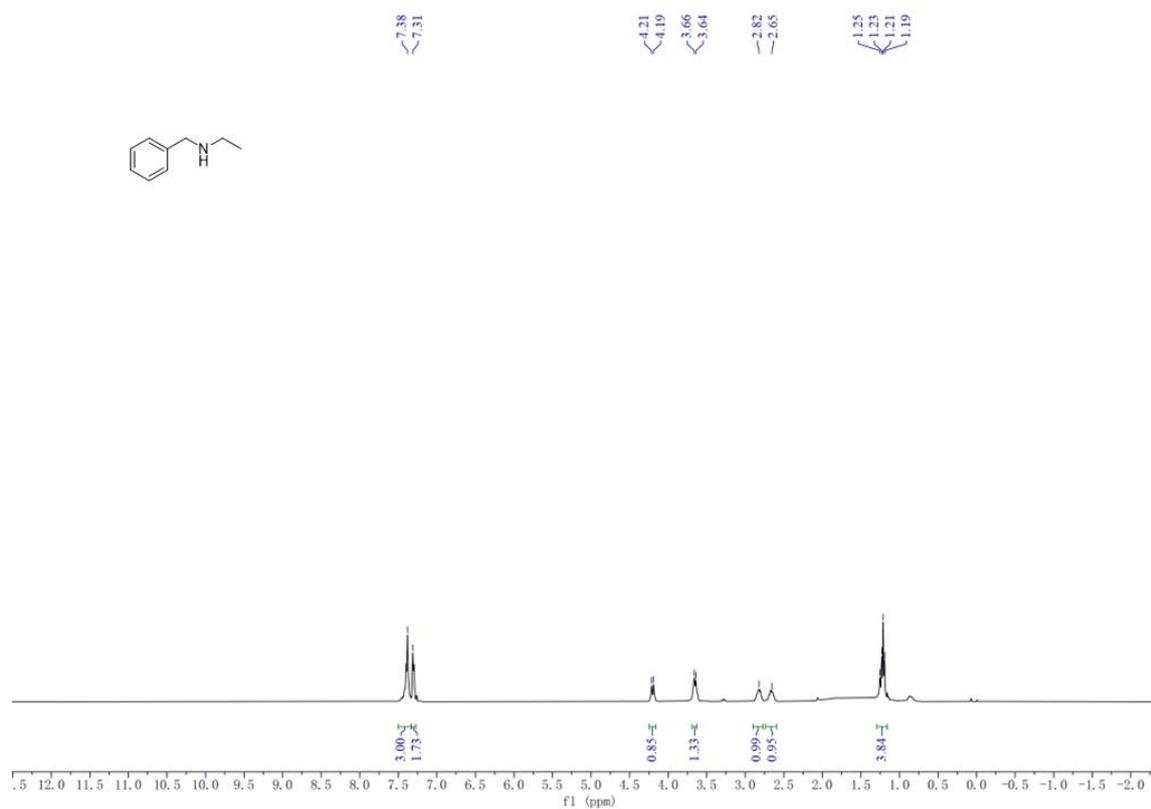


Figure S214. ^1H NMR (400 MHz, CDCl_3) spectrum of **4ah**

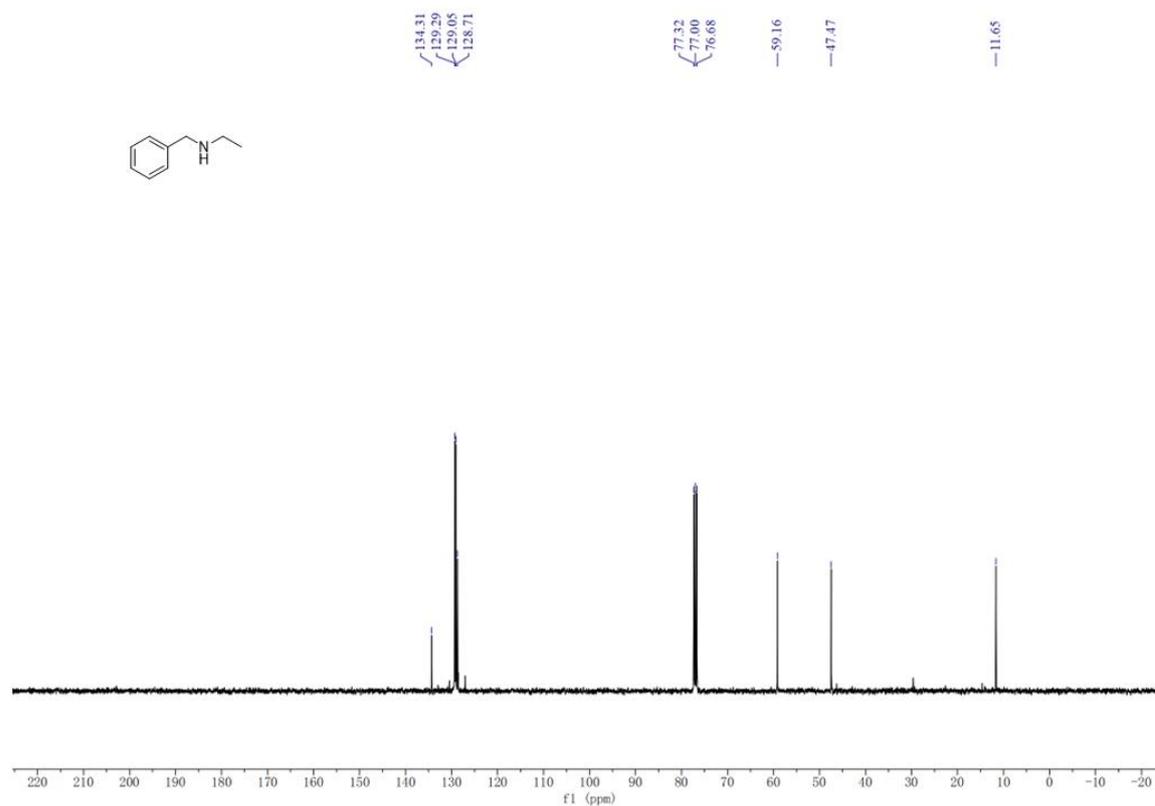


Figure S215. ¹³C NMR (100 MHz, CDCl₃) spectrum of **4ah**

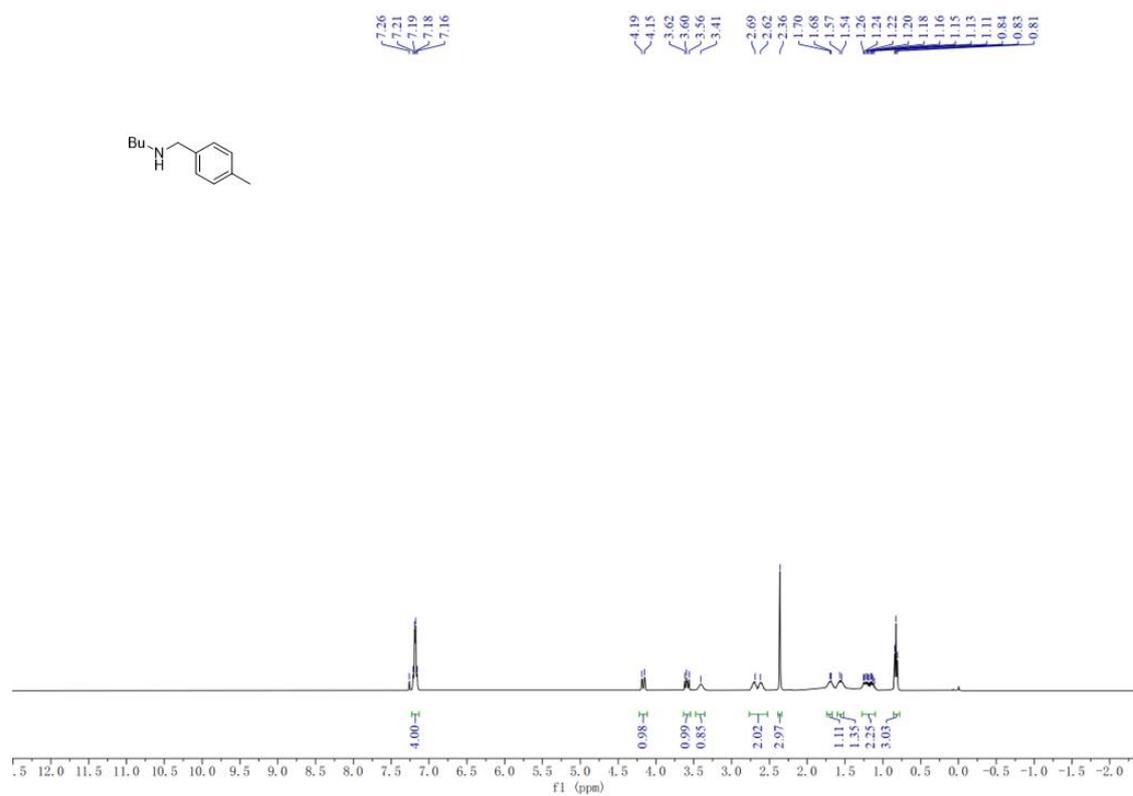


Figure S216. ¹H NMR (400 MHz, CDCl₃) spectrum of **4ai**

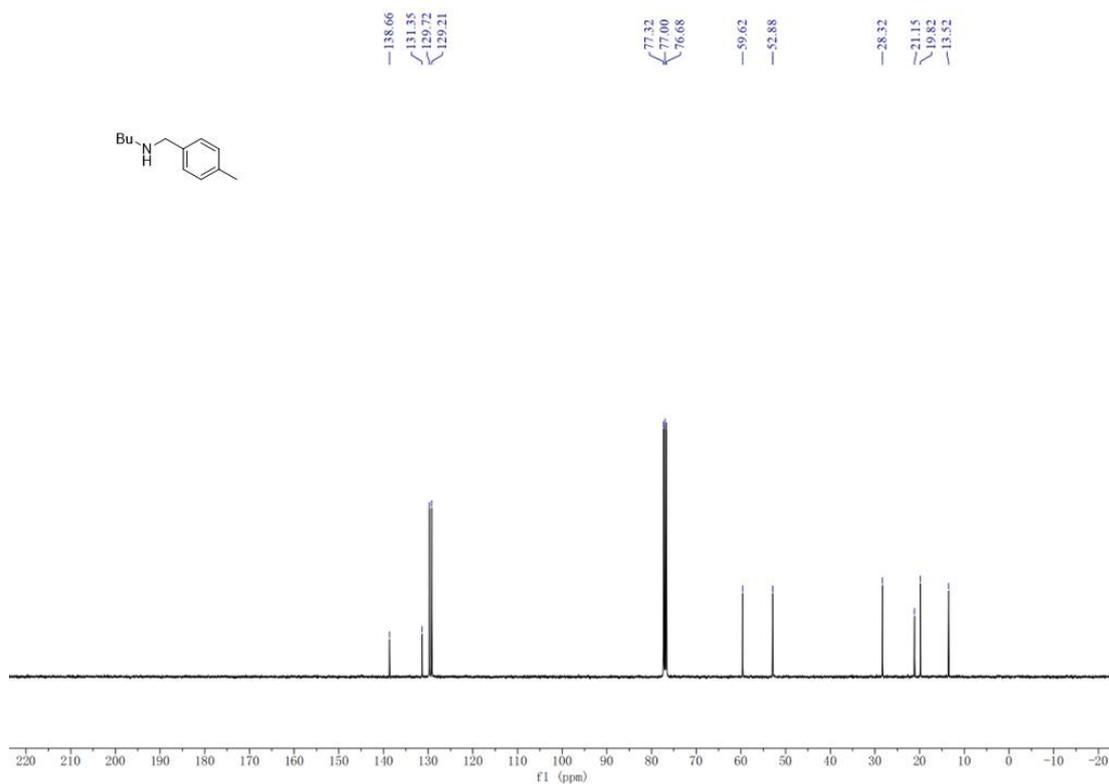


Figure S217. ¹³C NMR (100 MHz, CDCl₃) spectrum of 4a

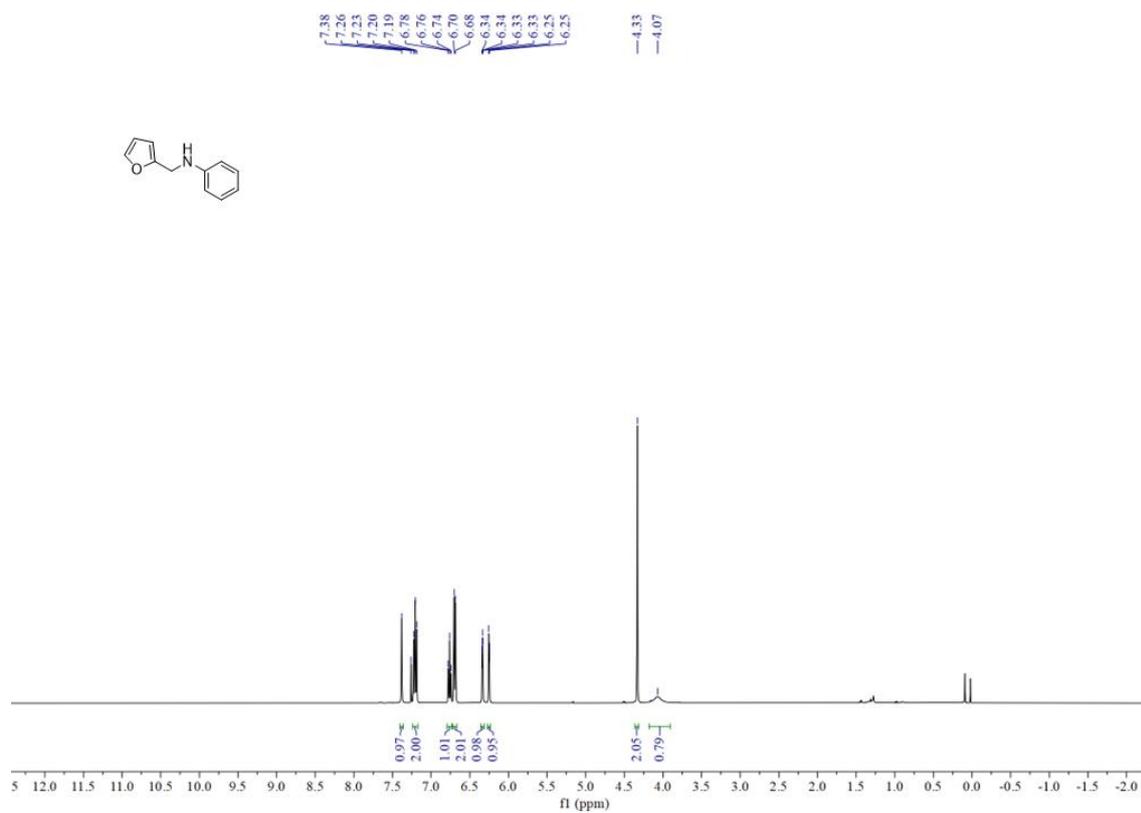


Figure S218. ¹H NMR (400 MHz, CDCl₃) spectrum of 4aj

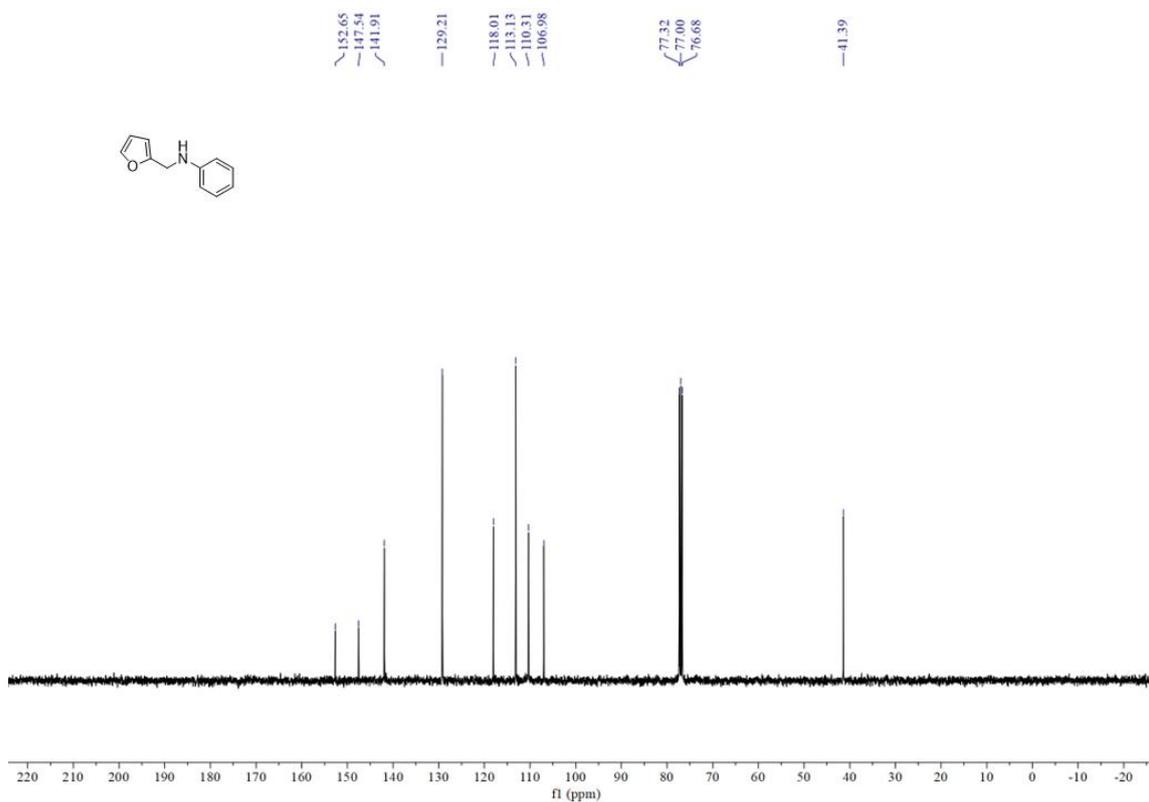


Figure S219. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4aj

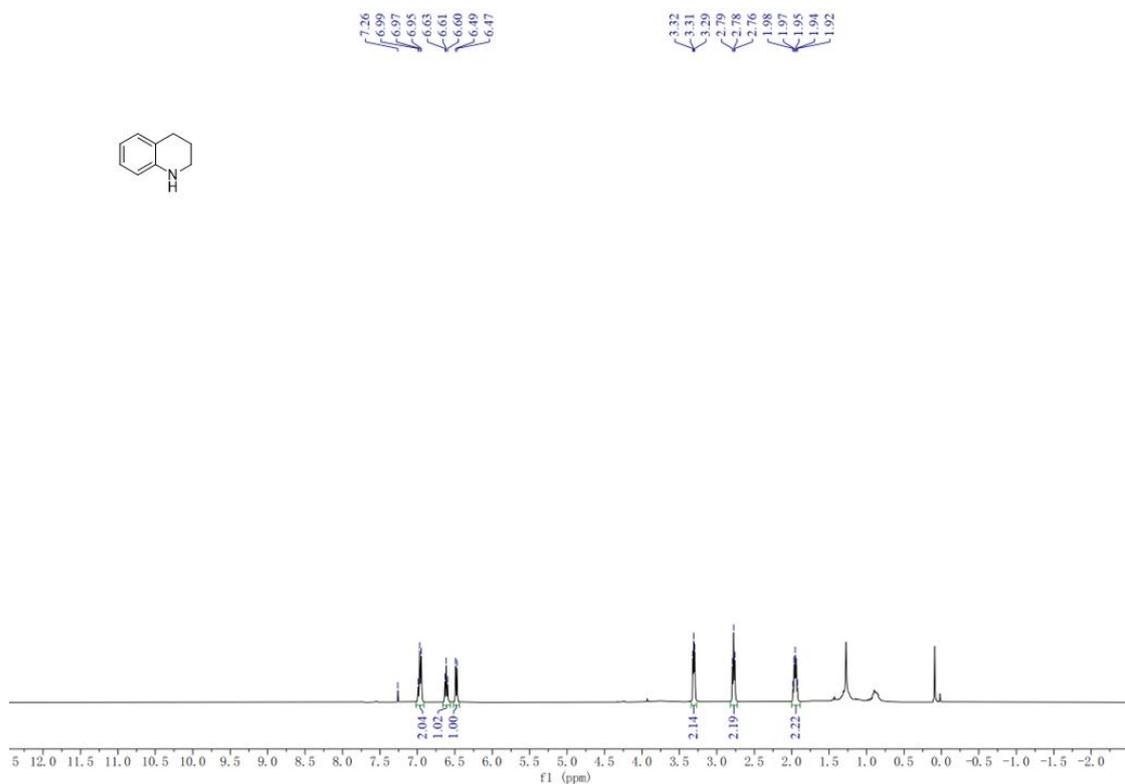


Figure S220. ^1H NMR (400 MHz, CDCl_3) spectrum of 4ak

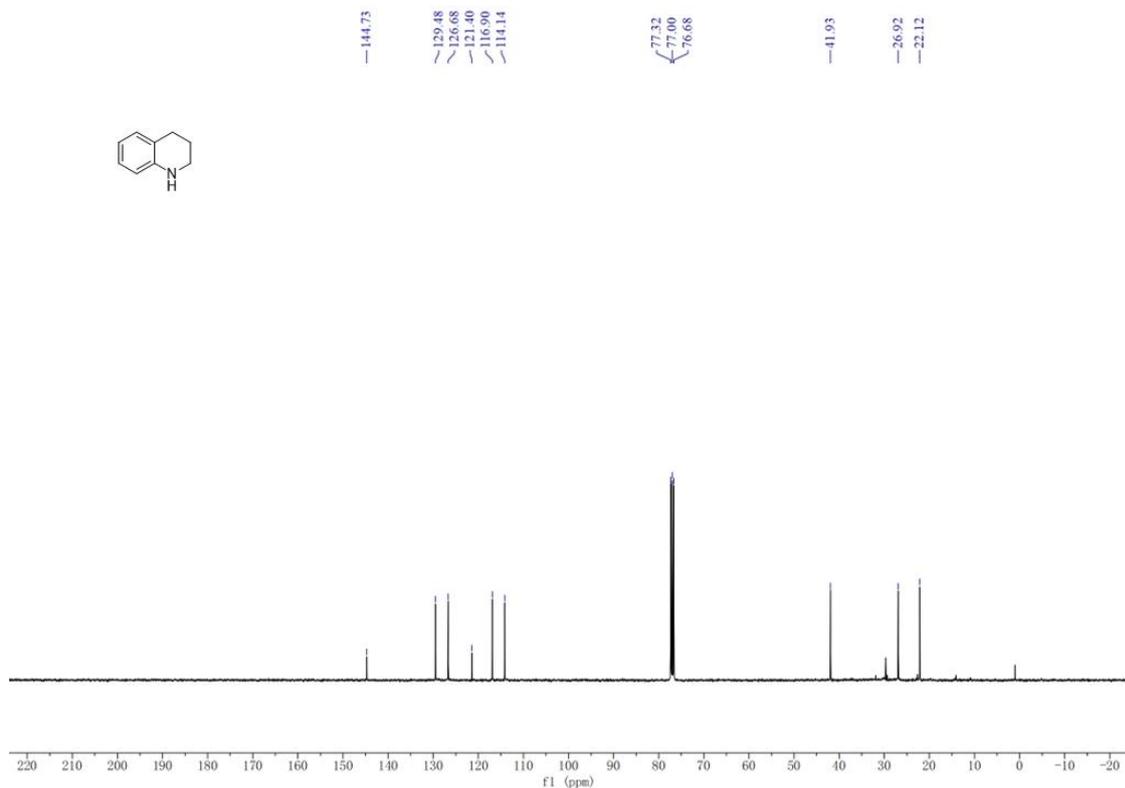


Figure S221. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4ak

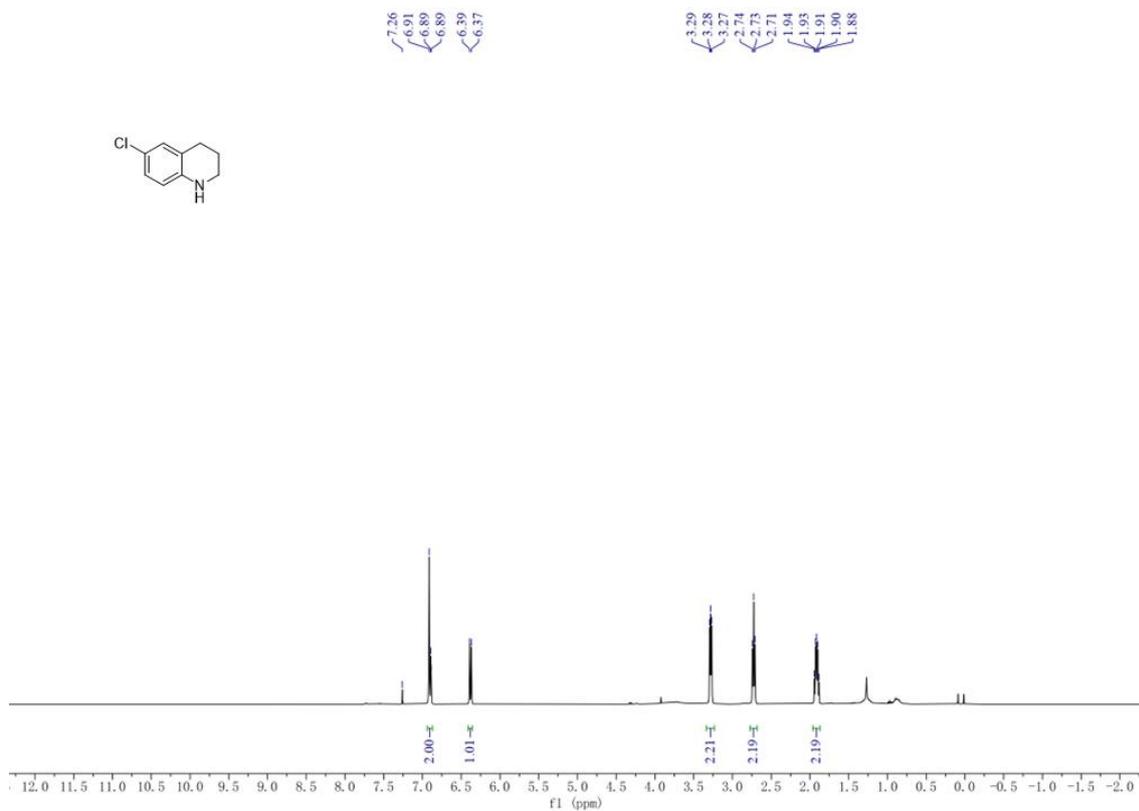


Figure S222. ^1H NMR (400 MHz, CDCl_3) spectrum of 4al

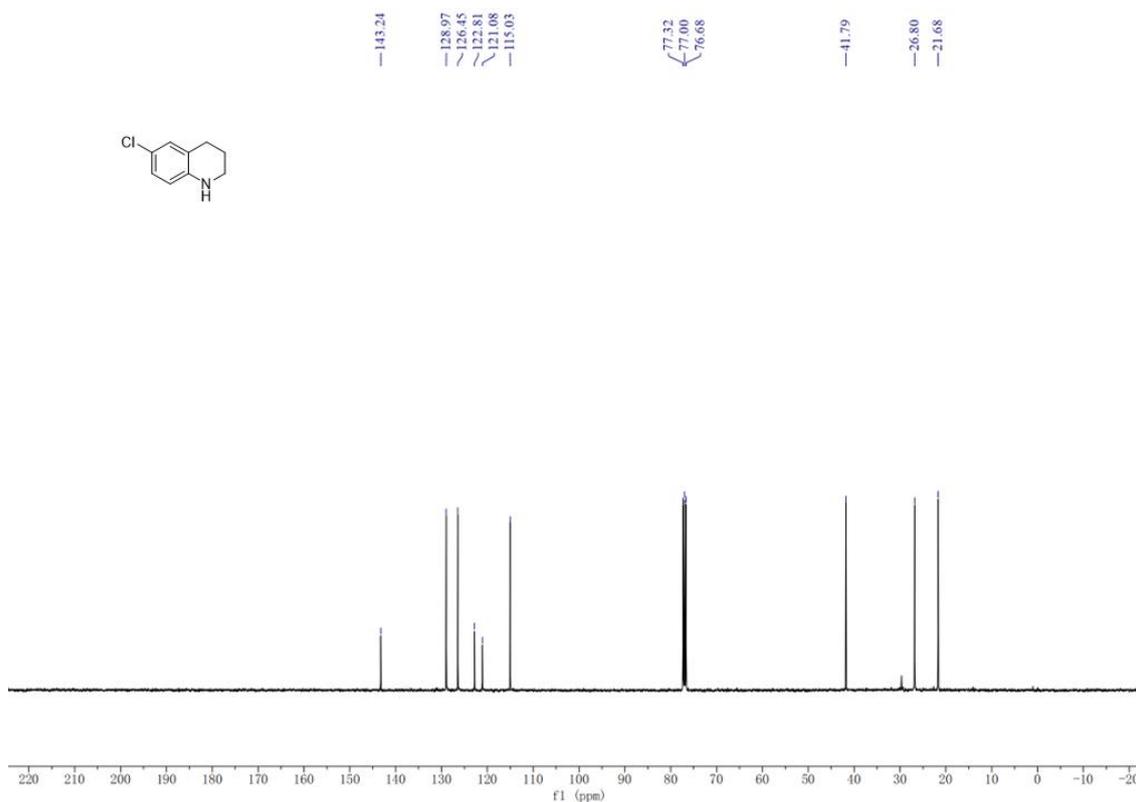


Figure S223. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4a

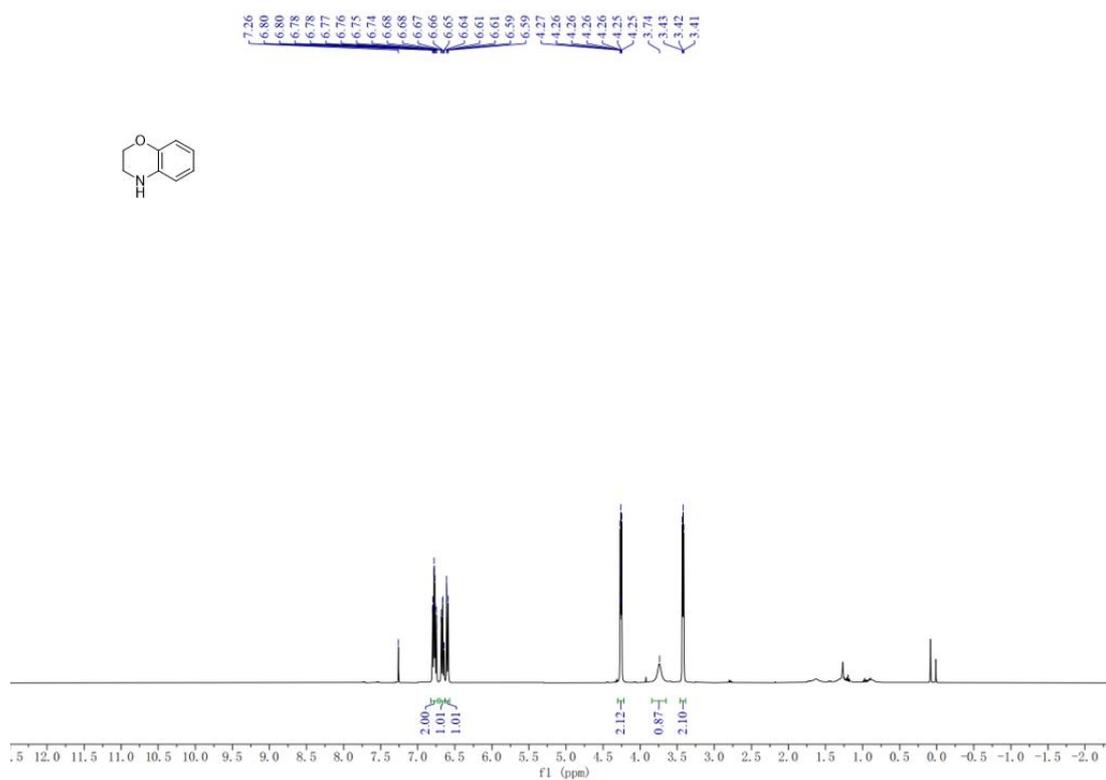


Figure S224. ^1H NMR (400 MHz, CDCl_3) spectrum of 4am

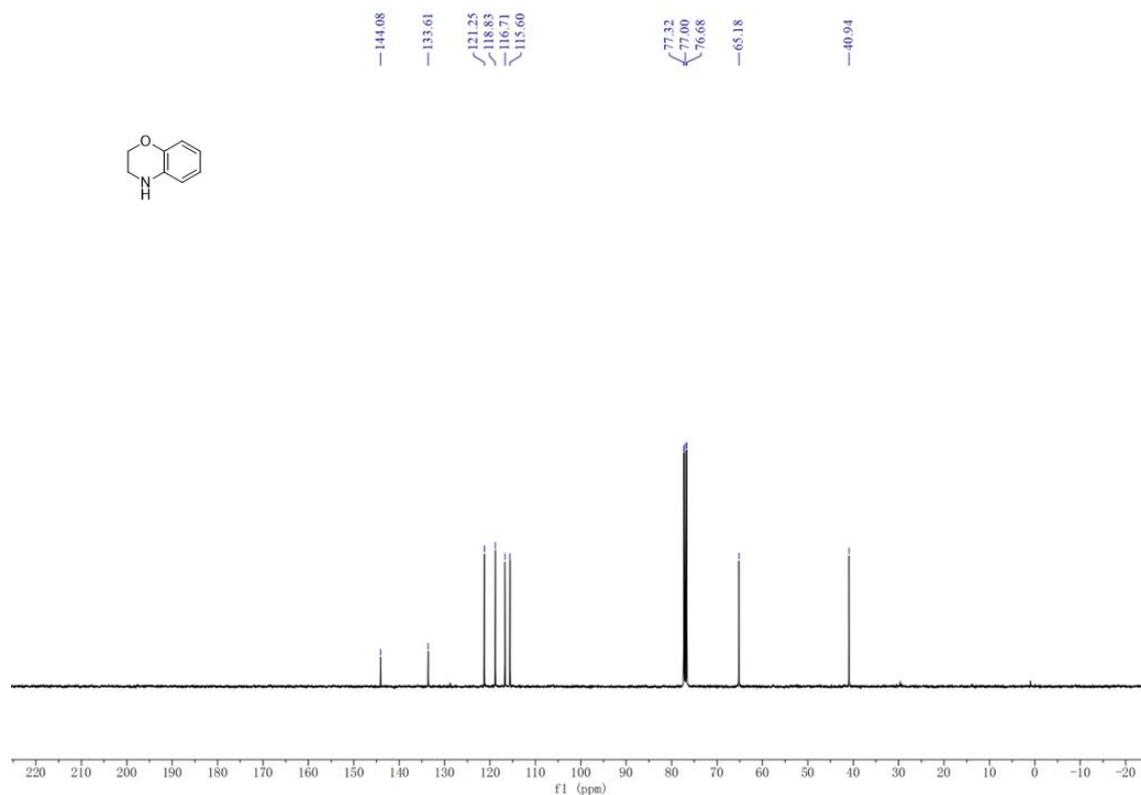


Figure S225. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4am

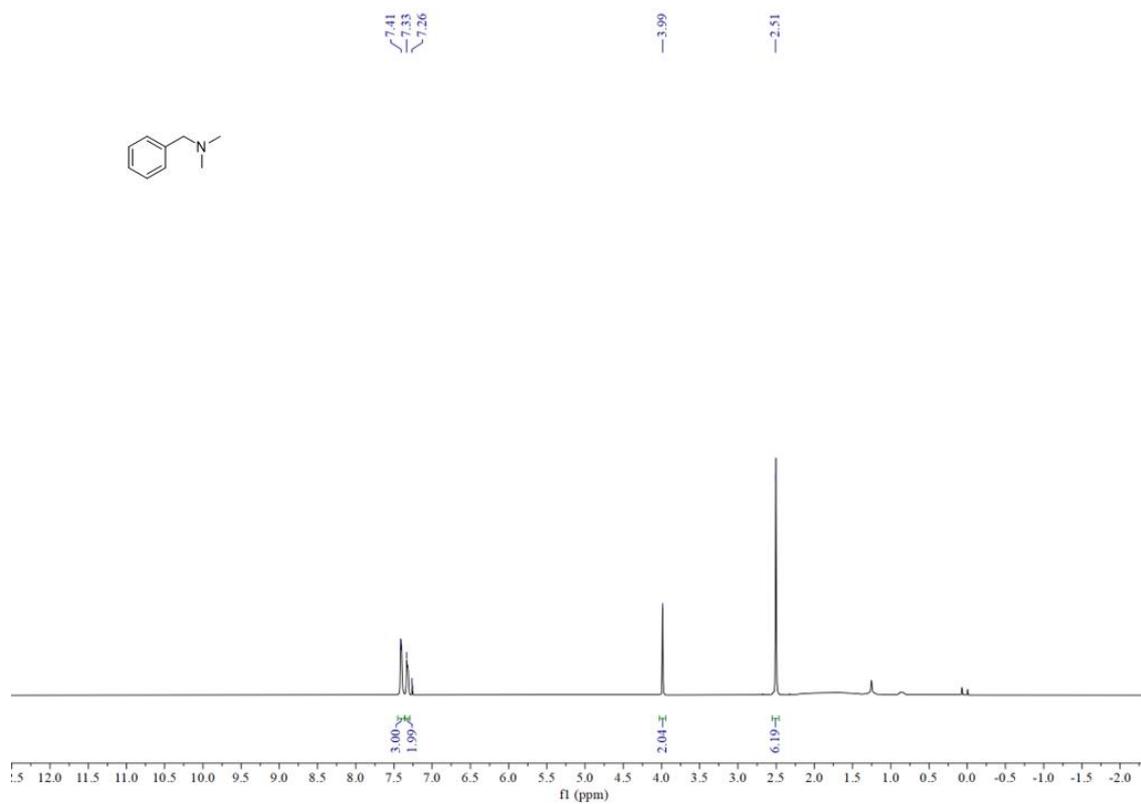


Figure S226. ^1H NMR (400 MHz, CDCl_3) spectrum of 4am

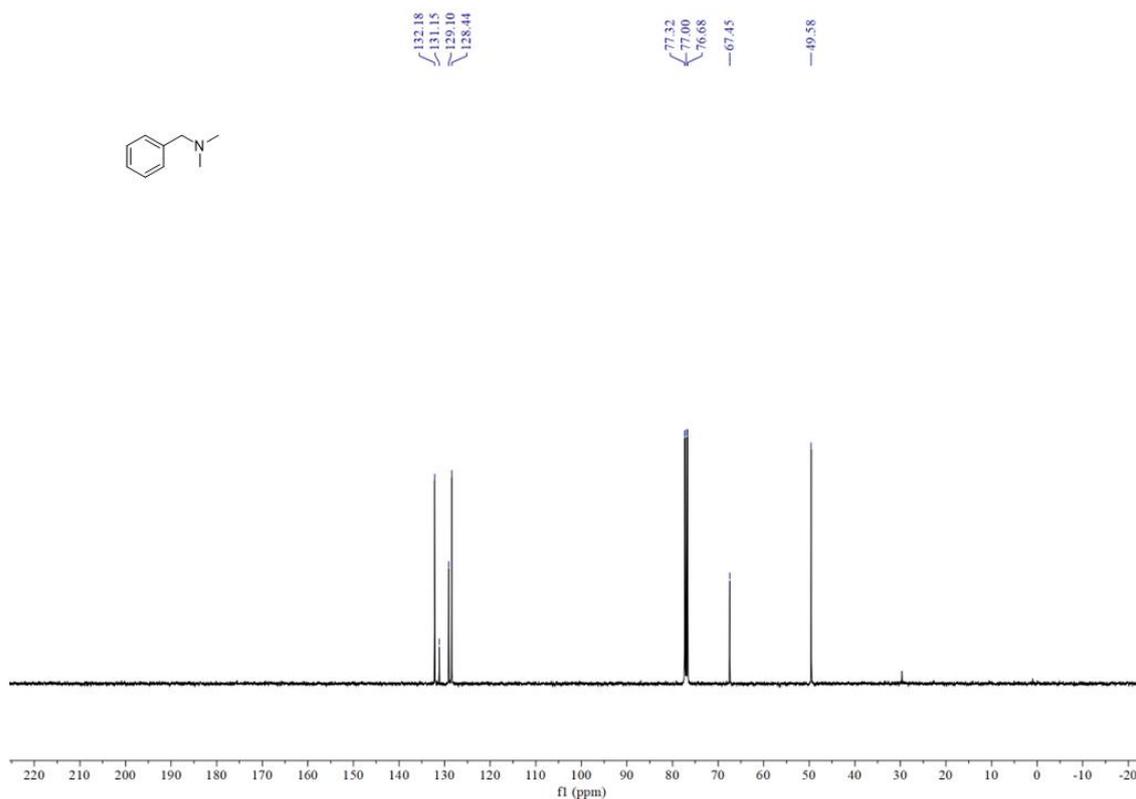


Figure S227. ^{13}C NMR (100 MHz, CDCl_3) spectrum of **4a**

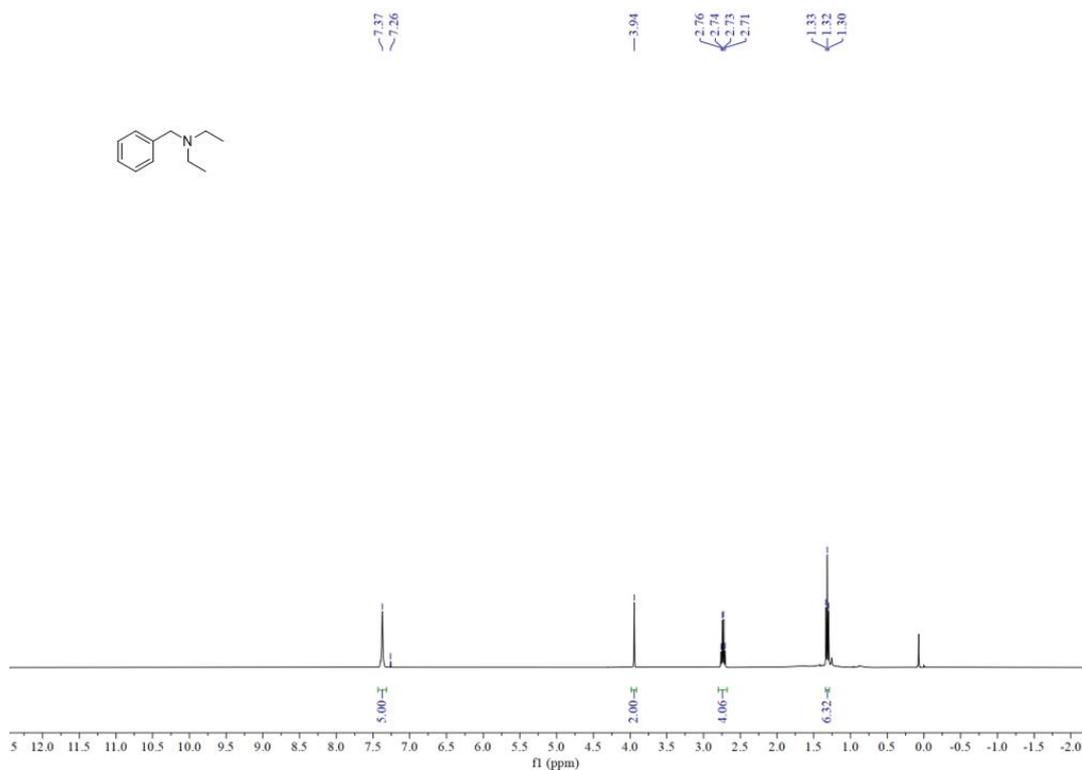


Figure S228. ^1H NMR (400 MHz, CDCl_3) spectrum of **4a**

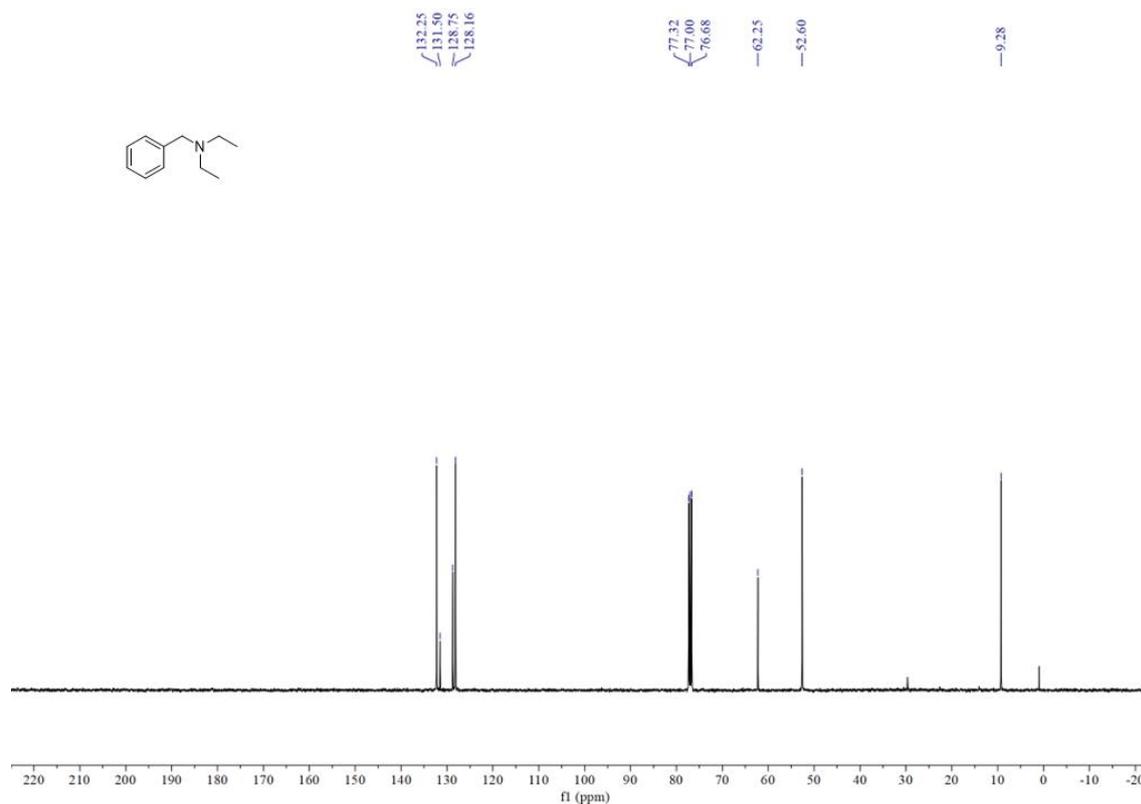


Figure S229. ¹³C NMR (100 MHz, CDCl₃) spectrum of 4ao

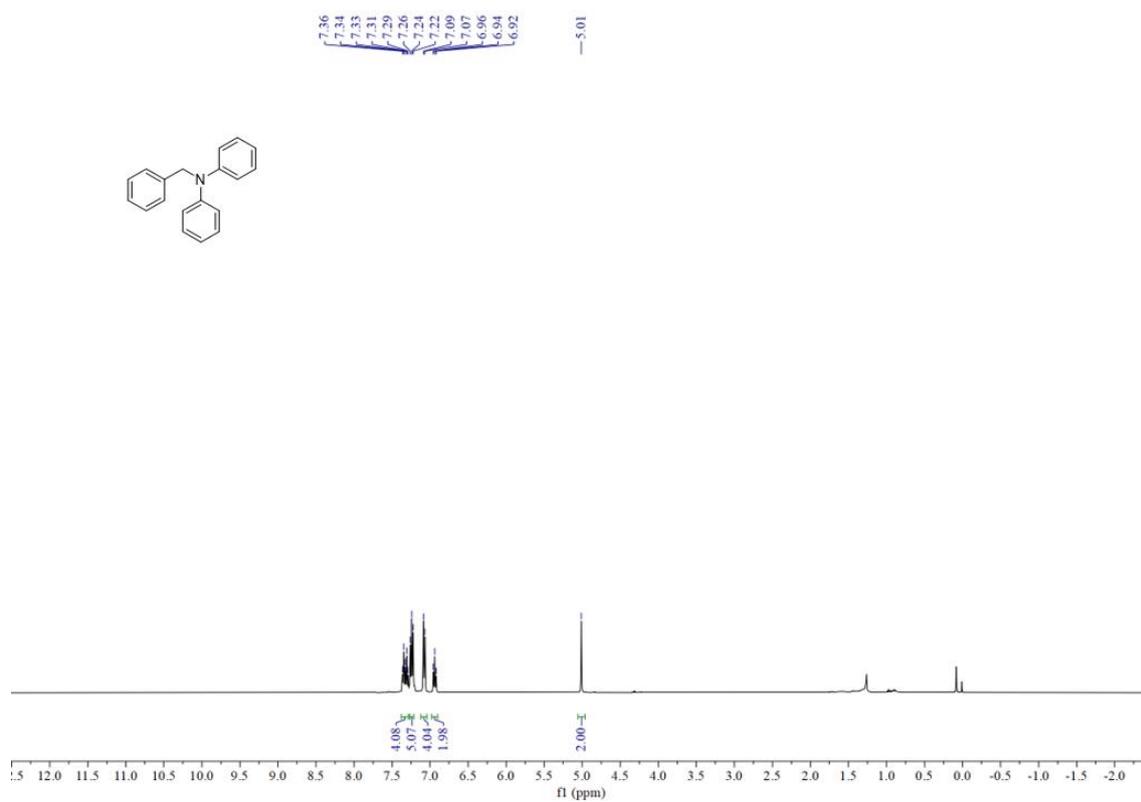


Figure S230. ¹H NMR (400 MHz, CDCl₃) spectrum of 4ap

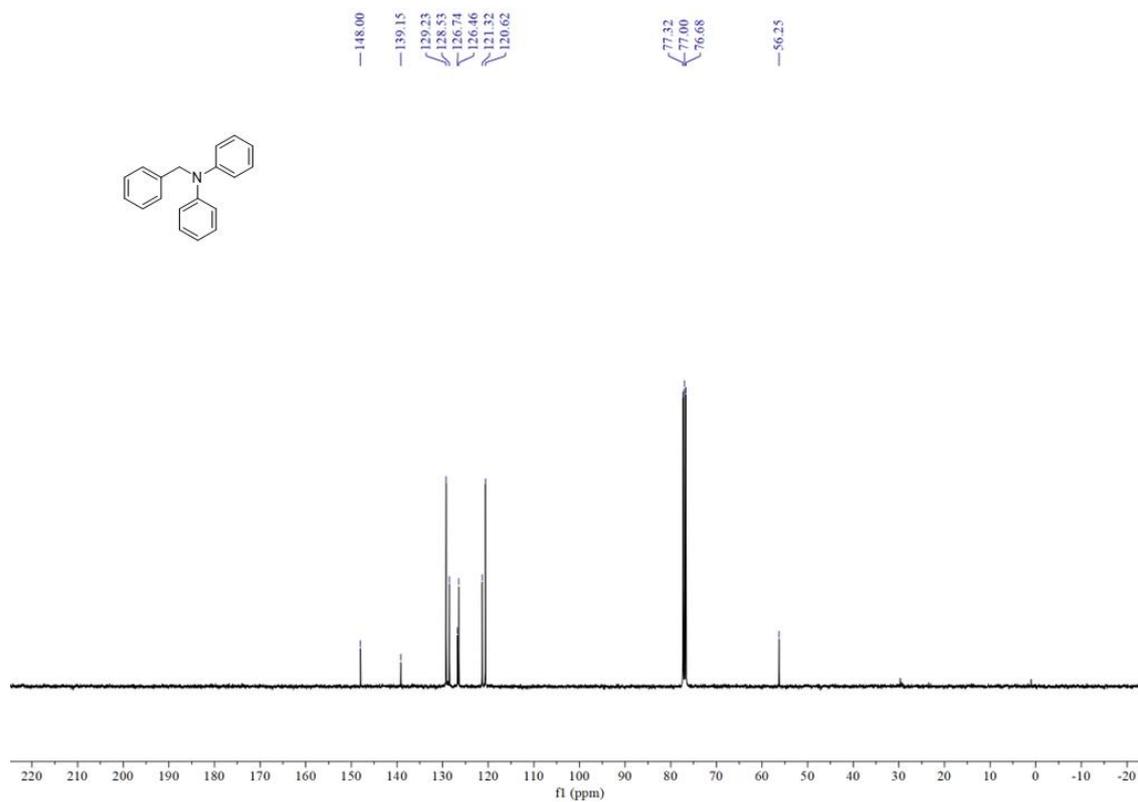


Figure S231. ^{13}C NMR (100 MHz, CDCl_3) spectrum of 4ap

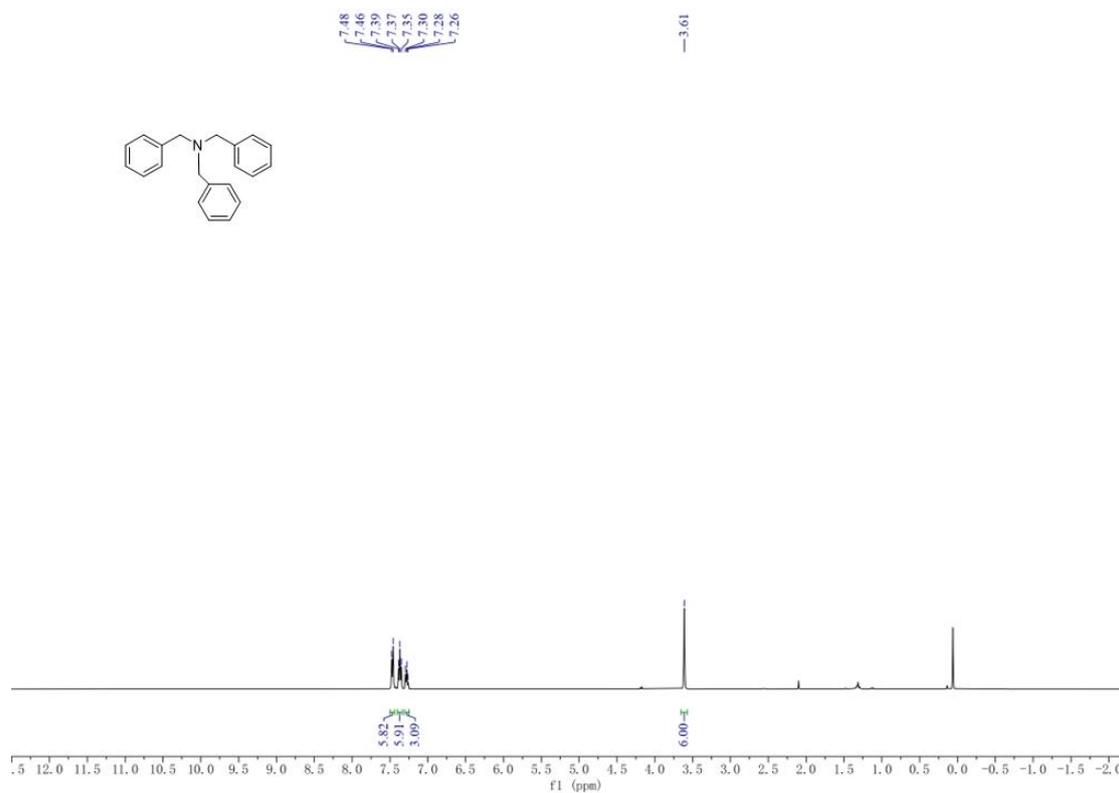


Figure S232. ^1H NMR (400 MHz, CDCl_3) spectrum of 4aq

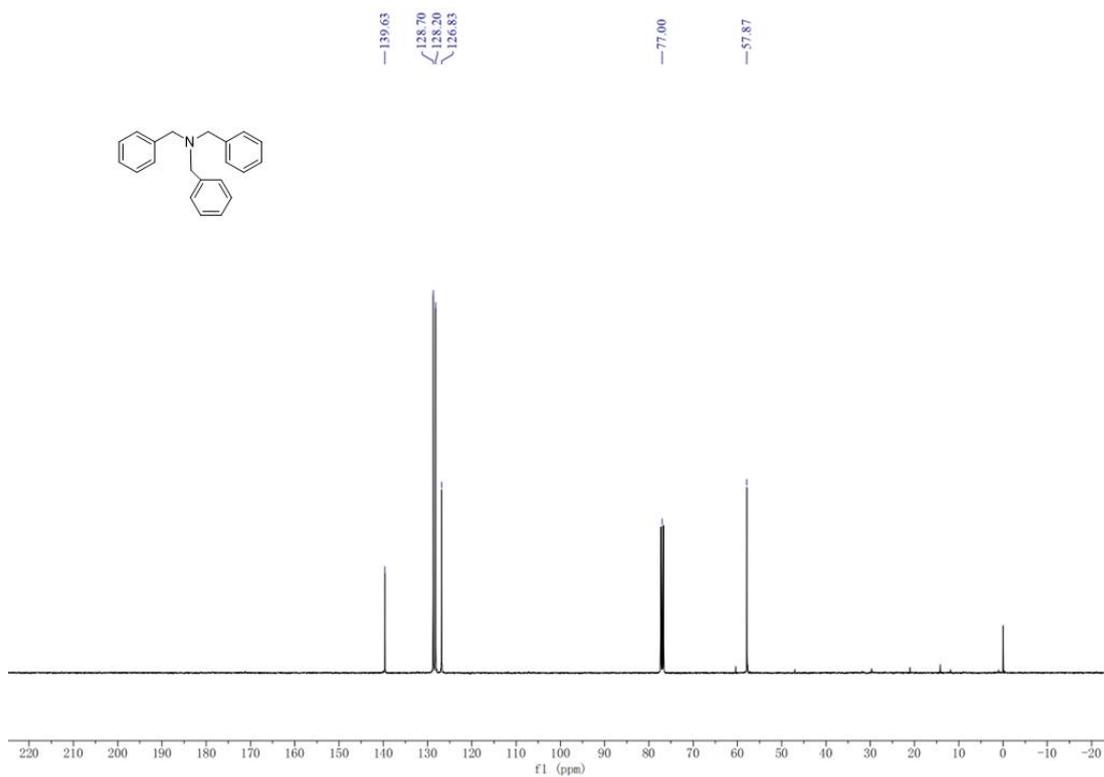


Figure S233. ¹³C NMR (100 MHz, CDCl₃) spectrum of **4aq**