Supporting Information

Enhanced Ester Dechloroacetylation through Transesterification with Trimethoxyborane

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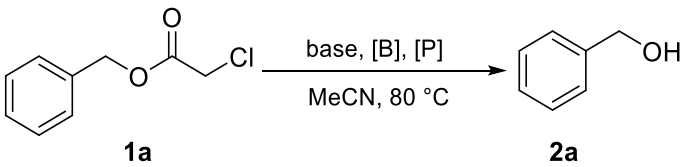
1. General Information

All the reactions were conducted in air tight Schlenk reactors fitted with stoppers that were cleaned, oven dried. All the chemicals and solvents were purchased from local vendors and used as such without further purification. However, solvents were dried according to the procedure reported in the literature. The ^{1}H NMR and ^{13}C NMR spectra were recorded on the Advance II-400 spectrometer (400 MHz for ^{1}H, 100 MHz for ^{13}C) or a Varian Inova-500 spectrometer (500 MHz for 1H, 125 MHz for ^{13}C). The $CDCl_3$ was used as solvent and TMS was used as internal standard for NMR. The chemical shifts are reported in ppm (parts per million, δ) and the residual solvent signal peak of $CDCl_3$ was taken as reference for ^{13}C NMR at 77.000 ppm and for ^{1}H NMR the signal of TMS at 0.000 ppm was taken a reference. The chemical shifts were calculated in δ (ppm) and the coupling constants J were reported in Hz with their multiplicity as: s (singlet), bs (broad singlet), d (doublet), dd (doublet of doublet), t (triplet), dt (doublet of triplet), m (multiplet) etc. High resolution mass spectra were recorded on either a Q-TOF mass spectrometry or a GC-TOF mass spectrometry. The reaction progress was monitored on TLC (thin layer chromatography) and spots were viewed under UV light. The products were purified through column chromatography with 80 mesh silica as stationary phase.

2. Optimization of Reaction Conditions

Table S1. Screening of the Reaction Conditions[a,b]



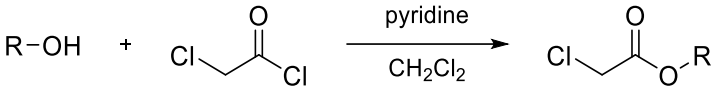
1a **2a**

entry	base	[P]	[B]	2a (%)[c]
1	K_2CO_3	$P(^{n}Bu)_3$	$B(OMe)_3$	43
2	CH_3COOK	$P(^{n}Bu)$	$B(OMe)_3$	0
3	$^{t}BuONa$	$P(^{n}Bu)_3$	$B(OMe)_3$	42
4	$^{t}BuOK$	$P(^{n}Bu)_3$	$B(OMe)_3$	13
5	Cs_2CO_3	$P(^{n}Bu)_3$	$B(OMe)_3$	52
6	KOH	$P(^{n}Bu)_3$	$B(OMe)_3$	52
7	NaOH	$P(^{n}Bu)_3$	$B(OMe)_3$	53
8	$K_4P_2O_7$	$P(^{n}Bu)_3$	$B(OMe)_3$	8

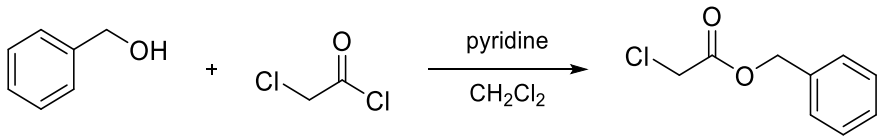
9	CsF	$P(^nBu)_3$	$B(OMe)_3$	71
10	K_3PO_4	$P(^nBu)_3$	$B(OMe)_3$	76
11	K_3PO_4	PCy_3	$B(OMe)_3$	77
12	K_3PO_4	PPh_3	$B(OMe)_3$	84
13	K_3PO_4	dppf	$B(OMe)_3$	81
14	K_3PO_4	TFP	$B(OMe)_3$	94(91)
15	K_3PO_4	TFP (5.0 mol%)	$B(OMe)_3$	94
16	K_3PO_4	TFP (1.0 mol%)	$B(OMe)_3$	94
17	K_3PO_4	TFP	$B(OH)_3$	0
18	K_3PO_4	TFP	$B(O^iBu)_3$	19
19	K_3PO_4	TFP		20
20		TFP	$B(OMe)_3$	trace
21	K_3PO_4	TFP	$B(OMe)_3$	71[d]
22	K_3PO_4	TFP	$B(OMe)_3$	85[e]
23	K_3PO_4	TFP	$B(OMe)_3$	91[f]

[a]Reaction conditions: benzyl chloroacetate (**1a**, 0.3 mmol), base (3.0 equiv.), boron reagent (1.5 equiv.), and phosphine catalyst (10 mol%) in dry solvent (1.5 mL) at 80 ºC under a N_2 atmosphere for 1 h. [b]dppf: 1,10-bis(diphenylphosphino)ferrocene. TFP: tri(2-furyl) phosphine. [c]Yields determined by ^1H NMR using CH_2Br_2 as an internal standard. Isolated yield is given in parentheses. [d]The reaction was conducted at 40 ºC. [e]The reaction was conducted at 60 ºC. [f]The reaction was conducted at 100 ºC.

3. General Methods to the Synthesis of Chloroacetate Compounds

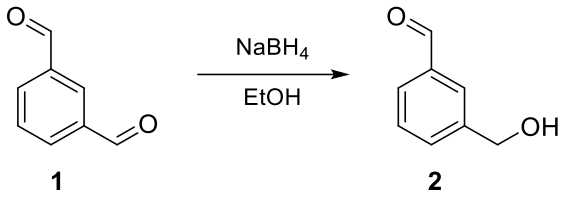


A solution of dry CH_2Cl_2 (5 mL), alcohol (4 mmol), and pyridine (4 mmol) was cooled to 0 °C with stirring, and chloroacetyl chloride (4 mmol) was slowly added dropwise. It is then stirred at 25 °C until the reaction is complete and then quenched with cold water. The two phases were separated, and the aqueous layer extracted twice with CH_2Cl_2. The organic extracts were combined and washed with water and brine, respectively. The CH_2Cl_2 solutions were dried over Na_2SO_4, filtered, and concentrated. The crude product was purified by column chromatography.

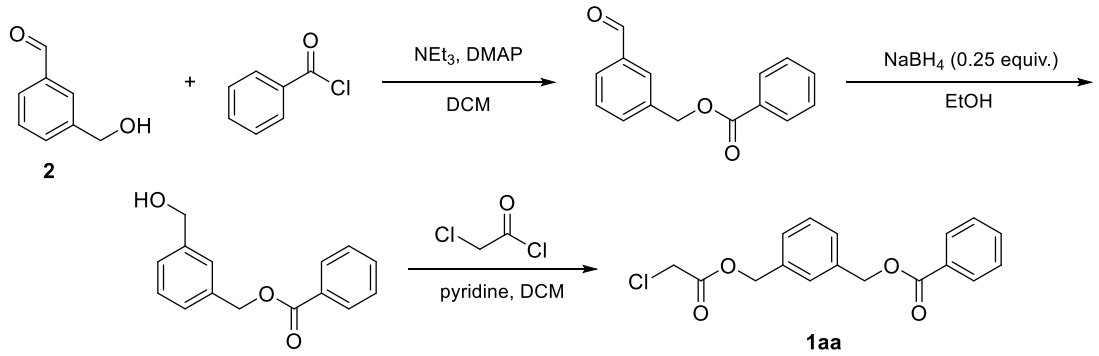


A representative example: A solution of dry CH_2Cl_2 (55 mL), benzyl alcohol (4.5 mL, 43 mmol), and pyridine (3.5 mL, 43 mmol) was cooled to 0 °C with stirring, and chloroacetyl chloride (3.4 mL, 43 mmol) was slowly added dropwise. The reaction was then stirred at 25 °C for 5 h and then quenched with cold water. The two phases were separated, and the aqueous layer extracted twice with CH_2Cl_2 (20 mL). The organic extracts were combined and washed with water and brine, respectively. The CH_2Cl_2 solutions were dried over Na_2SO_4, filtered, and concentrated. The product was purified by column chromatography to give the product (6.83 g, 0.037 mol, 86% yield) of a colorless oil: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43–7.31 (m, 5H), 5.22 (s, 2H), 4.10 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.3, 134.9, 128.7, 128.5, 67.9, 41.0.

4. Synthesis of Other Substrates [1,2]



To a solution of isophthalaldehyde **1** (4.75 g, 35.5 mmol) in ethanol (105 mL) was added sodium borohydride (0.33 g, 8.85 mmol) at 0 °C and the mixture was stirred overnight at 0 °C. After the solvent was removed, CH_2Cl_2 were added to the residue. The combined extracts were washed with brine, dried, and then concentrated in vacuo. The crude product was purified by SiO_2 column chromatography (hexane/ethyl acetate = 1/1) to furnish the desired 3-(hydroxymethyl)benzaldehyde (3.96 g, 82% yield) as a colorless oil.

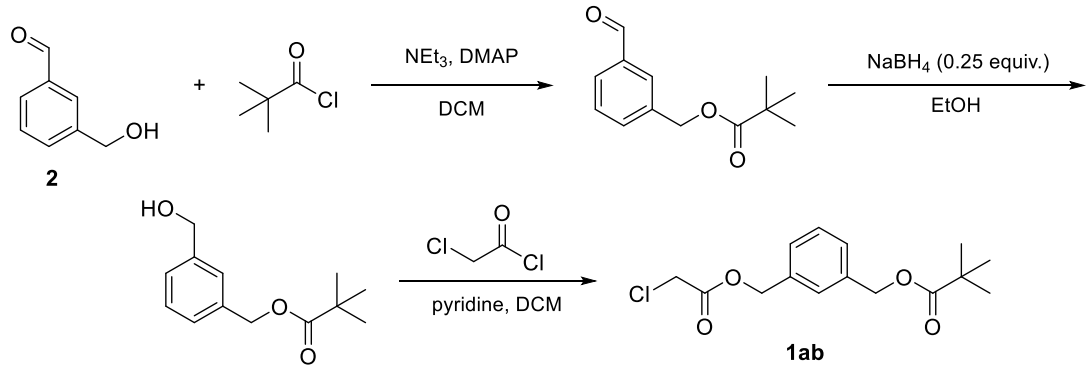


Substrate **2** (0.34 mL, 3 mmol) and DMAP (36.6 mg, 0.3 mmol, 0.1 equiv.) were charged into a two-necked round flask and the flask was refilled with N_2. CH_2Cl_2 (9 mL) and triethylamine (0.83 mL, 2.0 equiv.) were added to the flask. Benzoyl chloride (0.35 mL, 1.0 equiv.) was added dropwise to the mixture at 0 ˚C. The resulting mixture was allowed to warm

to room temperature and stirred overnight. The reaction was quenched with water (10 mL) and the resulting aqueous phase was extracted with CH_2Cl_2. The combined organic phase was washed with brine and dried over Na_2SO_4. After removal of the solvent, the resulting crude mixture was purified by silica gel column chromatography to give 3-formylbenzyl benzoate as a colorless oil (684.7 mg, 2.85 mmol, 95% yield).

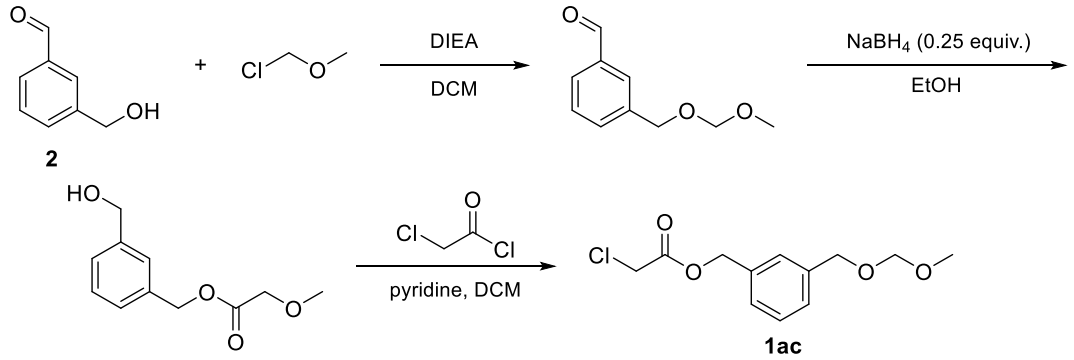
3-Formylbenzyl benzoate in ethanol (8 mL) was added sodium borohydride ($NaBH_4$) (0.25 equiv.) at 0 ℃, and the mixture was stirred for 4 h at room temperature. Solvent was removed and the residue was redissolved in ethyl acetate, washed with water and brine and dried in Na_2SO_4. Upon removal of the solvent, the crude product was purified by SiO_2 column chromatography obtained 3-(hydroxymethyl) benzyl benzoate (628.3 mg, 91% yield).

The compound 3-(hydroxymethyl) benzyl benzoate was then cooled to 0 °C by mixing a dry solution of dry CH_2Cl_2, alcohol (1.0 equiv.), and pyridine (1.0 equiv.) was cooled to 0 °C with stirring, and chloroacetyl chloride (1.0 equiv.) was slowly added dropwise. It is then heated to room temperature of 25 °C and stirred until the reaction is complete, and then quenched in cold water. Two phase separation, CH_2Cl_2 extraction of water layer twice. Mix organic extracts, wash with water, and then wash with saturated salt water. The organic layer solution was dried, filtered and concentrated with anhydrous Na_2SO_4. The product was protected by column chromatography of compound **1aa** (710.8 mg, 86% yield).



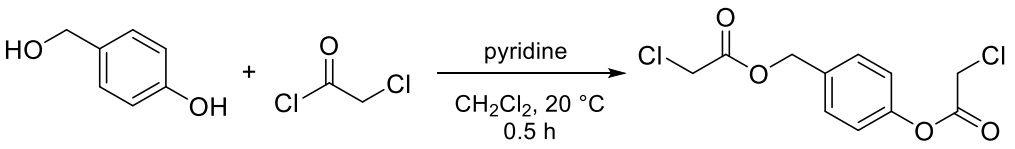
Substrate 2 (0.34 mL, 3 mmol) and DMAP (36.6 mg, 0.3 mmol, 0.1equiv) were charged into a two-necked round flask and the flask was refilled with N_2. CH_2Cl_2 (9 mL) and triethylamine (0.36 mL) were added to the flask. Pivaloyl chloride (0.36 mL) was added dropwise to the mixture at 0 ˚C. The resulting mixture was allowed to warm to room temperature and stirred overnight. The reaction was quenched with water (10 mL) and the resulting aqueous phase was extracted with CH_2Cl_2. The combined organic phase was washed with brine and dried over Na_2SO_4. After removal of the solvent, the resulting crude mixture was purified by silica gel column chromatography to give 3-formylbenzyl pivalate as a colorless oil (607.9 mg, 92% yield). Then obtained 3-(hydroxymethyl) benzyl pivalate (546.0 mg, 89% yield)

according to $NaBH_4$ reduction method, Finally, the compound **1ab** (623.8mg, 85% yield) was obtained through the reaction of 3-(hydroxymethyl) benzyl pivalate with chloroacetyl chloride.



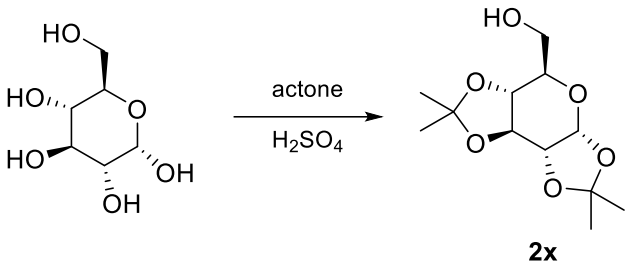
2 **1ac**

To a stirred solution of alcohol **2** (1.0 equiv.) in CH_2Cl_2, added DIEA (2.2 equiv.) and MOMCl (2 equiv.) at 0 °C, and the reaction mixture was stirred at room temperature until the reaction completed. After slow addition of NH_4Cl at 0 °C, the mixture was extracted with CH_2Cl_2 (5 mL×3). The combined organic layer was washed with brine, dried over Na_2SO_4, filtered, and concentrated in vacuo. The crude product was purified by flash column chromatography to afford 3-((methoxymethoxy) methyl) benzaldehyde (491.4 mg, 91% yield). 3-(hydroxymethyl) benzyl 2-methoxyacetate (522.3 mg, 91% yield) was obtained following the $NaBH_4$ reduction method. Finally, compound **1ac** (552.6 mg, 86% yield) was obtained through the reaction of 3-(hydroxymethyl) benzyl 2-methoxyacetate with chloroacetyl chloride.



1ae

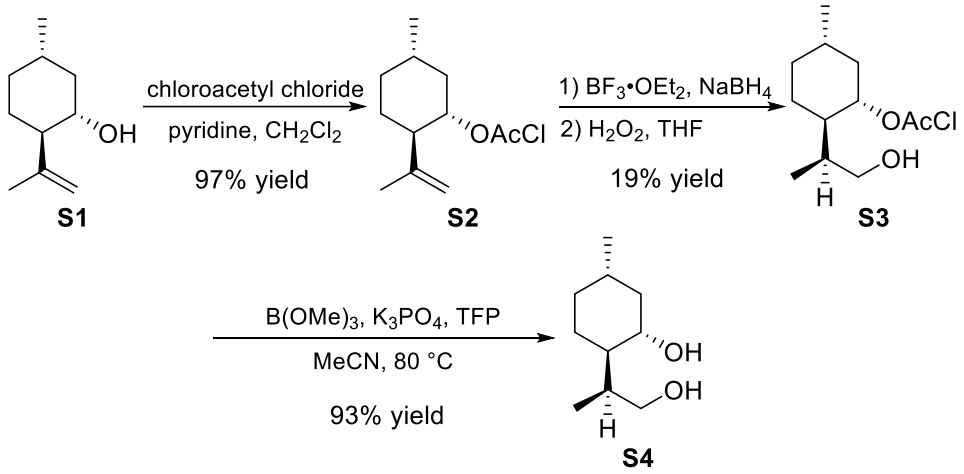
To a stirred solution of 4-(hydroxymethyl)phenol (1.0 equiv.) in CH_2Cl_2, chloroacetyl chloride (2.2 equiv.) was added at 0 °C and stirred for 10 minutes. Subsequently, pyridine (3.0 equiv.) was added, and the reaction mixture was stirred at room temperature until completion. The reaction mixture was then extracted with CH_2Cl_2 (5 mL × 3). The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4, filtered, and concentrated in vacuo. The crude product was purified by flash column chromatography to afford compound **1ae** (797.1 mg, 96% yield).



2x

D-(+)-glucose (1.12 g, 6 mmol, 1.0 equiv.) in acetone (42 mL) were treated in parallel with conc. H_2SO_4 (1.22 mL) at 0°C. The reaction mixtures were stirred at room temperature for 7 h and then neutralized by the addition of water (5 mL, 1 mL/g galactose) and Na_2CO_3 until pH = 7. The precipitate was removed by filtration through a pad of Celite. The filtrates were combined and concentrated under reduced pressure. the residue was purified by silica gel chromatography (petroleum ether/EtOAc = 2/1) to give **2x** (1.246 g, 80% yield) as a colorless oil.

5. Synthesis of Artemisinin Intermediate



S1 **S2** **S3** **S4**

The dry solutions of dichloromethane (8 mL), isopulegol **S1**(1 mL, 6 mmol), and pyridine (0.54 mL, 6 mmol) were stirred to cool to 0 °C, then chloracetyl chloride (0.48 mL, 6 mmol) was added dropwise. Then stirring at 25 °C until the reaction is complete, and quenching with cold water. Two phase separation, extraction of water layer with methylene chloride twice. Mix organic extracts, wash with water, and then wash with saturated salt water. The methylene chloride solution was dried, filtered and concentrated with Na_2SO_4. The product was purified by column chromatography to obtain **S2** (1.336g, 97% yield) as colorless oil-like liquid.

Diborane generated from $NaBH_4$ (100 mg, 2.39 mmol) and $BF_3 \cdot Et_2O$ (0.35 mL, 2.87 mmol) in diglyme was passed through a solution of compound **S2** (692 mg, 3 mmol) in dry THF (6 mL) maintained at 0 °C. After addition of diborane, there action mixture was stirred for 4 h at

room temperature. Then, THF (1 mL of a 50% aqueous solution) was added to the reaction mixture. The resultant solution was cooled at 0 °C, and then add NaOH aqueous (0.85 mL, 3.0 N), add 0.85 mL 30% hydrogen peroxide water solution drop by drop, the resulting mixture was stirred for 0.5 h. The product was extracted with ethyl acetate, and the organic phase was washed with water, dried with Na_2SO_4, and concentrated under vacuum. The crude product was purified by column chromatography on silica gel eluting with hexane: ethyl acetate = 7: 3, light yellow liquid **S3** (140.9 mg, 19% yield) was obtained. Then the compound **S4** (48.1 mg, 93% yield) was obtained by removing chloro-acetyl group under optimal conditions.

6. Mechanistic Studies

In order to verify another product of the reaction, the following experiment was conducted, as shown in Fig. S1. The presence of methoxy group could be clearly detected by ^{1}H NMR.

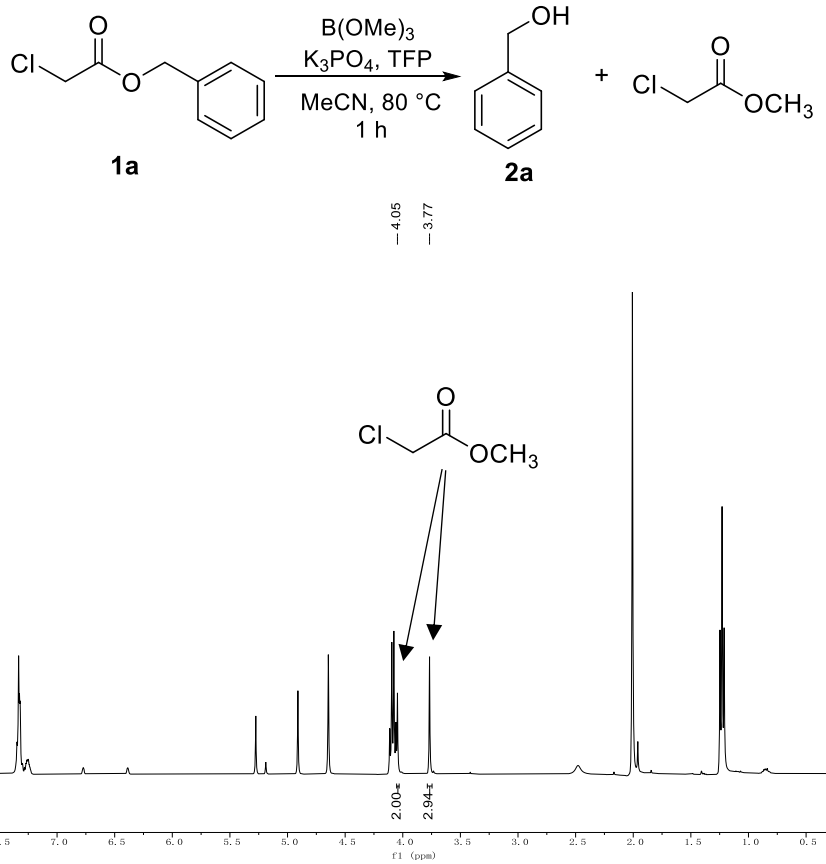


Fig. S1 ^{1}H NMR tracking on the reaction solution of the deprotection of benzyl chloroacetate (**1a**)

In order to have a deeper understanding of the role and mechanism of potassium phosphate, additives trimethyl borate and phosphine in the reaction, ^{11}B NMR was used to monitor the whole process, as shown in Fig. S2. Peaks of 18.2 and 2.5 were found at 20 minutes of reaction, while only peaks of 18.2 were found in the form of trimethyl borate.

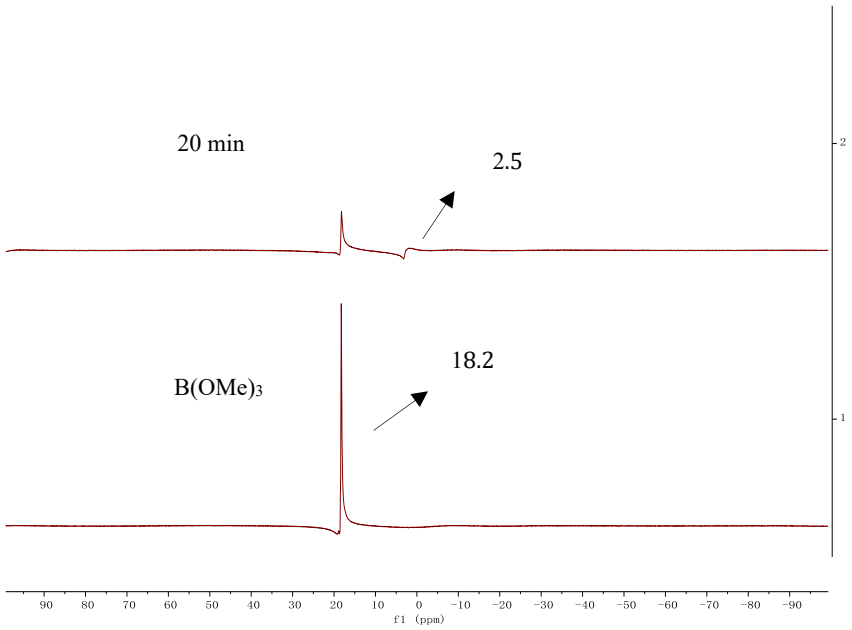
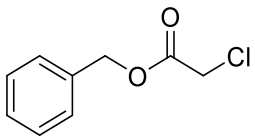


Fig. S2 ^{11}B NMR of the reaction solution

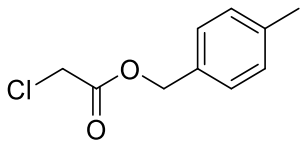
7. Characterization Data of Starting Materials and Products

Benzyl chloroacetate (1a) [3]



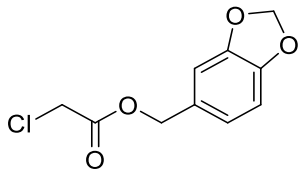
Benzyl alcohol (4.5 mL, 43 mmol) as starting material. Colorless oil, (6.83 g, 86% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43-7.31 (m, 5H), 5.22 (s, 2H), 4.10 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.3, 134.9, 128.7, 128.5, 67.9, 41.0.

4-Methylbenzyl 2-chloroacetate (1b)



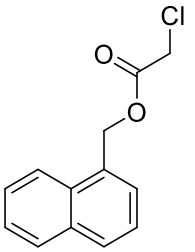
4-Methylbenzyl alcohol (488.6 mg, 4 mmol) as starting material. Colorless oil, (546 mg, 69% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (d, J = 7.8 Hz, 2H), 7.22 (d, J = 7.8 Hz, 2H), 5.21 (s, 2H), 4.11 (s, 2H), 2.39 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.2, 138.7, 131.9, 129.4, 128.7, 67.9, 41.0, 21.3; IR (neat) 1754, 1737, 1461, 1451, 1382, 1164, 843, 804, 445, 423 cm^{-1}; HRMS (EI) calcd for $C_{10}H_{11}ClO_2$ $[M]^+$, 198.0442; found: 198.0439.

Benzo[d] [1,3] dioxol-5-ylmethyl 2-chloroacetate (1c)



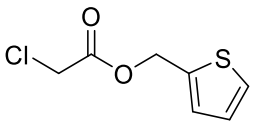
Piperonol (608.6 mg, 4 mmol) as starting material. Brown oil, (649.3 mg, 71% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.88-6.87 (d, J = 5.9 Hz, 2H), 6.83-6.81 (d, J = 7.6 Hz, 1H), 6.00 (s, 2H), 5.14 (s, 2H), 4.10 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.2, 148.0, 147.9, 128.6, 122.8, 109.3, 108.3, 101.3, 67.9, 41.0; IR (neat) 2957, 2899, 1749, 1503, 1447, 1252, 1169, 1039, 869, 809 cm^{-1}; HRMS (ESI) calcd for $C_{10}H_9ClNaO_4$ $[M+Na]^+$, 251.0082; found: 251.0077.

Naphthalen-1-ylmethyl 2-chloroacetate (1d)



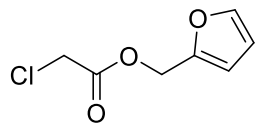
1-naphthalene methanol (632.8 mg, 4 mmol) as starting material. Colorless oil, (795.6 mg ,85% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 (d, J = 8.2 Hz, 1H), 7.92-7.83 (m, 2H), 7.61-7.48 (m, 3H), 7.45 (dd, J = 8.2, 7.0 Hz, 1H), 5.67 (s, 2H), 4.08 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.3, 133.8, 131.6, 130.5, 129.8, 128.9, 128.1, 126.8, 126.2, 125.3, 123.4, 66.2, 41.0; IR (neat) 1755, 1598, 1512, 1467, 1306, 1170, 964, 857, 791, 775 cm^{-1}; HRMS (ESI) calcd for $C_{13}H_{11}ClNaO_2$ $[M+Na]^+$,257.0340; found: 257.0339.

Thiophen-2-ylmethyl 2-chloroacetate (1e)



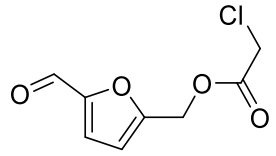
2-thiophenemethanol (465.7 mg, 4 mmol) as starting material. Colorless oil, (739.7 mg, 97% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.32 (m, 1H), 7.13 (d, J = 3.5 Hz, 1H), 7.00 (dd, J = 4.9, 3.7 Hz, 1H), 5.37 (s, 2H), 4.08 (s, 2H);^{13}C NMR (101 MHz, $CDCl_3$) δ 167.1, 136.6, 129.1, 127.5, 127.0, 62.0, 40.9; IR (neat) 3109, 3005, 2846, 1757, 1410, 1283, 1251, 1163, 1043, 959, 708 cm^{-1}; HRMS (ESI) calcd for $C_7H_7ClNaO_2S$ $[M+Na]^+$, 212.9747; found: 212.9743.

(Furan-2-yl)methyl 2-chloroacetate (1f) [4]



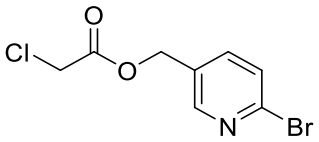
(2-furyl) methyl alcohol (392.0 mg, 4 mmol) as starting material. Pale yellow oil, (635.5 mg, 91% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 (s, 1H), 6.46 (d, J = 3.2 Hz, 1H), 6.41-6.36 (m, 1H), 5.17 (s, 2H), 4.09 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.0, 148.5, 143.7, 111.5, 110.7, 59.5, 40.8.

(5-Formylfuran-2-yl) methyl 2-chloroacetate (1g)



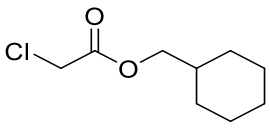
5-hydroxymethyl-2-furfuraldehyde (504.4 mg, 4 mmol) as starting material. Brown oil, (656.4 mg, 81% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.65 (s, 1H), 7.24 (d, J = 3.6 Hz, 1H), 6.67 (d, J = 3.6 Hz, 1H), 5.25 (s, 2H), 4.13 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 196.8, 165.4, 153.8, 135.2, 130.1, 121.4, 40.8, 26.6; IR (neat) 3126, 2838, 1755, 1678, 1525, 1414, 1367, 1163, 782, 569 cm^{-1}; HRMS (ESI) calcd for $C_8H_8ClO_4$ $[M+H]^+$, 203.0106; found: 203.0102.

(6-Bromopyridin-3-yl) methyl 2-chloroacetate (1h)



2-bromo-5-(hydroxymethyl) pyridine (752.1 mg, 4 mmol) as starting material.Colorless oil, (814.6 mg, 77% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 (d, J = 2.4 Hz, 1H), 7.61 (dd, J = 8.2, 2.4 Hz, 1H), 7.52 (d, J = 8.2 Hz, 1H), 5.20 (s, 2H), 4.12 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.0, 150.2, 142.5, 138.8, 130.0, 128.2, 64.4, 40.6; IR (neat) 2926, 1752, 1283, 1169,1087, 1018, 821, 789, 736, 632 cm^{-1}; HRMS (ESI) calcd for $C_8H_8BrClNO_2$ $[M+H]^+$, 263.9421; found: 263.9414.

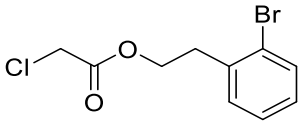
Cyclohexyl methyl 2-chloroacetate (1i)



Cyclohexyl methyl alcohol (456.7 mg, 4 mmol) as starting material. Colorless oil, (579.6 mg, 76% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.07 (s, 2H), 4.00 (d, J = 6.4 Hz, 2H), 1.78-1.65 (m, 6H), 1.30-1.16 (m, 3H), 1.04-0.91 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.4, 71.2,

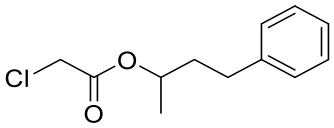
40.9, 37.0, 29.5, 26.2, 25.6; IR (neat) 2927, 2854, 1758, 1451, 1308, 1179, 995, 886, 841, 792 cm^{-1}; HRMS（EI）calcd for $C_8H_{13}O_2$ $[M-CH_2Cl]^+$, 141.0910; found: 141.0906.

2-Bromophenethyl 2-chloroacetate (1j)



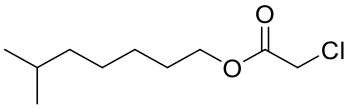
2-bromophenylethyl alcohol (804.3 mg, 4 mmol) as starting material. Colorless oil, (949 mg, 86% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.57 (d, J = 8.0 Hz, 1H), 7.28 (d, J = 3.8 Hz, 2H), 7.14 (ddd, J = 8.7, 5.5, 3.6 Hz, 1H), 4.45 (t, J = 6.9 Hz, 2H), 4.07 (s, 2H), 3.15 (t, J = 6.9 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.2, 136.6, 133.0, 131.2, 128.6, 127.6, 124.6, 65.0, 40.9, 35.1; IR (neat) 1759, 1592, 1472, 1441, 1311, 1286, 1170, 782, 752, 656 cm^{-1}; HRMS (ESI) calcd for $C_{10}H_{11}BrClO_2$ $[M+H]^+$, 276.9625; found: 276.9622.

4-Phenylbutan-2-yl 2-chloroacetate (1k)



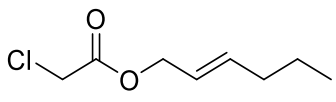
1-phenyl-3-butanol (600.9 mg, 4 mmol) as starting material. Colorless oil, (734.5 mg, 81% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.28 (d, J = 7.4 Hz, 2H), 7.20-7.13 (m, 3H), 5.08-4.95 (m, 1H), 3.99 (s, 2H), 2.73-2.59 (m, 2H), 2.06-1.77 (m, 2H), 1.30 (d, J = 6.3 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.0, 141.2, 128.5, 128.4, 126.1, 73.0, 41.2, 37.3, 31.7, 19.9; IR (neat) 3027, 2935, 2935, 1751, 1499, 1453, 1380, 1191, 1131, 1049, 743, 699 cm^{-1}; HRMS (ESI) calcd for $C_{12}H_{15}ClNaO_2$ $[M+Na]^+$, 249.0653; found: 249.0648.

2-Ethylhexyl 2-chloroacetate (1l)



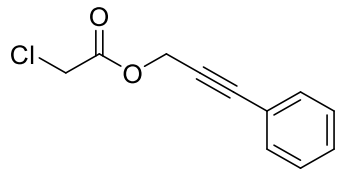
6-methylheptan-1-ol (520.9 mg, 4mmol) as starting material. Colorless oil, (785.5 mg, 95% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 4.11 (dd, J = 5.8, 2.3 Hz, 2H), 4.07 (s, 2H), 1.69-1.65 (m, J = 6.0 Hz, 1H), 1.38 (q, J = 7.2 Hz, 2H), 1.30 (d, J = 5.9 Hz, 6H), 0.90 (t, J = 7.5 Hz, 6H);^{13}C NMR (101 MHz, $CDCl_3$) δ 167.4, 68.6, 40.9, 38.7, 30.3, 28.8, 23.7, 22.9, 13.9, 10.9; IR (neat) 2960, 2931, 2861, 1759, 1463, 1413, 1382, 1181, 729, 700 cm^{-1}; HRMS (EI) calcd for $C_9H_{17}O_2$ $[M-CH_2Cl]^+$, 157.1223; found: 157.1220.

(E)-hex-2-en-1-yl 2-chloroacetate (1m)



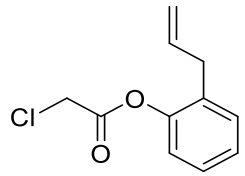
(2E)-hexen-1-ol (400.6 mg, 4 mmol) as starting material. Colorless oil, (607.5 mg, 86% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.82 (dt, J = 14.4, 6.7 Hz, 1H), 5.58 (dtd, J = 15.2, 6.6, 1.5 Hz, 1H), 4.63 (d, J = 6.6 Hz, 2H), 4.07 (s, 2H), 2.05 (q, J = 7.2 Hz, 2H), 1.46-1.37 (m, J = 7.4 Hz, 2H), 0.91 (t, J = 7.3 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.1, 137.7, 123.0, 67.0, 41.0, 34.3, 21.9, 13.6; IR (neat) 2927, 1745, 1634, 1409, 1316, 1196, 1041, 914, 780, 702 cm^{-1}; HRMS (EI) calcd for $C_8H_{13}ClO_2$ $[M]^+$, 176.0599; found: 176.0594.

3-Phenylprop-2-yn-1-yl 2-chloroacetate (1n)



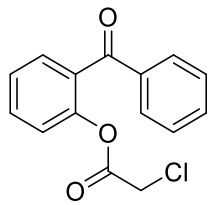
3-Phenyl-2-propyn-1-ol (528.6 mg, 4 mmol) as starting material. Pale yellow oil, (717.7 mg, 86% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48-7.43 (m, 2H), 7.37-7.29 (m, J = 6.8 Hz, 3H), 5.02 (s, 2H), 4.14 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.8, 132.0, 129.0, 128.4, 121.8, 87.4, 81.9, 54.5, 40.7; IR (neat) 1747, 1597, 1490, 1162, 758, 637, 691, 637 cm^{-1}; HRMS (ESI) calcd for $C_{11}H_9ClNaO_2$ $[M+Na]^+$, 231.0183; found: 231.0181.

2-allylphenyl 2-chloroacetate (1o)



2-Allylphenol (536.7 mg, 4 mmol) as starting material. Colorless oil, (514 mg, 61% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31-7.17 (m, 3H), 7.11-7.04 (m, 1H), 5.89 (ddt, J = 16.8, 10.2, 6.5 Hz, 1H), 5.12-5.01 (m, 2H), 4.29 (s, 2H), 3.32 (dt, J = 6.5, 1.5 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.8, 148.6, 135.7, 131.7, 130.7, 127.7, 126.8, 122.0, 116.4, 40.8, 34.6; IR (neat) 1750, 1650, 1452, 1410, 1309, 1210, 767, 690, 649, 547 cm^{-1}; HRMS (ESI) calcd for $C_{11}H_{11}ClNaO_2$ $[M+Na]^+$, 233.0340; found: 233.0336.

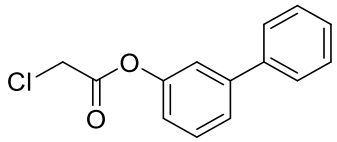
2-benzoylphenyl 2-chloroacetate (1p)



2-Hydroxybenzophenone (584.8 mg, 3 mmol) as starting material. Colorless oil, (453.2 mg, 55% yield).^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79-7.72 (m, 2H), 7.63-7.54 (m, 3H), 7.47 (dd,

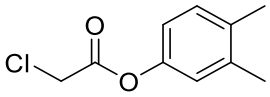
J = 8.3, 7.1 Hz, 2H), 7.40-7.36 (m, *J* = 7.6, 1.1 Hz, 1H), 7.28-7.22 (m, 1H), 3.95 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 194.4, 165.7, 148.5, 137.5, 133.2, 132.6, 131.01, 131.09, 129.8, 128.5, 126.3, 123.0, 40.4; IR (neat) 3063, 1782, 1664, 1605, 1580, 1274, 1199, 767, 766, 635 cm^{-1}; HRMS (EI) calcd for $C_{15}H_{11}ClO_3$ $[M]^+$, 274.0391; found: 274.0386

[1,1'-biphenyl]-3-yl 2-chloroacetate (1q)



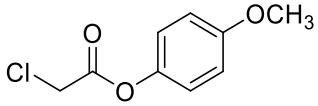
3-phenylphenol (680.8 mg, 4 mmol) as starting material. Colorless oil, (937.4 mg, 95% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50-7.36 (m, 8H), 7.22 (d, *J* = 7.9 Hz, 1H), 4.10 (s, 2H);^{13}C NMR (101 MHz, $CDCl_3$) δ 165.8, 147.4, 137.1, 134.8, 131.1, 128.9, 128.7, 128.5, 127.8, 127.0, 122.4, 40.7; IR (neat) 2852, 1777, 1279, 1244, 1187, 1141, 763, 739, 739, 700 cm^{-1}; HRMS（ESI）calcd for $C_{14}H_{11}ClNaO_2$ $[M+Na]^+$, 269.0340; found: 269.0334.

3,4-dimethylphenyl 2-chloroacetate (1r)



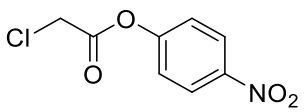
3,4-Dimethylphenol (488.6 mg, 4 mmol) as starting material. Colorless oil, (635.5 mg, 80% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.14 (s, 1H), 6.89 (d, *J* = 2.5 Hz, 1H), 6.87-6.80 (m, 1H), 4.27 (s, 2H), 2.24 (d, *J* = 4.9 Hz, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.2, 148.2, 138.2, 134.8, 130.5, 122.0, 118.2, 41.0, 19.9, 19.3; IR (neat) 2925, 2858, 1774, 1497, 1451, 1278, 1188, 1156, 1002, 700 cm^{-1}; HRMS (ESI) calcd for $C_{10}H_{11}ClNaO_2$ $[M+Na]^+$, 221.0340; found: 221.0336.

4-Methoxyphenyl 2-chloroacetate (1s)



4-Methoxy-phenol (496.5 mg, 4 mmol) as starting material. Yellow solid, (650 mg, 81% yield). mp 49-50 ℃, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.09-7.00 (m, 2H), 6.90 (d, *J* = 8.5 Hz, 2H), 4.29 (s, 2H), 3.81 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.3, 157.6, 143.8, 121.9, 114.6, 55.6, 40.9; IR (KBr) 1771, 1506, 1435, 1243, 1192, 1164, 1143, 1032, 825, 767 cm^{-1}; HRMS (EI) calcd for $C_9H_9ClO_3$ $[M]^+$, 200.0235; found: 200,0232.

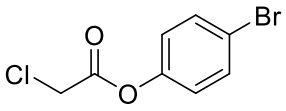
4-Nitrophenyl 2-chloroacetate(1t) [5]



4-Nitro-phenol (556.4 mg, 4 mmol) as starting material. Brown solid, (784.7 mg, 91% yield).mp 95-97 ℃, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.34-8.28 (m, 2H), 7.38-7.32 (m, 2H), 4.35

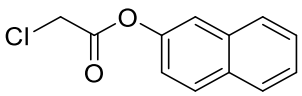
(s, 2H);^{13}C NMR (101 MHz, $CDCl_3$) δ 165.0, 154.7, 145.8, 125.4, 122.1, 40.7.

4-Bromophenyl 2-chloroacetate (1u)



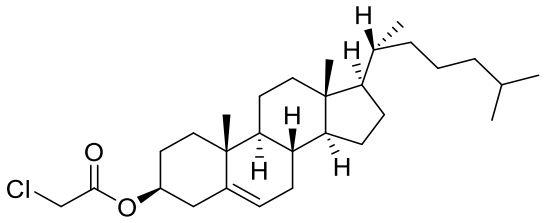
4-Bromo-phenol (692.0 mg, 4 mmol) as starting material. Colorless oil, (688.3 mg, 69% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58-7.48 (m, 2H), 7.08-6.97 (m, 2H), 4.32 (s, 2H);^{13}C NMR (101 MHz, $CDCl_3$) δ 165.6, 149.3, 132.7, 123.0, 119.6, 40.8; IR (neat) 1738, 1587, 1488, 1428, 1196, 1167, 1095, 1069, 823, 606 cm^{-1}; HRMS (EI) calcd for $C_8H_6BrClO_2$ $[M]^+$, 247.9234; found: 247.9233.

Naphthalen-2-yl 2-chloroacetate (1v)



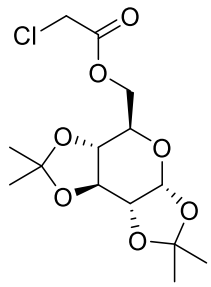
β-naphthol (576.7 mg, 4 mmol) as starting material. Brown solid, (662.0 mg, 75% yield). mp 95-97 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89-7.81 (m, J = 7.9 Hz, 2H), 7.82 (d, J = 8.0 Hz, 1H), 7.62 (d, J = 2.2 Hz, 1H), 7.54-7.47 (m, J = 9.2, 6.6 Hz, 2H), 7.27 (s, 1H), 4.37 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.1, 147.9, 133.7, 131.7, 129.7, 127.85, 127.76, 126.8, 126.1, 120.4, 118.4, 41.0; IR (KBr) 3060, 2999, 1768, 1638, 1613, 1499, 1313, 1243, 1212, 1172, 1040, 755 cm^{-1}; HRMS (EI) calcd for $C_{12}H_9ClO_2$ $[M]^+$, 220.0286; found: 220.0280.

Chloroacetic acid cholesterylester (1w) [6]



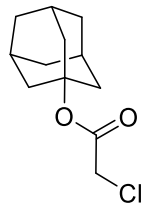
β-Cholesterol (1.160 g, 3 mmol) as starting material. Brown solid, (930.9 mg, 67% yield). mp 160-161 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.41 (d, J = 5.2 Hz, 1H), 4.73 (dtd, J = 12.3, 8.5, 4.5 Hz, 1H), 4.06 (s, 2H), 2.38 (d, J = 8.2 Hz, 2H), 2.10-1.76 (m, 6H), 1.68-1.43 (m, 7H), 1.43-1.24 (m, 5H), 1.15 (dtd, J = 13.5, 9.3, 8.9, 4.3 Hz, 5H), 1.04 (d, J = 7.5 Hz, 4H), 0.94 (d, J = 6.5 Hz, 3H), 0.92-0.81 (m, 8H), 0.71 (d, J = 4.7 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.8, 139.2, 123.2, 76.2, 56.7, 56.1, 50.0, 42.3, 41.2, 39.7, 39.5, 37.9, 36.9, 36.6, 36.2, 35.8, 31.9, 31.8, 28.2, 28.0, 27.6, 24.3, 23.8, 22.8, 22.6, 21.0, 19.3, 18.7, 11.9.

((3aR,5R,5aR,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-5H-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)methyl 2-chloroacetate (1x)



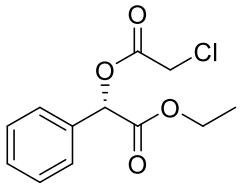
((3aR,5R,5aR,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-5H-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)methanol (780.9 mg, 3mmol) as starting material. Brown oil, (929.5 mg, 92% yield). ^{1}H NMR (400 MHz, CDCl3) δ 5.90 (d, J = 3.7 Hz, 1H), 5.33 (s, 1H), 4.53 (d, J = 3.7 Hz, 1H), 4.10 (s, 2H), 4.05-3.96 (m, 1H), 2.04 (s, 1H), 1.52 (s, 3H), 1.41 (s, 3H), 1.31 (s, 6H).; ^{13}C NMR (101 MHz, CDCl3) δ 167.1, 112.6, 104.9, 82.8, 78.6, 77.9, 68.3, 64.0, 40.7, 26.5, 26.1, 21.1, 14.2; IR (neat) 2935, 1752, 1454, 1258, 1088, 1022, 794, 516, 507, 455 cm-1; HRMS (ESI) calcd for $C_{14}H_{21}ClNaO_7$ $[M+Na]^+$, 359.0868; found: 359.0862.

(3s,5s,7s)-adamantan-1-yl 2-chloroacetate (1y)



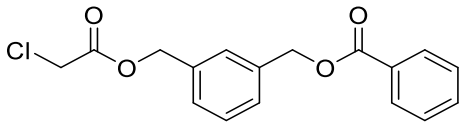
1-Adamantanol (608.9 mg, 4 mmol) as starting material. Colorless solid, (216.8 mg, 24% yield). mp 77-78 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.97 (s, 2H), 2.19 (s, 3H), 2.13 (d, J = 3.0 Hz, 6H), 1.67 (s, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.0, 83.2 , 42.0 , 41.2 , 36.0 , 30.9; IR (neat) 2942, 2913, 2851, 1741, 1454, 1196, 1180, 1055, 970, 950 cm^{-1}; HRMS (ESI) calcd for $C_{12}H_{17}ClNaO_2$ $[M+Na]^+$, 251.0809; found: 251.0805.

Ethyl (S)-2-(2-chloroacetoxy)-2-phenylacetate (1z)



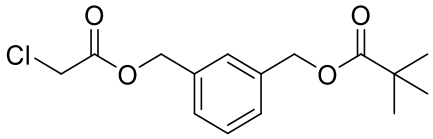
(S)-(-)-ethyl mandelate (720.8 mg, 4 mmol) as starting material. Colorless oil, (626.3 mg, 61% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50-7.47 (m, J = 5.6, 5.0, 4.0, 2.7 Hz, 2H), 7.43 (m, J = 5.8, 1.6 Hz, 3H), 6.01 (s, 1H), 4.33-4.11 (m, 4H), 1.25 (t, J = 7.1 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.1, 166.8, 133.1, 129.5, 128.9, 127.7, 75.8, 62.0, 40.6, 14.0; IR (neat) 1750, 1601, 1454, 1261, 1214, 1161, 1096, 1037, 736, 698 cm^{-1}; HRMS (ESI) calcd for $C_{12}H_{13}ClNaO_4$ $[M+Na]^+$, 279.0395; found: 279.0388.

3-((2-chloroacetoxy) methyl) benzyl benzoate (1aa)



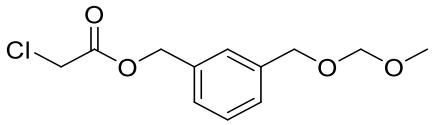
3-(hydroxymethyl) benzaldehyde (408.5 mg, 3 mmol) as starting material. Brown oil, (710.8 mg, 86% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03-7.96 (m, 2H), 7.53-7.43 (m, 1H), 7.40–7.24 (m, 6H), 5.29 (s, 2H), 5.15 (s, 2H), 4.01 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.3, 166.5, 136.7, 135.4, 133.2, 129.9, 129.8, 129.1, 128.5, 128.4, 128.3, 128.1, 67.6, 66.4, 41.0; IR (neat) 1756, 1719, 1600, 1451, 1165, 1111, 1070, 712, 890, 786 cm^{-1}; HMRS (ESI) calcd for $C_{17}H_{15}ClNaO_4$ $[M+Na]^+$, 341.0551; found: 341.0543.

3-((2-chloroacetoxy) methyl) benzyl pivalate (1ab)



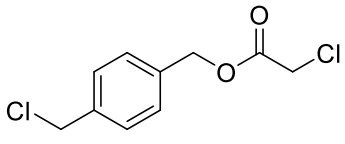
3-(hydroxymethyl) benzaldehyde (408.5 mg, 3 mmol) as starting material. Brown oil, (623.8 mg, 85% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42-7.30 (m, 4H), 5.24 (s, 2H), 5.13 (s, 2H), 4.12 (s, 2H), 1.25 (s, 9H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 178.4, 167.2, 137.1, 135.2, 128.9, 128.0, 127.9, 127.6, 67.7, 65.7, 40.9, 38.8, 27.2; IR (neat) 2972, 1730, 1480, 1458, 1458, 1282, 1156, 892, 699, 571 cm^{-1}; HRMS (ESI) calcd for $C_{15}H_{20}ClO_4$ $[M+H]^+$, 299.1045; found: 299.1039.

3-((methoxy methoxy) methyl) benzyl 2-chloroacetate (1ac)



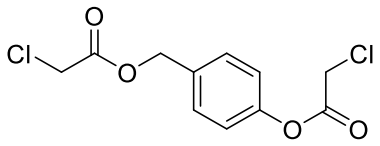
3-(hydroxymethyl) benzaldehyde (408.5 mg, 3 mmol) as starting material. Pale yellow oil, (552.6 mg, 86% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43-7.27 (m, 4H), 5.24 (s, 2H), 4.74 (s, 2H), 4.63 (s, 2H), 4.12 (s, 2H), 3.44 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.3, 138.4, 135.1, 128.9, 128.1,128.0, 127.9, 95.8, 68.9, 67.8, 55.4, 40.9; IR (neat) 1754, 1453, 1448, 1251, 1165, 1046, 893, 790, 752, 701 cm^{-1}; HRMS (ESI) calcd for $C_{12}H_{15}ClNaO_4$, $[M+Na]^+$, 281.0551; found: 281.0554.

4-(chloromethyl)benzyl 2-chloroacetate (1ad)



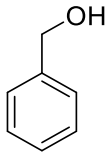
4-Chloromethylbenzyl alcohol (469.8 mg, 3 mmol) as starting material. White solid, 600.5 mg, 87% yield) ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46-7.36 (m, 4H), 5.24 (s, 2H), 4.61 (s, 2H), 4.12 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.14, 138.00, 135.18, 128.88 (d, J = 9.3 Hz), 67.37, 45.71, 40.85; IR (KBr): υ_{max} 3643.83, 2958.47, 1749, 1541, 1411, 1307, 1265, 1164, 972, 821, 771, 727, 674, 581 cm^{-1}; HRMS (ESI) calcd for $C_{16}H_{16}NaO_4$ $[M+Na]^+$, 232.0058; found: 232.0050.

4-(2-chloroacetoxy)benzyl 2-chloroacetate (1ae)



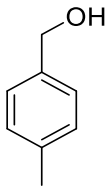
4-Hydroxybenzyl alcohol (372.4 mg, 3 mmol) as starting material. White solid, (797.1 mg, 96% yield), ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 (d, J = 8.6 Hz, 2H), 7.15 (d, J = 8.7 Hz, 2H), 5.22 (s, 2H), 4.32 (s, 2H), 4.11 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.2, 165.8, 150.4, 133.2, 130.0, 121.5, 67.1, 40.9; IR (KBr) : υ_{max} 3010, 2952, 1756, 1607, 1508, 1456, 1409, 1376, 1310, 1164, 1142, 969, 926, 857, 679, 549, 498 cm^{-1}; HMRS (EI) calcd for $C_{11}H_{10}Cl_2NaO_4$ $[M+Na]^+$, 298.9956; found: 298.9927.

Benzyl alcohol (2a) [7]



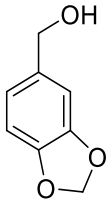
Colorless oil, (29.5 mg, 91% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45-7.34 (m, 5H), 4.69 (s, 2H), 2.12 (s, 1H).; ^{13}C NMR (101 MHz, $CDCl_3$) δ 140.9, 128.6, 127.6, 127.0, 65.2.

4-Methylbenzyl alcohol (2b) [7]



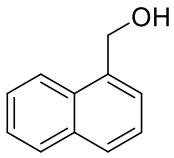
Yellow solid, (34.8 mg, 95% yield). mp59-61 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 (d, J = 7.9 Hz, 2H), 7.16 (s, 2H), 4.63 (s, 2H), 2.35 (s, 3H), 1.73 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.9, 137.4, 129.3, 127.1, 65.3, 21.2.

Piperonol (2c) [8]



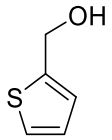
White solid, (39.7 mg, 87% yield). mp50-52 ℃, ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.89–6.84 (m, 1H), 6.81-6.76 (m, J = 5.9 Hz, 2H), 5.95 (s, 2H), 4.56 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 147.8, 147.1, 134.9, 120.5, 108.2, 107.9, 101.0, 65.3.

1-Naphthalene methanol (2d) [7]



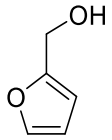
White solid, (42,7 mg, 90% yield). mp62–64 °C ,^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 (d, J = 8.2 Hz, 1H), 7.92-7.85 (m, 1H), 7.82 (d, J = 8.2 Hz, 1H), 7.59–7.48 (m, 3H), 7.47–7.43 (d, J = 7.6 Hz, 1H), 5.15 (s, 2H), 1.78 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 136.3, 133.8, 131.2, 128.7, 128.6, 126.4, 125.9, 125.43, 125.38, 123.7, 63.8.

2-Thiophenemethanol (2e) [7]



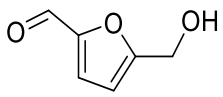
Yellow oil, (32.5 mg, 95% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 (d, J = 5.0 Hz, 1H), 7.03–6.93 (m, 2H), 4.82 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 144.0, 126.9, 125.7, 125.5, 60.0.

(2-Furyl)methyl alcohol (2f) [7]



Colorless oil, (23.8 mg, 81% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (s, 1H), 6.39–6.22 (m, 2H), 4.59 (s, 2H), 2.11 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.0, 142.6, 110.4, 107.8, 57.4.

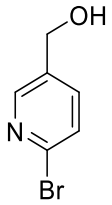
5-Hydroxymethyl-2-furfuraldehyde (2g) [9]



Yellow oil, (23.5 mg, 62% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.57 (s, 1H), 7.22 (d, J =

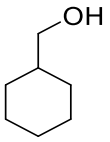
3.5 Hz, 1H), 6.52 (d, J = 3.6 Hz, 1H), 4.71 (s, 2H), 3.16 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 177.7, 160.9, 152.3, 123.0, 110.0, 57.5.

2-Bromo-5-(hydroxymethyl) pyridine (2h)



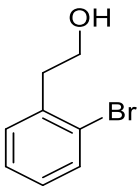
White solid, (54.1 mg, 96% yield). mp49 – 51 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (d, J = 2.5 Hz, 1H), 7.60 (dd, J = 8.2, 2.5 Hz, 1H), 7.47 (d, J = 8.2 Hz, 1H), 4.70 (s, 2H), 2.84 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 148.6, 140.9, 137.6, 135.8, 128.0, 61.7; IR (KBr) 3327, 2364, 2343, 1560, 1446, 1083, 1018, 812 cm^{-1}; HMRS (EI) calcd for C_6H_6BrNO $[M]^+$, 186.9627; found: 186.9627.

Cyclohexyl methyl alcohol (2i) [7]



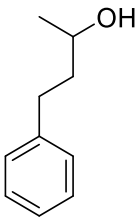
Colorless oil, (33.9 mg, 99% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.44 (d, J = 6.4 Hz, 2H), 1.79-1.64 (m, 5H), 1.56-1.41 (m, 1H), 1.36 (s, 1H), 1.31-1.11 (m, 3H), 0.92 (qt, J = 14.0, 6.2 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 68.8, 40.5, 29.6, 26.6, 25.9.

2-Bromophenylethyl alcohol (2j) [10]



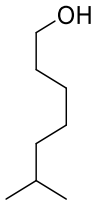
Yellow oil, (51 mg, 85% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (d, J = 8.0 Hz, 1H), 7.35-7.20 (m, 2H), 7.09 (ddd, J = 8.7, 6.6, 2.6 Hz, 1H), 3.84 (t, J = 6.9 Hz, 2H), 3.02 (t, J = 6.9 Hz, 2H), 2.74 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 137.9, 132.9, 131.4, 128.2, 127.5, 124.7, 61.9, 39.3.

1-Phenyl-3-butanol (2k) [11]



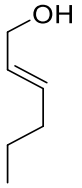
Colorless oil, (42.8 mg, 95% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30-7.24 (q, J = 7.5 Hz, 2H), 7.23-7.15 (m, 3H), 3.86-3.78 (m, J = 6.2 Hz, 1H), 2.71 (ddq, J = 30.0, 14.1, 7.6 Hz, 2H), 1.77 (dq, J = 11.6, 5.6, 5.1 Hz, 2H), 1.56 (s, 1H), 1.22 (d, J = 6.2 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.1, 128.4, 125.9, 67.5, 40.9, 32.2, 23.6.

6-Methylheptan-1-ol (2l) [12]



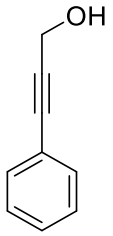
Colorless oil, (34.8 mg, 89% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.55 (d, J = 5.0 Hz, 2H), 1.43-1.27 (m, 9H), 0.93-0.87 (m, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 65.3, 42.0, 30.1, 29.1, 23.3, 23.1, 14.1, 11.1.

(2E)-hexen-1-ol (2m) [13]



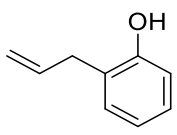
Colorless oil, (28.2 mg, 94% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.73-5.57 (m, 2H), 4.07 (d, J = 5.2 Hz, 2H), 2.14 (s, 1H), 2.02 (q, J = 6.6 Hz, 2H), 1.45-1.36 (m, J = 7.4 Hz, 2H), 0.91 (t, J = 7.4 Hz, 3H);^{13}C NMR (101 MHz, $CDCl_3$) δ 133.1, 129.0, 63.6, 34.3, 22.3, 13.7.

3-Phenyl-2-propyn-1-ol (2n) [14]



Colorless oil, (38.5 mg, 97% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54-7.41 (m, 2H), 7.37-7.30 (m, 3H), 4.53 (s, 2H), 2.19 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 131.7, 128.5, 128.4, 122.5, 87.2, 85.7, 51.6.

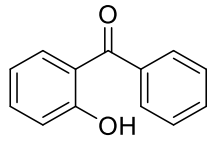
2-Allylphenol (2o) [15]



Colorless oil, (39 mg, 97% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.18-7.07 (m, 2H), 6.91-

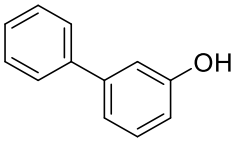
6.87 (m, J = 7.5, 1.2 Hz, 1H), 6.82-8.80 (dd, J = 7.9, 1.1 Hz, 1H), 6.07-5.97 (m, J = 17.9, 9.6, 6.3 Hz, 1H), 5.20-5.11 (m, 2H), 5.00 (s, 1H), 3.41 (dt, J = 6.4, 1.7 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.1, 136.4, 130.5, 127.9, 125.3, 121.0, 116.5, 115.8, 35.1.

2-Hydroxybenzophenone (2p) [16]



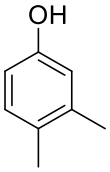
Yellow solid, (37.5 mg, 63% yield). mp37-39 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 12.03 (s, 1H), 7.72-7.64 (m, 2H), 7.62-7.55 (m, 2H), 7.52-7.48 (m, J = 7.8, 7.3, 1.7 Hz, 3H), 7.07 (dd, J = 8.4, 1.1 Hz, 1H), 6.87 (ddd, J = 8.2, 7.2, 1.2 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 201.7, 163.3, 137.9, 136.3, 133.6, 131.9, 129.2, 128.4, 119.2, 118.7, 118.4.

3-Phenylphenol (2q) [17]



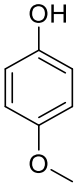
White solid, (50 mg, 98% yield). mp74-75 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (d, J = 7.2 Hz, 4H), 7.43-7.35 (m, 1H), 7.31-7.21 (m, 2H), 7.02-6.98 (m, J = 7.3 Hz, 2H), 5.21 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.4, 137.1, 130.3, 129.3, 129.2, 129.1, 127.9, 120.9, 115.8.

3,4-Dimethylphenol (2r) [18]



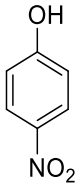
White solid, (36.2 mg, 99% yield). mp59-62 °C .^{1}H NMR (400 MHz, $CDCl_3$) δ 6.97 (d, J = 8.1 Hz, 1H), 6.64 (d, J = 2.7 Hz, 1H), 6.57 (dd, J = 8.1, 2.7 Hz, 1H), 4.85 (d, J = 8.2 Hz, 1H), 2.19 (d, J = 11.6 Hz, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.5, 138.0, 130.5, 128.7, 116.6, 112.4, 19.9, 18.8.

4-Methoxy-phenol (2s) [18]



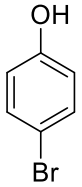
Colorless solid, (34.2 mg, 92% yield). mp56-57 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.88-6.71 (m, 4H), 4.60 (s, 1H), 3.76 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.7, 149.5, 116.1, 114.9, 55.8.

4-Nitro-phenol (2t) [18]



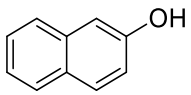
Yellow solid, (33.8 mg, 81% yield). mp111-113 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21-8.16 (m, 2H), 6.98-6.91 (m, 2H), 6.24 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.5, 141.6, 126.4, 115.8.

4-Bromo-phenol (2u) [18]



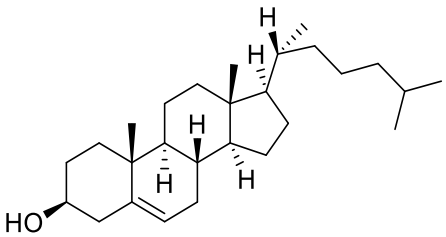
White solid, (44.1 mg, 85% yield). mp61-64 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (d, J = 8.5 Hz, 2H), 6.72 (d, J = 8.5 Hz, 2H), 4.97 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.6, 132.5, 117.2, 112.9.

***β*-Naphthol (2v)** [19]



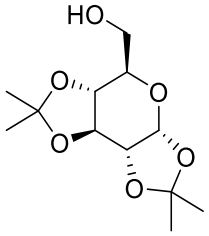
White solid, (39.4 mg, 91% yield). mp120-122 ℃, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78-7.72 (m, J = 7.9 Hz, 2H), 7.67 (d, J = 8.3 Hz, 1H), 7.44-7.39 (m, J = 8.4, 7.9 Hz, 1H), 7.34-7.29 (d, J = 7.9 Hz, 1H), 7.16-7.04 (m, 2H), 5.10 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.3, 134.6, 129.9, 128.9, 127.8, 126.6, 126.4, 123.7, 117.8, 109.5.

***β*-Cholesterol (2w)** [20]



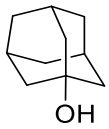
Pale yellow solid, (60.3 mg, 52% yield). mp148-150 ºC, ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.35 (s, 1H), 3.52 (tt, J = 10.6, 4.7 Hz, 1H), 2.35-2.16 (m, 2H), 1.99 (tt, J = 16.3, 3.1 Hz, 2H), 1.84 (dq, J = 14.4, 5.1, 4.3 Hz, 3H), 1.73 (s, 1H), 1.62 – 0.94 (m, 24H), 0.91 (d, J = 6.5 Hz, 3H), 0.86 (dd, J = 6.6, 1.8 Hz, 6H), 0.68 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 140.8, 121.7, 71.8, 56.8, 56.2, 50.1, 42.33, 42.30, 39.8, 39.5, 37.3, 36.5, 36.2, 35.8, 31.93, 31.91, 31.7, 28.3, 28.0, 24.3, 23.9, 22.9, 22.6, 21.1, 19.4, 18.7, 11.9.

((3aR,5R,5aR,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-5H-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)methanol (2x)



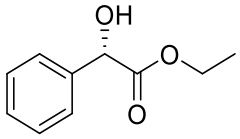
Colorless oil, (48 mg, 62% yield).^{1}H NMR (400 MHz, $CDCl_3$) δ 5.94 (d, J = 3.6 Hz, 1H), 4.53 (d, J = 3.6 Hz, 1H), 4.39-4.26 (m, 2H), 4.17 (dd, J = 8.7, 6.4 Hz, 1H), 4.06 (dd, J = 7.9, 2.6 Hz, 1H), 4.00 (dd, J = 8.7, 5.3 Hz, 1H), 2.82 (d, J = 3.9 Hz, 1H), 1.47 (d, J = 21.5 Hz, 6H), 1.34 (d, J = 19.1 Hz, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 111.8 , 109.6 , 105.3 , 85.1 , 81.1 , 75.0 , 73.3 , 67.6 , 26.84 , 26.78 , 26.2 , 25.2; IR (neat) 3427, 2984, 2869, 1321, 1315, 1221, 1159, 1118, 1062, 735 cm-1; HRMS (ESI) calcd for $C_{12}H_{20}NaO_6$ $[M+Na]^+$, 283.1152; found: 283.1156.

1-Adamantanol (2y) [8]



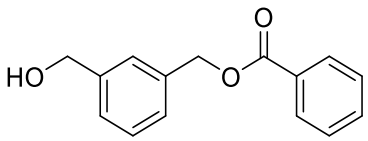
White solid, (33.3mg, 73% yield). mp280-282 ºC. ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.17 (s, 3H), 1.76-1.71 (s, 6H), 1.70-1.57 (m, 6H), 1.49 (s, 1H).; ^{13}C NMR (101 MHz, $CDCl_3$) δ 68.2, 45.3, 36.1, 30.7.

(S)-(-)-ethyl mandelate (2z) [22]



Colorless liquid, (45.6 mg, 84% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46-7.30 (m, 5H), 5.19 (s, 1H), 4.32-4.15 (dp, J = 33.8, 8.1 Hz, 2H), 3.63 (s, 1H), 1.26-1.22 (t, J = 7.0 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 173.7, 138.5, 128.6, 128.4, 126.6, 72.9, 62.2, 14.0.

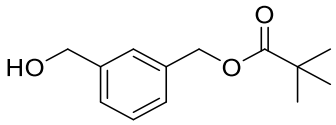
3-(hydroxymethyl) benzyl benzoate (2aa)



Pale yellow oil, (57.4 mg,79% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12-8.04 (m, 2H), 7.60-7.46 (m, J = 7.4 Hz, 1H), 7.49-7.41 (m, 3H), 7.43-7.31 (m, 3H), 5.37 (s, 2H), 4.72 (s, 2H), 2.25 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.5, 141.4, 136.4, 133.1, 130.1, 129.7, 128.9,

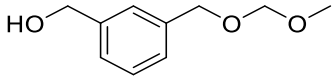
128.4, 127.4, 126.9, 126.7, 66.6, 65.0; IR (neat) 3337, 1718, 1451, 1273, 1112, 1026, 887, 788, 744, 711 cm^{-1}; HMRS (ESI) calcd for $C_{15}H_{14}NaO_3$ $[M+Na]^+$, 265.0835; found: 265.0831.

3-(hydroxymethyl) benzyl pivalate (2ab)



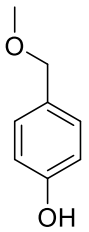
Colorless oil, (50.0 mg, 75% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.39-7.25 (m, 4H), 5.12 (s, 2H), 4.70 (s, 2H), 2.13 (s, 1H), 1.25 (s, 9H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 178.4, 141.3, 136.8, 128.8, 126.9, 126.6, 126.2, 66.0, 65.1, 38.8, 27.2; IR (neat) 3347, 1729, 1605, 1589, 1480, 1456, 1365, 1154, 1034, 700cm^{-1}; HRMS (ESI) calcd for $C_{13}H_{18}NaO_3$ $[M+Na]^+$, 245.1148; found: 245.1143.

(3-((methoxymethoxy) methyl) phenyl) methanol (2ac)



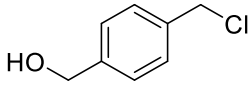
Brown oil, (39.9 mg, 73% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.35-7.05 (m, 4H), 4.63-4.53 (m, 4H), 4.52-4.43 (s, 2H), 3.35-3.23 (s, 3H), 2.06 (s, 1H); ^{13}C NMR (151 MHz, $CDCl_3$) δ 141.2, 138.2, 128.7, 127.1, 126.4, 126.3, 95.7, 69.1, 65.1, 55.4; IR (neat). 3401, 1459, 1373, 1208, 1155, 1105, 1046, 793, 749, 697cm^{-1}; HRMS (ESI) calcd for $C_{10}H_{14}NaO_3$ $[M+Na]^+$, 205.0835; found: 205.0831.

4-(methoxymethyl)phenol (2ae) [23]



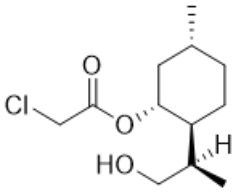
White solid, (55.7 mg, 90% yield), ^1H NMR (400 MHz, $CDCl_3$) δ 7.17 (d, J = 8.8 Hz, 2H), 6.94-6.57 (m, 3H), 4.40 (s, 2H), 3.37 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.9, 129.9, 129.2, 115.4, 74.6, 57.6.

4-(hydroxymethyl)benzyl chloride (2ad)[24]



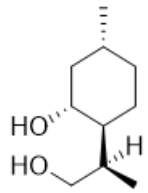
White solid, (42.0 mg, 91% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.60-7.34 (m, 4H), 4.73 (s, 2H), 4.62 (s, 2H), 3.41 (s, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.17, 128.85, 127.29, 64.94, 45.99.

(1R,2S,5R)-2-((R)-1-hydroxypropan-2-yl)-5-methylcyclohexyl 2-chloroacetate (S3)



(1S,2R,5S)-5-methyl-2-(prop-1-en-2-yl)cyclohexyl 2-chloroacetate (692 mg, 3 mmol) as starting material. Colorless oil, (140.9 mg, 19% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.92 (td, J = 11.0, 4.4 Hz, 1H), 4.07 (d, J = 2.3 Hz, 2H), 3.59 (dd, J = 10.7, 6.8 Hz, 1H), 3.41 (dd, J = 10.7, 7.3 Hz, 1H), 2.21 (s, 1H), 2.08-1.97 (m, 2H), 1.83 (tt, J = 7.2, 3.5 Hz, 1H), 1.77-1.64 (m, 2H), 1.65-1.45 (m, 1H), 1.28-1.22 (m, 1H), 1.01 (q, J = 11.8 Hz, 1H), 0.91 (dd, J = 6.8, 3.8 Hz, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.2, 76.9, 65.6, 44.7, 41.2, 40.8, 36.0, 34.2, 31.2, 26.2, 21.9, 14.6; IR (neat) 3334, 2923, 2870, 1736, 1456, 1253, 1191, 1023, 985, 786 cm^{-1}; HRMS (ESI) calcd for $C_{12}H_{21}ClNaO_3$ $[M+Na]^+$, 271.1071; found: 271.1068.

(−)-(1R,3R,4S,8R)-Menthane-3,9-diol (S4)



Colorless oil, (48.1 mg, 93% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.09 (s, 1H), 3.64 (dd, J = 10.7, 5.3 Hz, 1H), 3.56 (dd, J = 10.7, 3.4 Hz, 1H), 3.43 (td, J = 10.4, 4.3 Hz, 1H), 1.98 (d, J = 4.4 Hz, 1H), 1.82 (s, 1H), 1.69-1.50 (m, 2H), 1.47-1.29 (m, 2H), 1.23 (qd, J = 12.7, 3.4 Hz, 1H), 0.99 (d, J = 11.6 Hz, 1H), 0.95 (d, J = 7.2 Hz, 3H), 0.92 (d, J = 6.6 Hz, 3H), 0.86 (d, J = 3.5 Hz, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 69.9, 66.9, 48.6, 44.4, 38.6, 34.6, 31.4, 29.6, 22.1, 12.0.

8. References

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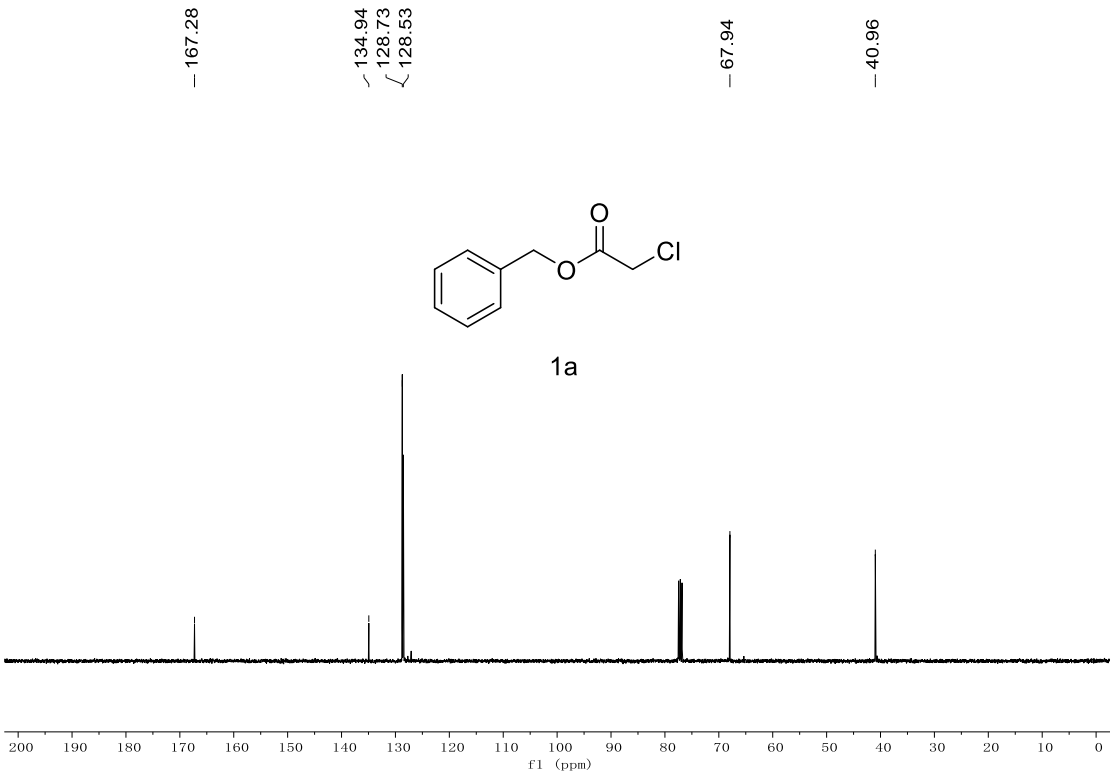
9. NMR Spectra of Starting Materials and Products

^{1}H NMR, 400 MHz, $CDCl_3$

1a

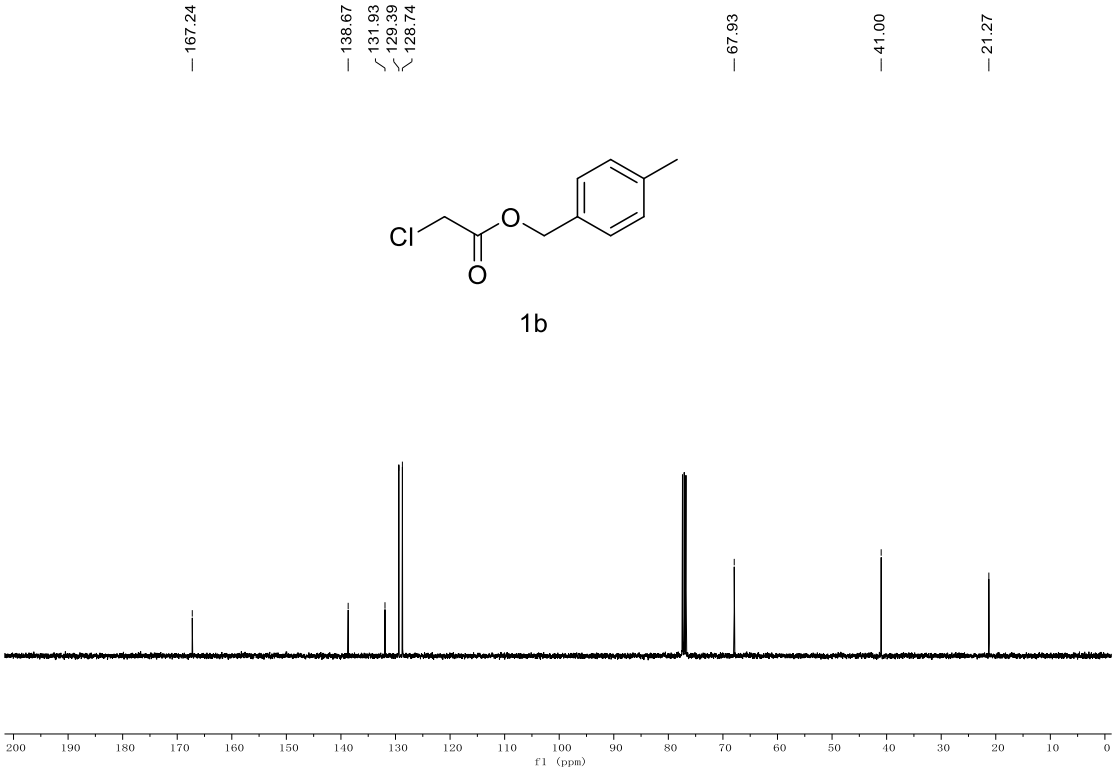
^{13}C NMR, 101 MHz, $CDCl_3$



1a

^{1}H NMR, 400 MHz, $CDCl_3$

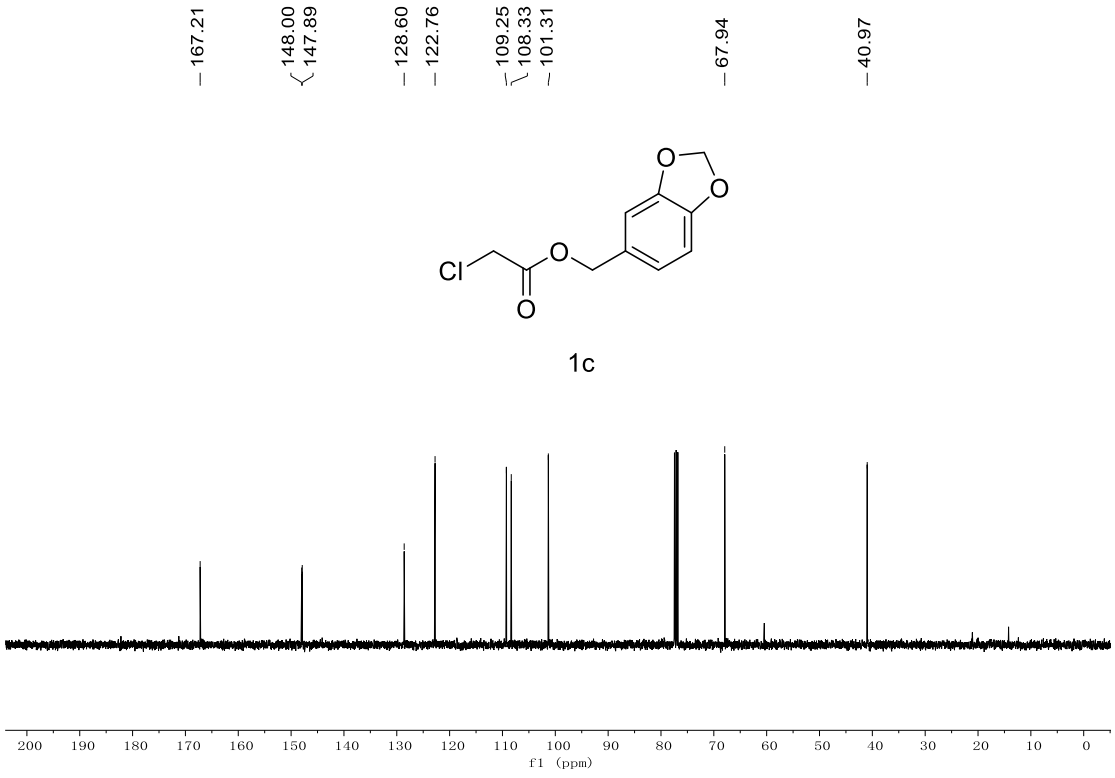
^{13}C NMR, 101 MHz, $CDCl_3$



^{1}H NMR, 400 MHz, $CDCl_3$

1c

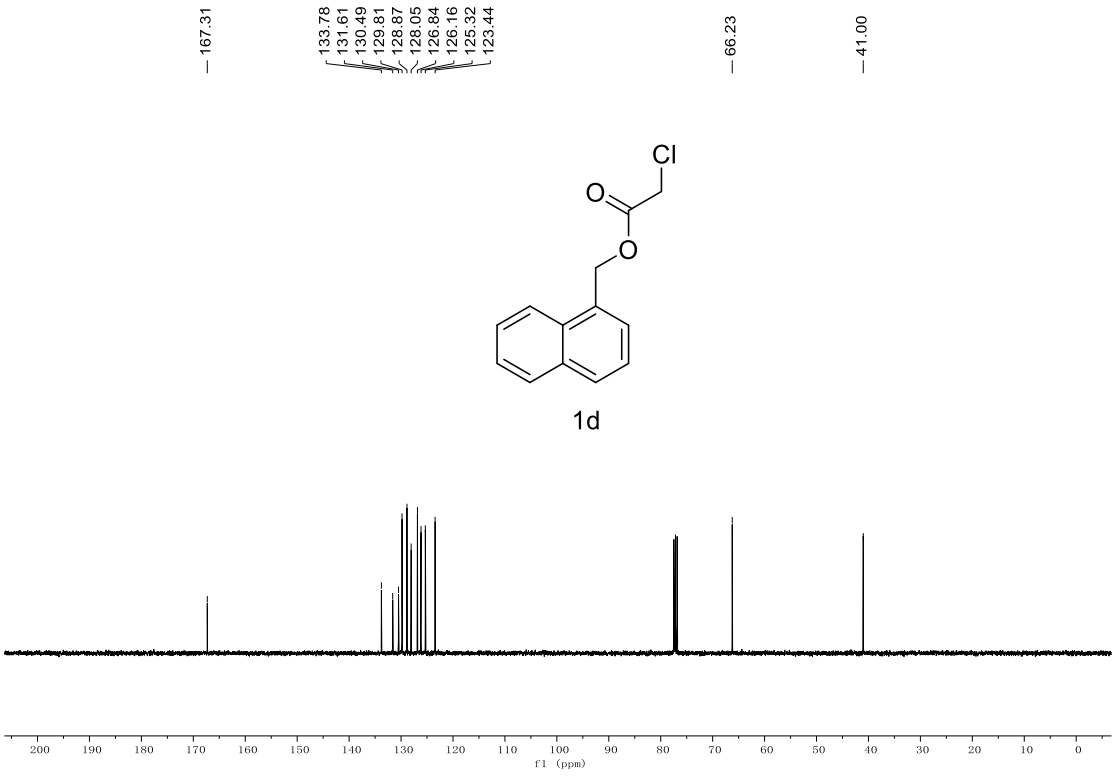
^{13}C NMR, 101 MHz, $CDCl_3$



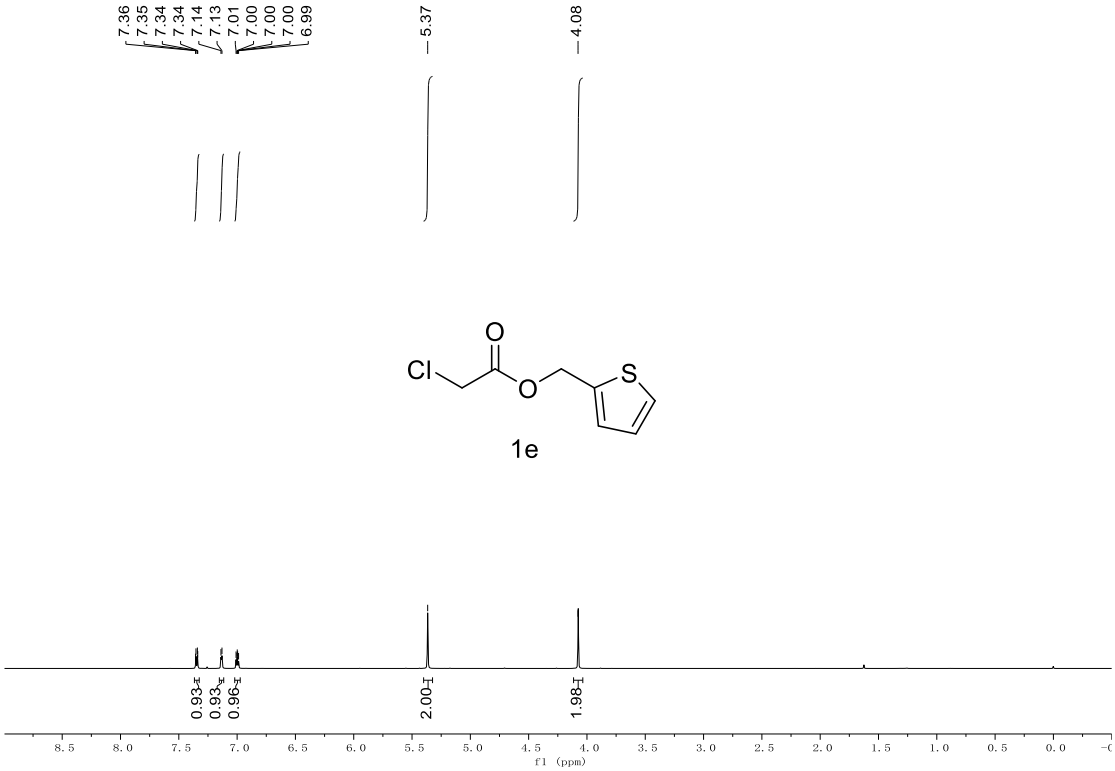
1c

^{1}H NMR, 400 MHz, $CDCl_3$

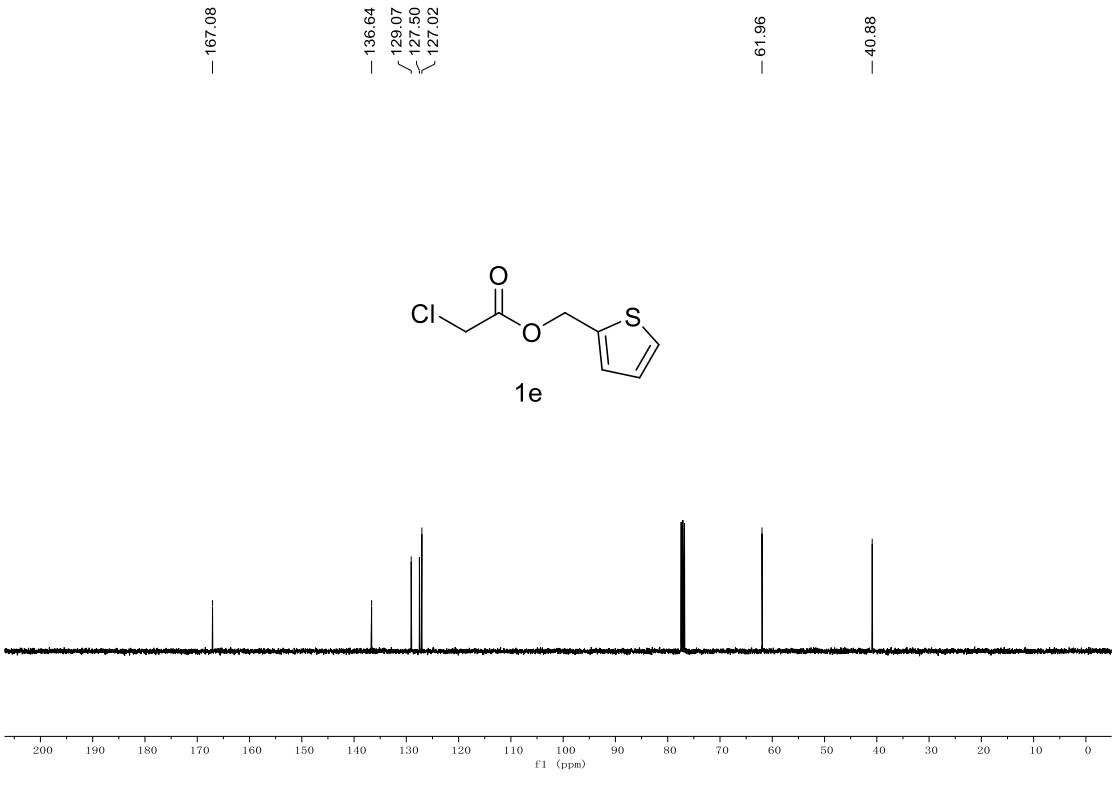
^{13}C NMR, 101 MHz, $CDCl_3$



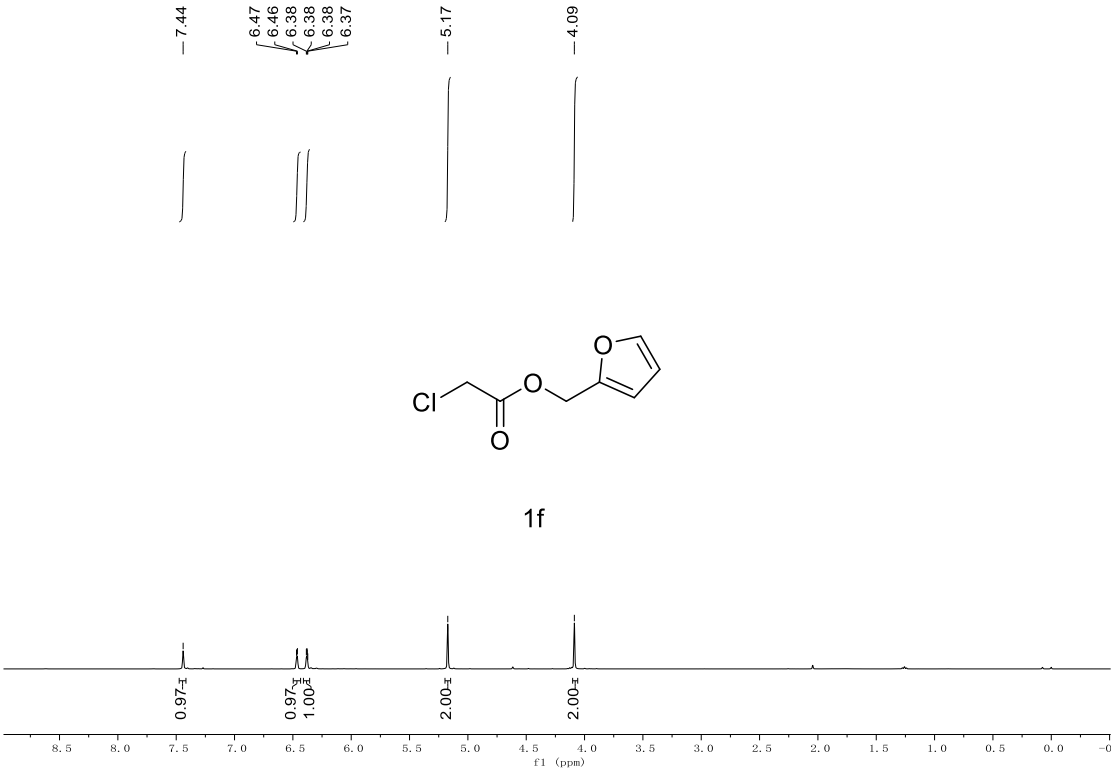
^{1}H NMR, 400 MHz, $CDCl_3$



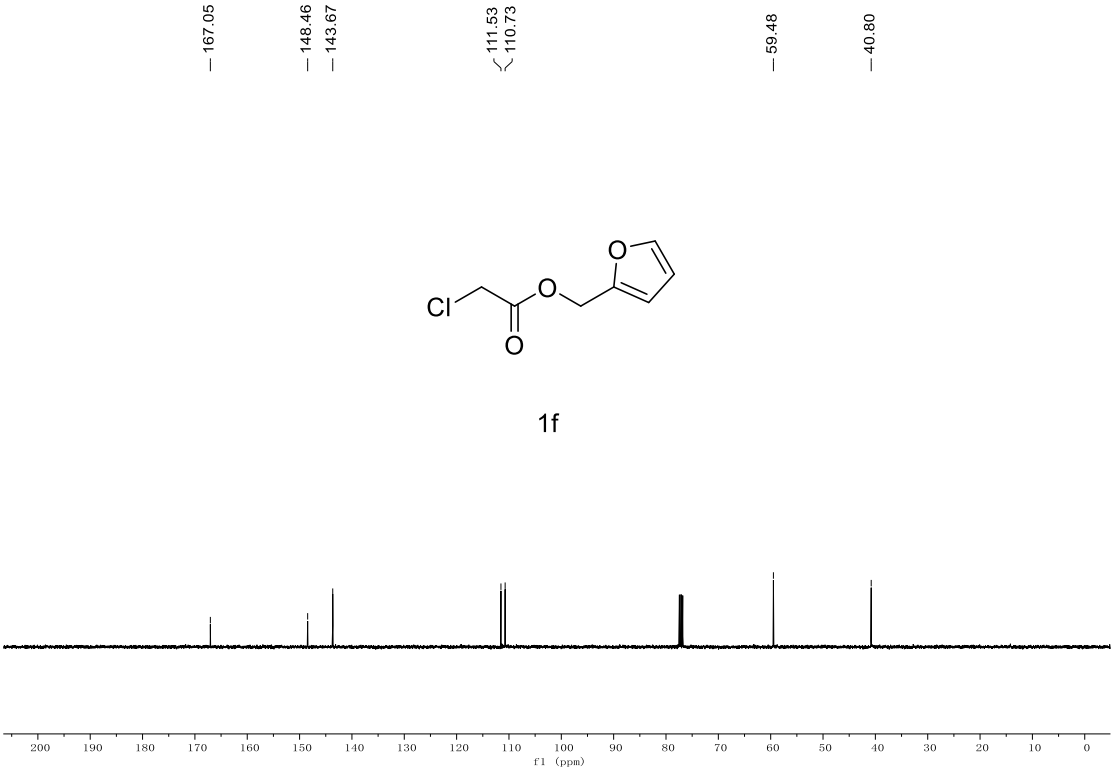
^{13}C NMR, 101 MHz, $CDCl_3$



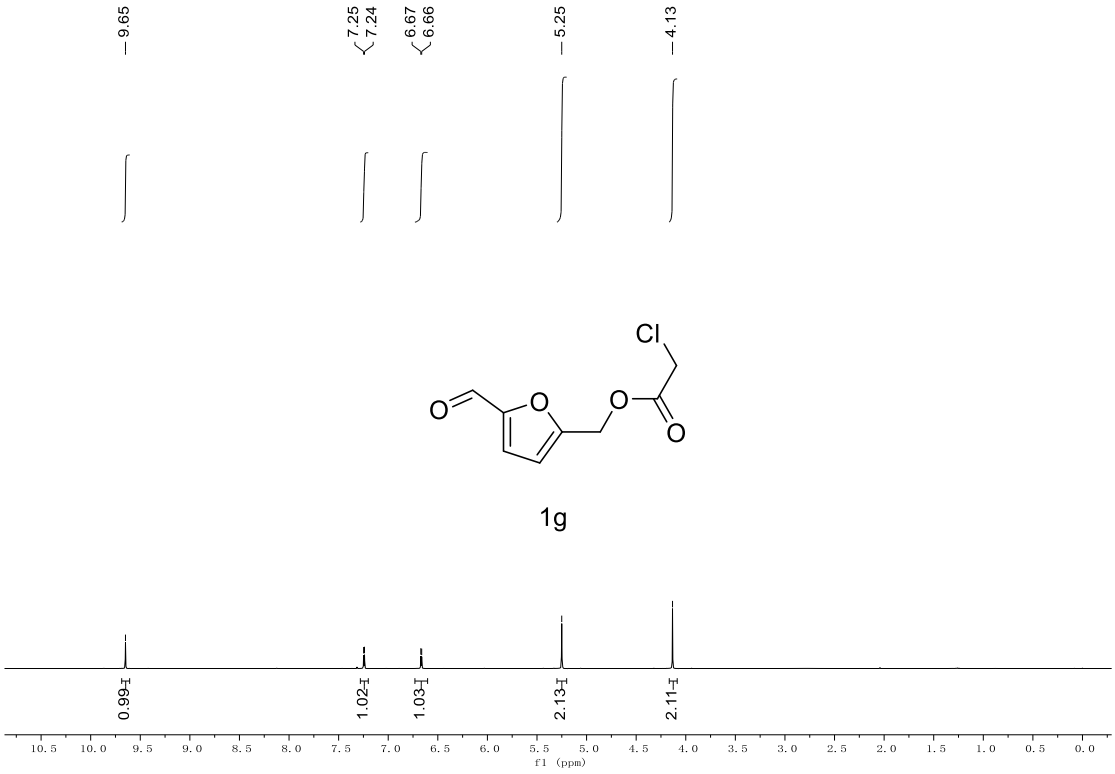
^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$

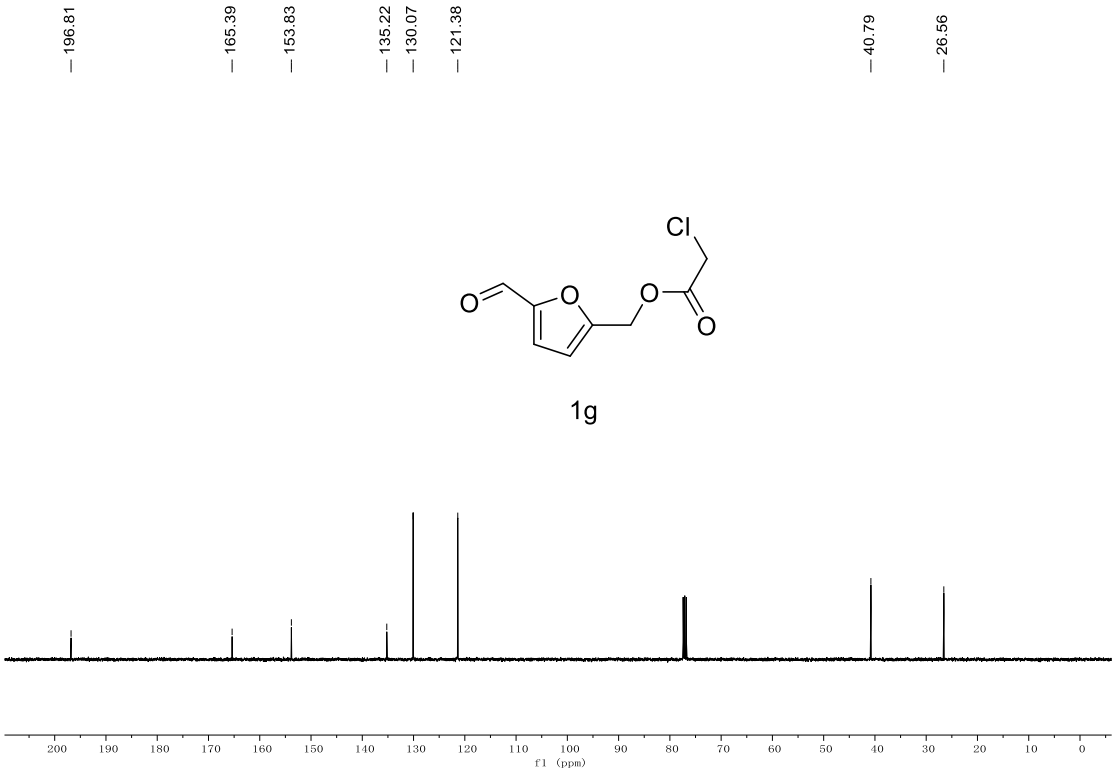


^{1}H NMR, 400 MHz, $CDCl_3$



1g

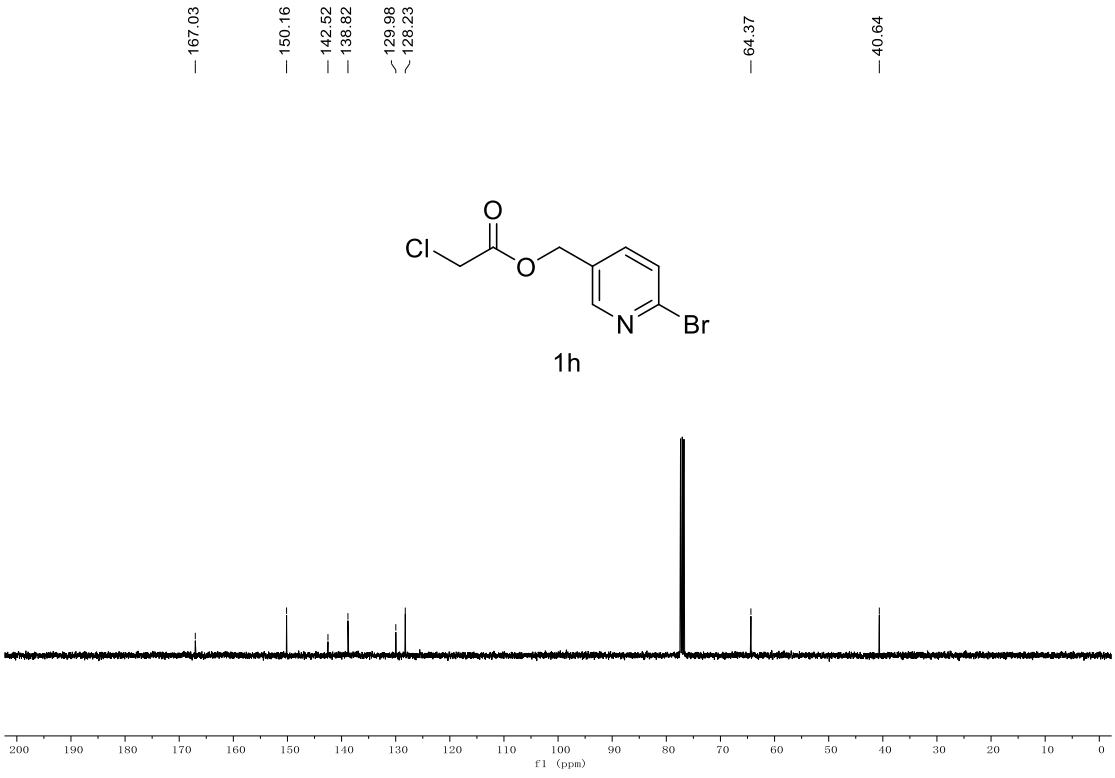
^{13}C NMR, 101 MHz, $CDCl_3$



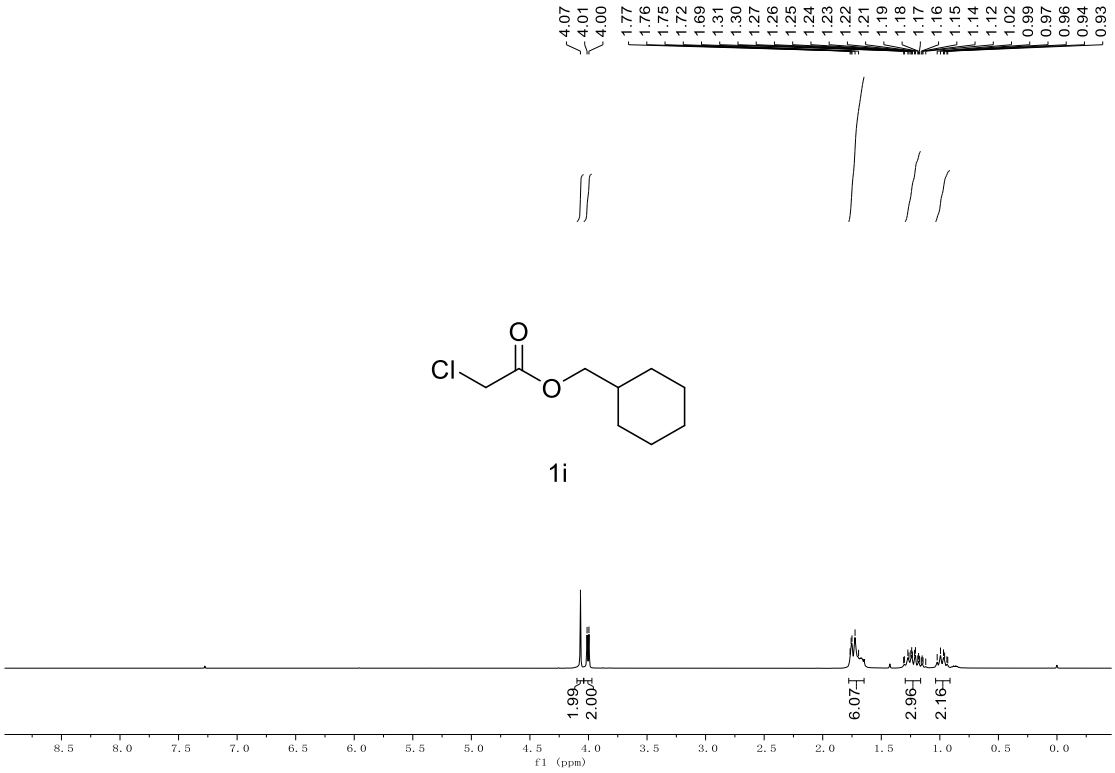
1g

^{1}H NMR, 400 MHz, $CDCl_3$

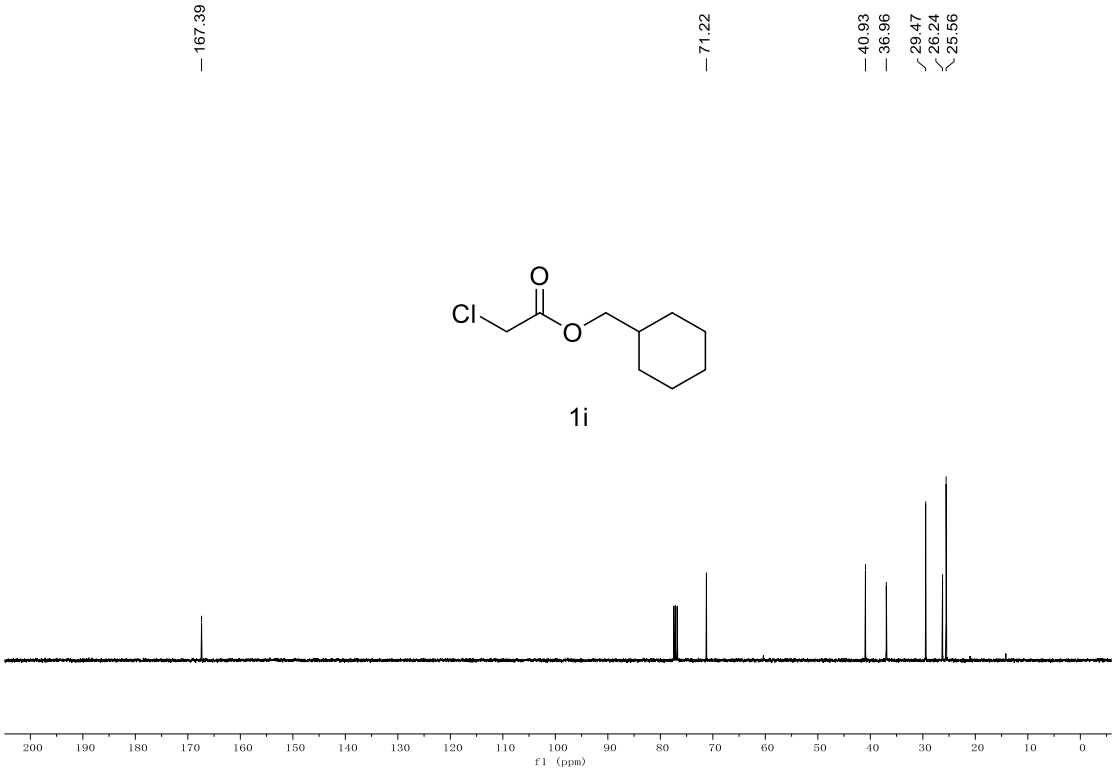
^{13}C NMR, 101 MHz, $CDCl_3$



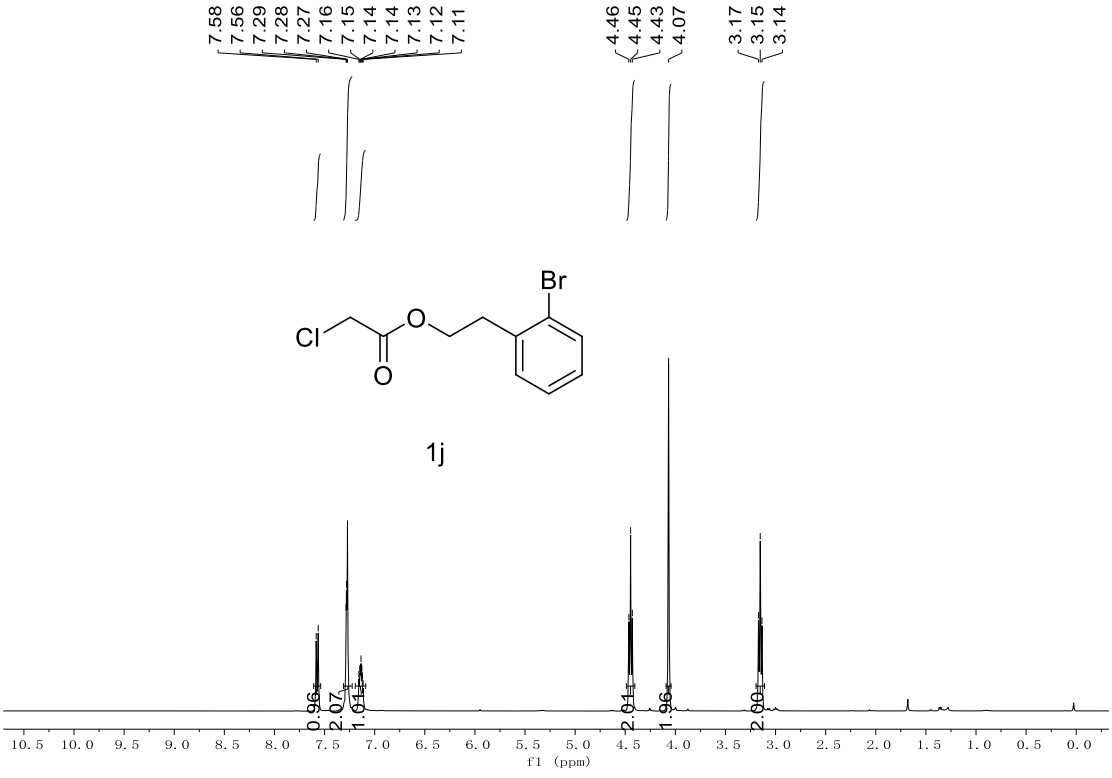
^{1}H NMR, 400 MHz, $CDCl_3$



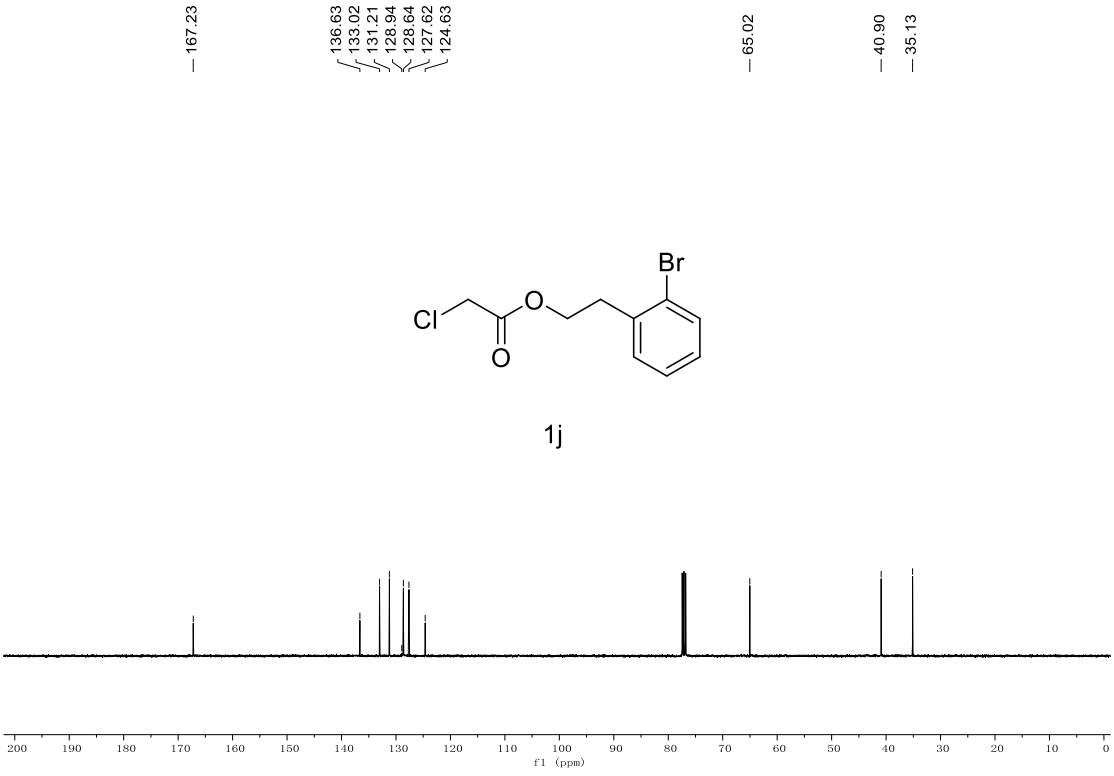
^{13}C NMR, 101 MHz, $CDCl_3$



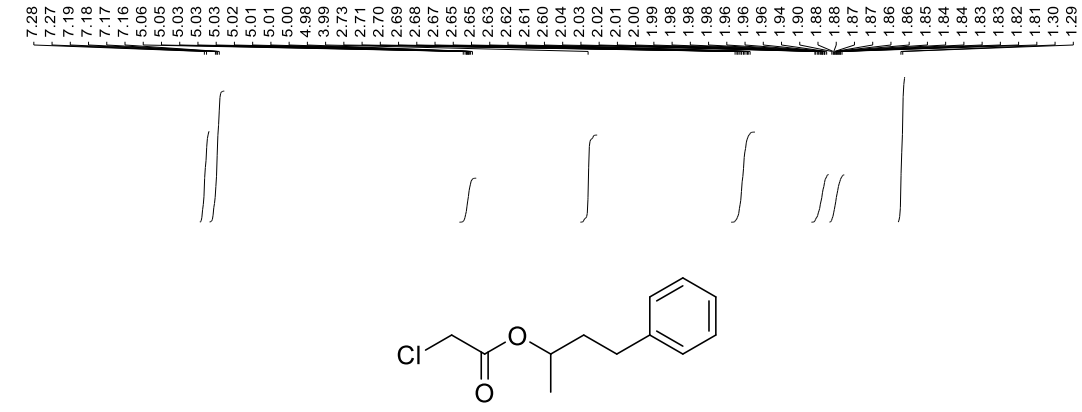
^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$



^{1}H NMR, 400 MHz, $CDCl_3$



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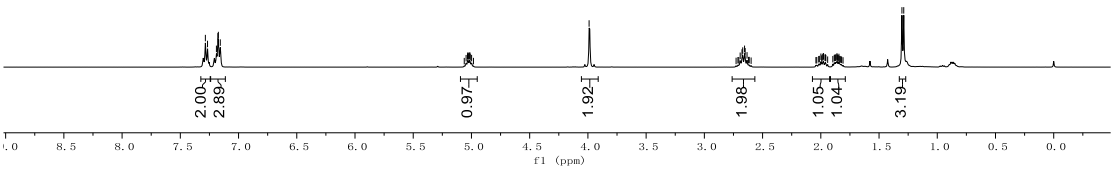
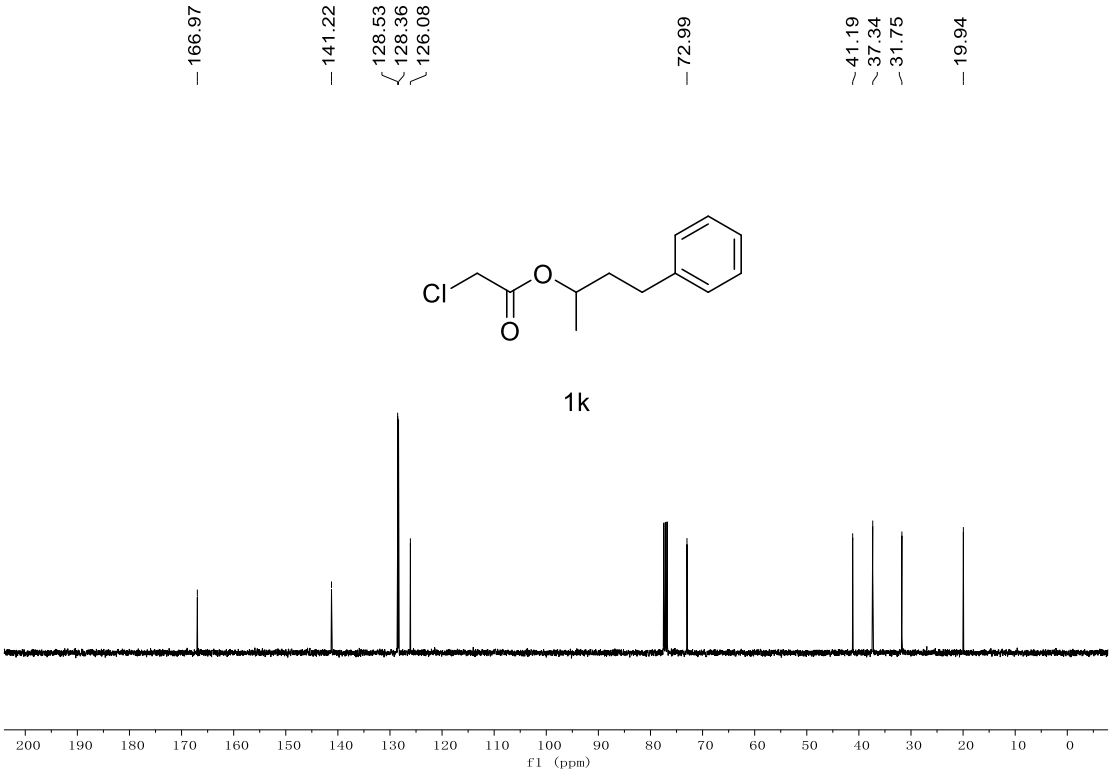


^{13}C NMR, 101 MHz, $CDCl_3$



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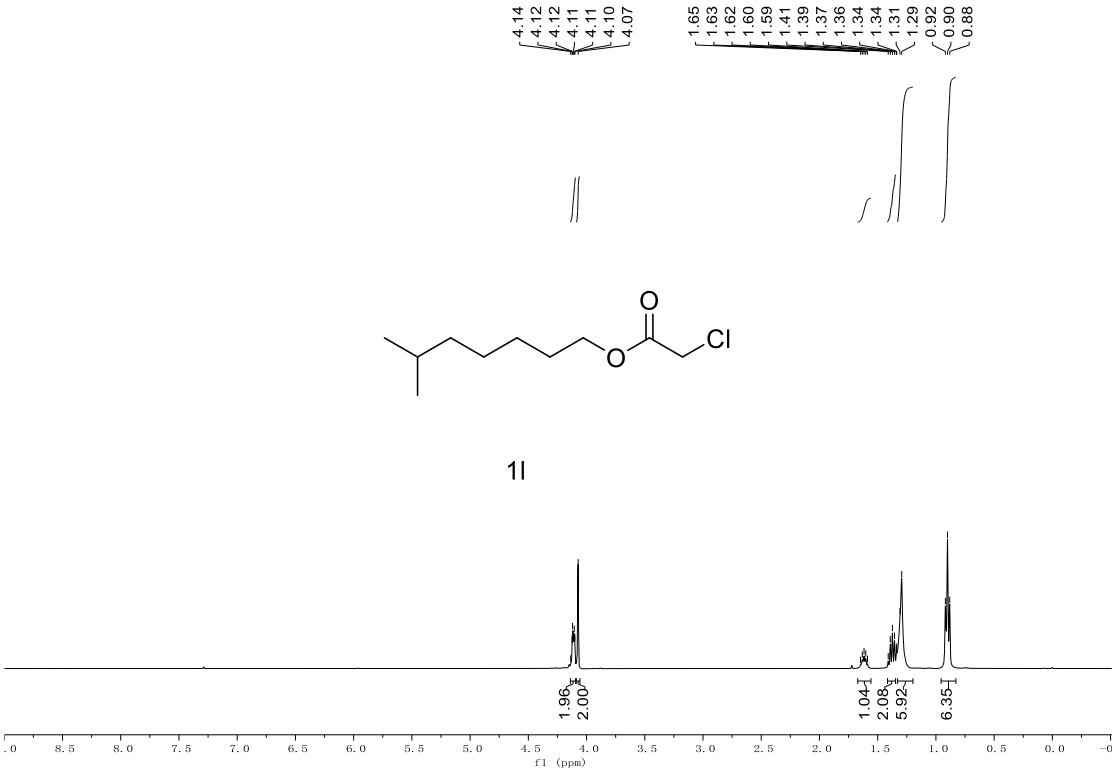
^{1}H NMR, 400 MHz, $CDCl_3$

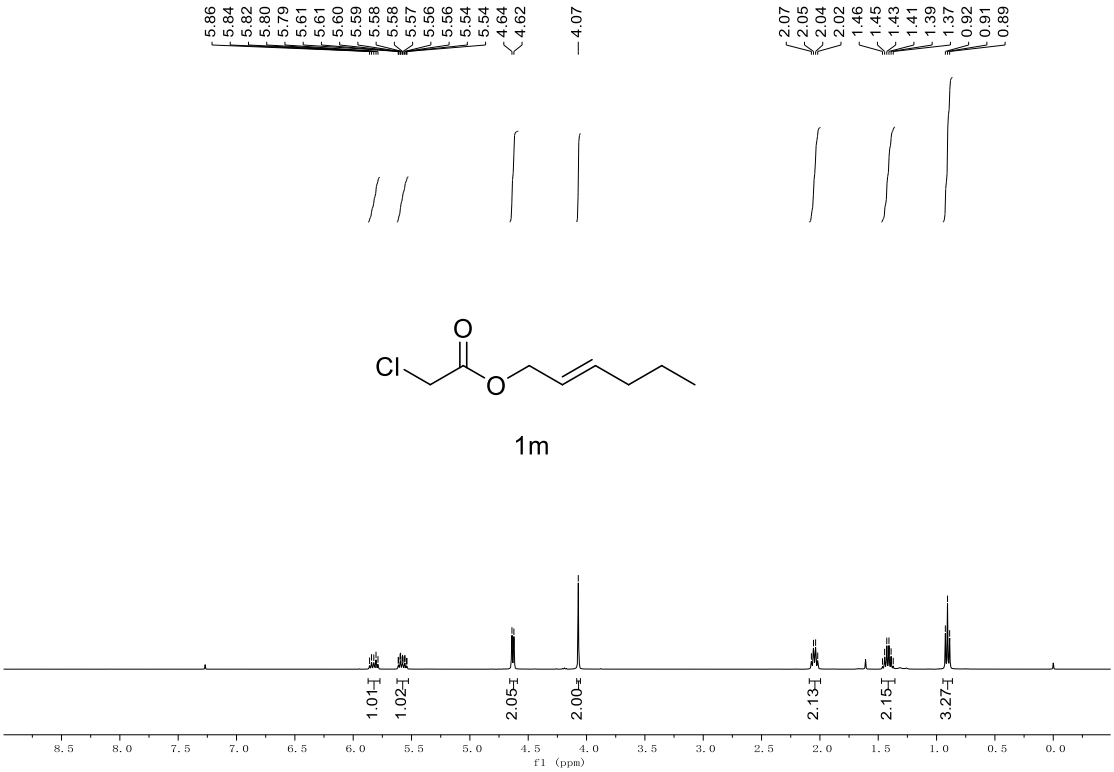


1l

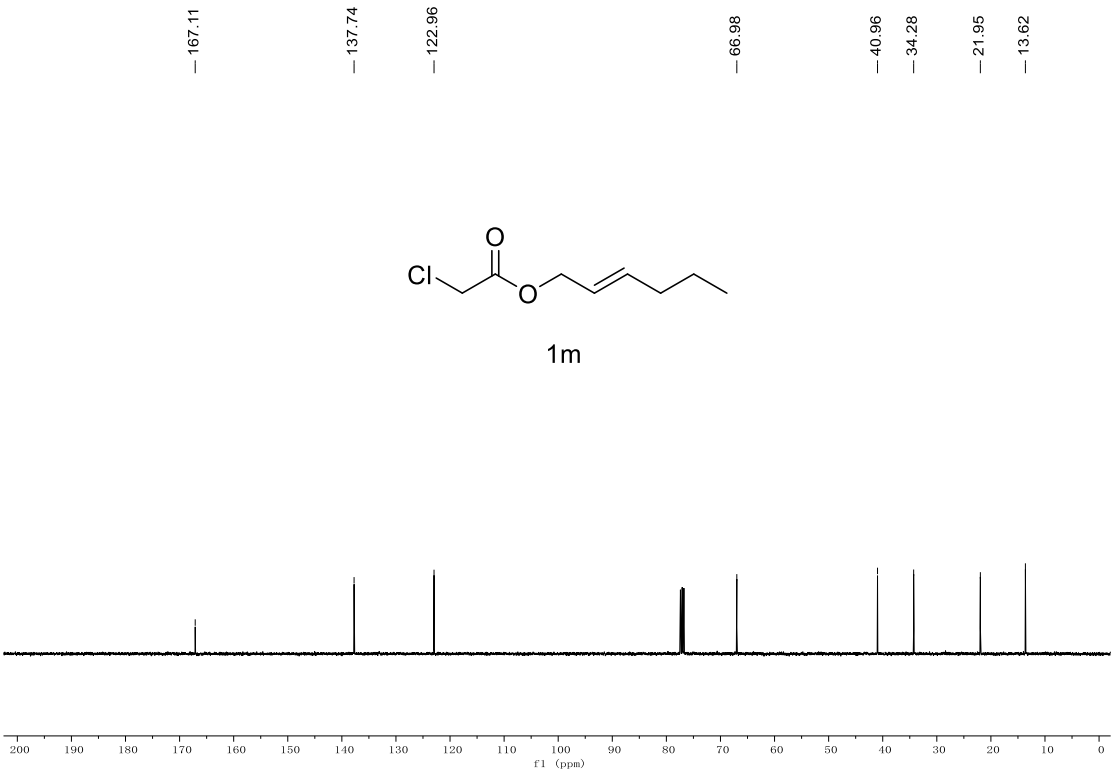
^{13}C NMR, 101 MHz, $CDCl_3$

1l

^{1}H NMR, 400 MHz, $CDCl_3$

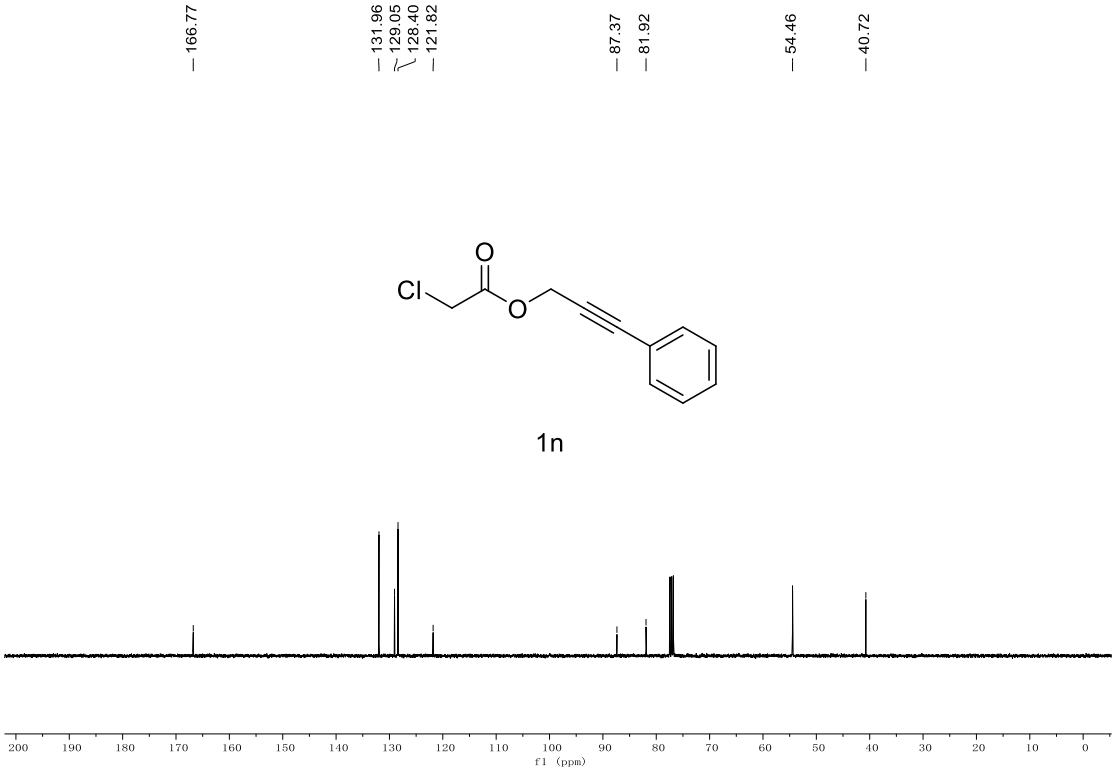


^{13}C NMR, 101 MHz, $CDCl_3$

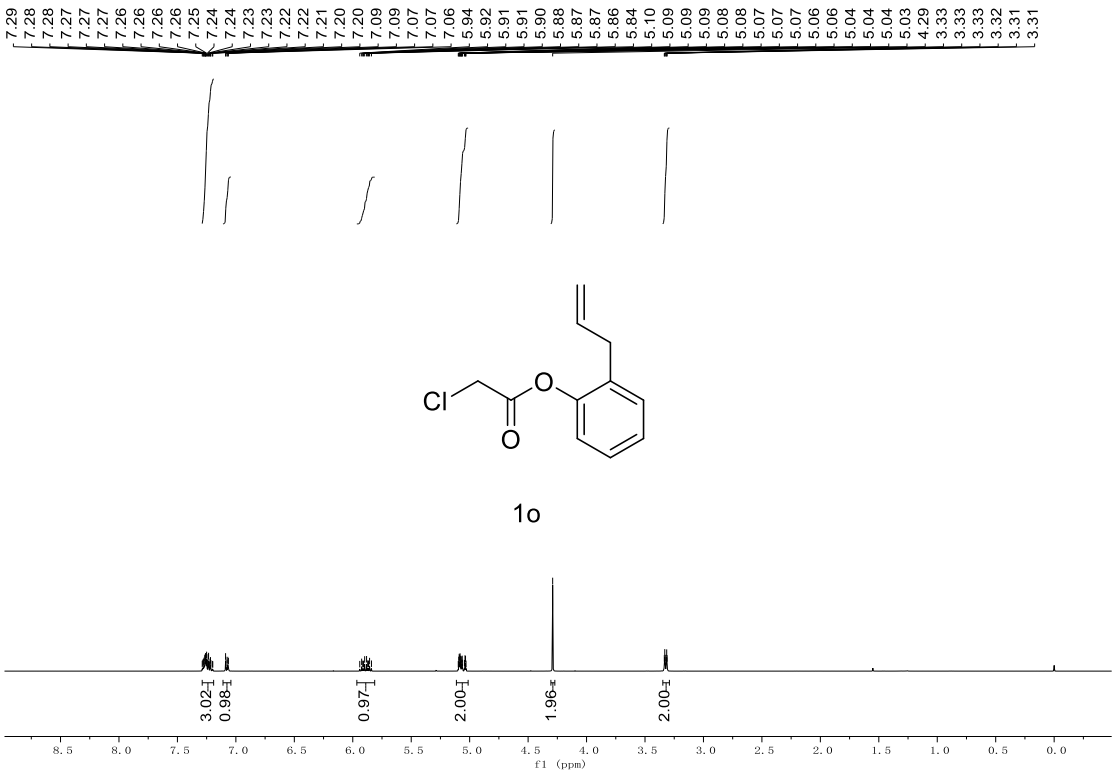


^{1}H NMR, 400 MHz, $CDCl_3$

^{13}C NMR, 101 MHz, $CDCl_3$

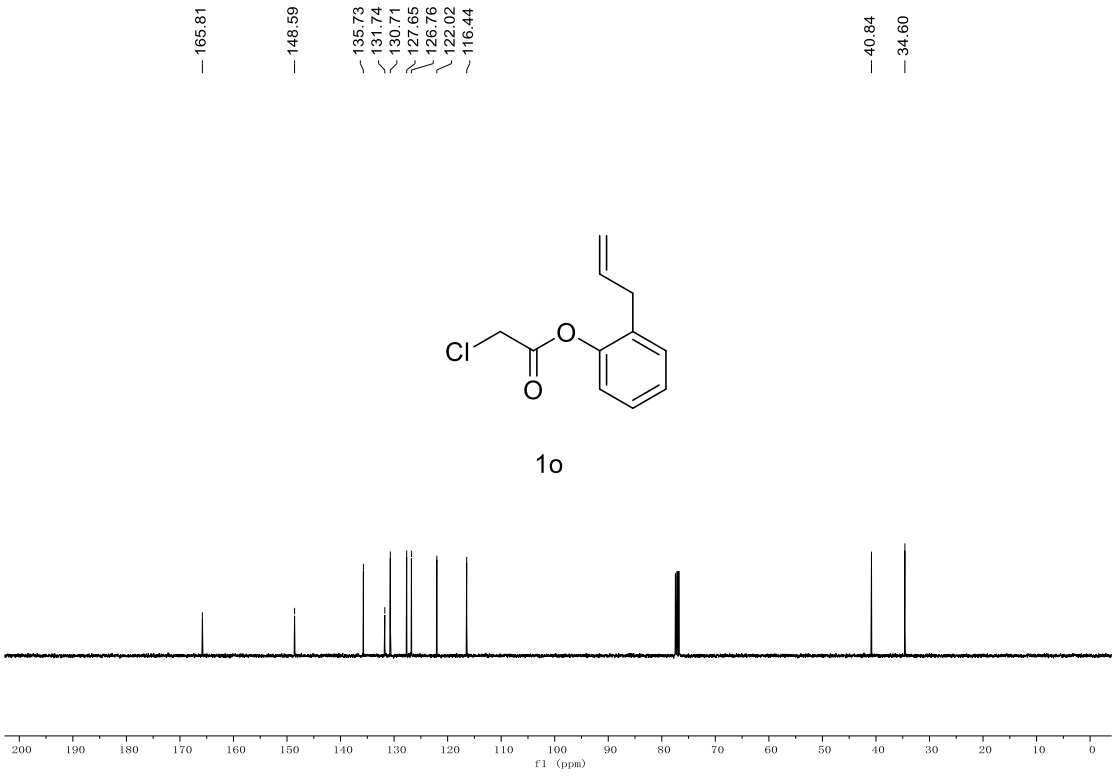


^{1}H NMR, 400 MHz, $CDCl_3$



1o

^{13}C NMR, 101 MHz, $CDCl_3$



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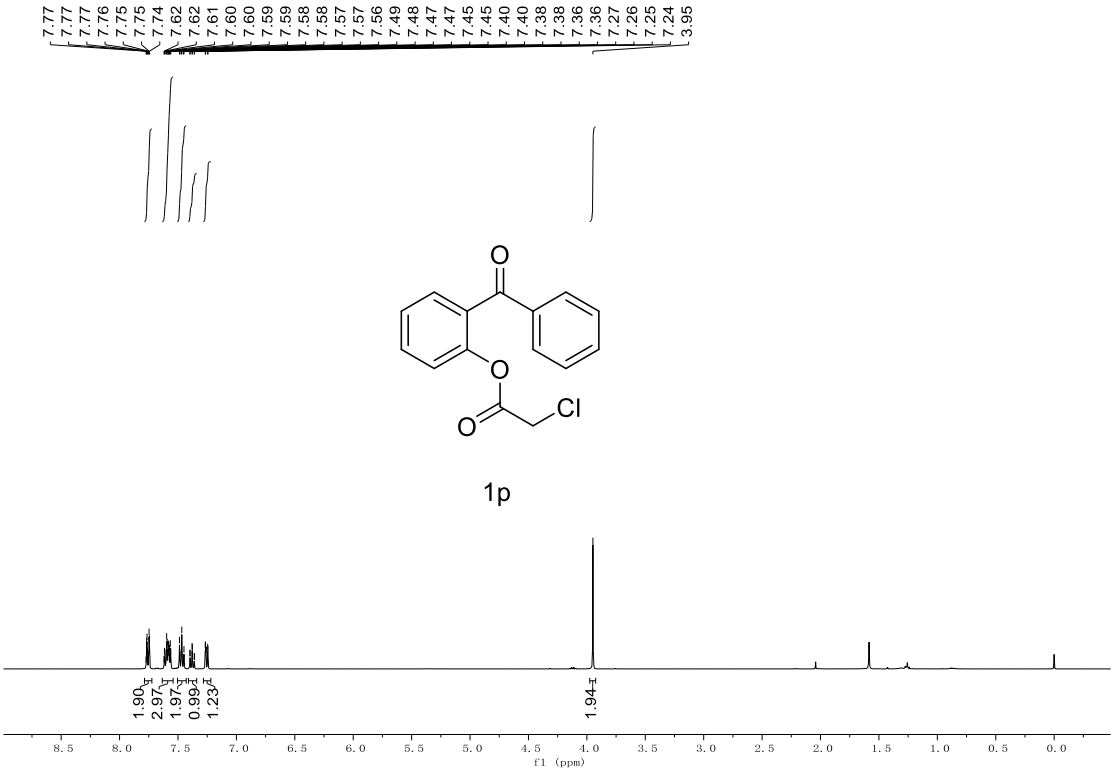

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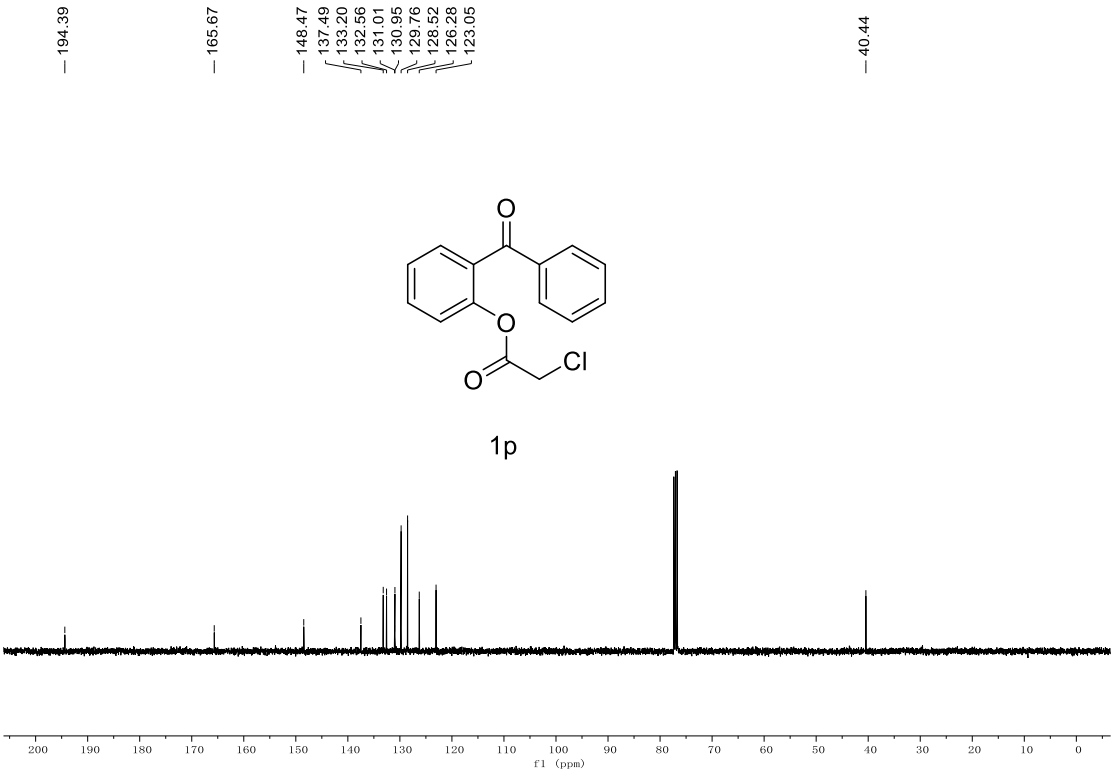
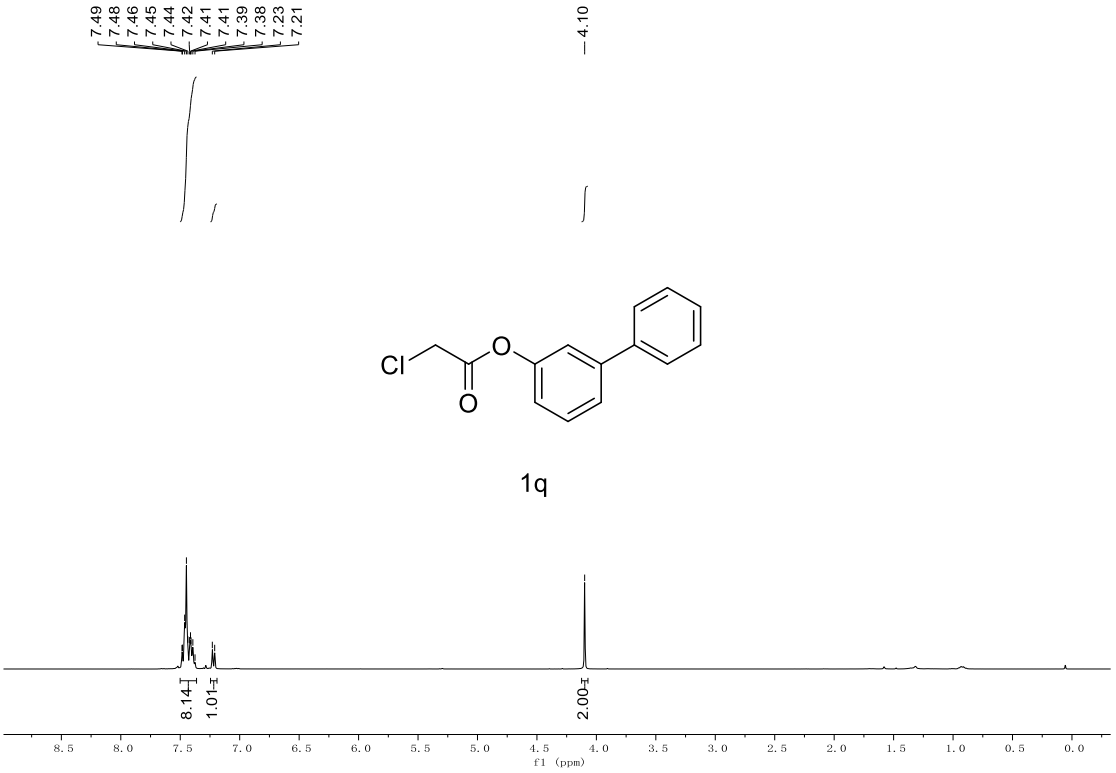
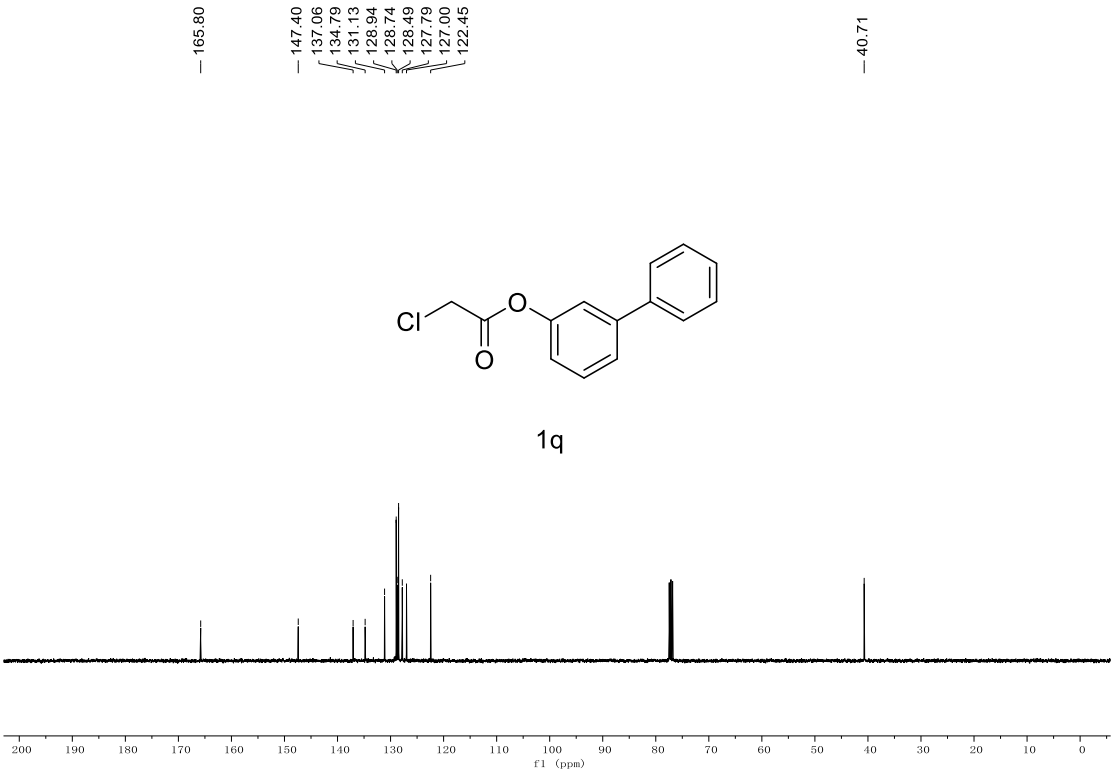


^{1}H NMR, 400 MHz, $CDCl_3$



1q

^{13}C NMR, 101 MHz, $CDCl_3$



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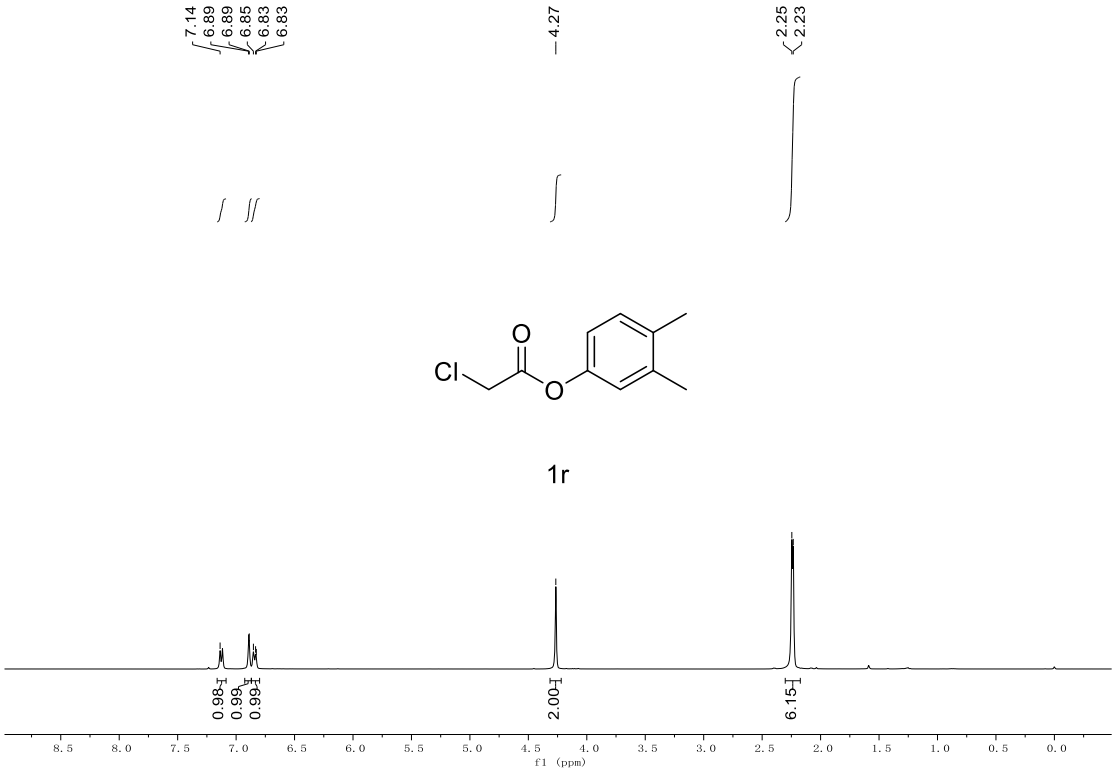
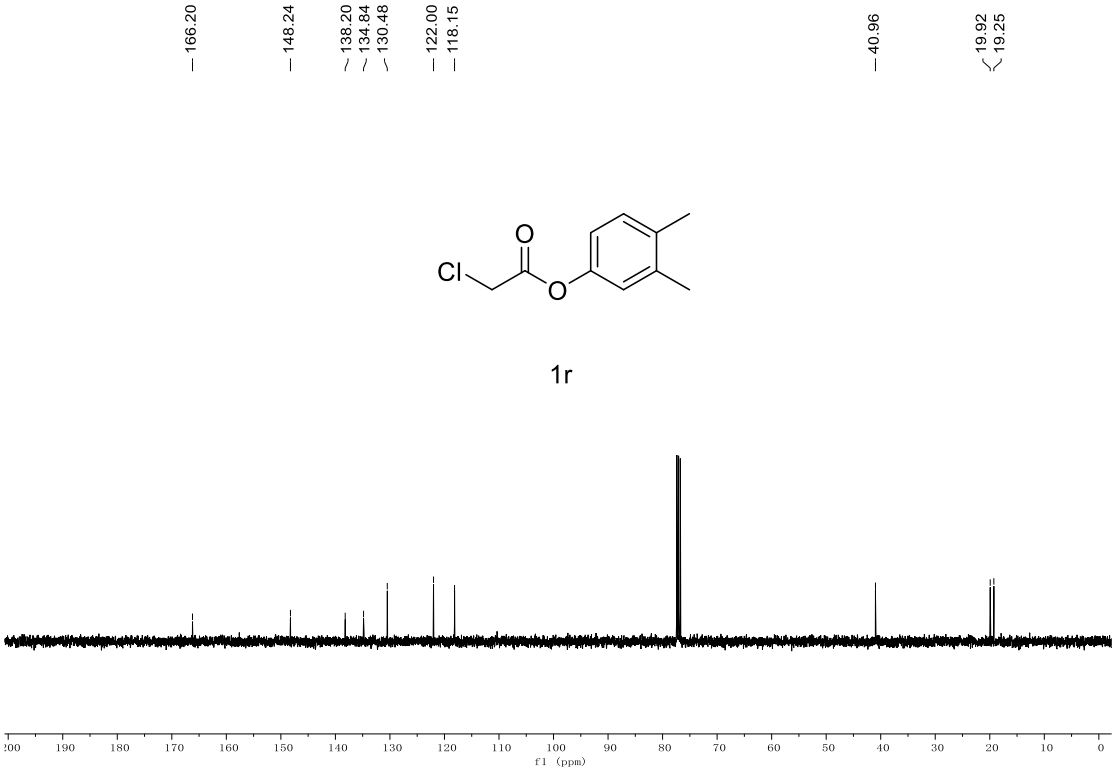
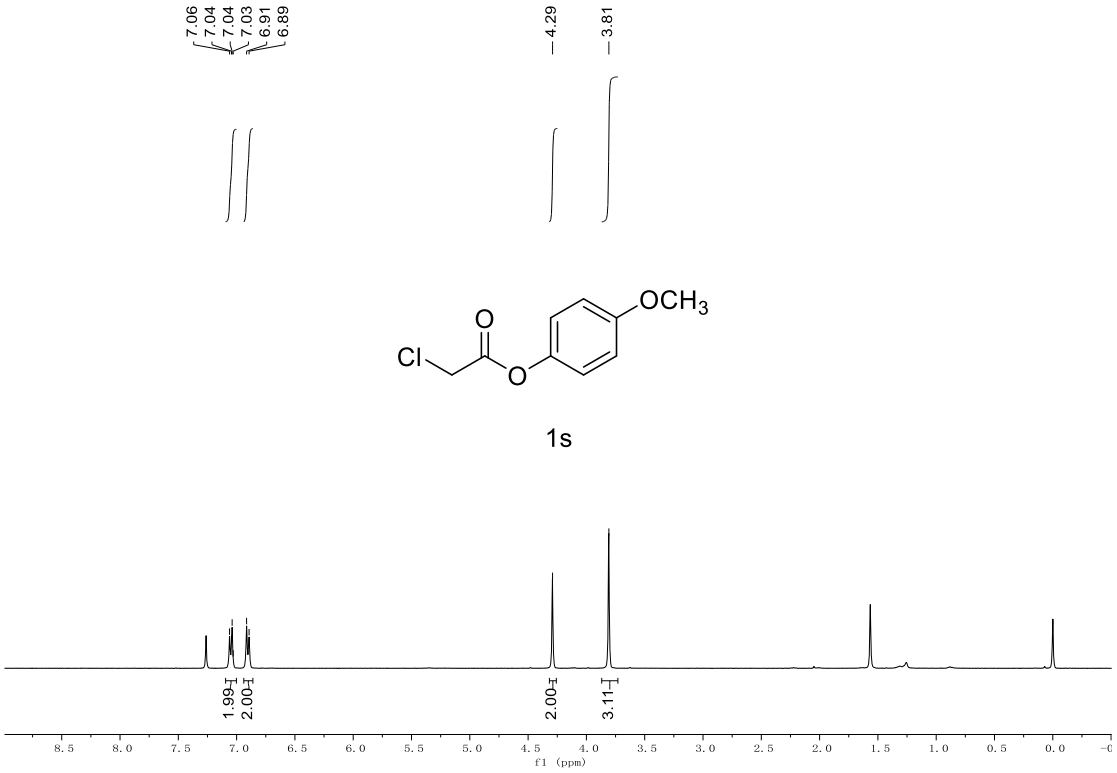


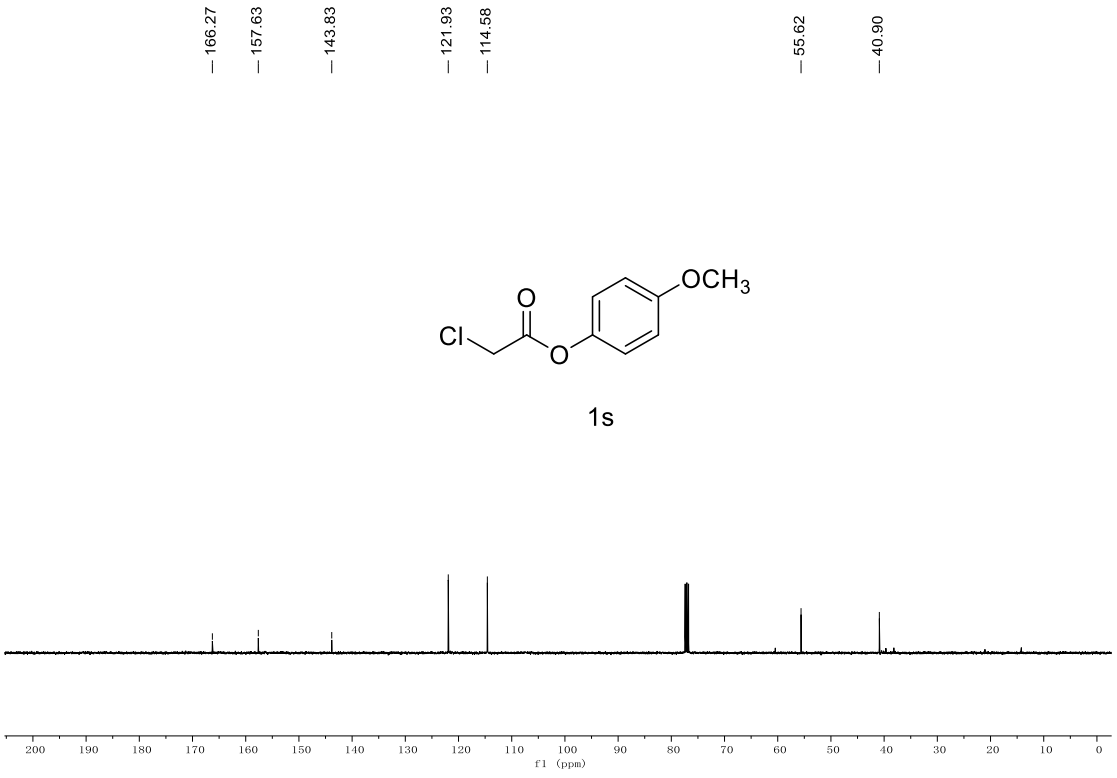
^{13}C NMR, 101 MHz, $CDCl_3$



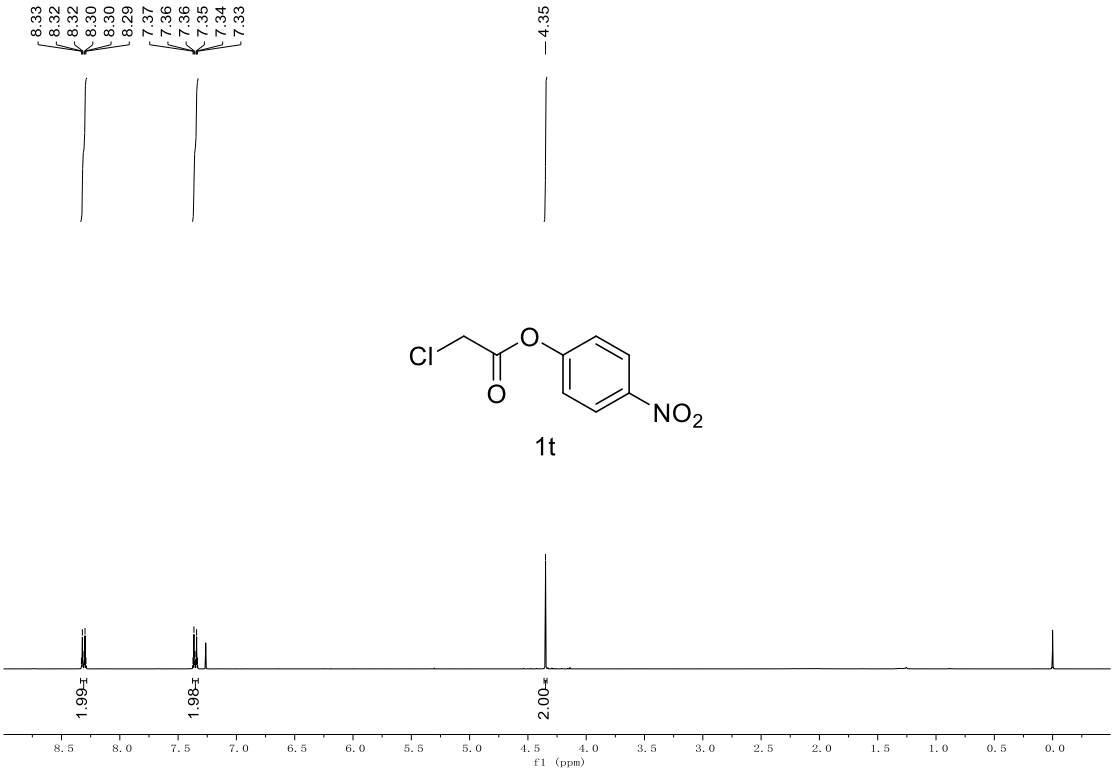
^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$



^{1}H NMR, 400 MHz, $CDCl_3$



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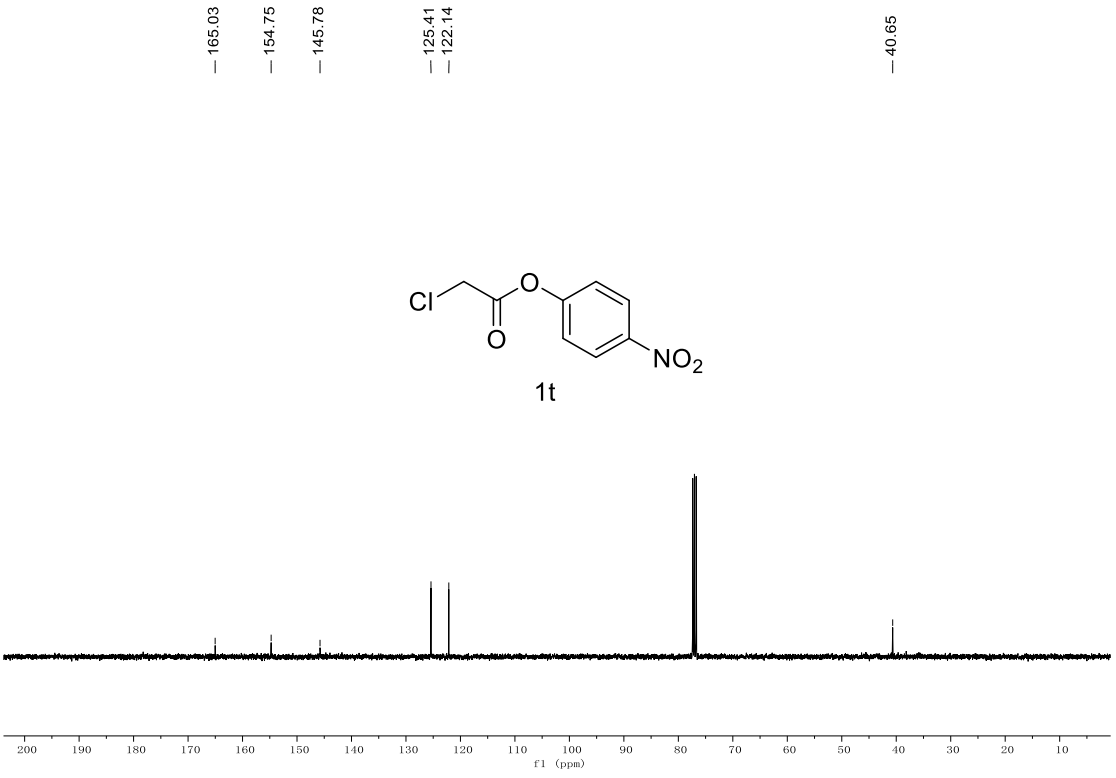
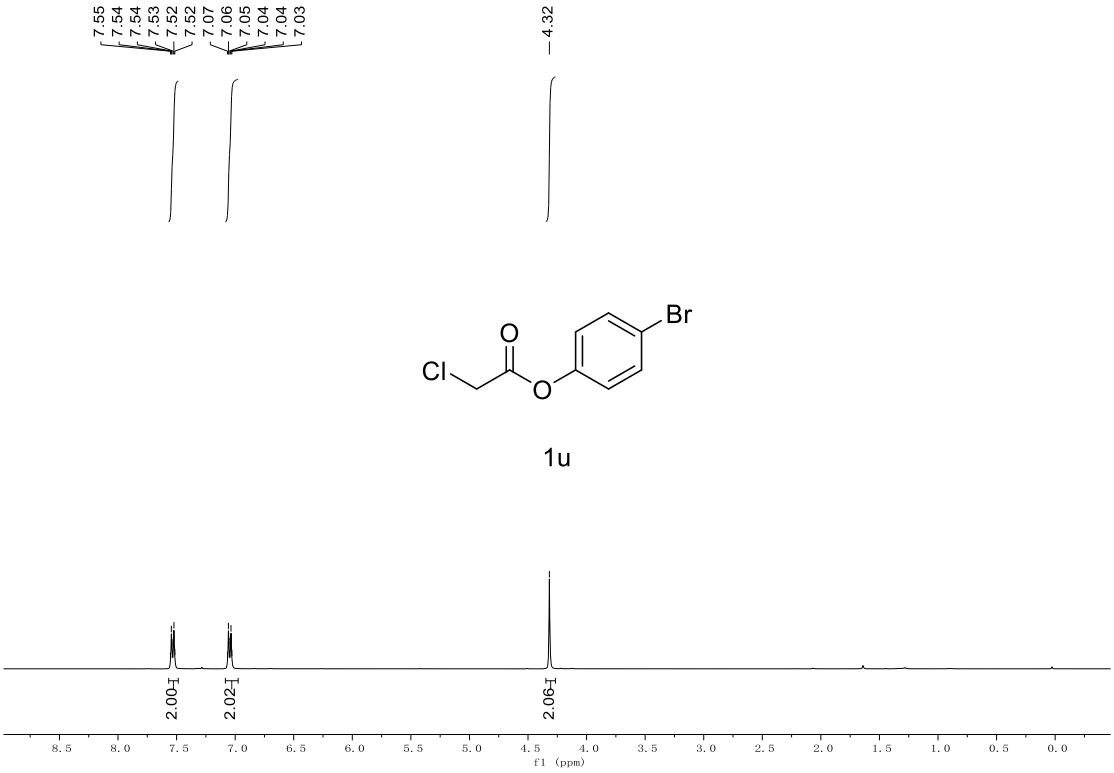
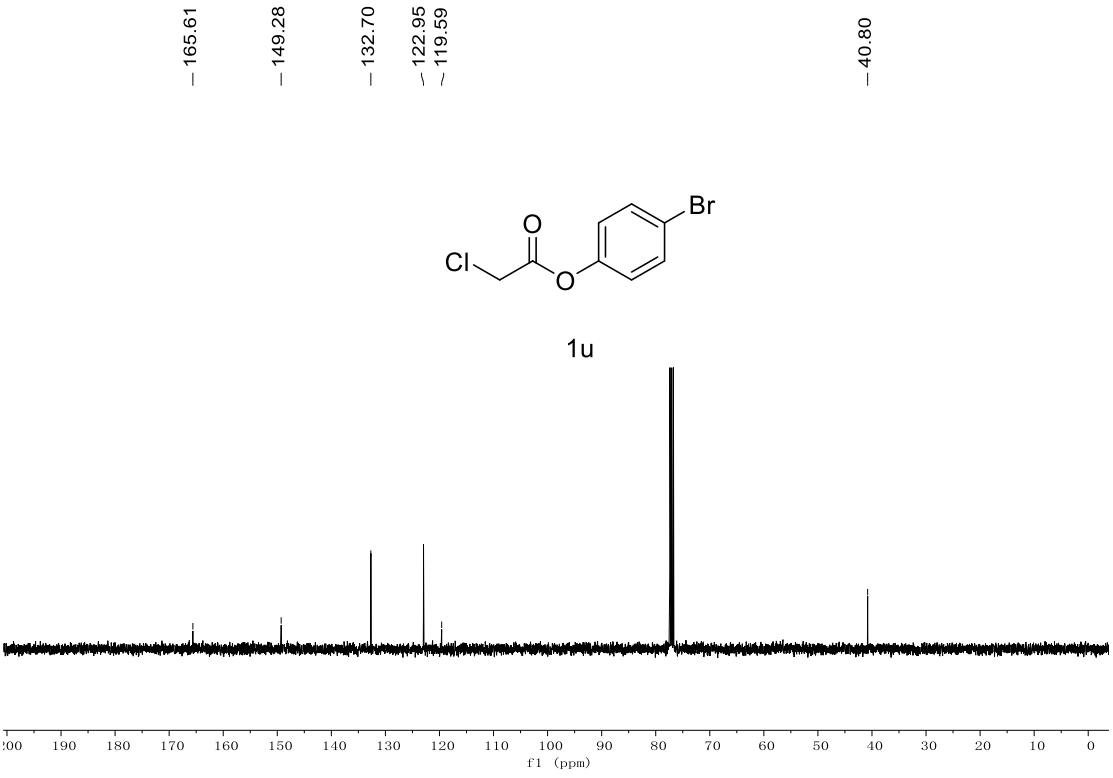


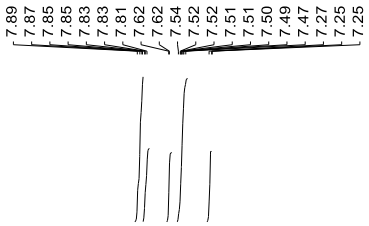
^{1}H NMR, 400 MHz, $CDCl_3$

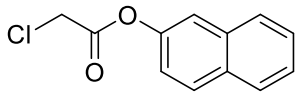


^{13}C NMR, 101 MHz, $CDCl_3$



^{1}H NMR, 400 MHz, $CDCl_3$





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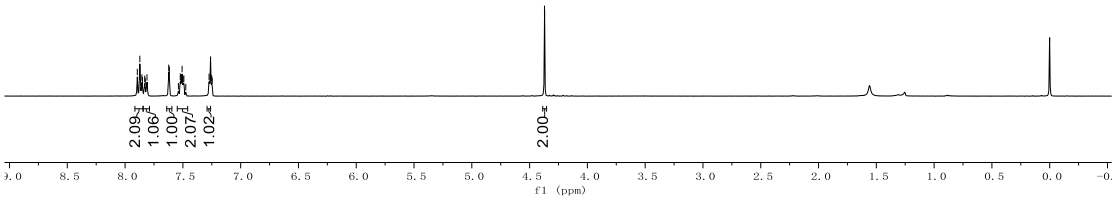
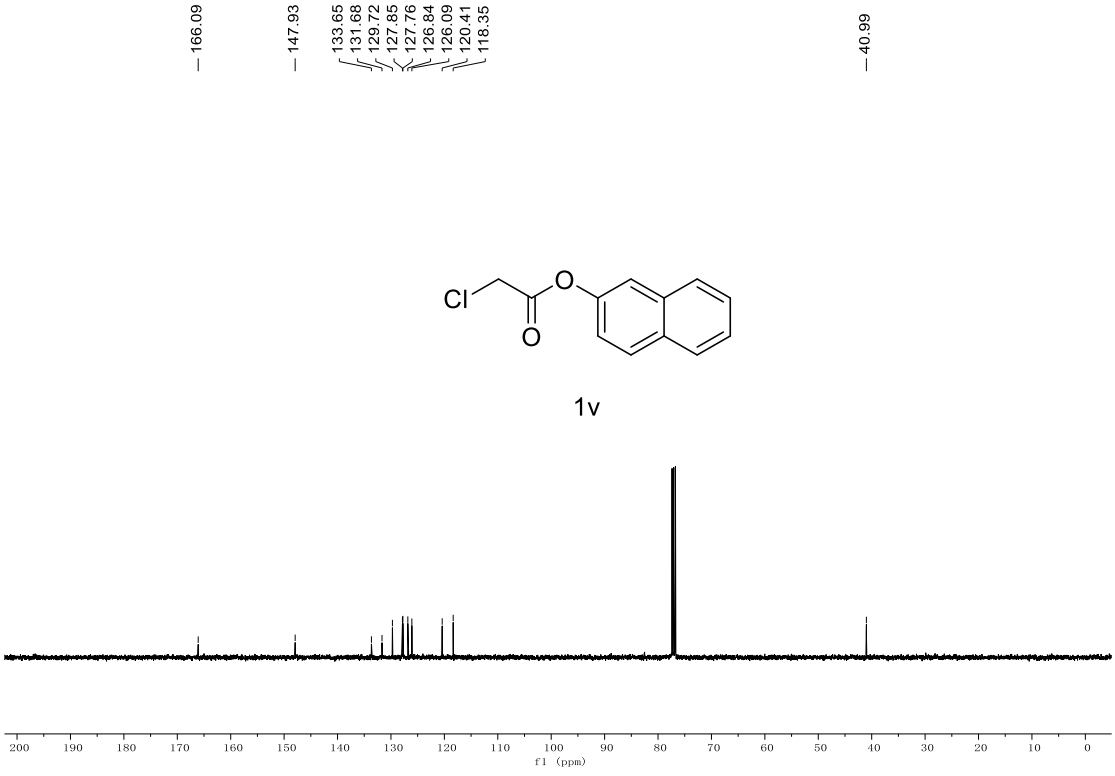


^{13}C NMR, 101 MHz, $CDCl_3$



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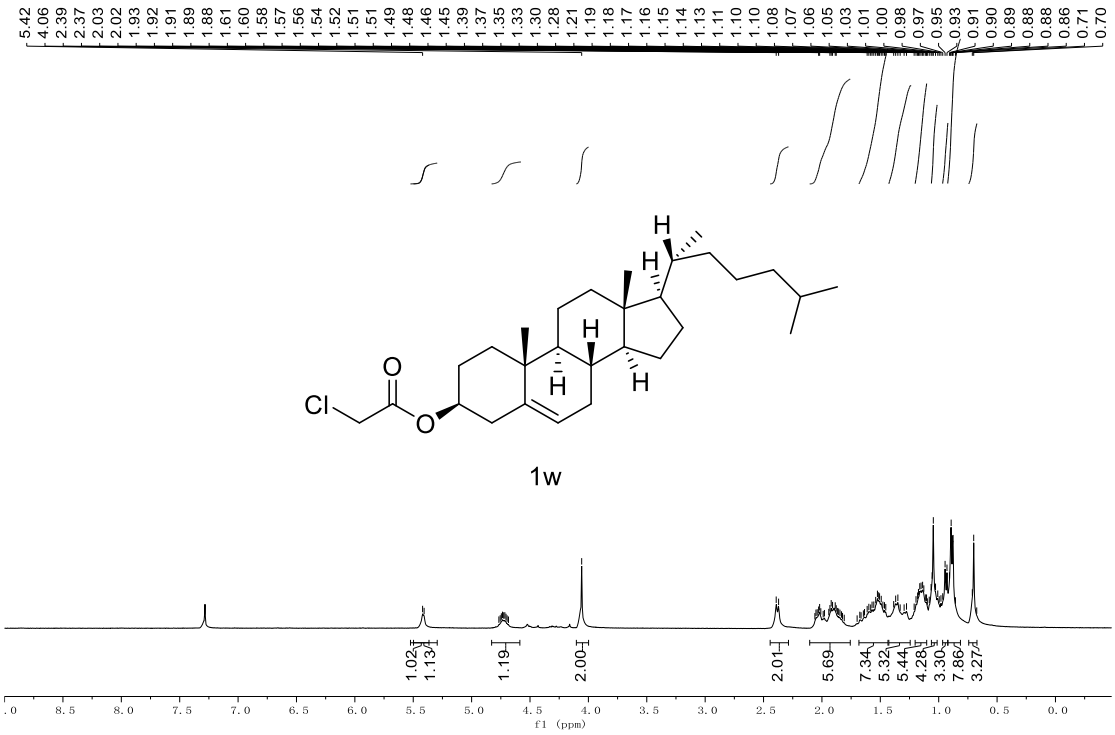
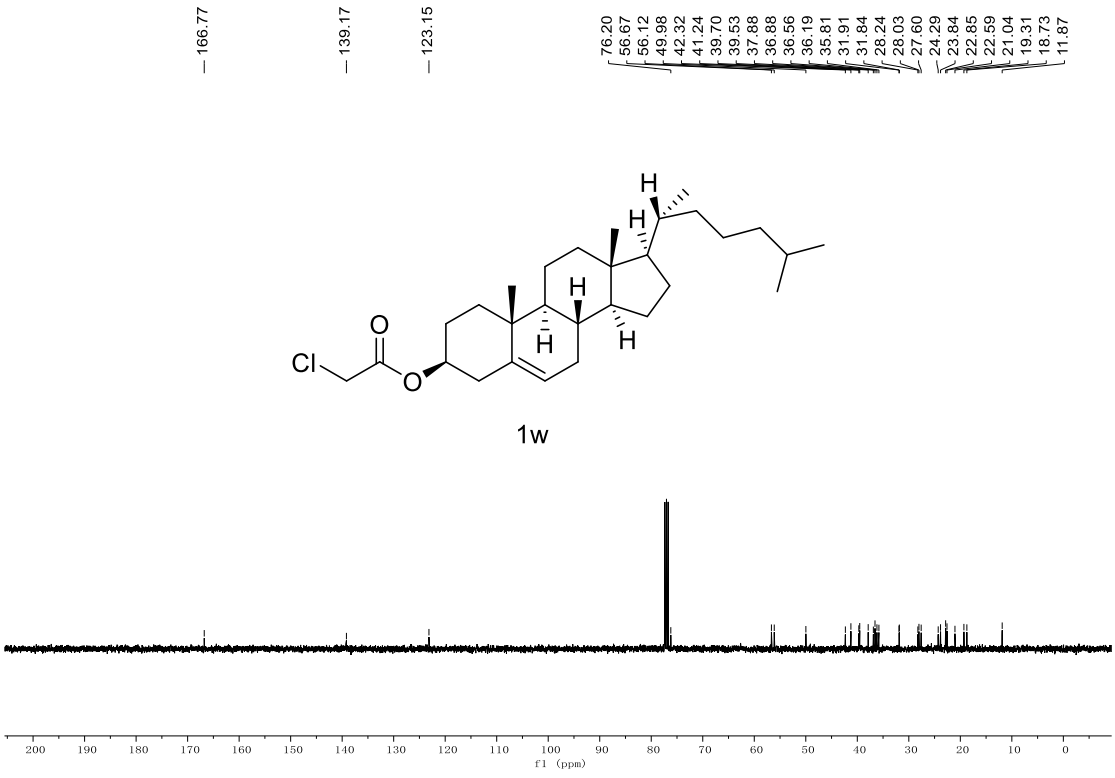
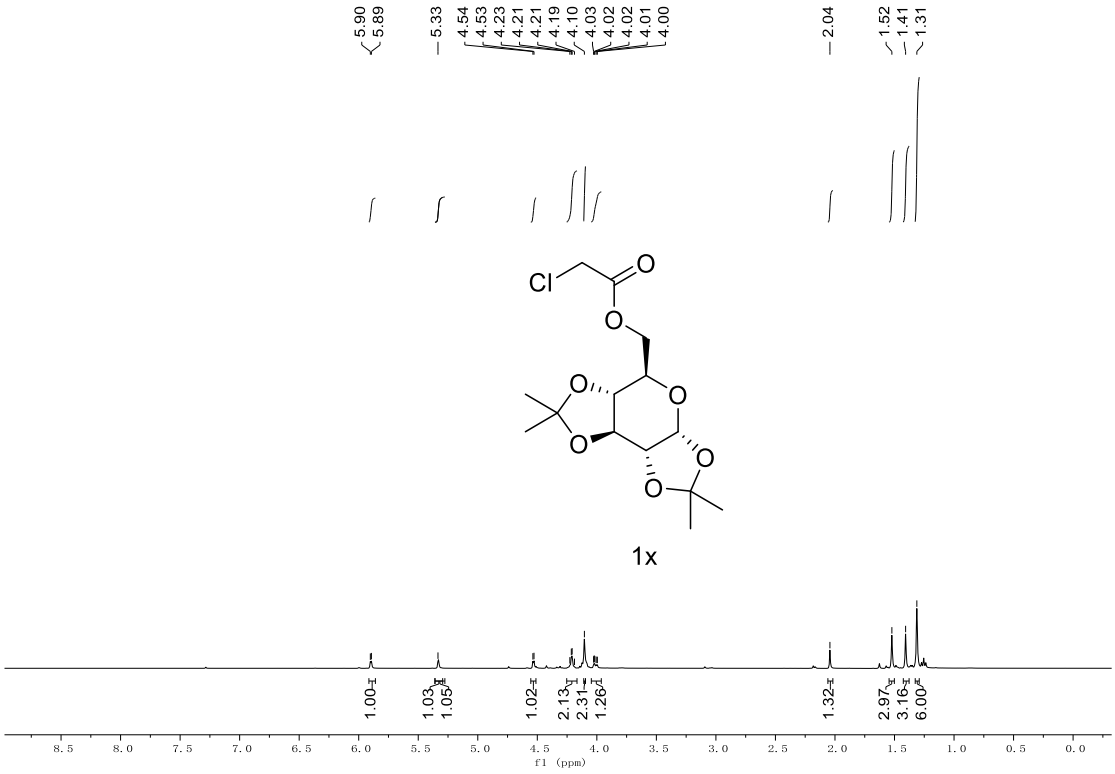


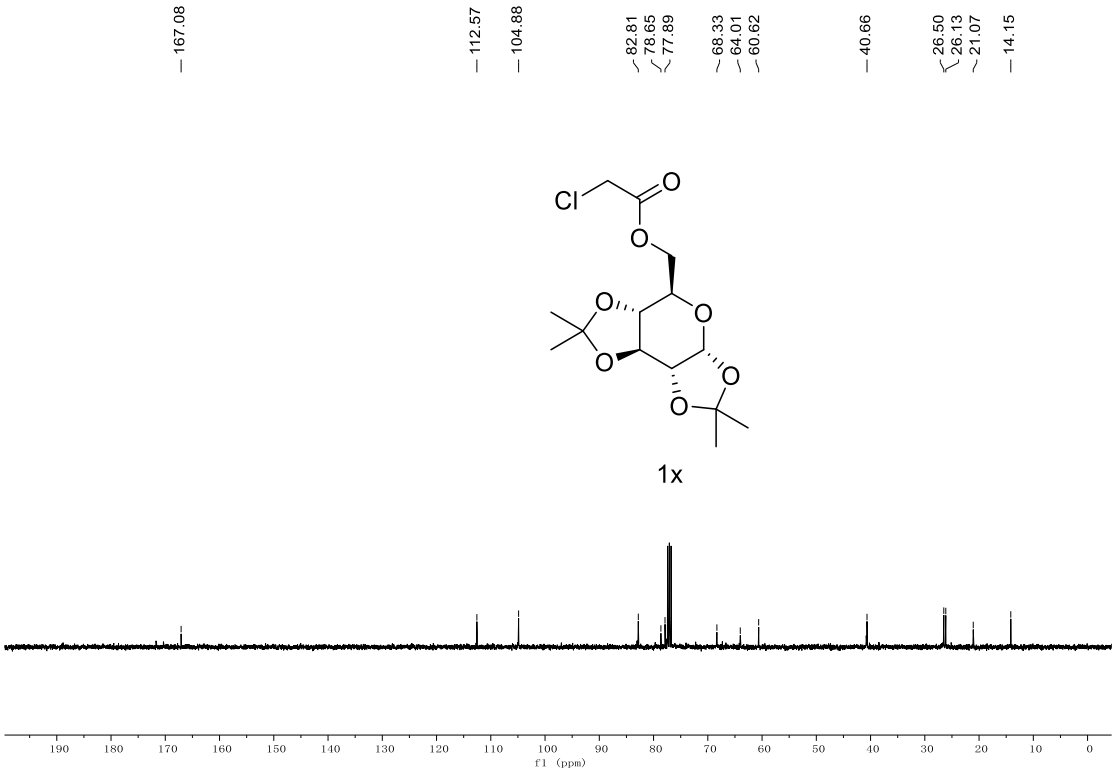
^{13}C NMR, 101 MHz, $CDCl_3$



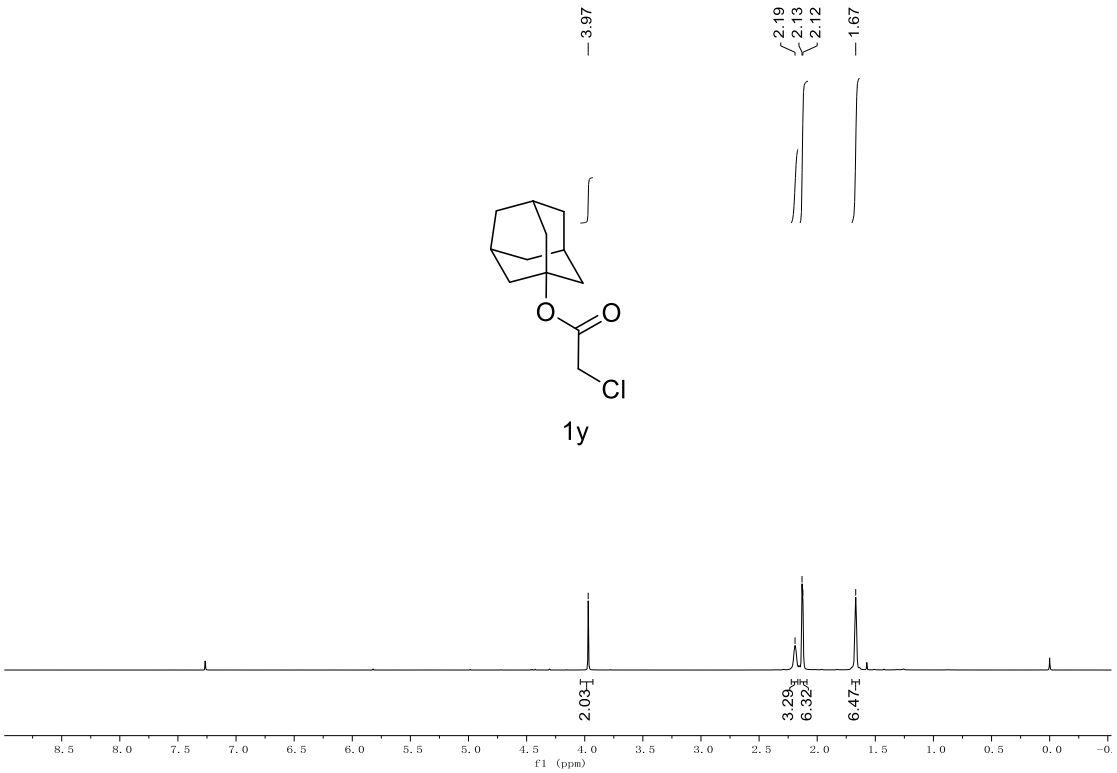
^{1}H NMR, 400 MHz, $CDCl_3$



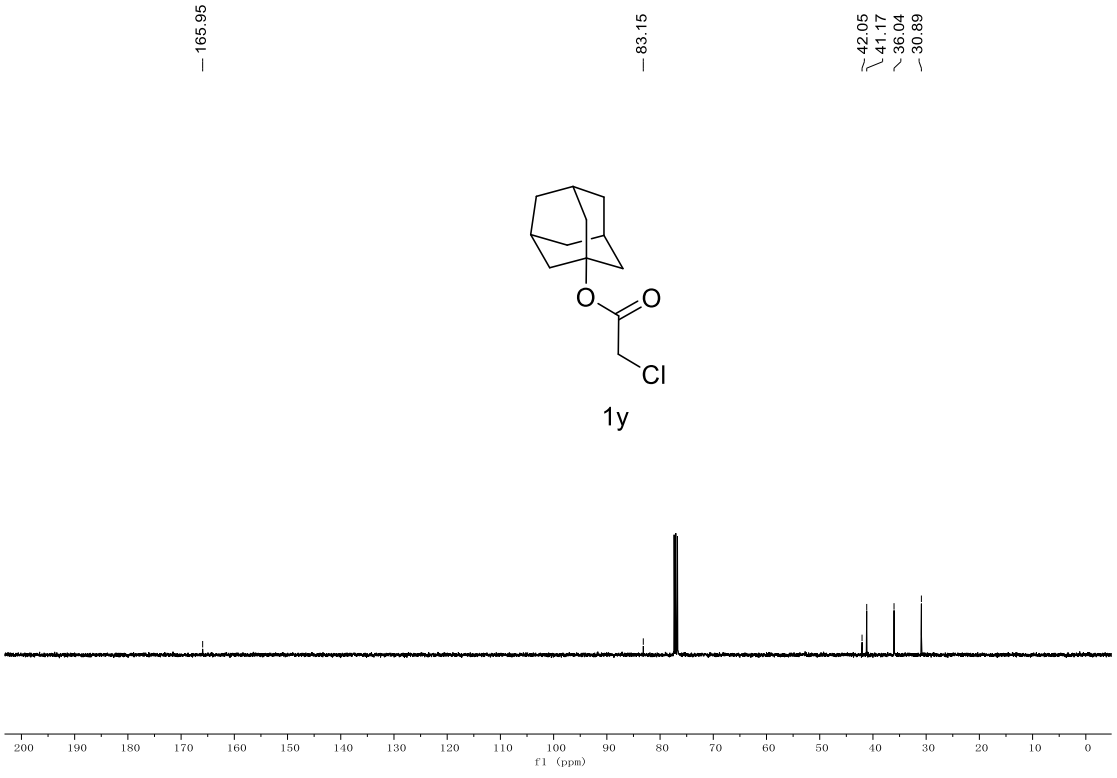
^{13}C NMR, 101 MHz, $CDCl_3$



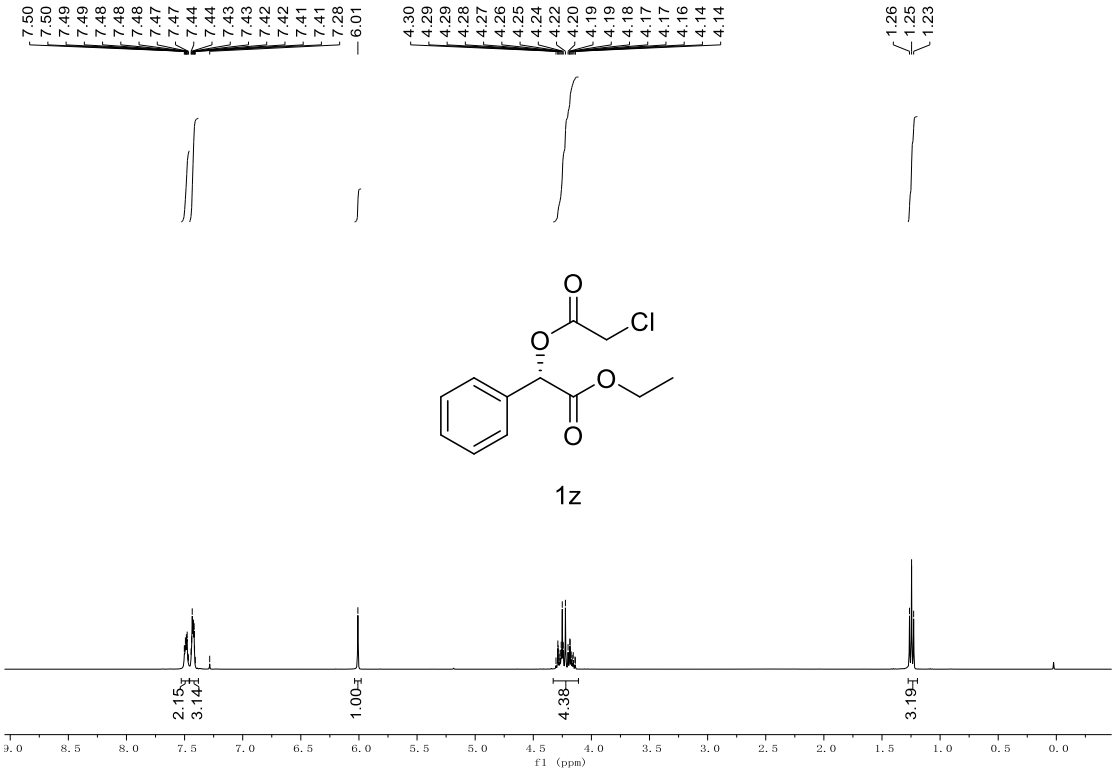
^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$

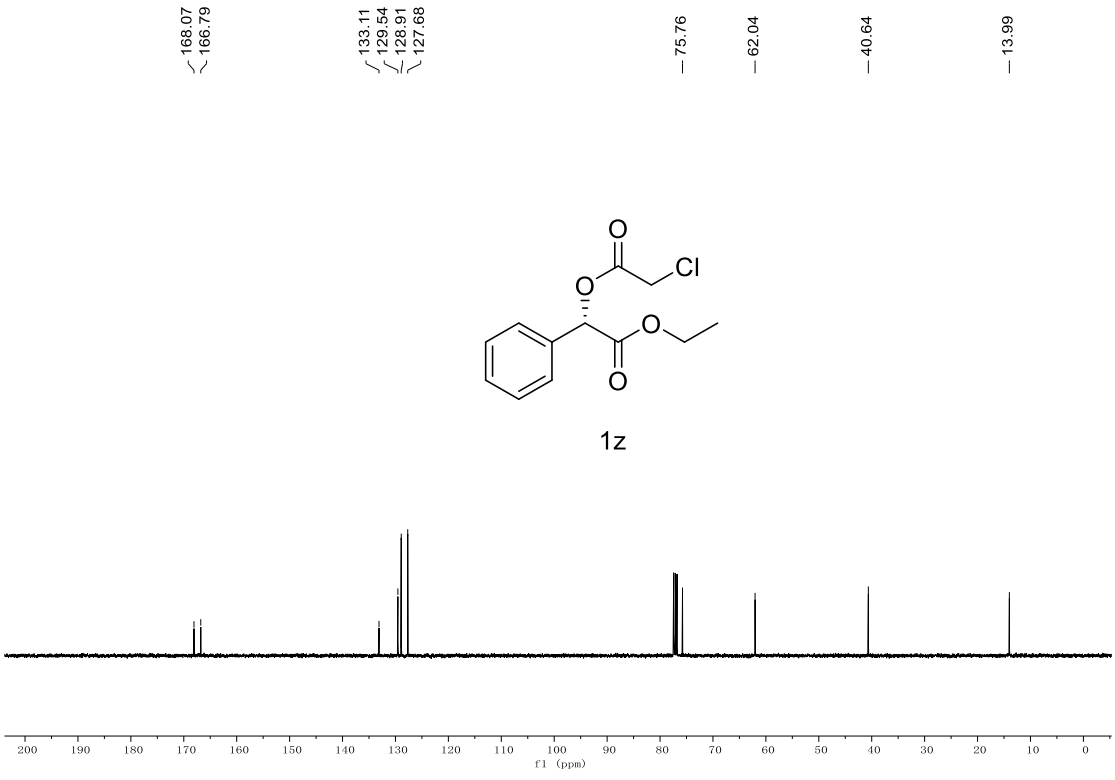


^{1}H NMR, 400 MHz, $CDCl_3$



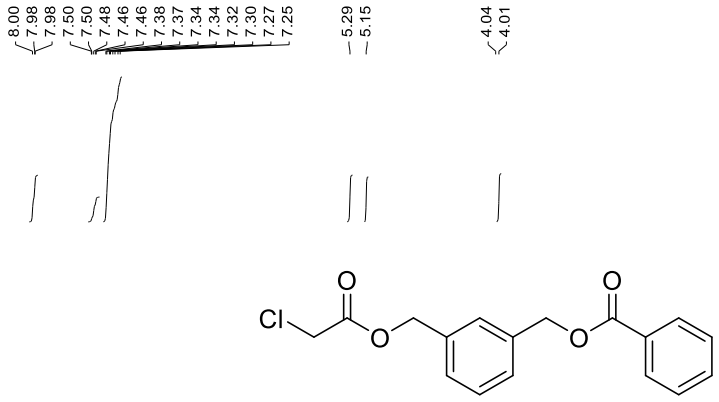
1z

^{13}C NMR, 101 MHz, $CDCl_3$



1z

^{1}H NMR, 400 MHz, $CDCl_3$



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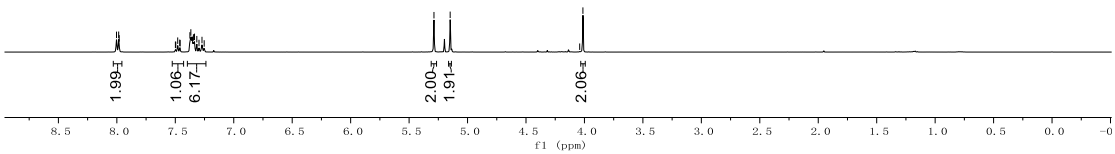
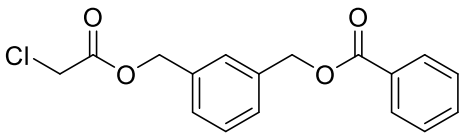


^{13}C NMR, 101 MHz, $CDCl_3$



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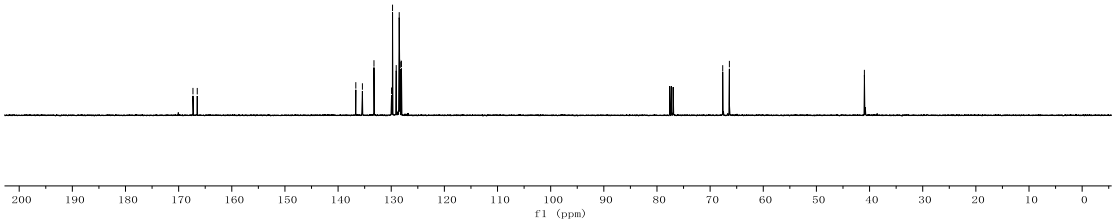
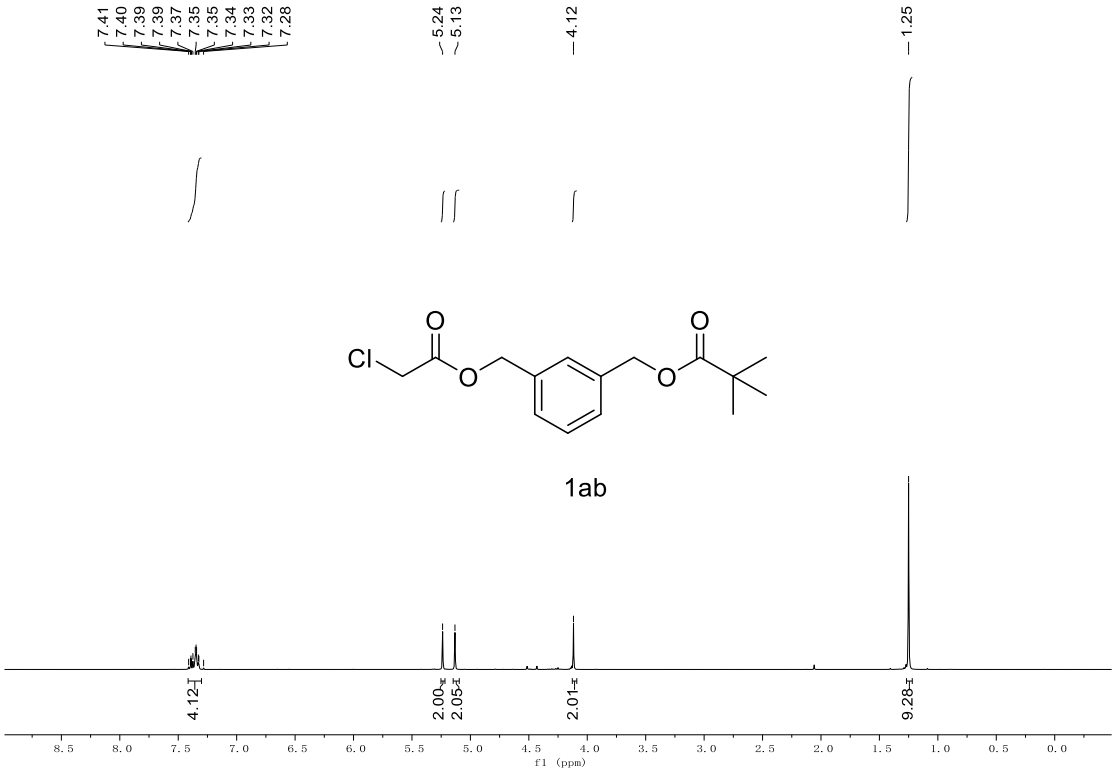
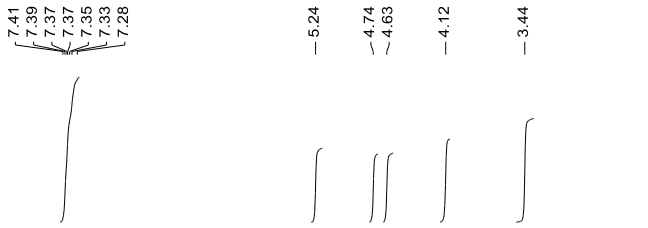


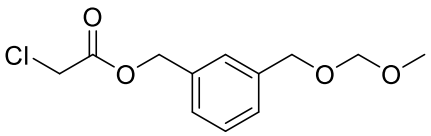
^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$

^{1}H NMR, 400 MHz, $CDCl_3$





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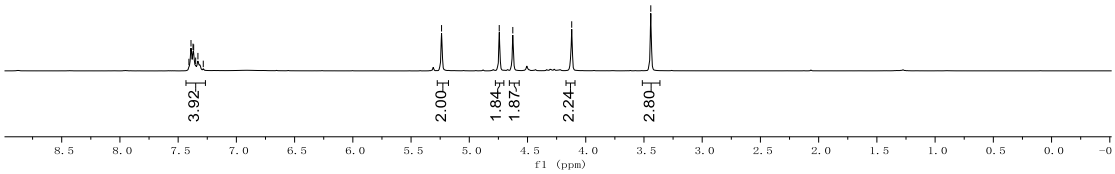
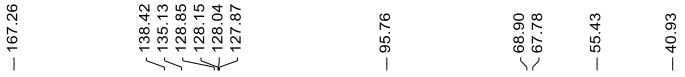
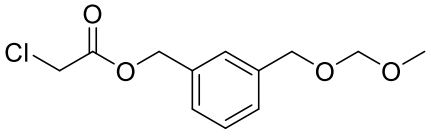


^{13}C NMR, 101 MHz, $CDCl_3$





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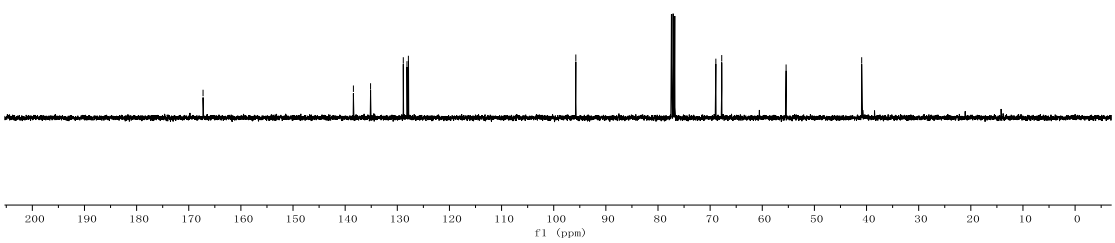
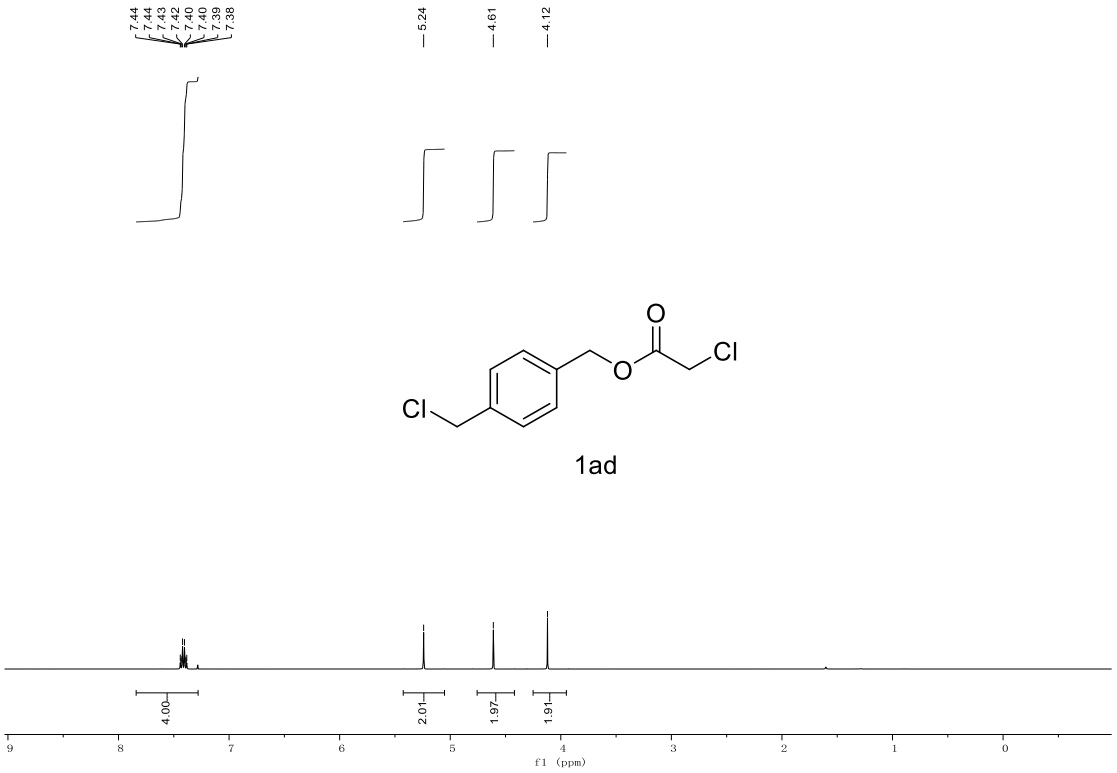
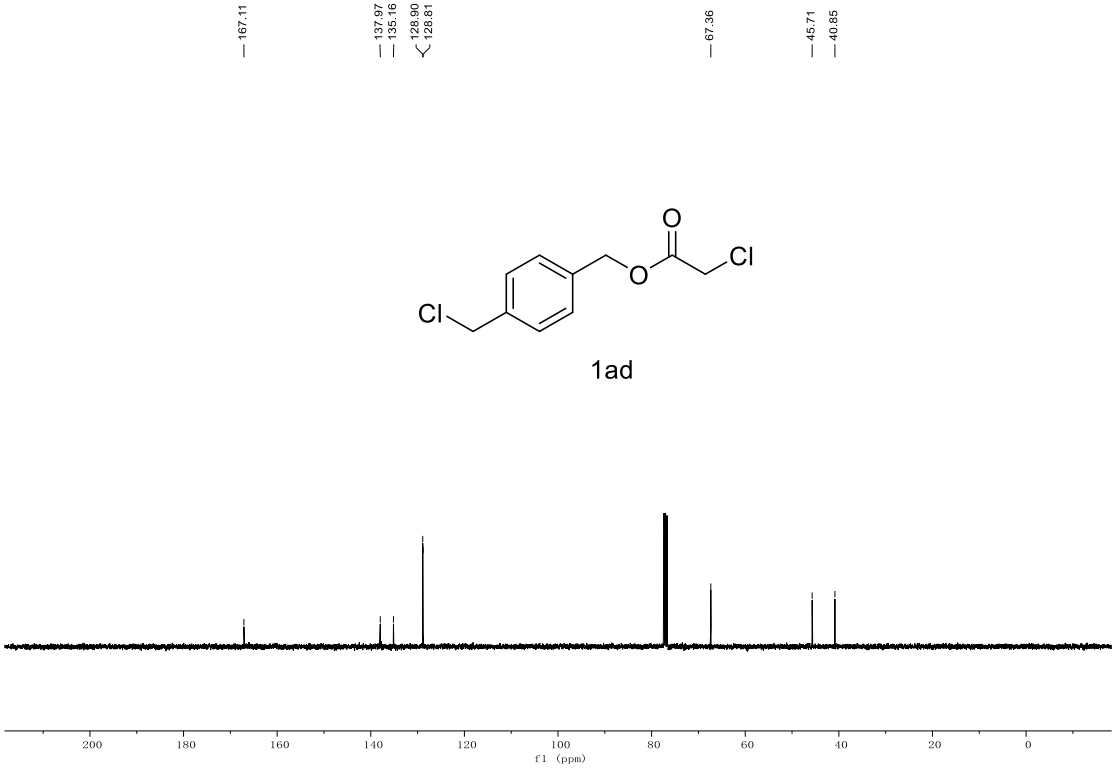


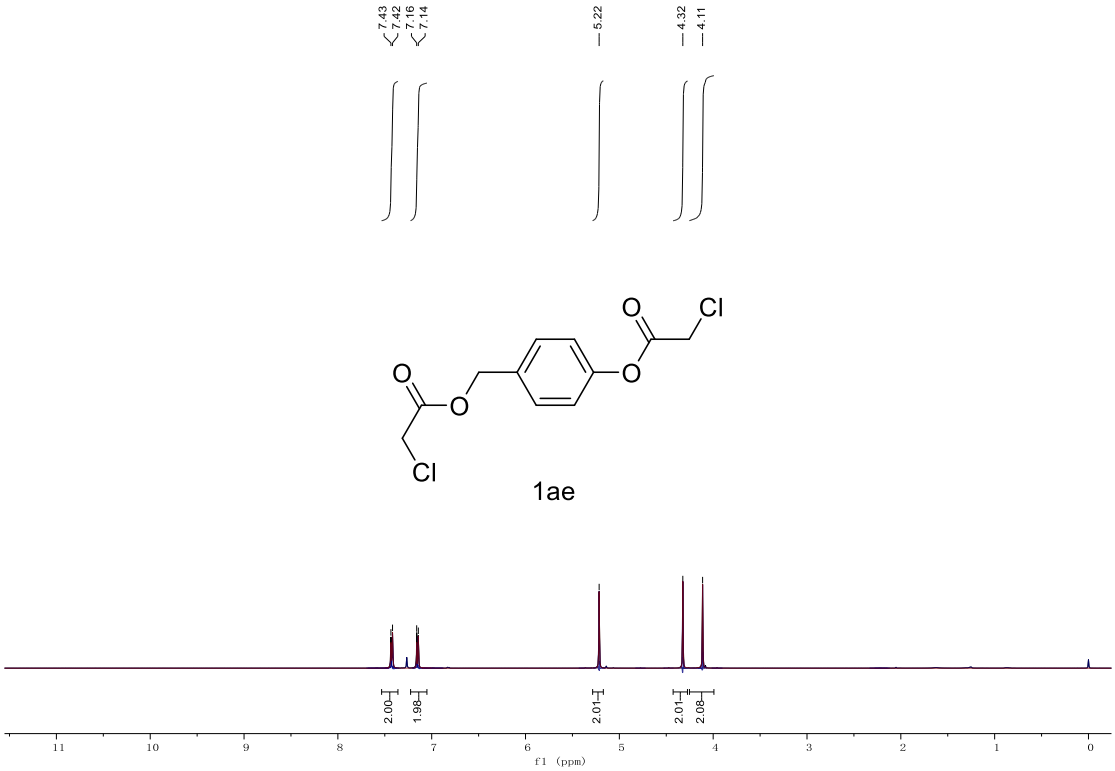
^{1}H NMR, 400 MHz, $CDCl_3$



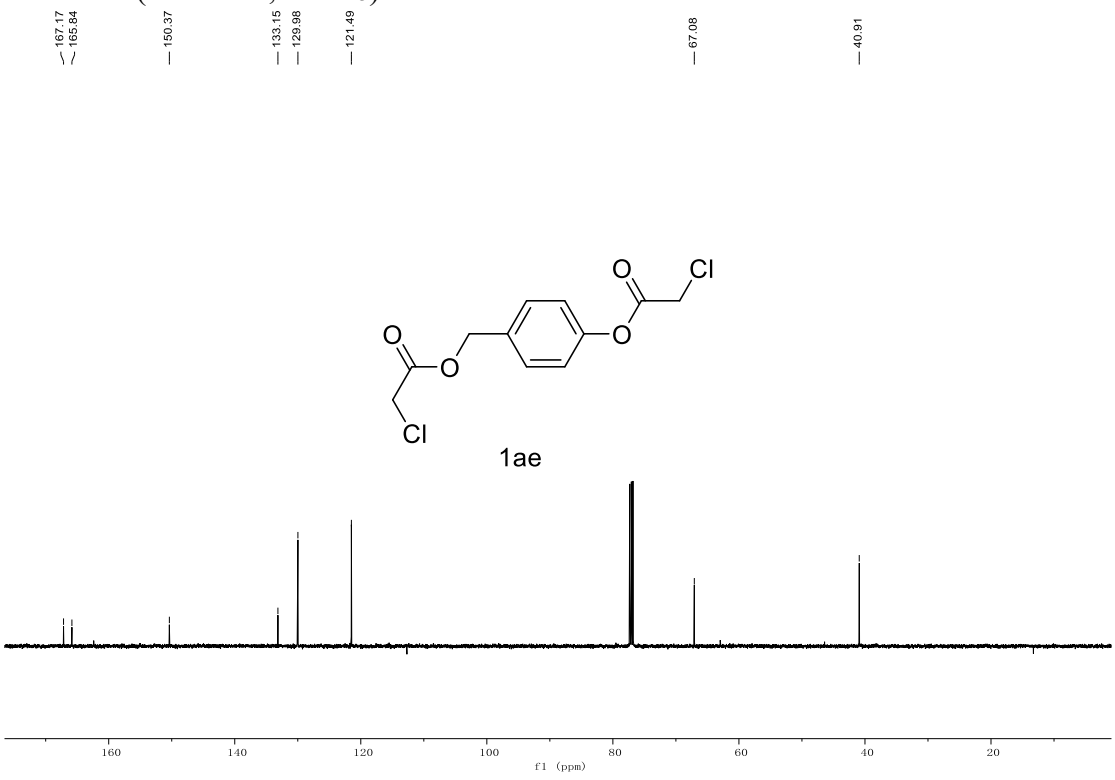
^{13}C NMR, 101 MHz, $CDCl_3$



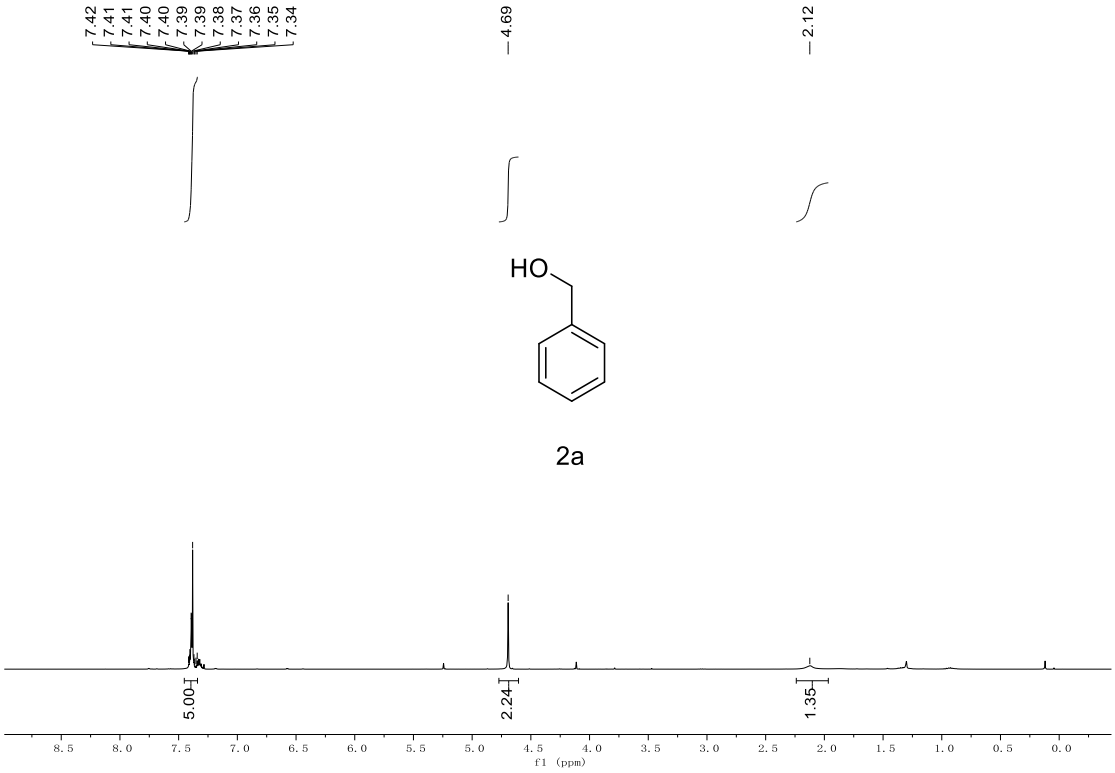
^{1}H NMR (400 MHz, $CDCl_3$)



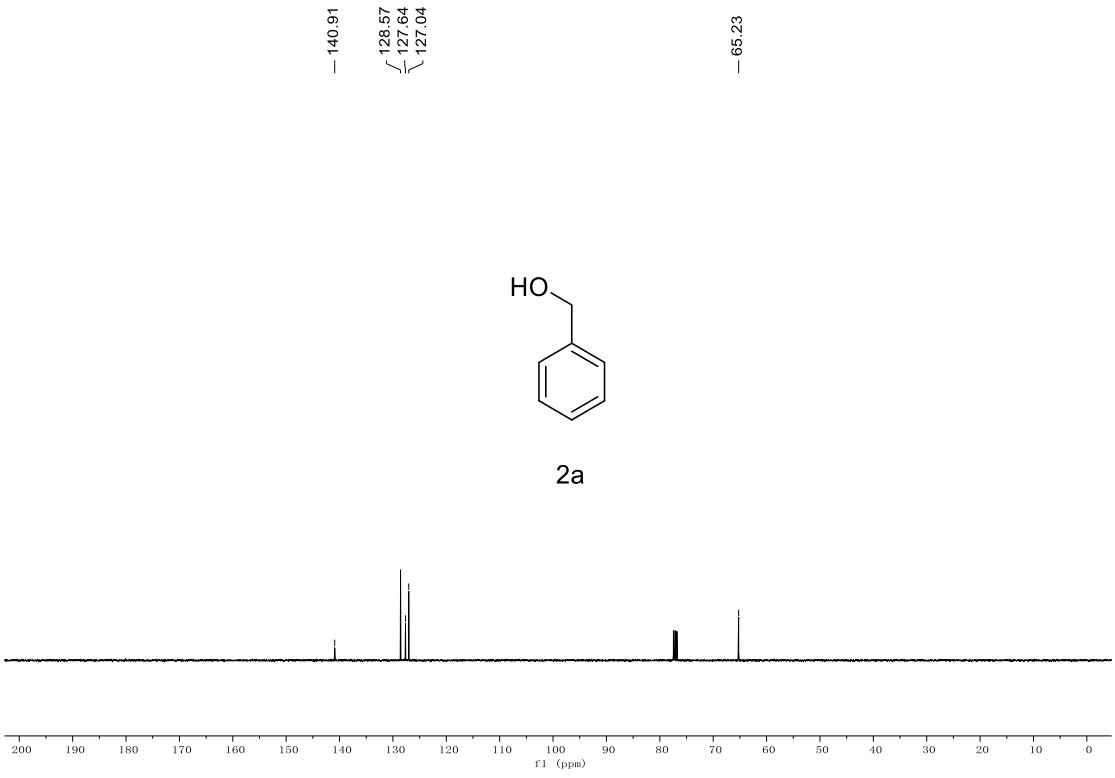
^{13}C NMR (101 MHz, $CDCl_3$)



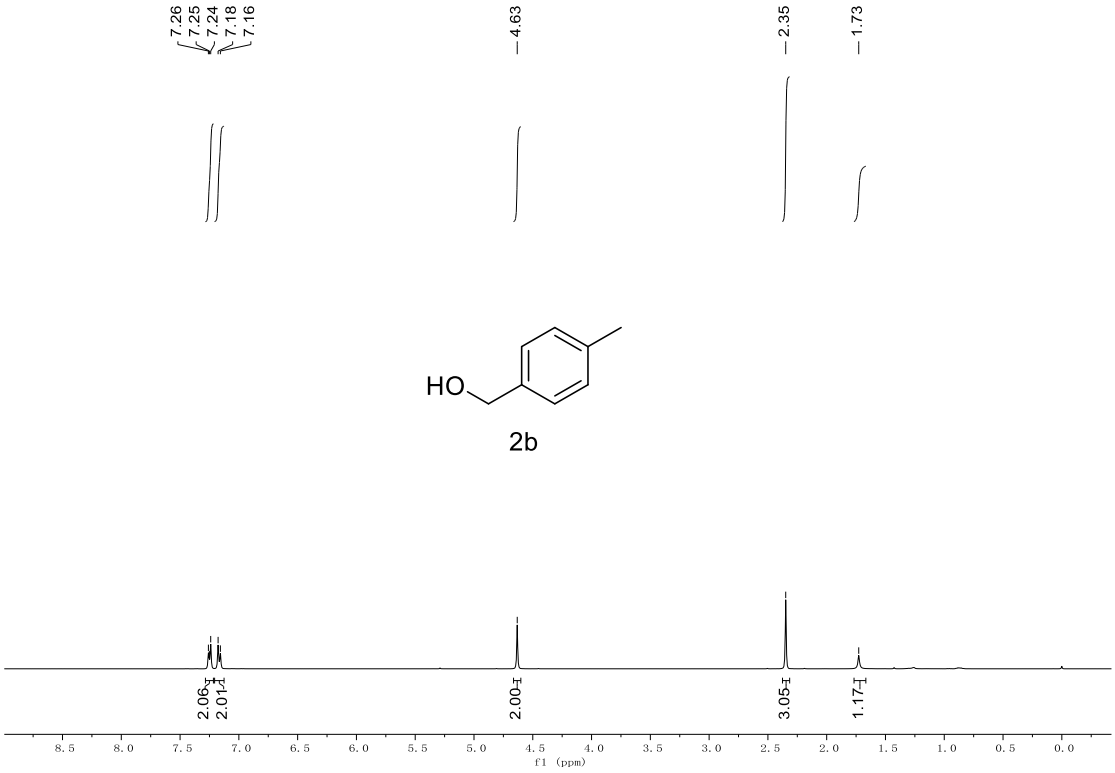
^{1}H NMR, 400 MHz, $CDCl_3$



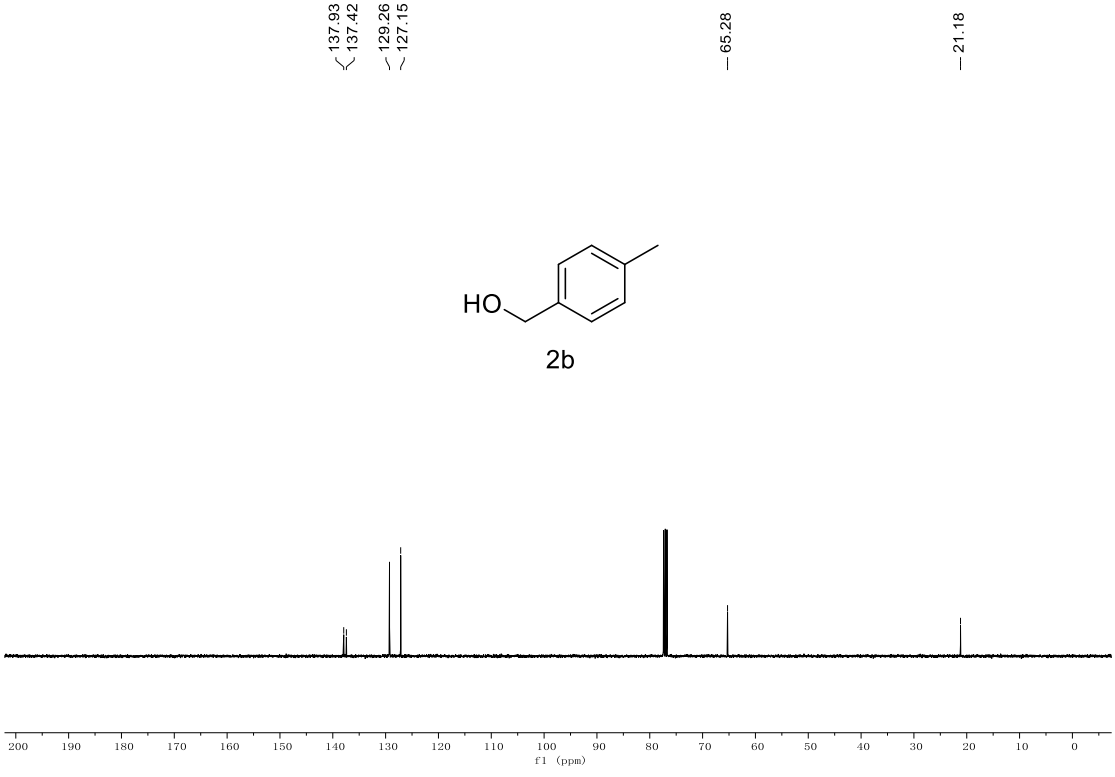
^{13}C NMR, 101 MHz, $CDCl_3$



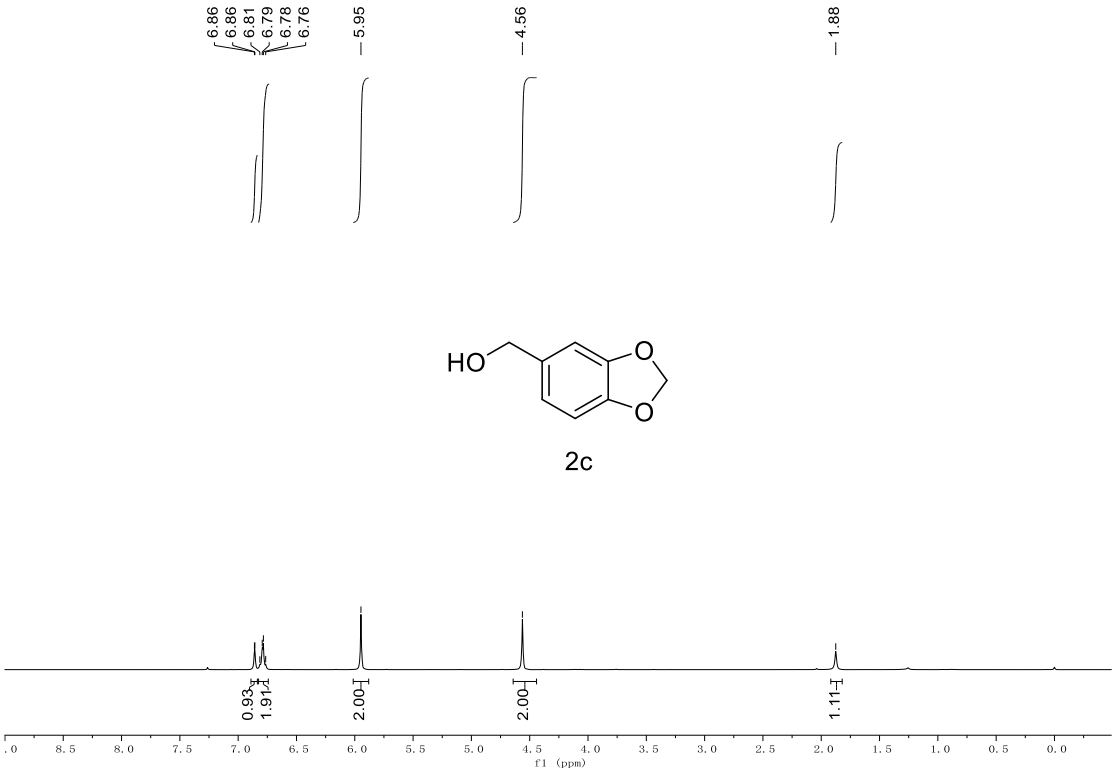
^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$

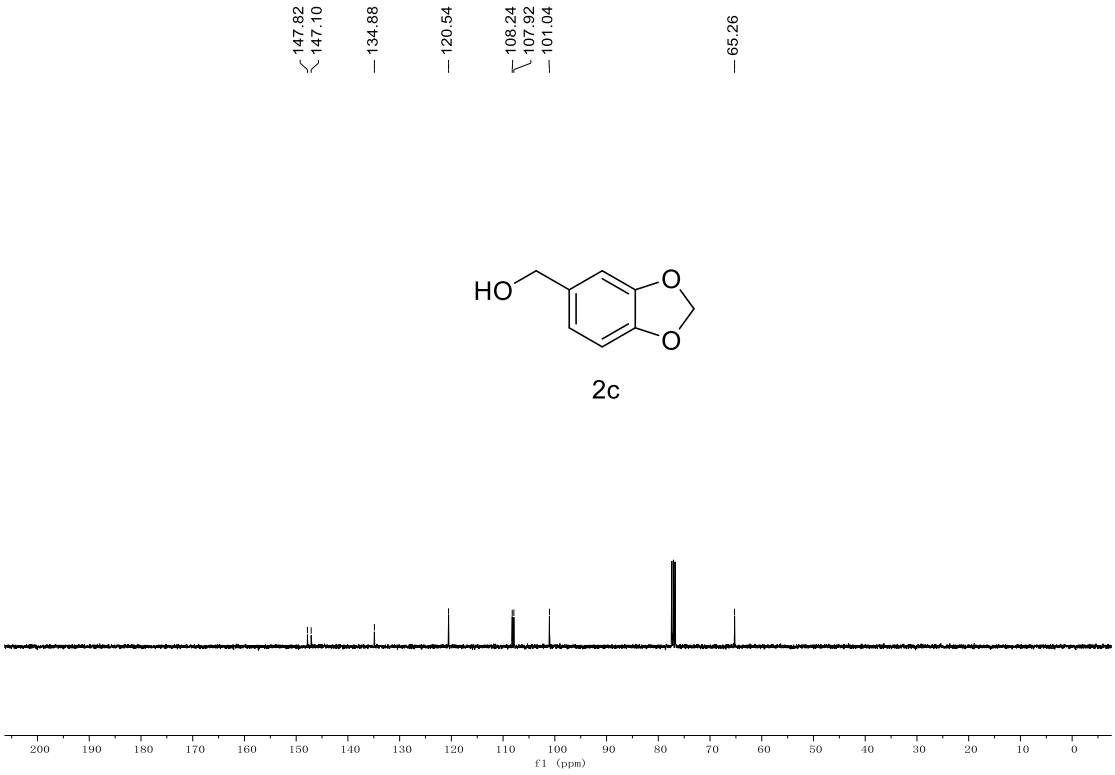


^{1}H NMR, 400 MHz, $CDCl_3$



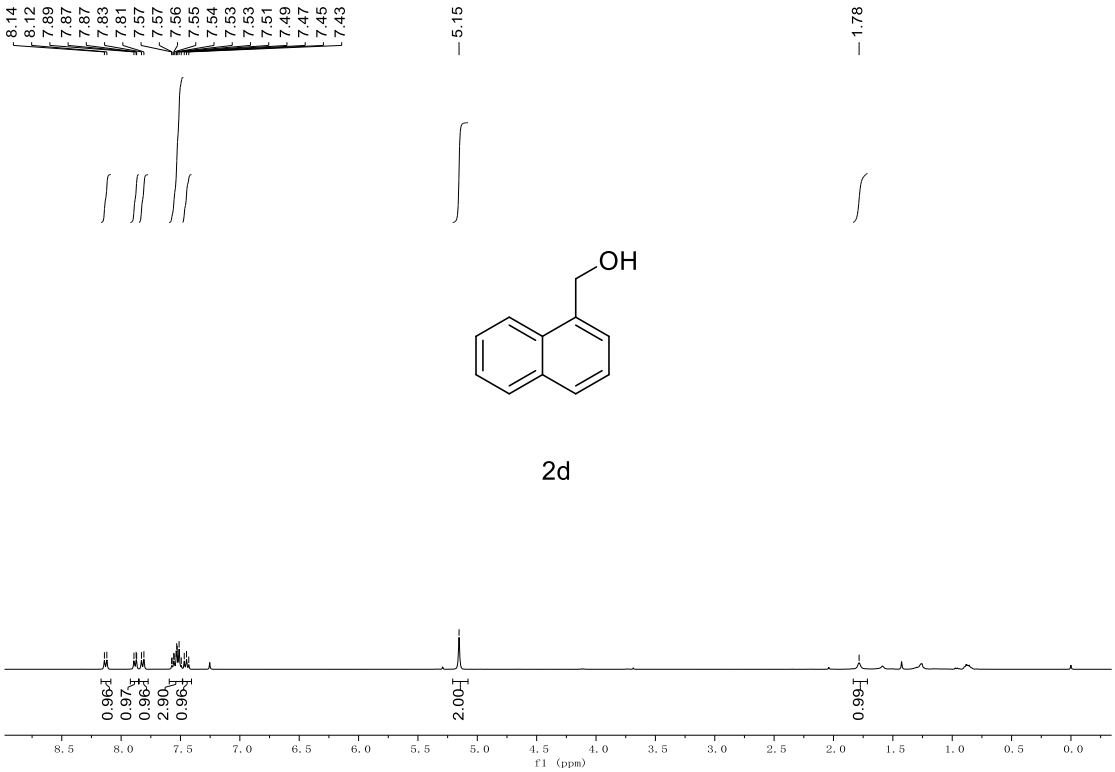
2c

^{13}C NMR, 101 MHz, $CDCl_3$



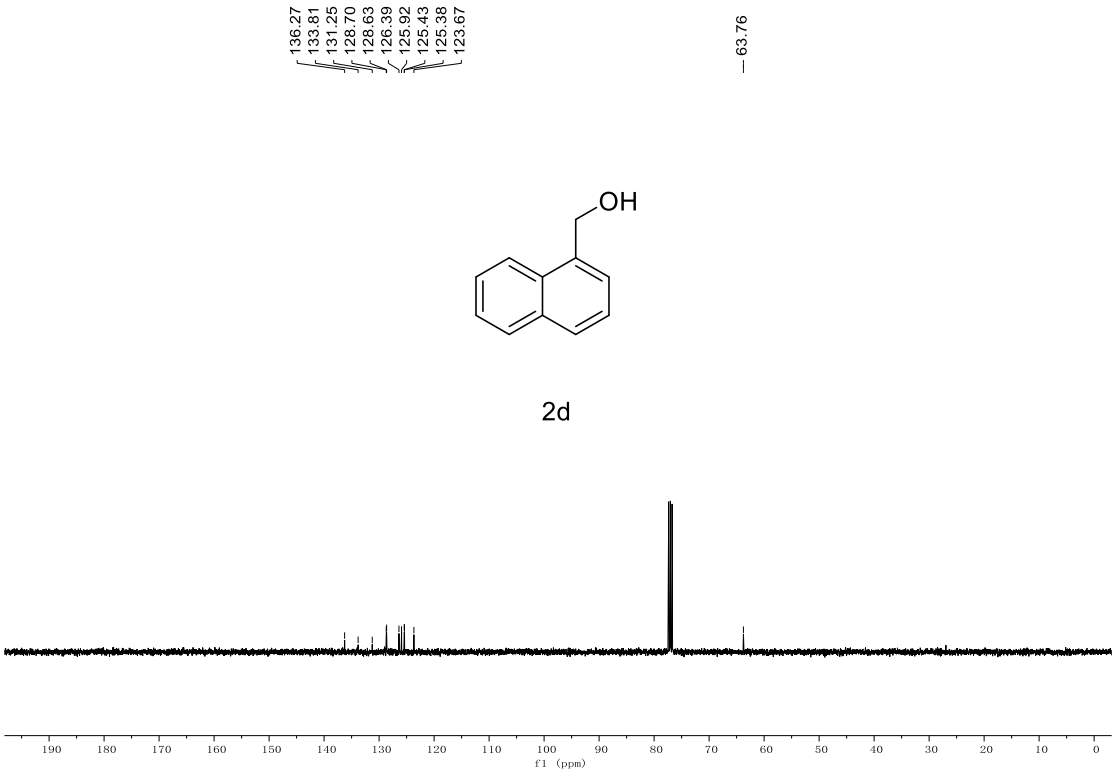
2c

^{1}H NMR, 400 MHz, $CDCl_3$



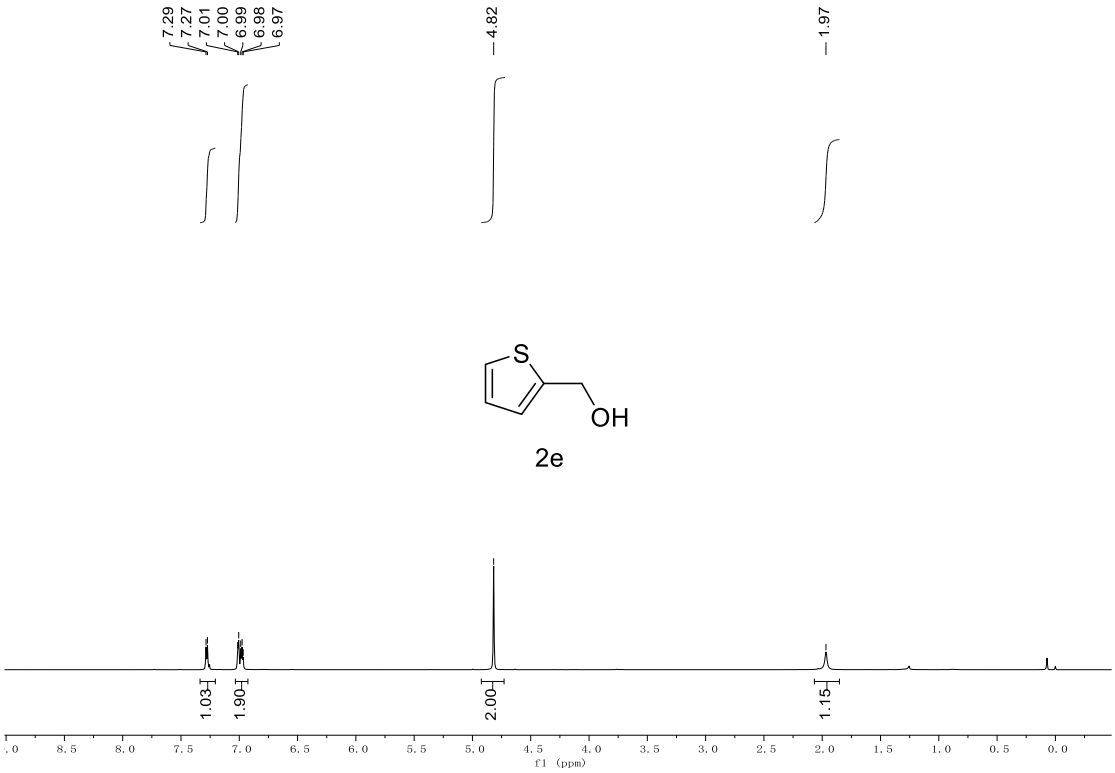
2d

^{13}C NMR, 101 MHz, $CDCl_3$



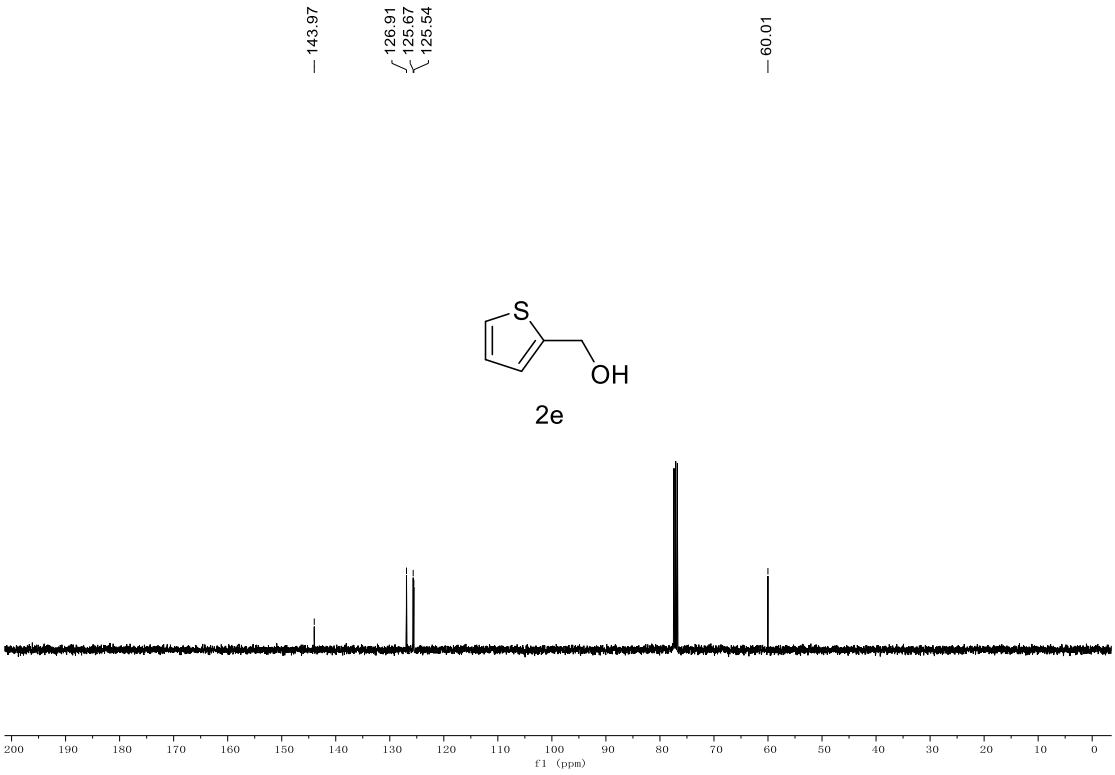
2d

^{1}H NMR, 400 MHz, $CDCl_3$



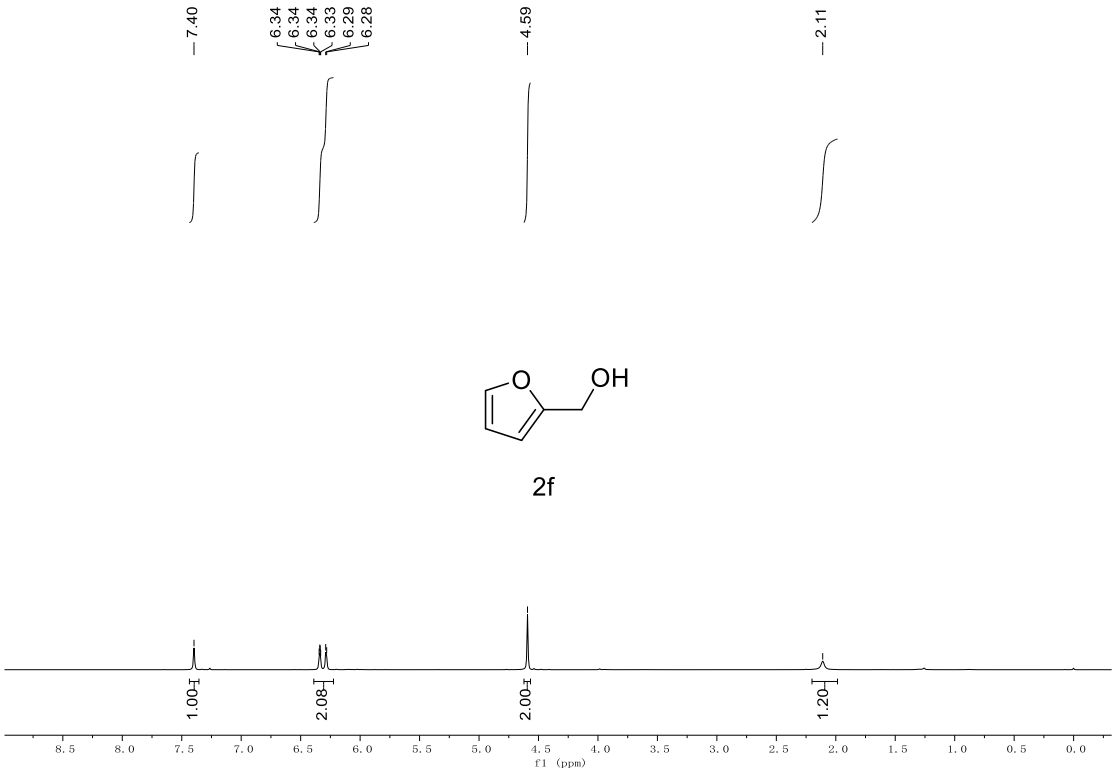
2e

^{13}C NMR, 101 MHz, $CDCl_3$



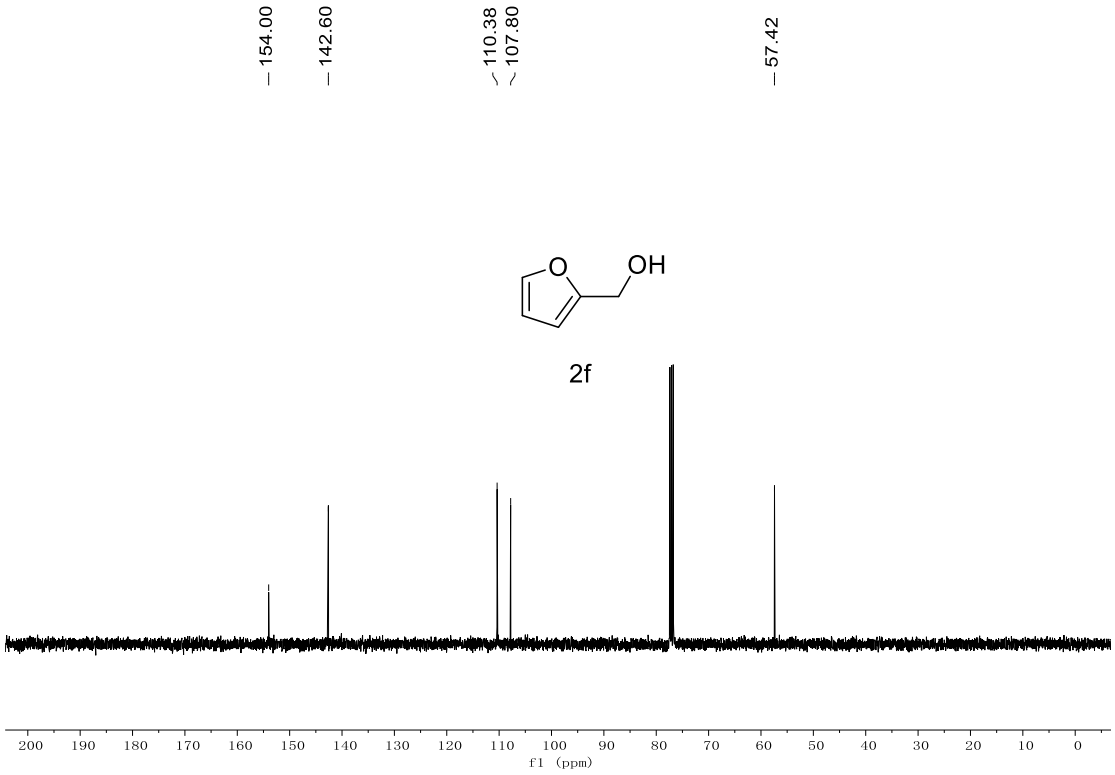
2e

^{1}H NMR, 400 MHz, $CDCl_3$



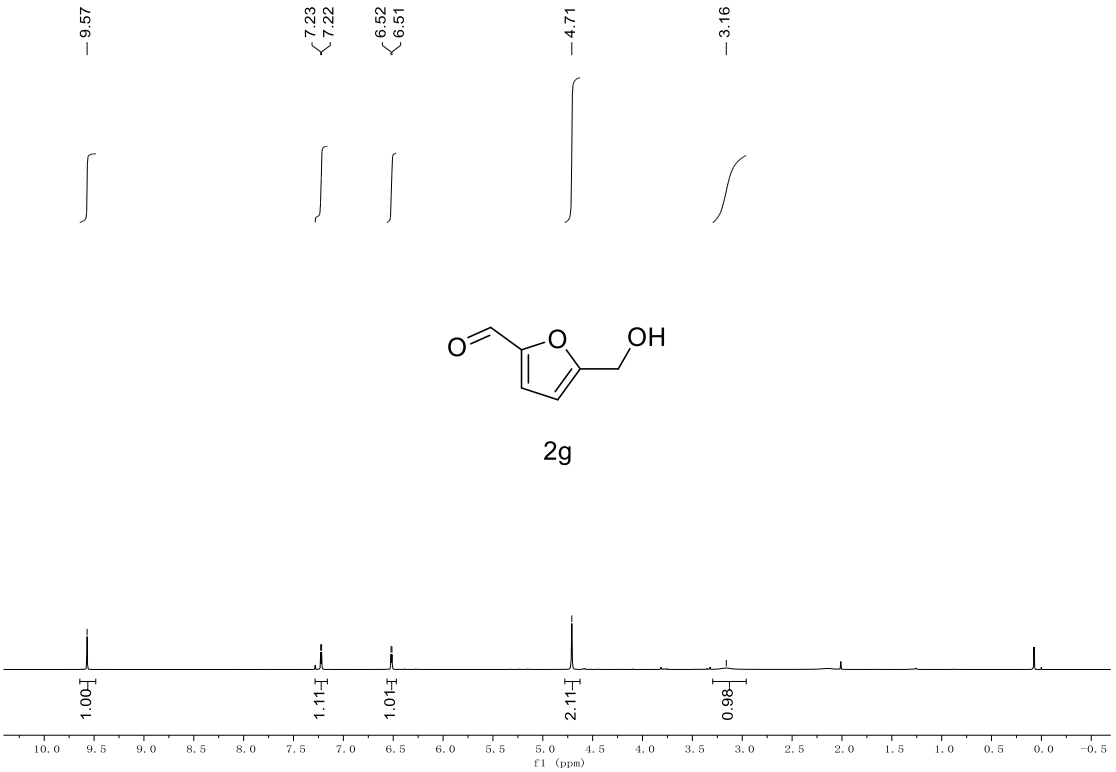
2f

^{13}C NMR, 101 MHz, $CDCl_3$



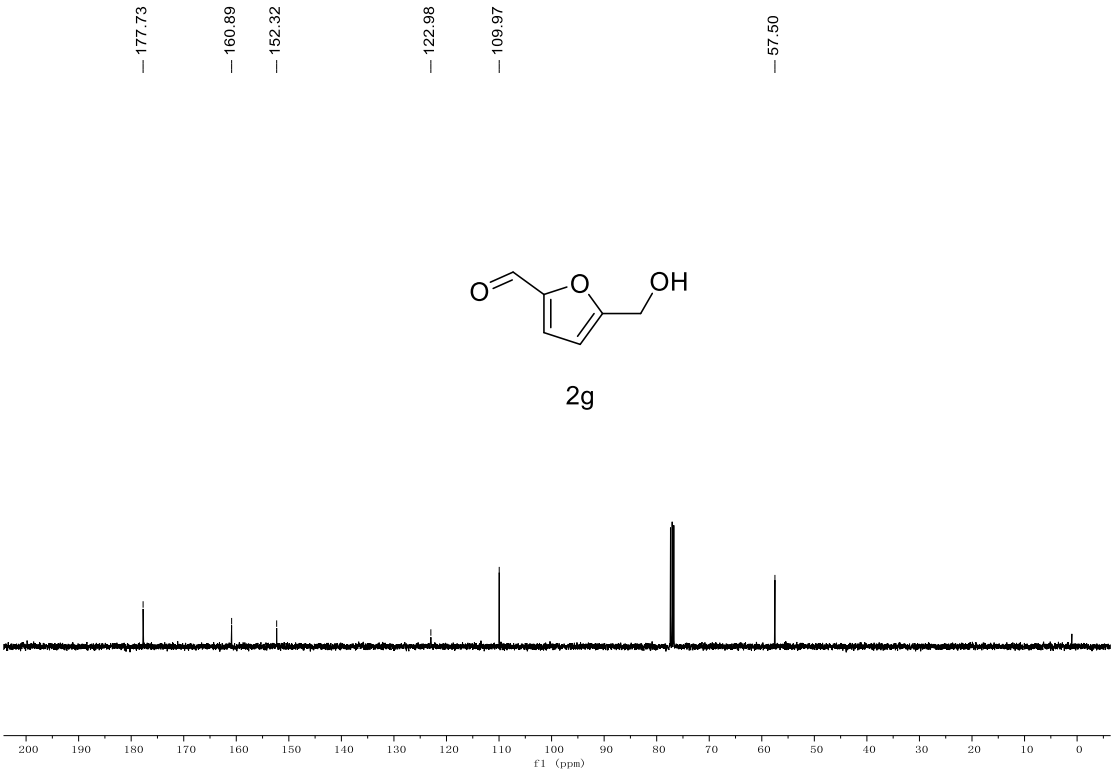
2f

^{1}H NMR, 400 MHz, $CDCl_3$



2g

^{13}C NMR, 101 MHz, $CDCl_3$

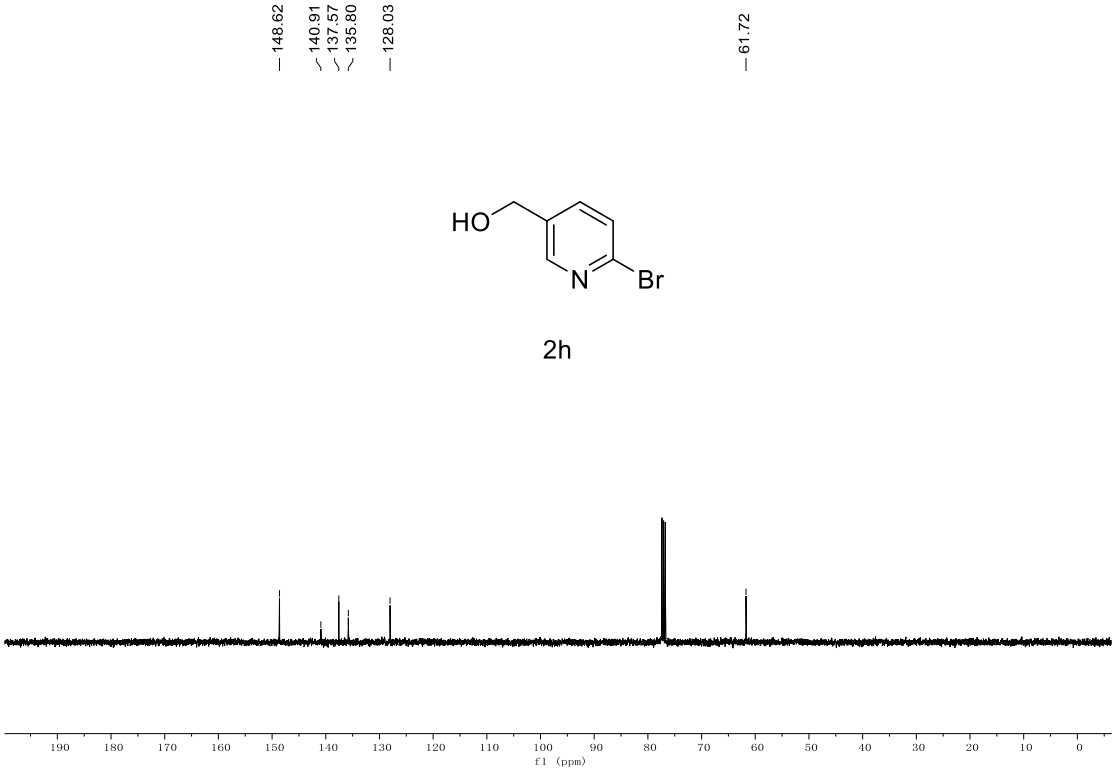


2g

^{1}H NMR, 400 MHz, $CDCl_3$

2h

^{13}C NMR, 101 MHz, $CDCl_3$



2h

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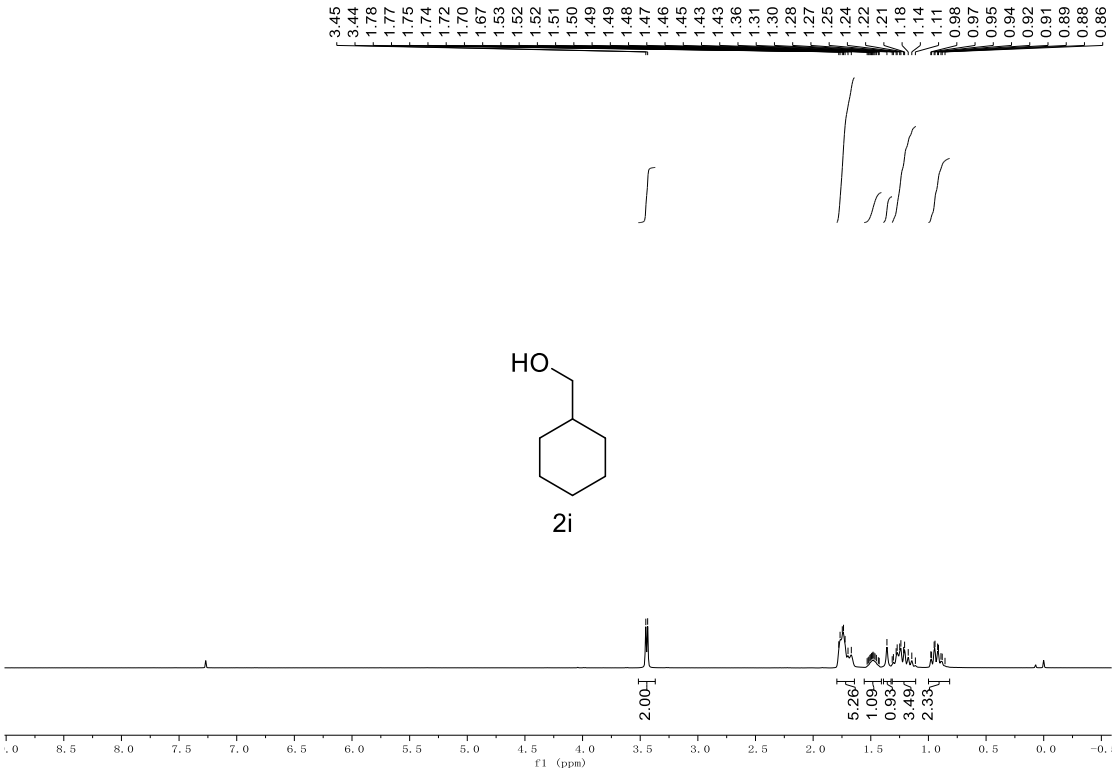
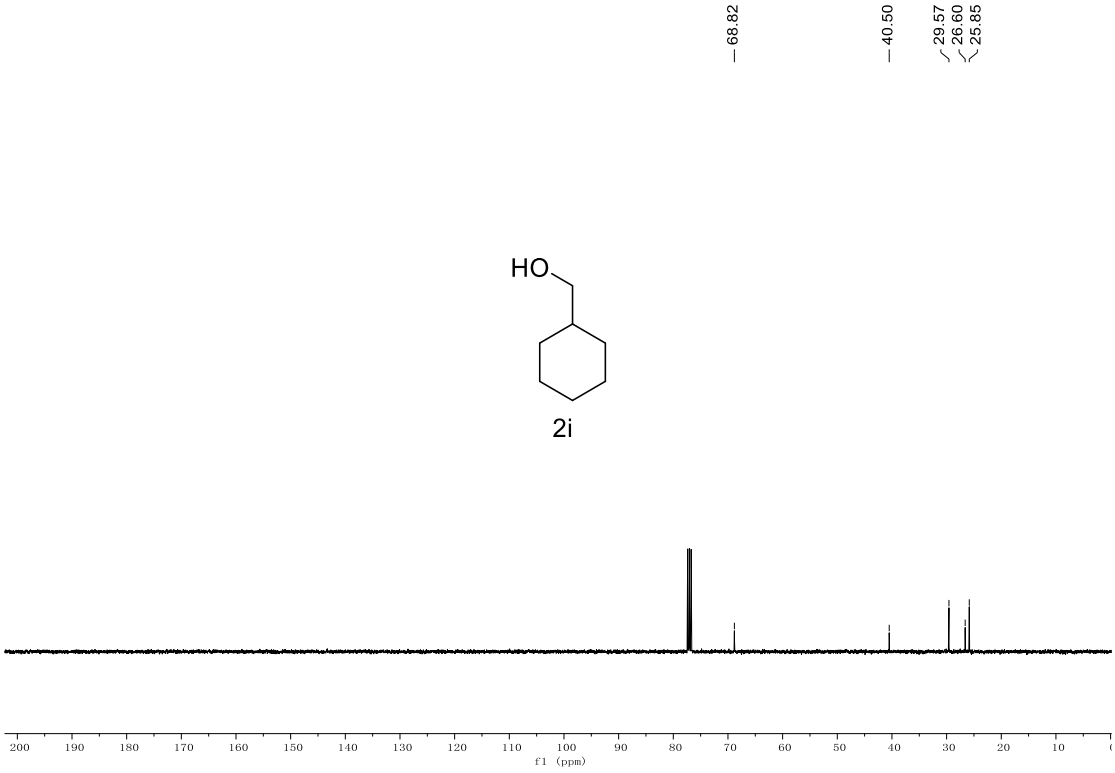
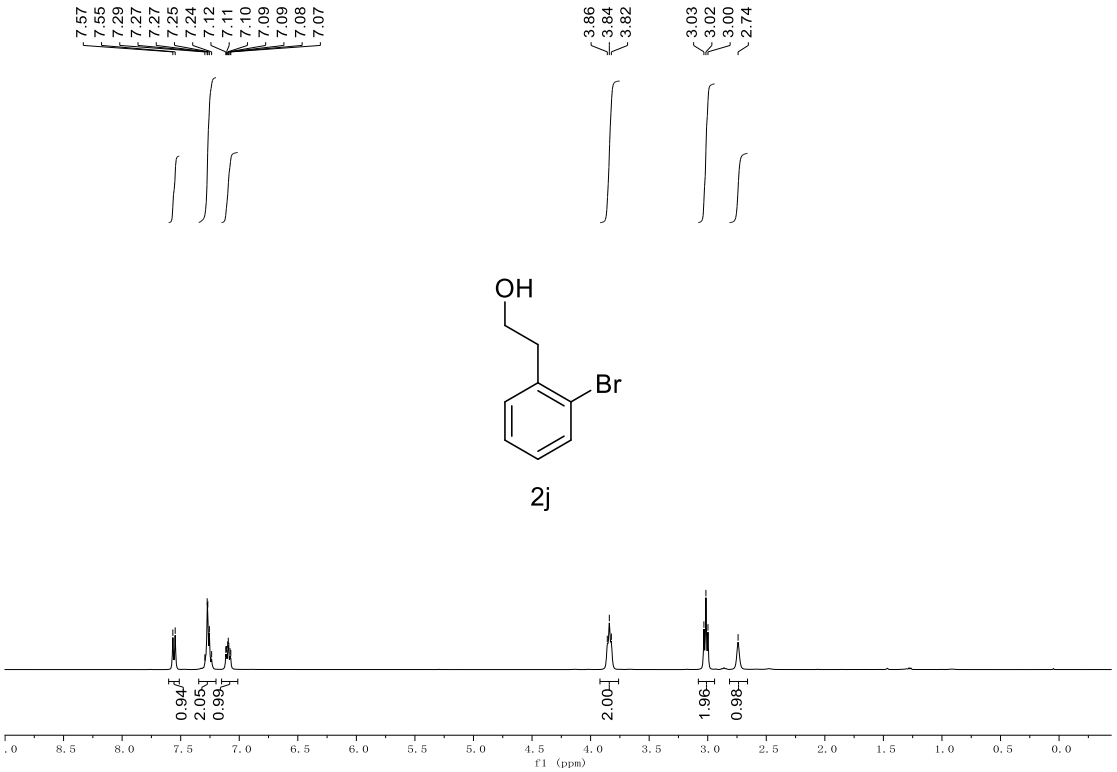


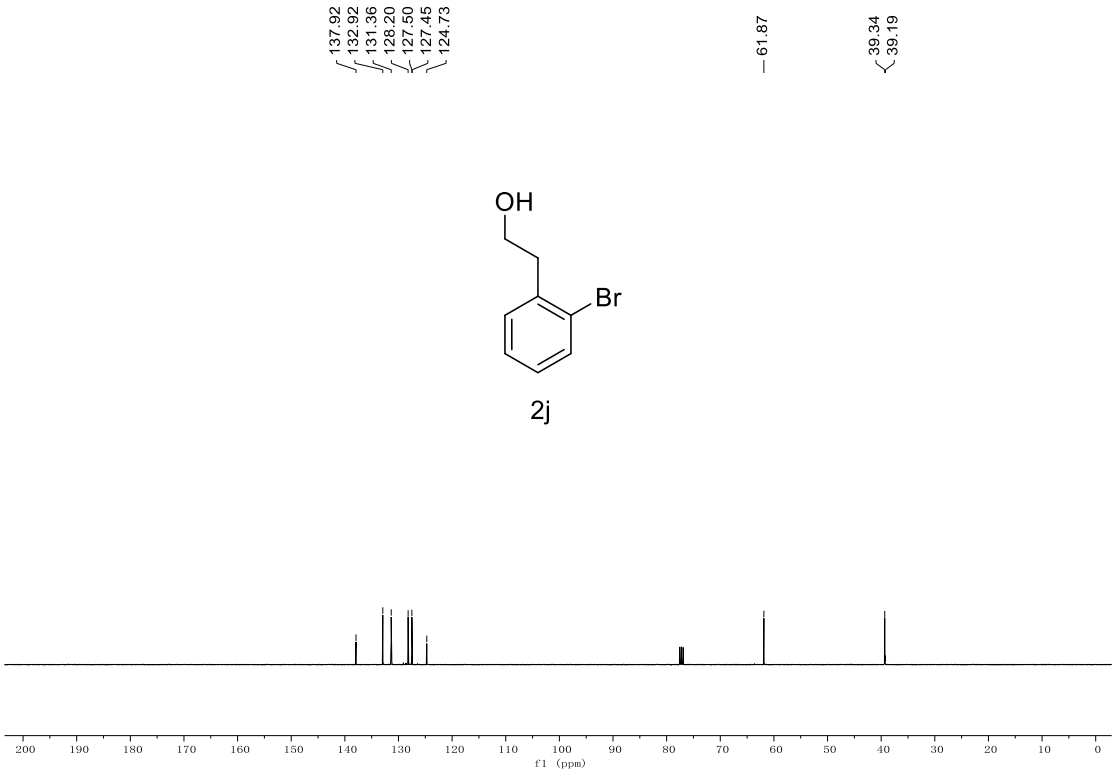
^{13}C NMR, 101 MHz, $CDCl_3$



^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$



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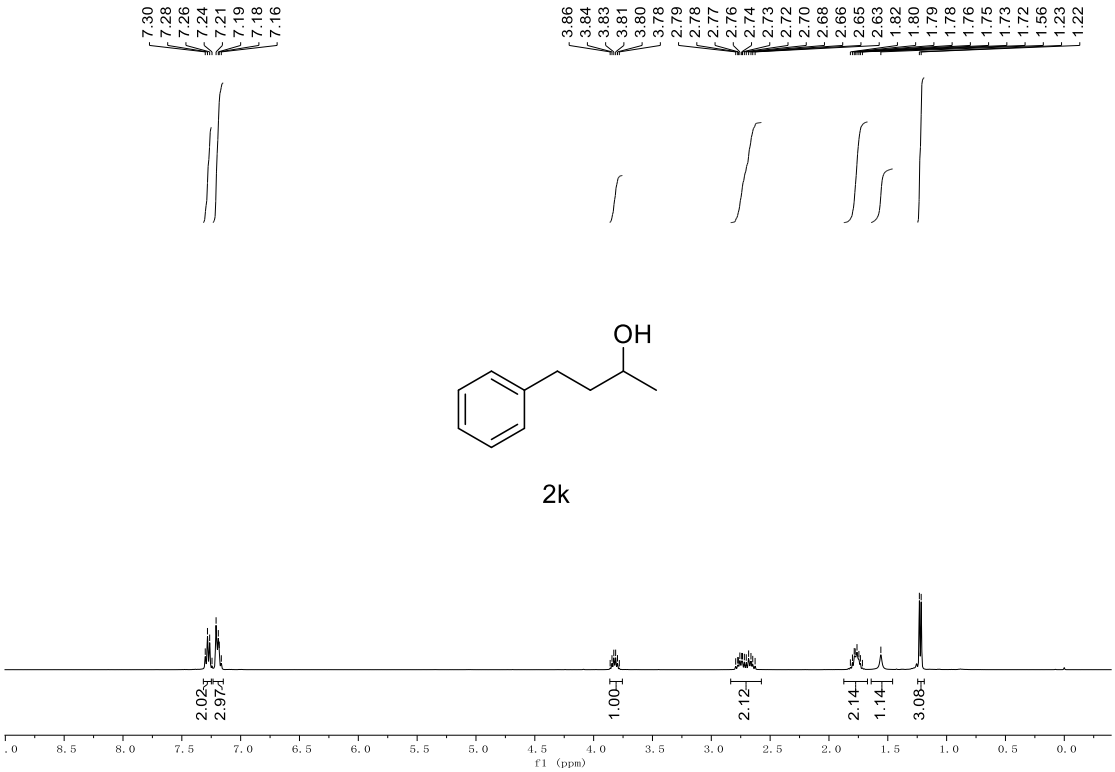
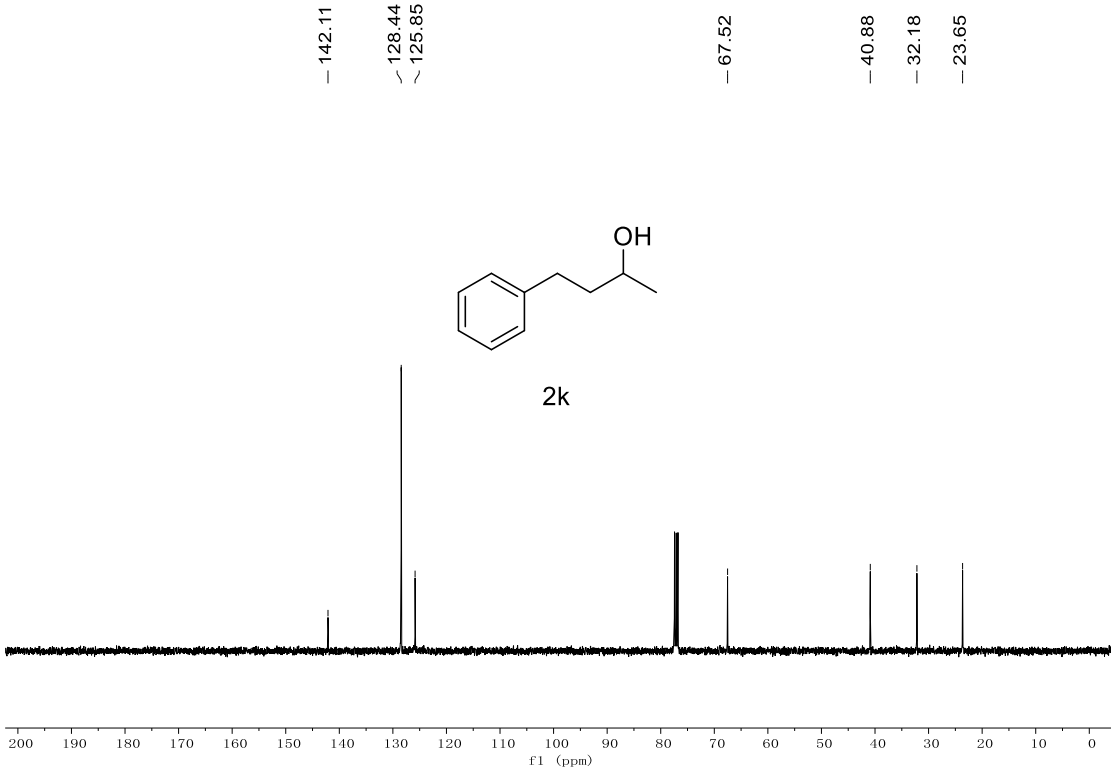


^{13}C NMR, 101 MHz, $CDCl_3$



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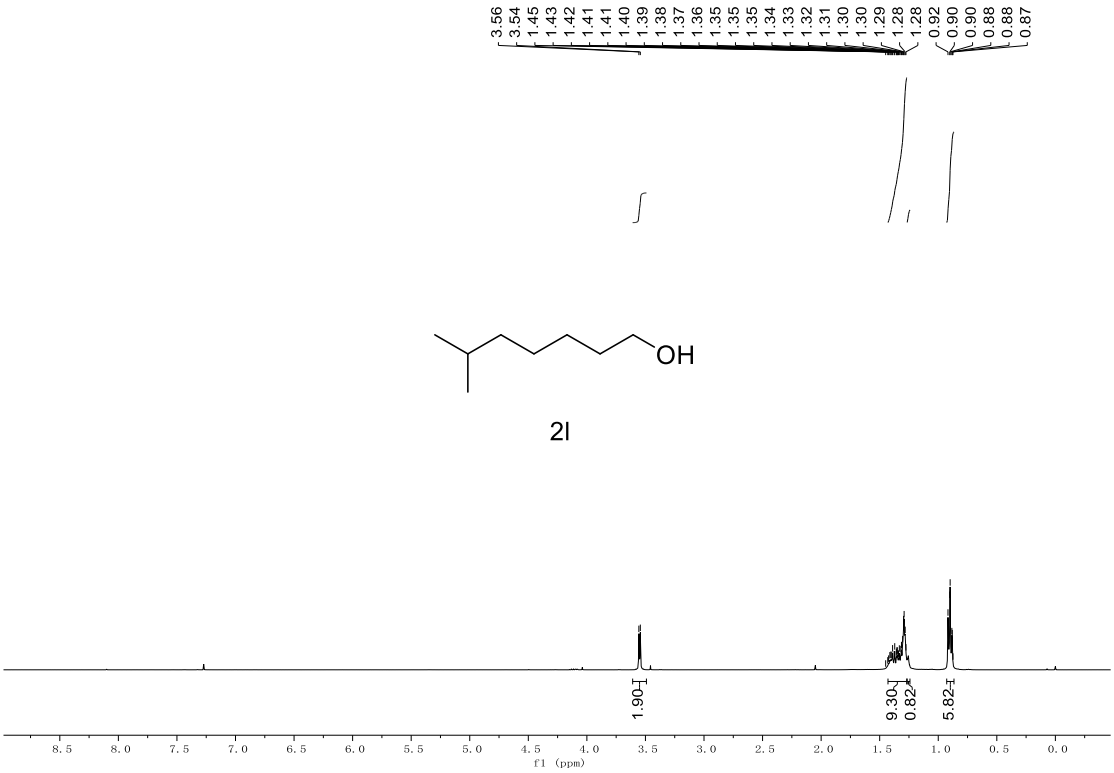
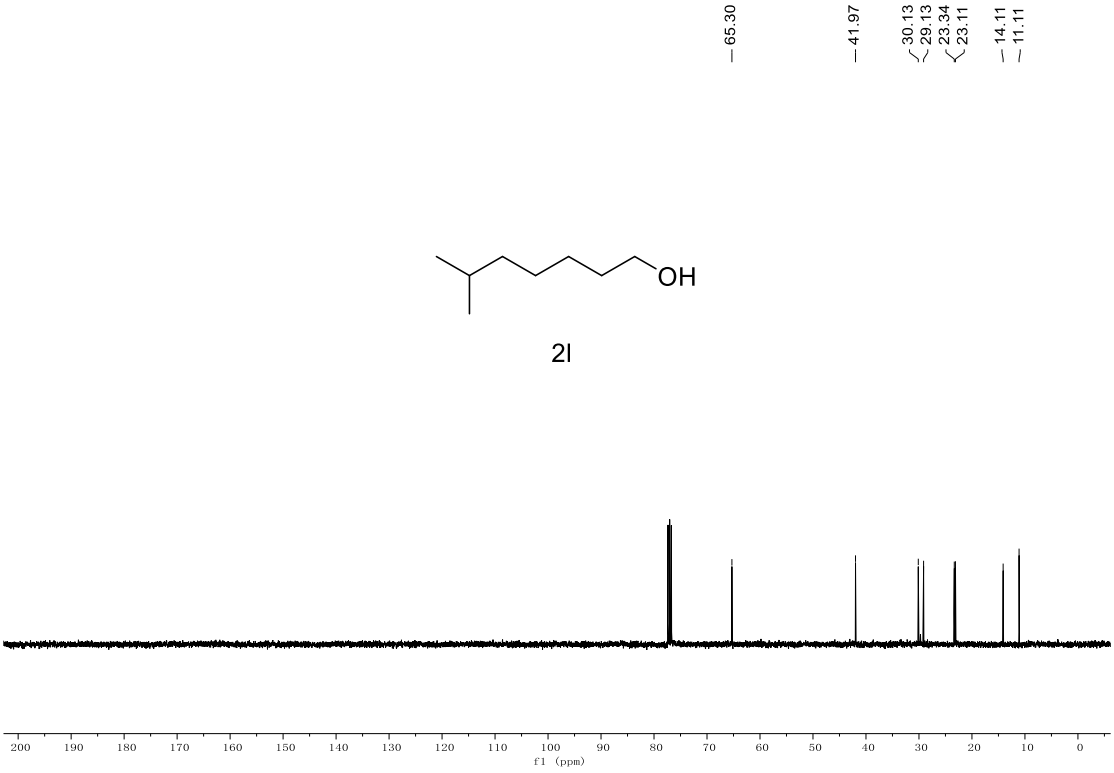


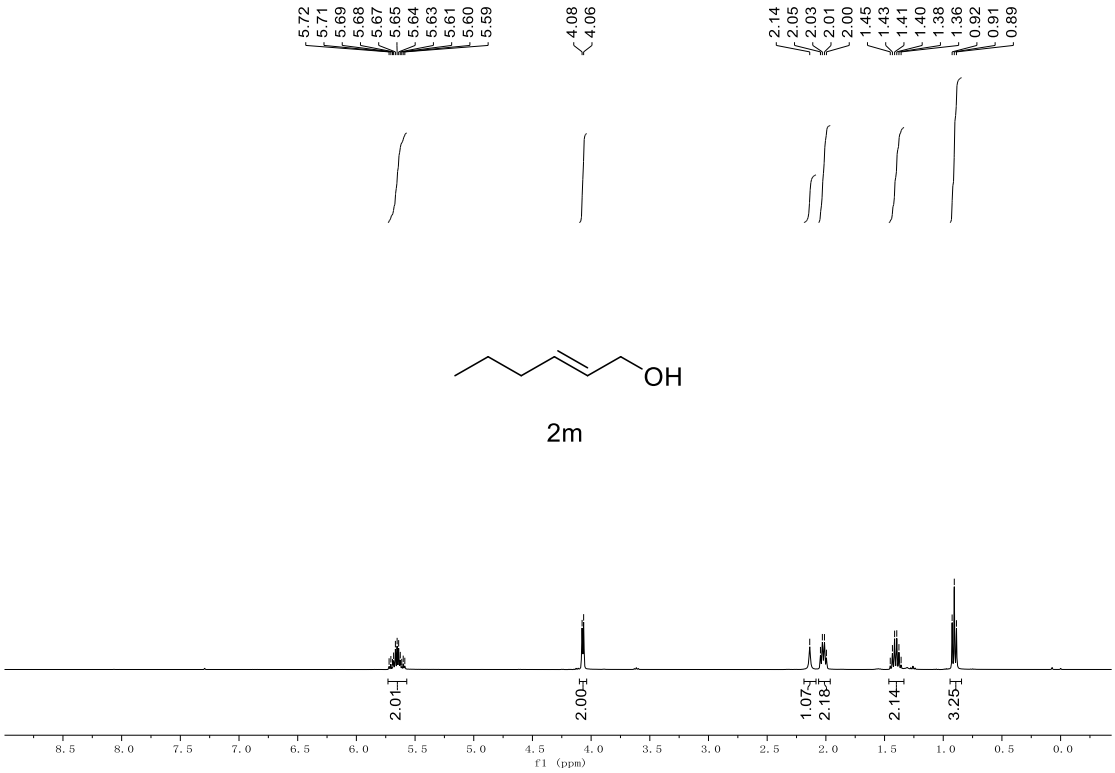
2l

^{13}C NMR, 101 MHz, $CDCl_3$

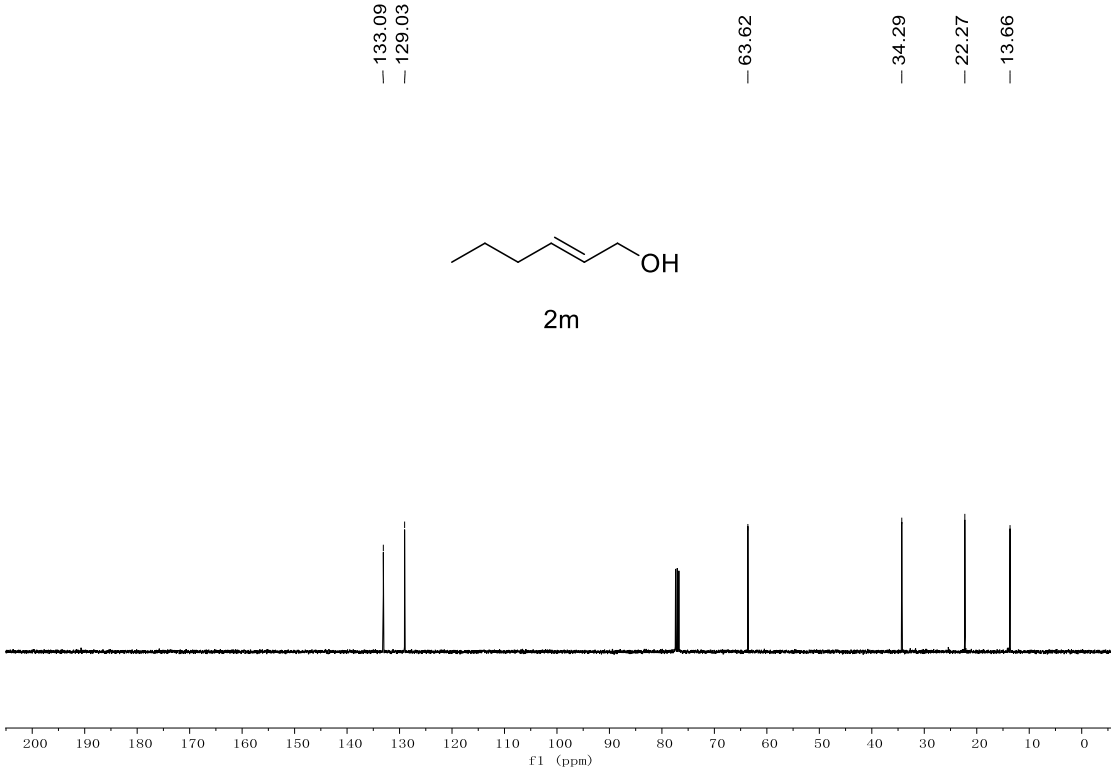


2l

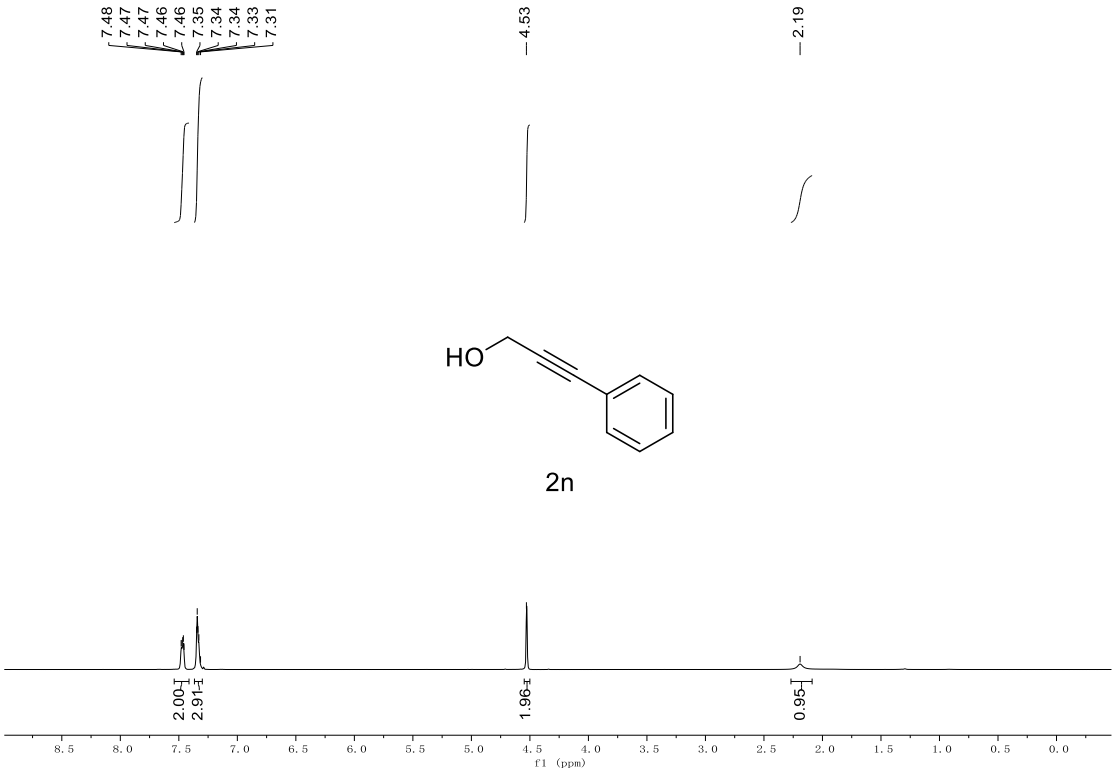
^{1}H NMR, 400 MHz, $CDCl_3$



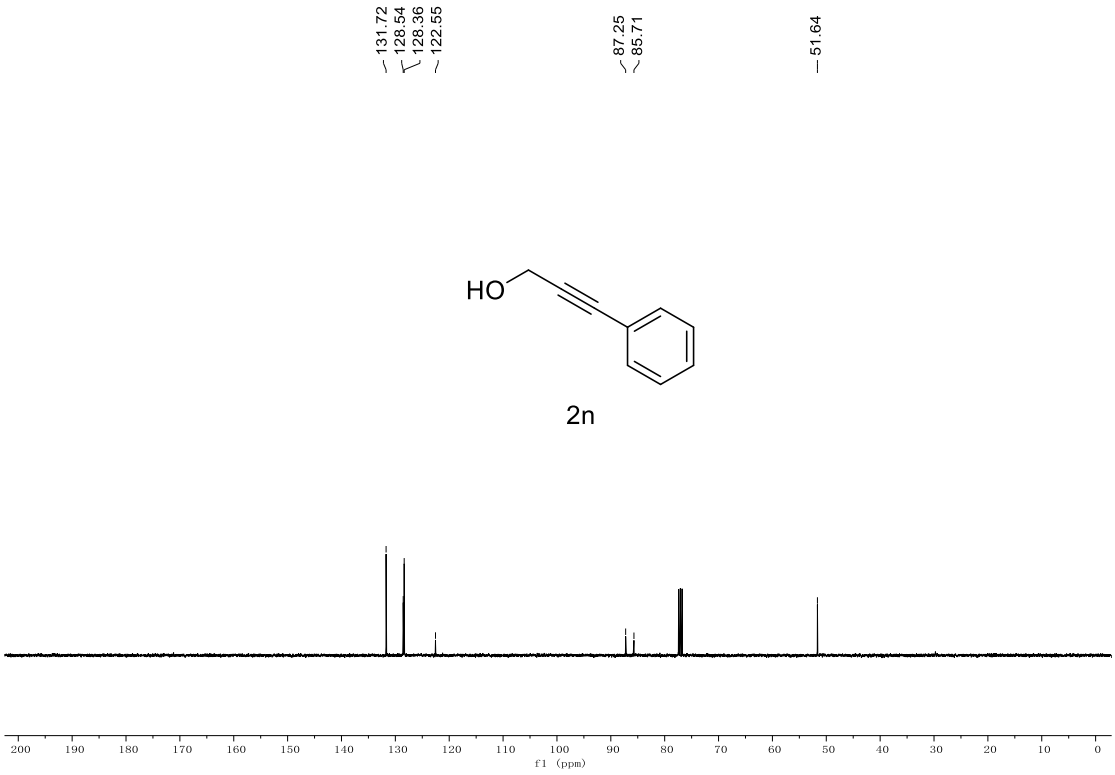
^{13}C NMR, 101 MHz, $CDCl_3$



^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$



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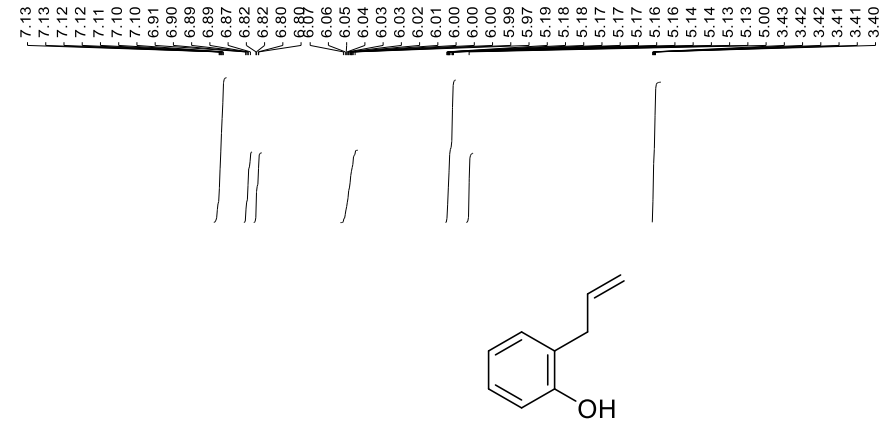

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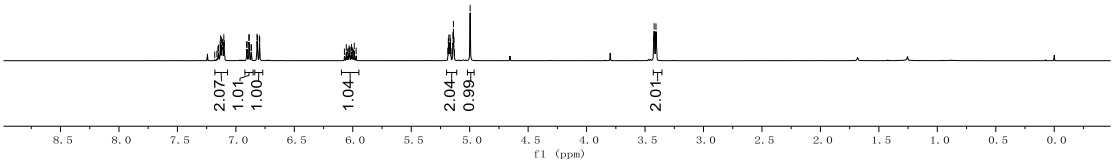
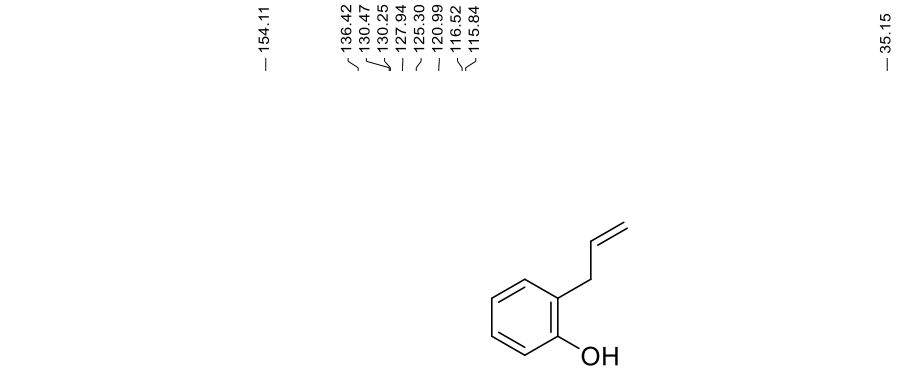


^{13}C NMR, 101 MHz, $CDCl_3$



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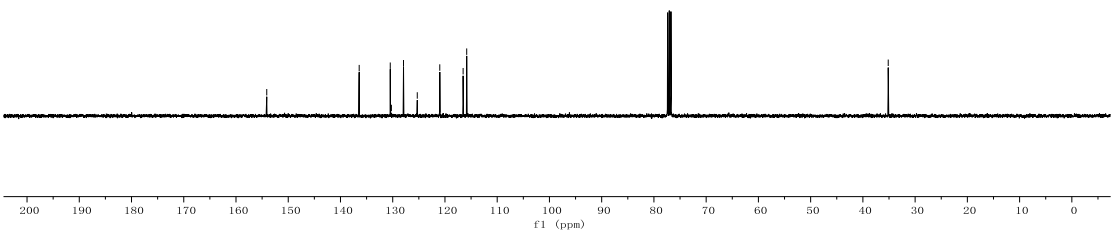

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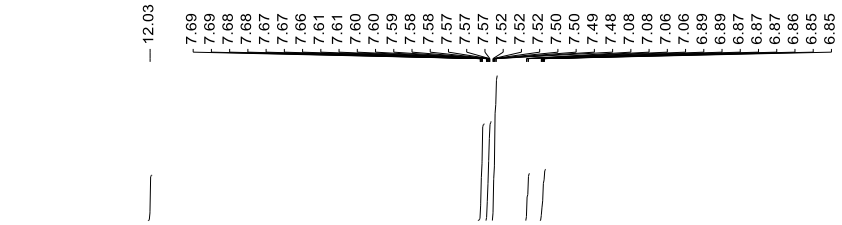

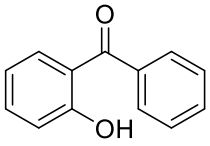

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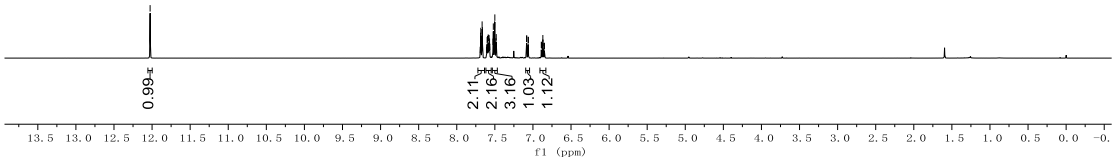
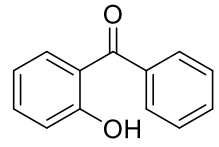


^{13}C NMR, 101 MHz, $CDCl_3$



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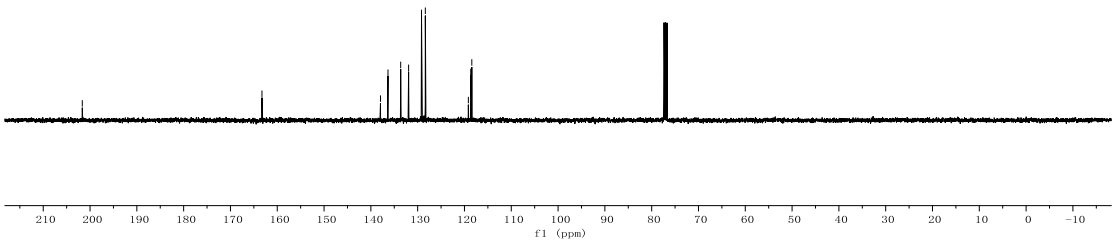
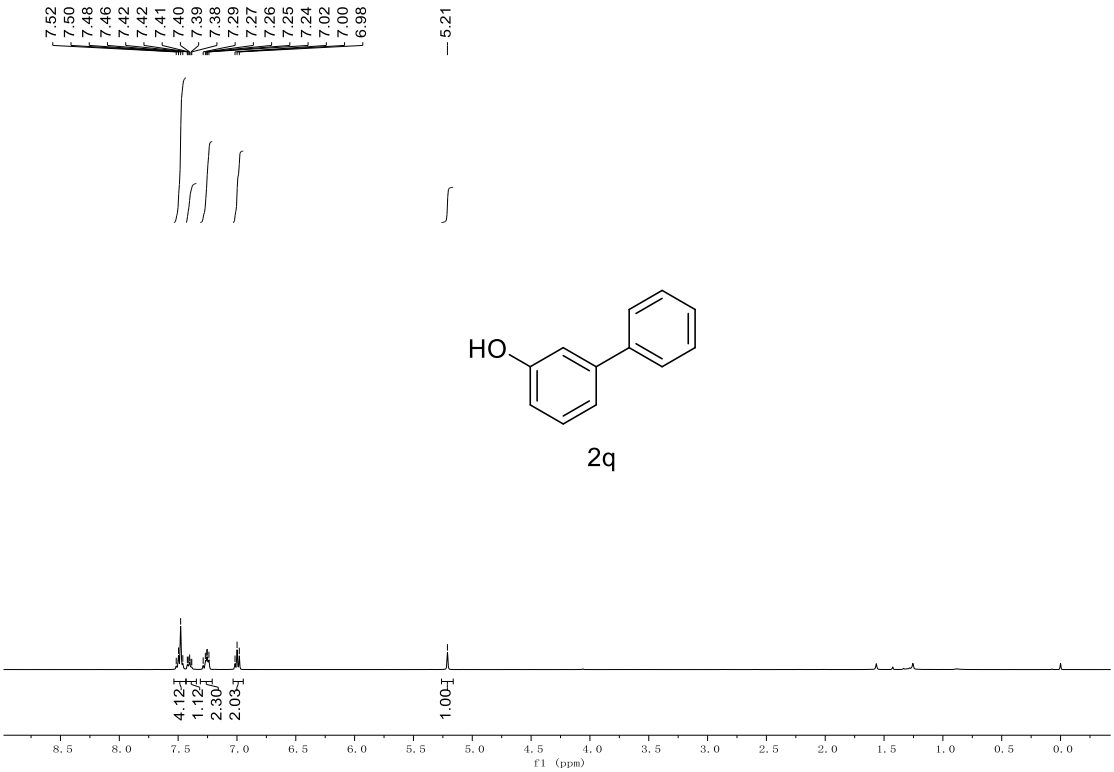
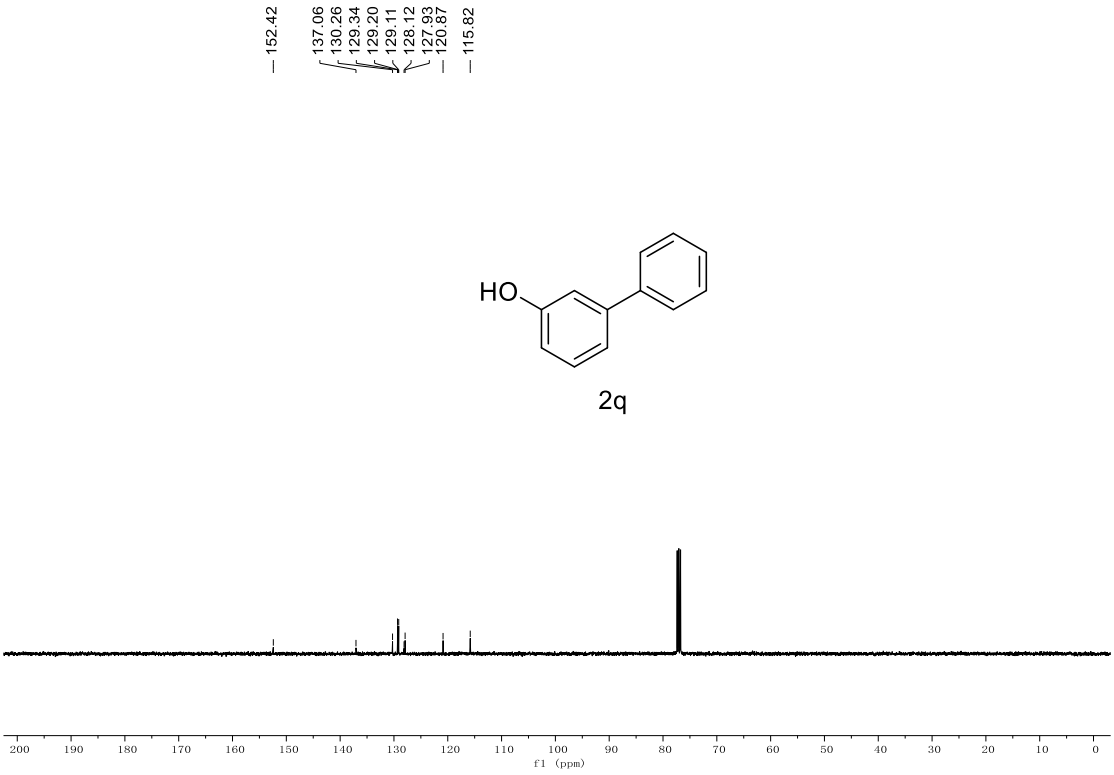


^{1}H NMR, 400 MHz, $CDCl_3$



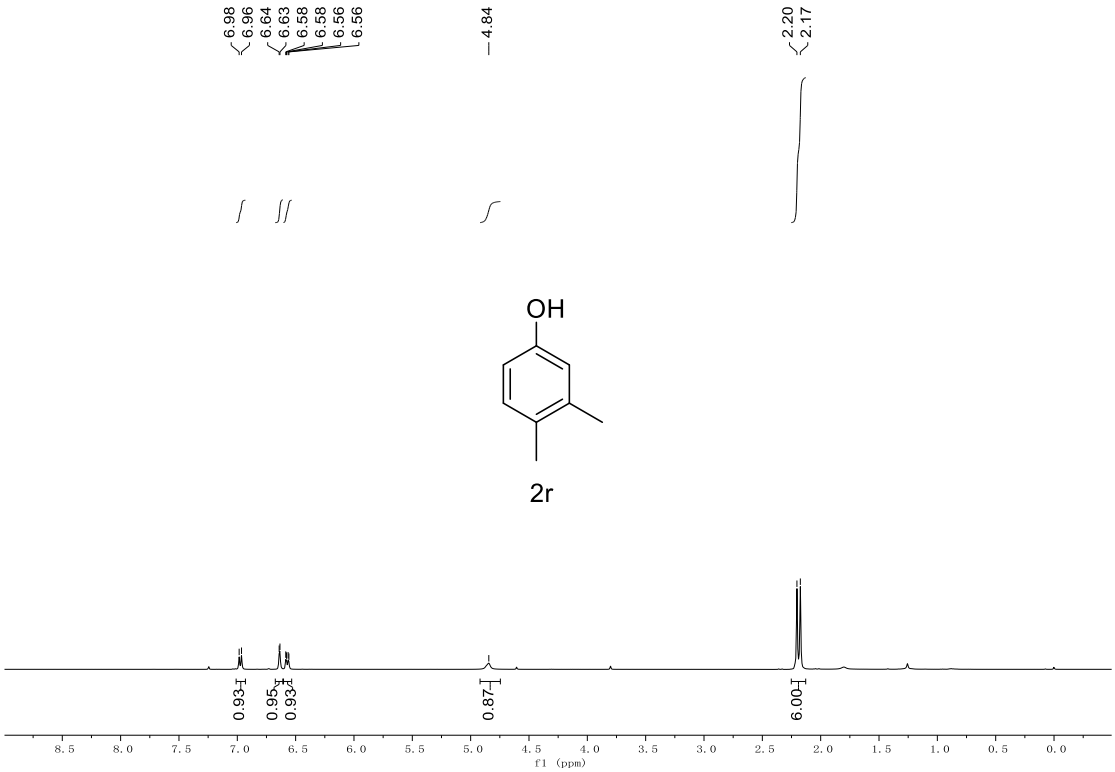
2q

^{13}C NMR, 101 MHz, $CDCl_3$

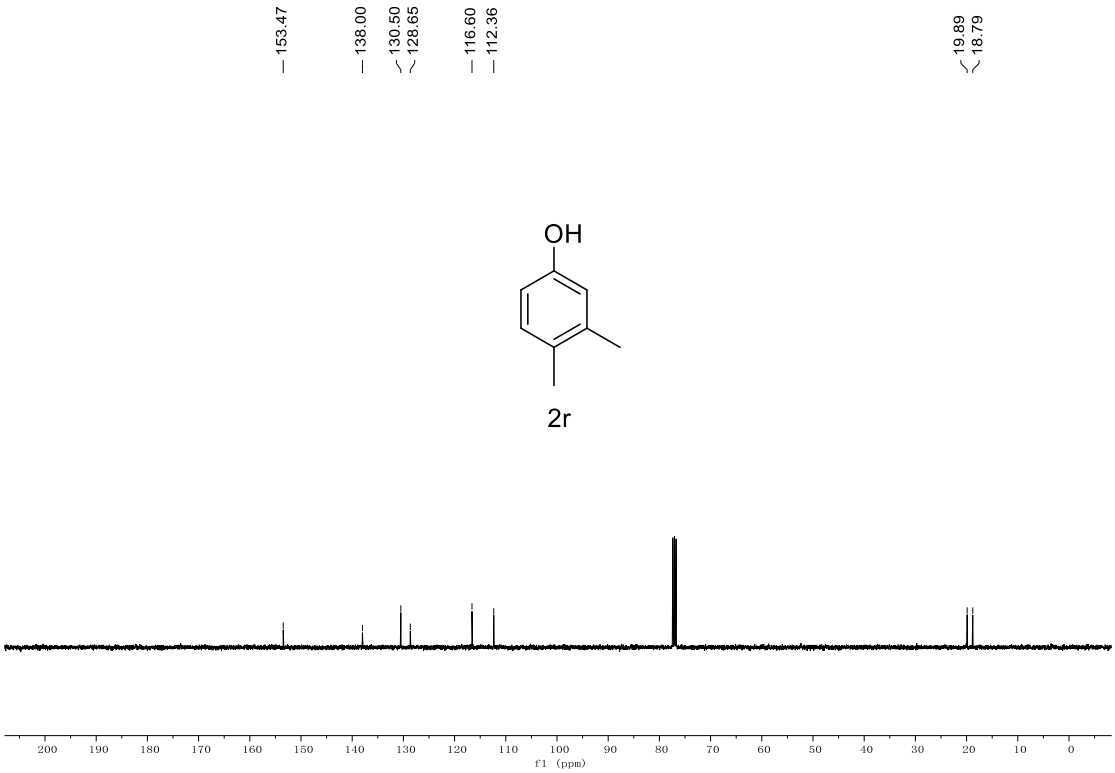


2q

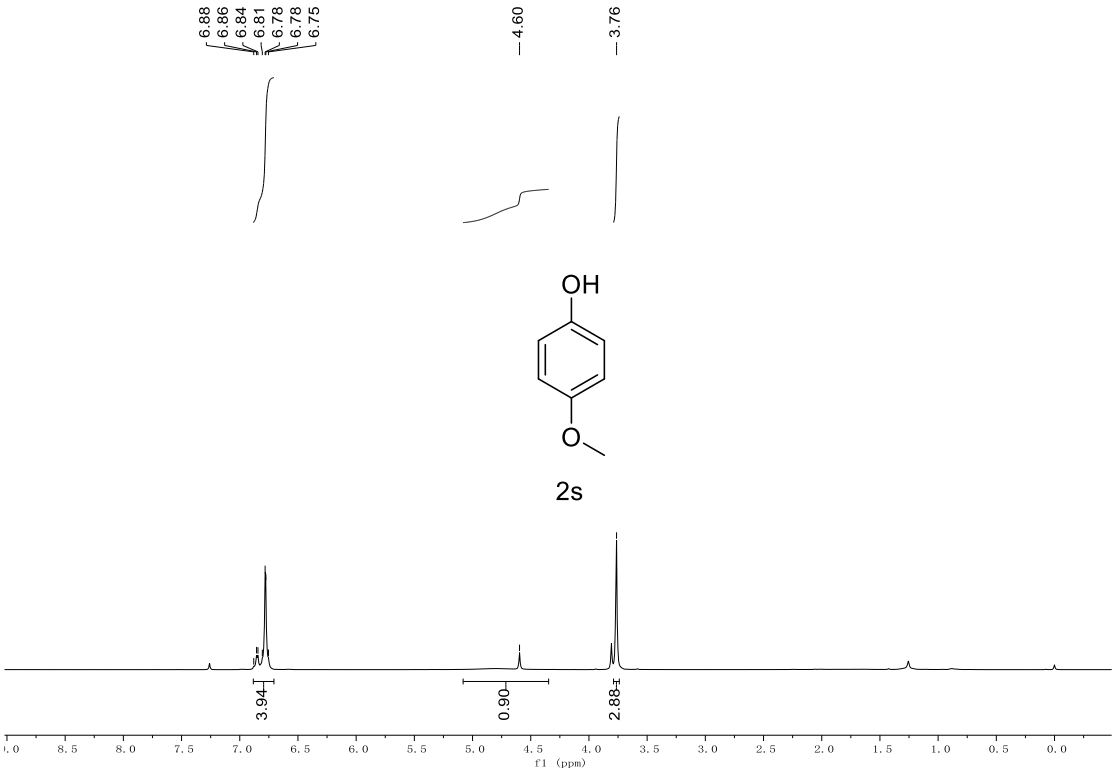
^{1}H NMR, 400 MHz, $CDCl_3$



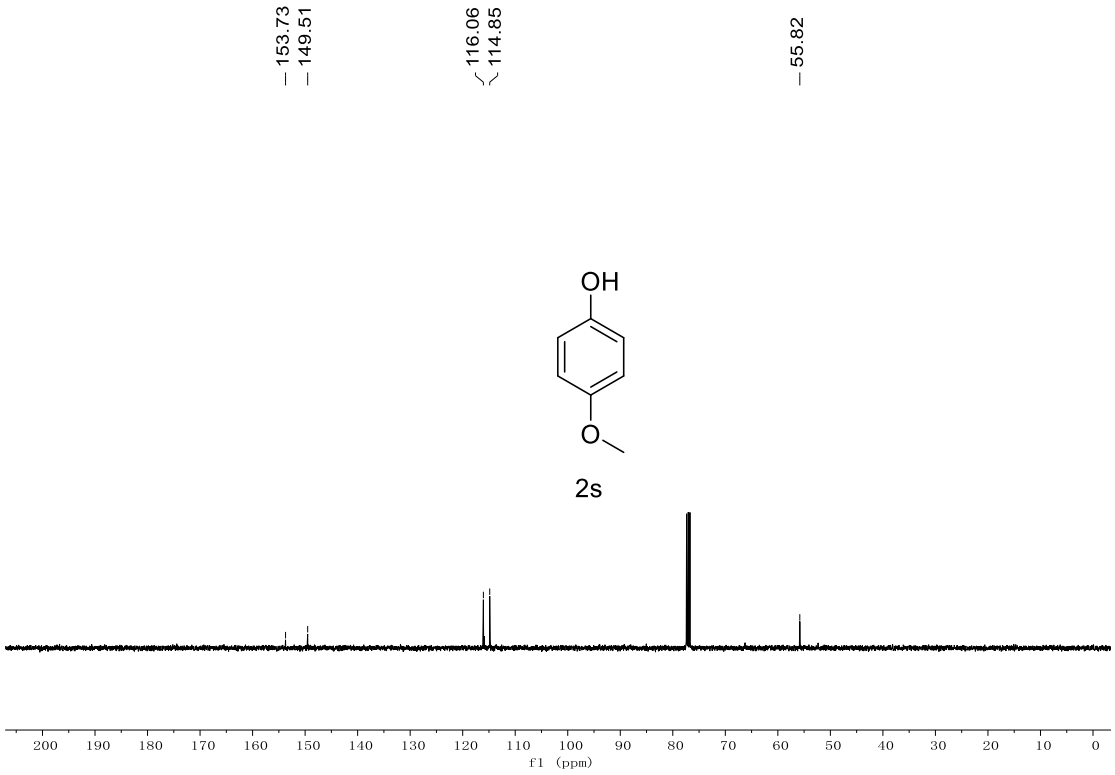
^{13}C NMR, 101 MHz, $CDCl_3$



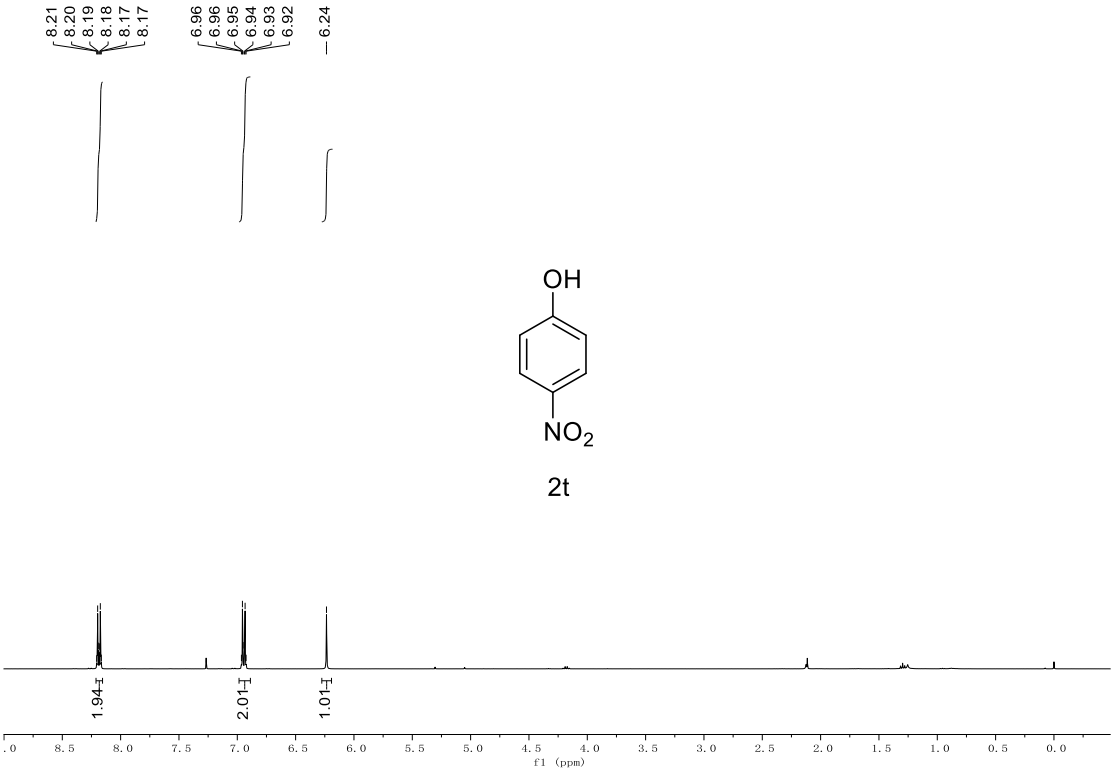
^{1}H NMR, 400 MHz, $CDCl_3$



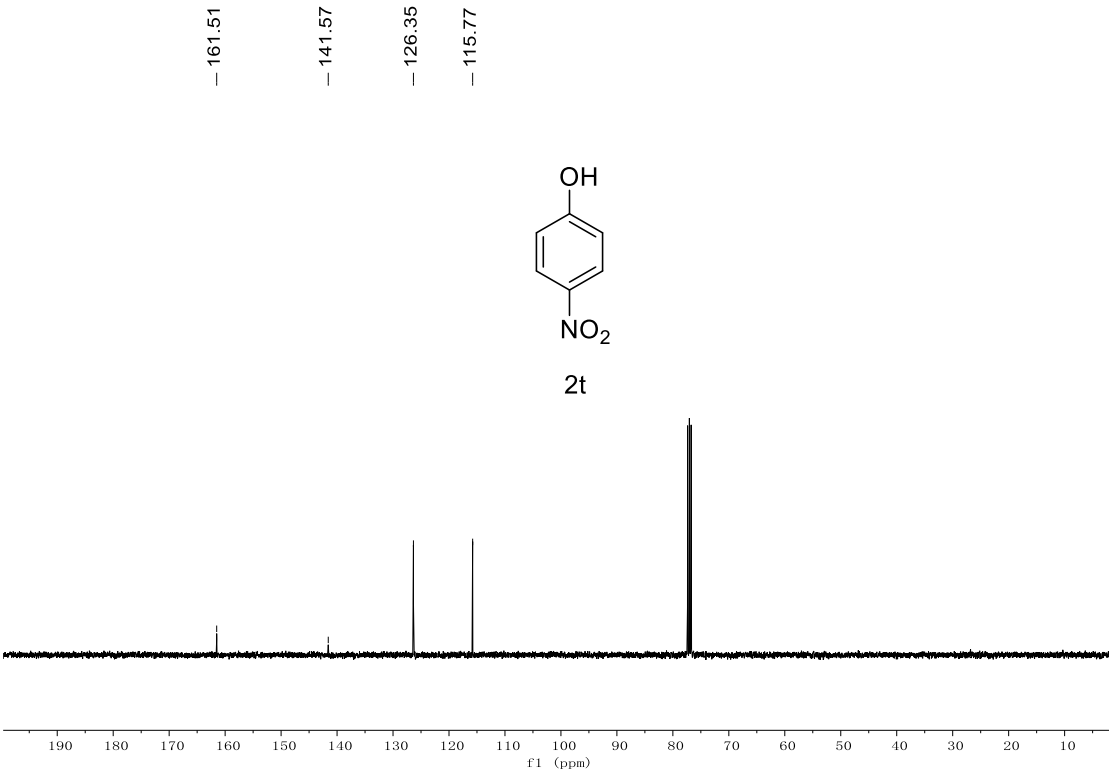
^{13}C NMR, 101 MHz, $CDCl_3$



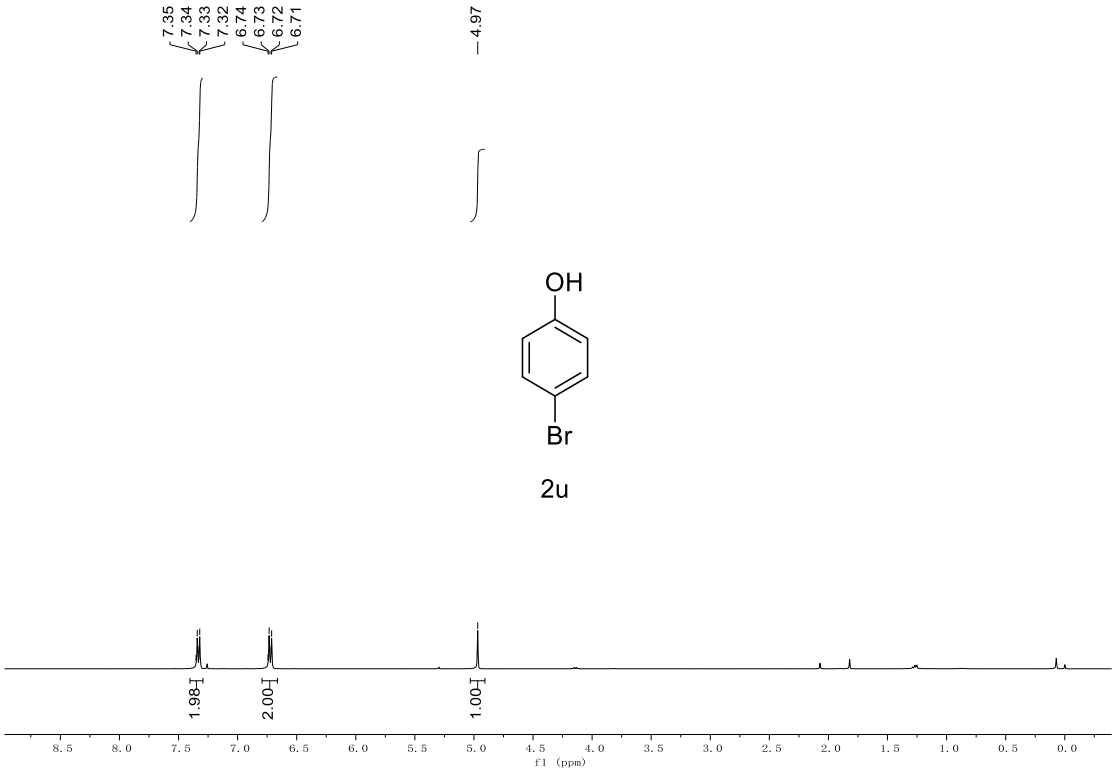
^{1}H NMR, 400 MHz, $CDCl_3$



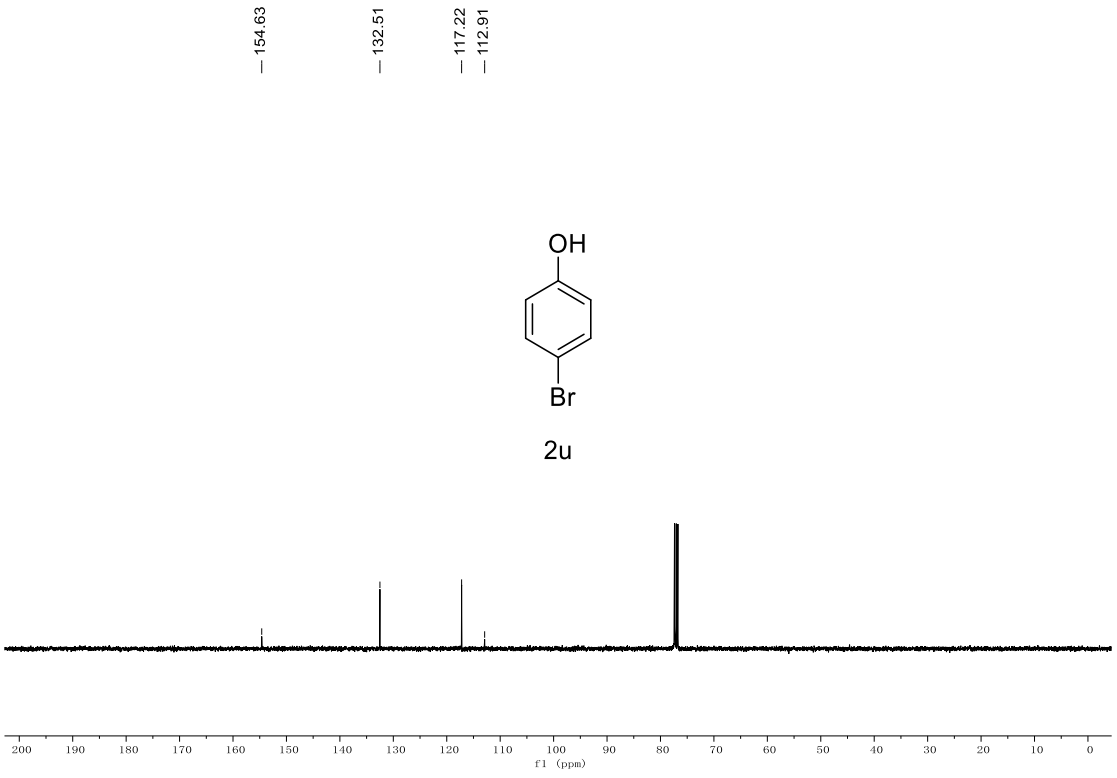
^{13}C NMR, 101 MHz, $CDCl_3$



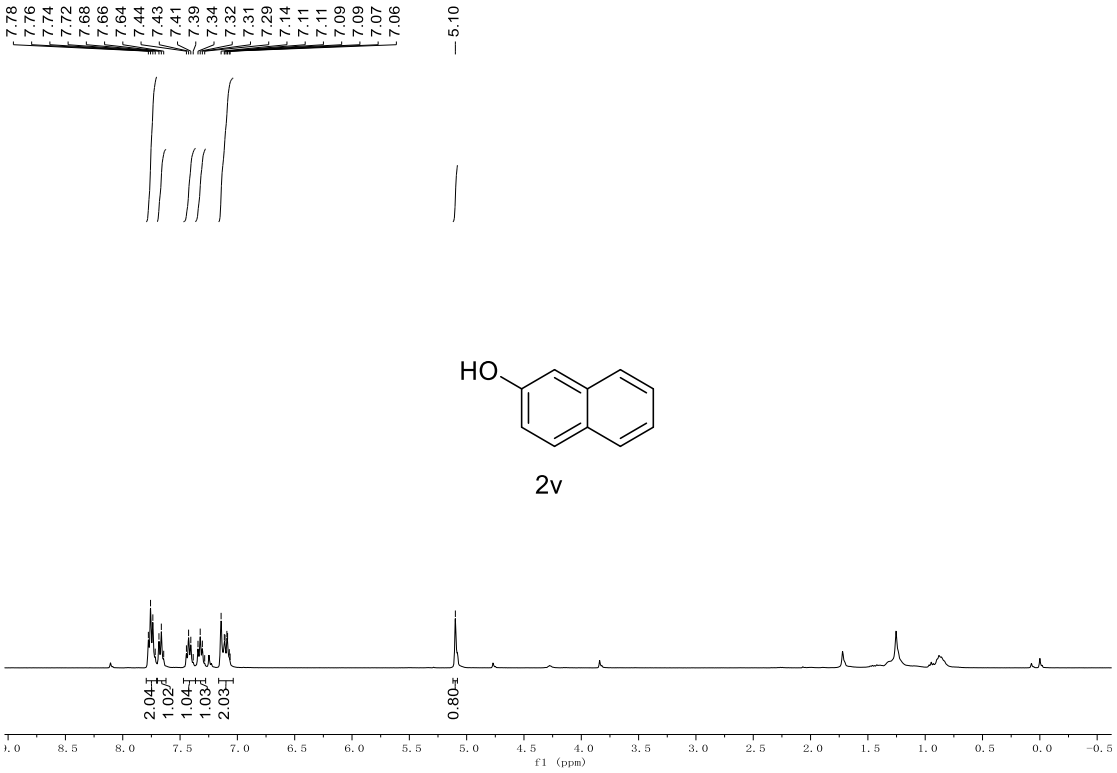
^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$

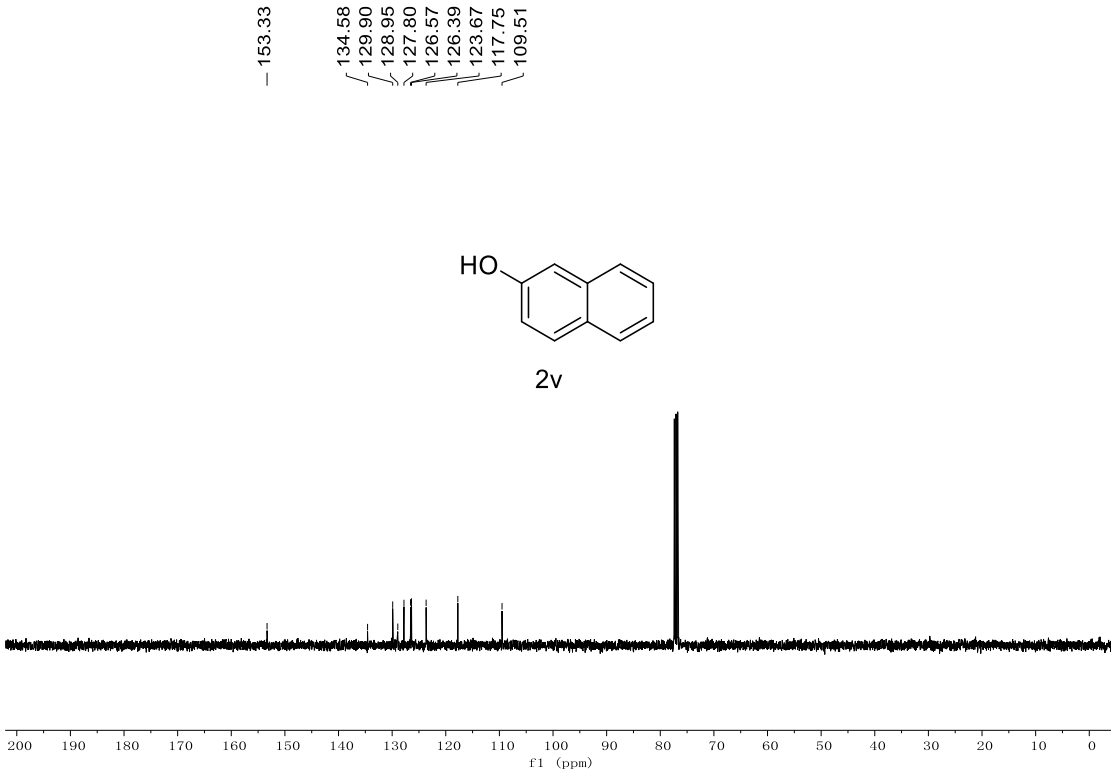


^{1}H NMR, 400 MHz, $CDCl_3$



2v

^{13}C NMR, 101 MHz, $CDCl_3$



2v

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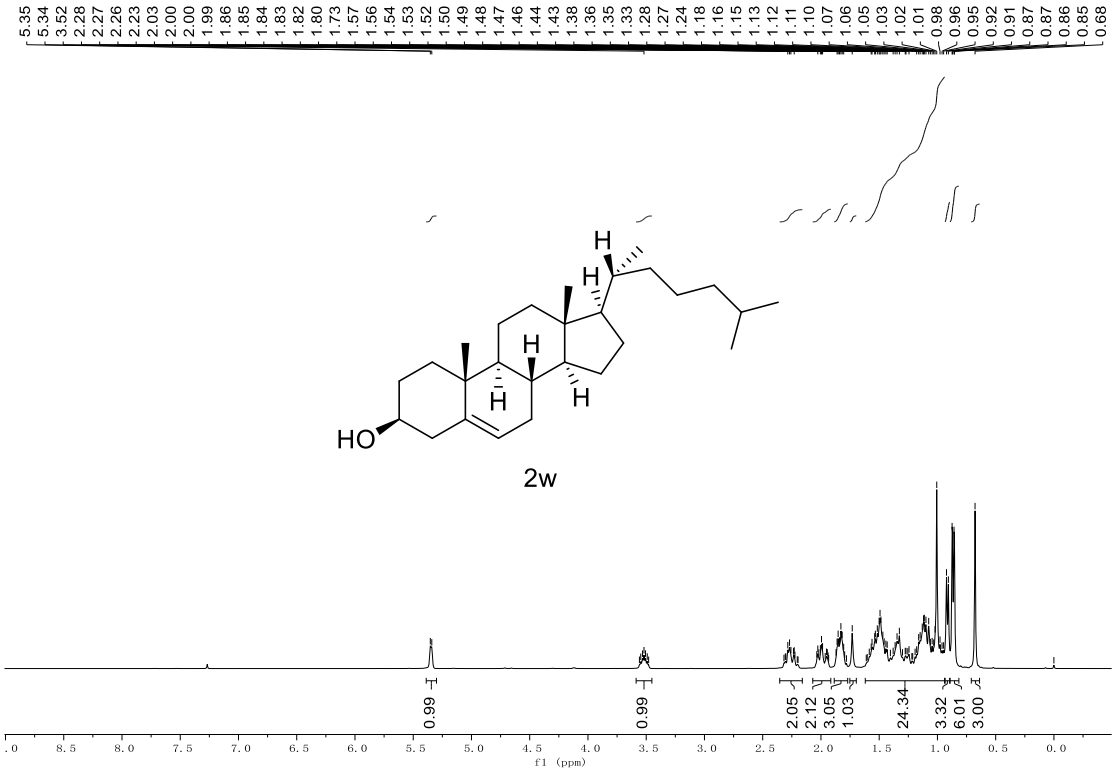
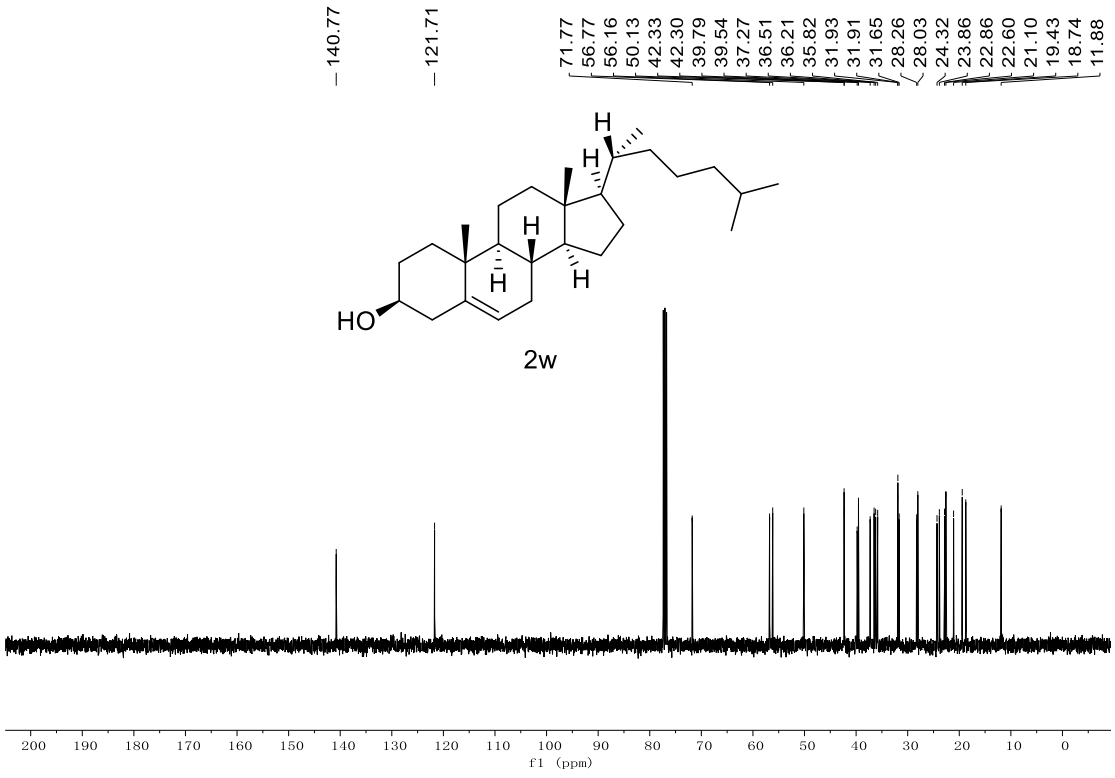
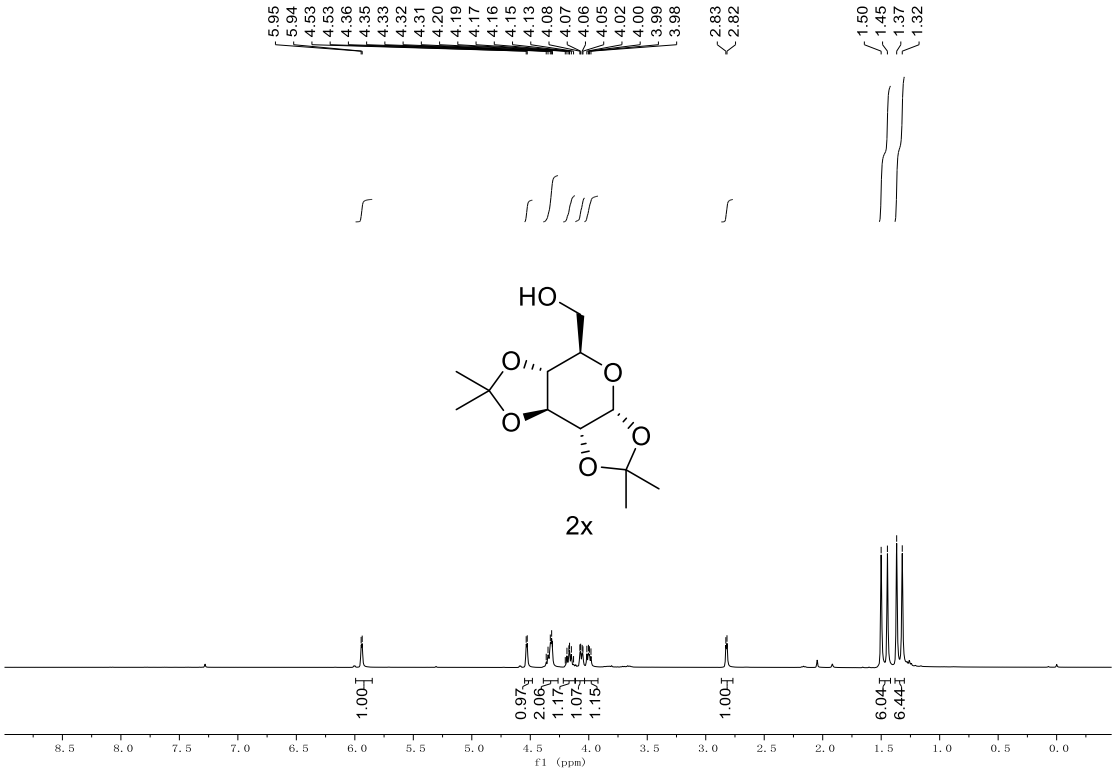


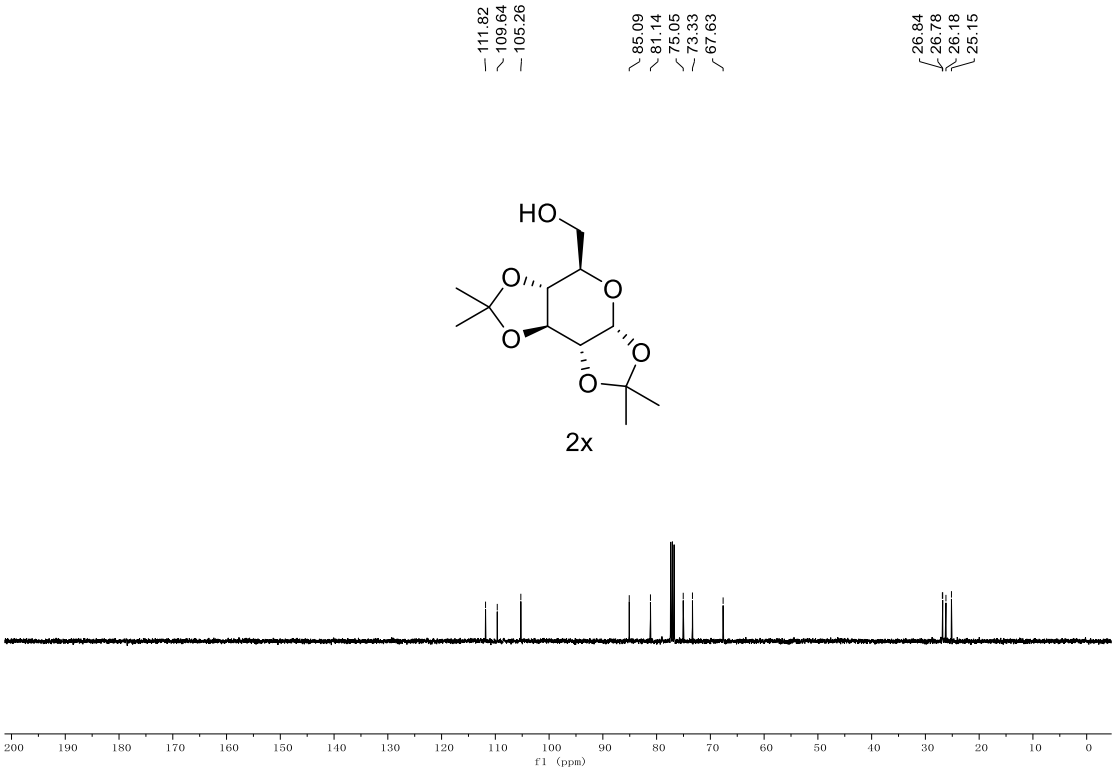
^{13}C NMR, 101 MHz, $CDCl_3$



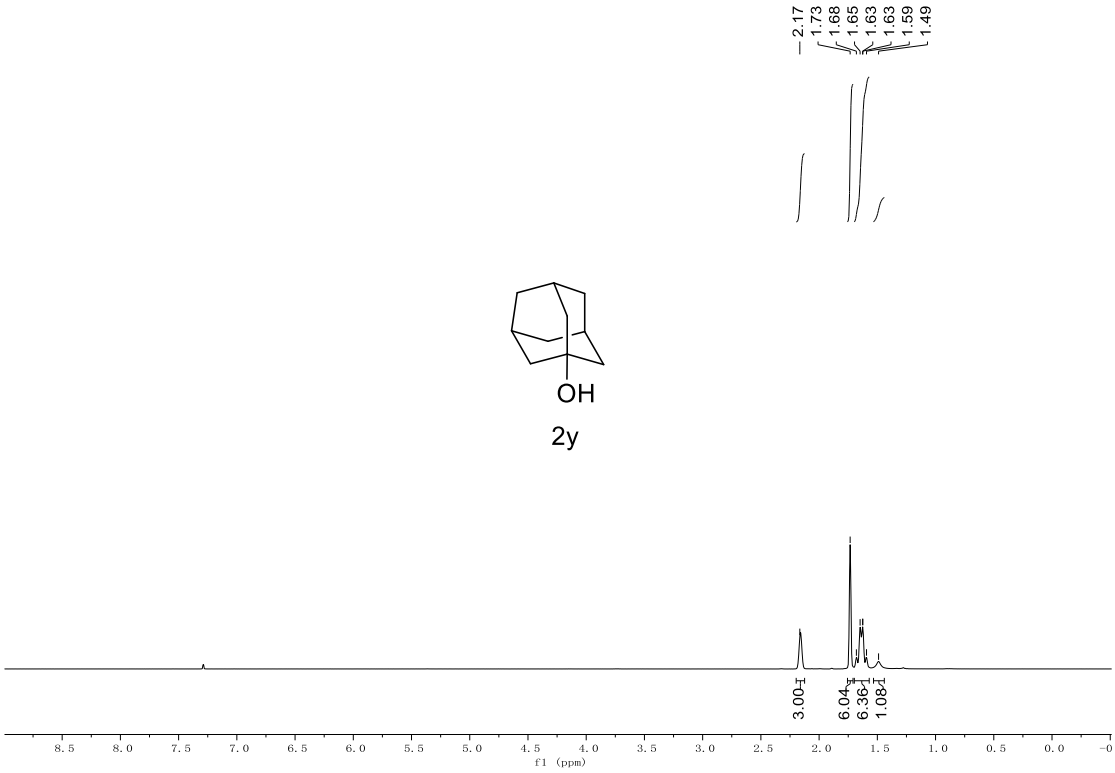
^{1}H NMR, 400 MHz, $CDCl_3$



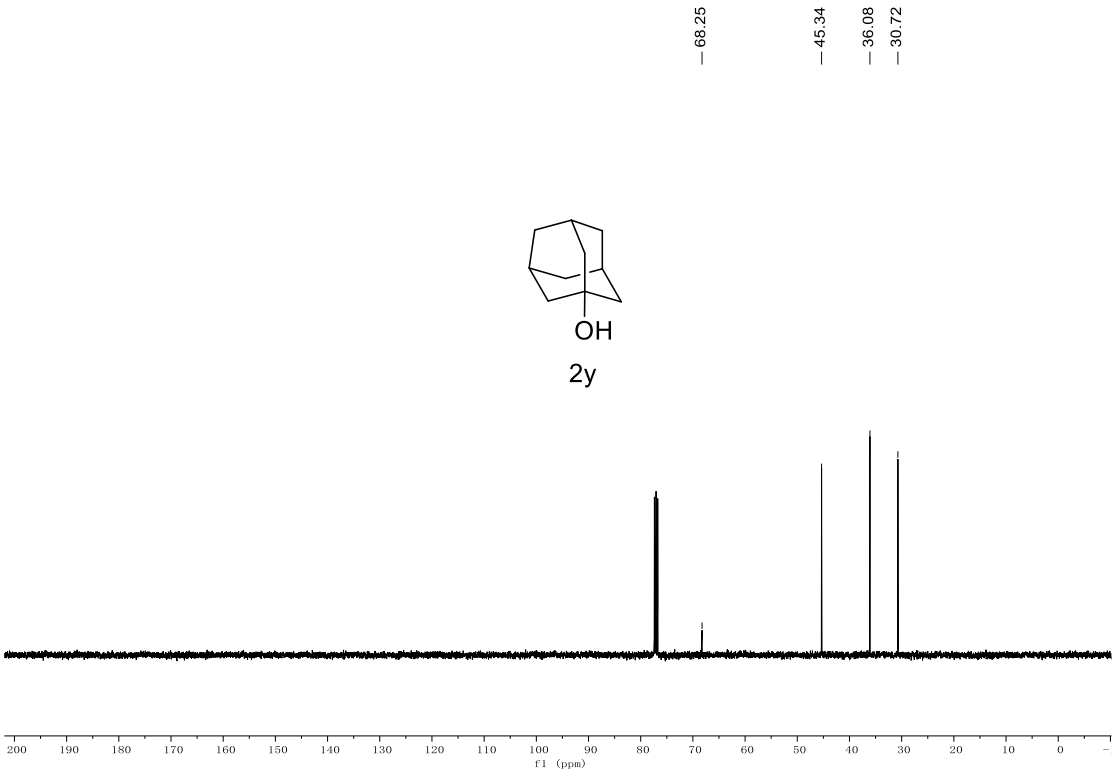
^{13}C NMR, 101 MHz, $CDCl_3$



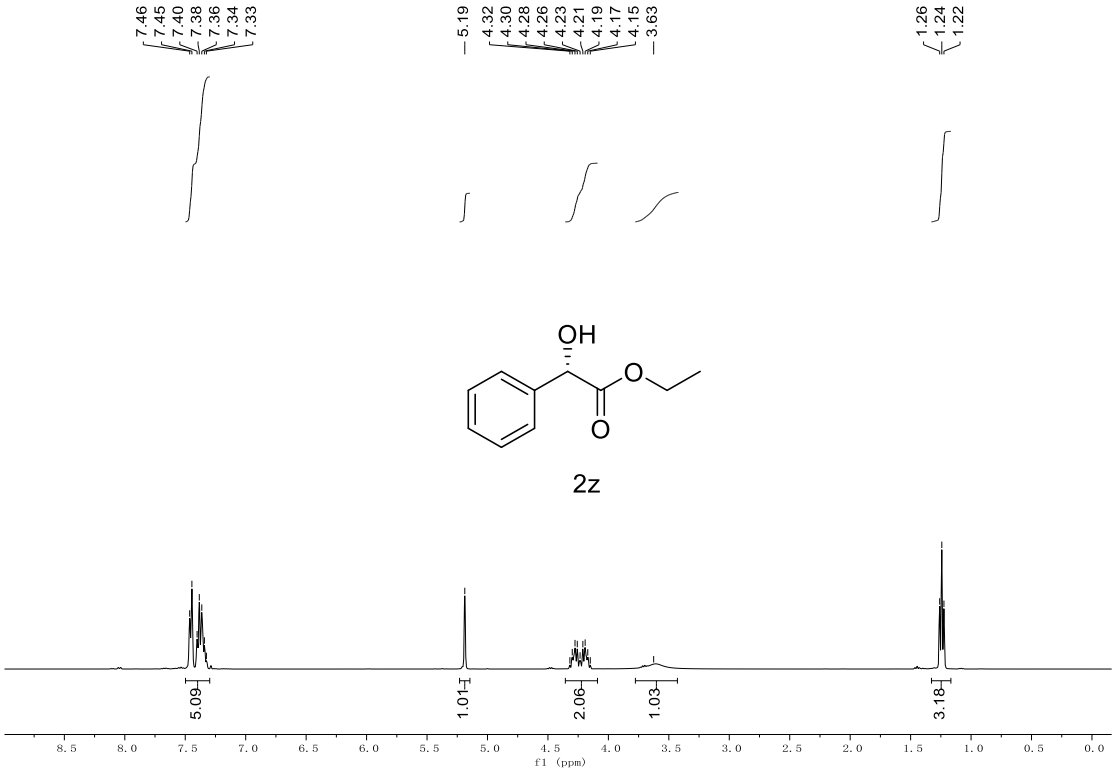
^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$

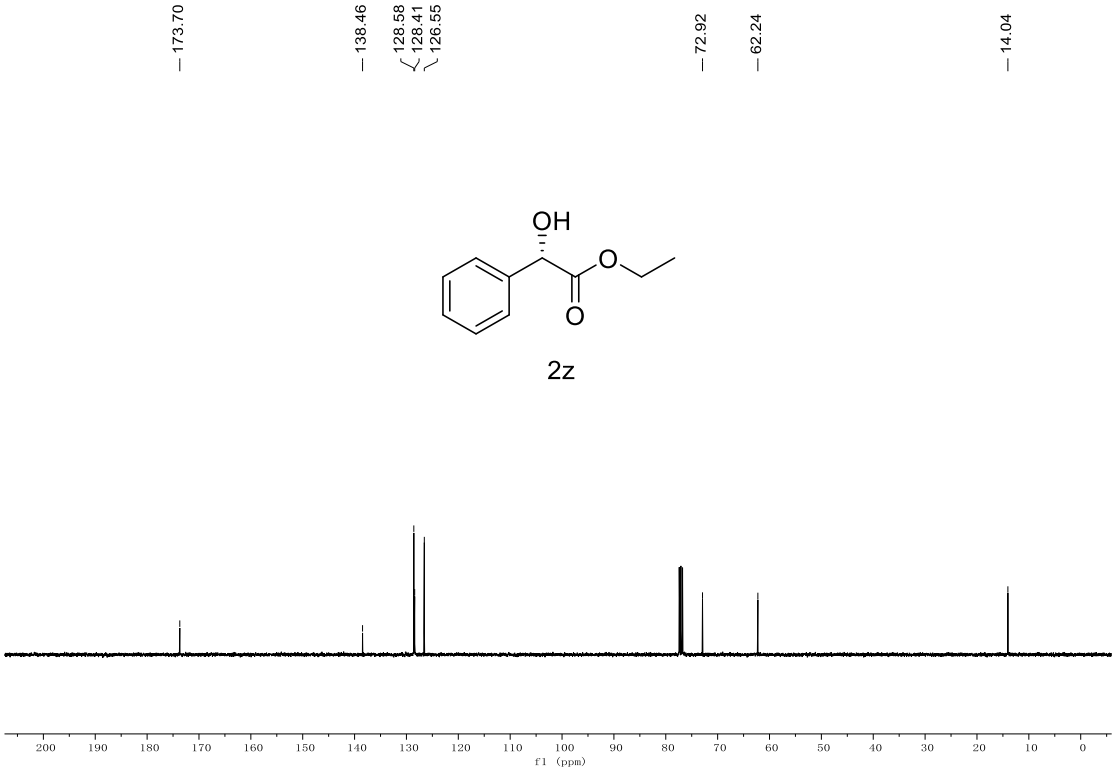


^{1}H NMR, 400 MHz, $CDCl_3$



2z

^{13}C NMR, 101 MHz, $CDCl_3$

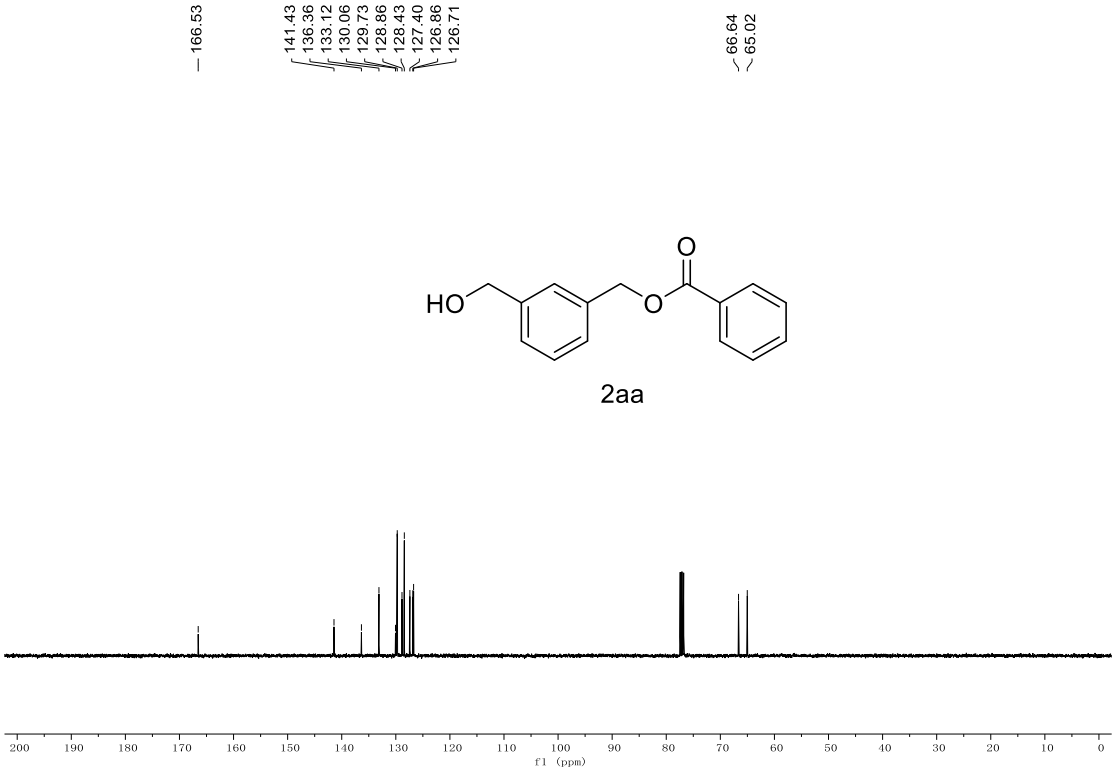


2z

^{1}H NMR, 400 MHz, $CDCl_3$

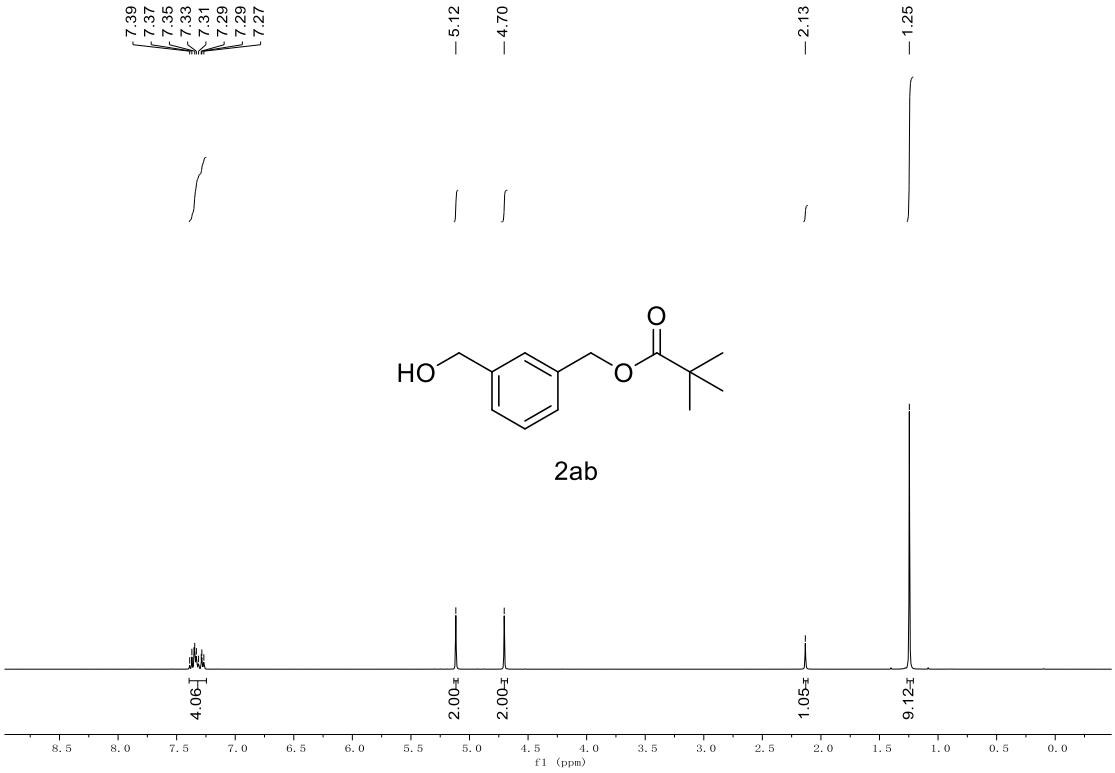
2aa

^{13}C NMR, 101 MHz, $CDCl_3$



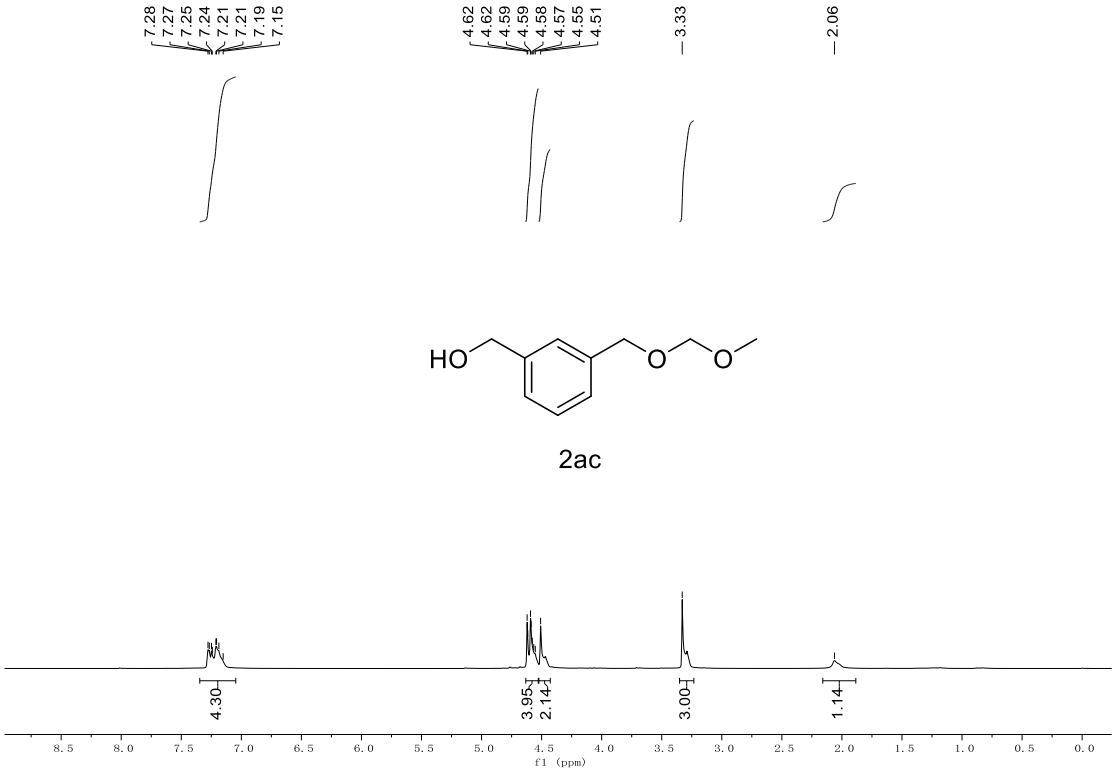
2aa

^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$

^{1}H NMR, 400 MHz, $CDCl_3$

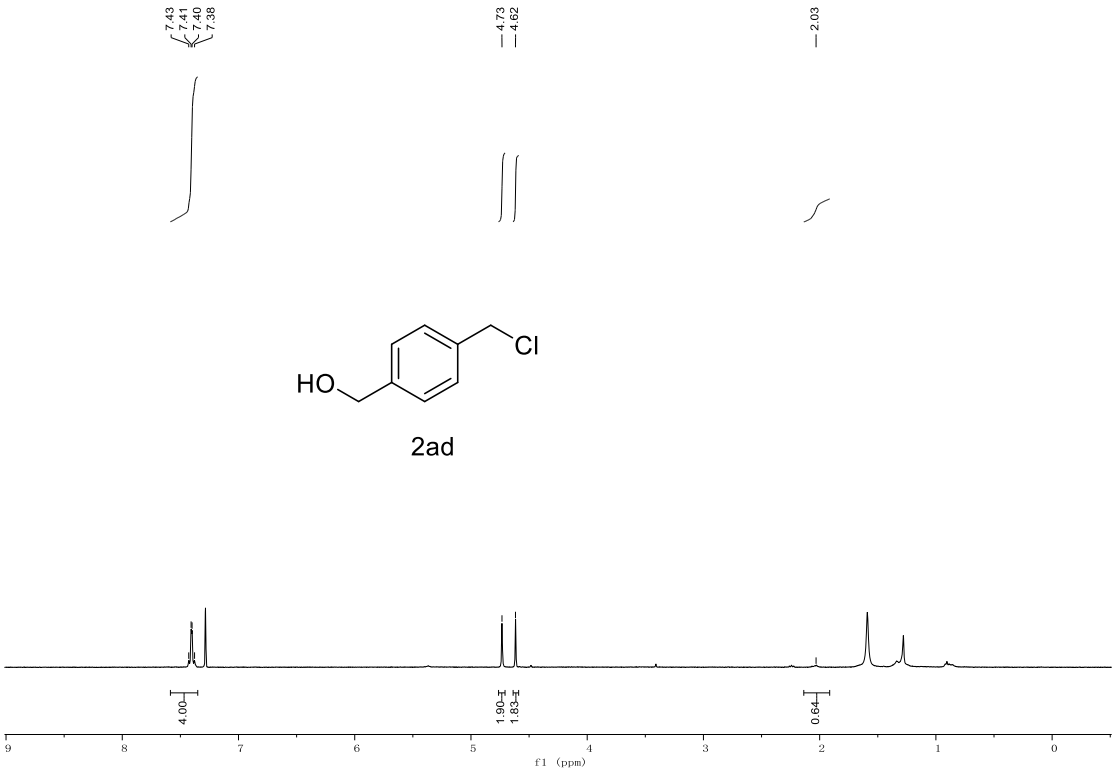


2ac

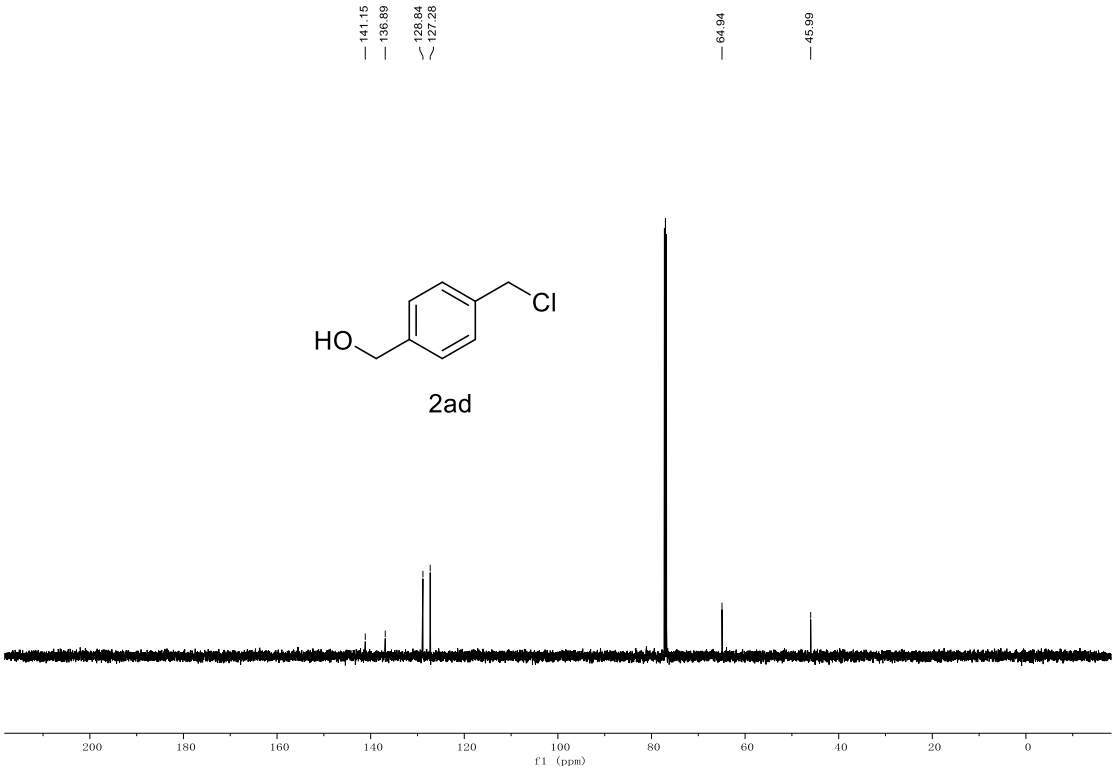
^{13}C NMR, 101 MHz, $CDCl_3$

2ac

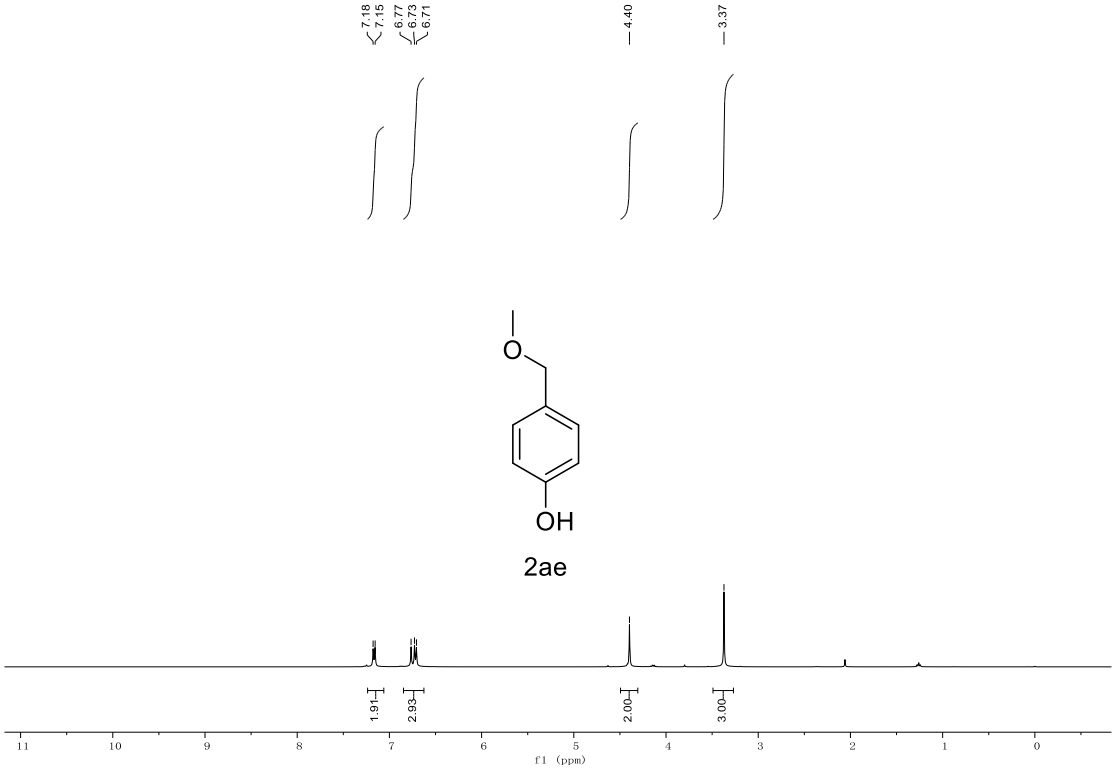
^{1}H NMR, 400 MHz, $CDCl_3$



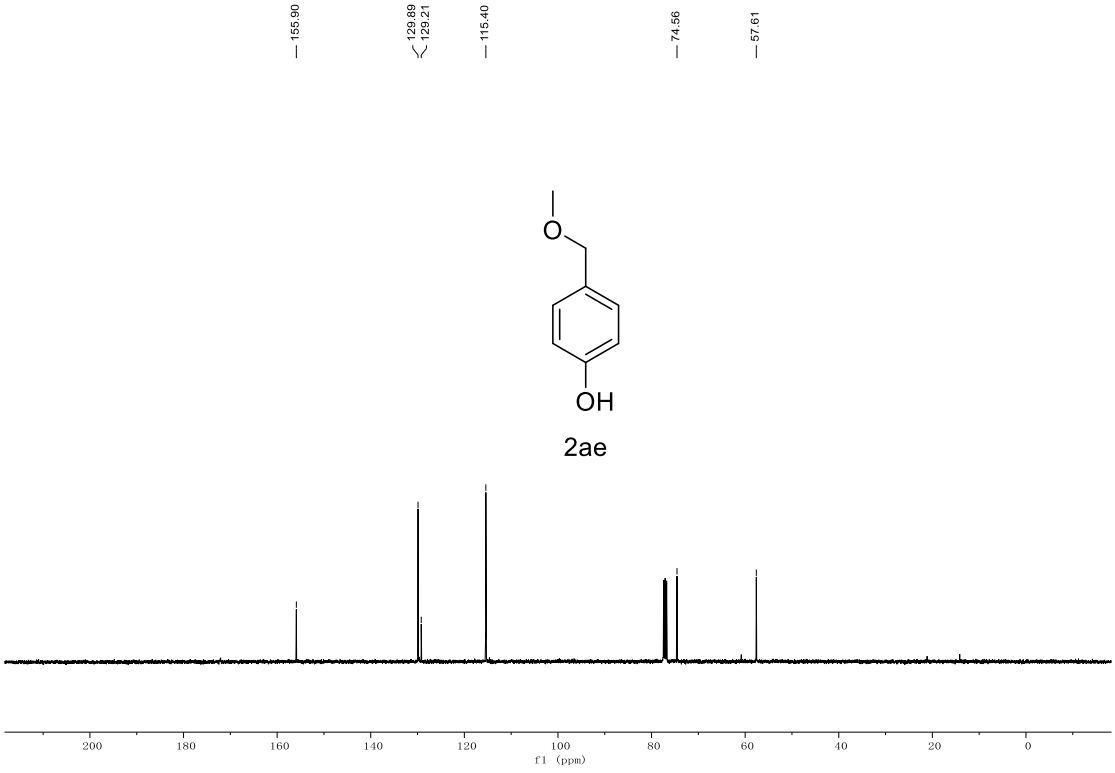
^{13}C NMR, 101 MHz, $CDCl_3$



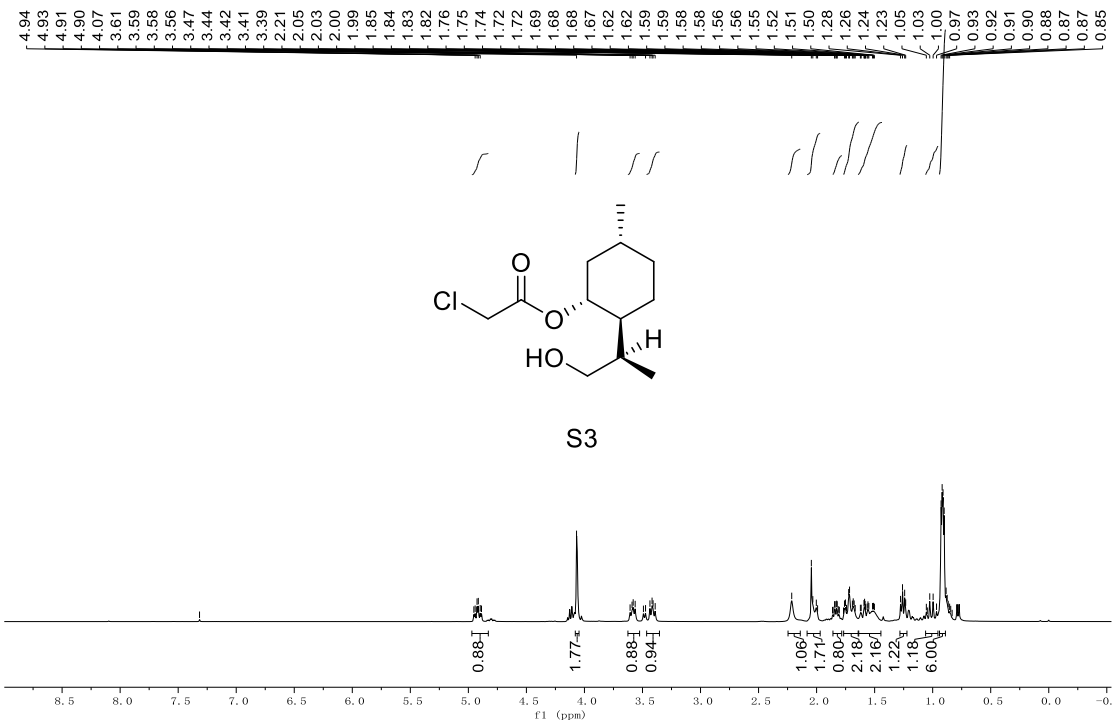
^{1}H NMR (400 MHz, $CDCl_3$)



^{13}C NMR (101 MHz, $CDCl_3$)

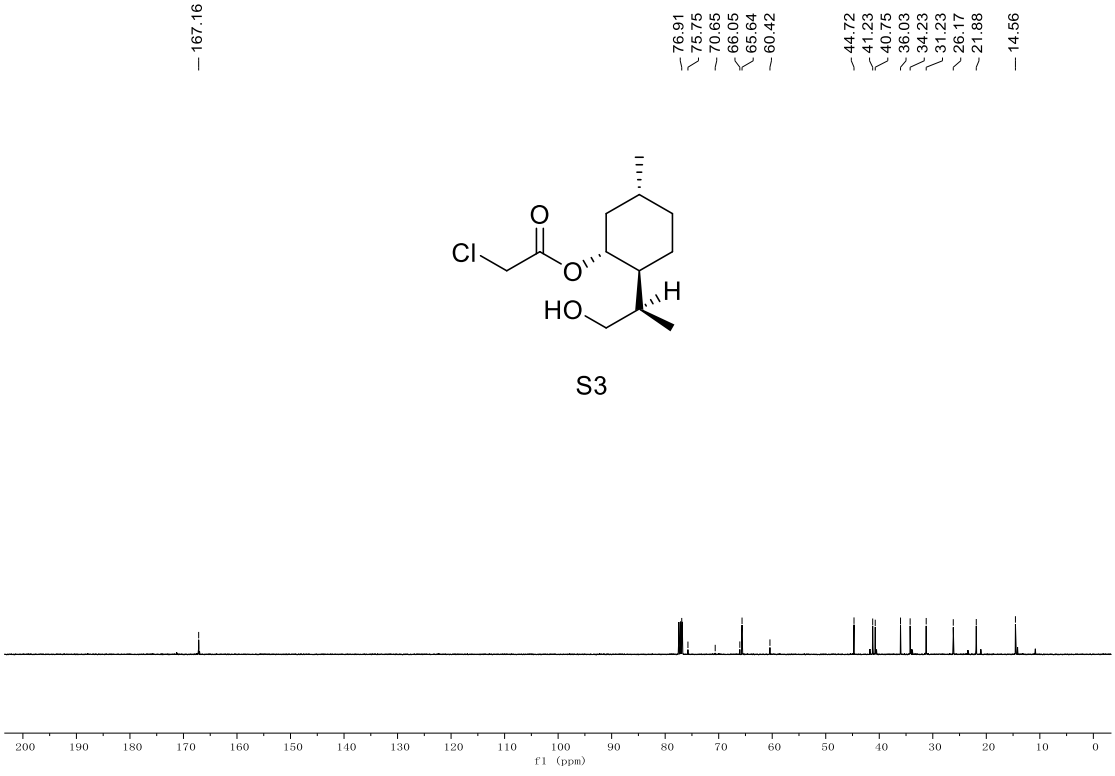


^{1}H NMR, 400 MHz, $CDCl_3$



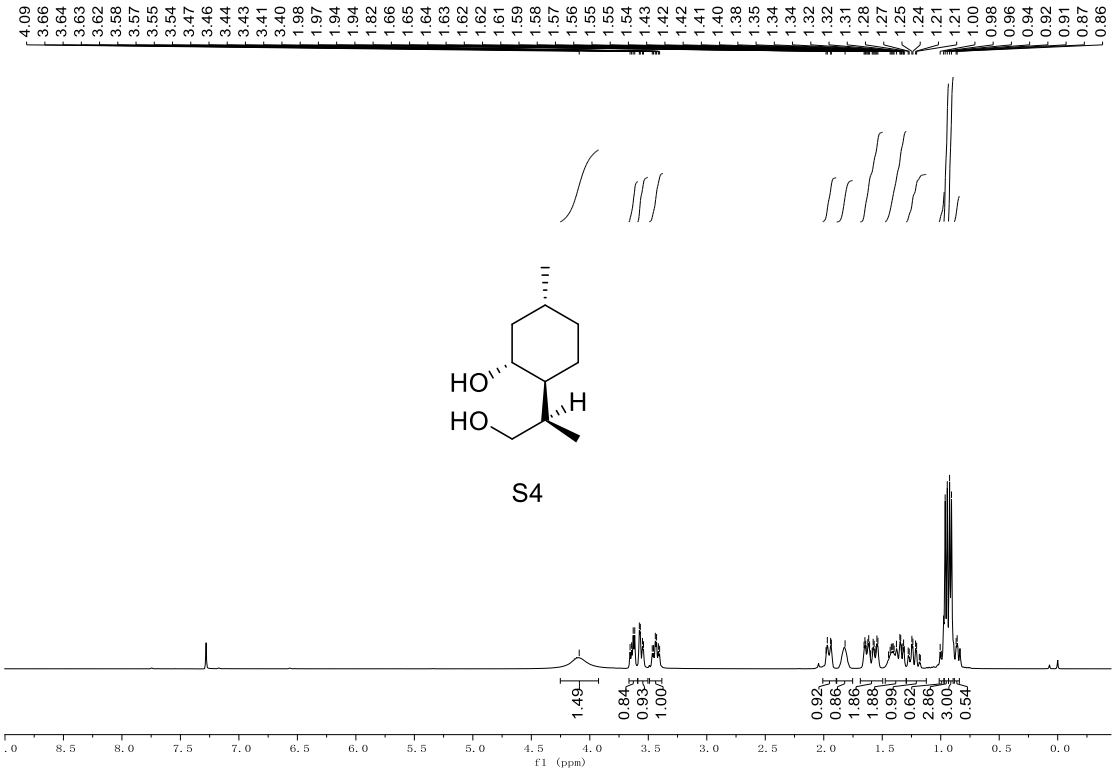
S3

^{13}C NMR, 101 MHz, $CDCl_3$



S3

^{1}H NMR, 400 MHz, $CDCl_3$



^{13}C NMR, 101 MHz, $CDCl_3$