Electronic Supplementary Material (ESI) for ChemComm.


# Room-Temperature Pd-Catalyzed Methoxycarbonylation of Terminal Alkynes with High Branched Selectivity Enabled by Bisphosphine-Picolinamide Ligand

Ding Liu[†[a]], Miaolin Ke[†[b,c]], Tong Ru[[b,c]], Yingtang Ning[*[b,c]], Fen-er Chen[*[a,b,c]]

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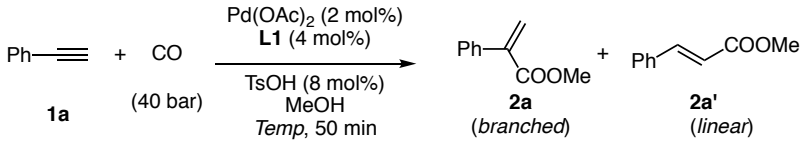
## 1. Supporting Tables and Figures.

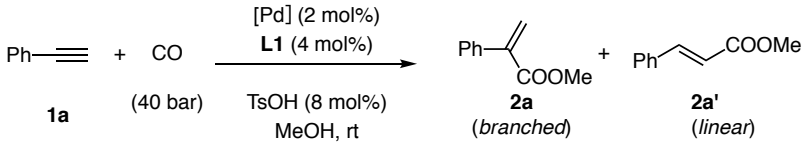
**Table S1.** Effect of reaction temperature [a]




| entry | *Temp* (°C) | Conv. (%) | *b*/*l* ratio |
|---|---|---|---|
| 1 | 60 | >99 | >99:1 |
| 2 | 40 | >99 | >99:1 |
| 3 | 25 | >99 | >99:1 |

[a]. Reactions were performed with **1a** (0.5 mmol) in MeOH (2 mL). The convertions and *b*/*l* ratios were determined with $^1$H-NMR and GC.

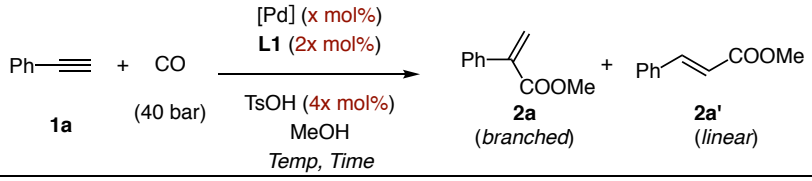
**Table S2.** Effect of palladium precursor. [a]




| entry | Pd salts | time | Conv. (%) | *b*/*l* ratio |
|---|---|---|---|---|
| 1 | $Pd(OAc)_2$ | 50 min | >99 | >99:1 |
| 2 | $Pd(dba)_2$ | 50 min | >99 | >99:1 |
| 3 | $Pd(PPh_3)_4$ | 50 min | >99 | >99:1 |
| 4 | $Pd(PhCN)_2Cl_2$ | 3 h | >99 | >99:1 |
| 5 | $PdCl_2$ | 3 h | >99 | >99:1 |

[a]. Reactions were performed with **1a** (0.5 mmol) in MeOH (2 mL). The convertions and *b*/*l* ratios were determined with $^1$H-NMR and GC.

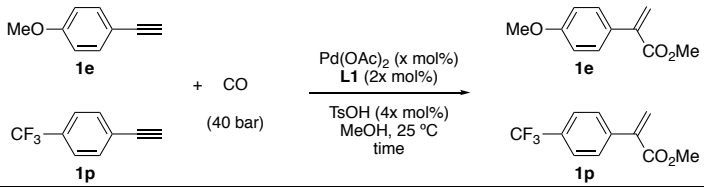
**Table S3.** Effect of catalyst loading. [a]




| entry | x (mol%) | *Temp* (°C) | *Time* | Conv. (%) | *b*/*l* ratio |
|---|---|---|---|---|---|
| 1 | 2 | 25 °C | 50 min | >99 | >99:1 |
| 2 | 1 | 25 °C | 6 h | >99 | >99:1 |
| 3 | 0.5 | 25 °C | 18 h | 55 | >99:1 |
| 4 | 0.03 | 80 °C | 24 h | 97 | 98:2 |

[a]. Reactions were performed with 1a (0.5 mmol) in MeOH (2 mL). The convertions and *b*/*l* ratios were determined with $^1$H-NMR and GC.

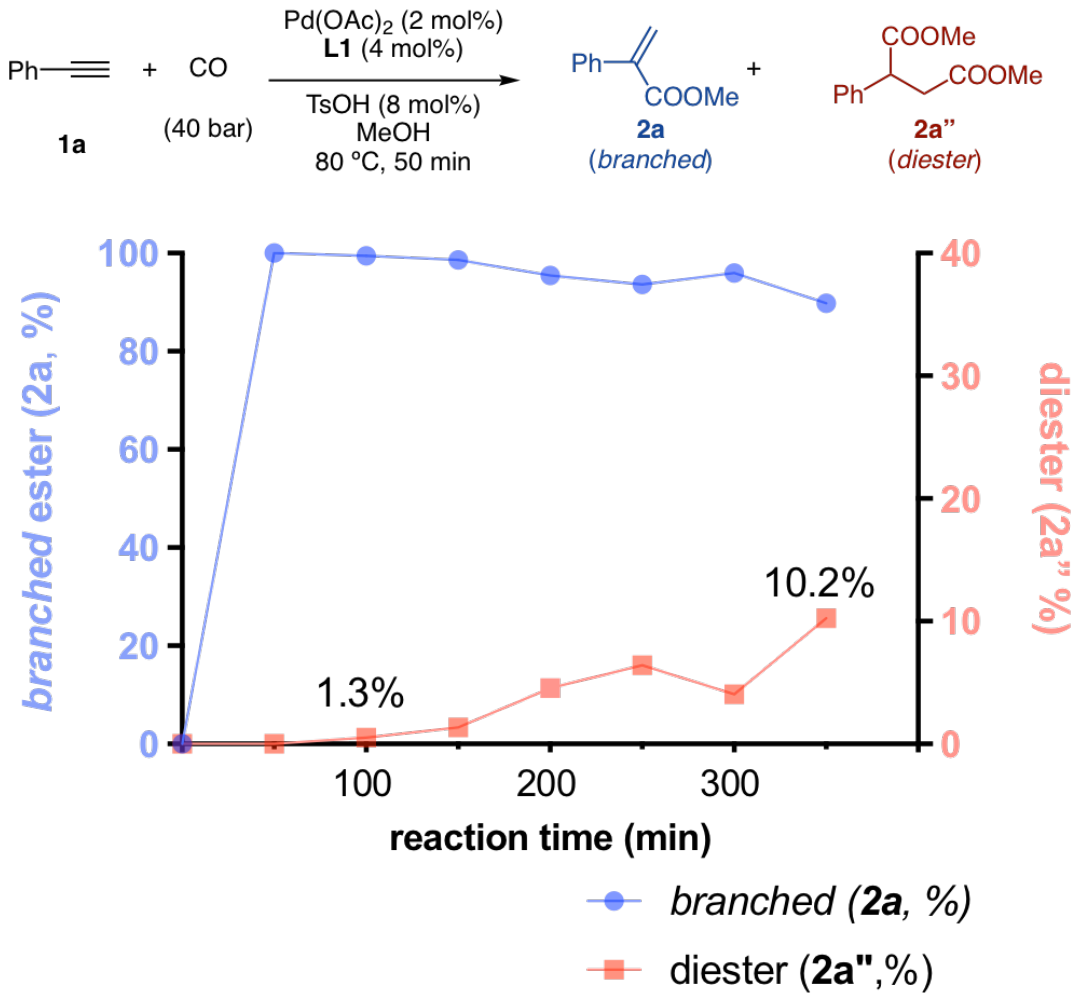
**Table S4.** Substrate competition experiments. [a]




| entry | [**1e**] (M) | [**1p**] (M) | [Pd(OAc)$_2$][b] | Time (h) | Conv. (%) | |
|---|---|---|---|---|---|---|
| | | | | | **1e** | **1p** |
| 1 | 0.25 | 0.25 | 2 mol% | 16 | >99 | 83 |
| 2 | 0.25 | 0.25 | 2 mol% | 16 | >99 | 98 |
| 3 | 0.125 | 0.125 | 4 mol% | 16 | >99 | 89 |
| 4 | 0.125 | 0.125 | 4 mol% | 1 | >99 | 85 |

[a]. Reactions were performed with **1e** (0.5 mmol) in different volumes of MeOH. b/l ratios were determined with $^1$H NMR and GC analysis. [b]. Catalyst concentration relative to **1e**.

**Figure S1.** Reaction profile for **1a** at 80 °C.



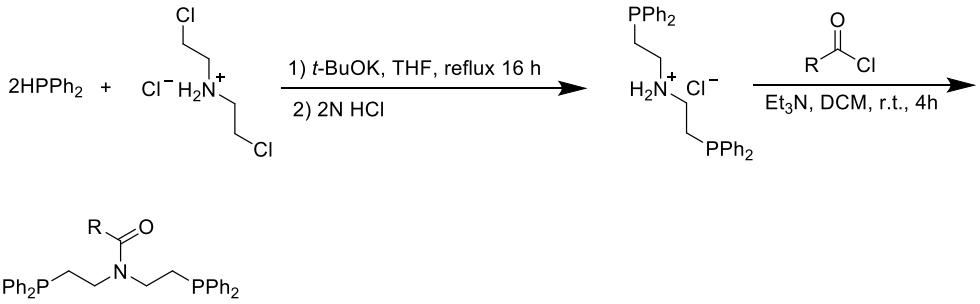
## 2. General information.

Commercial reagents and solvents were ordered from Aldrich, TCI and Bidepharm. Reagents and solvents were used as received unless otherwise stated. Where necessary, solvents were purified by passing through columns of alumina using a solvent purification system. Air- and moisture sensitive synthesis were performed under nitrogen atmosphere with oven-dried glassware. Column chromatography was performed on silica gel (100-200 mesh). Thin-layer chromatography (TLC) was performed on EM reagents 0.25 mm silica 60-F plates.

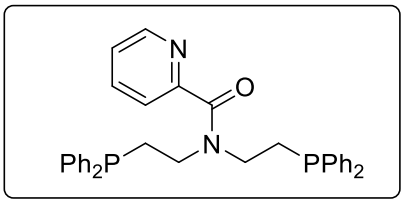
NMR spectra were recorded with a Bruker AVANCE III (400 MHz) spectrometer. Chemical shifts (δ, ppm) are given relative to solvent: references for $CDCl_3$ were 7.26 ppm ($^1H$ NMR) and 77.16 ppm ($^{13}C$ NMR). Data are reported as follows: chemical shift [multiplicity (br = broad, s = singlet, d = doublet, t = triplet, m = multiplet), coupling constant(s) in Hertz, integration]. GC-MS analysis was carried out on Agilent 7820A GC system and Angilent 5977B MSD. High-resolution mass spectra (HRMS) were recorded on a Bruker micrOTOF spectrometer with electronspray ionization (ESI). Infrared data (IR) were obtained with a Thermo Fisher Scientific FT-IR. Combustion elemental analysis was performed with varioMicro elemental analyzer.

## 3. Synthesis of ligands (L1, L2, L4-L8)

### 3.1 Synthesis of L1, L2, L4, L5.




**N,N-bis(2-(diphenylphosphaneyl)ethyl)picolinamide (L1):**




Diphenylphosphine (14.0 mL, 80.0 mmol) was added via syringe to a suspension of potassium *tert*-butoxide (14.0 g, 128.0 mmol) in anhydrous THF (250 mL) under nitrogen. The resulting deep red solution was stirred for 10 min and bis(2-chloroethyl)amine hydrochloride (7.0 g, 40.0 mmol) was added as a coarse powder. The mixture was refluxed for 16 h, poured into 400 mL of hexane, and washed in succession with 150-mL portions of 10% aqueous NaOH and brine. The hexane layer was separated, filtered, and stirred vigorously with aqueous hydrochloric acid (2N, 400 mL) to give a dense white precipitate. The precipitate was recrystallized from hot acetonitrile (100 mL) to afford bis(2-(diphenylphosphanyl)ethyl)ammonium chloride as fine white needles (16.2 g, 85%).

Triethylamine (2.8 mL, 20.0 mmol) was added slowly to a solution of picolinoyl chloride (1.2 g, 10.0 mmol) in DCM (10 mL) under nitrogen at 0°C. After 5 min, bis(2-(diphenylphosphanyl)ethyl)ammonium chloride (5.3 g,12.0 mmol) from the previous step was added to the mixture, and the reaction mixture was allowed to warm to room temperature and stirred for 4 h. Saturated aqueous $NaHCO_3$ was added, and the aqueous layer was extracted with DCM. The combined organic layers were dried over anhydrous sodium sulfate, were filtered, and were concentrated under reduced pressure. The

residue was further purified by flash chromatography (eluent: 2% Methanol in dichloromethane) to afford L1 as a white solid (2.52 g, 46% yield).

Mp. 103.8-104.7 °C.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.35 (d, *J* = 4.2 Hz, 1H), 7.68 (td, *J* = 7.7, 1.5 Hz, 1H), 7.53 (d, *J* = 7.8 Hz, 1H), 7.51-7.42 (m, 4H), 7.38-7.29 (m, 6H), 7.29-7.19 (m, 11H), 3.69-3.52 (m, 2H), 3.55-3.34 (m, 2H), 2.58-2.43 (m, 2H), 2.44-2.25 (m, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 168.4, 154.1, 148.1, 137.7 (d, *J* = 12.2 Hz), 137.2 (d, *J* = 11.9 Hz), 136.7, 132.6 (d, *J* = 17.0 Hz), 132.4 (d, *J* = 17.2 Hz), 128.6, 128.5, 128.43, 128.36, 124.2, 123.3, 46.7 (d, *J* = 28.2 Hz), 43.8 (d, *J* = 25.6 Hz), 27.6 (d, *J* = 14.6 Hz), 26.2 (d, *J* = 14.2 Hz).

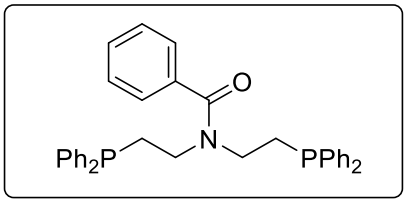
$^{31}$P NMR (162 MHz, $CDCl_3$) δ -20.73, -20.97.

IR ($cm^{-1}$): 3051.78, 1633.63, 1481.14, 1433.85, 1304.09, 1131.82, 738.01, 696.62.

HRMS(ESI): Calcd. for $C_{34}H_{32}N_2NaOP_2$: $[M+Na]^+$ 569.1882; found: 569.1874.

Anal. Calcd. for $C_{34}H_{32}N_2OP_2$: C, 74.71; H, 5.90; N, 5.13. Found: C, 74.57; H, 5.89; N, 5.13.

**N,N-bis(2-(diphenylphosphaneyl)ethyl)benzamide (L2)**




**L2** was synthesized following the general procedure of **L1**.

Sticky colorless oil, 59% yield.

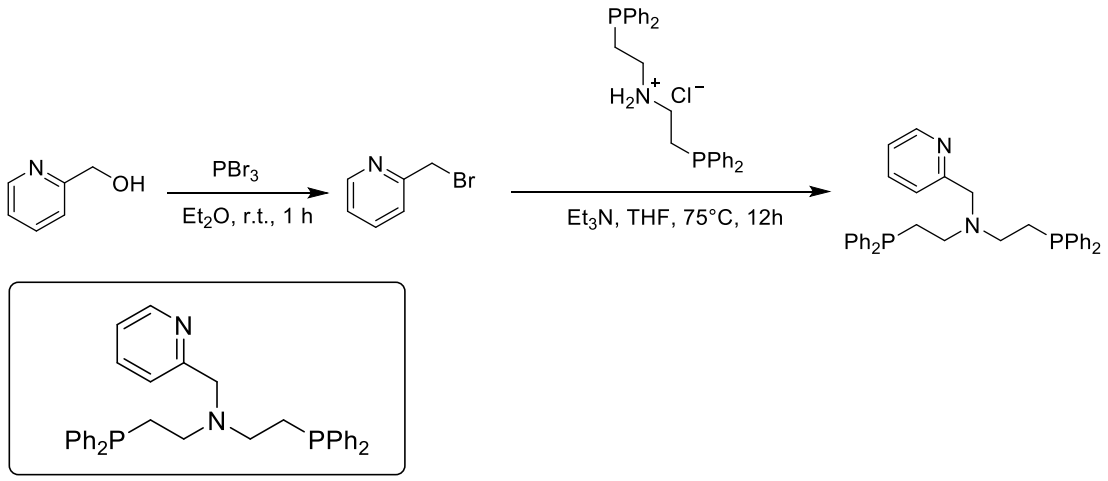
$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.47 (t, *J* = 7.5 Hz, 4H), 7.33-7.13 (m, 21H), 3.67-3.54 (m, 2H), 3.35-3.23 (m, 2H), 2.53-2.40 (m, 2H), 2.17-2.09 (m, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 171.3, 137.6 (d, *J* = 12.5 Hz), 136.7 (d, *J* = 12.2 Hz), 136.1, 132.3 (d, *J* = 35.3 Hz), 132.2 (d, *J* = 35.6 Hz), 129.0, 128.5, 128.4, 128.3, 128.2, 126.1, 46.7 (d, *J* = 26.5 Hz), 42.7 (d, *J* = 23.6 Hz), 27.4 (d, *J* = 14.6 Hz), 26.3 (d, *J* = 14.2 Hz).

$^{31}$P NMR (162 MHz, $CDCl_3$) δ -20.79, -21.62.

HRMS(ESI): Calcd. for $C_{35}H_{34}NOP_2$: $[M+H]^+$ 546.2110; found: 526.2091.

**2-(diphenylphosphaneyl)-N-(2-(diphenylphosphaneyl)ethyl)-N-(pyridin-2-ylmethyl)ethan-1-amine (L4)**[1]

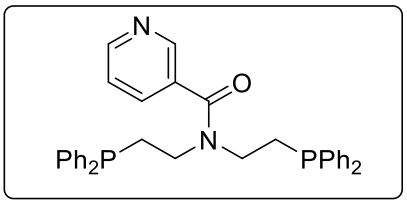



$PBr_3$ (0.52 mL, 5.5 mmol) was added to pyridin-2-ylmethanol (0.48 mL, 5.0 mmol) in Ethyl ether (10 mL) at room temperature. The reaction mixture was stirred for 1 h at room temperature and then quenched with methanol. After extraction with ethyl acetate, the combined organic layers were dried with $Na_2SO_4$ and the solvent was removed under reduced pressure, leading to crude compound as yellow oil(839.8 mg, 99%). Triethylamine (0.8 mL, 5.7 mmol) was added slowly to a solution of 2-(bromomethyl)pyridine (0.45 g, 2.5 mmol) in THF (8.0 ml) under nitrogen at 0°C. After 5 min, bis(2-(diphenylphosphanyl)ethyl)ammonium chloride (1.10 g, 2.3 mmol) was added to the mixture, and the reaction mixture was allowed to warm to room temperature and stirred for 12 h. Saturated aqueous $NaHCO_3$ was added, and the aqueous layer was extracted with DCM. The combined organic layers were dried over anhydrous sodium sulfate, were filtered, and were concentrated under reduced pressure. The residue was further purified by flash chromatography (eluent: 2% Methanol in dichloromethane) to afford **L4** as a colourless oil (0.42 g, 34% yield) [1].

$^1$H NMR (400 MHz, $CDCl_3$) δ 8.46 (d, $J$ = 4.2 Hz, 1H), 7.57-7.50 (m, 1H), 7.36-7.30 (m, 9H), 7.29-7.25 (m, 12H), 7.12-7.06 (m, 1H), 3.74 (s, 2H), 2.69-2.57 (m, 4H), 2.18-2.10 (m, 4H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ1 59.6, 148.8, 138.3 (d, *J* = 12.8 Hz), 136.3, 132.6 (d, *J* = 18.7 Hz), 128.5, 128.4 (d, *J* = 6.8 Hz), 122.9, 121.8, 59.8, 49.7 (d, *J* = 22.1 Hz), 25.2 (d, *J* = 12.8 Hz).

**N,N-bis(2-(diphenylphosphaneyl)ethyl)nicotinamide (L5)**




**L5** was synthesized following the general procedure of **L1**.

Sticky colorless oil, 55% yield.

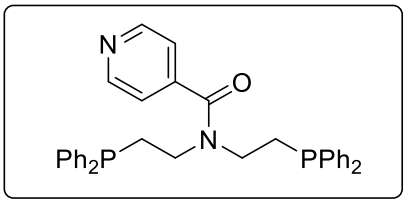
$^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.57 (d, *J* = 4.9 Hz, 1H), 8.50 (s, 1H), 7.51-7.42 (m, 5H), 7.34-7.21 (m, 12H), 7.20-7.09 (m, 5H), 3.68-3.54 (m, 2H), 3.34-3.18 (m, 2H), 2.51-2.39 (m, 2H), 2.17-2.08 (m, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 168.8, 150.2, 147.2, 137.5 (d, *J* = 12.1 Hz), 136.5 (d, *J* = 11.9 Hz), 133.9, 132.5 (d, *J* = 18.8 Hz), 132.2 (d, *J* = 19.1 Hz), 132.1, 128.8, 128.7, 128.5, 128.4, 123.0,46.8 (d, *J* = 26.4 Hz), 43.0 (d, *J* = 23.8 Hz), 27.7 (d, *J* = 16.4 Hz), 26.3 (d, *J* = 13.7 Hz).

$^{31}$P NMR (162 MHz, $CDCl_3$) δ -20.91, -22.21.

HRMS(ESI): Calcd. for $C_{34}H_{32}N_2NaOP_2$ $[M+Na]^+$: 569.1882; found: 569.1877.

**N,N-bis(2-(diphenylphosphaneyl)ethyl)isonicotinamide (L6)**




Sticky colorless oil, 62% yield.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.52 (d, *J* = 5.9 Hz, 2H), 7.59-7.41 (m, 4H), 7.39-7.21 (m, 12H), 7.20-7.10 (m, 4H), 7.07-6.98 (m, 2H), 3.69-3.49 (m, 2H), 3.35-3.04 (m, 2H), 2.59-2.35 (m, 2H), 2.23-2.05 (m, 2H).

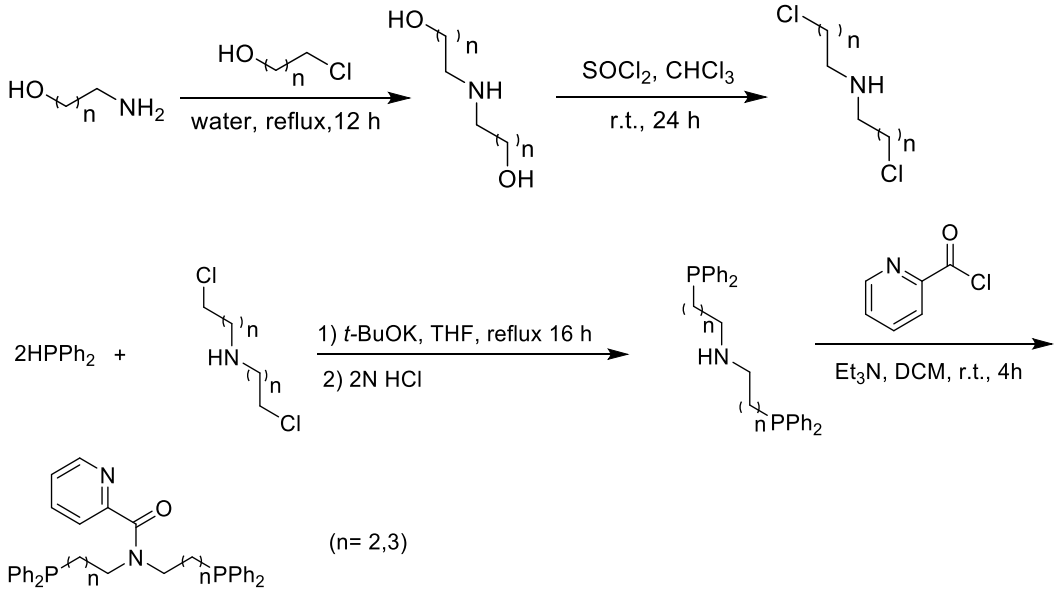
$^{13}$C NMR (101 MHz, $CDCl_3$) δ 168.7, 150.0, 143.7, 137.5 (d, $J$ = 12.1 Hz), 136.4 (d, $J$ = 11.9 Hz), 132.6 (d, $J$ = 18.8 Hz), 132.2 (d, $J$ = 18.9 Hz), 129.0, 128.8, 128.6 (d, $J$ = 2.5 Hz), 128.5 (d, $J$ = 2.5 Hz), 120.51, 46.5 (d, $J$ = 26.9 Hz), 42.8 (d, $J$ = 23.7 Hz), 27.7 (d, $J$ = 15.9 Hz), 26.3 (d, $J$ = 14.4 Hz).

$^{31}$P NMR (162 MHz, $CDCl_3$) δ -16.32, -17.17.

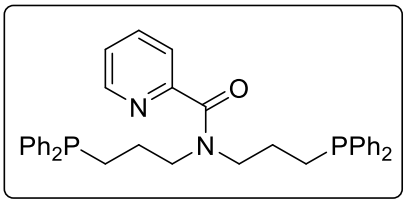
IR ($cm^{-1}$): 3069.23, 3052.66, 2936.38, 1634.13, 1481.43, 1433.74, 1307.38, 1281.79, 1131.40, 741.85, 697.98

HRMS(ESI): Calcd. for $C_{34}H_{32}N_2NaOP_2$ $[M+Na]^+$: 569.1882; found: 569.1880.

### 3.2 Synthesis of L7 and L8




**N,N-bis(3-(diphenylphosphaneyl)propyl)picolinamide (L7)**




Triethylamine (2.8 mL, 20.0 mmol) was added slowly to a solution of picolinoyl chloride (1.20 g, 10.0 mmol) in DCM (10 ml) under nitrogen at 0°C. After 5 min, bis(3-chloropropyl)amine (5.32 g,12.0 mmol) was added to the mixture, and the reaction mixture was allowed to warm to room temperature and stirred for 4 h. Saturated aqueous $NaHCO_3$ was added, and the aqueous layer was extracted with DCM. The

combined organic layers were dried over anhydrous sodium sulfate, were filtered, and were concentrated under reduced pressure. The residue was further purified by flash chromatography (eluent: 2% Methanol in dichloromethane) to afford **L7** as colourless oil (1.66 g, 29% yield).

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.46 (d, *J* = 5.5 Hz, 1H), 7.70 (td, *J* = 7.7, 1.8 Hz, 1H), 7.48 (d, *J* = 7.8 Hz, 1H), 7.45-7.38 (m, 4H), 7.37-7.24 (m, 17H), 3.52 (t, *J* = 7.5 Hz, 2H), 3.40 (t, *J* = 7.5 Hz, 2H), 2.21-2.02 (m, 2H), 1.84-1.72 (m, 4H), 1.71-1.57 (m, 2H).

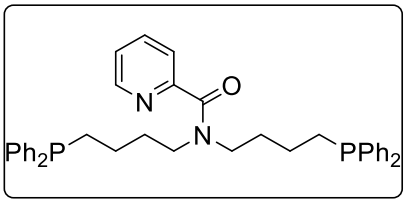
$^{13}$C NMR (100 MHz, $CDCl_3$) δ 168.8, 154.7, 148.1, 138.4 (d, *J* = 12.8 Hz), 138.2 (d, *J* = 12.9 Hz), 136.8, 132.7 (d, *J* = 18.5 Hz), 132.5 (d, *J* = 18.6 Hz), 128.62, 128.56, 128.44, 128.37, 124.1, 123.3, 49.5 (d, *J* = 14.8 Hz), 46.6 (d, *J* = 14.4 Hz), 25.2, 25.1, 24.9 (d, *J* = 12.5 Hz), 23.9 (d, *J* = 16.5 Hz).

$^{31}$P NMR (162 MHz, $CDCl_3$) δ -16.32, -17.17.

IR ($cm^{-1}$): 3069.23, 3052.66, 2936.38, 1634.13, 1481.43, 1433.74, 1307.38, 1281.79, 1131.40, 741.85, 697.98.

HRMS(ESI): Calcd. for $C_{36}H_{36}N_2NaOP_2$ $[M+Na]^+$: 597.2195; found: 597.2187.

**N,N-bis(4-(diphenylphosphaneyl)butyl)picolinamide (L8)**




A mixture of 4-aminobutan-1-ol (4.68 g, 50.0 mmol) and 4-chlorobutan-1-ol (3.40 g, 29.4 mmol) in water (25.0 mL) was refluxed for 12 h. Water was removed under reduced pressure and 4,4'-azanediylbis(butan-1-ol) was obtained as a yellow oil and used for the next step without further purification.

To a solution of 4,4'-azanediylbis(butan-1-ol) in chloroform at 0°C, a solution of thionyl chloride (15.0 mL, 20.8 mmol) in chloroform was added dropwise. The solution was stirred for 24 h at room temperature. The solvent was evaporated, and the crude product was purified by flash chromatography (eluent: 12.5% Methanol in dichloromethane) to afford bis(4-chlorobutyl)amine as a white solid (2.51 g, 43% yield).

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.36-7.29 (m, 8H), 7.28-7.22 (m, 12H), 2.83 (t, *J* = 8.0 Hz, 4H), 1.97 (t, *J* = 8.0 Hz, 4H), 1.87-1.69 (m, 4H), 1.45-1.32 (m, 4H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 138.2 (d, *J* = 12.0 Hz), 132.6 (d, *J* = 18.3 Hz), 128.6, 128.4 (d, *J* = 6.7 Hz), 39.8, 29.4 (d, *J* = 13.4 Hz), 27.3 (d, *J* = 11.4 Hz), 23.0 (d, *J* = 17.5 Hz).

$^{31}$P NMR (162 MHz, $CDCl_3$) δ -16.8.

Triethylamine (2.8 mL, 20.0 mmol) was added slowly to a solution of picolinoyl chloride (1.20 g, 10.0 mmol) in DCM (10 ml) under nitrogen at 0°C. After 5 min, bis(4-chlorobutyl)amine (2.50 g, 5.0 mmol) was added to the mixture, and the reaction mixture was allowed to warm to room temperature and stirred for 4 h. Saturated aqueous $NaHCO_3$ was added, and the aqueous layer was extracted with DCM. The combined organic layers were dried over anhydrous sodium sulfate, were filtered, and were concentrated under reduced pressure. The residue was further purified by flash chromatography (eluent: 2% Methanol in dichloromethane) to afford **L8** as colorless oil (0.75 g, 25% yield).

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.45 (d, *J* = 4.9 Hz, 1H), 7.65 (t, *J* = 7.7 Hz, 1H), 7.51-7.37 (m, 6H), 7.36-7.25 (m, 15H), 7.22-7.16 (m, 1H), 3.43 (t, *J* = 7.7 Hz, 2H), 3.27 (t, *J* = 7.6 Hz, 2H), 2.21-2.02 (m, 2H), 1.91-1.84 (m, 2H), 1.83-1.73 (m, 2H), 1.70-1.60 (m, 2H), 1.57-1.45 (m, 2H), 1.30-1.11 (m, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 168.4, 154.7, 147.9, 138.4 (d, *J* = 17.9 Hz), 138.3 (d, *J* = 17.9 Hz), 136.6, 132.44 (d, *J* = 18.4 Hz), 132.36 (d, *J* = 18.4 Hz), 128.33, 128.25, 128.2, 128.1, 123.8, 123.0, 48.1, 45.2, 30.0 (d, *J* = 12.5 Hz), 28.7 (d, *J* = 12.8 Hz), 27.5 (d, *J* = 11.6 Hz), 27.2 (d, *J* = 11.8 Hz), 23.2 (d, *J* = 16.6 Hz), 22.7 (d, *J* = 16.6 Hz).

$^{31}$P NMR (162 MHz, $CDCl_3$) δ -16.34, -16.72.

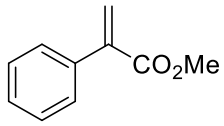
IR ($cm^{-1}$): 3049.12, 2928.64, 1629.15, 1432.12, 1418.24, 1305.52, 1128.02, 739.82, 695.12

HRMS(ESI): Calcd. for $C_{38}H_{40}N_2NaOP_2$ $[M+Na]^+$: 625.2508; found: 625.2505.

## 4. General procedure for Pd-catalyzed carbonylation of alkynes

A 10 mL reaction tube was charged with $Pd(OAc)_2$ (2.0 mol%), TsOH (8.0 mol%), and equipped with a stirring bar. MeOH (2.0 mL) was added to dissolve the catalyst, followed by the addition of substrate alkyne (0.5 mmol) and **L1** (4.0 mol%). The tube was placed in a WP-MSAR-250A autoclave. At room temperature, the autoclave was purged with nitrogen three times and carbon monoxide three times, then pressurized to 40 *bar* of carbon monoxide. The reaction was kept at room temperature for 12 h. Afterward, the pressure was carefully released. A sample of the mixture was analyzed by GC-MS and NMR. The pure product was obtained by column chromatography on silica gel (general eluent: petroleum ether /ethyl acetate = 30:1 to 15:1).

**methyl 2-phenylacrylate (2a)**[2]



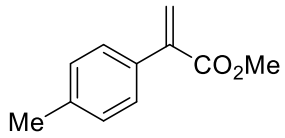

**2a**

68.8 mg, 85% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.43-7.38 (m, 2H), 7.38-7.32 (m, 3H), 6.37 (d, *J* = 1.3 Hz, 1H), 5.89 (d, *J* = 1.3 Hz, 1H), 3.82 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.3, 141.2, 136.6, 128.3, 128.1, 128.1, 126.9, 52.2.

**methyl 2-(*p*-tolyl)acrylate (2b)** [2]



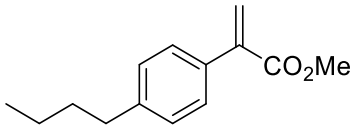

**2b**

68.1 mg, 77% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.35 (d, *J* = 8.2 Hz, 2H), 7.21 (d, *J* = 8.0 Hz, 2H), 6.36 (d, *J* = 1.3 Hz, 1H), 5.90 (d, *J* = 1.3 Hz, 1H), 3.85 (s, 3H), 2.40 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.4, 141.1, 138.0, 133.7, 128.8, 128.1, 126.2, 52.1, 21.1.

**methyl 2-(4-butylphenyl)acrylate (2c)**



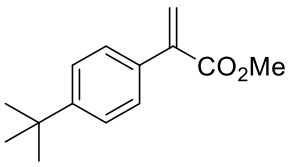

**2c**

83.8 mg, 77% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.32 (d, *J* = 8.2 Hz, 2H), 7.17 (d, *J* = 8.4 Hz, 2H), 6.31 (d, *J* = 1.3 Hz, 1H), 5.86 (d, *J* = 1.3 Hz, 1H), 3.81 (s, 3H), 2.68-2.53 (m, 2H), 1.69-1.54 (m, 2H), 1.46-1.30 (m, 2H), 0.93 (t, *J* = 7.3 Hz, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.4, 143.0, 141.1, 133.9, 128.1, 128.1, 126.1, 52.1, 35.3, 33.5, 22.3, 13.9.

**methyl 2-(4-(tert-butyl)phenyl)acrylate (2d)**[2]



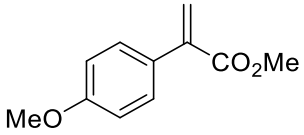

**2d**

83.8 mg, 77% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.47-7.33 (m, 4H), 6.35 (d, *J* = 1.3 Hz, 1H), 5.92 (d, *J* = 1.3 Hz, 1H), 3.85 (s, 3H), 1.36 (s, 9H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.5, 151.2, 141.0, 133.7, 127.9, 126.3, 125.1, 52.2, 34.6, 31.2.

**methyl 2-(4-methoxyphenyl)acrylate (2e)**[2]



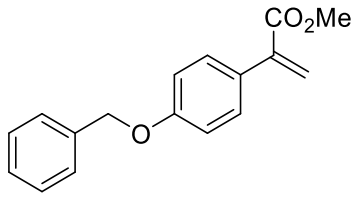

**2e**

**2e.** 81.1 mg, 84% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.47-7.31 (m, 2H), 6.98-6.79 (m, 2H), 6.28 (d, *J* = 1.2 Hz, 1H), 5.84 (d, *J* = 1.2 Hz, 1H), 3.82 (s, 6H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.5, 159.6, 140.6, 129.5, 129.1, 125.5, 113.5, 55.3, 52.2.

**methyl 2-(4-(benzyloxy)phenyl)acrylate (2f)**[3]



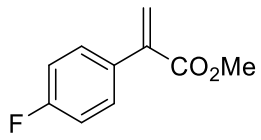

**2f**

**2f.** 83.4 mg, 62% yield, 0.5 mmol scale, colorless oil.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.56-7.27 (m, 7H), 7.06-6.87 (m, 2H), 6.27 (d, *J* = 1.3 Hz, 1H), 5.83 (d, *J* = 1.2 Hz, 1H), 5.07 (s, 2H), 3.81 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.5, 158.8, 140.5, 136.8, 129.5, 129.3, 128.6, 128.0, 127.4, 125.5, 114.4, 69.9, 52.2.

**methyl 2-(4-fluorophenyl)acrylate (2g)**[4]




**2g**

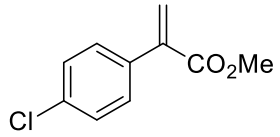
**2g.** 74.5 mg, 83% yield, 0.5 mmol scale, colorless oil.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.44-7.31 (m, 2H), 7.12-6.90 (m, 2H), 6.37 (d, *J* = 1.1 Hz, 1H), 5.88 (d, *J* = 1.1 Hz, 1H), 3.83 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.0, 162.7 (d, *J* = 247.5 Hz), 140.1, 132.7 (d, *J* = 3.5 Hz), 130.1 (d, *J* = 8.2 Hz), 127.0, 115.0 (d, *J* = 21.5 Hz). 52.3.

$^{19}$F NMR (376 MHz, $CDCl_3$) δ -113.78.

**methyl 2-(4-chlorophenyl)acrylate (2h)**[2]



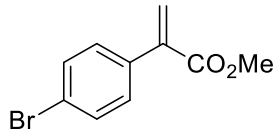

**2h**

**2h.** 73.4 mg, 75% yield, 0.5 mmol scale, colorless oil.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.38-7.28 (m, 4H), 6.39 (d, *J* = 1.1 Hz, 1H), 5.90 (d, *J* = 1.1 Hz, 1H), 3.82 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.8, 140.1, 135.0, 134.2, 129.6, 128.3, 127.4, 52.3.

**methyl 2-(4-bromophenyl)acrylate (2i)**[2]



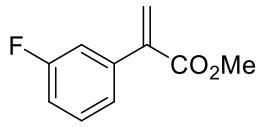

**2i**

**2i.** 87.9 mg,73% yield, 0.5 mmol scale, colorless oil.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.53-7.44 (m, 2H), 7.33-7.27 (m, 2H), 6.40 (d, *J* = 1.1 Hz, 1H), 5.91 (d, *J* = 1.1 Hz, 1H), 3.83 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.7, 140.1, 135.5, 131.2, 130.0, 127.5, 122.4, 52.3.

**methyl 2-(3-fluorophenyl)acrylate (2j)**[5]




**2j**

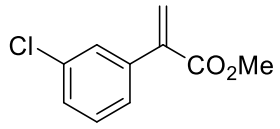
**2j.** 79.6 mg, 88% yield, 0.5 mmol scale, colorless oil.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.36-7.28 (m, 1H), 7.24-7.11 (m, 2H), 7.10-6.99 (m, 1H), 6.41 (d, *J* = 1.0 Hz, 1H), 5.93 (d, *J* = 1.1 Hz, 1H), 3.83 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.7 162.4 (d, *J* = 245.4 Hz), 140.1 (d, *J* = 2.3 Hz), 138.6 (d, *J* = 8.1 Hz), 129.6 (d, *J* = 8.3 Hz), 127.9, 124.0 (d, *J* = 2.9 Hz), 115.4 (d, *J* = 22.4 Hz), 115.1 (d, *J* = 21.1 Hz), 52.3.

$^{19}$F NMR (376 MHz, $CDCl_3$) δ -113.46.

**methyl 2-(3-chlorophenyl)acrylate (2k)**[4]



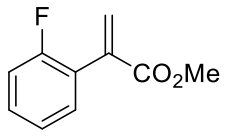

**2k**

**2k.** 51.7 mg, 53% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.45-7.37 (m, 1H), 7.34-7.25 (m, 3H), 6.41 (d, *J* = 1.1 Hz, 1H), 5.91 (d, *J* = 1.0 Hz, 1H), 3.82 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.6, 140.0, 138.3, 133.9, 129.3, 128.4, 128.2, 128.0, 126.5, 52.3.

**methyl 2-(2-fluorophenyl)acrylate (2l)**[6].




**2l**

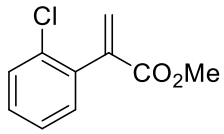
**2l.** 87.5 mg, 97% yield, 0.5 mmol scale, colorless oil

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.40-7.21 (m, 2H), 7.20-6.89 (m, 2H), 6.51 (d, *J* = 1.2 Hz, 1H), 5.89 (d, *J* = 1.3 Hz, 1H), 3.80 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.5, 159.8 (d, *J* = 248.1 Hz) , 136.4, 130.7 (d, *J* = 3.3 Hz), 130.1 (d, *J* = 8.3 Hz), 129.4 (d, *J* = 1.4 Hz), 125.0 (d, *J* = 14.9 Hz), 124.0 (d, *J* = 3.6 Hz), 115.5 (d, *J* = 21.8 Hz), 52.3.

$^{19}$F NMR (376 MHz, $CDCl_3$) δ -113.75.

**methyl 2-(2-chlorophenyl)acrylate (2m)**[4].



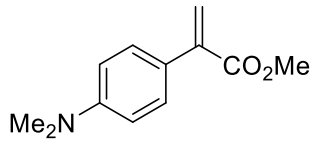

**2m**

**2m.** 83.7 mg, 85% yield, 0.5 mmol scale, colorless oil

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.42-7.20 (m, 4H), 6.53 (d, *J* = 1.3 Hz, 1H), 5.79 (d, *J* = 1.3 Hz, 1H), 3.78 (s, 3H)

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.4, 140.1, 136.4, 133.3, 130.8, 129.5, 129.2, 129.2, 126.7, 52.3.

**methyl 2-(4-(dimethylamino)phenyl)acrylate (2n)**




**2n**

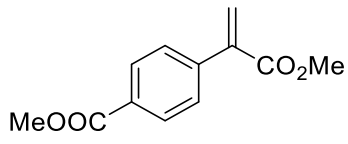
**2n.** 42.5 mg, 41% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.39-7.28 (m, 2H), 6.78-6.64 (m, 2H), 6.15 (d, *J* = 1.3 Hz, 1H), 5.78 (d, *J* = 1.3 Hz, 1H), 3.81 (s, 3H), 2.97 (s, 6H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 168.1, 150.3, 140.8, 129.0, 124.4, 123.3, 111.8, 52.1, 40.4.

HRMS(ESI): Calcd. for $C_{12}H_{16}NO_2$: $[M+H]^+$ 206.1176; found: 206.1178.

**methyl 4-(3-methoxy-3-oxoprop-1-en-2-yl)benzoate (2o)**[4]



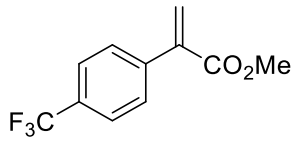

**2o**

**2o.** 79.0 mg, 72% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 8.09-7.96 (m, 2H), 7.55-7.43 (m, 2H), 6.46 (d, *J* = 1.0 Hz, 1H), 5.98 (d, *J* = 1.0 Hz, 1H), 3.92 (s, 3H), 3.83 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.7, 166.5, 141.0, 140.4, 129.6, 129.3, 128.3, 128.3, 52.3, 52.1.

**methyl 2-(4-(trifluoromethyl)phenyl)acrylate (2p)**[7]




**2p**

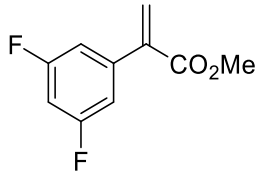
**2p.** 75.9 mg, 66% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.72-7.40 (m, 4H), 6.48 (d, *J* = 1.0 Hz, 1H), 5.96 (d, *J* = 1.0 Hz, 1H), 3.83 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.5, 140.2 (q, *J* = 1.6 Hz), 140.1, 128.7, 128.6, 125.0 (q, *J* = 3.8 Hz), 125.0 (q, *J* = 3.8 Hz), 124.0 (q, *J* = 271.9 Hz), 52.3.

$^{19}$F NMR (376 MHz, $CDCl_3$) δ -62.7.

**methyl 2-(3,5-difluorophenyl)acrylate (2q)**




**2q**

**2q.** 46.6 mg, 47% yield, 0.5 mmol scale, light yellow oil.

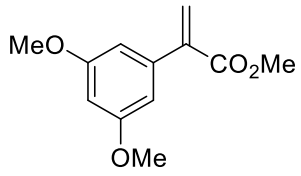
$^1$H NMR (400 MHz, $CDCl_3$) δ 7.03-6.94 (m, 2H), 6.86-6.76 (m, 1H), 6.47 (s, 1H), 5.97 (s, 1H), 3.86 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.1, 163.8 (d, *J* = 13.1 Hz), 161.3 (d, *J* = 12.9 Hz), 139.4 (d, *J* = 29.1 Hz), 128.7, 111.4 (dd, *J* = 26.3, 12.1 Hz), 103.6 (t, *J* = 25.3 Hz), 52.4.

$^{19}$F NMR (376 MHz, $CDCl_3$) δ -110.17.

HRMS(ESI): Calcd. for $C_{10}H_9F_2O_2$: $[M+H]^+$ 199.0565; found: 199.0563.

**methyl 2-(3,5-dimethoxyphenyl)acrylate (2r)**[8]



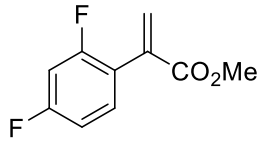

**2r**

**2r.** 82.3 mg, 74 yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 6.56 (d, *J* = 2.3 Hz, 2H), 6.45 (t, *J* = 2.3 Hz, 1H), 6.34 (d, *J* = 1.3 Hz, 1H), 5.89 (d, *J* = 1.3 Hz, 1H), 3.82 (s, 3H), 3.80 (s, 6H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.0, 160.3, 141.1, 138.5, 127.1, 106.5, 100.2, 55.3, 52.2.

**methyl 2-(2,4-difluorophenyl)acrylate (2s)**




**2s**

**2s.** 61.8 mg, 62% yield, 0.5 mmol scale, light yellow oil.

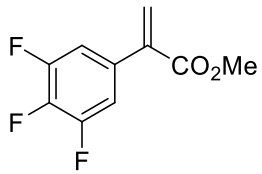
$^1$H NMR (400 MHz, $CDCl_3$) δ 7.30-7.20 (m, 1H), 6.95-6.78 (m, 2H), 6.52 (d, *J* = 1.1 Hz, 1H), 5.88 (d, *J* = 1.2 Hz, 1H), 3.80 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.3, 162.9 (dd, *J* = 249.1, 11.1 Hz), 160.0 (dd, *J* = 251.4, 12.5 Hz), 135.5, 131.5 (dd, *J* = 9.6, 4.7 Hz), 129.7, 121.2 (dd, *J* = 15.1, 3.9 Hz), 111.1 (dd, *J* = 21.3, 3.7 Hz), 103.9 (t, *J* = 25.7 Hz), 52.4.

$^{19}$F NMR (376 MHz, $CDCl_3$) δ -109.35 (d, *J* = 8.2 Hz), -109.68 (d, *J* = 8.2 Hz).

HRMS(ESI): Calcd. for $C_{10}H_9F_2O_2$: $[M+H]^+$ 199.0565; found: 199.0566.

**methyl 2-(3,4,5-trifluorophenyl)acrylate (2t)**




**2t**

**2t.** 83.5 mg, 77% yield, 0.5 mmol scale, light yellow oil.

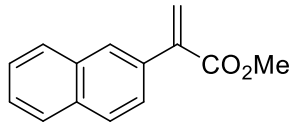
$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.15-7.06 (m, 2H), 6.47 (s, 1H), 5.96 (s, 1H), 3.86 (s, 3H).

$^{13}$C NMR (101 MHz, $CDCl_3$) δ 165.9, 150.70 (ddd, *J* = 249.3, 10.1, 4.3 Hz), 139.66 (dt, *J* = 253.0, 15.3 Hz), 138.50-138.42 (m), 132.39 (td, *J* = 8.3, 5.0 Hz), 128.7, 112.94-112.52 (m), 52.5.

$^{19}$F NMR (376 MHz, $CDCl_3$) δ -134.74 (dd, *J* = 20.4, 3.5 Hz), -160.64--161.06 (m).

HRMS(ESI): Calcd. for $C_{10}H_8F_3O_2$: $[M+H]^+$ 217.0471; found: 217.0478.

**methyl 2-(naphthalen-2-yl)acrylate (2u)**[2]



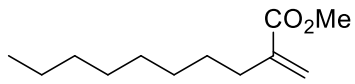

**2u**

**2u.** 58.3 mg, 55% yield, 0.5 mmol scale, colorless oil.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.92-7.88 (m, 1H), 7.87-7.75 (m, 3H), 7.54-7.43 (m, 3H), 6.44 (d, *J* = 1.1 Hz, 1H), 6.01 (d, *J* = 1.1 Hz, 1H), 3.85 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.3, 141.2, 134.1, 133.0, 132.9, 128.2, 127.6, 127.5, 127.4, 127.2, 126.3, 126.2, 126.1, 52.3.

**methyl 2-methylenedecanoate (4a)**



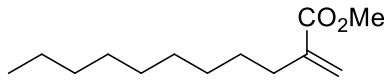

**4a**

**4a.** 87.0 mg, 88% yield, 0.5 mmol scale, colorless oil[9].

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 6.13 (d, *J* = 1.3 Hz, 1H), 5.52 (d, *J* = 1.5 Hz, 1H), 3.75 (s, 3H), 2.29 (t, *J* = 7.5 Hz, 2H), 1.51-1.40 (m, 2H), 1.31-1.22 (m, 10H), 0.87 (t, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.9, 140.8, 124.4, 53.4, 51.7, 31.8, 29.4, 29.2, 29.2, 28.3, 22.6, 14.1.

**methyl 2-methyleneundecanoate (4b)**[10]



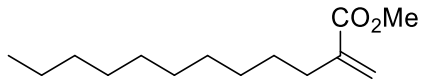

**4b**

**4b.** 91.2 mg, 86% yield, 0.5 mmol scale, colorless oil.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 6.13 (d, *J* = 1.5 Hz, 1H), 5.54-5.49 (m, 1H), 3.75 (s, 3H), 2.29 (t, 2H), 1.51-1.40 (m, 2H), 1.31-1.24 (m, 12H), 0.87 (t, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.8, 140.8, 124.4, 51.7, 31.9, 31.8, 29.5, 29.4, 29.3, 29.2, 28.3, 22.6, 14.1.

**methyl 2-methylenedodecanoate (4c)**[11]



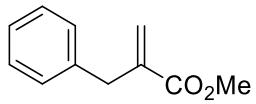

**4c**

**4c.** 100.4 mg, 89% yield, 0.5 mmol scale, colorless oil.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 6.13 (d, *J* = 1.5 Hz, 1H), 5.56-5.48 (m, 1H), 3.75 (s, 3H), 2.29 (t, *J* = 7.6 Hz, 2H), 1.50-1.40 (m, 2H), 1.31-1.24 (m, 14H), 0.87 (t, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.9, 140.8, 124.4, 51.7, 31.9, 31.8, 29.6, 29.6, 29.4, 29.3, 29.2, 28.3, 22.7, 14.1.

**methyl 2-benzylacrylate (4d)**[12]



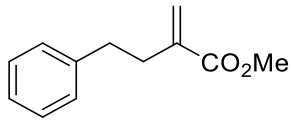

**4d**

**4d.** 68.8 mg, 78% yield, 0.5 mmol scale, light yellow oil.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.36-7.24 (m, 2H), 7.23-7.10 (m, 3H), 6.23 (s, 1H), 5.45 (s, 1H), 3.72 (s, 3H), 3.63 (s, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.4, 140.1, 138.7, 129.1, 128.5, 126.4, 126.3, 51.9, 38.1.

**methyl 2-methylene-4-phenylbutanoate (4e)**[13]



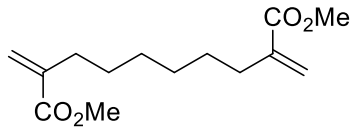

**4e**

**4e.** 84.5 mg, 89% yield, 0.5 mmol scale, light yellow oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.32-7.25 (m, 2H), 7.22-7.15 (m, 3H), 6.15 (d, *J* = 1.4 Hz, 1H), 5.50 (d, *J* = 1.5 Hz, 1H), 3.76 (s, 3H), 2.79 (t, 2H), 2.62 (t, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.5, 141.3, 139.7, 128.4, 128.3, 125.9, 125.4, 51.8, 34.8, 33.8.

**dimethyl 2,9-dimethylenedecanedioate (4f)**




**4f**

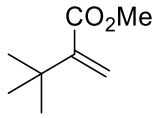
**4f.** 98.9 mg, 78% yield, 0.5 mmol scale, light yellow oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 6.13 (d, *J* = 1.5 Hz, 2H), 5.52 (d, *J* = 1.5 Hz, 2H), 3.75 (s, 6H), 2.29 (t, *J* = 7.6 Hz, 4H), 1.52-1.42 (m, 4H), 1.37-1.30 (m, 4H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.7, 140.6, 124.4, 51.7, 31.8, 28.9, 28.2.

HRMS(ESI): Calcd. for $C_{14}H_{23}N_2O_4$: $[M+H]^+$ 255.1591; found: 255.1590.

**methyl 3,3-dimethyl-2-methylenebutanoate (4g)**[14]

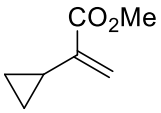



**4g**

**4g.** 66% GC yield, 0.5 mmol scale, light yellow oil. Volatile. $^1$H NMR spectrum was obtained from the crude reaction mixture.

$^1$H NMR (400 MHz, $CDCl_3$) δ 5.93 (d, *J* = 0.9 Hz, 1H), 5.53 (d, *J* = 0.9 Hz, 1H), 3.74 (s, 3H), 1.21 (s, 9H).

**methyl 2-cyclopropylacrylate (4h)**[15]



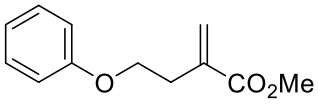
**4h**

**4h.** 71% GC yield, 0.5 mmol scale, colorless oil. Volatile

$^1$H NMR (400 MHz, $CDCl_3$) δ 6.03 (d, *J* = 1.1 Hz, 1H), 5.31 (t, *J* = 1.1 Hz, 1H), 3.78 (s, 3H), 1.80-1.68 (m, 1H), 0.83-0.76 (m, 2H), 0.53-0.47 (m, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.7, 142.2, 120.7, 51.8, 11.8, 7.1.

**methyl 2-methylene-4-phenoxybutanoate (4i)**



**4i**

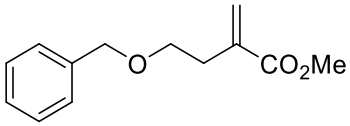
**4i.** 41.2 mg, 40% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.31-7.24 (m, 2H), 6.96-6.86 (m, 3H), 6.29 (d, *J* = 1.3 Hz, 1H), 5.73 (d, *J* = 1.3 Hz, 1H), 4.11 (t, *J* = 6.6 Hz, 2H), 3.77 (s, 3H), 2.80 (td, *J* = 6.6, 1.2 Hz, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.3, 158.6, 136.5, 129.4, 127.5, 120.7, 114.5, 66.0, 51.9, 31.9.

HRMS(ESI): Calcd. for $C_{12}H_{15}O_3$: $[M+H]^+$ 207.1016; found: 207.1020.

**methyl 4-(benzyloxy)-2-methylenebutanoate (4j)**[16]



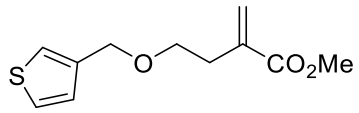
**4j**

**4j.** 74.8 mg, 68% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.36-7.29 (m, 4H), 7.29-7.23 (m, 1H), 6.22 (d, *J* = 1.3 Hz, 1H), 5.65 (d, *J* = 1.4 Hz, 1H), 4.50 (s, 2H), 3.73 (s, 3H), 3.61 (t, *J* = 6.6 Hz, 2H), 2.64 (td, *J* = 6.6, 1.2 Hz, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.3, 138.2, 137.2, 128.2, 127.5, 127.4, 126.6, 72.7, 68.5, 51.7, 32.2.

**methyl 2-methylene-4-(thiophen-3-ylmethoxy)butanoate (4k)**




**4k**

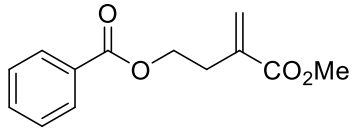
**4k.** 79.1 mg, 70% yield, 0.5 mmol scale, colorless oil.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.35-7.24 (m, 1H), 7.22-7.14 (m, 1H), 7.09-6.96 (m, 1H), 6.22 (d, *J* = 1.4 Hz, 1H), 5.64 (q, *J* = 1.3 Hz, 1H), 4.51 (s, 2H), 3.73 (s, 3H), 3.60 (t, *J* = 6.6 Hz, 2H), 2.62 (td, *J* = 6.6, 1.3 Hz, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.3, 139.4, 137.1, 127.1, 126.6, 125.8, 122.5, 68.4, 67.9, 51.7, 32.2.

HRMS(ESI): Calcd. for $C_{11}H_{15}O_3S$: $[M+H]^+$ 227.0736; found: 227.0735.

**3-(methoxycarbonyl)but-3-en-1-yl benzoate (4l)**




**4l**

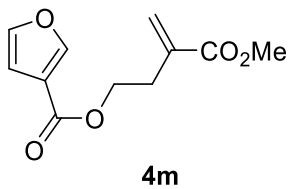
**4l.** 77.4 mg, 66% yield, 0.5 mmol scale, colorless oil.

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.09-7.97 (m, 2H), 7.62-7.51 (m, 1H), 7.43 (t, *J* = 7.6 Hz, 2H), 6.29 (s, 1H), 5.79-5.62 (m, 1H), 4.47 (t, *J* = 6.5 Hz, 2H), 3.76 (s, 3H), 2.80 (t, *J* = 8.0 Hz, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.0, 166.3, 136.5, 132.9, 130.1, 129.4, 128.3, 127.4, 63.1, 51.9, 31.4.

HRMS(ESI): Calcd. for $C_{13}H_{15}O_4$: $[M+H]^+$ 234.0965; found: 234.0963.

**3-(methoxycarbonyl)but-3-en-1-yl furan-3-carboxylate (4m)**



**4m**

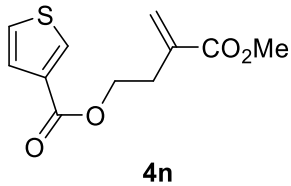
**4m.** 74.6 mg, 67% yield, 0.5 mmol scale, light yellow oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 8.03-7.95 (m, 1H), 7.42 (t, *J* = 1.7 Hz, 1H), 6.72 (d, *J* = 1.2 Hz, 1H), 6.27 (d, *J* = 1.3 Hz, 1H), 5.68 (q, *J* = 1.3 Hz, 1H), 4.39 (t, *J* = 6.6 Hz, 2H), 3.77 (s, 3H), 2.75 (td, *J* = 6.5, 1.2 Hz, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.9, 162.8, 147.6, 143.6, 136.4, 127.3, 119.2, 109.6, 62.6, 51.9, 31.4.

HRMS(ESI): Calcd. for $C_{11}H_{13}O_5$: $[M+H]^+$ 225.0767; found: 225.0763.

**3-(methoxycarbonyl)but-3-en-1-yl thiophene-3-carboxylate (4n)**



**4n**

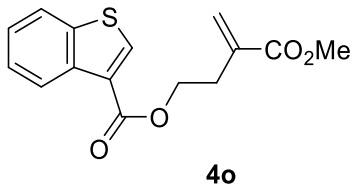
**4n.** 87.7 mg, 73% yield, 0.5 mmol scale, light yellow oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 8.15-8.02 (m, 1H), 7.56-7.43 (m, 1H), 7.34-7.20 (m, 1H), 6.27 (s, 1H), 5.69 (s, 1H), 4.42 (t, *J* = 6.5 Hz, 2H), 3.77 (s, 3H), 2.77 (t, *J* = 6.4 Hz, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.9, 162.4, 136.4, 133.4, 132.6, 127.7, 127.3, 125.9, 62.8, 51.9, 31.4.

HRMS(ESI): Calcd. for $C_{11}H_{13}O_4S$: $[M+H]^+$ 241.0529; found: 241.0524.

**3-(methoxycarbonyl)but-3-en-1-yl benzo[b]thiophene-3-carboxylate (4o)**



**4o**

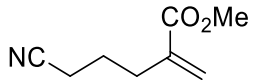
**4o.** 110.0 mg, 76% yield, 0.5 mmol scale, light yellow oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 8.66-8.48 (m, 1H), 8.43-8.24 (m, 1H), 7.95-7.78 (m, 1H), 7.58-7.34 (m, 2H), 6.30 (s, 1H), 5.73 (s, 1H), 4.61-4.42 (m, 2H), 3.78 (s, 3H), 2.94-2.73 (m, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.0, 162.5, 139.9, 136.6, 136.6, 136.6, 127.5, 127.0, 125.3, 125.0, 124.6, 122.4, 62.9, 52.0, 31.6.

HRMS(ESI): Calcd. for $C_{15}H_{15}O_4S$: $[M+H]^+$ 291.0686; found: 291.0684.

**methyl 5-cyano-2-methylenepentanoate (4p)**[17]



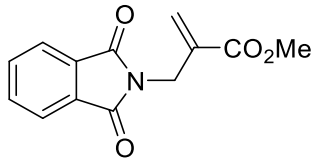

**4p**

**4p.** 136.0 mg, 89% yield, 1 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 6.24 (s, 1H), 5.70-5.59 (m, 1H), 3.77 (s, 3H), 2.47 (t, *J* = 7.5 Hz, 2H), 2.38 (t, *J* = 7.2 Hz, 2H), 1.87 (p, *J* = 7.3 Hz, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.7, 138.1, 126.3, 119.1, 51.7, 30.7, 23.9, 16.2.

**methyl 2-((1,3-dioxoisoindolin-2-yl)methyl)acrylate (4q)**[18]



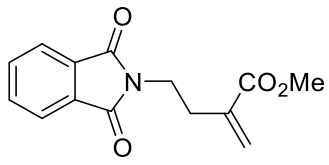

**4q**

**4q.** 97.2 mg, 79% yield, 0.5 mmol scale, white solid.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.96-7.83 (m, 2H), 7.81-7.71 (m, 2H), 6.33 (s, 1H), 5.65-5.55 (m, 1H), 4.56 (s, 2H), 3.80 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.6, 165.6, 134.2, 134.1, 131.8, 125.9, 123.3, 52.0, 38.1.

**methyl 4-(1,3-dioxoisoindolin-2-yl)-2-methylenebutanoate (4r)**



**4r**

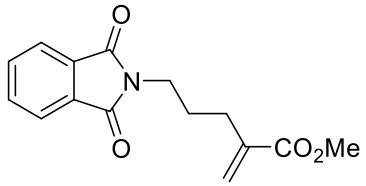
**4r.** 114.4 mg, 88% yield, 0.5 mmol scale, white solid.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.89-7.80 (m, 2H), 7.77-7.67 (m, 2H), 6.15 (d, *J* = 1.3 Hz, 1H), 5.54 (d, *J* = 1.3 Hz, 1H), 3.91 (t, *J* = 6.7 Hz, 2H), 3.79 (s, 3H), 2.78-2.67 (m, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 168.0, 166.6, 136.9, 133.8, 131.8, 127.2, 123.0, 51.8, 36.6, 31.3.

HRMS(ESI): Calcd. for $C_{14}H_{14}NO_4$: $[M+H]^+$ 260.0917; found: 260.0916.

**methyl 5-(1,3-dioxoisoindolin-2-yl)-2-methylenepentanoate (4s)**



**4s**

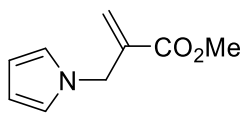
**4s.** 90.5 mg, 67% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.92-7.80 (m, 2H), 7.79-7.68 (m, 2H), 6.19 (d, *J* = 1.1 Hz, 1H), 5.62 (q, *J* = 1.4 Hz, 1H), 3.76-3.69 (m, 5H), 2.37 (t, *J* = 7.6 Hz, 2H), 1.99-1.80 (m, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 168.3, 167.3, 139.2, 133.9, 132.0, 125.4, 123.1, 51.8, 37.4, 29.0, 27.1.

HRMS(ESI): Calcd. for $C_{15}H_{16}NO_4$: $[M+H]^+$ 274.1074; found: 274.1077.

**methyl 2-((1H-pyrrol-1-yl)methyl)acrylate (4t)**



**4t**

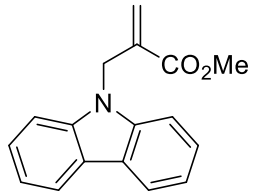
**4t.** 49.6 mg, 30% yield, 0.5 mmol scale, colorless oil. Volatile.

$^1$H NMR (400 MHz, $CDCl_3$) δ 6.65 (t, *J* = 2.1 Hz, 2H), 6.33-6.24 (m, 1H), 6.17 (t, *J* = 2.1 Hz, 2H), 5.34-5.24 (m, 1H), 4.81-4.69 (m, 2H), 3.78 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 165.9, 137.9, 126.3, 121.2, 108.5, 52.1, 49.9.

HRMS(ESI): Calcd. for $C_9H_{12}NO_2$: $[M+H]^+$ 166.0863; found: 166.0865.

**methyl 2-((9H-carbazol-9-yl)methyl)acrylate (4u)**




**4u**

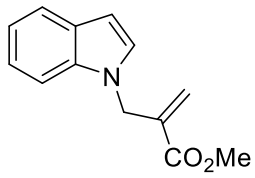
**4u.** 86.1 mg, 65% yield, 0.5 mmol scale, colorless oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 8.10 (d, *J* = 7.8 Hz, 2H), 7.52-7.38 (m, 2H), 7.31 (d, *J* = 8.2 Hz, 2H), 7.24 (t, *J* = 7.4 Hz, 2H), 6.17 (s, 1H), 5.15 (s, 2H), 5.02 (s, 1H), 3.84 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.3, 140.3, 134.6, 125.9, 125.6, 123.0, 120.4, 119.3, 108.7, 52.1, 43.3.

HRMS(ESI): Calcd. for $C_{17}H_{16}NO_2$: $[M+H]^+$ 266.1176; found: 266.1174.

**methyl 2-((1H-indol-1-yl)methyl)acrylate (4v)**




**4v**

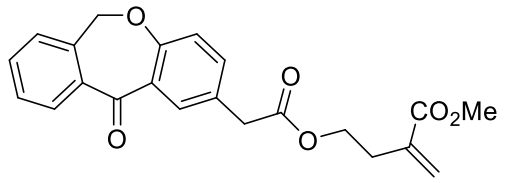
**4v.** 75.0 mg, 70% yield, 0.5 mmol scale, light yellow oil.

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.63 (dt, *J* = 7.8, 1.0 Hz, 1H), 7.27-7.22 (m, 1H), 7.21-7.16 (m, 1H), 7.14-7.06 (m, 2H), 6.52 (dd, *J* = 3.2, 0.9 Hz, 1H), 6.26-6.16 (m, 1H), 5.13 (td, *J* = 1.8, 0.7 Hz, 1H), 4.97 (t, *J* = 1.6 Hz, 2H), 3.78 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 166.0, 136.2, 135.9, 128.5, 128.3, 126.1, 121.7, 120.9, 119.5, 109.5, 101.8, 52.0, 46.7.

HRMS(ESI): Calcd. for $C_{13}H_{14}NO_2$: $[M+H]^+$ 216.1019; found: 216.1017.

**methyl 2-methylene-4-(2-(11-oxo-6,11-dihydrodibenzo[b,e]oxepin-2-yl)acetoxy)butanoate (4w)**




**4w**

**4w.** 95.6 mg, 50% yield, 0.5 mmol scale, colorless oil.

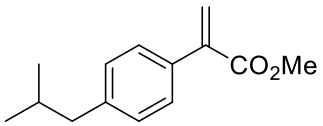
$^1$H NMR (400 MHz, $CDCl_3$) δ 8.10 (d, *J* = 2.4 Hz, 1H), 7.88 (d, *J* = 7.9 Hz, 1H), 7.54 (t, *J* = 7.4 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 1H), 7.40 (dd, *J* = 8.4, 2.4 Hz, 1H), 7.35 (d, *J* = 7.4 Hz, 1H), 7.01 (d, *J* = 8.4 Hz, 1H), 6.20 (s, 1H), 5.56 (s, 1H), 5.17 (s, 2H), 4.25 (t, *J* = 6.5 Hz, 2H), 3.75 (s, 3H), 3.62 (s, 2H), 2.64 (t, *J* = 6.5 Hz, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 190.6, 171.1, 166.8, 160.3, 140.3, 136.2, 136.0, 135.4, 132.6, 132.3, 129.3, 129.1, 127.7, 127.6, 127.4, 124.9, 120.9, 73.4, 62.9, 51.8, 40.0, 31.3.

HRMS(ESI): Calcd. for $C_{22}H_{21}O_6$: $[M+H]^+$ 381.1333; found: 381.1333.

**5. Synthesis of Ibuprofen and Venlafaxine**

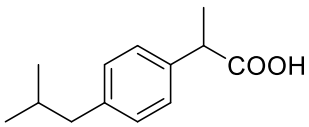
**Synthesis of Ibuprofen (9a)**[5]




**8**

**8.**[5] $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.37 (d, *J* = 8.2 Hz, 2H), 7.17 (d, *J* = 8.4 Hz, 2H), 6.35 (d, *J* = 1.3 Hz, 1H), 5.91 (d, *J* = 1.3 Hz, 1H), 3.86 (s, 3H), 2.52 (d, *J* = 7.2 Hz, 2H), 1.99-1.85 (m, 1H), 0.97 (s, 3H), 0.95 (s, 3H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 167.4, 141.8, 141.1, 134.0, 128.8, 127.9, 126.0, 52.1, 45.1, 30.1, 22.3.




**9**

A 10 mL reaction tube was charged with methyl 2-(4-isobutylphenyl)acrylate (220.8 mg, 1.0 mmol), $[Rh(COD)Cl]_2$ (5.3 mg, 1 mol%), BINAP (12.6 mg, 2 mol%) and equipped with a stirring bar before MeOH (2.0 mL) and triethylamine (52.1 mg, 0.5 mmol) was added. The tube was placed in a WP-MSAR-250A autoclave. At room temperature, the autoclave was purged with nitrogen three times and hydrogen three times, then pressurized to 40 *bar* of hydrogen, and the reaction mixture was stirred at room temperature for 12 h before releasing the hydrogen. The reaction mixture was extracted with ethyl acetate. Evaporation of solvent afforded the crude product methyl 2-(4-isobutylphenyl)propanoate.

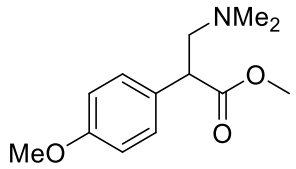
To a 10 mL round-bottom flask, methyl 2-(4-isobutylphenyl)propanoate, THF/$H_2O$ (1:1, 4 mL) and LiOH (174 mg, 4.0 mmol) were added sequentially at room temperature. The reaction mixture was heated to 80 °C for 4 h, and the resulting mixture was cooled to room temperature, acidified with 2N HCl and extracted with ethyl acetate. The combined organic layer was dried over $NaSO_4$, filtered and concentrated

under reduced pressure to afford 2-(4-isobutylphenyl)propanoic acid **9** (155.3 mg, 75% yield) as a white solid.

**9.** $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.21 (d, *J* = 8.1 Hz, 2H), 7.09 (d, *J* = 8.0 Hz, 2H), 3.69 (q, *J* = 7.1 Hz, 1H), 2.44 (d, *J* = 7.2 Hz, 2H), 1.91-1.71 (m, 1H), 1.48 (d, *J* = 7.1 Hz, 3H), 0.89 (d, *J* = 6.6 Hz, 6H).
$^{13}$C NMR (100 MHz, $CDCl_3$) δ 181.2, 140.8, 136.9, 129.4, 127.3, 45.0, 45.0, 30.2, 22.4, 18.1.

**Synthesi of Venlafaxine (6)**

**methyl 3-(dimethylamino)-2-(4-methoxyphenyl)propanoate (5)**

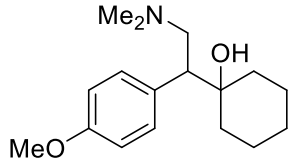



**5**

A 50 mL reaction tube was charged with $Pd(OAc)_2$ (22.4 mg, 2.0 mol%), TsOH (69.5 mg, 8.0 mol%), and equipped with a stirring bar. MeOH (2.0 mL) was added to dissolve the catalyst, followed by the addition of **1e** (1.32 g, 10.0 mmol) and **L1** (110.8 mg, 4.0 mol%). The tube was placed in a WP-MSAR-250A autoclave. At room temperature, the autoclave was purged with nitrogen three times and carbon monoxide three times, then pressurized to 40 *bar* of carbon monoxide. The reaction was kept at room temperature for 12 h. Afterward, the pressure was carefully released. A solution of dimethylamine in $H_2O$ (0.33 M, 2.76 g, 2.0 equiv) was added, and the mixture was reacted at room temperature for 2 h. The mixture was concentrated and the residue was purified by column chromatography on silica gel (eluent: petroleum ether /ethyl acetate = 3:1) to afford **5** as a colorless oil (2.07 g, 87% yield)[19].

**5.** [19] $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.24 (d, *J* = 8.7 Hz, 2H), 6.85 (d, *J* = 8.7 Hz, 2H), 3.79-3.70 (m, 4H), 3.67 (s, 3H), 3.15-3.04 (m, 1H), 2.45-2.36 (m, 1H), 2.26 (s, 6H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 173.8, 158.8, 129.4, 128.8, 114.0, 62.9, 55.1, 51.9, 49.3, 45.6.



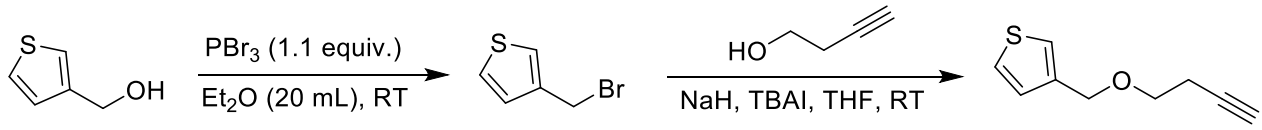

**6**

To a 25 mL round-bottom flask magnasium turnings (267.1 mg, 11.0 mmol) and a granular of iodine were added, followed by dropwise addition of a solution of dibromopentane (1.15 g, 5.0 mmol) in THF (10 mL) at room temperature. After addition, the reaction mixture was stirred for 1 h until most of the magnasium was consumed. The formed Grignard reagent (4.6 mL, 1.3 equiv.) was transferred to a 25 ml round-bottom flask andcooled to 0 °C. A solution of amino ester **5** (450.6 mg, 1.8 mmol) in THF (5 mL) was added dropwise. After the addition, the reaction mixture was allowed to warm to room temperature for 30 min and then heated to reflux for 3.5 h. The reaction mixture was cooled to room temperature, and 50% aq. NaOH solution was added to the reaction mixture (pH = 12). The mixture was extracted with ethyl acetate and washed with water and brine. The combined organic phase was dried over anhydrous $Na_2SO_4$, filtered, and concentrated under reduced pressure. The residue was purified by flash column chromatography (eluent: 5% MeOH in $CHCl_3$) to furnish venlafaxine **6** as a white solid (209.4 mg, 42% yield).

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.05 (d, $J$ = 8.7 Hz, 2H), 6.82 (d, $J$ = 8.7 Hz, 2H), 3.79 (s, 3H), 3.29 (t, $J$ = 12.6 Hz, 1H), 2.95 (dd, $J$ = 12.4, 3.4 Hz, 1H), 2.32 (s, 6H), 2.28 (d, $J$ = 3.4 Hz, 1H), 1.75-1.65 (m, 2H), 1.60-1.47 (m, 3H), 1.41-1.18 (m, 3H), 1.01-0.82 (m, 2H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 158.2, 132.6, 130.0, 113.2, 74.2, 61.1, 55.1, 51.5, 45.4, 38.0, 31.0, 25.9, 21.5, 21.2.

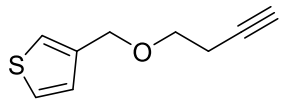
## 6. Synthesis of substrates




To a flask were added thiophen-3-ylmethanol (1.14 g, 10.0 mmol) and $Et_2O$ (20 mL) under air atmosphere. Followed by the addition of $PBr_3$, the mixture was then stirred at room temperature for 12 hours. After completion, the reaction was carefully quenched with $CH_3OH$ (3 mL). The solution was poured into water (40 mL), and the mixture was extracted with ethyl acetate. The organic layers were combined, washed with brine and dried over $Na_2SO_4$. After concentration in vacuo, crude product 3-(bromomethyl)thiophene (1.74 g, 98% yield) was obtained as a yellow oil and used for the next step without purification[20].

To a flask were added but-3-yn-1-ol (0.91 mL, 12.0 mmol) and THF (20 mL). Followed by the addition of NaH (60% in mineral oil, 0.48 g, 12.0 mmol), TBAI (0.37 g, 1.0 mmol) and crude 3-(bromomethyl)thiophene (1.74 g, 9.8 mmol) under nitrogen at 0 °C. The reaction mixture was allowed to warm to room temperature and stirred for 12 h until the reaction was completed. The reaction was quenched with saturated $NH_4Cl$ solution, and the mixture was extracted with ethyl ether. The organic layers were combined, washed with brine and dried over $Na_2SO_4$. The mixture was concentrated under reduced pressure, and the resulting residue was purified by column chromatography on silica gel (eluent: petroleum ether) to give **3k** as a yellow oil liquid (1.02 g, 63% yield).

**3-((but-3-yn-1-yloxy)methyl)thiophene (3k)**

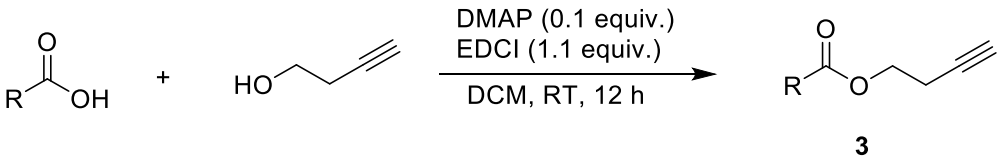



**3k**

$^1$H NMR (400 MHz, $CDCl_3$) δ 7.32-7.26 (m, 1H), 7.23-7.18 (m, 1H), 7.07 (d, $J$ = 4.9 Hz, 1H), 4.55 (s, 2H), 3.58 (t, $J$ = 6.9 Hz, 2H), 2.53-2.41 (m, 2H), 1.99 (t, $J$ = 2.7 Hz, 1H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 139.1, 127.2, 126.0, 122.8, 81.2, 69.3, 68.1, 67.9, 19.8.

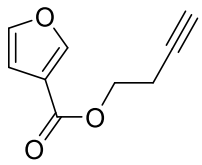
HRMS(ESI): Calcd. for $C_9H_{11}OS$: $[M+H]^+$ 167.0525; found: 167.0528.




**3**

A Schlenk tube was charged with carboxylic acid, EDCI (1.1 equiv.), DMAP (0.1 equiv.) and anhydrous DCM under nitrogen, followed by the addition of but-3-yn-1-ol (1.2 equiv.). The reaction mixture was stirred at room temperature for 12 h. Upon completion, the solvent was removed under reduced pressure, and the crude material was purified by silica gel column chromatography to afford the corresponding product[21].

**but-3-yn-1-yl furan-3-carboxylate (3m)**



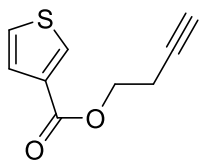
**3m**

$^1$H NMR (400 MHz, $CDCl_3$) δ 8.07-8.02 (m, 1H), 7.47-7.40 (m, 1H), 6.82-6.69 (m, 1H), 4.42-4.29 (m, 2H), 2.68-2.56 (m, 2H), 2.06-2.02 (m, 1H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 162.7, 147.9, 143.7, 119.0, 109.7, 79.9, 69.9, 62.0, 19.0.

HRMS(ESI): Calcd. for $C_9H_9O_3$: $[M+H]^+$ 165.0548; found: 165.0546.

**but-3-yn-1-yl thiophene-3-carboxylate (3n)**



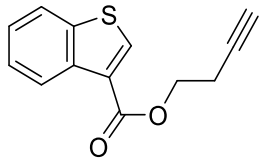
**3n**

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.18-8.06 (m, 1H), 7.58-7.48 (m, 1H), 7.35-7.26 (m, 1H), 4.43-4.28 (m, 2H), 2.70-2.51 (m, 2H), 2.08-1.98 (m, 1H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 162.3, 133.2, 132.9, 127.8, 126.0, 79.9, 70.0, 62.2, 19.0.

HRMS(ESI): Calcd. for $C_9H_9O_2S$: $[M+H]^+$ 181.0316; found: 181.0318.

**but-3-yn-1-yl benzo[b]thiophene-3-carboxylate (3o)**



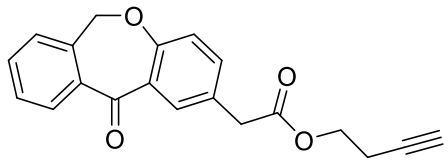
**3o**

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.63-8.57 (m, 1H), 8.41 (s, 1H), 7.86 (d, *J* = 8.1 Hz, 1H), 7.52-7.45 (m, 1H), 7.44-7.37 (m, 1H), 4.47 (t, *J* = 6.7 Hz, 2H), 2.70 (td, *J* = 6.7, 2.6 Hz, 2H), 2.06 (t, *J* = 2.7 Hz, 1H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 162.3, 139.9, 137.0, 136.6, 126.8, 125.4, 125.0, 124.7, 122.4, 80.1, 70.1, 62.2, 19.1.

HRMS(ESI): Calcd. for $C_{13}H_{11}O_2S$: $[M+H]^+$ 231.0474; found: 231.0477

**but-3-yn-1-yl 2-(11-oxo-6,11-dihydrodibenzo[b,e]oxepin-2-yl)acetate (3w)**



**3w**

$^{1}$H NMR (400 MHz, $CDCl_3$) δ 8.1 (d, *J* = 2.4 Hz, 1H), 7.9-7.8 (m, 1H), 7.6-7.5 (m, 1H), 7.5-7.4 (m, 2H), 7.3 (d, *J* = 7.5 Hz, 1H), 7.0 (d, *J* = 8.4 Hz, 1H), 5.2 (s, 2H), 4.2 (t, *J* = 6.8 Hz, 2H), 3.7 (s, 2H), 2.5 (td, *J* = 6.8, 2.7 Hz, 2H), 2.0 (t, *J* = 2.7 Hz, 1H).

$^{13}$C NMR (100 MHz, $CDCl_3$) δ 190.7, 171.0, 160.4, 140.3, 136.3, 135.4, 132.7, 132.4, 129.3, 129.1, 127.7, 127.4, 125.0, 120.9, 79.8, 73.4, 70.0, 62.4, 39.9, 18.8.

HRMS(ESI): Calcd. for $C_{20}H_{17}O_4$: $[M+H]^+$ 321.1121; found: 321.1118.

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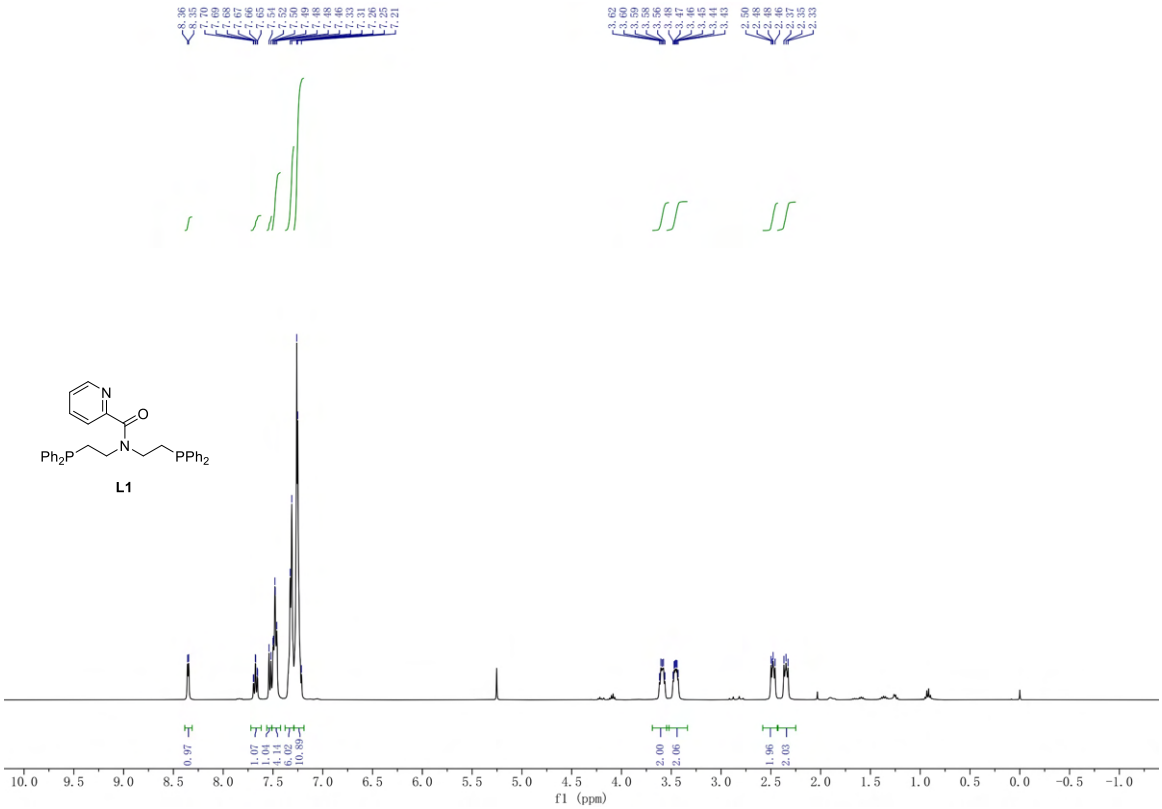
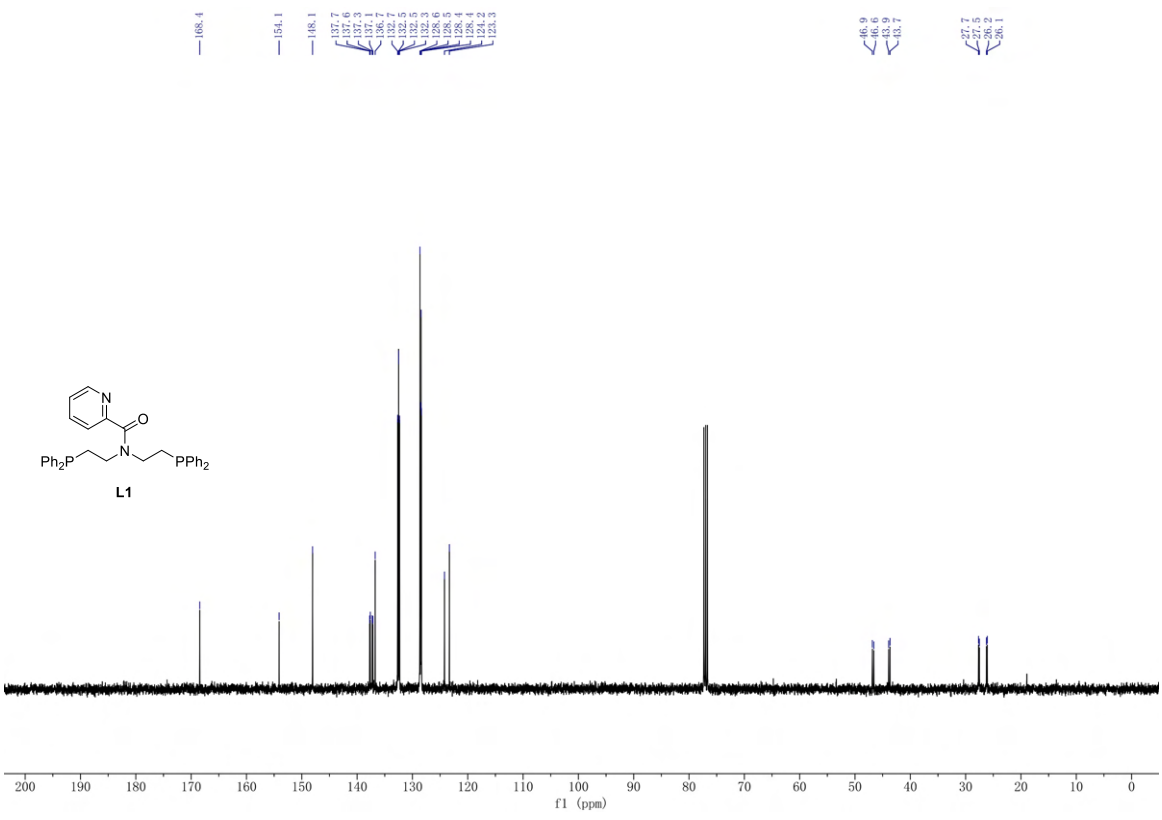
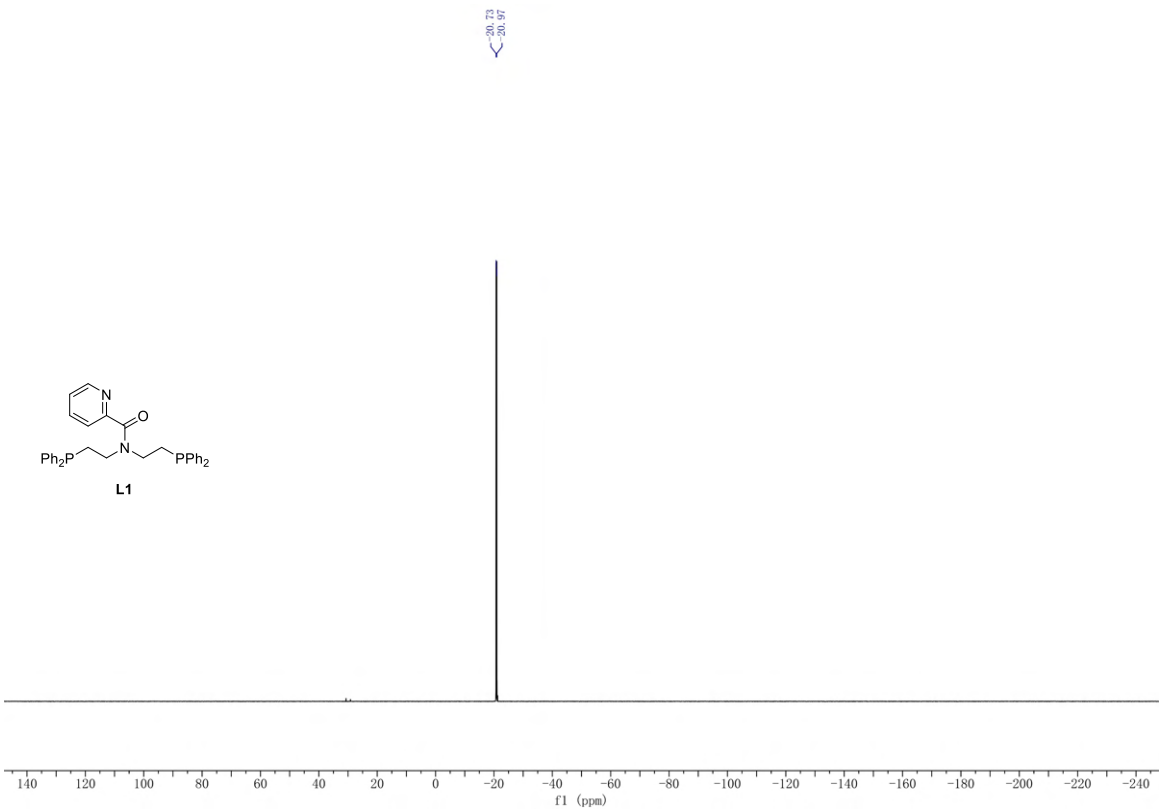
## 7. NMR Spectra

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N
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N
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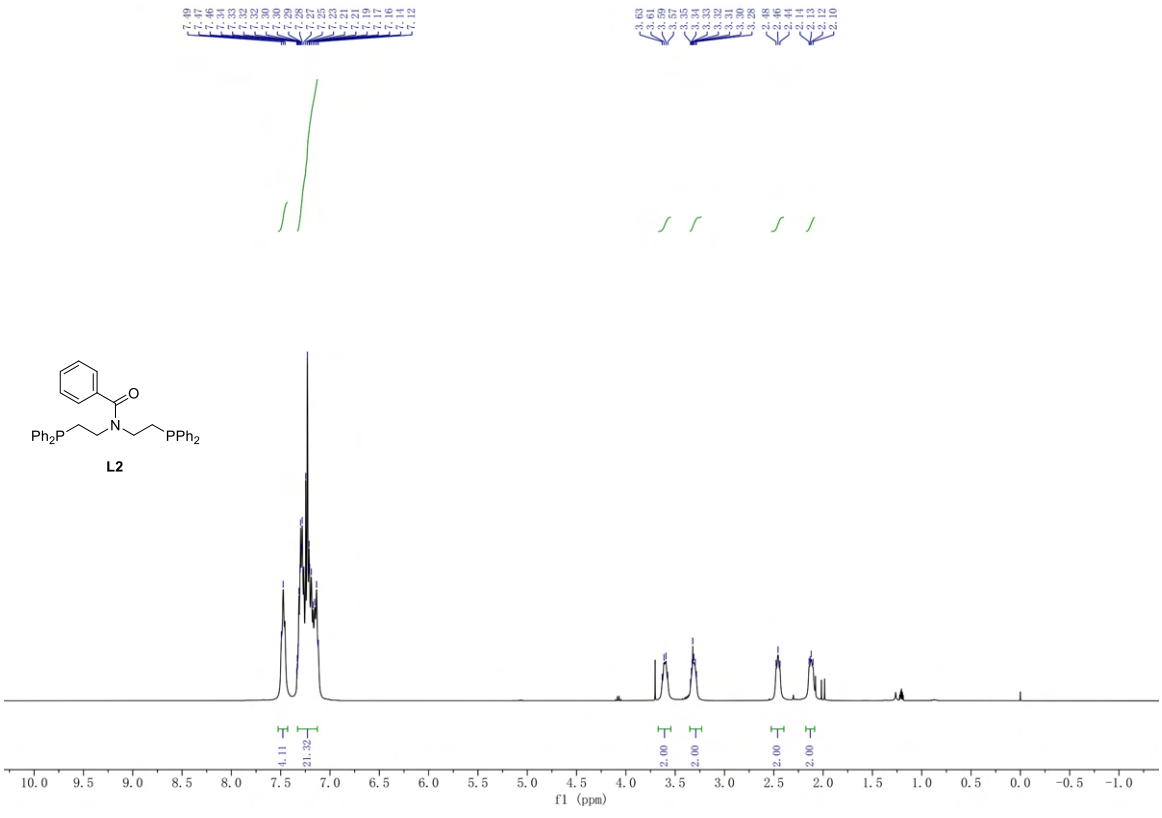
f1 (ppm)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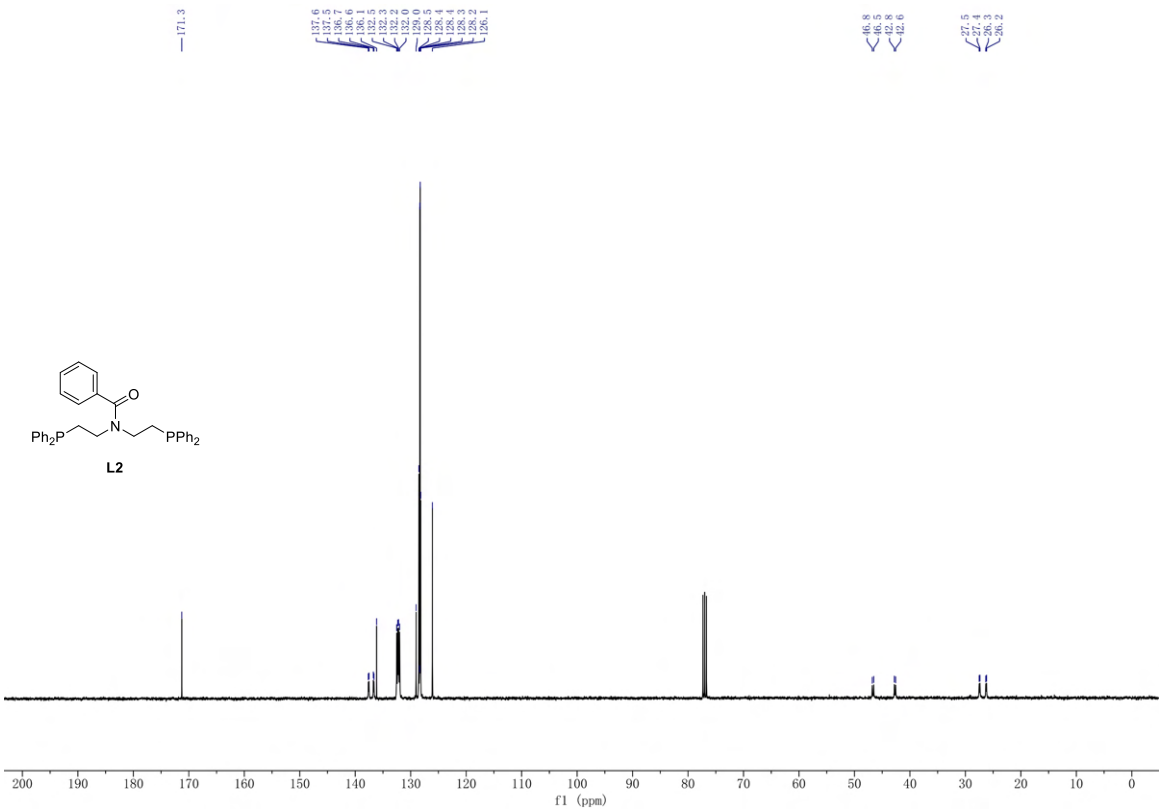
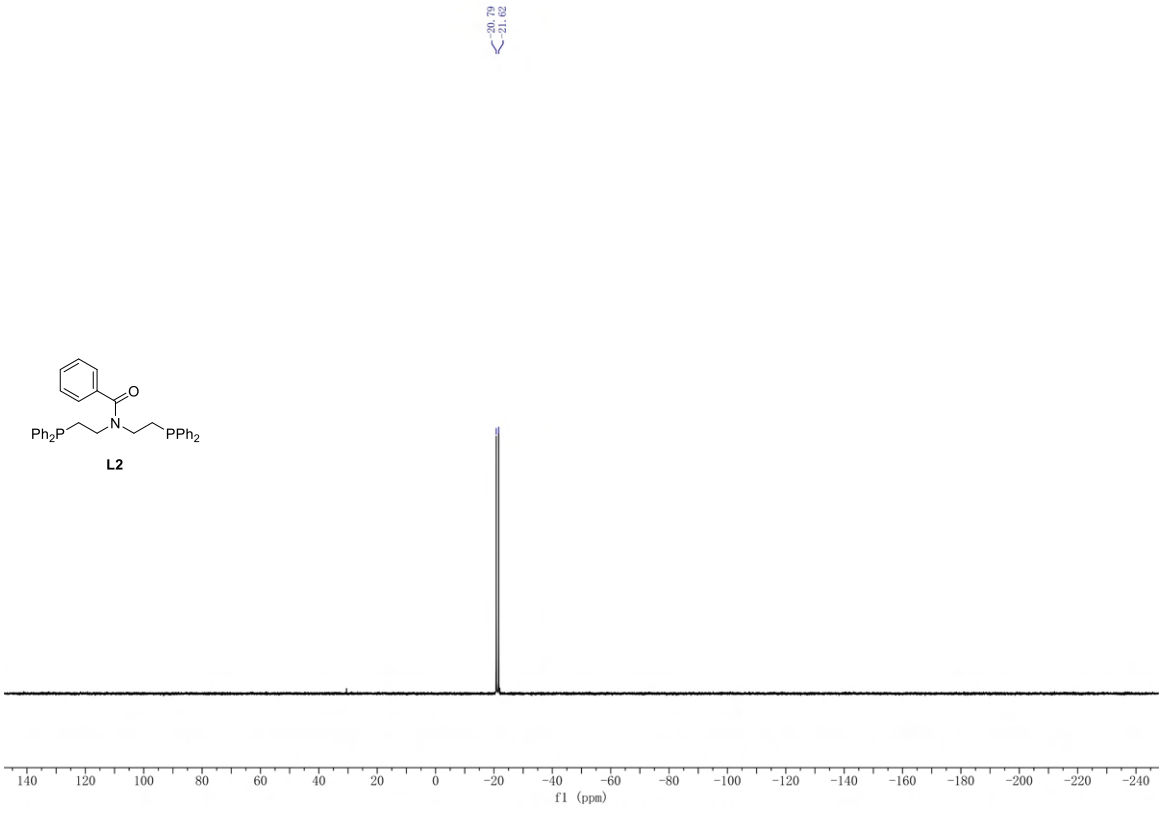
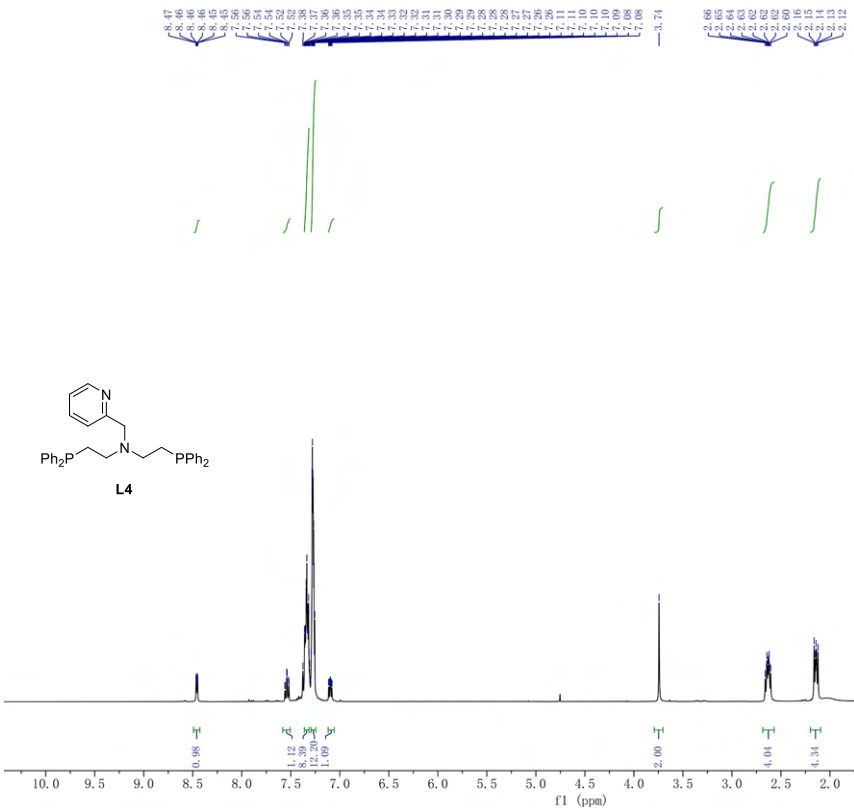
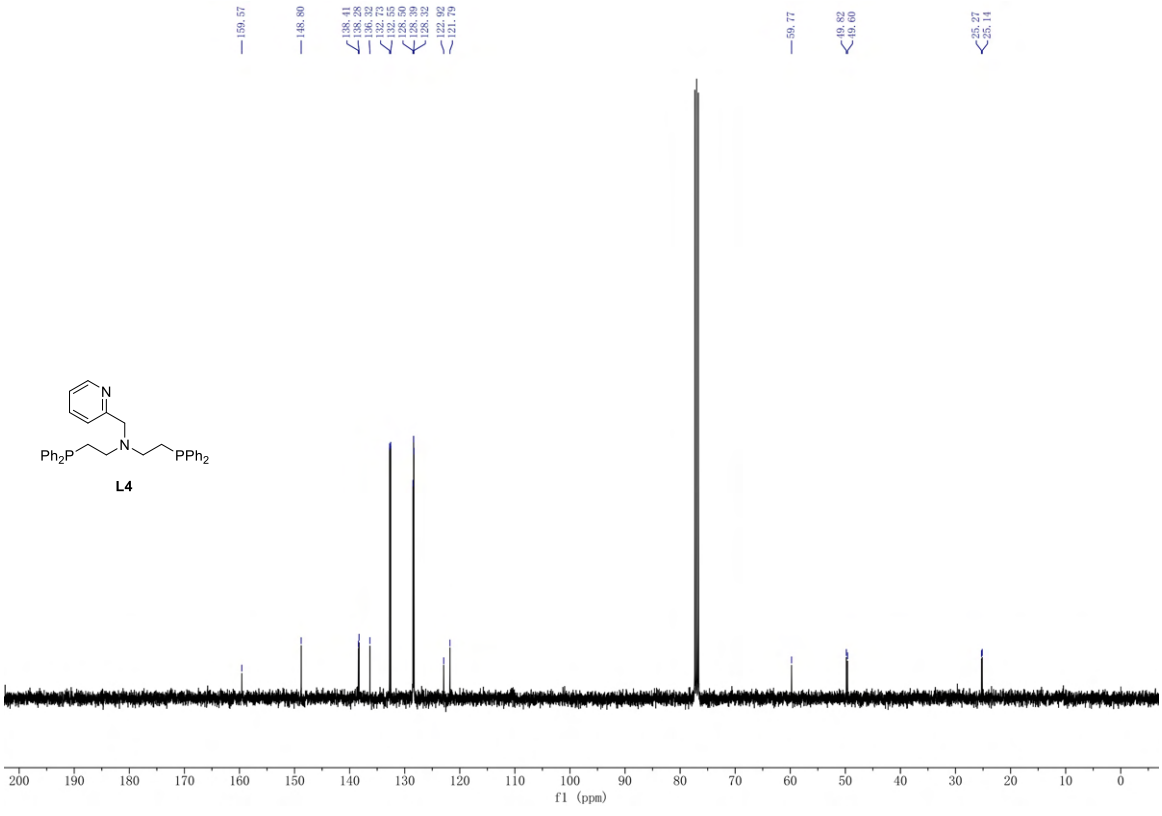
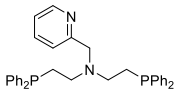
2.00
2.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


171.3
137.6
137.5
136.7
136.6
136.1
132.5
132.3
132.2
132.0
129.0
128.5
128.4
128.4
128.3
128.2
126.1
46.8
46.5
42.8
42.6
27.5
27.4
26.3
26.2
O
N
Ph2P
PPh2
L2
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


20.79
21.62
O
N
Ph2P
PPh2
L2
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
f1 (ppm)


L4
f1 (ppm)

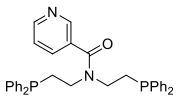

L4
f1 (ppm)



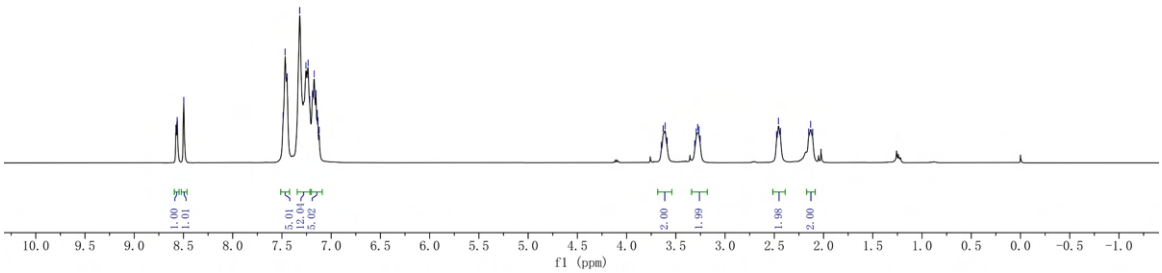
L4

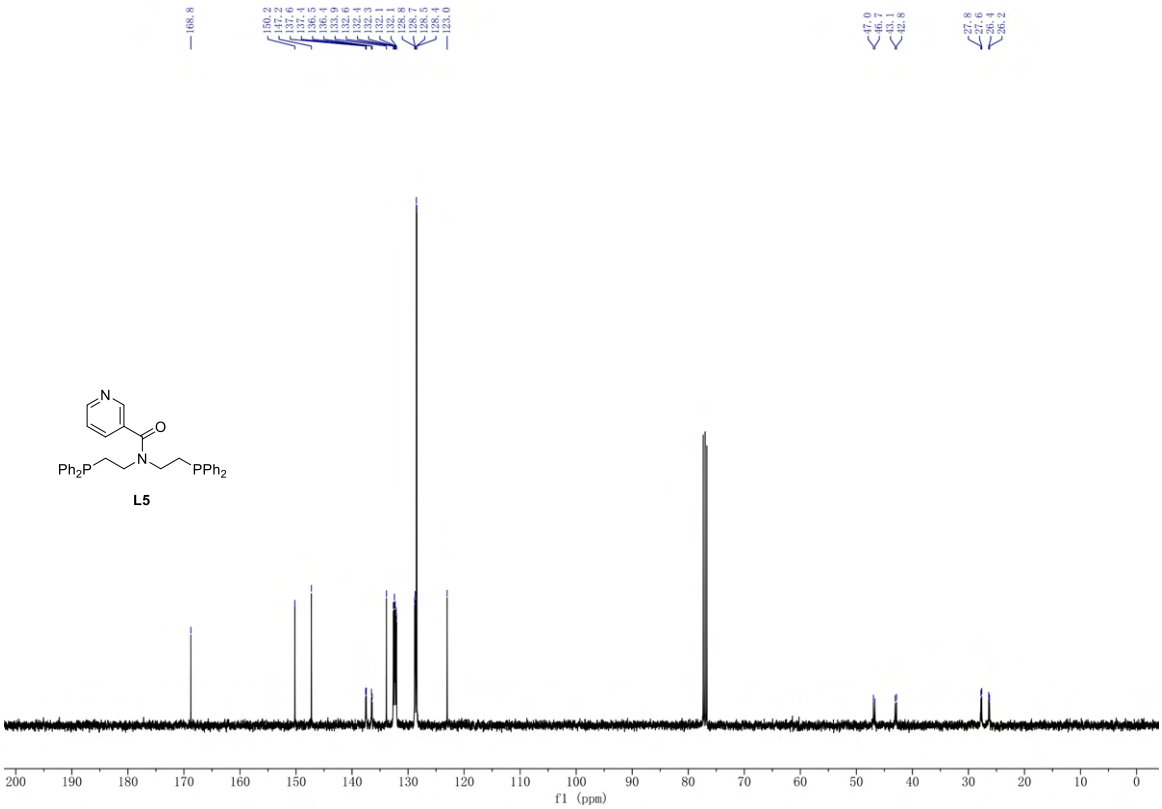

140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240
f1 (ppm)

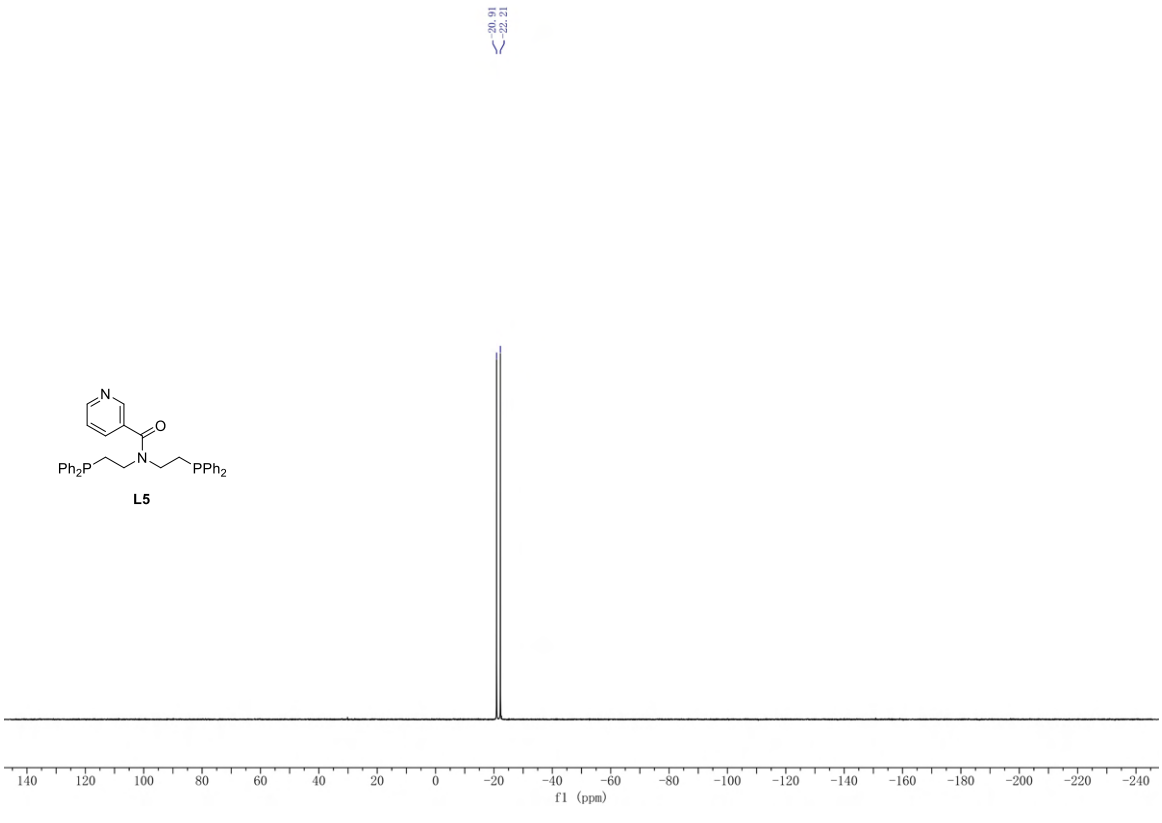

8.58
8.56
8.50
7.49
7.47
7.45
7.32
7.25
7.23
7.22
7.19
7.17
7.15
7.14
7.13
7.12
3.65
3.63
3.61
3.59
3.31
3.30
3.28
3.26
3.25
2.48
2.46
2.44
2.15
2.13
2.11

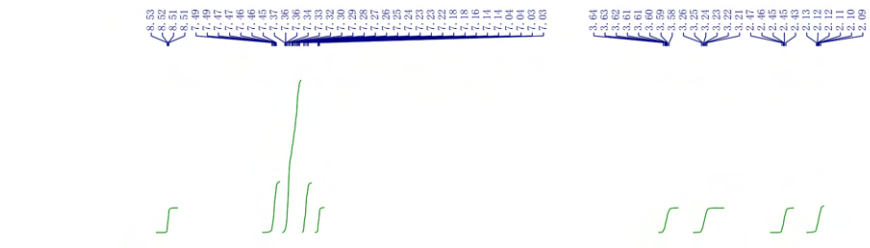


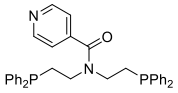
L5


1.00
1.01
5.01
12.04
5.02
2.00
1.99
1.98
2.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

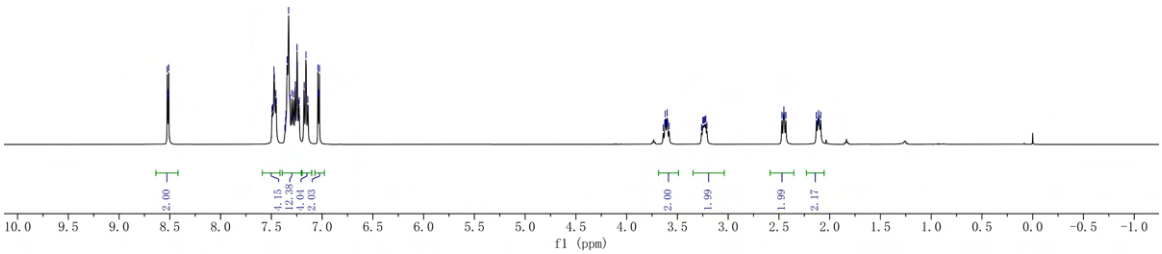

168.8
150.2
147.2
137.6
137.4
136.5
136.4
133.9
132.6
132.4
132.3
132.1
128.8
128.7
128.5
128.4
123.0
47.0
46.7
43.1
42.8
27.8
27.6
26.4
26.2
N
O
N
Ph2P
PPh2
L5
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

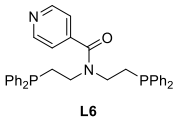

-20.91
-22.21
N
O
N
Ph2P
PPh2
L5
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
f1 (ppm)



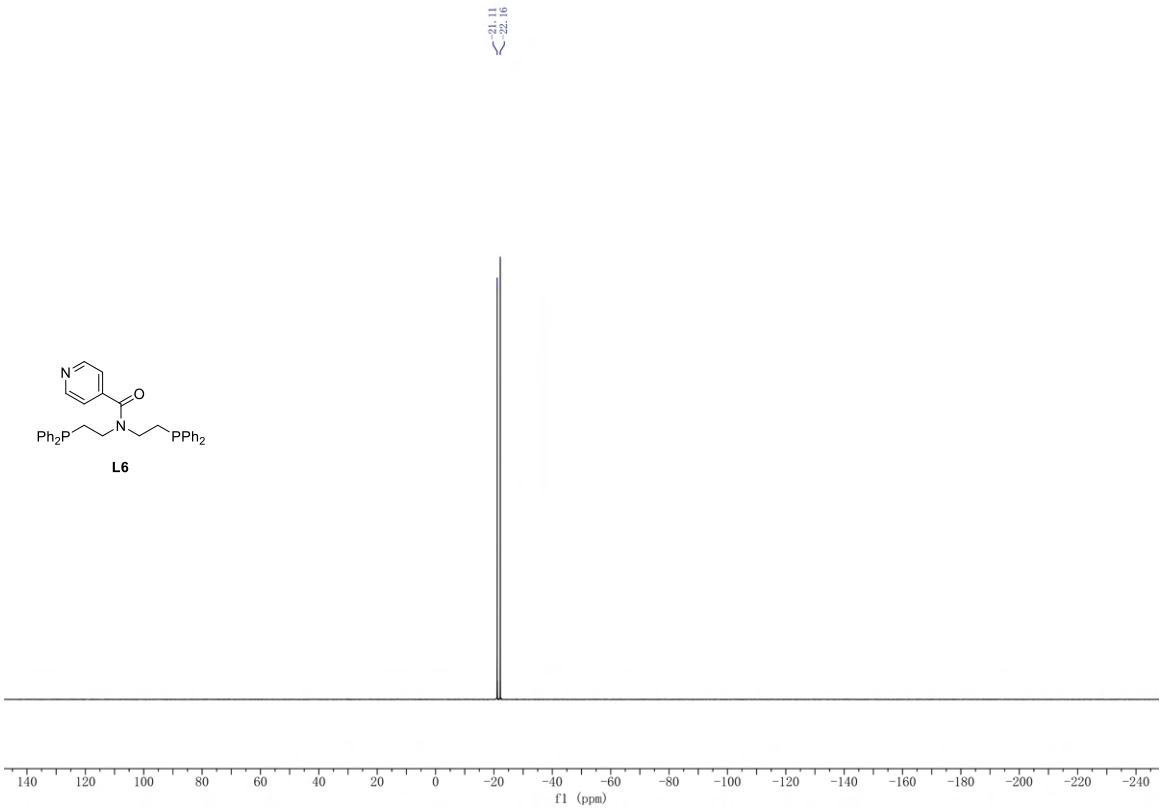


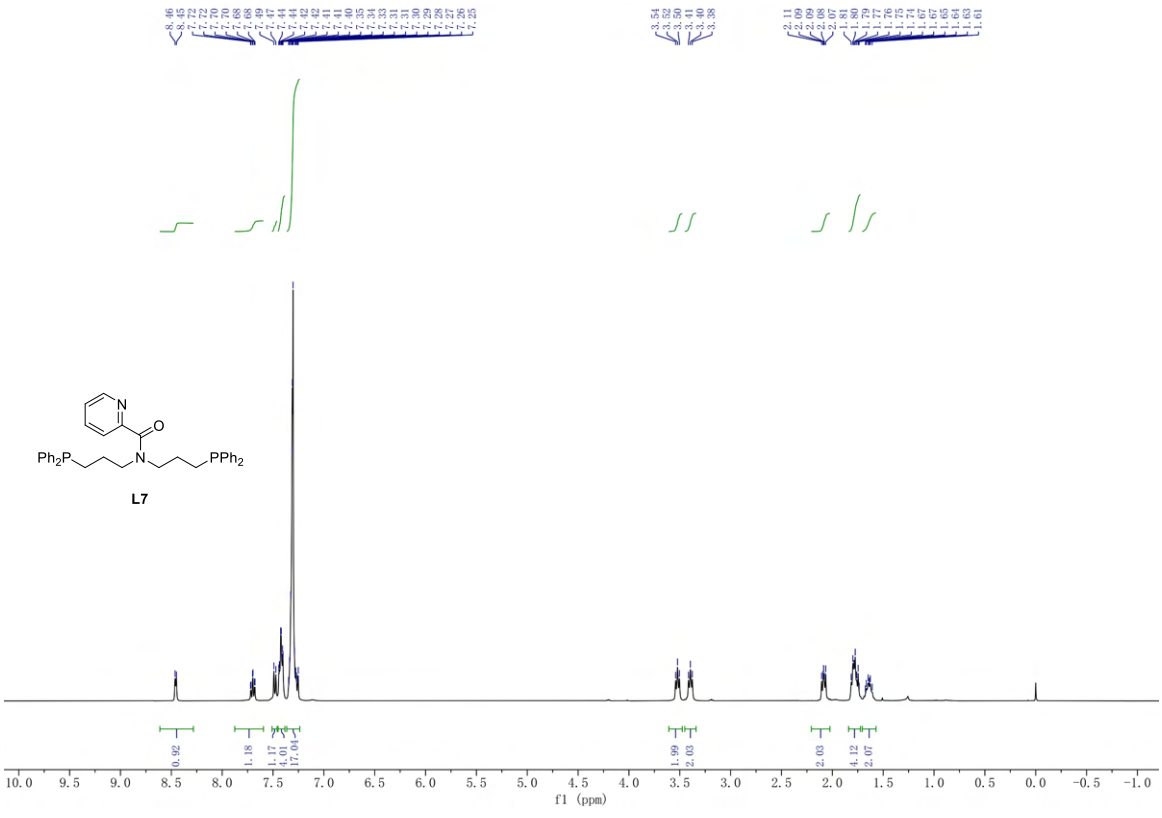
**L6**

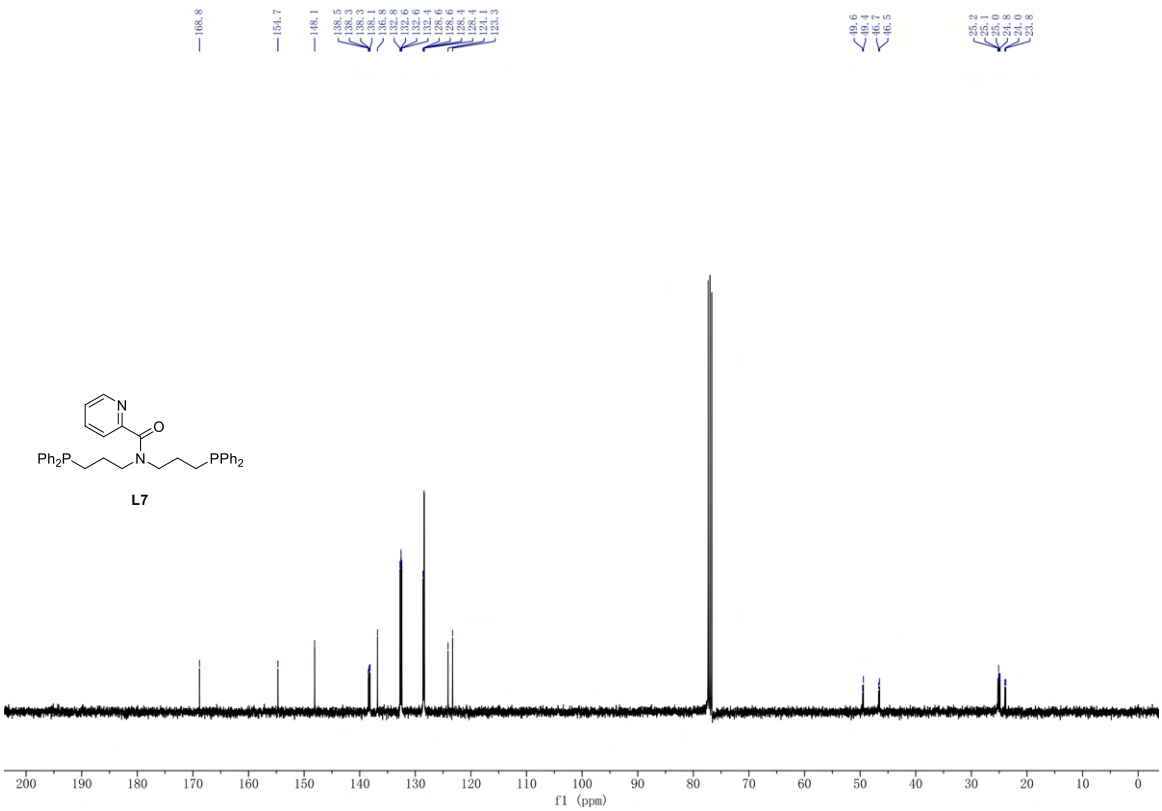


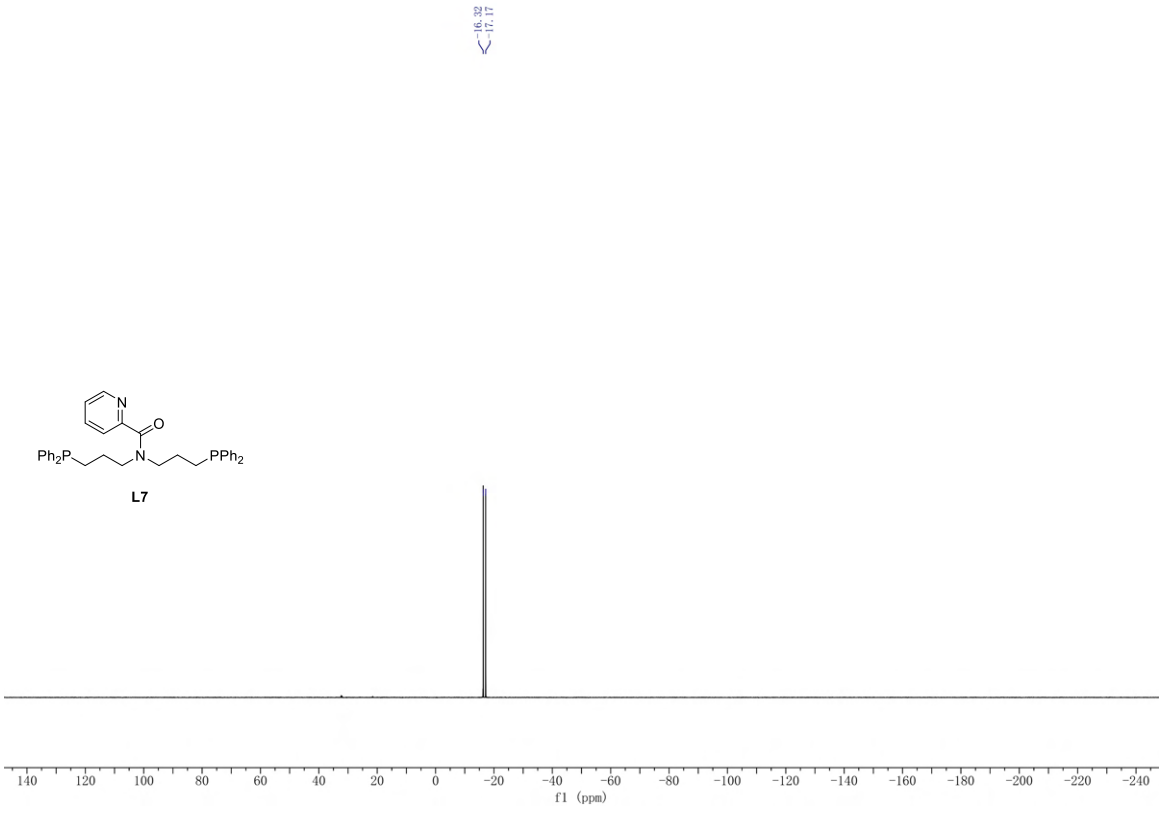


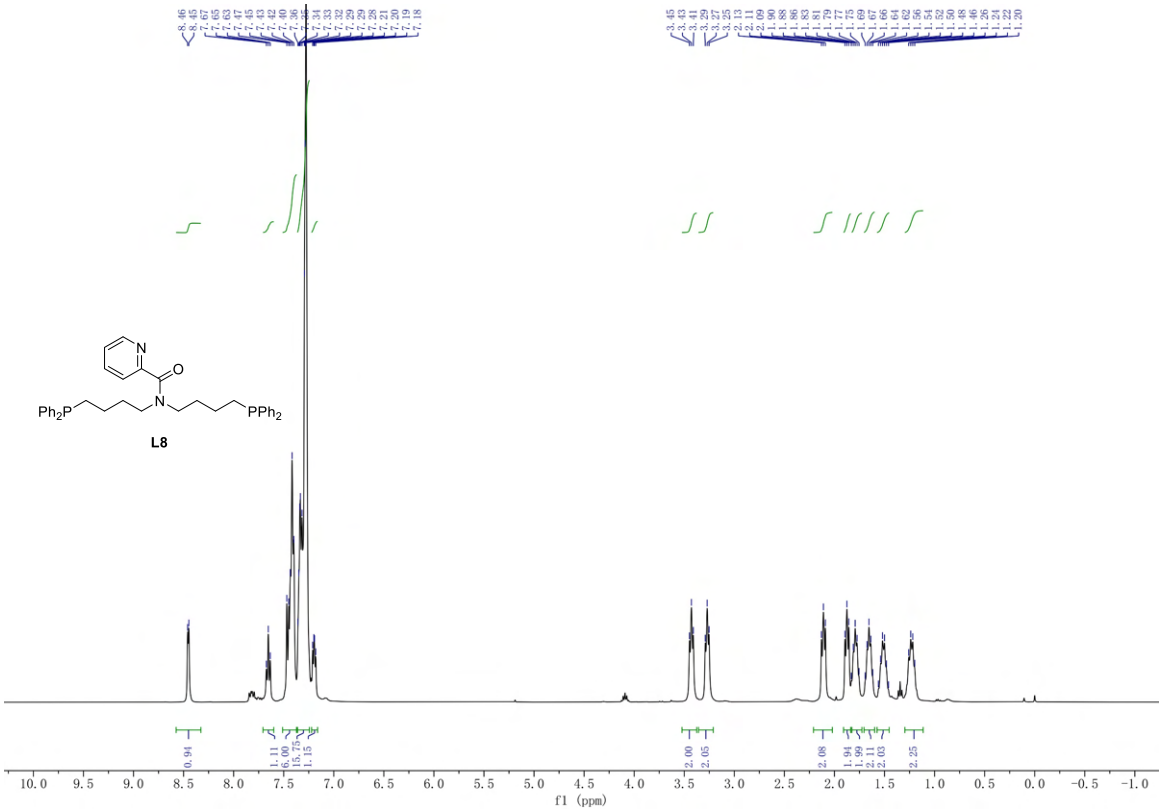
**L6**

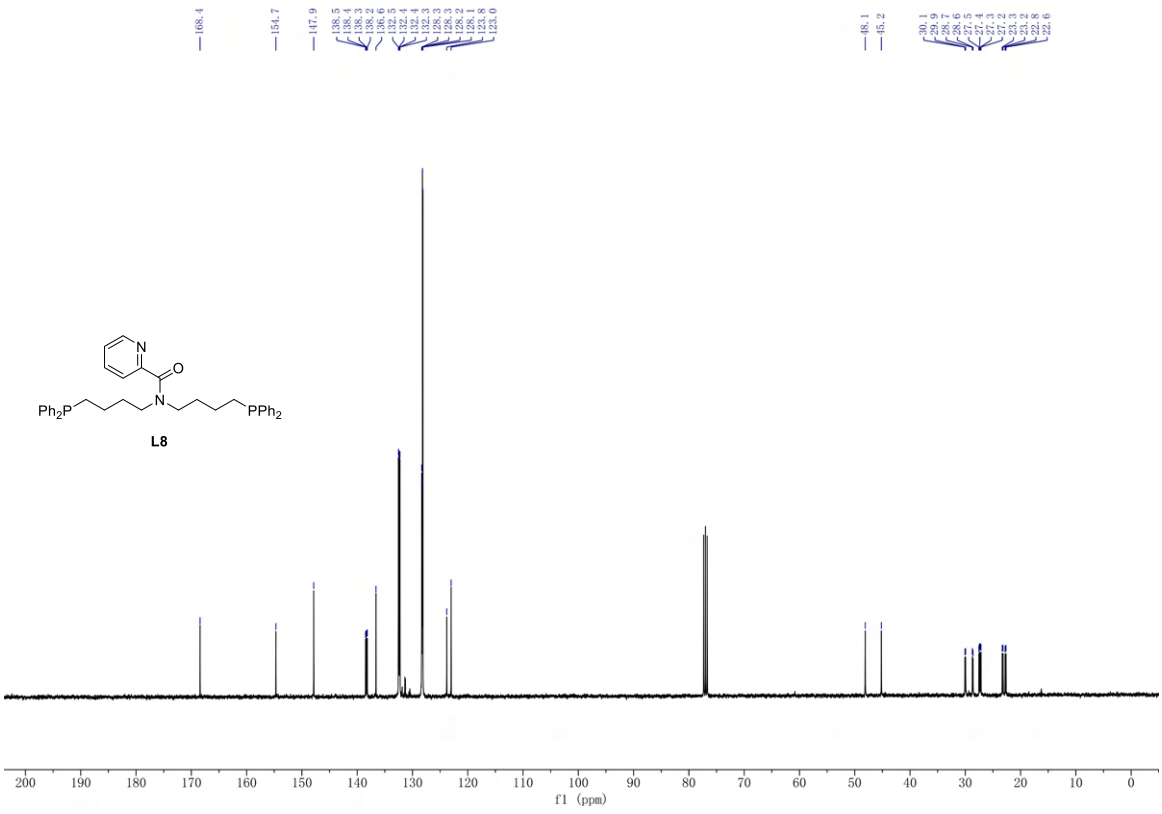

21.11
22.16
N
O
N
Ph2P
PPh2
L6
140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240
f1 (ppm)

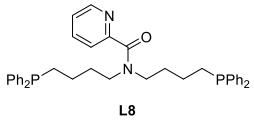

8.46 8.45 7.72 7.72 7.70 7.70 7.68 7.68 7.49 7.47 7.44 7.44 7.42 7.42 7.41 7.41 7.40 7.40 7.35 7.34 7.33 7.31 7.31 7.30 7.29 7.28 7.27 7.26 7.25
3.54 3.52 3.50 3.41 3.40 3.38
2.11 2.09 2.08 2.08 2.07 1.81 1.80 1.79 1.77 1.76 1.75 1.74 1.67 1.67 1.65 1.64 1.63 1.61
N
O
N
Ph2P
PPh2
L7
0.92 1.18 1.17 4.01 17.04 1.99 2.03 2.03 4.12 2.07
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


168.8
154.7
148.1
138.5
138.3
138.3
138.1
136.8
132.8
132.6
132.5
132.4
128.6
128.5
128.4
124.1
123.3
49.6
49.4
46.7
46.5
25.2
25.1
25.0
24.8
24.0
23.8
N
O
Ph2P
N
PPh2
L7
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


-16.32
-17.17
N
O
Ph2P
N
PPh2
L7
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
f1 (ppm)

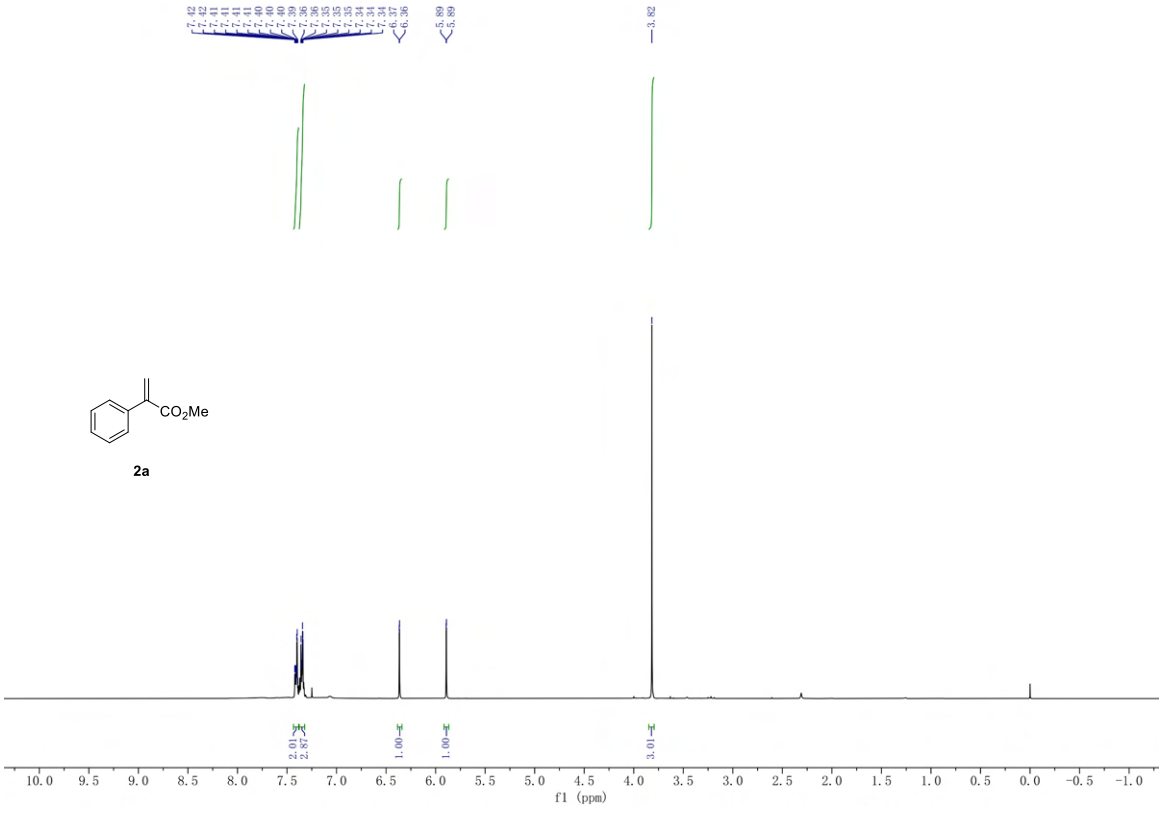

8.46
8.45
7.67
7.65
7.63
7.47
7.45
7.43
7.42
7.40
7.36
7.34
7.33
7.32
7.29
7.29
7.28
7.21
7.20
7.19
7.18
3.45
3.43
3.41
3.29
3.27
3.25
3.13
2.11
2.09
1.90
1.88
1.86
1.83
1.81
1.79
1.77
1.75
1.69
1.67
1.66
1.64
1.62
1.56
1.54
1.52
1.50
1.48
1.46
1.26
1.24
1.22
1.20
N
O
N
Ph2P
PPh2
L8
0.94
1.11
6.00
15.75
1.15
2.00
2.05
2.08
1.94
1.99
2.11
2.03
2.25
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


168.4
154.7
147.9
138.5
138.4
138.3
138.2
136.6
132.5
132.4
132.4
132.3
128.3
128.3
128.2
128.1
123.8
123.0
48.1
45.2
30.1
29.9
28.7
28.6
27.5
27.4
27.3
27.2
23.3
23.2
22.8
22.6
N
O
N
Ph2P
PPh2
L8
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


N
O
N
Ph2P
PPh2

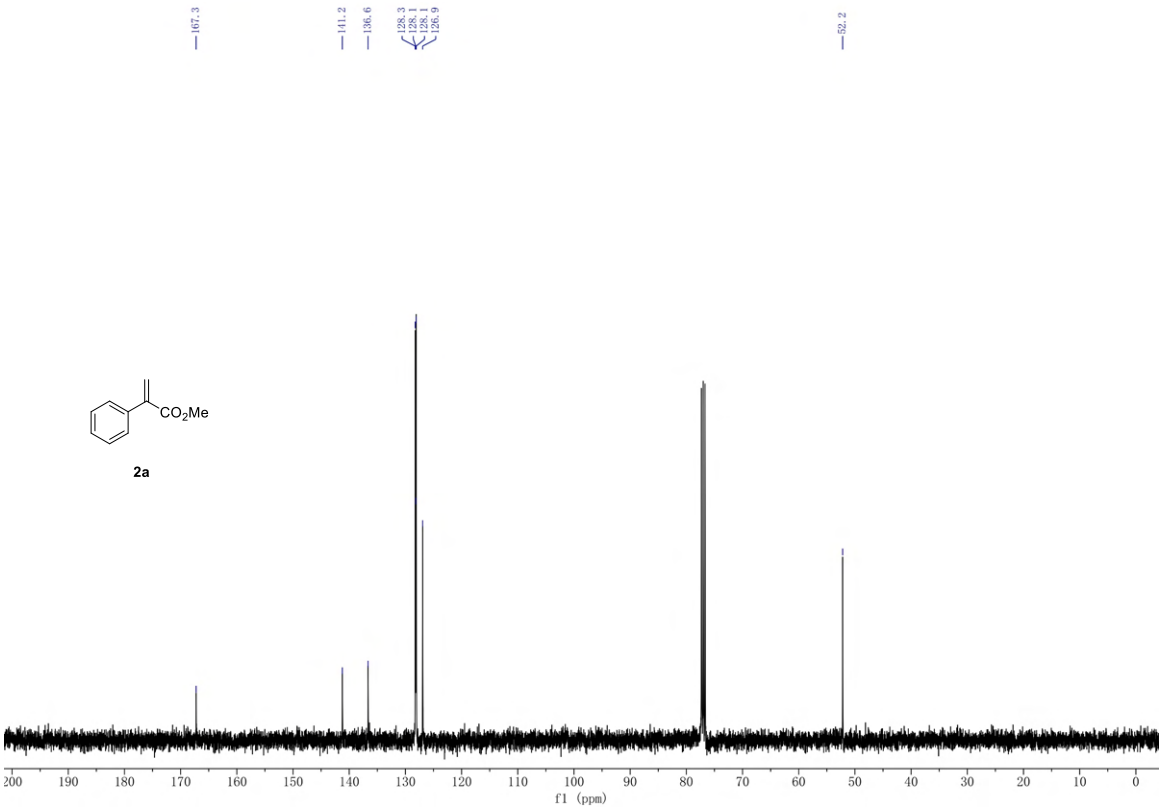
**L8**


16.34
16.72
140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240
f1 (ppm)

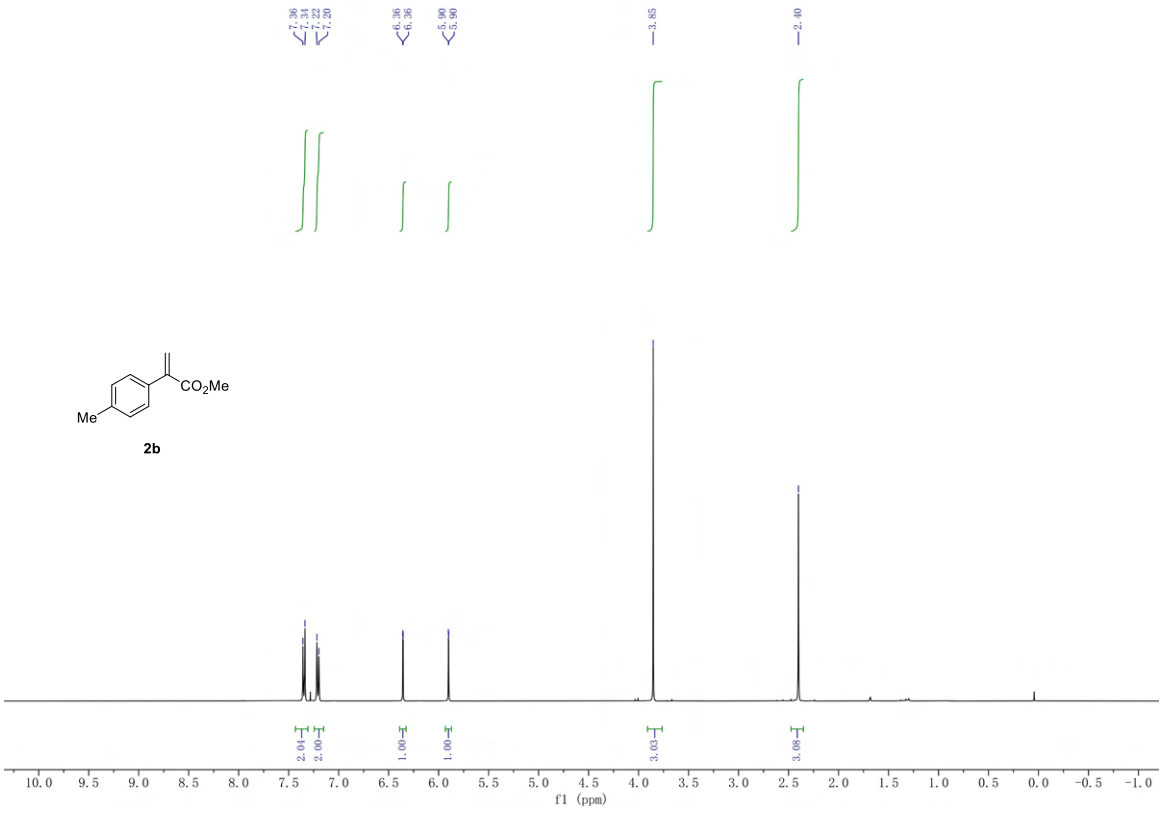

7.42
7.42
7.41
7.41
7.41
7.41
7.40
7.40
7.40
7.39
7.39
7.36
7.35
7.35
7.35
7.34
7.34
7.34
6.37
6.36
5.89
5.89
3.82
2.01
2.87
1.00
1.00
3.01
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


CO2Me

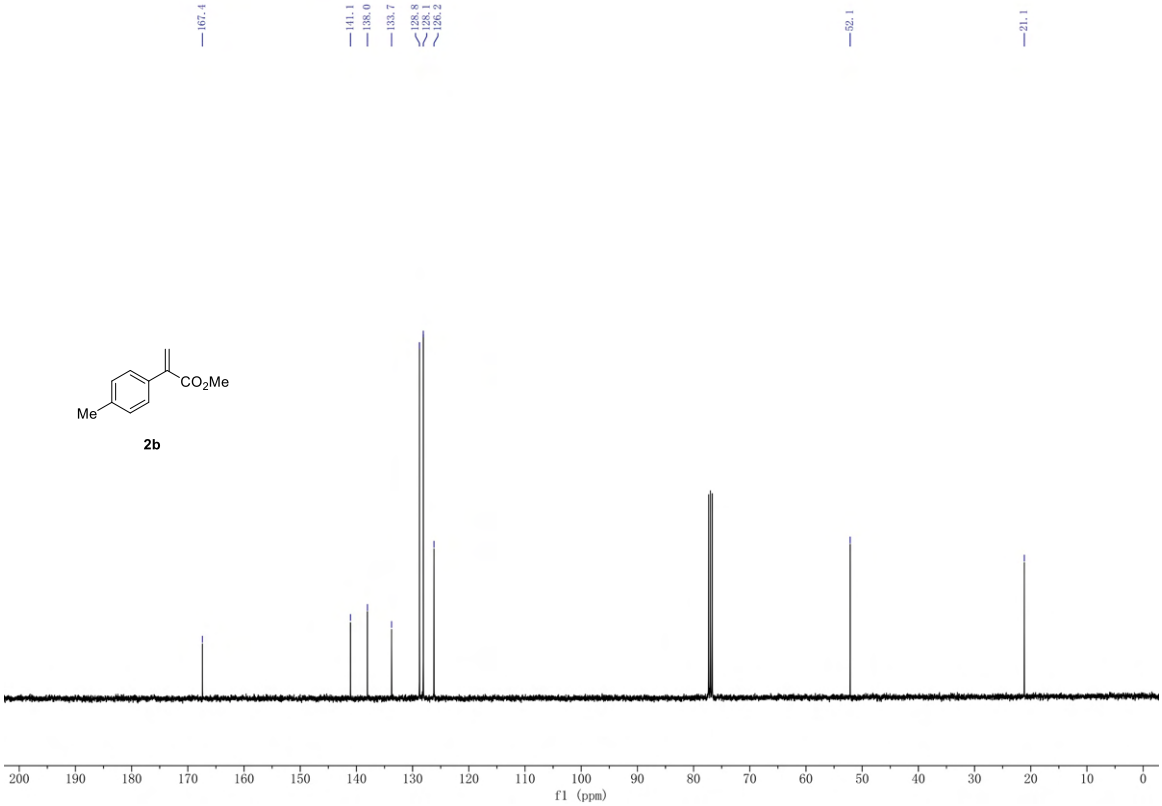
**2a**

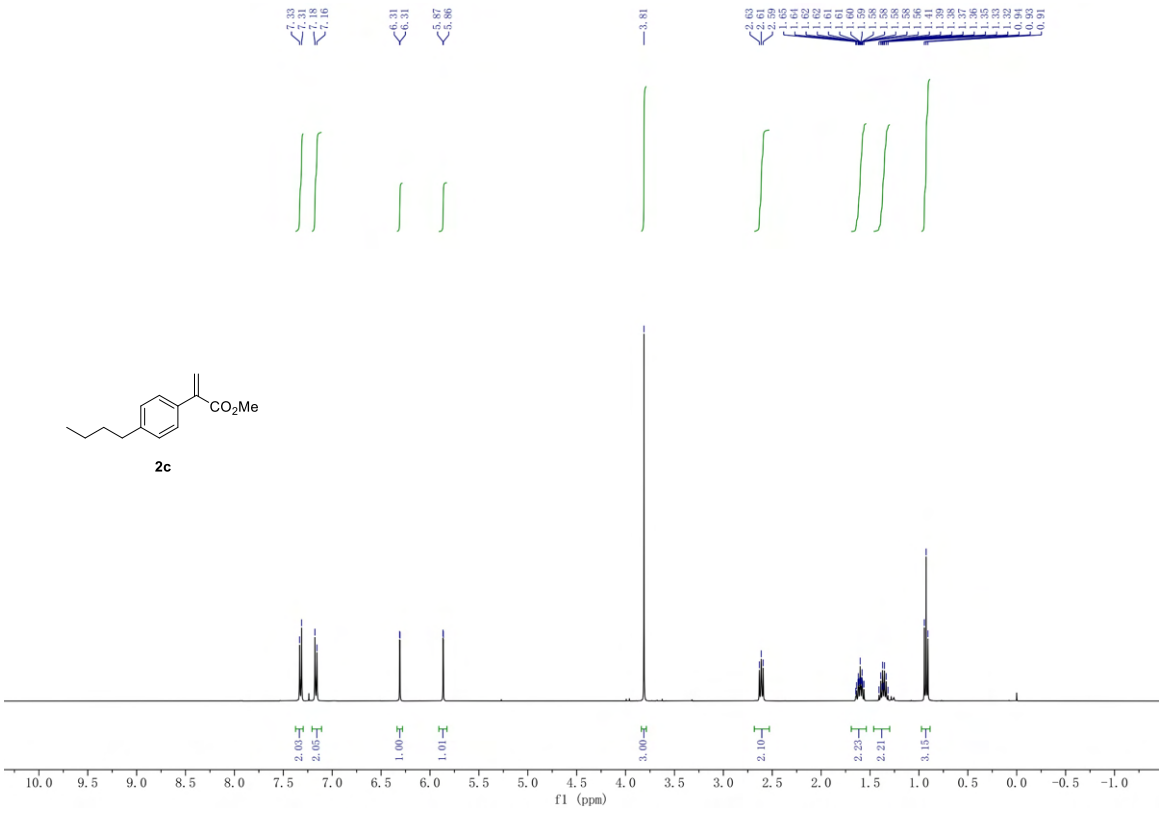

167.3
141.2
136.6
128.3
128.1
128.1
126.9
52.2
CO2Me
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

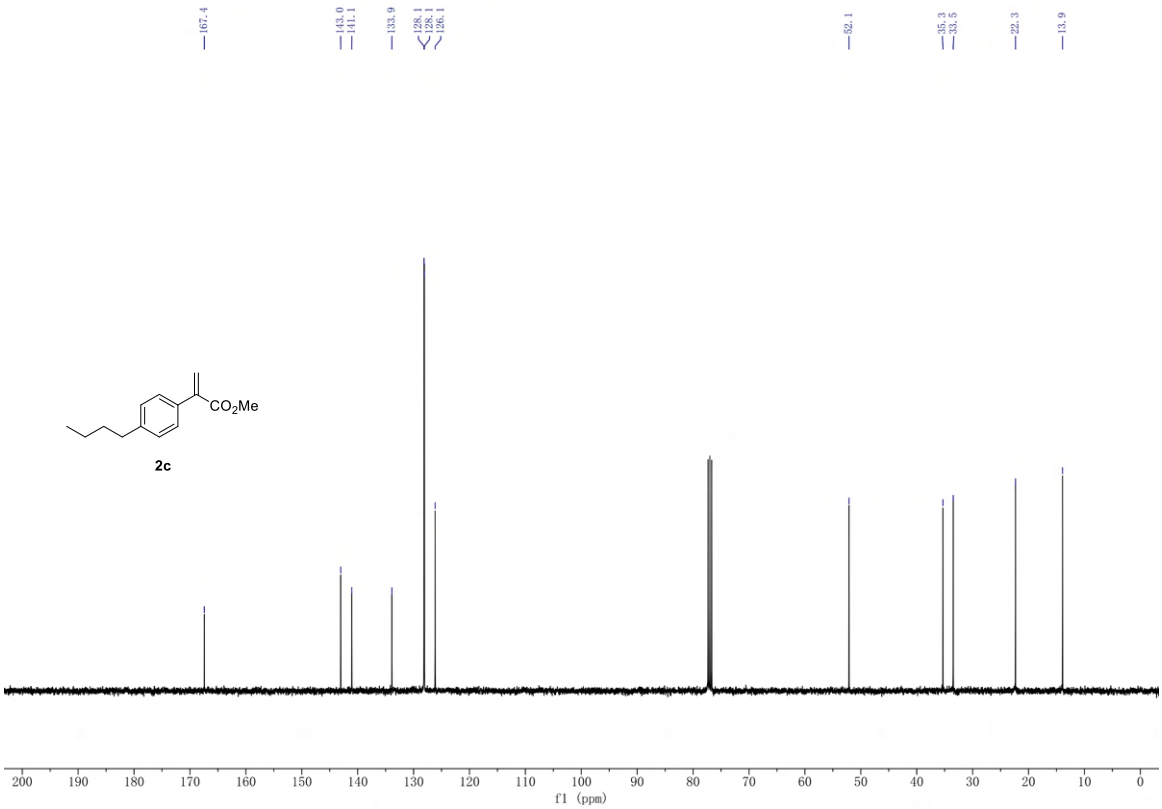
**2a**


7.36
7.34
7.22
7.20
6.36
6.36
5.90
5.90
3.85
2.40
CO2Me
Me
2.04
2.00
1.00
1.00
3.03
3.08
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

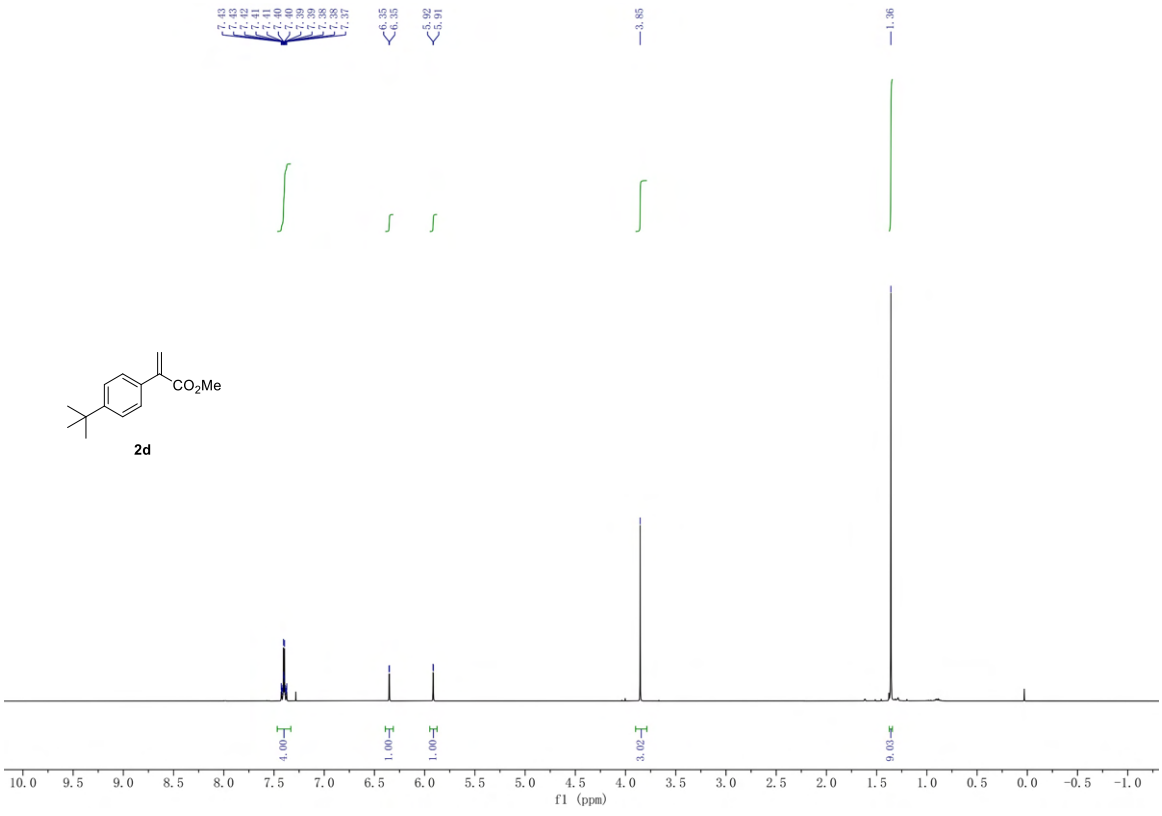
**2b**


167.4
141.1
138.0
133.7
128.8
128.1
126.2
52.1
21.1
CO2Me
Me
2b
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

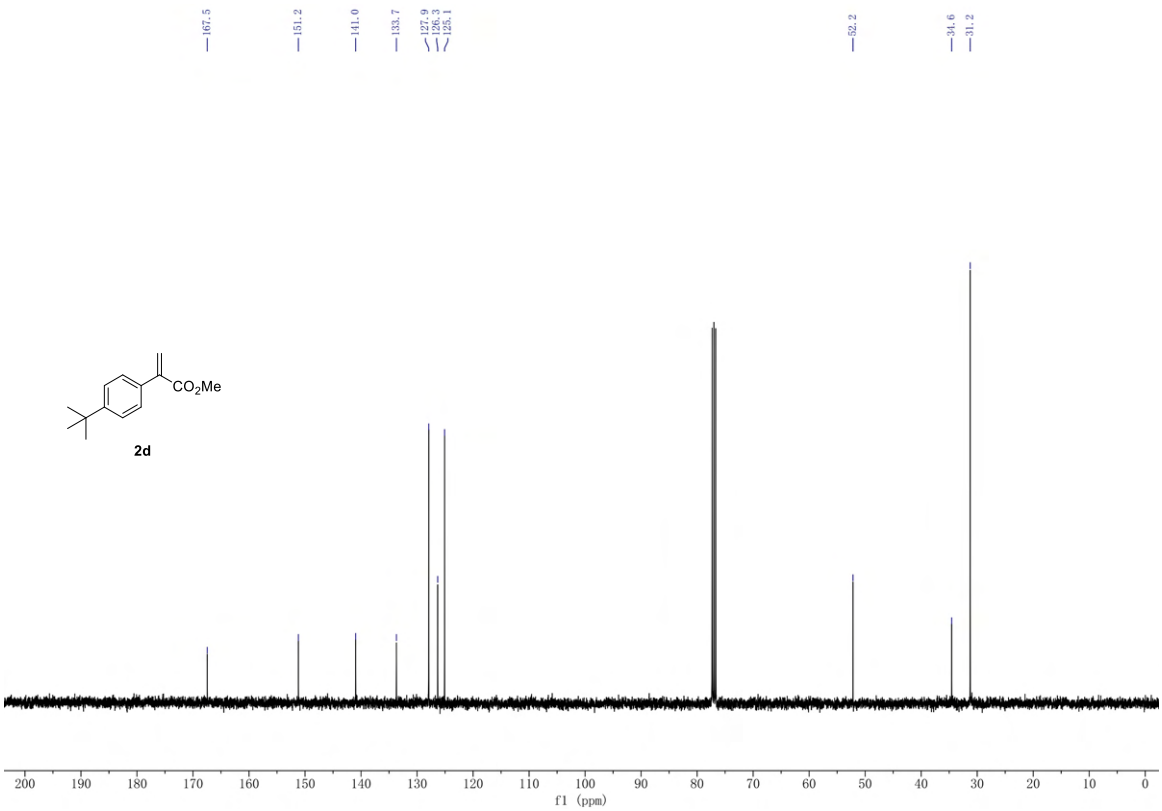

7.33
7.31
7.18
7.16
6.31
6.31
5.87
5.86
3.81
2.63
2.61
2.59
1.65
1.64
1.62
1.61
1.61
1.60
1.59
1.58
1.58
1.58
1.56
1.41
1.39
1.38
1.37
1.36
1.35
1.33
1.32
0.94
0.93
0.91
CO2Me
2c
2.03
2.05
1.00
1.01
3.00
2.10
2.23
2.21
3.15
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

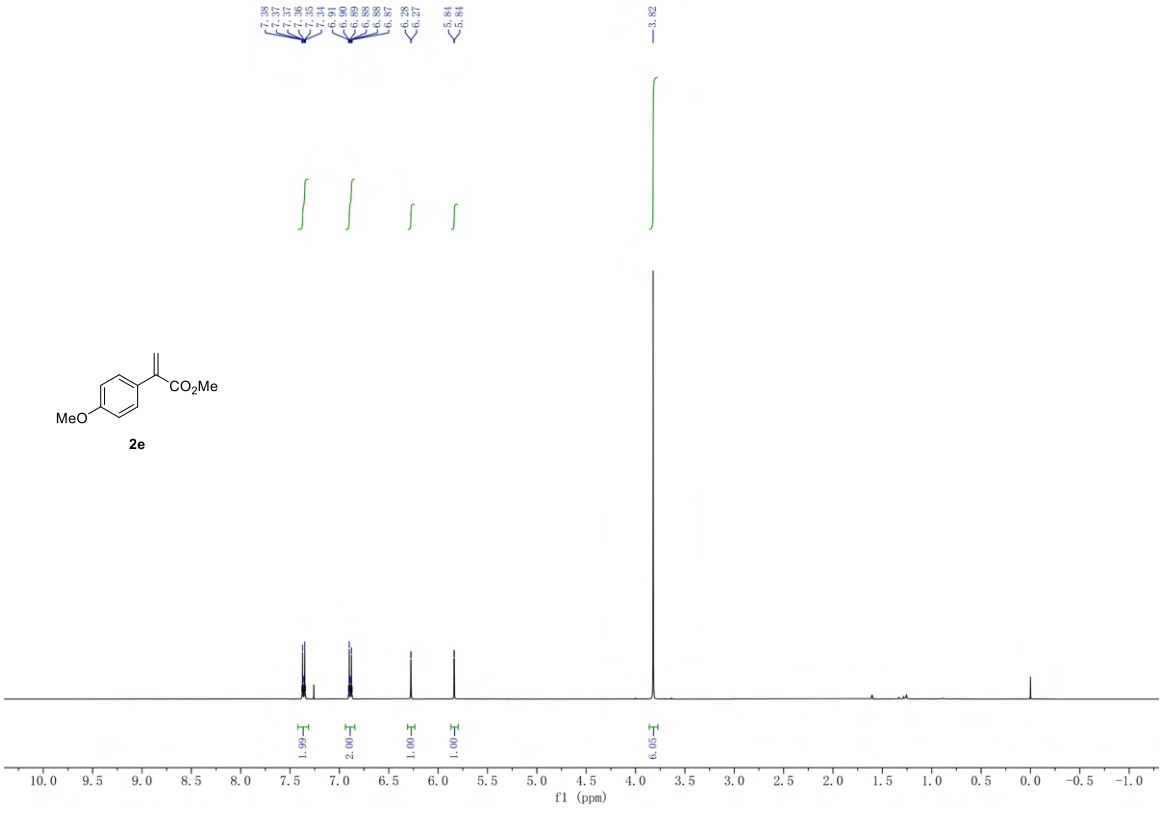

167.4
143.0
141.1
133.9
128.1
128.1
126.1
52.1
35.3
33.5
22.3
13.9
CO2Me
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

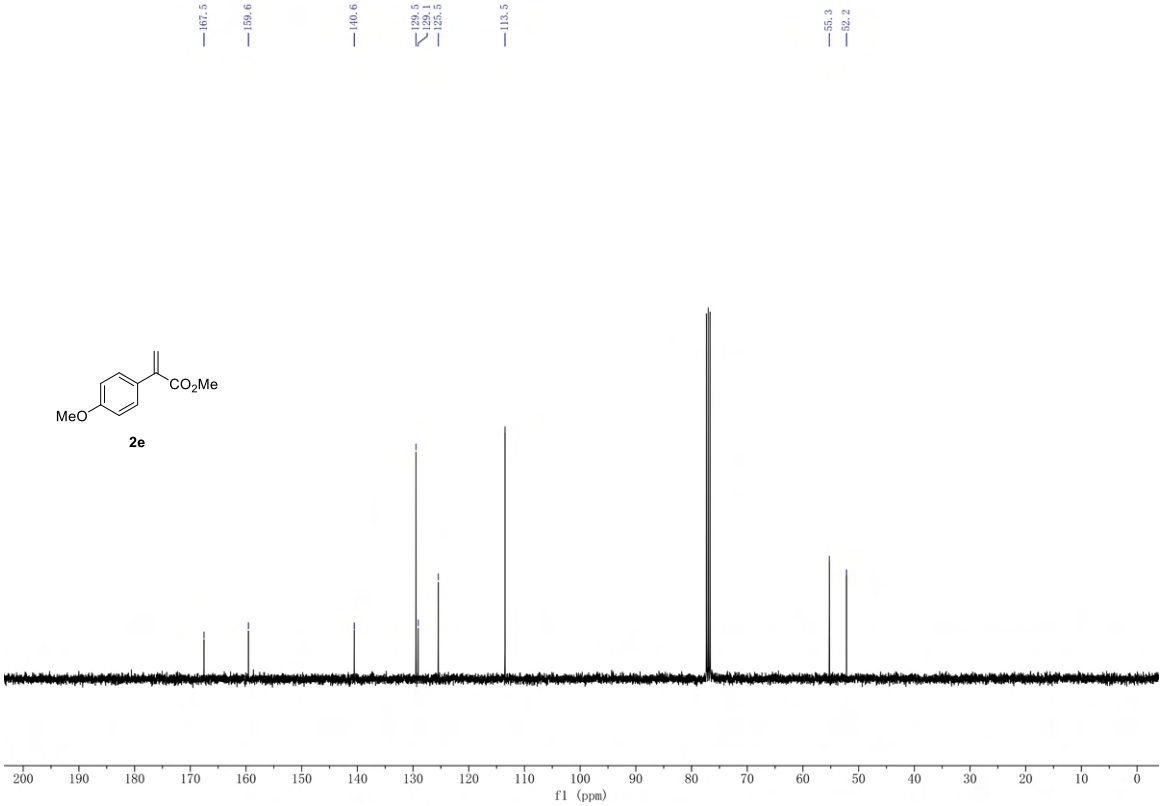
**2c**


7.43
7.43
7.42
7.41
7.41
7.40
7.40
7.39
7.39
7.38
7.38
7.37
6.35
6.35
5.92
5.91
3.85
1.36
CO2Me
4.00
1.00
1.00
3.02
9.03
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

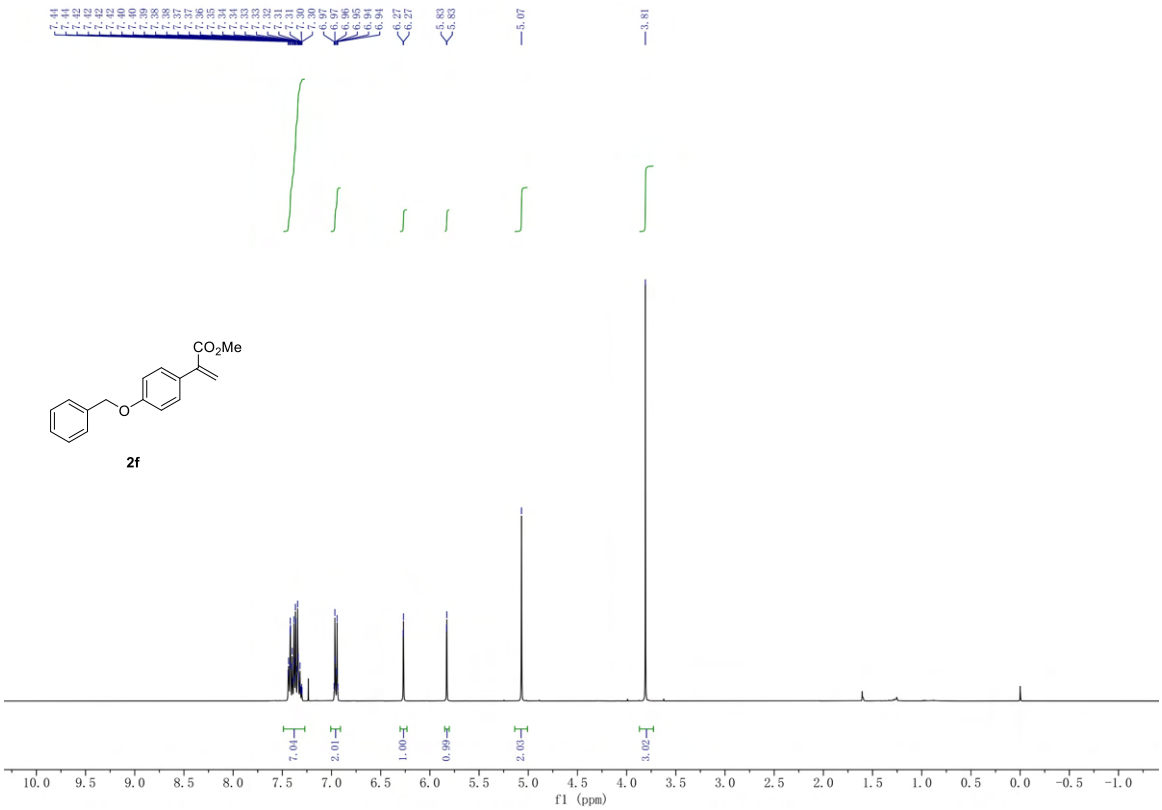
**2d**


167.5
151.2
141.0
133.7
127.9
126.3
125.1
52.2
34.6
31.2
CO2Me
2d
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.38
7.37
7.37
7.36
7.35
7.34
7.34
6.91
6.90
6.89
6.88
6.88
6.87
6.28
6.27
5.84
5.84
3.82
CO2Me
MeO
2e
1.99
2.00
1.00
1.00
6.05
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


167.5
159.6
140.6
129.5
129.1
125.5
113.5
55.3
52.2
CO2Me
MeO
f1 (ppm)

**2e**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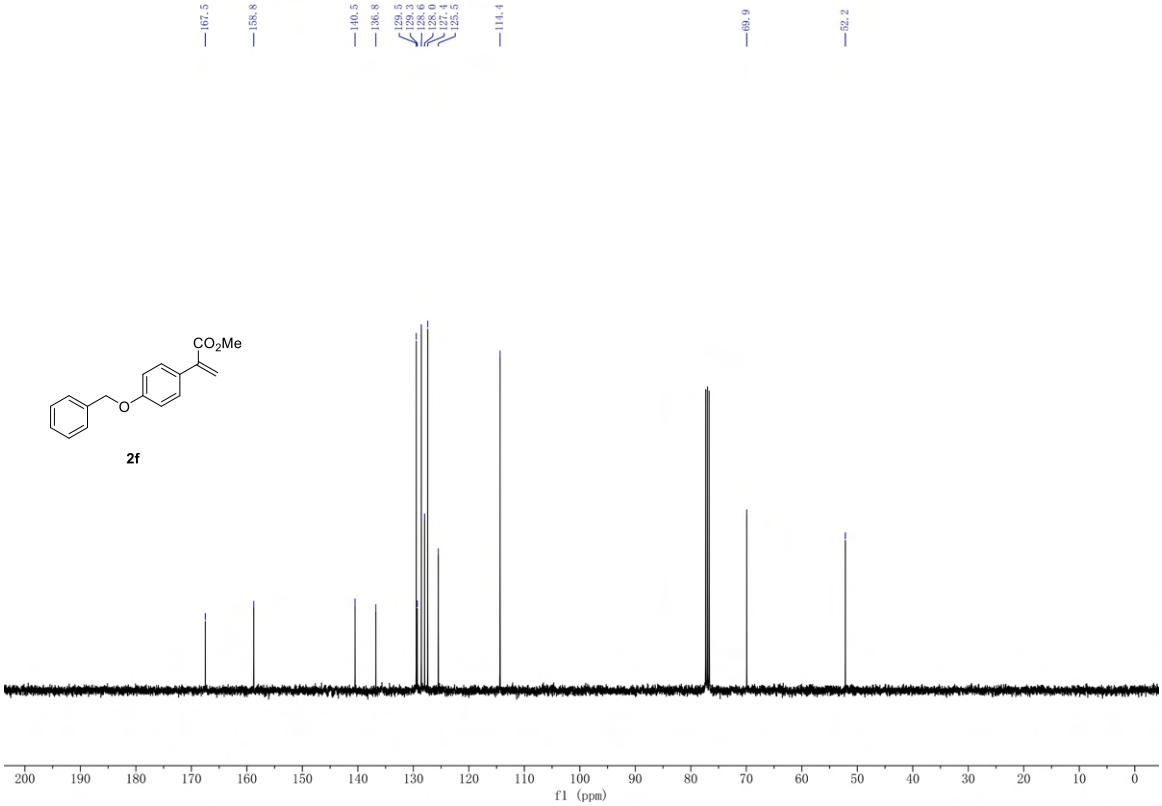
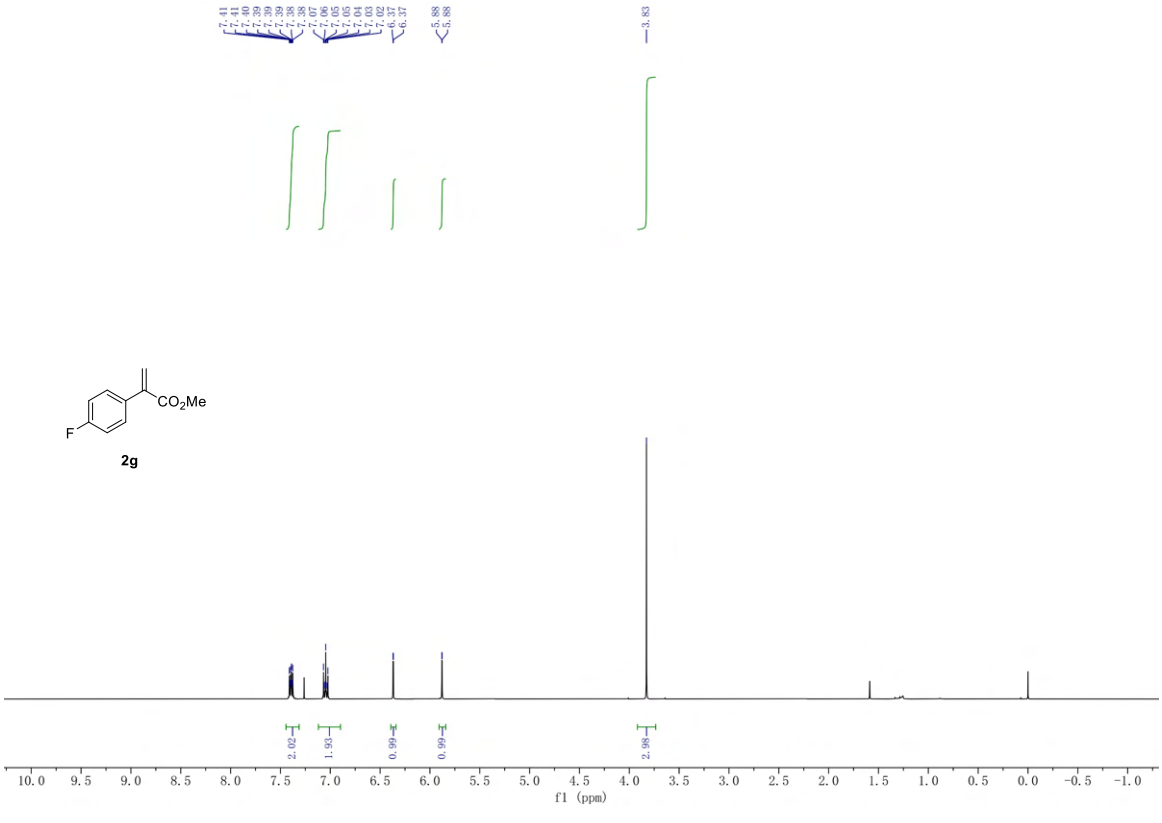
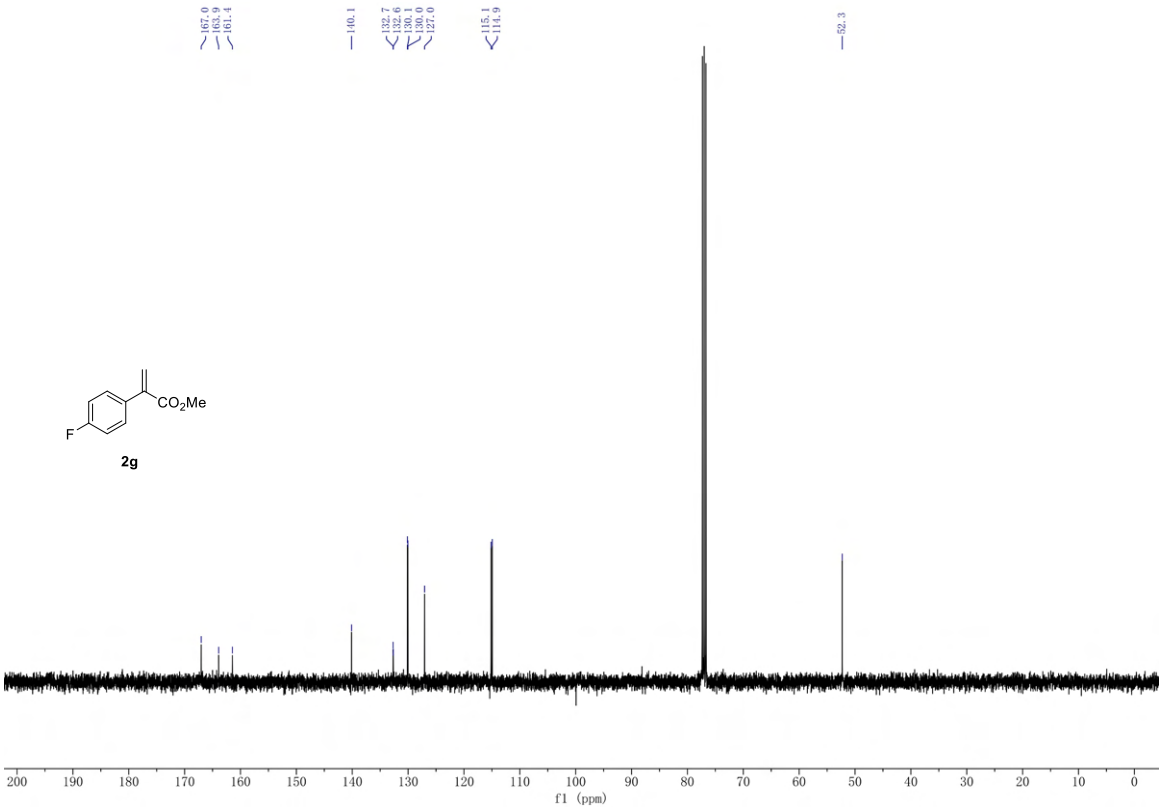
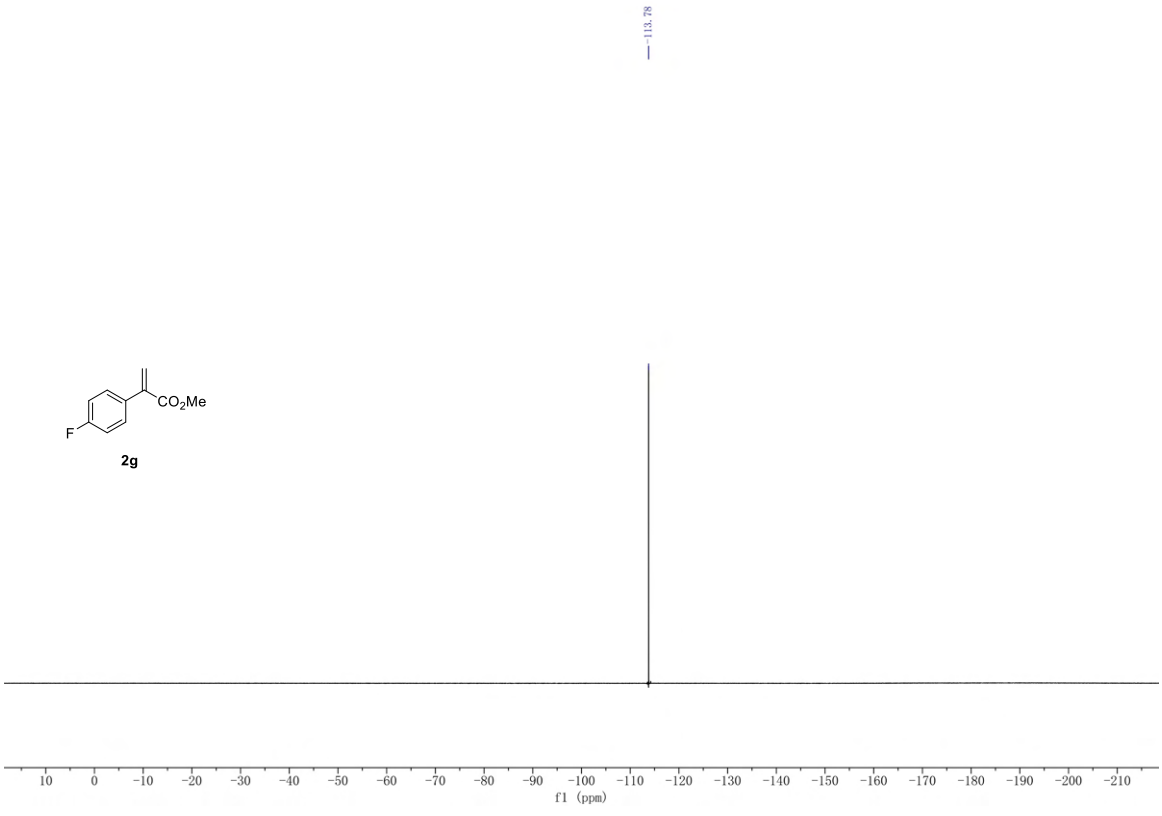
7.41
7.42
7.42
7.42
7.42
7.40
7.39
7.38
7.38
7.37
7.37
7.36
7.35
7.34
7.34
7.33
7.33
7.32
7.32
7.31
7.31
7.30
7.30
6.97
6.97
6.96
6.95
6.94
6.94
6.27
6.27
5.83
5.83
5.07
3.81
CO2Me
O
7.04
2.01
1.00
0.99
2.03
3.02
f1 (ppm)

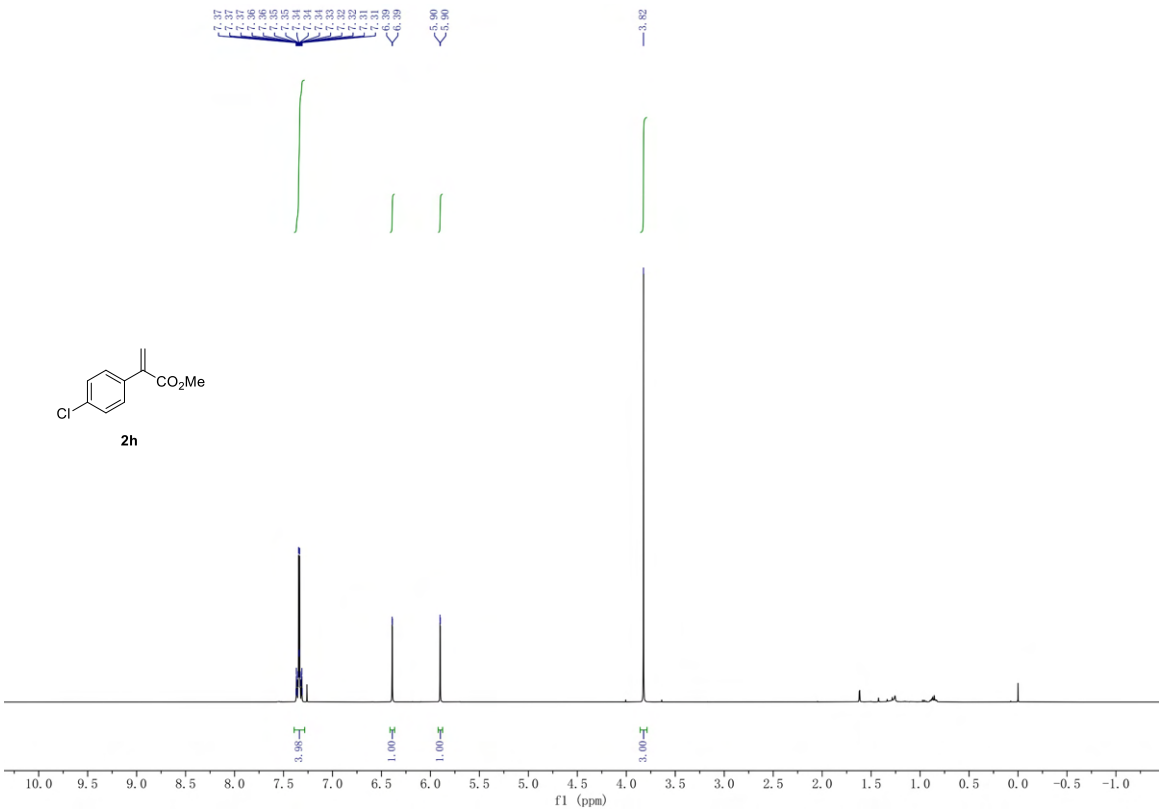
**2f**

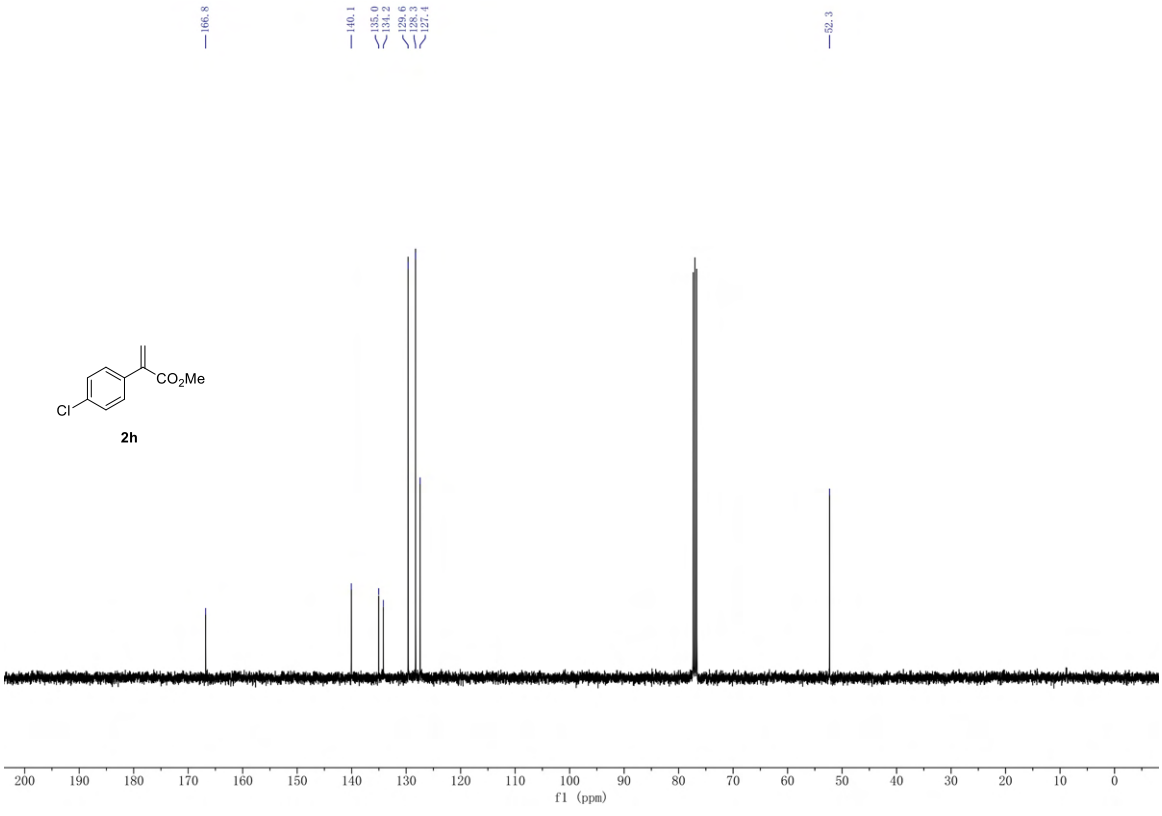

167.5
158.8
140.5
136.8
129.5
129.3
128.6
128.0
127.4
125.5
114.4
69.9
52.2
CO2Me
O
2f
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

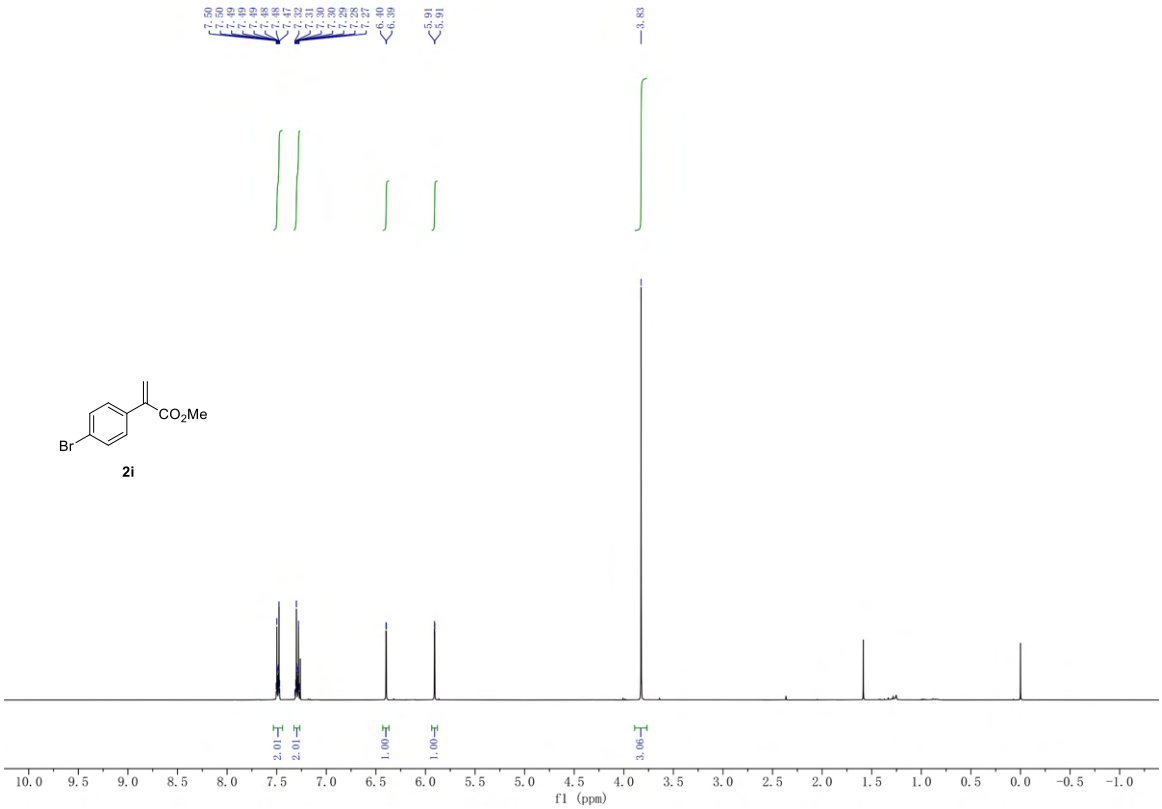

7.41
7.41
7.40
7.39
7.39
7.38
7.38
7.07
7.06
7.05
7.05
7.04
7.03
7.02
6.37
6.37
5.88
5.88
3.83
CO2Me
F
2g
2.02
1.93
0.99
0.99
2.98
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

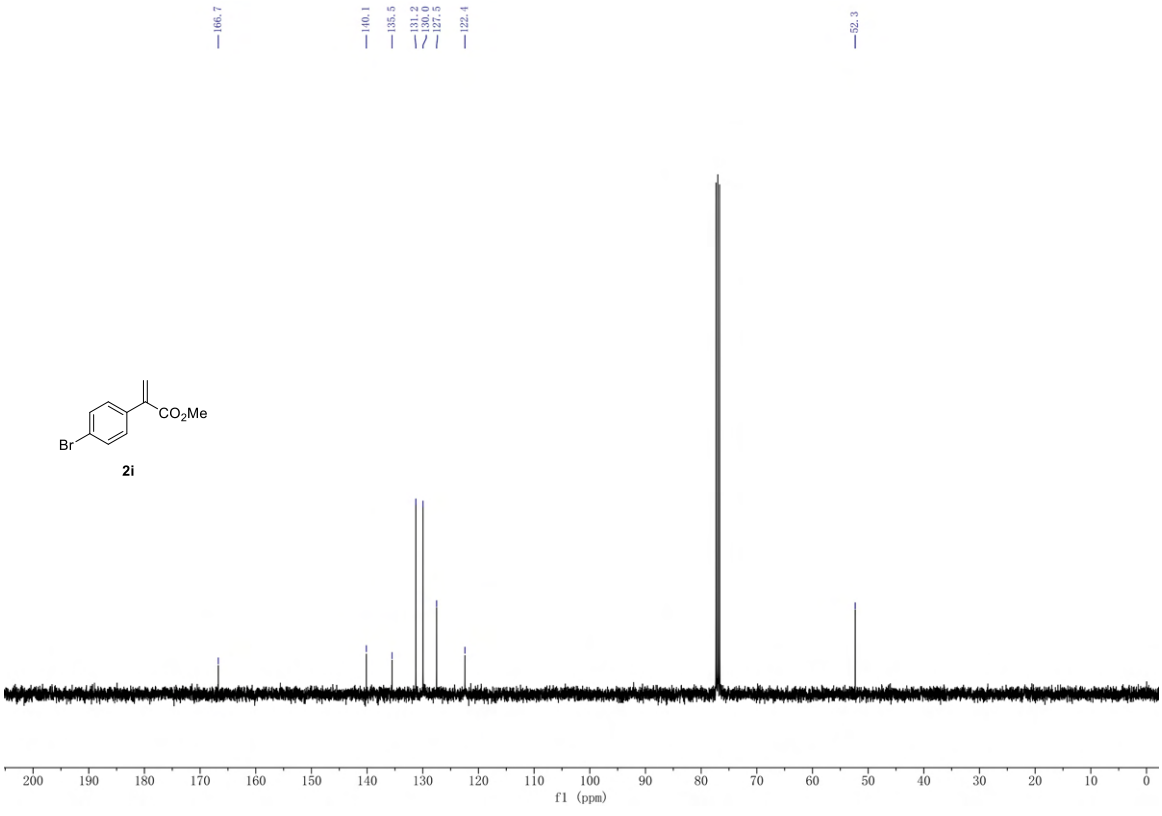

167.0
163.9
161.4
140.1
132.7
132.6
130.1
130.0
127.0
115.1
114.9
52.3
CO2Me
F
2g
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

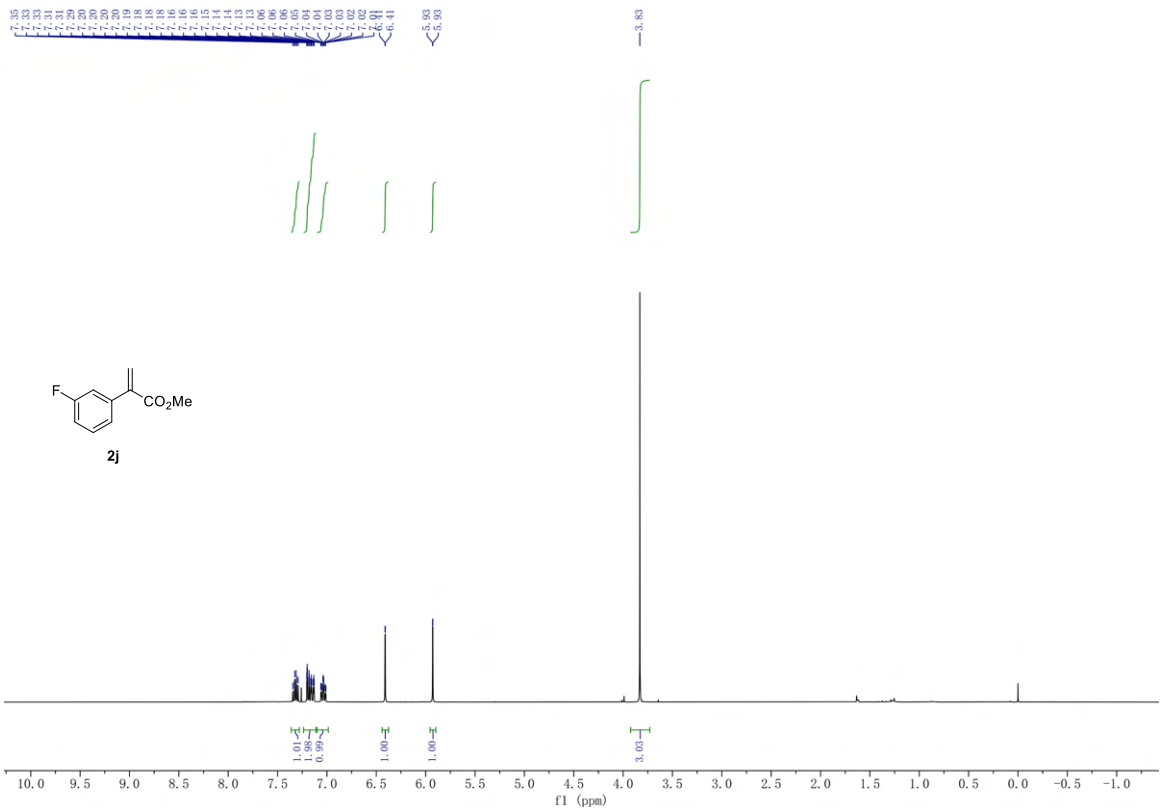

-113.78
CO2Me
F
2g
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

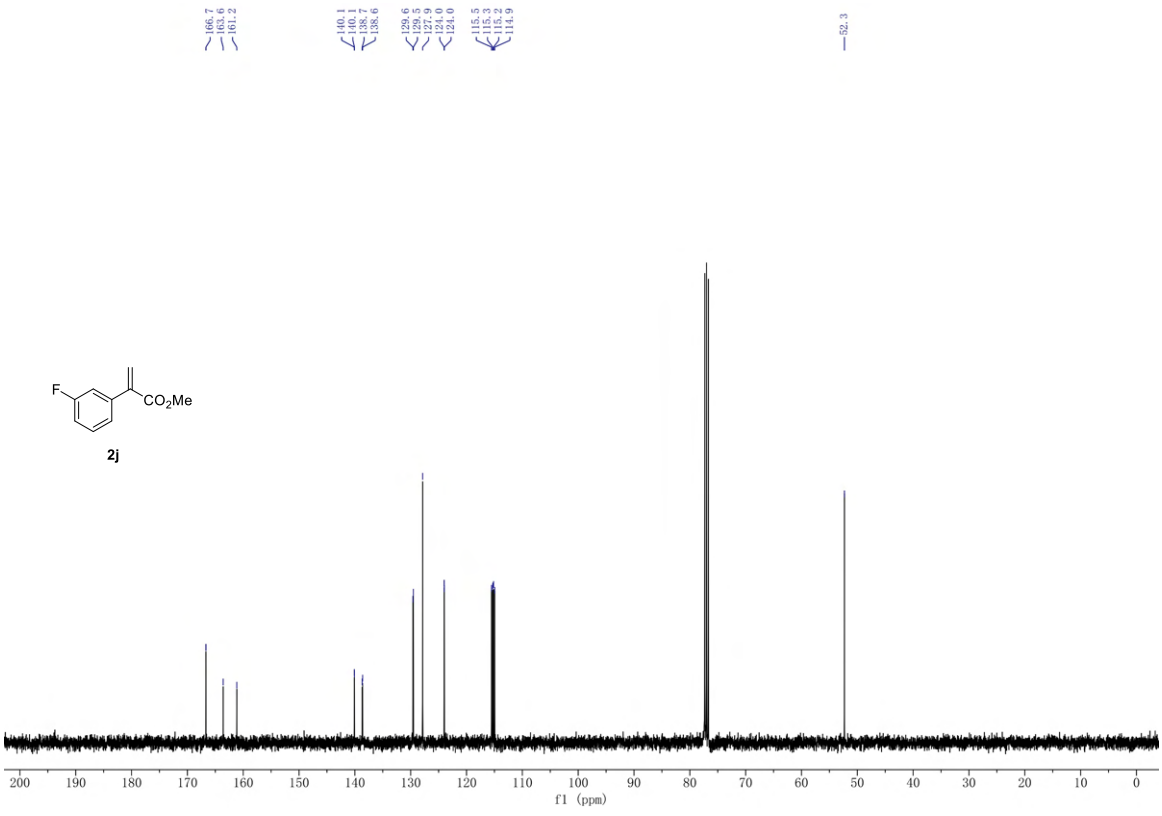

7.37
7.37
7.37
7.36
7.36
7.35
7.35
7.34
7.34
7.34
7.33
7.32
7.32
7.31
7.31
6.39
5.90
5.90
3.82
CO2Me
Cl
2h
3.98
1.00
1.00
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

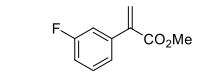

166.8
140.1
135.0
134.2
129.6
128.3
127.4
52.3
CO2Me
Cl
2h
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.50
7.50
7.49
7.49
7.49
7.48
7.48
7.47
7.32
7.31
7.30
7.30
7.29
7.28
7.27
6.40
6.39
5.91
5.91
3.83
CO2Me
Br
2i
2.01
2.01
1.00
1.00
3.06
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


166.7
140.1
135.5
131.2
130.0
127.5
122.4
52.3
CO2Me
Br
2i
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

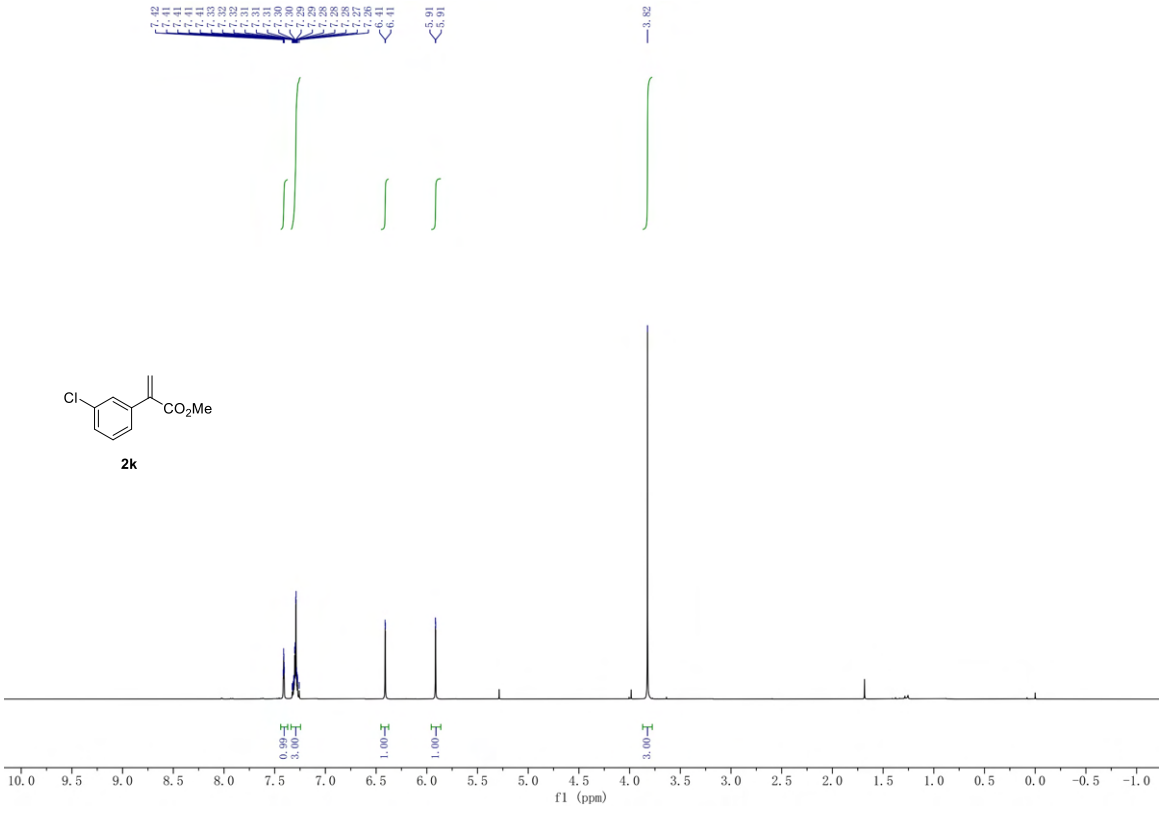

F
CO2Me
2j
f1 (ppm)


F
CO2Me
2j
f1 (ppm)


F
CO2Me

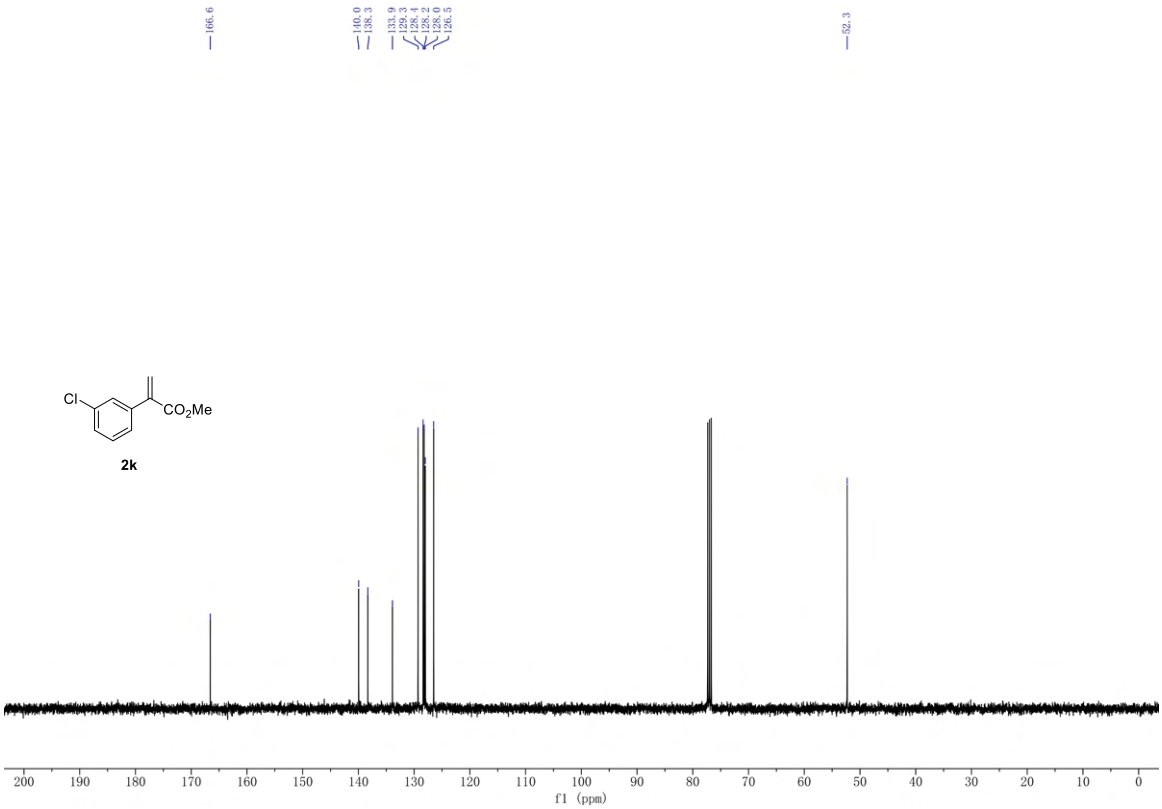
**2j**

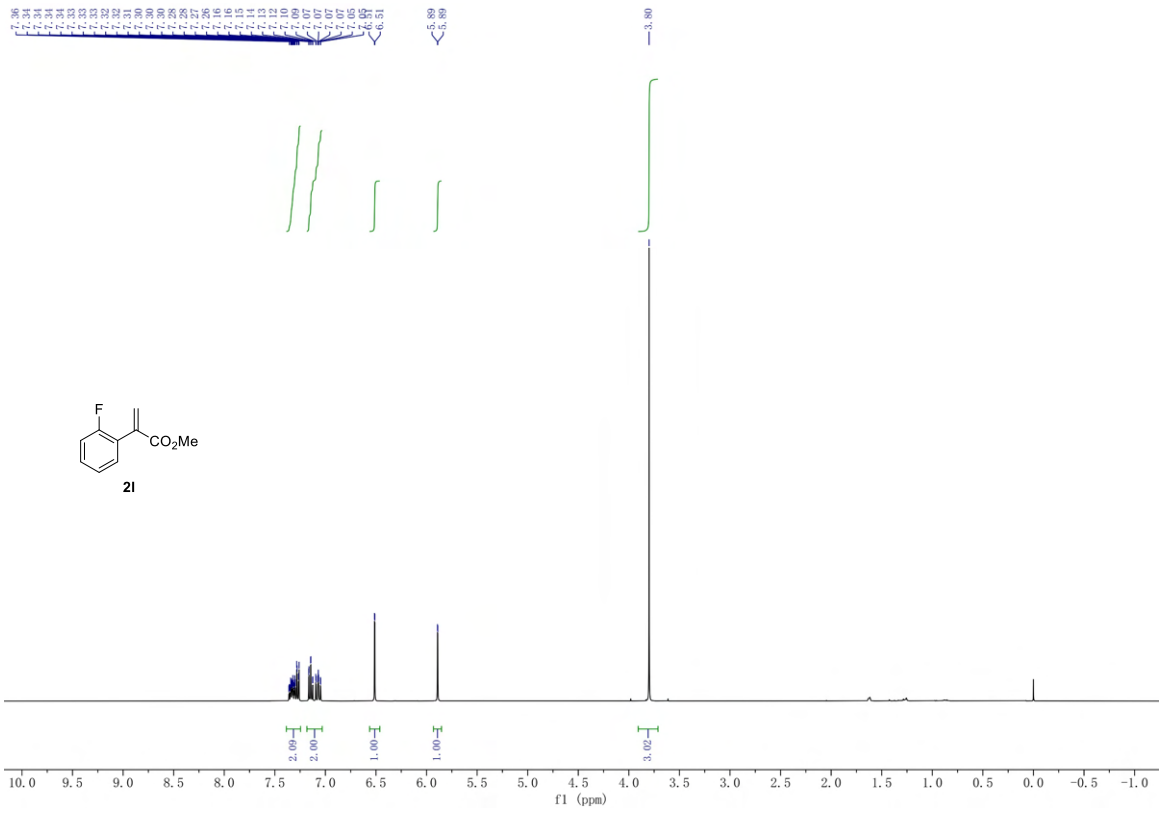

-113.46
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


7.42
7.41
7.41
7.41
7.41
7.33
7.32
7.32
7.31
7.31
7.31
7.30
7.30
7.29
7.29
7.28
7.28
7.28
7.27
7.26
6.41
6.41
5.91
5.91
3.82
0.99
3.00
1.00
1.00
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


Cl
CO2Me

**2k**


166.6
140.0
138.3
133.9
129.3
128.4
128.2
128.0
126.5
52.3
Cl
CO2Me
2k
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.36
7.34
7.34
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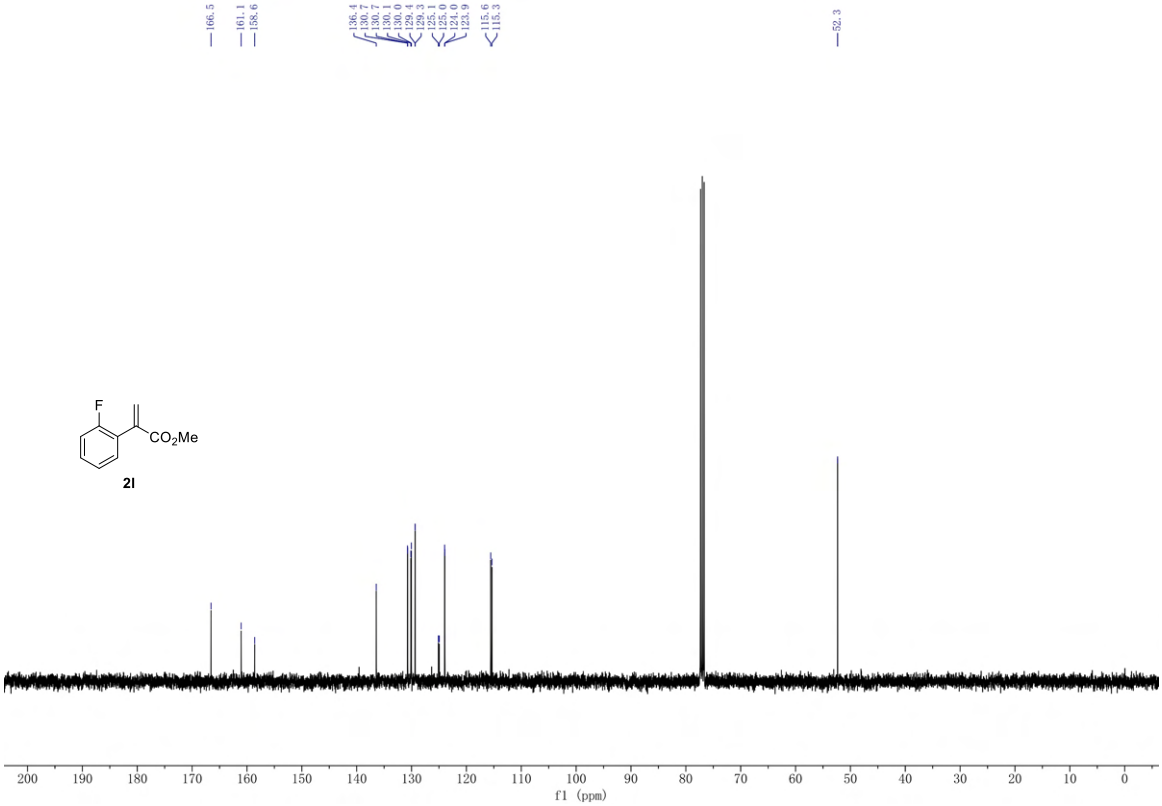
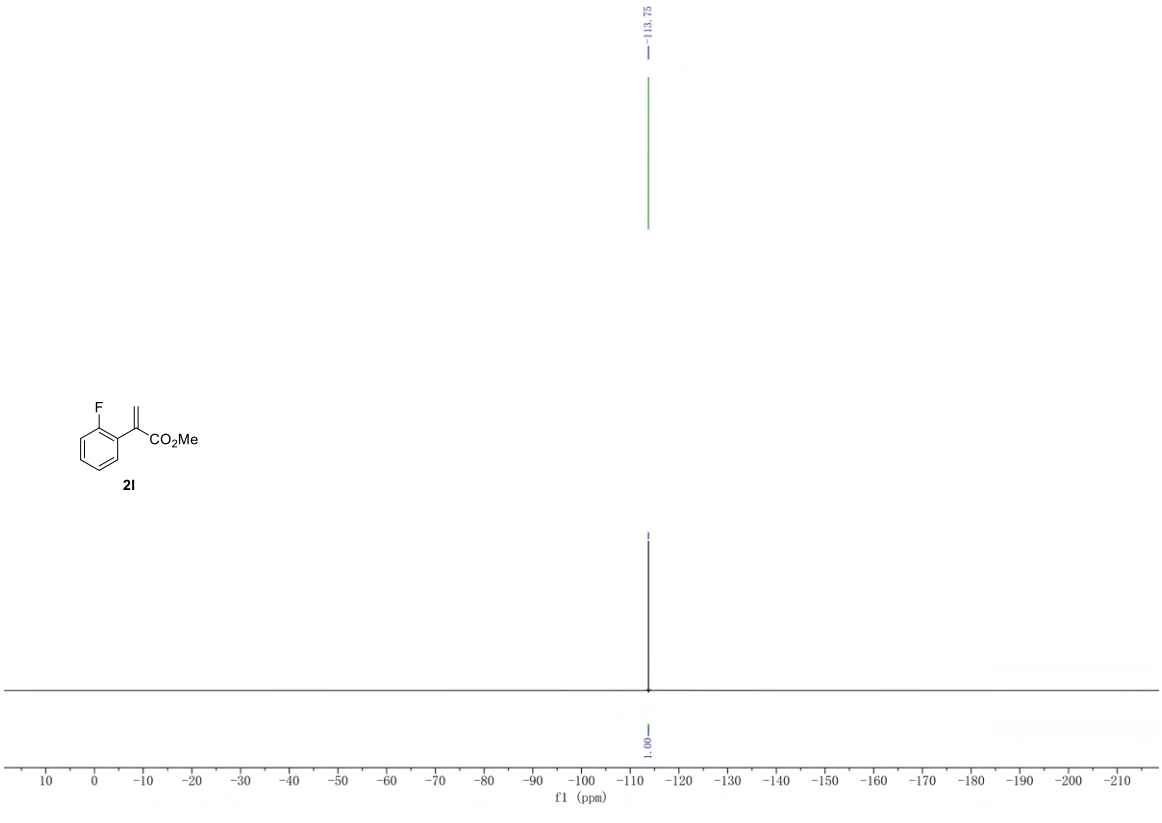
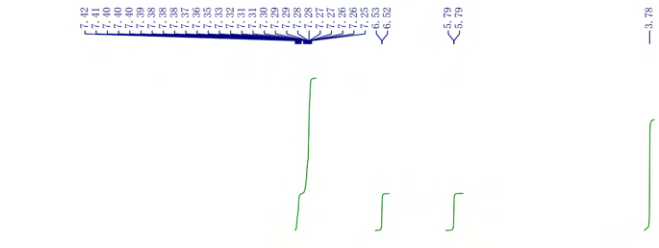
7.33
7.33
7.33
7.32
7.32
7.31
7.30
7.30
7.30
7.28
7.28
7.27
7.26
7.16
7.16
7.15
7.14
7.13
7.12
7.10
7.09
7.07
7.07
7.07
7.07
7.05
6.55
6.51
5.89
5.89
3.80
F
CO2Me
2l
2.69
2.60
1.00
1.00
3.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


166.5
161.1
158.6
136.4
130.7
130.7
130.1
130.0
129.4
129.3
125.1
125.0
124.0
123.9
115.6
115.3
52.3
F
CO2Me
2l
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-113.75
F
CO2Me
2l
1.00
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


7.42
7.41
7.40
7.40
7.40
7.39
7.38
7.38
7.38
7.37
7.36
7.35
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7.32
7.31
7.30
7.29
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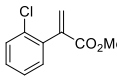
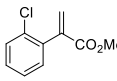
7.25
6.53
6.52
5.79
5.79
3.78


Cl
CO2Me

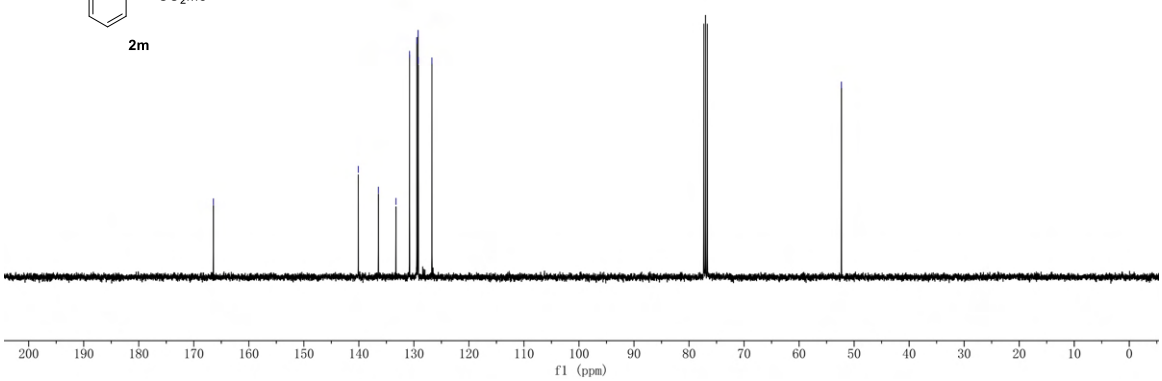
**2m**

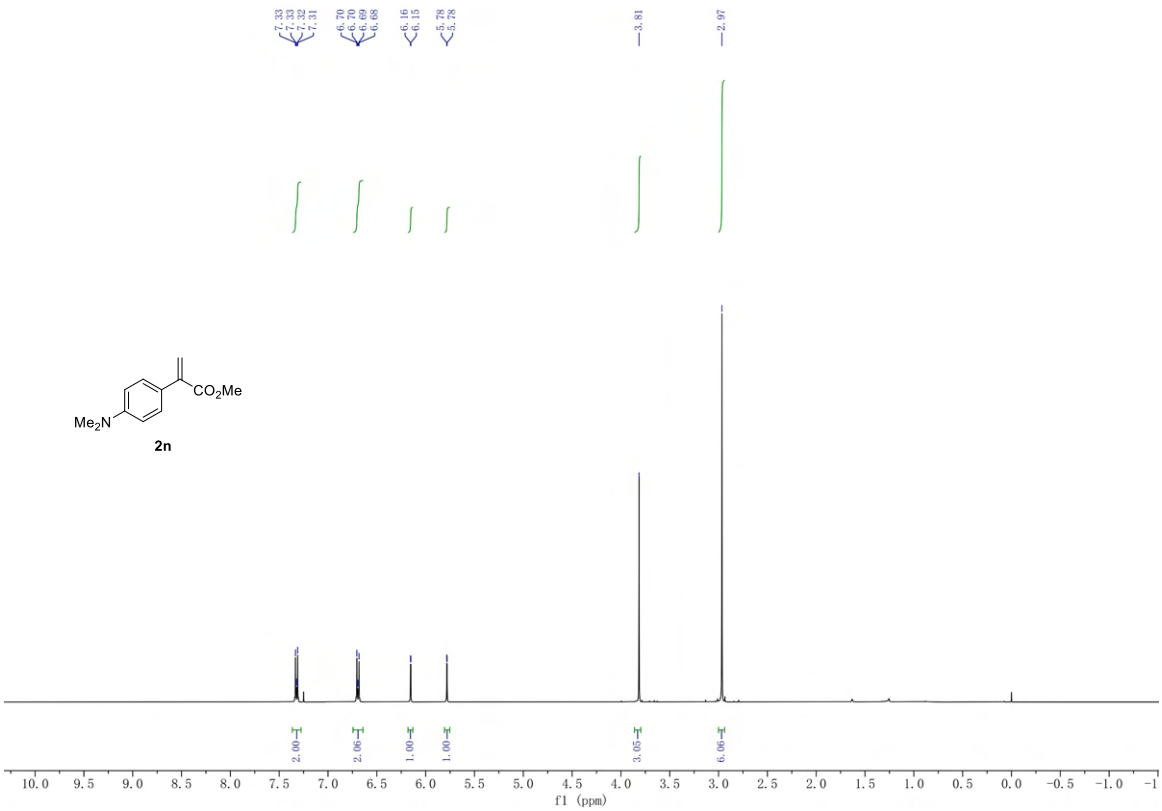

4.14
1.00
1.00
3.01
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

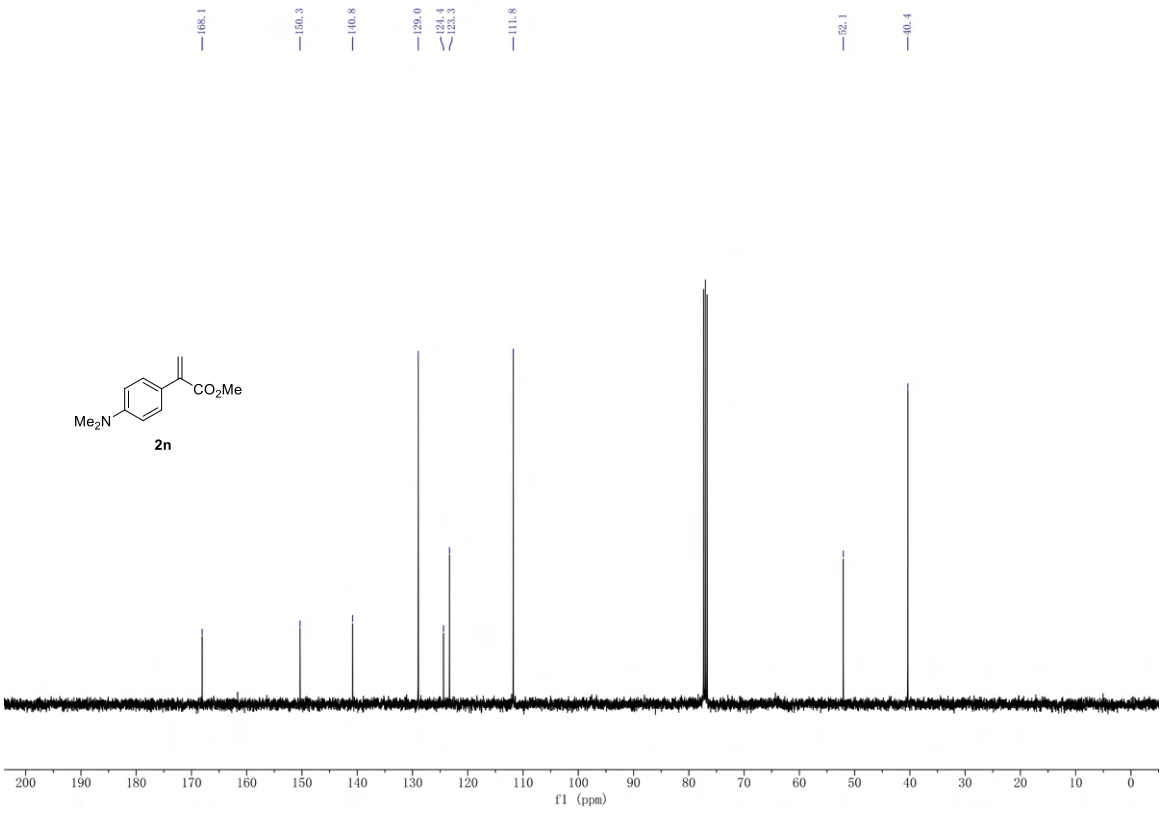

166.4
140.1
136.4
133.3
130.8
129.5
129.2
129.2
126.7
52.3

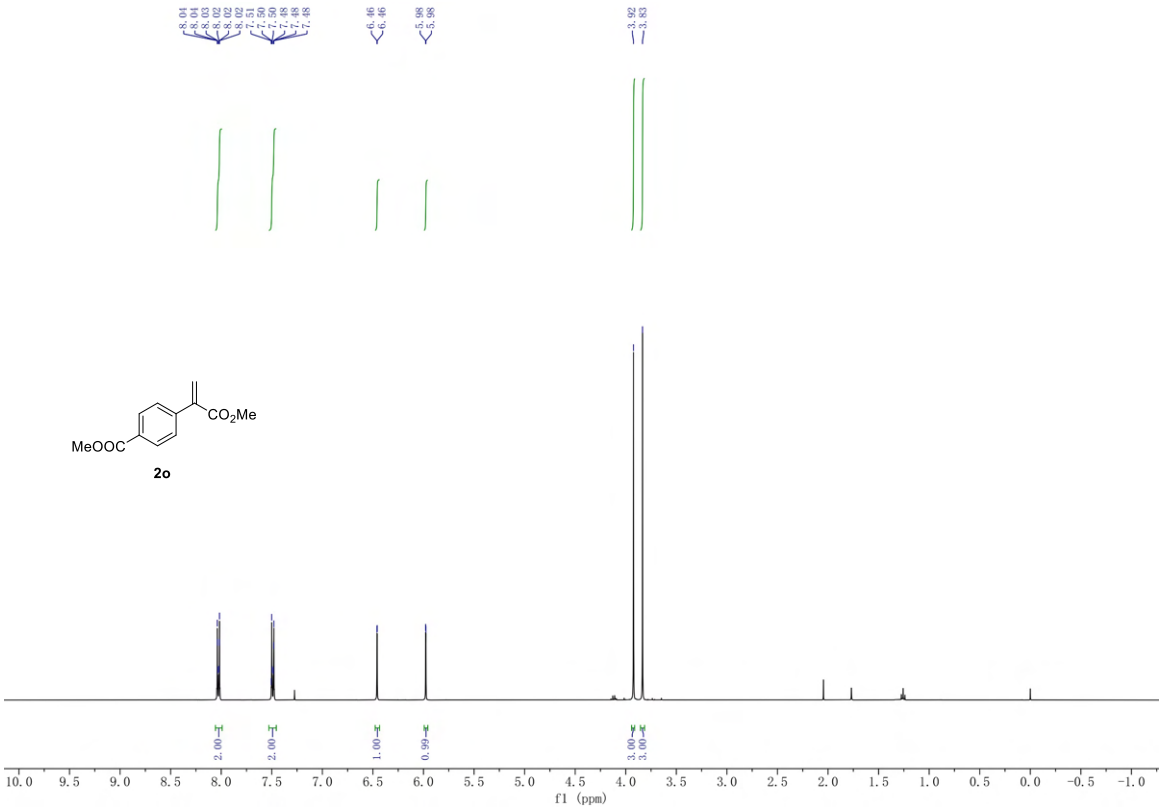

Cl
CO2Me

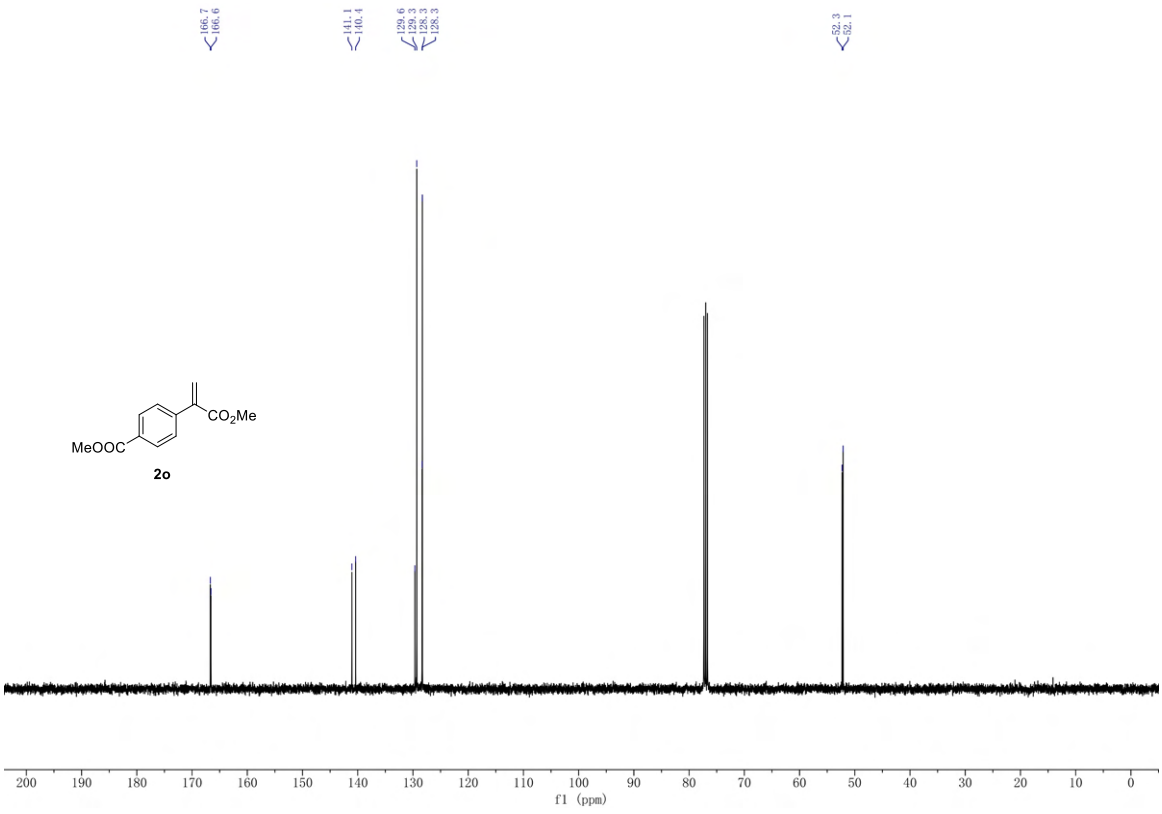
**2m**

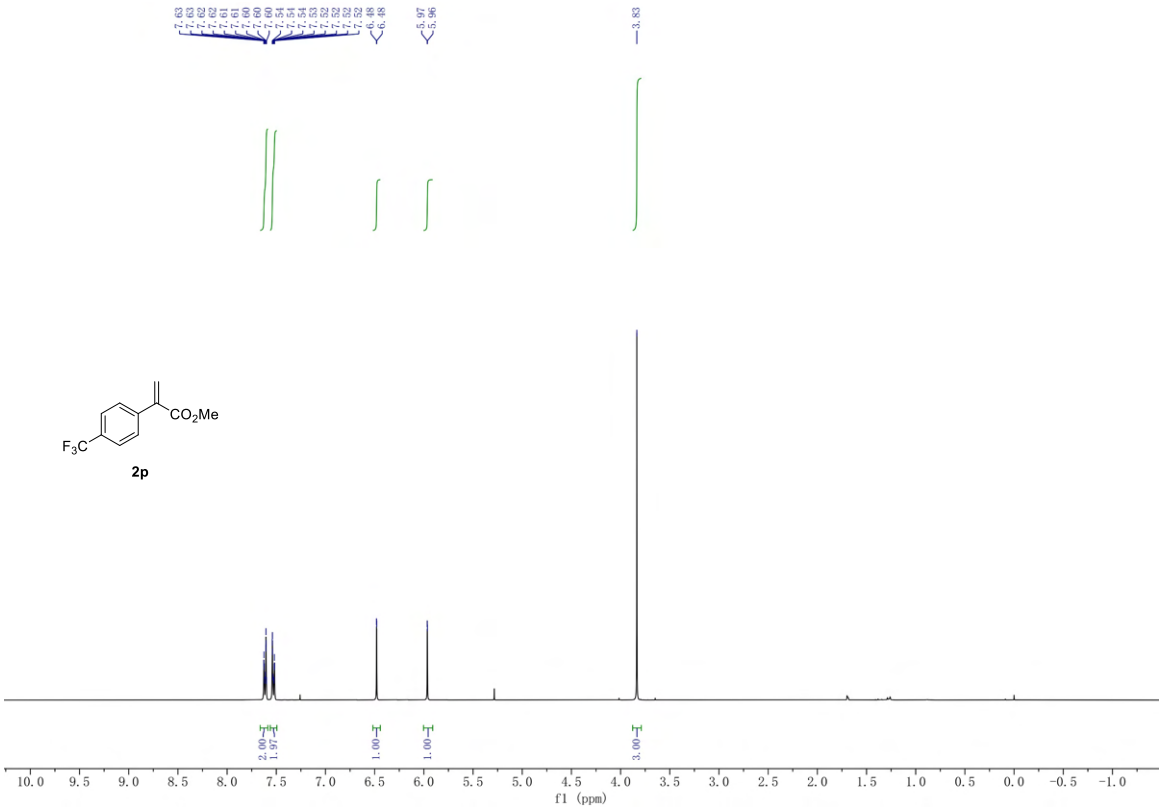

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.33
7.33
7.32
7.31
6.70
6.70
6.69
6.68
6.16
6.15
5.78
5.78
3.81
2.97
CO2Me
Me2N
2n
2.00
2.06
1.00
1.00
3.05
6.06
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1
f1 (ppm)


168.1
150.3
140.8
129.0
124.4
123.3
111.8
52.1
40.4
CO2Me
Me2N
2n
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


8.04
8.03
8.02
8.02
8.02
7.51
7.50
7.48
7.48
7.48
6.46
6.46
5.98
5.98
3.92
3.83
CO2Me
MeOOC
2o
2.00
2.00
1.00
0.99
3.00
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


166.7
166.6
141.1
140.4
129.6
129.3
128.3
128.3
52.3
52.1
CO2Me
MeOOC
2o
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.63
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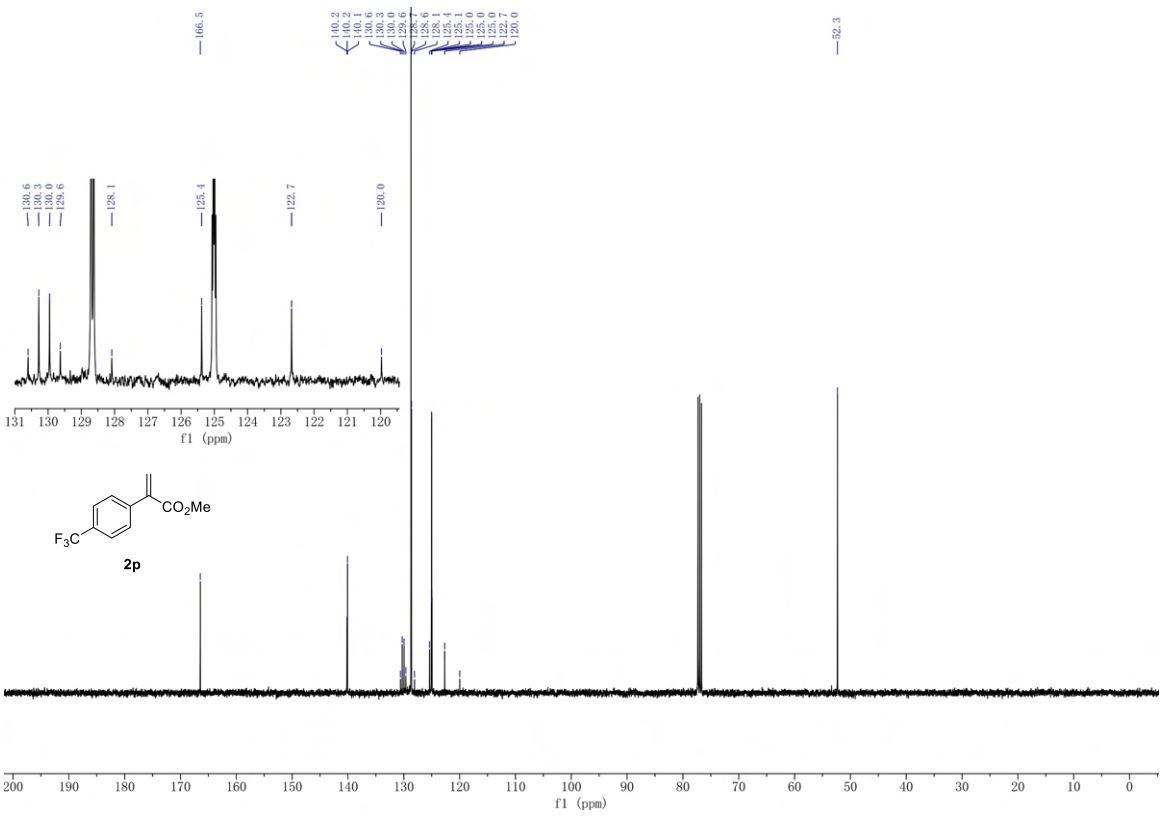
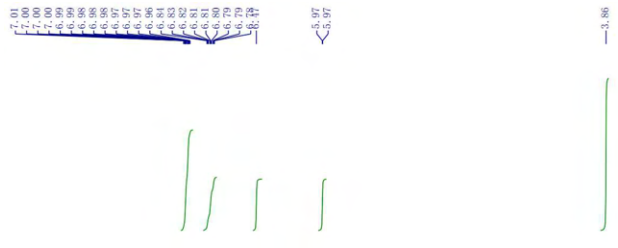
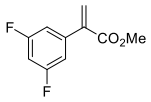
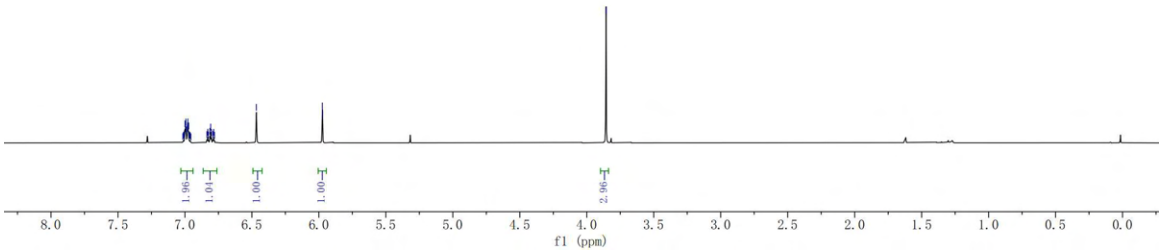
7.54
7.54
7.54
7.54
7.53
7.52
7.52
7.52
7.52
6.48
6.48
5.97
5.96
3.83
CO2Me
F3C
2p
2.00
1.97
1.00
1.00
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

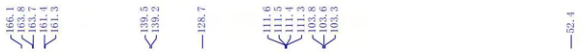

166.5
140.2
140.2
140.1
130.6
130.3
130.0
129.6
128.7
128.6
128.1
125.4
125.1
125.0
125.0
122.7
120.0
52.3
130.6
130.3
130.0
129.6
128.1
125.4
122.7
120.0
131 130 129 128 127 126 125 124 123 122 121 120
f1 (ppm)
CO2Me
F3C
2p
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

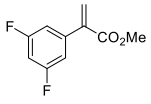



F
CO2Me
F

**2q**

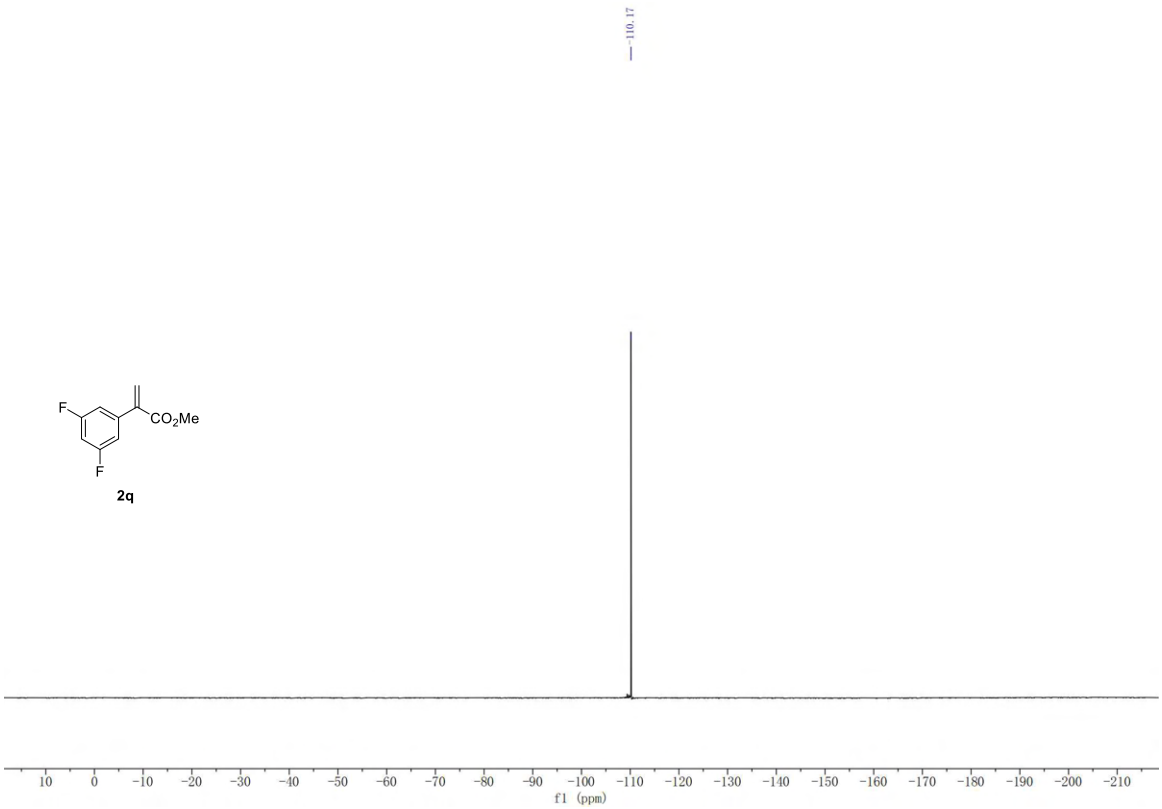

1.96
1.01
1.00
1.00
2.96
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)



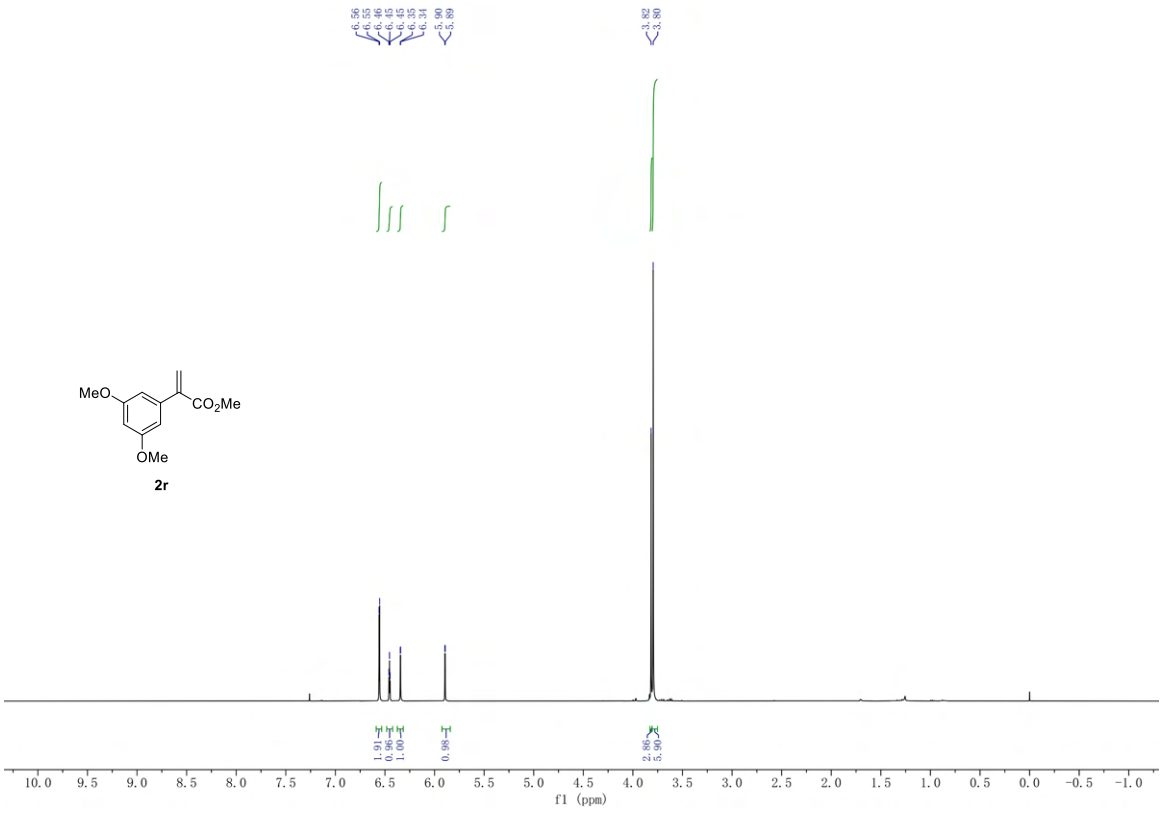

F
CO2Me
F

**2q**

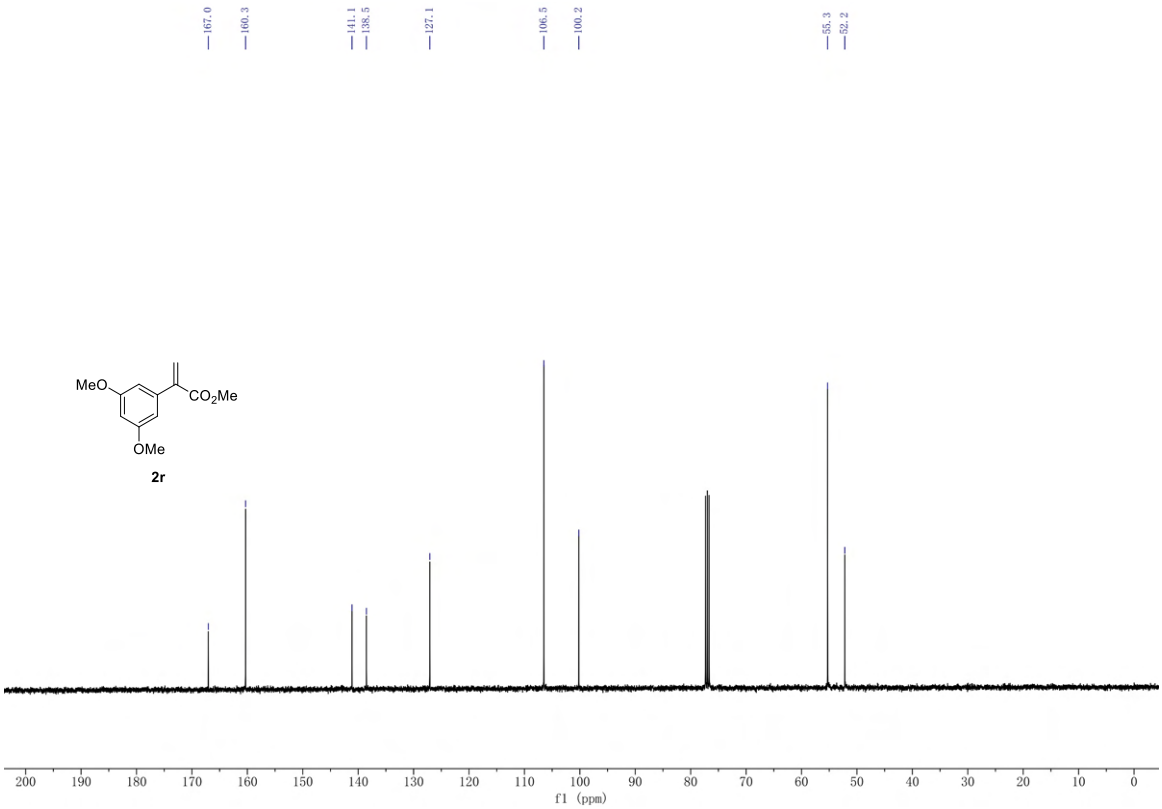

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

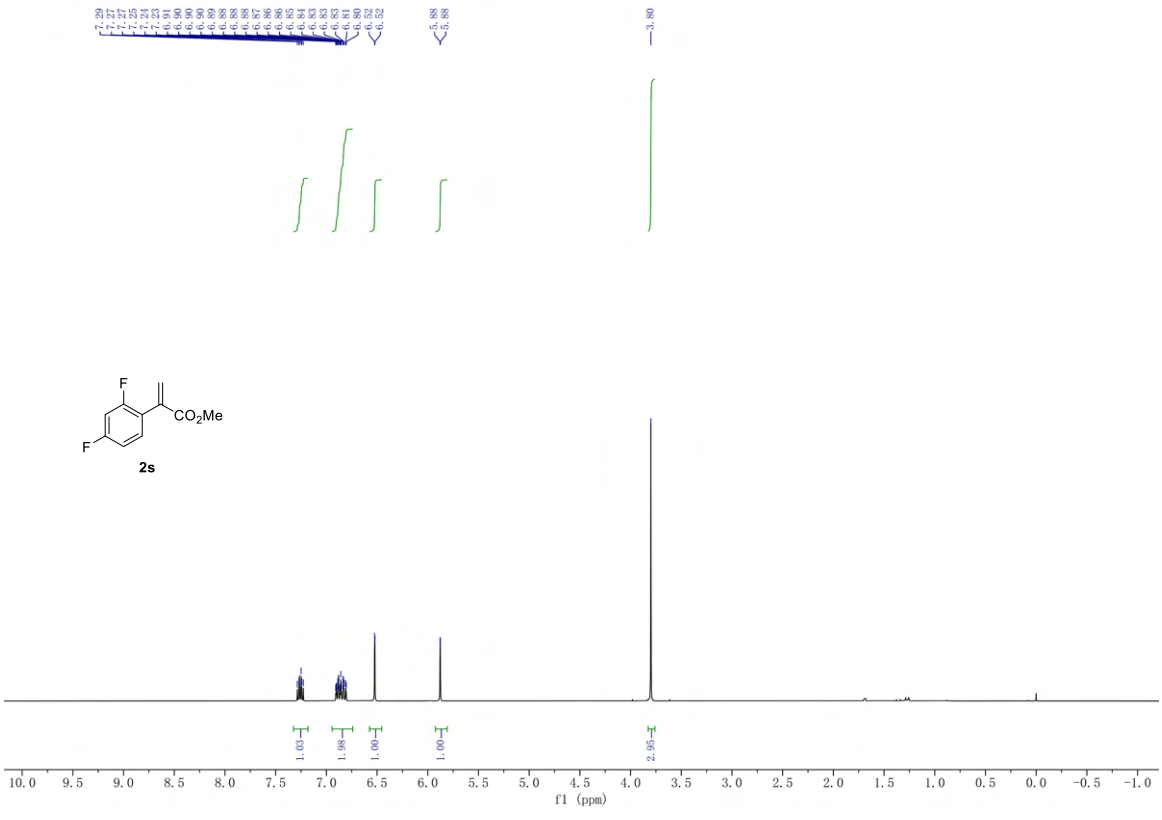

110.17
F
CO2Me
F
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

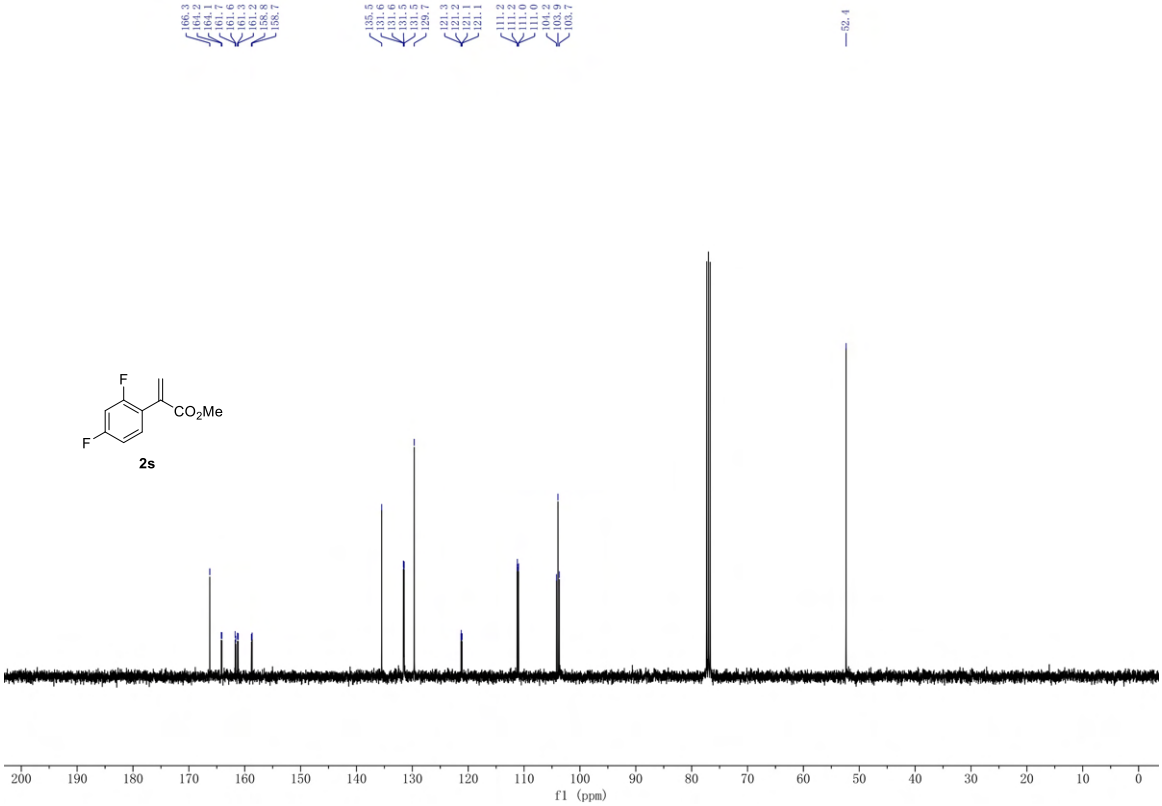
**2q**

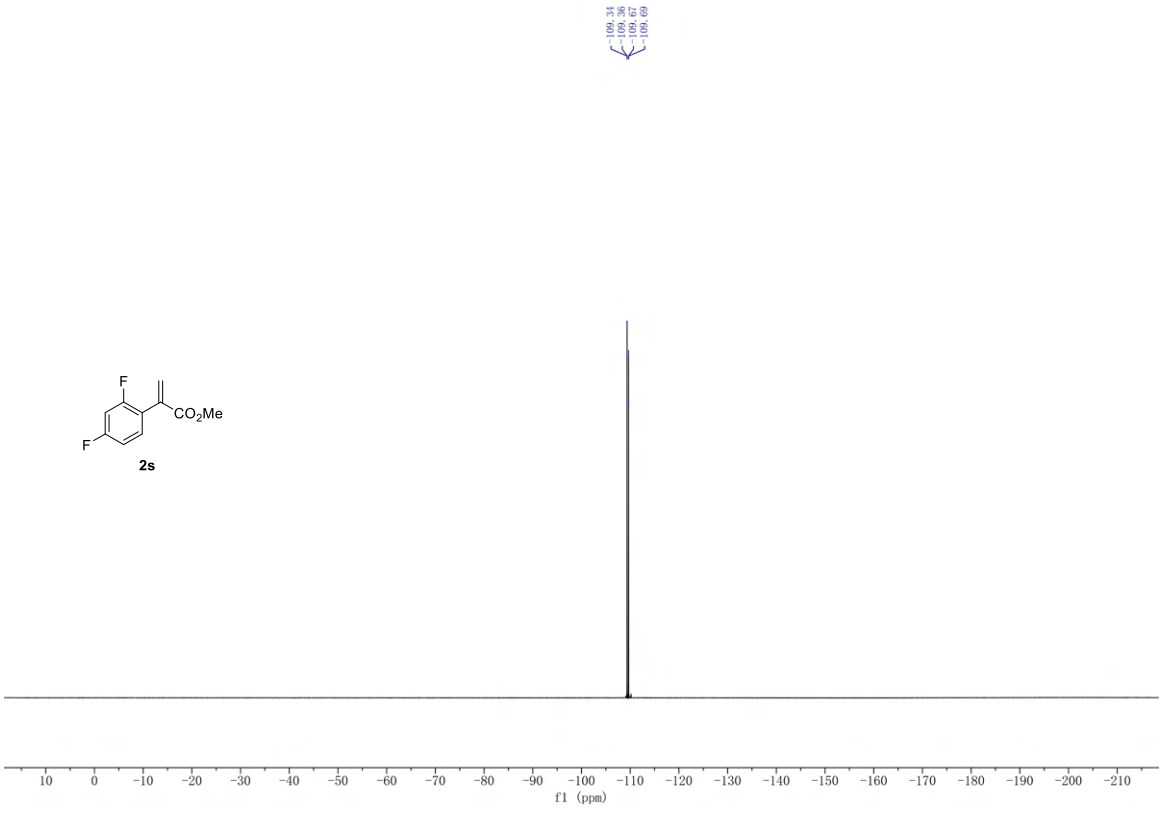

6.56
6.55
6.46
6.45
6.45
6.35
6.34
5.90
5.89
3.82
3.80
MeO
CO2Me
OMe
1.91
0.96
1.00
0.98
2.86
5.90
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

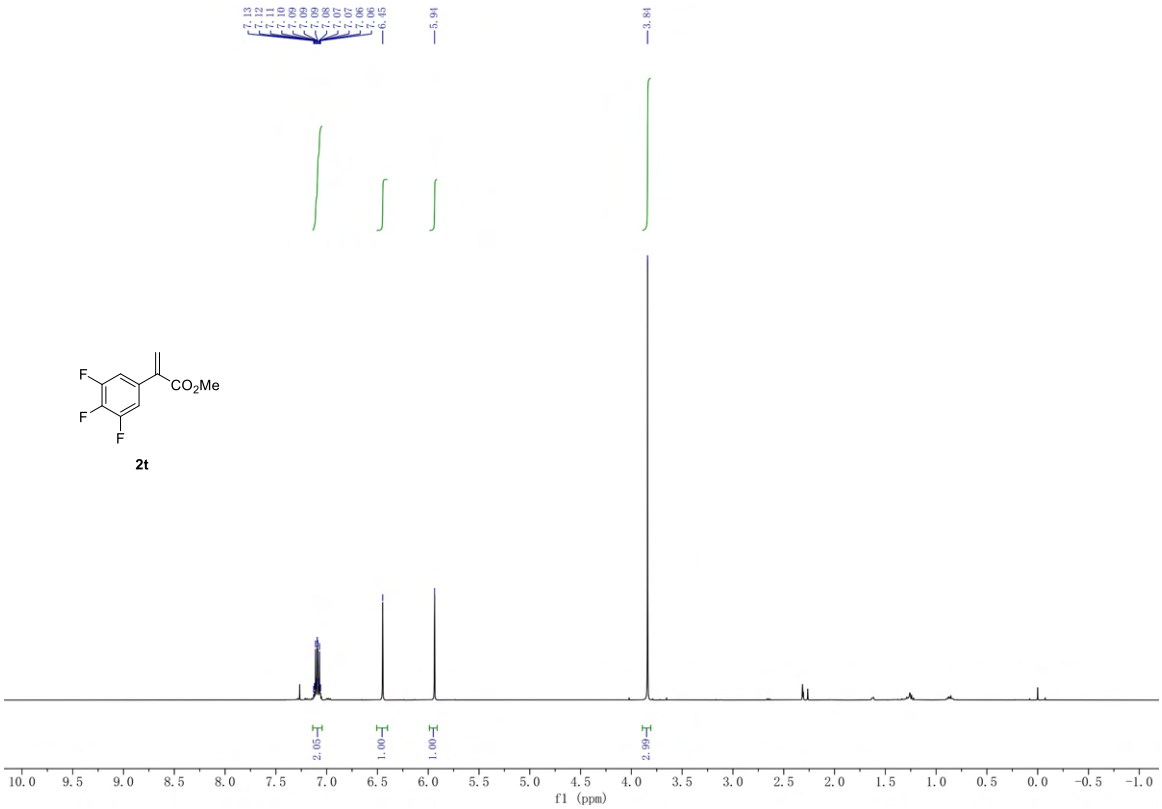
**2r**

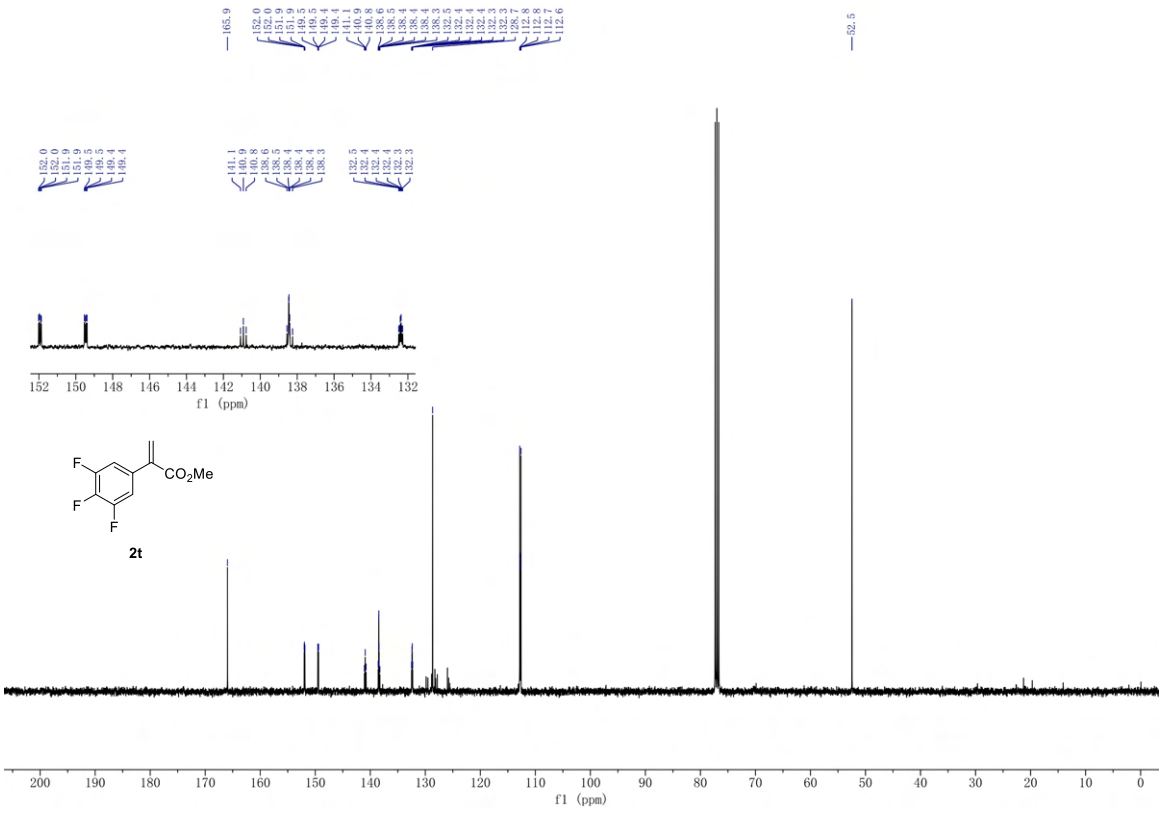

167.0
160.3
141.1
138.5
127.1
106.5
100.2
55.3
52.2
MeO
CO2Me
OMe
2r
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

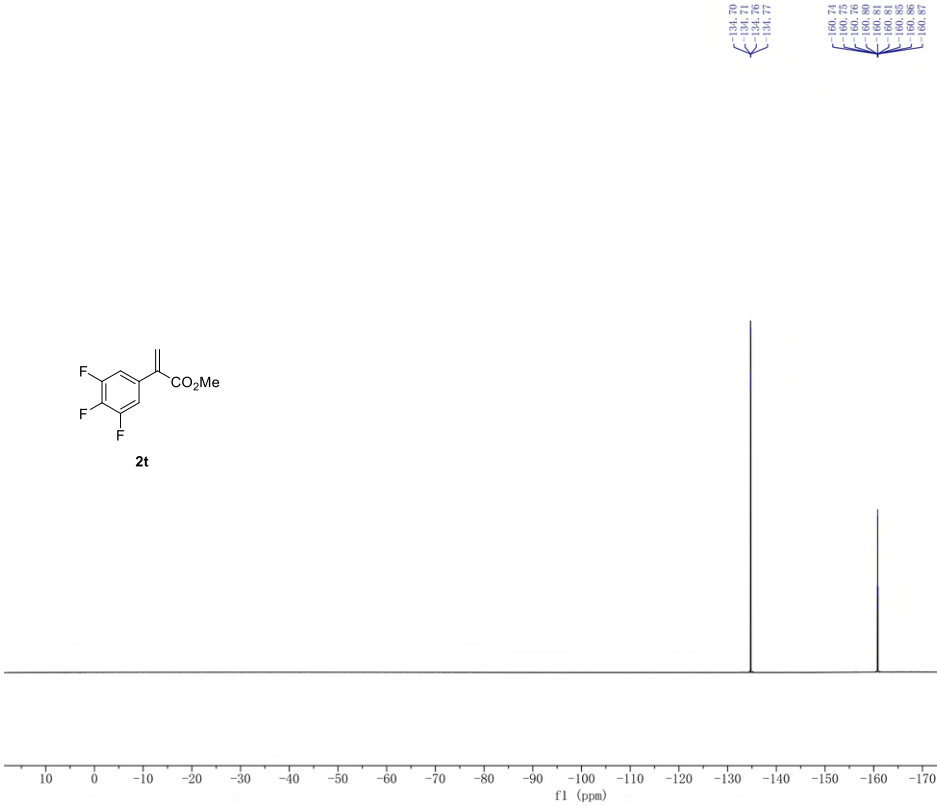

7.29
7.27
7.27
7.25
7.24
7.23
6.91
6.90
6.90
6.89
6.88
6.88
6.87
6.86
6.86
6.85
6.84
6.83
6.83
6.81
6.80
6.52
6.52
5.88
5.88
3.80
F
F
CO2Me
2s
1.03
1.98
1.00
1.00
2.95
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


166.3
164.2
164.1
161.7
161.6
161.3
161.2
158.8
158.7
135.5
131.6
131.5
131.5
129.7
121.3
121.2
121.1
121.1
111.2
111.2
111.0
111.0
104.2
103.9
103.7
52.4
F
CO2Me
F
2s
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

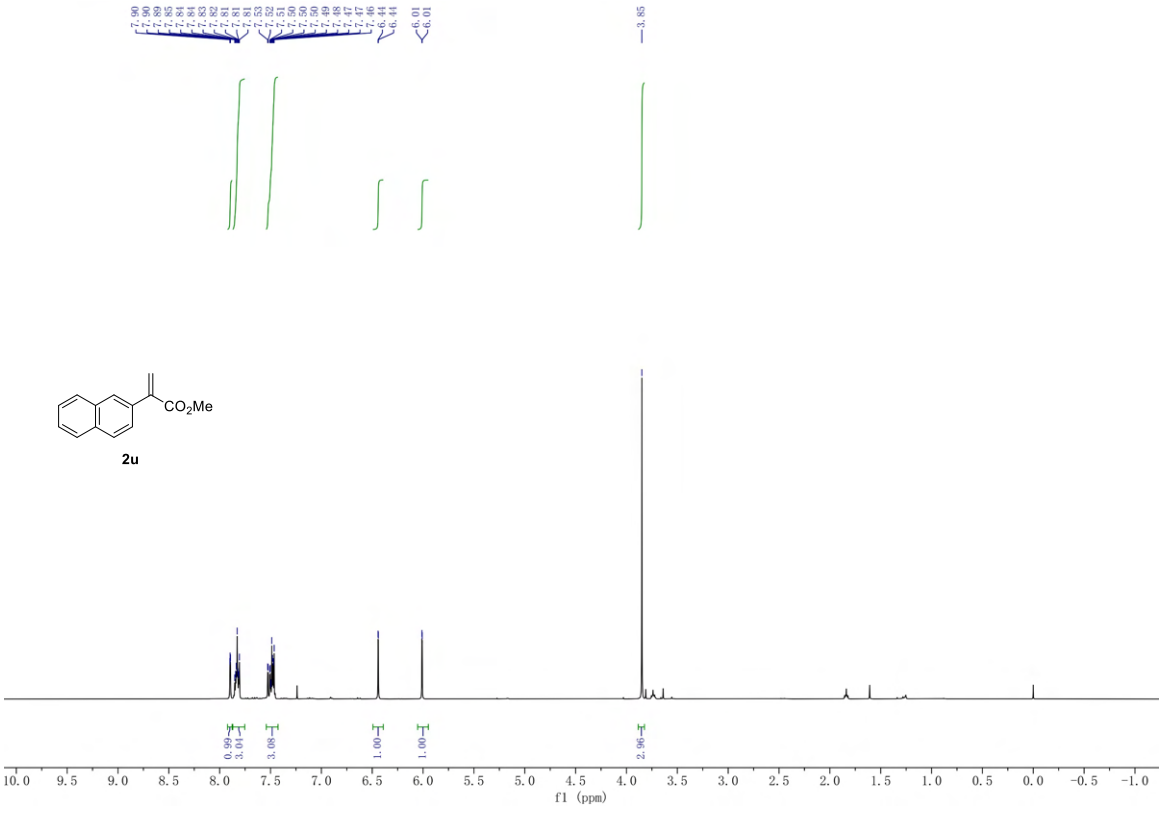

109.34
109.36
109.67
109.69
F
CO2Me
F
2s
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


7.13
7.12
7.11
7.10
7.09
7.09
7.09
7.08
7.07
7.07
7.06
7.06
6.45
5.94
3.84
F
F
F
CO2Me
2t
2.05
1.00
1.00
2.99
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

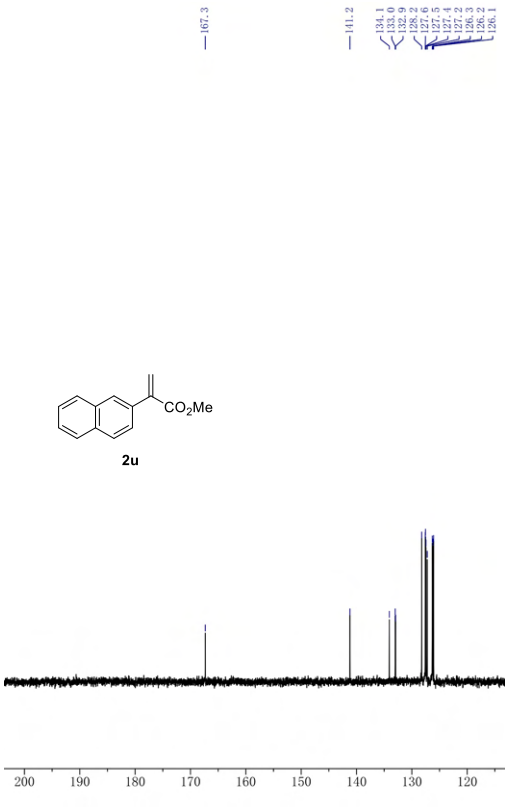

165.9
152.0
152.0
151.9
151.9
149.5
149.5
149.4
149.4
141.1
140.9
140.8
138.6
138.5
138.4
138.4
138.3
132.5
132.4
132.4
132.3
132.3
112.8
112.8
112.7
112.6
52.5
152 150 148 146 144 142 140 138 136 134 132
f1 (ppm)
F
F
F
CO2Me
2t
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

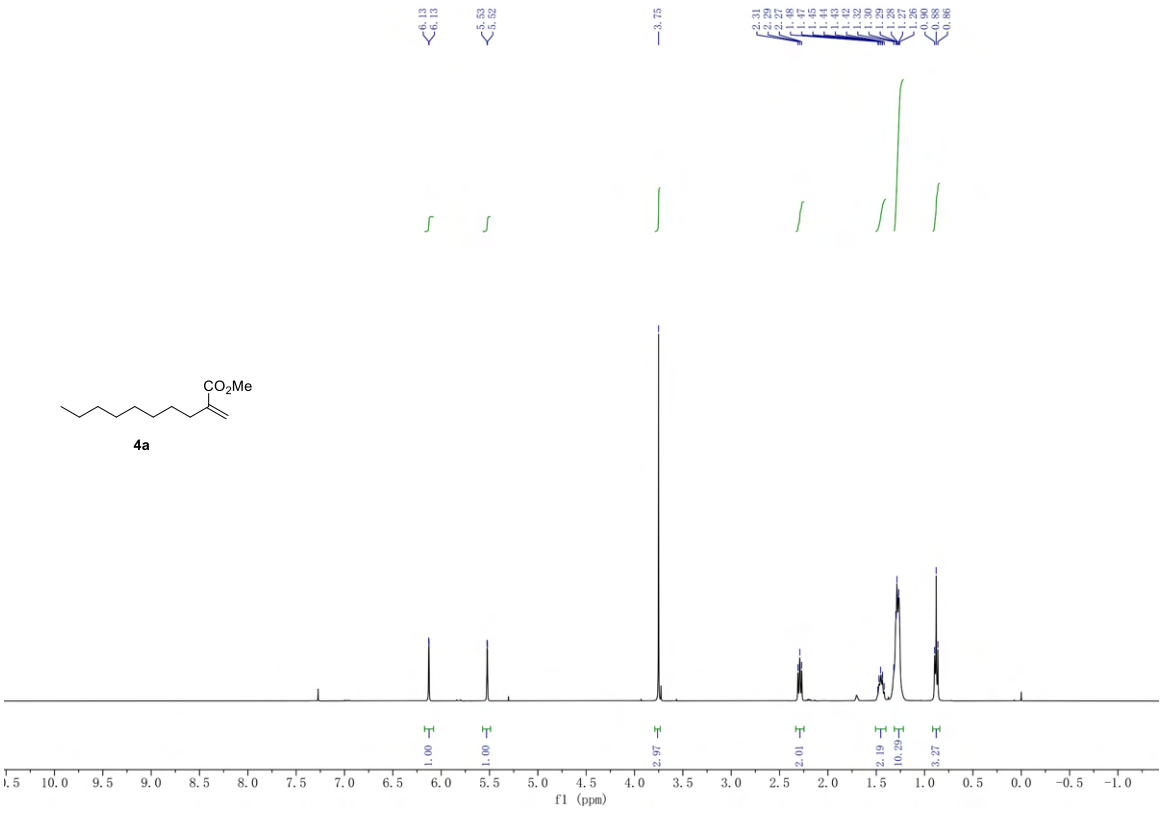

134.70
134.71
134.76
134.77
160.74
160.75
160.76
160.80
160.81
160.81
160.85
160.86
160.87
F
F
F
CO2Me
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

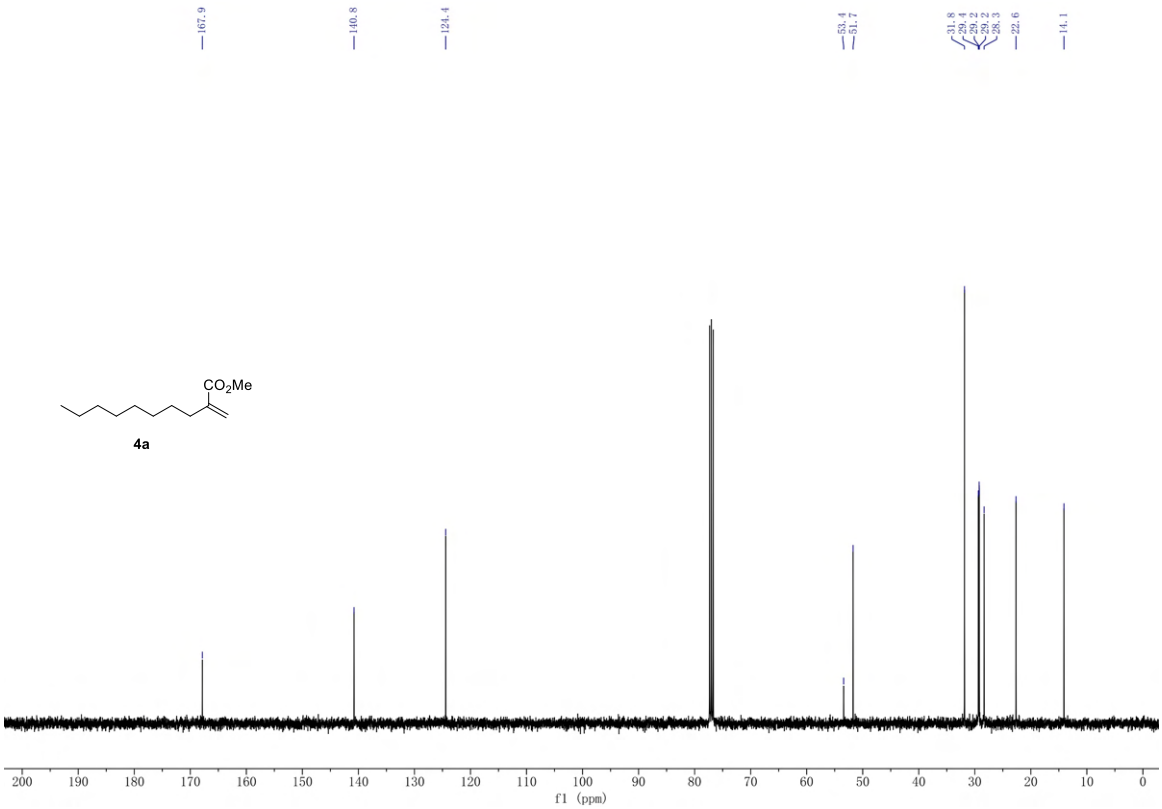
**2t**

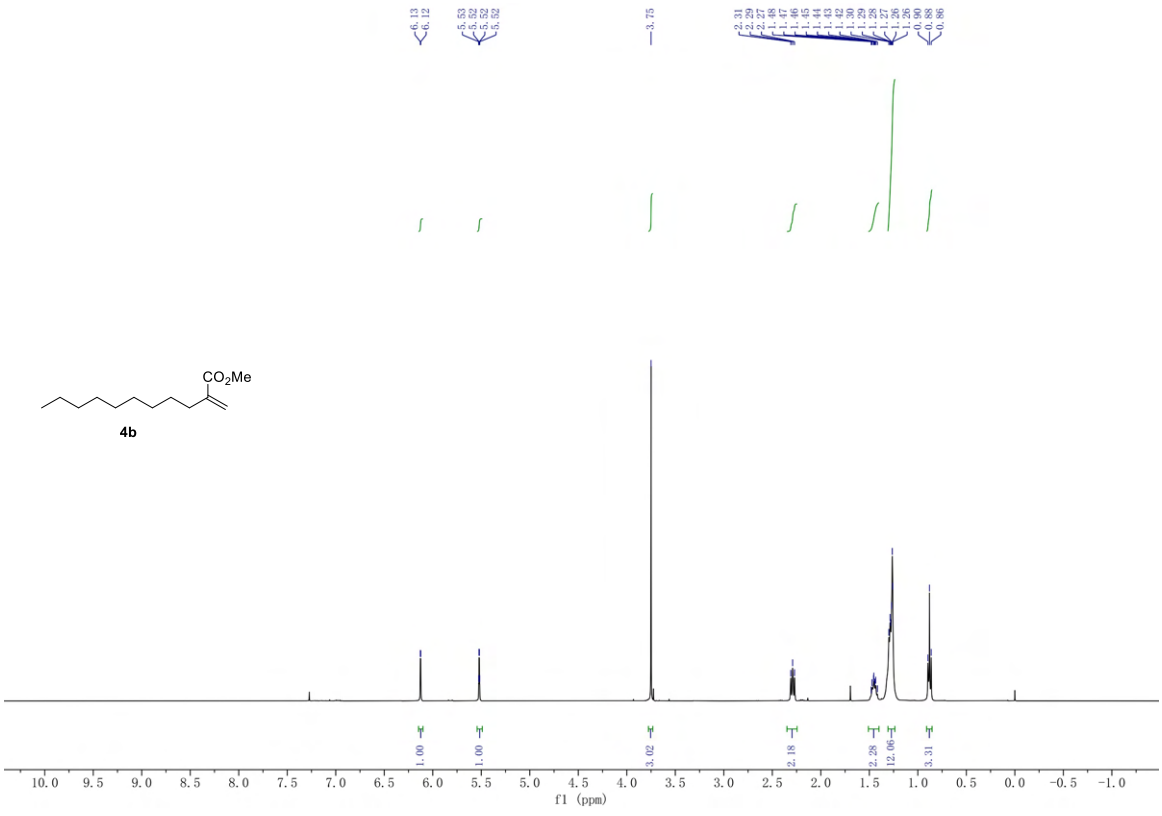

7.90
7.90
7.89
7.85
7.84
7.84
7.83
7.82
7.81
7.81
7.81
7.53
7.52
7.51
7.50
7.50
7.50
7.49
7.48
7.47
7.47
7.46
6.44
6.44
6.01
6.01
3.85
CO2Me
0.99
3.04
3.08
1.00
1.00
2.96
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

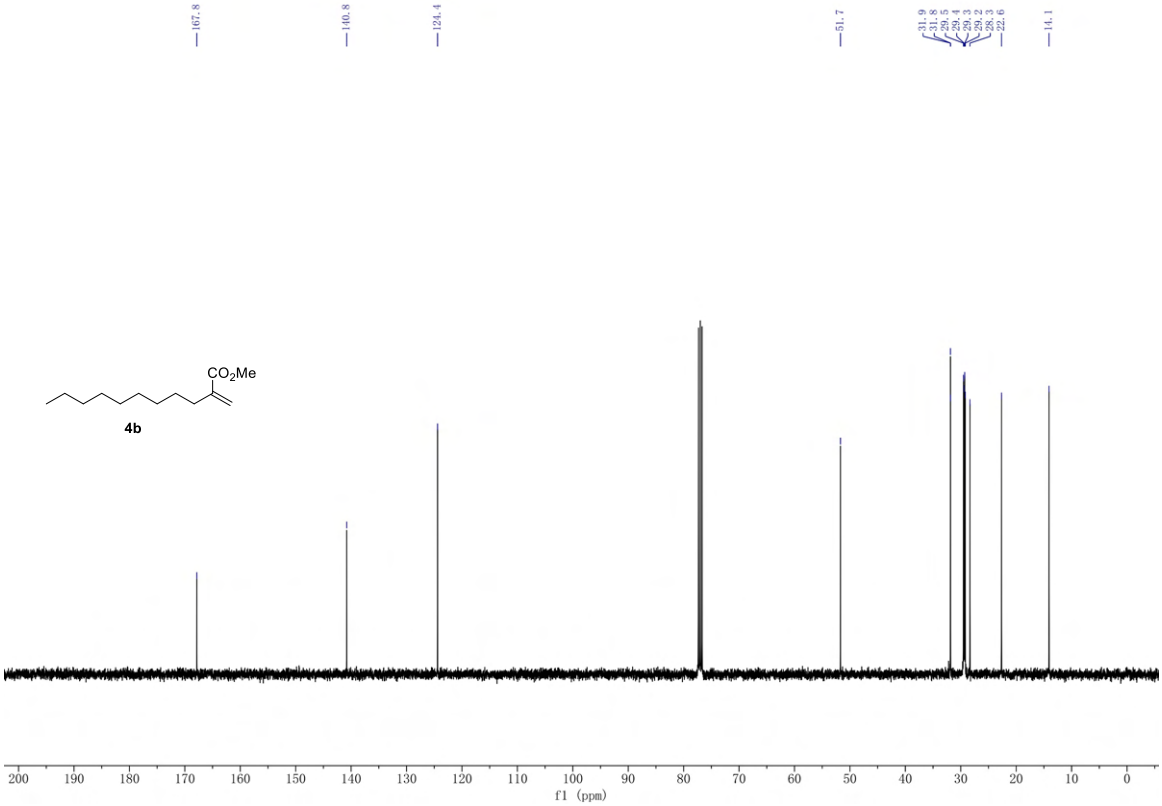
**2u**


167.3
141.2
134.1
133.0
132.9
128.2
127.6
127.5
127.4
127.2
126.3
126.2
126.1
52.3
CO2Me
2u
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


6.13
6.13
5.53
5.52
3.75
2.31
2.29
2.27
1.48
1.47
1.45
1.44
1.43
1.42
1.32
1.30
1.29
1.28
1.27
1.26
0.90
0.88
0.86
CO2Me
4a
1.00
1.00
2.97
2.01
2.19
10.29
3.27
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


167.9
140.8
124.4
53.4
51.7
31.8
29.4
29.2
29.2
28.3
22.6
14.1
CO2Me
4a
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


6.13
6.12
5.53
5.52
5.52
5.52
3.75
2.31
2.29
2.27
1.48
1.47
1.46
1.45
1.44
1.43
1.42
1.39
1.29
1.28
1.27
1.26
1.25
0.90
0.88
0.86
CO2Me
4b
1.00
1.00
3.02
2.18
2.28
12.06
3.31
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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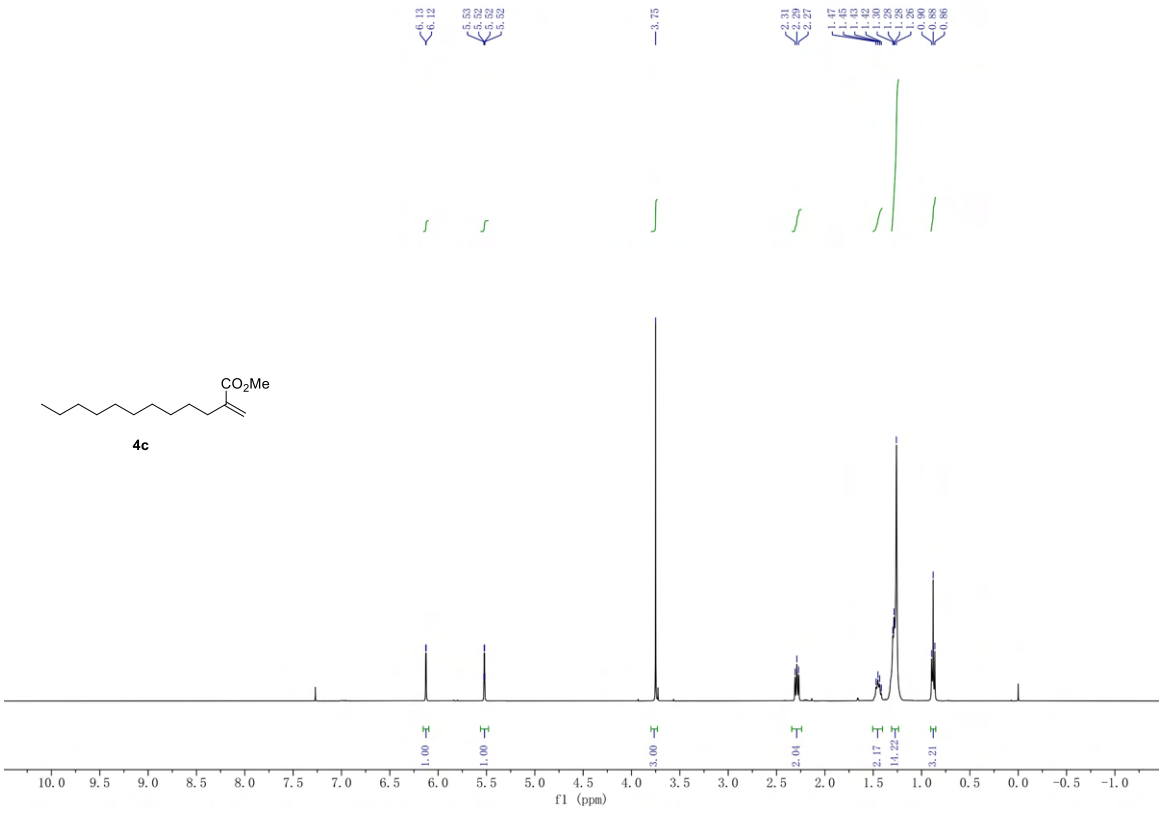
140.8
124.4
51.7
31.9
31.8
29.5
29.4
29.3
29.2
28.9
22.6
14.1
CO2Me
4b
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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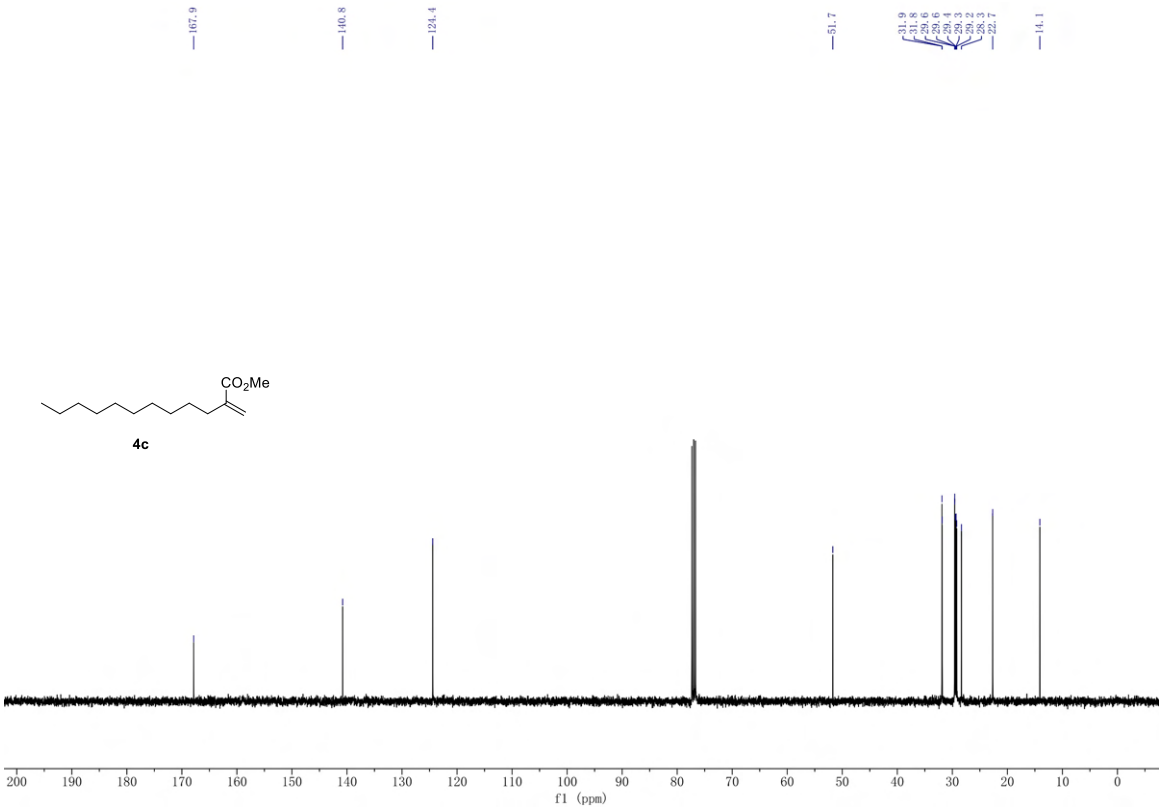
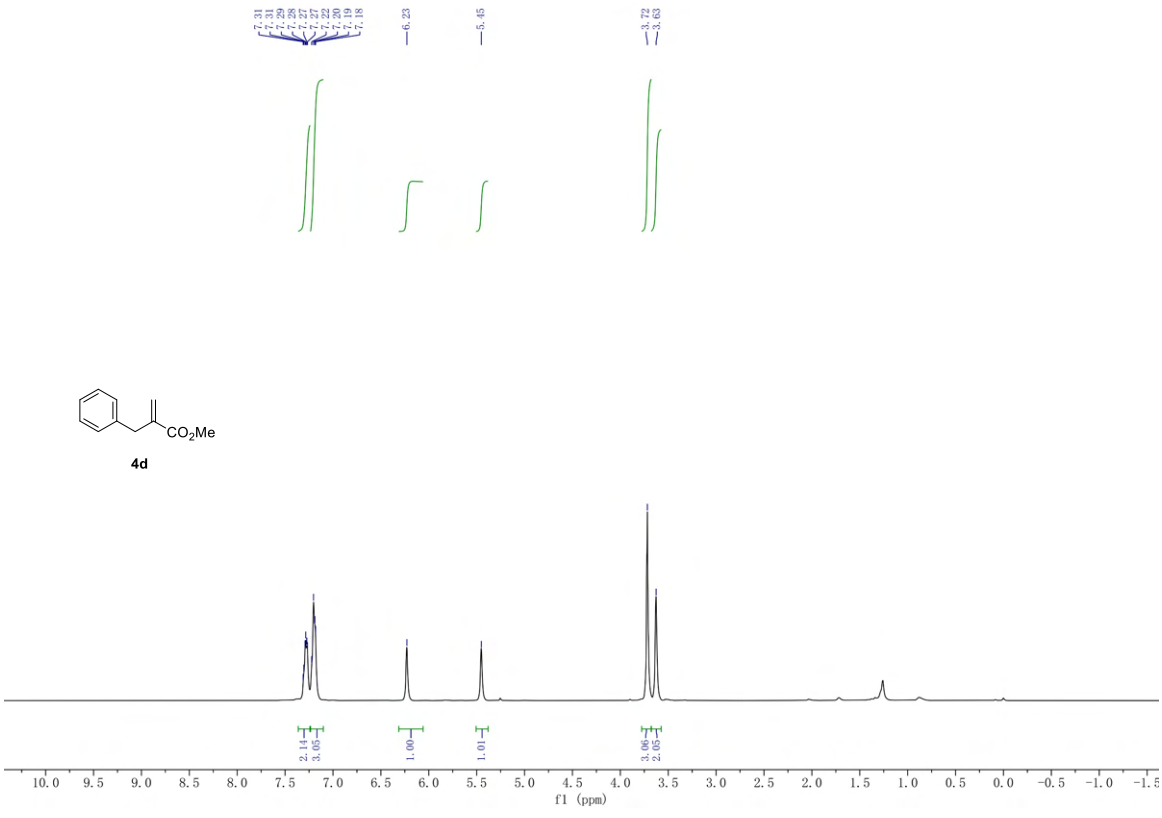
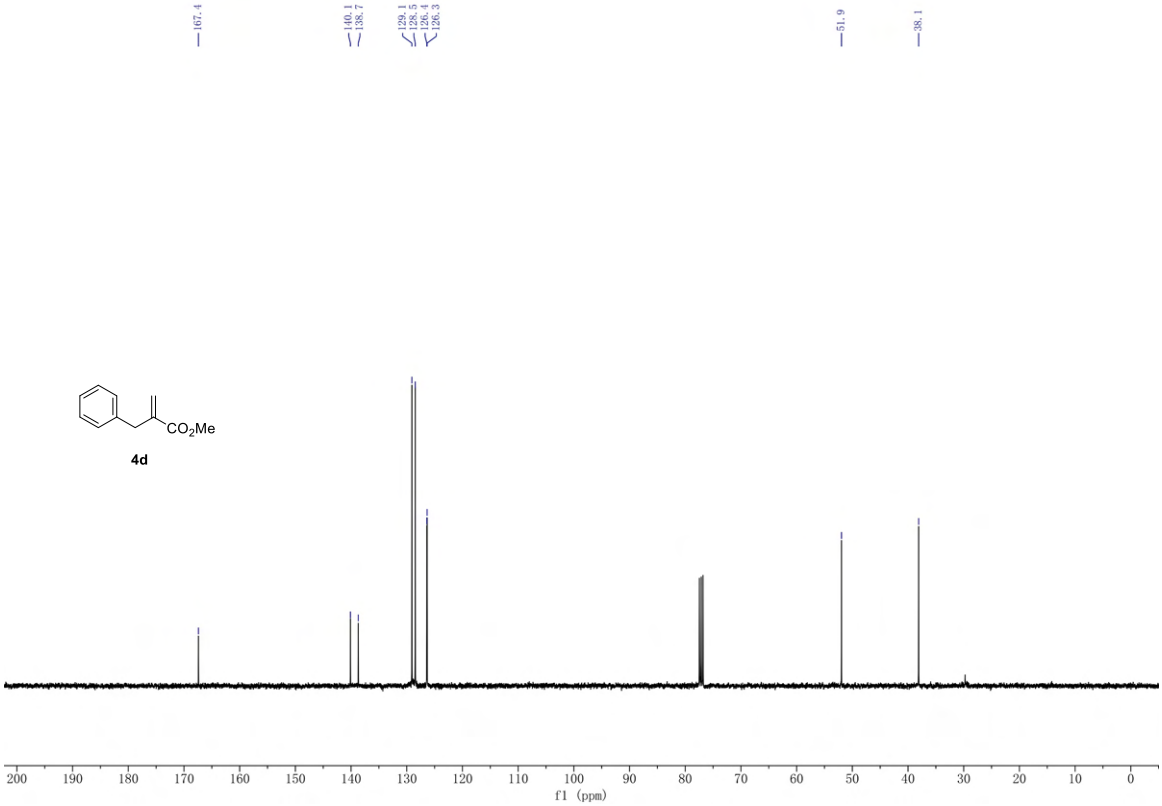
6.12
5.53
5.52
5.52
5.52
5.52
3.75
2.31
2.29
2.27
1.47
1.45
1.43
1.42
1.30
1.28
1.26
0.90
0.88
0.86
CO2Me
4c
1.00
1.00
3.00
2.04
2.17
14.22
3.21
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


167.9
140.8
124.4
51.7
31.9
31.8
29.6
29.6
29.4
29.3
29.2
28.3
22.7
14.1
CO2Me
4c
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.31
7.31
7.29
7.28
7.27
7.27
7.22
7.20
7.19
7.18
6.23
5.45
3.72
3.63
CO2Me
4d
2.14
3.05
1.00
1.01
3.06
2.65
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
f1 (ppm)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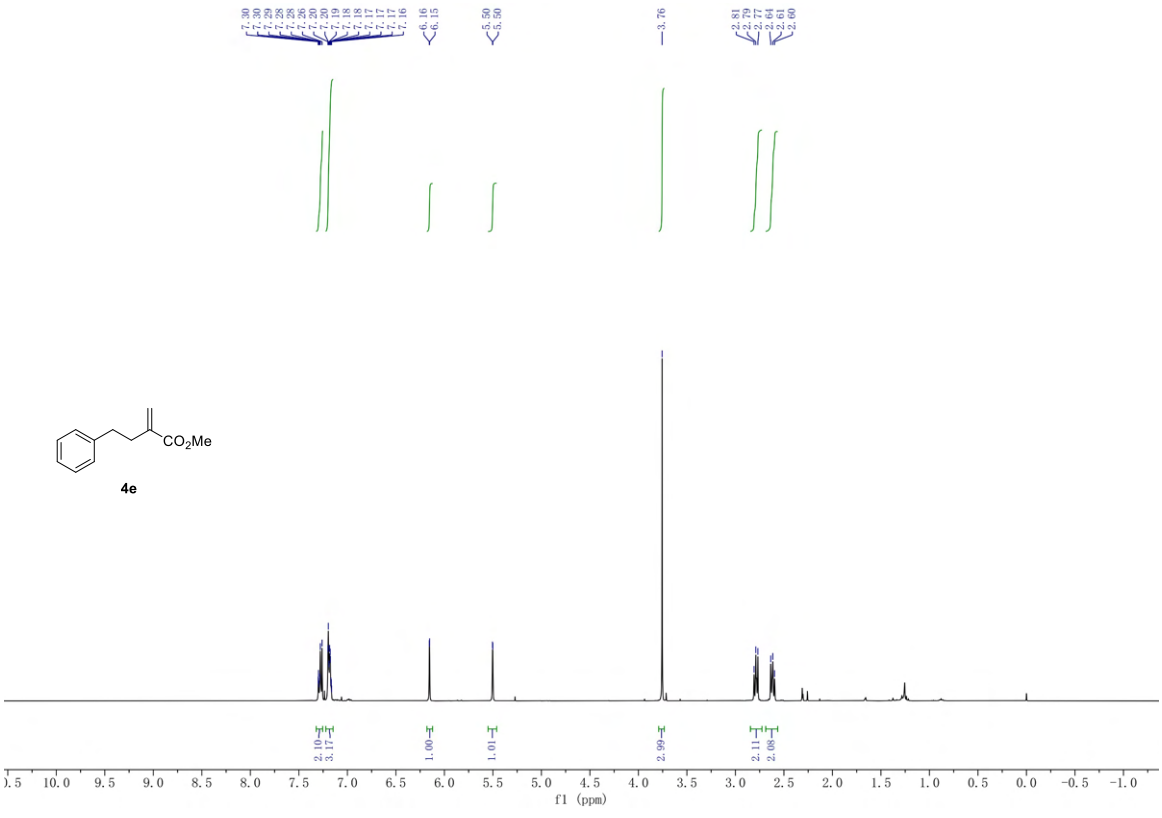
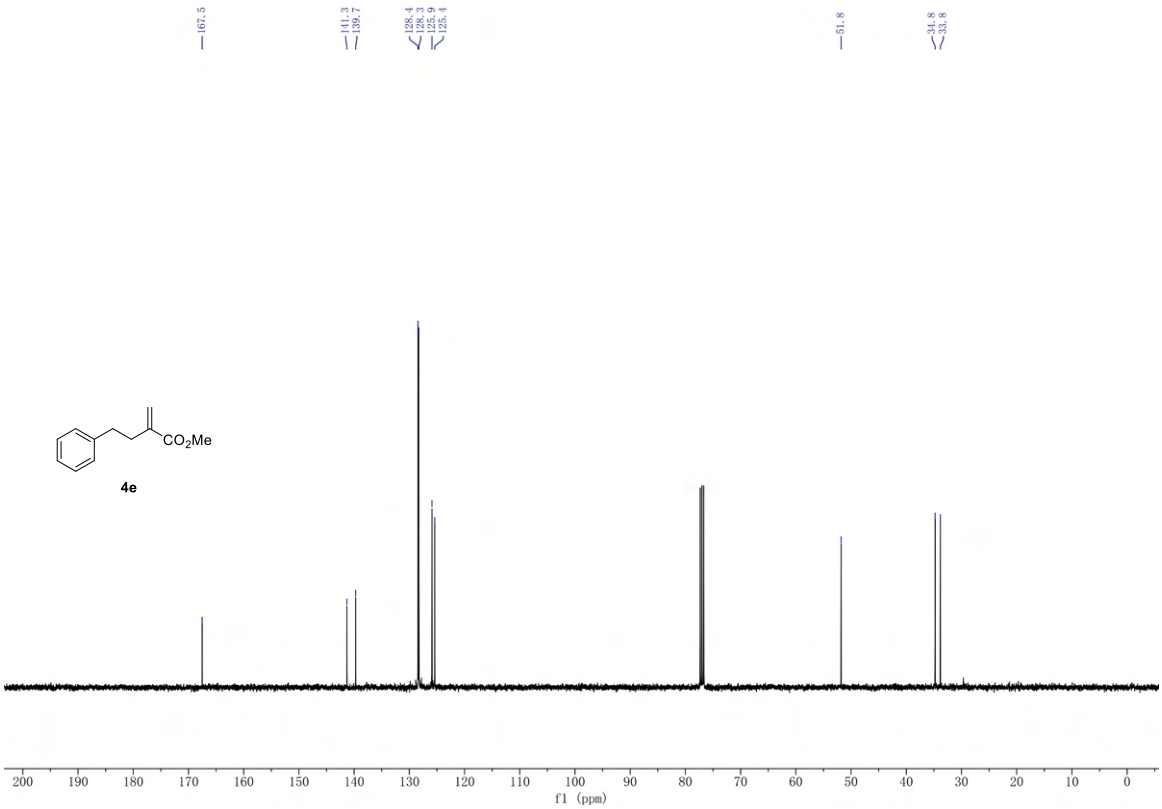
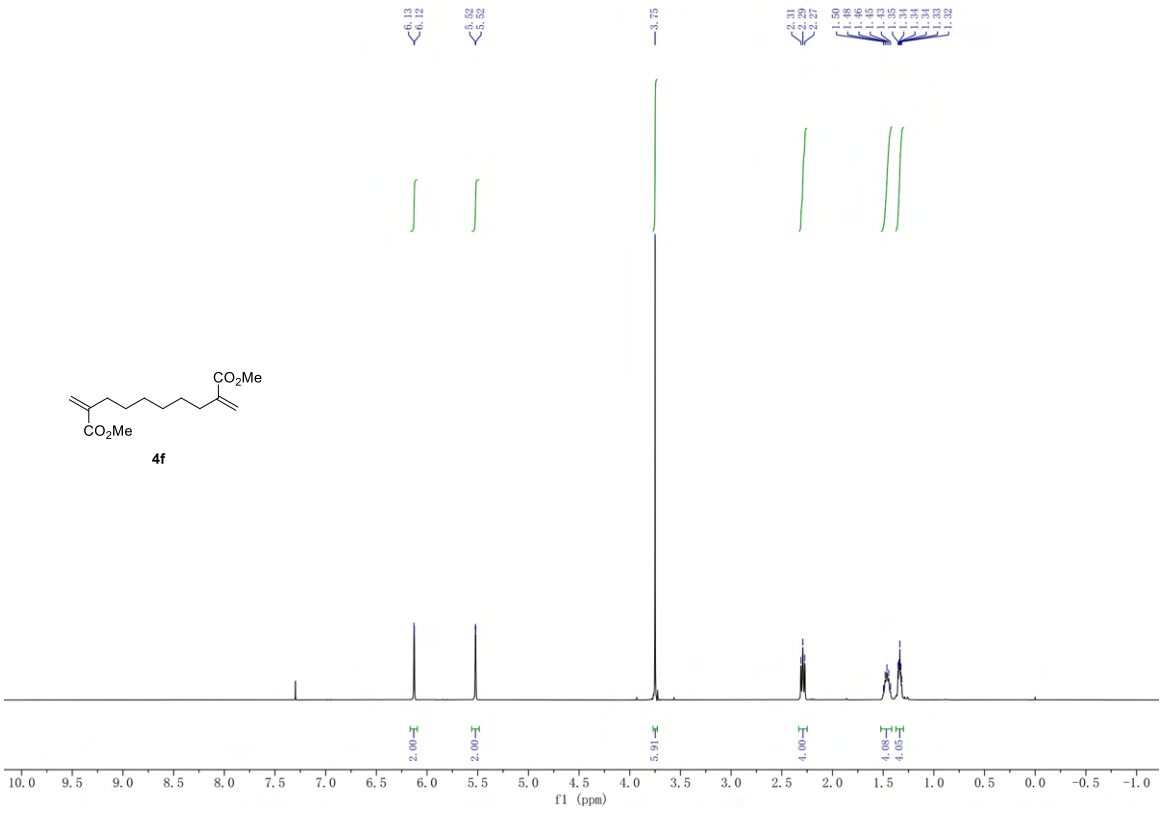
140.1
138.7
129.1
128.5
126.4
126.3
51.9
38.1
CO2Me
4d
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.30
7.30
7.29
7.28
7.28
7.26
7.20
7.20
7.19
7.18
7.18
7.17
7.17
7.17
7.17
7.16
6.16
6.15
5.50
5.50
3.76
2.81
2.79
2.77
2.64
2.62
2.60
CO2Me
4e
2.10
3.17
1.00
1.01
2.99
2.11
2.08
f1 (ppm)


167.5
141.3
139.7
128.4
128.3
125.9
125.4
51.8
34.8
33.8
CO2Me
4e
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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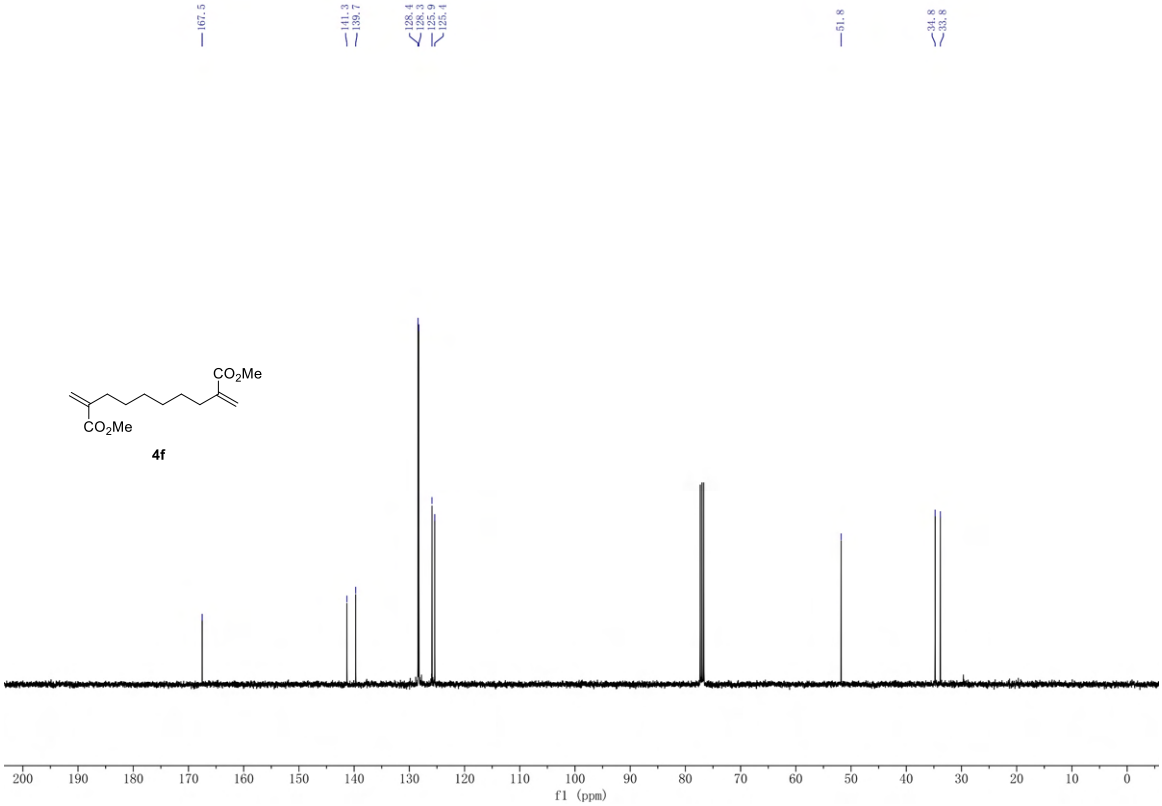
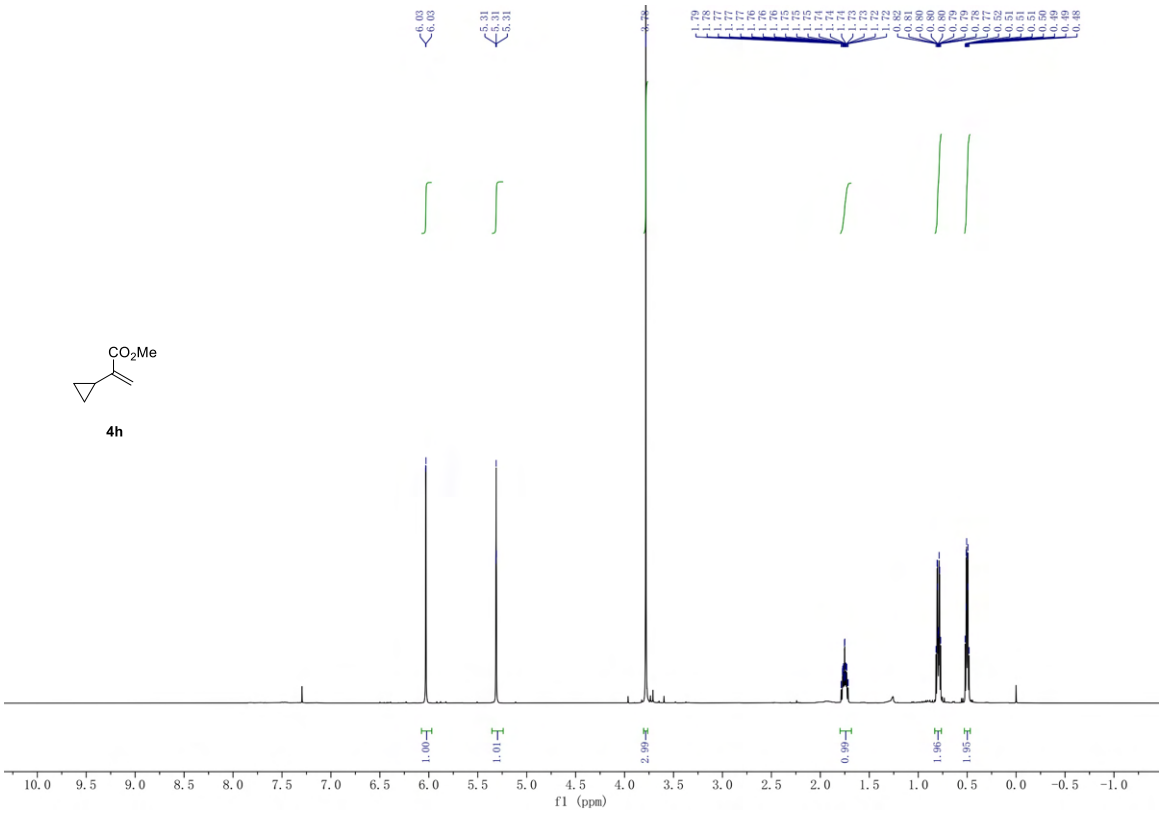
5.52
3.75
2.31
2.29
2.27
1.50
1.48
1.46
1.45
1.43
1.35
1.34
1.34
1.34
1.33
1.32
CO2Me
CO2Me
4f
2.00
2.00
5.91
4.00
4.08
4.05
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


167.5
141.3
139.7
128.4
128.3
125.9
125.4
51.8
34.8
33.8
CO2Me
CO2Me
4f
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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6.03
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1.78
1.77
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1.77
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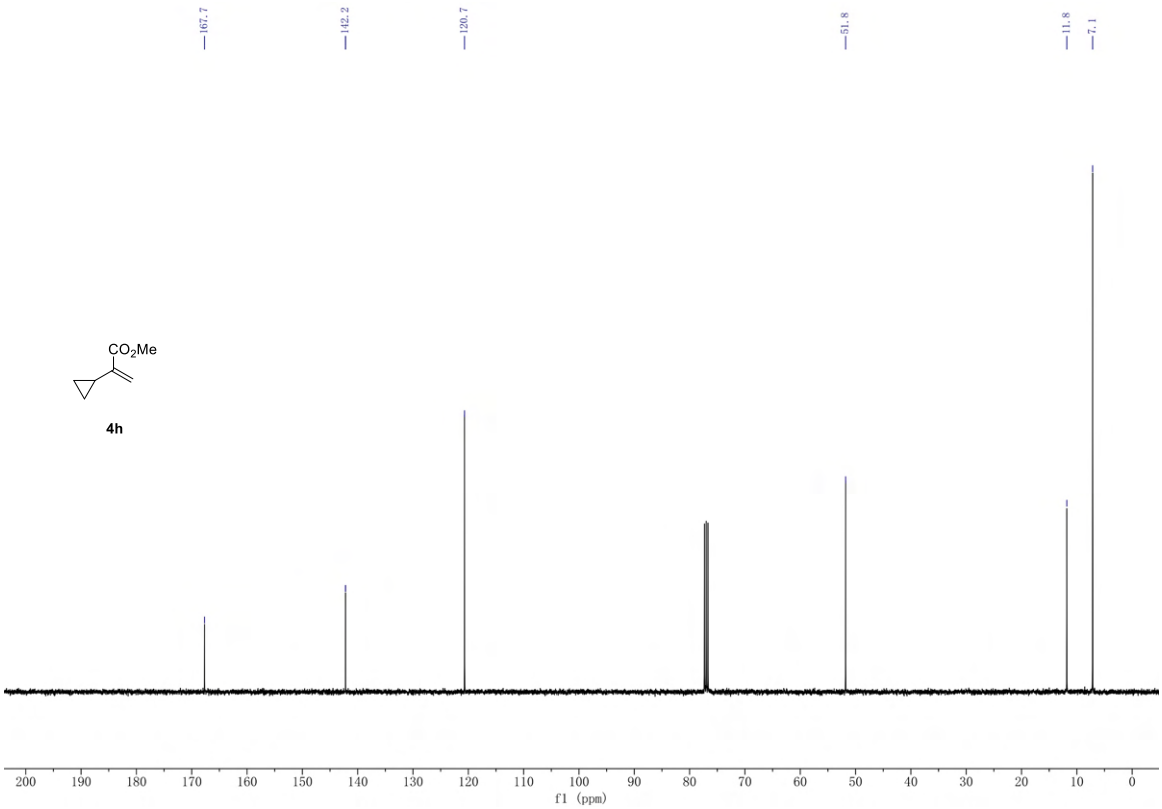
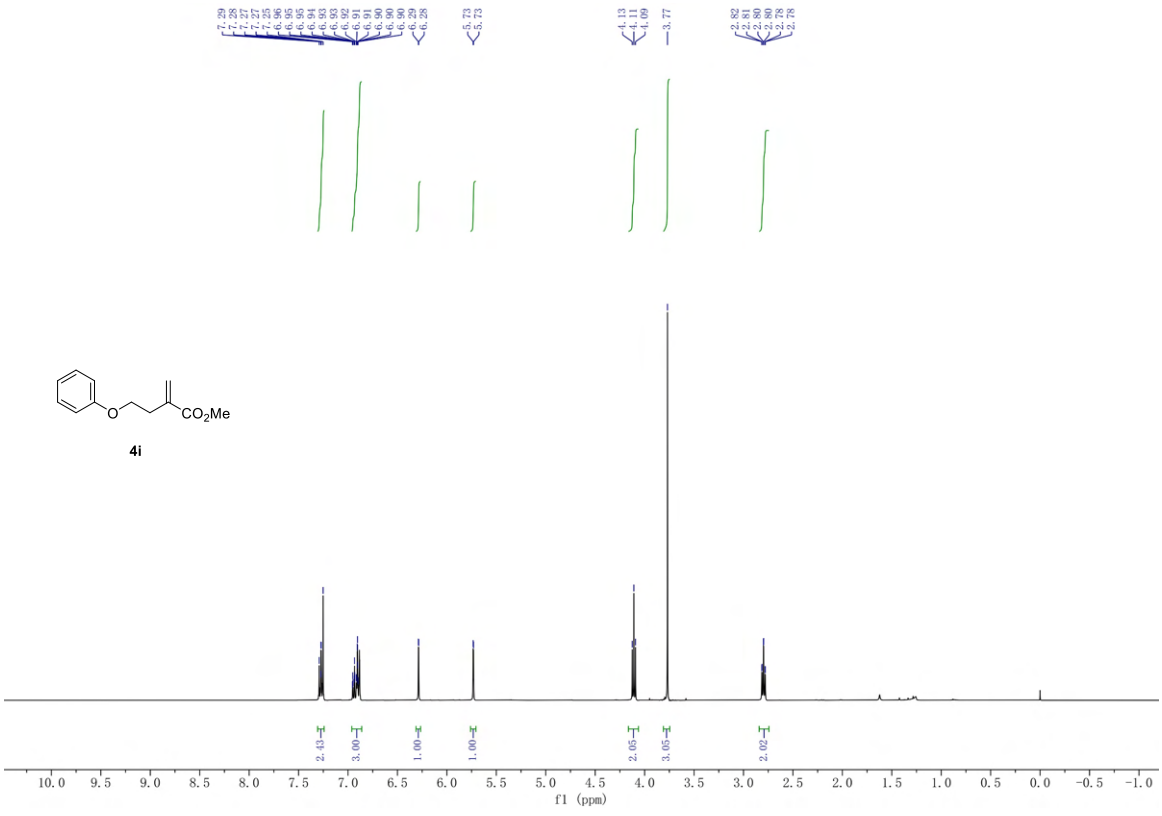
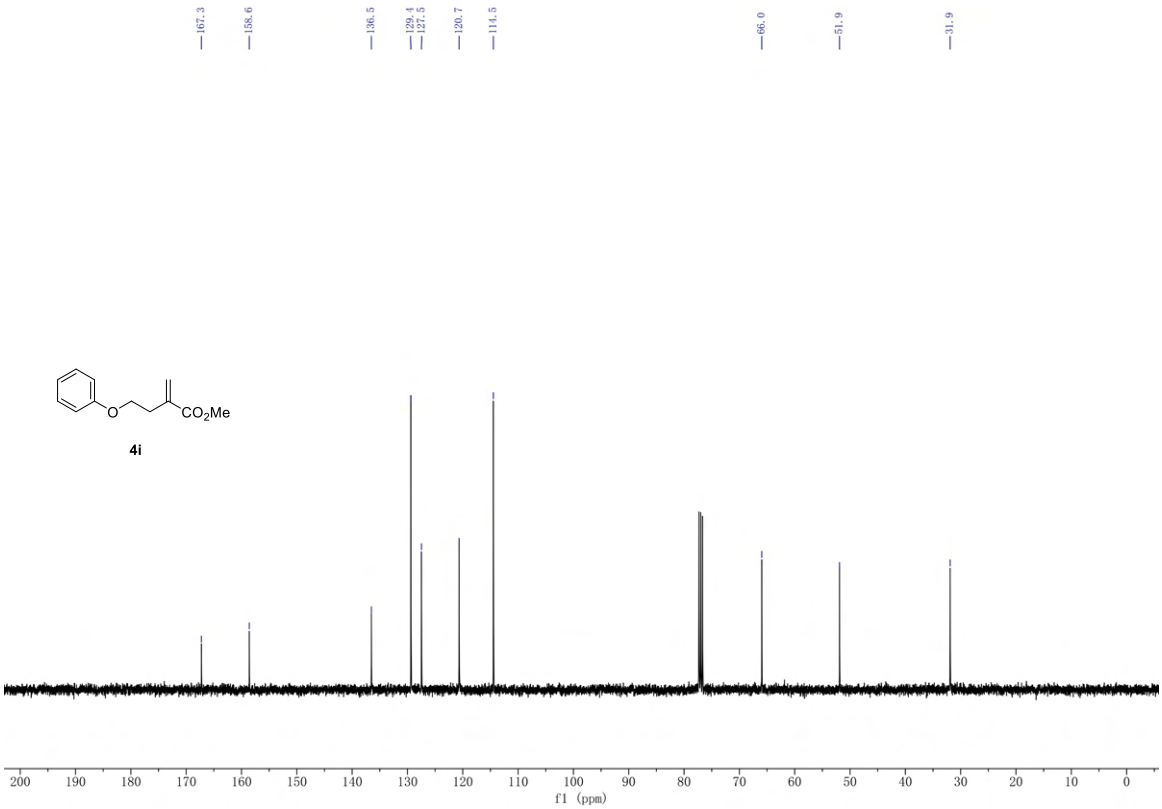
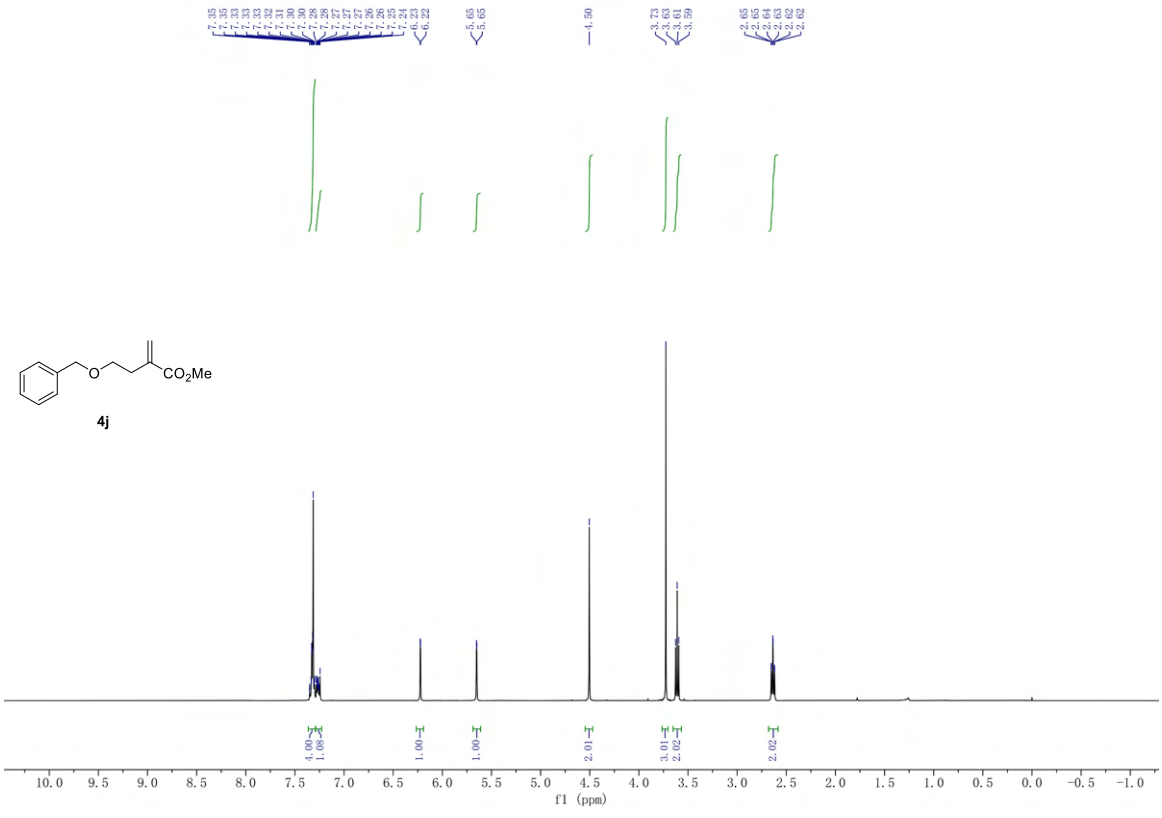
1.75
1.75
1.75
1.74
1.74
1.74
1.73
1.73
1.72
1.72
0.82
0.81
0.80
0.80
0.79
0.79
0.78
0.78
0.77
0.52
0.51
0.51
0.51
0.50
0.49
0.49
0.48
CO2Me
4h
1.00
1.01
2.99
0.99
1.96
1.95
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


167.7
142.2
120.7
51.8
11.8
7.1
CO2Me
4h
f1 (ppm)


7.29
7.28
7.27
7.27
7.25
6.96
6.95
6.94
6.93
6.92
6.91
6.91
6.90
6.90
6.90
6.29
6.28
5.73
5.73
4.13
4.11
4.09
3.77
2.82
2.81
2.80
2.80
2.79
2.78
O
CO2Me
4i
2.43
3.00
1.00
1.00
2.05
3.05
2.02
f1 (ppm)


167.3
158.6
136.5
129.4
127.5
120.7
114.5
66.0
51.9
31.9
O
CO2Me
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

**4i**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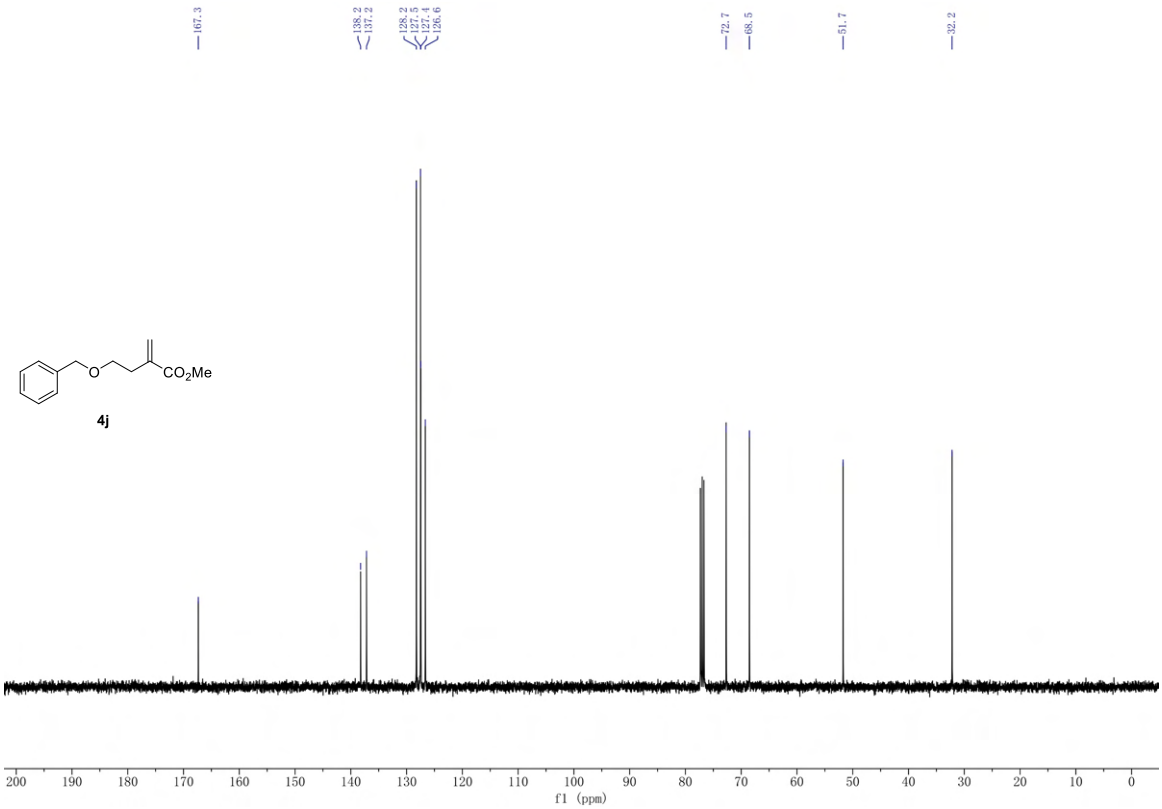
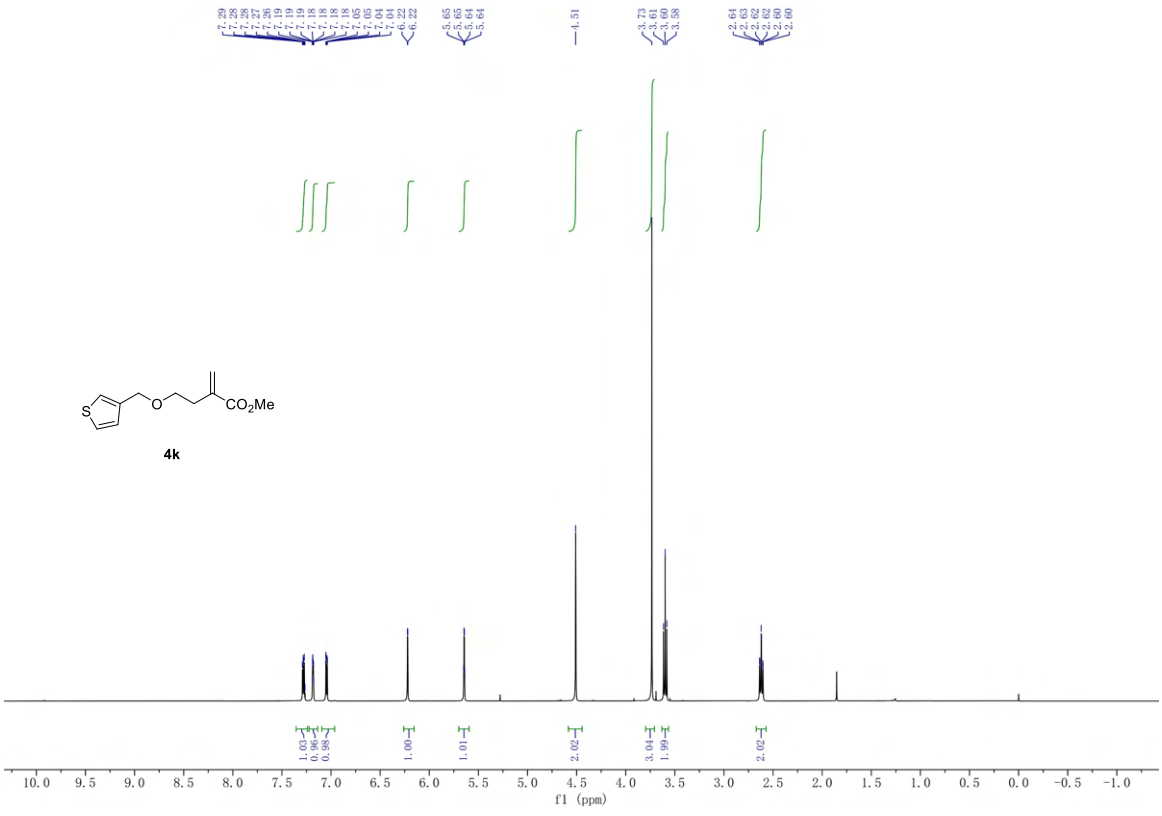
7.33
7.32
7.31
7.30
7.28
7.27
7.27
7.27
7.26
7.26
7.25
7.24
6.23
6.22
5.65
5.65
4.50
3.73
3.63
3.61
3.59
2.65
2.65
2.64
2.63
2.62
2.62
O
CO2Me
4.00
1.08
1.00
1.00
2.01
3.01
2.02
2.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

**4j**


167.3
138.2
137.2
128.2
127.5
127.4
126.6
72.7
68.5
51.7
32.2
CO2Me
O
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

**4j**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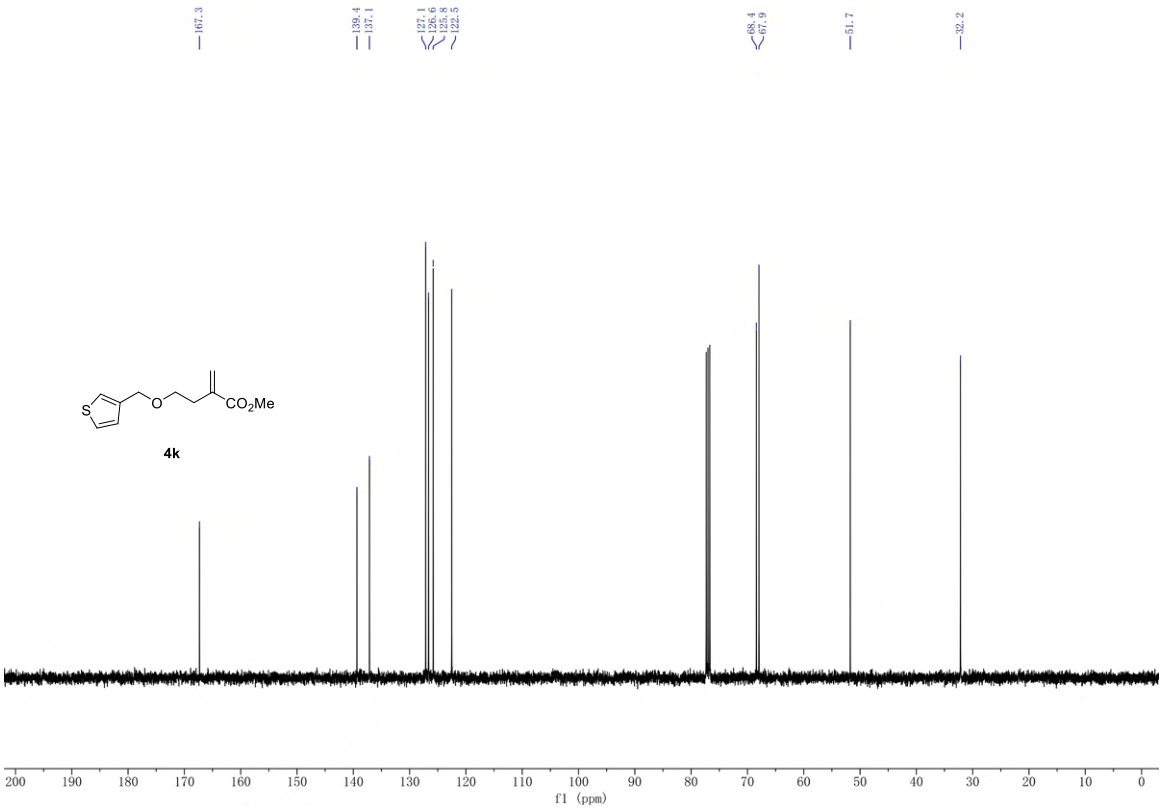
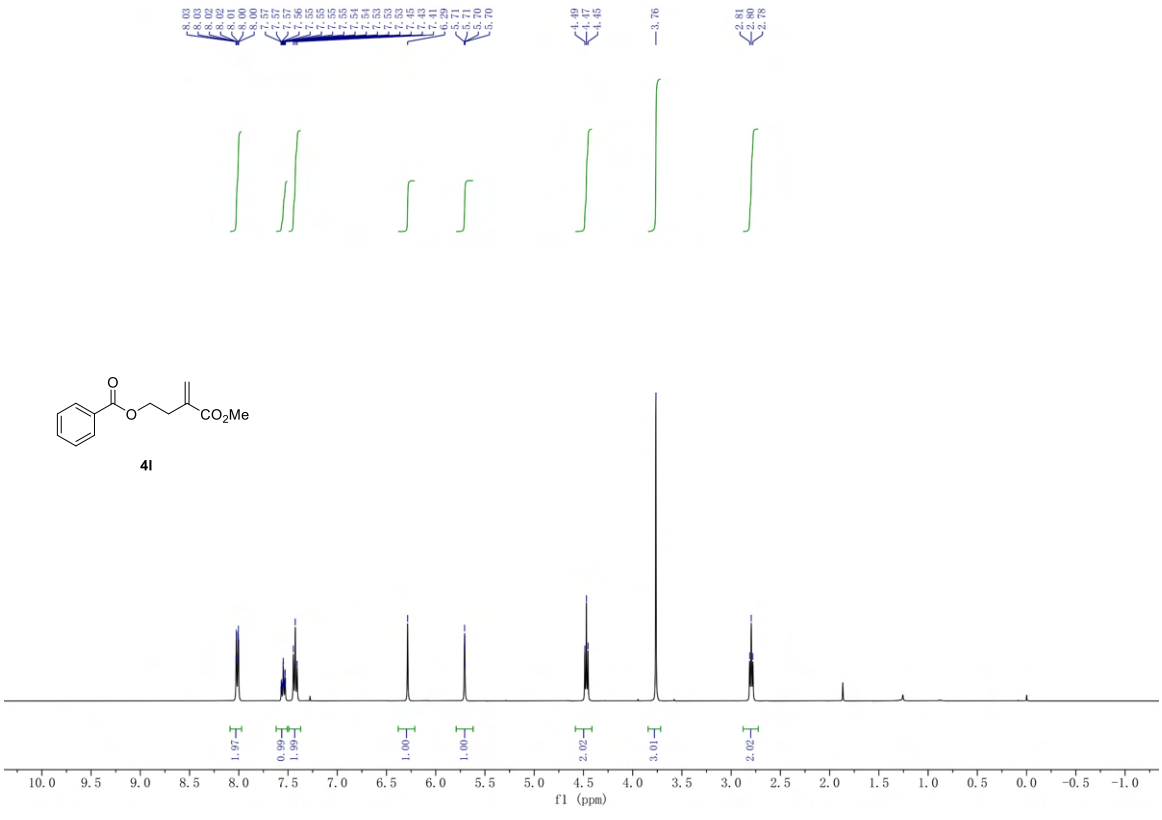
7.28
7.28
7.27
7.26
7.19
7.19
7.18
7.18
7.18
7.15
7.05
7.04
7.04
6.22
5.65
5.65
5.64
5.64
4.51
3.73
3.61
3.60
3.58
2.64
2.63
2.62
2.62
2.60
2.60
1.03
0.96
0.98
1.00
1.01
2.02
3.04
1.99
2.02
S
O
CO2Me
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

**4k**


167.3
139.4
137.1
127.1
126.6
125.8
122.5
68.4
67.9
51.7
32.2
S
O
CO2Me
4k
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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8.03
8.02
8.02
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8.00
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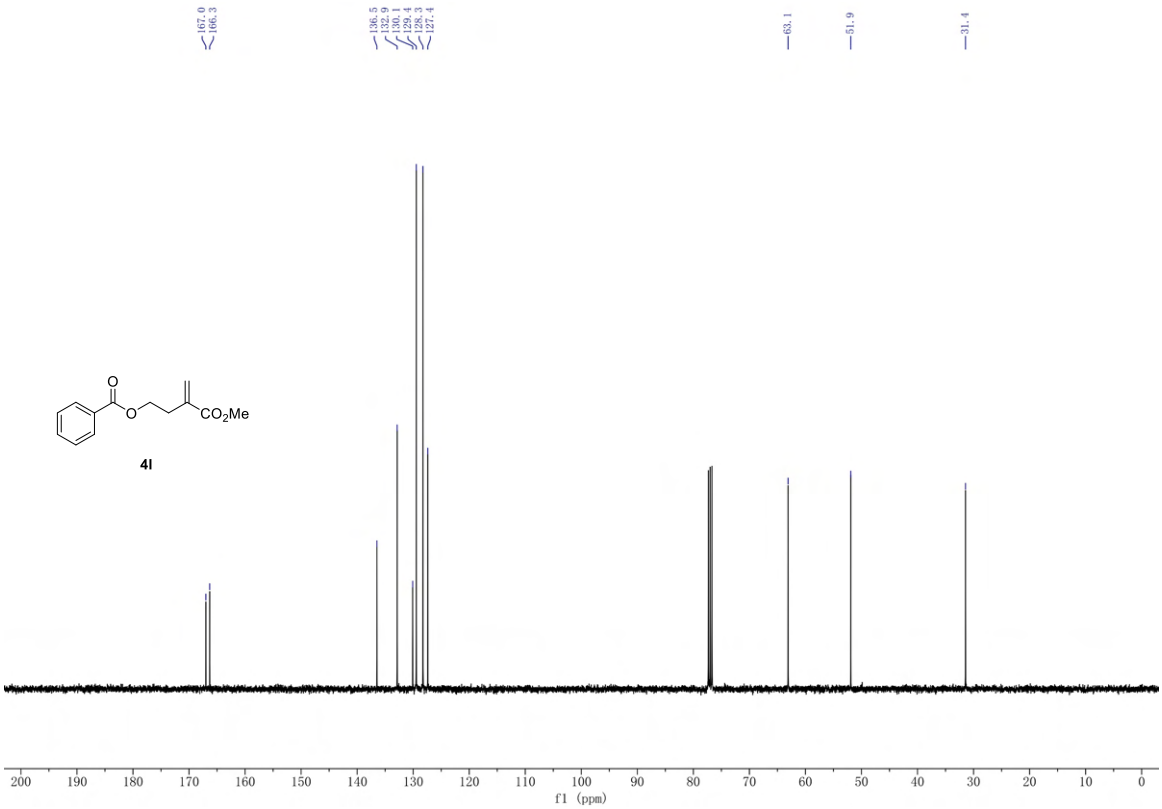
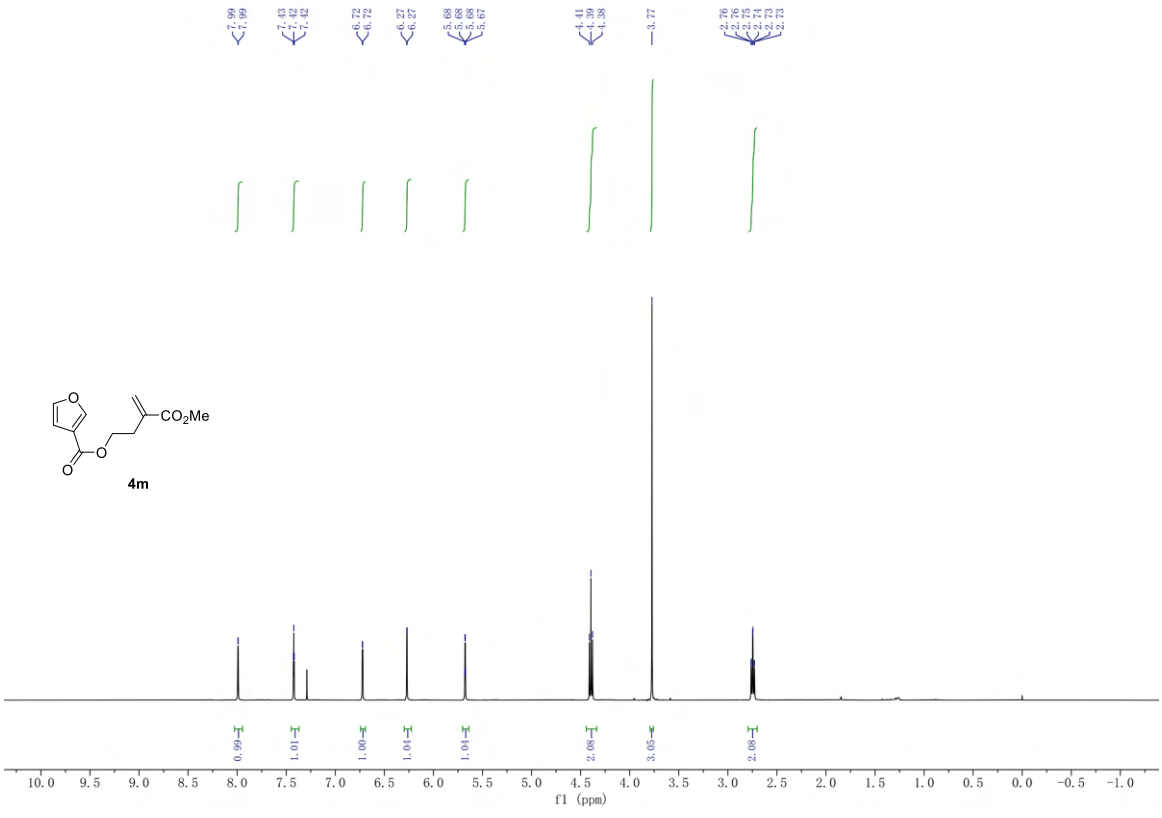
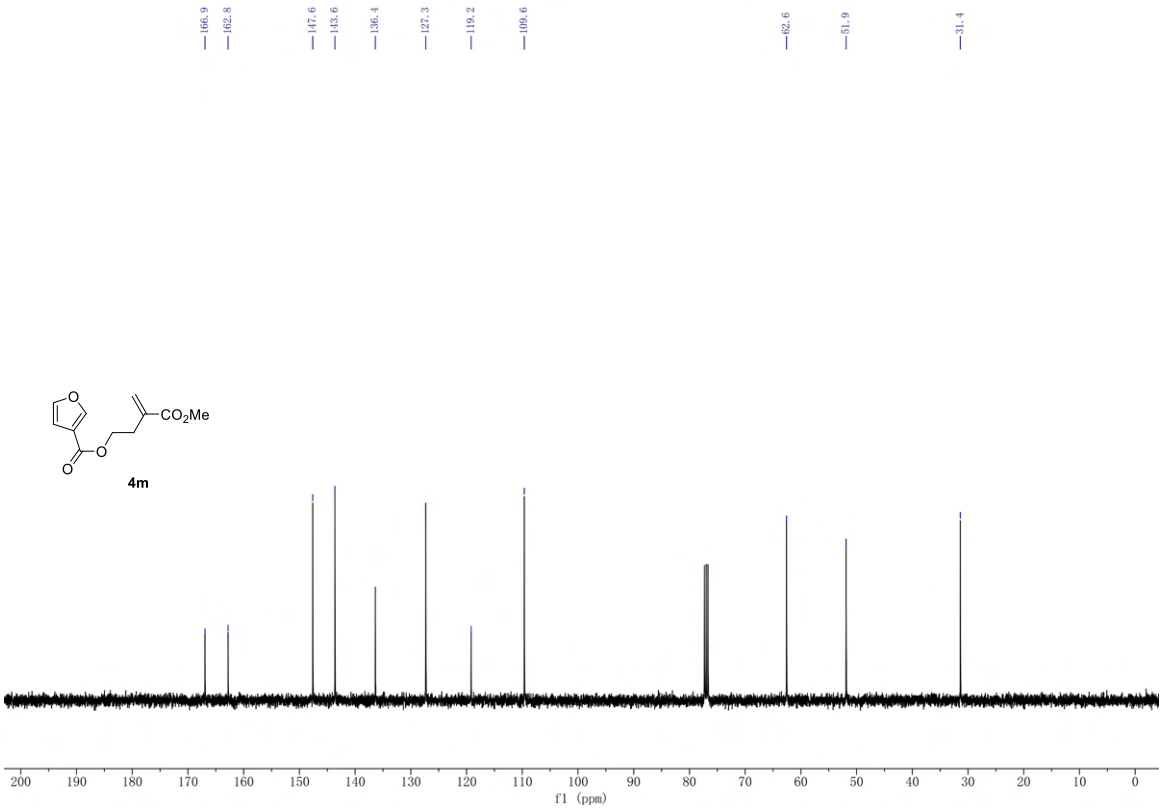
7.57
7.56
7.55
7.55
7.55
7.55
7.54
7.54
7.53
7.53
7.45
7.43
7.41
5.71
5.71
5.70
5.70
4.49
4.47
4.45
3.76
2.81
2.80
2.78
O
O
CO2Me
4l
1.97
0.99
1.99
1.00
1.00
2.02
3.01
2.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

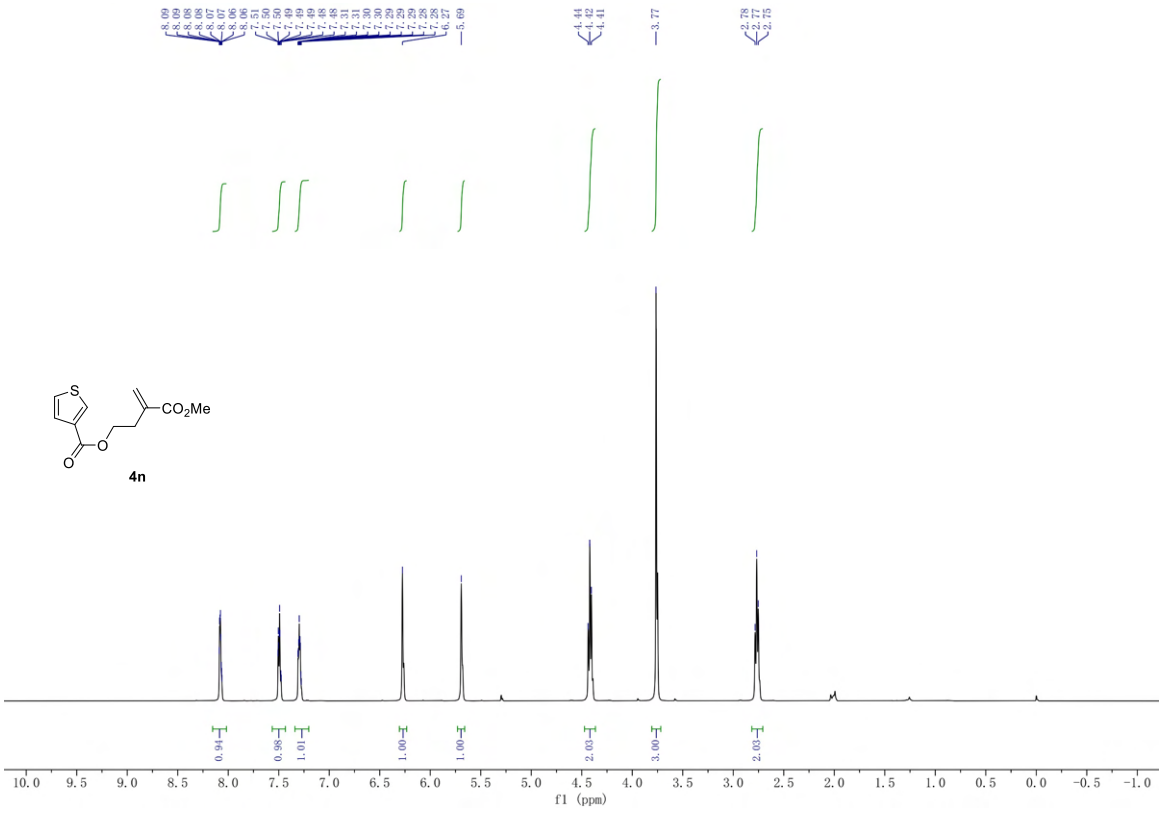

167.0
166.3
136.5
132.9
130.1
129.4
128.3
127.4
63.1
51.9
31.4
O
O
CO2Me
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

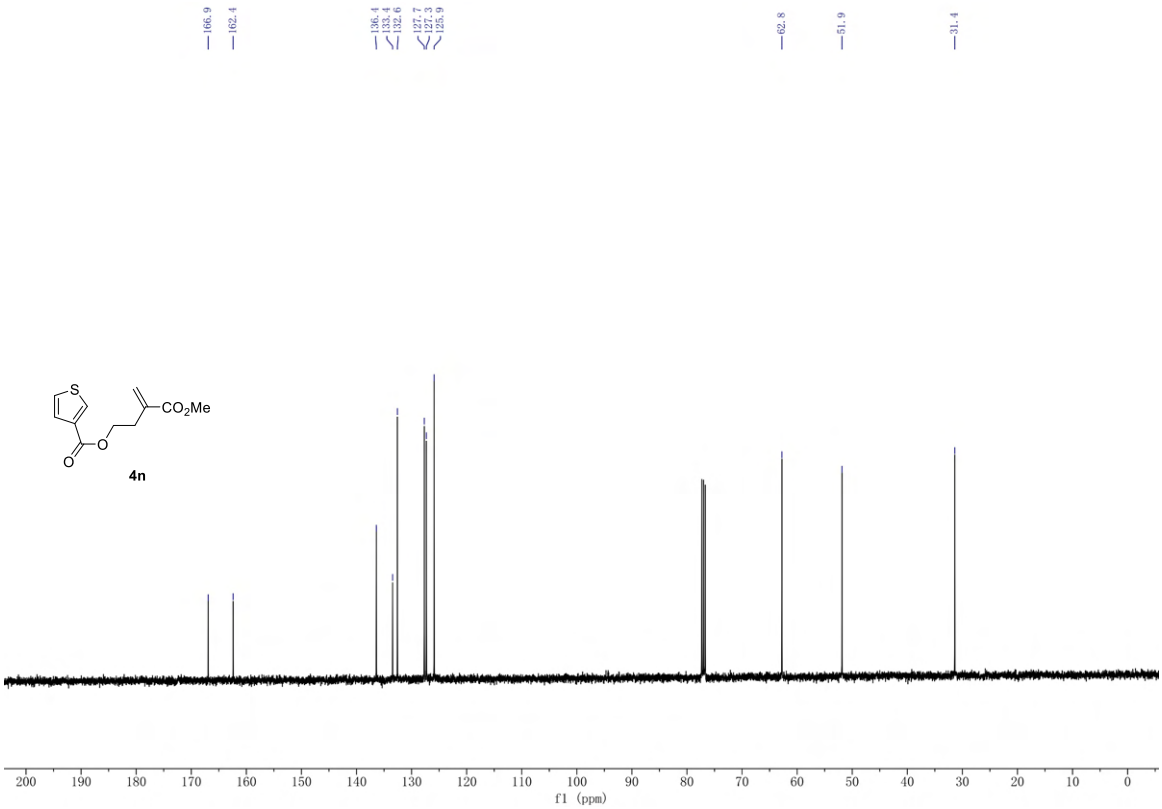
**4l**

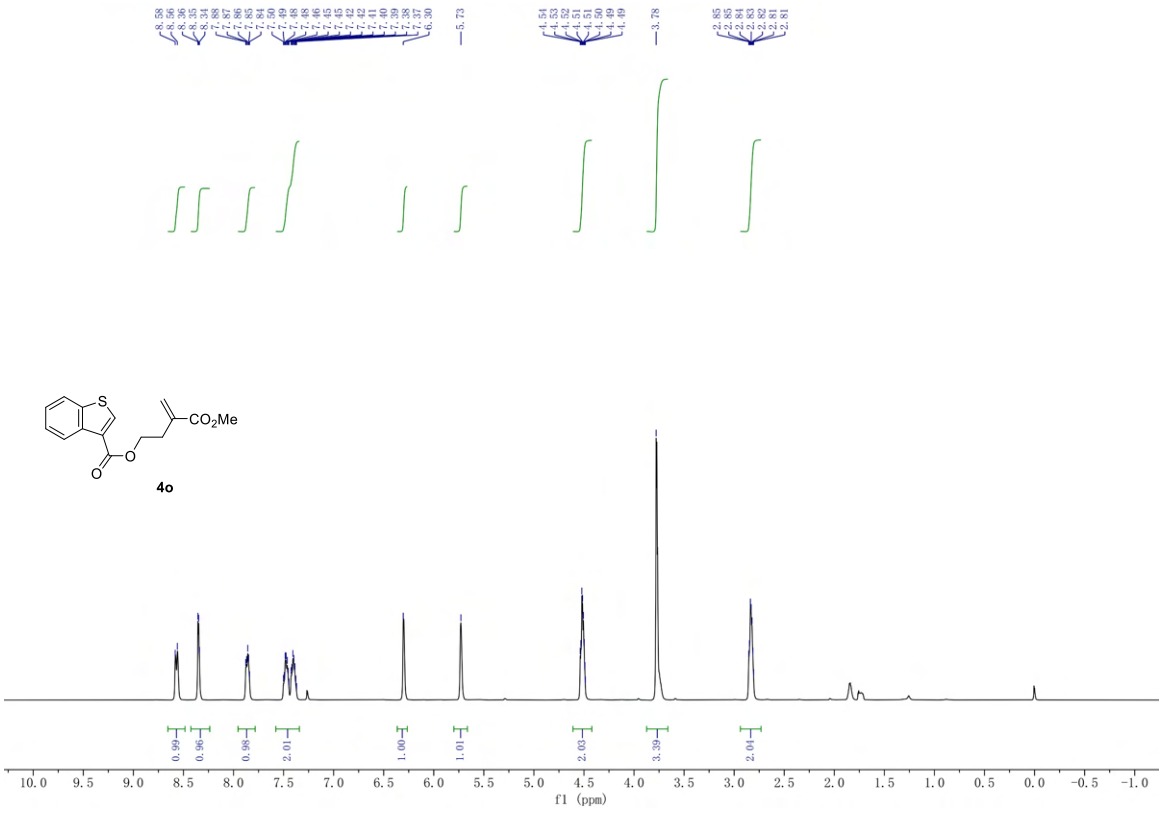

7.99
7.99
7.43
7.42
7.42
6.72
6.72
6.27
6.27
5.68
5.68
5.67
4.41
4.39
4.38
3.77
2.76
2.76
2.75
2.74
2.73
2.73
0.99
1.01
1.00
1.04
1.04
2.08
3.05
2.08
O
O
O
CO2Me
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

**4m**


166.9
162.8
147.6
143.6
136.4
127.3
119.2
109.6
62.6
51.9
31.4
CO2Me
O
O
O
4m
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


8.09
8.08
8.07
8.06
7.51
7.50
7.49
7.48
7.31
7.30
7.29
7.28
6.67
5.69
4.44
4.42
4.41
3.77
2.78
2.77
2.75
S
CO2Me
O
O
4n
0.94
0.98
1.01
1.00
1.00
2.03
3.00
2.03
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


166.9
162.4
136.4
133.4
132.6
127.7
127.3
125.9
62.8
51.9
31.4
S
CO2Me
O
O
4n
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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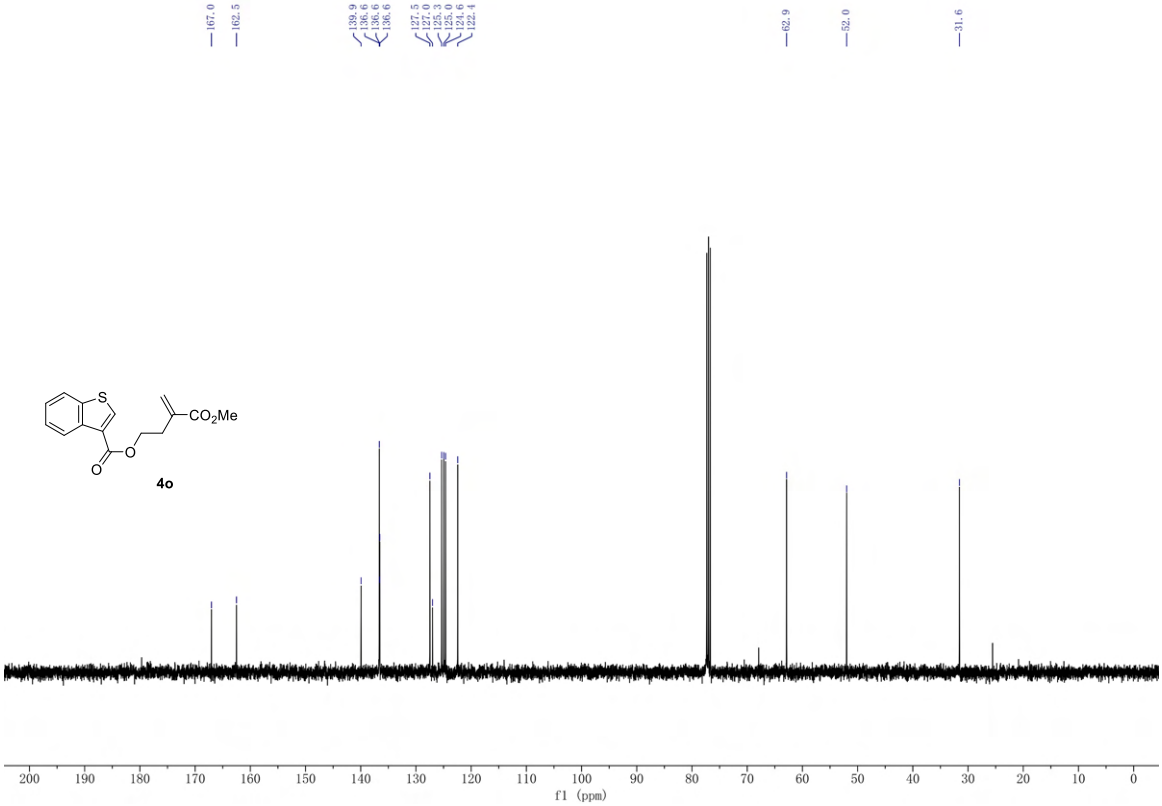
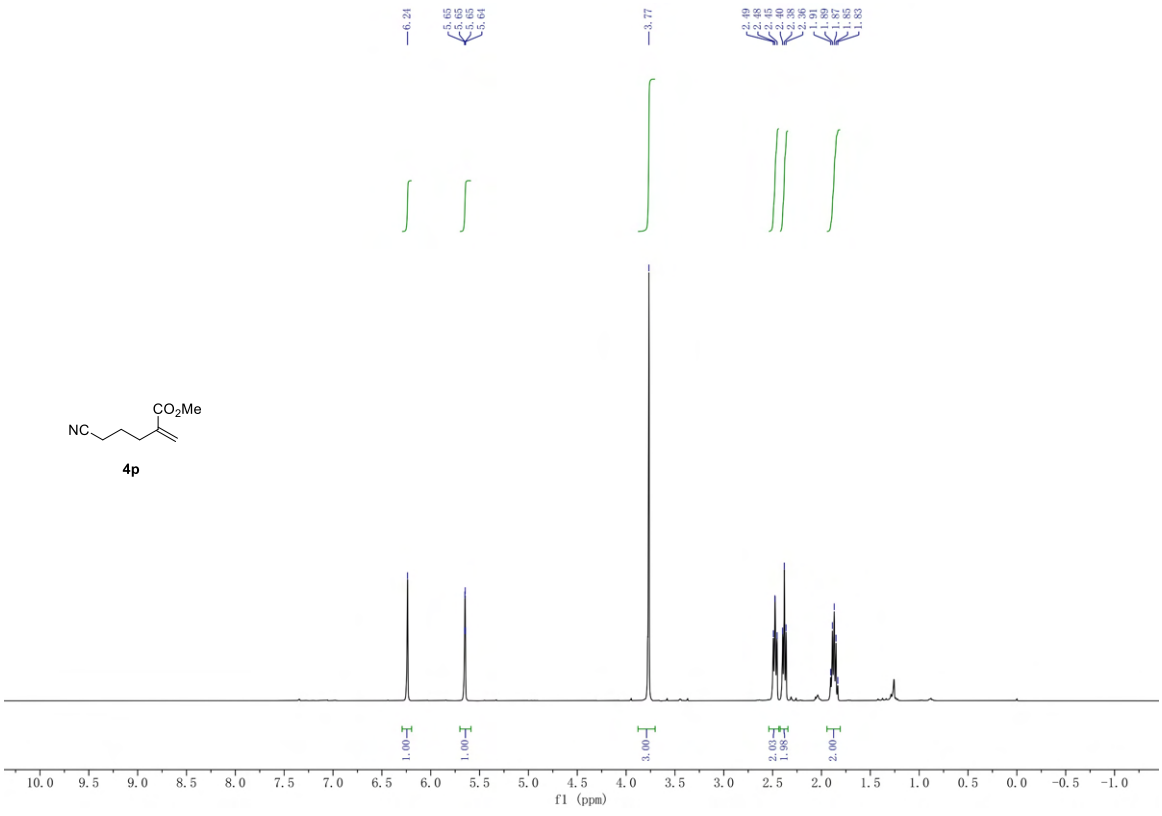
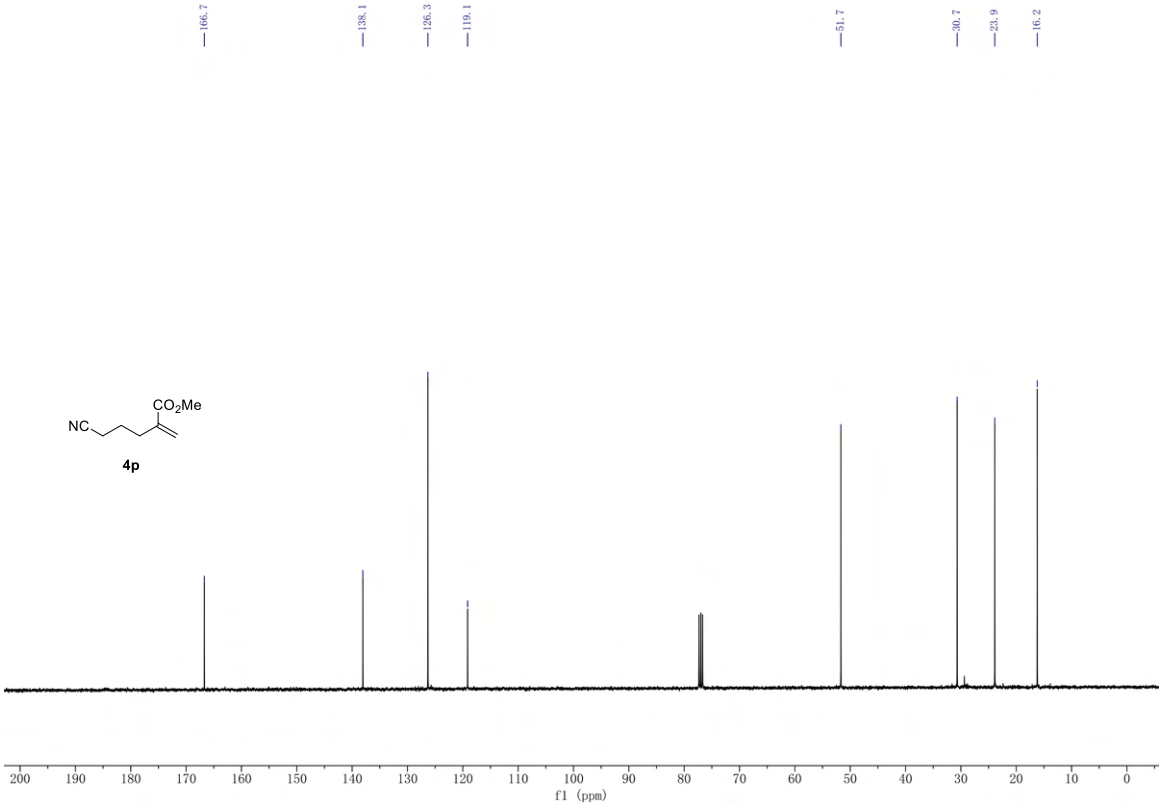
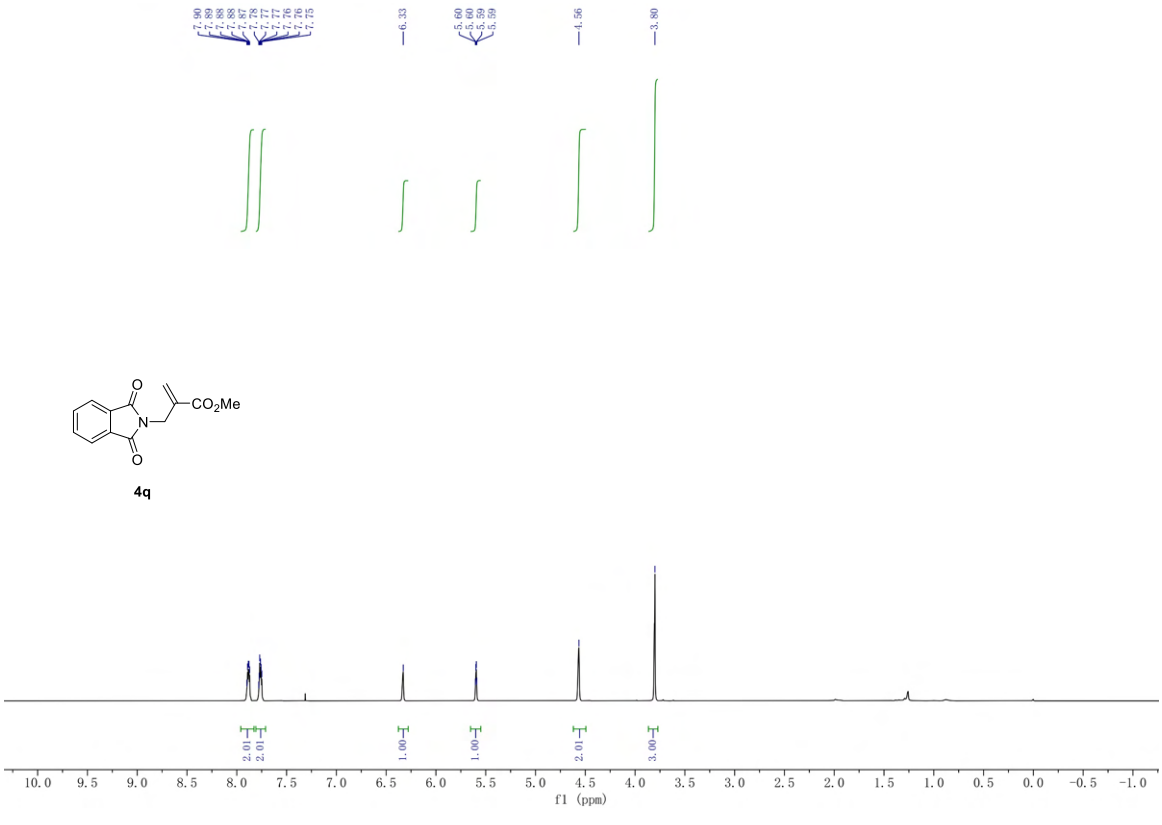
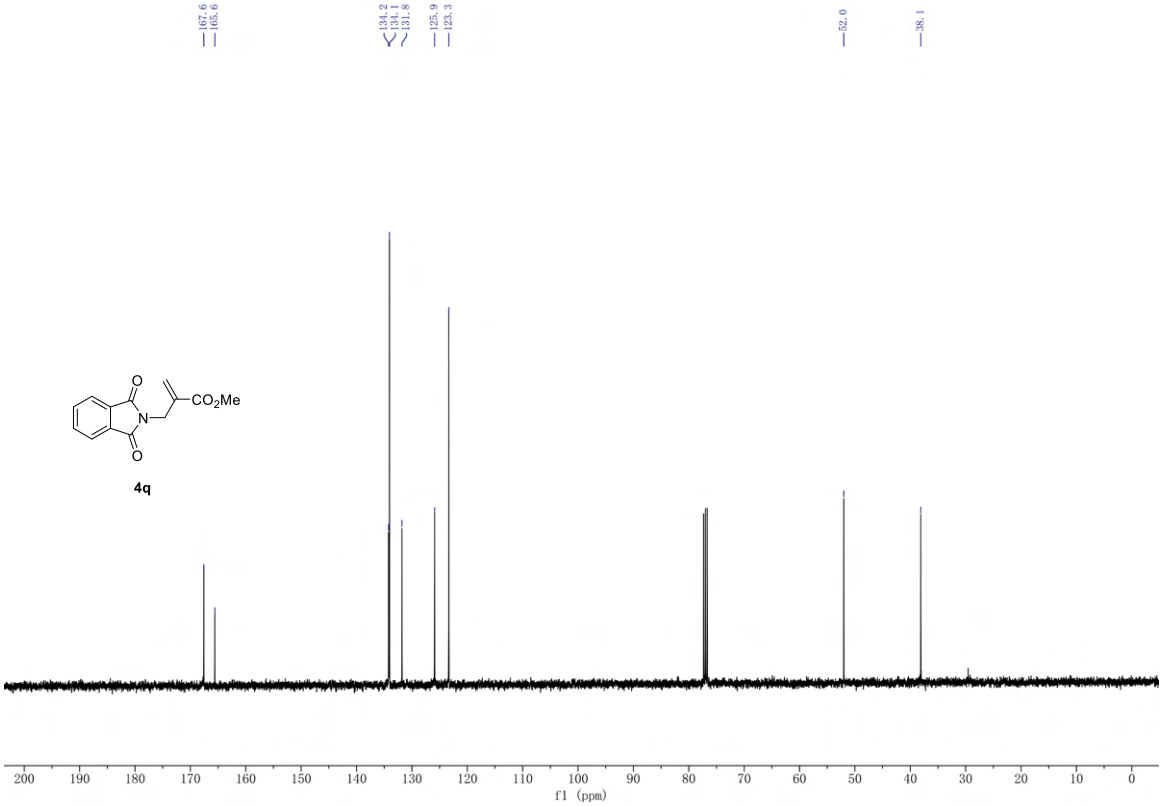
8.36
8.35
8.34
7.88
7.87
7.86
7.85
7.84
7.50
7.49
7.48
7.46
7.45
7.42
7.41
7.40
7.39
7.38
7.37
6.30
5.73
4.54
4.53
4.52
4.51
4.50
4.49
4.49
3.78
2.85
2.84
2.83
2.82
2.81
2.81
S
CO2Me
O
O
4o
0.99
0.96
0.98
2.01
1.00
1.01
2.03
3.39
2.01
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


167.0
162.5
139.9
136.6
136.6
136.6
127.5
127.0
125.3
125.0
124.6
122.4
62.9
52.0
31.6
S
CO2Me
O
O
4o
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

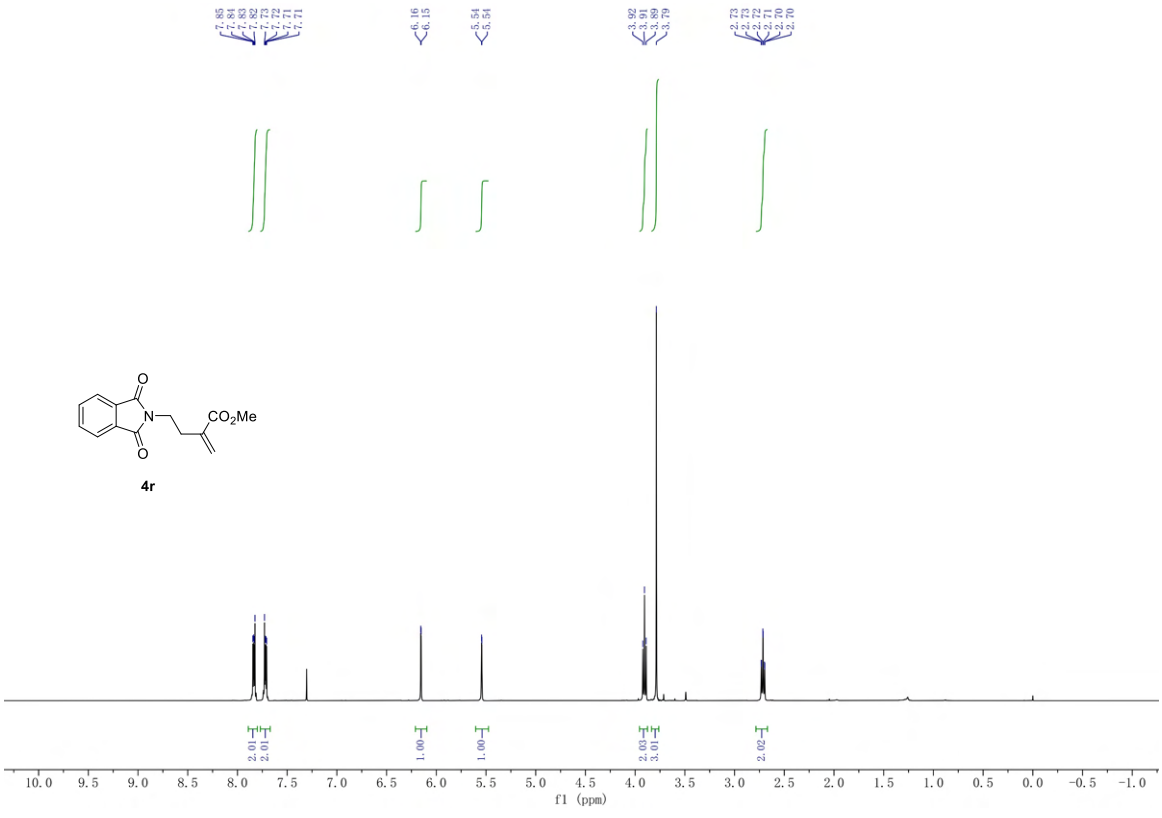

6.24
5.65
5.65
5.65
5.64
3.77
2.49
2.48
2.45
2.40
2.38
2.36
1.91
1.89
1.87
1.85
1.83
CO2Me
NC
4p
1.00
1.00
3.00
2.03
1.98
2.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


166.7
138.1
126.3
119.1
51.7
30.7
23.9
16.2
CO2Me
NC
4p
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

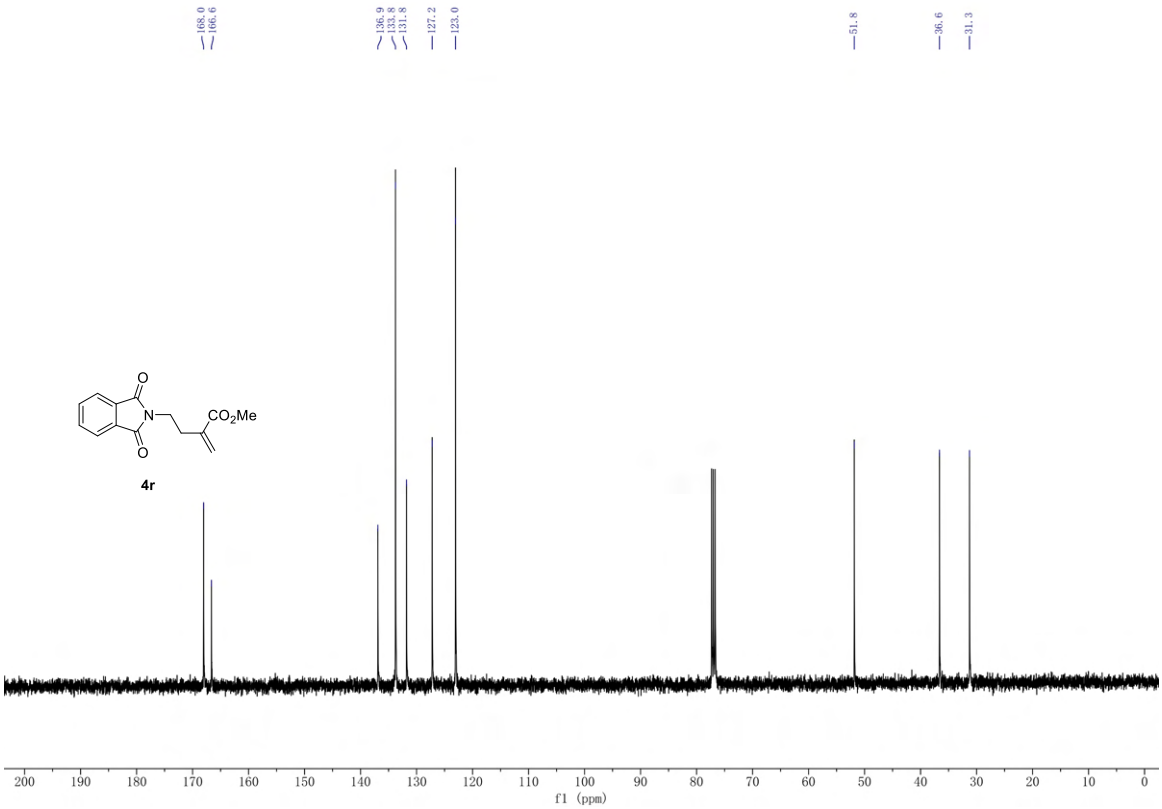

7.90
7.89
7.88
7.88
7.87
7.78
7.77
7.77
7.77
7.76
7.76
7.75
6.33
5.60
5.60
5.59
5.59
4.56
3.80
O
N
O
CO2Me
4q
2.01
2.01
1.60
1.00
2.01
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

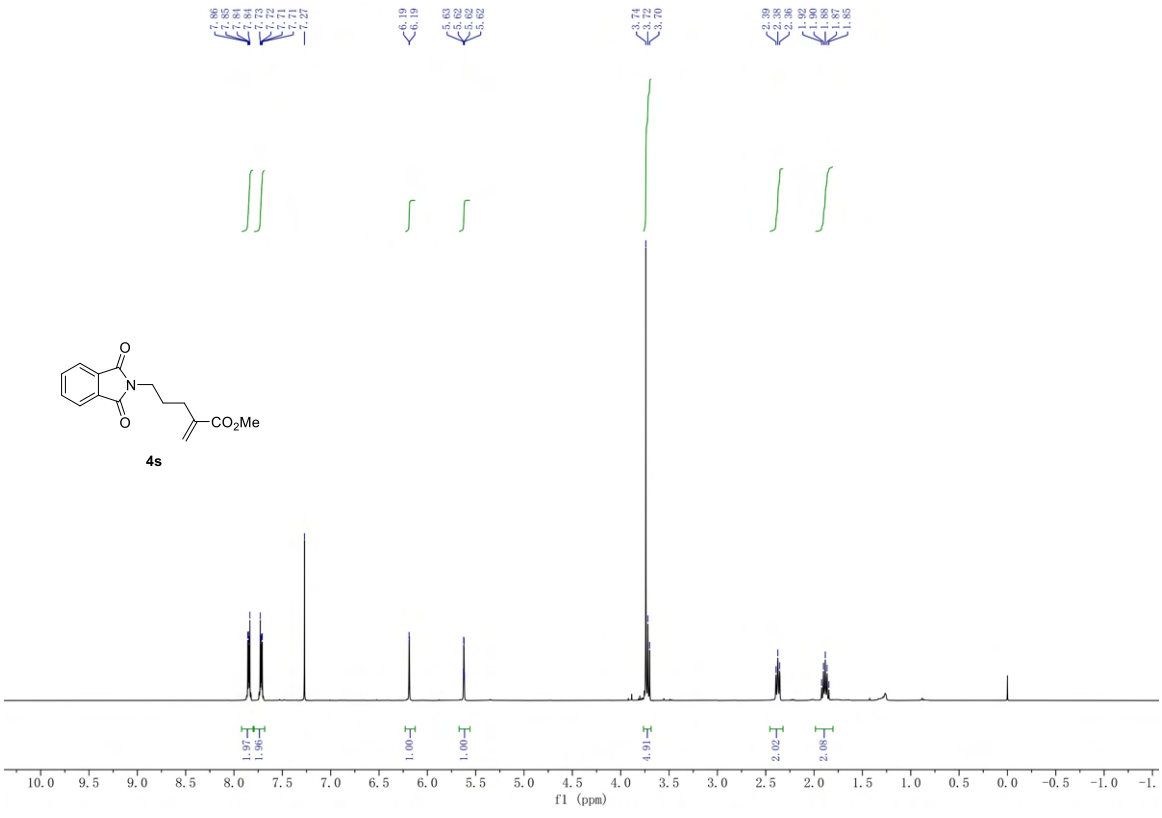

167.6
165.6
134.2
134.1
131.8
125.9
123.3
52.0
38.1
O
N
O
CO2Me
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

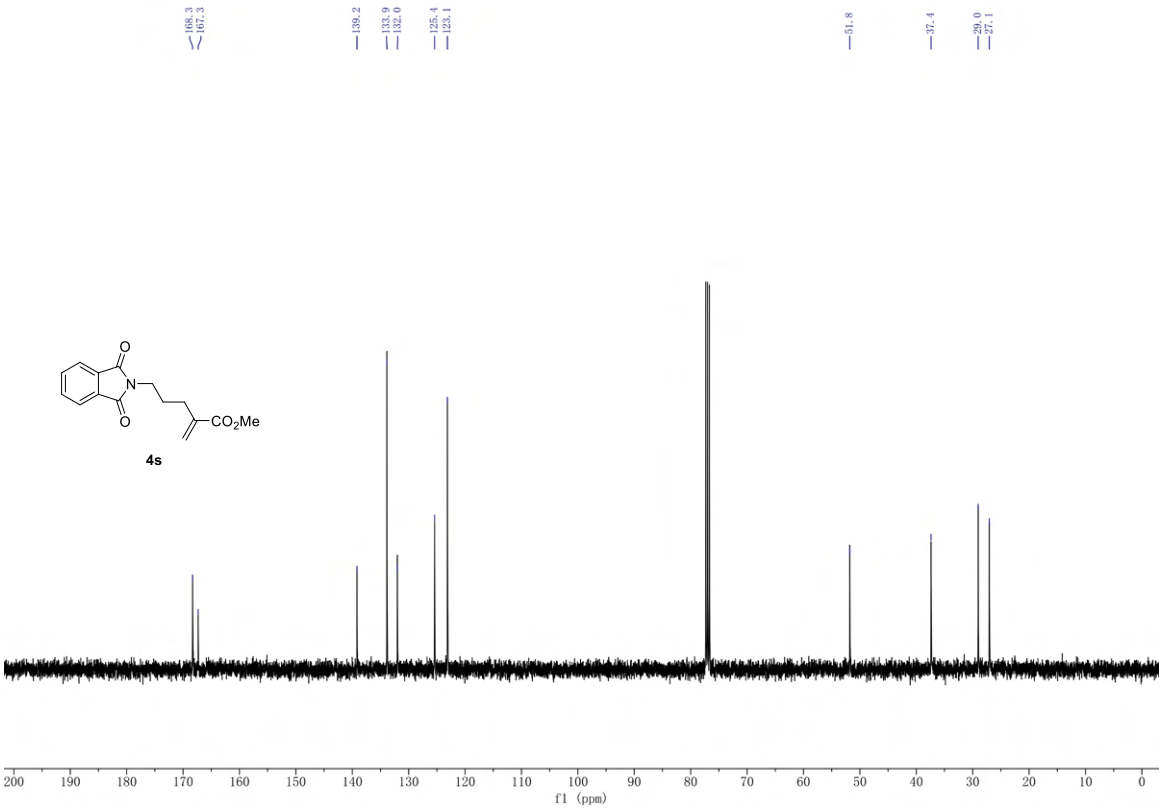
**4q**

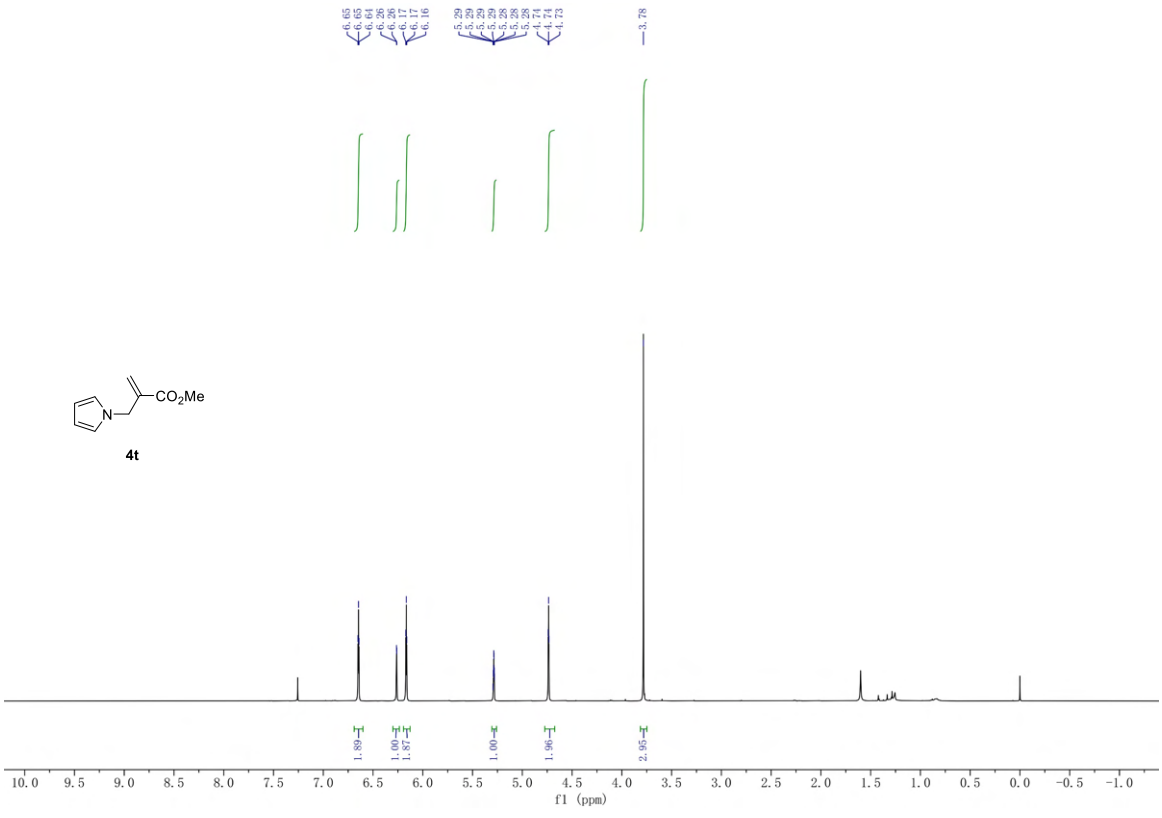

7.85
7.84
7.83
7.82
7.73
7.72
7.72
7.71
7.71
6.16
6.15
5.54
5.54
3.92
3.91
3.89
3.79
2.73
2.73
2.72
2.71
2.70
2.70
O
N
O
CO2Me
2.01
2.01
1.00
1.00
2.03
3.01
2.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

**4r**


168.0
166.6
136.9
133.8
131.8
127.2
123.0
51.8
36.6
31.3
O
N
O
CO2Me
4r
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.86
7.85
7.84
7.84
7.73
7.72
7.71
7.71
7.27
6.19
6.19
5.63
5.62
5.62
5.62
3.74
3.72
3.70
2.39
2.38
2.36
1.92
1.90
1.88
1.87
1.85
O
N
O
CO2Me
4s
1.97
1.96
1.00
1.00
4.91
2.02
2.08
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.
f1 (ppm)


168.3
167.3
139.2
133.9
132.0
125.4
123.1
51.8
37.4
29.0
27.1
O
N
O
CO2Me
4s
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


6.65
6.65
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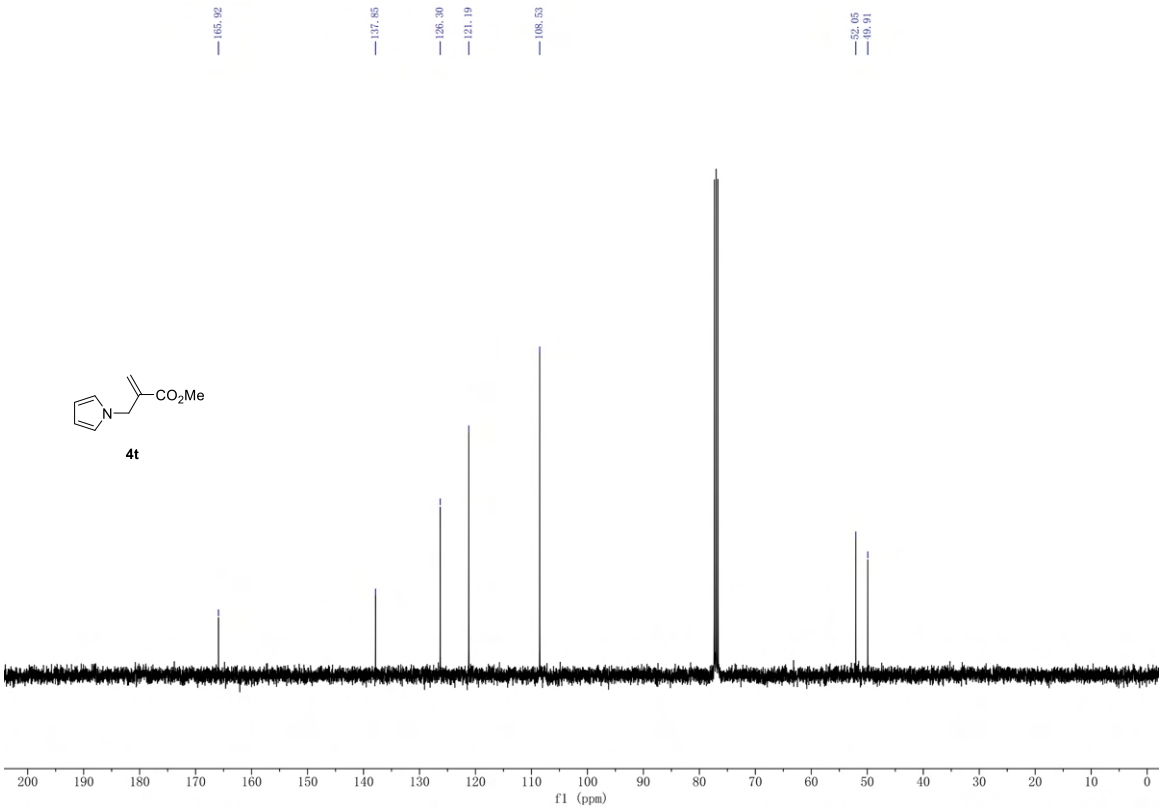
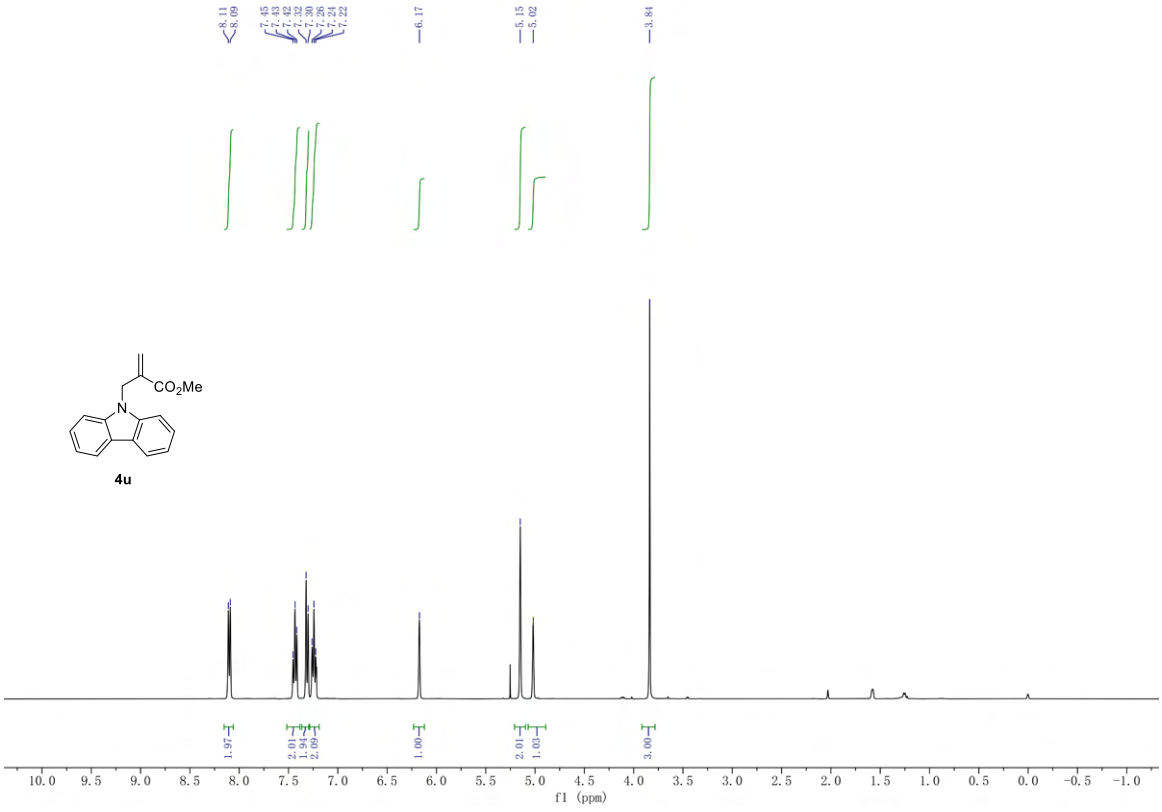
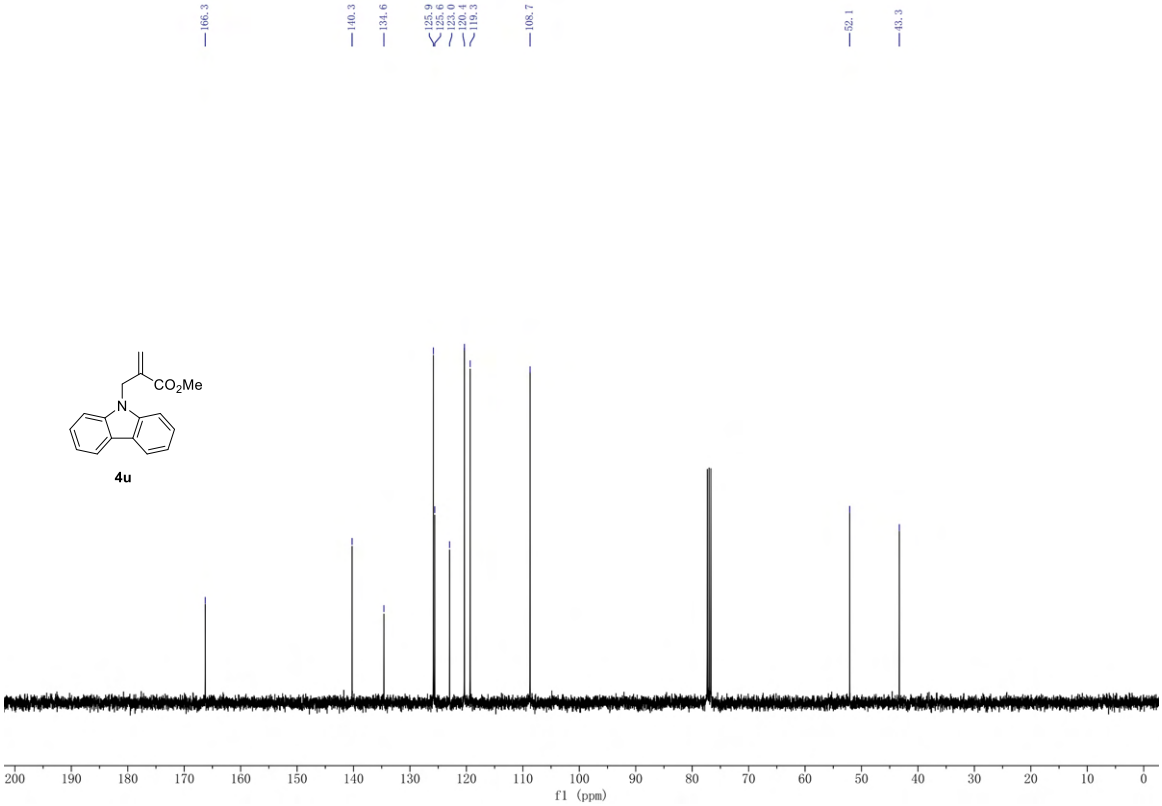
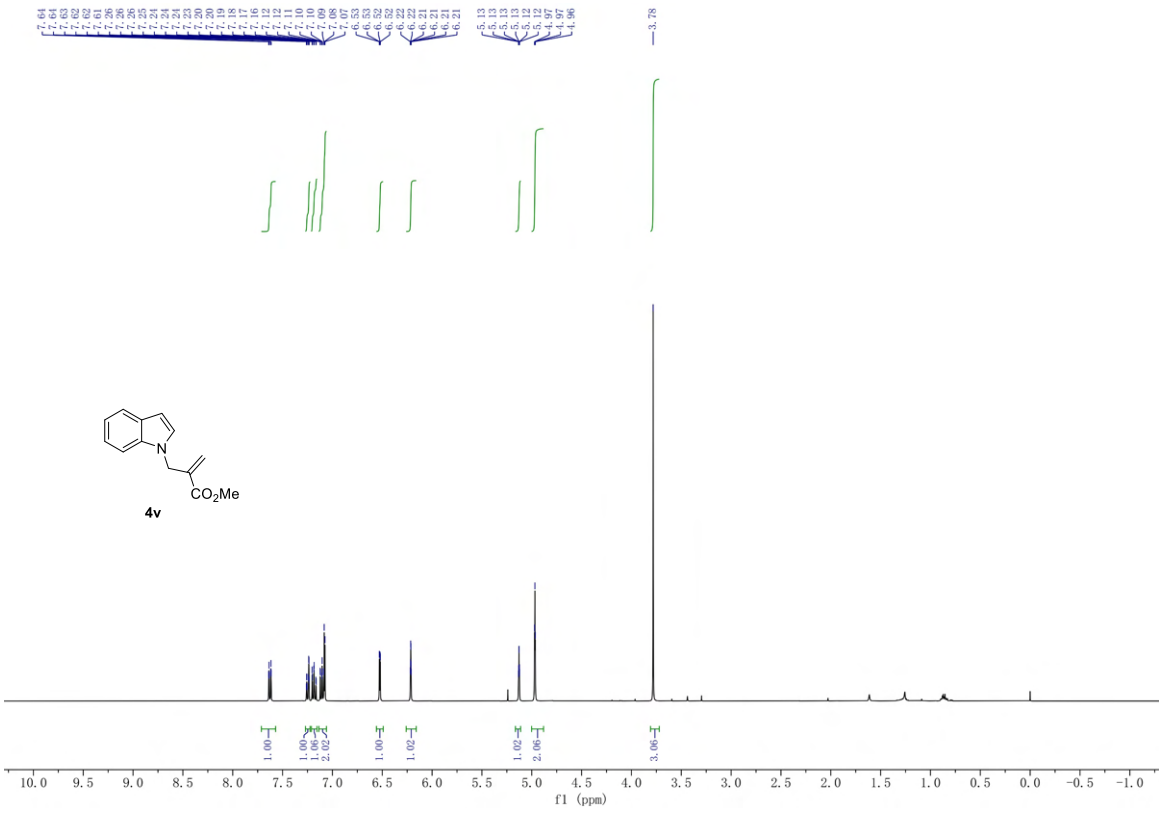
6.26
6.26
6.17
6.16
5.29
5.29
5.29
5.28
5.28
5.28
4.74
4.74
4.73
3.78
N
CO2Me
4t
1.89
1.00
1.87
1.00
1.96
2.95
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


165.92
137.85
126.30
121.19
108.53
52.05
49.91
CO2Me
N
4t
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


8.11
8.09
7.45
7.43
7.42
7.32
7.30
7.26
7.24
7.22
6.17
5.15
5.02
3.84
CO2Me
N
4u
1.97
2.01
1.94
2.09
1.00
2.01
1.03
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


166.3
140.3
134.6
125.9
125.6
123.0
120.4
119.3
108.7
52.1
43.3
CO2Me
N
4u
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.64
7.64
7.63
7.62
7.62
7.61
7.26
7.26
7.25
7.24
7.24
7.24
7.23
7.20
7.20
7.19
7.18
7.17
7.16
7.12
7.12
7.11
7.10
7.09
7.08
7.07
6.53
6.52
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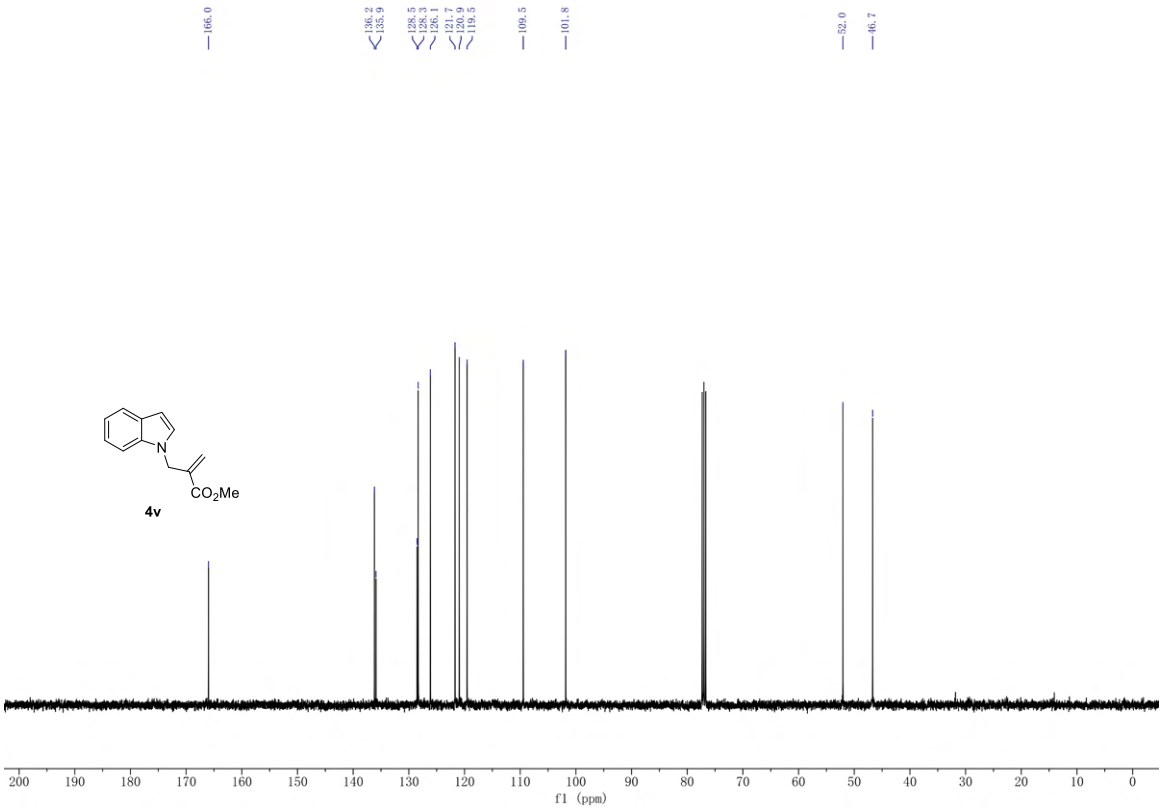
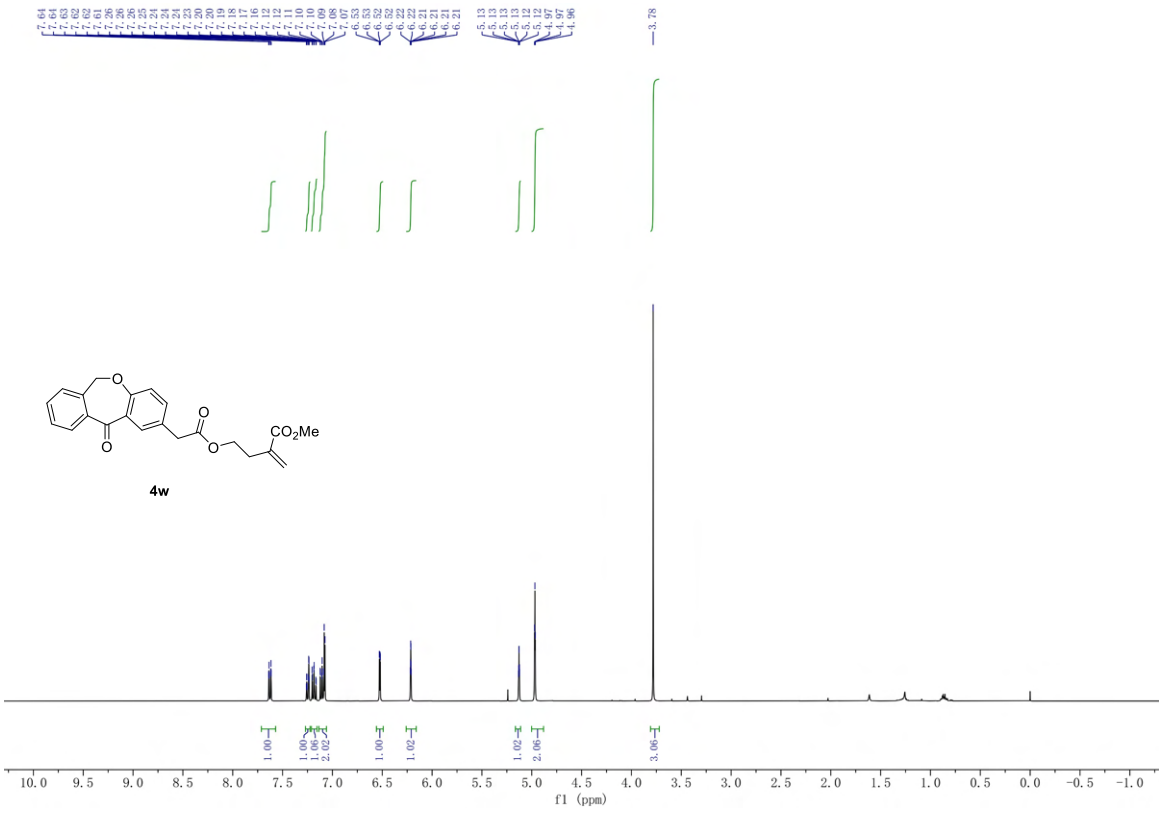
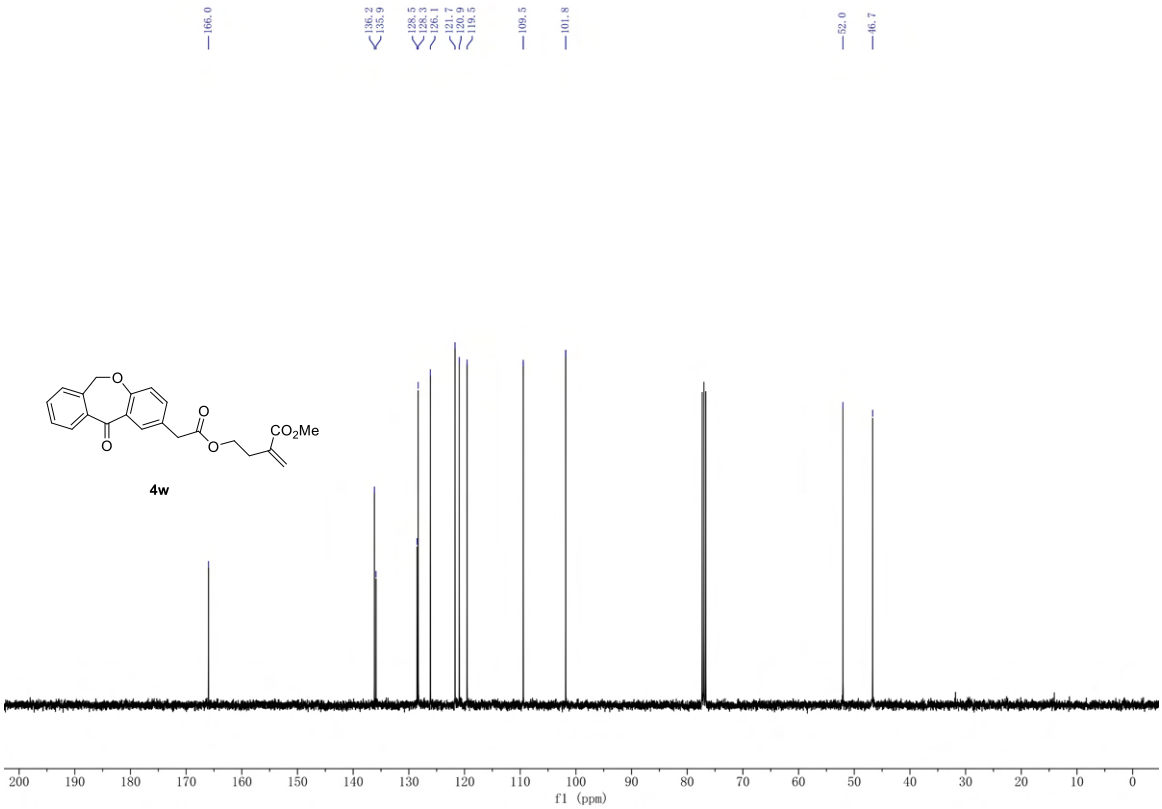
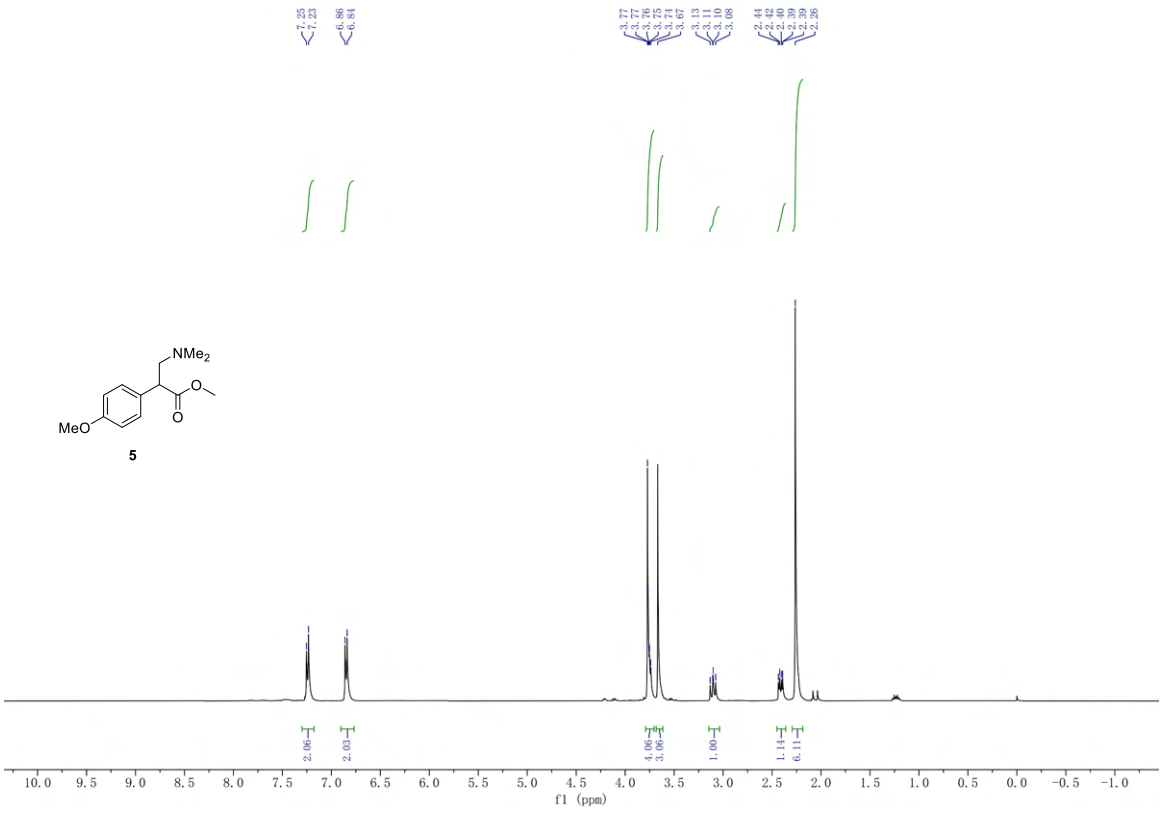
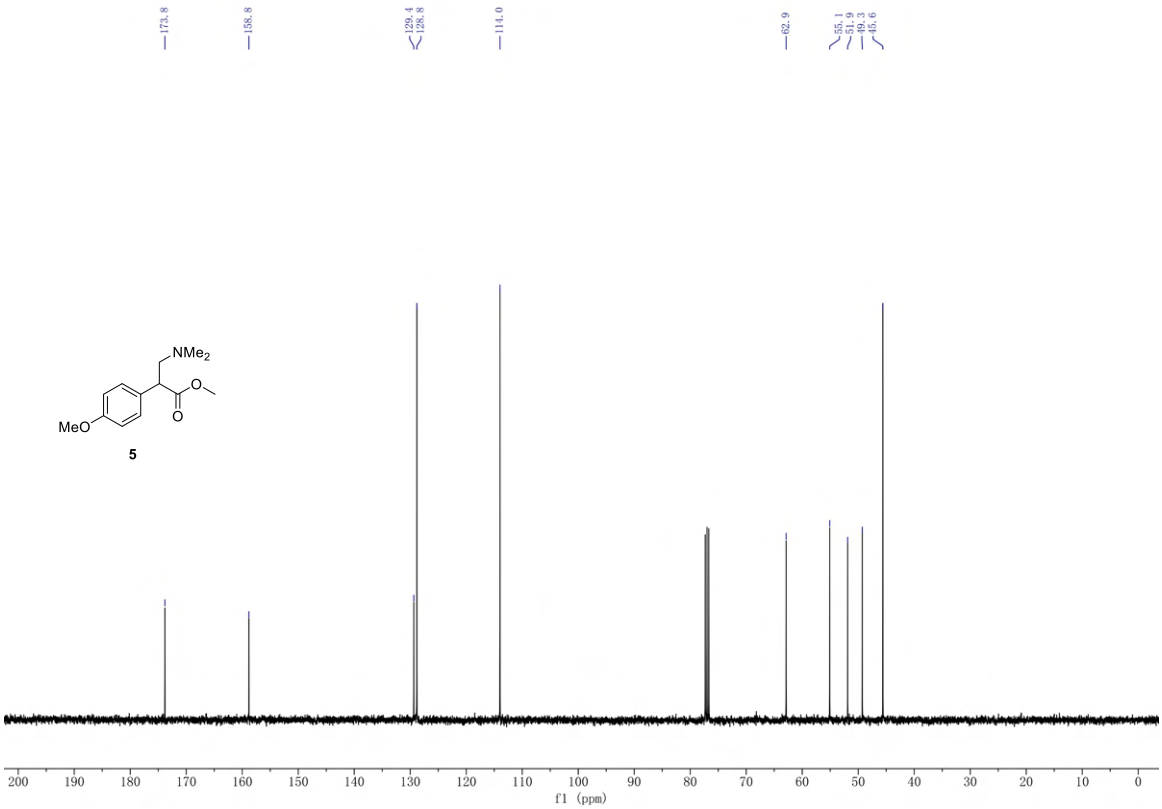
6.21
6.21
6.21
5.13
5.13
5.13
5.13
5.12
5.12
4.97
4.96
3.78
N
CO2Me
4v
1.00
1.00
1.06
2.02
1.00
1.02
1.02
2.06
3.06
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

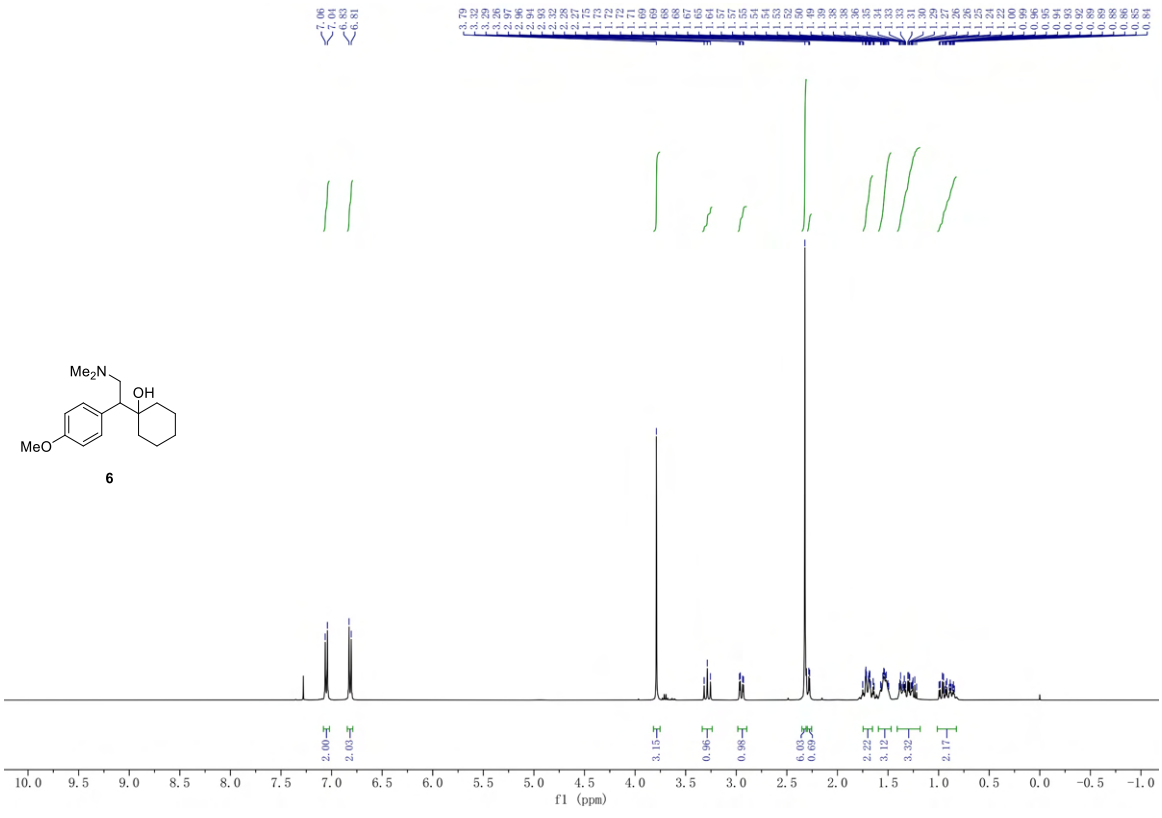

166.0
136.2
135.9
128.5
128.3
126.1
121.7
120.9
119.5
109.5
101.8
52.0
46.7
N
CO2Me
4v
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

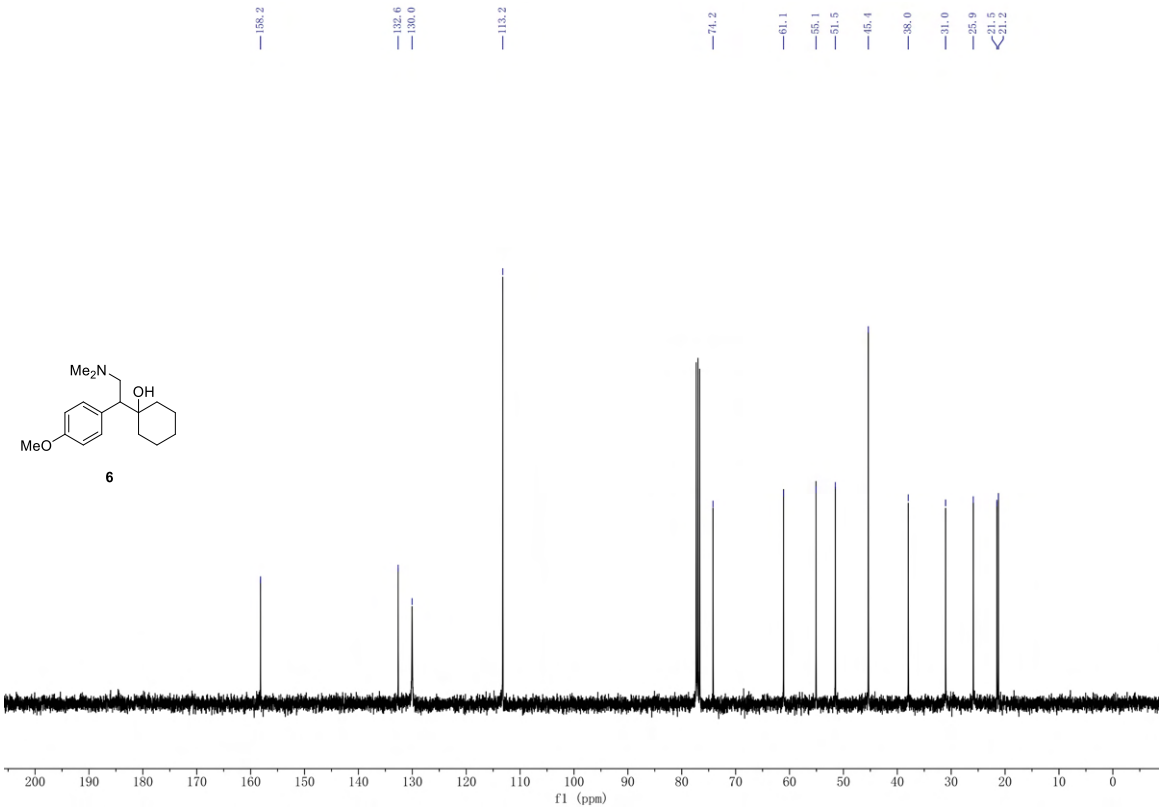

3.78
O
O
O
O
CO2Me
4w
1.00
1.00
1.06
2.02
1.00
1.02
1.02
2.06
3.06
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

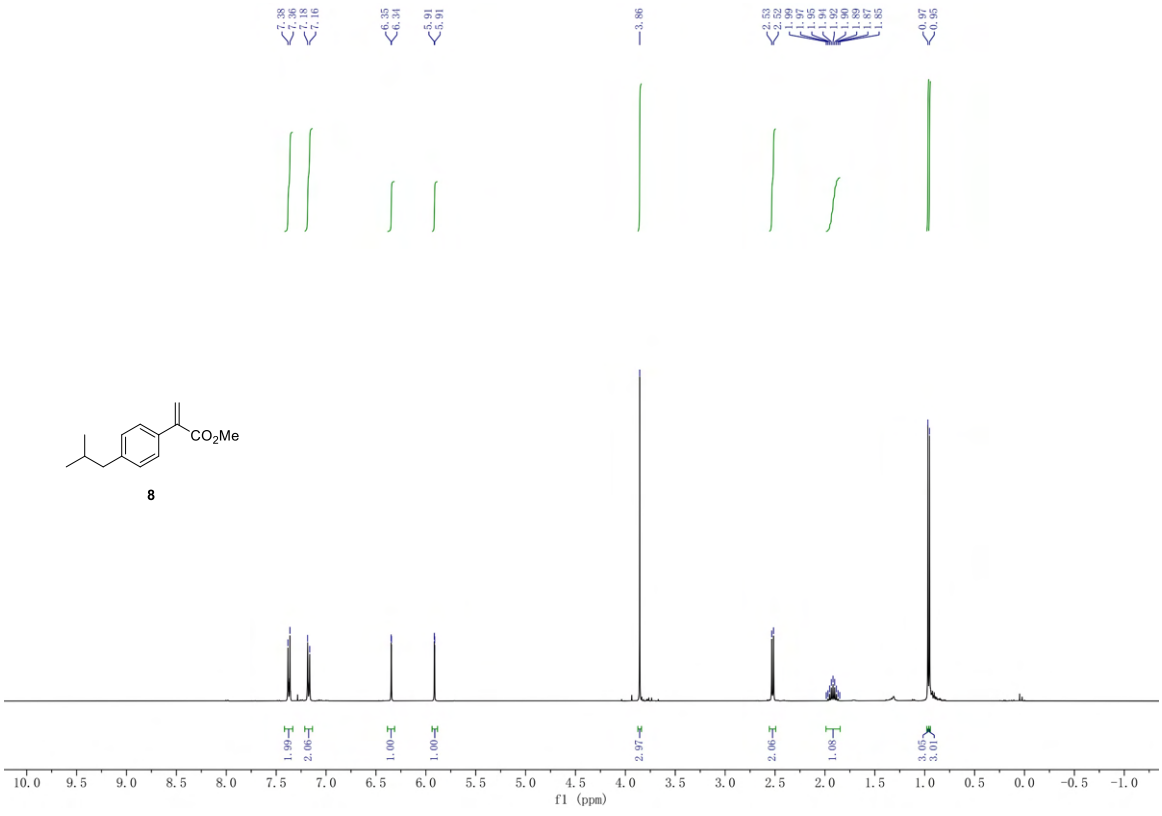

166.0
136.2
135.9
128.5
128.3
126.1
121.7
120.9
119.5
109.5
101.8
52.0
46.7
O
O
O
O
CO2Me
4w
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

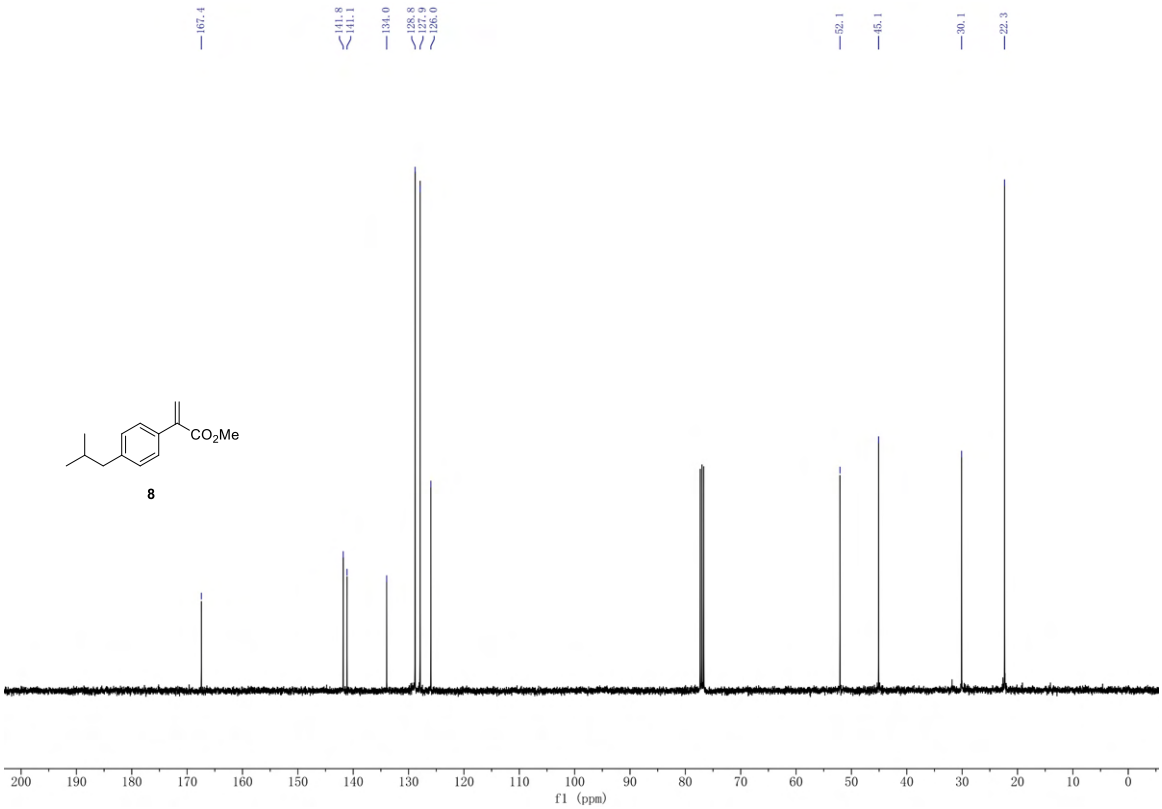

7.25
7.23
6.86
6.84
3.77
3.77
3.76
3.75
3.74
3.67
3.13
3.11
3.10
3.08
2.44
2.42
2.40
2.39
2.26
NMe2
O
O
MeO
5
2.06
2.03
4.06
3.06
1.00
1.14
6.11
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

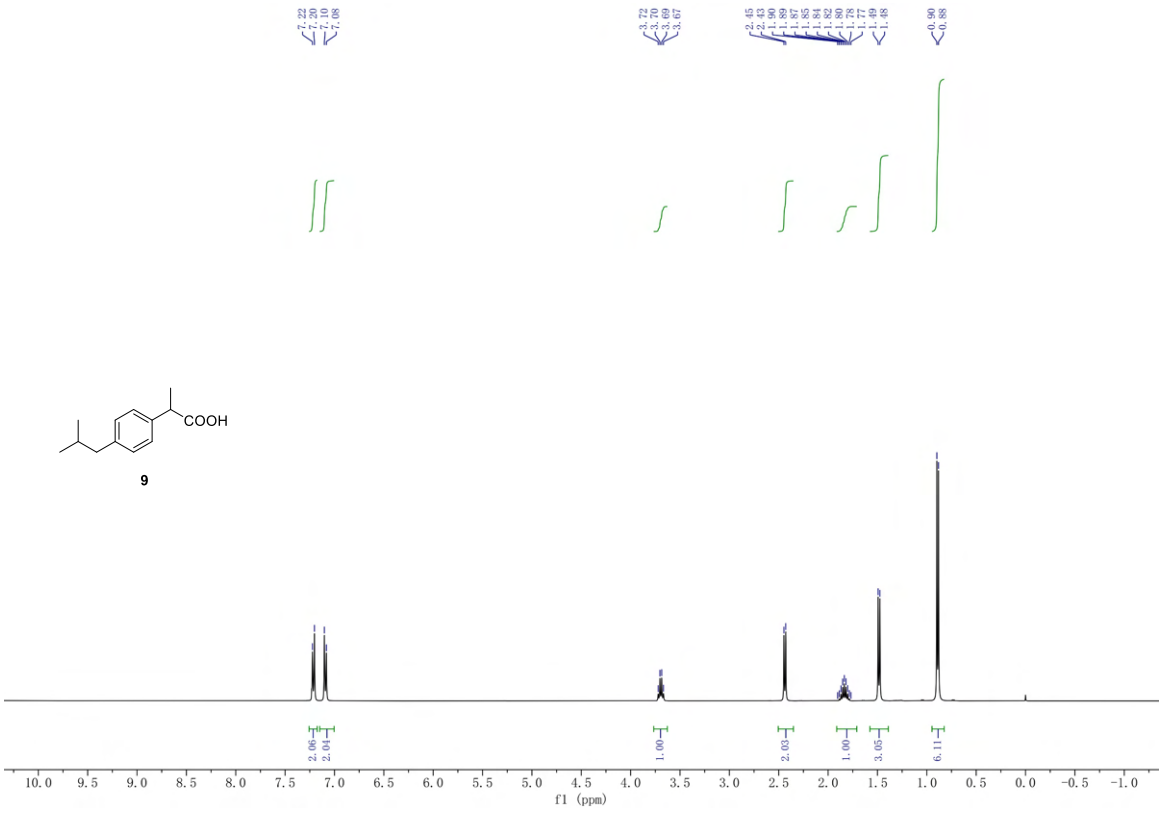

173.8
158.8
129.4
128.8
114.0
62.9
55.1
51.9
49.3
45.6
NMe2
O
O
MeO
5
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

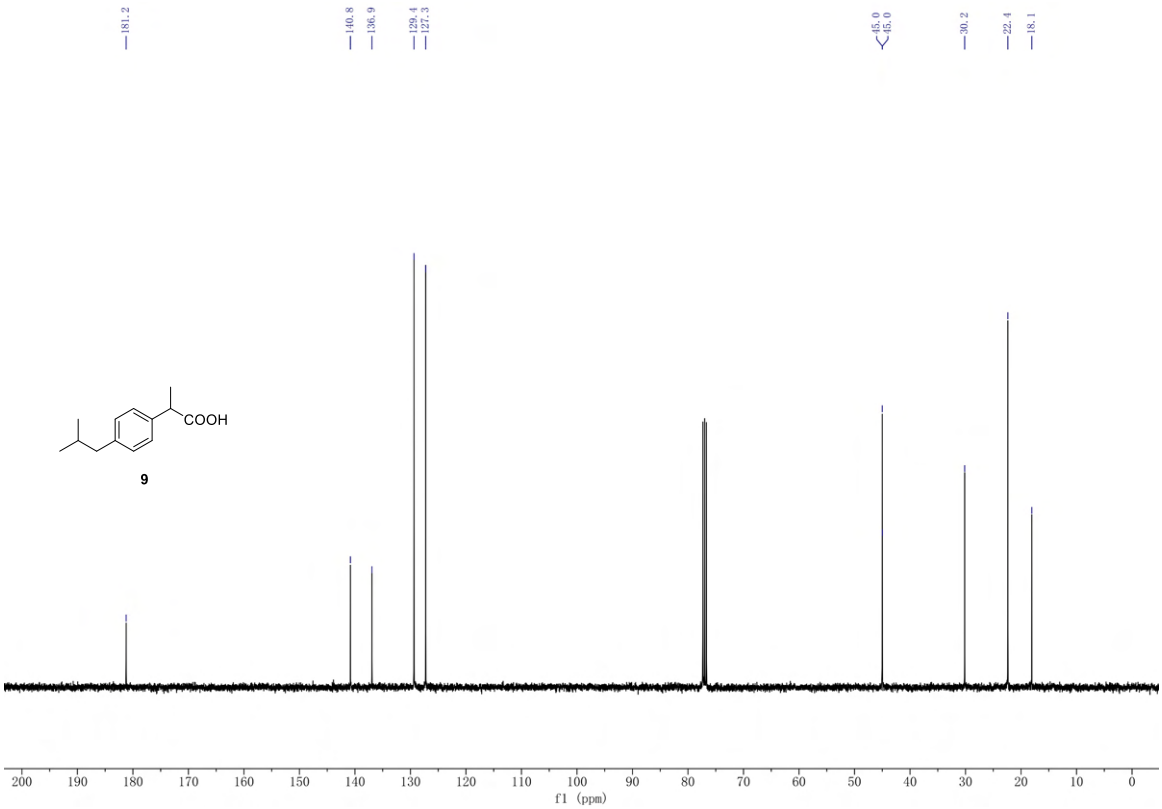

7.06
7.04
6.83
6.81
Me2N
OH
MeO
6
2.00
2.03
3.15
0.96
0.98
6.03
0.69
2.22
3.12
3.32
2.17
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

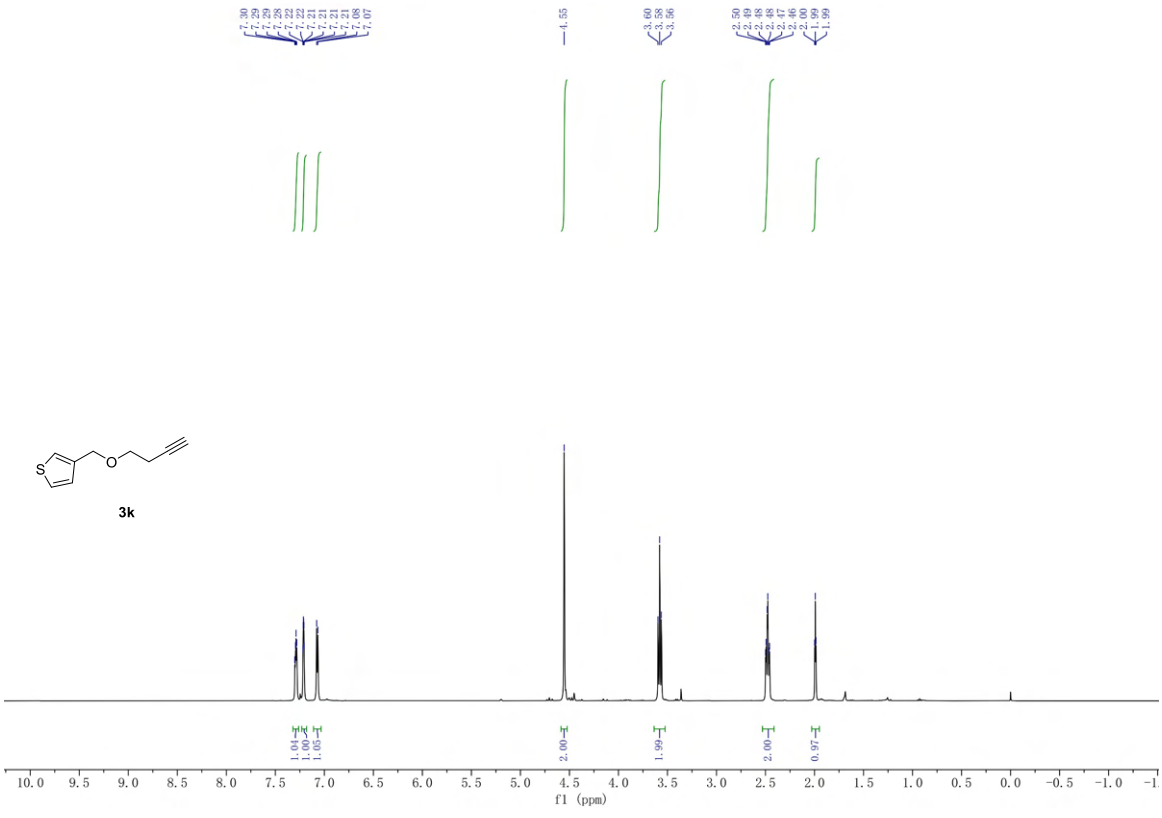

158.2
132.6
130.0
113.2
74.2
61.1
55.1
51.5
45.4
38.0
31.0
25.9
21.5
21.2
Me2N
OH
MeO
6
f1 (ppm)

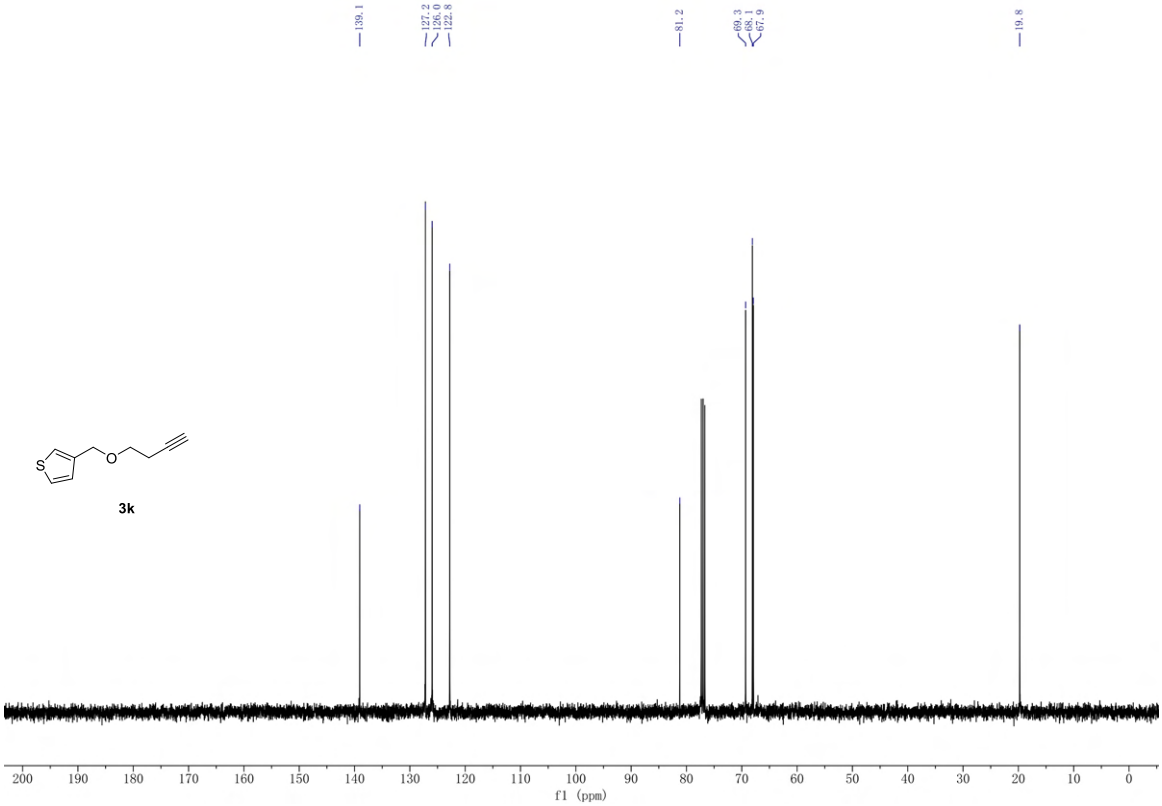

7.38
7.36
7.18
7.16
6.35
6.34
5.91
5.91
3.86
2.53
2.52
1.99
1.97
1.95
1.94
1.92
1.90
1.89
1.87
1.85
0.97
0.95
CO2Me
8
1.99
2.06
1.00
1.00
2.97
2.06
1.08
3.05
3.01
f1 (ppm)


167.4
141.8
141.1
134.0
128.8
127.9
126.0
52.1
45.1
30.1
22.3
CO2Me
8
f1 (ppm)

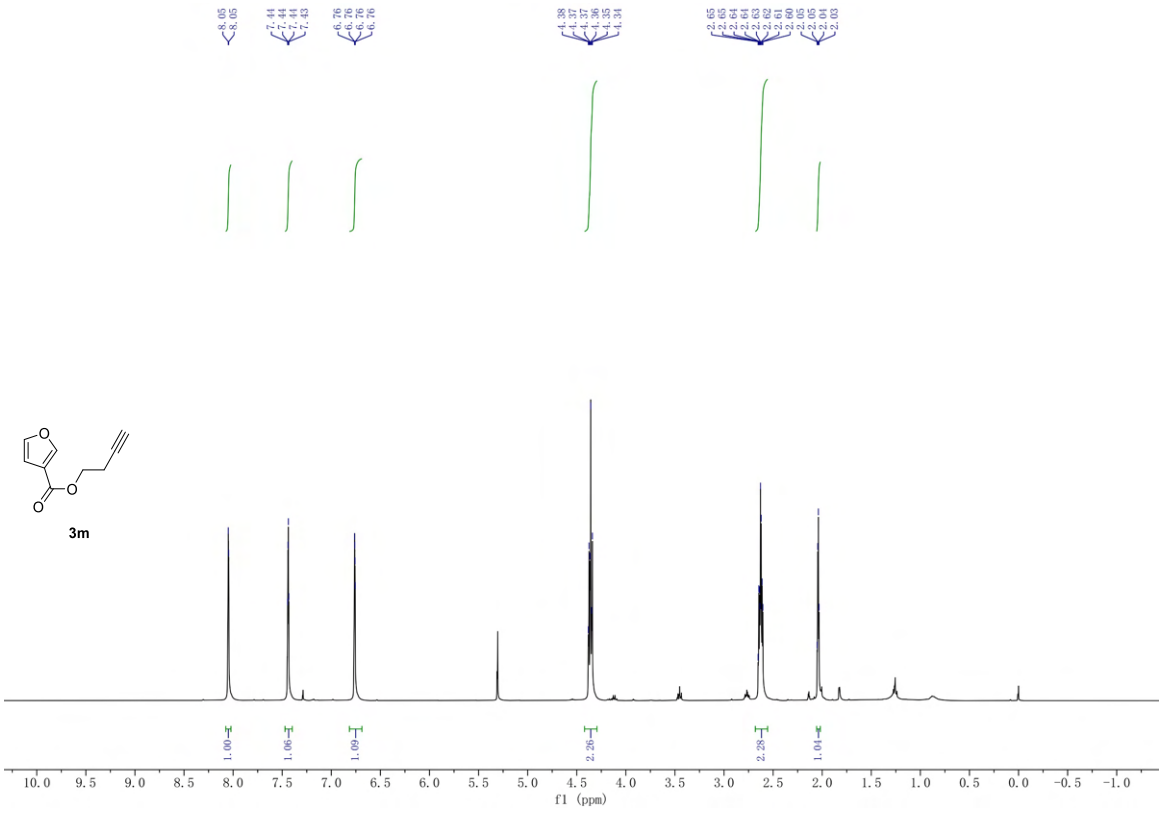

7.22
7.20
7.10
7.08
3.72
3.70
3.69
3.67
2.45
2.43
1.90
1.89
1.87
1.85
1.84
1.82
1.80
1.78
1.77
1.49
1.48
0.90
0.88
COOH
9
2.06
2.04
1.00
2.03
1.00
3.05
6.11
f1 (ppm)


181.2
140.8
136.9
129.4
127.3
45.0
45.0
30.2
22.4
18.1
COOH
9
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

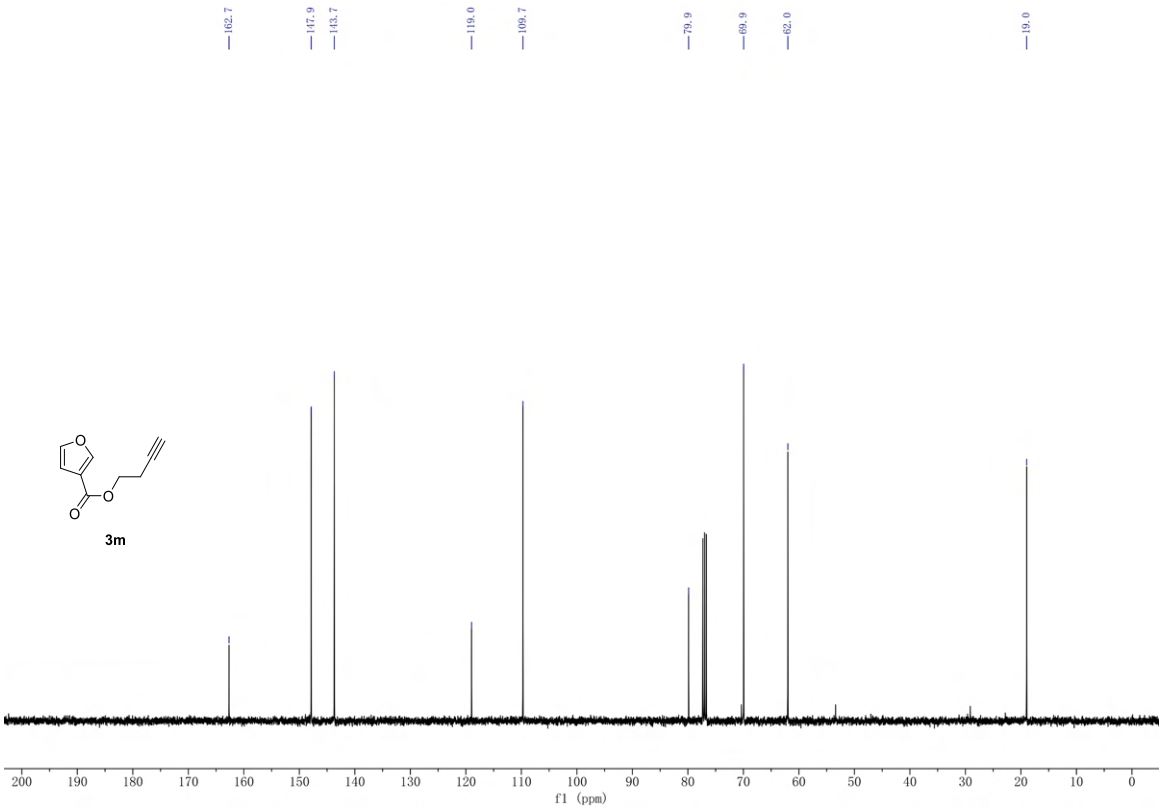

7.30
7.29
7.29
7.28
7.23
7.22
7.21
7.21
7.21
7.21
7.08
7.07
4.55
3.60
3.58
3.56
2.50
2.49
2.48
2.47
2.46
2.00
1.99
1.99
S
O
3k
1.04
1.02
1.00
2.00
1.99
2.00
0.97
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 −0.5 −1.0
f1 (ppm)

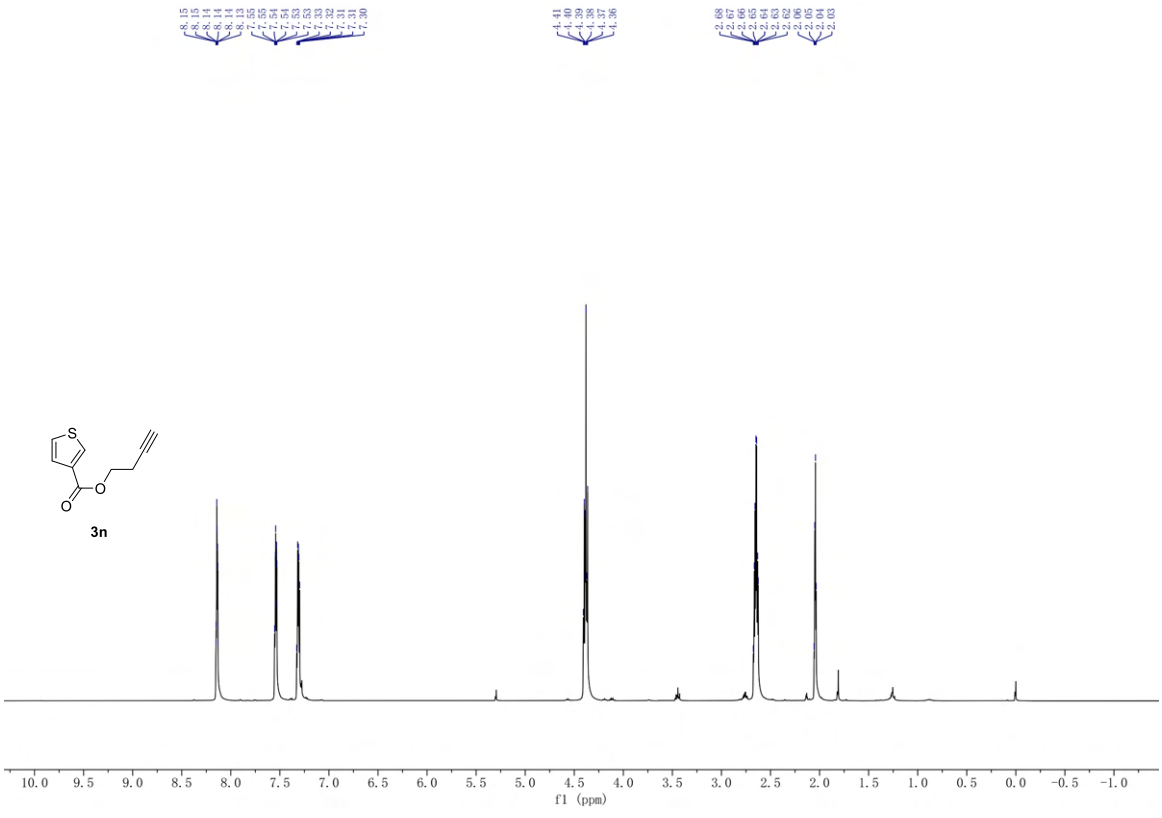

139.1
127.2
126.0
122.8
81.2
69.3
68.1
67.9
19.8
S
O
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

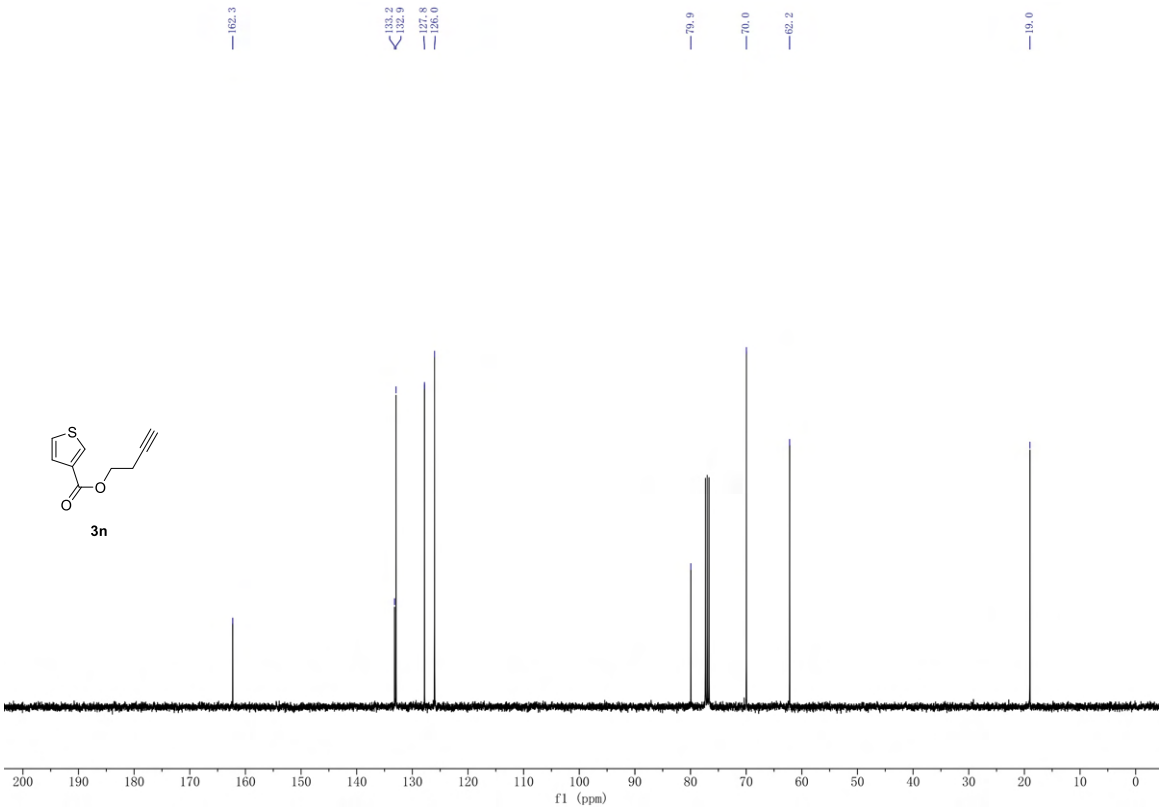
**3k**

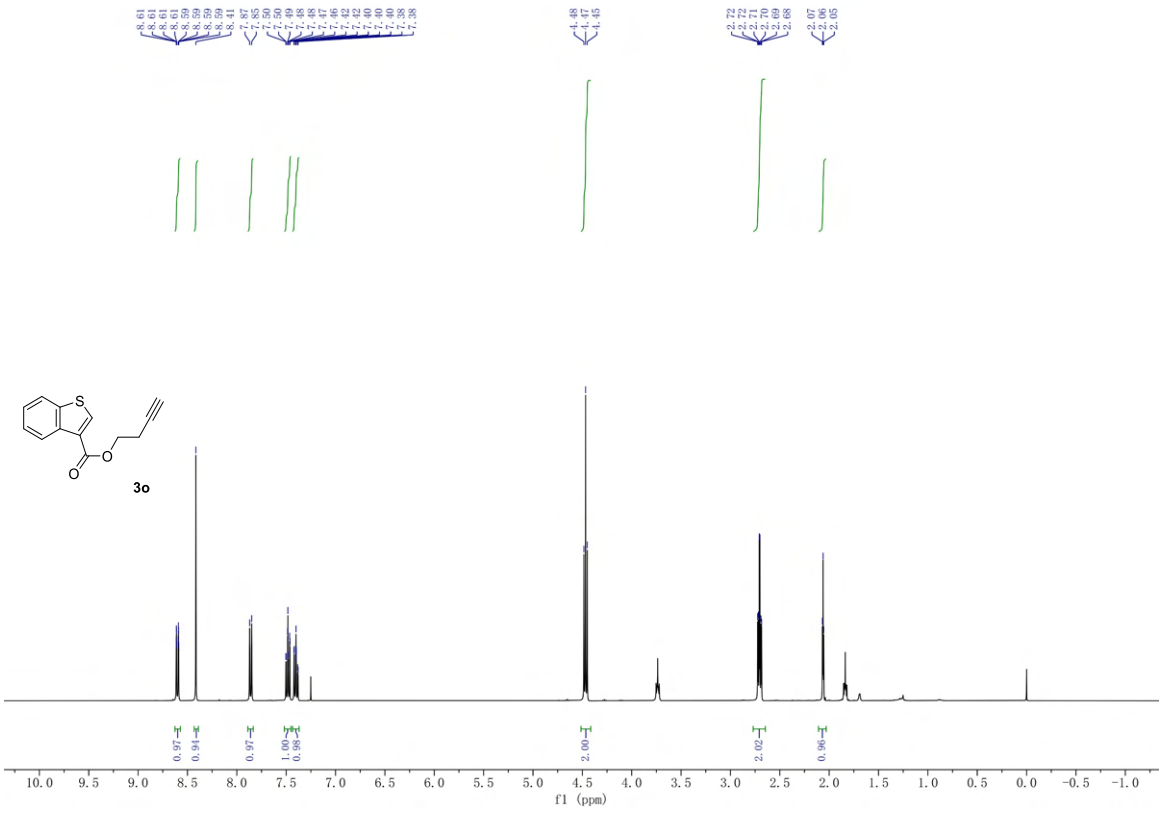

8.05
7.44
7.43
6.76
4.38
4.37
4.36
4.35
4.34
2.65
2.64
2.63
2.62
2.61
2.60
2.05
2.04
2.03
O
O
O
1.00
1.06
1.09
2.26
2.28
1.04
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

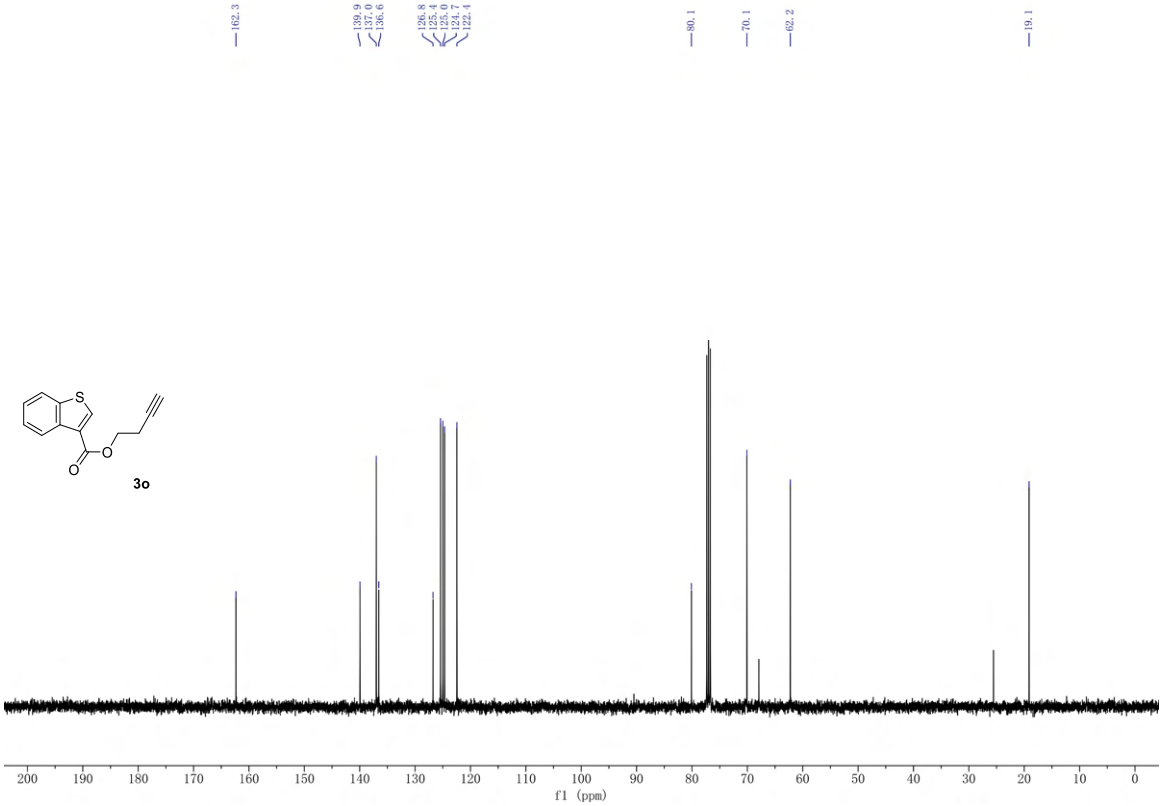
**3m**

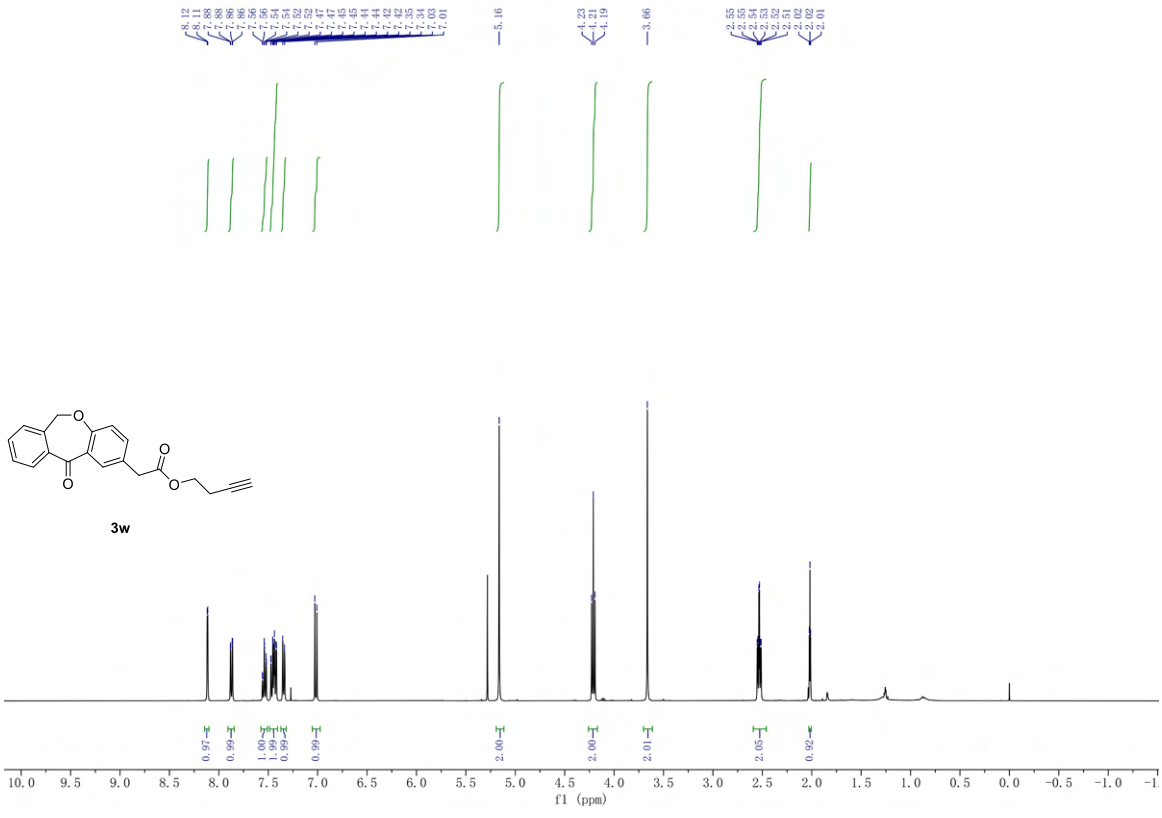

162.7
147.9
143.7
119.0
109.7
79.9
69.9
62.0
19.0
3m
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

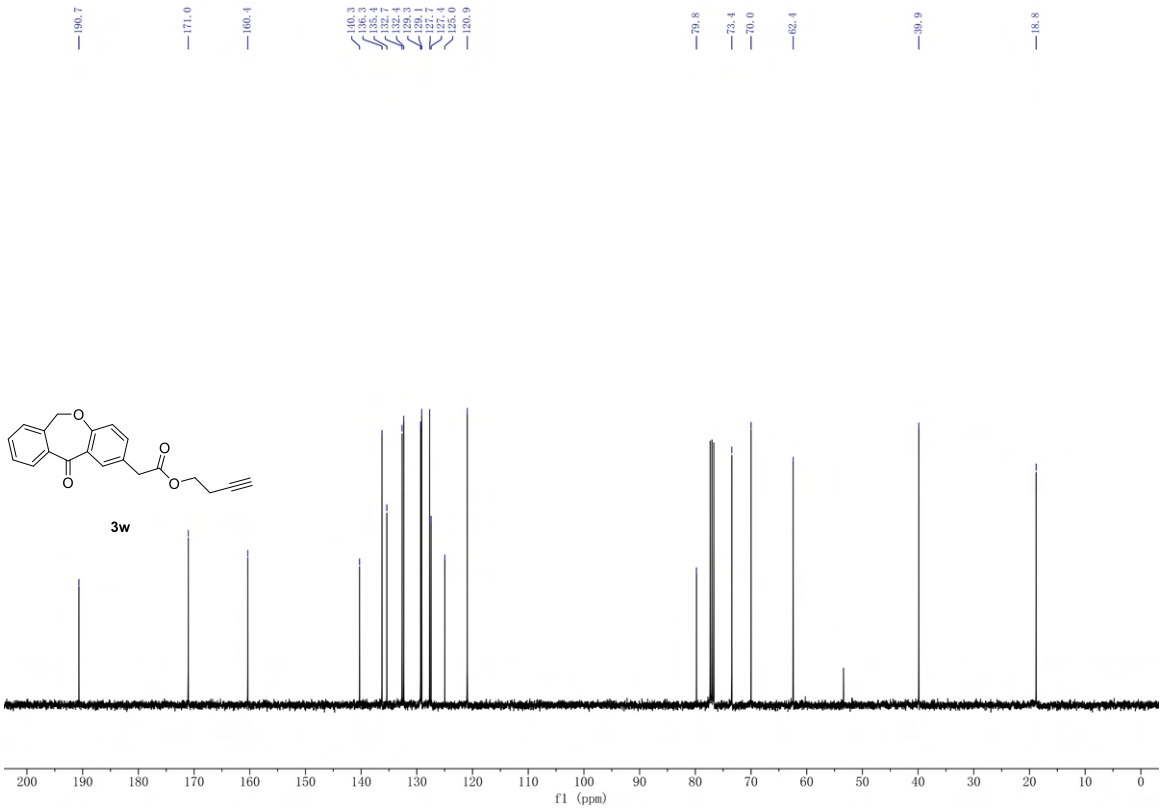

8.15
8.15
8.14
8.14
8.14
8.13
7.55
7.55
7.54
7.54
7.53
7.53
7.33
7.32
7.31
7.31
7.30
4.41
4.40
4.39
4.38
4.37
4.36
2.68
2.67
2.66
2.65
2.64
2.63
2.62
2.06
2.05
2.04
2.03
3n
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


162.3
133.2
132.9
127.8
126.0
79.9
70.0
62.2
19.0
3n
f1 (ppm)


8.61
8.59
8.41
7.87
7.50
7.49
7.48
7.47
7.46
7.42
7.40
7.38
4.48
4.47
4.45
2.72
2.71
2.70
2.69
2.68
2.07
2.06
2.05
3o
0.97
0.94
0.97
1.00
0.98
2.00
2.02
0.96
f1 (ppm)


162.3
139.9
137.0
136.6
126.8
125.4
125.0
124.7
122.4
80.1
70.1
62.2
19.1
3o
f1 (ppm)


8.12
8.11
7.88
7.88
7.86
7.86
7.56
7.56
7.54
7.54
7.52
7.52
7.47
7.47
7.45
7.45
7.44
7.44
7.42
7.42
7.35
7.34
7.03
7.01
5.16
4.23
4.21
4.19
3.66
2.55
2.55
2.54
2.54
2.53
2.52
2.51
2.02
2.02
2.01
3w
0.97
0.99
1.00
1.99
0.99
0.99
2.00
2.00
2.01
2.05
0.82
f1 (ppm)


190.7
171.0
160.4
140.3
136.3
135.4
132.7
132.4
129.3
128.1
127.7
127.4
125.0
120.9
79.8
73.4
70.0
62.4
39.9
18.8
3w
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)