Supporting Information for

Combining Visible Light Catalysis and Transfer Hydrogenation for *in situ* Efficient and Selective Semihydrogenation of Alkynes under Ambient Condition

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Experimental details

a) General information

Unless stated otherwise, all reactions were carried out under Argon. ^{1}H NMR spectra were recorded using a Bruker Avance DPX 400 MHz instrument with tetramethylsilane (TMS) as an internal standard. Multiplicities are indicated, s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet); coupling constants (*J*) are in Hertz (Hz). ^{13}C NMR spectra were obtained at 100 MHz and referenced to the internal solvent signals. ^{19}F NMR spectra were recorded on a Bruker Avance DPX 400 MHz spectrometer ($CFCl_3$ as an external reference (0 ppm)). High resolution mass spectra were recorded using a Trio-2000 GC-MS spectrometer. Hydrogen content was analyzed by gas chromatography (7890-II, Tianmei, China, TCD, nitrogen as a carrier gas and 5 Å molecular sieve column, a thermal conductivity detector). Commercially available reagents and solvents were used without further purification unless indicated otherwise. Irradiation with green light was performed using green LEDs (3W, $\lambda = 525 \pm 10$ nm, 145 lm @700mA).

b) Method for the synthesis of colloidal Pd nanoparticle aqueous solution.

A solution of 5.0×10^{-4} M K_2PdCl_4 was prepared in 100 mL water, to which we added 2.0 mL 1.0×10^{-2} M sodium polyacrylate (MW = 3000). Ar gas was bubbled through the solution for 20 min. Then a high flow rate of H_2 (150 mL/min) was bubbling through the solution for 5 min. The reaction vessel was then sealed, and the solution was left for about 5~6 h until the solution turned lightly dark. The lightly dark solution could be used for the reaction and it would be stable for about two months.

c) General procedure for the semihydrogenation of alkynes by visible light catalysis.

The corresponding alkynes **1** in 1.5 mL CH_3CN (0.1 mmol, 1 equiv.), TEOA (0.3 mmol, 3 equiv.), eosin Y (0.003 mmol, 3 mol %), colloidal Pd nanoparticle aqueous solution (4.0 mL, 5.0×10^{-4} M), were dissolved in a 15 mL reaction tube equipped with magnetic stirring bar, the reaction tube was sealed and the resulting mixed solution was strictly degassed with argon for 15 minutes, then reaction tube was irradiated by green LEDs for 2 h. After reaction, the organic layer was extracted with diethyl ether (3×5 mL). The combined organic phases were washed with brine and dried over sodium sulphate. The solvent was removed by rotary evaporation and purified by column chromatography on

silica gel using hexane/ethyl acetate (100:1) as eluent.

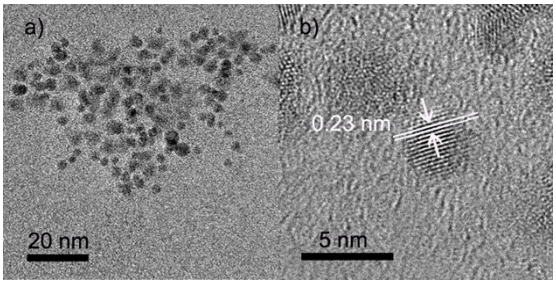
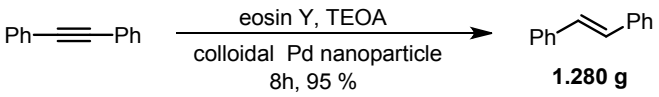


Figure S1. TEM images of colloidal Pd nanoparticle.

Table S1. Optimization of reaction conditions.[a]

entry	TEOA (eq.)	eosin Y (%)	solvent	con. [%]	yield (%)		
					alkene	*E*/*Z*	alkane
1	--	3%	H_2O/CH_3CN	--	--	--	--
2	3.0 eq.	--	H_2O/CH_3CN	--	--	--	--
3[b]	3.0 eq.	3%	H_2O/CH_3CN	--	--	--	--
4[c]	3.0 eq.	3%	H_2O/CH_3CN	--	--	--	--

[a] Reaction conditions: 0.1 mmol 1,2-diphenylacetylene **1a** in1.5 mL CH_3CN, 4 mL colloidal Pd nanoparticle aqueous solution (5.0×10^{-4} M), degassed by bubbling Ar gas, 2 h irradiation under 525 nm green LEDs; [b] no light; [c] no colloidal Pd nanoparticle.



Scheme S1. Gram-scale reaction (Reaction conditions: 7.5 mmol alkynes **1a** in 60 mL CH_3CN, 3.0 eq. TEOA, 2 % eosin Y, 160 mL colloidal Pd nanoparticle aqueous solution (5.0×10^{-4} M), 525 nm green LEDs, 18 h irradiation at room temperature and pressure).

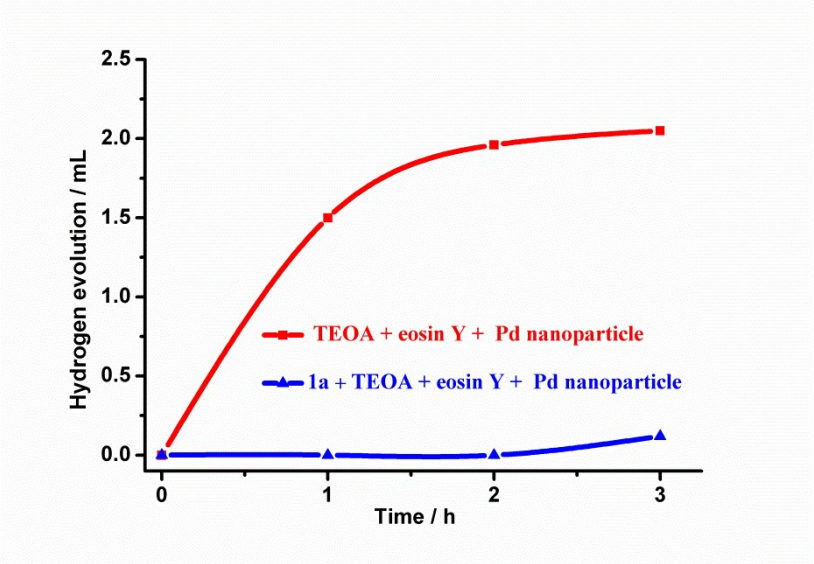


Figure S2. Hydrogen evolution performance in the system with (blue) and without (red) **1a**.

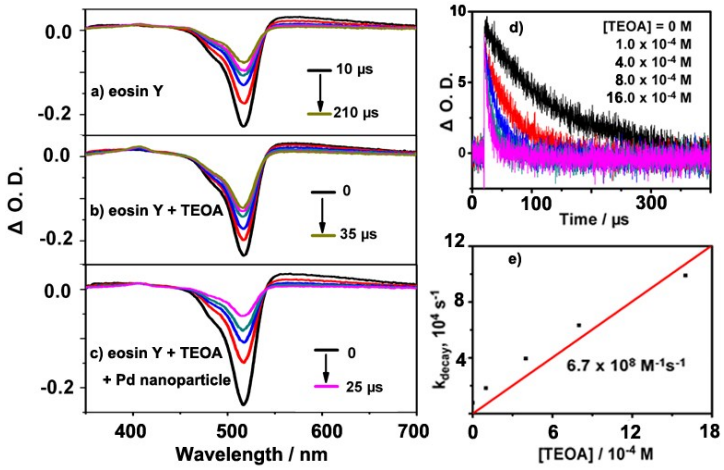


Figure S3. Transient absorption spectra observed after laser excitation (λ_{ex} = 532 nm) of system containing a) eosin Y (1.0×10^{-5} M), b) eosin Y (1.0×10^{-5} M), TEOA (1.0×10^{-3} M), c) eosin Y (1×10^{-5} M), TEOA (1.0×10^{-3} M), colloidal Pd nanoparticle aqueous solution (5.0×10^{-4} M). d) Transient absorbance time profiles at 560 nm due to ^{3}[eosin Y]* in the absence and presence of TEOA after laser excitation (λ_{ex} = 532 nm). e) plot of k_{decay} *versus* [TEOA] for the reaction of ^{3}[eosin Y]* with TEOA.

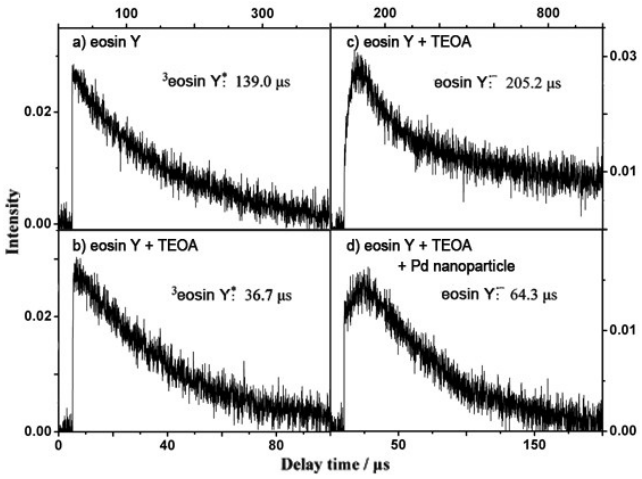
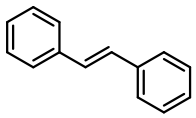


Figure S4. Decay profiles at a) 560 nm of eosin Y (1.0×10^{-5} M); b) 560 nm of eosin Y (1.0×10^{-5} M), TEOA (1.0×10^{-3} M); c) 410 nm of eosin Y (1.0×10^{-5} M), TEOA (1.0×10^{-3} M); d) 410 nm of eosin Y (1.0×10^{-5} M), TEOA (1.0×10^{-3} M), colloidal Pd nanoparticle (5.0×10^{-4} M).

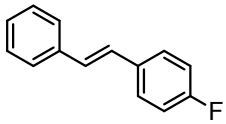
Characterization data of the products

(*E*)-1,2-Diphenylethylene



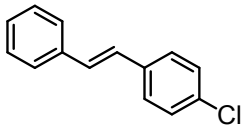
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.9), *E/Z* =95:5. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.57 – 7.49 (m, 4H), 7.37 (dd, *J* = 10.4, 4.8 Hz, 4H), 7.30 – 7.24 (m, 2H), 7.12 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 138.3, 129.6, 129.7, 128.5, 127.4. HRMS (EI^+HR) calcd. for $C_{14}H_{12}$: 180.0939, found: 180.0939.

(*E*)-1-(4-fluorophenyl)-2-phenylethene



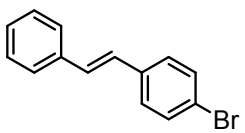
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.9), *E/Z* = 95:5. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.55 – 7.45 (m, 4H), 7.37 (t, *J* = 7.6 Hz, 2H), 7.30 – 7.24 (m, 1H), 7.13 – 6.98 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 163.6-161.1 (d, *J* = 250 Hz), 137.2, 133.5, 128.7, 128.5, 127.9, 127.7, 127.5, 126.5, 115.7. ^{19}F NMR (376 MHz, $CDCl_3$) δ = -114.3. HRMS (EI^+HR) calcd. for $C_{14}H_{11}F$: 198.0845, found: 198.0850.

(*E*)-1-(4-chloridephenyl)-2-phenylethene



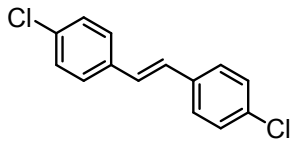
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.9), *E/Z* = 95:5. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.50 (d, *J* = 7.5 Hz, 2H), 7.43 (d, *J* = 8.5 Hz, 2H), 7.33 (dt, *J* = 16.8, 7.8 Hz, 5H), 7.06 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 137.0, 135.9, 133.2, 129.3, 128.8, 128.7, 127.9, 127.7, 127.4, 126.6. HRMS (EI^+HR) calcd. for $C_{14}H_{11}Cl$: 214.0549, found: 214.0546.

(*E*)-1-(4-bromidephenyl)-2-phenylethene



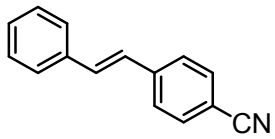
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.9), *E/Z* = 95:5. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.58 – 7.50 (m, 4H), 7.40 – 7.27 (m, 4H), 7.33 – 7.29 (m, 1H), 7.09 (dd, *J* = 28.3, 16.4 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 136.9, 136.3, 133.0, 131.8, 129.4, 128.7, 128.0, 127.6, 126.5, 121.3. HRMS (EI^+HR) calcd. for $C_{14}H_{11}Br$: 258.0044, found: 258.0046.

(*E*)-1,2-Di-(4-chloridephenyl)ethylene



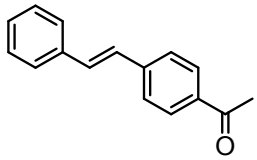
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.9), *E/Z* = 95:5. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.43 (d, *J* = 8.5 Hz, 4H), 7.33 (d, *J* = 8.5 Hz, 4H), 7.03 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 136.4, 134.4, 129.8, 128.9, 128.6. HRMS (EI^+HR) calcd. for $C_{14}H_{10}Cl_2$: 248.0160, found: 248.0161.

(*E*)-1-(4-cyanidephenyl)-2-phenylethene



Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.9), *E/Z* = 95:5. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.65 (d, *J* = 8.4 Hz, 2H), 7.60 (d, *J* = 8.4 Hz, 2H), 7.55 (d, *J* = 7.4 Hz, 2H), 7.41 (t, *J* = 7.4 Hz, 2H), 7.34 (dd, *J* = 8.3, 6.3 Hz, 1H), 7.24 (d, *J* = 16.3 Hz, 1H), 7.11 (d, *J* = 16.3 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 142.8, 137.2, 133.4, 133.4, 129.8, 129.6, 127.8, 127.8, 127.7, 119.9, 111.5. HRMS (EI^+HR) calcd. for $C_{15}H_{11}N$: 205.0891, found: 205.0899.

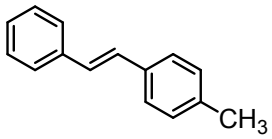
(*E*)-1-(4-Acetylphenyl)-2-phenylethene



Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.8), *E/Z* = 95:5. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.97 (d, *J* = 8.4 Hz, 2H), 7.60 (d, *J* = 8.4 Hz, 2H), 7.55 (d, *J* = 7.4 Hz, 2H), 7.39 (t, *J* = 7.5 Hz, 2H), 7.31 (t, *J* = 7.3 Hz, 1H), 7.22 (s, 1H), 7.14 (d, *J* = 16.3 Hz,

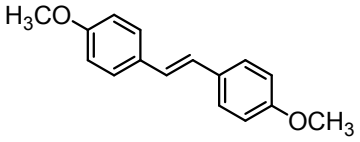
1H), 2.62 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 198.4, 142.9, 137.6, 136.9, 132.4, 129.8, 129.7, 129.2, 128.4, 127.7, 127.4, 27.5. HRMS (EI$^+$HR) calcd. for $C_{16}H_{14}O$: 222.1045, found: 222.1044.

(*E*)-1-(4-methylphenyl)-2-phenylethene



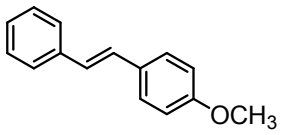
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.9), *E/Z* = 95:5. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.54 – 7.50 (m, 2H), 7.44 (d, *J* = 8.1 Hz, 2H), 7.37 (t, *J* = 7.6 Hz, 2H), 7.26 (t, *J* = 4.5 Hz, 1H), 7.19 (d, *J* = 7.9 Hz, 2H), 7.15 – 7.03 (dd, J = 16 Hz, m, 2H), 2.38 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 138.5, 135.5, 130.3, 129.6, 128.6, 128.3, 127.4, 127.3, 127.2, 22.2. HRMS (EI$^+$HR) calcd. for $C_{15}H_{14}$: 194.1096, found: 194.1106.

(*E*)-1,2-Di-(4-methoxyphenyl)ethylene



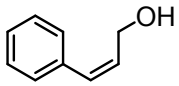
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.9), *E/Z* = 95:5. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.43 (d, *J* = 8.7 Hz, 4H), 6.94 (s, 2H), 6.90 (d, *J* = 8.7 Hz, 4H), 3.84 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 159.9, 131.4, 128.3, 127.1, 115.0, 56.2. HRMS (EI$^+$HR) calcd. for $C_{16}H_{16}O_2$: 240.1150, found: 240.1153.

(*E*)-1-(4-methoxyphenyl)-2-phenylethene



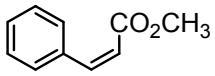
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.9), *E/Z* = 95:5. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.55 – 7.44 (m, 5H), 7.34 (d, *J* = 7.9 Hz, 2H), 7.08 (d, *J* = 16.3 Hz, 1H), 6.98 (d, *J* = 16.3 Hz, 1H), 6.91 (d, *J* = 8.8 Hz, 2H), 3.84 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 134.0, 132.4, 129.6, 129.2, 128.9, 128.6, 128.1, 127.6, 127.2, 115.1, 56.3. HRMS (EI$^+$HR) calcd. for $C_{15}H_{14}O$: 210.1045, found: 210.1044.

(*Z*)-3-phenylprop-2-en-1-ol



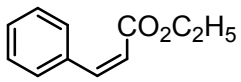
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 50:1, R_f = 0.7), *E/Z* = 5:95. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.35 (t, *J* = 7.4 Hz, 2H), 7.30 – 7.26 (m, 1H), 7.21 (d, *J* = 7.2 Hz, 2H), 6.58 (d, *J* = 11.7 Hz, 1H), 5.88 (dt, *J* = 11.9, 6.4 Hz, 1H), 4.45 (dd, *J* = 6.4, 1.6 Hz, 2H), 1.59 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 137.4, 132.1, 132.0, 129.7, 129.2, 128.2, 60.6. HRMS (EI^+HR) calcd. for $C_9H_{10}O$: 134.0732, found: 134.0733.

(*Z*)-methyl-3-phenylacrylate



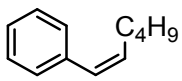
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 80:1, R_f = 0.8), *E/Z* = 5:95. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.59 (dd, *J* = 7.5, 1.6 Hz, 2H), 7.43 – 7.29 (m, 3H), 6.96 (d, *J* = 12.6 Hz, 1H), 5.96 (d, *J* = 12.6 Hz, 1H), 3.71 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 167.5, 144.3, 135.7, 130.6, 130.0, 129.0, 120.2, 52.3. HRMS (EI^+HR) calcd. for $C_{10}H_{10}O_2$: 162.0681, found: 162.0681.

(*Z*)-ethyl-3-phenylacrylate



Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 80:1, R_f = 0.8), *E/Z* = 5:95. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.61 – 7.55 (m, 2H), 7.35 (d, *J* = 7.5 Hz, 3H), 6.95 (d, *J* = 12.6 Hz, 1H), 5.95 (d, *J* = 12.6 Hz, 1H), 4.18 (q, *J* = 7.1 Hz, 2H), 1.25 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 167.2, 143.9, 135.8, 130.6, 129.9, 128.9, 120.8, 61.2, 15.0. HRMS (EI^+HR) calcd. for $C_{11}H_{12}O_2$: 176.0837, found: 176.0835.

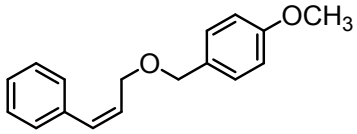
(*Z*)-hex-1-en-1-ylbenzene



Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.9), *E/Z* = 5:95. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.36 – 7.30 (m, 2H), 7.26 (dd, *J* = 13.7, 9.1 Hz, 3H), 6.40 (d, *J* = 11.6 Hz, 1H), 5.66 (dt, *J* = 11.6, 7.3 Hz, 1H), 2.38 – 2.27 (m, 2H), 1.46 – 1.41 (m, 2H), 1.35 (dd,

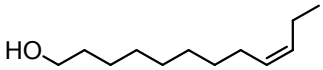
J = 14.9, 7.3 Hz, 2H), 0.89 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 137.9, 133.2, 128.8, 128.7, 128.5, 128.1, 126.4, 32.4, 28.4, 22.4, 14.0. HRMS (EI$^+$HR) calcd. for $C_{12}H_{16}$: 160.1252, found: 160.1255.

(*Z*)-1-methoxy-4-(((3-phenylallyl)oxy)methyl)benzene



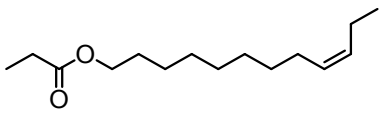
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 60:1, R_f = 0.7), *E/Z* = 7:93. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 7.34 – 7.31 (m, 2H), 7.29 – 7.25 (m, 3H), 7.23 – 7.19 (m, 2H), 6.90 – 6.85 (m, 2H), 6.63 (d, *J* = 11.8 Hz, 1H), 5.97 – 5.85 (m, 1H), 4.47 (s, 2H), 4.29 (dd, *J* = 6.4, 1.6 Hz, 2H), 3.81 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 160.2, 137.6, 132.7, 131.2, 130.4, 130.0, 129.7, 129.1, 128.1, 114.7, 73.0, 67.5, 56.2. HRMS (EI$^+$HR) calcd. for $C_{17}H_{18}O_2$: 254.1307, found: 254.1303.

(*Z*)-dodec-9-en-1-ol



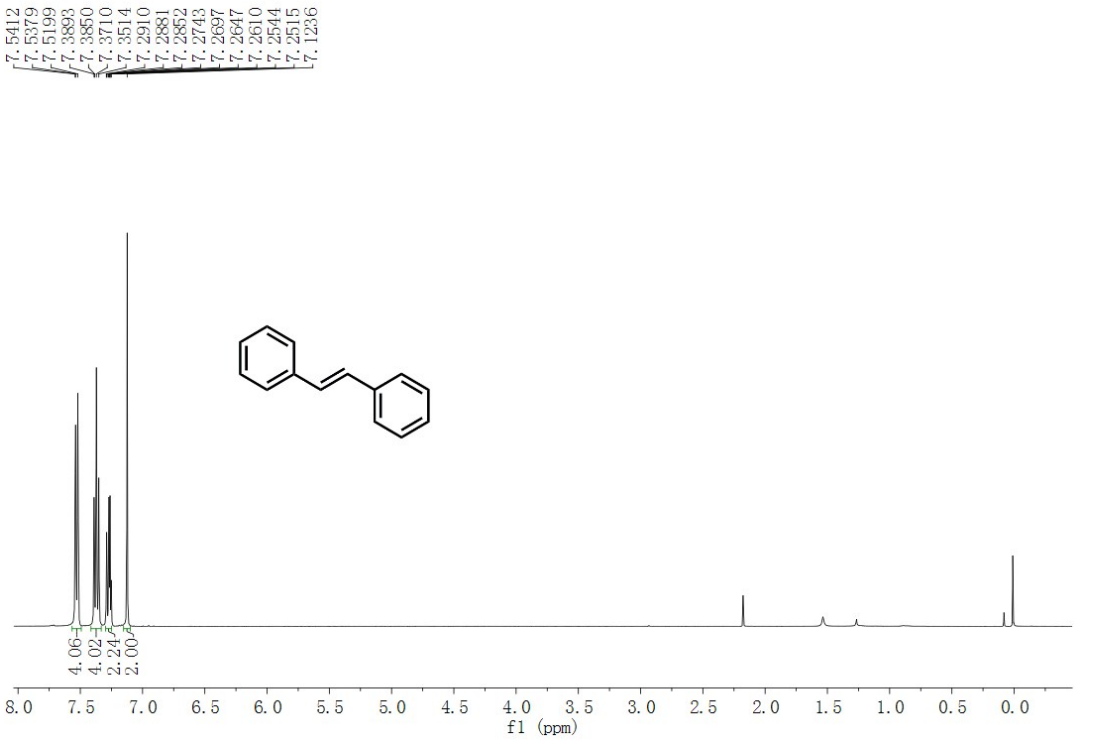
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 100:1, R_f = 0.8), *E/Z* = 8:92. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 5.48 – 5.26 (m, 2H), 3.63 (t, *J* = 6.6 Hz, 2H), 2.08 – 1.91 (m, 4H), 1.55 (dd, *J* = 14.0, 6.9 Hz, 2H), 1.47 (s, 1H), 1.32 (d, *J* = 19.1 Hz, 10H), 0.95 (td, *J* = 7.5, 2.7 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 132.5, 130.2, 64.0, 33.7, 30.7, 30.4, 30.3, 30.1, 28.0, 26.7, 21.4, 15.3. HRMS (EI$^+$HR) calcd. for $C_{12}H_{24}O$: 184.1827, found: 184.1832.

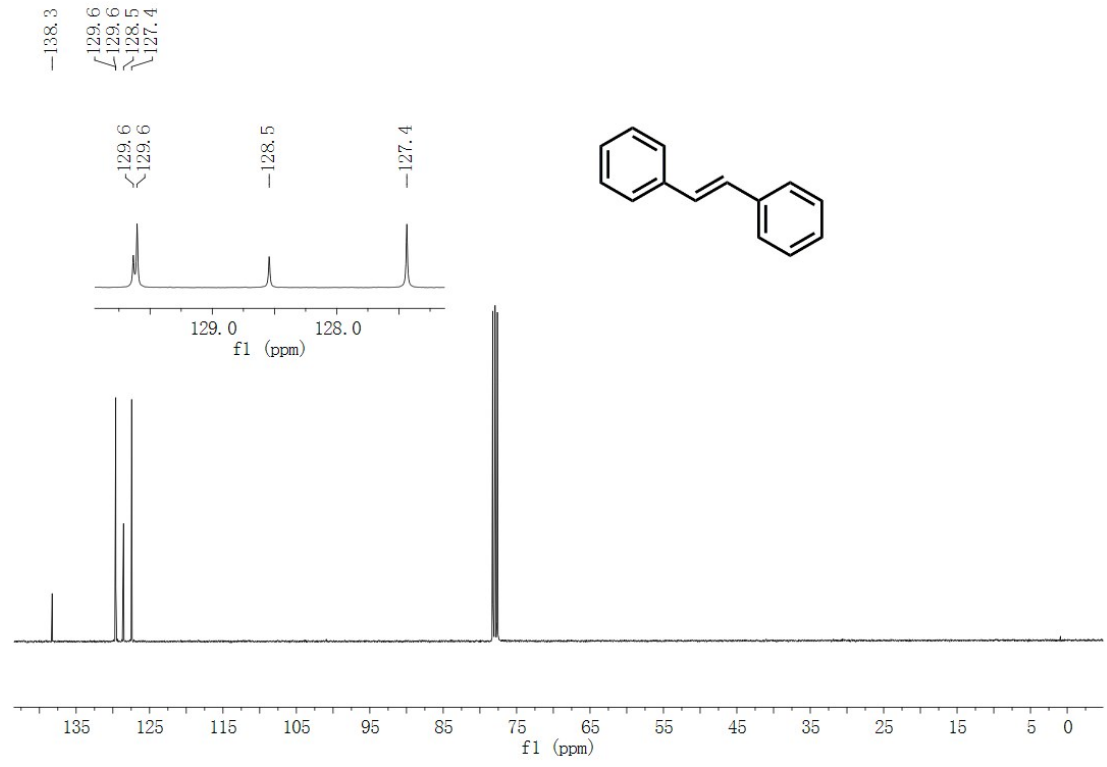
(*Z*)-dodec-9-en-1-yl propionate



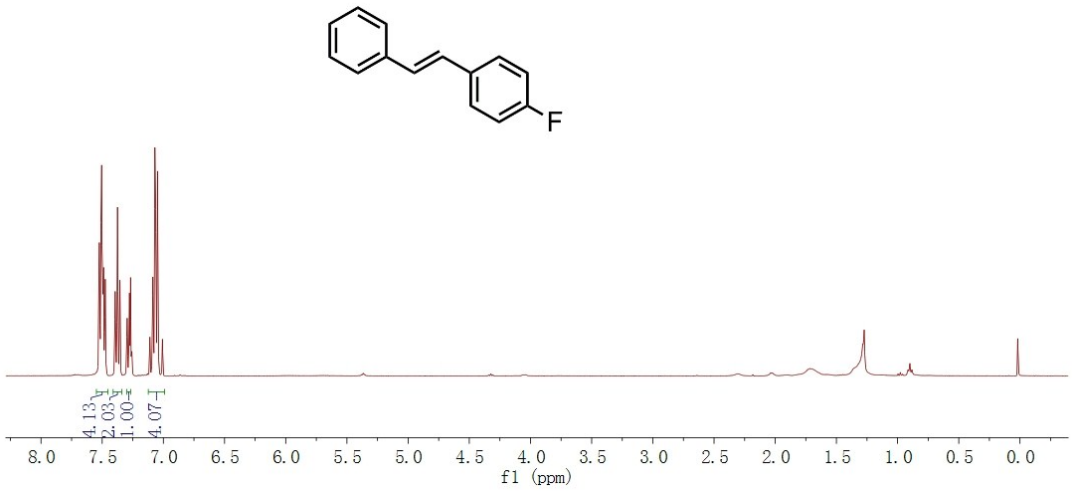
Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 80:1, R_f = 0.9), *E/Z* = 6:94. ^{1}H NMR (400 MHz, $CDCl_3$) δ = 5.47 – 5.26 (m, 2H), 4.06 (t, *J* = 6.7 Hz, 2H), 2.32 (q, *J* = 7.6 Hz, 2H), 2.09 – 1.93 (m, 4H), 1.61 (dd, *J* = 13.7, 6.8 Hz, 2H), 1.30 (s, 10H), 1.14 (t, *J* = 7.6 Hz, 3H), 0.95 (t, *J* = 7.5 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ = 175.5, 132.5, 130.2, 65.4, 30.6, 30.3, 30.1, 30.1, 29.6, 28.6, 28.0, 26.8, 21.4, 15.3, 10.1. HRMS (EI$^+$HR) calcd. for $C_{15}H_{28}O_2$: 240.2089, found: 240.2076.

^{1}H NMR and ^{13}C NMR spectra

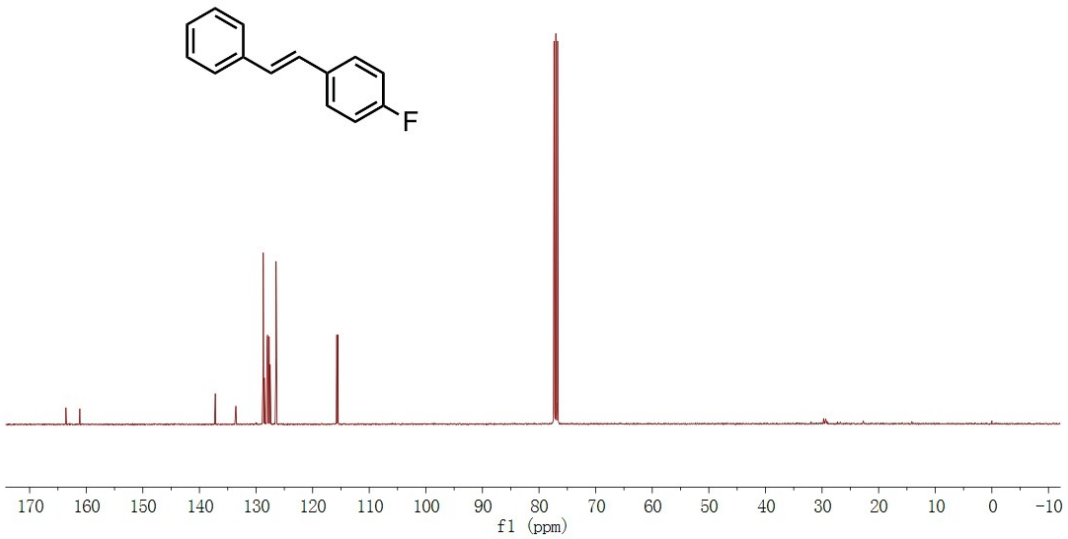


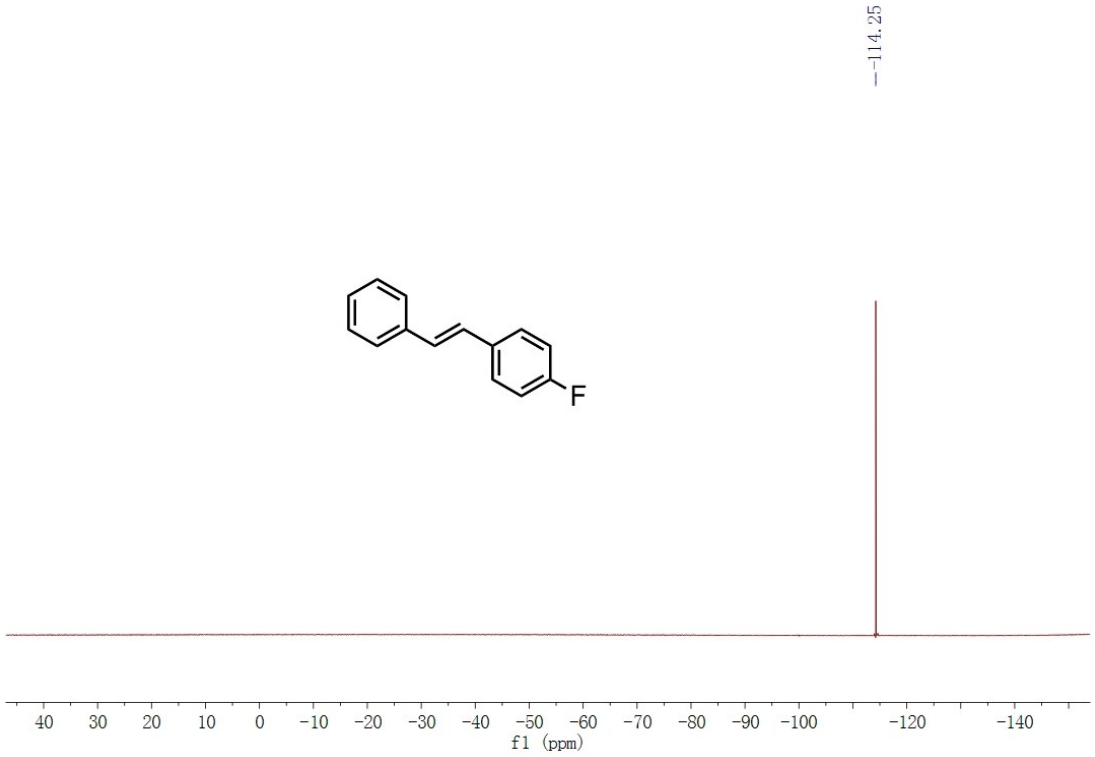


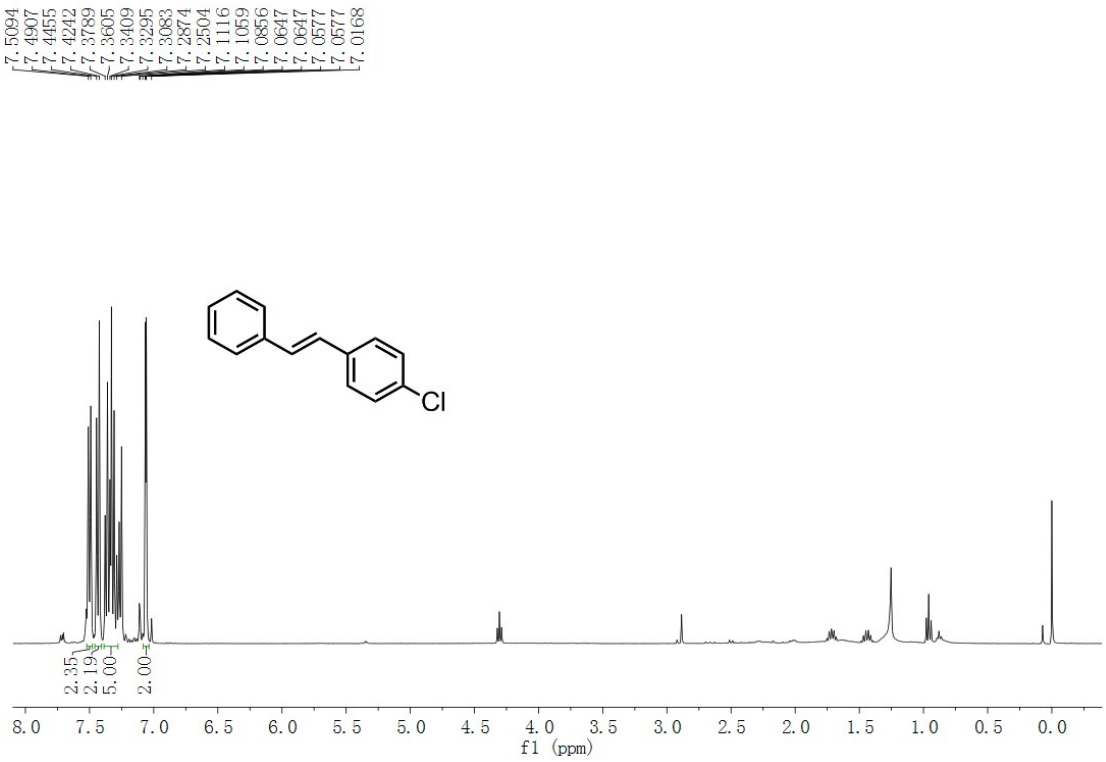

7.5233
7.5044
7.4964
7.4885
7.4748
7.3935
7.3748
7.3555
7.2957
7.2774
7.2678
7.2595
7.1100
7.0856
7.0689
7.0644
7.0482
7.0430
7.0076


F
4.13
2.03
1.00
4.07
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)


163.5904
161.1343
137.1946
133.5272
128.7260
128.5347
128.5111
128.0376
127.9586
127.6856
127.5054
126.4597


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


-114.25
F
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
f1 (ppm)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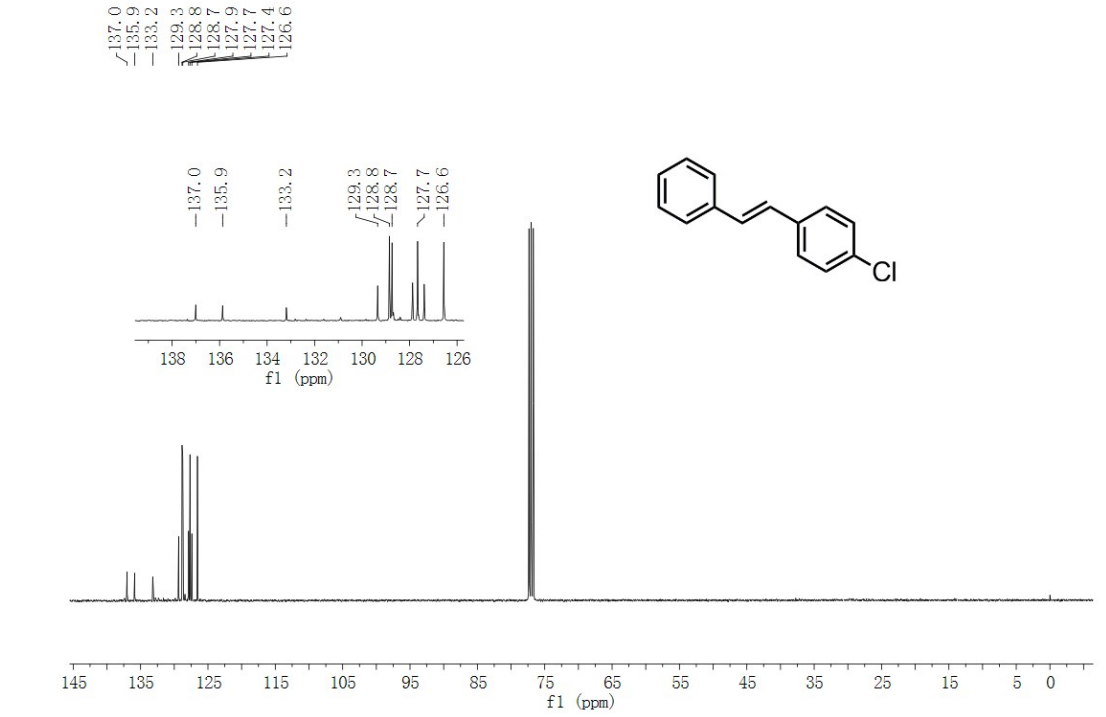
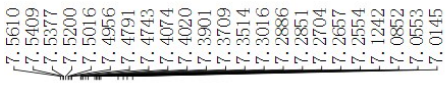
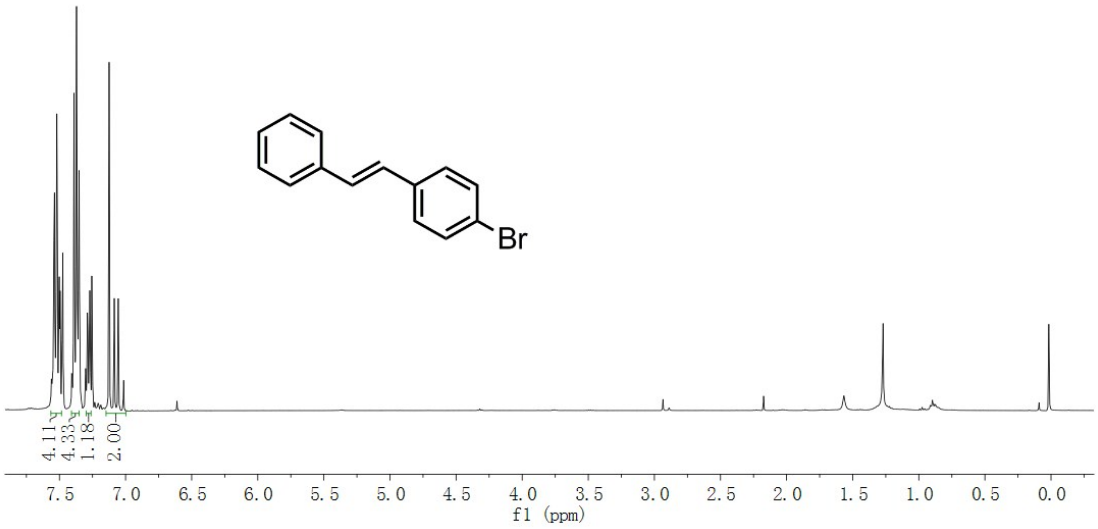
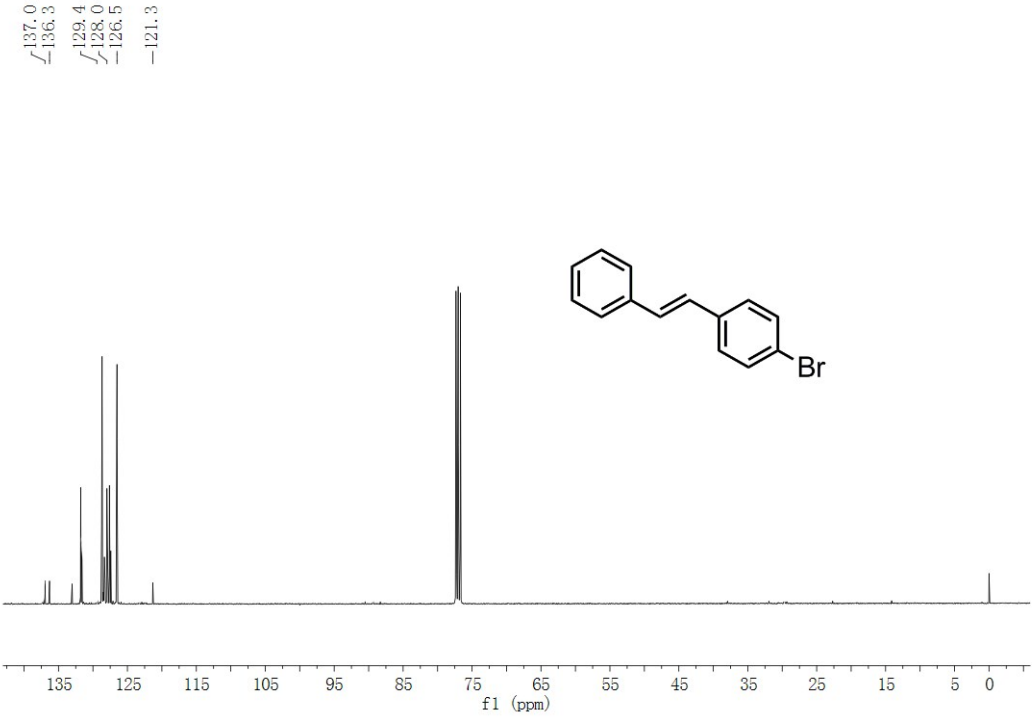
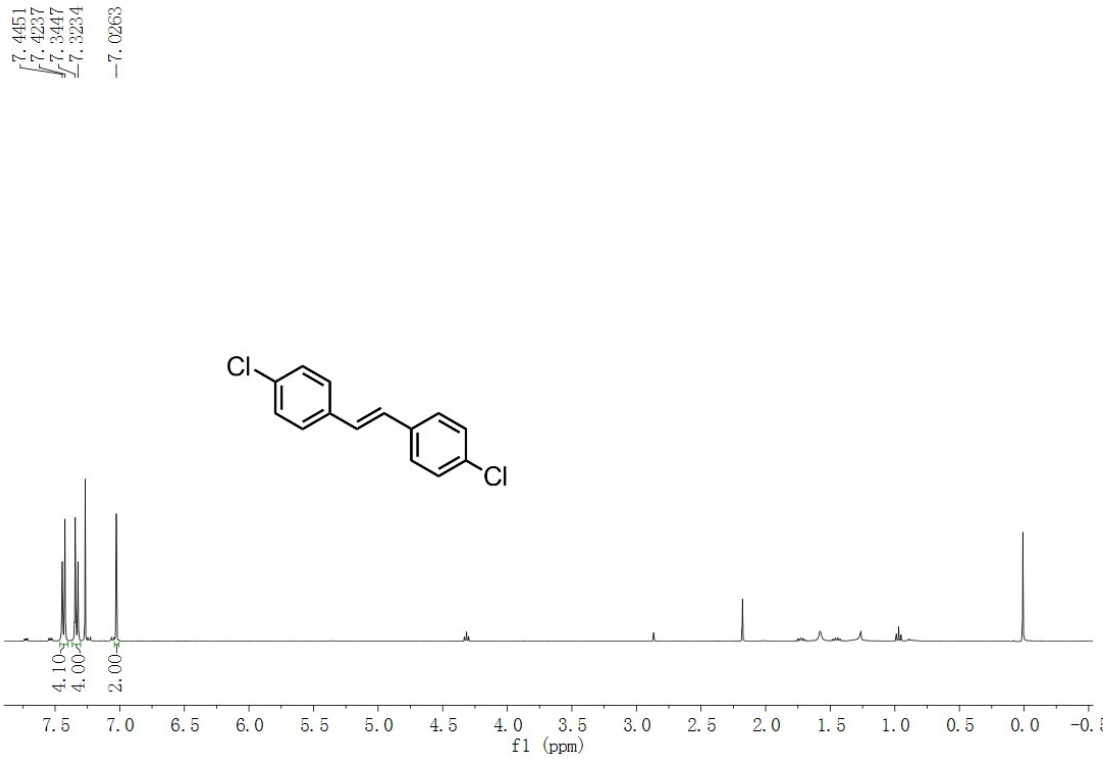
7.4907
7.4455
7.4242
7.3789
7.3605
7.3409
7.3295
7.3083
7.2874
7.2504
7.1116
7.1059
7.0856
7.0647
7.0647
7.0577
7.0577
7.0168
Cl
2.35
2.19
5.00
2.00
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

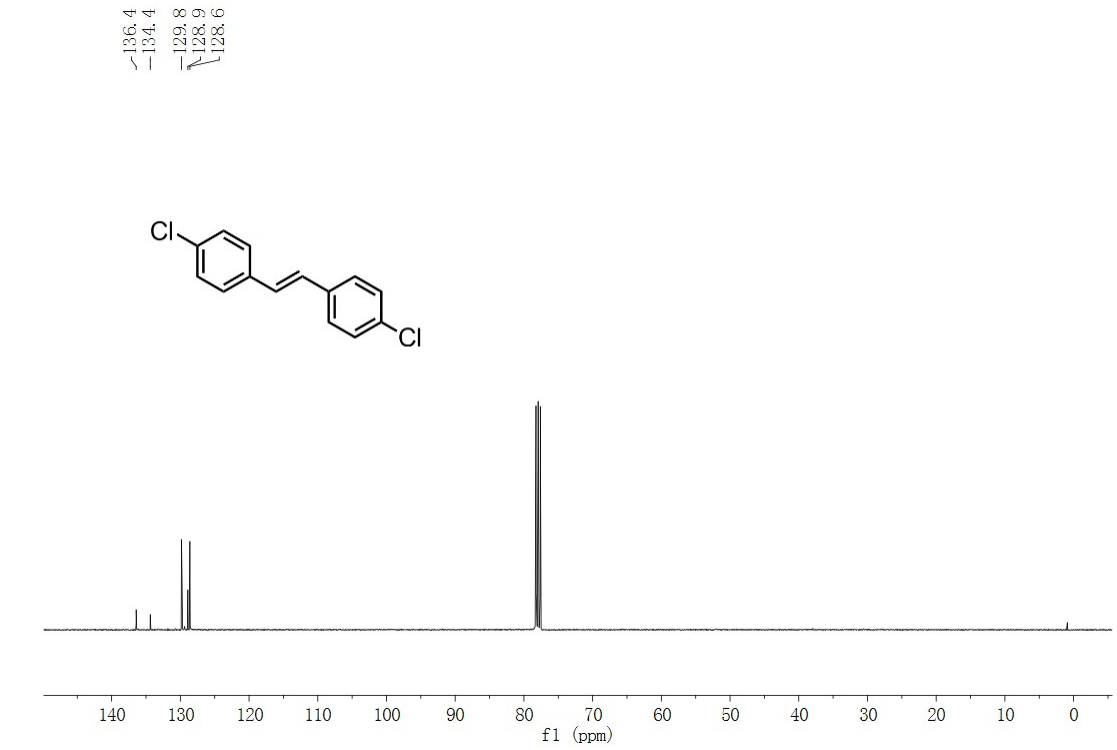

137.0
135.9
133.2
129.3
128.8
128.7
127.9
127.7
127.4
126.6
Cl
138 136 134 132 130 128 126
f1 (ppm)
145 135 125 115 105 95 85 75 65 55 45 35 25 15 5 0
f1 (ppm)

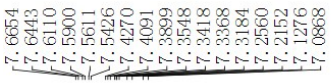

7.5610
7.5409
7.5377
7.5200
7.5016
7.4956
7.4791
7.4743
7.4074
7.4020
7.3901
7.3709
7.3514
7.3016
7.2886
7.2851
7.2704
7.2657
7.2554
7.1242
7.0852
7.0553
7.0145


Br
4.11
4.33
1.18
2.00
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)


137.0
136.3
129.4
128.0
126.5
121.3
Br
135 125 115 105 95 85 75 65 55 45 35 25 15 5 0
f1 (ppm)


7.4451
7.4237
7.3447
7.3234
7.0263
Cl
Cl
4.10
4.00
2.00
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)


136.4
134.4
129.8
128.9
128.6
Cl
Cl
140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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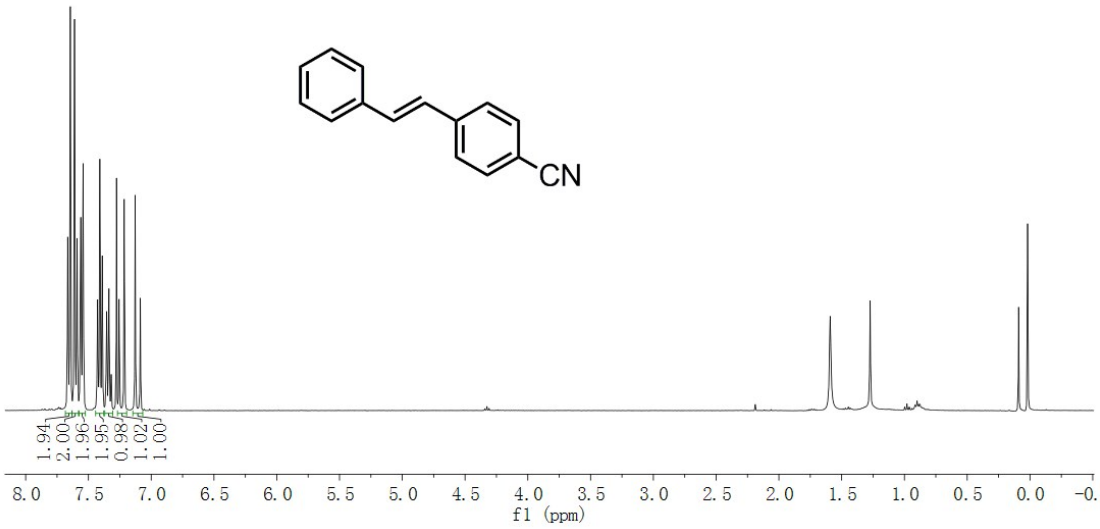
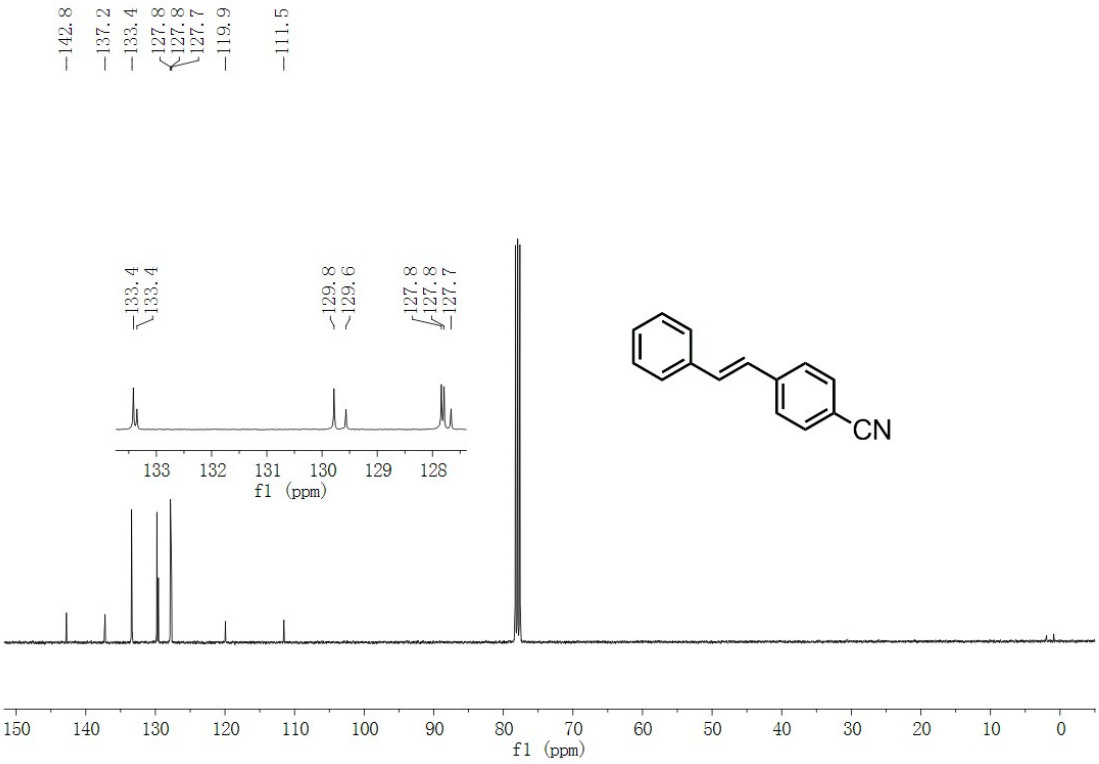
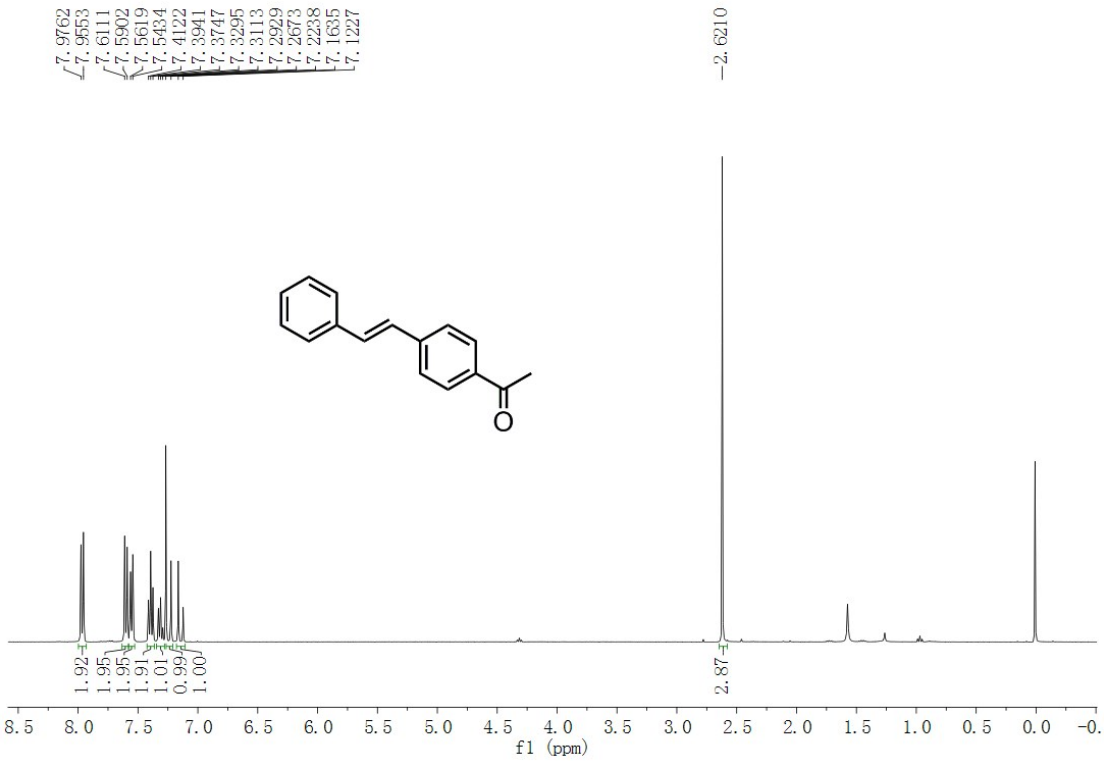
7.6643
7.6110
7.5900
7.5611
7.5426
7.4270
7.4091
7.3899
7.3548
7.3418
7.3368
7.3184
7.2560
7.2152
7.1276
7.0868


CN
1.94
2.00
1.96
1.95
0.98
1.02
1.00
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.
f1 (ppm)


142.8
137.2
133.4
127.8
127.8
127.7
119.9
111.5
133.4
133.4
129.8
129.6
127.8
127.8
127.7
CN
133 132 131 130 129 128
f1 (ppm)
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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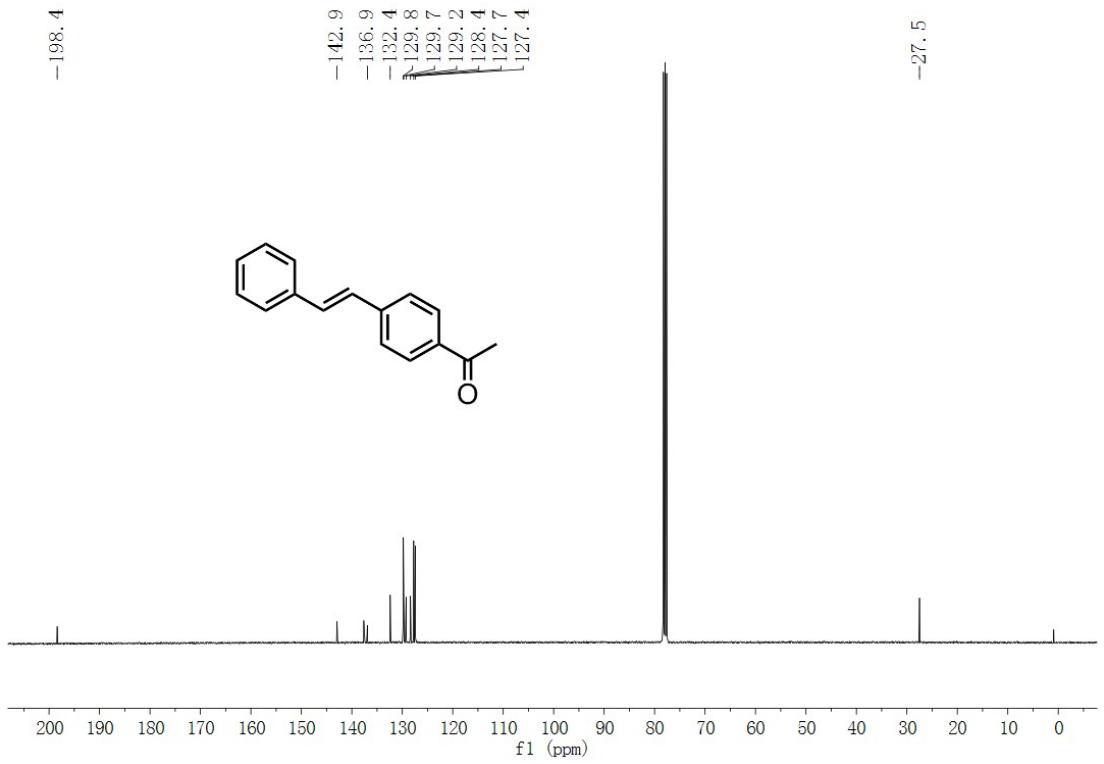
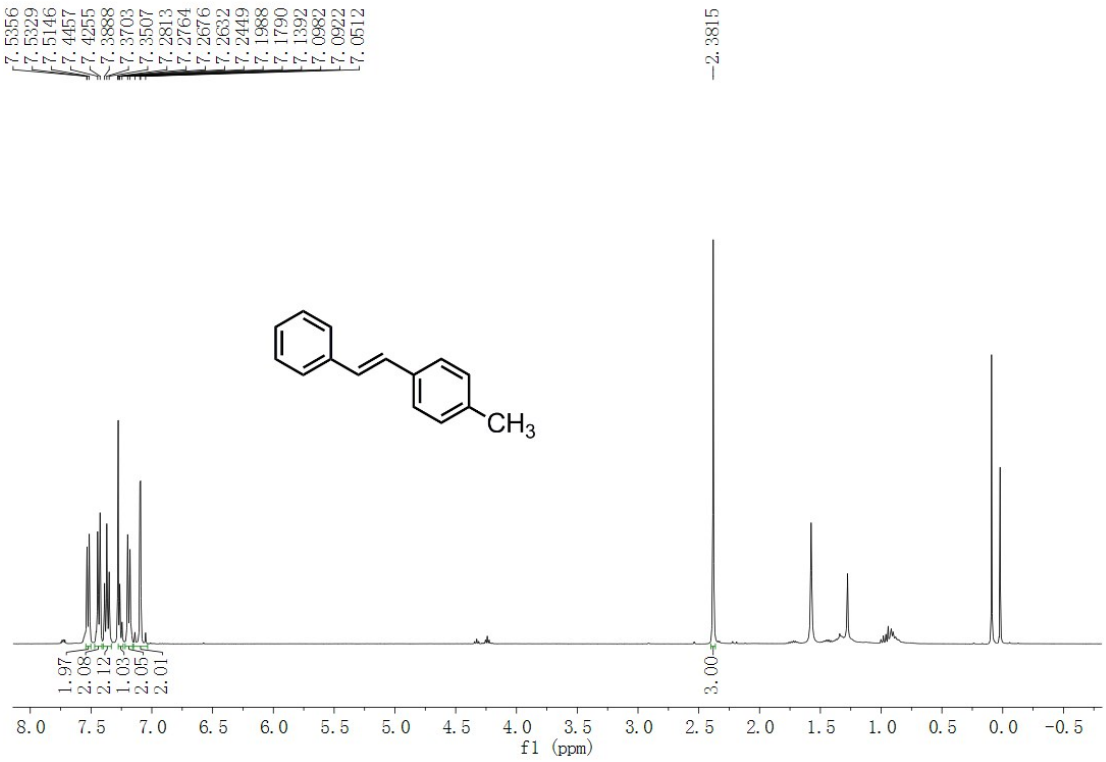
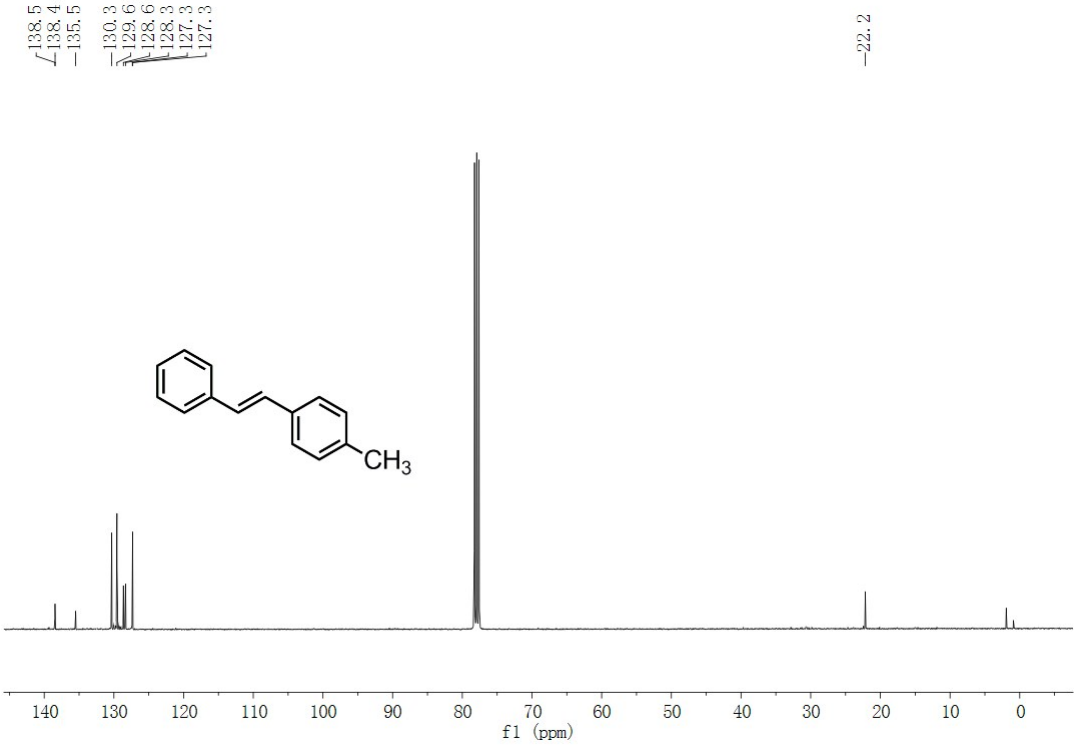
7.5619
7.5434
7.4122
7.3941
7.3747
7.3295
7.3113
7.2929
7.2673
7.2238
7.1635
7.1227
2.6210
1.92
1.95
1.95
1.91
1.01
0.99
1.00
2.87
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.
f1 (ppm)


198.4
142.9
136.9
132.4
129.8
129.7
129.2
128.4
127.7
127.4
27.5
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.5356
7.5329
7.5146
7.4457
7.4255
7.3888
7.3703
7.3507
7.2813
7.2764
7.2676
7.2632
7.2449
7.1988
7.1790
7.1392
7.0982
7.0922
7.0512
2.3815
CH3
1.97
2.08
2.12
1.03
2.05
2.01
3.00
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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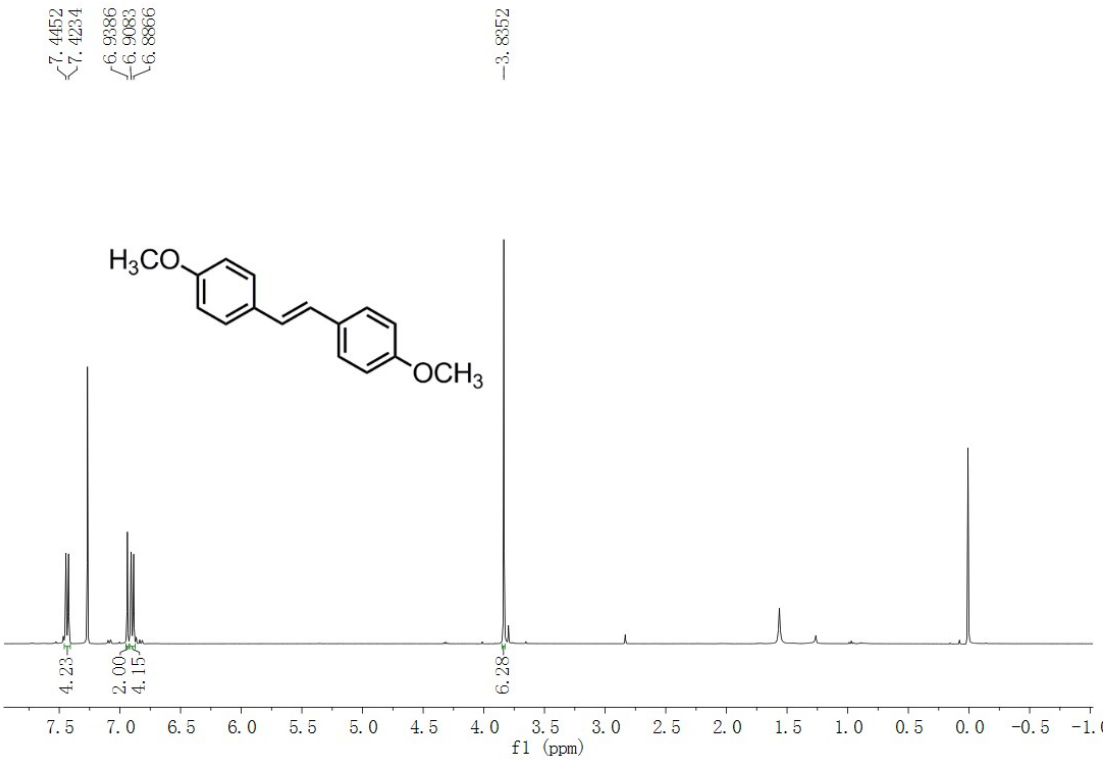
138.4
135.5
130.3
129.6
128.6
128.3
127.3
127.3
22.2
CH3
140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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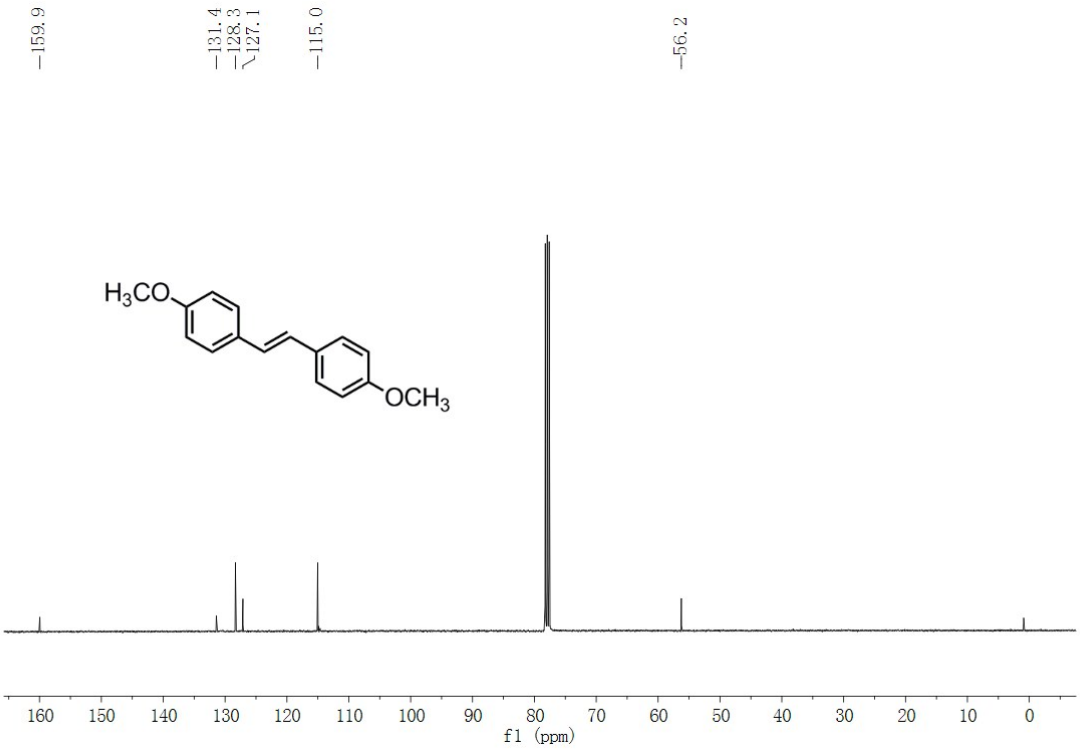
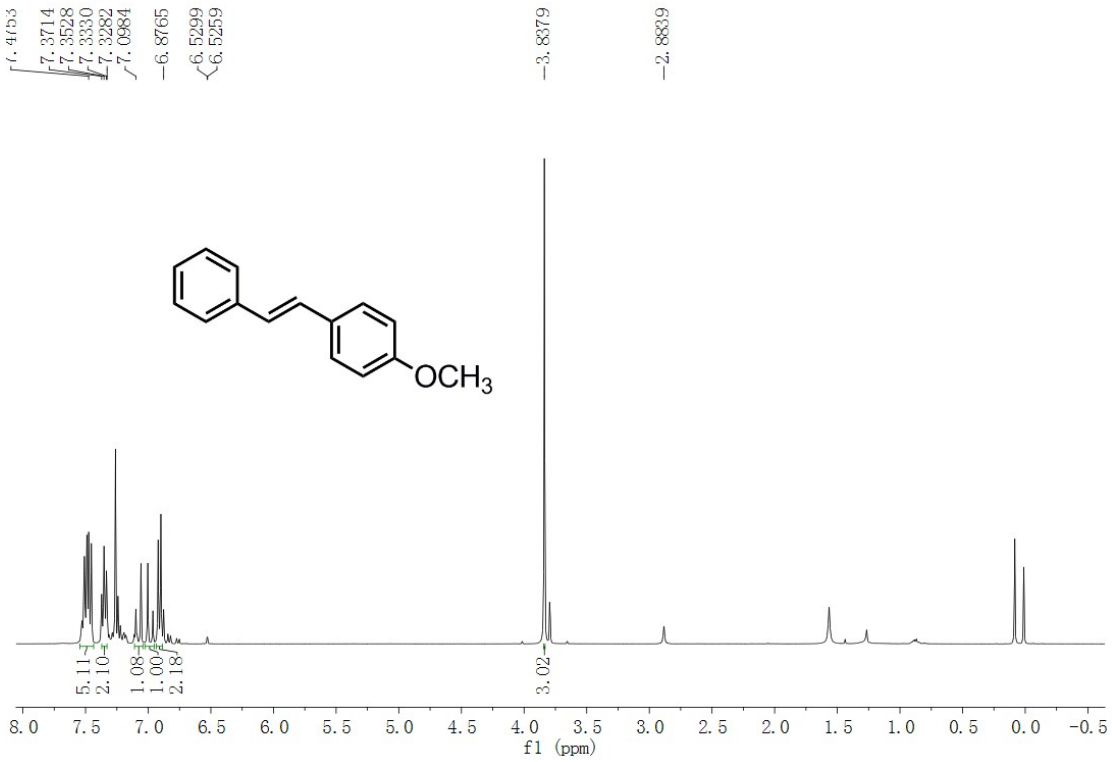
7.4234
6.9386
6.9083
6.8866
3.8352
H3CO
OCH3
4.23
2.00
4.15
6.28
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


159.9
131.4
128.3
127.1
115.0
56.2
H3CO
OCH3
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.3714
7.3528
7.3330
7.3282
7.0984
6.8765
6.5299
6.5259
3.8379
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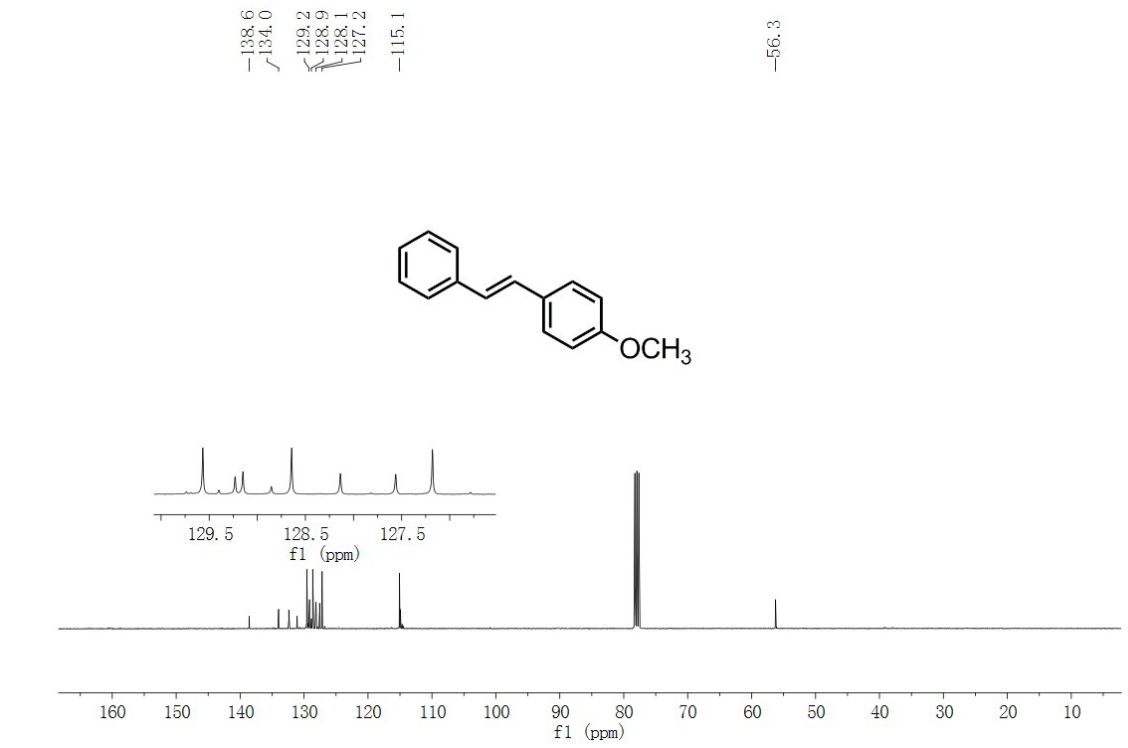
OCH3
5.11
2.10
1.08
1.00
2.18
3.02
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


138.6
134.0
129.2
128.9
128.1
127.2
115.1
56.3
OCH3
129.5
128.5
127.5
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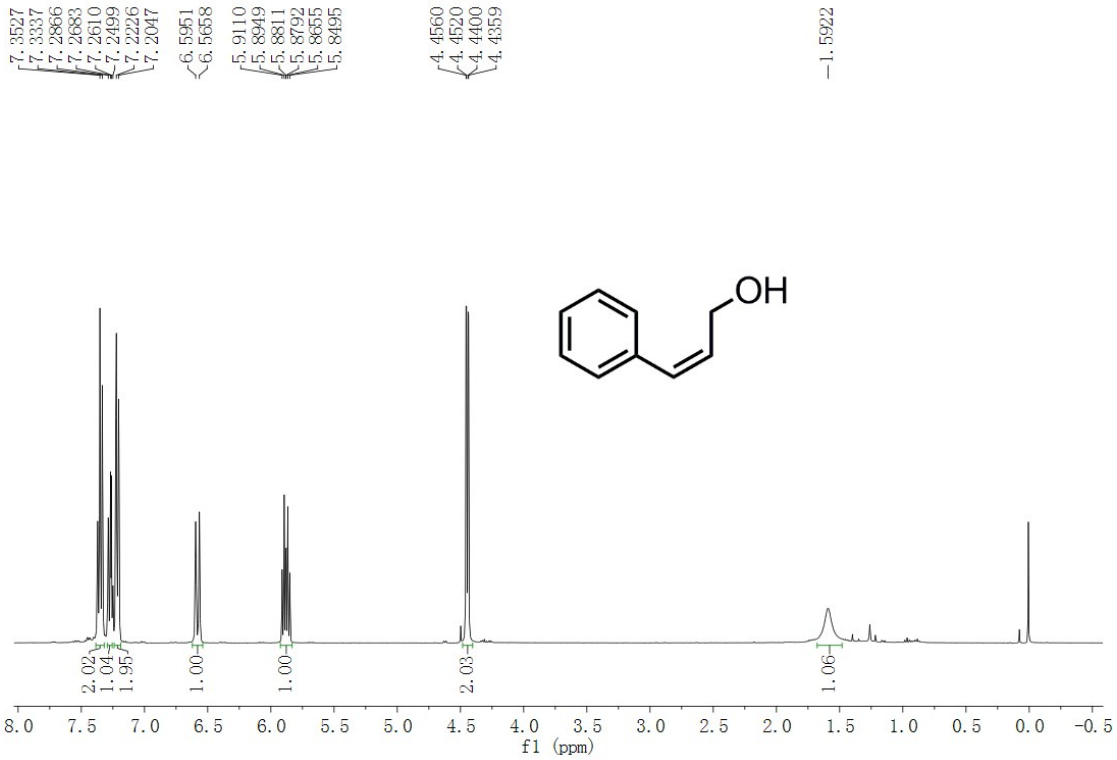
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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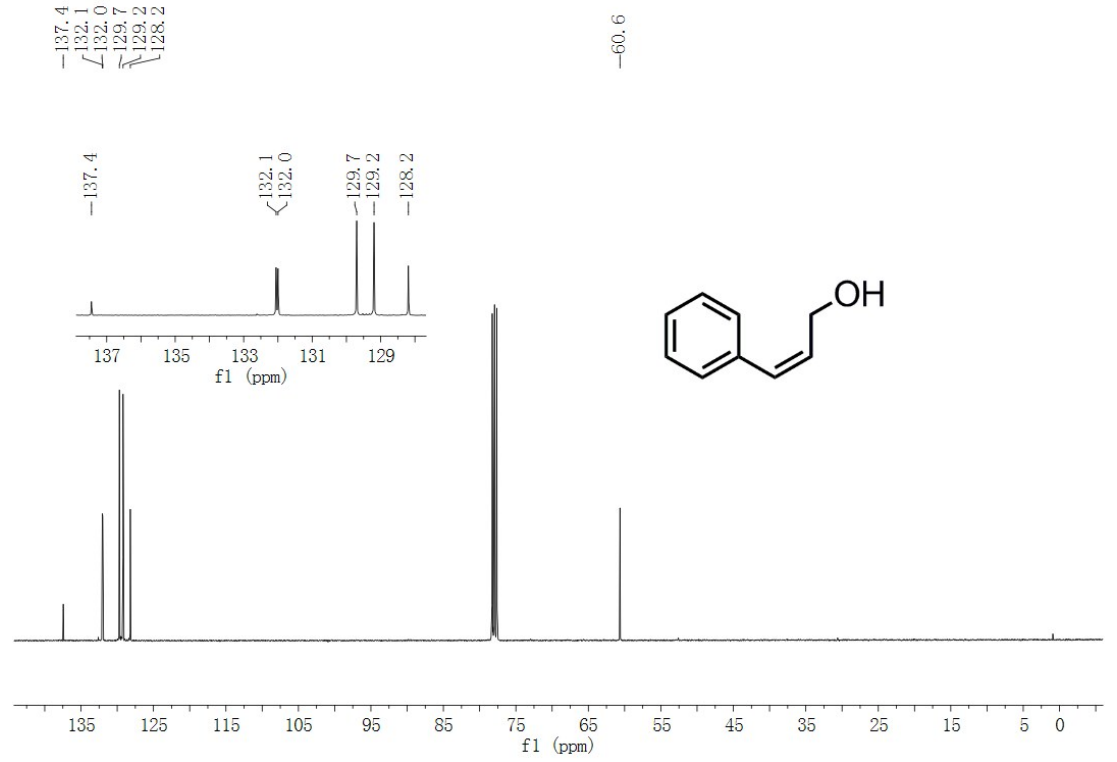
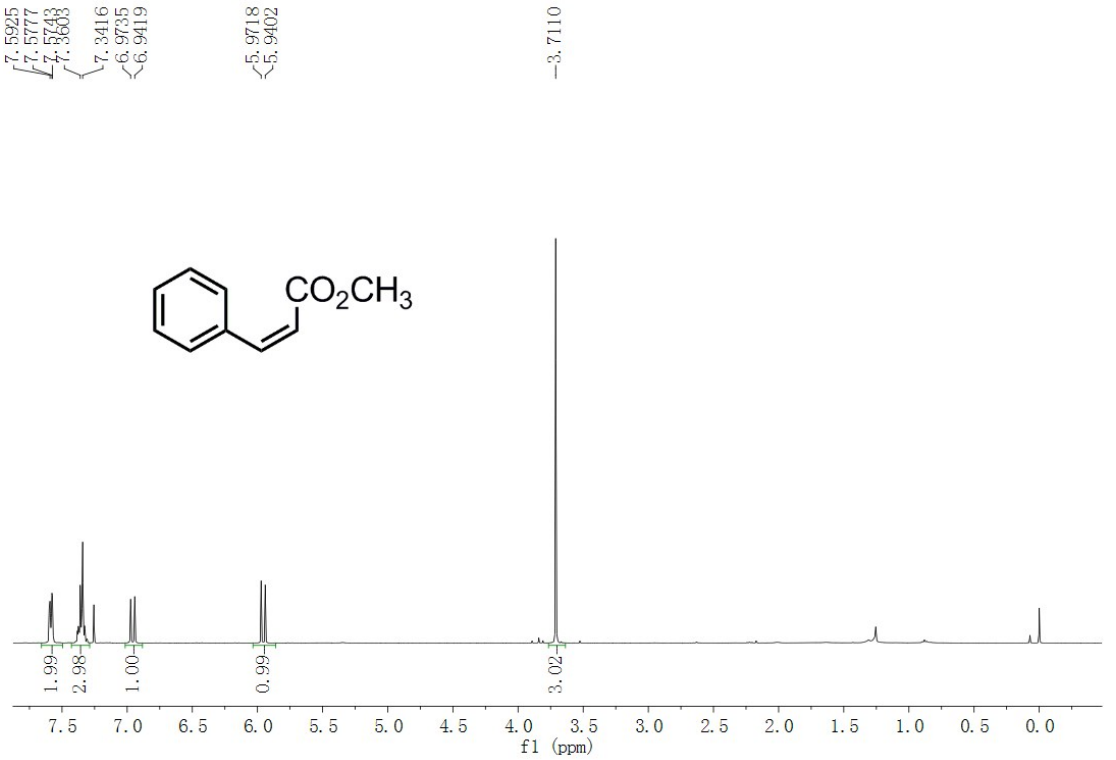
7.2866
7.2683
7.2610
7.2499
7.2226
7.2047
6.5951
6.5658
5.9110
5.8949
5.8811
5.8792
5.8655
5.8495
4.4560
4.4520
4.4400
4.4359
1.5922
OH
2.02
1.04
1.95
1.00
1.00
2.03
1.06
f1 (ppm)


137.4
132.1
132.0
129.7
129.2
128.2
60.6
137.4
132.1
132.0
129.7
129.2
128.2
137
135
133
131
129
f1 (ppm)
OH
135
125
115
105
95
85
75
65
55
45
35
25
15
5
0
f1 (ppm)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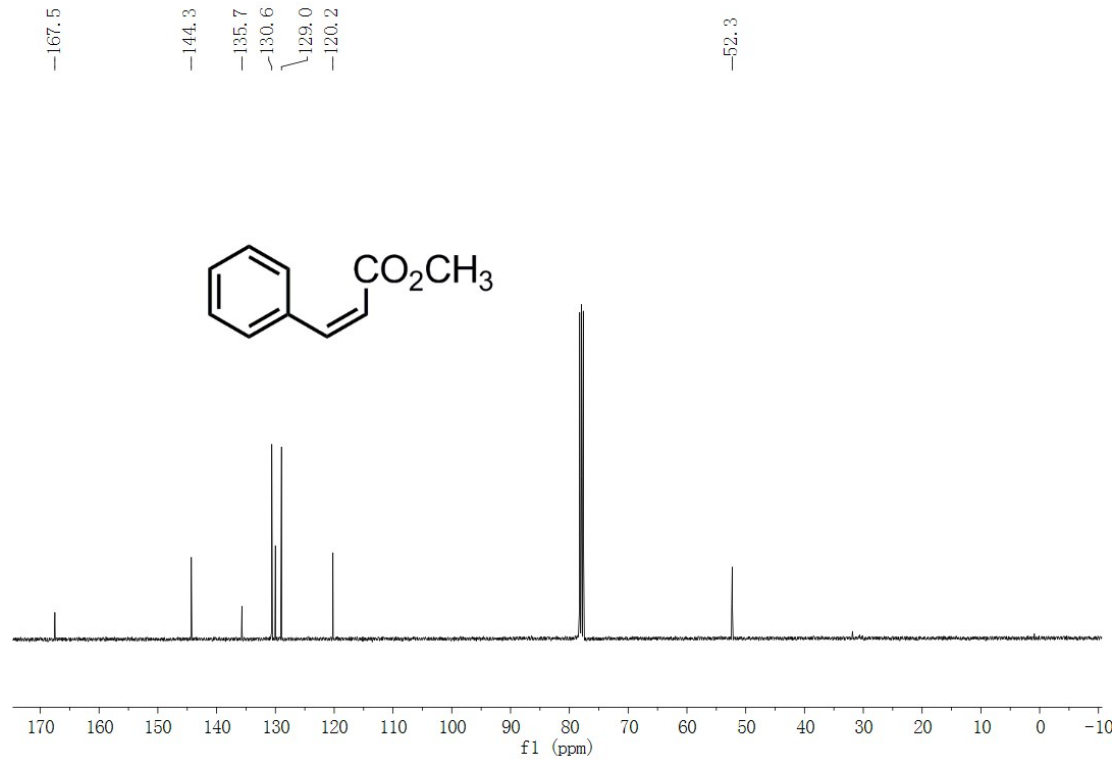
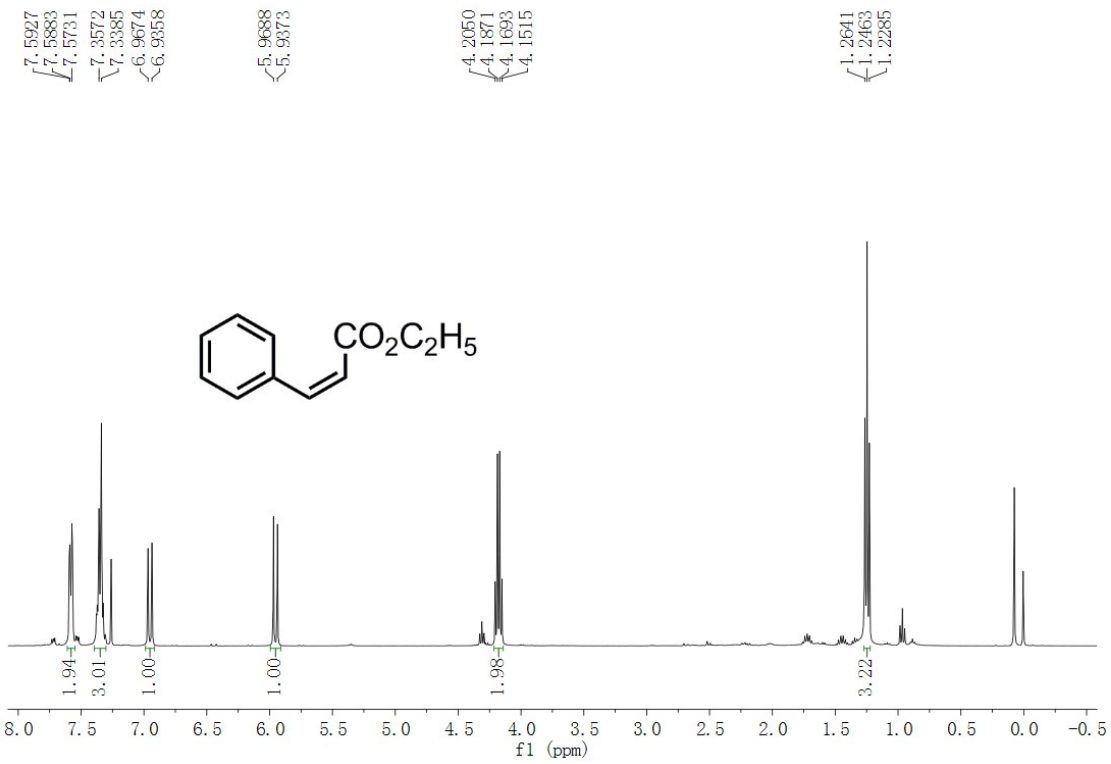
7.5743
7.3603
7.3416
6.9735
6.9419
5.9718
5.9402
3.7110
CO2CH3
1.99
2.98
1.00
0.99
3.02
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


167.5
144.3
135.7
130.6
129.0
120.2
52.3
CO2CH3
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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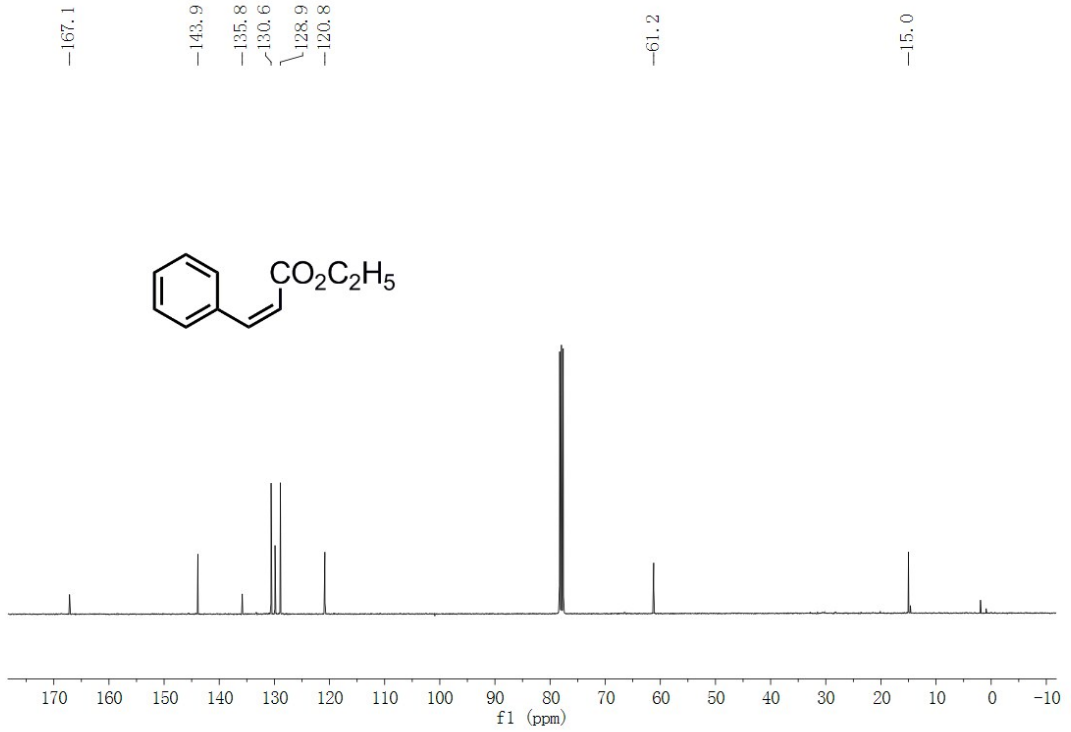
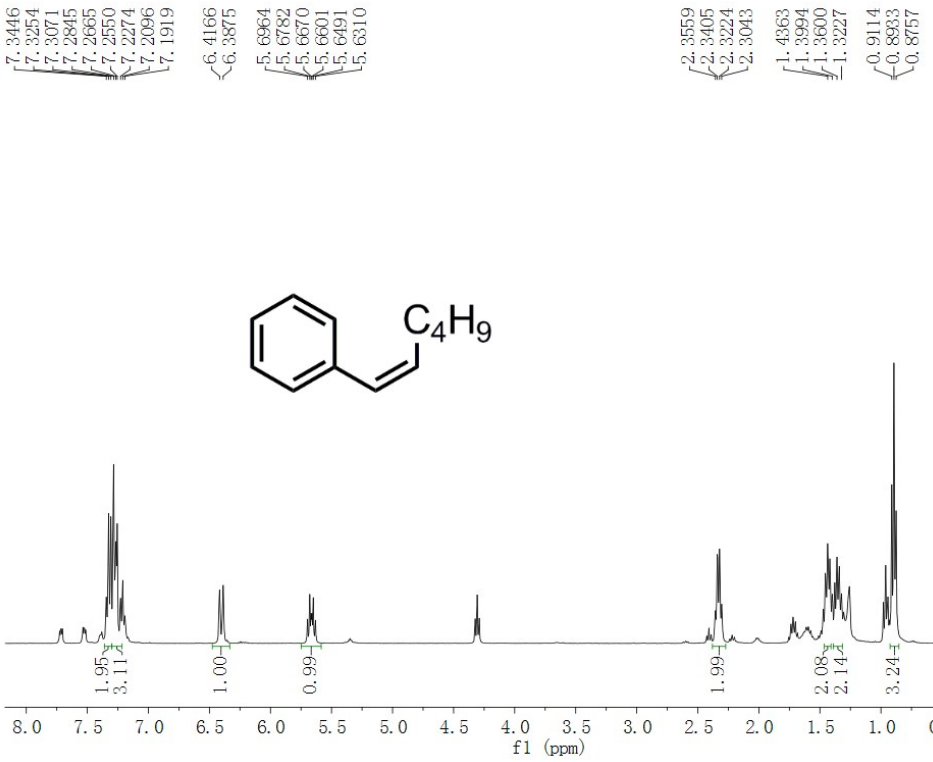
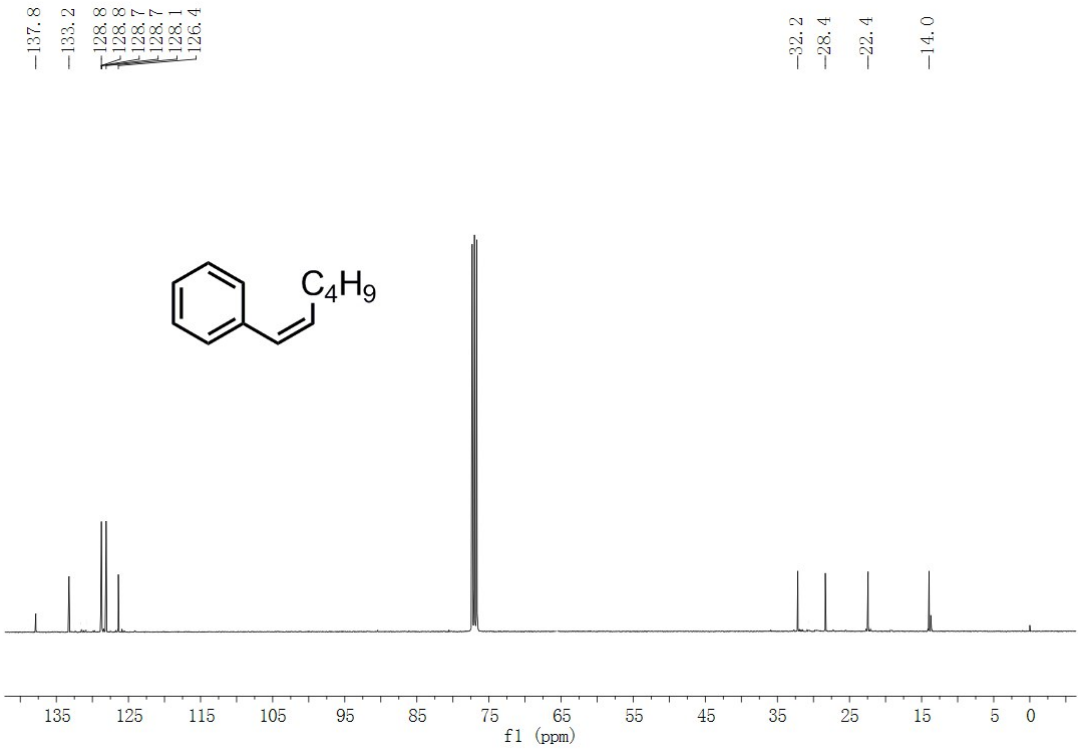
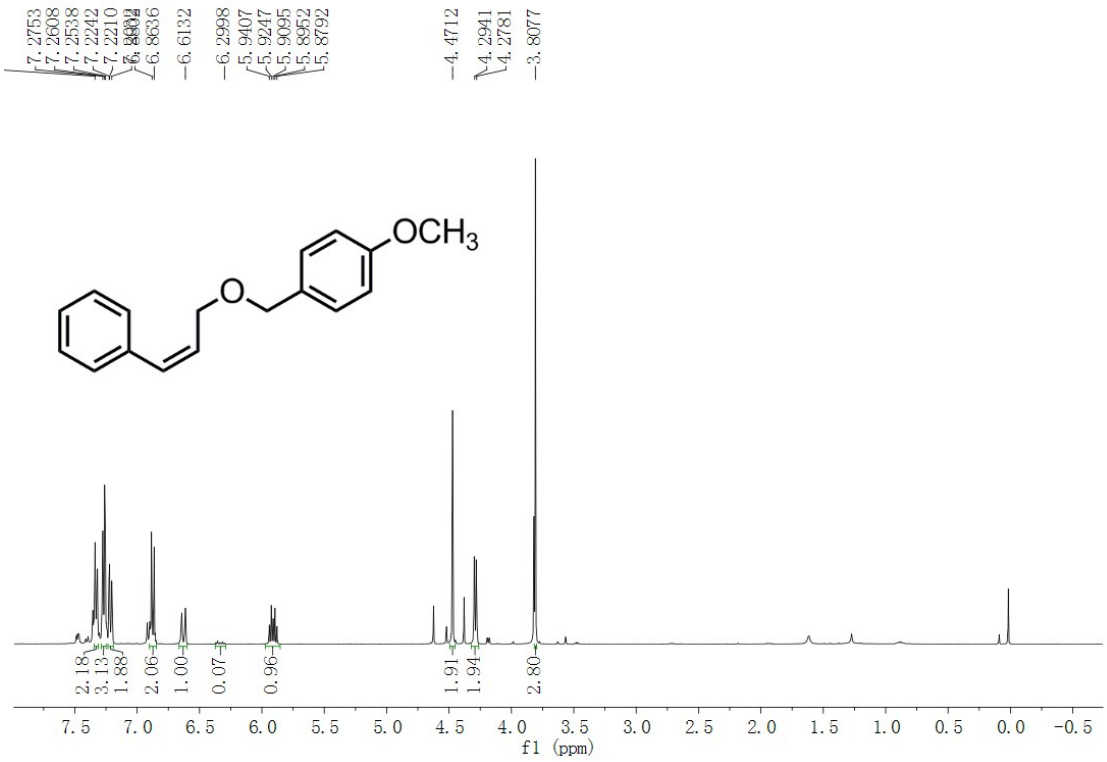
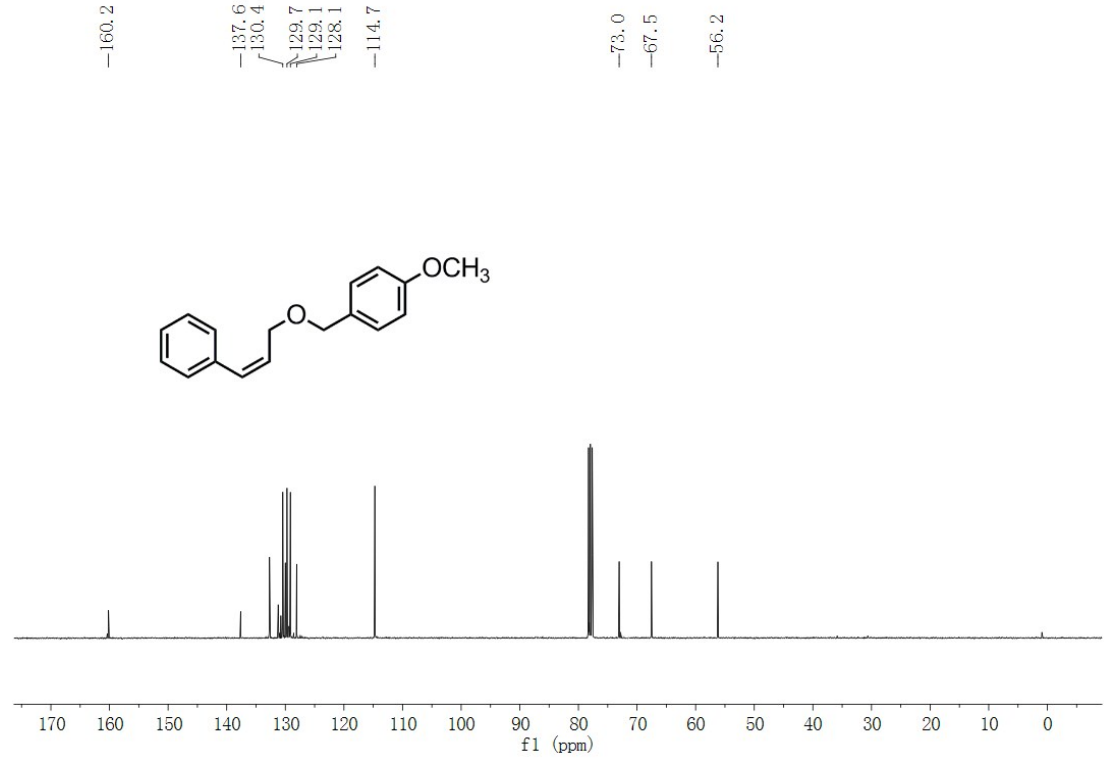
7.5731
7.3572
7.3385
6.9674
6.9358
5.9688
5.9373
4.2050
4.1871
4.1693
4.1515
1.2641
1.2463
1.2285
CO2C2H5
1.94
3.01
1.00
1.00
1.98
3.22
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

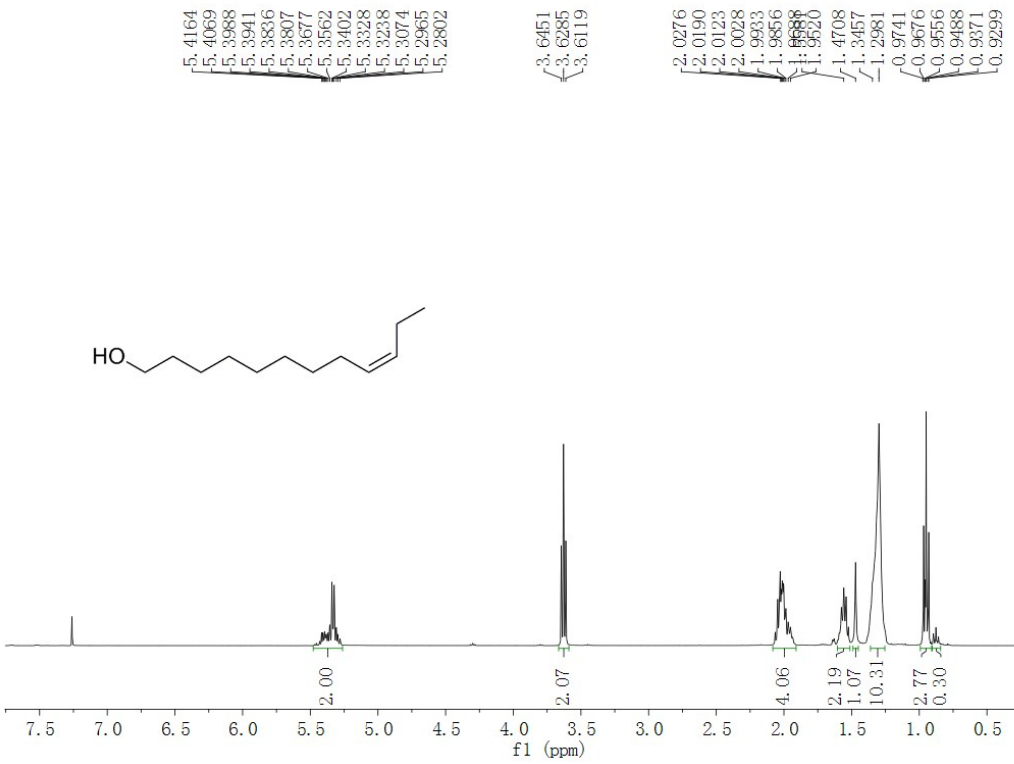

167.1
143.9
135.8
130.6
128.9
120.8
61.2
15.0
CO2C2H5
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

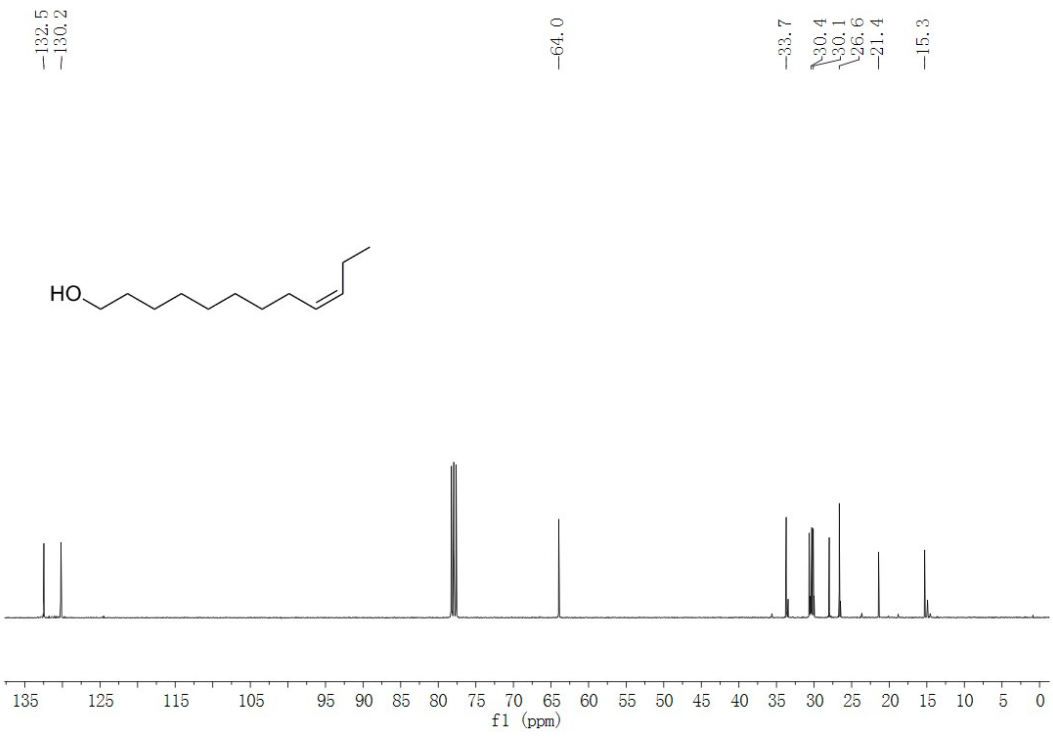

7.3446
7.3254
7.3071
7.2845
7.2665
7.2550
7.2274
7.2096
7.1919
6.4166
6.3875
5.6964
5.6782
5.6670
5.6601
5.6491
5.6310
2.3559
2.3405
2.3224
2.3043
1.4363
1.3994
1.3600
1.3227
0.9114
0.8933
0.8757
C4H9
1.95
3.11
1.00
0.99
1.99
2.08
2.14
3.24
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

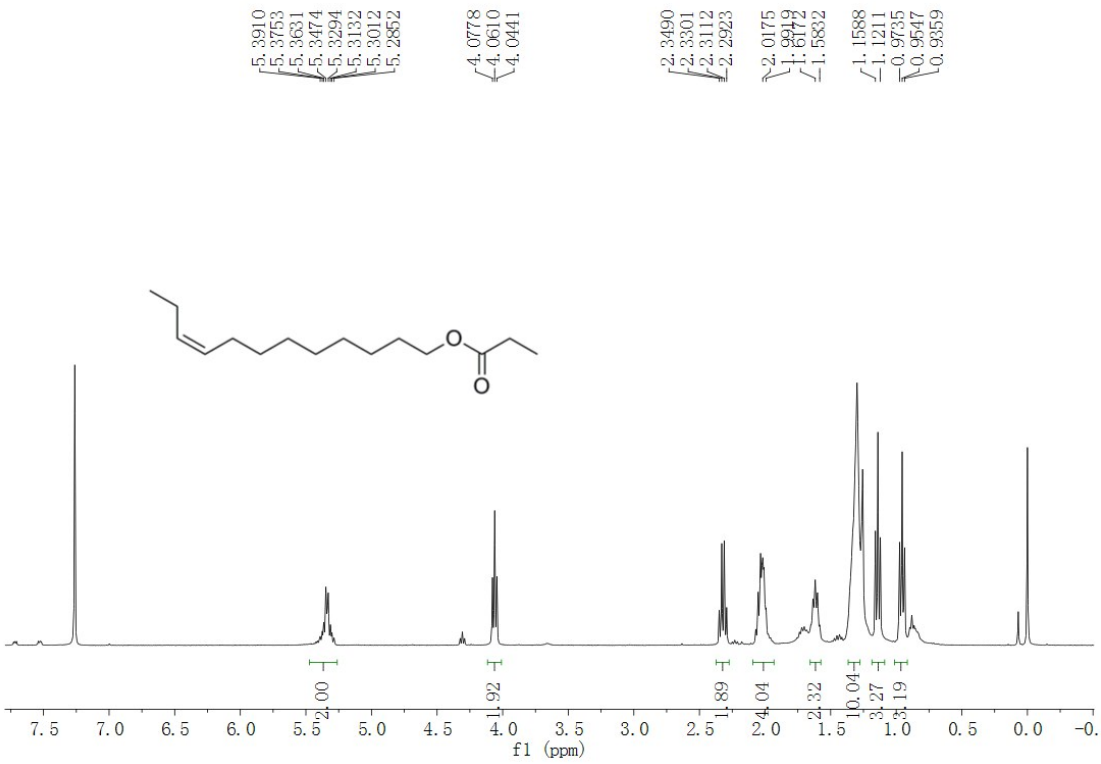

137.8
133.2
128.8
128.8
128.7
128.7
128.1
126.4
32.2
28.4
22.4
14.0
C4H9
135 125 115 105 95 85 75 65 55 45 35 25 15 5 0
f1 (ppm)

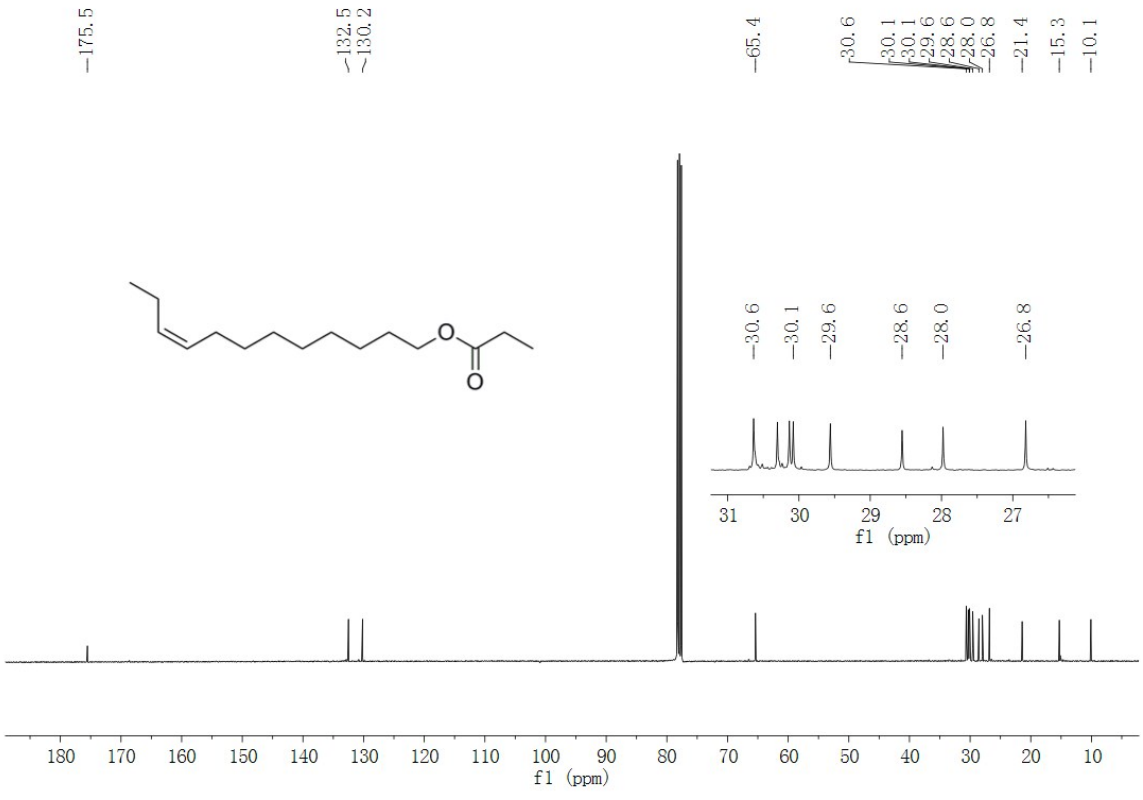

7.2753
7.2608
7.2538
7.2242
7.2210
6.8636
6.6132
6.2998
5.9407
5.9247
5.9095
5.8952
5.8792
4.4712
4.2941
4.2781
3.8077
OCH3
O
2.18
3.13
1.88
2.06
1.00
0.07
0.96
1.91
1.94
2.80
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


160.2
137.6
130.4
129.7
129.1
128.1
114.7
73.0
67.5
56.2
OCH3
O
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


5.4164
5.4069
5.3988
5.3941
5.3836
5.3807
5.3677
5.3562
5.3402
5.3328
5.3238
5.3074
5.2965
5.2802
3.6451
3.6285
3.6119
2.0276
2.0190
2.0123
2.0028
1.9933
1.9856
1.9520
1.4708
1.3457
1.2981
0.9741
0.9676
0.9556
0.9488
0.9371
0.9299
HO
2.00
2.07
4.06
2.19
1.07
10.31
2.77
0.30
f1 (ppm)


132.5
130.2
64.0
33.7
30.4
30.1
26.6
21.4
15.3
HO
f1 (ppm)


5.3910
5.3753
5.3631
5.3474
5.3294
5.3132
5.3012
5.2852
4.0778
4.0610
4.0441
2.3490
2.3301
2.3112
2.2923
2.0175
1.8979
1.6172
1.5832
1.1588
1.1211
0.9735
0.9547
0.9359
O
O
2.00
1.92
1.89
4.04
2.32
10.04
3.27
3.19
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.
f1 (ppm)


175.5
132.5
130.2
65.4
30.6
30.1
30.1
29.6
28.6
28.0
26.8
21.4
15.3
10.1
O
O
30.6
30.1
29.6
28.6
28.0
26.8
31 30 29 28 27
f1 (ppm)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)