Electronic Supplementary Material (ESI) for ChemComm.

Phosphine-catalysed (4+1) annulations of β'-acetoxy allenoate with β,γ-unsaturated carbonyl compounds

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1. General Information

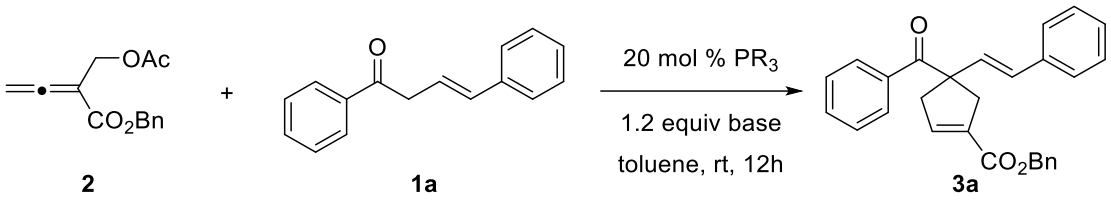
Unless otherwise noted, all reagents were obtained commercially and used without further purification.

NMR spectroscopy: ^{1}H and ^{13}C spectra are recorded on the Bruker AVANCE spectrometer, operating at 400 MHz (300 MHz or 500 MHz) for ^{1}H NMR and 100 MHz (75 MHz or 125 MHz) for ^{13}C NMR. Chemical shifts are reported in parts per million (ppm). Chemical shifts are reported downfield from CDCl3 (δ: 7.28 ppm) for ^{1}H NMR. Chemical shifts of ^{13}C NMR are reported in the scale relative to the solvent of CDCl3 (δ: 77.0 ppm) used as an internal reference. Multiplicities are recorded as follows: s (singlet), d (doublet), t (triplet), dd (doublet of doublet), dt (doublet of triplet), m (multiplet), brs (broad singlet), qd (quartet of double). Coupling constants are reported in Hertz (Hz).

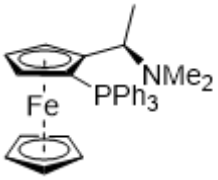
Mass spectroscopy: Mass spectra were in general recorded on an AMD 402/3 or a HP 5989A mass selective detector.

Chromatography: Column chromatography was performed with silica gel (200-300 mesh ASTM).

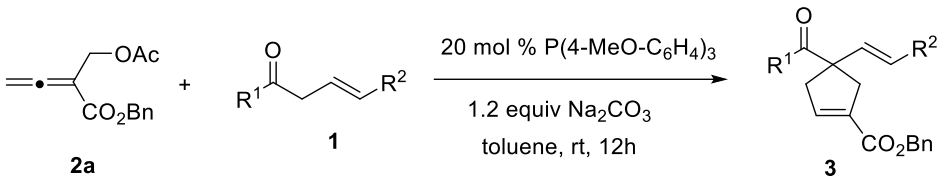
2. Optimization of Reaction Conditions



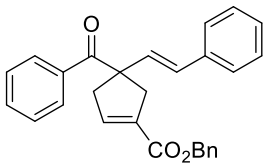
2 **1a** **3a**

Entry	**1a**/**2a**	Cat.	Solvent	Additive	T (ºC)	Yield (%)[b]
1	1 : 1.2	$P(4\text{-}MeOPh)_3$	PhMe	Cs_2CO_3	r.t.	34%
2	1 : 1.2	$P\text{-}(N\text{-}(CH_3)_2)_3$	PhMe	Cs_2CO_3	r.t.	22%
3	1 : 1.2	$P(4\text{-}CH_3Ph)_3$	PhMe	Na_2CO_3	r.t.	60%
4	1 : 1.2	$P(4\text{-}MeOPh)_3$	PhMe	Na_2CO_3	r.t.	71%
5	1 : 1.2	$P(4\text{-}FPh)_3$	PhMe	Na_2CO_3	r.t.	22%
6	1 : 1.2	$P(4\text{-}MeOPh)_3$	THF	Na_2CO_3	r.t.	47%
7	1 : 1.2	$P(4\text{-}MeOPh)_3$	PhMe	Na_2CO_3	60°C	46%
8	1 : 1.2	$P(4\text{-}MeOPh)_3$	CH_2Cl_2	Na_2CO_3	r.t.	20%
9	1 : 1.2	$P(4\text{-}MeOPh)_3$	Et_2O	Na_2CO_3	r.t.	22%
10	1 : 1.2	$PPhMe_2$	PhMe	Na_2CO_3	r.t.	41%
11	1 : 1.2	$P(4\text{-}MeOPh)_3$	PhMe	Et_3N	r.t.	56%
12	1.2 : 1	PPh_3	PhMe	Na_2CO_3	r.t.	30%
13	1 : 1.2	PPh_2Me	PhMe	Na_2CO_3	r.t.	55%
14	1 : 1.2	$P(4\text{-}MeOPh)_3$	Ph	Na_2CO_3	r.t.	50%
15	1 : 1.2	$P(4\text{-}MeOPh)_3$	PhMe	Et_3N	r.t.	56%
16	1 : 1.2	$P(4\text{-}MeOPh)_3$	PhMe	K_2CO_3	r.t.	52%
17	1 : 1.2		PhMe	Cs_2CO_3	r.t.	26%
18	1 : 1.2	PPh_3	THF	Na_2CO_3	r.t.	53%
19	1 : 1.2	$P(n\text{-}Bu)_3$	PhMe	Na_2CO_3	r.t.	28%

3. Synthesis and Data of Products 3



General Procedure: To a 25 mL flask was added catalyst P(4-MeO-C_6H_4)$_3$ (0.04 mmol), **1** (0.24 mmol), Na_2CO_3 (0.24 mmol) and toluene (1.5 mL). After the mixture was stirred at rt for five minutes, a solution of **2a** (0.20 mmol) in toluene (1.5 mL) was slowly added. After 12 h, the solvent was removed and the residue was directly subjected to silica gel column chromatography (petroleum ether/ethyl acetate as eluent) to give product.

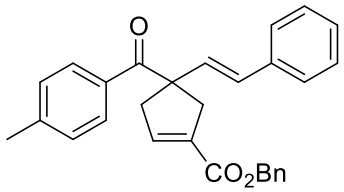


3a: Yield = 71 %, 57.9 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96-7.89 (m, 2H), 7.44-7.29 (m, 12H), 7.27-7.20 (m, 1H), 6.80 (s, 1H), 6.66 (d, *J* = 16.4 Hz, 1H), 6.43 (d, *J* = 16.4 Hz, 1H), 5.22 (s, 2H), 3.58 (dq, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.45 (dq, *J* = 17.2 Hz, *J* = 2.4 Hz, 1H), 3.15 (d, *J* = 17.2 Hz, 1H), 2.87(d, *J* = 18.8 Hz, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 200.9, 164.3, 141.2, 136.6, 136.0, 135.3, 134.4, 133.3, 132.6, 129.9, 129.8, 128.7, 128.6, 128.4, 128.2, 127.9, 126.4, 66.2, 59.9, 44.5, 42.5.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{28}H_{24}O_3$ 431.1618, found: 431.1619.



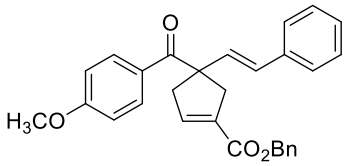
3b: Yield = 77 %, 65.1 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87-7.82 (m, 2H), 7.40-7.30 (m, 9H), 7.27-7.20 (m, 3H), 6.82-6.78 (m, 1H), 6.65 (d, *J* = 16.4 Hz, 1H), 6.41 (d, *J* = 16.4 Hz, 1H), 5.22 (s, 2H), 3.59 (dq, *J* =

18.8 Hz, *J* = 2.4 Hz, 1H), 3.44 (dq, *J* = 17.2 Hz, *J* = 2.4 Hz, 1H), 3.15 (d, *J* = 17.2 Hz, 1H), 2.86 (d, *J* = 18.8 Hz, 1H), 2.39 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 200.4, 164.4, 143.4, 141.2, 136.6, 136.0, 134.6, 133.3, 132.6, 130.1, 129.6, 129.1, 128.6, 128.6, 128.2, 127.8, 126.3, 66.2, 59.8, 44.6, 42.5, 21.6

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{26}O_3$ 445.1774, found: 445.1774.

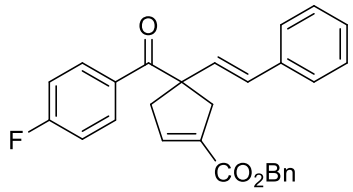


3c: Yield = 81 %, 70.8 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02-7.90 (m, 2H), 7.40-7.30 (m, 9H), 7.27-7.21 (m, 1H), 6.93-6.86 (m, 2H), 6.82-6.79 (m, 1H), 6.66 (d, *J* = 16.4 Hz, 1H), 6.42 (d, *J* = 16.4 Hz, 1H), 5.22 (s, 2H), 3.86 (s, 3H), 3.61 (dd, *J* = 19.2 Hz, *J* = 2.4 Hz, 1H), 3.46 (dd, *J* = 16.8 Hz, *J* = 2.4 Hz, 1H), 3.15 (d, *J* = 16.8 Hz, 1H), 2.88 (d, *J* = 19.2 Hz, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 201.1, 164.4, 159.4, 141.3, 136.0, 135.5, 133.3, 132.5, 132.2, 129.9, 129.3, 128.6, 128.4, 128.2, 128.2, 127.5, 114.1, 66.2, 59.8, 55.4, 44.6, 42.5.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{26}O_4$ 461.1723, found: 461.1725.



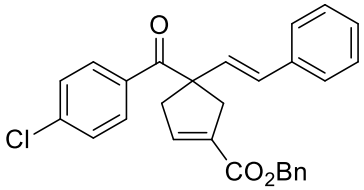
3d: Yield = 58 %, 47.6 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99(dd, *J* = 5.6 Hz, *J* = 3.2 Hz, 2H), 7.43-7.29 (m, 10H), 7.27-7.22 (m, 1H), 7.09 (t, *J* = 8.6 Hz, 1H), 6.82-6.77 (m, 1H), 6.64 (d, *J* = 16.4 Hz, 1H), 6.41 (d, *J* = 16.4 Hz, 1H), 5.22 (s, 2H), 3.59 (dq, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.43 (dq, *J* = 16.8

Hz, *J* = 2.4 Hz, 1H), 3.15 (d, *J* = 16.8 Hz, 1H), 2.86 (d, *J* = 18.8 Hz, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 199.1, 164.3, 141.1, 136.4, 136.0, 134.1, 133.2, 132.7, 132.6, 130.0, 128.7, 128.6, 128.3, 128.2, 128.0, 126.3, 115.4, 66.3, 59.7, 44.5, 42.5.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{28}H_{23}FO_3$ 449.1523, found: 449.1526.

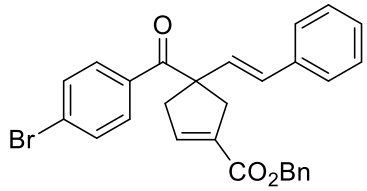


3e: Yield = 58 %, 51.7 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92-7.86 (m, 2H), 7.42-7.29 (m, 11H), 7.27-7.22 (m, 1H), 6.79 (t, *J* = 1.8 Hz, 1H), 6.62 (d, *J* = 16.4 Hz, 1H), 6.40 (d, *J* = 16.4 Hz, 1H), 5.22 (s, 2H), 3.57 (dq, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.41 (dq, *J* = 17.2 Hz, *J* = 2.4 Hz, 1H), 3.13 (d, *J* = 17.2 Hz, 1H), 2.85 (d, *J* = 18.8 Hz, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 199.5, 164.2, 141.0, 139.0, 136.3, 135.9, 134.0, 133.5, 133.2, 131.4, 130.1, 128.7, 128.6, 128.3, 128.2, 128.0, 126.3, 66.3, 59.7, 44.4, 42.4.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{28}H_{23}ClO_3$ 465.1228, found: 465.1229.



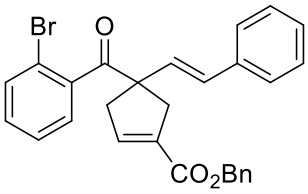
3f: Yield = 62 %, 60.5 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85-7.78 (m, 2H), 7.59-7.54 (m, 2H), 7.45-7.30 (m, 9H), 7.27-7.22 (m, 1H), 6.81-6.77 (m, 1H), 6.62 (d, *J* = 16.4 Hz, 1H), 6.40 (d, *J* = 16.4 Hz, 1H), 5.22 (s,

2H), 3.57 (dq, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.41 (dq, *J* = 16.8 Hz, *J* = 2.4 Hz, 1H), 3.13 (d, *J* = 16.8 Hz, 1H), 2.85 (d, *J* = 18.8 Hz, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 199.7, 164.2, 141.0, 136.3, 134.0, 133.2, 131.7, 131.5, 130.2, 128.7, 128.6, 128.3, 128.2, 127.8, 126.3, 66.3, 59.7, 44.4, 42.4.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{28}H_{23}BrO_3$ 509.0723, found: 509.0724.

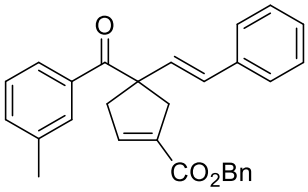


3g: Yield = 50 %, 48.3 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63-7.56 (m, 1H), 7.43-7.29 (m, 10H), 7.27-7.23 (m, 3H), 6.80 (t, *J* = 1.4 Hz, 1H), 6.55 (d, *J* = 16.4 Hz, 1H), 6.44 (d, *J* = 16.4 Hz, 1H), 5.22 (s, 2H), 3.44 (dq, *J* = 18.4 Hz, *J* = 2.4 Hz, 1H), 3.37 (dq, *J* = 16.4 Hz, *J* = 2.4 Hz, 1H), 2.99 (d, *J* = 16.4 Hz, *J* = 1.6 Hz, 1H), 2.83 (dd, *J* = 18.4 Hz, *J* = 1.6 Hz, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 205.5, 164.2, 141.3, 141.1, 136.4, 136.0, 133.8, 133.4, 131.3, 131.1, 130.7, 128.7, 128.6, 128.2, 128.2, 128.1, 127.2, 126.9, 126.5, 118.9, 66.2, 62.0, 42.7, 40.6.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{28}H_{23}BrO_3$ 509.0723, found: 509.0724.



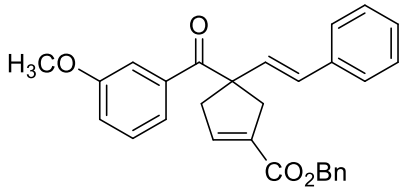
3h: Yield = 63 %, 53.1 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78-7.69 (m, 2H), 7.42-7.29 (m, 12H), 7.27-7.20 (m, 1H), 6.82-6.78 (m, 1H), 6.65 (d, *J* = 16.4 Hz, 1H), 6.44 (d, *J* = 16.4 Hz, 1H), 5.22 (s, 2H), 3.58 (dq, *J* = 19.2 Hz, *J* = 2.4 Hz, 1H), 3.44 (dq, *J* = 16.8 Hz, *J* = 2.4 Hz, 1H), 3.15 (d, *J* = 16.8 Hz, 1H), 2.87 (d, *J*

= 19.2 Hz, 1H), 2.40 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 201.2, 164.4, 141.2, 138.2, 136.6, 136.0, 135.4, 134.5, 133.3, 130.3, 129.7, 128.6, 128.6, 128.2, 128.1, 127.8, 127.1, 126.3, 66.2, 59.9, 44.6, 42.5, 21.5.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{26}O_3$ 445.1774, found: 445.1775.

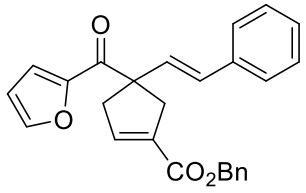


3i: Yield = 74 %, 64.5 mg, colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53-7.47 (m, 2H), 7.43-7.29 (m, 10H), 7.27-7.21 (m, 1H), 7.10-7.02 (m, 1H), 6.80 (s, 1H), 6.65 (d, *J* = 16.4 Hz, 1H), 6.44 (d, *J* = 16.4 Hz, 1H), 5.22 (s, 2H), 3.83 (s, 3H), 3.58 (dd, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.45 (dd, *J* = 16.8 Hz, *J* = 2.4 Hz, 1H), 3.15 (d, *J* = 16.8 Hz, 1H), 2.88 (d, *J* = 18.8 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 200.7, 164.3, 159.5, 141.1, 136.7, 136.6, 136.0, 134.3, 133.3, 129.8, 129.3, 128.7, 128.6, 128.2, 127.8, 126.3, 122.4, 118.8, 114.4, 66.2, 59.9, 55.4, 44.5, 42.5.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{26}O_4$ 461.1723, found: 461.1724.



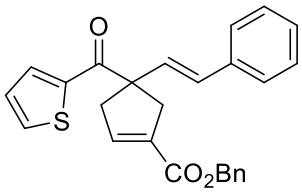
3j: Yield = 54 %, 43.1 mg, colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59-7.56 (m, 1H), 7.45-7.29 (m, 9H), 7.26-7.21 (m, 2H), 6.80 (t, *J* = 1.8 Hz, 1H), 6.58 (d, *J* = 17.6 Hz, 1H), 6.51 (dd, *J* = 3.6 Hz, *J* = 2.0 Hz, 1H), 6.45 (d, *J* = 16.4 Hz, 1H),

5.22 (s, 2H), 3.54 (dq, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.45 (dq, *J* = 16.8 Hz, *J* = 2.4 Hz, 1H), 3.17 (d, *J* = 16.8 Hz, 1H), 2.89 (d, *J* = 18.8 Hz, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 188.5, 164.4, 151.5, 146.2, 141.2, 136.6, 136.0, 133.3, 133.0, 130.2, 128.6, 128.6, 128.2, 127.8, 126.4, 119.3, 112.1, 66.2, 59.1, 42.6, 41.1.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{26}H_{22}O_4$ 421.1410, found: 421.1414.

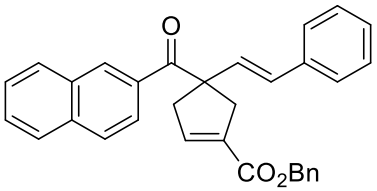


3k: Yield = 65 %, 53.8 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 3.6 Hz, 1H), 7.60 (d, *J* = 5.2 Hz, 1H), 7.42-7.29 (m, 9H), 7.27-7.22 (m, 1H), 7.69 (t, *J* = 4.4 Hz, 1H), 6.81 (s, 1H), 6.60 (d, *J* = 16.4 Hz, 1H), 6.50 (d, *J* = 16.0 Hz, 1H), 5.23 (s, 2H), 3.61 (dd, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.49 (dd, *J* = 16.8 Hz, *J* = 2.4 Hz, 1H), 3.17 (d, *J* = 16.8 Hz, 1H), 2.86 (d, *J* = 18.8 Hz, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 193.1, 164.3, 142.0, 141.0, 136.5, 136.0, 133.6, 133.2, 130.1, 128.7, 128.6, 128.2, 128.2, 128.0, 127.9, 126.4, 66.2, 59.9, 43.7, 42.0.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{26}H_{22}O_3S$ 437.1182, found: 437.1184.



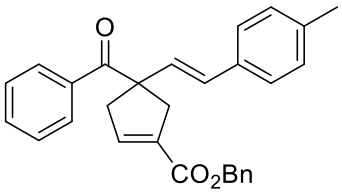
3l: Yield = 61 %, 58.7 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05-7.90 (m, 2H), 7.89-7.82 (m, 2H), 7.64-7.50 (m, 2H), 7.42-7.29 (m, 10H), 7.27-7.19 (m, 1H), 6.83 (t, *J* = 2.0 Hz, 1H), 6.75 (d, *J* = 16.4 Hz, 1H), 6.50 (d,

J = 16.0 Hz, 1H), 5.23 (s, 2H), 3.66 (dq, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.53 (dq, *J* = 16.8 Hz, *J* = 2.4 Hz, 1H), 3.25 (d, *J* = 16.8 Hz, 1H), 2.94 (d, *J* = 18.8 Hz, 1H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 200.8, 164.3, 141.2, 136.6, 136.0, 135.2, 134.5, 133.3, 132.6, 132.4, 131.5, 129.9, 129.7, 128.7, 128.6, 128.2, 128.0, 127.8, 127.7, 126.7, 126.4, 125.6, 66.2, 60.0, 44.6, 42.6.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{32}H_{26}O_3$ 481.1774, found: 481.1775.

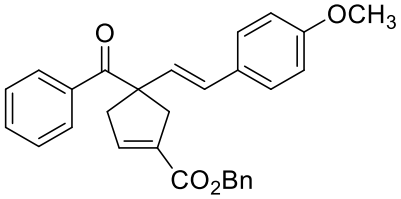


3m: Yield = 75 %, 57.8 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96-7.91 (m, 2H), 7.55-7.48 (m, 1H), 7.45-7.32 (m, 7H), 7.24 (d, *J* = 8.0 Hz, 2H), 7.13 (d, *J* = 8.0 Hz, 2H), 6.82-6.78 (m, 1H), 6.61 (d, *J* = 16.4 Hz, 1H), 6.41 (d, *J* = 16.4 Hz, 1H), 5.22 (s, 2H), 3.58 (dq, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.44 (dd, *J* = 16.8 Hz, *J* = 2.4 Hz, 1H), 3.15 (d, *J* = 16.8 Hz, 1H), 2.87 (d, *J* = 18.8 Hz, 1H), 2.34 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 219.4, 201.0, 164.4, 141.2, 137.8, 136.0, 135.4, 133.8, 133.3, 132.5, 129.9, 129.3, 128.6, 128.3, 128.2, 126.2, 66.2, 59.8, 44.5, 42.5, 21.2.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{26}O_3$ 445.1774, found: 445.1774.

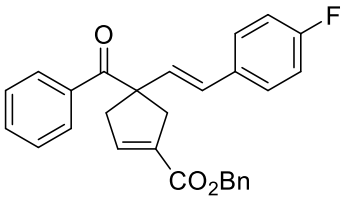


3n: Yield = 74 %, 65.0 mg, colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96-7.91 (m, 2H), 7.54-7.47 (m, 1H), 7.46-7.31 (m, 7H), 7.27 (d, *J* = 8.0 Hz, 2H), 6.85 (d, *J* = 8.0 Hz, 2H), 6.80 (t, *J* = 1.6 Hz, 1H), 6.51 (d, *J* = 16.4 Hz,

1H), 6.38 (d, *J* = 16.4 Hz, 1H), 5.22 (s, 2H), 3.81 (s, 3H), 3.56 (dq, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.43 (dq, *J* = 16.8 Hz, *J* = 2.4 Hz, 1H), 3.14 (d, *J* = 16.8 Hz, 1H), 2.86 (d, *J* = 18.8 Hz, 1H).

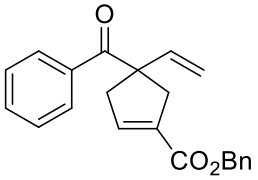
^{13}C NMR (100 MHz, $CDCl_3$) δ 201.1, 164.4, 159.4, 141.2, 136.0, 135.5, 133.3, 132.5, 132.1, 129.9, 129.3, 128.6, 128.3, 128.2, 127.5, 114.1, 66.2, 59.8, 55.3, 44.6, 42.5.
HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{26}O_4$ 461.1723, found: 461.1723.



3o: Yield = 45 %, 38.9 mg, yellow oil.

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.86-7.80 (m, 2H), 7.46-7.29 (m, 7H), 7.26-7.16 (m, 3H), 6.95-6.85 (m, 2H), 6.73-6.66 (m, 1H), 6.47 (d, *J* = 16.2 Hz, 1H), 6.29 (d, *J* = 16.2 Hz, 1H), 5.12 (s, 2H), 3.48 (dq, *J* = 18.9 Hz, *J* = 2.4 Hz, 1H), 3.45 (dq, *J* = 17.1 Hz, *J* = 2.4 Hz, 1H), 3.09-2.99 (m, 1H), 2.82-2.70(m, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 200.8, 164.3, 141.1, 136.0, 135.3, 133.3, 132.6, 129.8, 128.7, 128.6, 128.4, 128.2, 127.9, 127.8, 115.7, 115.4, 66.2, 59.8, 44.5, 42.5.
HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{28}H_{23}FO_3$ 449.1523, found: 449.1525.



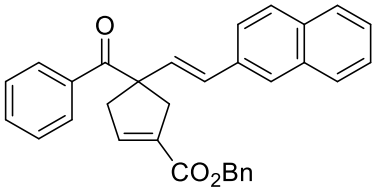
3p: Yield = 58 %, 38.3 mg, colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95-7.88 (m, 2H), 7.56-7.49 (m, 1H), 7.44-7.31 (m, 7H),6.77-6.73 (m, 1H), 6.28 (dd, *J* = 17.6 Hz, *J* = 10.8 Hz,1H), 5.21-5.17 (m, 3H), 5.14 (d, *J* = 17.6 Hz, 1H), 3.49 (dq, *J* = 19.2

Hz, *J* = 2.4 Hz, 1H), 3.37 (dq, *J* = 16.8 Hz, *J* = 2.4 Hz, 1H), 3.07 (d, *J* = 16.8 Hz, 1H), 2.85-2.74 (m, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 200.9, 164.3, 142.8, 141.0, 136.0, 135.4, 133.2, 132.5, 129.9, 128.6, 128.3, 128.2, 128.2, 114.7, 66.2, 60.4, 43.9, 41.8.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{22}H_{20}O_3$ 355.1305, found: 355.1306.

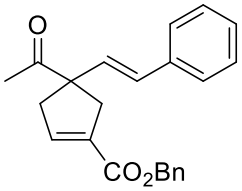


3q: Yield = 61 %, 56.1 mg, yellow oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07-8.01 (m, 2H), 7.88-7.72 (m, 3H), 7.56-7.34 (m, 13H), 7.16 (d, *J* = 16.0 Hz, 2H) 6.89-6.83 (m, 1H), 6.67 (d, *J* = 16.0 Hz, 1H), 5.24 (s, 2H), 3.81 (s, 3H), 3.69 (dq, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.55 (dq, *J* = 17.2 Hz, *J* = 2.4 Hz, 1H), 3.26 (d, *J* = 17.2 Hz, 1H), 2.98 (d, *J* = 18.8 Hz, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 200.8, 164.3, 141.2, 137.9, 136.0, 135.3, 134.5, 133.5, 133.4, 132.7, 131.1, 130.1, 128.6, 128.5, 128.4, 128.2, 128.2, 127.7, 126.2, 125.9, 125.6, 123.8, 123.6, 66.3, 60.2, 44.7, 42.7.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{32}H_{26}O_3$ 481.1774, found: 481.1776



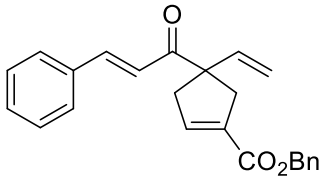
3r: Yield = 38 %, 26.5 mg, colorless oil

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41-7.29 (m, 10H), 6.77 (s, 1H), 6.49 (d, *J* = 16.0 Hz, 1H), 6.35 (d, *J* = 16.0 Hz, 1H), 5.22 (s, 2H), 3.30 (dd, *J* = 18.4 Hz, *J* = 2.0 Hz, 1H), 3.23 (dd, *J* = 16.8 Hz, *J* = 2.0 Hz, 1H), 2.96 (dd, *J* = 16.8 Hz, *J* = 1.2 Hz,1H), 2.70 (dd, *J* = 18.4 Hz, *J* = 1.2 Hz,1H), 2.24 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 207.3, 164.3, 141.4, 136.4, 136.0, 133.4, 131.7, 130.7,

128.7, 128.6, 128.2, 128.1, 128.0, 126.4, 66.2, 61.8, 41.3, 39.7, 26.3.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{23}H_{22}O_3$ 369.1461, found: 369.1463.



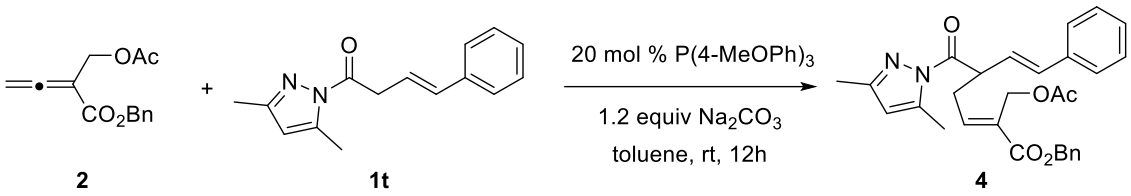
3s: Yield = 66 %, 47.5 mg, colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 (d, *J* = 15.6 Hz, 1H), 7.62-7.52 (m, 2H), 7.44-7.31 (m, 8H), 6.94 (d, *J* = 15.6 Hz, 1H), 6.77 (t, *J* = 1.6 Hz, 1H), 6.07 (dd, *J* = 10.4 Hz, *J* = 17.2 Hz, 1H), 5.28-7.19 (m, 4H), 3.35 (dq, *J* = 18.8 Hz, *J* = 2.4 Hz, 1H), 3.26 (dq, *J* = 16.8 Hz, *J* = 2.4 Hz, 1H), 2.95 (dd, *J* = 16.8 Hz, *J* = 1.6 Hz, 1H), 2.67 (dd, *J* = 1.6 Hz, *J* = 18.8 Hz, 1H).

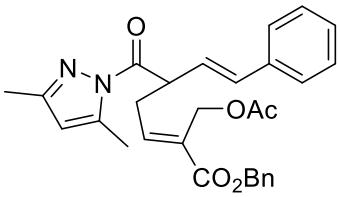
^{13}C NMR (100 MHz, $CDCl_3$) δ 197.9, 164.3, 143.7, 141.5, 140.4, 136.0, 134.6, 133.4, 130.6, 128.9, 128.6, 128.5, 128.2, 128.2, 122.2, 115.8, 66.2, 61.0, 40.9, 39.3.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{24}H_{22}O_3$ 381.1461, found: 381.1463.

4. Synthesis and Data of Products 4



General Procedure: To a 25 mL flask was added catalyst P(4-MeOPh)$_3$ (0.04 mmol), **1t** (0.24 mmol), Na_2CO_3 (0.24 mmol) and toluene (1.5 mL). After the mixture was stirred at rt for five minutes, a solution of **2** (0.20 mmol) in toluene (1.5 mL) was slowly added. After 12 h, the solvent was removed and the residue was directly subjected to silica gel column chromatography (petroleum ether/ethyl acetate as eluent) to give product.



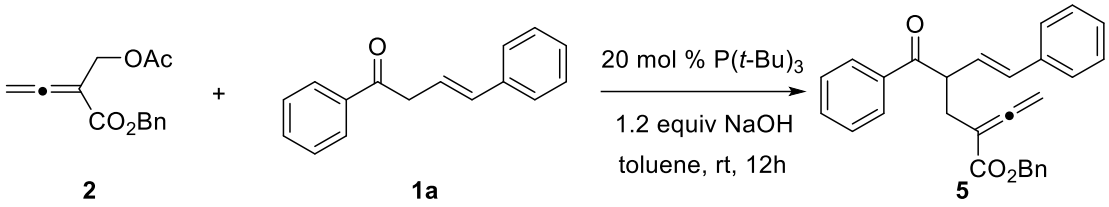
4: Yield = 30.8 %, 25.8 mg, colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40-7.30 (m, 10H), 7.16 (t, *J* = 7.6 Hz, 1H), 6.64 (d, *J* = 16.0 Hz, 2H), 6.36 (dd, *J* = 16.0 Hz, *J* = 8.8 Hz,1H), 5.99 (s, 1H), 5.22 (s, 2H), 4.94 (dd, *J* = 20.0 Hz, *J* = 12.0 Hz, 2H), 4.85 (dd, *J* = 15.6 Hz, *J* = 8.4 Hz, 1H), 3.09-2.98 (m, 1H), 2.88-2.74 (m, 1H), 2.55 (s, 1H), 2.26 (s, 3H), 2.01 (s, 3H).

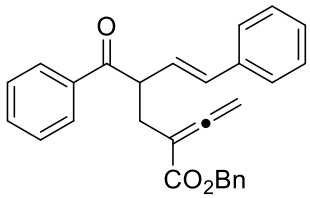
^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 170.8, 165.9, 152.4, 145.7, 144.4, 136.6, 136.0, 133.8, 128.9, 128.6, 128.5, 128.2, 128.0, 127.9, 126.5, 126.5, 126.0, 111.8, 66.6, 58.2, 46.5, 31.4, 20.8, 14.6, 13.9.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{29}H_{30}N_2O_5$ 509.2047, found: 509.2048.

5. Synthesis and Data of Products 5



General Procedure: To a 25 mL flask was added catalyst P(*t*-Bu)$_3$ (0.04 mmol), **1** (0.24 mmol), NaOH (0.24 mmol) and toluene (1.5 mL). After the mixture was stirred at rt for five minutes, a solution of **2a** (0.20 mmol) in toluene (1.5 mL) was slowly added. After 12 h, the solvent was removed and the residue was directly subjected to silica gel column chromatography (petroleum ether/ethyl acetate as eluent) to give product.



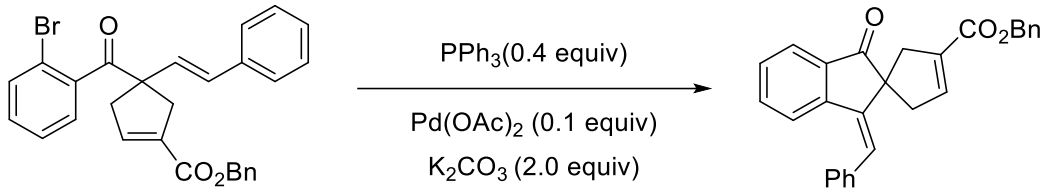
5: Yield = 69%, 56.4 mg, colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (d, *J* = 7.6 Hz, 2H), 7.60-7.54 (m, 1H), 7.48-7.44 (m, 2H), 7.38-7.20 (m, 10H), 6.50 (d, *J* = 16.0 Hz, 1H), 6.25 (dd, *J* = 8.8 Hz, *J* = 16.0 Hz, 1H), 5.22 (s, 2H), 5.10 (dt, *J* = 14.0 Hz, *J* = 2.4 Hz, 1H), 5.00 (dt, *J* = 14.0 Hz, *J* = 2.4 Hz, 1H), 3.07-2.99 (m, 1H), 2.69-2.61 (m, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 215.0, 200.0, 166.9, 136.8, 136.6, 136.1, 133.6, 133.2, 128.7, 128.7, 128.6, 128.3, 128.2, 127.9, 127.8, 127.5, 126.4, 97.6, 79.6, 66.7, 49.3, 31.6.

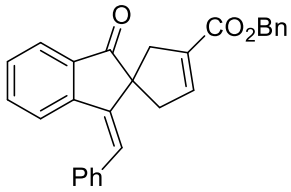
HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{28}H_{24}O_3$ 431.1618, found: 431.1619.

6. Synthetic Application



3g **6**

General Procedure: To a 25 mL flask was added catalyst PPh_3 (0.08 mmol), $Pd(OAc)_2$ (0.02 mmol), K_2CO_3 (0.40 mmol) and CH_3CN (1.5 mL). After the mixture was stirred at rt for one minutes, a solution of **3g** (0.20 mmol) in CH_3CN (1.5 mL) was slowly added, then, the solution was heated to 85℃. After 6 h, the solvent was removed and the residue was directly subjected to silica gel column chromatography (petroleum ether/ethyl acetate as eluent) to give product 6.



6: Yield = 73 %, 59.3 mg, yellow oil.

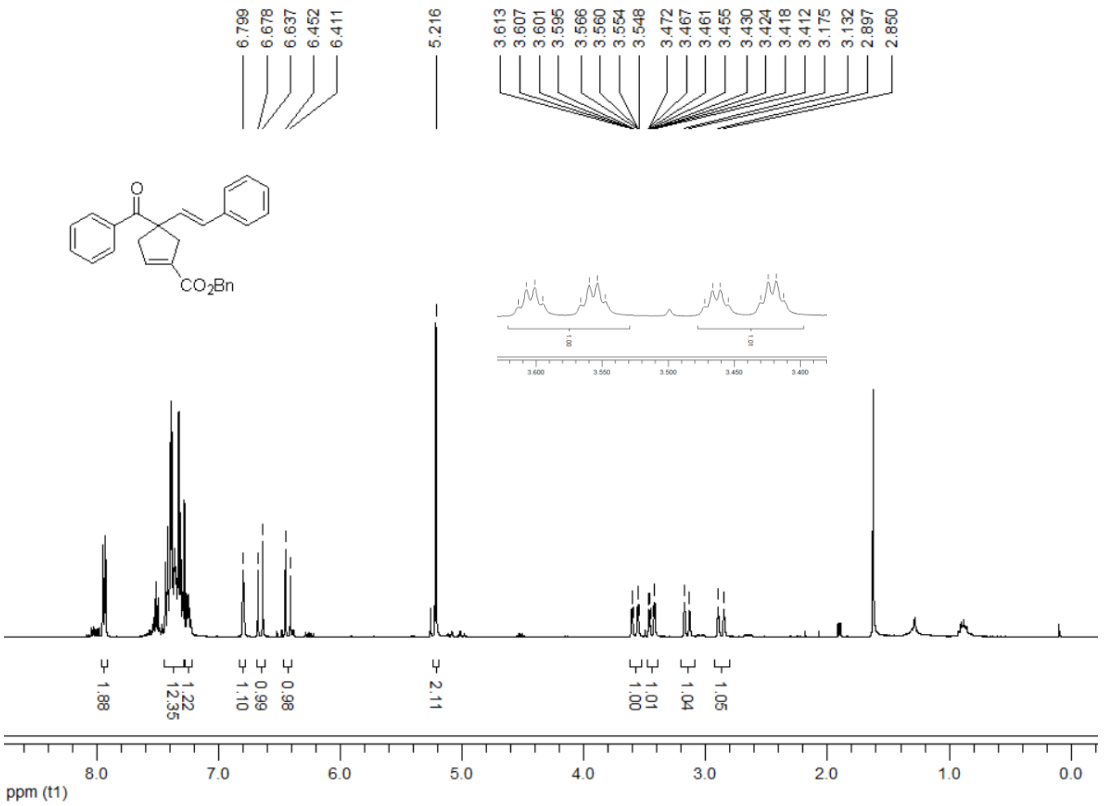
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 7.6 Hz, 1H), 7.85 (d, *J* = 7.6 Hz, 1H), 7.72 (dt, *J* = 8.0 Hz, *J* = 0.8 Hz, 1H), 7.49 (t, *J* = 7.4 Hz, 1H), 7.43-7.29 (m, 8H), 7.27-7.20 (m, 2H), 6.78 (t, *J* = 2.2 Hz, 1H), 5.21 (dd, *J* = 14.4 Hz, *J* = 12.8 Hz, 2H), 3.05 (d, *J* = 2.4 Hz, 1H), 2.90 (t, *J* = 2.2 Hz, 1H).

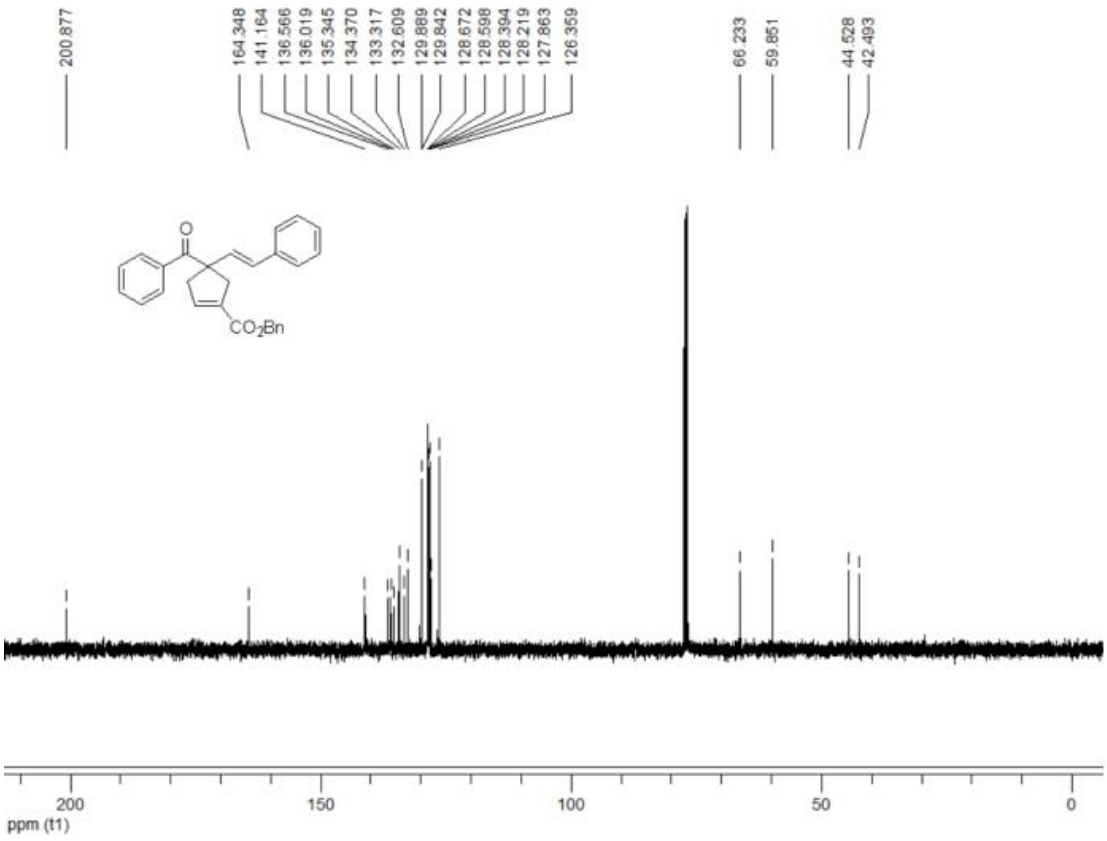
^{13}C NMR (100 MHz, $CDCl_3$) δ 219.4, 207.7, 163.9, 150.8, 142.5, 142.3, 136.1, 135.5, 135.4, 134.7, 133.3, 129.3, 129.1, 128.6, 128.4, 128.2, 128.1, 127.8, 124.4, 124.0, 120.7, 66.1, 55.1, 43.0, 42.2.

HRMS (ESI) m/z: $[M+H]^+$ Calcd for $C_{28}H_{22}O_3$ 429.1461, found: 429.1463.

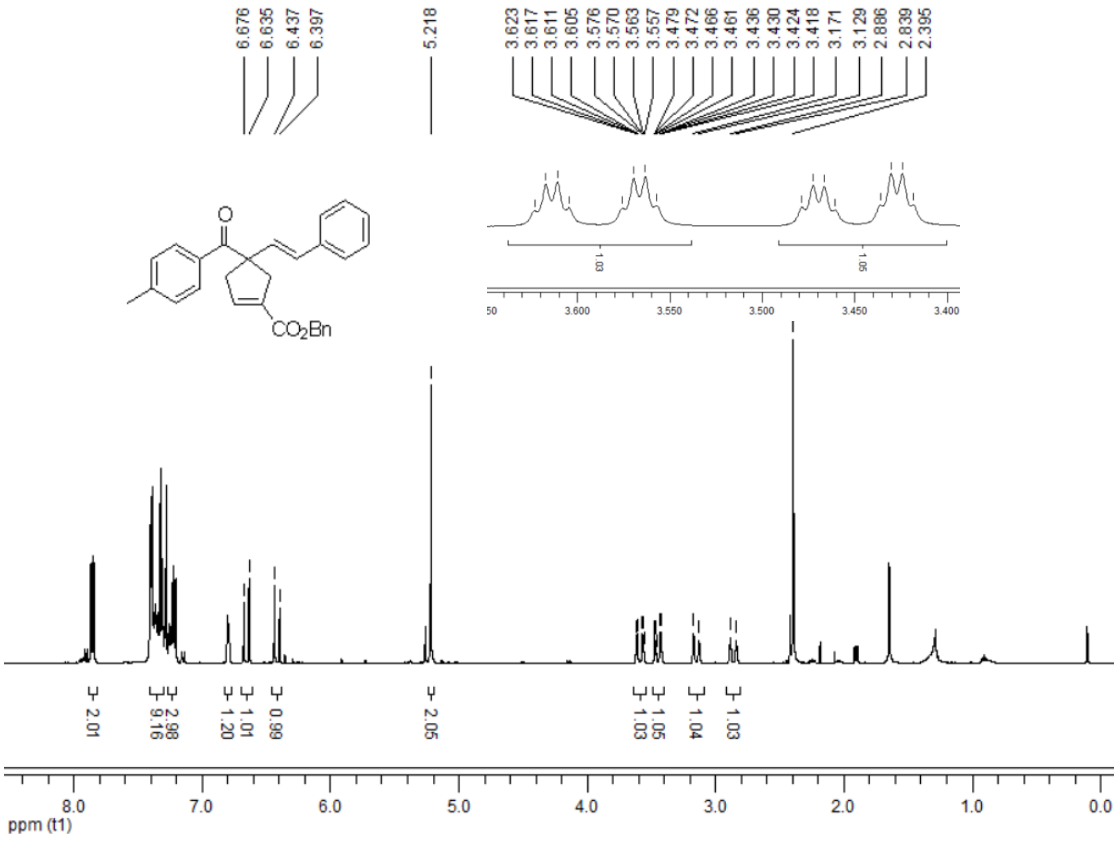
7. NMR Spectrum

3a





3b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3.557
3.479
3.472
3.466
3.461
3.436
3.430
3.424
3.418
3.171
3.129
2.886
2.839
2.395
O
CO2Bn
2.01
2.98
1.20
1.01
0.99
2.06
1.03
1.05
1.04
1.03
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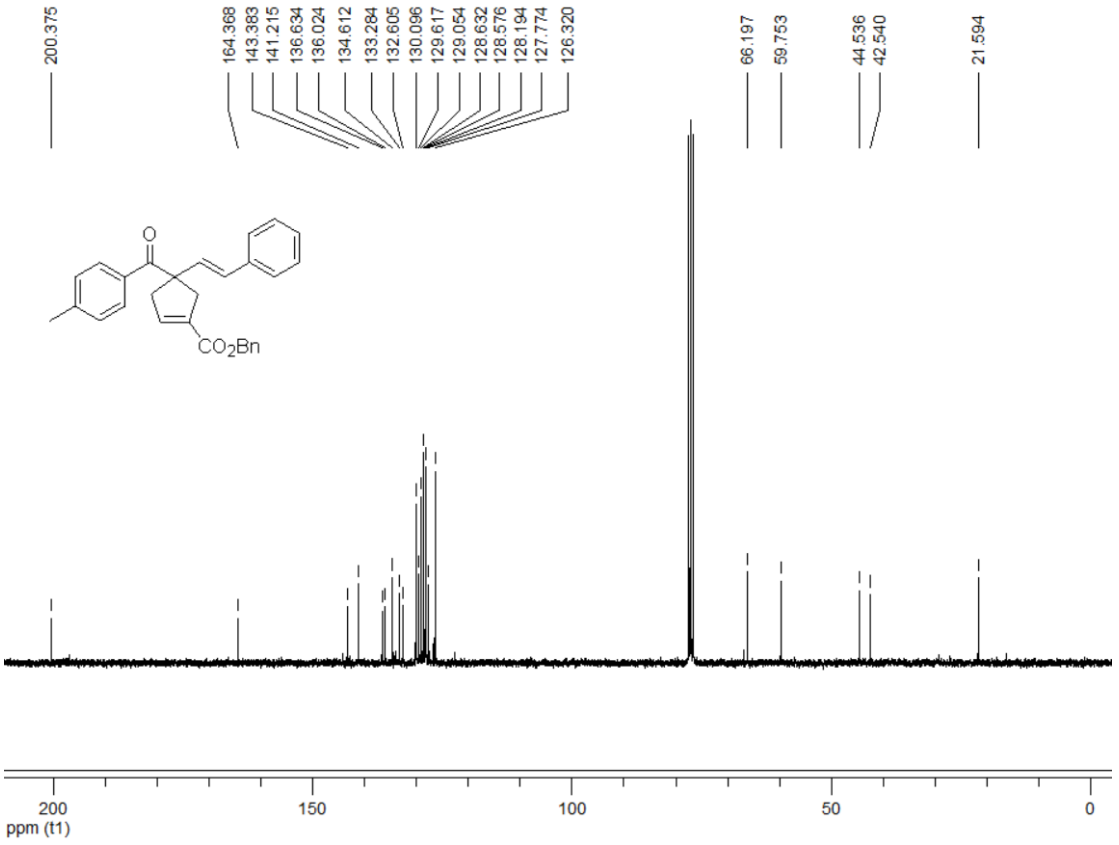
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)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134.612
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132.605
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128.194
127.774
126.320
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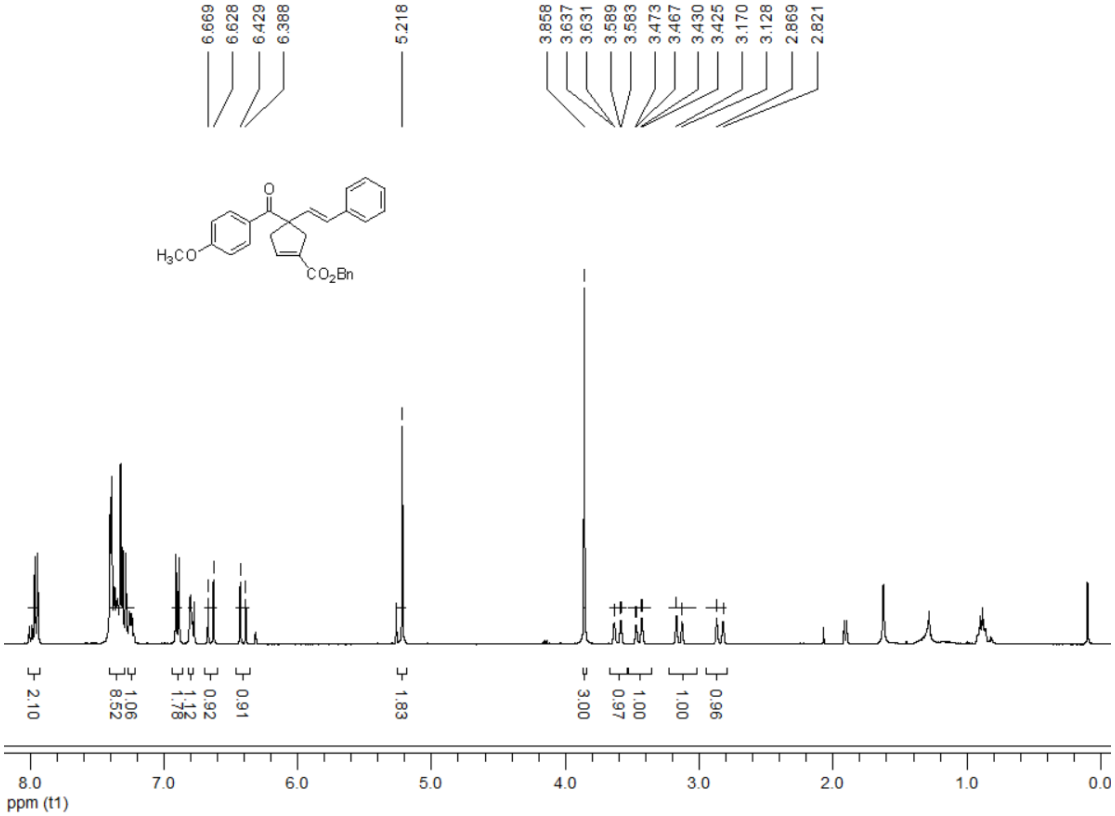
44.536
42.540
21.594
O
CO2Bn
200
150
100
50
0
ppm (t1)

3c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3.128
2.869
2.821
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H3CO
CO2Bn
2.10
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1.06
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1.12
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0.91
1.83
3.00
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2.0
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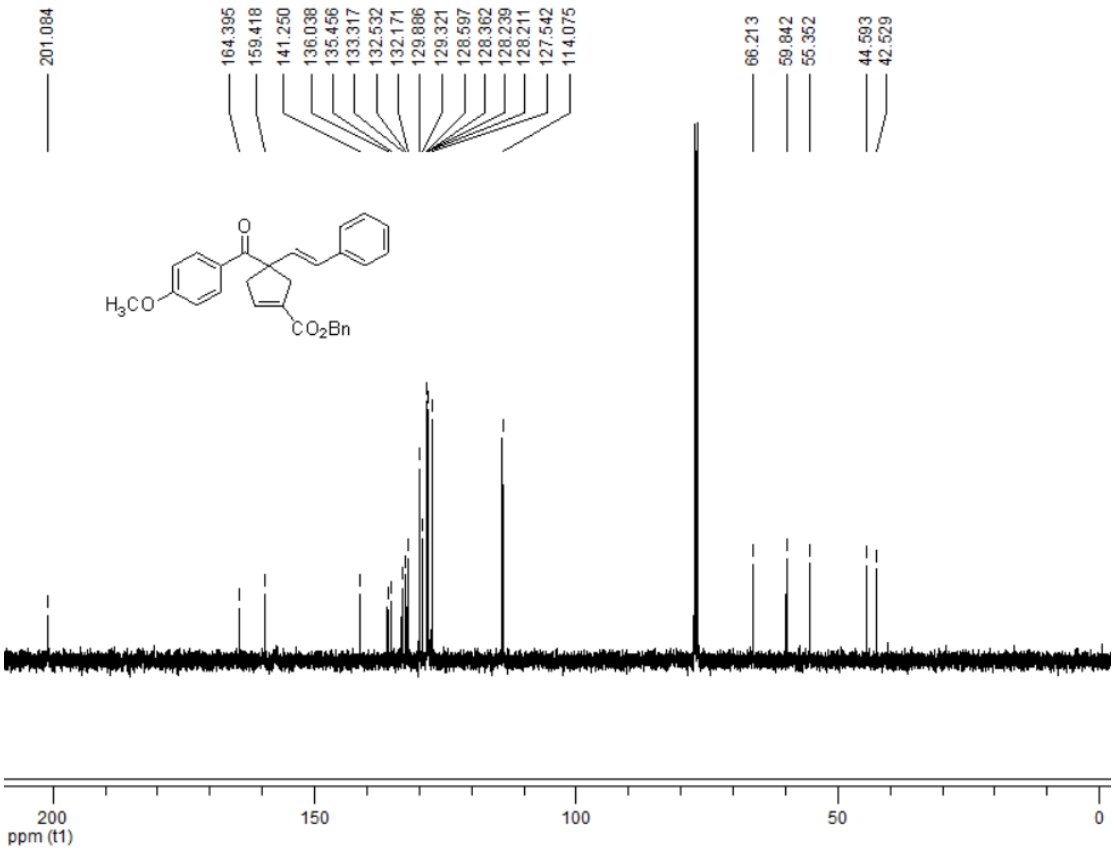
0.0
ppm (t1)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129.886
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128.211
127.542
114.075
66.213
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150
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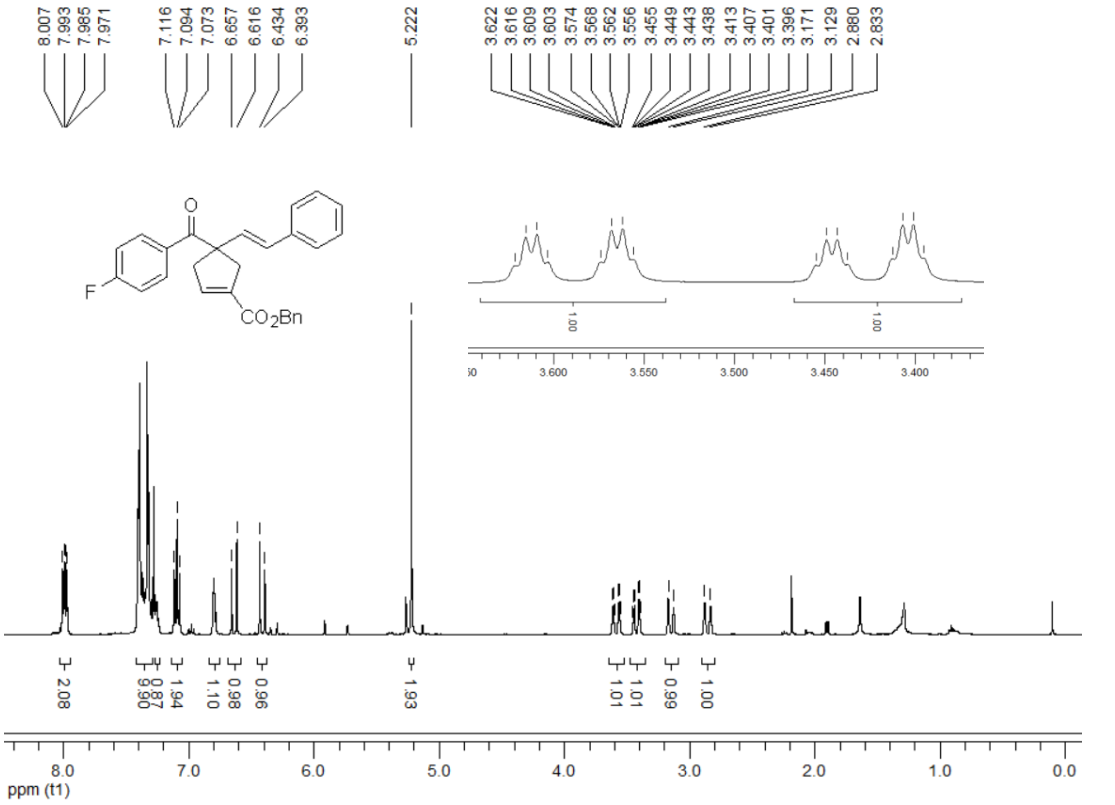
50
0
ppm (t1)

3d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3.129
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CO2Bn
2.08
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0.87
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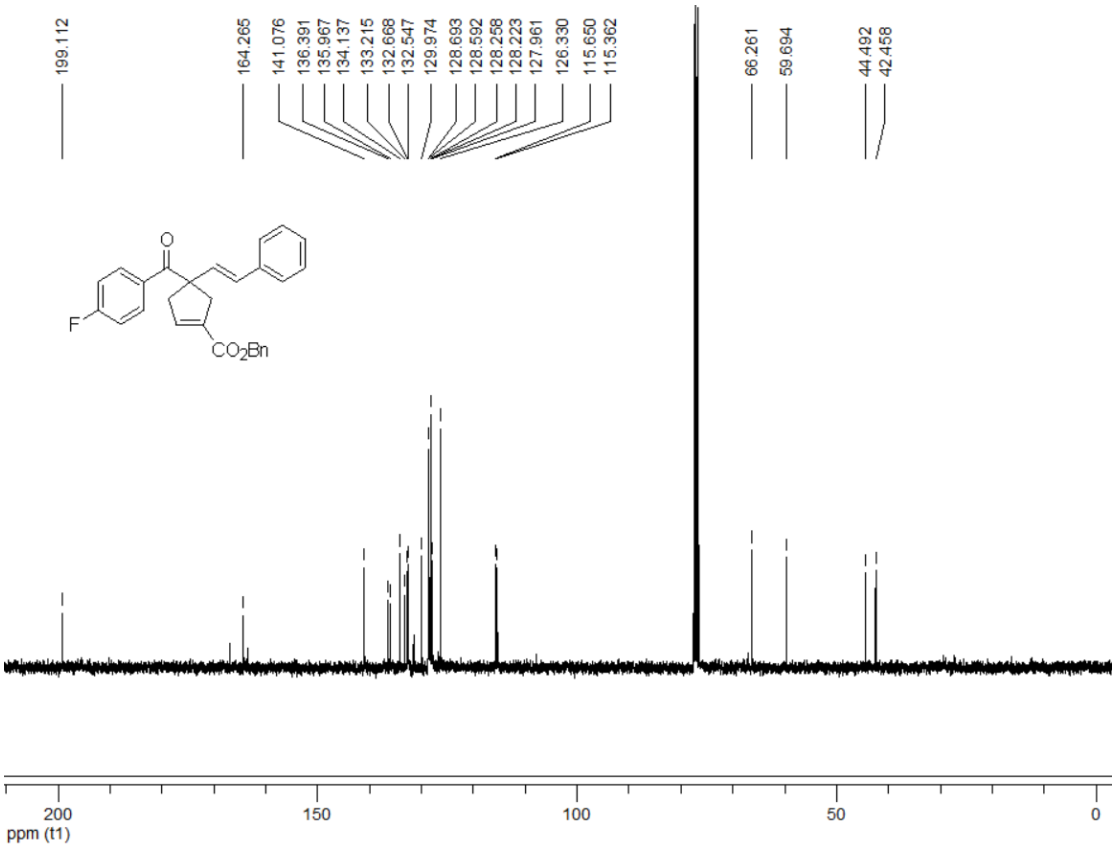
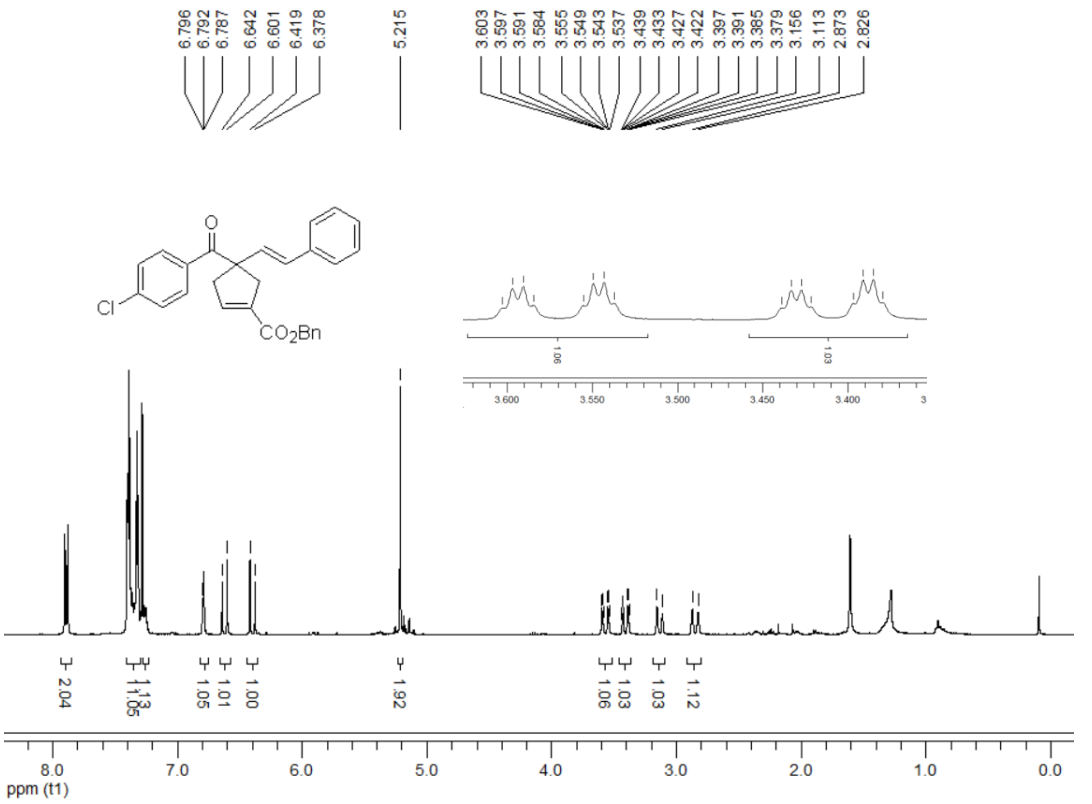
1.10
0.98
0.96
1.93
1.01
1.01
0.99
1.00
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)


199.112
164.265
141.076
136.391
135.967
134.137
133.215
132.668
132.547
129.974
128.693
128.592
128.258
128.223
127.961
126.330
115.650
115.362
66.261
59.694
44.492
42.458
O
F
CO2Bn
200
150
100
50
0
ppm (t1)

3e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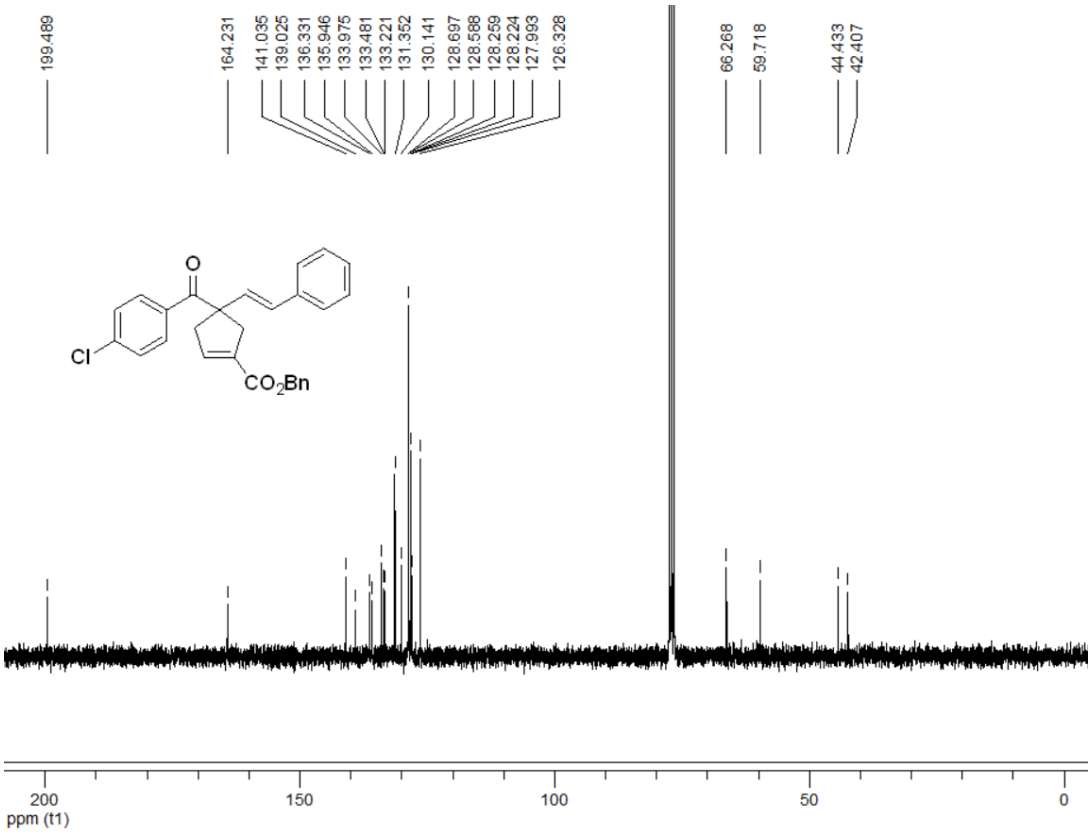
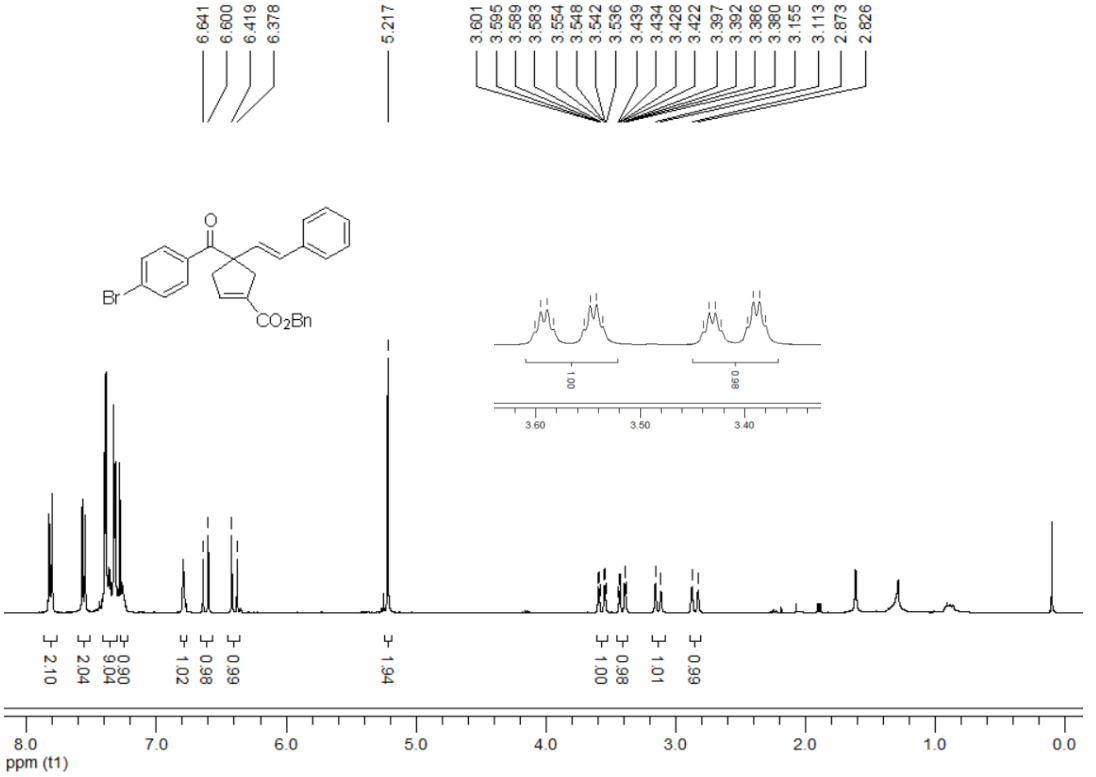
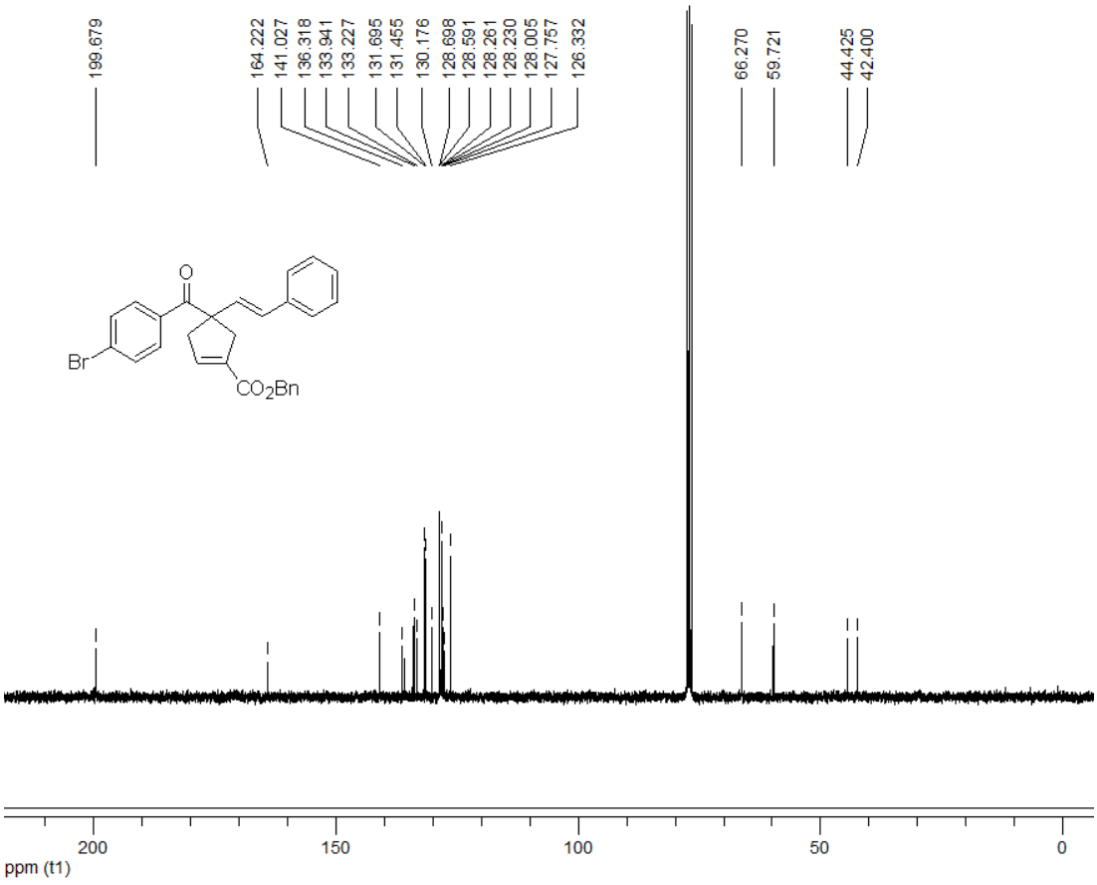
6.792
6.787
6.642
6.601
6.419
6.378
5.215
3.603
3.597
3.591
3.584
3.555
3.549
3.543
3.537
3.439
3.433
3.427
3.422
3.397
3.391
3.385
3.379
3.156
3.113
2.873
2.826
Cl
O
CO2Bn
2.04
3.13
1.05
1.06
1.01
1.00
1.92
1.06
1.03
1.03
1.12
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)

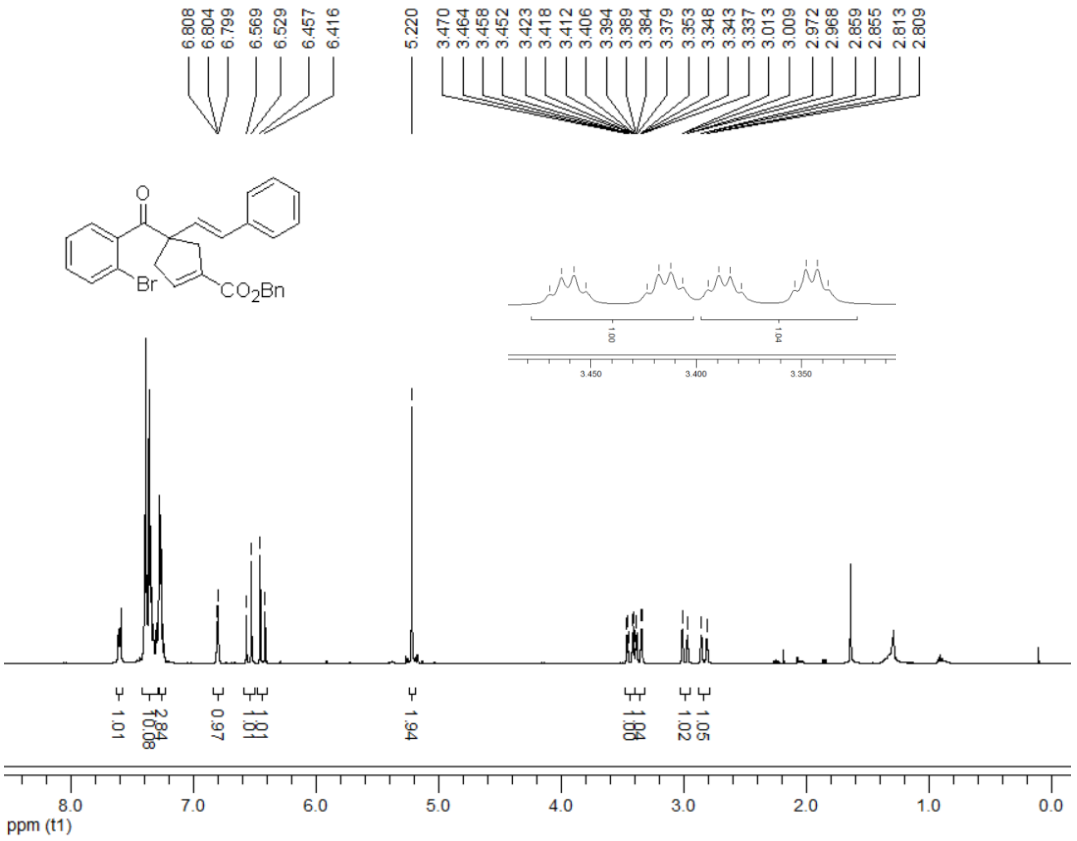

199.489
164.231
141.035
139.025
136.331
135.946
133.975
133.481
133.221
131.352
130.141
128.697
128.588
128.259
128.224
127.993
126.328
66.268
59.718
44.433
42.407
Cl
O
CO2Bn
200
150
100
50
0
ppm (t1)

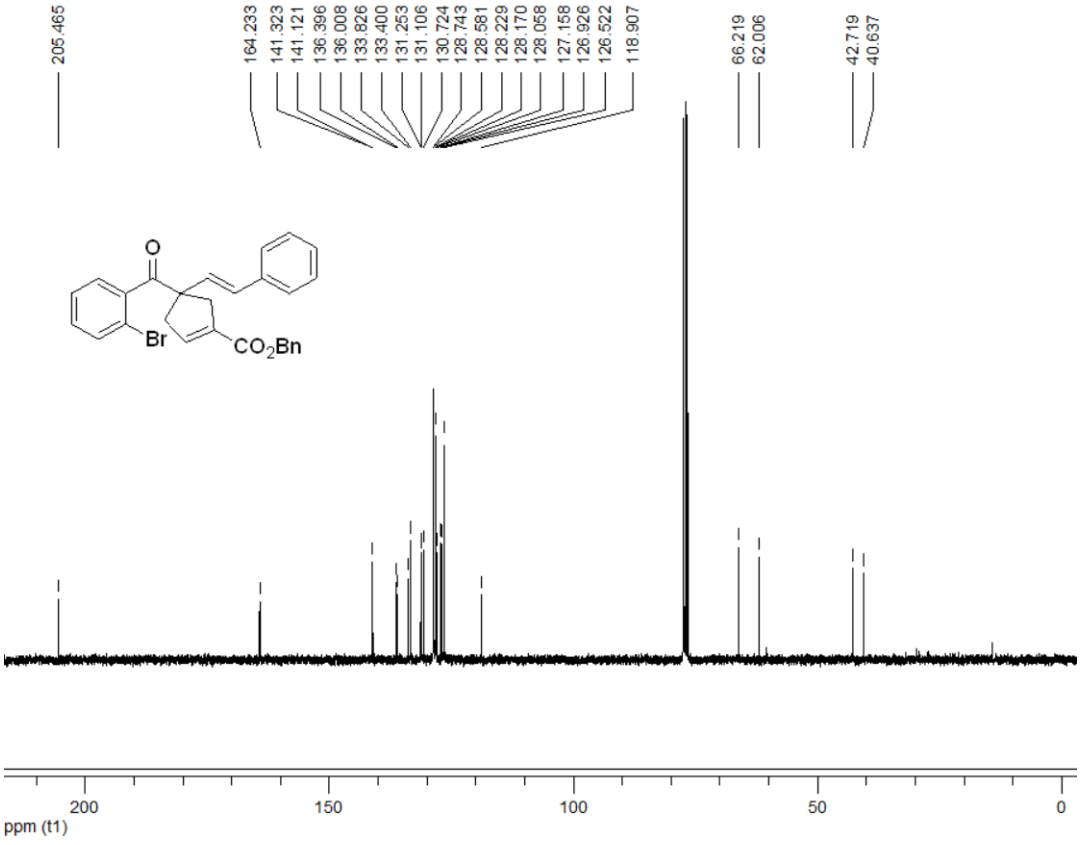
3f


6.641
6.600
6.419
6.378
5.217
3.601
3.595
3.589
3.583
3.554
3.548
3.542
3.536
3.439
3.434
3.428
3.422
3.397
3.392
3.386
3.380
3.155
3.113
2.873
2.826
Br
CO2Bn
2.10
2.04
0.90
0.94
1.02
0.98
0.99
1.94
1.00
0.98
1.01
0.99
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)

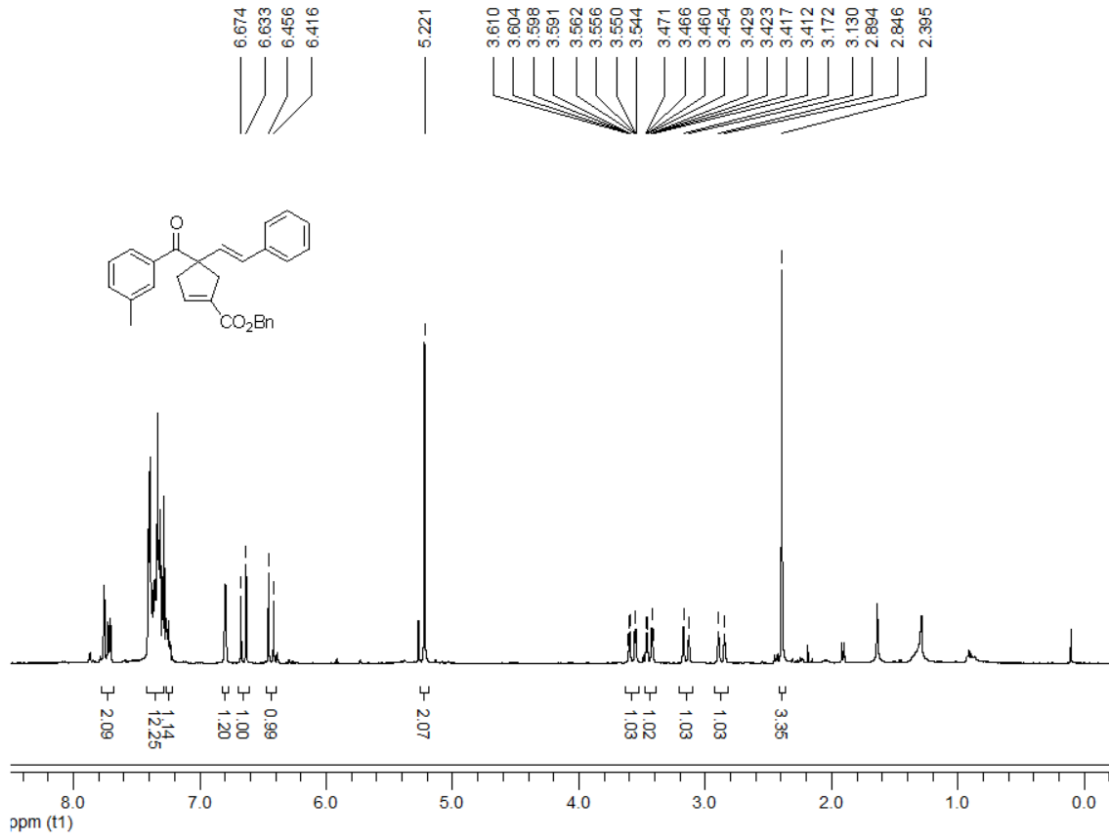

199.679
164.222
141.027
136.318
133.941
133.227
131.695
131.455
130.176
128.698
128.591
128.261
128.230
128.005
127.757
126.332
66.270
59.721
44.425
42.400
Br
CO2Bn
200
150
100
50
0
ppm (t1)

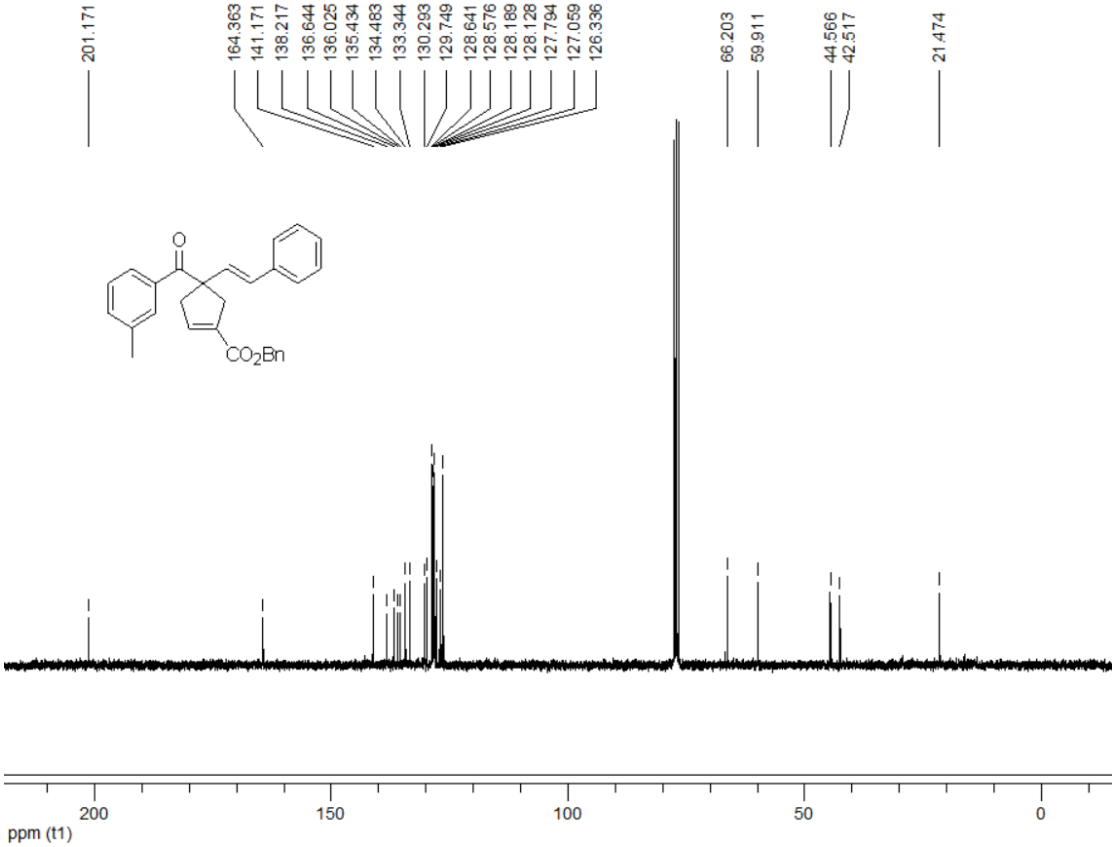
3g


6.808
6.804
6.799
6.569
6.529
6.457
6.416
5.220
3.470
3.464
3.458
3.452
3.423
3.418
3.412
3.406
3.394
3.389
3.384
3.379
3.353
3.348
3.343
3.337
3.013
3.009
2.972
2.968
2.859
2.855
2.813
2.809
O
Br
CO2Bn
3.450
3.400
3.350
1.01
2.84
1.08
0.97
1.81
1.94
1.80
1.04
1.02
1.05
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)

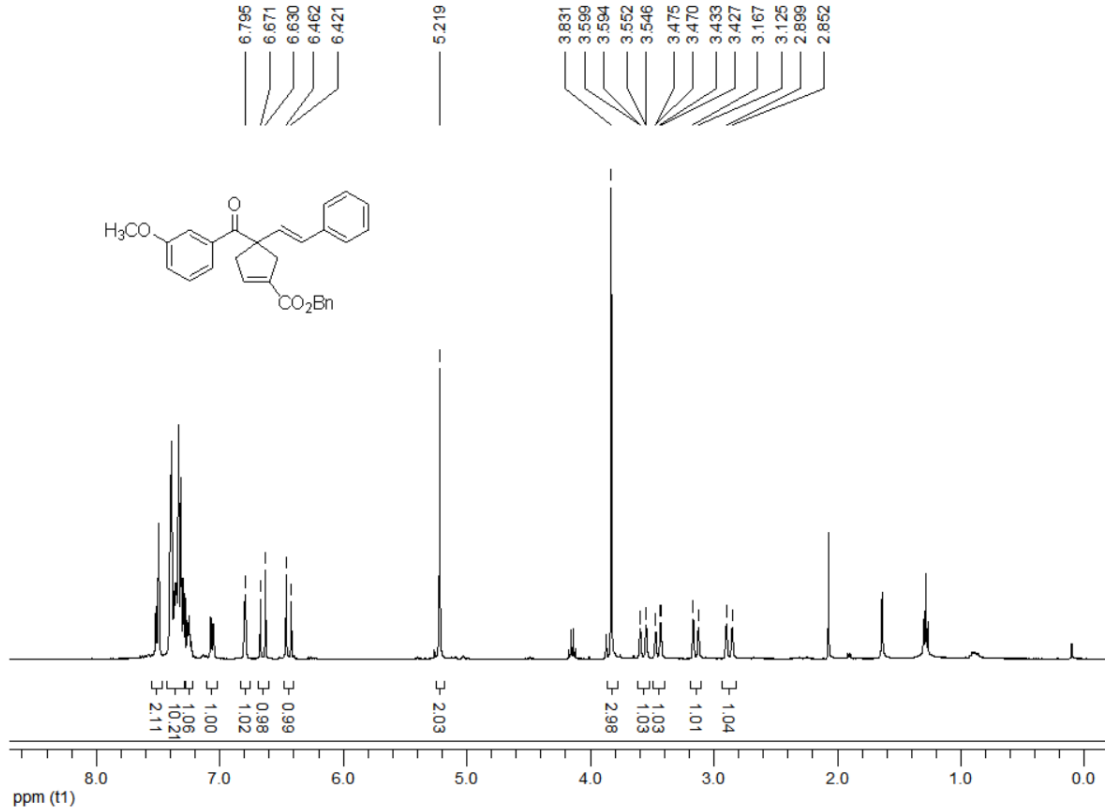

205.465
164.233
141.323
141.121
136.396
136.008
133.826
133.400
131.253
131.106
130.724
128.743
128.581
128.229
128.170
128.058
127.158
126.926
126.522
118.907
66.219
62.006
42.719
40.637
O
Br
CO2Bn
200
150
100
50
0
ppm (t1)

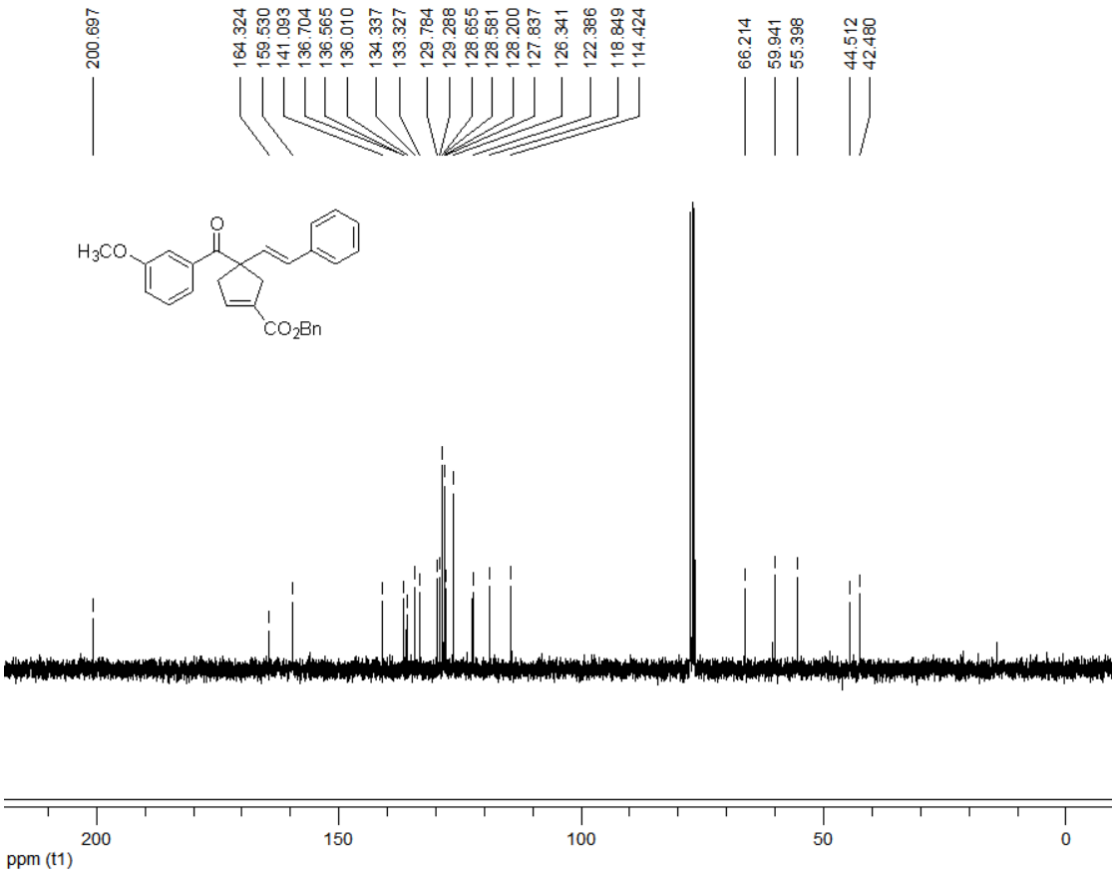
3h


6.674
6.633
6.456
6.416
5.221
3.610
3.604
3.598
3.591
3.562
3.556
3.550
3.544
3.471
3.466
3.460
3.454
3.429
3.423
3.417
3.412
3.172
3.130
2.894
2.846
2.395
CO2Bn
2.09
2.25
1.14
1.20
1.00
0.99
2.07
1.03
1.02
1.03
1.03
3.36
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)


201.171
164.363
141.171
138.217
136.644
136.025
135.434
134.483
133.344
130.293
129.749
128.641
128.576
128.189
128.128
127.794
127.059
126.336
66.203
59.911
44.566
42.517
21.474
CO2Bn
200
150
100
50
0
ppm (t1)

3i


6.795
6.671
6.630
6.462
6.421
5.219
3.831
3.599
3.594
3.552
3.546
3.475
3.470
3.433
3.427
3.167
3.125
2.899
2.852
H3CO
O
CO2Bn
2.11
1.21
1.06
1.00
1.02
0.98
0.99
2.03
2.98
1.03
1.03
1.01
1.04
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)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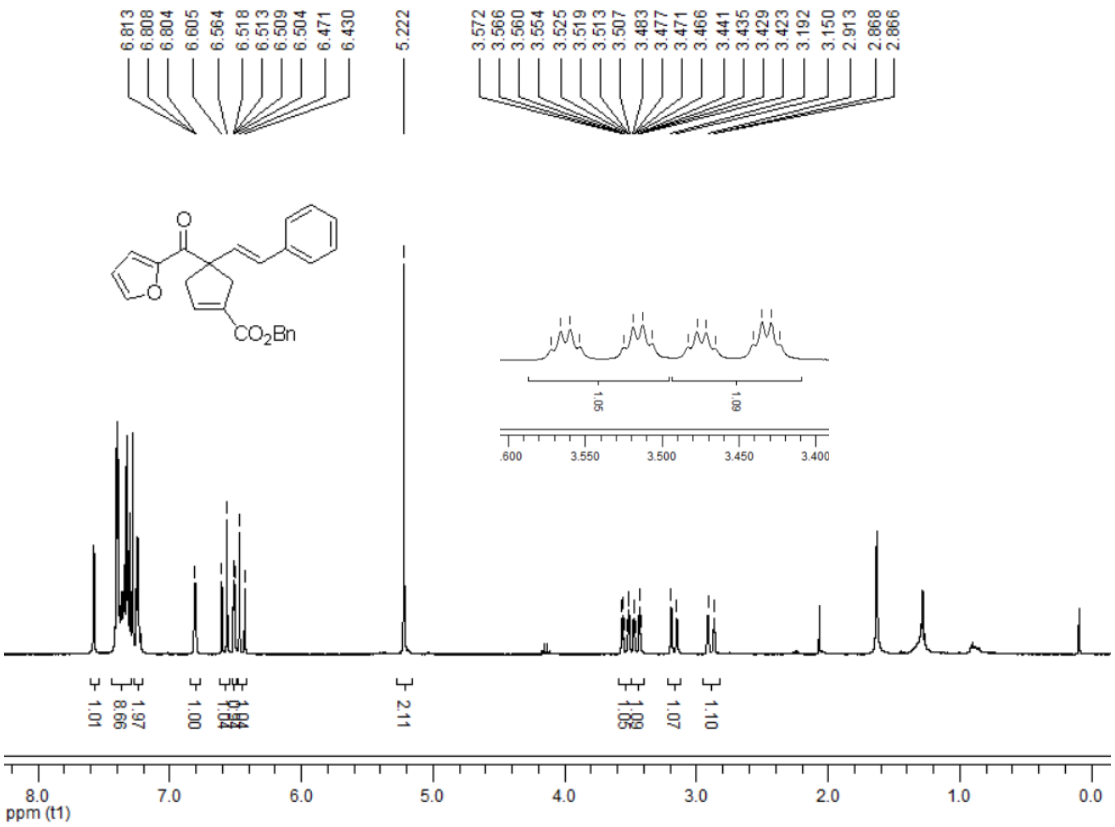
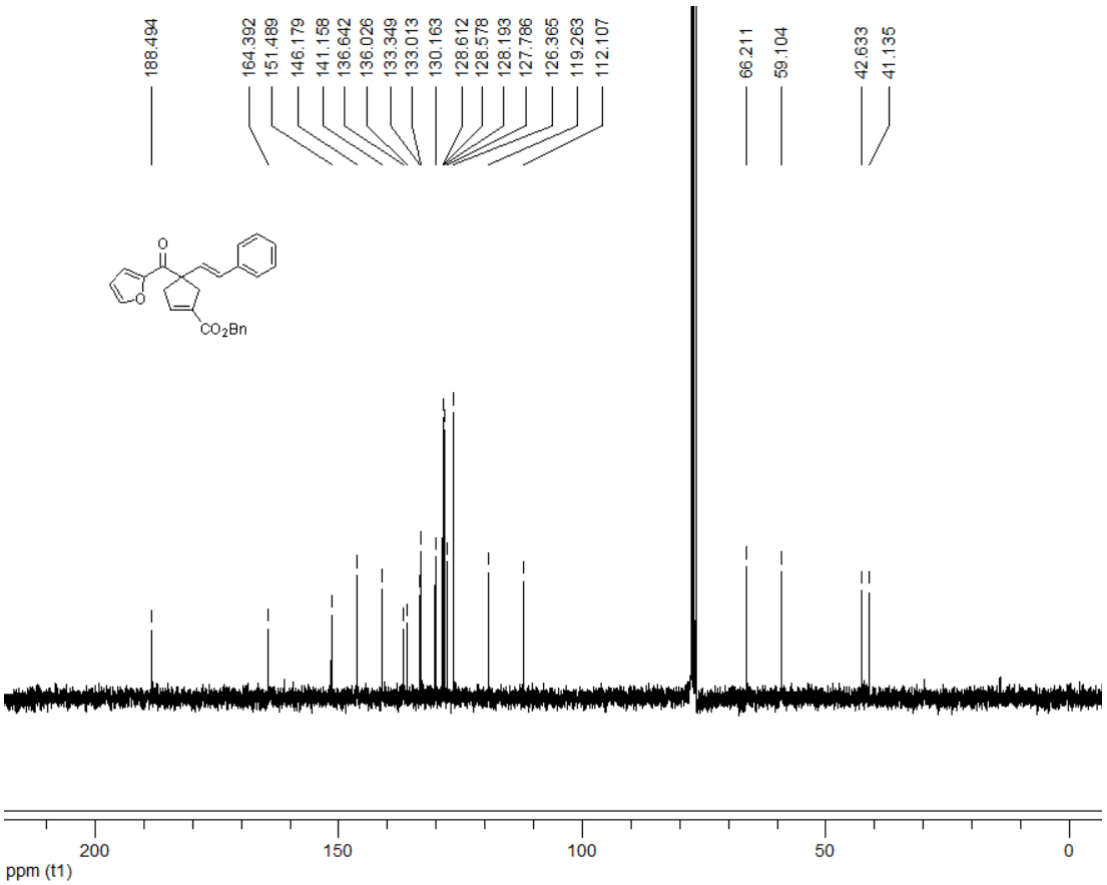
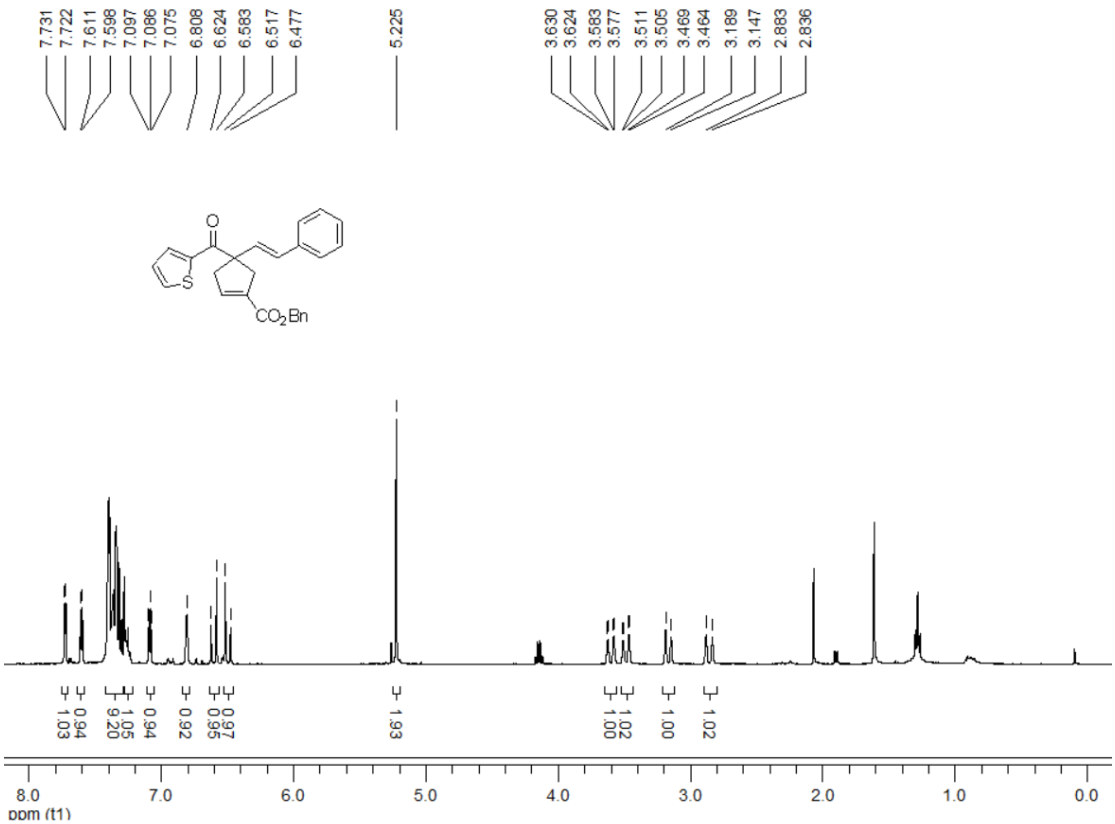
159.530
141.093
136.704
136.565
136.010
134.337
133.327
129.784
129.288
128.655
128.581
128.200
127.837
126.341
122.386
118.849
114.424
66.214
59.941
55.398
44.512
42.480
H3CO
O
CO2Bn
200
150
100
50
0
ppm (t1)

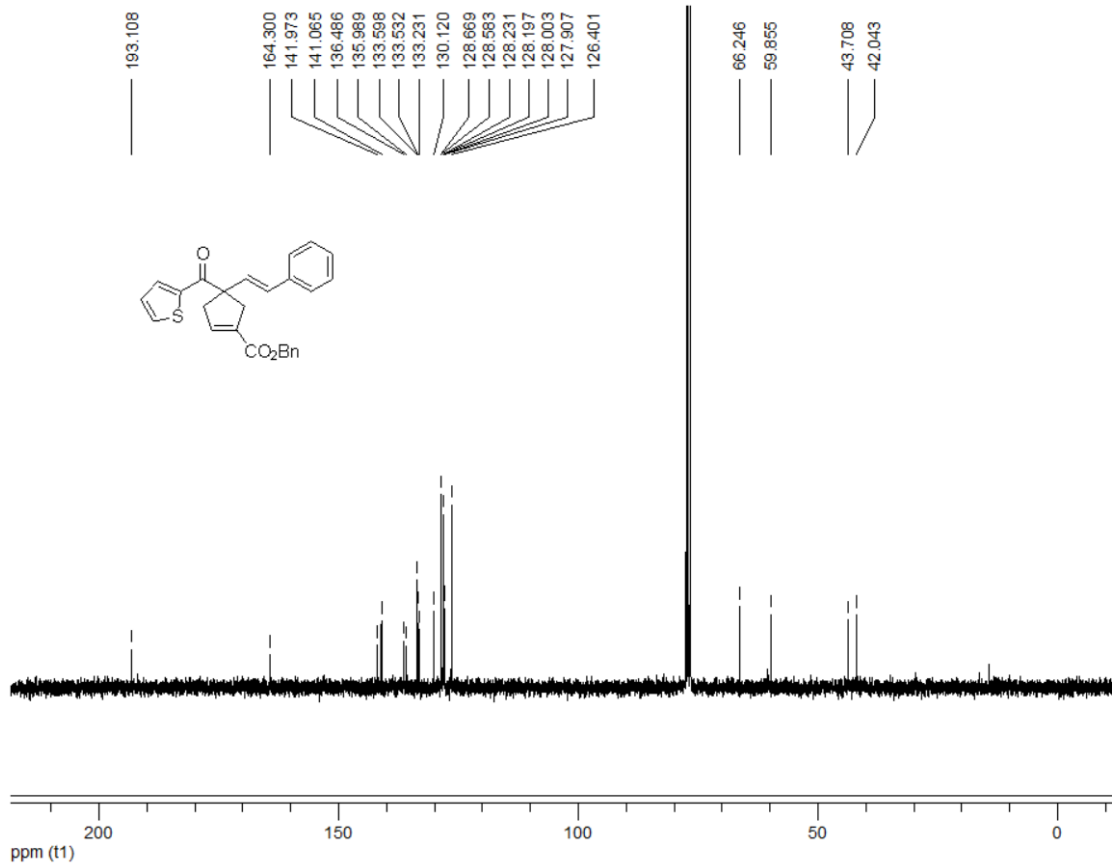
3j


6.813
6.808
6.804
6.605
6.564
6.518
6.513
6.509
6.504
6.471
6.430
5.222
3.572
3.566
3.560
3.554
3.525
3.519
3.513
3.507
3.483
3.477
3.471
3.466
3.441
3.435
3.429
3.423
3.192
3.150
2.913
2.868
2.866
CO2Bn
1.01
0.86
1.97
1.00
2.11
1.09
1.07
1.10
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)

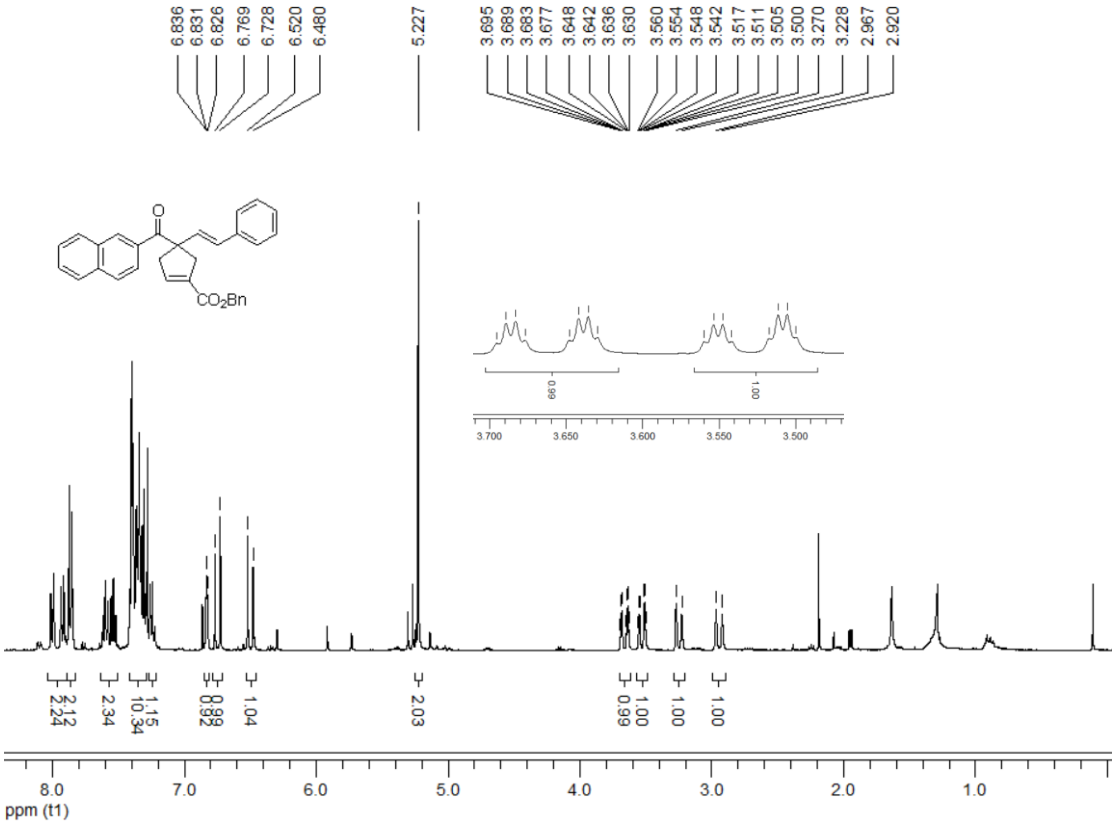

188.494
164.392
151.489
146.179
141.158
136.642
136.026
133.349
133.013
130.163
128.612
128.578
128.193
127.786
126.365
119.263
112.107
66.211
59.104
42.633
41.135
CO2Bn
200
150
100
50
0
ppm (t1)

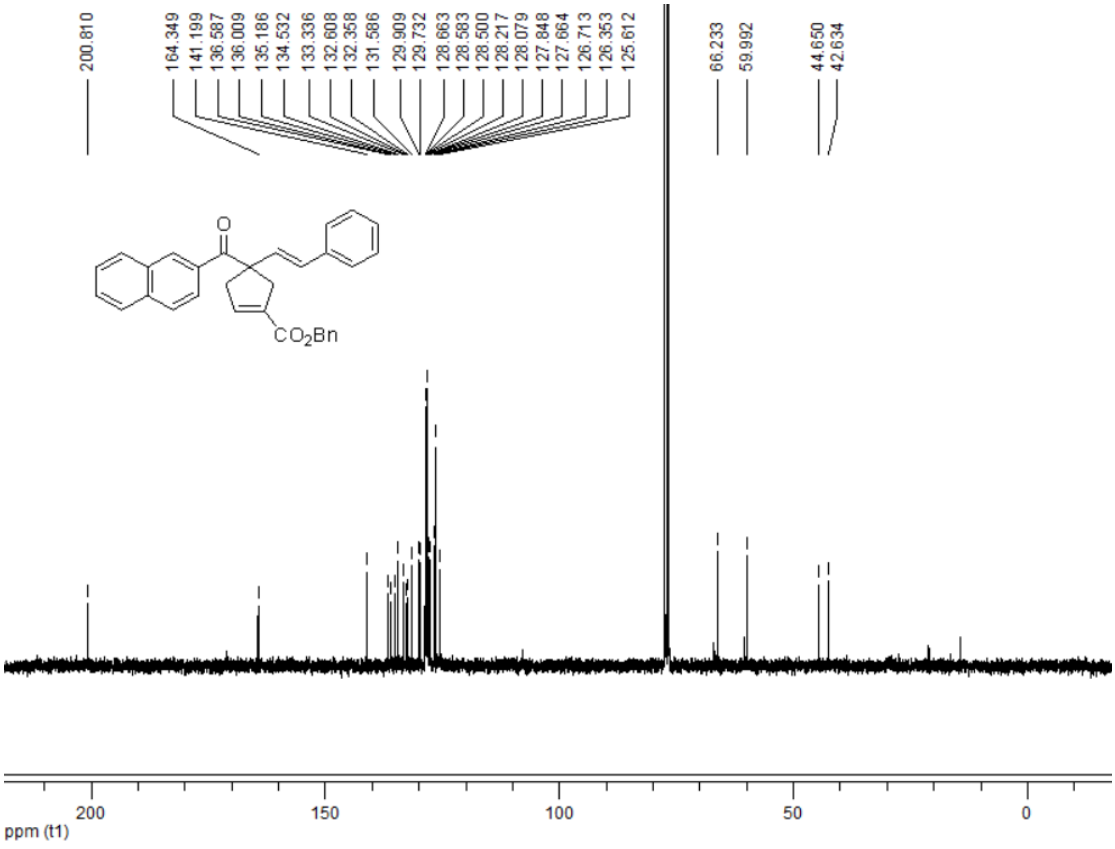
3k


7.731
7.722
7.611
7.598
7.097
7.086
7.075
6.808
6.624
6.583
6.517
6.477
5.225
3.630
3.624
3.583
3.577
3.511
3.505
3.469
3.464
3.189
3.147
2.883
2.836
O
S
CO2Bn
1.03
0.94
1.05
9.20
0.94
0.92
0.95
0.97
1.93
1.00
1.02
1.00
1.02
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)

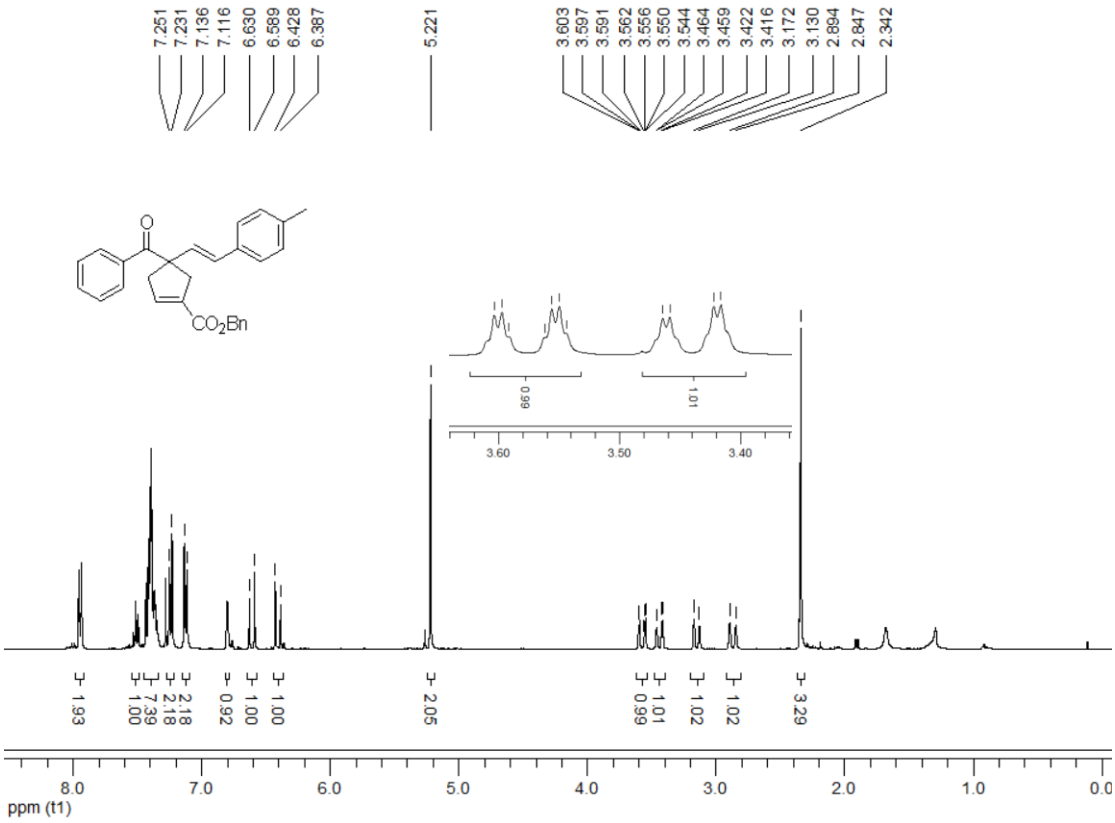

193.108
164.300
141.973
141.065
136.486
135.989
133.598
133.532
133.231
130.120
128.669
128.583
128.231
128.197
128.003
127.907
126.401
66.246
59.855
43.708
42.043
O
S
CO2Bn
200
150
100
50
0
ppm (t1)

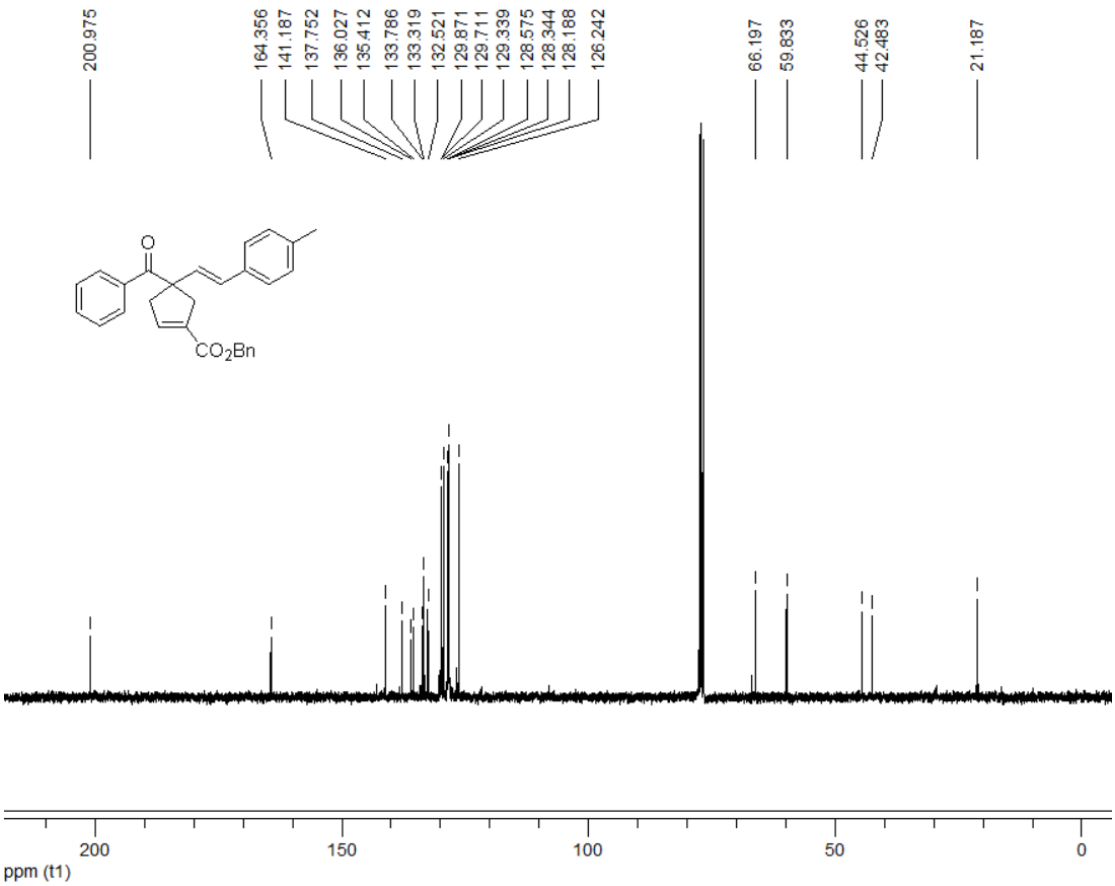
3l


6.836
6.831
6.826
6.769
6.728
6.520
6.480
5.227
3.695
3.689
3.683
3.677
3.648
3.642
3.636
3.630
3.560
3.554
3.548
3.542
3.517
3.511
3.505
3.500
3.270
3.228
2.967
2.920
CO2Bn
2.12
2.24
2.34
1.15
10.34
0.89
0.92
1.04
2.03
0.99
1.00
1.00
1.00
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
ppm (t1)

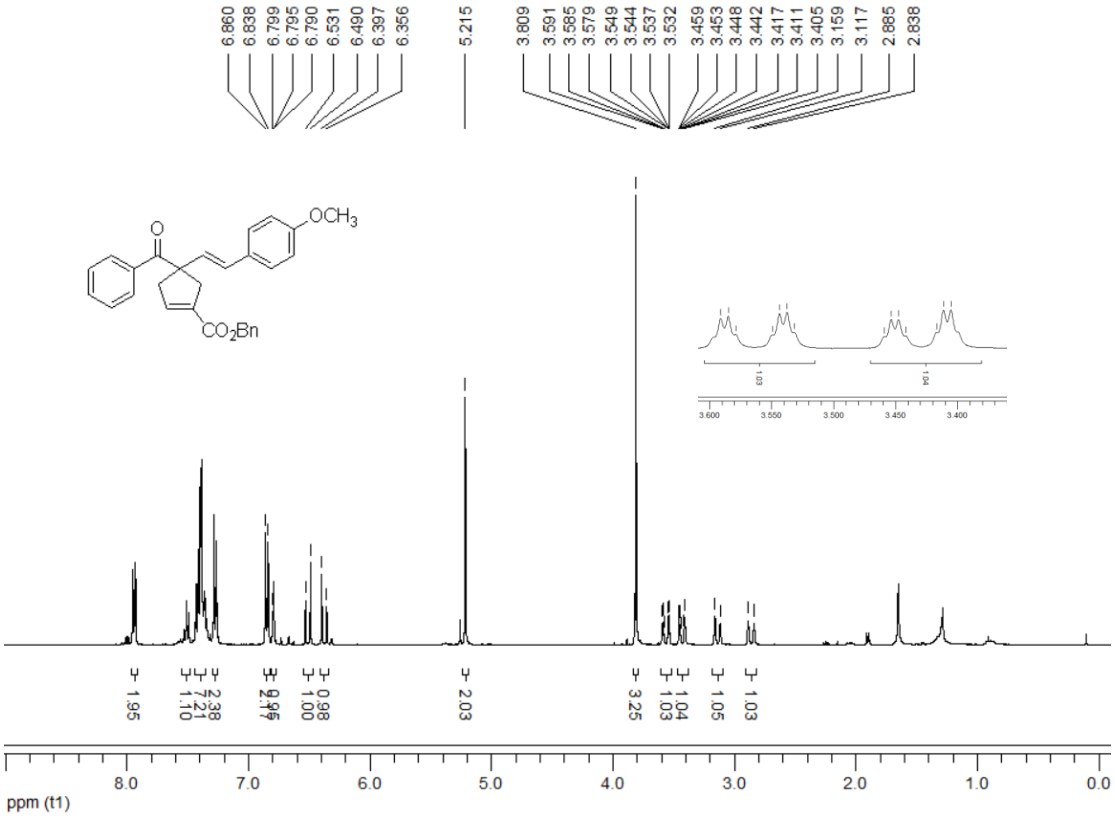

200.810
164.349
141.199
136.587
136.009
135.186
134.532
133.336
132.608
132.358
131.586
129.909
129.732
128.663
128.583
128.500
128.217
128.079
127.848
127.664
126.713
126.353
125.612
66.233
59.992
44.650
42.634
CO2Bn
200
150
100
50
0
ppm (t1)

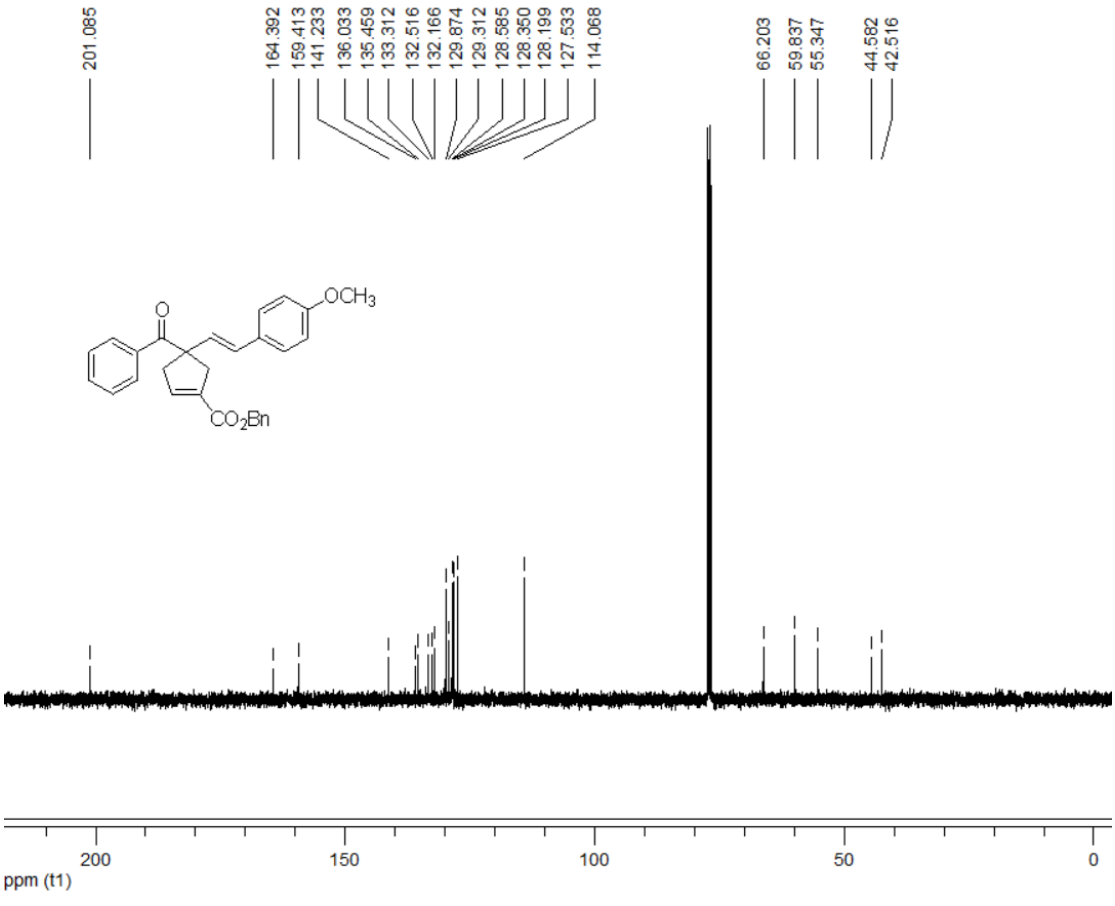
3m


7.251
7.231
7.136
7.116
6.630
6.589
6.428
6.387
5.221
3.603
3.597
3.591
3.562
3.556
3.550
3.544
3.464
3.459
3.422
3.416
3.172
3.130
2.894
2.847
2.342
CO2Bn
1.93
7.39
7.18
2.18
0.92
1.00
1.00
2.05
0.99
1.01
1.02
1.02
3.29
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
ppm (t1)

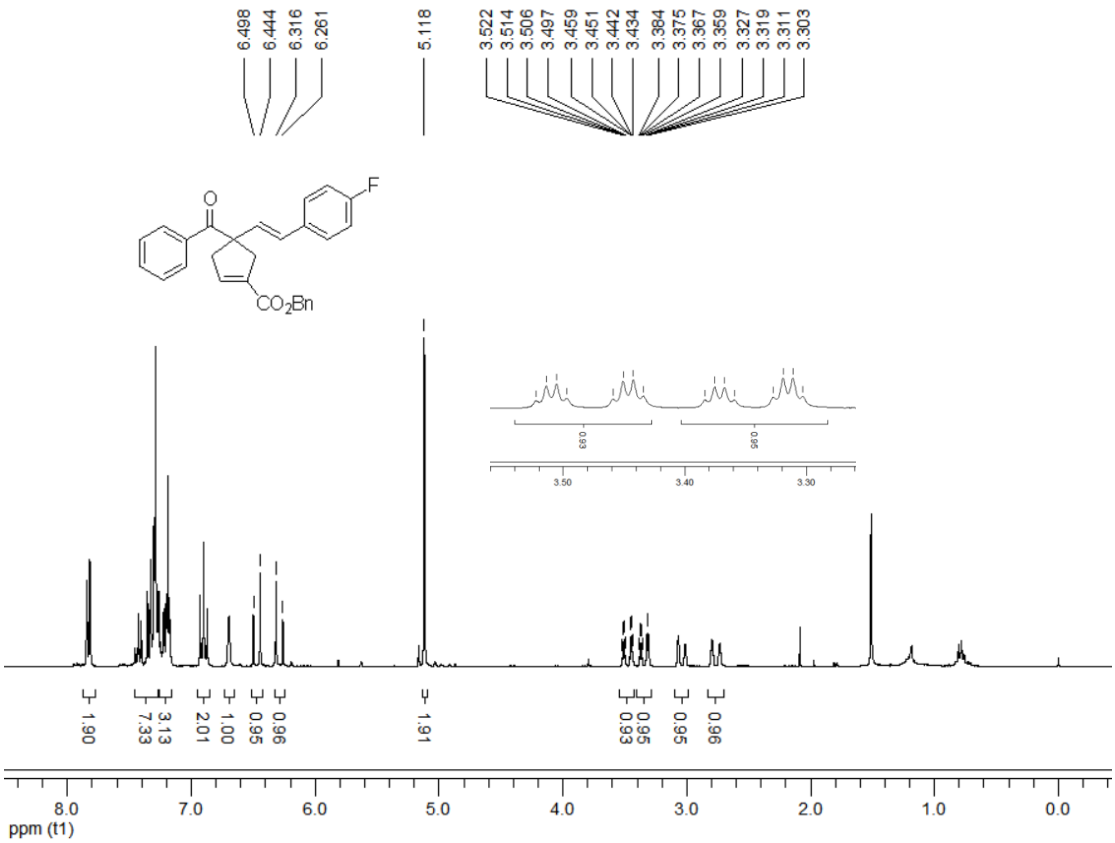

200.975
164.356
141.187
137.752
136.027
135.412
133.786
133.319
132.521
129.871
129.711
129.339
128.575
128.344
128.188
126.242
66.197
59.833
44.526
42.483
21.187
CO2Bn
200
150
100
50
0
ppm (t1)

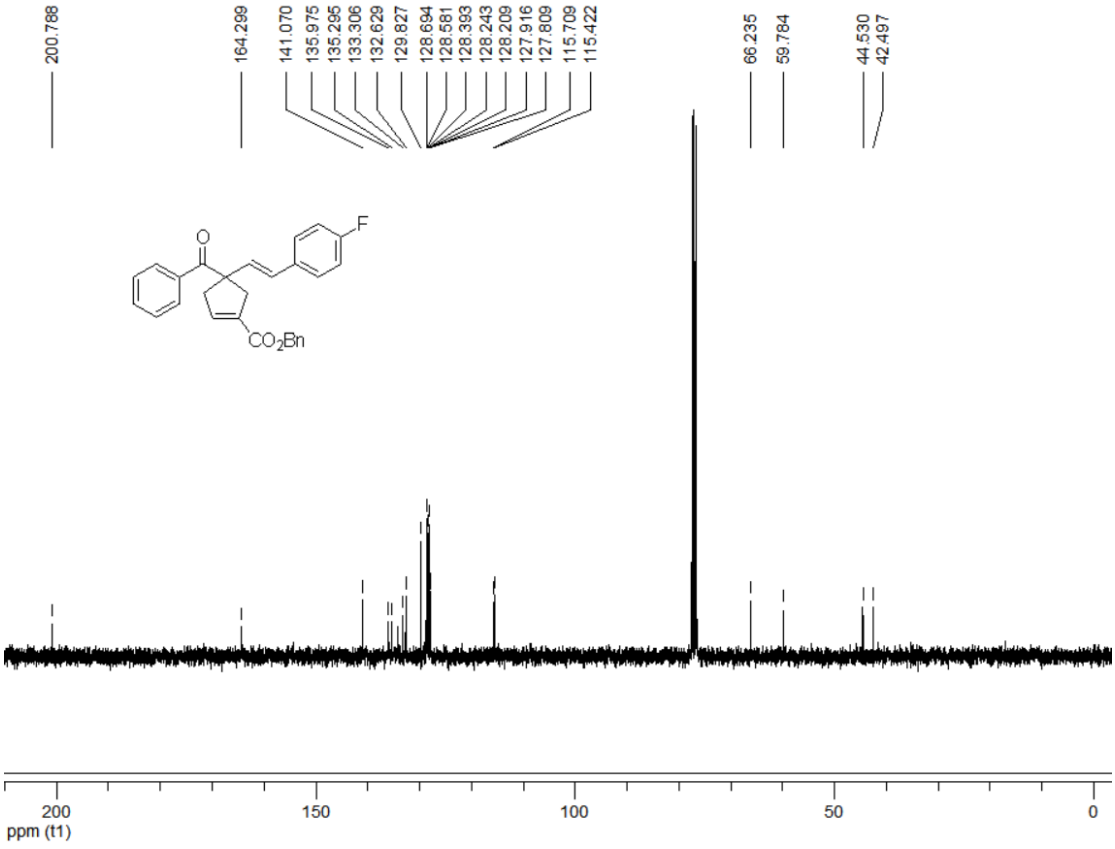
3n


6.860
6.838
6.799
6.795
6.790
6.531
6.490
6.397
6.356
5.215
3.809
3.591
3.585
3.579
3.549
3.544
3.537
3.532
3.459
3.453
3.448
3.442
3.417
3.411
3.405
3.159
3.117
2.885
2.838
OCH3
O
CO2Bn
1.95
4.21
1.10
2.38
2.16
0.96
1.00
0.98
2.03
3.25
1.03
1.04
1.05
1.03
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)


201.085
164.392
159.413
141.233
136.033
135.459
133.312
132.516
132.166
129.874
129.312
128.585
128.350
128.199
127.533
114.068
66.203
59.837
55.347
44.582
42.516
OCH3
O
CO2Bn
200
150
100
50
0
ppm (t1)

3o


6.498
6.444
6.316
6.261
5.118
3.522
3.514
3.506
3.497
3.459
3.451
3.442
3.434
3.384
3.375
3.367
3.359
3.327
3.319
3.311
3.303
F
O
CO2Bn
1.90
7.33
3.13
2.01
1.00
0.95
0.96
1.91
0.93
0.95
0.95
0.96
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)


200.788
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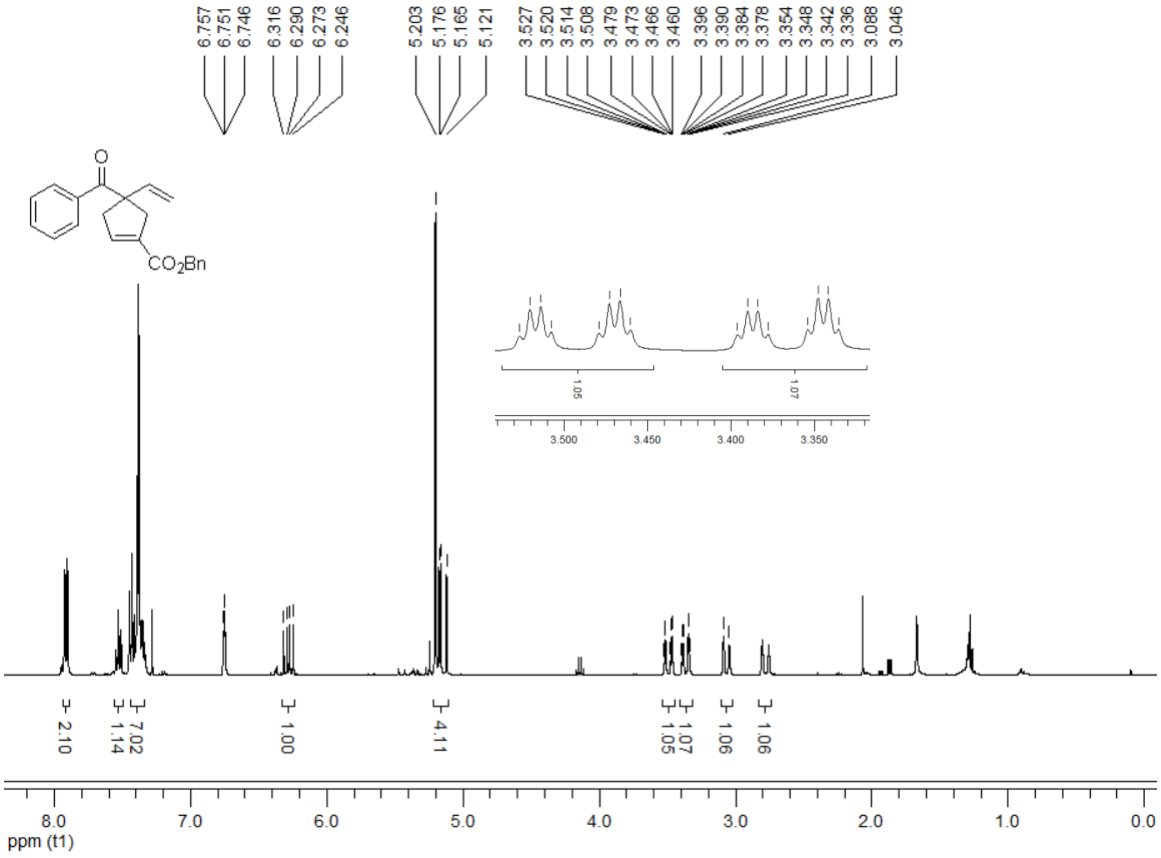
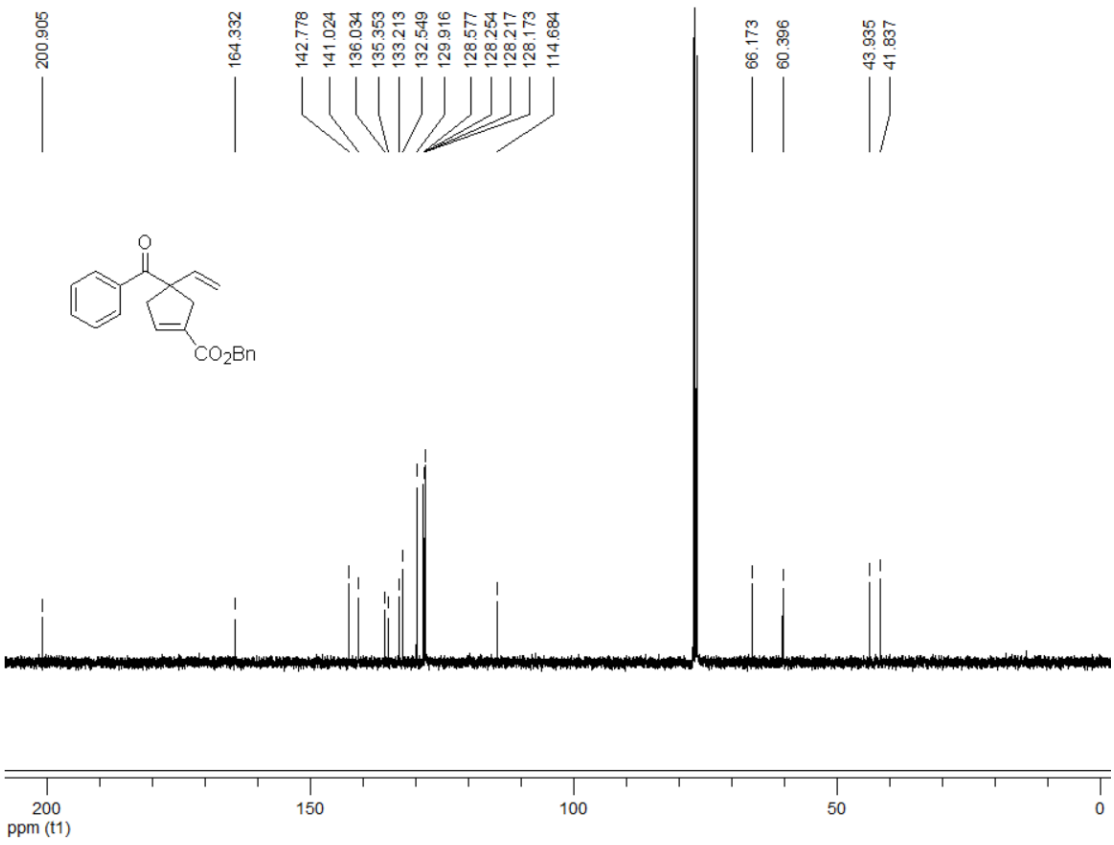
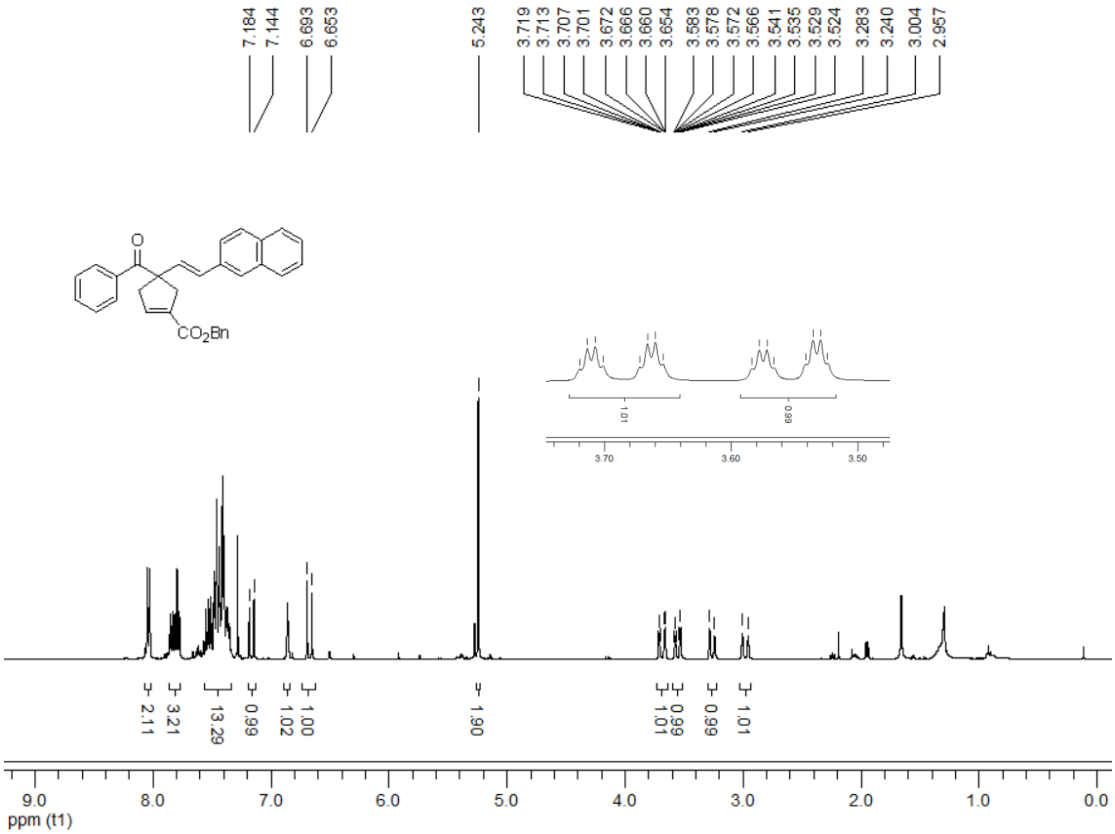
141.070
135.975
135.295
133.306
132.629
129.827
128.694
128.581
128.393
128.243
128.209
127.916
127.809
115.709
115.422
66.235
59.784
44.530
42.497
F
O
CO2Bn
200
150
100
50
0
ppm (t1)

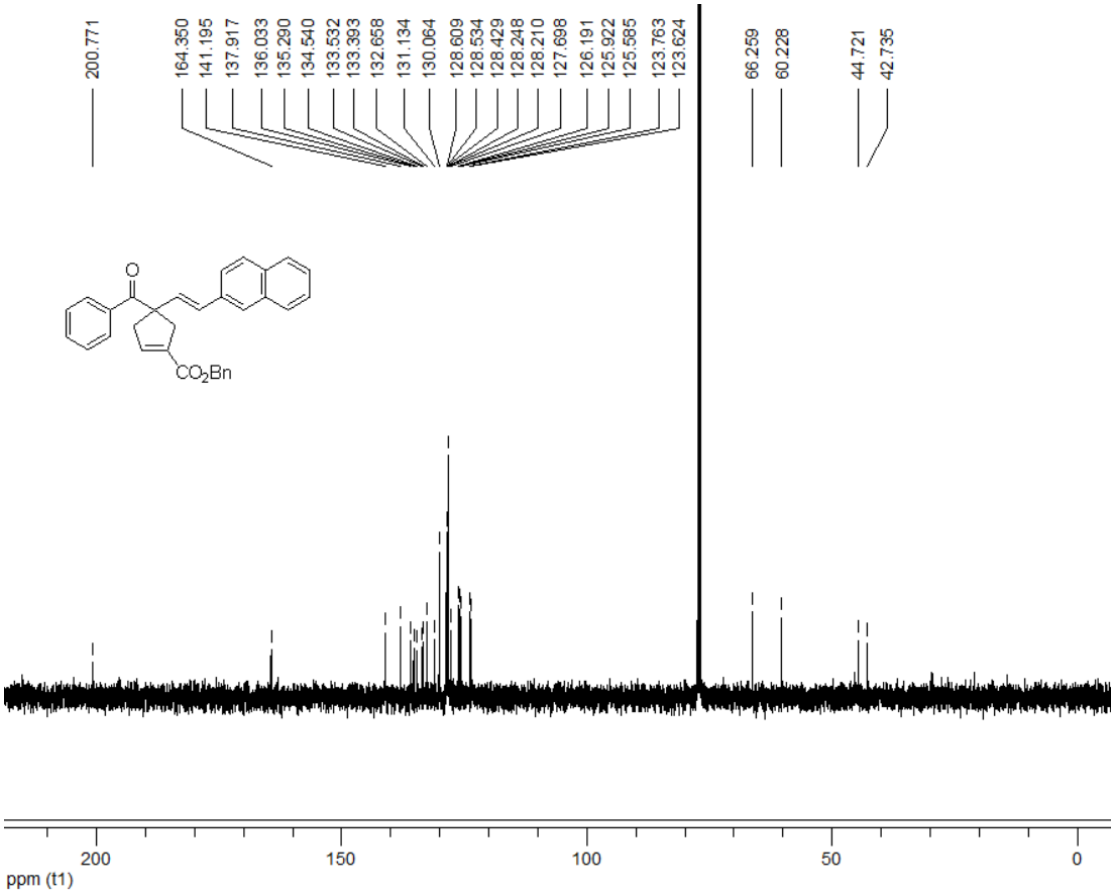
3p


6.757
6.751
6.746
6.316
6.290
6.273
6.246
5.203
5.176
5.165
5.121
3.527
3.520
3.514
3.508
3.479
3.473
3.466
3.460
3.396
3.390
3.384
3.378
3.354
3.348
3.342
3.336
3.088
3.046
CO2Bn
2.10
1.14
2.02
1.00
4.11
1.05
1.07
1.06
1.06
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)

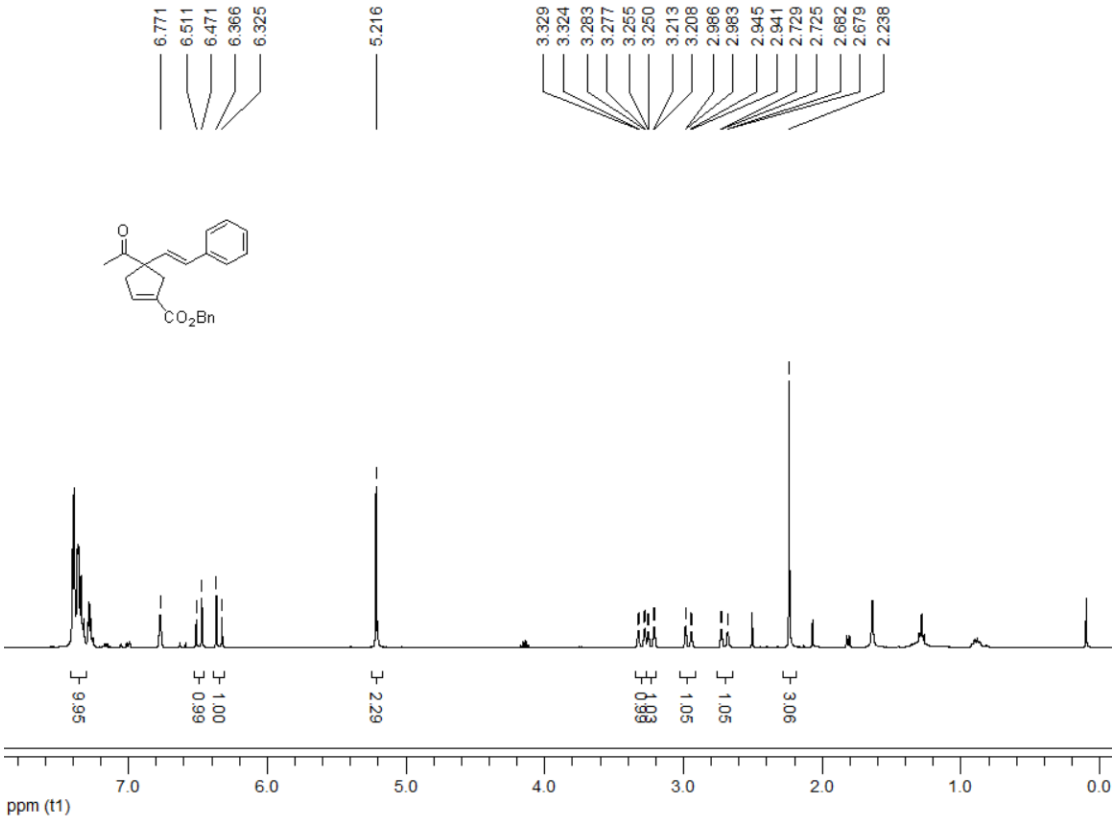

200.905
164.332
142.778
141.024
136.034
135.353
133.213
132.549
129.916
128.577
128.254
128.217
128.173
114.684
66.173
60.396
43.935
41.837
CO2Bn
200
150
100
50
0
ppm (t1)

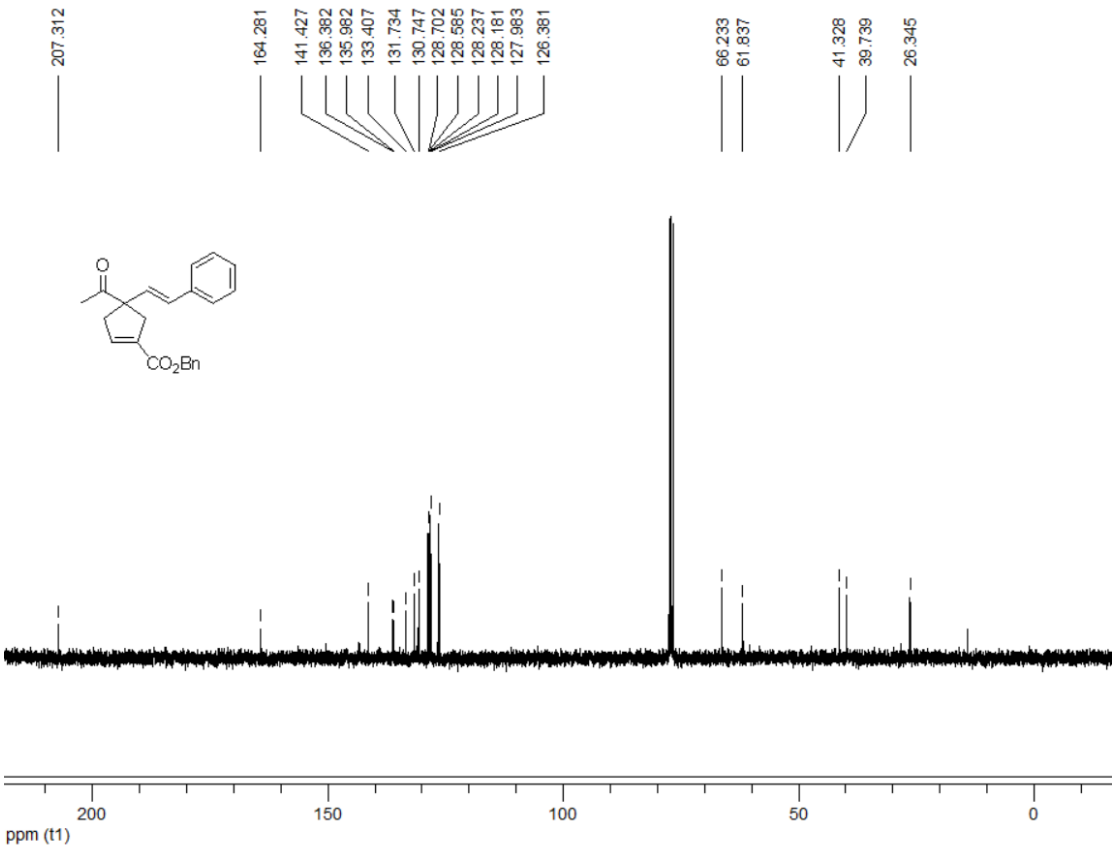
3q


7.184
7.144
6.693
6.653
5.243
3.719
3.713
3.707
3.701
3.672
3.666
3.660
3.654
3.583
3.578
3.572
3.566
3.541
3.535
3.529
3.524
3.283
3.240
3.004
2.957
O
CO2Bn
2.11
3.21
13.29
0.99
1.02
1.00
1.90
1.01
0.99
0.99
1.01
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)

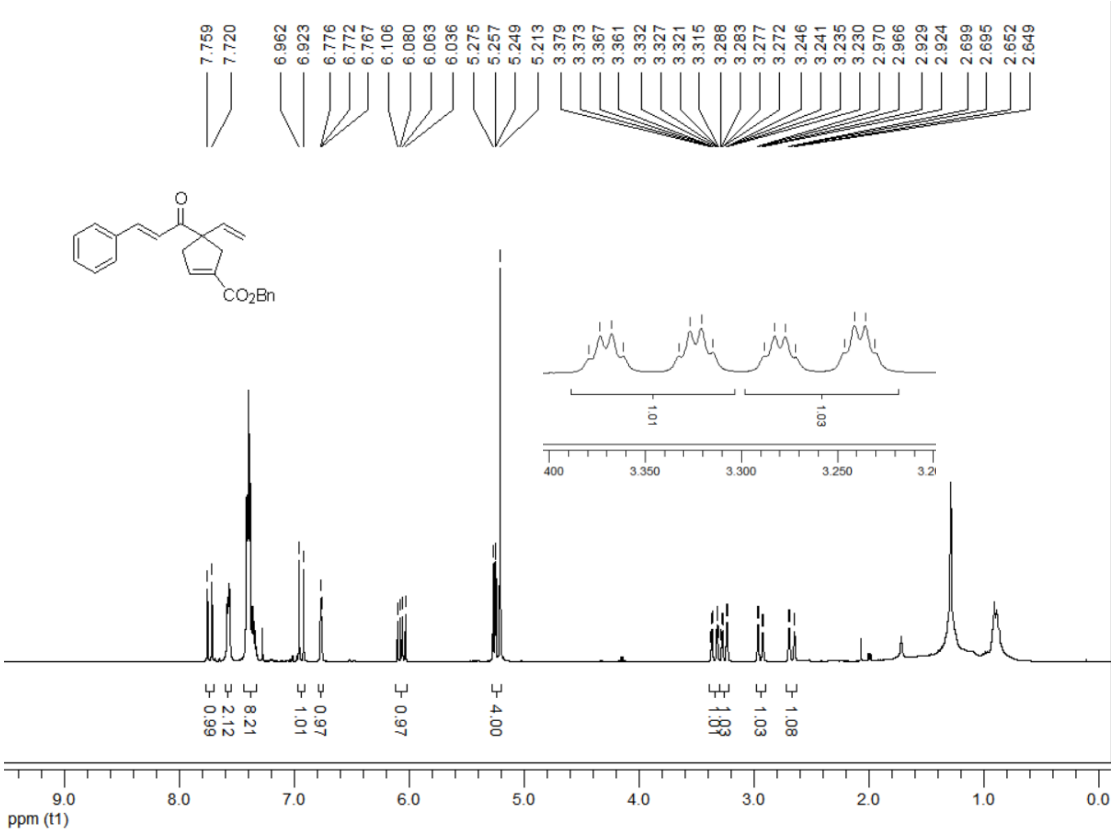

200.771
164.350
141.195
137.917
136.033
135.290
134.540
133.532
133.393
132.658
131.134
130.064
128.609
128.534
128.429
128.248
128.210
127.698
126.191
125.922
125.585
123.763
123.624
66.259
60.228
44.721
42.735
O
CO2Bn
200
150
100
50
0
ppm (t1)

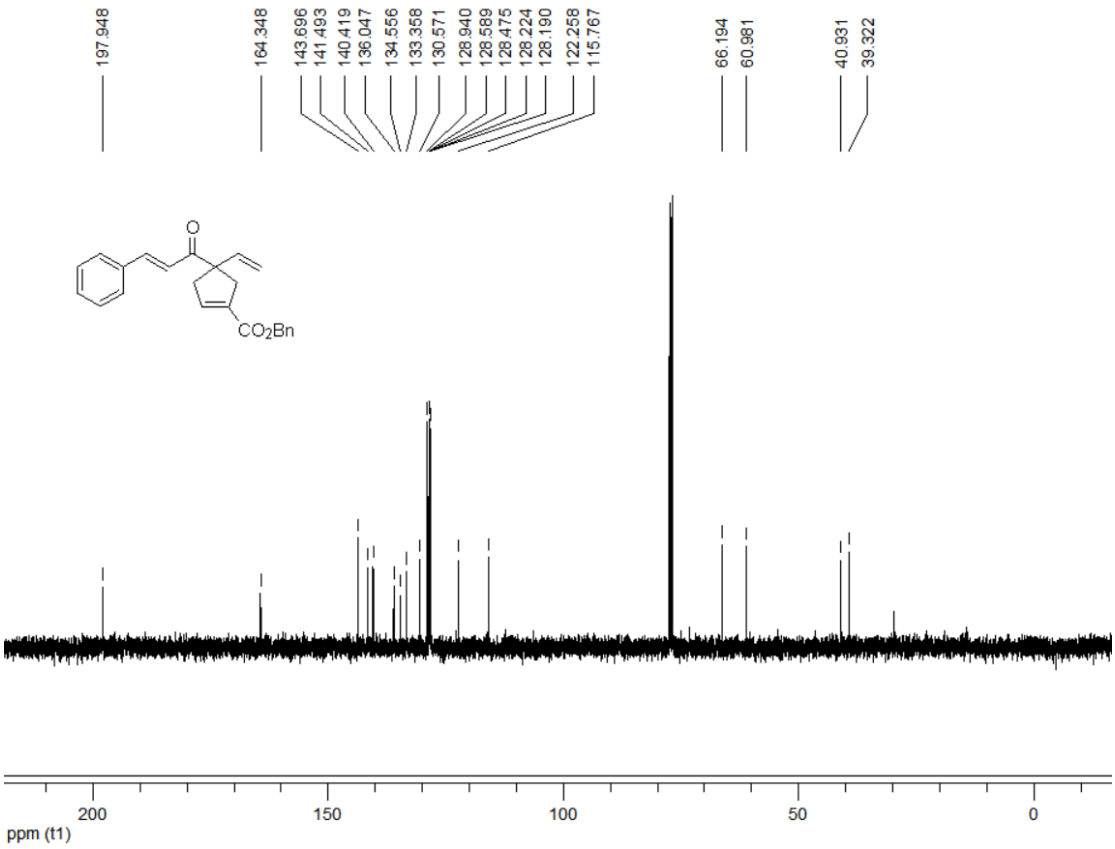
3r

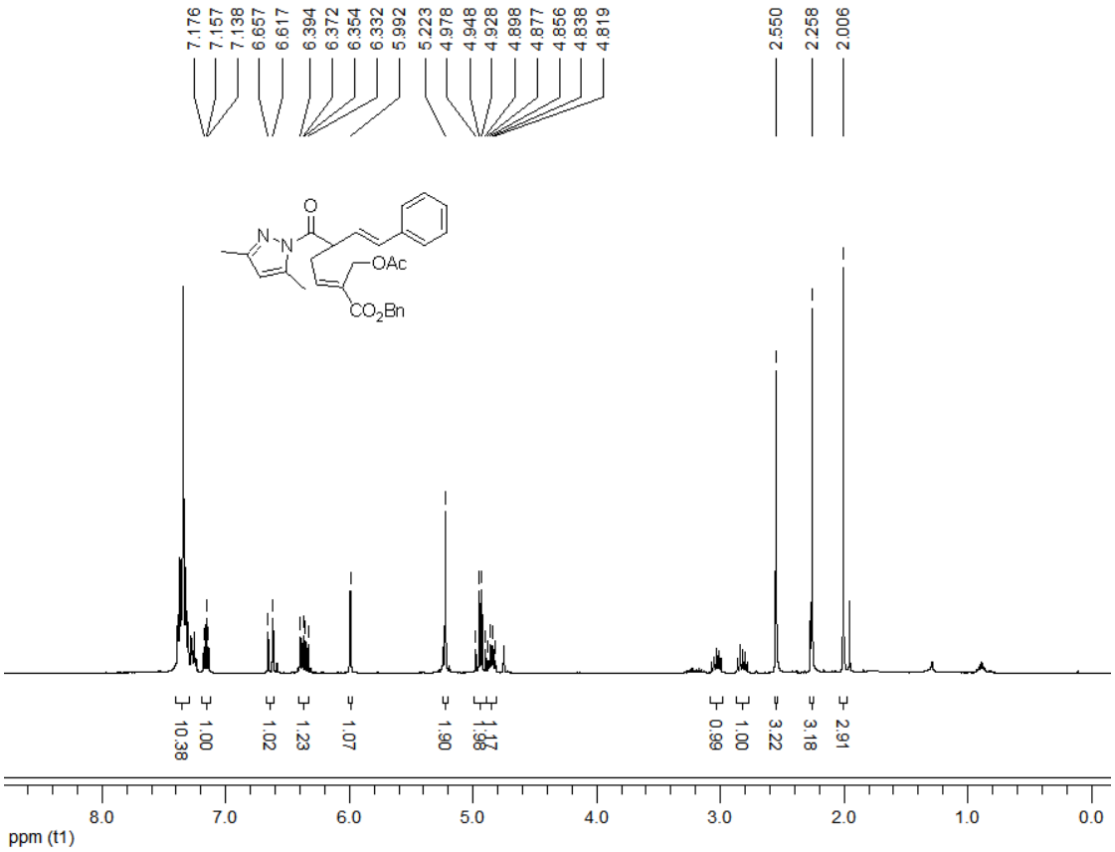

6.771
6.511
6.471
6.366
6.325
5.216
3.329
3.324
3.283
3.277
3.255
3.250
3.213
3.208
2.986
2.983
2.945
2.941
2.729
2.725
2.682
2.679
2.238
O
CO2Bn
9.95
0.99
1.00
2.29
0.99
1.03
1.05
1.05
3.06
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)

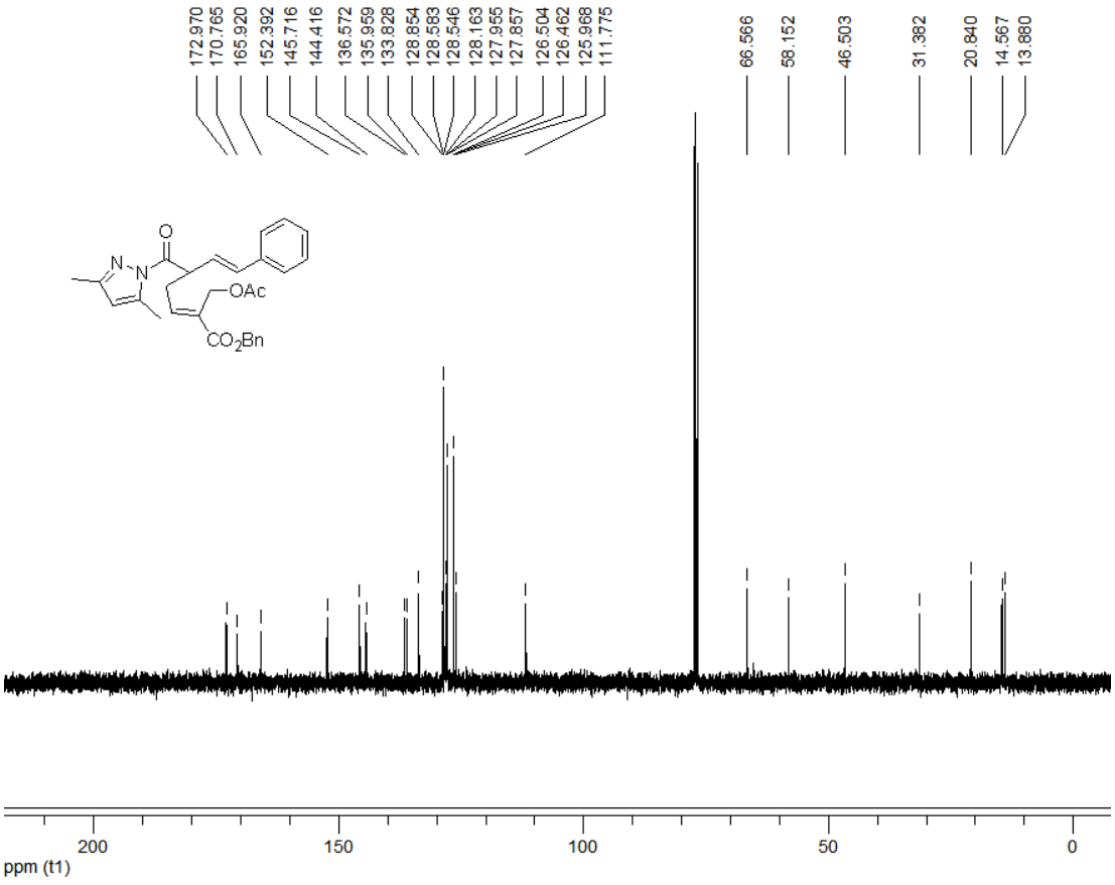

207.312
164.281
141.427
136.382
135.982
133.407
131.734
130.747
128.702
128.585
128.237
128.181
127.983
126.381
66.233
61.837
41.328
39.739
26.345
O
CO2Bn
200
150
100
50
0
ppm (t1)

3s

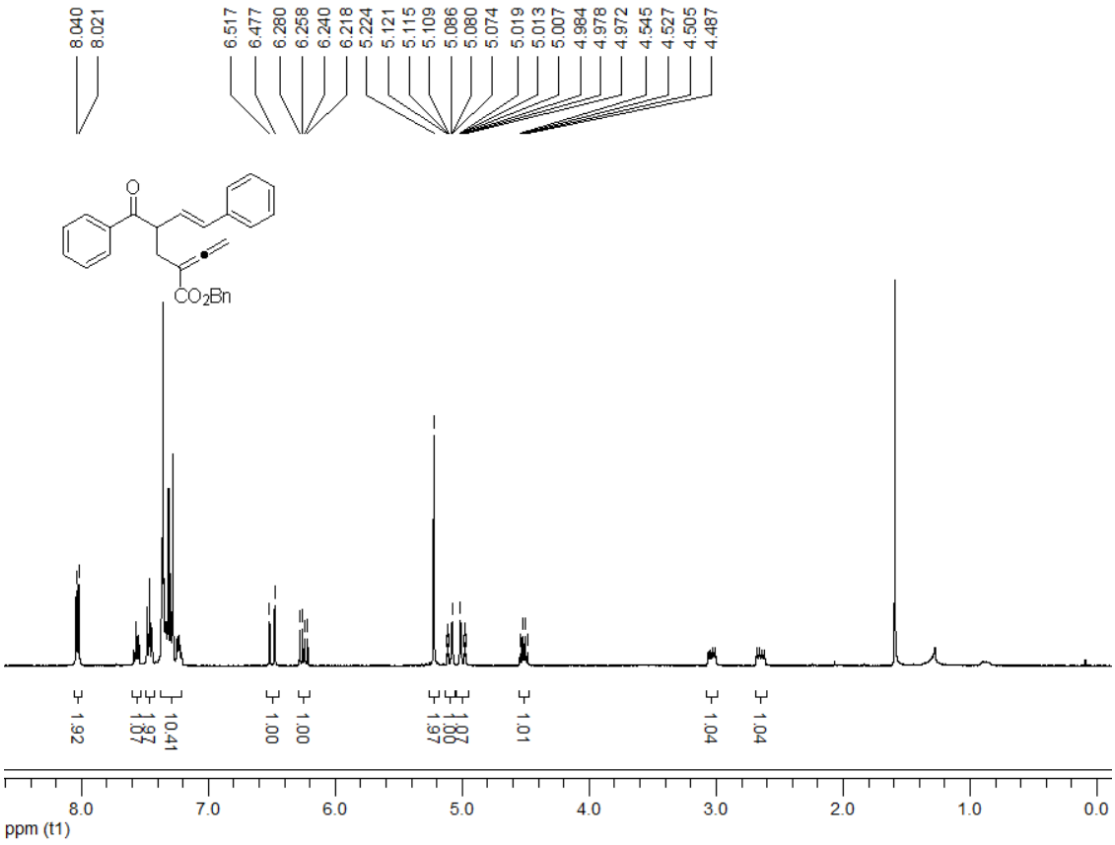

7.759
7.720
6.962
6.923
6.776
6.772
6.767
6.106
6.080
6.063
6.036
5.275
5.257
5.249
5.213
3.379
3.373
3.367
3.361
3.332
3.327
3.321
3.315
3.288
3.283
3.277
3.272
3.246
3.241
3.235
3.230
2.970
2.966
2.929
2.924
2.699
2.695
2.652
2.649
CO2Bn
1.01
1.03
400
3.350
3.300
3.250
0.99
2.12
8.21
1.01
0.97
0.97
4.00
1.03
1.03
1.08
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)

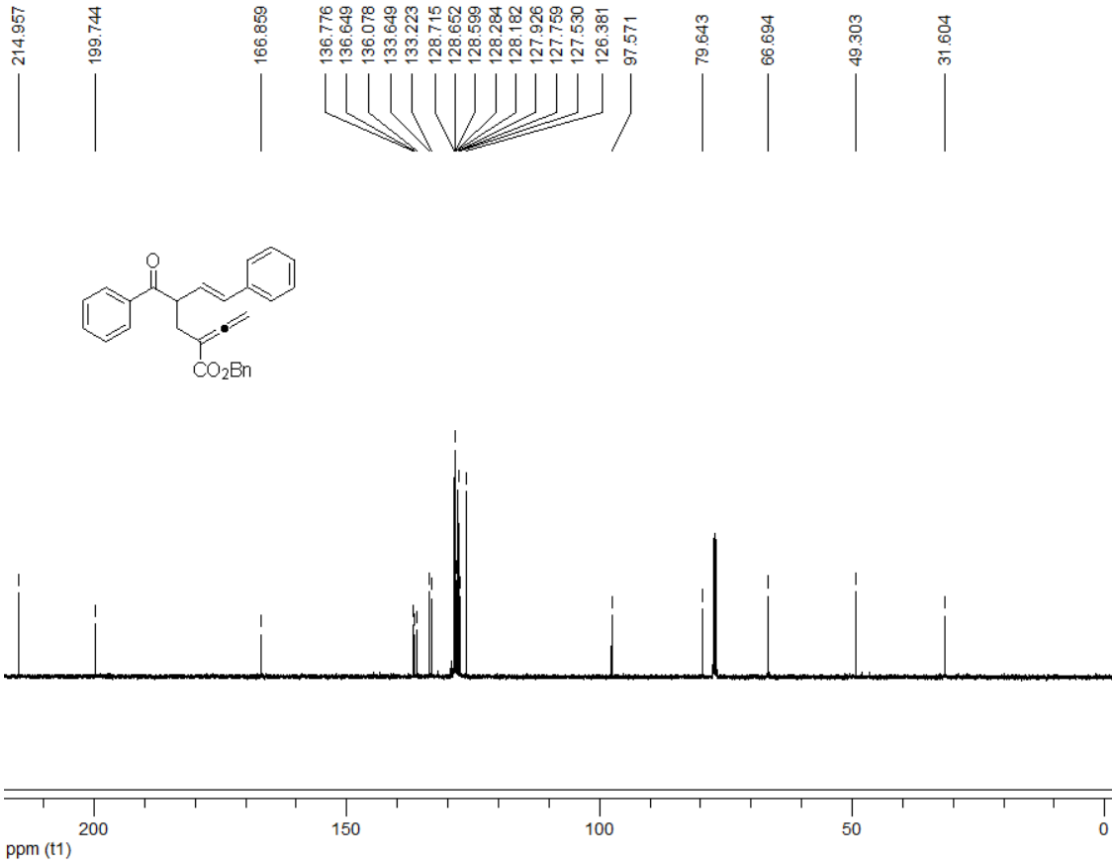

197.948
164.348
143.696
141.493
140.419
136.047
134.556
133.358
130.571
128.940
128.589
128.475
128.224
128.190
122.258
115.767
66.194
60.981
40.931
39.322
CO2Bn
200
150
100
50
0
ppm (t1)


7.176
7.157
7.138
6.657
6.617
6.394
6.372
6.354
6.332
5.992
5.223
4.978
4.948
4.928
4.898
4.877
4.856
4.838
4.819
2.550
2.258
2.006
OAc
CO2Bn
10.38
1.00
1.02
1.23
1.07
1.90
1.98
2.17
0.99
1.00
3.22
3.18
2.91
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)

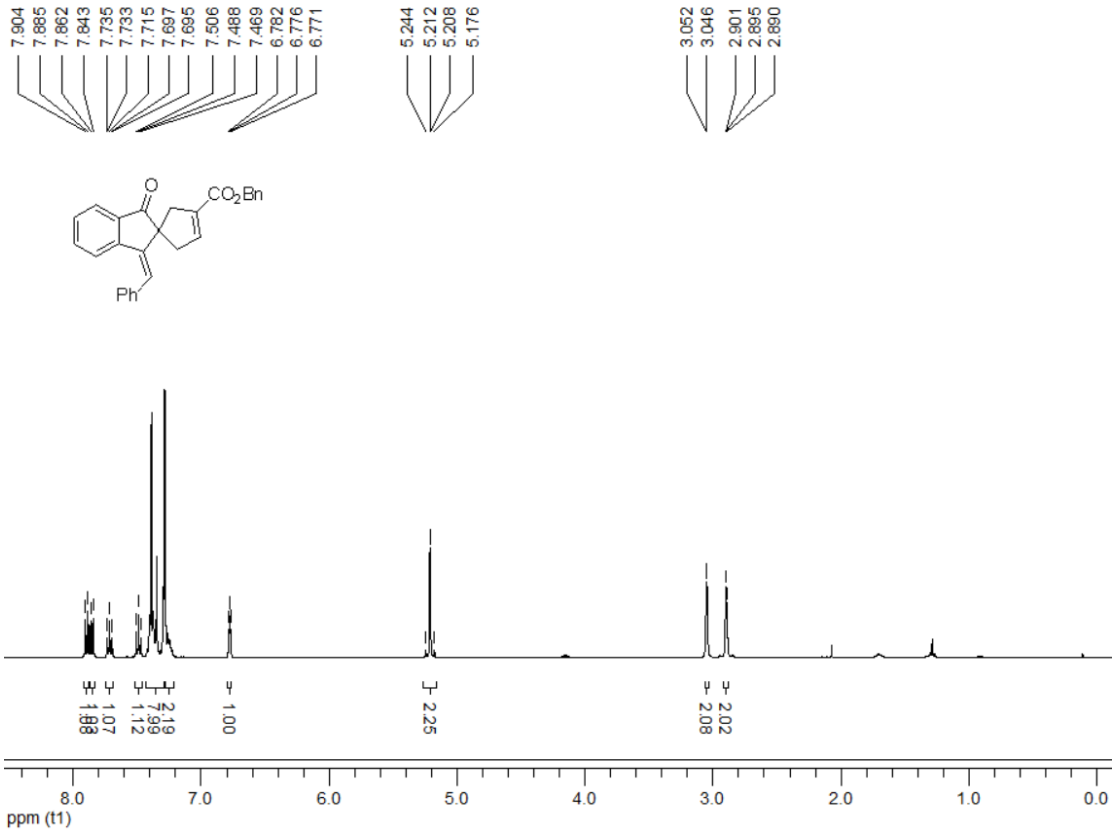

172.970
170.765
165.920
152.392
145.716
144.416
136.572
135.959
133.828
128.854
128.583
128.546
128.163
127.955
127.857
126.504
126.462
125.968
111.775
66.566
58.152
46.503
31.382
20.840
14.567
13.880
OAc
CO2Bn
200
150
100
50
0
ppm (t1)

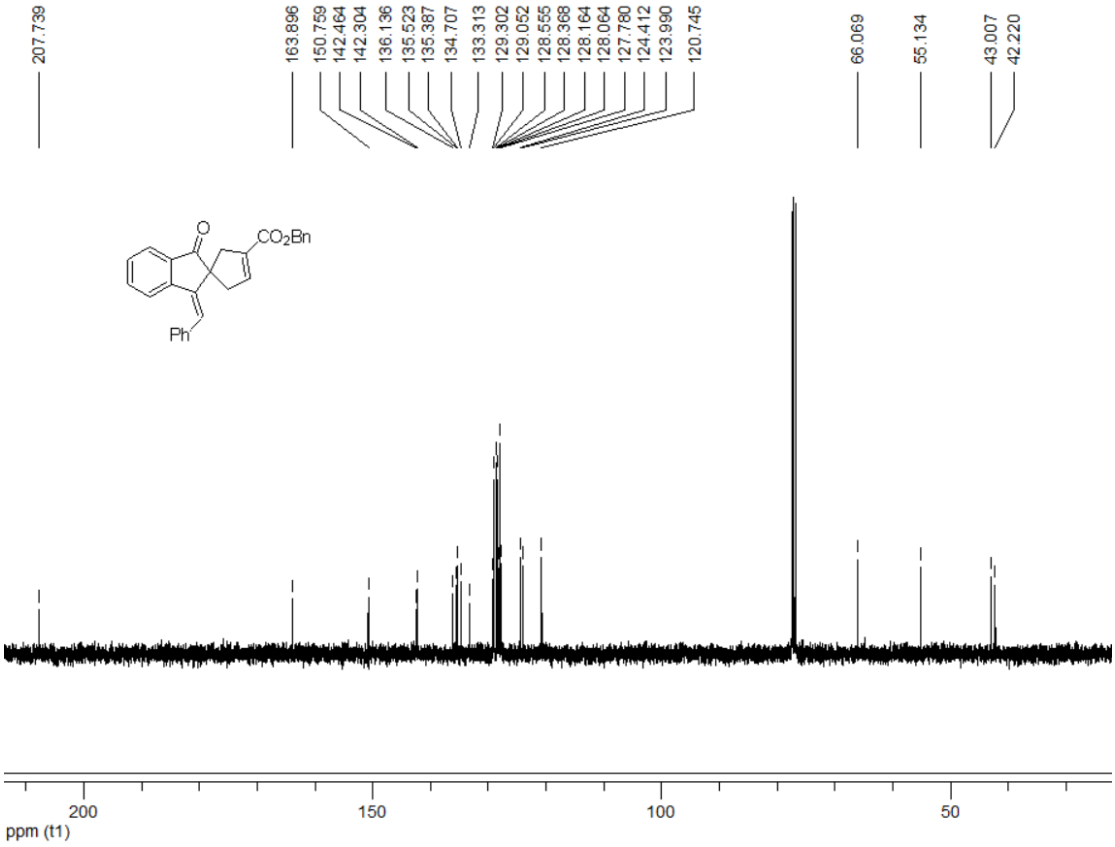
5


8.040
8.021
6.517
6.477
6.280
6.258
6.240
6.218
5.224
5.121
5.115
5.109
5.086
5.080
5.074
5.019
5.013
5.007
4.984
4.978
4.972
4.545
4.527
4.505
4.487
O
CO2Bn
1.92
1.87
1.87
1.41
1.00
1.00
1.97
1.90
1.01
1.04
1.04
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)


214.957
199.744
166.859
136.776
136.649
136.078
133.649
133.223
128.715
128.652
128.599
128.284
128.182
127.926
127.759
127.530
126.381
97.571
79.643
66.694
49.303
31.604
O
CO2Bn
200
150
100
50
0
ppm (t1)

6


7.904
7.885
7.862
7.843
7.735
7.733
7.715
7.697
7.695
7.506
7.488
7.469
6.782
6.776
6.771
5.244
5.212
5.208
5.176
3.052
3.046
2.901
2.895
2.890
O
CO2Bn
Ph
1.88
1.07
1.12
2.19
9.99
1.00
2.25
2.08
2.02
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (t1)


207.739
163.896
150.759
142.464
142.304
136.136
135.523
135.387
134.707
133.313
129.302
129.052
128.555
128.368
128.164
128.064
127.780
124.412
123.990
120.745
66.069
55.134
43.007
42.220
O
CO2Bn
Ph
200
150
100
50
ppm (t1)