Electronic Supplementary Material (ESI) for RSC Advances.

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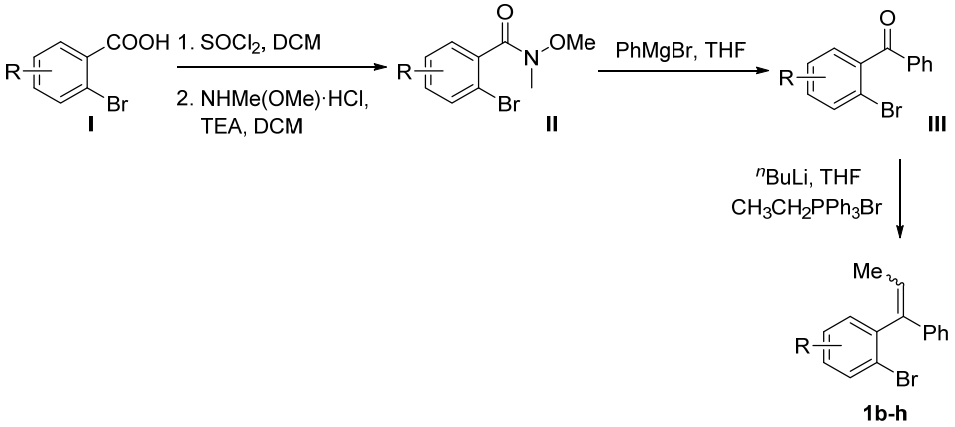
1. General Information

All commercially available chemical resources were used as received, unless otherwise stated. Reactions were monitored by thin layer chromatography (TLC) supplied by Yantai Jiangyou Silicon Material Company (China). Visualization was accomplished with UV light or basic aqueous potassium permangante ($KMnO_4$). Chromatography was achieved using forced flow (flash chromatography) of the indicated solvent system on 230-400 mesh silica gel (Silicycle flash F60) unless otherwise noted. ^1H NMR and ^{13}C NMR spectra were recorded on Varian mercury-400 and Bruker AM-400 spectrometers. Chemical shifts for ^1H and ^{13}C NMR spectra are expressed in parts per million (ppm, δ scale) downfield from $SiMe_4$ relative to the residual ^1H and ^{13}C signals of the solvent and TMS (TMS : δ 0.000 ppm (^1H NMR); $CDCl_3$: 77.06 ppm (^{13}C NMR)), and the multiplicities are presented as follows: s = singlet, d = doublet, t = triplet, m = multiplet, q = quartet. High-resolution mass spectra (HRMS) were acquired through the National Center for Organic Mass Spectrometry in Shanghai, Shanghai Institute of Organic Chemistry (CAS) and determined on a Waters Micromass GCT Premier spectrometer. The 1,1,2-trisubstituted alkenes **1a,1q**,[1,2] symmetrical alkynes **2a-h**,[3] were prepared according to the literatures. The alkynes **2i-k** were purchased and used directly from commercial sources.

2. Procedures for the synthesis 1b-1r

Typical procedure for the synthesis of substrate **1b-1r**:



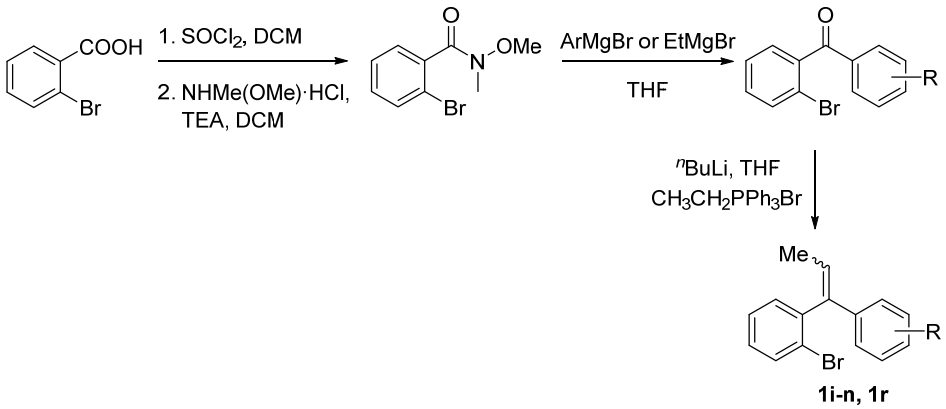
To a suspension of **I** (14.9 mmol) in CH_2Cl_2 (50 mL) was added $SOCl_2$ (5.4 mL, 74.3 mmol) portionwise at r.t. under Ar. Then it was heated to reflux and allowed to stir at this temperature for further 3 hours. The yellowish solution was cooled to r.t. and the solvent was removed under vacuo. To the mixture of NHMe(OMe)·HCl (2.19 g, 22.3 mmol) in CH_2Cl_2 (30 mL) was added TEA (6.2 mL, 44.6 mmol) dropwise, followed by the solution of acyl chloride in CH_2Cl_2 (10 mL) at 0 ºC under Ar. Then the mixture was stirred at r.t. overnight. The solid was dissolved by H_2O and diluted by CH_2Cl_2. The organic layer was separated and the aqueous layer was extracted with CH_2Cl_2. The combined organic phases were washed with brine, dried over anhydrous Na_2SO_4 and concentrated under vacuo. The residue was purified by flash chromatography on silica gel.

To a solution of **II** (3.9 mmol) in THF (10 mL) was added phenylmagnesium bromide (5.8 mmol) dropwise at 0 ºC under Ar. Then the mixture was allowed to stir at 0 ºC for 3 hours. Sat.NH_4Cl (aq) was added to quench the reaction and extracted with CH_2Cl_2. The combined organic phases were washed with brine, dried over anhydrous Na_2SO_4 and concentrated under

vacuo. The residue was purified by flash chromatography on silica gel.

To the stirred mixture of triphenyl phosphonium salt (1.39 g, 3.74 mmol) in THF (10 mL) was added ^{n}BuLi (1.5 mL, 2.5 N in hexane, 3.74 mmol) dropwise at 0 ºC under Ar. After stirring for 1 hour, a solution of **III** (2.9 mmol) in THF (5 mL) was added to the yellowish mixture dropwise at the same temperature. Then it was allowed to stir at r.t. overnight. H_2O and CH_2Cl_2 were added to the orange mixture above. The organic layer was separated and the aqueous layer was extracted with CH_2Cl_2. The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4 and concentrated under vacuo. The residue was purified by flash chromatography on silica gel.

Typical procedure for the synthesis of substrate **1i-1n**, **1r**:



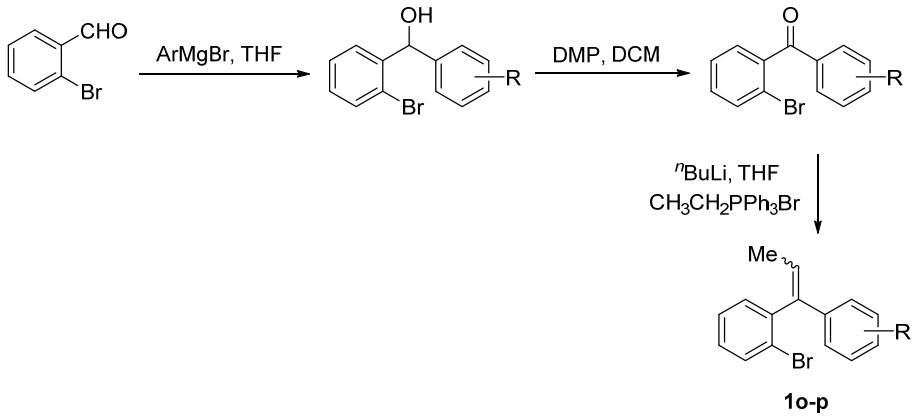
1i-n, 1r

To a suspension of 2-bromobenzoic acid (70 g, 0.35 mol) in CH_2Cl_2 (500 mL) was added $SOCl_2$ (127 mL, 1.75 mol) portionwise at r.t. under Ar. Then it was heated to reflux and allowed to stir at this temperature for further 3 hours. The yellowish solution was cooled to r.t. and the solvent was removed under vacuo. To the mixture of NHMe(OMe)·HCl (52 g, 0.525 mol) in CH_2Cl_2 (200 mL) was added TEA (146 mL, 1.05 mol) dropwise, followed by the solution of 2-bromobenzoyl chloride above in CH_2Cl_2 (100 mL) at 0 °C under Ar. Then the mixture was stirred at r.t. overnight. The solid was dissolved by H_2O and diluted with CH_2Cl_2. The organic layer was separated and the aqueous layer was extracted with CH_2Cl_2. The combined organic phases were washed with brine, dried over anhydrous Na_2SO_4 and concentrated under vacuo. The residue was purified by flash chromatography on silica gel to afford 2-bromo-*N*-methoxy-*N*-methylbenzamide.

To a solution of 2-bromo-N-methoxy-N-methylbenzamide (952 mg, 3.9 mmol) in THF (10 mL) was added arylmagnesium bromide (5.8 mmol) dropwise at 0 °C under Ar. Then the mixture was allowed to stir at 0 °C for 3 hours. Sat.NH_4Cl (aq) was added to quench the reaction and extracted with CH_2Cl_2. The combined organic phases were washed with brine, dried over anhydrous Na_2SO_4 and concentrated under vacuo. The residue was purified by flash chromatography on silica gel to afford aryl ketone.

To the stirred mixture of triphenyl phosphonium salt (1.39 g, 3.74 mmol) in THF (10 mL) was added ^{n}BuLi (1.5 mL, 2.5 N in hexane, 3.74 mmol) dropwise at 0 ºC under Ar. After 1 hour stirring at 0 ºC, a solution of aryl ketone (2.9 mmol) in THF (5 mL) was added to the yellowish mixture dropwise at the same temperature. Then it was allowed to stir at r.t. overnight. H_2O was added to quench the reaction and extracted with CH_2Cl_2. The combined organic layers were washed with brine, dried over anhydrous Na_2SO_4 and concentrated under vacuo. The residue was purified by flash chromatography on silica gel.

Typical procedure for the synthesis of substrate **1o-1p**:



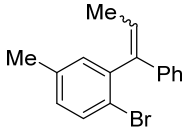
1o-p

To a solution of 2-bromobenzaldehyde (8.4 mL, 72 mmol) in THF (200 mL) was added arylmagnesium bromide (108 mmol) dropwise at 0 ºC under Ar. Then the mixture was allowed to stir at 0 ºC for 3 hours. Sat.NH_4Cl (aq) was added to quench the reaction and extracted with CH_2Cl_2. The combined organic phases were washed with brine, dried over anhydrous Na_2SO_4 and concentrated under vacuo. The residue was purified by flash chromatography on silica gel.

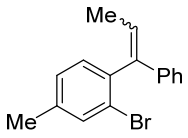
Dess-Martin Periodinane (14.3 g, 33.7 mmol) was added to the solution of arylalcohol (22.4 mmol) in CH_2Cl_2 (100 mL) portionwise at 0 ºC. Then the mixture was stirred at r.t. for 2 hours. The white solid was filtered through a celite pad and the filter cake was washed with CH_2Cl_2. The combined filtrates were washed with brine, dried over anhydrous Na_2SO_4 and concentrated under vacuo. The residue was purified by flash chromatography on silica gel.

To a stirred mixture of triphenyl phosphonium salt (1.39 g, 3.74 mmol) in THF (10 mL) was added *n*BuLi (1.5 mL, 2.5 N in hexane, 3.74 mmol) dropwise at 0 ºC under Ar. After 1 hour, a solution of aryl ketone (2.9 mmol) in THF (5 mL) was added to the yellowish mixture dropwise at the same temperature. Then it was allowed to stir at r.t. overnight. H_2O and CH_2Cl_2 were added to the orange mixture above. The organic layer was separated and the aqueous layer was extracted with CH_2Cl_2. The combined organic phases were washed with brine, dried over anhydrous Na_2SO_4 and concentrated under vacuo. The residue was purified by flash chromatography on silica gel.

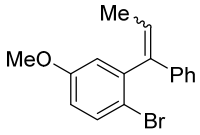
Characterization data of Compounds 1b-r



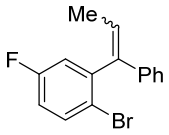
1-Bromo-4-methyl-2-(1-phenylprop-1-en-1-yl)benzene (1b) colorless oil R_f = 0.50 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 (d, *J* = 8.0 Hz, 0.7H), 7.39 (d, *J* = 8.0 Hz, 0.3H), 7.32-7.19 (m, 5H), 7.09-6.67 (m, 1.7H), 6.91 (d, *J* = 8.0 Hz, 0.3H), 6.31 (q, *J* =7.2 Hz, 0.7H), 5.82 (q, *J* = 7.2 Hz, 0.3H), 2.30 (s, 2.1H), 2.28 (s, 0.9H), 1.90 (d, *J* = 7.2 Hz, 0.9H), 1.62 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.58, 141.71, 141.23, 140.62, 140.38, 139.14, 137.30, 136.89, 132.69, 132.55, 132.48, 132.22, 129.68, 129.57, 129.24, 128.26, 127.82, 127.72, 126.82, 126.70, 126.19, 125.11, 120.90, 120.25, 20.94, 20.87, 15.55, 15.39 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{16}H_{15}Br^+$ 286.0357, found 286.0359.



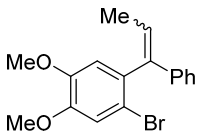
2-Bromo-4-methyl-1-(1-phenylprop-1-en-1-yl)benzene (1c) colorless oil R_f = 0.52 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 (s, 0.7H), 7.35 (s, 0.3H), 7.31-7.13 (m, 6H), 7.06-7.04 (m, 1H), 6.31 (q, *J* = 7.2 Hz, 0.7H), 5.82 (q, *J* = 7.2 Hz, 0.3H), 2.36 (s, 2H), 2.30 (s, 1H), 1.90 (d, *J* = 7.2 Hz, 0.9H), 1.62 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.00, 141.49, 141.11, 140.75, 139.29, 138.77, 138.47, 137.57, 133.44, 133.32, 131.49, 131.39, 129.68, 128.29, 128.25, 127.89, 127.81, 127.69, 126.78, 126.67, 126.17, 125.26, 124.03, 123.34, 20.86, 20.72, 15.55, 15.42 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{16}H_{15}Br^+$ 286.0357, found 286.0363.



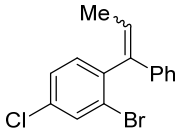
1-Bromo-4-methoxy-2-(1-phenylprop-1-en-1-yl)benzene (1d) colorless oil R_f = 0.15 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, *J* = 8.8 Hz, 0.7H), 7.40 (d, *J* = 8.8 Hz, 0.3H), 7.33-7.18 (m, 5H), 6.84-6.67 (m, 2H), 6.32 (q, *J* = 7.2 Hz, 0.7H), 5.85 (q, *J* = 7.2 Hz, 0.3H), 3.78 (s, 3H), 1.91 (d, *J* = 7.2 Hz, 0.9H), 1.64 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.96, 158.64, 145.74, 141.69, 141.57, 141.17, 140.24, 138.84, 133.52, 133.48, 129.68, 128.30, 127.87, 127.85, 126.90, 126.79, 126.13, 125.16, 117.41, 116.80, 114.78, 114.70, 114.19, 114.13, 55.51, 15.53, 15.38 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{16}H_{15}BrO^+$ 302.0306, found 302.0301.



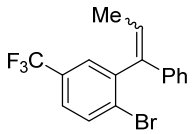
1-Bromo-4-fluoro-2-(1-phenylprop-1-en-1-yl)benzene (1e) colorless oil R_f = 0.35 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61-7.57 (m, 0.7H), 7.48-7.44 (m, 0.3H), 7.34-7.18 (m, 5H), 7.02-6.99 (m, 0.3H), 6.95-6.91 (m, 1.4H), 6.87-6.83 (m, 0.3H), 6.33 (q, *J* = 7.2 Hz, 0.7H), 5.86 (q, *J* = 7.2 Hz, 0.3H), 1.91 (d, *J* = 7.2 Hz, 0.9H), 1.63 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.93 (d, *J* = 246.0 Hz), 161.78 (d, *J* = 246.0 Hz), 146.58 (d, *J* = 7.5 Hz), 142.63 (d, *J* = 7.5 Hz), 140.92, 140.47, 139.84, 138.40, 134.14 (d, *J* = 8.2 Hz), 134.12 (d, *J* = 8.2 Hz), 129.64, 128.68, 128.38, 127.96, 127.10, 127.01, 126.12, 125.74, 118.68 (d, *J* = 22.3 Hz), 118.58 (d, *J* = 3.2 Hz), 118.56 (d, *J* = 22.3 Hz), 117.80 (d, *J* = 3.2 Hz), 115.99 (d, *J* = 22.3 Hz), 115.52 (d, *J* = 22.3 Hz), 15.50, 15.37 ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ -115.02, -115.71 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{15}H_{12}BrF^+$ 290.0106, found 290.0104.



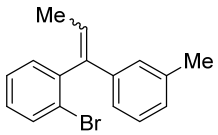
1-Bromo-4,5-dimethoxy-2-(1-phenylprop-1-en-1-yl)benzene (1f) colorless oil R_f = 0.10 (silica, petroleum ether, UV detection); major : minor = 1.5 : 1;^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 -7.20 (m, 5H), 7.11 (s, 0.6H), 7.00 (s, 0.4H), 6.77 (s, 0.4H), 6.65 (s, 0.6H), 6.33 (q, *J* = 7.2 Hz, 0.6H), 5.84 (q, *J* = 7.2 Hz, 0.4H), 3.91 (s, 1.8H), 3.86 (s, 1.2H), 3.84 (s, 1.2H), 3.82 (s, 1.8H), 1.91 (d, *J* = 7.2 Hz, 1.2H), 1.64 (d, *J* = 7.2 Hz, 1.8H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.61, 148.47, 148.45, 147.97, 141.46, 140.98, 140.51, 139.21, 137.19, 132.57, 129.60, 128.29, 127.84, 126.86, 126.73, 126.09, 125.42, 115.63, 115.39, 114.38, 114.30, 113.72, 113.62, 56.16, 56.10, 15.57, 15.43 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{17}H_{17}O_2Br^+$ 332.0412, found 332.0411.



2-Bromo-4-chloro-1-(1-phenylprop-1-en-1-yl)benzene (1g) colorless oil R_f = 0.31 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (s, 0.7H), 7.54 (s, 0.3H), 7.35-7.10 (m, 7H), 6.34 (q, *J* = 7.2 Hz, 0.7H), 5.84 (q, *J* = 7.2 Hz, 0.3H), 1.91 (d, *J* = 7.2 Hz, 0.9H), 1.62 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.44, 140.68, 140.28, 140.11, 139.27, 134.61, 133.63, 133.28, 132.61, 132.44, 132.42, 131.47, 129.63, 128.53, 128.37, 127.95, 127.80, 127.34, 127.06, 126.96, 126.12, 125.85, 124.76, 123.99, 15.55, 15.43 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{15}H_{12}ClBr^+$ 305.9802, found 305.9811.

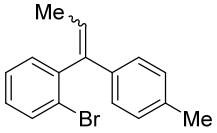


1-Bromo-2-(1-phenylprop-1-en-1-yl)-4-(trifluoromethyl)benzene (1h) colorless oil R_f = 0.53 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.8 Hz, 0.7H), 7.64 (d, *J* = 8.8 Hz, 0.3H), 7.54 (s, 0.3H), 7.46-7.45 (m, 1.3H), 7.38-7.23 (m, 3.4H), 7.20-7.16 (m, 2H), 6.38 (q, *J* = 7.2 Hz, 0.7H), 5.88 (q, *J* = 7.2 Hz, 0.3H), 1.94 (d, *J* = 7.2 Hz, 0.9H), 1.64 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.69, 141.72, 140.85, 140.25, 139.74, 138.15, 133.66, 133.62, 130.07 (q, *J* = 32.9 Hz), 129.67, 129.66 (q, *J* = 32.9 Hz), 129.18, 128.47, 128.40, 128.37, 128.33, 128.04, 127.71, 127.24, 127.14, 126.31, 126.14, 125.46 (q, *J* = 3.6 Hz), 125.05 (q, *J* = 3.6 Hz), 123.91 (q, *J* = 271.0 Hz), 123.86 (q, *J* = 271.0 Hz), 15.53, 15.42 ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.40 ppm; HRMS (DART) *m/z*: $[M+H]^+$ calcd for $C_{16}H_{12}BrF_3^+$ 340.0074, found 340.0067.

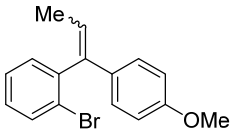


1-Bromo-2-(1-(*m*-tolyl)prop-1-en-1-yl)benzene (1i) colorless oil R_f = 0.45 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.0 Hz, 0.7H), 7.52 (d, *J* = 8.0 Hz, 0.3H), 7.35-7.08 (m, 4H), 7.03-6.96 (m, 3H), 6.31 (q, *J* = 7.2 Hz, 0.7H), 5.81 (q, *J* = 7.2 Hz, 0.3H), 2.31 (s, 0.9H), 2.29 (s, 2.1H), 1.90 (d, *J* = 7.2 Hz, 0.9H), 1.60 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.01, 141.69, 141.30, 140.82, 140.48, 138.99, 137.75, 137.35, 132.99, 132.88, 131.74, 131.71, 130.19, 128.63, 128.30, 128.17, 127.85,

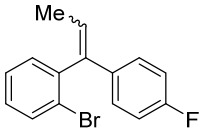
127.70, 127.54, 127.39, 127.05, 126.90, 126.78, 125.09, 124.32, 123.63, 123.45, 21.58, 21.54, 15.49, 15.43 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{16}H_{15}Br^+$ 286.0357, found 286.0359.



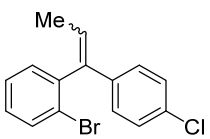
1-Bromo-2-(1-(*p*-tolyl)prop-1-en-1-yl)benzene (1j) colorless oil R_f = 0.42 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.0 Hz, 0.7H), 7.51 (d, *J* = 8.0 Hz, 0.3H), 7.35-7.32 (m, 0.7H), 7.28-7.24 (m, 1H), 7.20-7.16 (m, 1.3H), 7.11-7.05 (m, 4H), 6.29 (q, *J* = 7.2 Hz, 0.7H), 5.80 (q, *J* = 7.2 Hz, 0.3H), 2.33 (s, 0.9H), 2.30 (s, 2.1H), 1.91 (d, *J* = 7.2 Hz, 0.9H), 1.60 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.09, 141.56, 141.04, 140.86, 137.67, 136.56, 136.38, 136.11, 132.96, 132.87, 131.74, 131.68, 129.55, 129.01, 128.61, 128.57, 128.30, 127.40, 127.05, 126.01, 124.30, 124.24, 123.65, 21.27, 21.11, 15.44, 15.41 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{16}H_{15}Br^+$ 286.0357, found 286.0353.



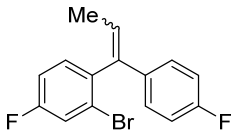
1-Bromo-2-(1-(4-methoxyphenyl)prop-1-en-1-yl)benzene (1k) colorless oil R_f = 0.21 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.0 Hz, 0.7H), 7.52 (d, *J* = 8.0 Hz, 0.3H), 7.34-7.32 (m, 0.7H), 7.27-7.25 (m, 1H), 7.21-7.16 (m, 1.3H), 7.13-7.11 (m, 2H), 6.86-6.79 (m, 2H), 6.22 (q, *J* = 7.2 Hz, 0.7H), 5.77 (q, *J* = 7.2 Hz, 0.3H), 3.80 (s, 0.9H), 3.77 (s, 2.1H), 1.91 (d, *J* = 7.2 Hz, 0.9H), 1.59 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.68, 158.32, 145.18, 141.27, 140.97, 140.68, 133.30, 133.01, 132.92, 131.74, 131.68, 131.58, 130.84, 128.62, 128.30, 127.43, 127.26, 127.07, 126.95, 124.29, 123.69, 123.31, 113.70, 113.27, 55.28, 55.23, 15.41, 15.40 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{16}H_{15}OBr^+$ 302.0306, found 302.0308.



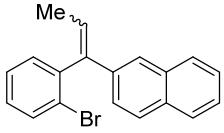
1-Bromo-2-(1-(4-fluorophenyl)prop-1-en-1-yl)benzene (1l) colorless oil R_f = 0.38 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.0 Hz, 0.7H), 7.52 (d, *J* = 8.0 Hz, 0.3H), 7.37-7.09 (m, 5H), 7.01-6.92 (m, 2H), 6.25 (q, *J* = 7.2 Hz, 0.7H), 5.83 (q, *J* = 7.2 Hz, 0.3H), 1.89 (d, *J* = 7.2 Hz, 0.9H), 1.61 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.98 (d, *J* = 245.0 Hz), 161.61 (d, *J* = 245.0 Hz), 144.70, 140.82, 140.51, 140.33, 136.73 (d, *J* = 3.2 Hz), 135.01 (d, *J* = 3.2 Hz), 133.10, 133.04, 131.72, 131.64, 131.34, 131.26, 128.85, 128.55, 128.01, 127.78, 127.70, 127.52, 127.18, 125.14, 124.23, 123.60, 115.10 (d, *J* = 21.4 Hz), 114.79 (d, *J* = 21.4 Hz), 15.49, 15.34 ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ -115.4, -116.0 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{15}H_{12}BrF^+$ 290.0106, found 290.0107.



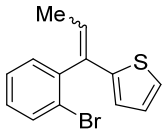
1-Bromo-2-(1-(4-chlorophenyl)prop-1-en-1-yl)benzene (1m) colorless oil R_f = 0.36 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8 Hz, 0.7H), 7.52 (d, *J* = 8 Hz, 0.3H), 7.37-7.25 (m, 2H), 7.23-7.10 (m, 5H), 6.31 (q, *J* = 7.2 Hz, 0.7H), 5.85 (q, *J* = 7.2 Hz, 0.3H), 1.90 (d, *J* = 7.2 Hz, 0.9H), 1.61 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.41, 140.73, 140.27, 140.17, 139.00, 137.47, 133.09, 133.04, 132.62, 132.53, 131.76, 131.64, 131.02, 128.94, 128.64, 128.50, 128.42, 128.08, 127.55, 127.43, 127.21, 125.89, 124.23, 123.60, 15.56, 15.39 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{15}H_{12}BrCl^+$ 305.9811, found 305.9804.



2-Bromo-4-fluoro-1-(1-(4-fluorophenyl)prop-1-en-1-yl)benzene (1n) colorless oil R_f = 0.39 (silica, petroleum ether, UV detection); major : minor = 2.3 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41-7.39 (m, 0.7H), 7.28-7.26 (m, 0.3H), 7.23-7.21 (m, 0.3H), 7.16-7.06 (m, 3.4H), 7.02-6.92 (m, 2.3H), 6.26 (q, *J* = 7.2 Hz, 0.7H), 5.82 (q, *J* = 7.2 Hz, 0.3H), 1.89 (d, *J* = 7.2 Hz, 0.9H), 1.60 (d, *J* = 7.2 Hz, 2.1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.01 (d, *J* = 245.0 Hz), 161.65 (d, *J* = 245.0 Hz), 161.59 (d, *J* = 249.0 Hz), 161.43 (d, *J* = 249.0 Hz), 140.85 (d, *J* = 3.5 Hz), 136.58 (d, *J* = 3.5 Hz), 136.47 (d, *J* = 3.6 Hz), 134.82 (d, *J* = 3.6 Hz), 139.85, 139.42, 132.43 (d, *J* = 8.2 Hz), 131.23 (d, *J* = 8.2 Hz), 128.47, 127.72, 127.64, 125.77, 124.33 (d, *J* = 9.5 Hz), 123.65 (d, *J* = 9.5 Hz), 120.24 (d, *J* = 24.1 Hz), 120.19 (d, *J* = 24.1 Hz), 115.17 (d, *J* = 21.2 Hz), 114.87 (d, *J* = 21.2 Hz), 114.85 (d, *J* = 20.8 Hz), 114.28 (d, *J* = 20.8 Hz), 15.51, 15.38 ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ -113.14, -113.79, -115.17, -115.81 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{15}H_{11}BrF_2^+$ 308.0012, found 308.0015.

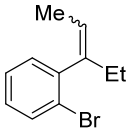


1-Bromo-2-(1-(*m*-tolyl)prop-1-en-1-yl)benzene (1o) colorless oil R_f = 0.79 (silica, petroleum ether, UV detection); major : minor = 1.5 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81-7.63 (m, 4H), 7.54-7.52 (m, 1H), 7.44-7.32 (m, 4H), 7.29-7.20 (m, 1.6H), 7.13-7.09 (m, 0.4H), 6.48 (q, *J* = 7.2 Hz, 0.6H), 5.93 (q, *J* = 7.2 Hz, 0.4H), 1.96 (d, *J* = 7.2 Hz, 1.2H), 1.66 (d, *J* = 7.2 Hz, 1.8H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.83, 141.70, 141.25, 140.64, 137.80, 136.64, 133.46, 133.14, 133.08, 133.01, 132.52, 132.30, 131.89, 131.81, 128.81, 128.54, 128.49, 128.44, 128.20, 128.05, 128.03, 127.86, 127.63, 127.51, 127.27, 127.14, 126.02, 125.95, 125.85, 125.64, 125.24, 124.41, 124.24, 123.72, 15.65, 15.52 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{19}H_{15}Br^+$ 322.0357, found 322.0369.



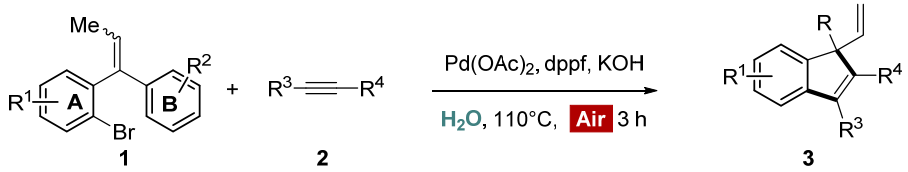
2-(1-(2-Bromophenyl)prop-1-en-1-yl)thiophene (1p) colorless oil R_f = 0.76 (silica, petroleum ether, UV detection); major : minor = 1.5 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8 Hz, 0.4H), 7.56 (d, *J* = 8 Hz, 0.6H), 7.36-7.28 (m, 2H), 7.23-7.09 (m, 2H), 6.98-6.96 (m, 0.6H), 6.87-

6.85 (m, 0.4H), 6.75 (d, J = 7.2 Hz, 0.6H), 6.44 (d, J = 7.2 Hz, 0.4H), 6.30 (q, J = 7.2 Hz, 0.4H), 5.72 (q, J = 7.2 Hz, 0.6H), 2.10 (d, J = 7.2 Hz, 1.8H), 1.58 (d, J = 7.2 Hz, 1.2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.44, 144.50, 141.73, 139.81, 135.75, 135.41, 132.92, 132.85, 131.41, 131.34, 129.05, 128.76, 127.46, 127.37, 127.24, 127.21, 127.19, 126.59, 125.36, 124.17, 124.09, 123.92, 123.54, 15.71, 15.02 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{13}H_{11}BrS^+$ 277.9765, found 277.9767.



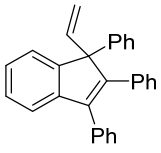
1-Bromo-2-(pent-2-en-3-yl)benzene (1r) colorless oil R_f = 0.85 (silica, petroleum ether, UV detection); major : minor = 4 : 1; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, J = 8.0 Hz, 0.8H), 7.53 (d, J = 8.0 Hz, 0.2H), 7.29-7.21 (m, 1H), 7.13-7.05 (m, 2H), 5.58 (q, J = 6.8 Hz, 0.8H), 5.37 (q, J = 6.8 Hz, 0.2H), 2.48-2.43 (m, 0.4H), 2.33-2.27 (m, 1.6H), 1.77 (d, J = 6.8 Hz, 0.6H), 1.40 (d, J = 6.8 Hz, 2.4H), 0.99 (t, J = 7.6 Hz, 2.4H) , 0.89 (t, J = 7.6 Hz, 0.6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.11, 143.11, 142.66, 142.27, 132.59, 132.56, 131.06, 130.61, 128.04, 127.91, 127.09, 126.87, 124.38, 123.21, 121.40, 30.95, 23.91, 14.50, 13.47, 12.50 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{11}H_{13}Br^+$ 224.0201, found 224.0208.

3. General procedure for the double Heck reaction of alkenes and alkynes



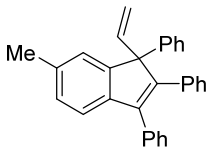
To the suspension of alkene **1** (0.30 mmol), alkyne **2** (0.36 mmol), $Pd(OAc)_2$ (3.4 mg, 0.015 mmol), dppf (16.6 mg, 0.03 mmol) and KOH (33.6 mg, 0.60 mmol) in a sealed tube was added H_2O (1.5 mL). The mixture was stirred at room temperature for 5 min and then reacted at 110 °C for further 3 h. After being cooled down to room temperature, H_2O was removed and the residue was purified by flash chromatography on silica gel.

Characterization data of Compounds 3aa-ra, 3ac-ai, 3aj+3aj', 3ak+3ak'

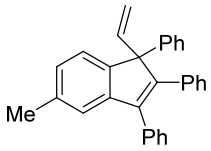


1,2,3-Triphenyl-1-vinyl-1*H*-indene (3aa) colorless oil (102 mg, 92% yield); R_f = 0.31 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41-7.33 (m, 7H), 7.31-7.25 (m, 3H), 7.23-7.21 (m, 1H), 7.20-7.01 (m, 6H), 6.89 (d, J = 7.2 Hz, 2H), 6.42 (dd, J = 17.2, 10.4 Hz, 1H), 5.20 (d, J = 17.2 Hz, 1H), 5.15 (d, J = 10.4 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.65, 148.43, 143.85, 142.29, 140.42, 138.16, 135.65, 135.43, 129.84, 129.68, 128.72, 128.56,

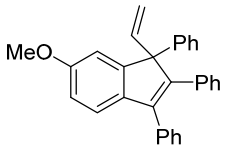
127.70, 127.40, 126.98, 126.94, 126.84, 126.77, 125.95, 124.99, 121.37, 115.25, 66.38 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{29}H_{22}^+$ 370.1715, found 370.1722.



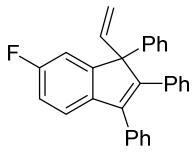
6-Methyl-1,2,3-triphenyl-1-vinyl-1*H*-indene (3ba) colorless oil (94 mg, 82% yield); R_f = 0.19 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40-7.33 (m, 6H), 7.30-7.23 (m, 5H), 7.06-6.99 (m, 4H), 6.91-6.86 (m, 3H), 6.42 (dd, *J* = 17.2, 10.4 Hz, 1H), 5.20 (d, *J* = 17.2 Hz, 1H), 5.20 (d, *J* = 10.4 Hz, 1H), 2.32 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.92, 147.45, 142.57, 141.24, 140.37, 138.36, 135.80, 135.78, 135.65, 129.83, 129.66, 128.70, 128.52, 127.66, 127.62, 127.32, 127.04, 126.77, 126.68, 125.70, 121.07, 115.16, 66.16, 21.65 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{30}H_{24}^+$ 384.1878, found 384.1876.



5-Methyl-1,2,3-triphenyl-1-vinyl-1*H*-indene (3ca) colorless oil (96 mg, 84% yield); R_f = 0.44 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40-7.32 (m, 7H), 7.29-7.21 (m, 3H), 7.15 (s, 1H), 7.06-6.96 (m, 5H), 6.89-6.87 (m, 2H), 6.41 (dd, *J* = 17.2, 10.4 Hz, 1H), 5.20 (d, *J* = 17.2 Hz, 1H), 5.14 (d, *J* = 10.4 Hz, 1H), 2.34 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.67, 147.96, 144.00, 142.57, 140.48, 138.37, 136.54, 135.74, 135.60, 129.85, 129.71, 128.69, 128.57, 127.67, 127.35, 126.96, 126.87, 126.81, 126.67, 124.66, 122.01, 115.13, 66.04, 21.58 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{30}H_{24}^+$ 384.1878, found 384.1877.

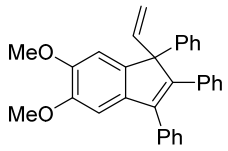


6-Methoxy-1,2,3-triphenyl-1-vinyl-1*H*-indene (3da) colorless oil (103 mg, 86% yield); R_f = 0.60 (silica, petroleum ether / ethyl acetate = 20:1 v/v, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40-7.31 (m, 6H), 7.30-7.22 (m, 5H), 7.05-6.99 (m, 3H), 6.88-6.86 (m, 2H), 6.79 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.66 (d, *J* = 2.4 Hz, 1H), 6.41 (dd, *J* = 17.2, 10.4 Hz, 1H), 5.21 (d, *J* = 17.2 Hz, 1H), 5.16 (d, *J* = 10.4 Hz, 1H), 3.74 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.51, 152.43, 146.49, 142.56, 140.01, 138.32, 136.83, 135.81, 135.68, 129.78, 129.64, 128.74, 128.54, 127.66, 127.34, 126.98, 126.75, 126.67, 121.93, 115.28, 112.05, 111.51, 66.20, 55.54 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{30}H_{24}O^+$ 400.1827, found 400.1819.

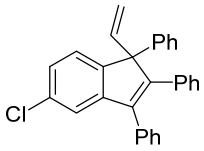


6-Fluoro-1,2,3-triphenyl-1-vinyl-1*H*-inden (3ea) colorless oil (90 mg, 77% yield); R_f = 0.31 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.32 (m, 7H), 7.30-7.26 (m, 4H), 7.10-7.01 (m, 3H), 7.96-7.91 (m, 1H), 6.88-6.86 (m, 2H), 6.80 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.39 (dd, *J* = 17.6, 10.4 Hz, 1H), 5.20 (d, *J* = 17.6 Hz, 1H), 5.17 (d, *J* =10.4 Hz, 1H) ppm;

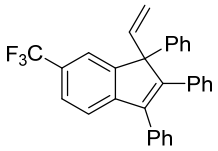
^{13}C NMR (100 MHz, $CDCl_3$) δ 161.72 (d, *J* = 244.0 Hz), 152.70 (d, *J* = 8.0 Hz), 148.17 (d, *J* = 4.0 Hz), 141.76, 139.71, 139.54, 137.76, 135.40, 135.21, 129.74, 129.60, 128.87, 128.65, 127.76, 127.56, 127.05, 127.02, 126.89, 122.21 (d, *J* = 8.0 Hz), 115.50, 113.79 (d, *J* = 23.0 Hz), 112.60 (d, *J* = 23.0 Hz), 66.27 ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ -115.90 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{29}H_{21}F^+$ 388.1627, found 388.1626.



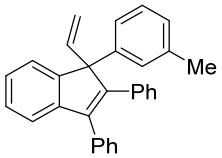
5,6-Dimethoxy-1,2,3-triphenyl-1-vinyl-1*H*-indene (3fa) colorless oil (99 mg, 77% yield); R_f = 0.20 (silica, petroleum ether / ethyl acetate = 20:1 v/v, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41-7.35 (m, 4H), 7.33-7.23 (m, 6H), 7.06-6.99 (m, 3H), 6.89-6.83 (m, 3H), 6.64 (s, 1H), 6.42 (dd, *J* = 17.2, 10.8 Hz, 1H), 5.21-5.13 (m, 2H), 3.84 (s, 3H), 3.80 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.47, 147.99, 147.58, 143.35, 142.55, 140.07, 138.69, 136.37, 135.80, 135.67, 129.73, 129.59, 128.72, 128.64, 127.65, 127.38, 126.94, 126.70, 126.67, 115.06, 108.59, 104.69, 66.21, 56.32, 56.15 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{31}H_{26}O_2^+$ 430.1933, found 430.1929.



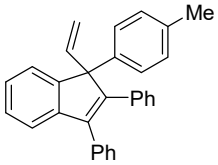
5-Chloro-1,2,3-triphenyl-1-vinyl-1*H*-indene (3ga) colorless oil (98 mg, 81% yield); R_f = 0.41 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38-7.37 (m, 4H), 7.33-7.29 (m, 6H), 7.27-7.26 (m, 1H), 7.16-7.13 (m, 1H), 7.11-7.07 (m, 1H), 7.05-6.99 (m, 3H), 6.87 (d, *J* = 6.8 Hz, 2H), 6.39 (dd, *J* = 17.6, 10.4 Hz, 1H), 5.17 (d, *J* = 17.6 Hz, 1H), 5.16 (d, *J* =10.4 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.13, 148.93, 145.77, 141.62, 139.53, 137.74, 135.19, 134.78, 132.96, 129.79, 129.55, 128.85, 128.75, 127.79, 127.71, 127.27, 127.04, 126.89, 125.94, 125.87, 121.53, 115.50, 66.10 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{29}H_{21}Cl^+$ 404.1332, found 404.1340.



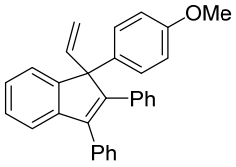
1,2,3-Triphenyl-6-(trifluoromethyl)-1-vinyl-1*H*-indene (3ha) white solid (115 mg, 88% yield); R_f = 0.19 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53-7.51 (m, 1H), 7.44-7.24 (m, 12H), 7.12-7.02 (m, 3H), 6.89-6.88 (m, 2H), 6.42 (dd, *J* = 16.8, 10.8 Hz, 1H), 5.19-5.14 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.38, 151.03, 147.45, 140.91, 139.52, 137.41, 135.00, 134.71, 129.81, 129.57, 128.98, 128.77, 127.84, 127.83 (q, *J* = 31.8 Hz) 127.78, 127.47, 127.26, 126.95, 124.60 (q, *J* = 270.7 Hz), 124.42 (q, *J* = 3.8 Hz), 121.64 (q, *J* = 3.8 Hz), 121.42, 115.72, 66.55 ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ -61.41 ppm; HRMS (DART) *m/z*: $[M+H]^+$ calcd for $C_{30}H_{22}F_3^+$ 439.1668, found 439.1665.



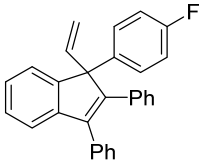
2,3-Diphenyl-1-(m-tolyl)-1-vinyl-1*H*-indene (3ia) colorless oil (72 mg, 63% yield); R_f = 0.34 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42-7.31 (m, 6H), 7.26-7.22(m, 1H), 7.19-7.14 (m, 4H), 7.10-7.01 (m, 5H), 6.91-6.89 (m, 2H), 6.40 (dd, *J* = 17.2, 10.4 Hz, 1H), 5.17 (d, *J* = 17.2 Hz, 1H), 5.13 (d, *J* = 10.4 Hz, 1H), 2.30 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.67, 148.43, 143.86, 142.16, 140.33, 138.39, 138.21, 135.73, 135.53, 129.90, 129.71, 128.56, 127.69, 127.60, 127.57, 127.38, 126.90, 126.77, 125.91, 124.97, 124.03, 121.33, 115.04, 66.34, 21.74 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{30}H_{24}^+$ 384.1878, found 384.1882.



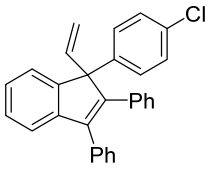
2,3-Diphenyl-1-(*p*-tolyl)-1-vinyl-1*H*-indene (3ja) colorless oil (100 mg, 87% yield); R_f = 0.25 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41-7.29 (m, 6H), 7.23-7.15 (m, 4H), 7.09-7.01 (m, 6H), 6.92-6.90 (m, 2H), 6.41 (dd, *J* = 17.2, 10.4 Hz, 1H), 5.18 (d, *J* = 17.2 Hz, 1H), 5.13 (d, *J* = 10.4 Hz, 1H), 2.32 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.83, 148.48, 143.81, 140.28, 139.13, 138.36, 136.28, 135.75, 135.51, 129.86, 129.70, 129.45, 128.54, 127.68, 127.36, 126.89, 126.85, 126.75, 125.93, 124.89, 121.30, 115.06, 66.10, 21.14 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{30}H_{24}^+$ 384.1878, found 384.1870.



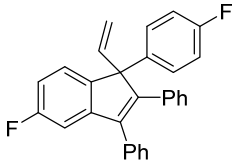
1-(4-Methoxyphenyl)-2,3-diphenyl-1-vinyl-1*H*-indene (3ka) colorless oil (111 mg, 93% yield); R_f = 0.52 (silica, petroleum ether / ethyl acetate = 20:1 v/v, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40-7.28 (m, 6H), 7.25-7.22 (m, 3H), 7.19-7.16 (m, 1H), 7.10-7.01 (m, 4H), 6.90 (d, *J* = 6.8 Hz, 2H), 6.82 (d, *J* = 8.4 Hz, 2H), 6.39 (dd, *J* = 17.2, 10.4 Hz, 1H), 5.19 (d, *J* = 17.2 Hz, 1H), 5.12 (d, *J* = 10.4 Hz, 1H), 3.78 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.40, 150.89, 148.61, 143.75, 140.13, 138.42, 135.76, 135.46, 133.98, 129.86, 129.68, 128.52, 128.11, 127.69, 127.35, 126.91, 126.76, 125.92, 124.88, 121.31, 115.04, 114.06, 65.81, 55.23 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{30}H_{24}O^+$ 400.1827, found 400.1825.



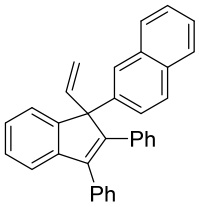
1-(4-Fluorophenyl)-2,3-diphenyl-1-vinyl-1*H*-indene (3la) colorless oil (101 mg, 87% yield); R_f = 0.38 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.32 (m, 6H), 7.30-7.25 (m, 3H), 7.21-7.18 (m, 1H), 7.09-7.02 (m, 4H), 6.96 (t, *J* = 8.4 Hz, 2H), 6.89-6.87 (m, 2H), 6.39 (dd, *J* = 17.2, 10.4 Hz, 1H), 5.20 (d, *J* = 17.2 Hz, 1H), 5.15 (d, *J* = 10.4 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.79 (d, *J* = 242.0 Hz), 150.47, 148.35, 143.75, 138.02, 137.89 (d, *J* = 3.0 Hz), 135.38 (d, *J* = 28.0 Hz), 129.80, 129.64, 128.68, 128.61, 128.57, 127.77, 127.48, 127.03 (d, *J* = 6.0 Hz) , 126.05, 124.91, 121.49, 115.62, 115.49, 115.41, 65.82 ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ -116.25 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{29}H_{21}F^+$ 388.1627, found 388.1617.



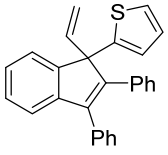
1-(4-Chlorophenyl)-2,3-diphenyl-1-vinyl-1*H*-indene (3ma) colorless oil (96 mg, 79% yield); R_f = 0.54 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.28 (m, 6H), 7.26-7.23 (m, 5H), 7.21-7.18 (m, 1H), 7.10-7.03 (m, 4H), 6.89 (d, *J* = 6.8 Hz, 2H), 6.38 (dd, *J* = 17.6, 10.8 Hz, 1H), 5.23-5.15 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) 150.19, 148.15, 143.79, 140.97, 140.68, 137.72, 135.41, 135.18, 132.56, 129.79, 129.63, 128.86, 128.59, 128.48, 127.82, 127.52, 127.11, 127.08, 126.10, 124.92, 121.54, 115.71, 65.89 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{29}H_{21}Cl^+$ 404.1332, found 404.1335.



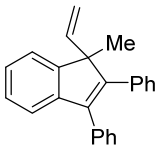
5-Fluoro-1-(4-fluorophenyl)-2,3-diphenyl-1-vinyl-1*H*-indene (3na) colorless oil (105 mg, 86% yield); R_f = 0.52 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.31 (m, 5H), 7.28-7.24 (m, 2H), 7.13-7.09 (m, 1H), 7.07-7.03 (m, 3H), 6.99-6.95 (m, 3H), 6.91-6.86 (m, 3H), 6.36 (dd, *J* = 17.4, 10.4 Hz, 1H), 5.19 (d, *J* = 17.4 Hz, 1H), 5.17 (d, *J* = 10.4 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.60 (d, *J* = 242.0 Hz), 161.87 (d, *J* = 244.0 Hz), 150.34, 145.85 (d, *J* = 9.0 Hz), 145.78, 139.69 (d, *J* = 2.0 Hz), 137.85, 137.51 (d, *J* = 4.0 Hz), 135.17, 134.67, 129.72, 129.48, 128.72, 128.60, 128.52, 127.85, 127.55 (d, *J* = 39.0 Hz), 125.80 (d, *J* = 8.0 Hz), 115.73, 115.56 (d, *J* = 8.0 Hz), 112.71 (d, *J* = 23.0 Hz), 108.63 (d, *J* = 24.0 Hz), 65.34 ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ -115.72, -115.93 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{29}H_{20}F_2^+$ 406.1533, found 406.1527.



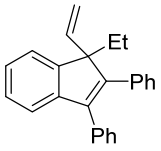
2-(2,3-Diphenyl-1-vinyl-1*H*-inden-1-yl)naphthalene (3oa) colorless oil (98 mg, 78% yield); R_f = 0.45 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (s, 1H), 7.85 (d, *J* = 7.6 Hz, 1H), 7.79 (d, *J* = 7.6 Hz, 1H), 7.67 (d, *J* = 8.4 Hz, 1H), 7.51 -7.43 (m, 4H), 7.41-7.32 (m, 4H), 7.28-7.24 (m, 1H), 7.20-7.14 (m, 2H), 7.09-7.03 (m, 2H), 6.98 (t, *J* = 7.2 Hz, 2H), 6.88 (d, *J* = 7.2 Hz, 2H), 6.54 (dd, *J* = 17.2, 10.4 Hz, 1H), 5.28-5.21 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) 150.25, 148.40, 144.03, 140.73, 140.07, 137.95, 135.66, 135.41, 133.78, 132.53, 129.78, 129.73, 128.59, 128.51, 127.95, 127.78, 127.60, 127.47, 127.01, 126.99, 126.06, 126.00, 125.85, 125.73, 125.30, 125.28, 121.45, 115.48, 66.49 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{33}H_{24}^+$ 420.1878, found 420.1869.



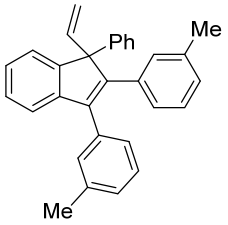
2-(2,3-Diphenyl-1-vinyl-1*H*-inden-1-yl)thiophene (3pa) colorless oil (91 mg, 81% yield); R_f = 0.29 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.32 (m, 5H), 7.30-7.23 (m, 4H), 7.14-7.07 (m, 4H), 7.02-7.00(m, 2H), 6.95-6.94 (m, 1H), 6.92-6.90 (m, 1H), 6.41 (dd, *J* = 17.2, 10.4 Hz, 1H), 5.27 (d, *J* = 17.2 Hz, 1H), 5.18 (d, *J* = 10.4 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) 150.04, 148.32, 146.07, 143.25, 139.95, 138.26, 135.39, 135.11, 130.04, 129.62, 128.50, 127.71, 127.45, 127.35, 127.10, 126.65, 126.08, 125.20, 124.75, 124.18, 121.43, 115.54, 63.70 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{27}H_{20}S^+$ 376.1286, found 376.1295.



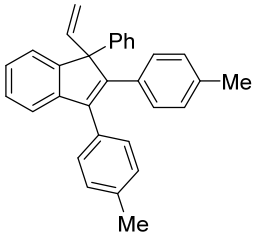
1-Methyl-2,3-diphenyl-1-vinyl-1*H*-indene (3qa) white solid (65 mg, 71% yield); R_f = 0.44 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35-7.30 (m, 6H), 7.27-7.21 (m, 5H), 7.18-7.16 (m, 3H), 5.82 (dd, *J* = 17.6, 10.4 Hz, 1H), 5.34 (d, *J* = 17.6 Hz, 1H), 5.25 (d, *J* = 10.4 Hz, 1H), 1.48 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.92, 150.19, 143.61, 141.50, 139.31, 136.11, 135.26, 129.72, 129.60, 128.35, 127.74, 127.17, 126.96, 126.94, 125.78, 122.98, 120.73, 113.67, 57.84, 19.54 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{24}H_{20}^+$ 308.1565, found 308.1577.



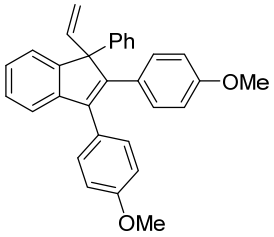
1-Ethyl-2,3-diphenyl-1-vinyl-1*H*-indene (3ra) colorless oil (71 mg, 74% yield); R_f = 0.31 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.30 (m, 5H), 7.28-7.23 (m, 6H), 7.19-7.16 (m, 3H), 5.89 (dd, *J* = 17.6, 10.4 Hz, 1H), 5.32 (d, *J* = 17.6 Hz, 1H), 5.22 (d, *J* = 10.4 Hz, 1H), 2.22-2.13 (m, 1H), 2.00-1.91 (m, 1H), 0.48 (t, *J* = 7.2 Hz, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.86, 147.62, 144.86, 141.97, 141.18, 136.22, 135.42, 129.66, 129.61, 128.37, 127.80, 127.16, 126.90, 126.83, 125.70, 123.04, 120.55, 113.50, 62.25, 25.64, 7.77 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{25}H_{22}^+$ 322.1722, found 322.1717.



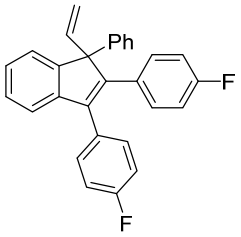
1-Phenyl-2,3-di-*p*-tolyl-1-vinyl-1*H*-indene (3ac) colorless oil (92 mg, 77% yield); R_f = 0.19 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35-7.32 (m, 3H), 7.29-7.22 (m, 6H), 7.18-7.07 (m, 4H), 6.93-6.87 (m, 2H), 6.71-6.69 (m, 2H), 6.44 (dd, *J* = 17.2, 10.8 Hz, 1H), 5.19 (d, *J* =17.2 Hz, 1H), 5.14 (d, *J* = 10.8 Hz, 1H), 2.33 (s, 3H), 2.05 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.65, 148.29, 144.11, 142.48, 140.37, 138.36, 138.00, 136.89, 135.49, 130.54, 130.12, 128.65, 128.40, 128.09, 127.62, 127.47, 126.99, 126.94, 126.77, 126.69, 125.81, 124.92, 121.38, 115.10, 66.31, 21.53, 21.44 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{31}H_{26}^+$ 398.2035, found 398.2022



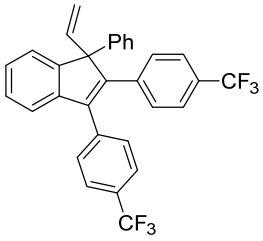
1-Phenyl-2,3-di-*p*-tolyl-1-vinyl-1*H*-indene (3ad) colorless oil (87 mg, 73% yield); R_f = 0.23 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35-7.29 (m, 6H), 7.25-7.13 (m, 6H), 7.08-7.06 (m, 1H), 6.85-6.79 (m, 4H), 6.42 (dd, *J* = 17.6, 10.4 Hz, 1H), 5.18 (d, *J* =17.6 Hz, 1H), 5.12 (d, *J* = 10.4 Hz, 1H), 2.37 (s, 3H), 2.20 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.59, 147.86, 144.11, 142.60, 139.87, 138.38, 136.95, 136.51, 132.72, 132.60, 129.66, 129.52, 129.31, 128.69, 128.46, 126.92, 126.75, 126.67, 125.70, 124.87, 121.26, 115.11, 66.22, 21.42, 21.20 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{31}H_{26}^+$ 398.2035, found 398.2041.



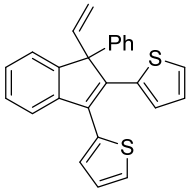
2,3-Bis(4-methoxyphenyl)-1-phenyl-1-vinyl-1*H*-indene (3ae) colorless oil (94 mg, 73% yield); R_f = 0.36 (silica, petroleum ether / ethyl acetate = 20:1 v/v, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35-7.33 (m, 5H), 7.29-7.21 (m, 4H), 7.16-7.12 (m, 1H), 7.07-7.06 (m, 1H), 6.92 (d, *J* = 8.8 Hz, 2H), 6.85 (d, *J* = 8.8 Hz, 2H), 6.58 (d, *J* = 8.8 Hz, 2H), 6.42 (dd, *J* = 17.6, 10.4 Hz, 1H), 5.18 (d, *J* = 17.6 Hz, 1H), 5.13 (d, *J* = 10.4 Hz, 1H), 3.84 (s, 3H), 3.69 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.79, 158.29, 150.55, 147.34, 144.20, 142.68, 138.96, 138.51, 131.00, 130.88, 128.71, 128.17, 127.95, 126.92, 126.76, 126.68, 125.60, 124.85, 121.09, 115.09, 114.07, 113.18, 66.17, 55.26, 55.05 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{31}H_{26}O_2^+$ 430.1933, found 430.1940.



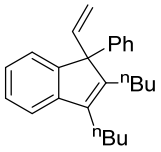
2,3-Bis(4-fluorophenyl)-1-phenyl-1-vinyl-1*H*-indene (3af) colorless oil (96 mg, 79% yield); R_f = 0.41 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36-7.29 (m, 5H), 7.28-7.17 (m, 5H), 7.10-7.04 (m, 3H), 6.85-6.81 (m, 2H), 6.76-6.72 (m, 2H), 6.37 (dd, *J* = 17.2, 10.4 Hz, 1H), 5.18 (d, *J* = 17.2 Hz, 1H), 5.16 (d, *J* = 10.4 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.17 (d, *J* = 246.0 Hz), 161.76 (d, *J* = 246.0 Hz), 150.54, 147.79, 143.50, 141.83, 139.47, 137.88, 131.53, 131.45 (d, *J* = 8.0 Hz), 131.33 (d, *J* = 8.0 Hz), 130.07, 130.04, 128.81, 126.99, 126.96, 126.19, 125.07, 121.17, 115.73 (d, *J* = 22.0 Hz), 115.45, 114.87 (d, *J* = 22.0 Hz), 66.39 ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ -114.13, -114.48 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{29}H_{20}F_2^+$ 406.1533, found 406.1527.



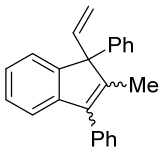
1-Phenyl-2,3-bis(4-(trifluoromethyl)phenyl)-1-vinyl-1*H*-indene (3ag) colorless oil (100 mg, 66% yield); R_f = 0.47 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 8.0 Hz, 2H), 7.50 (d, *J* = 8.0 Hz, 2H), 7.33-7.24 (m, 9H), 7.25-7.22 (m, 1H), 7.13 (d, *J* = 7.2 Hz, 1H), 6.95 (d, *J* = 7.2 Hz, 2H), 6.37 (dd, *J* = 17.2, 10.8 Hz, 1H), 5.21-5.17 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.69, 148.34, 142.78, 141.27, 140.60, 138.93, 138.69, 137.31, 130.52, 130.38, 130.06, 129.96, 129.93, 129.73, 129.65, 129.54, 129.41, 129.33, 128.98, 128.84, 128.72, 128.34, 128.21, 127.66, 127.64, 127.22, 126.95, 126.85, 125.78 (q, *J* = 3.8 Hz), 124.91 (q, *J* = 3.8 Hz),124.13 (q, *J* = 271 Hz), 124.04 (q, *J* = 271 Hz), 121.43, 115.90, 66.66 ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.56, -62.75 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{31}H_{20}F_6^+$ 506.1469, found 506.1461.



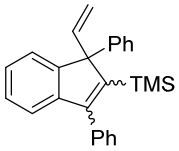
2,2'-(1-Phenyl-1-vinyl-1*H*-indene-2,3-diyl)dithiophene (3ah) colorless oil (64 mg, 56% yield); R_f = 0.48 (silica, petroleum ether / ethyl acetate = 20:1 v/v, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (dd, *J* = 4.8 Hz, 1.2 Hz, 2H), 7.35-7.14 (m, 9H), 7.11-7.027 (m, 2H), 6.79-6.77 (m, 1H), 6.67-6.66 (m, 1H), 6.59 (dd, *J* = 17.2, 10.4 Hz, 1H), 5.18 (d, *J* = 10.4 Hz, 1H), 5.12 (d, *J* = 17.2 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.74, 144.56, 143.77, 141.83, 138.35, 136.98, 135.37, 132.71, 128.79, 128.41, 128.32, 127.68, 127.21, 127.05, 127.01, 126.96, 126.45, 126.34, 126.17, 124.55, 121.38, 115.90, 66.47 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{25}H_{18}S_2^+$ 382.0850, found 382.0840.



2,3-Dibutyl-1-phenyl-1-vinyl-1*H*-indene (3ai) colorless oil (83 mg, 84% yield); R_f = 0.38 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28-7.16 (m, 5H), 7.13-7.11 (m, 2H), 7.08-7.02 (m, 2H), 6.42 (dd, *J* = 17.6, 10.4 Hz, 1H), 5.06 (d, *J* = 10.4 Hz, 1H), 5.01 (d, *J* = 17.6 Hz, 1H), 2.55 (t, 7.6 Hz, 2H), 2.30-2.17 (m, 2H), 1.67-1.59 (m, 2H), 1.49-1.41 (m, 2H), 1.29-1.22 (m, 4H), 0.97 (t, 7.2 Hz, 3H), 0.78 (t, 7.2 Hz, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.24, 148.88, 145.03, 142.46, 139.14, 137.95, 128.29, 127.28, 126.57, 126.49, 124.55, 124.06, 119.16, 113.63, 66.00, 32.02, 31.17, 26.87, 25.62, 23.36, 23.19, 14.14, 13.81 ppm; HRMS (DART) *m/z*: $[M+H]^+$ calcd for $C_{25}H_{31}^+$ 331.2420, found 331.2418.



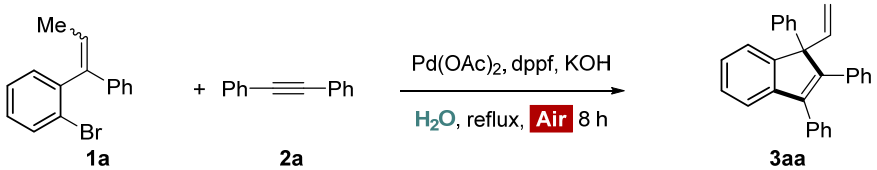
2-Methyl-1,3-diphenyl-1-vinyl-1*H*-indene and **3-methyl-1,2-diphenyl-1-vinyl-1*H*-indene (3aj + 3aj')** colorless oil (75 mg, 81% yield); R_f = 0.19 (silica, petroleum ether, UV detection); major : minor = 5.3 : 1, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48-7.46 (m, 0.64H), 7.41-7.39 (m, 1H), 7.32-7.11 (m, 10H), 7.05-7.01 (m, 2.36H), 6.46 (dd, *J* = 17.2, 10.4 Hz, 0.16H), 6.34 (dd, *J* = 17.2, 10.4 Hz, 0.84H), 5.19-5.16 (m, 0.16H), 5.12-5.06 (m, 1.84H), 2.22 (s, 2.52H), 1.87 (s, 0.48H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.26, 150.19, 147.71, 146.66, 145.04, 144.33, 142.19, 142.11, 138.65, 138.57, 138.44, 136.28, 135.20, 135.08, 129.41, 129.30, 128.59, 128.45, 127.93, 127.29, 127.18, 126.99, 126.89, 126.75, 126.70, 126.59, 125.70, 124.91, 124.62, 124.41, 120.20, 119.96, 114.72, 114.50, 66.38, 65.90, 12.20, 11.97 ppm; HRMS (DART) *m/z*: $[M+H]^+$ calcd for $C_{24}H_{21}^+$ 309.1638, found 309.1635.



(1,3-Diphenyl-1-vinyl-1*H*-inden-2-yl)trimethylsilane and **(1,2-diphenyl-1-vinyl-1*H*-inden-3-yl)tri-methylsilane (3ak + 3ak')** colorless oil (68 mg, 62% yield); R_f = 0.24 (silica, petroleum ether, UV detection); major : minor = 1.7 : 1, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (d, *J* = 7.6 Hz, 0.37H), 7.47-7.38 (m, 3.26H), 7.29-7.00 (m, 9H), 6.93 (d, *J* = 6.8 Hz, 0.63H), 6.83 (d, *J* = 7.6 Hz, 0.74H), 6.71 (dd, *J* = 16.8, 10.4 Hz, 0.63H), 6.23 (dd, *J* = 16.8, 10.4 Hz, 0.37H), 5.13-5.06 (m, 2H), 0.06 (s, 3.33H), -0.23 (s, 5.67H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.67, 154.20, 152.94, 151.28, 150.54, 147.75, 145.60, 142.56, 141.00, 138.45, 138.38, 138.33, 137.74, 137.39, 129.95, 129.38, 128.44, 128.26, 128.16, 127.56, 127.43, 127.39, 127.30, 126.73, 126.68, 126.62, 126.57, 126.55, 125.95, 125.38, 124.96, 124.29, 123.07, 121.05, 114.80, 113.82, 69.24, 69.09, 1.00, 0.30 ppm; HRMS (FI) *m/z*: $[M]^+$ calcd for $C_{26}H_{26}Si^+$ 366.1804, found 366.1803.

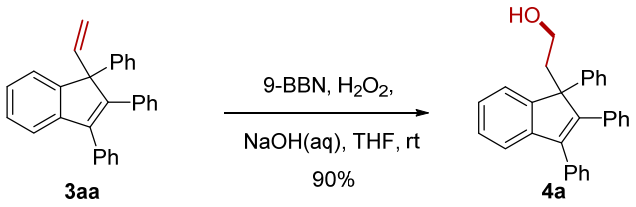
4. Studies on the synthetic utility:

Gram-scale reaction:

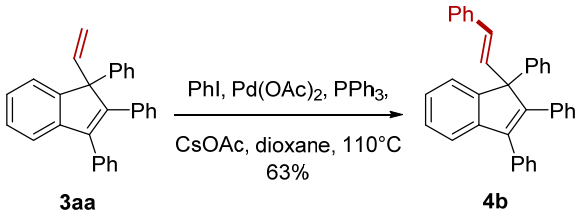


To the mixture of alkene **1a** (10 g, 36.8 mmol), alkyne **2a** (7.85 g, 44.1 mmol), $Pd(OAc)_2$ (413 mg, 1.84 mmol), dppf (2.04 g, 3.68 mmol) and KOH (4.1 g, 73.6 mmol) was added H_2O (180 mL). The mixture was stirred at room temperature for 5 min and then reacted at reflux for further 8 h. After being cooled down to room temperature, H_2O was removed and the residue was purified by flash chromatography on silica gel to afford 11.035 g **3aa** (81%).

Transformation of Products:

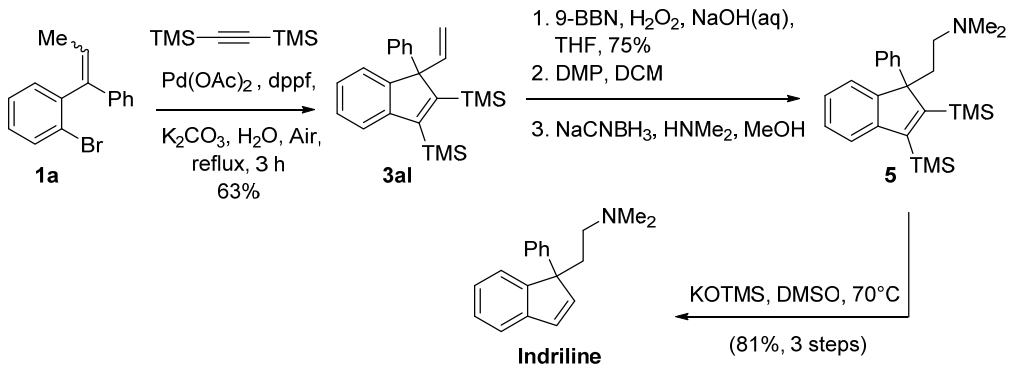


2-(1,2,3-Triphenyl-1*H*-inden-1-yl)ethan-1-ol (4a) To a solution of **3aa** (74 mg, 0.2 mmol) in THF (1 mL) was added 9-Borabicyclo[3.3.1]nonaneas (0.8 mL, 0.5 M in THF, 0.4 mmol) in THF dropwise at 0 °C. The resulting mixture was warmed to room temperature and allowed to stir at this temperature for 5 h. Then 3N NaOH (aq) was added to the mixture followed by 30% H_2O_2 (0.3 mL) at 0 °C. After stirring at room temperature 1 h, CH_2Cl_2 was added. The organic layer was separated and the aqueous layer was extracted with CH_2Cl_2. The combined organic layers were washed with brine and dried over Na_2SO_4. The solvent was removed under vacuo and the residue was purified by flash chromatography on silica gel to afford **4a** as a colorless oil (70 mg, 90% yield). R_f = 0.36 (silica, petroleum ether / ethyl acetate = 20:1 v/v, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.31 (m, 6H), 7.29-7.24 (m, 6H), 7.20-7.06 (m, 3H), 7.03-7.00 (m, 2H), 6.73 (d, *J* = 8.4 Hz, 2H), 3.49-3.42 (m, 1H), 3.25-3.19 (m, 1H), 2.85-2.79 (m, 1H), 2.58-2.51 (m, 1H), 0.95 (br, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.39, 148.99, 143.98, 142.46, 141.23, 135.19, 135.12, 129.55, 129.42, 128.79, 128.61, 127.89, 127.50, 127.15, 127.06, 126.76, 126.46, 126.31, 123.00, 120.98, 60.63, 59.24, 36.37 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{29}H_{24}O^+$ 388.1827, found 388.1833.



(*E*)-1,2,3-Triphenyl-1-styryl-1*H*-indene (4b) To a solution of **3aa** (74 mg, 0.2 mmol), $Pd(OAc)_2$ (2.3 mg, 0.01mmol), PPh_3 (10.5 mmol, 0.04 mmol) and CsOAc (77 mg, 0.4 mmol) in dioxane (1 mL) was added PhI (45 μL, 0.4 mmol) under Ar. The mixture was stirred at room temperature for 5 min and then reacted at 110 °C for further 3 h. The solvent was removed under vacuo and the residue was purified by flash chromatography on silica gel to afford **4b** as a colorless oil (56 mg, 63% yield). R_f = 0.34 (silica, petroleum ether, UV detection); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42-7.34 (m, 7H), 7.32-7.23 (m, 10H), 7.20-7.17 (m, 2H), 7.11-7.03 (m, 3H), 6.94-6.93 (m, 2H), 6.81 (d, *J* = 16.4 Hz, 1H), 6.54 (d, *J* = 16.4 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.93, 148.72, 143.92, 142.56, 140.43, 137.39, 135.66, 135.34, 130.39, 129.91, 129.68, 129.65, 128.74, 128.54, 128.52, 127.77, 127.41, 127.14, 127.01, 126.96, 126.85, 126.50, 126.12, 125.08, 121.45, 65.83 ppm; HRMS (EI) *m/z*: $[M]^+$ calcd for $C_{35}H_{26}^+$ 446.2035, found 446.2033.

Synthesis of the Indriline:



(1-Phenyl-1-vinyl-1H-indene-2,3-diyl)bis(trimethylsilane) (3al) To the mixture of alkene **1a** (81.6 mg, 0.30 mmol), 1,2-Bis(trimethylsilyl)ethyne (61.2 mg, 0.36 mmol), $Pd(OAc)_2$ (3.4 mg, 0.015 mmol), dppf (16.6 mg, 0.03 mmol) and K_2CO_3 (82.8 mg, 0.60 mmol) was added H_2O (1.5 mL). in a sealed tube was added H_2O (1.5 mL). The mixture was stirred at room temperature for 5 min and then reacted at 80 °C for further 3 h. After being cooled down to room temperature, H_2O was removed and the residue was purified by flash chromatography on silica gel to afford **3al** as a colorless oil (68 mg, 63% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (d, J = 7.6 Hz, 1H), 7.23-7.12 (m, 6H), 7.06-7.03 (m, 1H), 6.92-6.91 (m, 1H), 6.73 (dd, J = 17.2, 10.8 Hz, 1H), 5.01 (d, J = 10.8 Hz, 1H), 4.93 (dd, J = 17.2 Hz, 1H), 0.48 (s, 9H), 0.06 (s, 9H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.47, 153.62, 152.28, 147.90, 142.85, 138.16, 128.49, 126.39, 126.31, 126.11, 125.13, 124.35, 123.26, 114.00, 72.23, 2.81, 2.25 ppm; HRMS (FI) *m/z*: $[M]^+$ calcd for $C_{23}H_{30}Si_2^+$ 362.1886, found 362.1881.

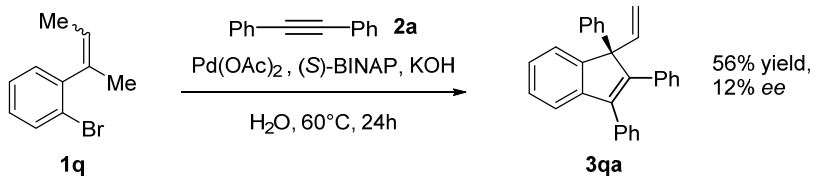
Indriline: (N,N-dimethyl-2-(1-phenyl-1H-inden-1-yl)ethan-1-amine) To a solution of **3al** (72 mg, 0.2 mmol) in THF (1 mL) was added 9-Borabicyclo[3.3.1]nonaneas (0.8 mL, 0.5 M in THF, 0.4 mmol) in THF dropwise at 0 °C. The resulting mixture was warmed to room temperature and allowed to stir at this temperature for 5 h. Then 3N NaOH (aq) was added to the mixture followed by 30% H_2O_2 (0.3 mL) at 0 °C. After stirring at room temperature 1 h, CH_2Cl_2 was added. The organic layer was separated and the aqueous layer was extracted with CH_2Cl_2. The combined organic layers were washed with brine and dried over Na_2SO_4. The solvent was removed under vacuo to afford crude product as a colorless oil. (57 mg, 75% yield).

Dess-Martin Periodinane (50 mg, 0.12 mmol) was added to the solution of the crude alcohol (30 mg, 0.08 mmol) in CH_2Cl_2 (1 mL) at 0 ºC. Then the mixture was stirred at r.t. for 2 hours. The white solid was filtered through a celite pad and the filter cake was washed with CH_2Cl_2. The combined filtrates were washed with brine, dried over anhydrous Na_2SO_4 and concentrated under vacuo to afford the crude aldehyde. The crude was used for the next step without further purification.

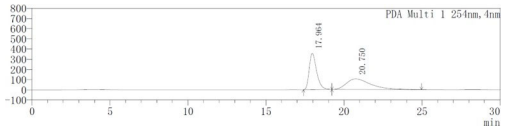
To a solution of crude aldehyde and $HNMe_2$ (40 μL, 0.08 mmol, 2 M in THF) in methanol (1 mL) was added $NaCNBH_3$ (6 mg, 0.10 mmol) at room temperature and allowed to stir at this temperature for 3 h. After removing the solvent, the residue was dissolved with DMSO(1 mL) and KOTMS (20 mg, 0.16 mmol) was added. Then the mixture was heated to 70 °C and allowed to stir at this temperature for 4 h. After being cooled down to room temperature, solvent was removed and the residue was purified by flash chromatography on silica gel to afford **Indriline** as a

colorless oil (17 mg, 81% yield, 3 steps) ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.30 (m, 3H), 7.27-7.24 (m, 4H), 7.20-7.14 (m, 2H), 6.81 (d, *J* = 5.2 Hz, 1H), 6.54 (d, *J* = 5.2 Hz, 1H), 2.61-2.55 (m, 1H), 2.38-2.24 (m, 2H), 2.20 (s, 6H), 1.94-1.86 (m, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) 150.77, 143.97, 143.40, 141.86, 130.43, 128.59, 127.01, 126.70, 126.24, 125.68, 123.10, 121.62, 59.74, 55.21, 45.26, 34.19 ppm; HRMS (FI) *m/z*: $[M]^+$calcd for $C_{19}H_{21}N^+$ 263.1674, found 263.1669.

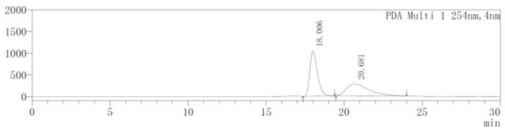
Preliminary enantioselective studies



To the suspension of alkene **1q** (0.20 mmol), alkyne **2a** (0.24 mmol), $Pd(OAc)_2$ (2.3 mg, 0.01 mmol), (*S*)-BINAP (12.4 mg, 0.02 mmol) and KOH (33.6 mg, 0.60 mmol) in a sealed tube was added H_2O (1.5 mL). The mixture was stirred at room temperature for 5 min and then reacted at 60 °C for further 24 h. After being cooled down to room temperature, H_2O was removed and the residue was purified by flash chromatography on silica gel. HPLC analysis: Chiracel OJ-H + Chiracel OJ-H column (the two columns were connected to each other in this order); detected at 254 nm, 30 °C; 1% ^{i}PrOH in n-Hexane; flow = 0.5 mL/min; Retention time: t (major) = 18.0 min, t (minor) = 20.7 min.

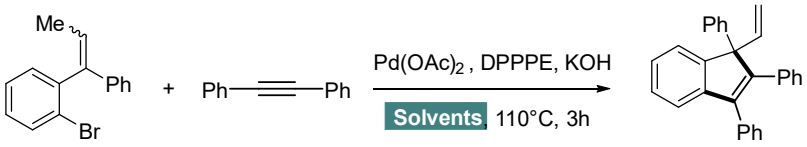


Entry	Retention time	Area%
1	17.964	50.958
2	20.750	49.042



Entry	Retention time	Area%
1	18.006	55.710
2	20.681	44.290

5. Control experiments

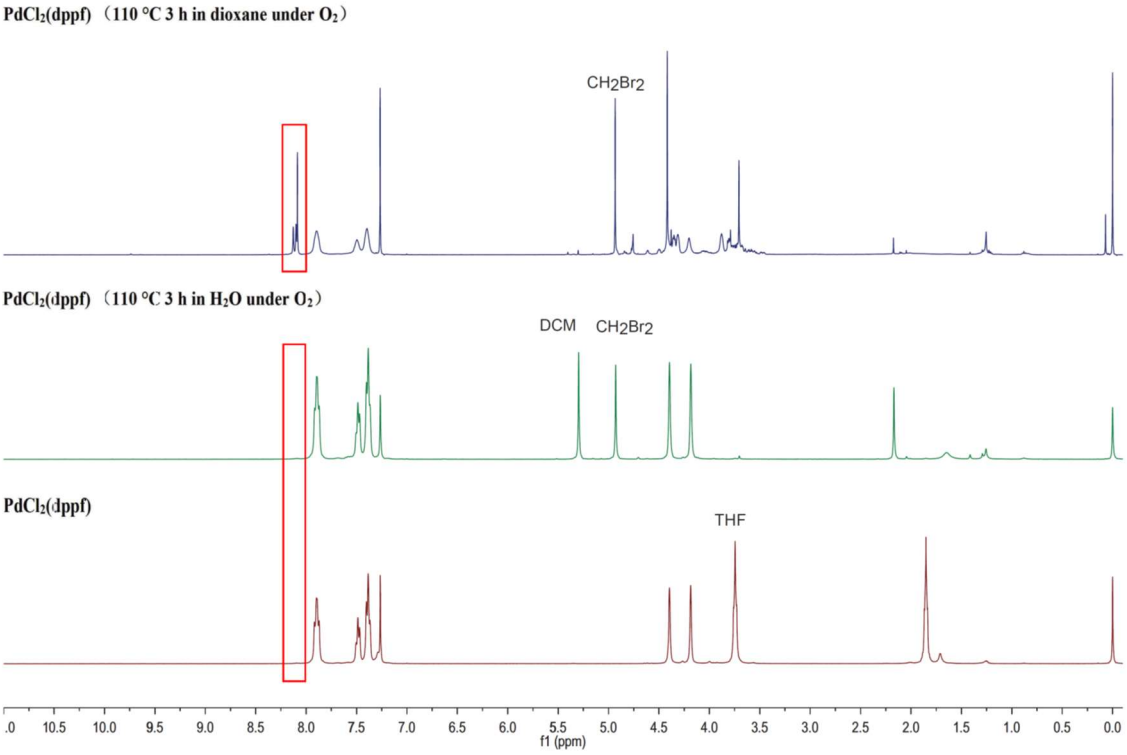


1a **2a** **3aa**

Entry	Solvent	Atmosphere	Yield (%)
1	dioxane	Ar	47
2	dioxane	Air	4
3	dioxane	O_2	0
4	H_2O	Ar	87
5	H_2O	Air	82
6	H_2O	O_2	63

Reaction condition: **1a** (0.20 mmol, 1.0 equiv), **2a** (1.2 equiv), $Pd(OAc)_2$ (0.05 equiv), DPPPE (0.1 equiv), KOH (0.40 mmol, 2.0 equiv), H_2O (1mL). Yields determined by NMR analysis using CH_2Br_2 as an internal standard.

6. Stability of catalyst under O_2



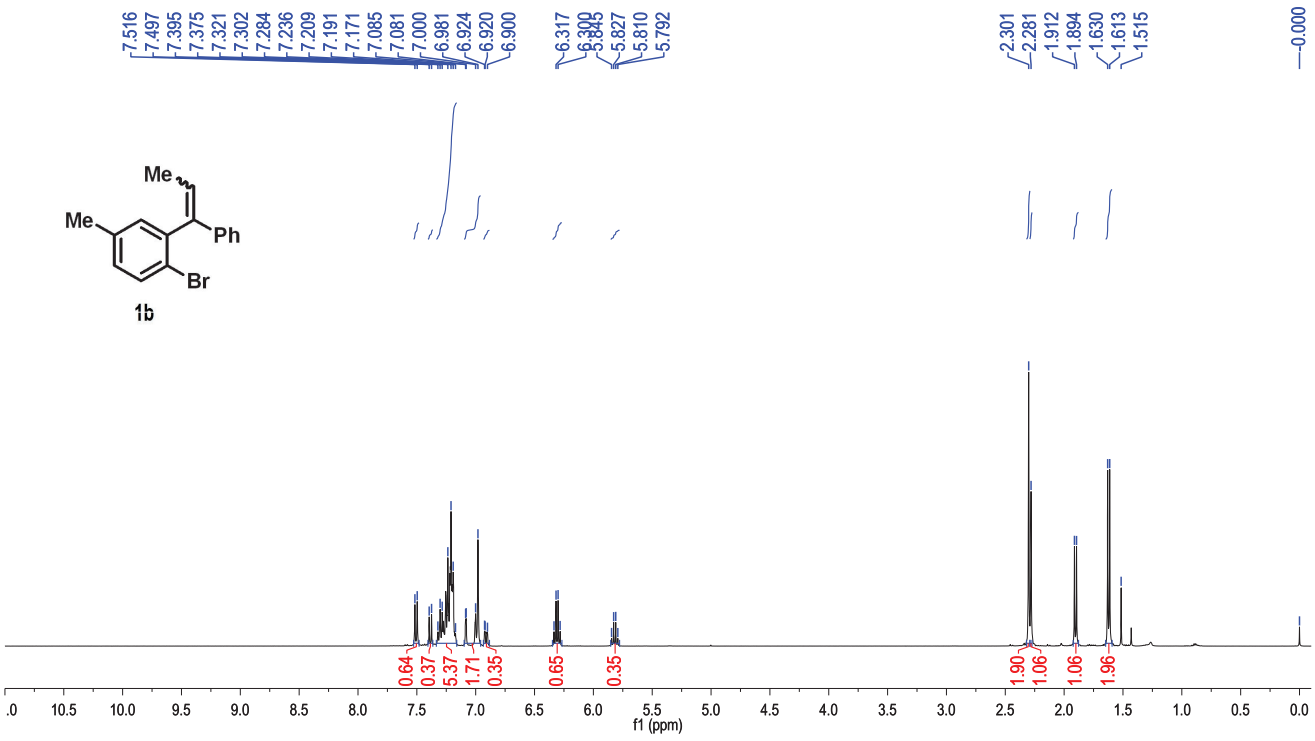
Reaction condition: $PdCl_2$(dppf) (0.20 mmol) Yields determined by NMR analysis using CH_2Br_2 as an internal standard

7. References

[1] S. Nicolai, S. Erard, D. F. González, J. Waser, *Org. Lett*. **2010**, *12*, 384;

[2] S. Maity, N. Zheng, *Angew. Chem. Int. Ed*., **2012**, *51*, 9562-9566;

[3] D. Wei, T.-J. Hu, C.-G. Feng, G.-Q. Lin, *Chin. J. Chem.* **2018**, *36*, 743.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7.236
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7.081
7.000
6.981
6.924
6.920
6.900
6.317
6.300
5.845
5.827
5.810
5.792
2.301
2.281
1.912
1.894
1.630
1.613
1.515
0.000
Me
Me
Ph
Br
1b
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1.71
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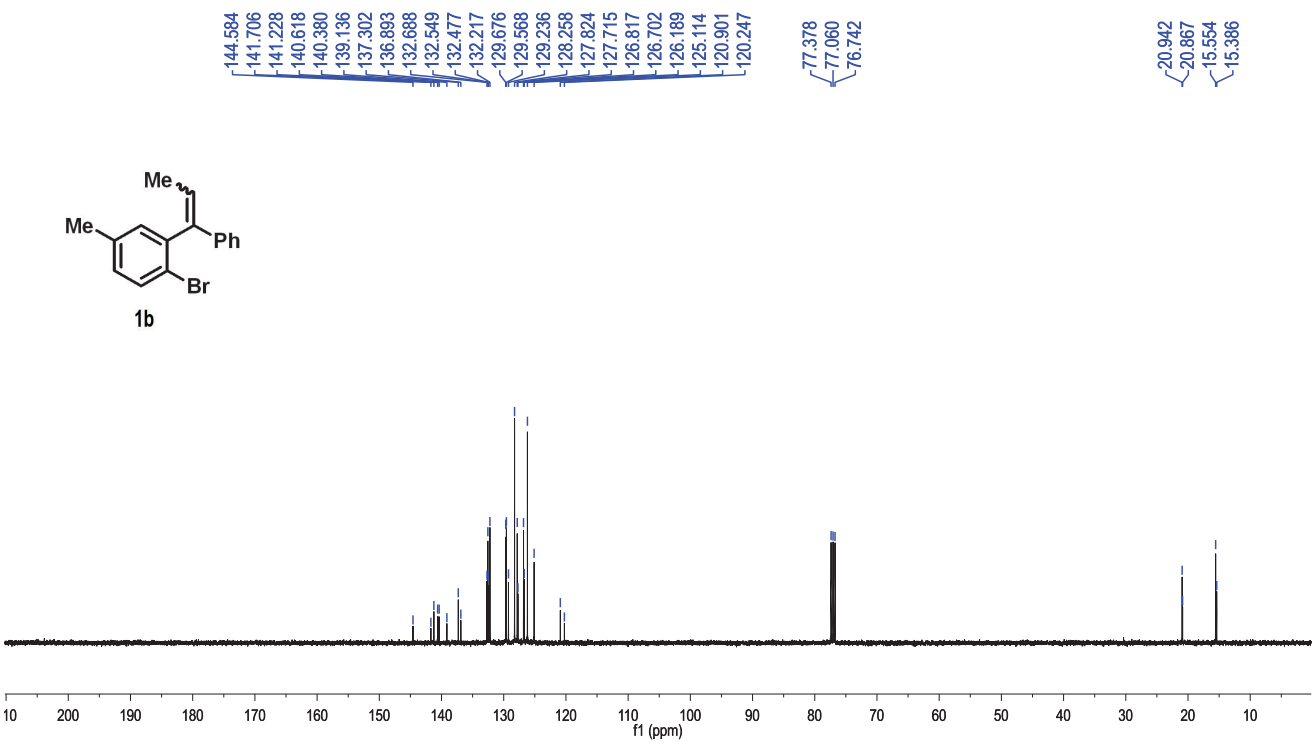
0.65
0.35
1.90
1.06
1.06
1.96
f1 (ppm)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141.228
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137.302
136.893
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132.217
129.676
129.568
129.236
128.258
127.824
127.715
126.817
126.702
126.189
125.114
120.901
120.247
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77.060
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20.942
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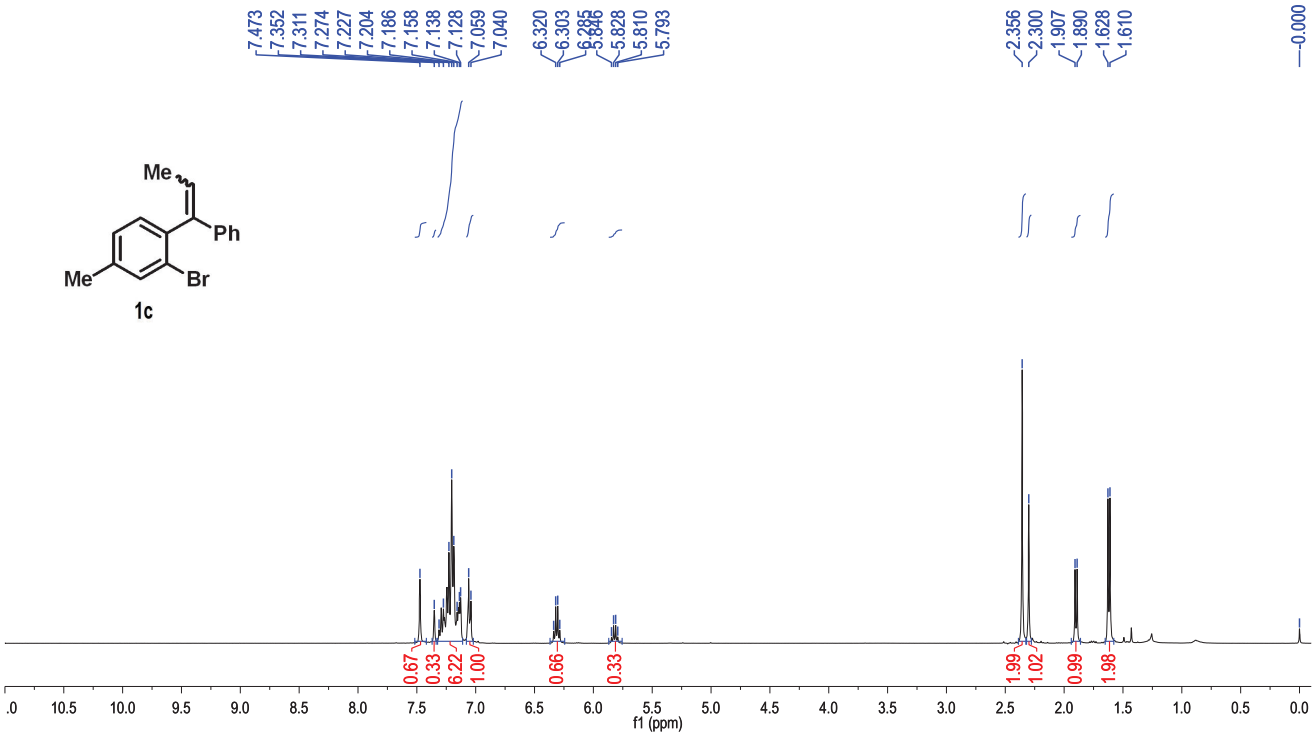
Me
Me
Ph
Br
1b
f1 (ppm)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7.059
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6.320
6.303
6.285
5.846
5.828
5.810
5.793
2.356
2.300
1.907
1.890
1.628
1.610
0.000
Me
Ph
Me
Br
1c
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6.22
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0.33
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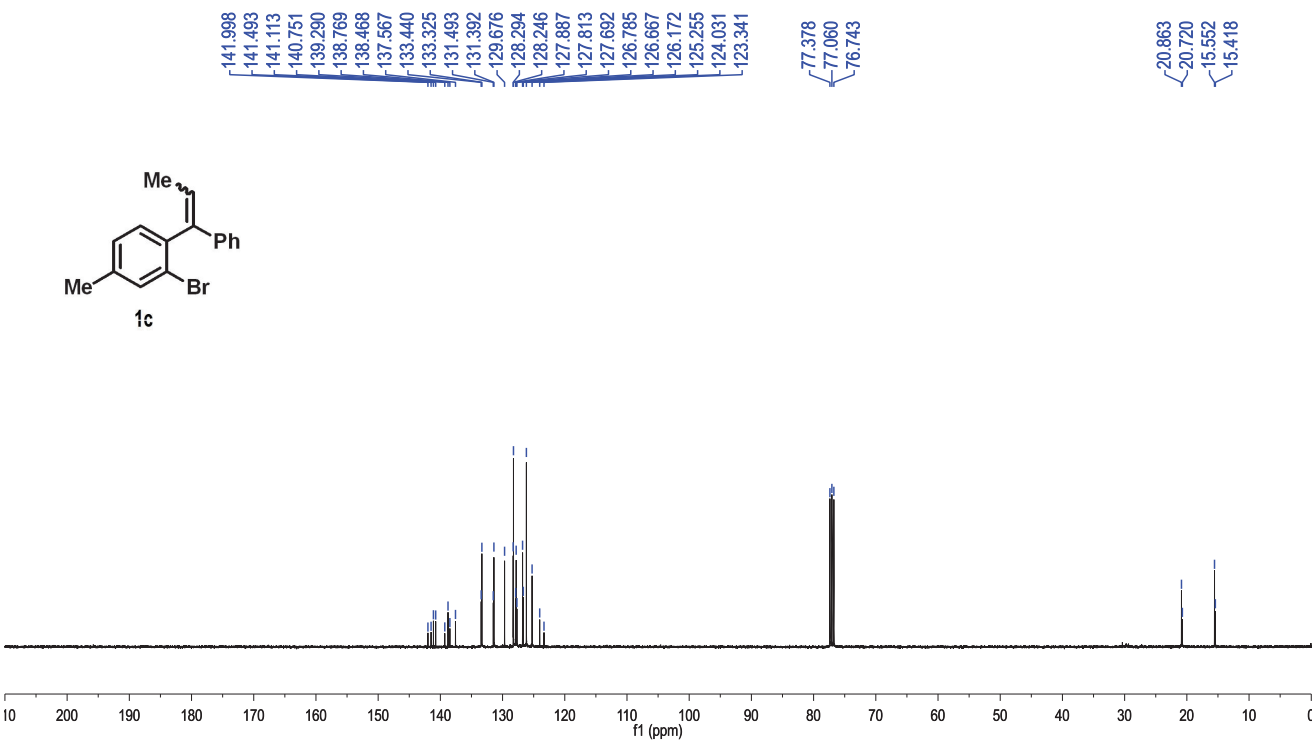
1.02
0.99
1.98
f1 (ppm)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140.751
139.290
138.769
138.468
137.567
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133.325
131.493
131.392
129.676
128.294
128.246
127.887
127.813
127.692
126.785
126.667
126.172
125.255
124.031
123.341
77.378
77.060
76.743
20.863
20.720
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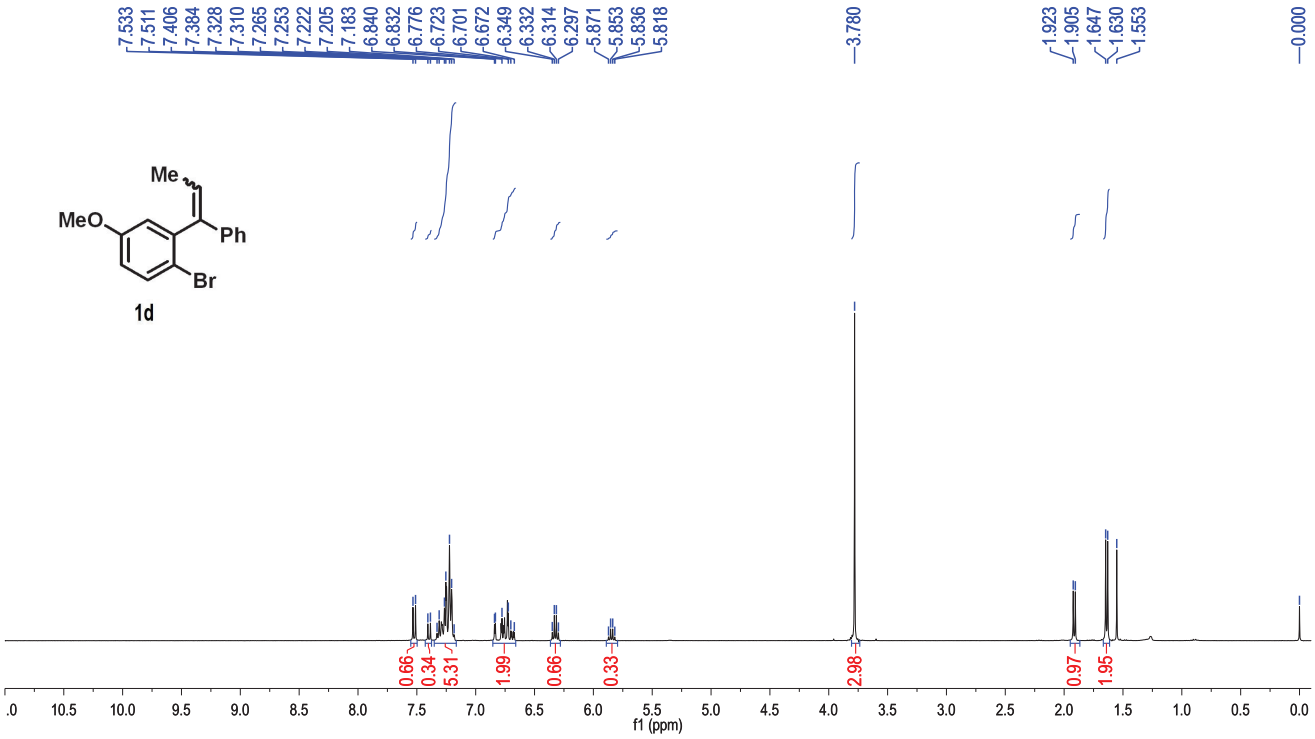
Me
Ph
Me
Br
1c
f1 (ppm)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7.253
7.222
7.205
7.183
6.840
6.832
6.776
6.723
6.701
6.672
6.349
6.332
6.314
6.297
5.871
5.853
5.836
5.818
3.780
1.923
1.905
1.647
1.630
1.553
0.000
Me
MeO
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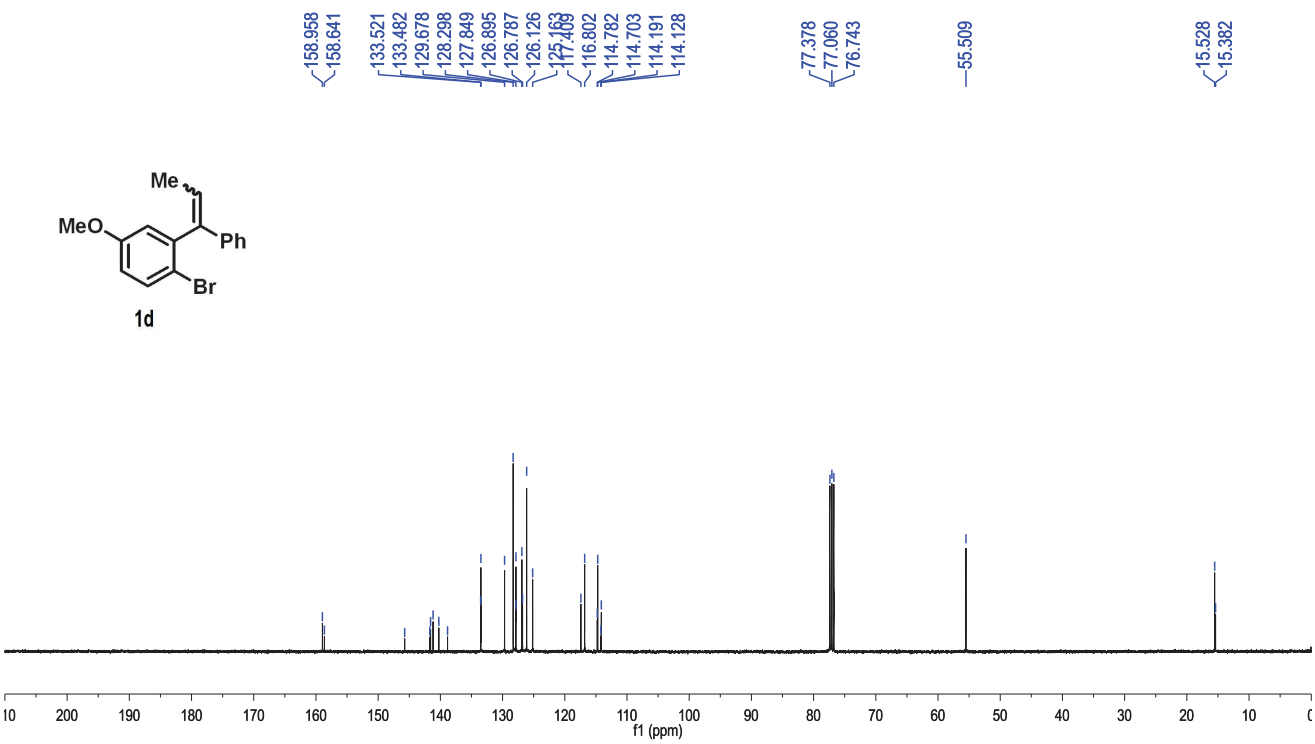
f1 (ppm)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126.895
126.787
126.126
125.163
117.409
116.802
114.782
114.703
114.191
114.128
77.378
77.060
76.743
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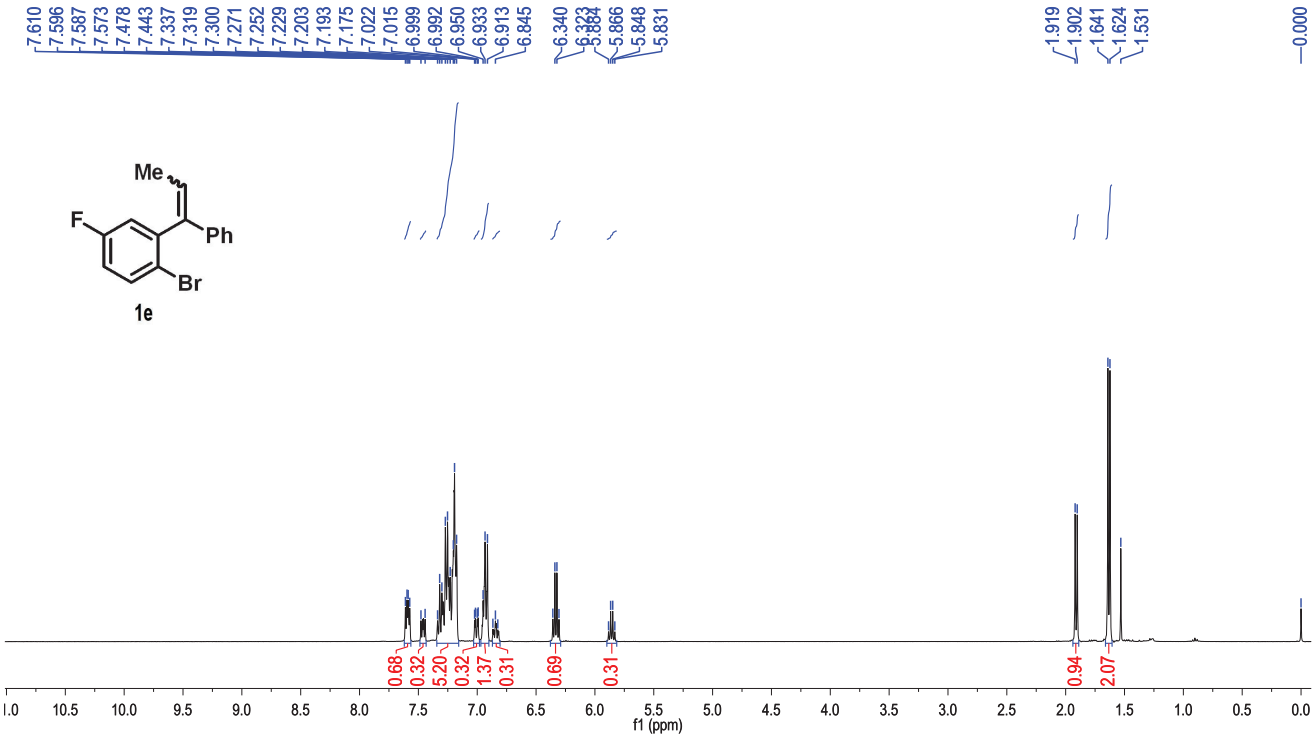
Me
MeO
Ph
Br
1d
f1 (ppm)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7.337
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7.271
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7.229
7.203
7.193
7.175
7.022
7.015
6.999
6.992
6.950
6.933
6.913
6.845
6.340
5.866
5.848
5.831
1.919
1.902
1.641
1.624
1.531
0.000
Me
F
Ph
Br
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1.37
0.31
0.69
0.31
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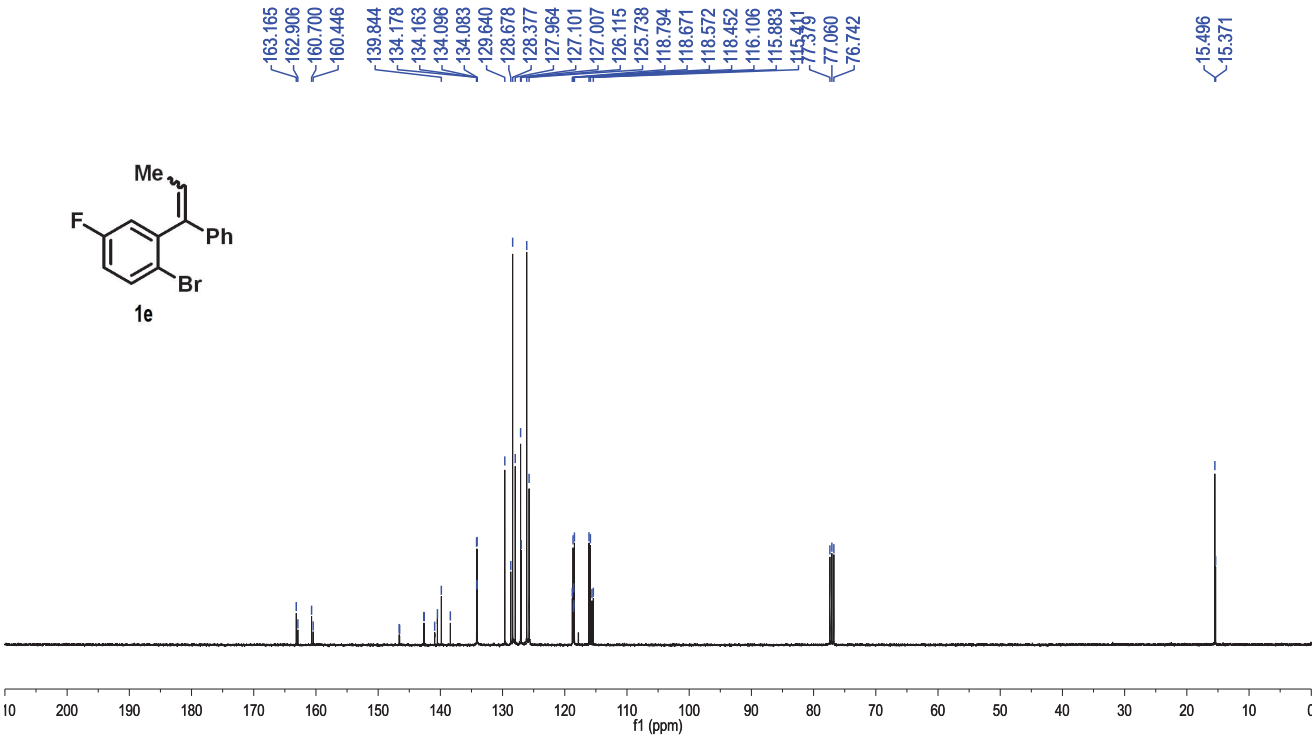
2.07
f1 (ppm)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128.377
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127.101
127.007
126.115
125.738
118.794
118.671
118.572
118.452
116.106
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77.379
77.060
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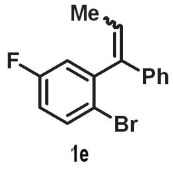
15.496
15.371
Me
F
Ph
Br
1e
f1 (ppm)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F
Ph
Br

1e

115.017
115.707
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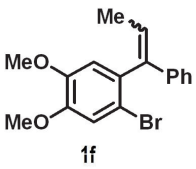
Me
MeO
Ph
MeO
Br

1f

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7.252
7.222
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7.115
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6.648
6.361
6.344
6.326
6.309
5.865
5.848
5.830
5.812
3.909
3.857
3.838
3.820
1.923
1.906
1.657
1.640
1.571
0.000
5.34
0.62
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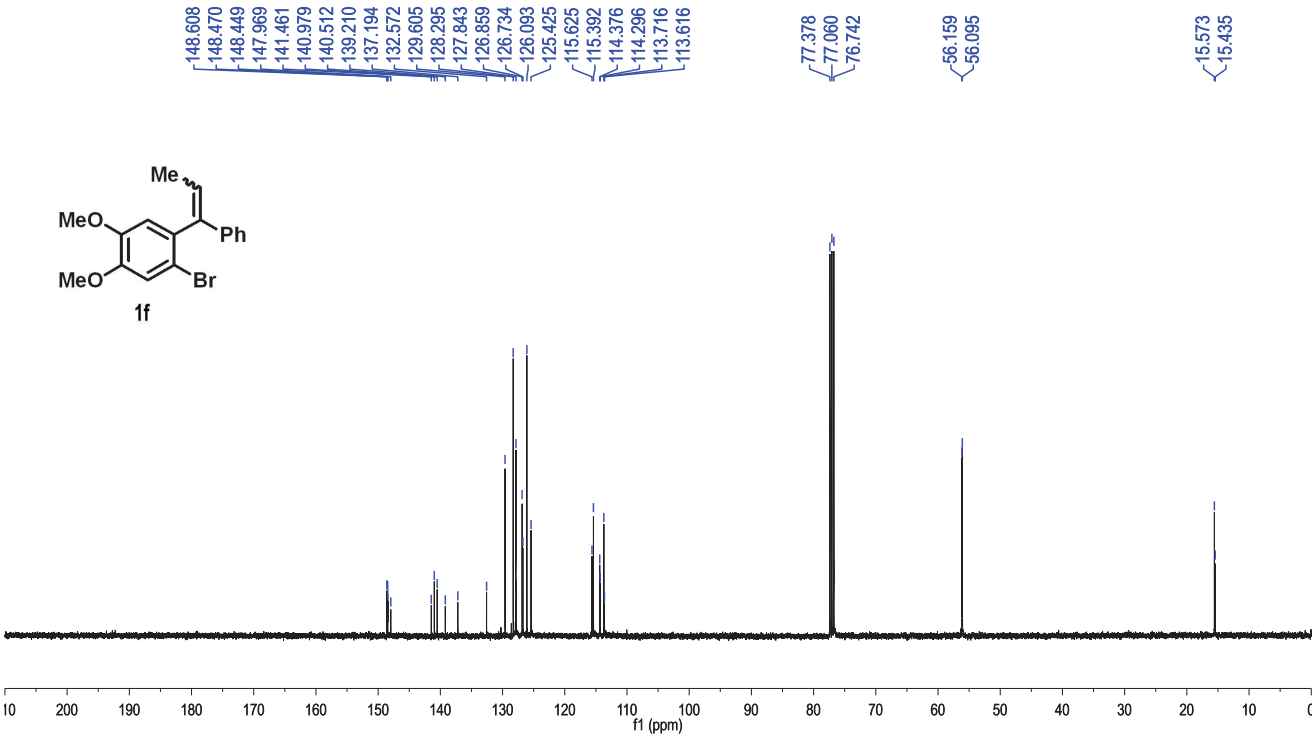
1.83
f1 (ppm)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126.734
126.093
125.425
115.625
115.392
114.376
114.296
113.716
113.616
77.378
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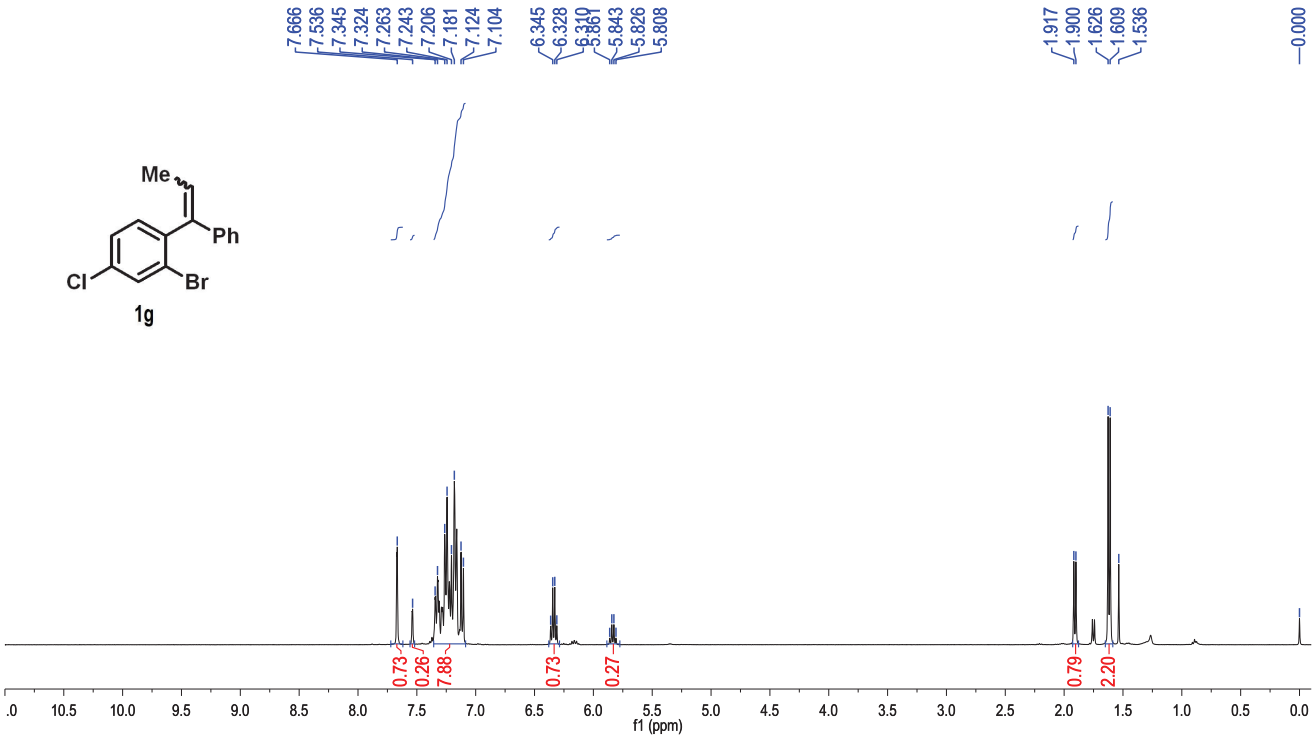
Ph
MeO
Br
1f
f1 (ppm)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6.310
6.301
5.843
5.826
5.808
1.917
1.900
1.626
1.609
1.536
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Cl
Br
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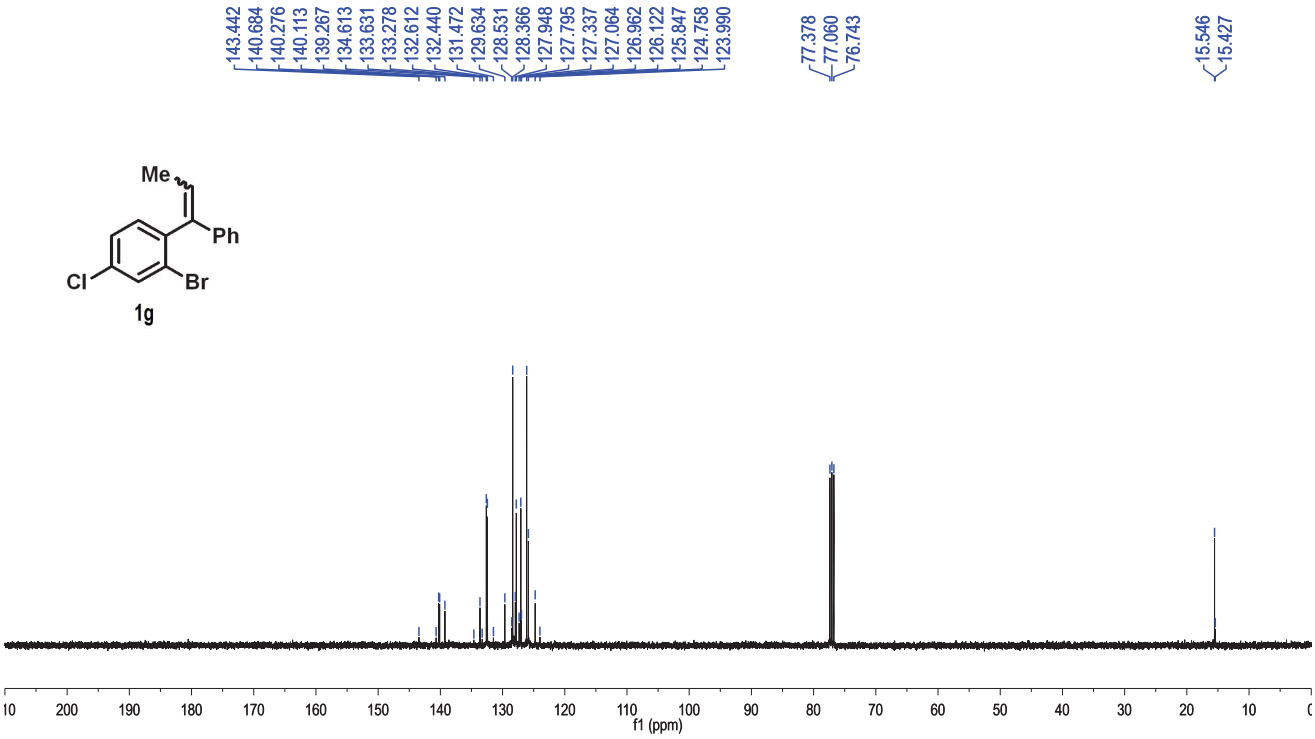
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127.948
127.795
127.337
127.064
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126.122
125.847
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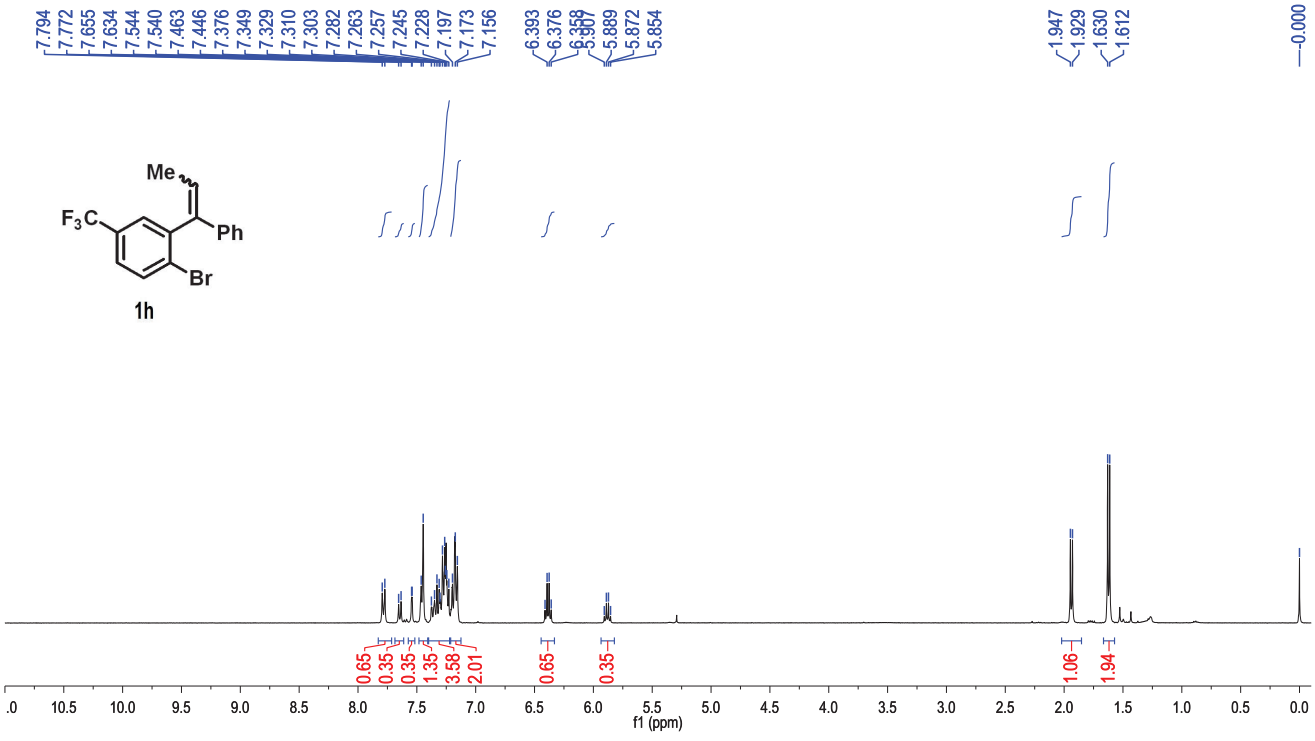
Ph
Cl
Br
1g
f1 (ppm)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6.376
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Me
F3C
Ph
Br
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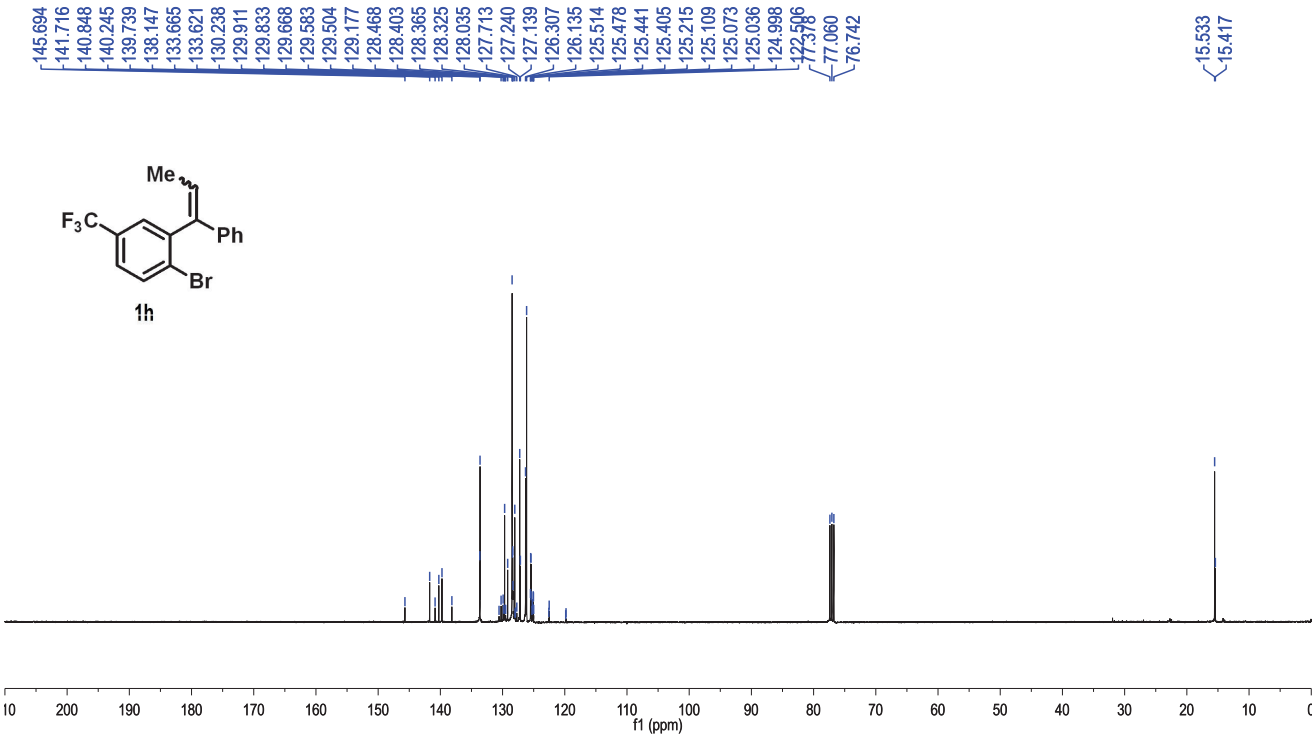
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127.139
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Br
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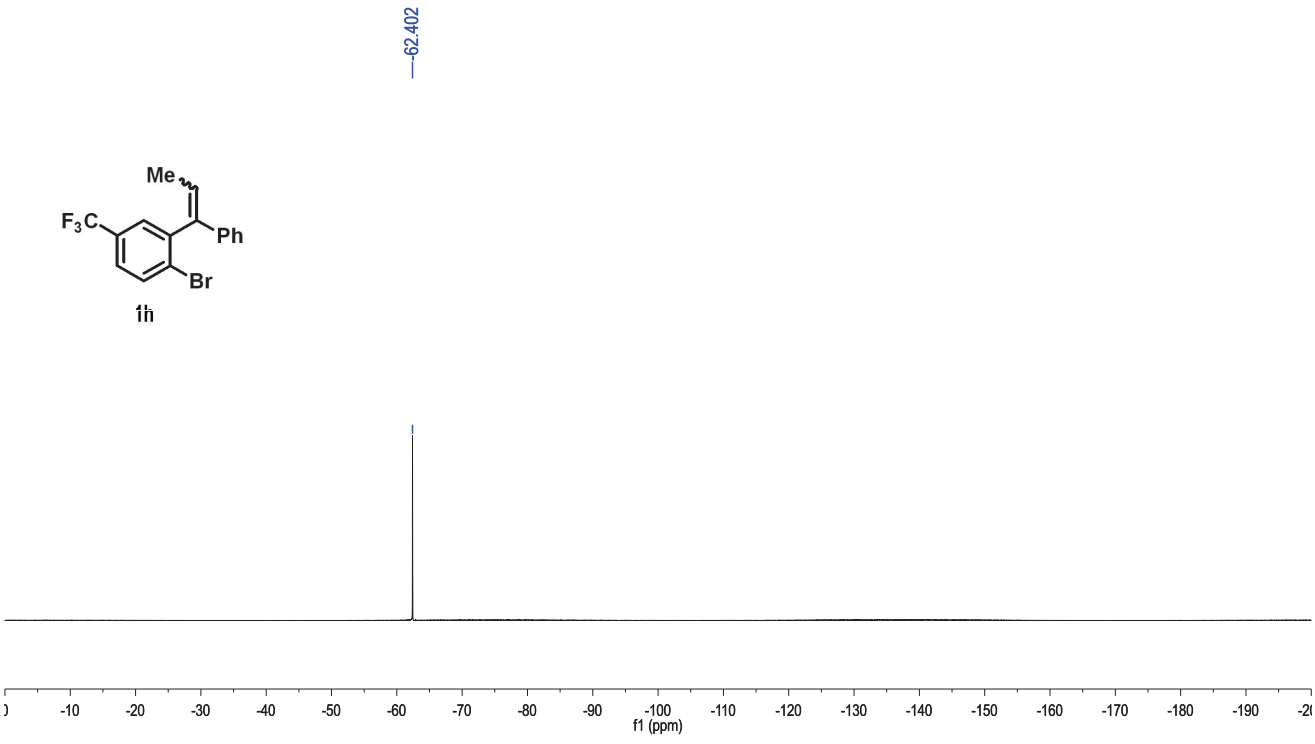
f1 (ppm)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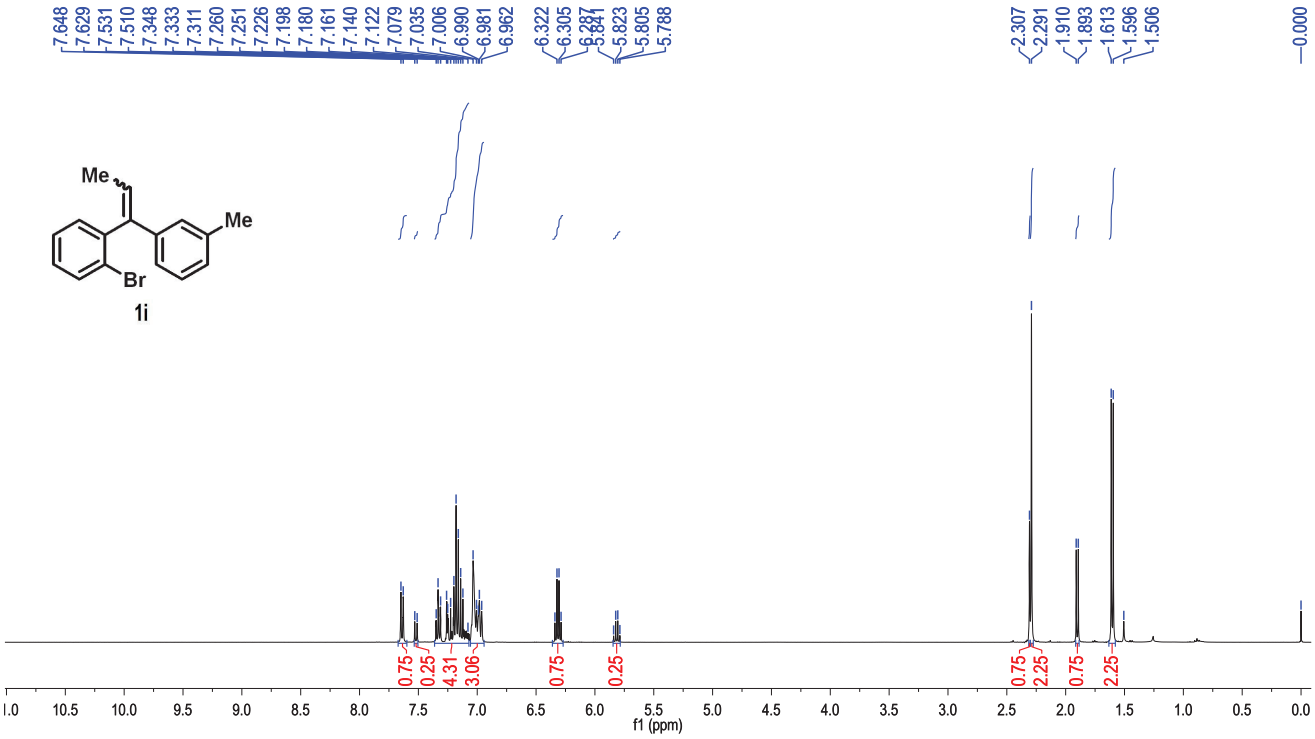
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7.140
7.122
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6.981
6.962
6.322
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6.287
6.281
5.823
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2.307
2.291
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1.893
1.613
1.596
1.506
0.000
Me
Me
Br
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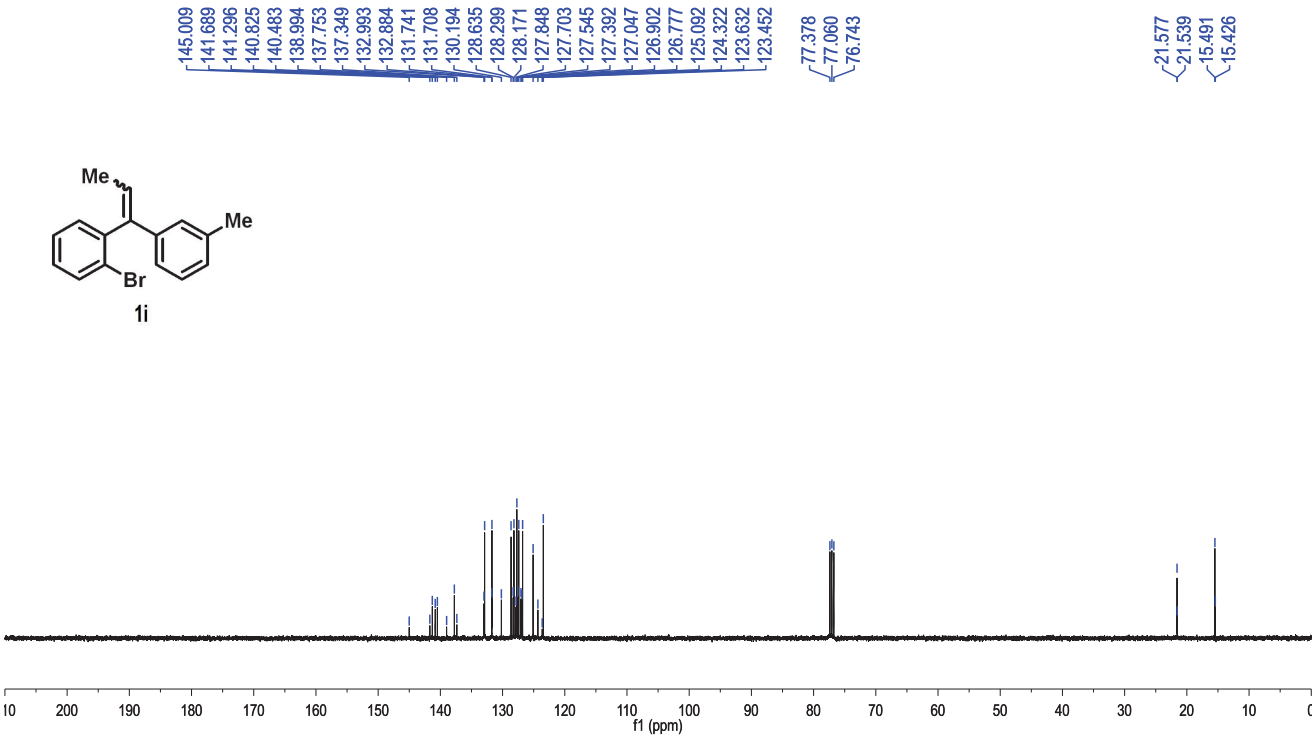
f1 (ppm)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128.171
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127.047
126.902
126.777
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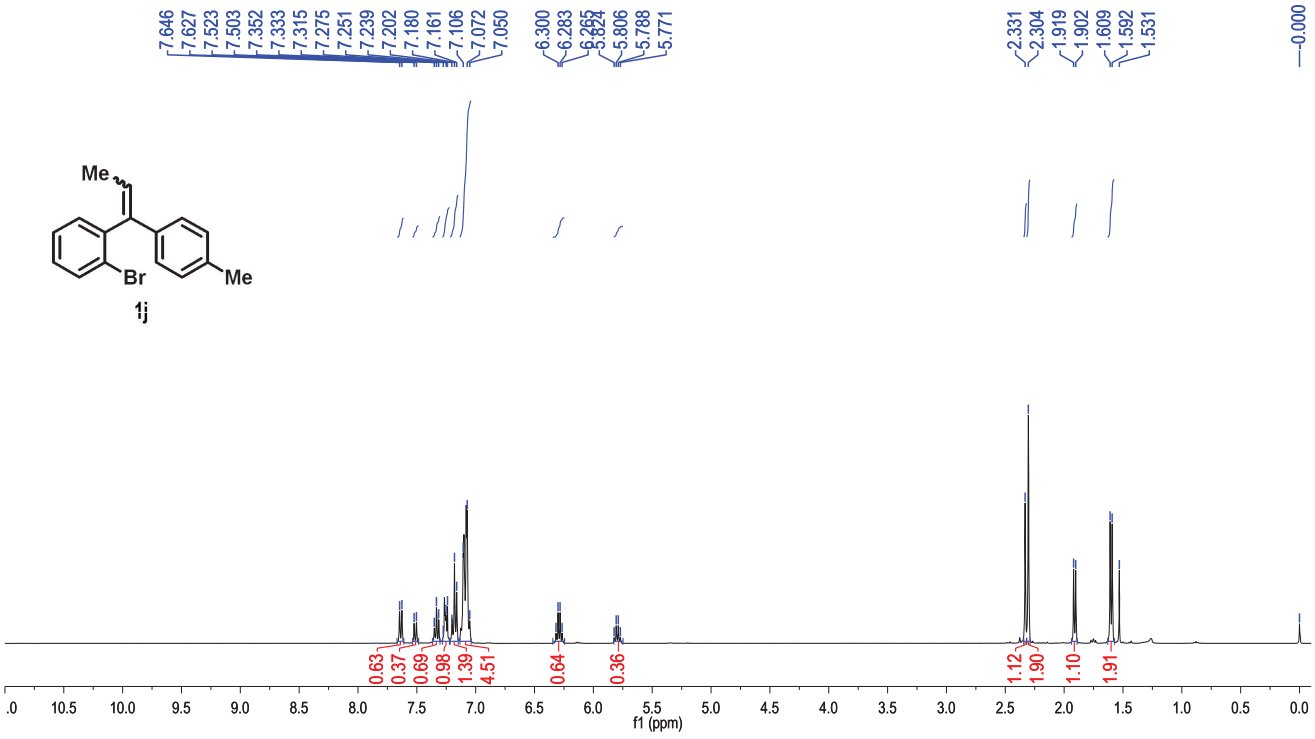
Me
Br
1i
f1 (ppm)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7.072
7.050
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6.247
5.824
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5.788
5.771
2.331
2.304
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1.902
1.609
1.592
1.531
0.000
Me
Br
Me
1j
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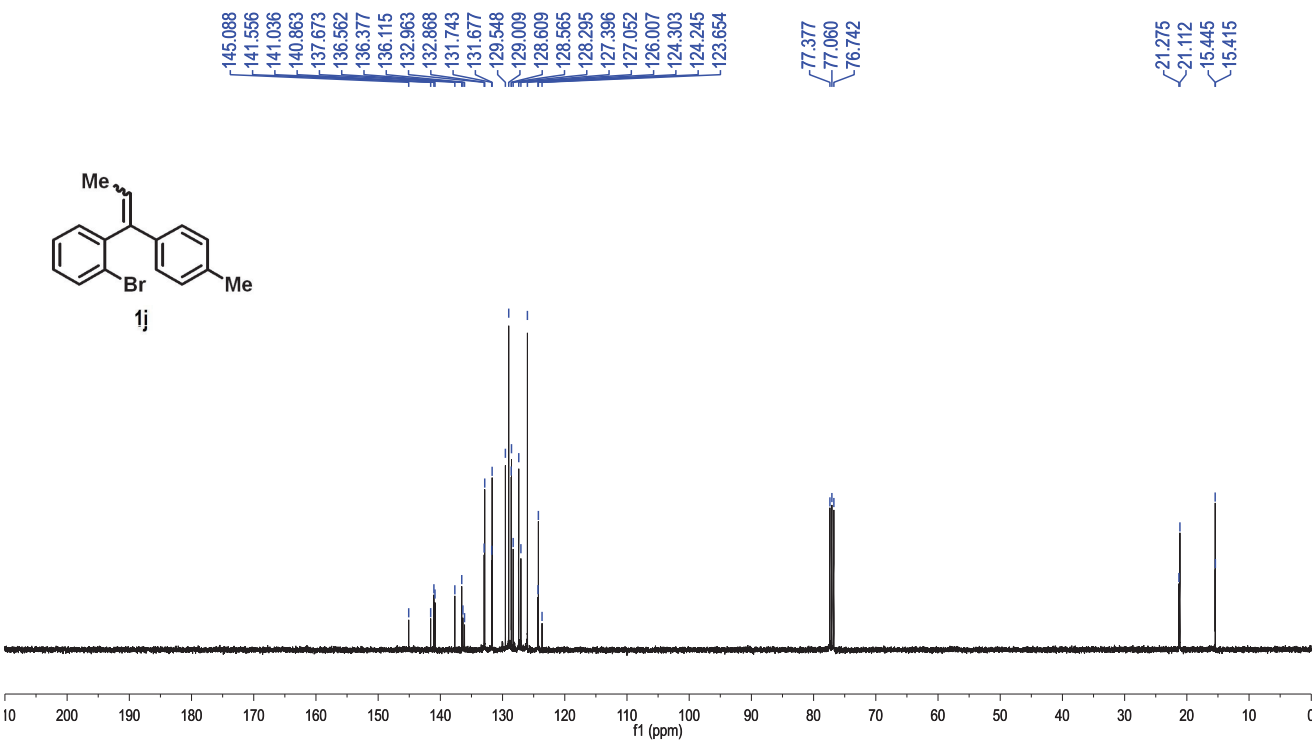
1.91
f1 (ppm)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129.009
128.609
128.565
128.295
127.396
127.052
126.007
124.303
124.245
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77.060
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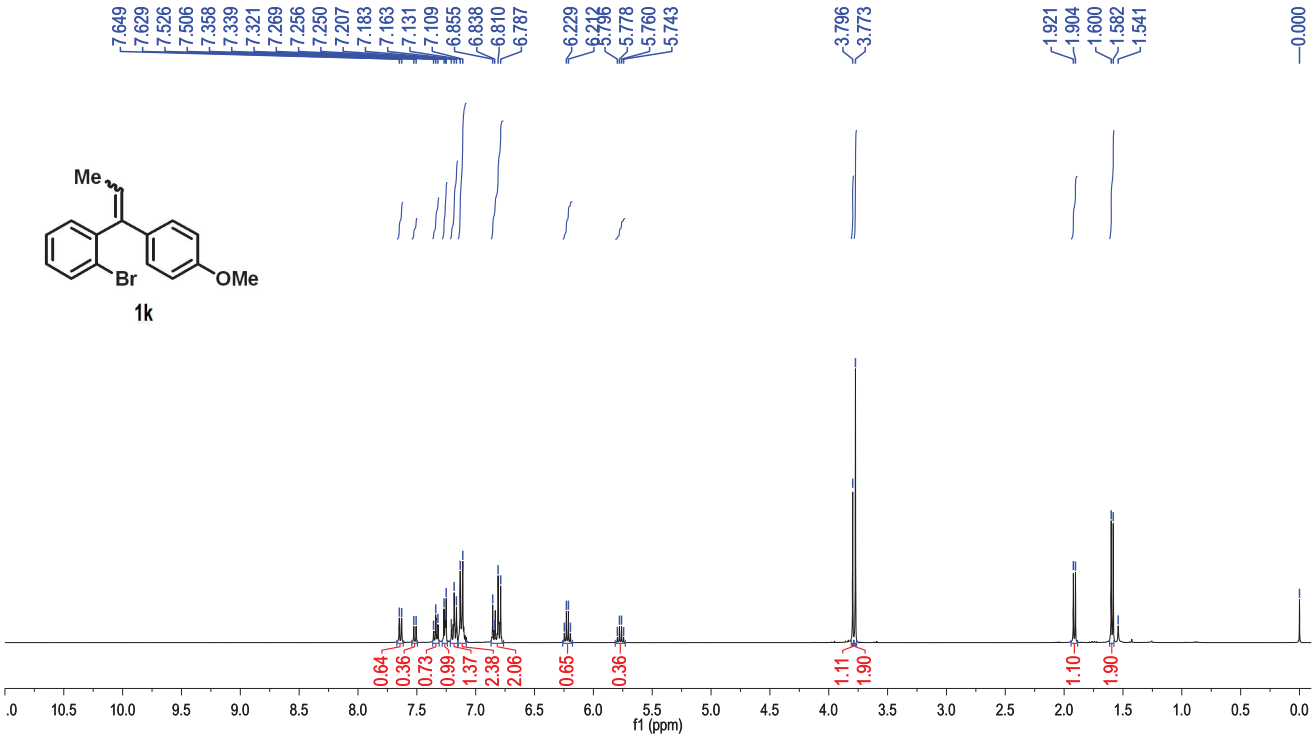
15.445
15.415
Me
Br
Me
1j
f1 (ppm)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7.131
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6.787
6.229
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5.796
5.778
5.760
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3.796
3.773
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1.904
1.600
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1.541
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Me
Br
OMe
1k
0.64
0.36
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1.90
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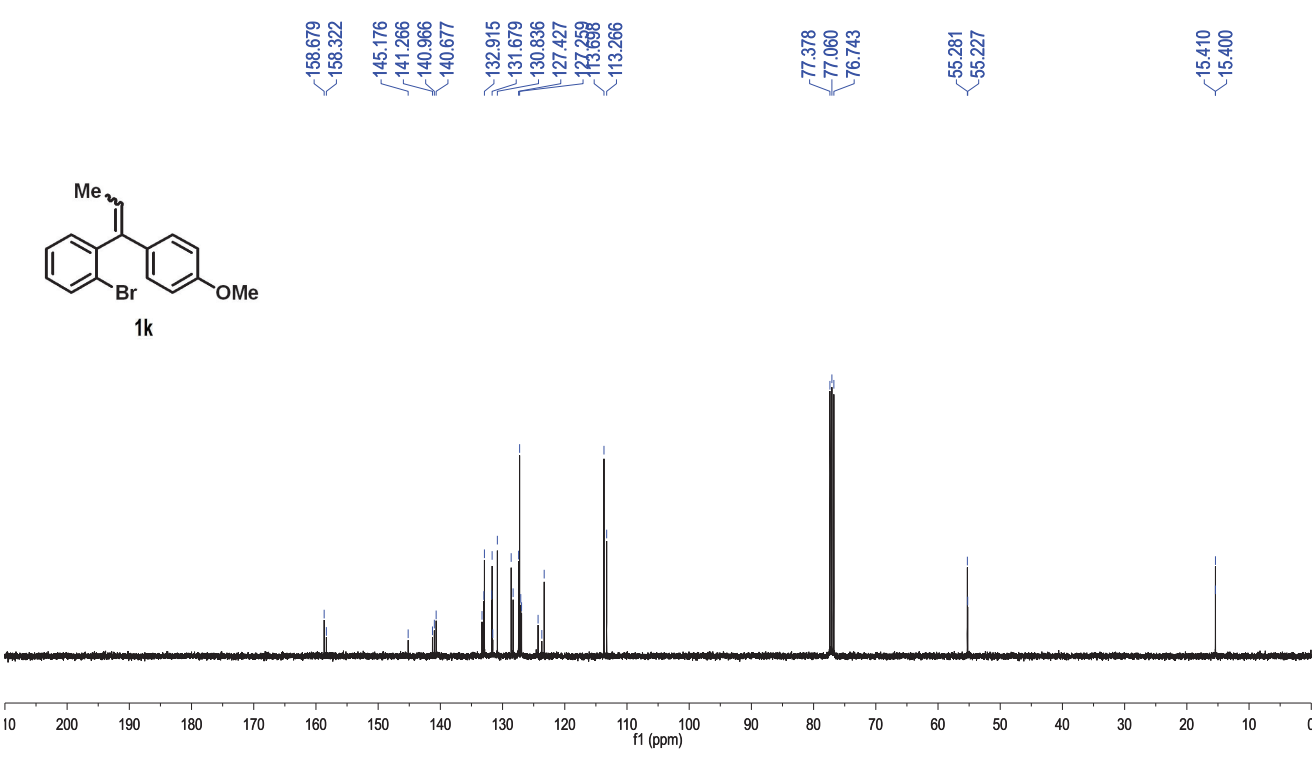
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113.698
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77.378
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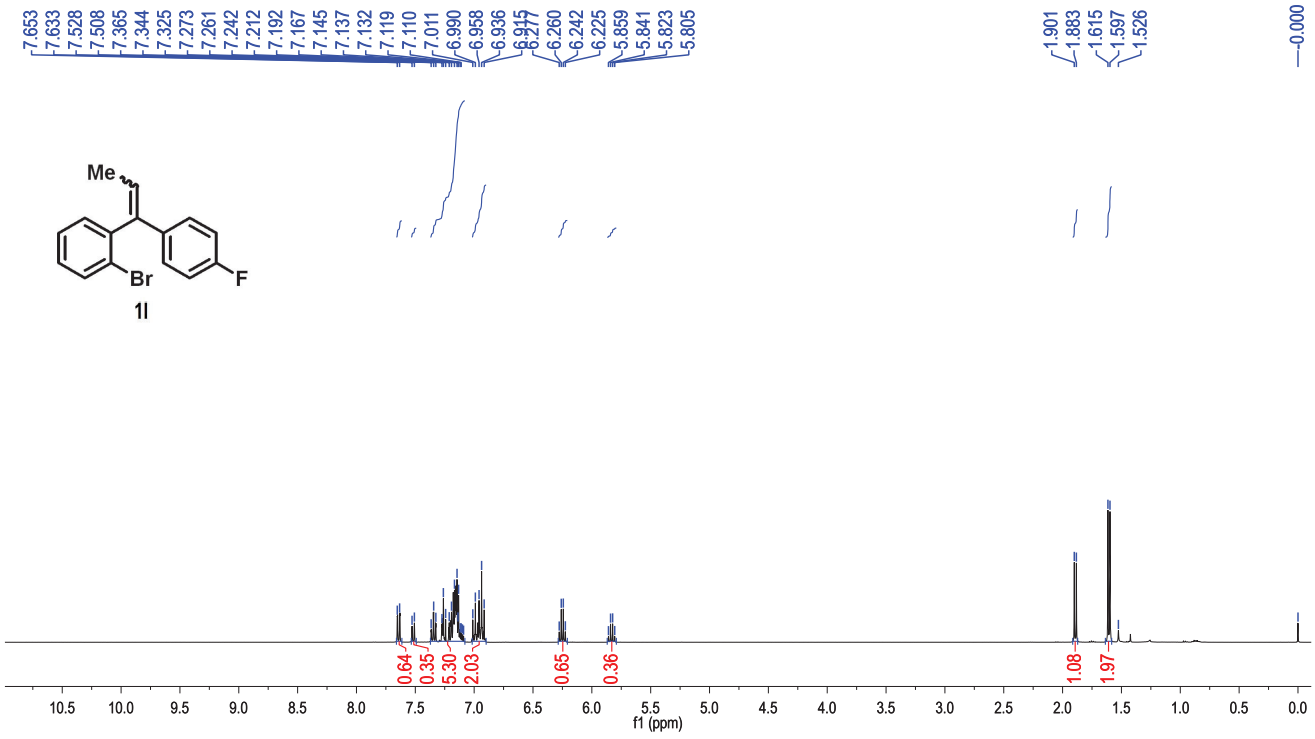
76.743
55.281
55.227
15.410
15.400
Me
Br
OMe
1k
f1 (ppm)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7.192
7.167
7.145
7.137
7.132
7.119
7.110
7.011
6.990
6.958
6.936
6.915
6.260
6.242
6.225
5.859
5.841
5.823
5.805
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1.883
1.615
1.597
1.526
0.000
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Br
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1l
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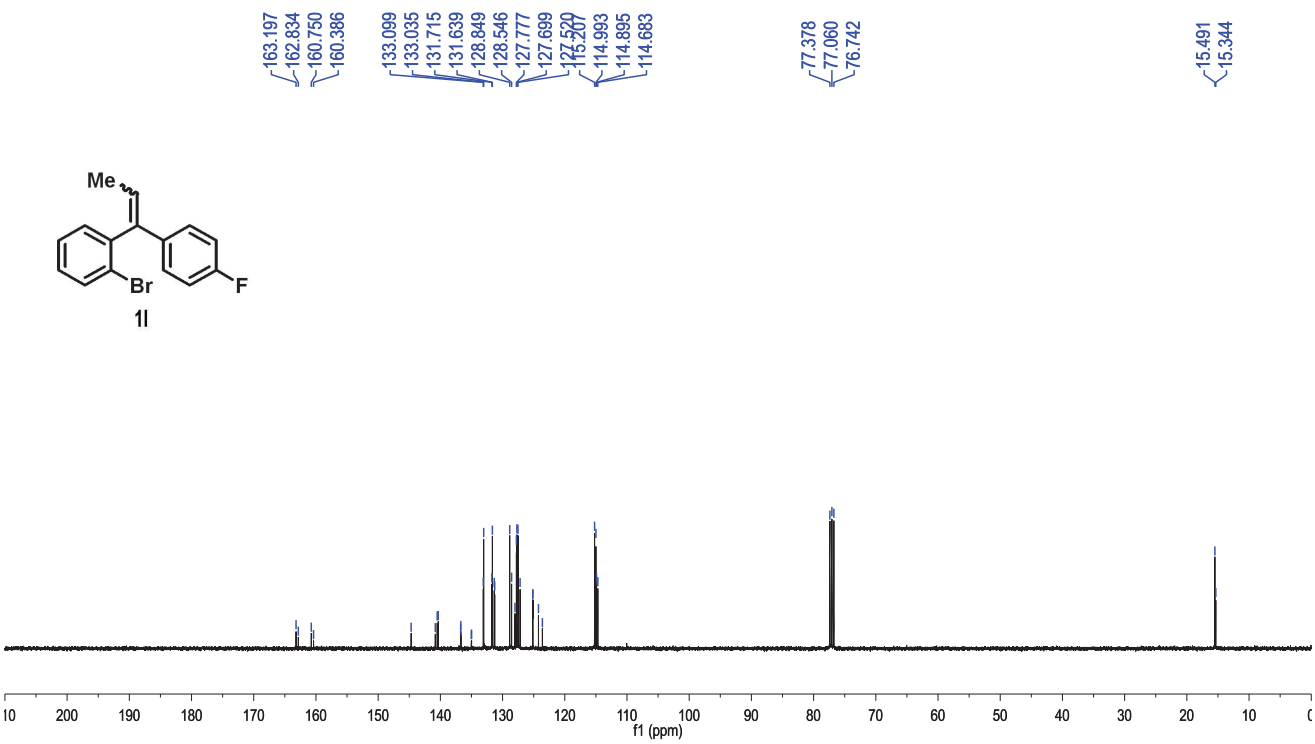
1.97
f1 (ppm)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115.207
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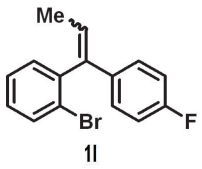
Me
Br
F
1l
f1 (ppm)


Me
Br
F

1l

115.416
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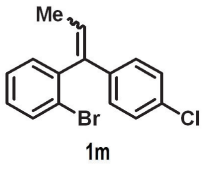
f1 (ppm)


Me
Br
Cl

1m

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7.528
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7.331
7.281
7.263
7.250
7.227
7.206
7.183
7.173
7.139
7.123
7.102
6.339
6.322
5.882
5.864
5.846
5.828
1.906
1.888
1.622
1.604
1.546
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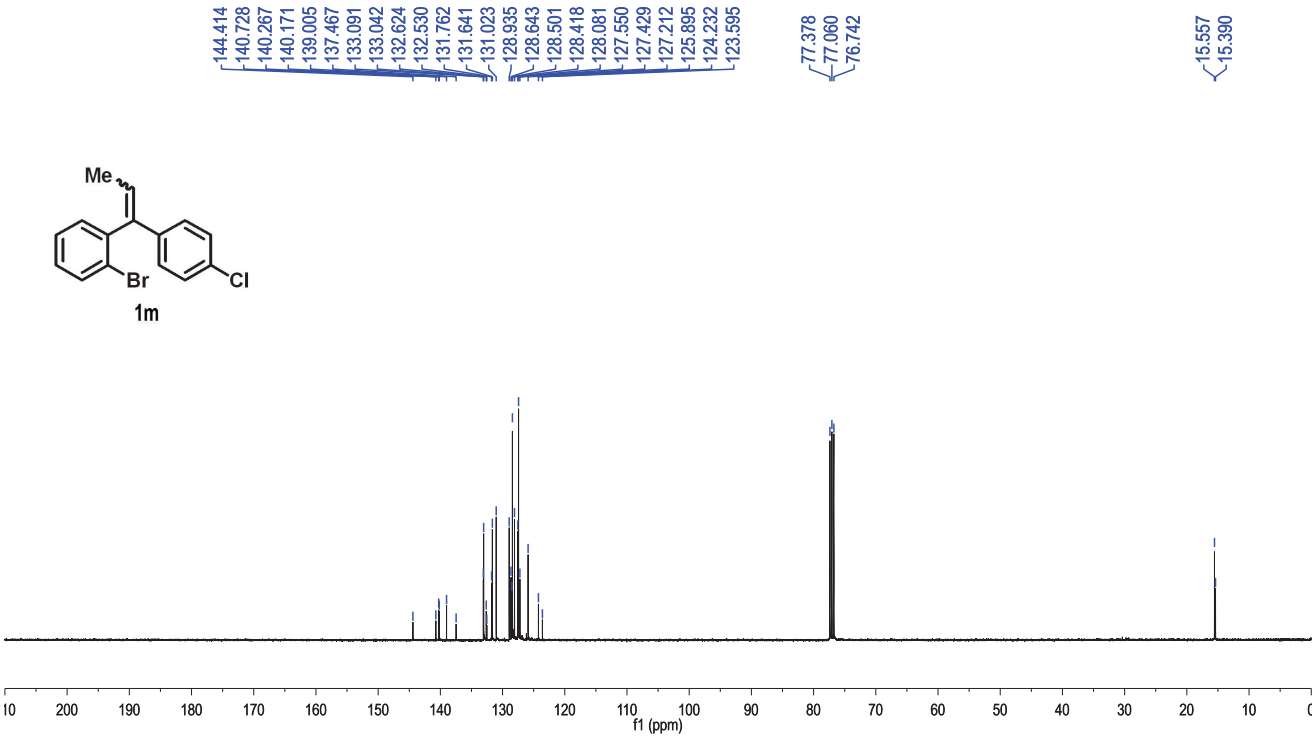
0.64
0.35
2.36
4.96
0.65
0.36
1.05
1.96
f1 (ppm)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133.042
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132.530
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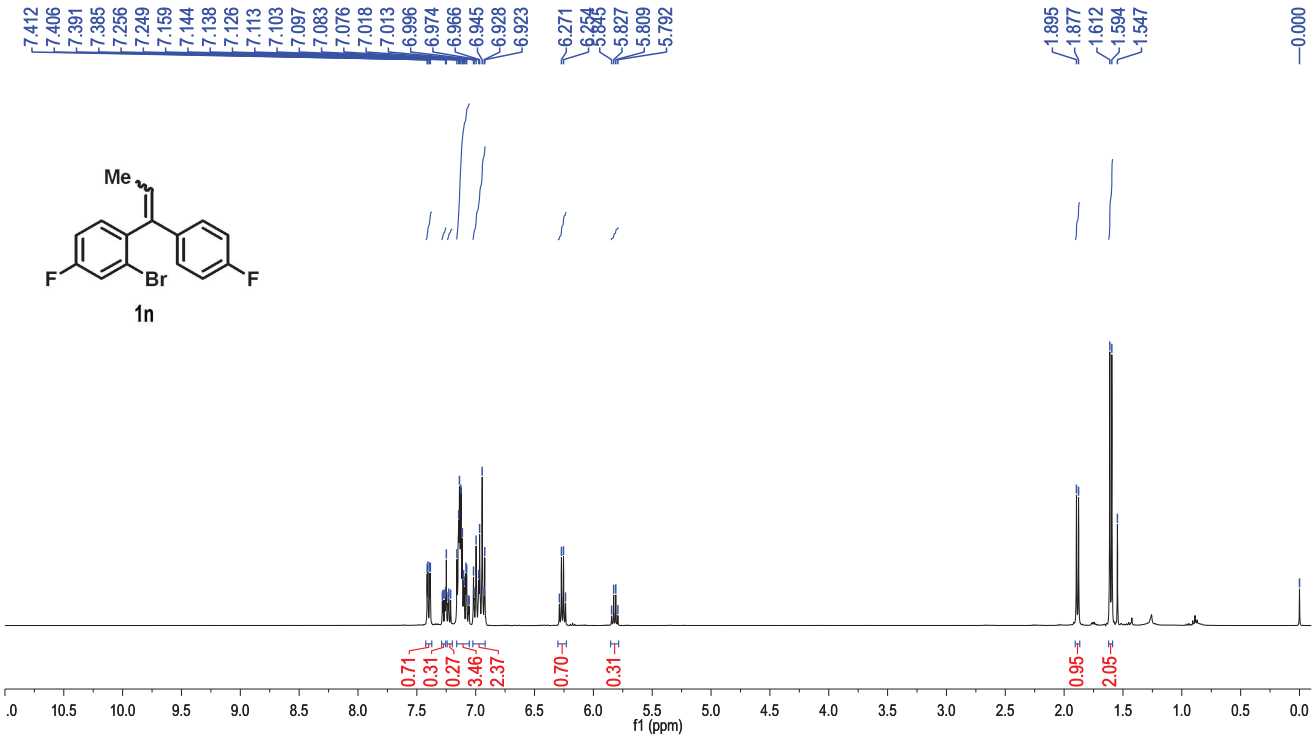
131.023
128.935
128.643
128.501
128.418
128.081
127.550
127.429
127.212
125.895
124.232
123.595
77.378
77.060
76.742
15.557
15.390
Me
Br
Cl
1m
f1 (ppm)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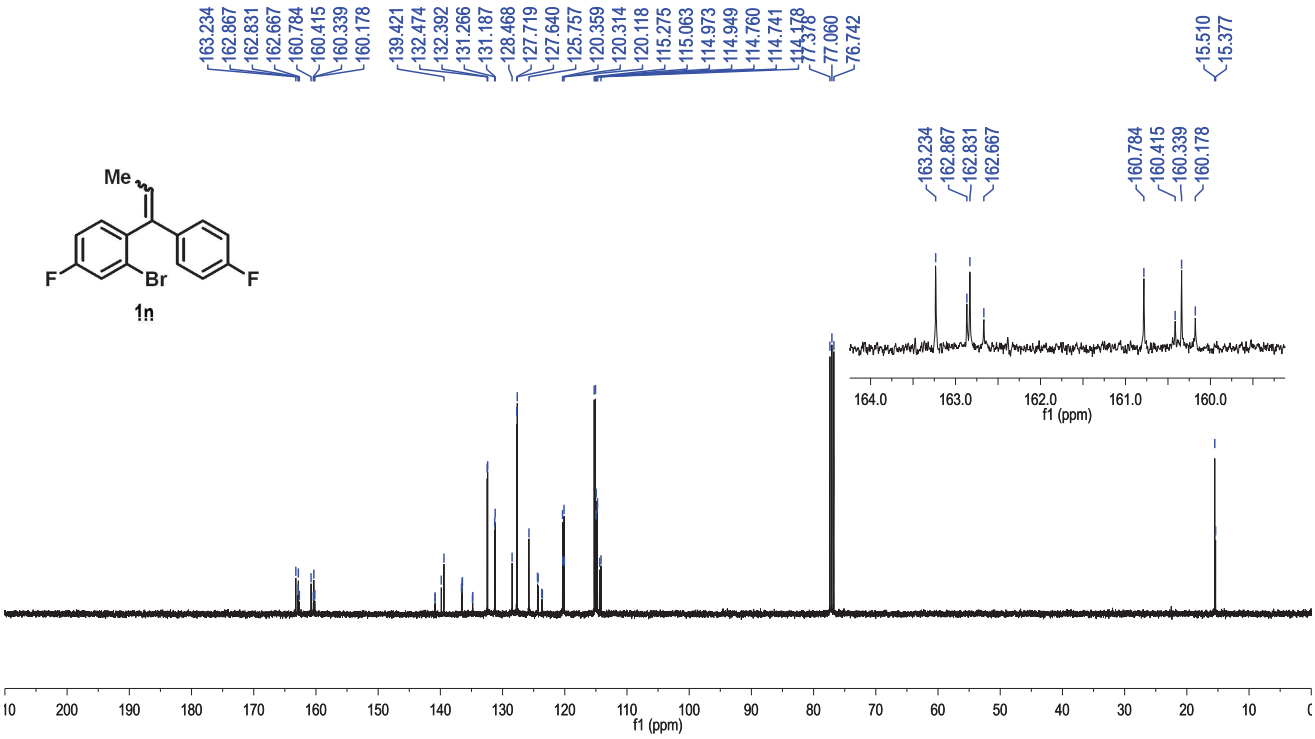
7.391
7.385
7.256
7.249
7.159
7.144
7.138
7.126
7.113
7.103
7.097
7.083
7.076
7.018
7.013
6.996
6.974
6.966
6.945
6.928
6.923
6.271
6.254
5.827
5.809
5.792
1.895
1.877
1.612
1.594
1.547
0.000
Me
F
Br
F
1n
0.71
0.31
0.27
3.46
2.37
0.70
0.31
0.95
2.05
f1 (ppm)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162.867
162.831
162.667
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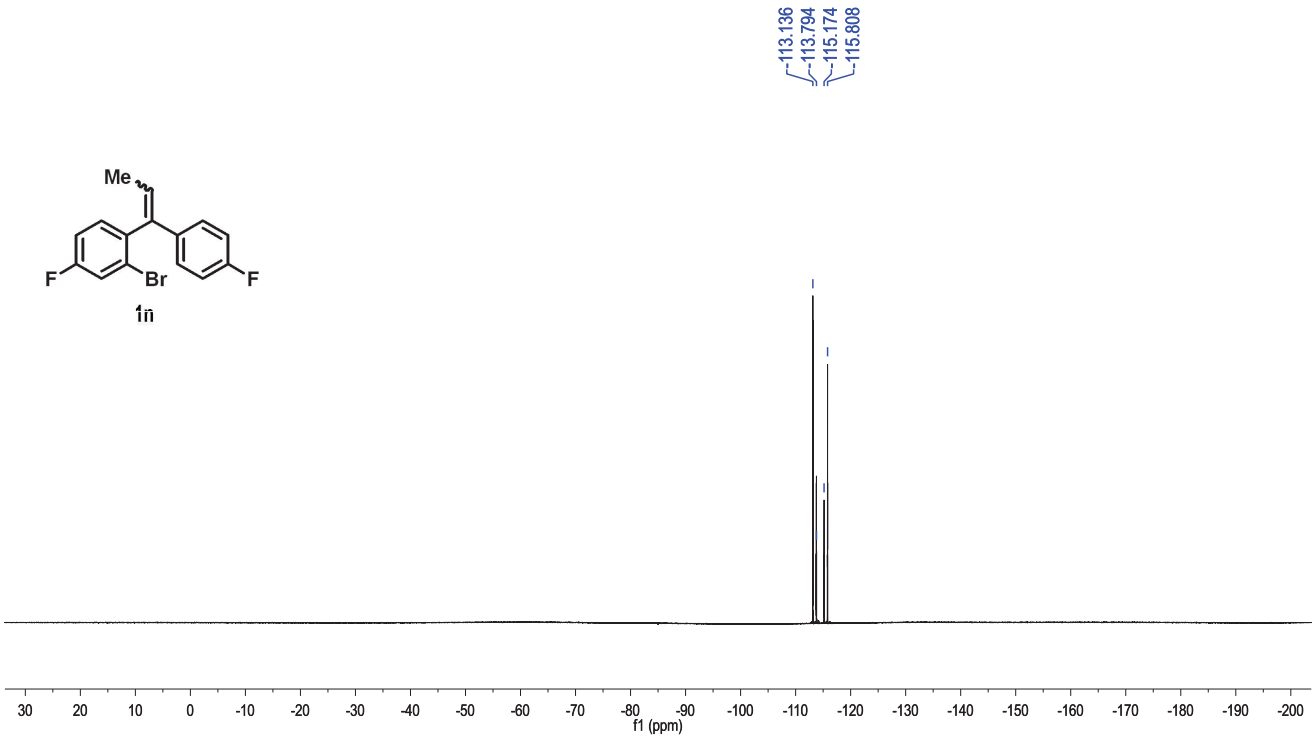
160.415
160.339
160.178
139.421
132.474
132.392
131.266
131.187
128.468
127.719
127.640
125.757
120.359
120.314
120.118
115.275
115.063
114.973
114.949
114.760
114.741
114.178
77.378
77.060
76.742
15.510
15.377
Me
F
Br
F
1n
f1 (ppm)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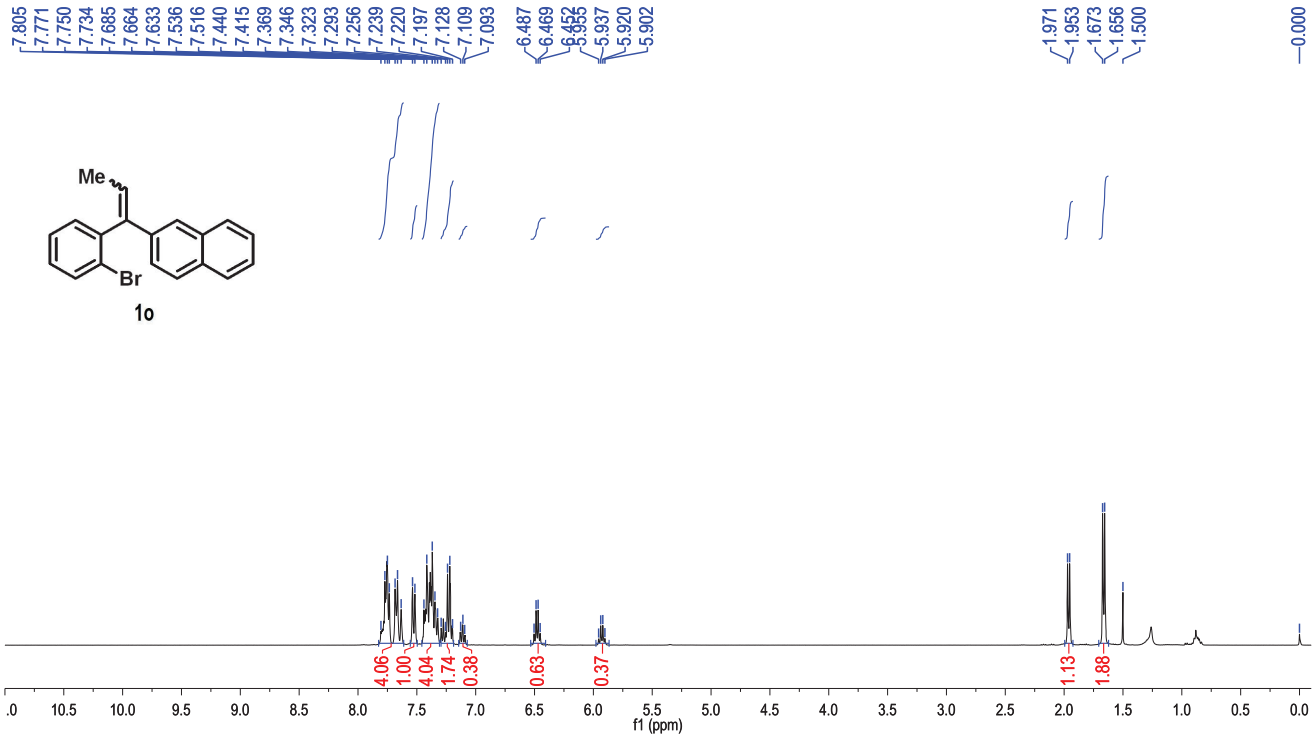
113.794
115.174
115.808
Me
F
Br
F
1n
f1 (ppm)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7.771
7.750
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7.685
7.664
7.633
7.536
7.516
7.440
7.415
7.369
7.346
7.323
7.293
7.256
7.239
7.220
7.197
7.128
7.109
7.093
6.487
6.469
5.937
5.920
5.902
1.971
1.953
1.673
1.656
1.500
0.000
Me
Br
1o
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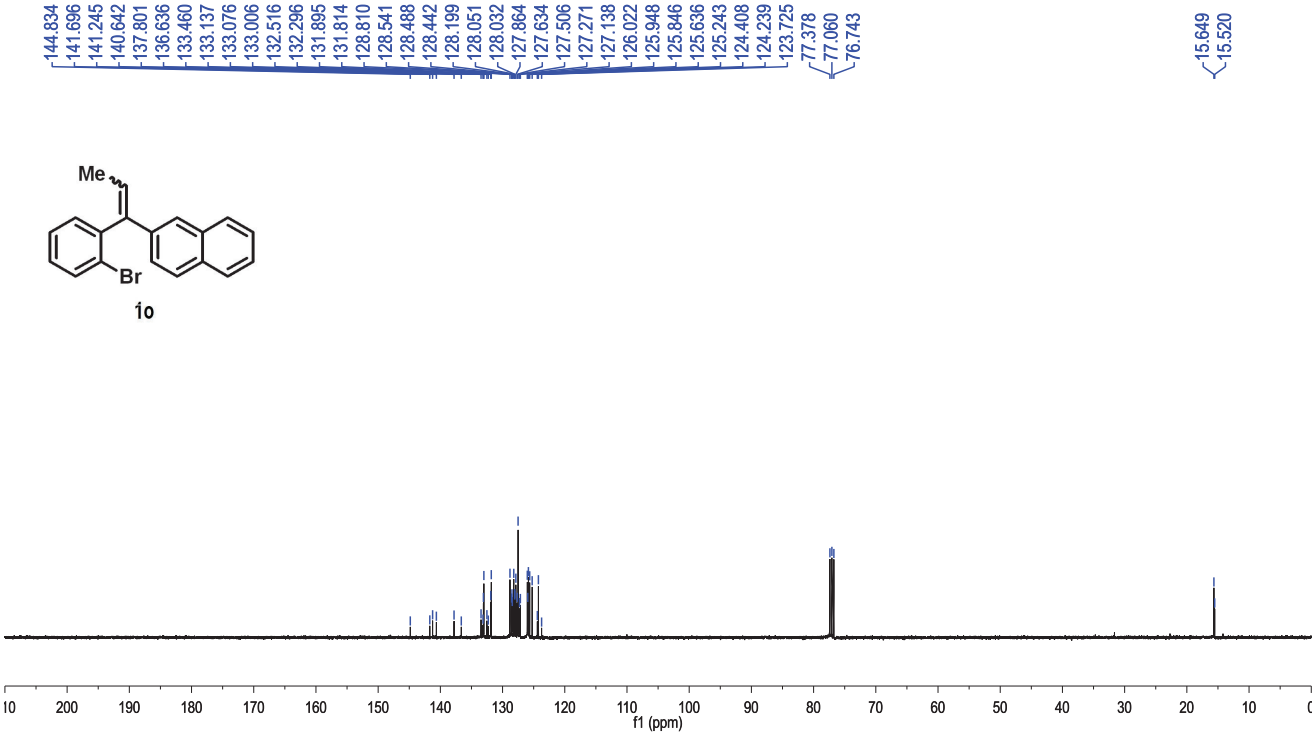
1.00
4.04
1.74
0.38
0.63
0.37
1.13
1.88
f1 (ppm)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141.245
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133.137
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133.006
132.516
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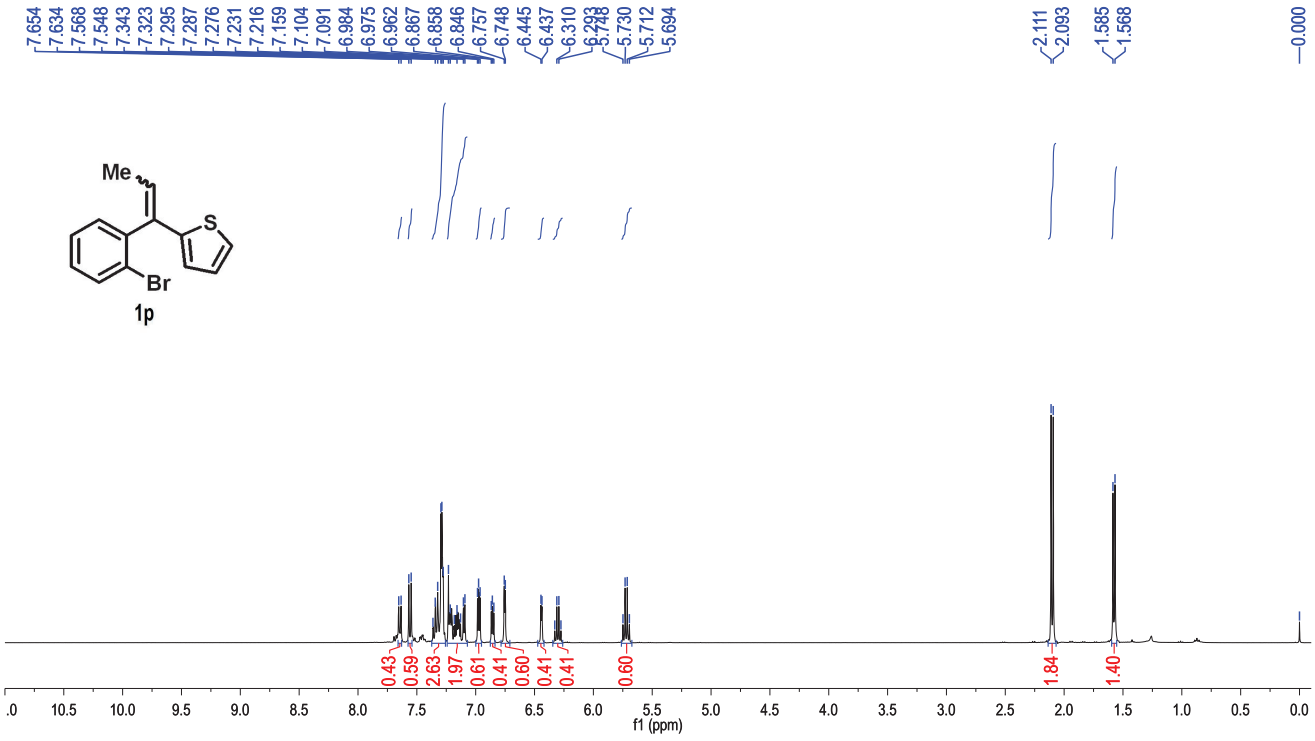
131.895
131.814
128.810
128.541
128.488
128.442
128.199
128.051
128.032
127.864
127.634
127.506
127.271
127.138
126.022
125.948
125.846
125.636
125.243
124.408
124.239
123.725
77.378
77.060
76.743
15.649
15.520
Me
Br
1o
f1 (ppm)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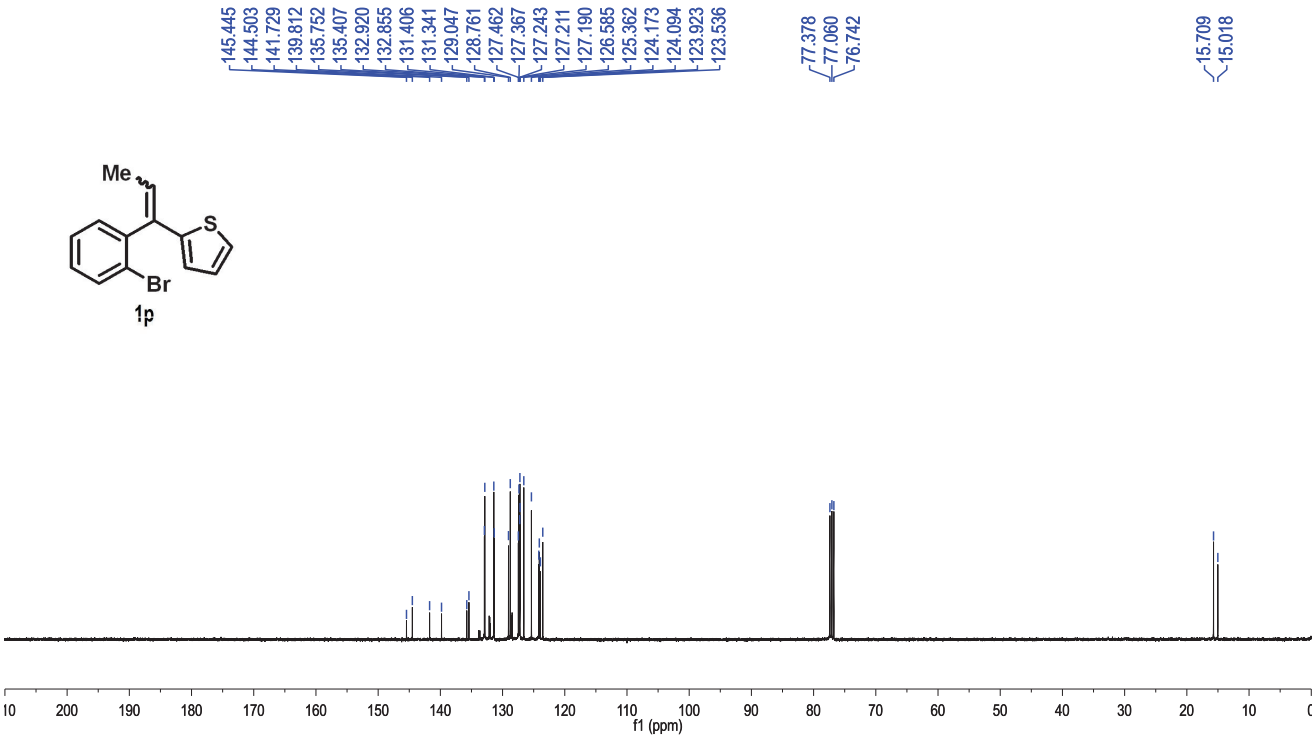
7.343
7.323
7.295
7.287
7.276
7.231
7.216
7.159
7.104
7.091
6.984
6.975
6.962
6.867
6.858
6.846
6.757
6.748
6.445
6.437
6.310
5.730
5.712
5.694
2.111
2.093
1.585
1.568
0.000
Me
S
Br
1p
0.43
0.59
2.63
1.97
0.61
0.41
0.60
0.41
0.41
0.60
1.84
1.40
f1 (ppm)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141.729
139.812
135.752
135.407
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132.855
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131.341
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128.761
127.462
127.367
127.243
127.211
127.190
126.585
125.362
124.173
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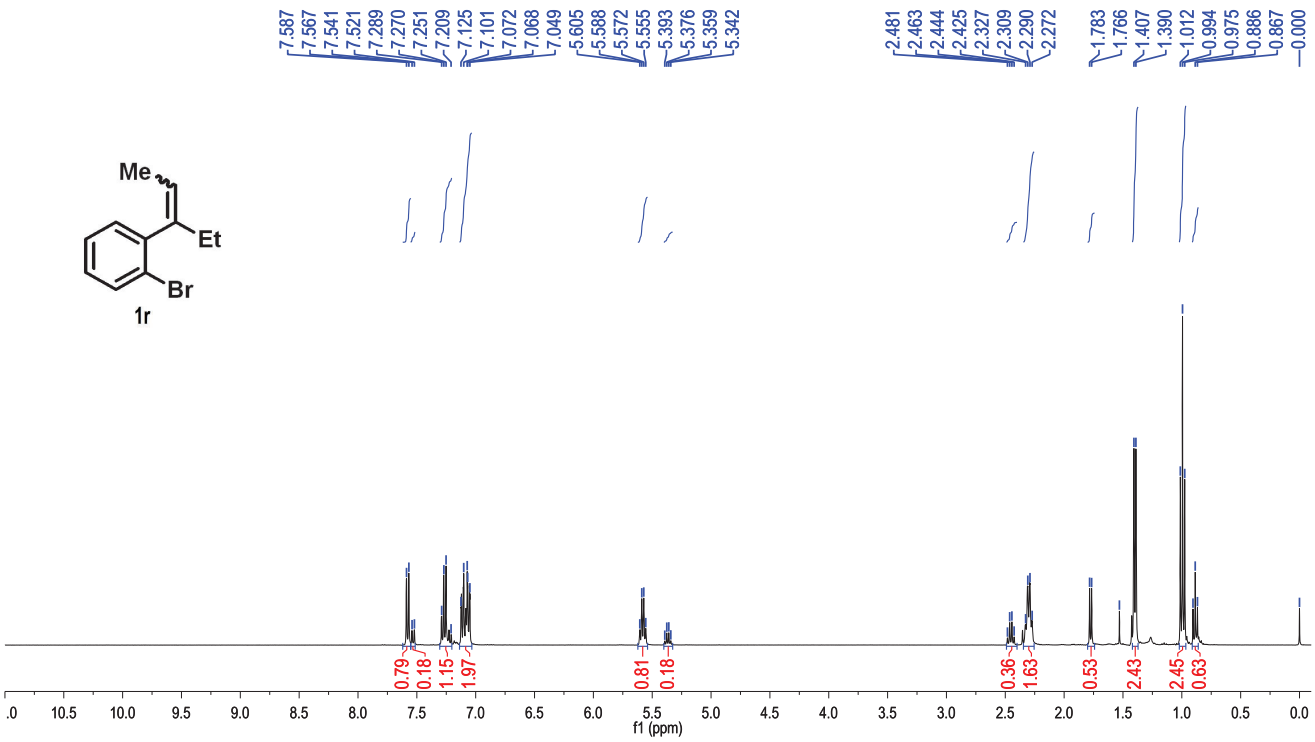
123.923
123.536
77.378
77.060
76.742
15.709
15.018
Me
S
Br
1p
f1 (ppm)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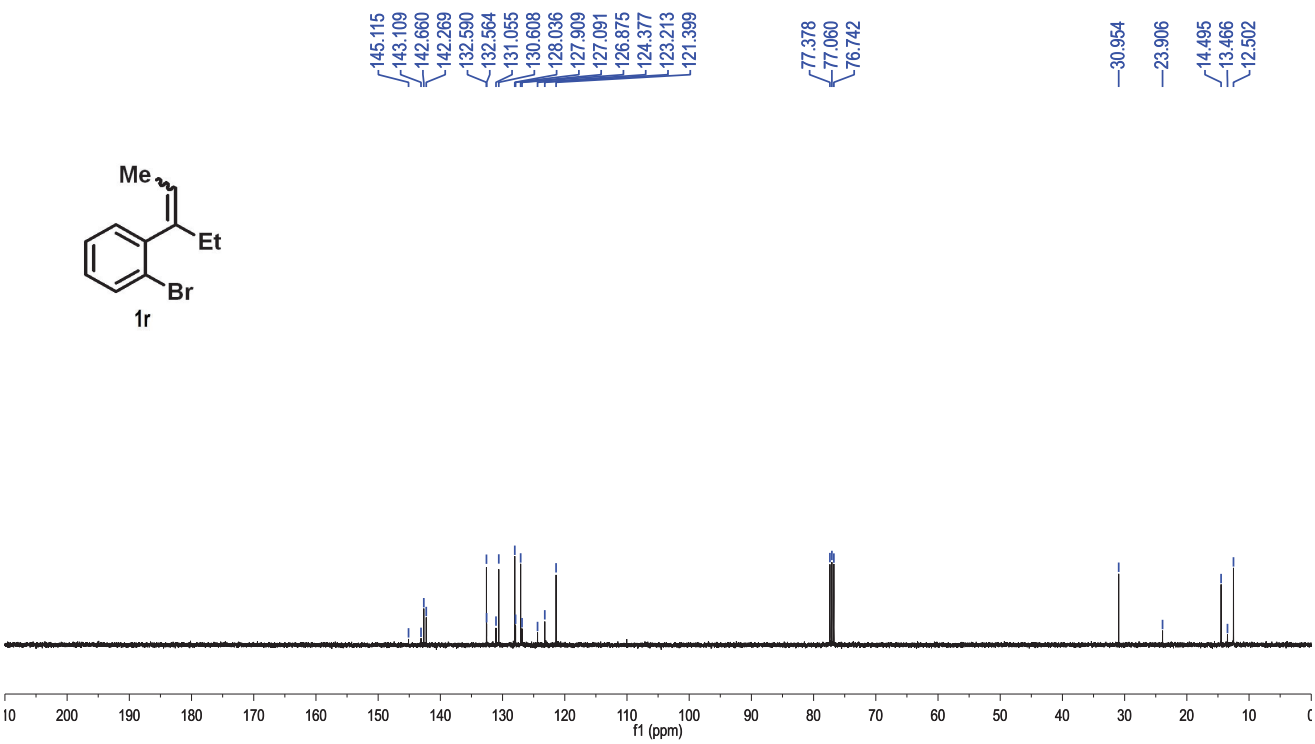
7.541
7.521
7.289
7.270
7.251
7.209
7.125
7.101
7.072
7.068
7.049
5.605
5.588
5.572
5.555
5.393
5.376
5.359
5.342
2.481
2.463
2.444
2.425
2.327
2.309
2.290
2.272
1.783
1.766
1.407
1.390
1.012
0.994
0.975
0.886
0.867
0.000
Me
Et
Br
1r
0.79
0.18
1.15
1.97
0.81
0.18
0.36
1.63
0.53
2.43
2.45
0.63
f1 (ppm)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143.109
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142.269
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132.564
131.055
130.608
128.036
127.909
127.091
126.875
124.377
123.213
121.399
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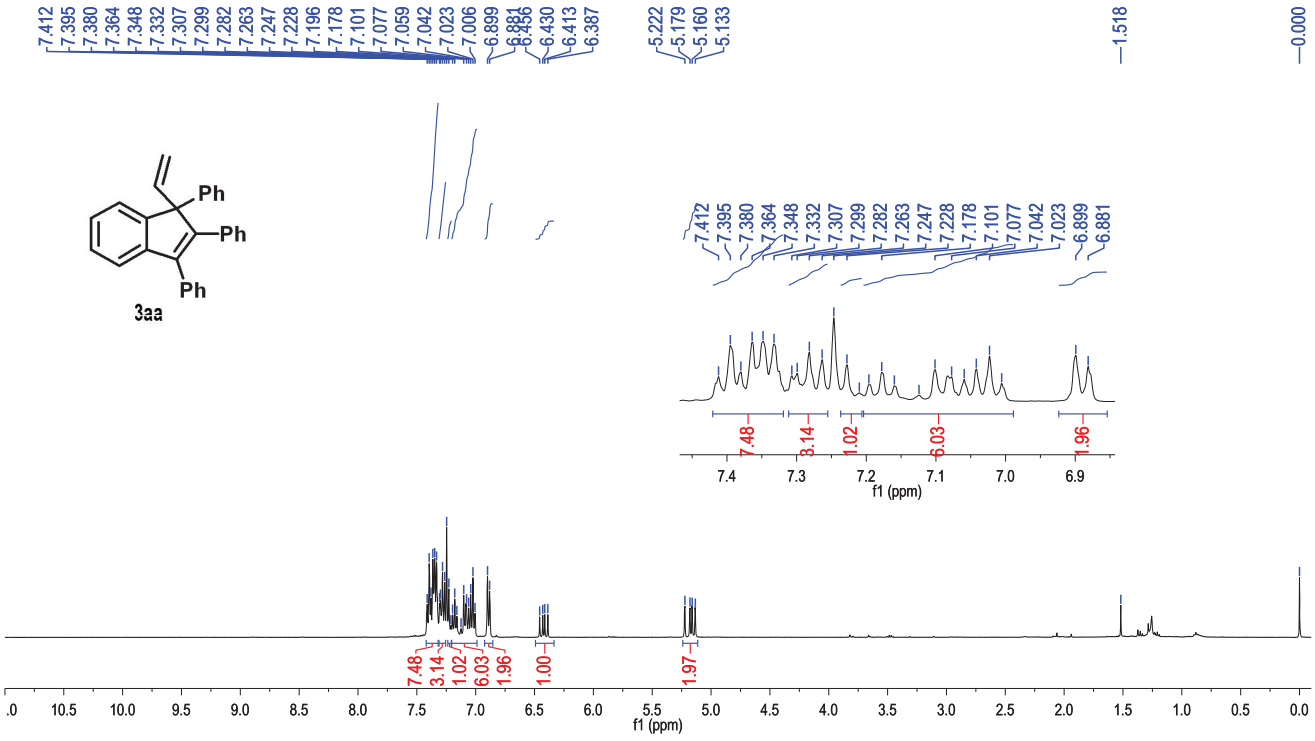
77.060
76.742
30.954
23.906
14.495
13.466
12.502
Me
Et
Br
1r
f1 (ppm)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7.332
7.307
7.299
7.282
7.263
7.247
7.228
7.196
7.178
7.101
7.077
7.059
7.042
7.023
7.006
6.899
6.881
6.456
6.430
6.413
6.387
5.222
5.179
5.160
5.133
1.518
0.000
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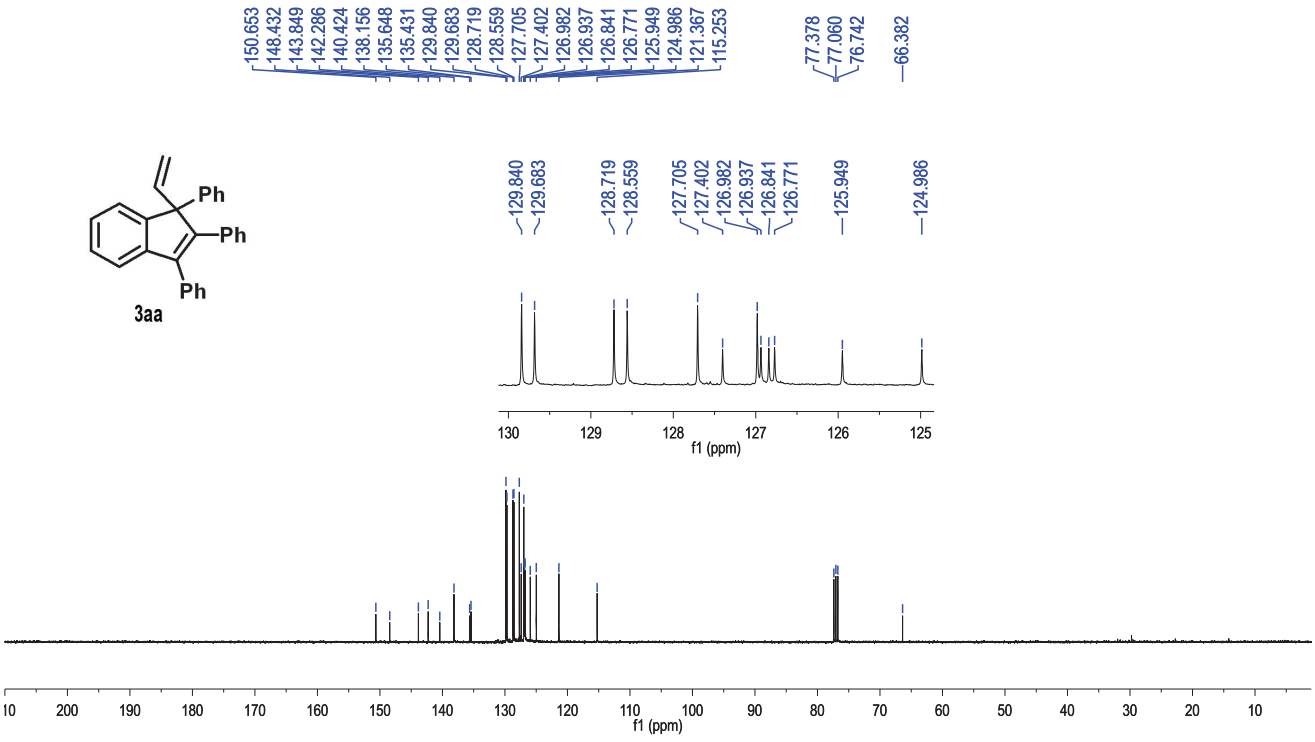
Ph
Ph
3aa
7.48
3.14
1.02
6.03
1.96
1.00
1.97
f1 (ppm)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129.683
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127.705
127.402
126.982
126.937
126.841
126.771
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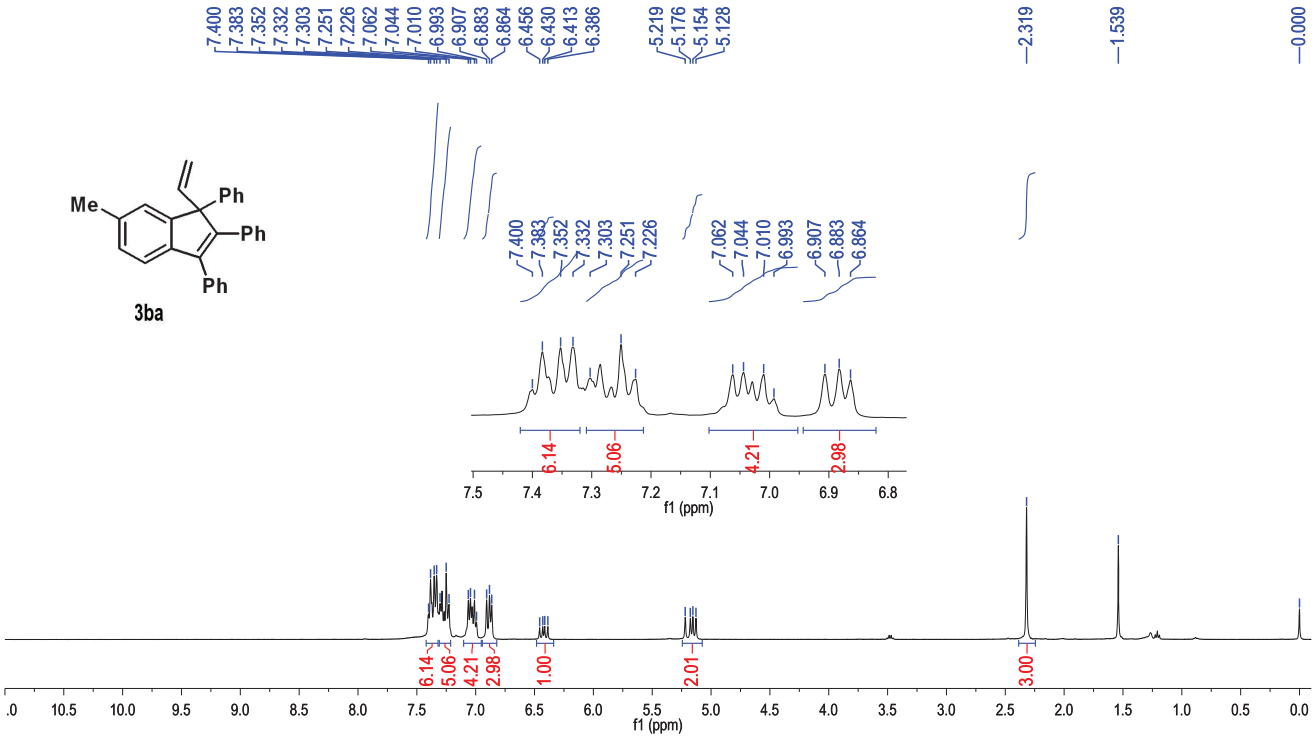
124.986
121.367
115.253
77.378
77.060
76.742
66.382
Ph
Ph
Ph
3aa
f1 (ppm)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7.383
7.352
7.332
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7.251
7.226
7.062
7.044
7.010
6.993
6.907
6.883
6.864
6.456
6.430
6.413
6.386
5.219
5.176
5.154
5.128
2.319
1.539
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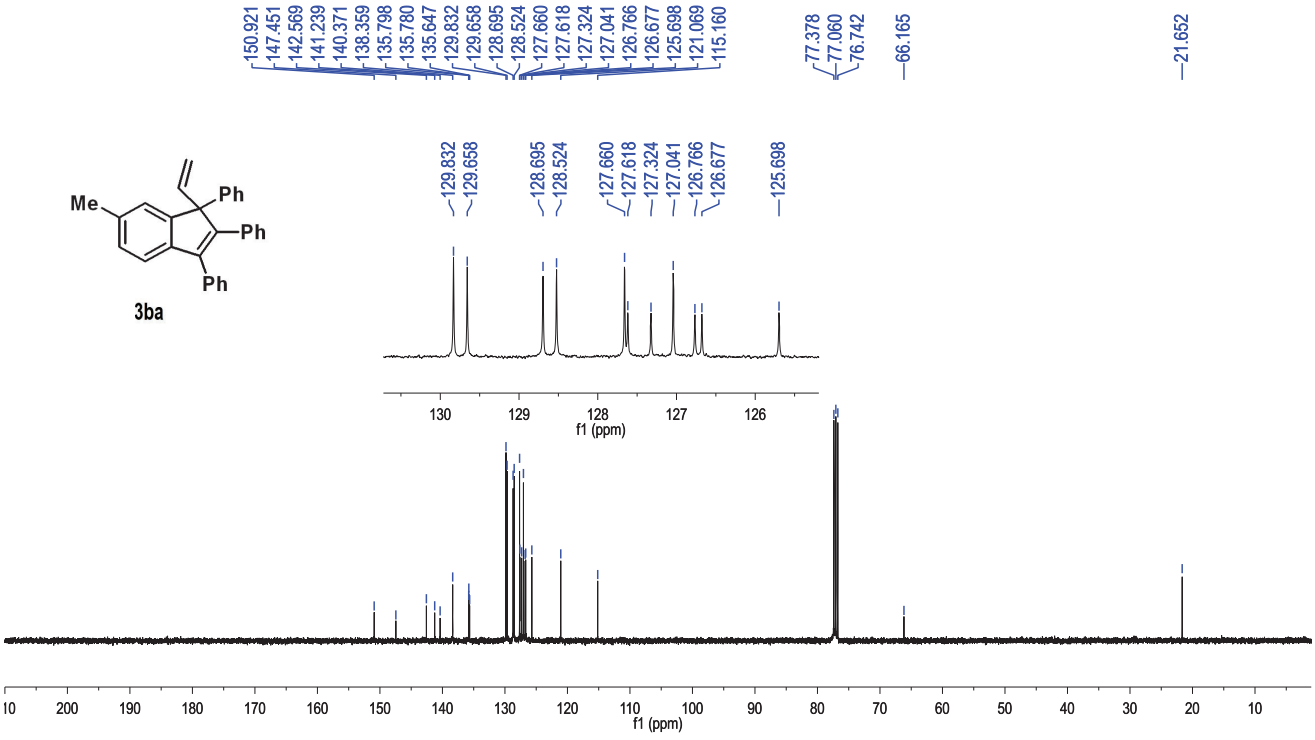
Me
Ph
Ph
Ph
3ba
6.14
5.06
4.21
2.98
1.00
2.01
3.00
f1 (ppm)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127.324
127.041
126.766
126.677
125.698
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77.060
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Me
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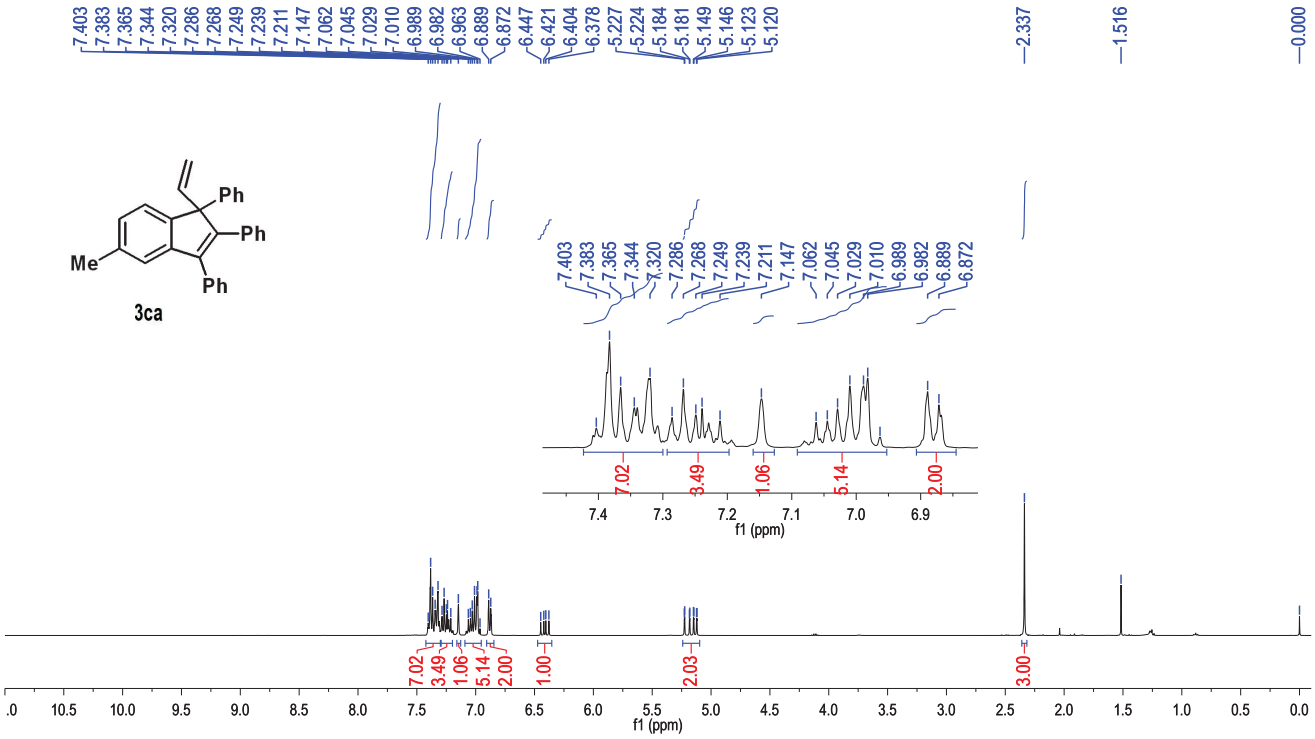
Ph
Ph
3ba
f1 (ppm)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7.249
7.239
7.211
7.147
7.062
7.045
7.029
7.010
6.989
6.982
6.963
6.889
6.872
6.447
6.421
6.404
6.378
5.227
5.224
5.184
5.181
5.149
5.146
5.123
5.120
2.337
1.516
0.000
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Ph
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3.49
1.06
5.14
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1.00
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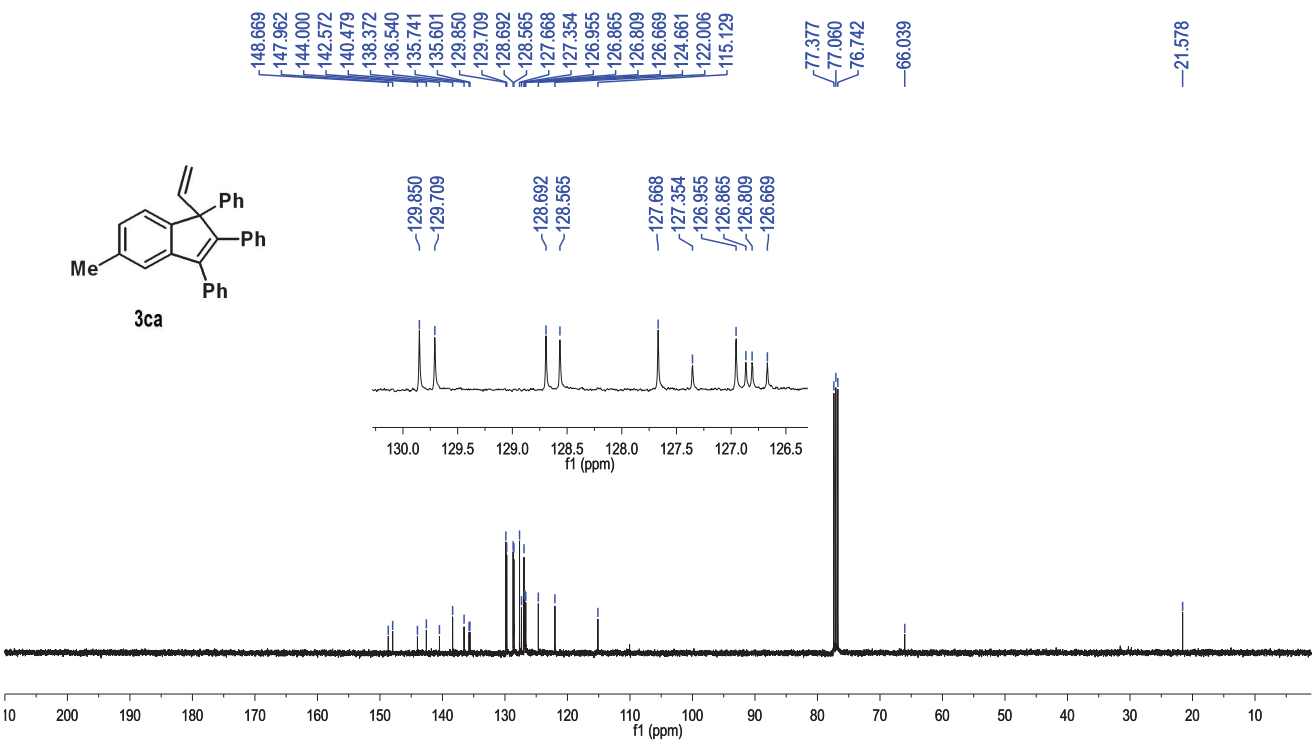
3.00
f1 (ppm)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127.668
127.354
126.955
126.865
126.809
126.669
124.661
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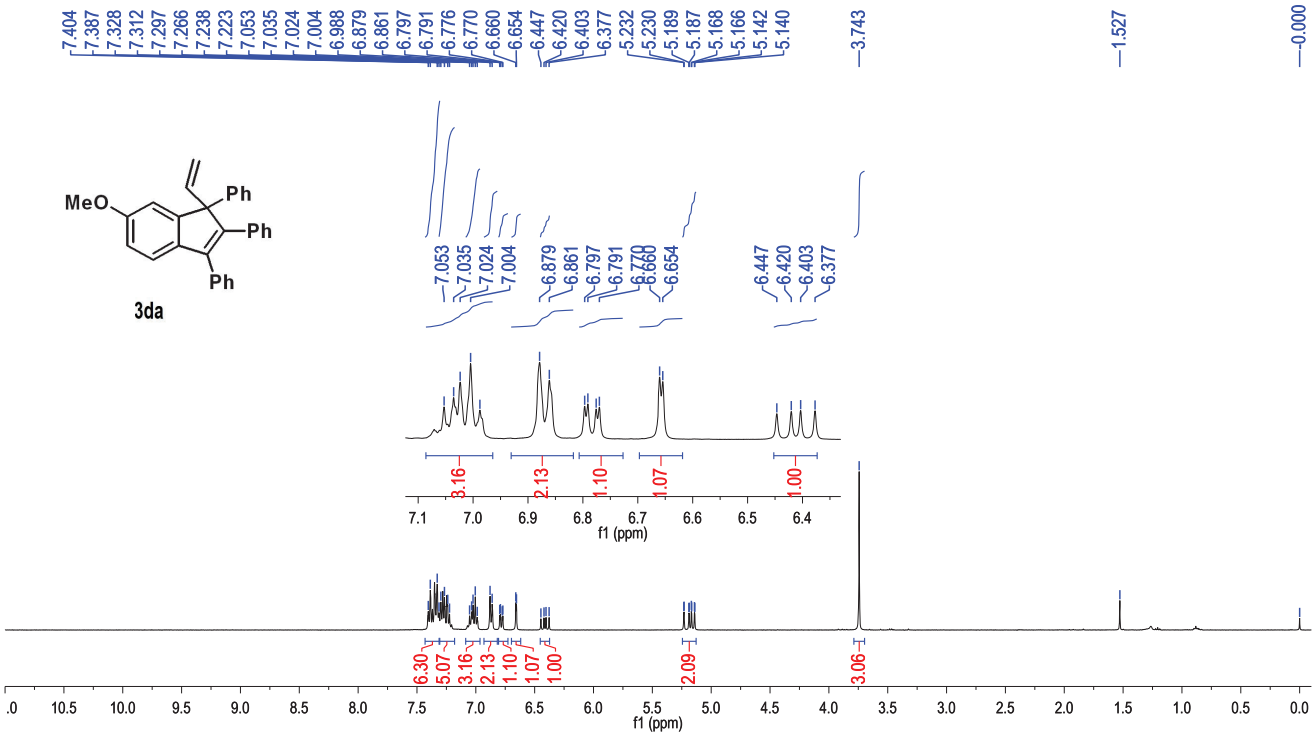
77.377
77.060
76.742
66.039
21.578
Ph
Ph
Ph
Me
3ca
f1 (ppm)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7.035
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7.004
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6.879
6.861
6.797
6.791
6.776
6.770
6.660
6.654
6.447
6.420
6.403
6.377
5.232
5.230
5.189
5.187
5.168
5.166
5.142
5.140
3.743
1.527
0.000
MeO
Ph
Ph
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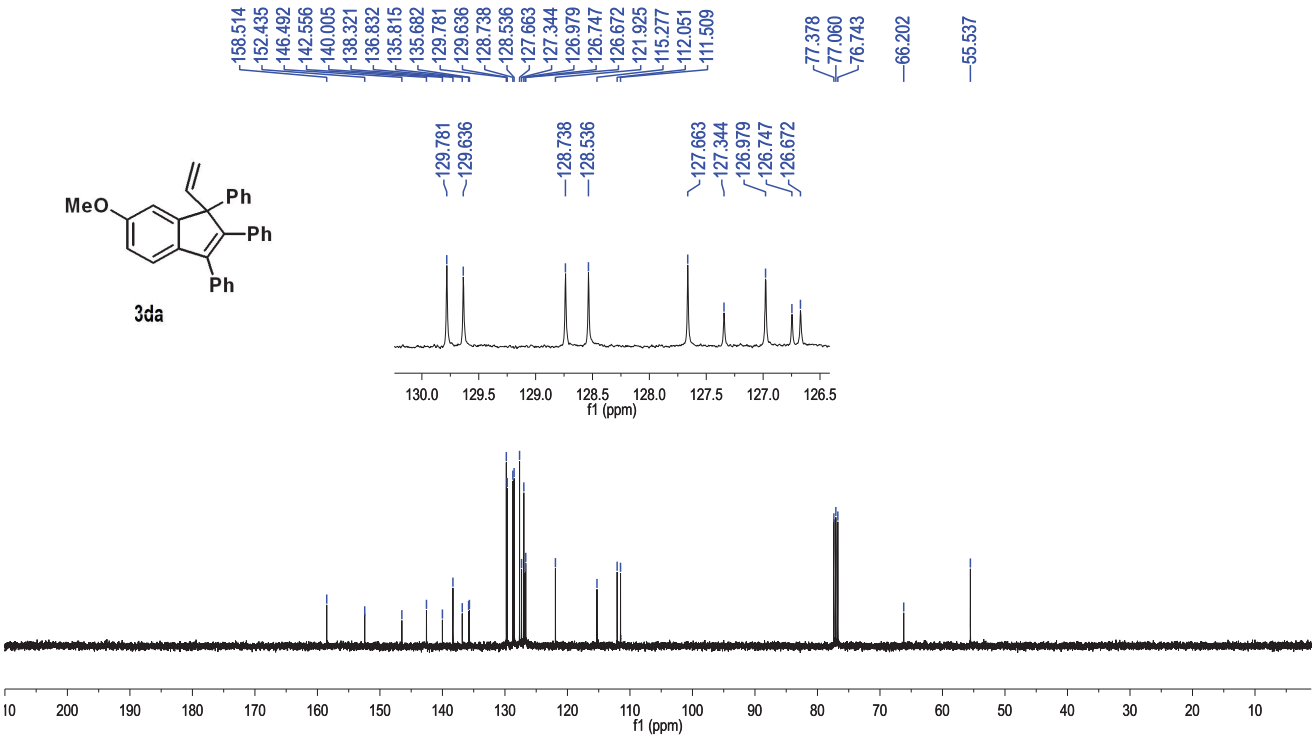
2.13
1.10
1.07
1.00
2.09
3.06
f1 (ppm)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128.536
127.663
127.344
126.979
126.747
126.672
121.925
115.277
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77.060
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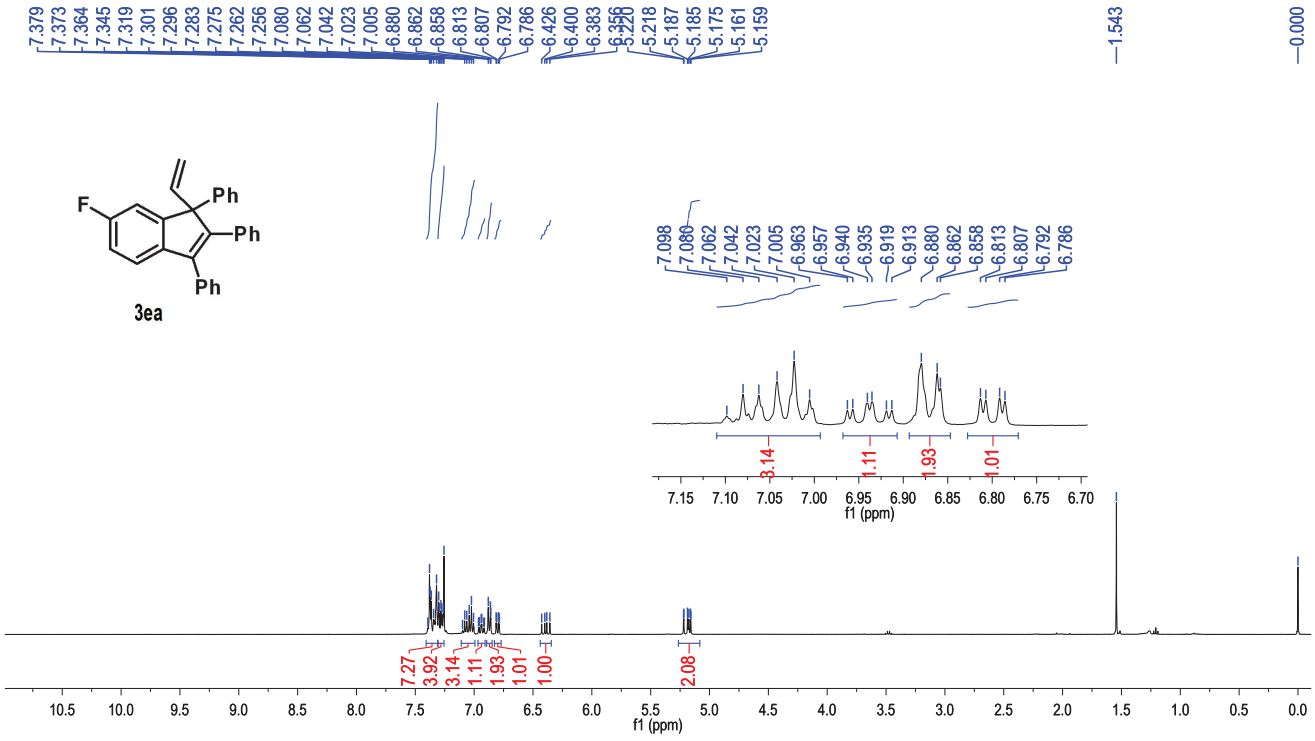
66.202
55.537
MeO
Ph
Ph
Ph
3da
f1 (ppm)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7.062
7.042
7.023
7.005
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6.862
6.858
6.813
6.807
6.792
6.786
6.426
6.400
6.383
5.218
5.187
5.185
5.175
5.161
5.159
1.543
0.000
F
Ph
Ph
Ph
3ea
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7.080
7.062
7.042
7.023
7.005
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6.957
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6.919
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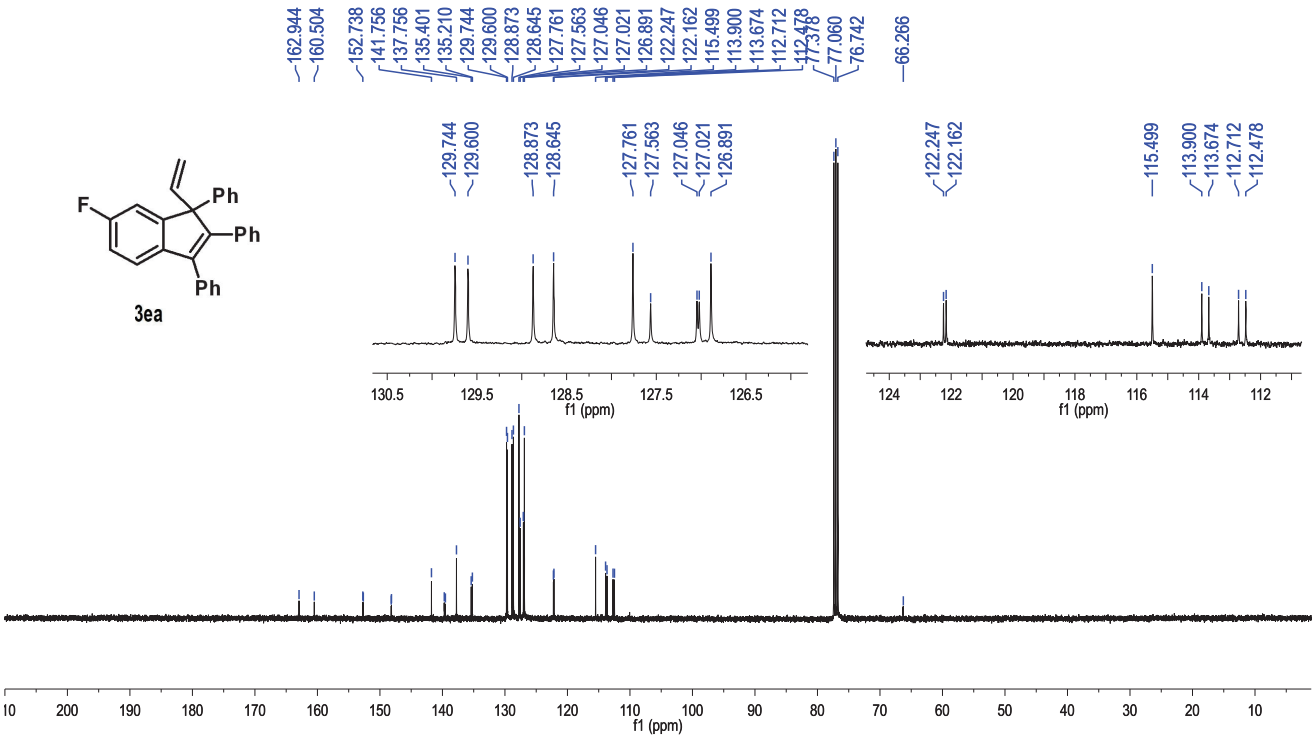
6.880
6.862
6.858
6.813
6.807
6.792
6.786
3.14
1.11
1.93
1.01
7.15 7.10 7.05 7.00 6.95 6.90 6.85 6.80 6.75 6.70
f1 (ppm)
7.27
3.92
3.14
1.11
1.93
1.01
1.00
2.08
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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127.021
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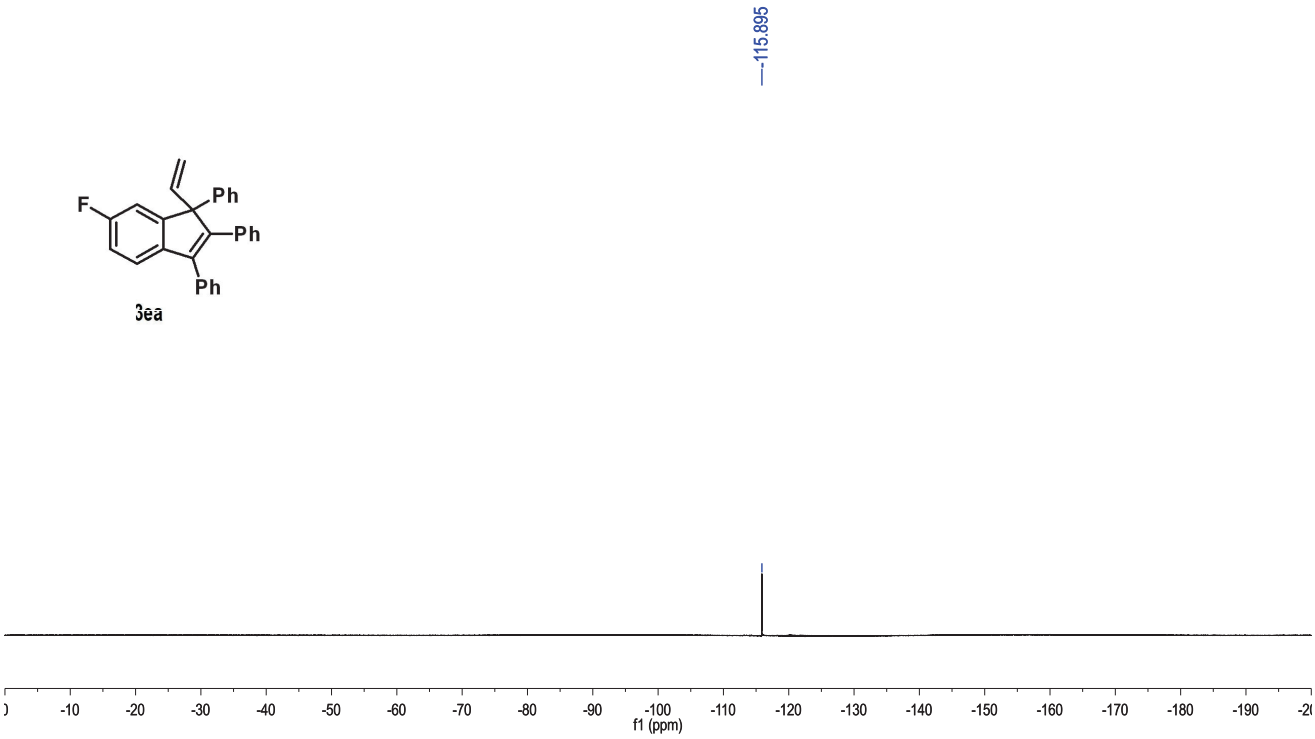
122.247
122.162
115.499
113.900
113.674
112.712
112.478
77.318
77.060
76.742
66.266
F
Ph
Ph
Ph
3ea
129.744
129.600
128.873
128.645
127.761
127.563
127.046
127.021
126.891
122.247
122.162
115.499
113.900
113.674
112.712
112.478
130.5 129.5 128.5 127.5 126.5
f1 (ppm)
124 122 120 118 116 114 112
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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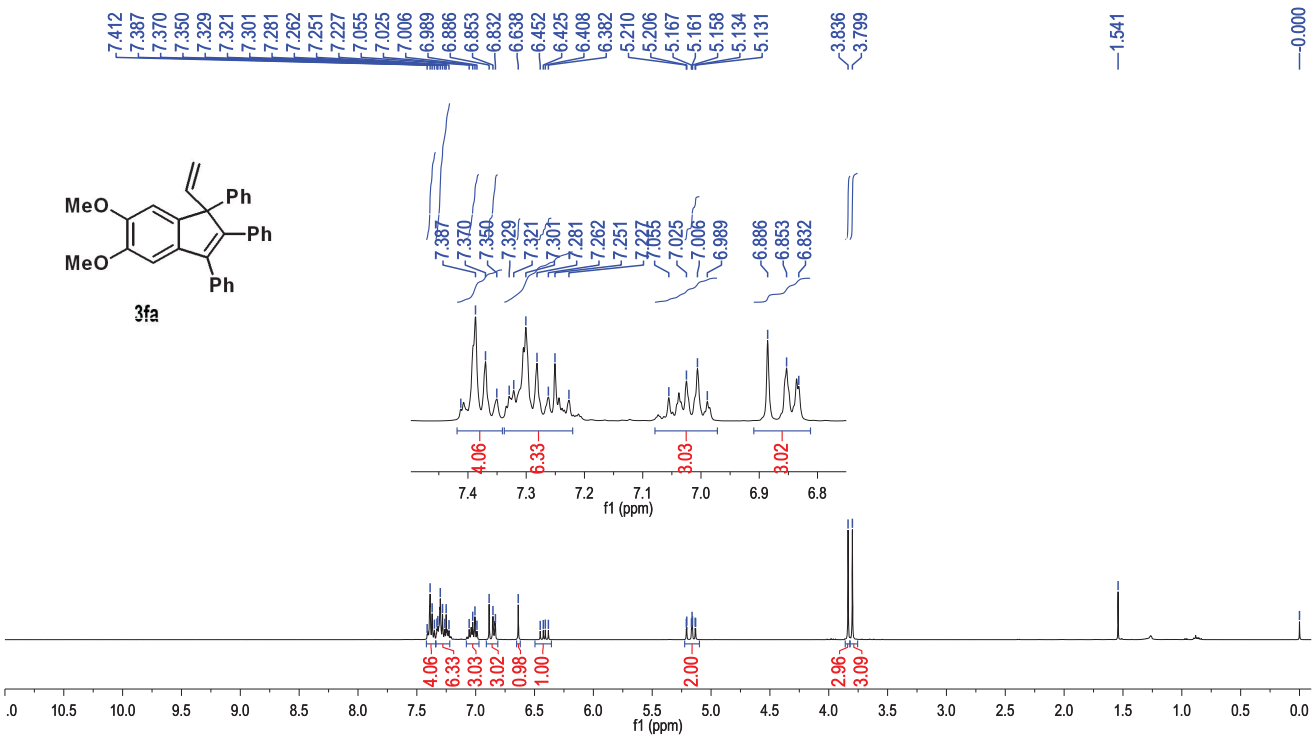
F
Ph
Ph
Ph
3ea
f1 (ppm)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7.025
7.006
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6.832
6.638
6.452
6.425
6.408
6.382
5.210
5.206
5.167
5.161
5.158
5.134
5.131
3.836
3.799
1.541
0.000
MeO
MeO
Ph
Ph
Ph
3fa
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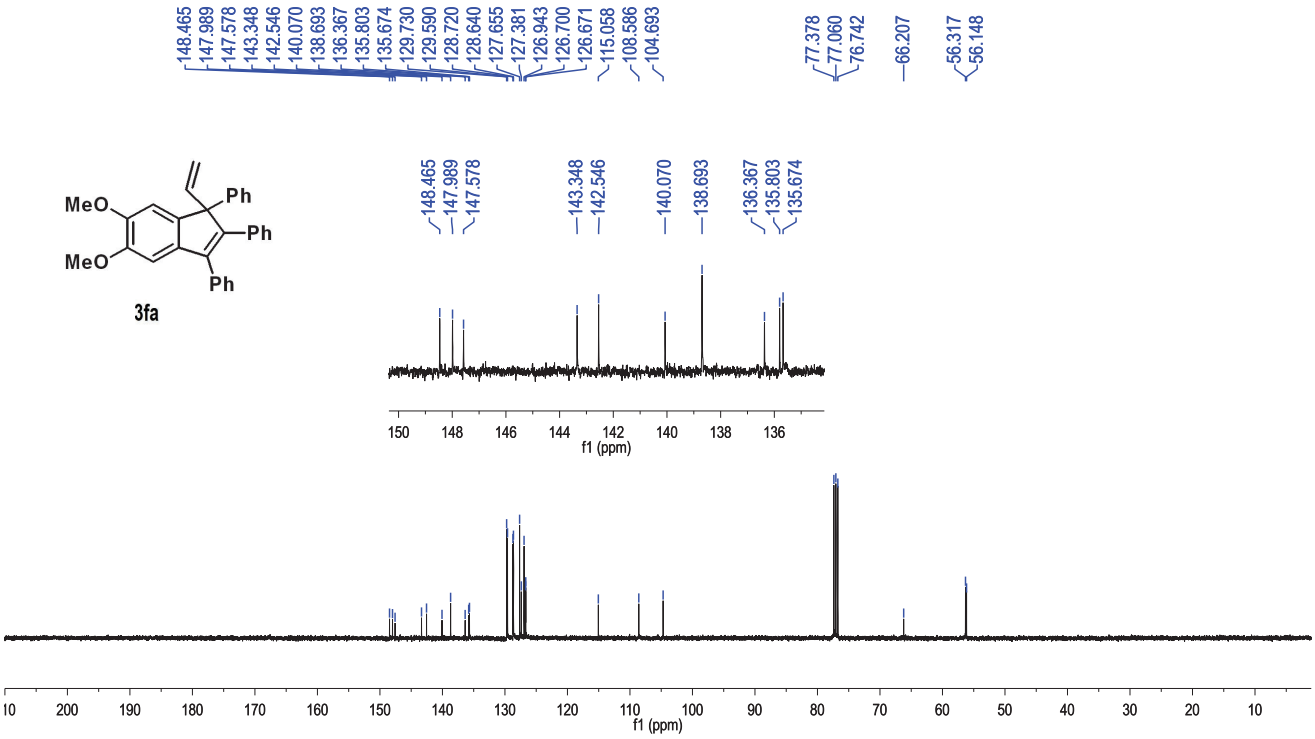
6.33
3.03
3.02
0.98
1.00
2.00
2.96
3.09
f1 (ppm)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128.640
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127.381
126.943
126.700
126.671
115.058
108.586
104.693
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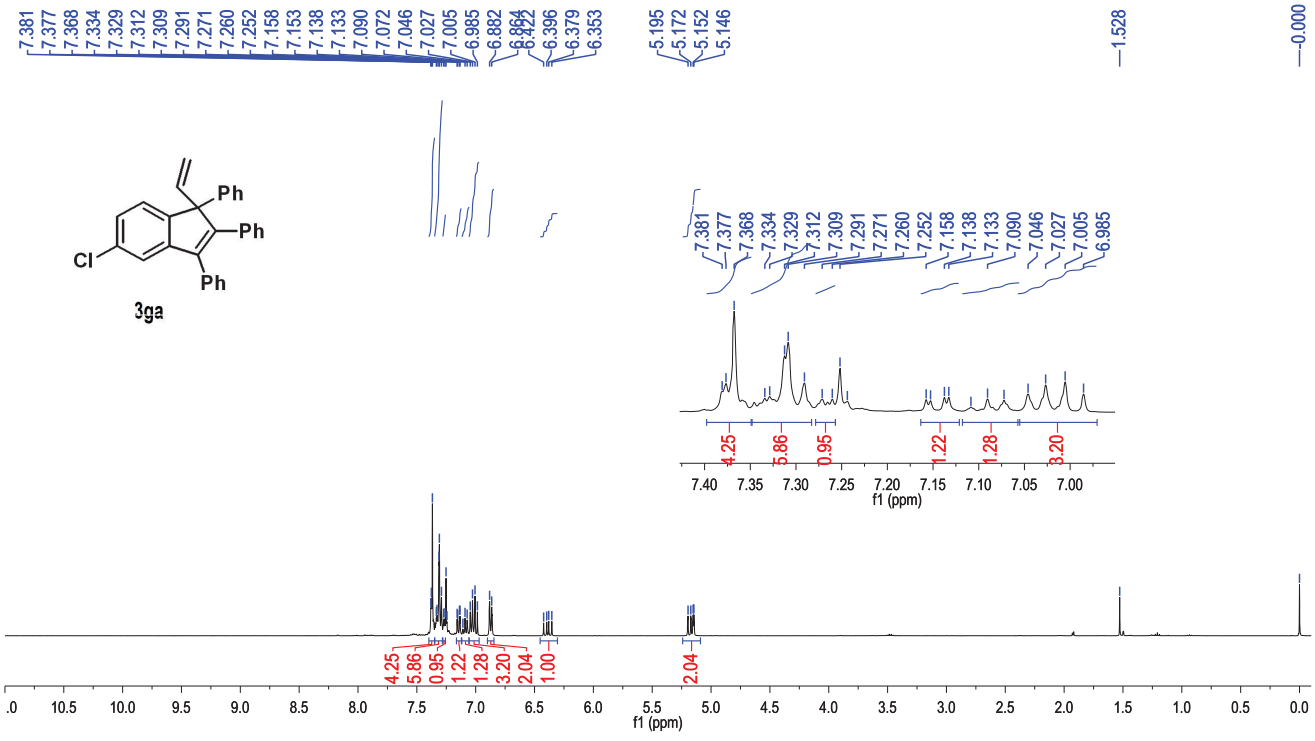
76.742
66.207
56.317
56.148
MeO
MeO
Ph
Ph
Ph
3fa
f1 (ppm)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7.133
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7.072
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7.027
7.005
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6.864
6.422
6.396
6.379
6.353
5.195
5.172
5.152
5.146
1.528
0.000
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Ph
Ph
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0.95
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1.28
3.20
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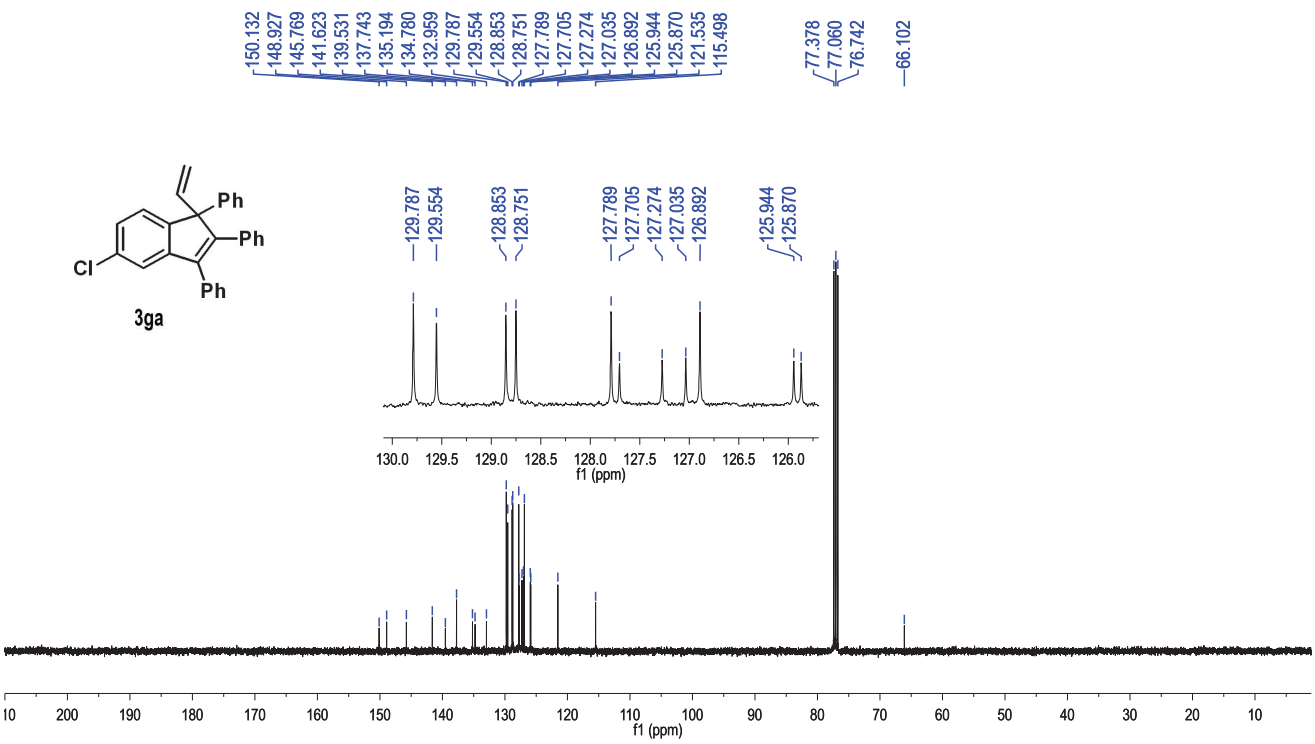
1.00
f1 (ppm)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127.705
127.274
127.035
126.892
125.944
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Ph
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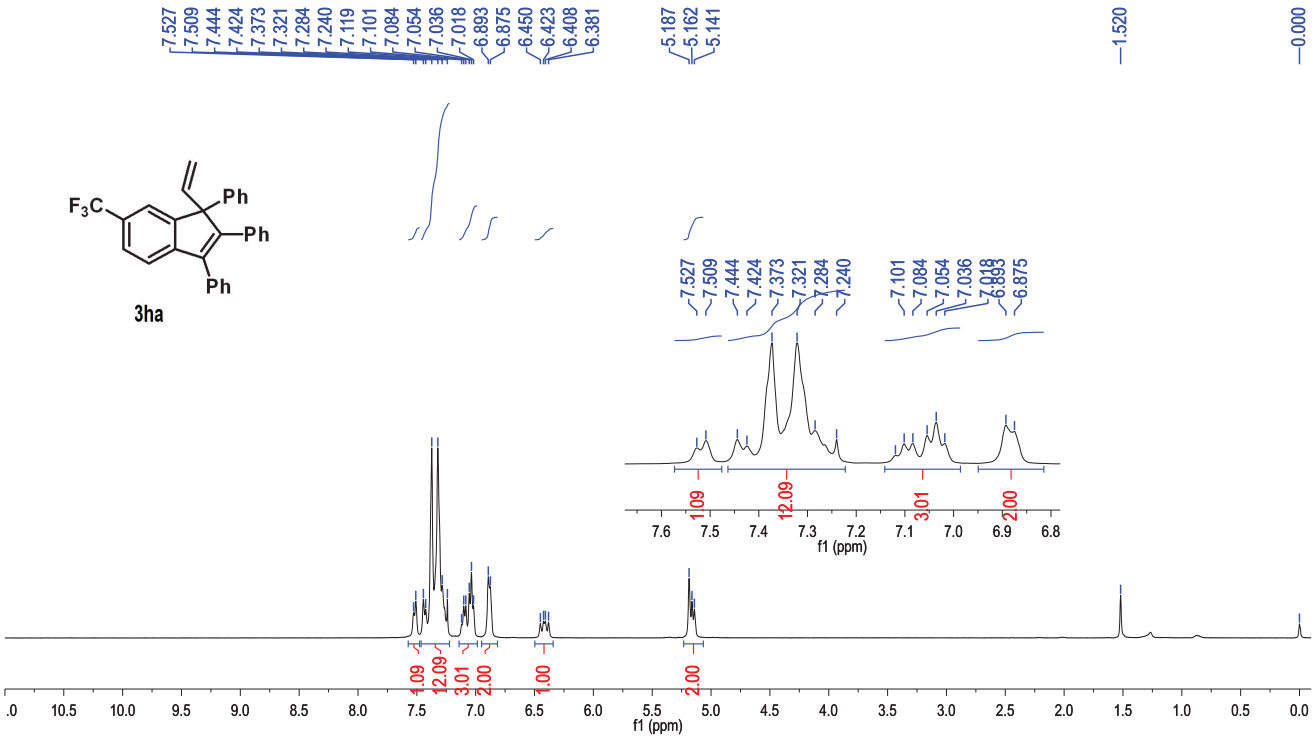
Ph
Cl
3ga
f1 (ppm)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7.036
7.018
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6.875
6.450
6.423
6.408
6.381
5.187
5.162
5.141
1.520
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Ph
Ph
F3C
3ha
1.09
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2.00
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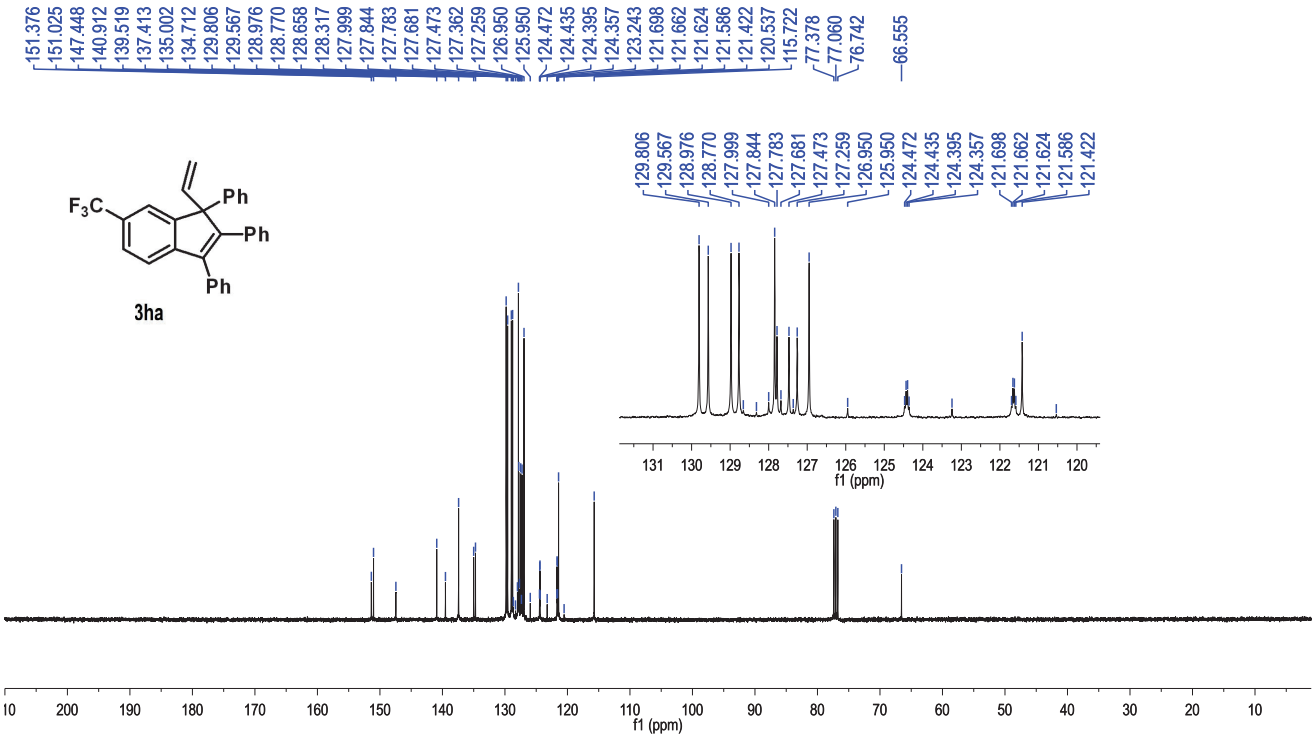
2.00
f1 (ppm)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127.783
127.681
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125.950
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123.243
121.698
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121.586
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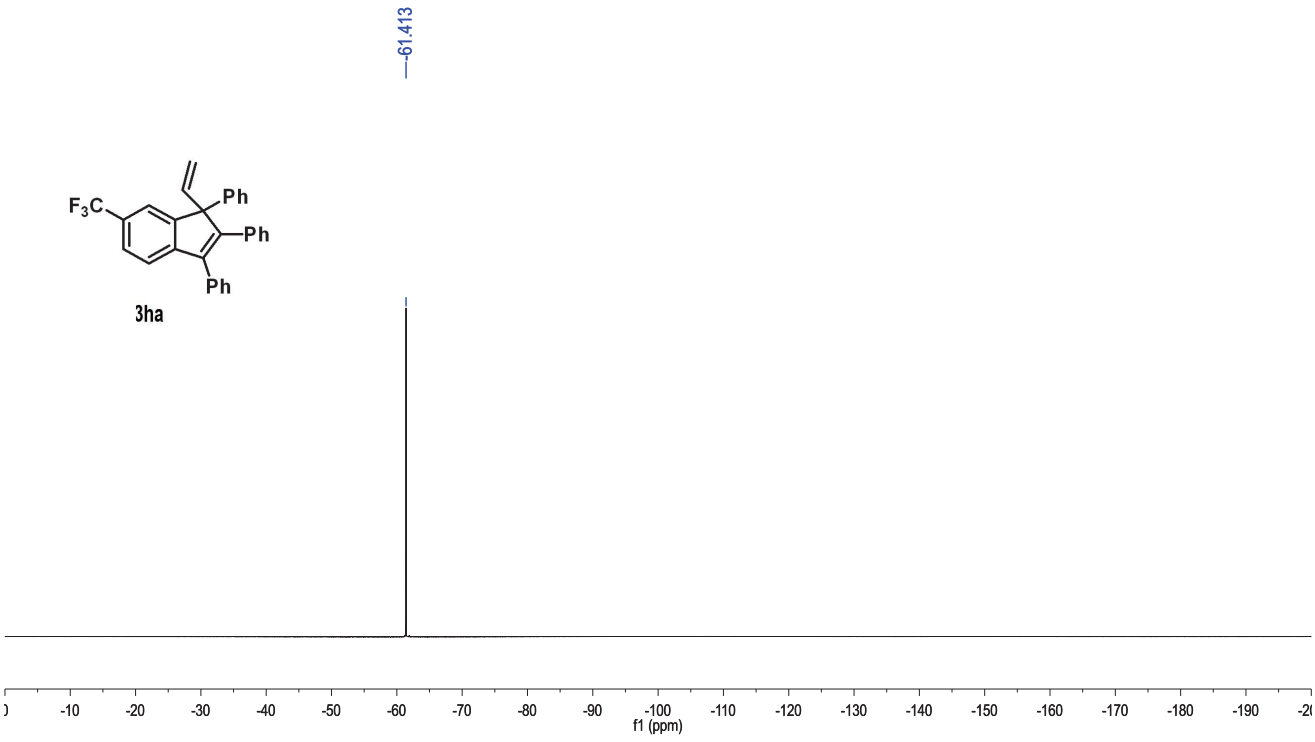
F3C
Ph
Ph
Ph
3ha
f1 (ppm)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F3C
Ph
Ph
Ph
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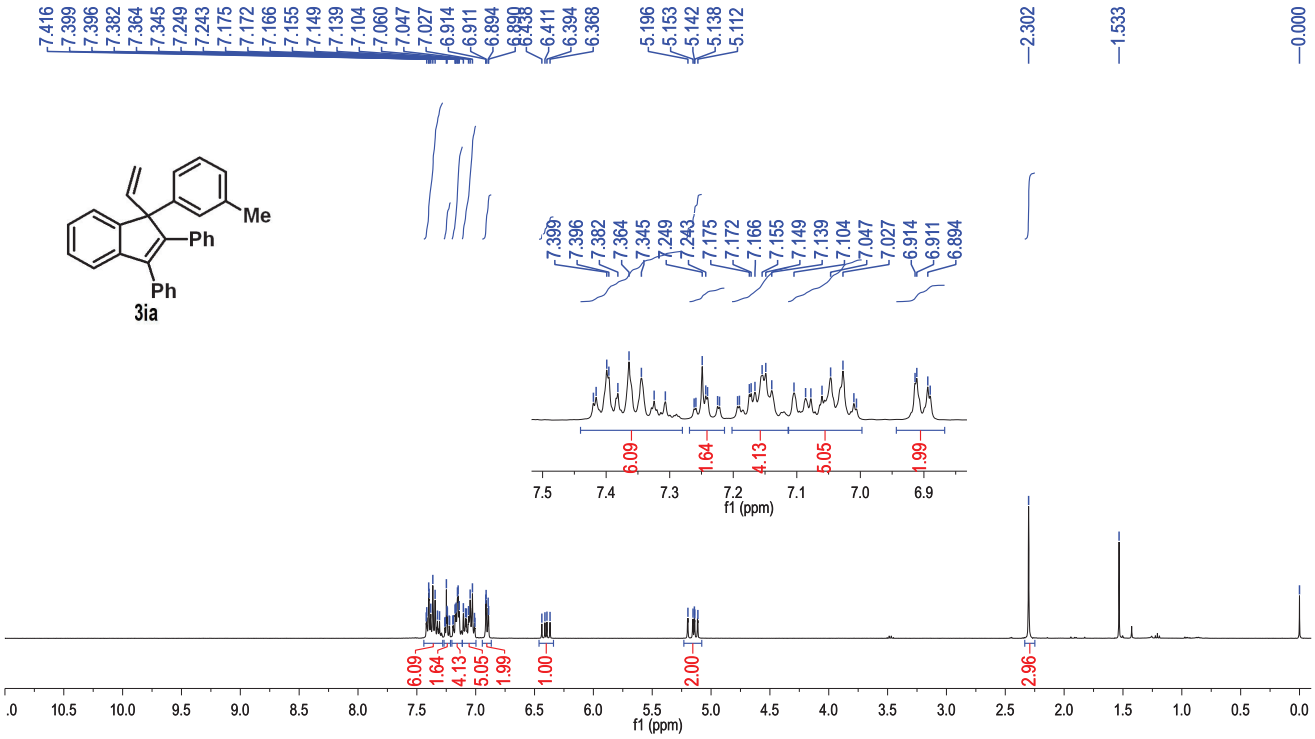
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7.243
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7.172
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7.155
7.149
7.139
7.104
7.060
7.047
7.027
6.914
6.911
6.894
6.890
6.438
6.411
6.394
6.368
5.196
5.153
5.142
5.138
5.112
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1.533
0.000
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Ph
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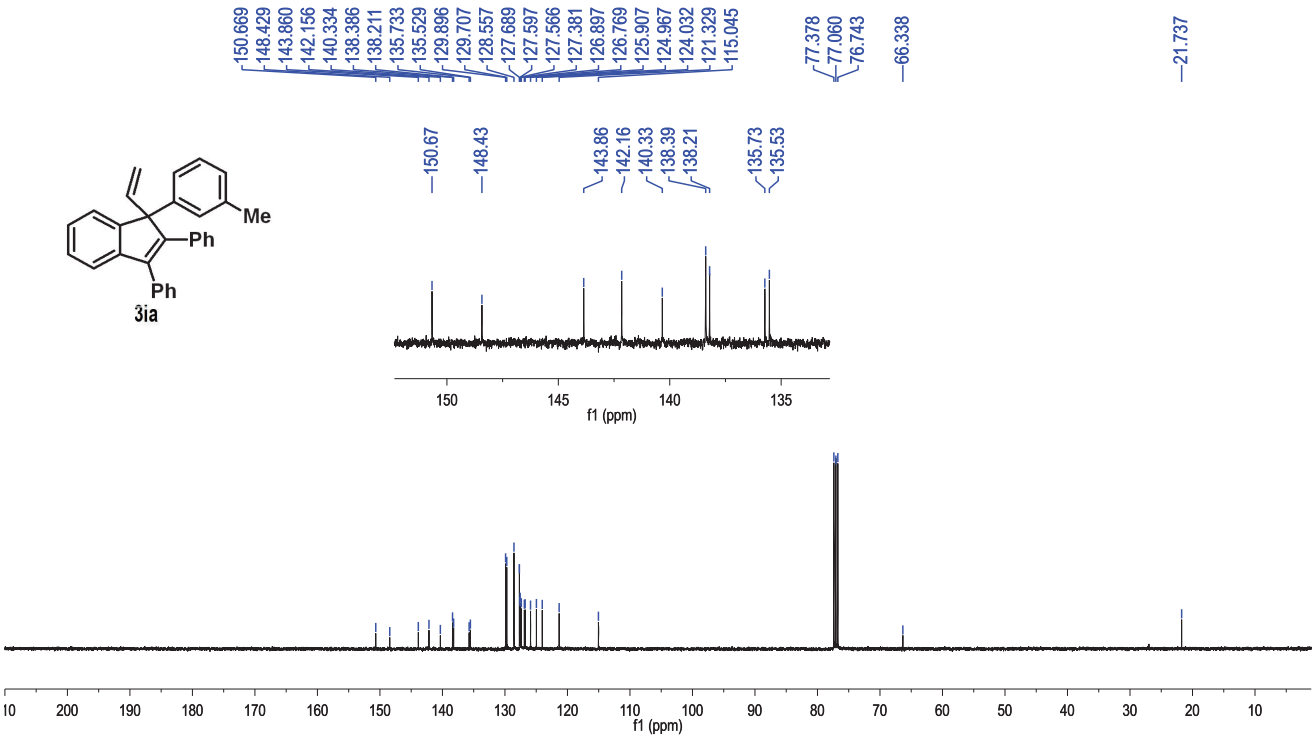
6.09
1.64
4.13
5.05
1.99
1.00
2.00
2.96
f1 (ppm)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124.032
121.329
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77.060
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135.53
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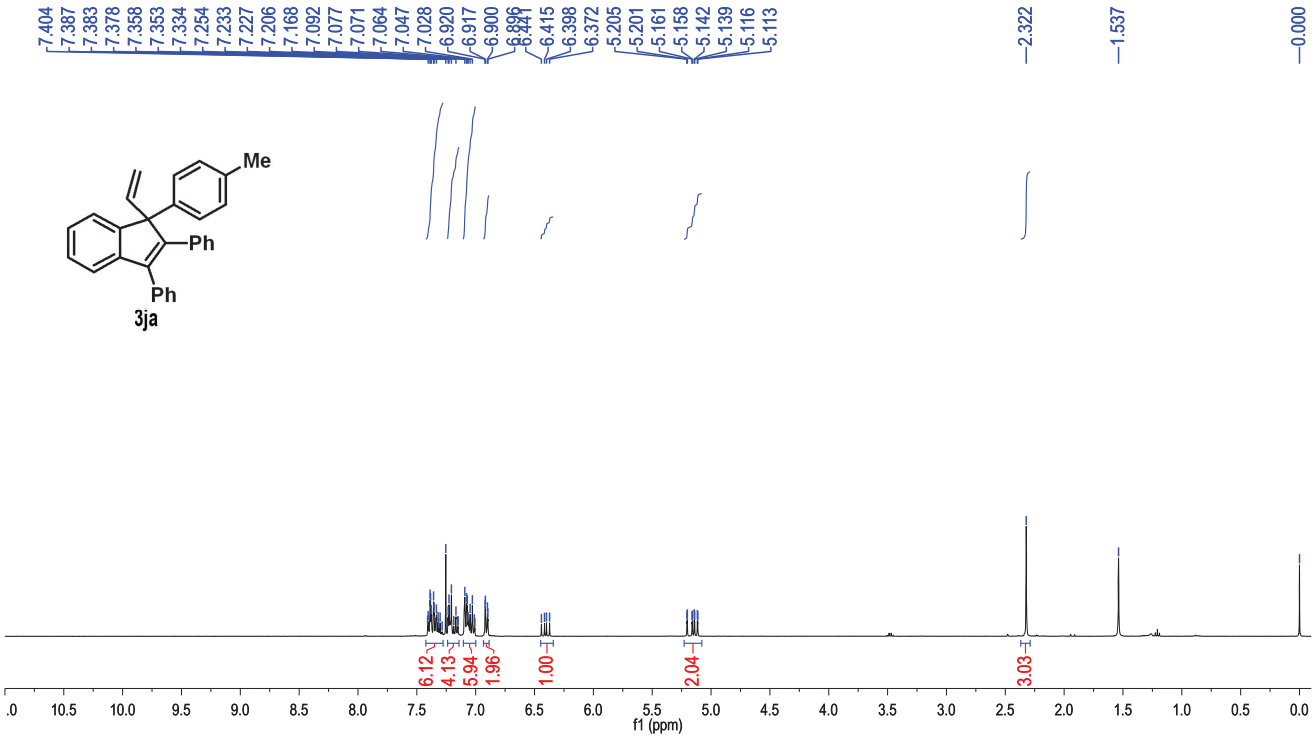
Ph
Ph
3ia
f1 (ppm)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7.092
7.077
7.071
7.064
7.047
7.028
6.920
6.917
6.900
6.896
6.441
6.415
6.398
6.372
5.205
5.201
5.161
5.158
5.142
5.139
5.116
5.113
2.322
1.537
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Ph
Ph
3ja
6.12
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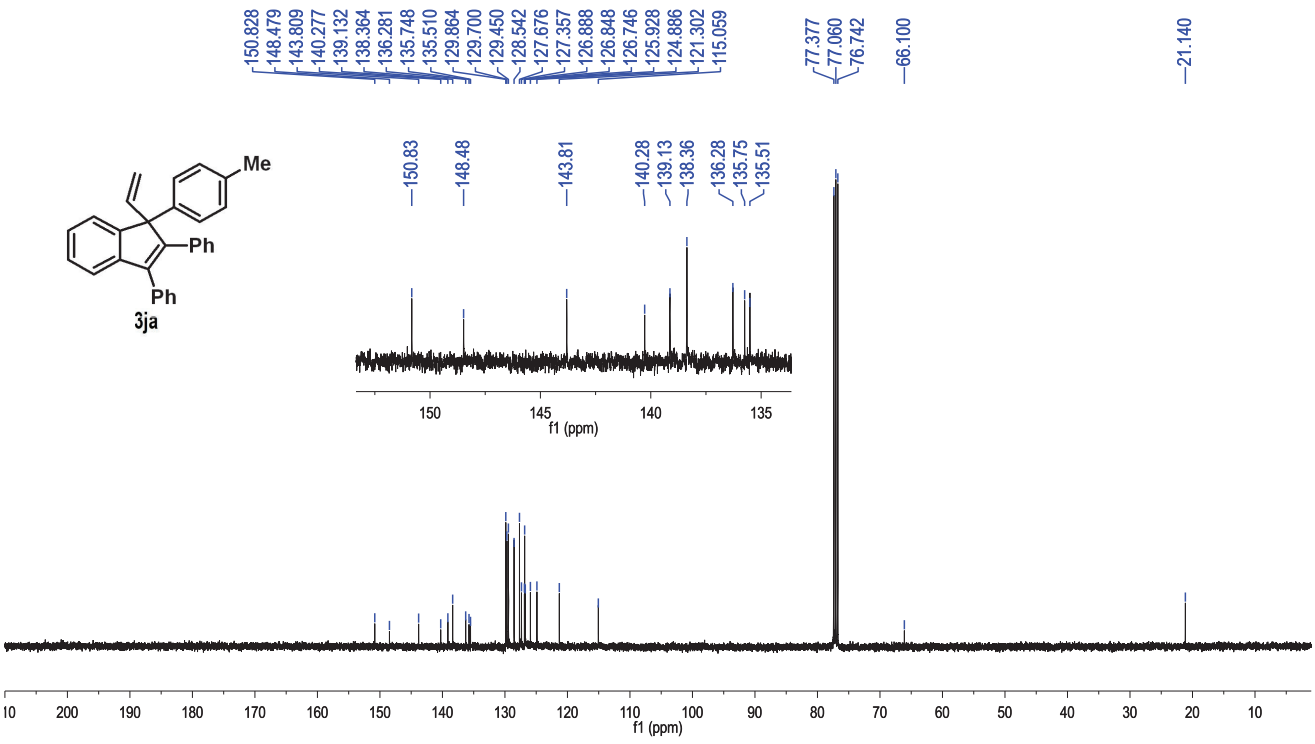
5.94
1.96
1.00
2.04
3.03
f1 (ppm)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138.364
136.281
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135.510
129.864
129.700
129.450
128.542
127.676
127.357
126.888
126.848
126.746
125.928
124.886
121.302
115.059
77.377
77.060
76.742
66.100
21.140
150.83
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139.13
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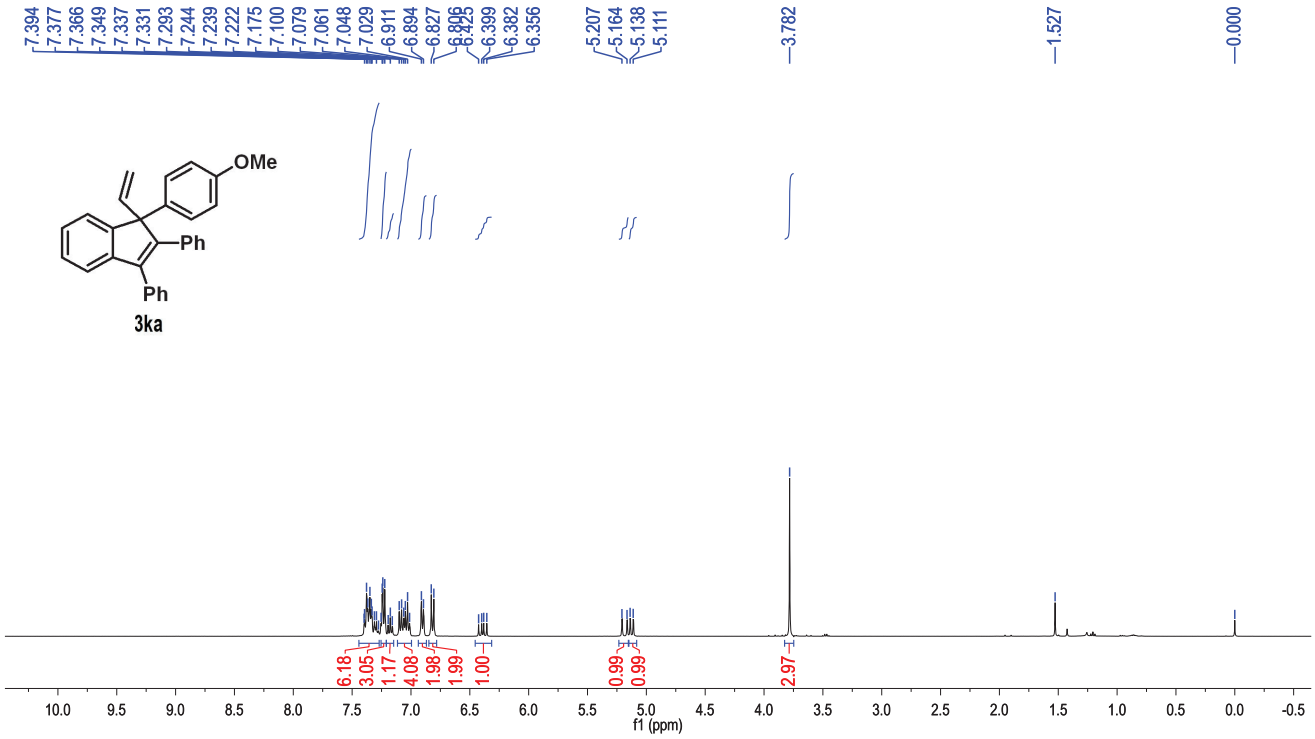
136.28
135.75
135.51
Me
Ph
Ph
3ja
f1 (ppm)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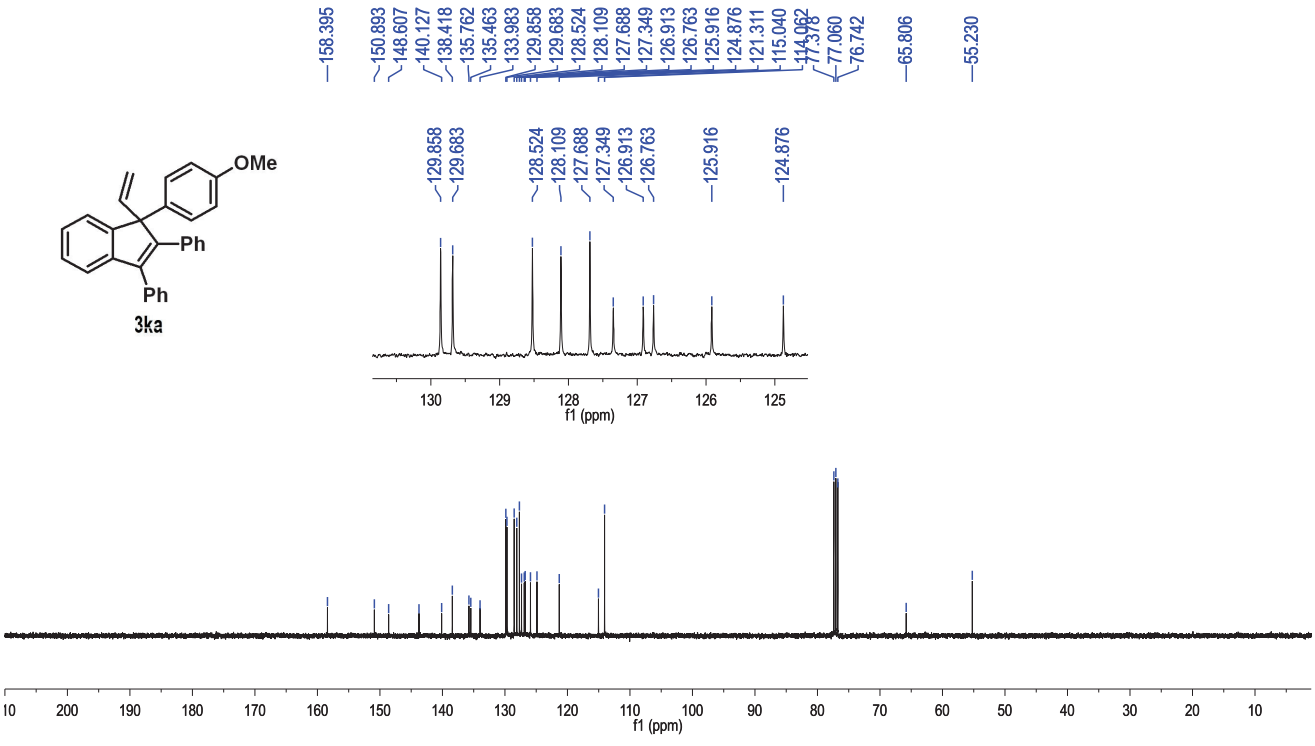
7.337
7.331
7.293
7.244
7.239
7.222
7.175
7.100
7.079
7.061
7.048
7.029
6.911
6.894
6.827
6.425
6.399
6.382
6.356
5.207
5.164
5.138
5.111
3.782
1.527
0.000
OMe
Ph
Ph
3ka
6.18
3.05
1.17
4.08
1.98
1.99
1.00
0.99
0.99
2.97
f1 (ppm)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128.524
128.109
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127.349
126.913
126.763
125.916
124.876
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77.378
77.060
76.742
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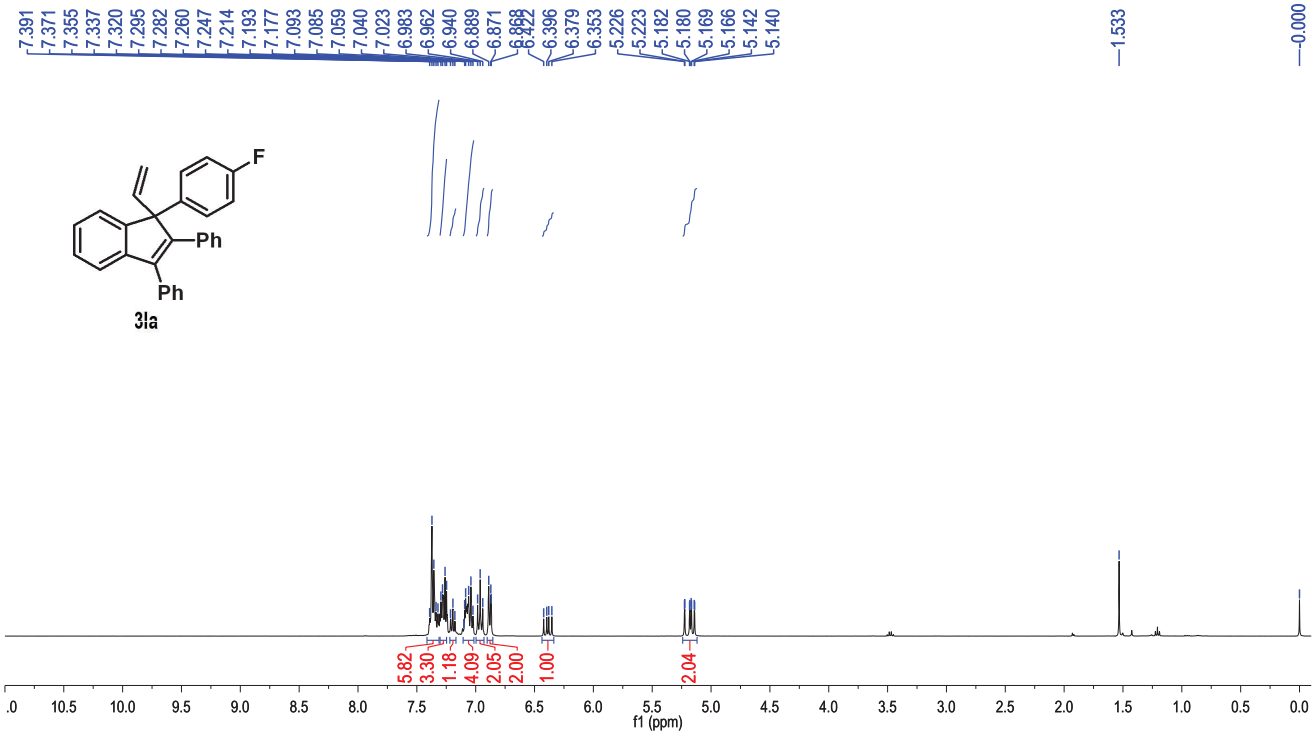
55.230
OMe
Ph
Ph
3ka
f1 (ppm)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7.337
7.320
7.295
7.282
7.260
7.247
7.214
7.193
7.177
7.093
7.085
7.059
7.040
7.023
6.983
6.962
6.940
6.889
6.871
6.868
6.422
6.396
6.379
6.353
5.226
5.223
5.182
5.180
5.169
5.166
5.142
5.140
1.533
0.000
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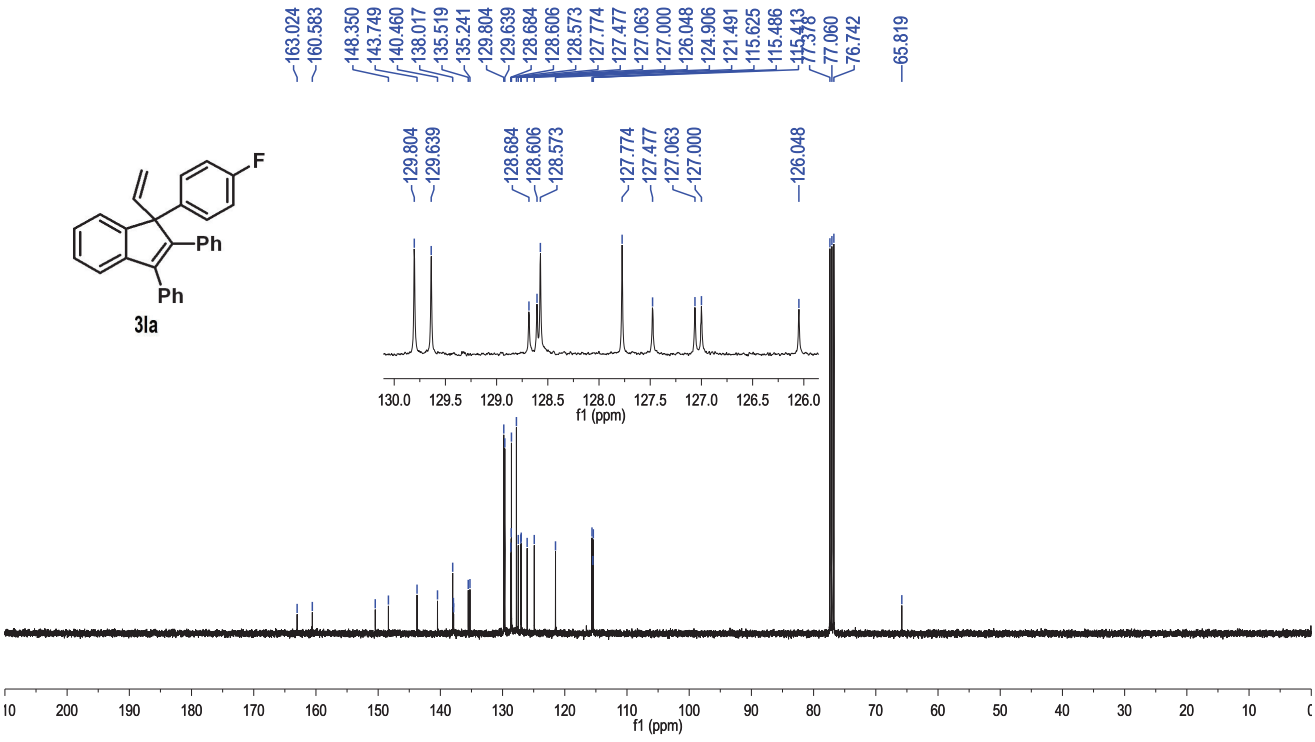
Ph
Ph
3la
5.82
3.30
1.18
4.09
2.05
2.00
1.00
2.04
f1 (ppm)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135.241
129.804
129.639
128.684
128.606
128.573
127.774
127.477
127.063
127.000
126.048
124.906
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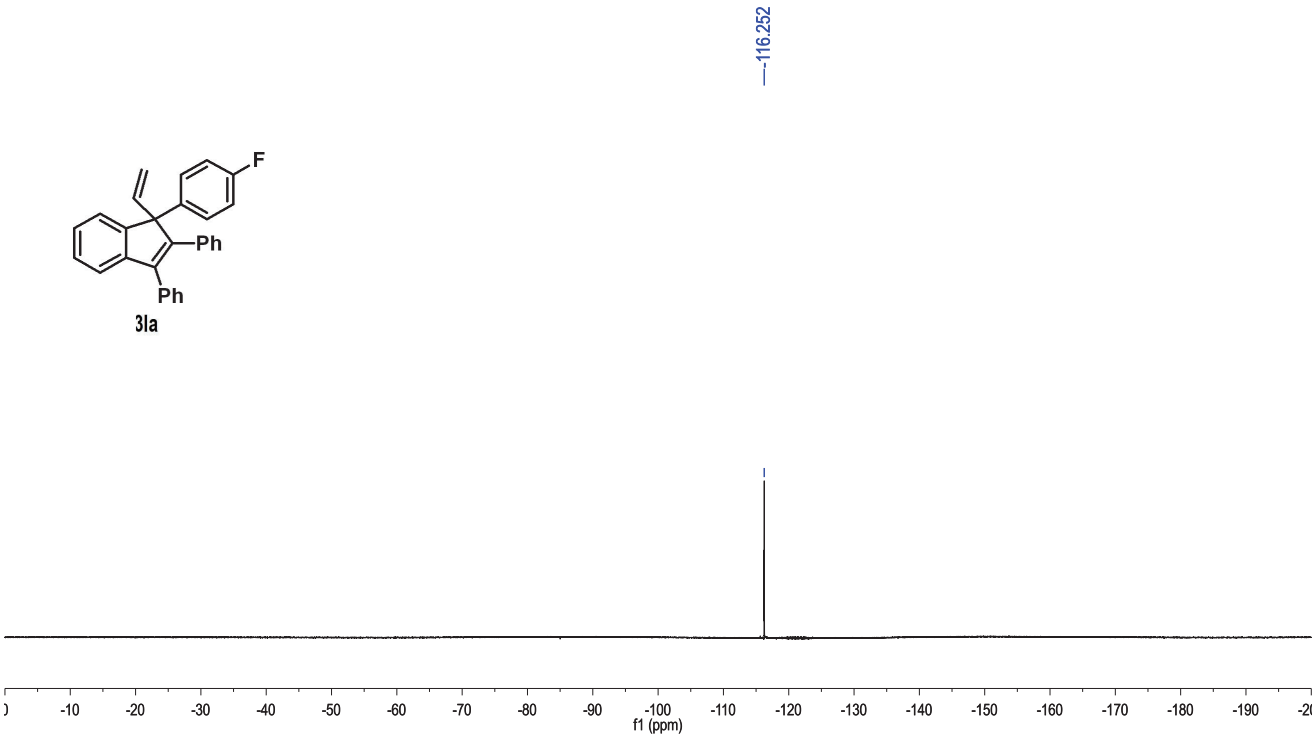
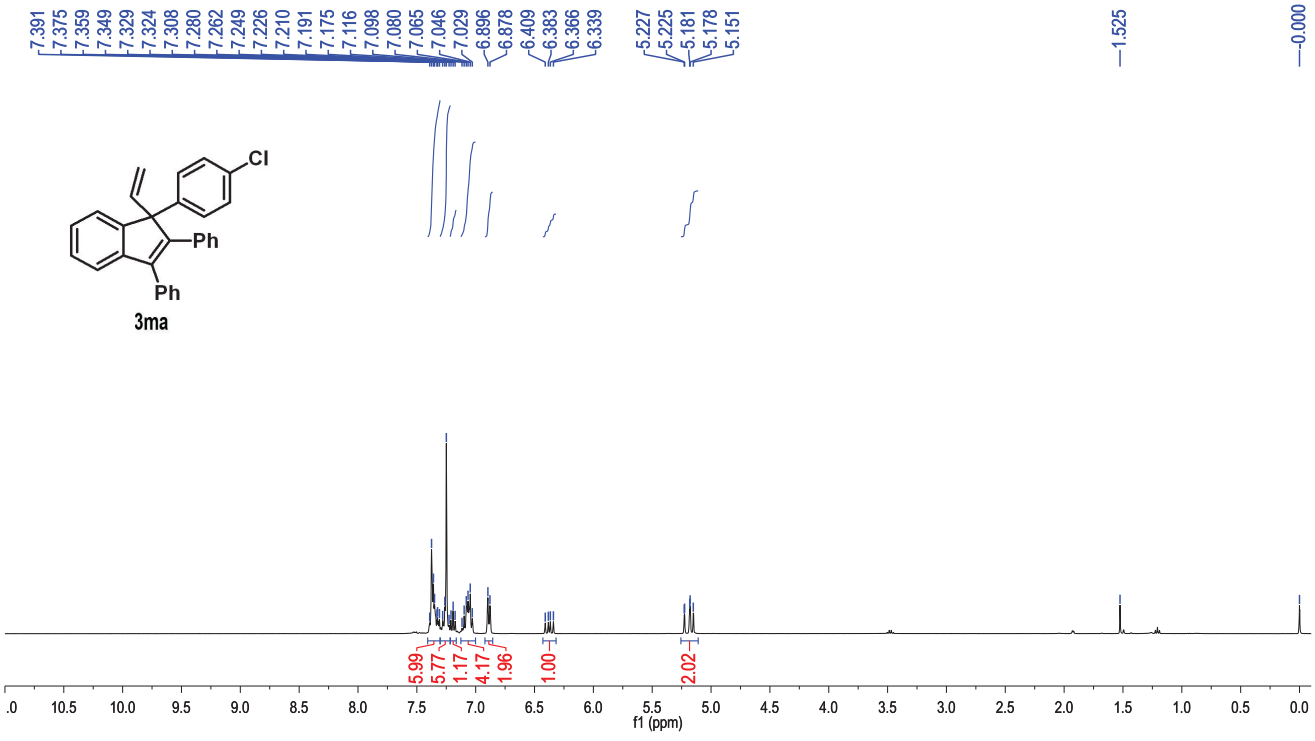
115.413
77.378
77.060
76.742
65.819
F
Ph
Ph
3la
f1 (ppm)


116.252
F
Ph
Ph
3la
f1 (ppm)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7.226
7.210
7.191
7.175
7.116
7.098
7.080
7.065
7.046
7.029
6.896
6.878
6.409
6.383
6.366
6.339
5.227
5.225
5.181
5.178
5.151
1.525
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Ph
3ma
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5.77
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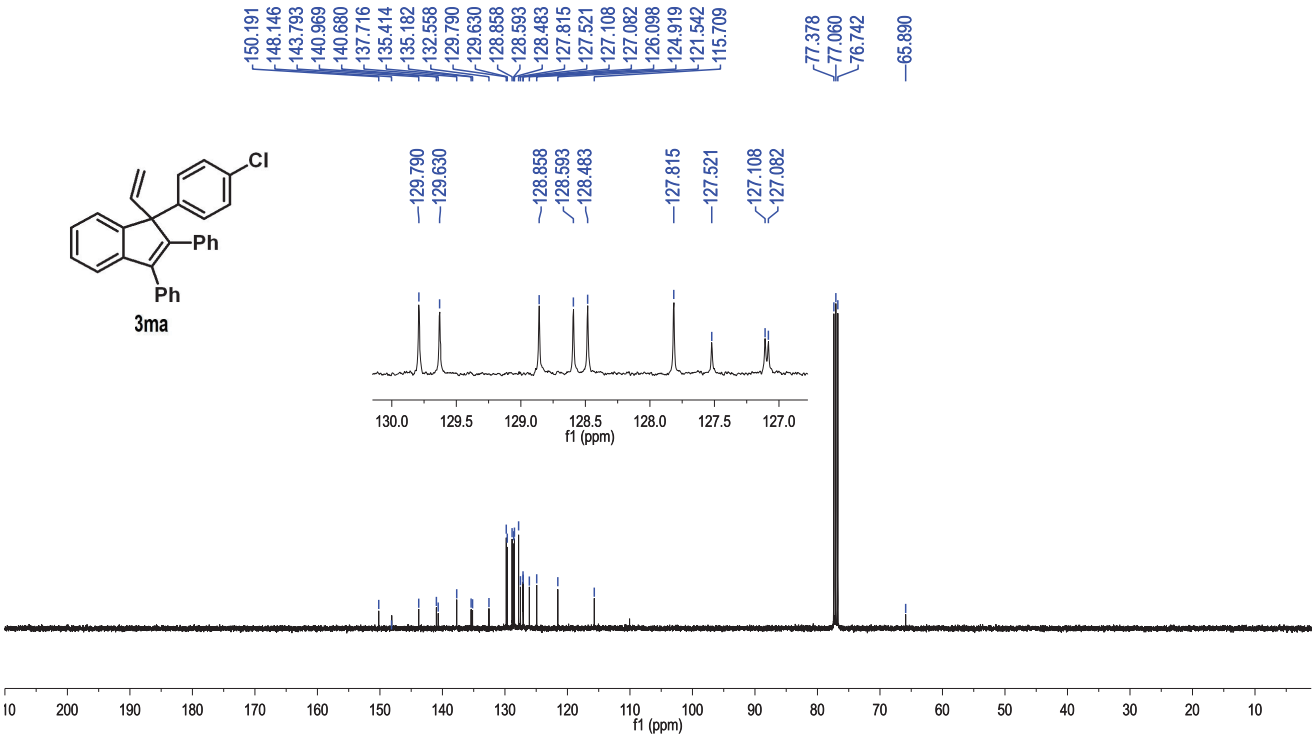
4.17
1.96
1.00
2.02
f1 (ppm)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128.593
128.483
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127.521
127.108
127.082
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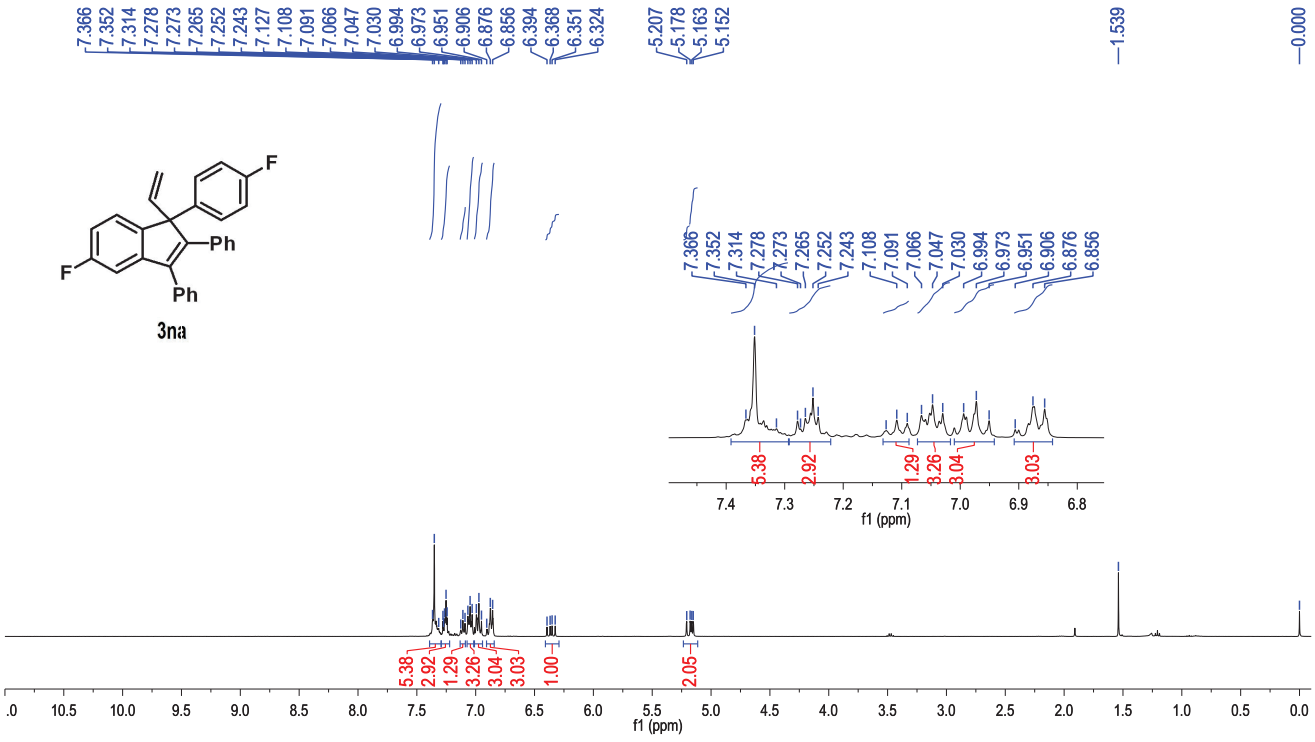
115.709
77.378
77.060
76.742
65.890
Cl
Ph
Ph
3ma
f1 (ppm)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6.906
6.876
6.856
6.394
6.368
6.351
6.324
5.207
5.178
5.163
5.152
1.539
0.000
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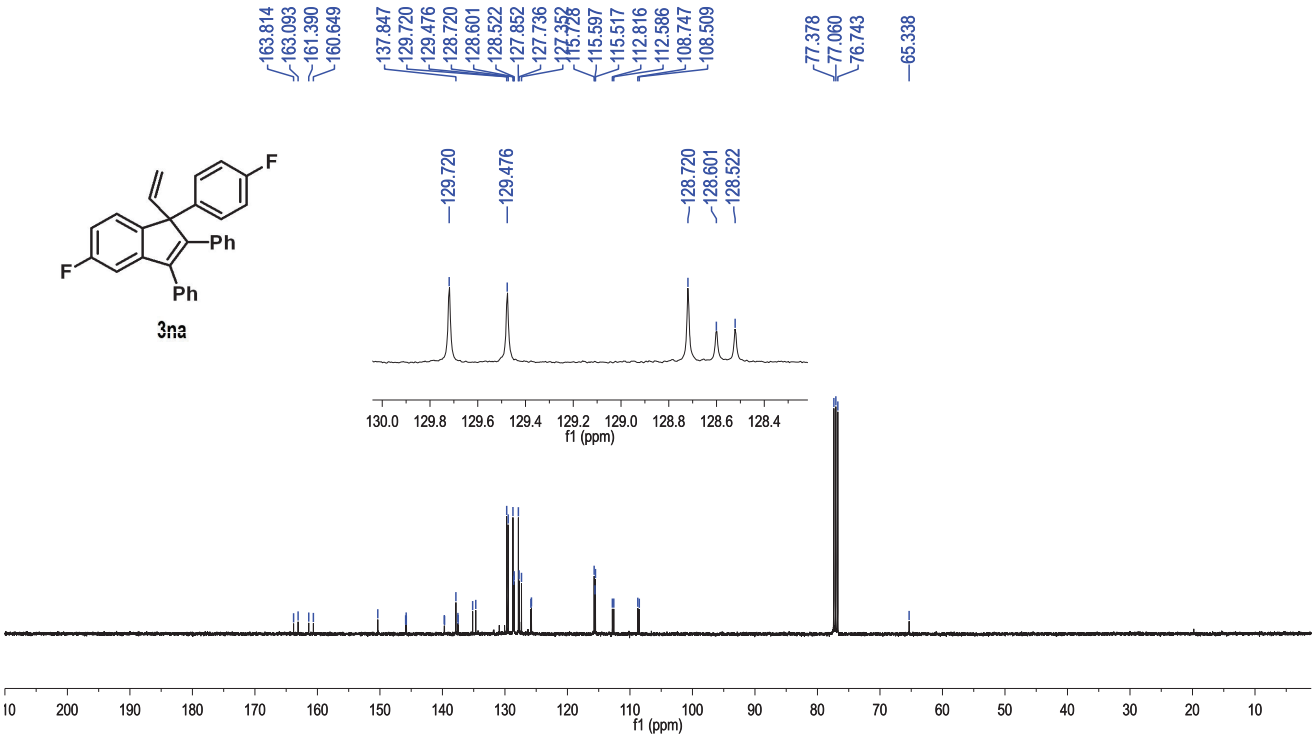
f1 (ppm)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115.517
112.816
112.586
108.747
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77.378
77.060
76.743
65.338
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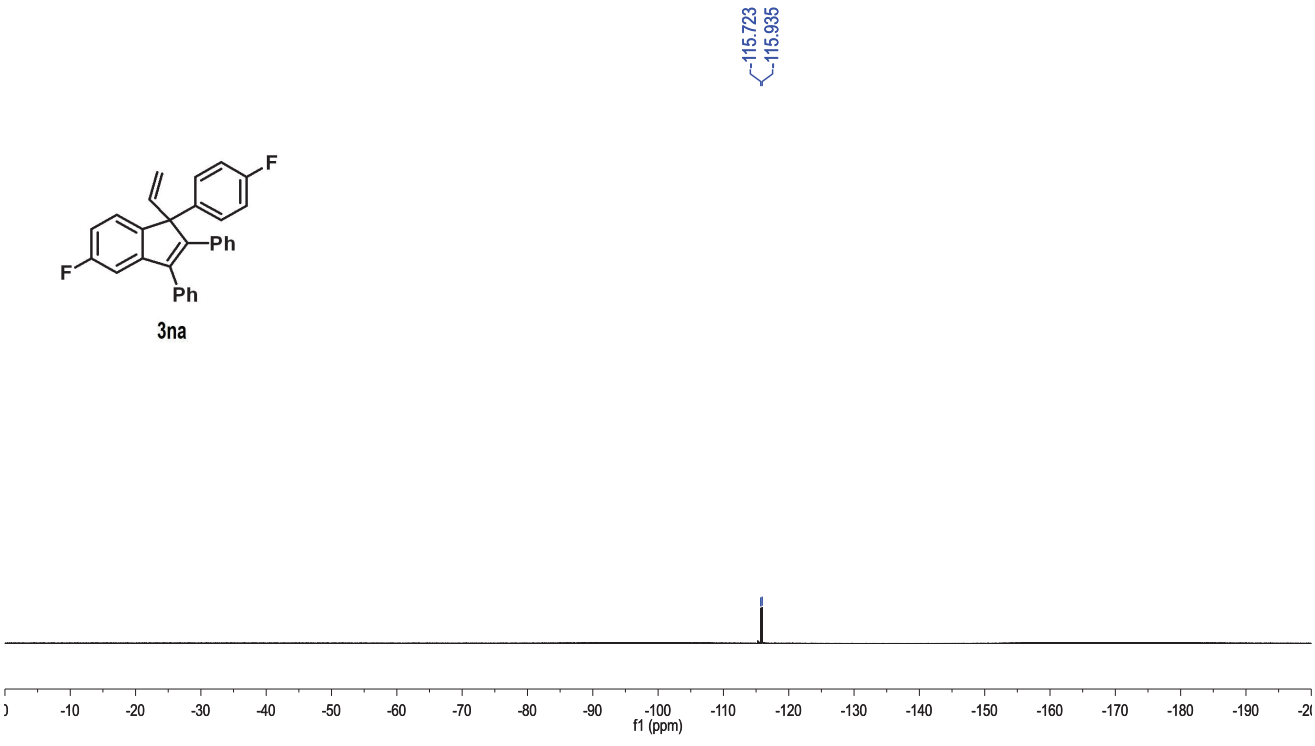
Ph
F
Ph
3na
129.720
129.476
128.720
128.601
128.522
130.0 129.8 129.6 129.4 129.2 129.0 128.8 128.6 128.4
f1 (ppm)
10 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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115.935
F
Ph
F
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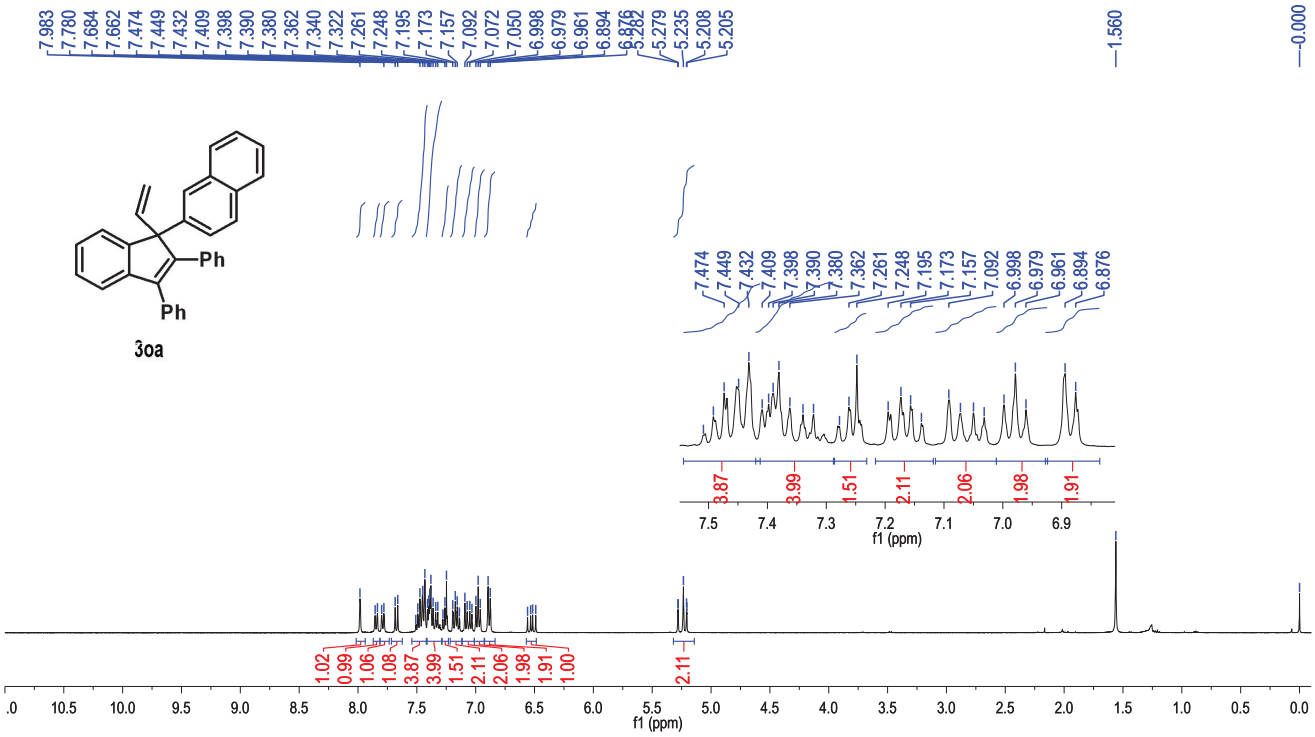
f1 (ppm)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7.248
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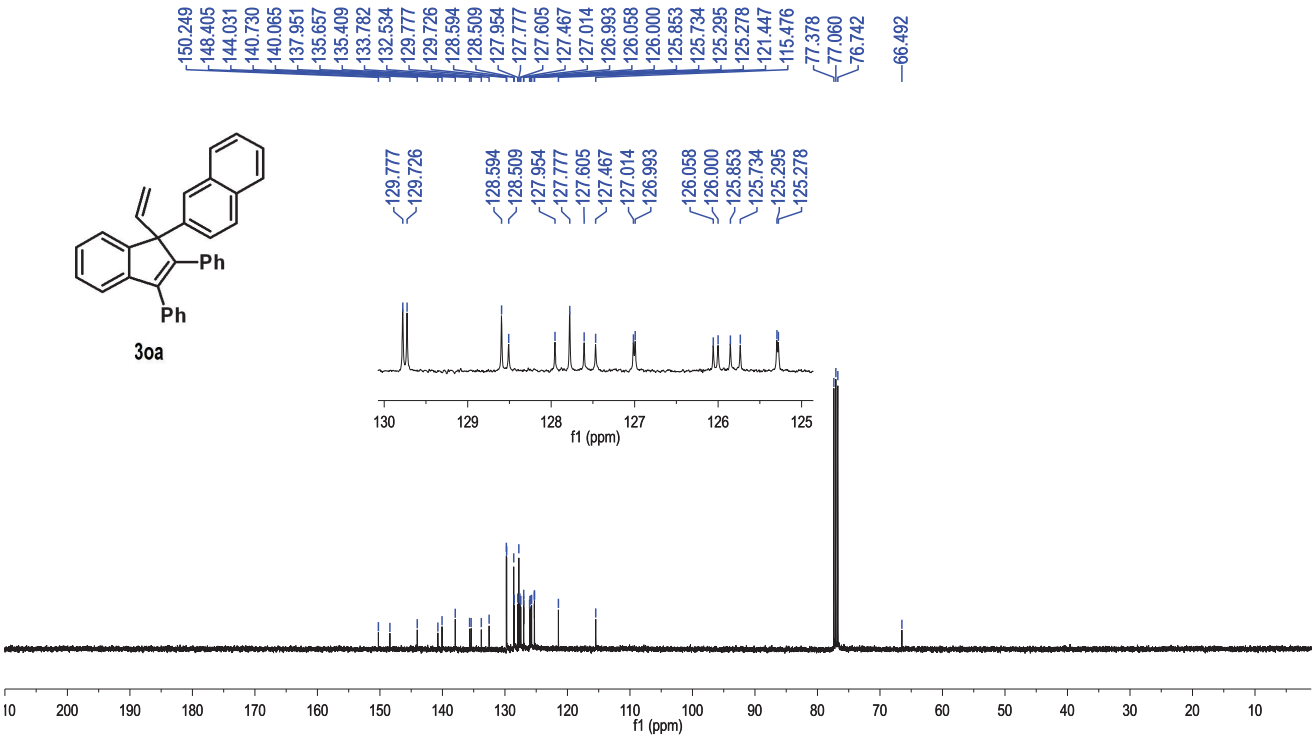
7.173
7.157
7.092
7.072
7.050
6.998
6.979
6.961
6.894
6.876
5.282
5.279
5.235
5.208
5.205
1.560
0.000
Ph
Ph
3oa
3.87
3.99
1.51
2.11
2.06
1.98
1.91
f1 (ppm)
1.02
0.99
1.06
1.08
3.87
3.99
1.51
2.11
2.06
1.98
1.91
1.00
2.11
f1 (ppm)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128.594
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127.777
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127.014
126.993
126.058
126.000
125.853
125.734
125.295
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76.742
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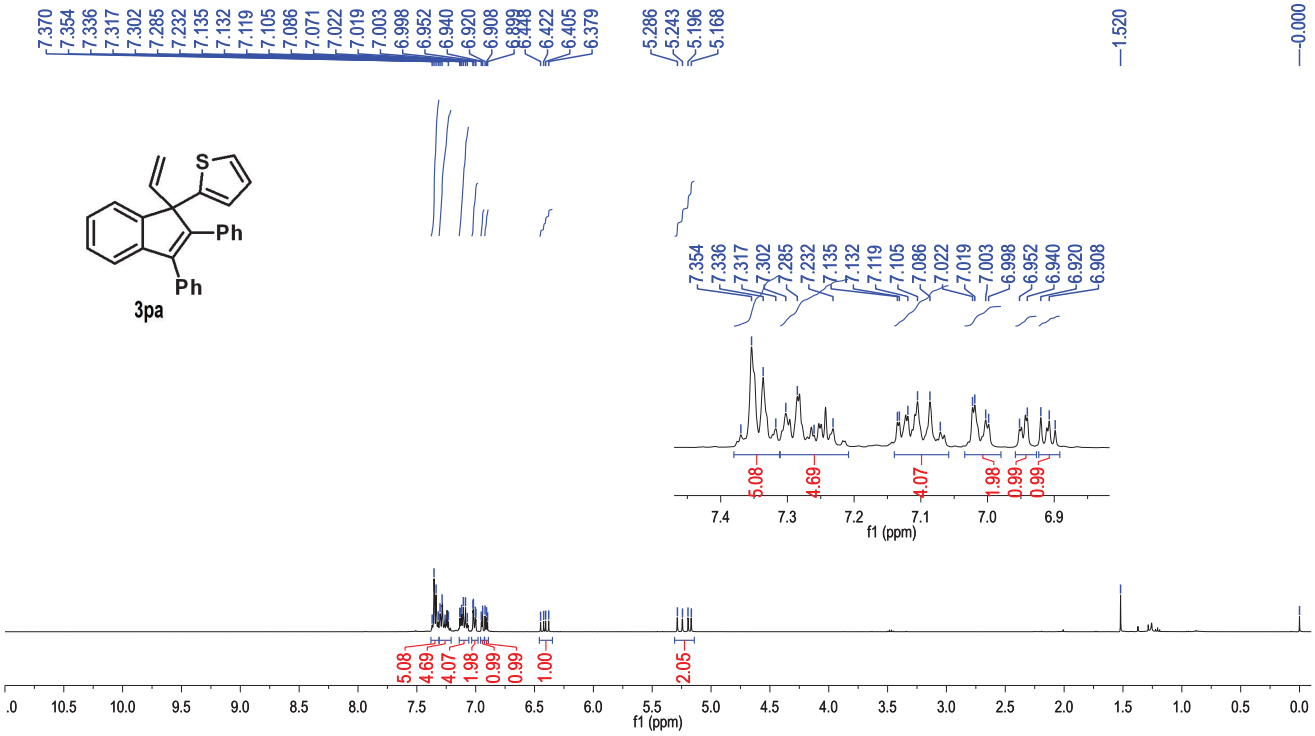
Ph
Ph
3oa
f1 (ppm)
f1 (ppm)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7.105
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7.071
7.022
7.019
7.003
6.998
6.952
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6.422
6.405
6.379
5.286
5.243
5.196
5.168
1.520
0.000
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0.99
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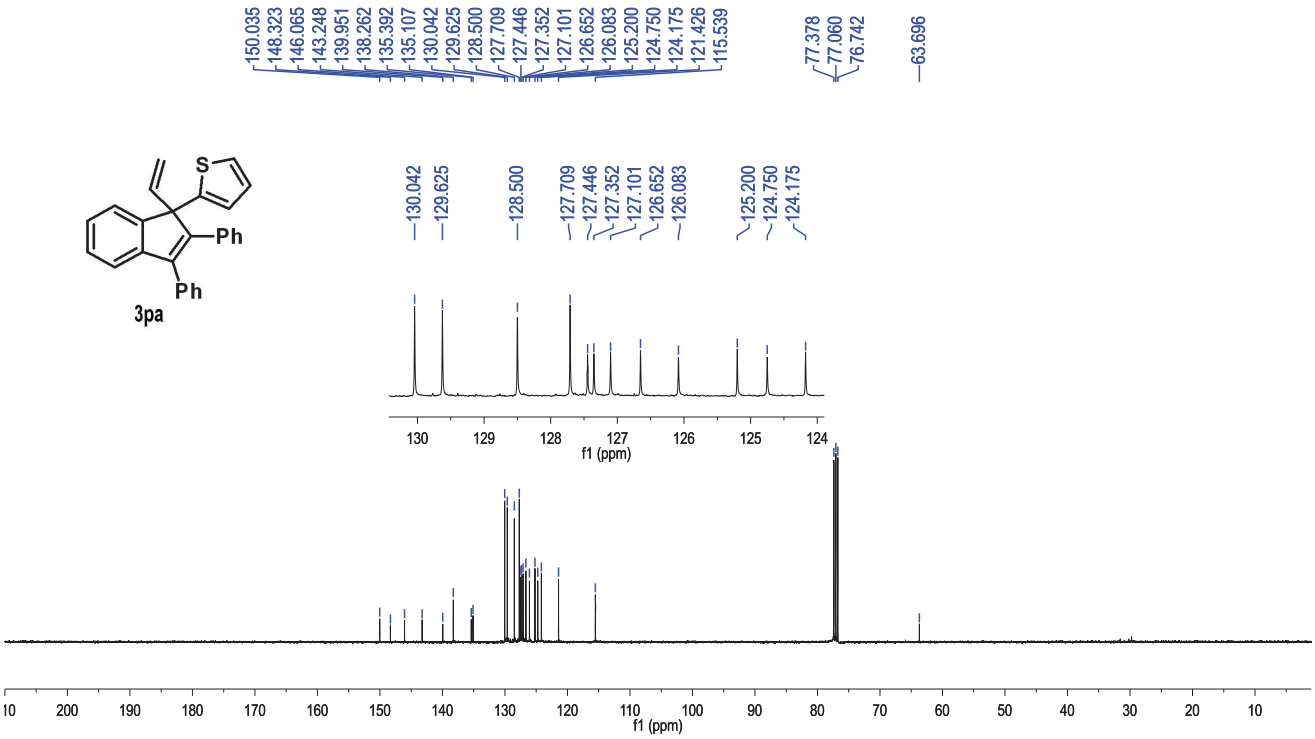
2.05
f1 (ppm)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127.446
127.352
127.101
126.652
126.083
125.200
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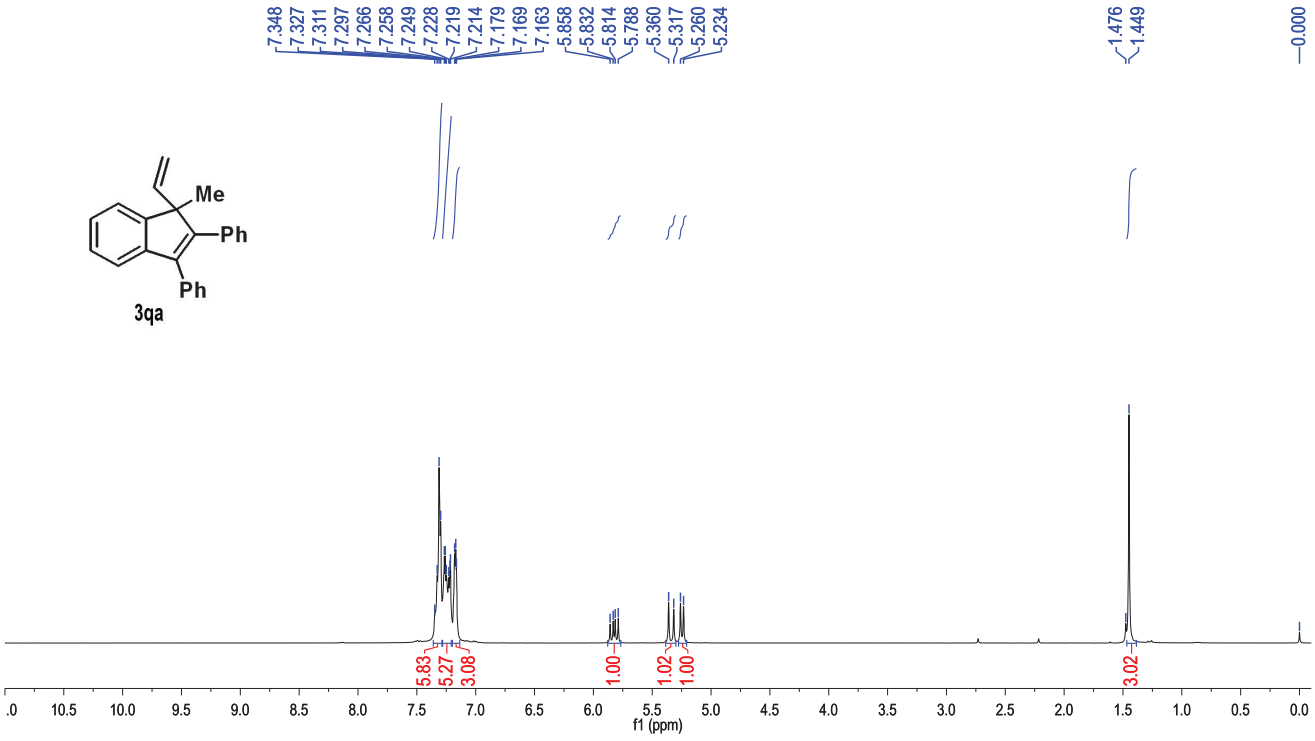
77.060
76.742
63.696
S
Ph
Ph
3pa
f1 (ppm)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7.163
5.858
5.832
5.814
5.788
5.360
5.317
5.260
5.234
1.476
1.449
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Ph
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5.27
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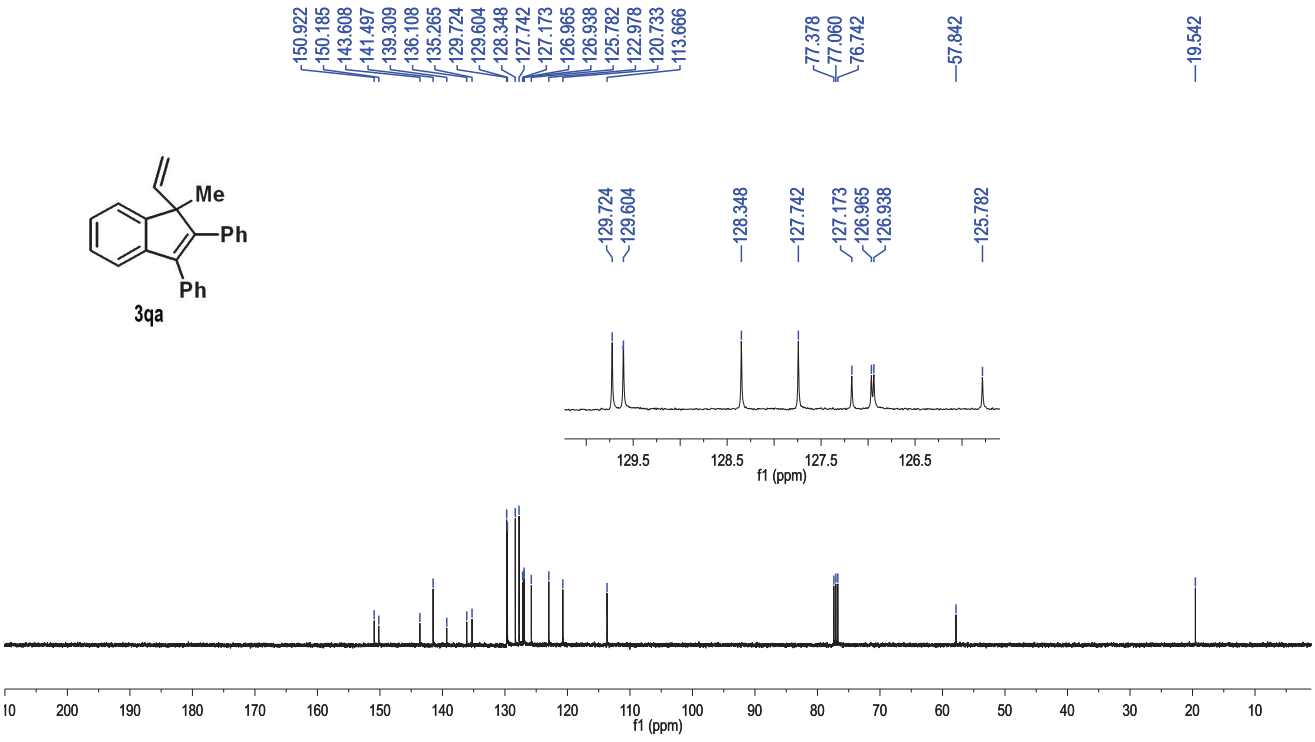
1.02
1.00
3.02
f1 (ppm)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113.666
77.378
77.060
76.742
57.842
19.542
Me
Ph
Ph
3qa
129.724
129.604
128.348
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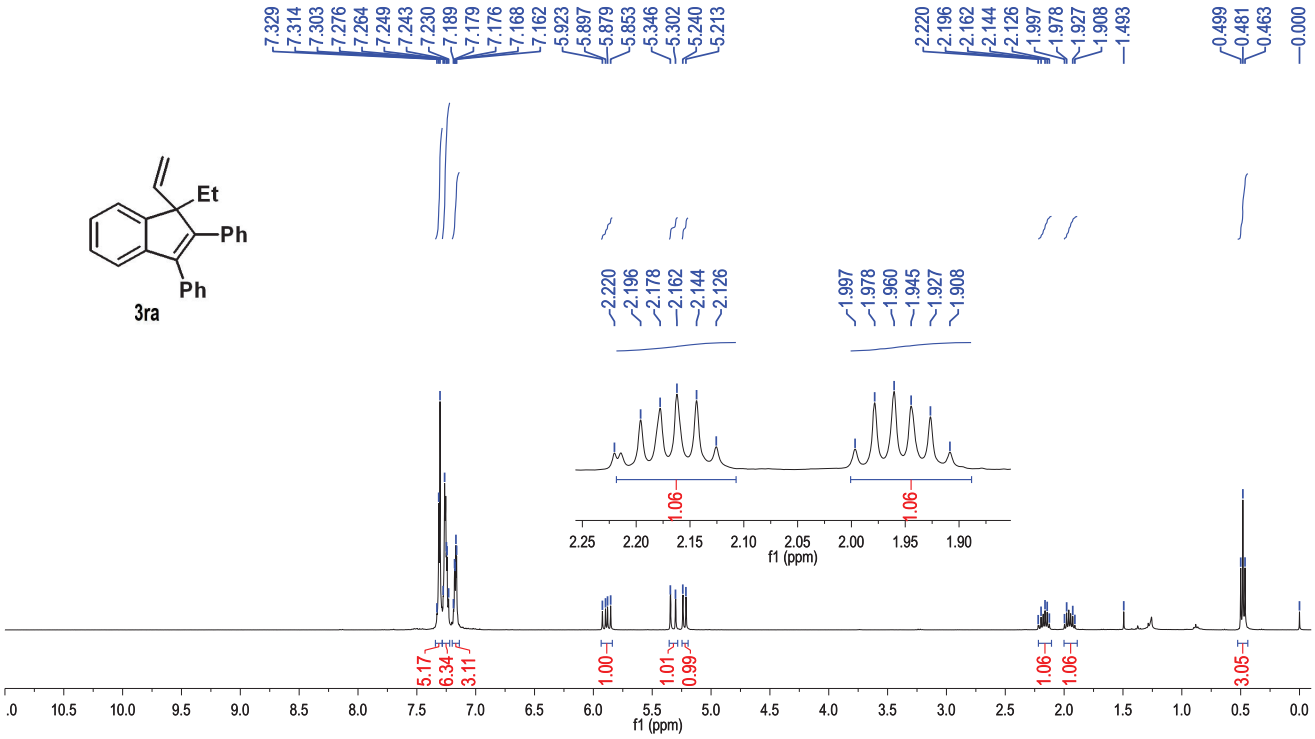
126.5
f1 (ppm)
f1 (ppm)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5.853
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5.302
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5.213
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2.196
2.162
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0.463
0.000
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Ph
Ph
3ra
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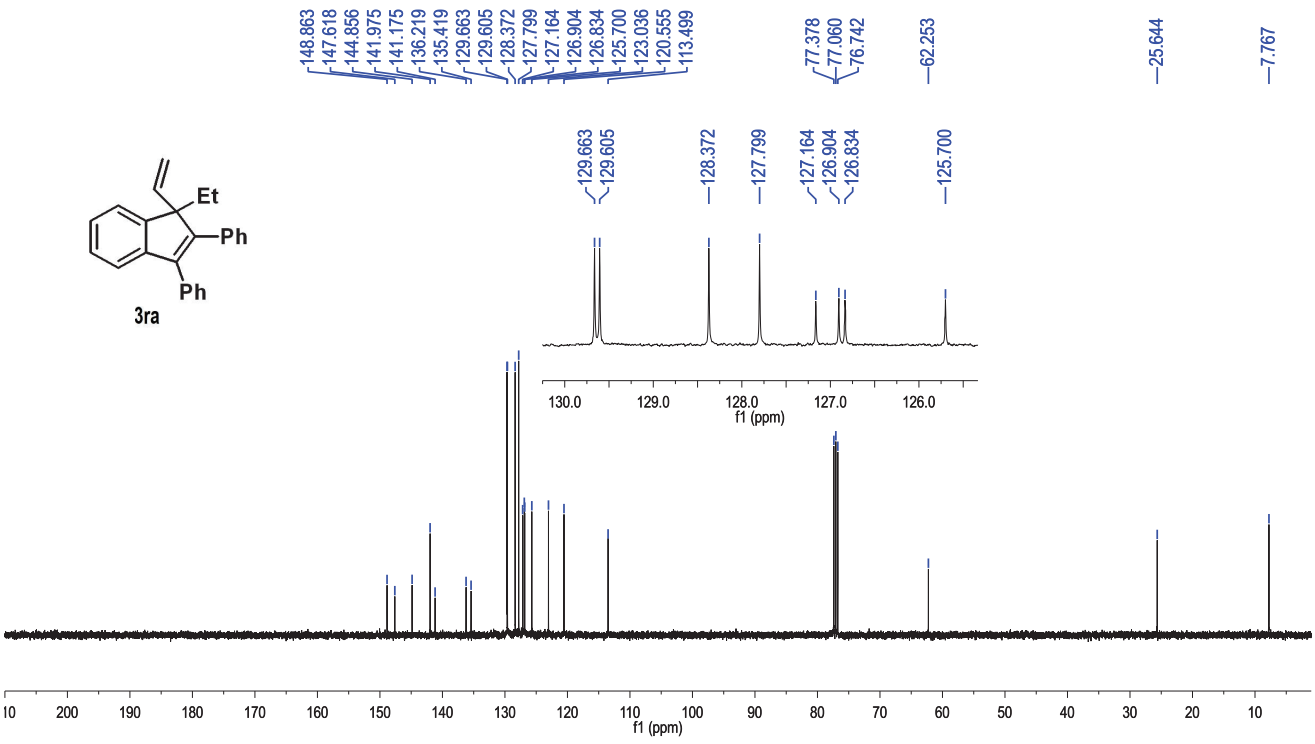
2.178
2.162
2.144
2.126
1.997
1.978
1.960
1.945
1.927
1.908
1.06
1.06
2.25 2.20 2.15 2.10 2.05 2.00 1.95 1.90
f1 (ppm)
5.17
6.34
3.11
1.00
1.01
0.99
1.06
1.06
3.05
.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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144.856
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141.175
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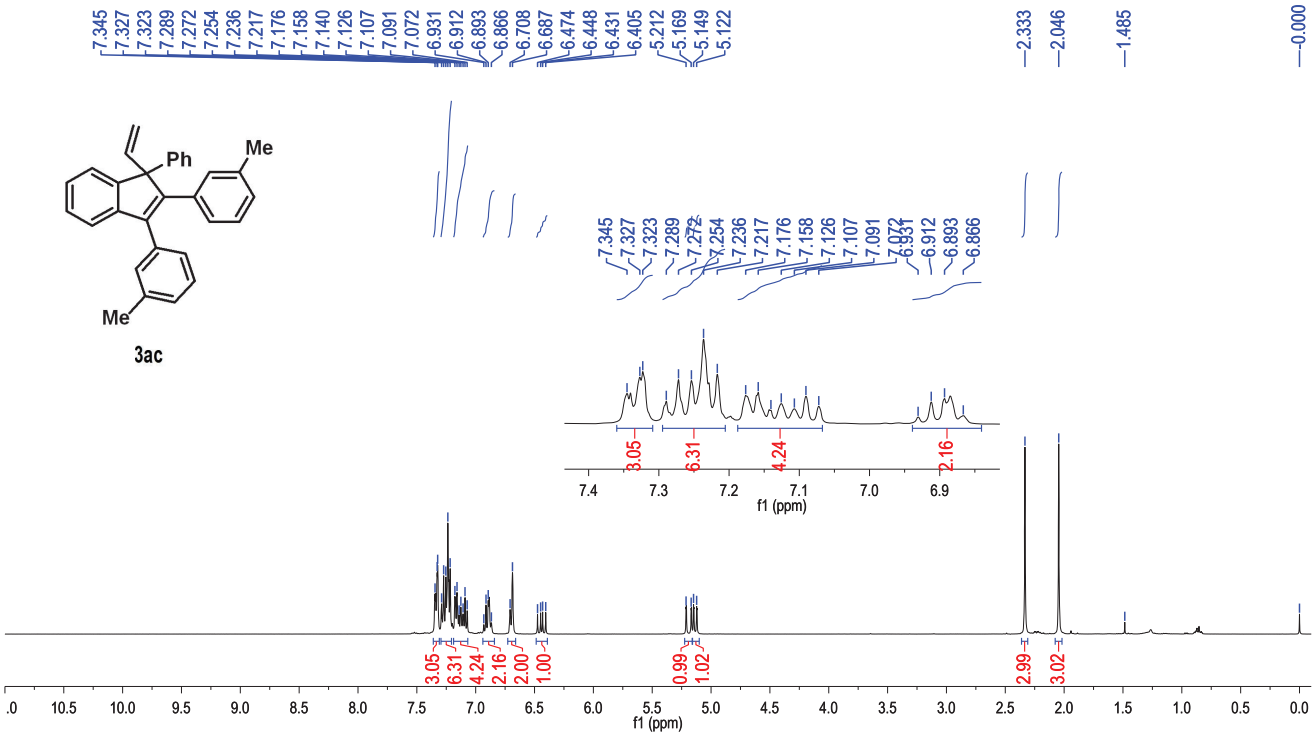
135.419
129.663
129.605
128.372
127.799
127.164
126.904
126.834
125.700
123.036
120.555
113.499
77.378
77.060
76.742
62.253
25.644
7.767
Et
Ph
Ph
3ra
129.663
129.605
128.372
127.799
127.164
126.904
126.834
125.700
130.0 129.0 128.0 127.0 126.0
f1 (ppm)
10 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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7.158
7.140
7.126
7.107
7.091
7.072
6.931
6.912
6.893
6.866
6.708
6.687
6.474
6.448
6.431
6.405
5.212
5.169
5.149
5.122
2.333
2.046
1.485
0.000
Ph
Me
Me
3ac
3.05
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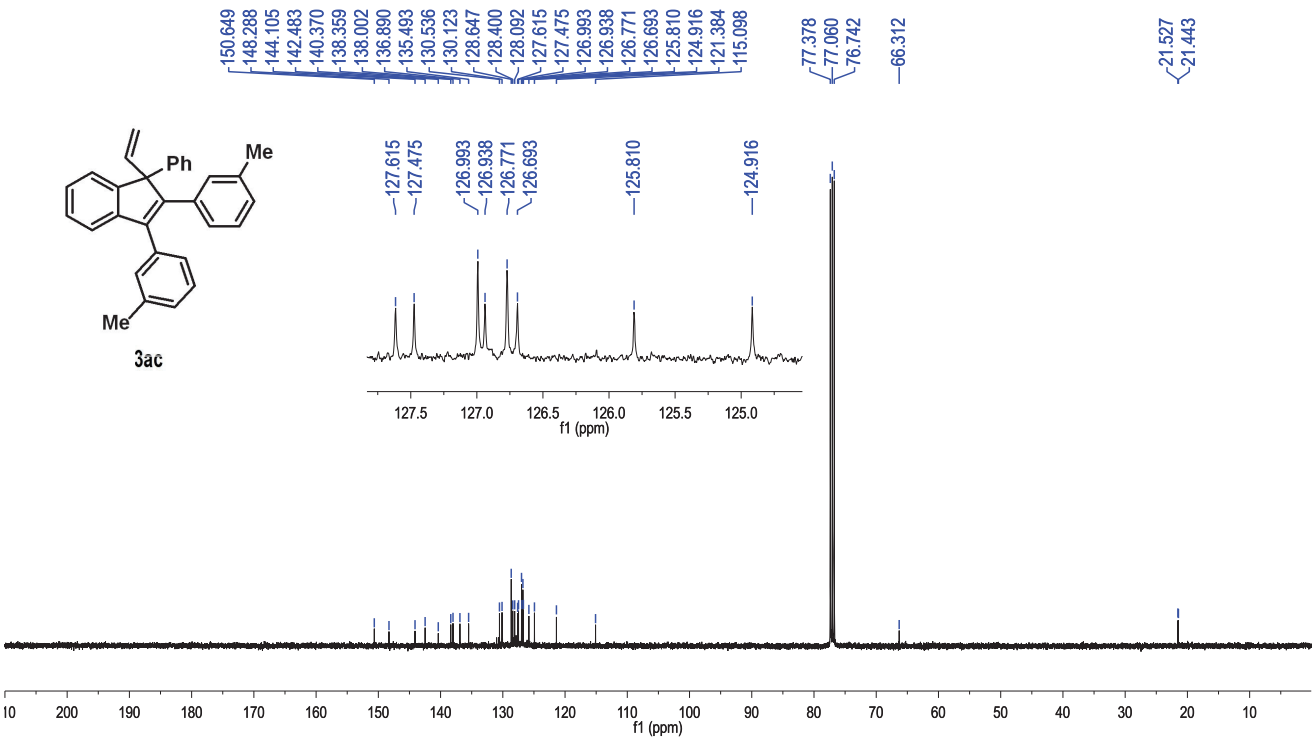
4.24
2.16
2.00
1.00
0.99
1.02
2.99
3.02
f1 (ppm)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128.400
128.092
127.615
127.475
126.993
126.938
126.771
126.693
125.810
124.916
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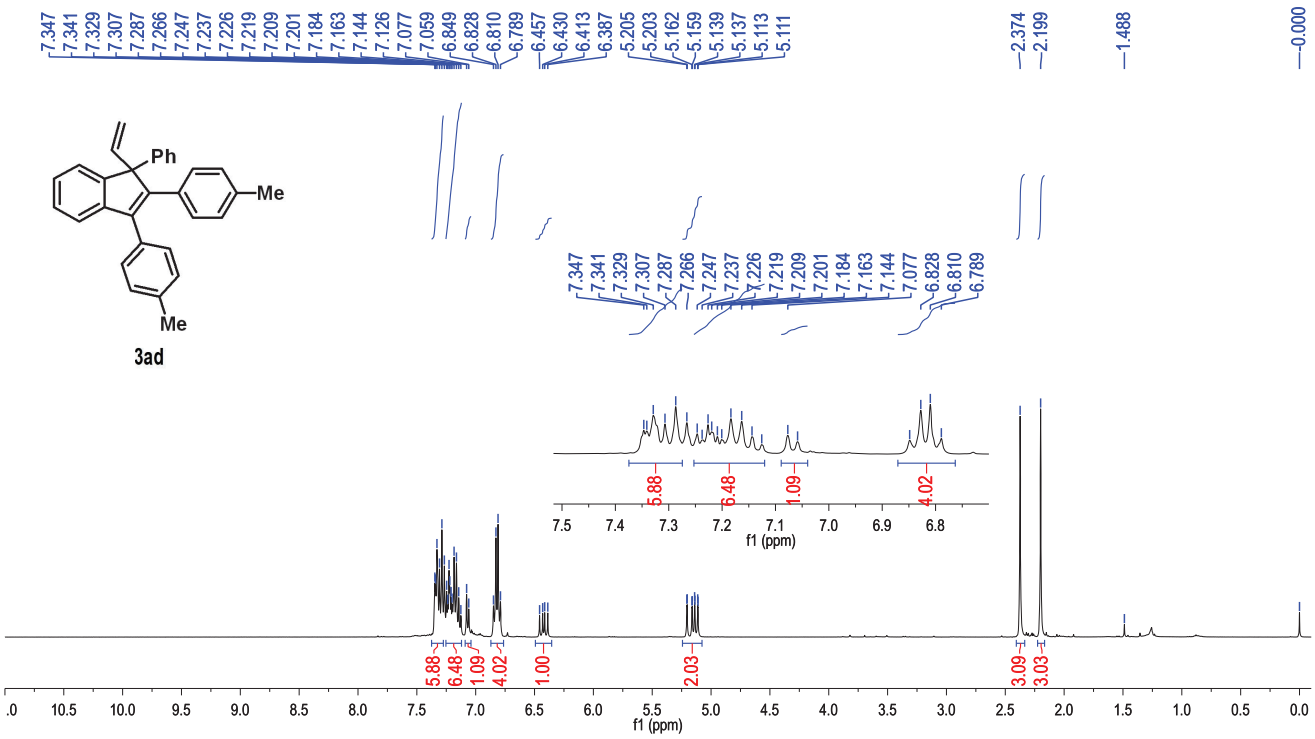
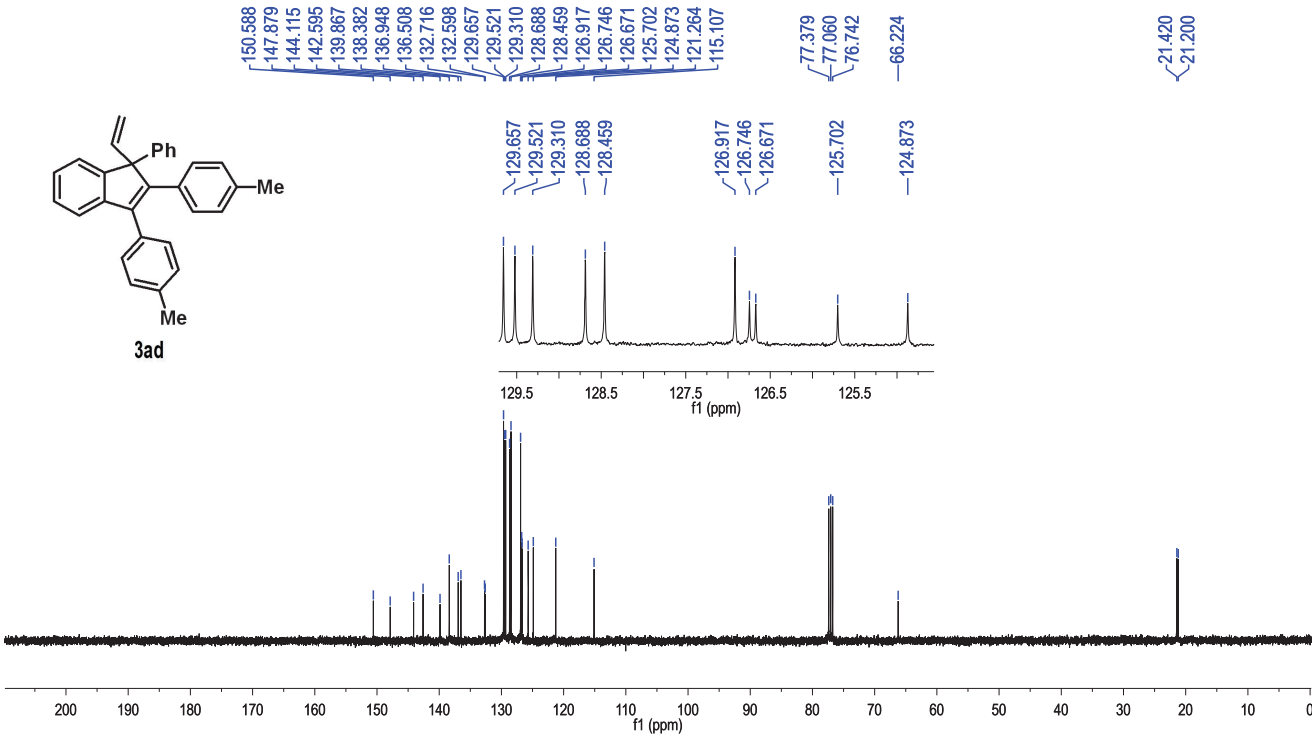
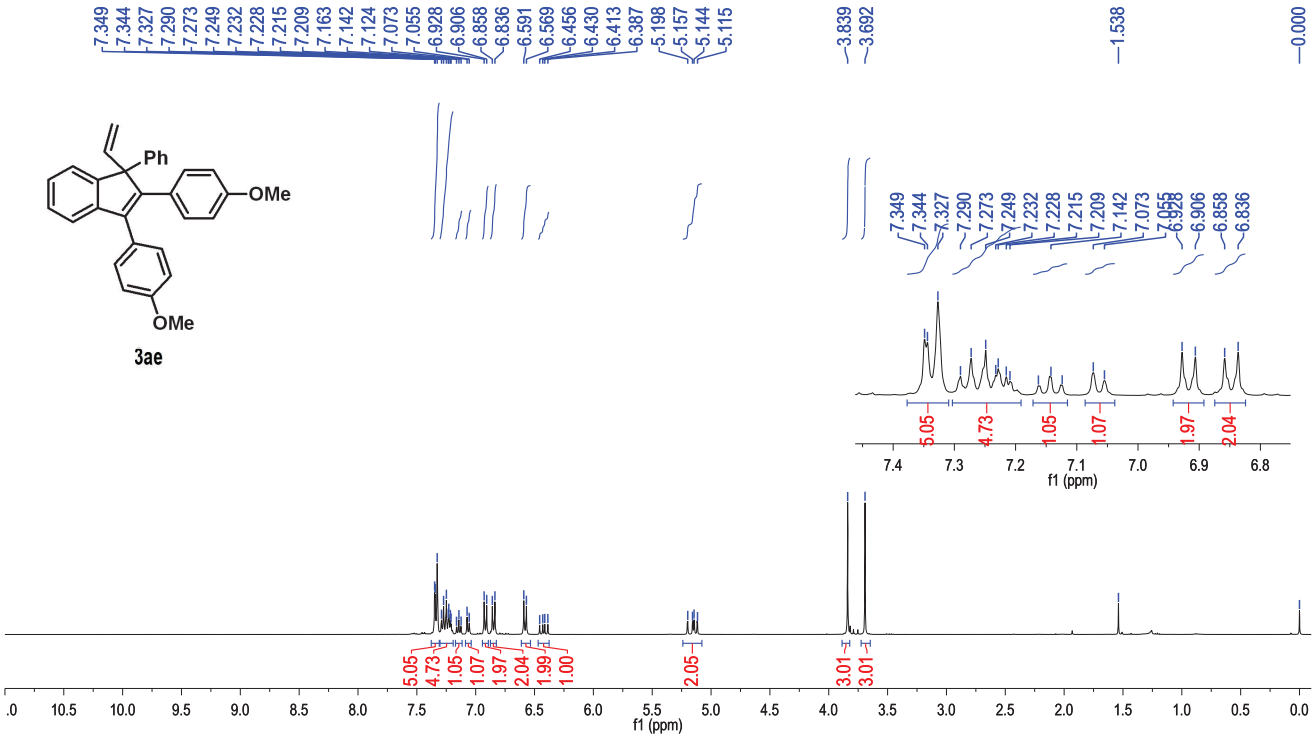
77.060
76.742
66.312
21.527
21.443
Ph
Me
Me
3ac
f1 (ppm)


Ph
Me
Me
3ad
f1 (ppm)


Ph
Me
Me
3ad
f1 (ppm)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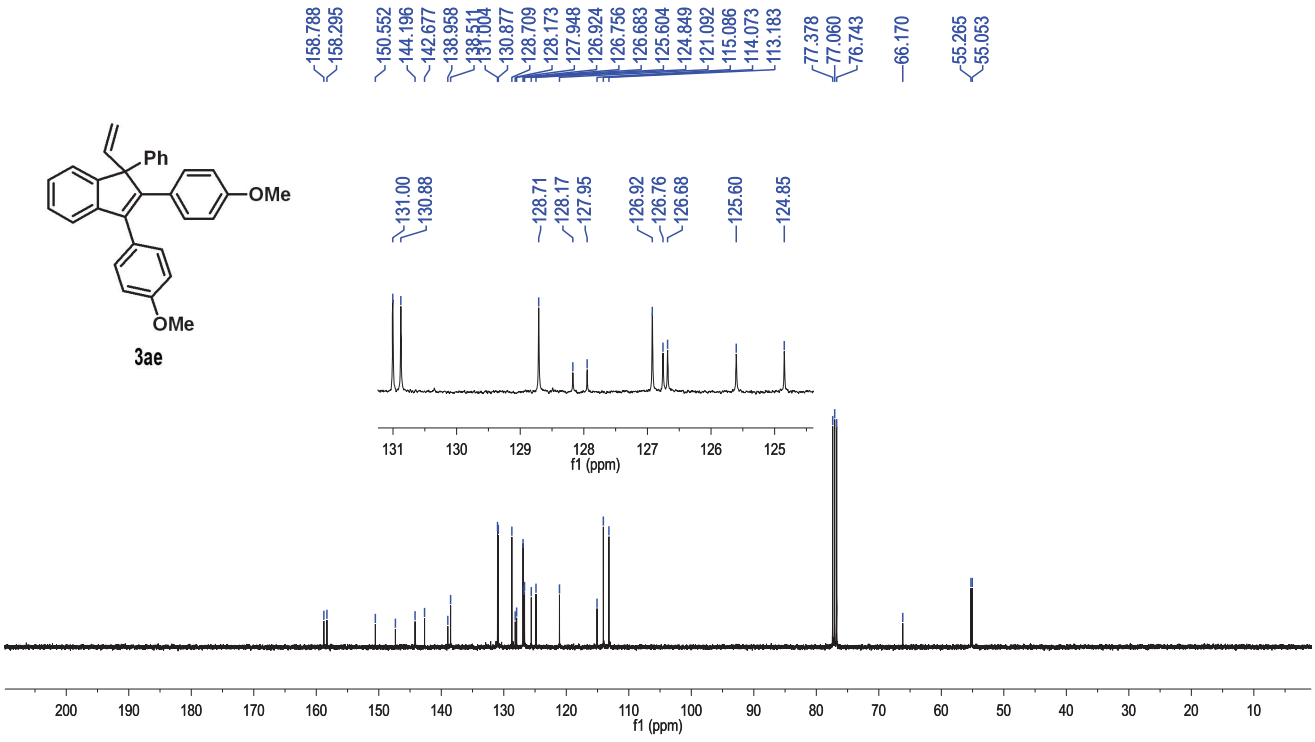
7.327
7.290
7.273
7.249
7.232
7.228
7.215
7.209
7.163
7.142
7.124
7.073
7.055
6.928
6.906
6.858
6.836
6.591
6.569
6.456
6.430
6.413
6.387
5.198
5.157
5.144
5.115
3.839
3.692
1.538
0.000
Ph
OMe
OMe
3ae
5.05
4.73
1.05
1.07
1.97
2.04
1.99
1.00
2.05
3.01
3.01
f1 (ppm)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144.196
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131.004
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128.173
127.948
126.924
126.756
126.683
125.604
124.849
121.092
115.086
114.073
113.183
77.378
77.060
76.743
66.170
55.265
55.053
Ph
OMe
OMe
3ae
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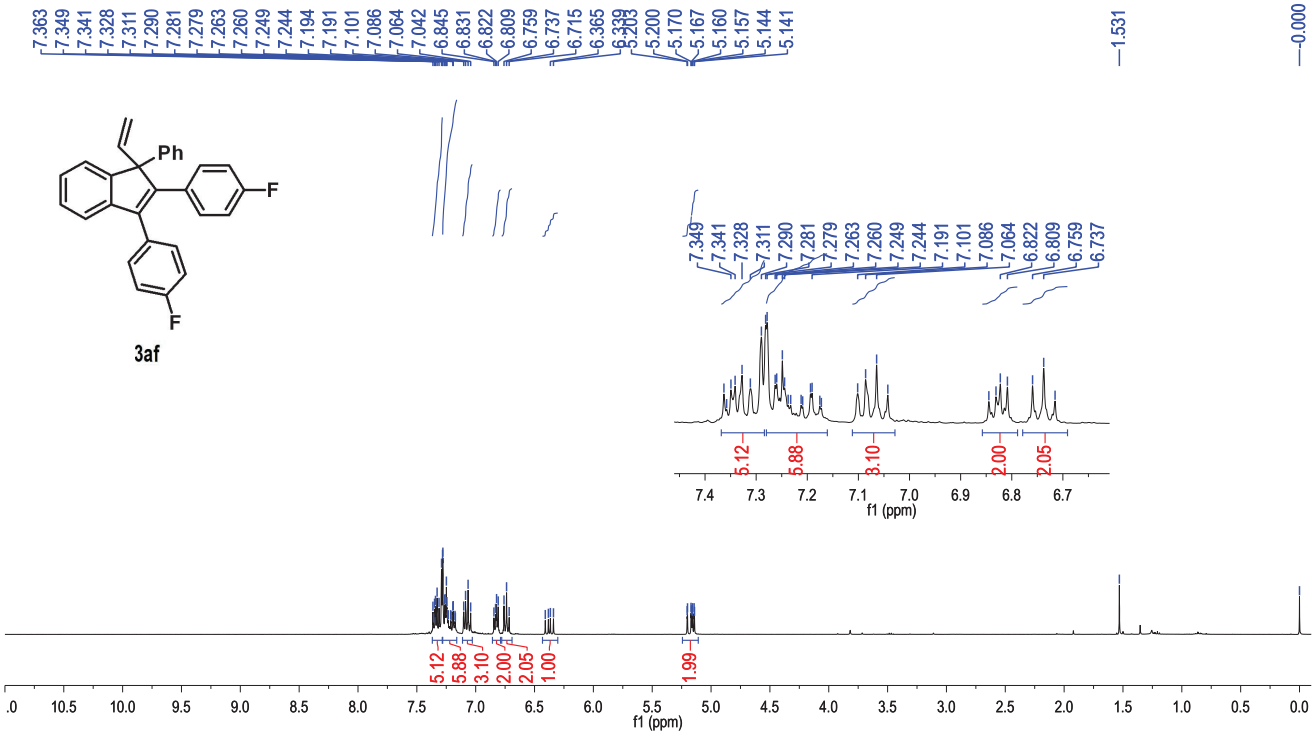
128.71
128.17
127.95
126.92
126.76
126.68
125.60
124.85
f1 (ppm)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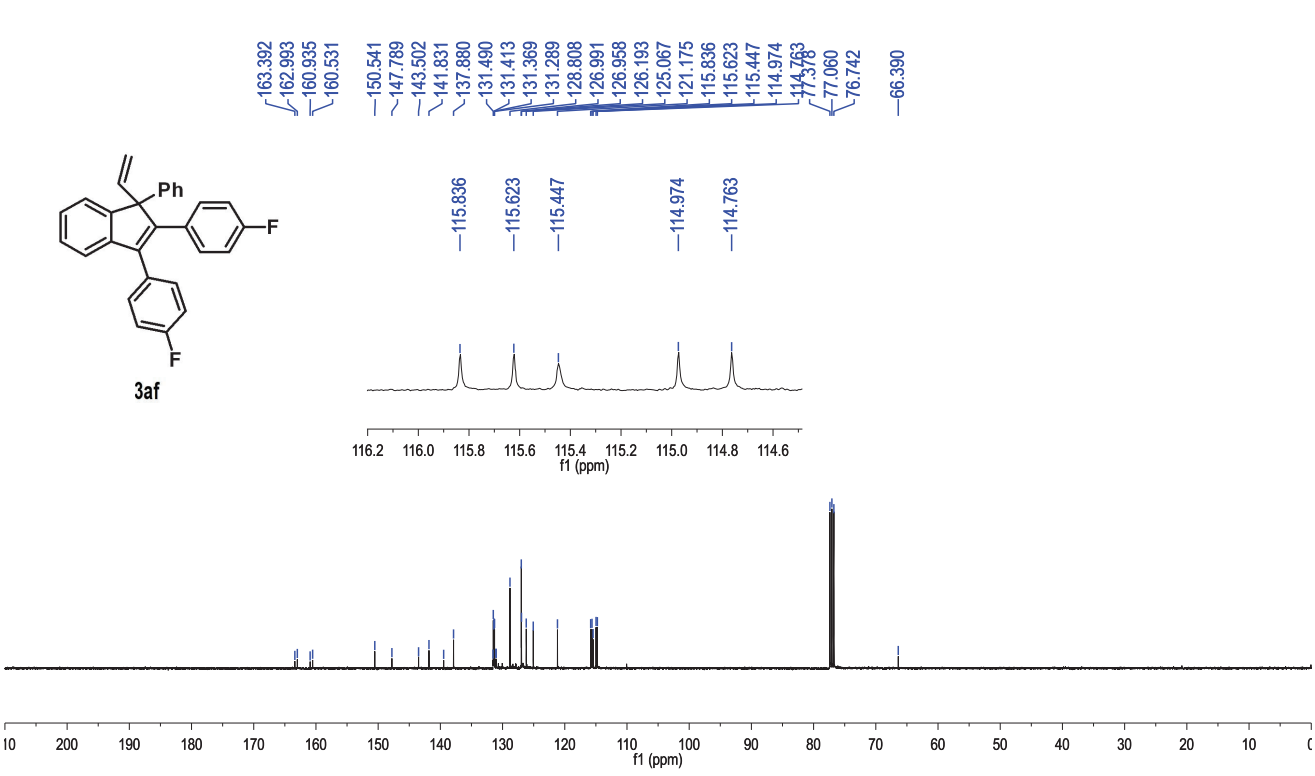
7.341
7.328
7.311
7.290
7.281
7.279
7.263
7.260
7.249
7.244
7.194
7.191
7.101
7.086
7.064
7.042
6.845
6.831
6.822
6.809
6.759
6.737
6.715
6.365
6.339
6.203
5.200
5.170
5.167
5.160
5.157
5.144
5.141
1.531
0.000
Ph
F
F
3af
5.12
5.88
3.10
2.00
2.05
1.00
1.99
f1 (ppm)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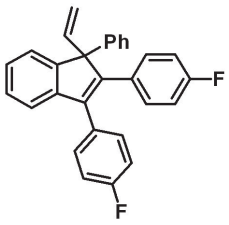
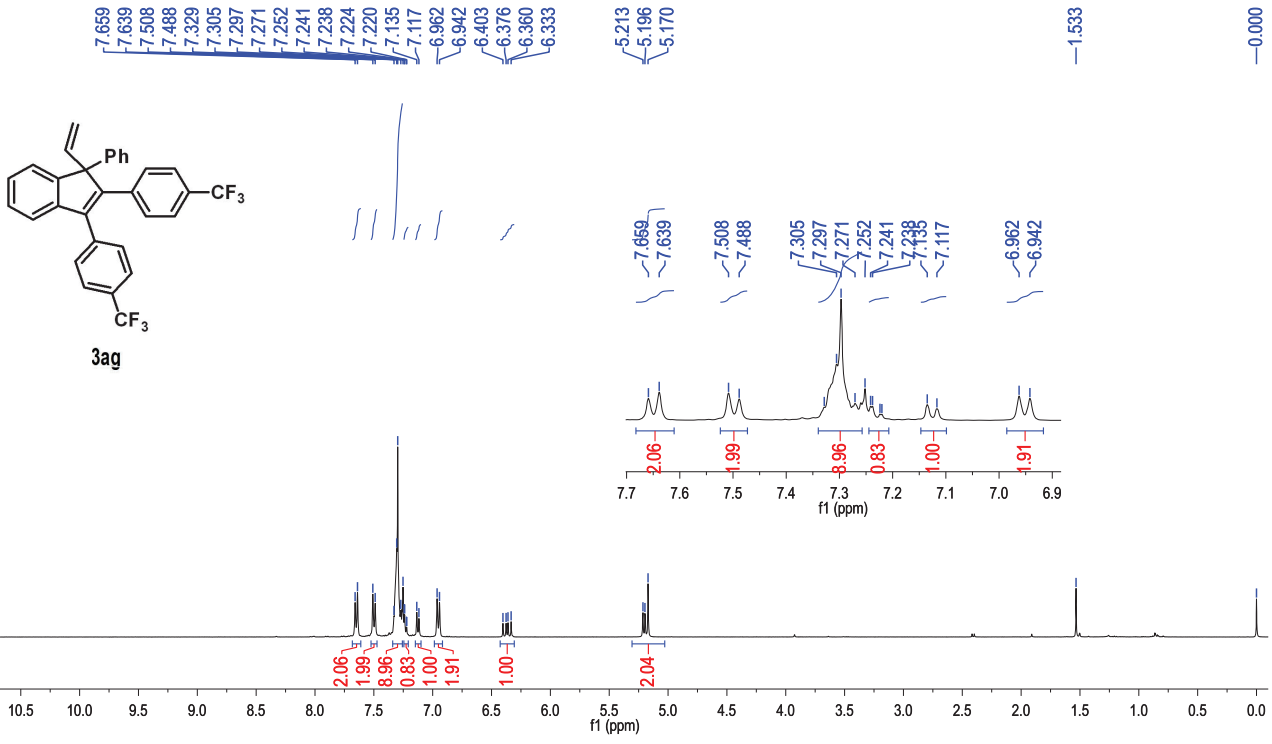
162.993
160.935
160.531
150.541
147.789
143.502
141.831
137.880
131.490
131.413
131.369
131.289
128.808
126.991
126.958
126.193
125.067
121.175
115.836
115.623
115.447
114.974
114.763
77.378
77.060
76.742
66.390
Ph
F
F
3af
115.836
115.623
115.447
114.974
114.763
f1 (ppm)

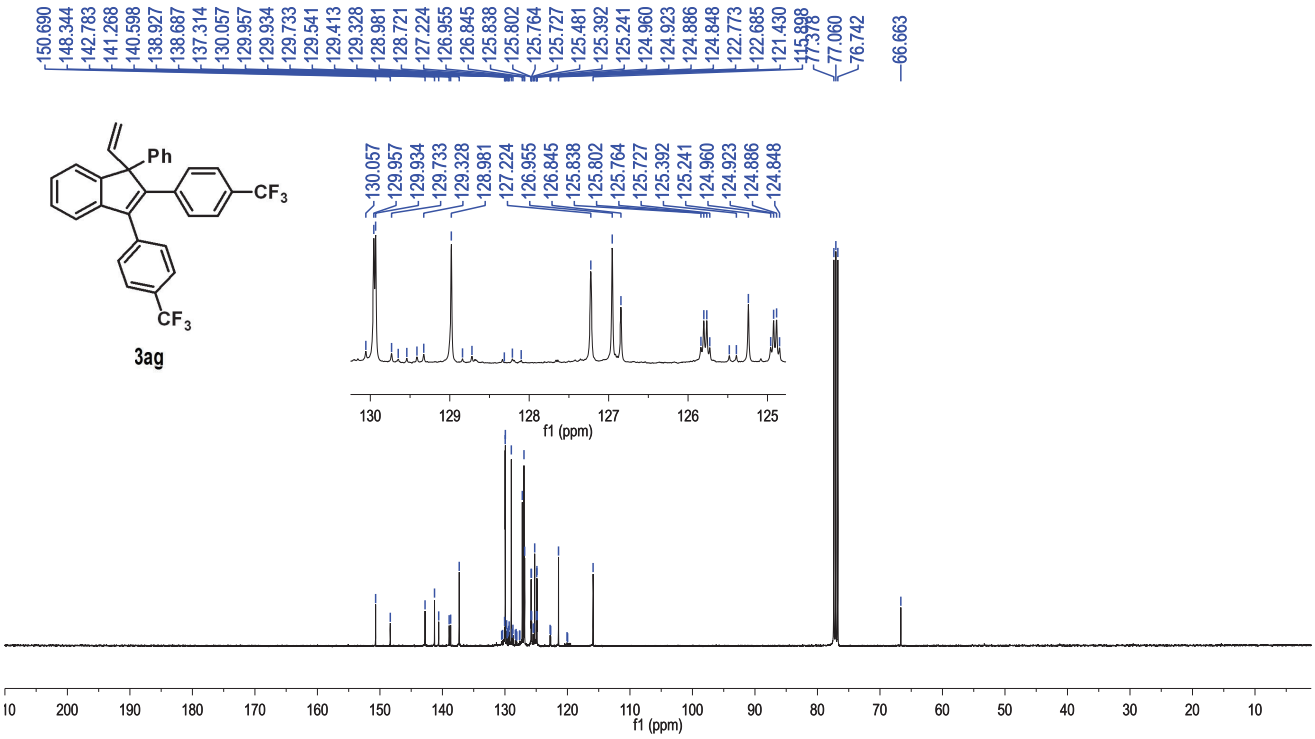

Ph
F
F

3af

114.128
114.478
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
f1 (ppm)


7.659
7.639
7.508
7.488
7.329
7.305
7.297
7.271
7.252
7.241
7.238
7.224
7.220
7.135
7.117
6.962
6.942
6.403
6.376
6.360
6.333
5.213
5.196
5.170
1.533
0.000
Ph
CF3
CF3
2.06
1.99
8.96
0.83
1.00
1.91
1.00
2.04
f1 (ppm)

3ag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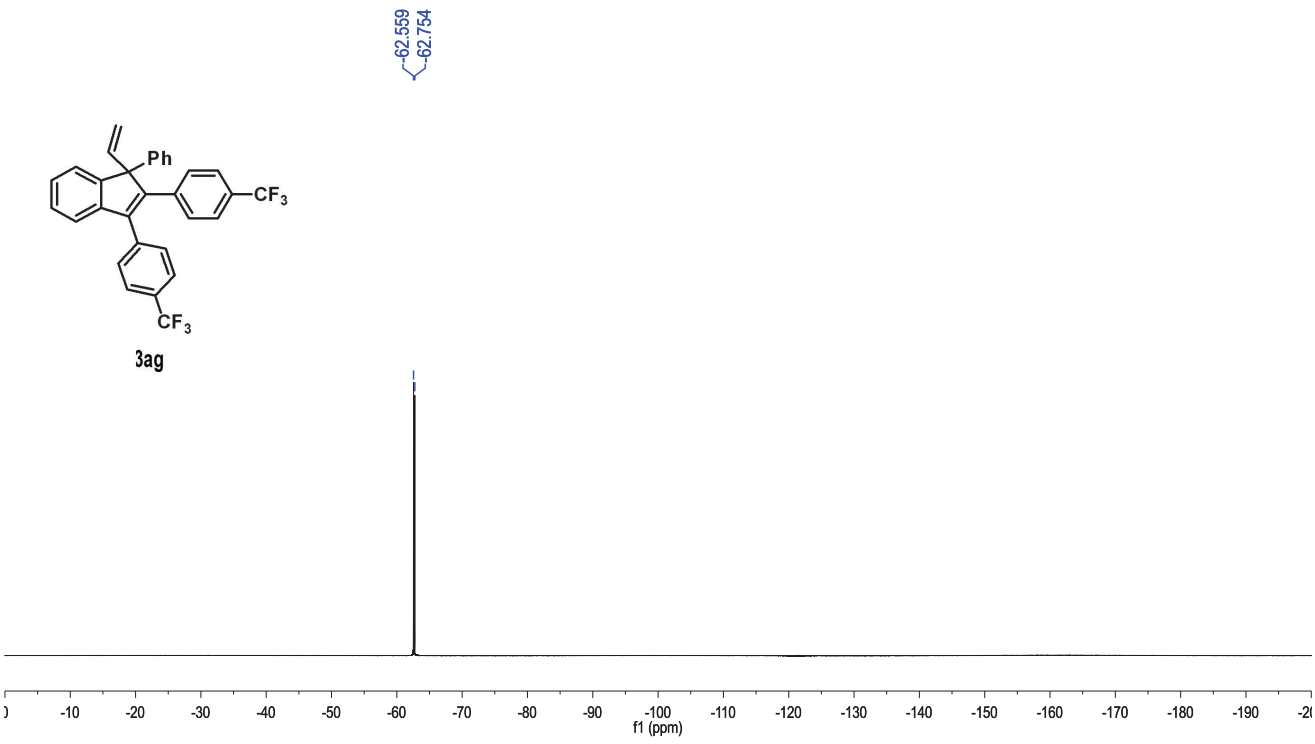
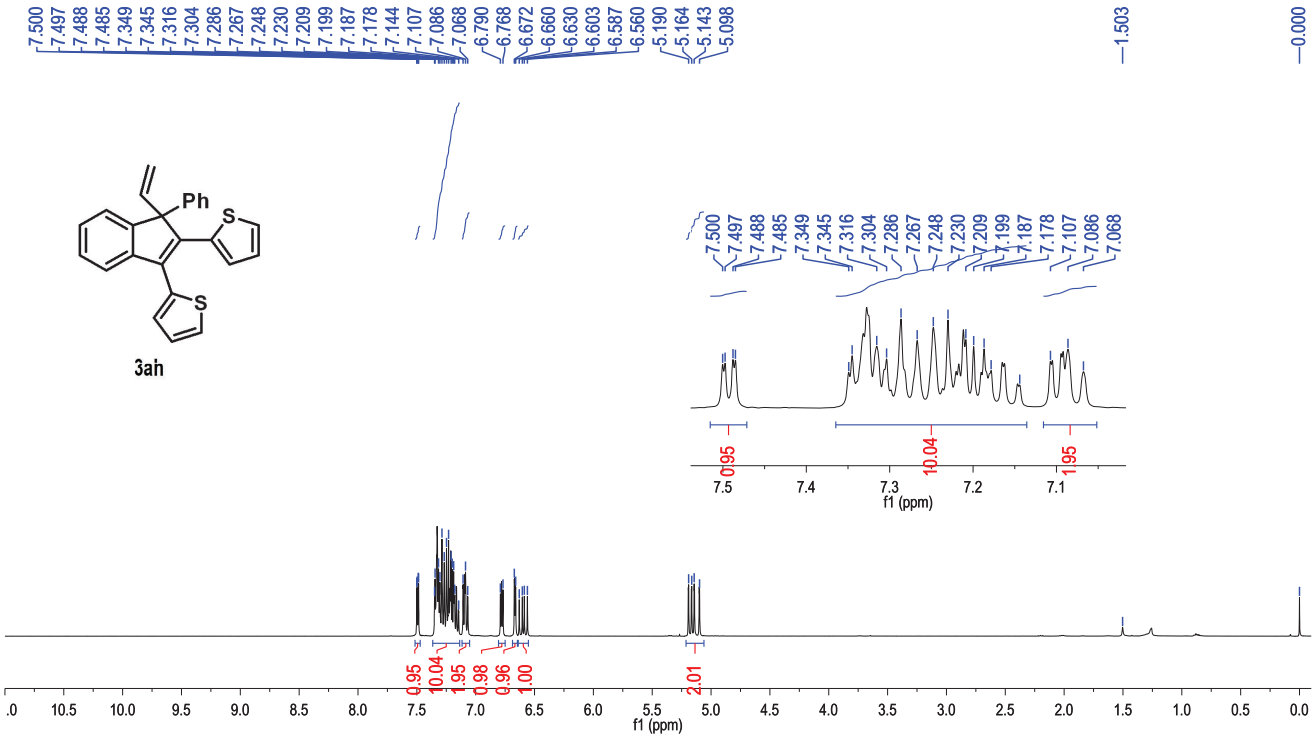
148.344
142.783
141.268
140.598
138.927
138.687
137.314
130.057
129.957
129.934
129.733
129.541
129.413
129.328
128.981
128.721
127.224
126.955
126.845
125.838
125.802
125.764
125.727
125.481
125.392
125.241
124.960
124.923
124.886
124.848
122.773
122.685
121.430
115.898
77.378
77.060
76.742
66.663
Ph
CF3
CF3
3ag
130.057
129.957
129.934
129.733
129.328
128.981
127.224
126.955
126.845
125.838
125.802
125.764
125.727
125.392
125.241
124.960
124.923
124.886
124.848
130
129
128
127
126
125
f1 (ppm)
10
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


62.559
62.754
Ph
CF3
CF3
3ag
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
f1 (ppm)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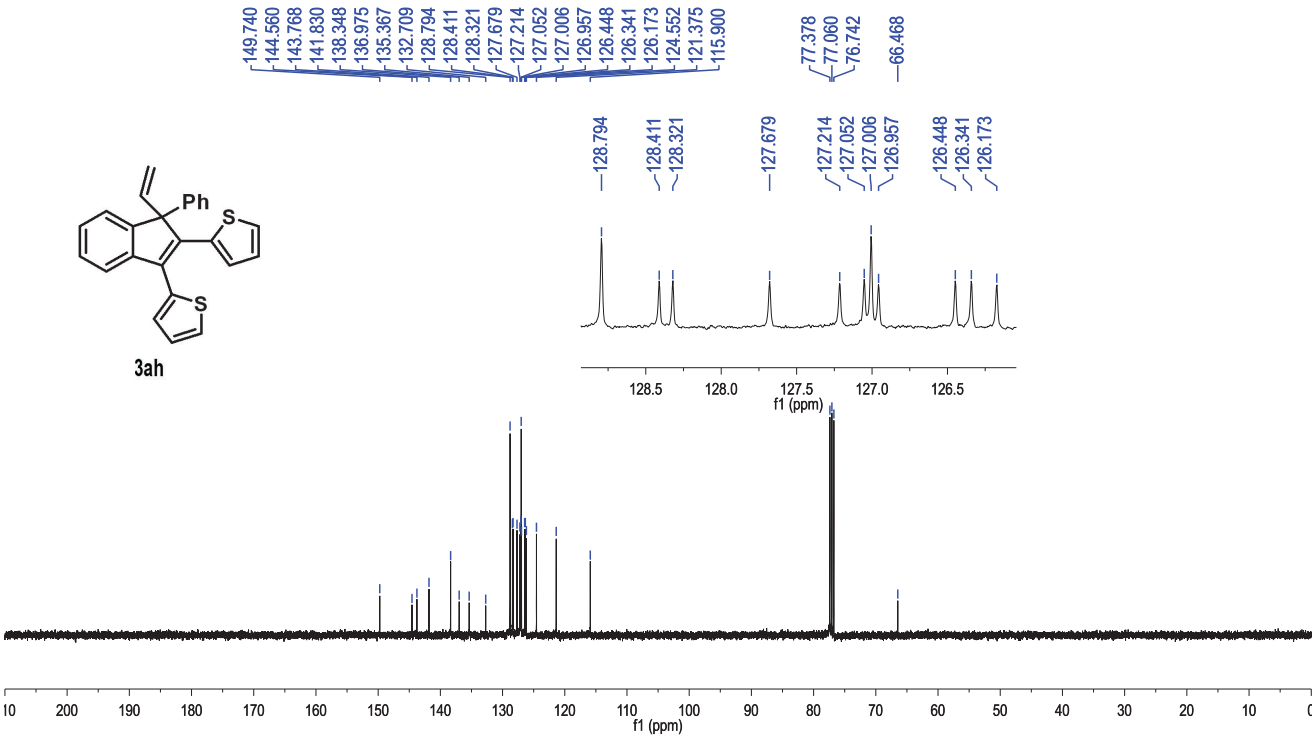
7.497
7.488
7.485
7.349
7.345
7.316
7.304
7.286
7.267
7.248
7.230
7.209
7.199
7.187
7.178
7.144
7.107
7.086
7.068
6.790
6.768
6.672
6.660
6.630
6.603
6.587
6.560
5.190
5.164
5.143
5.098
1.503
0.000
Ph
S
S
3ah
0.95
10.04
1.95
0.98
0.96
1.00
2.01
f1 (ppm)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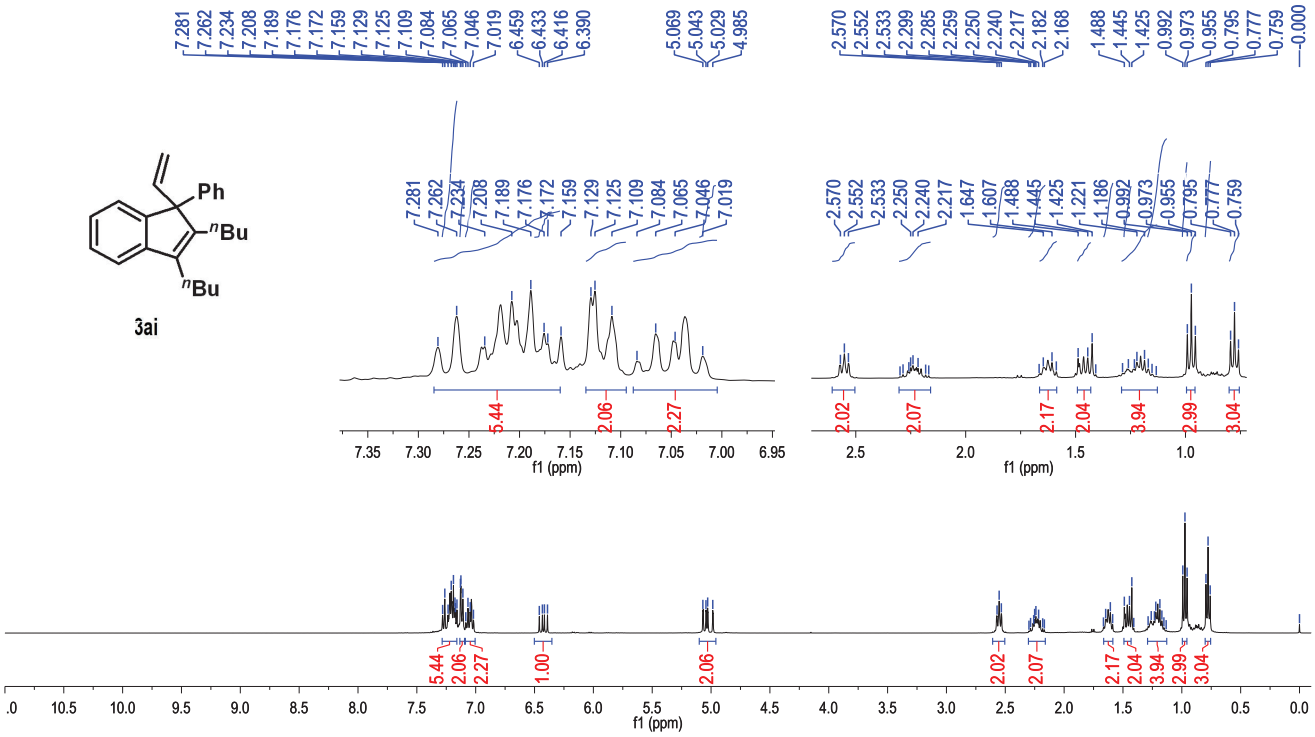
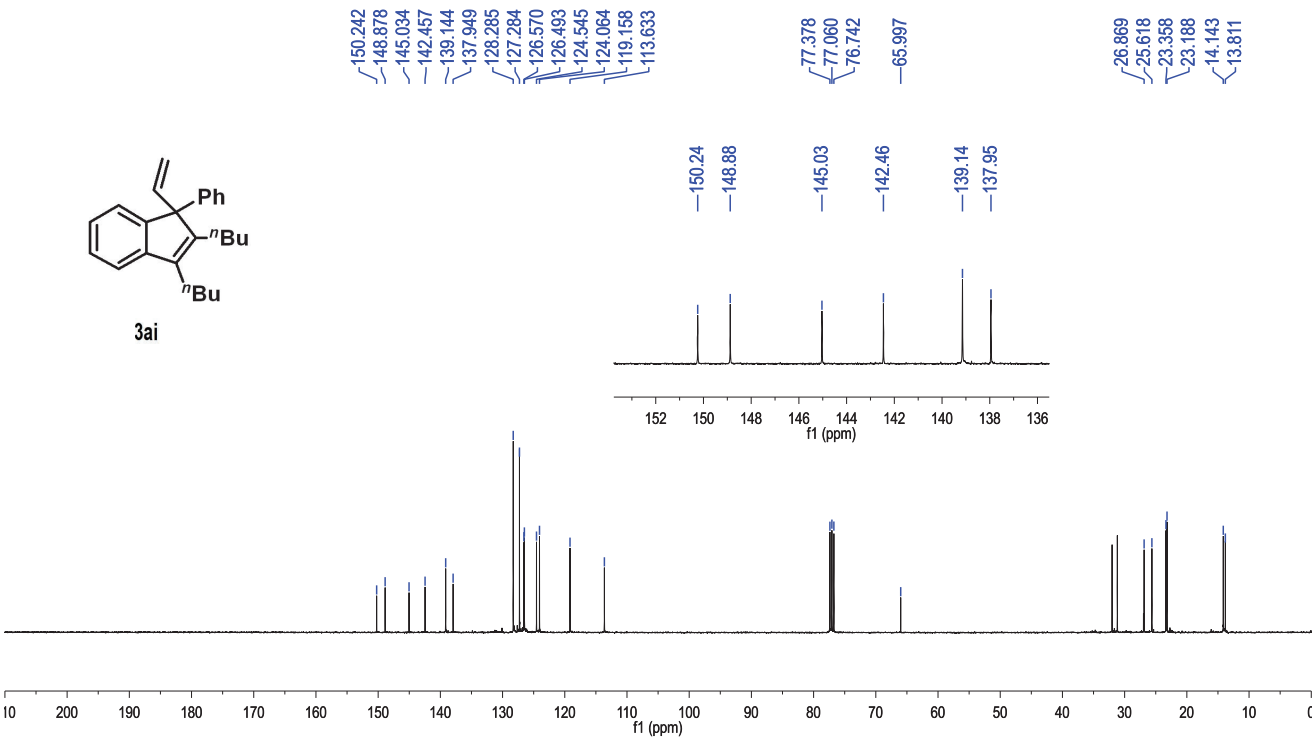
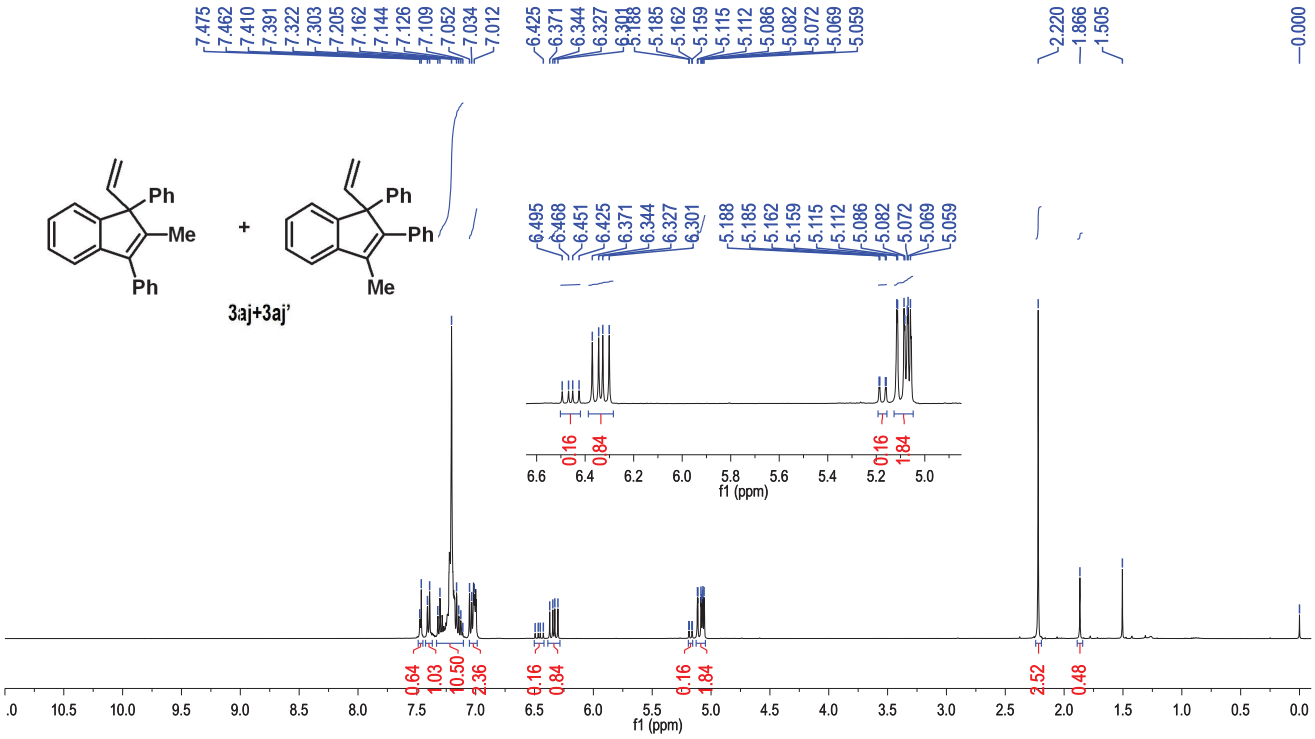
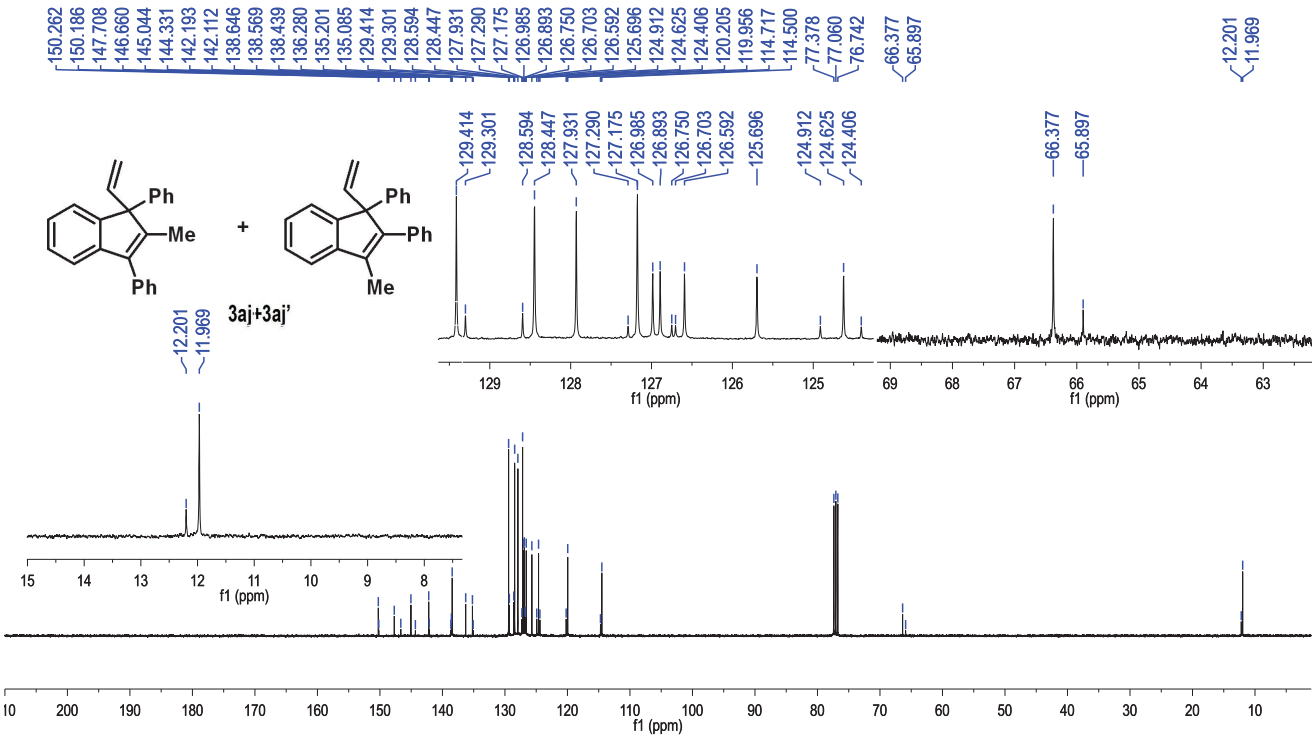
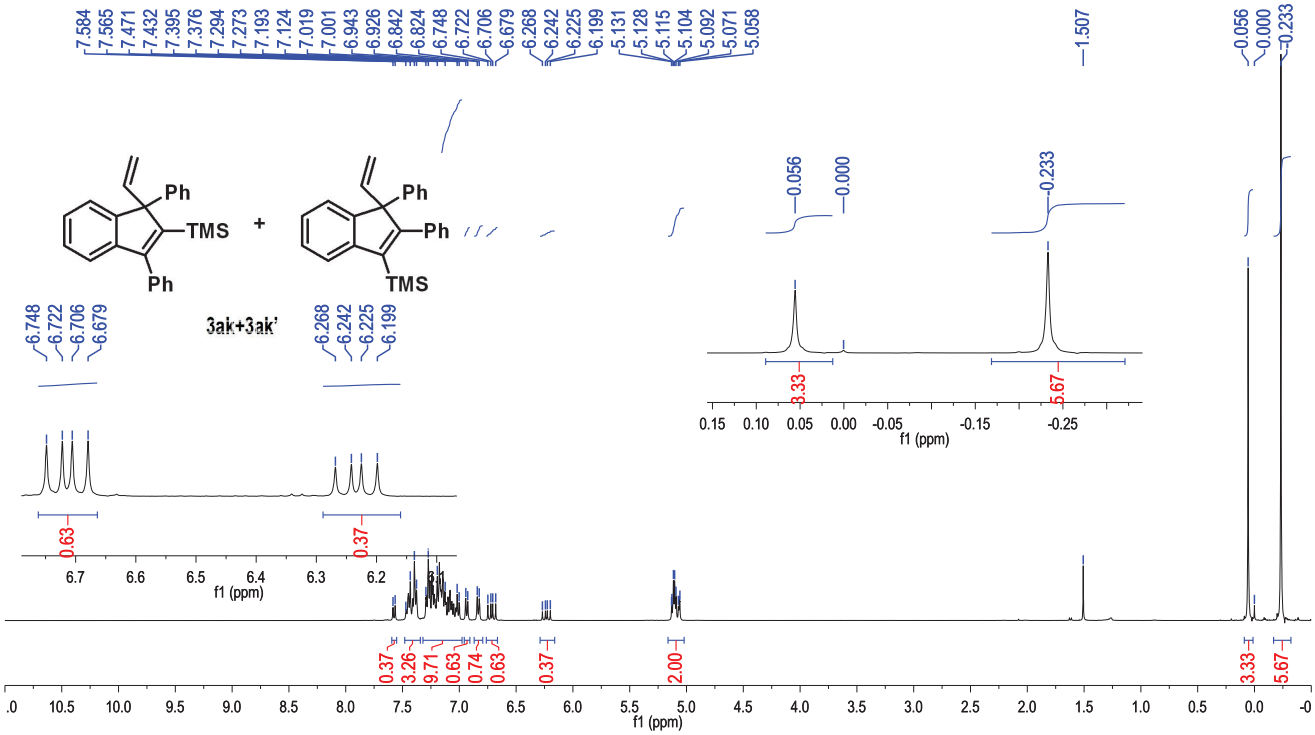
143.768
141.830
138.348
136.975
135.367
132.709
128.794
128.411
128.321
127.679
127.214
127.052
127.006
126.957
126.448
126.341
126.173
124.552
121.375
115.900
77.378
77.060
76.742
66.468
Ph
S
S
3ah
f1 (ppm)

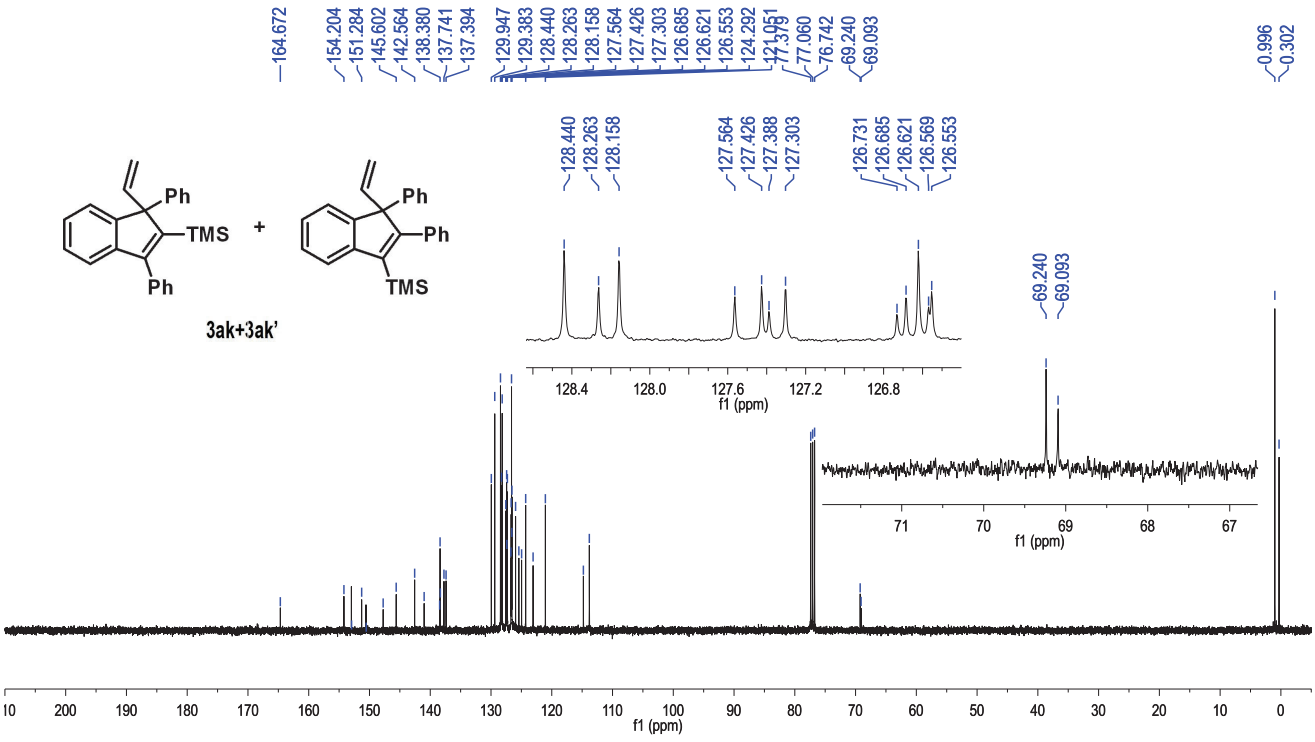

Ph
nBu
nBu
3ai
f1 (ppm)

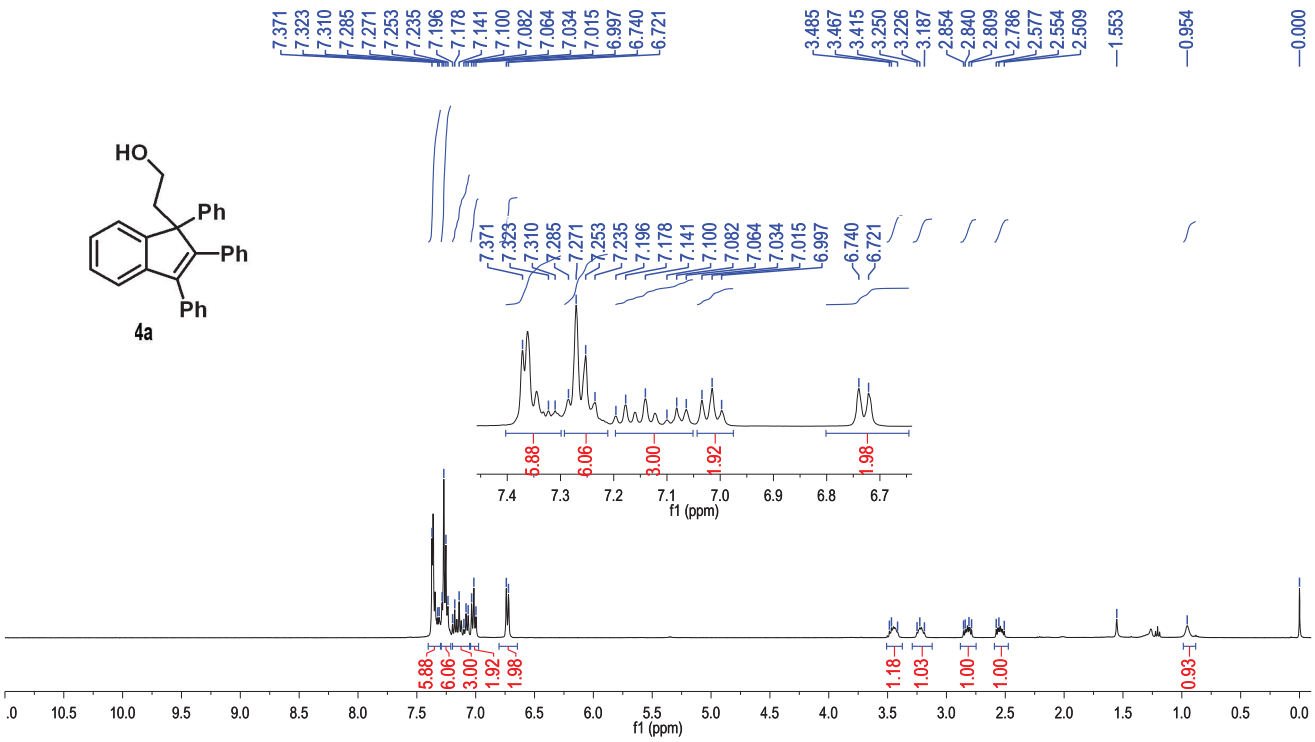

Ph
nBu
nBu
3ai
f1 (ppm)


Ph
Me
Ph
+
Ph
Ph
Me
3aj+3aj'
f1 (ppm)


Ph
Me
Ph
+
Ph
Ph
Me
3aj+3aj'
f1 (ppm)


Ph
TMS
Ph
+
Ph
Ph
TMS
3ak+3ak'
f1 (ppm)


Ph
TMS
Ph
+
Ph
Ph
TMS
3ak+3ak'
f1 (ppm)


HO
Ph
Ph
Ph
4a
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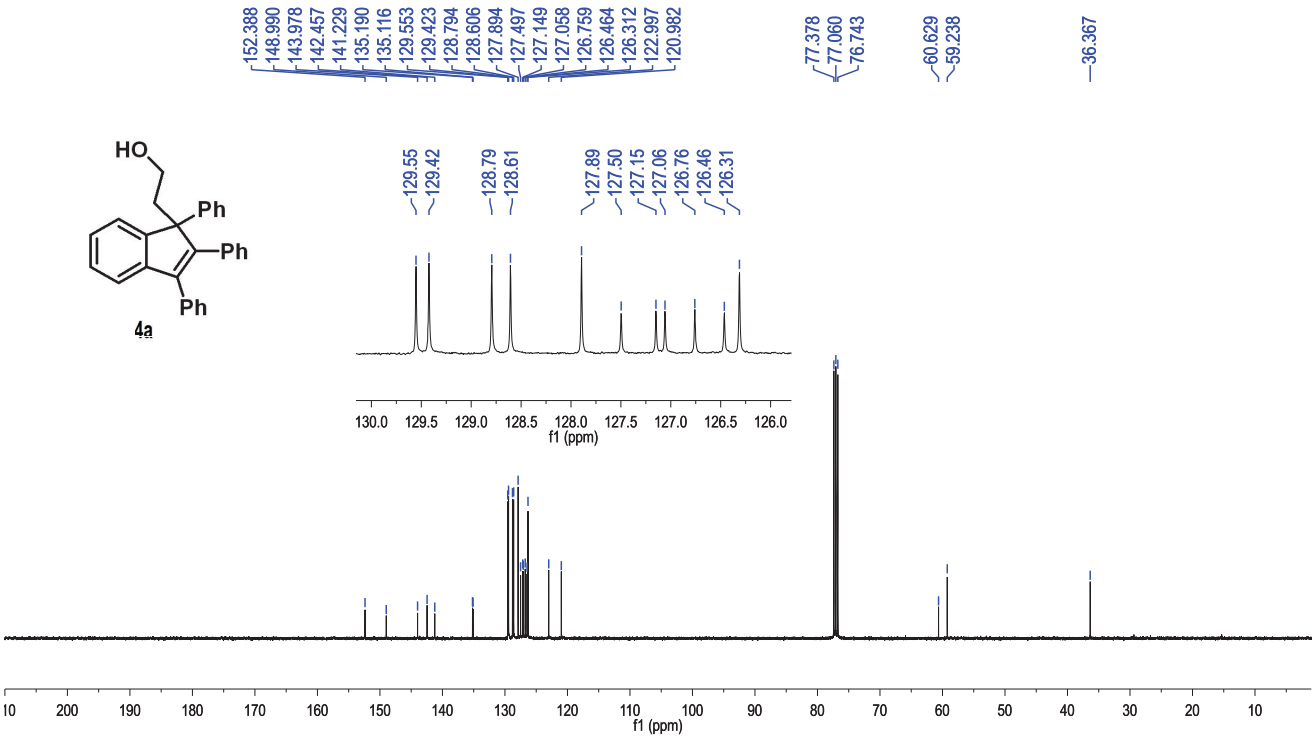
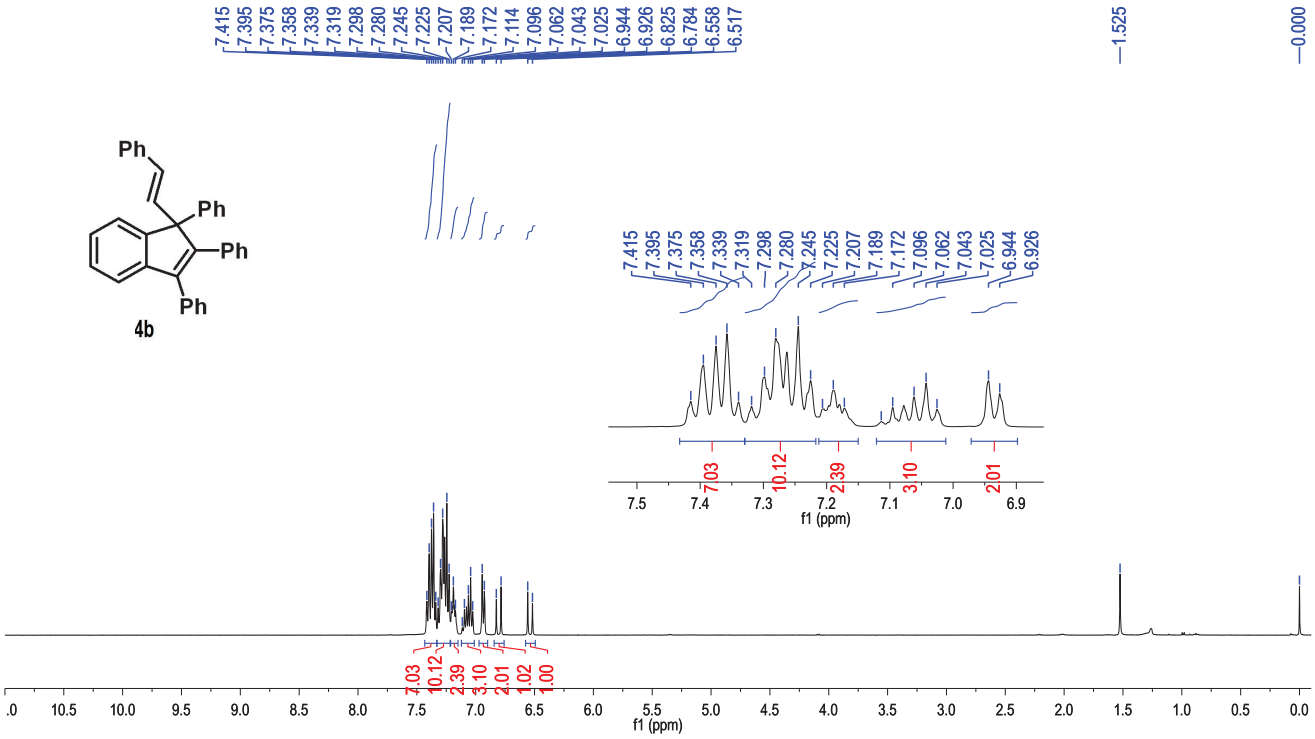
7.323
7.310
7.285
7.271
7.253
7.235
7.196
7.178
7.141
7.100
7.082
7.064
7.034
7.015
6.997
6.740
6.721
3.485
3.467
3.415
3.250
3.226
3.187
2.854
2.840
2.809
2.786
2.577
2.554
2.509
1.553
0.954
0.000
5.88
6.06
3.00
1.92
1.98
1.18
1.03
1.00
1.00
0.93
f1 (ppm)


HO
Ph
Ph
Ph
4a
152.388
148.990
143.978
142.457
141.229
135.190
135.116
129.553
129.423
128.794
128.606
127.894
127.497
127.149
127.058
126.759
126.464
126.312
122.997
120.982
77.378
77.060
76.743
60.629
59.238
36.367
129.55
129.42
128.79
128.61
127.89
127.50
127.15
127.06
126.76
126.46
126.31
f1 (ppm)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7.395
7.375
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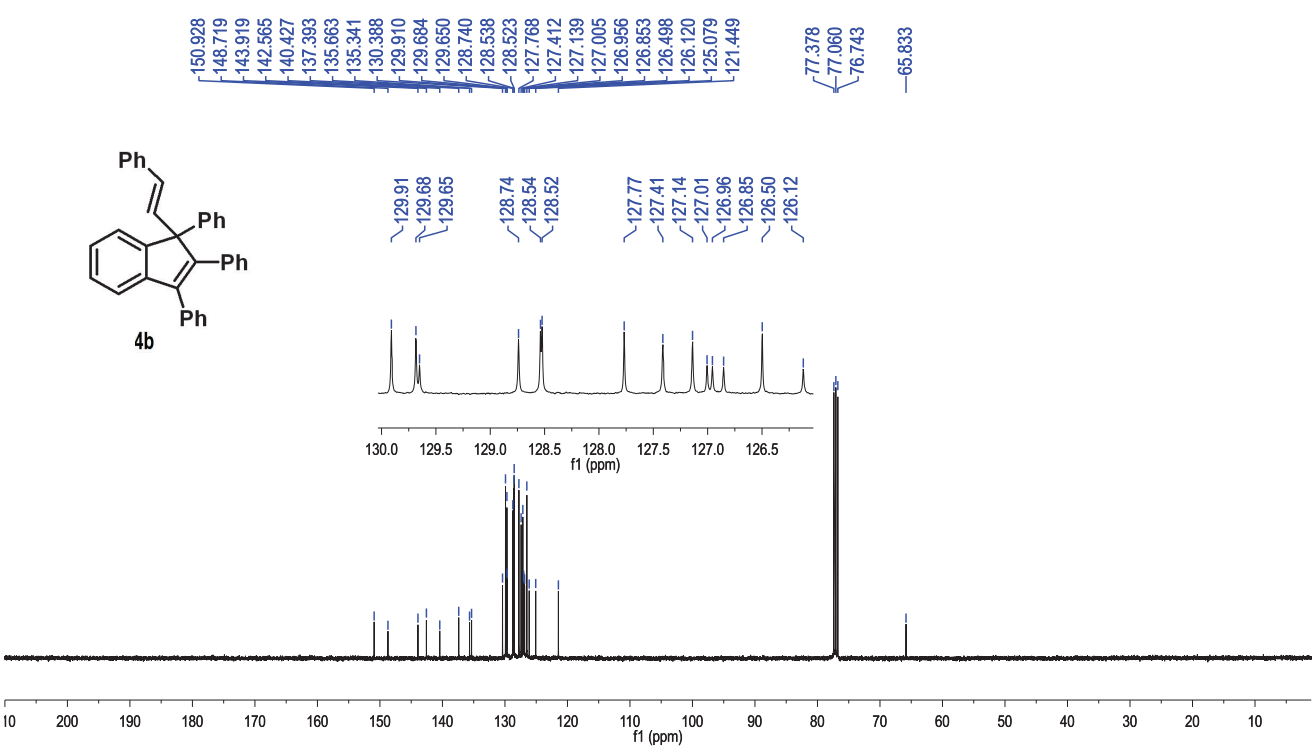
7.339
7.319
7.298
7.280
7.245
7.225
7.207
7.189
7.172
7.114
7.096
7.062
7.043
7.025
6.944
6.926
6.825
6.784
6.558
6.517
1.525
0.000
Ph
Ph
Ph
Ph
4b
7.03
10.12
2.39
3.10
2.01
1.02
1.00
f1 (ppm)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143.919
142.565
140.427
137.393
135.663
135.341
130.388
129.910
129.684
129.650
128.740
128.538
128.523
127.768
127.412
127.139
127.005
126.956
126.853
126.498
126.120
125.079
121.449
77.378
77.060
76.743
65.833
129.91
129.68
129.65
128.74
128.54
128.52
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127.41
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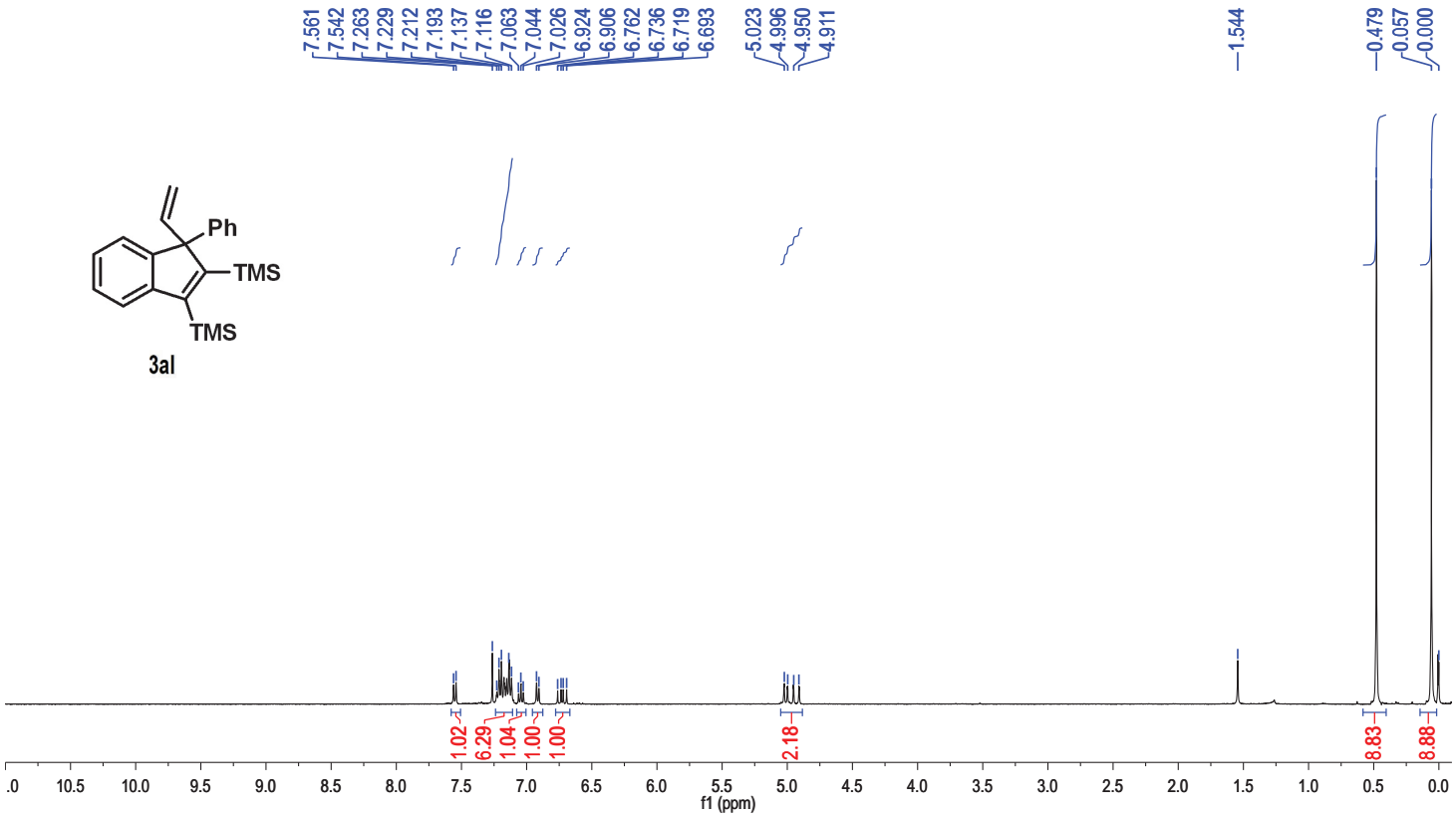
126.12
Ph
Ph
Ph
Ph
4b
f1 (ppm)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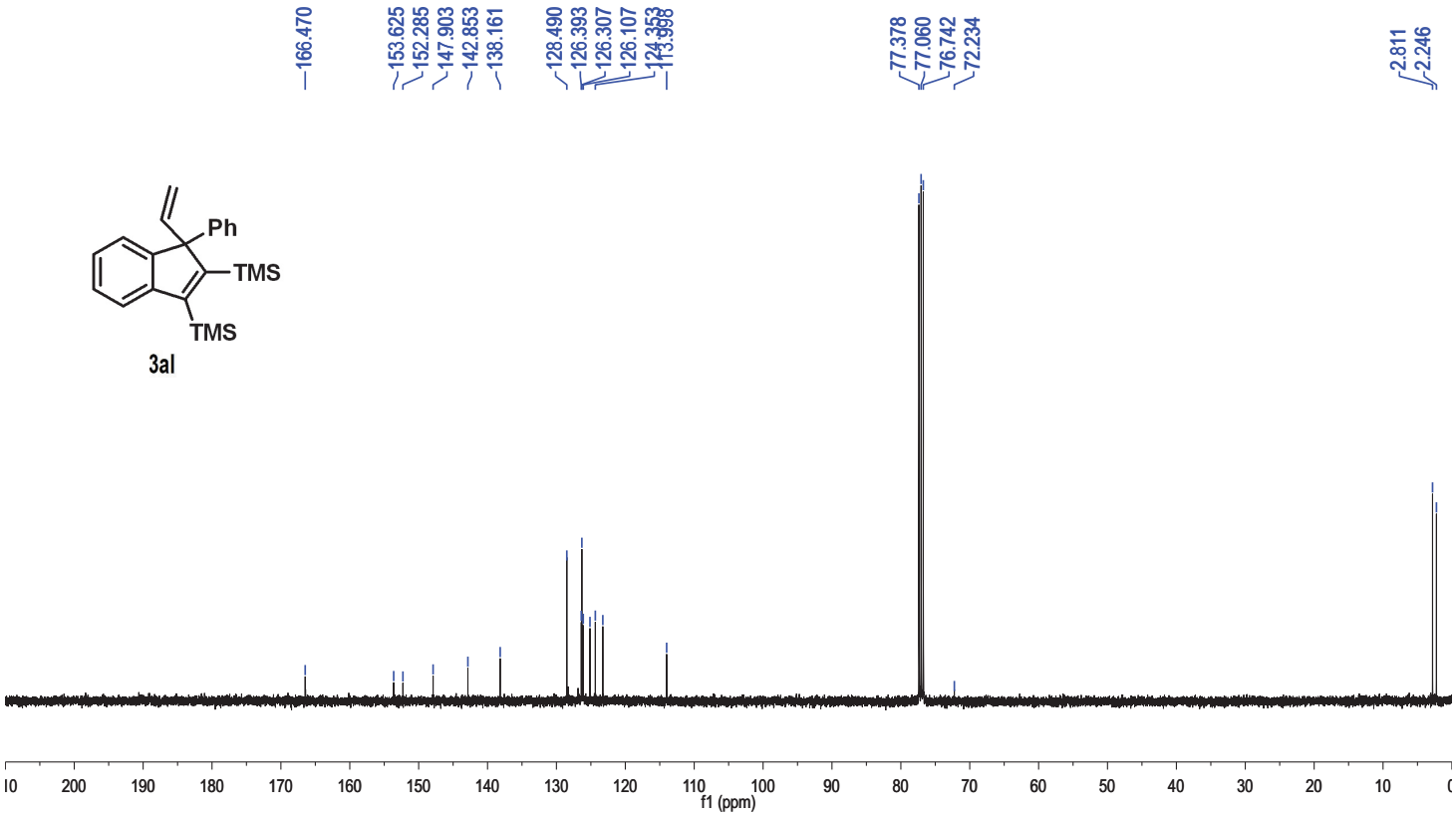
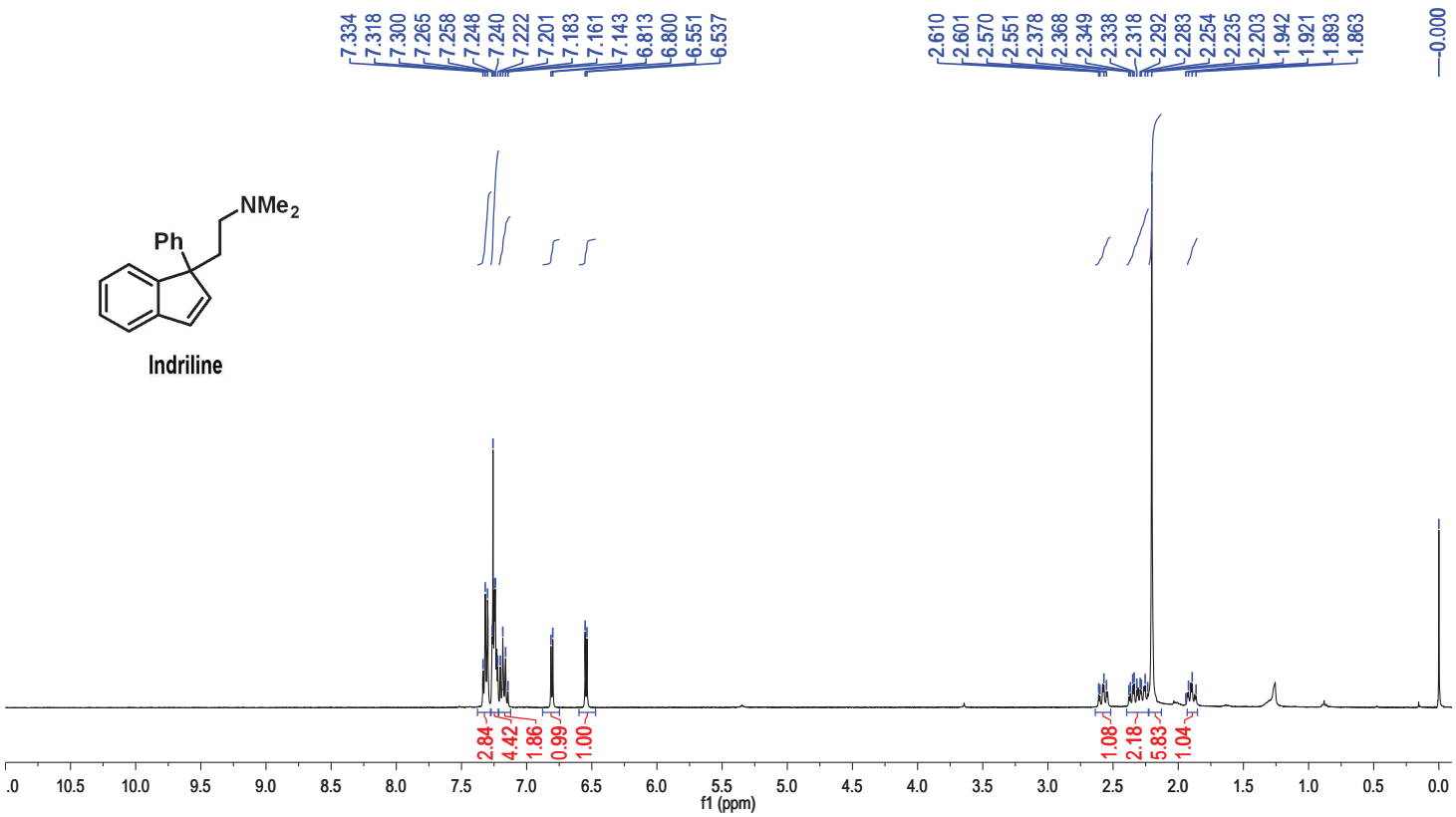
7.542
7.263
7.229
7.212
7.193
7.137
7.116
7.063
7.044
7.026
6.924
6.906
6.762
6.736
6.719
6.693
5.023
4.996
4.950
4.911
1.544
0.479
0.057
0.000
Ph
TMS
TMS
3al
1.02
6.29
1.04
1.00
1.00
2.18
8.83
8.88
f1 (ppm)


166.470
153.625
152.285
147.903
142.853
138.161
128.490
126.393
126.307
126.107
77.378
77.060
76.742
72.234
2.811
2.246
Ph
TMS
TMS
3al
f1 (ppm)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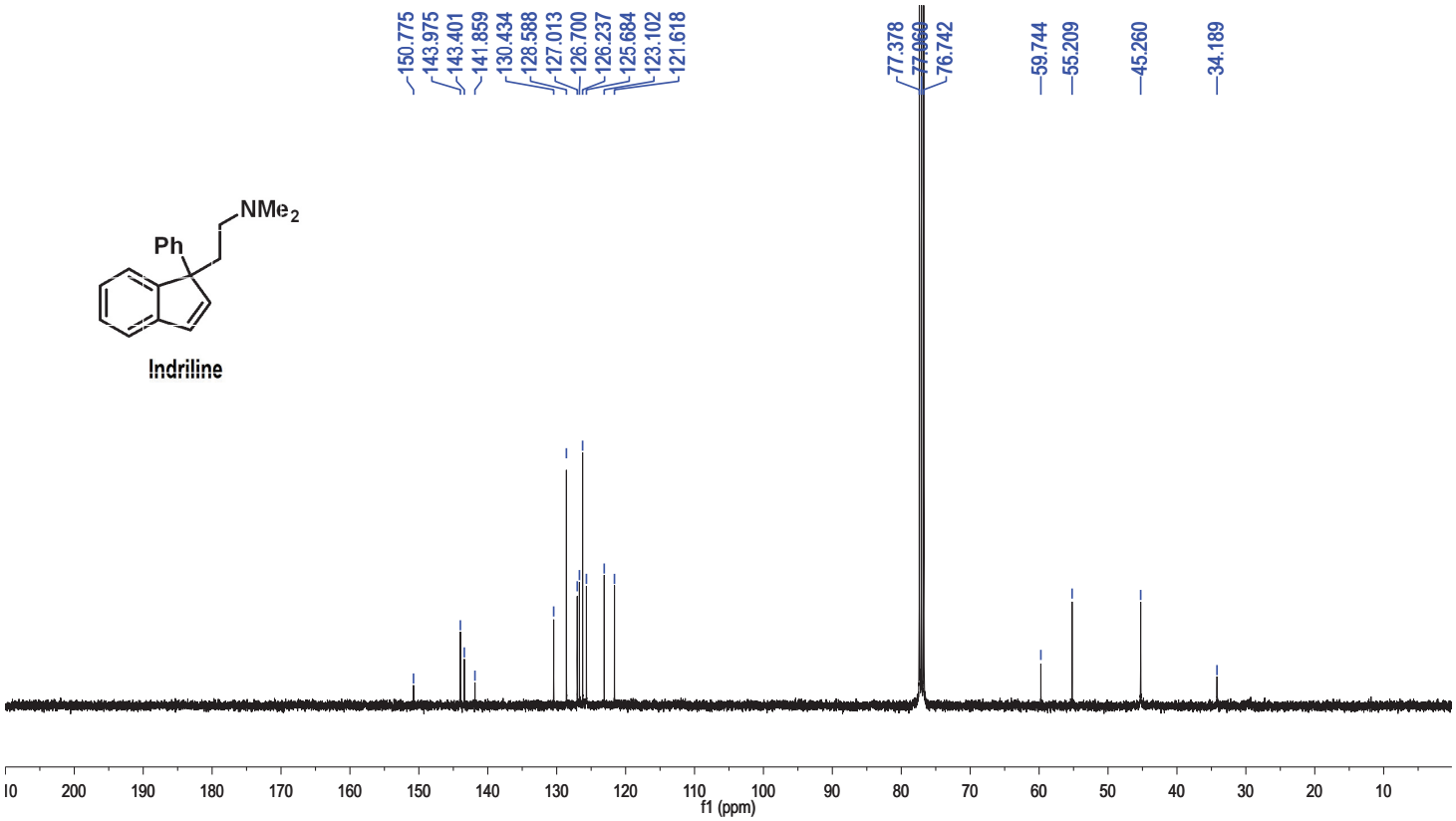
7.318
7.300
7.265
7.258
7.248
7.240
7.222
7.201
7.183
7.161
7.143
6.813
6.800
6.551
6.537
2.610
2.601
2.570
2.551
2.378
2.368
2.349
2.338
2.318
2.292
2.283
2.254
2.235
2.203
1.942
1.921
1.893
1.863
0.000
NMe2
Ph
Indriline
2.84
4.42
1.86
0.99
1.00
1.08
2.18
5.83
1.04
f1 (ppm)


150.775
143.975
143.401
141.859
130.434
128.588
127.013
126.700
126.237
125.684
123.102
121.618
77.378
77.060
76.742
59.744
55.209
45.260
34.189
NMe2
Ph
Indriline
f1 (ppm)