Supplementary Material (ESI) for RSC Advances


## Supporting information

# Pd-Catalyzed Ligand-free Suzuki Reaction of β-Substituted Allylic Halides with Arylboronic Acids in Water

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## 1. General Information

Unless otherwise noted, all experiments were carried out in air, and all commercially available chemicals including solvents and organoboronic compounds were used as received without any further purification. $^{1}$H NMR and $^{13}$C NMR spectra were recorded on a Bruker Model Avance DMX 400 Spectrometer ($^{1}$H 400 MHz and $^{13}$C 106 MHz, respectively). Chemical shifts (δ) are given in ppm and are referenced to residual solvent peaks. The β-arylated allylic halides (bromides and chlorides) (**1a-k**)[1] and methyl 2-(bromomethyl)acrylate (**1m**)[2] were prepared according to the previous reports.

## 2. General procedure for allylation of organoborons in water

A mixture of allyl halide **1** (1.0 mmol), arylboronic acid **2** (1.20 mmol), KOH (84.17 mg, 1.5 mmol), palladium trifluoroacetate (0.033 mg, 0.0001 mmol) in water (3.0 mL) in a round-bottom flask was stirred and heated at 90 °C for 3 h. Then the flask was removed from the oil bath and cooled to room temperature. Water (5.0 mL) was added, and the mixture was extracted with $CH_2Cl_2$ (3×5.0 mL). The combined organic extracts were dried over anhydrous $Na_2SO_4$, concentrated in vacuo. The residue was then purified via flash chromatography on silica gel using a mixture of ethyl acetate and hexane to give the pure product.

**1-Methoxy-3-(2-phenyl-allyl)-benzene (3aa)**, yellow oil; $^{1}$H NMR (400 MHz, $CDCl_3$) δ 3.81 (s, 3H), 3.88 (s, 2H), 5.11 (d, *J* = 1.28 Hz, 1H), 5.57 (d, *J* = 0.92 Hz, 1H), 6.80 (dd, *J* = 2.40, 8.16 Hz, 1H), 6.86 (m, 1H), 6.90 (d, *J* = 7.60 Hz, 1H), 7.24 (m, 1H), 7.35 (m, 3H), 7.51(m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.7, 55.1, 111.5, 114.7, 114.8, 121.5, 126.2, 127.6, 128.4, 129.4, 140.8, 141.2, 146.7, 159.7; HRMS (ESI) calcd. for $C_{16}H_{16}NaO[M+Na]^+$: 247.1093, found: 247.1089.

**2,3-Diphenyl propene (3ab),**[3] yellow oil; $^{1}$H NMR (400 MHz, $CDCl_3$) δ 3.88 (s, 2H), 5.06 (d, *J* = 1.24 Hz, 1H), 5.54 (d, *J* = 0.52 Hz, 1H), 7.22 (m, 1H), 7.28 (m, 4H), 7.33 (m, 3H), 7.48 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.8, 114.7, 126.3, 127.6,

128.4, 128.5, 129.1, 138.9, 139.6, 140.9, 147.0; HRMS (ESI) calcd. for $C_{15}H_{14}Na[M+Na]^+$: 217.0988, found: 217.0986.

**1-Methoxy-4-(2-phenylallyl)-benzene (3ac)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.81(s, 3H), 3.82 (s, 2H), 5.05 (d, *J* = 1.32 Hz, 1H), 5.52 (m, 1H), 6.86 (m, 2H), 7.20 (m, 2H), 7.32 (m, 3H), 7.49 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 40.8, 55.2, 113.8, 114.3, 126.2, 127.4, 128.3, 129.9, 131.5, 140.9, 147.4, 158.0; HRMS (ESI) calcd. for $C_{16}H_{17}O[M+H]^+$: 225.1274, found: 225.1271.

**1-Methyl-4-(2-phenyl-allyl)-benzene (3ad)**,[4] yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 2.34 (s, 3H), 3.83 (s, 2H), 5.05 (d, *J* = 1.24Hz, 1H), 5.52 (s, 1H), 7.14 (dd, *J* = 8.08, 18.28 Hz, 4H), 7.30 (m, 3H), 7.48 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 29.8, 41.3, 114.5, 126.2, 127.5, 128.3, 128.9, 129.2, 135.6, 136.5, 140.9, 147.2; HRMS (ESI) calcd. for $C_{16}H_{16}Na[M+Na]^+$: 231.1144, found: 231.1141.

**1-Methyl-2-(2-phenyl-allyl)-benzene (3ae)**,[5] colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 2.35 (s, 3H), 3.82 (s, 2H), 4.79 (s, 1H), 5.50 (d, *J* = 0.96 Hz, 1H), 7.20 (m, 3H), 7.38 (m, 3H), 7.46 (m, 1H), 7.54 (d, *J* = 8.04 Hz, 2H ); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 31.5, 38.9, 114.0, 126.0, 126.5, 127.6, 128.4, 130.0, 130.2, 136.8, 137.7, 138.8, 141.5, 146.4; HRMS (ESI) calcd. for $C_{16}H_{17}[M+H]^+$: 209.1325, found: 209.1321.

**1-Methoxy-2-(2-phenylallyl)benzene (3af)**,[6] yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.87 (s, 5H), 4.97 (s, 1H), 5.52 (s, 1H), 6.90 (m, 2H), 7.21 (m, 3H), 7.34 (m, 2H), 7.54 (d, *J* = 7.92 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 34.9, 55.4, 110.3, 113.8, 120.5, 126.1, 126.2, 127.4, 128.1, 128.2, 130.3, 141.1, 146.5, 157.4; HRMS (ESI) calcd. for $C_{16}H_{17}O[M+H]^+$: 225.1274, found: 225.1270.

**1-Fluoro-3-(2-phenyl-allyl)-benzene (3ag)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.86 (s, 2H), 5.09 (d, *J* = 1.20 Hz, 1H), 5.55 (s, 1H), 6.90 (td, *J* = 2.36, 8.48 Hz, 1H), 6.98 (m, 1H), 7.05 (d, *J* = 7.68 Hz, 1H), 7.26 (m, 2H), 7.33 (m, 2H), 7.45 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.4, 112.9, 113.2, 115.0, 115.6, 115.8, 124.6, 126.1, 127.6, 128.3, 129.7, 129.8, 140.4, 142.2, 146.2; HRMS (ESI) calcd. for $C_{15}H_{13}FNa[M+Na]^+$: 235.0893, found: 235.0888.

**1,2-Difluoro-4-(2-phenyl-allyl)-benzene (3ah)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.83 (s, 2H), 5.09 (d, *J* = 1.20 Hz, 1H), 5.55 (s, 1H), 6.97 (m, 1H), 7.07 (m, 2H), 7.33 (m, 3H), 7.43 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 40.8, 115.1, 116.9, 117.1, 117.5, 117.6, 124.6, 126.1, 127.7, 128.4, 136.5, 140.2, 146.2; HRMS (ESI) calcd. for $C_{15}H_{12}F_2Na[M+Na]^+$: 253.0799, found: 253.0798.

**1-Chloro-4-(2-phenyl-allyl)-benzene (3ai)**,[7] pale yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.84 (s, 2H), 5.07 (d, *J* = 1.20 Hz, 1H), 5.54 (s, 1H), 7.20 (d, *J* = 8.36 Hz, 2H), 7.27 (m, 3H), 7.34 (m, 2H), 7.45 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.0, 114.9, 126.1, 127.6, 128.3, 128.5, 130.3, 131.9, 138.0, 140.4, 146.5; HRMS (ESI) calcd. for $C_{15}H_{13}ClNa[M+Na]^+$: 251.0598, found: 251.0596.

**1-Chloro-2-(2-phenyl-allyl)-benzene (3aj)**, pale yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.98 (s, 2H), 4.93 (d, *J* = 1.20 Hz, 1H), 5.56 (d, *J* = 0.52 Hz, 1H), 7.20 (m, 2H), 7.28 (m, 2H), 7.36 (m, 2H), 7.41 (m, 1H), 7.52 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 38.7, 114.6, 126.0, 126.8, 127.6, 127.7, 128.4, 129.4, 130.9, 134.4, 137.2, 140.7, 145.5; HRMS (ESI) calcd. for $C_{15}H_{13}ClNa[M+Na]^+$: 251.0598, found: 251.0593.

**1-Bromo-4-(2-phenyl-allyl)-benzene (3ak)**, yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.82 (s, 2H), 5.07 (d, *J* = 1.04 Hz, 1H), 5.54 (s, 1H), 7.15 (d, *J* = 8.28 Hz, 2H), 7.33 (m, 3H), 7.43 (m, 4H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.1, 114.9, 120.0, 126.1, 127.6, 128.4, 130.7, 131.5, 138.5, 140.4, 146.4; HRMS (ESI) calcd. for $C_{15}H_{14}Br[M+H]^+$: 273.0273, found: 273.0270.

**1-Bromo-2-(2-phenyl-allyl)-benzene (3al)**, colorless oil, $^1$H NMR (400 MHz, $CDCl_3$) δ 3.99 (s, 2H), 4.92 (s, 1H), 5.58 (s, 1H), 7.13 (m, 1H), 7.28 (m, 3H), 7.39 (m, 2H), 7.54 (d, *J* = 7.96 Hz, 2H), 7.63 (d, *J* = 7.96 Hz, 1H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.4, 114.7, 125.2, 126.0, 127.4, 127.7, 128.0, 128.4, 131.0, 132.8, 139.0, 140.7, 145.5; HRMS (ESI) calcd. for $C_{15}H_{14}Br[M+H]^+$: 273.0273, found: 273.0268.

**[4-(2-Phenyl-allyl)-phenyl]-methanol (3am)**, white solid, mp: 31-32 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 2.06 (s, 1H), 3.89 (s, 2H), 4.63 (s, 2H), 5.09 (d, *J* = 1.0 Hz, 1H), 5.56 (s, 1H), 7.28 (m, 5H), 7.33 (m, 2H), 7.50 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$)

δ 41.4, 65.1, 114.7, 126.2, 127.2, 127.5, 128.3, 129.1, 138.7, 139.0, 140.7, 146.9; HRMS (ESI) calcd. for $C_{16}H_{16}ONa[M+Na]^+$: 247.1093, found: 247.1096.

**2-(2-Phenyl-allyl)-naphthalene (3an)**,[8] yellow solid, mp: 56-57 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 4.09 (s, 2H), 5.17 (s, 1H), 5.65 (s, 1H), 7.36 (m, 3H), 7.51 (m, 3H), 7.58 (d, *J* = 7.88 Hz, 2H), 7.77 (s, 1H), 7.86 (m, 3H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.9, 115.0, 125.4, 126.0, 126.2, 127.4, 127.6, 127.6, 127.7, 128.0, 128.3, 128.4, 132.2, 133.7, 137.2, 140.9, 146.9; HRMS (ESI) calcd. for $C_{19}H_{16}Na[M+Na]^+$: 267.1144., found: 267.1142.

**4-(2-Phenyl-allyl)-benzaldehyde (3ao)**, yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.95 (s, 2H), 5.10 (s, 1H), 5.57 (s, 1H), 7.32 (m, 3H), 7.43 (m, 4H), 7.82 (d, *J* = 8.12 Hz, 2H), 9.98 (s, 1H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.9, 115.3, 126.1, 127.7, 128.4, 129.5, 129.9, 134.8, 140.2, 145.9, 147.0, 192.0; HRMS (ESI) calcd. for $C_{16}H_{14}ONa[M+Na]^+$: 245.0937, found: 245.0936.

**1-(4-(2-phenylallyl)phenyl)ethanone (3ap)**,[9] yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 2.59 (s, 3H), 3.92 (s, 2H), 5.09 (d, *J* = 0.92 Hz, 1H), 5.55 (s, 1H), 7.28 (m, 2H), 7.33 (m, 3H), 7.44 (m, 2H), 7.89 (d, *J* = 8.20 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 31.9, 41.7, 115.2, 126.1, 127.7, 128.4, 128.5, 129.1, 135.3, 140.3, 145.4, 146.1, 197.9; HRMS (ESI) calcd. for $C_{17}H_{16}ONa[M+Na]^+$: 259.1093, found: 259.1091.

**4-(2-Phenyl-allyl)-benzoic acid methyl ester (3aq)**,[10] yellow solid, mp: 57-59 °C ; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.92 (s, 5H), 5.09 (d, *J* = 0.92 Hz, 1H), 5.56 (s, 1H), 7.28 (m, 2H), 7.34 (m, 3H), 7.45 (m, 2H), 7.99 (d, *J* = 8.24 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.7, 52.0, 115.1, 126.1, 127.7, 128.2, 128.4, 129.0, 129.7, 140.4, 145.1, 146.2, 167.1; HRMS (ESI) calcd. for $C_{17}H_{17}O_2[M+H]^+$: 253.1223, found: 253.1221.

**4-(2-Phenyl-allyl)-benzonitrile (3ar)**, orange oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.92 (s, 2H), 5.09 (d, *J* = 0.92 Hz, 1H), 5.57 (s, 1H), 7.29 (m, 2H), 7.34 (m, 3H), 7.42 (m, 2H), 7.56 (d, *J* = 8.28 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.8, 110.1, 115.5, 119.0, 126.1, 127.9, 128.5, 129.6, 132.2, 139.9, 145.3, 145.6; HRMS (ESI) calcd. for $C_{16}H_{13}NNa[M+Na]^+$: 242.0940, found: 242.0939.

**1-(2-Phenyl-allyl)-4-trifluoromethyl-benzene (3as)**, yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.95 (s, 2H), 5.10 (d, *J* = 0.96 Hz, 1H), 5.59 (s, 1H), 7.38 (m, 5H), 7.48 (m, 2H), 7.58 (d, *J* = 8.04 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.4, 115.3, 125.31, 125.4, 126.1, 127.8, 128.2, 128.4, 129.2, 138.8, 140.2, 143.7, 146.1; HRMS (ESI) calcd. for $C_{16}H_{14}F_3$[M+H]$^+$: 263.1042, found: 263.1034.

**1-(2-phenylallyl)-2-(trifluoromethyl)benzene (3at)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 4.06 (s, 2H), 4.92 (d, *J* = 1.08 Hz, 1H), 5.60 (s, 1H), 7.32 (m, 5H), 7.46 (m, 3H), 7.69 (d, *J* = 7.80 Hz, 1H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 37.7, 115.5, 123.4, 125.9, 126.0, 126.3, 127.6, 128.4, 128.7, 131.2, 131.7, 138.0, 140.5, 145.9; HRMS (ESI) calcd. for $C_{16}H_{14}F_3$[M+H]$^+$: 263.1042, found: 263.1038.

**1-Nitro-3-(2-phenyl-allyl)-benzene (3au)**, yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.97 (s, 2H), 5.12 (s, 1H), 5.59 (s, 1H), 7.31 (m, 3H), 7.44 (m, 3H), 7.57 (d, *J* = 7.56 Hz, 1H), 8.07 (d, *J* = 7.56 Hz, 1H ), 8.13 (s, 1H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.3, 115.7, 121.4, 123.7, 126.1, 127.9, 128.5, 129.2, 135.1, 139.9, 141.6, 145.7, 148.4; HRMS (ESI) calcd. for $C_{15}H_{13}NO_2Na$ [M+Na]$^+$: 262.0838, found: 262.0835.

**2-(2-Phenyl-allyl)-thiophene (3av)**, colorless oil, $^1$H NMR (400 MHz, $CDCl_3$) δ 4.06 (s, 2H), 5.21 (d, *J* = 1.16 Hz, 1H), 5.53 (s, 1H), 6.86 (m, 1H), 6.93 (m, 1H), 7.15 (dd, *J* = 1.16, 5.12 Hz, 1H), 7.33 (m, 3H), 7.49 (m, 2H);$^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 35.9, 114.6, 123.8, 125.4, 126.2, 126.8, 127.6, 128.3, 140.3, 142.6, 146.5; HRMS (ESI) calcd. for $C_{13}H_{13}S$[M+H]$^+$: 201.0732, found: 201.0729.

**3-(2-Phenyl-allyl)-thiophene (3aw)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.90 (s, 2H), 5.14 (d, *J* = 1.28 Hz, 1H), 5.54 (m, 1H), 7.02 (m, 2H), 7.28 (m, 1H), 7.36 (m, 3H), 7.50 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 36.4, 114.2, 121.5, 125.3, 126.1, 127.6, 128.3, 128.6, 140.1, 140.8, 146.6; HRMS (ESI) calcd. for $C_{13}H_{13}S$[M+H]$^+$: 201.0732, found: 201.0730.

**(*E*)-Penta-1,4-diene-1,4-diyldibenzene (3ax)**,[11] yellow soild, mp: 52-53 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.47 (d, *J* = 6.64 Hz, 2H), 5.22 (s, 1H), 5.50 (s, 1H), 6.38 (m, 1H), 6.56 (d, *J* = 15.88 Hz, 1H), 7.35 (m, 4H), 7.40 (m, 4H), 7.55 (d, *J* = 7.92 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 14.0, 22.2, 31.7, 32.2, 38.3, 112.7, 116.1,

126.1, 127.4, 128.3, 132.9, 141.3, 147.3; HRMS (ESI) calcd. for $C_{17}H_{16}Na[M+Na]^+$: 243.1144, found: 243.1143.

**(*E*)-1-methyl-4-(4-phenylpenta-1,4-dienyl)benzene (3ay)**, pale yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 2.37 (s, 3H), 3.45 (d, *J* = 6.72 Hz, 2H), 5.20 (d, *J* = 1.28 Hz, 1H), 5.48 (s, 1H), 6.30 (m, 1H), 6.52 (d, *J* = 15.84 Hz, 1H), 7.15 (d, *J* = 7.96 Hz, 2H), 7.32 (m, 3H), 7.38 (m, 2H), 7.54 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 21.2, 38.7, 113.3, 126.0, 127.0, 127.5, 128.3, 128.5, 129.2, 131.5, 134.8, 136.9, 141.0, 146.6; HRMS (ESI) calcd. for $C_{18}H_{18}Na[M+Na]^+$: 257.1301, found: 257.1299.

**(*E*)-nona-1,4-dien-2-ylbenzene (3az)**,[12] colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 0.91 (t, *J* = 7.08 Hz, 3H), 1.39 (m, 4H), 2.05 (m, 2H), 3.22 (d, *J* = 4.36 Hz, 2H), 5.11 (d, *J* = 1.28 Hz, 1H), 5.39 (s, 1H), 5.53 (m, 2H), 7.29 (m, 1H), 7.37 (m, 2H), 7.48 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 14.0, 22.2, 31.7, 32.2, 38.3, 112.7, 116.1, 126.1, 127.4, 128.3, 132.9, 141.3, 147.3; HRMS (ESI) calcd. for $C_{15}H_{20}Na[M+Na]^+$: 223.1457, found: 223.1455.

**3,3'-(Prop-2-ene-1,2-diyl)bis(methoxybenzene) (3ba)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.80 (s, 3H), 3.81 (s, 3H), 3.83 (s, 2H), 5.08 (d, *J* = 1.24 Hz, 1H), 5.54 (d, *J* = 1.0 Hz, 1H), 6.77 (dd, *J* = 2.18, 8.32 Hz, 1H), 6.83 (m, 2H), 6.87 (d, *J* = 7.52 Hz, 1H), 7.00 (t, *J* = 2.28, Hz, 1H), 7.07 (m, 1H), 7.24 (dd, *J* = 8.00, 15.92 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.7, 55.1, 55.2, 111.5, 112.1, 112.7, 114.6, 114.9, 118.7, 121.4, 129.2, 129.3, 141.1, 142.3, 146.6, 159.5, 159.6; HRMS (ESI) calcd. for $C_{17}H_{19}O_2[M+H]^+$: 255.1380, found: 255.1376.

**1-Methoxy-3-(3-phenylprop-1-en-2-yl)benzene (3bb)**, yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.84 (d, *J* = 1.20 Hz, 3H), 3.91 (s, 2H), 5.12 (d, *J* = 1.28 Hz, 1H), 5.59 (s, 1H), 6.89 (m, 1H), 7.07 (m, 1H), 7.14 (m, 1H), 7.29 (m, 2H), 7.36 (m, 4H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.8, 55.2, 112.2, 112.8, 114.9, 118.8, 126.2, 128.4, 129.0, 129.3, 139.6, 142.4, 146.9, 159.5; HRMS (ESI) calcd. for $C_{16}H_{17}O[M+H]^+$: 225.1274, found: 225.1273.

**1-(3-(4-Bromophenyl)prop-1-en-2-yl)-3-methoxybenzene (3bk)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.80 (s, 2H), 3.82 (s, 3H), 5.07 (s, 1H), 5.54 (s, 1H), 6.84 (m, 1H), 6.98 (m, 1H), 7.05 (m, 1H), 7.14 (d, *J* = 8.20 Hz, 2H), 7.25 (t, *J* = 8.0 Hz,

1H), 7.43 (d, *J* = 8.24 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.1, 55.2, 112.2, 112.7, 115.1, 118.7, 120.0, 129.3, 130.7, 131.5, 138.5, 141.9, 146.3, 159.5; HRMS (ESI) calcd. for $C_{16}H_{15}BrNaO[M+Na]^+$: 325.0198, found: 325.0202.

**4-(2-(3-Methoxyphenyl)allyl)benzaldehyde (3bo)**, yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.80 (s, 3H), 3.93 (s, 2H), 5.10 (d, *J* = 1.04 Hz, 1H), 5.57 (s, 1H), 6.83 (m, 1H), 6.97 (t, *J* = 2.24 Hz, 1H), 7.04 (m, 1H), 7.24 (t, *J* = 7.96 Hz, 1H), 7.43 (d, *J* = 8.04 Hz, 2H), 7.81 (d, *J* = 8.12 Hz, 2H), 9.97 (s, 1H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.9, 55.2, 112.2, 112.8, 115.6, 118.6, 129.4, 129.5, 130.0, 134.7, 141.7, 145.8, 147.0, 159.5, 192.0; HRMS (ESI) calcd. for $C_{17}H_{17}O_2[M+H]^+$: 253.1223, found: 253.1222.

**1-Methoxy-3-(3-(4-(trifluoromethyl)phenyl)prop-1-en-2-yl)benzene (3bs)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.82 (s, 3H), 3.92 (s, 2H), 5.10 (d, *J* = 1.08 Hz, 1H), 5.58 (s, 1H), 6.86 (dd, *J* = 1.88, 8.20 Hz, 1H), 7.00 (t, *J* = 2.16 Hz, 1H), 7.06 (m, 1H), 7.27 (t, *J* = 7.80 Hz, 1H ), 7.39 (d, *J* = 8.00 Hz, 2H), 7.57 (d, *J* = 8.04 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.5, 55.2, 112.2, 112.8, 113.5, 115.4, 117.1, 118.6, 125.3, 129.2, 129.4, 141.8, 143.7, 146.0, 159.6; HRMS (ESI) calcd. for $C_{17}H_{15}F_3ONa[M+Na]^+$: 315.0967, found: 315.0963.

**1-Methoxy-3-(3-(3-nitrophenyl)prop-1-en-2-yl)benzene (3bu)**, yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.81 (s, 3H), 3.95 (s, 2H), 5.12 (d, *J* = 1.04 Hz, 1H), 5.59 (s, 1H), 6.82 (m, 1H), 6.96 (t, *J* = 2.28 Hz, 1H), 7.03 (m, 1H), 7.26 (m, 1H), 7.44 (t, *J* = 7.92 Hz, 1H), 7.59 (d, *J* = 7.56 Hz, 1H), 8.07 (dd, *J* = 1.20, 8.16 Hz, 1H), 8.13 (m, 1H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.3, 55.2, 112.2, 112.9, 115.9, 118.6, 121.5, 123.7, 129.3, 129.5, 135.1, 141.4, 141.6, 145.6, 148.4, 159.6; HRMS (ESI) calcd. for $C_{16}H_{15}NO_3Na[M+Na]^+$: 292.0944., found: 292.0938.

**1-(3-(4-Methoxyphenyl)prop-1-en-2-yl)-2-methylbenzene (3cc)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 2.29 (s, 3H), 3.59 (s, 2H), 3.82 (s, 3H), 4.95 (m, 1H), 5.11 (m, 1H), 6.85 (m, 2H), 7.04 (d, *J* = 7.00 Hz, 1H), 7.08 (m, 2H), 7.14 (m, 1H), 7.19 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 19.8, 43.6, 55.2, 113.6, 115.0, 125.3, 126.8, 128.4, 130.0, 130.3, 131.1, 134.9, 142.7, 149.8, 158.0; HRMS (ESI) calcd. for $C_{17}H_{19}O[M+H]^+$: 239.1430., found: 239.1426.

**Methyl 4-(2-*o*-tolylallyl)benzoate (3cq)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 2.27 (s, 3H), 3.70 (s, 2H), 3.93 (s, 3H), 5.00 (m, 1H), 5.16 (m, 1H), 7.01(d, *J* = 7.28 Hz, 1H), 7.13 (m, 1H), 7.18 (m, 2H), 7.24 (d, *J* = 8.20 Hz, 2H), 7.97(d, *J* = 8,28 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 19.7, 44.6, 52.0, 115.9, 125.4, 127.1, 128.4, 129.4, 129.6, 130.1, 132.9, 134.8, 142.1, 144.5, 148.5, 167.1; $C_{18}H_{18}O_2Na[M+Na]^+$: 289.1199, found: 289.1198.

**2-(3-Phenylprop-1-en-2-yl)naphthalene (3db)**, white solid, mp: 43-44 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.99 (s, 2H), 5.16 (d, *J* = 1.20 Hz, 1H), 5.67 (s, 1H), 7.21 (m, 1H), 7.29 (m, 4H), 7.46 (m, 2H), 7.66 (dd, *J* = 1.80, 8.64 Hz, 1H), 7.80 (m, 3H), 7.88 (d, *J* = 1.24 Hz, 1H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.7, 115.2, 124.6, 125.0, 125.9, 126.1, 126.2, 127.5, 127.8, 128.3, 128.4, 129.0, 132.8, 133.4, 138.0, 139.6, 146.8; HRMS (ESI) calcd. for $C_{19}H_{17}[M+H]^+$: 245.1325, found: 245.1331.

**2-(3-(4-Methoxyphenyl)prop-1-en-2-yl)naphthalene (3dc)**, pale yellow solid, mp: 48-49 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.82 (s, 3H), 3.97 (s, 2H), 5.20 (d, *J* = 0.88 Hz, 1H), 5.70 (s, 1H), 6.90 (d, *J* = 8.56 Hz, 2H), 7.27 (d, *J* = 8.52 Hz, 2H), 7.52 (m, 2H), 7.70 (dd, *J* = 1.76, 8.60 Hz, 1H), 7.86 (m, 3H), 7.93 (s, 1H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 40.8, 55.2, 113.9, 114.9, 124.7, 125.0, 125.9, 126.1, 127.6, 127.8, 128.3, 129.9, 131.6, 132.9, 133.4, 138.1, 147.2, 158.0; HRMS (ESI) calcd. for $C_{20}H_{19}O[M+H]^+$: 275.1430, found: 275.1424.

**Methyl 4-(2-(naphthalen-2-yl)allyl)benzoate (3dq)**, white solid, mp:72-73 °C, $^1$H NMR (400 MHz, $CDCl_3$) δ 3.91 (s, 3H), 4.04 (s, 2H), 5.19 (d, *J* = 1.04 Hz, 1H), 5.70 (s, 1H), 7.38 (d, *J* = 8.24 Hz, 2H), 7.48 (m, 2H), 7.64 (dd, *J* = 1.80, 8.64 Hz, 1H), 7.84 (m, 4H), 7.98 (d, *J* = 8.24 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.7, 52.0, 115.7, 124.4, 125.0, 126.0, 126.2, 127.5, 127.9, 128.3, 128.9, 129.8, 130.9, 132.9, 133.3, 137.5, 145.1, 146.0, 167.1; $C_{21}H_{18}O_2Na[M+Na]^+$: 325.1199, found: 325.1193.

**4-(2-(4-Fluorophenyl)allyl)benzonitrile (3er)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.89 (s, 2H), 5.08 (s, 1H), 5.50 (s, 1H), 6.99 (m, 2H), 7.36 (m, 4H), 7.58 (d, *J* = 8.16 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.9, 115.2, 115.4, 115.5, 118.9, 127.7, 127.8, 128.9, 129.6, 132.3, 144.6, 145.0; HRMS (ESI) calcd. for $C_{16}H_{12}FNNa[M+Na]^+$: 260.0846, found: 260.0845.

**(*E*)-1-Fluoro-4-(5-phenylpenta-1,4-dien-2-yl)benzene (3ex)**, pale yellow oil; $^{1}$H NMR (400 MHz, $CDCl_3$) δ 3.45 (d, *J* = 6.76 Hz, 2H), 5.23 (d, *J* = 0.80 Hz, 1H), 5.46 (s, 1H), 6.36 (m, 1H), 6.57 (d, *J* = 15.84 Hz, 1H), 7.10 (m, 2H), 7.28 (m, 1H), 7.37 (t, *J* = 7.32 Hz, 2H), 7.43 (m, 2H), 7.52 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 38.9, 113.4, 115.3 (*J* = 21.2 Hz), 126.2, 127.2, 127.6, 127.7, 127.8, 128.6, 131.9, 137.5, 145.5, 163.7; HRMS (ESI) calcd. for $C_{17}H_{16}F[M+H]^+$: 239.1231, found: 239.1227.

**(*E*)-1-Fluoro-4-(5-p-tolylpenta-1,4-dien-2-yl)benzene (3ey)**, pale yellow solid, mp: 76-77 °C; $^{1}$H NMR (400 MHz, $CDCl_3$) δ 2.35 (s, 3H), 3.40 (d, *J* = 6.68 Hz, 2H), 5.17 (s, 1H), 5.40 (s, 1H), 6.25 (m, 1H), 6.48 (d, *J* = 15.84 Hz, 1H), 7.04 (m, 2H), 7.14 (d, *J* = 7.92 Hz, 2H), 7.28 (m, 2H), 7.47 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 21.2, 38.8, 113.2, 115.0, 115.2, 126.0, 126.7, 127.6, 127.7, 129.2, 131.6, 134.6, 137.0, 145.6; HRMS (ESI) calcd. for $C_{18}H_{17}FNa[M+Na]^+$: 275.1206, found: 275.1205.

**(*E*)-1-Fluoro-4-(nona-1,4-dien-2-yl)benzene (3ez)**, colorless oil; $^{1}$H NMR (400 MHz, $CDCl_3$) δ 0.90 (t, *J* = 7.08 Hz, 3H), 1.38 (m, 4H), 2.03 (q, *J* = 6.68 Hz, 2H), 3.18 (d, *J* = 5.32 Hz, 2H), 5.08 (d, *J* = 1.12 Hz, 1H), 5.32 (s, 1H), 5.50 (m, 2H), 7.02 (m, 2H), 7.42 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 13.9, 22.1, 31.6, 32.2, 38.5, 112.6, 114.8, 115.1, 127.1, 127.6, 127.7, 133.0, 146.2; HRMS (ESI) calcd. for $C_{15}H_{19}FNa[M+Na]^+$: 241.1363, found: 241.1358.

**(*E*)-1-Chloro-4-(5-phenylpenta-1,4-dien-2-yl)benzene (3fx)**, white solid, mp: 68-69 °C; $^{1}$H NMR (400 MHz, $CDCl_3$) δ 3.43 (d, *J* = 6.68 Hz, 2H), 5.23 (d, *J* = 1.00 Hz, 1H), 5.48 (s, 1H), 6.33 (m, 1H), 6.54 (d, *J* = 15.84 Hz, 1H), 7.26 (m, 1H), 7.35 (m, 4H), 7.40 (m, 2H), 7.46 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 38.6, 114.0, 126.2, 127.3, 127.4, 127.6, 128.5, 128.6, 131.9, 133.3, 137.4, 139.3, 145.4; HRMS (ESI) calcd. for $C_{17}H_{16}Cl[M+H]^+$: 255.0935, found: 255.0932.

**4,4'-(Prop-2-ene-1,2-diyl)bis(bromobenzene) (3gk)**, colorless oil; $^{1}$H NMR (400 MHz, $CDCl_3$) δ 3.78 (s, 2H), 5.10 (d, *J* = 1.08 Hz, 1H), 5.52 (S, 1H), 7.11 (d, *J* = 8.40 Hz, 2H), 7.29 (m, 2H), 7.42 (m, 4H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.0, 115.5, 120.1, 121.6, 127.8, 130.6, 131.45, 131.54, 138.1, 139.2, 145.4; HRMS (ESI) calcd. for $C_{15}H_{13}Br_2[M+H]^+$: 350.9379, found: 350.9379.

**(*E*)-1-bromo-4-(5-phenylpenta-1,4-dien-2-yl)benzene (3gx)**, white solid, mp: 79-80 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.41 (d, *J* = 6.64 Hz, 2H), 5.52 (s, 1H), 5.46 (s, 1H), 6.30 (m, 1H), 6.52 (d, *J* = 15.84 Hz, 1H), 7.24 (m, 1H), 7.32 (m, 2H), 7.38 (d, *J* = 8.20 Hz, 4H), 7.50 (d, *J* = 8.48 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 38.6, 114.0, 121.5, 126.1, 127.2, 127.6, 127.7, 128.5, 131.4, 131.9, 137.4, 139.8, 145.4; HRMS (ESI) calcd. for $C_{17}H_{16}Br[M+H]^+$: 299.0430, found: 299.0425.

**1-(4-(3-Phenylprop-1-en-2-yl)phenyl)ethanone (3hb)**, white solid, mp: 59-60 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 2.59 (s, 3H), 3.90 (s, 2H), 5.21 (d, *J* = 1.04 Hz, 1H), 5.64 (s, 1H), 7.26 (m, 5H), 7.56 (m, 2H), 7.92 (d, *J* = 8.48 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 26.6, 41.5, 116.8, 126.3, 128.4, 128.5, 128.9, 131.0, 136.0, 139.0, 145.3, 146.0, 197.7; HRMS (ESI) calcd. for $C_{17}H_{16}ONa[M+Na]^+$: 259.1093, found: 259.1090.

**Methyl 4-(3-(3-methoxyphenyl)prop-1-en-2-yl)benzoate (3ia)**, yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.78 (s, 3H), 3.86 (s, 2H), 3.92 (s, 3H), 5.20 (s, 1H), 5.62 (s, 1H), 6.77 (m, 2H), 6.84 (d, *J* = 7.60 Hz, 1H), 7.21 (dt, *J* = 7.80 , 15.84 Hz, 1H), 7.53 (d, *J* = 8.44 Hz, 2H), 7.99 (d, *J* = 8.40 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.5, 52.1, 55.1, 111.5, 114.7, 116.6, 121.3, 126.1, 129.0, 129.4, 129.6, 140.6, 145.2, 145.9, 159.7, 166.9; HRMS (ESI) calcd. for $C_{18}H_{18}O_3Na[M+Na]^+$: 305.1148, found: 305.1145.

**Methyl 4-(3-phenylprop-1-en-2-yl)benzoate (3ib)**, white soild, mp: 50-51 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.89 (s, 2H), 3.93 (s, 3H), 5.18 (d, *J* = 0.92 Hz, 1H), 5.62 (s, 1H), 7.24 (m, 3H), 7.31 (m, 2H), 7.54 (d, *J* = 8.52 Hz, 2H), 8.00 (d, *J* = 8.52 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.5, 52.1, 116.5, 126.2, 126.3, 128.5, 128.9, 129.0, 129.6, 139.0, 145.3, 146.2, 166.9; HRMS (ESI) calcd. for $C_{17}H_{16}O_2Na[M+Na]^+$: 275.1043, found: 275.1043.

**Methyl 4-(3-(3-nitrophenyl)prop-1-en-2-yl)benzoate (3iu)**, white solid, mp: 117-118 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.91 (s, 3H), 3.97 (s, 2H), 5.22 (s, 1H), 5.66 (s, 1H), 7.46 (m, 3H), 7.56 (d, *J* = 7.20 Hz, 1H), 7.98 (d, *J* = 7.92 Hz, 2H), 8.06 (d, *J* = 7.96 Hz, 1H), 8.10 (s, 1H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.0, 52.1, 117.5, 121.6,

123.7, 126.1, 129.35, 129.40, 129.8, 135.0, 141.1, 144.3, 145.0, 148.4, 166.7; HRMS (ESI) calcd. for $C_{17}H_{16}NO_4[M+H]^+$: 298.1074, found: 298.1068.

**4-(3-(3-Methoxyphenyl)prop-1-en-2-yl)benzonitrile (3ja)**, colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.79 (s, 3H), 3.84 (s, 2H), 5.27 (s, 1H), 5.62 (s, 1H), 6.77 (m, 2H), 6.83 (d, *J* = 7.64 Hz, 1H), 7.22 (m, 1H), 7.53 (d, *J* = 8.48 Hz, 2H), 7.59 (d, *J* = 8.44 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.3, 55.2, 111.0, 111.5, 114.7, 117.7, 118.9, 121.2, 126.8, 129.5, 132.1, 140.2, 145.1, 145.2, 159.8; HRMS (ESI) calcd. for $C_{17}H_{15}NNaO[M+Na]^+$: 272.1046., found: 272.1044.

**4-(3-Phenylprop-1-en-2-yl)benzonitrile (3jb)**, white soild, mp: 50-51 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.87 (s, 2H), 3.25 (d, *J* = 0.92 Hz, 1H), 5.63 (s, 1H), 7.23 (m, 3H), 7.31 (m, 2H), 7.54 (m, 2H), 7.58 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.3, 111.0, 117.6, 118.9, 126.5, 126.8, 128.6, 128.8, 132.2, 128.5, 145.2, 145.5; HRMS (ESI) calcd. for $C_{16}H_{13}NNa[M+Na]^+$: 242.0940., found: 242.0937.

**4-(3-(3-Nitrophenyl)prop-1-en-2-yl)benzonitrile (3ju)**, yellow solid, mp: 85-86 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.97 (s, 2H), 5.28 (s, 1H), 5.68 (s, 1H), 7.52 (m, 4H), 7.61 (d, *J* = 8.32 Hz, 2H), 8.08 (d, *J* = 8.28 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 40.8, 111.4, 118.6, 121.8, 123.6, 126.8, 129.5, 132.3, 135.0, 140.6, 144.28, 144.32, 148.5; HRMS (ESI) calcd. for $C_{16}H_{12}N_2NaO_2[M+Na]^+$: 287.0791, found: 287.0785.

**(2-Methyl-allyl)-benzene (3lb)**,[13] colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 1.76 (s, 3H), 3.40 (s, 2H), 4.81 (s, 1H), 4.89 (d, *J* = 0.52 Hz, 1H), 7.28 (m, 3H), 7.36 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 22.1, 44.7, 112.0, 126.1, 128.3, 129.0, 139.8, 145.2; HRMS (ESI) calcd. for $C_{10}H_{13}[M+H]^+$: 133.1012, found: 133.1011.

**1-Methoxy-4-(2-methyl-allyl)-benzene (3lc)**,[14] colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 1.73 (s, 3H), 3.31 (s, 2H), 3.84 (s, 3H), 4.77 (s, 1H), 4.84 (d, *J* = 0.32 Hz, 1H), 6.90 (d, *J* = 8.60 Hz, 2H), 7.17 (d, *J* = 8.60 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 22.0, 43.8, 55.2, 111.6, 113.7, 129.8, 131.9, 145.6, 158.0; HRMS (ESI) calcd. for $C_{11}H_{14}NaO[M+Na]^+$: 185.0937, found: 185.0933.

**Methyl 4-(2-methylallyl)benzoate (3lq)**,[10] colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 1.69 (s, 3H), 3.38 (s, 2H), 3.92 (s, 3H), 4.76 (s, 1H), 4.86 (s, 1H), 7.29 (d, *J* = 8.24 Hz, 2H), 7.80 (d, *J* = 8.28 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 22.0, 44.6, 52.0,

112.6, 128.1, 129.0, 129.7, 144.2, 145.3, 167.2; HRMS (ESI) calcd. for $C_{12}H_{14}NaO_2[M+Na]^+$: 213.0886, found: 213.0885.

**(*E*)-(4-Methylpenta-1,4-dienyl)benzene (3lx)**,[15] colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 1.82 (s, 3H), 2.96 (d, *J* = 7.00 Hz, 2H), 4.84 (m, 2H), 6.28 (m, 1H), 6.49 (d, *J* = 15.8 Hz, 1H), 7.27 (m, 1H), 7.35 (t, *J* = 7.36 Hz, 2H), 7.42 (d, *J* = 7.52 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 22.5, 41.5, 111.1, 126.1, 127.0, 128.2, 128.5, 131.4, 137.6, 144.6; HRMS (ESI) calcd. for $C_{12}H_{14}Na[M+Na]^+$: 181.0988, found: 181.0983.

**Ethyl 2-benzylacrylate (3mb)**,[16] colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 1.30 (t, *J* = 7.12 Hz, 3H), 3.67 (s, 2H), 4.22 (q, *J* = 7.16 Hz, 2H), 5.48 (d, *J* = 1.40 Hz, 1H), 6.26 (d, *J* = 0.44 Hz, 1H), 7.24 (m, 3H), 7.32 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 14.1, 38.1, 60.7, 126.0, 126.3, 128.4, 129.1, 138.8, 140.4, 166.9; HRMS (ESI) calcd. for $C_{12}H_{14}NaO_2[M+Na]^+$: 213.0886, found: 213.0882.

**Methyl 4-(2-(ethoxycarbonyl)allyl)benzoate (3mq)**,[17] colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 1.28 (t, *J* = 7.12 Hz, 3H), 3.70 (s, 2H), 3.92 (s, 3H), 4.20 (q, *J* = 7.16 Hz, 2H), 5.51 (d, *J* = 1.24 Hz, 1H), 6.29 (s, 1H), 7.30 (d, *J* = 8.28 Hz, 2H), 7.99 (d, *J* = 8.28 Hz, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 14.1, 38.2, 52.0, 60.9, 126.6, 128.3, 129.0, 129.7, 139.6, 144.3, 166.6, 167.1; HRMS (ESI) calcd. for $C_{14}H_{16}NaO_4[M+Na]^+$: 271.0941, found: 271.0937.

**(*E*)-Ethyl 2-methylene-5-phenylpent-4-enoate (3mx)**,[18] colorless oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 1.35 (t, *J* = 7.12 Hz, 3H), 3.26 (m, 2H), 4.26 (q, *J* = 7.12 Hz, 2H), 5.66 (d, *J* = 1.40 Hz, 1H), 6.29 (m, 2H), 6.51 (d, *J* = 15.80 Hz, 1H), 7.25 (m, 1H), 7.35 (m, 2H), 7.40 (m, 2H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 14.2, 35.2, 60.8, 125.4, 126.1, 126.9, 127.2, 128.5, 132.1, 137.4, 139.5, 166.9; HRMS (ESI) calcd. for $C_{14}H_{16}NaO_2[M+Na]^+$: 239.1043, found: 239.1042.

**Dimethyl 4,4'-(prop-2-ene-1,2-diyl)dibenzoate (3nq)**, white solid, mp:; $^1$H NMR (400 MHz, $CDCl_3$) δ 3.90 (s, 3H), 3.91 (s, 3H), 3.92 (s, 2H), 5.18 (d, *J* = 0.84 Hz, 1H), 5.62 (s, 1H), 7.30 (d, *J* = 8.20 Hz, 2H), 7.48 (d, *J* = 8.48 Hz, 2H), 7.96 (m, 4H); $^{13}$C NMR (100.6 MHz, $CDCl_3$) δ 41.5, 52.0, 52.1, 117.0, 126.1, 128.3, 128.9, 129.2, 129.7, 129.8, 144.5, 144.8, 145.5, 166.8, 167.0; HRMS (ESI) calcd. for $C_{19}H_{18}NaO_4[M+Na]^+$: 333.1097, found: 333.1095.

## 3. Reference


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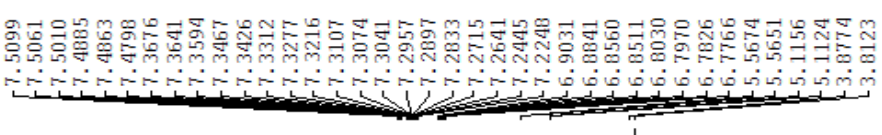
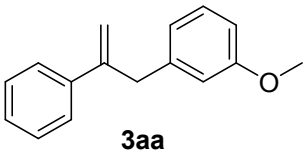
## 4. NMR spectra of allylated products





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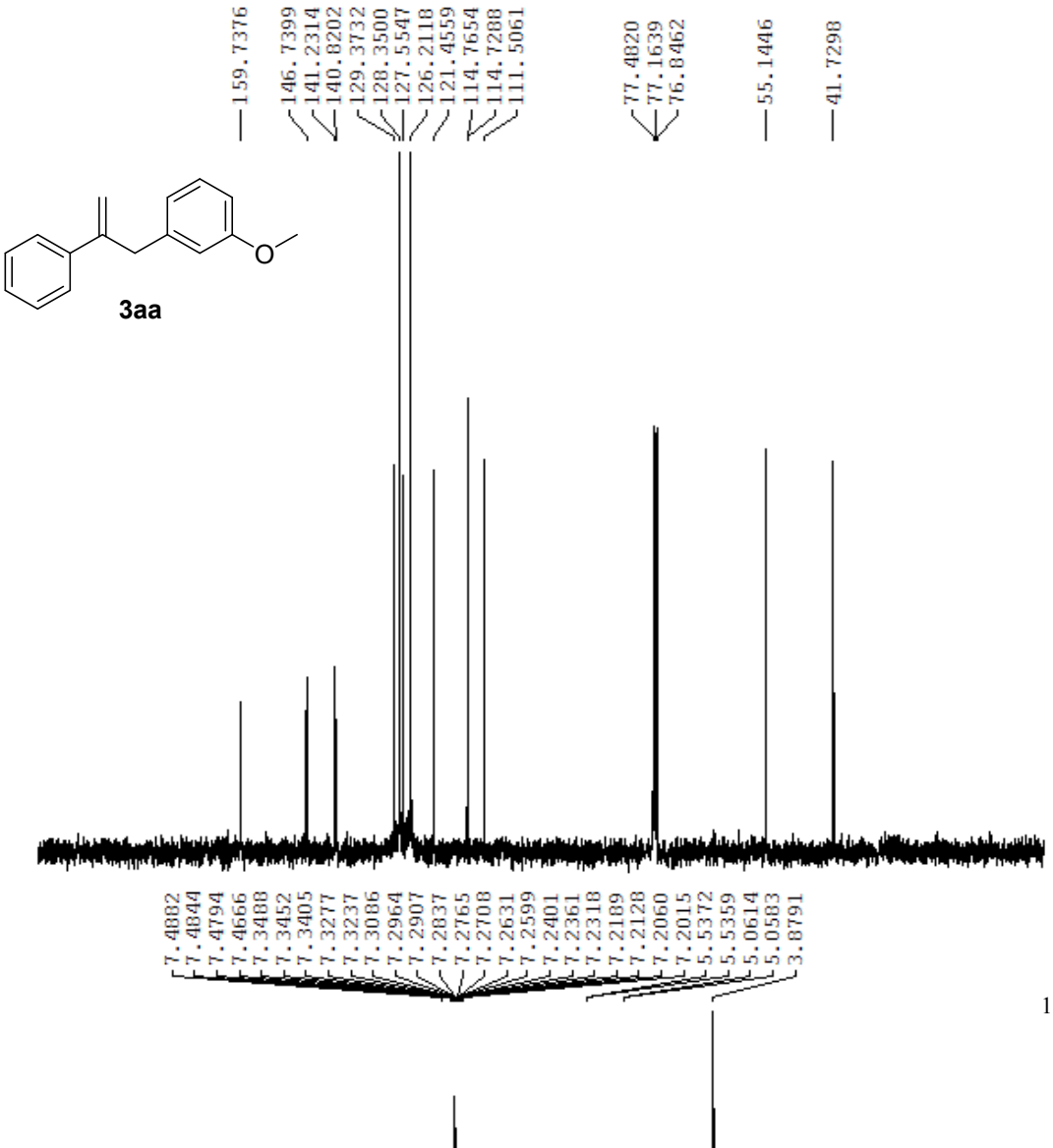
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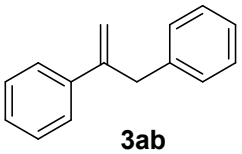

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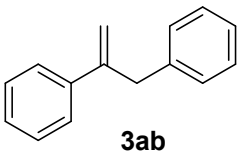

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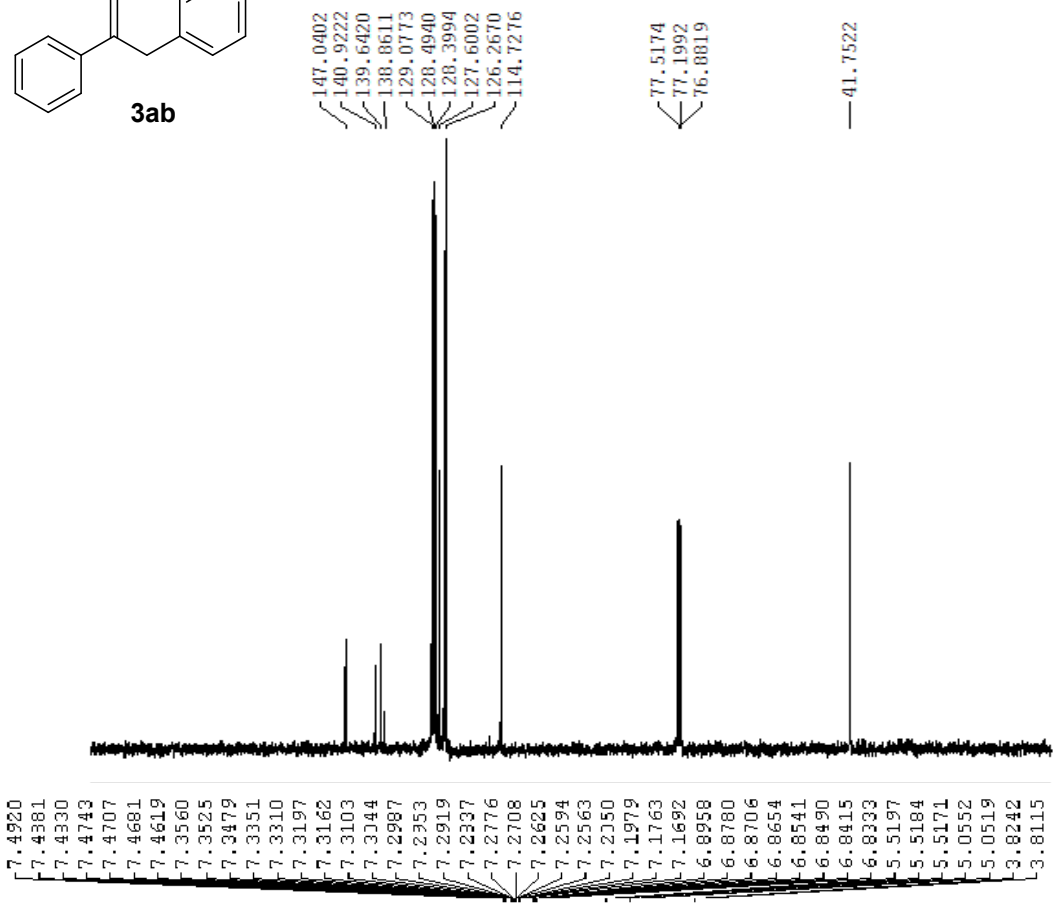
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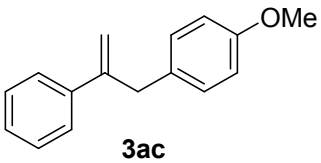
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**3ac**


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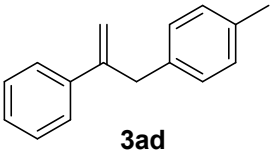

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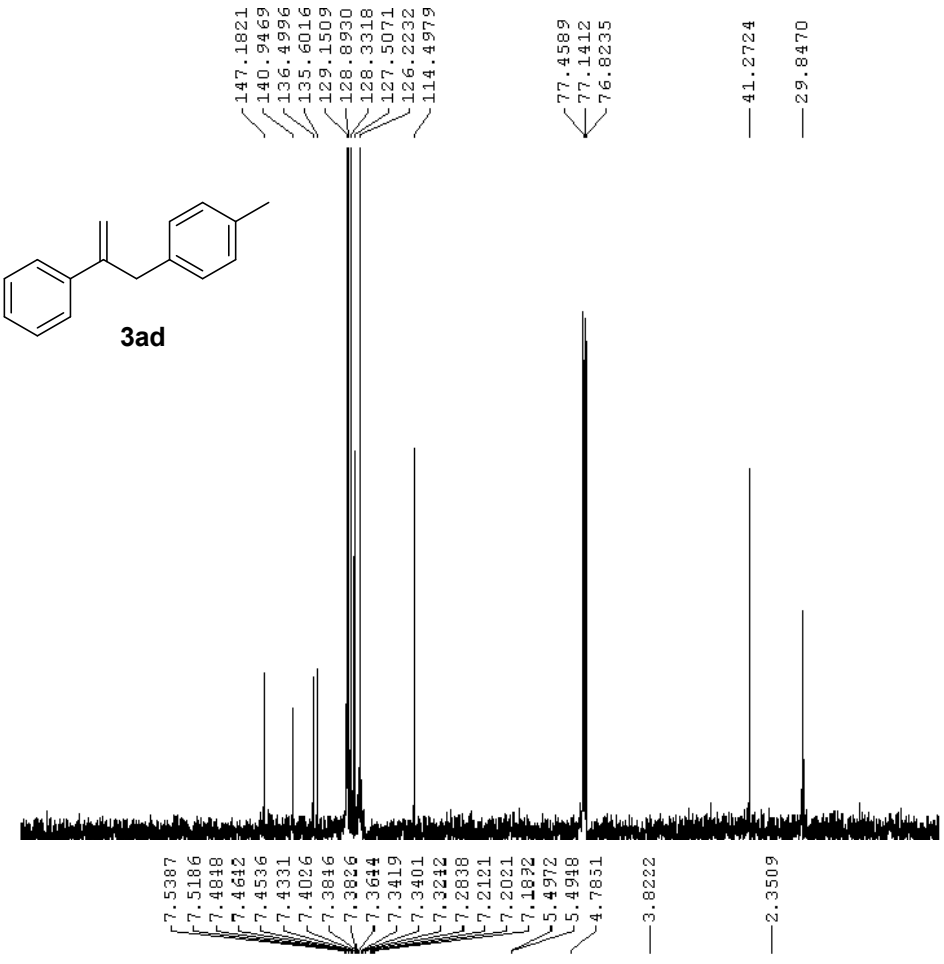
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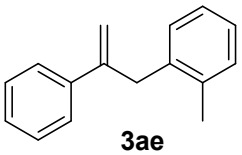

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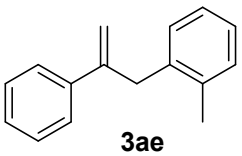

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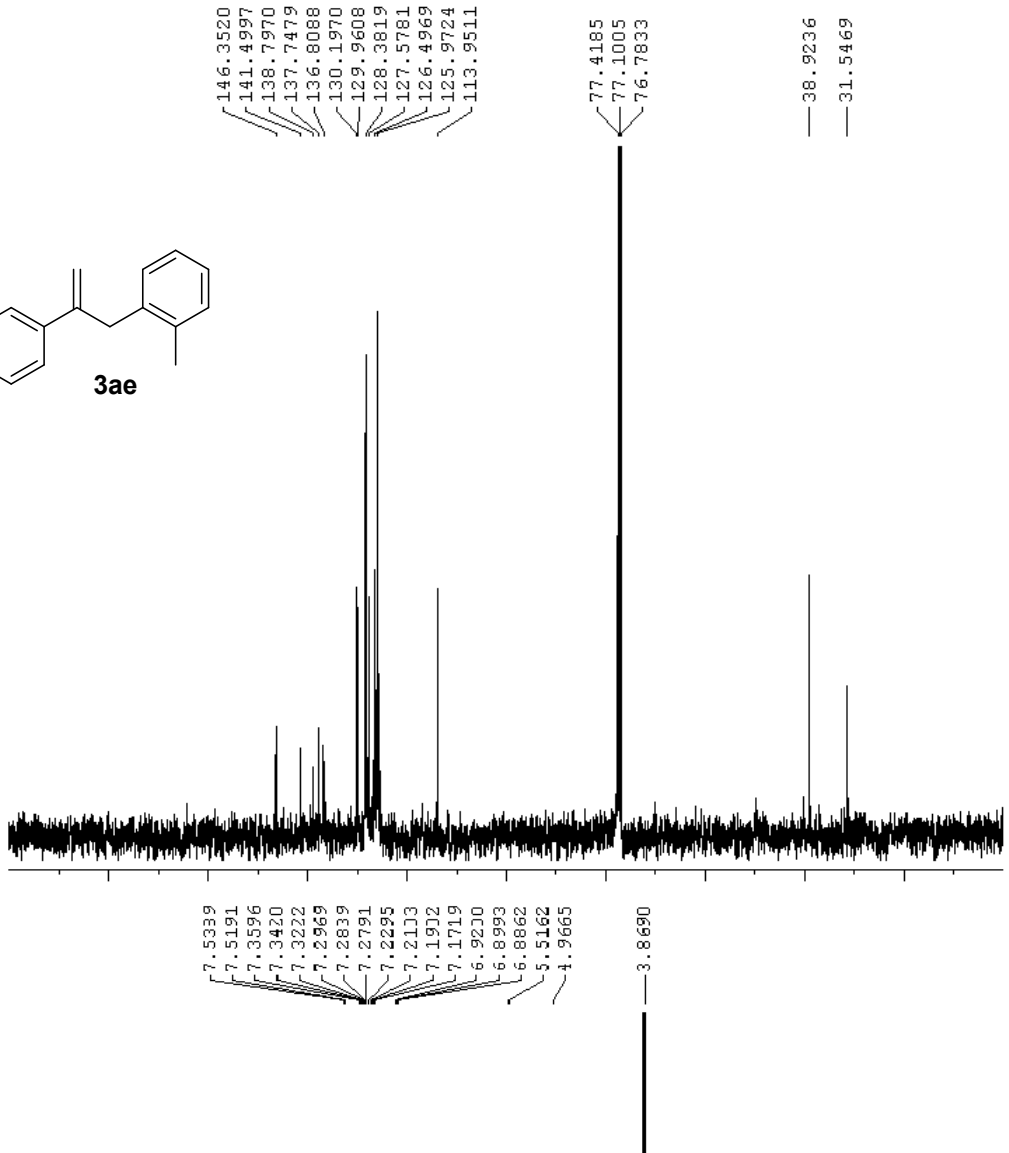
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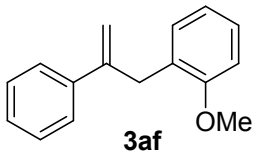
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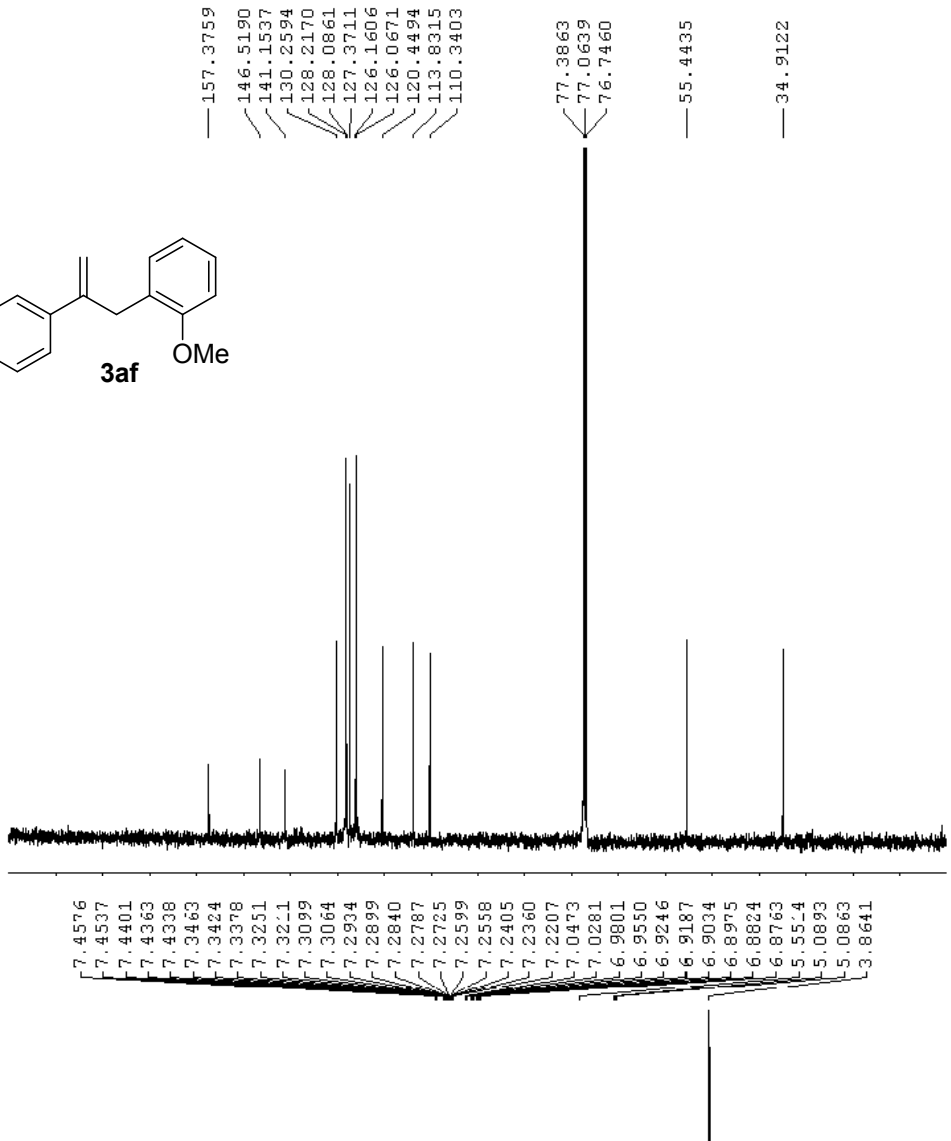
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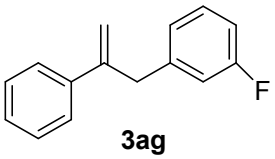
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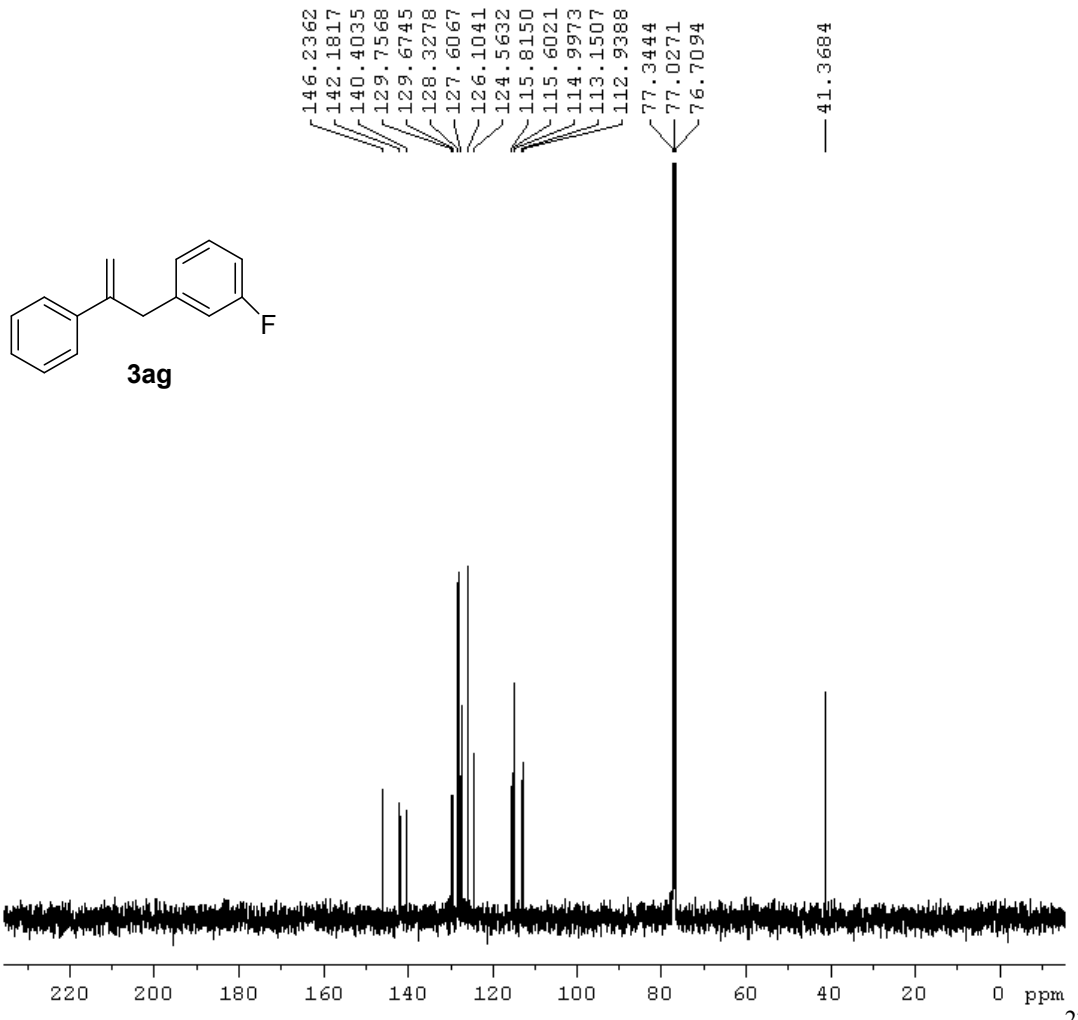
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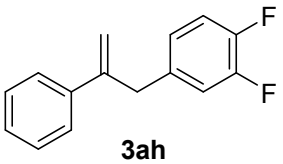
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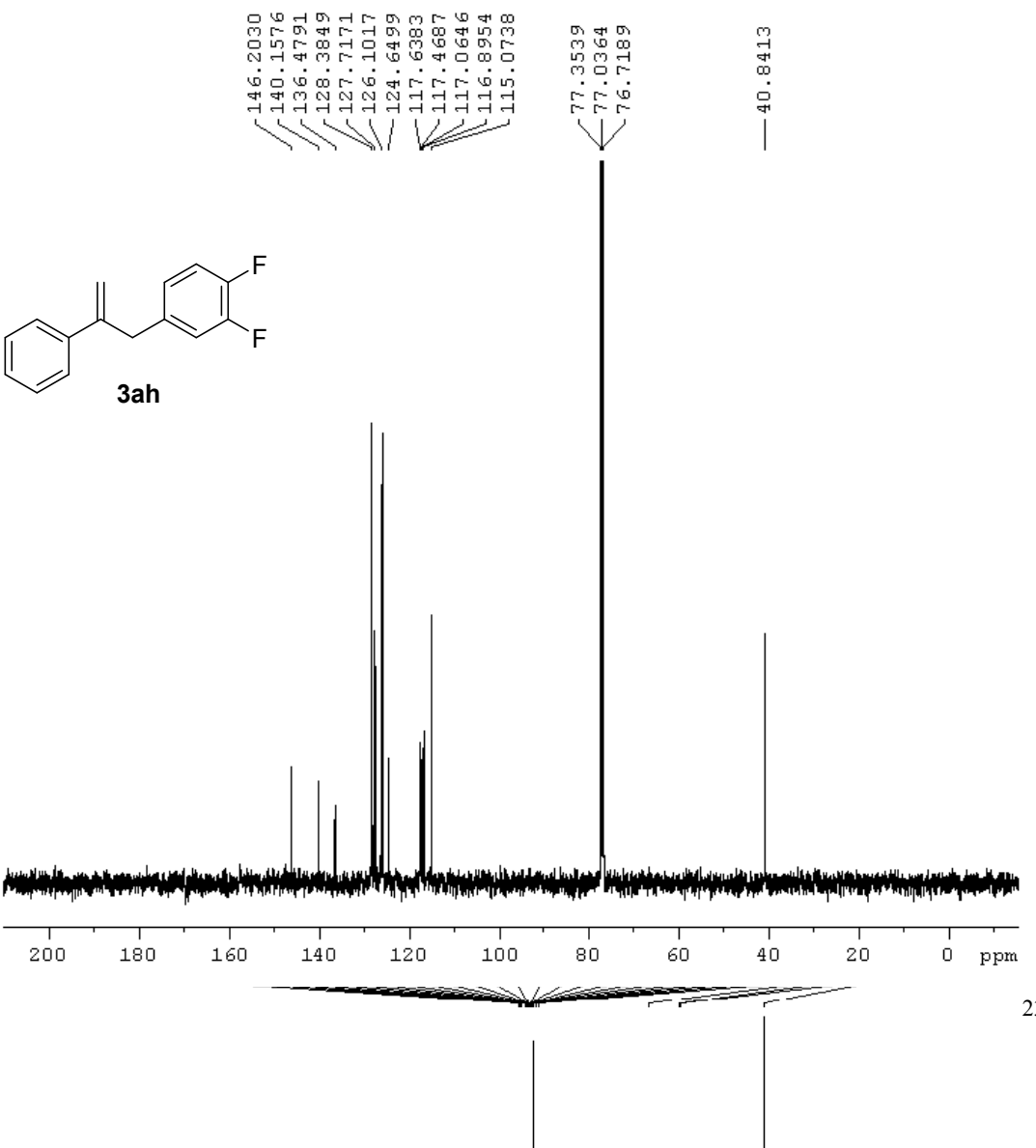
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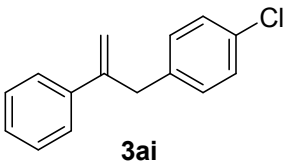
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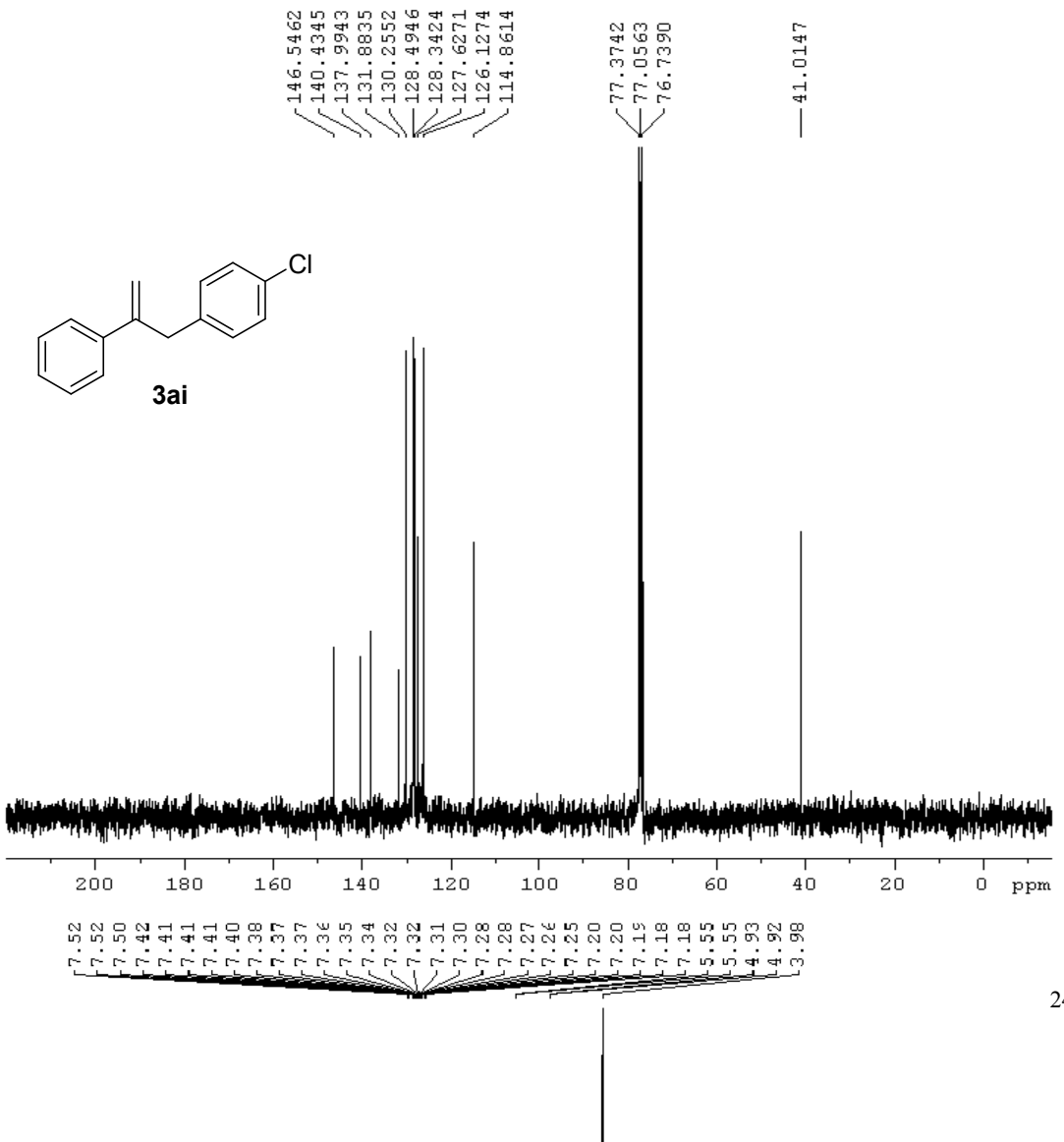
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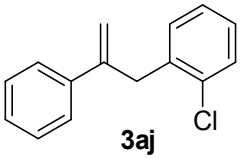
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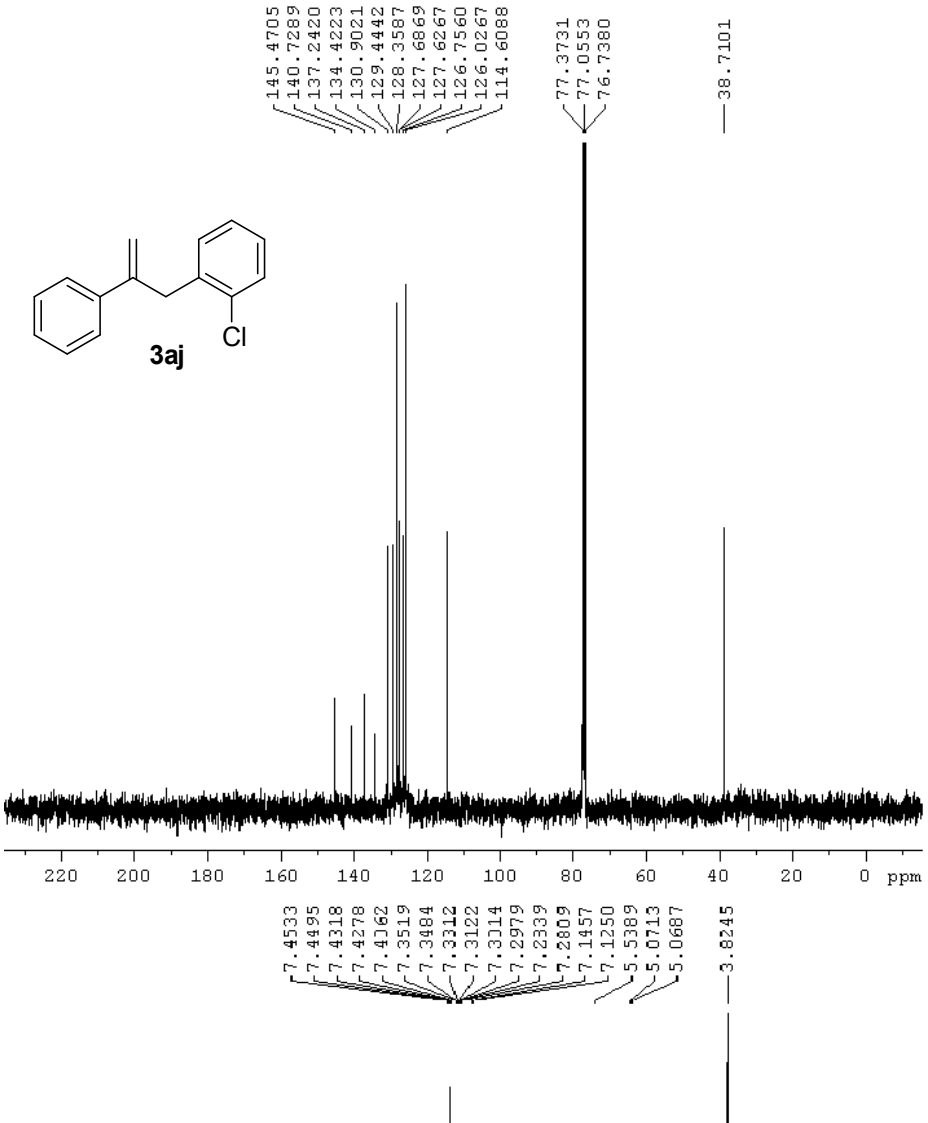
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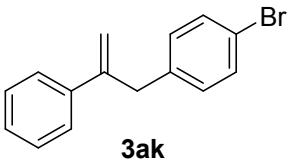
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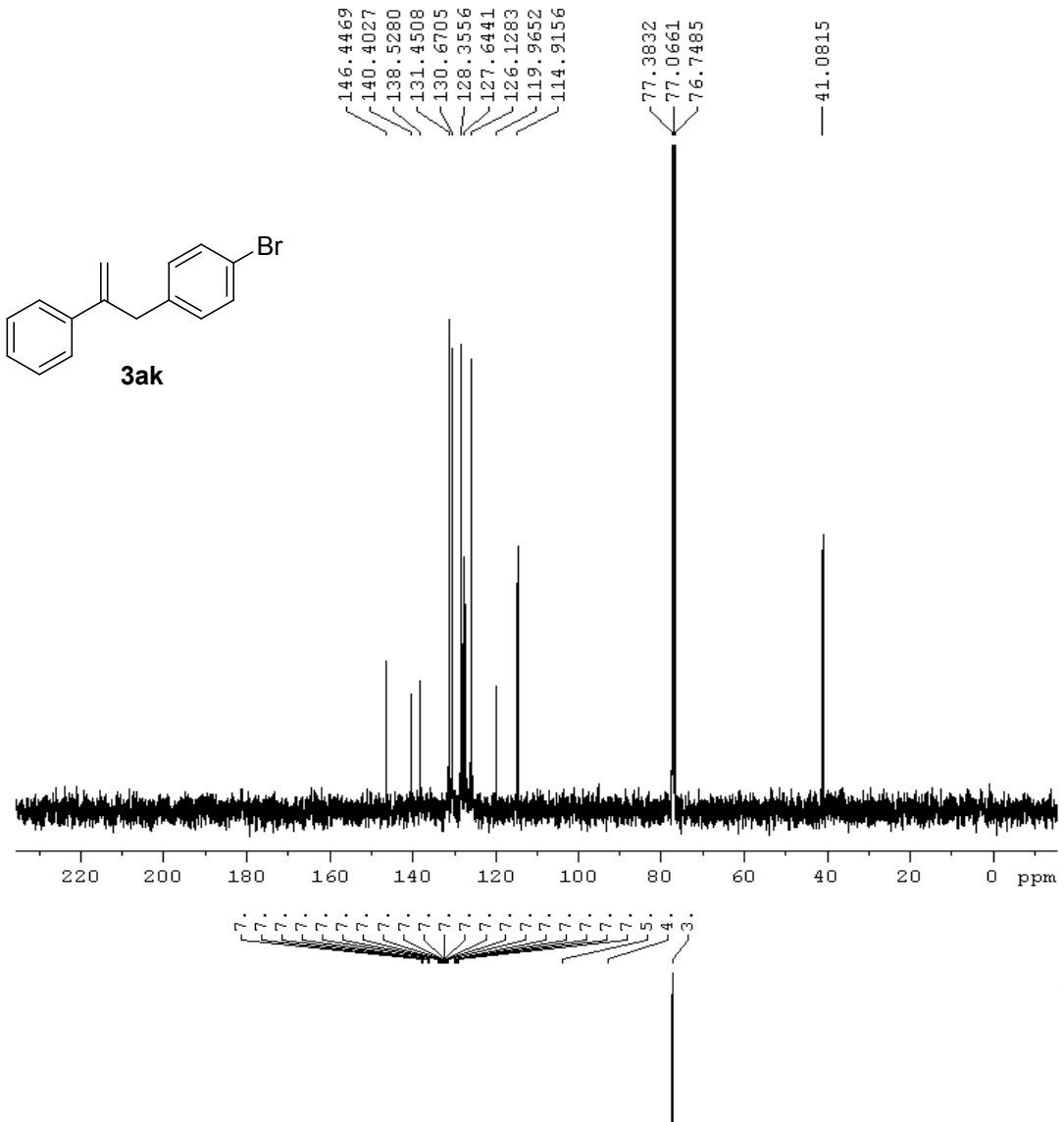
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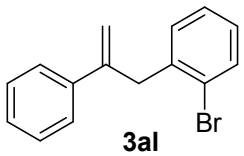
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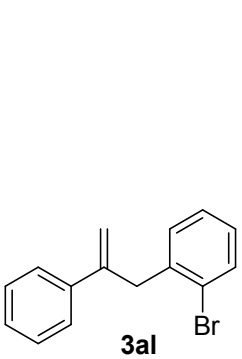
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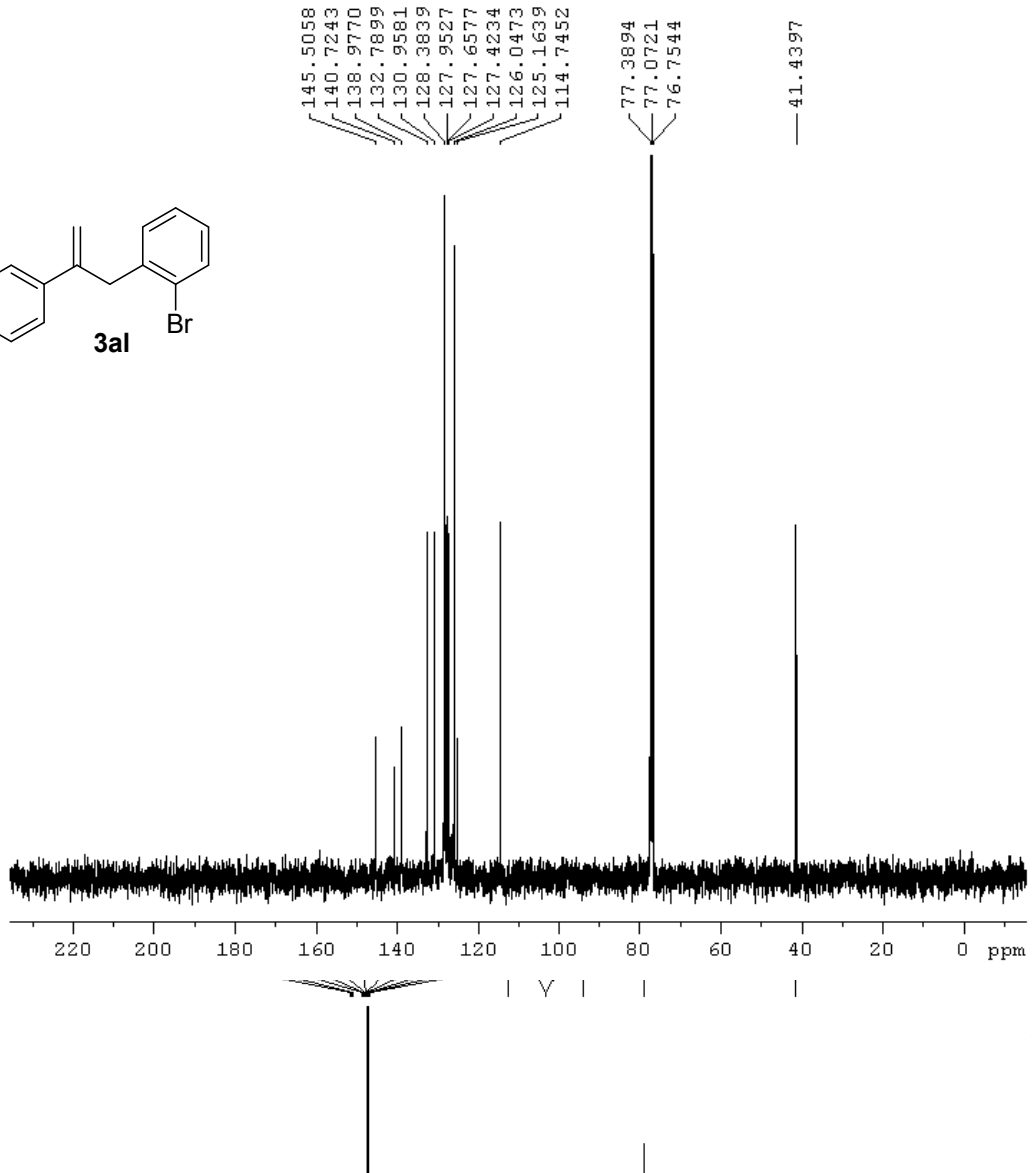
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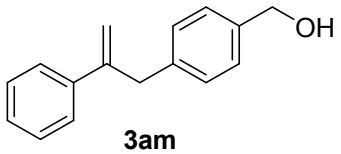
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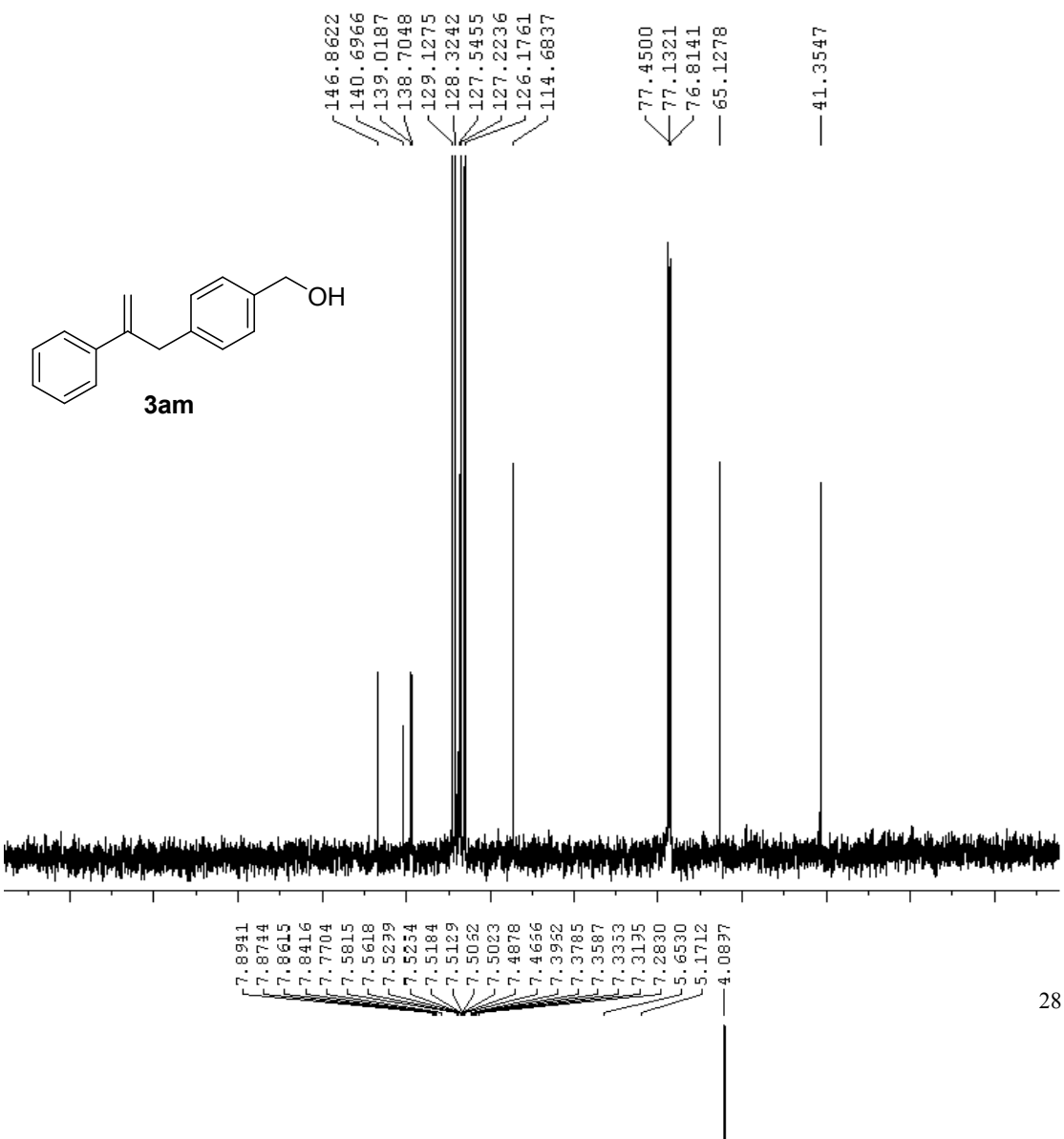
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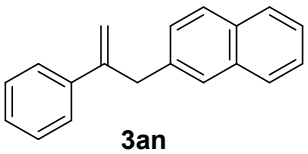

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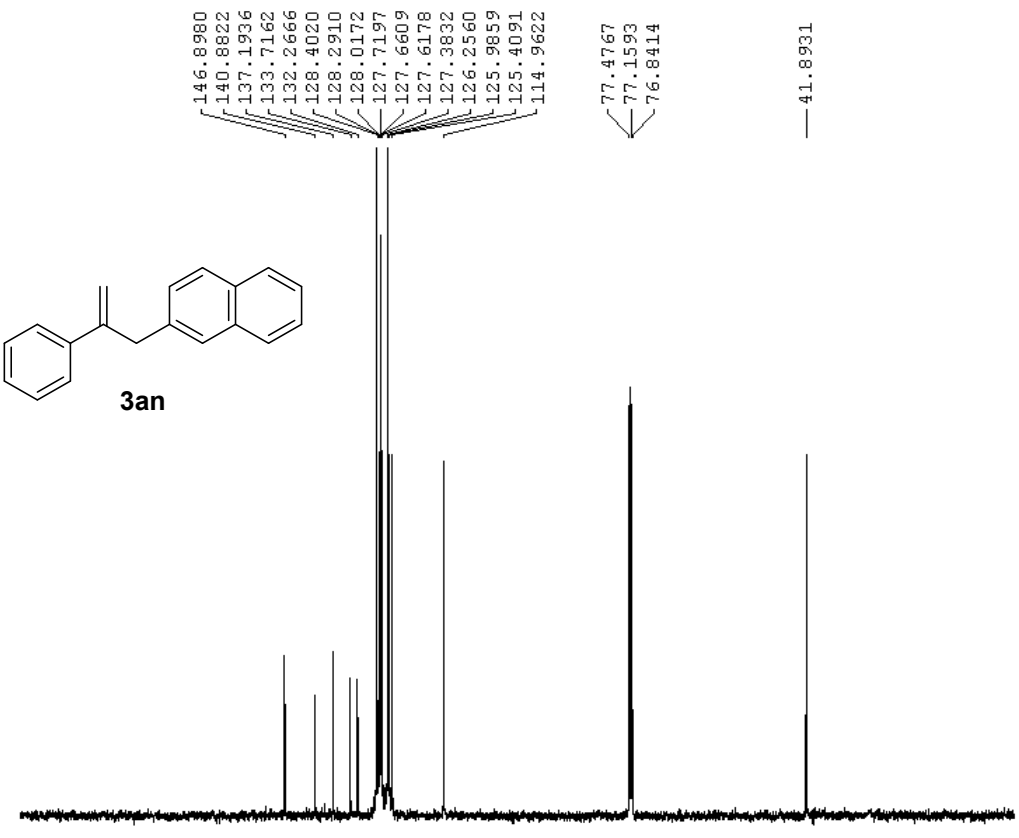
**3an**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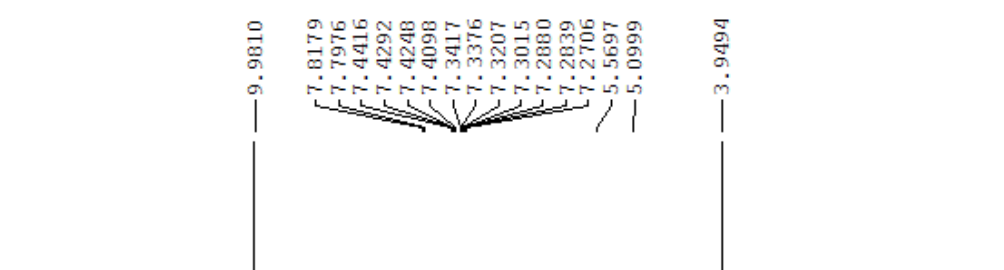
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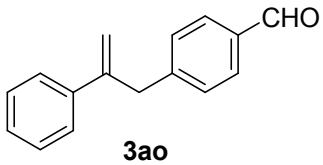
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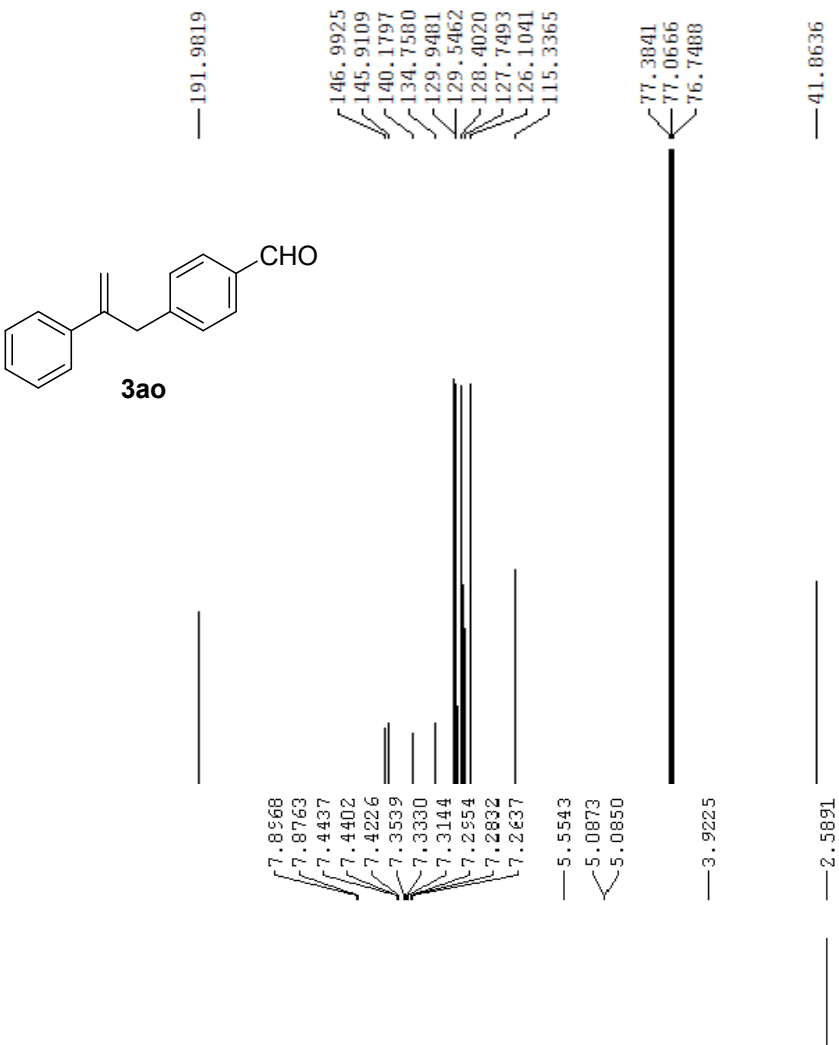
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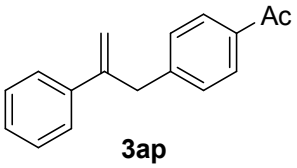
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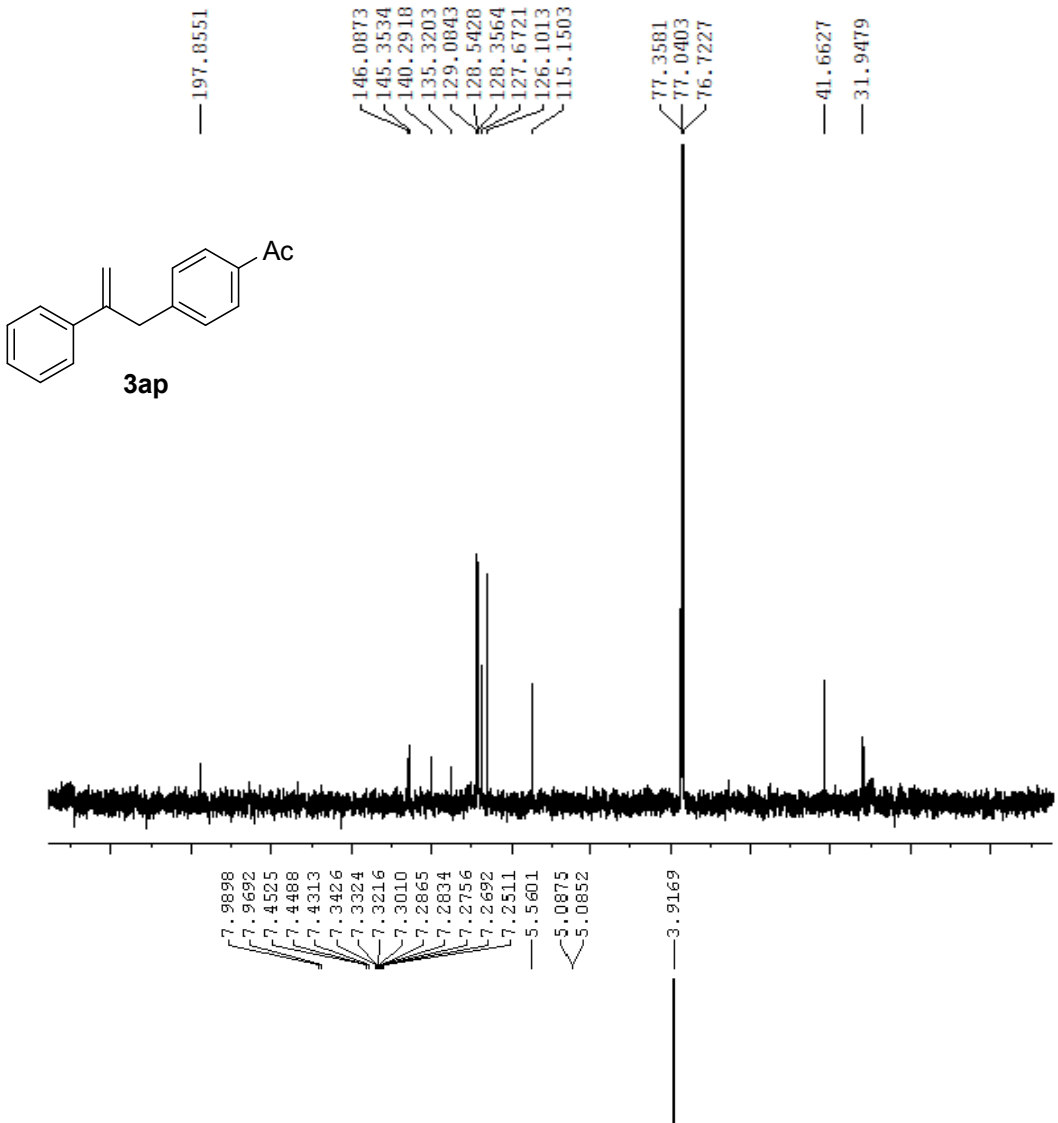
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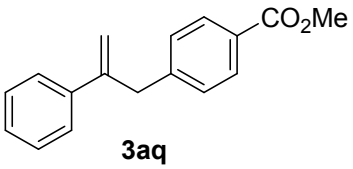
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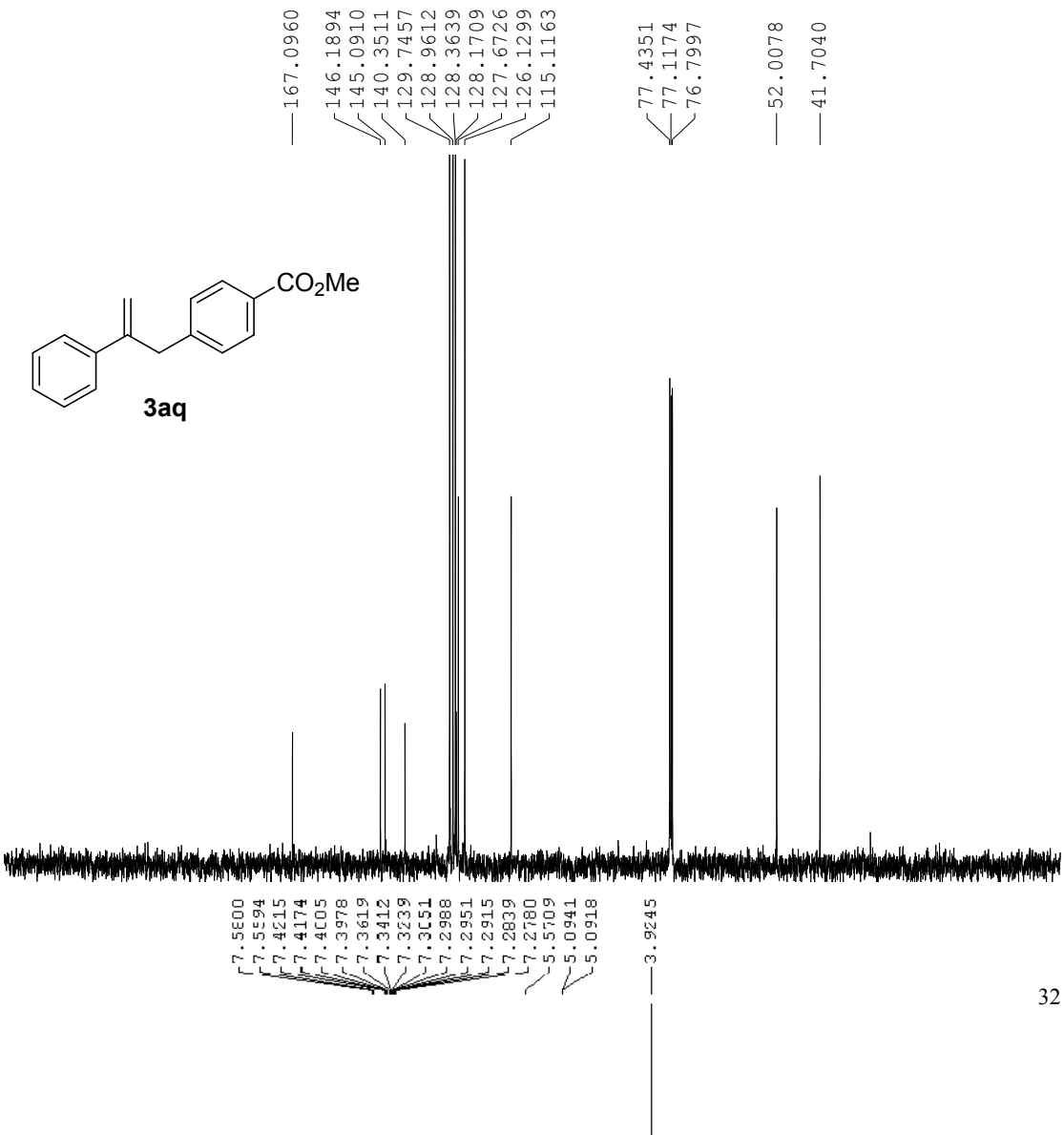
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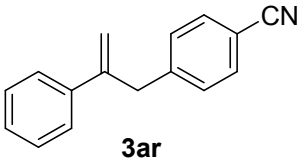
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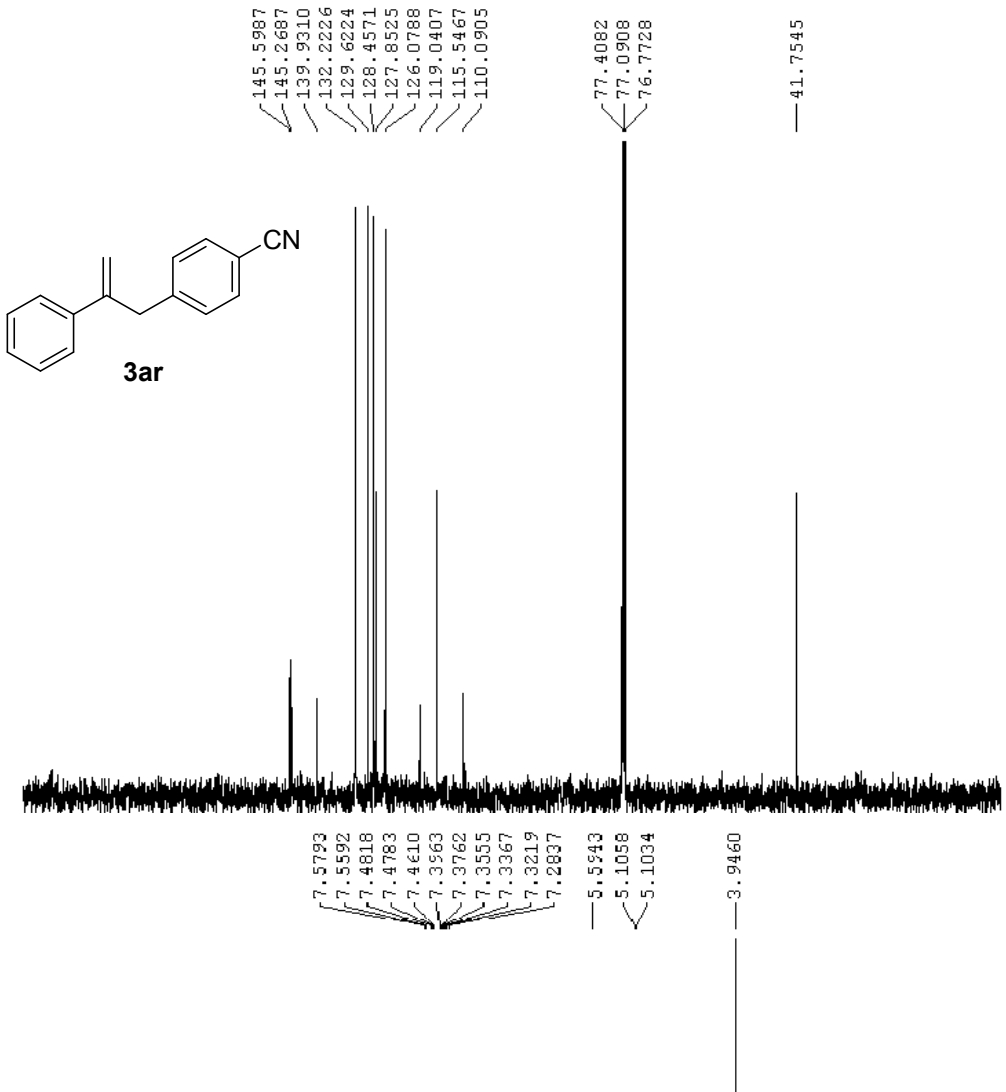
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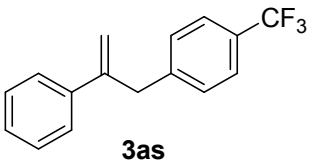
**3ar**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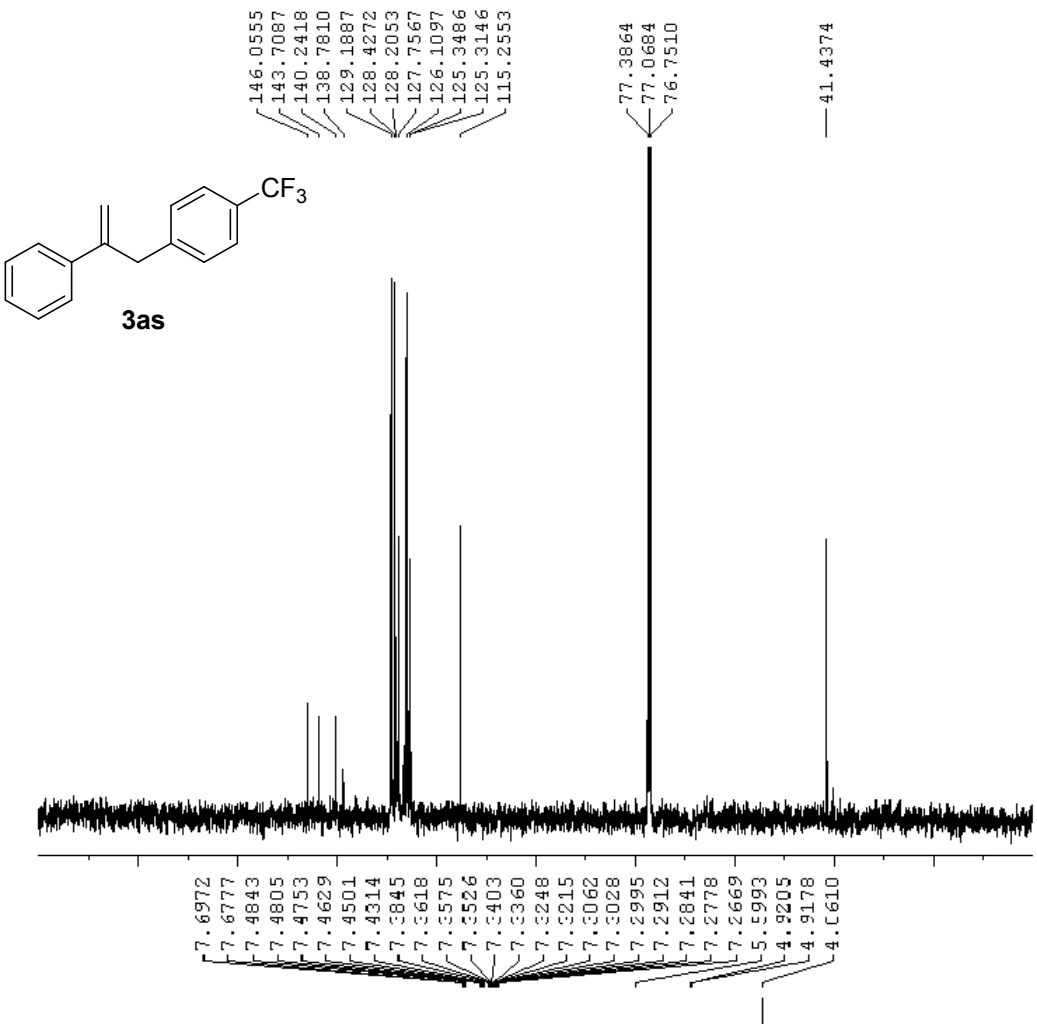
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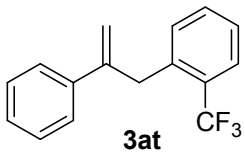
**3as**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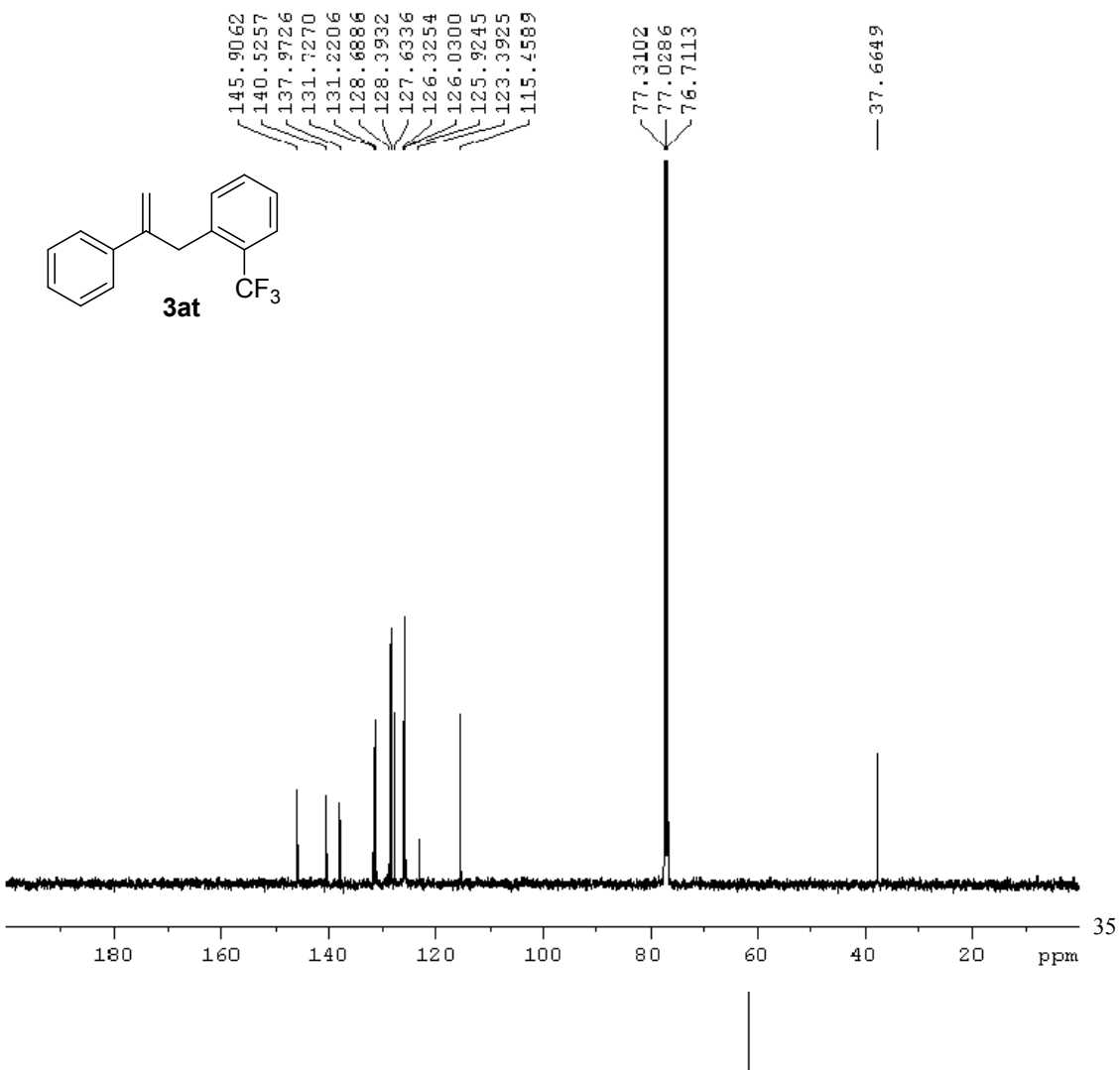
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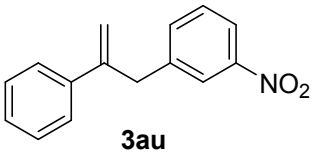
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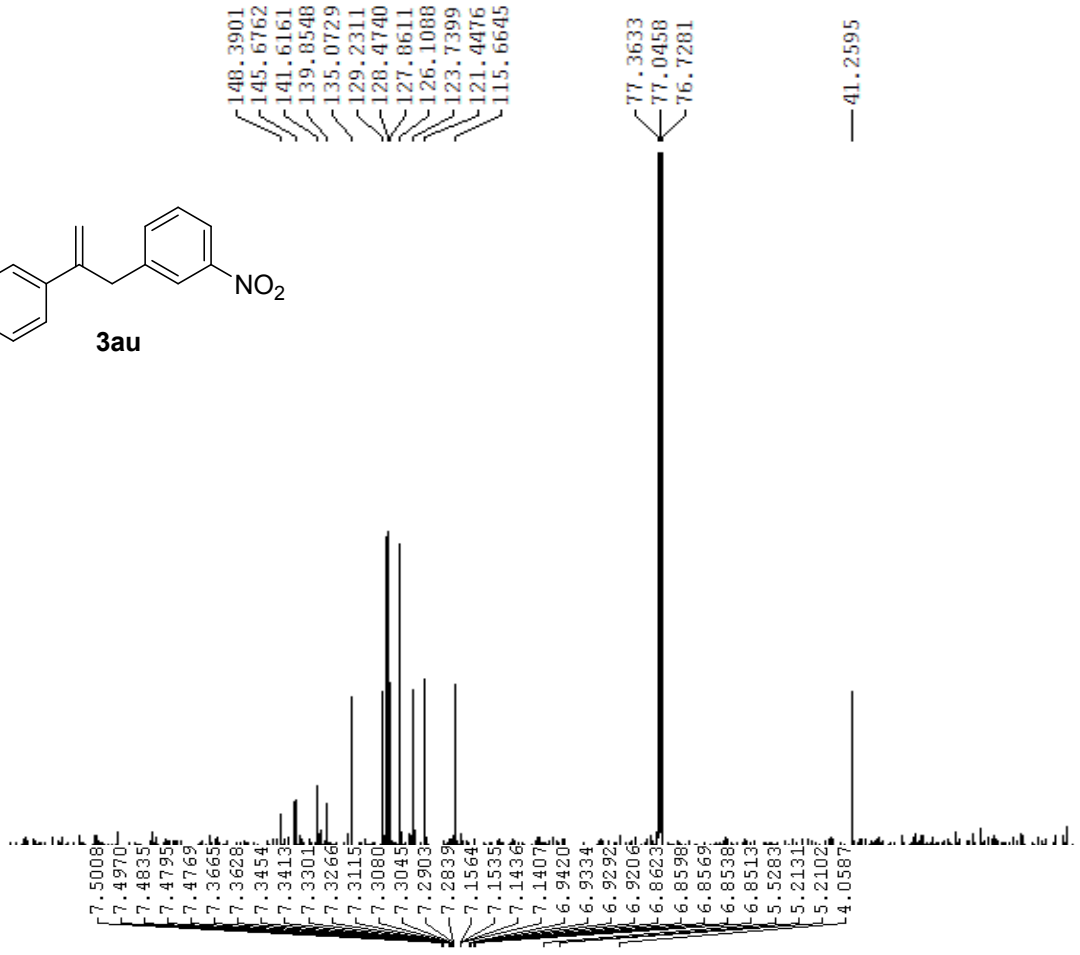
**3au**


NO2

**3au**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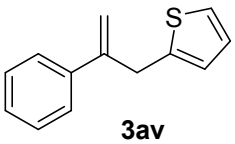
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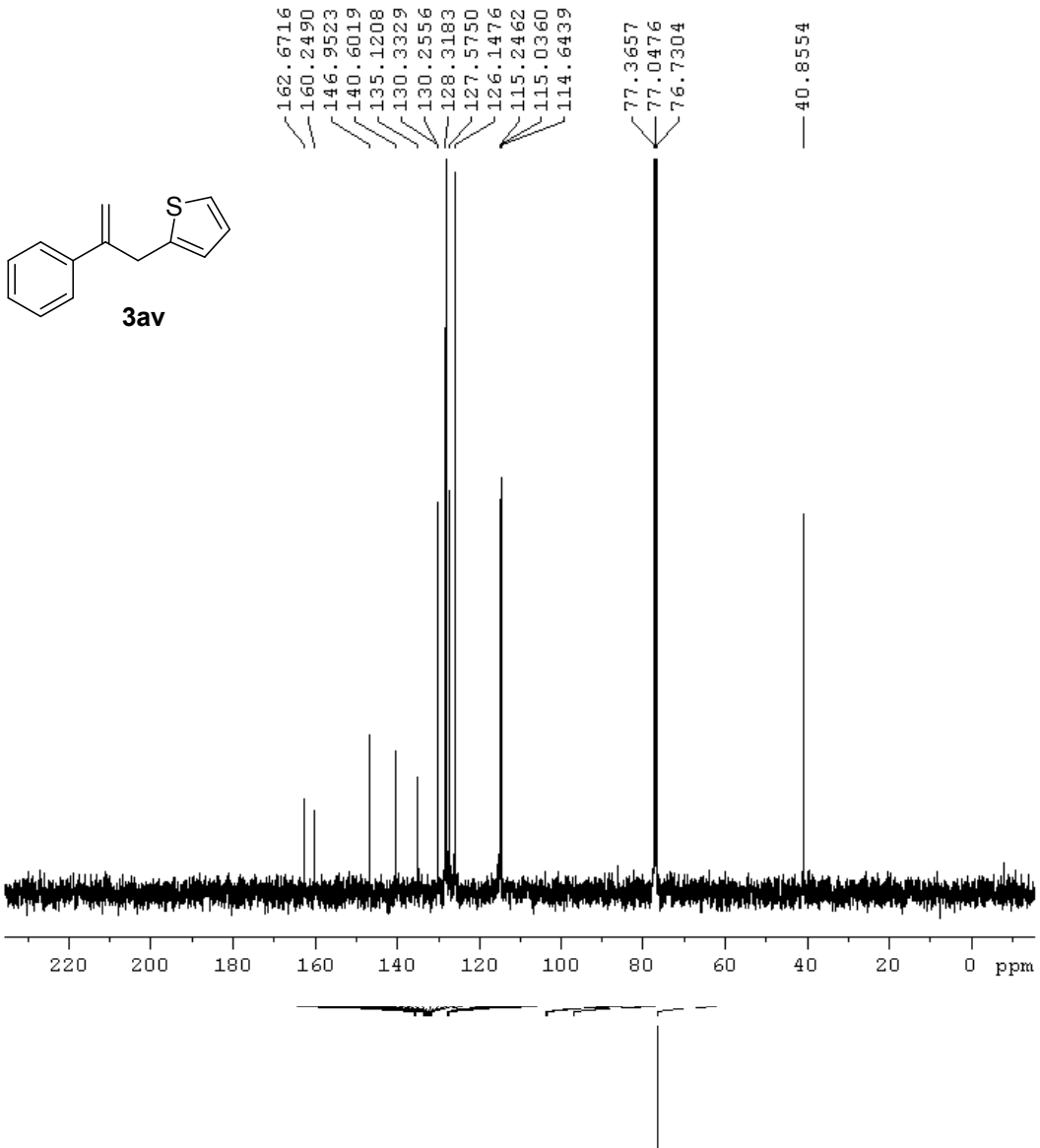
**3av**


S

**3av**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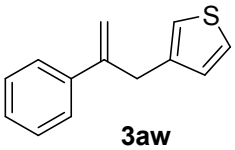
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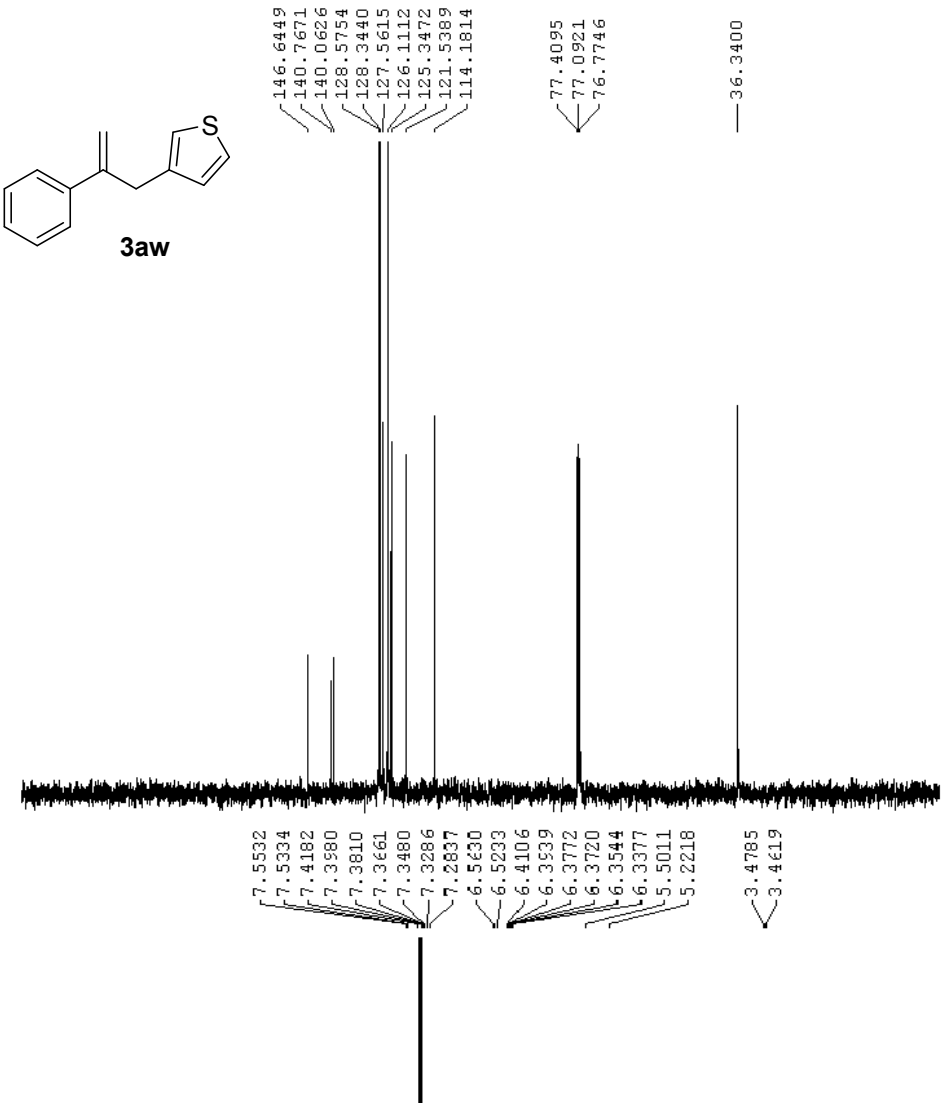
S

**3aw**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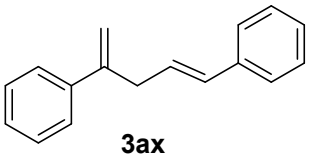

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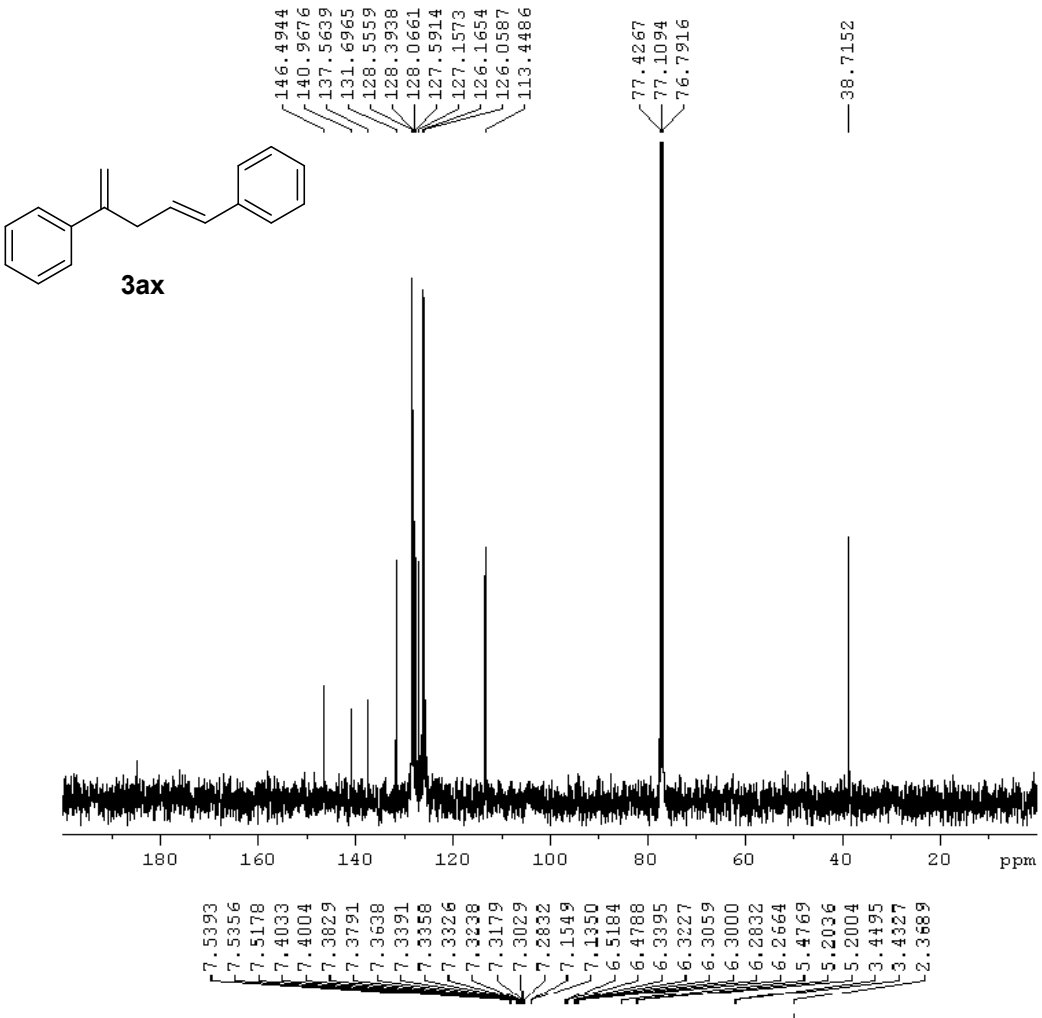
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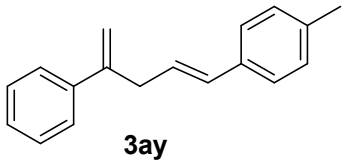

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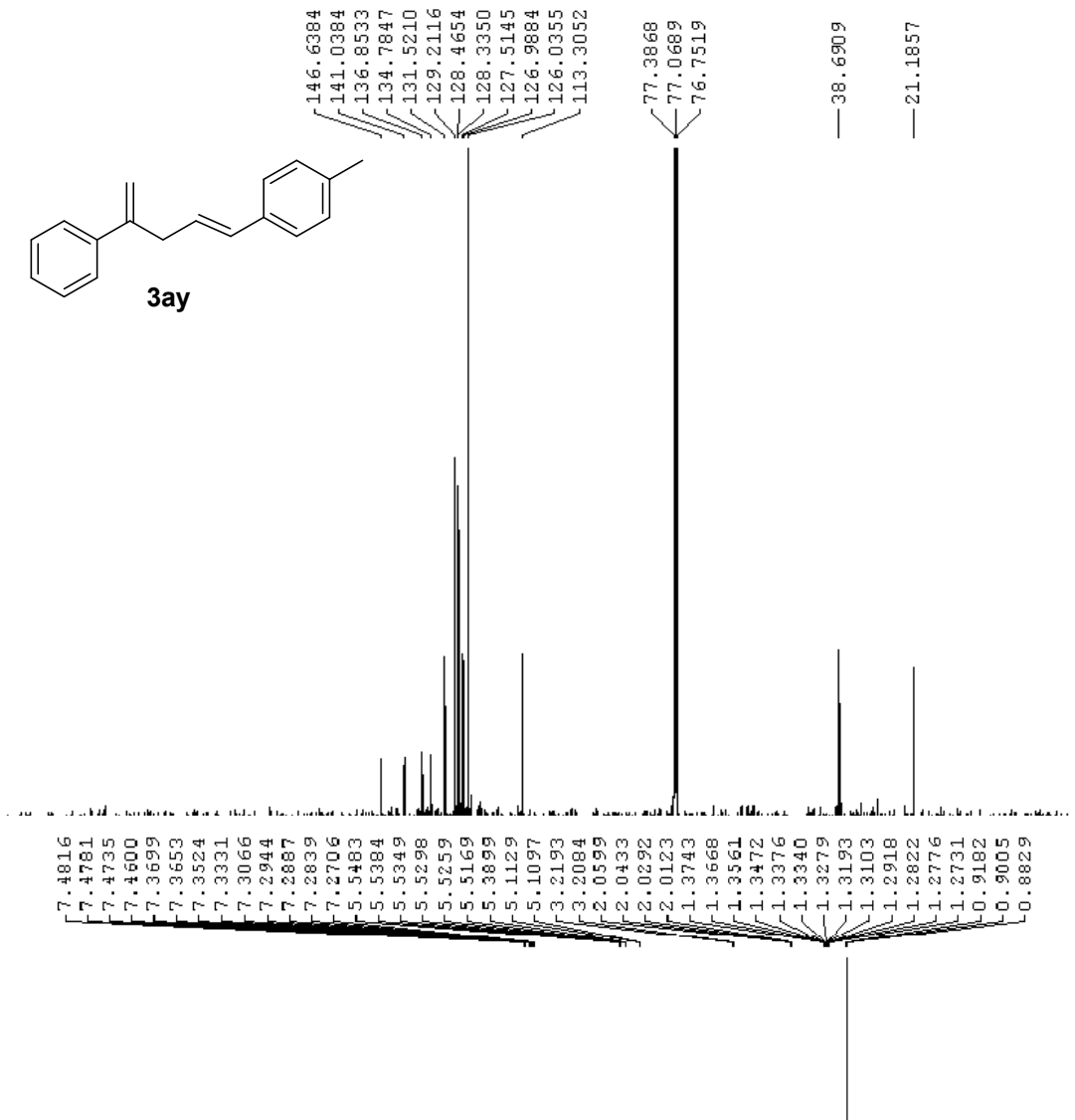
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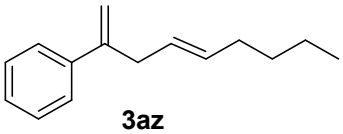

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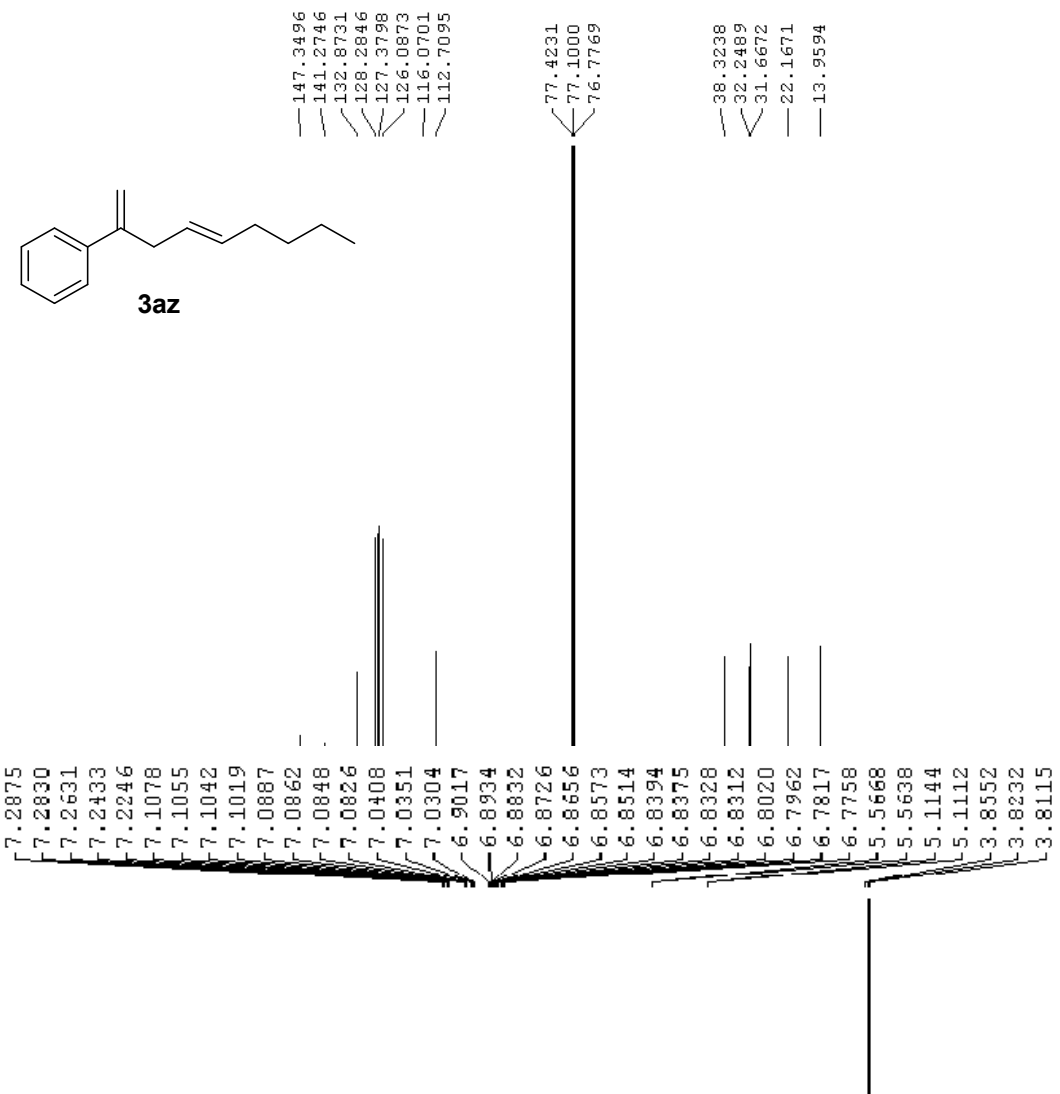
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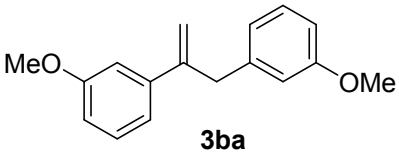
**3az**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OMe

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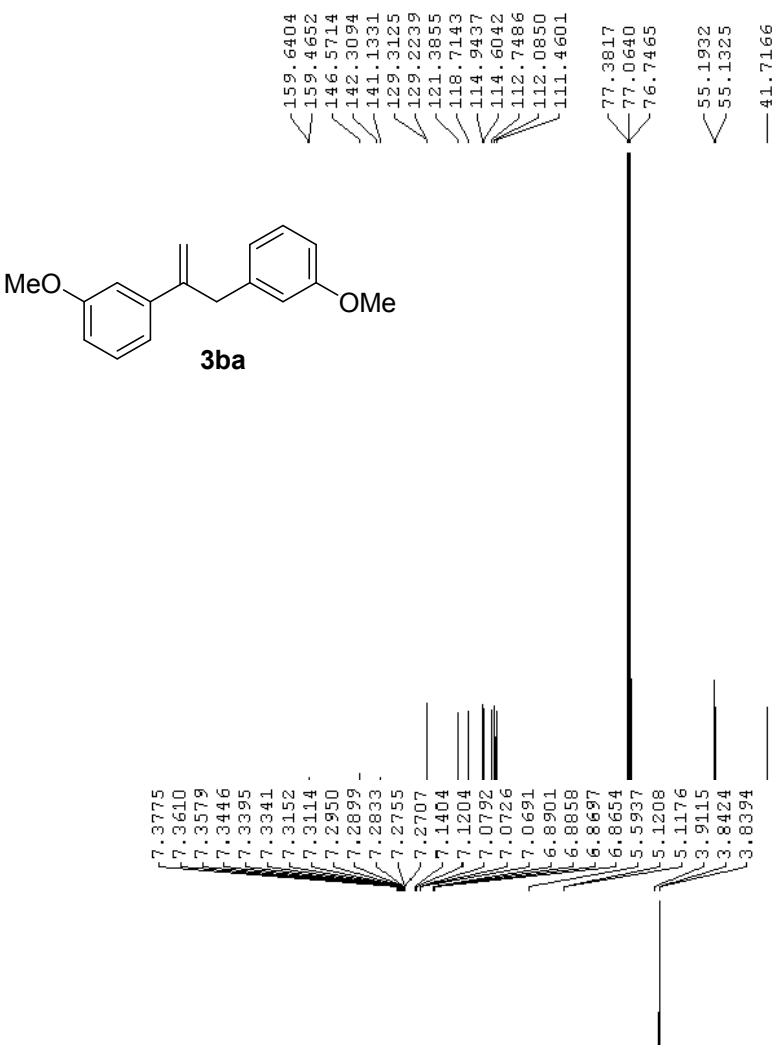
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OMe
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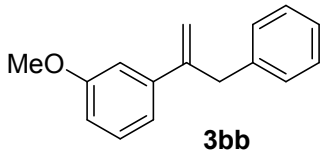
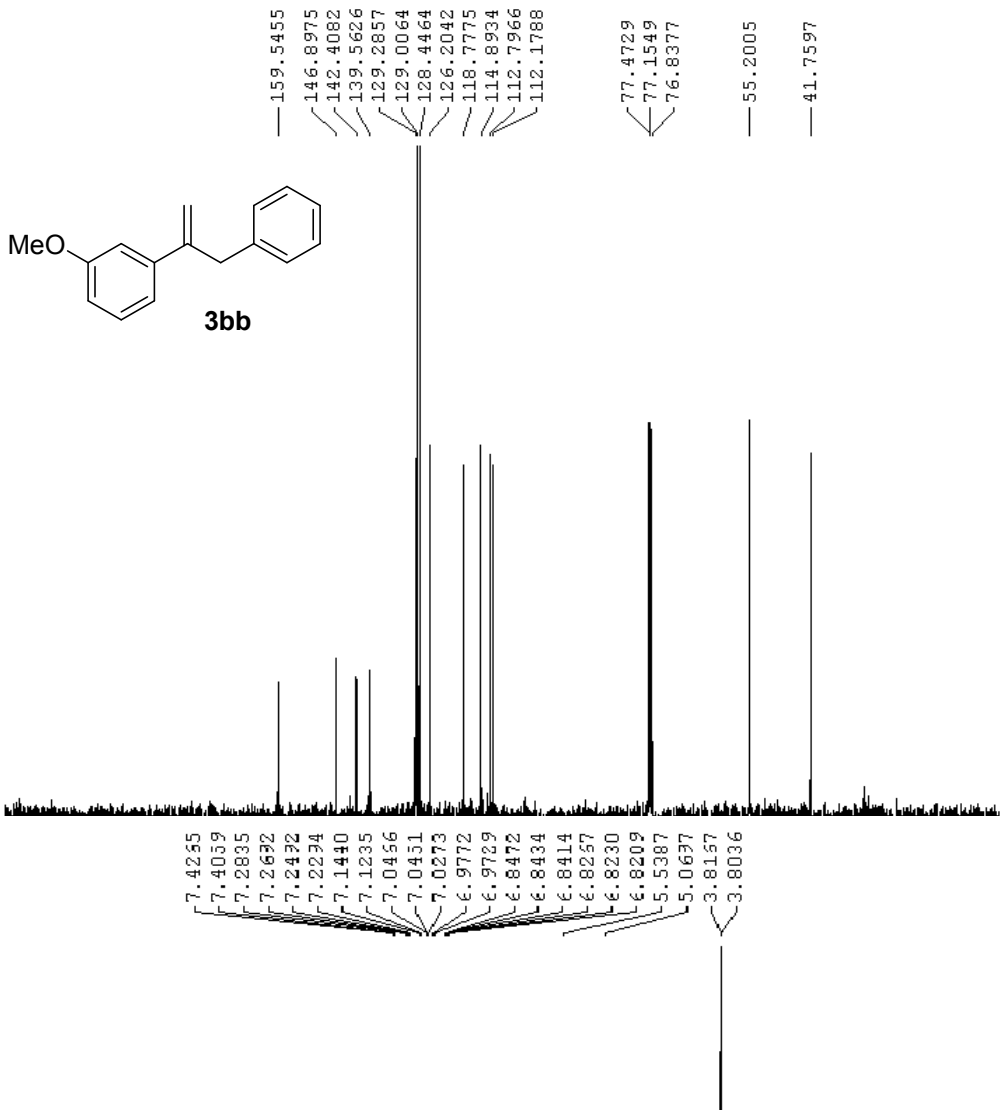

MeO

**3bb**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112.7966
112.1788
77.4729
77.1549
76.8377
55.2005
41.7597
MeO
7.4255
7.4059
7.2835
7.2632
7.2432
7.2294
7.1440
7.1235
7.0456
7.0451
7.0273
6.9772
6.9729
6.8472
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6.8414
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6.8230
6.8209
5.5387
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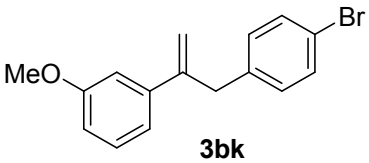
3.8157
3.8036

**3bb**


Br
MeO

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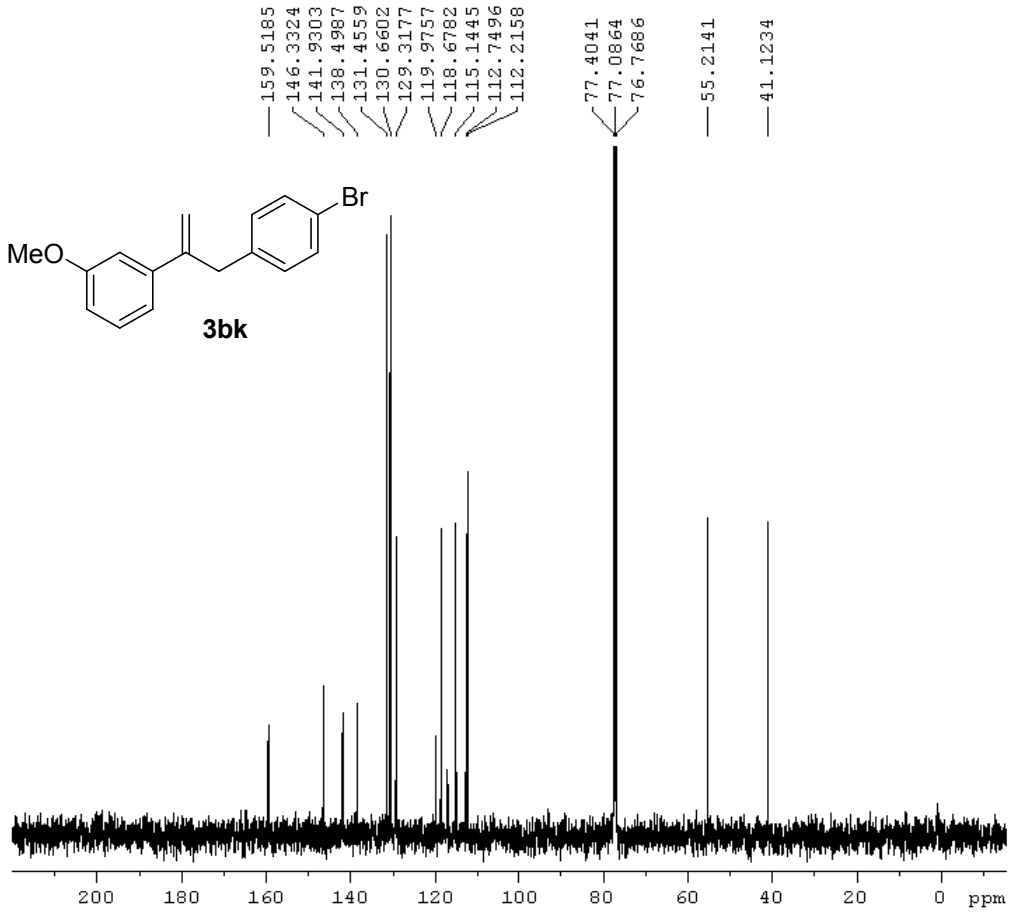
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112.2158
77.4041
77.0864
76.7686
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Br
MeO
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20
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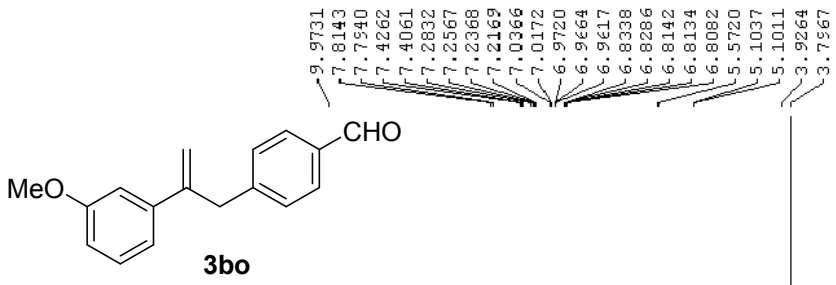
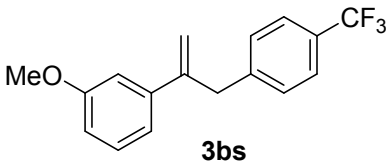
ppm




**3bo**




**3bo**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CF3

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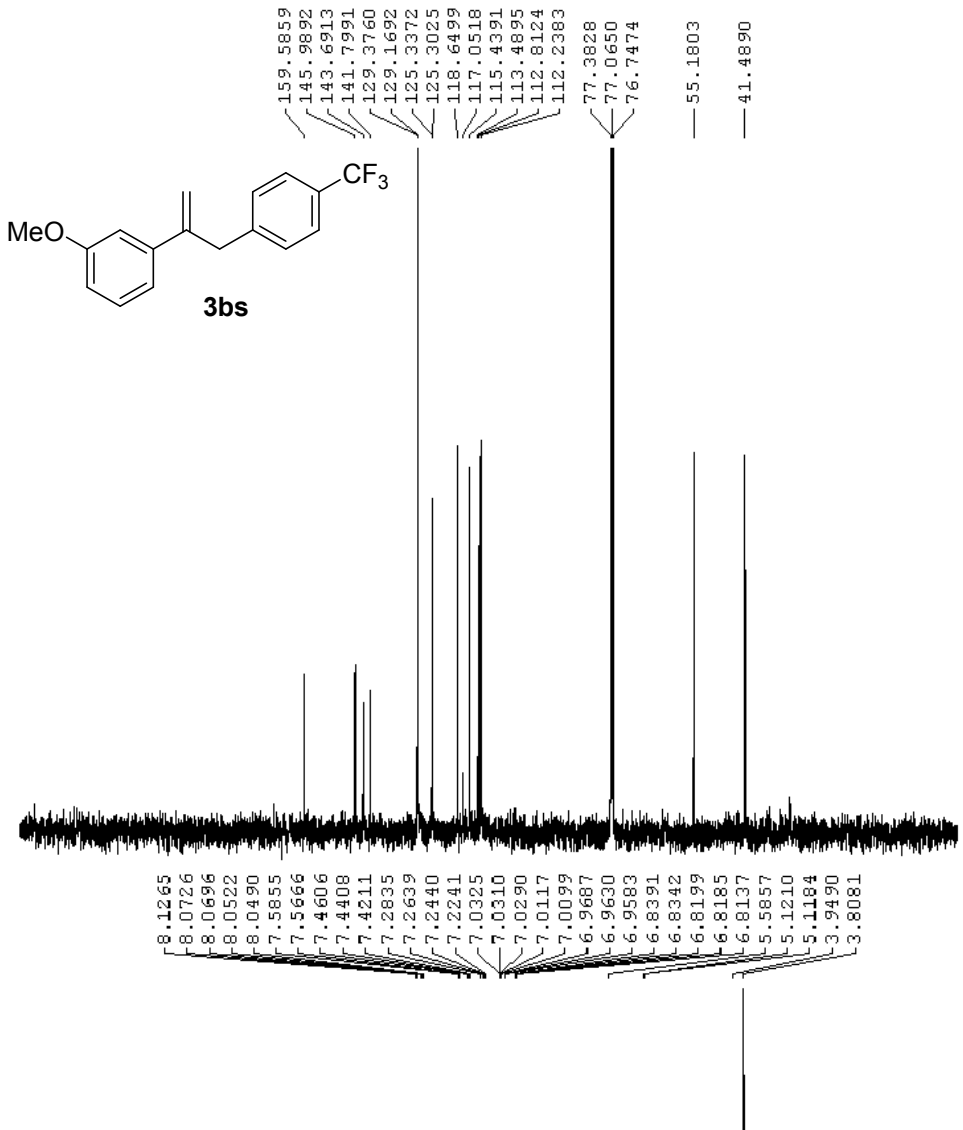
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112.8124
112.2383
77.3828
77.0650
76.7474
55.1803
41.4890
MeO
CF3
3bs
8.1265
8.0726
8.0696
8.0522
8.0490
7.5855
7.5666
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7.2639
7.2440
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7.0310
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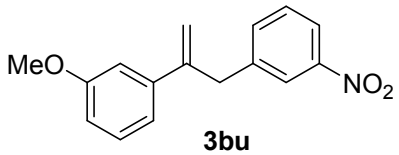
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NO2

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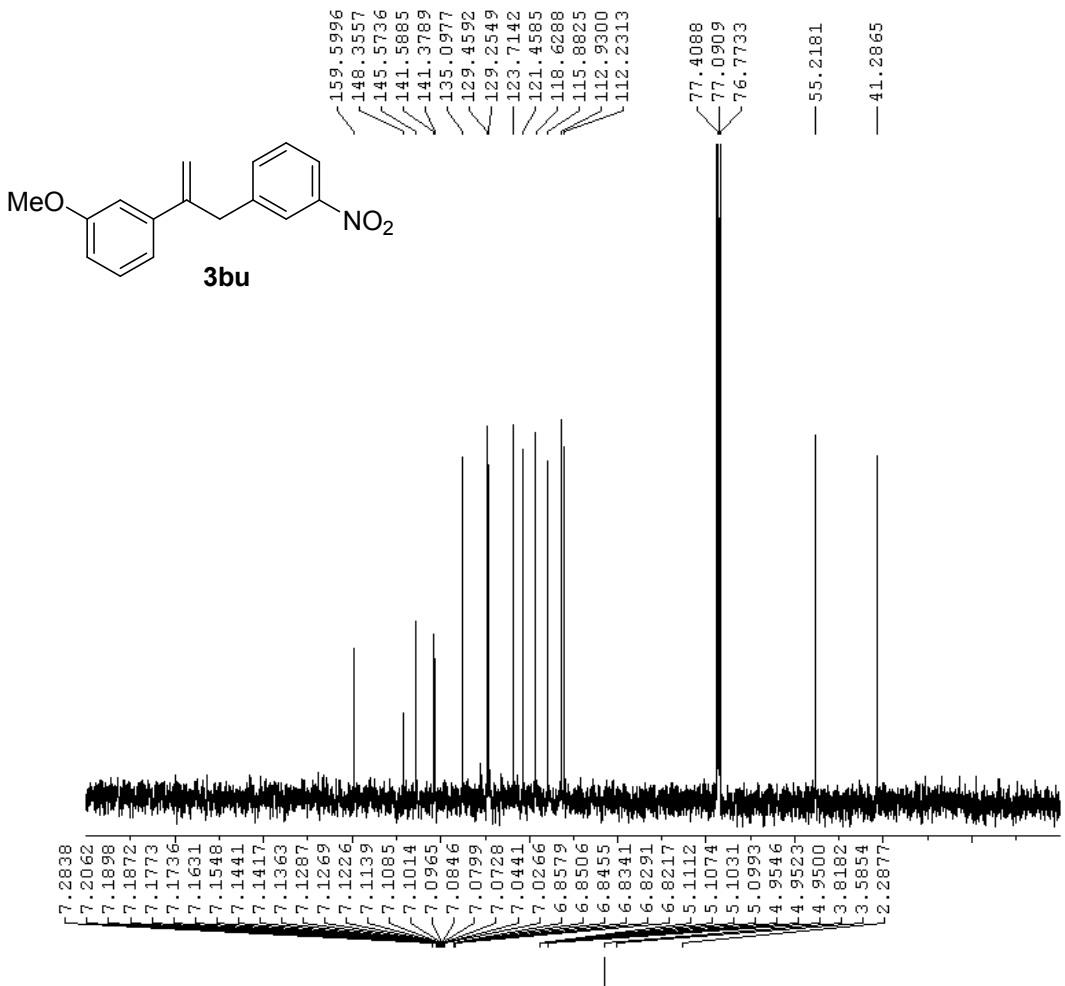
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112.9300
112.2313
77.4088
77.0909
76.7733
55.2181
41.2865
MeO
NO2
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7.2062
7.1898
7.1872
7.1773
7.1736
7.1631
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7.1287
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7.1226
7.1139
7.1085
7.1014
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7.0799
7.0728
7.0441
7.0266
6.8579
6.8506
6.8455
6.8341
6.8291
6.8217
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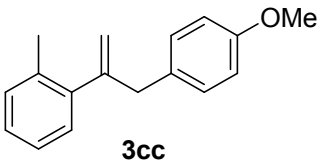
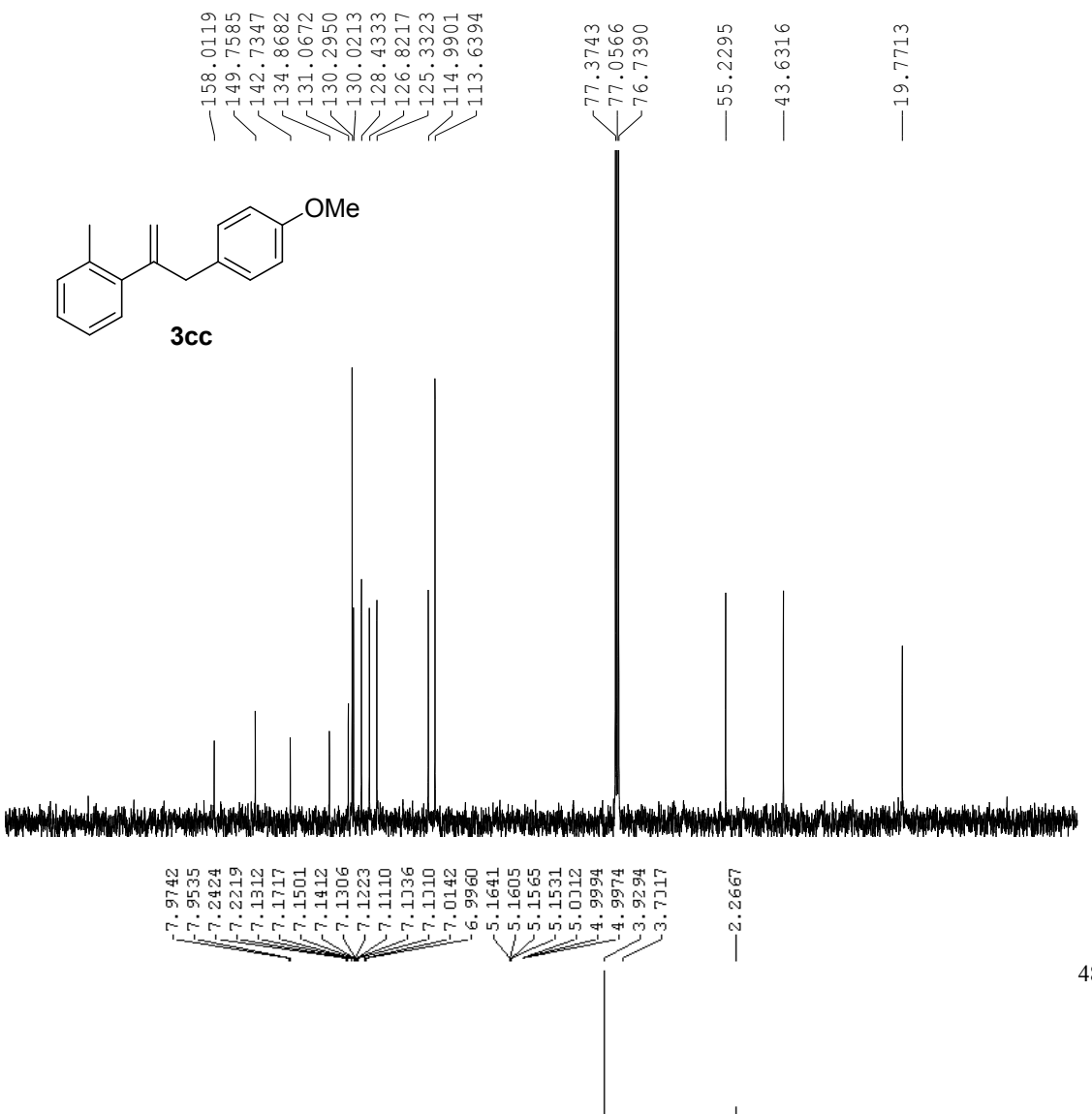
**3bu**


OMe

**3cc**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77.0566
76.7390
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43.6316
19.7713
OMe
3cc
7.9742
7.9535
7.2424
7.2219
7.1312
7.1717
7.1501
7.1412
7.1306
7.1223
7.1110
7.1336
7.1310
7.0142
6.9960
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5.0112
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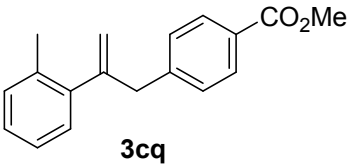
CO2Me

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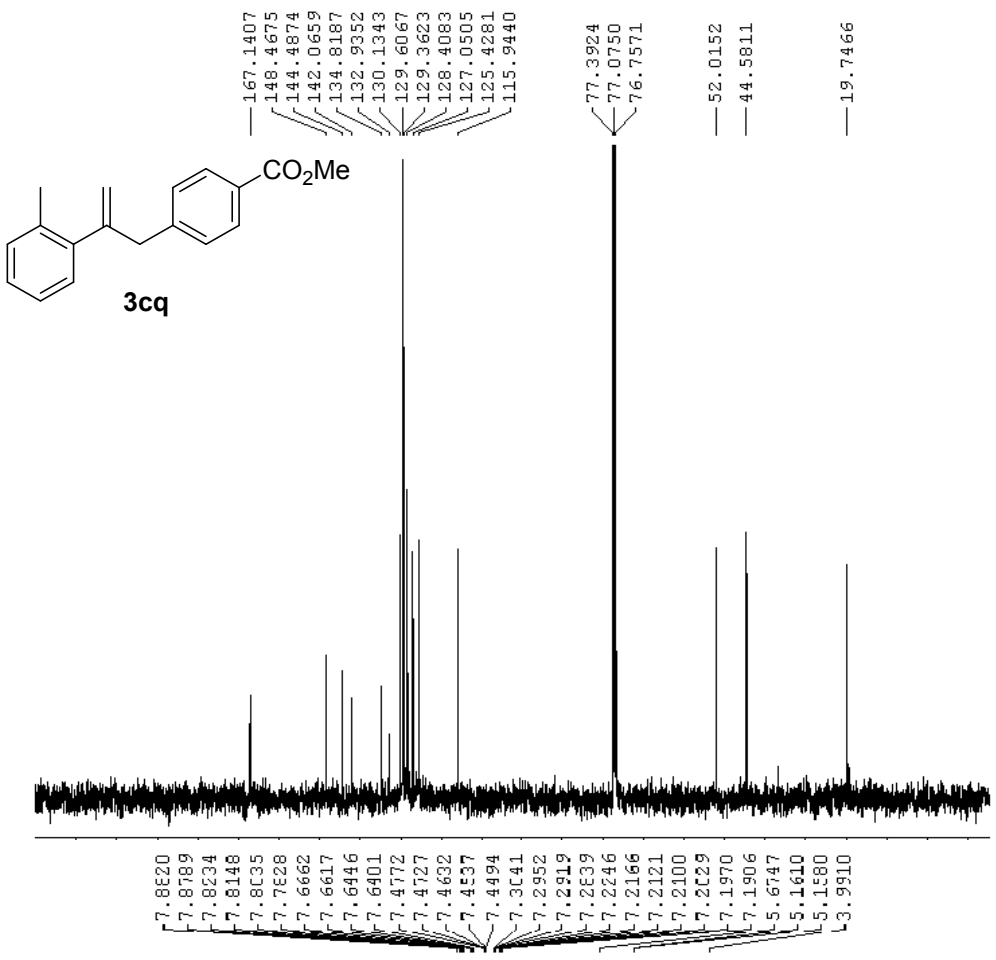
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CO2Me
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7.8234
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7.6446
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7.4537
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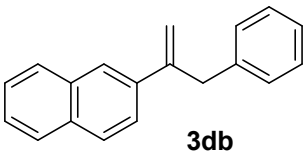
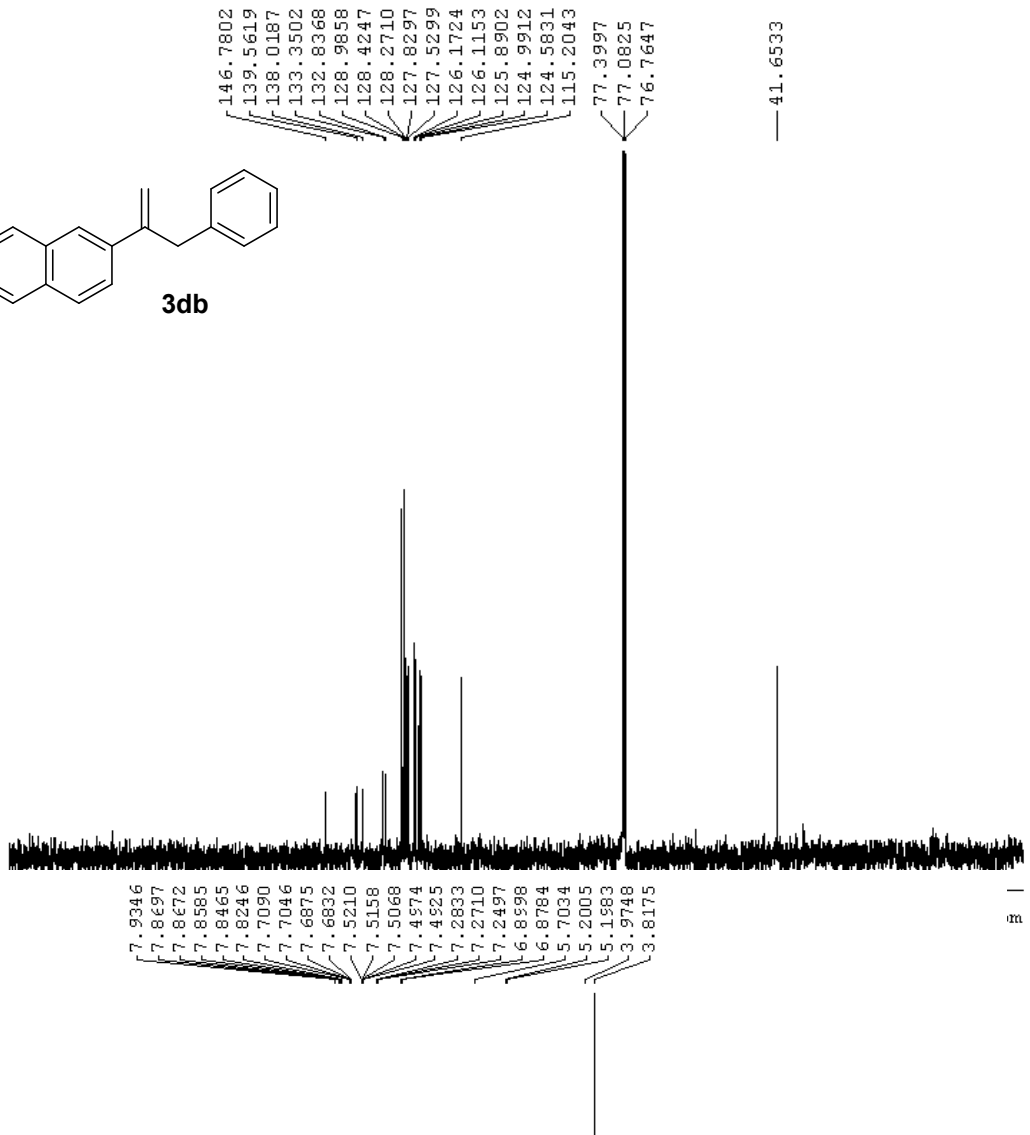
5.1580
3.9910



**3db**



**3db**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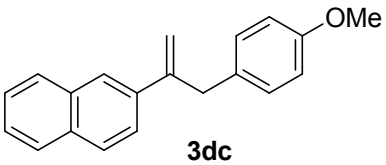
OMe

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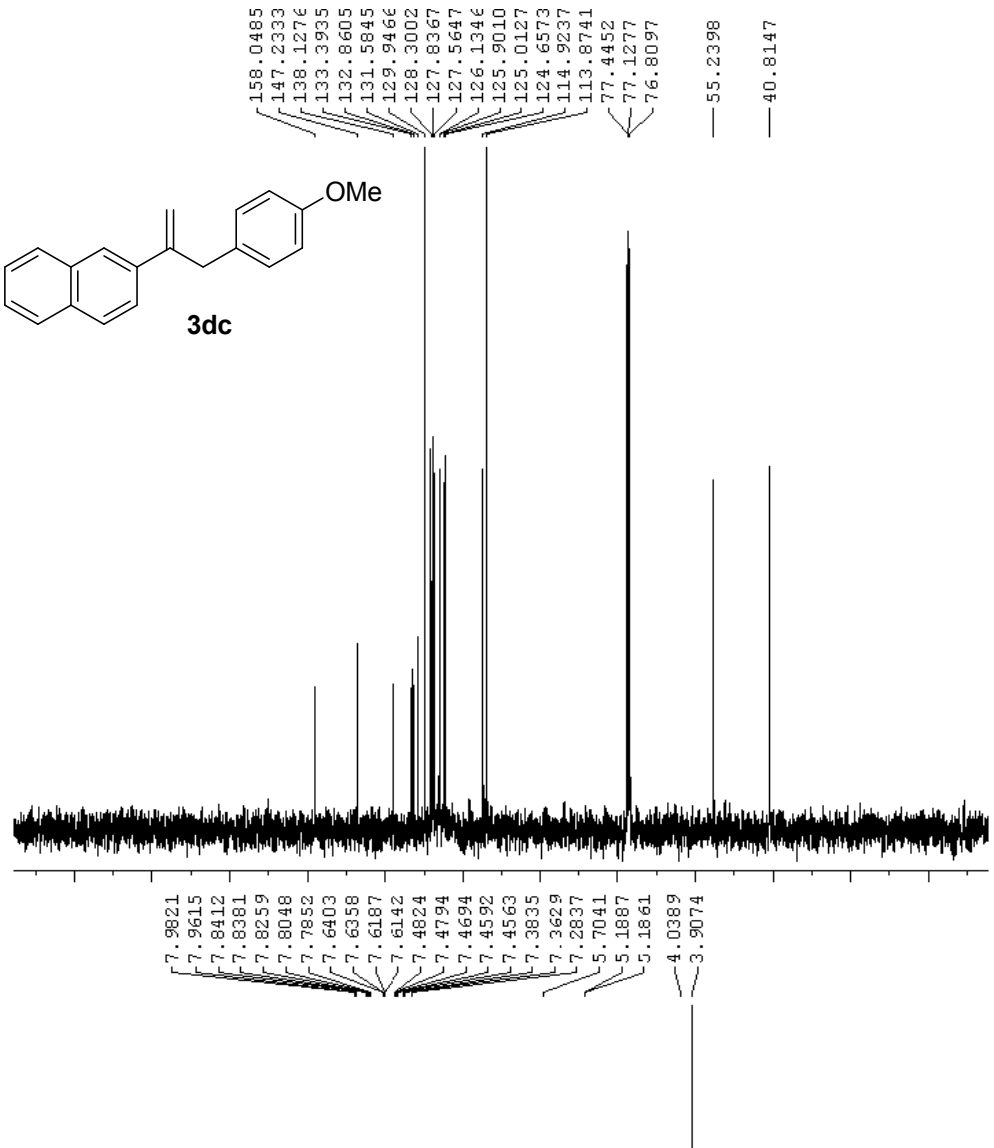
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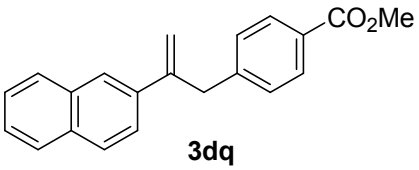
CO2Me

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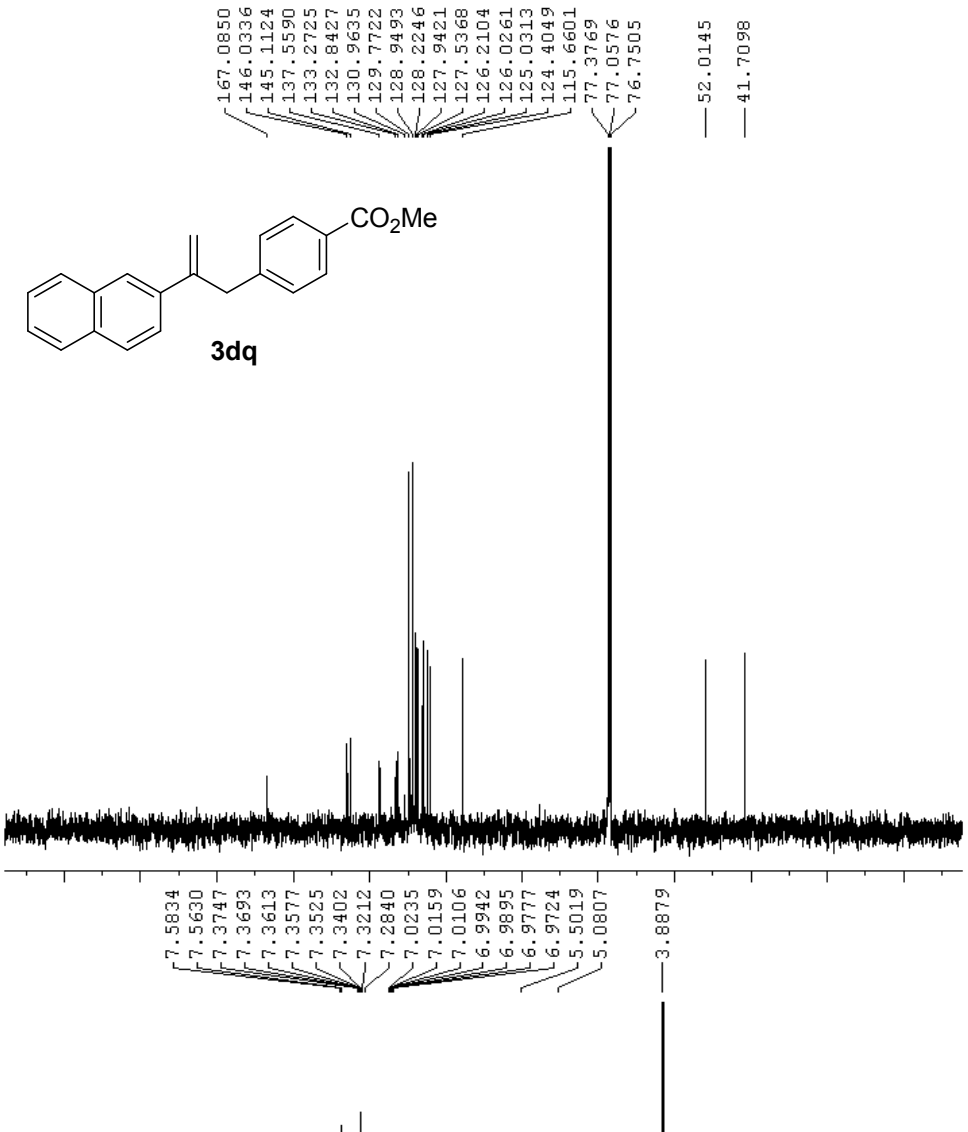
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126.0261
125.0313
124.4049
115.6601
77.3769
77.0576
76.7505
52.0145
41.7098
CO2Me
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7.5630
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7.3212
7.2840
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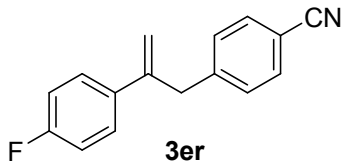
**3dq**


CN
F

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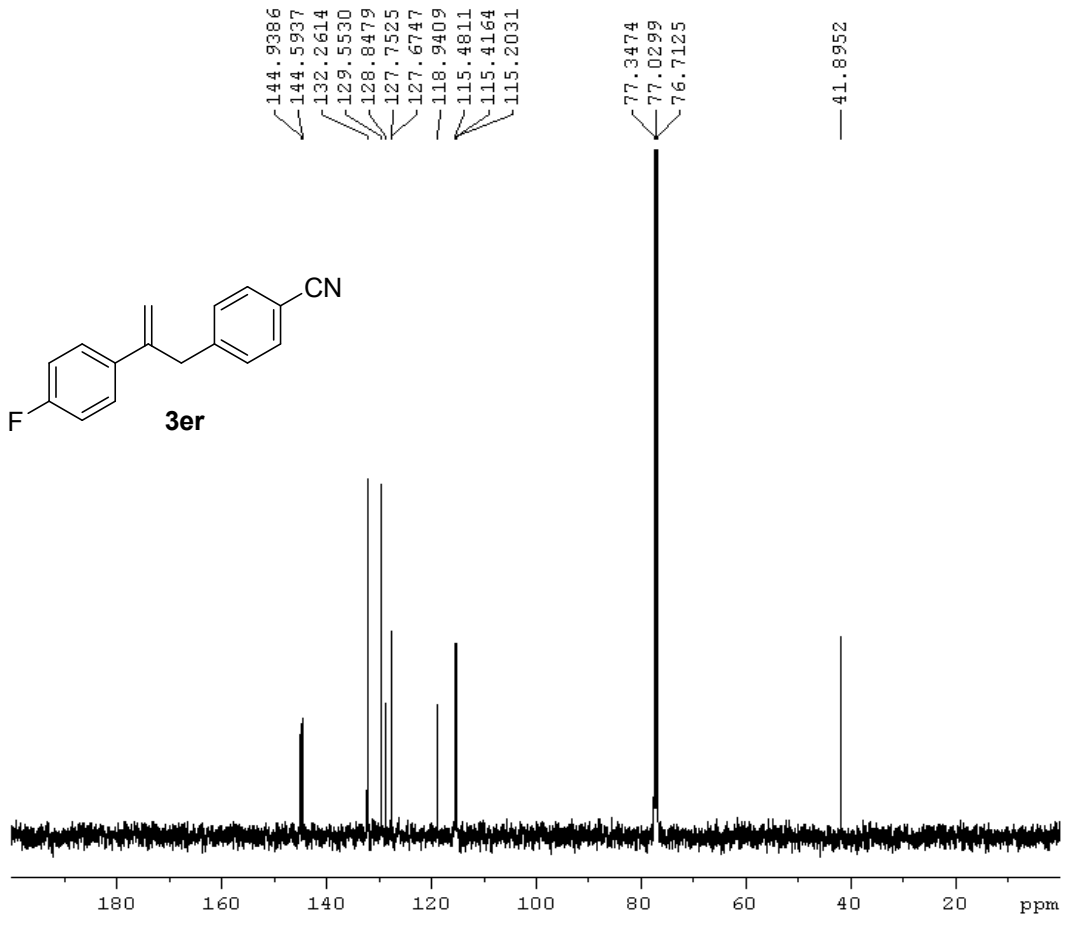
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115.2031
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CN
F
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80
60
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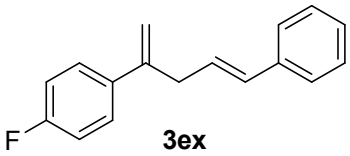
20
ppm

**3er**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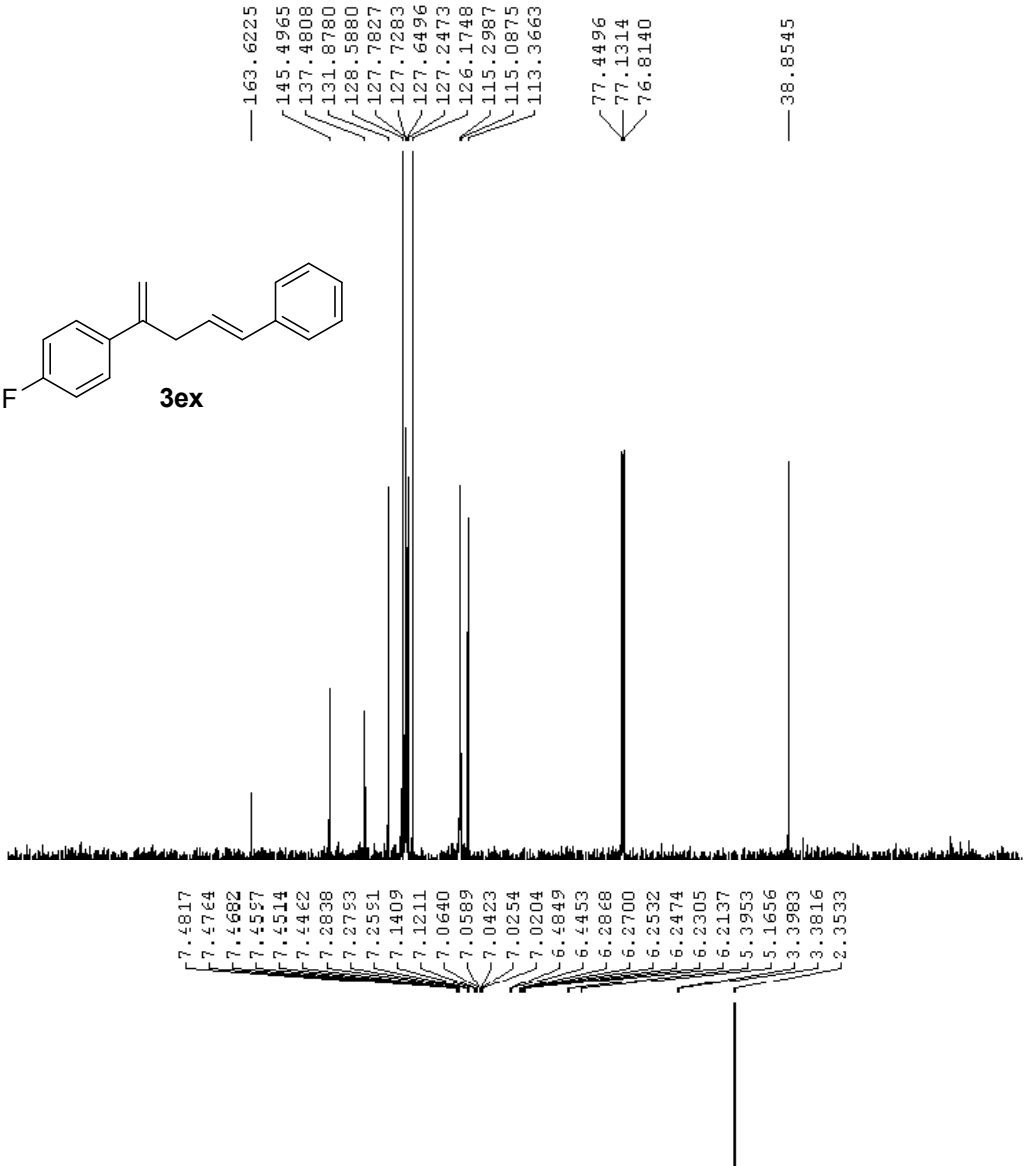
**3ex**


F

**3ex**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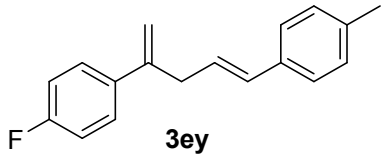
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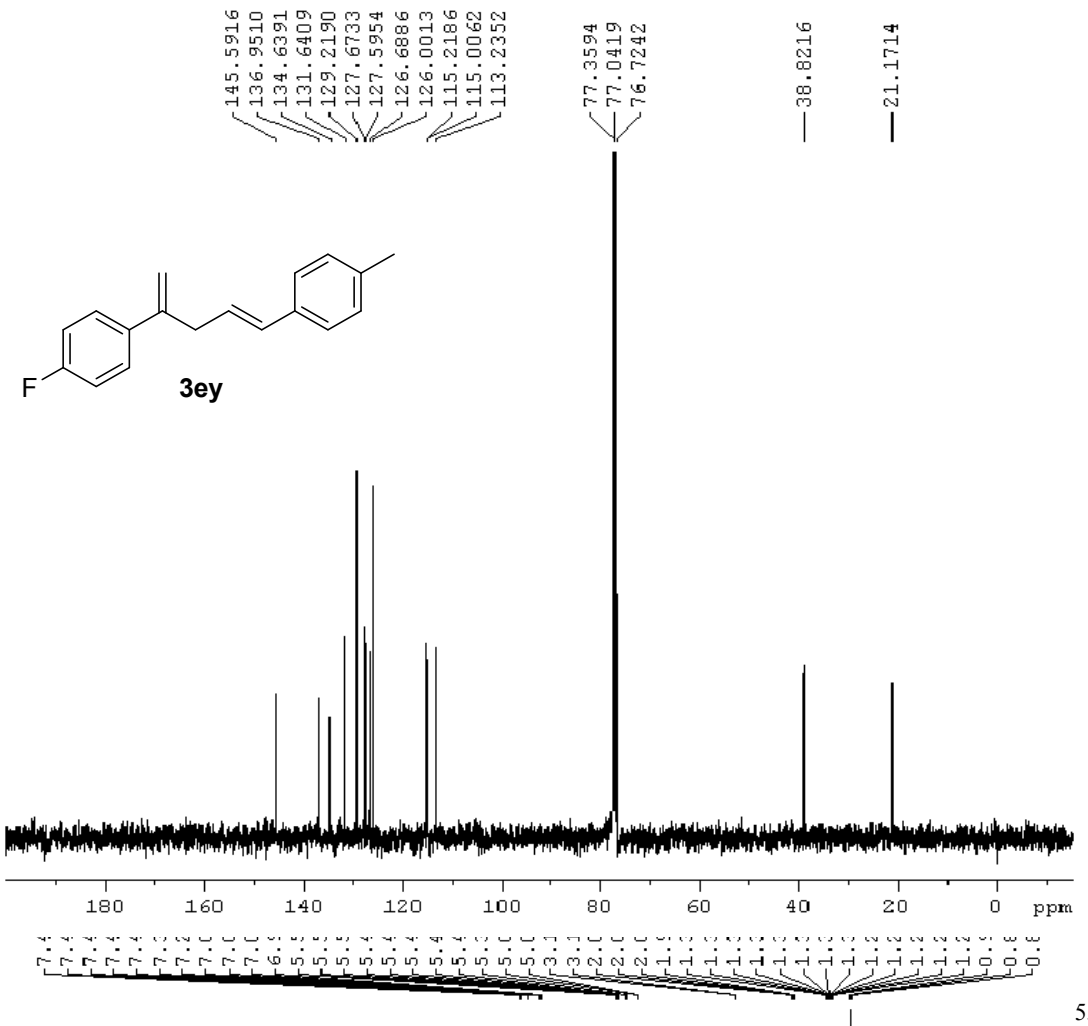
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77.0419
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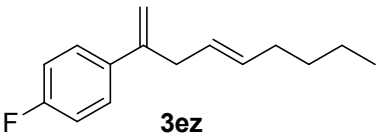
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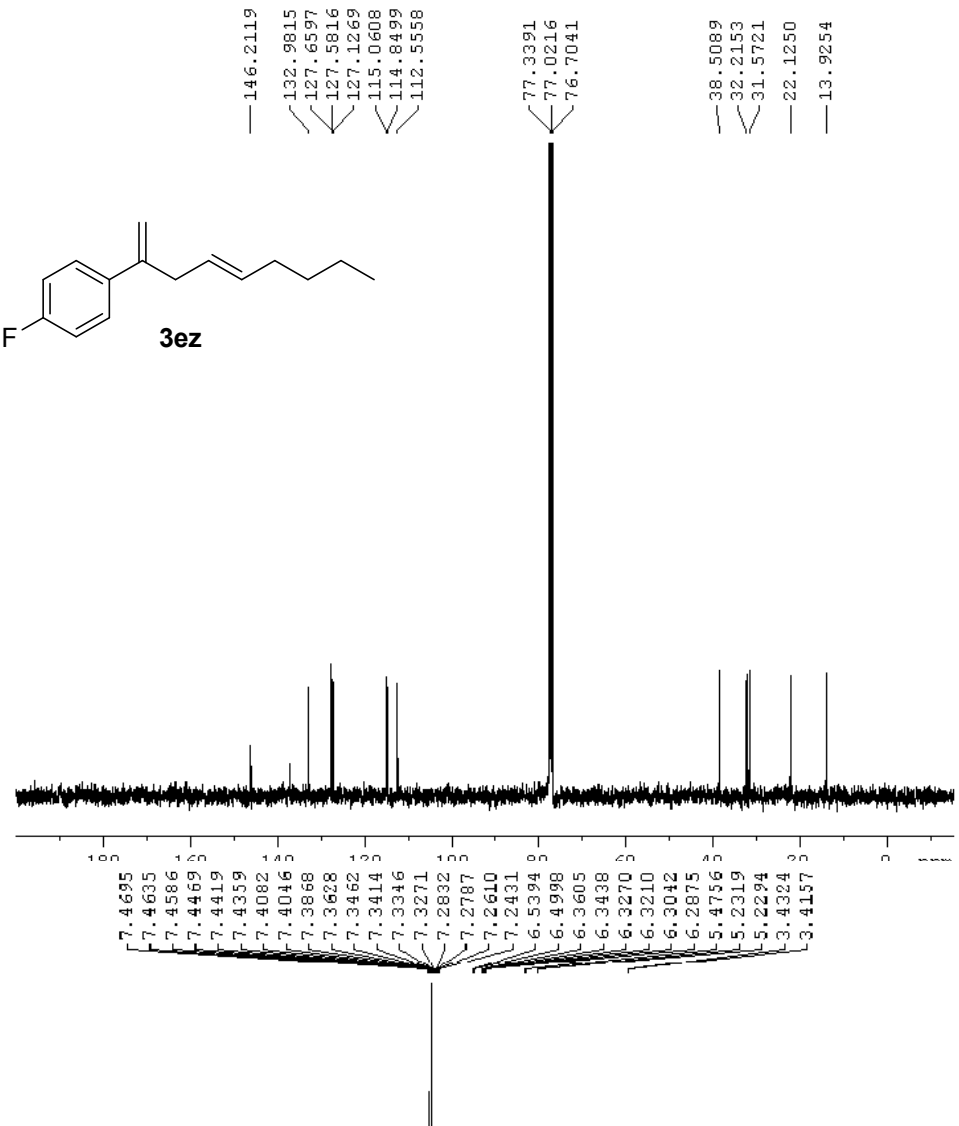
**3ez**


F

**3ez**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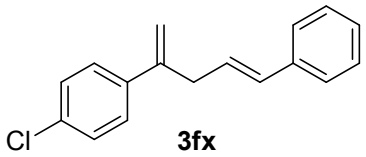
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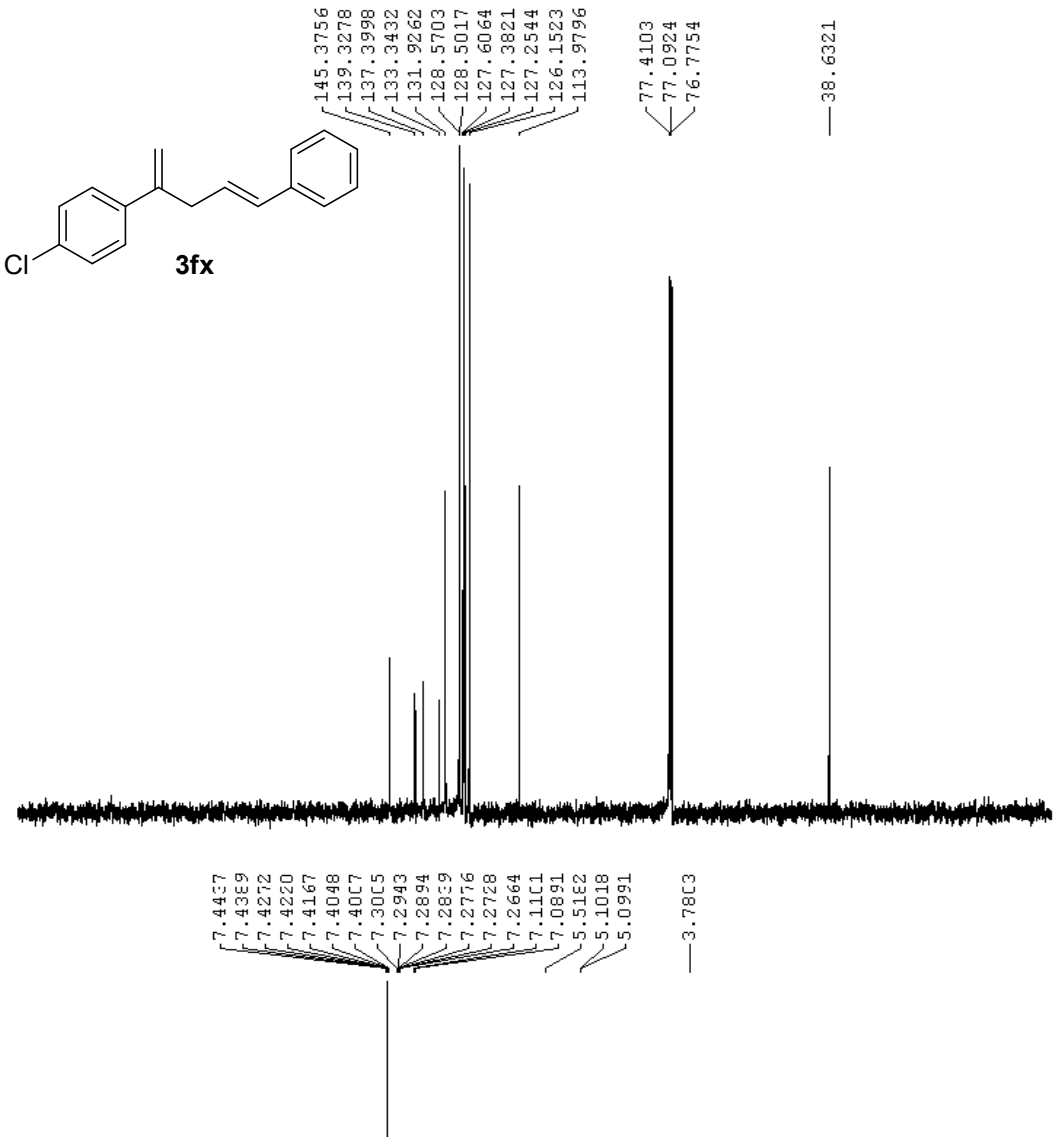
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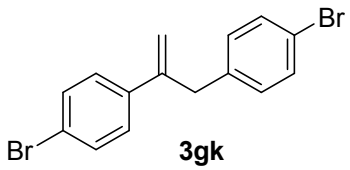
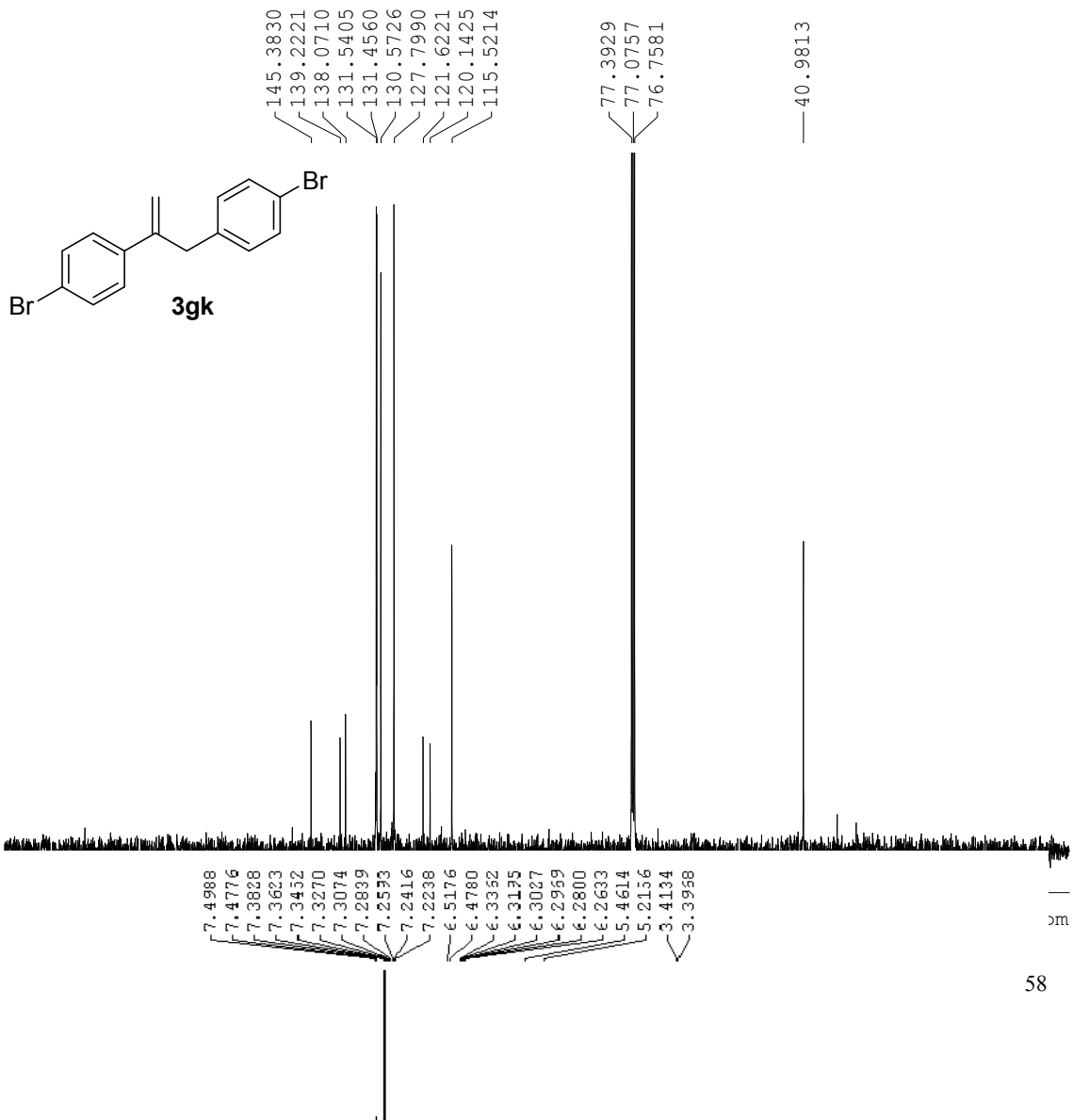

Br
Br

**3gk**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76.7581
40.9813
Br
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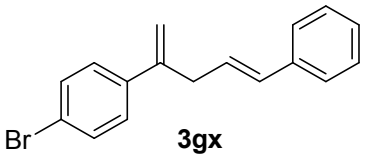
**3gk**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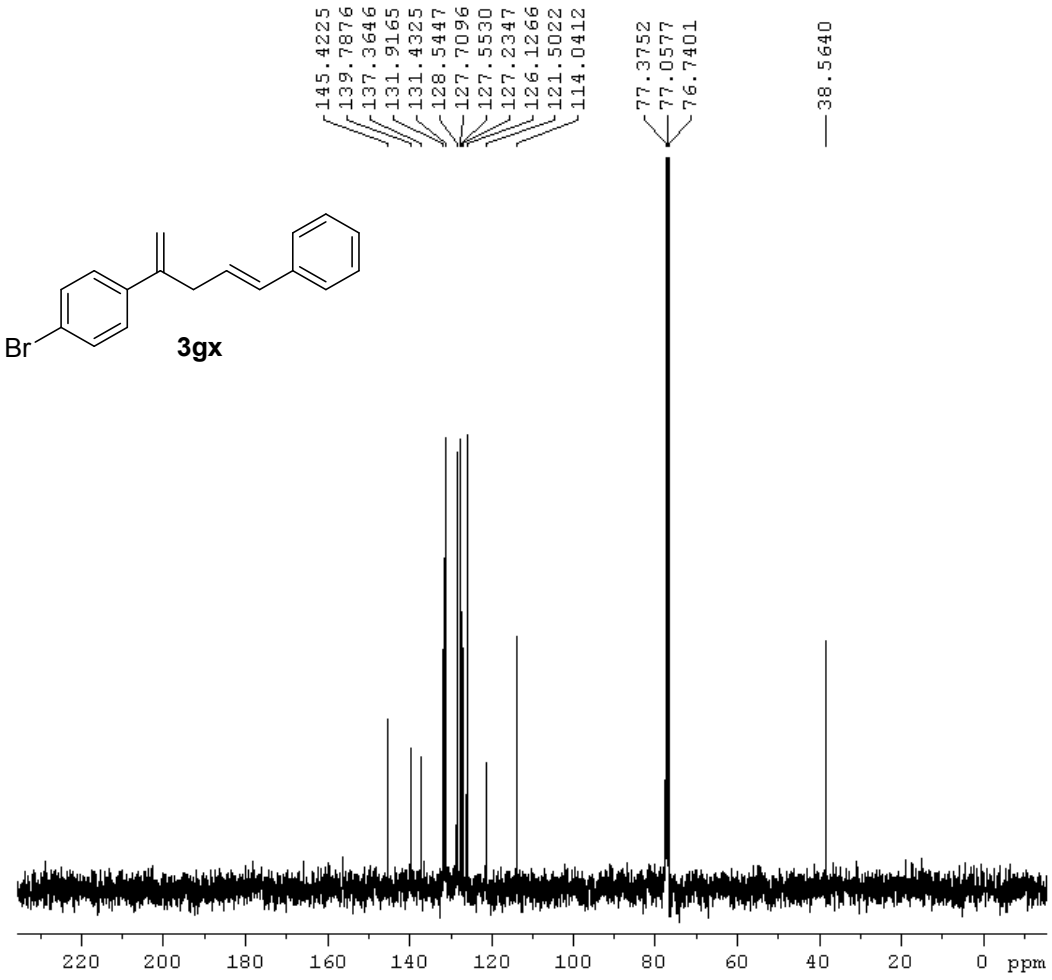
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139.7876
137.3646
131.9165
131.4325
128.5447
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127.5530
127.2347
126.1266
121.5022
114.0412
77.3752
77.0577
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Br
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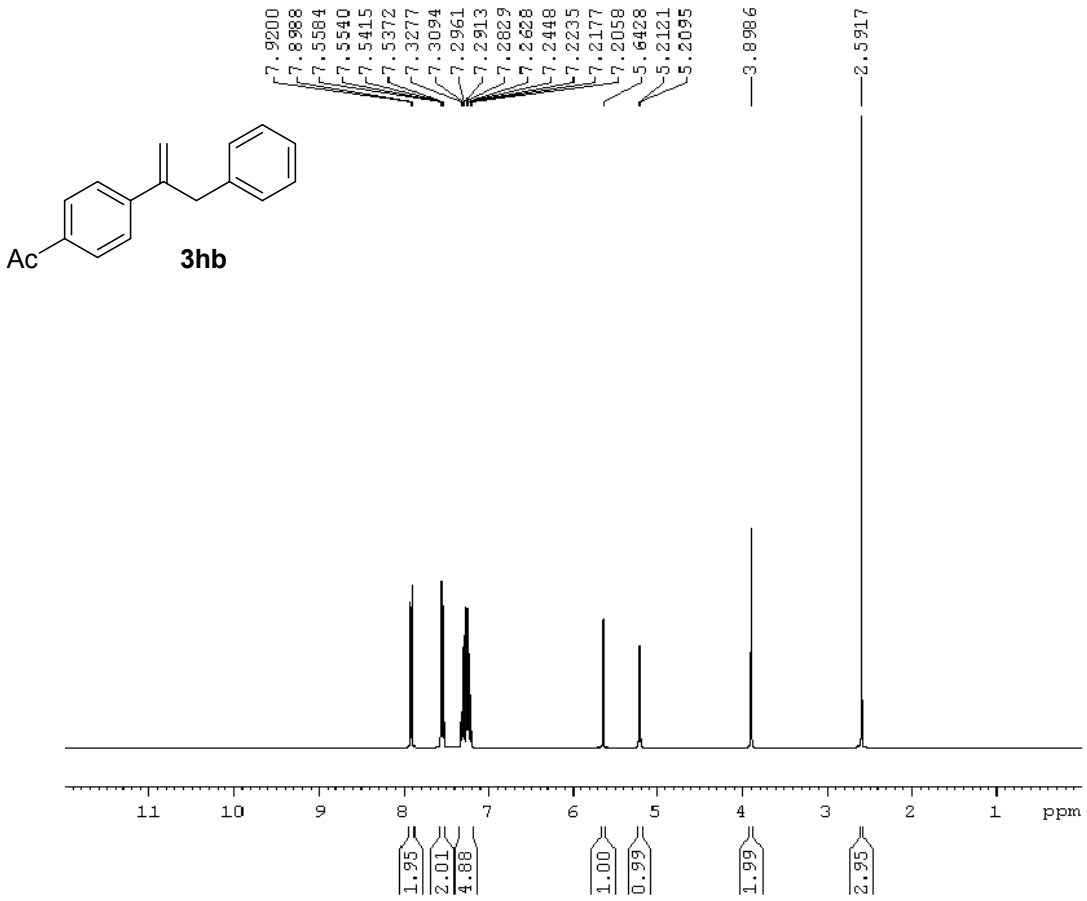
20
0
ppm

**3gx**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7.2628
7.2448
7.2235
7.2177
7.2058
5.6428
5.2121
5.2095
3.8986
2.5917
Ac
3hb
11
10
9
8
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2
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4.88
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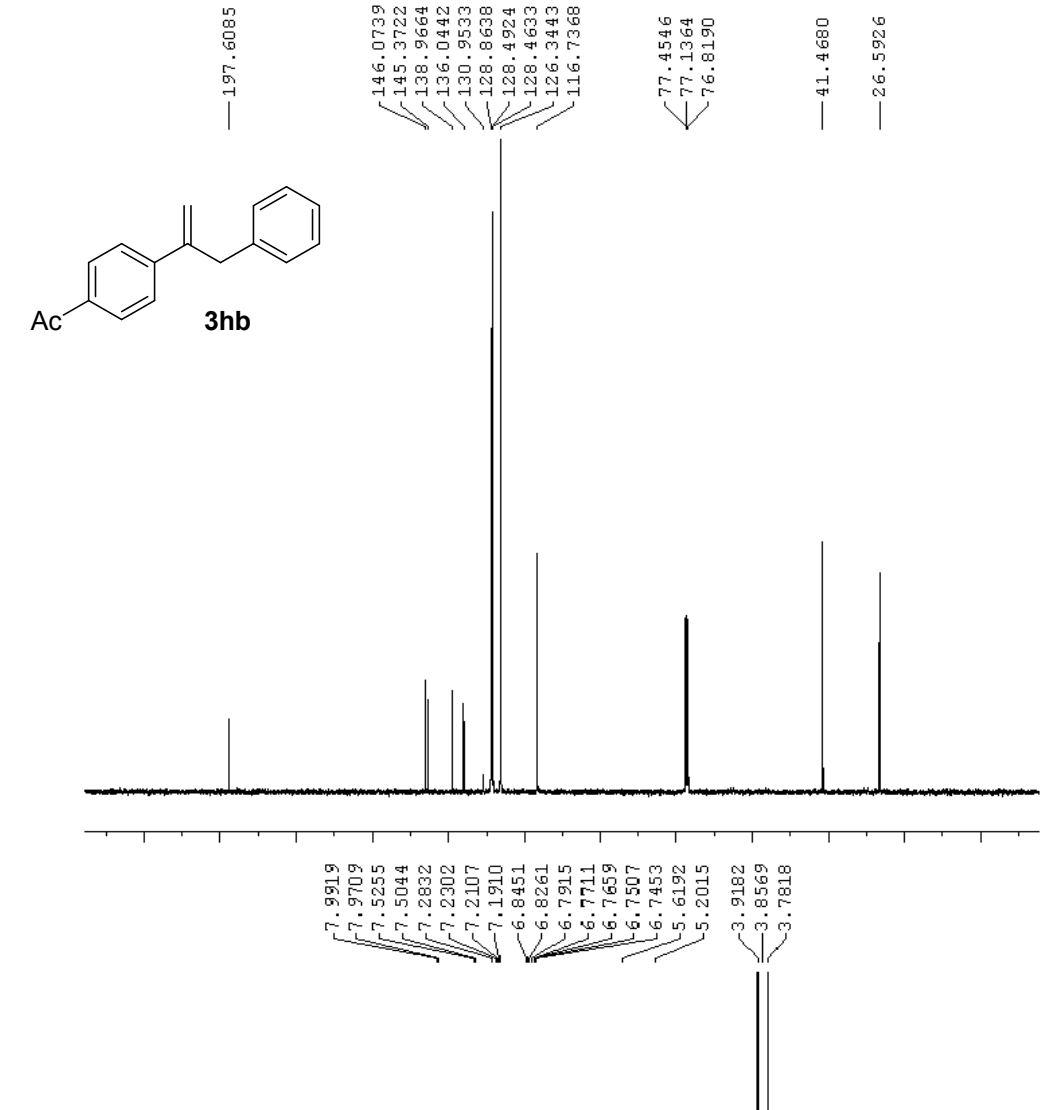
2.95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128.4633
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116.7368
77.4546
77.1364
76.8190
41.4680
26.5926
Ac
3hb
7.9919
7.9709
7.5255
7.5044
7.2832
7.2302
7.2107
7.1910
6.8451
6.8261
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5.2015
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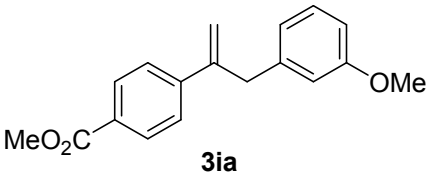
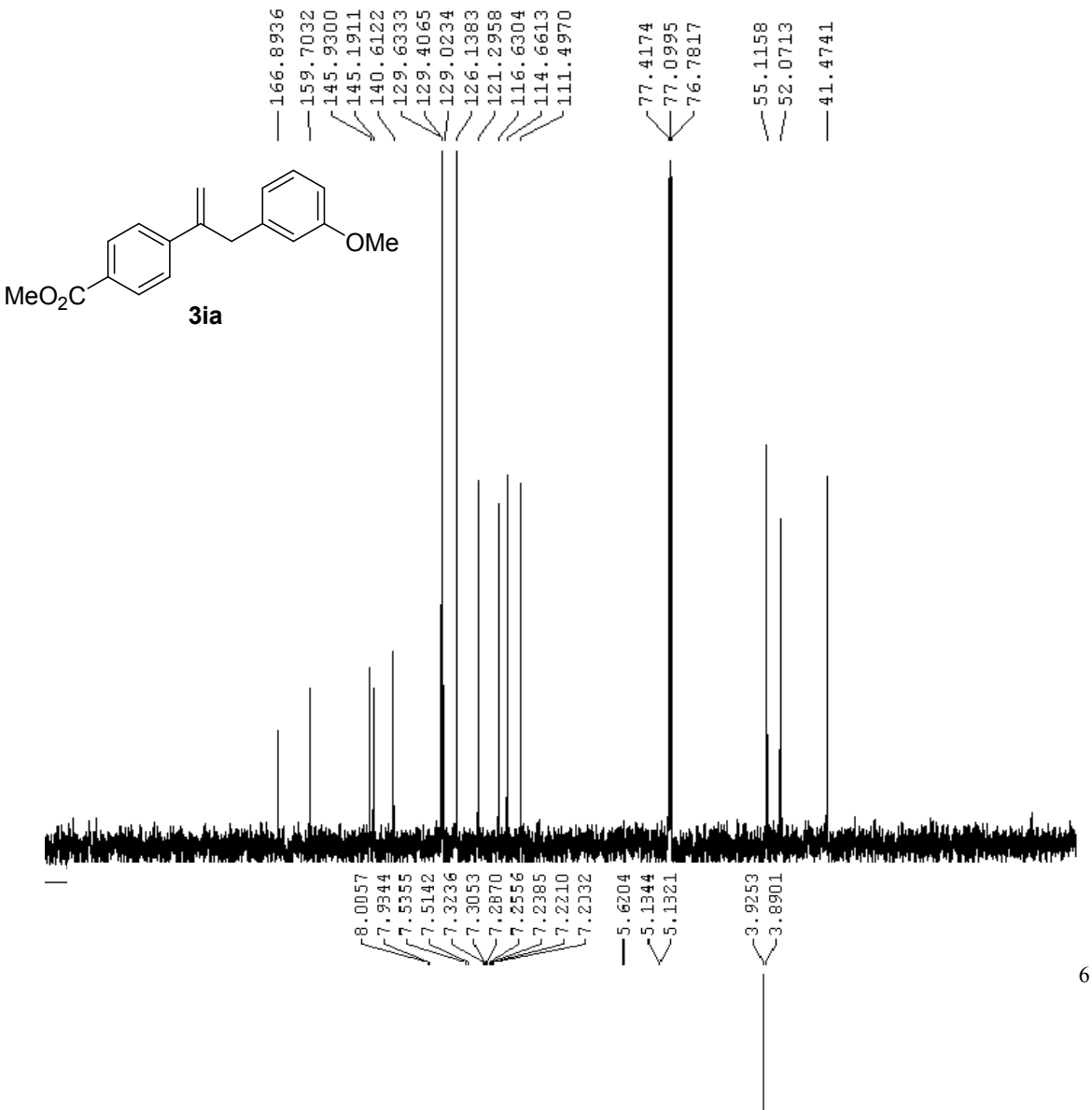
3.7818


OMe
MeO2C

**3ia**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129.4065
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116.6304
114.6613
111.4970
77.4174
77.0995
76.7817
55.1158
52.0713
41.4741
OMe
MeO2C
8.0057
7.9344
7.5355
7.5142
7.3236
7.3053
7.2870
7.2556
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7.2210
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5.1321
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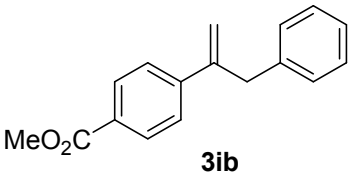
3.8901

**3ia**


MeO2C

**3ib**


MeO2C
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138.9887
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126.1618
116.5292
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77.1042
76.7862
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41.4746
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8.0632
8.0433
7.9846
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7.5565
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7.2838
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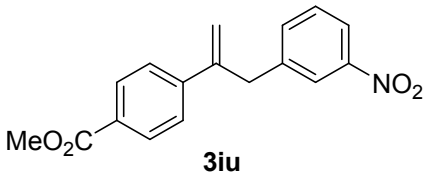
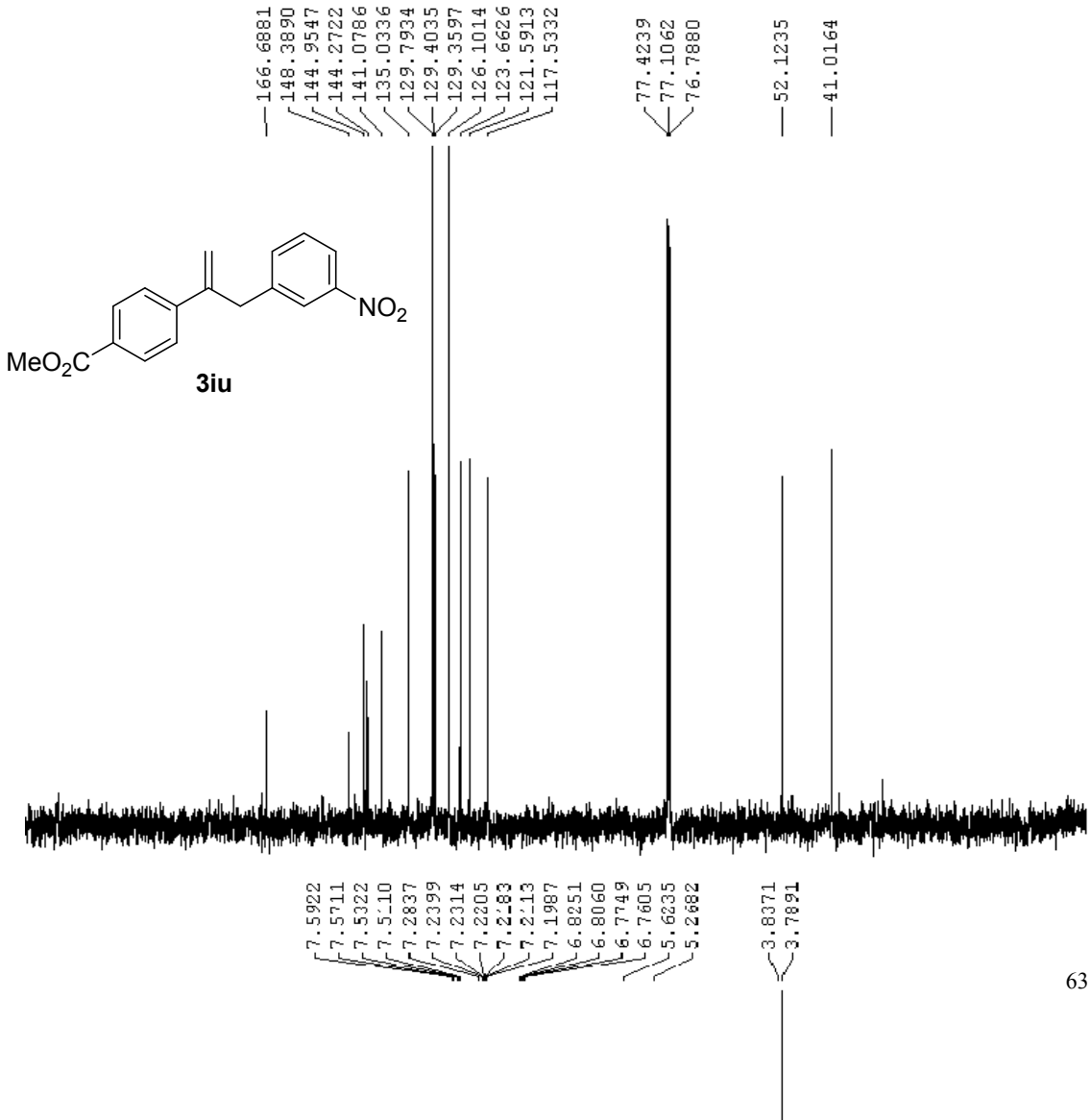
5.2171
3.9758
3.9054

**3ib**


NO2
MeO2C

**3iu**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129.7934
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123.6626
121.5913
117.5332
77.4239
77.1062
76.7880
52.1235
41.0164
NO2
MeO2C
3iu
7.5922
7.5711
7.5322
7.5110
7.2837
7.2399
7.2314
7.2205
7.2083
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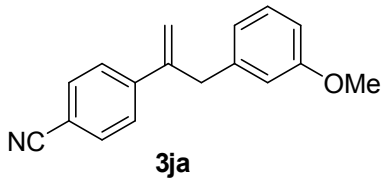
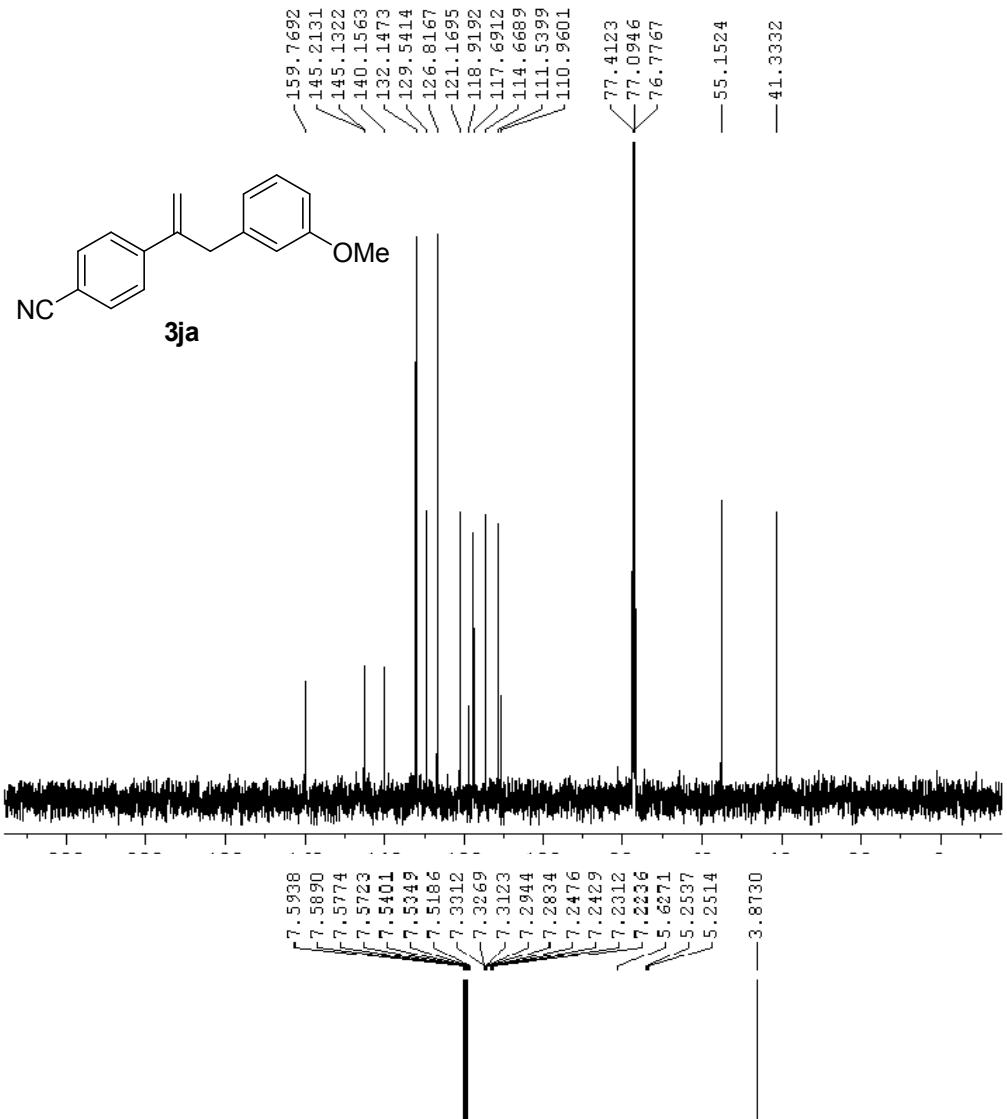
3.7891


OMe
NC

**3ja**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114.6689
111.5399
110.9601
77.4123
77.0946
76.7767
55.1524
41.3332
OMe
NC
7.5938
7.5890
7.5774
7.5723
7.5401
7.5349
7.5186
7.3312
7.3269
7.3123
7.2944
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7.2236
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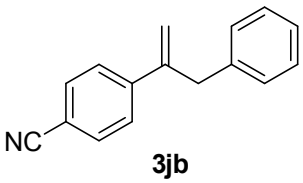
3.8730

**3ja**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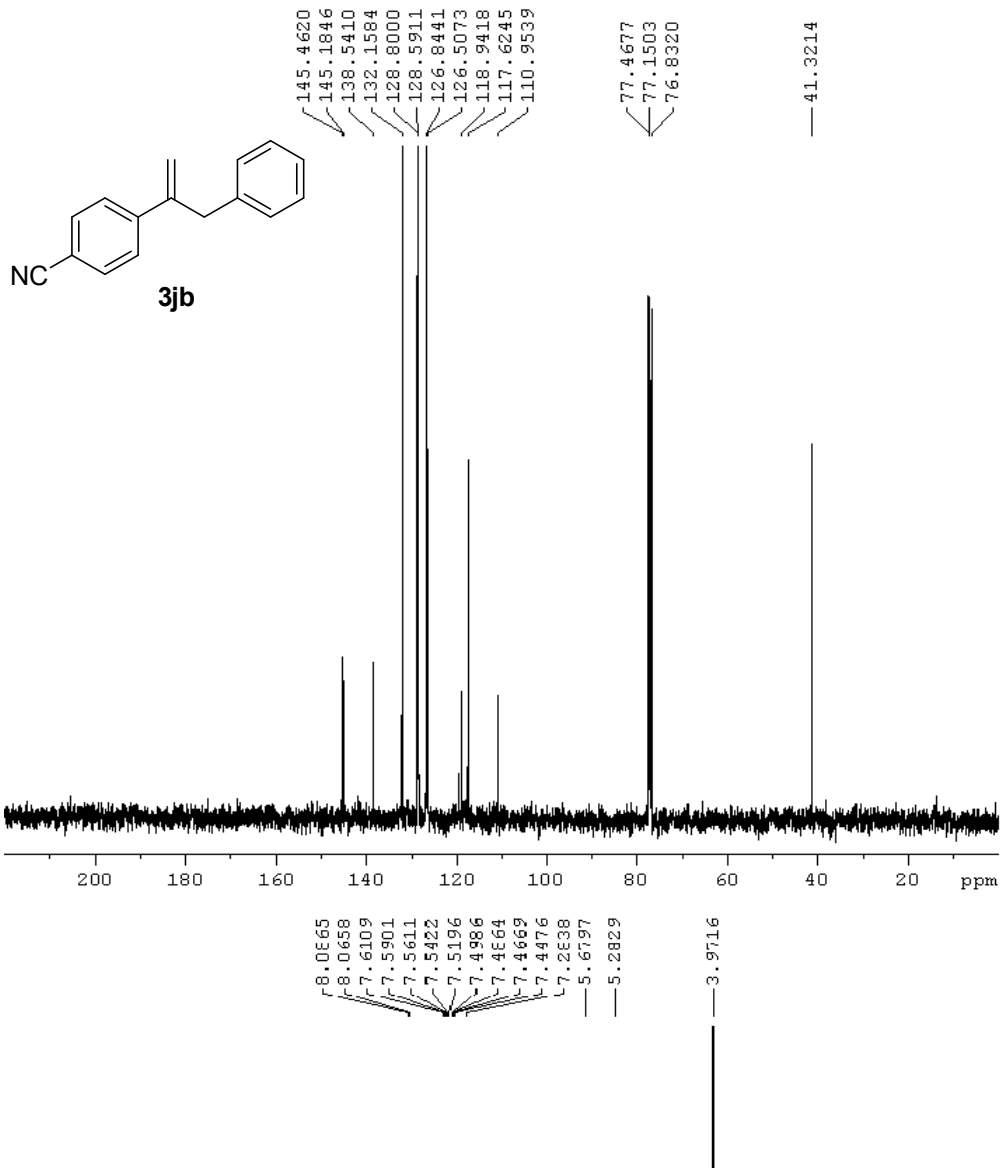
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77.1503
76.8320
41.3214
NC
3jb
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180
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140
120
100
80
60
40
20
ppm
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8.0658
7.6109
7.5901
7.5611
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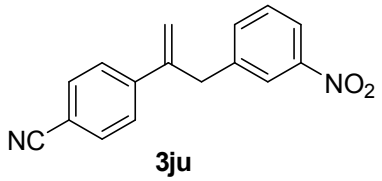
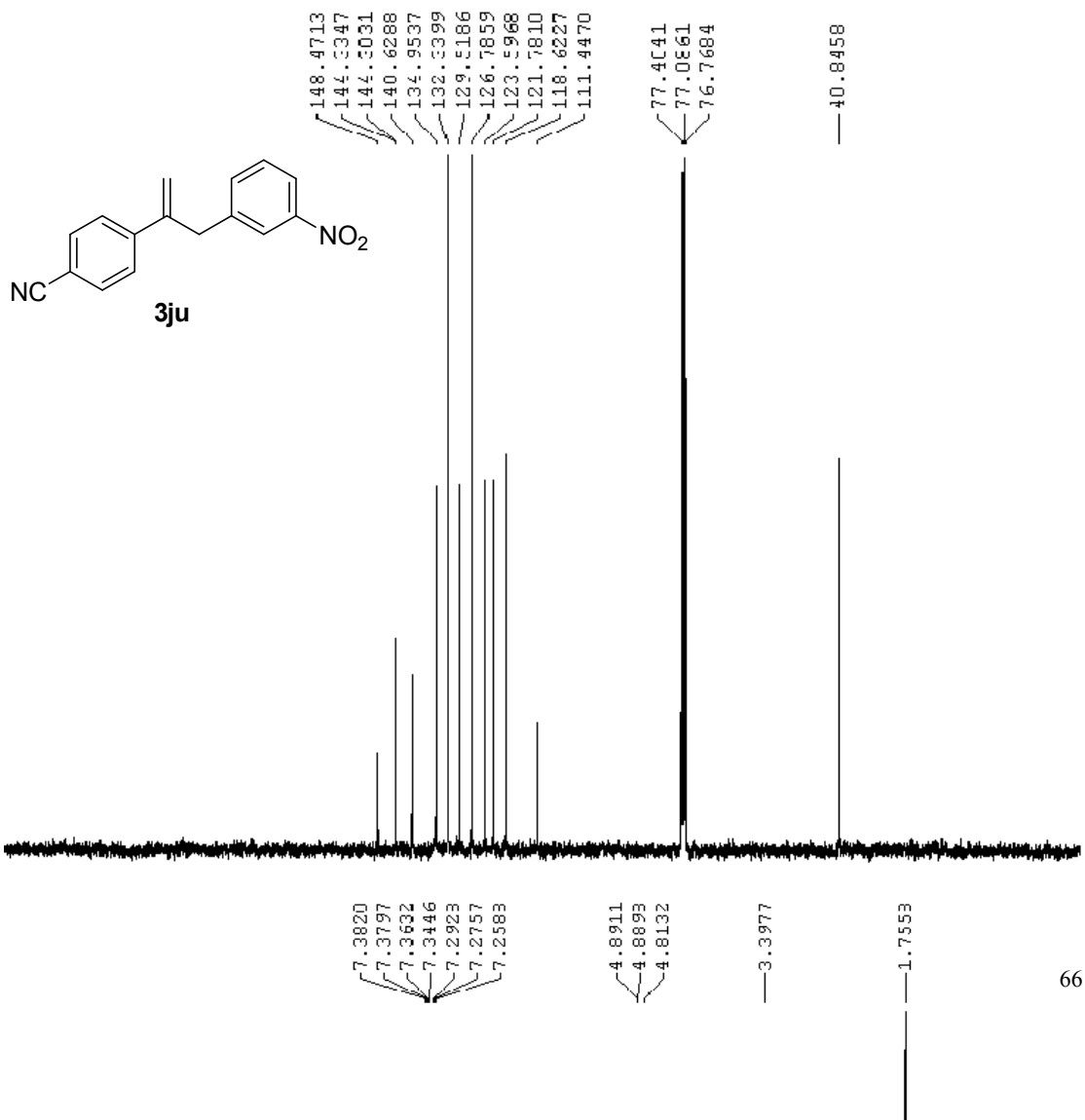
5.2829
3.9716


NC
NO2

**3ju**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132.3399
129.5186
126.7859
123.5968
121.7810
118.6227
111.4470
77.4041
77.0661
76.7684
40.8458
7.3820
7.3797
7.3632
7.3446
7.2923
7.2757
7.2583
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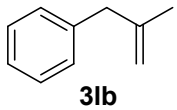
4.8893
4.8132
3.3977
1.7553
NC
NO2

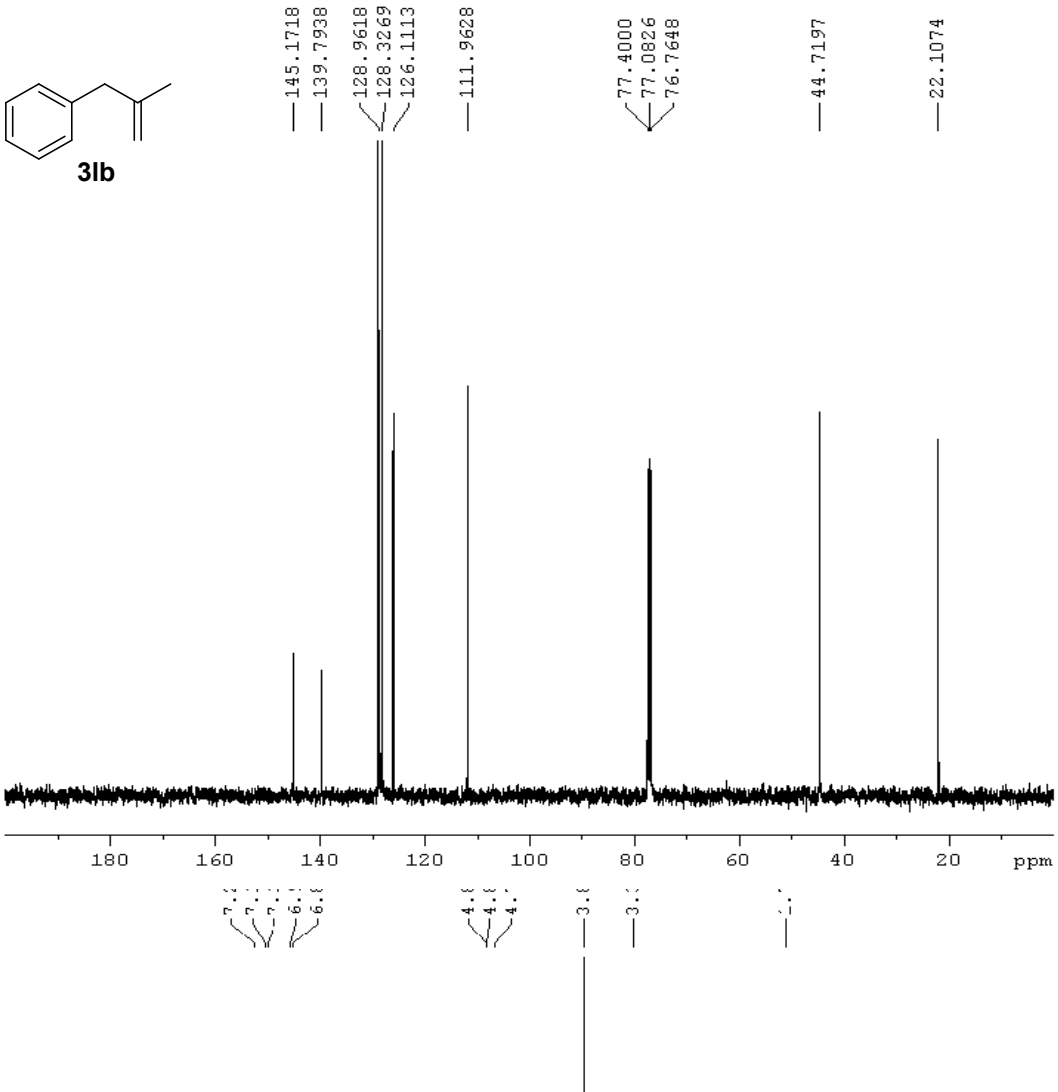
**3ju**



**3lb**



**3lb**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126.1113
111.9628
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22.1074
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140
120
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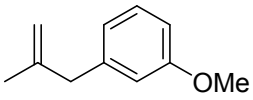
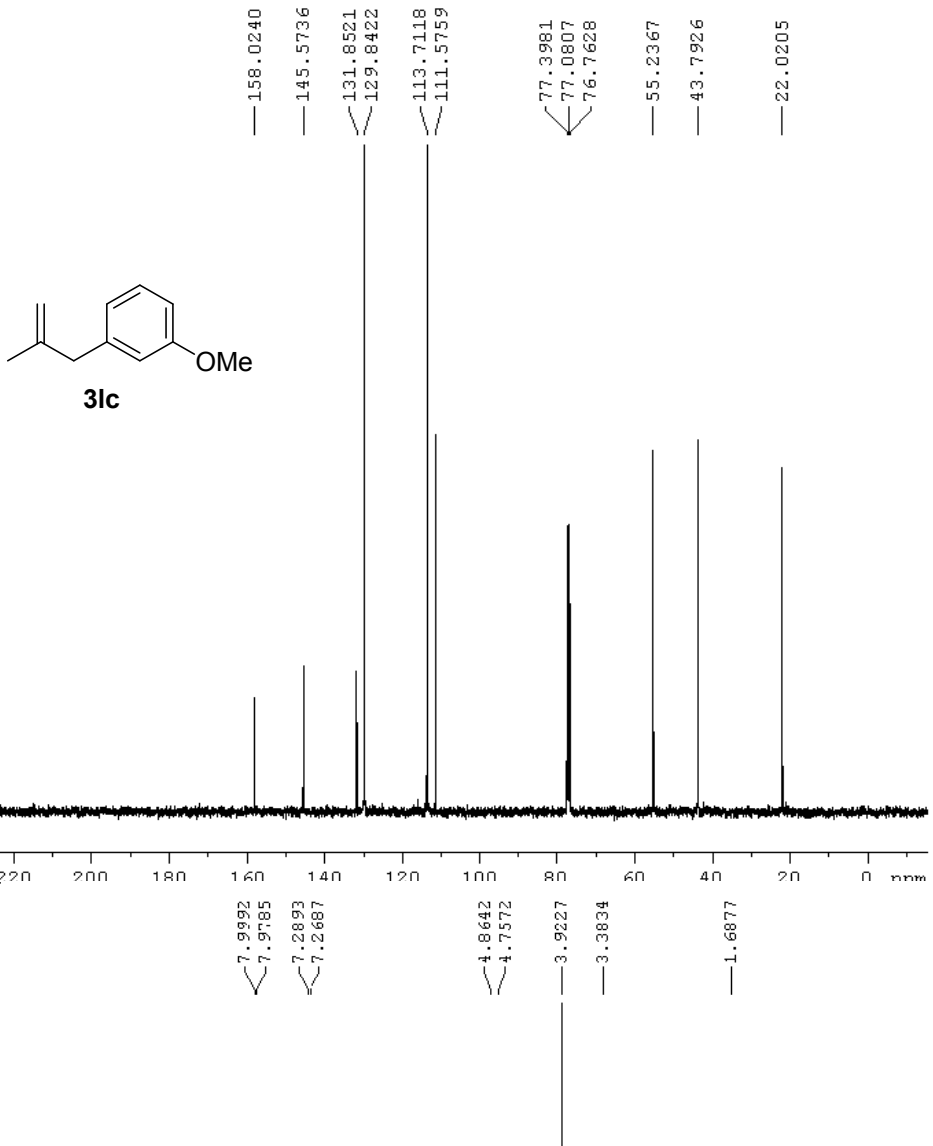
80
60
40
20
ppm


OMe

**3Ic**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76.7628
55.2367
43.7926
22.0205
OMe
3Ic
220
200
180
160
140
120
100
80
60
40
20
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3.3834
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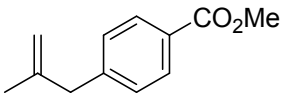
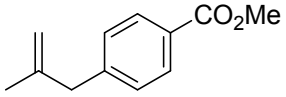
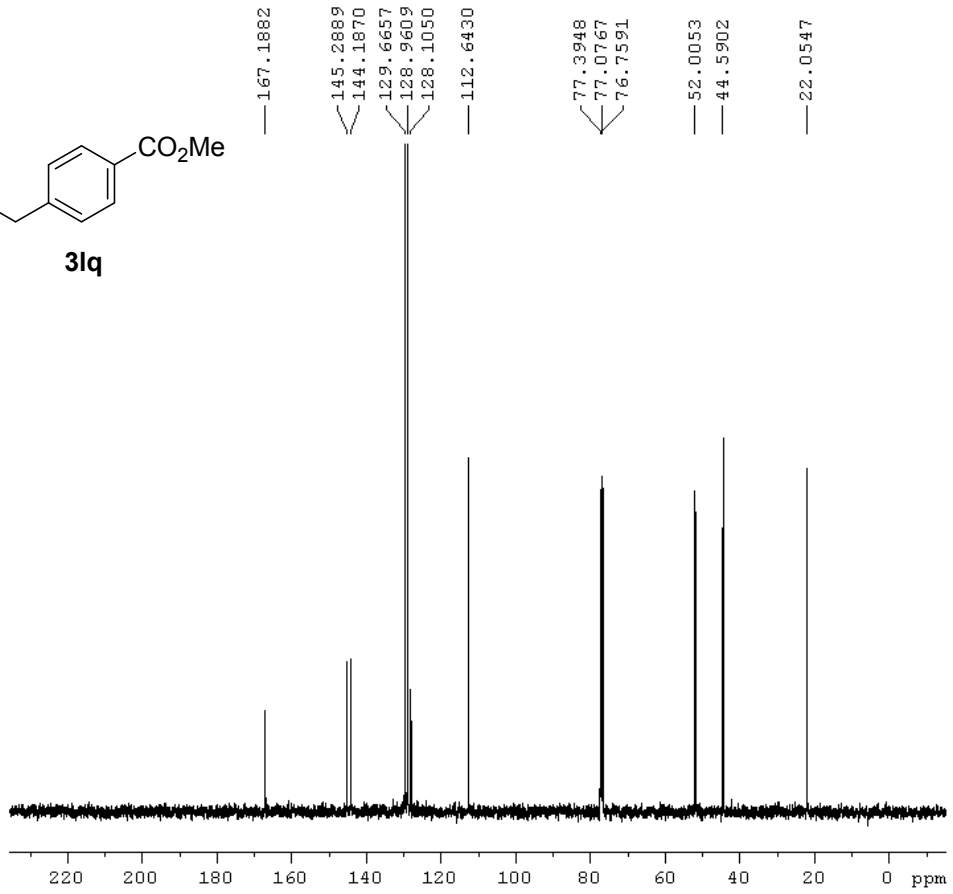

CO2Me

**3Iq**


CO2Me

**3Iq**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112.6430
77.3948
77.0767
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22.0547
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200
180
160
140
120
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80
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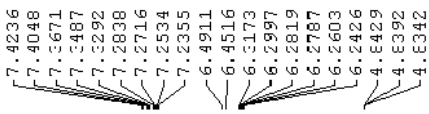
40
20
0
ppm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7.2716
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7.2355
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6.4516
6.3173
6.2997
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6.2603
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4.1342
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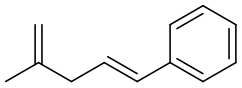
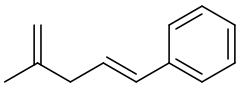
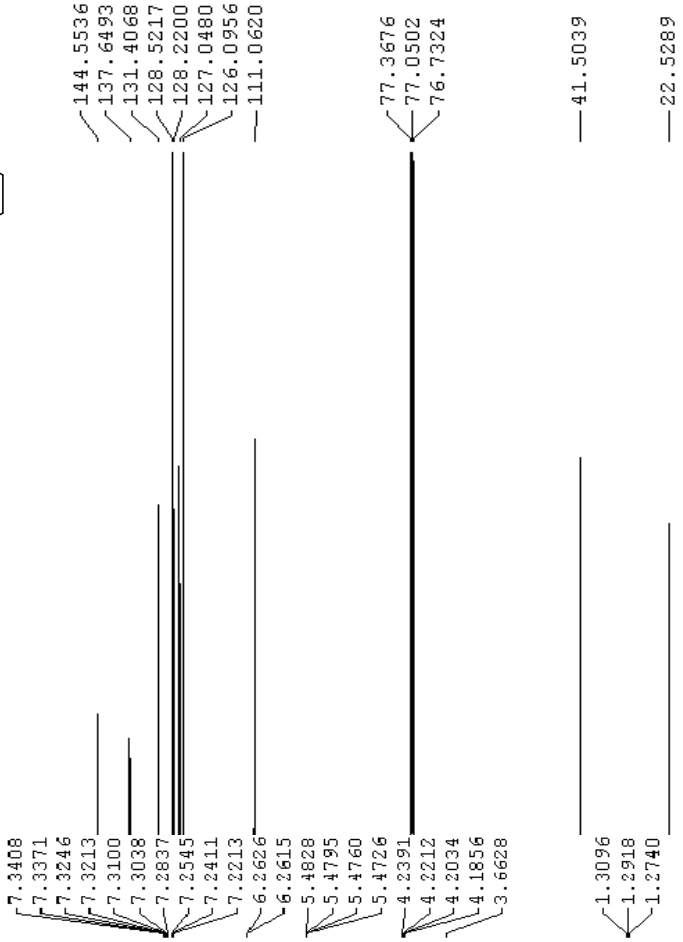
2.9440
1.1236



**3lx**



**3lx**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41.5039
22.5289
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7.3371
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7.3100
7.3038
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7.2545
7.2411
7.2213
6.2626
6.2615
5.4828
5.4795
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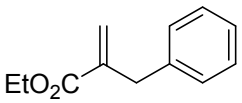
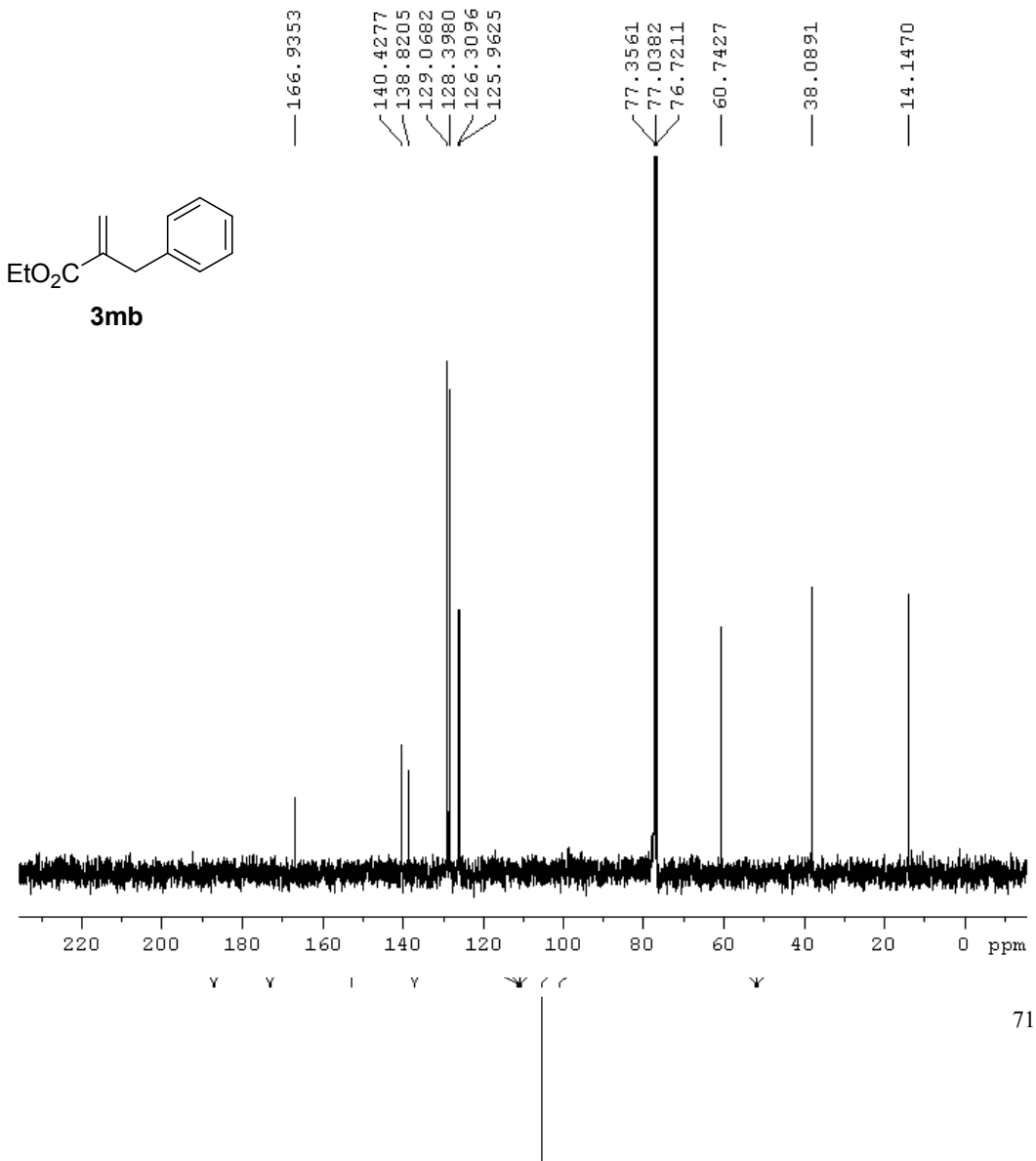
1.2740



**3mb**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76.7211
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160
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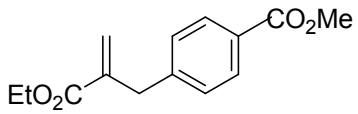
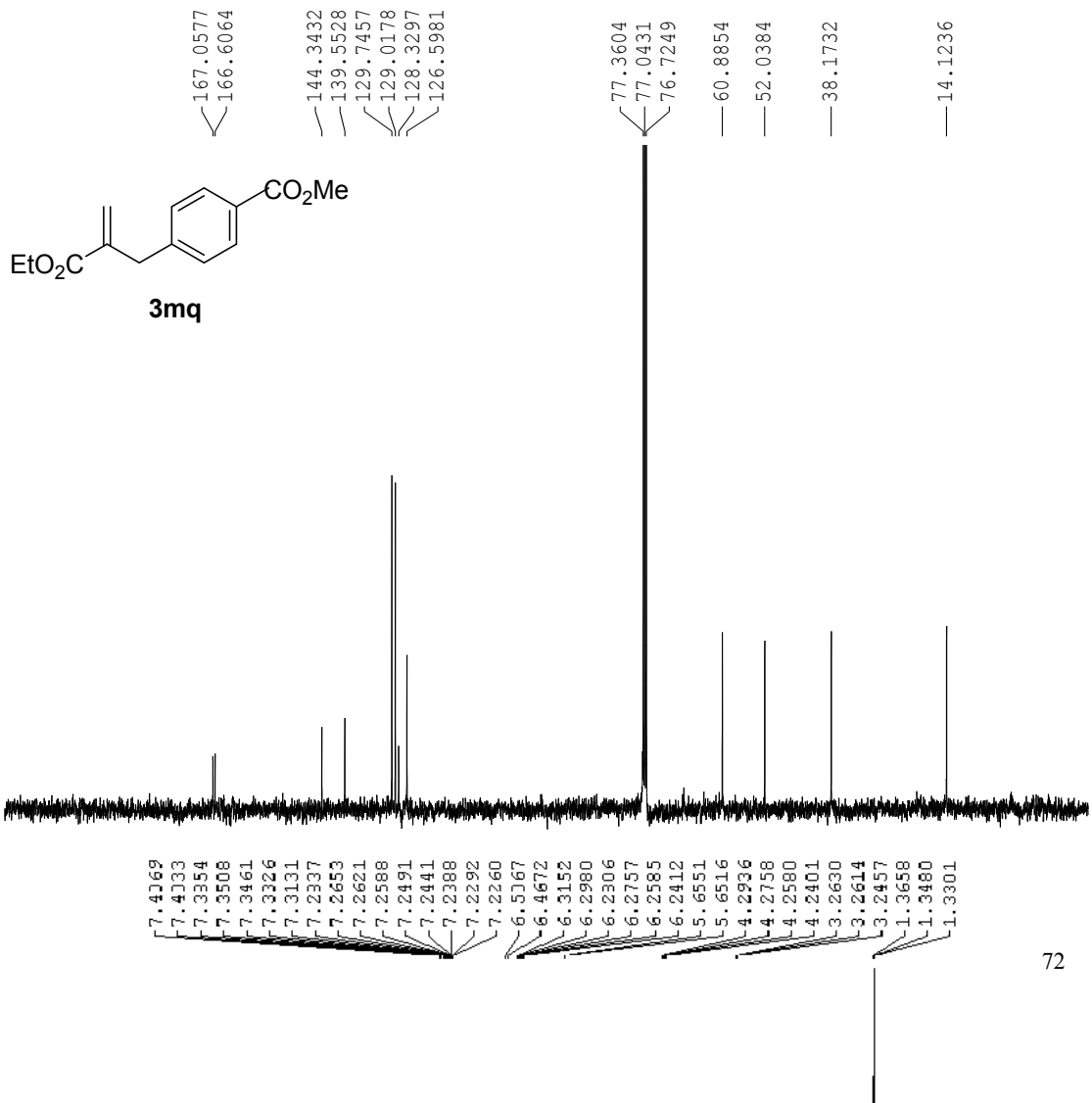
80
60
40
20
0
ppm

**3mb**


CO2Me
EtO2C

**3mq**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128.3297
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77.0431
76.7249
60.8854
52.0384
38.1732
14.1236
CO2Me
EtO2C
3mq
7.4169
7.4133
7.3354
7.3508
7.3461
7.3326
7.3131
7.2337
7.2653
7.2621
7.2588
7.2491
7.2441
7.2388
7.2292
7.2260
6.5167
6.4672
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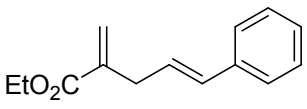
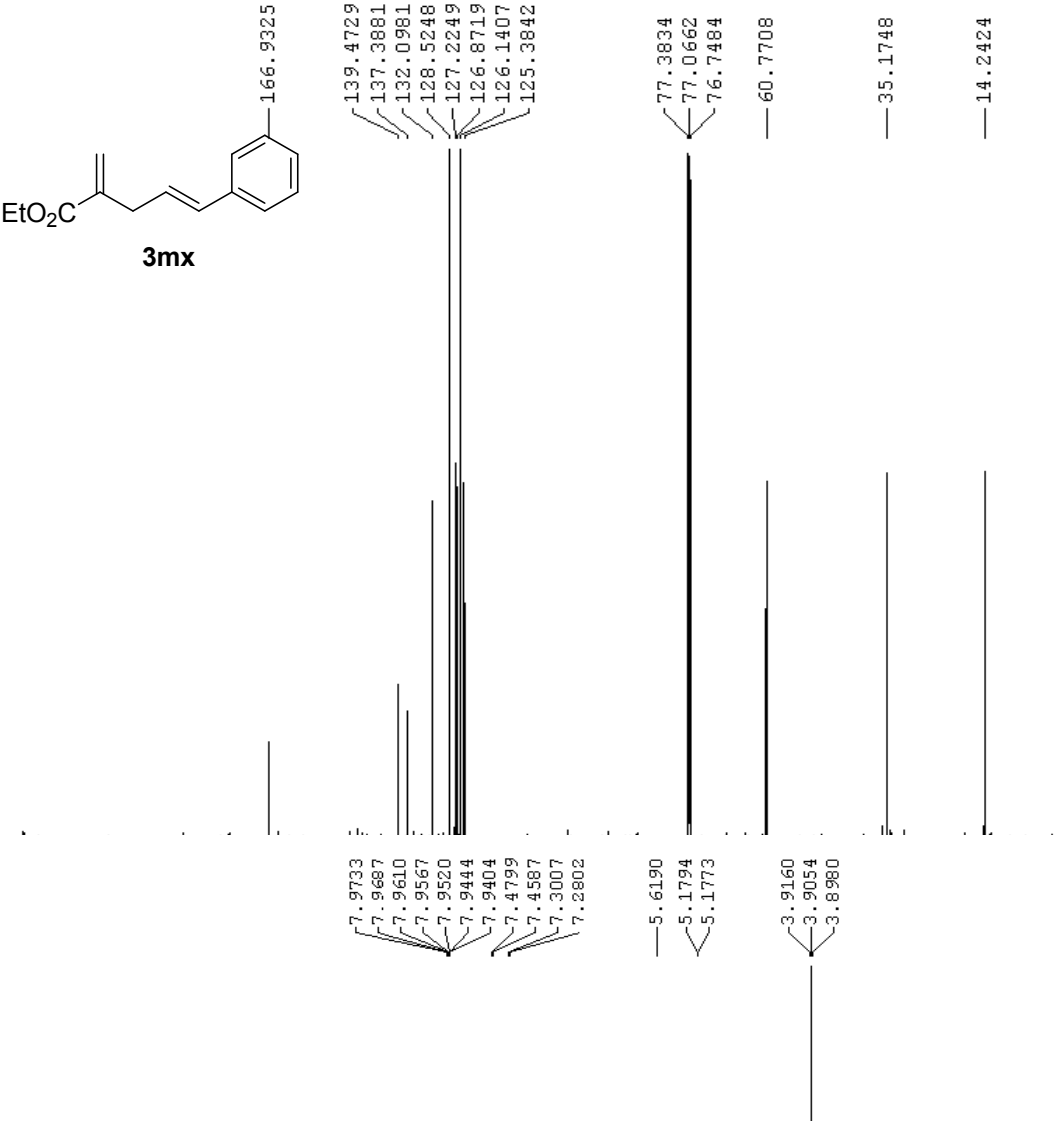
1.3301



**3mx**



**3mx**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77.0662
76.7484
60.7708
35.1748
14.2424
7.9733
7.9687
7.9610
7.9567
7.9520
7.9444
7.9404
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7.3007
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5.6190
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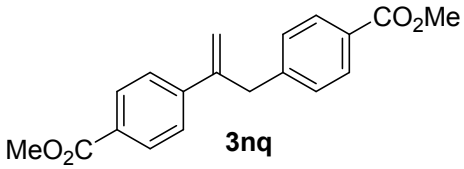
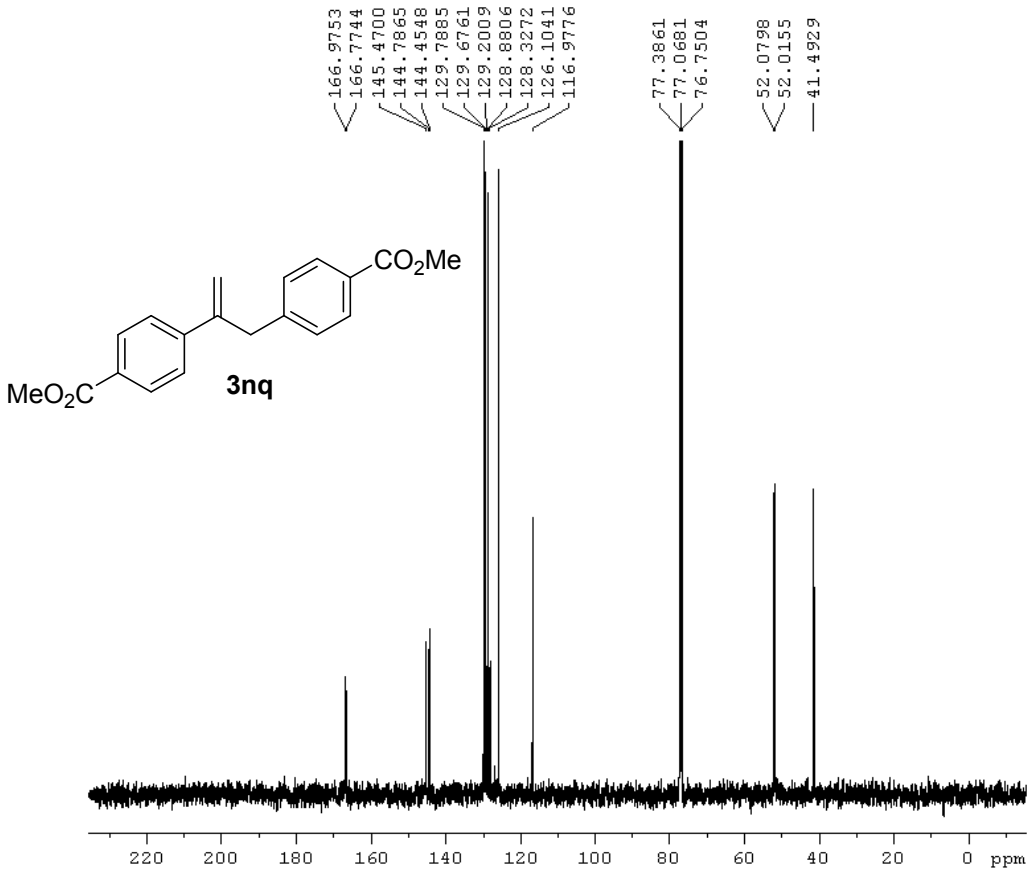
5.1773
3.9160
3.9054
3.8980


CO2Me
MeO2C

**3nq**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128.8806
128.3272
126.1041
116.9776
77.3861
77.0681
76.7504
52.0798
52.0155
41.4929
CO2Me
MeO2C
220
200
180
160
140
120
100
80
60
40
20
0
ppm

**3nq**