Supporting Information

Synthesis of Quinolines *via* Sequential Addition and I_2-Mediated Desulfurative Cyclization

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contents

1. General information.

All reagents were purchased from commercial sources and were used as received unless mentioned otherwise. Substrates 1,3-ynones were synthesized using the method developed by our group. (Ziwei Gao *et.al. Org. Lett.* **2015**, *17*, 3298−3301). Solvents were of AR and the reactions were monitored by TLC (thin layer chromatography). All procedures were carried out under open atmosphere with no precautions taken to exclude ambient moisture. Purification of the reaction products was carried out by flash chromatography on silica gel (200–300 mesh). Chemical yields refer to pure isolated substances. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker EQUINX55 (400 MHz for ^{1}H; 101 MHz for ^{13}C) spectrometer by using $CDCl_3$ as a solvent. For ^{1}H NMR, tetramethyl silane (TMS) served as internal standard (δ = 0) and ^{1}H NMR chemical shifts are reported in ppm downfield of tetramethyl silane and referenced to residual solvent peak ($CDCl_3$ at 7.26 ppm) unless otherwise noted. The data are reported as following: chemical shift, integration, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet and *m* = multiple), and coupling constant in Hz. For ^{13}C NMR, $CDCl_3$ -d_1 was used as internal standard (δ = 77.0 ppm) and spectra were obtained with complete proton decoupling. ESI-MS measurement was performed in the positive-ion mode (*m/z* 50−2500 range) on a MAXIS instrument from Bruker. This instrument has a hybrid quadrupole/ion mobility/orthogonal acceleration time-of-flight (oa-TOF) geometry and was used in the TOF V+ mode. All samples were dissolved in methanol and were directly infused into the ESI source at a flow rate of 4.0 mL/min after 1 min at 180 °C. ESI source conditions were as follows: capillary voltage 4.0 kV, nebulizer 0.4 bar, scan begin 100 *m/z*, scan end 1300 *m/z*, collision cell RF 200.0 Vpp, end plate offset -500 V.

2. ESI(+)-MS spectra of organometallic zirconocene complexes.

Organometallic zirconocene complexes were detected in the catalytic system.

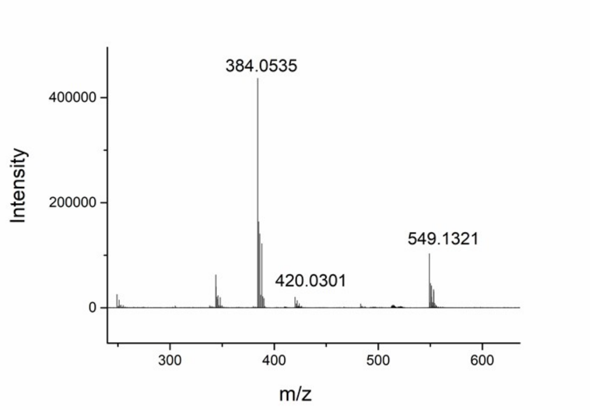


Figure S1. ESI(+)-MS spectra of the catalytic system.

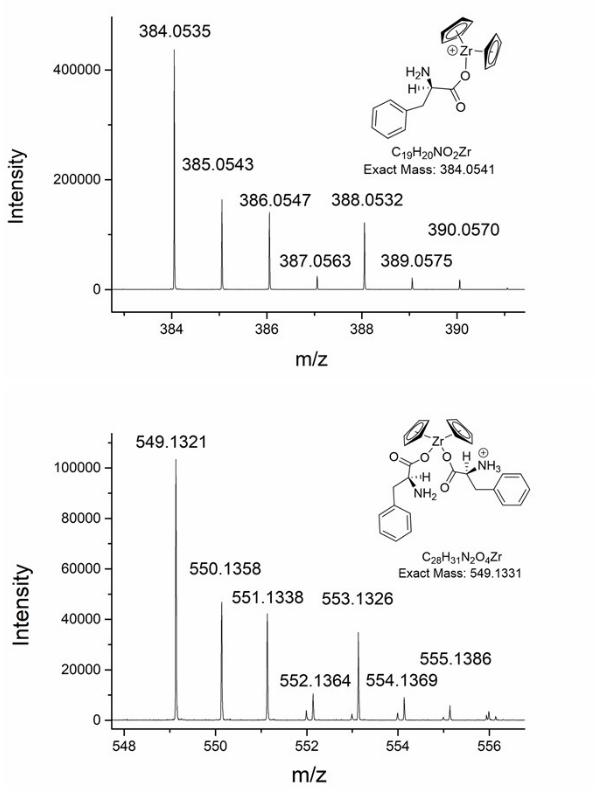
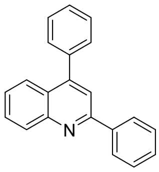
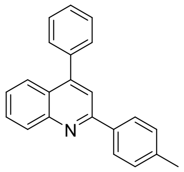


Figure S2. ESI(+)-MS spectra of organometallic zirconocene complexes.

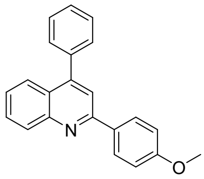
3. Experimental and characterization data of quinolines.



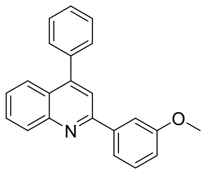
2,4-diphenylquinoline, **(3a)** (white solid, 129 mg, 92%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.24 (d, *J* = 8.4 Hz, 1H), 8.17 (d, *J* = 7.4 Hz, 2H), 7.87 (d, *J* = 8.4 Hz, 1H), 7.78 (s, 1H), 7.69 (t, *J* = 7.5 Hz, 1H), 7.54 – 7.45 (m, 7H), 7.42 (t, *J* = 7.3 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.9, 149.2, 148.9, 139.7, 138.5, 130.2, 129.6, 129.6, 129.4, 128.9, 128.6, 128.5, 127.7, 126.4, 125.8, 125.7, 119.4. J. Heterocyclic Chem. 2011, 48, 153-157.



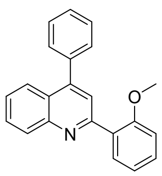
4-phenyl-2-(p-tolyl)quinoline, **(3b)** (white solid, 124 mg, 84%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.10 (d, *J* = 8.5 Hz, 1H), 7.96 (d, *J* = 8.2 Hz, 2H), 7.73 (dd, *J* = 8.4, 1.4 Hz, 1H), 7.64 (s, 1H), 7.54 (ddd, *J* = 8.2, 6.8, 1.5 Hz, 1H), 7.41 – 7.30 (m, 5H), 7.27 (ddd, *J* = 8.3, 6.8, 1.3 Hz, 1H), 7.16 (d, *J* = 7.9 Hz, 2H), 2.26 (s, 3H).^{13}C NMR (101 MHz, $CDCl_3$) δ 156.9, 149.1, 148.9, 139.5, 138.6, 136.9, 130.1, 129.6, 129.5, 128.6, 128.4, 127.5, 126.2, 125.8, 125.7, 119.2, 21.4. J. Heterocyclic Chem. 2011, 48, 153-157.



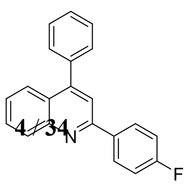
2-(4-methoxyphenyl)-4-phenylquinoline, **(3c)** (pale yellow solid, 97 mg, 62%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.14 (dd, *J* = 8.5, 1.1 Hz, 1H), 8.12 – 8.08 (m, 2H), 7.82 – 7.79 (m, 1H), 7.71 (s, 1H), 7.64 (ddd, *J* = 8.4, 6.8, 1.5 Hz, 1H), 7.51 – 7.46 (m, 4H), 7.45 (d, *J* = 2.9 Hz, 1H), 7.37 (ddd, *J* = 8.3, 6.8, 1.3 Hz, 1H), 6.99 – 6.96 (m, 2H), 3.82 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.8, 155.4, 148.0, 147.8, 137.5, 131.2, 128.9, 128.5, 128.4, 127.9, 127.5, 127.3, 124.9, 124.6, 124.5, 117.9, 113.2, 54.4. J. Heterocyclic Chem. 2011, 48, 153-157.



2-(3-methoxyphenyl)-4-phenylquinoline, **(3d)** (pale yellow solid, 145 mg, 93%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.20 – 8.13 (m, 1H), 7.81 (dd, *J* = 8.4, 1.4 Hz, 1H), 7.71 (s, 2H), 7.67 – 7.61 (m, 2H), 7.49 – 7.40 (m, 5H), 7.40 – 7.30 (m, 2H), 6.93 (dd, *J* = 8.2, 2.6 Hz, 1H), 3.83 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 160.2, 156.7, 149.2, 148.8, 141.2, 138.4, 130.2, 129.8, 129.6, 129.6, 128.6, 128.4, 126.4, 125.9, 125.7, 120.1, 119.5, 115.5, 112.7, 55.5. ChemistrySelect 2019, 4, 8493-8499.

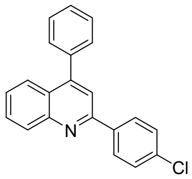


2-(2-methoxyphenyl)-4-phenylquinoline, **(3e)** (pale yellow solid, 131 mg, 84%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.24 (d, *J* = 8.4 Hz, 1H), 7.93 – 7.86 (m, 2H), 7.83 (s, 1H), 7.68 (t, *J* = 7.5 Hz, 1H), 7.54 (d, *J* = 7.0 Hz, 2H), 7.50 (t, *J* = 7.2 Hz, 2H), 7.47 – 7.41 (m, 2H), 7.41 – 7.36 (m, 1H), 7.12 (t, *J* = 7.5 Hz, 1H), 6.99 (d, *J* = 8.3 Hz, 1H), 3.80 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.3, 156.8, 148.9, 147.4, 138.6, 131.6, 130.4, 130.1, 129.8, 129.8, 129.1, 128.6, 128.3, 126.3, 125.7, 125.6, 123.7, 121.3, 111.5, 55.7. ChemistrySelect 2019, 4, 8493-8499.

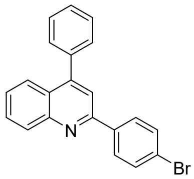


2-(4-fluorophenyl)-4-phenylquinoline, **(3f)** (pale yellow solid, 135 mg, 90%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.16 – 8.06 (m, 3H), 7.83 – 7.77

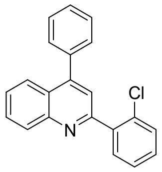
(m, 1H), 7.69 – 7.60 (m, 2H), 7.49 – 7.40 (m, 5H), 7.38 (ddd, J = 8.2, 6.8, 1.3 Hz, 1H), 7.11 (t, J = 8.7 Hz, 2H).^{13}C NMR (101 MHz, $CDCl_3$) δ 165.1, 162.6, 155.8, 149.4, 148.8, 138.3, 135.8, 135.8, 130.0, 129.7, 129.6, 129.5, 129.4, 128.6, 128.5, 126.4, 125.7, 125.7, 119.0, 115.9, 115.7. Heterocycles 2011, 83, 331-338.



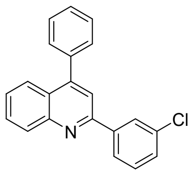
2-(4-chlorophenyl)-4-phenylquinoline, **(3g)** (pale yellow solid, 133 mg, 84%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.12 (d, J = 8.4 Hz, 1H), 8.05 (d, J = 8.4 Hz, 2H), 7.80 (d, J = 8.3 Hz, 1H), 7.68 – 7.60 (m, 2H), 7.48 – 7.41 (m, 5H), 7.38 (d, J = 8.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.5, 149.4, 148.8, 138.3, 138.0, 135.6, 130.1, 129.7, 129.6, 129.0, 128.8, 128.7, 128.5, 126.6, 125.8, 125.7, 118.9. J. Heterocyclic Chem. 2011, 48, 153-157.



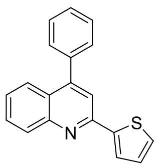
2-(4-bromophenyl)-4-phenylquinoline, **(3h)** (pale yellow solid, 144 mg, 80%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.12 (d, J = 8.4 Hz, 1H), 7.97 (d, J = 8.3 Hz, 2H), 7.79 (d, J = 8.3 Hz, 1H), 7.66 (s, 1H), 7.62 (t, J = 7.9 Hz, 1H), 7.53 (d, J = 8.3 Hz, 2H), 7.46 – 7.39 (m, 5H), 7.36 (d, J = 7.5 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.5, 148.3, 147.7, 137.4, 137.2, 130.9, 129.0, 128.6, 128.5, 128.0, 127.6, 127.4, 125.5, 124.8, 124.6, 122.9, 117.8. J. Heterocyclic Chem. 2011, 48, 153-157.



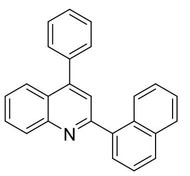
2-(2-chlorophenyl)-4-phenylquinoline, **(3i)** (pale yellow solid, 101 mg, 64%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.15 (d, J = 8.4 Hz, 1H), 7.85 (d, J = 8.4 Hz, 1H), 7.63 (d, J = 7.4 Hz, 2H), 7.59 (s, 1H), 7.44 (d, J = 6.8 Hz, 2H), 7.46 – 7.43 (m, 5H), 7.42 – 7.35 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.9, 147.6, 147.0, 138.5, 137.0, 131.3, 130.7, 129.0, 129.0, 128.8, 128.6, 128.5, 127.5, 127.4, 126.1, 125.7, 124.6, 124.6, 121.9. J. Heterocyclic Chem. 2011, 48, 153-157.



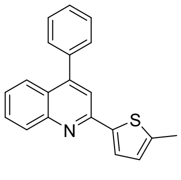
2-(3-chlorophenyl)-4-phenylquinoline, **(3j)** (pale yellow solid, 128 mg, 81%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.23 – 8.07 (m, 2H), 7.98 (dt, J = 6.6, 1.9 Hz, 1H), 7.85 – 7.78 (m, 1H), 7.71 – 7.62 (m, 2H), 7.49 – 7.41 (m, 5H), 7.41 – 7.32 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.2, 148.5, 147.7, 140.4, 137.1, 133.9, 129.1, 129.0, 128.7, 128.5, 128.3, 127.6, 127.5, 126.7, 125.6, 124.9, 124.6, 124.6, 118.0. J. Heterocyclic Chem. 2011, 48, 153-157.



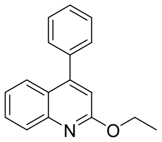
4-phenyl-2-(thiophen-2-yl)quinoline, **(3k)** (pale yellow solid, 105 mg, 73%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.05 (d, J = 8.4 Hz, 1H), 7.73 (d, J = 8.3 Hz, 1H), 7.62 (s, 2H), 7.58 (t, J = 7.8 Hz, 1H), 7.42 (d, J = 8.3 Hz, 5H), 7.36 (d, J = 4.9 Hz, 1H), 7.32 (t, J = 7.6 Hz, 1H), 7.06 – 7.01 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 151.9, 149.1, 148.7, 145.4, 138.2, 129.7, 129.7, 129.5, 128.6, 128.6, 128.5, 128.1, 126.2, 125.9, 125.9, 125.7, 117.9. Heterocycles 2011, 83, 331-338.



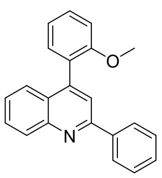
2-(naphthalen-1-yl)-4-phenylquinoline, **(3l)** (white solid, 83 mg, 50%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.20 (d, *J* = 8.4 Hz, 1H), 8.13 (d, *J* = 7.9 Hz, 1H), 7.90 (d, *J* = 8.4 Hz, 1H), 7.81 (t, *J* = 7.5 Hz, 2H), 7.65 (t, *J* = 7.1 Hz, 2H), 7.55 (s, 1H), 7.49 – 7.44 (m, 3H), 7.43 – 7.33 (m, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.1, 148.8, 148.7, 138.7, 138.1, 134.1, 131.4, 130.2, 129.7, 129.2, 128.7, 128.5, 128.5, 127.9, 126.7, 126.7, 126.0, 125.8, 125.8, 125.6, 125.4, 123.5. Chem-Eur. J. 2009, 15, 6332-6334.



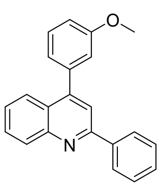
2-(5-methylthiophen-2-yl)-4-phenylquinoline, **(3m)** (pale yellow solid, 95 mg, 63%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.97 (d, *J* = 8.4 Hz, 1H), 7.64 (d, *J* = 8.3 Hz, 1H), 7.49 (d, *J* = 10.1 Hz, 2H), 7.37 – 7.27 (m, 6H), 7.21 (t, *J* = 7.5 Hz, 1H), 6.63 – 6.58 (m, 1H), 2.37 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 150.9, 147.6, 147.5, 142.5, 141.8, 137.1, 128.4, 128.4, 127.4, 127.3, 125.3, 125.0, 124.7, 124.5, 124.5, 116.4, 14.6. US20140346446 A1 2014-11-27.



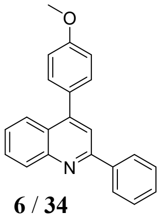
2-ethoxy-4-phenylquinoline, **(3n)** (yellow oil, 105 mg, 84%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.15 (d, *J* = 7.4 Hz, 2H), 7.07 (d, *J* = 7.2 Hz, 4H), 6.89 (d, *J* = 8.0 Hz, 1H), 6.41 (t, *J* = 8.8 Hz, 2H), 6.07 (s, 1H), 4.30 (m, 2H), 1.36 – 1.31 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.1, 160.7, 148.7, 138.0, 137.4, 130.6, 128.4, 128.3, 127.4, 117.9, 116.3, 114.8, 114.3, 60.3, 14.4. Eur. J. Org. Chem. 2012, 5803–5809.



4-(2-methoxyphenyl)-2-phenylquinoline, **(3o)** (pale yellow solid, 154 mg, 99%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.15 (d, *J* = 8.5 Hz, 1H), 8.10 (d, *J* = 7.9 Hz, 2H), 7.73 (s, 1H), 7.61 (t, *J* = 7.6 Hz, 1H), 7.52 (d, *J* = 8.3 Hz, 1H), 7.47 – 7.30 (m, 5H), 7.24 (d, *J* = 7.3 Hz, 1H), 7.02 (dd, *J* = 18.5, 7.9 Hz, 2H), 3.63 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.8, 155.8, 147.4, 145.5, 138.8, 130.3, 128.9, 128.9, 128.3, 128.2, 127.7, 126.6, 126.1, 125.4, 125.1, 124.9, 119.7, 119.2, 110.1, 54.5. Org. Lett. 2008, 10, 4117–4120.

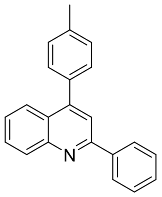


4-(3-methoxyphenyl)-2-phenylquinoline, **(3p)** (pale yellow solid, 146 mg, 94%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.14 (d, *J* = 8.4 Hz, 1H), 8.08 (d, *J* = 7.5 Hz, 2H), 7.82 (d, *J* = 8.4 Hz, 1H), 7.71 (s, 1H), 7.60 (t, *J* = 7.6 Hz, 1H), 7.40 (t, *J* = 7.4 Hz, 2H), 7.33 (dd, *J* = 10.0, 5.9 Hz, 3H), 7.02 (d, *J* = 7.5 Hz, 1H), 6.98 (s, 1H), 6.95 – 6.88 (m, 1H), 3.74 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.7, 156.9, 149.1, 148.9, 139.8, 139.7, 130.2, 129.7, 129.6, 129.4, 128.9, 127.6, 126.4, 125.8, 125.7, 122.0, 119.3, 115.3, 113.9, 55.4. RSC Adv. 2015, 5, 88214-88217.

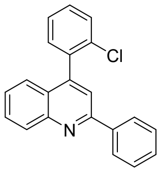


4-(4-methoxyphenyl)-2-phenylquinoline, **(3q)** (pale yellow solid, 154 mg, 99%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.15 (d, *J* = 8.4 Hz, 1H), 8.10 (d, *J* = 7.4 Hz, 2H), 7.85 (d, *J* = 8.4 Hz, 1H), 7.70 (s, 1H), 7.63 (t, *J* = 7.6 Hz, 1H), 7.46 – 7.34 (m, 6H), 6.98 (d, *J* = 8.5 Hz, 2H), 3.80 (s, 3H). ^{13}C NMR

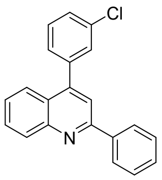
(101 MHz, $CDCl_3$) δ 158.8, 155.9, 147.8, 138.7, 129.8, 129.6, 129.1, 128.4, 128.2, 127.8, 126.5, 125.2, 124.9, 124.6, 118.3, 113.0, 54.4. RSC Adv. 2015, 5, 88214-88217.



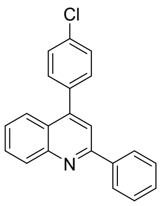
2-phenyl-4-(p-tolyl)quinoline, **(3r)** (pale yellow solid, 145 mg, 98%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.13 (d, *J* = 8.5 Hz, 1H), 8.10 – 8.03 (m, 2H), 7.80 (dd, *J* = 8.4, 1.3 Hz, 1H), 7.67 (s, 1H), 7.58 (ddd, *J* = 8.3, 6.8, 1.4 Hz, 1H), 7.39 (t, *J* = 7.5 Hz, 2H), 7.36 – 7.28 (m, 4H), 7.21 (d, *J* = 7.7 Hz, 2H), 2.33 (s, 3H).^{13}C NMR (101 MHz, $CDCl_3$) δ 155.8, 148.1, 147.8, 138.6, 137.2, 134.4, 129.0, 128.4, 128.3, 128.2, 127.7, 126.5, 125.1, 124.8, 124.6, 118.2, 20.2. Adv. Synth. Catal., 2019, 361, 1995-1999



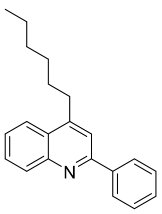
4-(2-chlorophenyl)-2-phenylquinoline, **(3s)** (pale yellow solid, 137 mg, 87%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.14 (d, *J* = 8.4 Hz, 1H), 8.07 (d, *J* = 7.6 Hz, 2H), 7.67 (s, 1H), 7.58 (ddd, *J* = 8.5, 6.6, 1.6 Hz, 1H), 7.43 (d, *J* = 7.1 Hz, 1H), 7.41 – 7.34 (m, 3H), 7.34 – 7.26 (m, 3H), 7.25 (dd, *J* = 6.1, 3.9 Hz, 2H).^{13}C NMR (101 MHz, $CDCl_3$) δ 155.7, 147.4, 145.4, 138.4, 135.9, 132.2, 130.3, 129.0, 128.8, 128.7, 128.6, 128.3, 127.7, 126.5, 125.7, 125.4, 124.7, 124.5, 118.7. RSC Adv. 2018, 8, 31603-31607.



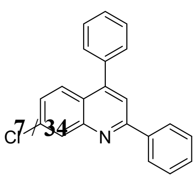
4-(3-chlorophenyl)-2-phenylquinoline, **(3t)** (pale yellow solid, 131 mg, 83%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.09 (d, *J* = 8.5 Hz, 1H), 8.07 – 7.99 (m, 2H), 7.65 (d, *J* = 8.4 Hz, 1H), 7.59 (s, 1H), 7.58 – 7.51 (m, 1H), 7.38 (s, 1H), 7.34 (t, *J* = 7.4 Hz, 2H), 7.31 – 7.20 (m, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.6, 147.6, 146.4, 139.0, 138.2, 133.4, 129.1, 128.7, 128.6, 128.4, 128.3, 127.7, 127.4, 126.6, 126.4, 125.5, 124.2, 124.1, 118.1. RSC Adv. 2018, 8, 31603-31607.



4-(4-chlorophenyl)-2-phenylquinoline, **(3u)** (pale yellow solid, 133 mg, 84%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.09 (d, *J* = 8.4 Hz, 1H), 8.02 (d, *J* = 7.5 Hz, 2H), 7.66 (d, *J* = 8.4 Hz, 1H), 7.59 (s, 1H), 7.55 (t, *J* = 7.6 Hz, 1H), 7.39 – 7.31 (m, 4H), 7.31 – 7.26 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.7, 147.7, 146.7, 138.3, 135.6, 133.5, 129.7, 129.1, 128.5, 128.3, 127.7, 126.4, 125.4, 124.4 124.1, 118.1. Adv. Synth. Catal., 2019, 361, 1995-1999.

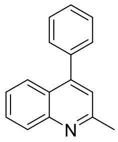


4-hexyl-2-phenylquinoline, **(3v)** (pale yellow oil, 82 mg, 57%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.16 (dd, *J* = 13.8, 8.0 Hz, 3H), 8.02 (d, *J* = 8.3 Hz, 1H), 7.70 (d, *J* = 4.8 Hz, 2H), 7.51 (t, *J* = 7.4 Hz, 3H), 7.44 (t, *J* = 7.2 Hz, 1H), 3.14 – 3.06 (m, 2H), 1.79 (p, *J* = 7.6 Hz, 2H), 1.49 – 1.43 (m, 2H), 1.38 – 1.30 (m, 4H), 0.90 (t, *J* = 6.9 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.1, 149.4, 148.5, 140.0, 130.5, 129.2, 128.8, 127.6, 126.6, 125.9, 123.4, 118.7, 32.6, 31.7, 30.2, 29.5, 22.6, 14.1. Sci. China Chem. 2018, 61, 687-694.

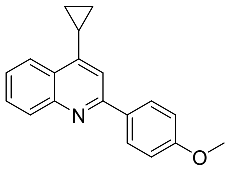


7-chloro-2,4-diphenylquinoline, **(3w)** (pale yellow solid, 128 mg, 81%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.14 (d, *J* = 1.8 Hz, 1H), 8.08 (d, *J* = 7.1

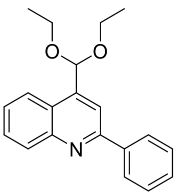
Hz, 2H), 7.73 (d, *J* = 9.0 Hz, 1H), 7.70 (s, 1H), 7.46 – 7.40 (m, 7H), 7.38 (d, *J* = 7.0 Hz, 1H), 7.30 (dd, *J* = 8.9, 2.0 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.9, 149.3, 149.2, 139.2, 137.9, 135.5, 129.7, 129.5, 129.0, 128.9, 128.7, 128.7, 128.7, 127.6, 127.2, 127.1, 124.2, 119.4. Tetrahedron 2011, 67, 8465-8469.



2-methyl-4-phenylquinoline, **(3x)** (pale yellow oil, 57 mg, 52%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.09 (d, *J* = 8.3 Hz, 1H), 7.85 (d, *J* = 8.4 Hz, 1H), 7.67 (t, *J* = 7.6 Hz, 1H), 7.49 (d, *J* = 2.2 Hz, 5H), 7.42 (t, *J* = 7.6 Hz, 1H), 7.22 (s, 1H), 2.77 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.5, 148.6, 148.3, 138.1, 129.5, 129.3, 129.0, 128.5, 128.3, 125.8, 125.7, 125.1, 122.2, 25.3. Org. Lett. 2008, 10, 4117–4120.

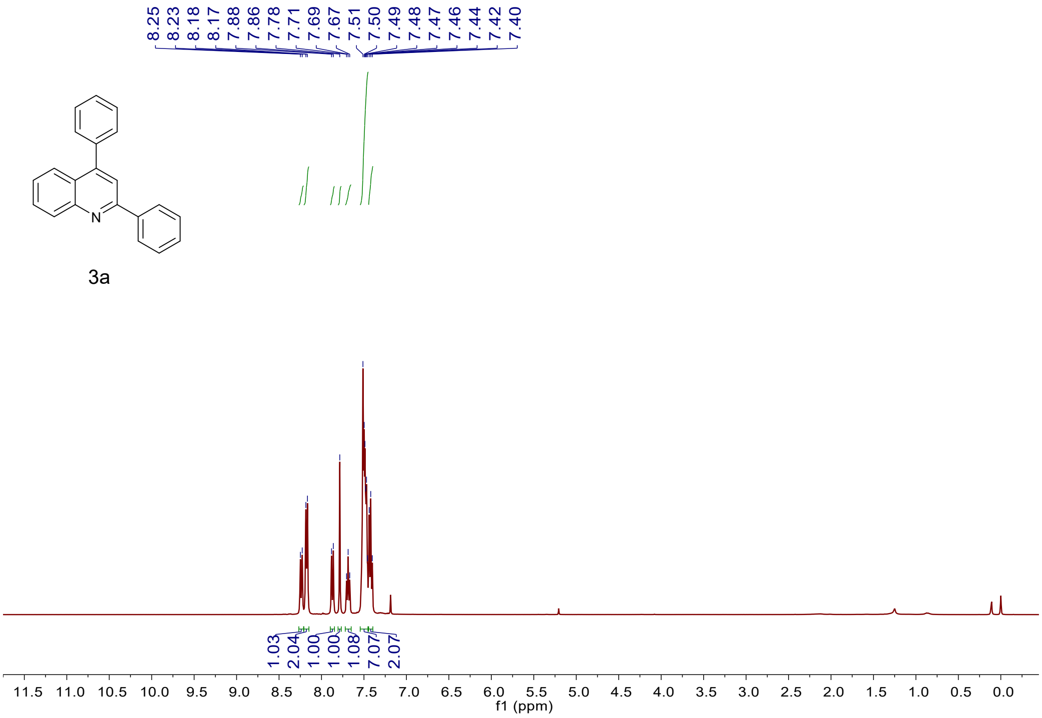


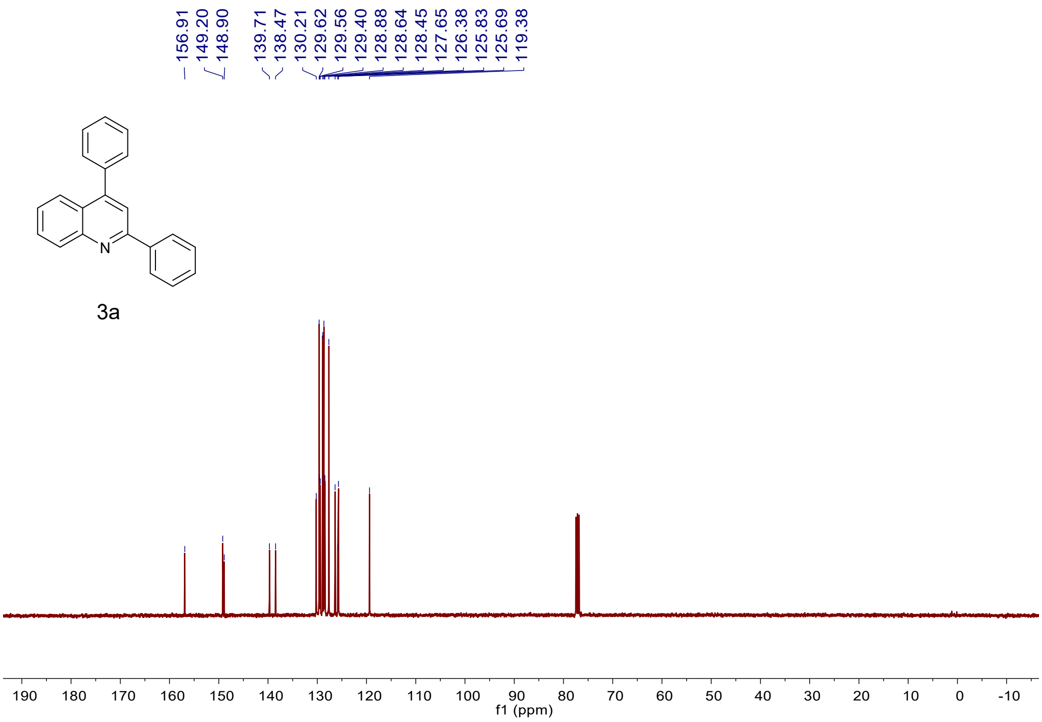
4-cyclopropyl-2-(4-methoxyphenyl)quinoline, **(3y)** (brown oil, 66 mg, 48%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.00 – 7.91 (m, 2H), 7.36 – 7.29 (m, 2H), 7.27 (d, *J* = 1.4 Hz, 1H), 7.13 (ddd, *J* = 7.8, 6.7, 2.0 Hz, 1H), 7.01 – 6.85 (m, 2H), 6.49 (s, 1H), 3.86 (s, 3H), 1.80 (tt, *J* = 8.1, 4.9 Hz, 1H), 1.04 – 0.91 (m, 2H), 0.87 – 0.75 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 164.4, 161.7, 154.4, 150.5, 132.3, 132.1, 129.5, 129.1, 127.9, 126.1, 125.9, 122.9, 113.7, 55.4, 18.7, 6.4.

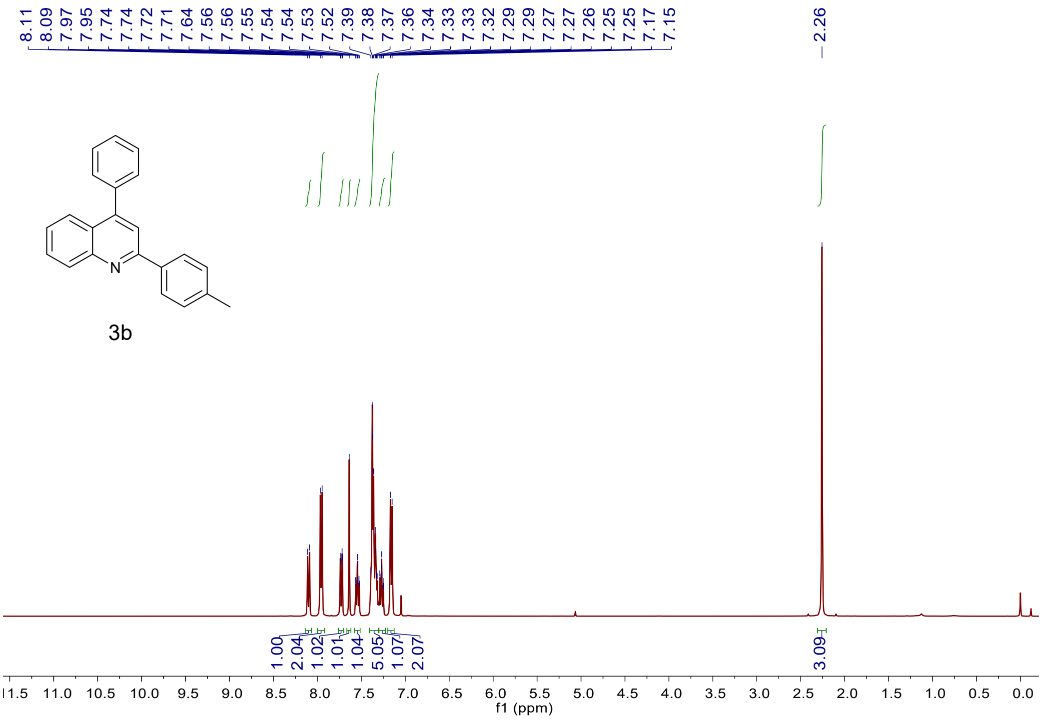


4-(diethoxymethyl)-2-phenylquinoline, **(3z)** (brown oil, 97 mg, 63%) ^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.27 (dd, *J* = 8.5, 1.4 Hz, 1H), 8.22 – 8.18 (m, 3H), 8.15 (s, 1H), 7.72 (ddd, *J* = 8.4, 6.8, 1.4 Hz, 1H), 7.55 (dt, *J* = 2.8, 1.5 Hz, 1H), 7.54 – 7.51 (m, 2H), 7.49 – 7.45 (m, 1H), 6.09 (s, 1H), 3.67 (q, *J* = 7.1 Hz, 4H), 1.27 (t, *J* = 7.0 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.0, 148.7, 143.8, 139.7, 130.3, 129.3, 129.3, 128.8, 127.6, 126.4, 124.8, 124.1, 117.0, 99.0, 61.6, 15.3. Tetrahedron 1997, 53, 641-646.

4. ^{1}H NMR and ^{13}C NMR Spectra for quinoline products.



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2.26
N
3b
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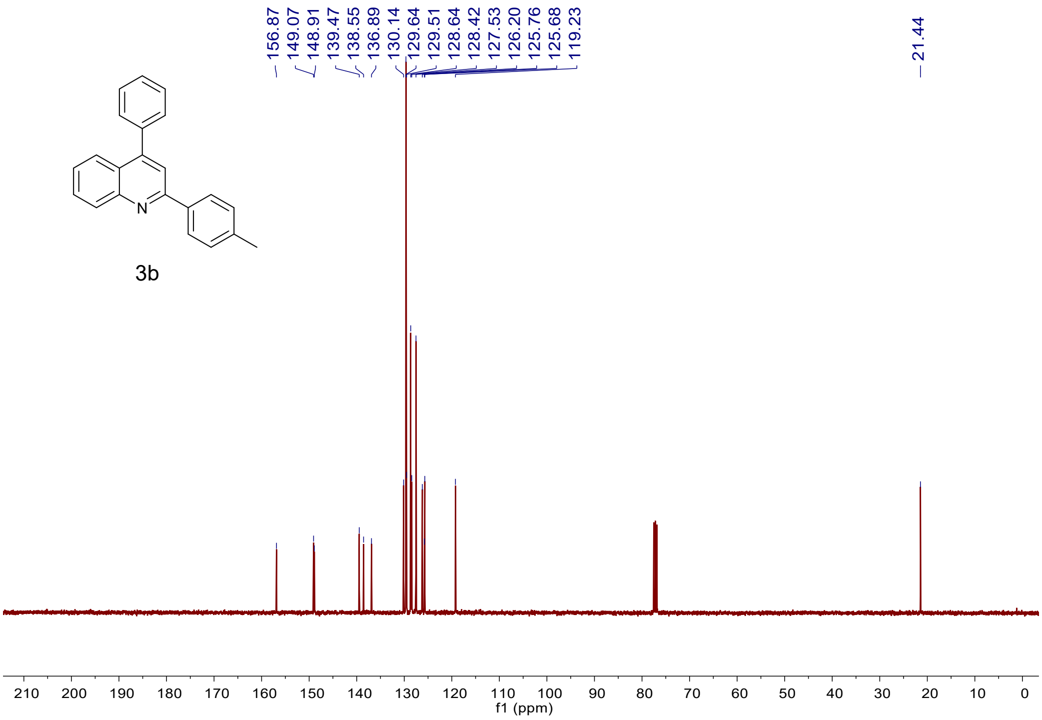
3.09
f1 (ppm)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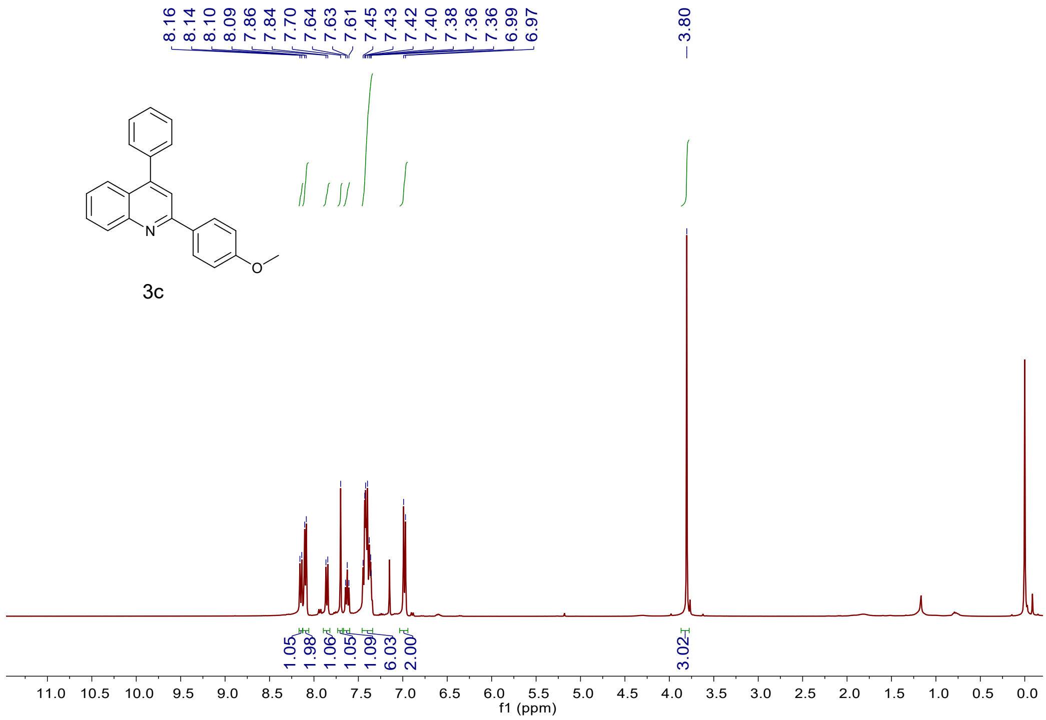
N
3b
f1 (ppm)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8.14
8.10
8.09
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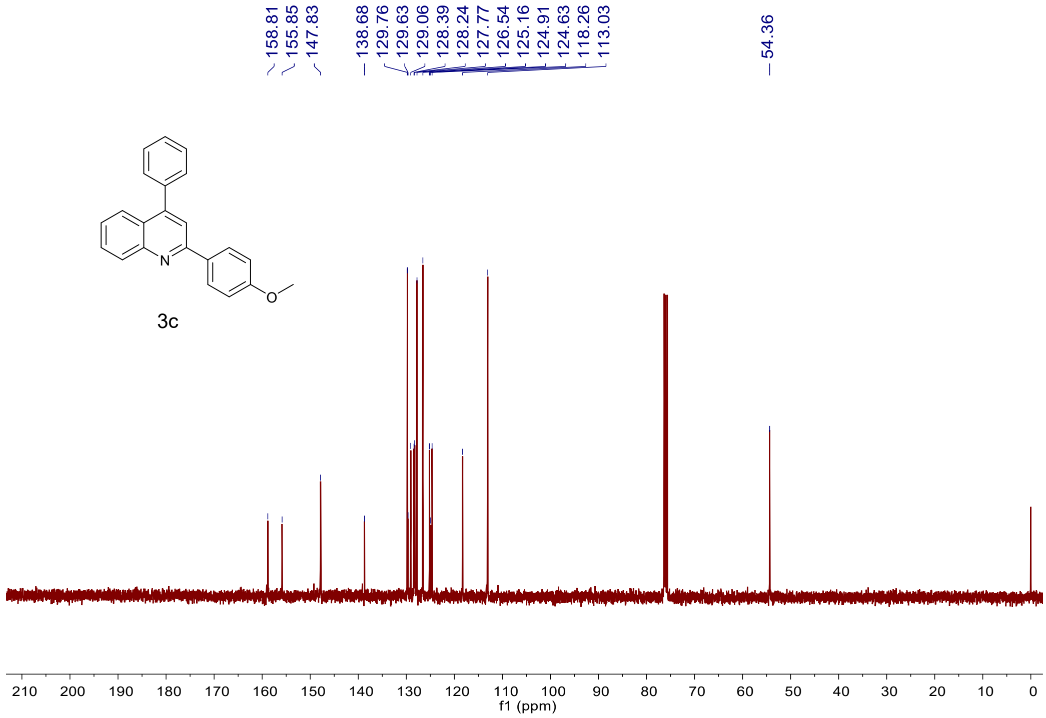
7.84
7.70
7.64
7.63
7.61
7.45
7.43
7.42
7.40
7.38
7.36
7.36
6.99
6.97
3.80
3c
1.05
1.98
1.06
1.05
1.09
6.03
2.00
3.02
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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155.85
147.83
138.68
129.76
129.63
129.06
128.39
128.24
127.77
126.54
125.16
124.91
124.63
118.26
113.03
54.36
3c
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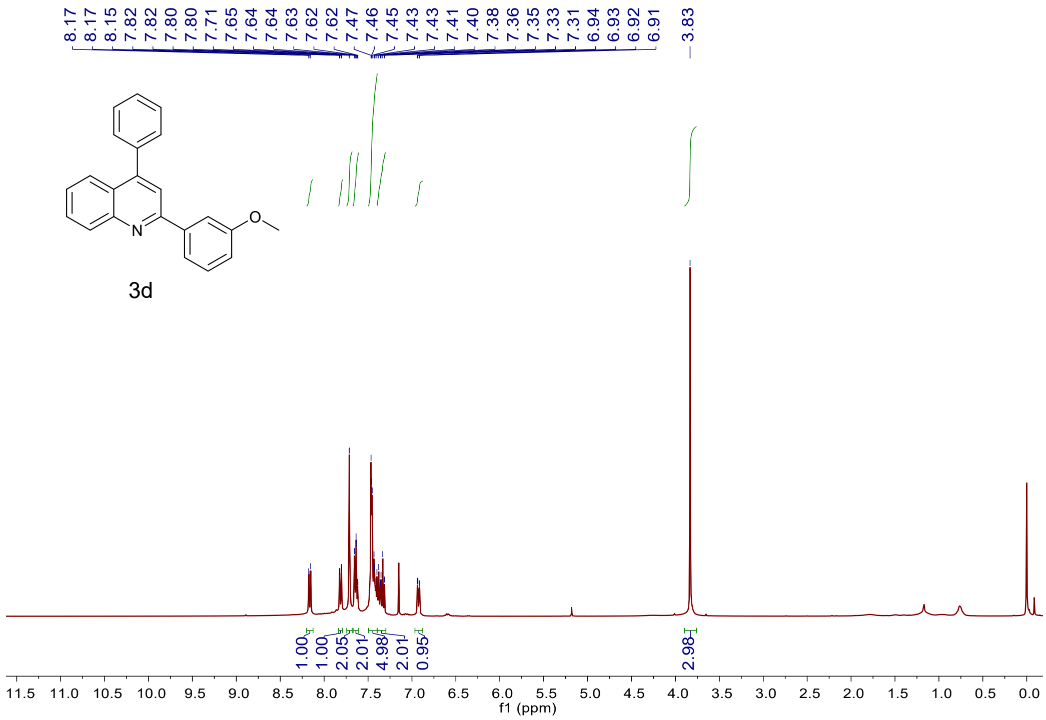
f1 (ppm)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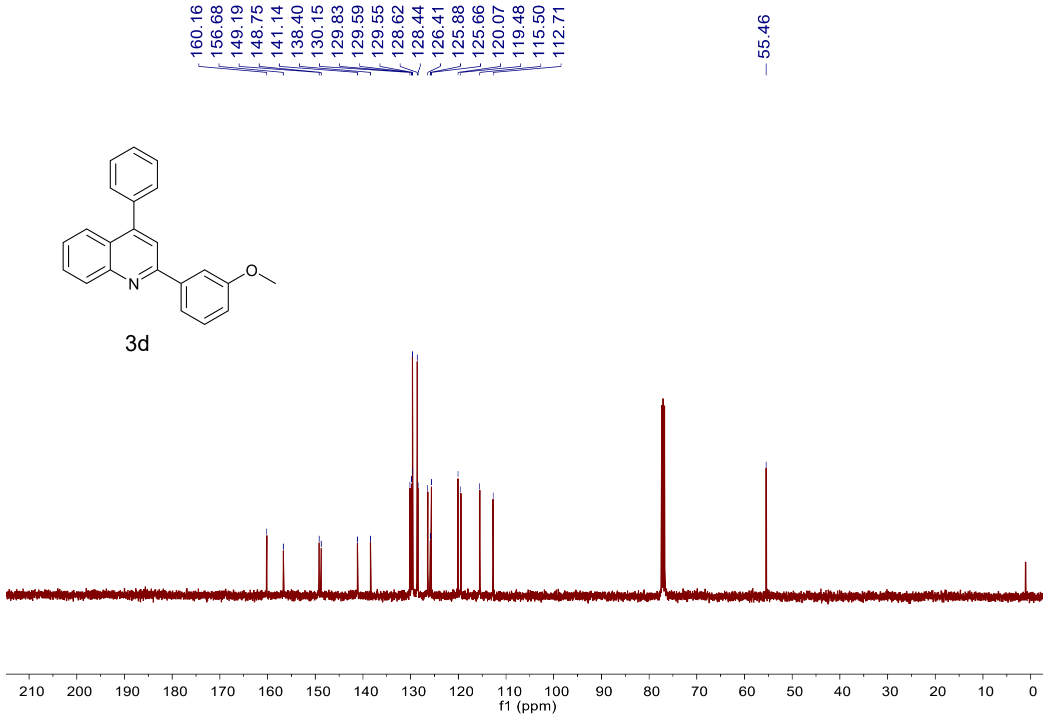
3.83
N
O
3d
1.00 1.00 2.05 2.01 4.98 2.01 0.95
2.98
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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O
3d
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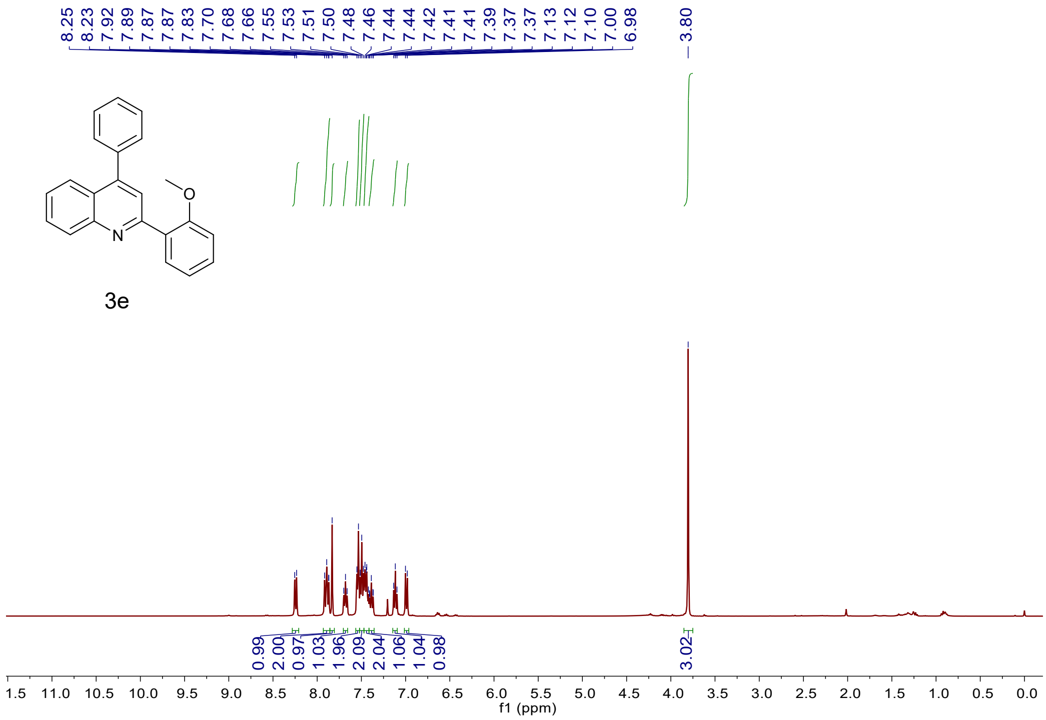
f1 (ppm)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8.23
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7.87
7.83
7.70
7.68
7.66
7.55
7.53
7.51
7.50
7.48
7.46
7.44
7.44
7.42
7.41
7.41
7.39
7.37
7.37
7.13
7.12
7.10
7.00
6.98
3.80
N
O
3e
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2.00
0.97
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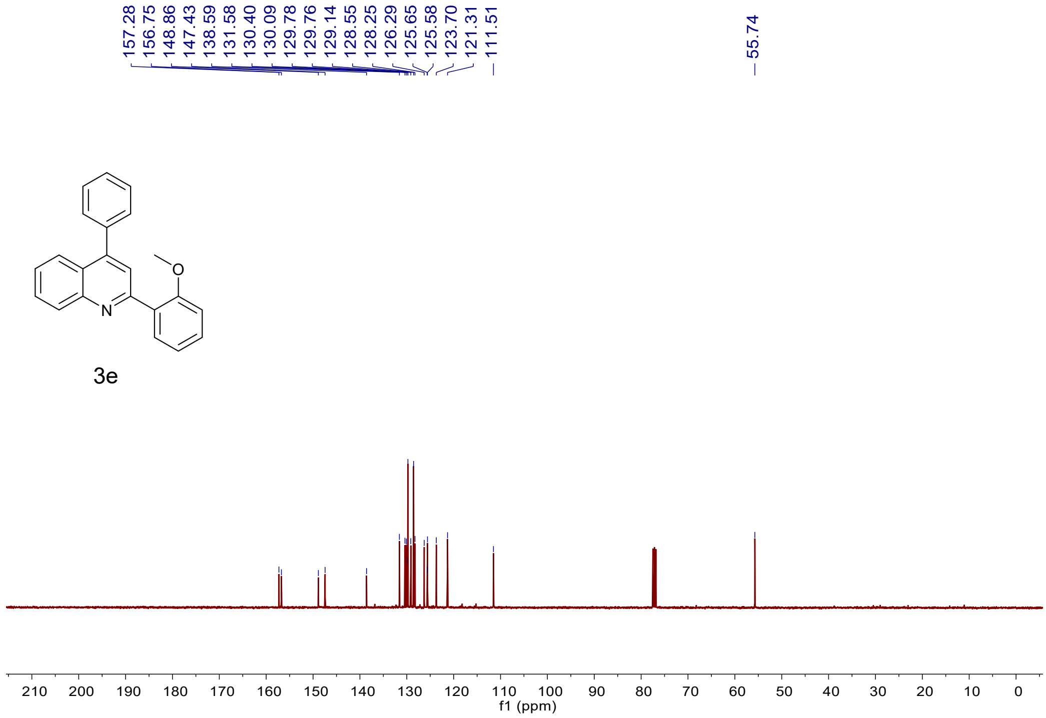
2.09
2.04
1.06
1.04
0.98
3.02
f1 (ppm)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129.76
129.14
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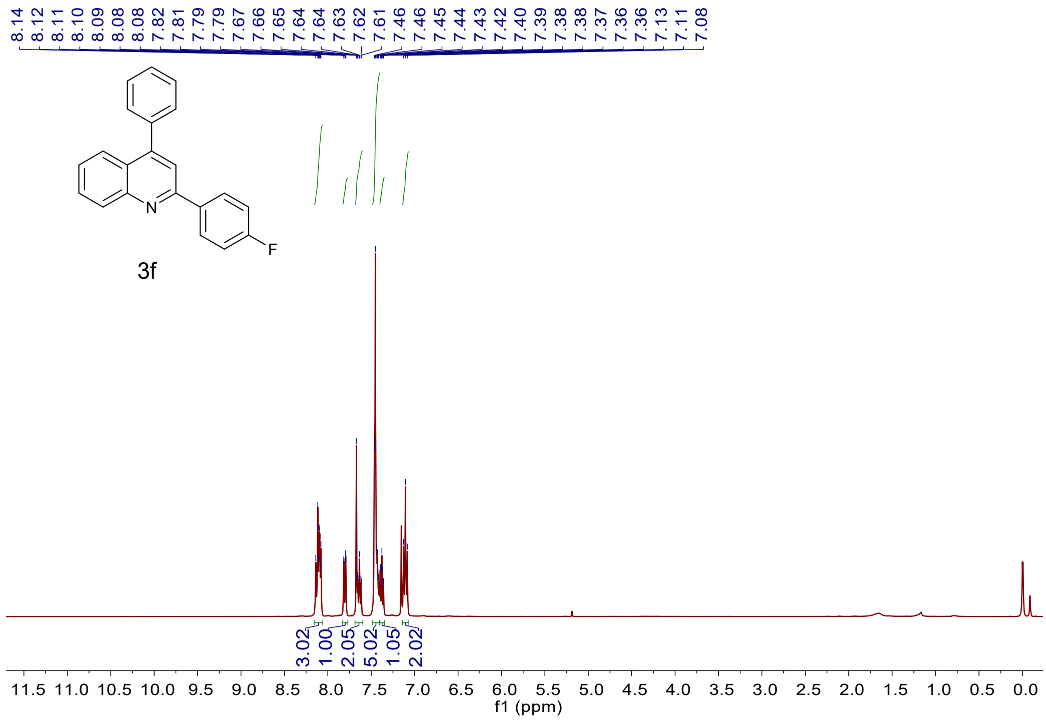
N
O
3e
f1 (ppm)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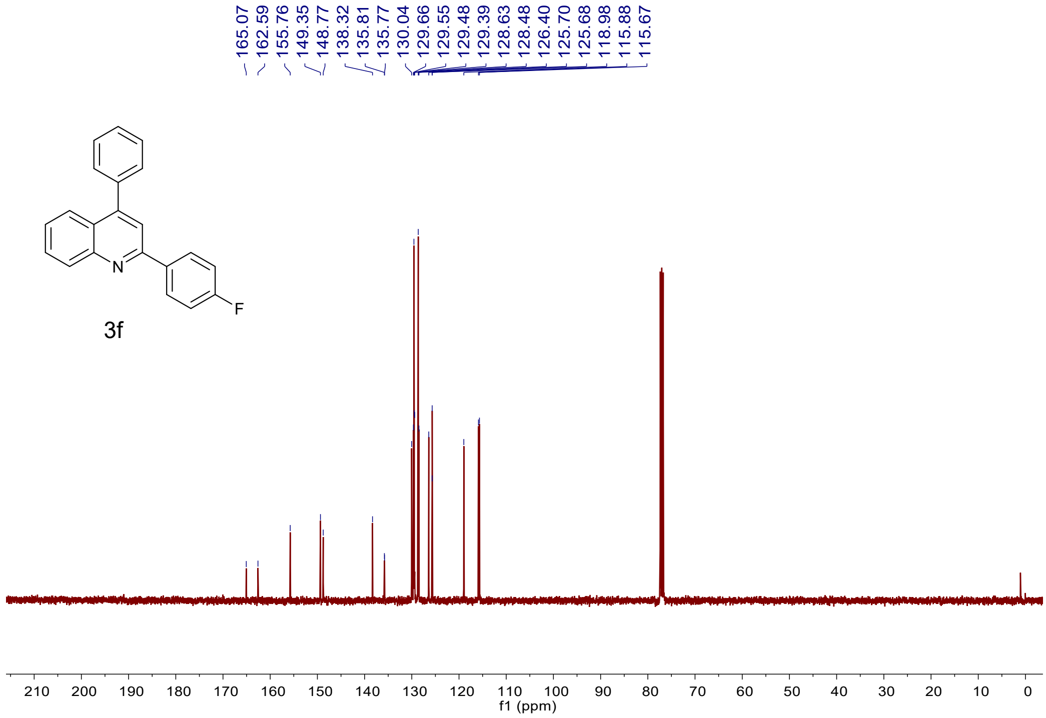
N
F
3f
3.02 1.00 2.05 5.02 1.05 2.02
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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F
3f
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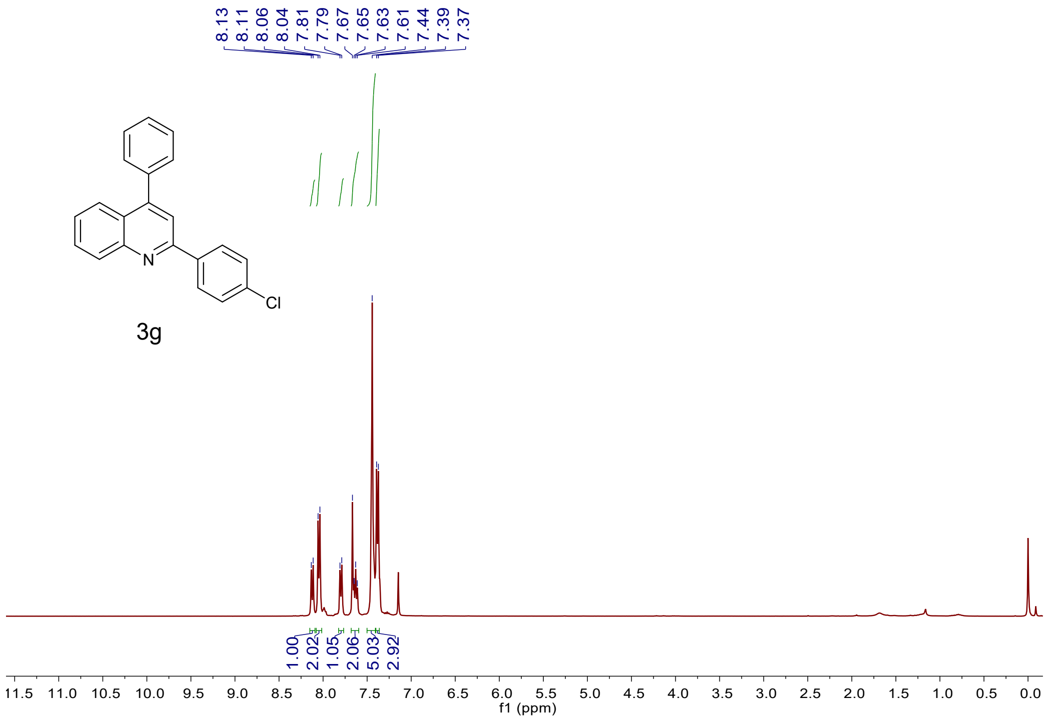
f1 (ppm)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8.04
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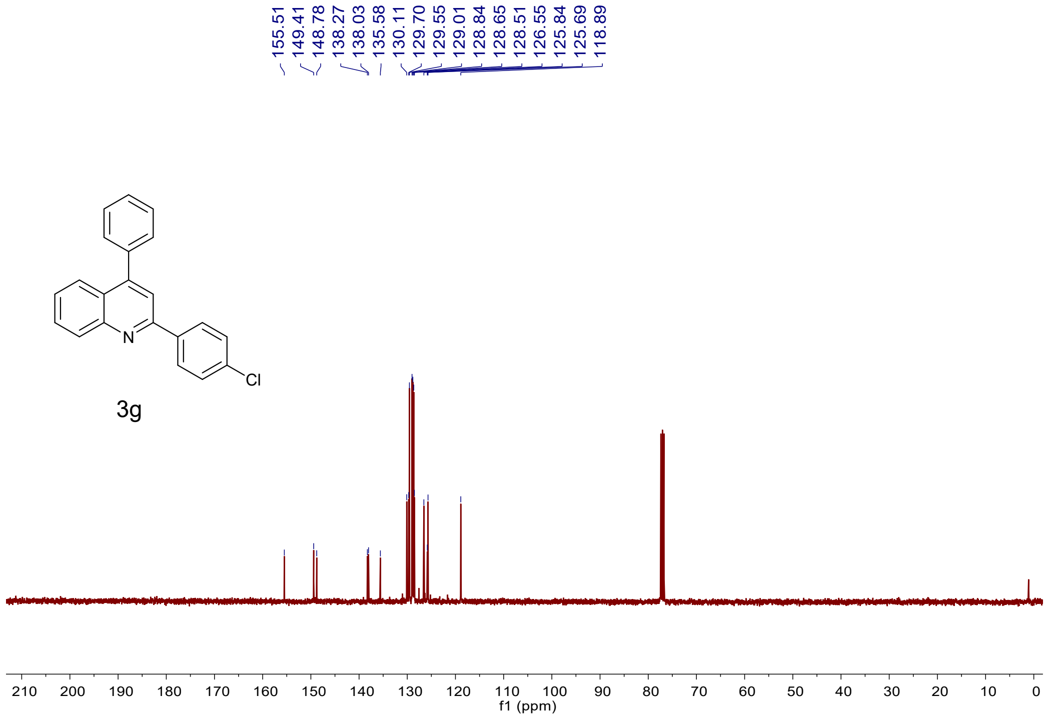
7.79
7.67
7.65
7.63
7.61
7.44
7.39
7.37
N
Cl
3g
1.00
2.02
1.05
2.06
5.03
2.92
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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135.58
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129.01
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128.65
128.51
126.55
125.84
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118.89
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Cl
3g
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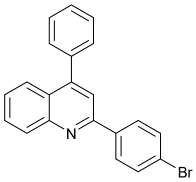
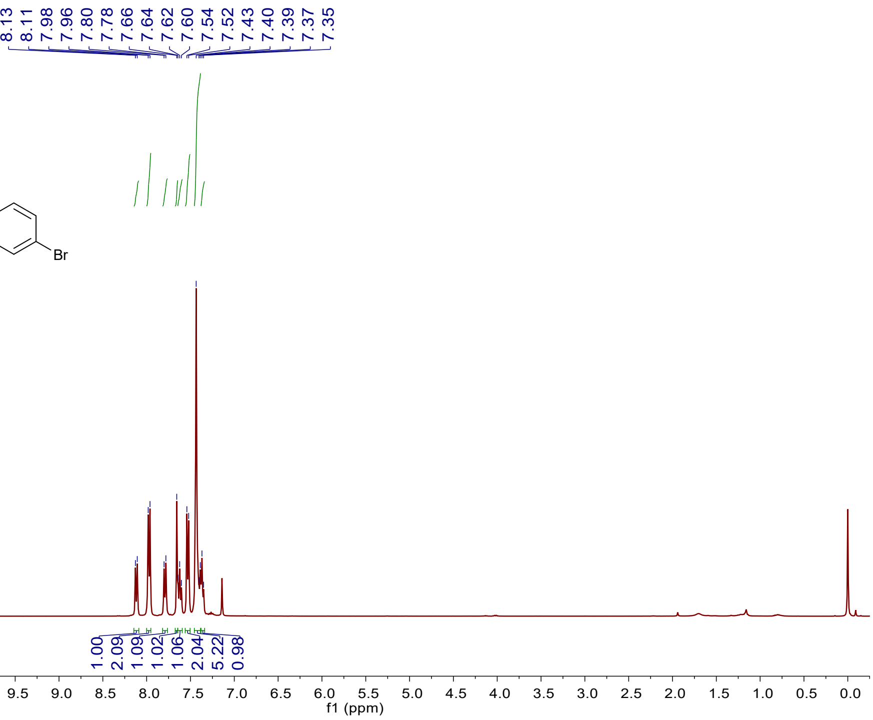
f1 (ppm)


N
Br

3h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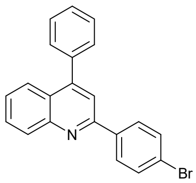
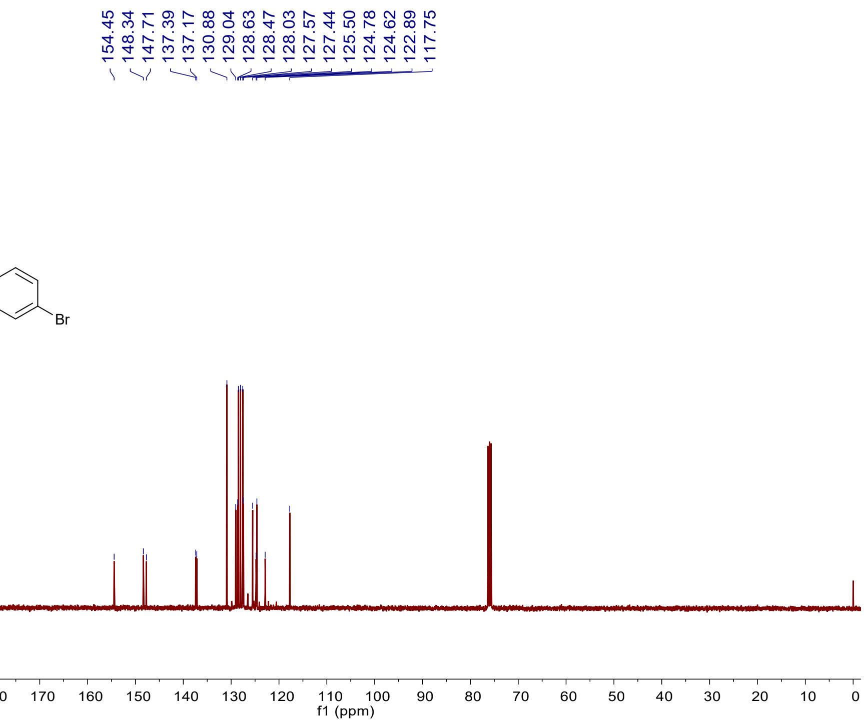
1.00 2.09 1.09 1.02 1.06 2.04 5.22 0.98
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


N
Br

3h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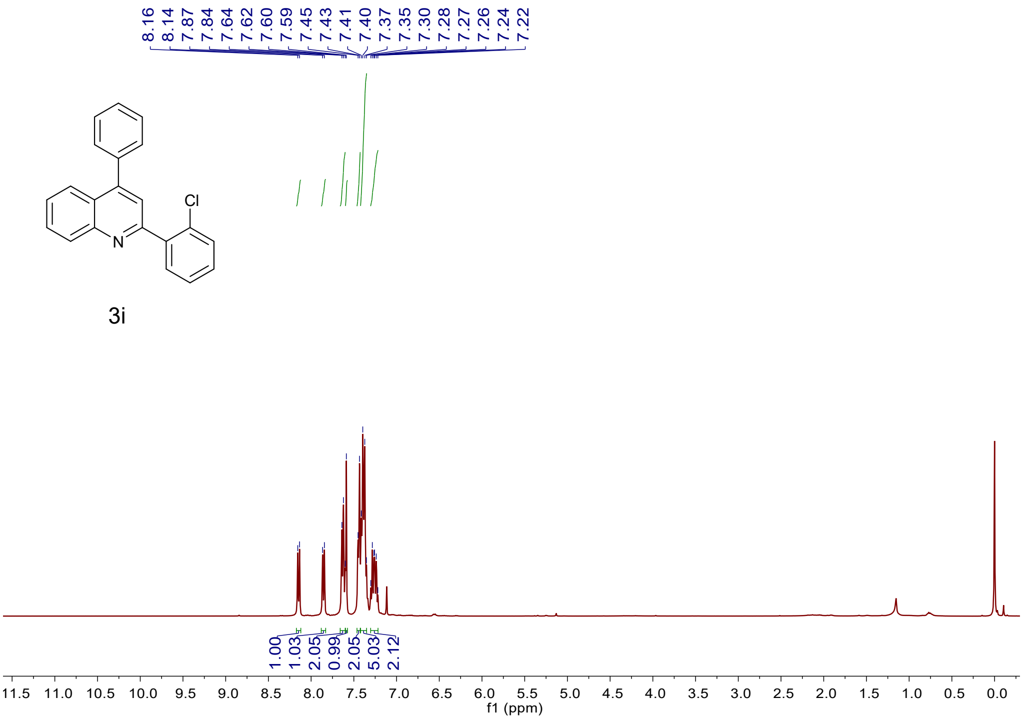
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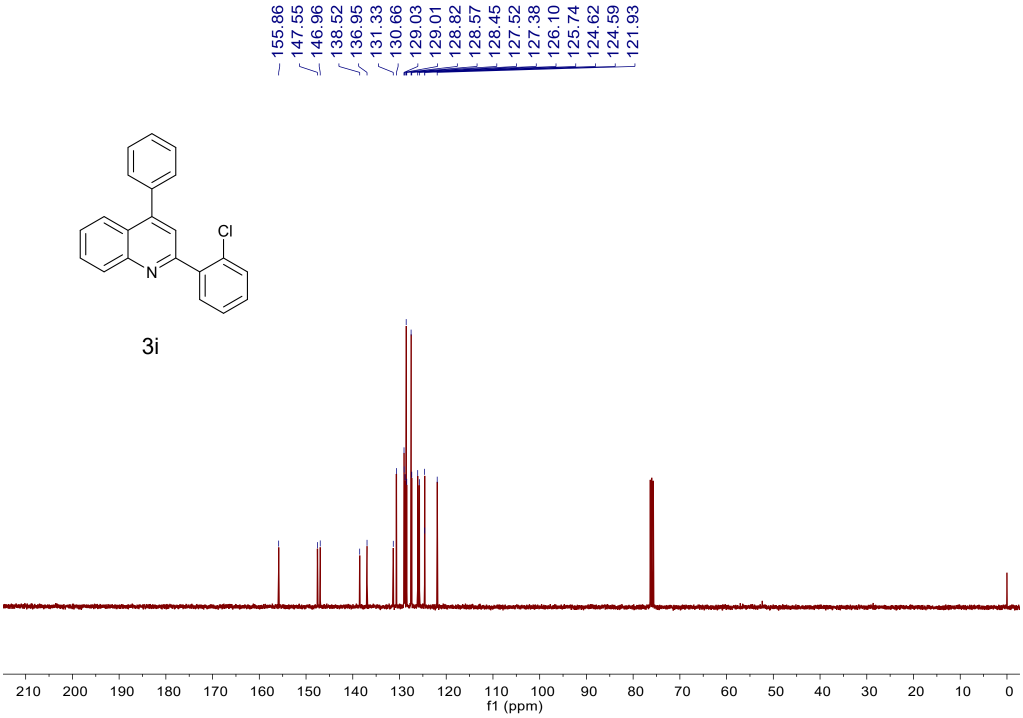
Cl
N
3i
1.00 1.03 2.05 0.99 2.05 5.03 2.12
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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N
3i
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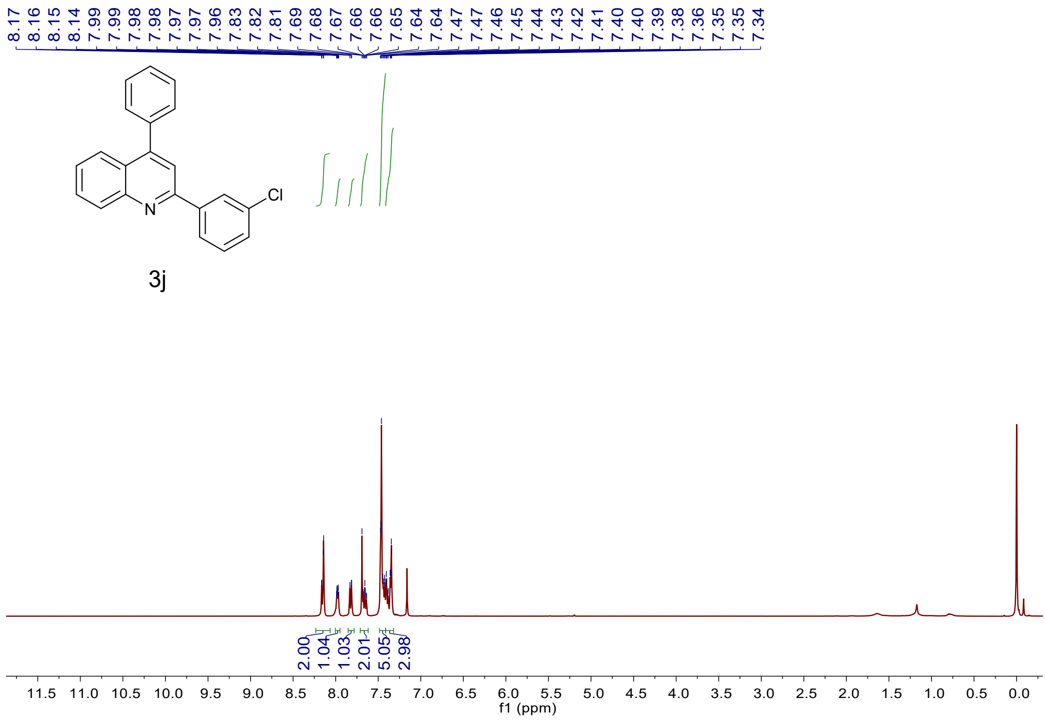
f1 (ppm)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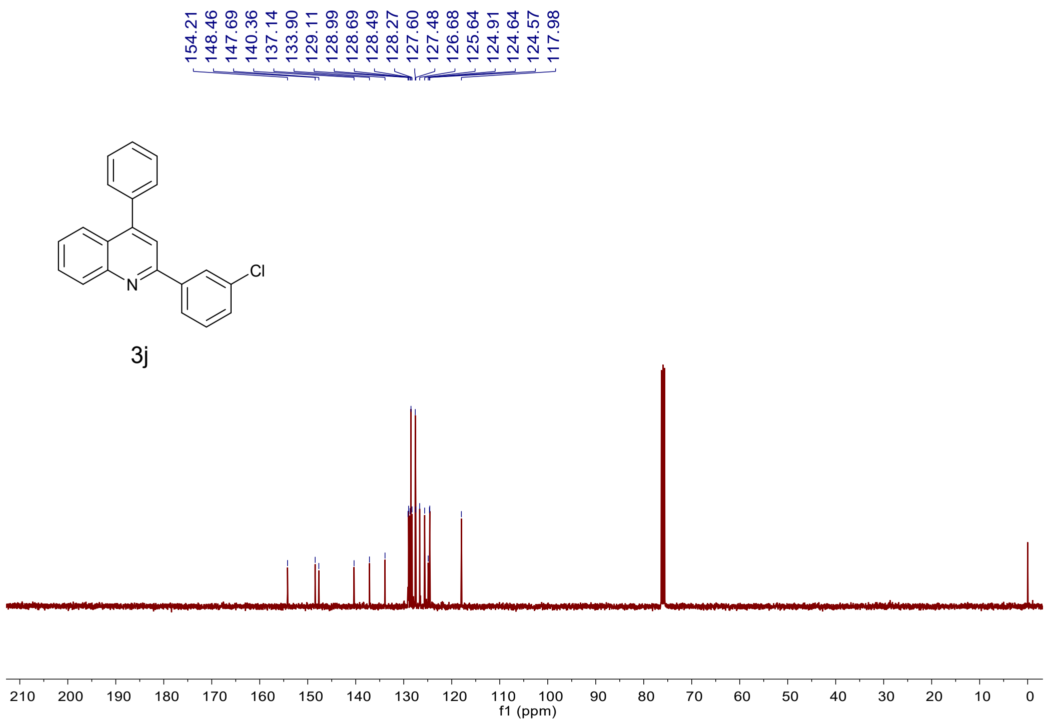
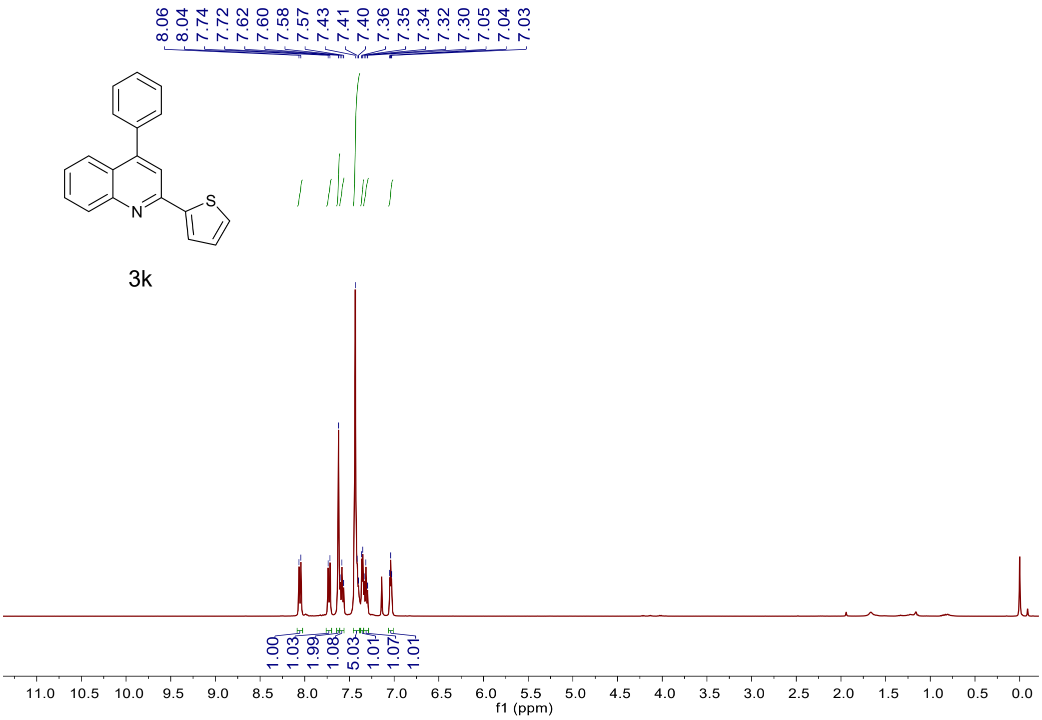
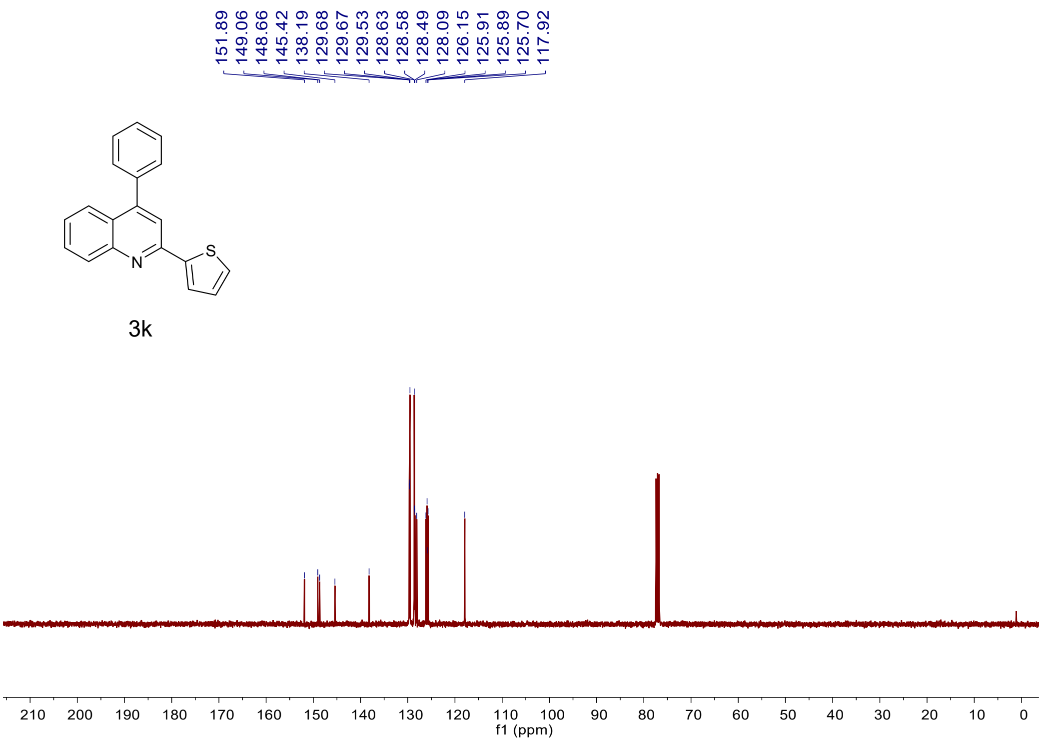
Cl
N
3j
2.00 1.04 1.03 2.01 5.05 2.98
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


154.21 148.46 147.69 140.36 137.14 133.90 129.11 128.99 128.69 128.49 128.27 127.60 127.48 126.68 125.64 124.91 124.64 124.57 117.98
Cl
N
3j
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



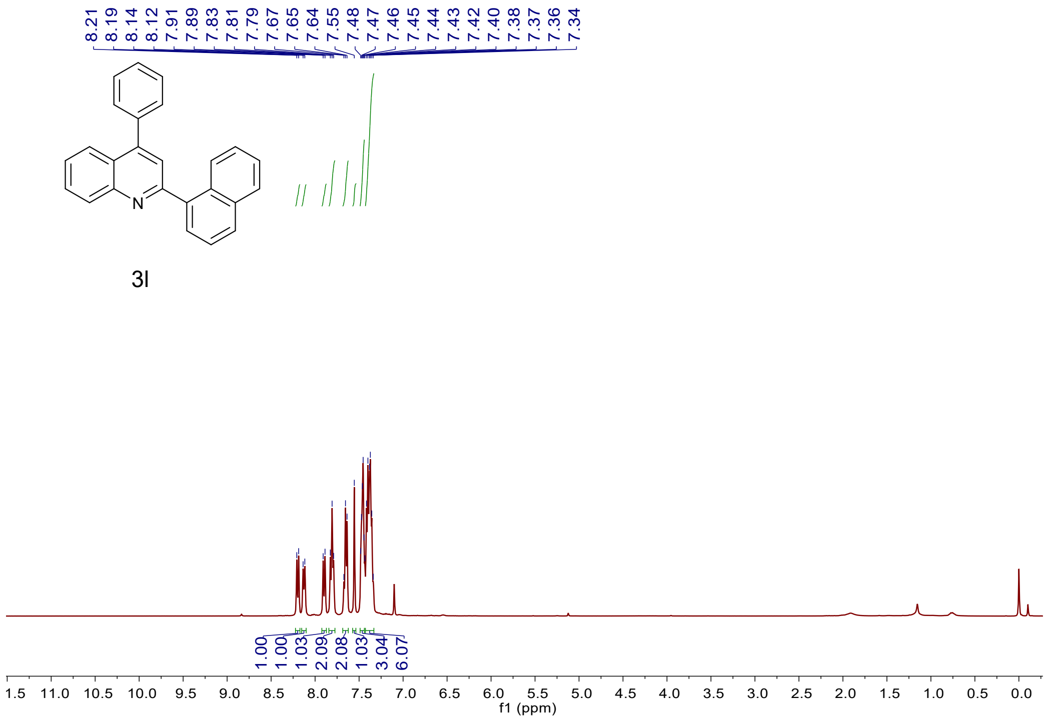
8.06 8.04 7.74 7.72 7.62 7.60 7.58 7.57 7.43 7.41 7.40 7.36 7.35 7.34 7.32 7.30 7.05 7.04 7.03
S
N
1.00 1.03 1.99 1.08 5.03 1.01 1.07 1.01
f1 (ppm)

3k



151.89 149.06 148.66 145.42 138.19 129.68 129.67 129.53 128.63 128.58 128.49 128.09 126.15 125.91 125.89 125.70 117.92
S
N
f1 (ppm)

3k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N
3l
1.00 1.00 1.03 2.09 2.08 1.03 3.04 6.07
1.5 11.0 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
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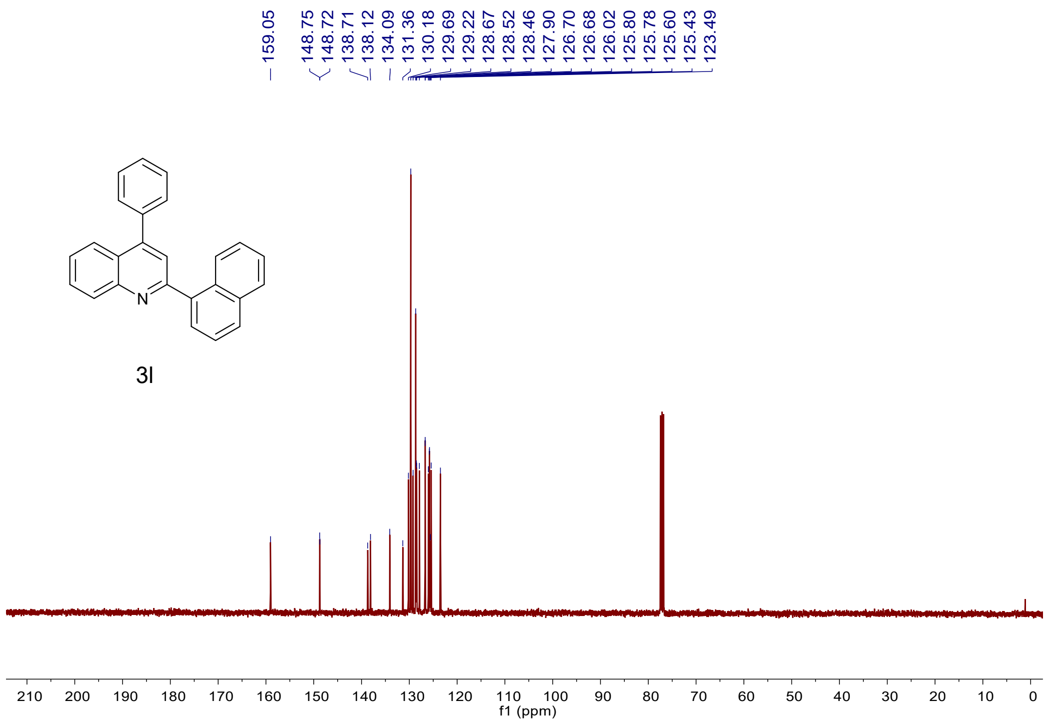
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N
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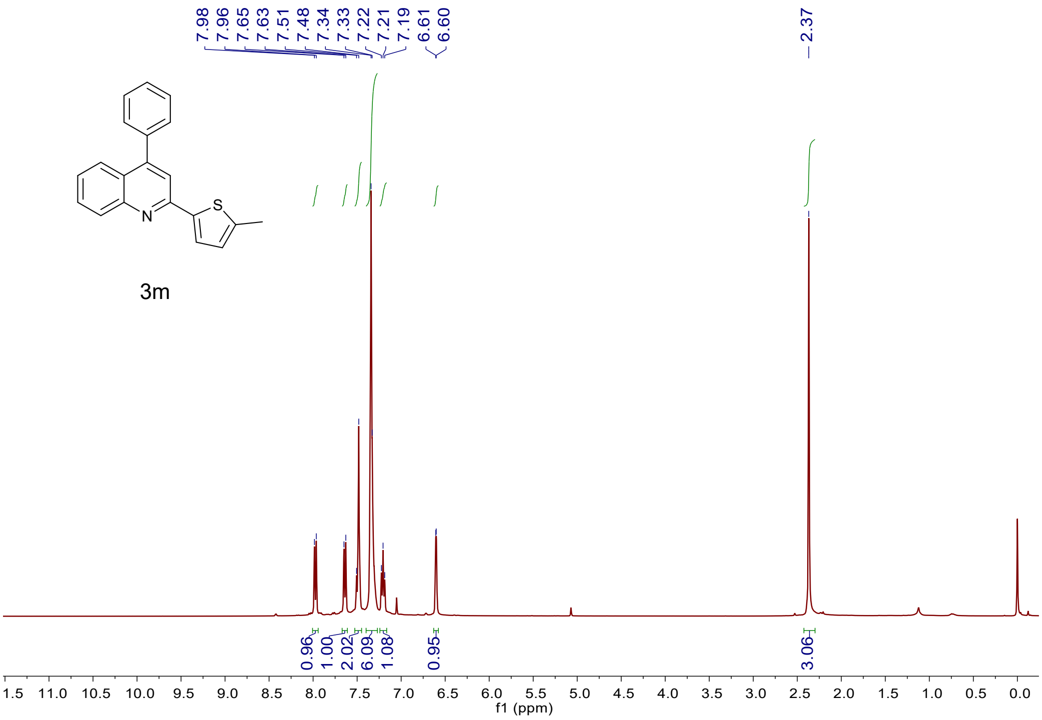
f1 (ppm)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7.65
7.63
7.51
7.48
7.34
7.33
7.22
7.21
7.19
6.61
6.60
2.37
S
N
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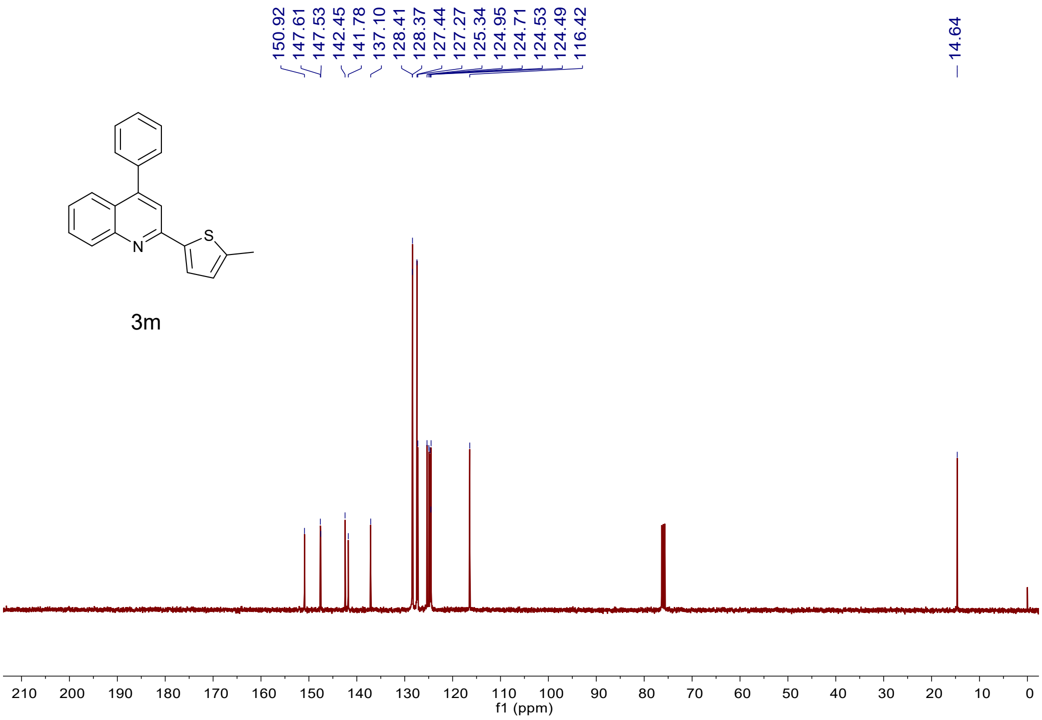
1.00
2.02
6.09
1.08
0.95
3.06
f1 (ppm)

3m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147.61
147.53
142.45
141.78
137.10
128.41
128.37
127.44
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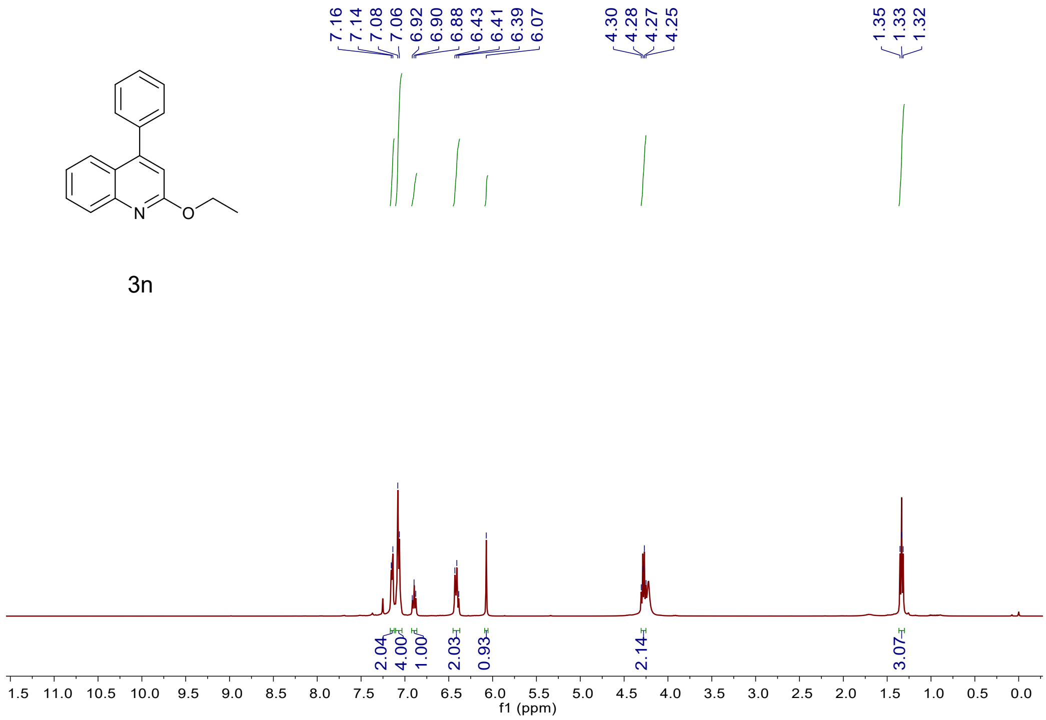
124.95
124.71
124.53
124.49
116.42
14.64
S
N
f1 (ppm)

3m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7.08
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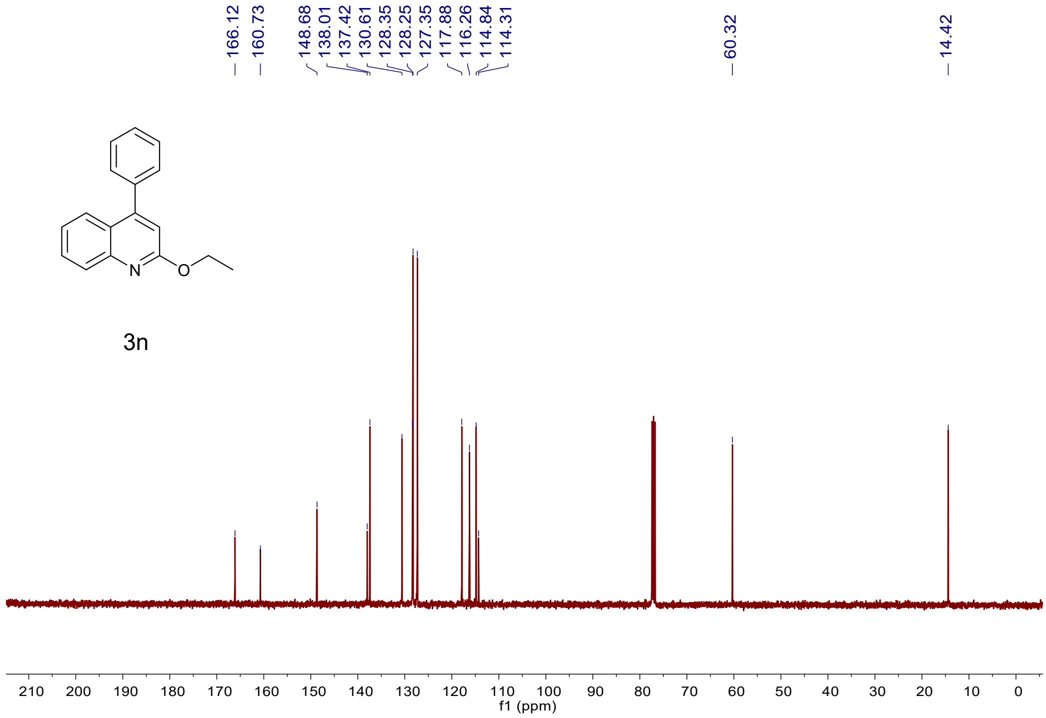
6.90
6.88
6.43
6.41
6.39
6.07
4.30
4.28
4.27
4.25
1.35
1.33
1.32
N
O
2.04
4.00
1.00
2.03
0.93
2.14
3.07
f1 (ppm)

3n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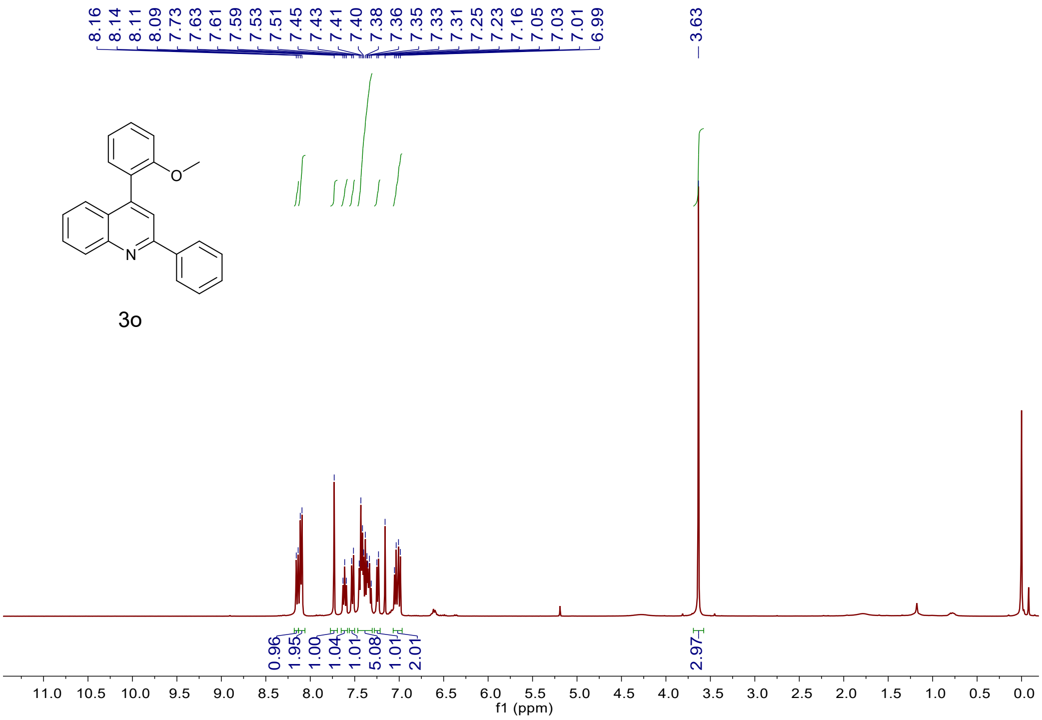
114.31
60.32
14.42
N
O
f1 (ppm)

3n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7.59
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7.51
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7.43
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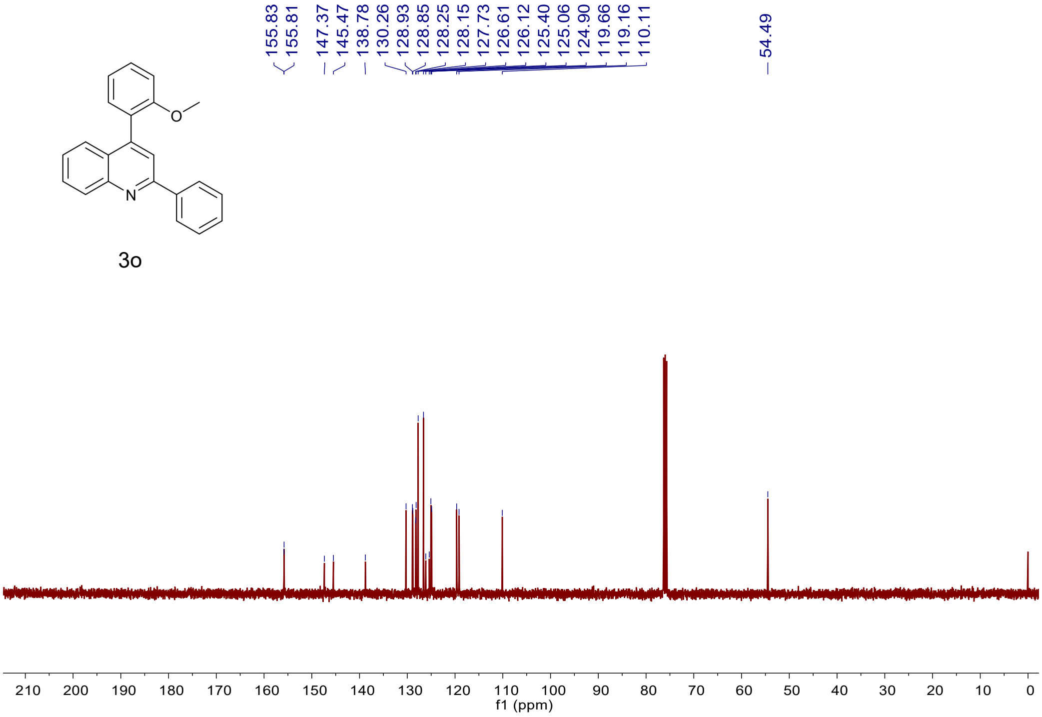
7.40
7.38
7.36
7.35
7.33
7.31
7.25
7.23
7.16
7.05
7.03
7.01
6.99
3.63
O
N
3o
0.96
1.95
1.00
1.04
1.01
5.08
1.01
2.01
2.97
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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130.26
128.93
128.85
128.25
128.15
127.73
126.61
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125.40
125.06
124.90
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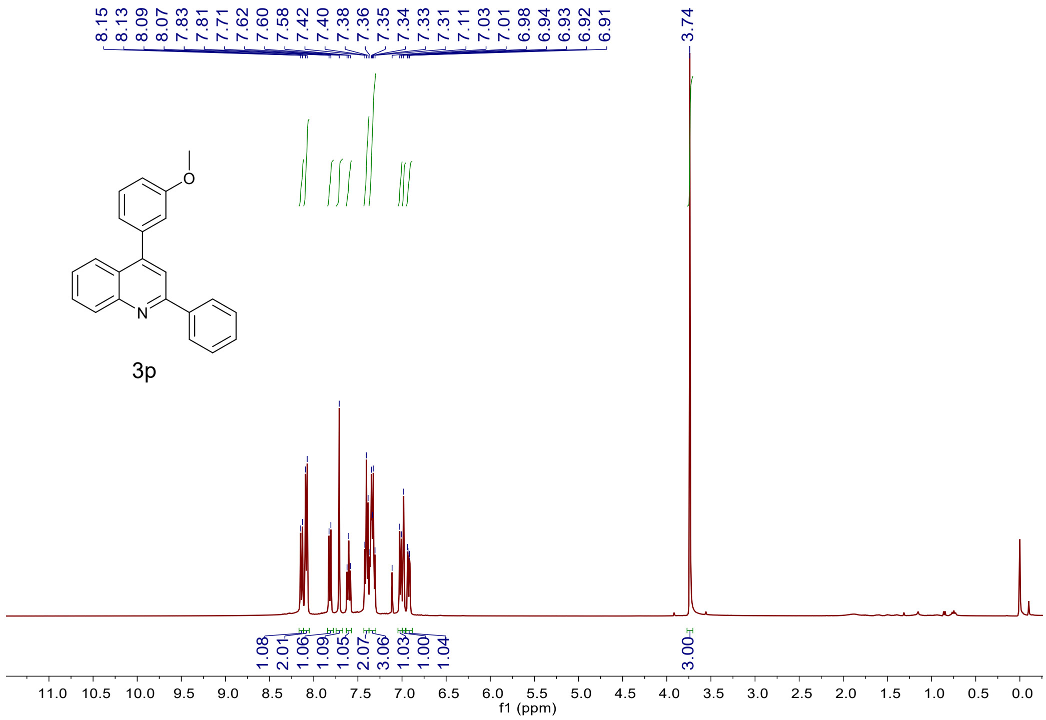
54.49
O
N
3o
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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8.13
8.09
8.07
7.83
7.81
7.71
7.62
7.60
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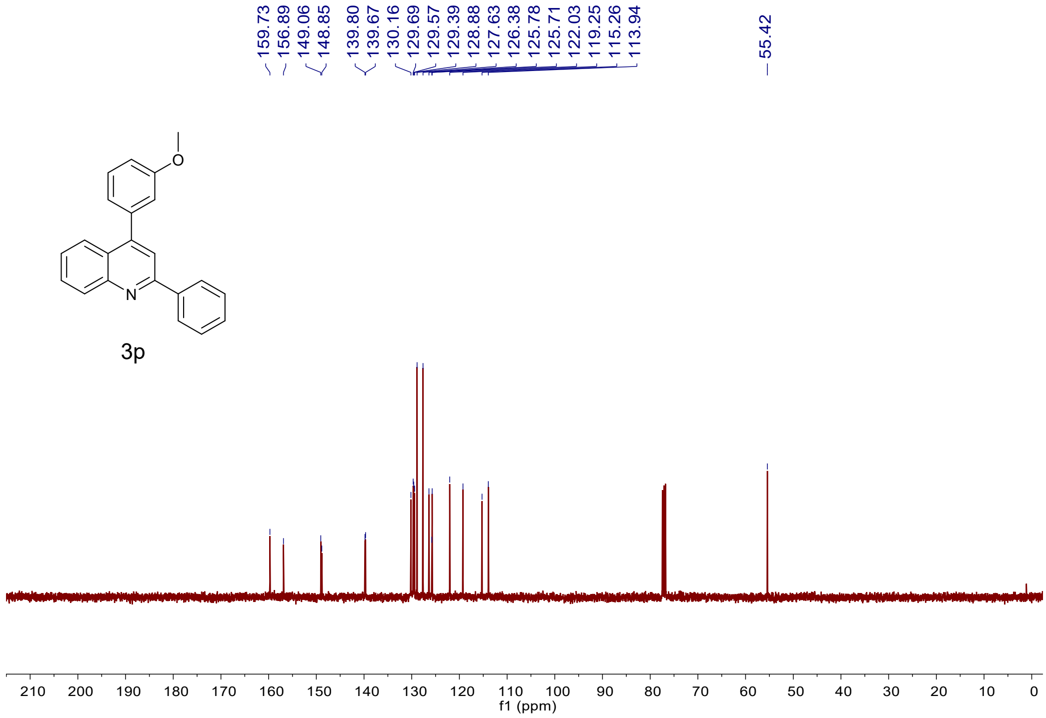
7.40
7.38
7.36
7.35
7.34
7.33
7.31
7.11
7.03
7.01
6.98
6.94
6.93
6.92
6.91
3.74
O
N
3p
1.08
2.01
1.06
1.09
1.05
2.07
3.06
1.03
1.00
1.04
3.00
f1 (ppm)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139.80
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129.57
129.39
128.88
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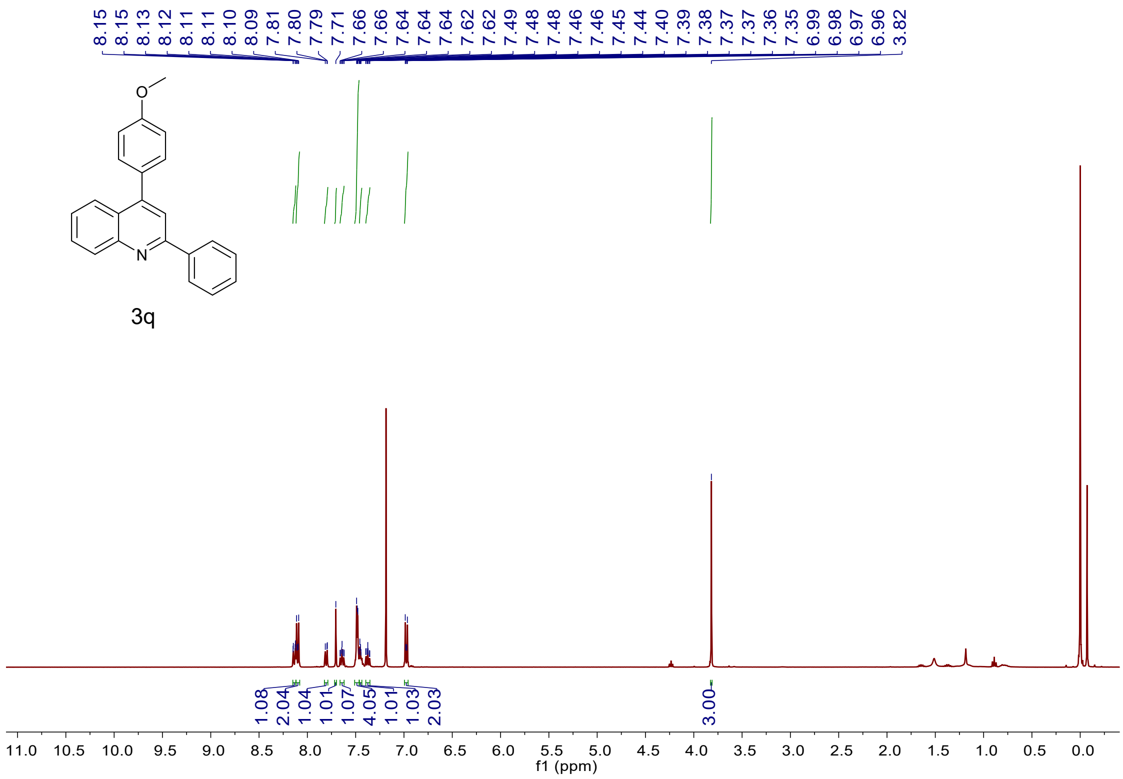
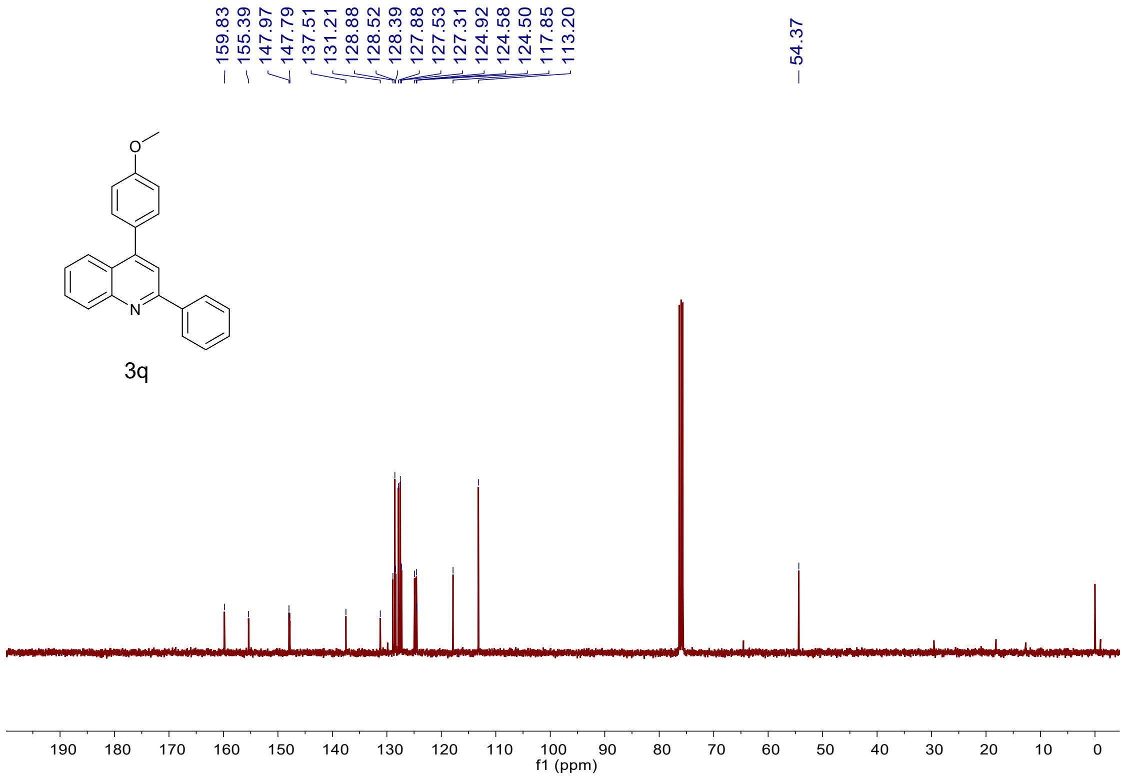
126.38
125.78
125.71
122.03
119.25
115.26
113.94
55.42
O
N
3p
f1 (ppm)


8.15 8.15 8.13 8.12 8.11 8.11 8.10 8.09 7.81 7.80 7.79 7.71 7.66 7.66 7.64 7.64 7.62 7.62 7.49 7.48 7.46 7.46 7.45 7.44 7.40 7.39 7.38 7.37 7.37 7.36 7.35 6.99 6.98 6.97 6.96 3.82
O
N
3q
1.08 2.04 1.04 1.01 1.07 4.05 1.01 1.03 2.03
3.00
11.0 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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54.37
O
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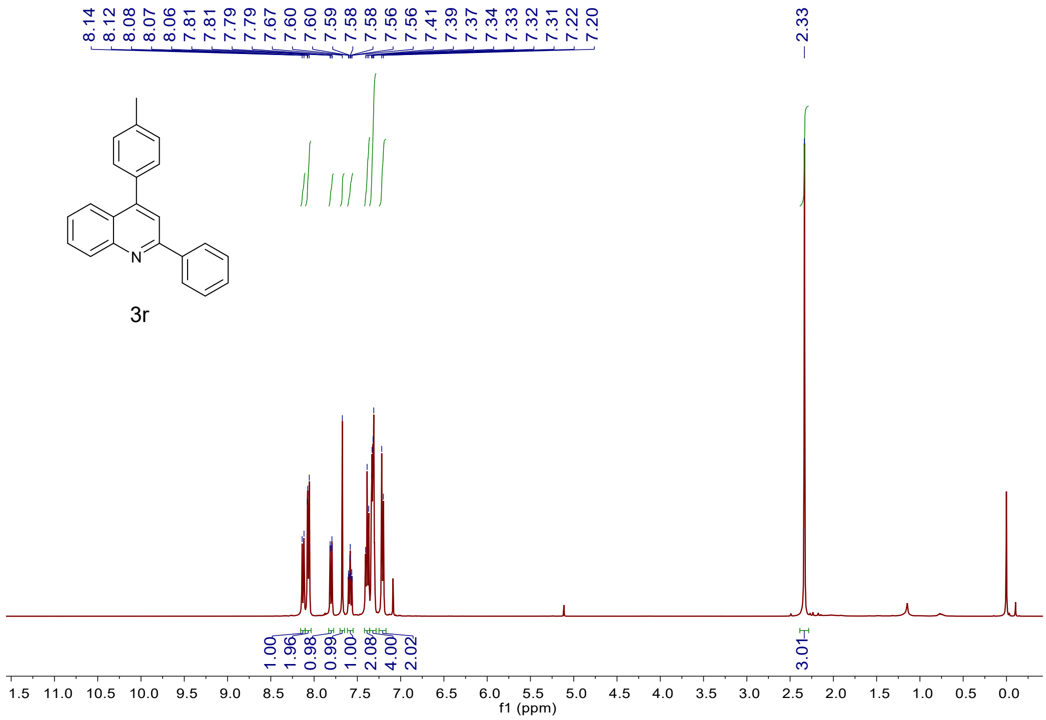
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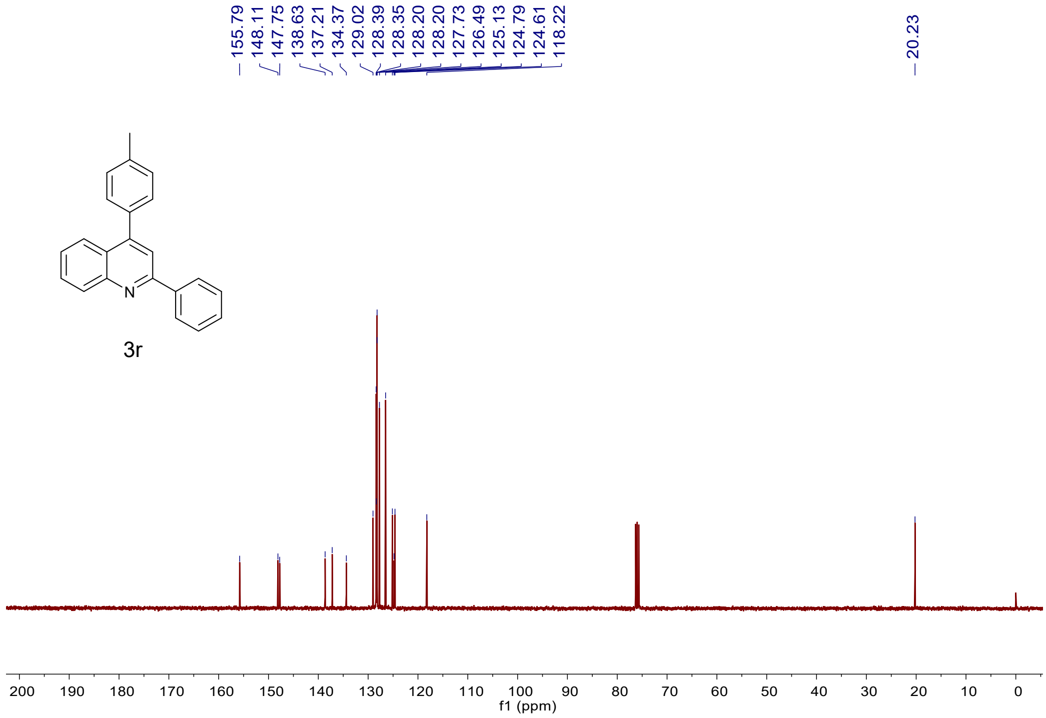
2.33
N
3r
1.00 1.96 0.98 0.99 1.00 2.08 4.00 2.02
3.01
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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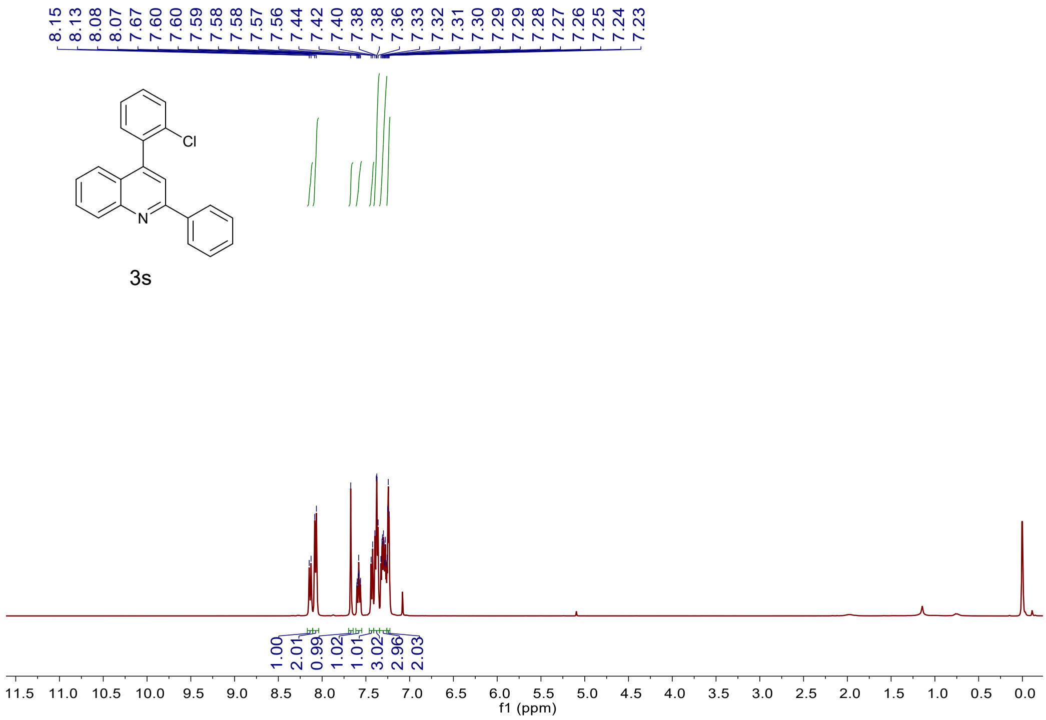
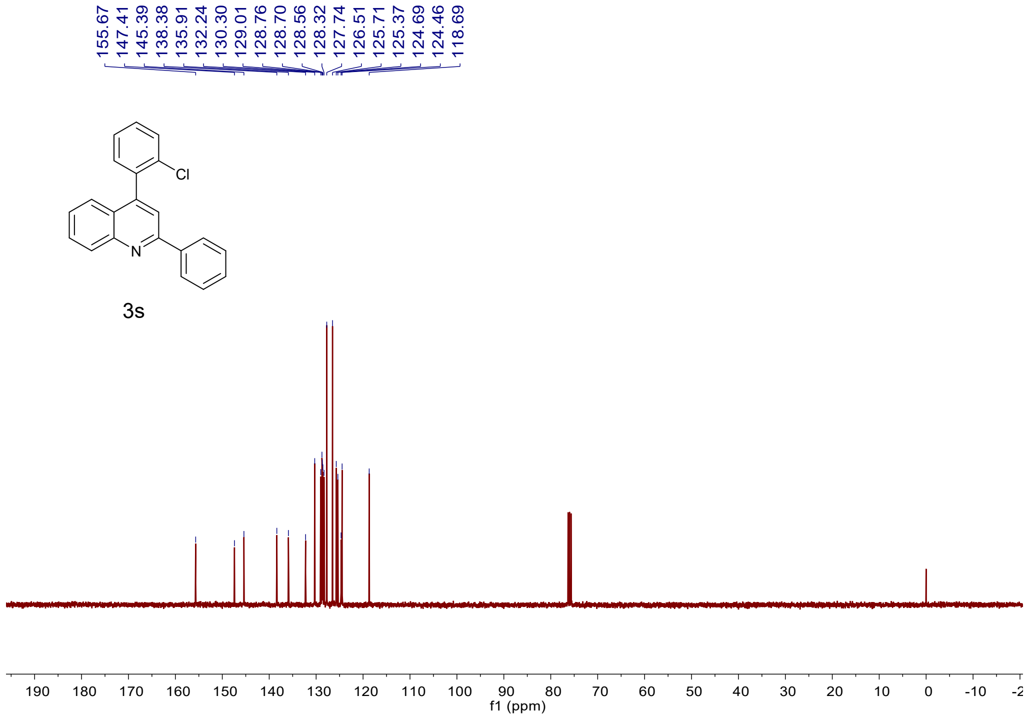
f1 (ppm)


8.15 8.13 8.08 8.07 7.67 7.60 7.59 7.58 7.58 7.57 7.56 7.44 7.42 7.40 7.38 7.38 7.36 7.33 7.32 7.31 7.30 7.29 7.29 7.28 7.27 7.26 7.25 7.24 7.23
Cl
N
3s
1.00 2.01 0.99 1.02 1.01 3.02 2.96 2.03
11.5 11.0 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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Cl
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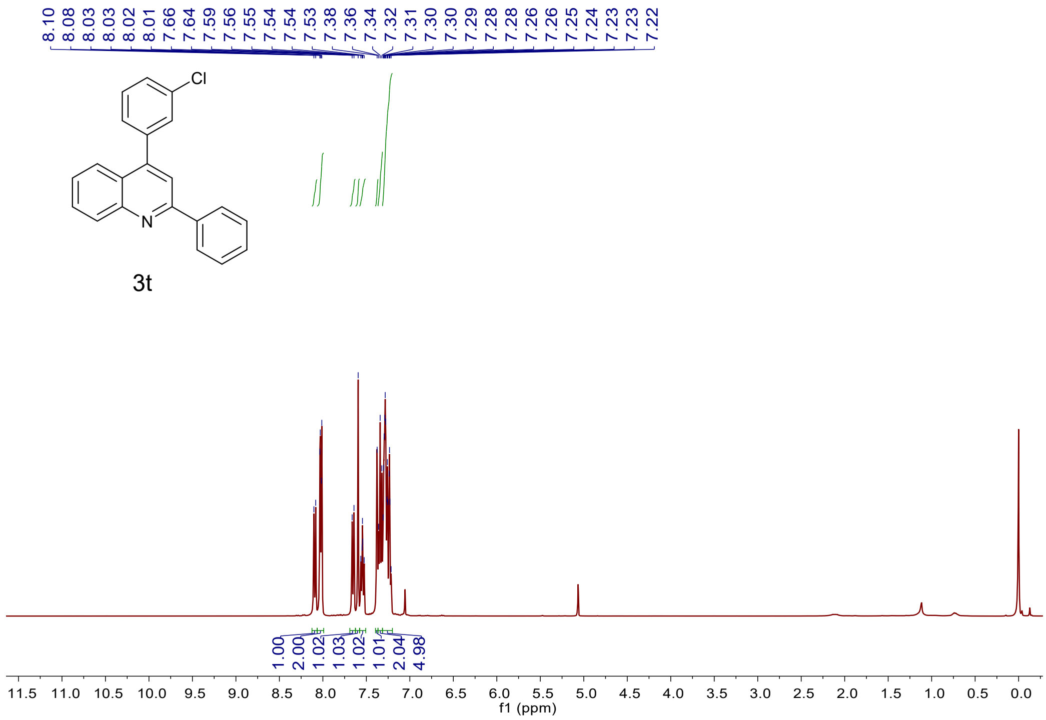
f1 (ppm)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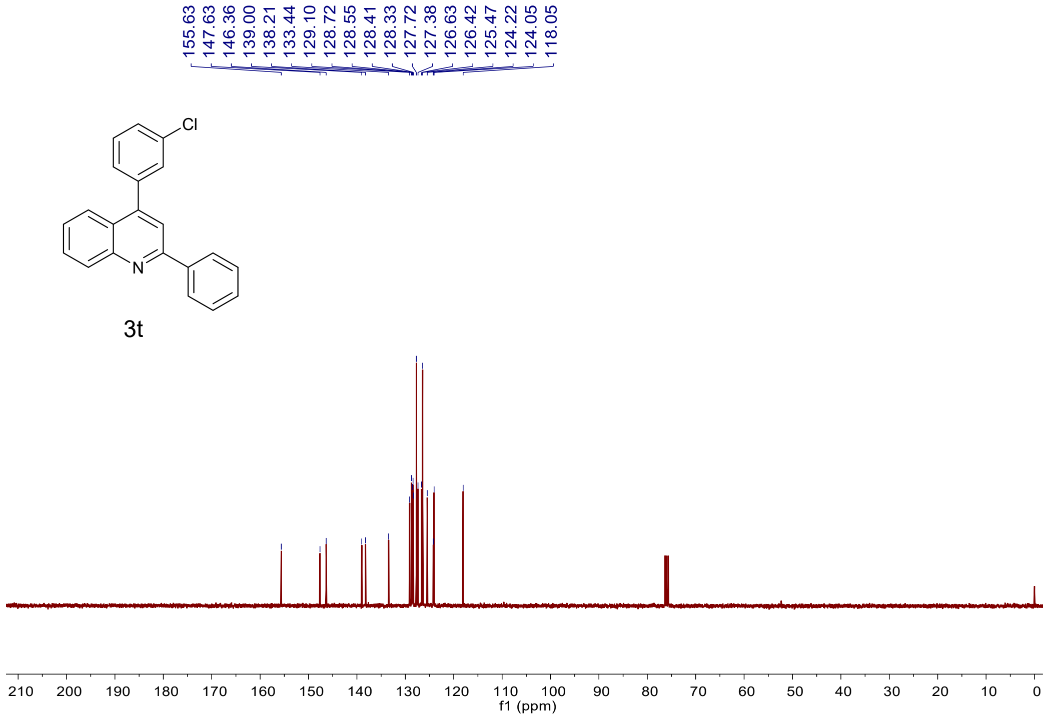
Cl
N
3t
1.00 2.00 1.02 1.03 1.02 1.01 2.04 4.98
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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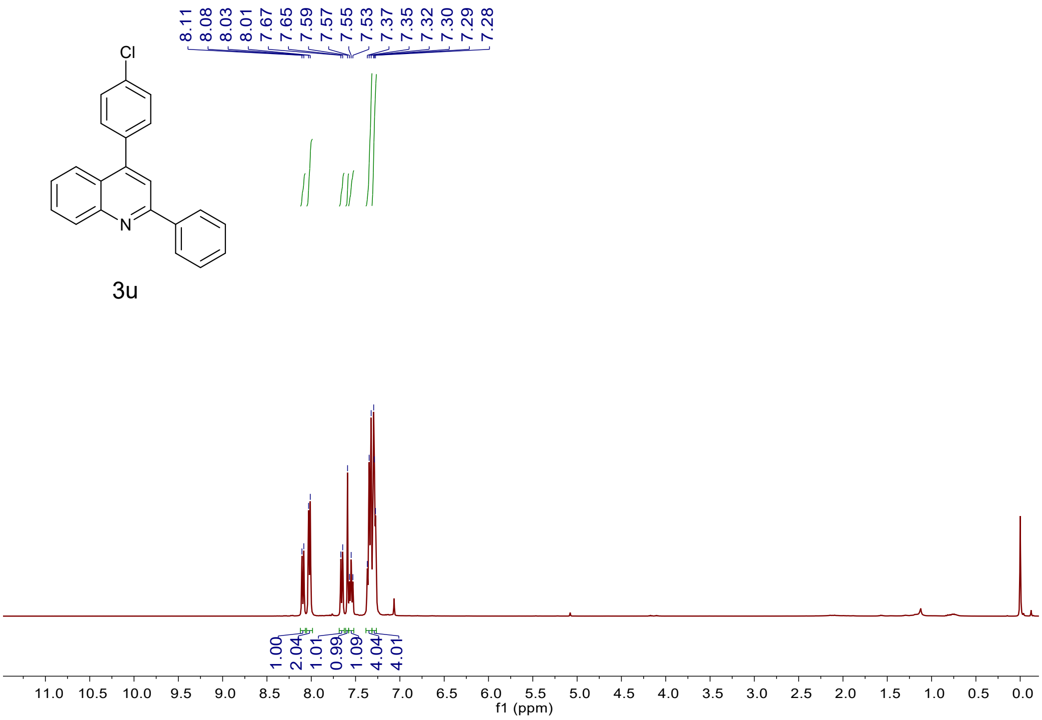
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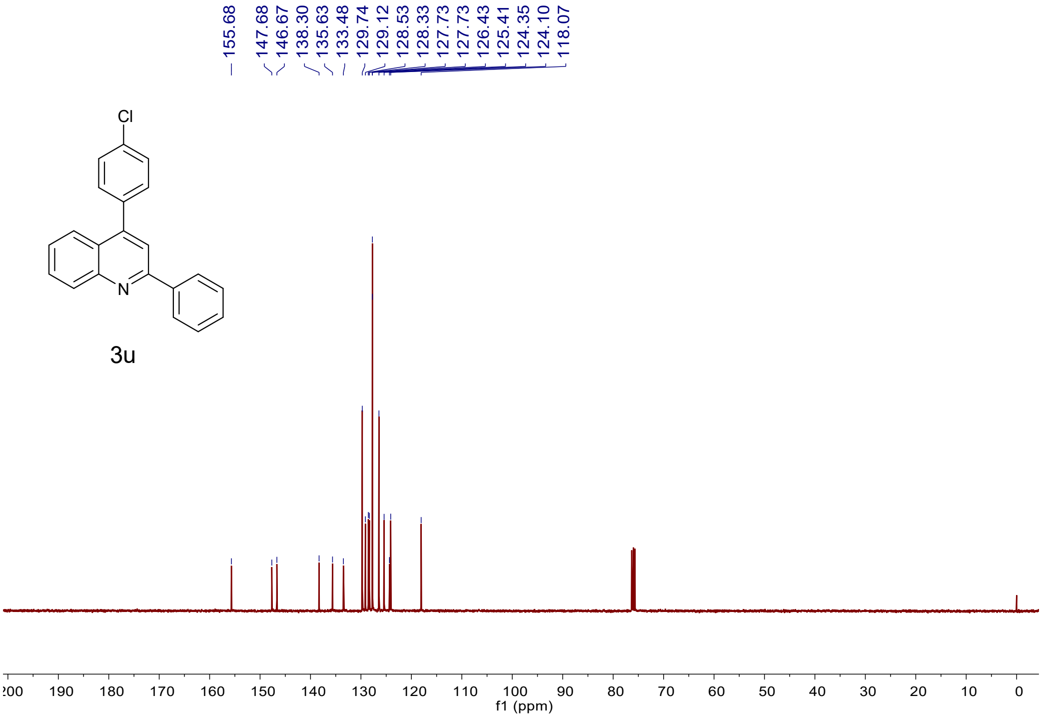
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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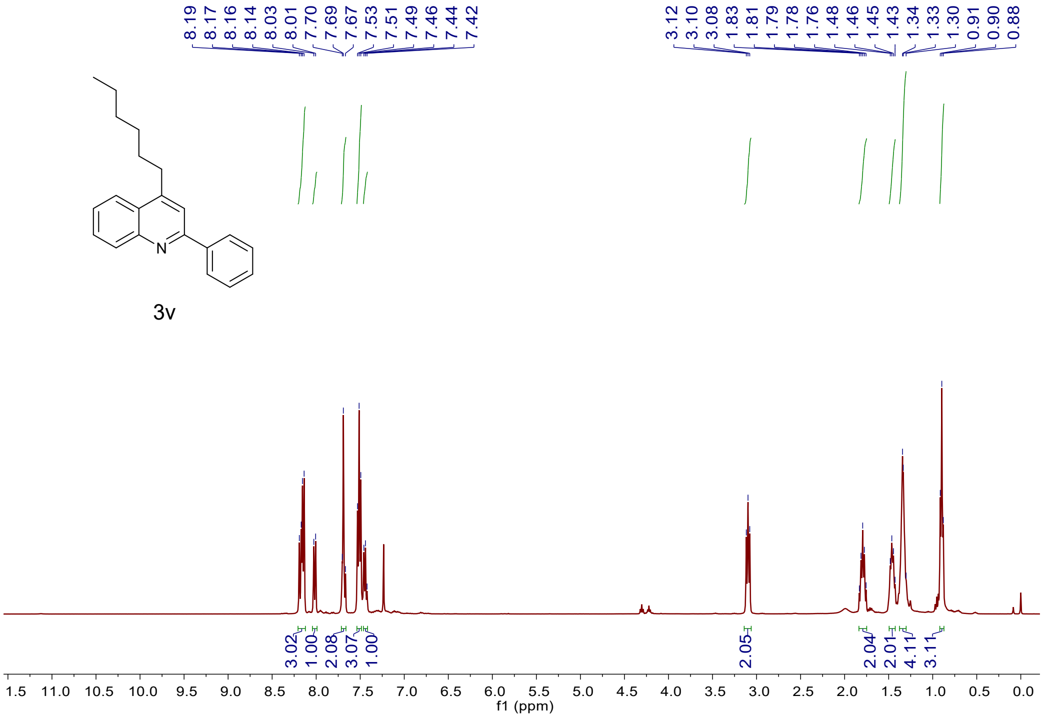
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1.46
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0.90
0.88
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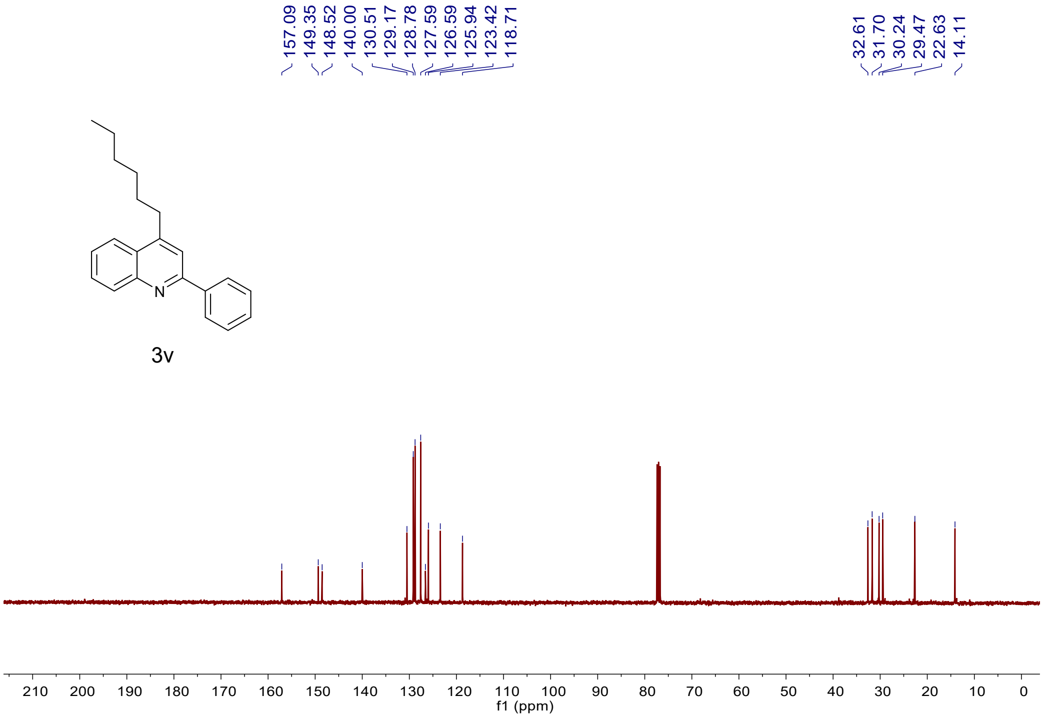
2.08
3.07
1.00
2.05
2.04
2.01
4.11
3.11
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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125.94
123.42
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32.61
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30.24
29.47
22.63
14.11
N
3v
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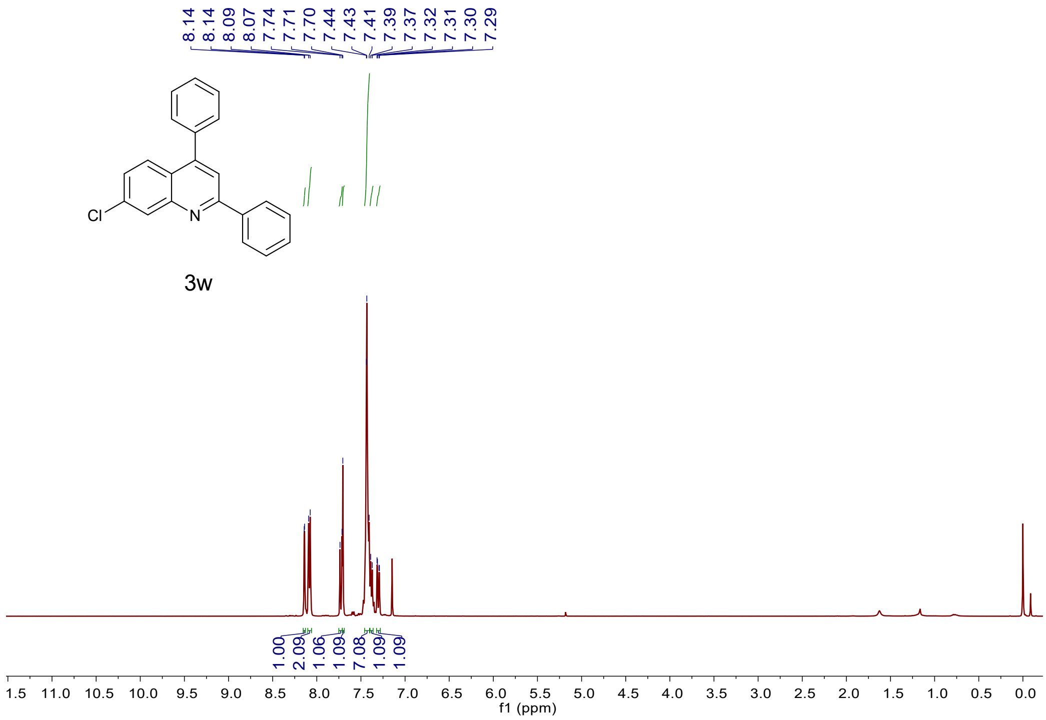
f1 (ppm)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7.41
7.39
7.37
7.32
7.31
7.30
7.29
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3w
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1.06
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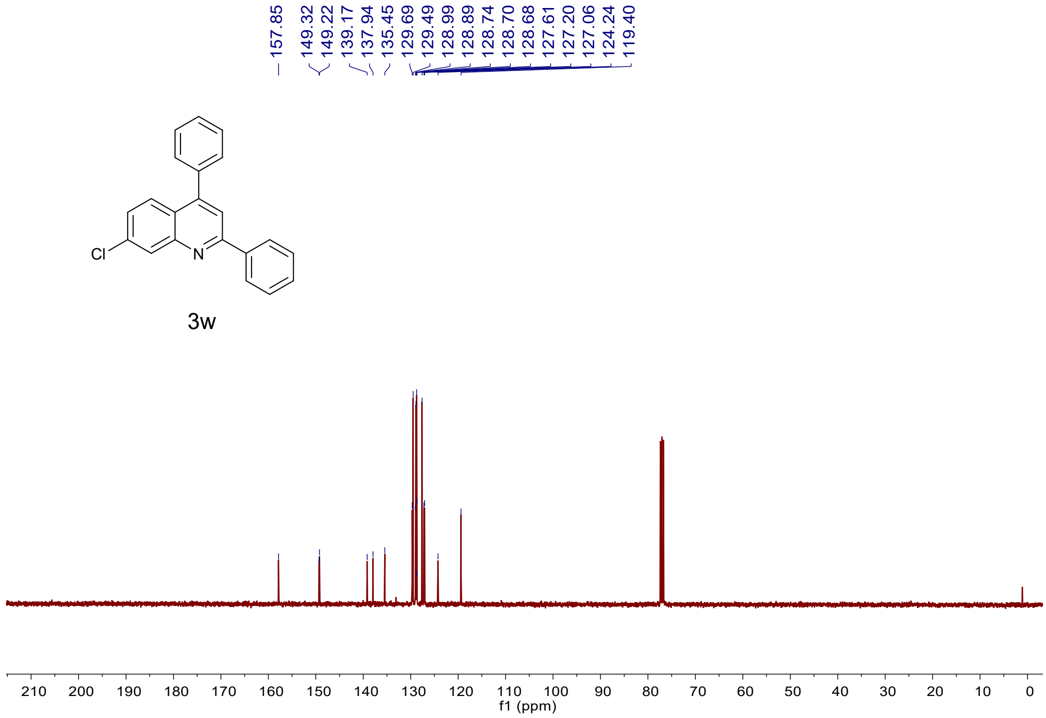
7.08
1.09
1.09
f1 (ppm)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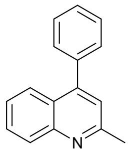
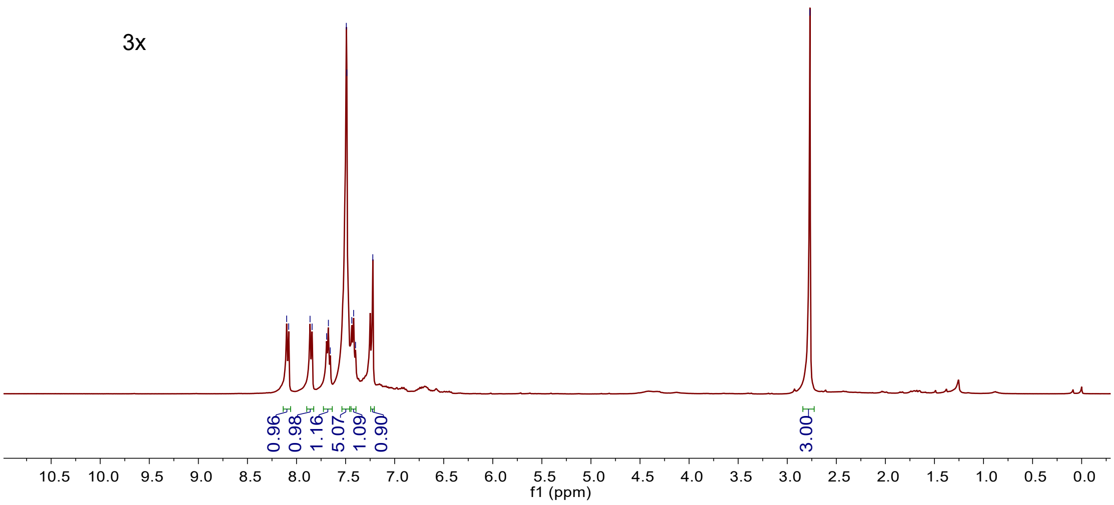
127.20
127.06
124.24
119.40
Cl
N
3w
f1 (ppm)



3x



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8.08
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7.68
7.66
7.49
7.49
7.44
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7.40
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2.77
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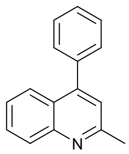
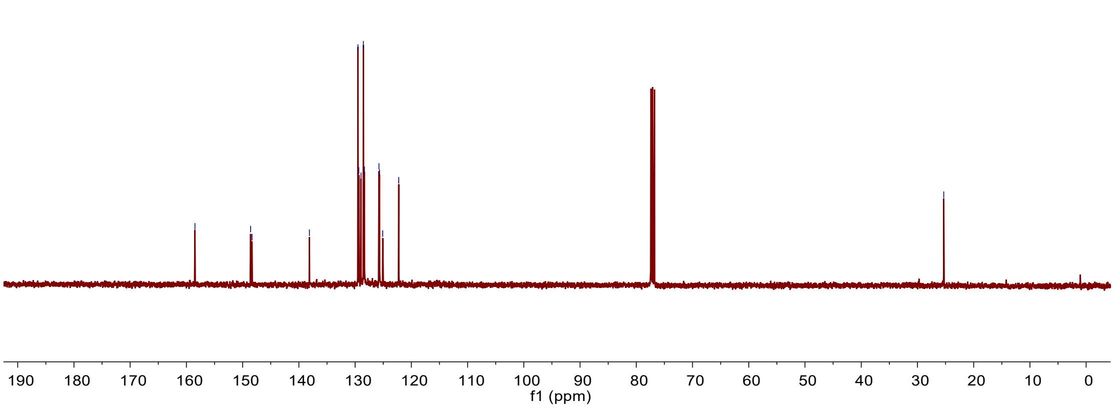
0.98
1.16
5.07
1.09
0.90
3.00
f1 (ppm)



3x



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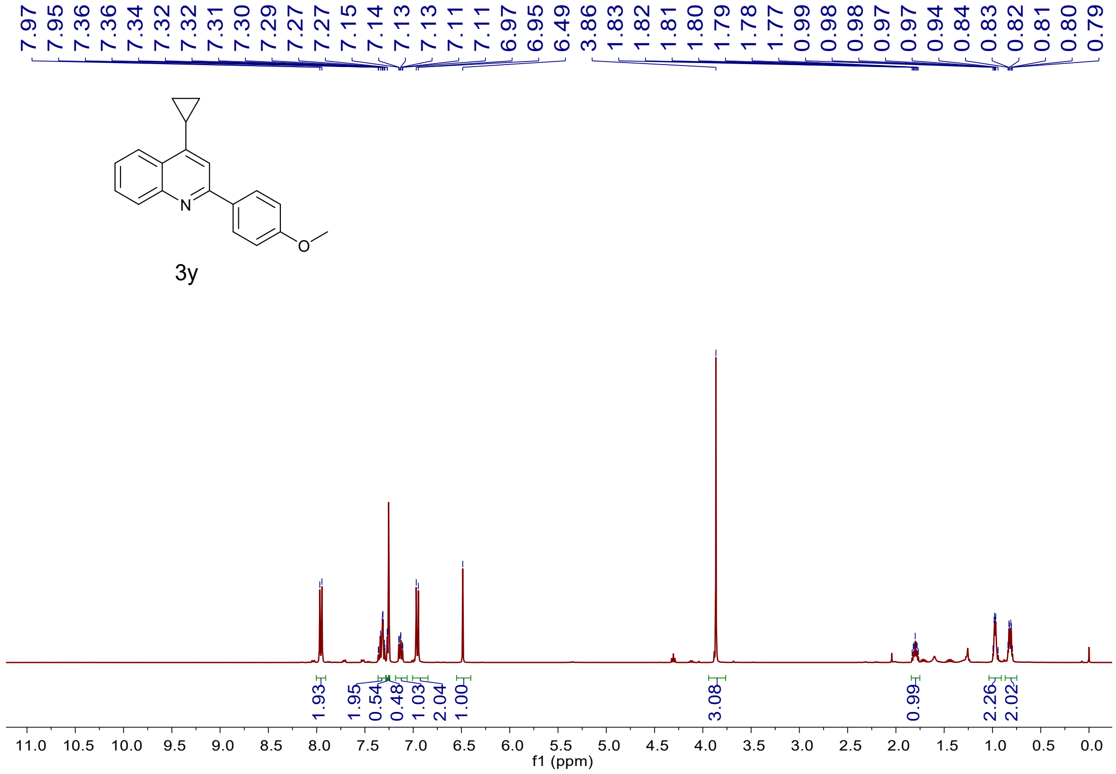
25.33
f1 (ppm)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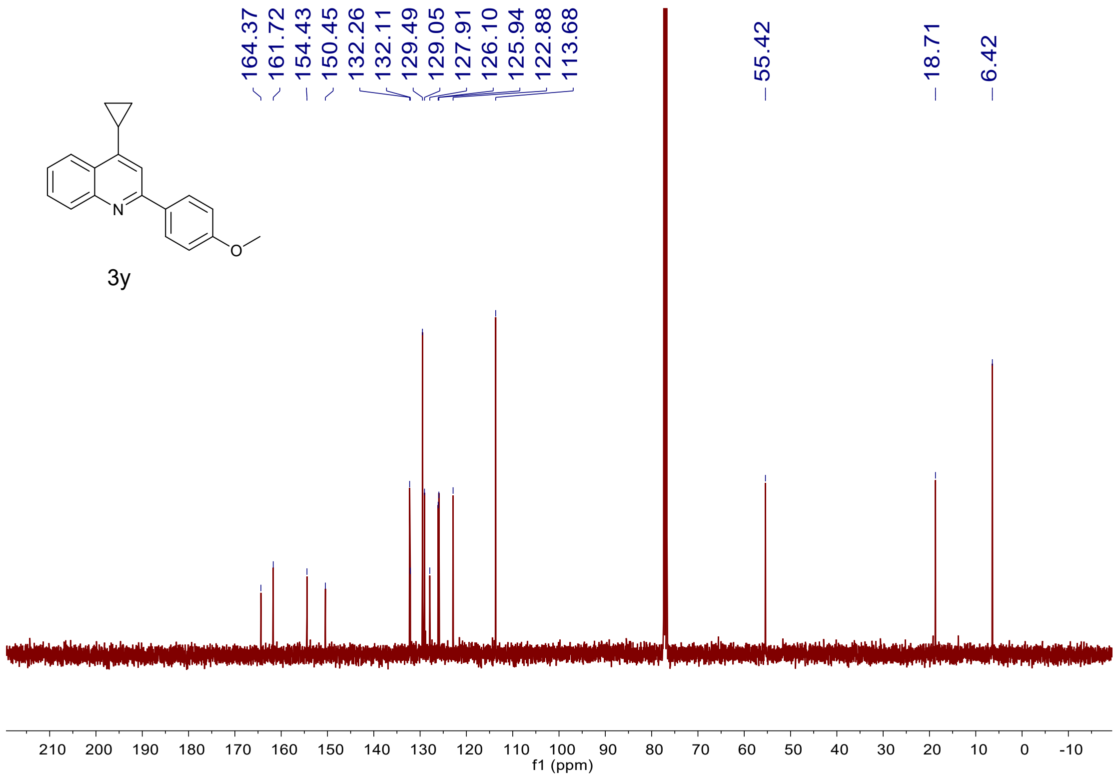
N
O
3y
1.93 1.95 0.54 0.48 1.03 2.04 1.00 3.08 0.99 2.26 2.02
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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6.42
N
O
3y
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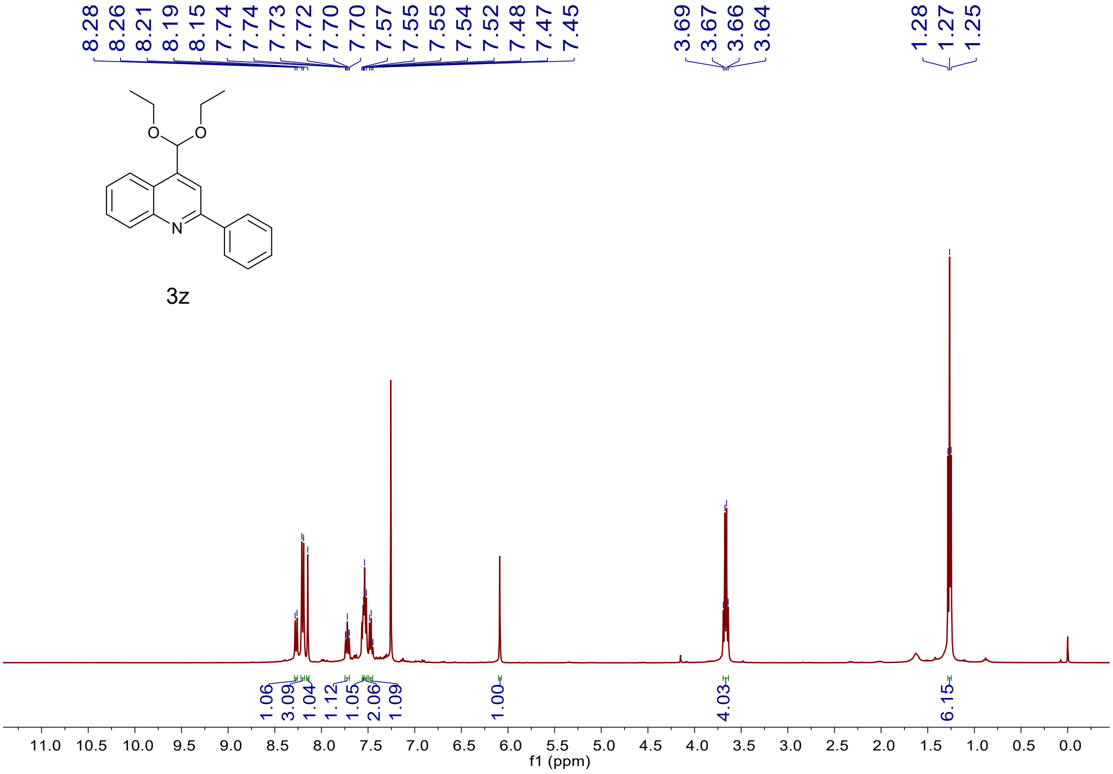
f1 (ppm)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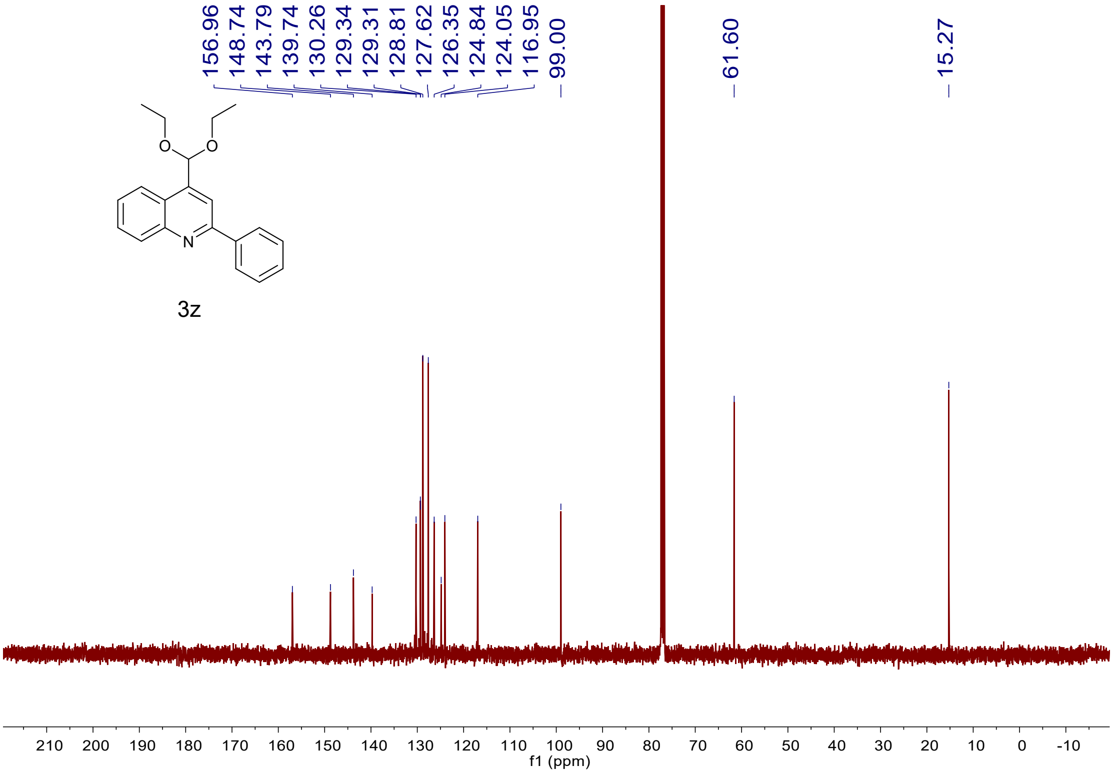
3.69 3.67 3.66 3.64
1.28 1.27 1.25
3z
1.06 3.09 1.04 1.12 1.05 2.06 1.09
1.00
4.03
6.15
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


156.96 148.74 143.79 139.74 130.26 129.34 129.31 128.81 127.62 126.35 124.84 124.05 116.95
99.00
61.60
15.27
3z
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)