Electronic Supplementary Information

Fe-Catalyzed Decarbonylative Alkylative Arylation of *N*-aryl Cinnamamides with Aliphatic Aldehydes to construct 3,4-dihydroquinolin-2(1*H*)-ones

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Ⅰ. General information

Unless otherwise noted, all commercially available compounds were used as provided without further purification. Dry solvents (toluene, ethylacetate, dichloroethane, acetonitrile, chlorobenzene, fluorobenzene) were used as commercially available. The tertiary amide substrates were synthesized accord to the literature reports. [1, 2] Thin-layer chromatography (TLC) was performed using E. Merck silica gel 60 F254 precoated plates (0.25 mm) or Sorbent Silica Gel 60 F254 plates. The developed chromatography was analyzed by UV lamp (254 nm). Gas chromatograph (GC) was measured on Shimadzu GC-2014 instrument with a FID detector and *n*-dodecane as the internal standard; Gas Chromatograph-Mass Spectrometer (GC-MS) was measured on Agilent 7890-5975C instrument under the EI ionization model, instead. High-resolution mass spectra (HRMS) were obtained from a JEOL JMS-700 instrument (ESI). Melting points are uncorrected. Nuclear magnetic resonance (NMR) spectra were recorded on a Bruker Avance 400 spectrometer at ambient temperature. Chemical shifts for ^{1}H NMR spectra are reported in parts per million (ppm) from tetramethylsilane with the solvent resonance as the internal standard (chloroform: δ 7.26 ppm). Chemical shifts for ^{13}C NMR spectra are reported in parts per million (ppm) from tetramethylsilane with the solvent as the internal standard ($CDCl_3$: δ 77.16 ppm). Data are reported as following: chemical shift, multiplicity (s = singlet, d = doublet, dd = doublet of doublets, t = triplet, q = quartet, m = multiplet, br = broad signal), coupling constant (Hz), and integration.

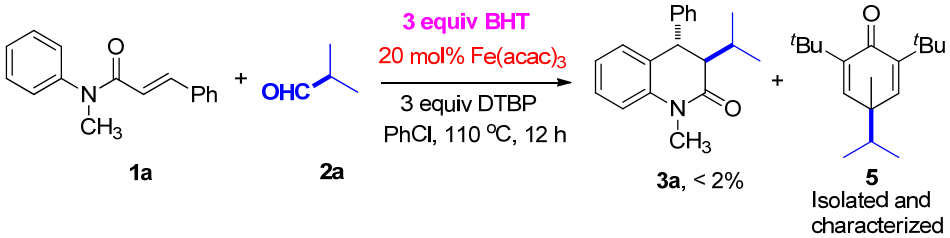
II. General experimental procedures

A general experimental procedure is described as following:

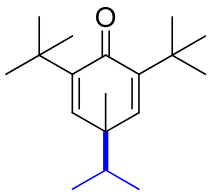
An oven-dried microwave reaction vessel was charged with *N*-methyl-*N*-phenylcinnamamide (**1a**, 0.2 mmol, 1 equiv), $Fe(acac)_3$ (0.04 mmol, 20 mol%) and isobutyraldehyde (**2a**, 0.8 mmol, 4 equiv) in chlorobenzene (1.0 mL) at ambient temperature, then DTBP (0.6 mmol, 3.0 equiv) was added with vigorous stirring under argon atmosphere. The reaction mixture was stirred at 110°C (oil bath temperature) for 12h. Afterwards the resulting mixture was cooled to room temperature, transferred to silica gel column directly and purified by column chromatography with a mixture of EtOAc in petroleum ether as eluent to give the pure product **3a**.

III. Radical inhibition experiment

The cascade reaction of **1a** and **2a** was completely inhibited in the presence of 2,6-di-*tert*-butyl-4-methylphenol (BHT); instead, the decarbonylated alkyl radical was captured as 2,6-di-*tert*-butyl-4-isopropyl-4-methylcyclohexa-2,5-dienone **5**, which was isolated by column chromatography and characterized by NMR and MS.



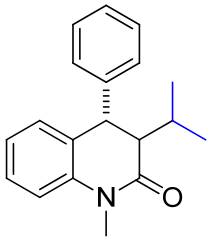
(5) 2,6-di-tert-butyl-4-isopropyl-4-methylcyclohexa-2,5-dienone



^{1}H NMR (400 MHz, $CDCl_3$) δ 6.44 (s, 2H), 1.81 − 1.74 (m, 1H), 1.24 (s, 18H), 1.17 (s, 3H), 0.84 (d, *J* = 6.8 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 186.91, 146.95, 145.81, 42.43, 37.54, 34.88, 29.70, 24.72, 18.09. IR: 2998, 2959, 2872, 1658, 1639, 1458, 1374, 1248, 1061, 880, 741 cm^{-1}. HRMS (+ESI) calculated for $C_{18}H_{30}ONa$ $[M+Na]^+$ 285.2189, found: 285.2173.

IV. Spectra data of products 3a-3k, 4b-4s, 6

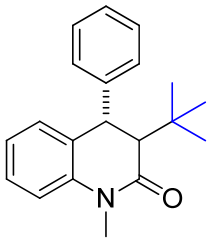
(3a) 3-isopropyl-1-methyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one[1]



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-phenylcinnamamide (**1a**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (43.0 mg, 77%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (td, *J* = 7.6, 1.2 Hz, 1H), 7.24 – 7.15 (m, 4H), 7.07 – 7.04 (m, 2H), 6.98 (d, *J* = 7.2 Hz, 2H), 4.19 (s, 1H), 3.36 (s, 3H), 2.60 (dd, *J* = 9.2, 2.0 Hz, 1H), 1.70 – 1.64 (m, 1H), 1.04 (d, *J* = 6.8 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.75, 142.16, 140.19, 129.66, 128.80, 128.14, 127.19, 126.80, 126.77, 123.33, 114.90, 56.52, 45.09, 29.58, 28.57, 21.13, 21.05. IR: 3061, 2961, 1673, 1602, 1468, 1360, 755, 698 cm^{-1}.

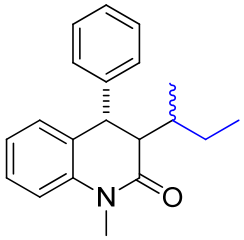
(3b) 3-(tert-butyl)-1-methyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one[1]



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-phenylcinnamamide (**1a**) with pivalaldehyde (**2b**), and purified by flash column chromatography as colorless oil (36.3 mg, 62%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (td, *J* = 8.0, 1.6Hz 1H), 7.23 – 7.12 (m, 4H), 7.06 – 7.02 (m, 2H), 6.96 (d, *J* = 7.2 Hz, 2H), 4.31 (s, 1H), 3.41 (s, 3H), 2.68 (s, 1H), 0.94 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.63, 143.79, 140.78, 129.18, 128.89, 128.08, 127.56, 127.05, 126.68, 123.55, 114.75, 59.40, 43.93, 34.66, 29.70, 28.99. IR: 3060, 2958, 1661, 1599, 1463, 1357, 1128, 753 cm^{-1}.

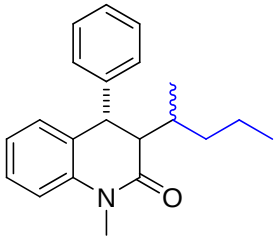
(3c) 3-(sec-butyl)-1-methyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-phenylcinnamamide (**1a**) with 2-methylbutanal (**2c**), and purified by flash column chromatography as colorless oil (39.9mg, 68%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (td, *J* = 8.0, 1.6 Hz, 1H), 7.25 – 7.21 (m, 2H), 7.18 – 7.15 (m, 2H), 7.07 – 7.05 (m, 2H), 6.98 (d, *J* = 8.0 Hz, 2H), 4.18 (s, 1H), 3.36 (s, 3H), 2.74 – 2.70 (m, 1H), 1.64 – 1.47 (m, 2H), 1.37 – 1.26 (m, 1H), 0.96 – 0.84 (m, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.01, 170.86, 142.42, 142.29, 140.23, 129.68, 129.60, 128.84, 128.14, 127.25, 127.22, 127.00, 126.92, 126.84, 126.81, 123.39, 123.35, 114.93, 114.87, 54.99, 54.22, 45.18, 44.66, 35.13, 34.43, 29.66, 29.62, 27.31, 26.95, 16.99, 16.94, 11.36, 10.64. IR: 3060, 2962, 1672, 1601, 1463, 1363, 1120, 754, 697 cm^{-1}. HRMS (+ESI) calculated for $C_{20}H_{23}NONa$ $[M+Na]^+$ 316.1672, found: 316.1652.

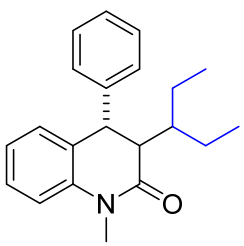
(3d) 1-methyl-3-(pentan-2-yl)-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-phenylcinnamamide (**1a**) with 2-methylpentanal (**2d**), and purified by flash column chromatography as colorless oil (43.6 mg, 71%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (td, *J* = 8.0, 1.6 Hz, 1H), 7.25 – 7.20 (m, 2H), 7.17 – 7.14 (m, 2H), 7.06 – 7.03 (m, 2H), 6.99 – 6.96 (m, 2H), 4.18 (s, 1H), 3.36 (d, *J* = 1.6 Hz, 3H), 2.71 (dd, *J* = 8.4, 2.0 Hz, 1H), 1.57 – 1.53 (m, 1H), 1.41 – 1.26 (m, 4H), 0.95 – 0.90 (m, 3H), 0.88 – 0.81 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.03, 170.81, 142.47, 142.24, 140.26, 140.21, 129.68, 129.57, 128.84, 128.13, 127.29, 127.24, 127.05, 126.99, 126.84, 126.80, 123.39, 123.33, 114.89, 114.87, 55.19, 54.64, 45.32, 44.57, 36.99, 36.79, 33.62, 33.00, 29.68, 29.61, 20.18, 19.58, 17.56, 17.49, 14.41, 14.34. IR: 3025, 2957, 1672, 1599, 1462, 1358, 1120, 753 cm^{-1}. HRMS (+ESI) calculated for $C_{21}H_{25}NONa$ $[M+Na]^+$ 330.1828, found : 330.1792.

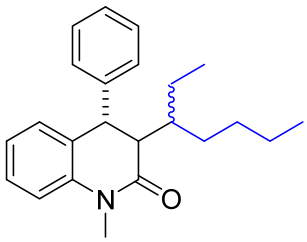
(3e) 1-methyl-3-(pentan-3-yl)-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one[1]



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-phenylcinnamamide (**1a**) with 2-ethylbutanal (**2e**), and purified by flash column chromatography as colorless oil (42.4 mg, 69%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (td, *J* = 7.6, 1.2 Hz, 1H), 7.25 – 7.21 (m, 2H), 7.17 – 7.16 (m, 2H), 7.07 – 7.03 (m, 2H), 6.97 (d, *J* = 7.2 Hz, 2H), 4.17 (d, *J* = 1.6 Hz, 1H), 3.36 (s, 3H), 2.85 (dd, *J* = 8.0, 2.0 Hz, 1H), 1.57 – 1.52 (m, 1H), 1.46 – 1.38 (m, 4H), 0.87 (t, *J* = 7.2 Hz, 3H), 0.81 (t, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.13, 142.32, 140.28, 129.62, 128.84, 128.13, 127.24, 126.97, 126.82, 123.35, 114.89, 51.94, 44.72, 40.06, 29.68, 22.72, 21.85, 11.24, 9.56. IR: 3060, 2961, 1672, 1600, 1462, 1363, 753 cm^{-1}.

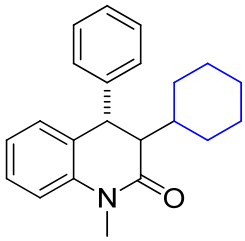
(3f) 1-methyl-3-(octan-3-yl)-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-phenylcinnamamide (**1a**) with 2-ethylhexanal (**2f**), and purified by flash column chromatography as colorless oil (46.9 mg, 70%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (t, *J* = 7.2 Hz, 1H), 7.26 – 7.21 (m, 2H), 7.16 (t, *J* = 7.2 Hz, 2H), 7.06 – 7.03 (m, 2H), 6.98 (d, *J* = 7.6 Hz, 2H), 4.16 (s, 1H), 3.35 (s, 3H), 2.84 (d, *J* = 5.6 Hz, 1H), 1.46 – 1.38 (m ,5H), 1.26 – 1.18 (m, 4H), 0.90 – 087 (m, 3H), 0.83 – 0.80 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.17, 142.36, 140.31, 129.65, 128.87, 128.15, 127.32, 127.10, 126.86, 123.36, 114.89, 52.39, 44.86, 39.12, 29.70, 29.50, 27.77, 23.52, 23.17, 14.19, 11.22. IR: 2925, 1672, 1599, 1462, 1359, 1120, 669 cm^{-1}. HRMS (+ESI) calculated for $C_{23}H_{29}NONa$ $[M+Na]^+$ 358.2141, found: 358.2113.

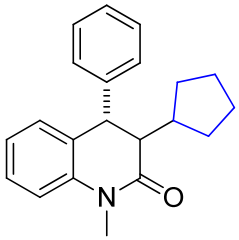
(3g) 3-cyclohexyl-1-methyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one[2]



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-phenylcinnamamide (**1a**) with cyclohexanecarbaldehyde (**2g**), and purified by flash column chromatography as colorless oil (46.6 mg, 73%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (td, *J* = 7.6, 1.2Hz, 1H), 7.23 – 7.14 (m, 4H), 7.07 – 7.04 (m, 2H), 6.96 (d, *J* = 7.2 Hz, 2H), 4.21 (s, 1H), 3.36 (s, 3H), 2.67 (dd, *J* = 8.8, 1.2Hz, 1H), 1.93 – 1.91 (m,1H), 1.74 – 1.71 (m, 2H), 1.58 – 1.57 (m, 2H), 1.38 – 1.33 (m, 1H), 1.29 – 1.20 (m, 1H), 1.16 – 1.07 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.62, 142.46, 140.21, 129.73, 128.81, 128.13, 127.19, 126.82, 126.77, 123.36, 114.95, 55.75, 44.56, 37.86, 31.50, 31.22, 29.58, 26.27, 26.25, 26.09. IR: 3024, 2925, 1673, 1601, 1463, 1362, 1128, 753, 696 cm^{-1}.

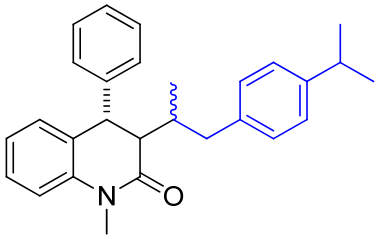
(3h) 3-cyclopentyl-1-methyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one[2]



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-phenylcinnamamide (**1a**) with cyclopentanecarbaldehyde (**2h**), and purified by flash column chromatography as colorless oil (40.3 mg, 66%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (td, *J* = 8.0, 1.6 Hz, 1H), 7.25 – 7.20 (m, 3H), 7.16 – 7.14 (m, 1H), 7.08 – 7.04 (m, 2H), 6.97 (d, *J* = 7.6 Hz, 2H), 4.13 (s, 1H), 3.35 (s, 3H), 2.70 (dd, *J* = 10.4, 1.2 Hz, 1H), 1.92 – 1.89 (m, 1H), 1.78 – 1.74 (m, 1H), 1.67 – 1.65 (m, 2H), 1.57 – 1.43 (m, 4H), 1.37 – 1.36 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.95, 142.15, 140.14, 129.84, 128.81, 128.16, 127.12, 126.81, 126.55, 123.33, 114.90, 55.15, 46.63, 40.39, 31.48, 30.93, 29.56, 25.22, 24.67. IR: 3061, 2950, 1674, 1601, 1467, 1362, 1130, 753, 697 cm^{-1}.

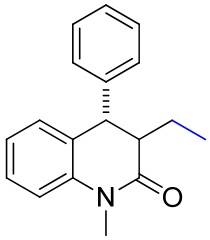
(3i)(4*S*)-3-(1-(4-isopropylphenyl)propan-2-yl)-1-methyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-phenylcinnamamide (**1a**) with 3-(4-isopropylphenyl)-2-methylpropanal (**2i**), and purified by flash column chromatography as colorless oil (66.7 mg, 84 %).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 – 7.29 (m, 1H), 7.25 – 7.02 (m, 8H), 6.98 – 6.92 (m, 4H), 4.22 (s, 1H), 3.33 (d, *J* = 17.2 Hz, 3H), 2.99 – 2.79 (m, 3H), 2.49 – 2.42 (m, 1H), 1.93 – 1.85 (m, 1H), 1.22 (dd, J = 6.8, 4.8 Hz, 6H), 0.90 (dd, *J* = 11.6, 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.81, 170.60, 146.73, 146.45, 142.04, 141.86, 140.23, 140.16, 137.79, 137.71, 129.55, 129.51, 129.30, 129.24, 128.86, 128.23, 128.18, 127.50, 127.37, 127.32, 126.99, 126.93, 126.91, 126.42, 126.26, 123.45, 123.38, 114.96, 114.89, 54.86, 53.58, 45.63, 44.87, 41.32, 40.30, 35.80, 35.50, 33.82, 33.78, 29.67, 29.63, 24.20, 17.76, 17.39. IR: 3024, 2960, 1673, 1601, 1462, 1363, 754, 698 cm^{-1}. HRMS (+ESI) calculated for $C_{28}H_{31}NONa$ $[M+Na]^+$ 420.2298, found: 420.2252.

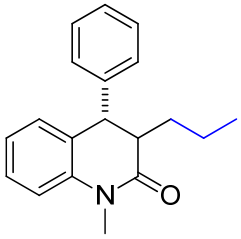
(3j) 3-ethyl-1-methyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-phenylcinnamamide (**1a**) with propionaldehyde (**2j**), and purified by flash column chromatography as colorless oil (22.8 mg, 43%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.25 (m, 3H), 7.22 – 7.18 (m, 1H), 7.06 – 7.00 (m, 5H), 4.05 (d, *J* = 4.4 Hz, 1H), 3.38 (s, 3H), 2.87 – 2.82 (m, 1H), 1.60 – 1.54 (m, 2H), 1.01 (t, *J* = 7.6 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.55, 141.80, 139.89, 129.57, 128.88, 128.04, 127.66, 127.36, 126.98, 123.24, 114.75, 49.96, 46.20, 29.71, 23.57, 11.60. IR: 3027, 2964, 1673, 1599, 1461, 1365, 753, 699 cm^{-1}. HRMS (+ESI) calculated for $C_{18}H_{19}NONa$ $[M+Na]^+$ 288.1359, found : 288.1333.

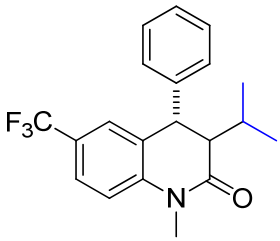
(3k) 1-methyl-4-phenyl-3-propyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-phenylcinnamamide (**1a**) with butyraldehyde (**2k**), and purified by flash column chromatography as colorless oil (23.4 mg, 42%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (td, *J* = 8.0, 1.6 Hz,1H), 7.27 – 7.24 (m, 2H), 7.20 – 7.17 (m, 1H), 7.10 –7.02 (m, 5H), 4.03 (d, *J* = 3.6 Hz, 1H), 3.37 (s, 3H), 2.93 (dd, *J* = 10.0, 6.4 Hz, 1H), 1.52 – 1.42 (m, 4H), 0.89 (t, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.71, 141.98, 139.90, 129.72, 128.89, 128.09, 127.53, 127.12, 126.97, 123.30, 114.81, 48.55, 46.65, 32.82, 29.71, 20.38, 14.06. IR: 3027, 2957, 1672, 1600, 1463, 1368, 754, 699 cm^{-1}. HRMS (+ESI) calculated for $C_{19}H_{21}NONa$ $[M+Na]^+$ 302.1515, found : 302.1489.

(4b) 3-isopropyl-1-methyl-4-phenyl-6-(trifluoromethyl)-3,4-dihydroquinolin-2(1*H*)-one

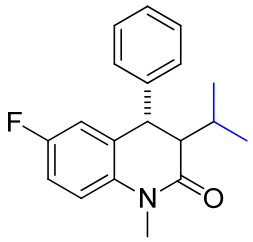


The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-(4-(trifluoromethyl)phenyl) cinnamamide (**1b**) with isobutylraldehyde (**2a**), and purified by flash column chromatography as colorless oil (37.8 mg, 62%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, *J* = 8.4 Hz, 1H), 7.45 (s, 1H), 7.27 – 7.13 (m, 4H), 6.95 (d, *J* = 7.6 Hz, 2H), 4.26 (s, 1H), 3.39 (s, 3H), 2.64 (dd, *J* = 9.2, 1.6 Hz, 1H), 1.70 – 1.61 (m, 1H), 1.06

(d, *J* = 6.8 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.66, 143.11, 141.29, 129.07, 127.34, 127.23, 127.07, 126.56 (q, *J* = 3.7 Hz), 125.59 (q, *J* = 3.7 Hz), 125.32 (q, *J* = 32.7 Hz), 124.18 (d, *J* = 269.8 Hz), 114.90, 56.27, 45.10, 29.74, 28.77, 21.10, 21.05. ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.41 (s, 3F). IR: 2964, 1683, 1619, 1152, 1324, 1118, 746 cm^{-1}. HRMS (+ESI) calculated for $C_{20}H_{20}F_3NONa$ $[M+Na]^+$ 370.1389, found: 370.1362.

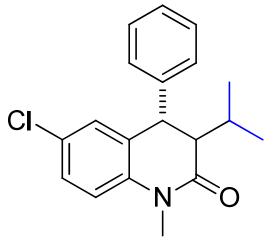
(4c) 6-fluoro-3-isopropyl-1,4-dimethyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-(4-fluorophenyl)-*N*-methylcinnamamide (**1c**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (41.6 mg, 70%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (t, *J* = 7.2 Hz, 2H), 7.19 – 7.16 (m, 1H), 7.02 – 6.96 (m, 4H), 6.93 – 6.91 (m, 1H), 4.15 (d, *J*=1.6 Hz, 1H), 3.35 (s, 3H), 2.59 (dd, *J* = 9.2, 2.0 Hz, 1H), 1.70 – 1.64 (m, 1H), 1.04 (d, *J* = 6.4 Hz, 3H), 0.98 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.98, 140.76 (d, *J* = 229.7 Hz), 137.33, 129.91, 128.73(d, *J* = 11.0 Hz), 128.14, 127.27(d, *J* = 44.1 Hz), 127.04(d, *J* = 33.9 Hz), 126.82, 123.45, 115.77, 56.55, 46.09, 45.01, 28.48, 21.36, 21.03. ^{19}F NMR (376 MHz, $CDCl_3$) δ -120.27 (s, 1F). IR: 2961, 1673, 1502, 1356, 1115, 697 cm^{-1}. HRMS (+ESI) calculated for $C_{19}H_{20}FNONa$ $[M+Na]^+$ 320.1421, found: 320.1389.

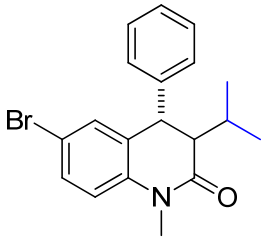
(4d) 6-chloro-3-isopropyl-1-methyl-4-phenyl-3,4-dihydroquinolin- 2(1*H*)-one[1]



The title compound was prepared according to the general procedure described above by the reaction between *N*-(4-chlorophenyl)-*N*-methylcinnamamide (**1d**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil(43.8 mg, 70%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.22 (m, 3H), 7.19 – 7.16 (m, 2H), 6.97 (t, *J* = 8.8 Hz, 3H), 4.15 (s, 1H), 3.34 (s, 3H), 2.59 (dd, *J* = 9.2, 2.0 Hz, 1H), 1.69 – 1.62 (m, 1H), 1.04 (d, *J* = 6.4 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.40, 141.43, 138.91, 129.49, 128.98, 128.66, 128.43, 128.05, 127.10, 116.14, 56.24, 44.98, 29.71, 28.69, 21.06. IR: 3027, 2960, 1676, 1493, 1348, 1109, 697 cm^{-1}.

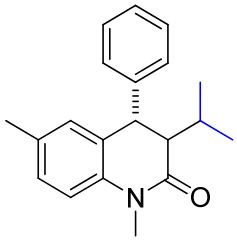
(4e) 6-bromo-3-isopropyl-1-methyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-(4-bromophenyl)-*N*-methylcinnamamide (**1e**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (47.8 mg, 67%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 (dd, *J* = 8.8, 2.4 Hz, 1H), 7.32 (d, *J* = 2.4 Hz, 1H) 7.26 – 7.18 (m, 3H), 6.97 – 6.92 (m, 3H), 4.15 (s, 1H), 3.33 (s, 3H), 2.58 (dd, *J* = 9.2, 2.0 Hz, 1H), 1.69 – 1.62 (m, 1H), 1.04 (d, *J* = 6.8 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.39, 141.43, 139.42, 132.32, 131.02, 129.03, 128.99, 127.12, 127.10, 116.55, 115.97, 56.27, 44.94, 29.67, 28.69, 21.08. IR: 3060, 2959, 1672, 1490, 1413, 1346, 1150, 696 cm^{-1}. HRMS (+ESI) calculated for $C_{19}H_{20}BrNONa$ $[M+Na]^+$ 380.0620, found: 380.0606.

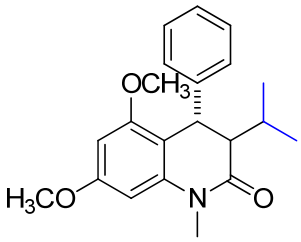
(4f) 3-isopropyl-1,6-dimethyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one[1]



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-(p-tolyl)cinnamamide (**1f**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (41.6 mg, 71%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22 (t, *J* = 7.2 Hz, 2H), 7.16 – 7.10 (m, 2H), 6.99 – 6.94 (m, 4H), 4.13 (s, 1H), 3.34 (s, 3H), 2.56 (dd, *J* = 9.2, 1.6 Hz, 1H), 2.29 (s, 3H), 1.70 – 1.64 (m, 1H), 1.04 (d, *J* = 6.8 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.64, 142.41, 137.86, 132.88, 130.36, 128.82, 128.57, 127.21, 126.78, 126.61, 114.82, 56.77, 45.20, 29.60, 28.60, 21.19, 21.09, 20.74. IR: 3024, 2960, 1672, 1505, 1355, 809, 697 cm^{-1}.

(4g) 3-isopropyl-5,7-dimethoxy-1-methyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one

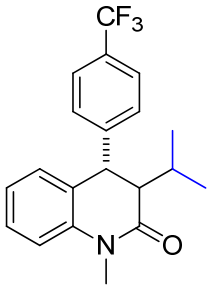


The title compound was prepared according to the general procedure described above by the reaction between *N*-(3,5-dimethoxyphenyl)-*N*-methylcinnamamide (**1g**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as white solid (47.5 mg, 70%). M.p187- 188 ºC.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22 – 7.18 (m, 2H), 7.15 – 7.11 (m, 1H), 7.01 (d, *J* = 7.2 Hz, 2H), 6.26 (dd, *J* = 7.6, 2.0 Hz, 2H), 4.53 (s, 1H), 3.85 (s, 3H), 3.76 (s, 3H), 3.33 (s, 3H), 2.52 (dd, *J* = 9.2

Hz, 1.2 1H), 1.68 – 1.61 (m, 1H), 1.02 (d, *J* = 6.8 Hz, 3H), 0.96 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.46, 160.30, 158.18, 142.59, 141.93, 128.66, 127.14, 126.55, 107.52, 94.06, 92.97, 56.73, 55.93, 55.54, 37.31, 29.90, 28.92, 21.39, 21.29. IR: 2958, 1673, 1597, 1336, 742, 697 cm^{-1}. HRMS (+ESI) calculated for $C_{21}H_{25}NO_3Na$ $[M+Na]^+$ 362.1727, found: 362.1700.

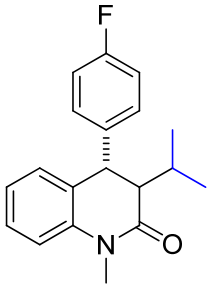
(4h) 3-isopropyl-1-methyl-4-(4-(trifluoromethyl)phenyl)-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between (*E*)-*N*-methyl-*N*-phenyl-3-(4-(trifluoromethyl) phenyl) acrylamide (**1h**) with isobutyraldehyde (**2a**) , and purified by flash column chromatography as colorless oil (46.5 mg, 67%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 8.0 Hz, 2H), 7.38 – 7.34 (m, 1H), 7.18 (d, *J* = 7.6 Hz, 1H), 7.10 – 7.06 (m, 4 H), 4.24 (s, 1H), 3.36 (s, 3H), 2.58 (dd, *J* = 9.2, 1.6 Hz, 1H), 1.71 – 1.65 (m, 1H), 1.05 (d, *J* = 6.4 Hz, 3H), 0.98 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.32, 146.26, 140.18, 129.64, 129.32 (q, *J* = 32.3 Hz), 128.64, 127.65, 125.81 (q, *J* = 3.7 Hz), 125.76, 125.53 (q, *J* = 270.1 Hz), 123.59, 115.15, 56.46, 45.00, 29.63, 28.58, 21.13, 21.01. ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.87 (s, 3F). IR: 2964, 2934, 1675, 1602, 1469, 1326, 1121, 755 cm^{-1}. HRMS (+ESI) calculated for $C_{20}H_{20}F_3NONa$ $[M+Na]^+$ 370.1389, found: 370.1360.

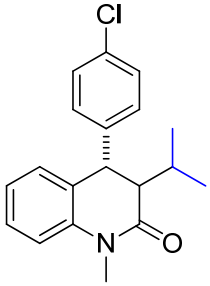
(4i) 4-(4-fluorophenyl)-3-isopropyl-1-methyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between (*E*)-3-(4-fluorophenyl)-*N*-methyl-*N*-phenylacrylamide (**1i**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (41.6 mg, 70%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 (td, *J* = 8.0, 1.2 Hz, 1H), 7.18 – 7.16 (m, 1H), 7.08 – 7.05 (m, 2H), 6.95 – 6.88 (m, 4H), 4.16 (s, 1H), 3.35 (s, 3H), 2.55 (dd, *J*= 9.2, 1.6 Hz, 1H), 1.68 – 1.60 (m, 1H), 1.03 (d, *J* = 6.4 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.63, 161.71(d, *J* = 243.7 Hz), 140.13, 137.86 (d, *J* = 3.1 Hz), 129.64, 128.75(d, *J* = 8.0 Hz), 128.35, 126.60, 123.47, 115.64(d, *J* = 21.2 Hz), 115.05, 56.72, 44.41, 29.62, 28.51, 21.17, 21.04. ^{19}F NMR (376 MHz, $CDCl_3$) δ -116.70 (s, 1F). IR: 3068, 2962, 1673, 1601, 1508, 1361, 755 cm^{-1}. HRMS (+ESI) calculated for $C_{19}H_{20}FNONa$ $[M+Na]^+$ 320.1421, found: 320.1389.

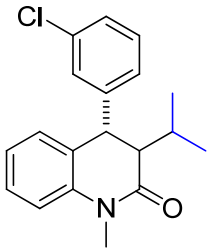
(4j) 4-(4-chlorophenyl)-3-isopropyl-1-methyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-(4-chlorophenyl)-*N*-methylcinnamamide (**1j**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as white solid (42.6 mg, 68%). M.p101-102 ^{o}C

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 (td, *J* = 8.0, 1.6 Hz, 1H), 7.21 – 7.15 (m, 3H), 7.08 – 7.05 (m, 2H), 6.90 (d, *J* = 8.8 Hz, 2H), 4.15 (d, *J* = 1.2 Hz, 1H), 3.35 (s, 3H), 2.55 (dd, *J* = 9.2, 2.0 Hz, 1H), 1.68 – 1.62 (m, 1H), 1.03 (d, *J* = 6.8 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.51, 140.66, 140.16, 132.66, 129.63, 128.97, 128.64, 128.44, 126.27, 123.50, 115.08, 56.53, 44.54, 29.63, 28.52, 21.16, 21.04. IR: 2961, 1673, 1601, 1490, 1360, 754 cm^{-1}. HRMS (+ESI) calculated for $C_{19}H_{20}ClNONa$ $[M+Na]^+$ 336.1126, found: 336.1079.

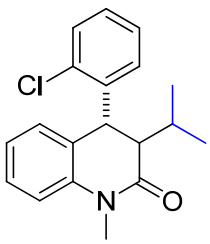
(4k) 4-(3-chlorophenyl)-3-isopropyl-1-methyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-(3-chlorophenyl)-*N*-methylcinnamamide (**1k**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (43.2 mg, 69%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 (td, *J* = 8.0, 1.2 Hz, 1H), 7.17 – 7.14 (m, 3H), 7.09 – 7.06 (m, 2H), 6.94 (s, 1H), 6.84 (d, *J* = 6.0 Hz, 1H), 4.16 (s, 1H), 3.36 (s, 3H), 2.56 (dd, *J* = 9.2, 2.0 Hz, 1H), 1.68 – 1.61 (m, 1H), 1.03 (d, *J* = 6.4 Hz, 3H), 0.97 (d, *J* = 6.8Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.40, 144.29, 140.19, 134.62, 130.11, 129.68, 128.54, 127.60, 127.11, 125.88, 125.36, 123.54, 115.12, 56.54, 44.85, 29.63, 28.58, 21.15, 21.02. IR: 3066, 2962, 1673, 1602, 1471, 1361, 754 cm^{-1}. HRMS (+ESI) calculated for $C_{19}H_{20}ClNONa$ $[M+Na]^+$ 336.1126, found: 336.1088.

(4l) 4-(2-chlorophenyl)-3-isopropyl-1-methyl-3,4-dihydroquinolin-2(1*H*)-one

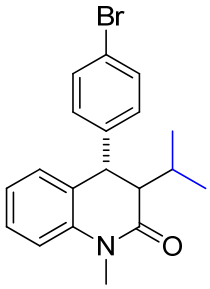


The title compound was prepared according to the general procedure described above by the reaction

between *N*-(2-chlorophenyl)-*N*-methylcinnamamide (**1l**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (47.0 mg, 75%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.35 (m, 2H), 7.15 – 7.02 (m, 5H), 6.51 (dd, *J* = 7.6, 1.2Hz, 1H), 4.66 (d, *J* = 0.8 Hz, 1H), 3.40 (s, 3H), 2.61 (dd, *J* = 9.6, 2.0 Hz, 1H), 1.70 – 1.66 (m, 1H), 1.12 (d, *J* = 6.4 Hz, 3H) , 0.96 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.51, 140.98, 139.00, 133.28, 130.15, 129.86, 128.58, 128.54, 128.23, 127.28, 126.03, 123.64, 114.95, 54.60, 42.53, 29.63, 29.24, 21.27, 20.77. IR: 32962, 1677, 1602, 1469, 1274, 1039, 751, 689 cm^{-1}. HRMS (+ESI) calculated for $C_{19}H_{20}ClNONa$ $[M+Na]^+$ 336.1126, found: 336.1087.

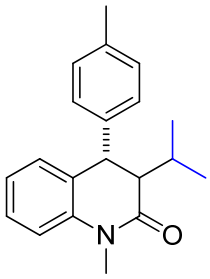
(4m) 4-(4-bromophenyl)-3-isopropyl-1-methyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-(4-bromophenyl)-*N*-methylcinnamamide (**1m**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (50.7 mg, 71%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 – 7.32 (m, 3H), 7.17 – 7.15 (m, 1H), 7.08 – 7.05 (m, 2H), 6.85 (d, *J* = 8.4 Hz, 2H), 4.13 (s, 1H), 3.35 (s, 3H), 2.54 (dd, *J* = 9.2, 1.6 Hz, 1H), 1.67 – 1.62 (m, 1H), 1.03 (d, *J* =6.8 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.45, 141.16, 140.11, 131.87, 129.58, 128.99, 128.43, 126.14, 123.48, 120.72, 115.05, 56.43, 44.55, 29.60, 28.48, 21.13, 21.01. IR: 3041, 2961, 1672, 1467, 1360, 754 cm^{-1}. HRMS (+ESI) calculated for $C_{19}H_{20}BrNONa$ $[M+Na]^+$ 380.0620, found: 380.0599.

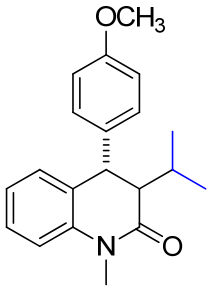
(4n) 3-isopropyl-1-methyl-4-(p-tolyl)-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-(p-tolyl)cinnamamide (**1n**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (41.6 mg, 71%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (td, *J* = 8.0, 1.6 Hz, 1H), 7.19 – 7.17 (m, 1H), 7.06 – 7.02 (m, 4H), 6.86 (d, *J* = 8.0 Hz, 2H), 4.15 (s, 1H), 3.35 (s, 3H), 2.58 (dd, *J* = 9.2, 2.0 Hz, 1H), 2.26 (s, 3H), 1.68 – 1.62 (m, 1H), 1.03 (d, *J*= 6.8 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.89, 140.18, 139.13, 136.36, 129.62, 129.50, 128.05, 127.05, 123.31, 114.89, 56.56, 44.72, 29.58, 28.51, 21.15, 21.06, 21.03. IR: 3020, 2961, 1675, 1601, 1360, 754, cm^{-1}. HRMS (+ESI) calculated for $C_{20}H_{23}NONa$ $[M+Na]^+$ 316.1672, found: 316.1646.

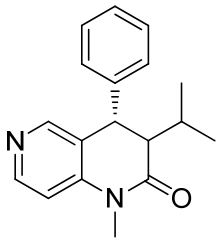
(4o) 3-isopropyl-4-(4-methoxyphenyl)-1-methyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-(4-methoxyphenyl)-*N*-methylcinnamamide (**1o**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (46.4 mg, 75%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (td, *J* = 8.0, 1.2 Hz, 1H), 7.18 – 7.17 (m, 1H), 7.07 – 7.03 (m, 2H), 6.89 (d, *J* = 8.0 Hz, 2H), 6.76 (d, *J* = 8.8 Hz, 2H), 4.14 (s, 1H), 3.73 (s, 3H), 3.35 (s, 3H), 2.57 (dd, *J* = 9.2, 2.0 Hz, 1H), 1.67 – 1.62 (m, 1H), 1.03 (d, *J* = 6.4 Hz, 3H), 0.96 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.12, 142.19, 139.13, 130.07, 128.71, 128.16, 127.31, 126.97, 126.76, 123.14, 114.72, 56.58, 45.23, 37.12, 28.39, 21.09, 21.00, 12.77. IR: 2960, 1673, 1601, 1361, 1250, 1035, 755 cm^{-1}. HRMS (+ESI) calculated for $C_{20}H_{23}NO_2Na$ $[M+Na]^+$ 332.1621, found: 332.1586.

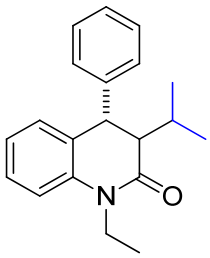
(4p) 3-isopropyl-1-methyl-4-phenyl-3,4-dihydro-1,6-naphthyridin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*-methyl-*N*-(pyridin-4-yl)cinnamamide (**1p**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (29.1 mg, 52%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.51 (d, *J* = 5.6 Hz, 1H), 8.36 (s, 1H), 7.25 – 7.19 (m, 3H), 6.99 – 6.93 (m, 3H), 4.27 (s, 1H), 3.35 (s, 3H), 2.68 (dd, *J* = 9.2, 2.0 Hz, 1H), 1.70 – 1.65 (m, 1H), 1.07 (d, *J* = 6.4 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.74, 150.07, 149.99, 146.74, 141.27, 129.05, 127.23, 126.97, 121.76, 109.18, 56.05, 42.21, 29.01, 28.91, 21.02, 20.97. IR: 2962, 1685, 1590, 1499, 1358, 742, 698.

(4q) 1-ethyl-3-isopropyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one

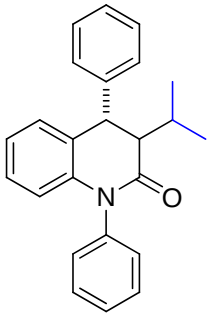


The title compound was prepared according to the general procedure described above by the reaction

between *N*-ethyl-*N*-phenylcinnamamide (**1p**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (37.5 mg, 64%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (td, *J* = 8.4, 1.2 Hz, 1H), 7.23 – 7.12 (m, 4H), 7.09 – 7.02 (m, 2H), 6.98 (d, *J* = 7.2 Hz, 2H), 4.17 (s, 1H), 4.06 – 3.99 (m, 1H), 3.96 – 3.87 (m, 1H), 2.55 (dd, *J* = 9.2, 1.6 Hz, 1H), 1.70 – 1.61 (m, 1H), 1.20 (t, *J* = 6.8 Hz, 3H), 1.04 (d, *J* = 6.8 Hz, 3H), 0.98 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.91, 158.40, 140.14, 134.23, 129.61, 128.19, 128.06, 127.22, 123.32, 114.91, 114.22, 56.63, 55.33, 44.33, 29.58, 28.48, 21.15, 21.07. IR: 3061, 2964, 1673, 1601, 1461, 1378, 753, 697 cm^{-1}. HRMS (+ESI) calculated for $C_{20}H_{23}NONa$ $[M+Na]^+$ 316.1672, found: 316.1663.

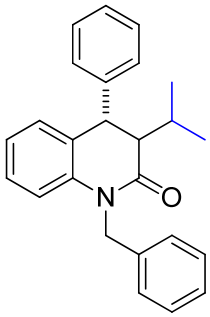
(4r) 3-isopropyl-1,4-diphenyl-3,4-dihydroquinolin-2(1*H*)-one



The title compound was prepared according to the general procedure described above by the reaction between *N*, *N*-diphenylcinnamamide (**1q**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as white solid (52.5 mg, 77%).

M.p161-162 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (t, *J* = 7.2 Hz, 2H), 7.41 – 7.39 (m, 1H), 7.31 – 7.09 (m, 9H), 7.05 – 7.03 (m, 1H), 6.44 (d, *J* = 8.0 Hz, 1H), 4.32 (s, 1H), 2.72 (dd, *J* = 9.6, 2.0 Hz, 1H), 1.89 – 1.84 (m, 1H), 1.14 (d, *J* = 2.8 Hz, 3H), 1.12 (d, *J* = 3.2 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.69, 142.19, 141.24, 138.70, 130.00, 129.78, 128.92, 128.24, 127.85, 127.41, 126.99, 126.15, 123.52, 117.17, 56.89, 45.43, 28.54, 21.26, 21.10. IR: 3061, 2960, 1682, 1493, 753, 694 cm^{-1}. HRMS (+ESI) calculated for $C_{24}H_{23}NONa$ $[M+Na]^+$ 364.1672, found: 364.1644.

(4s) 1-benzyl-3-isopropyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one

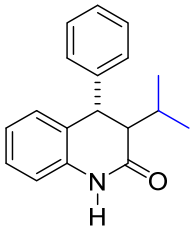


The title compound was prepared according to the general procedure described above by the reaction between *N*-benzyl-*N*-phenylcinnamamide (**1r**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as white solid (51.1 mg, 72%).

M.p119-120 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 – 7.14 (m, 10H), 7.04 – 6.96 (m, 4H), 5.26 (d, *J* = 16.0 Hz, 1H), 5.02 (d, *J* = 16.0 Hz, 1H), 4.26 (s, 1H), 2.70 (dd, *J* = 9.6, 1.6 Hz, 1H), 1.81 – 1.75 (m, 1H), 1.09 (d, *J* = 6.4 Hz, 3H), 1.06 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.36,

160.05, 157.63, 141.45, 136.53, 136.51, 128.97, 128.90, 127.14, 127.10, 116.67, 116.45, 116.14, 116.06, 114.61, 114.38, 56.20, 45.12, 29.86, 28.66, 21.07, 21.04. IR: 3027, 2960, 1672, 1494, 1462, 753, 696 cm^{-1}. HRMS (+ESI) calculated for $C_{25}H_{25}NONa$ $[M+Na]^+$ 378.1828, found: 378.1808.

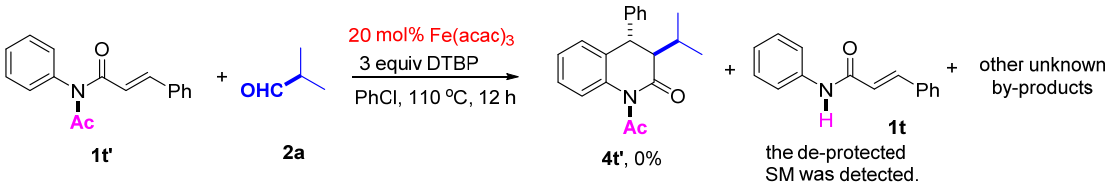
(4t) 3-isopropyl-4-phenyl-3,4-dihydroquinolin-2(1*H*)-one

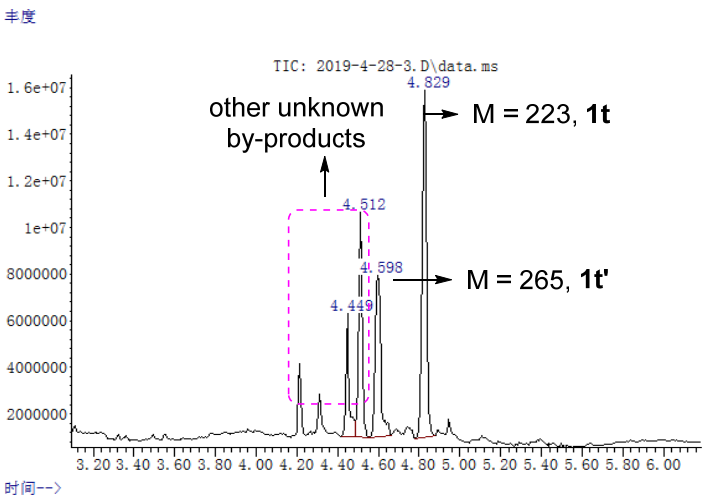


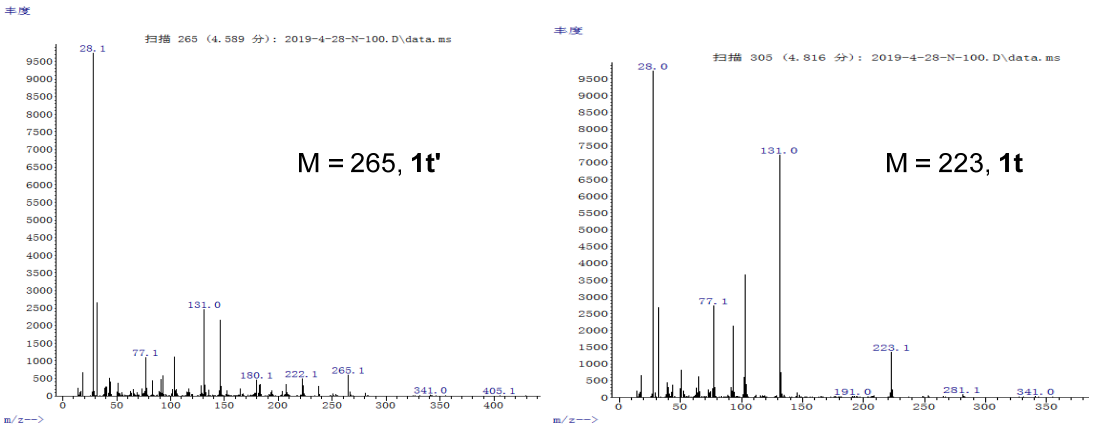
The title compound was prepared according to the general procedure described above by the reaction between *N*-phenylcinnamamide (**1s**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (4.8 mg, 9%).

^1H NMR (400 MHz, $CDCl_3$) δ 7.64 (s, 1H), 7.24 – 7.16 (m, 3H), 7.18 – 7.16 (m, 2H), 7.04 – 7.02 (m, 3H), 6.79 (d, J = 8.0 Hz, 1H), 4.26 (s, 1H), 2.53 (d, J = 8.0 Hz, 1H), 1.85 – 1.79 (m, 1H), 1.06 (dd, J = 14.8, 6.4 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.10, 142.61, 136.76, 129.78, 128.92, 128.21, 127.29, 126.93, 125.19, 123.71, 115.44, 56.17, 45.54, 29.12, 21.03, 20.89. IR: 2960, 2925, 1676, 1597, 1494, 1373, 753, 698 cm^{-1}. HRMS (+ESI) calculated for $C_{18}H_{19}NONa$ $[M+Na]^+$ 288.1359, found: 288.1330.

(4t') For the *N*-acetyl analog (**1t'**), no cyclized product could be detected at all, and the *N*-acetyl group of substrate (**1t'**) was de-protected to produce amide **1t** as the main product.

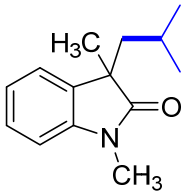






The MS spectrum of **1t'** (left) and **1t** (right)

(6) 3-isobutyl-1, 3-dimethylindolin-2-one [3]



The title compound was prepared according to the general procedure described above by the reaction between *N*-phenyl methacrylamide (**1u**) with isobutyraldehyde (**2a**), and purified by flash column chromatography as colorless oil (37.3 mg, 86%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.26 (t, *J* = 7.6 Hz, 1H), 7.16 (d, *J* = 7.2 Hz, 1H), 7.06 (t, *J* = 7.6 Hz,1H), 6.84 (d, *J* = 7.6 Hz, 1H), 3.22 (s, 3H), 1.94 (dd, *J* =14.0, 7.6 Hz, 1H), 1.76 (dd, *J* = 14.0, 5.6 Hz, 1H), 1.32 (s, 3H), 1.32 – 1.23 (m, 1H), 0.65 (d, *J* = 6.8 Hz, 3H), 0.61 (d, *J* = 6.4 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 181.19, 143.29, 134.31, 127.66, 122.91, 122.43, 108.05, 48.18, 46.84, 26.28, 26.24, 25.63, 24.22, 22.93.

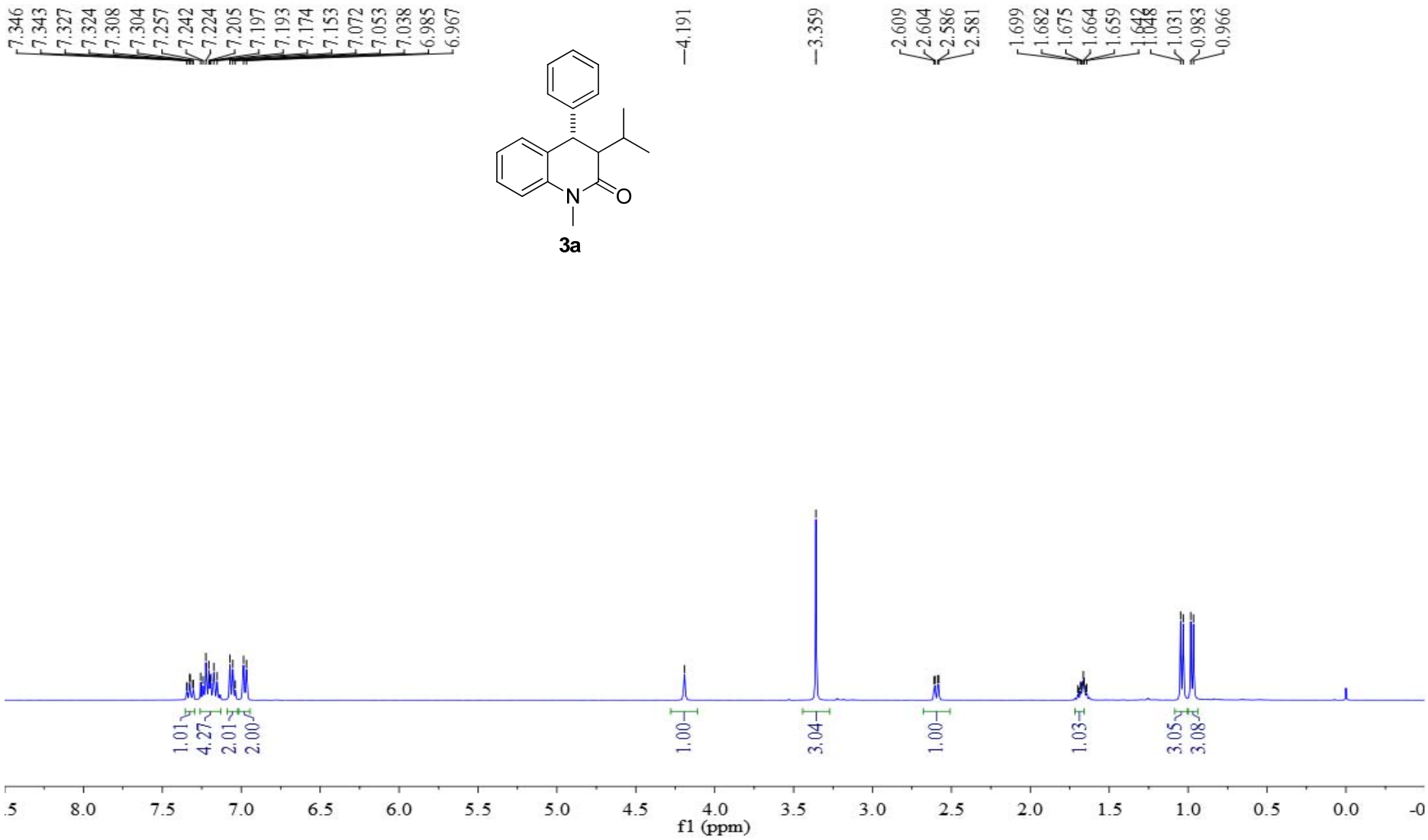
V. References

[1] W. P. Mai, J. T. Wang, L. R. Yang, J. W. Yuan, Y. M. Xiao, P. Mao, L. B. Qu, *Org. Lett*. **2014**, *16*, 204-207.

[2] S. L. Zhou, L. N. Guo, S. Wang, X. H. Duan, *Chem. Commun*. **2014**, *50*, 3589-3591.

[3] L. Yang, W. Lu, W. Zhou, F. Zhang, *Green Chem.* **2016**, *18*, 2941-2945.

VI. Copies of ^{1}H and ^{13}C NMR spectra of products 3a-3k, 4b-4s, 5, 6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7.174
7.153
7.072
7.053
7.038
6.985
6.967
4.191
3.359
2.609
2.604
2.586
2.581
1.699
1.682
1.675
1.664
1.659
1.031
0.983
0.966
N
O
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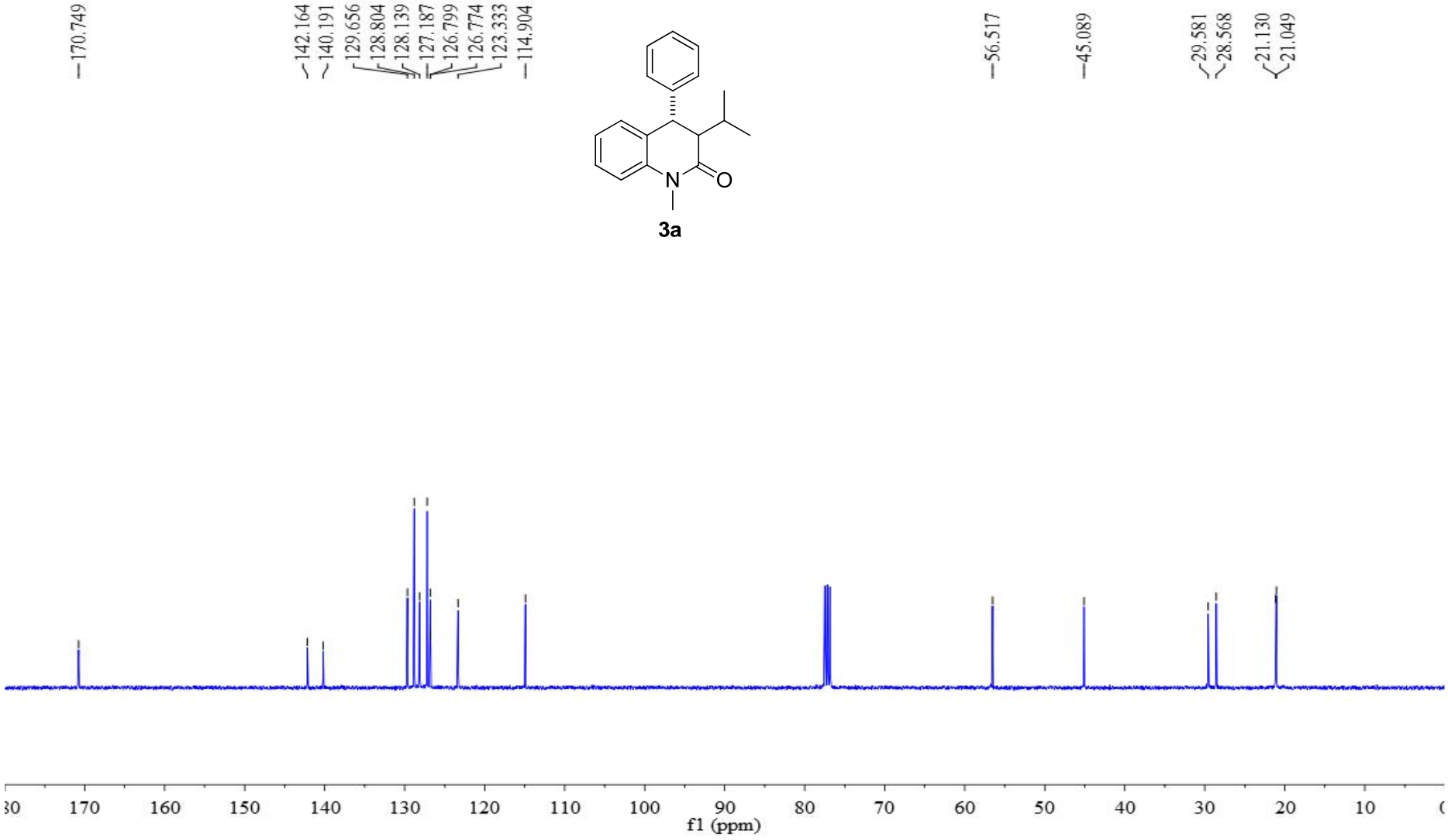
2.01
2.00
1.00
3.04
1.00
1.03
3.05
3.08
f1 (ppm)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127.187
126.799
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45.089
29.581
28.568
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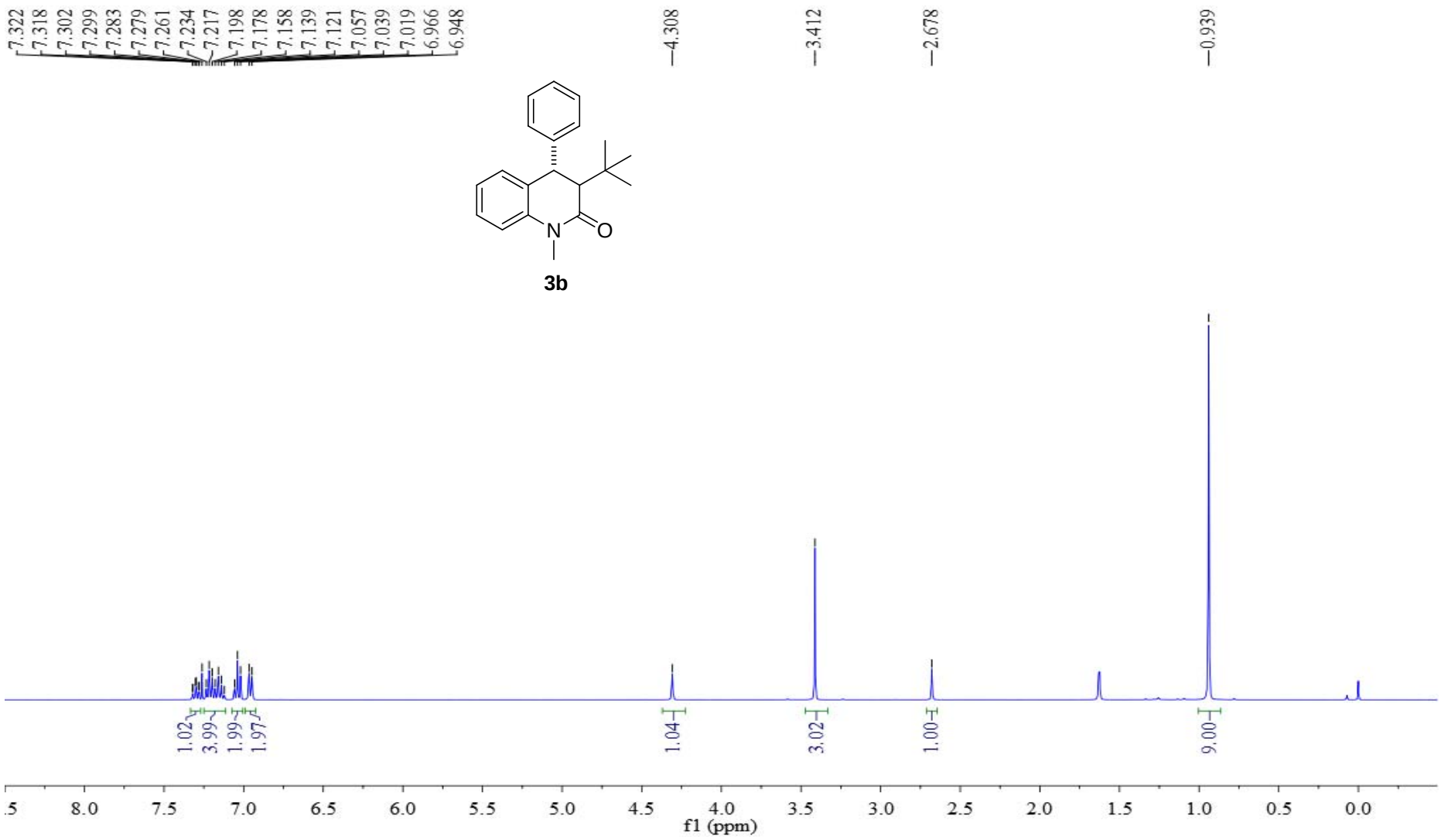
21.049
N
O
3a
f1 (ppm)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7.198
7.178
7.158
7.139
7.121
7.057
7.039
7.019
6.966
6.948
4.308
3.412
2.678
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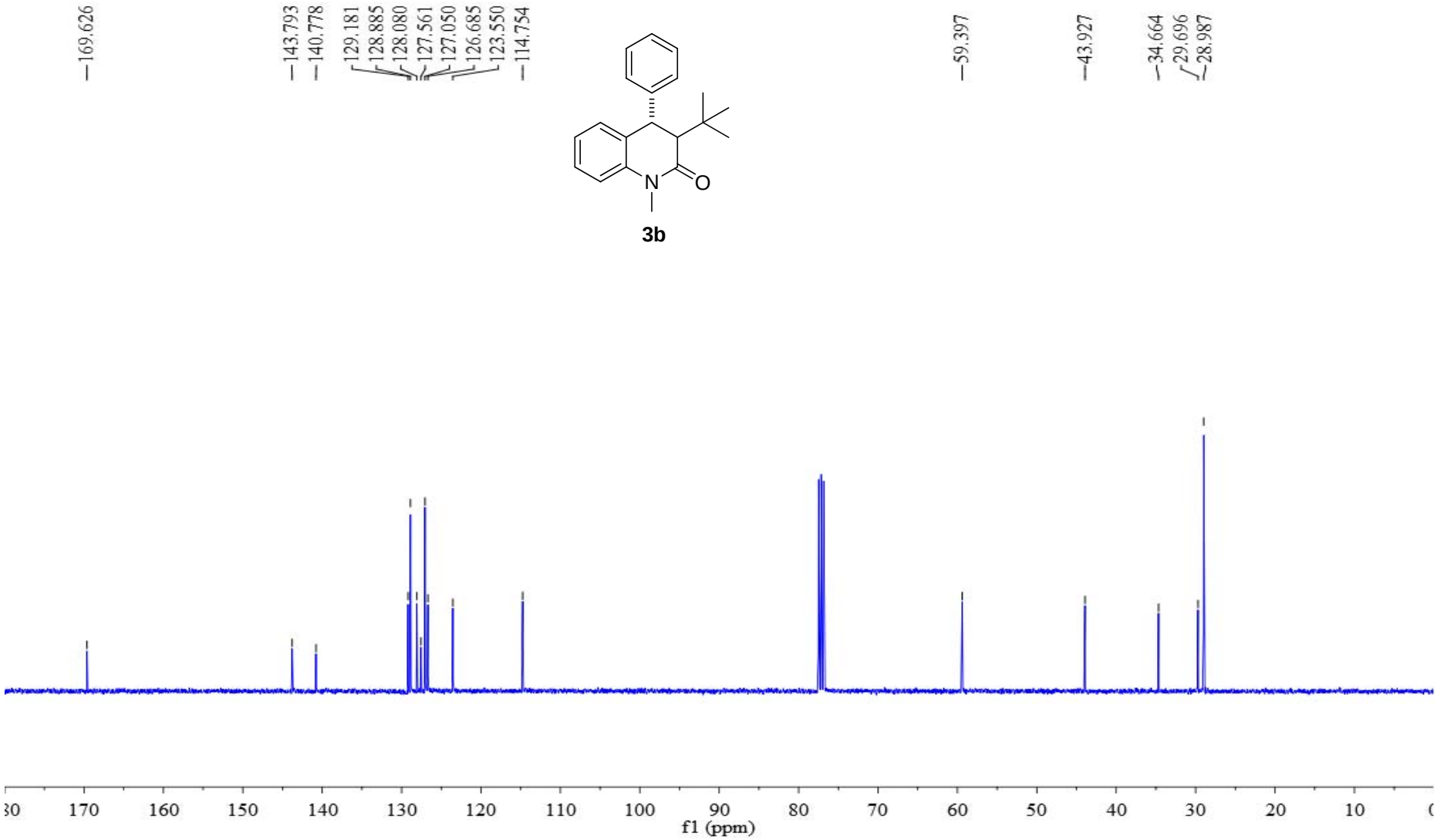
3.99
1.99
1.97
1.04
3.02
1.00
9.00
f1 (ppm)

3b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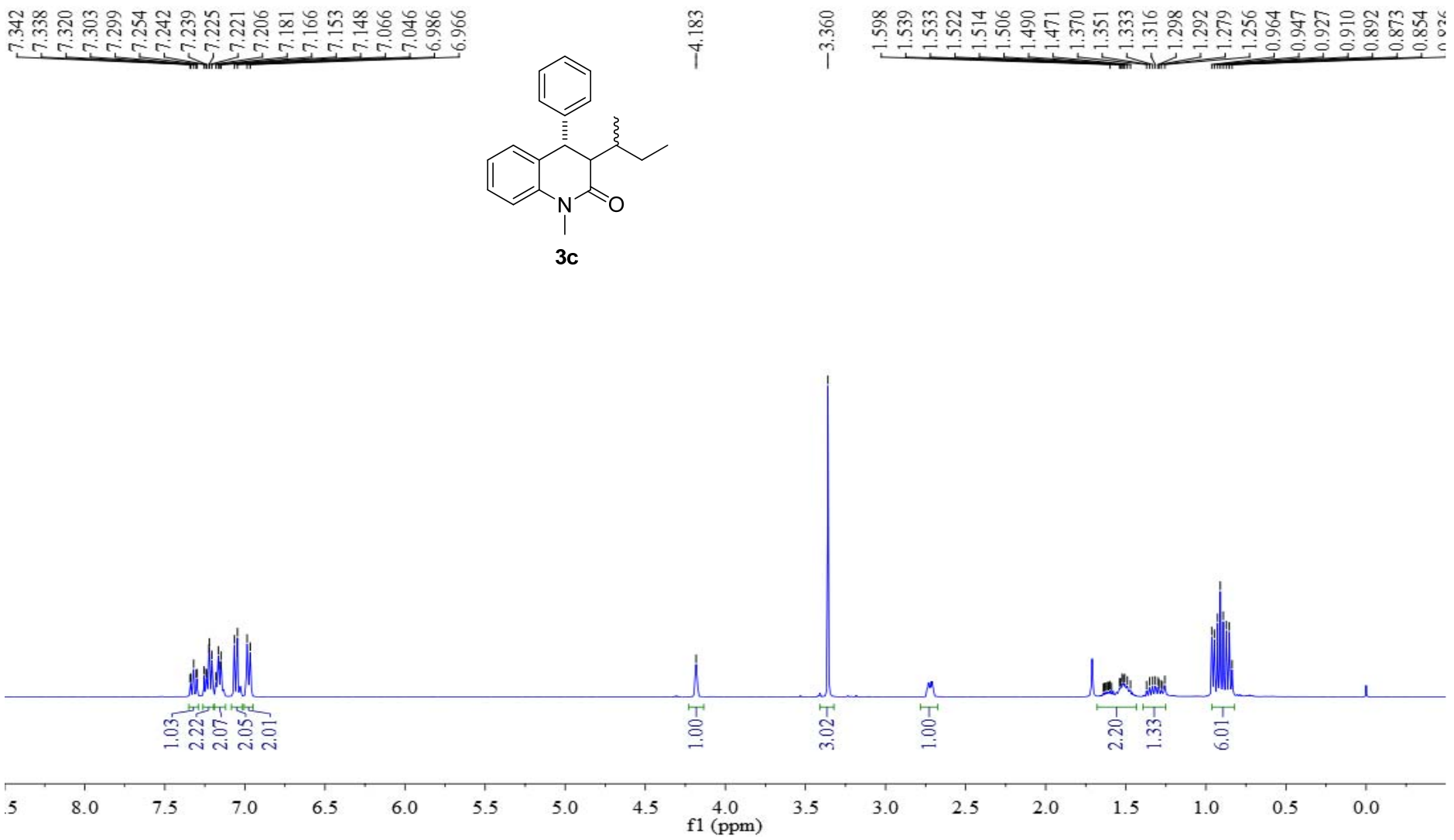
28.987
N
O
f1 (ppm)

3b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4.183
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1.539
1.533
1.522
1.514
1.506
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0.927
0.910
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0.873
0.854
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O
3c
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2.22
2.07
2.05
2.01
1.00
3.02
1.00
2.20
1.33
6.01
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
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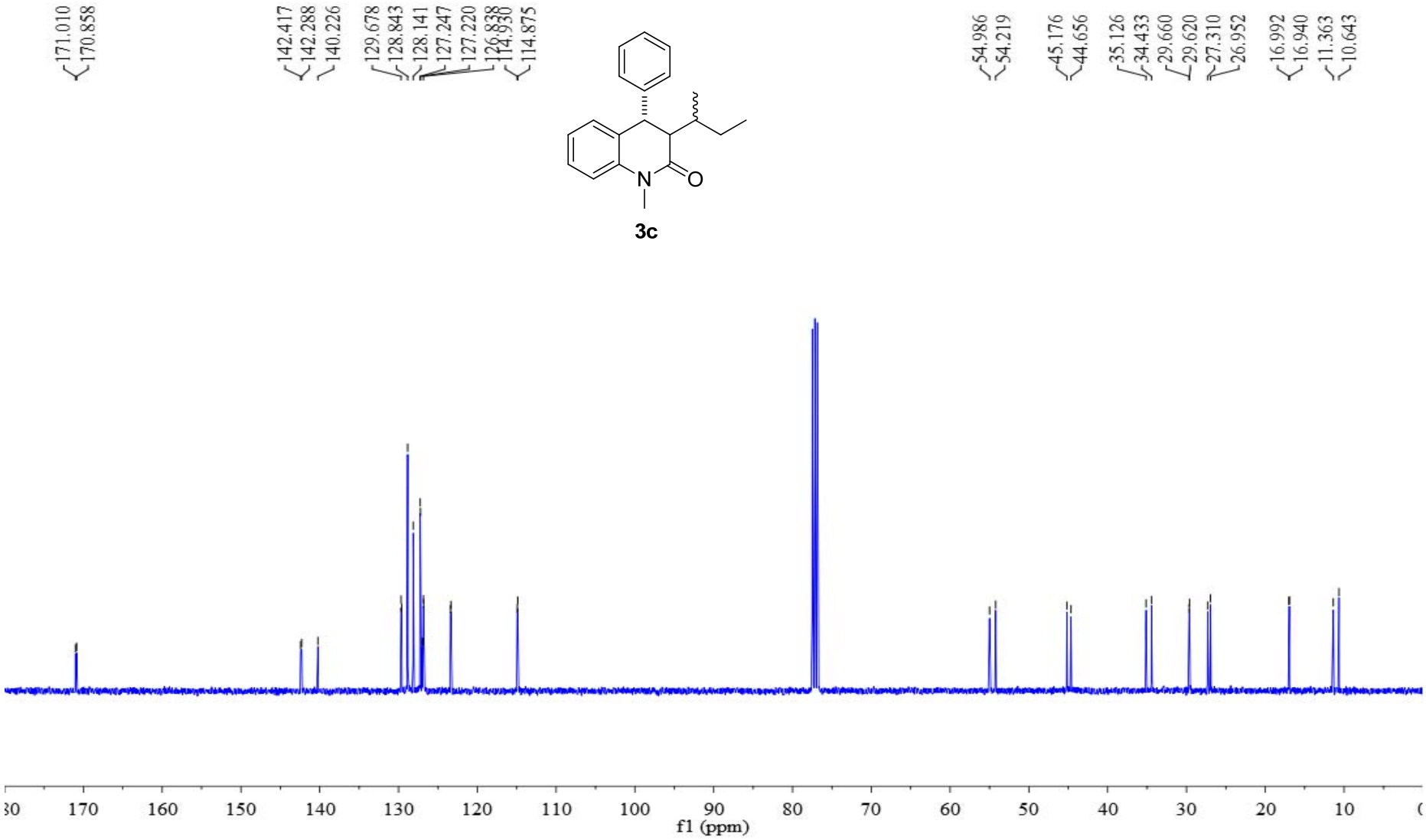
0.0
f1 (ppm)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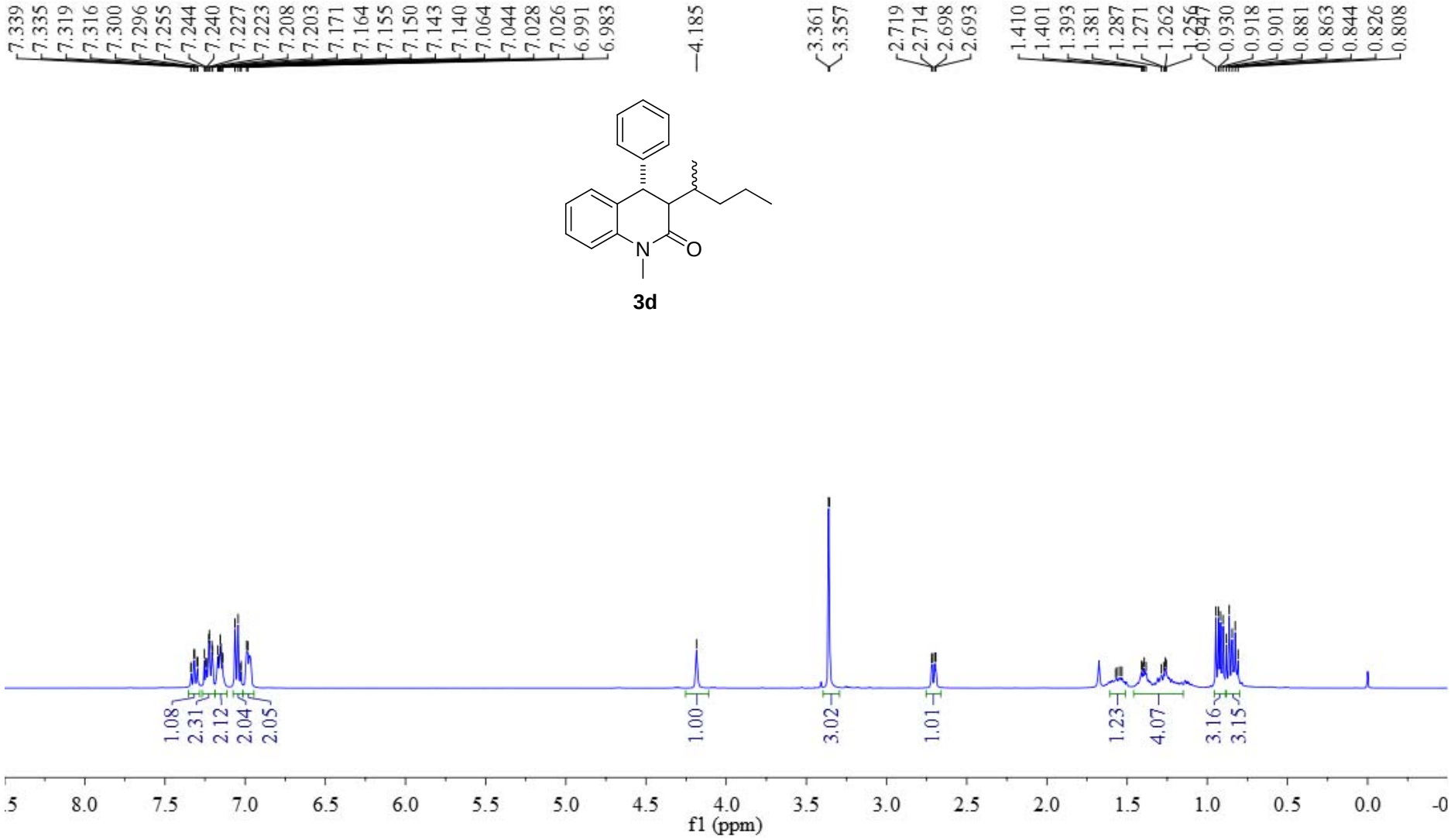
O
3c
f1 (ppm)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7.171
7.164
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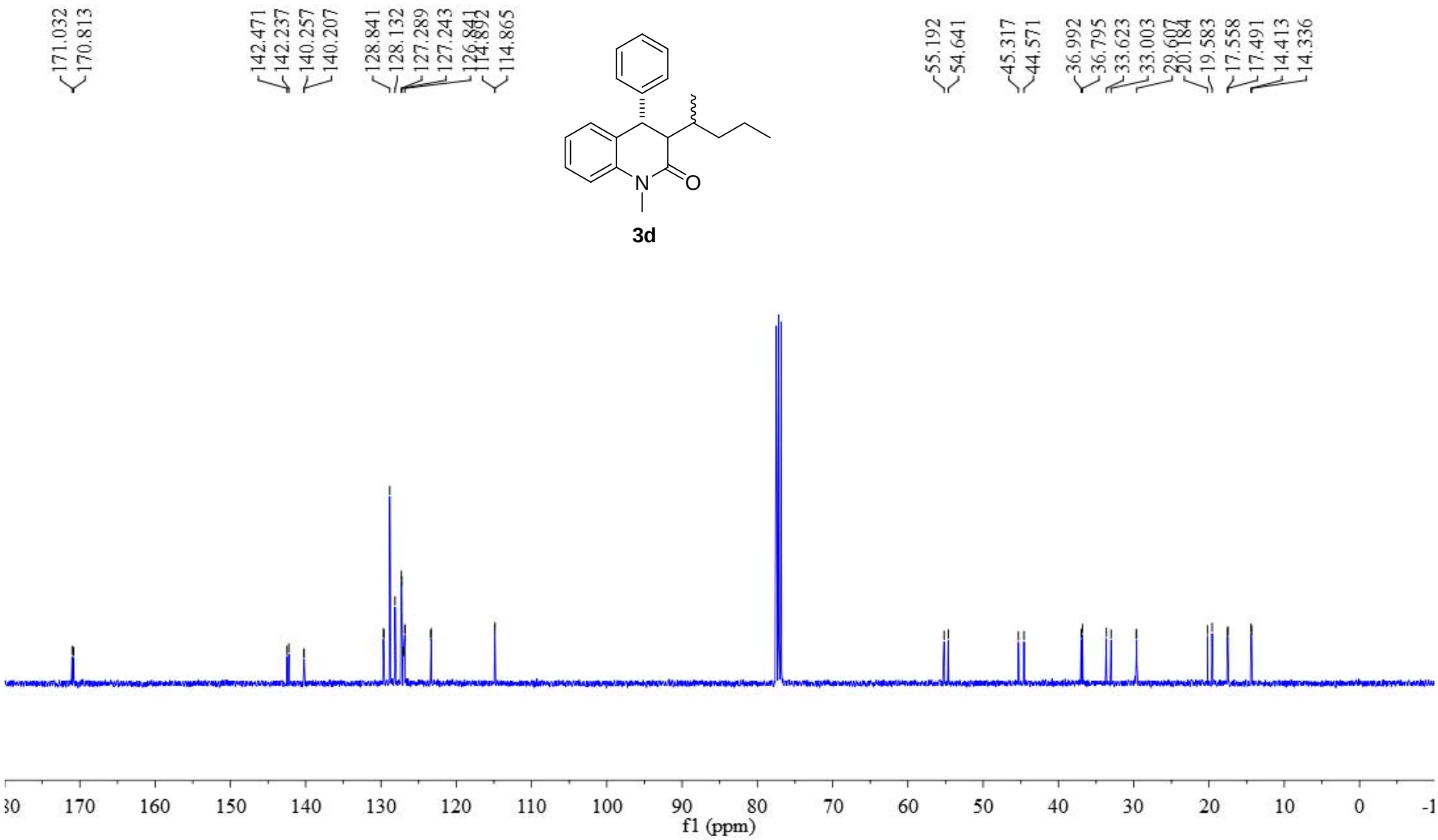
f1 (ppm)

3d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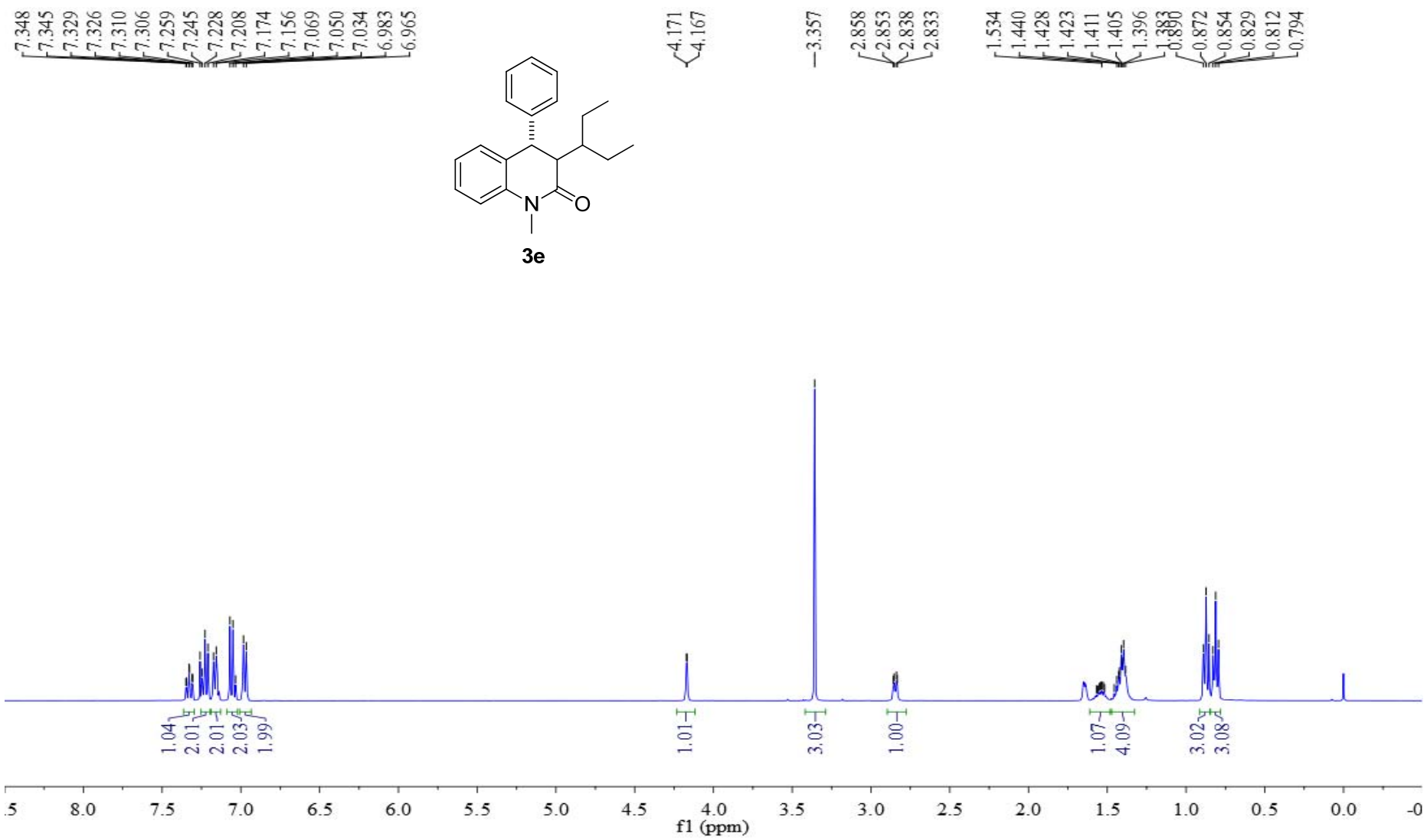
O
f1 (ppm)

3d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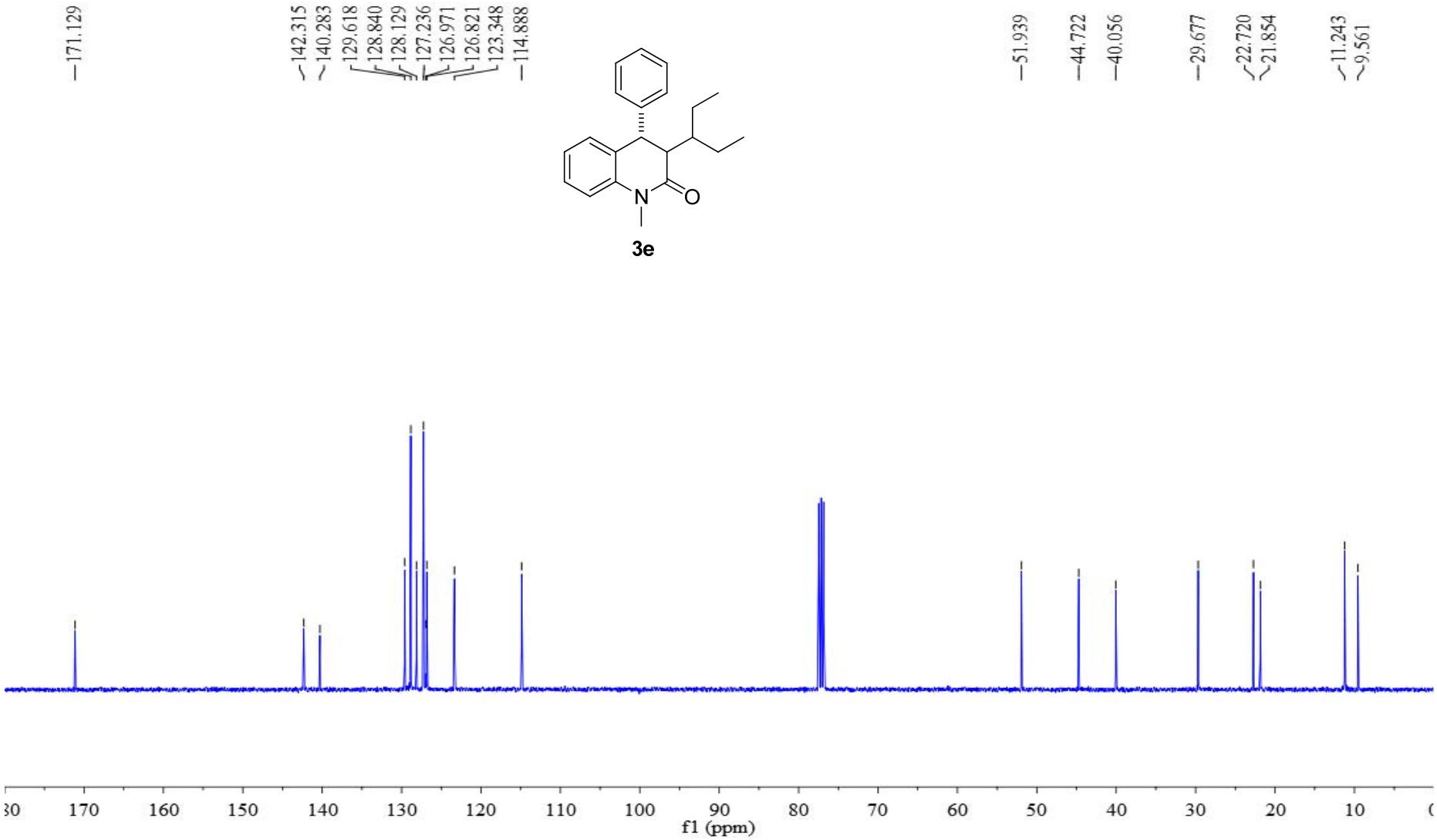
f1 (ppm)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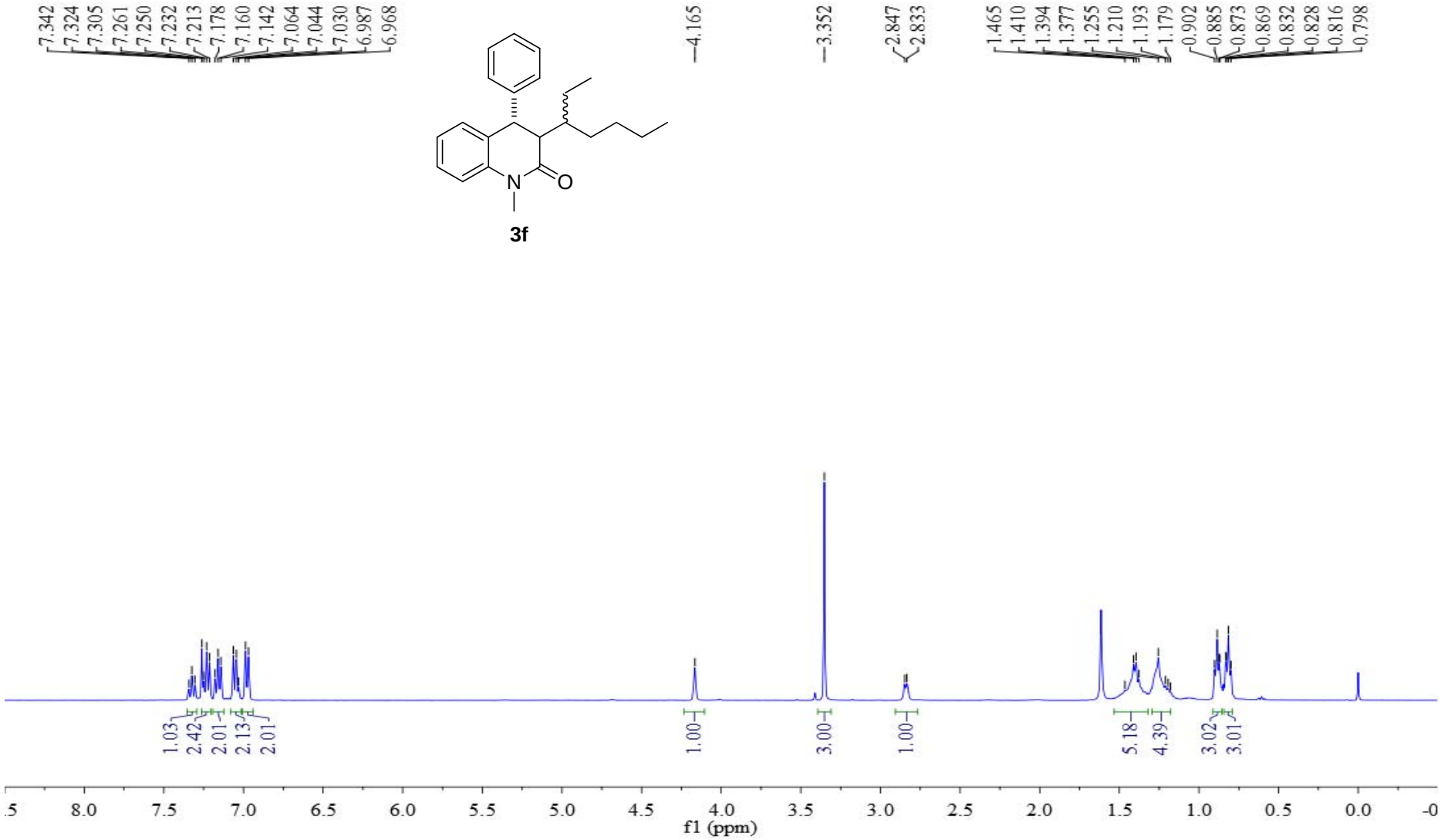
O
3e
f1 (ppm)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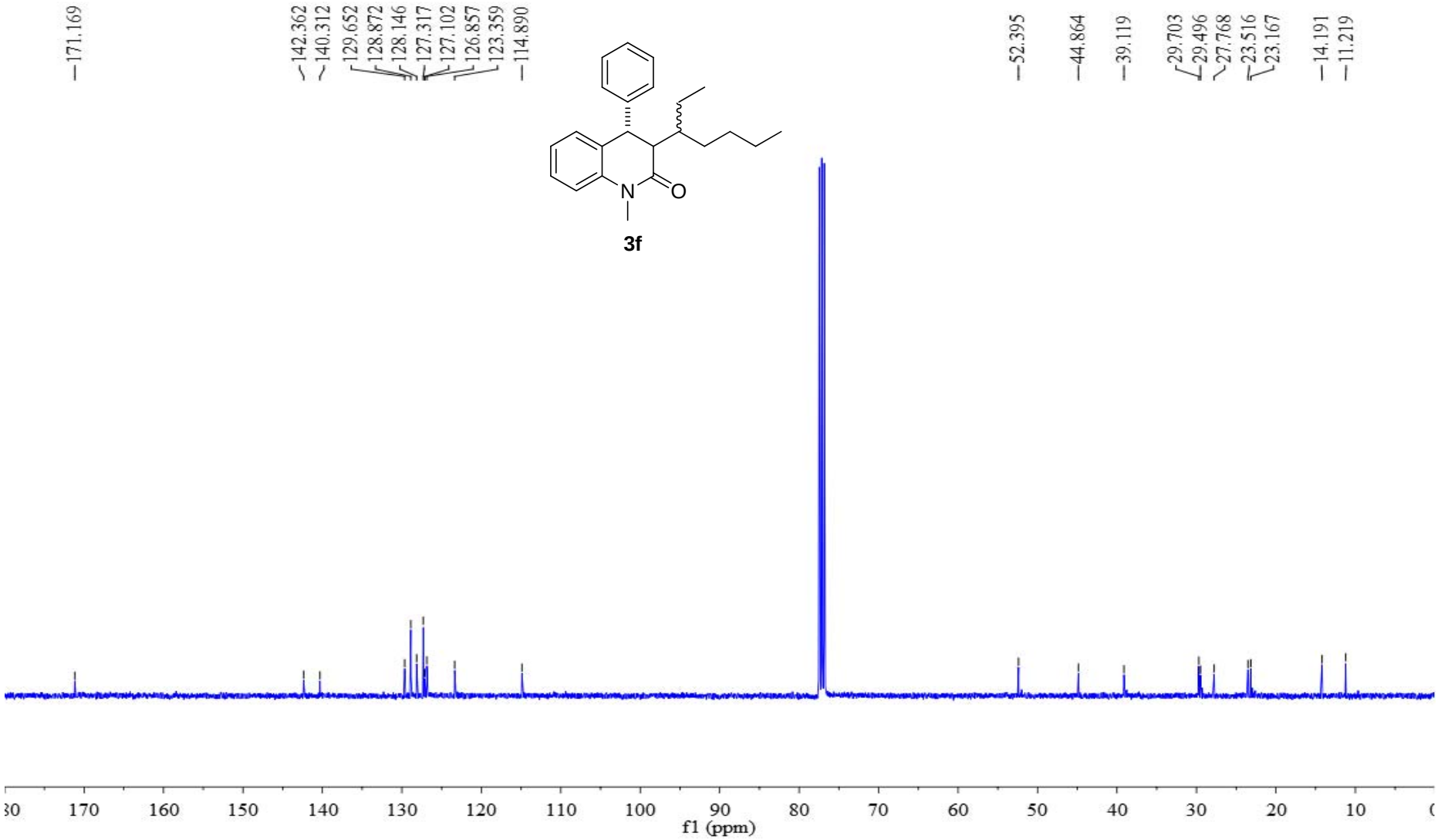
3f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23.516
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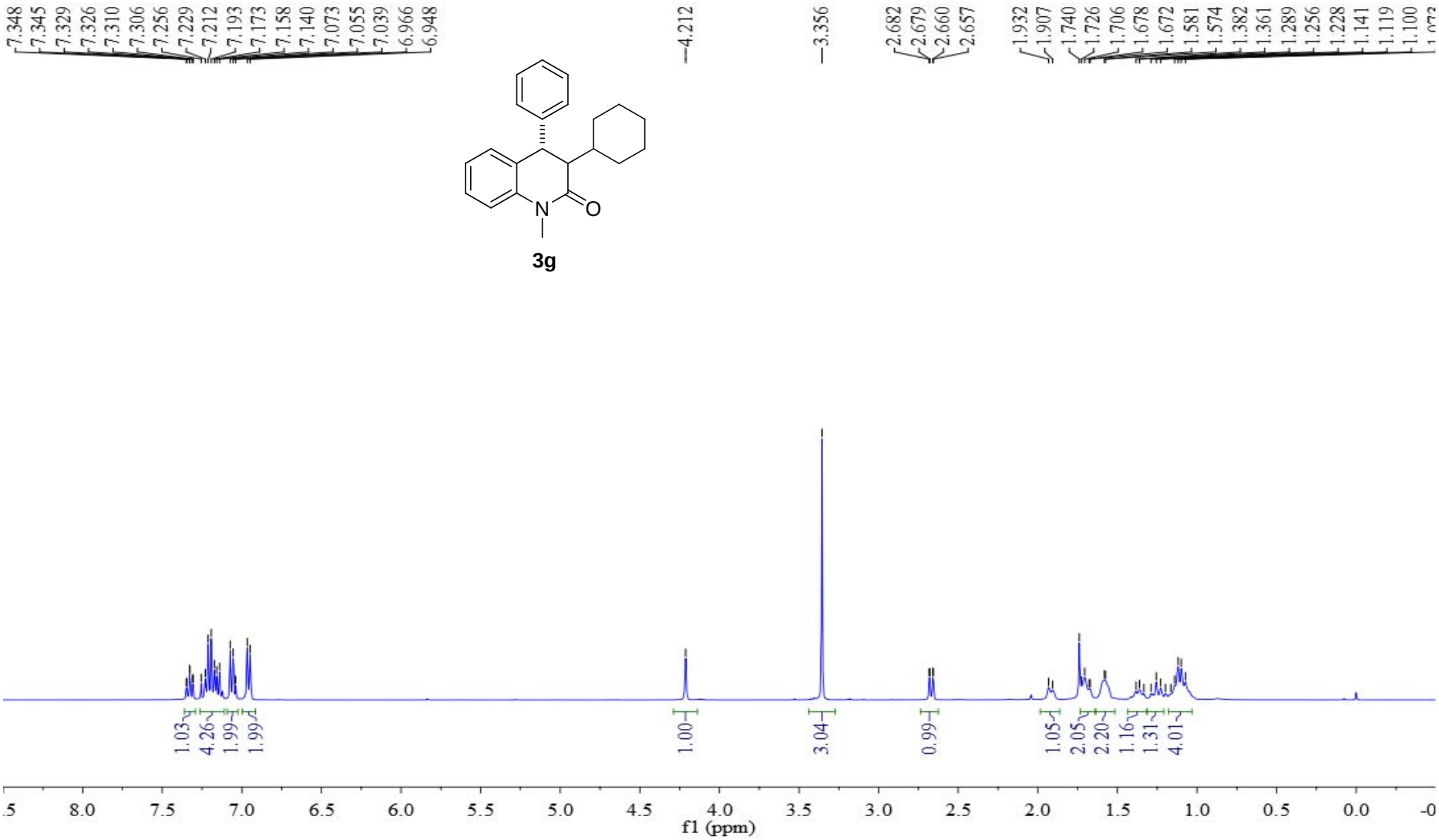
N
O
3f
f1 (ppm)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1.574
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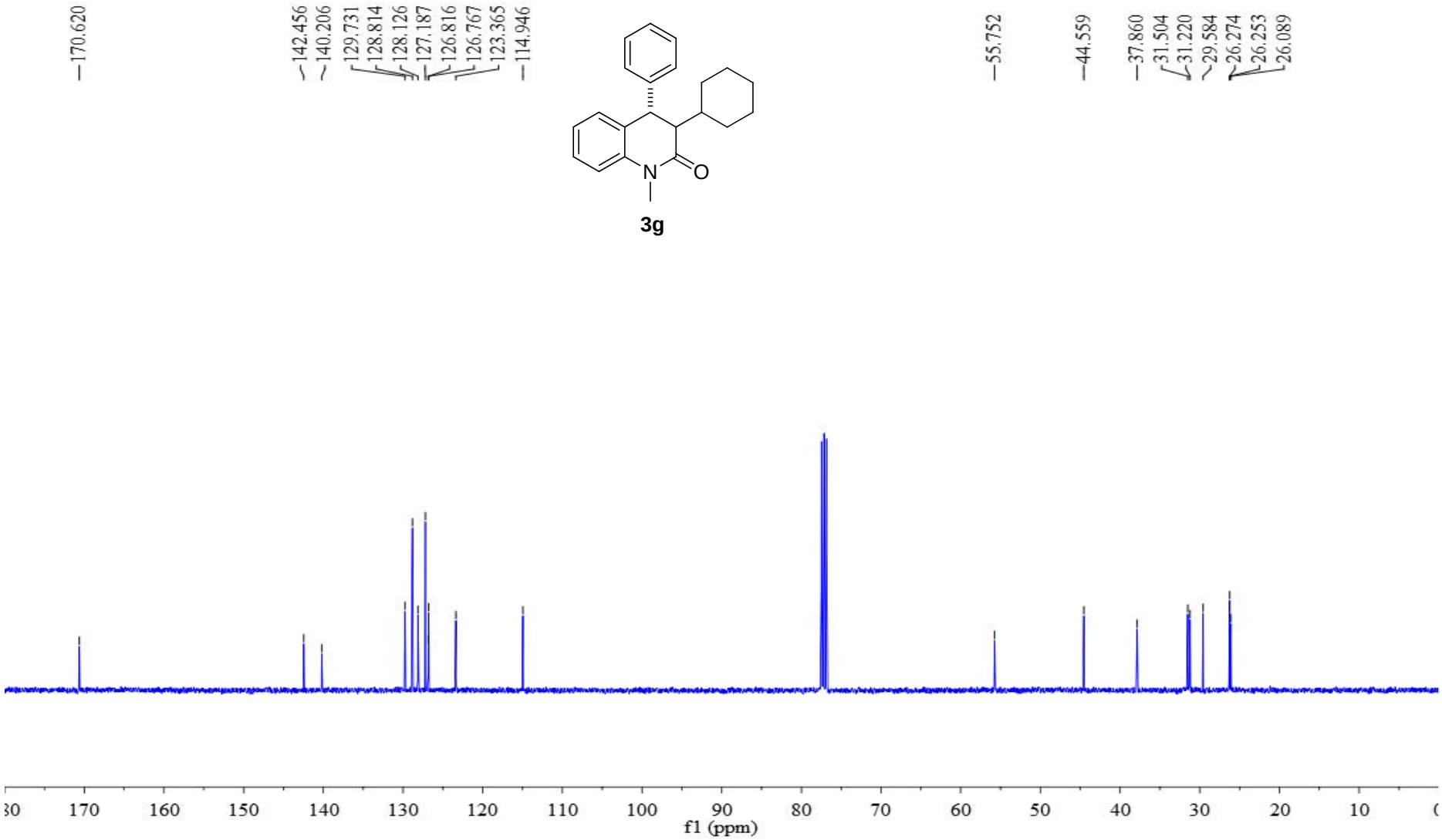
1.256
1.228
1.141
1.119
1.100
N
O
3g
1.03
4.26
1.99
1.99
1.00
3.04
0.99
1.05
2.05
2.20
1.16
1.31
4.01
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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126.816
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123.365
114.946
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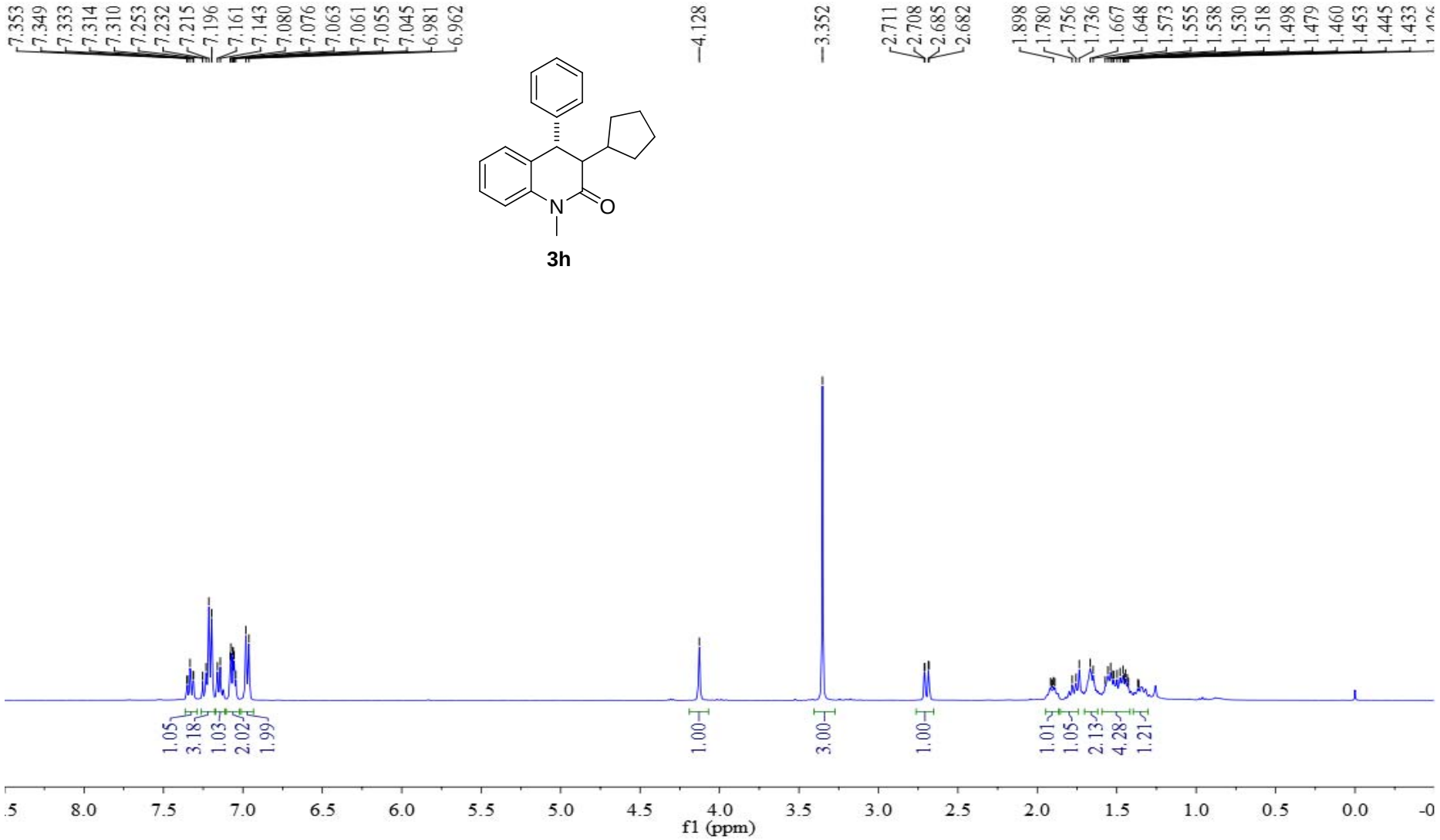
37.860
31.504
31.220
29.584
26.274
26.253
26.089
N
O
3g
f1 (ppm)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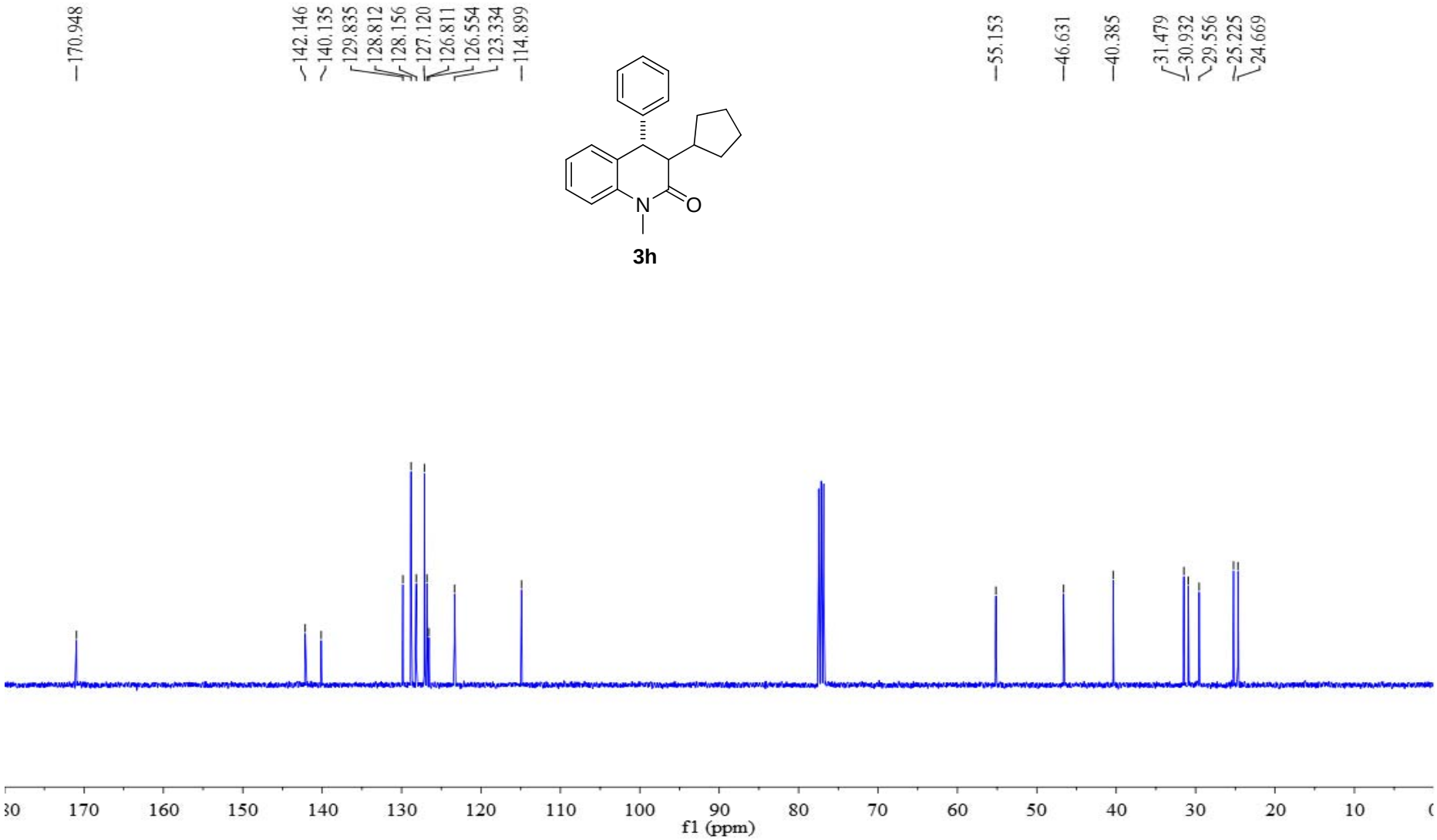
7.253
7.232
7.215
7.196
7.161
7.143
7.080
7.076
7.063
7.061
7.055
7.045
6.981
6.962
4.128
3.352
2.711
2.708
2.685
2.682
1.898
1.780
1.756
1.736
1.667
1.648
1.573
1.555
1.538
1.530
1.518
1.498
1.479
1.460
1.453
1.445
1.433
N
O
3h
1.05
3.18
1.03
2.02
1.99
1.00
3.00
1.00
1.01
1.05
2.13
4.28
1.21
f1 (ppm)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140.135
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128.156
127.120
126.811
126.554
123.334
114.899
55.153
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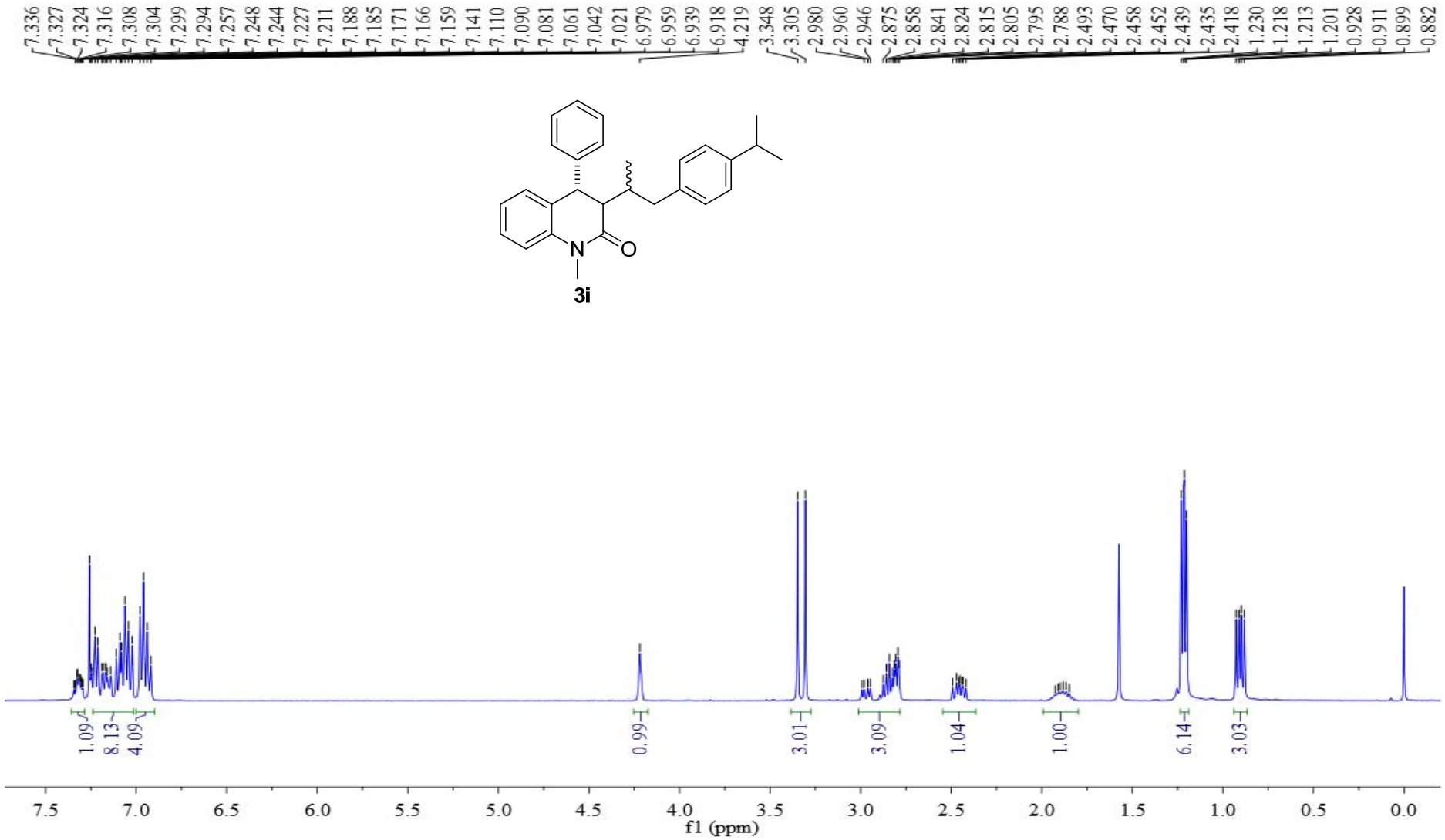
40.385
31.479
30.932
29.556
25.225
24.669
N
O
3h
f1 (ppm)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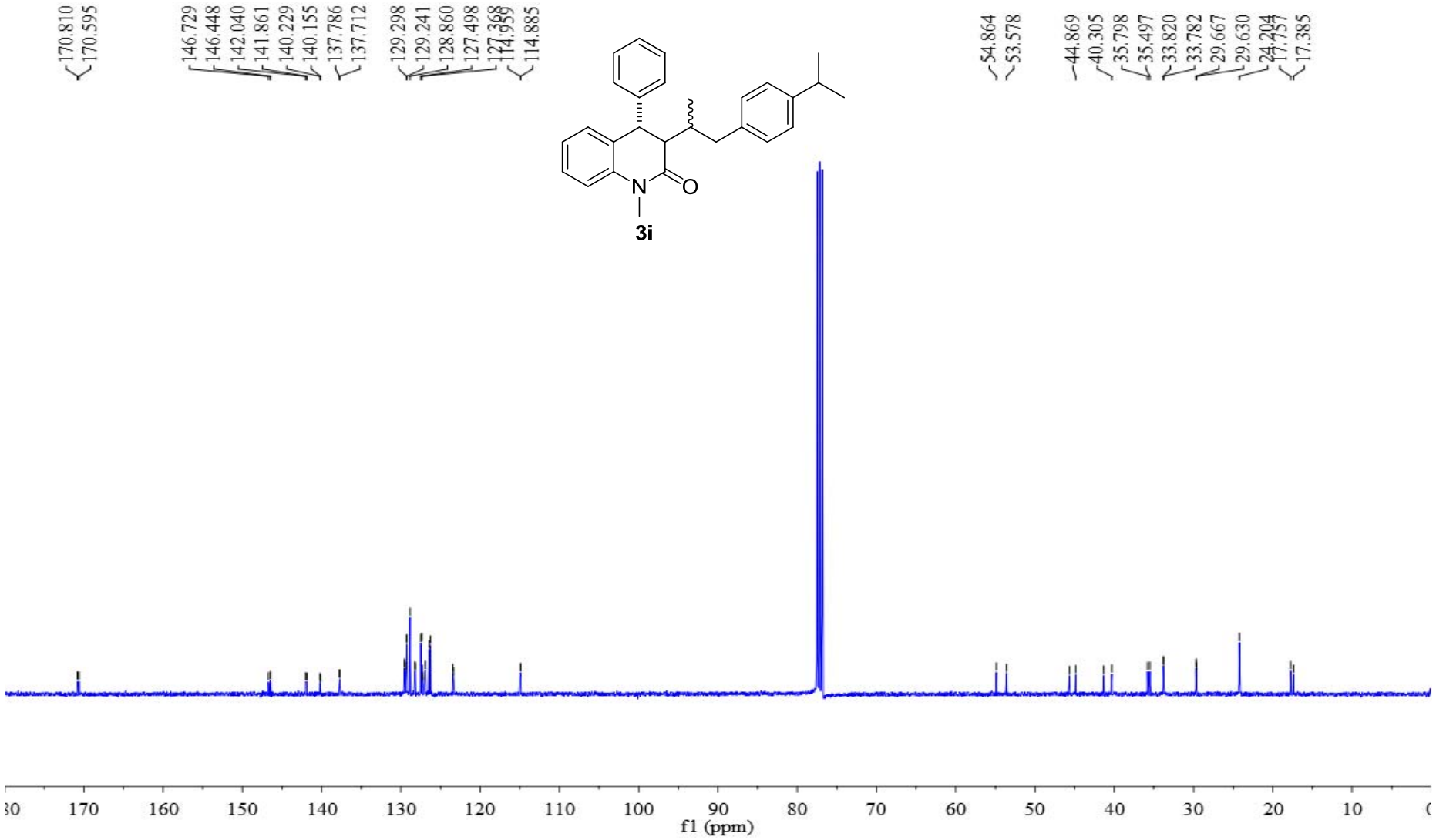
7.304
7.299
7.294
7.257
7.248
7.244
7.227
7.211
7.188
7.185
7.171
7.166
7.159
7.141
7.110
7.090
7.081
7.061
7.042
7.021
6.979
6.959
6.939
6.918
4.219
3.348
3.305
2.980
2.960
2.946
2.875
2.858
2.841
2.824
2.815
2.805
2.795
2.788
2.493
2.470
2.458
2.452
2.439
2.435
2.418
1.230
1.218
1.213
1.201
0.928
0.911
0.899
0.882
N
O
3i
1.09
8.13
4.09
0.99
3.01
3.09
1.04
1.00
6.14
3.03
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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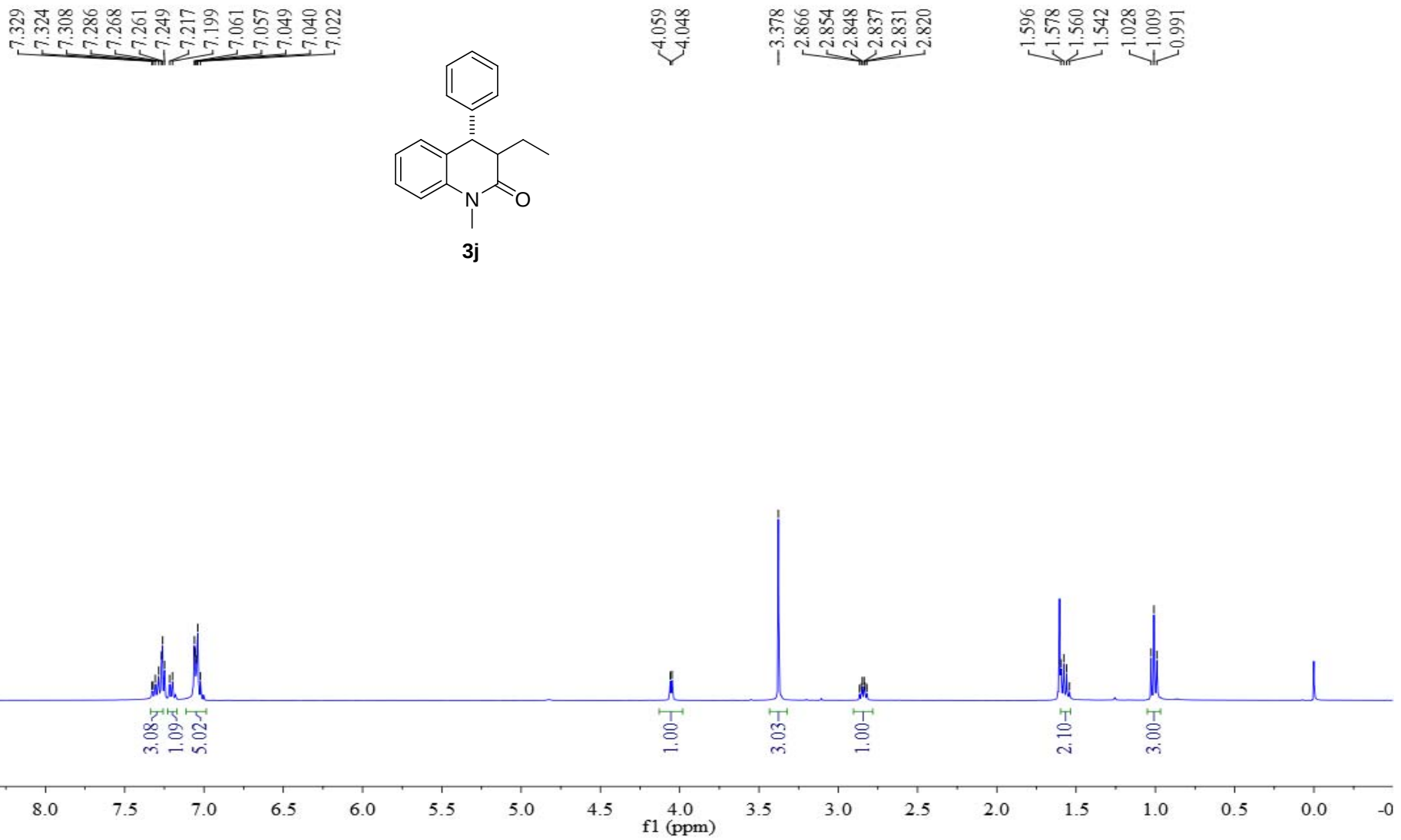
146.729
146.448
142.040
141.861
140.229
140.155
137.786
137.712
129.298
129.241
128.860
127.498
114.959
114.885
54.864
53.578
44.869
40.305
35.798
35.497
33.820
33.782
29.667
29.630
24.204
17.757
17.385
N
O
3i
f1 (ppm)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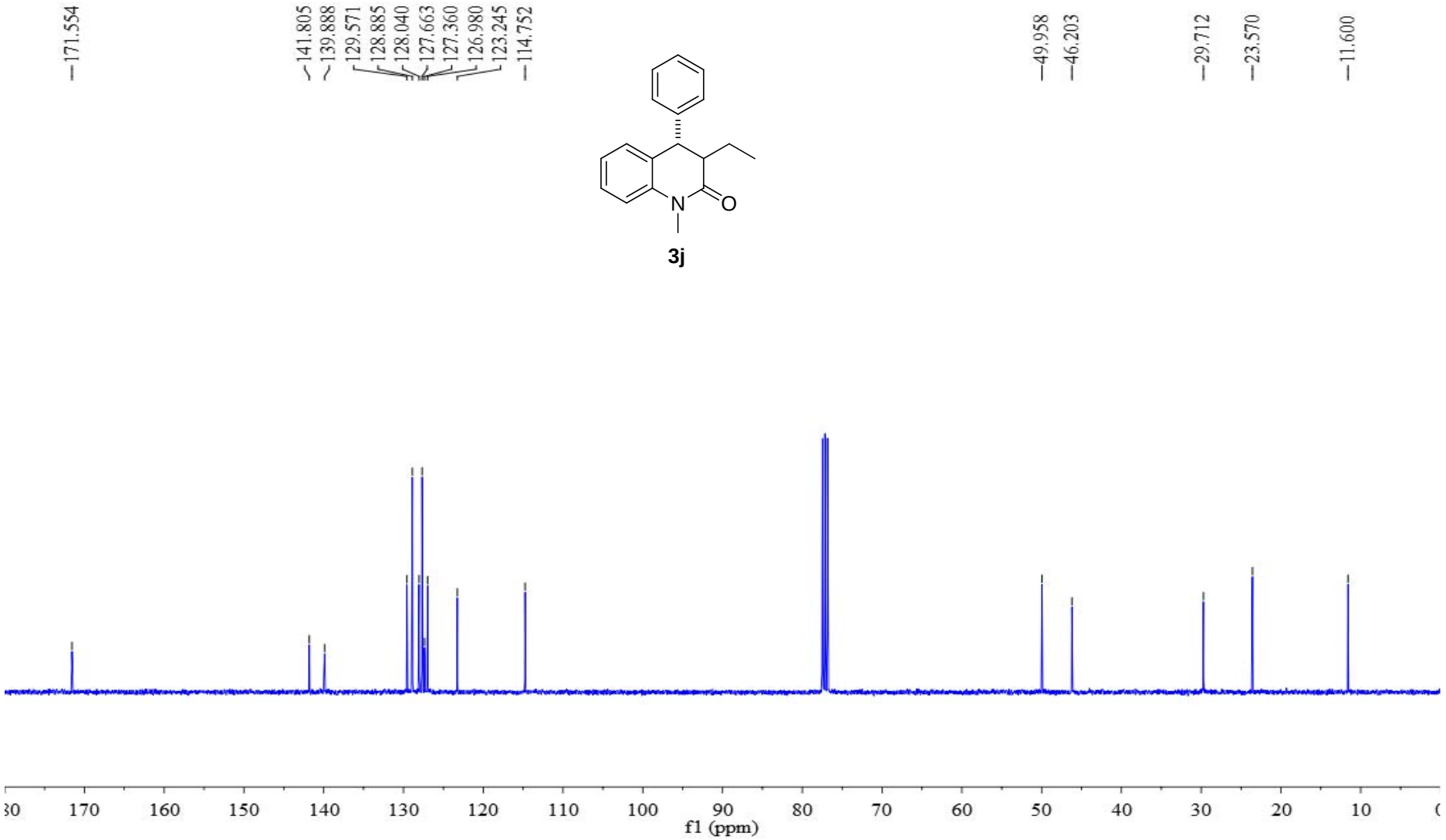
7.324
7.308
7.286
7.268
7.261
7.249
7.217
7.199
7.061
7.057
7.049
7.040
7.022
4.059
4.048
3.378
2.866
2.854
2.848
2.837
2.831
2.820
1.596
1.578
1.560
1.542
1.028
1.009
0.991
N
O
3j
3.08
1.09
5.02
1.00
3.03
1.00
2.10
3.00
f1 (ppm)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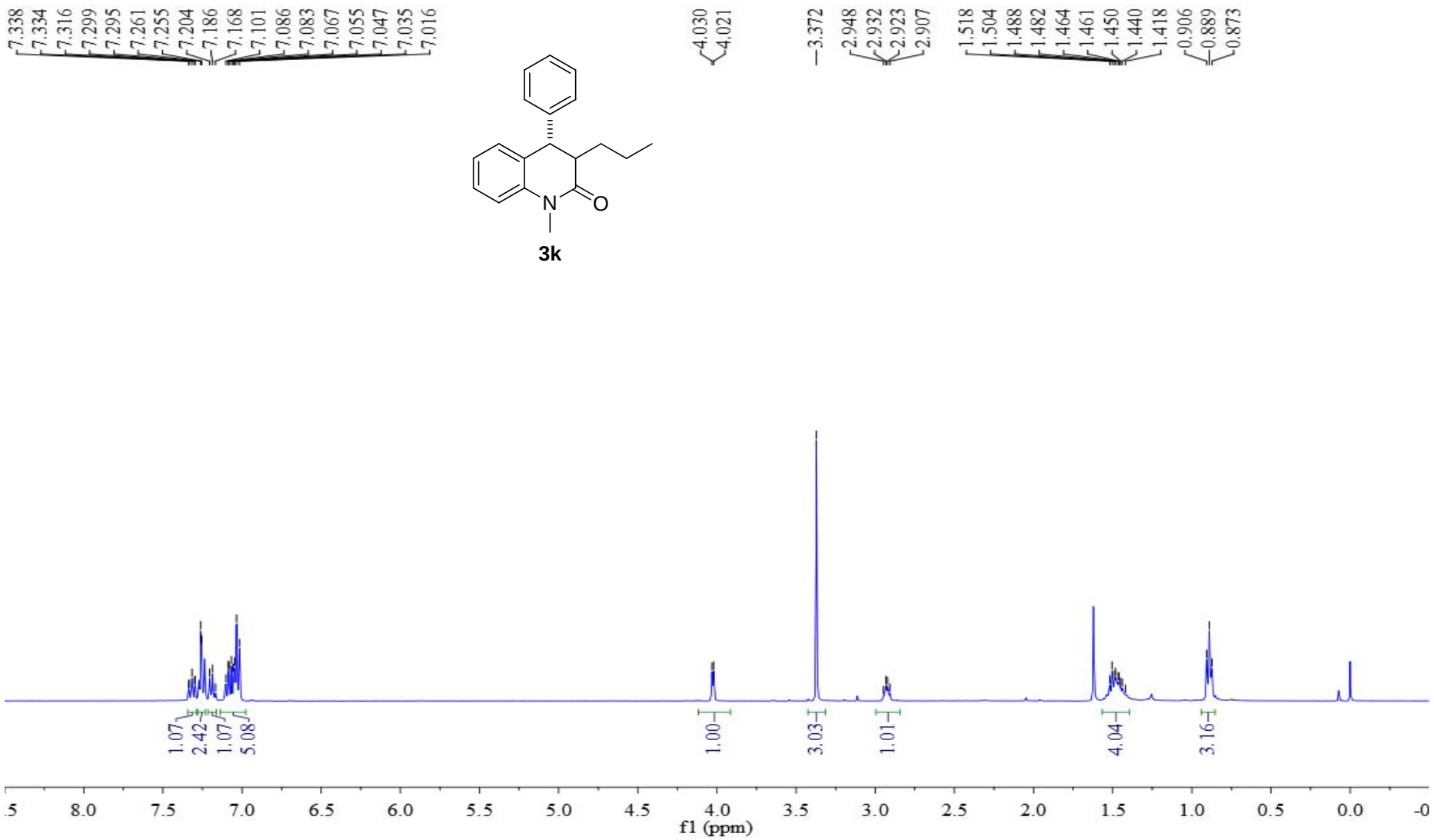
141.805
139.888
129.571
128.885
128.040
127.663
127.360
126.980
123.245
114.752
49.958
46.203
29.712
23.570
11.600
N
O
3j
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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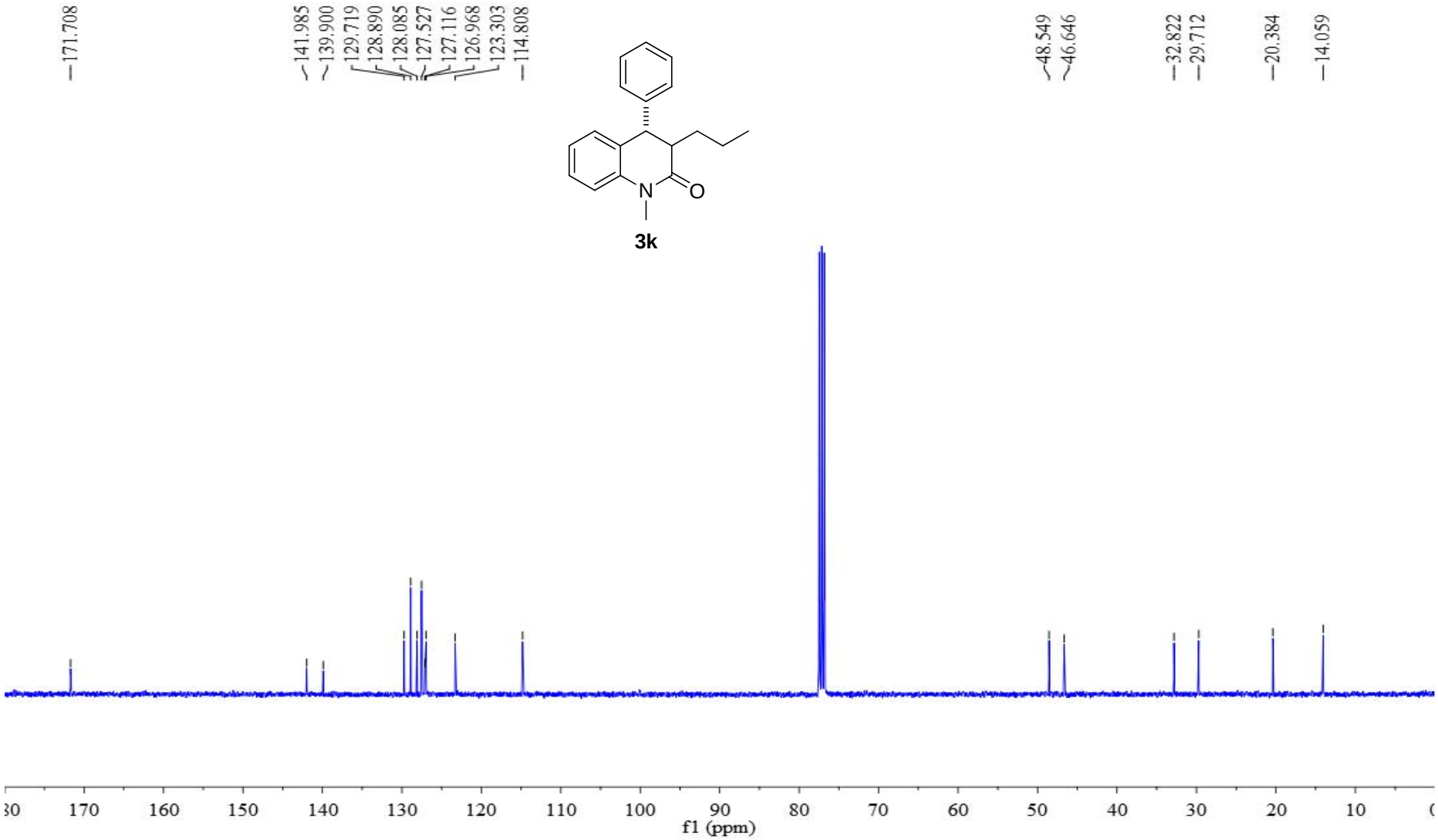
7.334
7.316
7.299
7.295
7.261
7.255
7.204
7.186
7.168
7.101
7.086
7.083
7.067
7.055
7.047
7.035
7.016
4.030
4.021
3.372
2.948
2.932
2.923
2.907
1.518
1.504
1.488
1.482
1.464
1.461
1.450
1.440
1.418
0.906
0.889
0.873
N
O
1.07
2.42
1.07
5.08
1.00
3.03
1.01
4.04
3.16
f1 (ppm)

3k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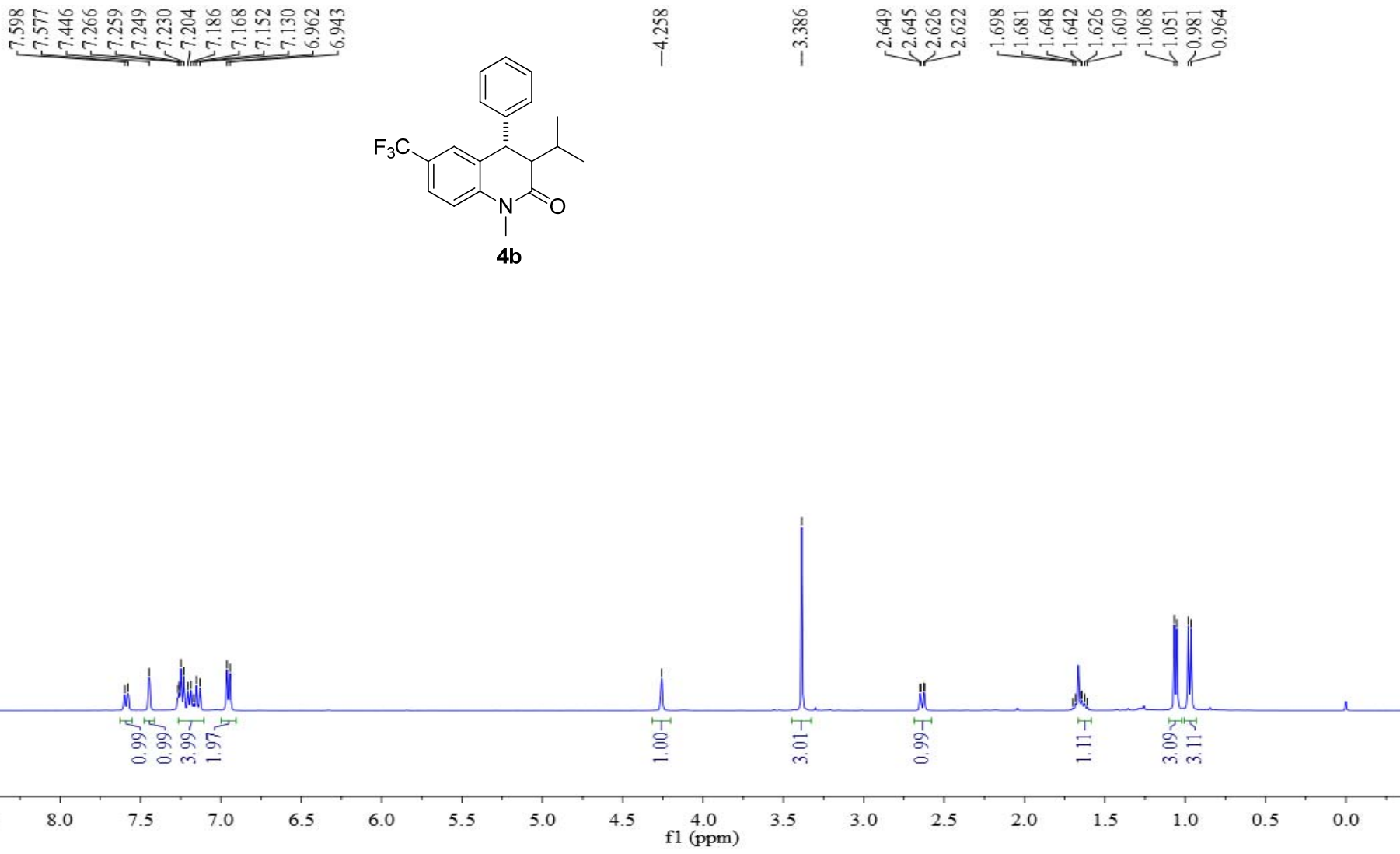
139.900
129.719
128.890
128.085
127.527
127.116
126.968
123.303
114.808
48.549
46.646
32.822
29.712
20.384
14.059
N
O
3k
f1 (ppm)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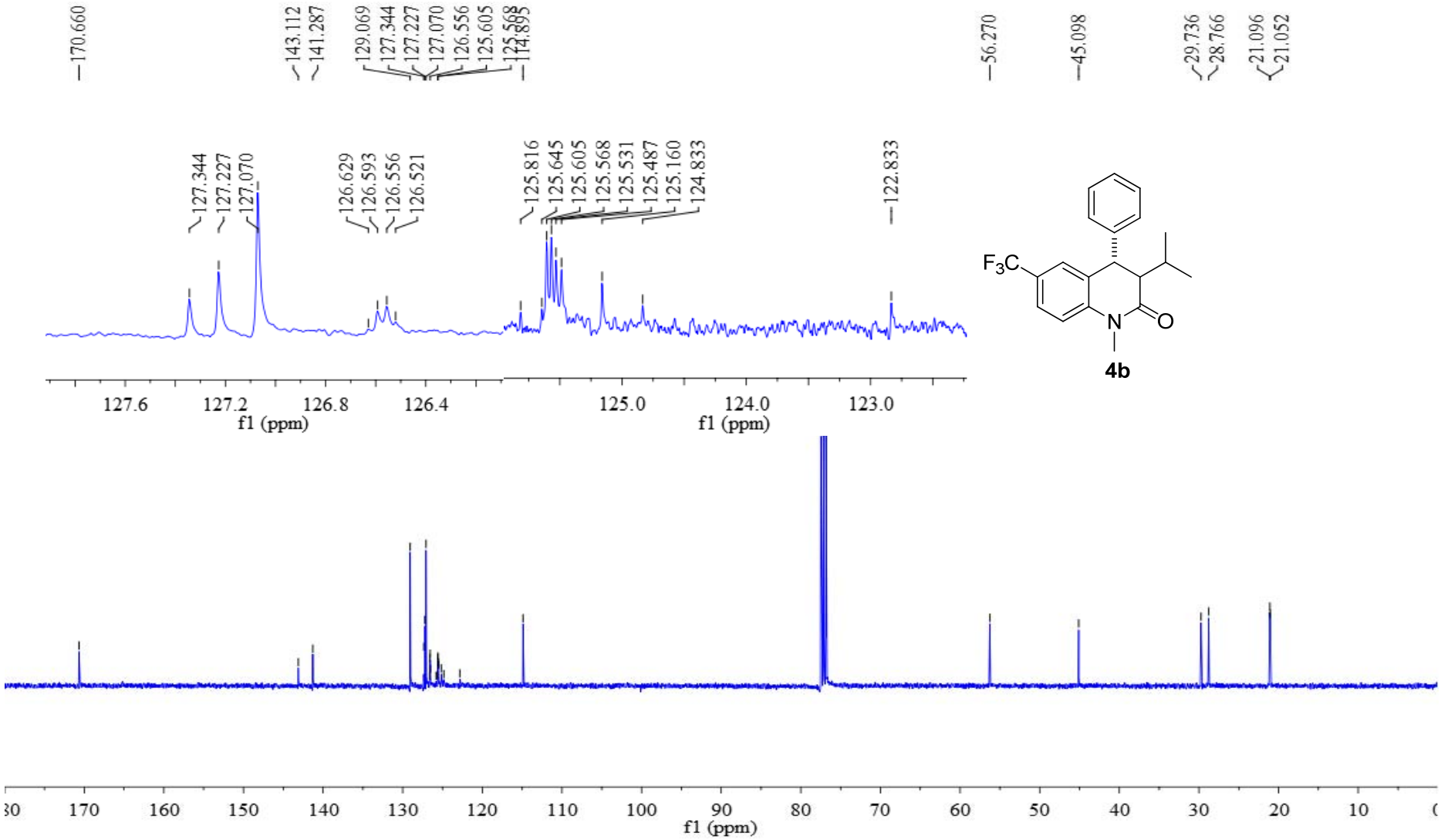
7.577
7.446
7.266
7.259
7.249
7.230
7.204
7.186
7.168
7.152
7.130
6.962
6.943
4.258
3.386
2.649
2.645
2.626
2.622
1.698
1.681
1.648
1.642
1.626
1.609
1.068
1.051
0.981
0.964
F3C
N
O
4b
0.99
0.99
3.99
1.97
1.00
3.01
0.99
1.11
3.09
3.11
f1 (ppm)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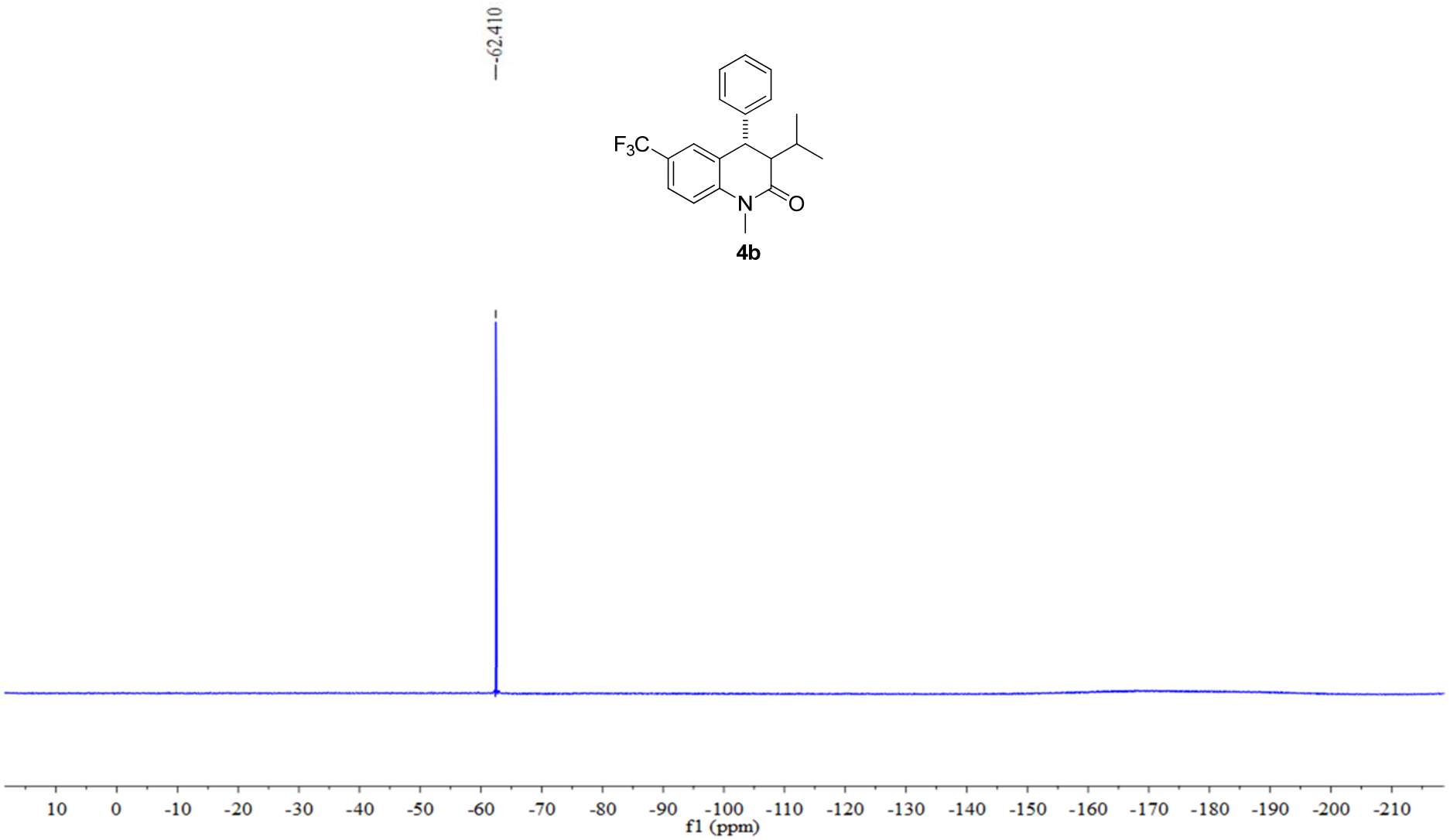
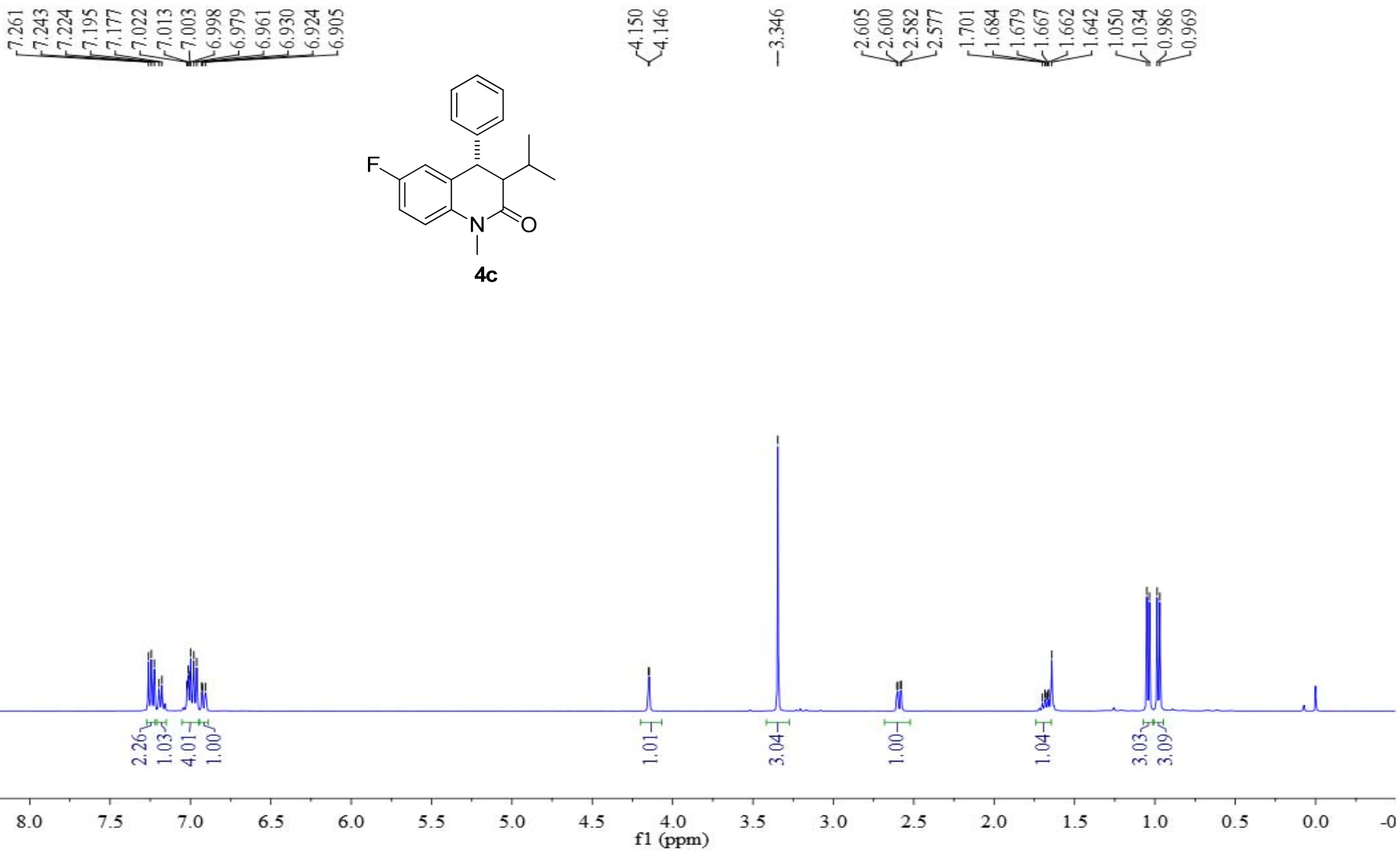
127.227
127.070
126.556
125.605
125.568
125.487
56.270
45.098
29.736
28.766
21.096
21.052
127.344
127.227
127.070
126.629
126.593
126.556
126.521
125.816
125.645
125.605
125.568
125.531
125.487
125.160
124.833
122.833
F3C
N
O
4b
127.6
127.2
126.8
126.4
f1 (ppm)
125.0
124.0
123.0
f1 (ppm)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


-62.410
F3C
N
O
4b
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)


7.261
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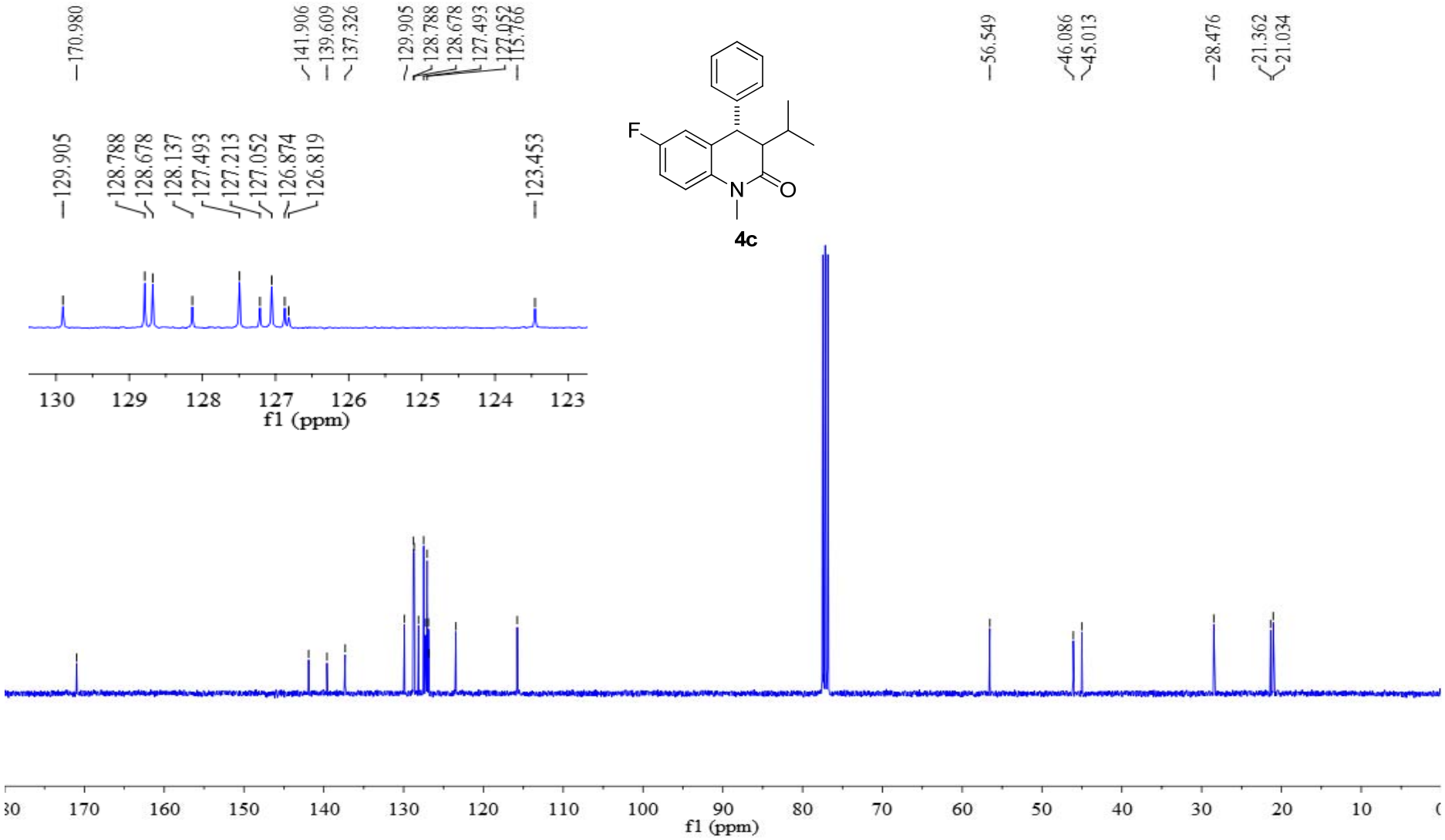
7.224
7.195
7.177
7.022
7.013
7.003
6.998
6.979
6.961
6.930
6.924
6.905
4.150
4.146
3.346
2.605
2.600
2.582
2.577
1.701
1.684
1.679
1.667
1.662
1.642
1.050
1.034
0.986
0.969
F
N
O
4c
2.26
1.03
4.01
1.00
1.01
3.04
1.00
1.04
3.03
3.09
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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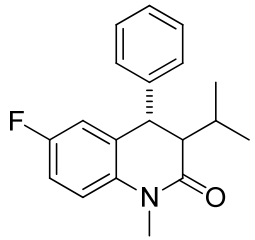
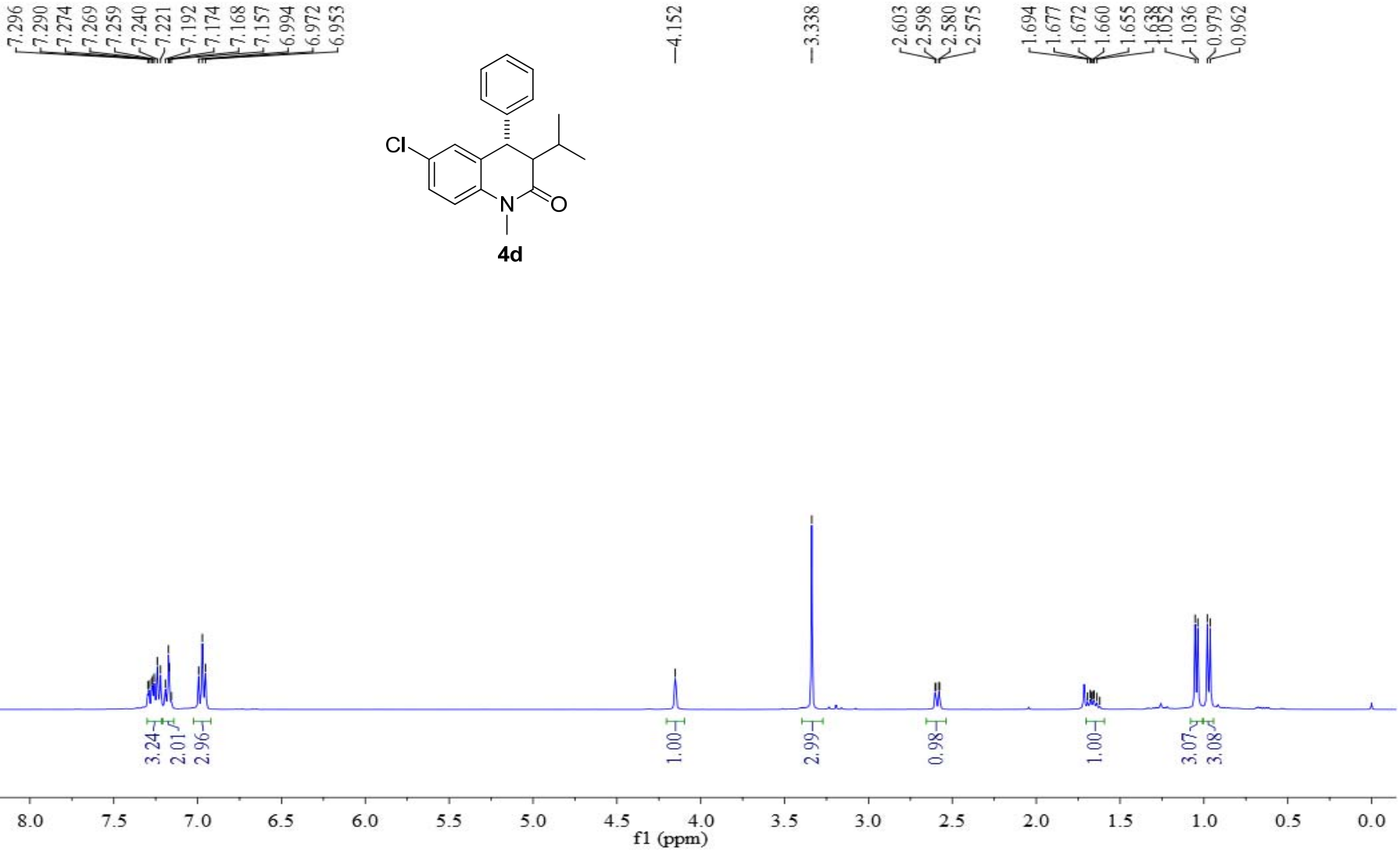
137.326
129.905
128.788
128.678
127.493
127.052
115.766
56.549
46.086
45.013
28.476
21.362
21.034
129.905
128.788
128.678
128.137
127.493
127.213
127.052
126.874
126.819
123.453
F
N
O
4c
130
129
128
127
126
125
124
123
f1 (ppm)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


F
N
O

4c

-120.266
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)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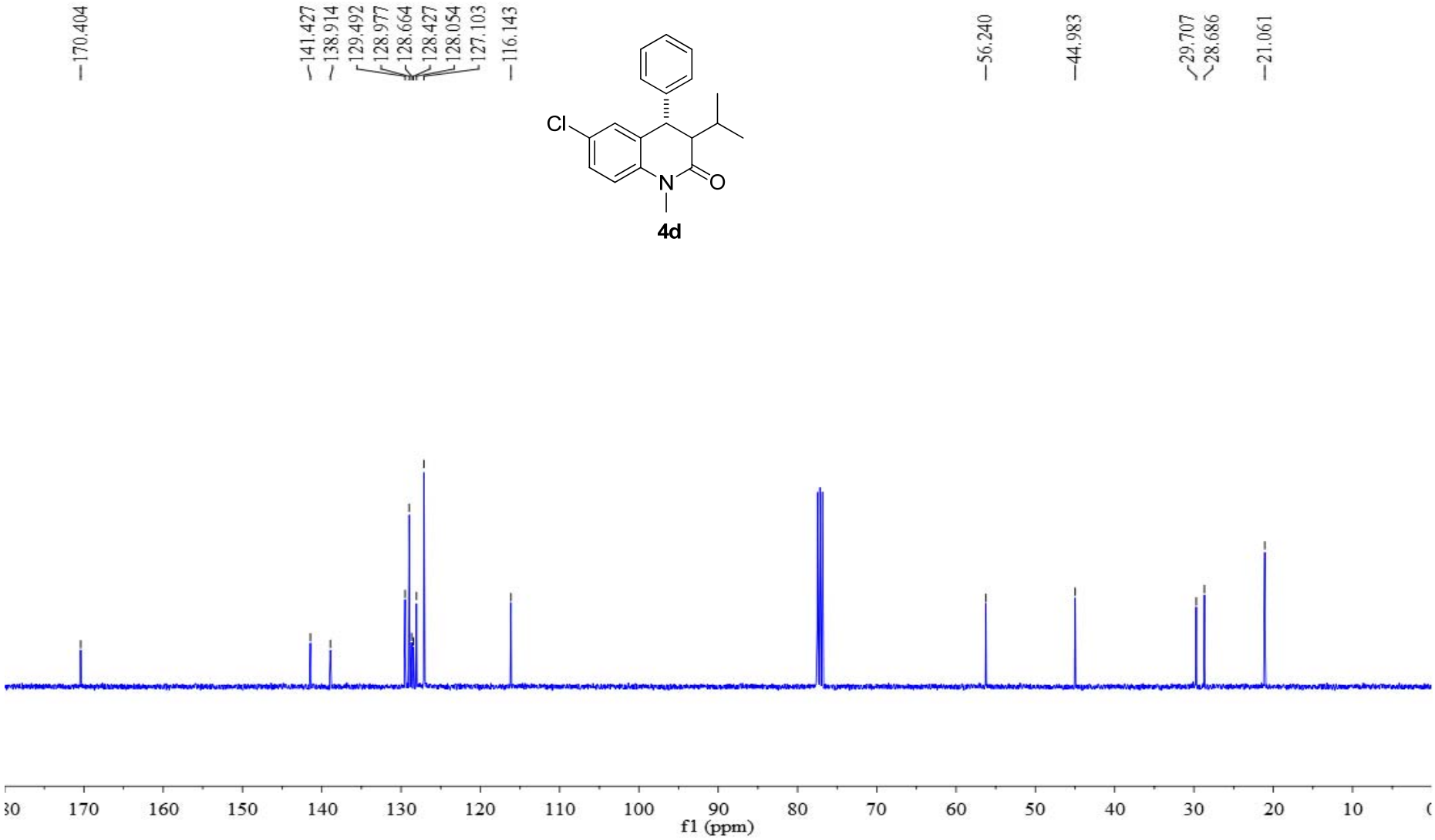
7.269
7.259
7.240
7.221
7.192
7.174
7.168
7.157
6.994
6.972
6.953
4.152
3.338
2.603
2.598
2.580
2.575
1.694
1.677
1.672
1.660
1.655
1.638
1.052
1.036
0.979
0.962
Cl
N
O
4d
3.24
2.01
2.96
1.00
2.99
0.98
1.00
3.07
3.08
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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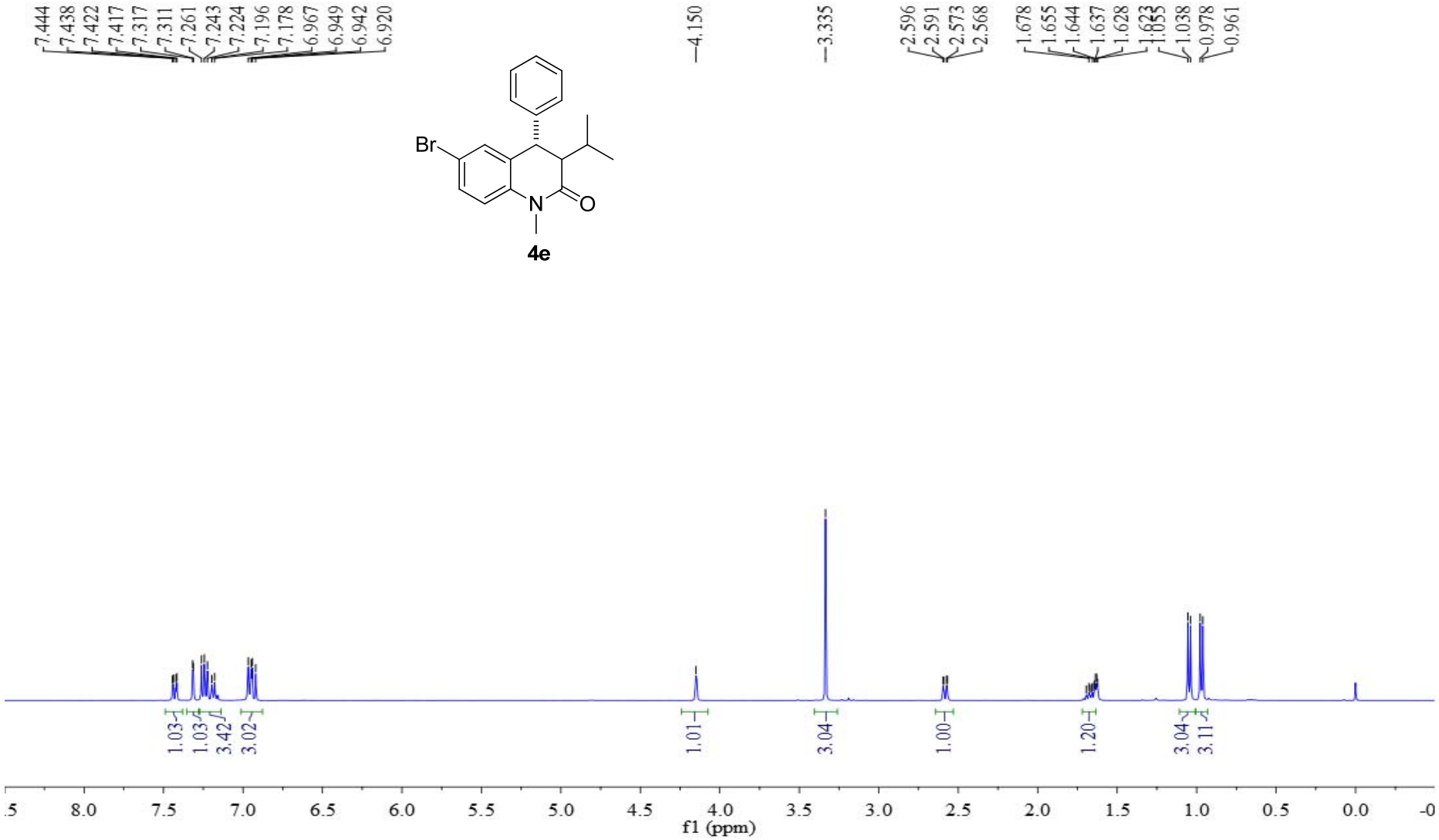
141.427
138.914
129.492
128.977
128.664
128.427
128.054
127.103
116.143
56.240
44.983
29.707
28.686
21.061
Cl
N
O
4d
f1 (ppm)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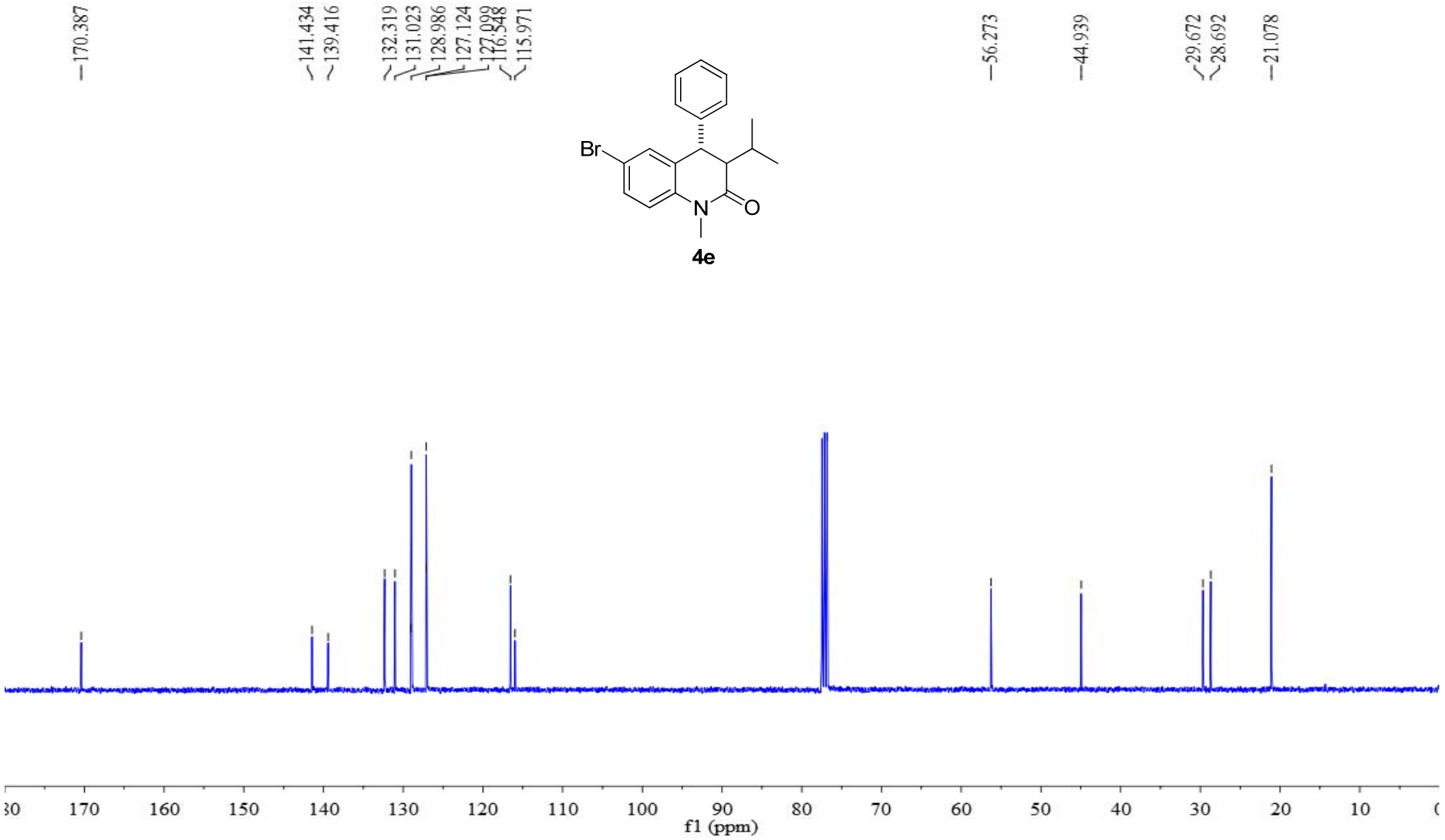
7.422
7.417
7.317
7.311
7.261
7.243
7.224
7.196
7.178
6.967
6.949
6.942
6.920
4.150
3.335
2.596
2.591
2.573
2.568
1.678
1.655
1.644
1.637
1.628
1.623
1.055
1.038
0.978
0.961
Br
N
O
4e
1.03
1.03
3.42
3.02
1.01
3.04
1.00
1.20
3.04
3.11
f1 (ppm)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128.986
127.124
127.099
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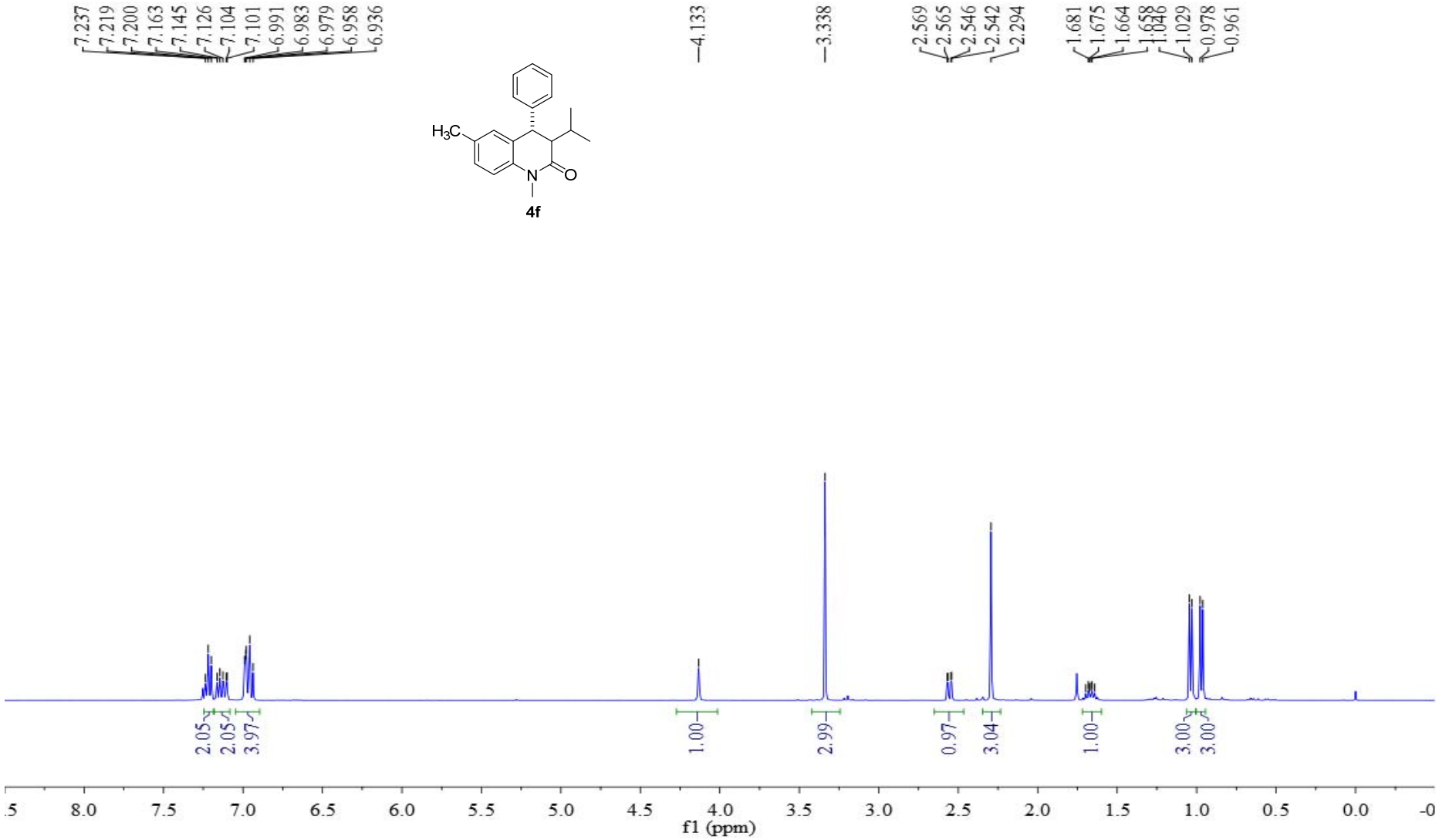
56.273
44.939
29.672
28.692
21.078
Br
N
O
4e
f1 (ppm)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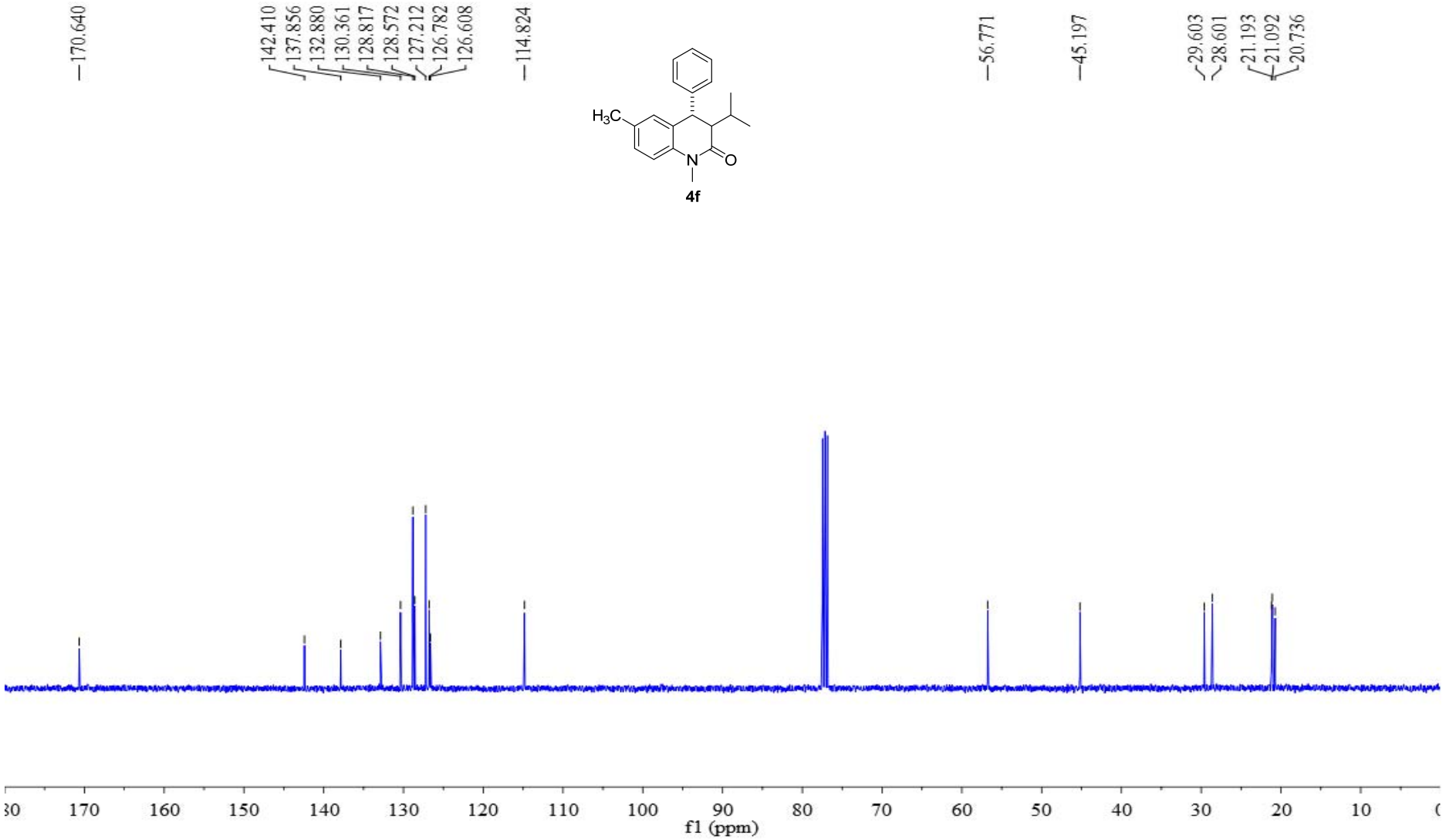
7.200
7.163
7.145
7.126
7.104
7.101
6.991
6.983
6.979
6.958
6.936
4.133
3.338
2.569
2.565
2.546
2.542
2.294
1.681
1.675
1.664
1.658
1.046
1.029
0.978
0.961
H3C
N
O
4f
2.05
2.05
3.97
1.00
2.99
0.97
3.04
1.00
3.00
3.00
f1 (ppm)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127.212
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126.608
114.824
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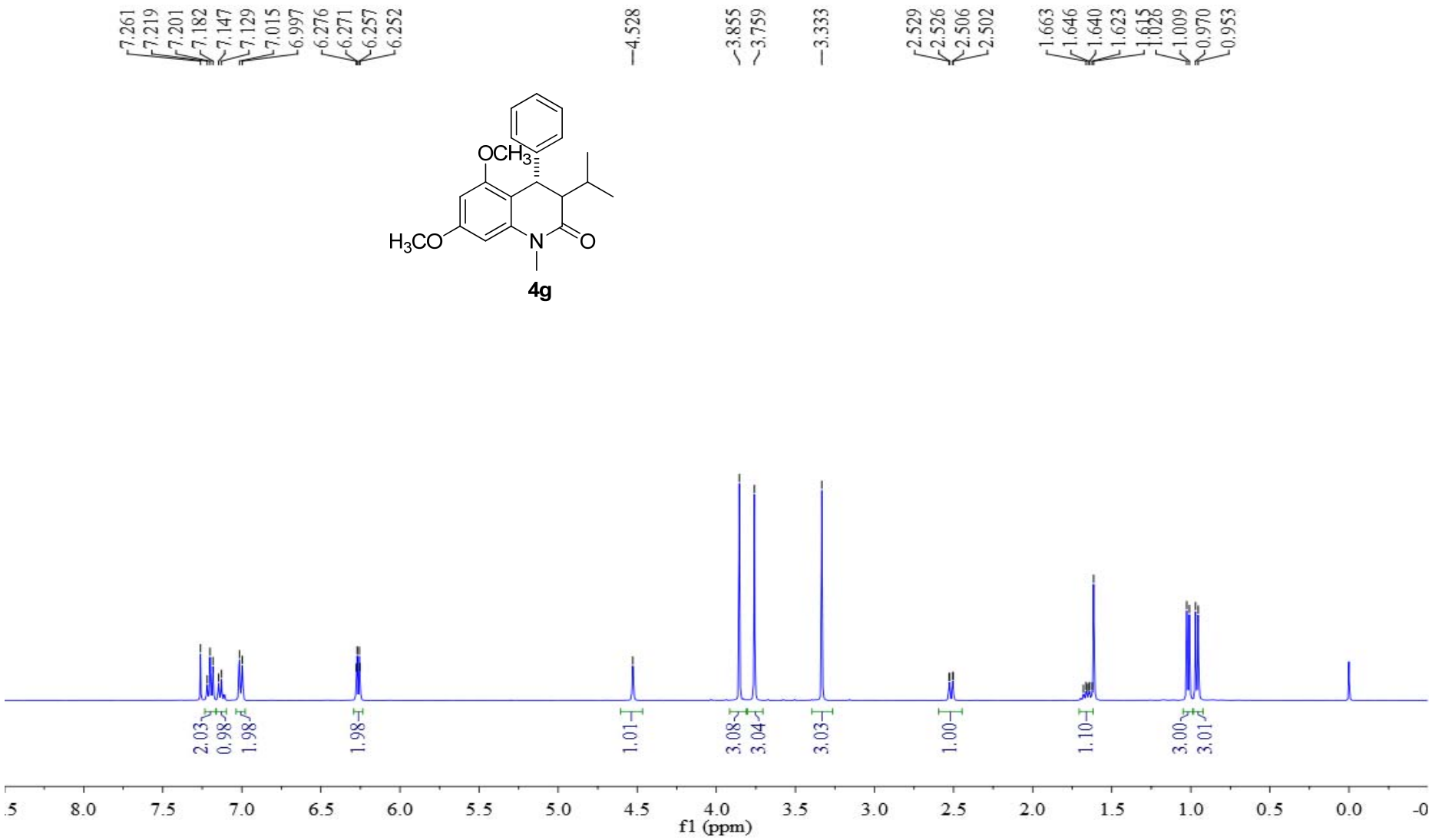
29.603
28.601
21.193
21.092
20.736
H3C
N
O
4f
f1 (ppm)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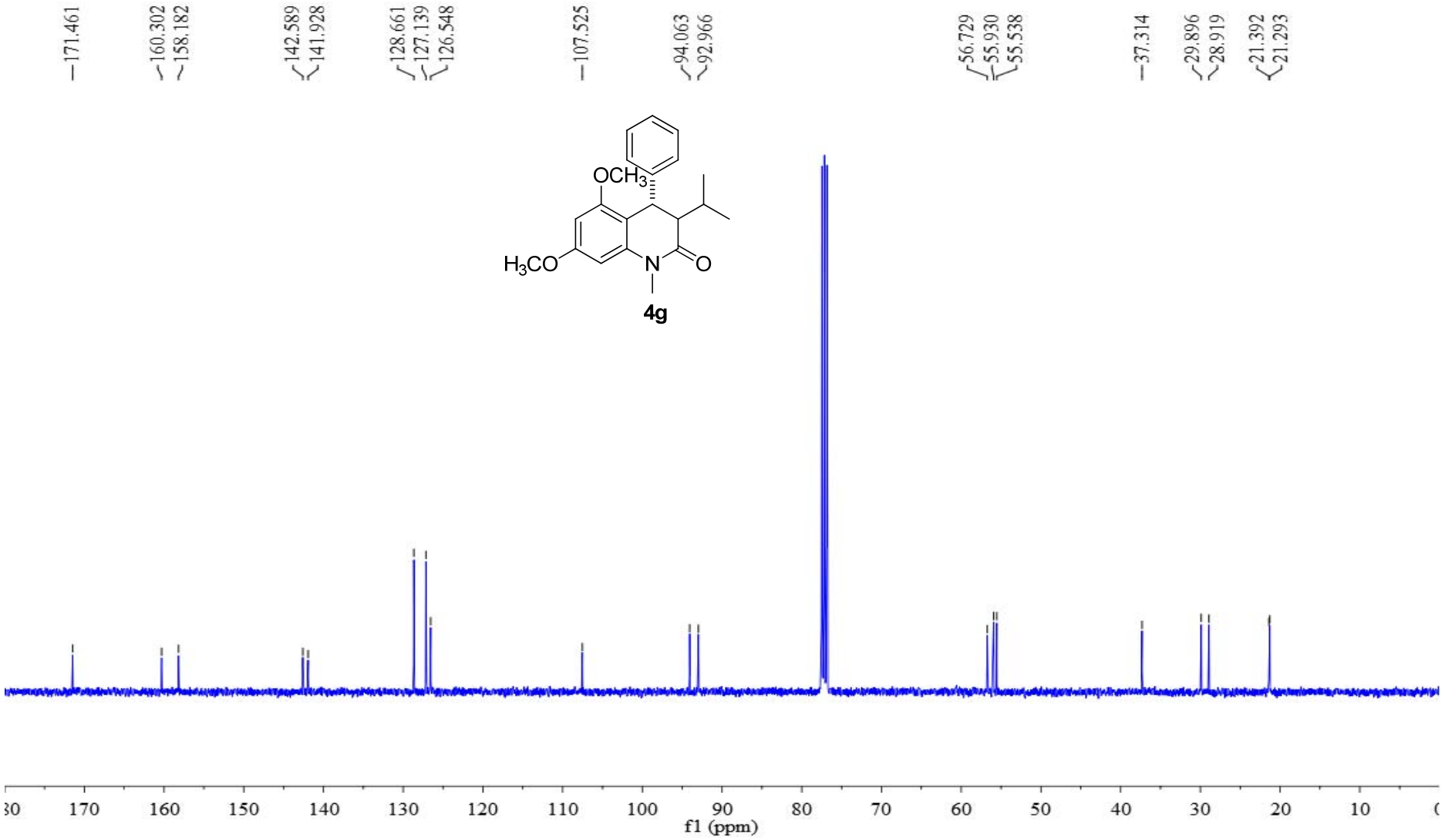
7.182
7.147
7.129
7.015
6.997
6.276
6.271
6.257
6.252
4.528
3.855
3.759
3.333
2.529
2.526
2.506
2.502
1.663
1.646
1.640
1.623
1.615
1.026
1.009
0.970
0.953
OCH3
H3CO
N
O
4g
2.03
0.98
1.98
1.98
1.01
3.08
3.04
3.03
1.00
1.10
3.00
3.01
f1 (ppm)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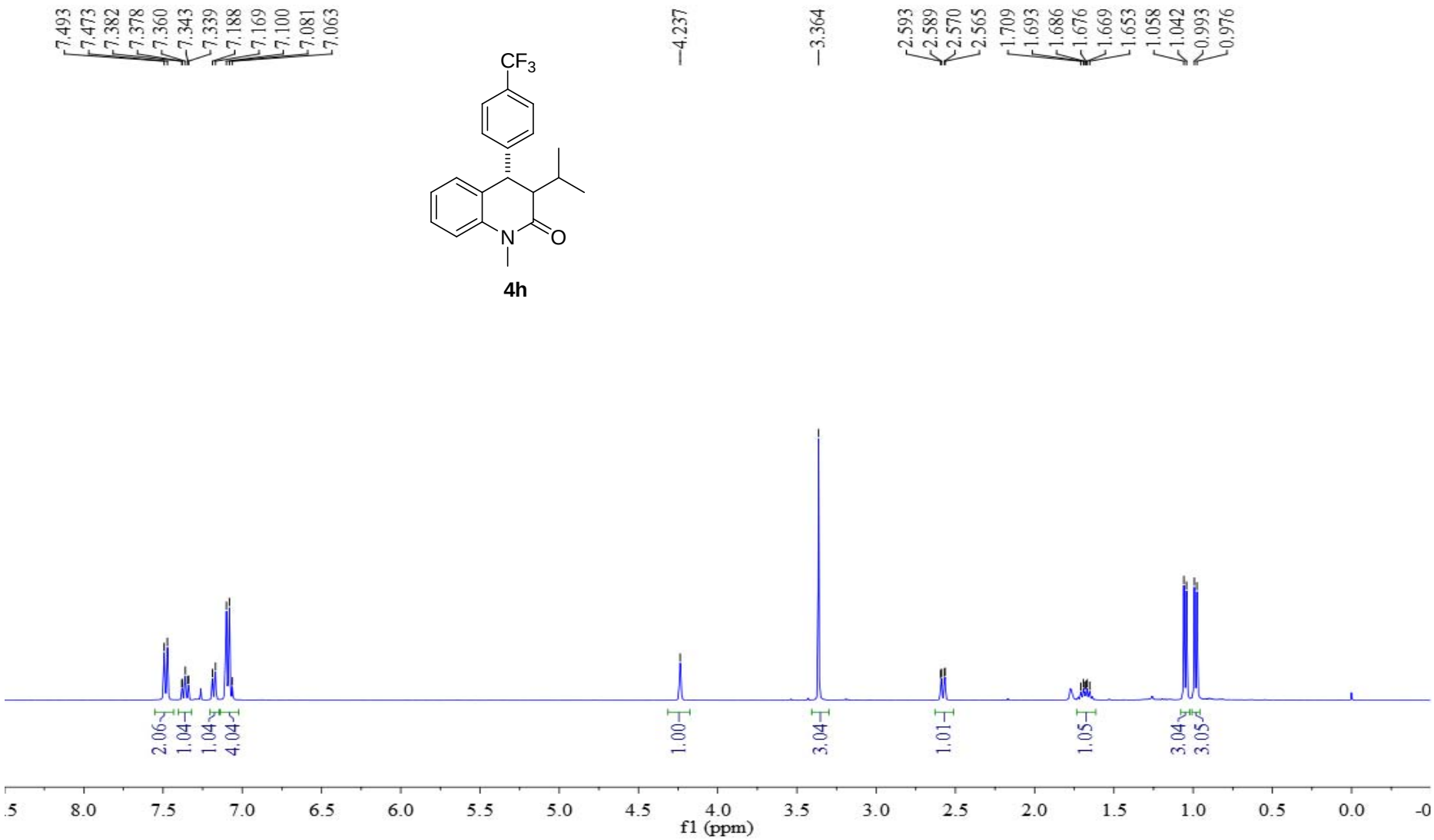
126.548
107.525
94.063
92.966
56.729
55.930
55.538
37.314
29.896
28.919
21.392
21.293
OCH3
H3CO
N
O
4g
f1 (ppm)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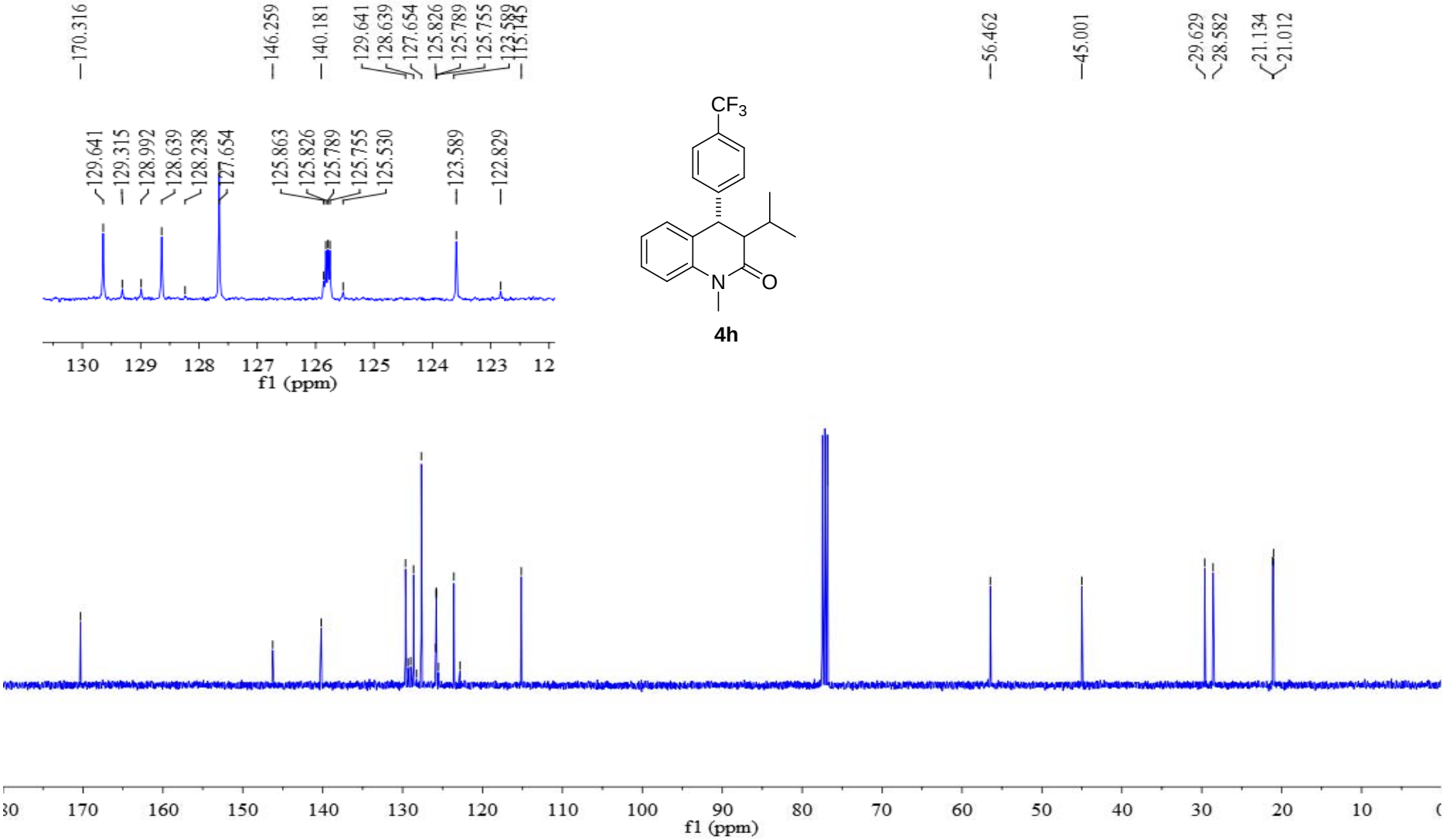
7.188
7.169
7.100
7.081
7.063
4.237
3.364
2.593
2.589
2.570
2.565
1.709
1.693
1.686
1.676
1.669
1.653
1.058
1.042
0.993
0.976
CF3
N
O
2.06
1.04
1.04
4.04
1.00
3.04
1.01
1.05
3.04
3.05
f1 (ppm)

4h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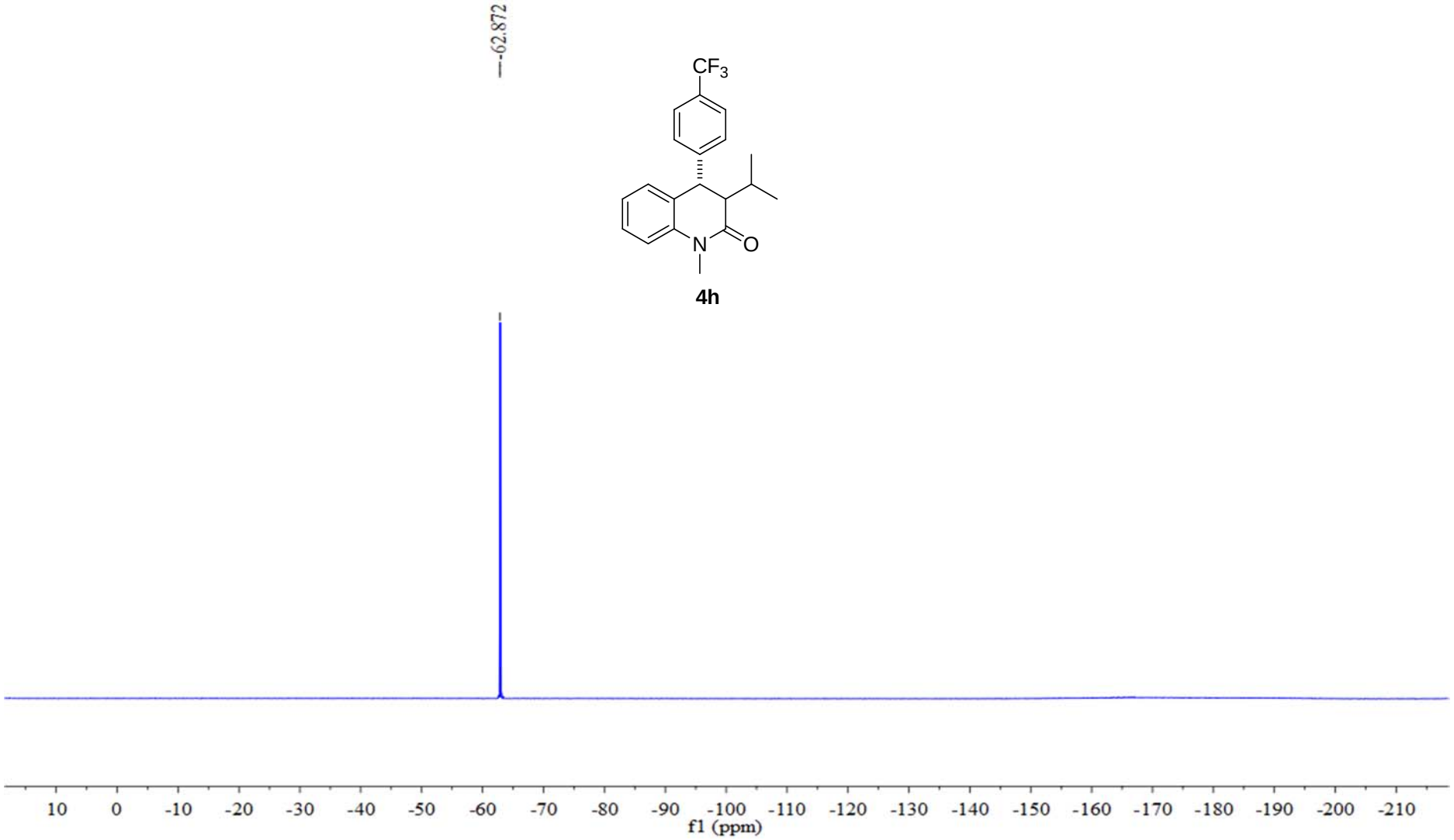
140.181
129.641
128.639
127.654
125.826
125.789
125.755
123.589
115.145
56.462
45.001
29.629
28.582
21.134
21.012
129.641
129.315
128.992
128.639
128.238
127.654
125.863
125.826
125.789
125.755
125.530
123.589
122.829
130 129 128 127 126 125 124 123 12
f1 (ppm)
CF3
N
O
4h
30 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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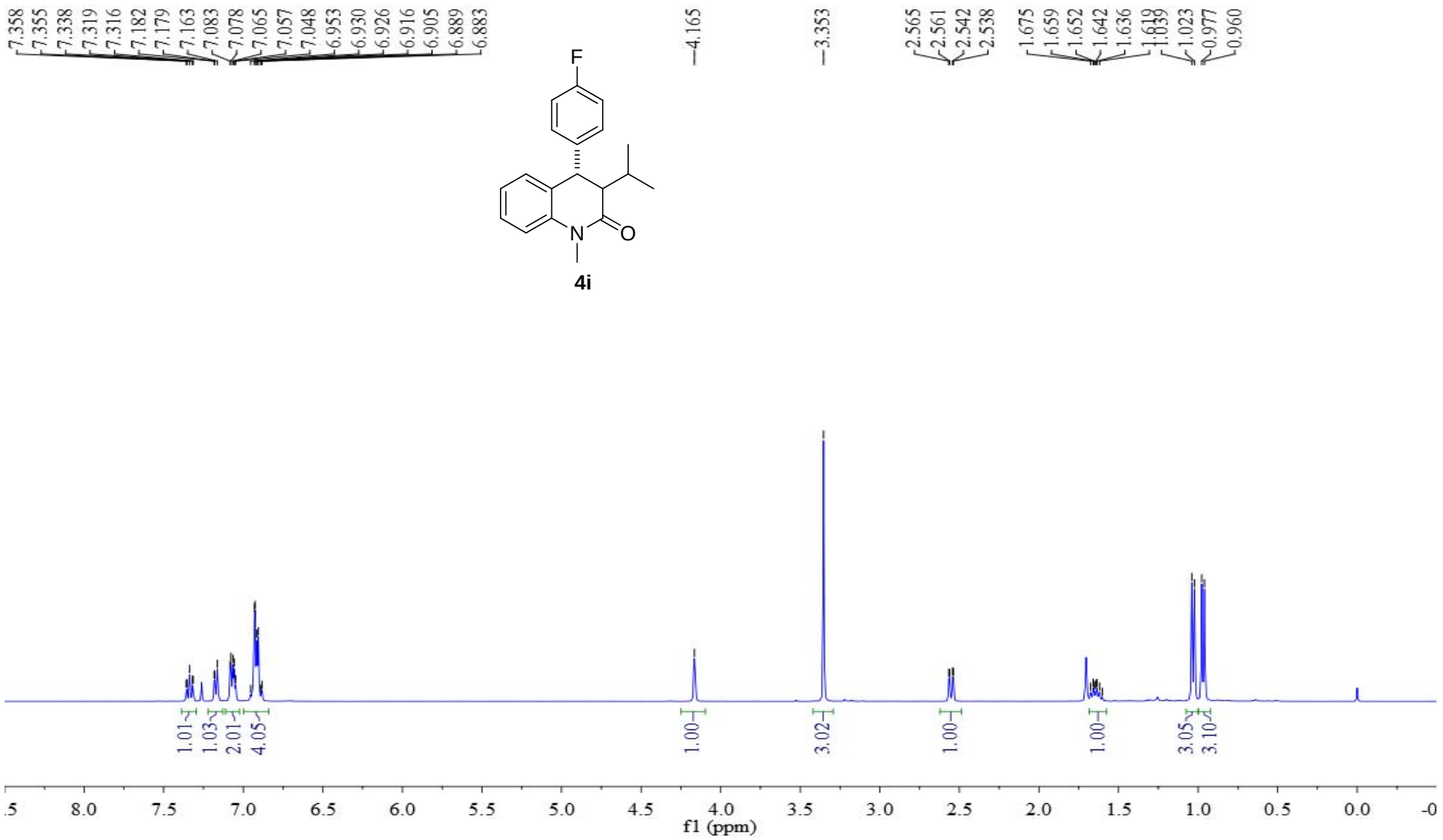
CF3
N
O
4h
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)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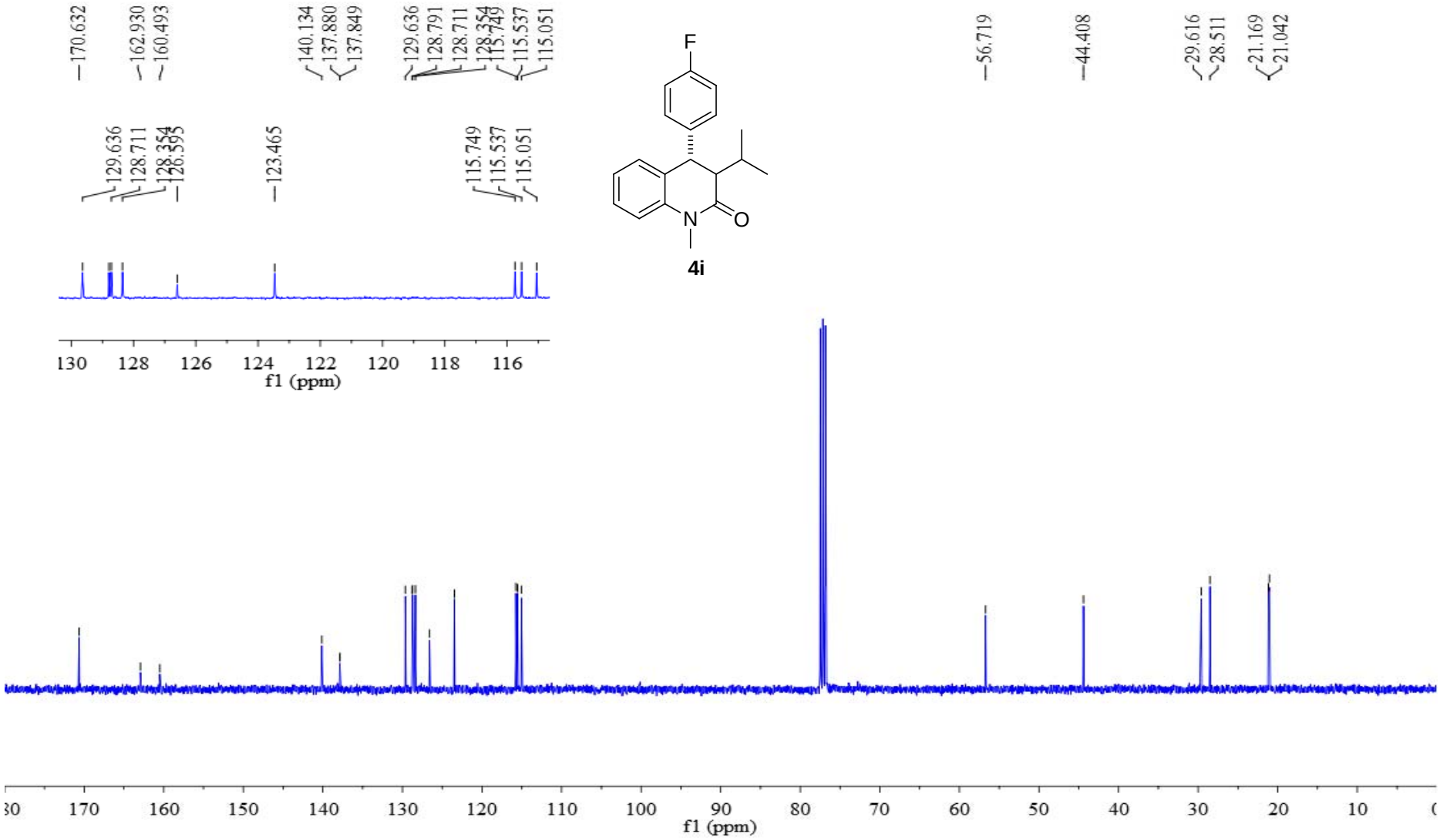
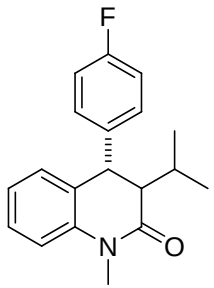
7.182
7.179
7.163
7.083
7.078
7.065
7.057
7.048
6.953
6.930
6.926
6.916
6.905
6.889
6.883
4.165
3.353
2.565
2.561
2.542
2.538
1.675
1.659
1.652
1.642
1.636
1.619
1.039
1.023
0.977
0.960
F
N
O
1.01
1.03
2.01
4.05
1.00
3.02
1.00
1.00
3.05
3.10
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

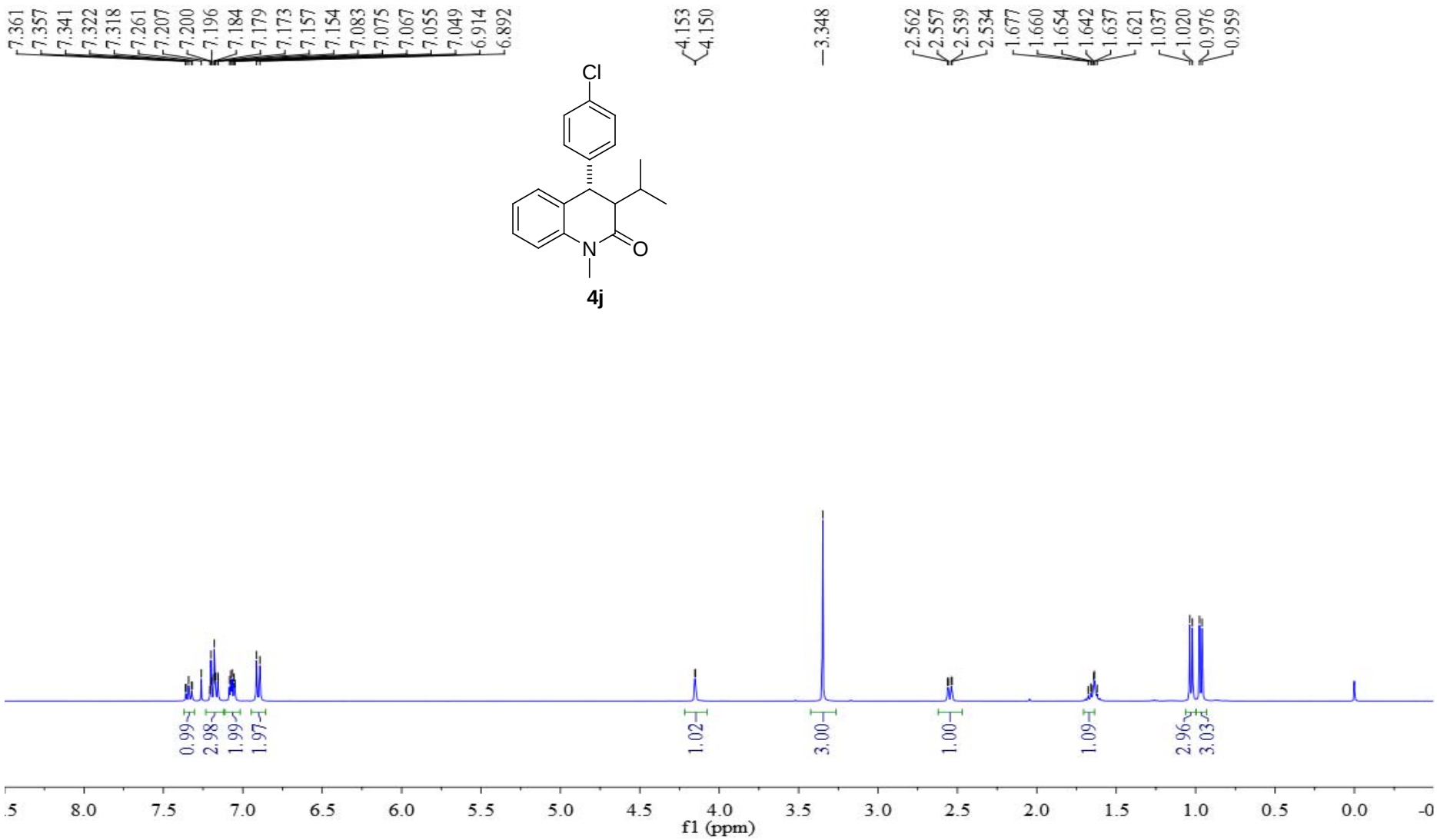
4i

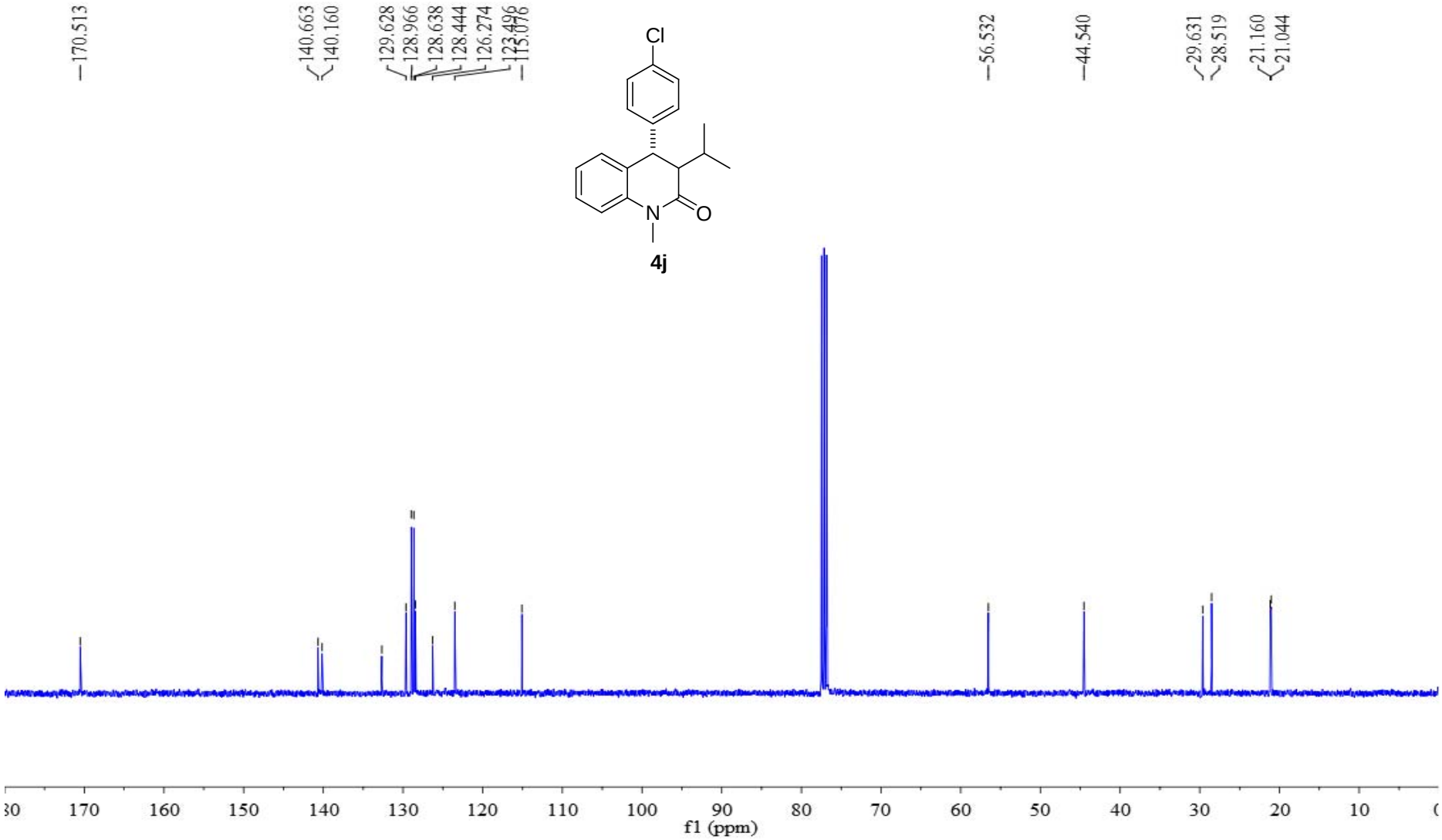

170.632
162.930
160.493
140.134
137.880
137.849
129.636
128.791
128.711
128.354
115.749
115.537
115.051
56.719
44.408
29.616
28.511
21.169
21.042
129.636
128.711
128.354
126.595
123.465
115.749
115.537
115.051
F
N
O
4i
130
128
126
124
122
120
118
116
f1 (ppm)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

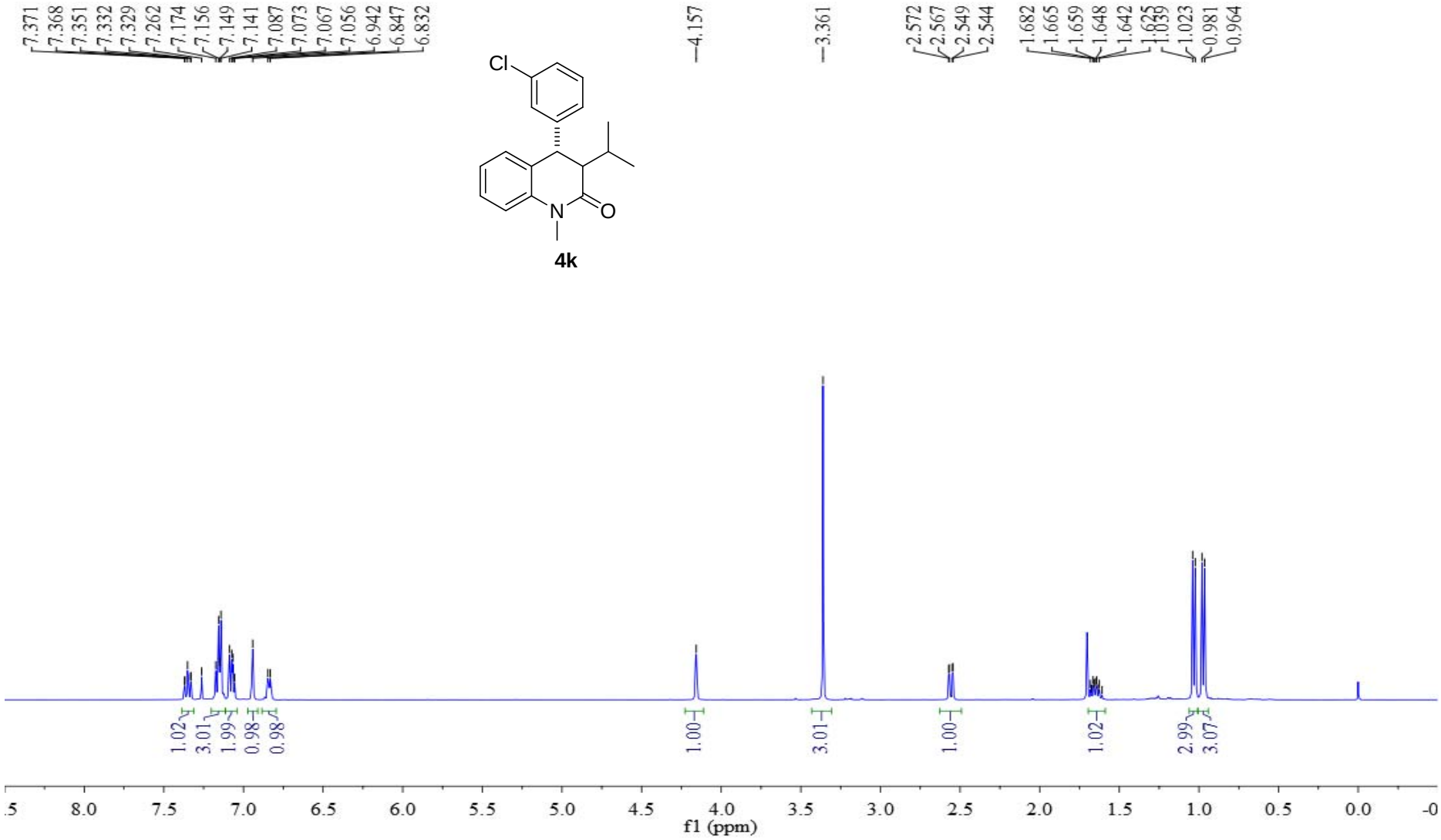

F
N
O

4i

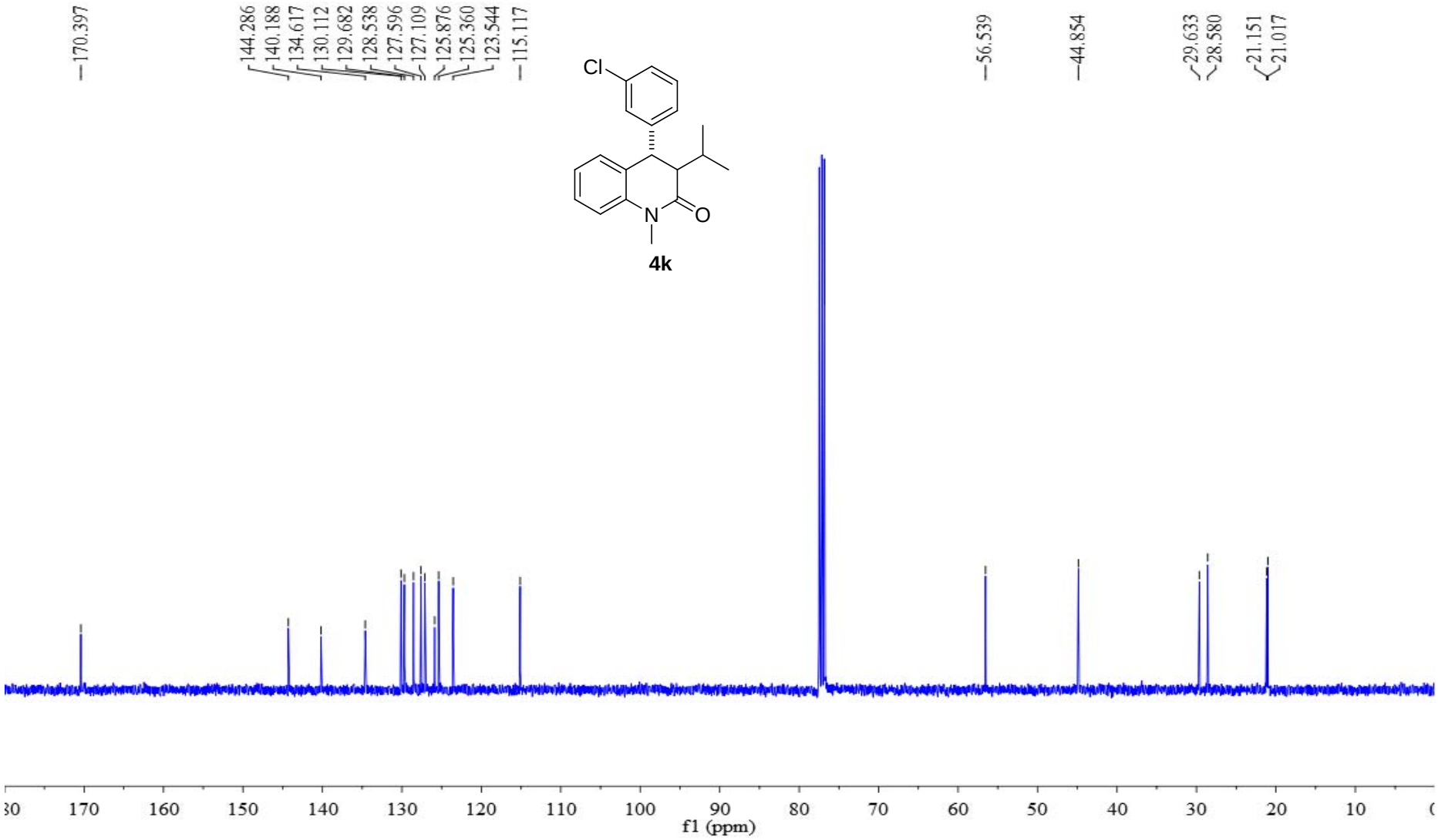
-116.701
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)


7.361
7.357
7.341
7.322
7.318
7.261
7.207
7.200
7.196
7.184
7.179
7.173
7.157
7.154
7.083
7.075
7.067
7.055
7.049
6.914
6.892
4.153
4.150
3.348
2.562
2.557
2.539
2.534
1.677
1.660
1.654
1.642
1.637
1.621
1.037
1.020
0.976
0.959
Cl
N
O
4j
0.99
2.98
1.99
1.97
1.02
3.00
1.00
1.09
2.96
3.03
f1 (ppm)


170.513
140.663
140.160
129.628
128.966
128.638
128.444
126.274
123.486
115.076
56.532
44.540
29.631
28.519
21.160
21.044
Cl
N
O
4j
f1 (ppm)


7.371
7.368
7.351
7.332
7.329
7.262
7.174
7.156
7.149
7.141
7.087
7.073
7.067
7.056
6.942
6.847
6.832
4.157
3.361
2.572
2.567
2.549
2.544
1.682
1.665
1.659
1.648
1.642
1.625
1.039
1.023
0.981
0.964
Cl
N
O
1.02
3.01
1.99
0.98
0.98
1.00
3.01
1.00
1.02
2.99
3.07
f1 (ppm)

4k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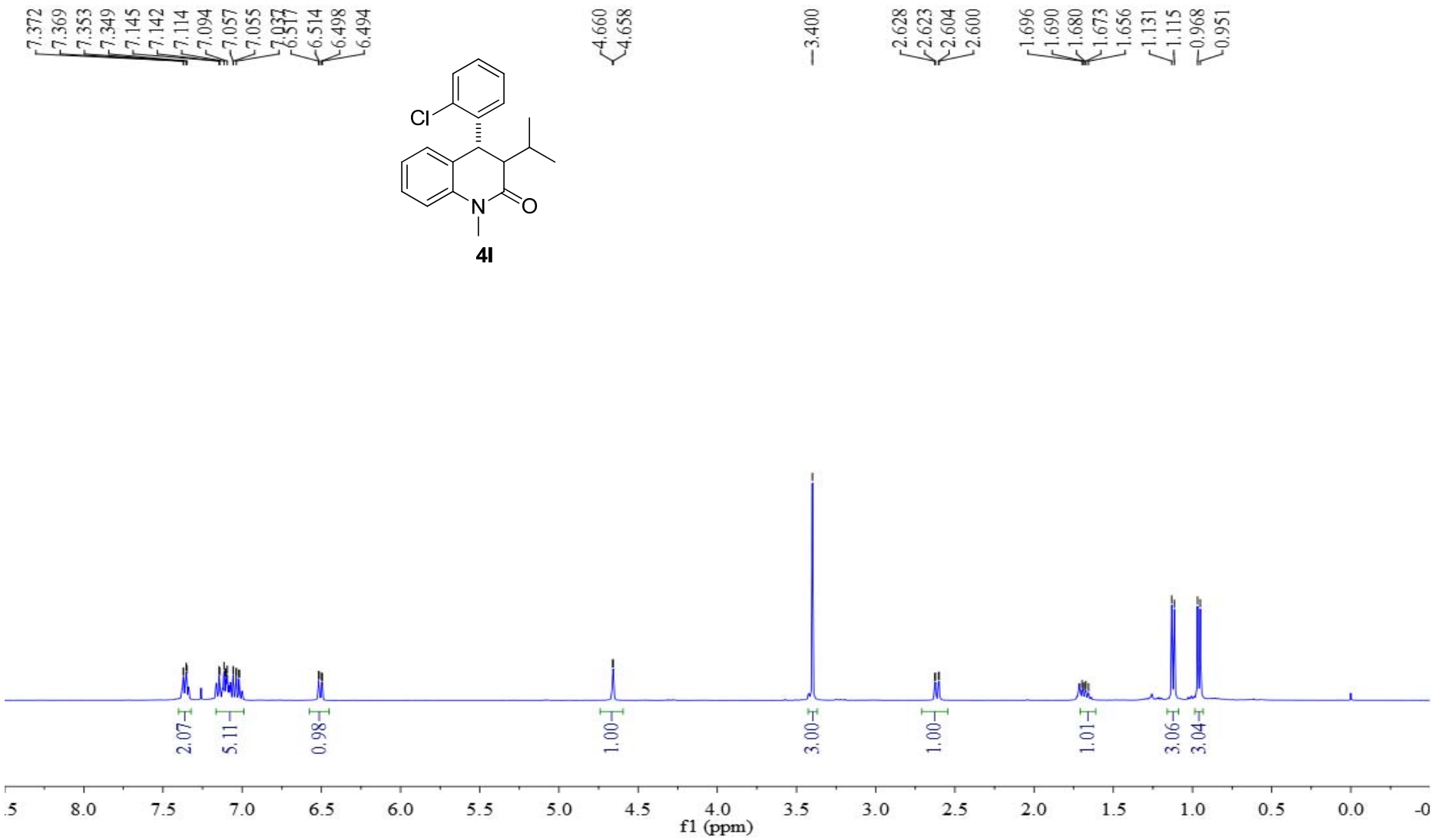
144.286
140.188
134.617
130.112
129.682
128.538
127.596
127.109
125.876
125.360
123.544
115.117
56.539
44.854
29.633
28.580
21.151
21.017
Cl
N
O
4k
f1 (ppm)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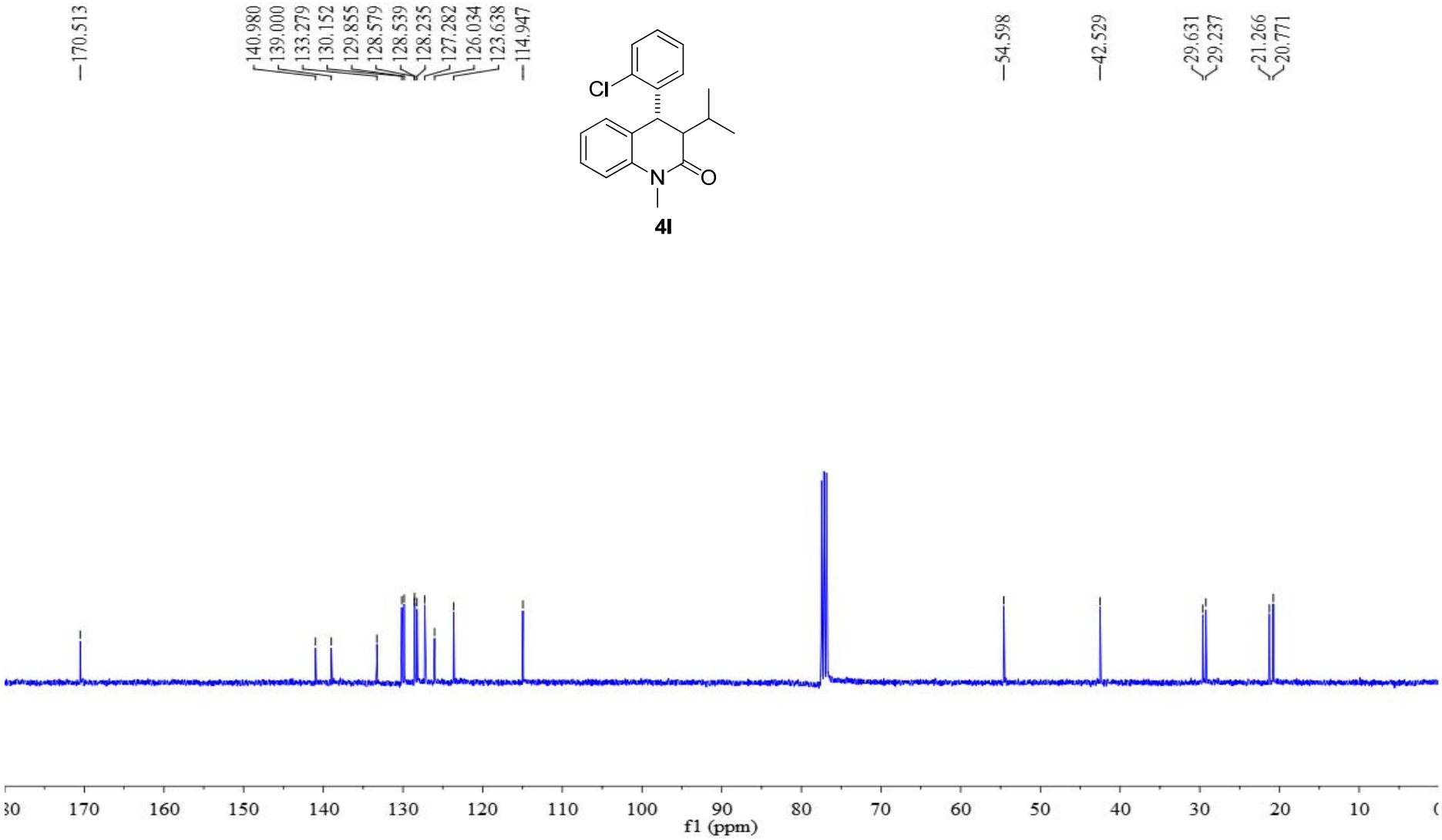
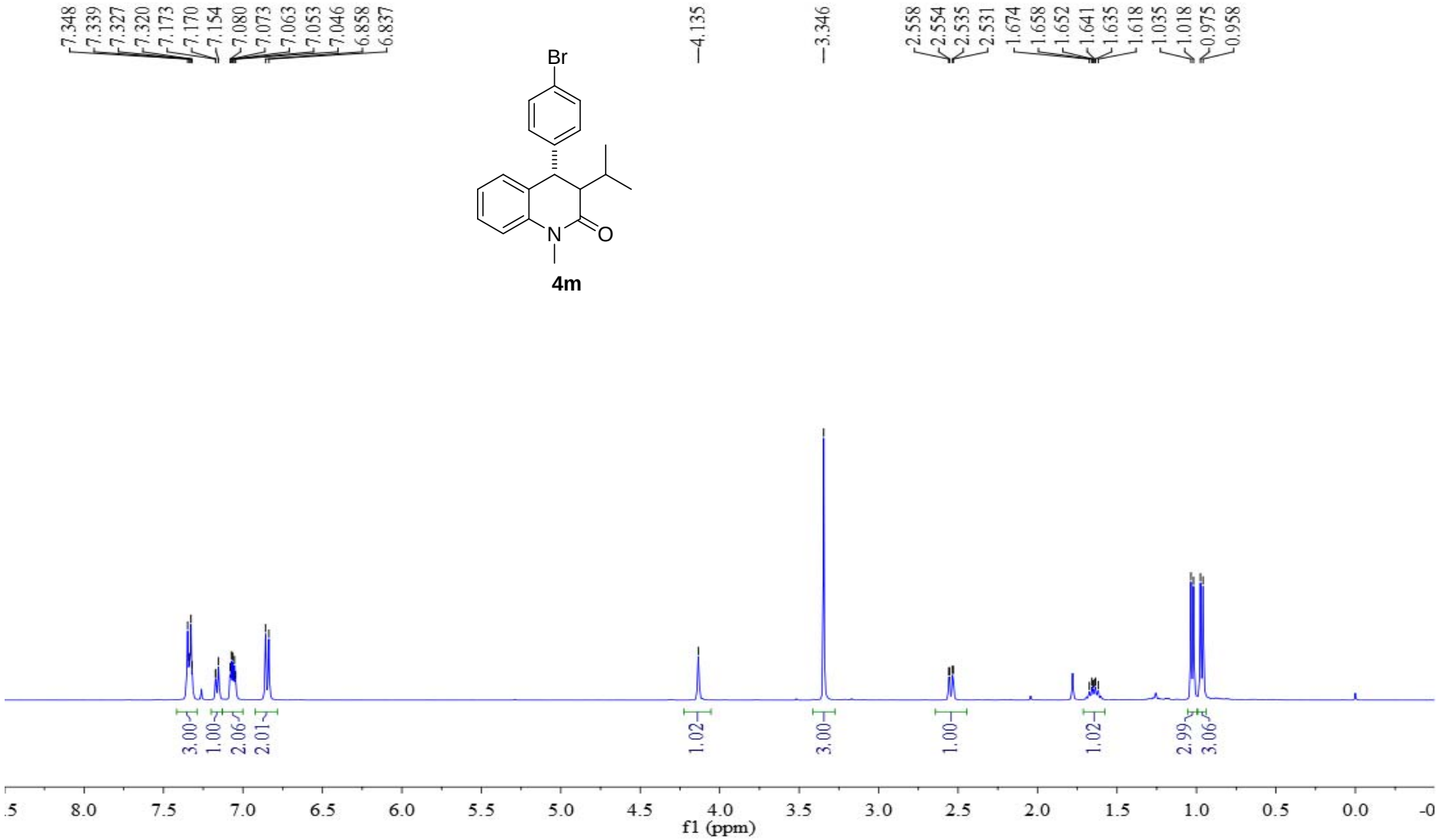
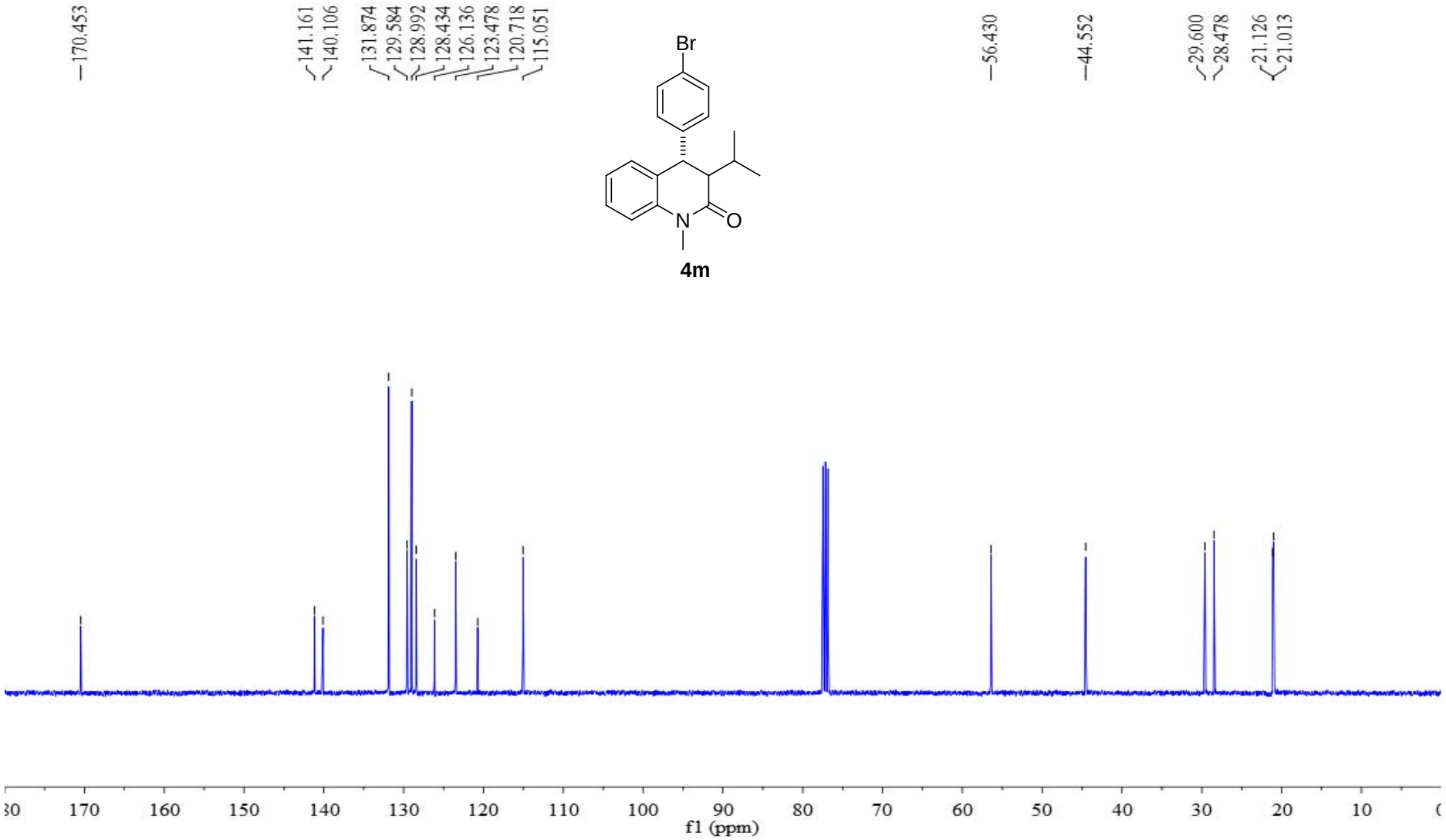
7.369
7.353
7.349
7.145
7.142
7.114
7.094
7.057
7.055
7.037
7.017
6.514
6.498
6.494
4.660
4.658
3.400
2.628
2.623
2.604
2.600
1.696
1.690
1.680
1.673
1.656
1.131
1.115
0.968
0.951
Cl
N
O
4l
2.07
5.11
0.98
1.00
3.00
1.00
1.01
3.06
3.04
f1 (ppm)


170.513
140.980
139.000
133.279
130.152
129.855
128.579
128.539
128.235
127.282
126.034
123.638
114.947
54.598
42.529
29.631
29.237
21.266
20.771
Cl
N
O
4l
f1 (ppm)


7.348
7.339
7.327
7.320
7.173
7.170
7.154
7.080
7.073
7.063
7.053
7.046
6.858
6.837
4.135
3.346
2.558
2.554
2.535
2.531
1.674
1.658
1.652
1.641
1.635
1.618
1.035
1.018
0.975
0.958
Br
N
O
4m
3.00
1.00
2.06
2.01
1.02
3.00
1.00
1.02
2.99
3.06
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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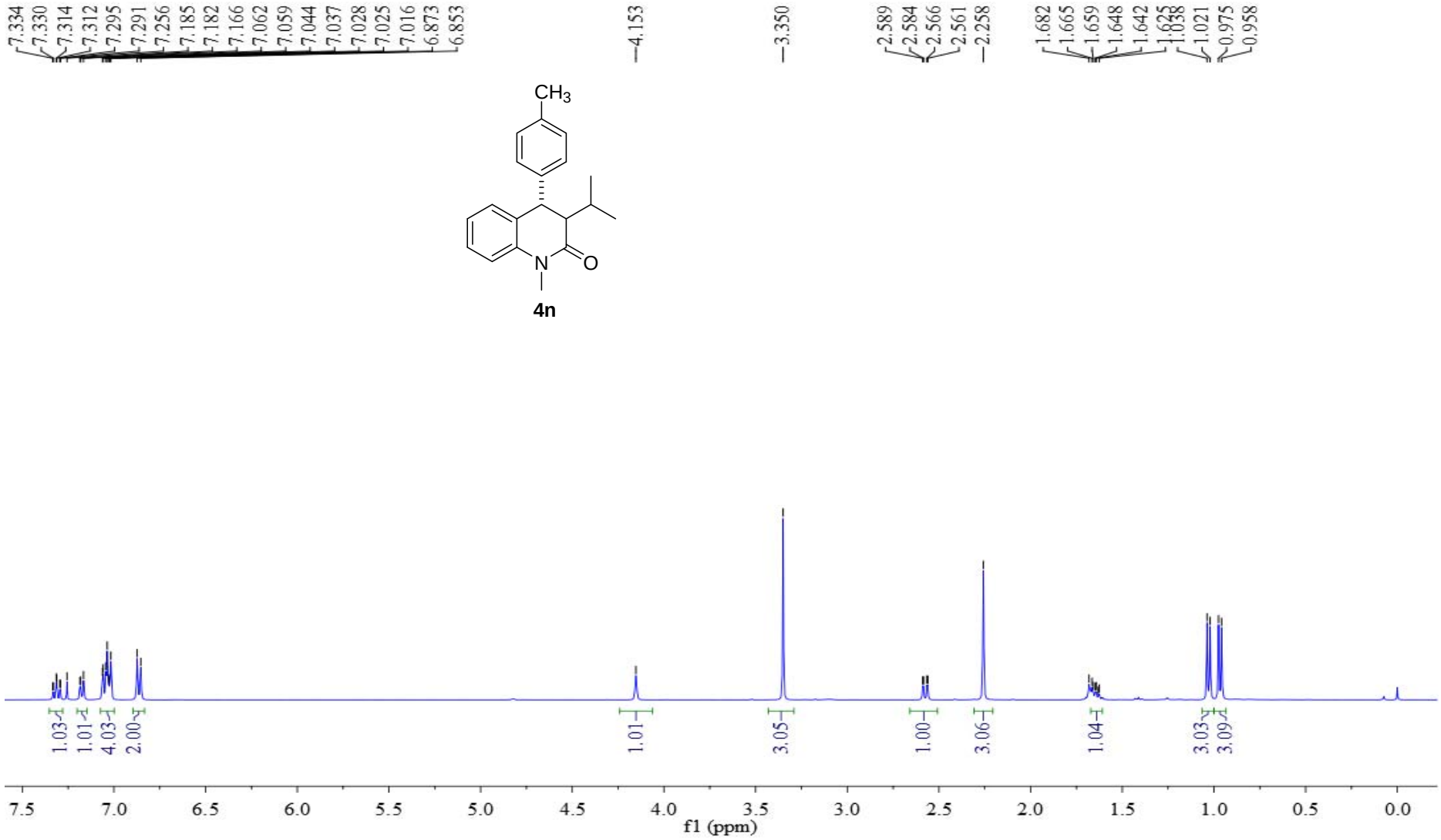
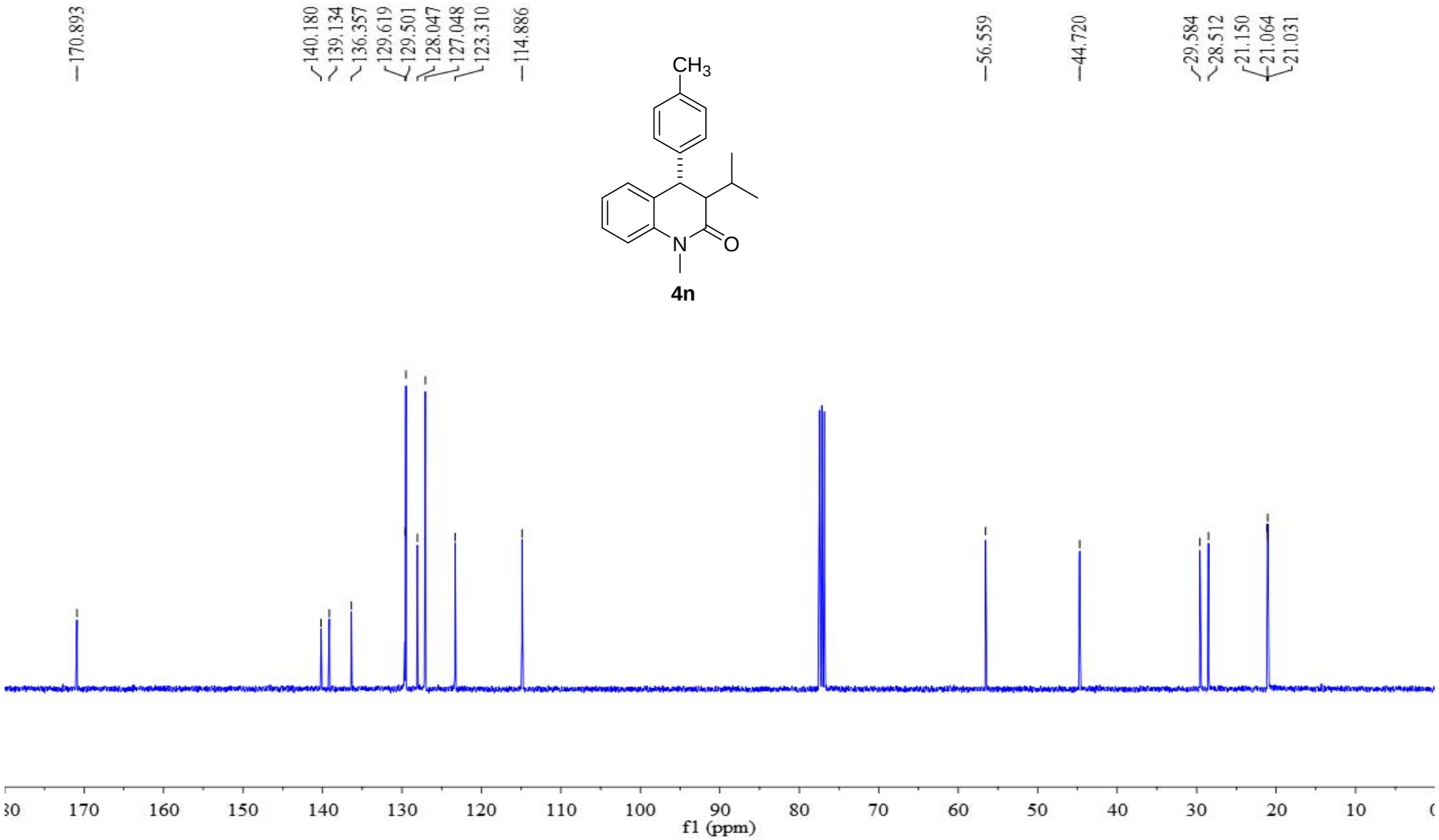
141.161
140.106
131.874
129.584
128.992
128.434
126.136
123.478
120.718
115.051
56.430
44.552
29.600
28.478
21.126
21.013
Br
N
O
4m
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.334
7.330
7.314
7.312
7.295
7.291
7.256
7.185
7.182
7.166
7.062
7.059
7.044
7.037
7.028
7.025
7.016
6.873
6.853
4.153
3.350
2.589
2.584
2.566
2.561
2.258
1.682
1.665
1.659
1.648
1.642
1.625
1.038
1.021
0.975
0.958
CH3
N
O
4n
1.03
1.01
4.03
2.00
1.01
3.05
1.00
3.06
1.04
3.03
3.09
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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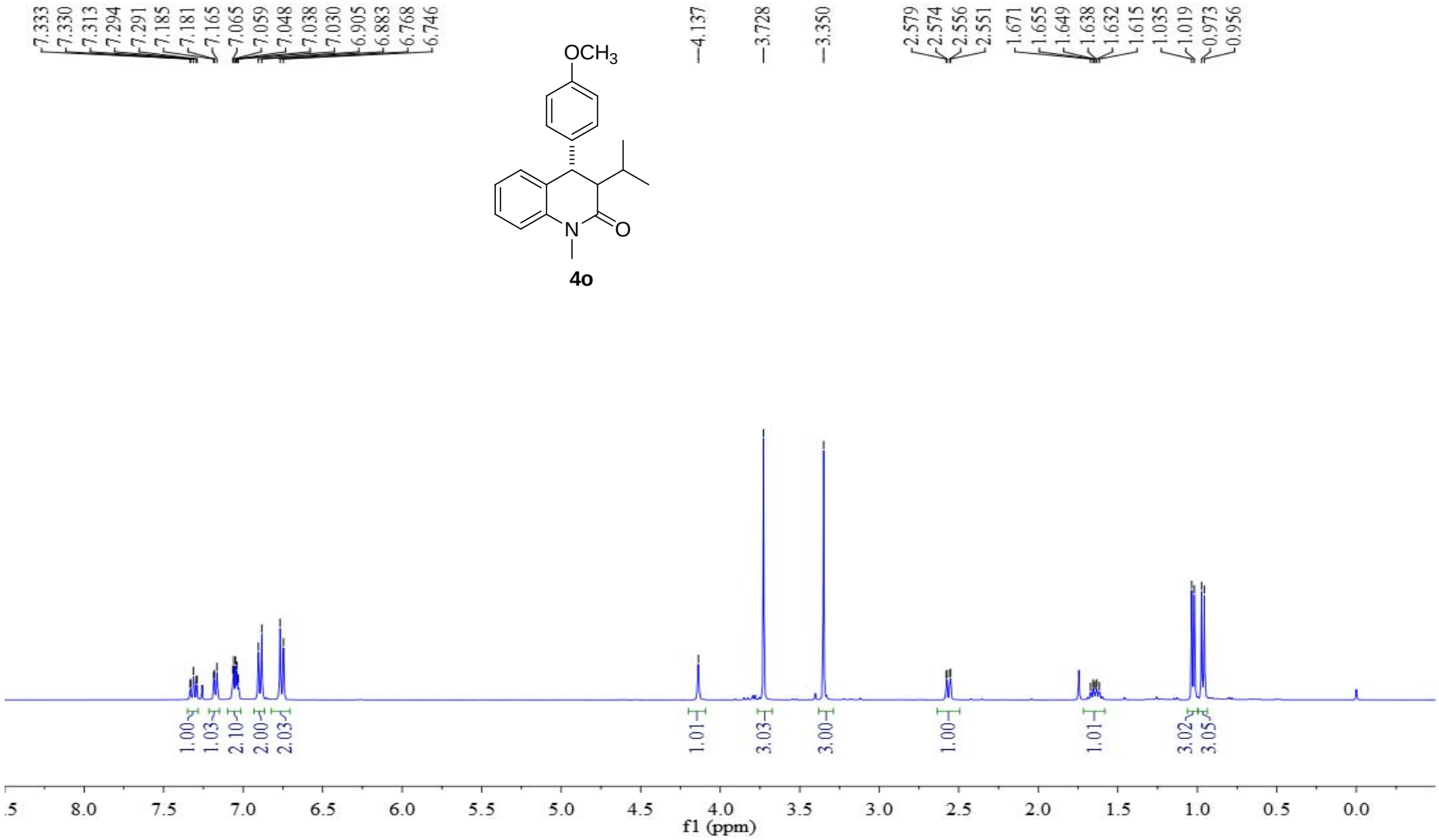
136.357
129.619
129.501
128.047
127.048
123.310
114.886
56.559
44.720
29.584
28.512
21.150
21.064
21.031
CH3
N
O
4n
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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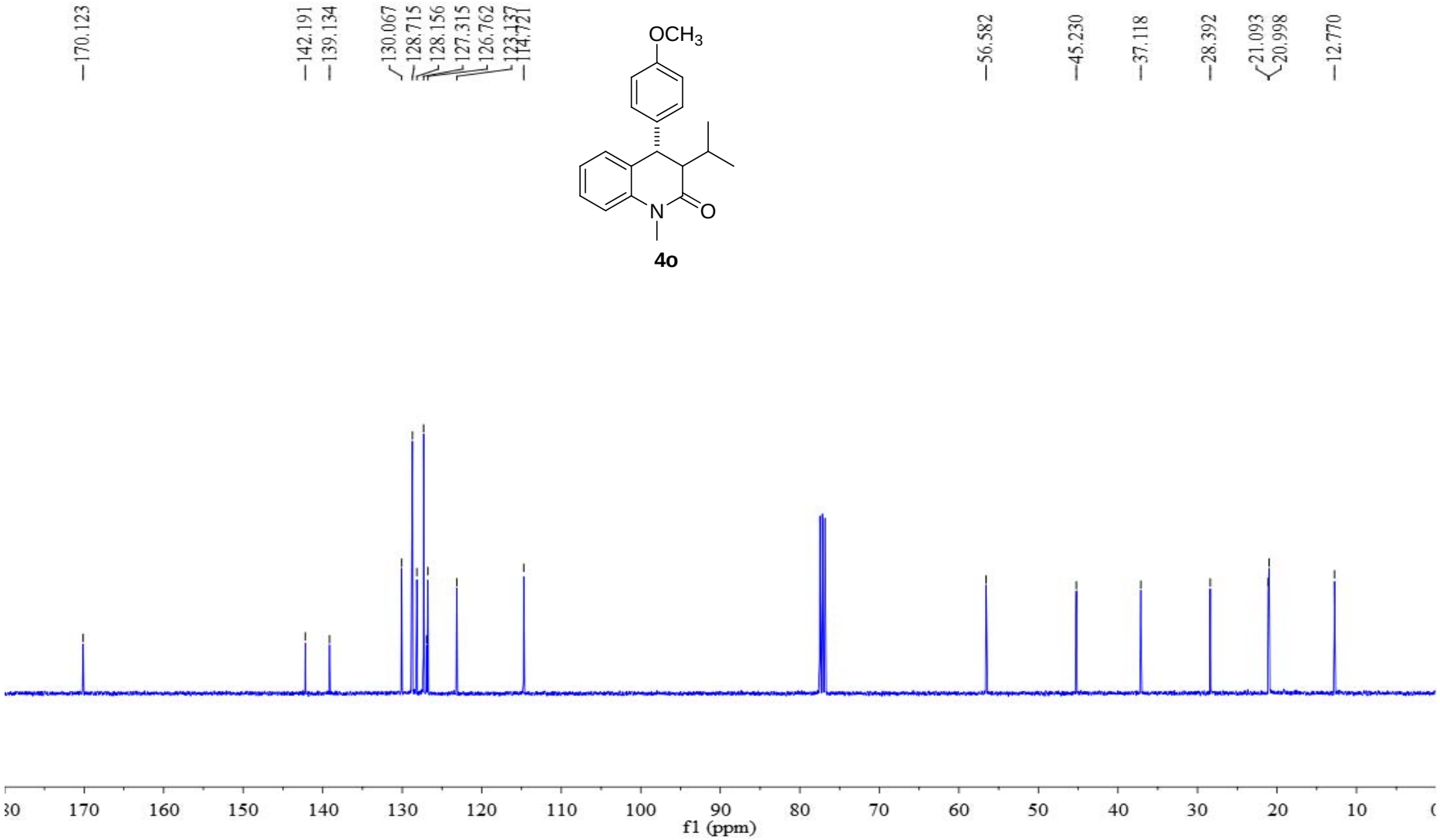
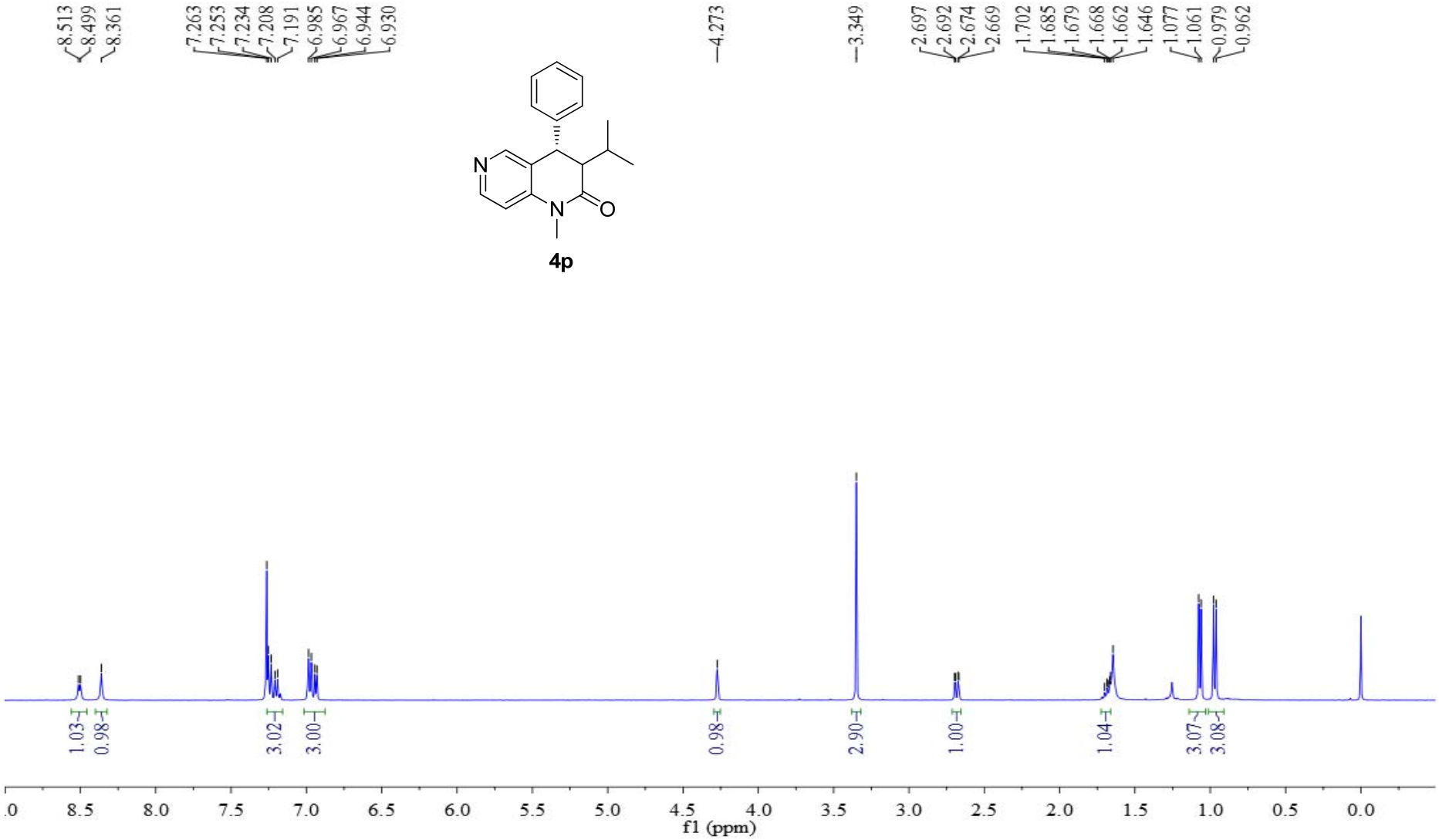
7.291
7.185
7.181
7.165
7.065
7.059
7.048
7.038
7.030
6.905
6.883
6.768
6.746
4.137
3.728
3.350
2.579
2.574
2.556
2.551
1.671
1.655
1.649
1.638
1.632
1.615
1.035
1.019
0.973
0.956
OCH3
N
O
4o
1.00
1.03
2.10
2.00
2.03
1.01
3.03
3.00
1.00
1.01
3.02
3.05
f1 (ppm)


170.123
142.191
139.134
130.067
128.715
128.156
127.315
126.762
123.137
114.721
56.582
45.230
37.118
28.392
21.093
20.998
12.770
OCH3
N
O
4o
f1 (ppm)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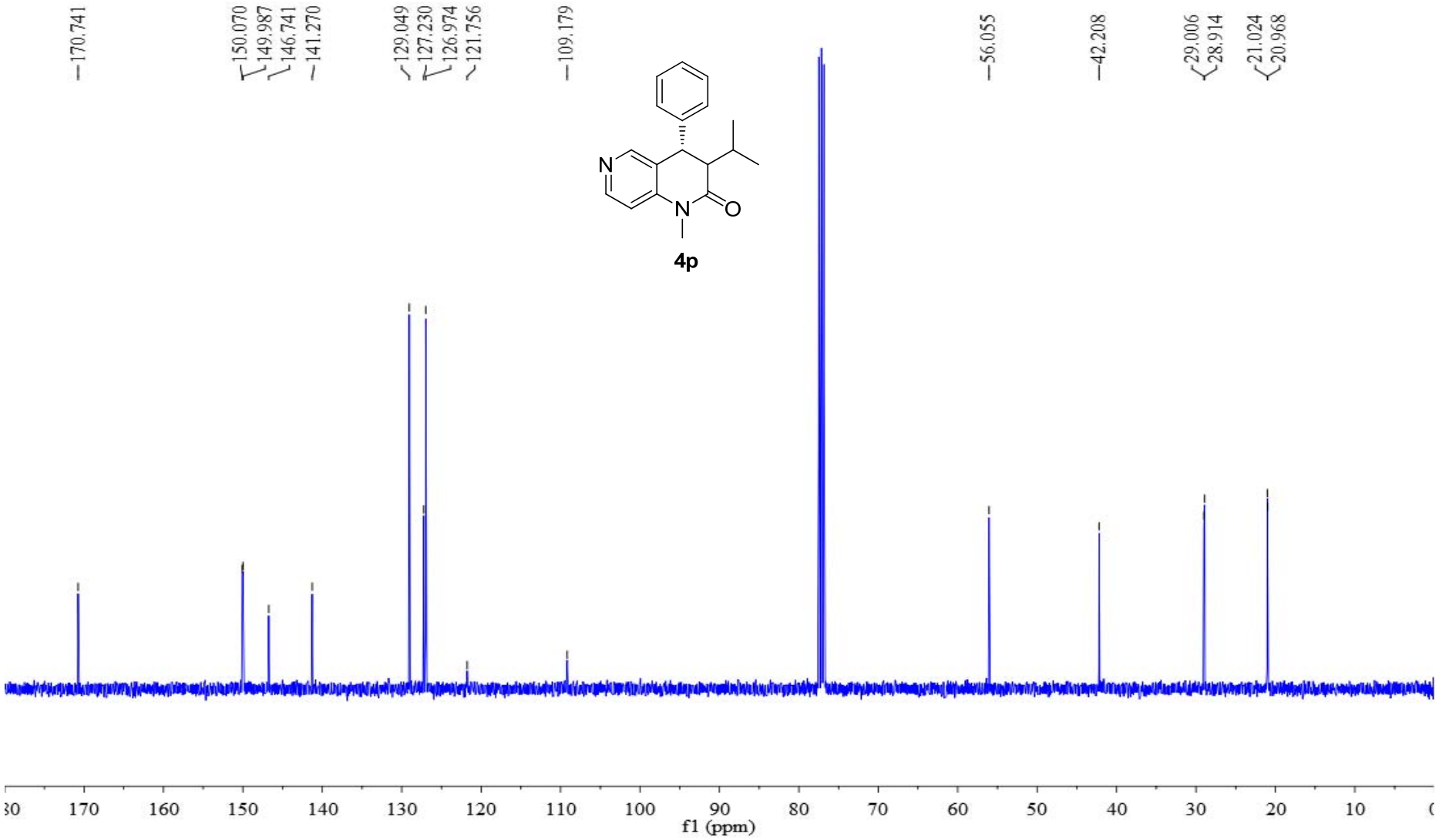
8.499
8.361
7.263
7.253
7.234
7.208
7.191
6.985
6.967
6.944
6.930
4.273
3.349
2.697
2.692
2.674
2.669
1.702
1.685
1.679
1.668
1.662
1.646
1.077
1.061
0.979
0.962
N
N
O
4p
1.03
0.98
3.02
3.00
0.98
2.90
1.00
1.04
3.07
3.08
f1 (ppm)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127.230
126.974
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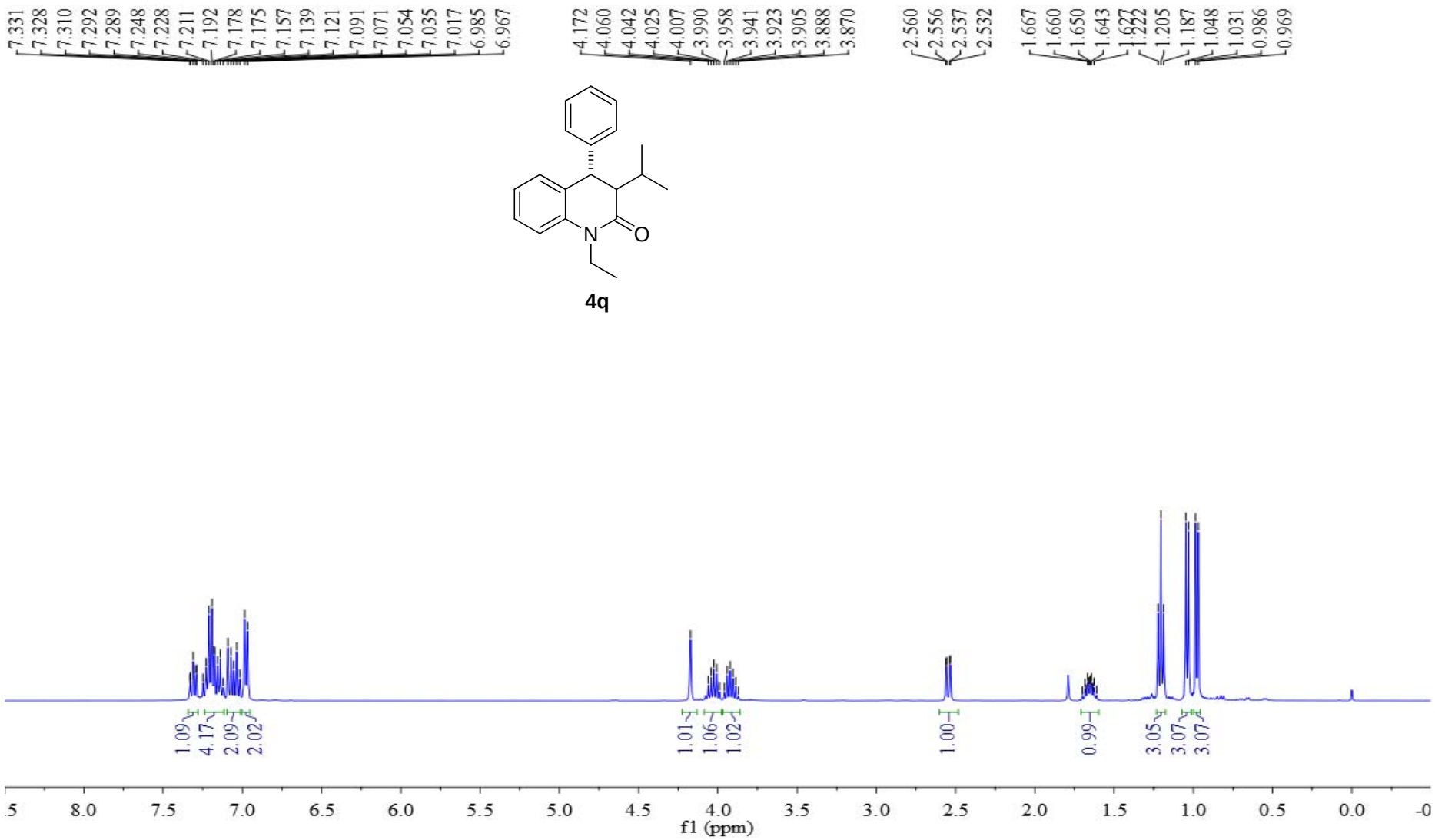
42.208
29.006
28.914
21.024
20.968
N
N
O
4p
f1 (ppm)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7.178
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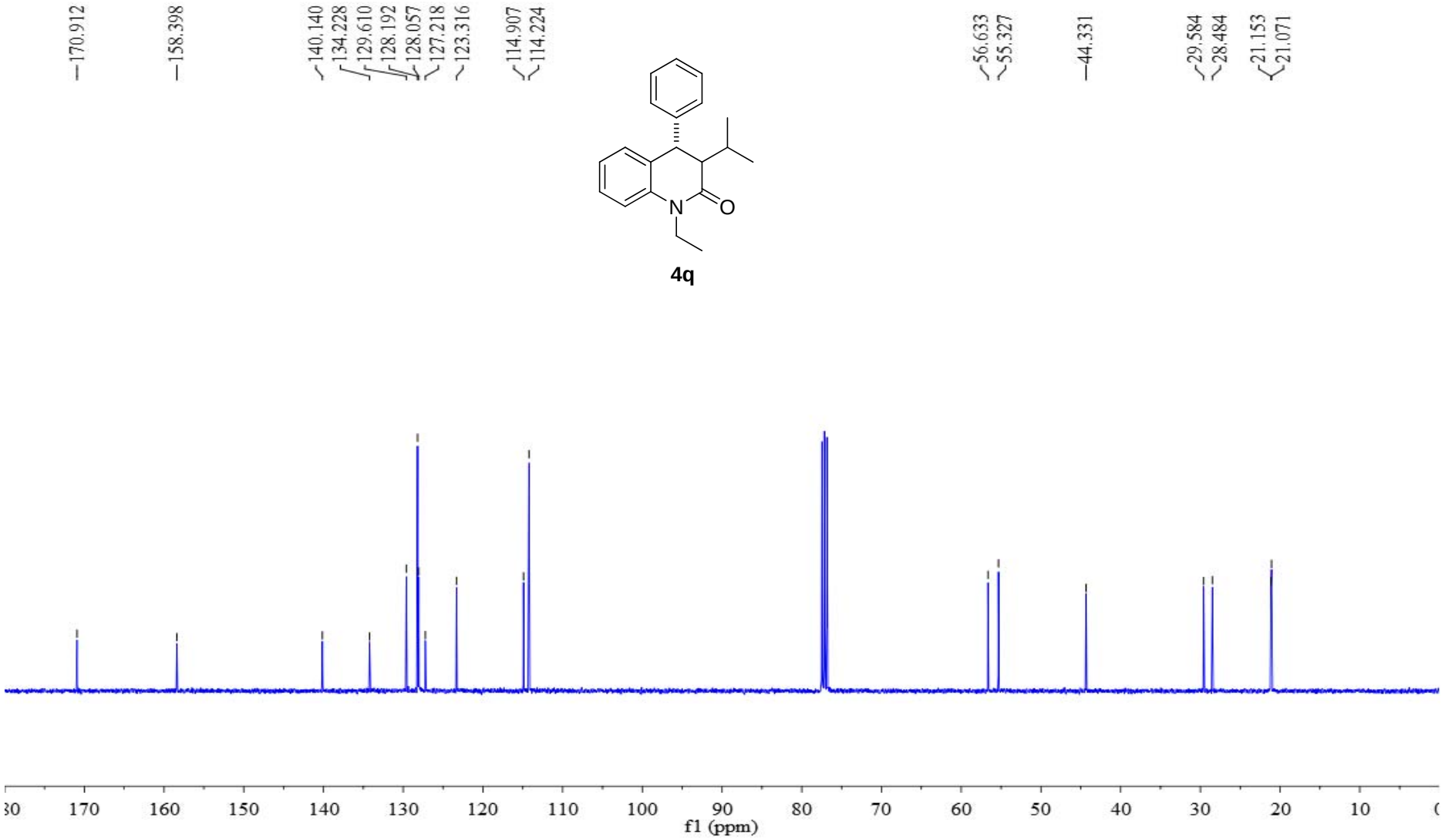
7.157
7.139
7.121
7.091
7.071
7.054
7.035
7.017
6.985
6.967
4.172
4.060
4.042
4.025
4.007
3.990
3.958
3.941
3.923
3.905
3.888
3.870
2.560
2.556
2.537
2.532
1.667
1.660
1.650
1.643
1.627
1.622
1.205
1.187
1.048
1.031
0.986
0.969
N
O
1.09
4.17
2.09
2.02
1.01
1.06
1.02
1.00
0.99
3.05
3.07
3.07
f1 (ppm)

4q


170.912
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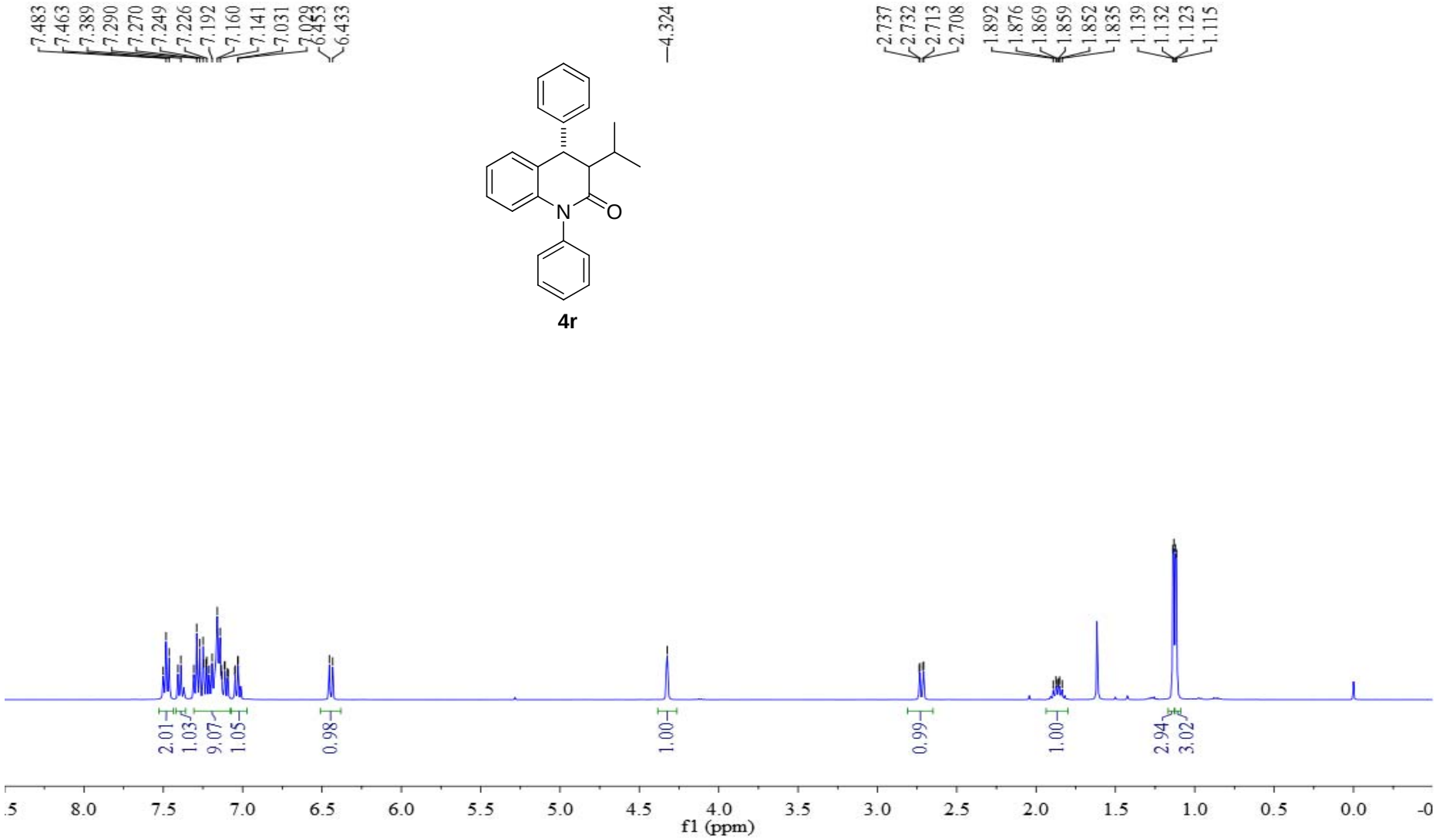
140.140
134.228
129.610
128.192
128.057
127.218
123.316
114.907
114.224
56.633
55.327
44.331
29.584
28.484
21.153
21.071
N
O
f1 (ppm)

4q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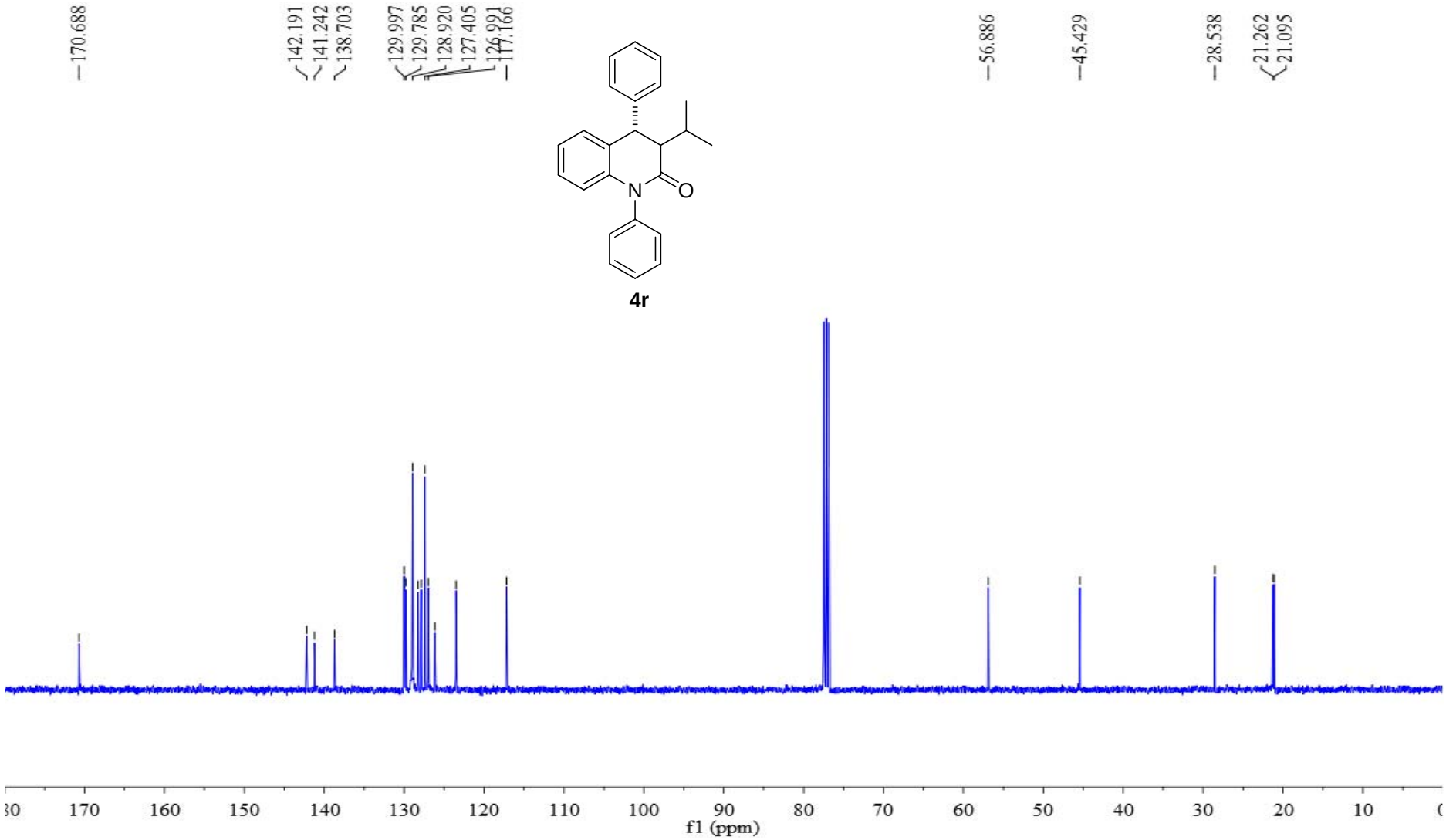
7.290
7.270
7.249
7.226
7.192
7.160
7.141
7.031
6.453
6.433
4.324
2.737
2.732
2.713
2.708
1.892
1.876
1.869
1.859
1.852
1.835
1.139
1.132
1.123
1.115
N
O
2.01
1.03
9.07
1.05
0.98
1.00
0.99
1.00
2.94
3.02
f1 (ppm)

4r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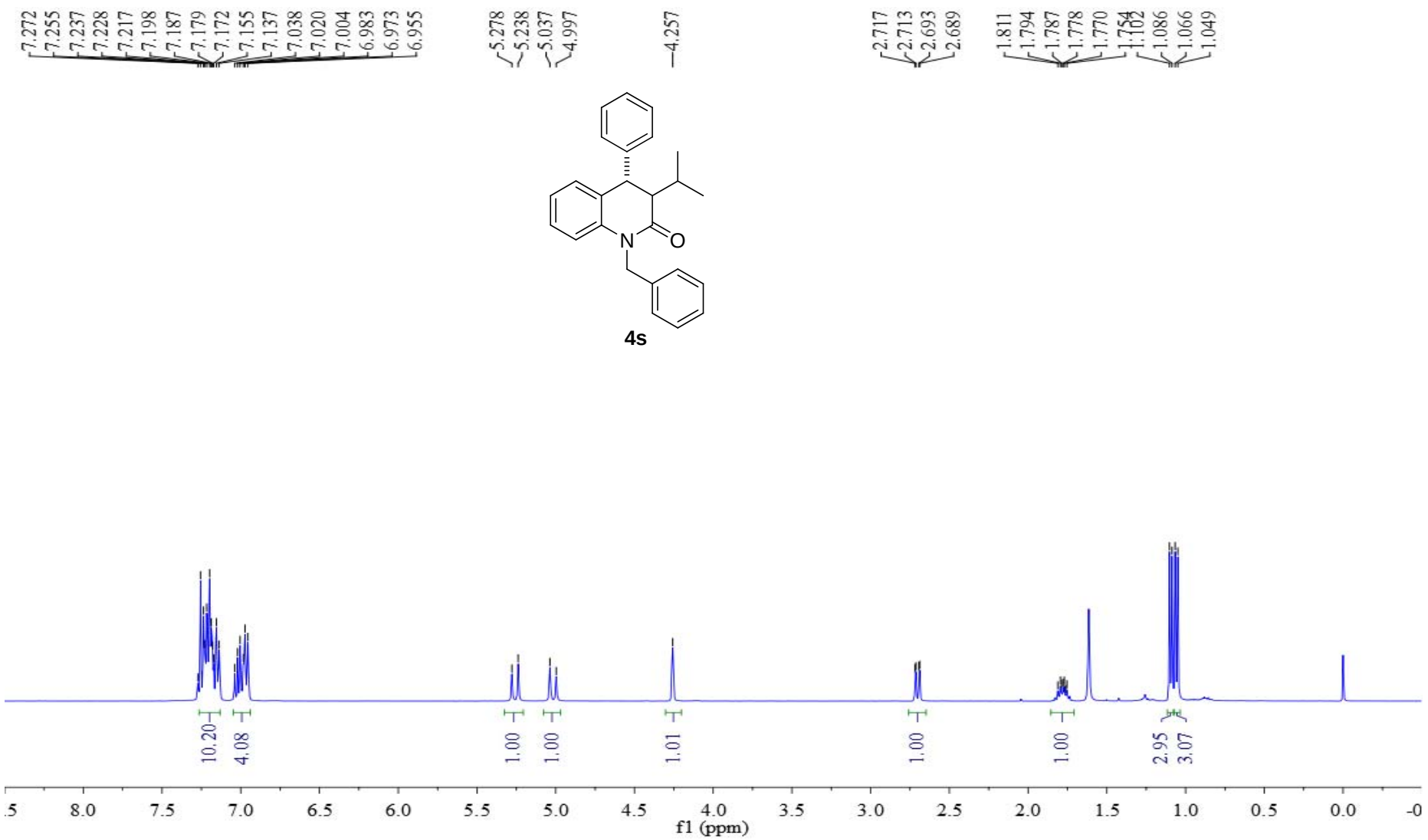
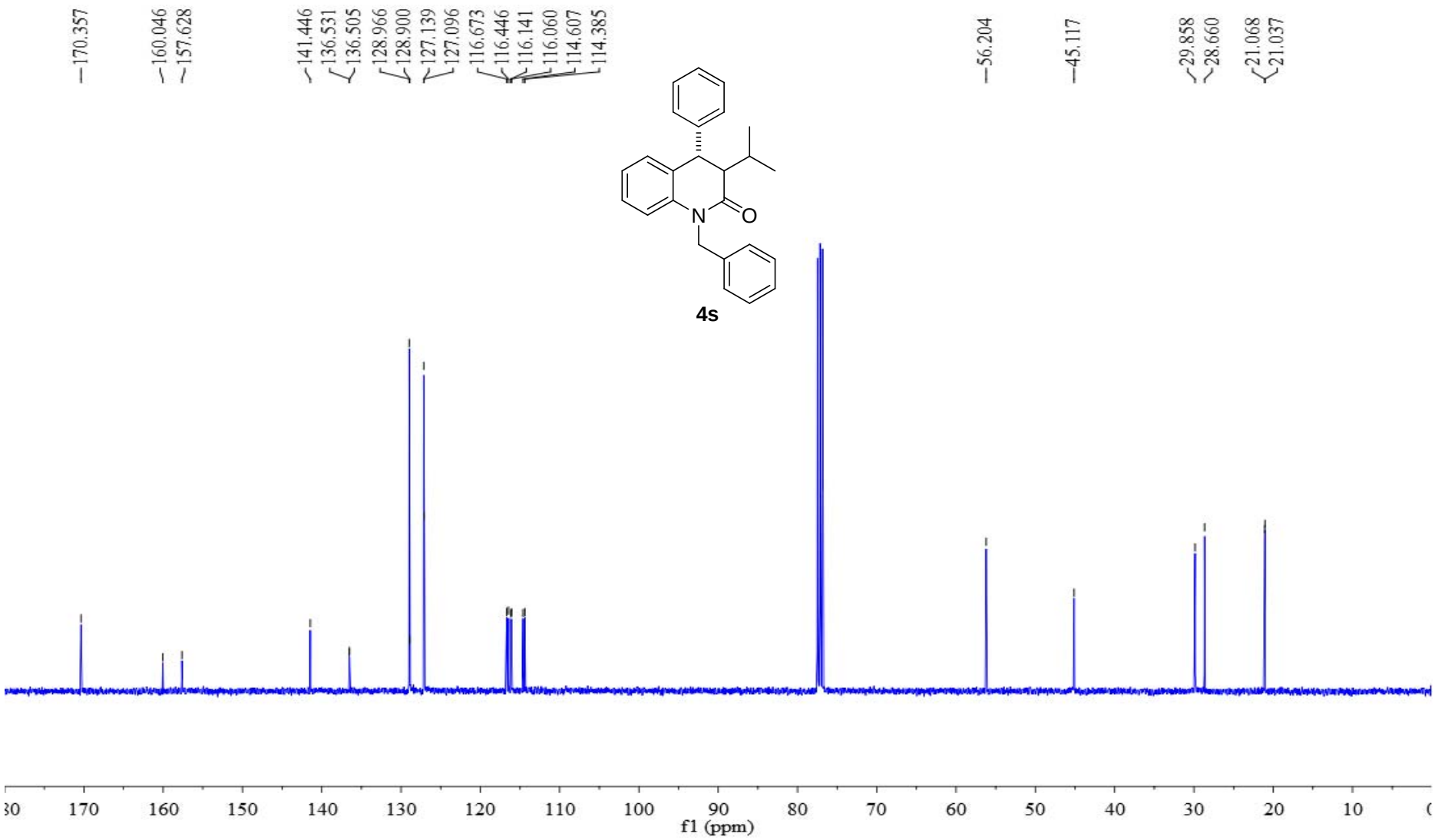
129.997
129.785
128.920
127.405
126.991
117.166
56.886
45.429
28.538
21.262
21.095
N
O
4r
f1 (ppm)


7.272
7.255
7.237
7.228
7.217
7.198
7.187
7.179
7.172
7.155
7.137
7.038
7.020
7.004
6.983
6.973
6.955
5.278
5.238
5.037
4.997
4.257
2.717
2.713
2.693
2.689
1.811
1.794
1.787
1.778
1.770
1.754
1.102
1.086
1.066
1.049
N
O
10.20
4.08
1.00
1.00
1.01
1.00
1.00
2.95
3.07
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

4s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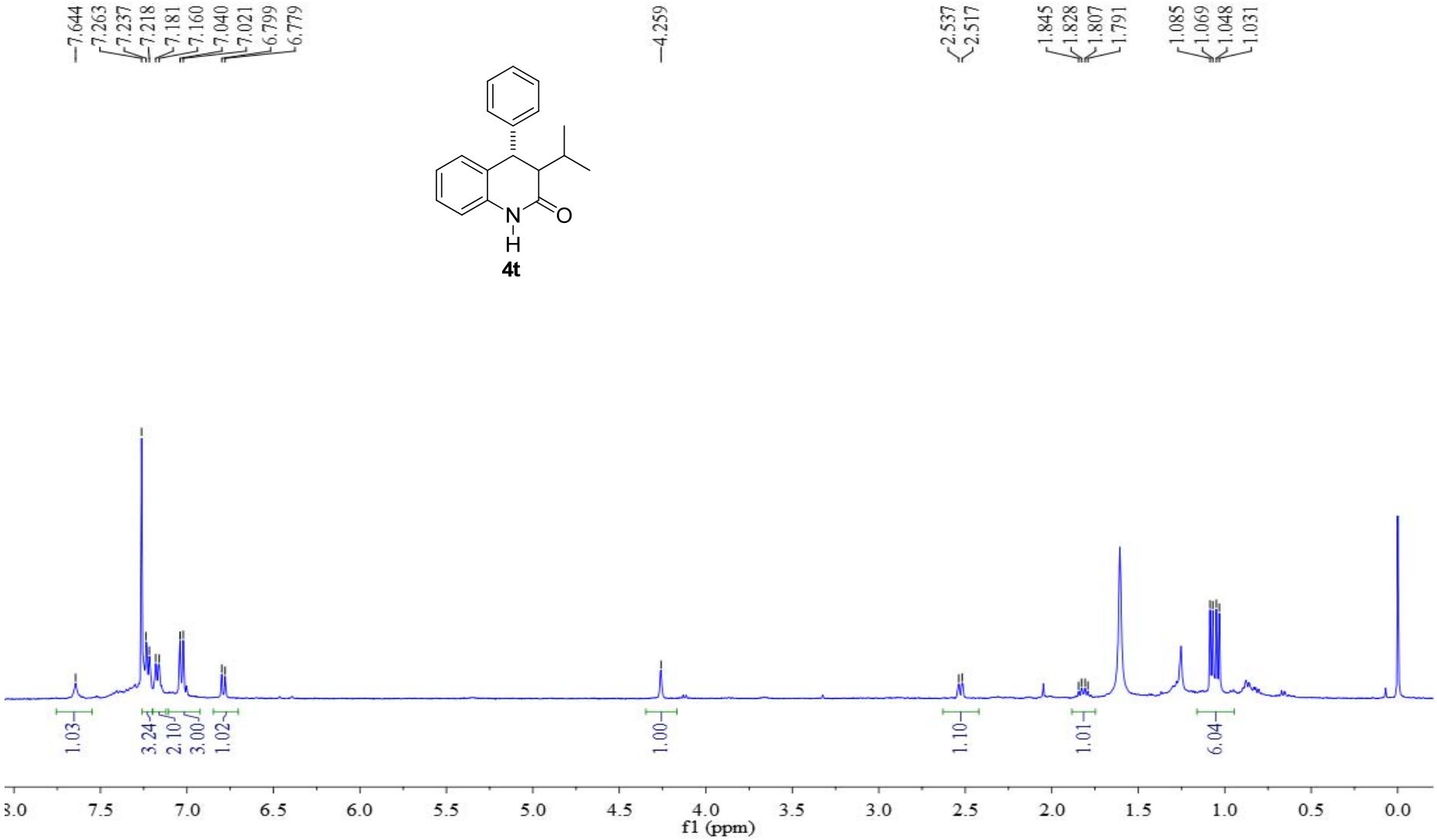
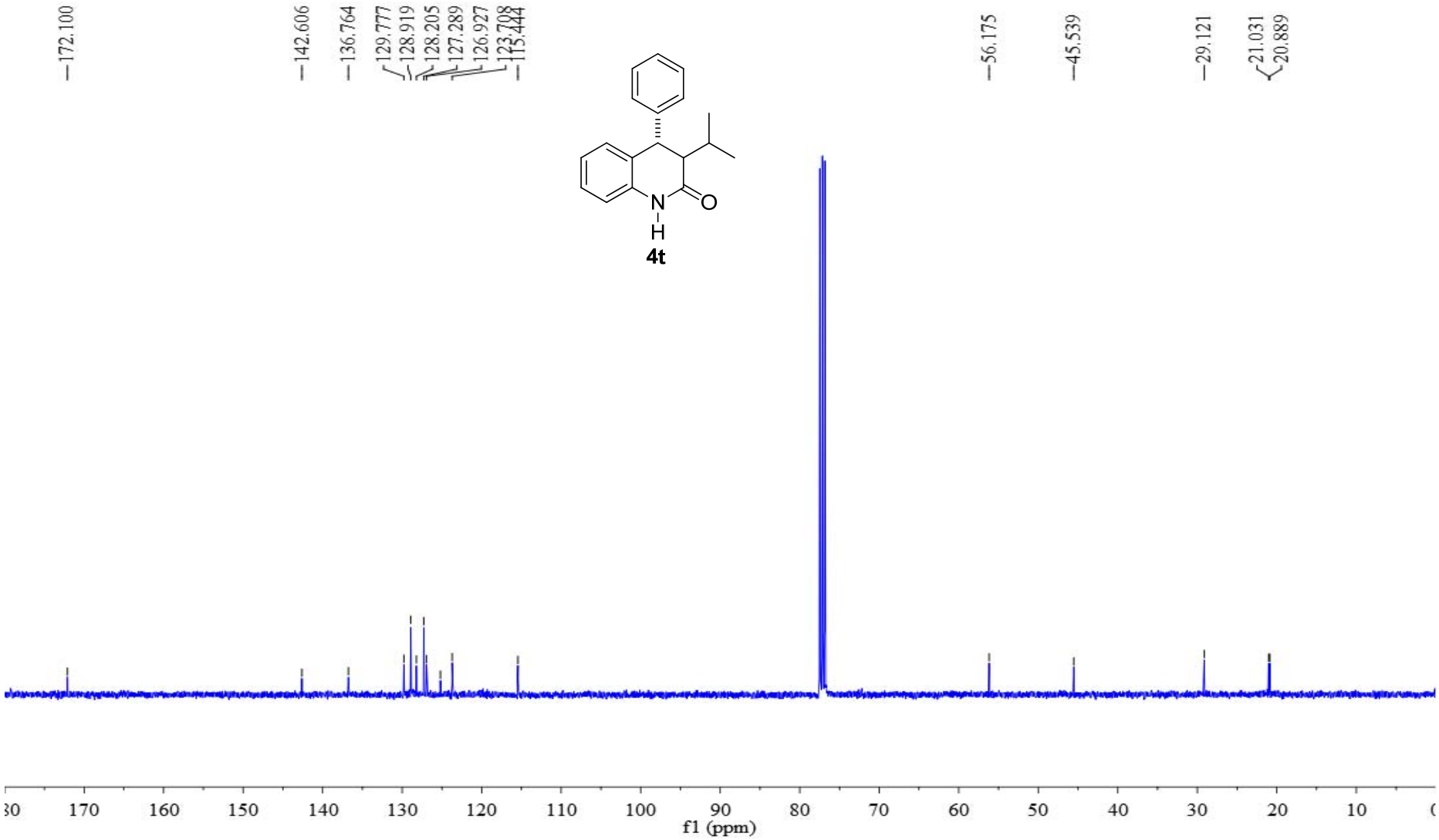
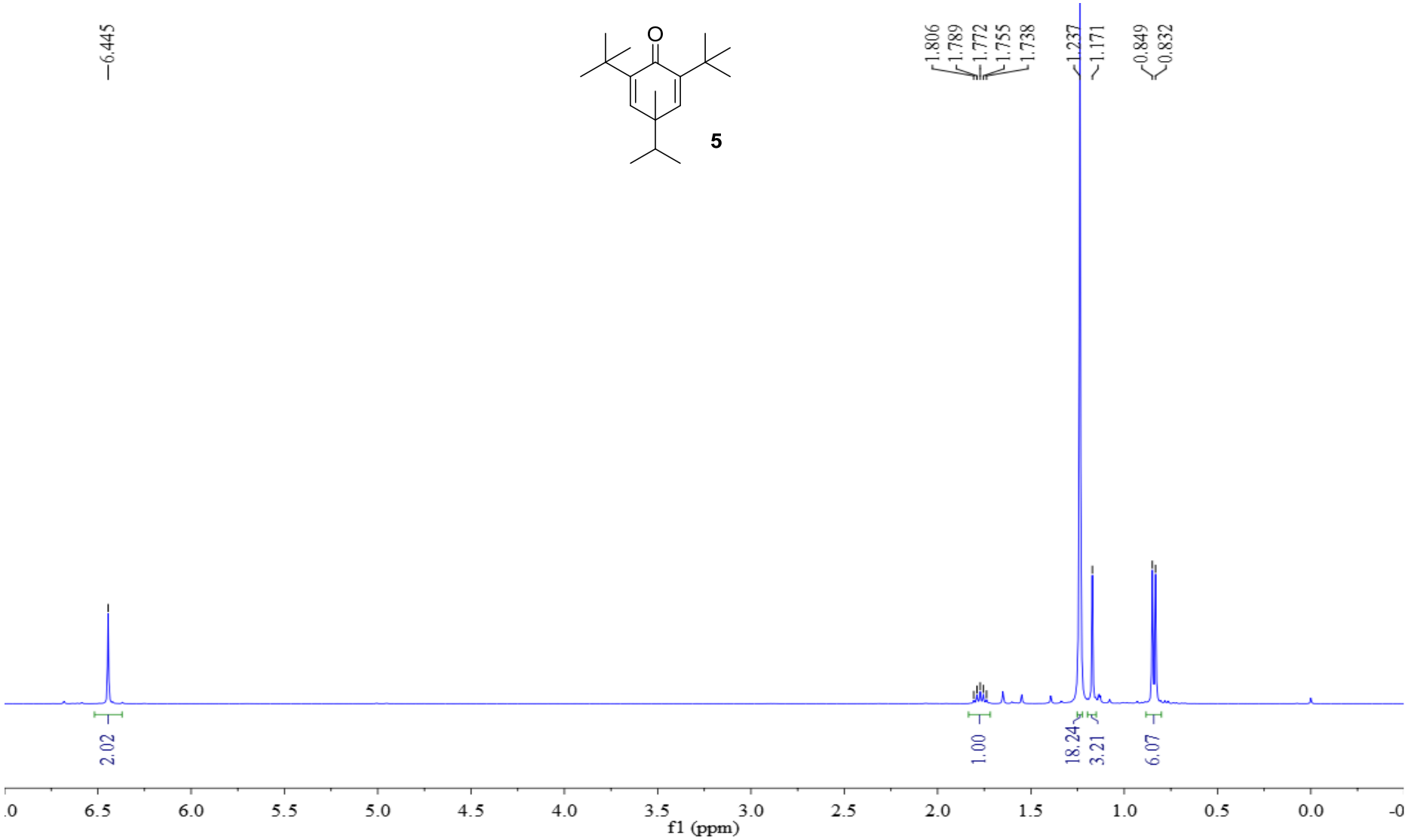
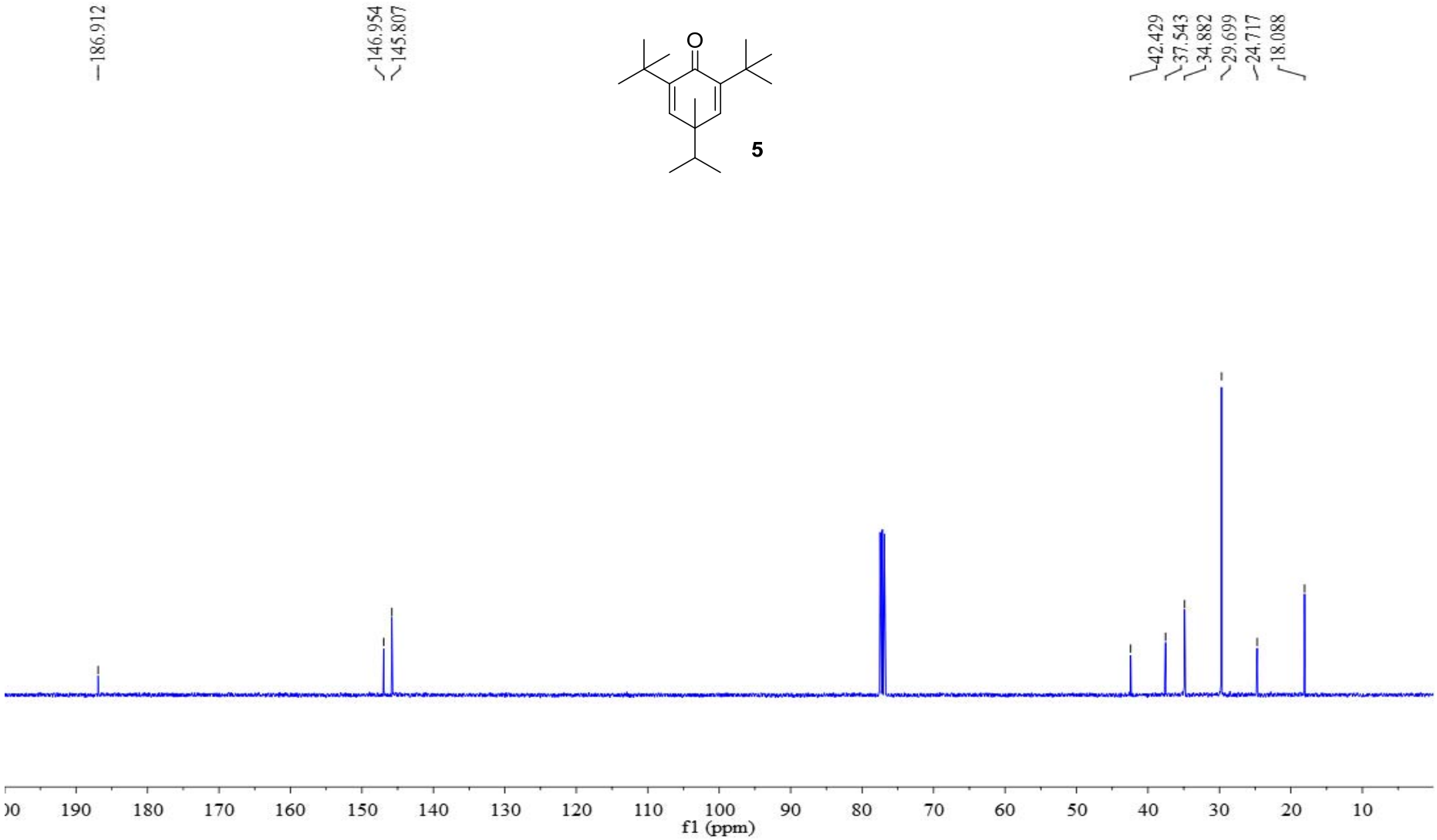
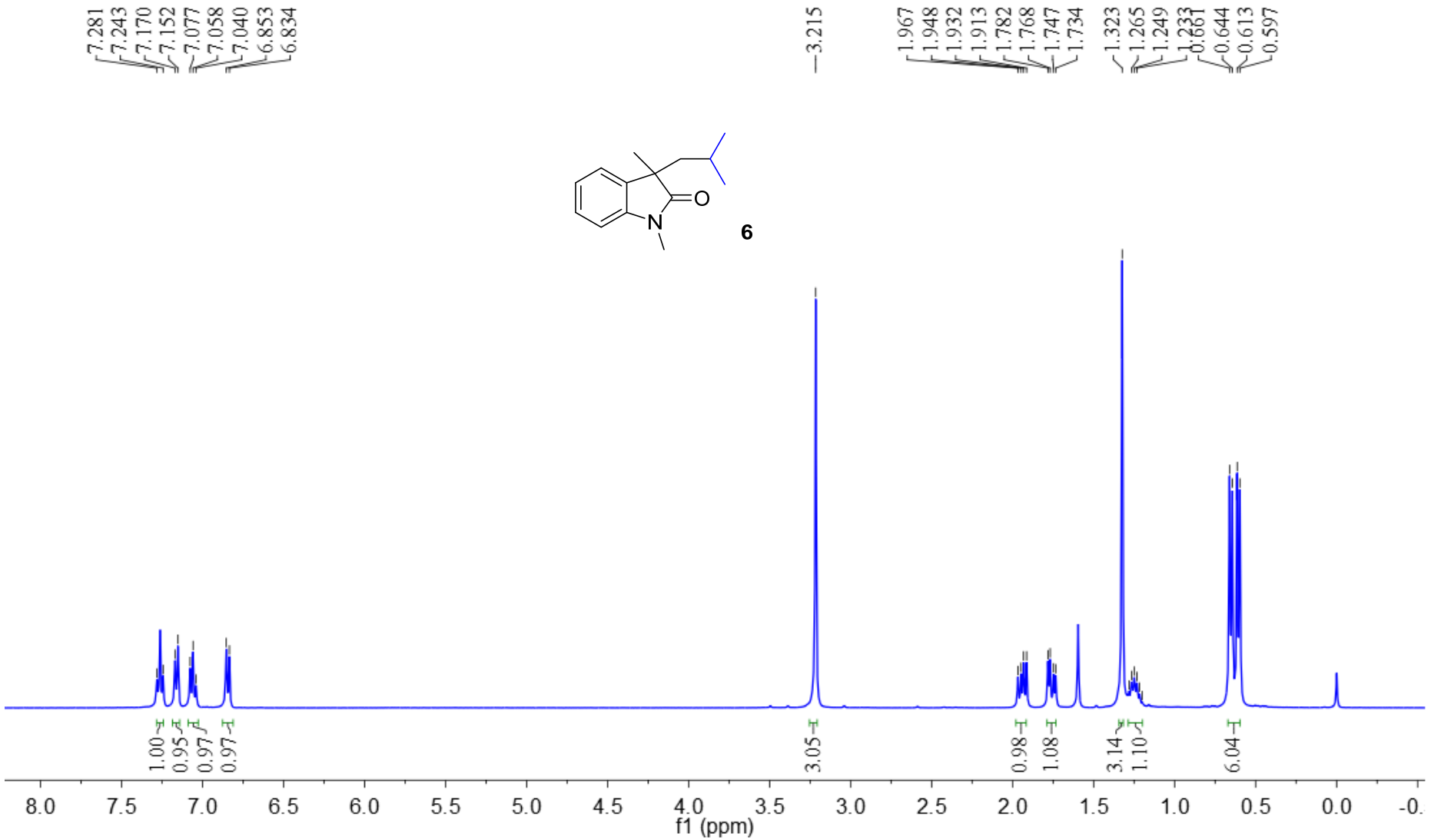
141.446
136.531
136.505
128.966
128.900
127.139
127.096
116.673
116.446
116.141
116.060
114.607
114.385
56.204
45.117
29.858
28.660
21.068
21.037
N
O
4s
f1 (ppm)

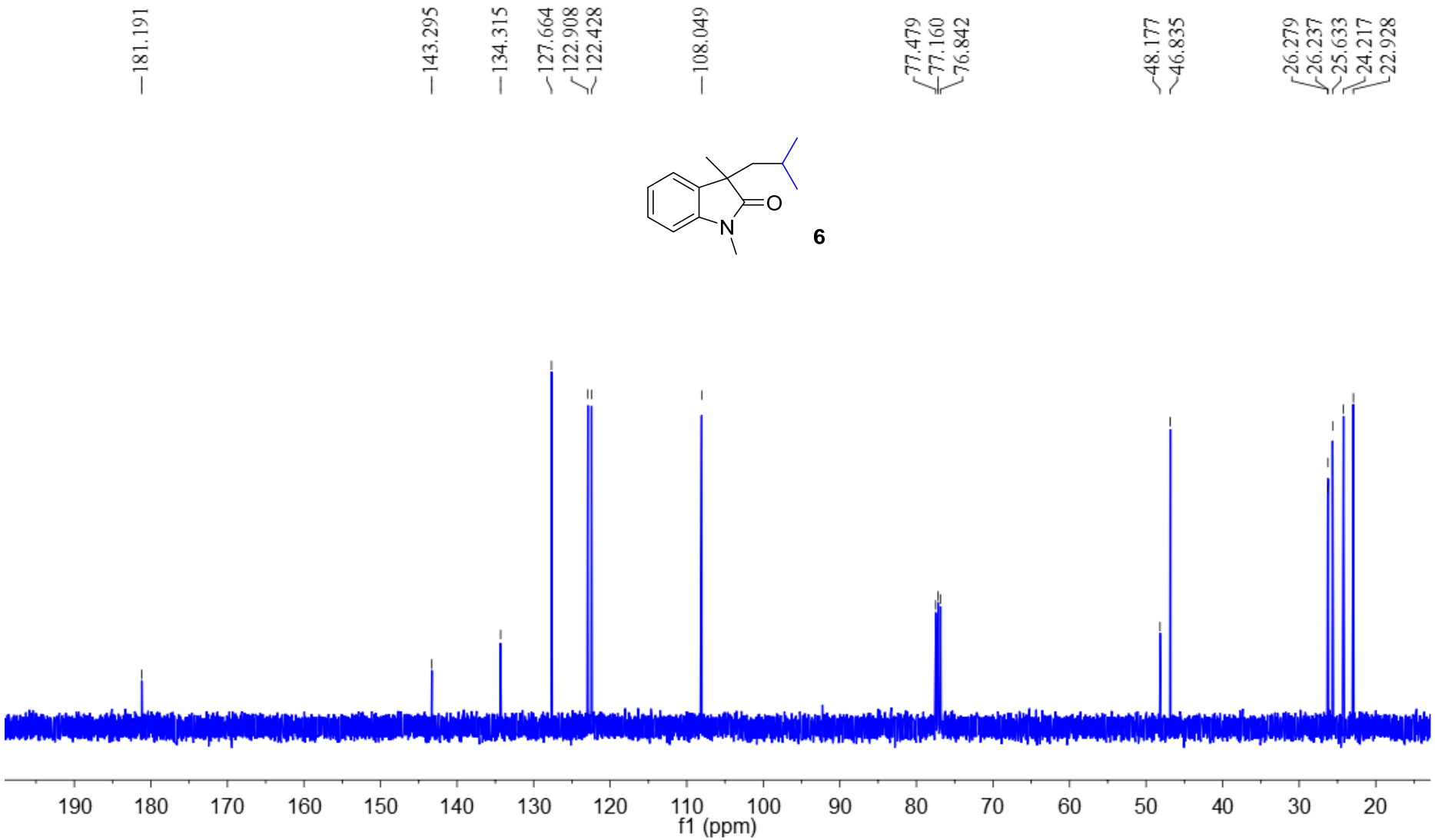

7.644
7.263
7.237
7.218
7.181
7.160
7.040
7.021
6.799
6.779
4.259
2.537
2.517
1.845
1.828
1.807
1.791
1.085
1.069
1.048
1.031
N
H
O
4t
1.03
3.24
2.10
3.00
1.02
1.00
1.10
1.01
6.04
f1 (ppm)


172.100
142.606
136.764
129.777
128.919
128.205
127.289
126.927
123.708
115.444
56.175
45.539
29.121
21.031
20.889
N
H
O
4t
f1 (ppm)


6.445
1.806
1.789
1.772
1.755
1.738
1.237
1.171
0.849
0.832
5
2.02
1.00
18.24
3.21
6.07
f1 (ppm)


186.912
146.954
145.807
42.429
37.543
34.882
29.699
24.717
18.088
O
5
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.281
7.243
7.170
7.152
7.077
7.058
7.040
6.853
6.834
3.215
1.967
1.948
1.932
1.913
1.782
1.768
1.747
1.734
1.323
1.265
1.249
1.233
0.661
0.644
0.613
0.597
O
N
6
1.00
0.95
0.97
0.97
3.05
0.98
1.08
3.14
1.10
6.04
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)


181.191
143.295
134.315
127.664
122.908
122.428
108.049
77.479
77.160
76.842
48.177
46.835
26.279
26.237
25.633
24.217
22.928
O
N
6
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
f1 (ppm)