Electronic Supplementary Material (ESI) for Chemical Communications

Supporting Information

Facile Synthesis of 2-Alkyl/Aryloxy-2*H*-azirines and Their Application in the Synthesis of Pyrroles

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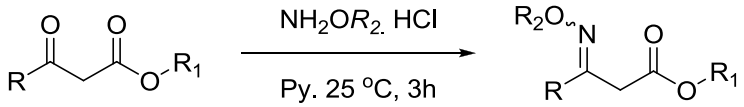
General methods: All reactions were carried out in flame or oven dried glasswares under nitrogen atmosphere with freshly distilled dry solvents under anhydrous conditions unless otherwise indicated. Flash column chromatography was performed with silica gel 60 (230 – 400 mesh). Chromatograms were visualized by fluorescence quenching with UV light at 254 nm or by staining using base solution of potassium permanganate and molybdate. Photolysis was performed at 302 nm by using Rayonet Chamber Reactor RMR-600. NMR spectra were recorded at room temperature on 400 M Hz Bruker DPX 400 and 400 M Hz *J*EOL ECA 400 NMR spectrometers. The residual solvent signals were taken as the reference (0.00 ppm or 7.26 ppm for ^{1}H NMR spectra and 77.0 ppm for ^{13}C NMR spectra in $CDCl_3$). Chemical shift (δ) is reported in ppm, coupling constants (J) are given in Hz. The following abbreviations classify the multiplicity: s = singlet, d = doublet, t = triplet, m = multiplet, dd = doublet of doublet, q = quartet and br = broad signal. HRMS (ESI) spectra were recorded on a Waters Q-Tof premierTM mass spectrometer.

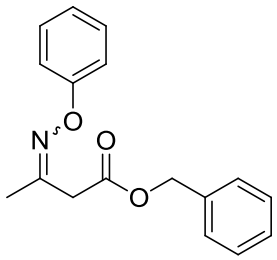
Materials: All solvents were distilled under nitrogen from the following drying agents immediately before use: acetonitrile and dichloroethane were distilled from P_2O_5. Anhydrous benzene, pyridine and DBU were purchased from commercial suppliers and used without further purification.

General procedure for β-oximino esters:



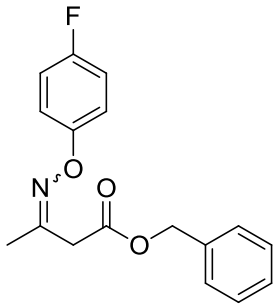
To a solution of β-ketoester (1.0 eq.) in pyridine at room temperature was added alkoxyamine hydrochloride (1.1 eq.) in one portion, and the reaction mixture was stirred at RT for 3 h. Upon completion of the reaction as indicated by TLC, the reaction mixture was diluted with water, extracted with ethyl acetate, washed with water, brine and dried over anhydrous Na_2SO_4. The crude material was concentrated under vacuo and purified by column chromatography using hexane: ethyl acetate (9:1).

Benzyl 3-(phenoxyimino)butanoate:



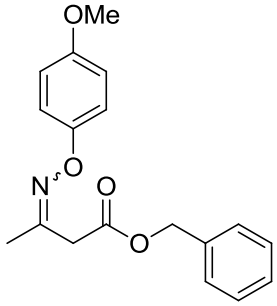
The title compound was prepared according to the general procedure. The product was obtained as pale yellow oil (*cis:trans* = 64:36). Yield: 70%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35-7.25 (m, 7H), 7.17-7.12 (m, 2H), 7.10-6.98 (m, 1H), 5.18 & 5.16 (s, 2H), 3.58 & 3.41 (s, 2H), 2.13 & 2.11 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.0, 168.2, 159.1, 158.9, 155.1, 154.0, 135.5, 135.4, 129.2, 128.6, 128.6, 128.4, 128.3, 128.2, 122.2, 122.2, 114.8, 114.7, 67.0, 66.9, 41.3, 36.0, 20.7, 15.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{17}H_{17}NO_3$: 284.1287. Found: 284.1277.

Benzyl 3-((4-fluorophenoxy)imino)butanoate:



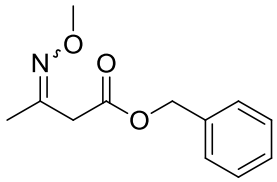
The title compound was prepared according to the general procedure. The product was obtained as pale yellow oil (*cis:trans* = 64:36). Yield: 71%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.33 (m, 5H), 7.13-7.10 & 7.08-7.04 (m, 2H), 7.01-6.95 (m, 2H), 5.20 & 5.18 (s, 2H), 3.58 & 3.42 (s, 2H), 2.13 & 2.12 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.9, 168.0,159.4, 159.3, 157.0, 156.9, 155.2, 154.9, 154.9, 154.1, 135.4, 135.3, 128.6, 128.5, 128.4, 128.3, 128.2, 116.1, 116.0, 116.0, 115.9, 115.6, 115.4, 67.0, 66.9, 41.2, 35.9, 20.7, 15.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{17}H_{16}FNO_3$: 302.1192. Found: 302.1195.

Benzyl 3-((4-methoxyphenoxy)imino)butanoate:



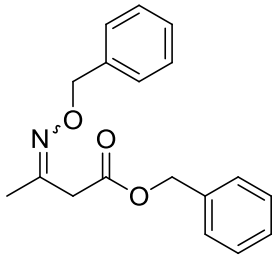
The title compound was prepared according to the general procedure. The product was obtained as pale yellow oil (*cis:trans* = 74:26). Yield: 57%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.33 (m, 5H), 7.09-7.07 & 7.04-7.02 (m, 2H), 6.84-6.80 (m, 2H), 5.18 & 5.16 (s, 2H), 3.77 (s, 3H), 3.57 & 3.39 (s, 2H), 2.11 & 2.09 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.1, 168.3, 155.1, 155.0, 154.5, 153.3, 153.3, 153.1, 135.4, 128.6, 128.6, 128.4, 128.3, 128.2, 116.3, 116.2, 114.3, 114.3, 66.9, 66.9, 55.7, 41.3, 35.9, 20.7, 15.2 ; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{19}NO_4$: 314.1392. Found: 314.1397.

Benzyl 3-(methoxyimino)butanoate:



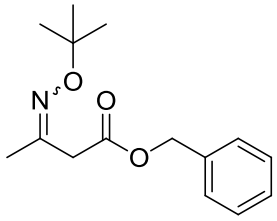
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 58:42). Yield: 85%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.31 (m, 5H), 5.16 & 5.15 (s, 2H), 3.86 & 3.80 (s, 3H), 3.37 & 3.26 (s, 2H), 1.96 & 1.90 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 168.7, 151.2, 150.1, 135.7, 135.5, 128.6, 128.5, 128.4, 128.3, 128.2, 66.8, 66.7, 61.5, 61.4, 41.3, 35.3, 20.6, 14.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{15}NO_3$: 222.1130. Found: 222.1124.

Benzyl 3-((benzyloxy)imino)butanoate:



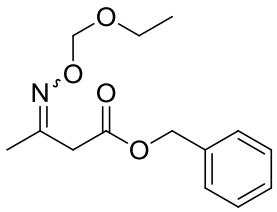
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 50:50). Yield: 95%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.30 (m, 10H), 5.16 & 5.11 (s, 2H), 5.11 & 5.07 (s, 2H), 3.43 & 3.28 (s, 2H), 1.98 & 1.96 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 168.6, 151.7, 150.7, 137.9, 137.8, 135.6, 135.5, 128.6, 128.5, 128.3, 128.3, 128.3, 128.2, 128.1, 127.9, 127.8, 127.7, 127.6, 75.7, 75.5, 66.8, 66.7, 41.4, 35.6, 20.7, 14.8; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{19}NO_3$: 298.1443. Found: 298.1442.

Benzyl 3-(*tert*-butoxyimino)butanoate:



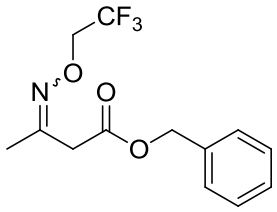
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 69:31). Yield: 81%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.31 (m, 5H), 5.16 & 5.14 (s, 2H), 3.34 & 3.27 (s, 2H), 1.96 & 1.89 (s, 3H), 1.26 & 1.23 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 169.2, 149.3, 148.3, 135.8, 135.7, 128.5, 128.5, 128.2, 128.2, 128.1, 128.1, 78.0, 78.0, 66.6, 66.5, 41.7, 35.5, 27.5, 27.5, 20.9, 14.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{15}H_{21}NO_3$: 264.1600. Found: 264.1603.

Benzyl 3-((ethoxymethoxy)imino)butanoate:



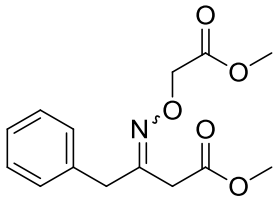
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 55:45). Yield: 90%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.31 (m, 5H), 5.15 & 5.15 (s, 2H), 5.14 & 5.08 (s, 2H), 3.65 & 3.59 (q, J = 7.1 Hz, J = 6.9 Hz, 2H), 3.42 & 3.31 (s, 2H), 1.99 & 1.96 (s, 3H), 1.22-1.16 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.3, 168.4, 153.0, 151.7, 135.6, 135.5, 128.5, 128.3, 128.3, 128.2, 128.2, 97.0, 96.8, 66.8, 66.7, 64.4, 64.2, 41.3, 35.6, 20.7, 15.1, 15.1, 14.8; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{14}H_{19}NO_4$: 266.1392. Found: 266.1396.

Benzyl 3-((2,2,2-trifluoroethoxy)imino)butanoate:



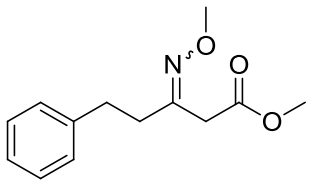
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 54:46). Yield: 73%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.32 (m, 5H), 5.16 & 5.15 (s, 2H), 4.44-4.33 (m, 2H), 3.42 & 3.27 (s, 2H), 1.97 & 1.96 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.0, 168.0, 154.2, 153.1, 135.5, 135.4, 128.6, 128.6, 128.4, 128.4, 128.3, 128.2, 123.6 (m), 69.0 (m), 67.0, 66.9, 41.0, 35.4, 20.5, 14.7; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{14}F_3NO_3$: 290.1004. Found: 290.1006.

Methyl 3-((2-methoxy-2-oxoethoxy)imino)-4-phenylbutanoate:



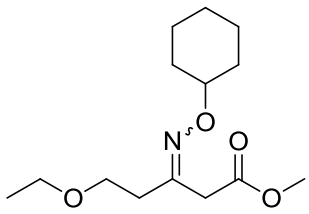
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 86:14). Yield: 61%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.29 (m, 2H), 7.26-7.21 (m, 3H), 4.70 & 4.67 (s, 2H), 3.90 & 3.63 (s, 2H), 3.79 & 3.77 (s, 3H), 3.63 & 3.62 (s, 3H), 3.30 & 3.11 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 169.7, 168.8, 155.0, 154.5, 135.6, 135.5, 129.4, 129.2, 128.7, 127.0, 126.8, 70.5, 70.4, 52.1, 51.8, 40.5, 38.4, 34.2, 33.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{14}H_{17}NO_5$: 280.1185. Found: 280.1187.

Methyl 3-(methoxyimino)-5-phenylpentanoate:



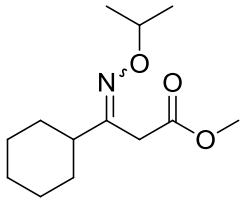
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 66:34). Yield: 80%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31-7.27 (m, 2H), 7.22-7.18 (m, 3H), 3.87 & 3.85 (s, 3H), 3.70 & 3.69 (s, 3H), 3.32 & 3.11 (s, 2H), 2.89-2.79 (m, 2H), 2.70-2.66 & 2.60-2.56 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.1, 169.3, 154.2, 152.6, 141.0, 141.0, 128.4, 128.4, 128.3, 126.2, 126.1, 61.6, 61.5, 52.1, 39.8, 36.5, 34.2, 32.4, 31.4, 30.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{17}NO_3$: 236.1287. Found: 236.1279.

Methyl 3-((cyclohexyloxy)imino)-5-ethoxypentanoate:



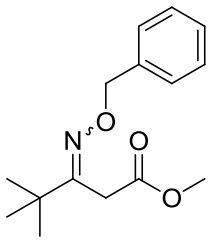
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 62:38). Yield: 85%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.06-4.02 (m, 1H), 3.69 & 3.67 (s, 3H), 3.63-3.56 (m, 2H), 3.49-3.42 (m, 2H), 3.36 & 3.29 (s, 2H), 2.69 & 2.55 (t, J = 6.6 Hz, J = 6.8 Hz, 2H), 1.89-1.82 (m, 2H), 1.69-1.67 (m, 2H), 1.51-1.48 (m, 1H), 1.41-1.23 (m, 5H), 1.17 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.5, 169.7, 152.0, 150.9, 80.4, 80.2, 67.8, 66.6, 66.2, 66.1, 51.9, 51.8, 40.2, 35.1, 34.6, 31.6, 31.5, 29.1, 25.7, 25.7, 23.7, 23.5, 15.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{14}H_{25}NO_4$: 272.1862. Found: 272.1860.

Methyl 3-cyclohexyl-3-(isopropoxyimino)propanoate:



The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 91:9). Yield: 81%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.29-4.23 (m, 1H), 3.67 & 3.64 (s, 3H), 3.17 & 3.14 (s, 2H), 3.00-2.96 & 2.24-2.18 (m, 1H), 1.80-1.75 (m, 4H), 1.67-1.64 (m, 1H), 1.31-1.23 (m, 4H), 1.21-1.18 (m, 1H), 1.17-1.11 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.8, 170.0, 157.2, 156.4, 75.0, 74.9, 51.9, 51.8, 51.7, 43.8, 40.2, 37.6, 37.3, 33.0, 30.0, 29.8, 28.6, 26.0, 26.0, 25.9, 25.7, 21.6, 21.5, 21.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{23}NO_3$: 242.1756. Found: 242.1749.

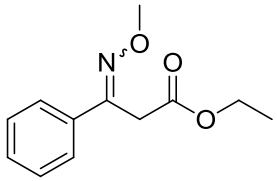
Methyl 3-((benzyloxy)imino)-4,4-dimethylpentanoate:



The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 0:100). Yield: 65%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35-7.29 (m, 4H), 7.28-7.25 (m, 1H), 5.07 (s, 2H), 3.55 (s, 3H), 3.24 (s, 2H), 1.14 (s, 9H);

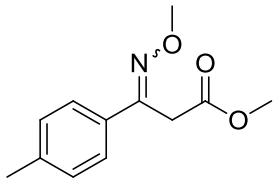
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.8, 159.9, 137.9, 128.1, 127.9, 127.5, 75.6, 51.8, 36.9, 31.7, 27.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{15}H_{21}NO_3$: 264.1600. Found: 264.1608.

Ethyl 3-(methoxyimino)-3-phenylpropanoate:



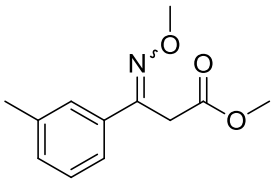
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 7:93). Yield: 98%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65-7.61 & 7.48-7.46 (m, 2H), 7.41-7.35 (m, 3H), 4.18-4.07 (m, 2H), 4.01 & 3.89 (s, 3H), 3.75 & 3.57 (s, 2H), 1.21 & 1.16 (t, *J* = 7.0 Hz, *J* =7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 168.8, 151.3, 150.9, 135.3, 129.3, 129.1, 128.5, 128.1, 128.0, 126.2, 62.2, 62.1, 61.1, 41.2, 33.2, 14.0, 14.0; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{15}NO_3$: 222.1130. Found: 222.1135.

Methyl 3-(methoxyimino)-3-(p-tolyl)propanoate :



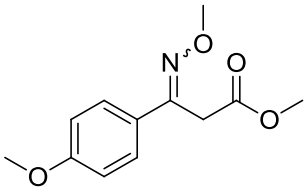
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 8:92). Yield: 98%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 & 7.40 (d, *J* = 8.0 Hz, *J* = 8.4 Hz, 2H), 7.21-7.17 (m, 2H), 4.00 & 3.89 (s, 3H), 3.76 & 3.58 (s, 2H), 3.68 & 3.64 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.4, 151.0, 139.4, 132.4, 129.2, 128.9, 128.0, 126.0, 62.2, 62.1, 52.2, 52.1, 40.9, 32.8, 21.4, 21.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{15}NO_3$: 222.1130. Found: 222.1134.

Methyl 3-(methoxyimino)-3-(m-tolyl)propanoate:



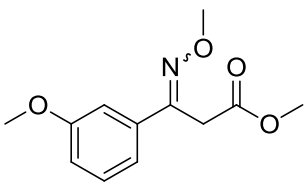
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 8:92). Yield: 98%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 (s, 1H), 7.40 (d, J = 8.0 Hz, 1H), 7.27-7.23 (m, 1H), 7.17 (d, J = 7.6 Hz, 1H), 3.99 & 3.87 (s, 3H), 3.74 & 3.56 (s, 2H), 3.67 & 3.63 (s, 3H), 2.36 & 2.35 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 169.2, 151.2, 150.8, 138.1, 137.7, 135.1, 132.7, 130.1, 129.9, 128.3, 128.0, 126.6, 125.0, 123.2, 62.1, 62.0, 52.1, 52.0, 40.9, 32.8, 21.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{15}NO_3$: 222.1130. Found: 222.1131.

Methyl 3-(methoxyimino)-3-(4-methoxyphenyl)propanoate:



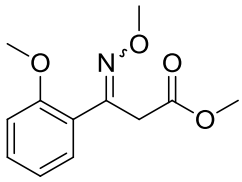
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 7:93). Yield: 85%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60-7.57 & 7.54-7.51 (m, 2H), 6.91-6.87 (m, 2H), 3.98 & 3.90 (s, 3H), 3.81 (s, 3H), 3.75 & 3.58 (s, 2H), 3.68 & 3.64 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.4, 160.6, 150.6, 129.9, 127.7, 127.5, 113.9, 113.5, 62.1, 55.3, 55.2, 52.2, 52.1, 40.8, 32.7; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{15}NO_4$: 238.1079. Found: 238.1077.

Methyl 3-(methoxyimino)-3-(3-methoxyphenyl)propanoate:



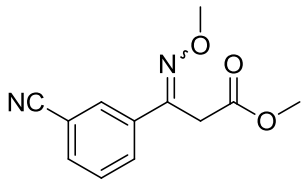
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 8:92). Yield: 84%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.27 (m, 1H), 7.23-7.22 (m, 1H), 7.19-7.17 & 7.05-7.00 (m, 1H), 6.94-6.88 (m, 1H), 4.01 & 3.89 (s, 3H), 3.83 & 3.81 (s, 3H), 3.76 & 3.57 (s, 2H), 3.69 & 3.65 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 169.2, 159.7, 159.3, 150.9, 150.5, 136.6, 134.1, 129.5, 129.3, 120.2, 118.7, 115.4, 114.7, 113.9, 111.4, 62.3, 62.2, 55.3, 55.2, 52.2, 52.1, 41.0, 32.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{15}NO_4$: 238.1079. Found: 238.1088.

Methyl 3-(methoxyimino)-3-(2-methoxyphenyl)propanoate:



The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 8:92). Yield: 96%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46-7.44 (m, 1H), 7.37-7.32 (m, 1H), 6.99-6.95 (m, 1H), 6.88 (d, J = 8.4 Hz, 1H), 3.98 & 3.86 (s, 3H), 3.82 & 3.81 (s, 3H), 3.76 & 3.59 (s, 2H), 3.65 & 3.63 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.6, 157.3, 152.4, 130.6, 130.2, 130.1, 125.0, 120.8, 120.3, 111.0, 110.8, 62.0, 55.5, 55.3, 51.9, 40.3, 35.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{15}NO_4$: 238.1079. Found: 238.1079.

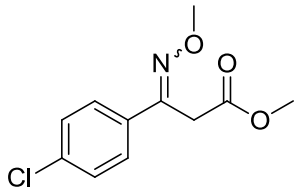
Methyl 3-(3-cyanophenyl)-3-(methoxyimino)propanoate:



The title compound was prepared according to the general procedure. The product was obtained as white solid (*cis:trans* = 11:89). mp: 69-71 °C. Yield: 86%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97-7.96 (m, 1H), 7.88-7.81 (m, 1H), 7.69-7.64 (m, 1H), 7.53-7.47 (m, 1H), 4.04 & 3.90 (s, 3H), 3.76 & 3.59 (s, 2H), 3.71 & 3.67 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ

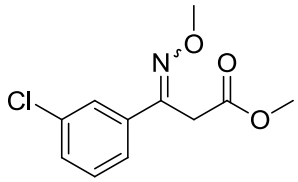
169.6, 168.7, 149.0, 148.4, 136.5, 134.0, 132.5, 132.3, 132.0, 130.2, 129.8, 129.4, 129.1, 118.4, 112.9, 62.7, 62.4, 52.4, 52.3, 40.3, 32.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{12}N_2O_3$: 233.0926. Found: 233.0927.

Methyl 3-(4-chlorophenyl)-3-(methoxyimino)propanoate:



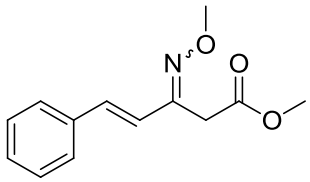
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 9:91). Yield: 92%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60-7.56 & 7.45-7.43 (m, 2H), 7.37-7.32 (m, 2H), 4.01 & 3.89 (s, 3H), 3.74 & 3.57 (s, 2H), 3.69 & 3.65 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.8, 169.1, 149.9, 149.5, 135.4, 135.1, 133.6, 131.0, 129.6, 128.7, 128.5, 127.4, 62.4, 62.2, 52.3, 52.2, 40.7, 32.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{11}H_{12}ClNO_3$: 242.0584. Found: 242.0575.

Methyl 3-(3-chlorophenyl)-3-(methoxyimino)propanoate:



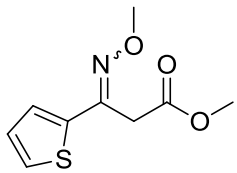
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 10:90). Yield: 78%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67-7.66 (m, 1H), 7.50-7.48 (m, 1H), 7.36-7.28 (m, 2H), 4.02 & 3.89 (s, 3H), 3.74 & 3.56 (s, 2H), 3.69 & 3.66 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.0, 149.8, 149.2, 136.9, 134.6, 129.7, 129.5, 129.3, 129.3, 128.2, 126.2, 126.1, 124.2, 62.5, 62.3, 52.3, 52.2, 40.6, 32.6; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{11}H_{12}ClNO_3$: 242.0584. Found: 242.0579.

(4E)-methyl 3-(methoxyimino)-5-phenylpent-4-enoate:



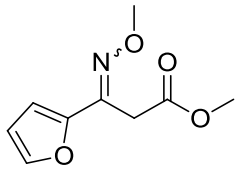
The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 21:79). Yield: 97%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51-7.41 (m, 2H), 7.36-7.27 (m, 3H), 6.91-6.80 (m, 2H), 3.98 & 3.97 (s, 3H), 3.72 & 3.71 (s, 3H), 3.65 & 3.52 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 169.1, 151.8, 149.6, 136.3, 136.1, 136.0, 133.5, 129.2, 128.7, 128.6, 127.5, 126.9, 124.5, 116.3, 62.3, 62.1, 52.3, 37.3, 30.6; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{15}NO_3$: 234.1130. Found: 234.1132.

Methyl 3-(methoxyimino)-3-(thiophen-2-yl)propanoate:



The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 36:64). Yield: 98%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54-7.52 & 7.30-7.28 (m, 1H), 7.41-7.40 & 7.21-7.20 (m, 1H), 7.08-7.06 & 7.02-7.00 (m, 1H), 4.09 & 3.98 (s, 3H), 3.76 & 3.70 (s, 2H), 3.70 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.2, 168.8, 146.9, 143.7, 138.9, 131.6, 130.8, 129.3, 127.3, 127.1, 126.5, 125.7, 62.4, 62.3, 52.4, 52.3, 39.7, 33.0; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_9H_{11}NO_3S$: 214.0538. Found: 214.0541.

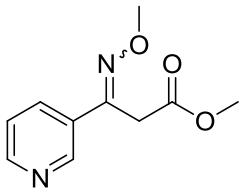
Methyl 3-(furan-2-yl)-3-(methoxyimino)propanoate:



The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 18:82). Yield: 92%. ^{1}H NMR (400 MHz, $CDCl_3$) δ

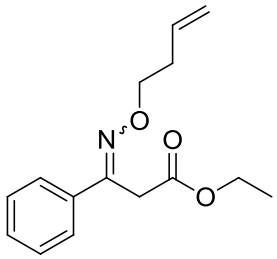
7.47-7.41 (m, 1H), 7.32-7.31 & 6.67-6.66 (m, 1H), 6.50-6.44 (m, 1H), 4.03 & 4.00 (s, 3H), 3.69 (s, 3H), 3.67 & 3.63 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 168.7, 149.0, 145.2, 143.9, 143.4, 142.6, 140.6, 117.9, 112.1, 111.5, 110.3, 62.6, 62.6, 52.3, 52.2, 37.3, 31.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_9H_{11}NO_4$: 198.0766. Found: 198.0771.

Methyl 3-(methoxyimino)-3-(pyridin-3-yl)propanoate:



The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 18:82). Yield: 89%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.86-8.85 & 8.72-8.71 (m, 1H), 8.60-8.57 (m, 1H), 7.97-7.94 & 7.84-7.82 (m, 1H), 7.34-7.28 (m, 1H), 4.03 & 3.90 (s, 3H), 3.77 & 3.61 (s, 2H), 3.69 & 3.65 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.6, 168.8, 150.2, 150.0, 148.9, 148.7, 147.9, 147.4, 135.8, 133.4, 131.0, 128.8, 123.3, 123.0, 62.6, 62.3, 52.4, 52.3, 40.4, 32.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{10}H_{12}N_2O_3$: 209.0926. Found: 209.0923.

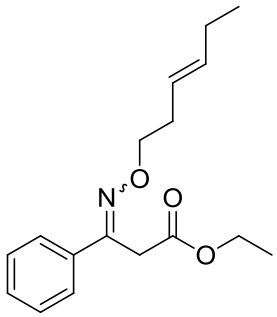
Ethyl 3-((but-3-en-1-yloxy)imino)-3-phenylpropanoate:



The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 9:91). Yield: 92%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65-7.62 & 7.52-7.49 (m, 2H), 7.39-7.36 (m, 3H), 5.91-5.80 (m, 1H), 5.15-5.04 (m, 2H), 4.28-4.21 (m, 2H), 4.17-4.08 (m, 2H), 3.75 & 3.58 (s, 2H), 2.51-2.42 (m, 2H), 1.22 & 1.16 (t, J = 7.2 Hz, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 168.8, 151.2, 150.5, 135.5, 134.7, 134.7, 133.7, 129.2, 129.0, 128.7, 128.4, 126.1, 126.0, 116.6, 116.5, 73.6, 73.5, 61.4,

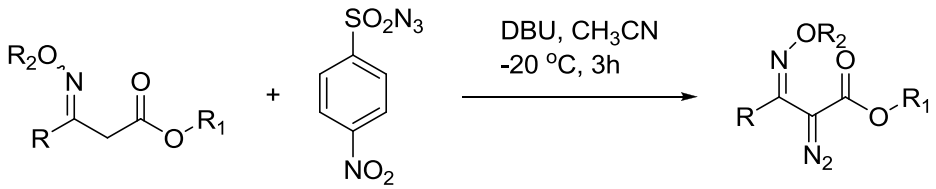
61.0, 45.9, 41.1, 33.7, 33.3, 14.0, 13.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{15}H_{19}NO_3$: 262.1443. Found: 262.1443.

Ethyl 3-(((E)-hex-3-en-1-yloxy)imino)-3-phenylpropanoate:

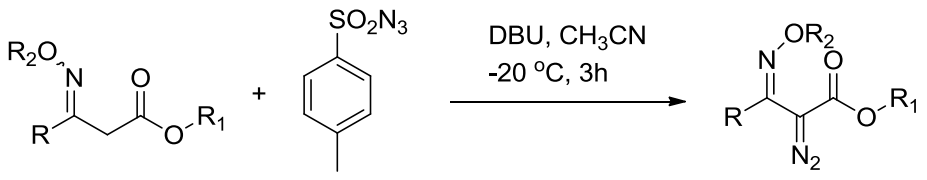


The title compound was prepared according to the general procedure. The product was obtained as colorless oil (*cis:trans* = 7:93). Yield: 86%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65-7.62 & 7.52-7.50 (m, 2H), 7.39-7.35 (m, 3H), 5.60-5.53 (m, 1H), 5.47-5.39 (m, 1H), 4.22 (t, J = 7.0 Hz, 2H), 4.17-4.08 (m, 2H), 3.75 & 3.58 (s, 2H), 2.43-2.35 (m, 2H), 2.06-1.97 (m, 2H), 1.22 & 1.16 (t, J = 7.0 Hz, J = 7.2 Hz, 3H), 1.00-0.95 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.9, 151.1, 135.5, 134.4, 129.2, 129.0, 128.4, 128.2, 128.0, 126.1, 124.7, 124.7, 74.3, 74.0, 61.0, 41.1, 33.3, 32.5, 32.4, 25.6, 14.0, 13.7; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{17}H_{23}NO_3$: 290.1756. Found: 290.1758.

General procedure for α-diazo oxime ethers (1a-z):

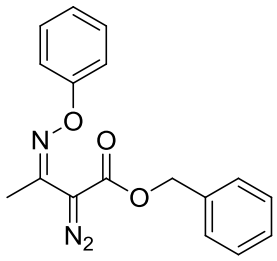


or



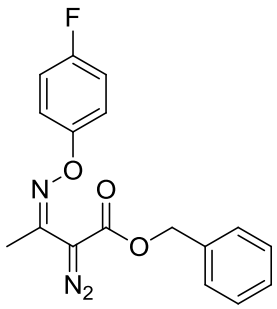
To a solution of β-oximino ester (1.0 eq.) and 4-nitrobenzenesulfonyl azide or TsN_3 (1.1 eq.) in CH_3CN at -20 °C was added DBU (1.1 eq.) dropwise. The resulting orange color solution was stirred for 2 h at -20 °C and slowly brought to RT. Upon completion of the reaction as indicated by TLC, the solvent was removed under reduced pressure, and the crude material was purified by column chromatography using hexane:ethyl acetate (9:1).

(Z)-benzyl 2-diazo-3-(phenoxyimino)butanoate (1a):



The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 50%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.35 (m, 5H), 7.32-7.28 (m, 2H), 7.13-7.11 (m, 2H), 7.03-7.00 (m, 1H), 5.26 (s, 2H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.2, 158.4, 145.6, 135.4, 129.3, 128.7, 128.5, 128.2, 122.4, 114.2, 66.9, 19.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{17}H_{15}N_3O_3$: 310.1192. Found: 310.1195.

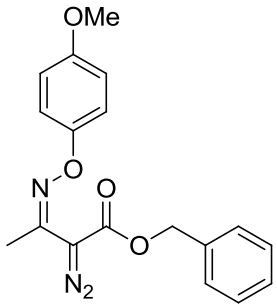
(Z)-benzyl 2-diazo-3-((4-fluorophenoxy)imino)butanoate (1b):



The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 52%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40-7.36 (m, 5H), 7.09-7.06 (m, 2H), 7.01-6.97 (m, 2H), 5.27 (s, 2H), 2.31 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.1, 159.5, 157.1, 154.5, 154.5, 145.7, 135.3, 128.7, 128.5, 128.2, 115.8, 115.6,

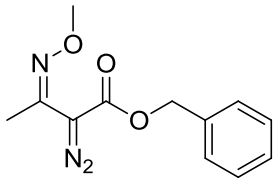
115.5, 67.0, 19.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{17}H_{14}FN_3O_3$: 328.1097. Found: 328.1105.

(Z)-benzyl 2-diazo-3-((4-methoxyphenoxy)imino)butanoate (1c):



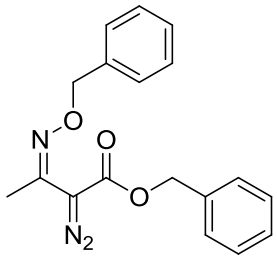
The title compound was prepared according to the general procedure. The product was obtained as yellow solid. mp: 61-63 °C. Yield: 20%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41-7.33 (m, 5H), 7.07-7.02 (m, 2H), 6.86-6.82 (m, 2H), 5.26 (s, 2H), 3.77 (s, 3H), 2.29 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.3, 155.2, 152.6, 144.9, 135.4, 128.7, 128.5, 128.2, 115.7, 114.4, 66.9, 55.7, 19.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{17}N_3O_4$: 340.1297. Found: 340.1302.

(Z)-benzyl 2-diazo-3-(methoxyimino)butanoate (1d):



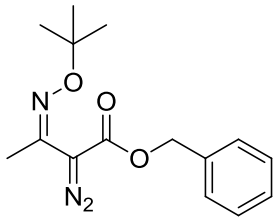
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 64%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40-7.32 (m, 5H), 5.23 (s, 2H), 3.83 (s, 3H), 2.16 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.7, 141.4, 135.6, 128.6, 128.4, 128.1, 66.7, 61.7, 19.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{13}N_3O_3$: 248.1035. Found: 248.1038.

(Z)-benzyl 3-((benzyloxy)imino)-2-diazobutanoate (1e):



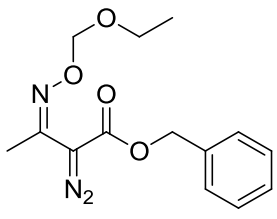
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 55%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.30 (m, 10H), 5.22 (s, 2H), 5.07 (s, 2H), 2.18 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.7, 141.8, 137.0, 135.5, 128.6, 128.4, 128.1, 128.0, 76.4, 66.7, 19.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{17}N_3O_3$: 324.1348. Found: 324.1355.

(Z)-benzyl 3-(*tert*-butoxyimino)-2-diazobutanoate (1f):



The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 52%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40-7.32 (m, 5H), 5.23 (s, 2H), 2.16 (s, 3H), 1.27 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.2, 139.1, 135.7, 128.6, 128.3, 128.1, 79.4, 66.5, 27.3, 19.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{15}H_{19}N_3O_3$: 290.1505. Found: 290.1513.

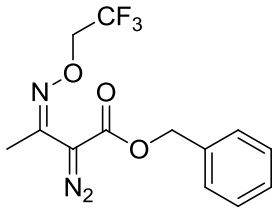
(Z)-benzyl 2-diazo-3-((ethoxymethoxy)imino)butanoate (1g):



The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 50%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.34 (m, 5H), 5.23 (s, 2H), 5.10 (s, 2H), 3.63 (q, J = 7.1 Hz, 2H), 2.19 (s, 3H), 1.22 (t, J = 7.0 Hz, 3H); ^{13}C

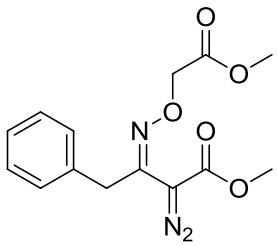
NMR (100 MHz, $CDCl_3$) δ 163.6, 143.0, 135.5, 128.6, 128.4, 128.1, 97.2, 66.8, 64.9, 19.4, 15.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{14}H_{17}N_3O_4$: 292.1297. Found: 292.1304.

(Z)-benzyl 2-diazo-3-((2,2,2-trifluoroethoxy)imino)butanoate (1h):



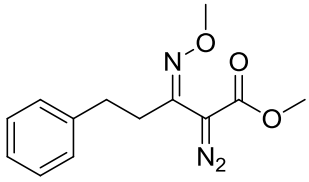
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 50%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40-7.34 (m, 5H), 5.23 (s, 2H), 4.38 (q, J = 8.5 Hz, 2H), 2.17 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.1, 144.7, 135.4, 128.7, 128.5, 128.2, 123.4 (q, J = 278.0 Hz), 70.9 (q, J = 33.9 Hz), 66.9. 19.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{12}F_3N_3O_3$: 316.0909. Found: 316.0910.

(Z)-methyl 2-diazo-3-((2-methoxy-2-oxoethoxy)imino)-4-phenylbutanoate (1i):



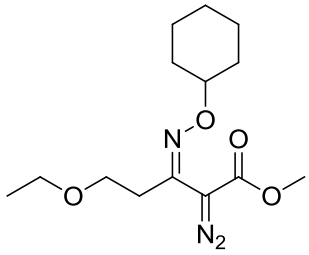
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 47%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31-7.21 (m, 5H), 4.69 (s, 2H), 3.93 (s, 2H), 3.78 (s, 3H), 3.72 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 163.6, 146.4, 137.0, 128.8, 128.4, 126.7, 70.7, 52.0, 51.9, 37.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{14}H_{15}N_3O_5$: 306.1090. Found: 306.1078.

(Z)-methyl 2-diazo-3-(methoxyimino)-5-phenylpentanoate (1j):



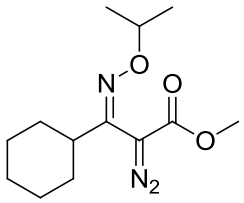
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 80%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30-7.26 (m, 2H), 7.23-7.17 (m, 3H), 3.84 (s, 3H), 3.79 (s, 3H), 2.90-2.87 (m, 2H), 2.86-2.81 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.1, 144.2, 141.0, 128.5, 128.3, 126.0, 61.8, 52.1, 34.3, 33.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{15}N_3O_3$: 262.1192. Found: 262.1187.

(Z)-methyl 3-((cyclohexyloxy)imino)-2-diazo-5-ethoxypentanoate (1k):



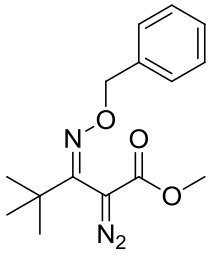
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 43%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.09-4.04 (m, 1H), 3.79 (s, 3H), 3.60 (t, J = 6.7 Hz, 2H), 3.49 (q, J = 7.0 Hz, 2H), 2.86 (t, J = 6.7 Hz, 2H), 1.90-1.86 (m, 2H), 1.68-1.67 (m, 2H), 1.51-1.26 (m, 6H), 1.17 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.5, 141.1, 81.2, 68.1, 65.9, 52.0, 32.4, 31.3, 25.6, 23.5, 15.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{14}H_{23}N_3O_4$: 298.1767. Found: 298.1762.

(Z)-methyl 3-cyclohexyl-2-diazo-3-(isopropoxyimino)propanoate (1l):



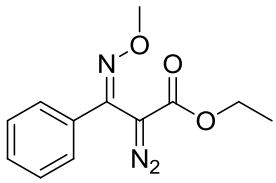
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 61%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.34-4.25 (m, 1H), 3.77 (s, 3H), 2.82-2.76 (m, 1H), 1.91-1.88 (m, 2H), 1.77-1.74 (m, 2H), 1.68-1.65 (m, 1H), 1.40-1.24 (m, 5H), 1.21 (d, J = 6.0 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.7, 146.8, 75.8, 51.9, 40.2, 31.5, 26.4, 26.2, 21.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{21}N_3O_3$: 268.1661. Found: 268.1655.

(Z)-methyl 3-((benzyloxy)imino)-2-diazo-4,4-dimethylpentanoate (1m):



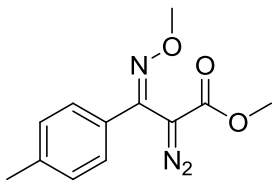
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 42%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.29 (m, 5H), 5.14 (s, 2H), 3.72 (s, 3H), 1.21 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.4, 150.0, 137.5, 128.2, 128.1, 127.8, 76.3, 52.1, 39.1, 28.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{15}H_{19}N_3O_3$: 290.1505. Found: 290.1510.

(Z)-ethyl 2-diazo-3-(methoxyimino)-3-phenylpropanoate (1n):



The title compound was prepared according to the general procedure. The product was obtained as yellow solid. mp: 58-60 °C. Yield: 90%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55-7.52 (m, 2H), 7.39-7.34 (m, 3H), 4.11 (q, J = 7.1 Hz, 2H), 4.05 (s, 3H), 1.08 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.9, 144.2, 133.7, 129.6, 128.2, 127.7, 62.6, 61.2, 14.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{13}N_3O_3$: 248.1035. Found: 248.1035.

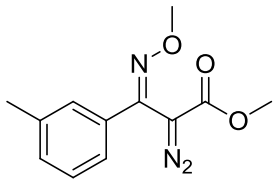
(Z)-methyl 2-diazo-3-(methoxyimino)-3-(p-tolyl)propanoate (1o):



The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 89%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 (d, J = 8.4 Hz, 2H),

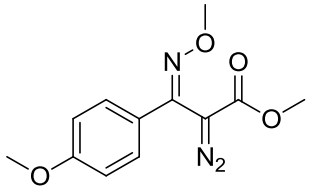
7.17 (d, J = 8.0 Hz, 2H), 4.03 (s, 3H), 3.68 (s, 3H), 2.36 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.2, 143.9, 139.8, 130.6, 129.1, 127.5, 62.6, 52.1. 21.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{13}N_3O_3$: 248.1035. Found: 248.1044.

(Z)-methyl 2-diazo-3-(methoxyimino)-3-(m-tolyl)propanoate (1p):



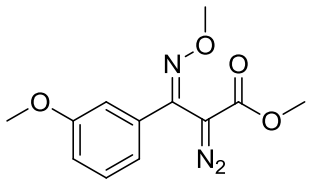
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 87%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 (s, 1H), 7.32-7.27 (m, 1H), 7.25-7.20 (m, 2H), 4.05 (s, 3H), 3.68 (s, 3H), 2.37 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.2, 144.1, 138.0, 133.4, 130.5, 128.1, 128.0, 124.9, 62.6, 52.1, 21.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{13}N_3O_3$: 248.1035. Found: 248.1035.

(Z)-methyl 2-diazo-3-(methoxyimino)-3-(4-methoxyphenyl)propanoate (1q):



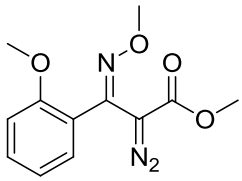
The title compound was prepared according to the general procedure. The product was obtained as yellow solid. mp: 75-77 °C. Yield: 98%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (d, J = 8.8 Hz, 2H), 6.89 (d, J = 9.2 Hz, 2H), 4.02 (s, 3H), 3.81 (s, 3H), 3.68 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.2, 160.9, 143.5, 129.0, 125.8, 113.8, 62.5, 55.3, 52.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{13}N_3O_4$: 264.0984. Found: 264.0986.

(Z)-methyl 2-diazo-3-(methoxyimino)-3-(3-methoxyphenyl)propanoate (1r):



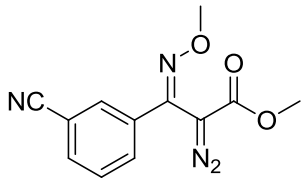
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 96%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30-7.26 (m, 1H), 7.12-7.10 (m, 2H), 6.96-6.93 (m, 1H), 4.05 (s, 3H), 3.83 (s, 3H), 3.68 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.1, 159.5, 143.8, 134.9, 129.3, 120.2, 115.6, 112.8, 62.7, 55.3, 52.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{13}N_3O_4$: 264.0984. Found: 264.0984.

(Z)-methyl 2-diazo-3-(methoxyimino)-3-(2-methoxyphenyl)propanoate (1s):



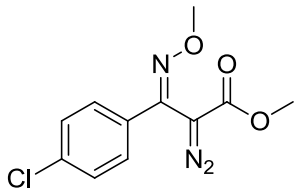
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 16%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38-7.34 (m, 2H), 7.00-6.96 (m, 1H), 6.86 (d, J = 8.4 Hz, 1H), 4.00 (s, 3H), 3.79 (s, 3H), 3.62 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.2, 157.7, 142.8, 130.9, 130.5, 122.8, 120.7, 110.5, 62.4, 55.6, 51.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{13}N_3O_4$: 264.0984. Found: 264.0980.

(Z)-methyl 3-(3-cyanophenyl)-2-diazo-3-(methoxyimino)propanoate (1t):



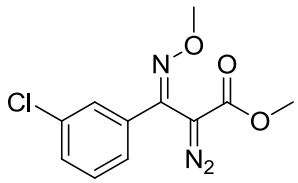
The title compound was prepared according to the general procedure. The product was obtained as yellow solid. mp: 128-130 °C. Yield: 91%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84-7.83 (m, 1H), 7.76-7.73 (m, 1H), 7.68-7.66 (m, 1H), 7.48 (t, J = 7.8 Hz, 1H), 4.07 (s, 3H), 3.70 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.6, 142.3, 135.0, 132.8, 131.9, 131.3, 129.1, 118.4, 112.6, 63.1, 52.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{10}N_4O_3$: 259.0831. Found: 259.0835.

(Z)-methyl 3-(4-chlorophenyl)-2-diazo-3-(methoxyimino)propanoate (1u):



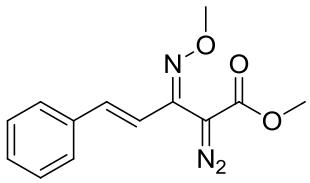
The title compound was prepared according to the general procedure. The product was obtained as yellow solid. mp: 61-63 °C. Yield: 97%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 (d, J = 8.8 Hz, 2H), 7.34 (d, J = 8.4 Hz, 2H), 4.04 (s, 3H), 3.69 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.9, 143.0, 135.7, 132.0, 128.9, 128.6, 62.8, 52.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{11}H_{10}ClN_3O_3$: 268.0489. Found: 268.0490.

(Z)-methyl 3-(3-chlorophenyl)-2-diazo-3-(methoxyimino)propanoate (1v):



The title compound was prepared according to the general procedure. The product was obtained as yellow solid. mp: 59-61 °C. Yield: 95%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56-7.55 (m, 1H), 7.41-7.35 (m, 2H), 7.32-7.28 (m, 1H), 4.06 (s, 3H), 3.69 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.9, 135.4, 134.3, 129.7, 129.4, 127.6, 125.9, 62.9, 52.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{11}H_{10}ClN_3O_3$: 268.0489. Found: 268.0482.

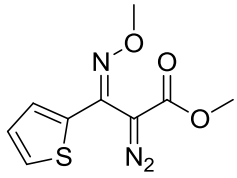
(3Z,4E)-methyl 2-diazo-3-(methoxyimino)-5-phenylpent-4-enoate (1w):



The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 77%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48-7.45 (m, 2H), 7.36-7.27 (m, 3H), 6.99 (d, J = 16.4 Hz, 1H), 6.81 (d, J = 16.0 Hz, 1H), 4.01 (s, 3H), 3.80 (s,

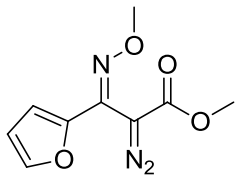
3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.4, 142.7, 136.1, 135.0, 128.7, 128.6, 127.1, 121.7, 62.7, 52.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{13}N_3O_3$: 260.1035. Found: 260.1028.

(E)-methyl 2-diazo-3-(methoxyimino)-3-(thiophen-2-yl)propanoate (1x):



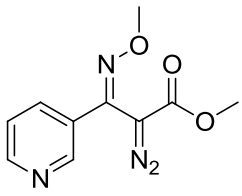
The title compound was prepared according to the general procedure. The product was obtained as yellow solid. mp: 58-60 °C. Yield: 73%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.32 (m, 1H), 7.21-7.20 (m, 1H), 7.04-7.02 (m, 1H), 4.04 (s, 3H), 3.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.0, 138.6, 136.3, 128.4, 127.5, 127.2, 62.9, 52.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_9H_9N_3O_3S$: 240.0443. Found: 240.0437.

(E)-methyl 2-diazo-3-(furan-2-yl)-3-(methoxyimino)propanoate (1y):



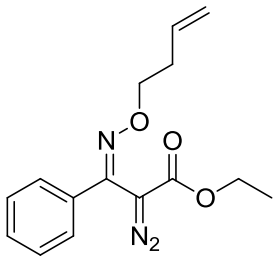
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 84%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48-7.47 (m, 1H), 6.66-6.65 (m, 1H), 6.46-6.45 (m, 1H), 4.05 (s, 3H), 3.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.7, 146.8, 143.9, 135.4, 111.7, 111.6, 63.0, 52.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_9H_9N_3O_4$: 224.0671. Found: 224.0671.

(Z)-methyl 2-diazo-3-(methoxyimino)-3-(pyridin-3-yl)propanoate (1z):



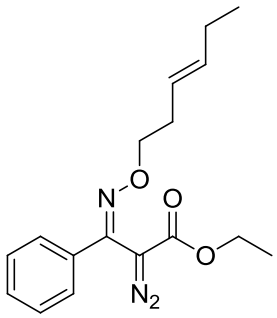
The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 93%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.73-8.72 (m, 1H), 8.60-8.59 (m, 1H), 7.82-7.79 (m, 1H), 7.29-7.27 (m, 1H), 4.05 (s, 3H), 3.66 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.7, 150.3, 148.7, 141.5, 134.9, 129.5, 122.9, 62.9, 52.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{10}H_{10}N_4O_3$: 235.0831. Found: 235.0835.

(Z)-ethyl 3-((but-3-en-1-yloxy)imino)-2-diazo-3-phenylpropanoate (5a):



The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 81%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55-7.52 (m, 2H), 7.41-7.34 (m, 3H), 5.90-5.80 (m, 1H), 5.17-5.07 (m, 2H), 4.30 (t, J = 6.6 Hz, 2H), 4.11 (q, J = 7.1 Hz, 2H), 2.54-2.48 (m, 2H), 1.08 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.9, 144.1, 134.4, 133.9, 129.5, 128.2, 127.7, 116.9, 74.2, 61.2, 33.6, 14.0; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{15}H_{17}N_3O_3$: 288.1348. Found: 288.1356.

(Z)-ethyl 2-diazo-3-(((E)-hex-3-en-1-yloxy)imino)-3-phenylpropanoate (5b):

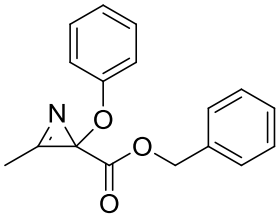


The title compound was prepared according to the general procedure. The product was obtained as yellow oil. Yield: 82%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54-7.52 (m, 2H), 7.39-7.35 (m, 3H), 5.61-5.55 (m, 1H), 5.46-5.38 (m, 1H), 4.26 (t, J = 6.6 Hz, 2H), 4.11 (q, J = 7.2 Hz, 2H), 2.46-2.41 (m, 2H), 2.05-2.00 (m, 2H), 1.08 (t, J = 7.0 Hz, 3H), 0.98 (t, J = 7.4

Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.0, 143.9, 134.7, 134.0, 129.4, 128.2, 127.6, 124.5, 74.8, 61.2, 32.4, 25.6, 14.0, 13.6; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{17}H_{21}N_3O_3$: 316.1661. Found: 316.1658.

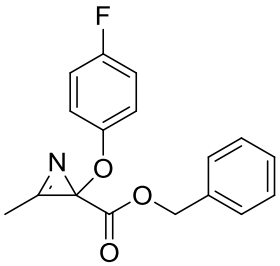
General procedure for 2*H*-azirines: A solution of α-diazo oxime ethers in benzene was irradiated at 302 nm in Rayonet photoreactor for 2-5 h. After the completion of the reaction, the solvent was evaporated under reduced pressure, and the crude material was purified by flash column chromatography (silica gel, hexane: ethyl acetate = 9:1) to give 2*H*-azirines.

Benzyl 3-methyl-2-phenoxy-2*H*-azirine-2-carboxylate (2a):



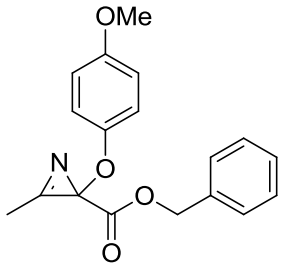
The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 62-64 °C. Yield 84%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29-7.24 (m, 5H), 7.15-7.09 (m, 4H), 7.05-7.01 (m, 1H), 5.20 (d, J = 12.4 Hz, 1H), 5.12 (d, J = 12.4 Hz, 1H), 2.54 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.6, 164.8, 155.3, 135.0, 129.5, 128.4, 128.2, 127.9, 122.6, 67.6, 64.5, 11.7; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{17}H_{15}NO_3$: 282.1130. Found: 282.1128.

Benzyl 2-(4-fluorophenoxy)-3-methyl-2*H*-azirine-2-carboxylate (2b):



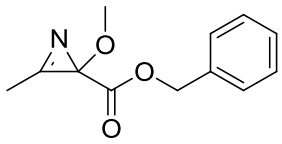
The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield: 81%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31-7.30 (m, 3H), 7.19-7.16 (m, 2H), 7.08-7.05 (m, 2H), 6.98-6.93 (m, 2H), 5.22 (d, J = 12.4 Hz, 1H), 5.12 (d, J = 12.4 Hz, 1H), 2.57 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.5, 164.7, 159.6, 157.2, 151.3, 151.3, 135.0, 128.5, 128.4, 128.0, 117.9, 117.8, 116.1, 115.9, 67.8, 65.1, 11.7; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{17}H_{14}FNO_3$: 300.1036. Found: 300.1039.

Benzyl 2-(4-methoxyphenoxy)-3-methyl-2*H*-azirine-2-carboxylate (2c):



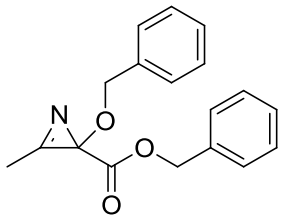
The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield 71%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.28 (m, 3H), 7.21-7.18 (m, 2H), 7.05-7.01 (m, 2H), 6.82-6.77 (m, 2H), 5.22 (d, J = 12.8 Hz, 1H), 5.13 (d, J = 12.4 Hz, 1H), 3.77 (s, 3H), 2.52 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.9, 164.8, 155.3, 149.0, 135.1, 128.5, 128.3, 128.0, 118.0, 114.6, 67.6, 65.4, 55.6, 11.8; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{17}NO_4$: 312.1236. Found: 312.1229.

Benzyl 2-methoxy-3-methyl-2*H*-azirine-2-carboxylate (2d):



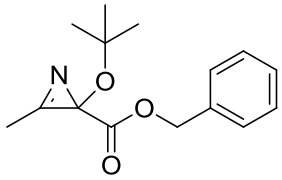
The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield 92%. ^{1}H NMR (400 MHz, $CDCl_3$) 7.38-7.31 (m, 5H), 5.23 (d, J = 12.4 Hz, 1H), 5.14 (d, J = 12.0 Hz, 1H), 3.45 (s, 3H), 2.53 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 166.3, 135.3, 128.6, 128.4, 128.1, 67.4, 66.4, 54.0, 12.0; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{12}H_{13}NO_3$: 220.0974. Found: 220.0978.

Benzyl 2-(benzyloxy)-3-methyl-2*H*-azirine-2-carboxylate (2e):



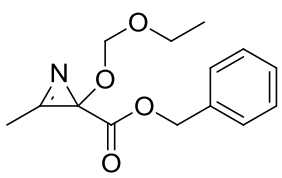
The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield 88%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.28 (m, 10H), 5.25 (d, J = 12.4 Hz, 1H), 5.18 (d, J = 12.4 Hz, 1H), 4.89 (d, J = 11.2 Hz, 1H), 4.63 (d, J = 11.2 Hz, 1H), 2.41 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.6, 166.5, 136.9, 135.3, 128.6, 128.4, 128.4, 128.3, 128.2, 128.0, 69.1, 67.5, 65.7, 11.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{17}NO_3$: 296.1287. Found: 296.1280.

Benzyl 2-(*tert*-butoxy)-3-methyl-2*H*-azirine-2-carboxylate (2f):



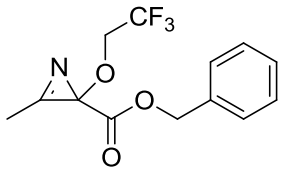
The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield 92%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35-7.31 (m, 5H), 5.20 (d, J = 12.4 Hz, 1H), 5.13 (d, J = 12.4 Hz, 1H), 2.52 (s, 3H), 1.27 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.2, 167.5, 135.5, 128.5, 128.3, 128.1, 78.4, 67.3, 62.4, 28.9, 12.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{15}H_{19}NO_3$: 262.1443. Found: 262.1442.

Benzyl 2-(ethoxymethoxy)-3-methyl-2*H*-azirine-2-carboxylate (2g):



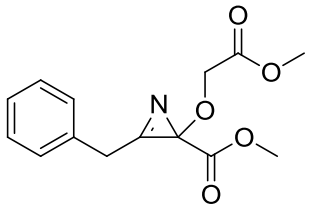
The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield 95%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.31 (m, 5H), 5.22-5.15 (m, 2H), 4.84 (d, J = 6.8 Hz, 1H), 4.69 (d, J = 6.8 Hz, 1H), 3.60-3.53 (m, 2H), 2.56 (s, 3H), 1.14 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.6, 167.0, 135.3, 128.5, 128.3, 128.1, 92.3, 67.5, 64.2, 64.0, 14.9, 12.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{14}H_{17}NO_4$: 264.1236. Found: 264.1246.

Benzyl 3-methyl-2-(2,2,2-trifluoroethoxy)-2*H*-azirine-2-carboxylate (2h):



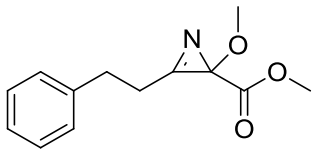
The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield 94%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.30 (m, 5H), 5.22 (d, J = 12.4 Hz, 1H), 5.16 (d, J = 12.4 Hz, 1H), 4.35-4.26 (m, 1H), 4.05-3.95 (m, 1H), 2.56 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.6, 165.9, 134.9, 128.7, 128.6, 128.1, 123.1 (q, J = 275.9 Hz), 67.7, 66.1, 64.3 (q, J = 18.4 Hz), 11.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{12}F_3NO_3$: 288.0848. Found: 288.0837.

Methyl 3-benzyl-2-(2-methoxy-2-oxoethoxy)-2*H*-azirine-2-carboxylate (2i):



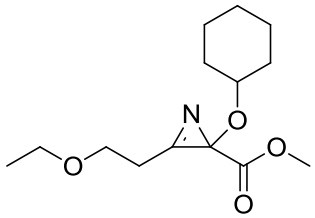
The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 46-47 °C. Yield 84%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38-7.31 (m, 5H), 4.43 (d, J = 16.0 Hz, 1H), 4.28-4.16 (m, 3H), 3.74 (s, 3H), 3.69 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 169.2, 168.9, 131.5, 129.0, 128.9, 127.8, 66.7, 64.1, 52.8, 52.0, 32.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{14}H_{15}NO_5$: 278.1028. Found: 278.1026.

Methyl 2-methoxy-3-phenethyl-2*H*-azirine-2-carboxylate (2j):



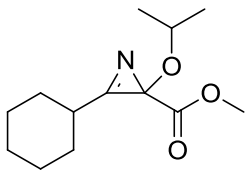
The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield 91%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.30 (m, 2H), 7.26-7.22 (m, 3H), 3.71 (s, 3H), 3.40 (s, 3H), 3.19-3.15 (m, 2H), 3.13-3.08 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.0, 169.0, 139.2, 128.7, 128.3, 126.8, 66.8, 53.9, 52.8, 30.3, 28.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{15}NO_3$: 234.1130. Found: 234.1133.

Methyl 2-(cyclohexyloxy)-3-(2-ethoxyethyl)-2*H*-azirine-2-carboxylate (2k):



The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield 93%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 3.84-3.74 (m, 2H), 3.73 (s, 3H), 3.71-3.66 (m, 1H), 3.54-3.49 (m, 2H), 3.17-3.03 (m, 2H), 1.95-1.85 (m, 2H), 1.75-1.66 (m, 2H), 1.52-1.22 (m, 6H), 1.18 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.7, 168.3, 66.6, 64.9, 64.8, 52.7, 33.0, 32.7, 27.8, 25.4, 24.1, 24.1, 15.0; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{14}H_{23}NO_4$: 270.1705. Found: 270.1708.

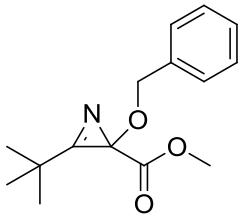
Methyl 3-cyclohexyl-2-isopropoxy-2*H*-azirine-2-carboxylate (2l):



The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield 93%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.06-4.00 (m, 1H), 3.73

(s, 3H), 2.95-2.90 (m, 1H), 2.03-1.93 (m, 2H), 1.79-1.73 (m, 2H), 1.67-1.59 (m, 2H), 1.57-1.52 (m, 1H), 1.45-1.34 (m, 3H), 1.24 (d, *J* = 6.0 Hz, 3H), 1.17 (d, *J* = 6.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.5, 171.1, 71.2, 65.4, 52.6, 35.7, 28.1, 28.0, 25.6, 24.8, 24.7, 23.1, 22.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{21}NO_3$: 240.1600. Found: 240.1598.

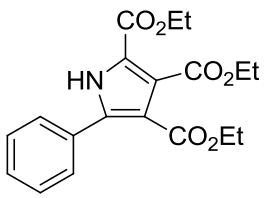
Methyl 2-(benzyloxy)-3-(tert-butyl)-2*H*-azirine-2-carboxylate (2m):



The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 52-54 °C. Yield 73%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36-7.28 (m, 5H), 4.87 (d, *J* = 11.2 Hz, 1H), 4.65 (d, *J* = 10.8 Hz, 1H), 3.76 (s, 3H), 1.34 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.9, 170.4, 137.1, 128.3, 128.0, 127.8, 68.8, 67.5, 52.7, 33.5, 26.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{15}H_{19}NO_3$: 262.1443. Found: 262.1446.

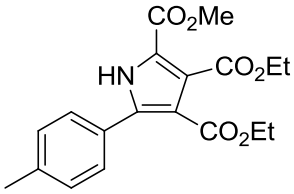
General procedure for pyrroles via intermolecular reaction: A solution of α-diazo oxime ethers (1.0 eq.) and diethyl fumarate (5.0 eq.) in benzene was irradiated at 302 nm in Rayonet photoreactor at RT for 12-18 h. After concentration, the crude material was dissolved in THF and treated with aqueous 1 N HCl at RT overnight. After the completion of the reaction, the mixture was diluted with CH_2Cl_2, dried over anhydrous $MgSO_4$ and concentrated under reduced pressure. The crude compound was purified by column chromatography using hexane: ethyl acetate (3:2) to give pyrroles.

Triethyl 5-phenyl-1*H*-pyrrole-2,3,4-tricarboxylate (4n):



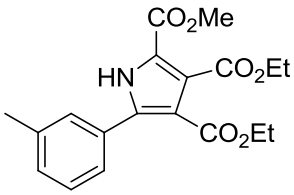
The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 117-119 °C. Yield: 72%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.77 (br, 1H), 7.57-7.54 (m, 2H), 7.43-7.41 (m, 3H), 4.40 (q, J = 7.1 Hz, 2H), 4.22-4.15 (m, 4H), 1.41 (t, J = 7.0 Hz, 3H), 1.28 (t, J = 7.2 Hz, 3H), 1.19 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.5, 162.7, 159.9, 140.0, 130.2, 129.4, 129.4, 128.1, 124.9, 119.6, 112.2, 61.6, 61.4, 60.4, 14.1, 14.1, 13.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{21}NO_6$: 360.1447. Found: 360.1460.

3,4-diethyl 2-methyl 5-(p-tolyl)-1*H*-pyrrole-2,3,4-tricarboxylate (4o):



The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 108-110 °C. Yield: 81%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.66 (br, 1H), 7.45 (d, J = 8.4 Hz, 2H), 7.21 (d, J = 8.0 Hz, 2H), 4.41 (q, J = 7.1 Hz, 2H), 4.18 (q, J = 7.1 Hz, 2H), 3.78 (s, 3H), 2.38 (s, 3H), 1.40 (t, J = 7.0 Hz, 3H), 1.21 (d, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.4, 162.7, 160.3, 140.3, 139.6, 129.2, 128.8, 127.1, 125.1, 119.1, 112.1, 61.6, 60.4, 52.1, 21.3, 14.1, 13.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{21}NO_6$: 360.1447. Found: 360.1447.

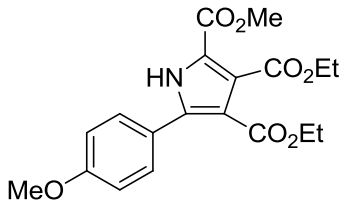
3,4-diethyl 2-methyl 5-(m-tolyl)-1*H*-pyrrole-2,3,4-tricarboxylate (4p):



The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 79-81 °C. Yield: 45%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.44 (br, 1H), 7.37-7.33 (m, 2H), 7.31-7.29 (m, 1H), 7.25-7.23 (m, 1H), 4.43 (q, J = 7.2 Hz, 2H), 4.19 (q, J = 7.1 Hz, 2H), 3.82 (s, 3H), 2.39 (s, 3H), 1.41 (t, J = 7.0 Hz, 3H), 1.21 (t, J = 7.2 Hz,

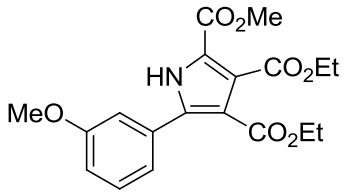
3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.4, 162.7, 160.2, 140.1, 137.9, 130.3, 130.0, 129.8, 128.1, 126.5, 125.1, 119.2, 112.3, 61.7, 60.4, 52.2, 21.4, 14.2, 13.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{21}NO_6$: 360.1447. Found: 360.1451.

3,4-diethyl 2-methyl 5-(4-methoxyphenyl)-1*H*-pyrrole-2,3,4-tricarboxylate (4q):



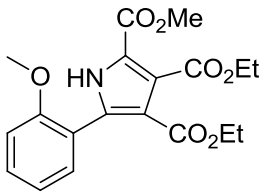
The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 113-115 °C. Yield: 55%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.35 (br, 1H), 7.51 (d, J = 8.8 Hz, 2H), 6.95 (d, J = 8.8 Hz, 2H), 4.42 (q, J = 7.2 Hz, 2H), 4.20 (q, J = 7.1 Hz, 2H), 3.84 (s, 3H), 3.84 (s, 3H), 1.41 (t, J = 7.2 Hz, 3H), 1.23 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.5, 162.7, 160.6, 160.2, 140.1, 130.7, 125.1, 122.3, 119.0, 113.7, 111.8, 61.6, 60.4, 55.4, 52.2, 14.2, 14.0; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{21}NO_7$: 376.1396. Found: 376.1385.

3,4-diethyl 2-methyl 5-(3-methoxyphenyl)-1*H*-pyrrole-2,3,4-tricarboxylate (4r):



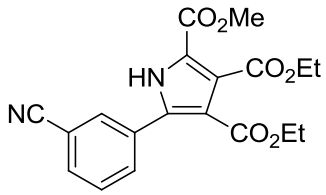
The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 93-95 °C. Yield: 63%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.62 (br, 1H), 7.33 (t, J = 8.2 Hz, 1H), 7.13-7.11 (m, 2H), 6.98-6.95 (m, 1H), 4.42 (q, J = 7.1 Hz, 2H), 4.19 (q, J = 7.1 Hz, 2H), 3.82 (s, 3H), 3.80 (s, 3H), 1.40 (t, J = 7.2 Hz, 3H), 1.21 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.4, 162.6, 160.2, 159.2, 139.7, 131.2, 129.3, 125.1, 121.6, 119.3, 115.1, 115.0, 112.4, 61.7, 60.5, 55.3, 52.2, 14.1, 13.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{21}NO_7$: 376.1396. Found: 376.1390.

3,4-diethyl 2-methyl 5-(2-methoxyphenyl)-1*H*-pyrrole-2,3,4-tricarboxylate (4s):



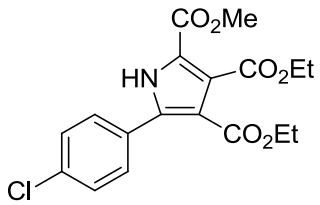
The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield: 42%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.62 (br, 1H), 7.52-7.49 (m, 1H), 7.41-7.37 (m, 1H), 7.03-6.96 (m, 2H), 4.42 (q, J = 7.1 Hz, 2H), 4.17 (q, J = 7.2 Hz, 2H), 3.84 (s, 3H), 3.81 (s, 3H), 1.41 (t, J = 7.0 Hz, 3H), 1.18 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.6, 162.9, 160.2, 156.8, 136.0, 132.2, 130.9, 124.4, 120.3, 119.0, 118.4, 113.4, 111.0, 61.6, 60.3, 55.6, 52.1, 14.2, 13.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{21}NO_7$: 376.1396. Found: 376.1392.

3,4-diethyl 2-methyl 5-(3-cyanophenyl)-1*H*-pyrrole-2,3,4-tricarboxylate (4t):



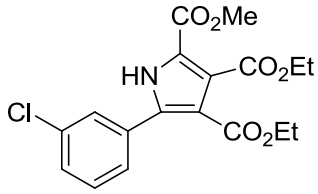
The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 111-113 °C. Yield: 50%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.00 (br, 1H), 7.90-7.89 (m, 1H), 7.83-7.81 (m, 1H), 7.73-7.70 (m, 1H), 7.56 (t, J = 7.8 Hz, 1H), 4.42 (q, J = 7.2 Hz, 2H), 4.19 (q, J = 7.1 Hz, 2H), 3.80 (s, 3H), 1.40 (t, J = 7.2 Hz, 3H), 1.22 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.0, 162.3, 160.2, 137.1, 133.9, 133.1, 132.7, 131.4, 129.1, 125.2, 120.2, 118.0, 113.1, 112.5, 61.8, 60.8, 52.4, 14.1, 13.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{18}N_2O_6$: 371.1243. Found: 371.1240.

3,4-diethyl 2-methyl 5-(4-chlorophenyl)-1*H*-pyrrole-2,3,4-tricarboxylate (4u):



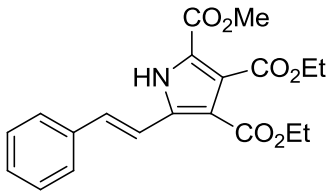
The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 104-106 °C. Yield: 51%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.69 (br, 1H), 7.51 (d, J = 8.8 Hz, 2H), 7.40 (d, J = 8.4 Hz, 2H), 4.42 (q, J = 7.1 Hz, 2H), 4.19 (q, J = 7.2 Hz, 2H), 3.80 (s, 3H), 1.40 (t, J = 7.2 Hz, 3H), 1.21 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.2, 162.5, 160.2, 138.7, 135.7, 130.7, 128.5, 125.1, 119.6, 112.6, 61.7, 60.6, 52.3, 14.1, 13.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{18}ClNO_6$: 380.0901. Found: 380.0905.

3,4-diethyl 2-methyl 5-(3-chlorophenyl)-1*H*-pyrrole-2,3,4-tricarboxylate (4v):



The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 97-99 °C. Yield: 64%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.67 (br, 1H), 7.57-7.56 (m, 1H), 7.46-7.34 (m, 3H), 4.42 (q, J = 7.2 Hz, 2H), 4.20 (q, J = 7.1 Hz, 2H), 3.81 (s, 3H), 1.40 (t, J = 7.2 Hz, 3H), 1.21 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.1, 162.4, 160.1, 138.0, 134.1, 131.8, 129.5, 129.5, 129.5, 127.6, 125.2, 119.8, 112.9, 61.7, 60.6, 52.3, 14.1, 13.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{18}ClNO_6$: 380.0901. Found: 380.0907.

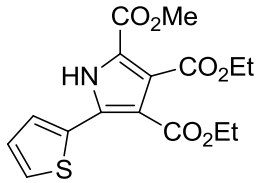
(E)-3,4-diethyl 2-methyl 5-styryl-1*H*-pyrrole-2,3,4-tricarboxylate (4w):



The title compound was prepared according to the general procedure. The product was obtained as colorless oil. Yield: 51%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.63 (br, 1H), 7.77 (d, J = 16.8 Hz, 1H), 7.52 (d, J = 7.2 Hz, 2H), 7.39-7.35 (m, 2H), 7.33-7.29 (m, 1H), 7.06 (d, J = 16.8 Hz, 1H), 4.41 (q, J = 7.2 Hz, 2H), 4.30 (q, J = 7.2 Hz, 2H), 3.86 (s, 3H), 1.39 (t, J = 7.0

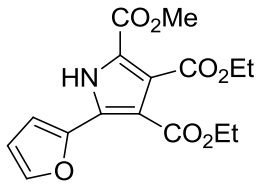
Hz, 3H), 1.35 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.4, 163.0, 160.2, 137.5, 135.8, 132.1, 128.9, 128.8, 127.0, 124.9, 119.5, 116.1, 112.8, 61.7. 60.5, 52.3, 14.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{20}H_{21}NO_6$: 372.1447. Found: 372.1450.

3,4-diethyl 2-methyl 5-(thiophen-2-yl)-1*H*-pyrrole-2,3,4-tricarboxylate (4x):



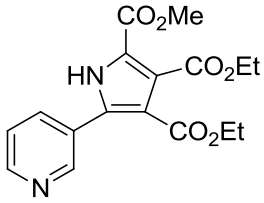
The title compound was prepared according to the general procedure. The product was obtained as light brown solid. mp: 105-107 °C. Yield: 50%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.41 (br, 1H), 7.58-7.57 (m, 1H), 7.46-7.44 (m, 1H), 7.12-7.09 (m, 1H), 4.41 (q, *J* = 7.2 Hz, 2H), 4.26 (q, *J* = 7.1 Hz, 2H), 3.86 (s, 3H), 1.40 (t, *J* = 7.0 Hz, 3H), 1.28 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.1, 162.5, 159.9, 133.0, 130.4, 129.5, 128.1, 127.4, 125.2, 119.4, 112.4, 61.7, 60.7, 52.3, 14.1, 14.0; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{16}H_{17}NO_6S$: 352.0855. Found: 352.0861.

3,4-diethyl 2-methyl 5-(furan-2-yl)-1*H*-pyrrole-2,3,4-tricarboxylate (4y):



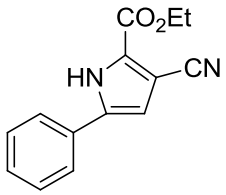
The title compound was prepared according to the general procedure. The product was obtained as pale yellow solid. mp: 115-117 °C. Yield: 37%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.60 (br, 1H), 7.61-7.61 (m, 1H), 7.50-7.49 (m, 1H), 6.54-6.53 (m, 1H), 4.40 (q, *J* = 7.1 Hz, 2H), 4.30 (q, *J* = 7.2 Hz, 2H), 3.88 (s, 3H), 1.40 (t, *J* = 7.2 Hz, 3H), 1.34 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.2, 162.4, 159.8, 144.0, 143.0, 129.8, 125.3, 119.0, 113.9, 112.5, 110.4, 61.6, 60.7, 52.2, 14.1, 14.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{16}H_{17}NO_7$: 336.1083. Found: 336.1085.

3,4-diethyl 2-methyl 5-(pyridin-3-yl)-1*H*-pyrrole-2,3,4-tricarboxylate (4z):



The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 148-150 °C. Yield: 40%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.77 (br, 1H), 8.66 (br, 2H), 8.01 (d, J = 8.0 Hz, 1H), 7.39 (br, 1H), 4.43 (q, J = 7.1 Hz, 2H), 4.19 (q, J = 7.1 Hz, 2H), 3.84 (s, 3H), 1.41 (t, J = 7.0 Hz, 3H), 1.20 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.3, 162.4, 160.2, 150.1, 149.4, 137.7, 136.4, 126.7, 125.2, 122.9, 120.4, 113.1, 61.8, 60.7, 52.4, 14.2, 13.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{17}H_{18}N_2O_6$: 347.1243. Found: 347.1239.

Ethyl 3-cyano-5-phenyl-1*H*-pyrrole-2-carboxylate (4aa):

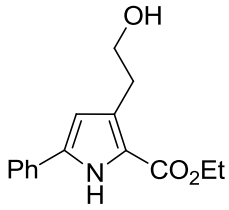


The title compound was prepared according to the general procedure. The product was obtained as colorless solid. mp: 181-183 °C. Yield: 30%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.0 (br, 1H), 7.59-7.57 (m, 2H), 7.47-7.43 (m, 2H), 7.41-7.37 (m, 1H), 6.81 (d, J = 2.4 Hz, 1H), 4.43 (q, J = 7.2 Hz, 2H), 1.43 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.4, 136.8, 129.5, 129.3, 129.0, 127.2, 125.2, 114.7, 111.8, 99.5, 62.0, 14.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{14}H_{12}N_2O_2$: 241.0977. Found: 241.0972. For NOESY data, see p. 123 and 124.

General procedure for pyrroles via intramolecular reaction: A solution of α-diazo oxime ethers in ACN was irradiated at 302 nm under Rayonet photoreactor at RT for 16 h. Then the mixtures were treated with aqueous 1N HCl at RT overnight. After the completion of the reaction, it was diluted with CH_2Cl_2, dried over anhydrous $MgSO_4$ and evaporated under

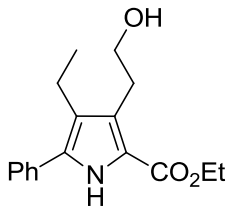
reduced pressure. The crude compound was purified by column chromatography using hexane: ethyl acetate (3:2) to give pyrroles.

Ethyl 3-(2-hydroxyethyl)-5-phenyl-1*H*-pyrrole-2-carboxylate (6a):

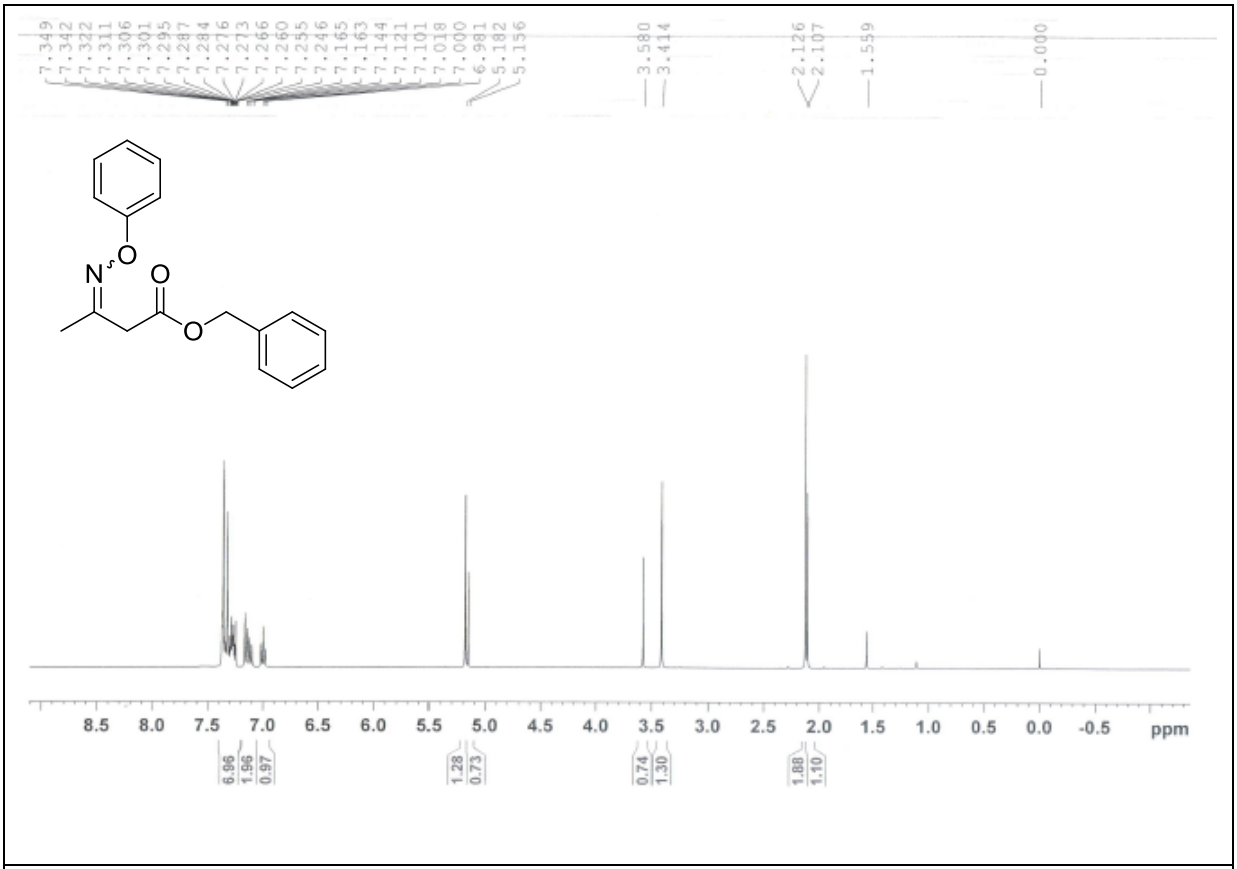


The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 103-105 °C. Yield: 48%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.31 (br, 1H), 7.55-7.53 (m, 2H), 7.41-7.38 (m, 2H), 7.32-7.28 (m, 1H), 6.46 (d, J = 2.8 Hz, 1H), 4.34 (q, J = 7.2 Hz, 2H), 3.90 (t, J = 6.2 Hz, 2H), 3.10 (t, J = 6.4 Hz, 2H), 1.37 (t, J = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.6, 135.6, 131.1, 130.4, 129.0, 127.8, 124.7, 120.0, 109.7, 63.4, 60.4, 30.6, 14.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{15}H_{17}NO_3$: 260.1287. Found: 260.1292.

Ethyl 4-ethyl-3-(2-hydroxyethyl)-5-phenyl-1*H*-pyrrole-2-carboxylate (6b):



The title compound was prepared according to the general procedure. The product was obtained as white solid. mp: 81-83 °C. Yield: 43%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.84 (br, 1H), 7.47-7.42 (m, 4H), 7.38-7.34 (m, 1H), 4.34 (q, J = 7.1 Hz, 2H), 3.87 (t, J = 6.6 Hz, 2H), 3.09 (t, J = 6.6 Hz, 2H), 2.60 (q, J = 7.6 Hz, 2H), 2.30 (br, 1H), 1.37 (t, J = 7.2 Hz, 3H), 1.15 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.6, 133.0, 132.4, 128.9, 128.6, 127.8, 127.4, 124.8, 119.1, 63.8, 60.2, 28.4, 17.3, 16.2, 14.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{17}H_{21}NO_3$: 288.1600. Found: 288.1601.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7.144
7.121
7.101
7.018
7.000
6.981
5.182
5.156
3.580
3.414
2.126
2.107
1.559
0.000
O
N
O
O
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 -0.5 ppm
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0.73
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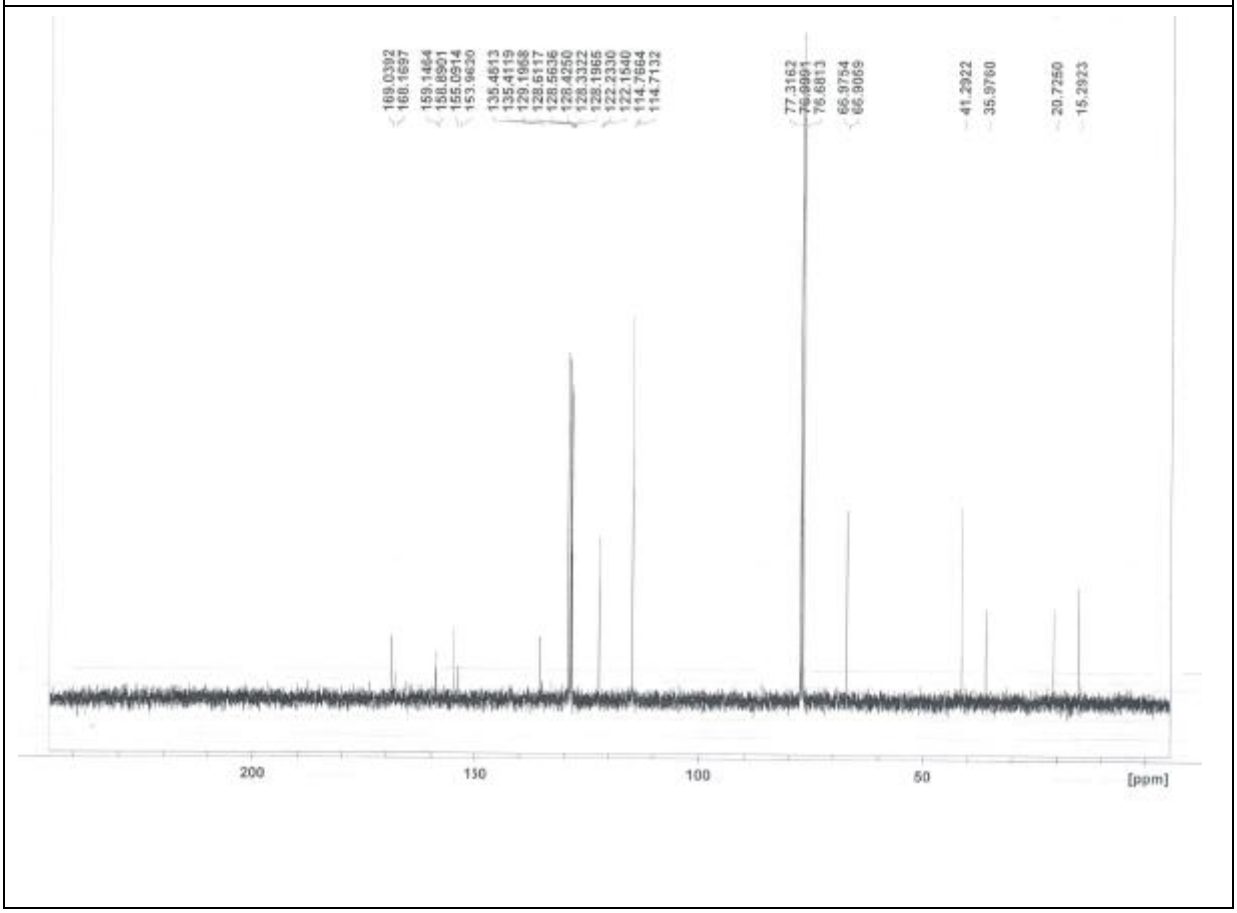
1.30
1.88
1.10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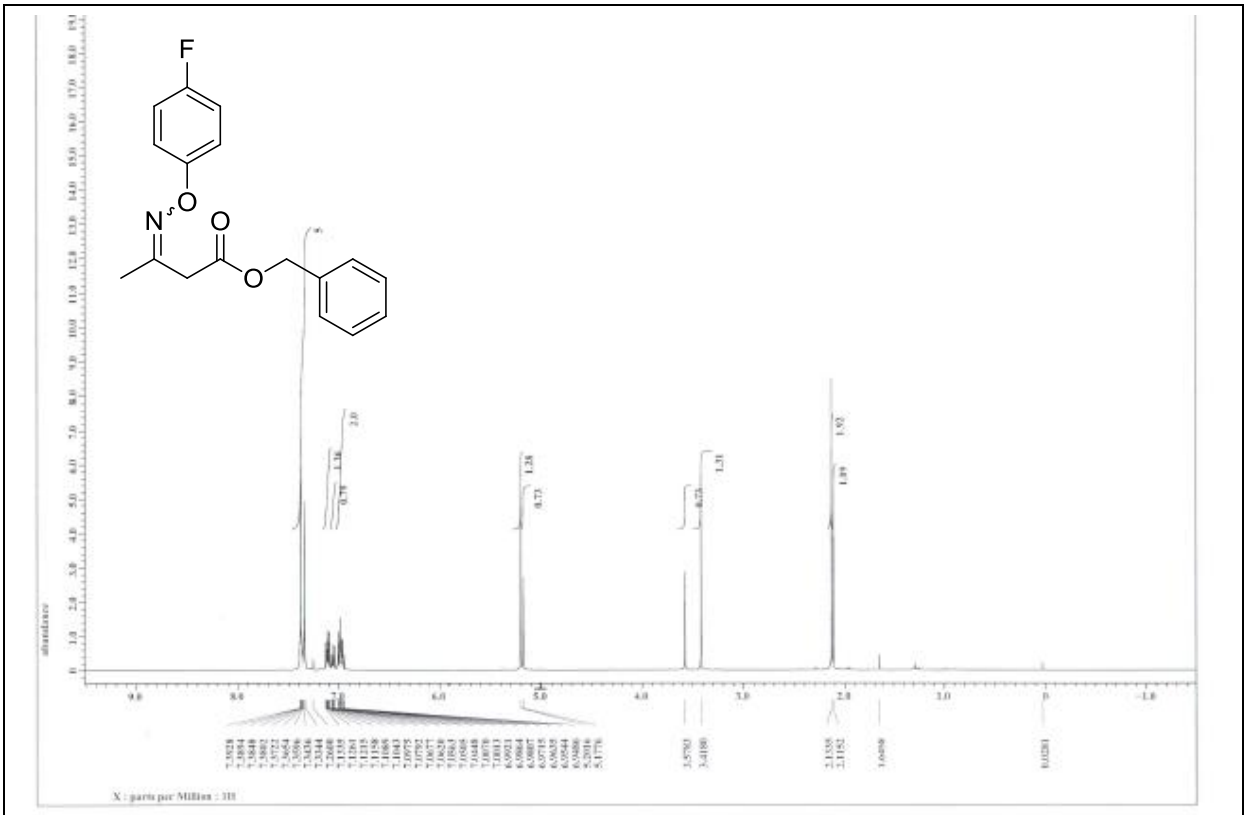
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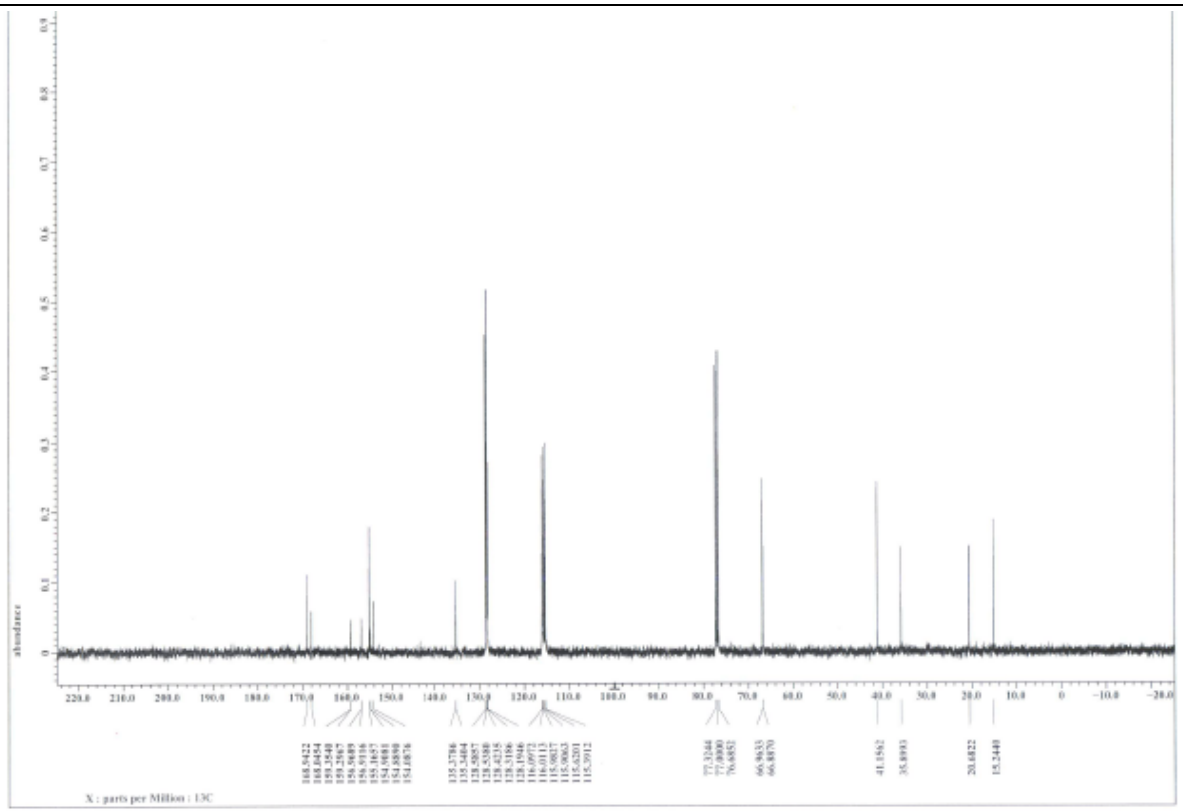
O
N
O
O




7.369
7.359
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7.065
7.039
7.017
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6.833
6.825
6.822
6.816
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2.108
2.085
1.575
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6.0
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0.5
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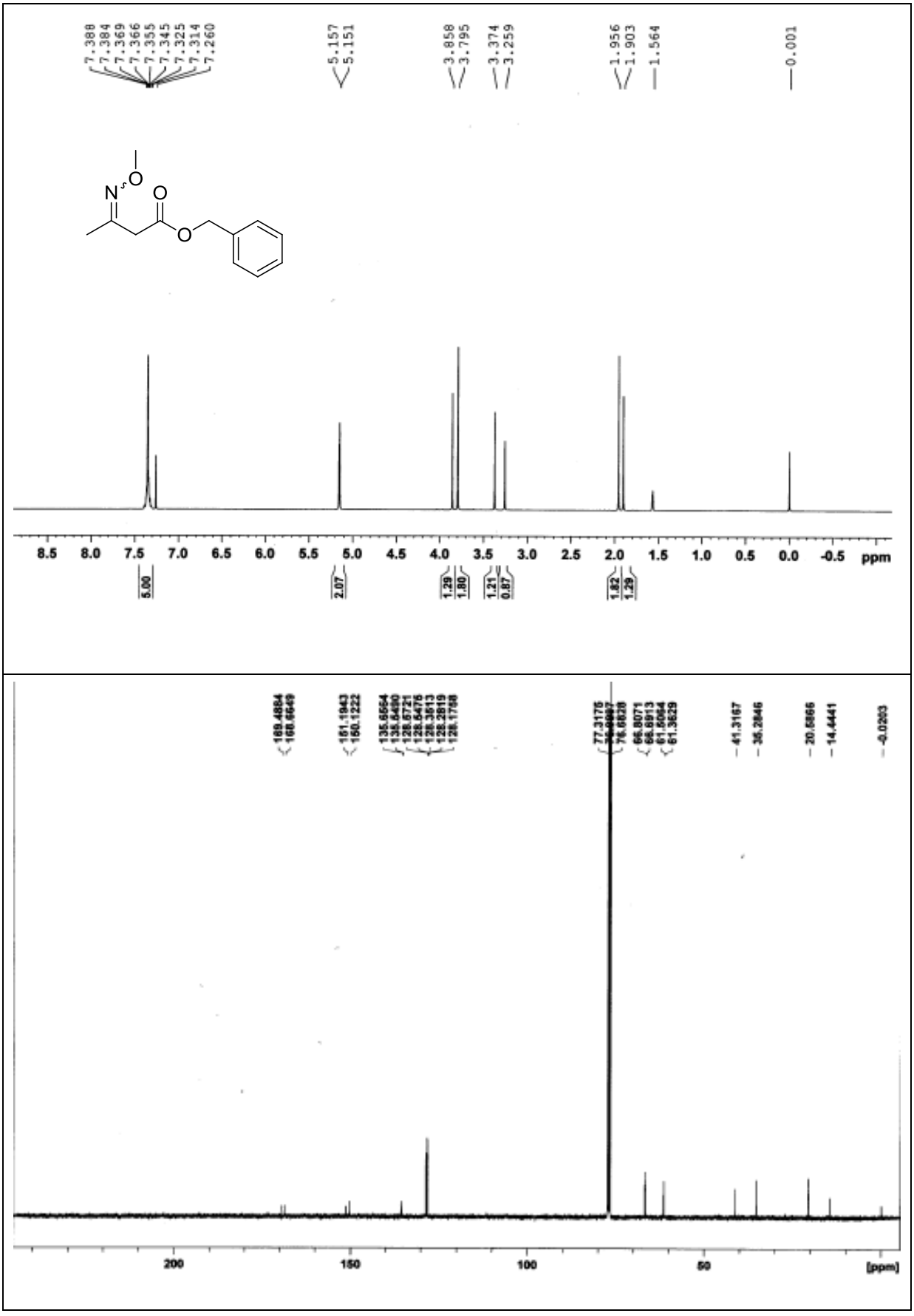
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3.259
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1.564
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1.21
0.87
1.82
1.29
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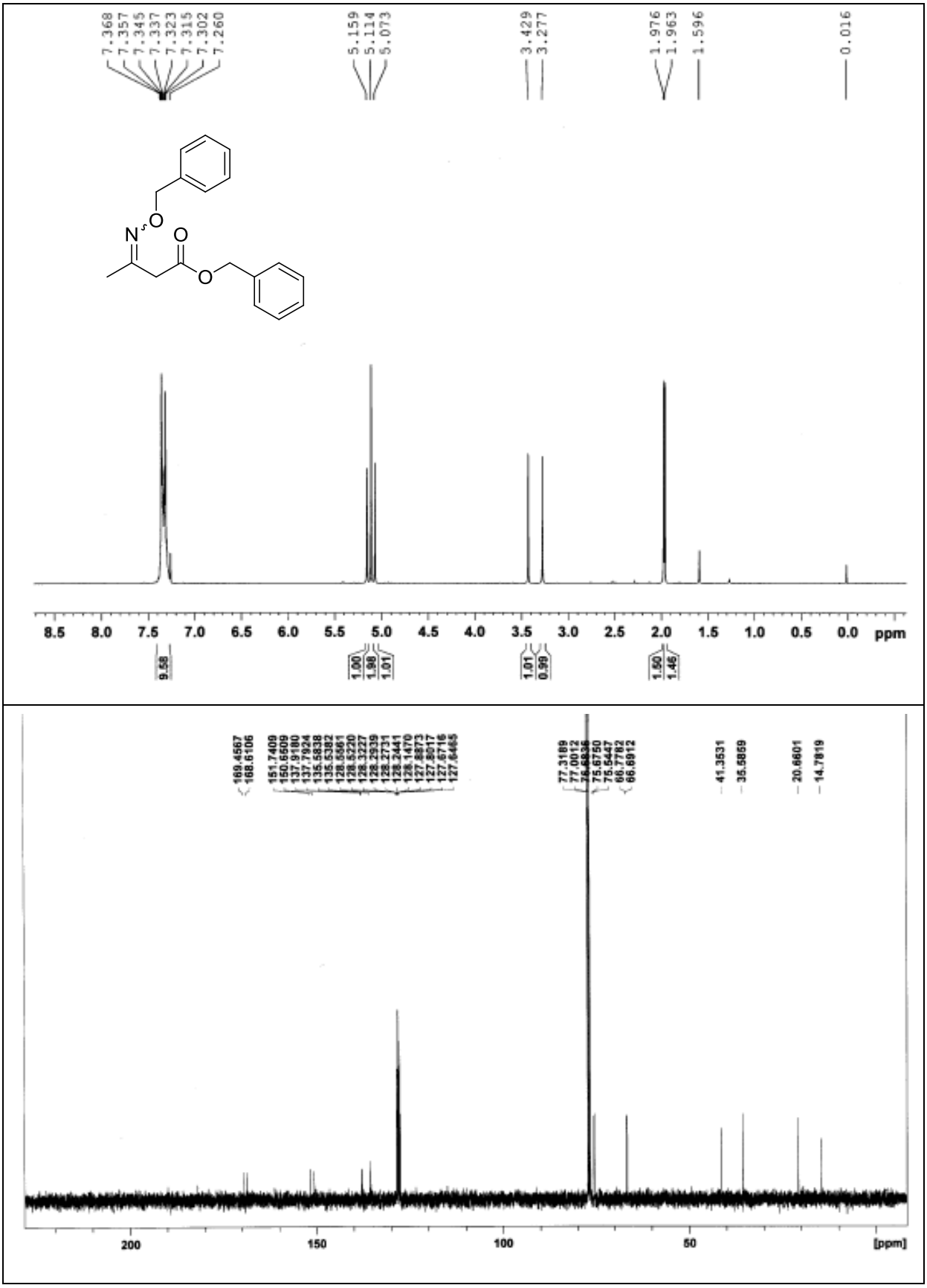
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1.963
1.596
0.016
N
O
O
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8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
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1.00
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0.99
1.50
1.46
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128.1470
127.8873
127.8017
127.6716
127.6465
77.3189
77.0012
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66.7782
66.6912
41.3531
35.5859
20.6601
14.7819
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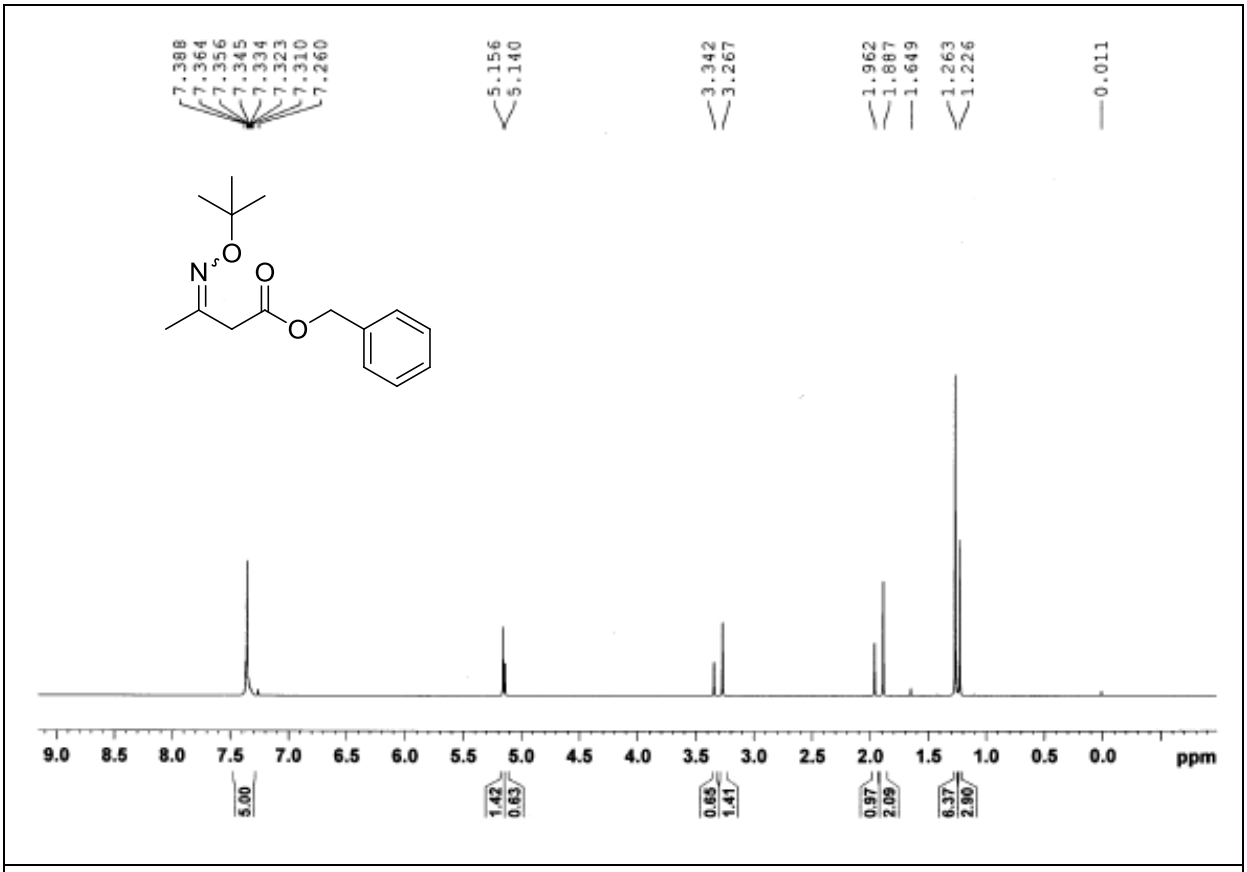
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5.140
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3.267
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1.887
1.649
1.263
1.226
0.011
N
O
O
O
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
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1.41
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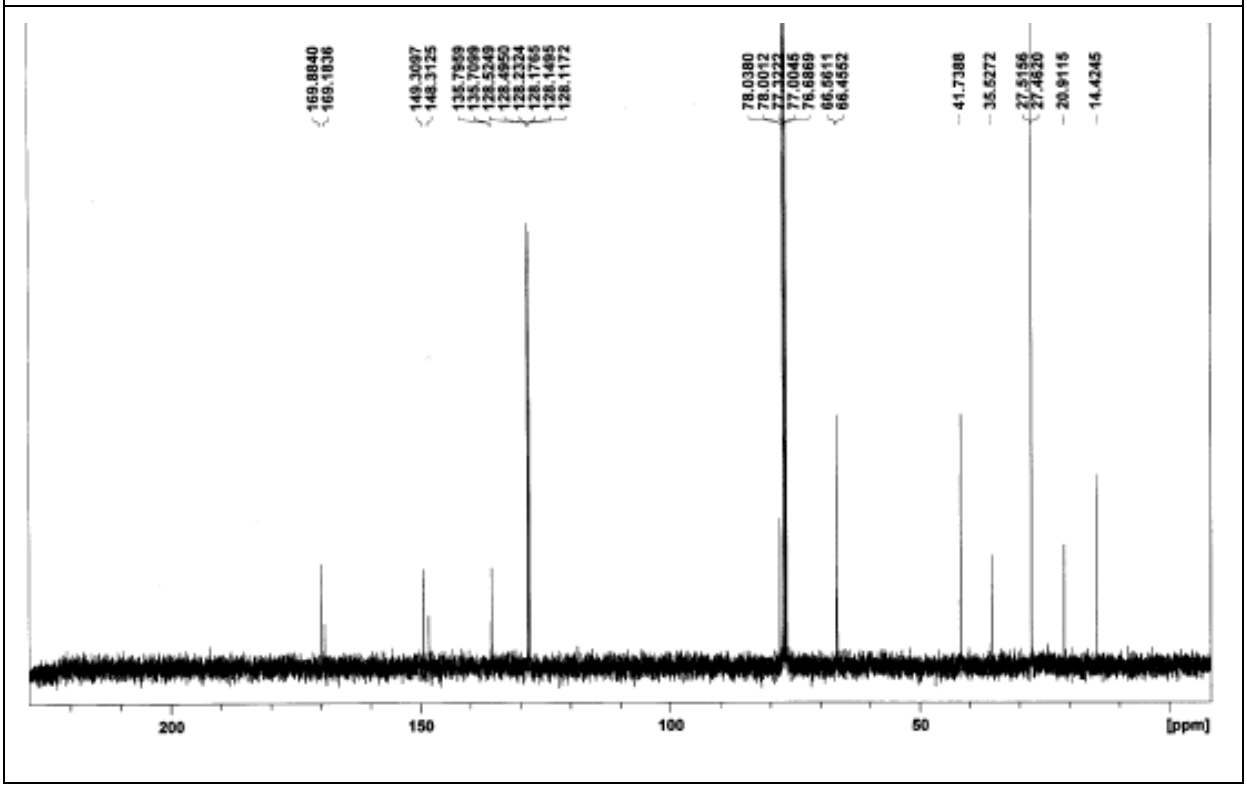
2.90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128.1495
128.1172
78.0380
78.0012
77.3322
77.0045
76.6869
66.6611
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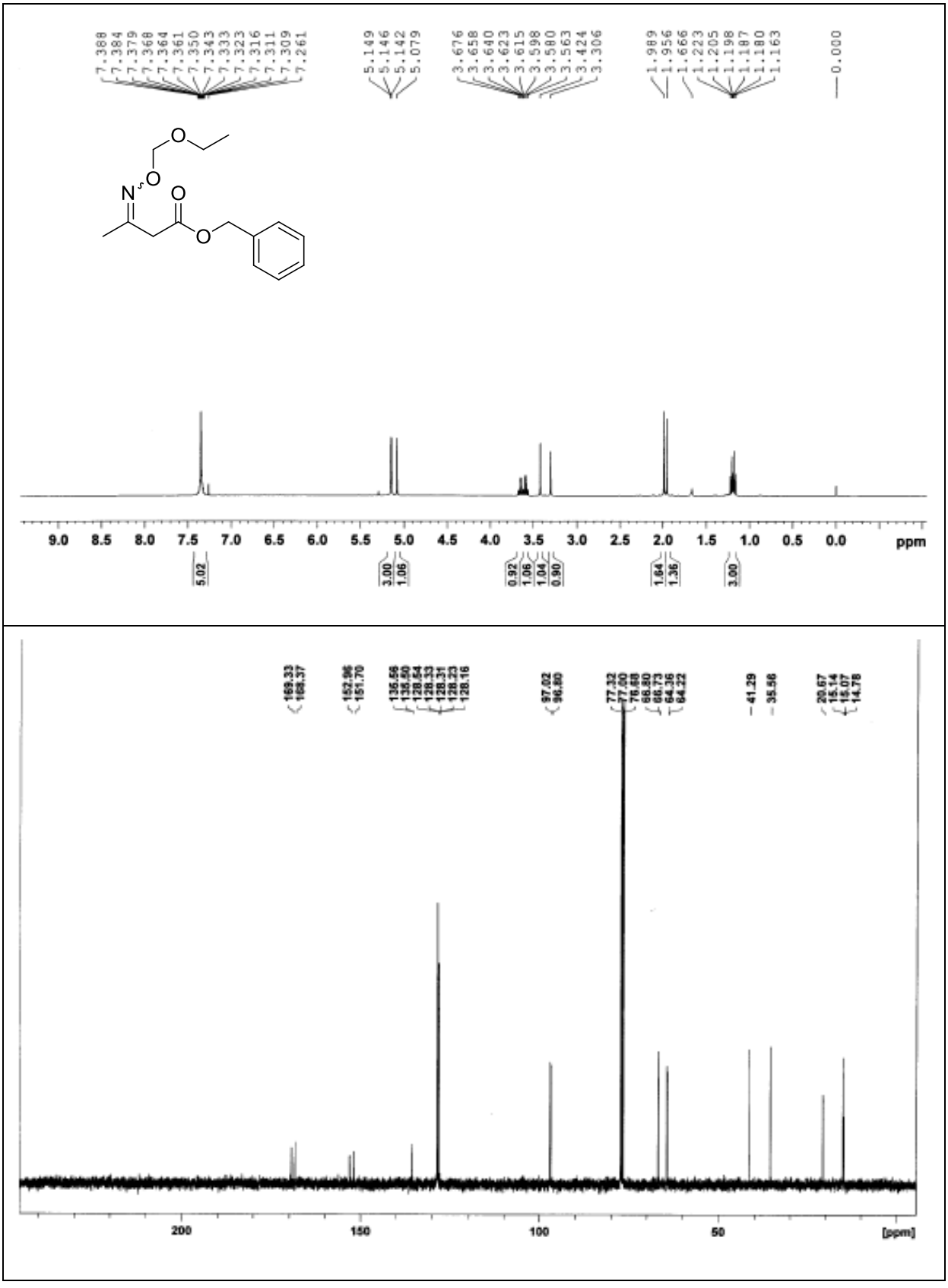

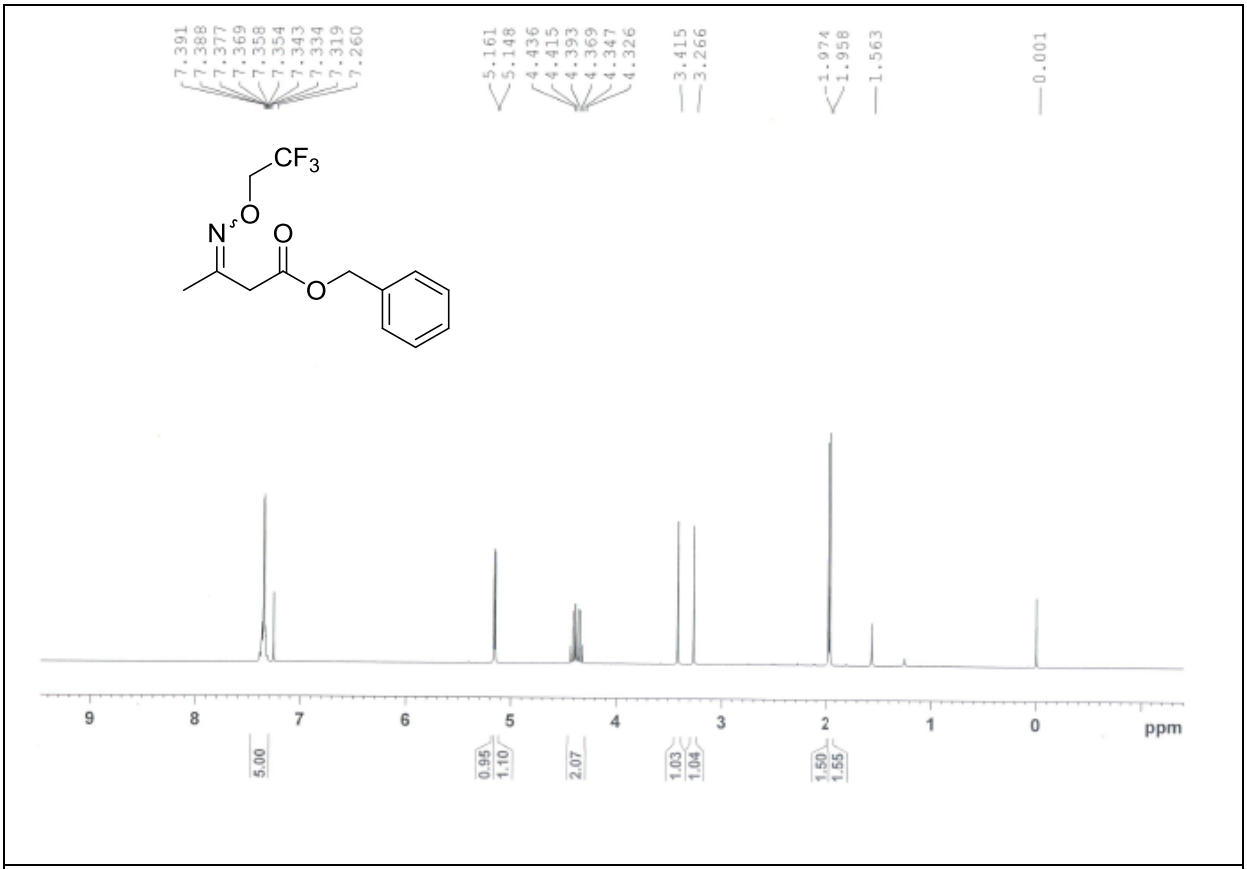
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7.343
7.334
7.319
7.260
5.161
5.148
4.436
4.415
4.393
4.369
4.347
4.326
3.415
3.266
1.974
1.958
1.563
0.001
CF3
N
O
O
O
9
8
7
6
5
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3
2
1
0
ppm
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2.07
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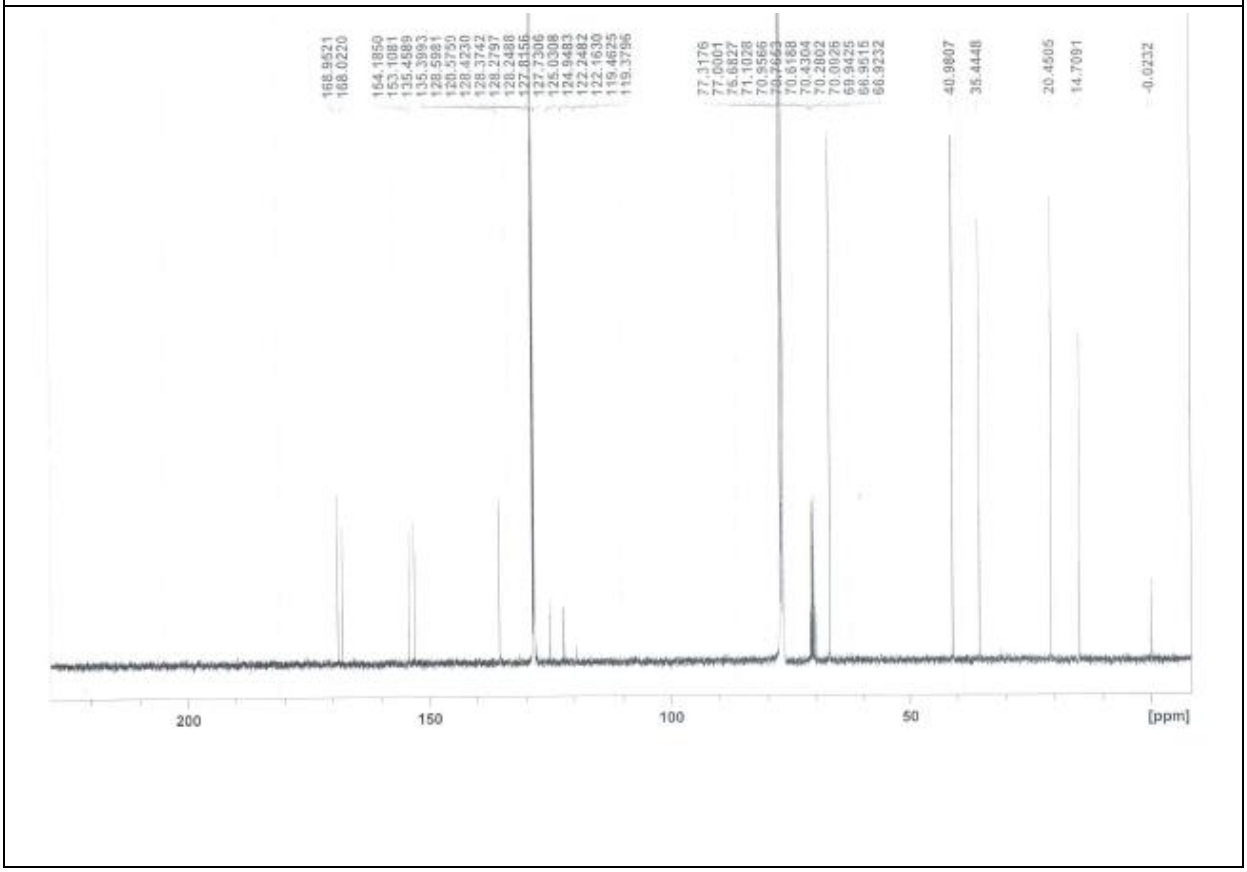
1.04
1.50
1.55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122.2482
122.1630
119.4625
119.3796
77.3176
77.0001
76.6827
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70.9566
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70.4304
70.2802
70.0926
69.9425
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150
100
50
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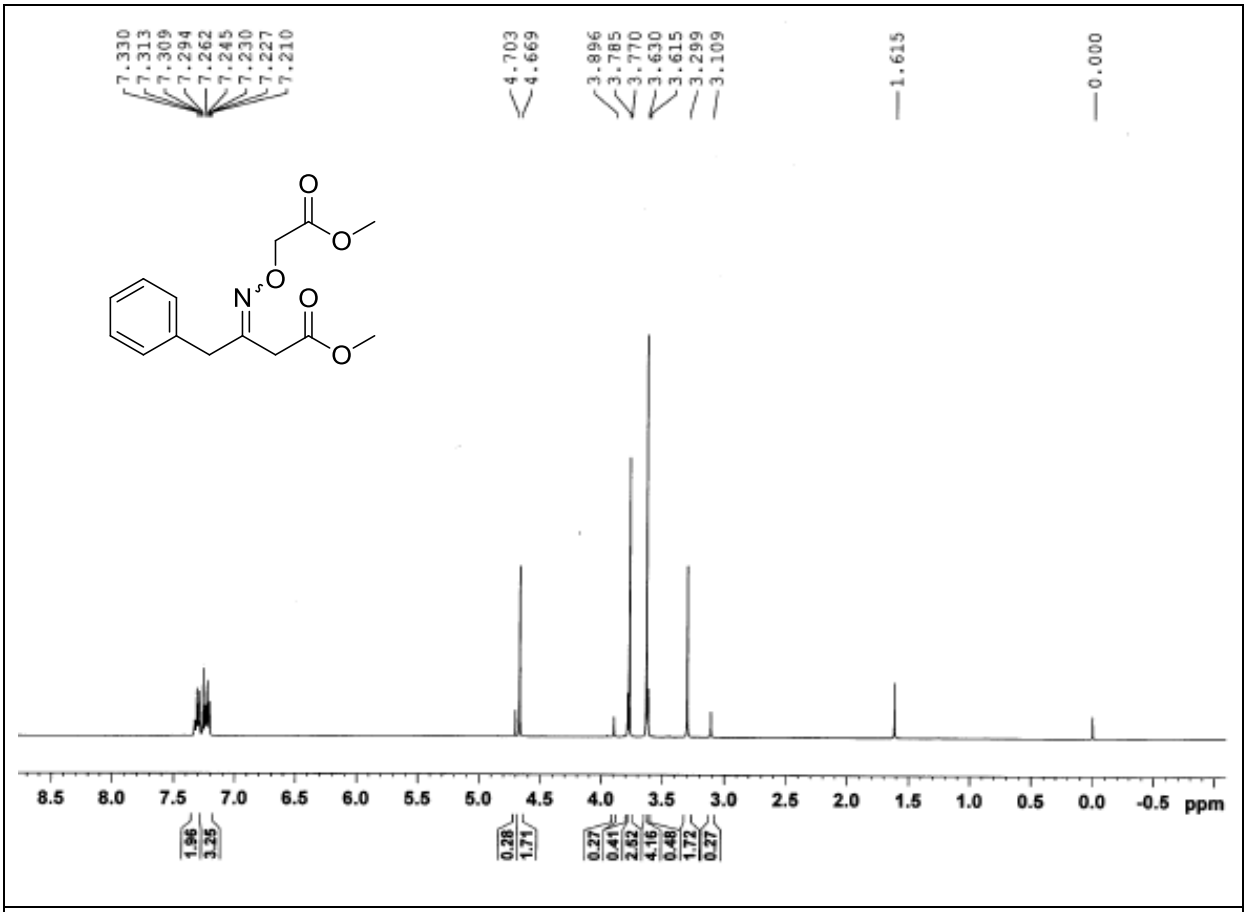
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7.227
7.210
4.703
4.669
3.896
3.785
3.770
3.630
3.615
3.299
3.109
1.615
0.000
O
O
N
O
O
O
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
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3.25
0.28
1.71
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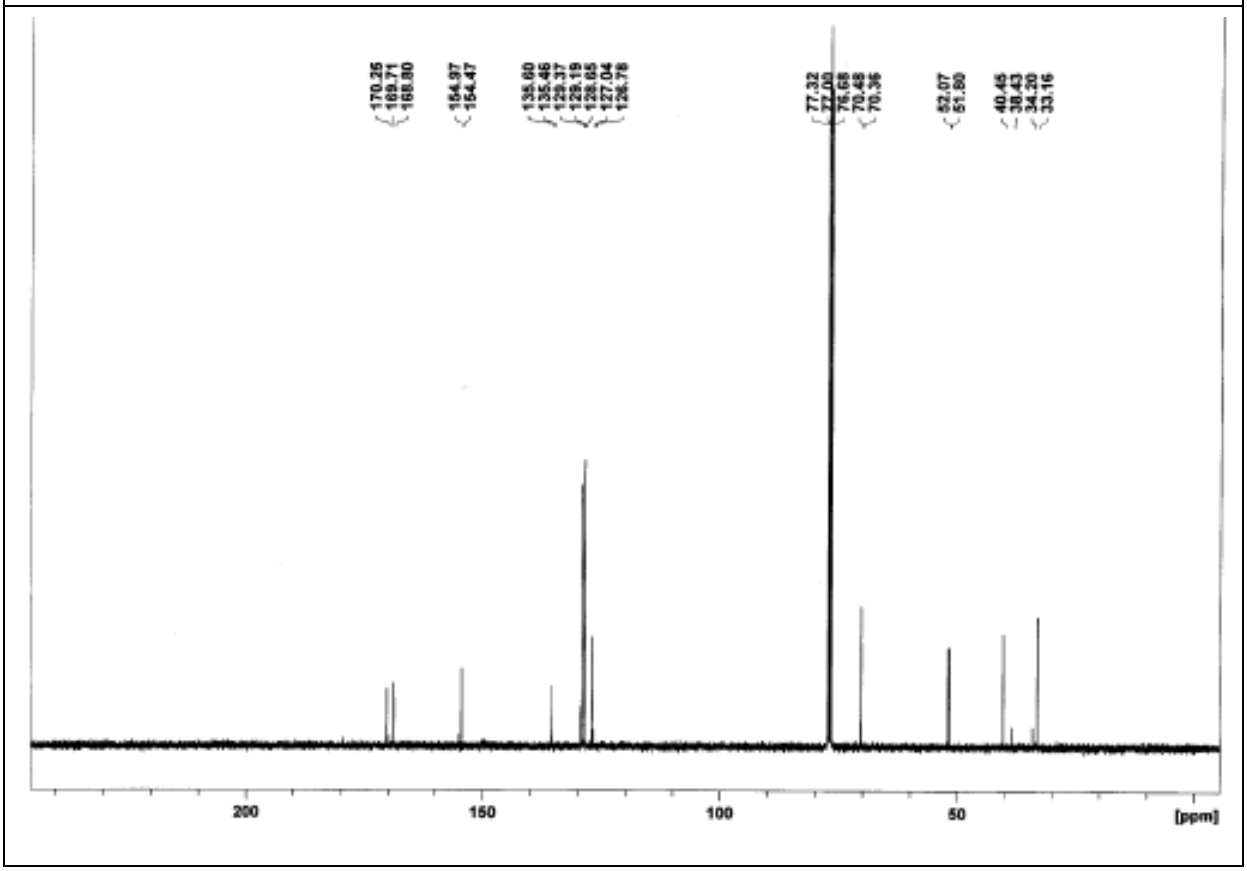
2.52
4.16
0.48
1.72
0.27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128.65
127.04
126.78
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77.00
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70.48
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52.07
51.80
40.45
38.43
34.20
33.16
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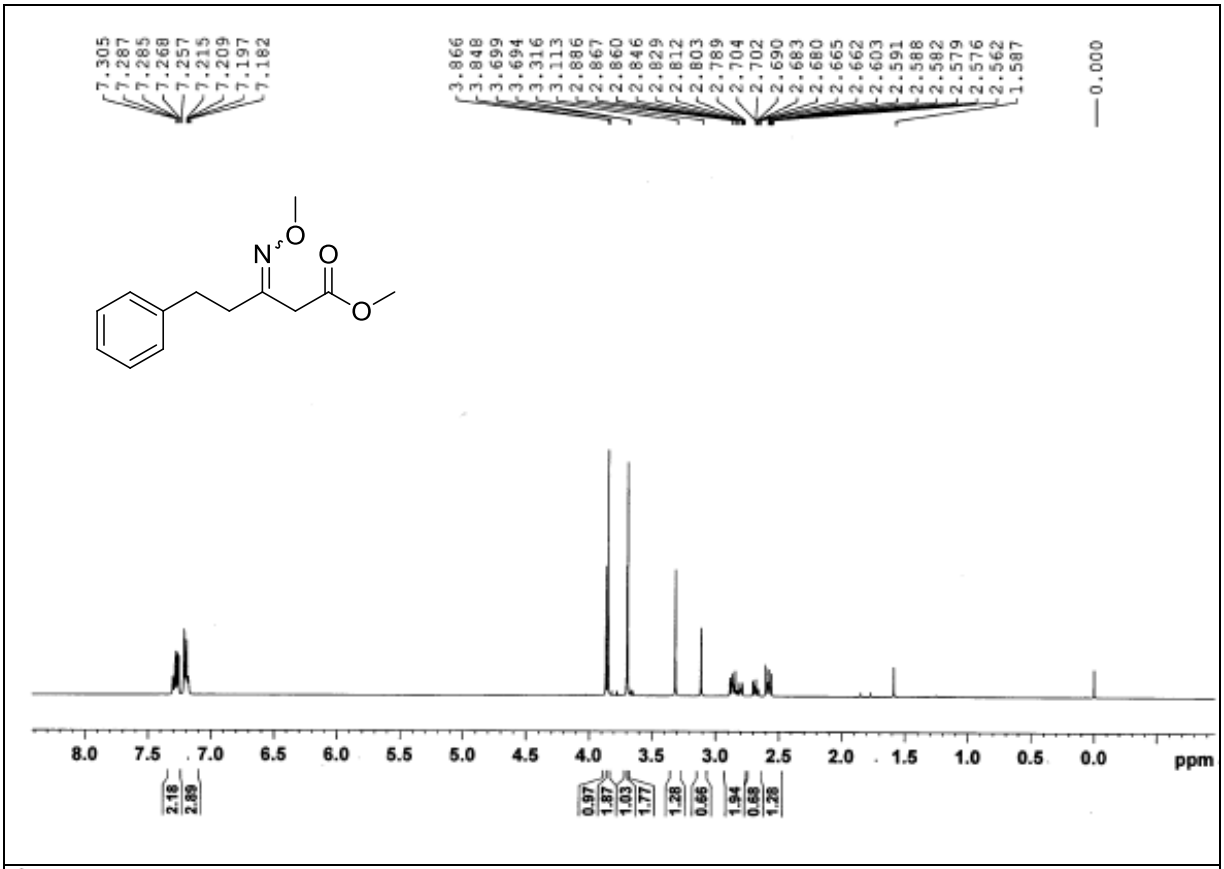
150
100
50
[ppm]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7.215
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7.197
7.182
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3.848
3.699
3.694
3.316
3.113
2.886
2.867
2.860
2.846
2.829
2.812
2.803
2.789
2.704
2.702
2.690
2.683
2.680
2.665
2.662
2.603
2.591
2.588
2.582
2.579
2.576
2.562
1.587
0.000
N
O
O
O
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
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0.97
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1.03
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1.28
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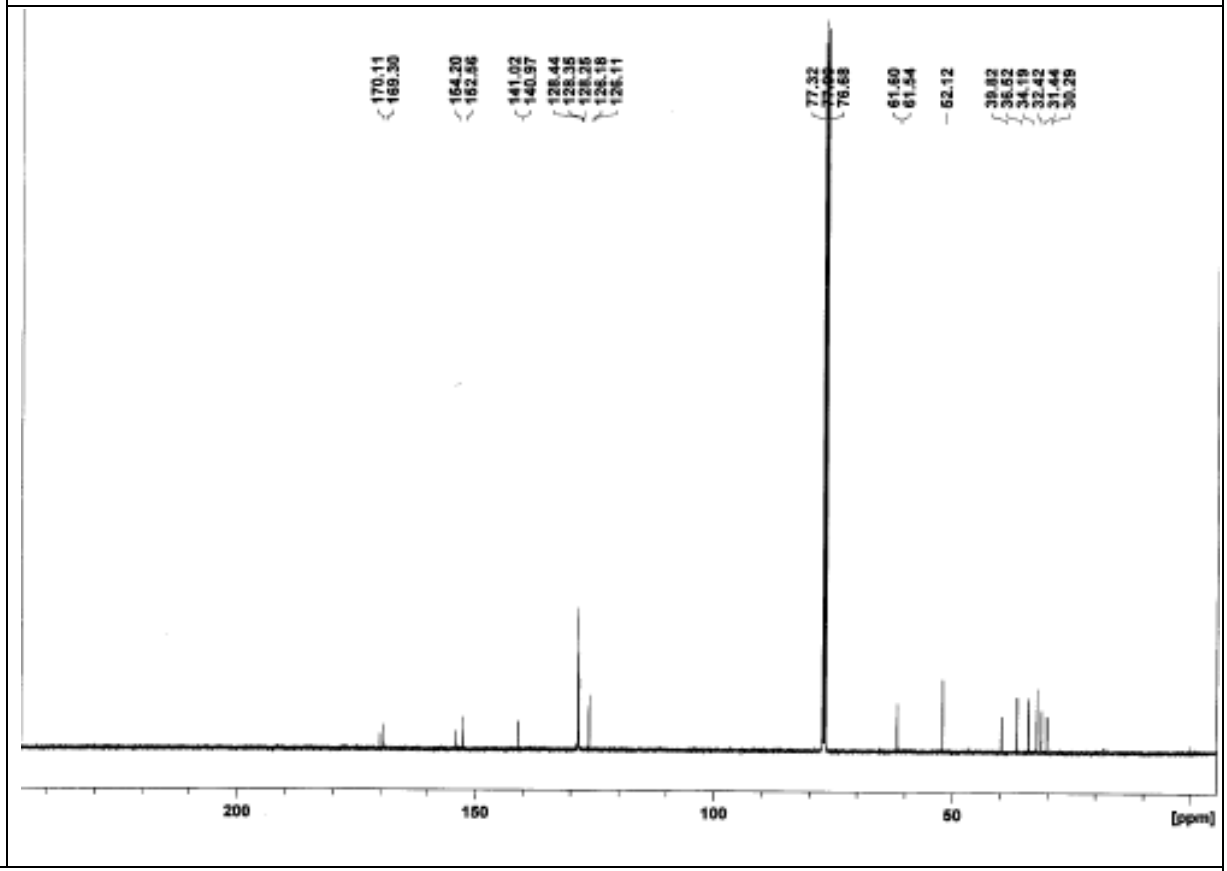
1.94
0.68
1.28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140.97
128.44
128.35
128.25
128.18
126.11
77.32
76.68
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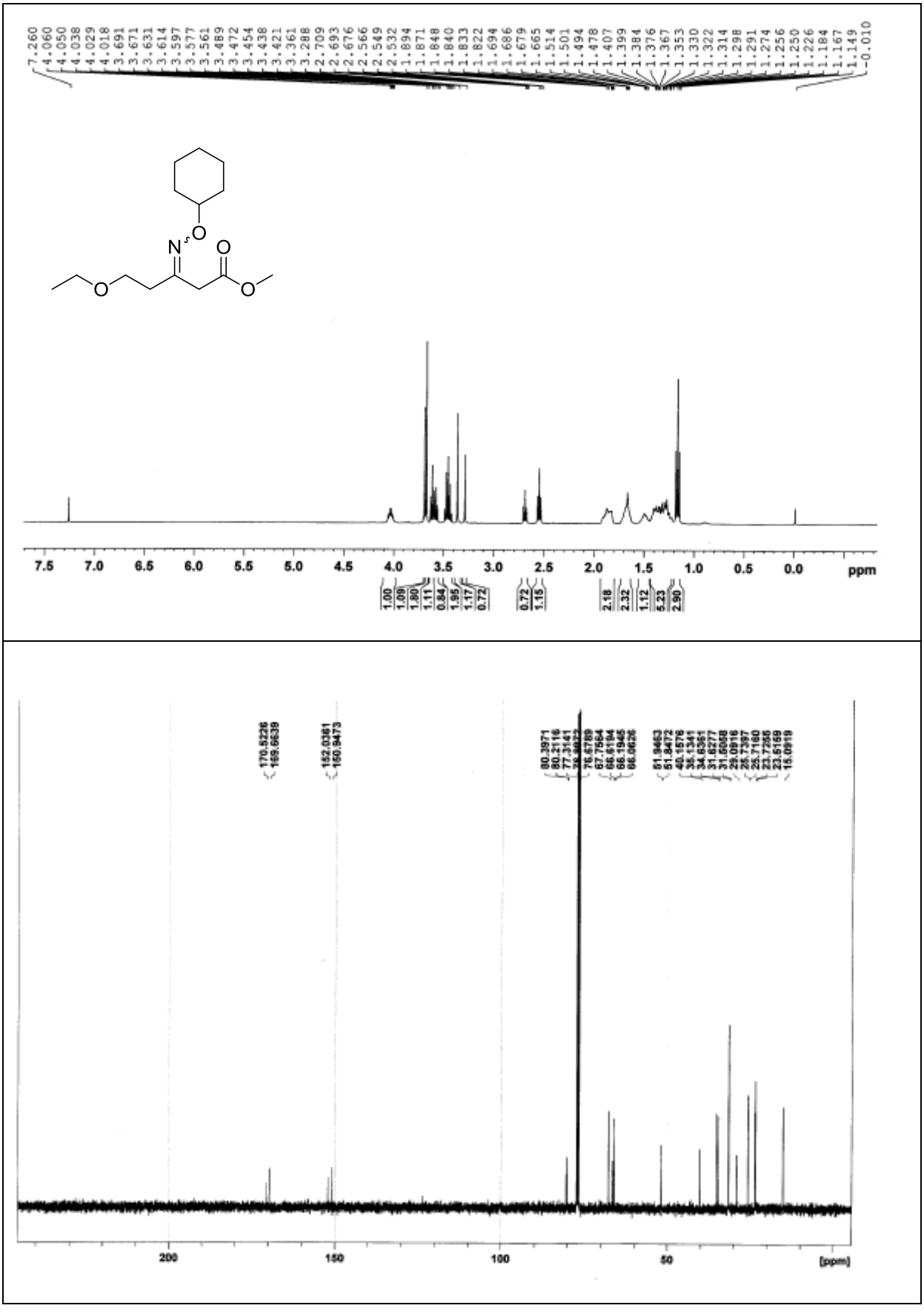
61.54
52.12
39.82
36.52
34.19
32.42
31.44
30.29
200
150
100
50
[ppm]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4.018
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3.614
3.597
3.577
3.561
3.489
3.472
3.454
3.438
3.421
3.361
3.288
2.709
2.693
2.676
2.566
2.549
2.532
1.894
1.871
1.848
1.840
1.833
1.822
1.694
1.686
1.679
1.665
1.514
1.501
1.494
1.478
1.407
1.399
1.384
1.376
1.367
1.353
1.330
1.322
1.314
1.298
1.291
1.274
1.256
1.250
1.226
1.184
1.167
1.149
0.010
N
O
O
O
O
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
ppm
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0.72
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2.18
2.32
1.12
5.23
2.90
170.5226
169.6639
152.0361
150.9473
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80.2116
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76.6789
67.7564
66.4194
66.1945
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40.1576
38.1341
34.6361
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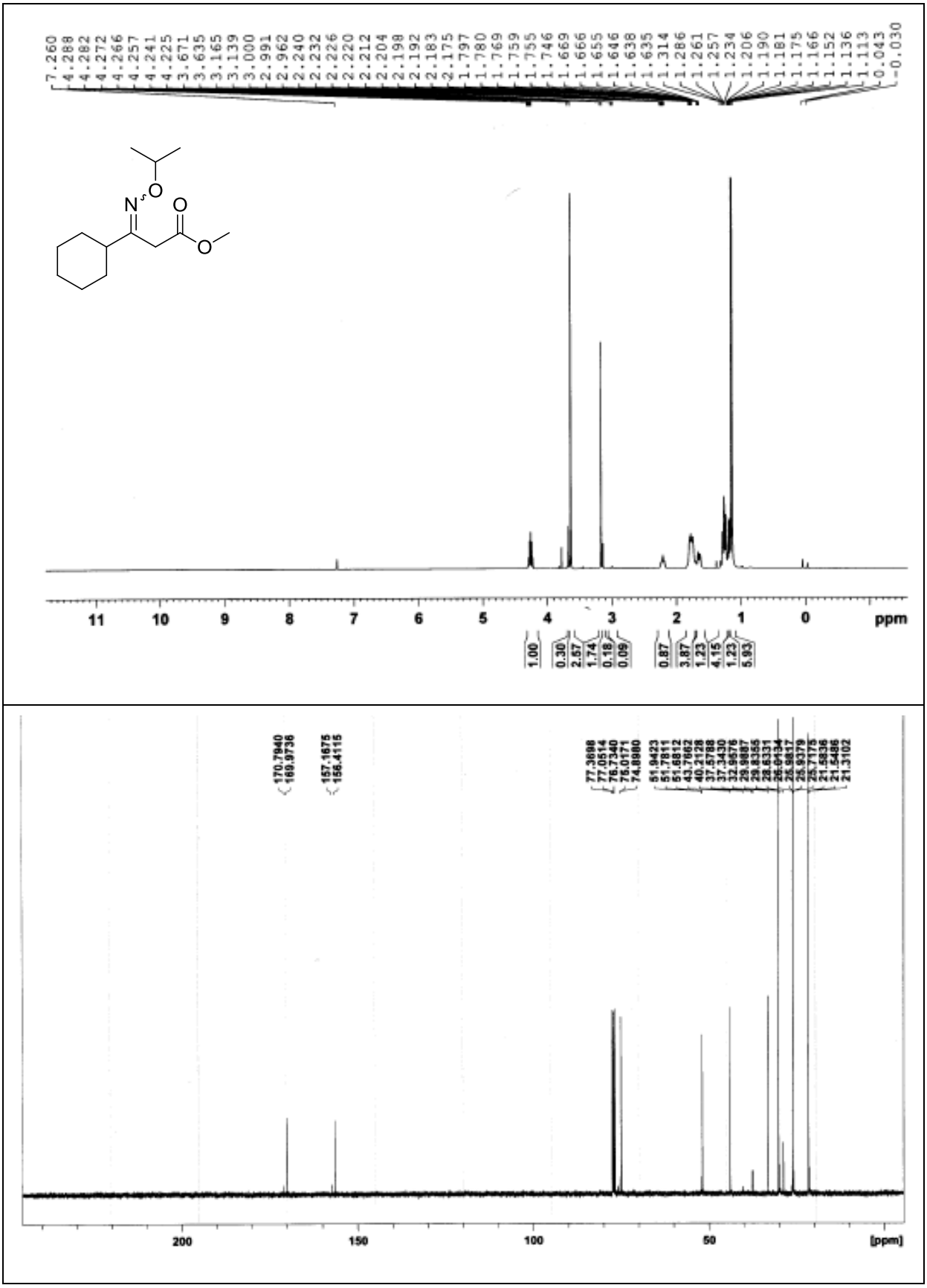
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3.139
3.000
2.991
2.962
2.240
2.232
2.226
2.220
2.212
2.204
2.198
2.192
2.183
2.175
1.797
1.780
1.769
1.759
1.755
1.746
1.669
1.666
1.655
1.646
1.638
1.635
1.314
1.286
1.261
1.257
1.234
1.206
1.190
1.181
1.175
1.166
1.152
1.136
1.113
0.043
-0.030
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O
O
O
11
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
0.30
2.57
1.74
0.18
0.09
0.87
3.87
1.23
4.15
1.23
5.93
170.7940
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157.1675
156.4115
77.3698
77.0514
76.7340
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74.8980
51.9423
51.7811
51.6812
43.7662
40.2128
37.5788
37.3430
32.9576
29.9887
29.8355
28.6331
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25.9379
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100
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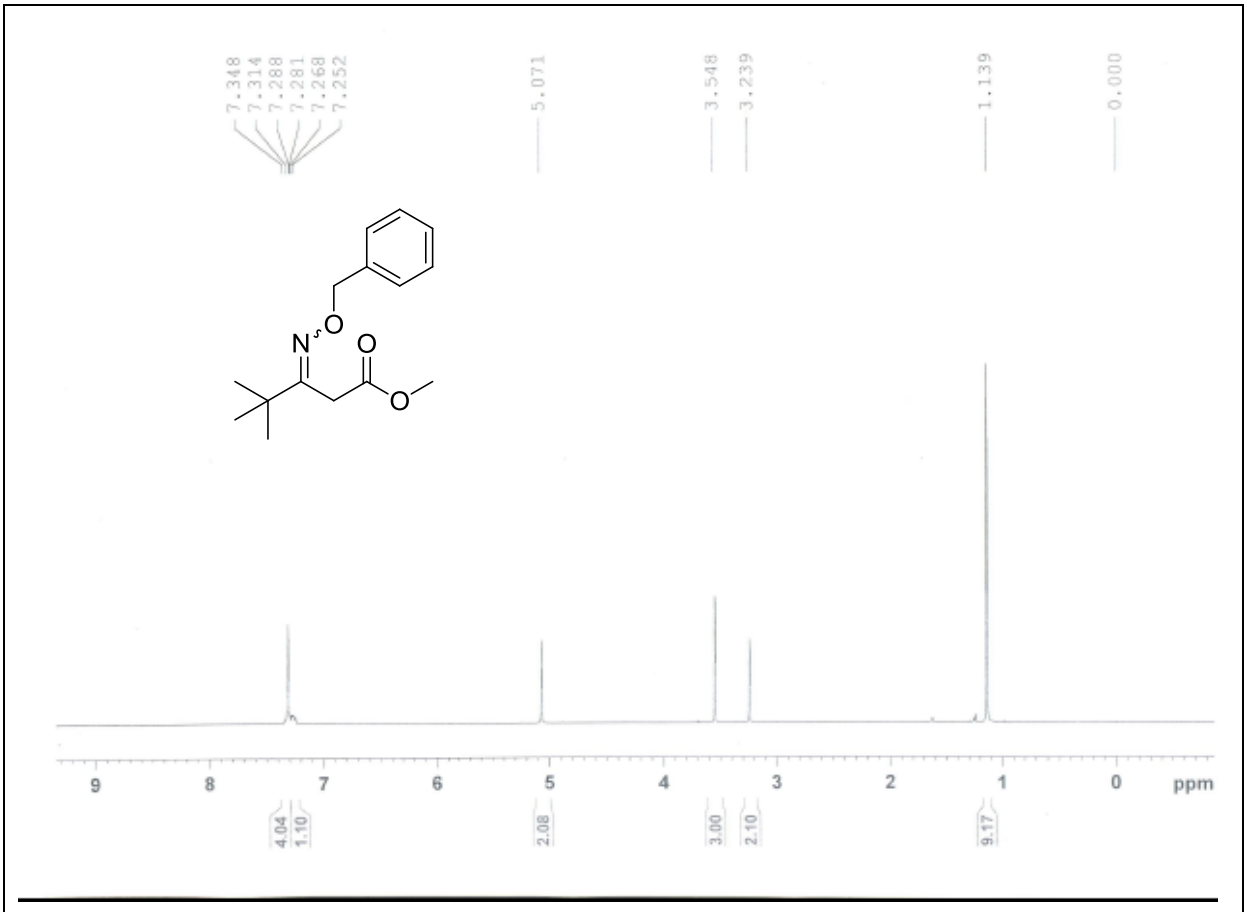
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7.268
7.252
5.071
3.548
3.239
1.139
0.000
N
O
O
O
9
8
7
6
5
4
3
2
1
0
ppm
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1.10
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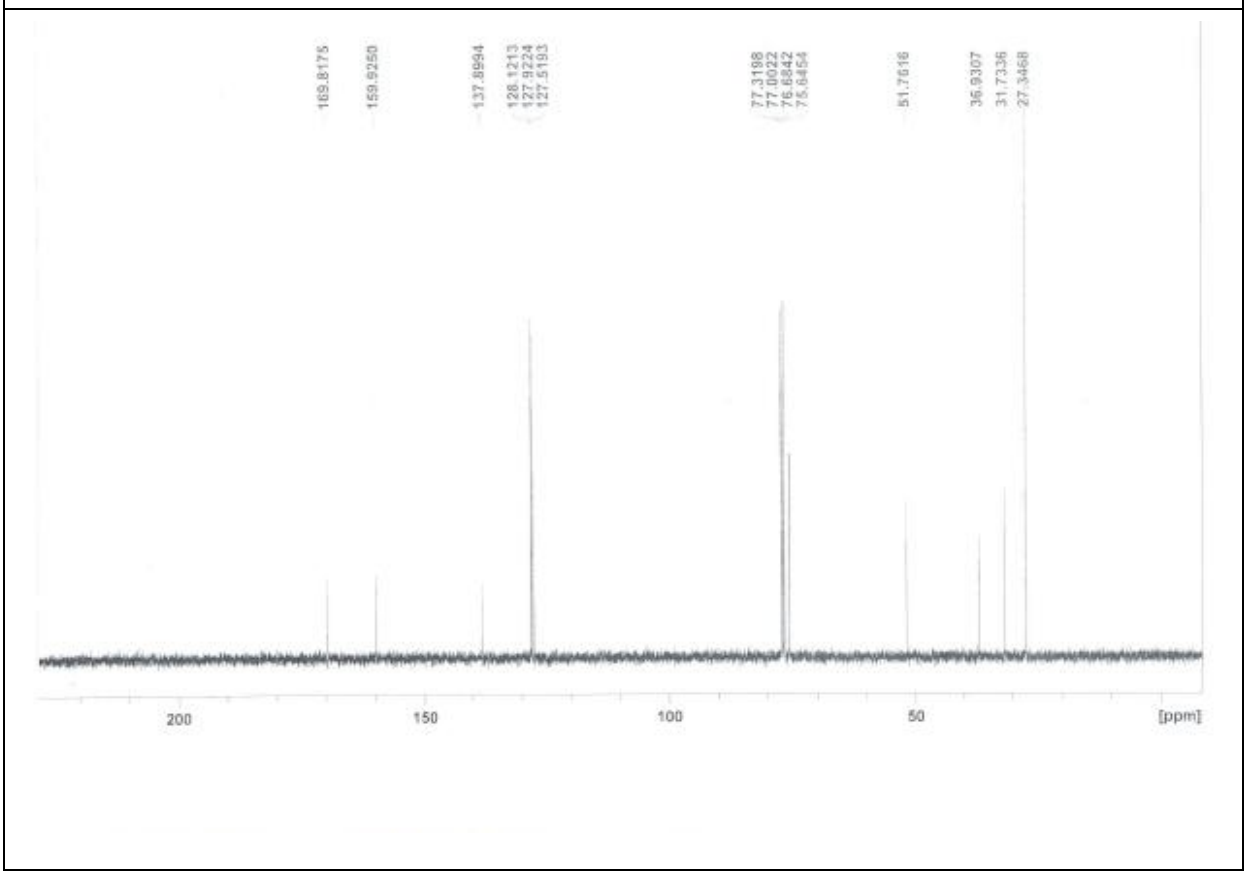
3.00
2.10
9.17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150
100
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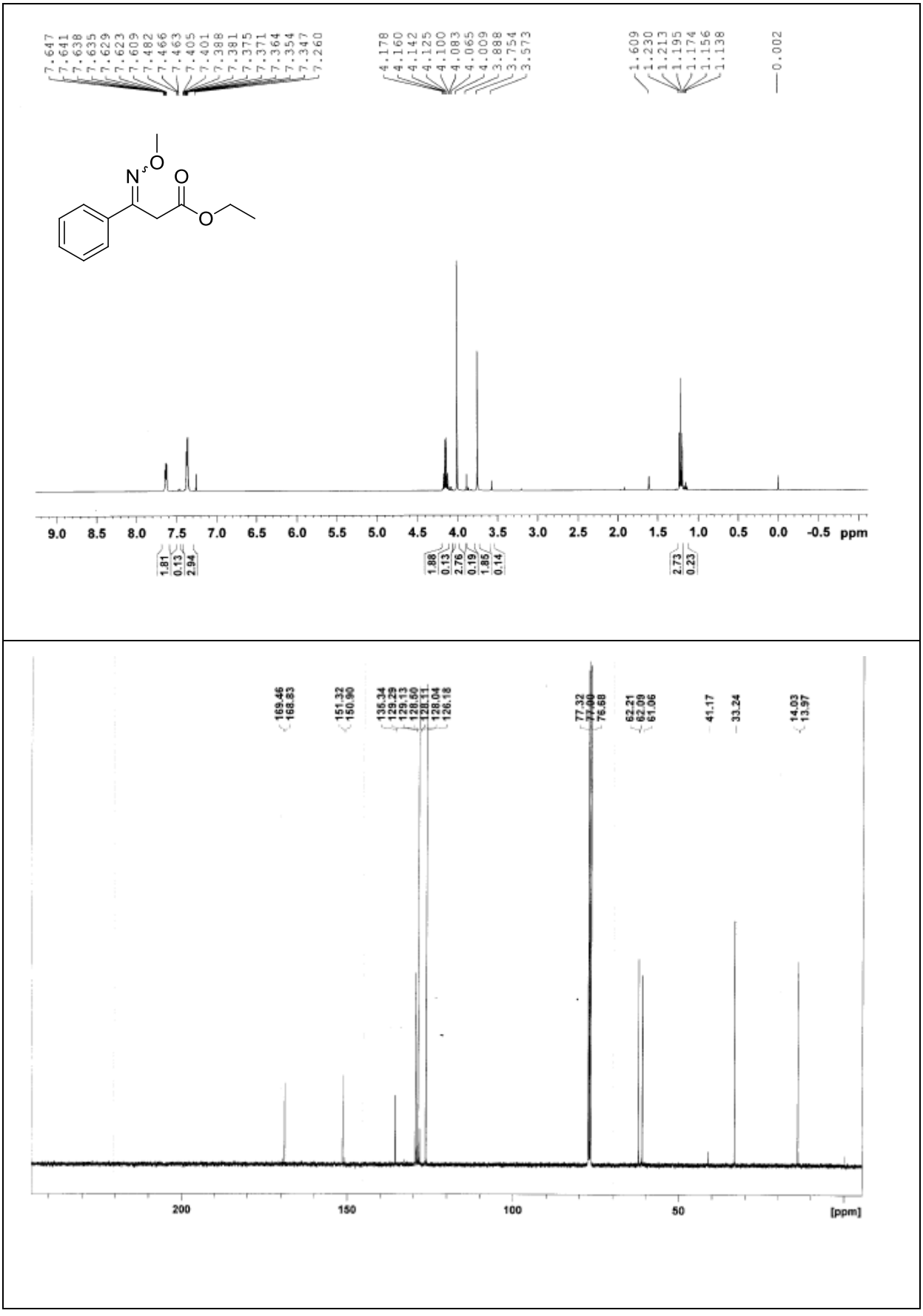
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7.623
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7.463
7.405
7.401
7.388
7.381
7.375
7.371
7.364
7.354
7.347
7.260
4.178
4.160
4.142
4.125
4.100
4.083
4.065
4.009
3.888
3.754
3.573
1.609
1.230
1.213
1.195
1.174
1.156
1.138
0.002
N
O
O
O
9.0 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 -0.5 ppm
1.81
0.13
2.94
1.88
0.13
2.76
0.19
1.85
0.14
2.73
0.23
169.46
168.83
151.32
150.90
136.34
129.29
129.13
128.60
128.11
128.04
126.18
77.32
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62.09
61.06
41.17
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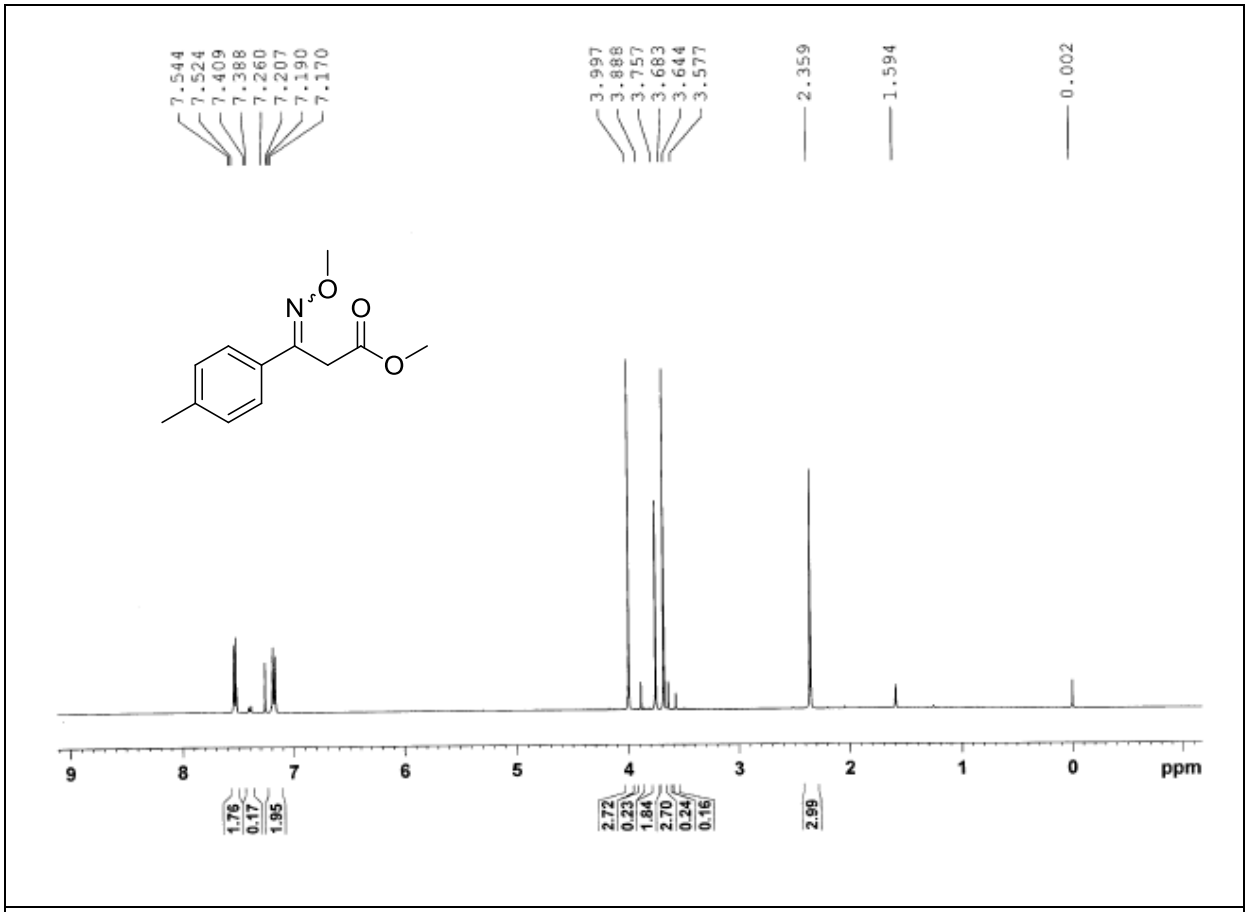
100
50
[ppm]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3.888
3.757
3.683
3.644
3.577
2.359
1.594
0.002
N
O
O
O
9
8
7
6
5
4
3
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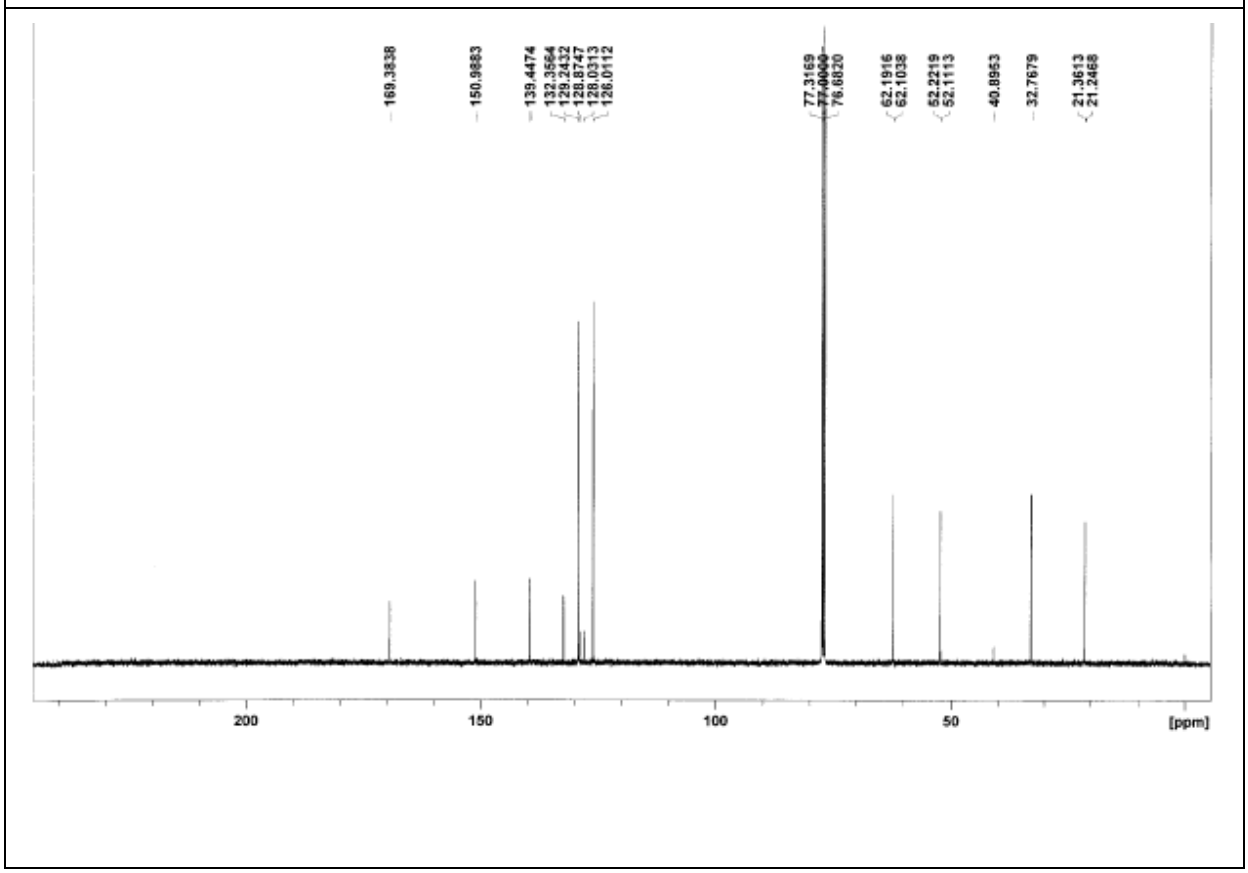
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77.0000
76.6820
62.1916
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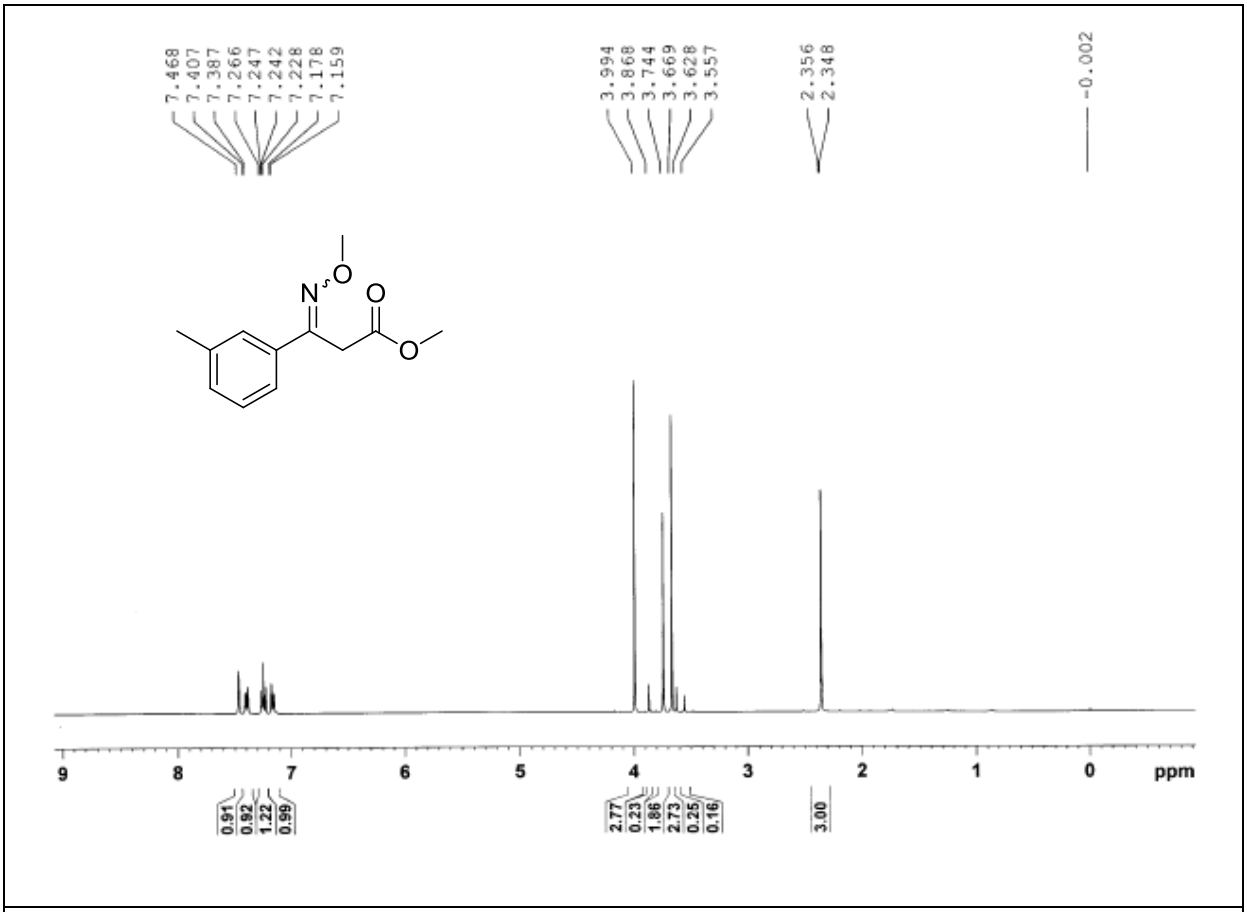
100
50
[ppm]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7.228
7.178
7.159
3.994
3.868
3.744
3.669
3.628
3.557
2.356
2.348
-0.002
N
O
O
O
9
8
7
6
5
4
3
2
1
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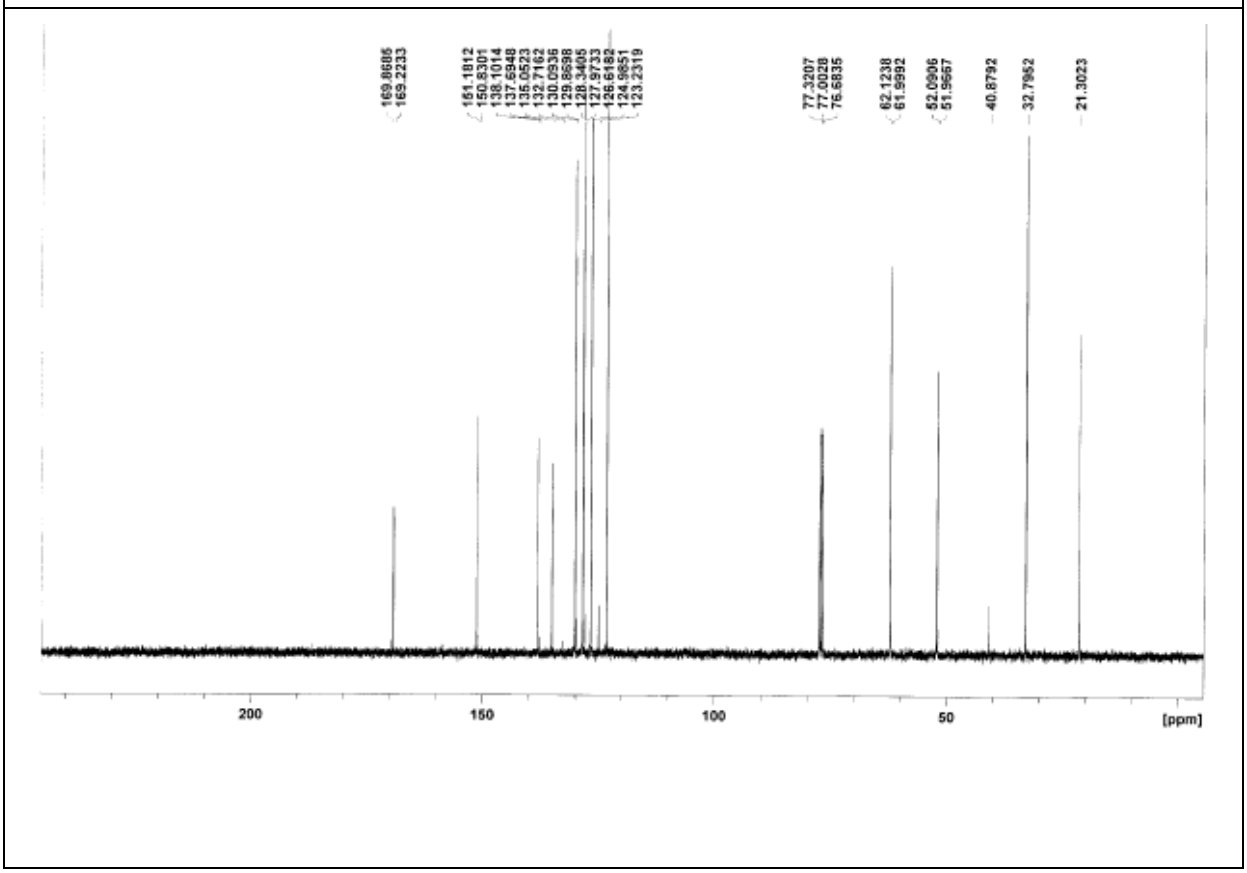
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124.9851
123.2319
77.3207
77.0028
76.6835
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100
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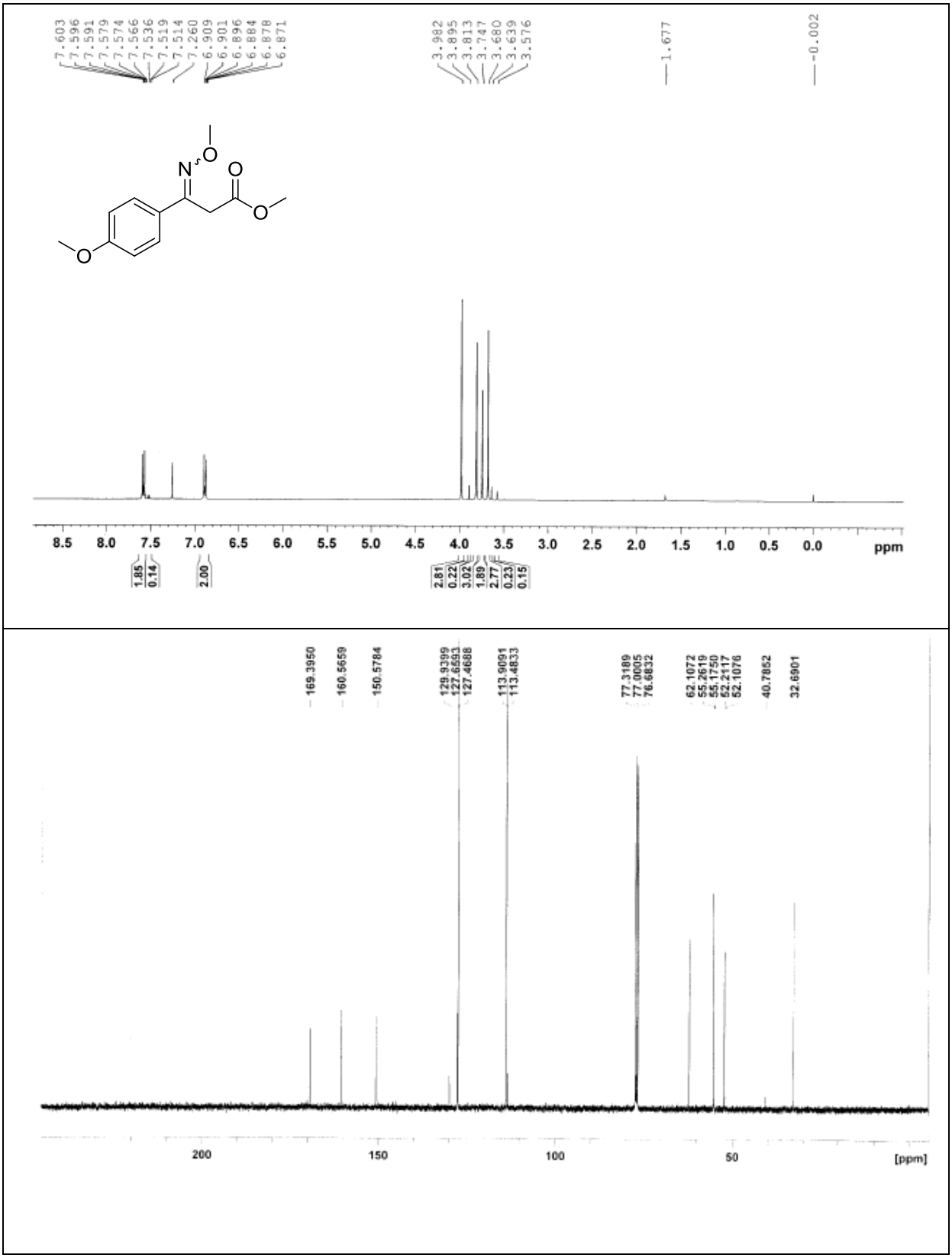
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7.260
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6.896
6.884
6.878
6.871
3.982
3.895
3.813
3.747
3.680
3.639
3.576
1.677
0.002
N
O
O
O
O
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
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0.14
2.00
2.81
0.22
3.02
1.89
2.77
0.23
0.15
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150.5784
129.9399
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113.9091
113.4833
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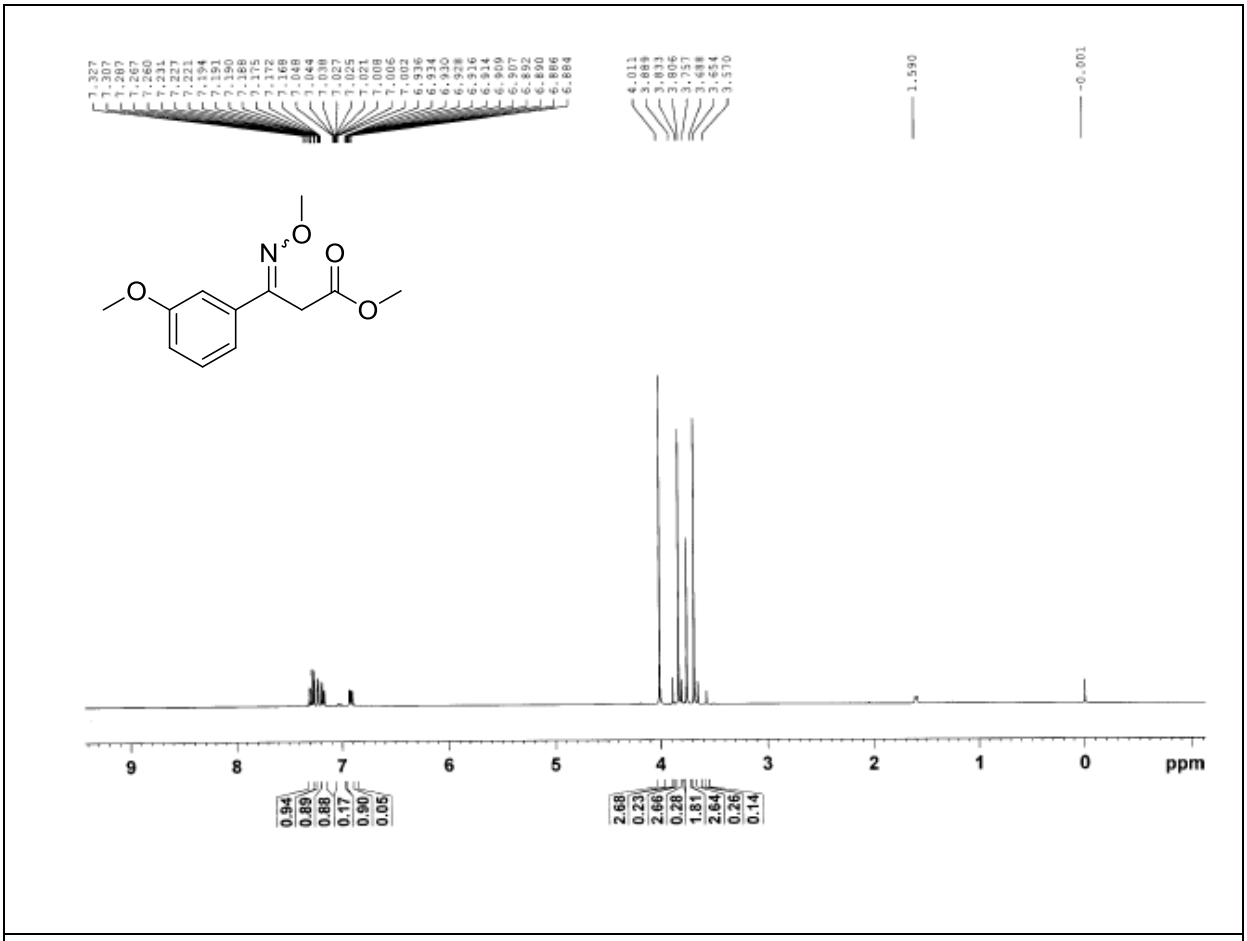
200 150 100 50 [ppm]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7.191
7.190
7.188
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7.172
7.168
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7.044
7.030
7.027
7.025
7.021
7.008
7.006
7.002
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6.934
6.930
6.928
6.916
6.914
6.909
6.907
6.892
6.890
6.886
6.884
4.011
3.889
3.833
3.806
3.757
3.688
3.654
3.370
1.590
-0.001
O
N
O
O
O
9
8
7
6
5
4
3
2
1
0
ppm
0.94
0.89
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0.28
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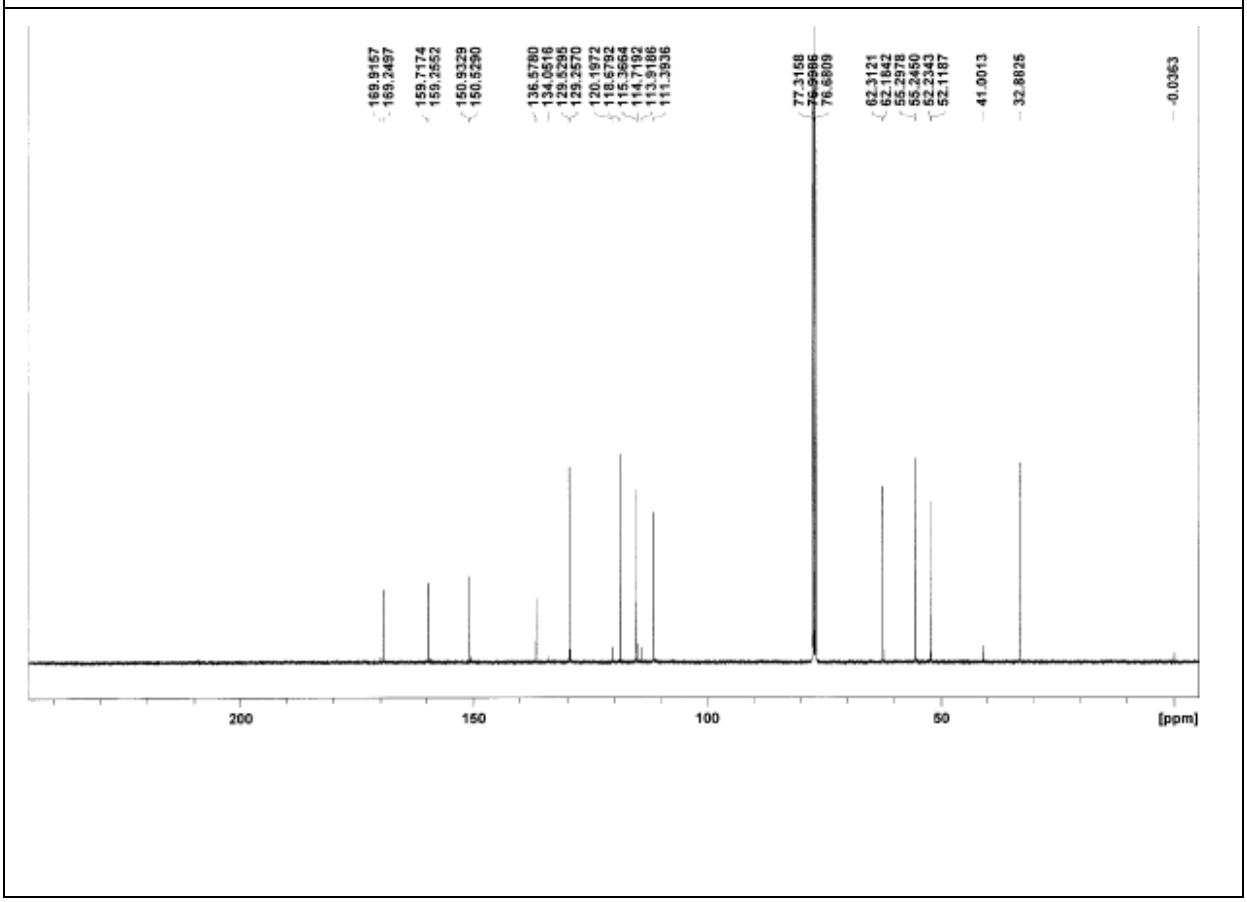
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114.7192
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111.3936
77.3158
76.9986
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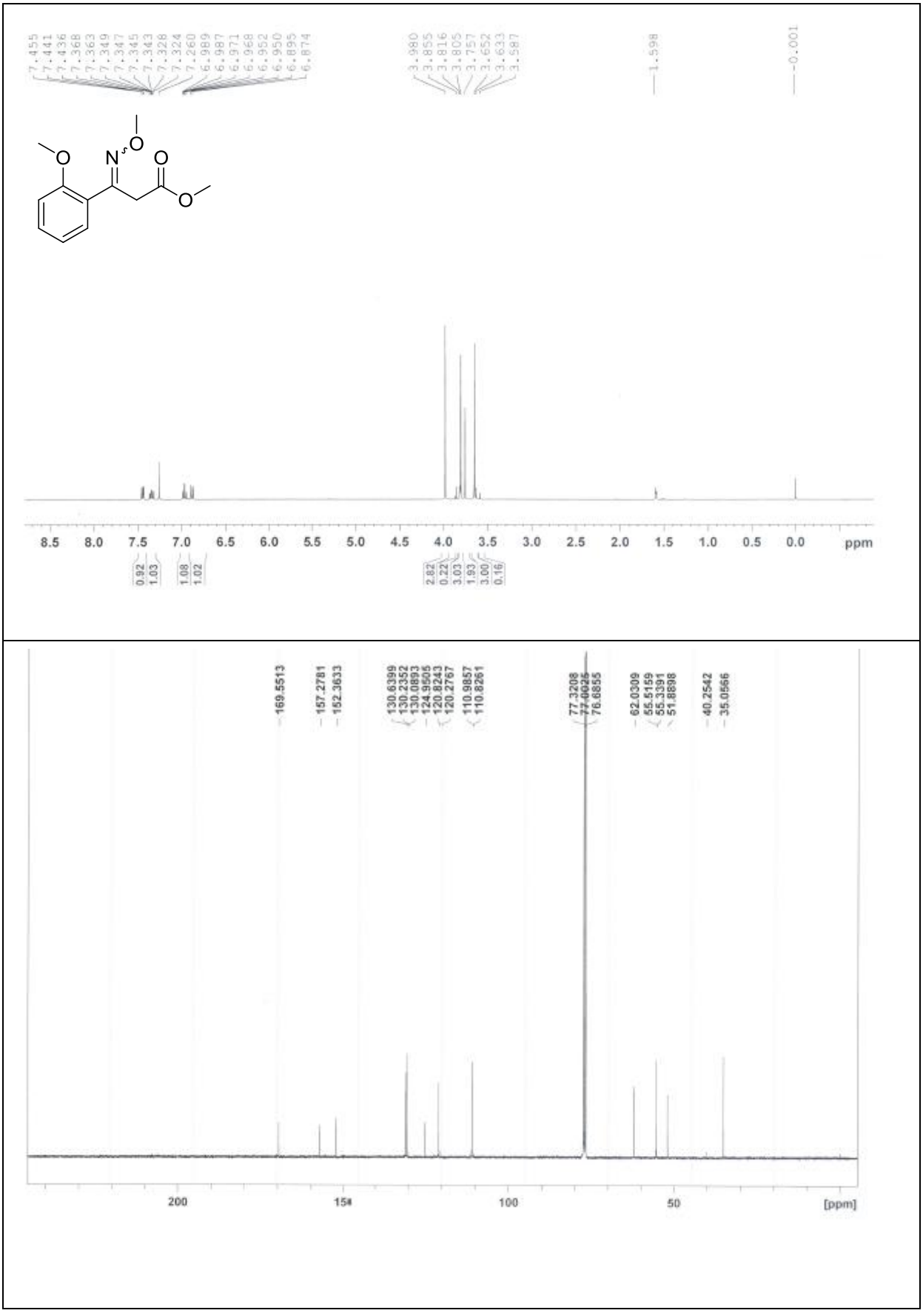
-0.0363
200
150
100
50
[ppm]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7.349
7.347
7.345
7.343
7.328
7.324
7.260
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6.987
6.971
6.968
6.952
6.950
6.895
6.874
3.980
3.855
3.816
3.805
3.757
3.652
3.633
3.587
1.598
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N
O
O
O
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6.0
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5.0
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4.0
3.5
3.0
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1.0
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0.0
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1.08
1.02
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0.22
3.03
1.93
3.00
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130.2352
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120.8243
120.2767
110.9857
110.8261
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100
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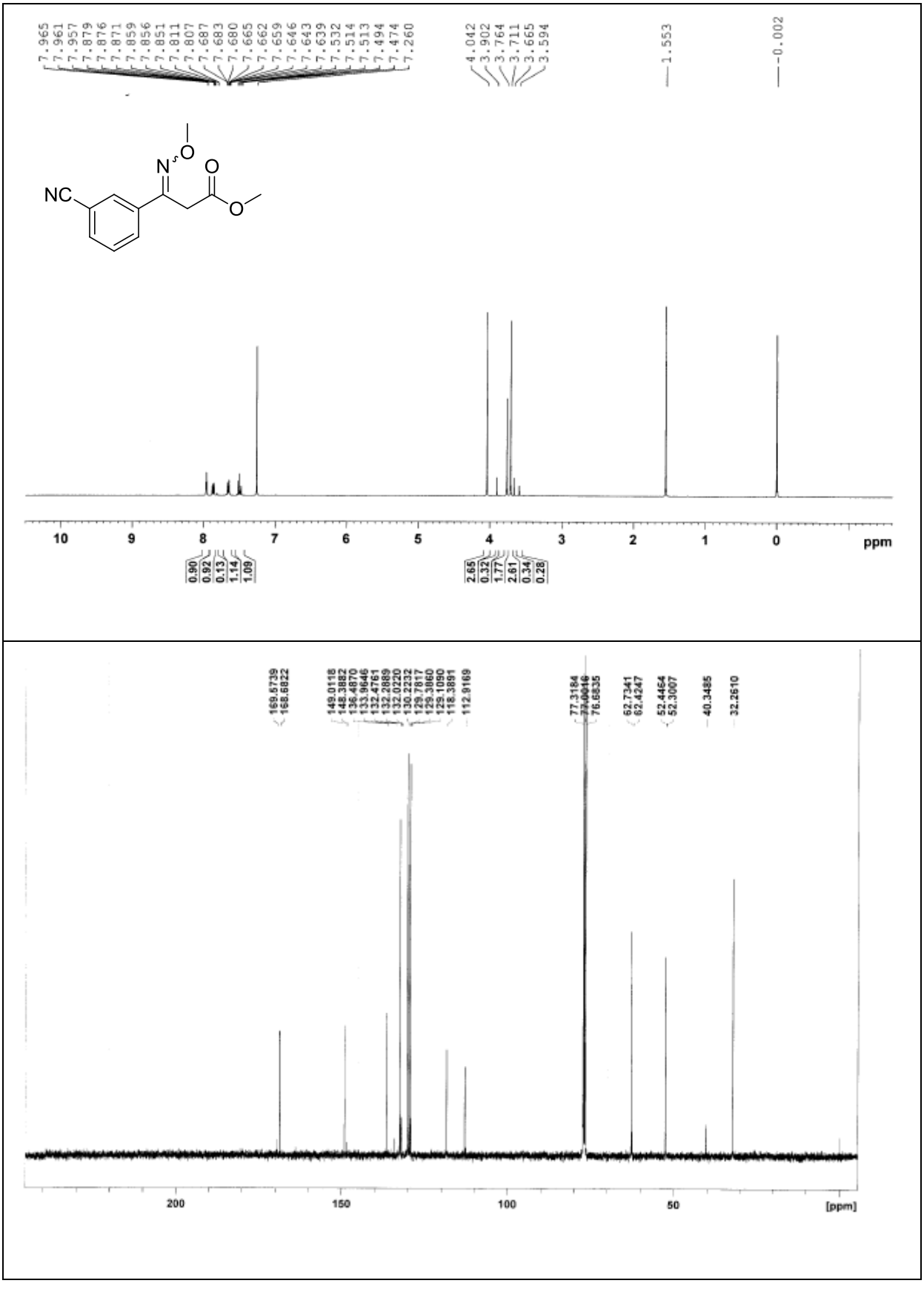
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7.680
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7.639
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7.513
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7.474
7.260
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3.711
3.665
3.594
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O
O
O
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8
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148.3882
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132.2889
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129.3860
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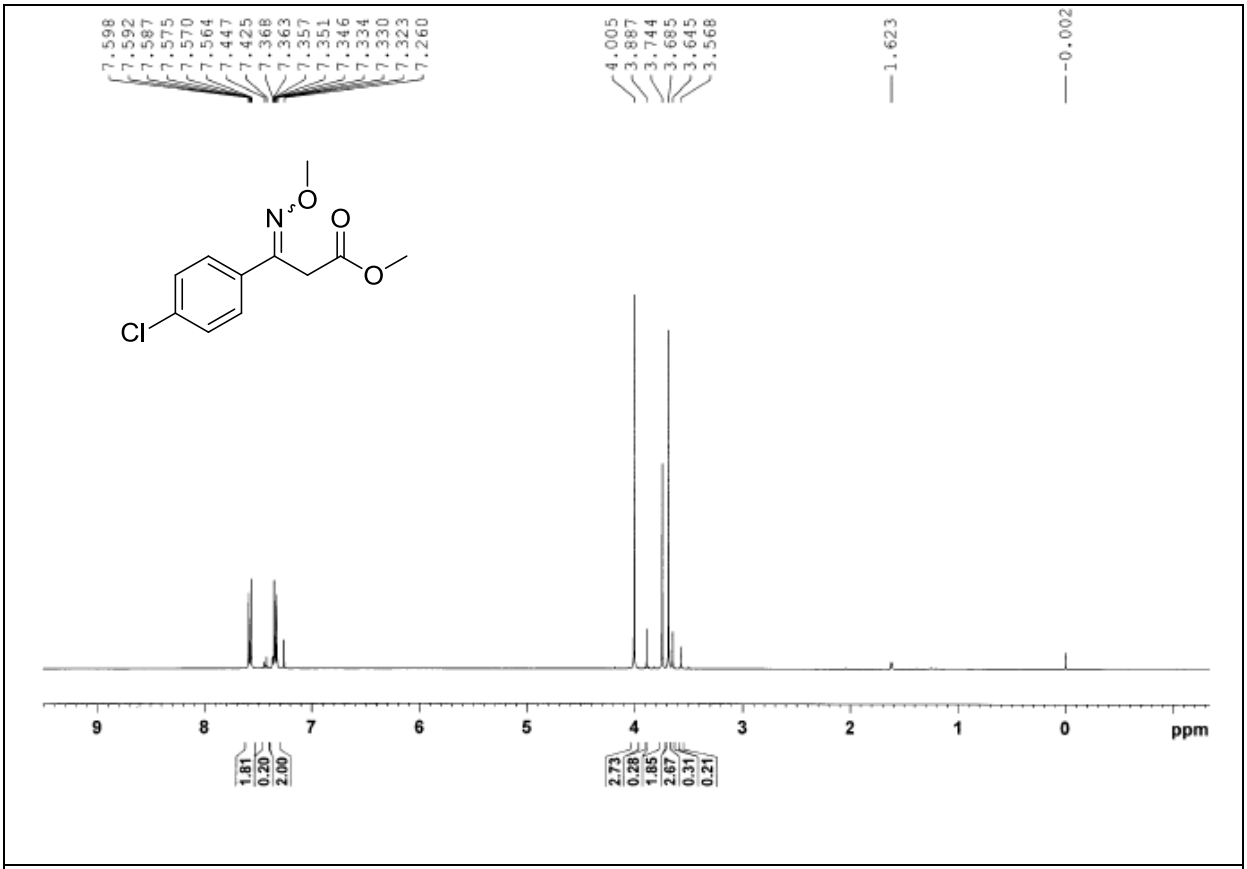
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7.346
7.334
7.330
7.323
7.260
4.005
3.887
3.744
3.685
3.645
3.568
1.623
-0.002
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O
O
O
Cl
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8
7
6
5
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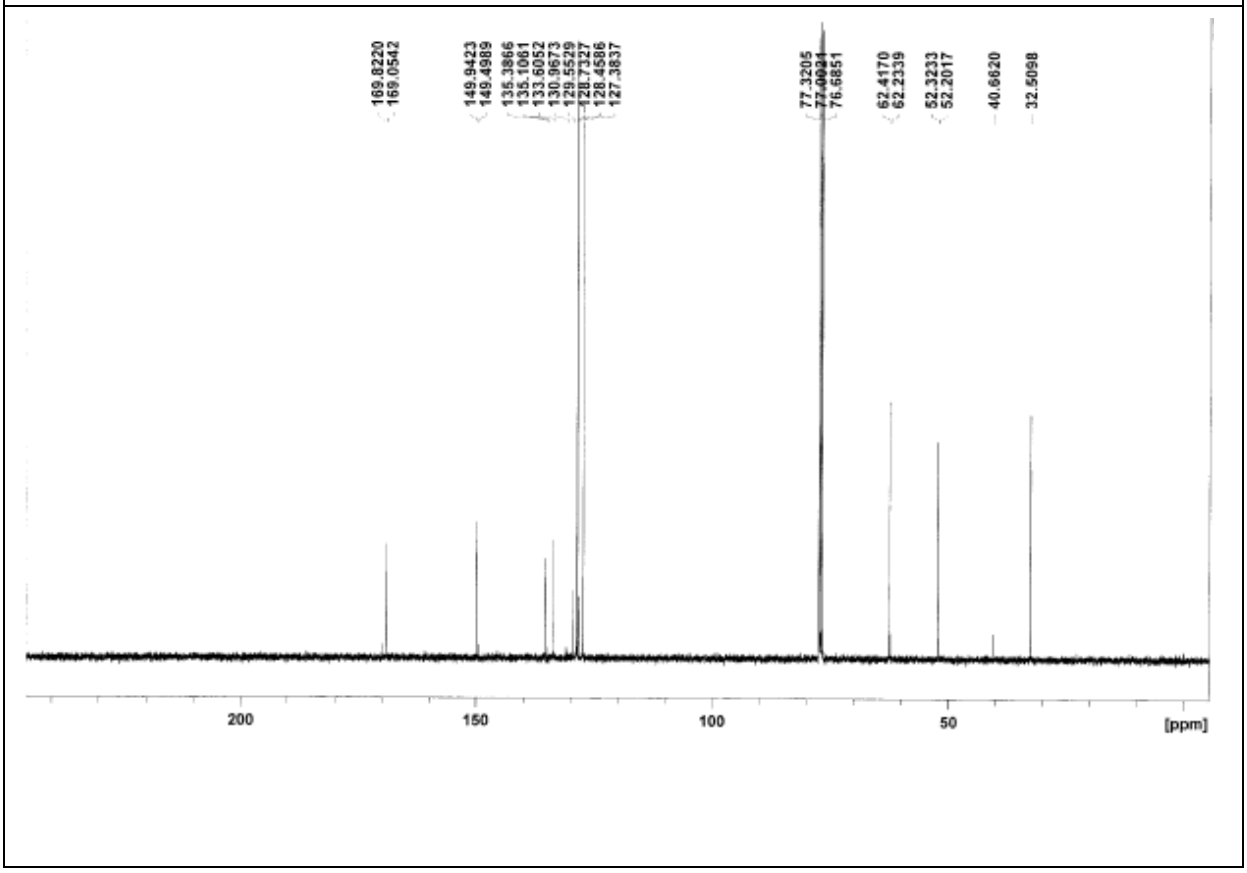
0.21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77.3205
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100
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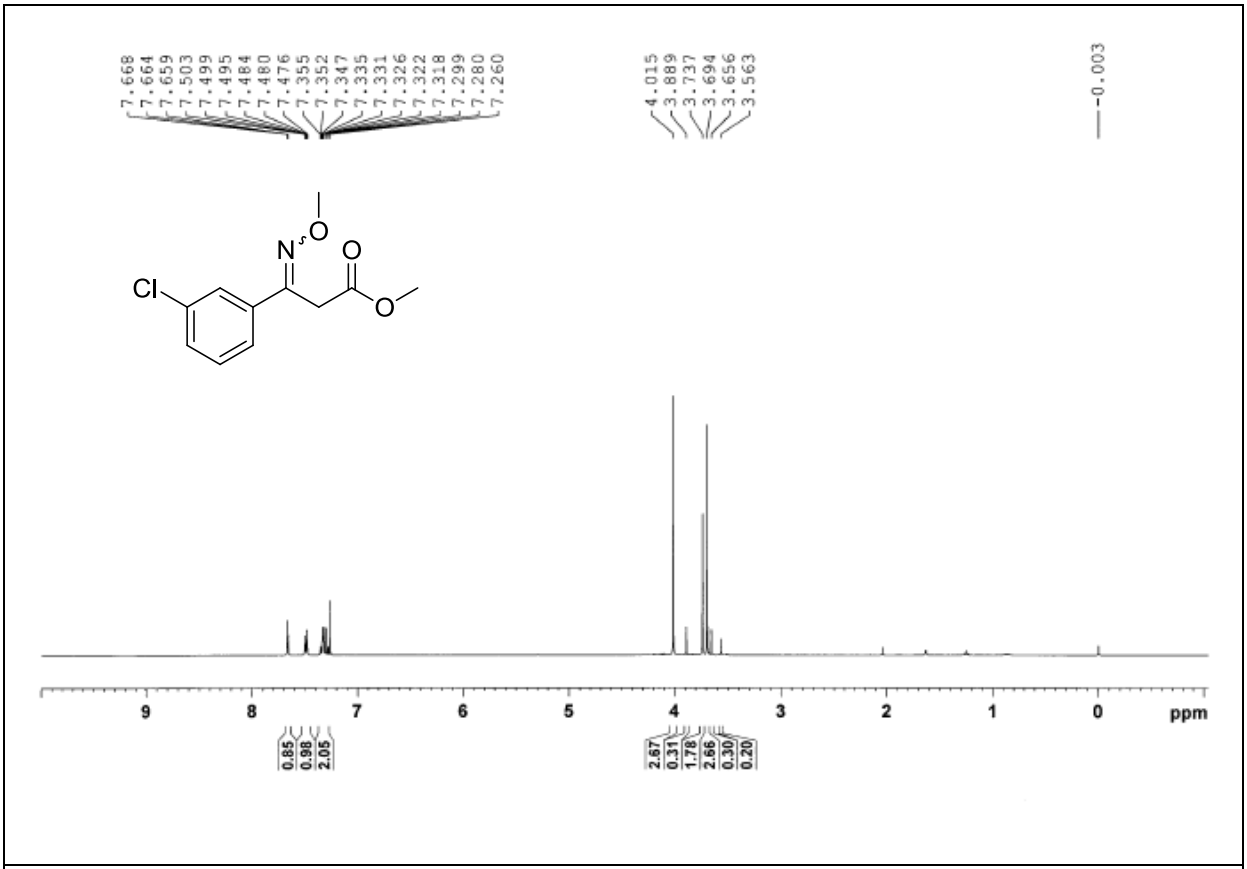
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7.335
7.331
7.326
7.322
7.318
7.299
7.280
7.260
4.015
3.889
3.737
3.694
3.656
3.563
0.003
Cl
N
O
O
O
9
8
7
6
5
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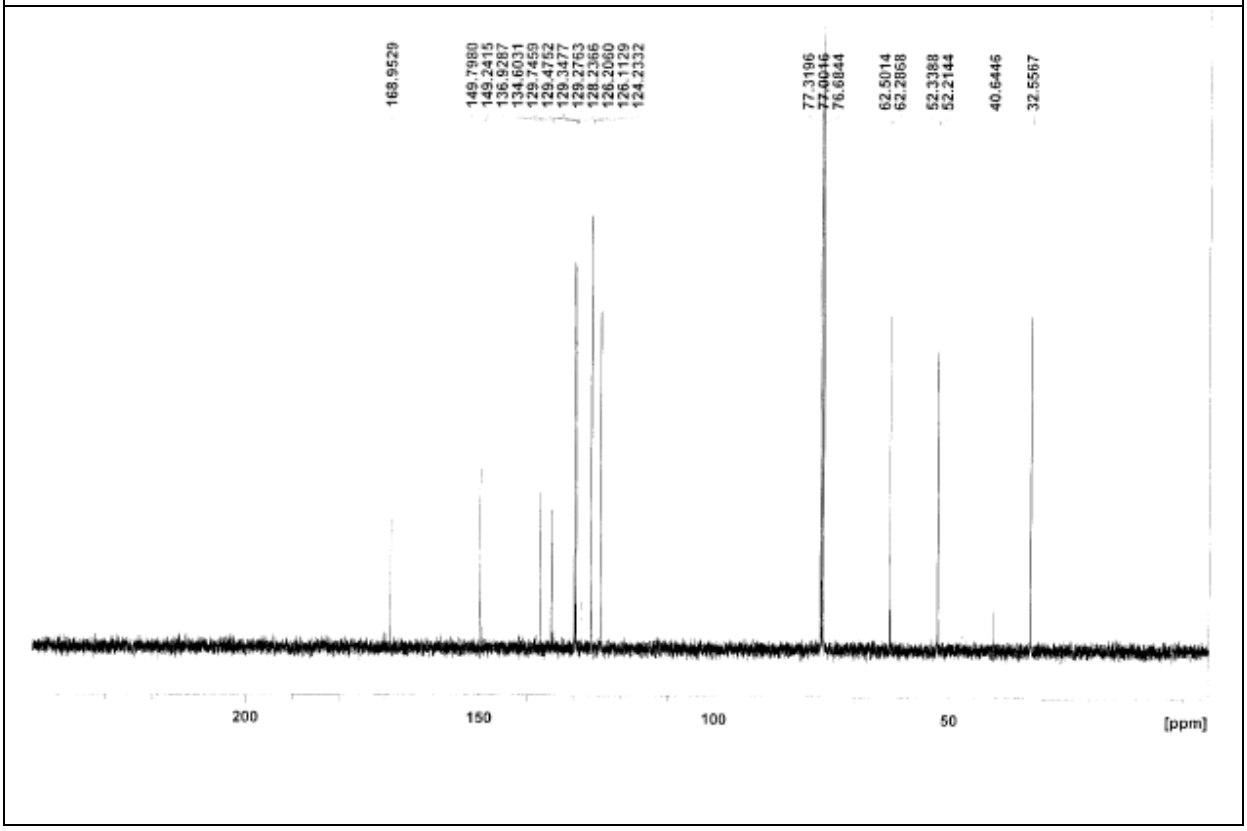
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126.1129
124.2332
77.3196
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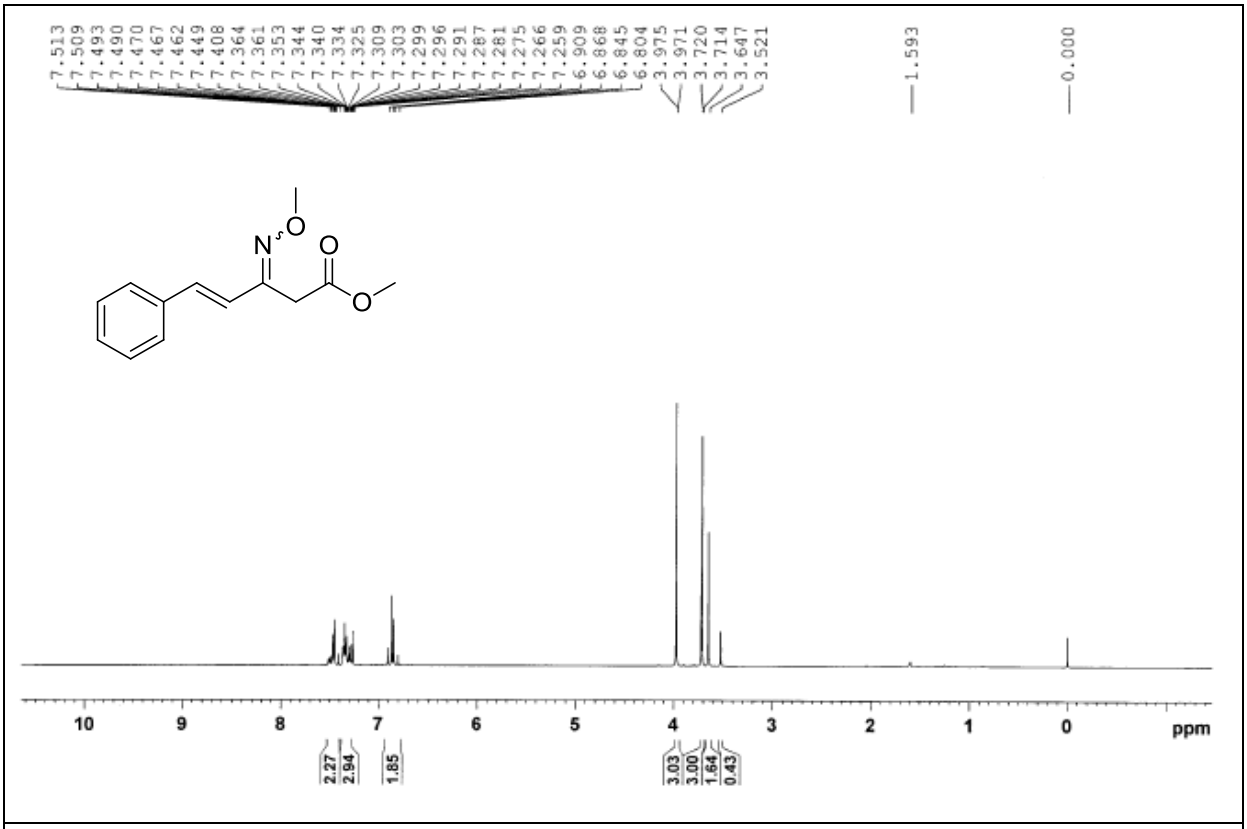

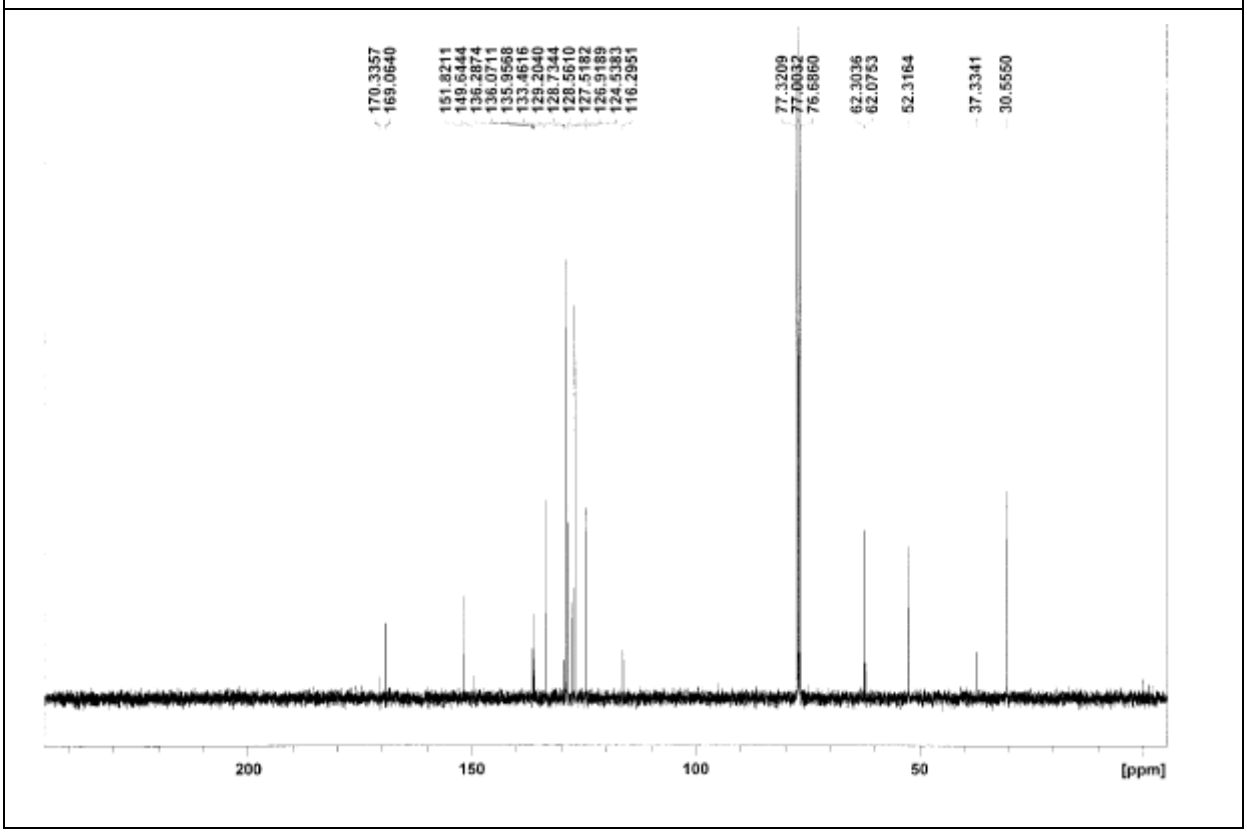

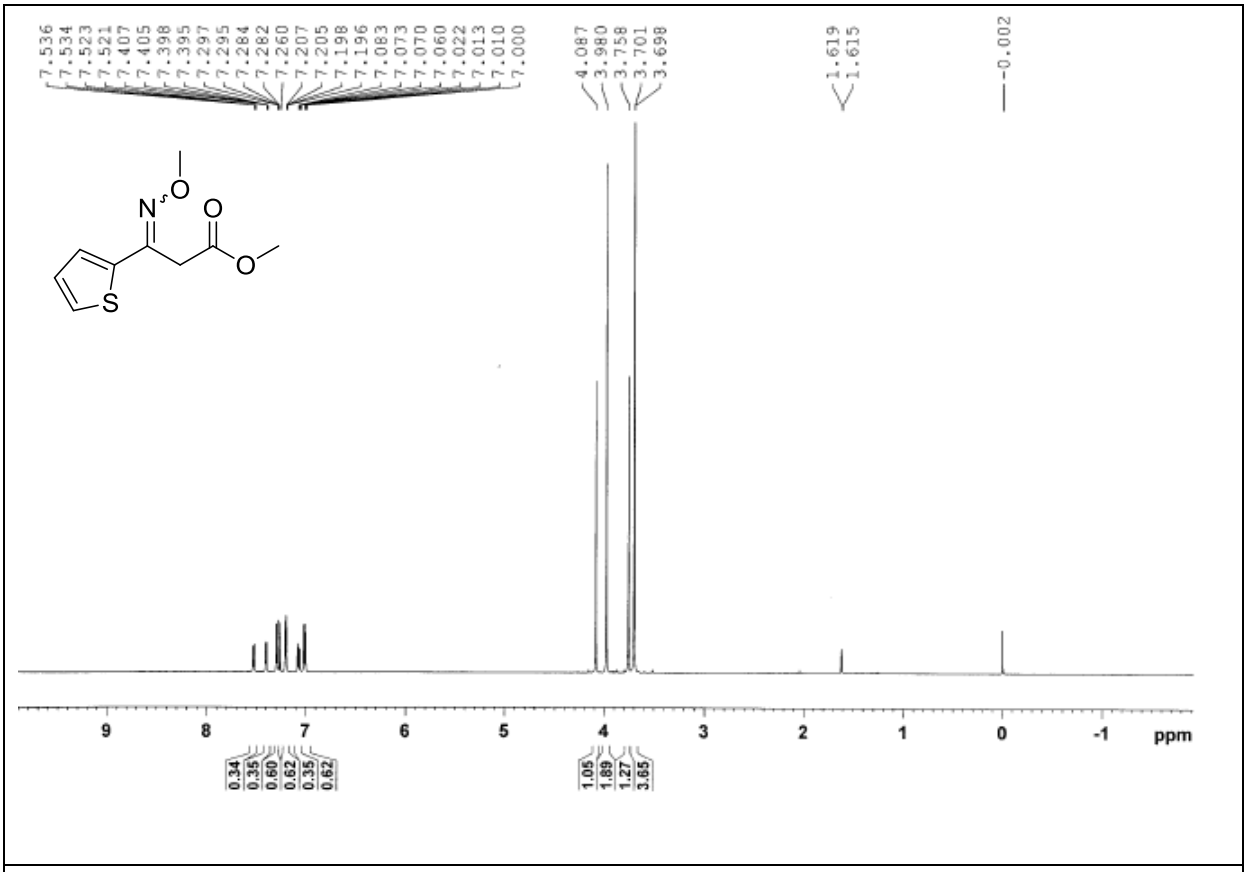
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7.395
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7.295
7.284
7.282
7.260
7.207
7.205
7.198
7.196
7.083
7.073
7.070
7.060
7.022
7.013
7.010
7.000
4.087
3.980
3.758
3.701
3.698
1.619
1.615
0.002
N
O
O
O
S
9
8
7
6
5
4
3
2
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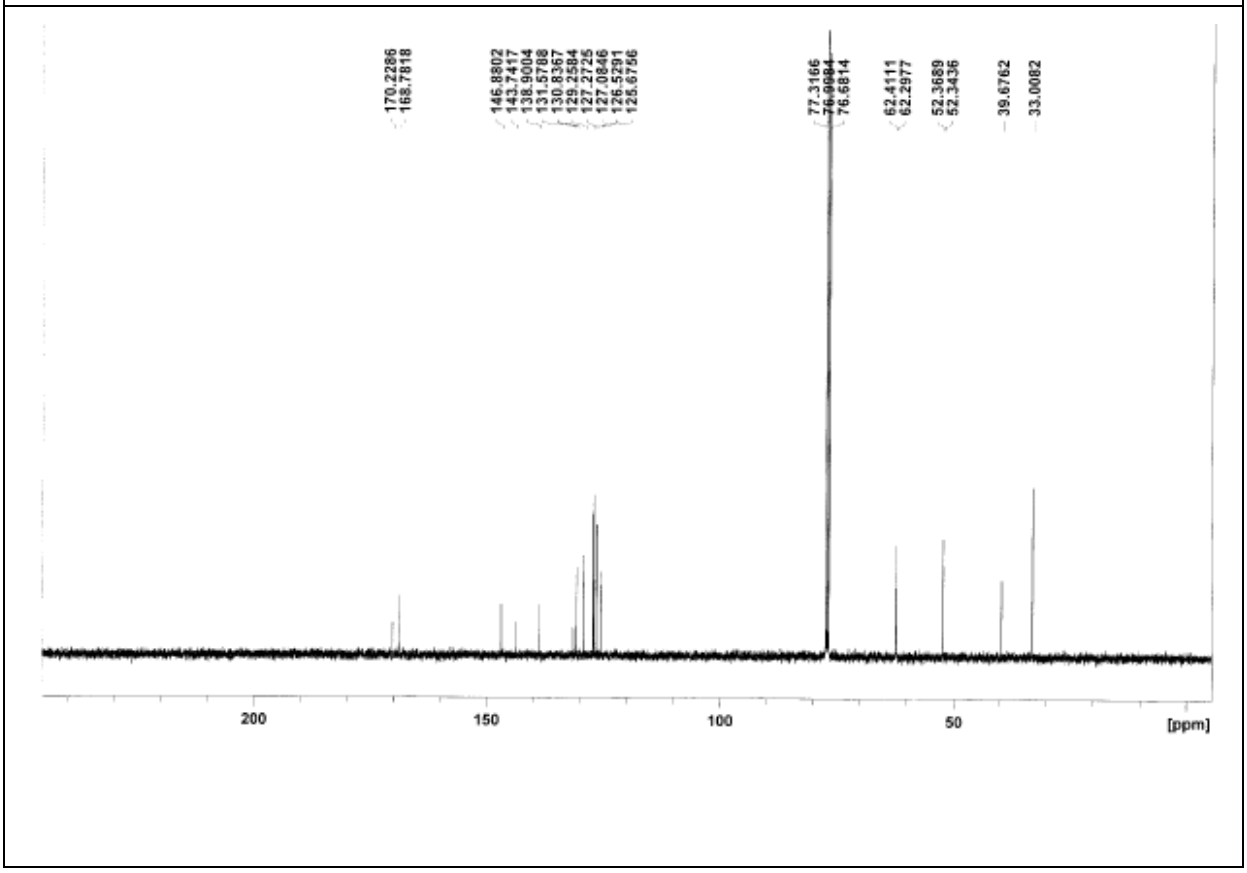
1.27
3.85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126.5291
125.6756
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76.9984
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52.3436
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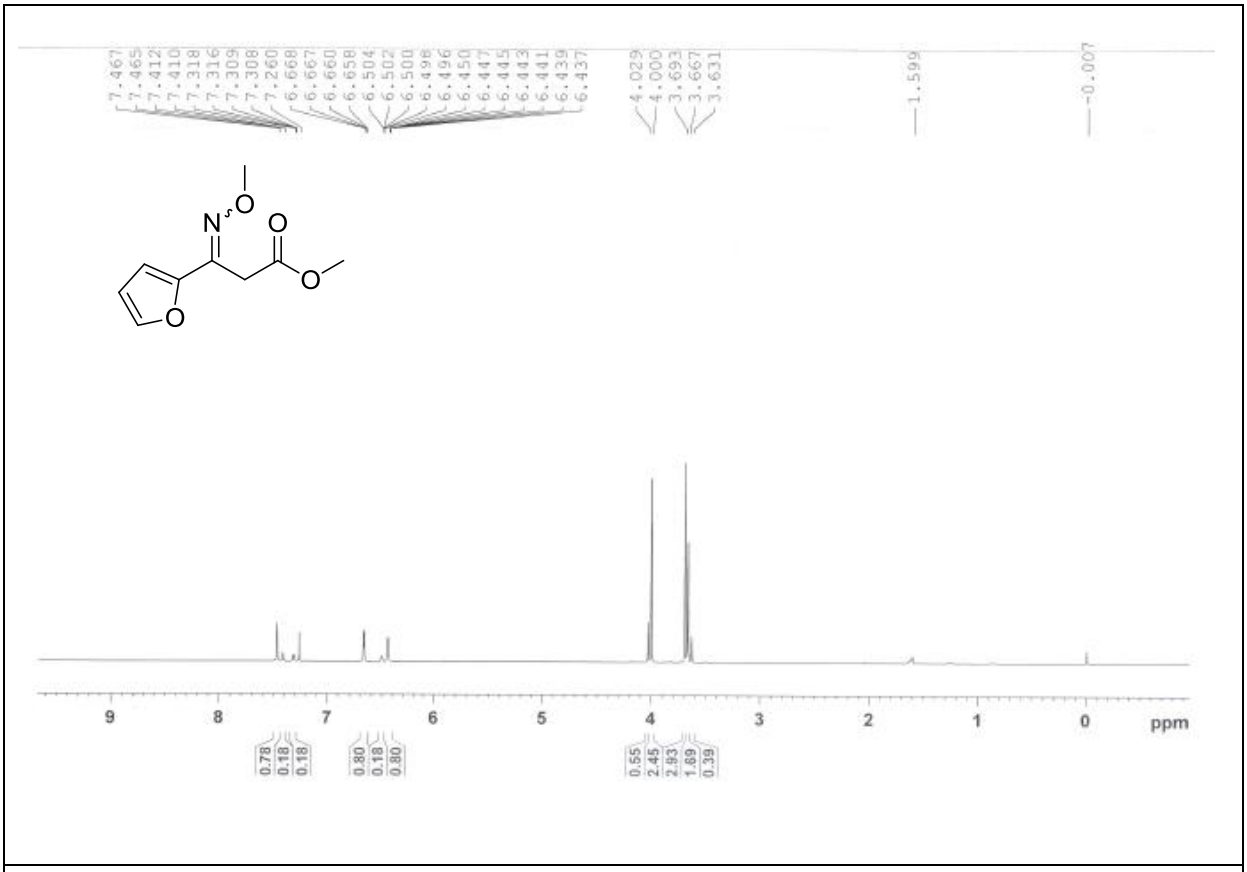
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7.308
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6.667
6.660
6.658
6.504
6.502
6.500
6.498
6.496
6.450
6.447
6.445
6.443
6.441
6.439
6.437
4.029
4.000
3.693
3.667
3.631
1.599
0.007
N
O
O
O
O
9
8
7
6
5
4
3
2
1
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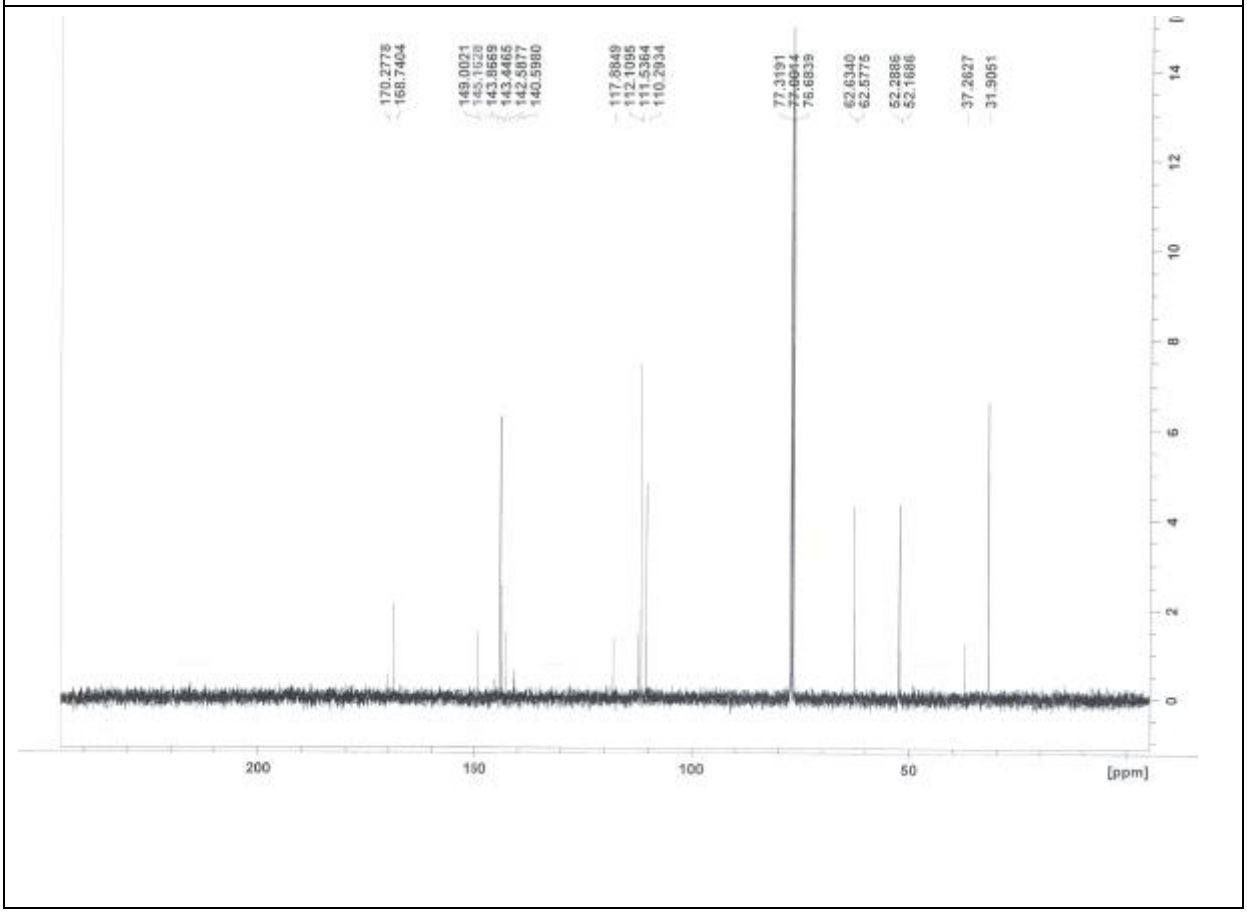
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77.0044
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100
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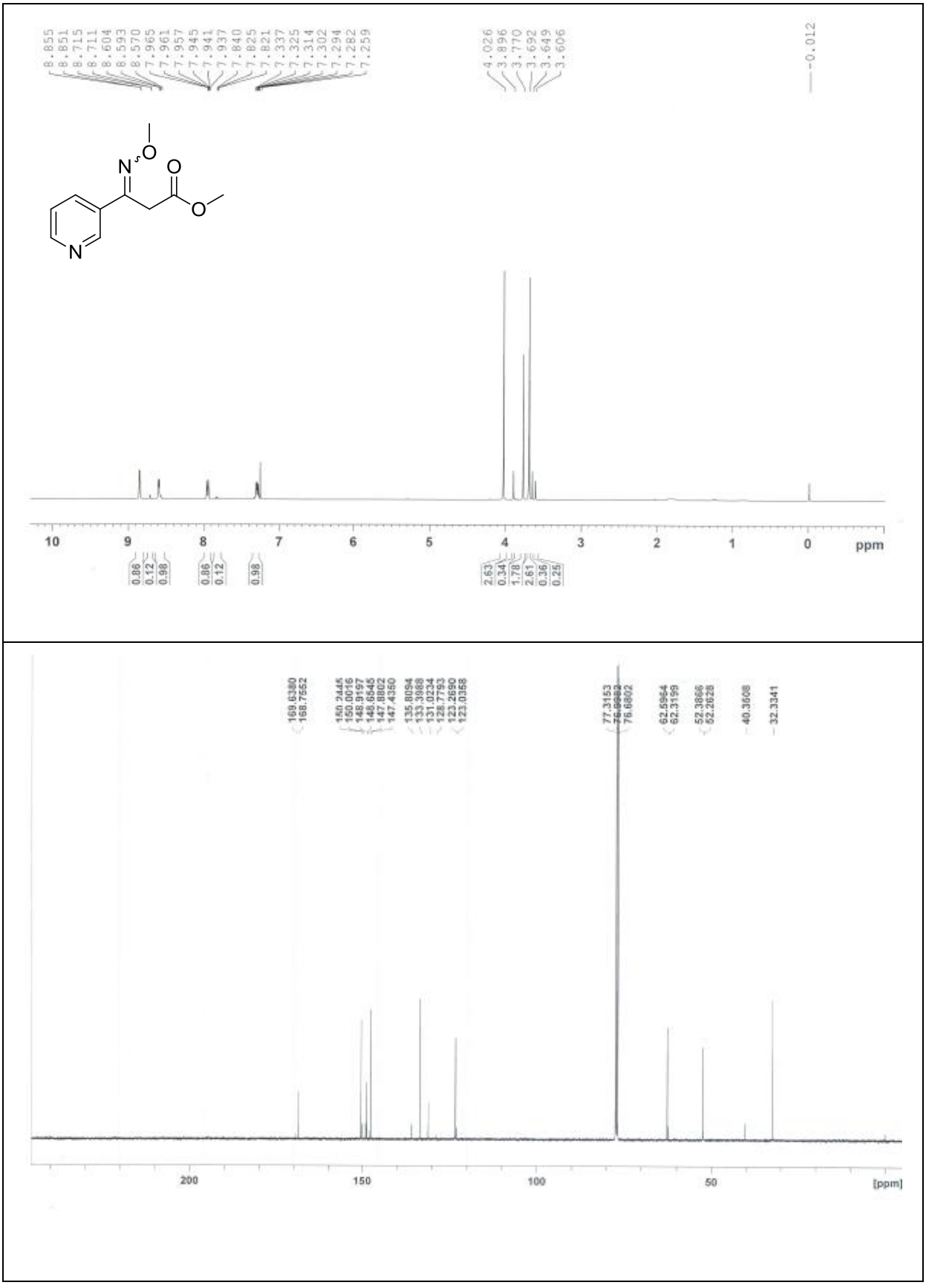
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7.937
7.840
7.825
7.821
7.337
7.325
7.314
7.302
7.294
7.282
7.259
4.026
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3.770
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3.649
3.606
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O
O
O
N
10
9
8
7
6
5
4
3
2
1
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0.98
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0.12
0.98
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100
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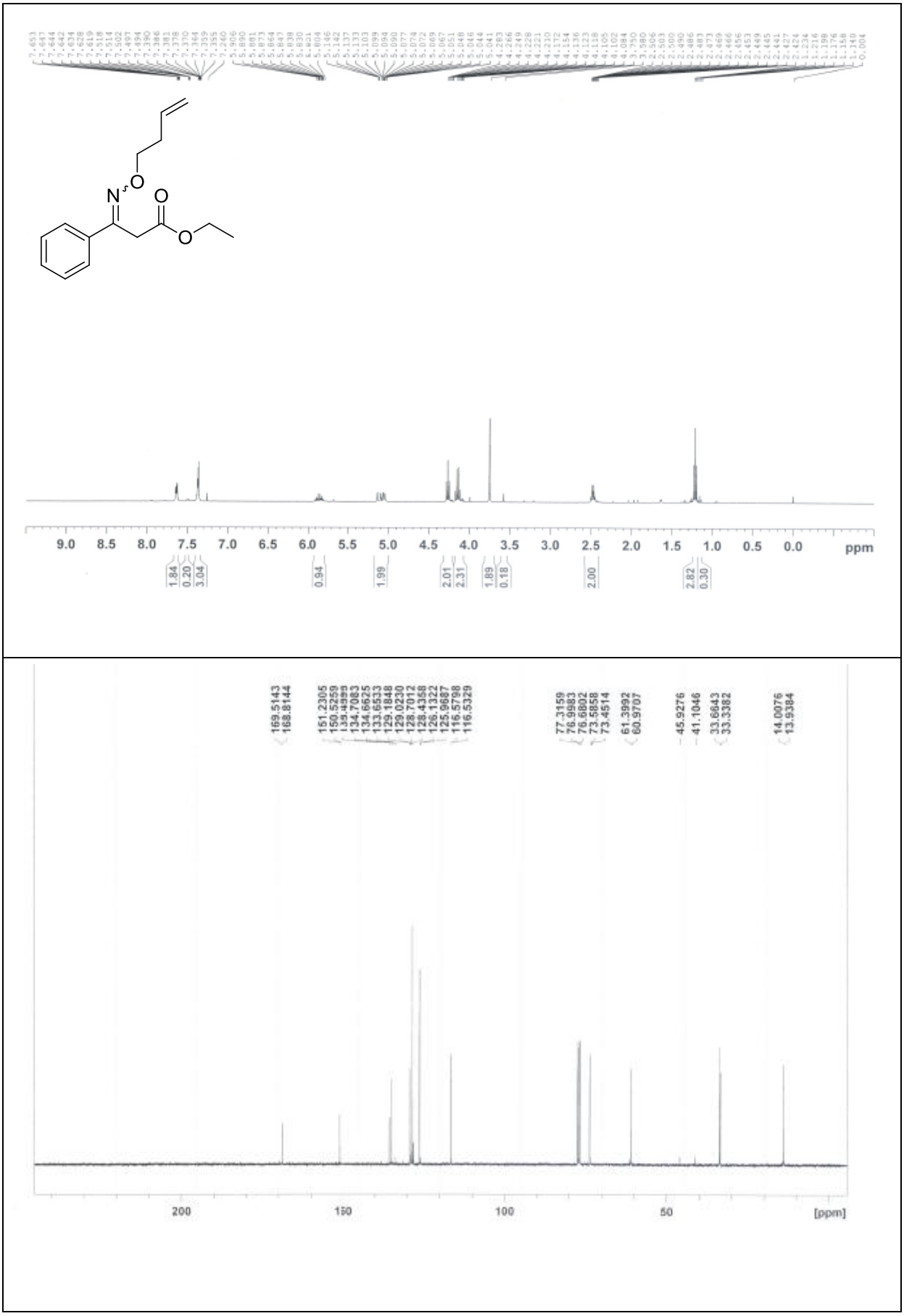
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ppm
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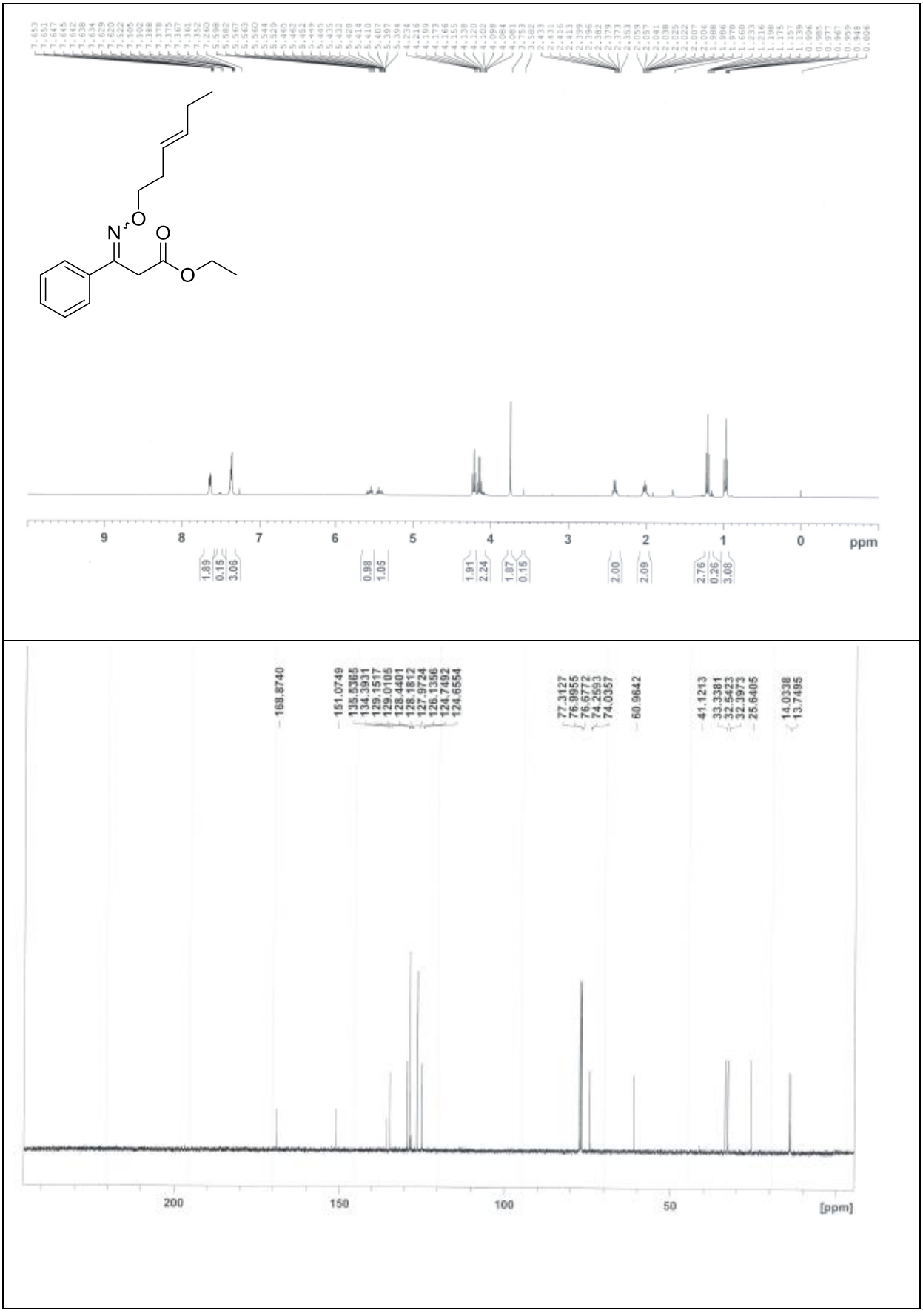
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O
O
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7
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1.05
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2.09
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0.26
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129.1517
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124.6554
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74.0357
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32.5423
32.3973
25.6405
14.0338
13.7495
200
150
100
50
[ppm]


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7.366
7.363
7.356
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7.319
7.314
7.301
7.297
7.284
7.279
7.250
7.132
7.129
7.124
7.110
7.107
7.034
7.016
6.997
5.260
2.315
0.000
N
O
O
O
N2
1a
9
8
7
6
5
4
3
2
1
0
-1
ppm
4.91
2.03
2.04
1.01
2.01
3.00
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128.1957
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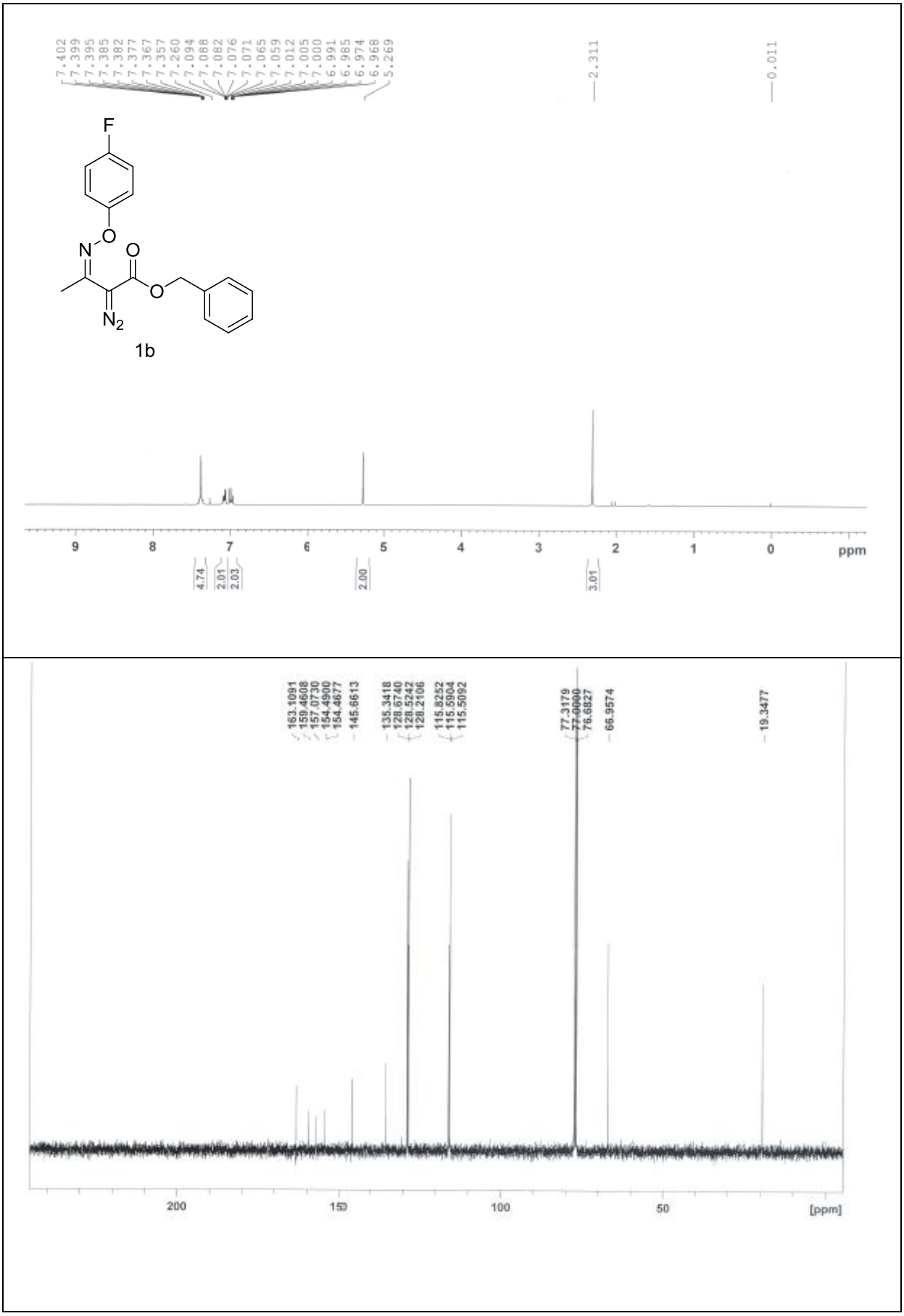
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7.012
7.005
7.000
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F
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O
O
N2
1b
9
8
7
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5
4
3
2
1
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ppm
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3.01
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154.4677
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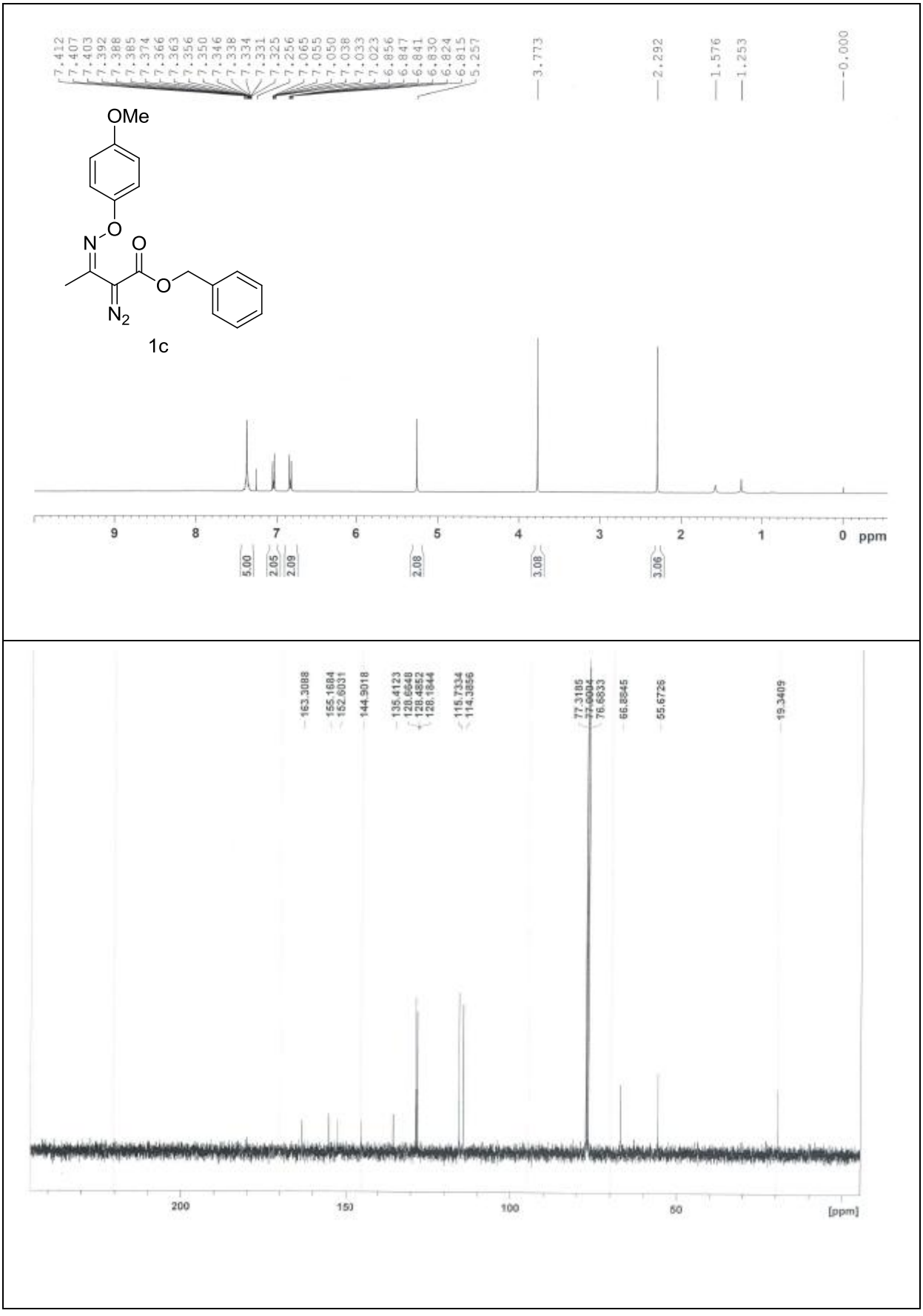
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7.334
7.331
7.325
7.256
7.065
7.055
7.050
7.038
7.033
7.023
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6.847
6.841
6.830
6.824
6.815
5.257
3.773
2.292
1.576
1.253
0.000
OMe
N
O
O
O
N2
1c
9
8
7
6
5
4
3
2
1
0 ppm
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2.05
2.09
2.08
3.08
3.06
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128.4852
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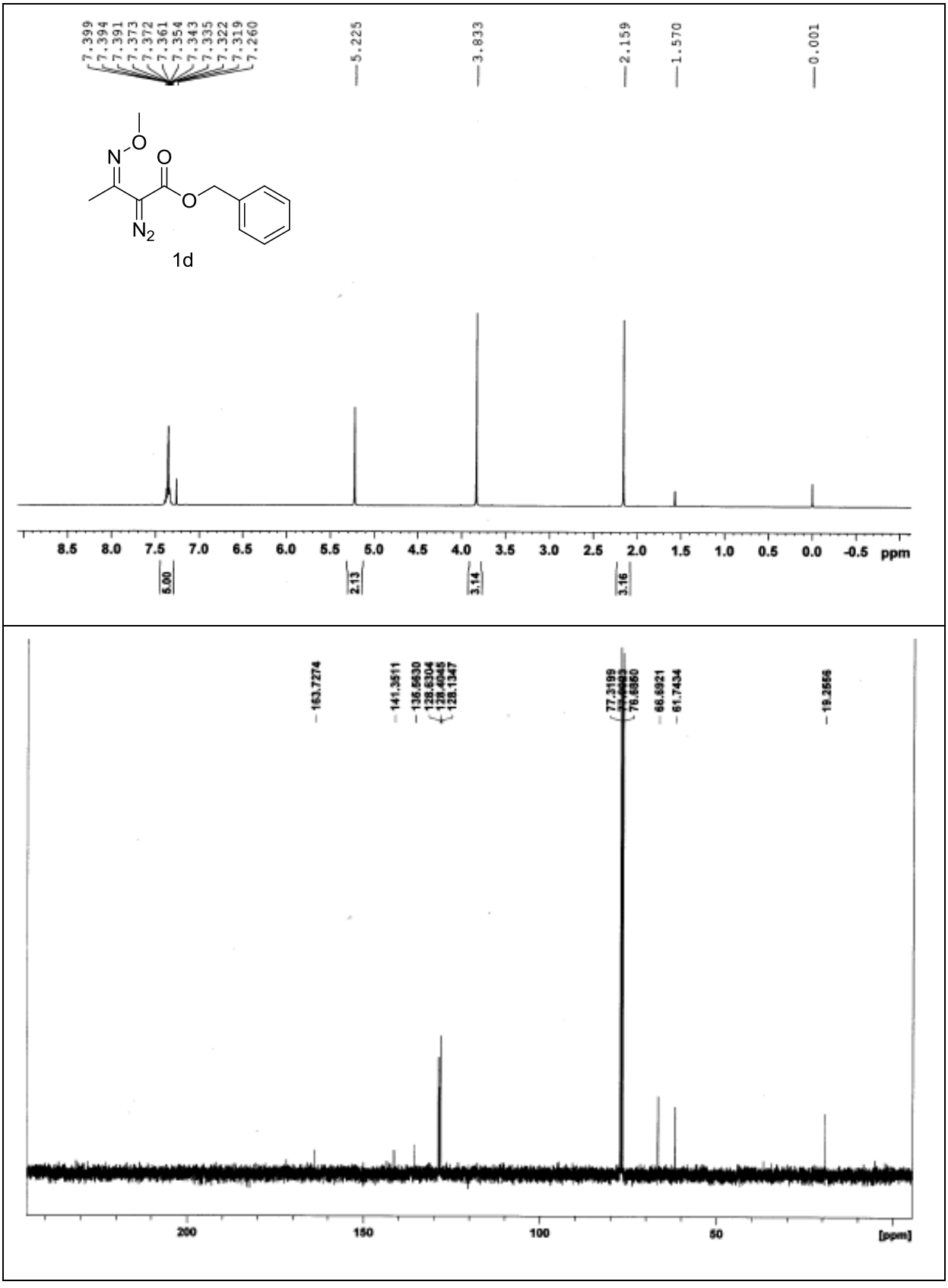

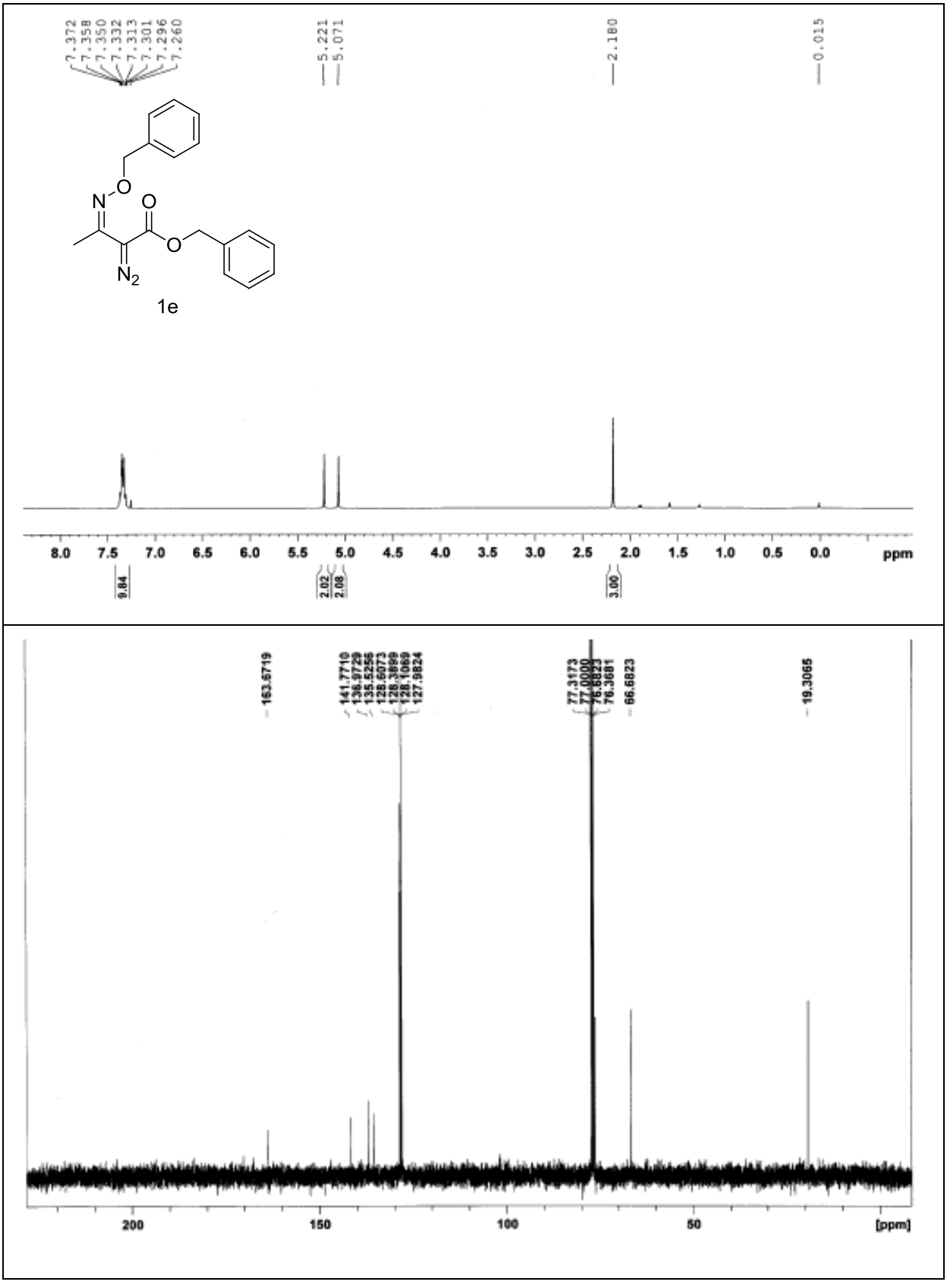
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O
O
O
N2
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7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
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2.08
3.00
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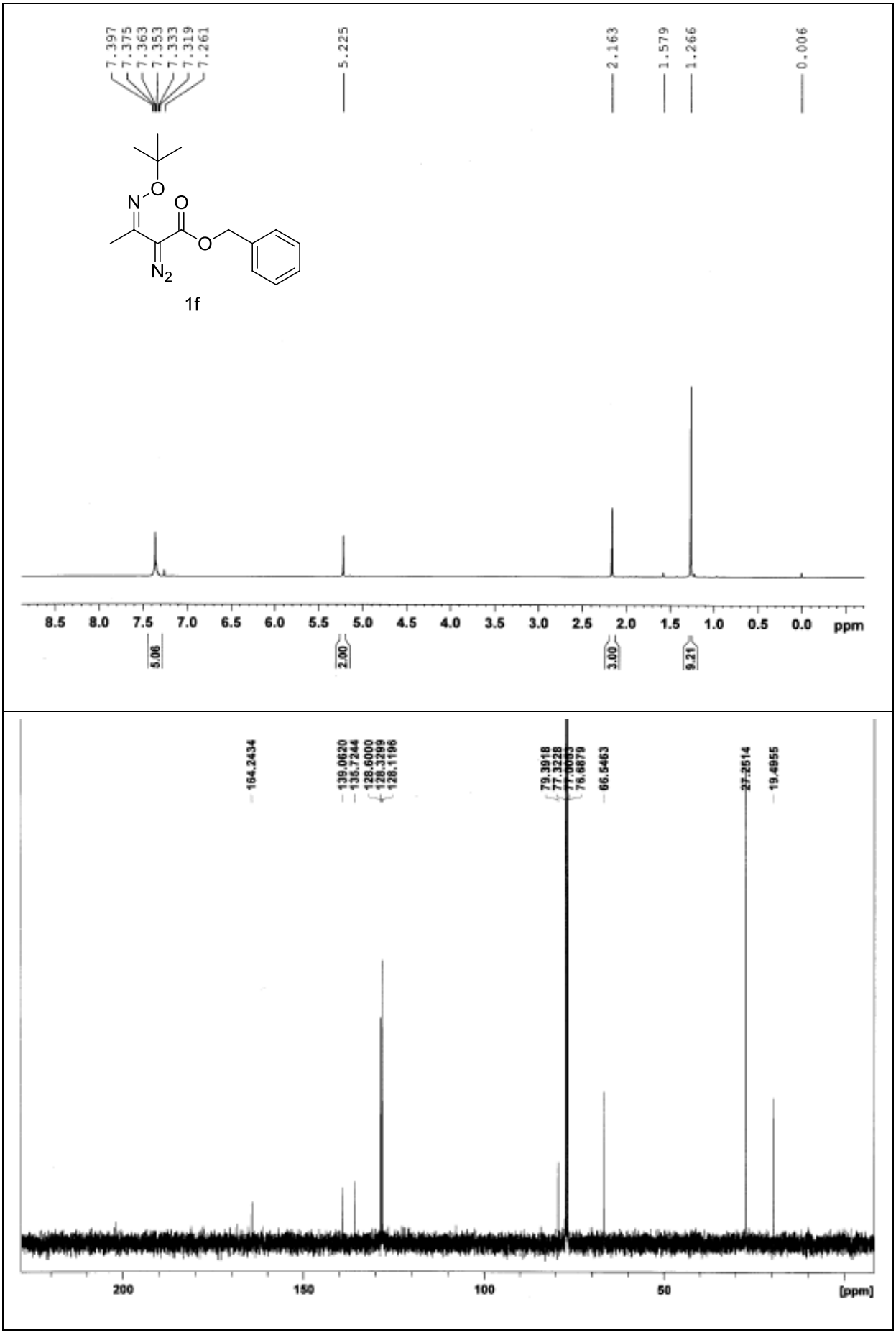
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0.006
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O
O
O
N2
1f
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
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2.00
3.00
9.21
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135.7244
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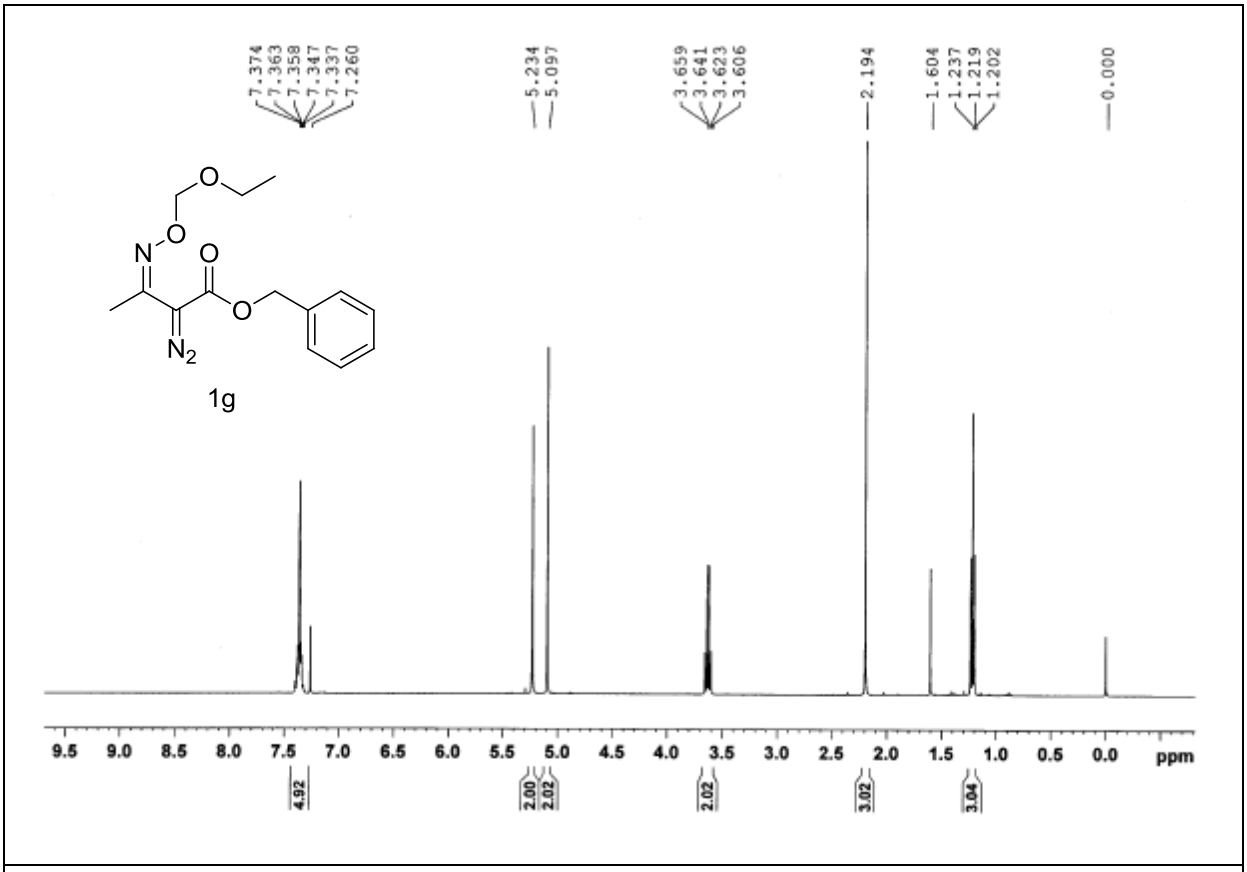
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1.604
1.237
1.219
1.202
0.000
O
O
N
O
O
N2
1g
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
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2.02
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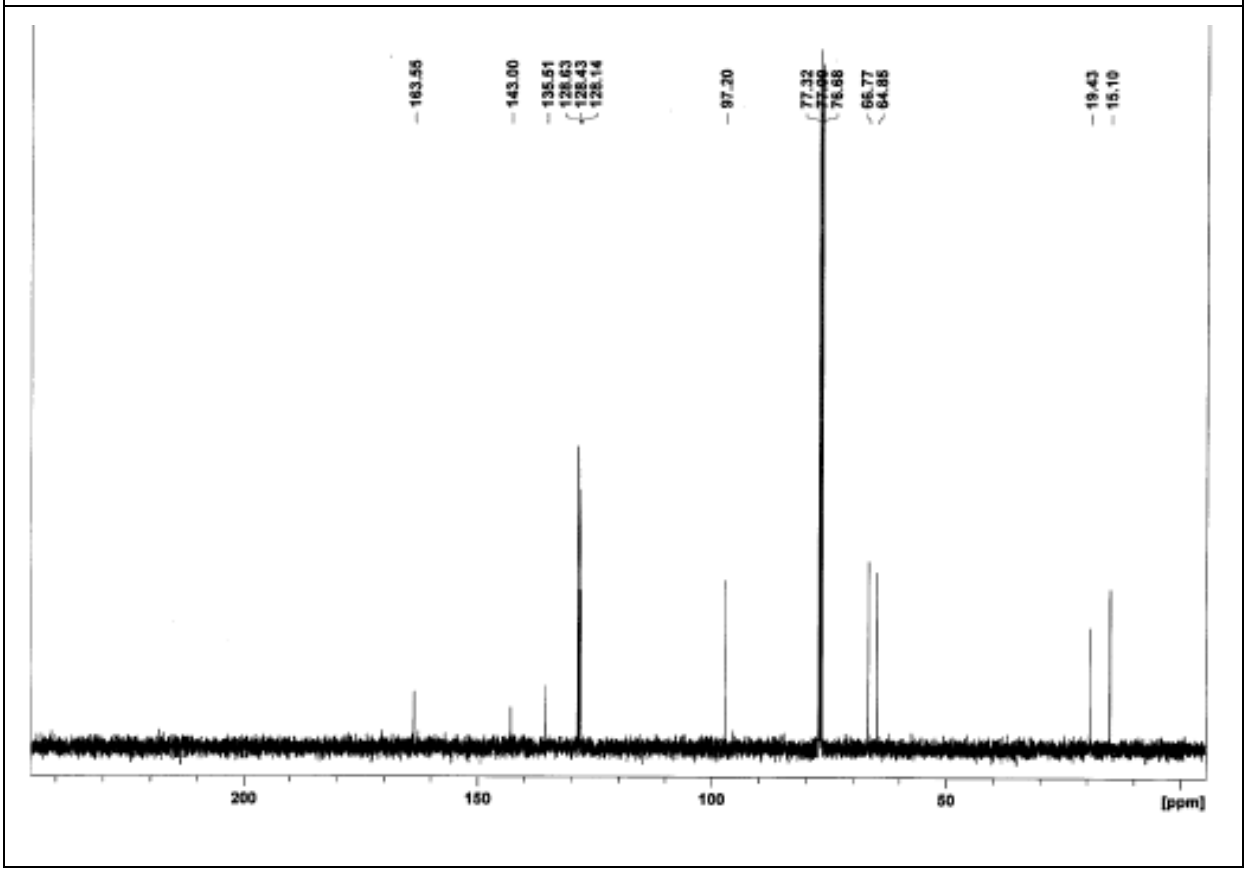
3.04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200
150
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50
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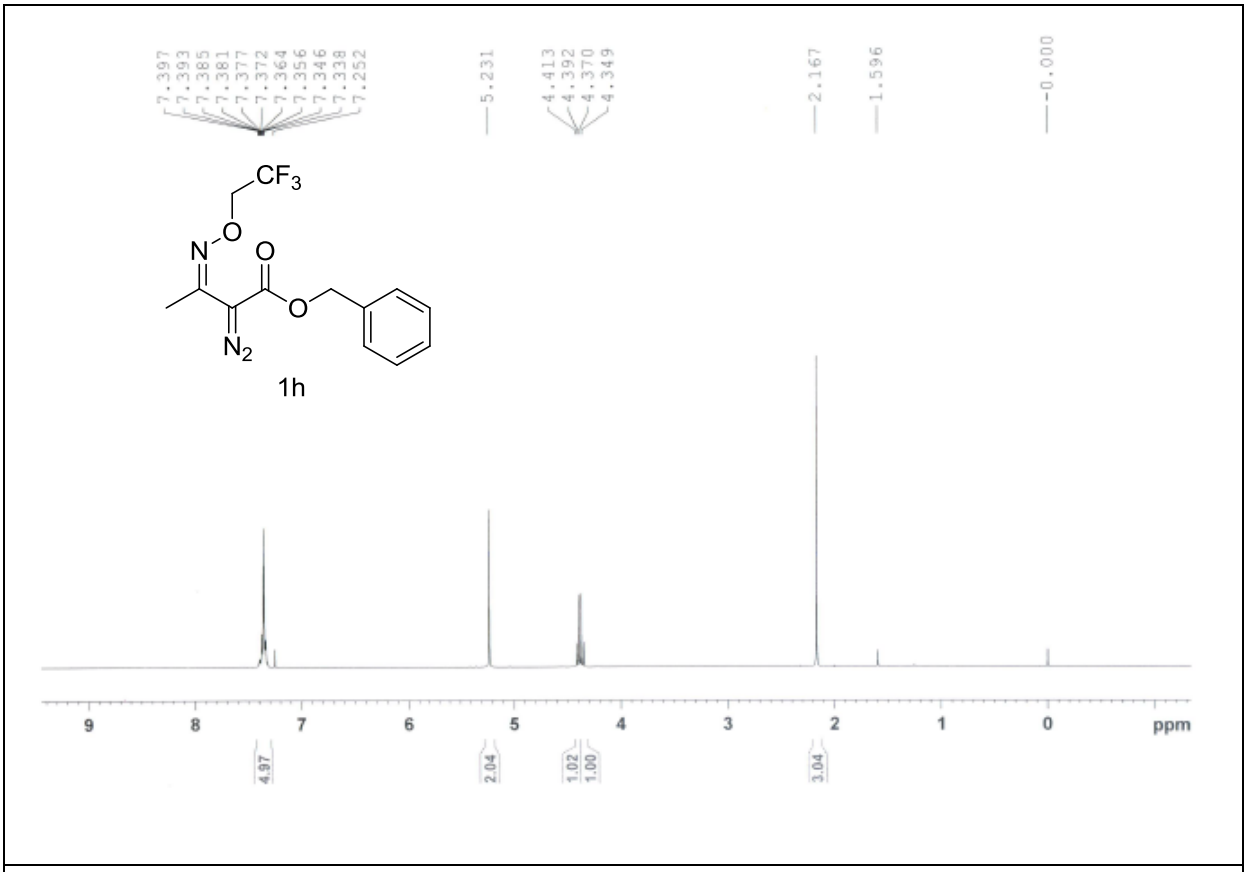

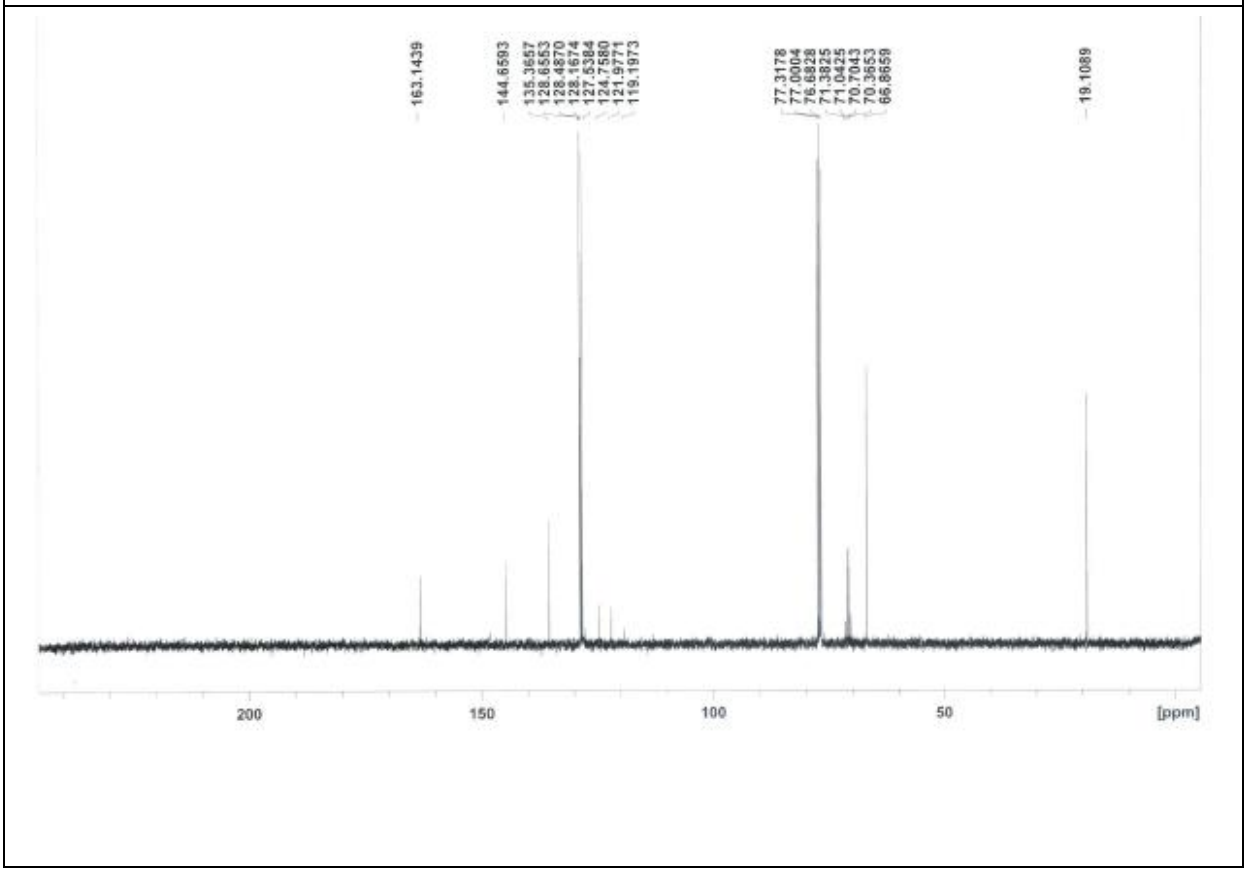

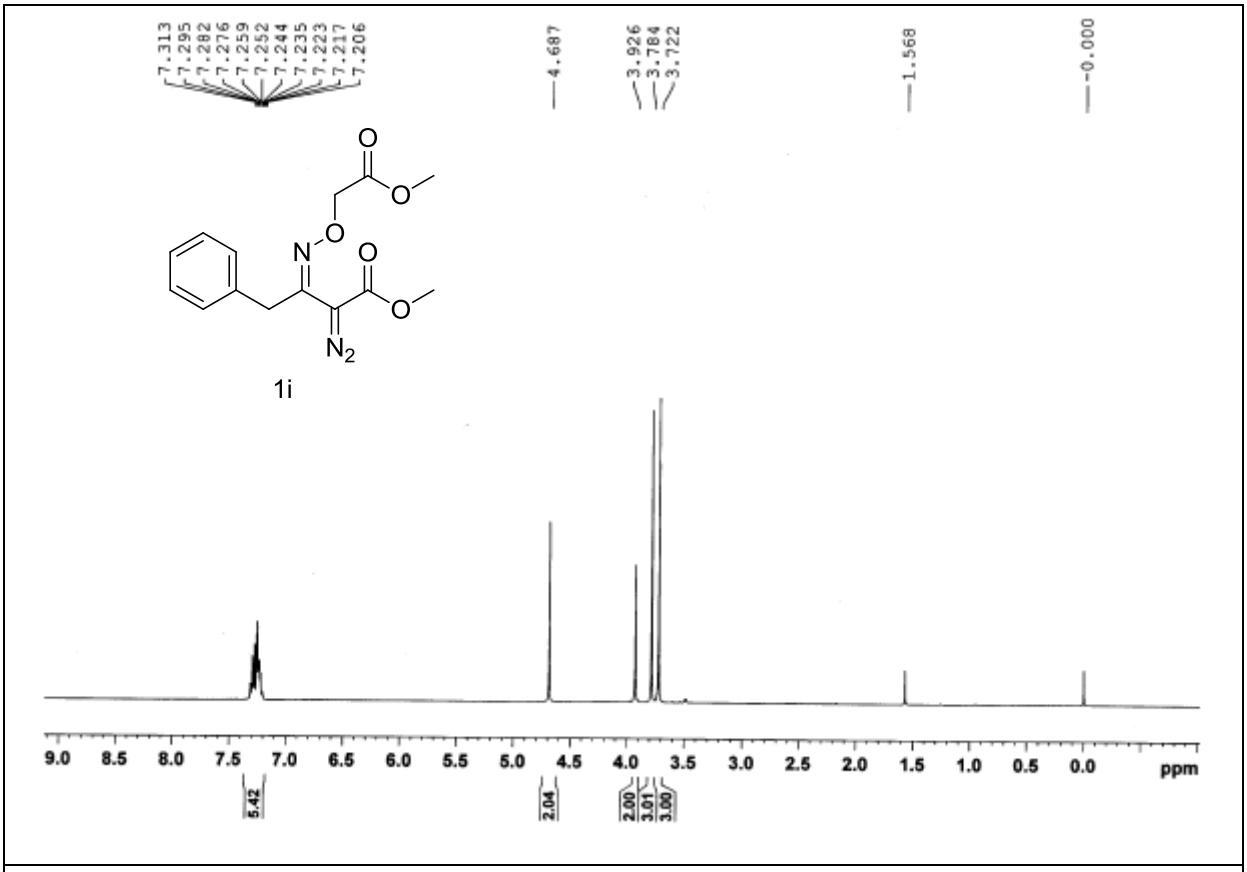
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7.252
7.244
7.235
7.223
7.217
7.206
4.687
3.926
3.784
3.722
1.568
0.000
O
O
N
O
O
O
N2
1i
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
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1.5
1.0
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5.42
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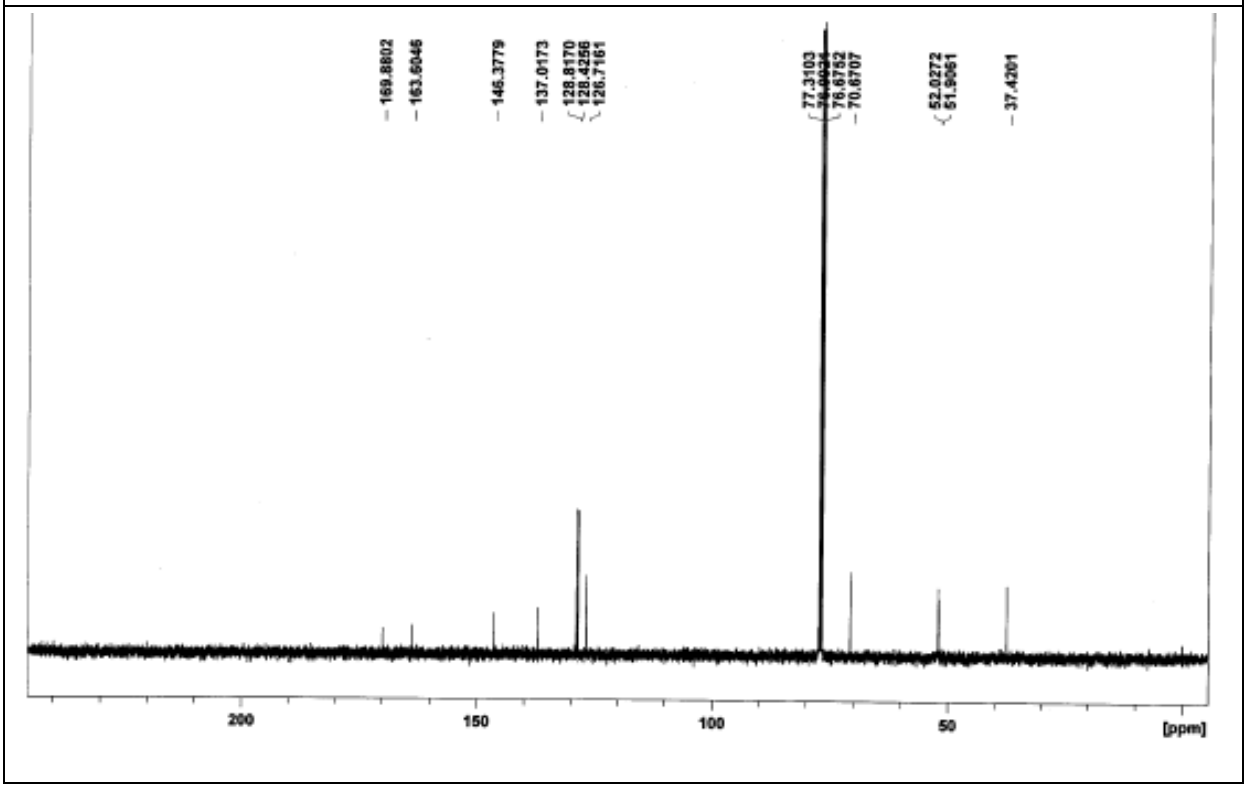
3.01
3.00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137.0173
128.8170
128.4256
126.7161
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76.8752
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52.0272
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37.4201
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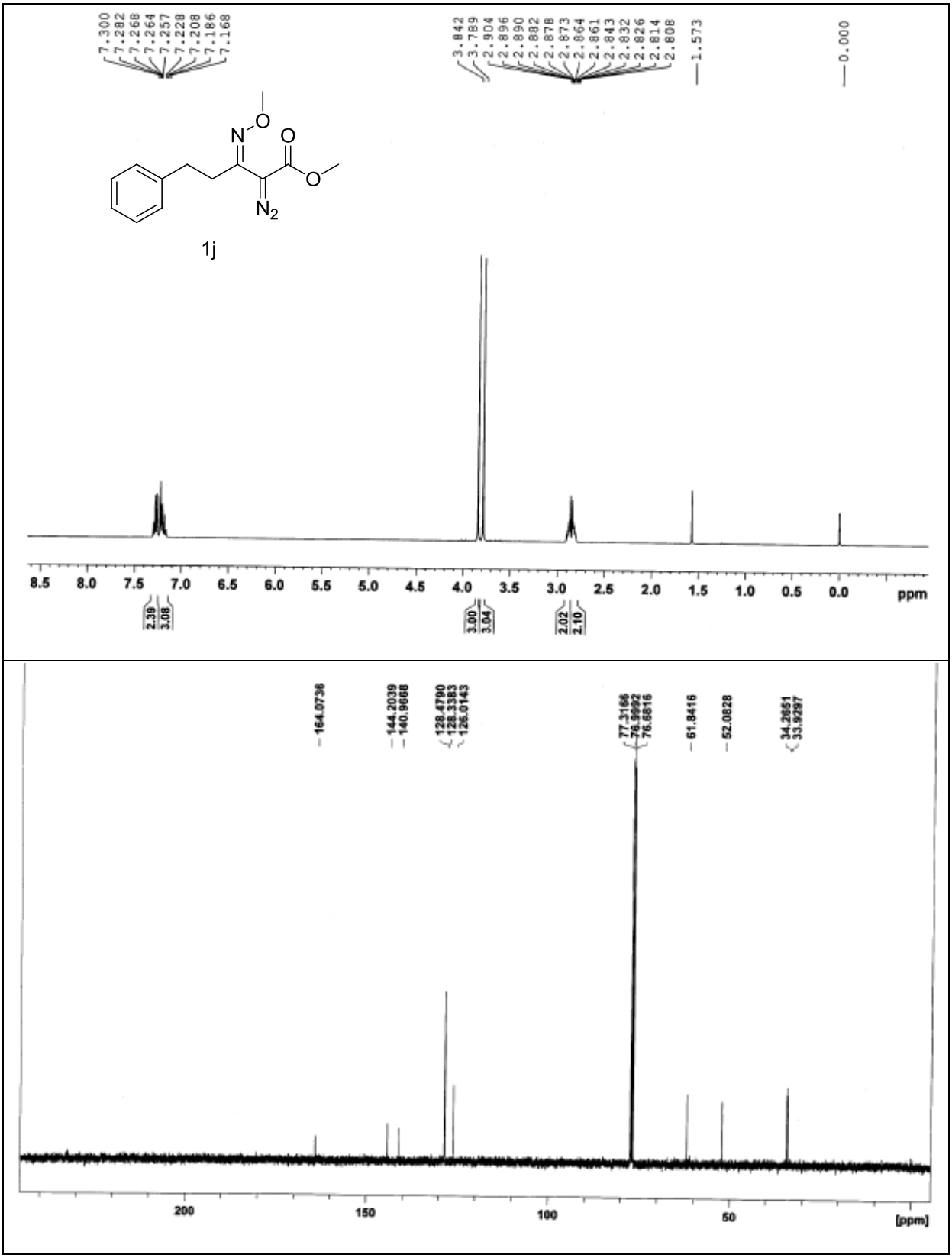
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7.268
7.264
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7.228
7.208
7.186
7.168
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3.789
2.904
2.896
2.890
2.882
2.878
2.873
2.864
2.861
2.843
2.832
2.826
2.814
2.808
1.573
0.000
N
O
O
O
N2
1j
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
ppm
2.39
3.08
3.00
3.04
2.02
2.10
164.0736
144.2039
140.9668
128.4790
128.3383
126.0143
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33.9297
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100
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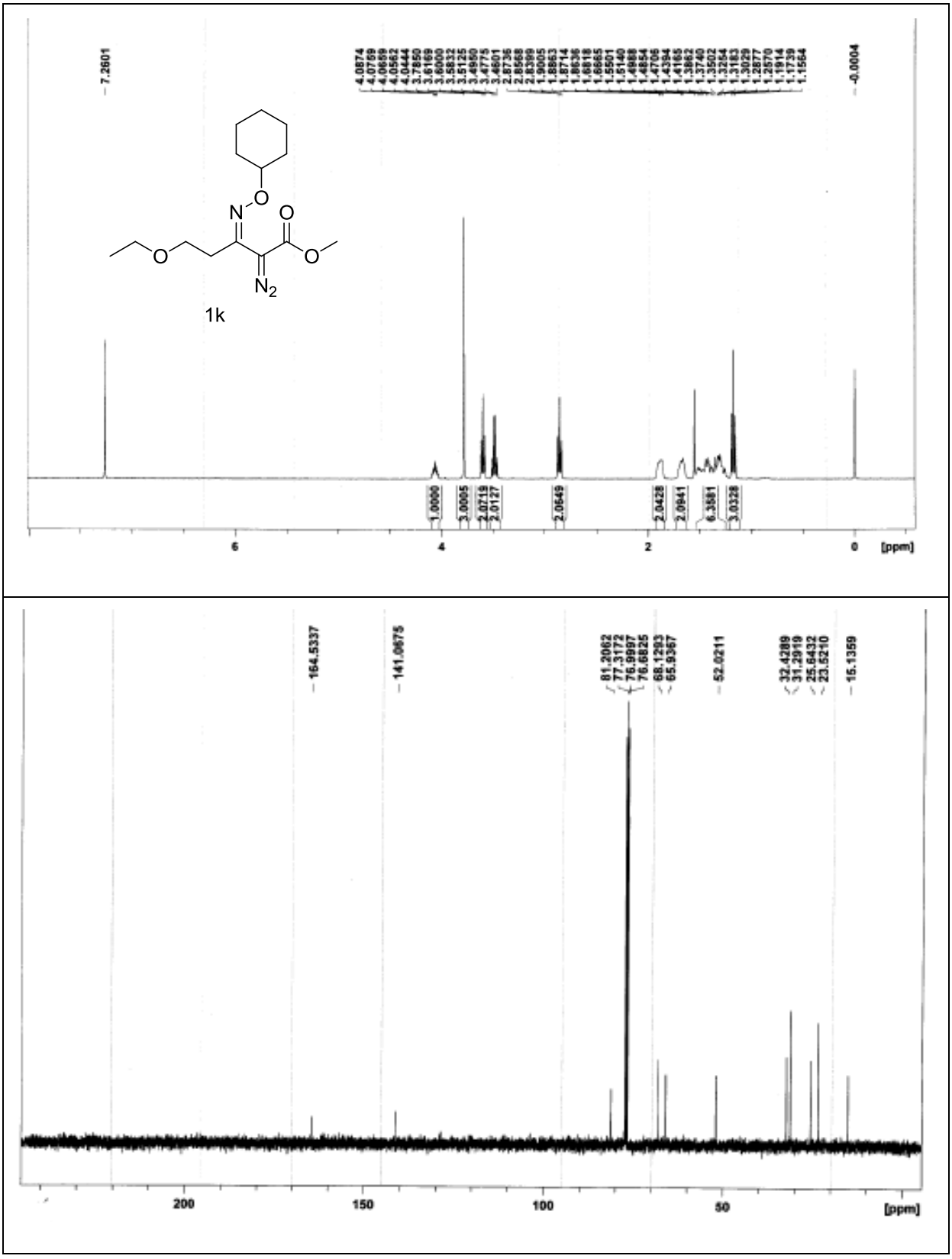
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4.0759
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4.0444
3.7850
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3.6000
3.5832
3.5125
3.4950
3.4775
3.4601
2.8736
2.8568
2.8399
1.9005
1.8863
1.8714
1.8636
1.6818
1.6665
1.5501
1.5140
1.4988
1.4854
1.4706
1.4394
1.4165
1.3862
1.3740
1.3502
1.3254
1.3163
1.3029
1.2877
1.2670
1.1914
1.1739
1.1564
-0.0004
O
N
O
O
O
N2
1k
1.0000
3.0005
2.0719
2.0127
2.0649
2.0428
2.0941
6.3581
3.0328
6
4
2
0
[ppm]
164.5337
141.0675
81.2062
77.3172
76.9997
76.6825
68.1293
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32.4289
31.2919
25.6432
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15.1359
200
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100
50
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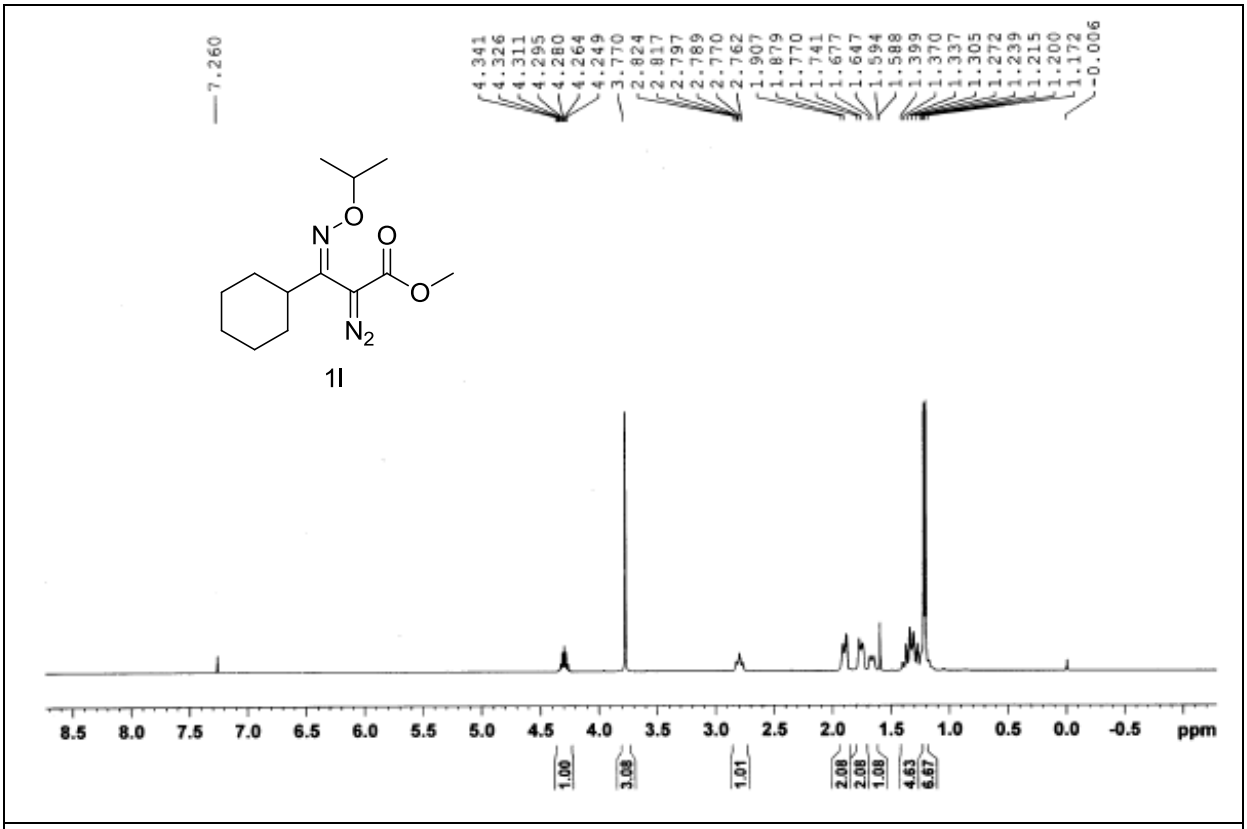
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4.326
4.311
4.295
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4.264
4.249
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2.824
2.817
2.797
2.789
2.770
2.762
1.907
1.879
1.770
1.741
1.677
1.647
1.594
1.588
1.399
1.370
1.337
1.305
1.272
1.239
1.215
1.200
1.172
0.006
O
N
O
O
N2
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
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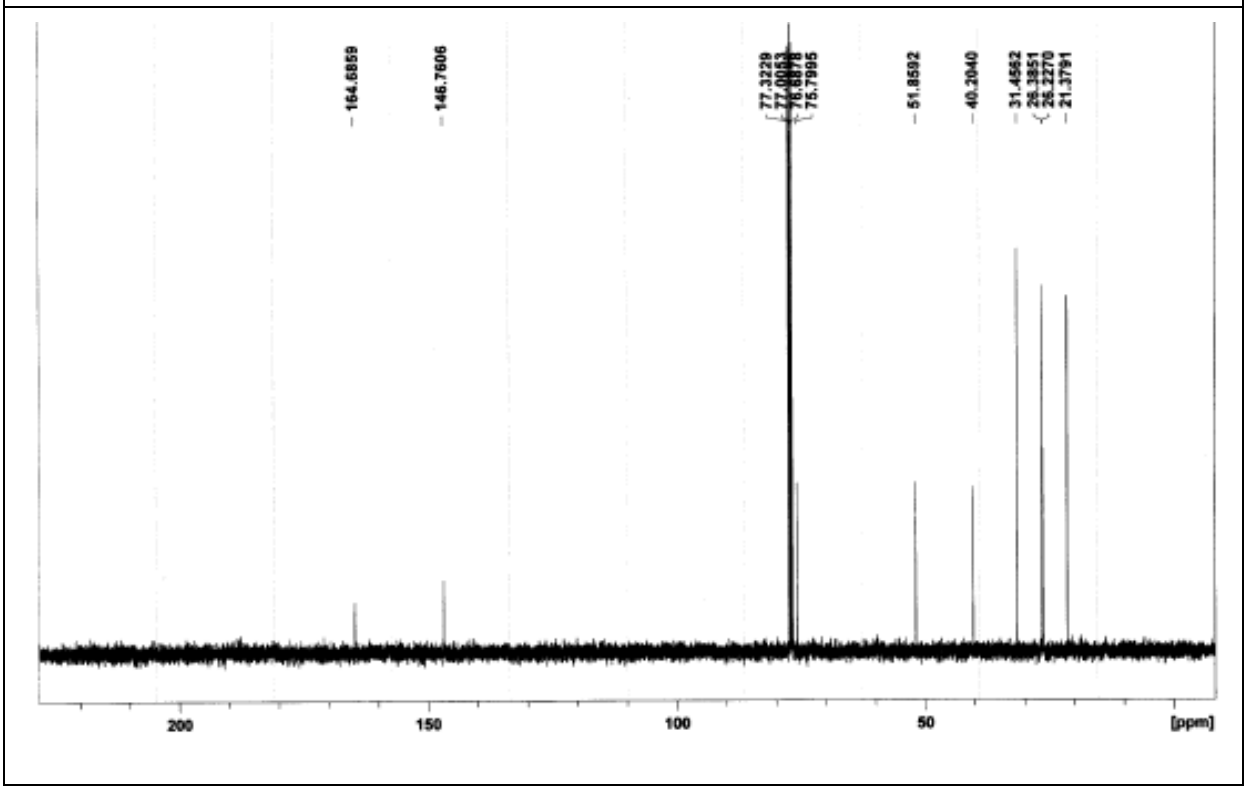
ppm
1.00
3.08
1.01
2.08
2.08
1.08
4.63
6.67

1l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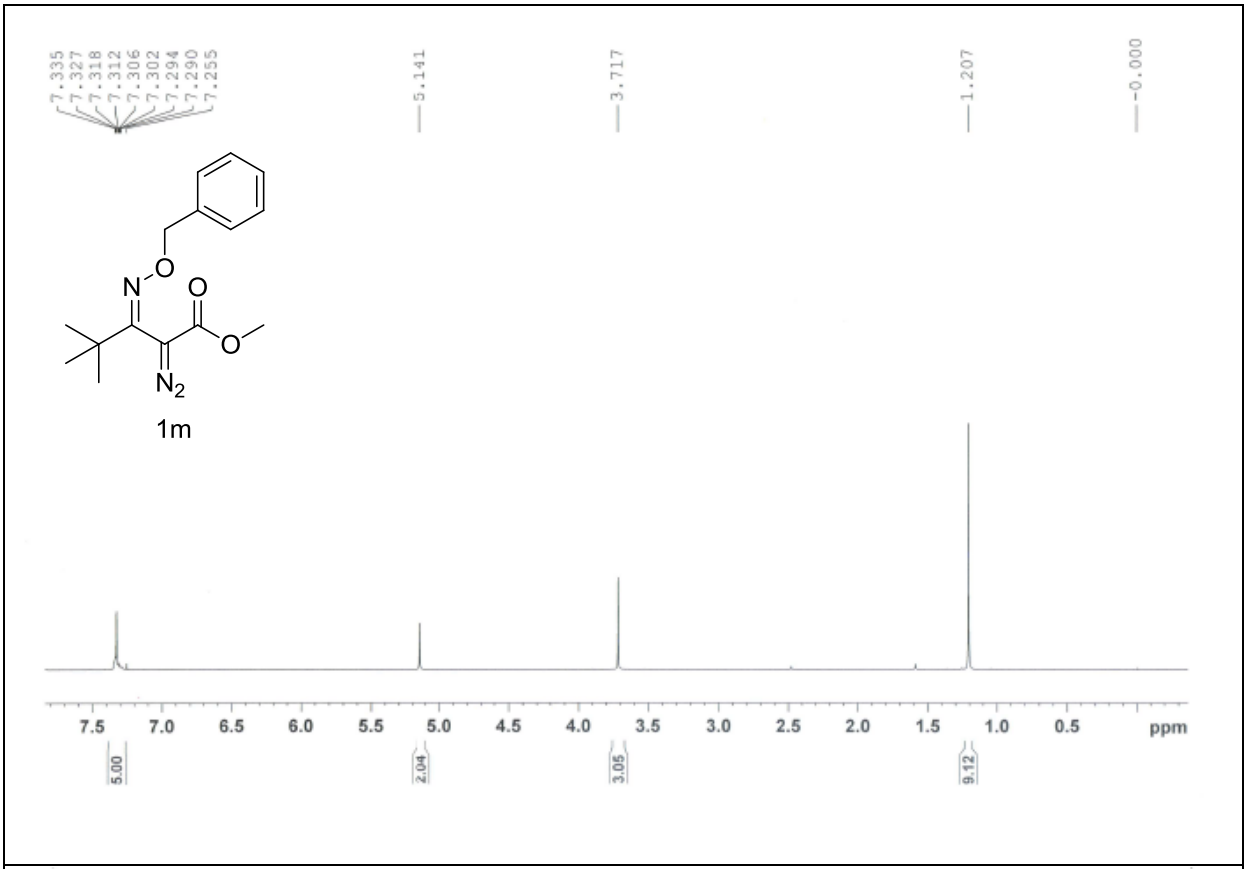
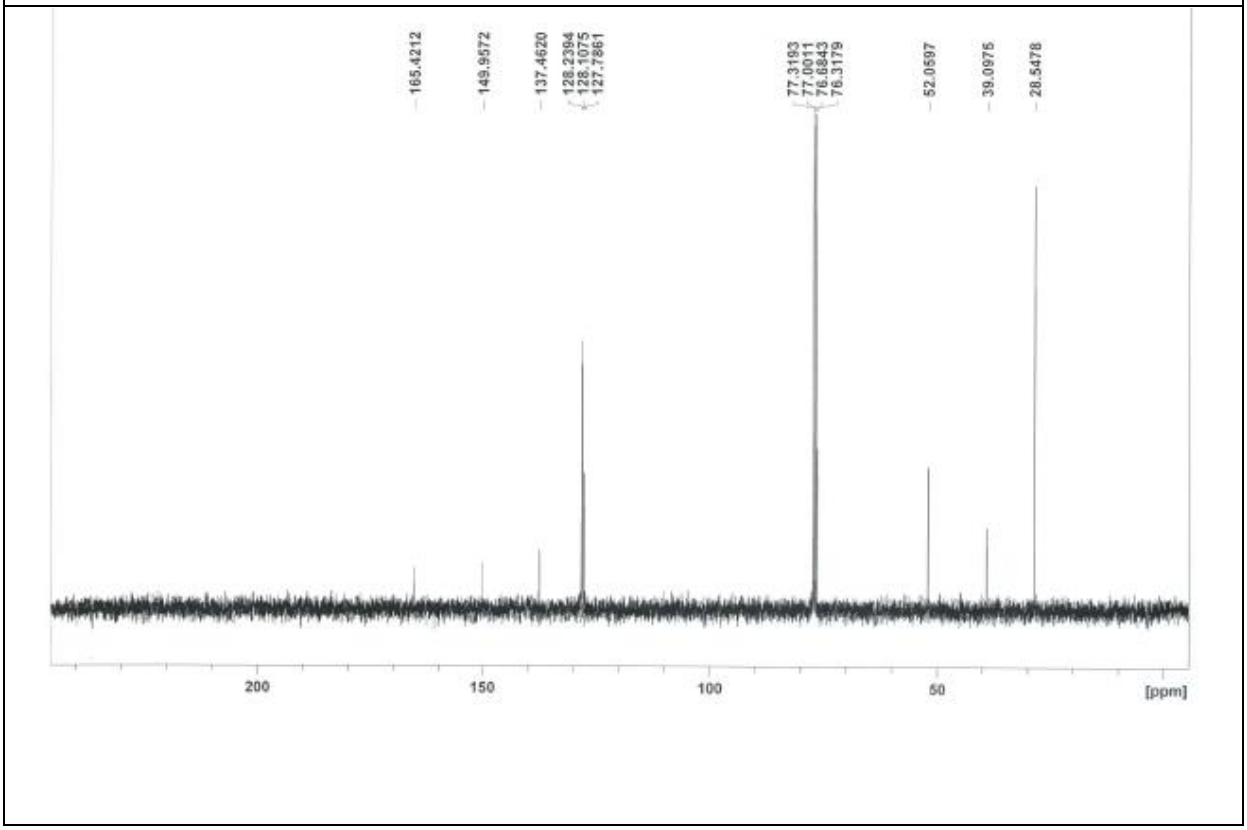
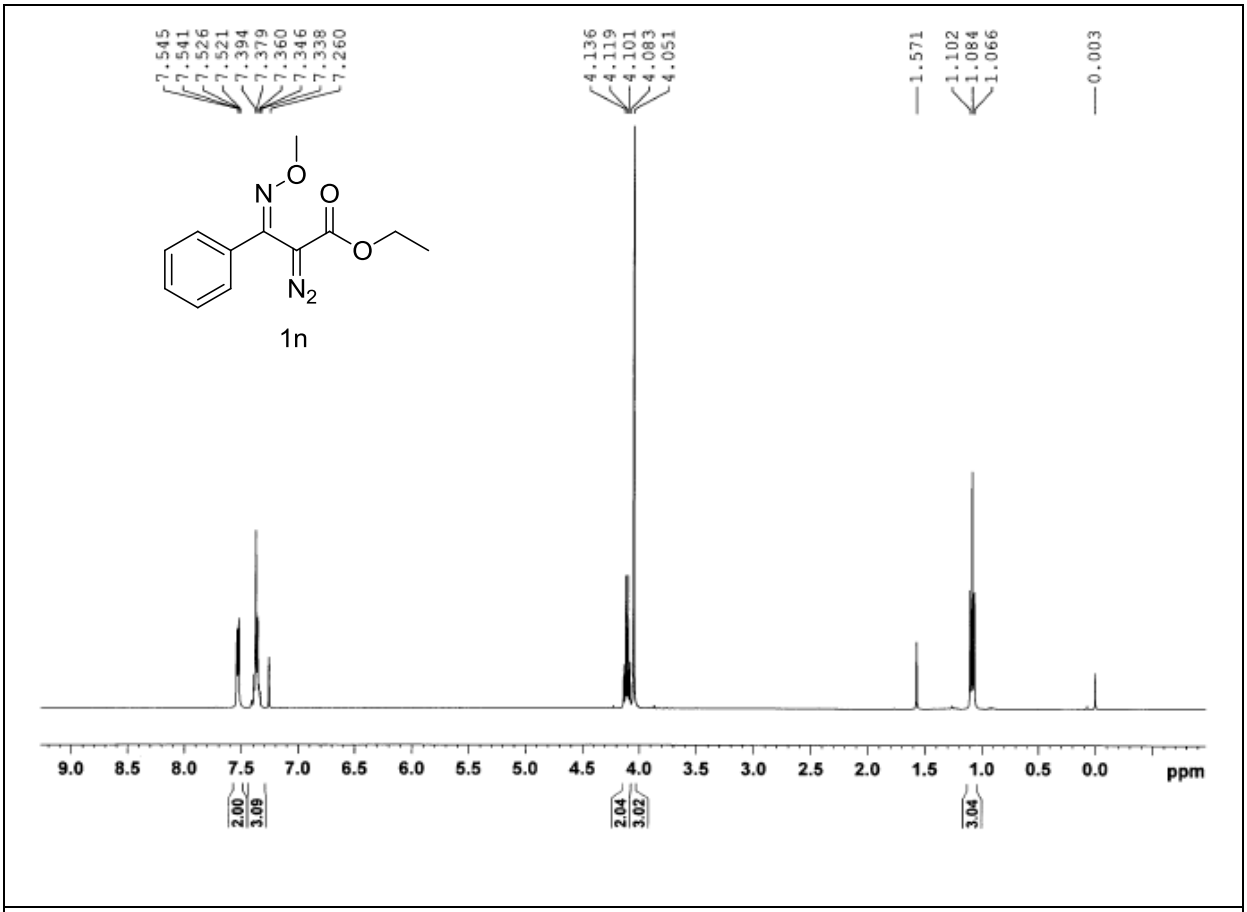
31.4562
28.3851
28.2270
21.3791
200
150
100
50
[ppm]


7.335
7.327
7.318
7.312
7.306
7.302
7.294
7.290
7.255
5.141
3.717
1.207
0.000
O
N
O
O
N2
1m
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
ppm
5.00
2.04
3.05
9.12


165.4212
149.9572
137.4620
128.2394
128.1075
127.7861
77.3193
77.0011
76.6843
76.3179
52.0597
39.0976
28.5478
200
150
100
50
[ppm]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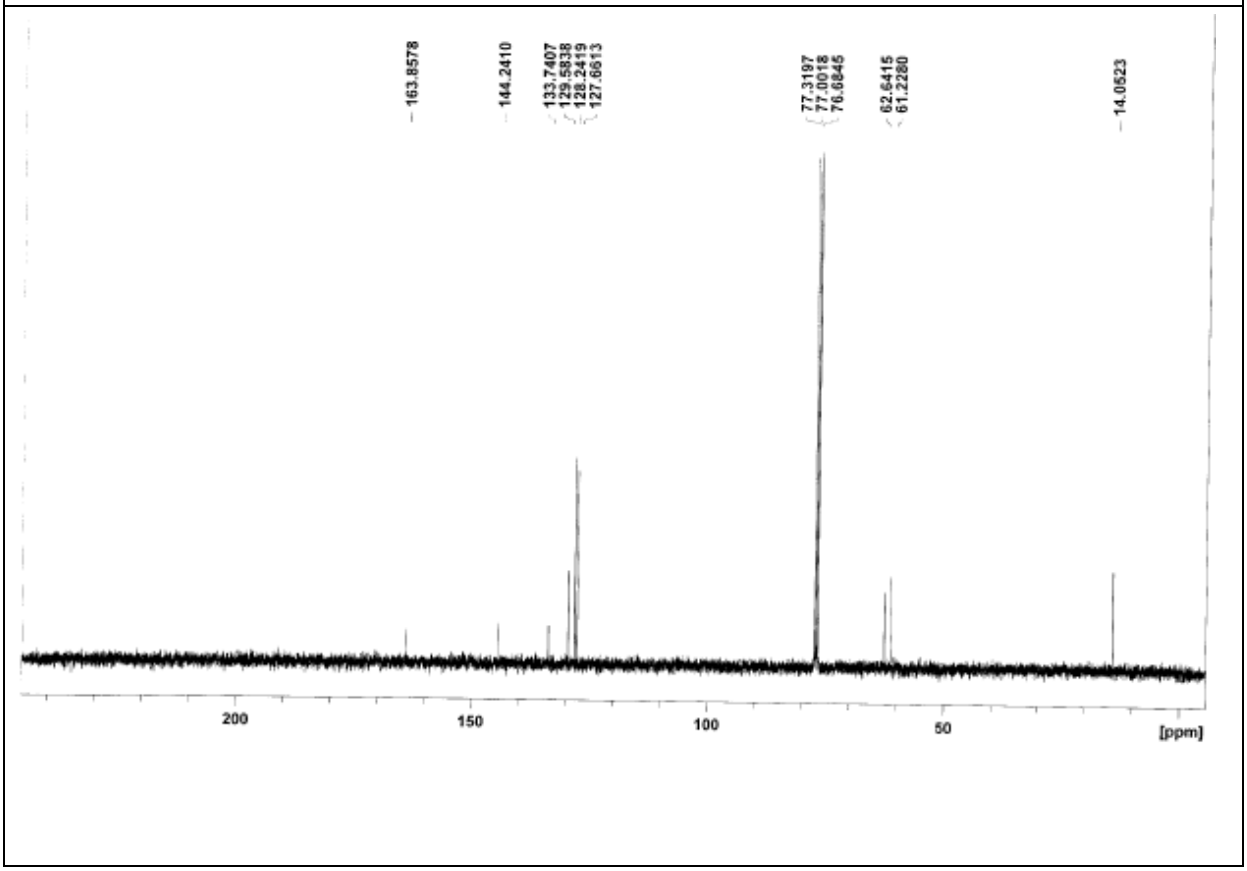
7.541
7.526
7.521
7.394
7.379
7.360
7.346
7.338
7.260
4.136
4.119
4.101
4.083
4.051
1.571
1.102
1.084
1.066
0.003
N
O
O
O
N2
1n
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
3.09
2.04
3.02
3.04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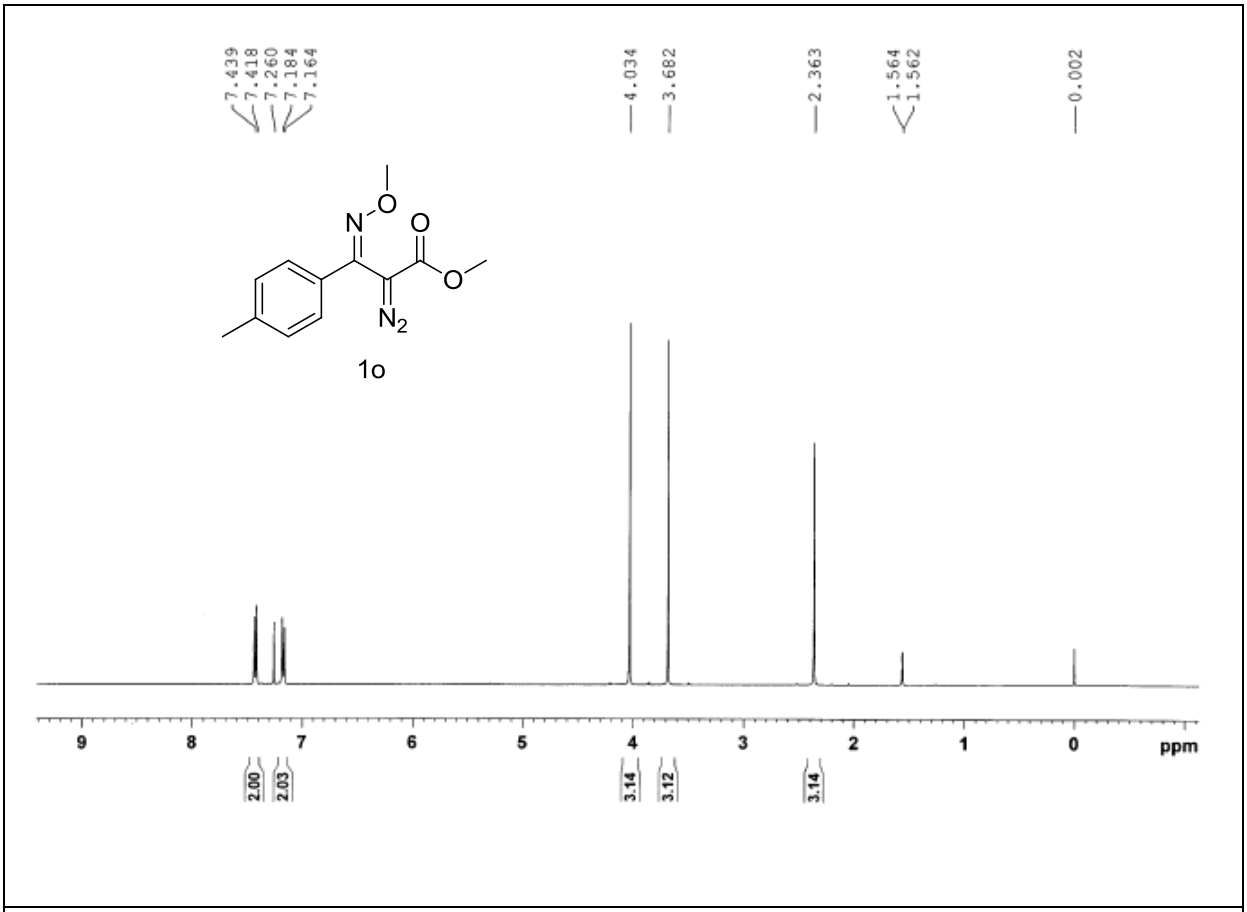
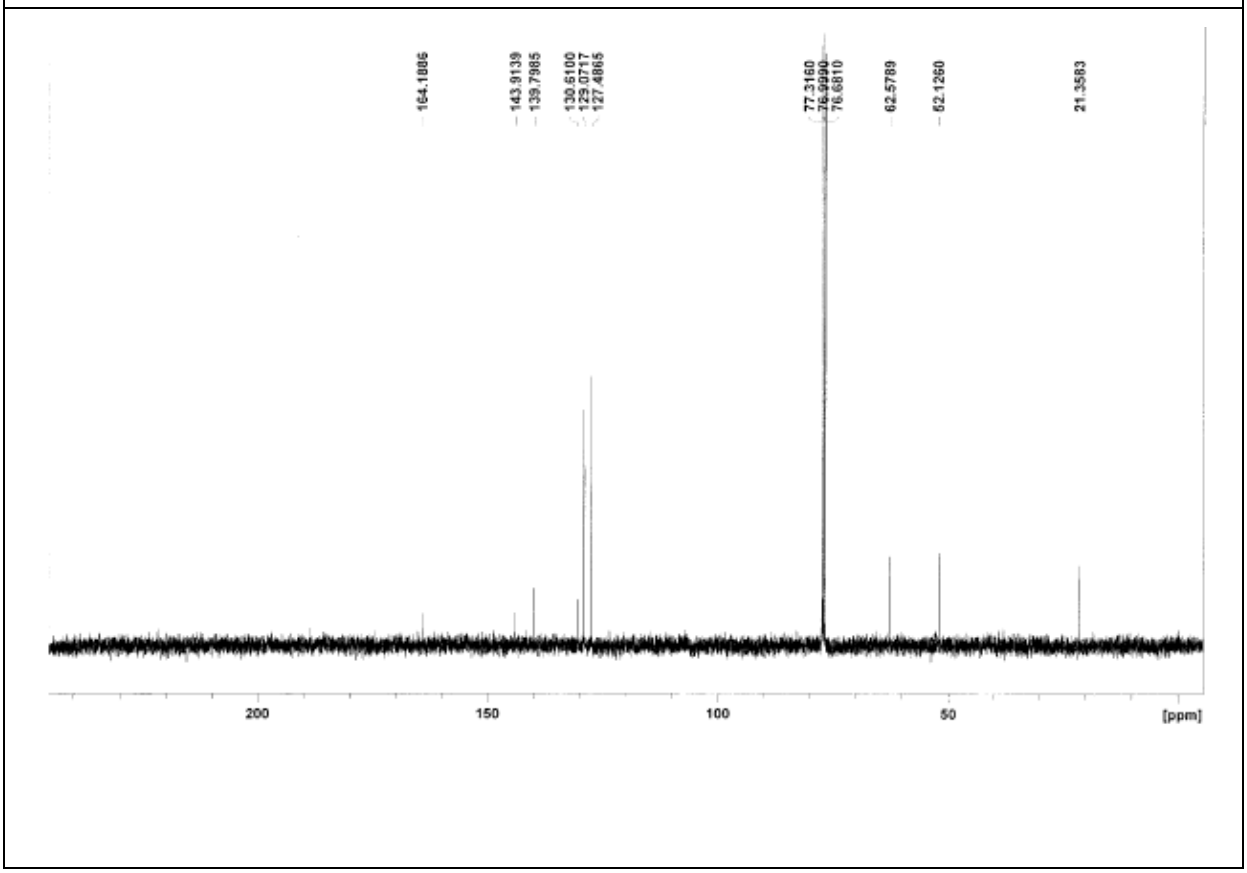
144.2410
133.7407
129.5838
128.2419
127.6613
77.3197
77.0018
76.6845
62.6415
61.2280
14.0523
200 150 100 50 [ppm]


7.439
7.418
7.260
7.184
7.164
4.034
3.682
2.363
1.564
1.562
0.002
N
O
O
O
N2
1o
9
8
7
6
5
4
3
2
1
0
ppm
2.00
2.03
3.14
3.12
3.14


164.1886
143.9139
139.7985
130.6100
129.0717
127.4865
77.3160
76.9990
76.6810
62.5789
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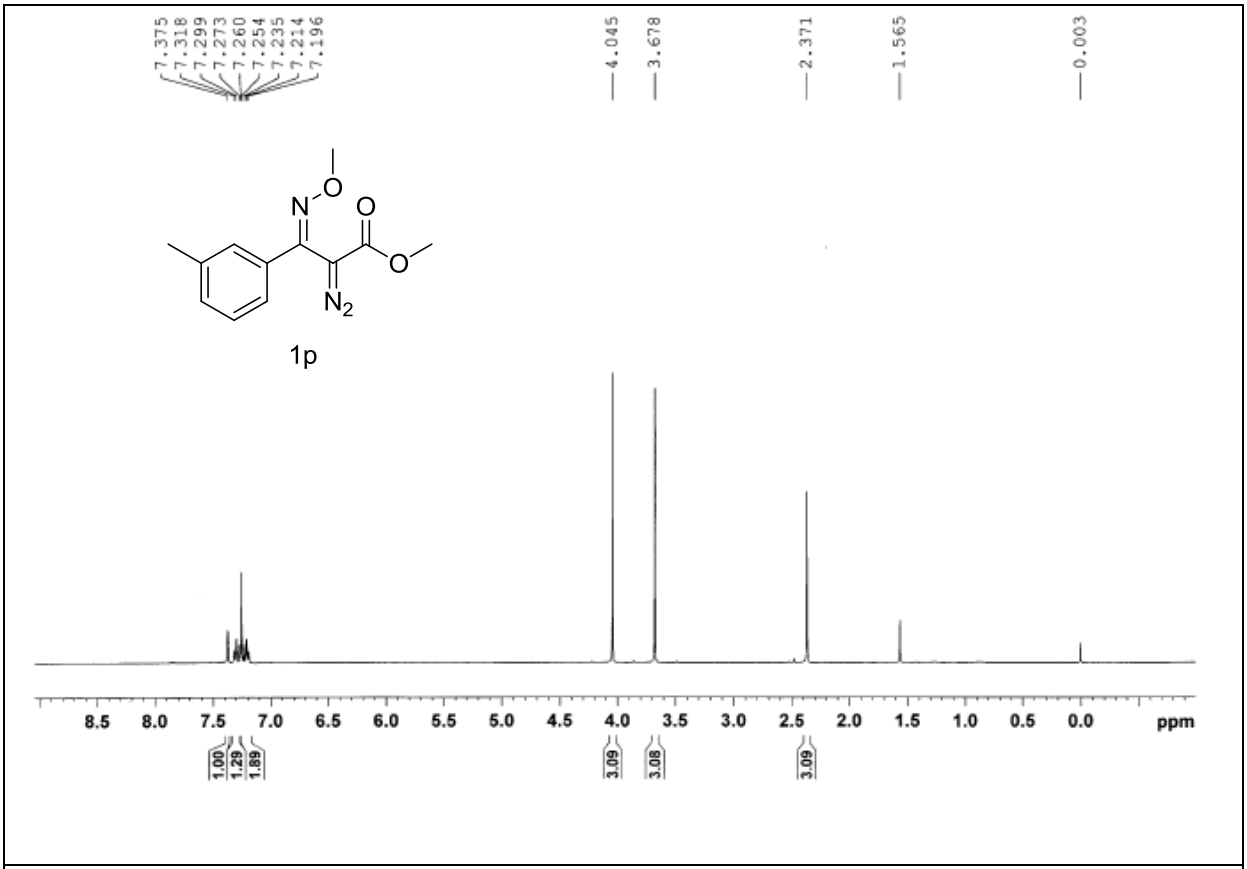
21.3583
200
150
100
50
[ppm]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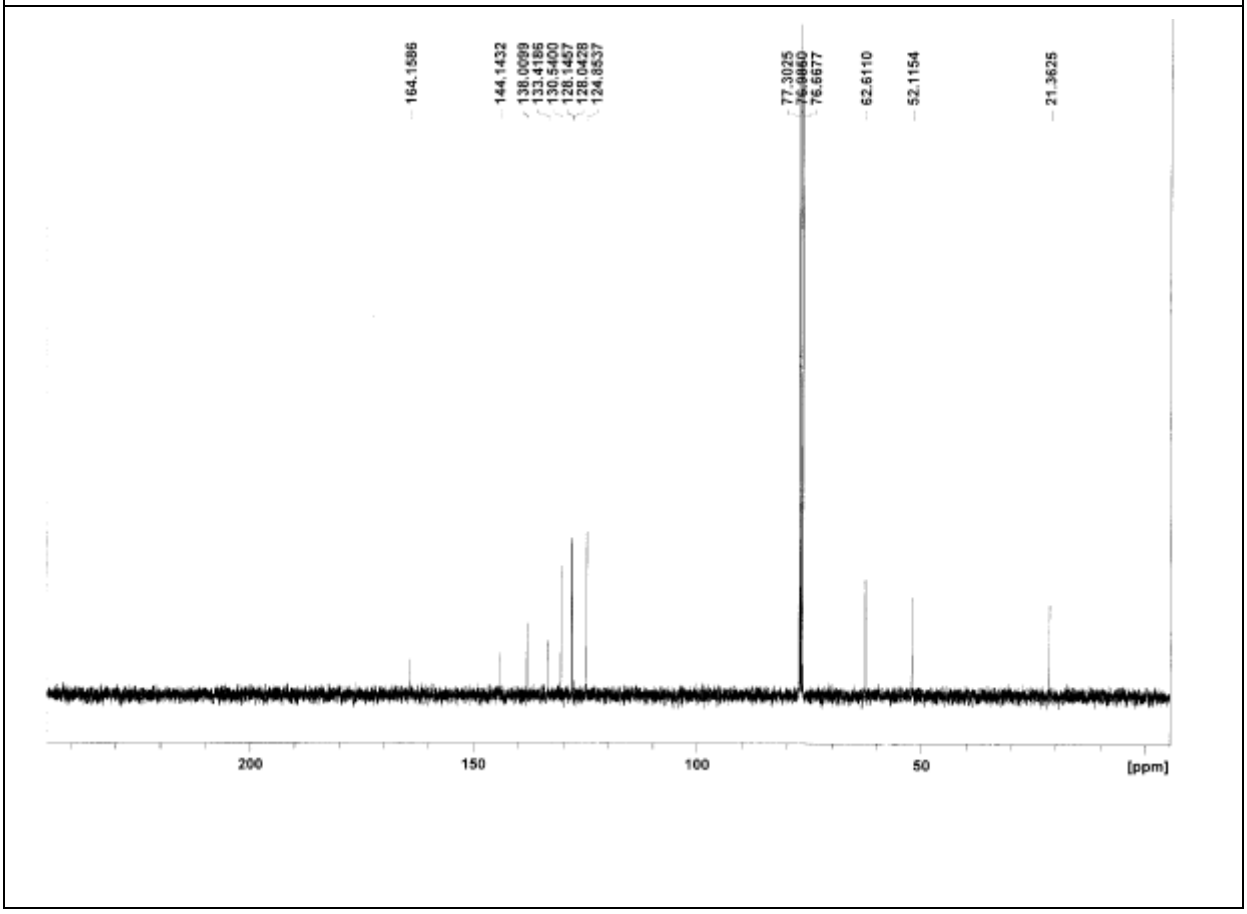
7.318
7.299
7.273
7.260
7.254
7.235
7.214
7.196
4.045
3.678
2.371
1.565
0.003
N
O
O
O
N2
1p
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
1.00
1.29
1.89
3.09
3.08
3.09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138.0099
133.4185
130.5400
128.1457
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77.3025
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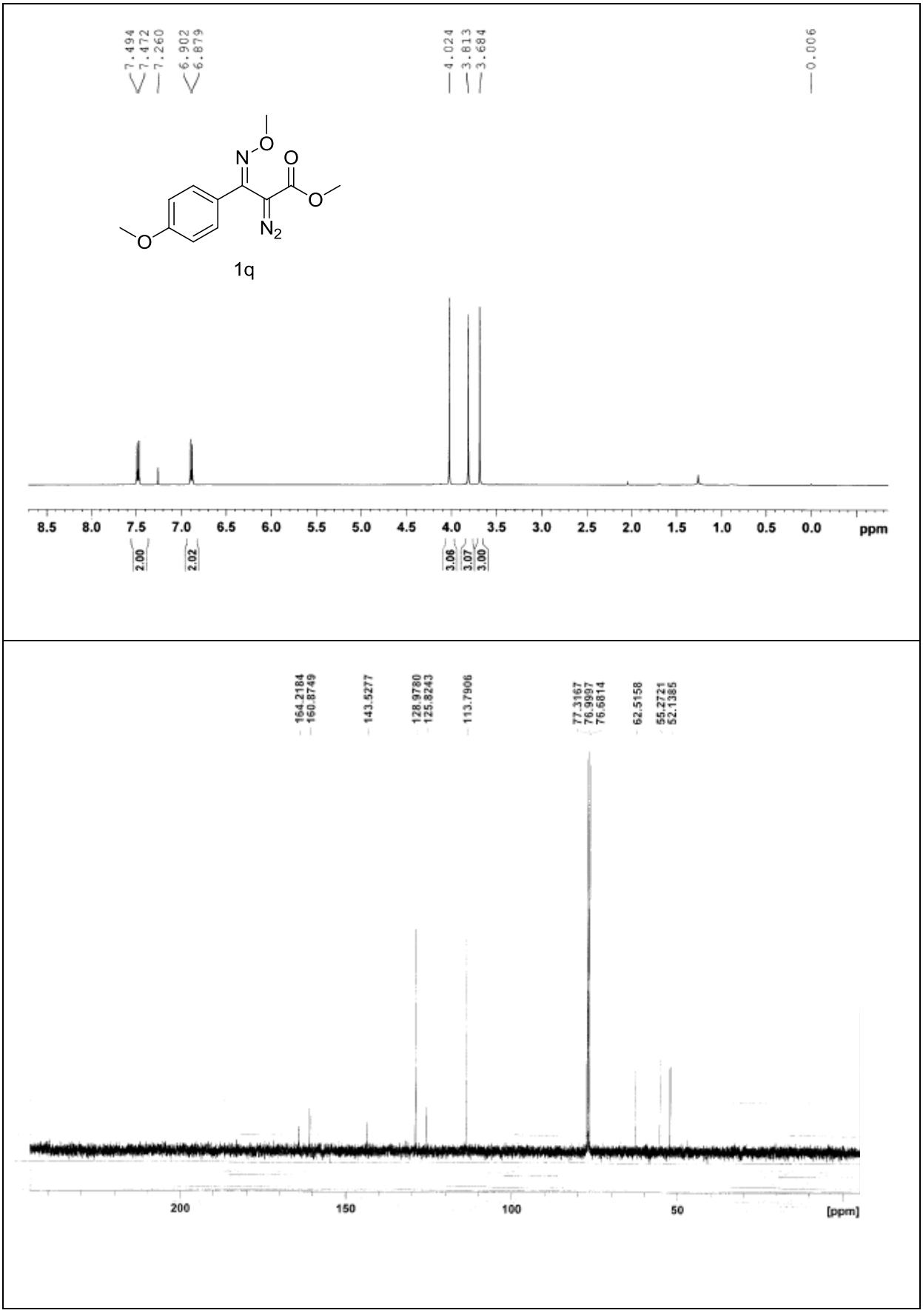
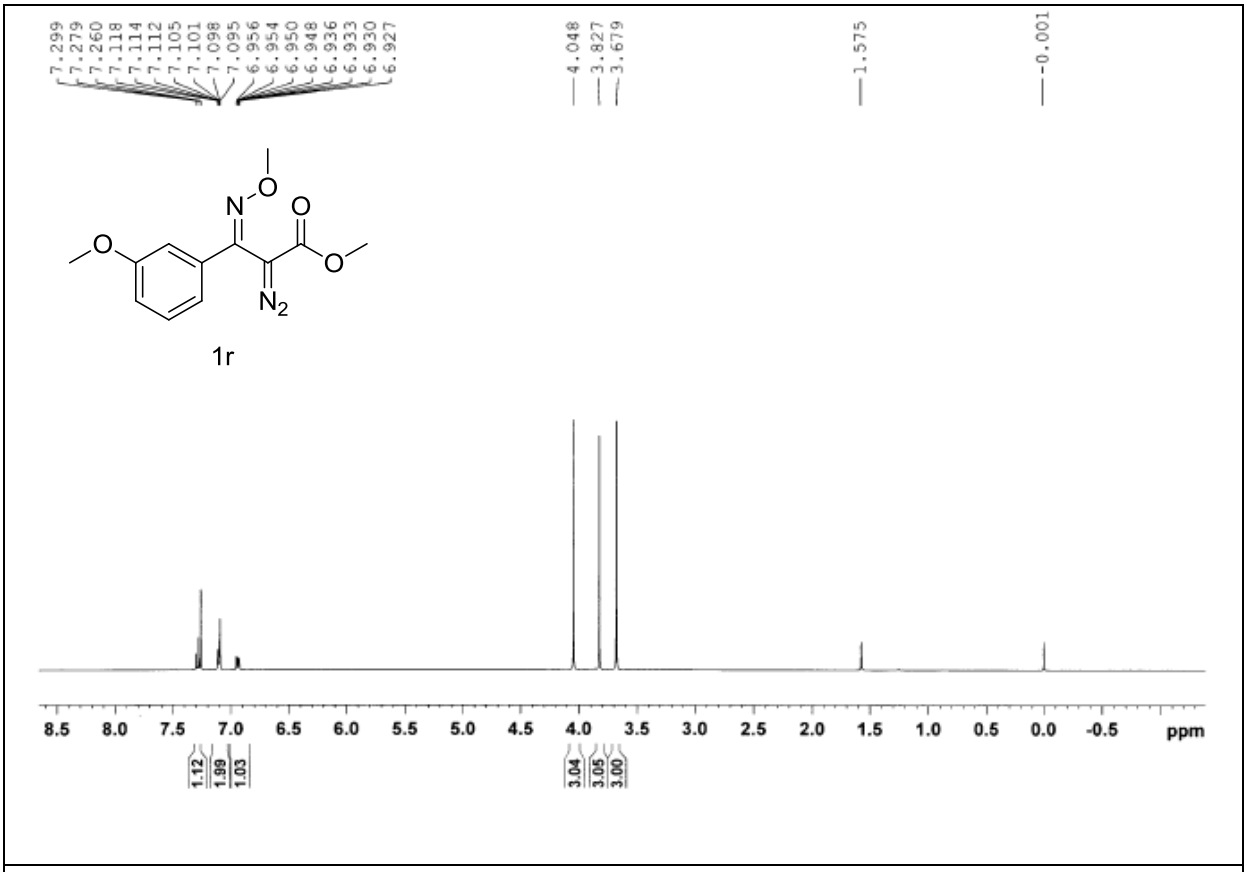
62.6110
52.1154
21.3625
200
150
100
50
[ppm]

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7.279
7.260
7.118
7.114
7.112
7.105
7.101
7.098
7.095
6.956
6.954
6.950
6.948
6.936
6.933
6.930
6.927
4.048
3.827
3.679
1.575
0.001
N
O
O
O
O
N2
1r
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
-0.5
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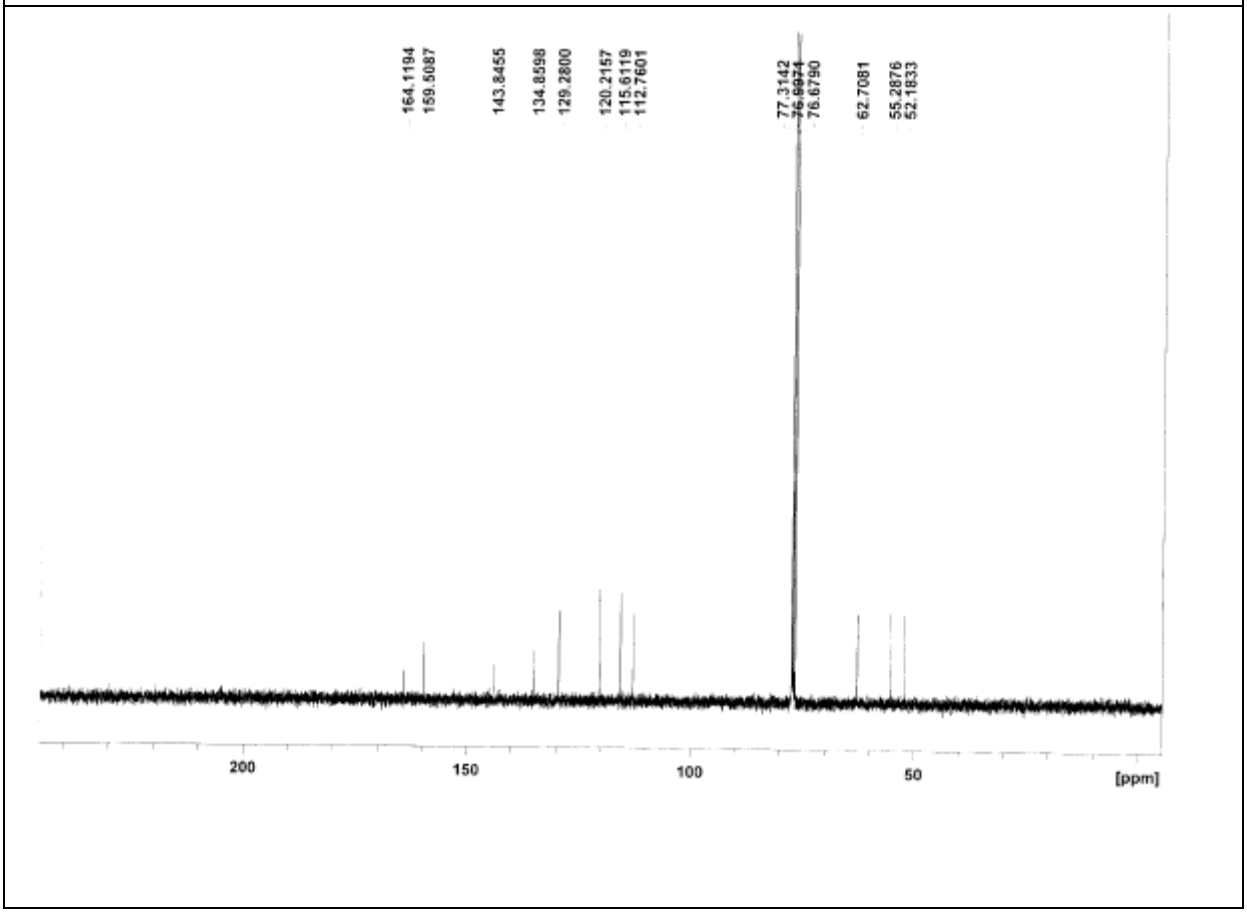
1.99
1.03
3.04
3.05
3.00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143.8455
134.8598
129.2800
120.2157
115.6119
112.7601
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76.6974
76.6790
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52.1833
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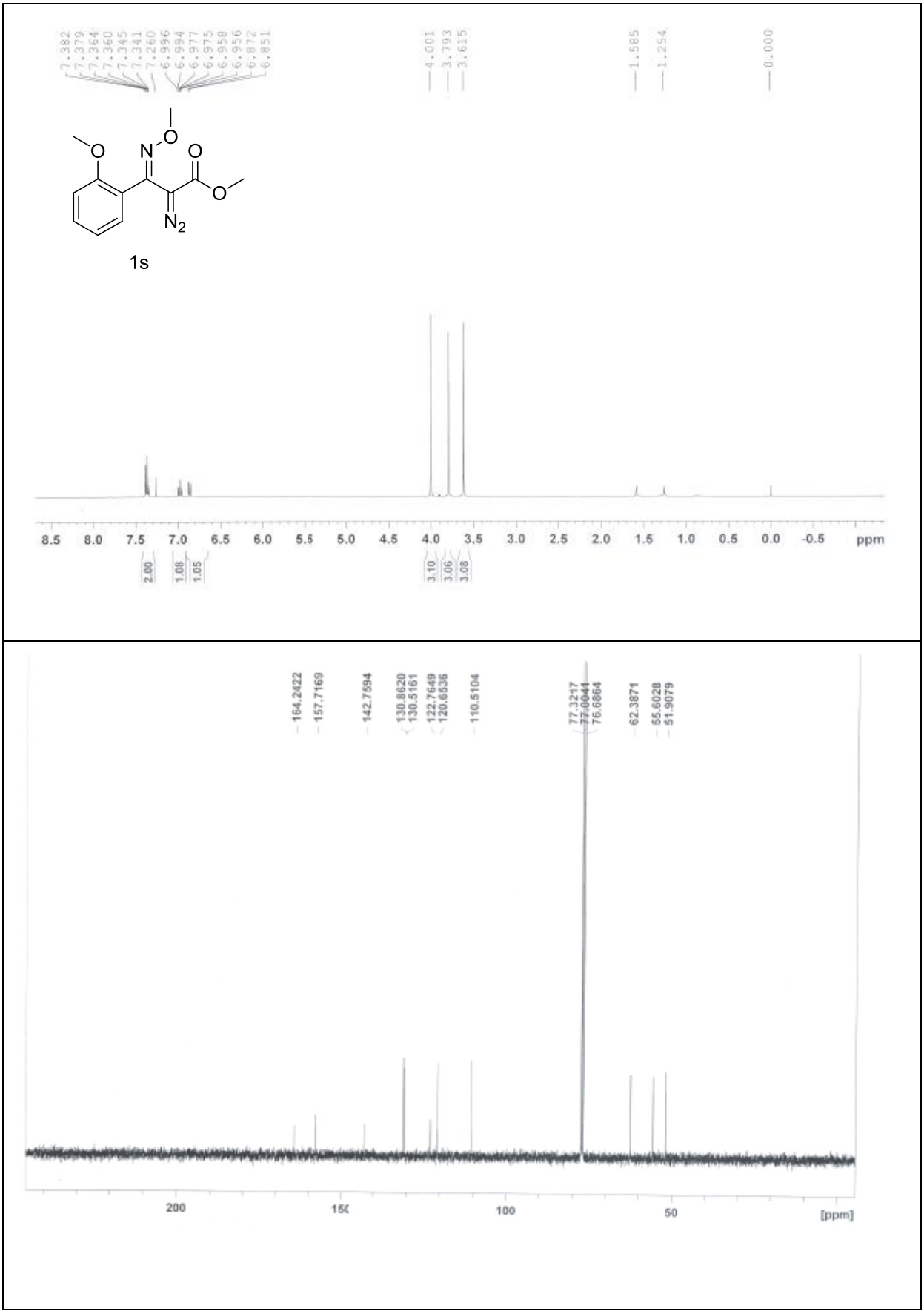
100
50
[ppm]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7.360
7.345
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7.260
6.996
6.994
6.977
6.975
6.958
6.956
6.872
6.851
4.001
3.793
3.615
1.585
1.254
0.000
O
N
O
O
O
N2
1s
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
ppm
2.00
1.08
1.05
3.10
3.06
3.08
164.2422
157.7169
142.7594
130.8620
130.5161
122.7649
120.6536
110.5104
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77.0041
76.6864
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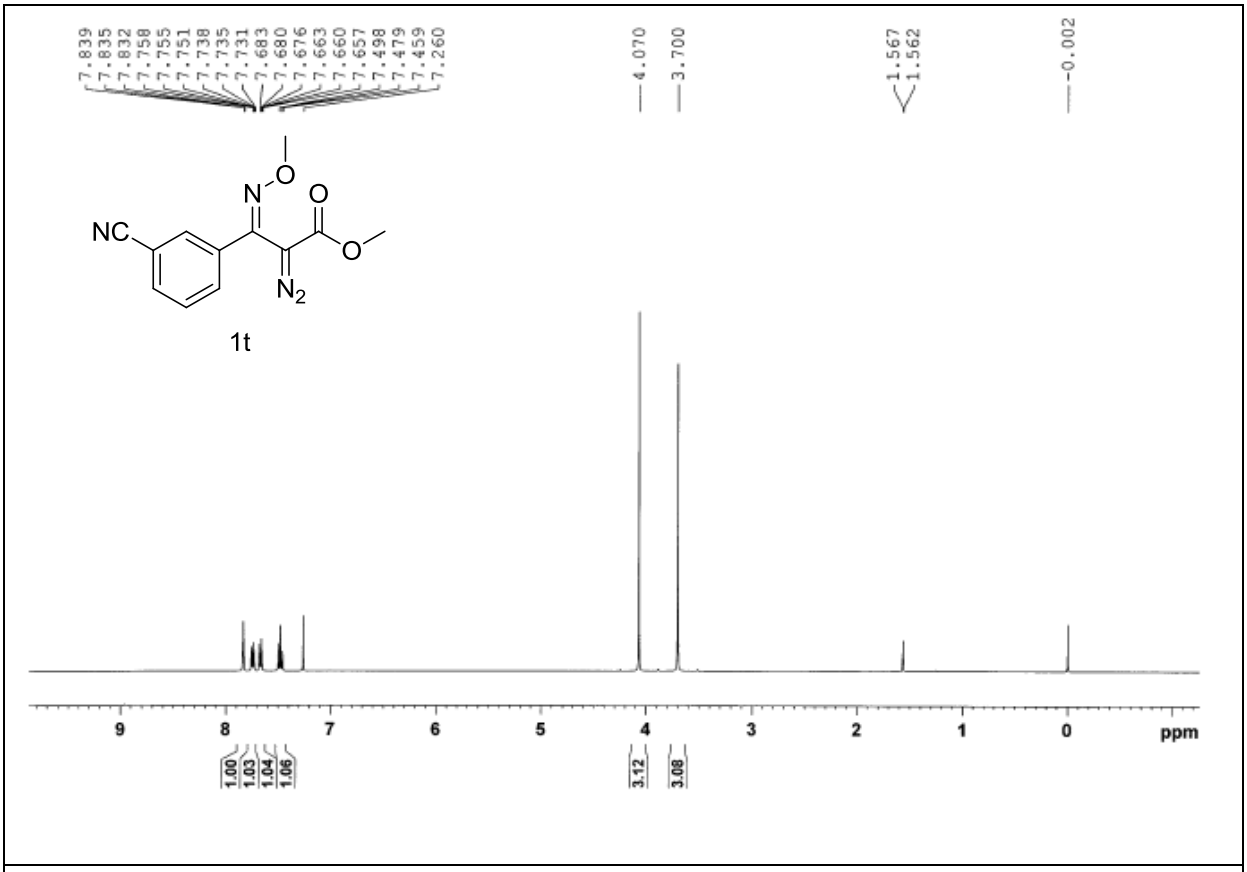
51.9079
200
150
100
50
[ppm]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7.832
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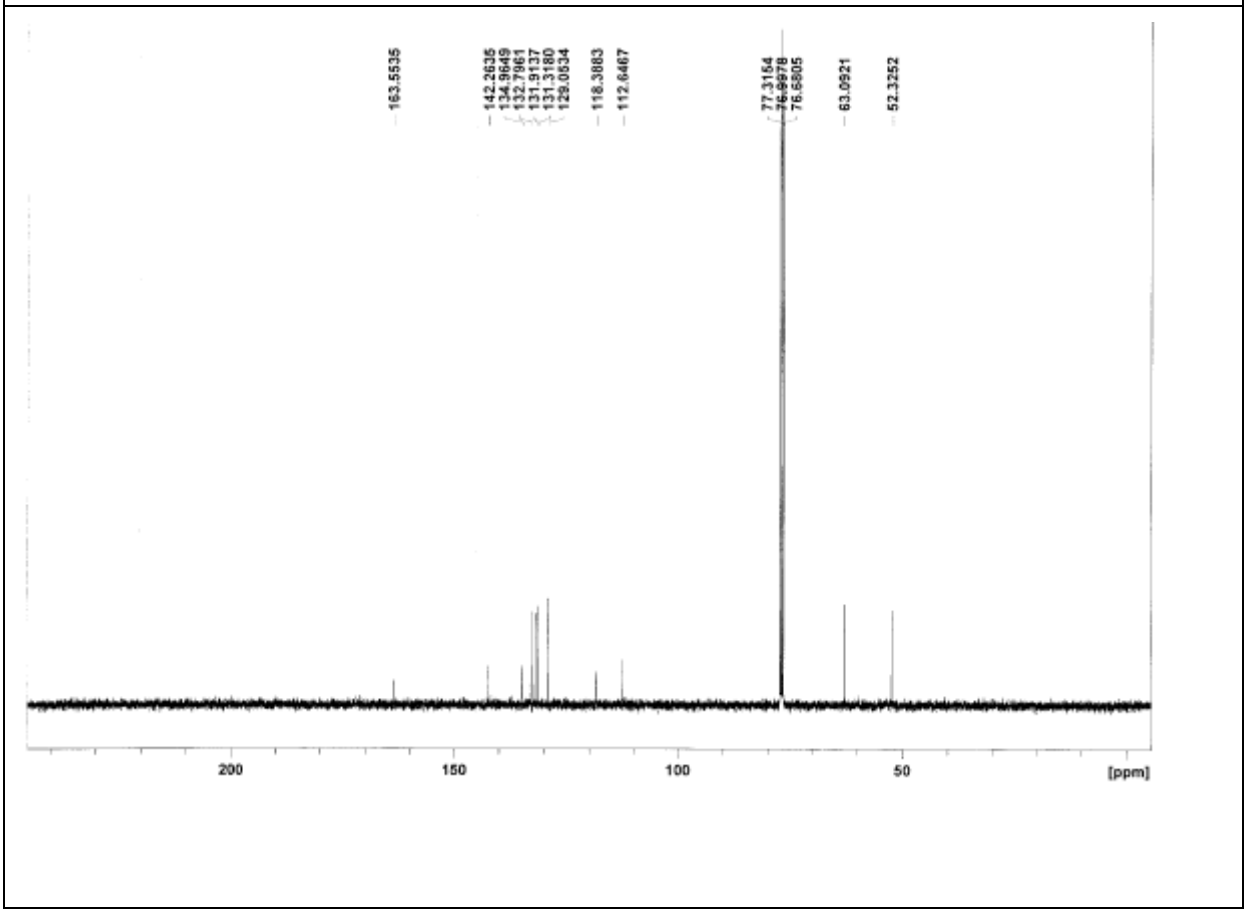
7.751
7.738
7.735
7.731
7.683
7.680
7.676
7.663
7.660
7.657
7.498
7.479
7.459
7.260
4.070
3.700
1.567
1.562
0.002
NC
N
O
O
O
N2
1t
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.03
1.04
1.06
3.12
3.08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131.9137
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129.0534
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76.6805
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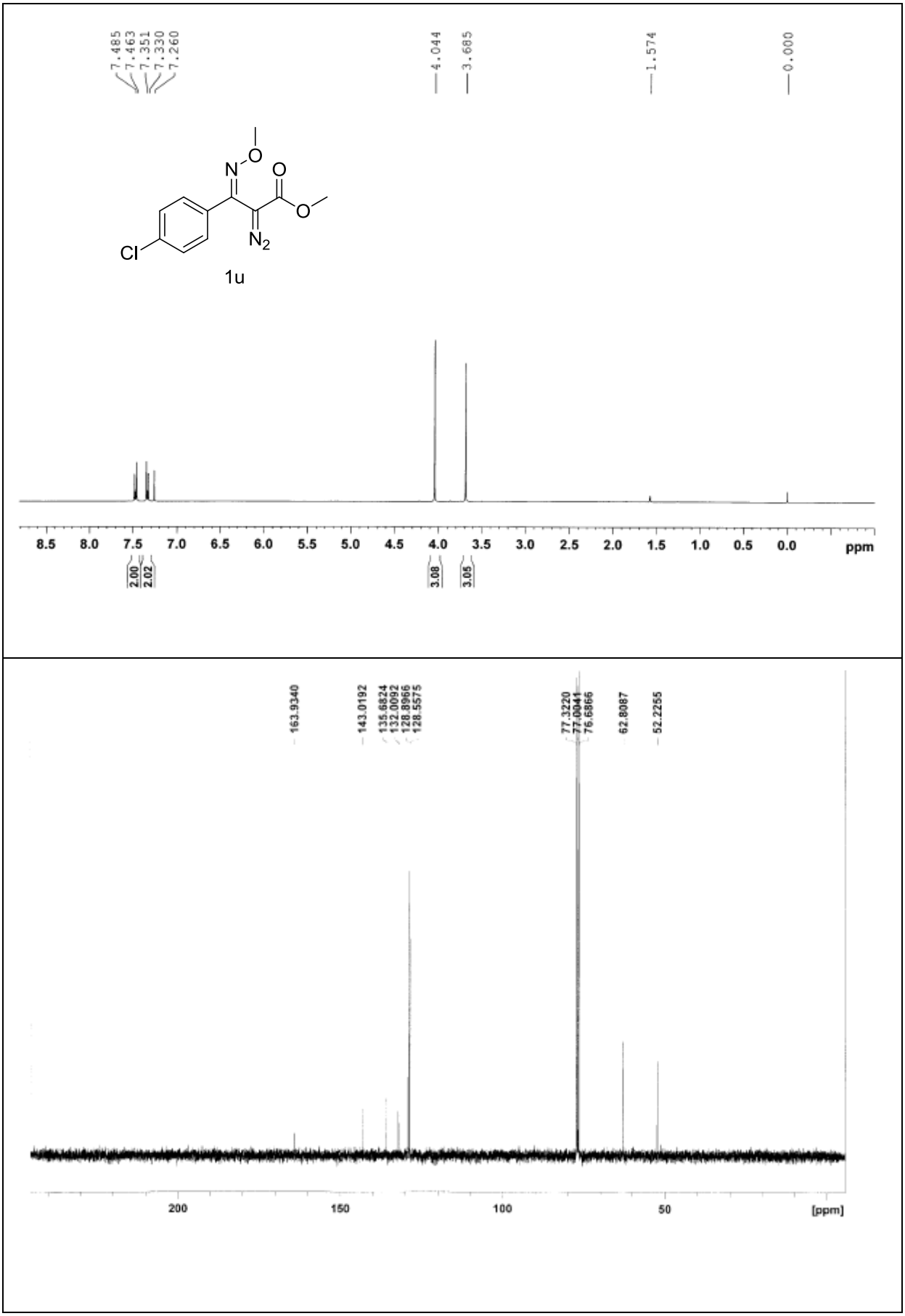
52.3252
200
150
100
50
[ppm]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4.044
3.685
1.574
0.000
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O
O
O
N2
Cl
1u
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
2.02
3.08
3.05
163.9340
143.0192
135.6824
132.0092
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77.3220
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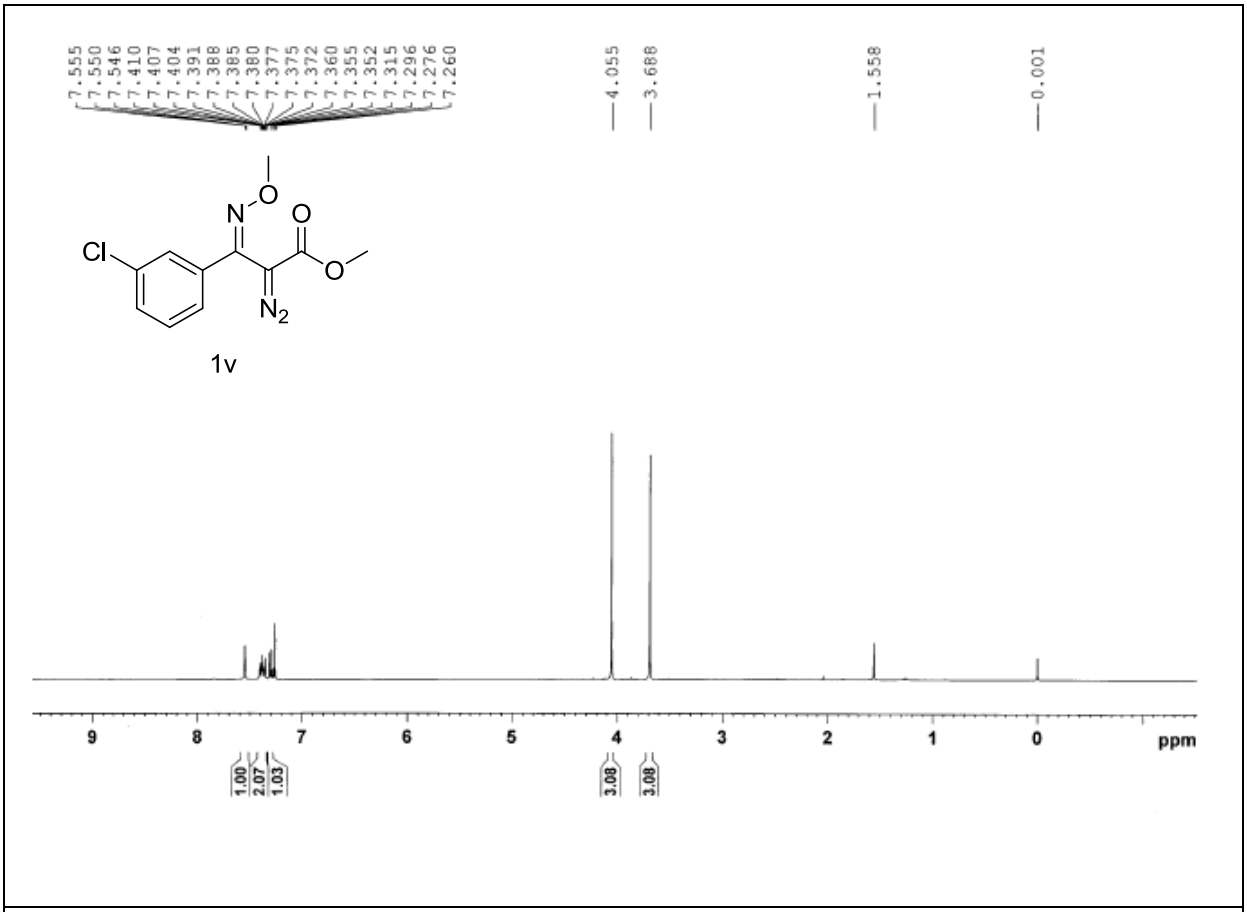
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7.407
7.404
7.391
7.388
7.385
7.380
7.377
7.375
7.372
7.360
7.355
7.352
7.315
7.296
7.276
7.260
4.055
3.688
1.558
0.001
Cl
N
O
O
O
N2
1v
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8
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6
5
4
3
2
1
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1.00
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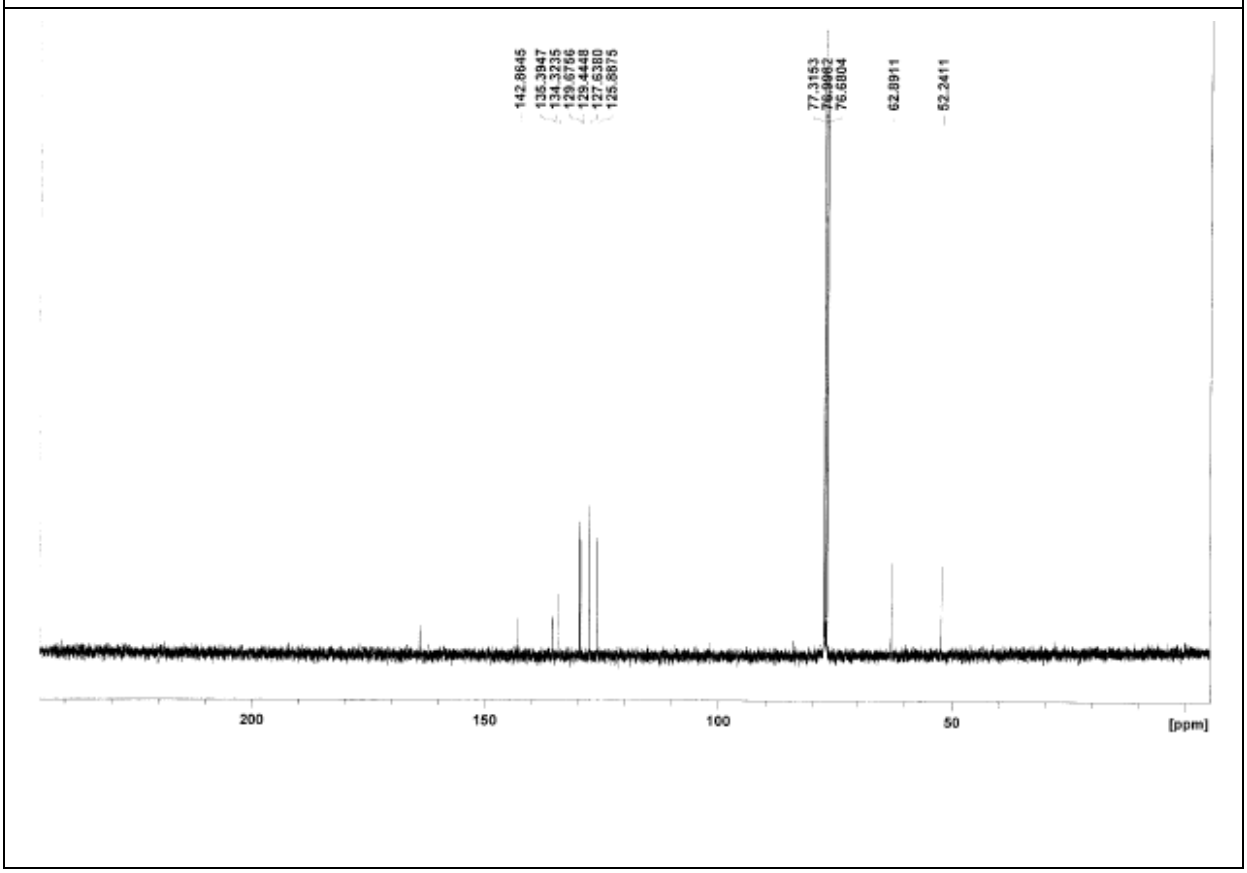
3.08
3.08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129.4448
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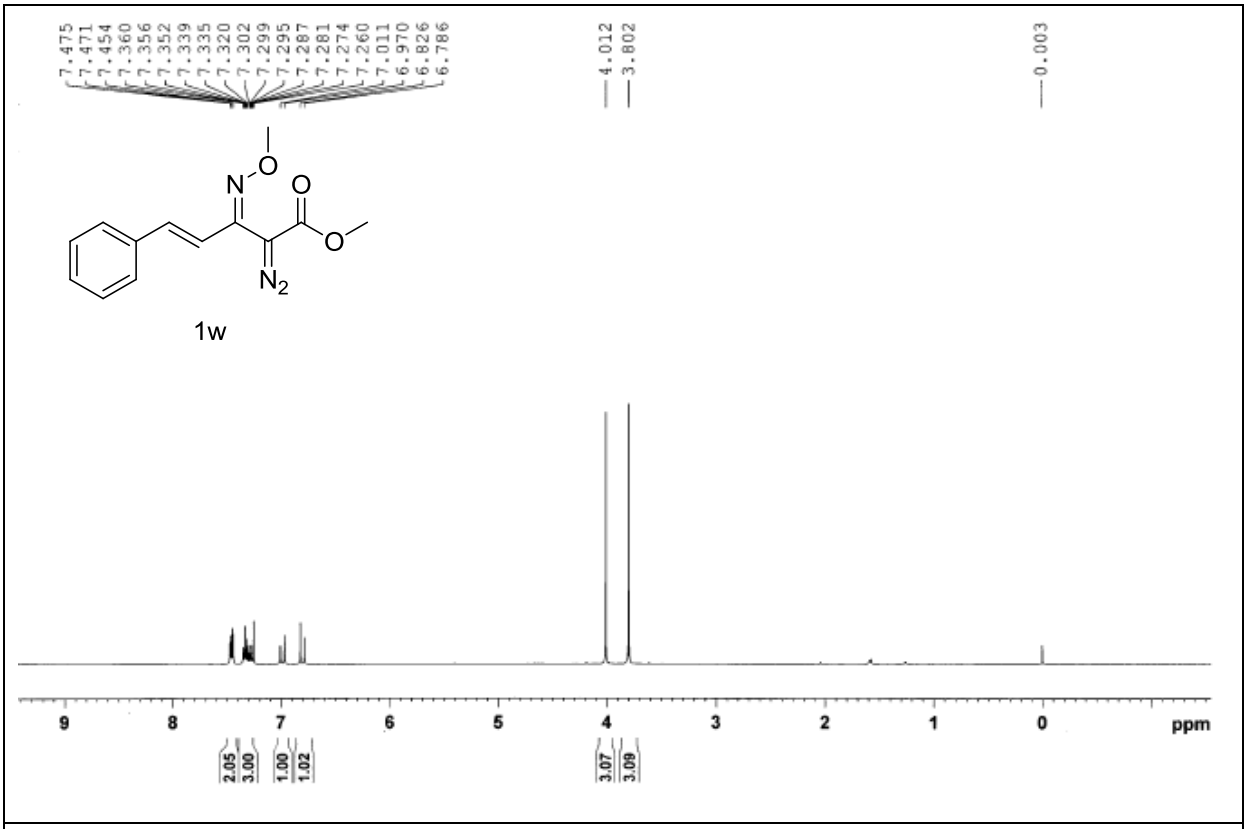
52.2411
200
150
100
50
[ppm]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7.360
7.356
7.352
7.339
7.335
7.320
7.302
7.299
7.295
7.287
7.281
7.274
7.260
7.011
6.970
6.826
6.786
4.012
3.802
0.003
N
O
O
O
N2
1w
9
8
7
6
5
4
3
2
1
0
ppm
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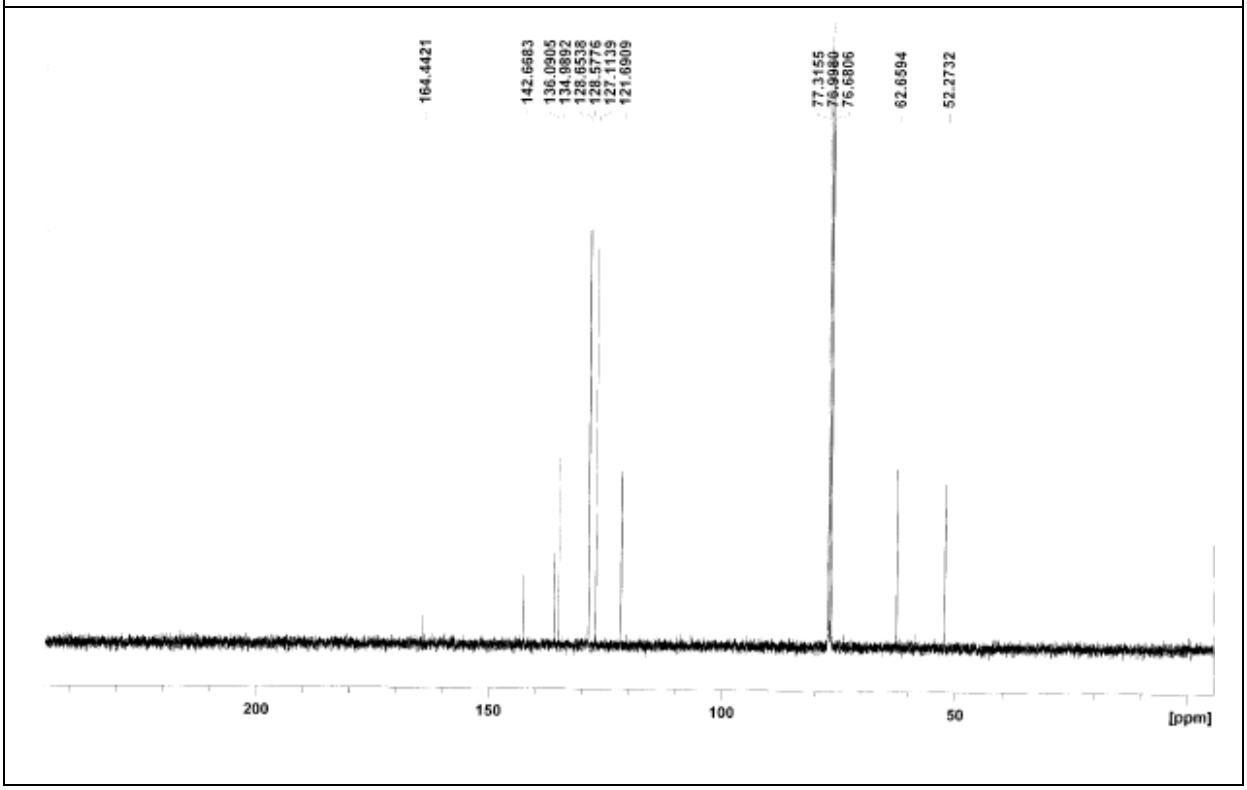
3.00
1.00
1.02
3.07
3.09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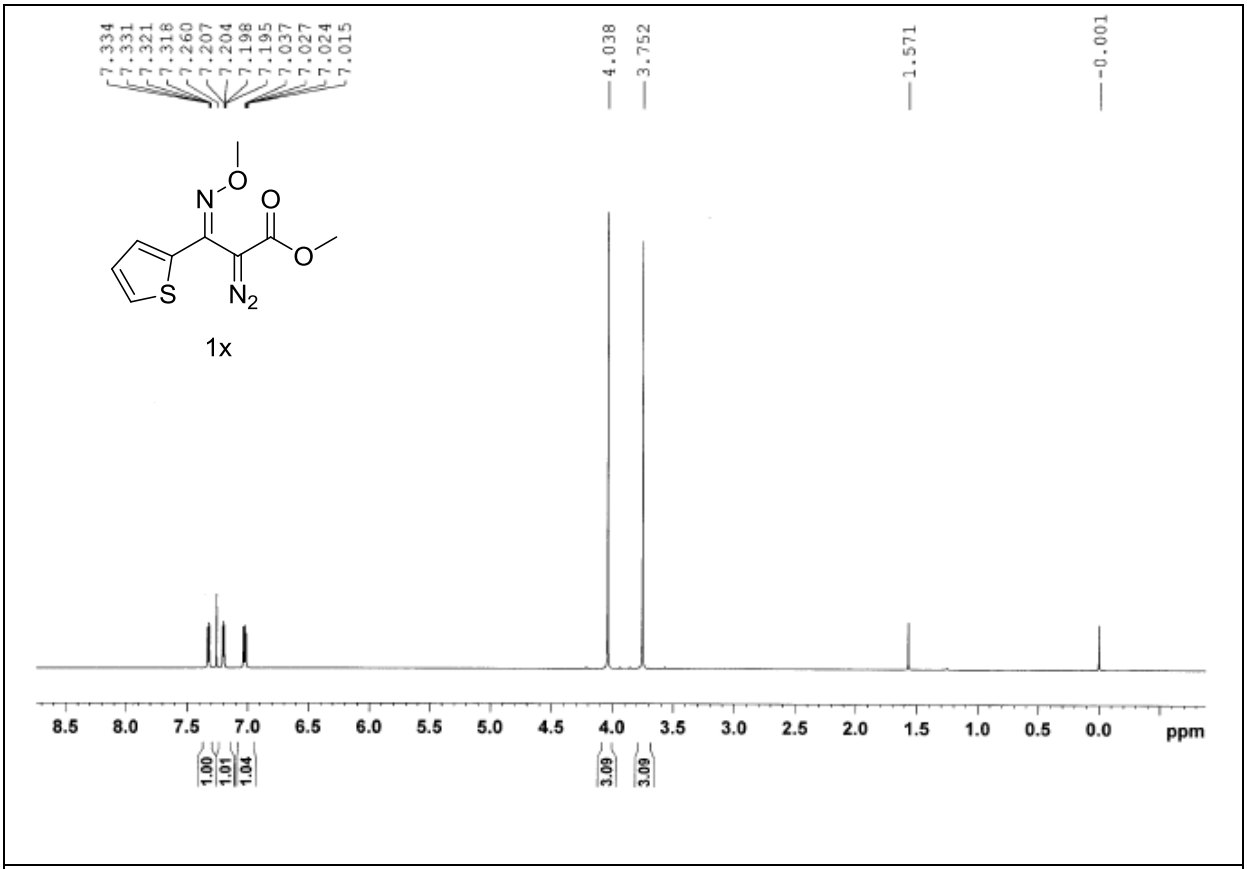
52.2732
200
150
100
50
[ppm]


7.334
7.331
7.321
7.318
7.260
7.207
7.204
7.198
7.195
7.037
7.027
7.024
7.015
4.038
3.752
1.571
0.001
N
O
O
O
S
N2
1x
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
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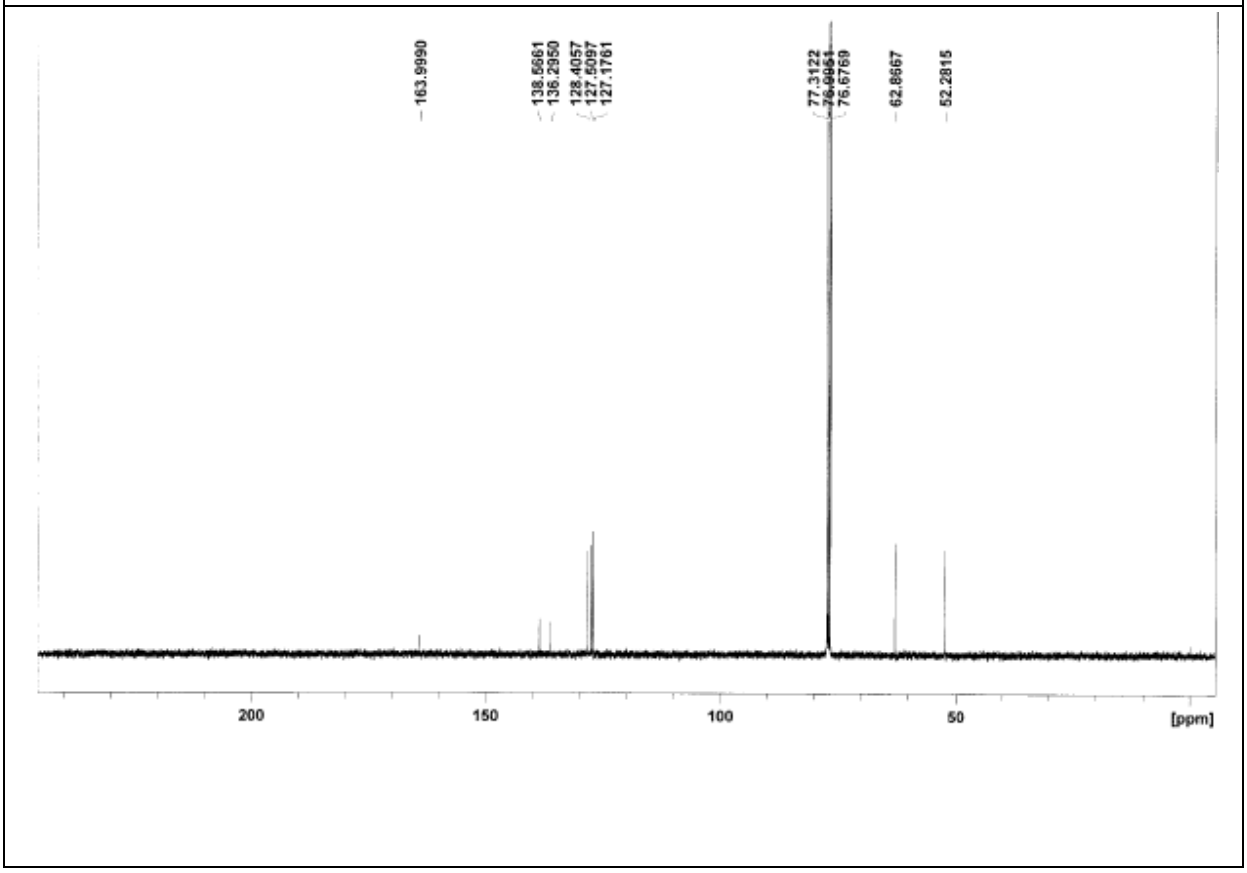
1.5
1.0
0.5
0.0
ppm
1.00
1.01
1.04
3.09
3.09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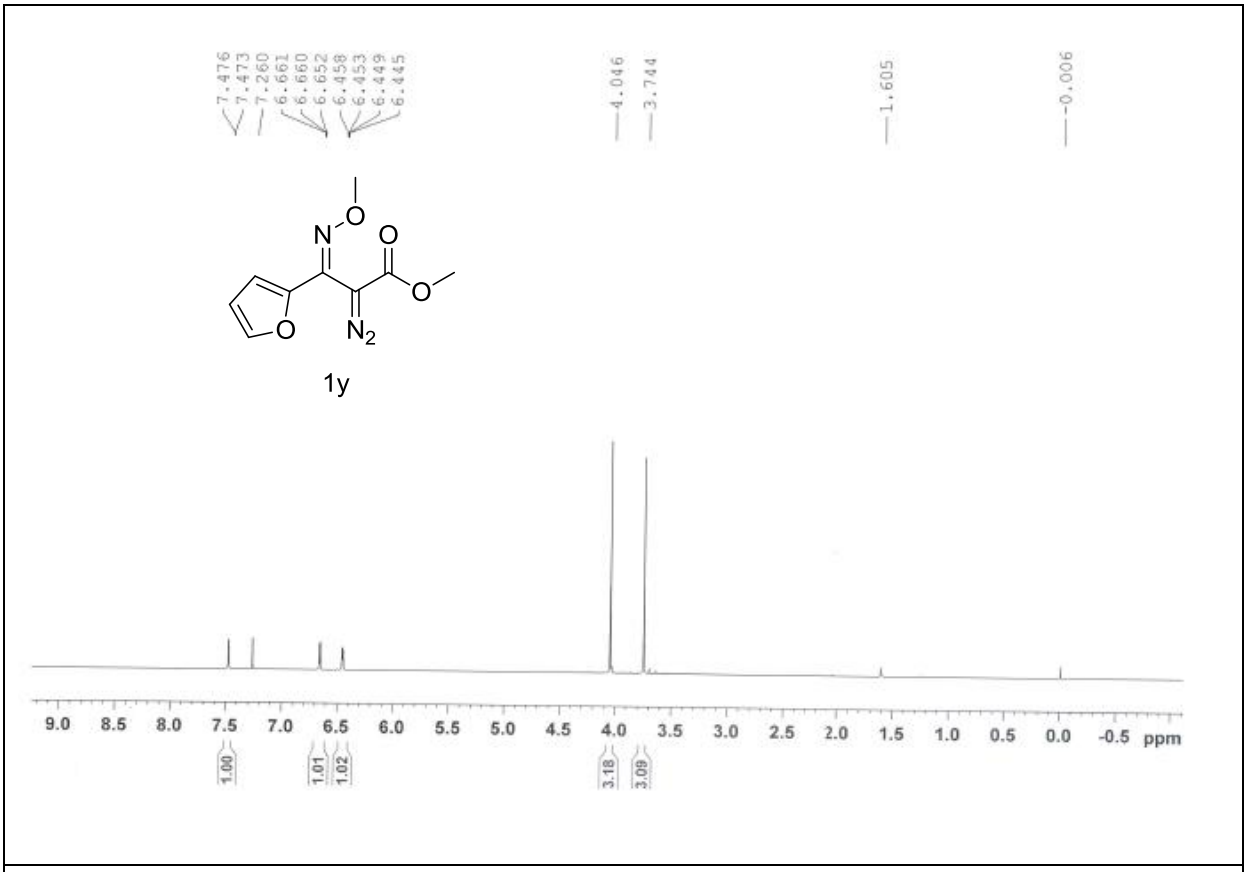
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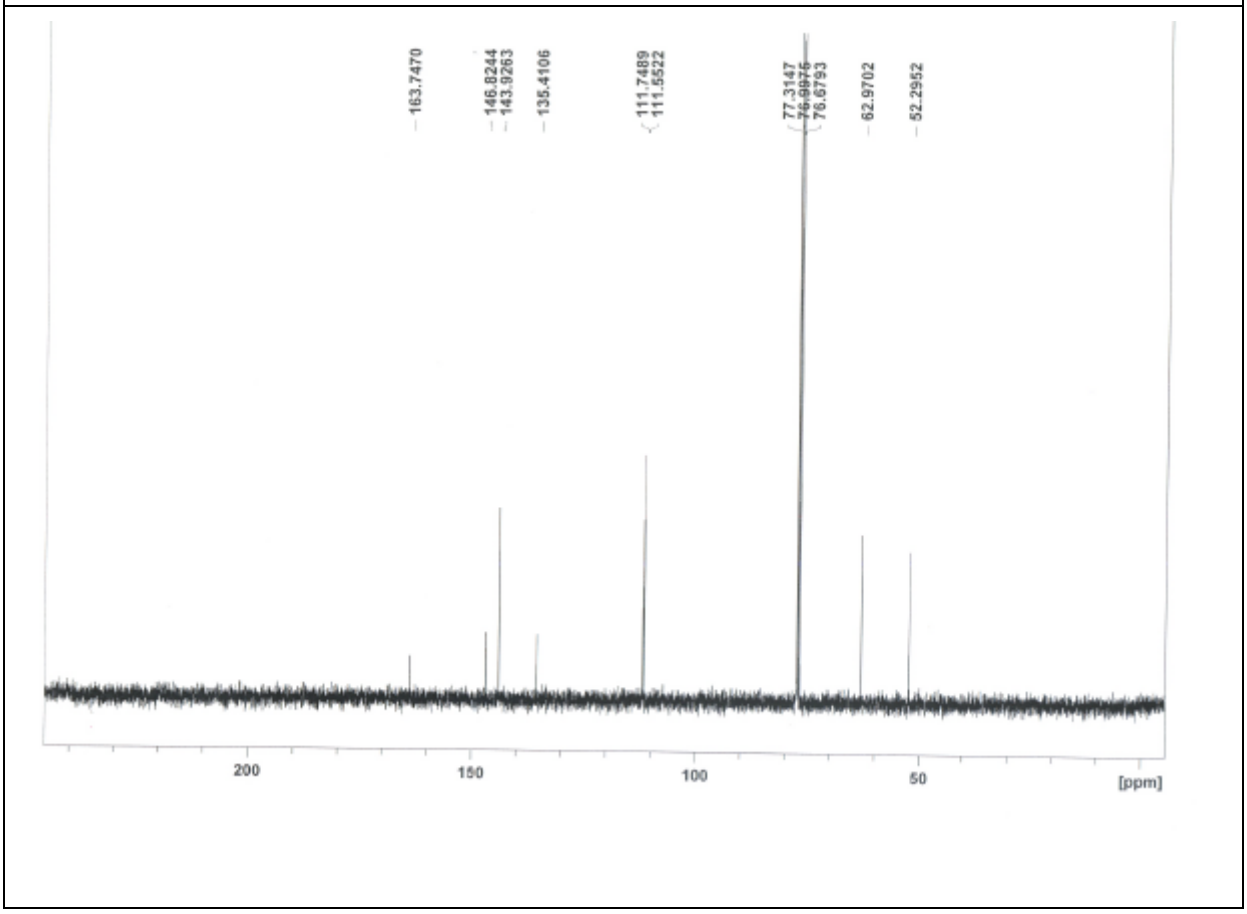
6.453
6.449
6.445
4.046
3.744
1.605
0.006
N
O
O
O
O
N2
1y
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
1.00
1.01
1.02
3.18
3.09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143.9263
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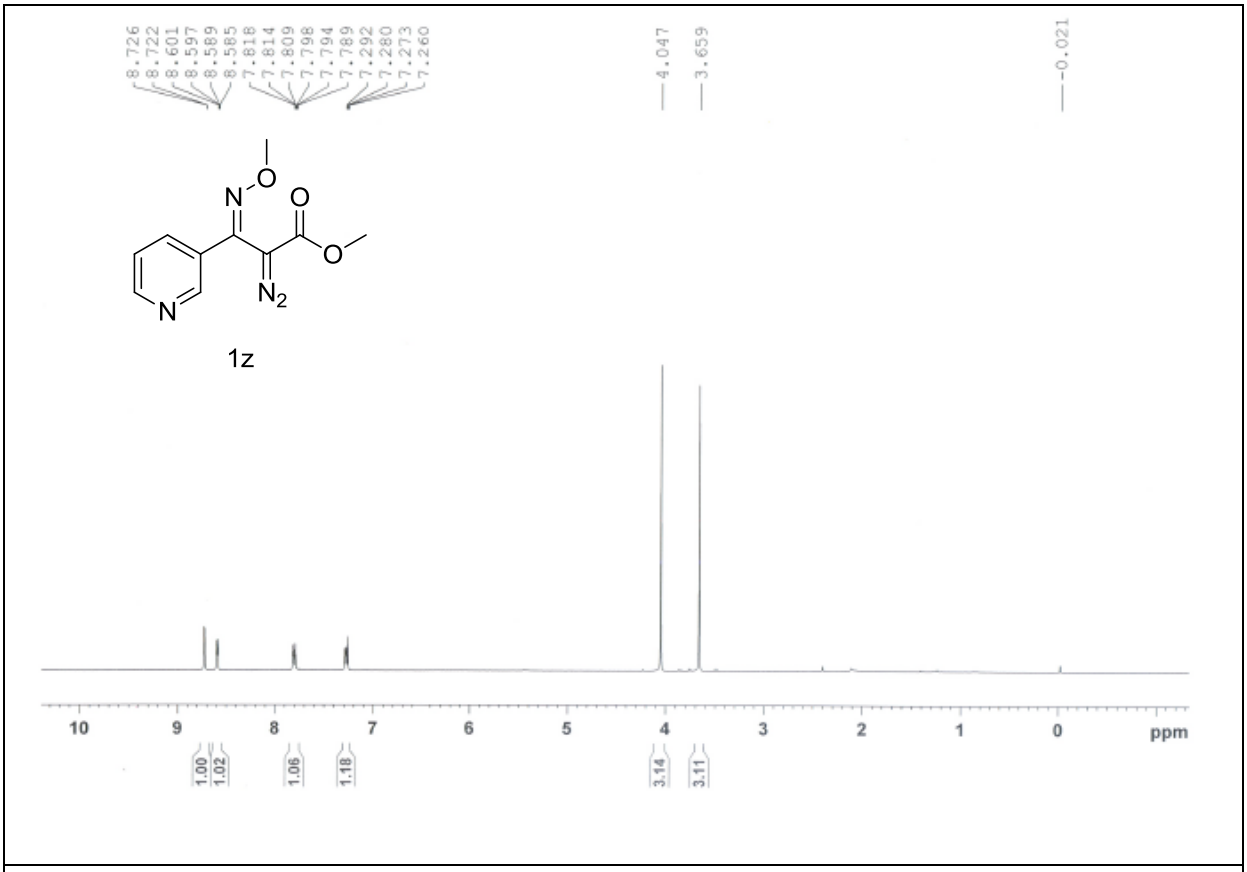
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7.814
7.809
7.798
7.794
7.789
7.292
7.280
7.273
7.260
4.047
3.659
0.021
N
O
O
O
N2
N
1z
10
9
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7
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4
3
2
1
0
ppm
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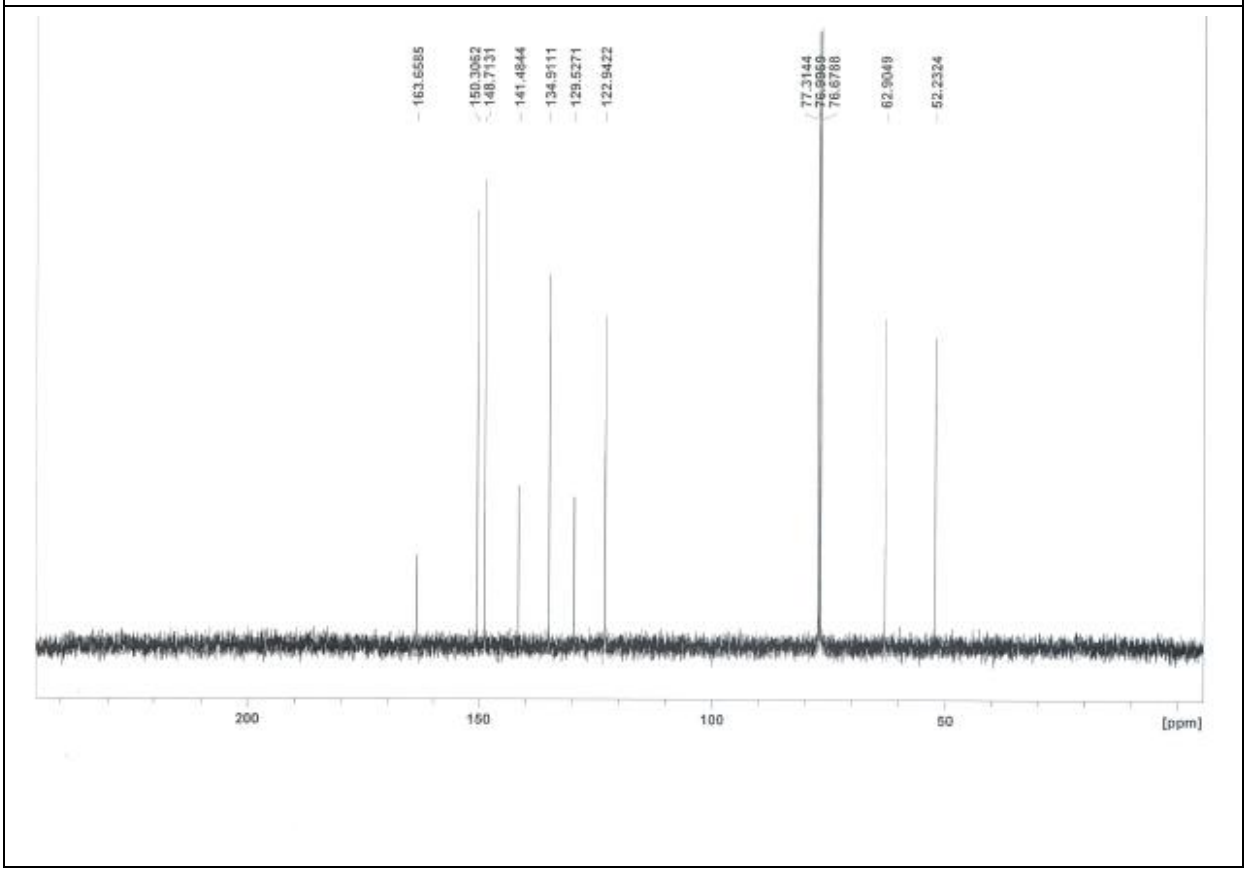
1.02
1.06
1.18
3.14
3.11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100
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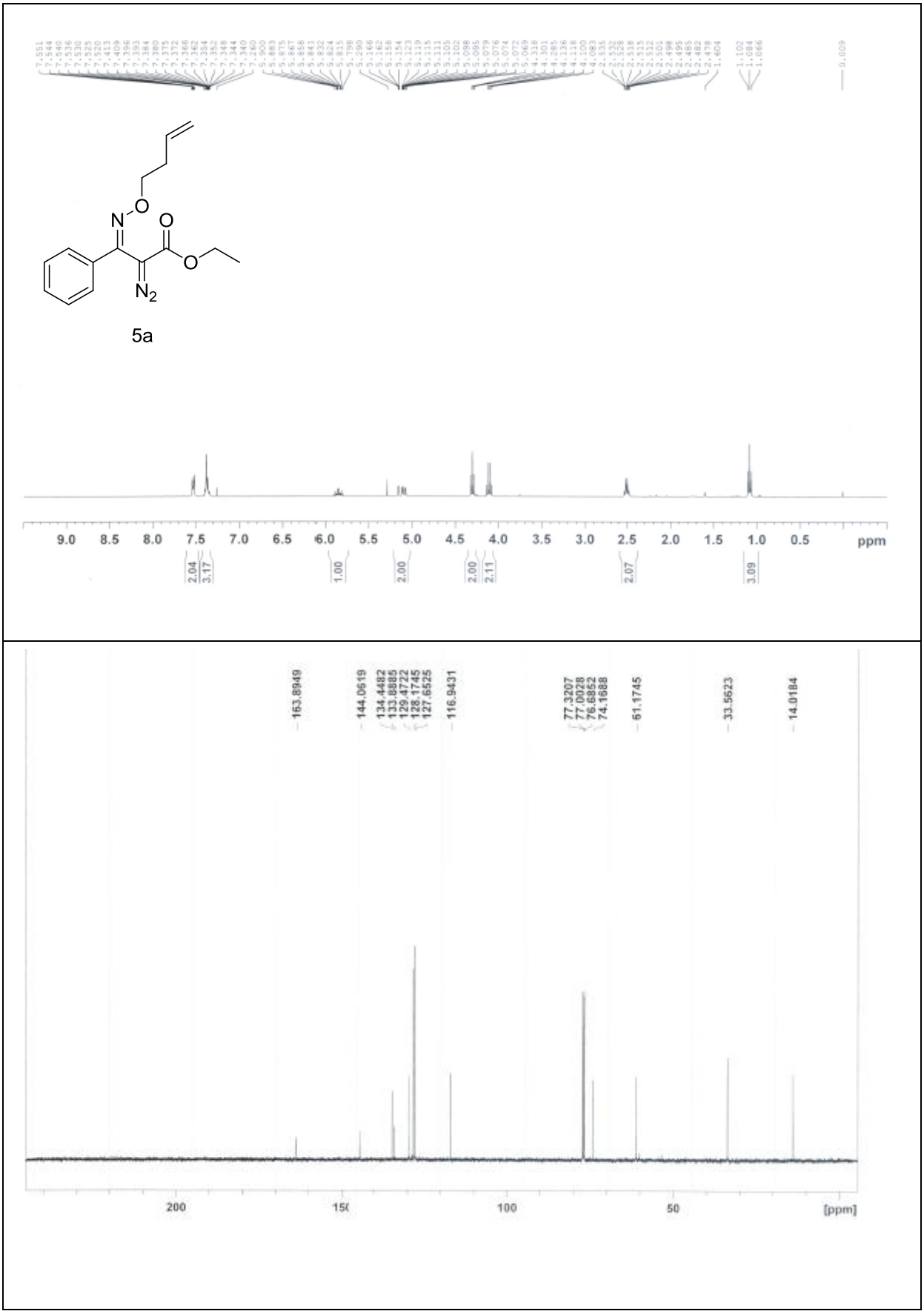
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O
O
N_2
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7.5
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6.5
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5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.04
3.17
1.00
2.00
2.00
2.11
2.07
3.09
163.8949
144.0619
134.4482
133.8885
129.4722
128.1745
127.6525
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100
50
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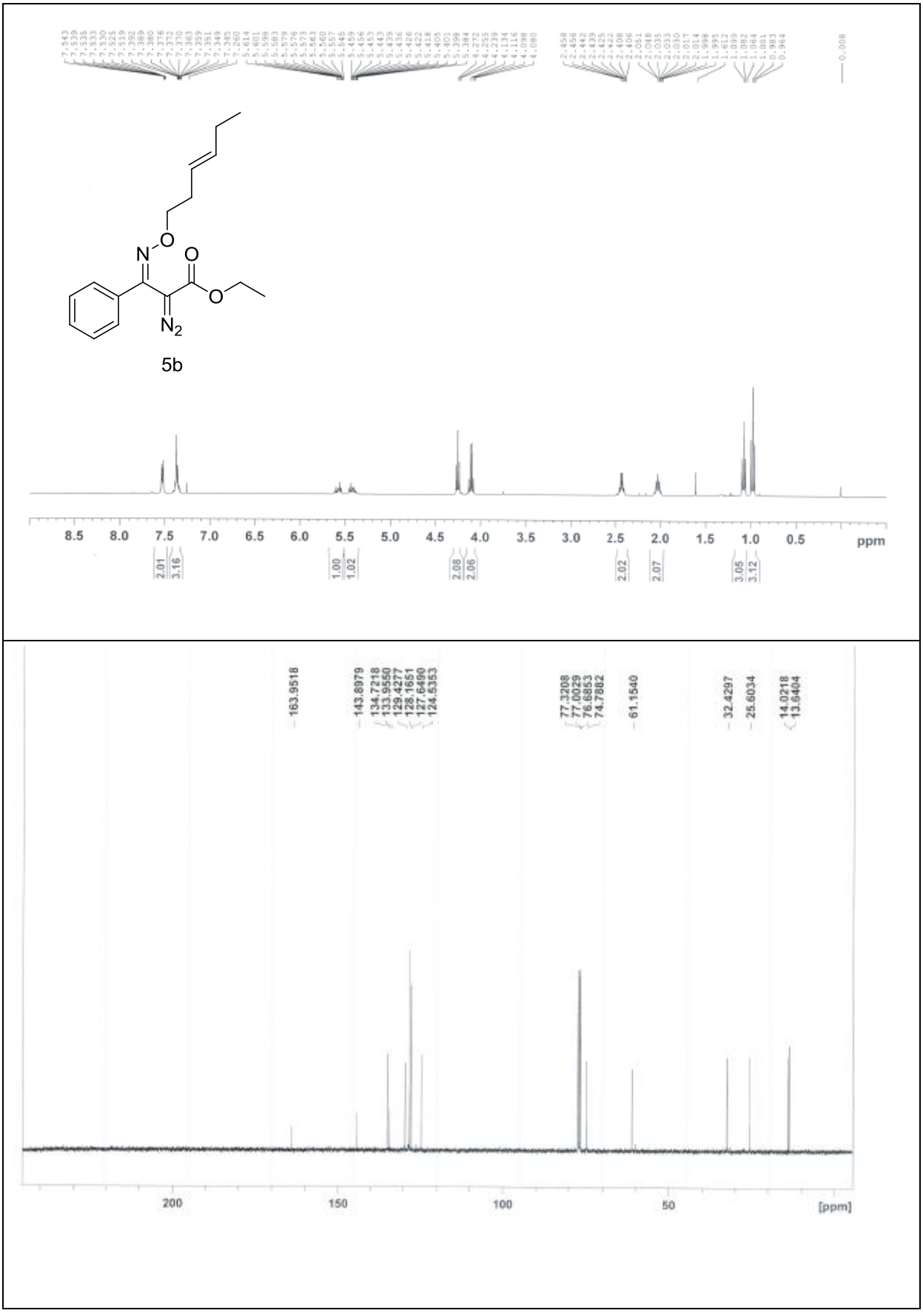
N
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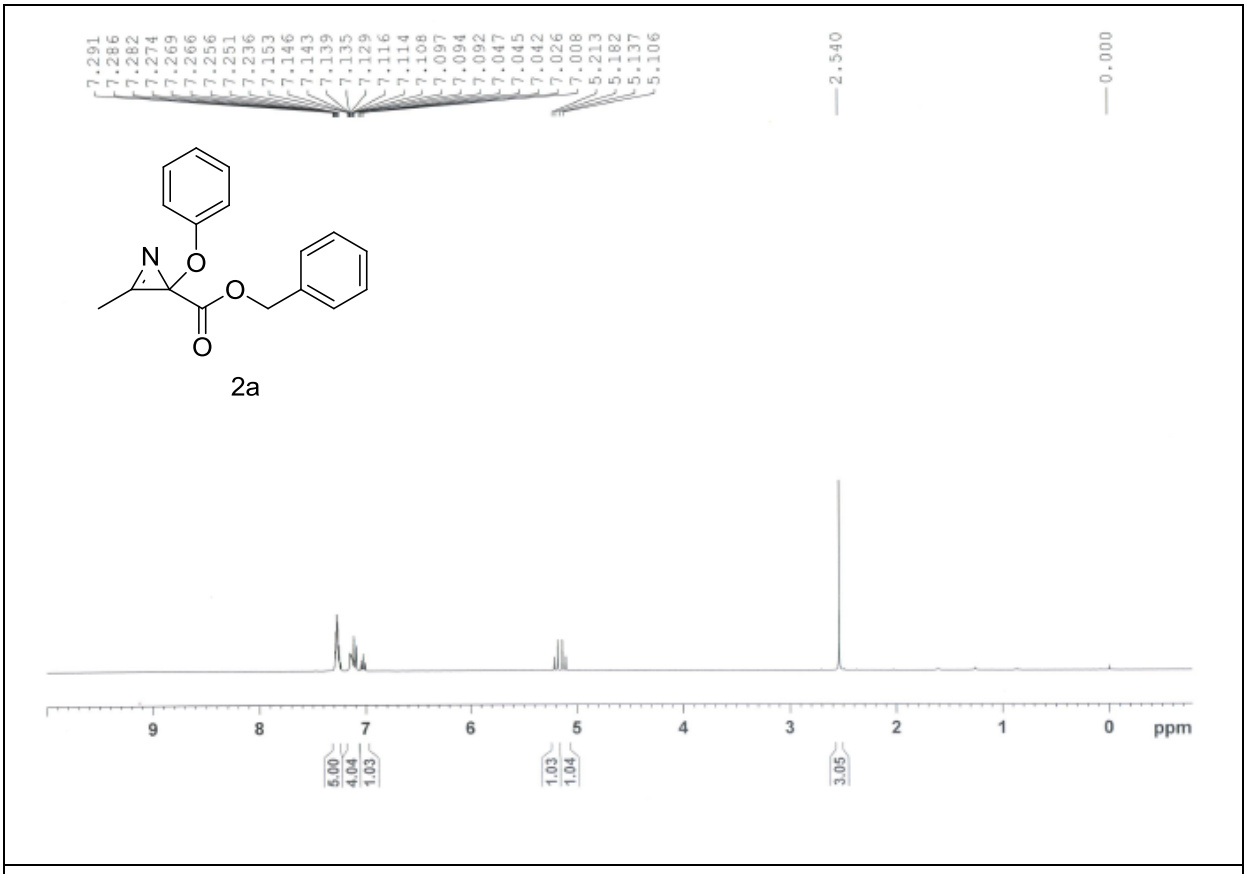
O
O
N2
5b
ppm
[ppm]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7.251
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7.146
7.143
7.139
7.135
7.129
7.116
7.114
7.108
7.097
7.094
7.092
7.047
7.045
7.042
7.026
7.008
5.213
5.182
5.137
5.106
2.540
0.000
N
O
O
O
9
8
7
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3
2
1
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ppm
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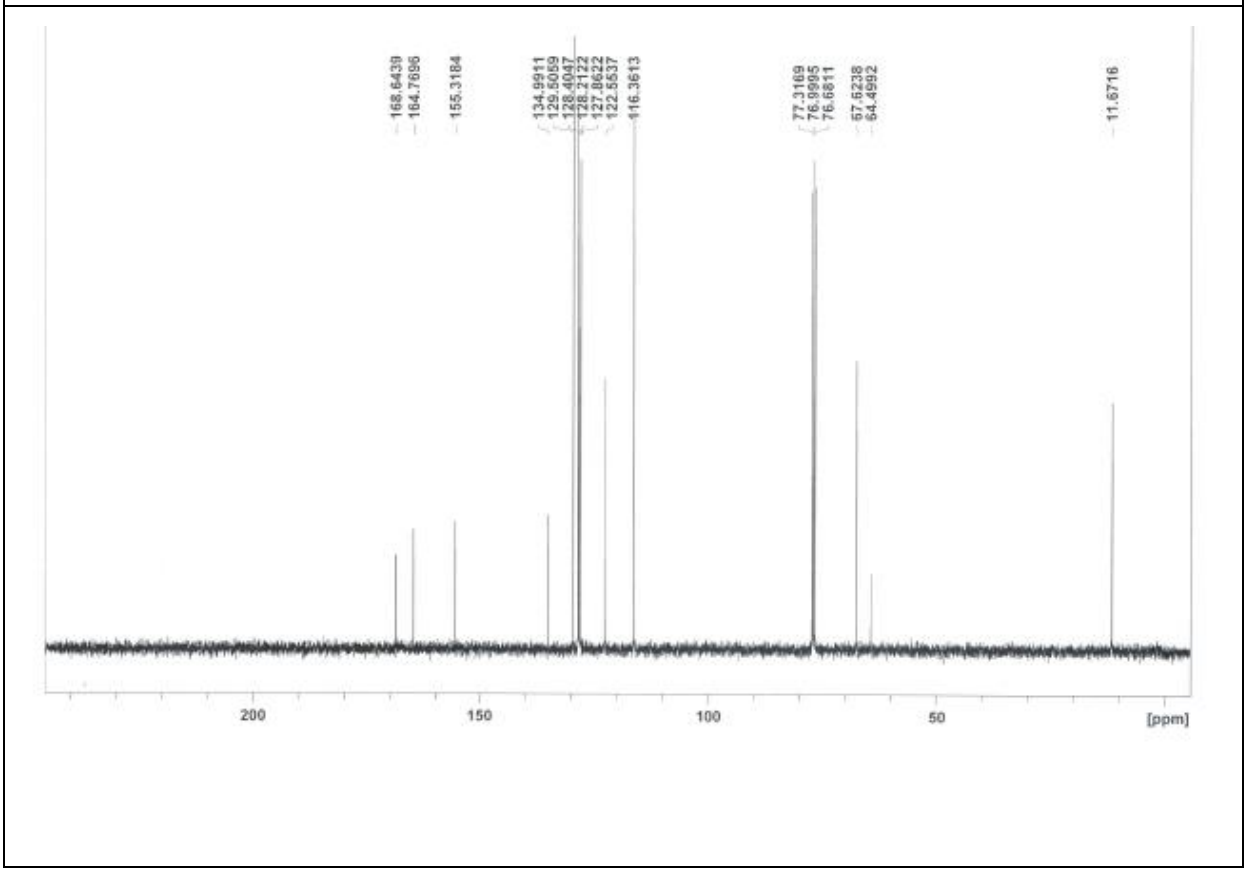
1.03
1.03
1.04
3.05

2a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128.4047
128.2122
127.8622
122.5537
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76.9995
76.6811
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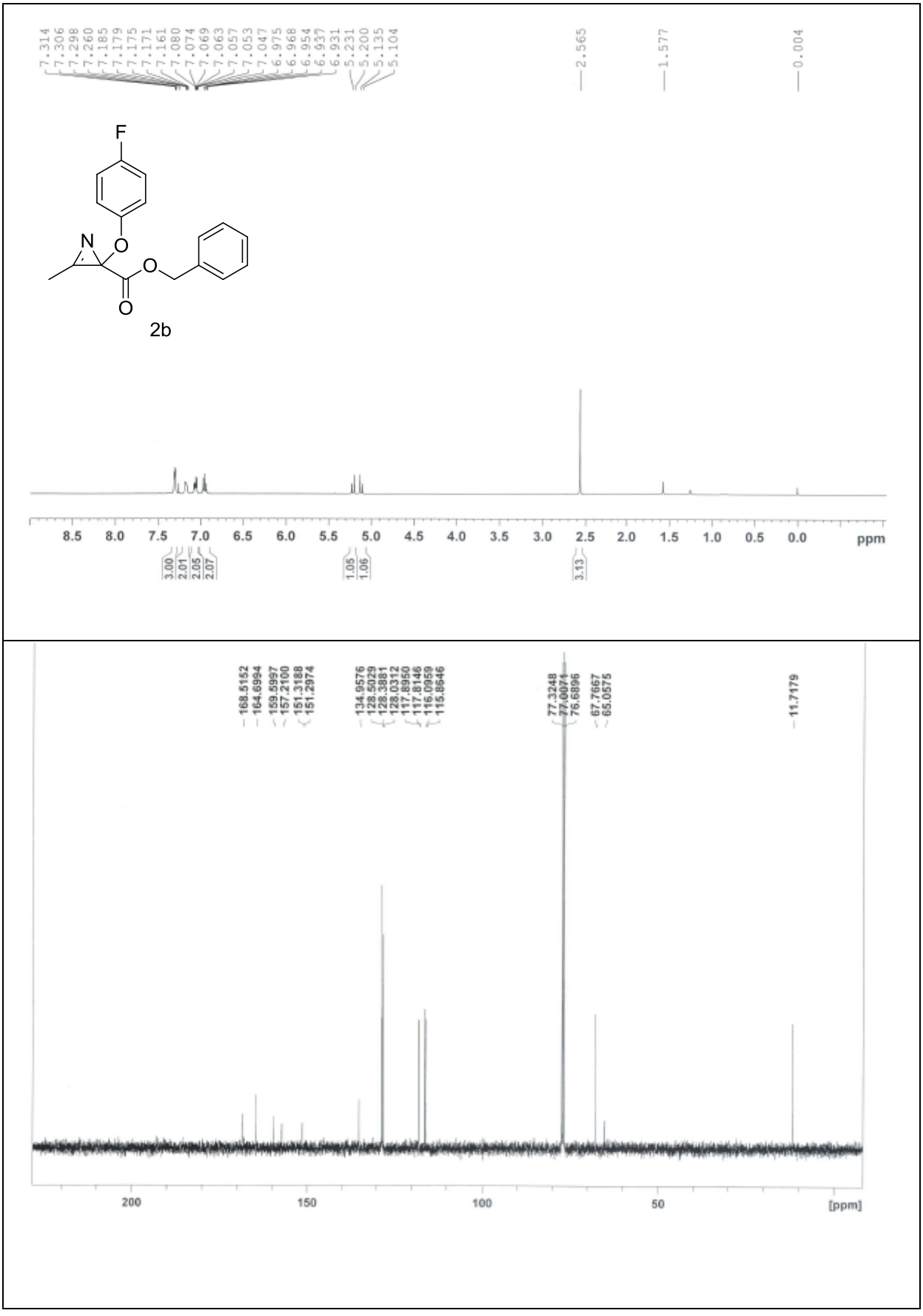
11.6716
200
150
100
50
[ppm]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7.298
7.260
7.185
7.179
7.175
7.171
7.161
7.080
7.074
7.069
7.063
7.057
7.053
7.047
6.975
6.968
6.954
6.937
6.931
5.231
5.200
5.135
5.104
2.565
1.577
0.004
F
N
O
O
O
2b
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
3.00
2.01
2.05
2.07
1.05
1.06
3.13
168.5152
164.6994
159.5997
157.2100
151.3188
151.2974
134.9576
128.5029
128.3881
128.0312
117.8950
117.8146
116.0959
115.8646
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77.0071
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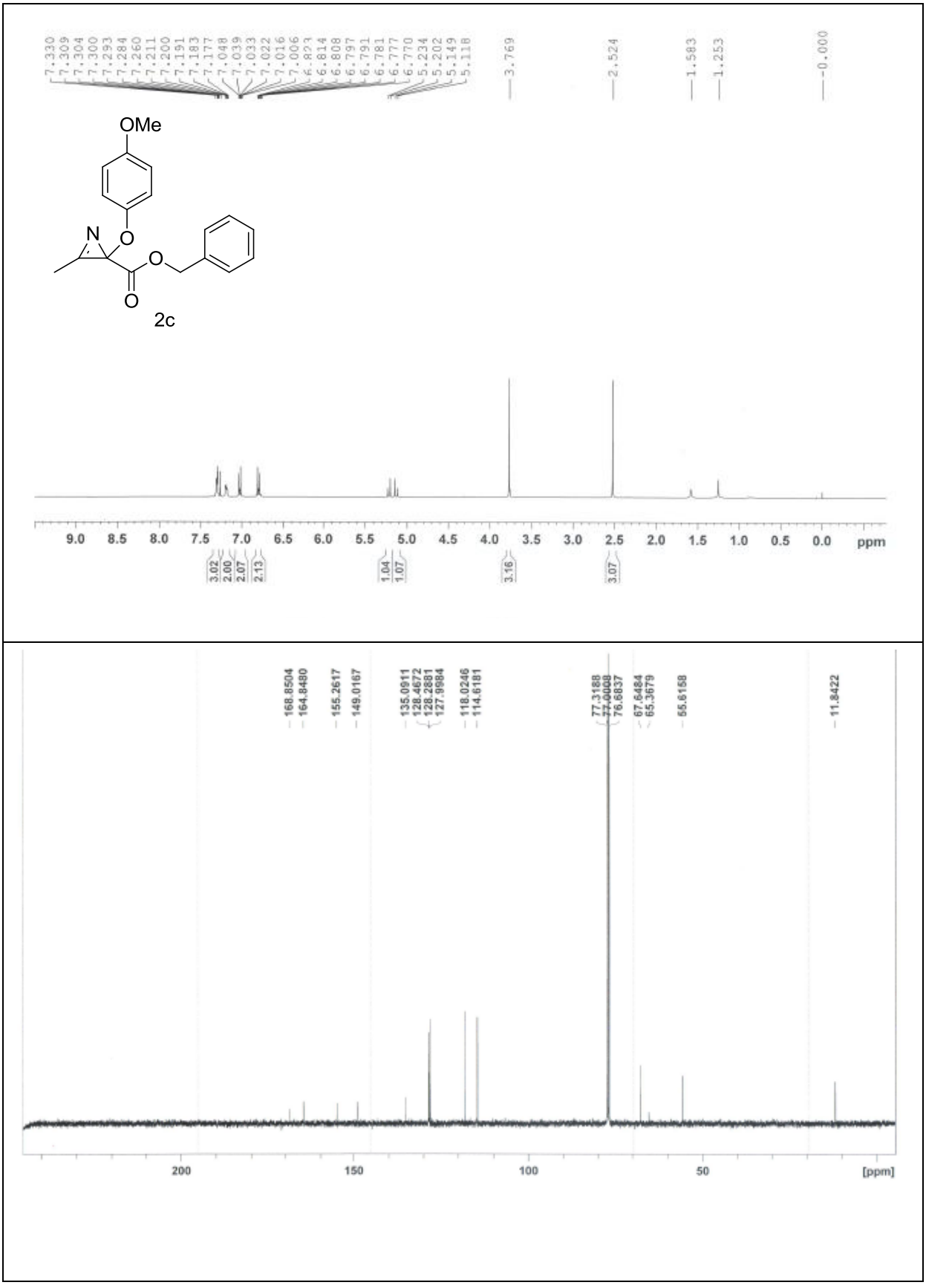
11.7179
200
150
100
50
[ppm]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7.304
7.300
7.293
7.284
7.260
7.211
7.200
7.191
7.183
7.177
7.048
7.039
7.033
7.022
7.016
7.006
6.823
6.814
6.808
6.797
6.791
6.781
6.777
6.770
5.234
5.202
5.149
5.118
3.769
2.524
1.583
1.253
0.000
OMe
N
O
O
O
2c
9.0 8.5 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 ppm
3.02
2.00
2.07
2.13
1.04
1.07
3.16
3.07
168.8504
164.8480
155.2617
149.0167
135.0911
128.4672
128.2881
127.9984
118.0246
114.6181
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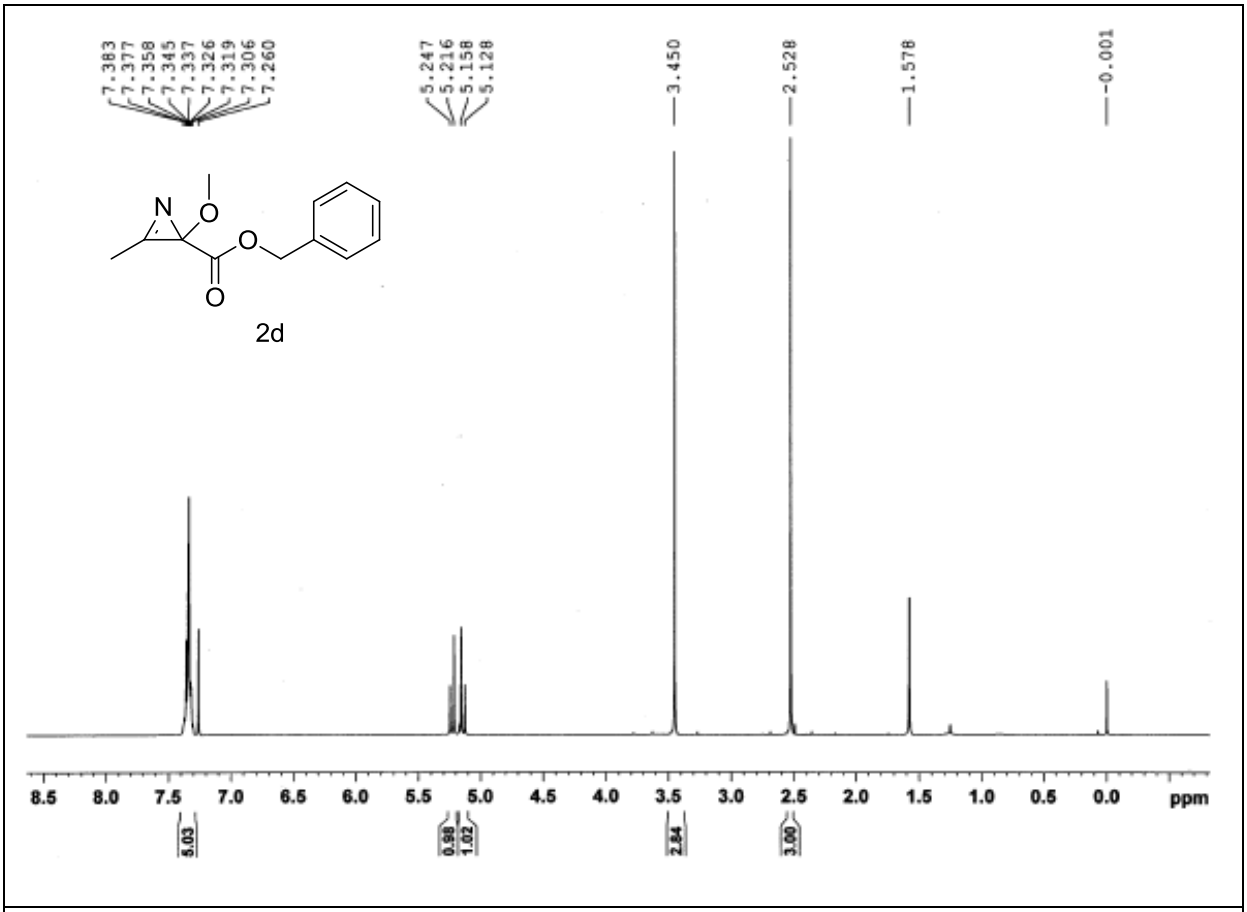
200
150
100
50
[ppm]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7.319
7.306
7.260
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5.216
5.158
5.128
3.450
2.528
1.578
0.001
N
O
O
O
2d
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
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1.5
1.0
0.5
0.0
ppm
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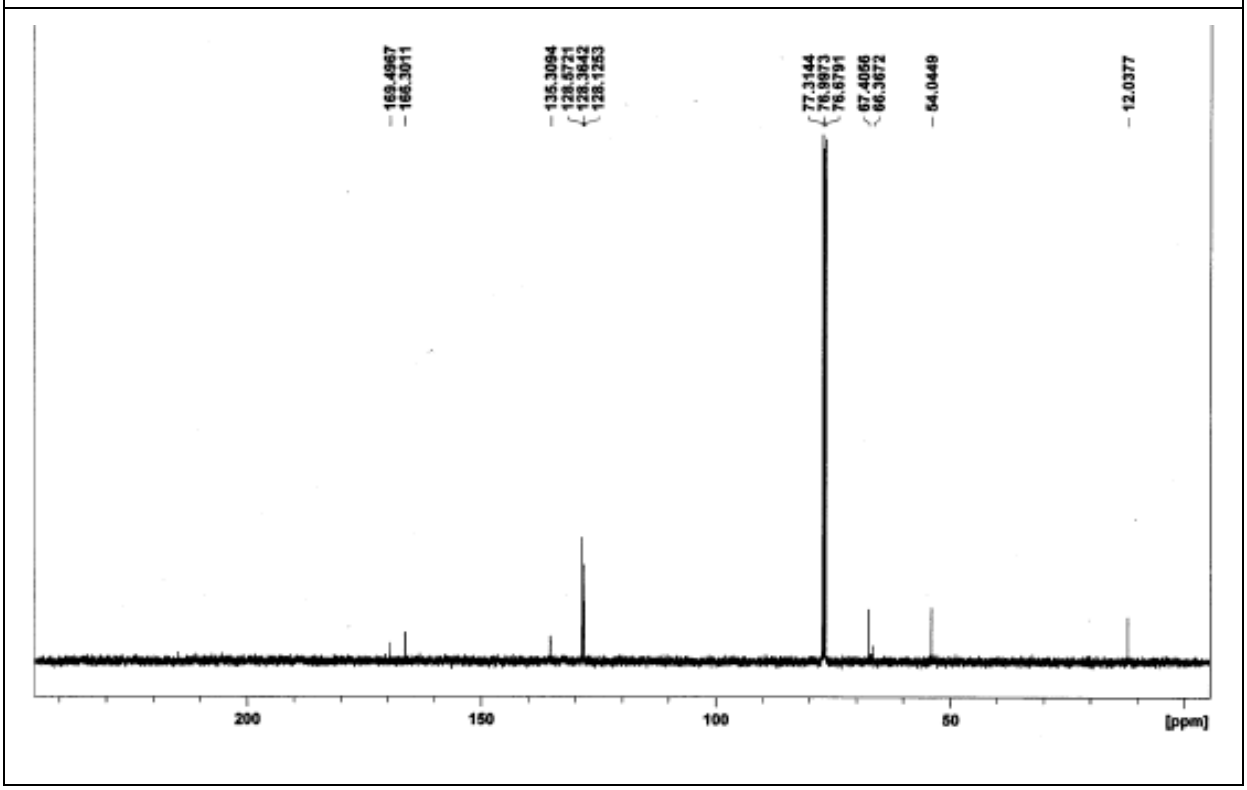
1.02
2.84
3.00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67.4056
66.3672
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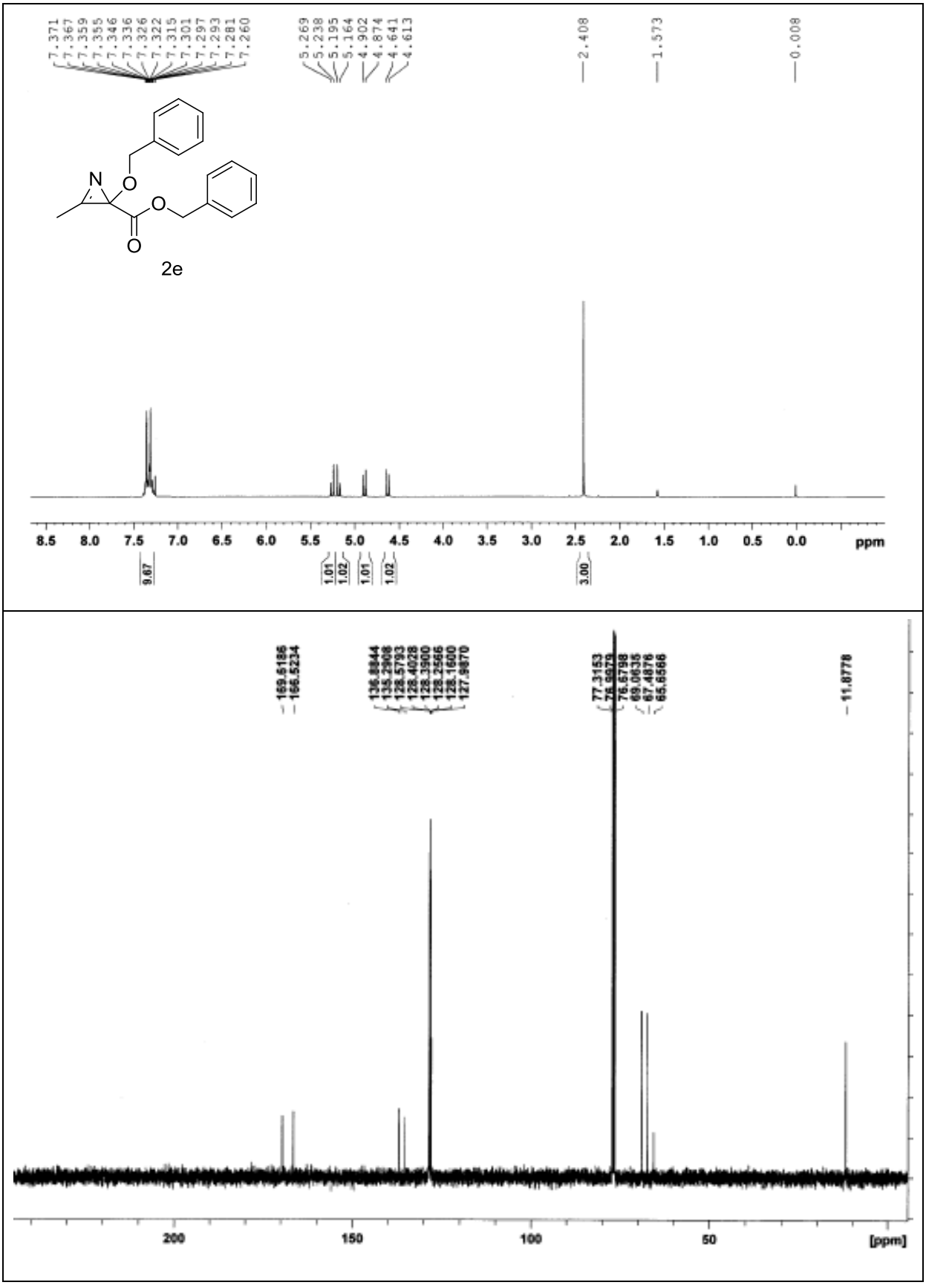
12.0377
200
150
100
50
[ppm]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7.322
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7.301
7.297
7.293
7.281
7.260
5.269
5.238
5.195
5.164
4.902
4.874
4.641
4.613
2.408
1.573
0.008
N
O
O
O
2e
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
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1.02
1.01
1.02
3.00
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166.5234
136.8844
135.2908
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128.4028
128.3900
128.2566
128.1600
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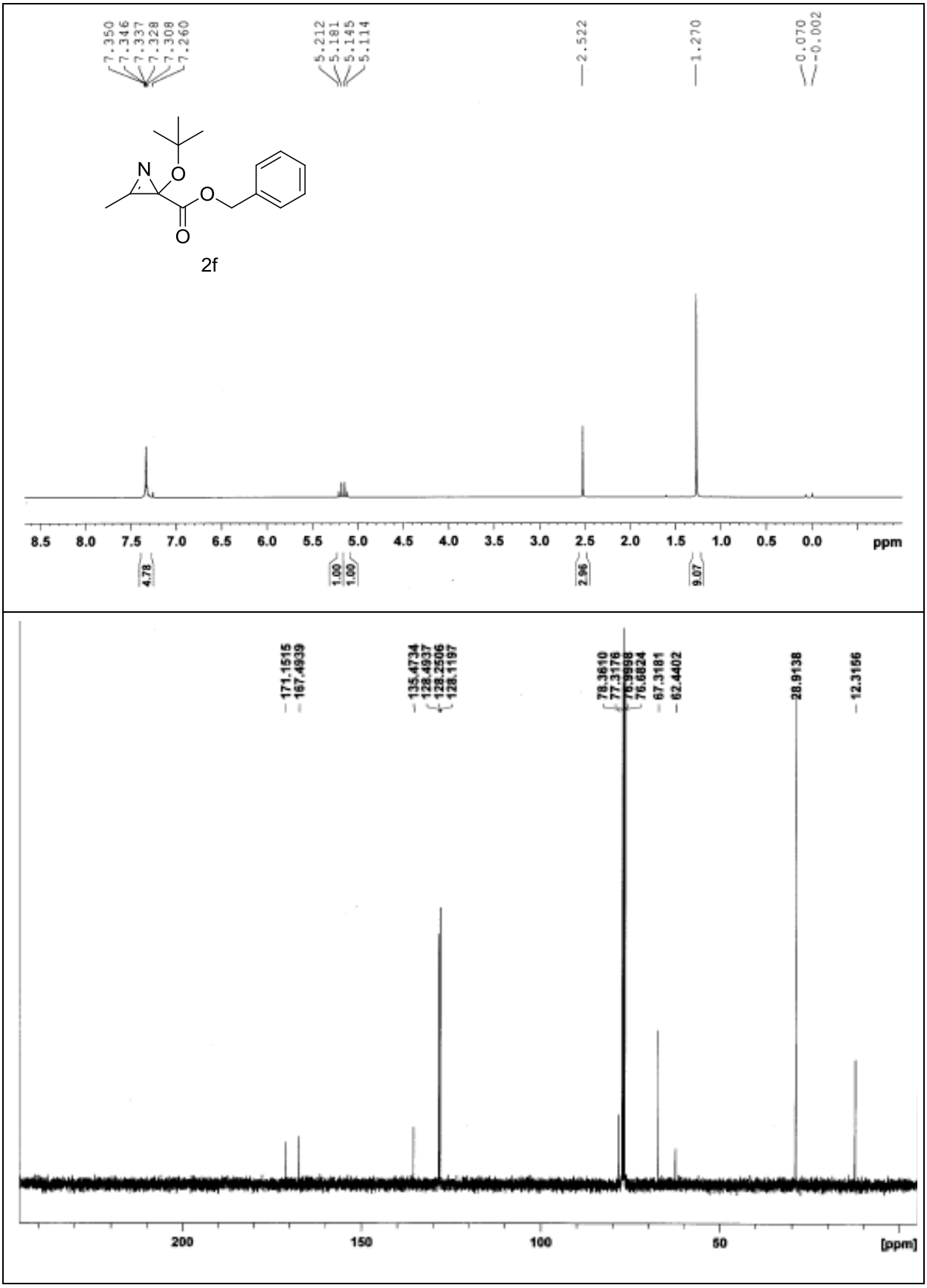
100
50
[ppm]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5.114
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-0.002
N
O
O
O
2f
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
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1.00
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128.2506
128.1197
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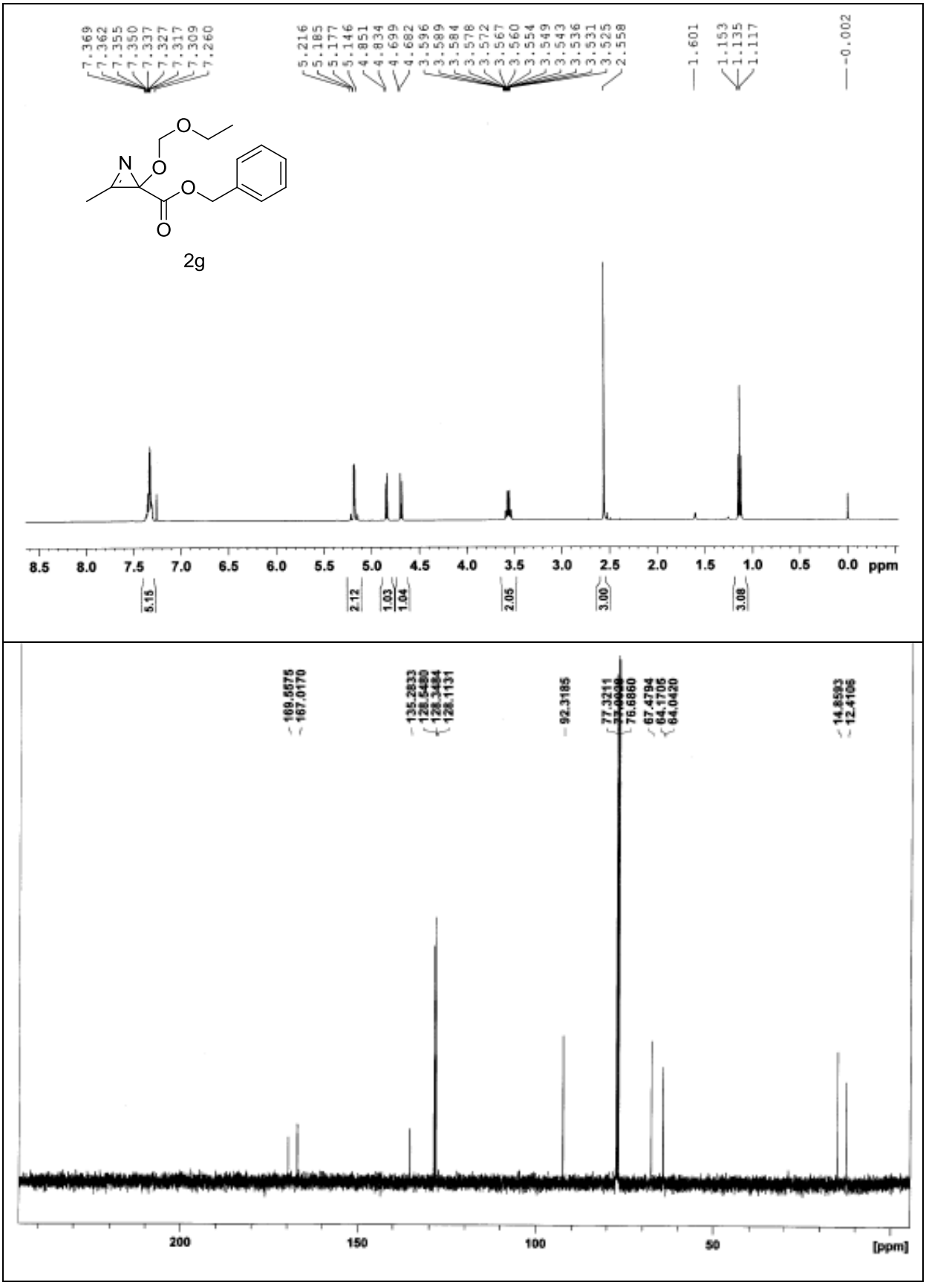
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5.185
5.177
5.146
4.851
4.834
4.699
4.682
3.596
3.589
3.584
3.578
3.572
3.567
3.560
3.554
3.549
3.543
3.536
3.531
3.525
2.558
1.601
1.153
1.135
1.117
-0.002
O
N
O
O
O
2g
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
5.15
2.12
1.03
1.04
2.05
3.00
3.08
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167.0170
135.2833
128.5480
128.3484
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12.4106
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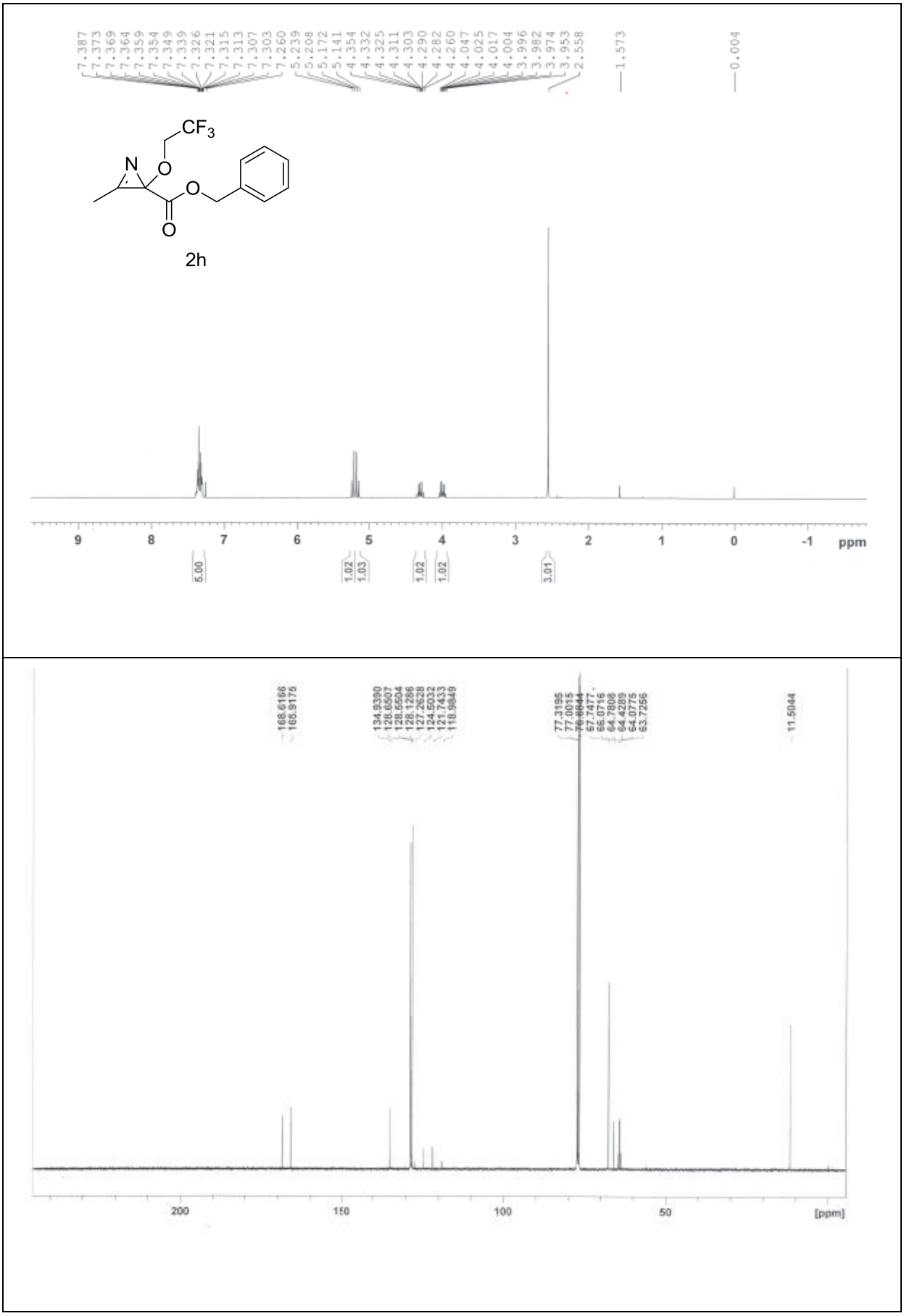
150
100
50
[ppm]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7.313
7.307
7.303
7.260
5.239
5.208
5.172
5.141
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4.332
4.325
4.311
4.303
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4.282
4.260
4.047
4.025
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3.982
3.974
3.953
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1.573
0.004
CF3
N
O
O
O
2h
9
8
7
6
5
4
3
2
1
0
-1
ppm
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1.03
1.02
1.02
3.01
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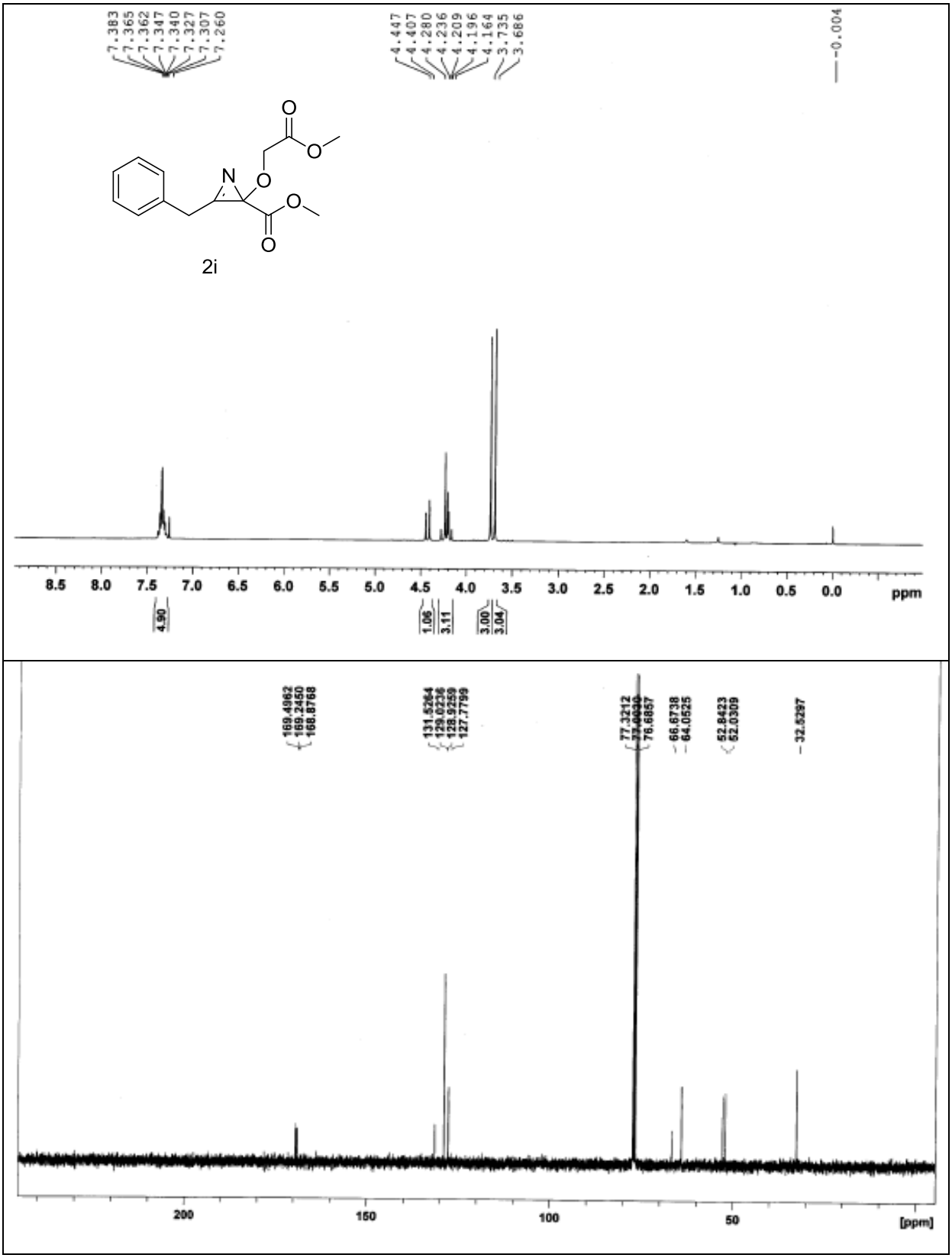

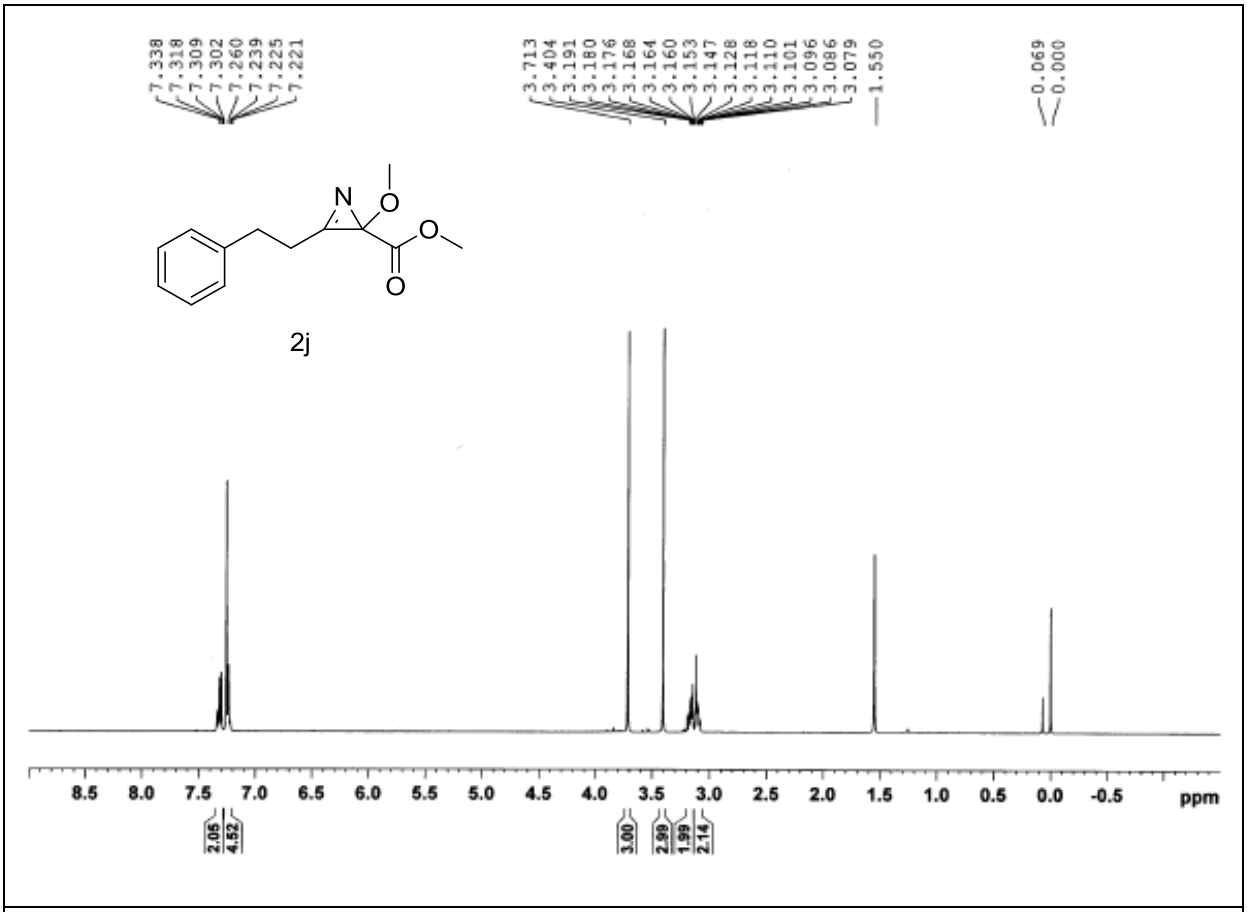
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3.404
3.191
3.180
3.176
3.168
3.164
3.160
3.153
3.147
3.128
3.118
3.110
3.101
3.096
3.086
3.079
1.550
0.069
0.000
N
O
O
O
2j
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 ppm
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4.52
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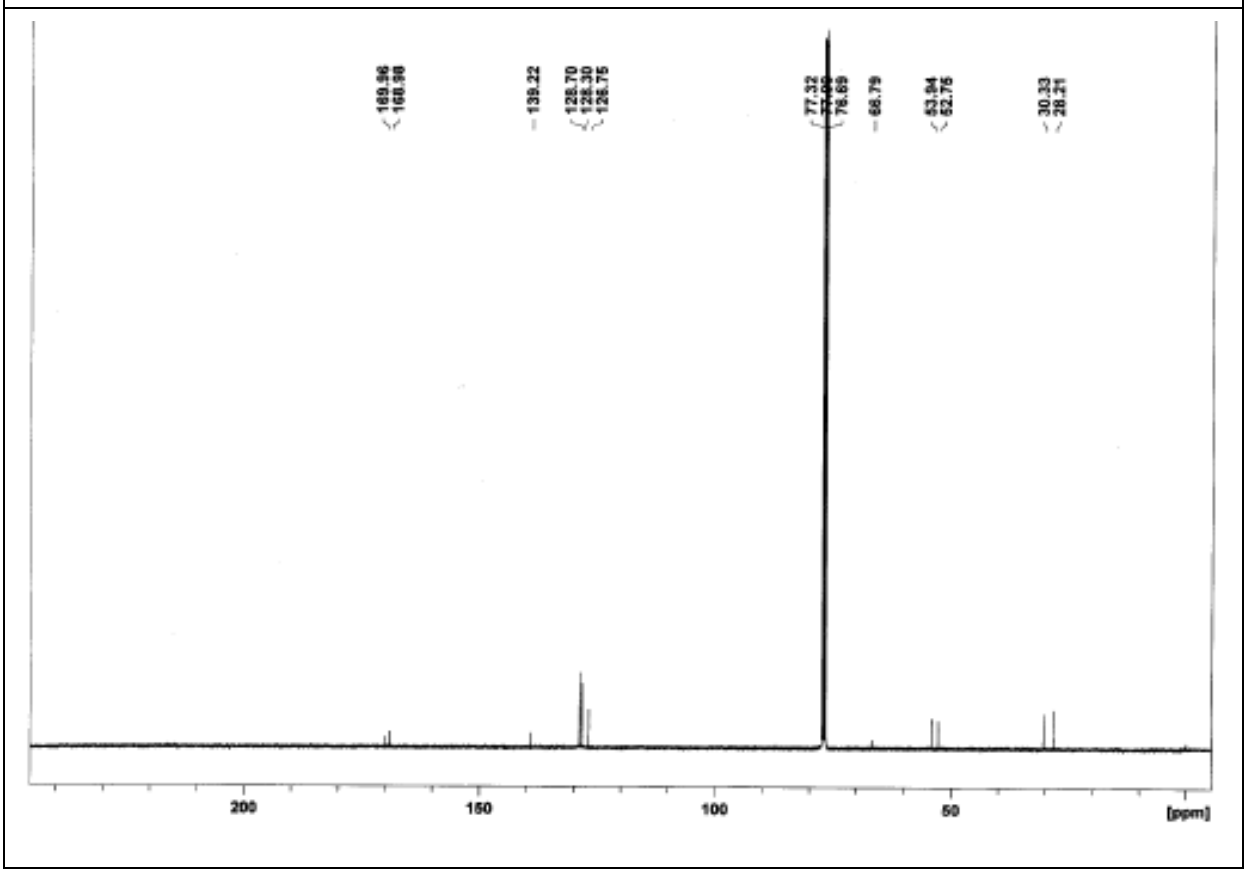
1.99
2.14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126.75
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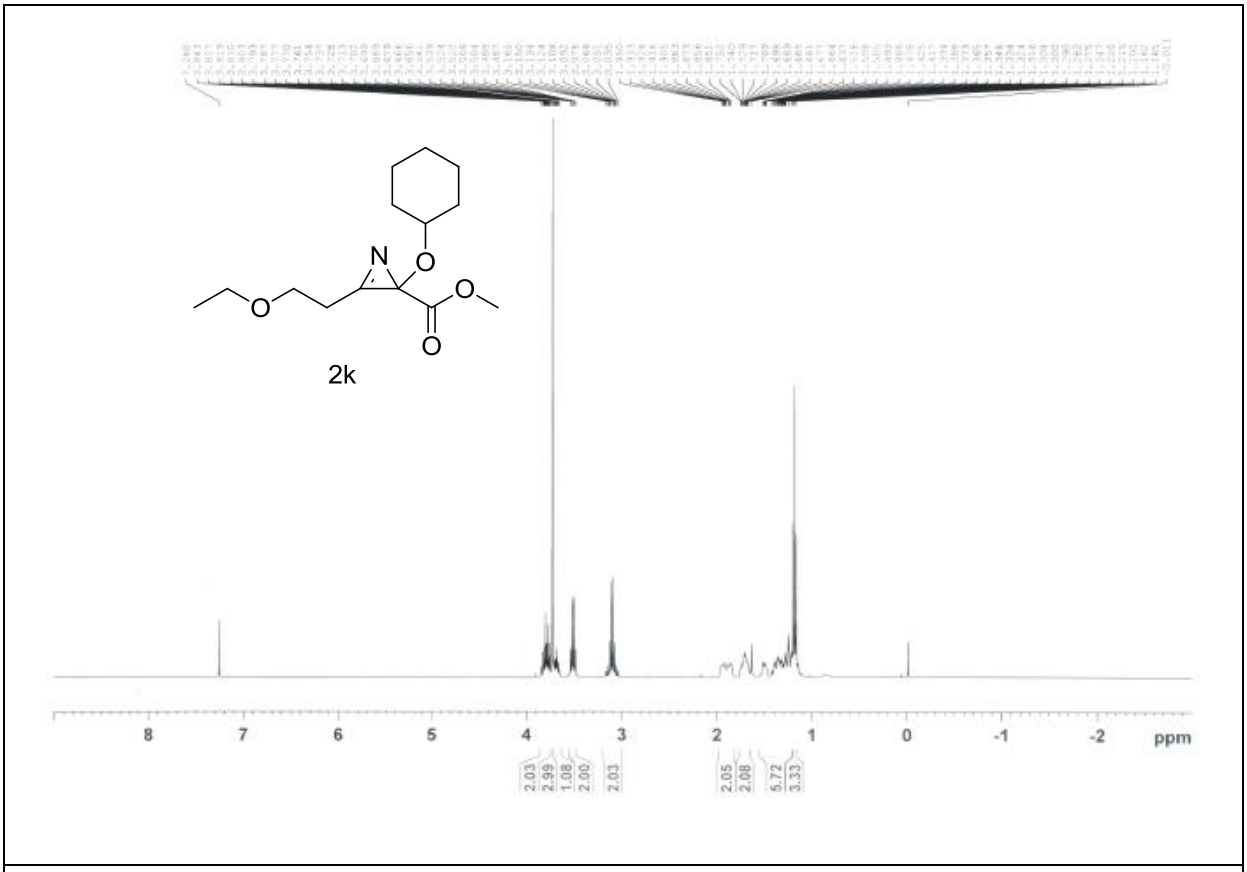
76.89
66.79
53.84
52.75
30.33
28.21
200 150 100 50 [ppm]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O
O
O
O
2k
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7
6
5
4
3
2
1
0
-1
-2
ppm
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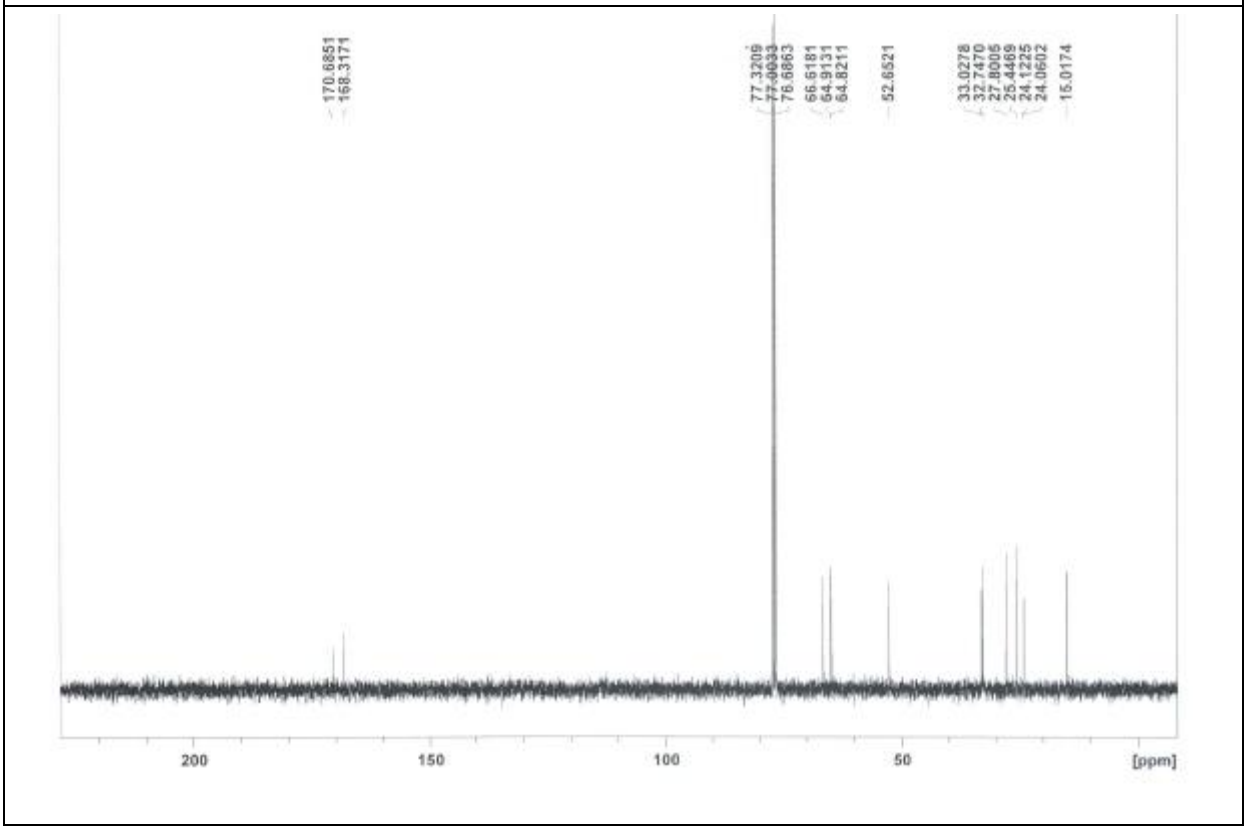
1.08
2.00
2.03
2.05
2.08
5.72
3.33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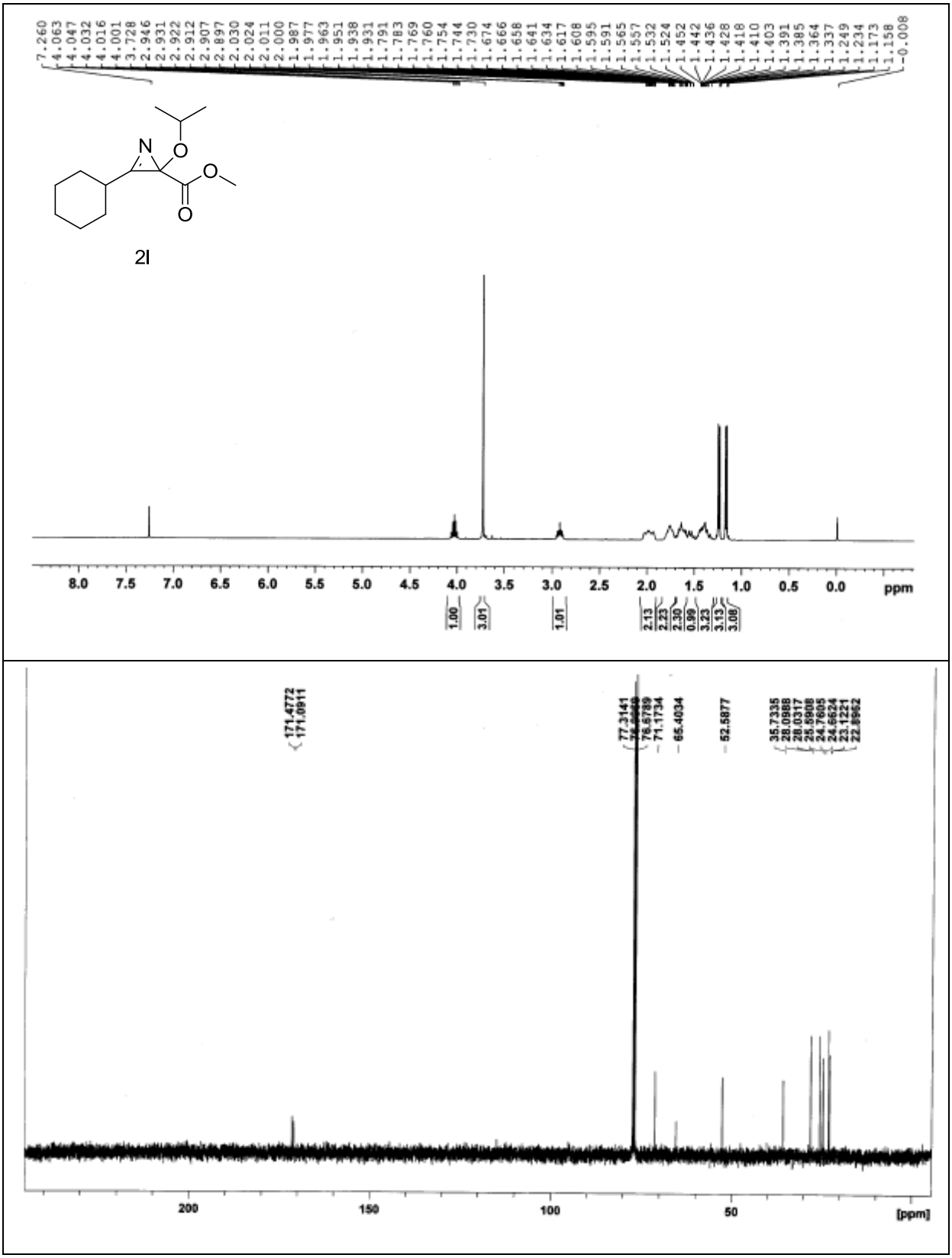

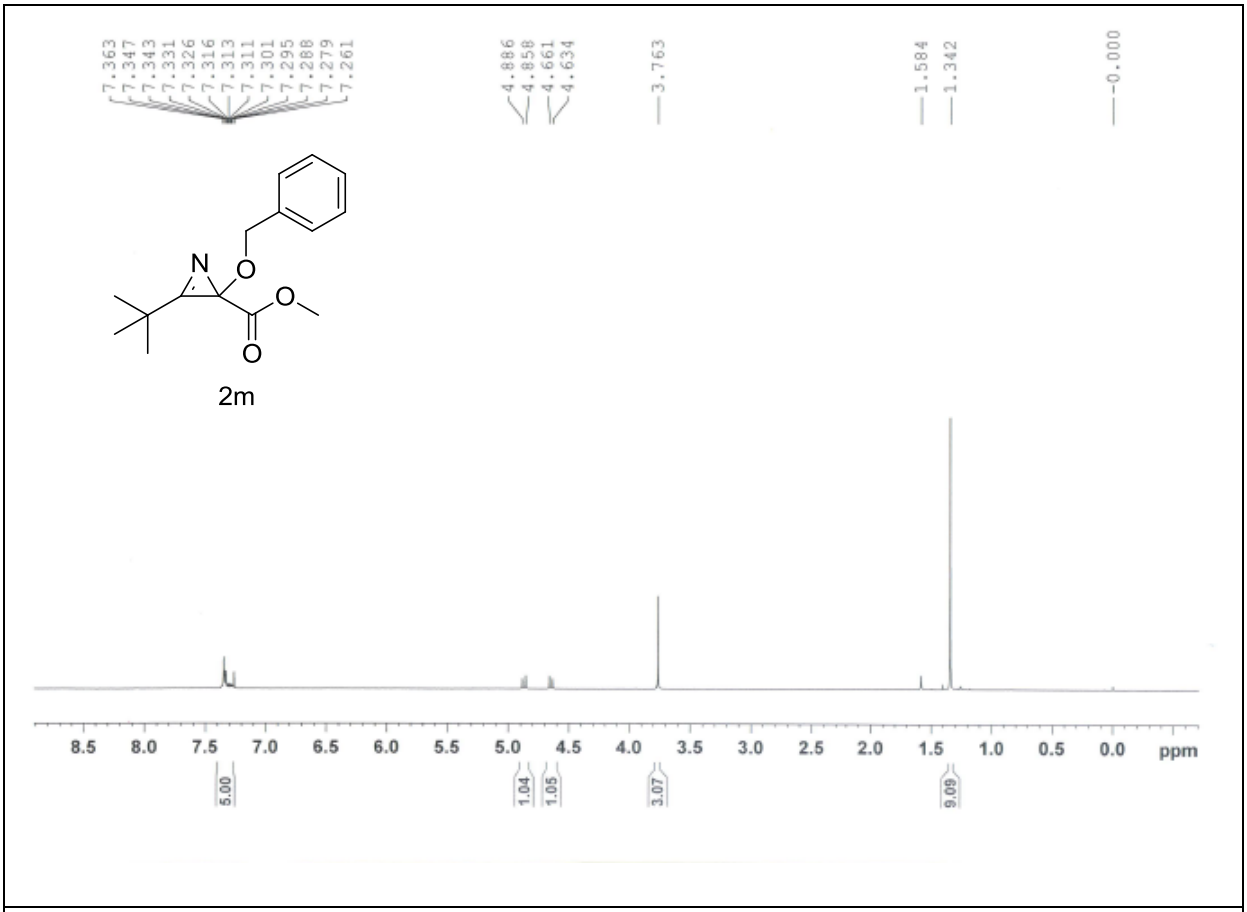
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7.311
7.301
7.295
7.288
7.279
7.261
4.886
4.858
4.661
4.634
3.763
1.584
1.342
0.000
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O
O
O
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
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1.0
0.5
0.0
ppm
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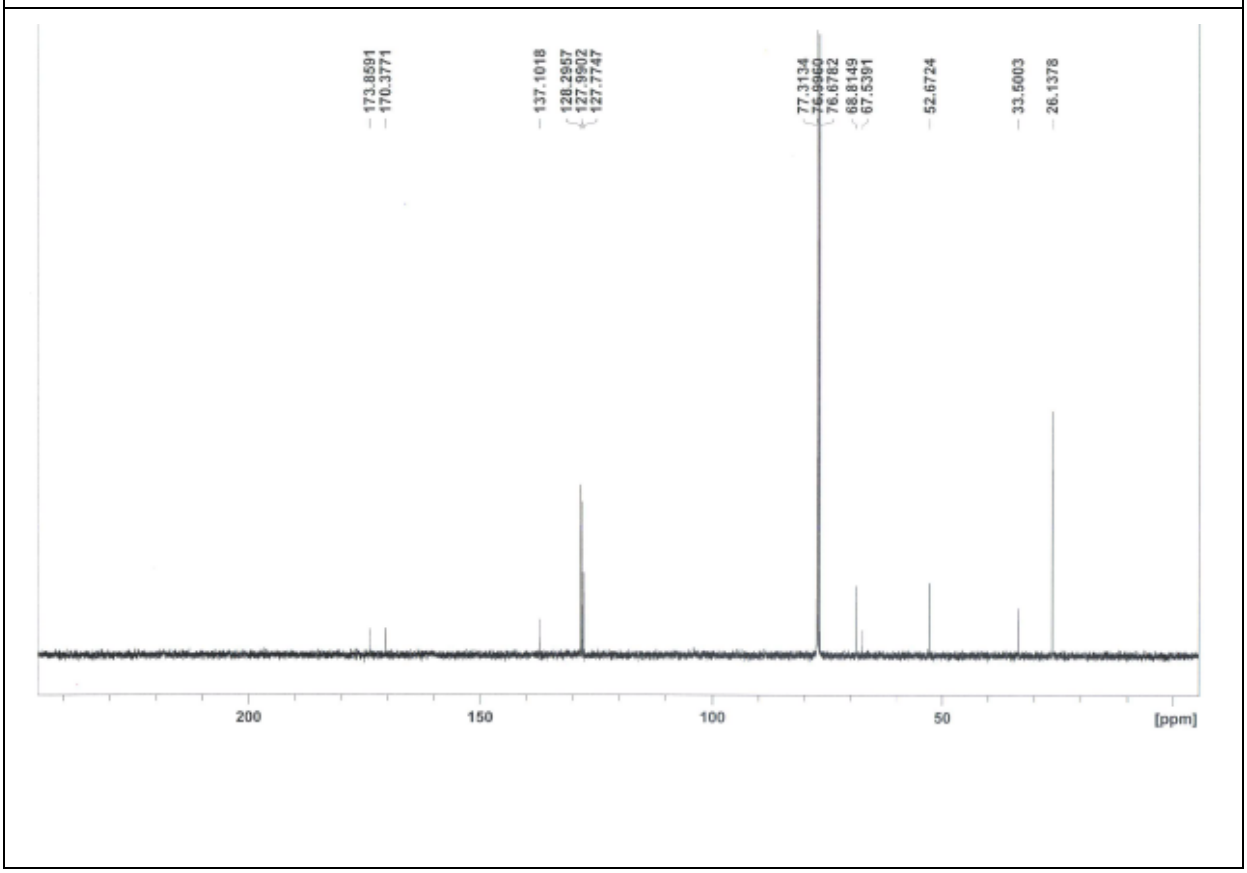
1.04
1.05
3.07
9.09

2m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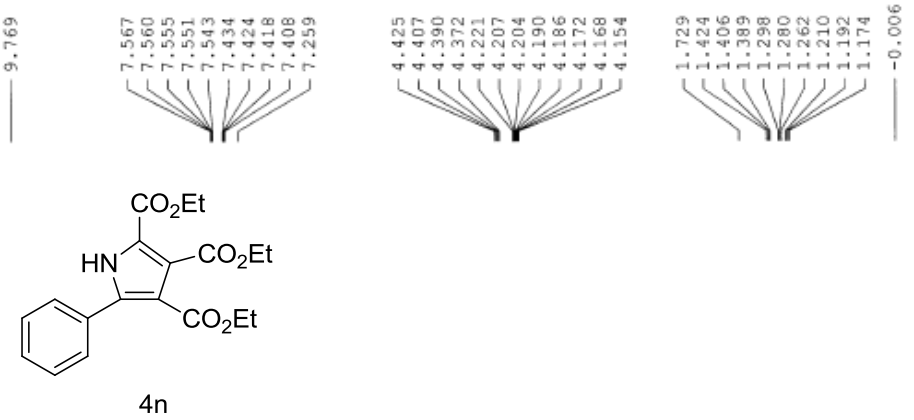
26.1378
200
150
100
50
[ppm]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7.408
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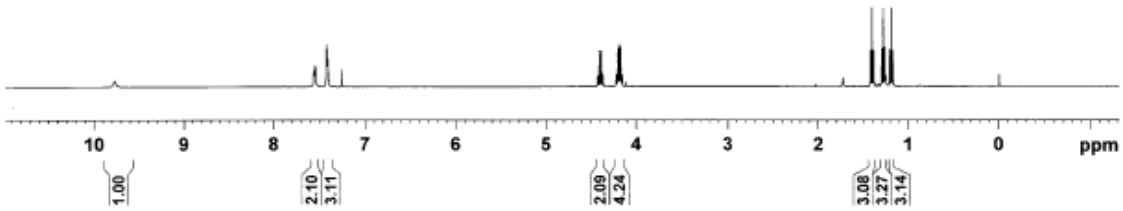
4.425
4.407
4.390
4.372
4.221
4.207
4.204
4.190
4.186
4.172
4.168
4.154
1.729
1.424
1.406
1.389
1.298
1.280
1.262
1.210
1.192
1.174
-0.006

CO2Et
HN
CO2Et
CO2Et

4n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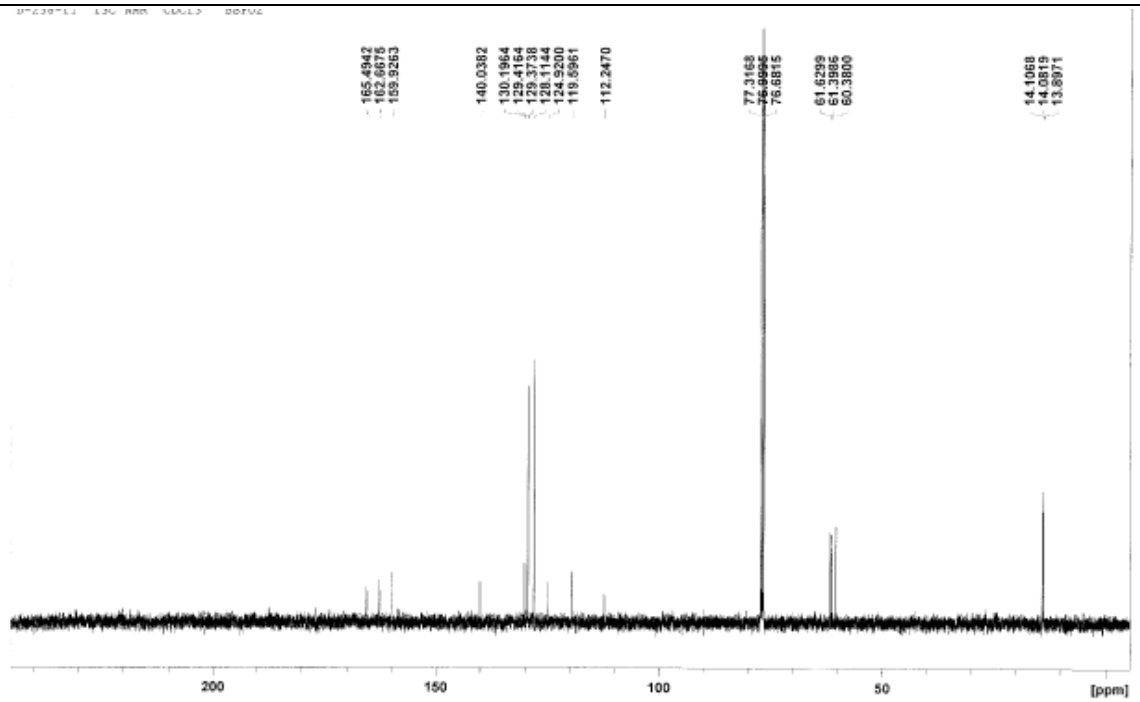
9
8
7
6
5
4
3
2
1
0
ppm
1.00
2.10
3.11
2.09
4.24
3.08
3.27
3.14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159.9263
140.0382
130.1964
129.4164
129.3738
128.1144
124.9200
119.5961
112.2470
77.3168
76.9995
76.6815
61.6299
61.3985
60.3800
14.1068
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13.8971
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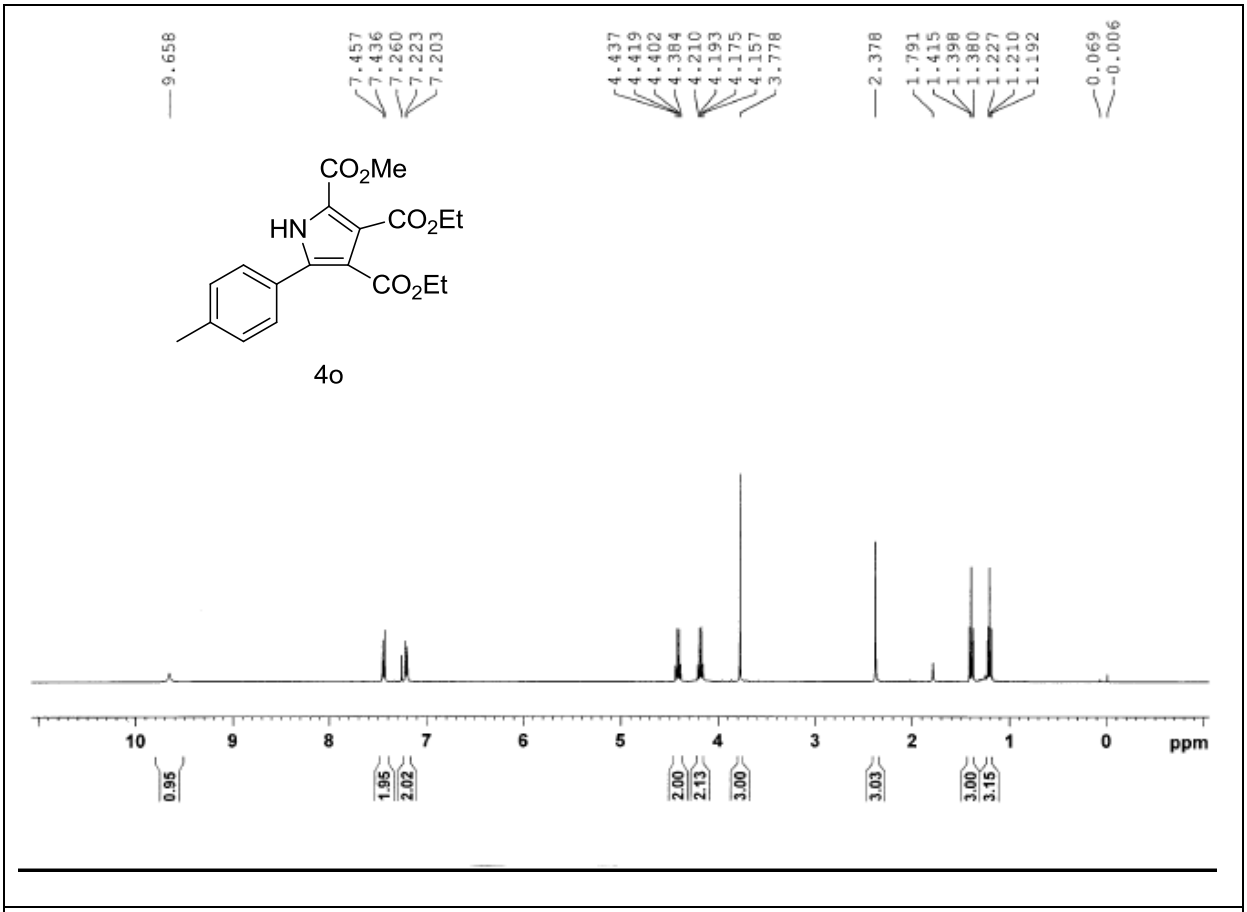
100
50
[ppm]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7.436
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7.223
7.203
4.437
4.419
4.402
4.384
4.210
4.193
4.175
4.157
3.778
2.378
1.791
1.415
1.398
1.380
1.227
1.210
1.192
0.069
-0.006
CO2Me
HN
CO2Et
CO2Et
4o
10
9
8
7
6
5
4
3
2
1
0
ppm
0.95
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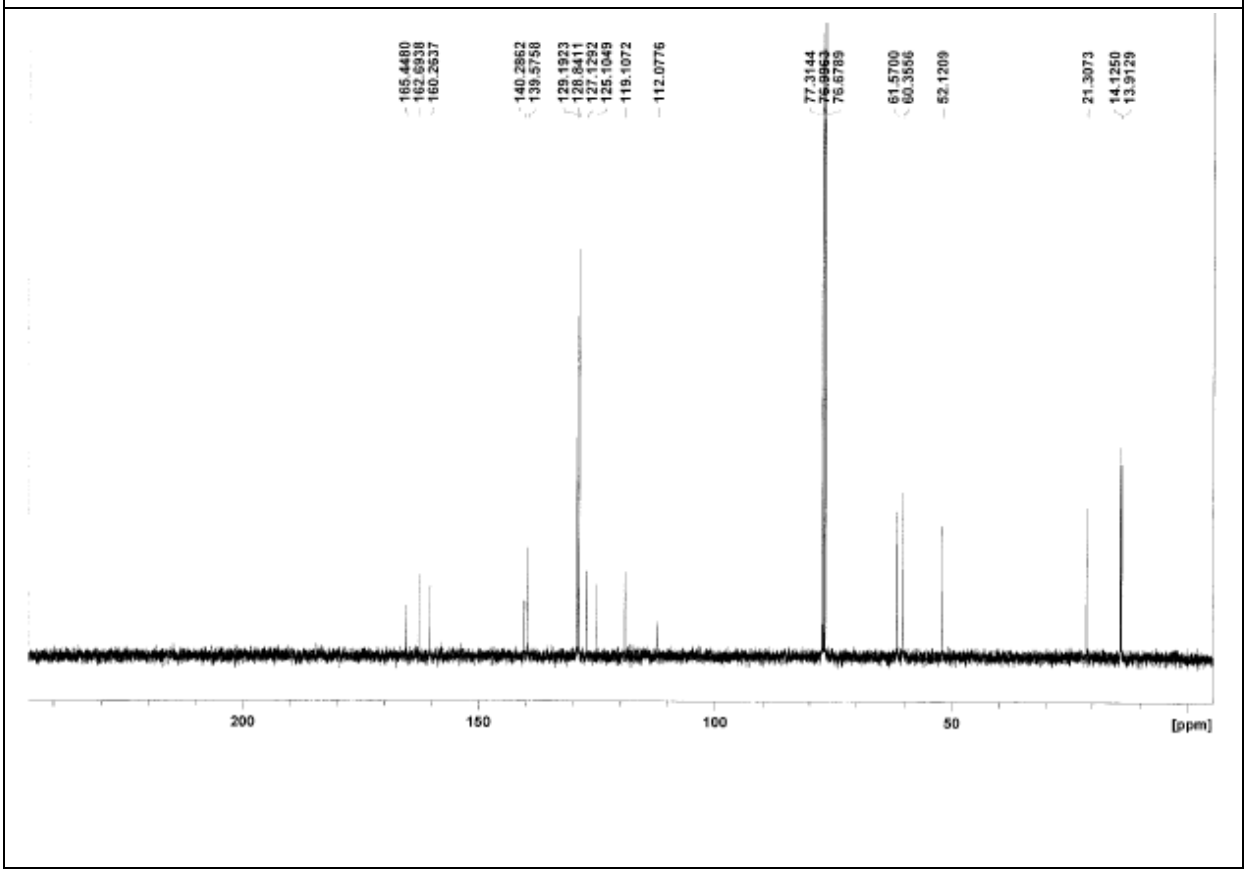
2.02
2.00
2.13
3.00
3.03
3.00
3.15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129.1923
128.8411
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125.1049
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112.0776
77.3144
76.8963
76.6789
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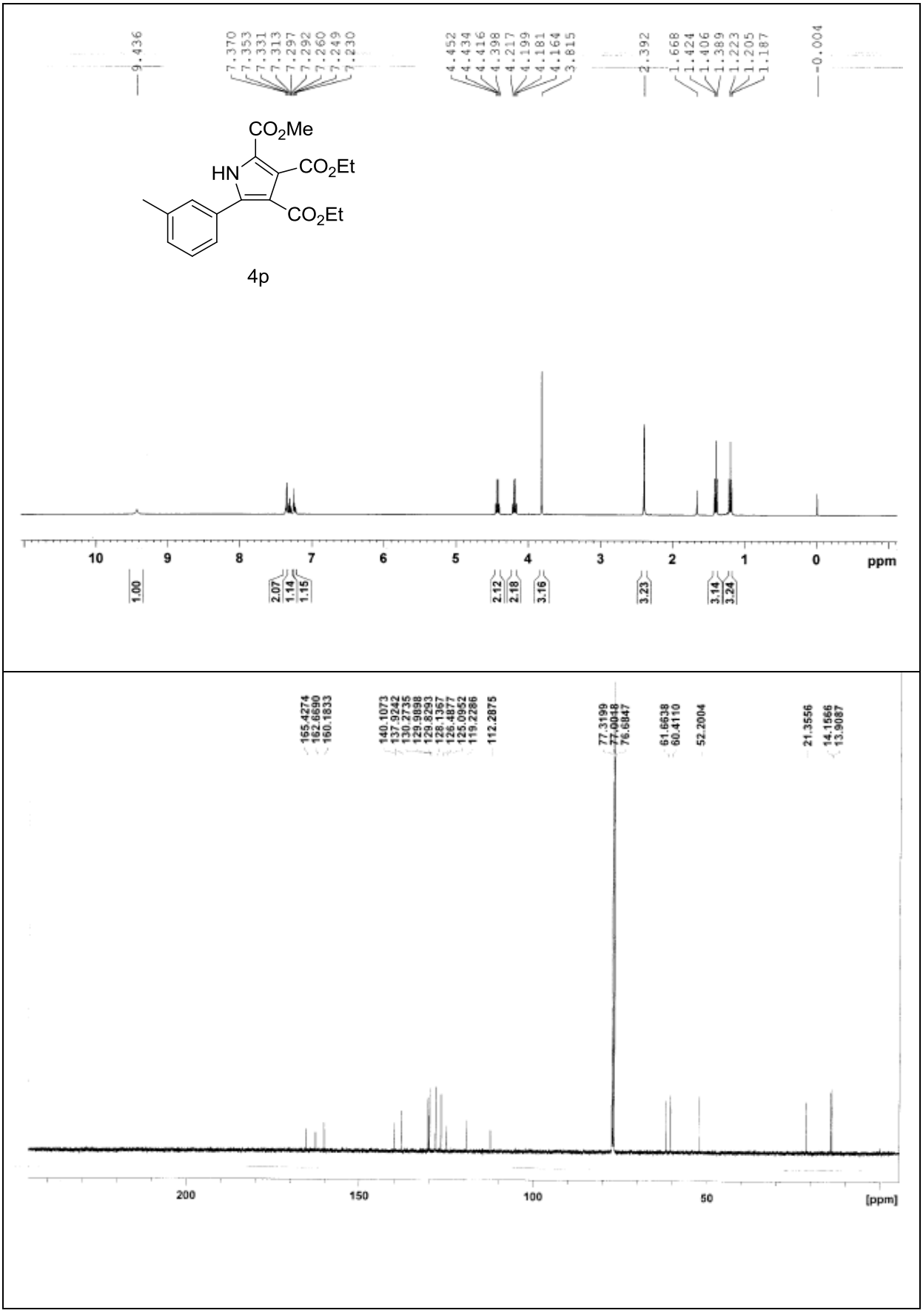
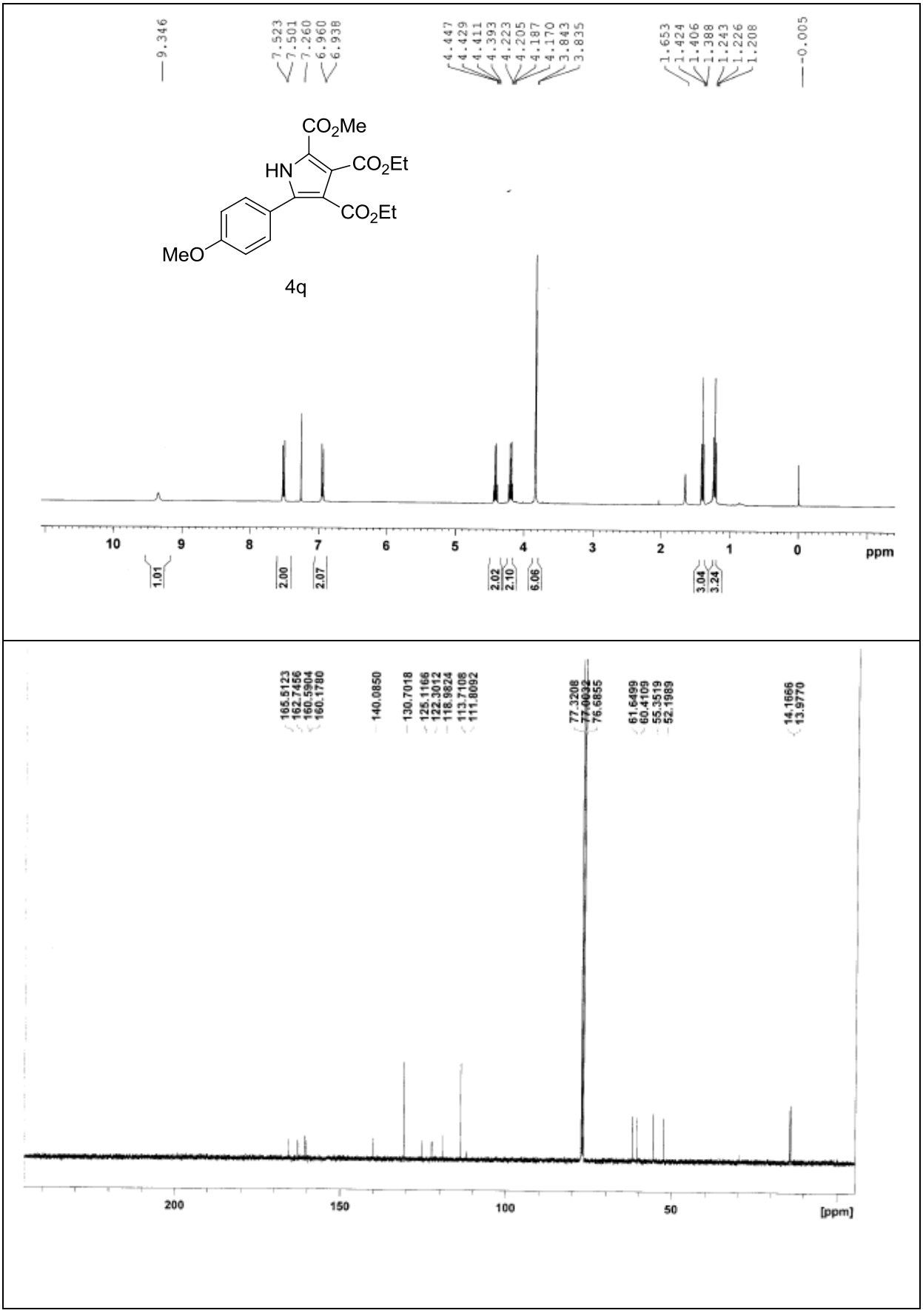
60.3556
52.1209
21.3073
14.1250
13.9129
200
150
100
50
[ppm]


9.436
7.370
7.353
7.331
7.313
7.297
7.292
7.260
7.249
7.230
4.452
4.434
4.416
4.398
4.217
4.199
4.181
4.164
3.815
2.392
1.668
1.424
1.406
1.389
1.223
1.205
1.187
0.004
CO2Me
HN
CO2Et
CO2Et
4p
ppm
1.00
2.07
1.14
1.15
2.12
2.18
3.16
3.23
3.14
3.24
165.4274
162.6690
160.1833
140.1073
137.9242
130.2735
129.9898
129.8293
128.1367
126.4877
125.0952
119.2286
112.2875
77.3199
77.0048
76.6847
61.6638
60.4110
52.2004
21.3556
14.1566
13.9087
[ppm]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7.523
7.501
7.260
6.960
6.938
4.447
4.429
4.411
4.393
4.223
4.205
4.187
4.170
3.843
3.835
1.653
1.424
1.406
1.388
1.243
1.226
1.208
-0.005
CO2Me
HN
CO2Et
CO2Et
MeO
4q
ppm
1.01
2.00
2.07
2.02
2.10
6.06
3.04
3.24
165.5123
162.7456
160.5904
160.1780
140.0850
130.7018
125.1166
122.3012
118.9824
113.7108
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76.6855
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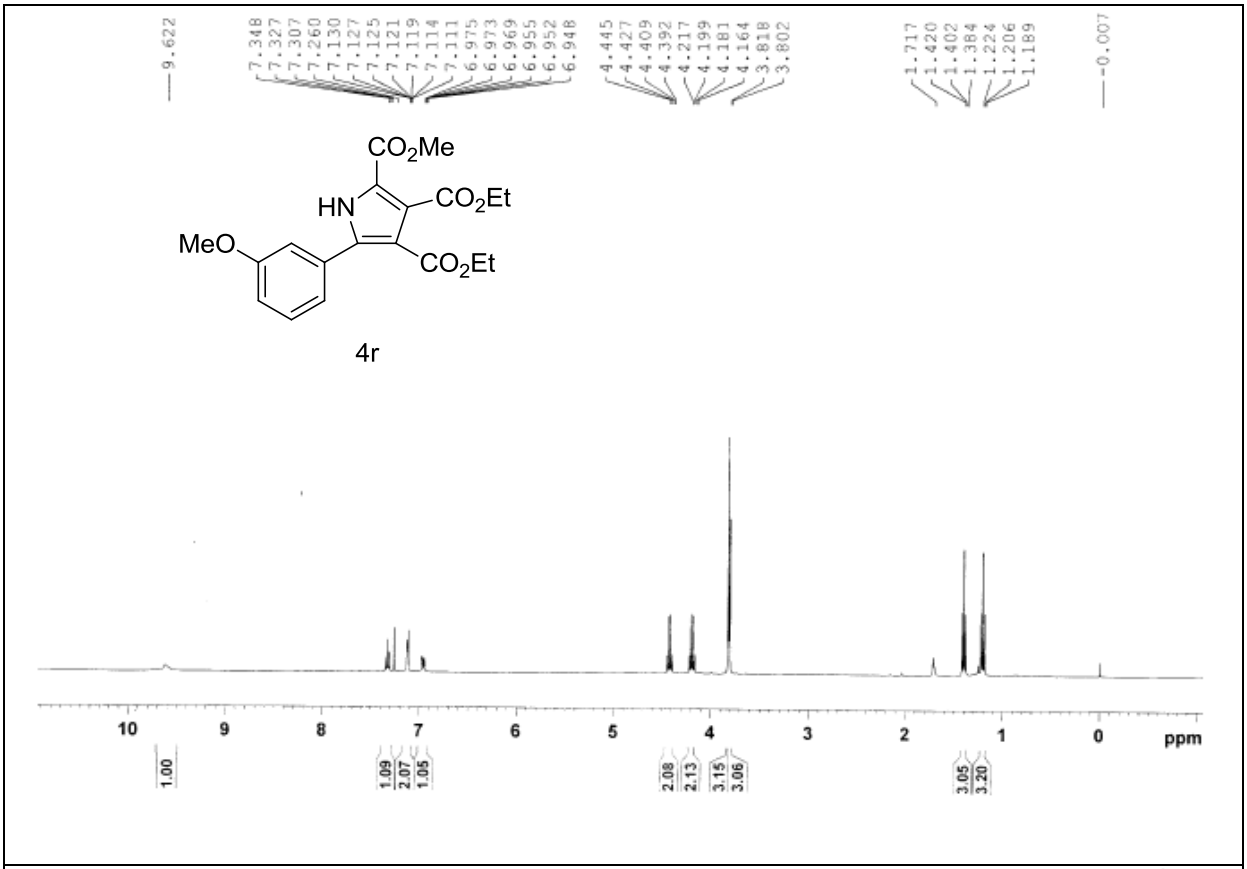
55.3519
52.1989
14.1666
13.9770
[ppm]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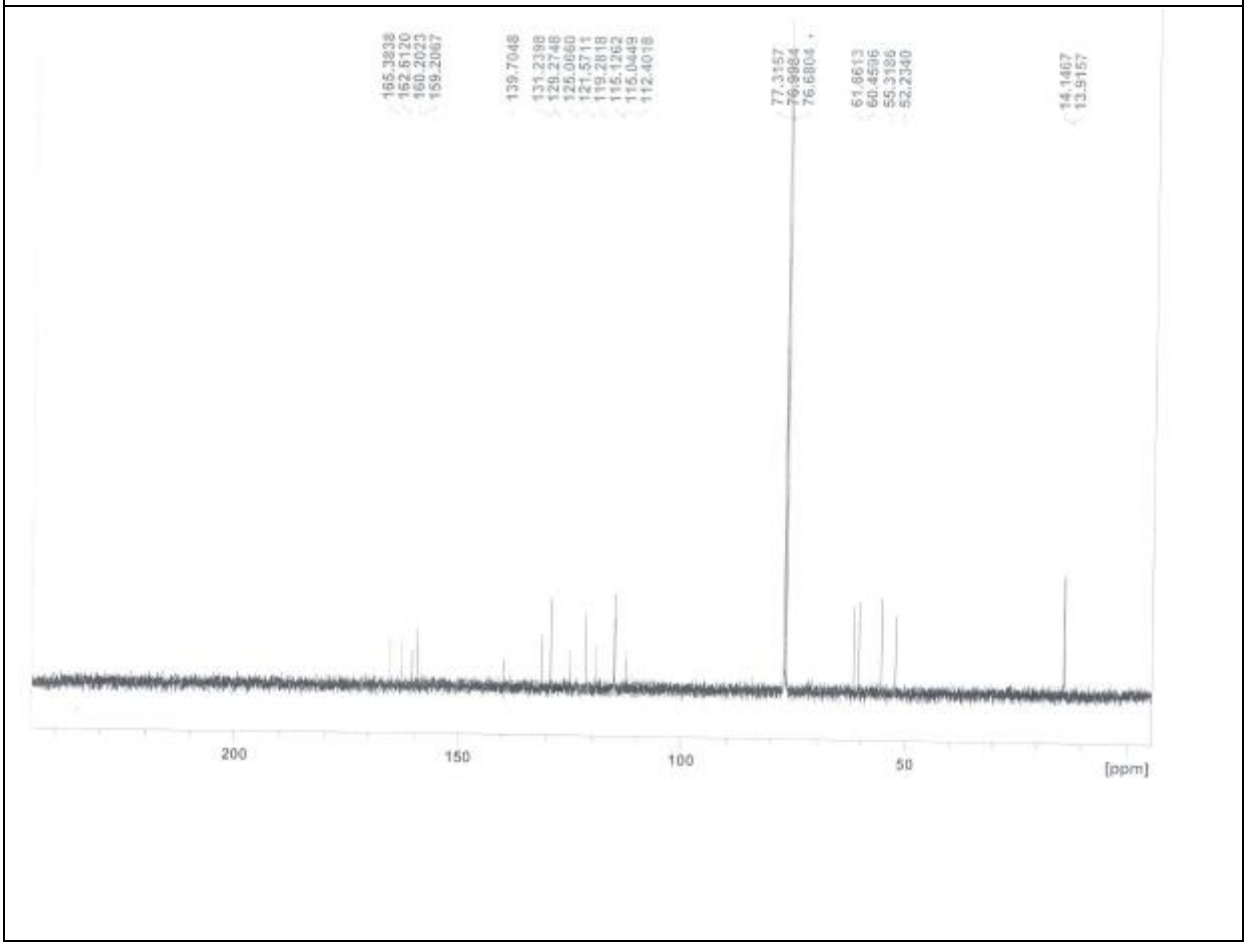
7.348
7.327
7.307
7.260
7.130
7.127
7.125
7.121
7.119
7.114
7.111
6.975
6.973
6.969
6.955
6.952
6.948
4.445
4.427
4.409
4.392
4.217
4.199
4.181
4.164
3.818
3.802
1.717
1.420
1.402
1.384
1.224
1.206
1.189
0.007
CO2Me
HN
CO2Et
MeO
CO2Et
4r
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.09
2.07
1.05
2.08
2.13
3.15
3.06
3.05
3.20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160.2023
159.2067
139.7048
131.2398
129.2748
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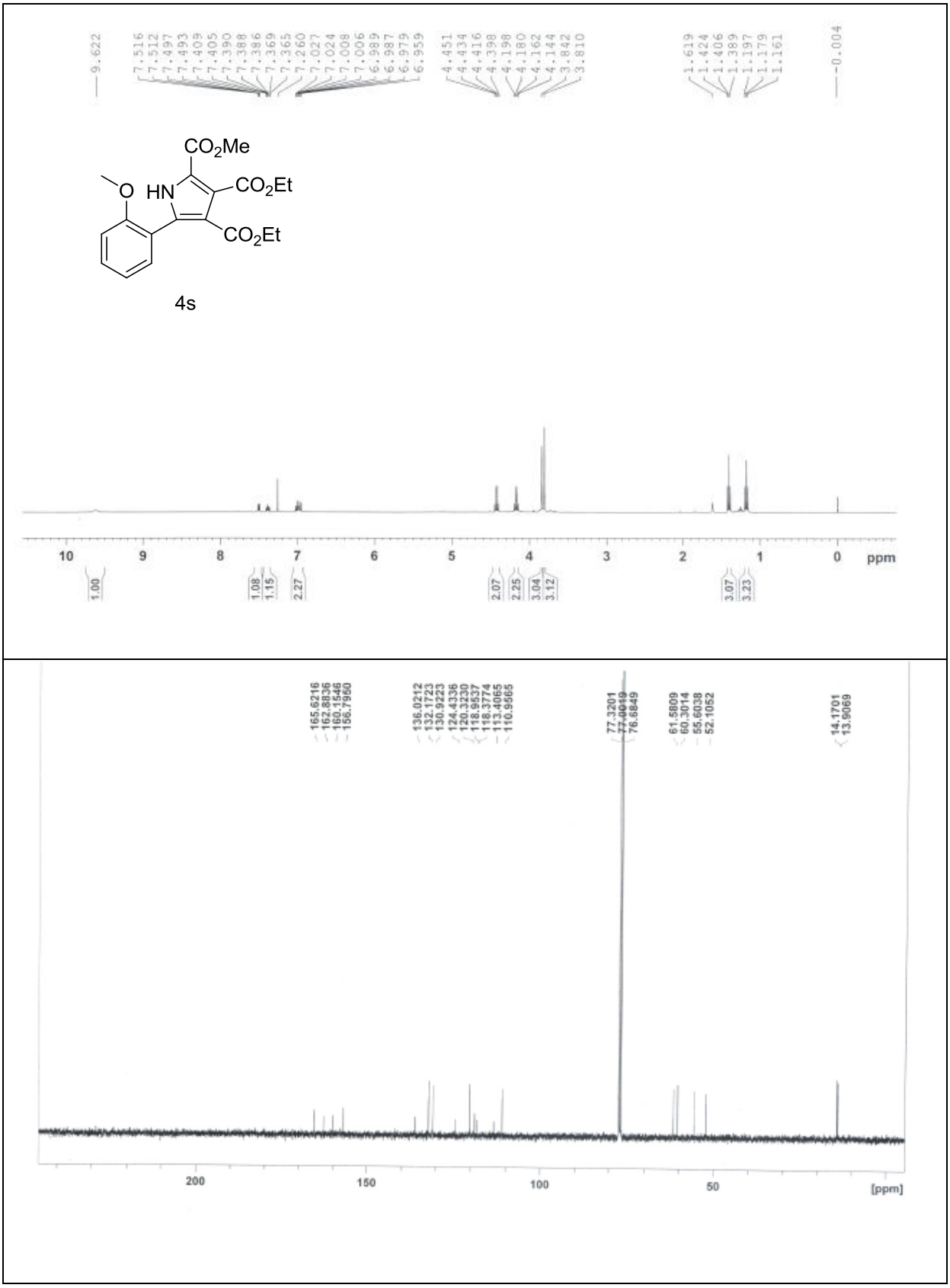
121.5711
119.2818
115.1262
115.0449
112.4018
77.3157
76.9884
76.6804
61.6613
60.4596
55.3186
52.2340
14.1467
13.9157
200
150
100
50
[ppm]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7.409
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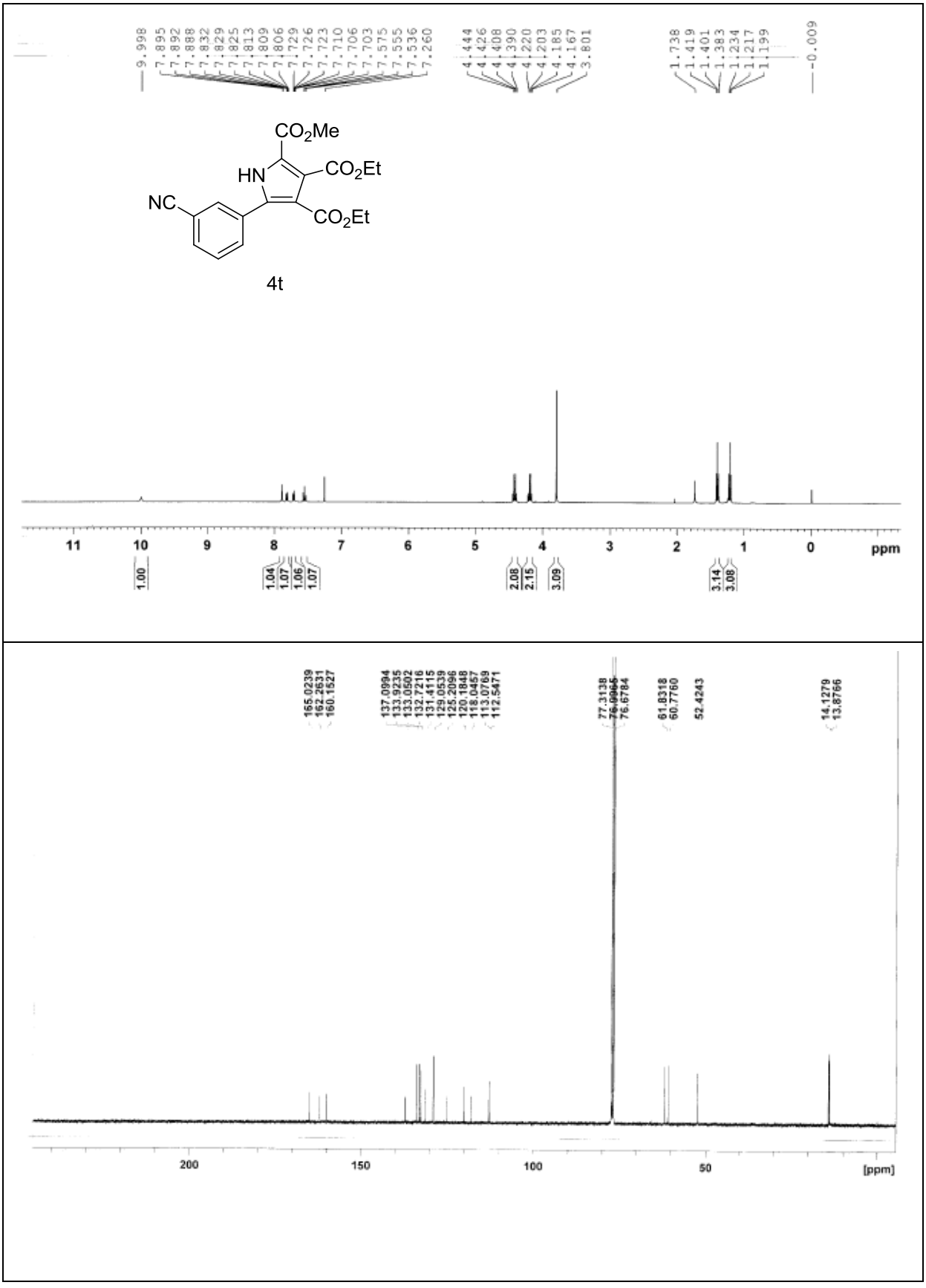
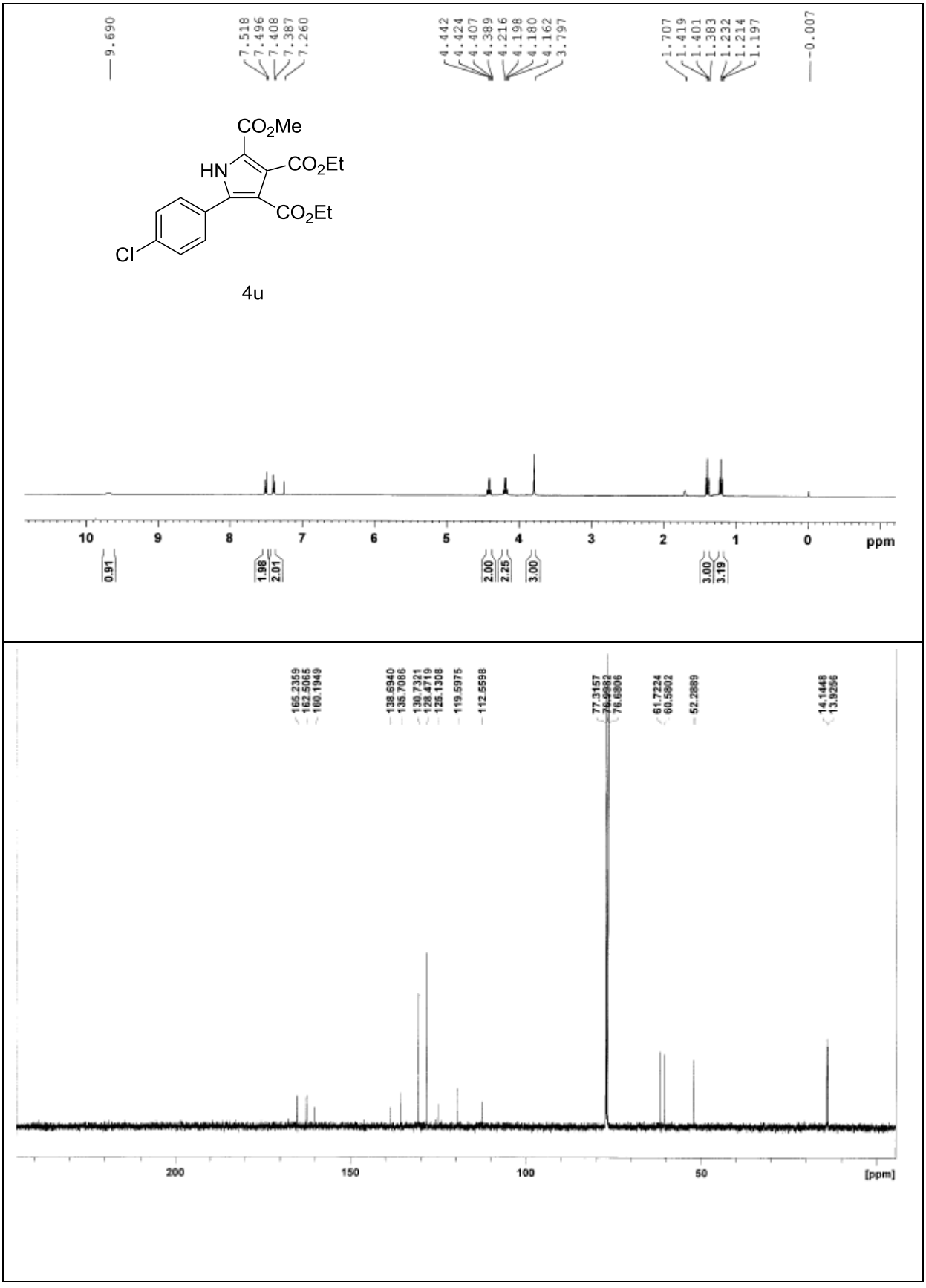
7.390
7.388
7.386
7.369
7.365
7.260
7.027
7.024
7.008
7.006
6.989
6.987
6.979
6.959
4.451
4.434
4.416
4.398
4.198
4.180
4.162
4.144
3.842
3.810
1.619
1.424
1.406
1.389
1.197
1.179
1.161
0.004
CO2Me
O
HN
CO2Et
CO2Et
4s
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.08
1.15
2.27
2.07
2.25
3.04
3.12
3.07
3.23
165.6216
162.8836
160.1546
156.7950
136.0212
132.1723
130.9223
124.4336
120.3230
118.9537
118.3774
113.4065
110.9565
77.3201
77.0049
76.6849
61.5809
60.3014
55.6038
52.1052
14.1701
13.9069
200
150
100
50
[ppm]


9.998
7.895
7.892
7.888
7.832
7.829
7.825
7.813
7.809
7.806
7.729
7.726
7.723
7.710
7.706
7.703
7.575
7.555
7.536
7.260
4.444
4.426
4.408
4.390
4.220
4.203
4.185
4.167
3.801
1.738
1.419
1.401
1.383
1.234
1.217
1.199
0.009
CO2Me
HN
CO2Et
NC
CO2Et
4t
11
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.04
1.07
1.06
1.07
2.08
2.15
3.09
3.14
3.08
165.0239
162.2631
160.1527
137.0994
133.9235
133.0502
132.7216
131.4115
129.0539
125.2096
120.1848
118.0457
113.0769
112.5471
77.3138
76.0965
76.6784
61.8318
60.7760
52.4243
14.1279
13.8766
200
150
100
50
[ppm]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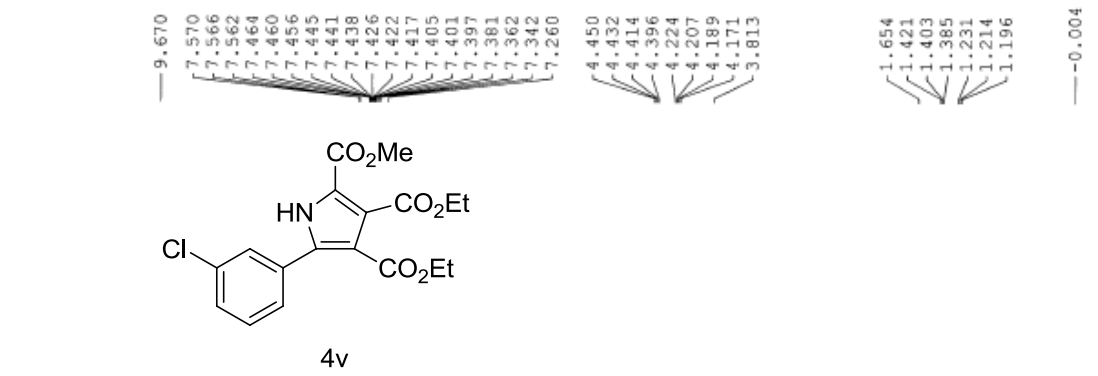
7.518
7.496
7.408
7.387
7.260
4.442
4.424
4.407
4.389
4.216
4.198
4.180
4.162
3.797
1.707
1.419
1.401
1.383
1.232
1.214
1.197
0.007
CO2Me
HN
CO2Et
CO2Et
Cl
4u
10
9
8
7
6
5
4
3
2
1
0
ppm
0.91
1.98
2.01
2.00
2.25
3.00
3.00
3.19
165.2359
162.5065
160.1949
138.6940
135.7086
130.7321
128.4719
125.1308
119.5975
112.5598
77.3157
76.9982
76.6806
61.7224
60.5802
52.2889
14.1448
13.9256
200
150
100
50
[ppm]


9.670
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7.566
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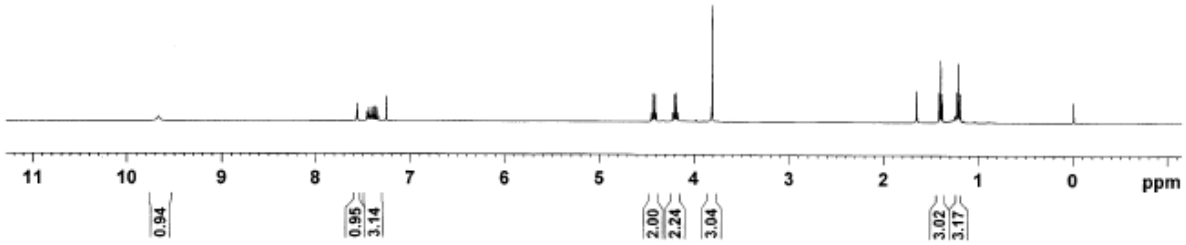
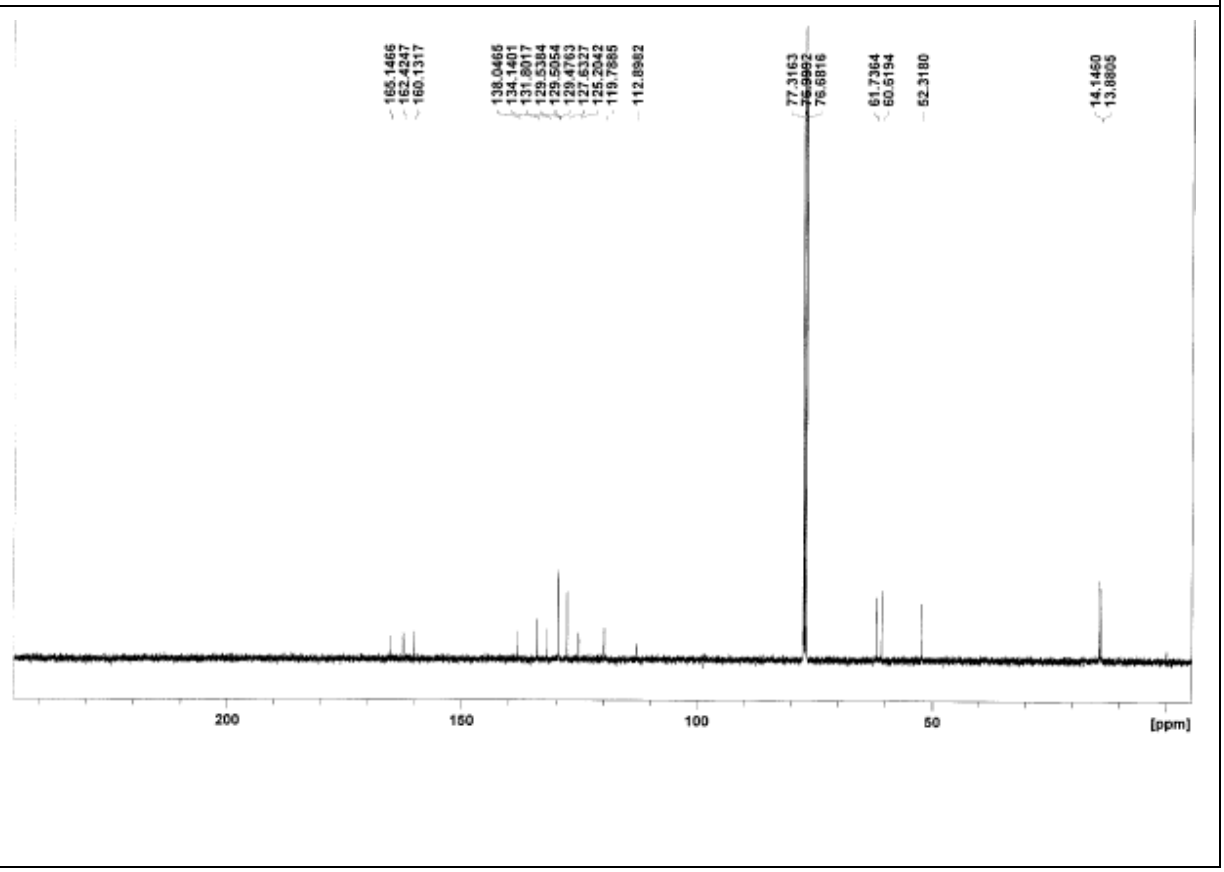
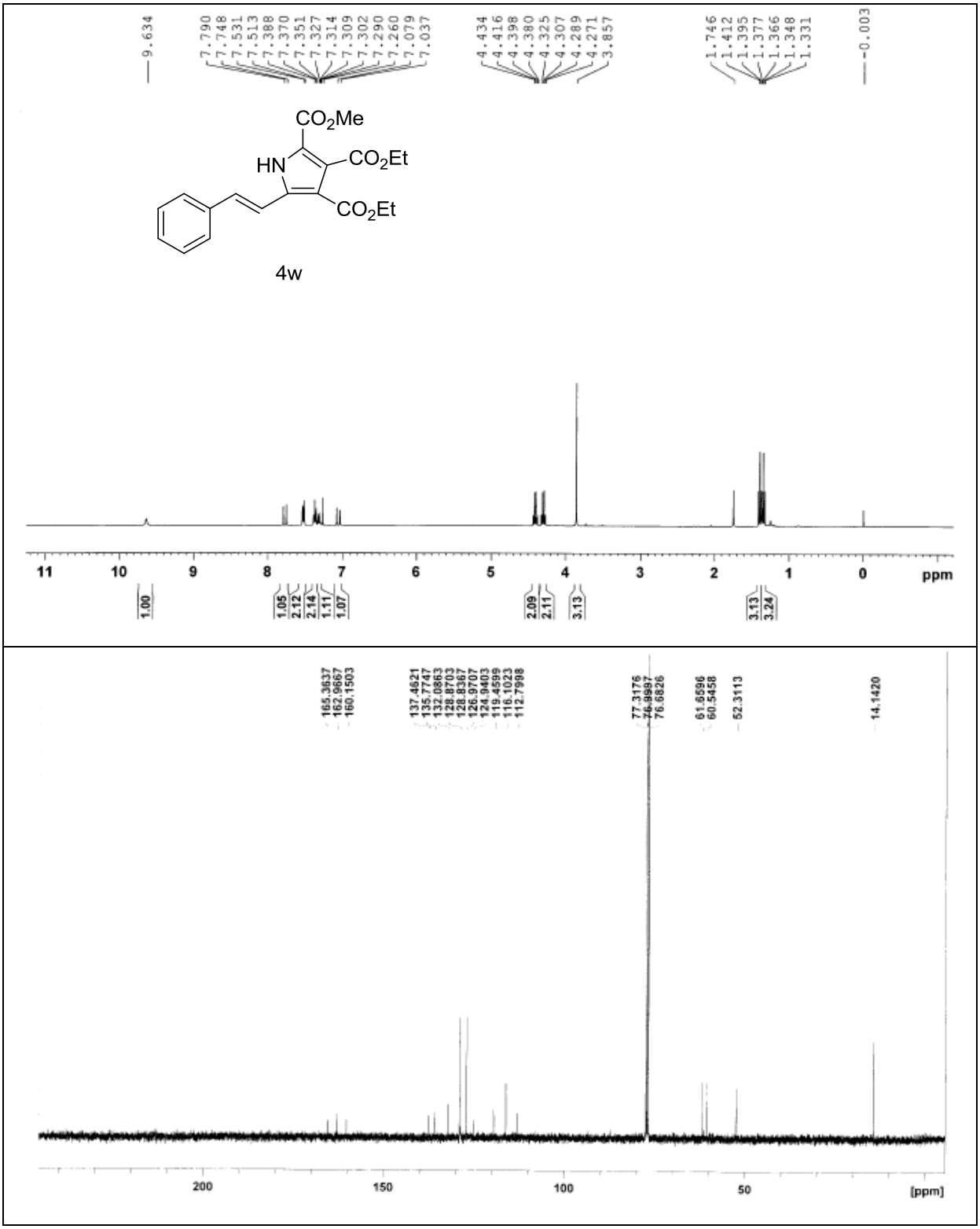
7.464
7.460
7.456
7.445
7.441
7.438
7.426
7.422
7.417
7.405
7.401
7.397
7.381
7.362
7.342
7.260
4.450
4.432
4.414
4.396
4.224
4.207
4.189
4.171
3.813
1.654
1.421
1.403
1.385
1.231
1.214
1.196
-0.004

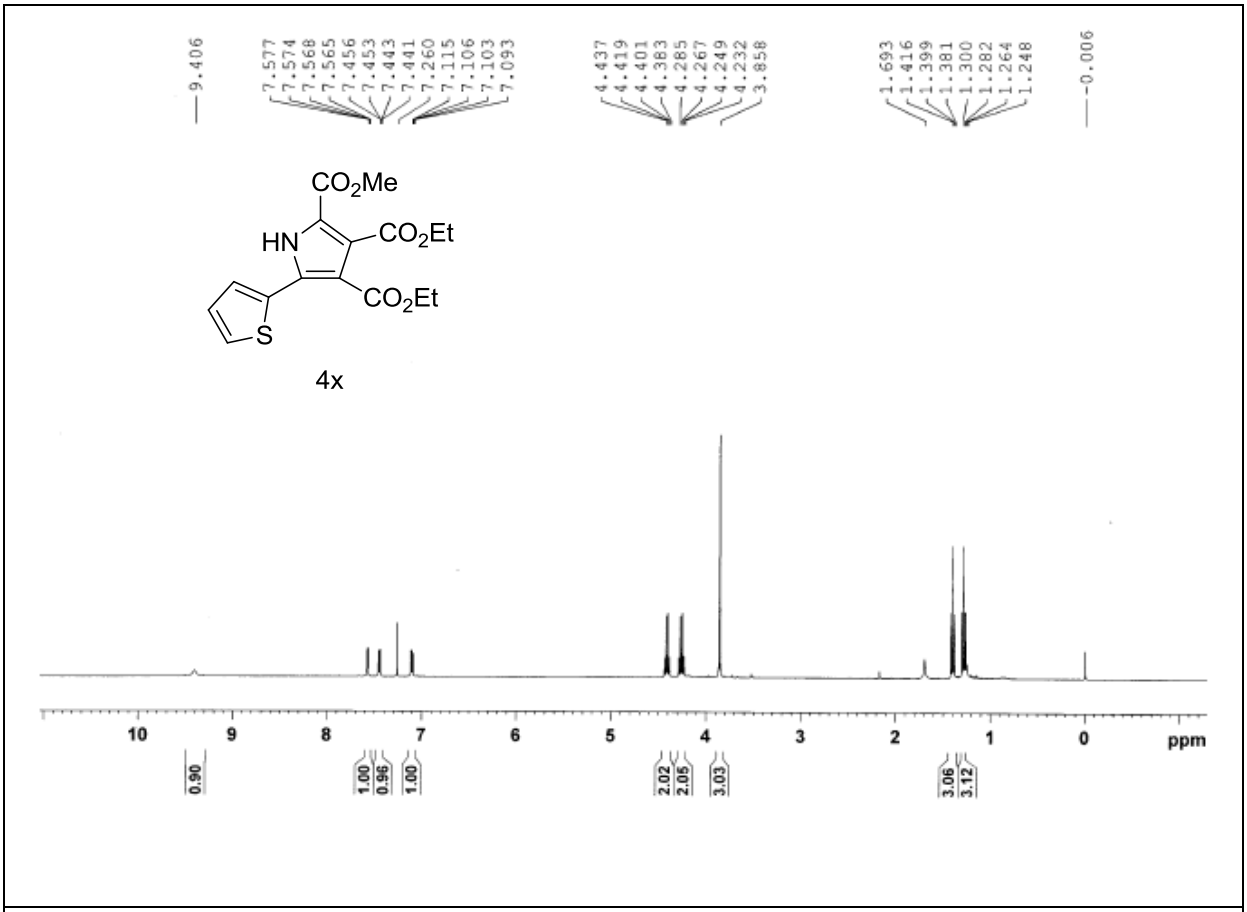
CO2Me
HN
CO2Et
Cl
CO2Et

4v


11
10
9
8
7
6
5
4
3
2
1
0
ppm
0.94
0.95
3.14
2.00
2.24
3.04
3.02
3.17


165.1466
162.4247
160.1317
138.0466
134.1401
131.8017
129.5384
129.5054
129.4763
127.6327
125.2042
119.7885
112.8982
77.3163
76.9992
76.6816
61.7364
60.6194
52.3180
14.1460
13.8805
200
150
100
50
[ppm]

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7.456
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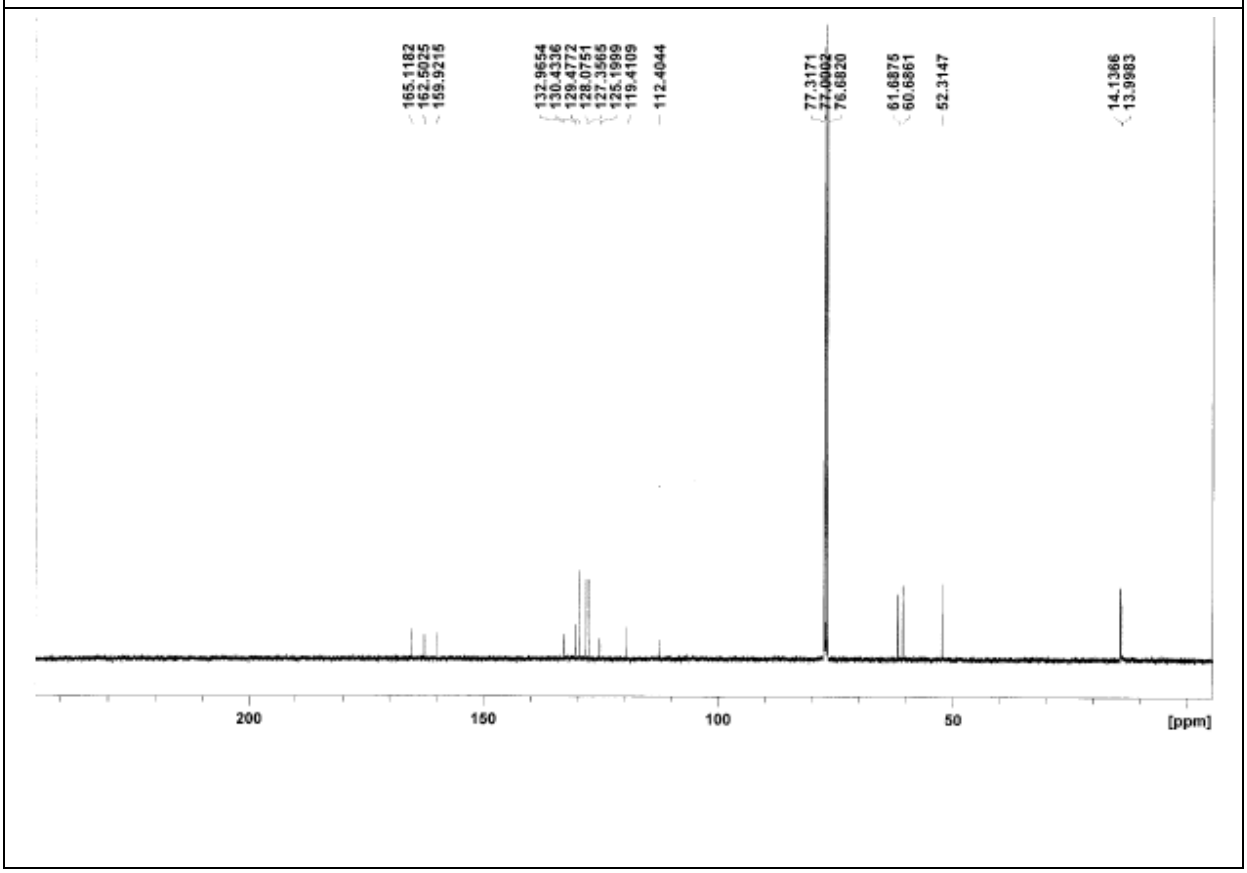
7.443
7.441
7.260
7.115
7.106
7.103
7.093
4.437
4.419
4.401
4.383
4.285
4.267
4.249
4.232
3.858
1.693
1.416
1.399
1.381
1.300
1.282
1.264
1.248
0.006
CO2Me
HN
CO2Et
CO2Et
S
4x
10
9
8
7
6
5
4
3
2
1
0
ppm
0.90
1.00
0.96
1.00
2.02
2.05
3.03
3.06
3.12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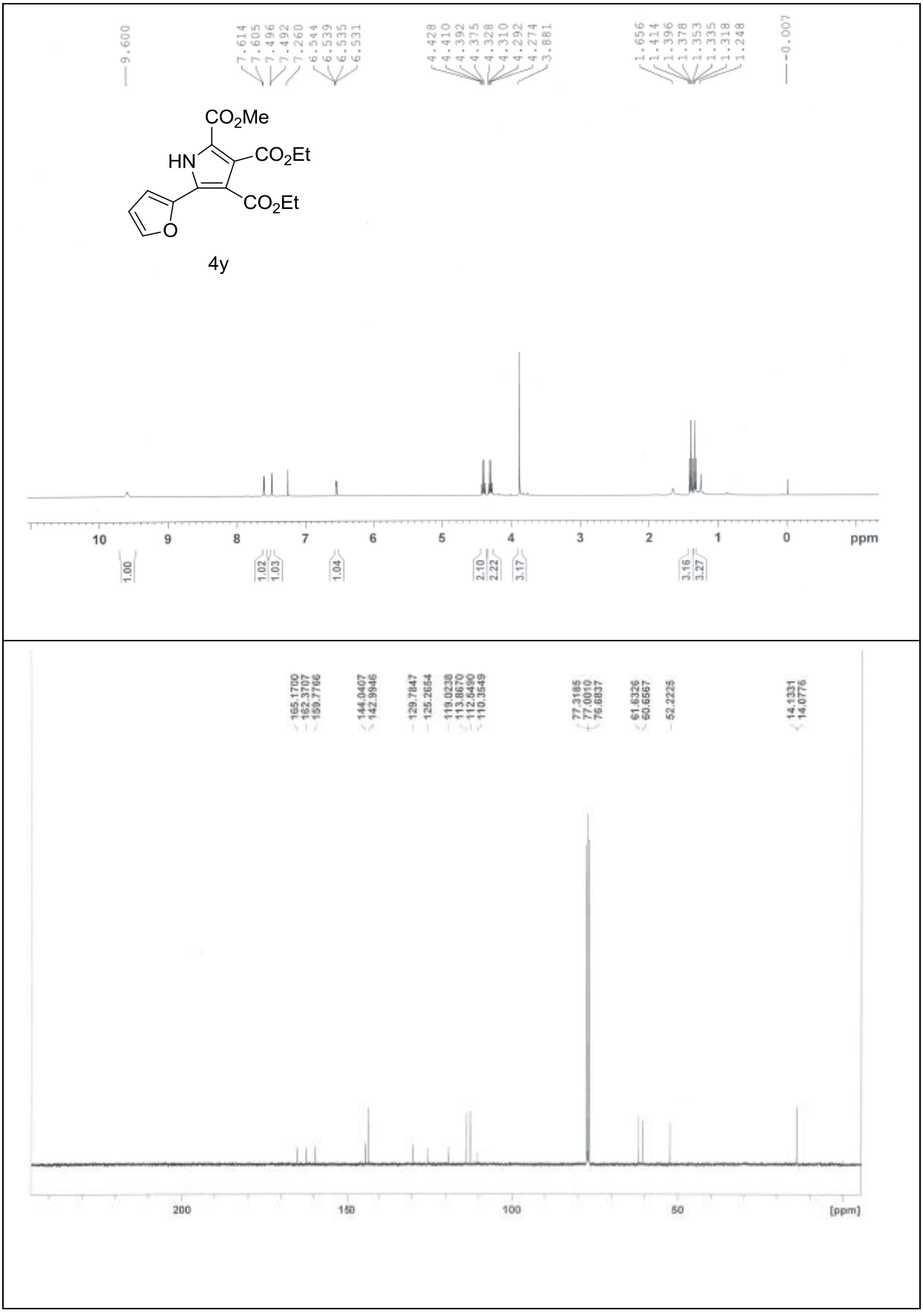
162.5025
159.9215
132.9654
130.4336
129.4772
128.0751
127.3565
125.1999
119.4109
112.4044
77.3171
77.0002
76.6820
61.6875
60.6861
52.3147
14.1366
13.9983
200
150
100
50
[ppm]


9.600
7.614
7.605
7.496
7.492
7.260
6.544
6.539
6.535
6.531
4.428
4.410
4.392
4.375
4.328
4.310
4.292
4.274
3.881
1.656
1.414
1.396
1.378
1.353
1.335
1.318
1.248
0.007
CO2Me
HN
CO2Et
CO2Et
O
4y
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.02
1.03
1.04
2.10
2.22
3.17
3.16
3.27
165.1700
162.3707
159.7766
144.0407
142.9946
129.7847
125.2654
119.0238
113.8670
112.5490
110.3549
77.3185
77.0010
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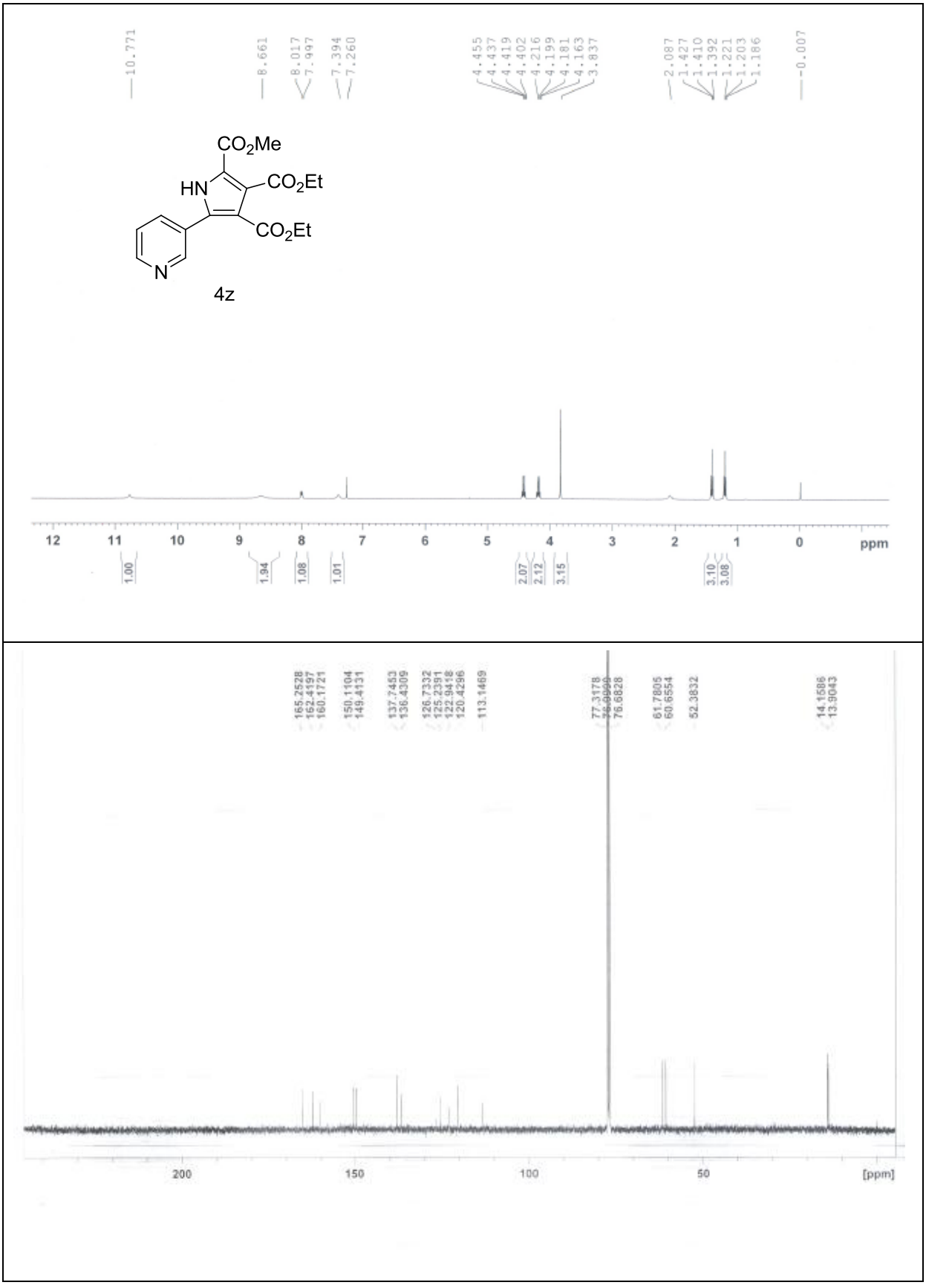
61.6326
60.6567
52.2225
14.1331
14.0776
200
150
100
50
[ppm]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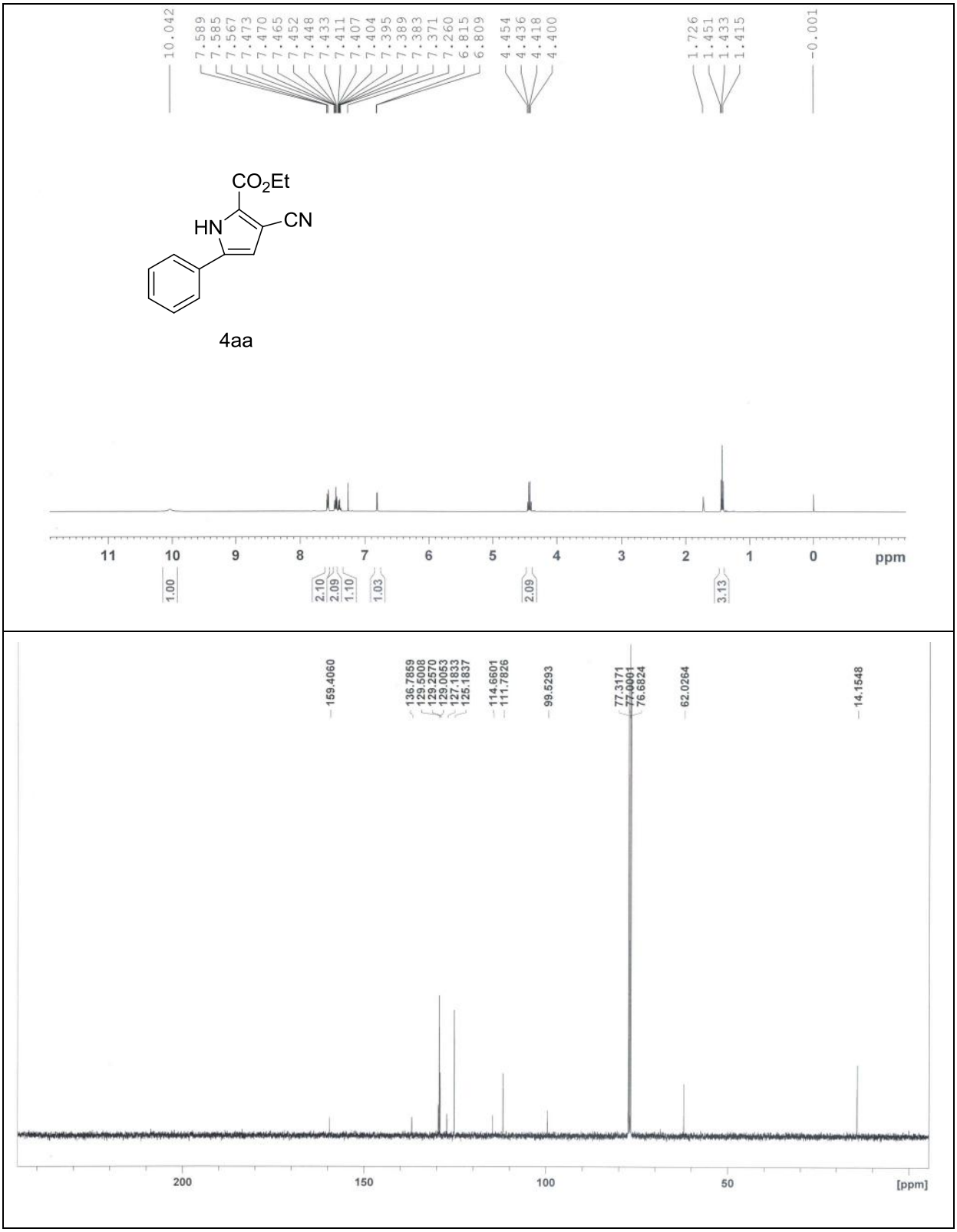
7.260
4.455
4.437
4.419
4.402
4.216
4.199
4.181
4.163
3.837
2.087
1.427
1.410
1.392
1.221
1.203
1.186
0.007
CO2Me
HN
CO2Et
CO2Et
N
4z
12
11
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
1.94
1.08
1.01
2.07
2.12
3.15
3.10
3.08
165.2528
162.4197
160.1721
150.1104
149.4131
137.7453
136.4309
126.7332
125.2391
122.9418
120.4296
113.1469
77.3178
76.8996
76.6828
61.7805
60.6554
52.3832
14.1586
13.9043
200
150
100
50
[ppm]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7.585
7.567
7.473
7.470
7.465
7.452
7.448
7.433
7.411
7.407
7.404
7.395
7.389
7.383
7.371
7.260
6.815
6.809
4.454
4.436
4.418
4.400
1.726
1.451
1.433
1.415
-0.001
CO2Et
HN
CN
4aa
11
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
2.10
2.09
1.10
1.03
2.09
3.13
159.4060
136.7859
129.5008
129.2570
129.0053
127.1833
125.1837
114.6601
111.7826
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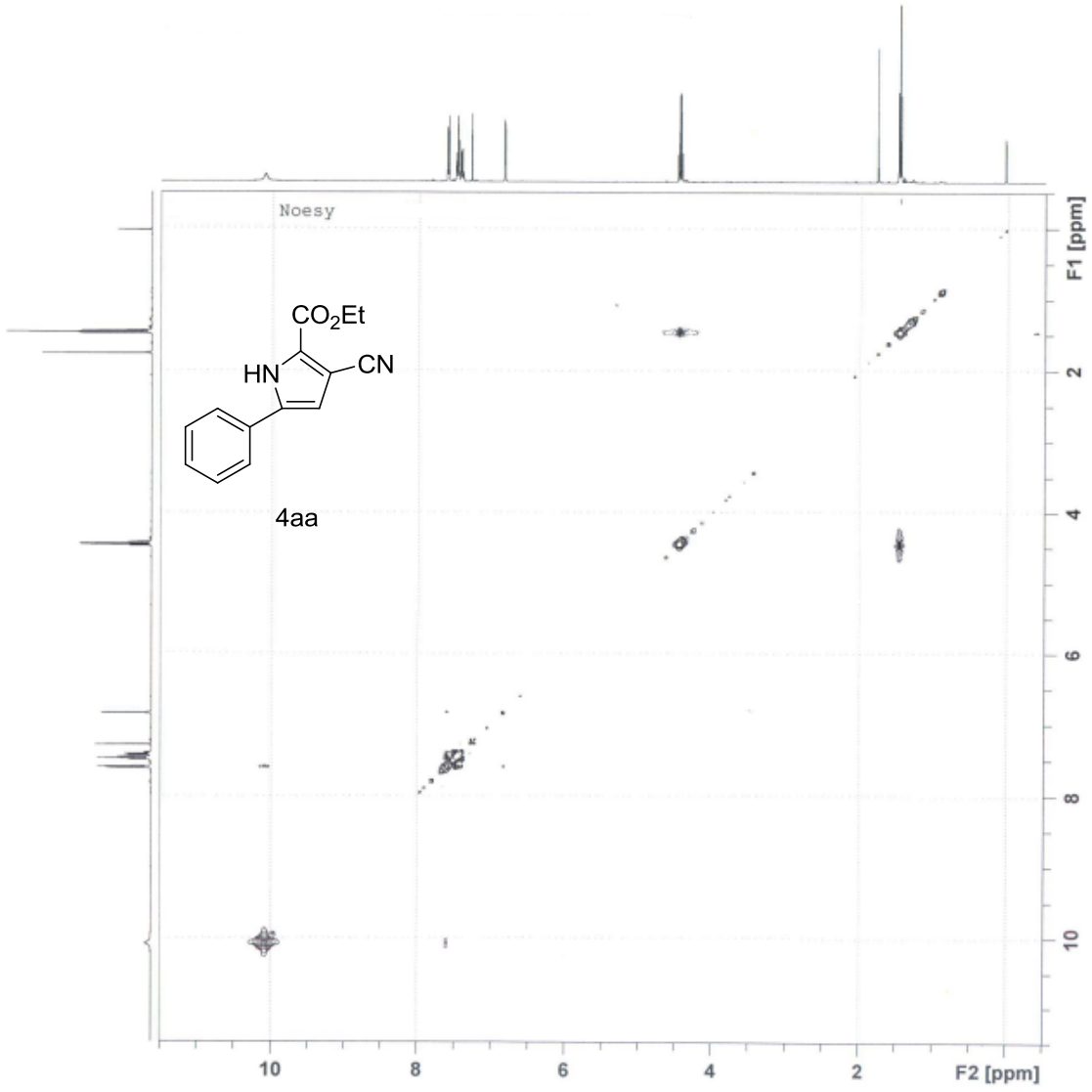
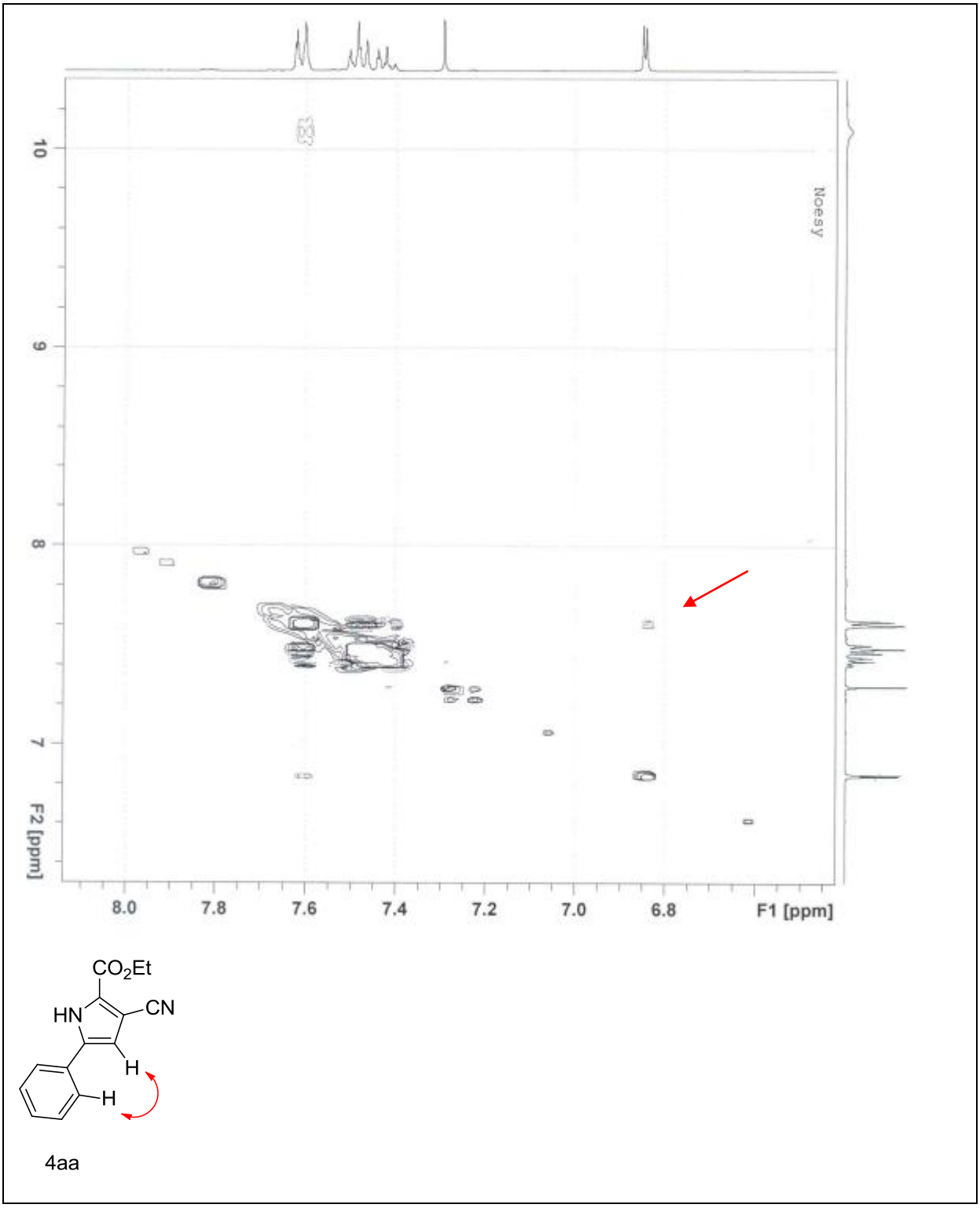
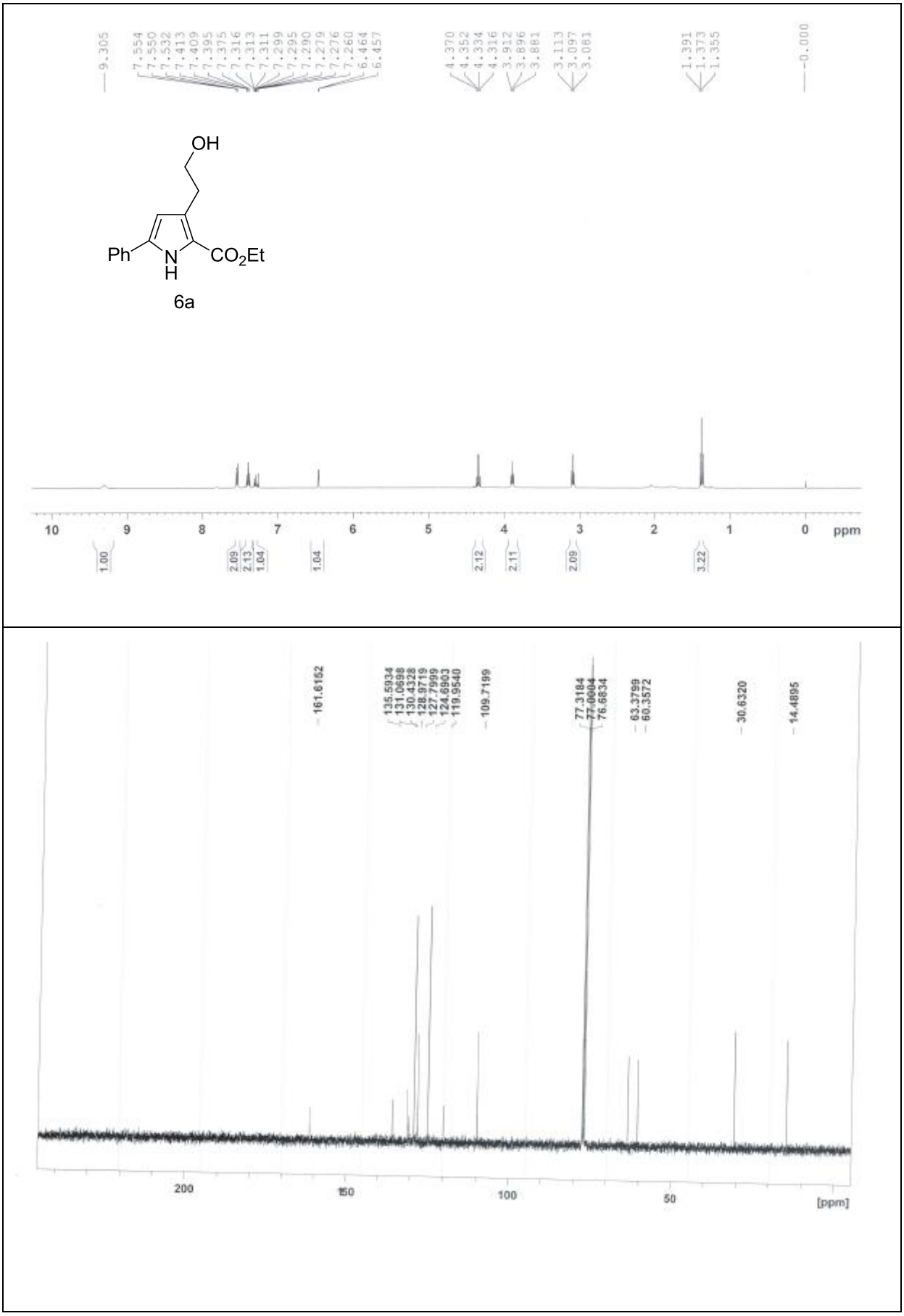
77.3171
77.0001
76.6824
62.0264
14.1548
200
150
100
50
[ppm]



For the expanded, see p. 124.



4aa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7.550
7.532
7.413
7.409
7.395
7.375
7.316
7.313
7.311
7.299
7.295
7.290
7.279
7.276
7.260
6.464
6.457
4.370
4.352
4.334
4.316
3.912
3.896
3.881
3.113
3.097
3.081
1.391
1.373
1.355
0.000
OH
Ph
N
H
CO2Et
6a
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
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2.13
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1.04
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2.09
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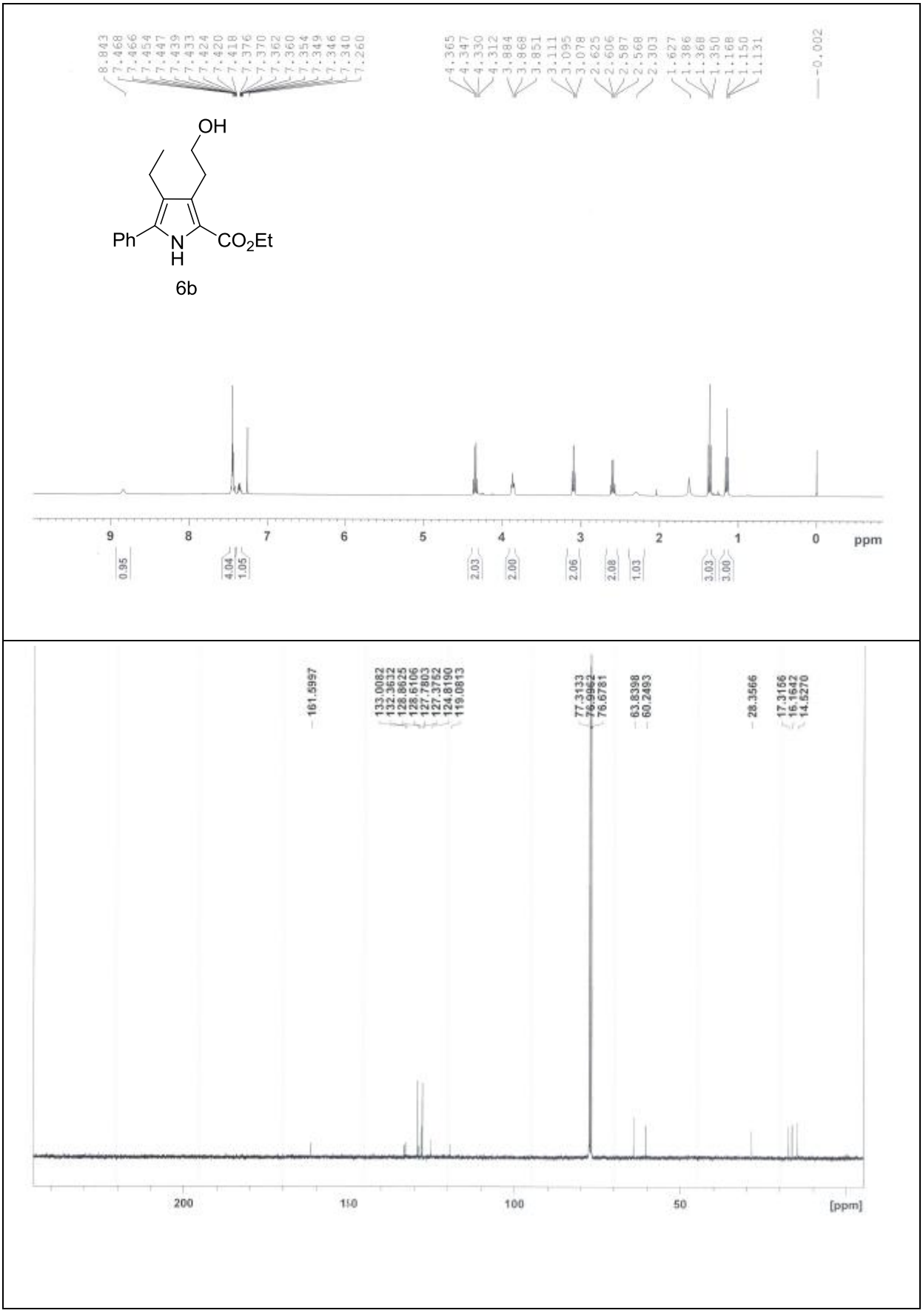
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OH
Ph
N
H
CO2Et
6b
9
8
7
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4
3
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ppm
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2.03
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