Supporting Information

Visible-light-induced selective amination of enol ethers with *N*-alkoxyamides by using DDQ as photoredox catalyst

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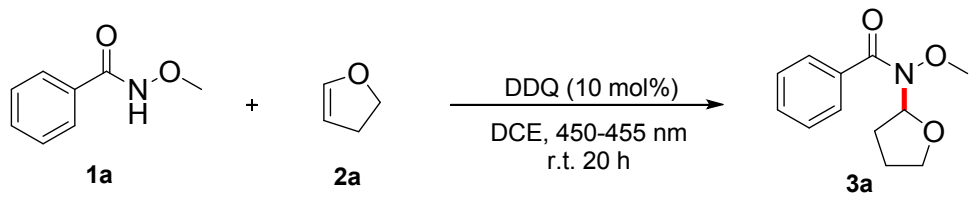
1. General considerations

All ^{1}H NMR and ^{13}C NMR spectra were recorded on a 400 MHz Bruker FT-NMR spectrometer (400 MHz or 100 MHz, respectively). All chemical shifts are given as δ value (ppm) with reference to tetramethylsilane (TMS) as an internal standard. The peak patterns are indicated as follows: s, singlet; d, doublet; t, triplet; m, multiplet; q, quartet. The coupling constants, *J*, are reported in Hertz (Hz). High resolution mass spectroscopy data of the product were collected on an an Agilent Technologies 6540 UHD Accurate-Mass Q-TOF LC/MS (ESI) or a Waters Micromass GCT Premier (oa-TOF) Mass Spectrometer (EI).

N-Alkoxyamides were prepared according to the reported method [Y. Fukui, P. Liu, Q. Liu, Z.-T. He, N.-Y. Wu, P. Tian, and G.-Q. Lin, *J. Am. Chem. Soc.,* 2014, **136**, 15607]. The chemicals and solvents were purchased from commercial suppliers either from Aldrich (USA) or Shanghai Chemical Company (China) without further purification. All the solvents were dried and freshly distilled prior to use. Products were purified by flash chromatography on 200–300 mesh silica gels, SiO_2.

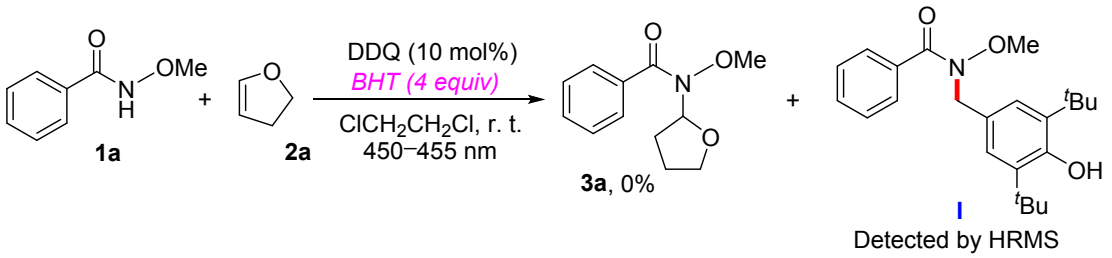
2. General procedure for the model reaction



N-Methoxybenzamide (**1a**, 0.20 mmol), 2,3-dihydrofuran (**2a**, 0.60 mmol), DDQ (0.020 mmol, 10 mol%) and DCE (3.0 mL) were sequence added to an oven-dried reaction vessel equipped with magnetic stirring bar. Then the reaction vessel was irradiated using blue LED (450–455 nm, 1.5 W) under air atmosphere at room temperature for 20 h. After the reaction was completed, the mixture was concentrated to yield the crude product, which was further purified by flash chromatography (silica gel, petroleum ether/ethyl acetate = 7/1) to give the desired product **3a** in 86% yield as a colorless oil.

3. Free radical trapping experiments

3.1 Free radical trapping with BHT



N-Methoxybenzamide (**1a**, 0.20 mmol), 2,3-dihydrofuran (**2a**, 0.60 mmol), DDQ (0.020 mmol, 10 mol%), DCE (3.0 mL) and 2,6-di-*tert*-butyl-4-methylphenol (butylated hydroxytoluene, BHT, 0.80 mmol) were added to an oven-dried reaction vessel equipped with magnetic stirring bar. Then the reaction vessel was irradiated by using 1.5 W LED (450–455 nm) under air atmosphere at room temperature for 20 h. After the reaction was completed, no desired product **3a** was detected and an adduct **I** of *N*-radical from **1a** with BHT was detected by HPLC-HRMS analysis (Figure S1), indicating that the desired reaction was completely inhibited. It is suggested that a radical pathway might be involved in this transformation.

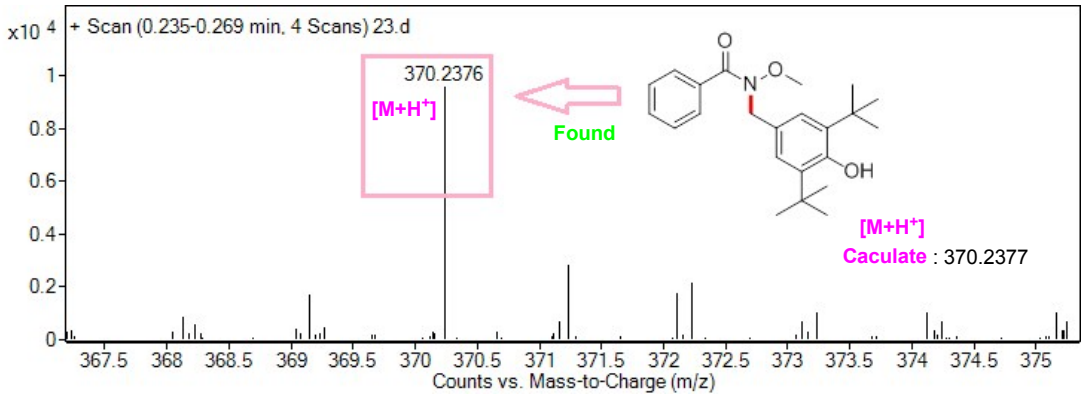
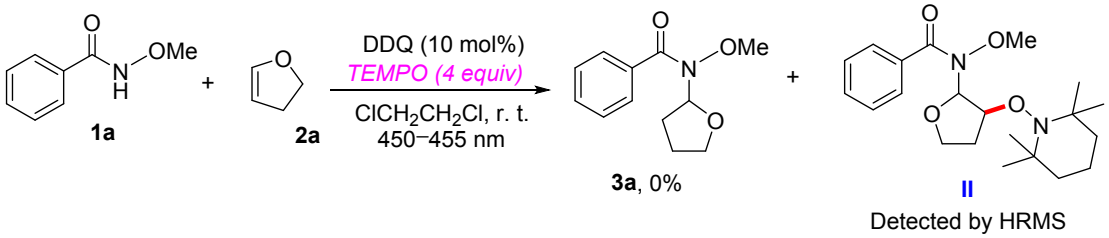


Figure S1. HRMS analysis of the adduct **I** of *N*-radical from **1a** with BHT

3.2 Free radical trapping with TEMPO



N-Methoxybenzamide (**1a**, 0.20 mmol), 2,3-dihydrofuran (**2a**, 0.60 mmol), DDQ (0.020 mmol, 10 mol%), DCE (3.0 mL) and 2,2,6,6-tetramethyl-1-oxylpiperidine (TEMPO, 0.80 mmol) were added to an oven-dried reaction vessel equipped with magnetic stirring bar. Then the reaction vessel was irradiated by using 1.5 W LED (450–455 nm) under air atmosphere at room temperature for 20 h. After the reaction was completed, no desired product **3a** was detected and the corresponding adduct **II** of *N*-radical from **1a** with **2a** and TEMPO was observed by HPLC-HRMS analysis (Figure S2), illustrating that the desired reaction was completely inhibited. It is suggested that the new carbon-centered radical might be a key intermediate in reaction and a radical pathway might be involved in this transformation.

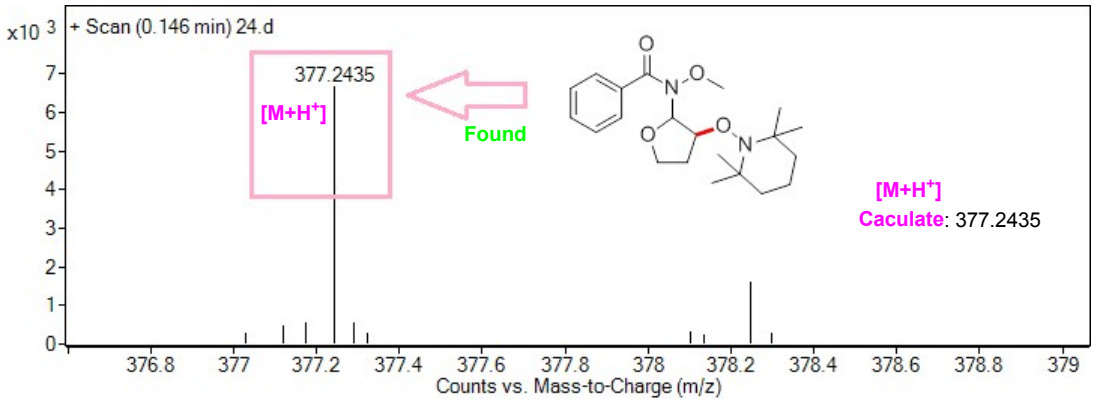


Figure S2. HRMS analysis of the adduct of **II** of *N*-radical from **1a** with **2a** and TEMPO

4. Absorption spectra of DDQ in DCE

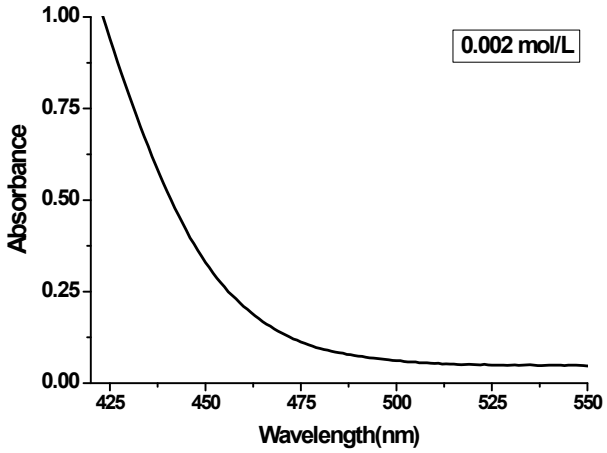


Figure S3 Absorption spectra of DDQ in DCE

5. Cyclic voltammetry (CV) measurements

The cyclic voltammetry (CV) measurements (using an Ag/AgCl reference electrode) were carried out using tetrabultylammonium tetrafluoroborate (0.1 M in DCE) as electrolyte and selected *N*-methoxybenzamide, DDQ and 2,3-dihydrofuran as 0.002 M in DCE and the results were summarized in the following Figure S4. The applied potential range is 1.5~-1.0 V vs. Ag/AgCl at a sweep rate of 140 mV/s using a CHI 760E electrochemical workstation at ambient temperature.

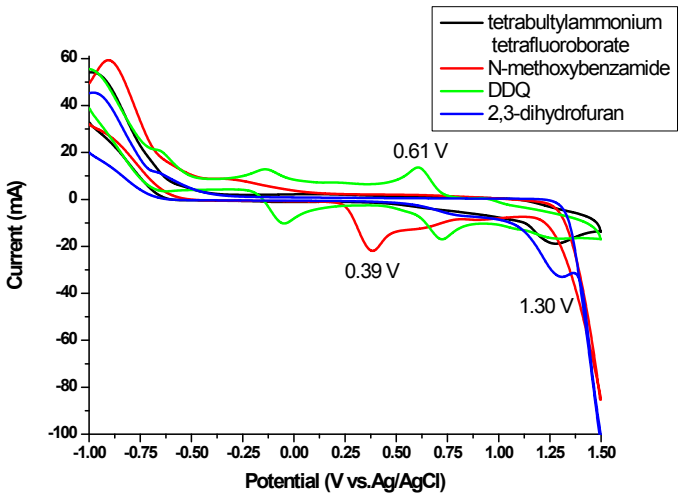
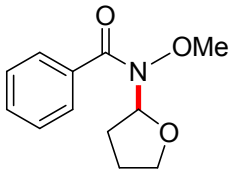
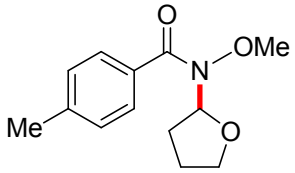


Figure S4 Cyclic voltammetry (CV) curves of DDQ, *N*-methoxybenzamide, 2,3-dihydrofuran and tetrabultylammonium tetrafluoroborate

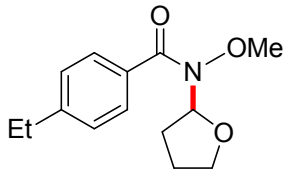
6. Characterization data for all products



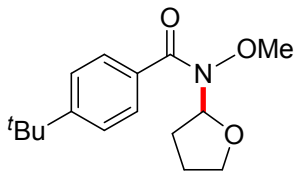
***N*-Methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3a):**[8a] Colorless liquid; 86% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.66−7.64 (m, 2H), 7.48−7.38 (m, 3H), 5.85 (q, *J* = 3.8 Hz, 1H), 4.10 (q, *J* = 7.2 Hz, 1H), 3.83−3.77 (m, 4H), 2.30−2.24 (m, 1H), 2.17−2.08 (m, 1H), 2.04−1.97 (m, 1H), 1.93−1.87 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.73, 134.17, 130.51, 127.97, 127.73, 88.90, 68.60, 64.13, 28.00, 25.30.



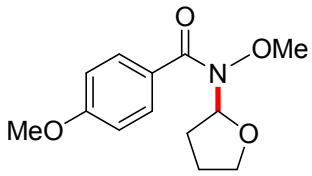
***N*-Methoxy-4-methyl-*N*-(tetrahydrofuran-2-yl)benzamide (3b):** Colorless liquid; 78% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.57 (d, *J* = 8.1 Hz, 2H), 7.21 (d, *J* = 7.9 Hz, 2H), 5.87 (q, *J* = 7.1 Hz, 1H), 4.13−4.08 (m, 1H), 3.84−3.80 (m, 1H), 3.79 (s, 3H), 2.38 (s, 3H), 2.32−2.24 (m, 1H), 2.19−2.09 (m, 1H), 2.06−1.97 (m, 1H), 1.94−1.87 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.07, 141.14, 131.47, 128.84, 128.16, 89.29, 68.81, 64.31, 28.22, 25.56, 21.37. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 235.1208, found: 235.1218.



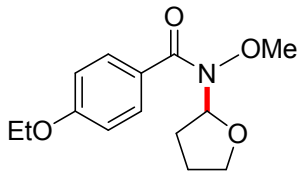
4-Ethyl-*N*-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3c): Colorless liquid; 72% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.59 (d, *J* = 8.0 Hz, 2H), 7.23 (d, *J* = 7.9 Hz, 2H), 5.86 (q, *J* = 3.9 Hz, 1H), 4.11 (q, *J* = 7.0 Hz, 1H), 3.84−3.78 (m, 4H), 2.68 (q, *J* = 7.6 Hz, 2H), 2.32−2.24 (m, 1H), 2.17−2.11 (m, 1H), 2.06−1.97 (m, 1H), 1.94−1.87 (m, 1H), 1.24 (t, *J* = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.02, 147.31, 131.64, 128.16, 127.62, 89.28, 68.75, 64.23, 28.65, 28.16, 25.50, 15.11. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 249.1365, found: 249.1367.



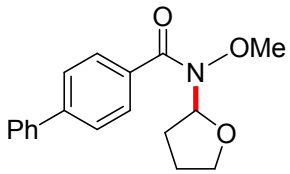
4-(tert-Butyl)-*N*-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3d):[8a] Colorless liquid; 80% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.61 (d, *J* = 7.9 Hz, 2H), 7.42 (d, *J* = 8.0 Hz, 2H), 5.88−5.85 (m, 1H), 4.11 (q, *J* = 6.9 Hz, 1H), 3.84−3.79 (m, 4H), 2.32−2.25 (m, 1H), 2.18−2.11 (m, 1H), 2.06−1.99 (m, 1H), 1.94−1.89 (m, 1H), 1.33 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.88, 154.11, 131.36, 127.86, 125.07, 89.33, 68.75, 64.20, 34.71, 31.00, 28.14, 25.50.



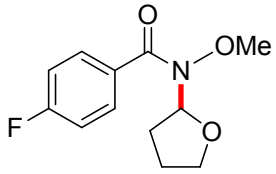
***N*,4-Dimethoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3e):** Colorless liquid; 85% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.69 (d, *J* = 8.8 Hz, 2H), 6.91 (d, *J* = 8.8 Hz, 2H), 5.91 (q, *J* = 4.0 Hz, 1H), 4.14−4.08 (m, 1H), 3.84−3.81 (m, 4H), 3.78 (s, 3H), 2.32−2.25 (m, 1H), 2.20−2.10 (m, 1H), 2.07−2.00 (m, 1H), 1.97−1.89 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.69, 161.69, 130.28, 126.32, 113.45, 88.30, 68.78, 64.27, 55.25, 28.18, 25.56. HRMS (EI): Calcd. for $C_{13}H_{17}NO_4$: 251.1158, found: 251.1161.



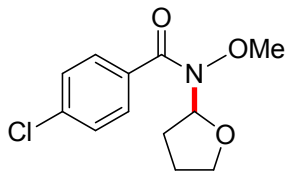
4-Ethoxy-*N*-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3f): Colorless liquid; 80% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.67 (d, *J* = 8.7 Hz, 2H), 6.90 (d, *J* = 8.6 Hz, 2H), 5.91 (q, *J* = 4.0 Hz, 1H), 4.13−4.04 (m, 3H), 3.82 (q, *J* = 7.2 Hz, 1H), 3.77 (s, 3H), 2.32−2.25 (m, 1H), 2.19−2.11 (m, 1H), 2.05−1.98 (m, 1H), 1.95−1.88 (m, 1H), 1.42 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.72, 161.08, 130.23, 126.11, 113.90, 89.29, 68.72, 64.20, 63.46, 28.14, 25.51, 14.54. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 265.1314, found: 265.1318.



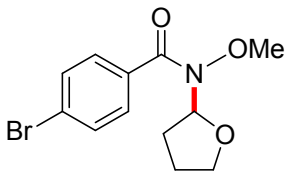
***N*-Methoxy-*N*-(tetrahydrofuran-2-yl)-[1,1'-biphenyl]-4-carboxamide (3g):** Colorless liquid; 70% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.75 (d, *J* = 8.2 Hz, 2H), 7.64−7.59 (m, 4H), 7.45 (t, *J* = 7.5 Hz, 2H), 7.39−7.35 (m, 1H), 5.92 (q, *J* = 3.9 Hz, 1H), 4.12 (q, *J* = 7.4 Hz, 1H), 3.86−3.80 (m, 4H), 2.35−2.27 (m, 1H), 2.21−2.12 (m, 1H), 2.09−2.02 (m, 1H), 1.96−1.90 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.81, 143.65, 140.04, 133.10, 128.81, 128.66, 127.85, 127.09, 126.88, 89.24, 68.87, 64.47, 28.28, 25.57. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 297.1365, found: 297.1375.



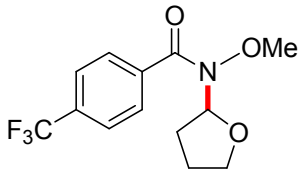
4-Fluoro-*N*-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3h): Colorless liquid; 77% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.74−7.70 (m, 2H), 7.12-7.08 (m, 2H), 5.89 (q, *J* = 4.0 Hz, 1H), 4.11 (q, *J* = 7.4 Hz, 1H), 3.83 (q, *J* = 7.1 Hz, 1H), 3.77 (s, 3H), 2.33−2.25 (m, 1H), 2.20−2.12 (m, 1H), 2.10−2.01 (m, 1H), 1.95−1.89 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.98, 164.13 (d, *J* = 249.9 Hz), 130.62 (d, *J* = 8.7 Hz), 130.33 (d, *J* = 3.1 Hz), 115.30 (d, *J* = 21.6 Hz), 88.95, 68.86, 64.51, 28.26, 25.54. HRMS (EI): Calcd. for $C_{12}H_{14}FNO_3$: 239.0958, found: 239.0956.



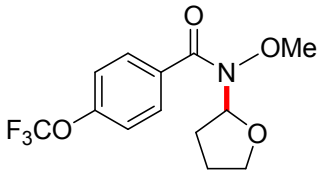
4-Chloro-*N*-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3i): Colorless liquid; 75% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.64 (d, *J* = 8.3 Hz, 2H), 7.39 (d, *J* = 8.2 Hz, 2H), 5.89−5.87 (m, 1H), 4.11 (q, *J* = 7.2 Hz, 1H), 3.83 (q, *J* = 7.2 Hz, 1H), 3.76 (s, 3H), 2.32−2.24 (m, 1H), 2.20−2.11 (m, 1H), 2.07−2.01 (m, 1H), 1.97−1.90 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.97, 136.98, 132.68, 129.65, 128.48, 88.86, 68.87, 64.60, 28.27, 25.52. HRMS (EI): Calcd. for $C_{12}H_{14}ClNO_3$: 255.0662, found: 255.0667.



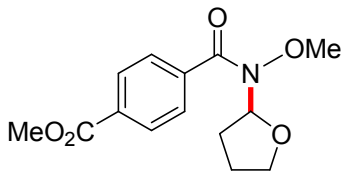
4-Bromo-*N*-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3j):[8a] Colorless liquid; 77% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.56 (s, 4H), 5.89−5.86 (m, 1H), 4,13−4.08 (m, 1H), 3.85−3.80 (m, 1H), 3.76 (s,3H), 2.32−2.24 (m, 1H), 2.19−2.11 (m, 1H), 2.07−2.01 (m, 1H), 1.97−1.90 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.07, 133.20, 131.49, 129.84, 125.41, 88.89, 68.91, 64.66, 28.31, 25.56.



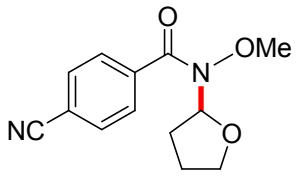
***N*-Methoxy-*N*-(tetrahydrofuran-2-yl)-4-(trifluoromethyl)benzamide (3k):**[8a] White solid; 73% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.79 (d, J = 8.0 Hz, 2H), 7.69 (d, J = 8.1 Hz, 1H), 5.87 (s, 1H), 4.12 (q, J = 7.0 Hz, 1H), 3.84 (q, J = 7.3 Hz, 1H), 3.77 (s, 3H), 2.34−2.26 (m, 1H), 2.19−2.05 (m, 2H), 1.99−1.92 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.69, 137.86, 132.38 (q, J = 32.6 Hz), 128.38, 125.16 (q, J = 3.6 Hz), 123.56 (q, J = 270.8 Hz), 88.66, 68.88, 64.69, 28.25, 25.44.



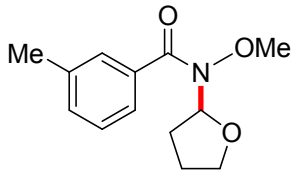
***N*-Methoxy-*N*-(tetrahydrofuran-2-yl)-4-(trifluoromethoxy)benzamide (3l):** Colorless liquid; 62% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.75 (d, J = 8.7 Hz, 2H), 7.26 (d, J = 8.6 Hz, 2H), 5.90−5.88 (m, 1H), 4.14−4.09 (m, 1H), 3.84 (q, J = 7.2 Hz, 1H), 3.77 (s, 3H), 2.33−2.26 (m, 1H), 2.21−2.13 (m, 1H), 2.11−2.04 (m, 1H), 1.98−1.92 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.74, 150.88, 132.84, 120.37, 120.30 (q, J = 256.6 Hz), 88.90, 68.92, 64.65, 28.31, 25.54. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 305.0875, found: 305.0869.



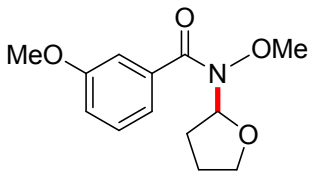
Methyl 4-(methoxy(tetrahydrofuran-2-yl)carbamoyl)benzoate (3m): Colorless liquid; 61% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.09 (d, *J* = 8.1 Hz, 2H), 7.72 (d, *J* = 8.2 Hz, 2H), 5.86 (s, 1H), 4.11 (q, *J* = 6.6 Hz, 1H), 3.94 (s, 3H), 3.83 (q, *J* = 7.1 Hz, 1H), 3.77 (s, 3H), 2.33−2.25 (m, 1H), 2.20−2.12 (m, 1H), 2.10−2.02 (m, 1H), 1.98−1.92 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.21, 166.21, 138.57, 132.00, 129.43, 127.96, 88.78, 68.91, 64.68, 52.25, 28.32, 25.50. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 279.1107, found: 279.1115.



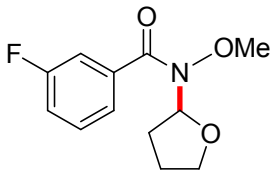
4-Cyano-*N*-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3n): Colorless liquid; 56% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.79−7.77 (m, 2H), 7.73−7.71 (m, 2H), 5.88−5.87 (m, 1H), 4.14−4.09 (m, 1H), 3.87−3.82 (m, 1H), 3.75 (s, 3H), 2.32−2.26 (m, 1H), 2.19−2.06 (m, 2H), 1.99−1.94 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.32, 138.62, 132.05, 128.74, 117.96, 114.45, 88.60, 69.01, 64.96, 28.39, 25.51. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 246.1004, found: 246.1007.



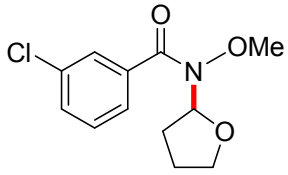
***N*-Methoxy-3-methyl-*N*-(tetrahydrofuran-2-yl)benzamide (3o):** Colorless liquid; 82% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.45−7.42 (m, 2H), 7.31−7.26 (m, 2H), 5.85−5.82 (m, 1H), 4.11 (q, *J* = 7.2 Hz, 1H), 3.84−3.79 (m, 4H), 2.38 (s, 3H), 2.32−2.24 (m,1H), 2.19−2.09 (m, 1H), 2.04−1.99 (m, 1H), 1.95−1.87 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.14, 138.06, 134.35, 131.42, 128.46, 128.02, 124.91, 89.26, 68.82, 64.27, 28.20, 25.51, 21.19. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 235.1208, found: 235.1209.



***N*-Methoxy-3-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3p):** Colorless liquid; 79% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.34−7.29 (m, 1H), 7.23−7.18 (m, 2H), 7.00 (dd, J_1 = 8.2 Hz, J_2 = 2.5 Hz, 1H), 5.84 (q, J = 3.8 Hz, 1H), 4.11 (q, J = 7.4 Hz, 1H), 3.83 (s, 3H), 3.82−3.81 (m, 4H), 2.32−2.24 (m, 1H), 2.20−2.11 (m, 1H), 2.07−2.00 (m, 1H), 1.96−1.90 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.67, 159.32, 135.61, 129.30, 120.15, 116.85, 113.04, 89.26, 68.85, 64.34, 55.29, 28.22, 25.53. HRMS (EI): Calcd. for $C_{13}H_{17}NO_4$: 251.1158, found: 251.1166.

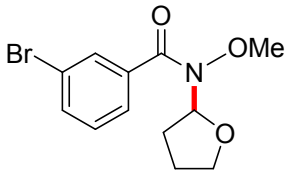


3-Fluoro-*N*-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3q): Colorless liquid; 71% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.46 (d, J = 7.6 Hz, 1H), 7.43−7.37 (m, 1H), 7.20−7.15 (m, 1H), 5.87 (s, 1H), 4.14−4.09 (m, 1H), 3.83 (q, J = 7.0 Hz, 1H), 3.78 (s, 3H), 2.32−2.25 (m, 1H), 2.20−2.12 (m, 1H), 2.11−2.04 (m, 1H), 1.97−1.91 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.58, 162.18 (d, J = 246.1 Hz), 136.33 (d, J = 7.1 Hz), 129.95 (d, J = 7.9 Hz), 123.79 (d, J = 3.2 Hz), 117.77 (d, J = 21.1 Hz), 115.25 (d, J = 23.2 Hz), 88.87, 68.90, 64.59, 28.28, 25.50. HRMS (EI): Calcd. for $C_{12}H_{14}FNO_3$: 239.0958, found: 239.0955.

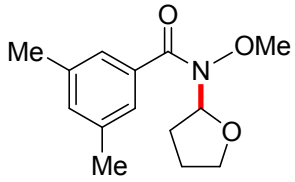


3-Chloro-*N*-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3r): Colorless liquid; 72% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.66 (t, J = 1.7 Hz, 1H), 7.55 (d, J = 7.6 Hz, 1H), 7.46−7.43 (m, 1H), 7.38−7.34 (m, 1H), 5.87 (s, 1H), 4.14−4.09 (m, 1H), 3.84 (q, J = 6.8 Hz, 1H), 3.78 (s, 3H), 2.32−2.25 (m, 1H), 2.20−2.12 (m, 1H), 2.11−2.04 (m, 1H), 1.97−1.91 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.62,

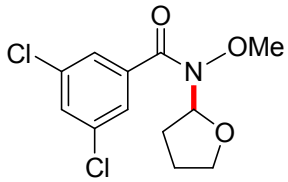
136.11, 134.29, 130.87, 129.59, 128.21, 126.22, 88.89, 68.96, 64.68, 28.36, 25.54. HRMS (EI): Calcd. for $C_{12}H_{14}ClNO_3$: 255.0662, found: 255.0659.



3-Bromo-*N*-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3s): Colorless liquid; 78% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.81 (t, J = 1.7 Hz, 1H), 7.60 (dd, J_1 = 7.9 Hz, J_2 = 1.8 Hz, 2H), 7.32−7.28 (m, 1H), 5.87 (s, 1H), 4.14−4.08 (m, 1H), 3.86−3.81 (m, 1H), 3.77 (s, 3H), 2.32−2.24 (m, 1H), 2.20−2.12 (m, 1H), 2.11−2.04 (m, 1H), 1.97−1.92 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.39, 136.23, 133.72, 130.97, 129.77, 126.58, 122.19, 88.79, 68.89, 64.62, 28.29, 25.47. HRMS (EI): Calcd. for $C_{12}H_{14}BrNO_3$: 299.0157, found: 299.0153.

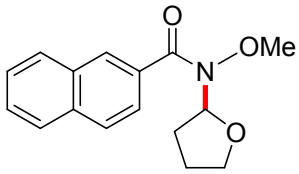


***N*-Methoxy-3,5-dimethyl-*N*-(tetrahydrofuran-2-yl)benzamide (3t)**: Colorless liquid; 82% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.23 (s, 2H), 7.08 (s, 1H), 5.82 (q, J = 3.8 Hz, 1H), 4.10 (q, J = 6.8 Hz, 1H), 3.84−3.80 (m, 4H), 2.34 (s, 6H), 2.29−2.23 (m, 1H), 2.17−2.11 (m, 1H), 2.03−1.98 (m, 1H), 1.93−1.85 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.37, 137.87, 134.40, 132.28, 125.48, 89.39, 68.83, 64.22, 28.22, 25.52, 21.08. HRMS (EI): Calcd. for $C_{14}H_{19}NO_3$: 249.1365, found: 249.1370.

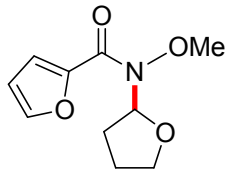


3,5-Dichloro-*N*-methoxy-*N*-(tetrahydrofuran-2-yl)benzamide (3u): Colorless liquid; 73% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.56 (s, 2H), 7.46−7.45 (m, 1H), 5.89 (s, 1H), 4.12−4.08 (m, 1H), 3.85−3.82 (m, 1H), 3.76 (s, 3H), 2.29−2.24 (m, 1H), 2.18−2.07 (m, 2H), 1.98−1.94 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.20, 137.03, 134.91, 130.63, 126.49, 88.52, 68.92, 64.84, 28.34, 25.40. HRMS (EI): Calcd.

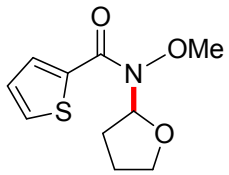
for $C_{12}H_{13}Cl_2NO_3$: 289.0272, found: 289.0279.



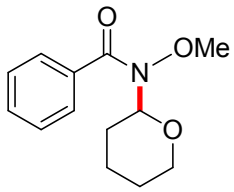
***N*-Methoxy-*N*-(tetrahydrofuran-2-yl)-2-naphthamide (3v):**[8a] Colorless liquid; 59% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.20 (s, 1H), 7.92−7.85 (m, 3H), 7.74−7.72 (m, 1H), 7.57−7.50 (m, 2H), 5.94 (q, *J* = 4.0 Hz, 1H), 4.16−4.10 (m, 1H), 3.85−3.80 (m, 4H), 2.36−2.28 (m, 1H), 2.21−2.11 (m, 1H), 2.08−1.99 (m, 1H), 1.94−1.88 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.07, 134.25, 132.43, 131.65, 128.74, 128.51, 127.99, 127.67, 127.46, 126.59, 124.74, 89.25, 68.89, 64.52, 28.30, 25.58.



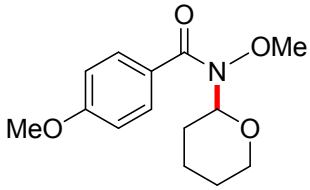
***N*-Methoxy-*N*-(tetrahydrofuran-2-yl)furan-2-carboxamide (3w):**[8a] Colorless liquid; 67% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.60 (s, 1H), 7.19 (q, *J* = 3.5 Hz, 1H), 6.52 (t, *J* = 1.7 Hz, 1H), 6.28−6.25 (m, 1H), 4.11 (q, *J* = 6.6 Hz, 1H), 3.89 (s, 3H), 3.87−3.85 (m, 1H), 2.27−2.20 (m, 1H), 2.18−2.11 (m, 2H), 2.01−1.95 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 159.10, 145.78, 145.43, 117.87, 111.59, 88.09, 68.84, 65.33, 28.41, 25.42.



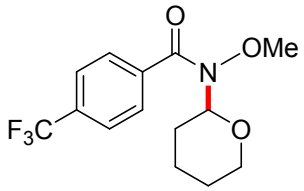
***N*-Methoxy-*N*-(tetrahydrofuran-2-yl)thiophene-2-carboxamide (3x):**[8a] Colorless liquid; 84% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.95 (d, *J* = 3.8 Hz, 1H), 7.57 (d, *J* = 5.0 Hz, 1H), 7.10 (t, *J* = 4.5 Hz, 1H), 6.30 (q, *J* = 4.5 Hz, 1H), 4.11 (q, *J* = 6.4 Hz, 1H), 3.90 (s, 3H), 3.87−3.85 (m, 1H), 2.27−2.19 (m, 1H), 2.17−2.09 (m, 2H), 2.00−1.94 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 162.59, 134.43, 133.80, 132.48, 126.81, 88.17, 68.73, 65.88, 28.46, 25.42.



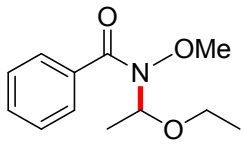
***N*-Methoxy-*N*-(tetrahydro-2*H*-pyran-2-yl)benzamide (4a):**[8a] Colorless liquid; 62% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.70-7.68 (m, 2H), 7.49−7.45 (m, 1H), 7.42−7.38 (m, 2H), 5.25−5.23 (m, 1H), 4.07 (d, *J* = 11.2 Hz, 1H), 3.71 (s, 3H), 3.48 (t, *J* = 11.3 Hz, 1H), 2.11−2.01 (m, 1H), 1.98−1.95 (m, 1H), 1.77−1.74 (m, 1H), 1.59−1.47 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.41, 134.21, 130.65, 127.97, 85.89, 68.11, 64.80, 27.66, 24.91, 22.99.



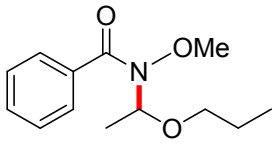
***N*-Methoxy-4-methoxy-*N*-(tetrahydro-2*H*-pyran-2-yl)benzamide (4b):**[8a] Colorless liquid; 61% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.75−7.73 (m, 2H), 6.91−6.89 (m, 2H), 5.29 (d, *J* = 10.5 Hz, 1H), 4.09−4.06 (m, 1H), 3.85 (s, 3H), 3.70 (s, 3H), 3.54−3.49 (m, 1H), 2.07−1.95 (m, 2H), 1.77−1.74 (m, 1H), 1.60−1.47 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.91, 161.69, 130.43, 126.19, 113.29, 86.02, 68.16, 64.77, 55.25, 27.76, 25.02, 23.11.



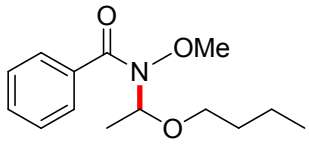
***N*-Methoxy-*N*-(tetrahydro-2*H*-pyran-2-yl)-4-(trifluoromethyl)benzamide (4c):**[8a] White solid; 59% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.82 (d, *J* = 8.2 Hz, 2H), 7.68 (d, *J* = 8.4 Hz, 2H), 5.29 (s, 1H), 4.11−4.07 (m, 1H), 3.69 (s, 3H), 3.52 (t, *J* = 11 Hz, 1H), 2.08−1.98 (m, 2H), 1.79−1.76 (m, 1H), 1.62−1.52 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.20, 137.70, 132.40 (q, *J* = 32.5 Hz), 128.44, 125.02 (q, *J* = 3.7 Hz), 122.29, 85.53, 68.23, 65.14, 27.61, 24.90, 22.96.



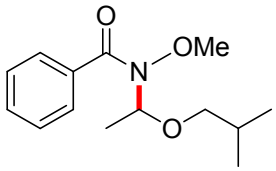
***N*-(1-Ethoxyethyl)-*N*-methoxybenzamide (4d)**: Colorless liquid; 41% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.68−7.65 (m, 2H), 7.50−7.39 (m, 3H), 5.70 (s, 1H), 3.74−3.68 (m, 1H), 3.67 (s, 3H), 1.61 (d, *J* = 1.8 Hz, 1H), 1.53 (d, *J* = 6.0 Hz, 3H), 1.21 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.33, 134.40, 130.71, 128.11, 83.52, 64.80, 63.61, 18.32, 14.99. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 223.1208, found: 223.1202.



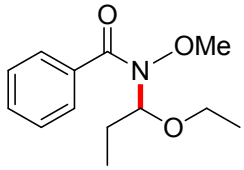
***N*-Methoxy-*N*-(1-propoxyethyl)benzamide (4e)**: Colorless liquid; 45% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.67 (d, *J* = 7.8 Hz, 2H), 7.48−7.39 (m, 3H), 5.69 (s, 1H), 3.66 (s, 3H), 3.65−3.59 (m, 1H), 3.42 (q, *J* = 6.8 Hz, 1H), 1.62−1.57 (m, 2H), 1.53 (d, *J* = 6.0 Hz, 3H), 0.93 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.21, 134.31, 130.60, 128.00, 83.70, 69.87, 64.68, 22.68, 18.14, 10.47. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 237.1365, found: 237.1368.



***N*-(1-Butoxyethyl)-*N*-methoxybenzamide (4f)**: Colorless liquid; 47% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.66 (d, *J* = 7.8 Hz, 2H), 7.48−7.39 (m, 3H), 5.68 (s, 1H), 3.69−3.63 (m, 4H), 3.46 (q, *J* = 6.7 Hz, 1H), 1.59−1.54 (m, 2H), 1.52 (d, *J* = 6.0 Hz, 3H), 1.40−1.35 (m, 2H), 0.91 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.24, 134.39, 130.60, 128.02, 83.74, 68.06, 64.69, 31.58, 19.23, 18.17, 13.74. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 251.1521, found: 251.1522.

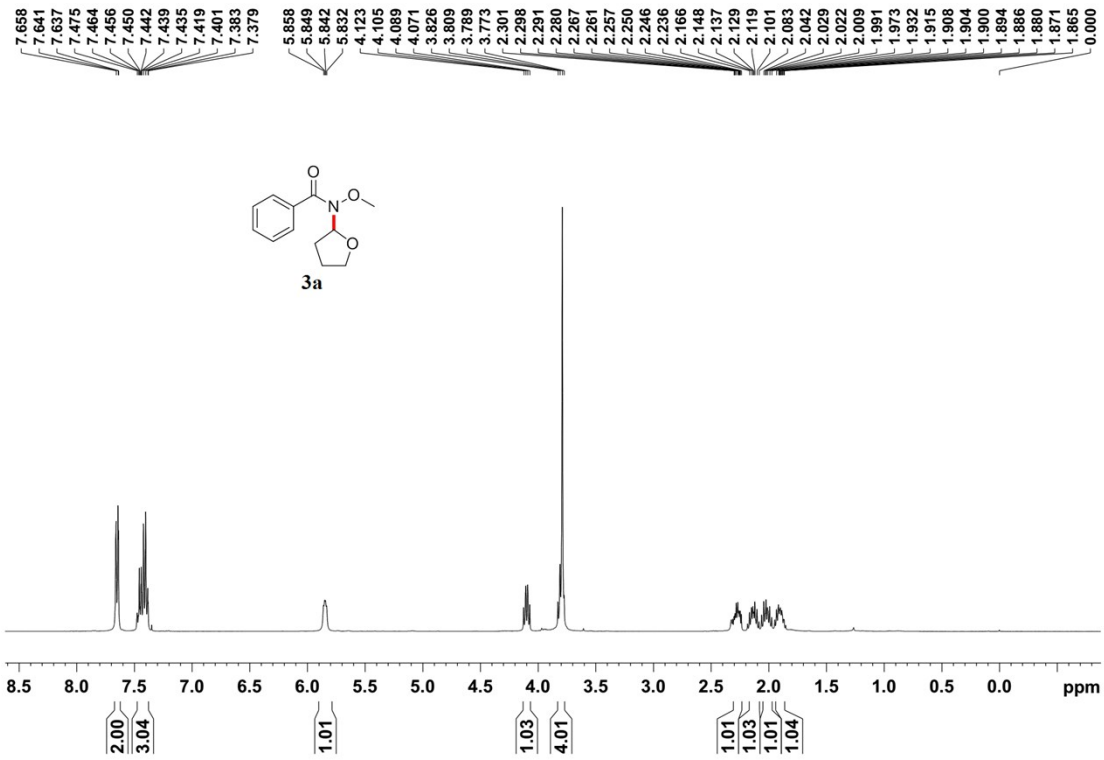


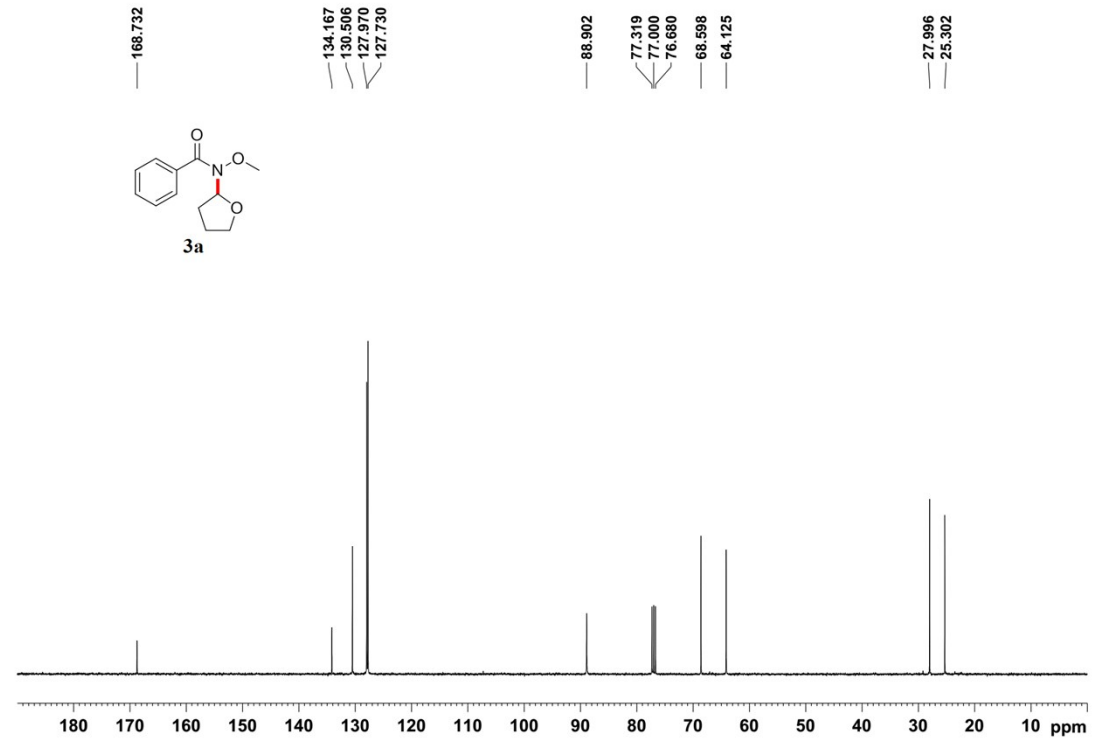
***N*-(1-*iso*-Butoxyethyl)-*N*-methoxybenzamide (4g)**: Colorless liquid; 43% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.67−7.65 (m, 2H), 7.49−7.45 (m, 1H), 7.43−7.39 (m, 2H), 5.67 (s, 1H), 3.67 (s, 3H), 3.42 (q, J = 6.8 Hz, 1H), 3.26−3.22 (m, 1H), 1.90−1.80 (m, 1H), 1.52 (d, J = 6.0 Hz, 3H), 0.91 (dd, J_1 = 6.7 Hz, J_2 = 0.9 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.29, 134.43, 130.66, 128.08, 84.05, 75.17, 64.75, 28.40, 19.33, 19.31, 18.15. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 251.1521, found: 251.1526.

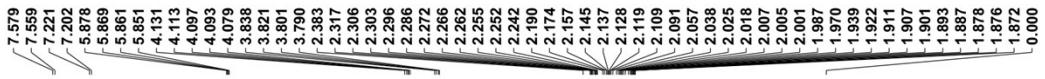


***N*-(1-Ethoxypropyl)-*N*-methoxybenzamide (4h)**: Colorless liquid; 43% yield; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.67 (d, J = 7.4 Hz, 2H), 7.49−7.39 (m, 3H), 5.47−5.44 (m, 1H), 3.81−3.73 (m, 1H), 3.65 (s, 3H), 3.56 (s, 1H), 1.97−1.88 (m, 2H), 1.22 (t, J = 7.0 Hz, 3H), 0.98 (t, J = 7.5 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.67, 134.40, 130.61, 128.10, 128.04, 88.35, 64.74, 63.80, 25.31, 14.96, 9.48. HRMS (EI): Calcd. for $C_{13}H_{17}NO_3$: 237.1365, found: 237.1370.

7. ^{1}H and ^{13}C NMR spectra of the products



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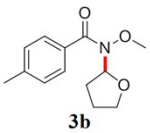
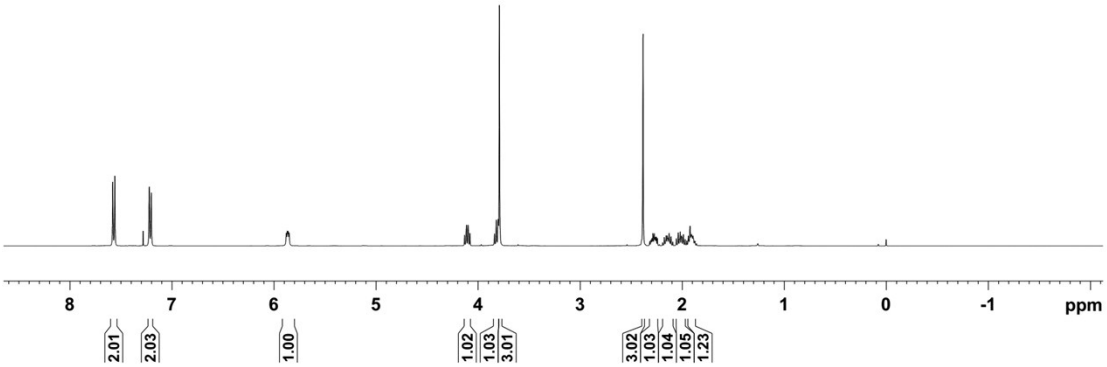
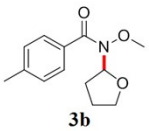
7.559
7.221
7.202
5.878
5.869
5.861
5.851
4.131
4.113
4.097
4.093
4.079
3.838
3.821
3.801
3.790
2.383
2.317
2.306
2.303
2.296
2.286
2.272
2.266
2.262
2.255
2.252
2.242
2.190
2.174
2.157
2.145
2.137
2.128
2.119
2.109
2.091
2.057
2.038
2.025
2.018
2.007
2.005
2.001
1.987
1.970
1.939
1.922
1.911
1.907
1.901
1.893
1.887
1.878
1.876
1.872
0.000



3b


8
7
6
5
4
3
2
1
0
-1
ppm
2.01
2.03
1.00
1.02
1.03
3.01
3.02
1.03
1.04
1.05
1.23


169.071
141.139
131.465
128.844
128.156
89.289
77.318
77.000
76.683
68.812
64.312
28.217
25.563
21.368



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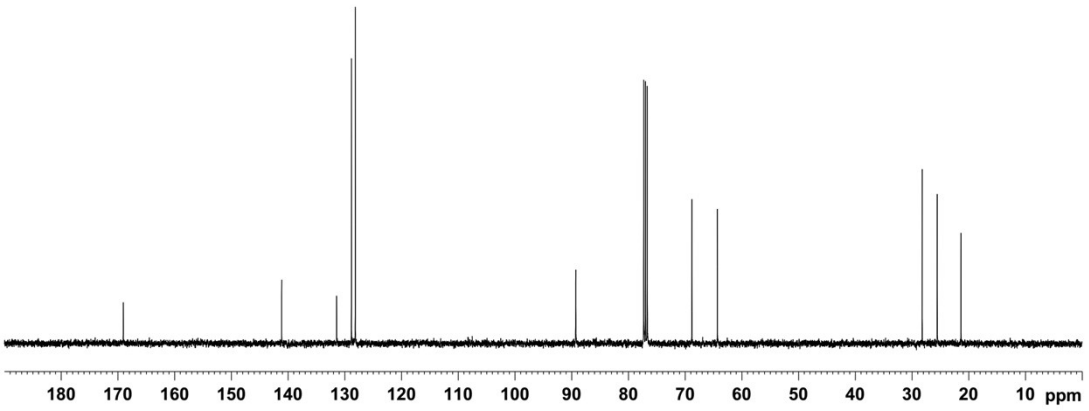
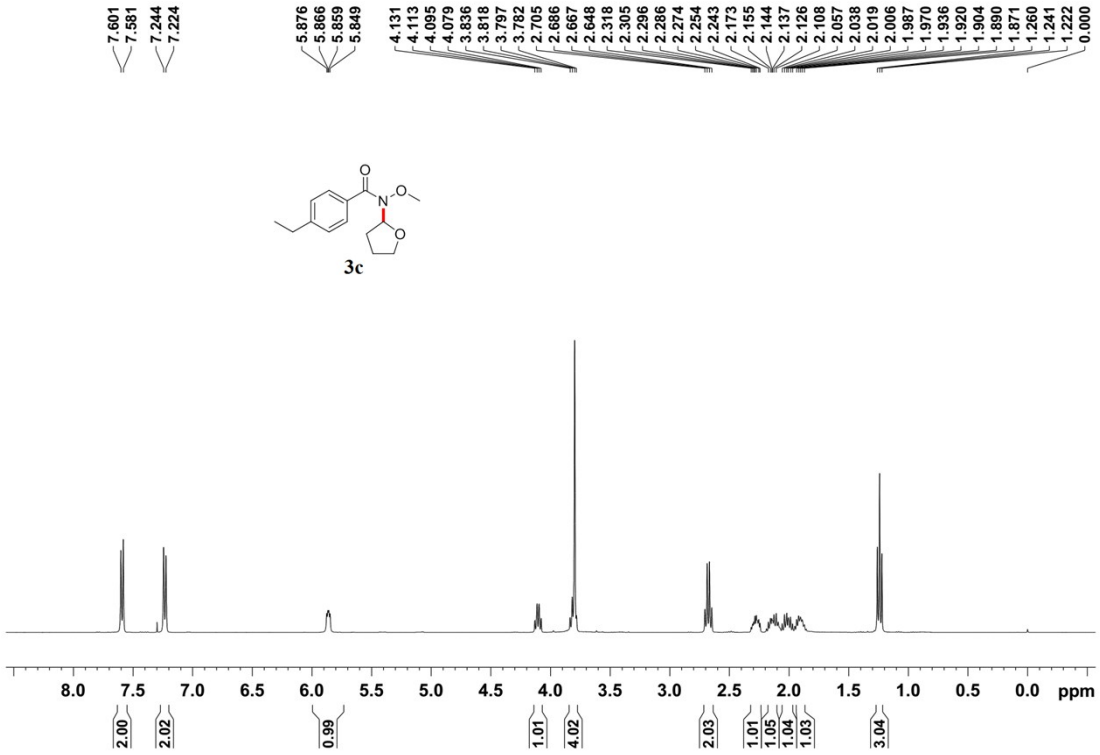
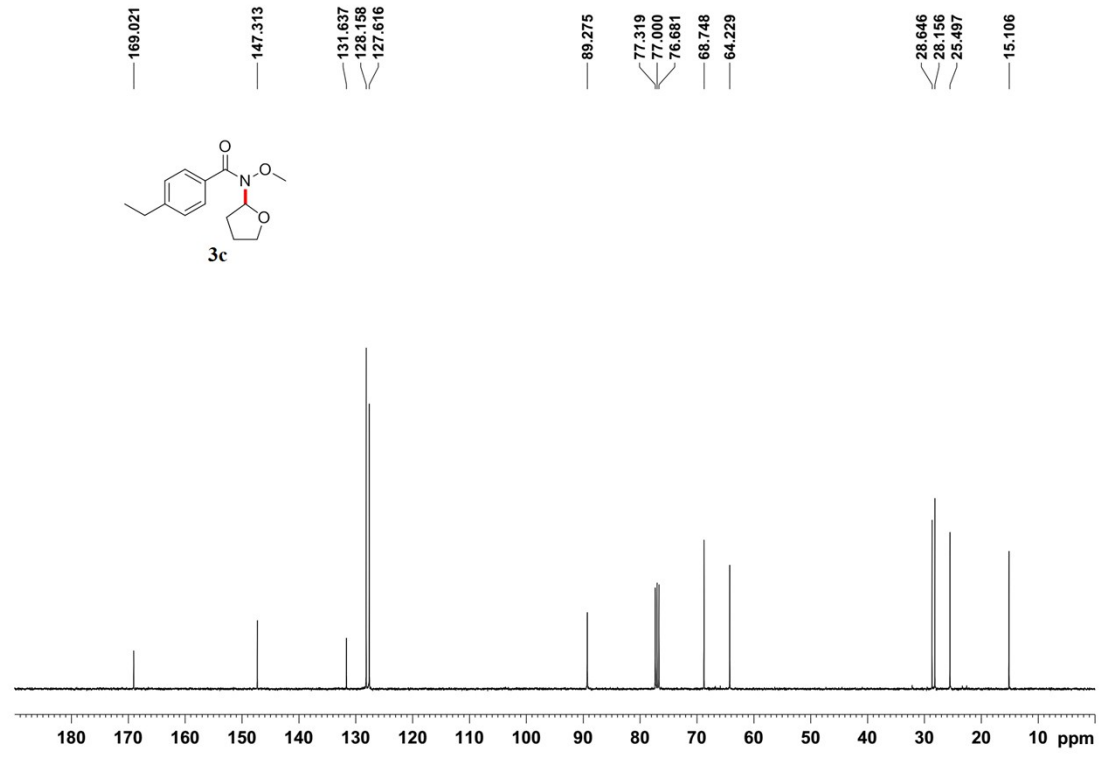
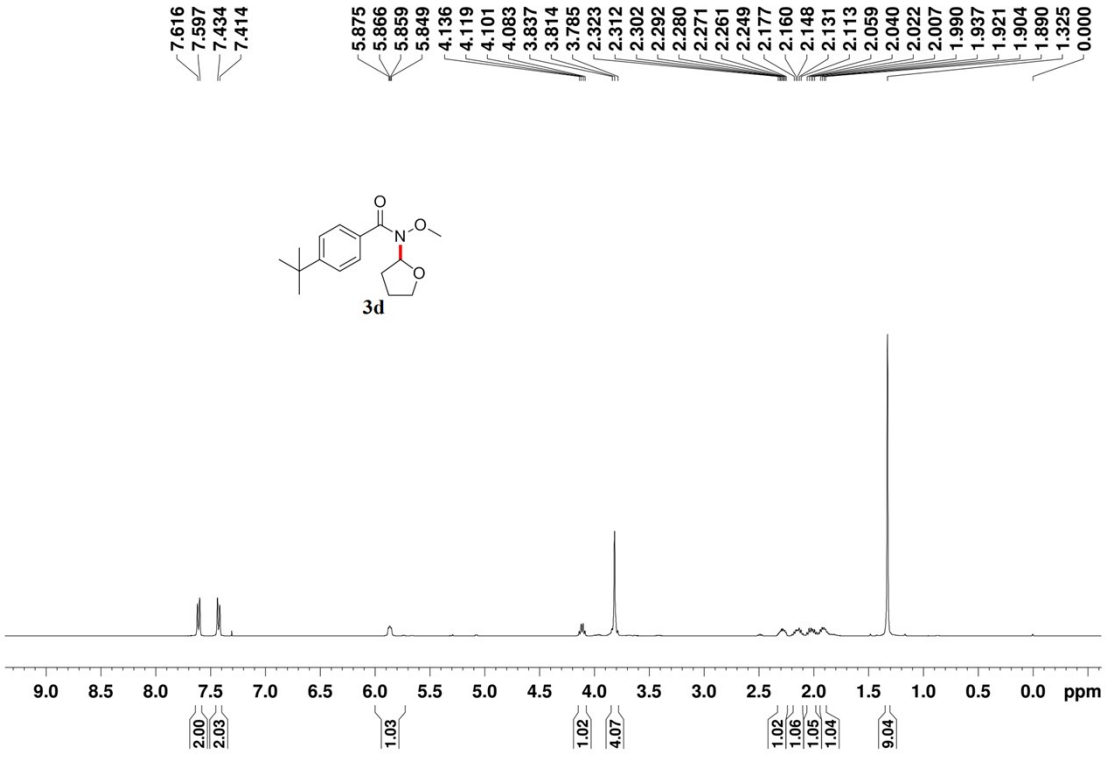
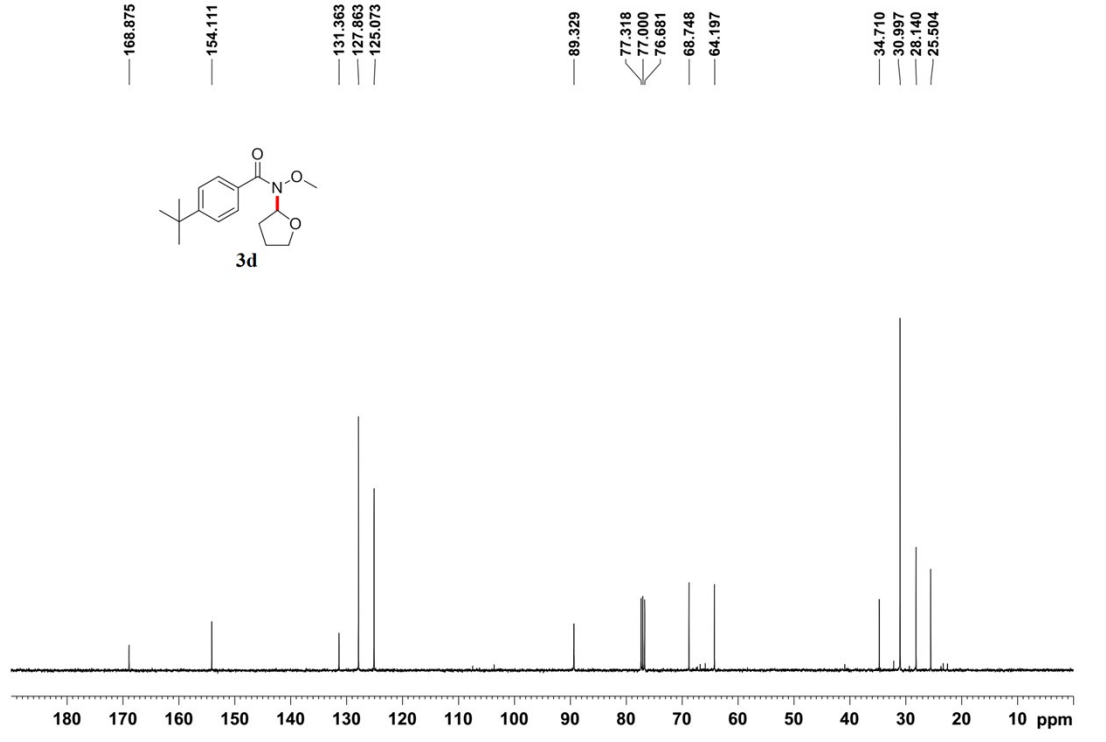
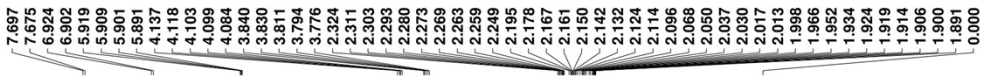

180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

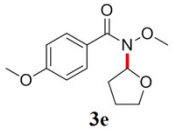

7.601
7.581
7.244
7.224
5.876
5.866
5.859
5.849
4.131
4.113
4.095
4.079
3.836
3.818
3.797
3.782
2.705
2.686
2.667
2.648
2.318
2.305
2.296
2.286
2.274
2.254
2.243
2.173
2.155
2.144
2.137
2.126
2.108
2.057
2.038
2.019
2.006
1.987
1.970
1.936
1.920
1.904
1.890
1.871
1.260
1.241
1.222
0.000
3c
8.0 7.5 7.0 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
0.99
1.01
4.02
2.03
1.01
1.05
1.04
1.03
3.04


169.021
147.313
131.637
128.158
127.616
89.275
77.319
77.000
76.681
68.748
64.229
28.646
28.156
25.497
15.106
3c
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

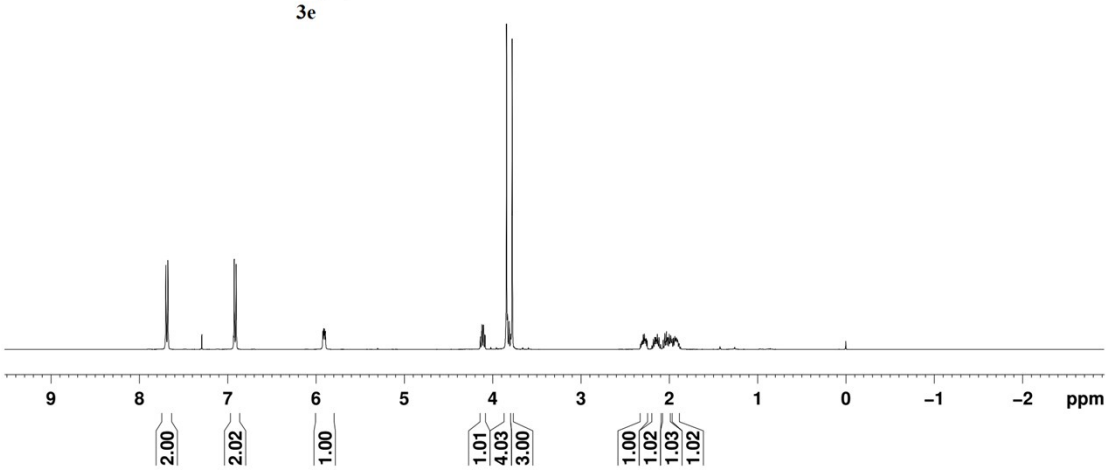

7.616
7.597
7.434
7.414
5.875
5.866
5.859
5.849
4.136
4.119
4.101
4.083
3.837
3.814
3.785
2.323
2.312
2.302
2.292
2.280
2.271
2.261
2.249
2.177
2.160
2.148
2.131
2.113
2.059
2.040
2.022
2.007
1.990
1.937
1.921
1.904
1.890
1.325
0.000
3d
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.00
2.03
1.03
1.02
4.07
1.02
1.06
1.05
1.04
9.04


168.875
154.111
131.363
127.863
125.073
89.329
77.318
77.000
76.681
68.748
64.197
34.710
30.997
28.140
25.504
3d
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

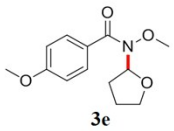

7.697
7.675
6.924
6.902
5.919
5.909
5.901
5.891
4.137
4.118
4.103
4.099
4.084
3.840
3.830
3.811
3.794
3.776
2.324
2.311
2.303
2.293
2.280
2.273
2.269
2.263
2.259
2.249
2.195
2.178
2.167
2.161
2.150
2.142
2.132
2.124
2.114
2.096
2.068
2.050
2.037
2.030
2.017
2.013
1.998
1.966
1.952
1.934
1.924
1.919
1.914
1.906
1.900
1.891
0.000



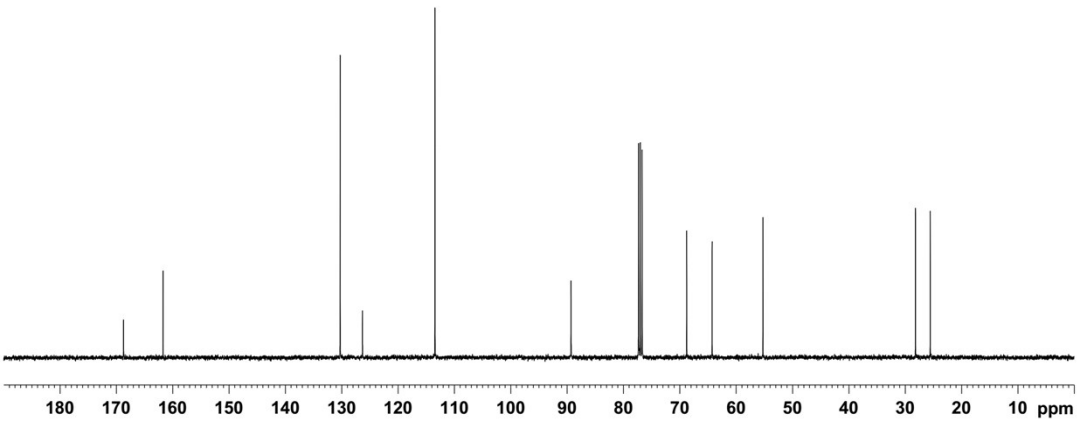
3e

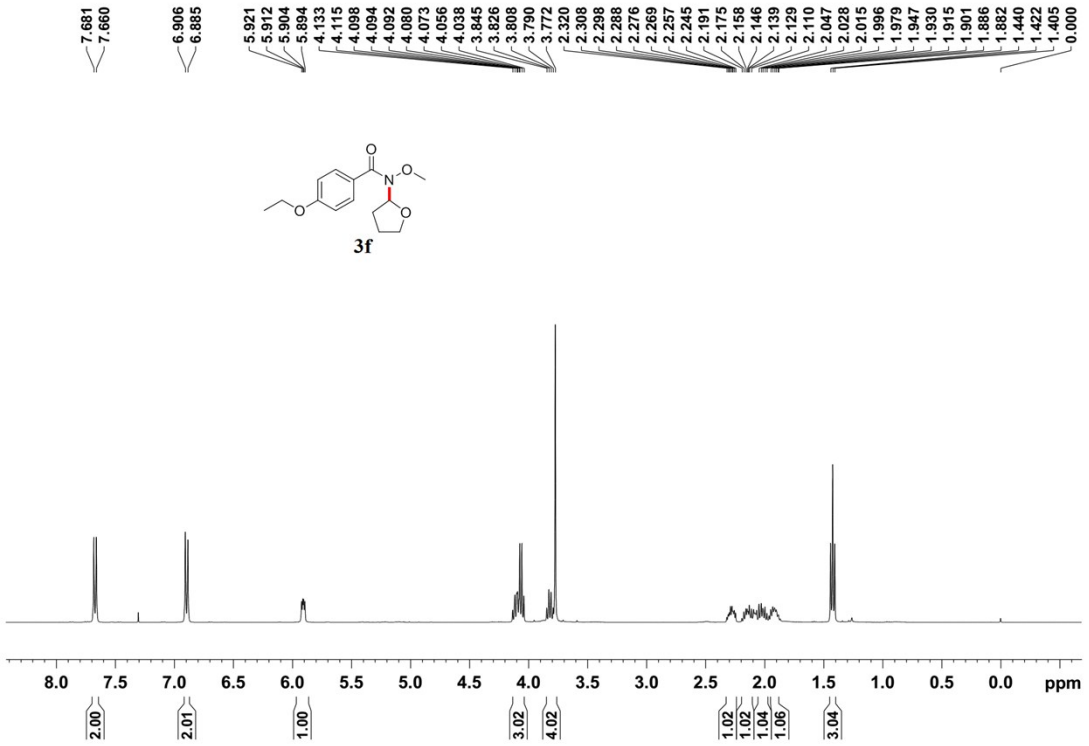

9
8
7
6
5
4
3
2
1
0
−1
−2
ppm
2.00
2.02
1.00
1.01
4.03
3.00
1.00
1.02
1.03
1.02

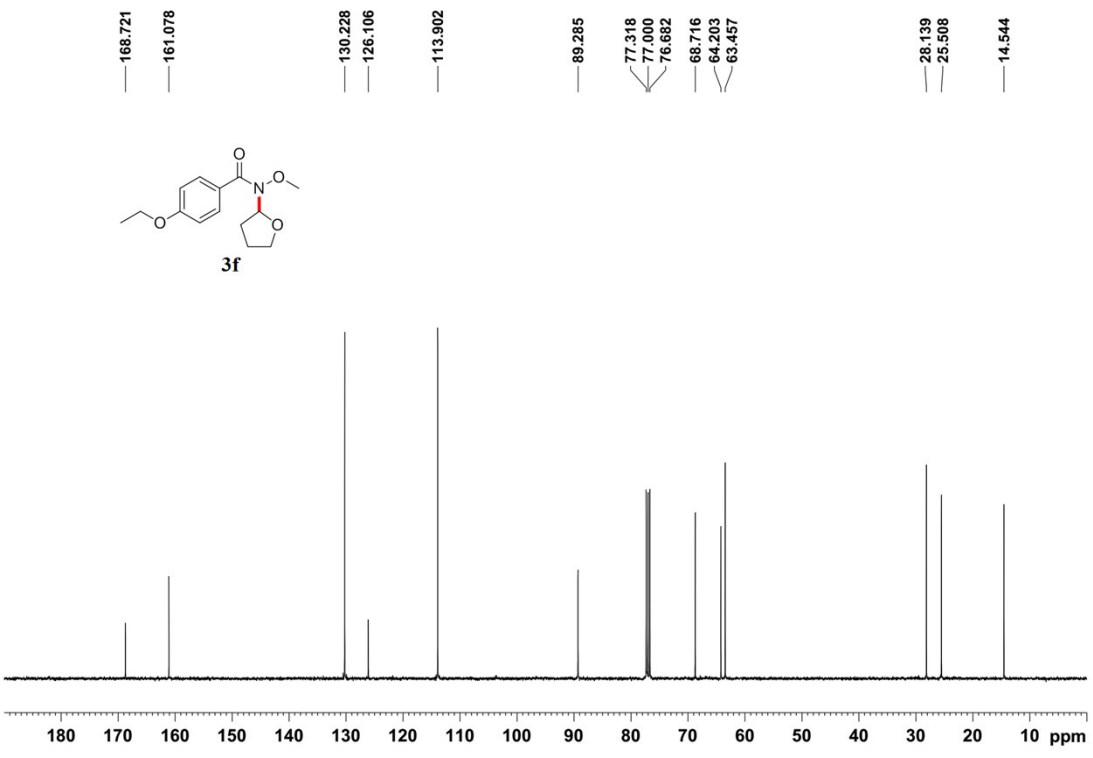

168.690
161.687
130.277
126.324
113.454
89.302
77.319
77.000
76.682
68.775
64.271
55.251
28.180
25.559

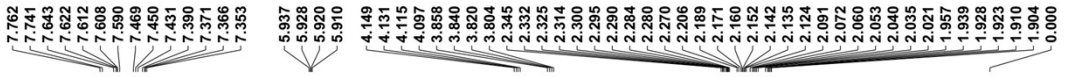


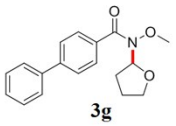
3e


180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

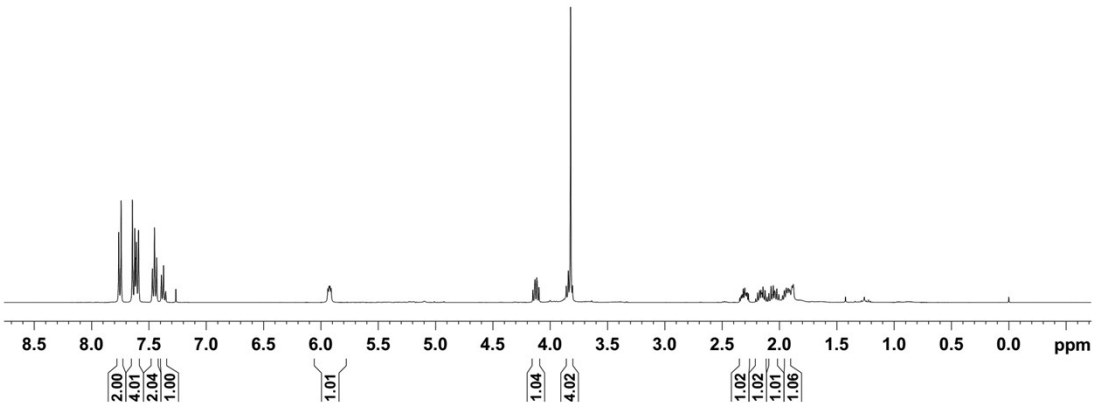

7.681
7.660
6.906
6.885
5.921
5.912
5.904
5.894
4.133
4.115
4.098
4.094
4.092
4.080
4.073
4.056
4.038
3.845
3.826
3.808
3.790
3.772
2.320
2.308
2.298
2.288
2.276
2.269
2.257
2.245
2.191
2.175
2.158
2.146
2.139
2.129
2.110
2.047
2.028
2.015
1.996
1.979
1.947
1.930
1.915
1.901
1.886
1.882
1.440
1.422
1.405
0.000
3f
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
2.01
1.00
3.02
4.02
1.02
1.02
1.04
1.06
3.04


168.721
161.078
130.228
126.106
113.902
89.285
77.318
77.000
76.682
68.716
64.203
63.457
28.139
25.508
14.544
3f
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

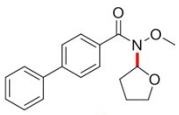

7.762
7.741
7.643
7.622
7.612
7.608
7.590
7.469
7.450
7.431
7.390
7.371
7.366
7.353
5.937
5.928
5.920
5.910
4.149
4.131
4.115
4.097
3.858
3.840
3.820
3.804
3.345
2.332
2.325
2.314
2.300
2.295
2.290
2.284
2.280
2.270
2.206
2.189
2.171
2.160
2.152
2.142
2.135
2.124
2.091
2.072
2.060
2.053
2.040
2.035
2.021
1.957
1.939
1.928
1.923
1.910
1.904
0.000



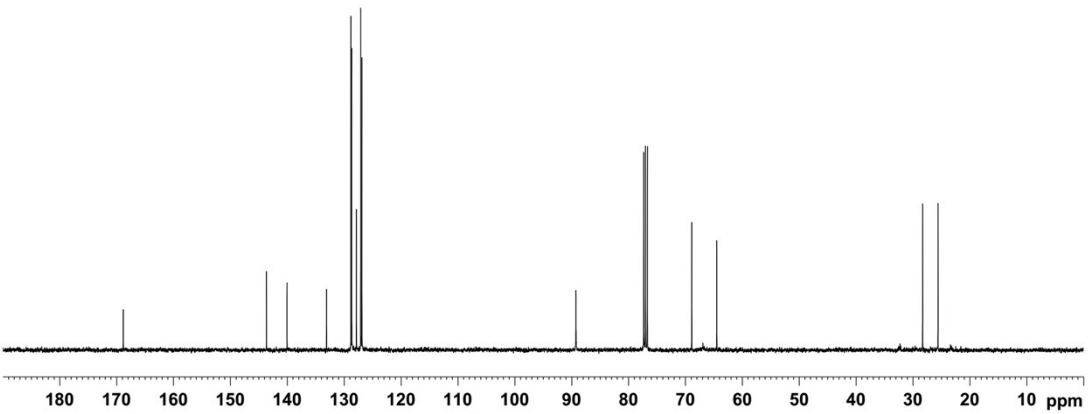
3g

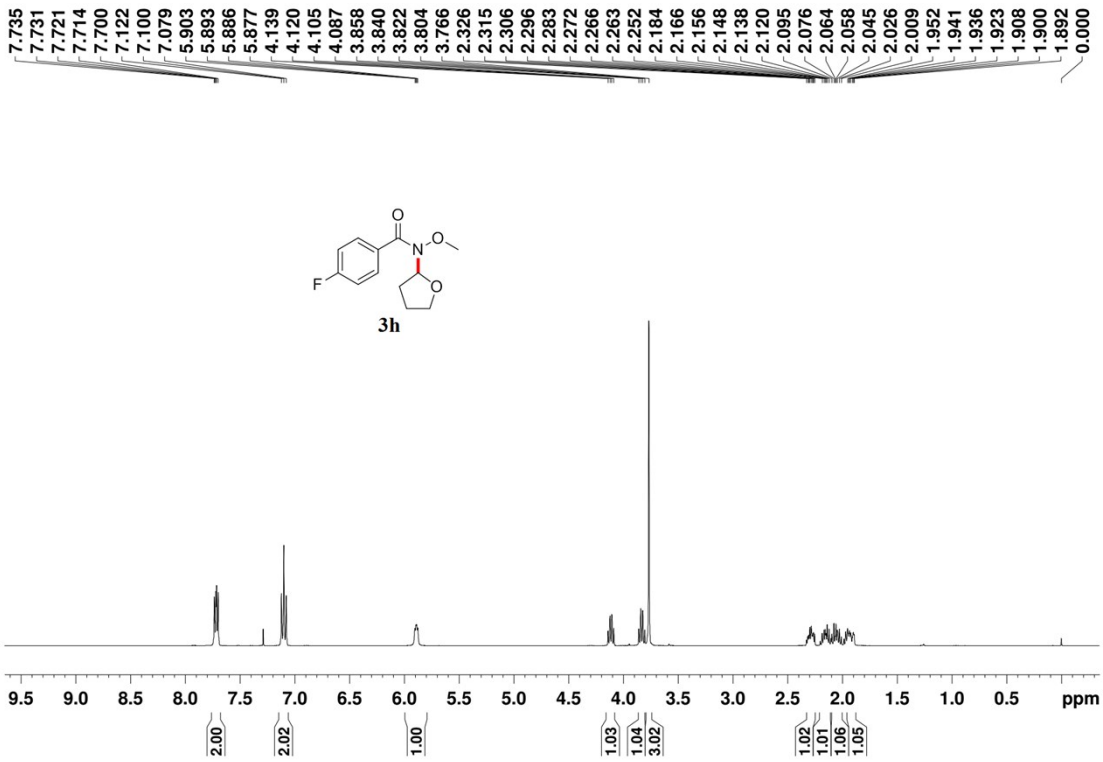

8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
2.00
4.01
2.04
1.00
1.01
1.04
4.02
1.02
1.02
1.01
1.06

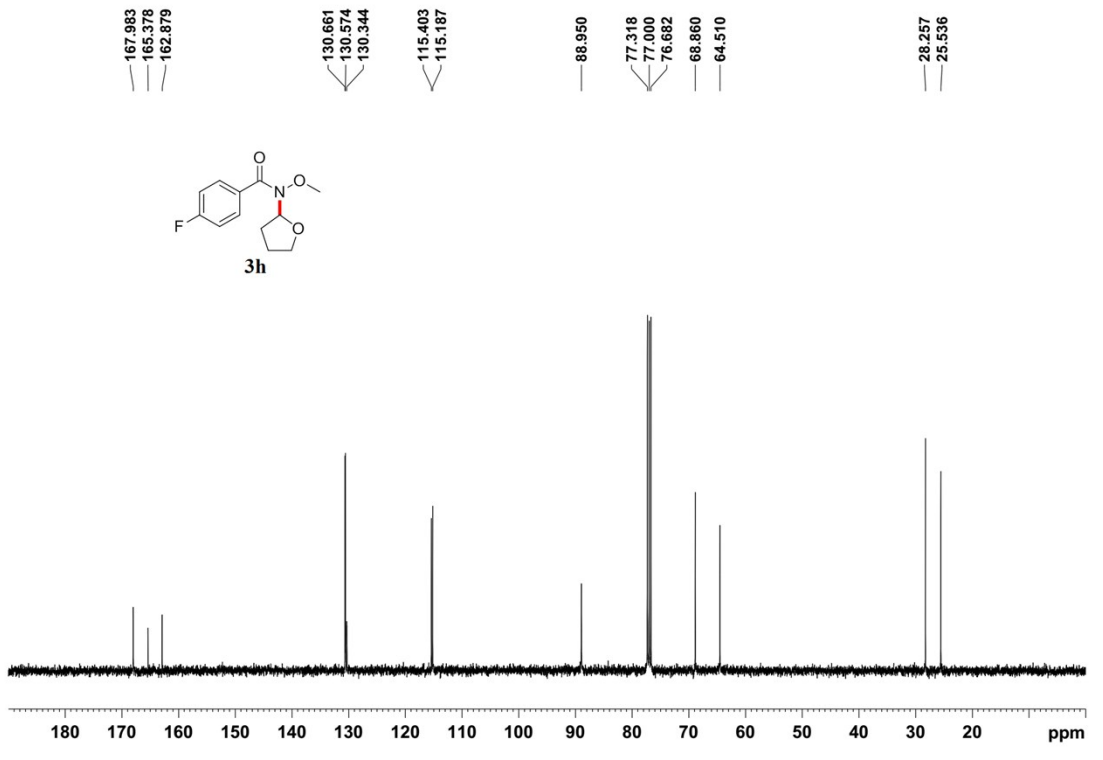

168.814
143.652
140.036
133.100
128.813
128.662
127.845
127.094
126.882
89.236
77.317
77.000
76.682
68.870
64.473
28.278
25.571



3g


180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


7.735
7.731
7.721
7.714
7.700
7.122
7.100
7.079
5.903
5.893
5.886
5.877
4.139
4.120
4.105
4.087
3.858
3.840
3.822
3.804
3.766
2.326
2.315
2.306
2.296
2.283
2.272
2.266
2.263
2.252
2.184
2.166
2.156
2.148
2.138
2.120
2.095
2.076
2.064
2.058
2.045
2.026
2.009
1.952
1.941
1.936
1.923
1.908
1.900
1.892
0.000
3h
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 ppm
2.00
2.02
1.00
1.03
1.04
3.02
1.02
1.01
1.06
1.05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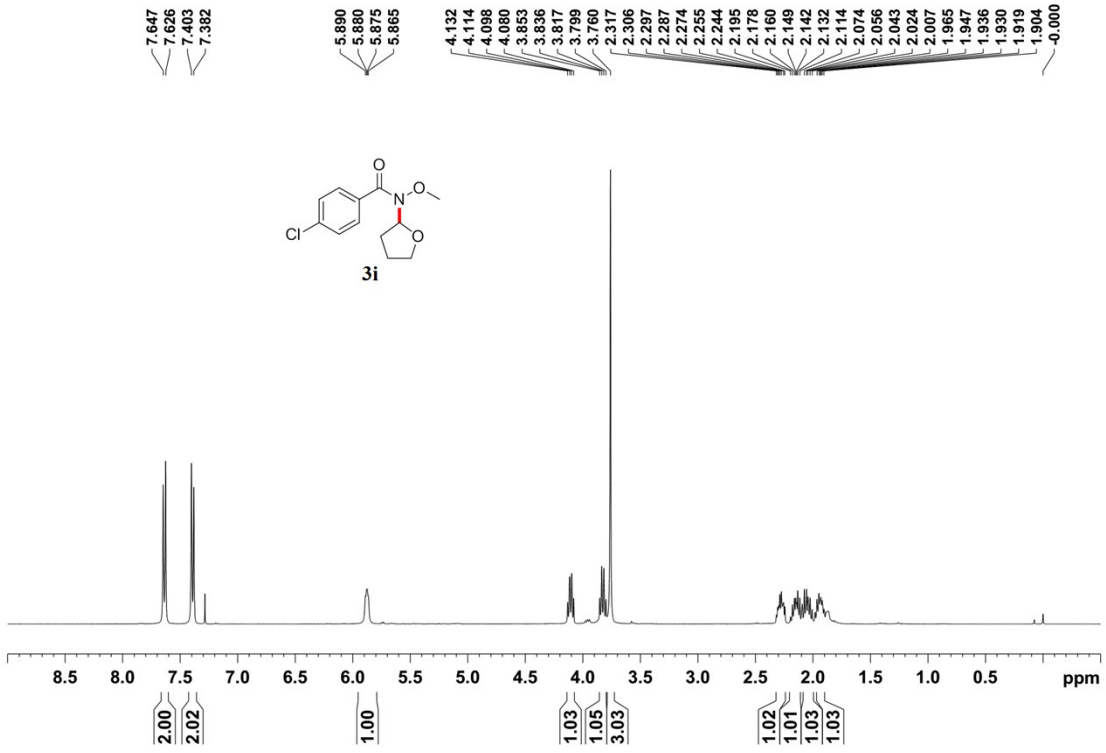
165.378
162.879
130.661
130.574
130.344
115.403
115.187
88.950
77.318
77.000
76.682
68.860
64.510
28.257
25.536
3h
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm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7.626
7.403
7.382
5.890
5.880
5.875
5.865
4.132
4.114
4.098
4.080
3.853
3.836
3.817
3.799
3.760
2.317
2.306
2.297
2.287
2.274
2.255
2.244
2.195
2.178
2.160
2.149
2.142
2.132
2.114
2.074
2.056
2.043
2.024
2.007
1.965
1.947
1.936
1.930
1.919
1.904
-0.000
O
N
O
Cl
O
3i
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
ppm
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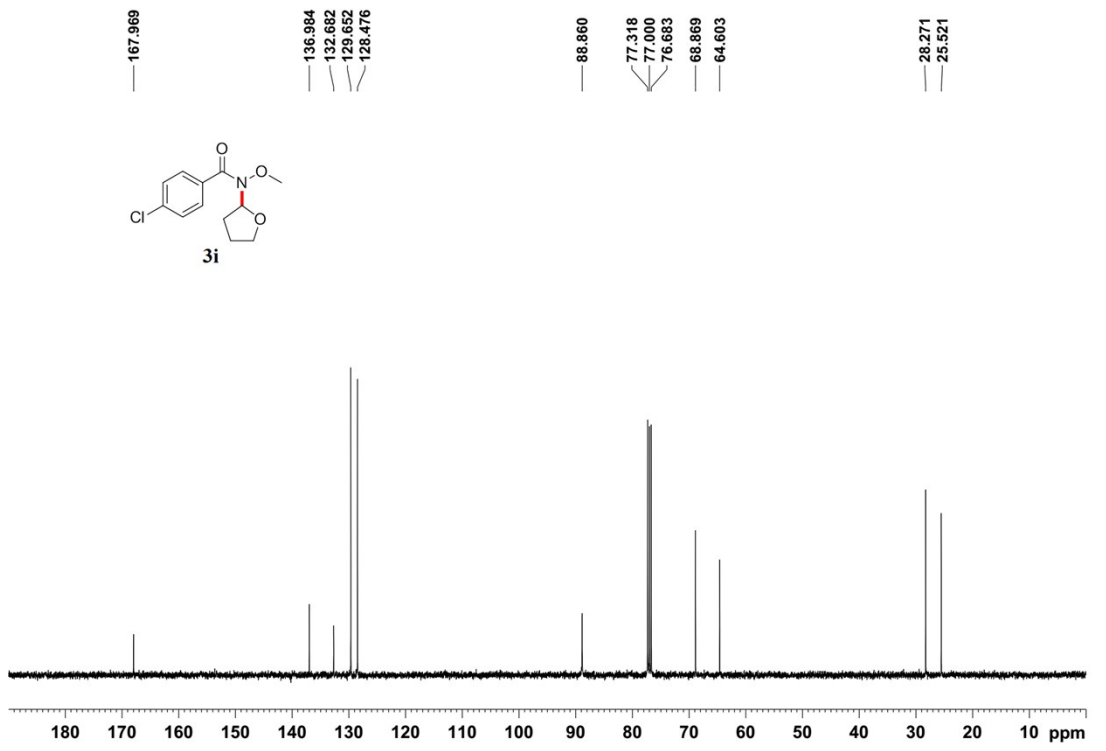
2.02
1.00
1.03
1.05
3.03
1.02
1.01
1.03
1.03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132.682
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128.476
88.860
77.318
77.000
76.683
68.869
64.603
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25.521
O
N
O
Cl
O
3i
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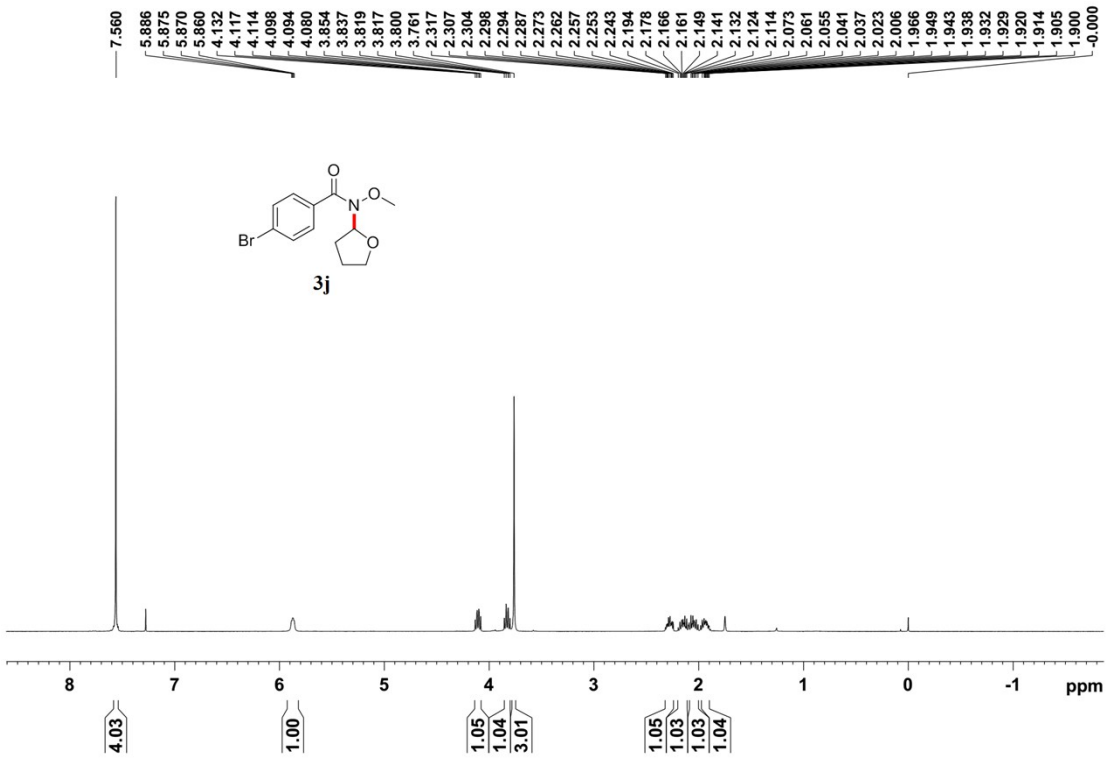
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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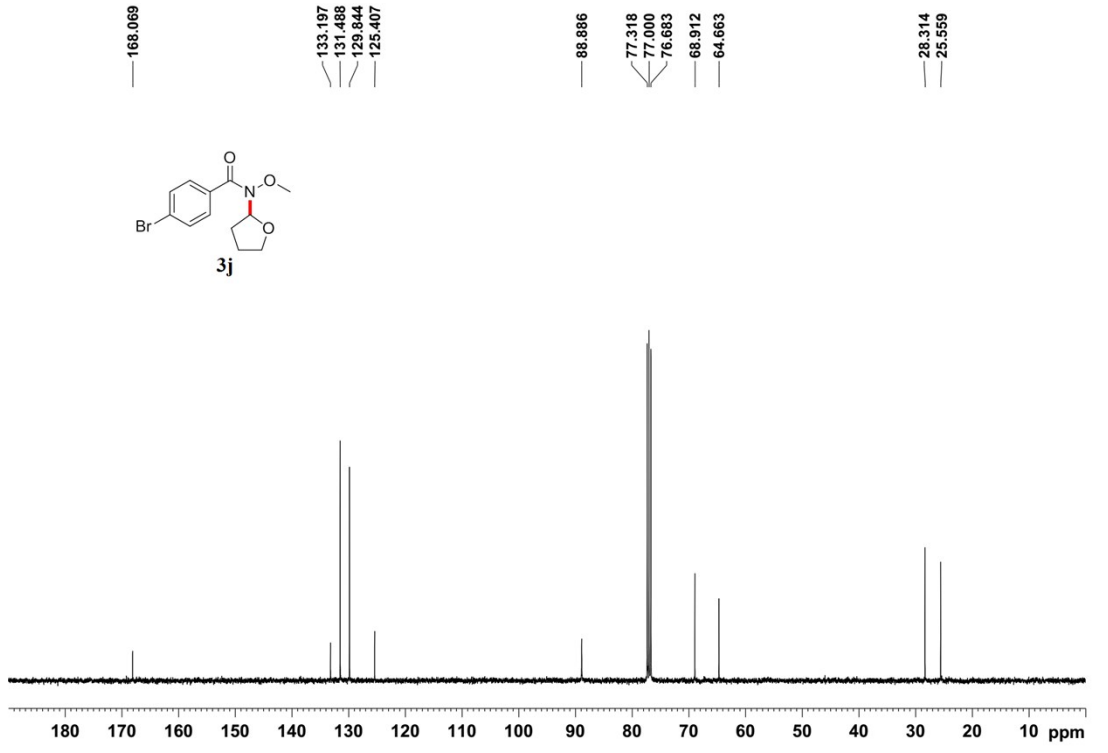
5.875
5.870
5.860
4.132
4.117
4.114
4.098
4.094
4.080
3.854
3.837
3.819
3.817
3.800
3.761
2.317
2.307
2.304
2.298
2.294
2.287
2.273
2.262
2.257
2.253
2.243
2.194
2.178
2.166
2.161
2.149
2.141
2.132
2.124
2.114
2.073
2.061
2.055
2.041
2.037
2.023
2.006
1.966
1.949
1.943
1.938
1.932
1.929
1.920
1.914
1.905
1.900
-0.000
Br
O
N
O
O
3j
8
7
6
5
4
3
2
1
0
-1
ppm
4.03
1.00
1.05
1.04
3.01
1.05
1.03
1.03
1.04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125.407
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77.000
76.683
68.912
64.663
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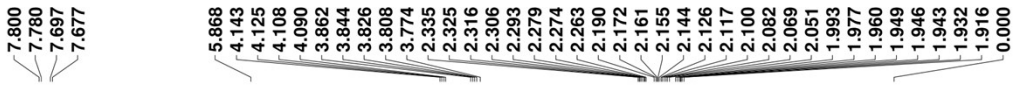
25.559
Br
O
N
O
O
3j
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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7.780
7.697
7.677
5.868
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4.125
4.108
4.090
3.862
3.844
3.826
3.808
3.774
2.335
2.325
2.316
2.306
2.293
2.279
2.274
2.263
2.190
2.172
2.161
2.155
2.144
2.126
2.117
2.100
2.082
2.069
2.051
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1.977
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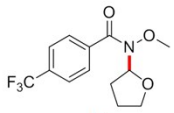
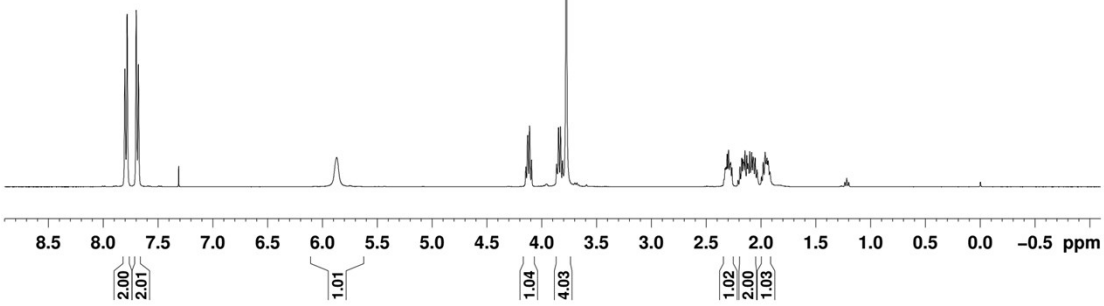
1.946
1.943
1.932
1.916
0.000


O
N
O
F3C
O

3k


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
2.01
1.01
1.04
4.03
1.02
2.00
1.03


167.693
137.859
132.865
132.540
132.215
131.890
128.382
127.624
125.215
125.180
125.143
125.108
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122.206
119.499
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77.000
76.681
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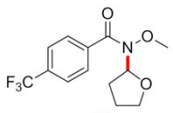
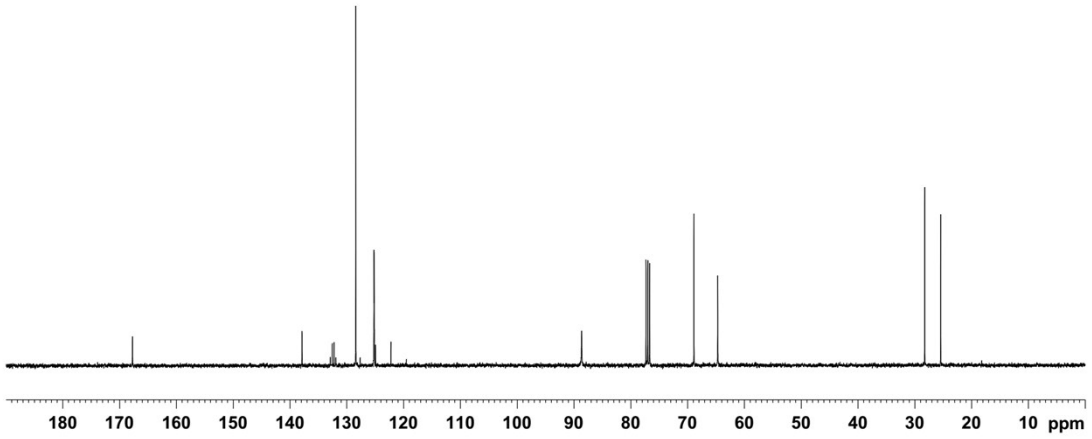
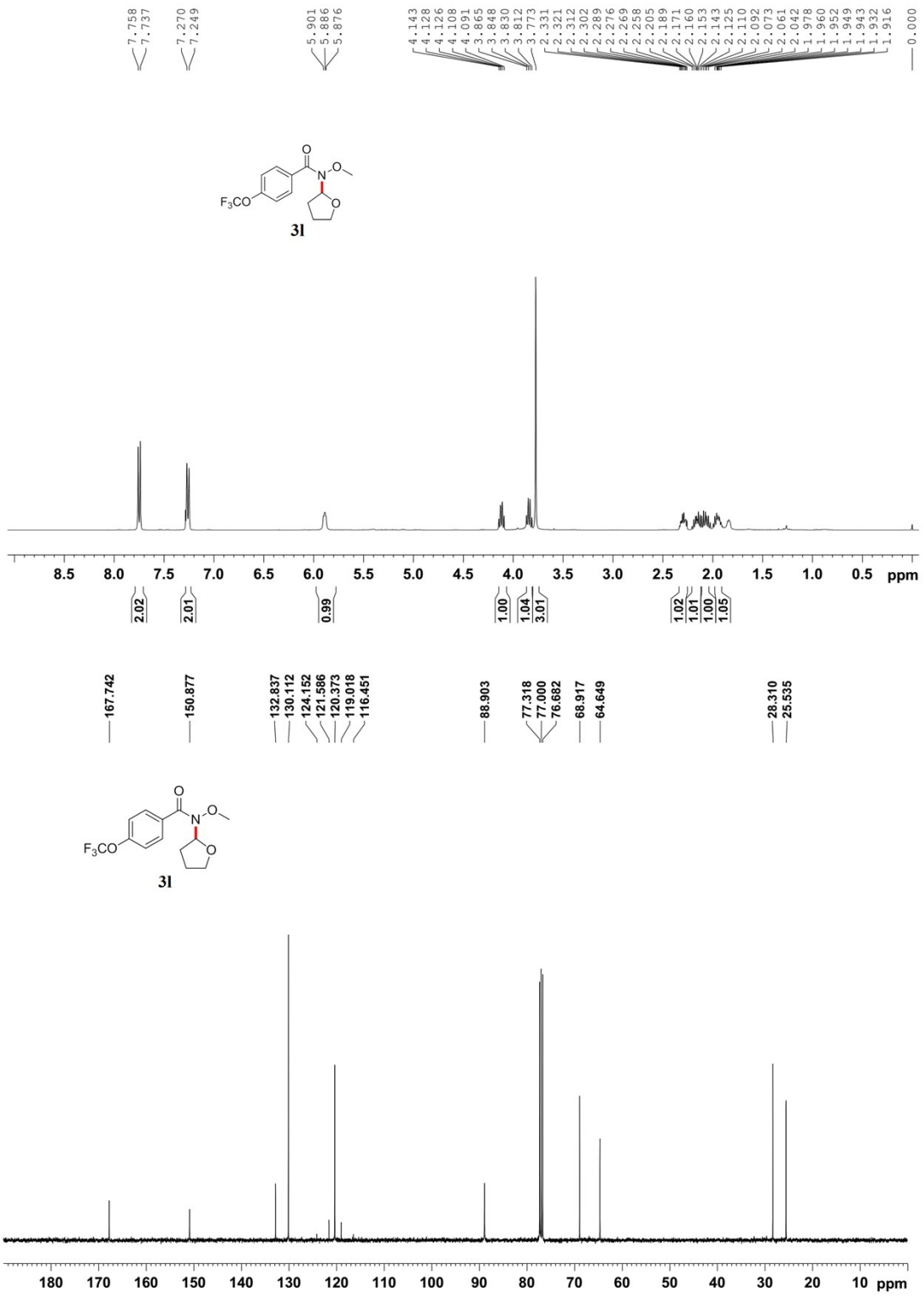
28.252
25.439


O
N
O
F3C
O

3k


180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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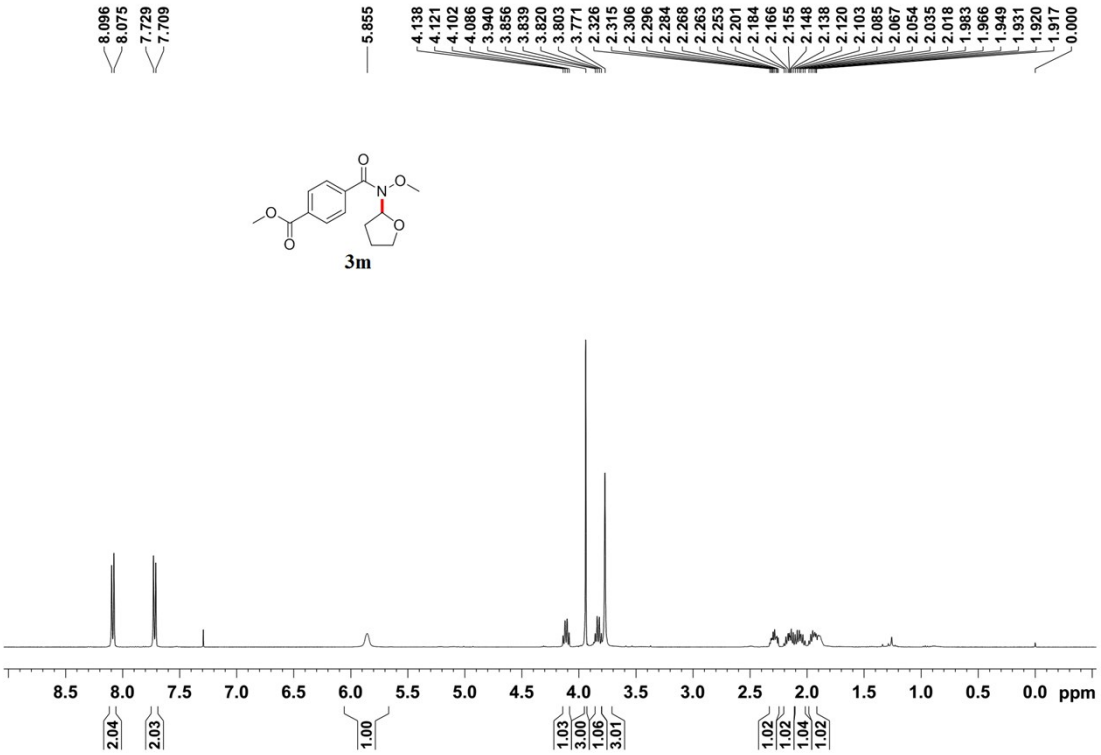
7.737
7.270
7.249
5.901
5.886
5.876
4.143
4.128
4.126
4.108
4.091
3.865
3.848
3.830
3.812
3.773
2.331
2.321
2.312
2.302
2.289
2.276
2.269
2.258
2.205
2.189
2.171
2.160
2.153
2.143
2.125
2.110
2.092
2.073
2.061
2.042
1.978
1.960
1.952
1.949
1.943
1.932
1.916
0.000
F3CO
3l
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
2.02
2.01
0.99
1.00
1.04
3.01
1.02
1.01
1.00
1.05
167.742
150.877
132.837
130.112
124.152
121.586
120.373
119.018
116.451
88.903
77.318
77.000
76.682
68.917
64.649
28.310
25.535
F3CO
3l
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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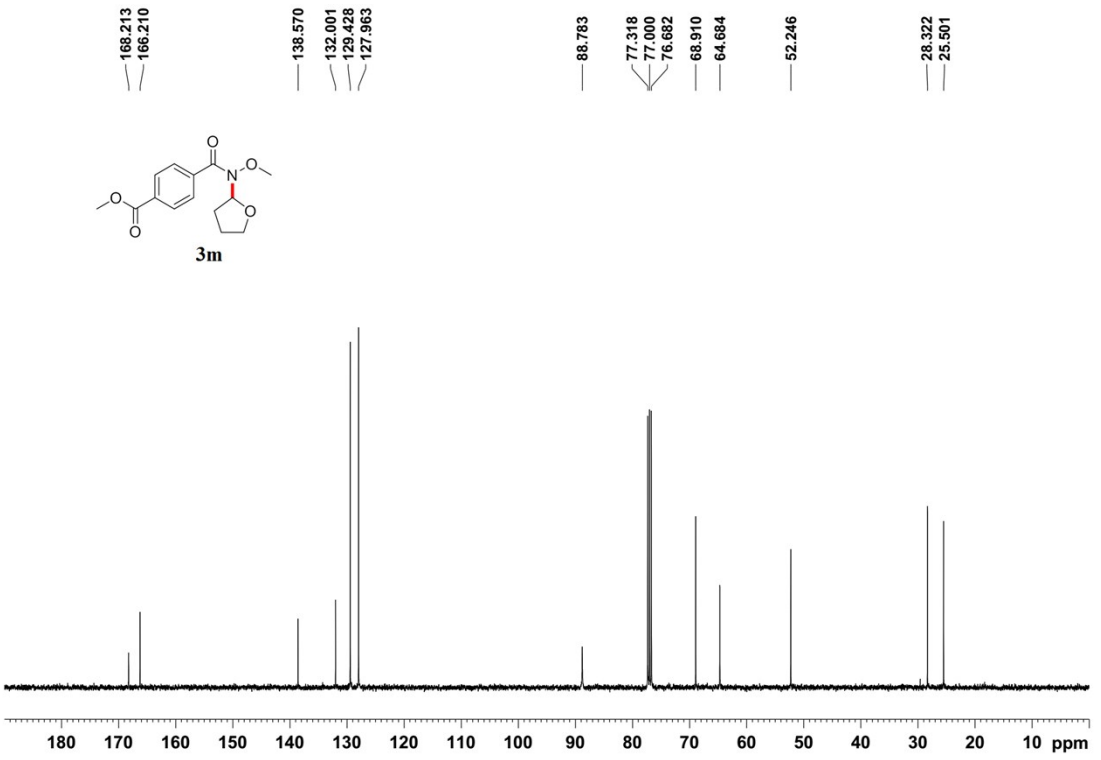
8.075
7.729
7.709
5.855
4.138
4.121
4.102
4.086
3.940
3.856
3.839
3.820
3.803
3.771
2.326
2.315
2.306
2.296
2.284
2.268
2.263
2.253
2.201
2.184
2.166
2.155
2.148
2.138
2.120
2.103
2.085
2.067
2.054
2.035
2.018
1.983
1.966
1.949
1.931
1.920
1.917
0.000
3m
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.04
2.03
1.00
1.03
3.00
1.06
3.01
1.02
1.02
1.04
1.02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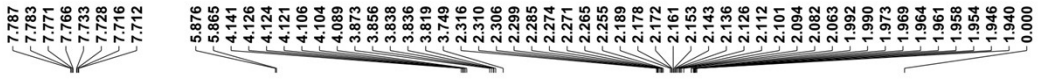
166.210
138.570
132.001
129.428
127.963
88.783
77.318
77.000
76.682
68.910
64.684
52.246
28.322
25.501
3m
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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7.783
7.771
7.766
7.733
7.728
7.716
7.712
5.876
5.865
4.141
4.126
4.124
4.121
4.106
4.104
4.089
3.873
3.856
3.838
3.836
3.819
3.749
2.316
2.310
2.306
2.299
2.285
2.274
2.271
2.265
2.255
2.189
2.178
2.172
2.161
2.153
2.143
2.136
2.126
2.112
2.101
2.094
2.082
2.063
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1.973
1.969
1.964
1.961
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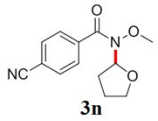
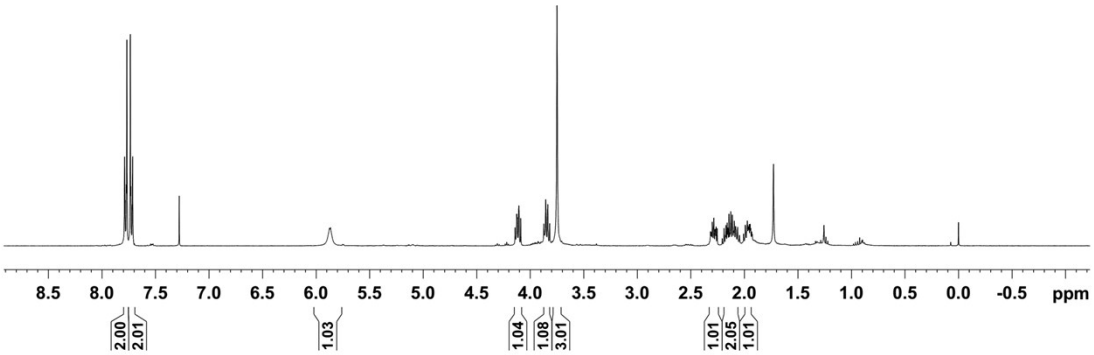
1.954
1.946
1.940
0.000


O
N
O
NC
O

3n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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
2.01
1.03
1.04
1.08
3.01
1.01
2.05
1.01


167.321
138.617
132.050
128.743
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114.446
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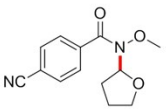
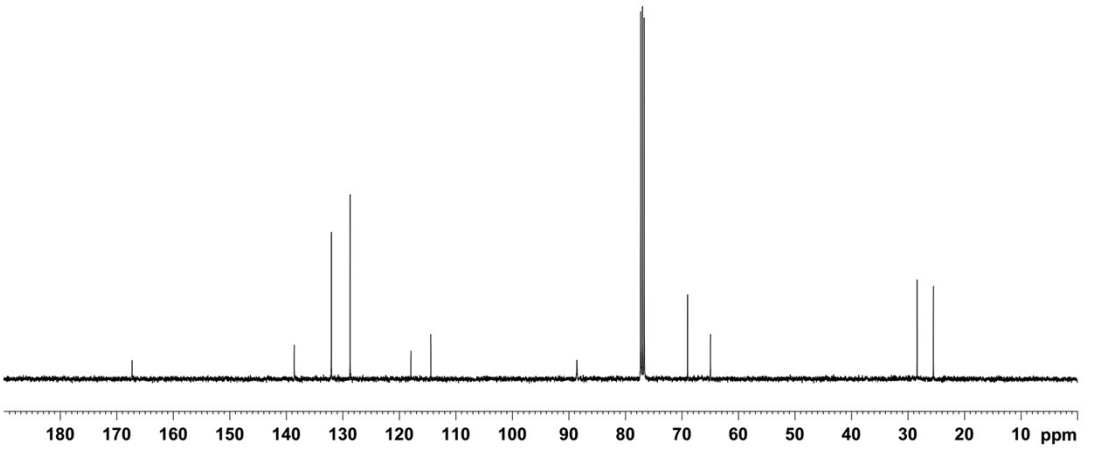
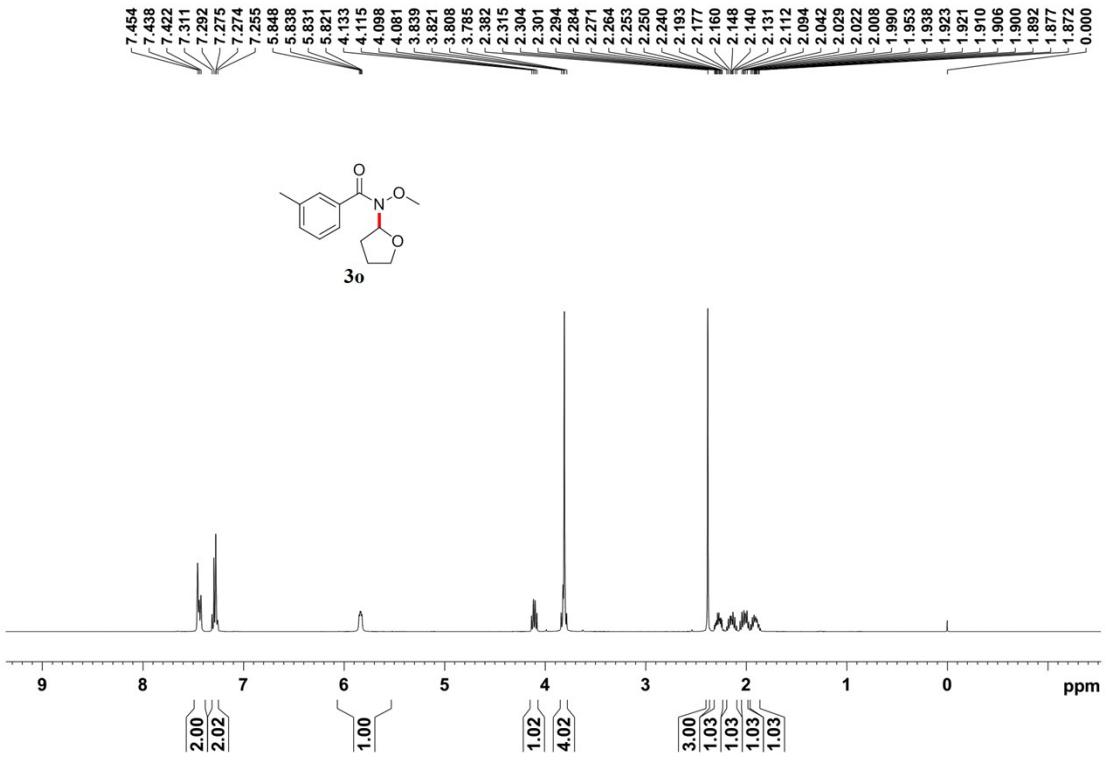
77.318
77.000
76.683
69.009
64.960
28.390
25.508


O
N
O
NC
O

3n


180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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7.422
7.311
7.292
7.275
7.274
7.255
5.848
5.838
5.831
5.821
4.133
4.115
4.098
4.081
3.839
3.821
3.808
3.785
2.382
2.315
2.304
2.301
2.294
2.284
2.271
2.264
2.253
2.250
2.240
2.193
2.177
2.160
2.148
2.140
2.131
2.112
2.094
2.042
2.029
2.022
2.008
1.990
1.953
1.938
1.923
1.921
1.910
1.906
1.900
1.892
1.877
1.872
0.000
3o
9
8
7
6
5
4
3
2
1
0
ppm
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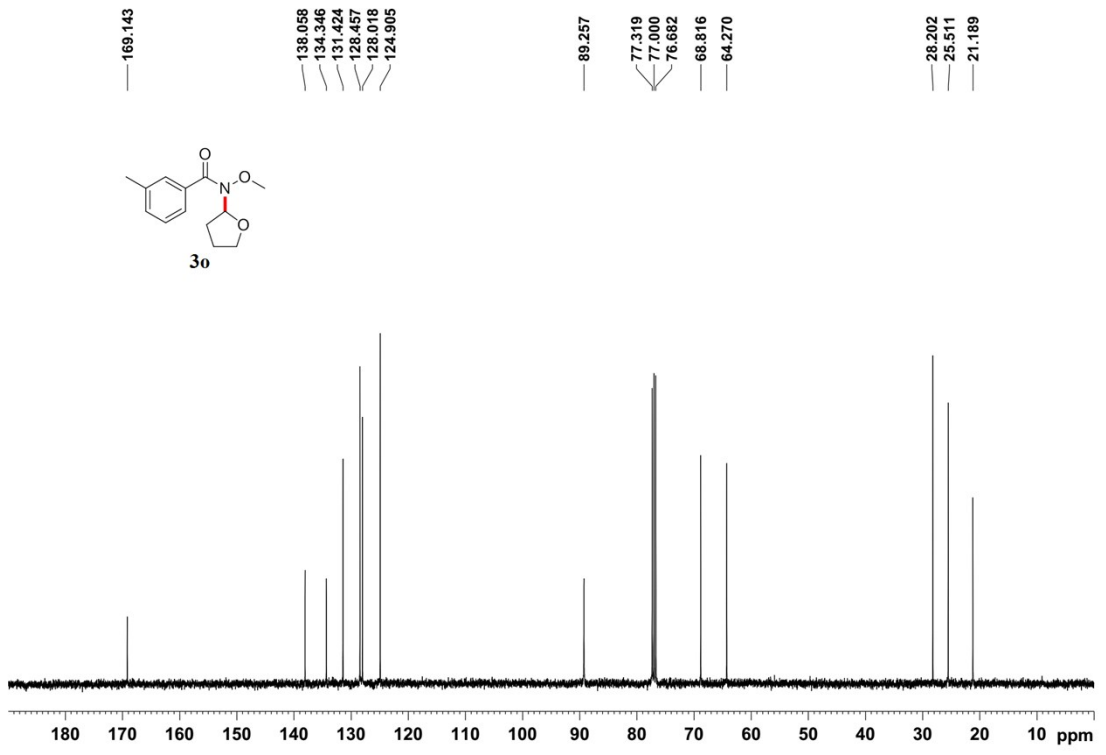
1.00
1.02
4.02
3.00
1.03
1.03
1.03
1.03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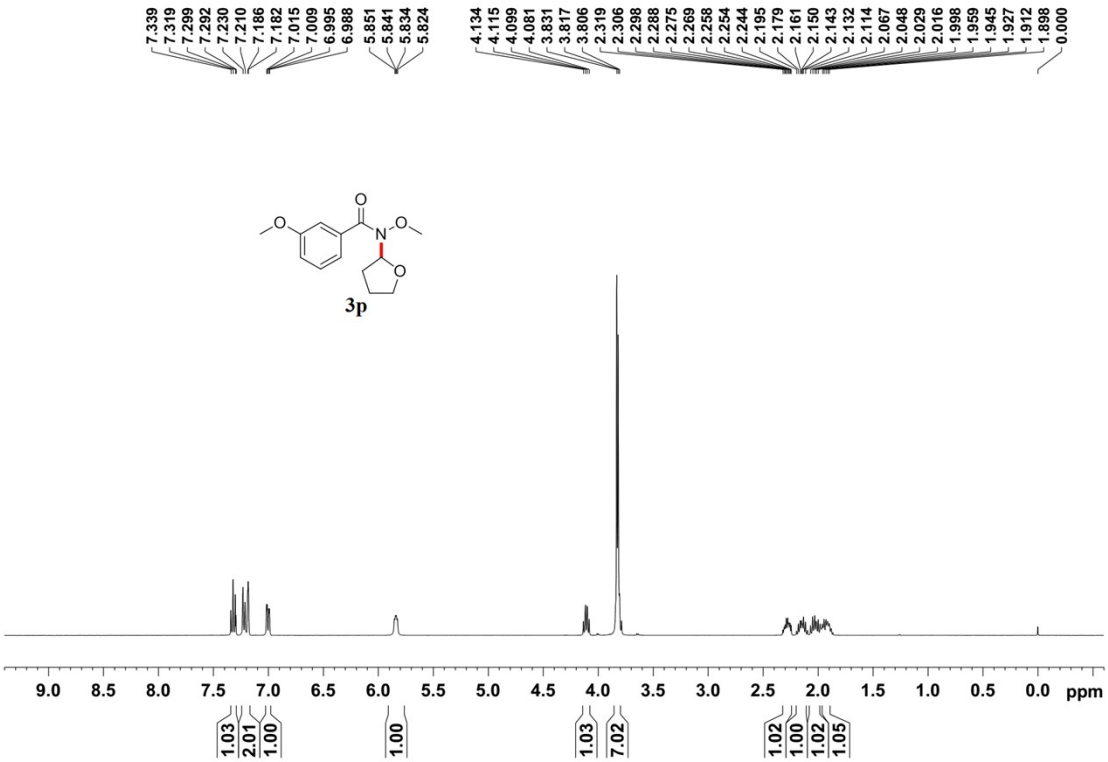
134.346
131.424
128.457
128.018
124.905
89.257
77.319
77.000
76.682
68.816
64.270
28.202
25.511
21.189
3o
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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7.299
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7.230
7.210
7.186
7.182
7.015
7.009
6.995
6.988
5.851
5.841
5.834
5.824
4.134
4.115
4.099
4.081
3.831
3.817
3.806
2.319
2.306
2.298
2.288
2.275
2.269
2.258
2.254
2.244
2.195
2.179
2.161
2.150
2.143
2.132
2.114
2.067
2.048
2.029
2.016
1.998
1.959
1.945
1.927
1.912
1.898
0.000
3p
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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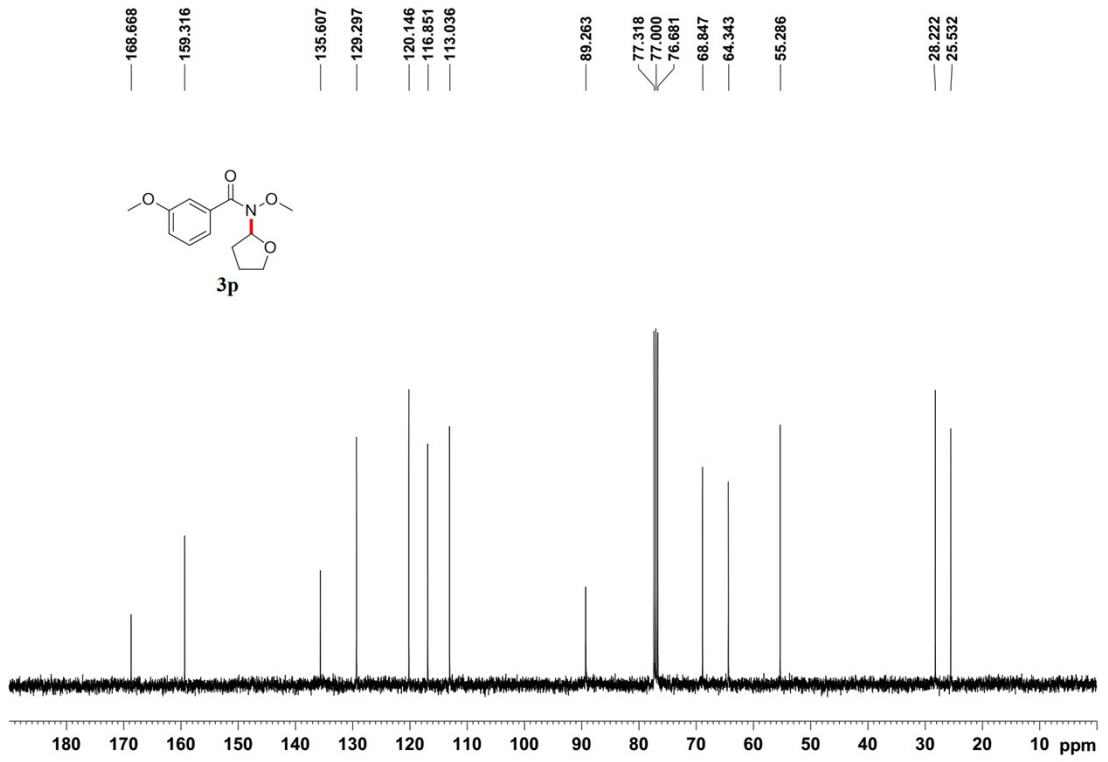
2.01
1.00
1.00
1.03
7.02
1.02
1.00
1.02
1.05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120.146
116.851
113.036
89.263
77.318
77.000
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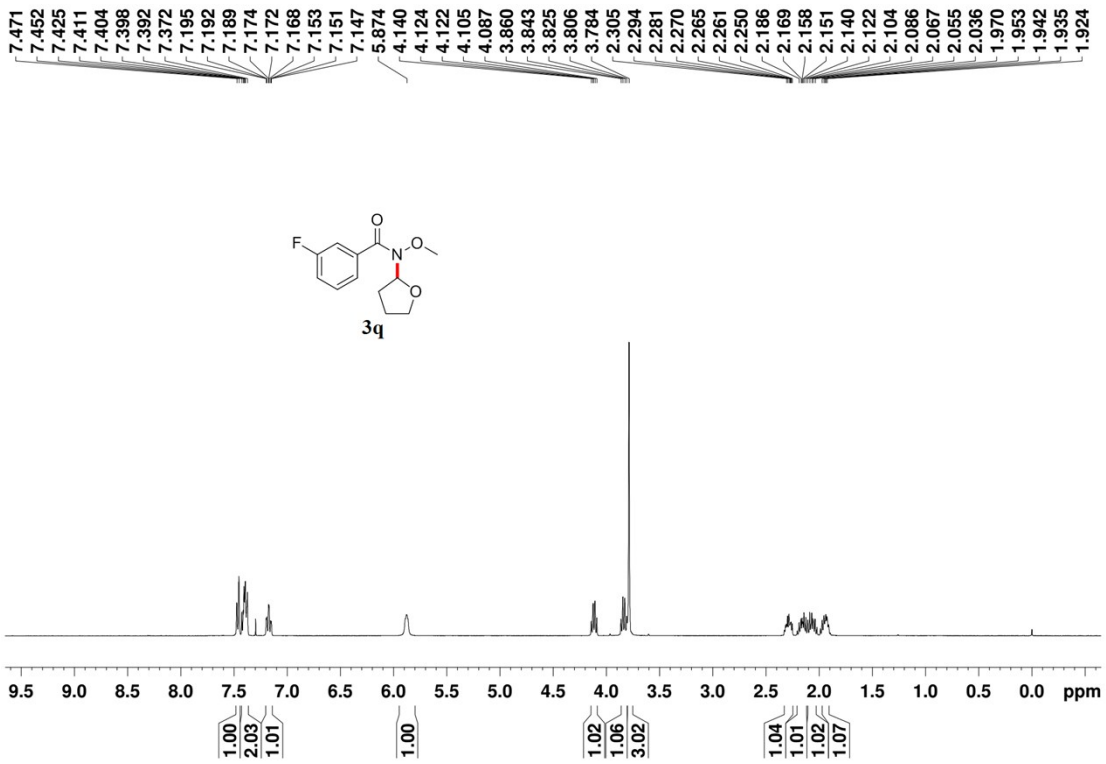
64.343
55.286
28.222
25.532
3p
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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7.452
7.425
7.411
7.404
7.398
7.392
7.372
7.195
7.192
7.189
7.174
7.172
7.168
7.153
7.151
7.147
5.874
4.140
4.124
4.122
4.105
4.087
3.860
3.843
3.825
3.806
3.784
2.305
2.294
2.281
2.270
2.265
2.261
2.250
2.186
2.169
2.158
2.151
2.140
2.122
2.104
2.086
2.067
2.055
2.036
1.970
1.953
1.942
1.935
1.924
F
O
N
O
O
3q
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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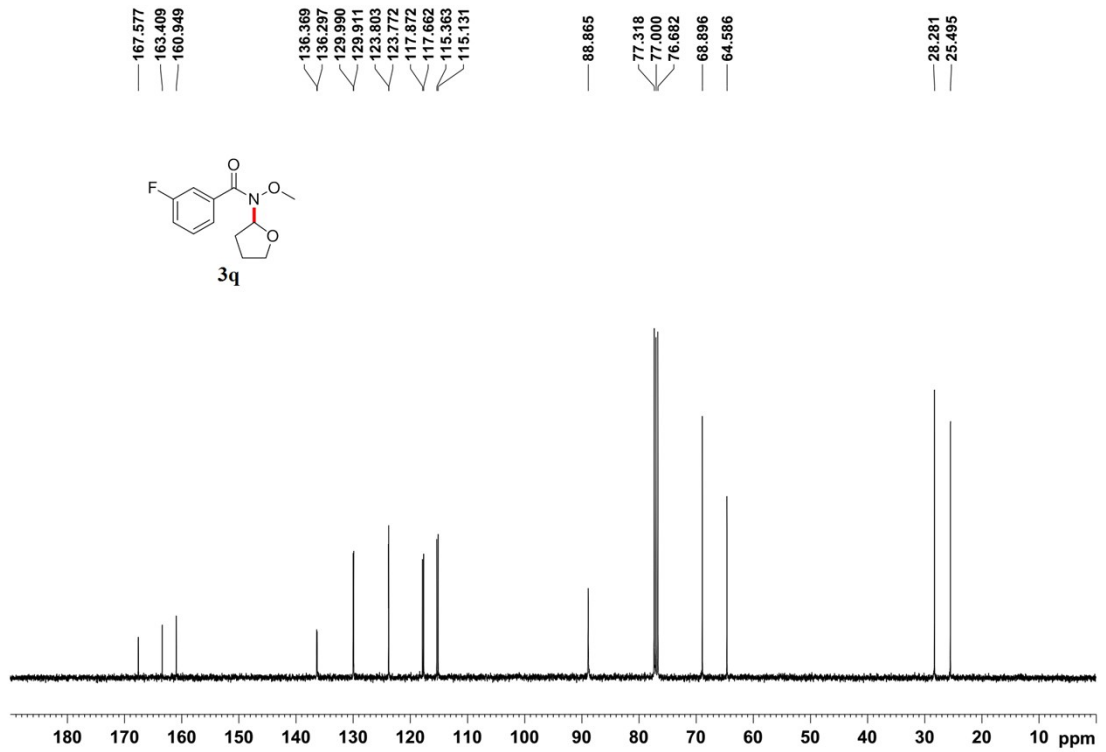
1.01
1.00
1.02
1.06
3.02
1.04
1.01
1.02
1.07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136.369
136.297
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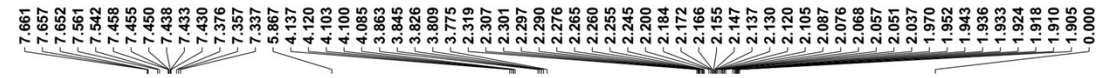
129.911
123.803
123.772
117.872
117.662
115.363
115.131
88.865
77.318
77.000
76.682
68.896
64.586
28.281
25.495
F
O
N
O
O
3q
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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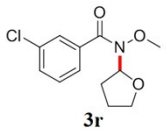
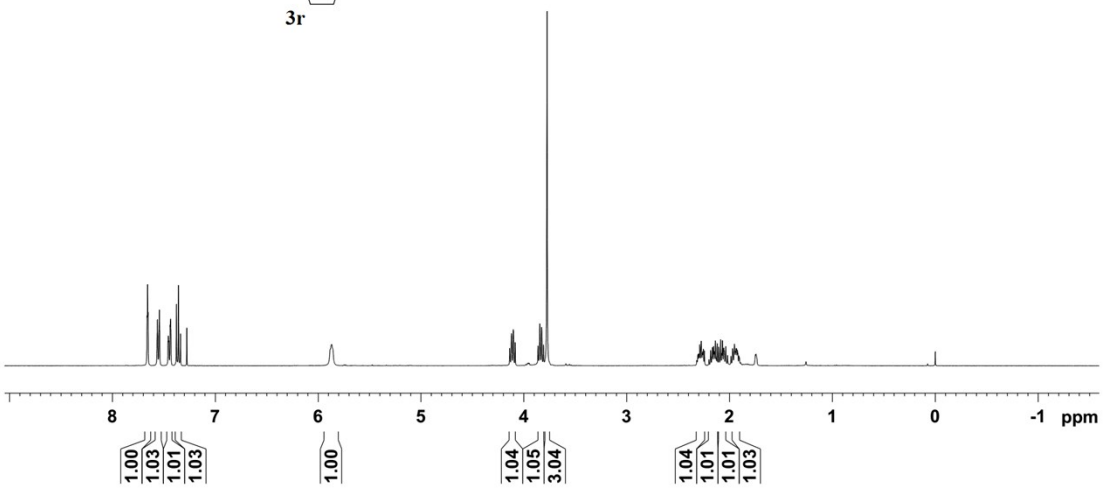
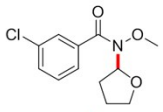
7.357
7.337
5.867
4.137
4.120
4.103
4.100
4.085
3.863
3.845
3.826
3.809
3.775
2.319
2.307
2.301
2.297
2.290
2.276
2.265
2.260
2.255
2.245
2.200
2.184
2.172
2.166
2.155
2.147
2.137
2.130
2.120
2.105
2.087
2.076
2.068
2.057
2.051
2.037
1.970
1.952
1.943
1.936
1.933
1.924
1.918
1.910
1.905
0.000


Cl
O
N
O
O

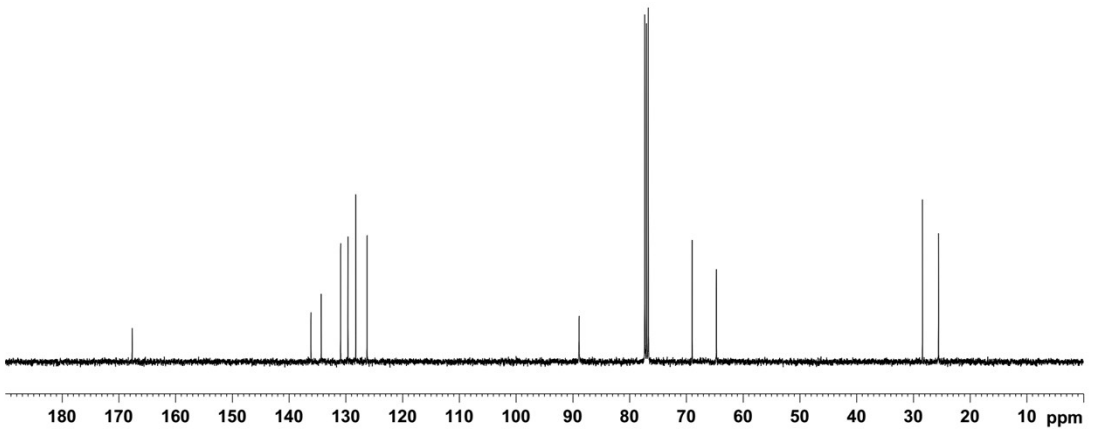
3r

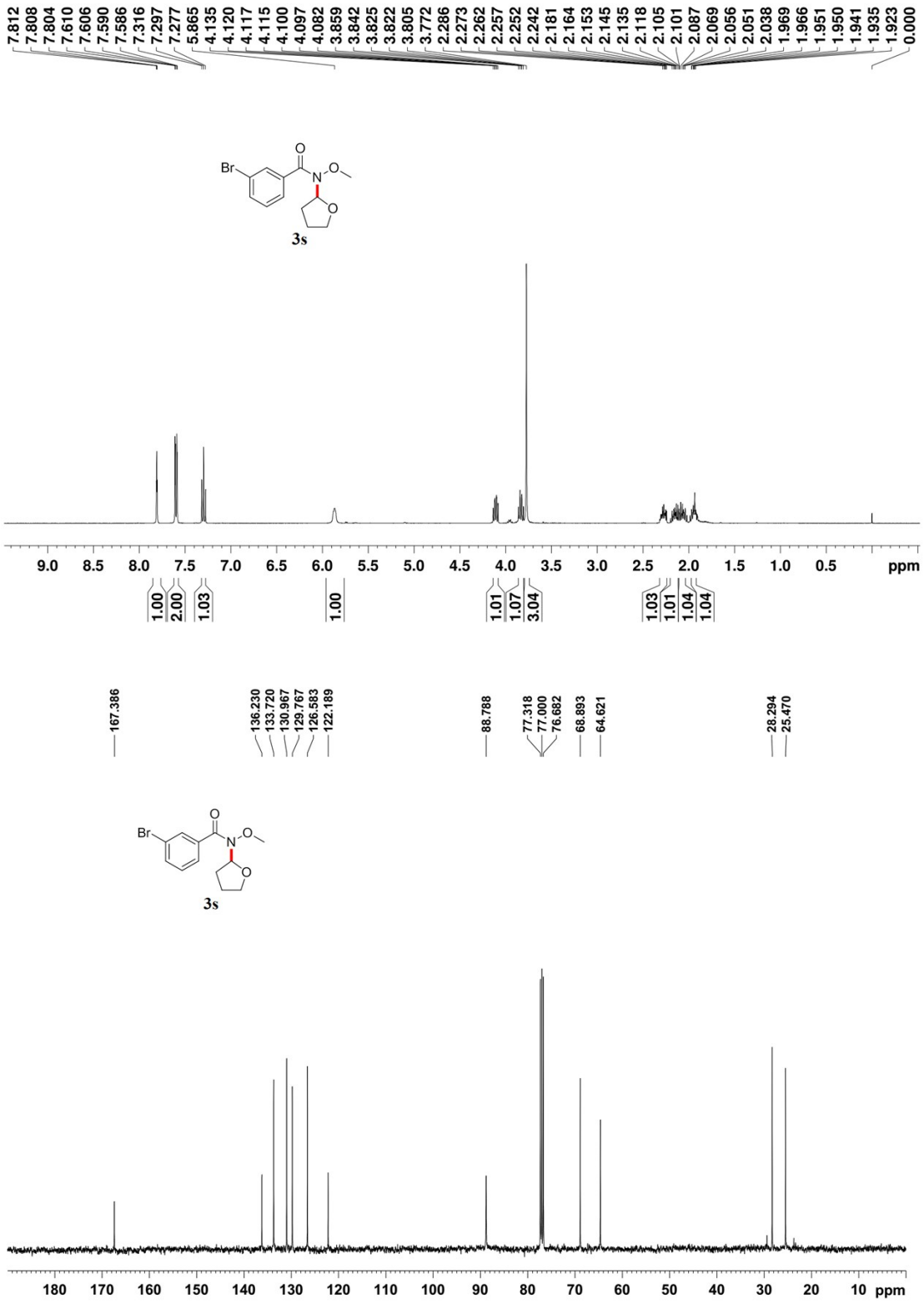

8
7
6
5
4
3
2
1
0
-1
ppm
1.00
1.03
1.01
1.03
1.00
1.04
1.05
3.04
1.04
1.01
1.01
1.03


167.617
136.107
134.292
130.867
129.587
128.210
126.215
88.887
77.317
77.000
76.682
68.958
64.682
28.364
25.537


Cl
O
N
O
O

3r


180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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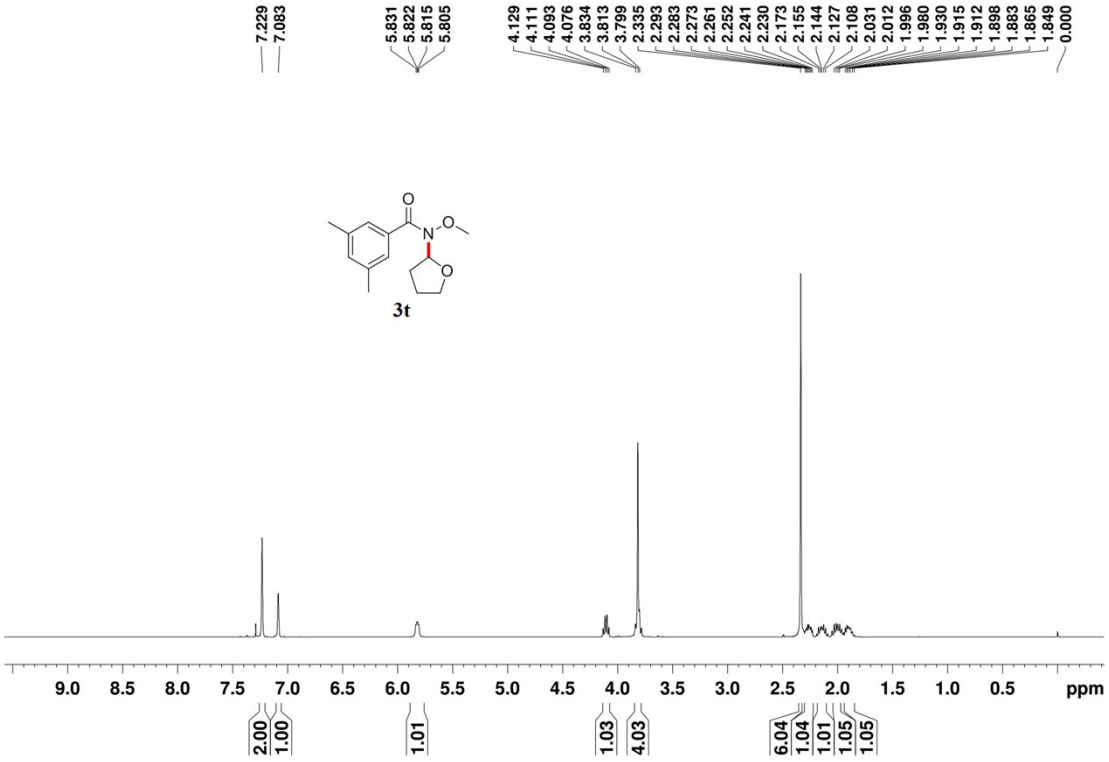
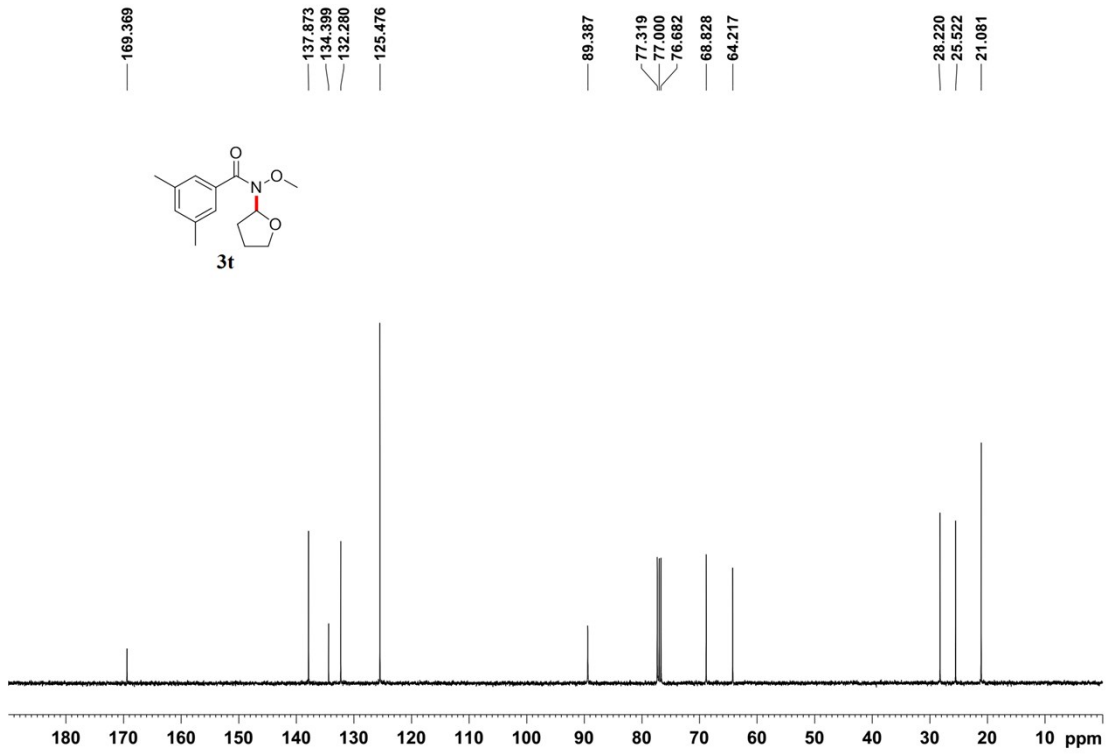
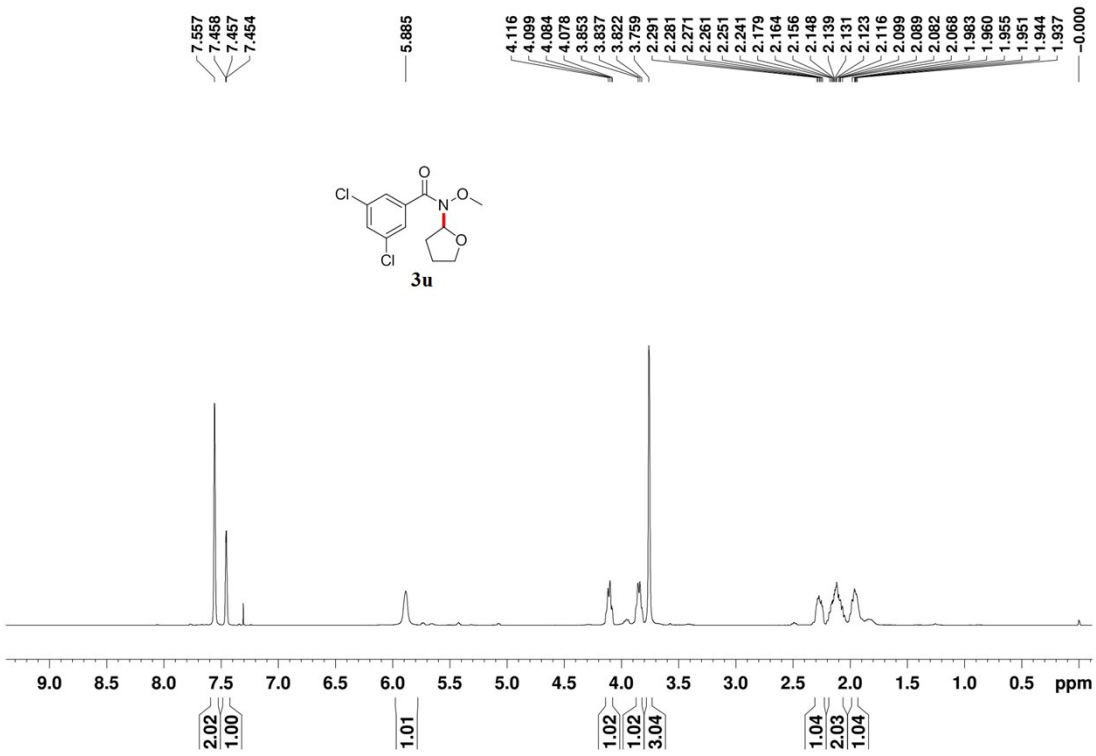
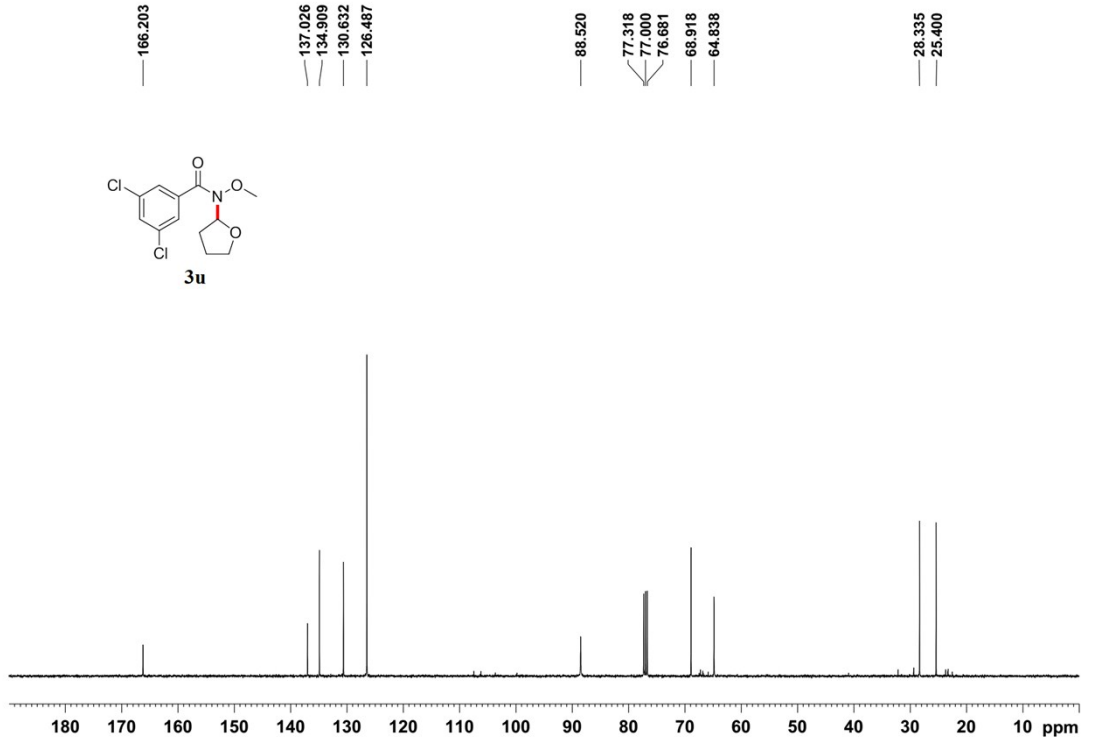
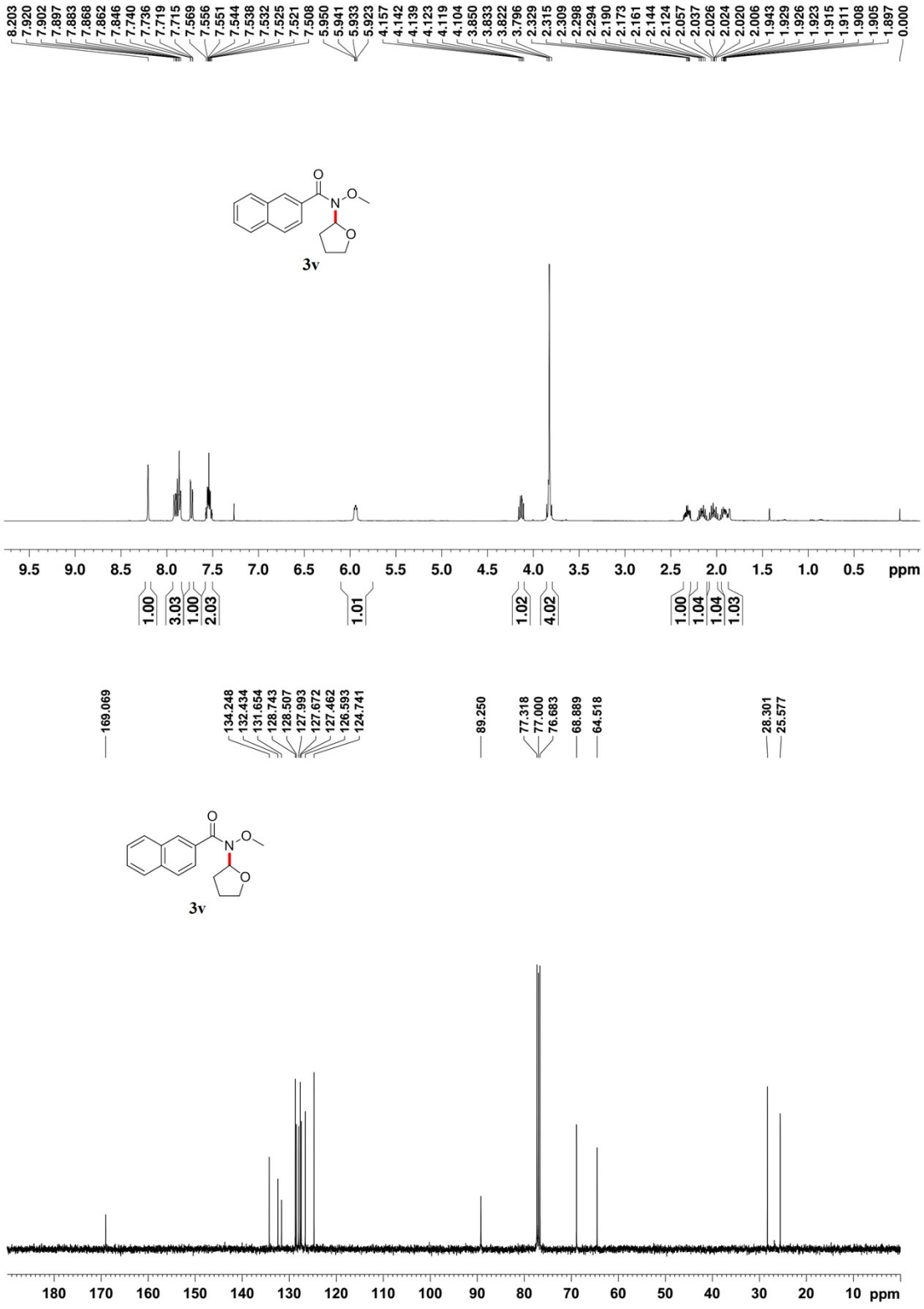
7.808
7.804
7.610
7.606
7.590
7.586
7.316
7.297
7.277
5.865
4.135
4.120
4.117
4.115
4.100
4.097
4.082
3.859
3.842
3.825
3.822
3.805
3.772
2.286
2.273
2.262
2.257
2.252
2.242
2.181
2.164
2.153
2.145
2.135
2.118
2.105
2.101
2.087
2.069
2.056
2.051
2.038
1.969
1.966
1.951
1.950
1.941
1.935
1.923
0.000
Br
O
N
O
O
3s
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
ppm
1.00
2.00
1.03
1.00
1.01
1.07
3.04
1.03
1.01
1.04
1.04
167.386
136.230
133.720
130.967
129.767
126.583
122.189
88.788
77.318
77.000
76.682
68.893
64.621
28.294
25.470
Br
O
N
O
O
3s
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

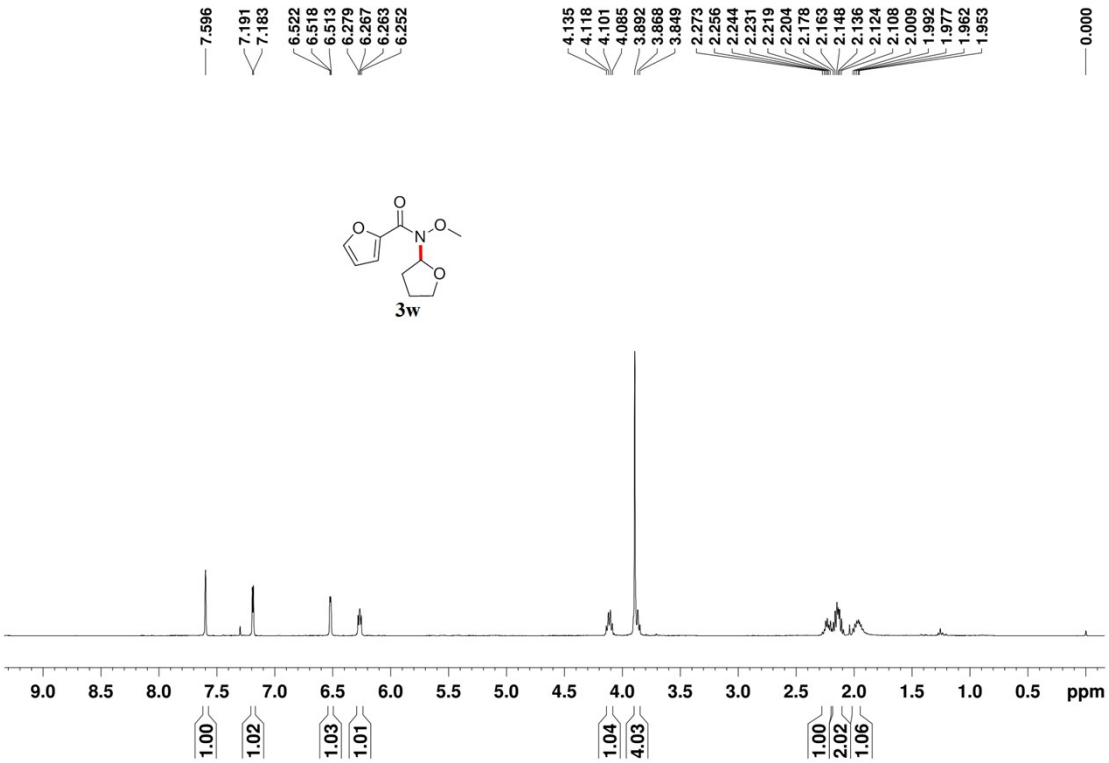

7.229
7.083
5.831
5.822
5.815
5.805
4.129
4.111
4.093
4.076
3.834
3.813
3.799
2.335
2.293
2.283
2.273
2.261
2.252
2.241
2.230
2.173
2.155
2.144
2.127
2.108
2.031
2.012
1.996
1.980
1.930
1.915
1.912
1.898
1.883
1.865
1.849
0.000
3t
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
2.00
1.00
1.01
1.03
4.03
6.04
1.04
1.01
1.05
1.05

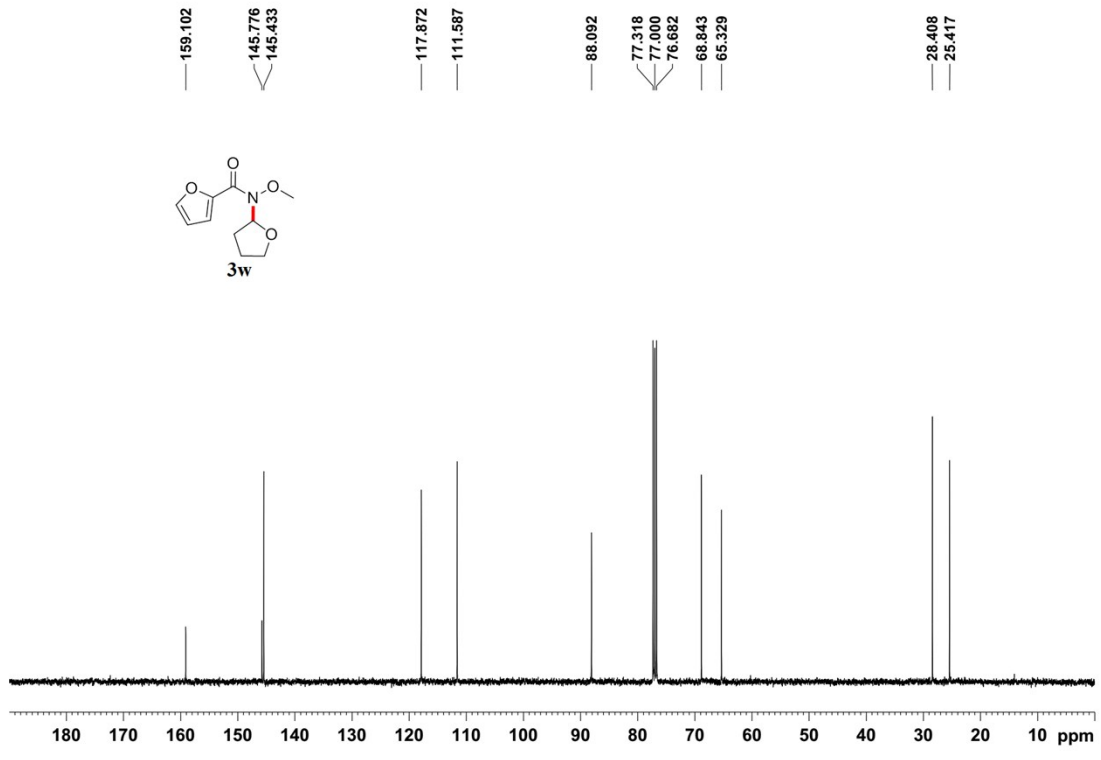

169.369
137.873
134.399
132.280
125.476
89.387
77.319
77.000
76.682
68.828
64.217
28.220
25.522
21.081
3t
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

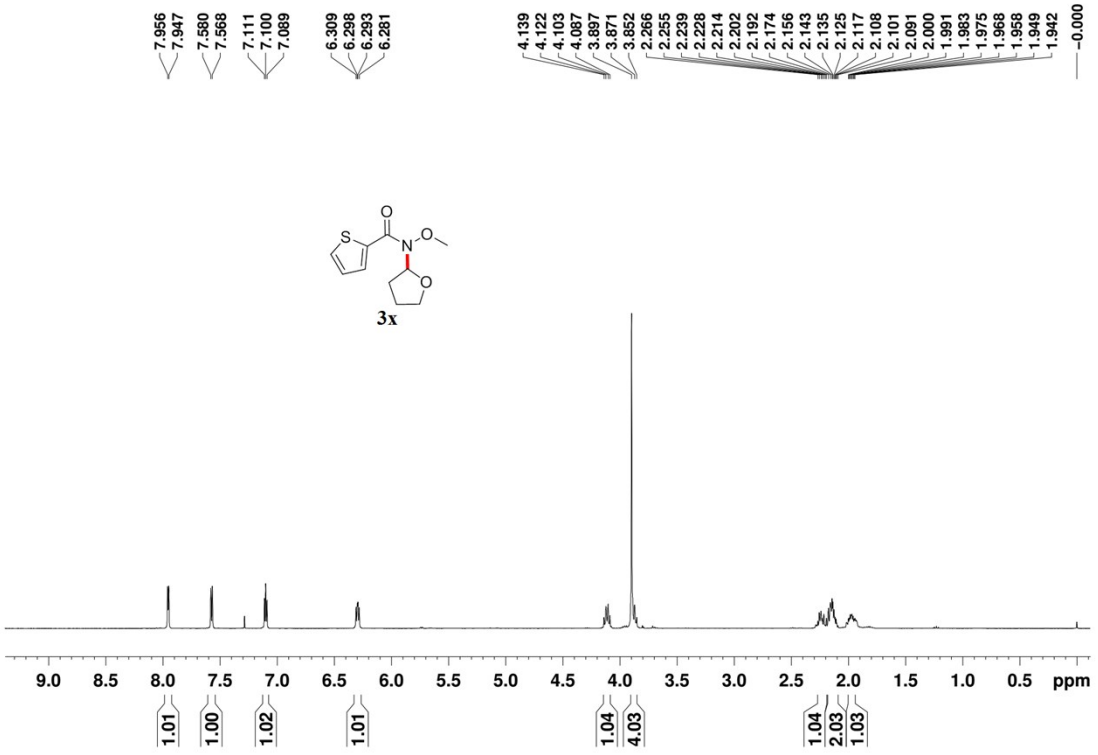

7.557
7.458
7.457
7.454
5.885
4.116
4.099
4.084
4.078
3.853
3.837
3.822
3.759
2.291
2.281
2.271
2.261
2.251
2.241
2.179
2.164
2.156
2.148
2.139
2.131
2.123
2.116
2.099
2.089
2.082
2.068
1.983
1.960
1.955
1.951
1.944
1.937
0.000
Cl
O
N
O
Cl
O
3u
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
2.02
1.00
1.01
1.02
1.02
3.04
1.04
2.03
1.04

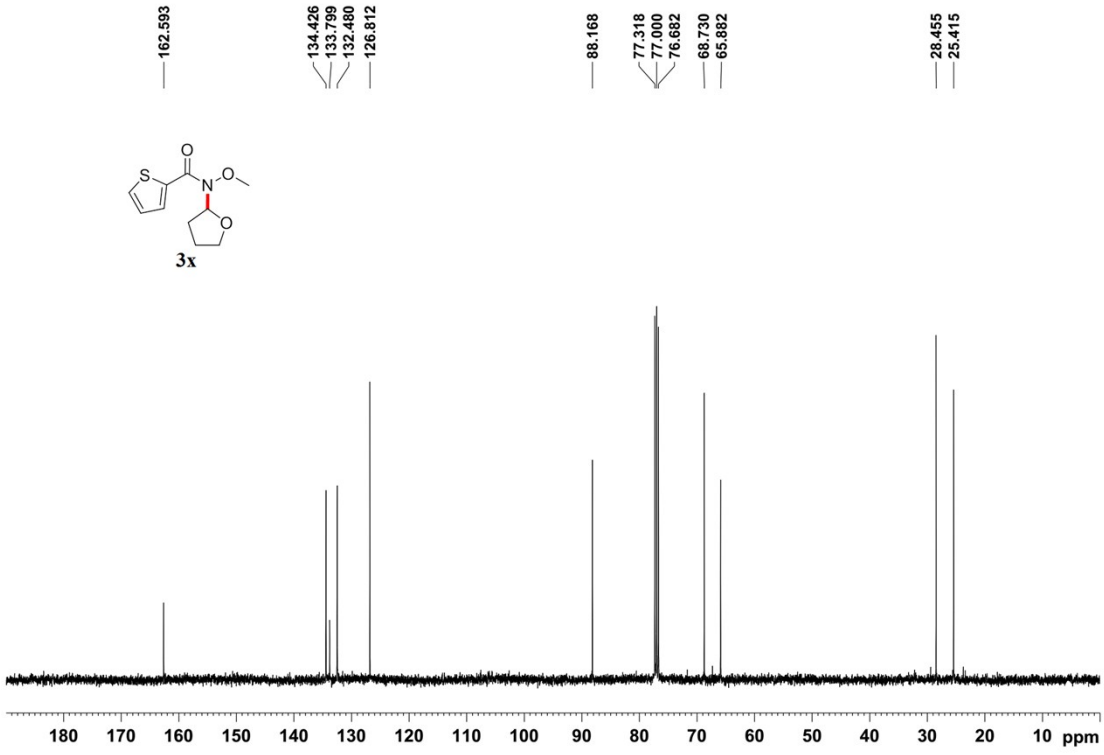

166.203
137.026
134.909
130.632
126.487
88.520
77.318
77.000
76.681
68.918
64.838
28.335
25.400
Cl
O
N
O
Cl
O
3u
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

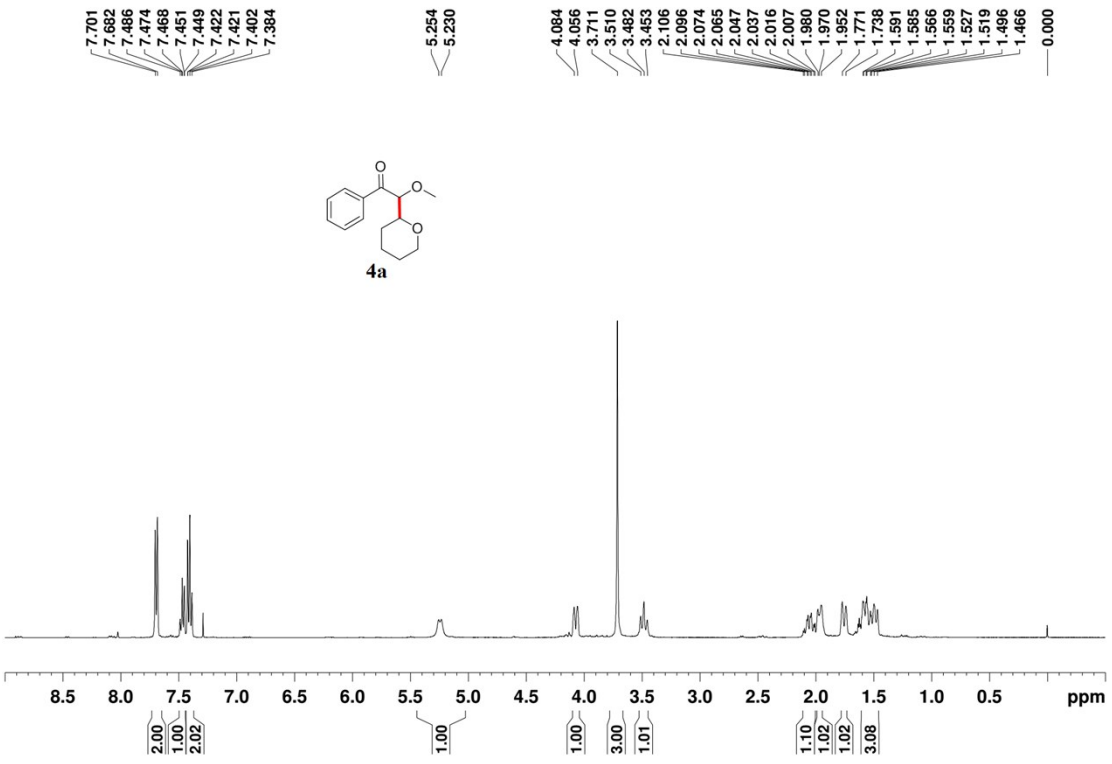

8.203
7.920
7.902
7.897
7.883
7.868
7.862
7.846
7.740
7.736
7.719
7.715
7.569
7.556
7.551
7.544
7.538
7.532
7.525
7.521
7.508
5.950
5.941
5.933
5.923
4.157
4.142
4.139
4.123
4.119
4.104
3.850
3.833
3.822
3.796
2.329
2.315
2.309
2.298
2.294
2.190
2.173
2.161
2.144
2.124
2.057
2.037
2.026
2.024
2.020
2.006
1.943
1.929
1.926
1.923
1.915
1.911
1.908
1.905
1.897
0.000
3v
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 ppm
1.00
3.03
1.00
2.03
1.01
1.02
4.02
1.00
1.04
1.04
1.03
169.069
134.248
132.434
131.654
128.743
128.507
127.993
127.672
127.462
126.593
124.741
89.250
77.318
77.000
76.683
68.889
64.518
28.301
25.577
3v
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

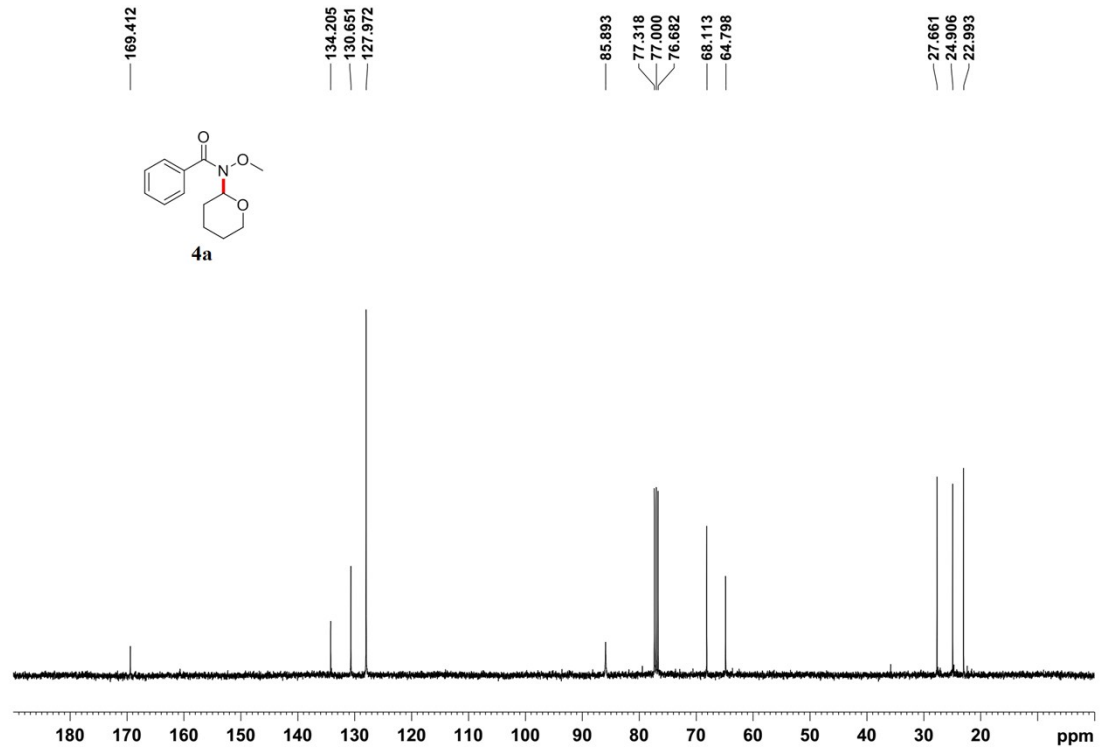

7.596
7.191
7.183
6.522
6.518
6.513
6.279
6.267
6.263
6.252
4.135
4.118
4.101
4.085
3.892
3.868
3.849
2.273
2.256
2.244
2.231
2.219
2.204
2.178
2.163
2.148
2.136
2.124
2.108
2.009
1.992
1.977
1.962
1.953
0.000
O
O
N
O
O
3w
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.00
1.02
1.03
1.01
1.04
4.03
1.00
2.02
1.06

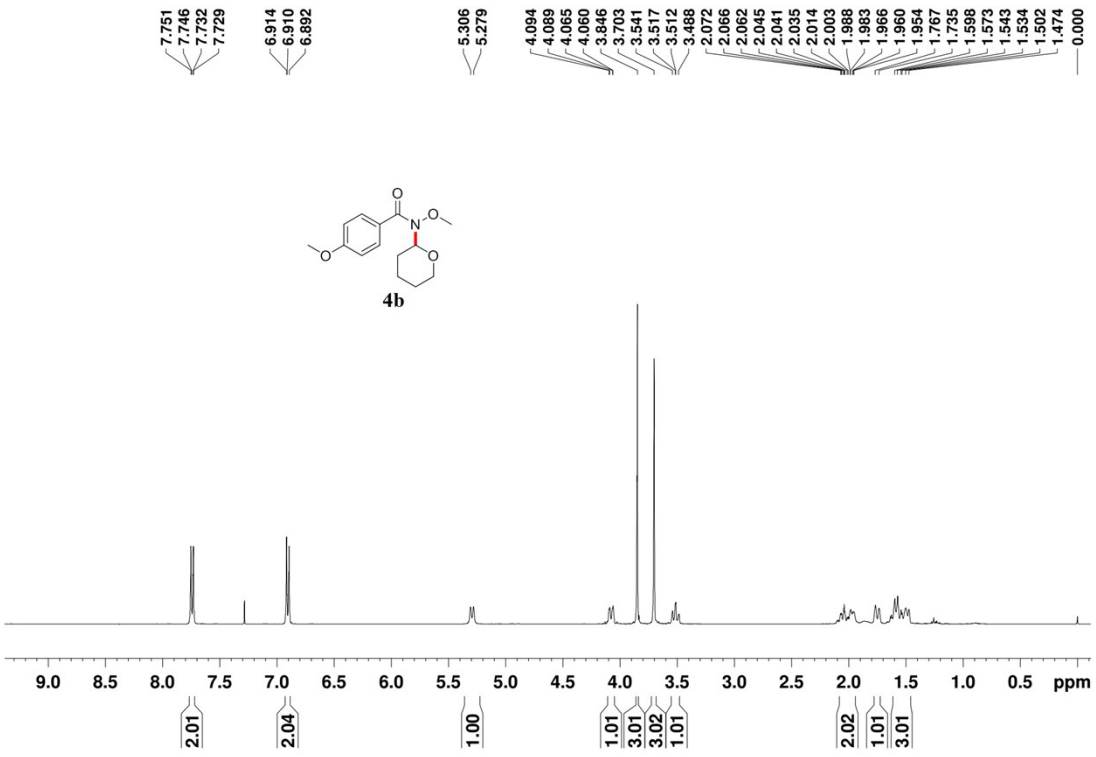

159.102
145.776
145.433
117.872
111.587
88.092
77.318
77.000
76.682
68.843
65.329
28.408
25.417
O
O
N
O
O
3w
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

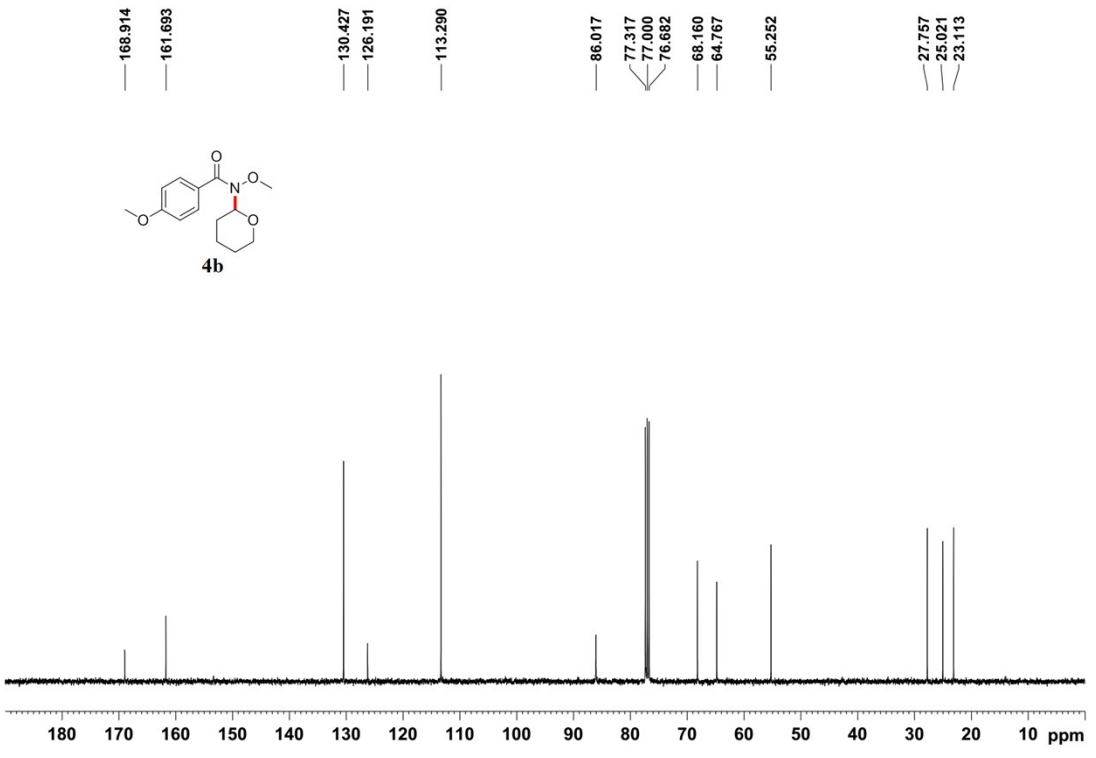

7.956
7.947
7.580
7.568
7.111
7.100
7.089
6.309
6.298
6.293
6.281
4.139
4.122
4.103
4.087
3.897
3.871
3.852
2.266
2.255
2.239
2.228
2.214
2.202
2.192
2.174
2.156
2.143
2.135
2.125
2.117
2.108
2.101
2.091
2.000
1.991
1.983
1.975
1.968
1.958
1.949
1.942
0.000
3x
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
1.01
1.00
1.02
1.01
1.04
4.03
1.04
2.03
1.03

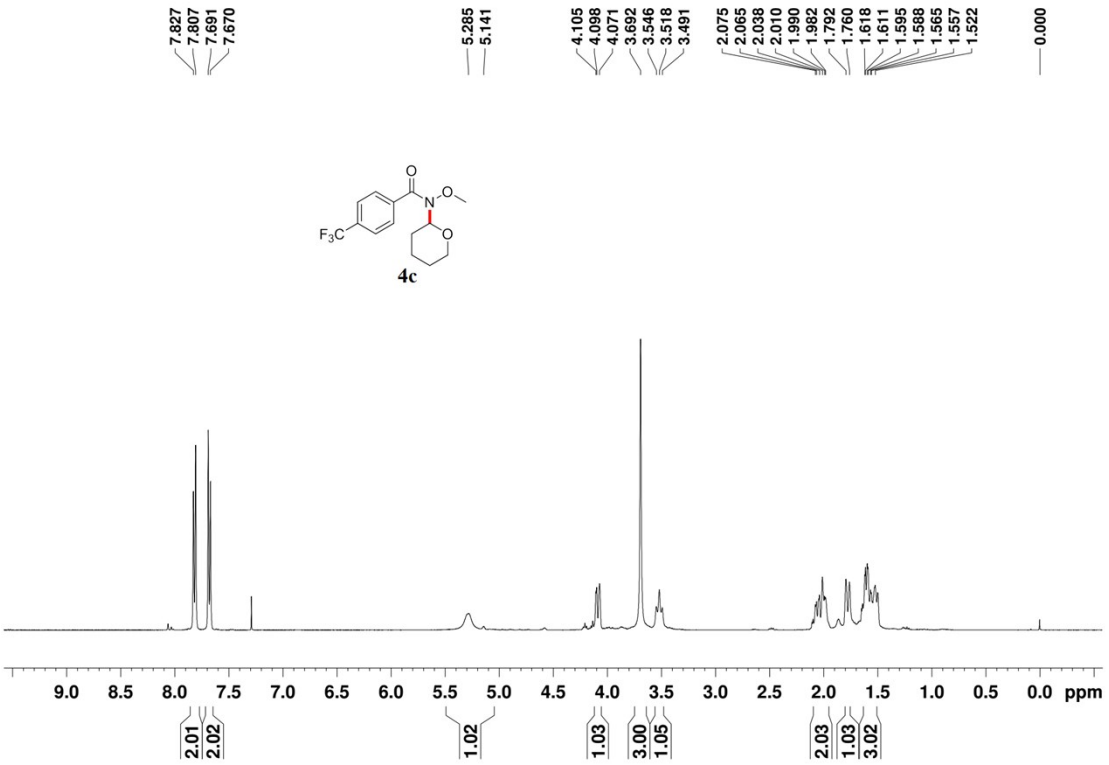

162.593
134.426
133.799
132.480
126.812
88.168
77.318
77.000
76.682
68.730
65.882
28.455
25.415
3x
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


7.701
7.682
7.486
7.474
7.468
7.451
7.449
7.422
7.421
7.402
7.384
5.254
5.230
4.084
4.056
3.711
3.510
3.482
3.453
2.106
2.096
2.074
2.065
2.047
2.037
2.016
2.007
1.980
1.970
1.952
1.771
1.738
1.591
1.585
1.566
1.559
1.527
1.519
1.496
1.466
0.000
4a
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
ppm
2.00
1.00
2.02
1.00
1.00
3.00
1.01
1.10
1.02
1.02
3.08


169.412
134.205
130.651
127.972
85.893
77.318
77.000
76.682
68.113
64.798
27.661
24.906
22.993
4a
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm


7.751
7.746
7.732
7.729
6.914
6.910
6.892
5.306
5.279
4.094
4.089
4.065
4.060
3.846
3.703
3.541
3.517
3.512
3.488
2.072
2.066
2.062
2.045
2.041
2.035
2.014
2.003
1.988
1.983
1.966
1.960
1.954
1.767
1.735
1.598
1.573
1.543
1.534
1.502
1.474
0.000
4b
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 ppm
2.01
2.04
1.00
1.01
3.01
3.02
1.01
2.02
1.01
3.01


168.914
161.693
130.427
126.191
113.290
86.017
77.317
77.000
76.682
68.160
64.767
55.252
27.757
25.021
23.113
4b
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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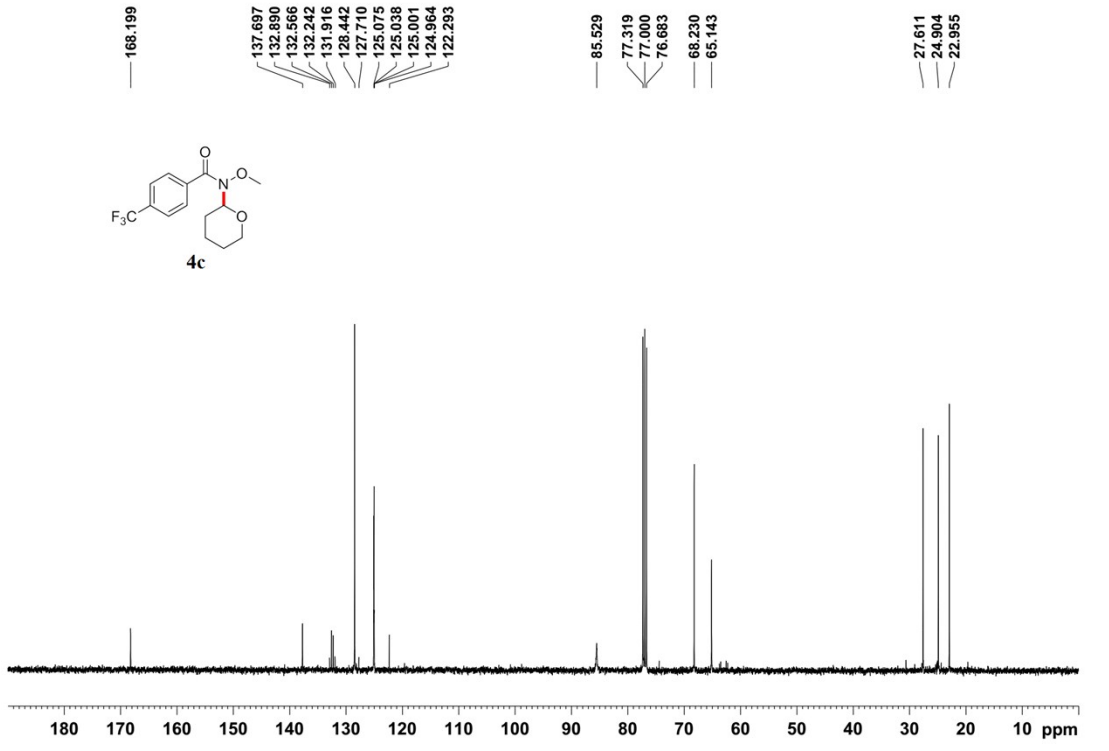
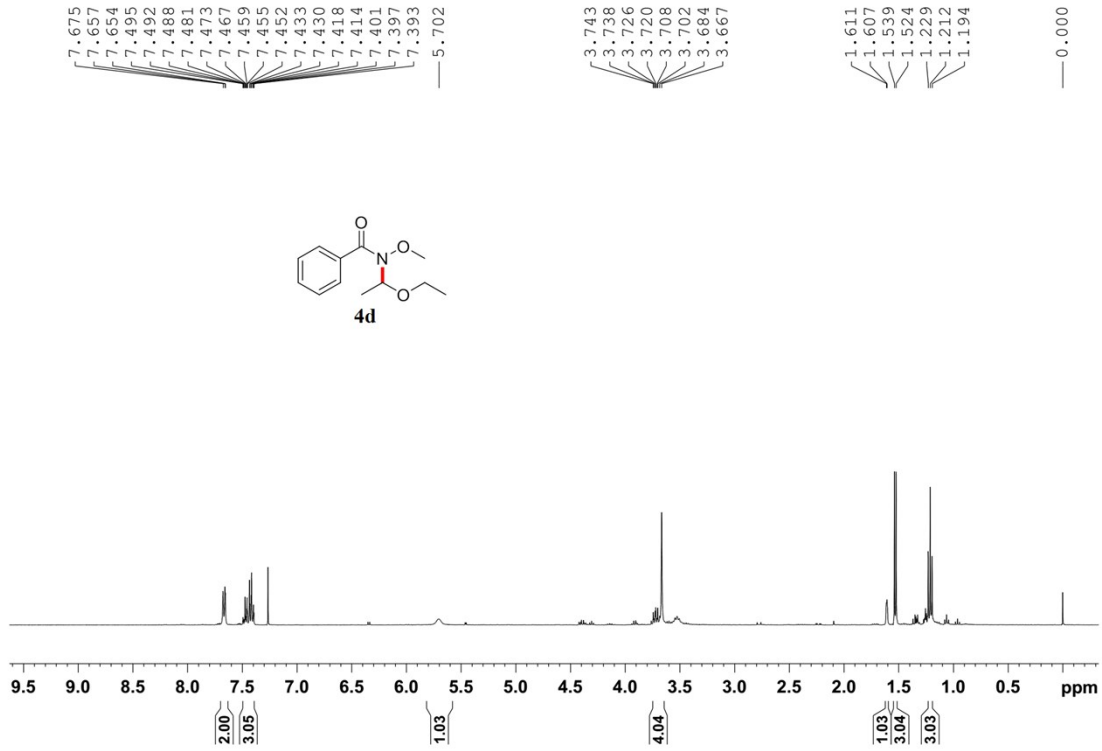
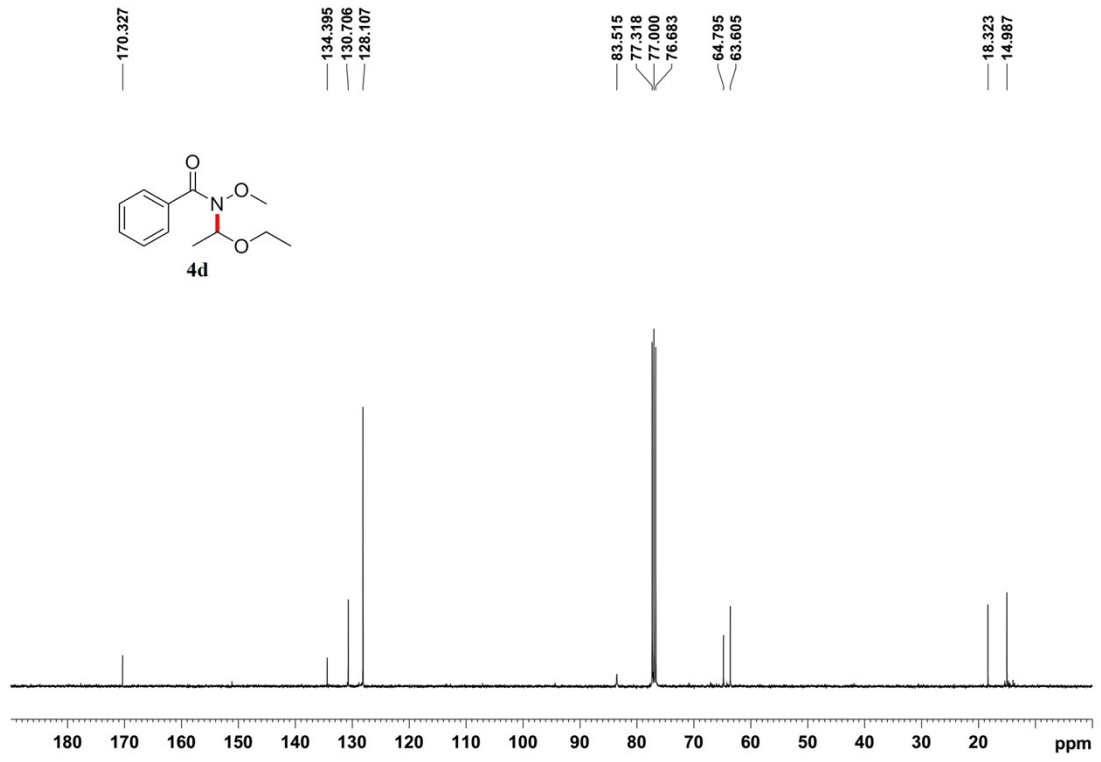
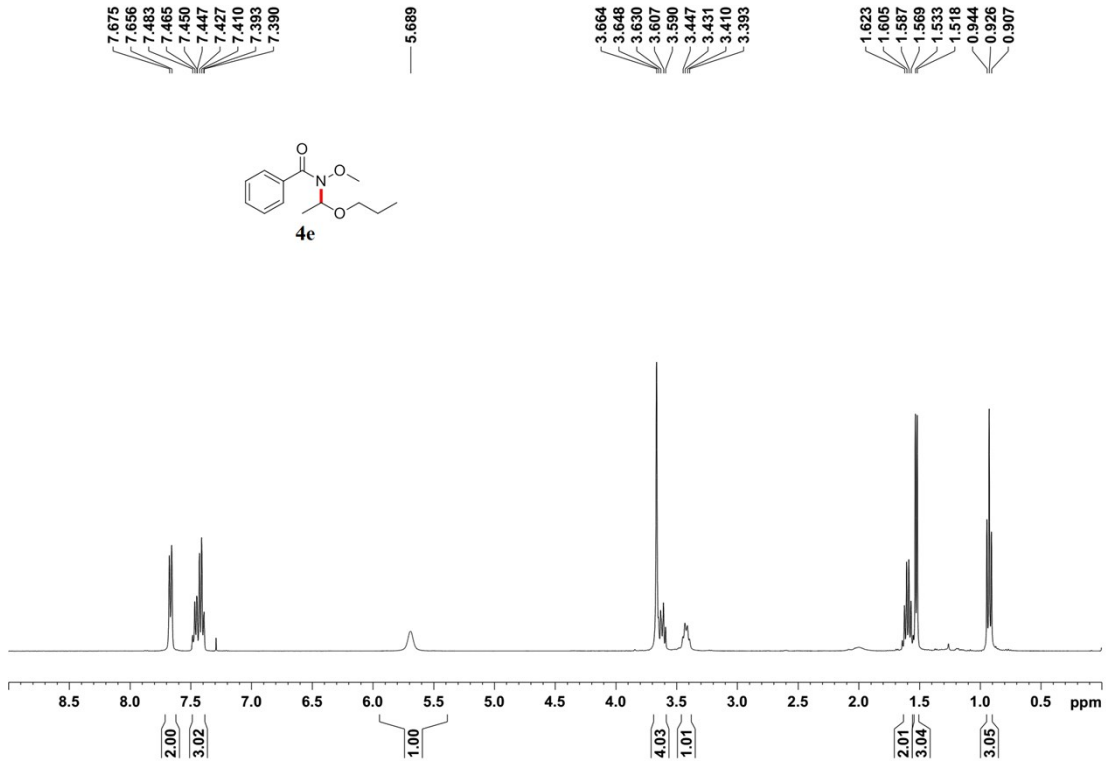
7.807
7.691
7.670
5.285
5.141
4.105
4.098
4.071
3.692
3.546
3.518
3.491
2.075
2.065
2.038
2.010
1.990
1.982
1.792
1.760
1.618
1.611
1.595
1.588
1.565
1.557
1.522
0.000
F3C
O
N
O
O
4c
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 ppm
2.01
2.02
1.02
1.03
3.00
1.05
2.03
1.03
3.02


168.199
137.697
132.890
132.566
132.242
131.916
128.442
127.710
125.075
125.038
125.001
124.964
122.293
85.529
77.319
77.000
76.683
68.230
65.143
27.611
24.904
22.955
F3C
O
N
O
O
4c
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


7.675
7.657
7.654
7.495
7.492
7.488
7.481
7.473
7.467
7.459
7.455
7.452
7.433
7.430
7.418
7.414
7.401
7.397
7.393
5.702
3.743
3.738
3.726
3.720
3.708
3.702
3.684
3.667
1.611
1.607
1.539
1.524
1.229
1.212
1.194
0.000
4d
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 ppm
2.00
3.05
1.03
4.04
1.03
3.04
3.03


170.327
134.395
130.706
128.107
83.515
77.318
77.000
76.683
64.795
63.605
18.323
14.987
4d
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm


7.675
7.656
7.483
7.465
7.450
7.447
7.427
7.410
7.393
7.390
5.689
3.664
3.648
3.630
3.607
3.590
3.447
3.431
3.410
3.393
1.623
1.605
1.587
1.569
1.533
1.518
0.944
0.926
0.907
4e
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 ppm
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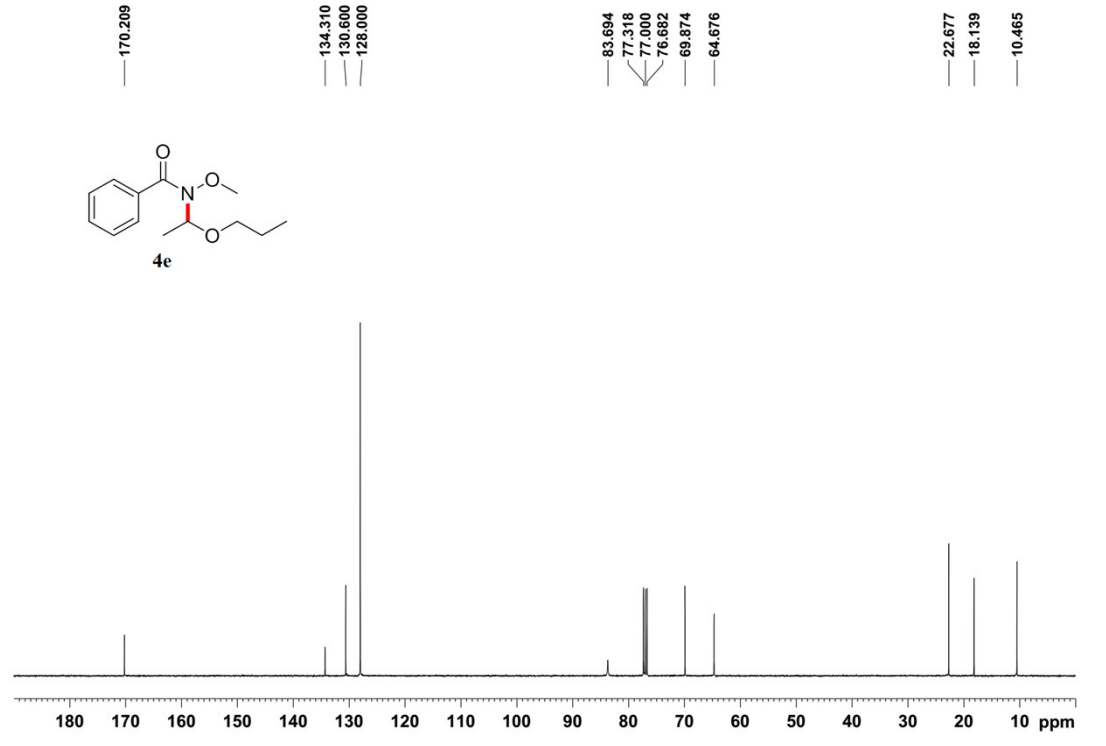
3.02
1.00
4.03
1.01
2.01
3.04
3.05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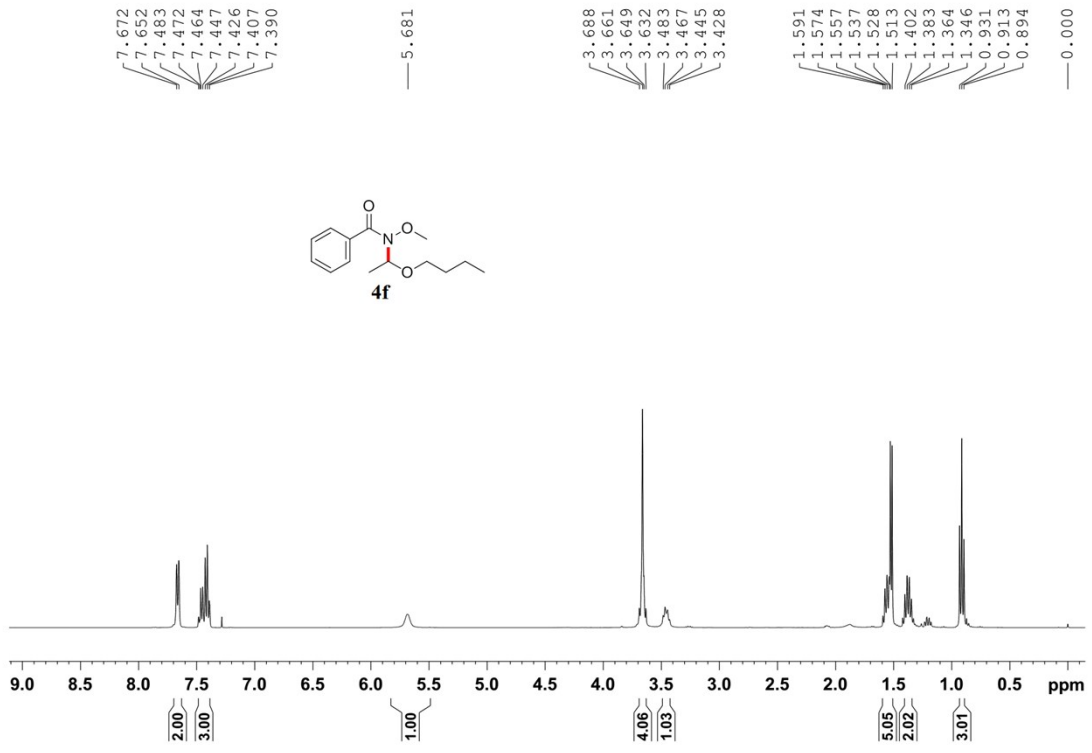
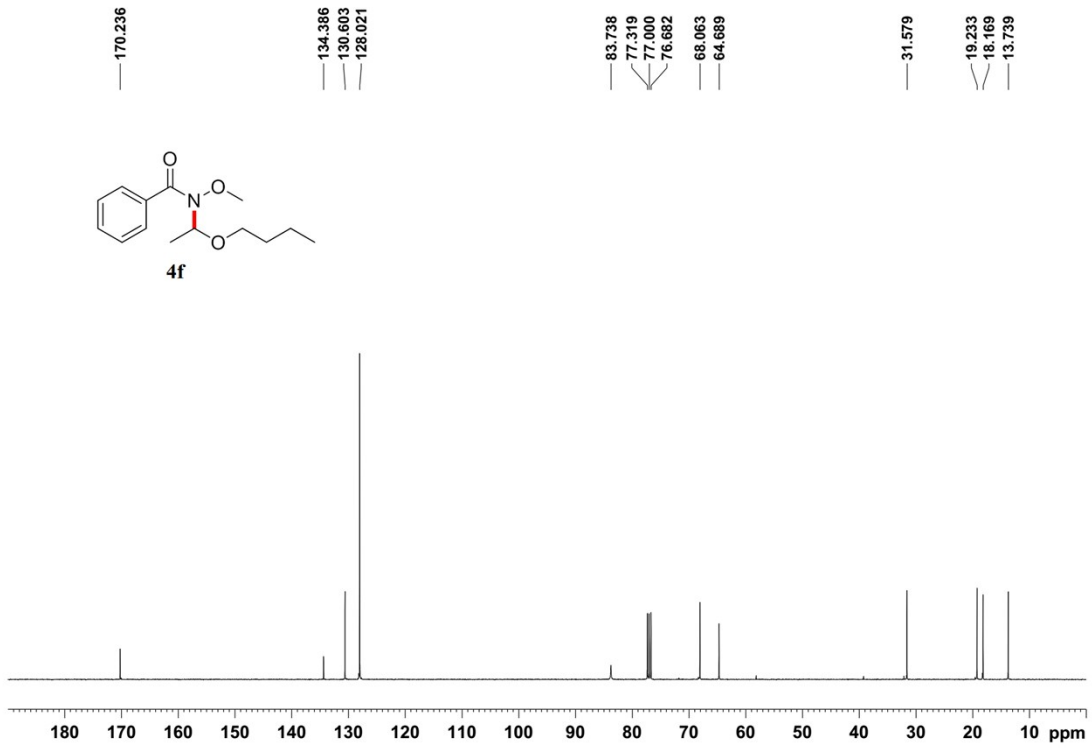
134.310
130.600
128.000
83.694
77.318
77.000
76.682
69.874
64.676
22.677
18.139
10.465
4e
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


7.672
7.652
7.483
7.472
7.464
7.447
7.426
7.407
7.390
5.681
3.688
3.661
3.649
3.632
3.483
3.467
3.445
3.428
1.591
1.574
1.557
1.537
1.528
1.513
1.402
1.383
1.364
1.346
0.931
0.913
0.894
0.000
4f
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 ppm
2.00
3.00
1.00
4.06
1.03
5.05
2.02
3.01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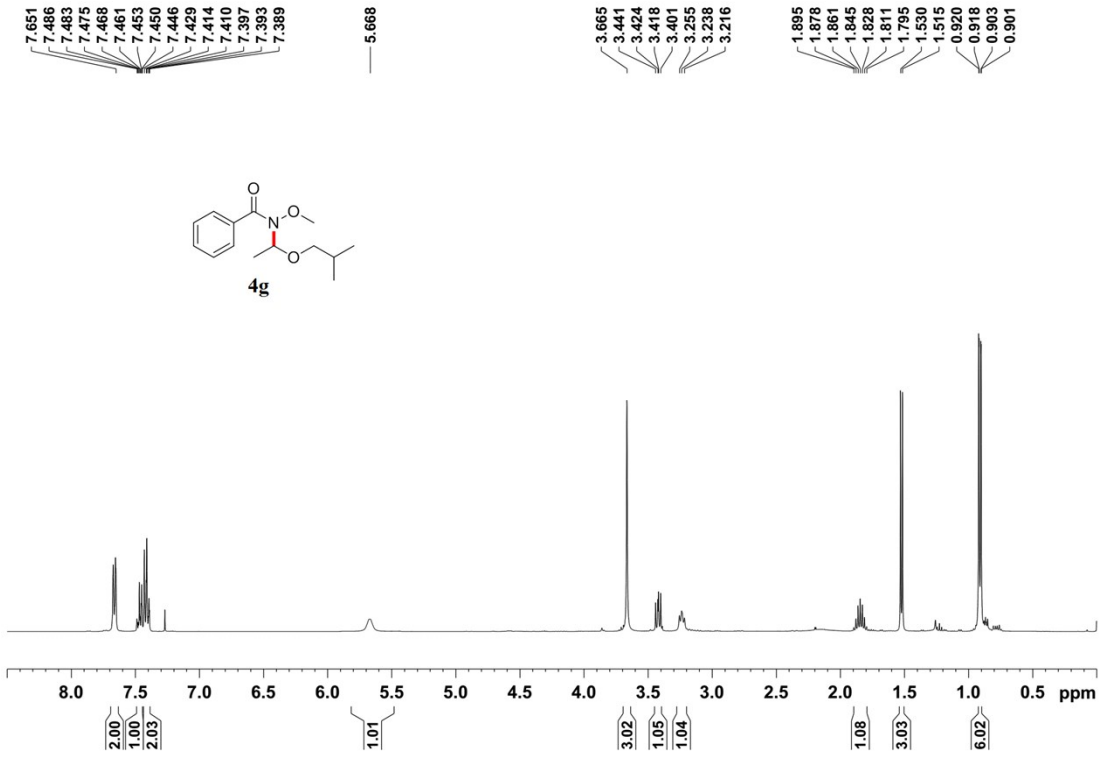
134.386
130.603
128.021
83.738
77.319
77.000
76.682
68.063
64.689
31.579
19.233
18.169
13.739
4f
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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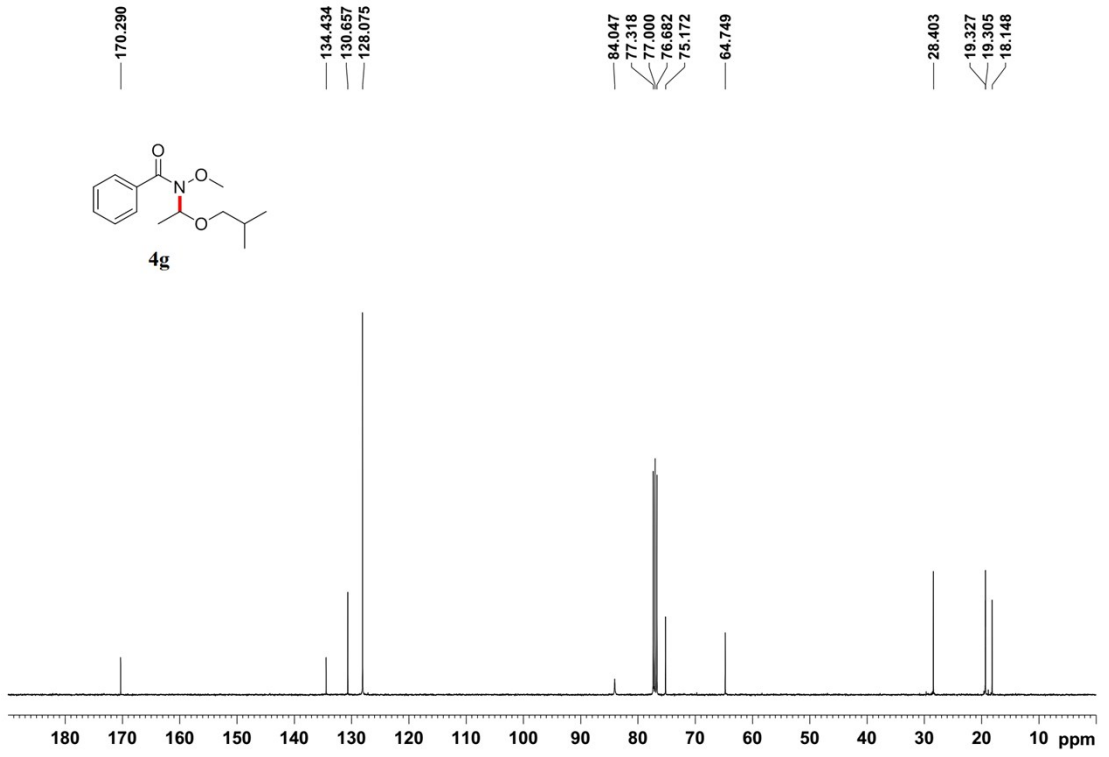
7.486
7.483
7.475
7.468
7.461
7.453
7.450
7.446
7.429
7.414
7.410
7.397
7.393
7.389
5.668
3.665
3.441
3.424
3.418
3.401
3.255
3.238
3.216
1.895
1.878
1.861
1.845
1.828
1.811
1.795
1.530
1.515
0.920
0.918
0.903
0.901
4g
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.00
1.00
2.03
1.01
3.02
1.05
1.04
1.08
3.03
6.02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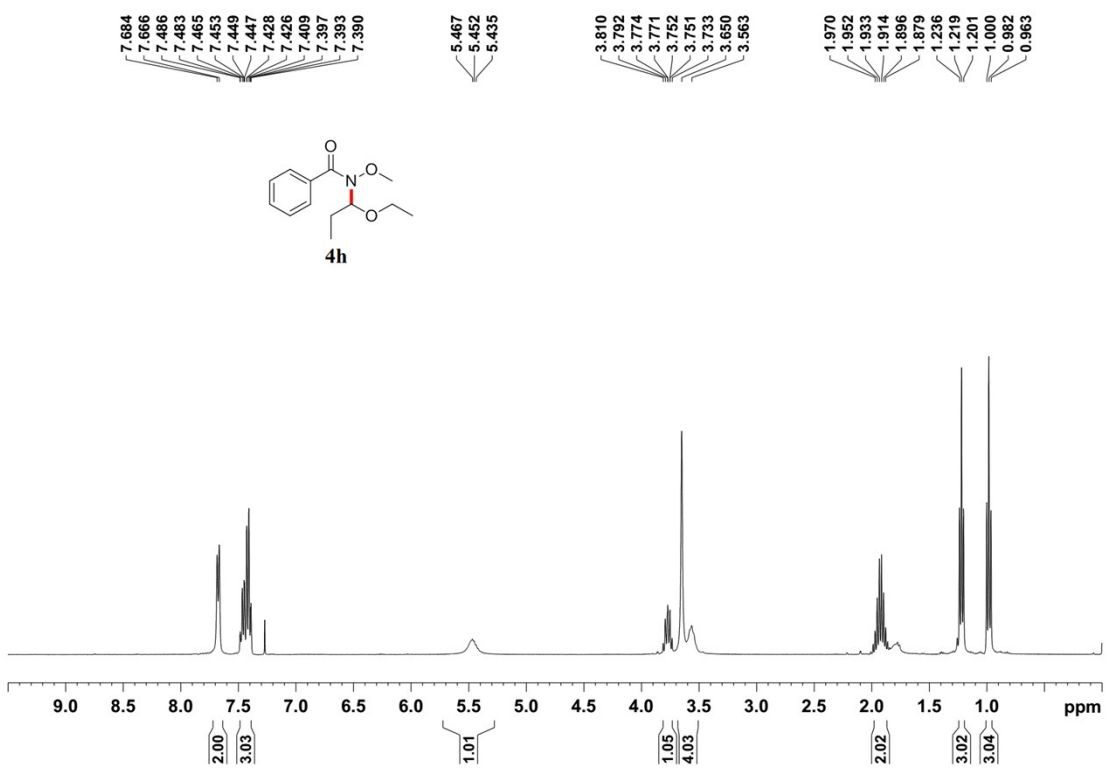
77.000
76.682
75.172
64.749
28.403
19.327
19.305
18.148
4g
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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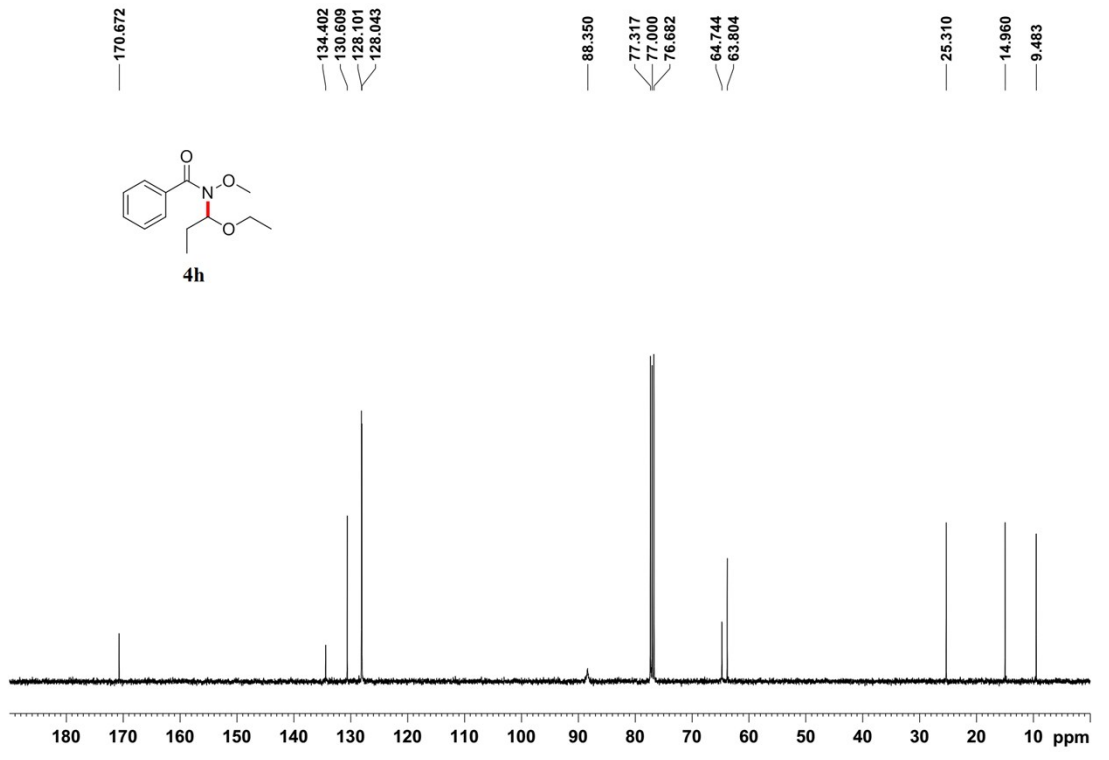
7.486
7.483
7.465
7.453
7.449
7.447
7.428
7.426
7.409
7.397
7.393
7.390
5.467
5.452
5.435
3.810
3.792
3.774
3.771
3.752
3.751
3.733
3.650
3.563
1.970
1.952
1.933
1.914
1.896
1.879
1.236
1.219
1.201
1.000
0.982
0.963
4h
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
ppm
2.00
3.03
1.01
1.05
4.03
2.02
3.02
3.04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130.609
128.101
128.043
88.350
77.317
77.000
76.682
64.744
63.804
25.310
14.960
9.483
4h
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm