Supporting Information

The Protecting Group Enabled *para*-Selective C-H Benzylation of Anilide via Iron(II) Catalysis: A Convenient Approach for the Synthesis of Triarylmethanes

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Reagents

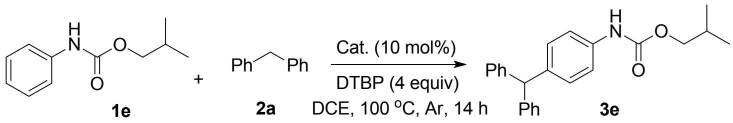
Unless otherwise noted, all raw materials and solvents were purchased from commercial suppliers and used without further purification. Thin layer chromatograms (TLC) was visualized via UV with a wavelength of 254/365nm. Column chromatography purifications were performed using 200-300 mesh silica gel.

Instruments

NMR spectra were recorded on Varian Inova-400 MHz, Inova-300 MHz, Bruker DRX-400 or Bruker DRX-500 instruments. Spectra were recorded in $CDCl_3$ solutions referenced to TMS or solvent residual peak. High Resolution Mass Spectra were Multiplicities are recorded as: s = singlet, d = doublet, dd = doublet of doublets, m = multiplet. HRMS analysis were carried out using TOF-MS instrument with EI source.

Optimization of reaction conditions

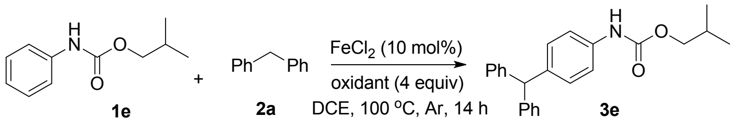
Table S1. Screening of catalyst[a]



Entry	Catalyst	Isolated Yield(%)
1	$PdCl_2$	30
2	$CuCl_2$	15
3	$InCl_3$	55
4	$Zr(Cp^*)Cl_2$	52
5	$FeCl_2$	84
6	AgOTf	67
7	$FeCl_3$	54
8	$FeBr_2$	57
9	$Fe(OAc)_2$	62
10	$Fe_2(CO)_9$	35
11	Ferrocene	48
12[b]	$FeCl_2$	52

[a]Reaction conditions: **1e** (0.2 mmol), **2a** (1 mmol), catalyst (10 mol%), DTBP (0.8 mmol), in DCE (1.5 mL) at 100 °C for 14 h under argon in a sealed tube. [b]5 mol% of $FeCl_2$.

Table S2. Screening of oxidant[a]

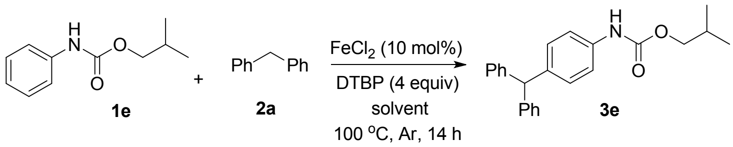


Entry	Oxidant	Isolated Yield(%)
1	DDQ	47
2	$K_2S_2O_8$	33
3	DTBP	84

4	TBHP	65
5	$Cu(OAc)_2$	-
6	$PhI(OAc)_2$	-

[a]Reaction conditions: **1e** (0.2 mmol), **2a** (1 mmol), $FeCl_2$ (10 mol%), oxidant (0.8 mmol), in DCE (1.5 mL) at 100 °C for 14 h under argon in a sealed tube.

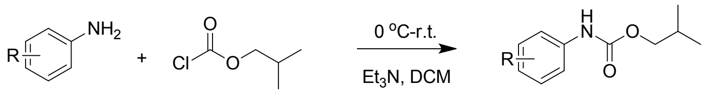
Table S3. Screening of solvent[a]



Entry	Solvent	Isolated Yield(%)
1	DMF	-
2	Dioxane	-
3	MeOH	-
4	HFIP	-
5	DCE	84
6	DCM	63
7	Toluene	-
8	Cyclohexane	-

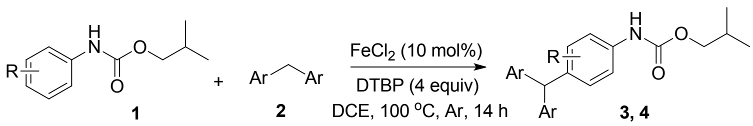
[a]Reaction conditions: **1e** (0.2 mmol), **2a** (1 mmol), $FeCl_2$ (10 mol%), DTBP (0.8 mmol), in solvent (1.5 mL) at 100 °C for 14 h under argon in a sealed tube.

General procedure for the preparation of isobutyl phenyl carbamate



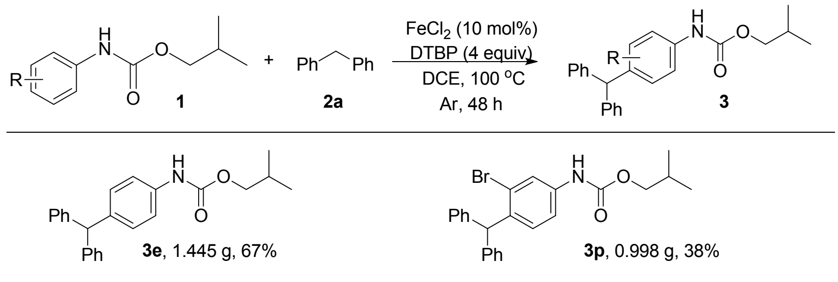
A solution of isobutyl chloroformate (2.2 mL, 1.7 equiv) in 20 mL of DCM was cooled to 0 °C, and a solution of aniline (10 mmol) and triethylamine (1.8 mL, 1.3 equiv) in 10 mL of DCM was added dropwise. The mixture was warmed to room temperature and stirred overnight. The mixture was extracted with $NaHCO_3$ saturated solution (20 mL x 3), dried over anhydrous Na_2SO_4 and concentrated in vacuo. The residue was purified by column chromatography on silica gel to give the corresponding product as a white solid with >90% yield.

General procedure for the *para*-selective benzylation



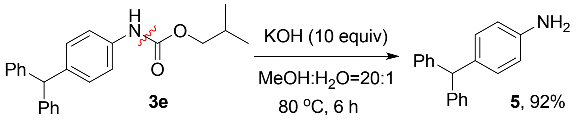
A mixture of **1** (0.2 mmol), **2** (1.0 mmol), $FeCl_2$ (2.5 mg, 10 mol%), DTBP (0.8 mmol, 4 equiv) and DCE (1.5 mL) in a 15 mL sealed glass vial was heated with oil bath at 100 °C under argon with vigorous stirring for 14 hours. The reaction mixture cooled to room temperature and concentrated in vacuo. The resulting residue was purified by column chromatography on silica gel (EA/PE = 1:100 to 1:80) to give the product **3** or **4**.

Gram-scale reaction of 3e and 3p



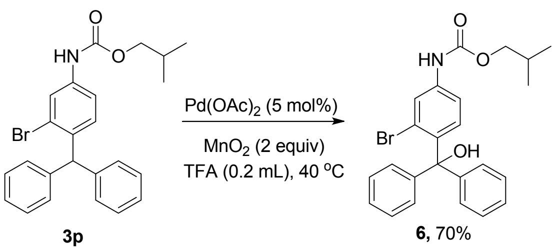
A mixture of **1** (6 mmol), **2a** (12 mmol), $FeCl_2$ (76.0 mg, 10 mol%), DTBP (24 mmol, 4 equiv) and DCE (35 mL) in a 100 mL round bottom flask was heated at 100 °C under argon with vigorous stirring for 48 hours. The reaction mixture cooled to room temperature and concentrated in vacuo. The resulting residue was purified by column chromatography on silica gel (EA/PE = 1:100 to 1:80) to give the product.

Removal of the protecting group



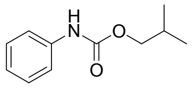
A mixture of **3e** (0.3 mmol), KOH (168.3 mg, 3 mmol), MeOH (2.0 mL) and H_2O (0.2 mL) in a 15 mL sealed glass vial was heated at 80 °C stirring for 6 hours. The reaction mixture cooled to room temperature, the mixture was diluted with H_2O, and adjusted to pH=8 with 1M HCl. The mixture was extracted with ethyl acetate, and dried over anhydrous Na_2SO_4. Evaporate the residual solvent to afford **5** as a white solid in 92% yield.

Synthesis of 6



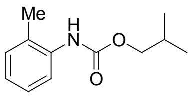
A mixture of **3p** (0.3 mmol), manganese dioxide (52.2 mg, 0.6 mmol), palladium diacetate (3.4 mg, 5 mol%), and trifluoroacetic acid (0.2 mL) was stirred at 40 °C for 24 hours. After being cooled to room temperature, the mixture was diluted with ethyl acetate (12 mL), and washed with water, saturated aqueous sodium bicarbonate, and brine. The organic layer was dried over anhydrous Na_2SO_4 and concentrated. The resulting residue was purified by column chromatography on silica gel (EA/PE = 1:10) to give the product **6** as white solid in 70% yield.

Spectroscopic data of compounds



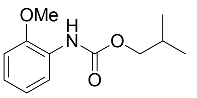
1e

White solid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (d, *J* = 7.8 Hz, 2H), 7.32 – 7.28 (m, 2H), 7.07 – 7.04 (m, 1H), 6.78 (br, s, 1H), 3.96 (d, *J* = 6.7 Hz, 2H), 2.03 – 1.93 (m, 1H), 0.97 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.9, 138.1, 129.1, 123.4, 118.8, 71.4, 28.1, 19.2. HRMS data for the desired product were in agreement with the previously reported literature data[1].



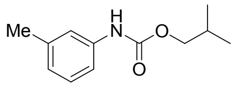
1j

White solid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 (s, 1H), 7.23 – 7.15 (m, 2H), 7.04 – 7.01 (m, 1H), 6.38 (br, s, 1H), 3.96 (d, *J* = 6.7 Hz, 2H), 2.26 (s, 3H), 2.04 – 1.94 (m, 1H), 0.97 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.2, 136.1, 130.5, 127.0, 124.2, 121.3, 71.6, 28.1, 19.2, 17.8. HRMS data for the desired product were in agreement with the previously reported literature data[1].



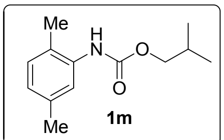
1k

White solid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09 (br, s, 1H), 7.23 (s, 1H), 7.01 – 6.93 (m, 2H), 6.85 (dd, *J* = 7.5, 1.9 Hz, 1H), 3.95 (d, *J* = 6.7 Hz, 2H), 3.86 (s, 3H), 2.04 – 1.94 (m, 1H), 0.97 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.8, 147.6, 127.8, 122.7, 121.2, 118.2, 110.0, 71.4, 55.7, 28.1, 19.2. HRMS Calcd for $C_{12}H_{17}NO_3$ [M+Na$^+$]: 246.1106; Found: 246.1104.



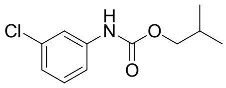
1l

White solid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (s, 1H), 7.21 – 7.17 (m, 2H), 6.87 (d, *J* = 6.6 Hz, 1H), 6.63 (br, s, 1H), 3.95 (d, *J* = 6.7 Hz, 2H), 2.33 (s, 3H), 2.03 – 1.93 (m, 1H), 0.97 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.9, 139.1, 138.0, 129.0, 124.3, 119.4, 115.9, 71.4, 28.1, 21.6, 19.2. HRMS Calcd for $C_{12}H_{17}NO_2$ [M+Na$^+$]: 230.1157; Found: 230.1159.



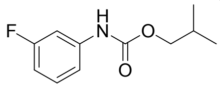
1m

White solid; 1H NMR (400 MHz, $CDCl_3$) δ 7.62 (s, 1H), 7.04 (d, J = 7.7 Hz, 1H), 6.84 (d, J = 7.5 Hz, 1H), 6.33 (br, s, 1H), 3.95 (d, J = 6.7 Hz, 2H), 2.32 (s, 3H), 2.22 (s, 3H), 2.04 – 1.94 (m, 1H), 0.97 (d, J = 6.7 Hz, 6H). 13C NMR (101 MHz, CDCl3) δ 156.3, 154.3, 136.7, 135.8, 130.2, 125.0, 122.0, 71.5, 28.1, 21.3, 19.2, 17.3. HRMS Calcd for $C_{13}H_{19}NO_2$ [M+H$^+$]: 222.1494; Found: 222.1497.



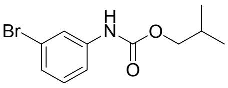
1n

White solid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 (br, s, 1H), 7.25 – 7.17 (m, 2H), 7.02 – 6.99 (m, 2H), 3.95 (d, J = 6.6 Hz, 2H), 2.01 – 1.91 (m, 1H), 0.95 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.7, 139.4, 134.8, 130.0, 123.4, 118.8, 116.7, 71.7, 28.0, 19.1. HRMS Calcd for $C_{11}H_{14}ClNO_2$ [M+Na$^+$]: 250.0611; Found: 250.0607.



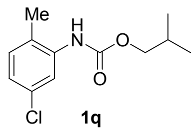
1o

White solid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (d, J = 11.0 Hz, 1H), 7.25 – 7.19 (m, 1H), 7.03 (d, J = 8.1 Hz, 1H), 6.81 (br, s, 1H), 6.77 – 6.72 (m, 1H), 3.96 (d, J = 6.7 Hz, 2H), 2.02 – 1.92 (m, 1H), 0.96 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 163.3 (J_{C-F} = 244.4 Hz), 153.6, 139.7 (J_{C-F} = 10.9 Hz), 130.2 (J_{C-F} = 9.5 Hz), 113.9, 110.0 (J_{C-F} = 21.4 Hz), 106.1 (J_{C-F} = 27.9 Hz), 71.7, 28.0, 19.1. ^{19}F NMR (376 MHz, $CDCl_3$) δ -111.6. HRMS Calcd for $C_{11}H_{14}FNO_2$ [M+Na$^+$]: 234.0906; Found: 234.0908.



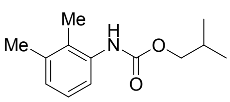
1p

White solid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (br, s, 1H), 7.30 (d, J = 7.3 Hz, 1H), 7.23 (s, 1H), 7.15 – 7.08 (m, 2H), 3.93 (d, J = 6.7 Hz, 2H), 1.99 – 1.89 (m, 1H), 0.93 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.6, 139.5, 130.4, 126.4, 122.8, 121.7, 117.2, 71.7, 28.0, 19.2. HRMS Calcd for $C_{11}H_{14}BrNO_2$ [M+Na$^+$]: 294.0106; Found: 294.0110.



1q

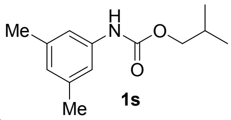
White solid;^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (s, 1H), 7.06 (d, J = 8.1 Hz, 1H), 6.97 (dd, J = 8.1, 1.8 Hz, 1H), 6.40 (br, s, 1H), 3.96 (d, J = 6.7 Hz, 2H), 2.21 (s, 3H), 2.04 – 1.94 (m, 1H), 0.97 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.8, 145.0, 137.1, 132.4, 131.3, 123.8, 120.7, 71.8, 28.1, 19.2, 17.3. HRMS Calcd for $C_{12}H_{16}ClNO_2$ [M+Na$^+$]: 264.0767; Found: 264.0763.



1r

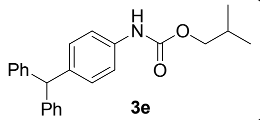
White solid; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (s, 1H), 7.14 – 7.10 (m, 1H), 6.99 (d, J = 7.5 Hz, 1H), 6.37 (br, s, 1H), 3.97 (d, J = 6.7 Hz, 2H), 2.32 (s, 3H), 2.19 (s, 3H), 2.05 – 1.95 (m, 1H), 0.99 (d, J = 6.7 Hz, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 156.3, 154.6, 137.4, 135.7, 126.6, 126.0, 120.5, 71.5, 28.1, 20.7, 19.2, 13.6. HRMS Calcd for $C_{13}H_{19}NO_2$ [M+Na$^+$]: 244.1313; Found: 244.1315.



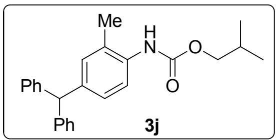
1s

White solid; ^1H NMR (400 MHz, $CDCl_3$) δ 7.02 (s, 2H), 6.70 (s, 1H), 6.56 (br, s, 1H), 3.94 (d, *J* = 6.6 Hz, 2H), 2.29 (s, 6H), 2.02 – 1.92 (m, 1H), 0.96 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.9, 138.8, 137.9, 125.2, 116.5, 71.4, 28.1, 21.5, 19.2. HRMS Calcd for $C_{13}H_{19}NO_2$ [M+Na$^+$]: 244.1313; Found: 244.1312.



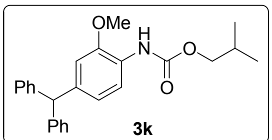
3e

Pale yellow oil, 84%, 60.4 mg; ^1H NMR (400 MHz, $CDCl_3$) δ 7.32 – 7.27 (m, 6H), 7.23 – 7.21 (m, 2H), 7.12 (d, *J* = 7.1 Hz, 4H), 7.06 (d, *J* = 8.5 Hz, 2H), 6.63 (br, s, 1H), 5.52 (s, 1H), 3.95 (d, *J* = 6.7 Hz, 2H), 2.02 – 1.92 (m, 1H), 0.97 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 144.0, 139.0, 136.3, 130.1, 129.5, 129.0, 128.4, 126.4, 118.8, 71.5, 56.3, 28.1, 19.2. HRMS Calcd for $C_{24}H_{25}NO_2$ [M+Na$^+$]: 382.1783; Found: 382.1789.



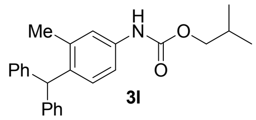
3j

Pale yellow oil, 92%, 68.7 mg; ^1H NMR (400 MHz, $CDCl_3$) δ 7.69 (s, 1H), 7.31 – 7.27 (m, 4H), 7.23 – 7.20 (m, 2H), 7.12 (d, *J* = 7.2 Hz, 4H), 6.97 – 6.94 (m, 2H), 6.35 (br, s, 1H), 5.49 (s, 1H), 3.96 (d, *J* = 6.7 Hz, 2H), 2.20 (s, 3H), 2.04 – 1.94 (m, 1H), 0.97 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.3, 144.0, 139.7, 134.3, 131.5, 129.5, 129.0, 128.6, 128.4, 128.0, 126.4, 71.6, 56.4, 28.1, 19.2, 17.9. HRMS Calcd for $C_{25}H_{27}NO_2$ [M+Na$^+$]: 396.1939; Found: 396.1955.



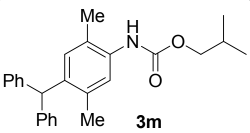
3k

Pale yellow oil, 58%, 45.2 mg; ^1H NMR (400 MHz, $CDCl_3$) δ 7.89 (s, 1H), 7.23 – 7.19 (m, 4H), 7.15 – 7.12 (m, 2H), 7.07 – 7.03 (m, 5H), 6.61 (d, *J* = 8.3 Hz, 1H), 6.56 (br, s, 1H), 5.42 (s, 1H), 3.87 (d, *J* = 6.7 Hz, 2H), 3.67 (s, 3H), 1.95 – 1.85 (m, 1H), 0.89 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.9, 147.7, 144.1, 138.6, 129.5, 128.4, 126.4, 126.1, 122.2, 118.0, 111.5, 71.4, 56.7, 55.7, 28.1, 19.2. HRMS Calcd for $C_{25}H_{27}NO_3$ [M+Na$^+$]: 412.1889; Found: 412.1908.



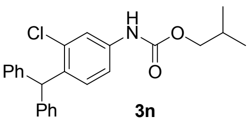
3l

Pale yellow oil, 79%, 59.0 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.27 (m, 3H), 7.26 (s, 1H), 7.23 – 7.19 (m, 3H), 7.08 – 7.04 (m, 5H), 6.73 (d, J = 8.4 Hz, 1H), 6.55 (br, s, 1H), 5.62 (s, 1H), 3.94 (d, J = 6.7 Hz, 2H), 2.19 (s, 3H), 2.02 – 1.92 (m, 1H), 0.96 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.9, 143.5, 137.7, 136.2, 130.2, 129.7, 128.4, 126.4, 120.8, 116.1, 71.4, 53.2, 28.1, 20.2, 19.2. HRMS Calcd for $C_{25}H_{27}NO_2$ [M+Na$^+$]: 396.1939; Found: 396.1948.



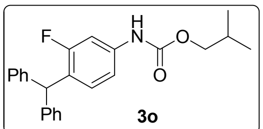
3m

Pale yellow oil, 66%, 51.2 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (s, 1H), 7.20 – 7.15 (m, 4H), 7.13 – 7.09 (m, 2H), 6.96 (d, J = 7.1 Hz, 4H), 6.49 (s, 1H), 6.23 (br, s, 1H), 5.52 (s, 1H), 3.86 (d, J = 6.7 Hz, 2H), 2.09 (s, 3H), 2.01 (s, 3H), 1.94 – 1.84 (m, 1H), 0.88 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.2, 144.0, 139.7, 134.3, 131.5, 129.5, 128.4, 128.0, 126.4, 71.6, 56.4, 28.1, 19.2, 18.0. HRMS Calcd for $C_{26}H_{29}NO_2$ [M+Na$^+$]: 410.2096; Found: 410.2103.



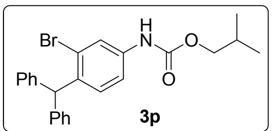
3n

Pale yellow oil, 57%, 44.9 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (s, 1H), 7.31 – 7.27 (m, 4H), 7.24 – 7.21 (m, 2H), 7.15 – 7.12 (m, 1H), 7.08 – 7.06 (m, 4H), 6.86 (d, J = 8.5 Hz, 1H), 6.65 (br, s, 1H), 5.90 (s, 1H), 3.95 (d, J = 6.6 Hz, 2H), 2.02 – 1.93 (m, 1H), 0.96 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.6, 142.8, 137.5, 136.5, 135.0, 131.5, 129.6, 128.5, 126.6, 119.7, 116.8, 71.7, 53.0, 28.1, 19.2. HRMS Calcd for $C_{24}H_{24}ClNO_2$ [M+Na$^+$]: 416.1393; Found: 416.1383.



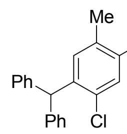
3o

Pale yellow oil, 54%, 40.8 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 – 7.27 (m, 5H), 7.25 – 7.21 (m, 2H), 7.12 – 7.10 (m, 4H), 6.94 – 6.92 (m, 1H), 6.86 – 6.82 (m, 1H), 6.68 (br, s, 1H), 5.77 (s, 1H), 3.95 (d, J = 6.7 Hz, 2H), 2.02 – 1.93 (m, 1H), 0.96 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 160.9 (J_{C-F} = 246.0 Hz), 153.6, 142.8, 138.1 (J_{C-F} = 11.2 Hz), 131.1 (J_{C-F} = 5.4 Hz), 129.3, 128.5, 126.6, 125.9 (J_{C-F} = 15.0 Hz), 113.8, 106.2 (J_{C-F} = 26.4 Hz), 71.7, 49.1 (J_{C-F} = 2.6 Hz), 28.1, 19.2. ^{19}F NMR (376 MHz, $CDCl_3$) δ -114.3. HRMS Calcd for $C_{24}H_{24}FNO_2$ [M+Na$^+$]: 400.1689; Found: 400.1703.



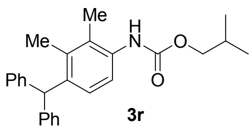
3p

Pale yellow oil, 51%, 44.7 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (s, 1H), 7.31 – 7.27 (m, 4H), 7.25 – 7.19 (m, 3H), 7.07 (d, *J* = 7.1 Hz, 4H), 6.86 (d, *J* = 8.5 Hz, 1H), 6.62 (br, s, 1H), 5.89 (s, 1H), 3.95 (d, *J* = 6.6 Hz, 2H), 2.02 – 1.92 (m, 1H), 0.96 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.6, 142.8, 138.2, 137.5, 131.5, 129.7, 128.5, 126.6, 125.7, 122.9, 117.5, 71.7, 55.5, 28.1, 19.2. HRMS Calcd for $C_{24}H_{24}BrNO_2$ [M+Na$^+$]: 460.0888; Found: 460.0900.



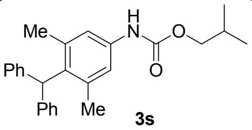
3q

Pale yellow oil, 52%, 42.4 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.30 – 7.26 (m, 4H), 7.24 – 7.20 (m, 2H), 7.06 (d, *J* = 7.2 Hz, 4H), 6.69 (s, 1H), 6.33 (br, s, 1H), 5.90 (s, 1H), 3.96 (d, *J* = 6.7 Hz, 2H), 2.17 (s, 3H), 2.03 – 1.93 (m, 1H), 0.97 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.9, 142.9, 136.7, 135.4, 132.6, 132.5, 129.6, 128.4, 126.6, 71.8, 52.9, 28.1, 19.2, 17.6. HRMS Calcd for $C_{25}H_{26}ClNO_2$ [M+Na$^+$]: 430.1550; Found: 430.1541.



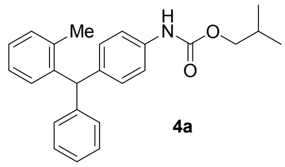
3r

Pale yellow oil, 69%, 53.5 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 – 7.18 (m, 6H), 7.15 – 7.11 (m, 2H), 6.97 (d, *J* = 7.2 Hz, 3H), 6.57 (d, *J* = 8.5 Hz, 1H), 6.24 (br, s, 1H), 5.63 (s, 1H), 3.86 (d, *J* = 6.7 Hz, 2H), 2.11 (s, 3H), 2.07 (s, 3H), 1.94 – 1.84 (m, 1H), 0.88 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.8, 143.8, 139.3, 136.0, 134.0, 129.8, 128.4, 127.9, 126.4, 122.2, 117.7, 71.5, 54.0, 28.1, 19.2, 16.4, 14.5. HRMS Calcd for $C_{26}H_{29}NO_2$ [M+Na$^+$]: 410.2096; Found: 410.2088.



3s

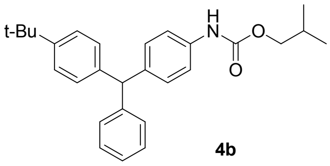
Pale yellow oil, 54%, 41.9 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 – 7.27 (m, 2H), 7.25 (s, 1H), 7.22 – 7.18 (m, 3H), 7.09 (d, *J* = 7.6 Hz, 6H), 6.50 (br, s, 1H), 5.98 (s, 1H), 3.95 (d, *J* = 6.6 Hz, 2H), 2.01 (s, 6H), 2.00 – 1.95 (m, 1H), 0.97 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.9, 142.4, 138.9, 136.3, 135.5, 129.4, 128.3, 126.1, 119.4, 71.4, 50.9, 28.2, 22.4, 19.2. HRMS Calcd for $C_{26}H_{29}NO_2$ [M+Na$^+$]: 410.2096; Found: 410.2107.



4a

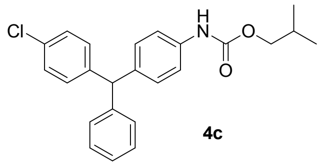
Pale yellow oil, 52%, 38.8 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.27 (m, 4H), 7.21 (d, *J* = 7.2 Hz, 1H), 7.15– 7.13 (m, 2H), 7.12 – 7.09 (m, 1H), 7.05 – 6.98 (m, 4H), 6.80 (d, *J* = 7.2 Hz, 1H), 6.56 (br, s, 1H), 5.62 (s, 1H), 3.94 (d, *J* = 6.6 Hz, 2H), 2.21 (s, 3H), 2.02 – 1.92 (m, 1H), 0.96 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101

MHz, $CDCl_3$) δ 153.9, 143.6, 142.4, 138.6, 136.7, 136.3, 130.5, 130.3, 129.7, 129.5, 128.4, 126.5, 126.4, 125.9, 118.7, 71.5, 53.0, 28.1, 20.0, 19.2. HRMS Calcd for $C_{25}H_{27}NO_2$ [M+Na$^+$]: 396.1939; Found: 396.1949.



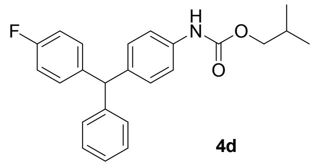
4b

Pale yellow oil, 73%, 60.7 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.28 (m, 5H), 7.22 – 7.18 (m, 2H), 7.12 (d, J = 7.4 Hz, 2H), 7.08 – 7.02 (m, 4H), 6.57 (br, s, 1H), 5.47 (s, 1H), 3.94 (d, J = 6.7 Hz, 2H), 2.02 – 1.92 (m, 1H), 1.30 (s, 9H), 0.96 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 149.2, 144.3, 140.9, 139.4, 136.2, 130.1, 129.5, 129.2, 129.0, 128.4, 126.3, 125.3, 118.7, 71.5, 55.9, 34.5, 31.5, 28.1, 19.2. HRMS Calcd for $C_{28}H_{33}NO_2$ [M+Na$^+$]: 438.2409; Found: 438.2397.



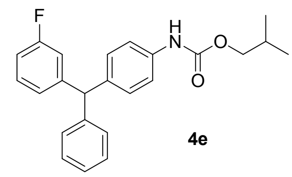
4c

Pale yellow oil, 48%, 37.8 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 – 7.20 (m, 3H), 7.18 – 7.13 (m, 4H), 6.99 (d, J = 7.2 Hz, 2H), 6.94 (dd, J = 8.4, 3.7 Hz, 4H), 6.55 (br, s, 1H), 5.39 (s, 1H), 3.86 (d, J = 6.7 Hz, 2H), 1.93 – 1.83 (m, 1H), 0.87 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.9, 143.5, 142.6, 138.5, 136.6, 132.3, 130.8, 130.0, 129.4, 128.6, 126.7, 118.8, 71.6, 55.7, 28.1, 19.2. HRMS Calcd for $C_{24}H_{24}ClNO_2$ [M+Na$^+$]: 416.1393; Found: 416.1387.



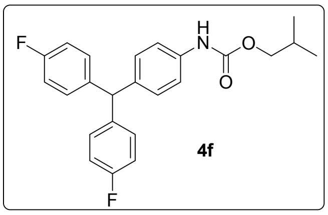
4d

Pale yellow oil, 61%, 46.0 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23 – 7.18 (m, 4H), 7.01 – 6.99 (m, 3H), 6.97 – 6.93 (m, 4H), 6.89 – 6.85 (m, 2H), 6.56 (br, s, 1H), 5.40 (s, 1H), 3.86 (d, J = 6.7 Hz, 2H), 1.93 – 1.83 (m, 1H), 0.87 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.5 ($J_{C\text{-}F}$ = 244.8 Hz), 153.9, 143.9, 139.8, 138.9, 136.5, 130.9 ($J_{C\text{-}F}$ = 7.8 Hz), 130.0, 129.4, 128.5, 126.6, 118.8, 115.2 ($J_{C\text{-}F}$ = 21.2 Hz), 71.5, 55.5, 28.1, 19.2. ^{19}F NMR (376 MHz, $CDCl_3$) δ -116.8. HRMS Calcd for $C_{24}H_{24}FNO_2$ [M+Na$^+$]: 400.1689; Found: 400.1705.

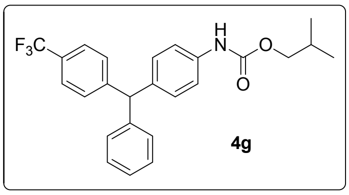


4e

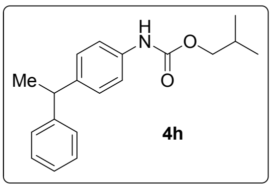
Pale yellow oil, 67%, 50.6 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.28 (m, 4H), 7.25 – 7.21 (m, 2H), 7.07 (dd, J = 22.4, 7.9 Hz, 4H), 6.93 – 6.89 (m, 2H), 6.80 (d, J = 10.1 Hz, 1H), 6.64 (br, s, 1H), 5.50 (s, 1H), 3.95 (d, J = 6.6 Hz, 2H), 2.02 – 1.92 (m, 1H) 0.97 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 163.0 ($J_{C\text{-}F}$ = 245.7 Hz), 153.89, 146.7 ($J_{C\text{-}F}$ = 6.8 Hz), 143.4, 138.4, 136.6, 130.1, 129.8 ($J_{C\text{-}F}$ = 8.2 Hz), 129.4, 128.6, 126.7, 125.2 ($J_{C\text{-}F}$ = 2.8 Hz), 118.8, 116.4 ($J_{C\text{-}F}$ = 21.7 Hz), 113.4 ($J_{C\text{-}F}$ = 21.1 Hz), 71.5, 56.0 ($J_{C\text{-}F}$ = 1.5 Hz), 28.1, 19.2. ^{19}F NMR (376 MHz, $CDCl_3$) δ -113.2. HRMS Calcd for $C_{24}H_{24}FNO_2$ [M+Na$^+$]: 400.1689; Found: 400.1796.



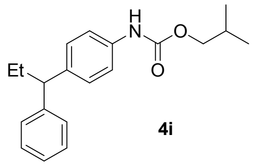
Pale yellow oil, 47%, 37.2 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (d, J = 8.1 Hz, 2H), 7.06 – 6.95 (m, 10H), 6.65 (br, s, 1H), 5.47 (s, 1H), 3.95 (d, J = 6.7 Hz, 2H), 2.02 – 1.92 (m, 1H), 0.96 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.6 ($J_{C\text{-}F}$ = 245.2 Hz), 153.9, 139.6 ($J_{C\text{-}F}$ = 3.3 Hz), 138.7, 136.6, 130.8 ($J_{C\text{-}F}$ = 7.9 Hz), 129.9, 118.8, 115.3 ($J_{C\text{-}F}$ = 21.2 Hz), 71.6, 54.8, 28.1, 19.2. ^{19}F NMR (376 MHz, $CDCl_3$) δ -116.6. HRMS Calcd for $C_{24}H_{23}F_2NO_2$ [M+Na$^+$]: 418.1595; Found: 418.1587.



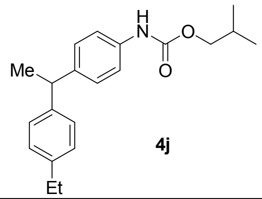
Pale yellow oil, 45%, 38.5 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, J = 8.2 Hz, 2H), 7.35 – 7.29 (m, 4H), 7.24 -7.22 (m, 3H), 7.09 (d, J = 7.2 Hz, 2H), 7.04 (d, J = 8.5 Hz, 2H), 6.66 (br, s, 1H), 5.56 (s, 1H), 3.95 (d, J = 6.7 Hz, 2H), 2.03 – 1.92 (m, 1H), 0.97 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.9, 148.2, 143.1, 138.0, 136.7, 130.1, 129.8, 129.4, 128.6, 126.8, 125.7, 125.4 ($J_{C\text{-}F}$ = 3.8 Hz), 118.9, 71.5, 56.1, 28.1, 19.2. ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.3. HRMS Calcd for $C_{25}H_{24}F_3NO_2$ [M+Na$^+$]: 450.1657; Found: 450.1652.



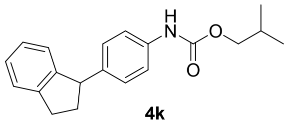
Pale yellow oil, 72%, 42.8 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.28 (m, 4H), 7.21 – 7.14 (m, 5H), 6.55 (br, s, 1H), 4.14 – 4.09 (m, 1H), 3.94 (d, J = 6.7 Hz, 2H), 2.01 – 1.91 (m, 1H), 1.61 (d, J = 7.2 Hz, 3H), 0.96 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.0, 146.6, 141.6, 136.0, 128.5, 128.3, 127.7, 126.1, 118.9, 71.5, 44.3, 28.1, 22.0, 19.2. HRMS Calcd for $C_{19}H_{23}NO_2$ [M+Na$^+$]: 320.1626; Found: 320.1635.



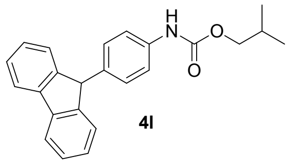
Pale yellow oil, 58%, 36.1 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 – 7.24 (m, 4H), 7.22 – 7.14 (m, 5H), 6.57 (br, s, 1H), 3.93 (d, J = 6.7 Hz, 2H), 3.76 – 3.72 (m, 1H), 2.07 – 2.00 (m, 2H), 1.99 – 1.90 (m, 1H), 0.95 (d, J = 6.7 Hz, 6H), 0.90 – 0.86 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.9, 145.4, 140.4, 136.0, 128.6, 128.5, 128.0, 126.1, 118.9, 71.4, 52.7, 28.7, 28.1, 19.2, 12.9. HRMS Calcd for $C_{20}H_{25}NO_2$ [M+Na$^+$]: 334.1783; Found: 334.1798.



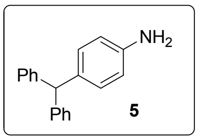
Pale yellow oil, 67%, 43.6 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (d, J = 8.0 Hz, 1H), 7.33 – 7.29 (m, 2H), 7.17 (d, J = 8.5 Hz, 2H), 7.13 (s, 3H), 6.60 (br, s, 1H), 4.12 – 4.07 (m, 1H), 3.95 (d, J = 6.8 Hz, 2H), 2.65 – 2.59 (m, 2H), 2.03 – 1.93 (m, 1H), 1.61 (d, J = 7.2 Hz, 3H), 1.25 – 1.21 (m, 3H), 0.97 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.0, 143.8, 142.0, 136.0, 129.2, 128.3, 127.9, 127.6, 123.4, 118.9, 71.4, 43.9, 28.5, 28.1, 22.1, 19.2, 15.7. HRMS Calcd for $C_{21}H_{27}NO_2$ [M+H$^+$]: 326.2120; Found: 326.2108.



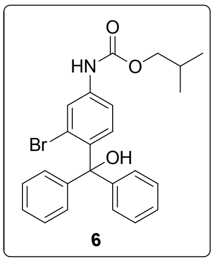
Pale yellow oil, 47%, 29.1 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 – 7.27 (m, 3H), 7.20 – 7.16 (m, 1H), 7.14 – 7.12 (m, 3H), 6.94 (d, J = 7.4 Hz, 1H), 6.55 (br, s, 1H), 4.32 – 4.28 (m, 1H), 3.95 (d, J = 6.6 Hz, 2H), 3.07 – 3.00 (m, 1H), 2.98 – 2.90 (m, 1H), 2.60 – 2.52 (m, 1H), 2.04 – 2.01 (m, 1H), 1.99 – 1.94 (m, 1H), 0.96 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 146.8, 144.2, 128.6, 126.5, 126.3, 124.8, 124.3, 71.3, 51.0, 36.6, 31.7, 27.9, 19.0. HRMS Calcd for $C_{20}H_{23}NO_2$ [M+Na$^+$]: 332.1626; Found: 332.1621.



Pale yellow oil, 42%, 30.0 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (d, J = 7.6 Hz, 2H), 7.40 – 7.37 (m, 3H), 7.32 – 7.28 (m, 5H), 7.04 (d, J = 8.5 Hz, 2H), 6.57 (br, s, 1H), 5.02 (s, 1H), 3.95 (d, J = 6.7 Hz, 2H), 2.02 – 1.92 (m, 1H), 0.96 (d, J = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.7, 147.9, 140.9, 136.7, 136.5, 128.9, 127.3, 125.3, 125.0, 119.8, 114.9, 71.3, 53.8, 27.9, 19.0. HRMS Calcd for $C_{24}H_{23}NO_2$ [M+Na$^+$]: 380.1626; Found: 332.1632.

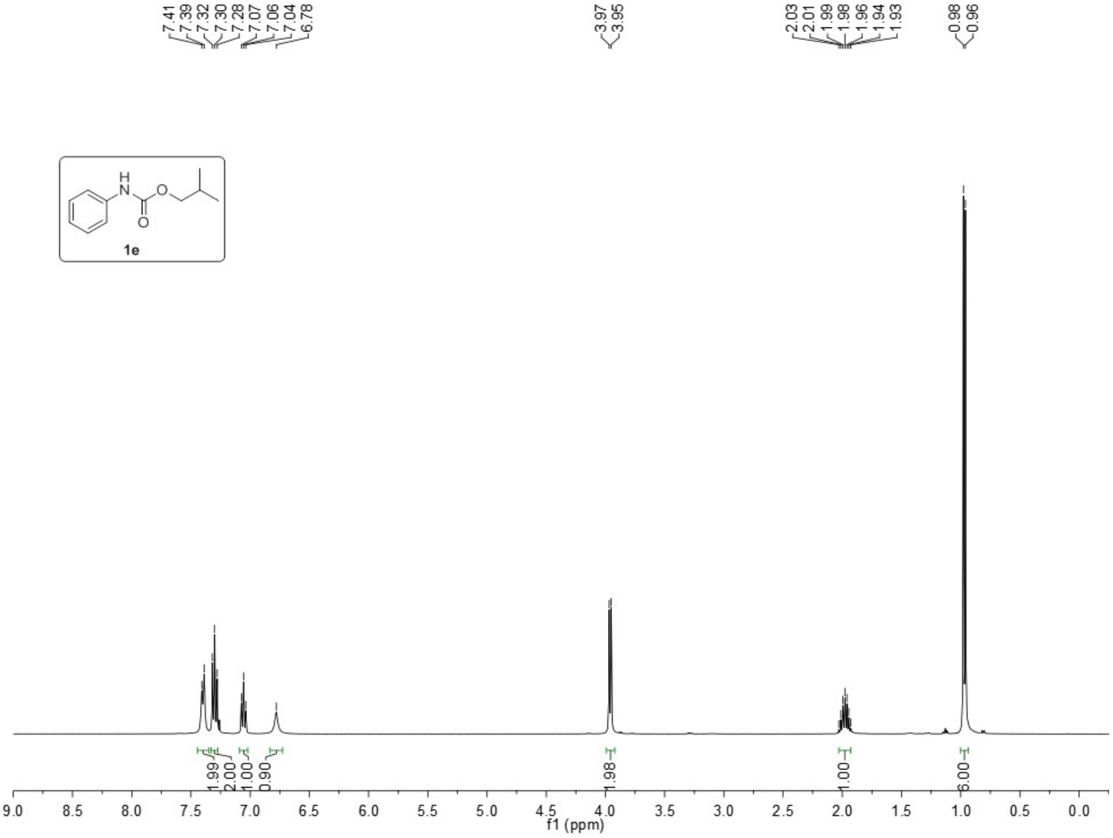


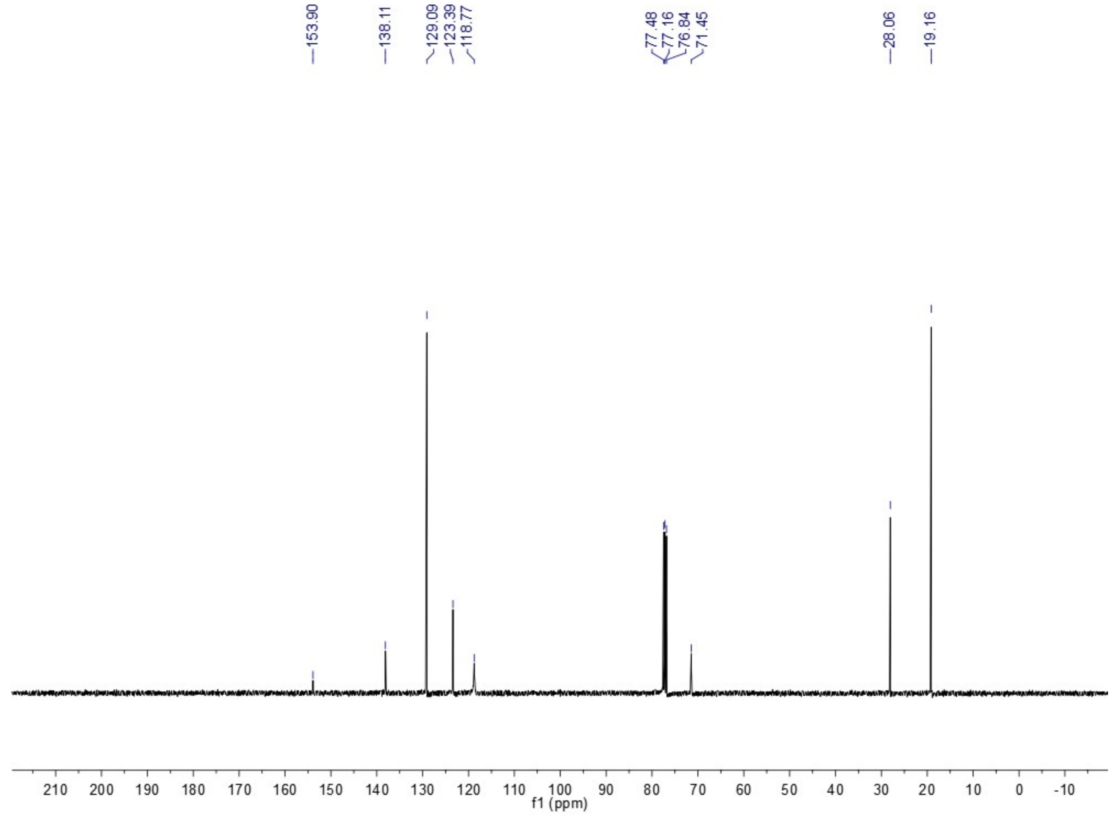
White solid, 92%, 71.6 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.26 (m, 4H), 7.22 – 7.18 (m, 2H), 7.12 (d, *J* = 7.4 Hz, 4H), 6.90 (d, *J* = 8.3 Hz, 2H), 6.62 (d, *J* = 8.4 Hz, 2H), 5.46 (s, 1H), 3.61 (br, s, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 144.7, 144.6, 134.2, 130.4, 129.5, 128.3, 126.2, 115.2, 56.2. HRMS Calcd for $C_{19}H_{17}N$ [$M+Na^+$]: 282.1259; Found: 282.1265.

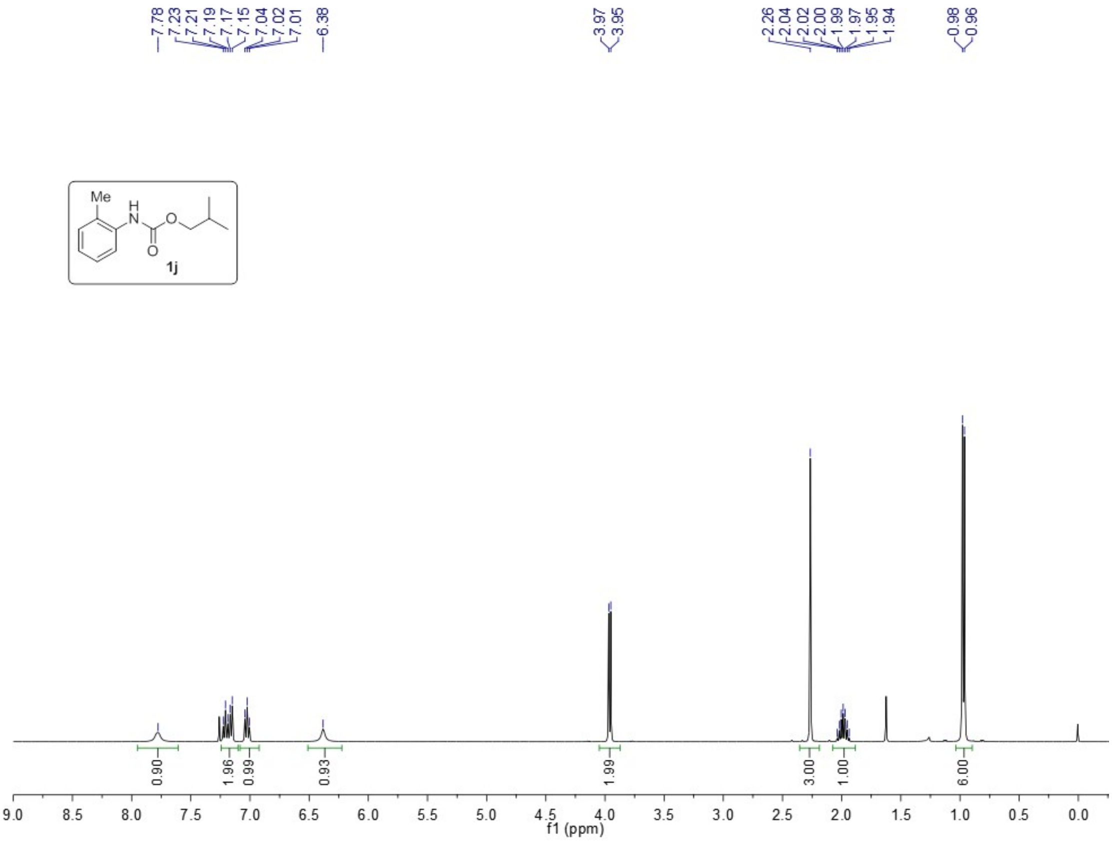


White solid, 70%, 95.4 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (s, 1H), 7.33 – 7.29 (m, 6H), 7.26 – 7.24 (m, 4H), 7.08 (d, *J* = 7.2 Hz, 1H), 6.70 (br s, 1H), 6.61 (d, *J* = 8.6 Hz, 1H), 4.45 (br, s, 1H), 3.95 (d, *J* = 6.6 Hz, 2H), 2.02 – 1.92 (m, 1H), 0.96 (d, *J* = 6.7 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.4, 145.8, 139.8, 138.5, 132.2, 128.1, 128.0, 127.4, 124.5, 123.3, 116.3, 82.9, 71.8, 28.0, 19.1. HRMS Calcd for $C_{24}H_{24}BrNO_3$ [$M+Na^+$]: 476.0837; Found: 476.0849.

^{1}H NMR and ^{13}C NMR spectra



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1.95
1.94
0.98
0.96
0.90
1.96
0.99
0.93
1.99
3.00
1.00
6.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
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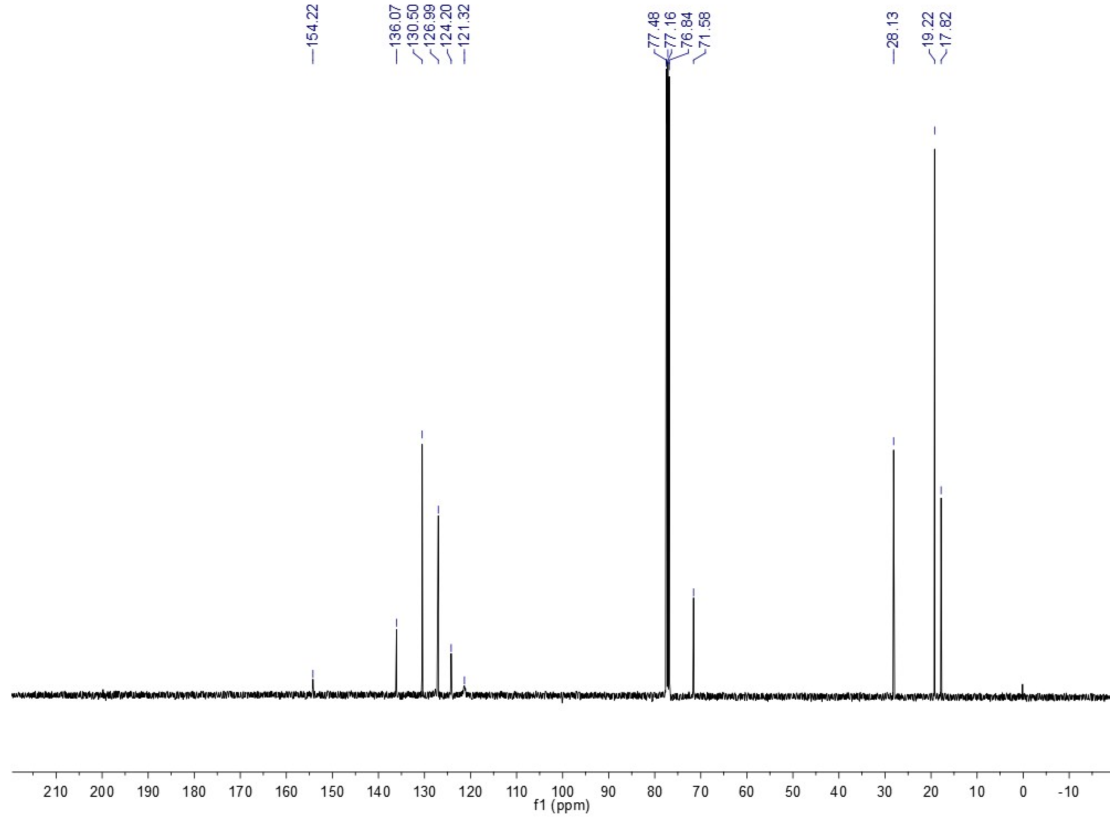
N
O
O
1j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17.82
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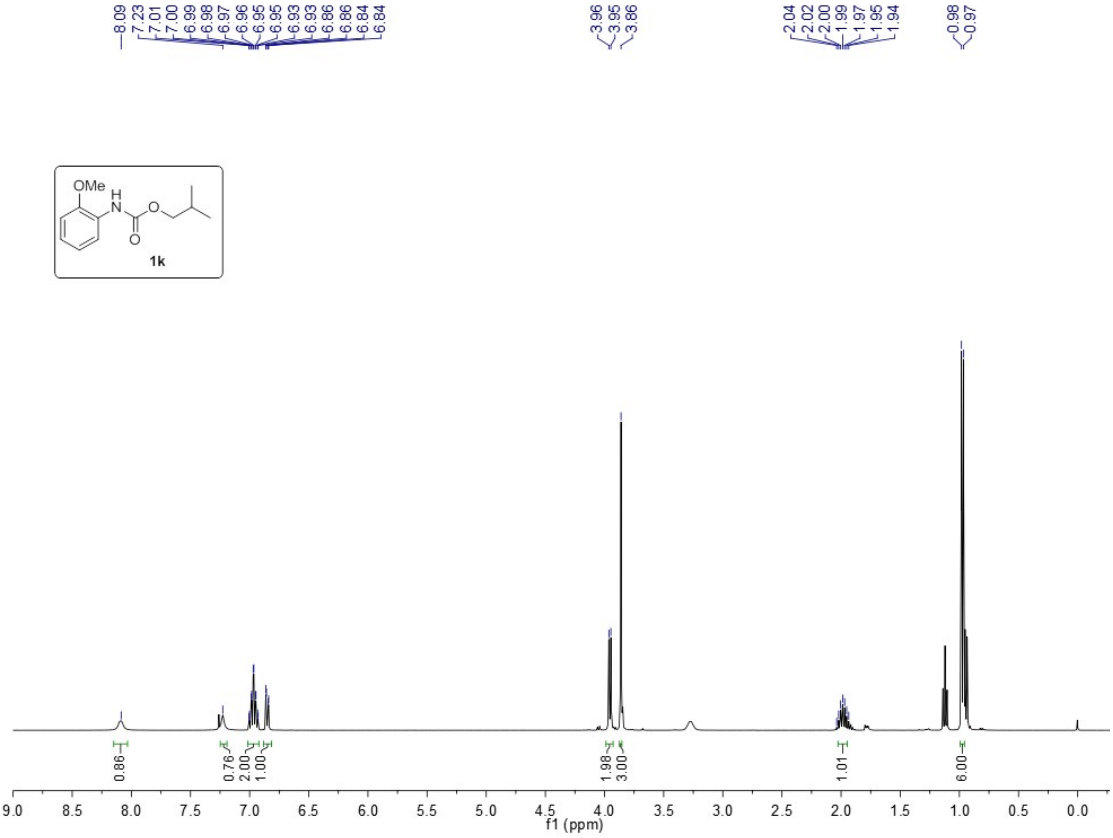
f1 (ppm)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6.84
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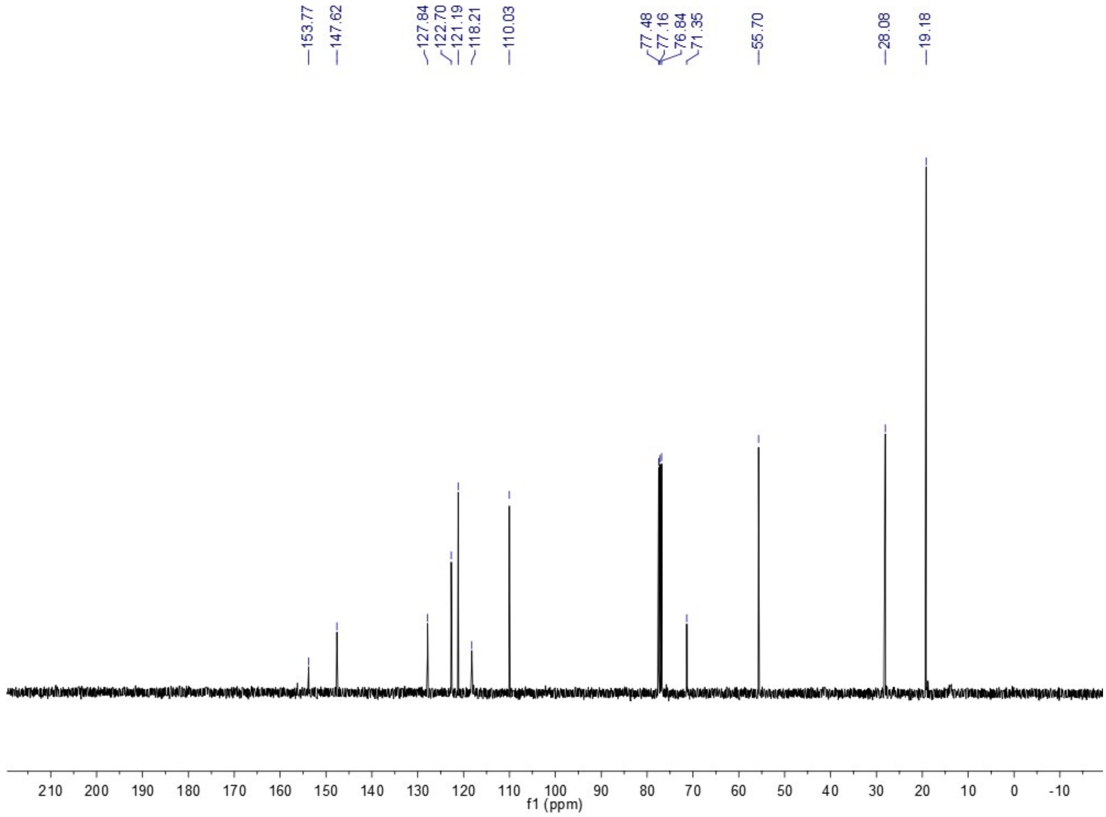
6.00
f1 (ppm)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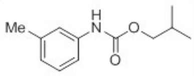
19.18
f1 (ppm)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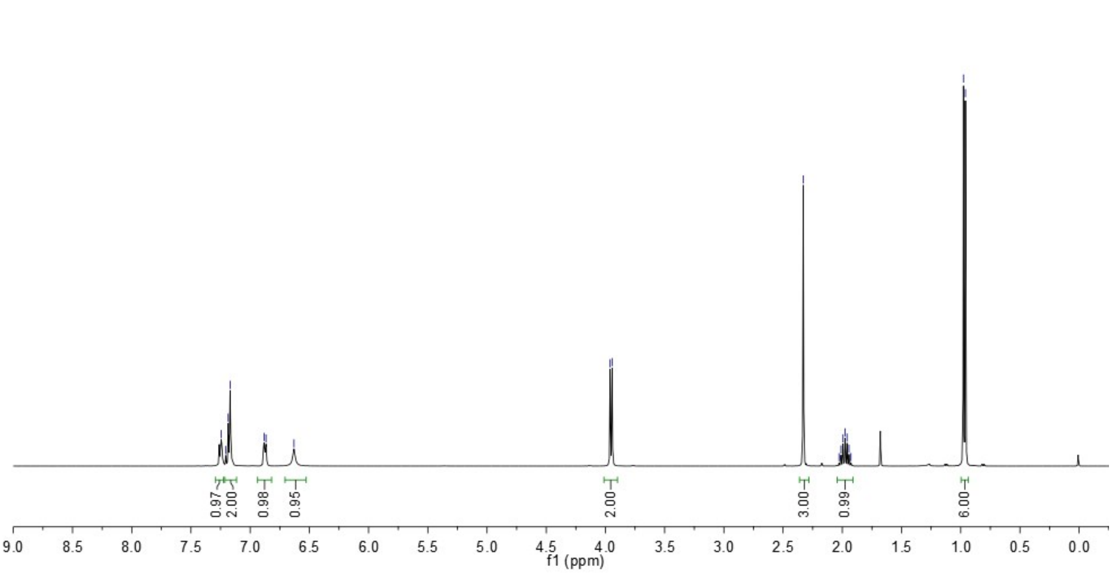
H
N
O
O

1l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1.94
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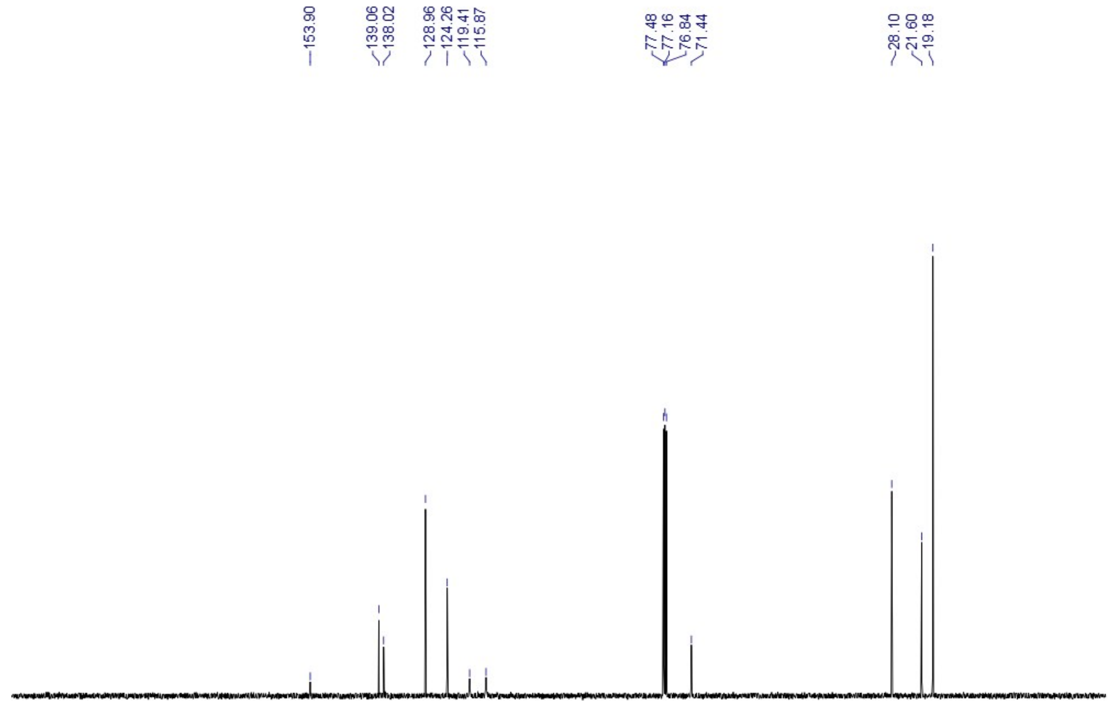
2.00
3.00
0.99
6.00
f1 (ppm)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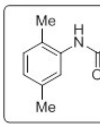
f1 (ppm)



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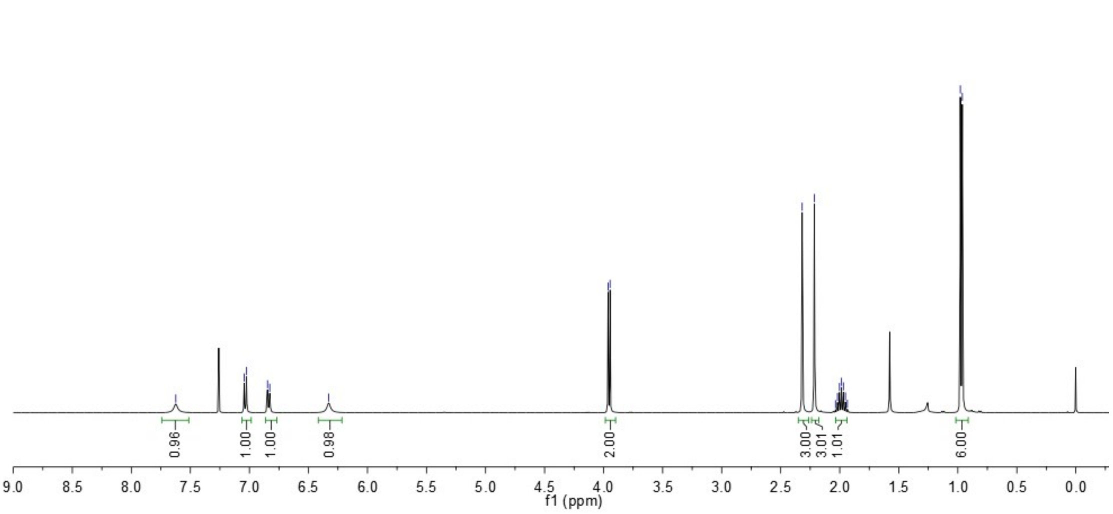

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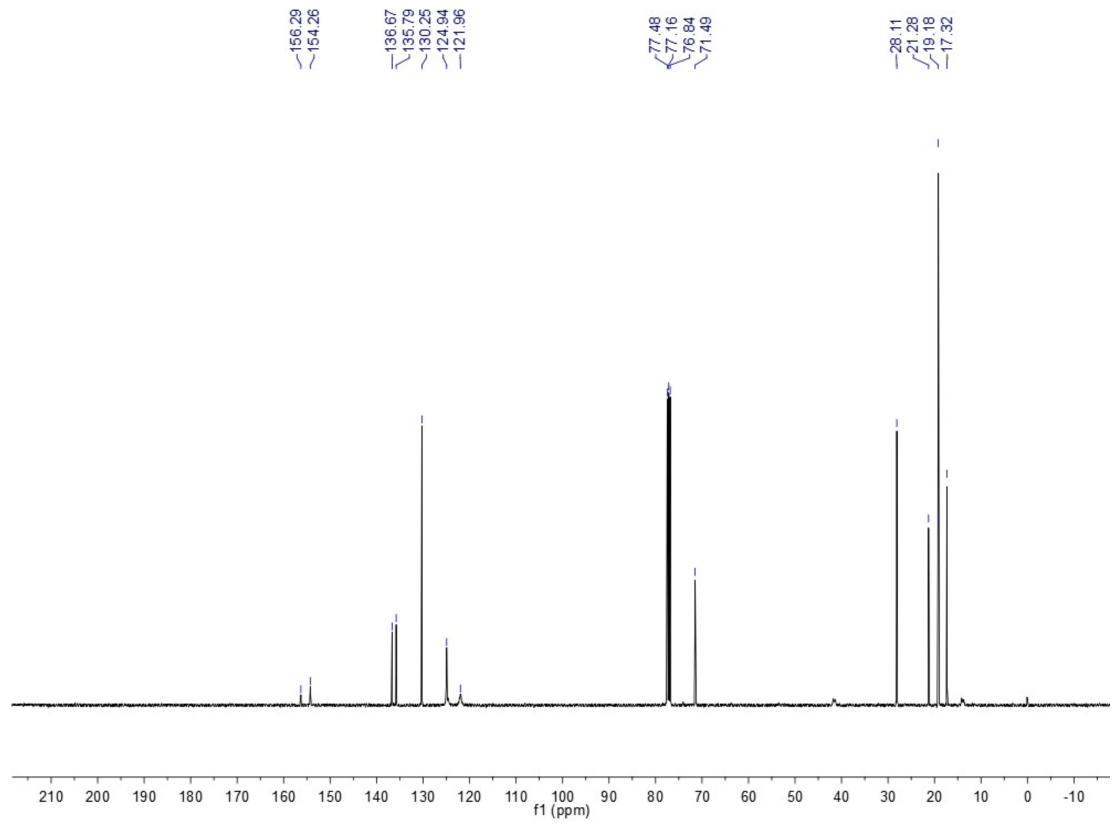
1.95
1.94
0.98
0.96
0.96
1.00
1.00
0.98
2.00
3.00
3.01
1.01
6.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)



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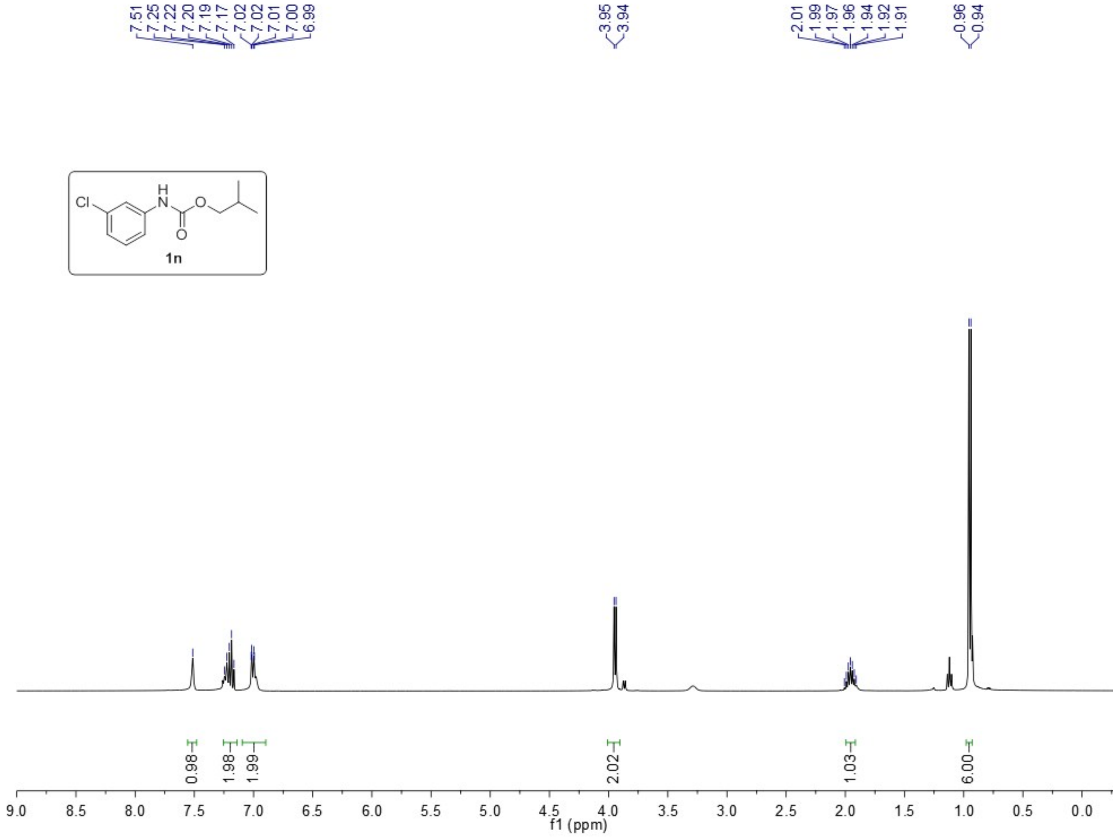
f1 (ppm)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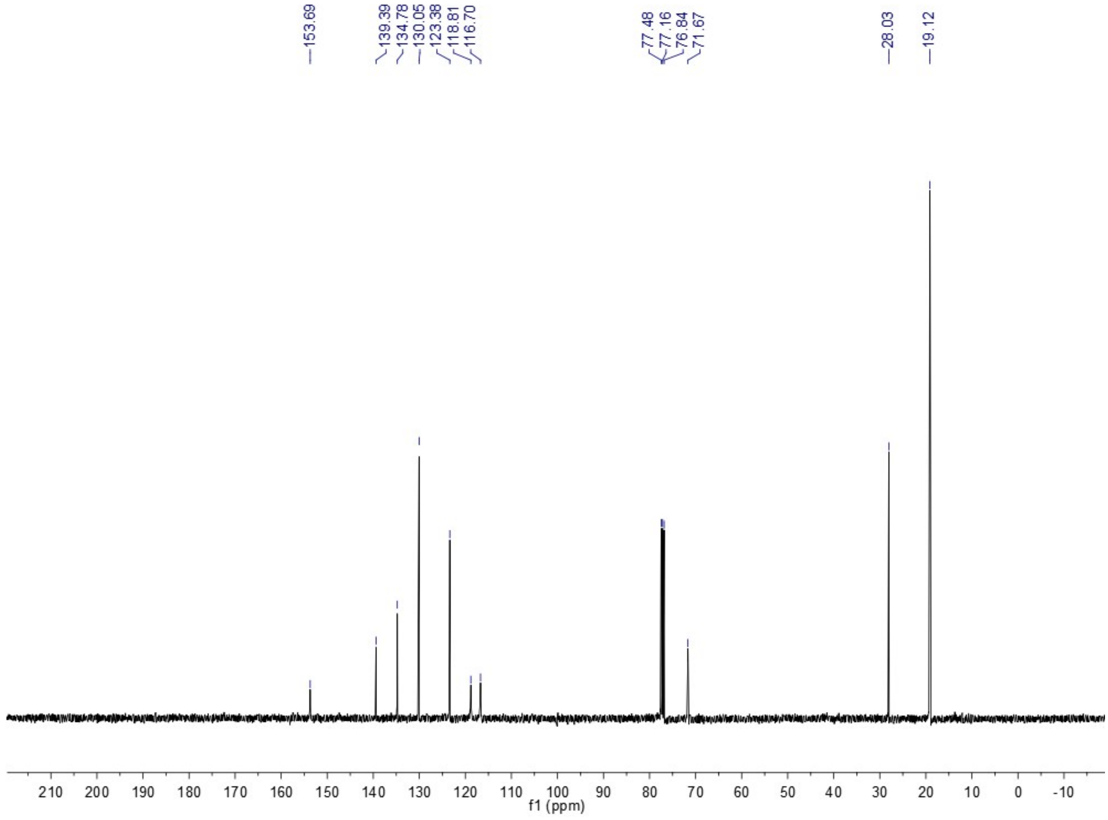
1.99
1.97
1.96
1.94
1.92
1.91
0.96
0.94
Cl
H
N
O
O
1n
0.98
1.98
1.99
2.02
1.03
6.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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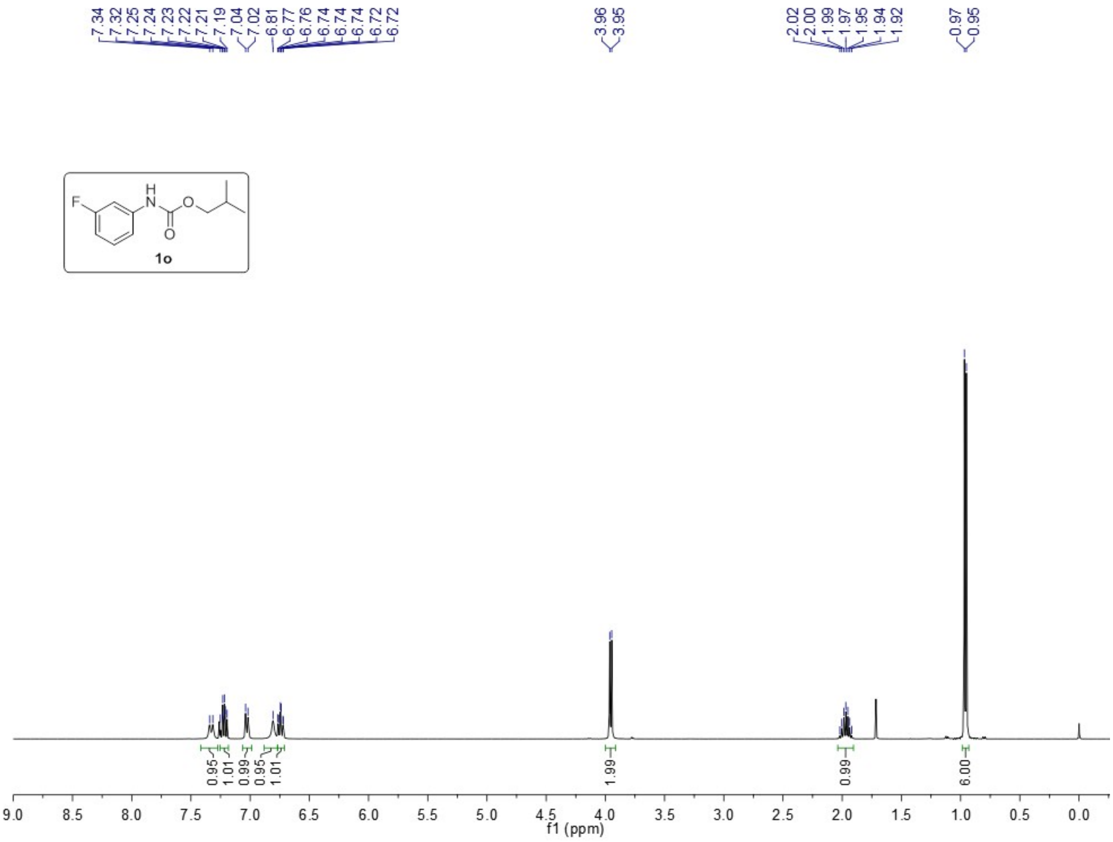
f1 (ppm)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6.74
6.72
6.72
3.96
3.95
2.02
2.00
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1.95
1.94
1.92
0.97
0.95
F
H
N
O
O
1o
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1.01
0.99
0.95
1.01
1.99
0.99
6.00
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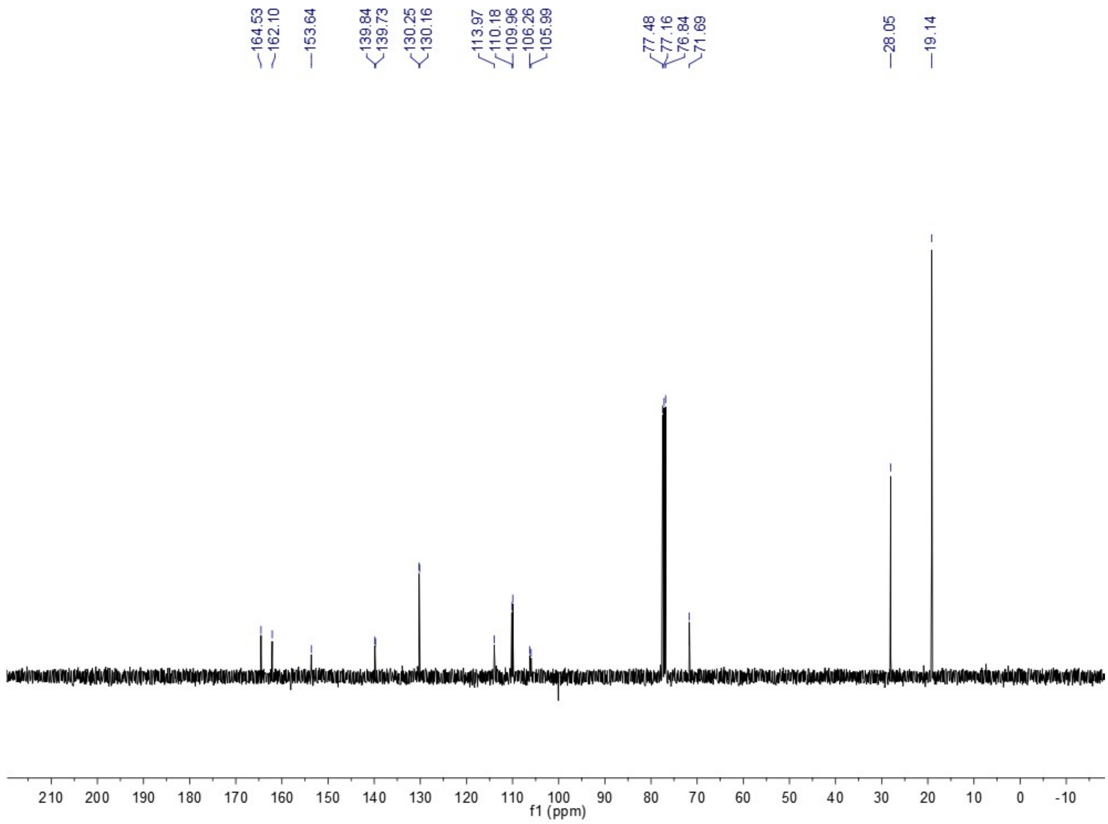
f1 (ppm)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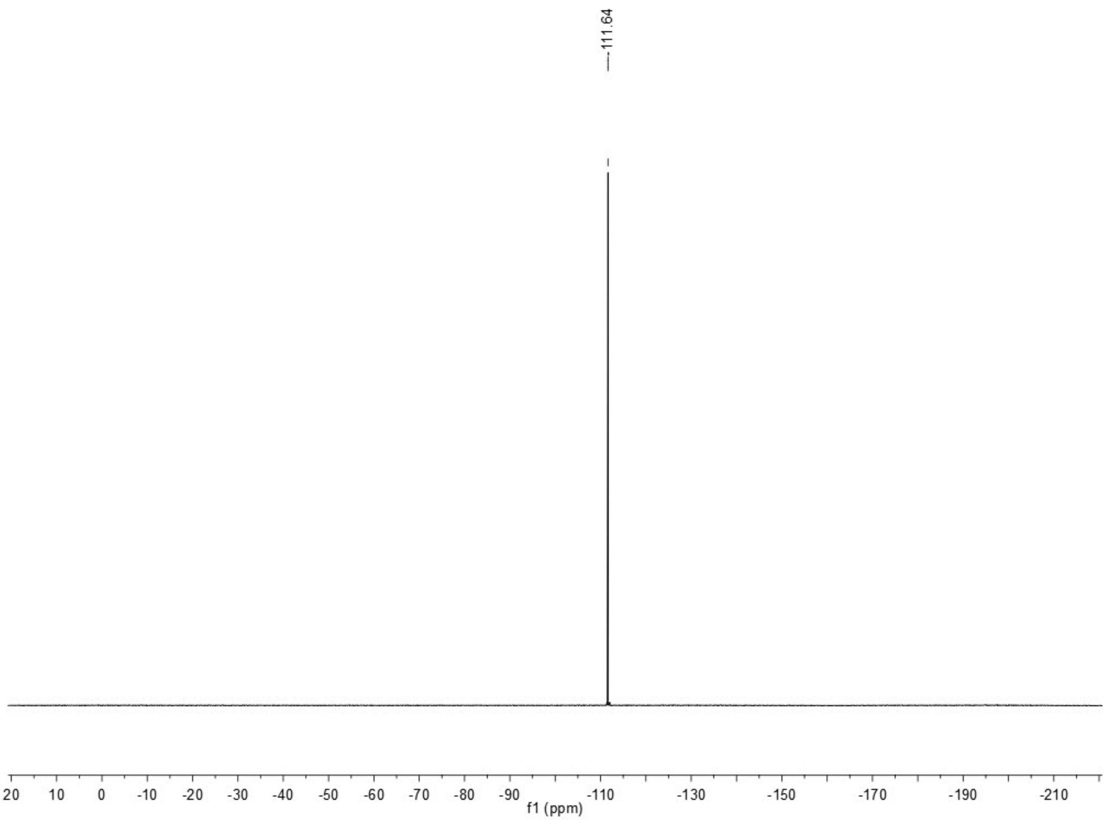
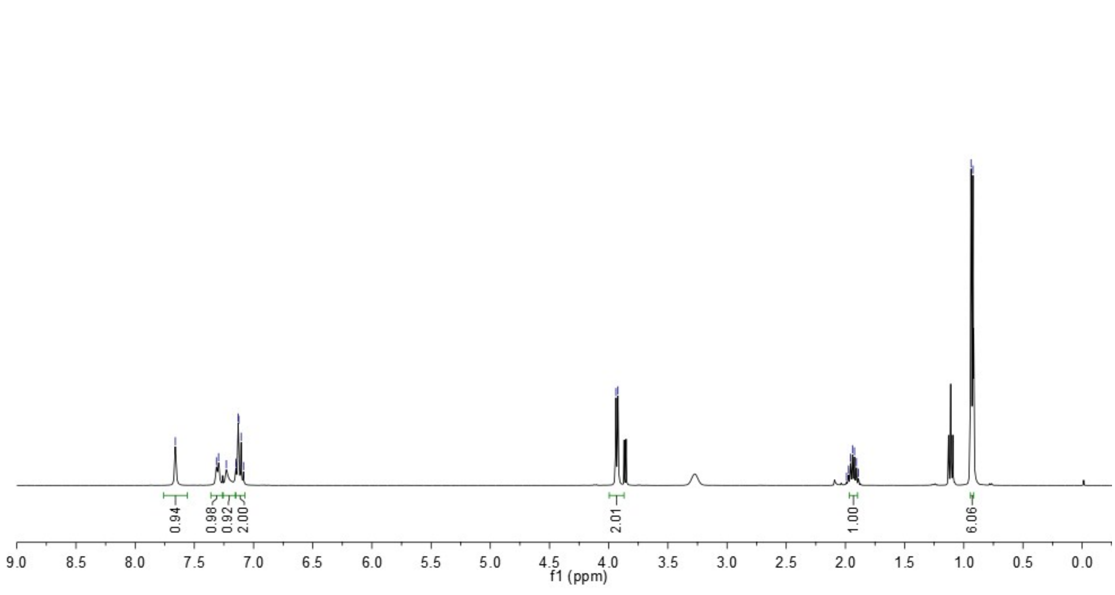
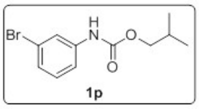
f1 (ppm)



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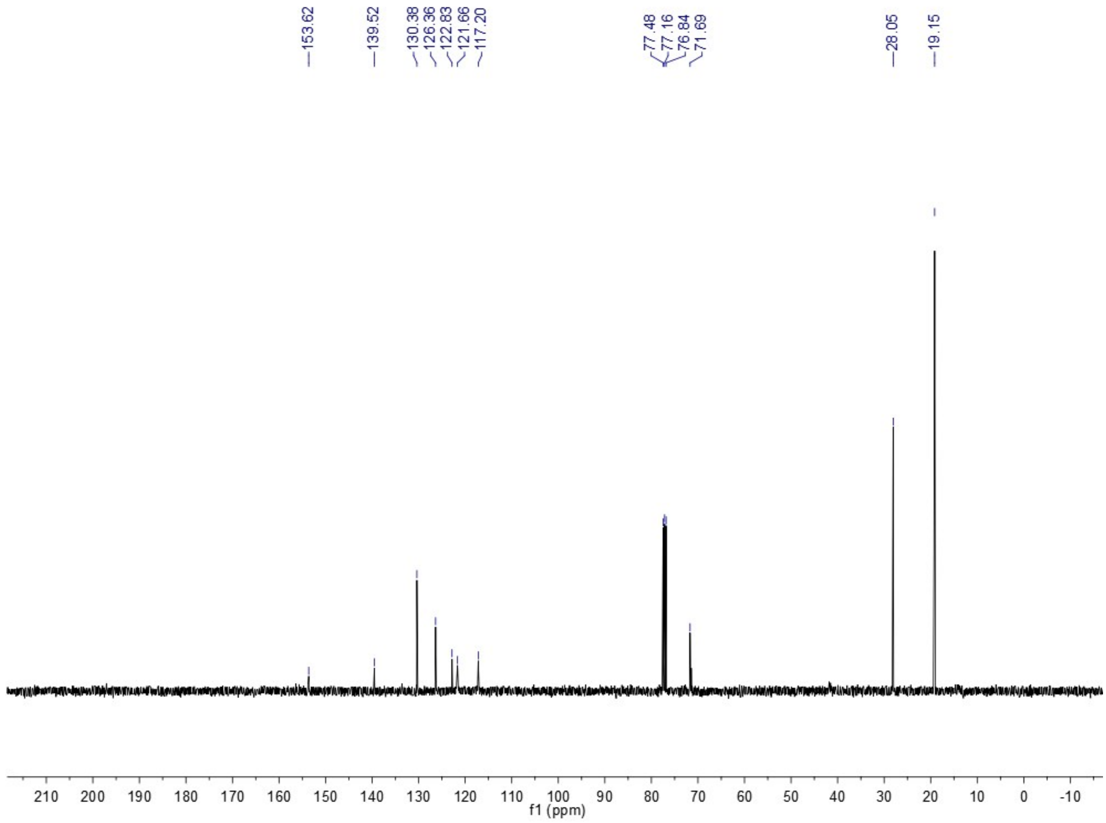
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19.15
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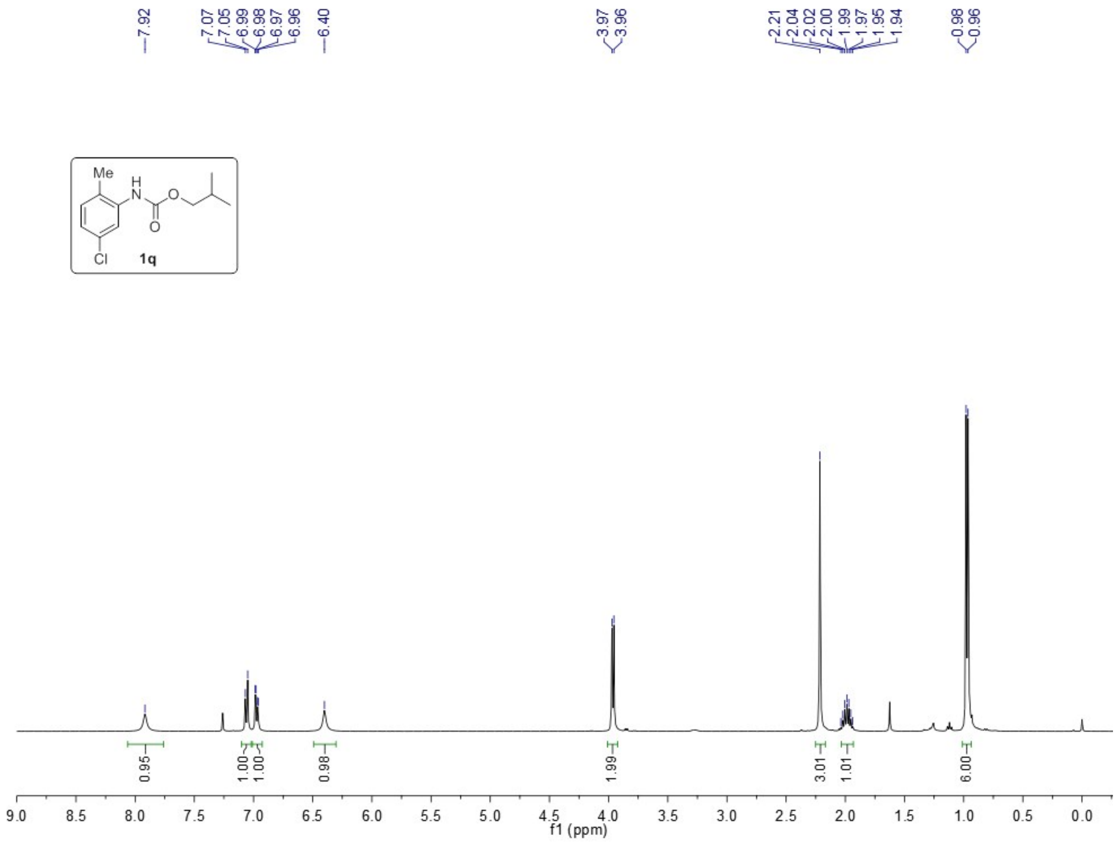
f1 (ppm)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0.98
1.99
3.01
1.01
6.00
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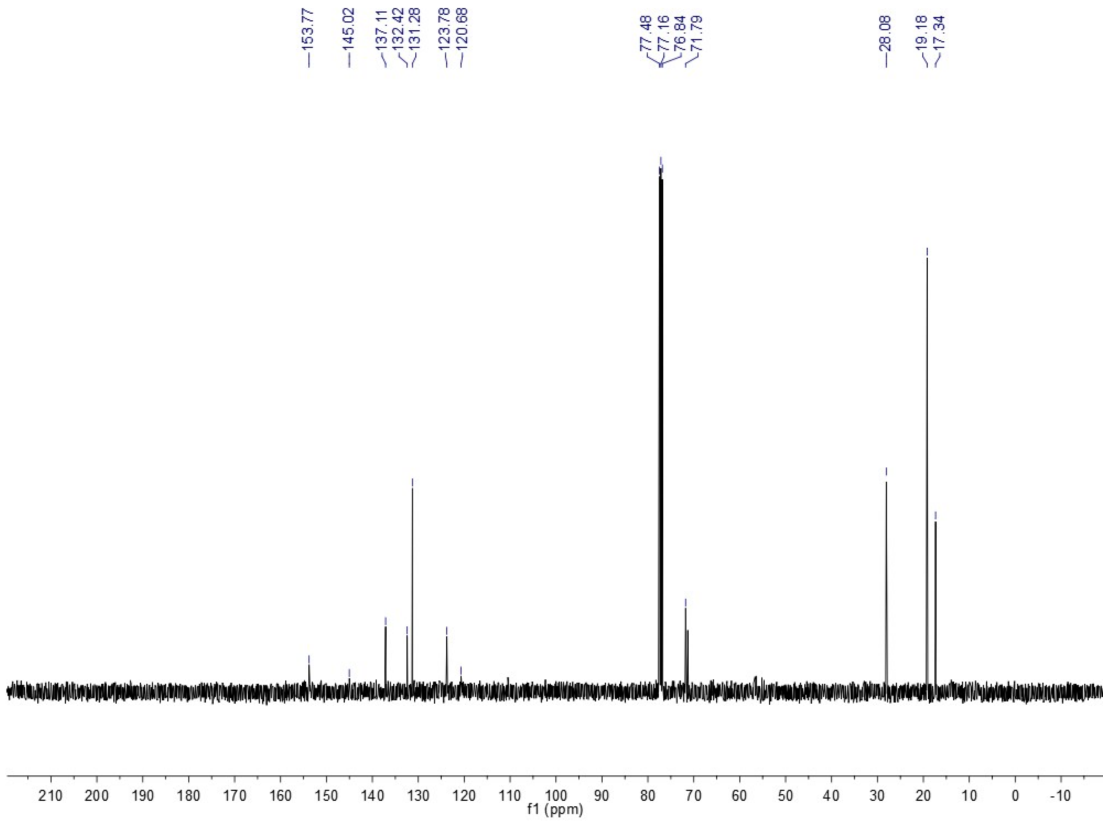
f1 (ppm)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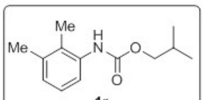
f1 (ppm)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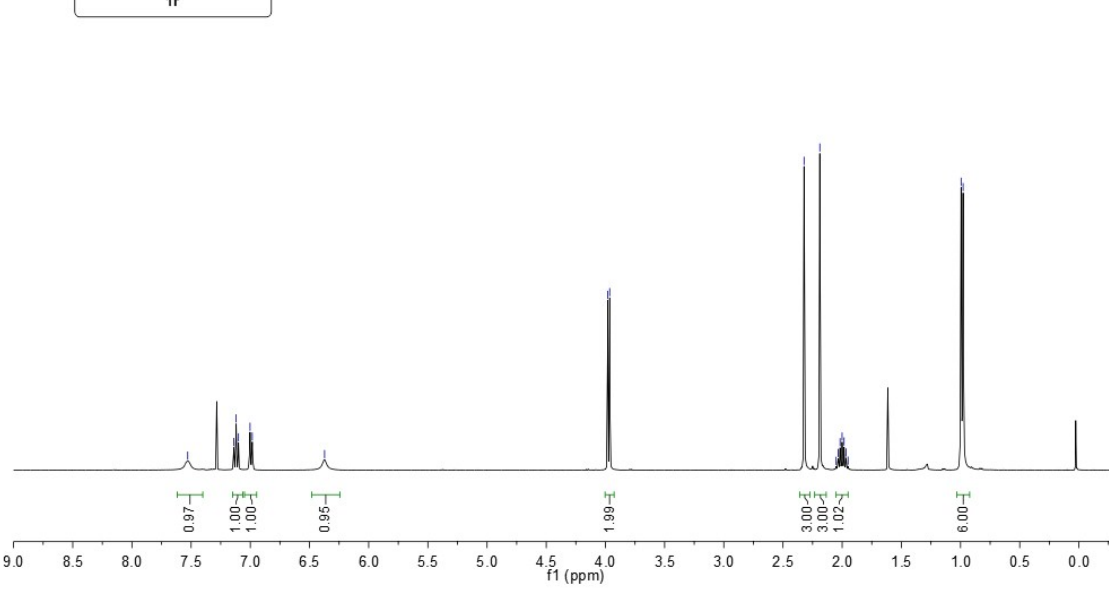
1r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0.98
0.97
1.00
1.00
0.95
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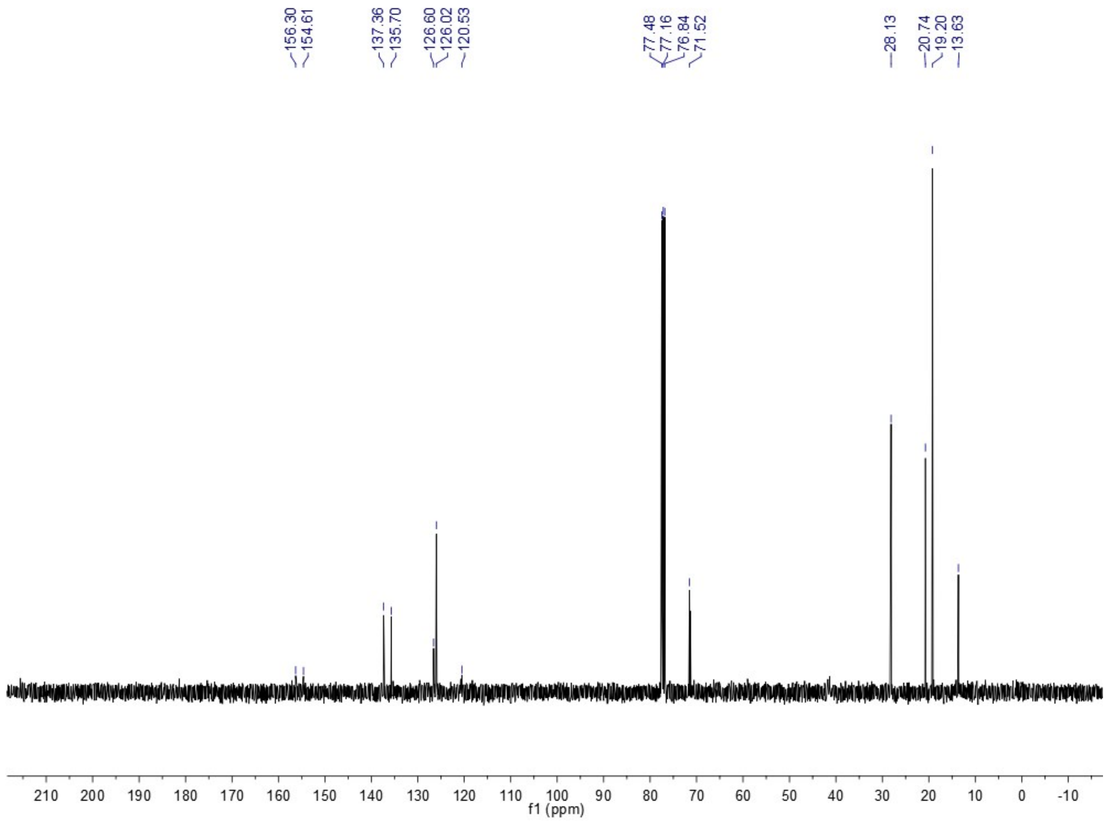
3.00
1.02
6.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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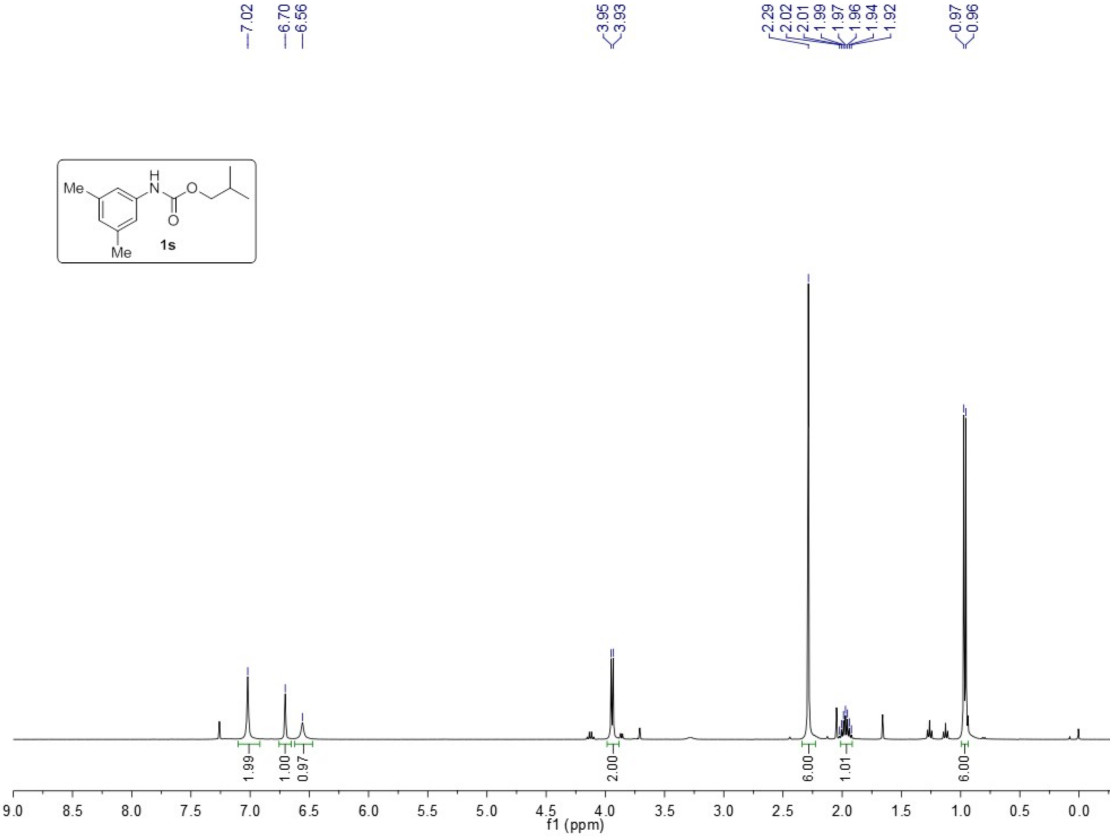
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0.97
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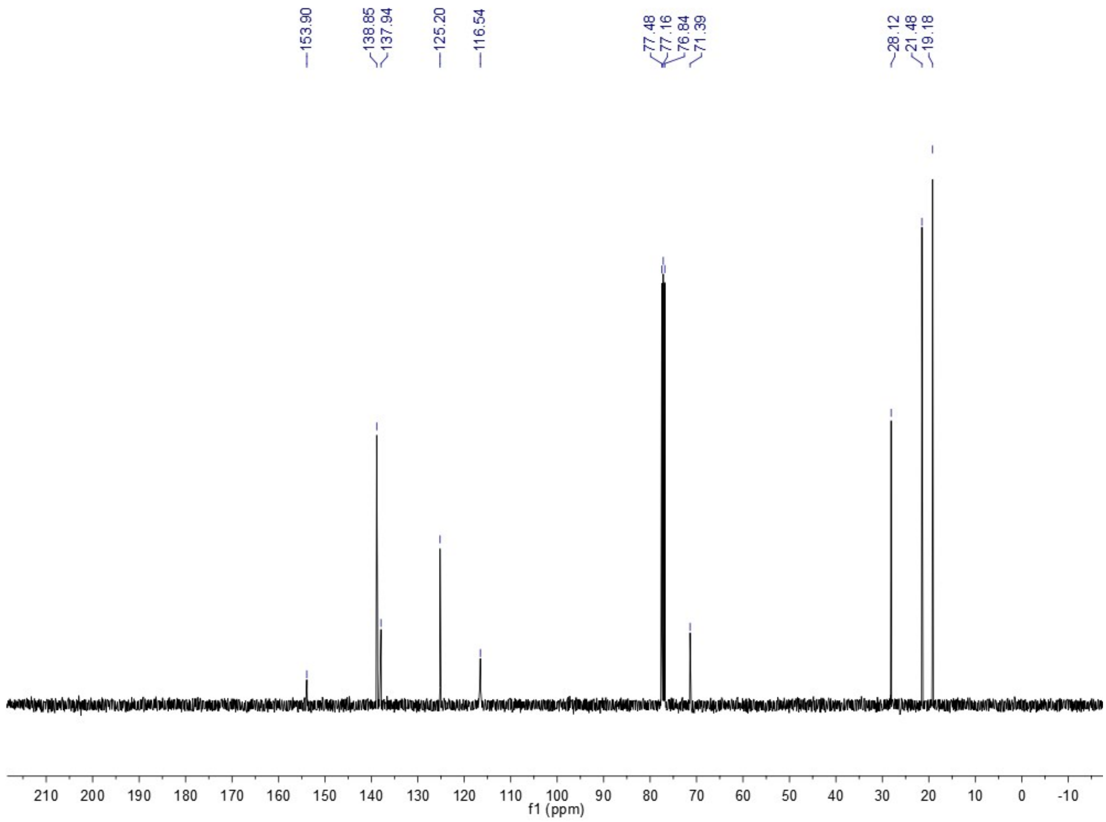
1.01
6.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)



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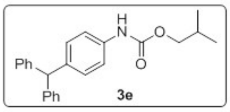
f1 (ppm)



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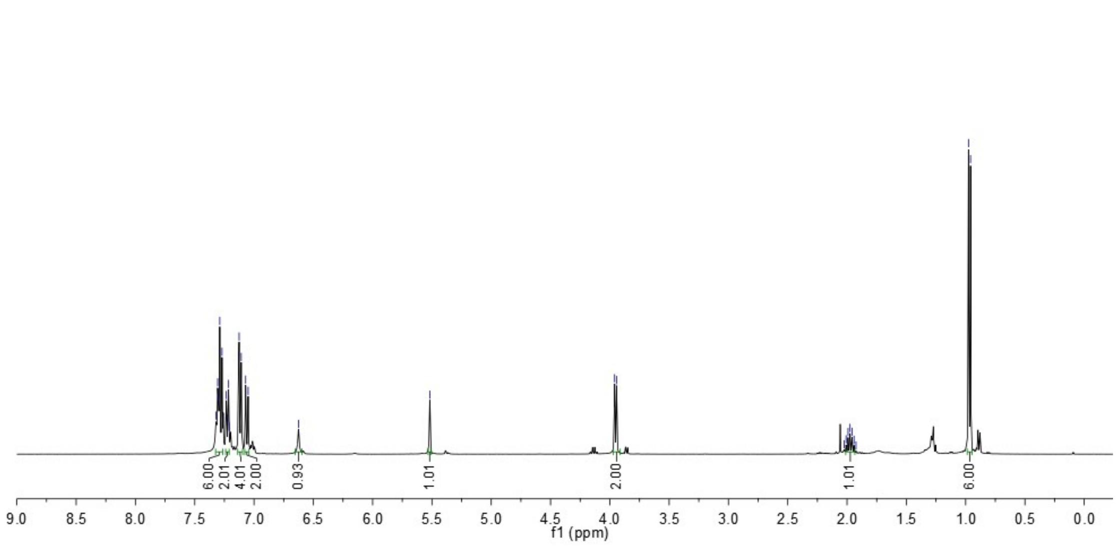
Ph
Ph

3e



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0.98
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6.00
2.01
4.01
2.00
0.93
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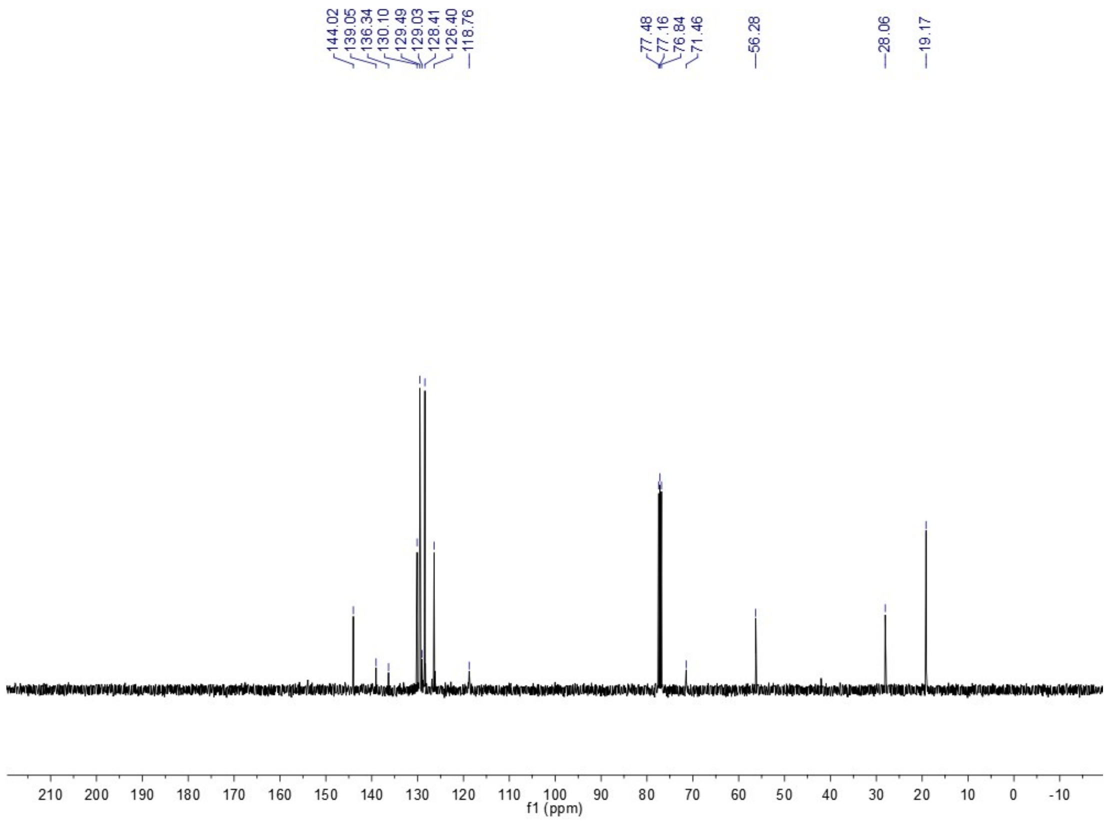
2.00
1.01
6.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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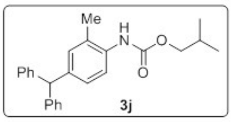
f1 (ppm)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Ph
Ph
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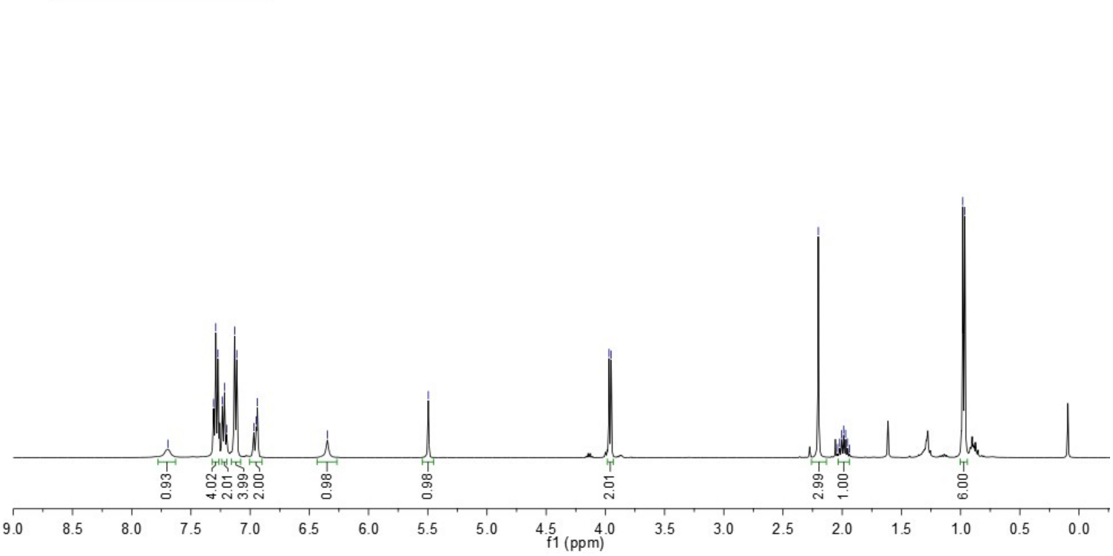
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2.01
1.99
1.97
1.95
1.94
0.98
0.96
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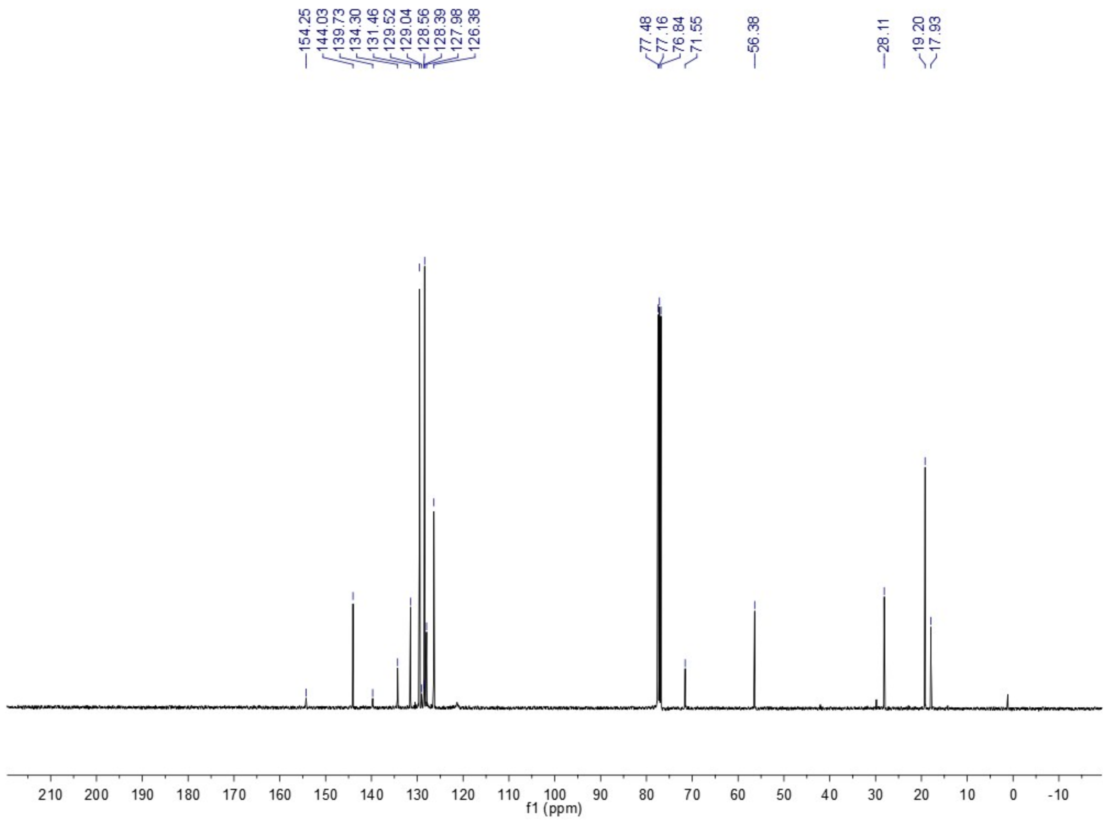
f1 (ppm)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28.11
19.20
17.93
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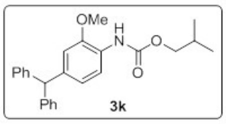
f1 (ppm)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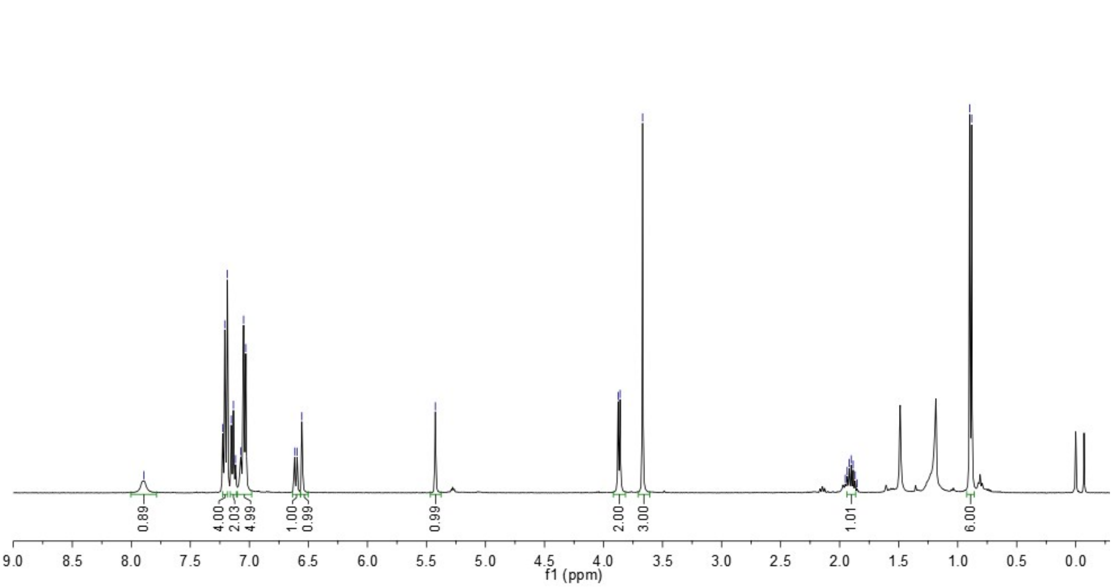
O
Ph
Ph
3k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6.00
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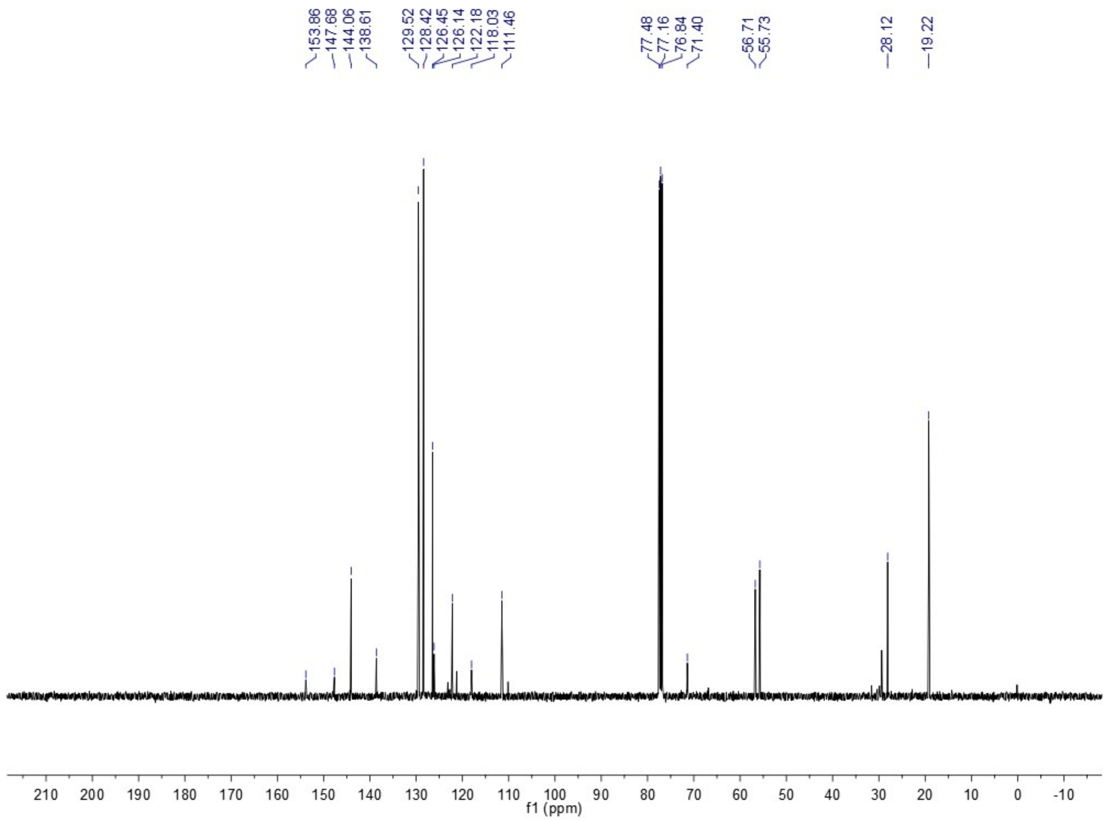
f1 (ppm)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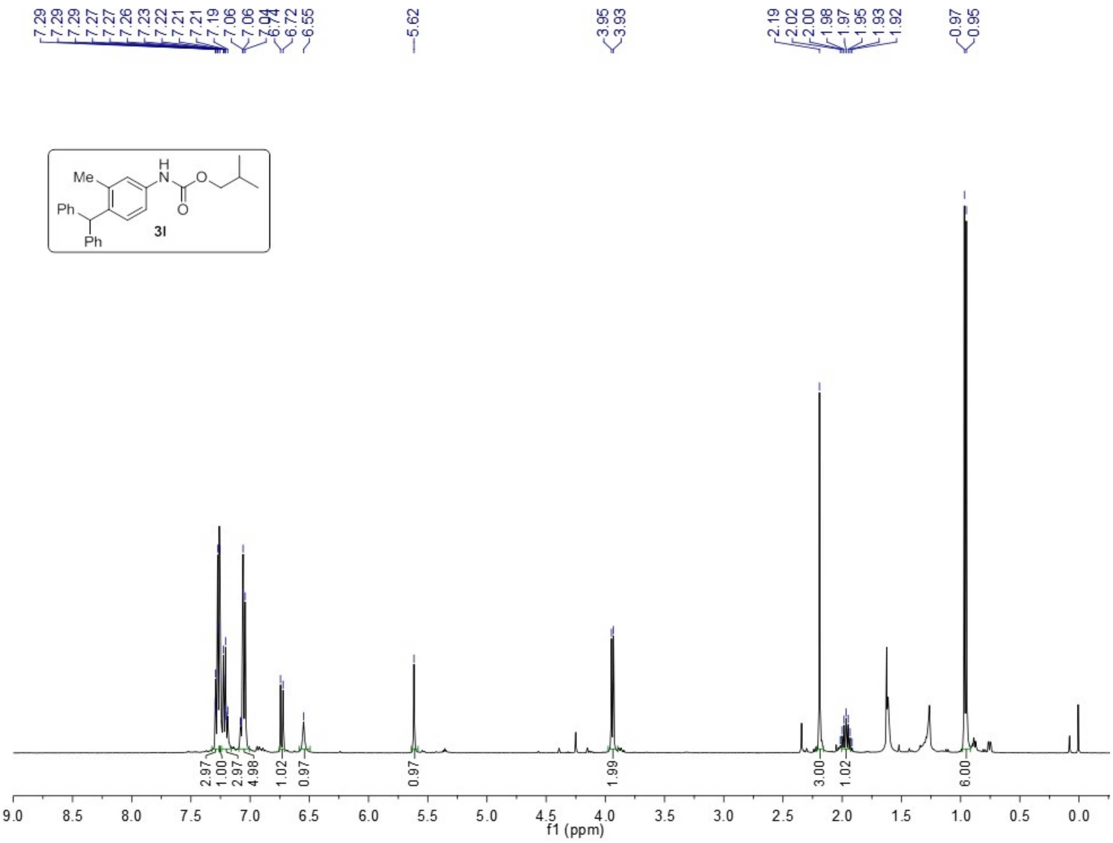
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3.00
1.02
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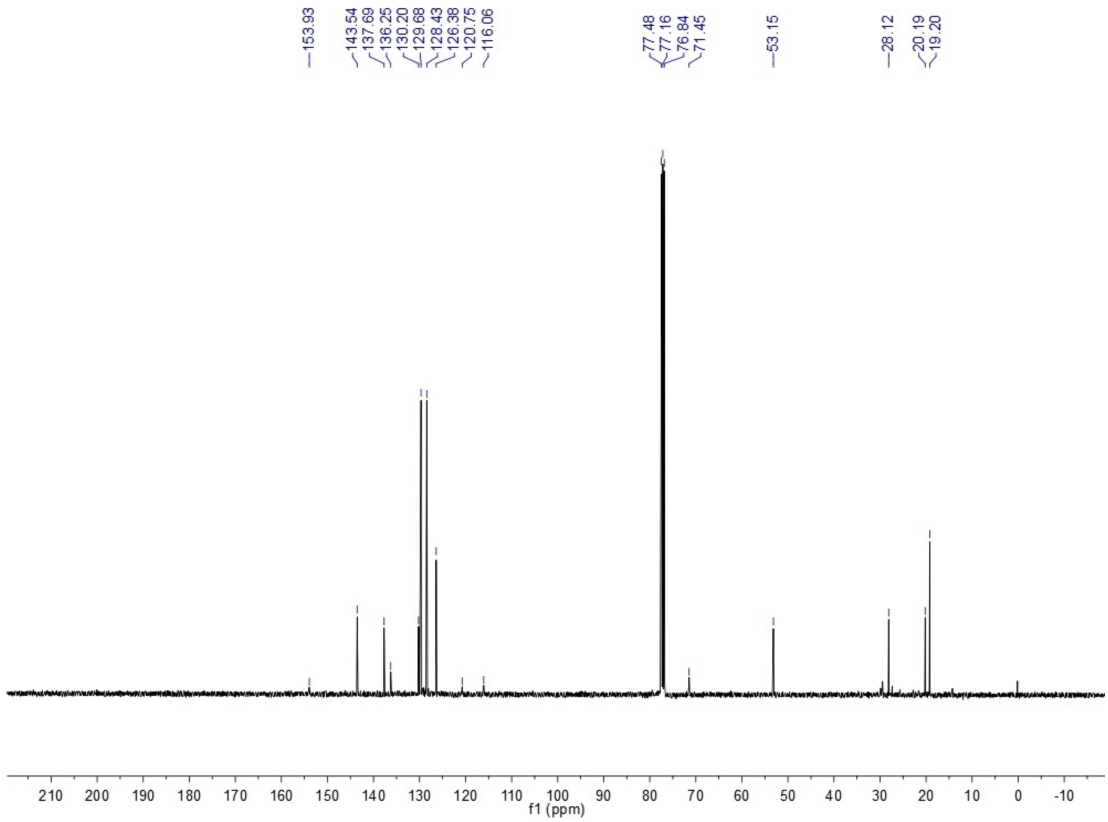
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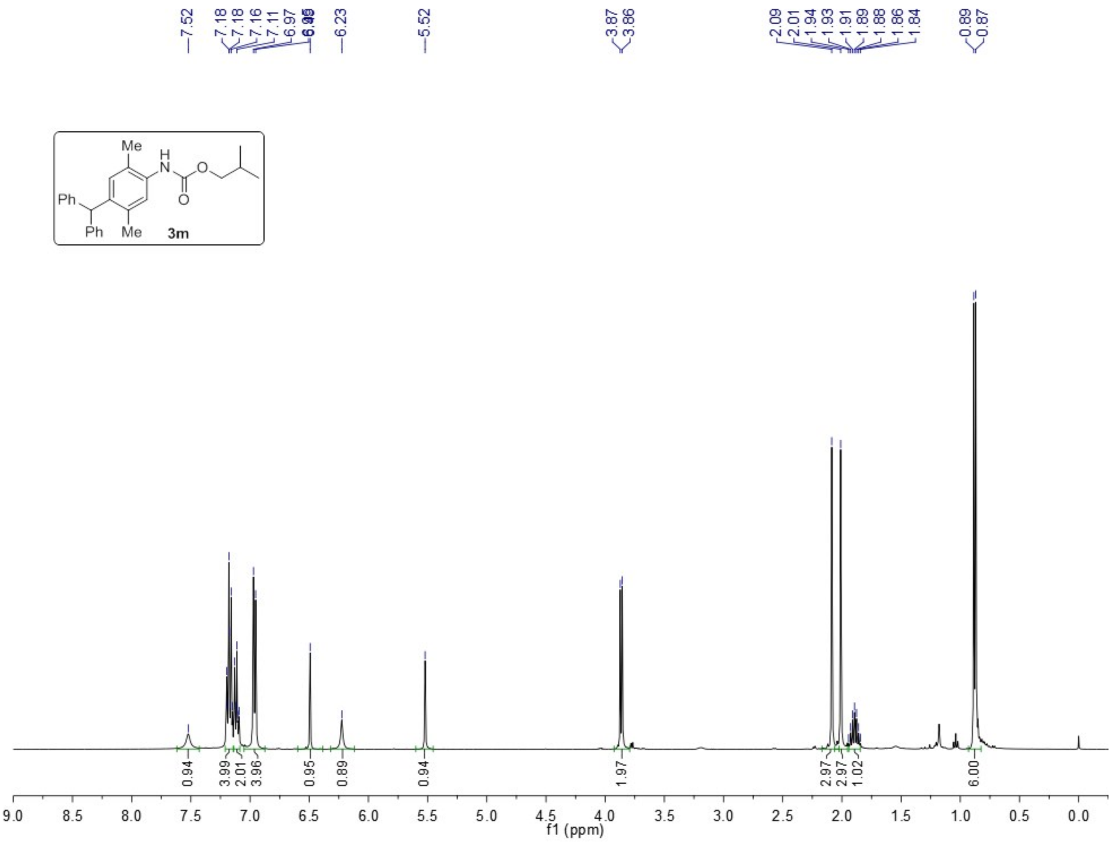
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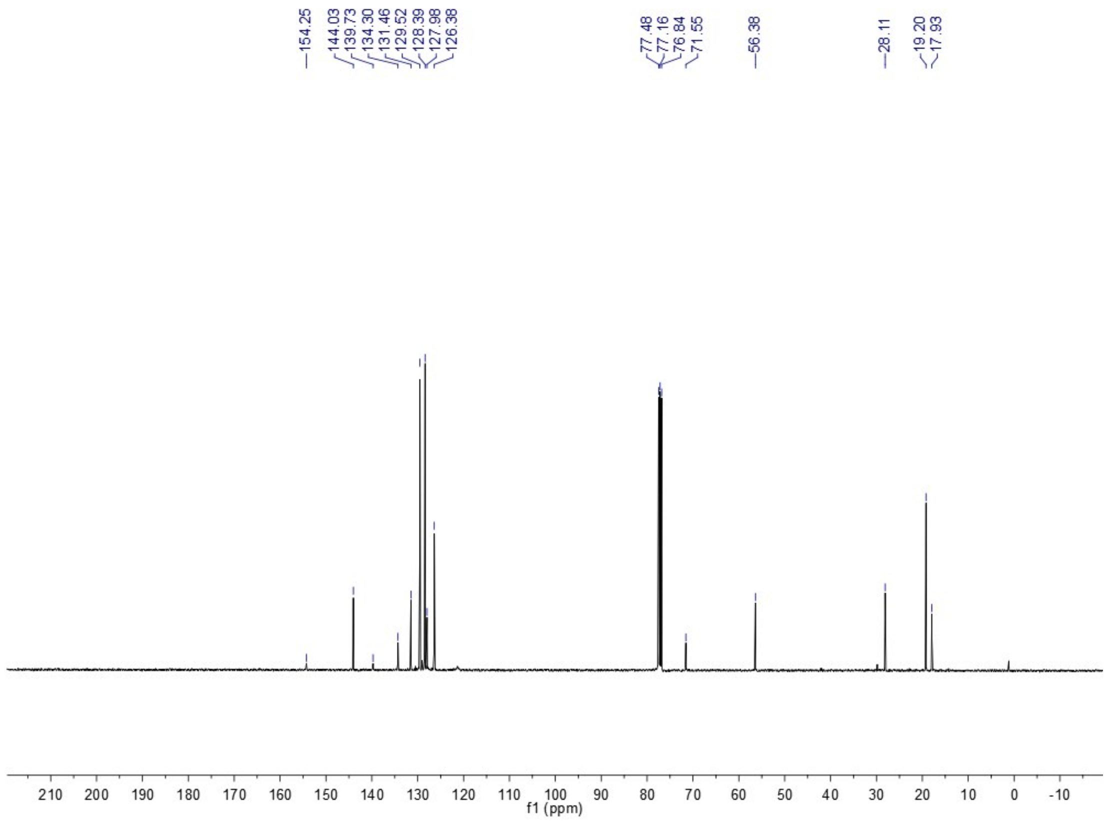
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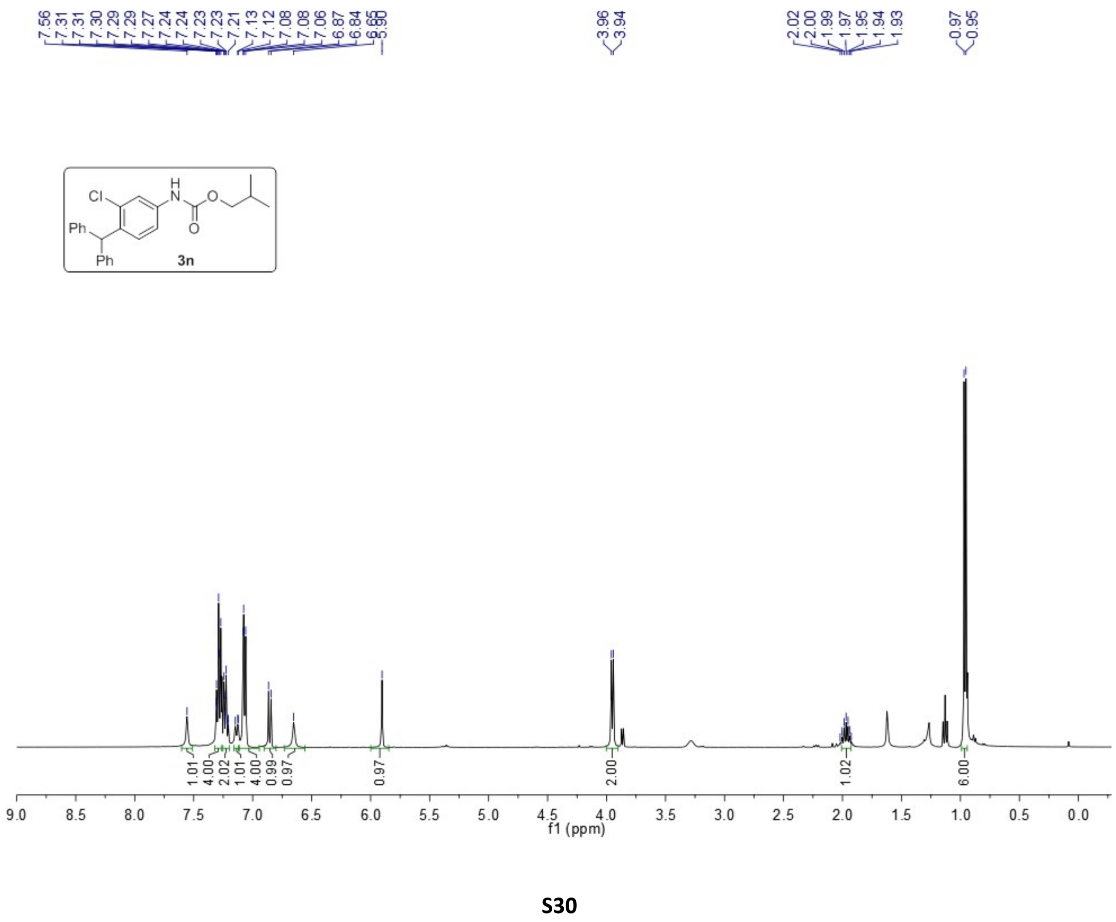
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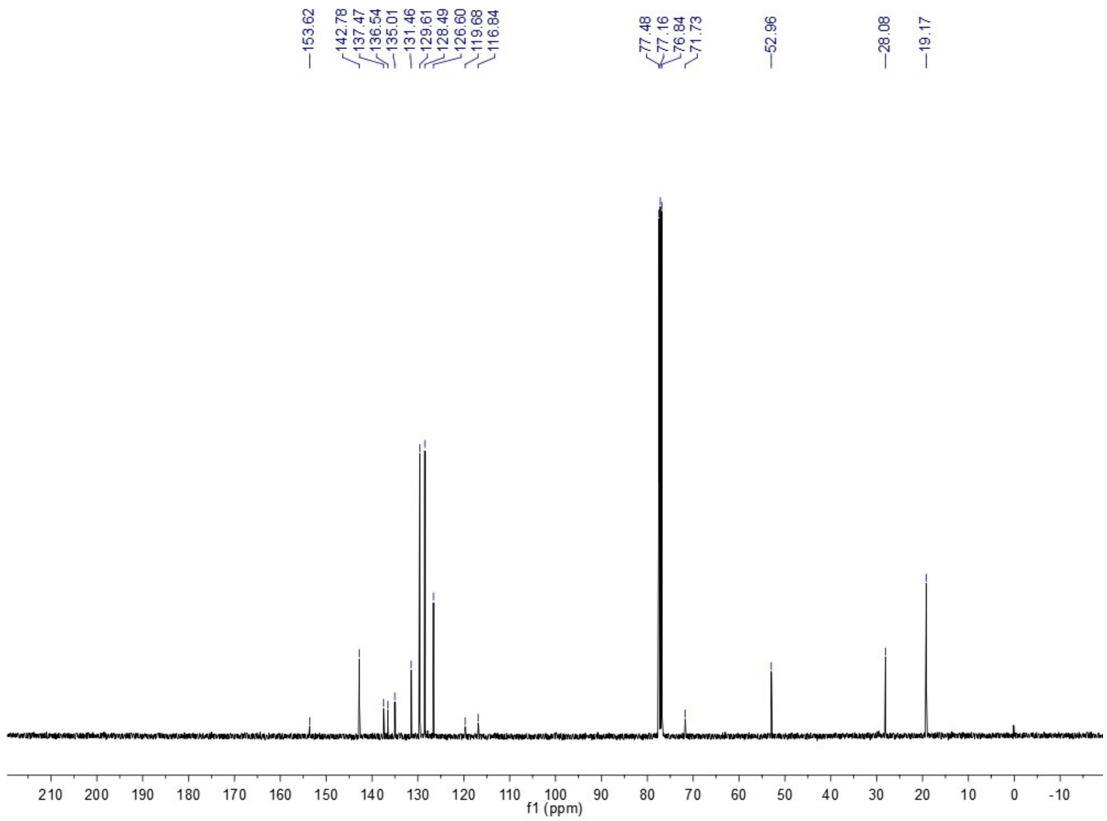

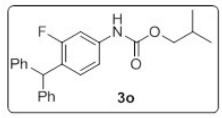

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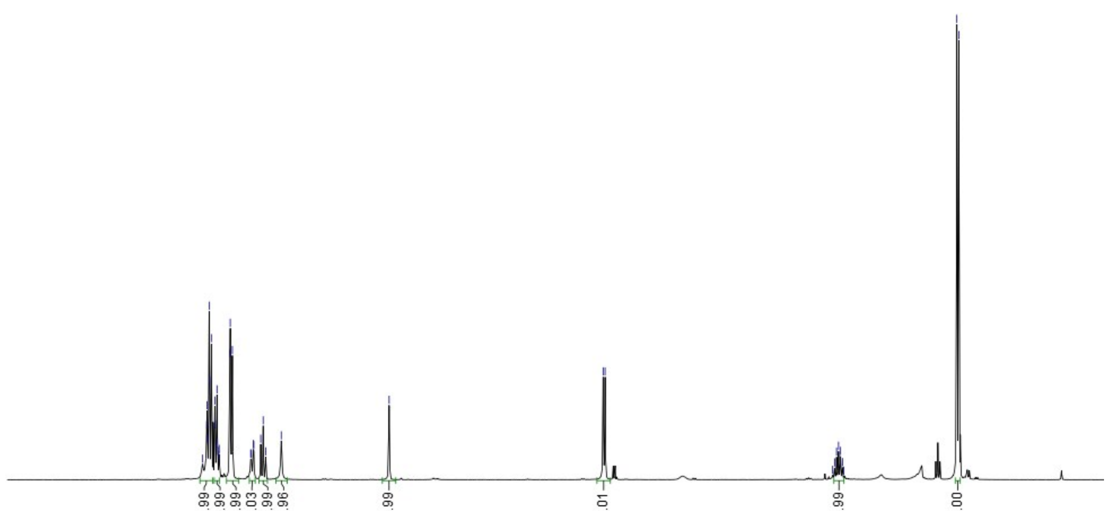

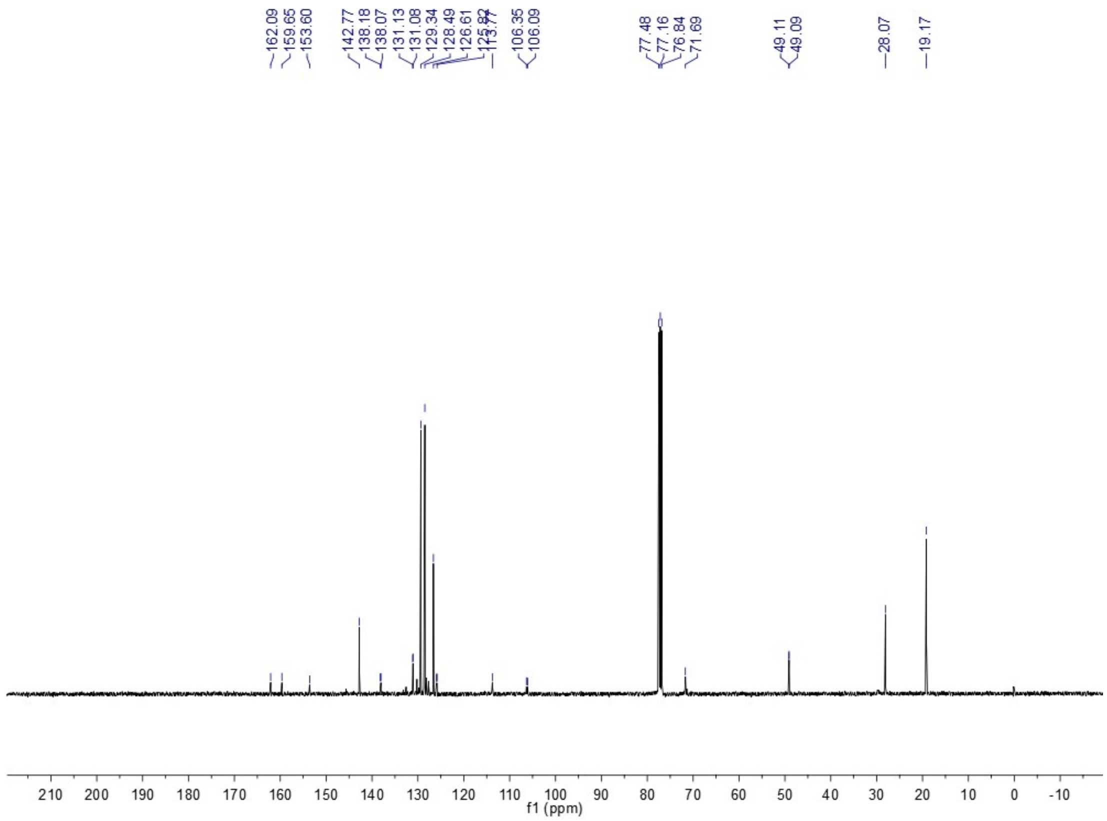
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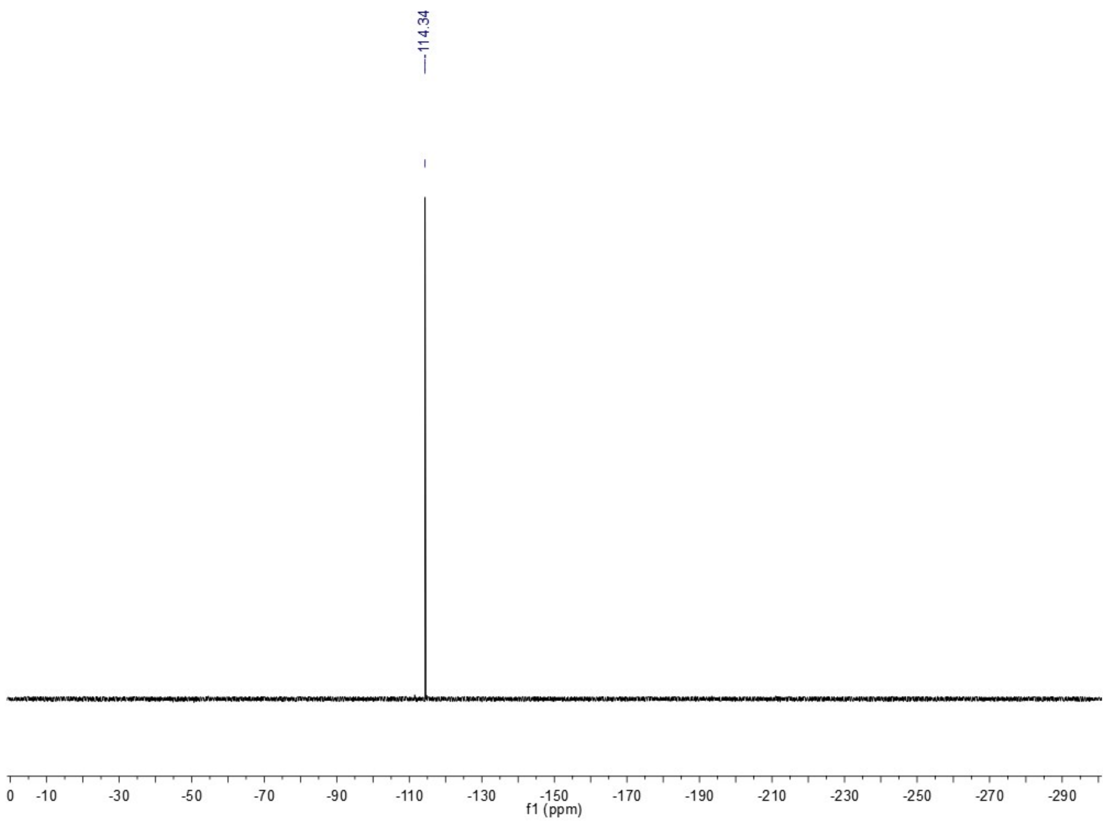
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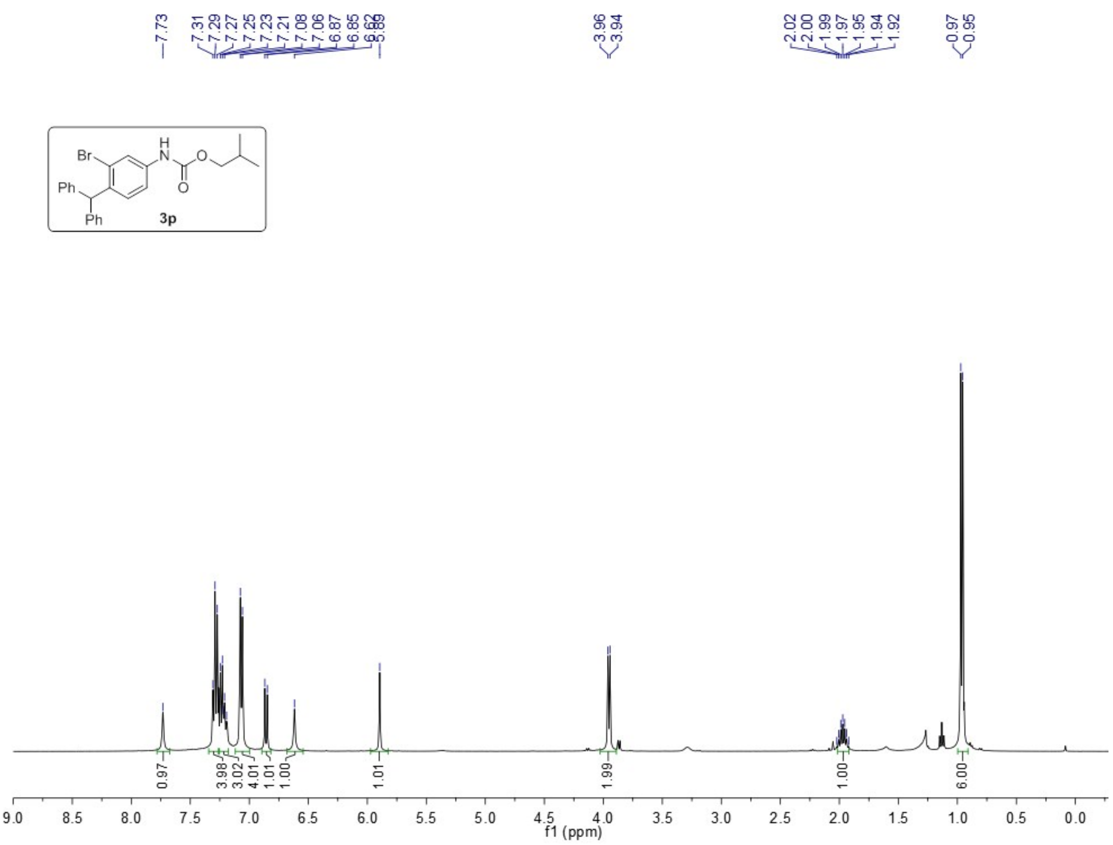
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0.95
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O
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Ph
Ph
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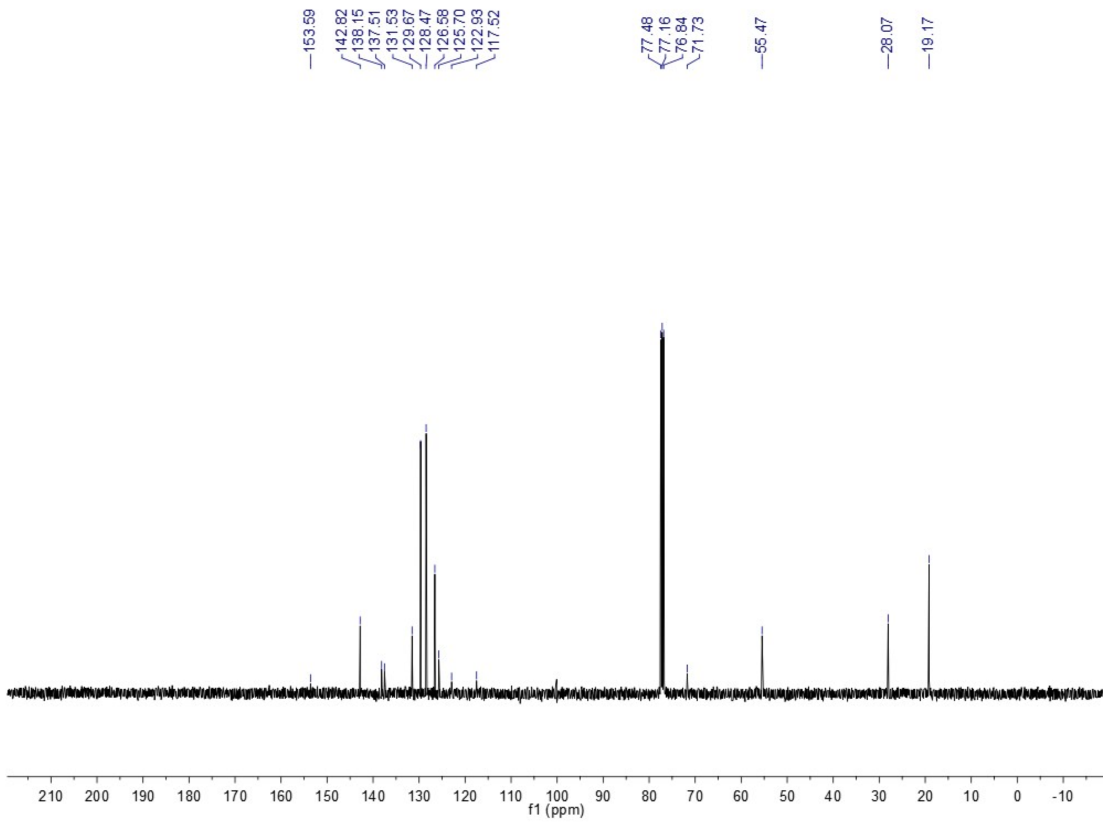
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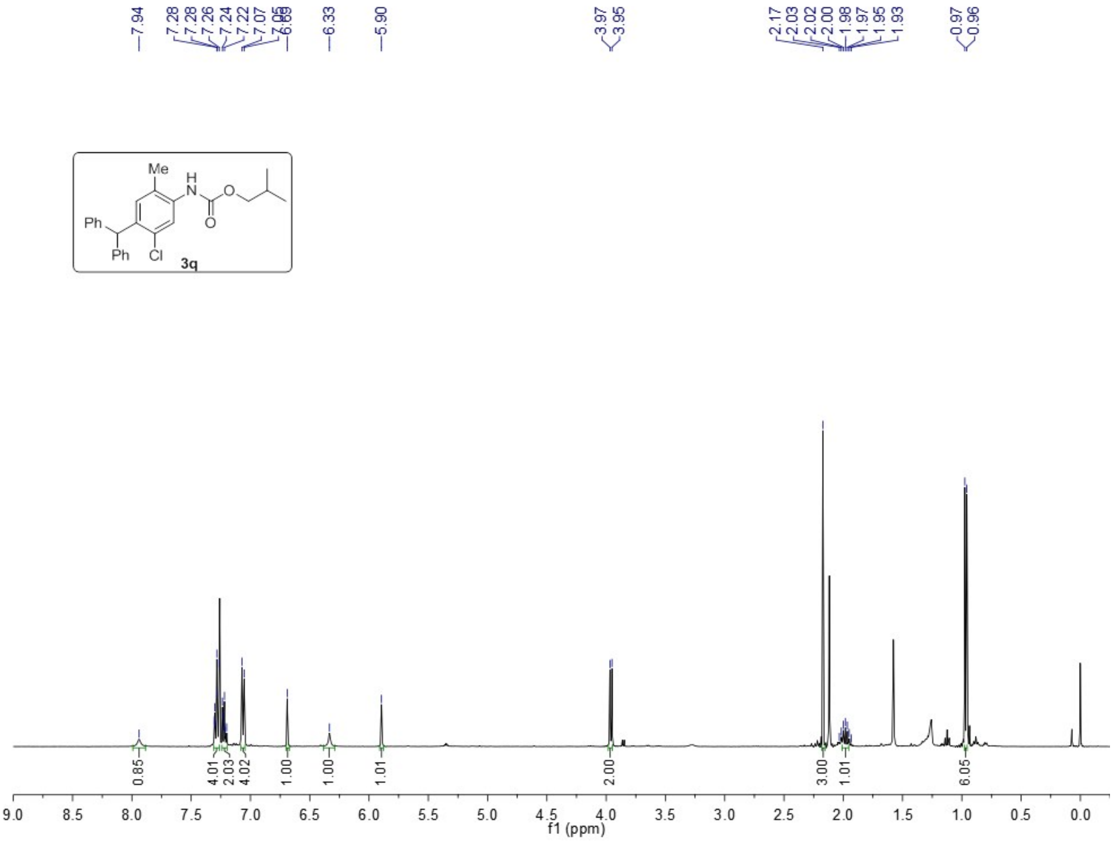
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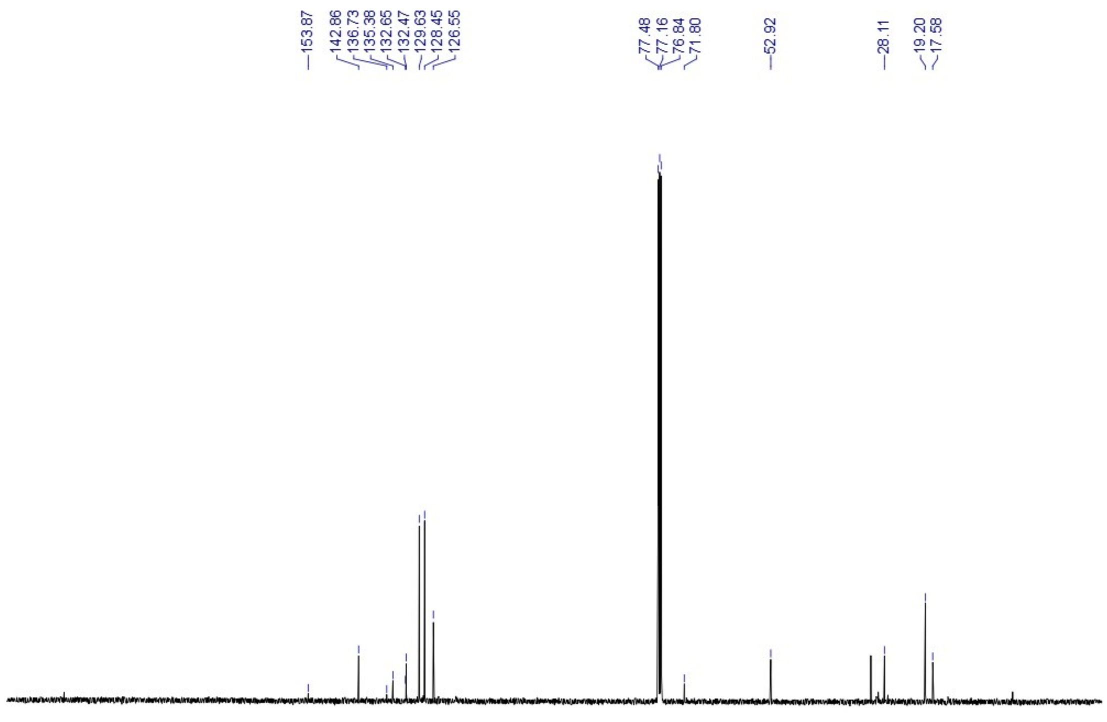
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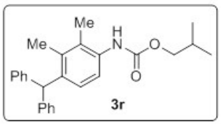
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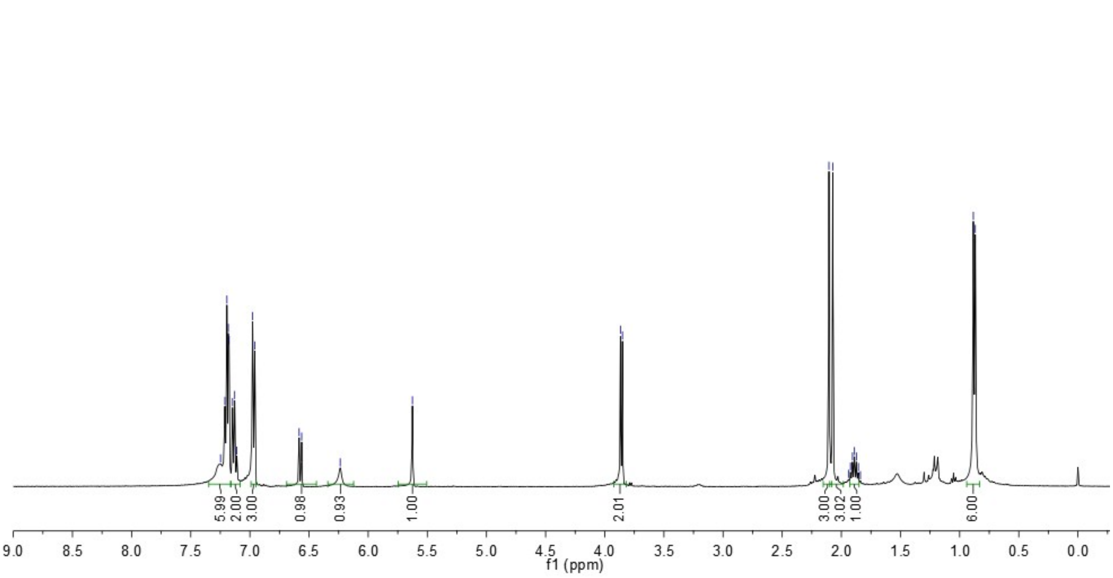
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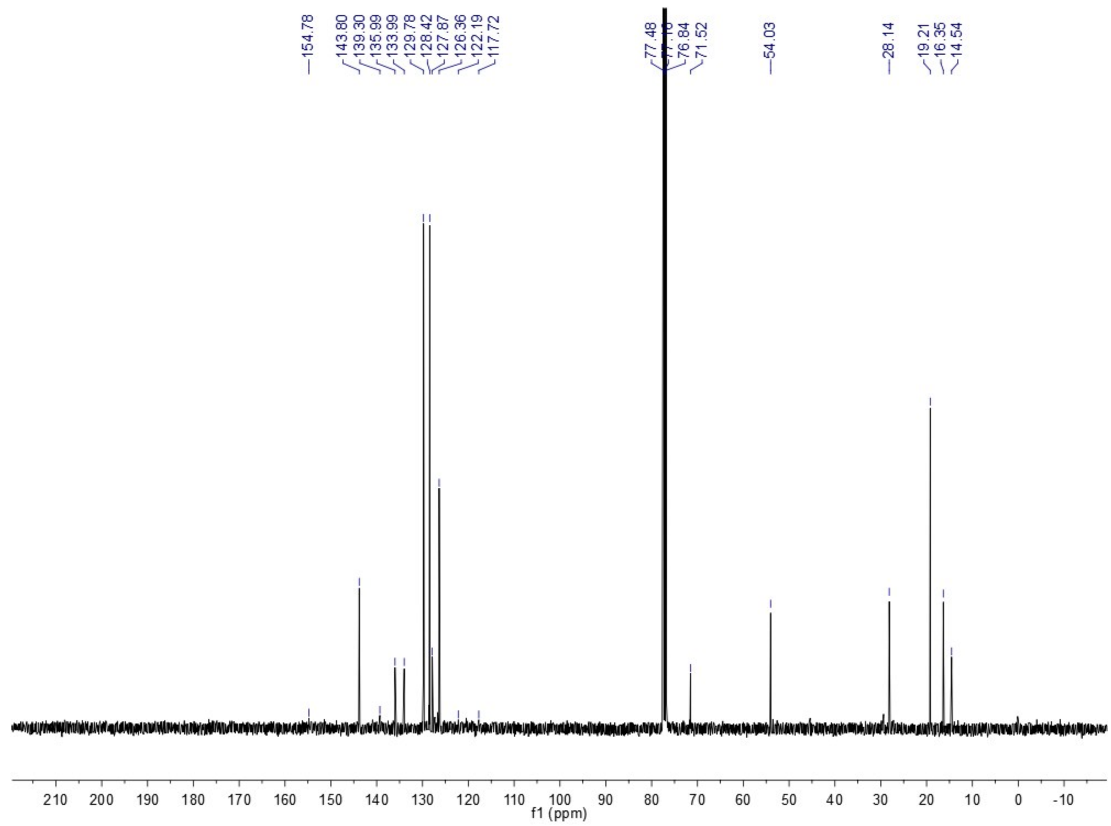
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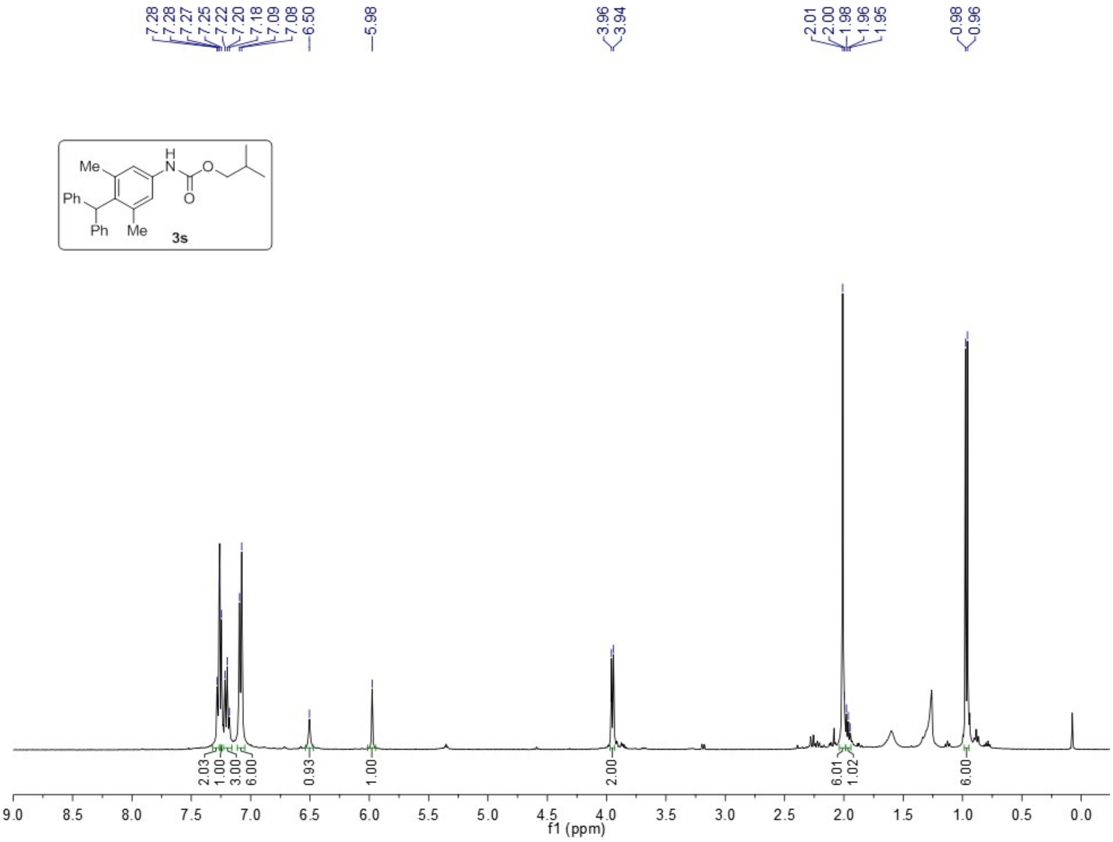
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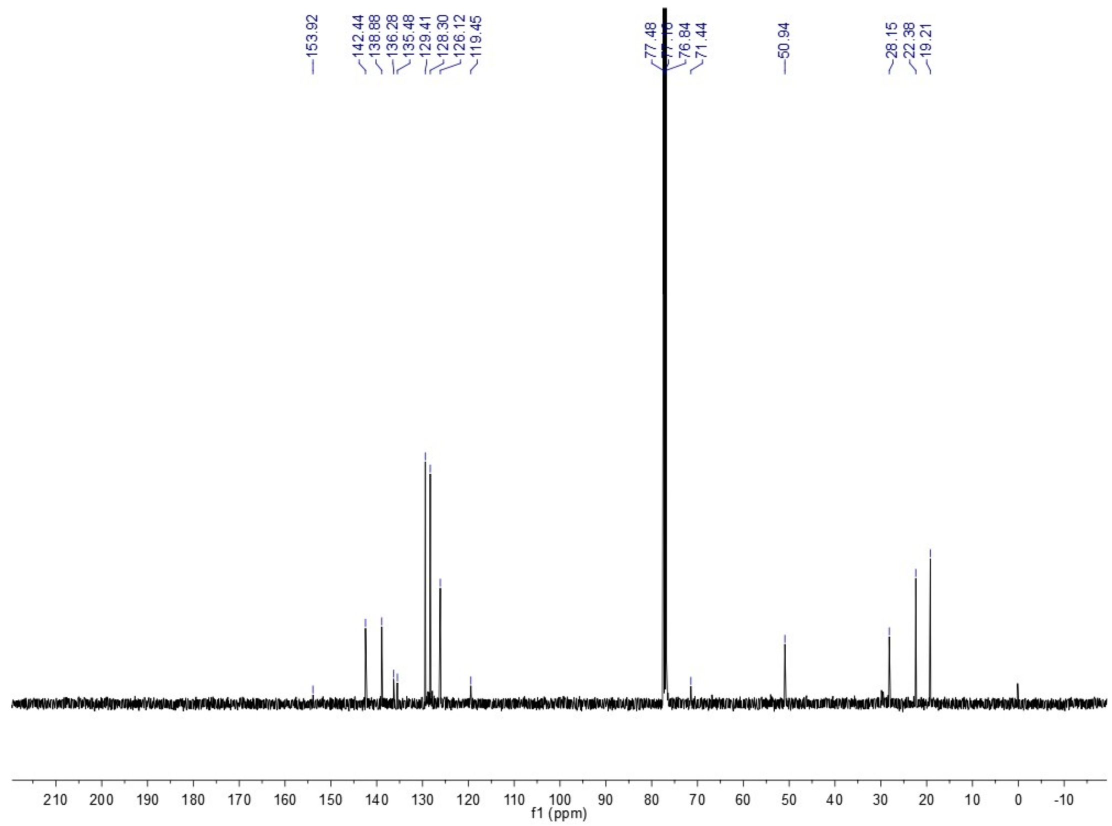
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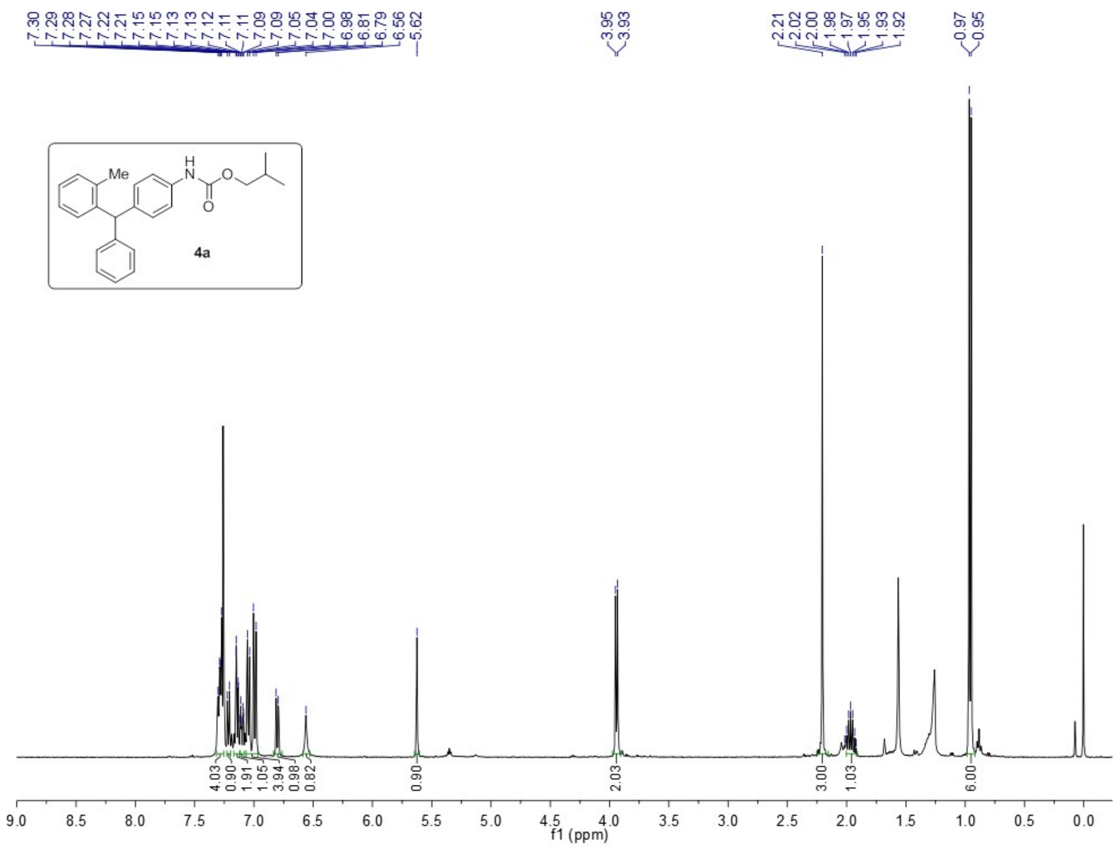
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3.95 3.93
2.21 2.02 2.00 1.98 1.97 1.95 1.93 1.92
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N
O
O
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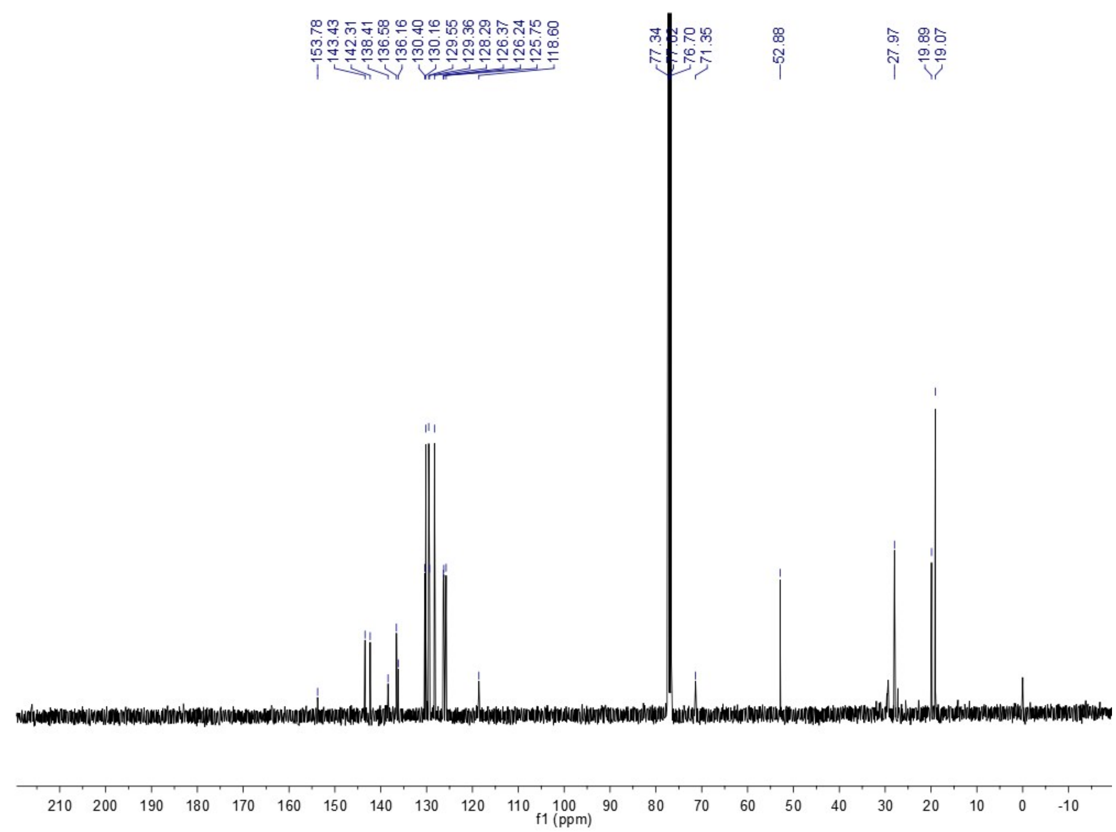
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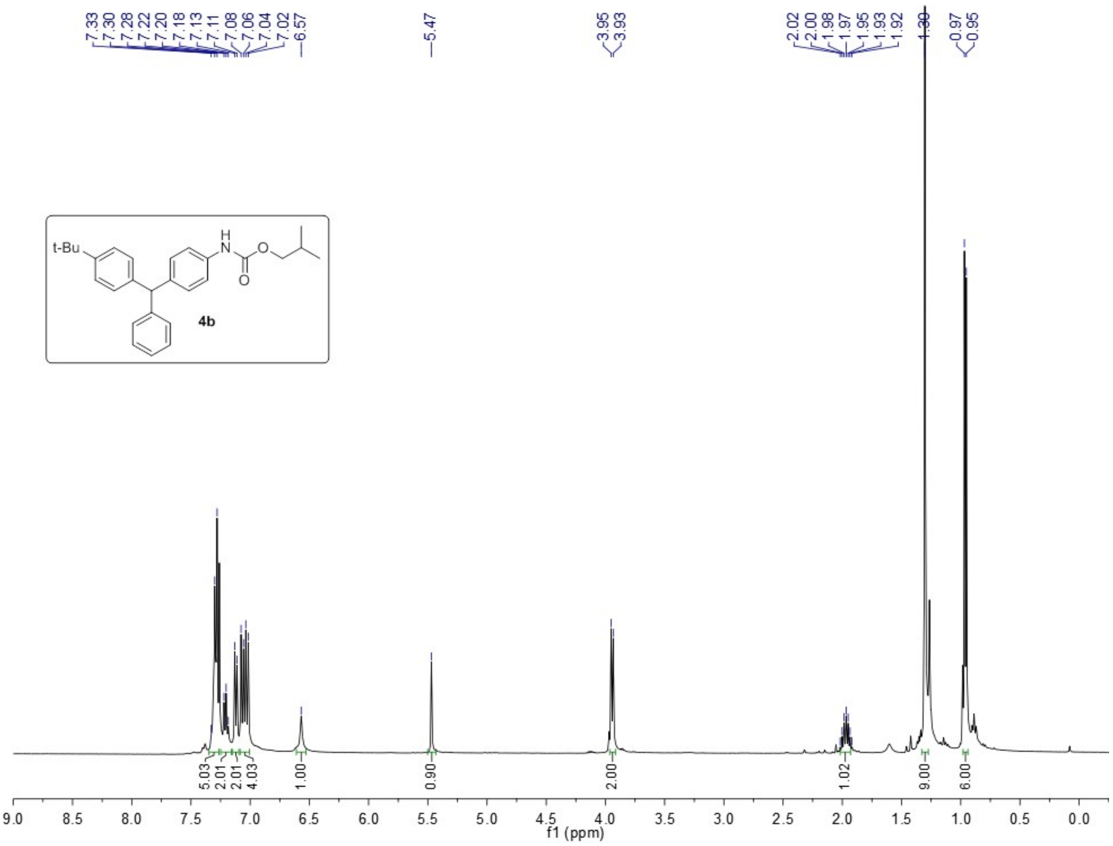
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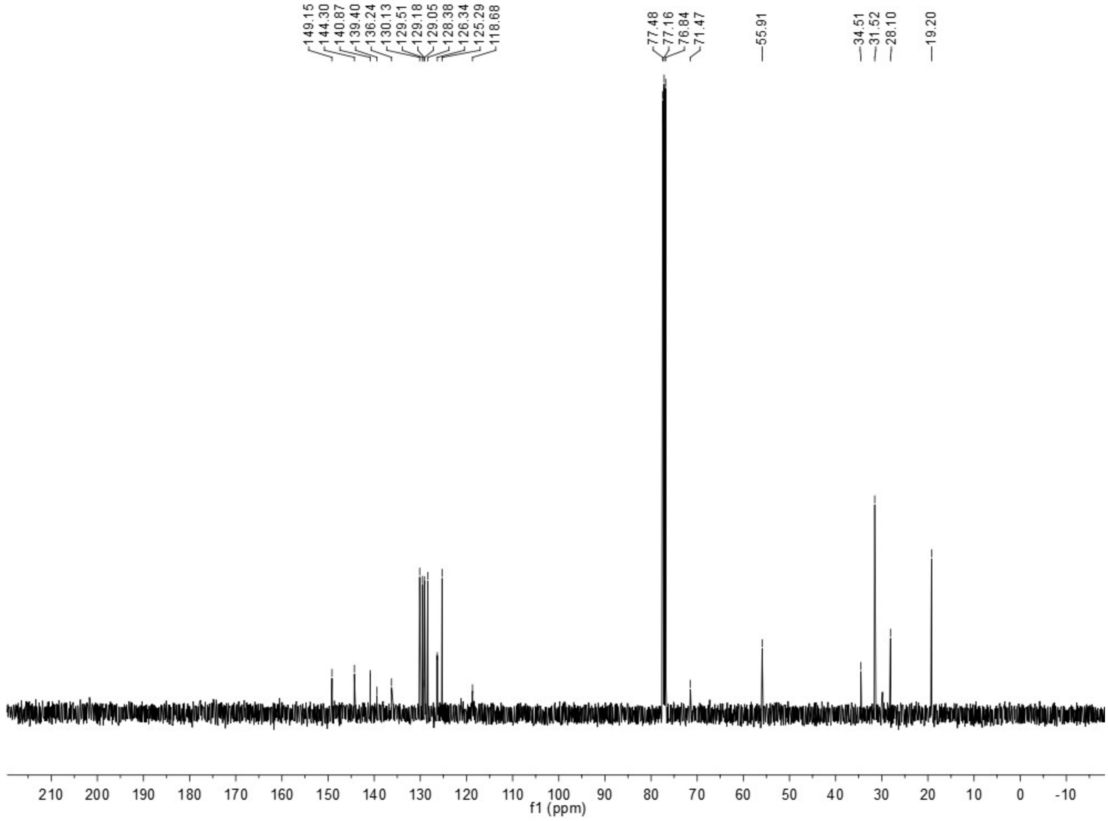
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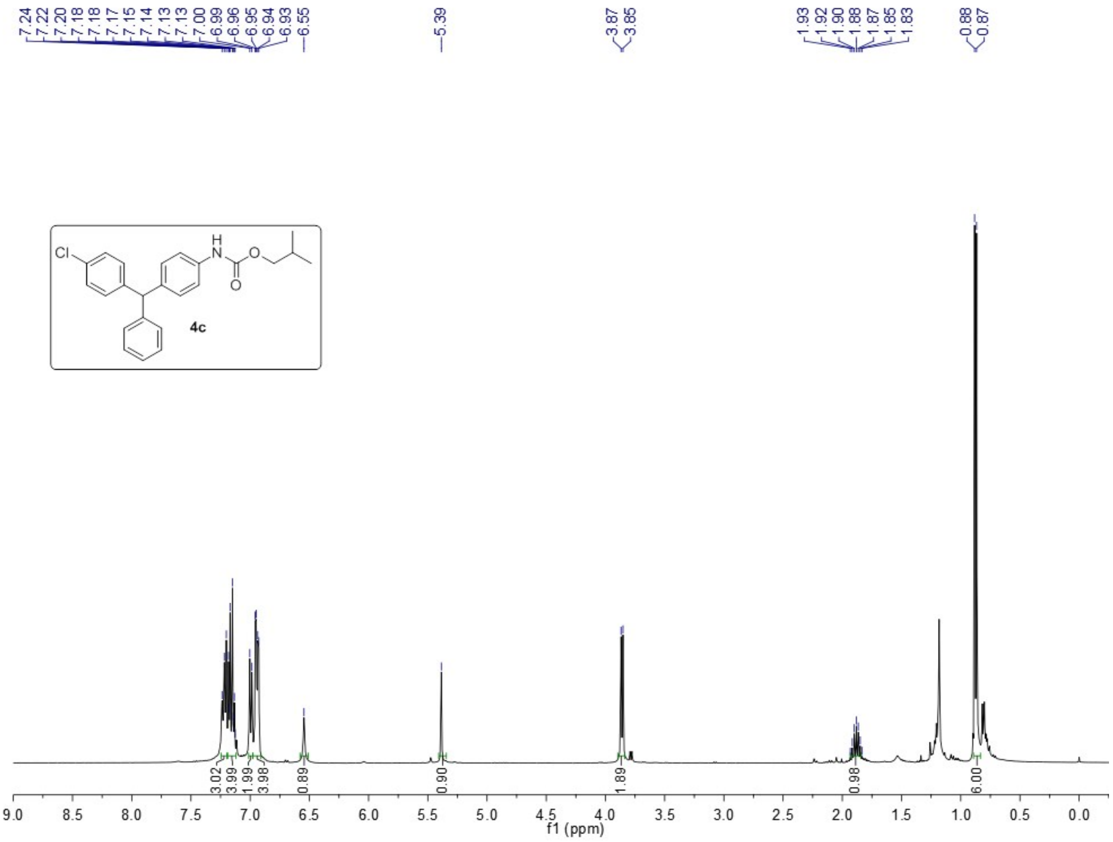

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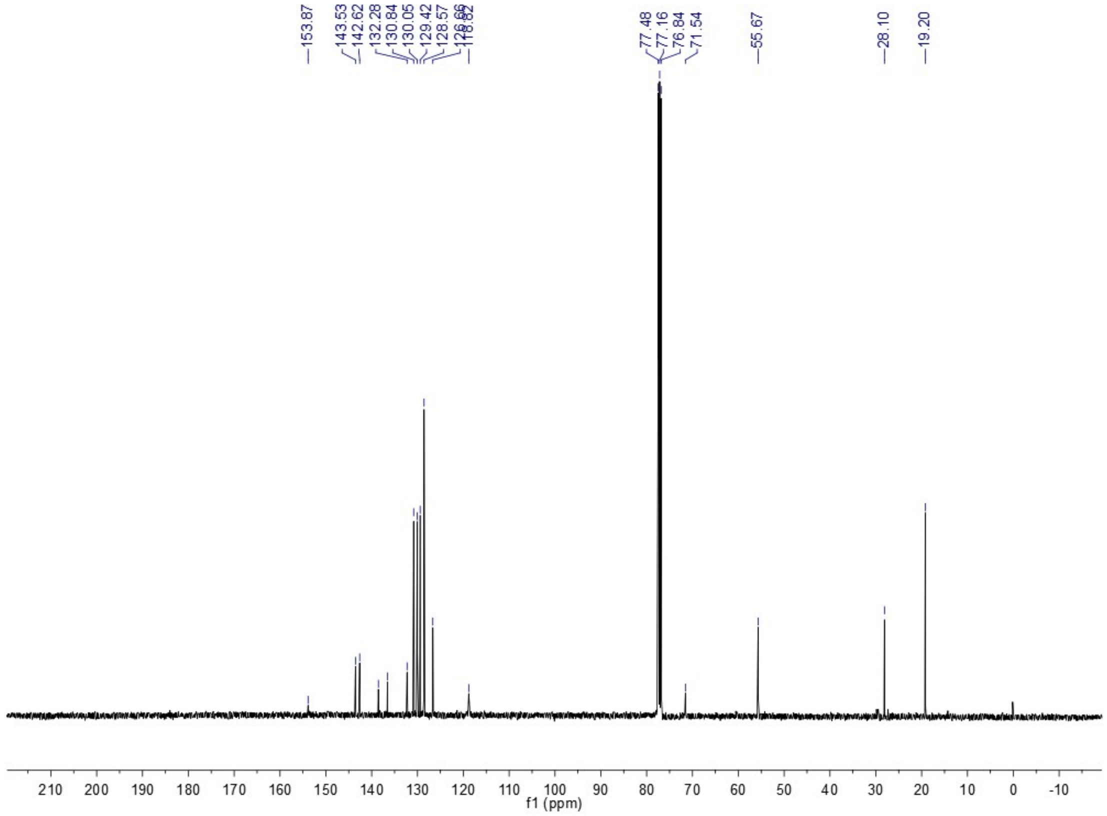

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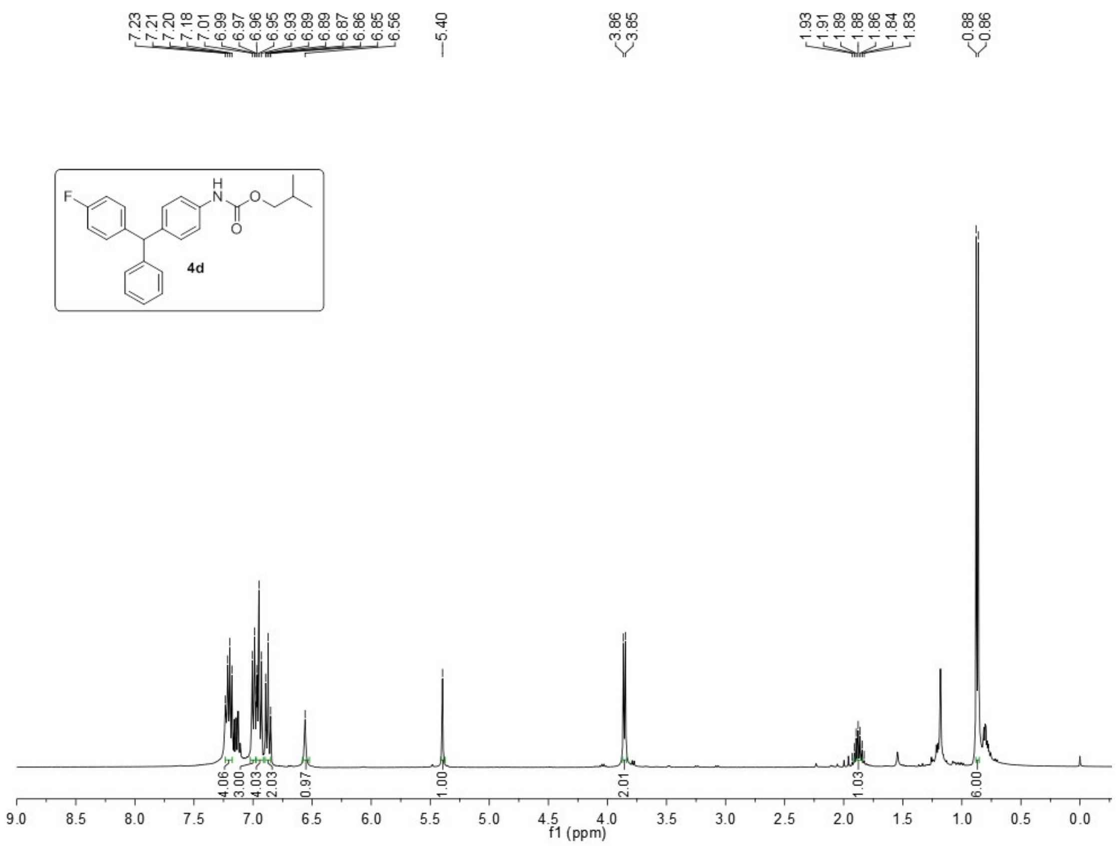

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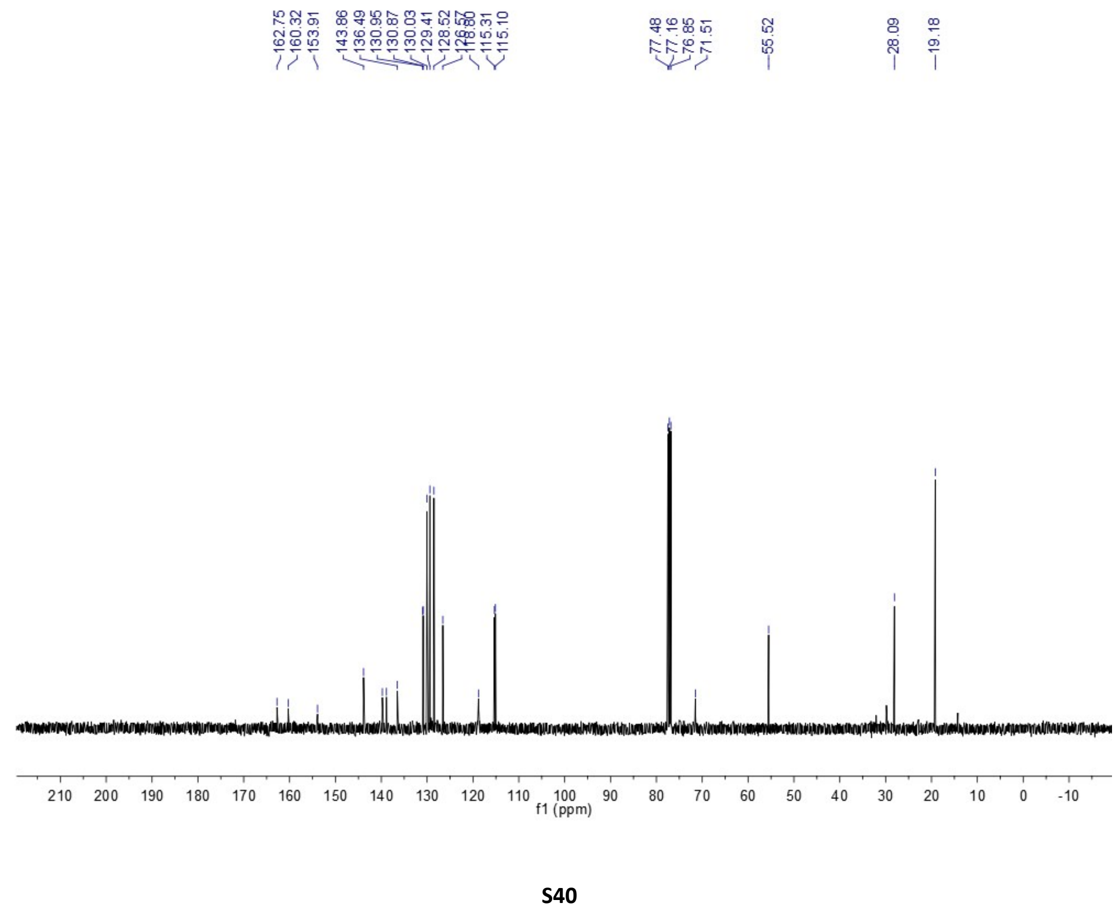

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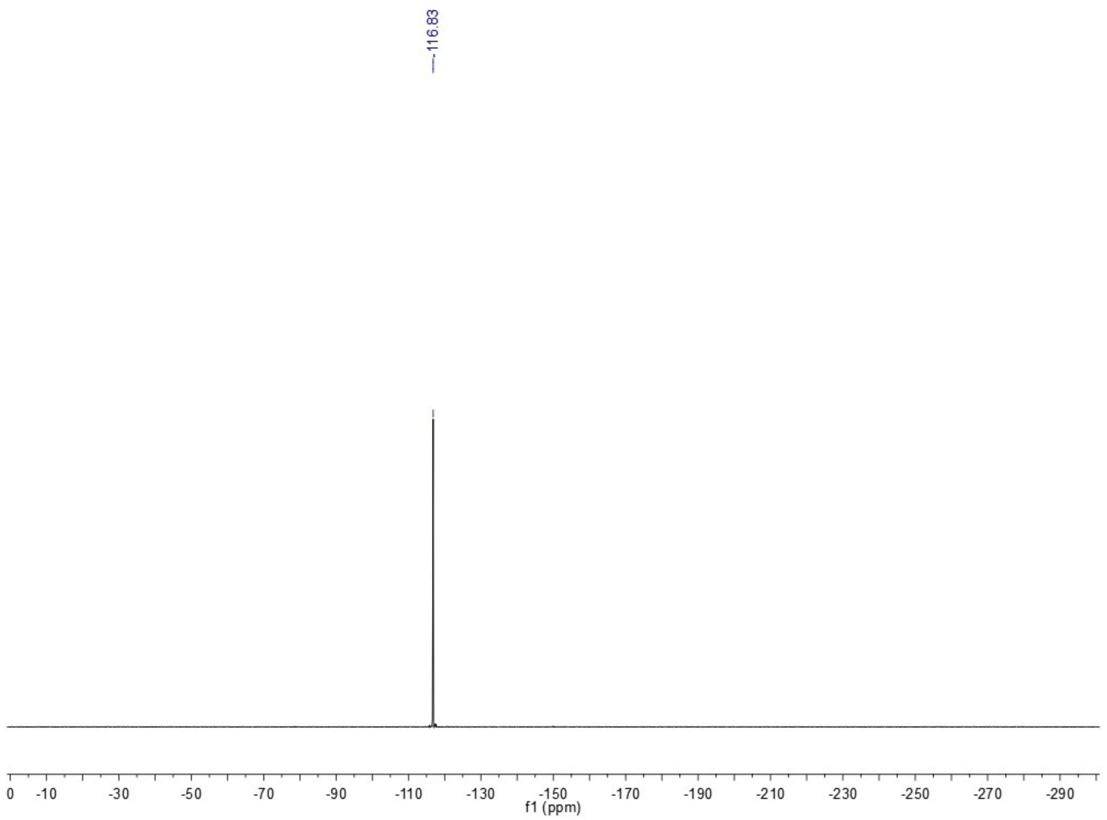
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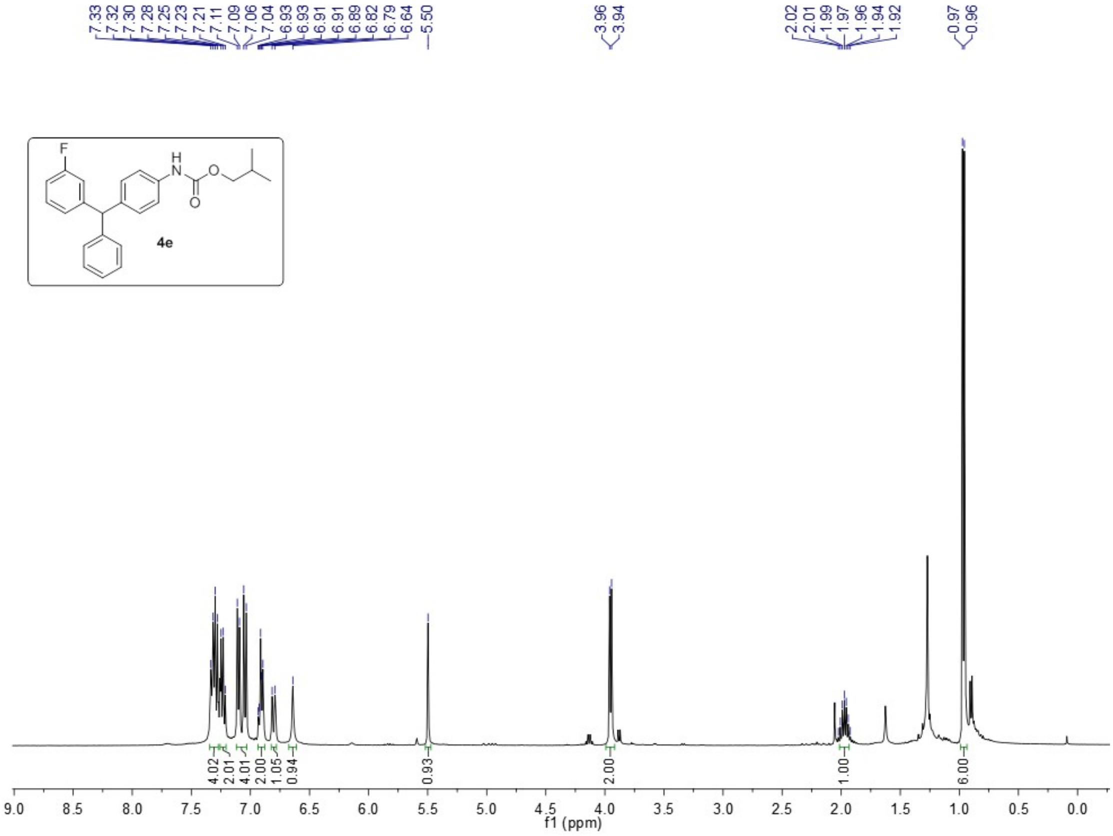
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4.02 2.01 4.01 2.00 1.05 0.94 0.93 2.00 1.00 6.00
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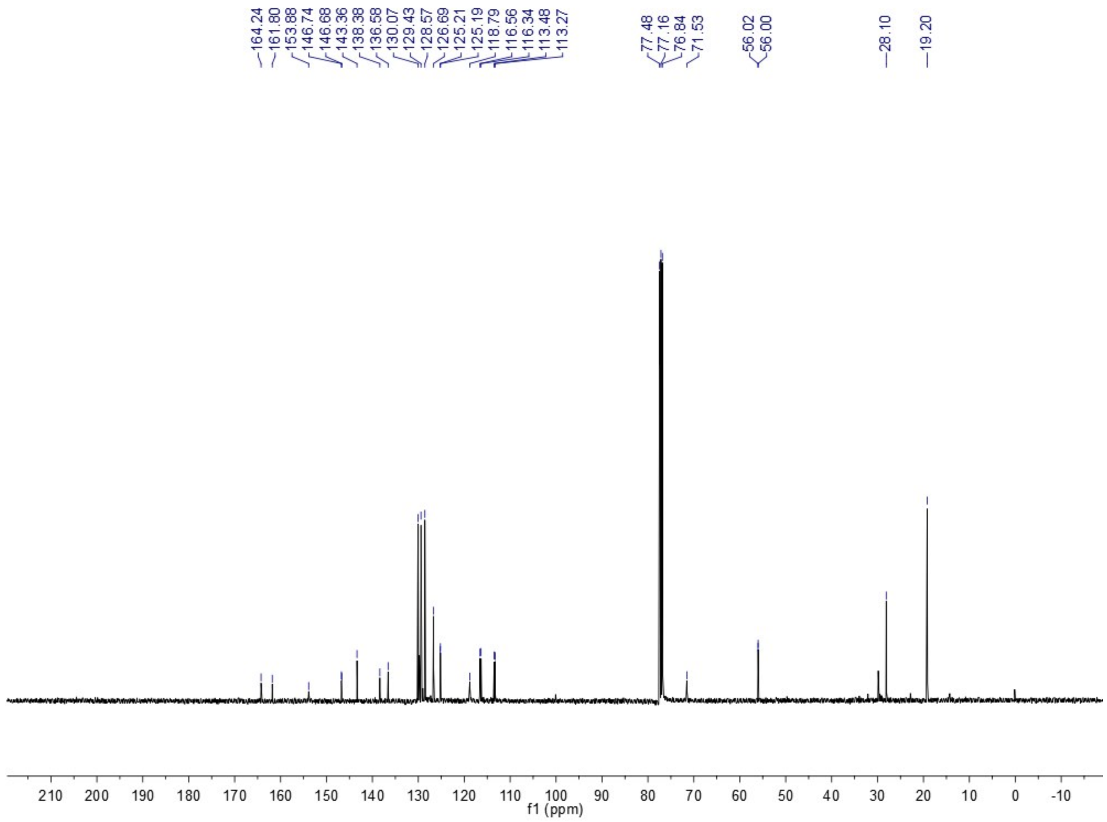
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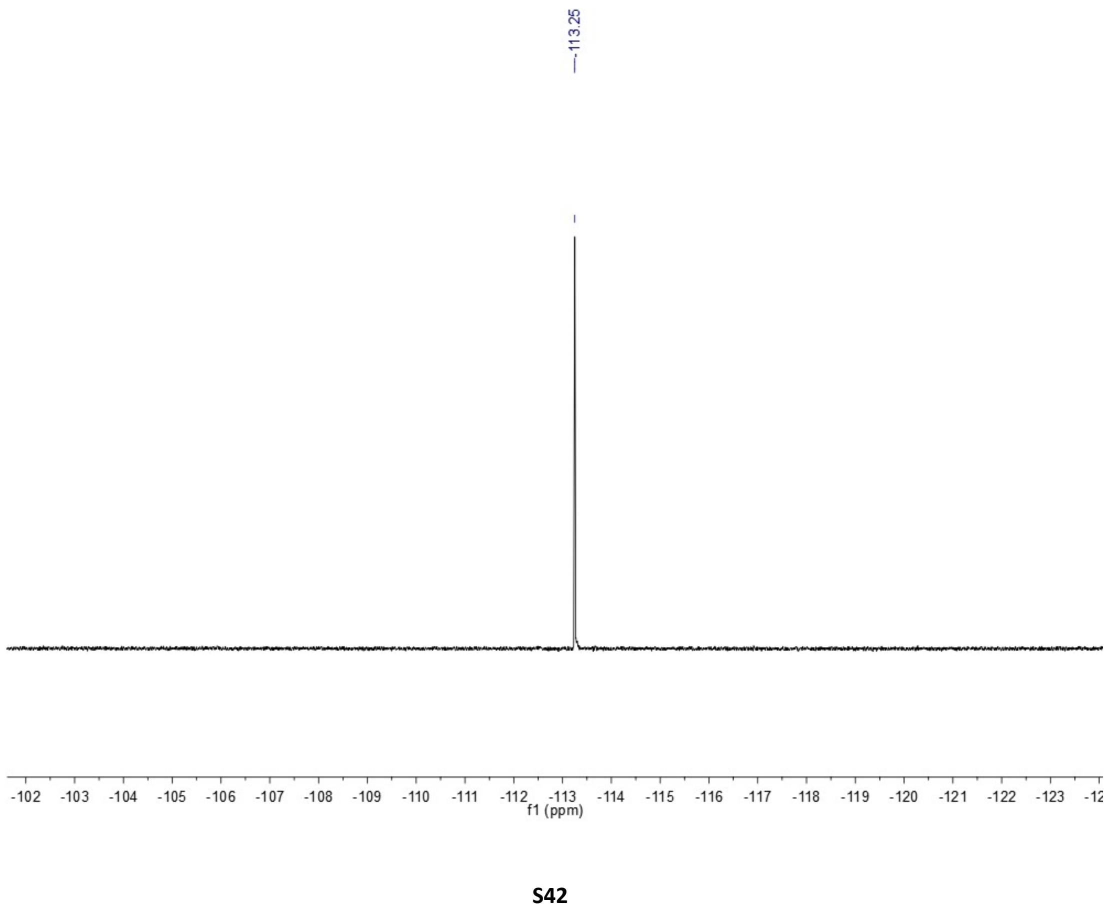
f1 (ppm)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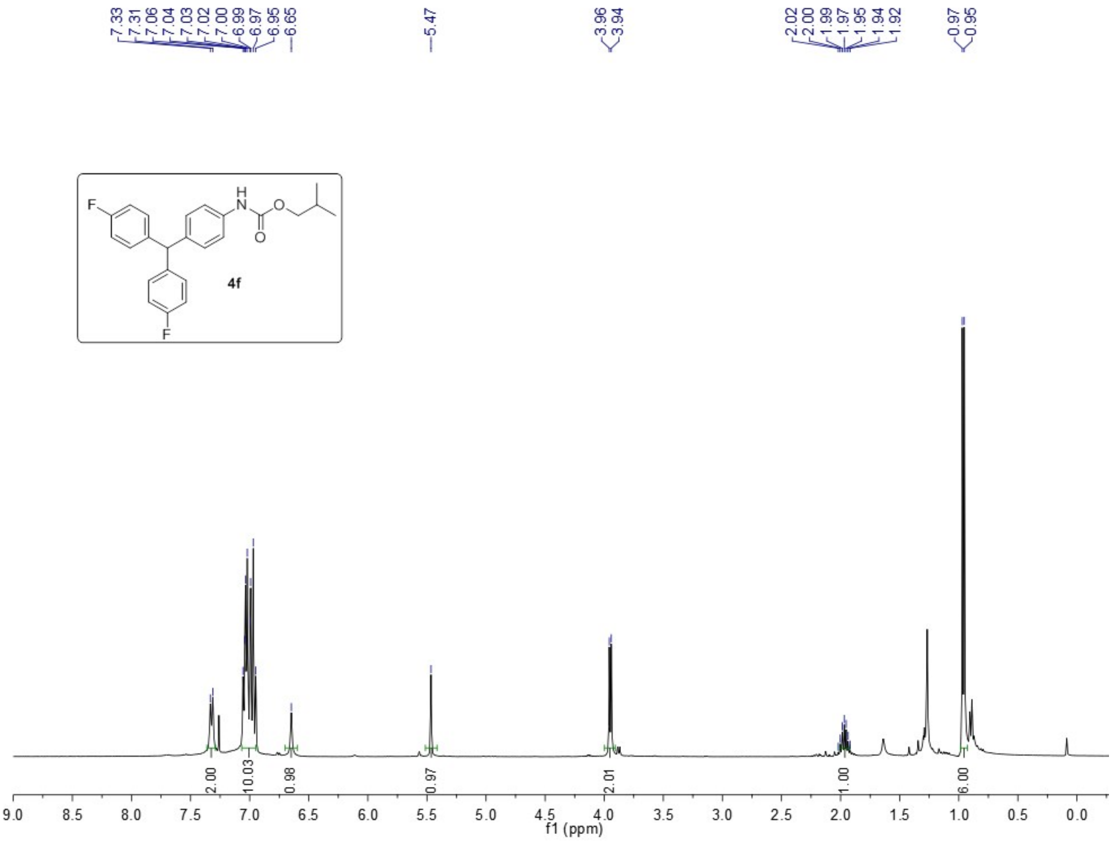
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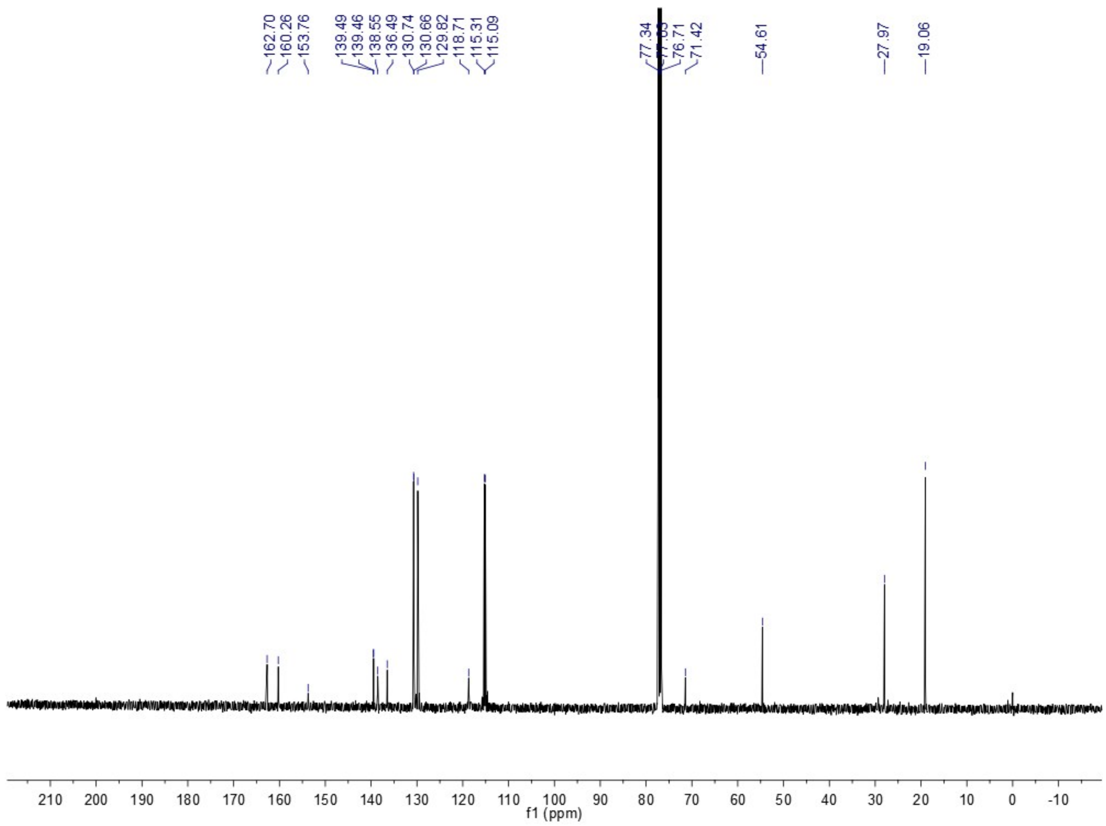
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139.49
139.46
138.55
136.49
130.74
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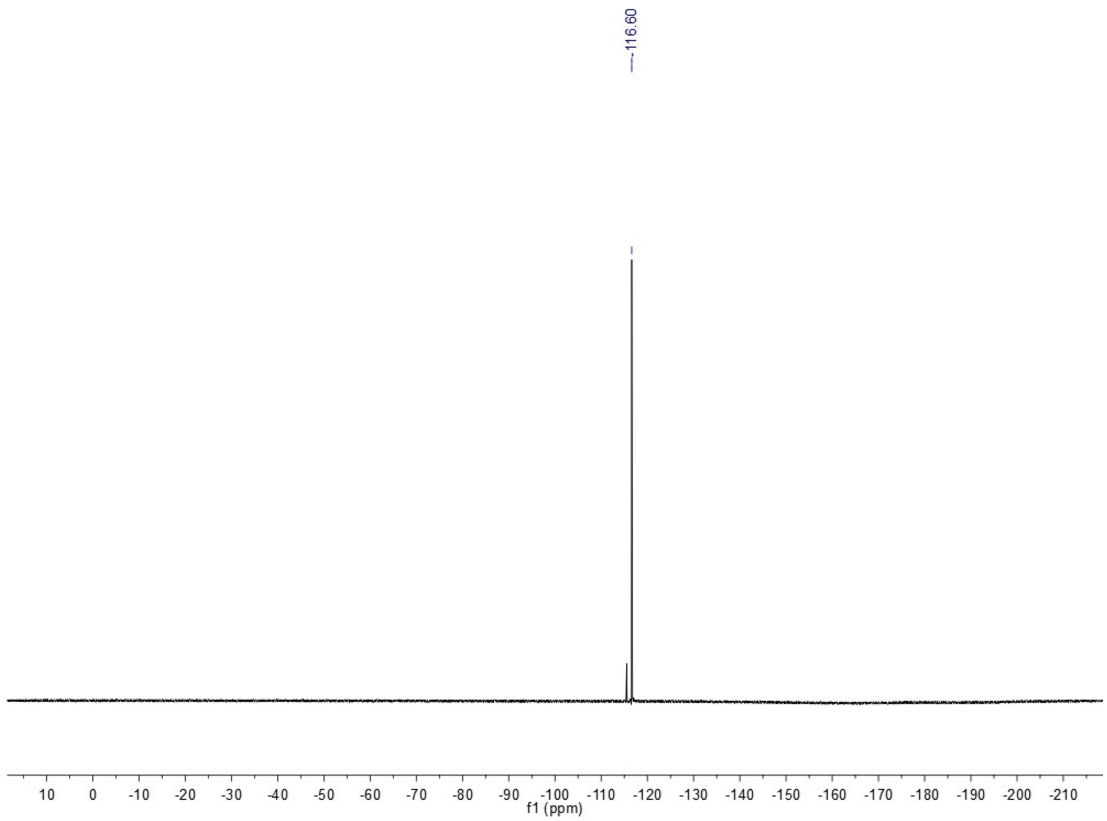
115.31
115.09
77.34
76.71
71.42
54.61
27.97
19.06
f1 (ppm)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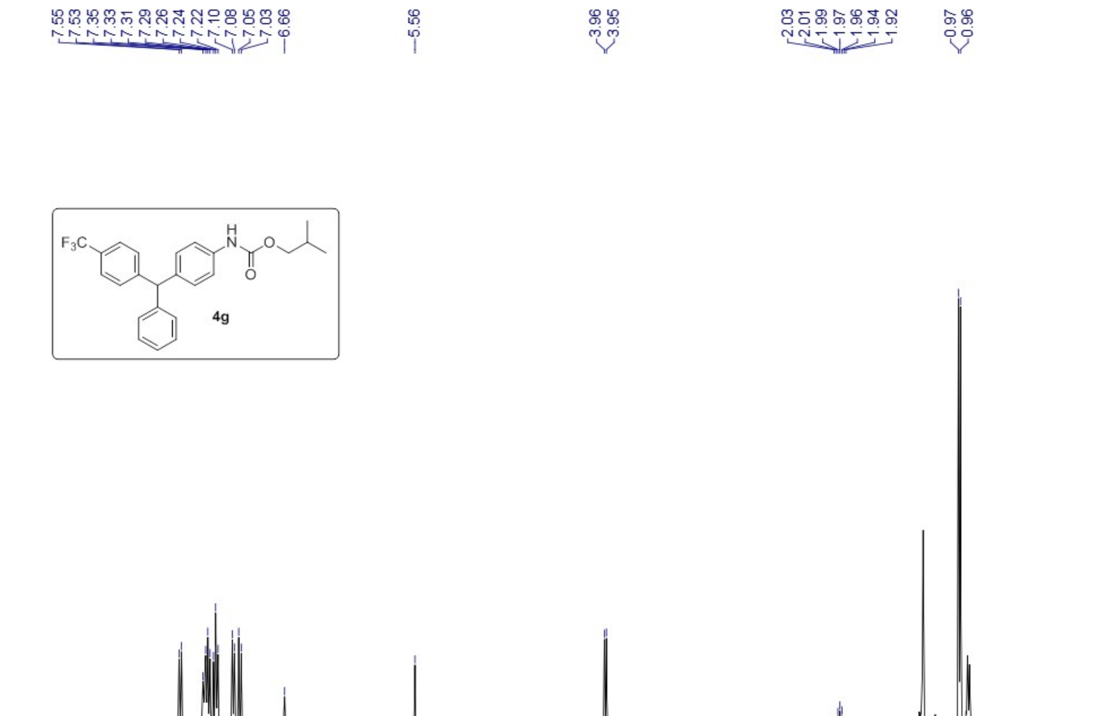
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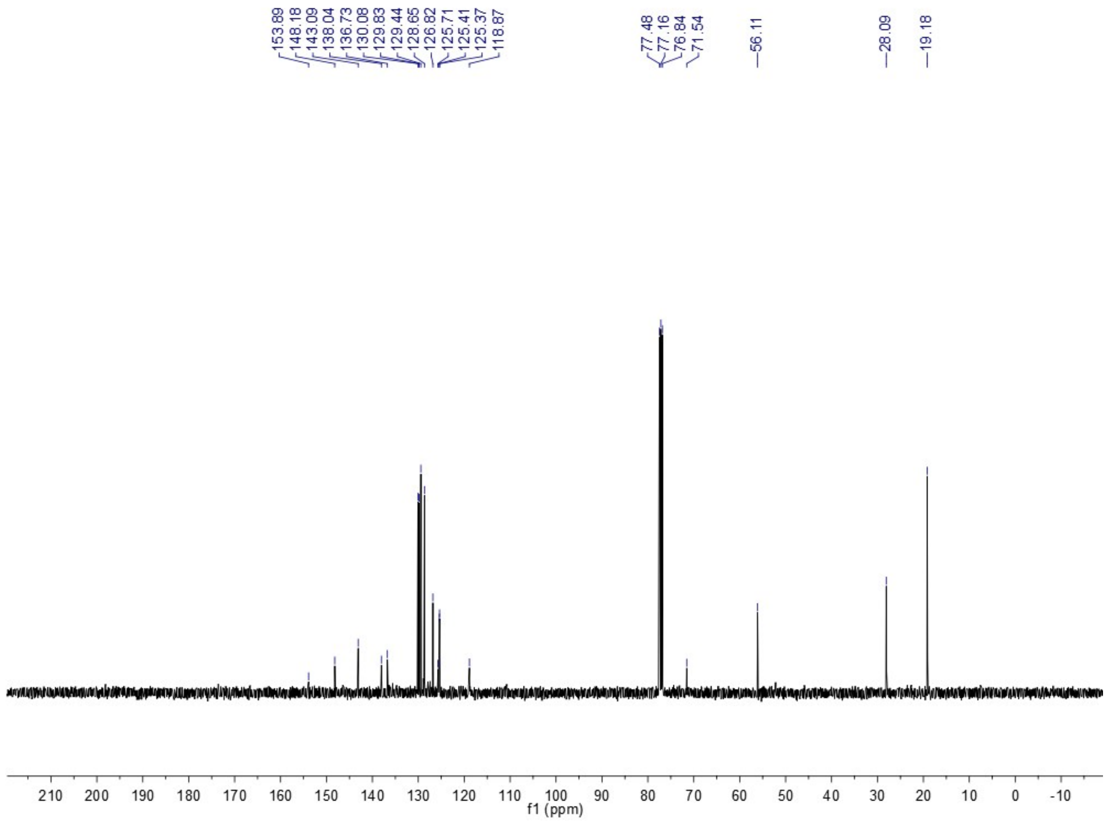
5.56
3.96 3.95
2.03 2.01 1.99 1.97 1.96 1.94 1.92
0.97 0.96
F_3C
H
N
O
O
4g
1.98 4.01 2.99 1.99 1.98 0.91 0.87 1.99 1.00 6.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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118.87
77.48
77.16
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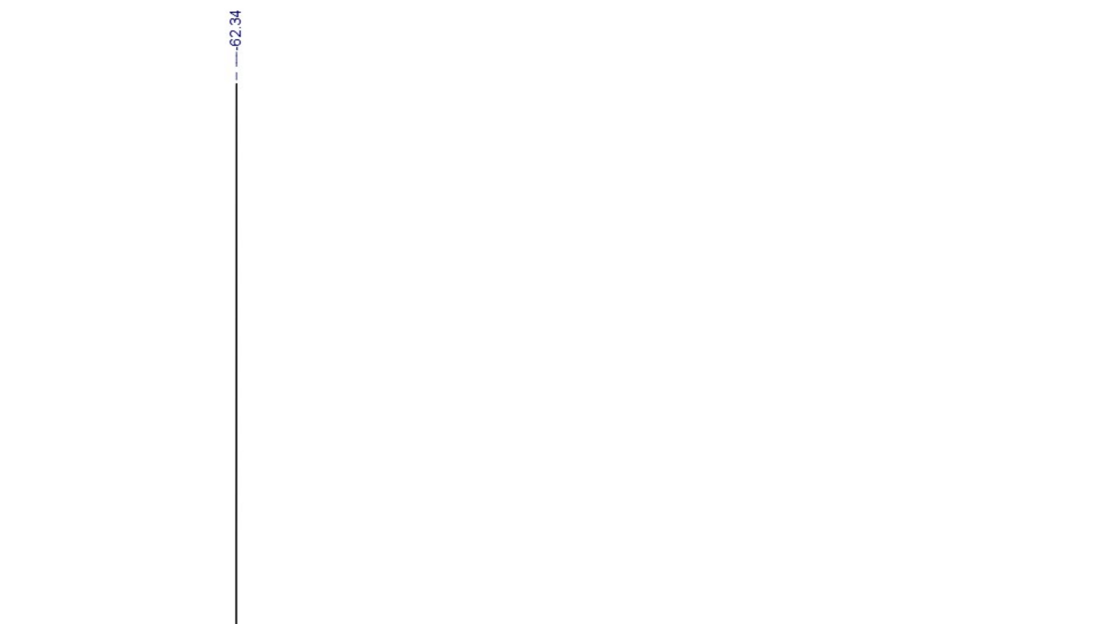
56.11
28.09
19.18
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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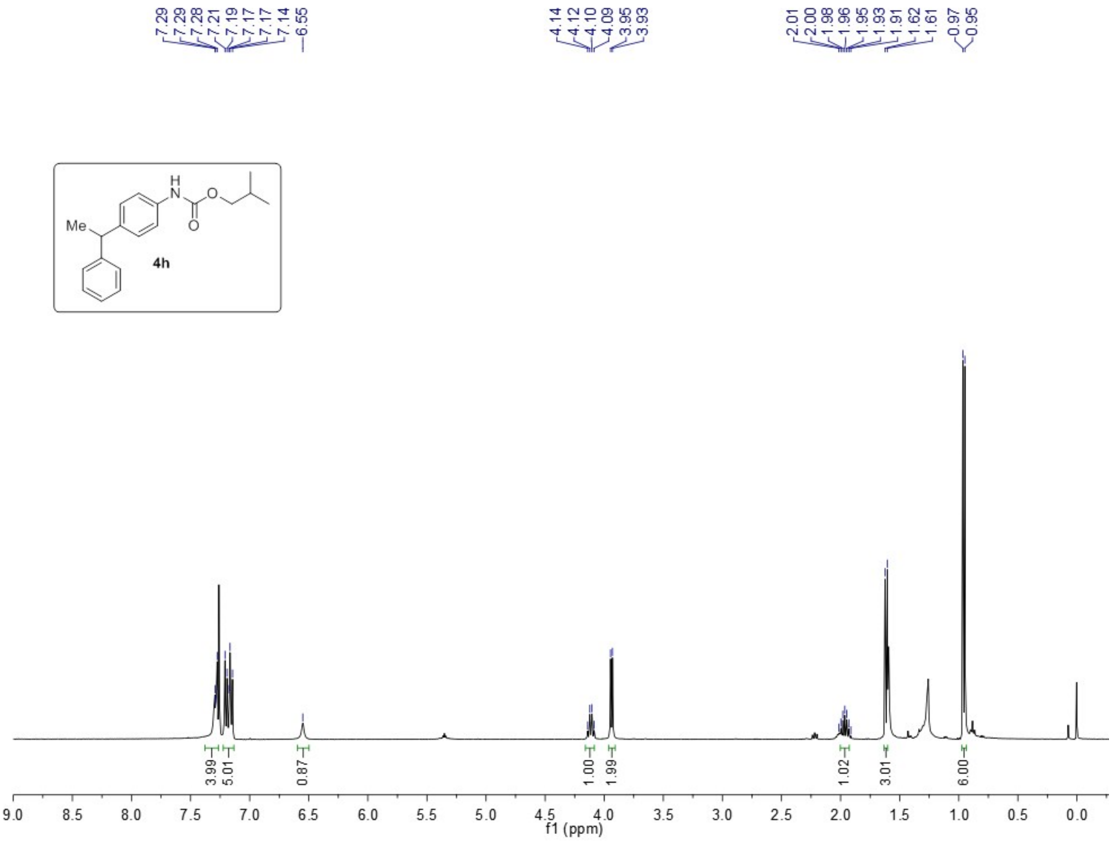

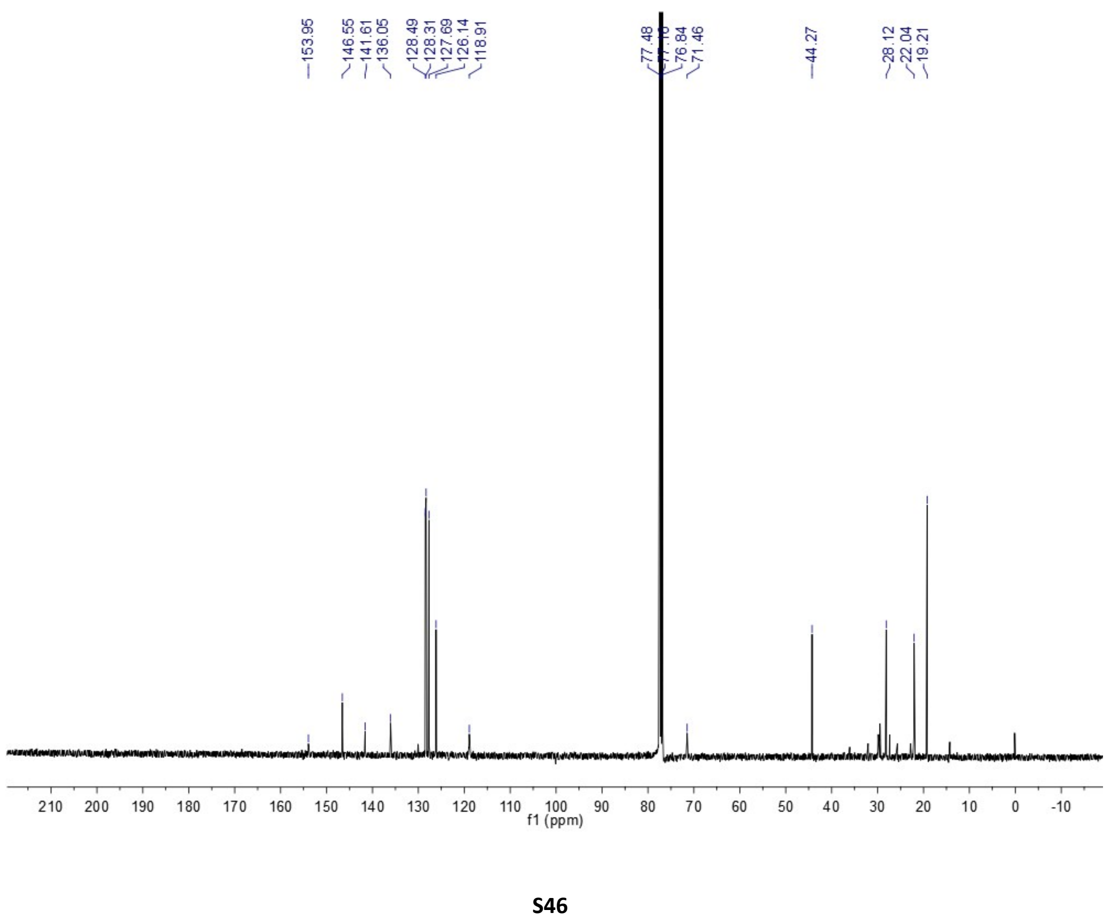

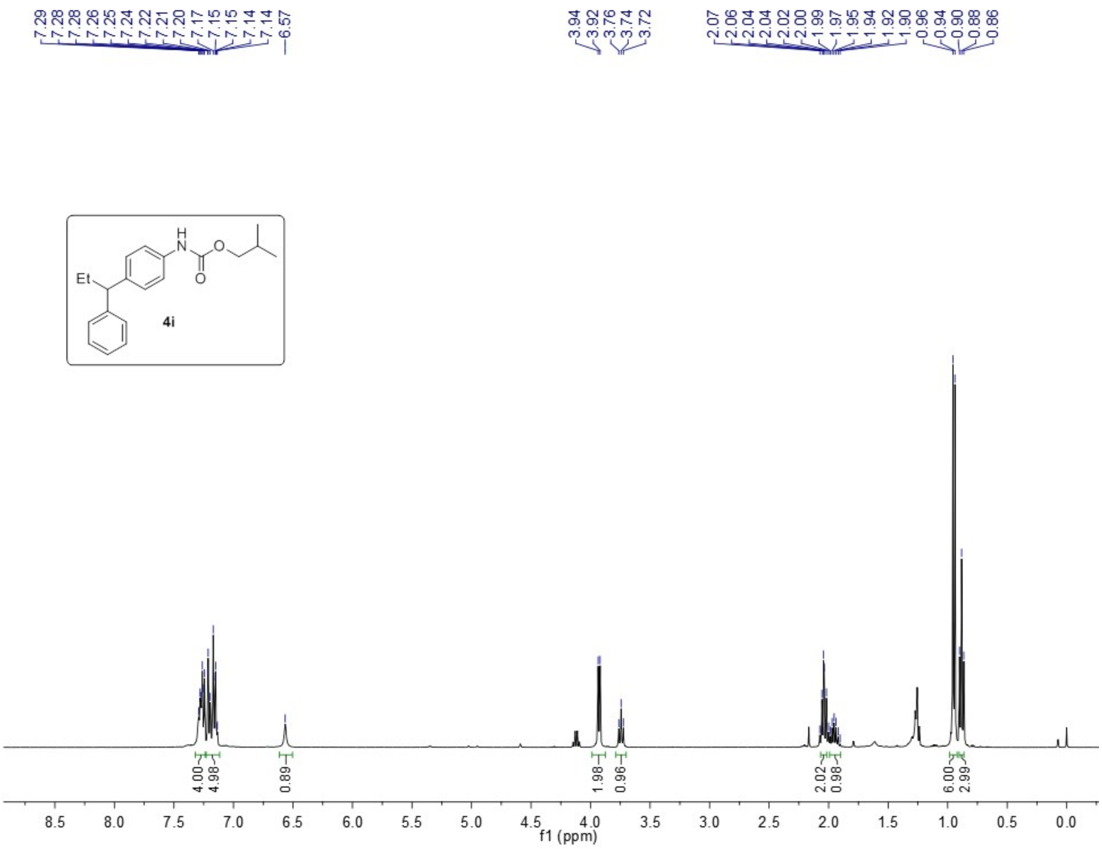
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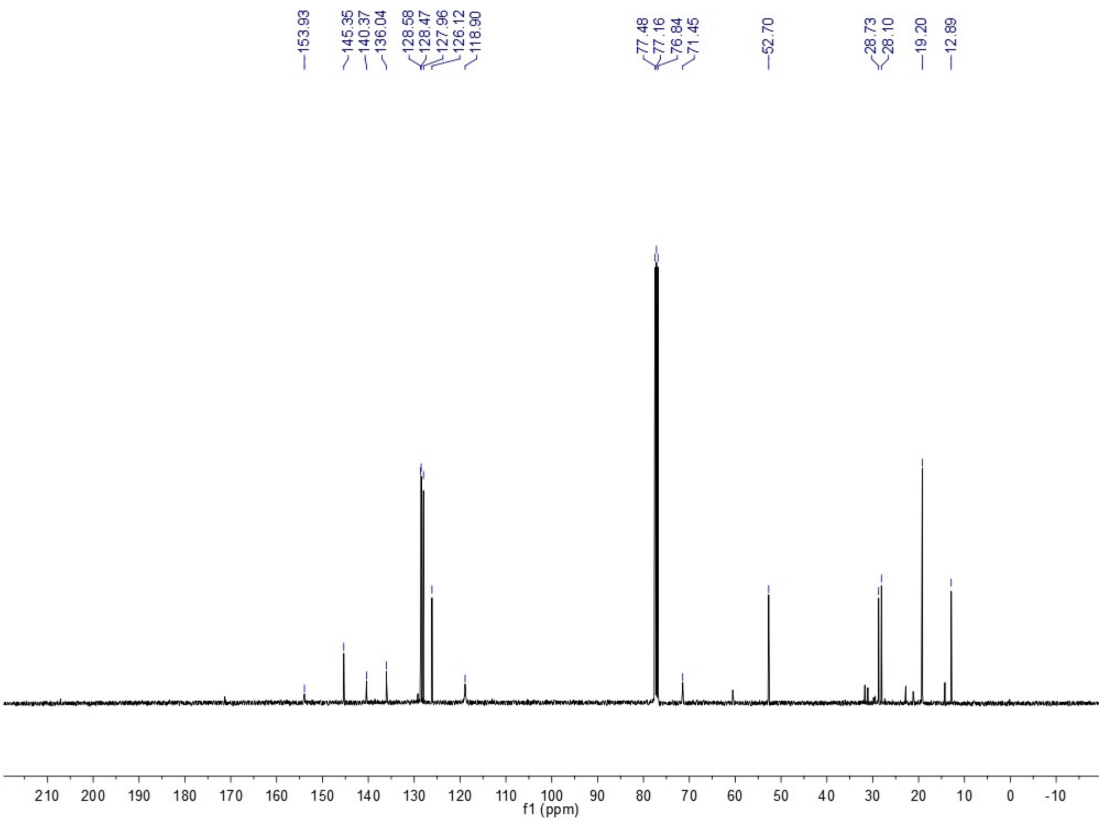
3.94 3.92 3.76 3.74 3.72
2.07 2.06 2.04 2.04 2.02 2.00 1.99 1.97 1.95 1.94 1.92 1.90 0.96 0.94 0.90 0.88 0.86
Et
H
N
O
O
4i
4.00 4.98 0.89 1.98 0.96 2.02 0.98 6.00 2.99
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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145.35 140.37 136.04 128.58 128.47 127.96 126.12 118.90
77.48 77.16 76.84 71.45
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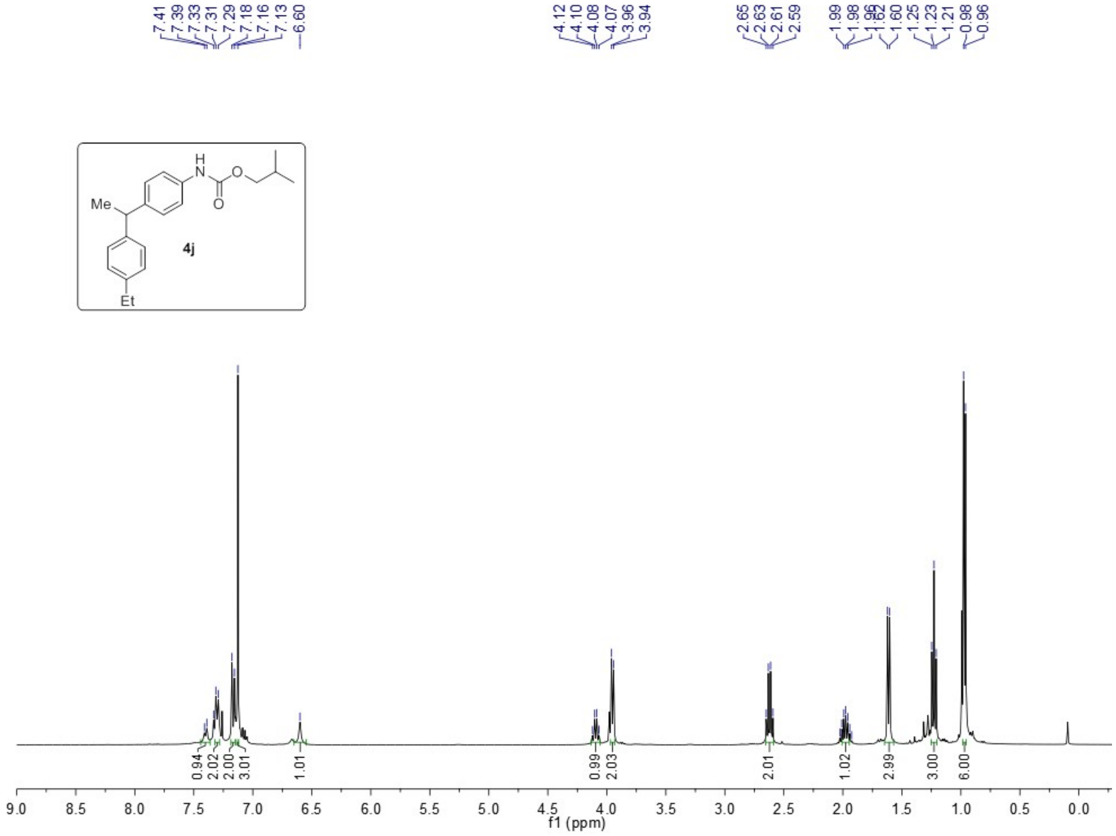
28.73 28.10 19.20 12.89
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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4.12
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3.96
3.94
2.65
2.63
2.61
2.59
1.99
1.98
1.96
1.62
1.60
1.25
1.23
1.21
0.98
0.96
Me
Et
4j
0.94
2.02
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0.99
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2.01
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2.99
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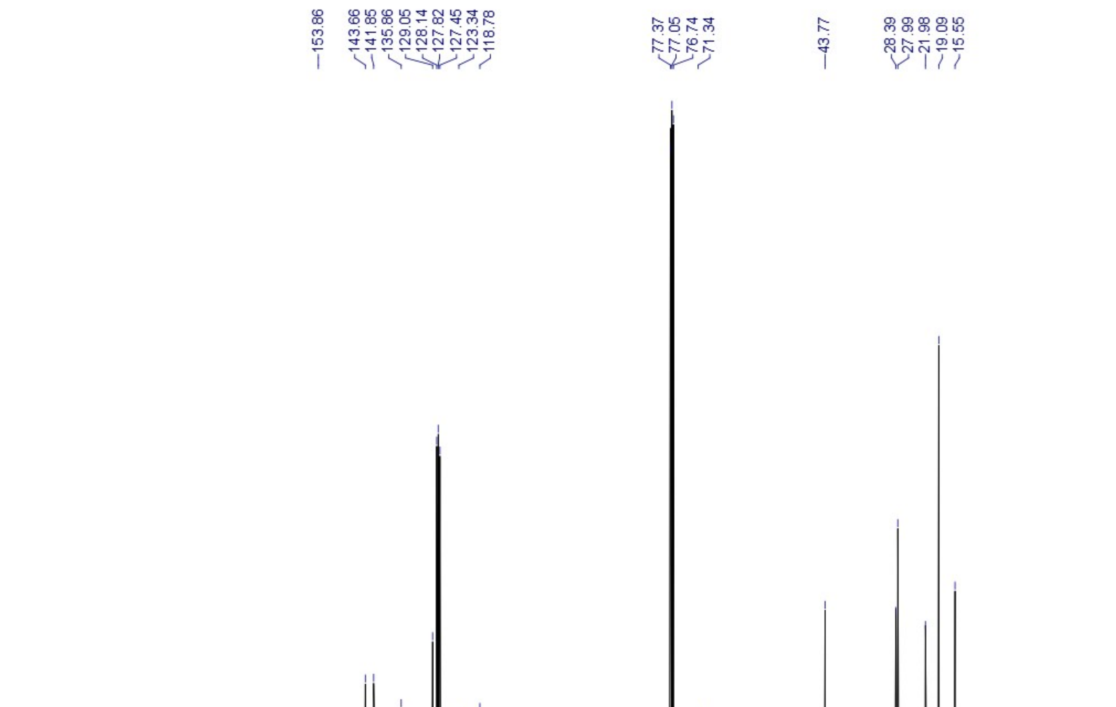
6.00
f1 (ppm)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21.98
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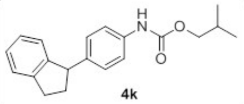
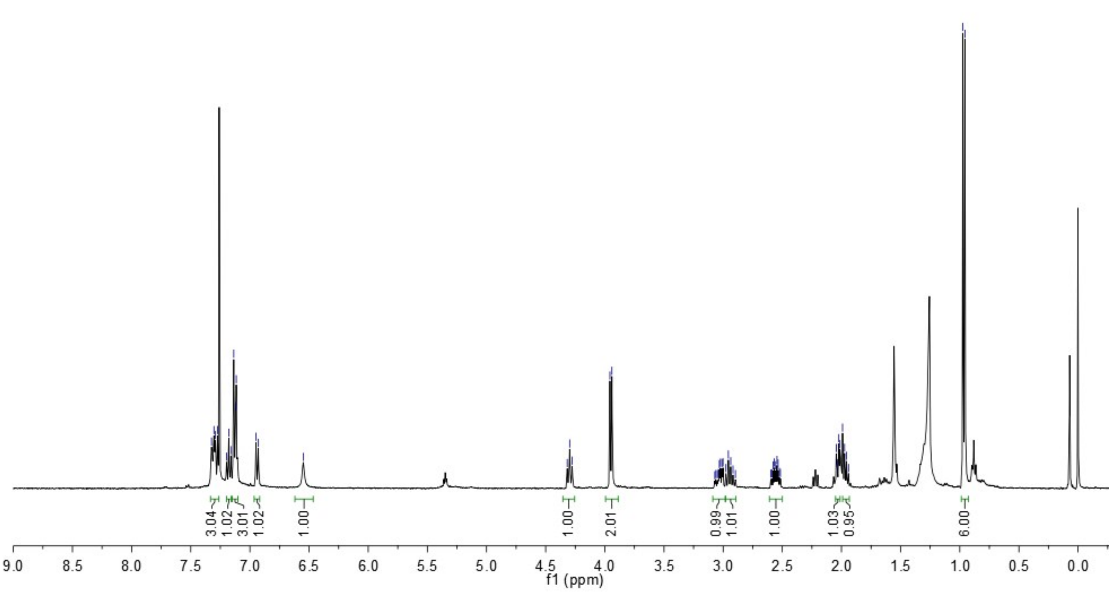
f1 (ppm)


H
N
O
O

4k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7.14
7.12
7.12
6.95
6.93
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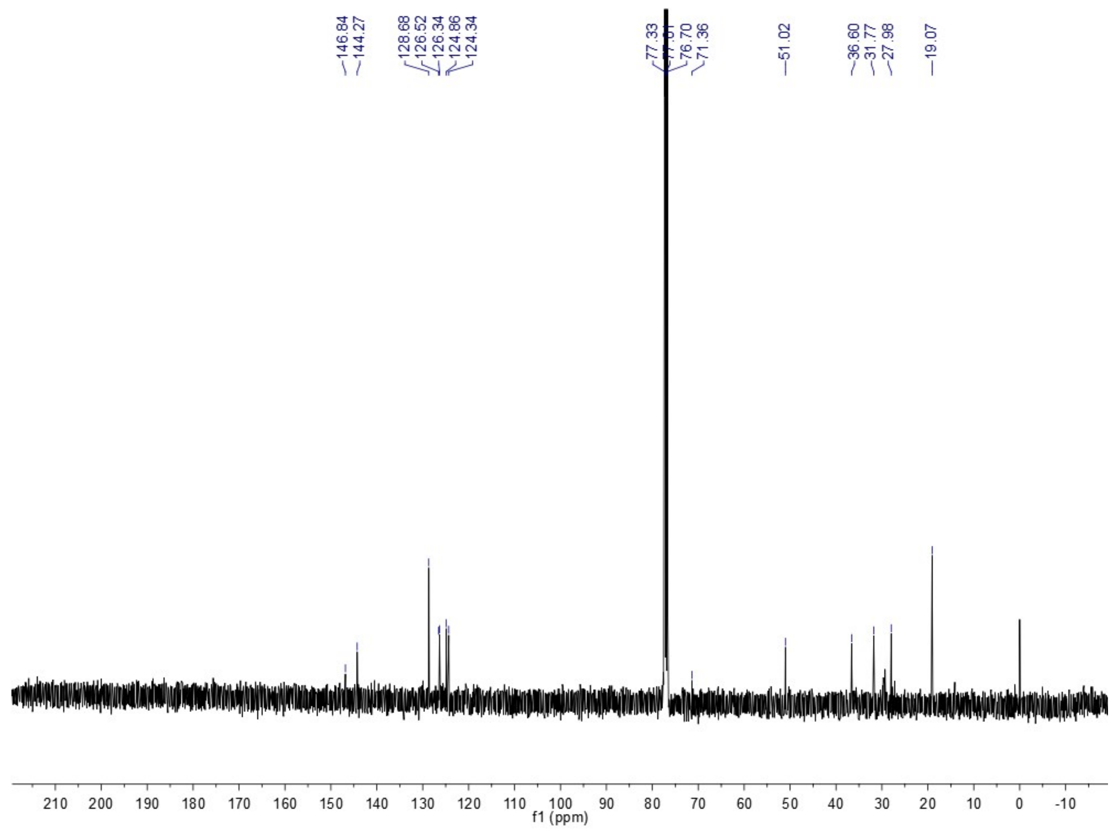
4.32
4.30
4.28
3.96
3.94
3.03
3.02
3.01
3.00
2.98
2.96
2.94
2.57
2.55
2.54
2.04
2.04
2.02
2.01
1.99
1.97
1.96
0.97
0.96
3.04
1.02
3.01
1.02
1.00
1.00
2.01
0.99
1.01
1.00
1.03
0.95
6.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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31.77
27.98
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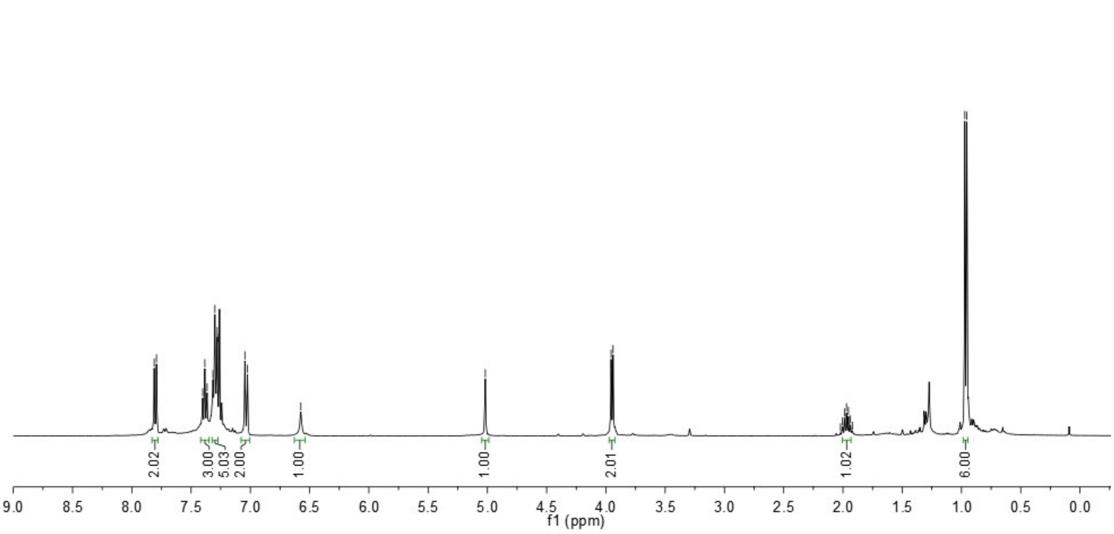
f1 (ppm)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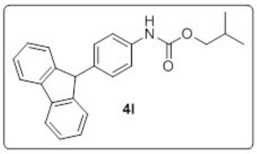
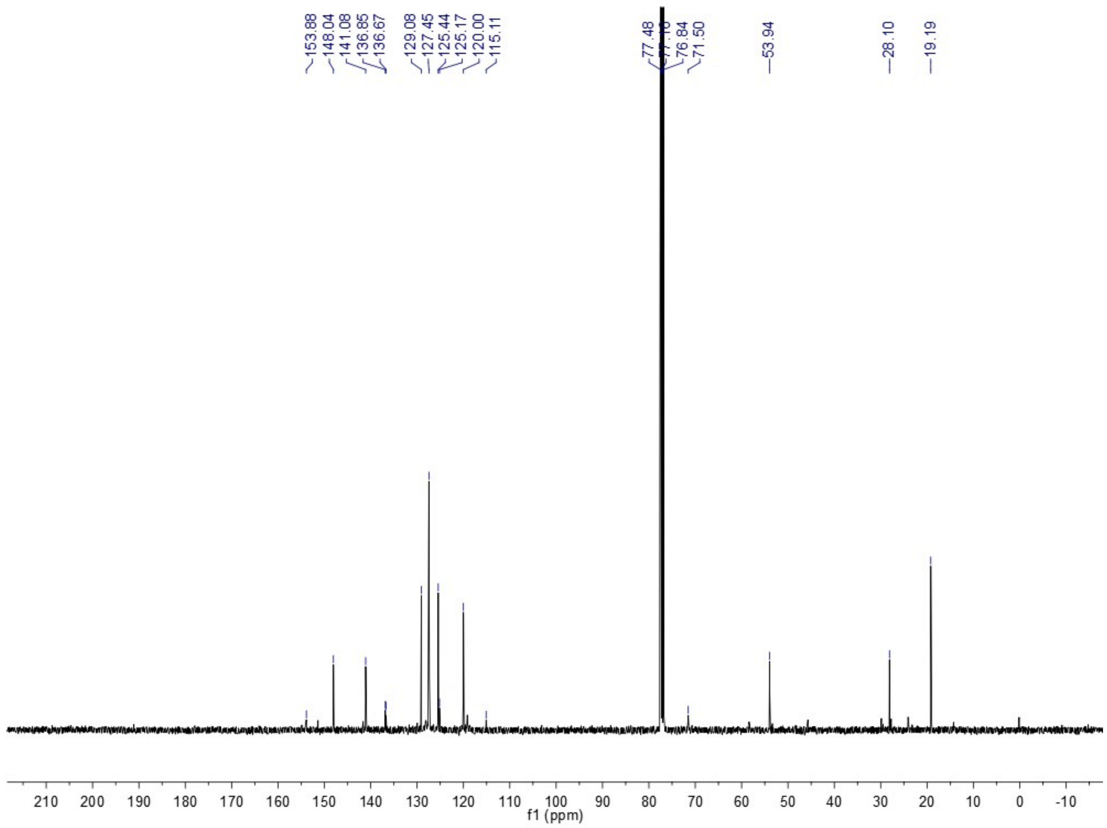
3.94
2.02
2.00
1.99
1.97
1.95
1.94
1.92
0.97
0.96
2.02
3.00
5.03
2.00
1.00
1.00
2.01
1.02
6.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)



4l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120.00
115.11
77.48
77.16
76.84
71.50
53.94
28.10
19.19
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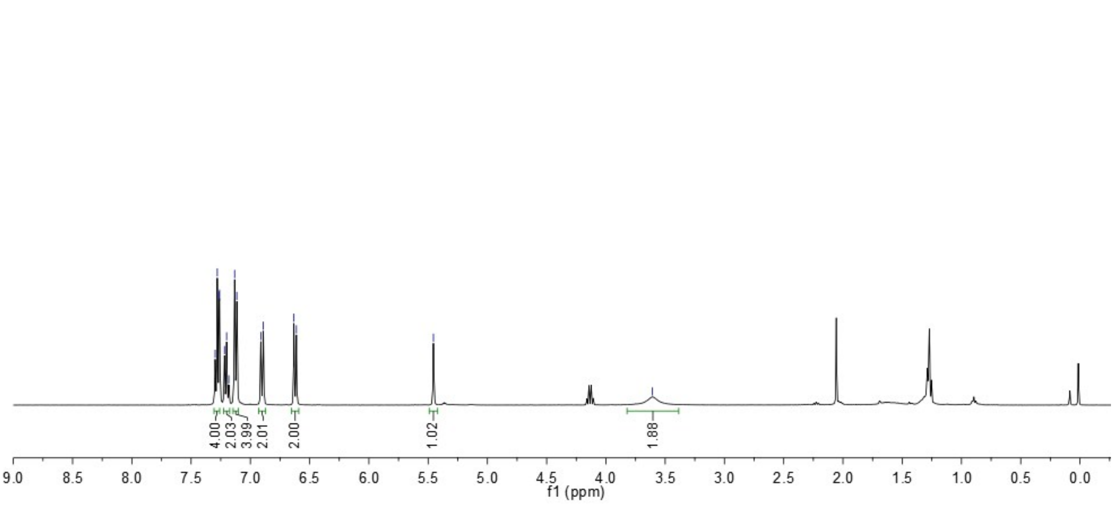
f1 (ppm)



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4.00
2.03
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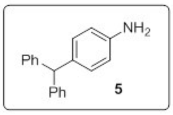
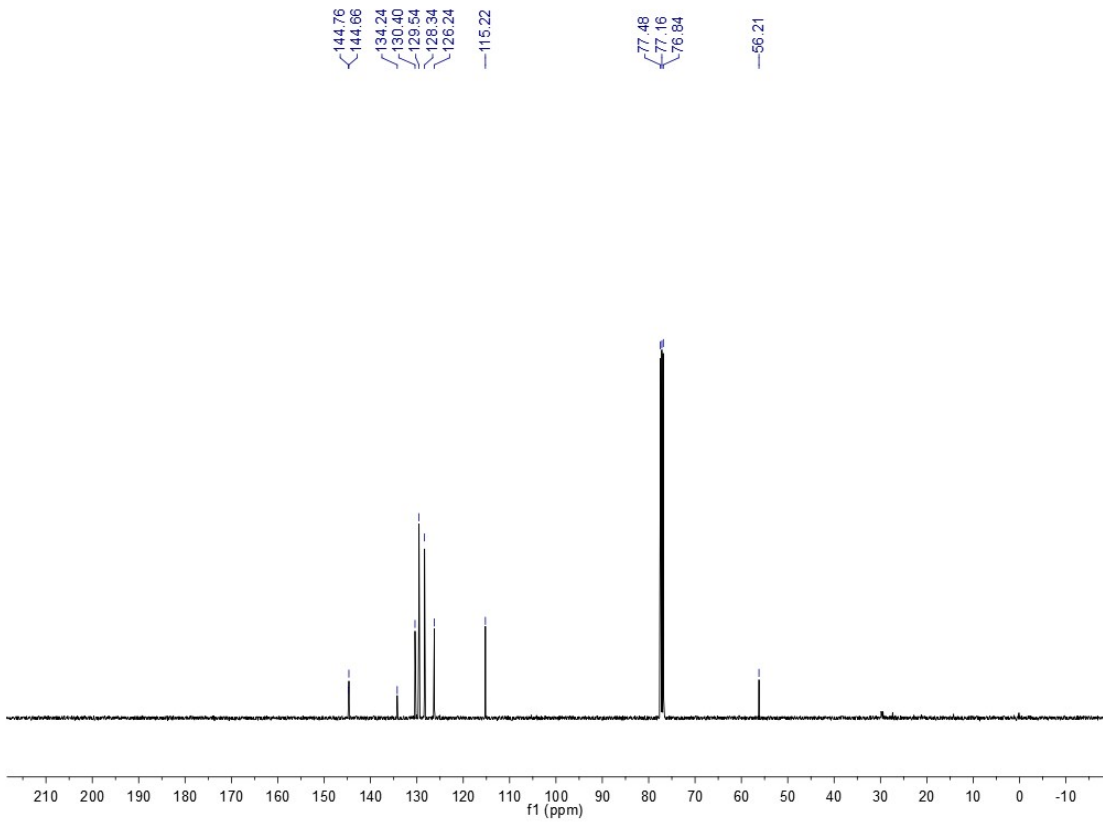
2.01
2.00
1.02
1.88
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)



NH2
Ph
Ph
5



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134.24
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128.34
126.24
115.22
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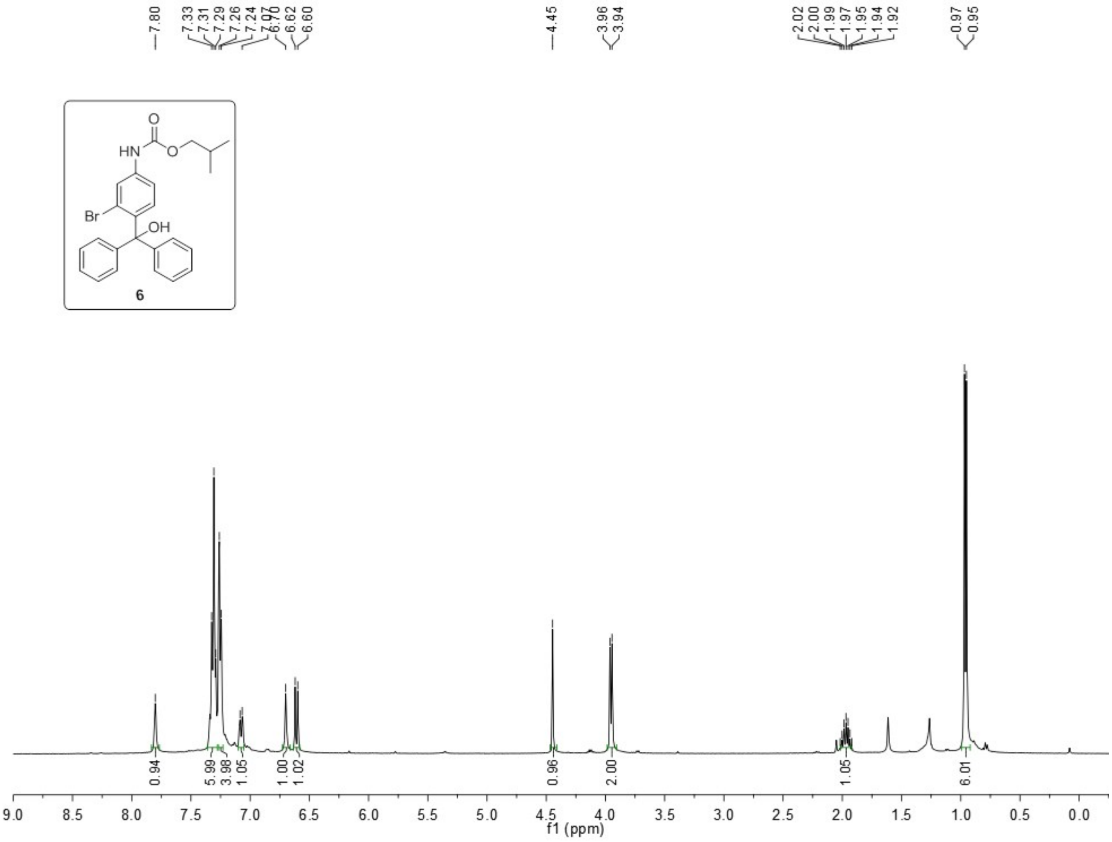
77.16
76.84
56.21
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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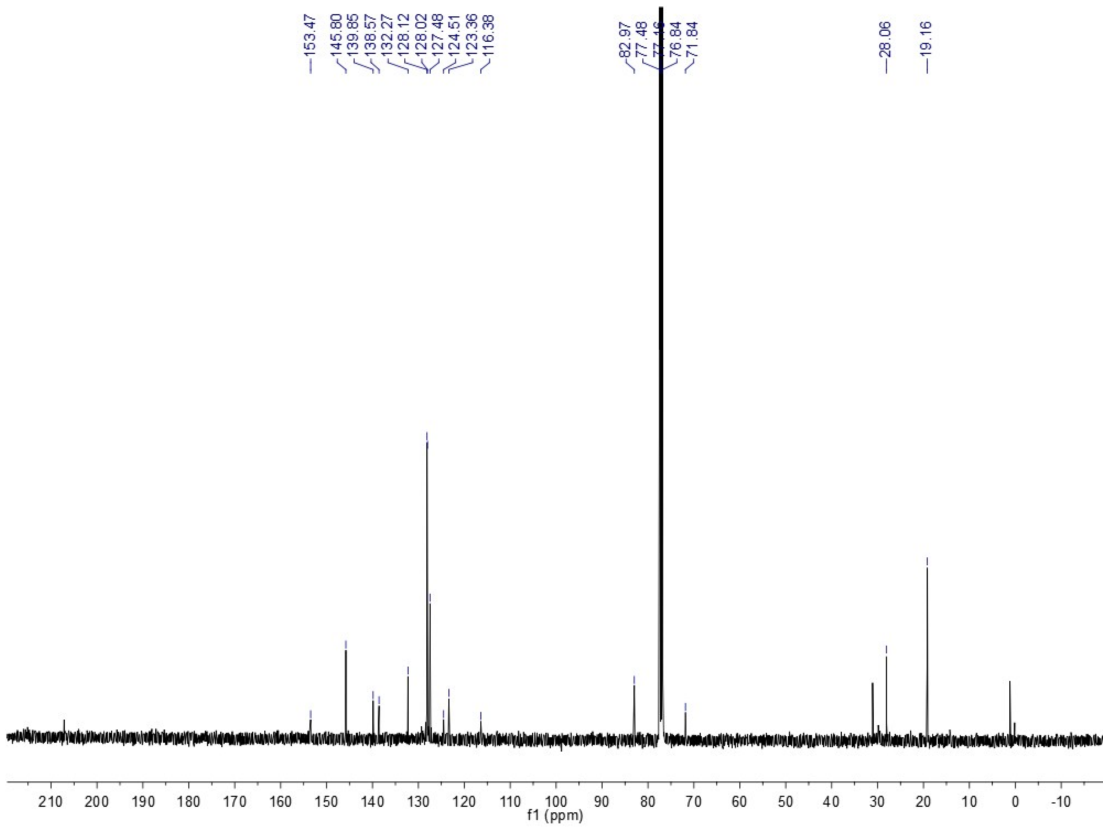
6.62
6.60
4.45
3.96
3.94
2.02
2.00
1.99
1.97
1.95
1.94
1.92
0.97
0.95
HN
O
O
Br
OH
6
0.94
5.99
3.98
1.05
1.00
1.02
0.96
2.00
1.05
6.01
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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77.48
77.16
76.84
71.84
28.06
19.16
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

References

(1) H. R. Yang, D. F. Huang, K. –H. Wang, C. M. Xu, T. Niu, and Y. L. Hu, Reaction of organozinc halides with aryl isocyanates. *Tetrahedron* **2013,** *69,* 2588-2593.