Supporting infomation

Photoinduced hydroxylperfluoroalkylation of styrenes

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1. General Methods

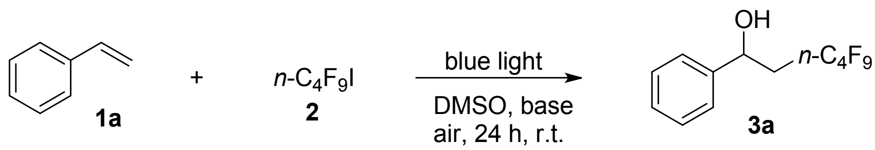
All reagents were used without further purification. Thin layer chromatography (TLC) was visualized by staining with potassium permanganate. Chemical shifts for ^{1}H NMR spectra are reported in ppm downfield from TMS or residual $CHCl_3$ (δ 7.26 ppm). Chemical shifts for ^{19}F NMR are reported in ppm downfield from fluorotrichloromethane ($CFCl_3$). Chemical shifts for ^{13}C NMR spectra are recorded in ppm relative to residual chloroform (δ 77.0 ppm for $CDCl_3$). ^{13}C NMR was broad-band decoupled from hydrogen nuclei. Chemical shifts are expressed in parts per million (ppm) with respect to the residual solvent peak. Coupling constants are reported as hertz (Hz). Signal shapes and splitting patterns are indicated as follows: s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet; br, broad.

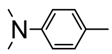
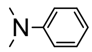
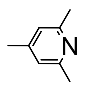
General procedures for synthesis of **3**

A 50 mL Schlenk tube equipped with a rubber septum and a magnetic stirring bar was charged with DMSO (5 mL). Then styrene **1** (1 mmol, 1.0 equiv), *n*-C_4F_9I (2 mmol, 2.0 equiv), TMEDA (2 mmol, 2.0 equiv) were added. The mixture was stirred under an air atmosphere by irradiation of blue LEDs (15 W × 2) for 48 h. After the reaction was complete, the solution was added CH_2Cl_2 (30 mL) and washed with saturated brine (50 mL × 3). The organic layer was dried by anhydrous Na_2SO_4. After that, the organic layer was seperated and concentrated under vacuum. The residue was purified with silica gel column chromatography to provide the desired product.

2. Reaction Condition Optimization

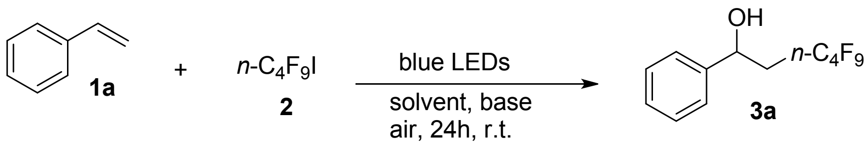
Table S1. Screening of bases



Entry[a]	Base	Yield (%)[b]	Entry[a]	Base	Yield (%)[b]
1	$^{i}Pr_2NEt$	81	8	$HOCH_2CH_2NH_2$	38
2	$^{i}Pr_2NH$	45	9	$(HOCH_2CH_2)_3N$	84
3	Et_2NH	9	10		0
4	Et_3N	58			
5	Ph_3N	0	11		0
6	DBU	23	12		0
7	TMEDA	91			

[a]Reaction conditions: **1a** (0.2 mmol), **2** (0.4 mmol), base (0.4 mmol), anhydrous DMSO (2 mL), blue light (15 W × 2), 24 h, under an air atmosphere; [b]Yield were determined by ^{19}F NMR spectroscopy using benzotrifluoride as the internal standard.

Table S2. Screening of concentration and ratios of substrates

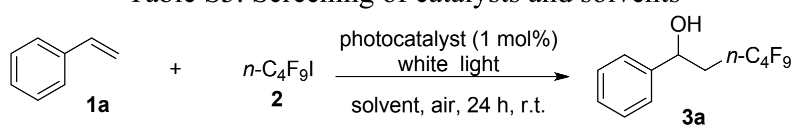


Entry[a]	**2**	TMEDA	DMSO	Yield (%)[b]
1	2 equiv.	2 equiv.	1 mL	99
2	2 equiv.	2 equiv.	2 mL	91
3	2 equiv.	2 equiv.	3 mL	84
4	1.5 equiv.	1.5 equiv.	1 mL	91
5	2 equiv.	1.5 equiv.	1 mL	81
6	1.5 equiv.	2 equiv.	1 mL	83
7	2.5 equiv.	2.5 equiv.	1 mL	96

[a]Reaction conditions: **1a** (0.2 mmol, 1 equiv.), **2**, TMEDA, anhydrous DMSO, blue light (15W × 2), 24 h, under an air atmosphere; [b]Yield were determined by ^{19}F NMR spectroscopy using benzotrifluoride as the internal standard.

3. Optimization of Condition B (with a photocatalyst)

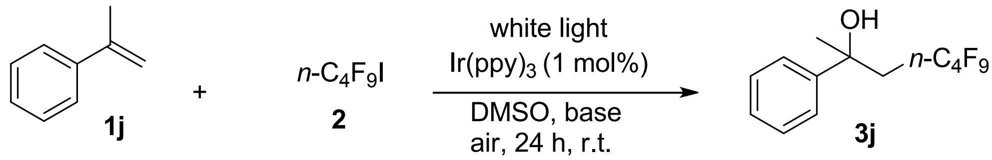
Table S3. Screening of catalysts and solvents

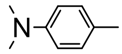
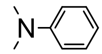
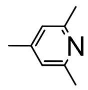


Entry[a]	catalyst	Base	Solvent	Yield (%)[b]
1	$Ir[dF(CF_3)ppy]_2(dtbbpy(PF_6)$	$^iPr_2NEt$	MeCN	18
2	$Ir(ppy)_2(dtbbpy)(PF_6)$	$^iPr_2NEt$	MeCN	14
3	$[Ir(ppy)_2Cl]_2$	$^iPr_2NEt$	MeCN	16
4	$Ru(bpy)_3(PF_6)_2$	$^iPr_2NEt$	MeCN	20
5	$Ir(ppy)_3$	$^iPr_2NEt$	MeCN	33
6	$Ir(ppy)_3$	$^iPr_2NEt$	THF	15
7	$Ir(ppy)_3$	$^iPr_2NEt$	DMF	53
8	$Ir(ppy)_3$	$^iPr_2NEt$	DMSO	69

[a]Reaction conditions: **1a** (0.2 mmol), **2** (0.4 mmol), photocatalyst (0.002 mmol), base (0.4 mmol), solvent (2 mL), 24 W white fluorescent irradiation, 24 h, under an air atmosphere; [b]Yield were determined by ^{19}F NMR spectroscopy using benzotrifluoride as the internal standard.

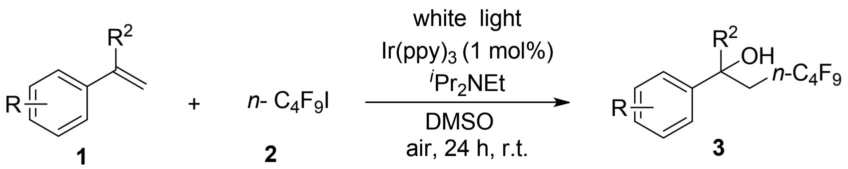
Table S4. Screening of bases

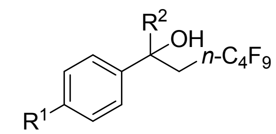


Entry[a]	Base	Yield (%)[b]	Entry[a]	Base	Yield (%)[b]
1	$^{i}Pr_2NEt$	90	8	$HOCH_2CH_2NH_2$	46
2	$^{i}Pr_2NH$	72	9	$(HOCH_2CH_2)_3N$	40
3	Et_2NH	69	10		0
4	Et_3N	72			
5	Ph_3N	0	11		0
6	DBU	83	12		0
7	TMEDA	83			

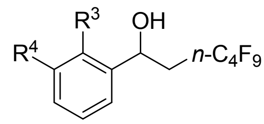
[a]Reaction conditions: **1j** (0.2 mmol), **2** (0.4 mmol), base (0.4 mmol), anhydrous DMSO (2 mL), 24 W white fluorescent irradiation, 24 h, under an air atmosphere; [b]Yield were determined by ^{19}F NMR spectroscopy using benzotrifluoride as the internal standard.

Table S5. Substrate scope of condition B

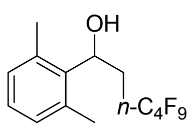




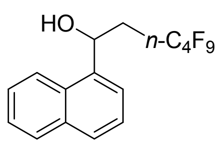
3a: R^1 = H, R^2 = H, 60%
3b: R^1 = F, R^2 = H, 65%
3c: R^1 = Cl, R^2 = H, 65%
3d: R^1 = Br, R^2 = H, 68%
3e: R^1 = *t*Bu, R^2 = H, 55%
3f: R^1 = OMe, R^2 = H, 55%
3g: R^1 = OAc, R^2 = H, 40%
3j: R^1 = H, R^2 = Me, 85%
3k: R^1 = F, R^2 = Me, 60%
3l: R^1 = Cl, R^2 = Me, 57%
3m: R^1 = H, R^2 = Ph, 60%



3n: R^3 = Cl, R^4 = H, 57%
3o: R^3= Br, R^4 = H, 75%



3s, 66%



3t, 51%

[a] Reaction conditions: **1** (0.5 mmol), **2** (1 mmol), $^{i}Pr_2NEt$ (1 mmol), anhydrous DMSO (10 mL), 24

W white fluorescent irradiation, 24 h, under an air atmosphere; [b] Isolated yield.

4. NMR spectra and data for all products

Data of **3**

3,3,4,4,5,5,6,6,6-nonafluoro-1-phenylhexan-1-ol (3a), yellow liquid, 309.4 mg, yield: 91%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42-7.35 (m, 5H), 5.19 (dd, J = 8.8, 3.2 Hz, 1H), 2.70-2.55 (m, 1H), 2.49-2.35 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.6, 128.9, 128.4, 125.6, 68.0, 39.8 (t, J = 20.2 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.2 (t, J = 9.4 Hz, 3F), -112.3 to -114.6 (m, 2F), -124.7 (m, 2F), -126.0 to -126.1 (m, 2F); HRMS(EI) Calcd for $C_{12}H_9F_9O$ (M^+): 340.0510; found: 340.0520.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(4-fluorophenyl)hexan-1-ol (3b), yellow liquid, 318.6 mg, yield: 89%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39-7.35 (m, 2H), 7.10-7.05 (t, J = 8.6 Hz, 2H), 5.21 (dd, J = 8.8, 3.2 Hz, 1H), 2.68-2.53 (m, 1H), 2.46-2.24 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.6 (d, J = 245.4 Hz), 138.4 (d, J = 3.1 Hz), 127.4 (t, J = 8.2 Hz), 115.8 (t, J = 21.5 Hz), 67.3, 39.9 (t, J = 19.5 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (tt, J = 9.8, 2.6 Hz, 3F), -112.4 to -114.4 (m, 2F), -113.6 (s, 1F), -124.6 (m, 2F), -126.0 (m, 2F); HRMS(EI) Calcd for $C_{12}H_8F_{10}O$ (M+): 358.0415; found: 358.0410.

1-(4-chlorophenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3c), yellow liquid, 336.6 mg, yield: 90%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.31 (m, 4H), 5.21-5.18 (m, 1H), 2.66-2.05 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.0, 134.2, 129.0, 127.0, 67.3, 39.8 (t, J = 20.0 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 to -81.2 (m, 3F), -112.3 to -114.4 (m, 2F), -124.6 (m, 2F), -125.9 to -126.0 (m, 2F); HRMS(EI) Calcd for $C_{12}H_8ClF_9O$ (M^+): 374.0120; found: 374.0116.

1-(4-bromophenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3d), yellow liquid, 384.5 mg, yield: 92%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (dd, J = 8.4, 2.4 Hz, 2H), 7.22 (t, J = 7.2 Hz, 2H), 5.13 (m, 1H), 3.10-2.29 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.7, 131.6, 126.8, 122.1, 67.4, 39.8 (t, J = 20.4 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.4 (tt, J = 9.8, 3.1 Hz, 3F), -112.4 to -114.6 (m, 2F), -124.8 (m, 2F), -126.2 to -126.3 (m, 2F); HRMS(EI) Calcd for $C_{12}H_8BrF_9O$ (M^+): 417.9615; found: 417.9607.

1-(4-(tert-butyl)phenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3e), yellow liquid, 368.3 mg, yield: 93%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45-7.32 (m, 4H), 5.19 (dd, J = 8.8, 2.8 Hz, 1H), 2.71-2.56 (m, 1H), 2.50-2.40 (m, 2H), 1.36 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.5, 139.7, 125.8, 125.4, 67.6, 39.6 (t, J = 20.3 Hz), 34.6, 31.2; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.2 (t, J = 9.8 Hz, 3F), -112.4 to -114.8 (m, 2F), -124.7 (m, 2F), -126.0 (m, 2F); HRMS(EI) Calcd for $C_{16}H_{17}F_9O$ (M^+): 396.1136; found: 396.1139.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(4-methoxyphenyl)hexan-1-ol (3f), yellow liquid, 325.6 mg, yield: 88%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (d, J = 8.0 Hz, 2H), 6.90 (d, J = 8.0 Hz, 2H), 5.14 (dd, J = 8.0, 2.4 Hz, 1H), 3.80 (s, 3H), 2.68-2.53 (m, 1H), 2.42-2.05 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.5, 134.6, 126.8, 114.1, 67.3, 55.1, 39.6 (t, J = 20.3 Hz); ^{19}F NMR (376 MHz, $CDCl_3$)

δ -81.1 (tt, J = 9.4, 3.8 Hz, 3F), -112.4 to -114.7 (m, 2F), -124.7 (m, 2F), -126.0 to -126.1 (m, 2F); HRMS(EI) Calcd for $C_{13}H_{11}F_9O_2$ (M^+): 370.0615; found: 370.0614.

4-(3,3,4,4,5,5,6,6,6-nonafluoro-1-hydroxyhexyl)phenyl acetate (3g), yellow liquid, 342.3 mg, yield: 86%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 (d, J = 8.4 Hz, 2H), 7.08 (d, J = 8.0 Hz, 2H), 5.18 (dd, J = 8.8, 2.8 Hz, 1H), 2.64-2.30 (m, 3H), 2.29 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.6, 150.4, 140.3, 126.8, 121.9, 67.2, 39.7 (t, J = 20.3 Hz), 21.0; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.2 (t, J = 7.5 Hz, 3F), -113.1 to -114.6 (m, 2F), -124.7 (m, 2F), -126.1 (m, 2F); HRMS(EI) Calcd for $C_{14}H_{11}F_9O_3$ (M^+): 398.0564; found: 398.0562.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(4-(hydroxymethyl)phenyl)hexan-1-ol (3h), yellow liquid, 355.0 mg, yield: 96%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 (t, J = 8.8 Hz, 4H), 5.12 (d, J = 6.4 Hz, 1H), 4.56 (s, 2H), 3.05-2.65 (br, 2H), 2.60-2.48 (m, 1H), 2.42-2.29 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.1, 140.8, 127.3, 125.8, 67.5, 64.6, 39.6 (t, J = 20.4 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.3 (d, J = 2.6 Hz, 3F), -112.3 to -114.7 (m, 2F), -124.7 (m, 2F), -126.1 (m, 2F); HRMS(EI) Calcd for $C_{13}H_{11}F_9O_2$ (M^+): 370.0615; found: 370.0618.

4-(3,3,4,4,5,5,6,6,6-nonafluoro-1-hydroxyhexyl)benzonitrile (3i), yellow liquid, 255.4 mg, yield: 70%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, J = 8.4 Hz, 2H), 7.53 (d, J = 8.0 Hz, 2H), 5.30 (dd, J = 2.8, 8.4 Hz, 1H), 2.68-2.32 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.6, 132.7, 126.4, 118.4, 112.2, 67.2, 38.9 (t, J = 27.8 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (tt, J = 3.4, 6.4 Hz, 3F), -112.2 to -114.2 (m, 2F), -124.5 (m, 2F), -124.6 to -126.0 (m, 2F); HRMS(EI) Calcd for $C_{13}H_8F_9NO$ (M^+): 365.0462; found: 365.0465.

4,4,5,5,6,6,7,7,7-nonafluoro-2-phenylheptan-2-ol (3j), yellow liquid, 325.7 mg, yield: 92%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, J = 8.0 Hz, 2H), 7.41 (t, J = 8.0 Hz, 2H), 7.32 (t, J = 7.2 Hz, 1H), 2.76-2.53 (m, 2H), 2.48 (s, 1H), 1.79 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.6, 128.4, 127.4, 124.4, 72.8, 42.5 (t, J = 19.4 Hz), 29.9; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.4 (t, J = 11.3 Hz, 3F), -110.4 to -113.7 (m, 2F), -124.8 (m, 2F), -126.0 (m, 2F); HRMS(EI) Calcd for $C_{13}H_{11}F_9O$ (M^+): 354.0666; found: 354.0659.

4,4,5,5,6,6,7,7,7-nonafluoro-2-(4-fluorophenyl)heptan-2-ol (3k), yellow liquid, 327.4 mg, yield: 88%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47-7.44 (m, 2H), 7.04 (t, J = 8.8 Hz, 2H), 2.71-2.48 (m, 3H), 1.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.0 (d, J = 252.3 Hz), 142.4, 126.3 (t, J = 8.1 Hz), 115.3, 115.1, 72.5, 42.6 (t, J = 19.4 Hz), 30.1; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.6 (tt, J = 11.3 Hz, 3.0 Hz, 3F), -110.6 to -113.9 (m, 2F), -115.8 to -115.9 (m, 1F), -124.9 (m, 2F), -126.1 to -126.2 (m, 2F); HRMS(EI) Calcd for $C_{13}H_{10}F_{10}O$ (M^+): 372.0572; found: 372.0567.

2-(4-chlorophenyl)-4,4,5,5,6,6,7,7,7-nonafluoroheptan-2-ol (3l), yellow liquid, 345.3 mg, yield: 89%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 (d, J = 8.8 Hz, 2H), 7.34 (d, J = 8.8 Hz, 2H), 2.70-2.48 (m, 3H), 1.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.8, 133.2, 128.4, 72.3, 42.4 (t, J = 19.3 Hz), 30.0; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.5 (tt, J = 11.3 , 3.0 Hz, 3F), -110.5 to -113.7 (m, 2F), -124.9 (m, 2F), -126.1 to -126.2 (m, 2F); HRMS(EI) Calcd for $C_{13}H_{10}ClF_9O$ (M^+): 388.0276; found: 388.0270.

3,3,4,4,5,5,6,6,6-nonafluoro-1,1-diphenylhexan-1-ol (3m), yellow liquid, 386.9 mg, yield: 93%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (d, J = 8.0 Hz, 4H), 7.39 (t, J = 8.0 Hz, 4H), 7.32 (t, J = 7.2 Hz, 2H), 3.24 (t, J = 18.4 Hz, 2H), 2.86 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.5, 128.4, 127.5, 125.4, 76.5, 40.8 (t, J = 18.9 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.2 (t, J = 10 Hz, 3F), -109.2 to -109.4 (m, 2F), -124.54 (m, 2F), -125.7 to -125.9 (m, 2F); HRMS(EI) Calcd for $C_{18}H_{13}F_9O$ (M^+): 416.0823; found: 416.0832.

1-(2-chlorophenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3n), yellow liquid, 329.1 mg, yield: 88%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67-7.64 (m, 1H), 7.38-7.25 (m, 3H), 5.64 (dd, J = 9.2, 2.0 Hz, 1H), 2.60-2.37 (m, 2H), 2.26 (br, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.8, 131.2, 129.7, 129.3, 127.5, 127.0, 64.7, 38.3 (t, J = 20.5 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (tt, J = 9.8, 2.6 Hz, 3F), -111.9 to -115.2 (m, 2F), -124.6 (m, 2F), -126.0 (m, 2F); HRMS(EI) Calcd for $C_{12}H_8ClF_9O$ (M^+): 374.0120; found: 374.0118.

1-(2-bromophenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3o), yellow liquid, 376.1 mg, yield: 90%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, J = 6.8 Hz, 1H), 7.55 (d, J = 7.2 Hz, 1H), 7.39 (t, J = 7.2 Hz, 1H), 7.19 (t, J = 7.2 Hz, 1H), 5.60 (d, J = 9.2 Hz, 1H), 2.61-2.34 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.4, 133.0, 129.6, 128.1, 127.3, 121.1, 66.9, 38.3 (t, J = 20.4 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (t, J = 9.8 Hz, 3F), -111.8 to -115.2 (m, 2F), -124.7 (m, 2F), -126.0 (q, J = 14.3 Hz, 2F); HRMS(EI) Calcd for $C_{12}H_8BrF_9O$ (M^+): 417.9615; found: 417.9613.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(o-tolyl)hexan-1-ol (3p), yellow liquid, 322.1 mg, yield: 91%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (d, J = 7.2 Hz, 1H), 7.28-7.15 (m, 3H), 5.46 (dd, J = 9.2, 2.0 Hz, 1H), 2.63-2.47 (m, 1H), 2.33-2.27 (m, 4H), 2.14 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.8, 133.9, 130.8, 128.1, 126.7, 125.1, 64.2, 38.9 (t, J = 20.6 Hz), 18.7; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (tt, J = 9.8, 2.6 Hz, 3F), -112.7 to -114.9 (m, 2F), -124.6 (m, 2F), -125.9 to -126.0 (m, 2F); HRMS(EI) Calcd for $C_{13}H_{11}F_9O$ (M^+): 354.0666; found: 354.0658.

1-(3-bromophenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3q), yellow liquid, 355.2 mg, yield: 85%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (s, 1H), 7.46 (dt, J = 7.6, 1.2 Hz, 1H), 7.31-7.23 (m, 2H), 5.18 (dd, J = 8.8, 3.2 Hz, 1H), 2.66-2.31 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.8, 131.5, 130.4, 128.8, 124.2, 122.9, 67.3, 39.9 (t, J = 20.4 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (tt, J = 9.8, 3.0 Hz, 3F), -112.2 to -114.5 (m, 2F), -124.6 (m, 2F), -125.9 to -126.0 (m, 2F); HRMS(EI) Calcd for $C_{12}H_8BrF_9O$ (M^+): 417.9615; found: 417.9603.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(3-methoxyphenyl)hexan-1-ol (3r), yellow liquid, 329.3 mg, yield: 89%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29-7.24 (m, 1H), 6.93-6.92 (m, 2H), 6.84 (d, J = 8.4 Hz, 1H), 5.14 (d, J = 8.4 Hz, 1H), 3.79 (s, 3H), 2.66-2.50 (m, 1H), 2.45-2.32 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.1, 144.2, 130.0, 117.7, 113.5, 111.2, 67.8, 55.0, 39.8 (t, J = 20.4 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.2 (tt, J = 12.4, 3.4 Hz, 3F), -112.2 to -114.7 (m, 2F), -124.7 (m, 2F), -126.0 to -126.1 (m, 2F); HRMS(EI) Calcd for $C_{13}H_{11}F_9O_2$ (M^+)：370.0615；found: 370.0607.

1-(2,6-dimethylphenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3s), yellow liquid, 257.6 mg, yield: 70%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 (s, 1H), 7.08 (t, J = 8.0 Hz, 2H), 5.44 (d, J = 8.8 Hz, 1H), 2.65-2.50 (m, 1H), 2.43-2.38 (m, 5H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.6, 136.3, 130.7, 128.7, 125.7, 64.2, 38.9 (t, J = 20.5 Hz), 20.9, 18.1; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.3 (t, J = 9.4 Hz, 3F), -112.7 to -115.0 (m, 2F), -124.7 (m, 2F), -126.1 (m,2F); HRMS(EI) Calcd for $C_{14}H_{13}F_9O$ (M^+): 368.0823; found: 368.0819.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(naphthalen-1-yl)hexan-1-ol (3t), yellow liquid, 304.2 mg, yield: 78%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, J = 8.0 Hz, 1H), 7.92 (d, J = 8.0 Hz, 1H), 7.84 (d, J = 8.0 Hz, 1H), 7.73 (d, J = 7.2 Hz, 1H), 7.61-7.48 (m, 3H), 5.99 (d, J = 9.2 Hz, 1H), 2.77-2.53 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.0, 133.8, 129.4, 129.2, 128.8, 126.7, 125.9, 125.5, 123.1, 122.0, 64.6, 39.2 (t, J = 20.4 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (t, J = 9.8 Hz, 3F), -112.6 to -114.8 (m, 2F), -124.6 (m, 2F), -126.0 (m, 2F); HRMS(EI) Calcd for $C_{16}H_{11}F_9O$ (M^+): 390.0666; found: 390.0672.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(naphthalen-2-yl)hexan-1-ol (3u), yellow liquid, 296.4 mg, yield: 76%. ^{1}H NMR (400 MHz, $(CD_3)_2SO$) δ 7.98-7.88 (m, 4H), 7.61 (t, J = 8.4 Hz, 1H), 7.53-7.47 (m, 2H), 6.00 (s, 1H), 5.28 (s, 1H), 2.77-2.56 (m, 2H); ^{13}C NMR (100 MHz, $(CD_3)_2SO$) δ 142.1, 133.1, 132.8, 128.2, 128.0, 127.7, 126.3, 126.0, 124.7, 124.4, 66.7; ^{19}F NMR (376 MHz, $(CD_3)_2SO$) δ -81.4 (m, 3F), -111.2 to -113.9 (m, 2F), -124.5 (s, 2F), -126.1 (s, 2F); HRMS(EI) Calcd for $C_{16}H_{11}F_9O$ (M^+): 390.0666; found: 390.0668.

1-(benzo[b]thiophen-2-yl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3v), yellow liquid, 344.5 mg, yield: 87%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84-7.73 (m, 2H), 7.35-7.32 (m, 2H), 7.25 (s, 1H), 5.6 (dd, J = 8.4, 3.2 Hz, 1H), 2.72-2.47 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.6, 139.3, 139.1, 124.8, 124.6, 123.8, 122.6, 120.8, 64.6, 39.8 (t, J = 20.5 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (t, J = 9.4 Hz, 3F), -112.2 to -114.6 (m, 2F), -124.6 (m, 2F), -126.0 (m, 2F); HRMS(EI) Calcd for $C_{14}H_9F_9OS$ (M^+): 396.0230; found: 396.0233.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(4-methylthiazol-5-yl)hexan-1-ol (3w), yellow liquid, 267.1 mg, yield: 74%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (s, 1H), 5.45 (m, 2H), 2.73-2.59 (m, 1H), 2.43-2.34 (m, 1H), 2.23 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.6, 147.7, 135.7, 60.8, 39.8 (t, J = 20.4 Hz), 14.5; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.4 (d, J = 7.1 Hz, 3F), -112.8 to -115.0 (AB, J = 272 Hz, 2F), -124.8 (s, 2F), -126.2 (m, 2F); HRMS(EI) Calcd for $C_{10}H_8F_9NOS$ (M^+): 361.0183; found: 361.0187.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(pyridin-2-yl)hexan-1-ol (3x), yellow liquid, 231.1 mg, yield: 68%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.46 (d, J = 4.8 Hz, 1H), 7.68 (td, J = 7.6, 1.6 Hz, 1H), 7.38 (d, J = 8.0 Hz, 1H), 7.20-7.17 (m, 1H), 5.19 (dd, J = 8.4, 3.6 Hz, 1H), 4.80 (s, 1H), 2.68-2.43 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.5, 148.6, 137.3, 123.0, 120.6, 67.3, 38.7 (t, J = 20.3 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.5 (tt, J = 9.8, 2.6 Hz, 3F), -112.2 to -114.6 (m, 2F), -124.8 (m, 2F), -126.3 (m, 2F); HRMS(EI) Calcd for $C_{11}H_8F_9NO$ (M^+): 340.0384; found: 340.0382.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(pyrazin-2-yl)hexan-1-ol (3y), yellow liquid, 215.5 mg, yield:

63%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.76 (s, 1H), 8.53 (s, 2H), 5.33 (dd, J = 8.4, 3.6 Hz, 1H), 4.35-3.65 (m, 1H), 2.84-2.70 (m, 1H), 2.67-2.52 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.0, 144.0, 143.7, 142.7, 66.2, 38.2 (t, J = 20.1 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.2 to -81.3 (m, 3F), -111.9 to -114.2 (m, 2F), -124.7 (m, 2F), -126.1 (m, 2F); HRMS(EI) Calcd for $C_{10}H_7F_9N_2O$ (M^+): 342.0415; found: 342.0412.

(8R,9S,13S,14S)-13-methyl-3-(3,3,4,4,5,5,6,6,6-nonafluoro-1-hydroxyhexyl)-6,7,8,9,11,12,13,14,15,16-decahydro-17H-cyclopenta[a]phenanthren-17-one (3z), yellow liquid, 428.4 mg, yield: 83%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (d, J = 8.0 Hz, 1H), 7.18-7.14 (m, 2H), 5.16 (dd, J = 8.4, 2.4 Hz, 1H), 2.95-2.93 (m, 2H), 2.63-1.96 (m, 10H), 1.68-1.40 (m, 6H), 0.91(s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 220.8, 140.2, 140.0, 137.2, 126.2 (d, J = 2.9 Hz), 125.9, 123.0, 67.6, 50.5, 47.9, 44.3, 39.7 (t, J = 20.4 Hz), 38.1, 35.8, 31.4, 29.40, 29.38, 25.7, 21.5, 13.8; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.2 (t, J = 9.8 Hz, 3F), -110.9 to -111.8 (m, 2F), -124.7 (m, 2F), -125.8 to -125.9 (m, 2F); HRMS(EI) Calcd for $C_{24}H_{25}F_9O_2$ (M^+): 516.1711; found: 516.1721

3,3,4,4,4-pentafluoro-1-phenylbutan-1-ol (3aa), yellow liquid, 215.9 mg, yield: 90%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.25 (m, 5H), 5.04 (dd, J = 8.8, 3.6 Hz, 1H), 2.89 (s, 1H), 2.55-2.21 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.7, 128.8, 128.3, 125.6, 67.8, 39.5 (t, J = 20.2 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -86.1 (m, 3F), -116.1 to -118.3 (m, 2F); HRMS(EI) Calcd for $C_{10}H_9F_5O$ (M^+); 240.0574; found: 240.0576.

4,4,5,5,6,6,7,7,8,8,9,9,9-tridecafluoro-2-phenylnonan-2-ol (3ab), yellow liquid, 358.6 mg, yield: 79%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, J = 7.6 Hz, 2H), 7.40 (t, J = 7.6 Hz, 2H), 7.32 (t, J = 7.2 Hz, 1H), 2.77-2.50 (m, 3H), 1.79 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.6, 128.5, 127.4, 124.4, 72.9, 42.5 (t, J = 19.4 Hz), 29.9; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.3 (t, J = 9.8 Hz, 3F), -110.2 to -113.6 (m, 2F), -121.9 (s, 2F), -123.2 (s, 2F), -124.0 (s, 2F), -126.5 to -126.6 (m, 2F); HRMS(EI) Calcd for $C_{15}H_{11}F_{13}O$ (M^+): 454.0602; found: 454.0598.

Data of **3** (under condition B)

3,3,4,4,5,5,6,6,6-nonafluoro-1-phenylhexan-1-ol (3a), yellow liquid, 102.1 mg, yield: 60%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40-7.33 (m, 5H), 5.16 (dd, J = 8.8, 3.2 Hz, 1H), 2.68-2.33 (m, 3H), ; ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.7, 128.9, 128.4, 125.6, 67.9, 39.8 (t, J = 20.5 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.3 (m, 3F), -112.3 to -114.7 (m, 2F), -124.7 (m, 2F), -126.1 (m, 2F); HRMS(EI) Calcd for $C_{12}H_9F_9O$ (M^+): 340.0510; found: 340.0508.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(4-fluorophenyl)hexan-1-ol (3b), yellow liquid, 116.4 mg, yield: 65%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38-7.31 (m, 2H), 7.09-7.01 (m, 2H), 5.22-5.16 (m, 1H), 2.68-1.90 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.6 (d, J = 240.0 Hz), 138.4 (d, J = 3.2 Hz), 127.4 (d, J = 8.2 Hz), 115.8 (d, J = 21.5 Hz), 67.4, 39.9 (t, J = 20.4 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 to -81.2 (m, 3F), -112.3 to -114.5 (m, 3F), -124.6 (m, 2F), -126.0 (m, 2F); HRMS(EI) Calcd for $C_{12}H_8F_{10}O$ (M^+): 358.0415; found: 358.0417.

1-(4-chlorophenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3c), yellow liquid, 121.5 mg, yield:

65%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37-7.31 (m, 4H), 5.19 (dd, J = 8.8, 3.2 Hz, 1H), 2.67-2.05 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.0, 134.2, 129.0, 127.0, 67.3, 39.8 (t, J = 20.2 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 to -81.2 (m, 3F), -112.3 to -114.4 (m, 2F), -124.6 (m, 2F), -126.0 (t, J = 11.7 Hz, 2F); HRMS(EI) Calcd for $C_{12}H_8ClF_9O$ (M^+): 374.0120; found: 374.0119.

1-(4-bromophenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3d), yellow liquid, 142.0 mg, yield: 68%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46-7.43 (m, 2H), 7.19 (dd, J = 8.4, 2.0 Hz, 2H), 5.14-5.10 (m, 1H), 2.60-1.87 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.5, 132.0, 127.4, 122.3, 67.3, 39.8 (t, J = 22.8 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (m, 3F), -112.2 to -114.3 (m, 2F), -124.6 (m, 2F), -125.9 to -126.0 (m, 2F); HRMS(EI) Calcd for $C_{12}H_8BrF_9O$ (M^+)：417.9615；found: 417.9612.

1-(4-(tert-butyl)phenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3e), yellow liquid, 108.9 mg, yield: 55%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 (d, J = 8.0 Hz, 2H), 7.33 (d, J = 8.0 Hz, 2H), 5.19 (dd, J = 8.8, 2.8 Hz, 1H), 2.71-2.56 (m, 1H), 2.50-2.40 (m, 2H), 1.35 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.5, 139.7, 125.8, 125.4, 67.7, 39.7 (t, J = 20.4 Hz), 34.6, 31.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.2 (t, J = 9.4 Hz, 3F), -112.3 to -114.9 (m, 2F), -124.7 (m, 2F), -126.0 to -126.1 (m, 2F); HRMS(EI) Calcd for $C_{16}H_{17}F_9O$ (M^+): 396.1136; found: 396.1129.

3,3,4,4,5,5,6,6,6-nonafluoro-1-(4-methoxyphenyl)hexan-1-ol (3f), yellow liquid, 101.7 mg, yield: 55%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (d, J = 8.8 Hz, 2H), 6.91 (d, J = 8.8 Hz, 2H), 5.16 (dd, J = 8.4, 3.2 Hz, 1H), 3.81 (s, 3H), 2.69-2.54 (m, 1H), 2.46-2.32 (m, 1H), 2.17 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.6, 134.9, 126.9, 114.2, 67.5, 55.2, 39.6 (t, J = 19.7 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (m, 3F), -112.4 to -114.7 (m, 2F), -124.7 (m, 2F), -126.0 (m, 2F); HRMS(EI) Calcd for $C_{13}H_{11}F_9O_2$ (M^+): 370.0615; found: 370.0621.

4-(3,3,4,4,5,5,6,6,6-nonafluoro-1-hydroxyhexyl)phenyl acetate (3g), yellow liquid, 79.6 mg, yield: 40%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (d, J = 8.4 Hz, 2H), 7.07 (d, J = 8.8 Hz, 2H), 5.16 (dd, J = 8.8, 3.2 Hz, 1H), 2.65-2.31 (m, 3H), 2.28 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.6, 150.4, 140.3, 126.8, 122.0, 67.3, 39.7 (t, J = 20.6 Hz), 21.0; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.2 (tt, J = 9.8, 3.0 Hz, 3F), -112.3 to -114.6 (m, 2F), -124.7 (m, 2F), -126.0 to -126.1 (m, 2F); HRMS(EI) Calcd for $C_{14}H_{11}F_9O_3$ (M^+): 398.0564; found: 398.0569.

4,4,5,5,6,6,7,7,7-nonafluoro-2-phenylheptan-2-ol (3j), yellow liquid, 150.5 mg, yield: 85%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53-7.50 (m, 2H), 7.42-7.28 (m , 2H), 7.34-7.30 (m, 1H), 2.77-2.54 (m, 2H), 2.42 (s, 1H), 1.79 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.6, 128.4, 127.4, 124.4, 72.8, 42.5 (t, J = 19.4 Hz), 29.9; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.3 (tt, J = 9.8, 3.0 Hz, 3F), -110.4 to -113.7 (m, 2H), -124.8 (m, 2F), -126.0 (m, 2F); HRMS(EI) Calcd for $C_{13}H_{11}F_9O$ (M^+): 354.0666; found: 354.0668.

4,4,5,5,6,6,7,7,7-nonafluoro-2-(4-fluorophenyl)heptan-2-ol (3k), yellow liquid, 111.6 mg, yield: 60%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46-7.42 (m, 2H), 7.01 (t, J = 8.4 Hz, 2H), 2.73-2.48 (m, 3H), 1.73 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.2 (d, J = 250.0 Hz), 142.4 (d, J = 3.2 Hz), 126.4 (d, J = 7.5 Hz), 115.2, 115.0, 72.6, 42.6 (t, J = 19.4 Hz), 30.0; ^{19}F NMR (376 MHz, $CDCl_3$)

δ -81.7 (t, J = 9.8 Hz, 3F), -110.7 to -113.8 (m, 2F), -116.0 to -116.1 (m, 1F), -125.0 (m, 2F), -126.2 (m, 2F); HRMS(EI) Calcd for $C_{13}H_{10}F_{10}O$ (M^+): 372.0572; found: 372.0558.

2-(4-chlorophenyl)-4,4,5,5,6,6,7,7,7-nonafluoroheptan-2-ol (3l), yellow liquid, 110.6 mg, yield: 57%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (d, J = 8.4 Hz, 2H), 7.30 (d, J = 8.4 Hz, 2H), 2.67-2.47 (m, 3H), 1.71 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.0, 133.3, 128.5, 126.0, 72.6, 42.4 (t, J = 19.4 Hz), 29.9; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.6 (m, 3F), -110.5 to -113.7 (m, 2F), -124.9 (m, 2F), -126.1 to -126.2 (m, 2F); HRMS(EI) Calcd for $C_{13}H_{10}ClF_9O$ (M^+): 388.0276; found: 388.0280.

3,3,4,4,5,5,6,6,6-nonafluoro-1,1-diphenylhexan-1-ol (3m), yellow liquid, 124.8 mg, yield: 60%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (d, J = 7.6 Hz, 4H), 7.39 (t, J = 7.2 Hz, 4H), 7.31 (t, J = 7.2 Hz, 2H), 3.24 (t, J = 18.8 Hz, 2H), 2.82 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.5, 128.4, 127.5, 125.4, 76.5, 40.8 (t, J = 18.8 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.2 (tt, J = 9.8, 2.6 Hz, 3F), -109.2 to -109.4 (m, 2F), -124.5 (m, 2F), -125.8 (m, 2F); HRMS(EI) Calcd for $C_{18}H_{13}F_9O$ (M^+): 416.0823; found: 416.0811.

1-(2-chlorophenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3n), yellow liquid, 106.6 mg, yield: 57%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, J = 7.6 Hz, 1H), 7.37-7.24 (m, 3H), 5.64 (d, J = 9.6 Hz, 1H), 2.60-2.36 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.5, 132.0, 127.4, 122.3, 67.3, 39.8 (t, J = 17.9 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (t, J = 9.8 Hz, 3F), -111.9 to -115.2 (m, 2F), -124.6 (m, 2F), -125.9 (m, 2F); HRMS(EI) Calcd for $C_{12}H_8ClF_9O$ (M^+): 374.0120; found: 374.0125.

1-(2-bromophenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3o), yellow liquid, 156.7 mg, yield: 75%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (dd, J = 7.6, 1.6 Hz, 1H), 7.55 (dd, J = 7.6, 1.2 Hz, 1H), 7.38 (td, J = 8.0, 1.2 Hz, 1H), 7.19 (td, J = 7.6, 1.6 Hz, 1H), 5.60 (dd, J = 9.2, 1.6 Hz, 1H), 2.61-2.34 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.3, 133.0, 129.7, 128.1, 127.3, 121.1, 66.9, 38.3 (t, J = 20.4 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.1 (t, J = 9.8 Hz, 3F), -111.8 to -115.1 (m, 2F), -124.6 (m, 2F), -126.0 (m, 2F); HRMS(EI) Calcd for $C_{12}H_8BrF_9O$ (M^+): 417.9615; found: 417.9616.

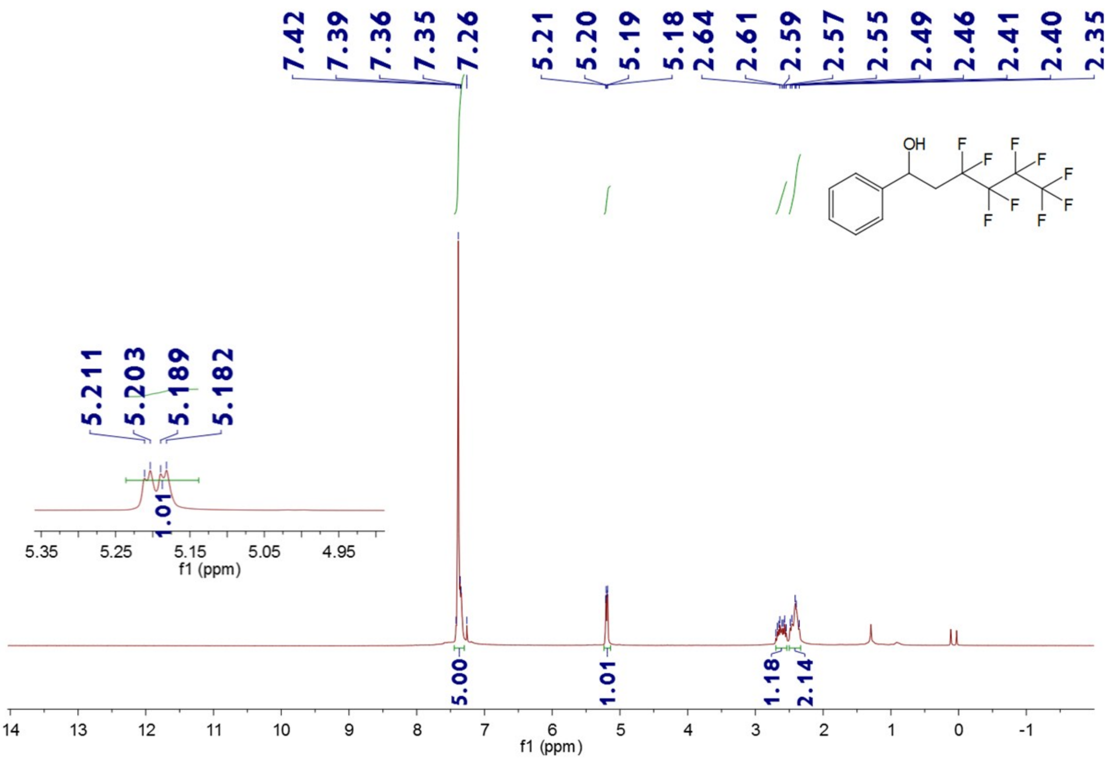
1-(2,6-dimethylphenyl)-3,3,4,4,5,5,6,6,6-nonafluorohexan-1-ol (3s), yellow liquid, 121.5 mg, yield: 66%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (s, 1H), 7.00 (s, 2H), 5.36-5.34 (m, 1H), 2.50-2.30 (m, 6H), 2.23 (d, J = 2.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 140.6, 136.3, 130.7, 128.7, 125.7, 64.2, 38.9 (t, J = 20.5 Hz), 20.9, 18.1; ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.4 to -81.5 (m, 3F), -112.7 to -115.0 (m, 2F), -124.7 (m, 2F), -126.1 (m, 2F); HRMS(EI) Calcd for $C_{14}H_{13}F_9O$ (M^+): 368.0823; found: 368.0831.

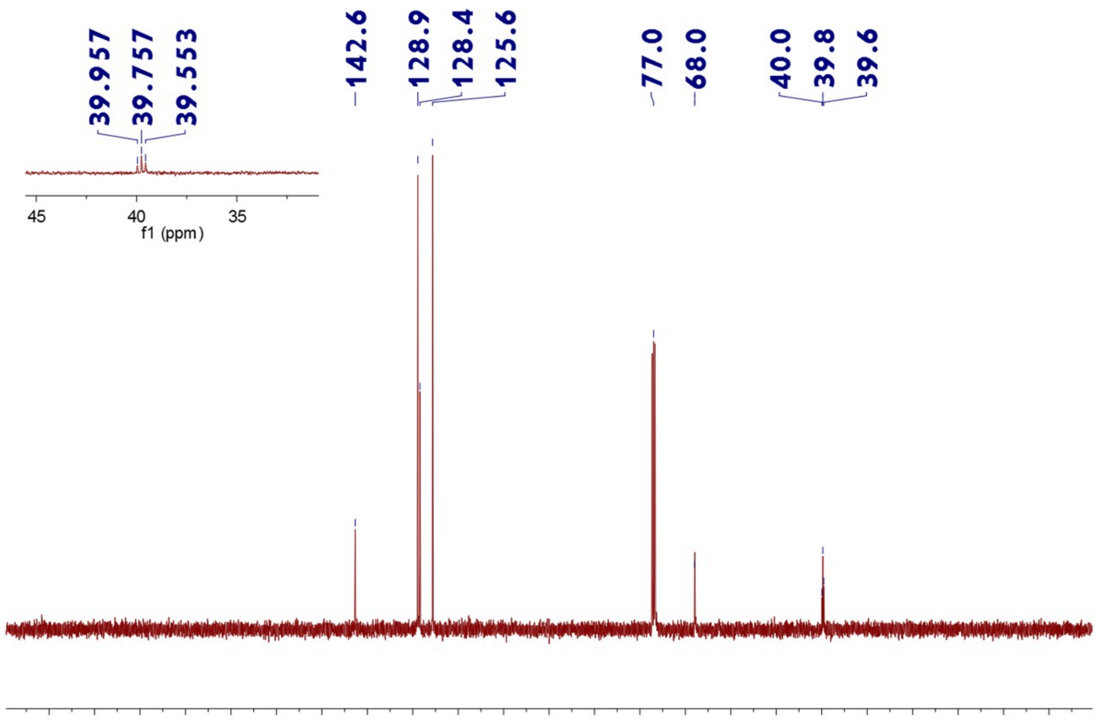
3,3,4,4,5,5,6,6,6-nonafluoro-1-(naphthalen-1-yl)hexan-1-ol (3t), yellow liquid, 99.5 mg, yield: 51%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, J = 8.0 Hz, 1H), 7.92 (d, J = 7.6 Hz, 1H), 7.84 (d, J = 8.4 Hz, 1H), 7.73 (d, J = 6.4 Hz, 1H), 7.60-7.48 (m, 3H), 6.00-5.98 (m, 1H), 2.78-2.41 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.0, 133.9, 129.4, 129.2, 128.8, 126.7, 125.9, 125.5, 123.1, 122.1, 64.6, 39.2 (t, J = 20.3 Hz); ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.2 (m, 3F), -112.6 to -114.8

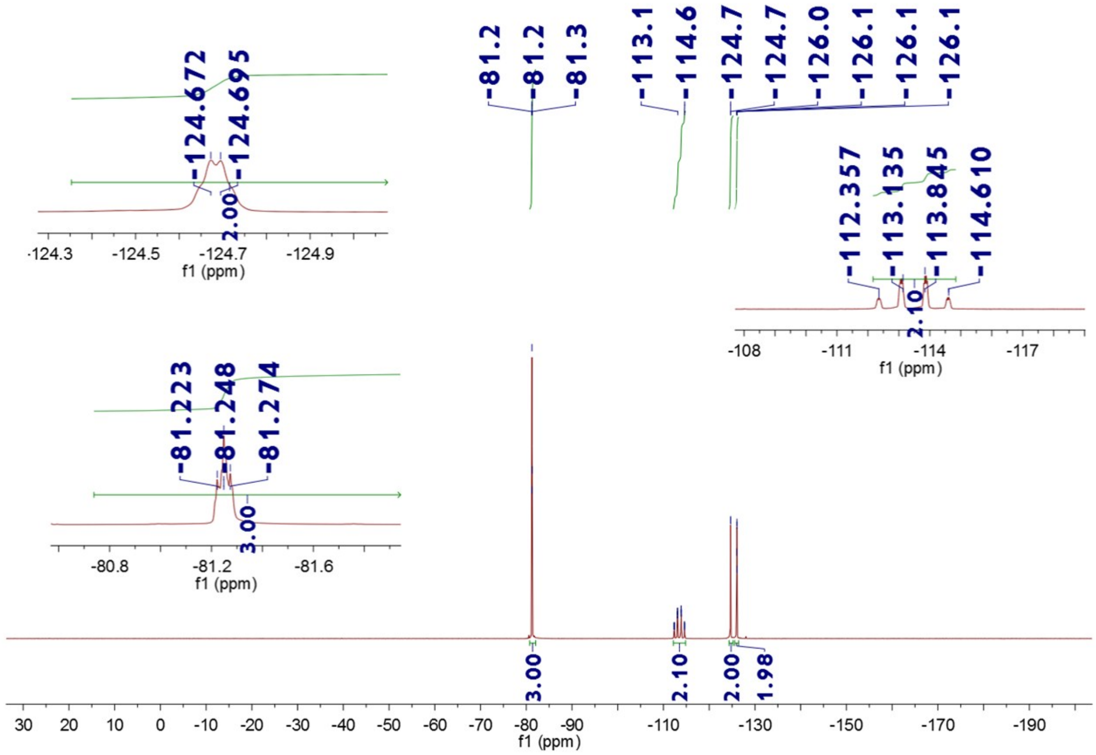
(m, 2F), -124.5 (m, 2F), -125.9 (m, 2F); HRMS(EI) Calcd for $C_{16}H_{11}F_9O$ (M^+): 390.0666; found: 390.0669.

NMR spectra

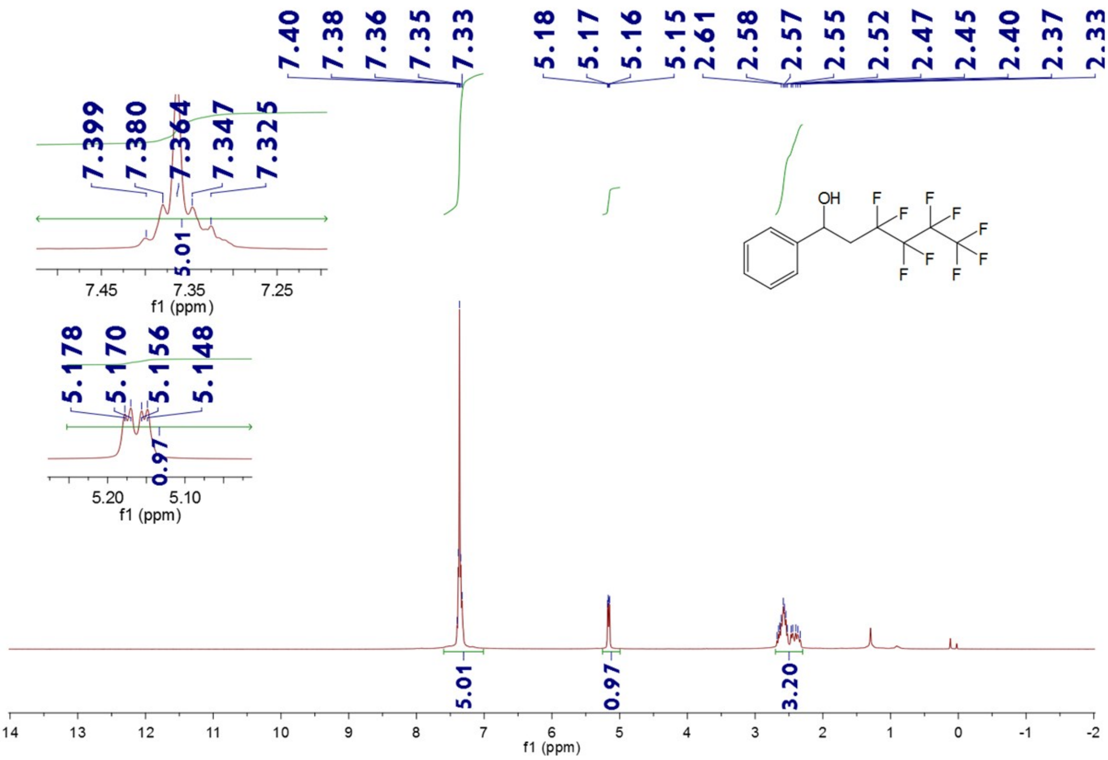
3a

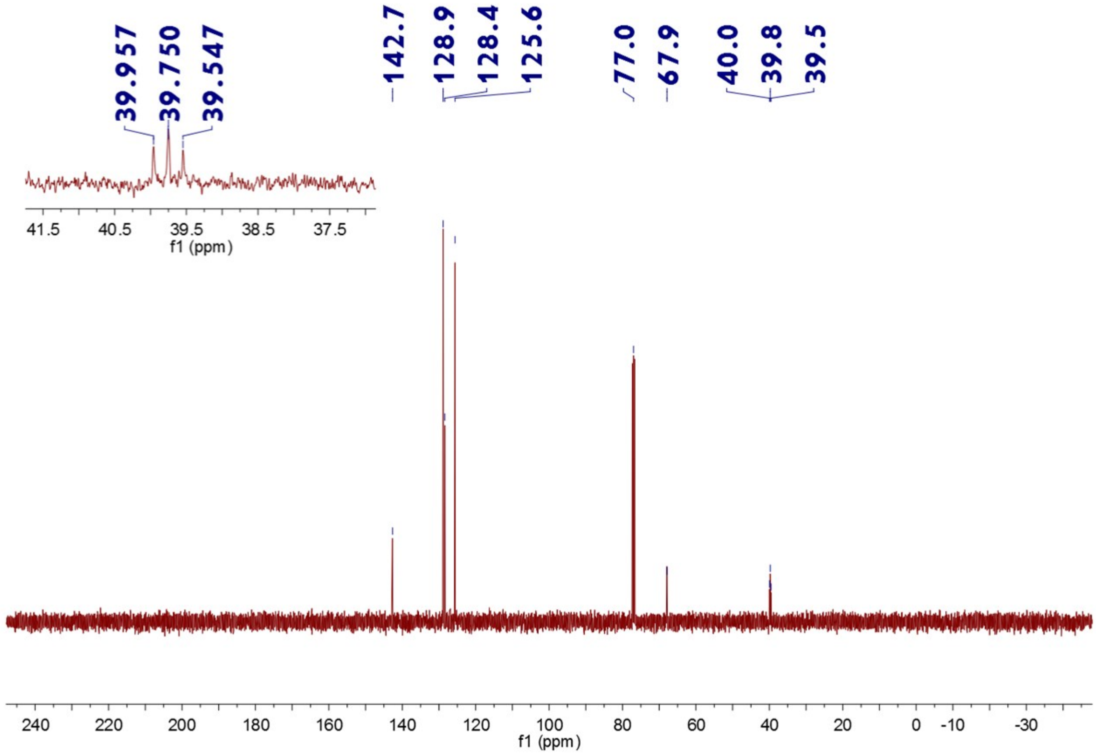


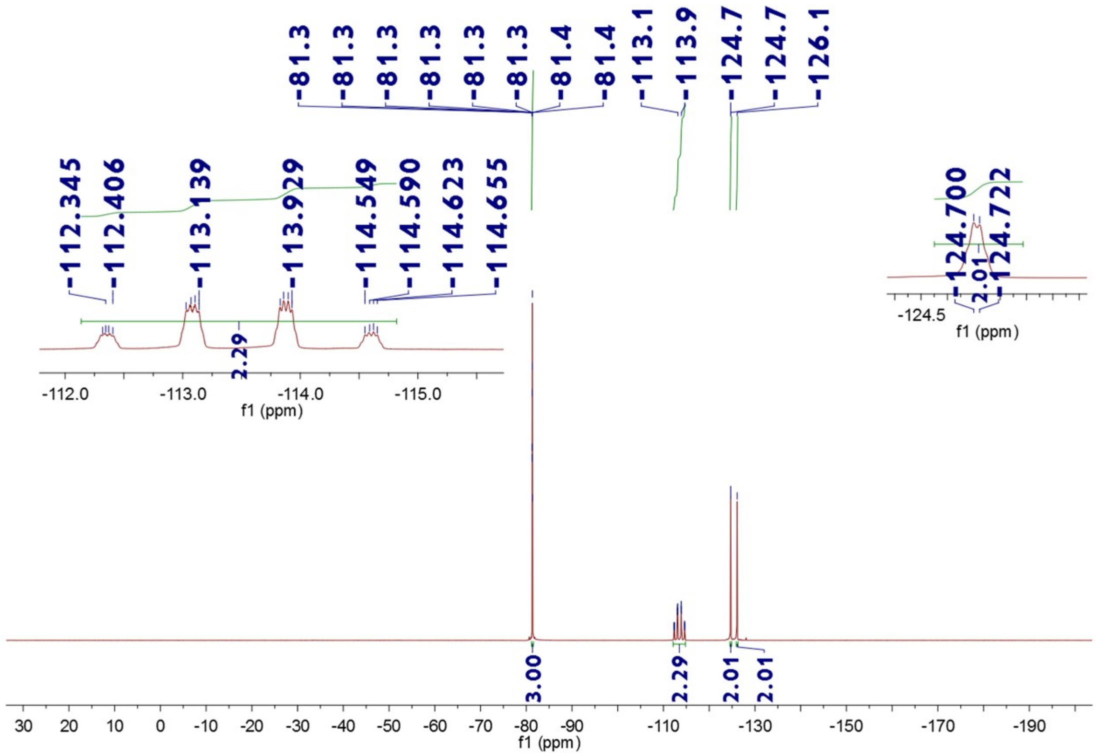




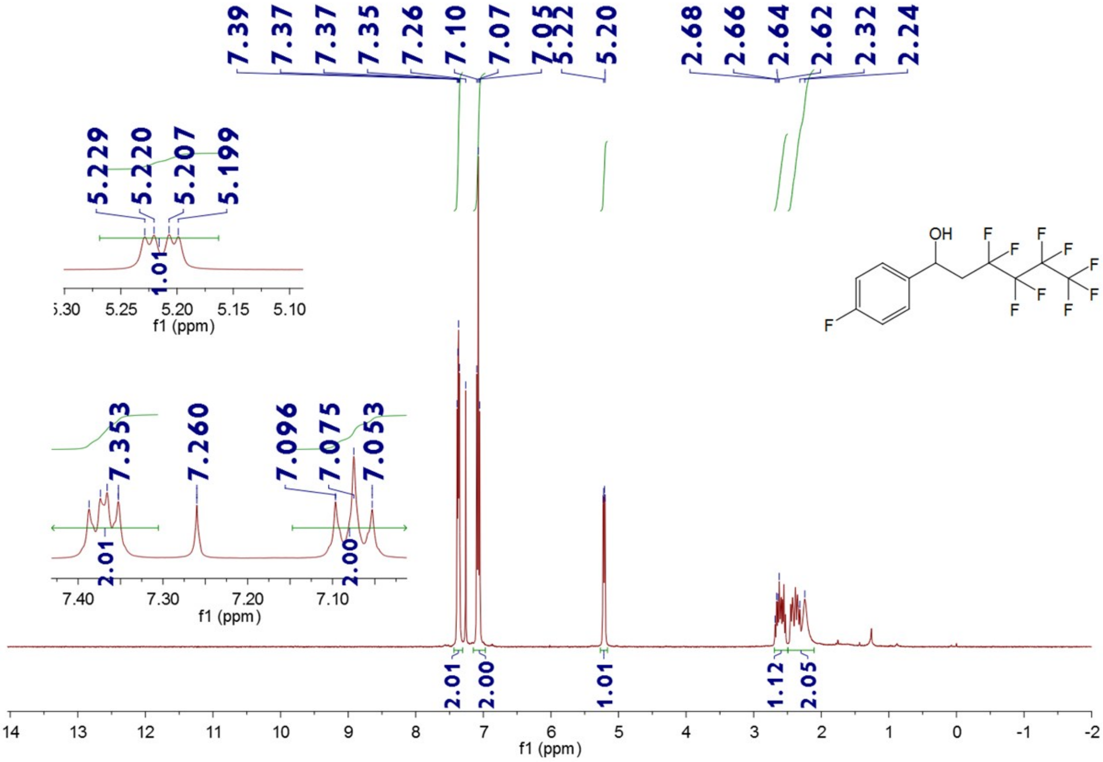
3a (under condition B)

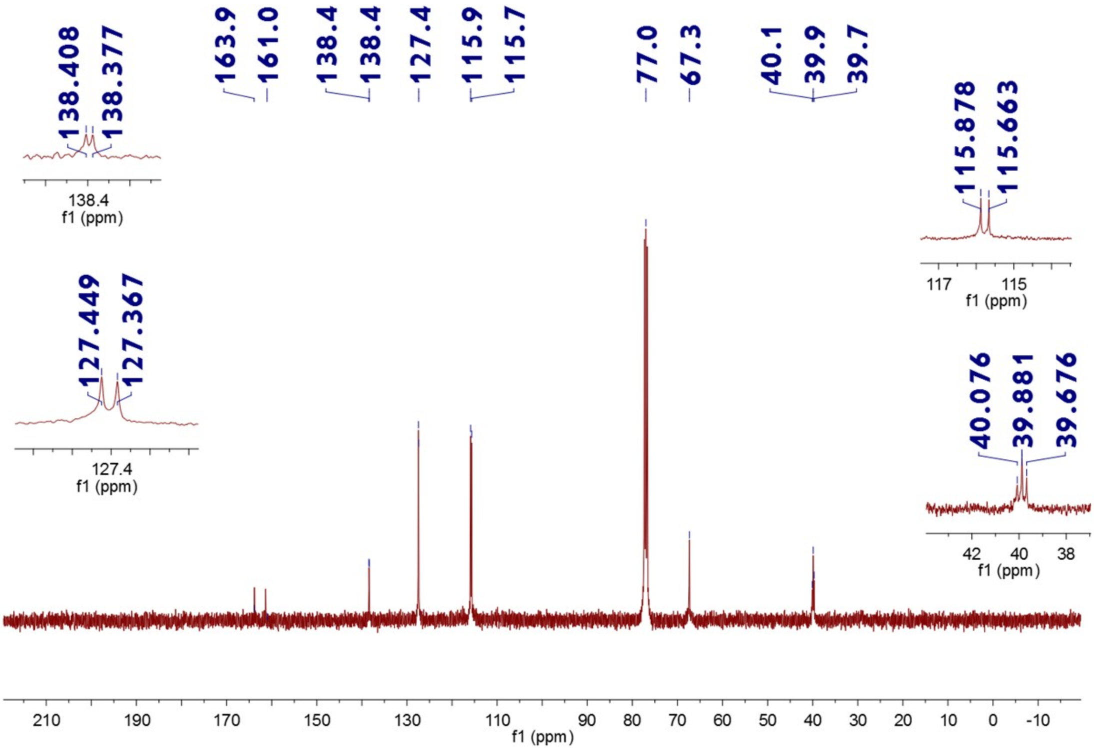


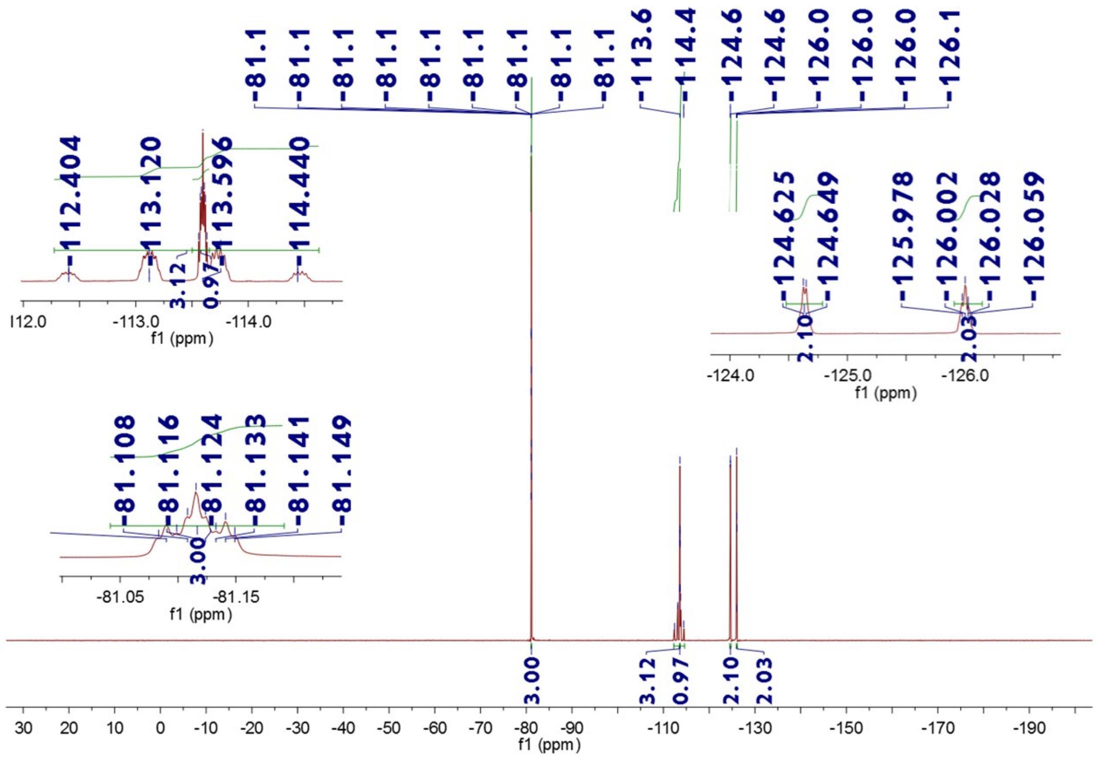

39.957
39.750
39.547
41.5 40.5 39.5 38.5 37.5
f1 (ppm)
142.7
128.9
128.4
125.6
77.0
67.9
40.0
39.8
39.5
240 220 200 180 160 140 120 100 80 60 40 20 0 -10 -30
f1 (ppm)


-81.3
-81.3
-81.3
-81.3
-81.3
-81.3
-81.4
-81.4
-113.1
-113.9
-124.7
-124.7
-126.1
-112.345
-112.406
-113.139
-113.929
-114.549
-114.590
-114.623
-114.655
2.29
-112.0 -113.0 -114.0 -115.0
f1 (ppm)
-124.700
-124.722
2.01
-124.5
f1 (ppm)
3.00
2.29
2.01
2.01
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

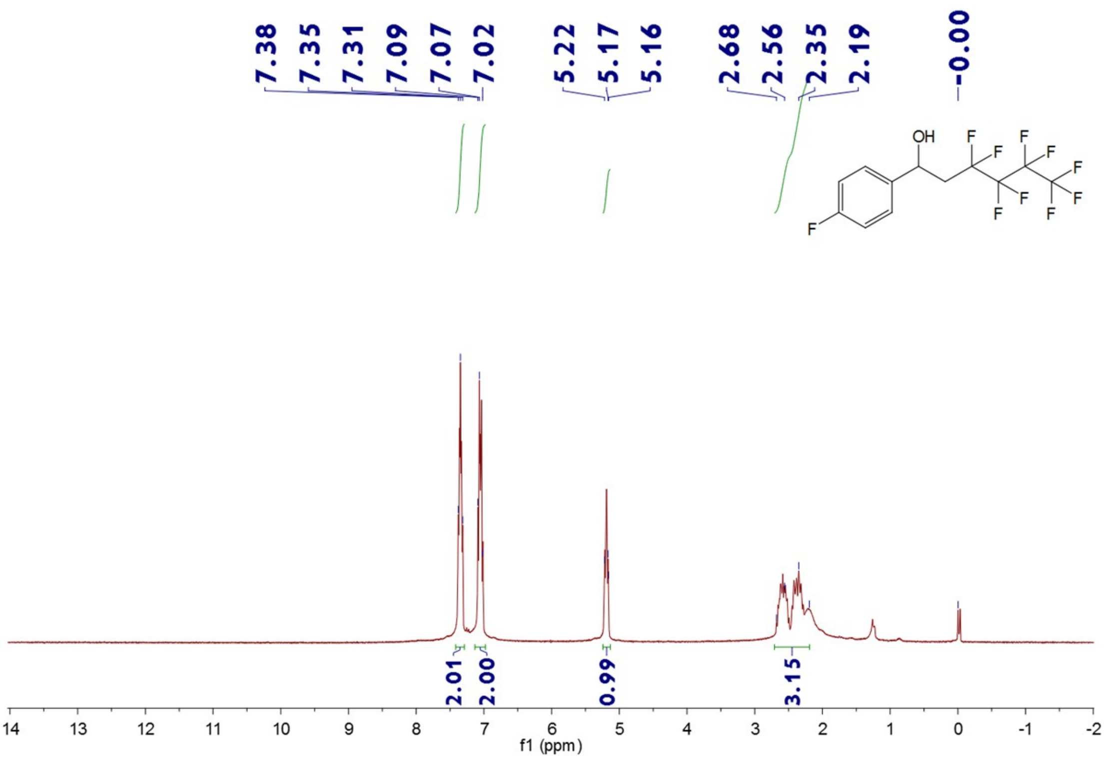
3b

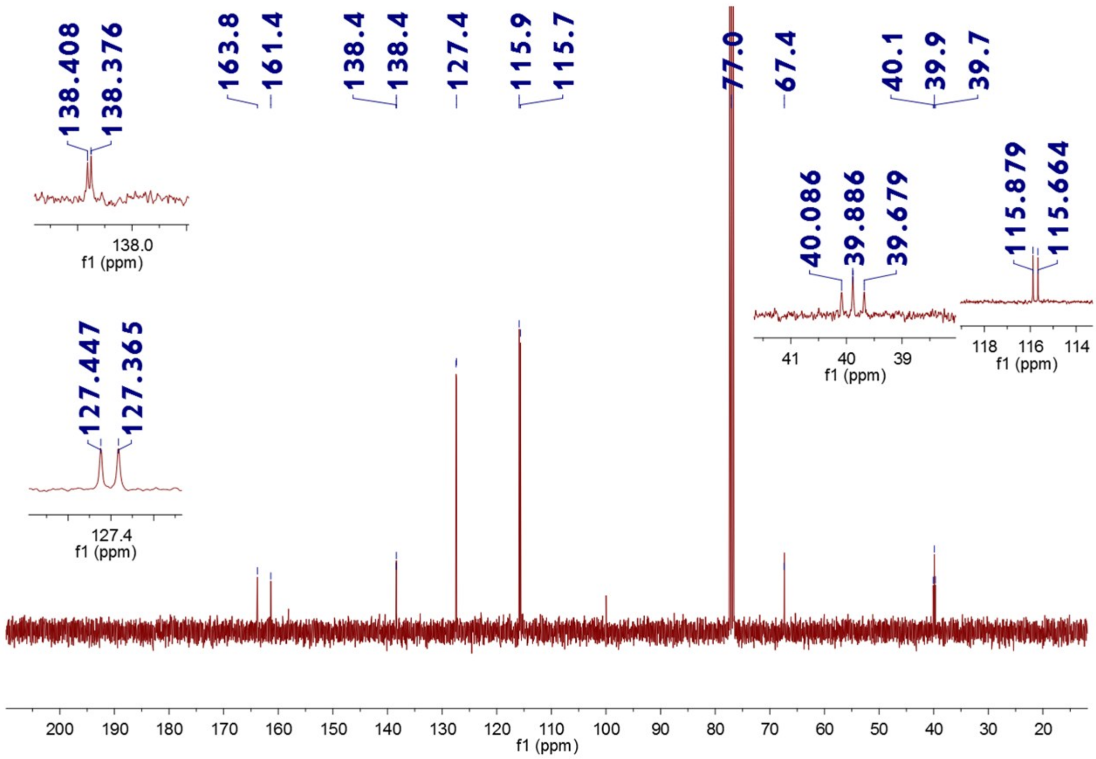

7.39 7.37 7.37 7.35 7.26 7.10 7.07 7.05 5.22 5.20 2.68 2.66 2.64 2.62 2.32 2.24
5.229 5.220 5.207 5.199
1.01
5.30 5.25 5.20 5.15 5.10
f1 (ppm)
OH
F
7.353 7.260 7.096 7.075 7.053
2.01 2.00
7.40 7.30 7.20 7.10
f1 (ppm)
2.01 2.00 1.01 1.12 2.05
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

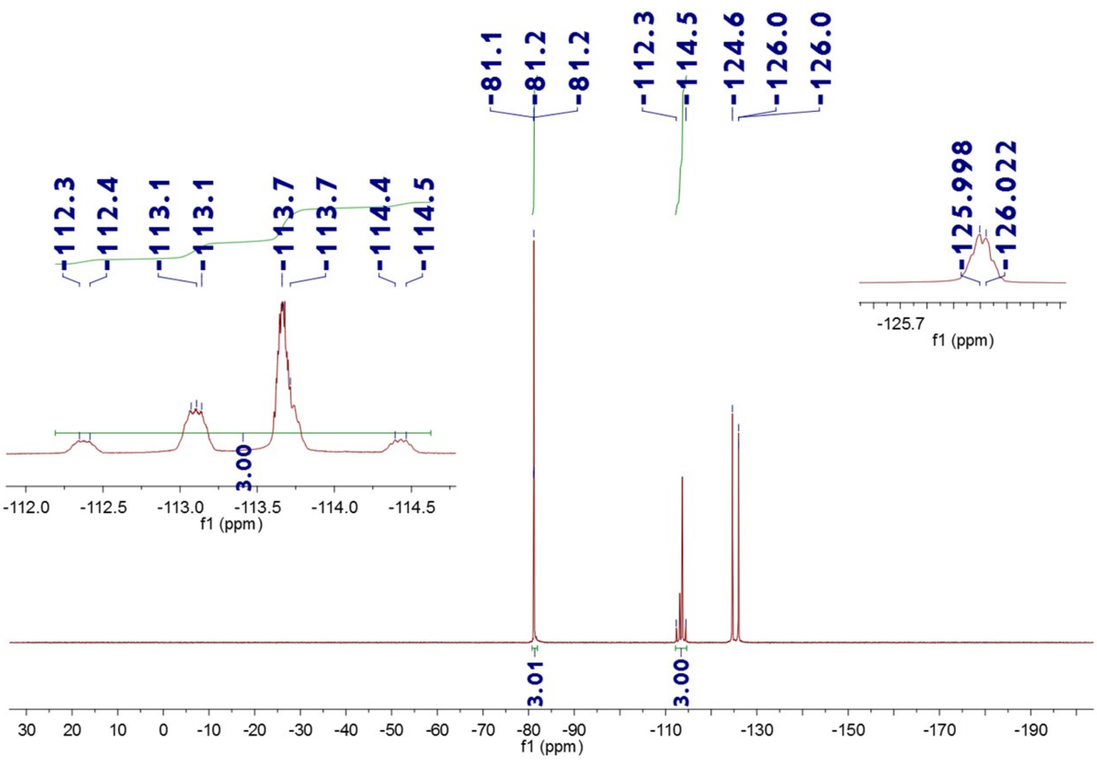

138.408 138.377
138.4
f1 (ppm)
163.9 161.0 138.4 138.4 127.4 115.9 115.7 77.0 67.3 40.1 39.9 39.7
115.878 115.663
117 115
f1 (ppm)
127.449 127.367
127.4
f1 (ppm)
40.076 39.881 39.676
42 40 38
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



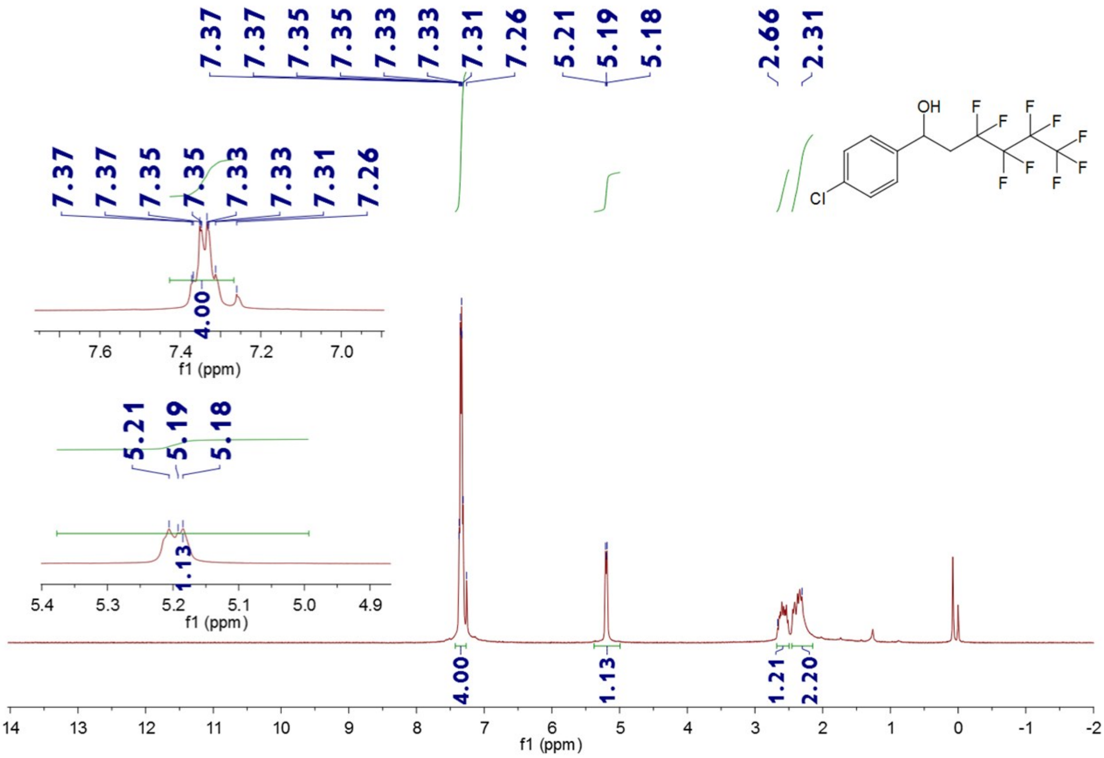
3b (under condition B)

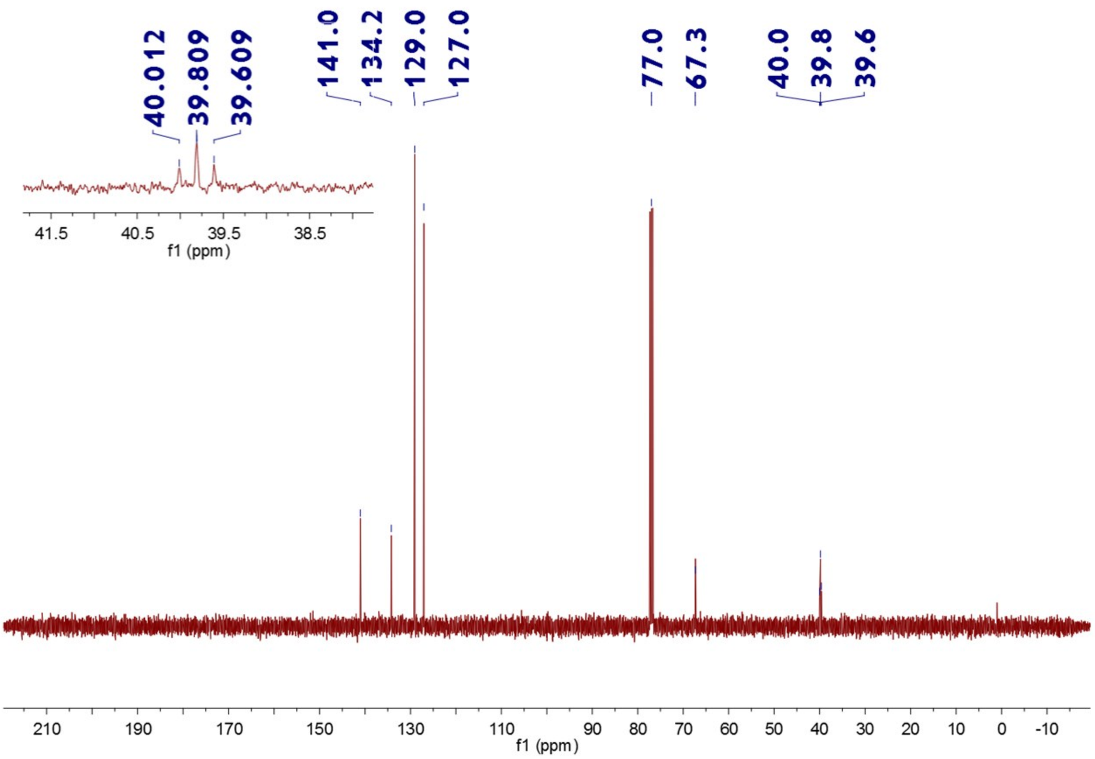


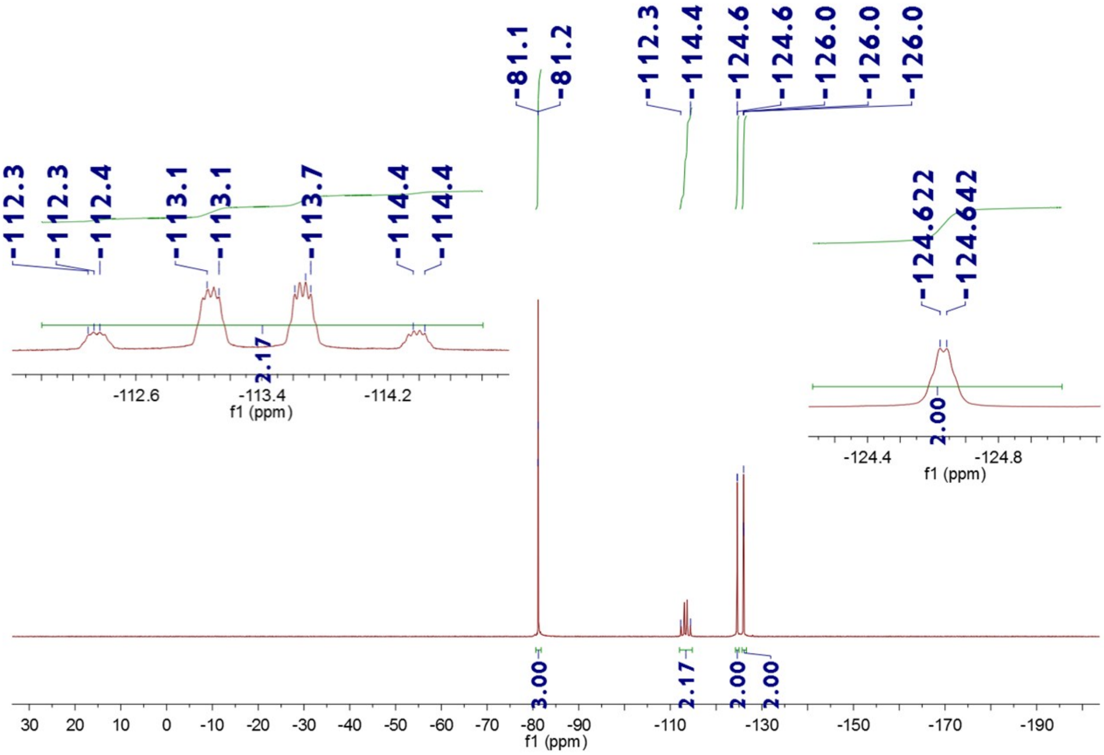

138.408
138.376
138.0
f1 (ppm)
163.8
161.4
138.4
138.4
127.4
115.9
115.7
77.0
67.4
40.1
39.9
39.7
40.086
39.886
39.679
41
40
39
f1 (ppm)
115.879
115.664
118
116
114
f1 (ppm)
127.447
127.365
127.4
f1 (ppm)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
f1 (ppm)


-81.1
-81.2
-81.2
-112.3
-114.5
-124.6
-126.0
-126.0
-112.3
-112.4
-113.1
-113.1
-113.7
-113.7
-114.4
-114.5
3.00
-112.0
-112.5
-113.0
-113.5
-114.0
-114.5
f1 (ppm)
-125.998
-126.022
-125.7
f1 (ppm)
3.01
3.00
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

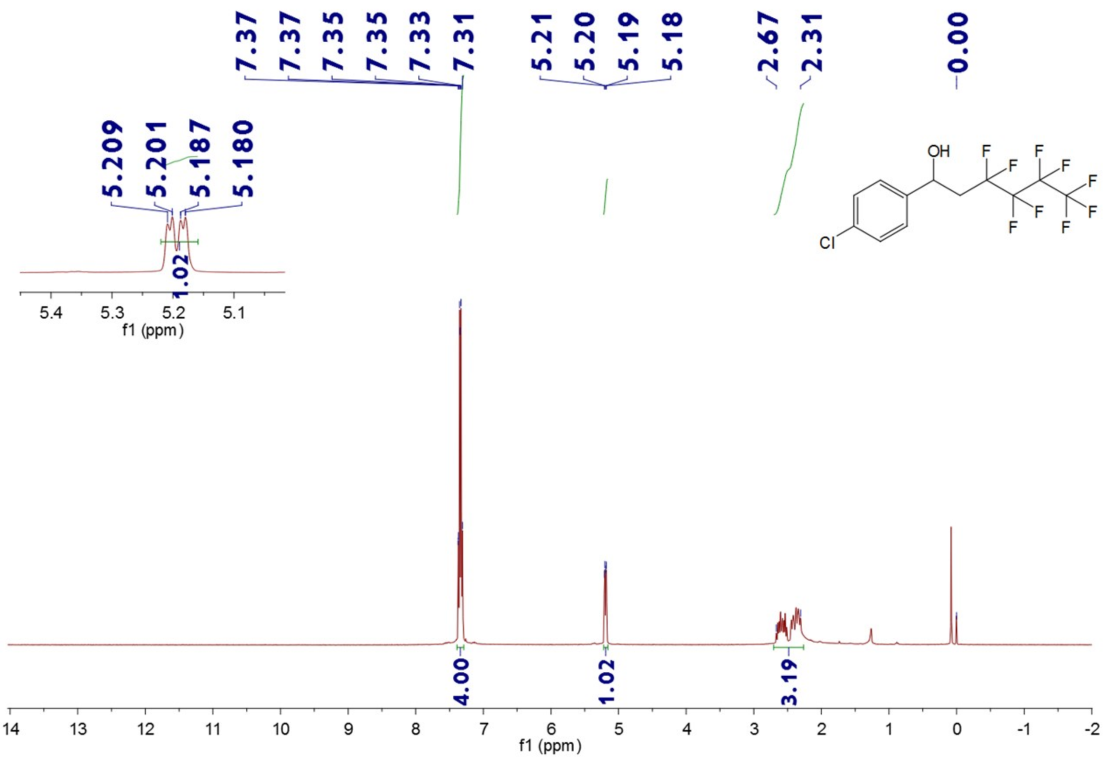
3c

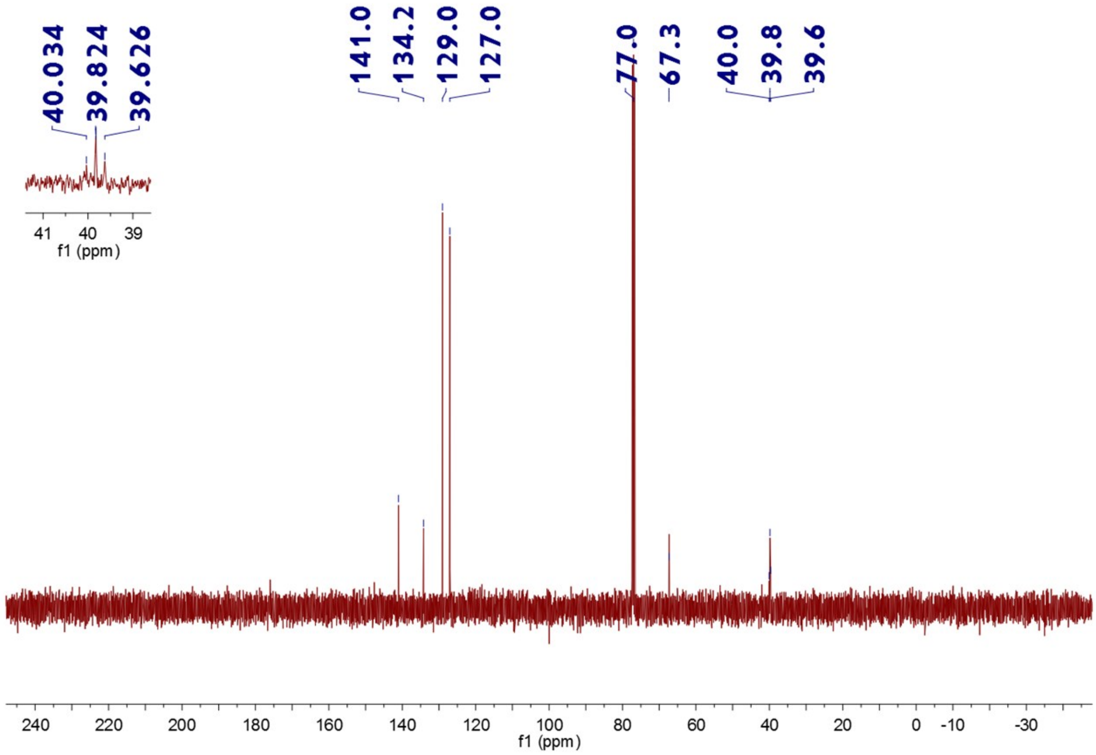

7.37 7.37 7.35 7.35 7.33 7.33 7.31 7.26 5.21 5.19 5.18 2.66 2.31
OH
F
Cl
4.00
1.13
1.21
2.20
f1 (ppm)

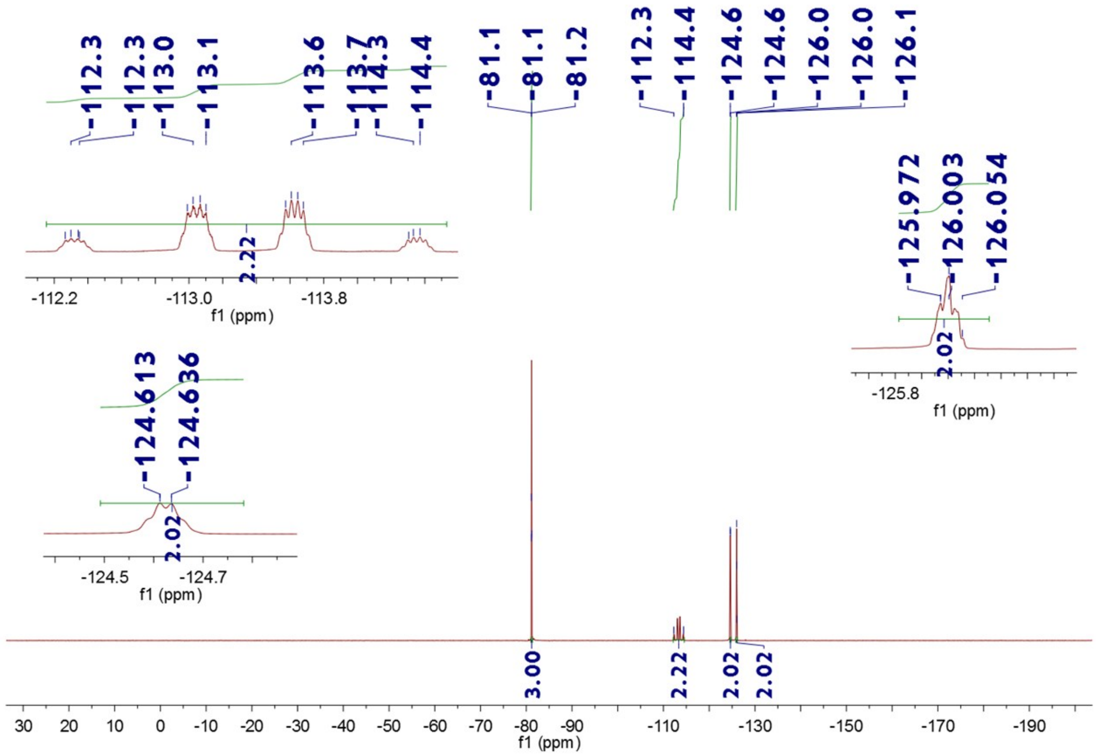

40.012 39.809 39.609
141.0 134.2 129.0 127.0 77.0 67.3 40.0 39.8 39.6
f1 (ppm)



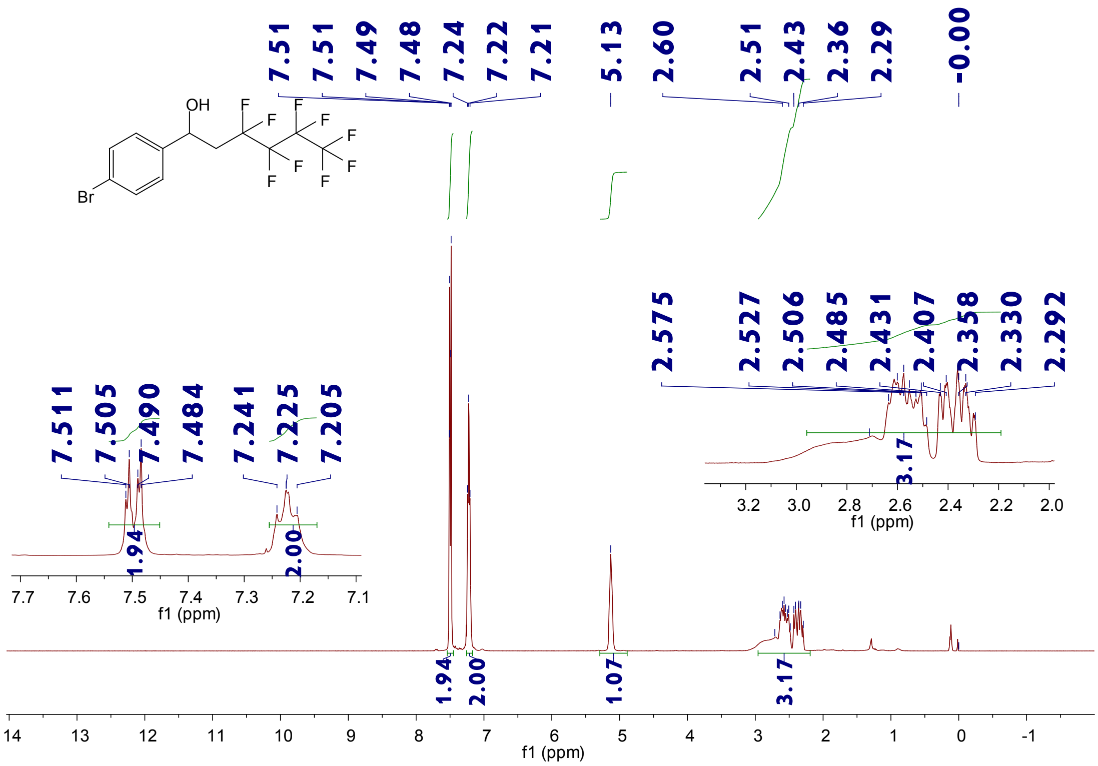
3c (under condition B)



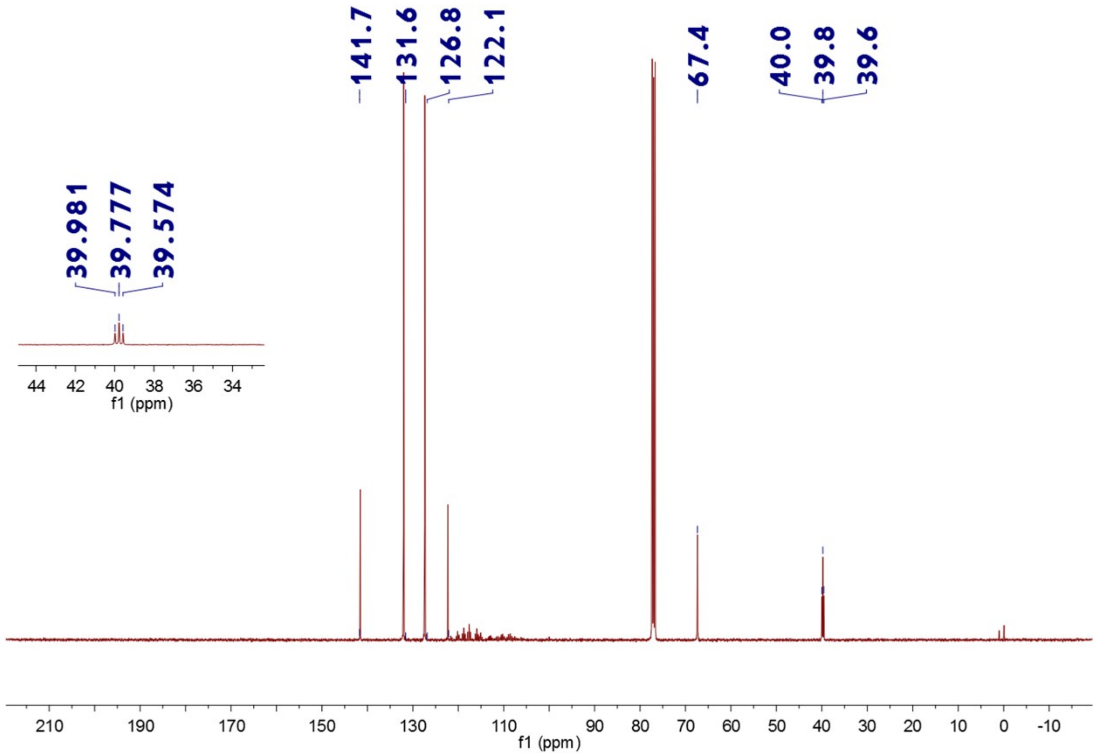

40.034
39.824
39.626
41 40 39
f1 (ppm)
141.0
134.2
129.0
127.0
77.0
67.3
40.0
39.8
39.6
240 220 200 180 160 140 120 100 80 60 40 20 0 -10 -30
f1 (ppm)


-112.3
-112.3
-113.0
-113.1
-113.6
-113.7
-114.3
-114.4
-81.1
-81.1
-81.2
-112.3
-114.4
-124.6
-124.6
-126.0
-126.0
-126.1
2.22
-112.2 -113.0 -113.8
f1 (ppm)
-125.972
-126.003
-126.054
2.02
-125.8
f1 (ppm)
-124.613
-124.636
2.02
-124.5 -124.7
f1 (ppm)
3.00
2.22
2.02
2.02
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

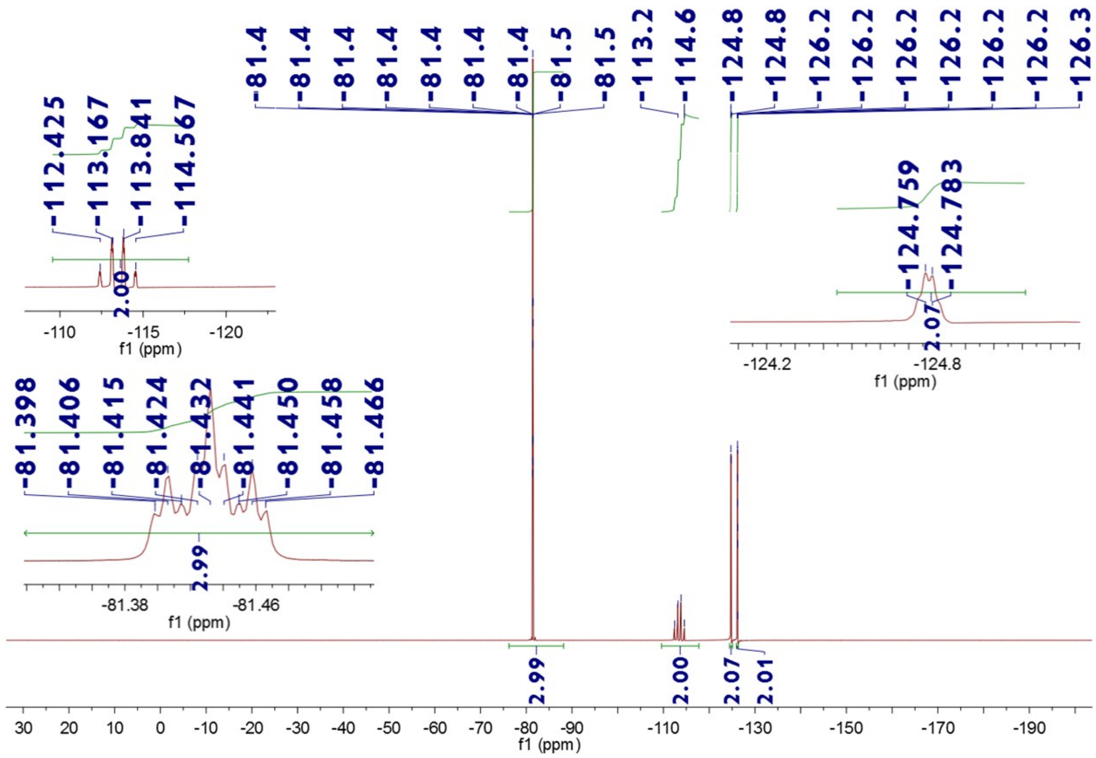
3d



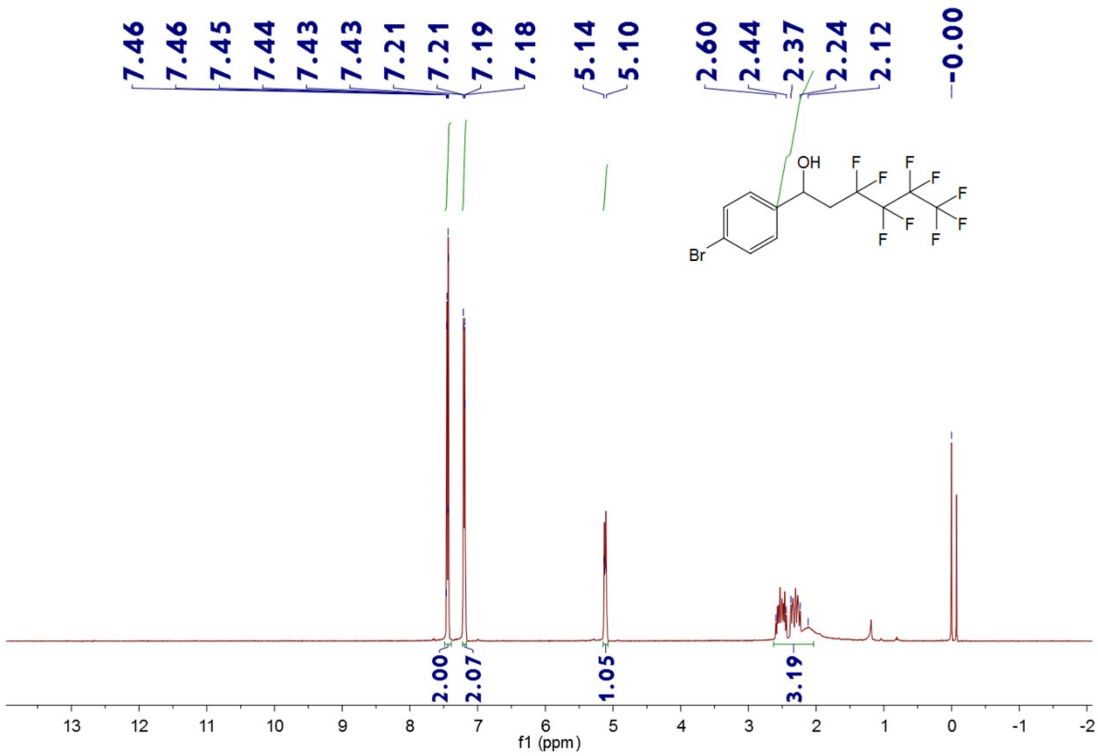
7.51
7.51
7.49
7.48
7.24
7.22
7.21
5.13
2.60
2.51
2.43
2.36
2.29
-0.00
OH
F
Br
7.511
7.505
7.490
7.484
7.241
7.225
7.205
1.94
2.00
2.575
2.527
2.506
2.485
2.431
2.407
2.358
2.330
2.292
3.17
1.07
f1 (ppm)

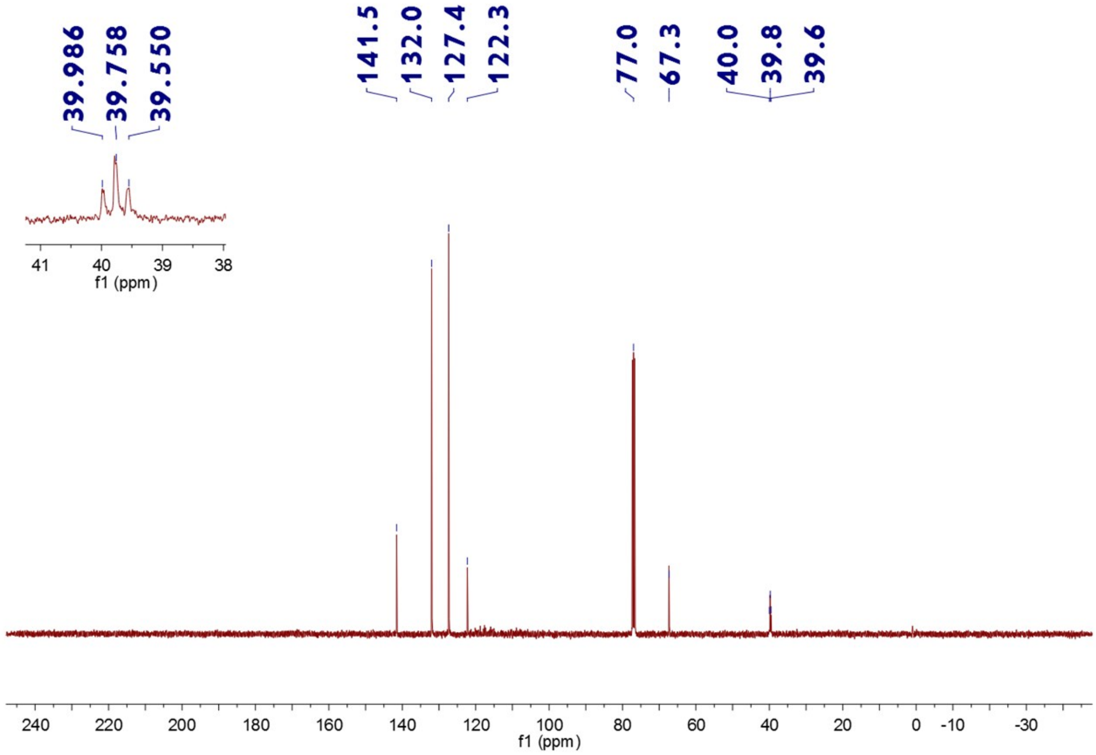


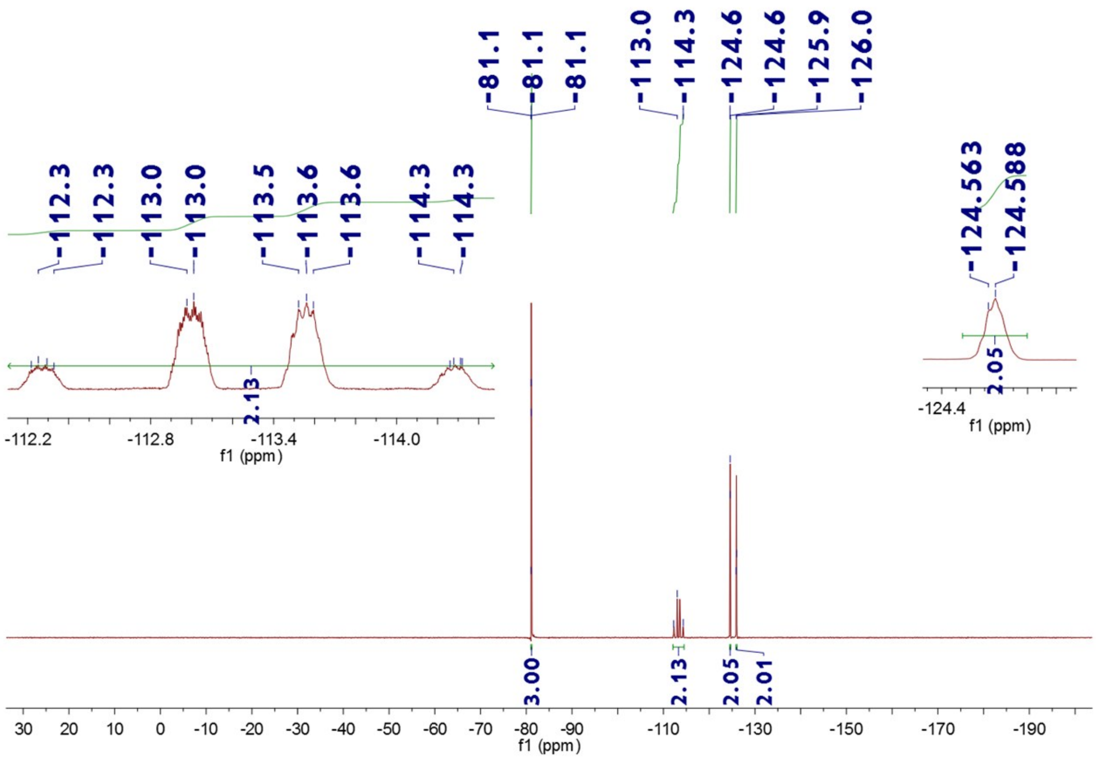
141.7
131.6
126.8
122.1
67.4
40.0
39.8
39.6
39.981
39.777
39.574
f1 (ppm)



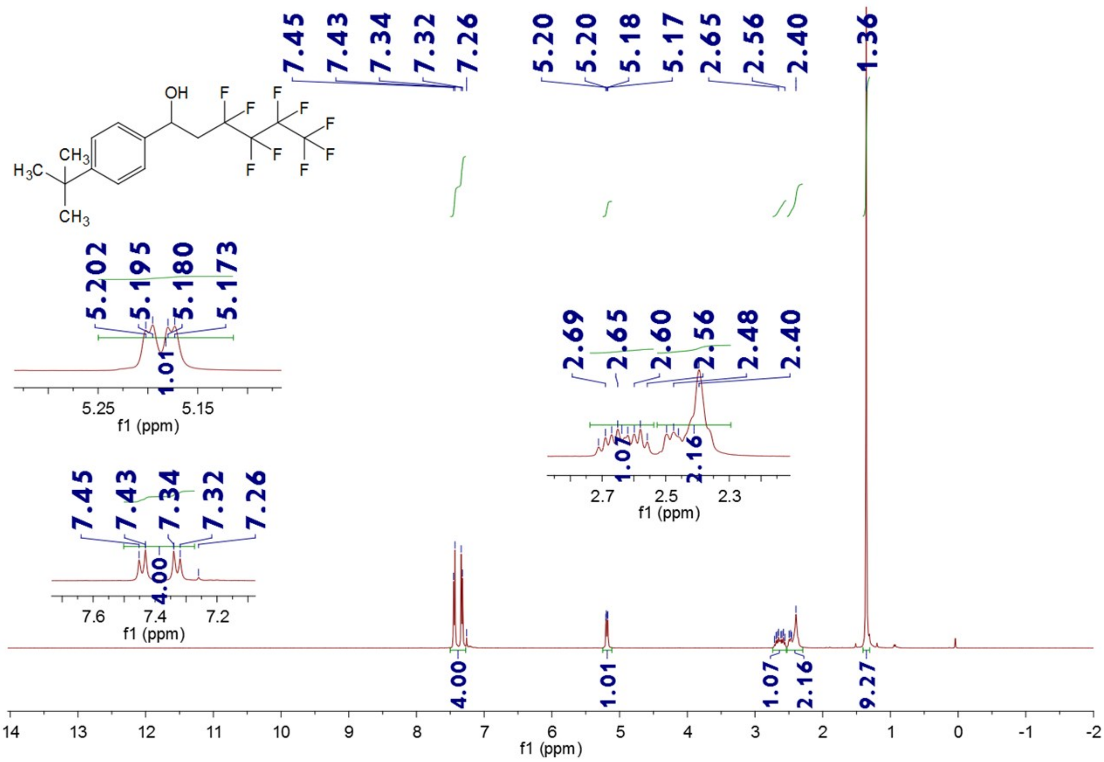
3d (under condition B)

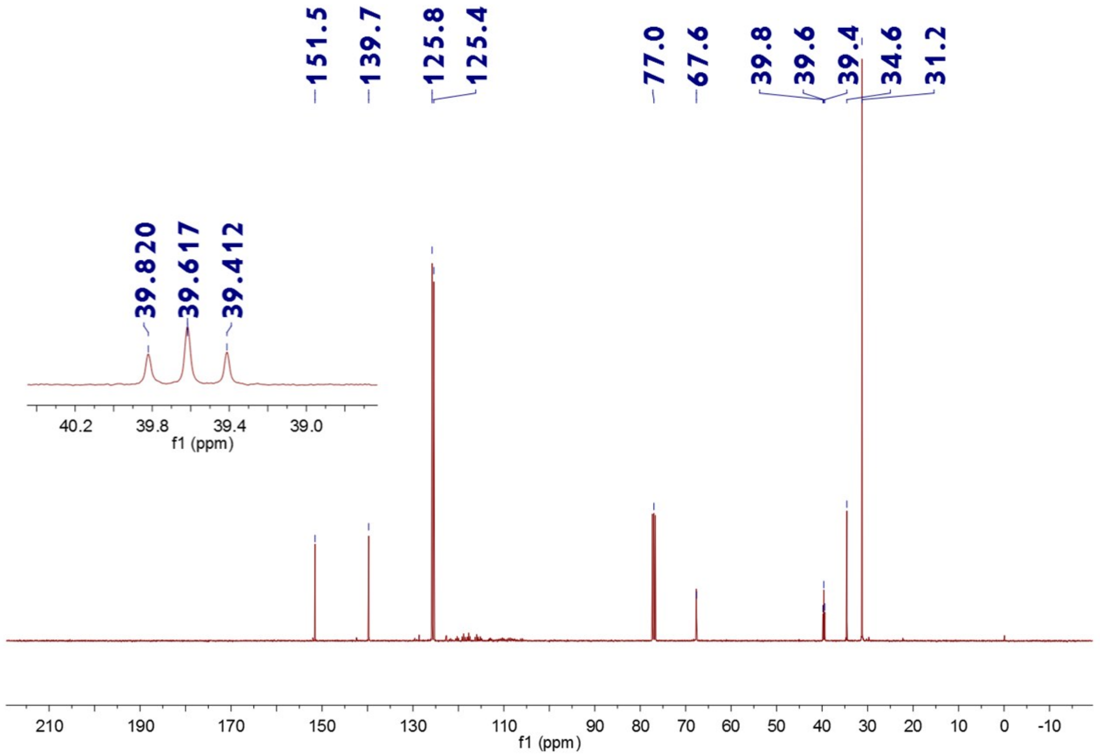


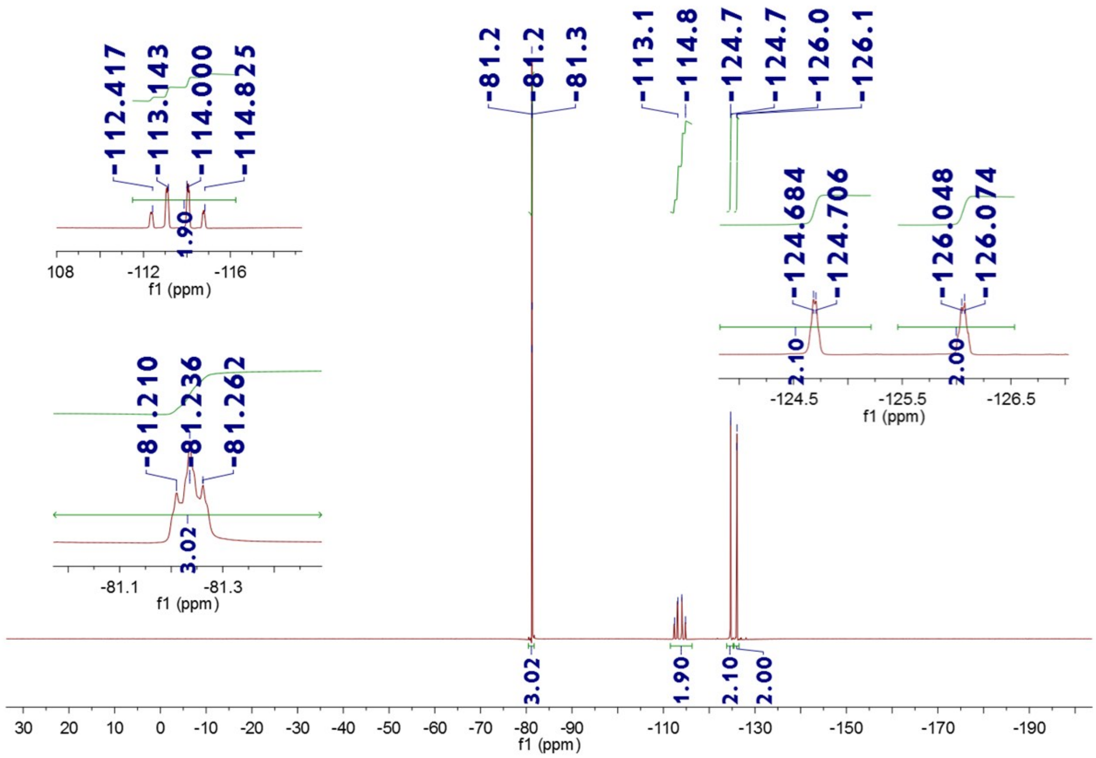

39.986
39.758
39.550
141.5
132.0
127.4
122.3
77.0
67.3
40.0
39.8
39.6
f1 (ppm)


-81.1
-81.1
-81.1
-113.0
-114.3
-124.6
-124.6
-125.9
-126.0
-112.3
-112.3
-113.0
-113.0
-113.5
-113.6
-113.6
-114.3
-114.3
-124.563
-124.588
2.13
2.05
3.00
2.13
2.05
2.01
f1 (ppm)

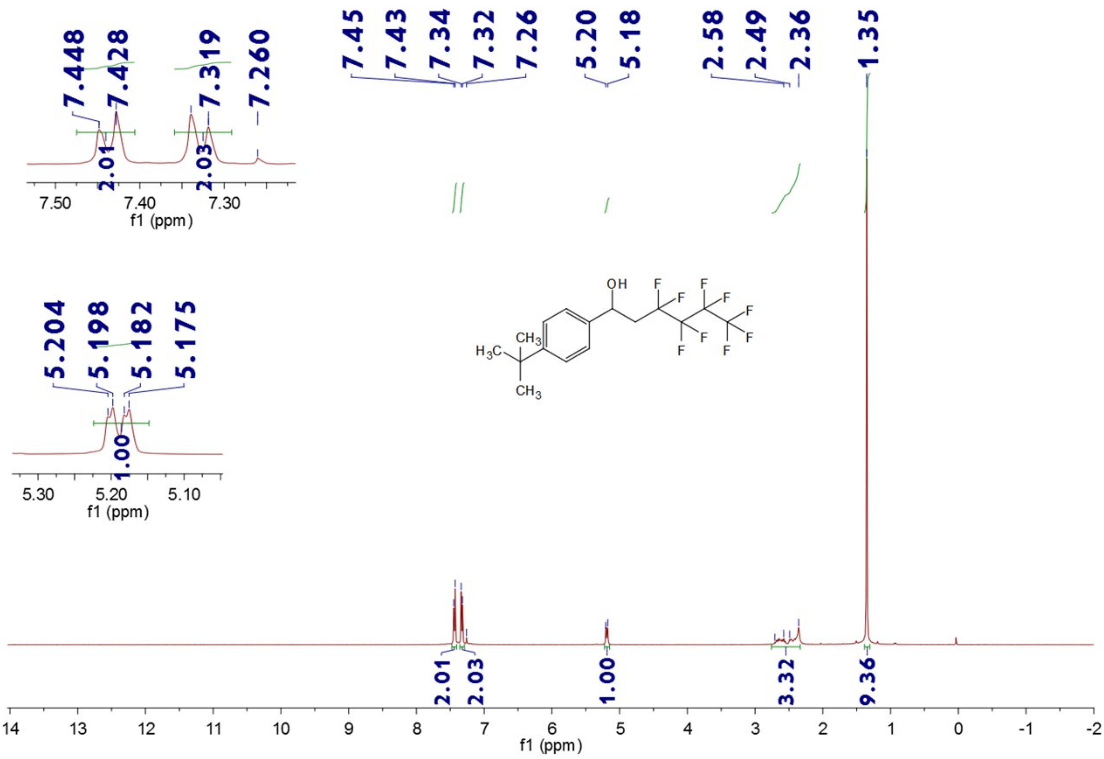
3e

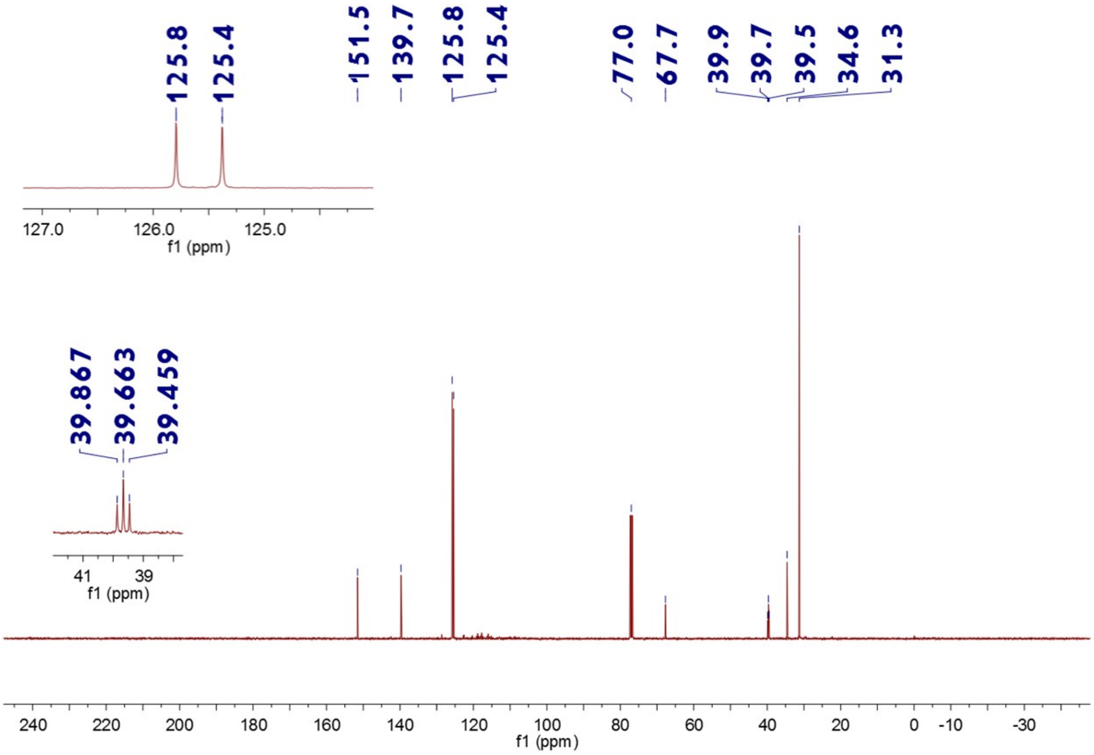

7.45
7.43
7.34
7.32
7.26
5.20
5.20
5.18
5.17
2.65
2.56
2.40
1.36
OH
F
F
F
F
F
F
F
F
F
H3C
CH3
CH3
5.202
5.195
5.180
5.173
1.01
5.25
5.15
f1 (ppm)
2.69
2.65
2.60
2.56
2.48
2.40
1.07
2.16
2.7
2.5
2.3
f1 (ppm)
7.45
7.43
7.34
7.32
7.26
4.00
7.6
7.4
7.2
f1 (ppm)
4.00
1.01
1.07
2.16
9.27
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

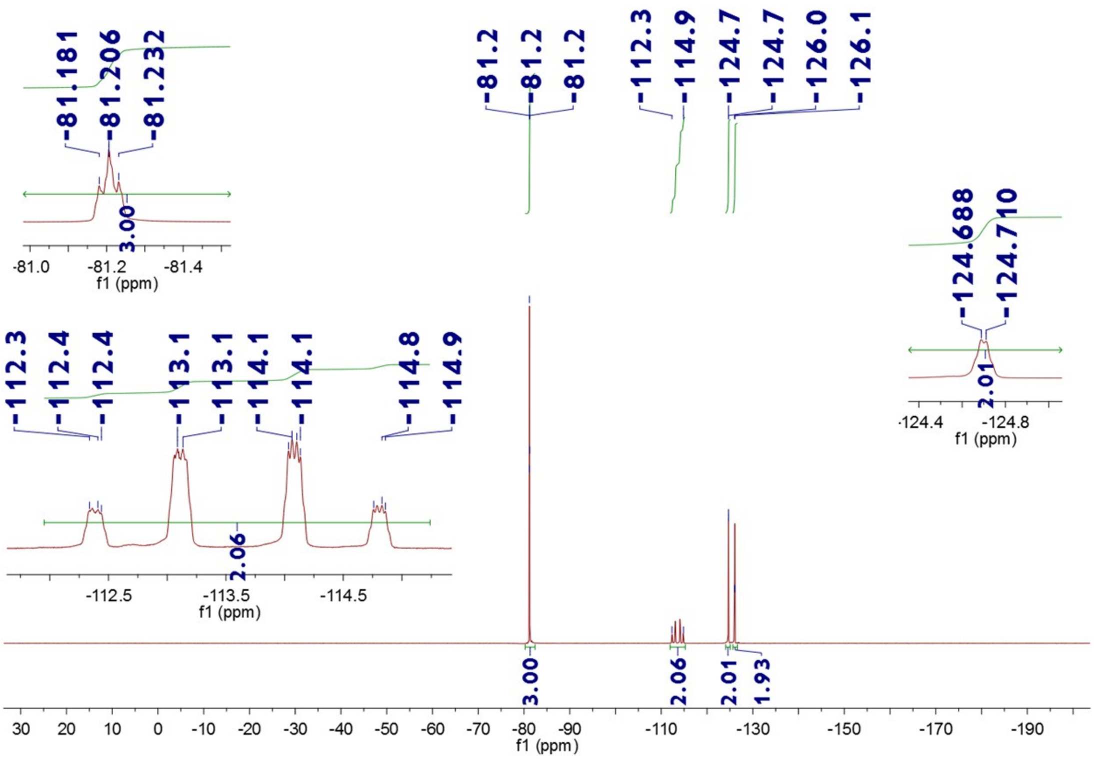

151.5
139.7
125.8
125.4
77.0
67.6
39.8
39.6
39.4
34.6
31.2
39.820
39.617
39.412
40.2
39.8
39.4
39.0
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



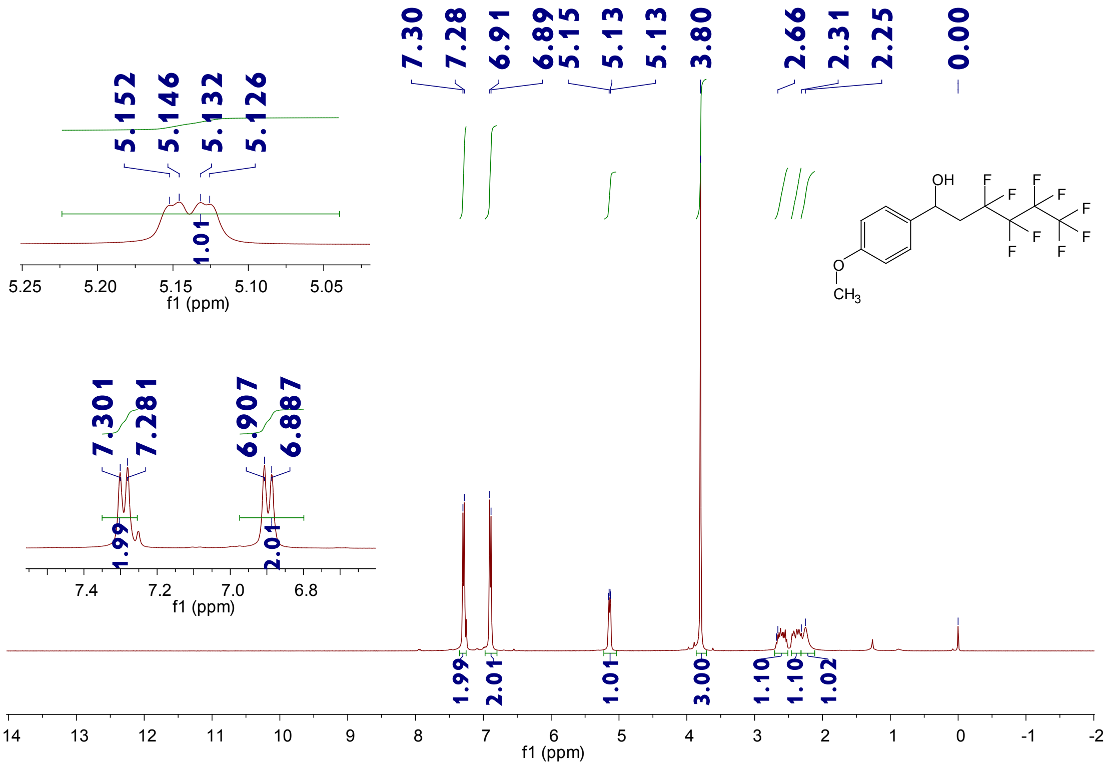
3e (under condition B)

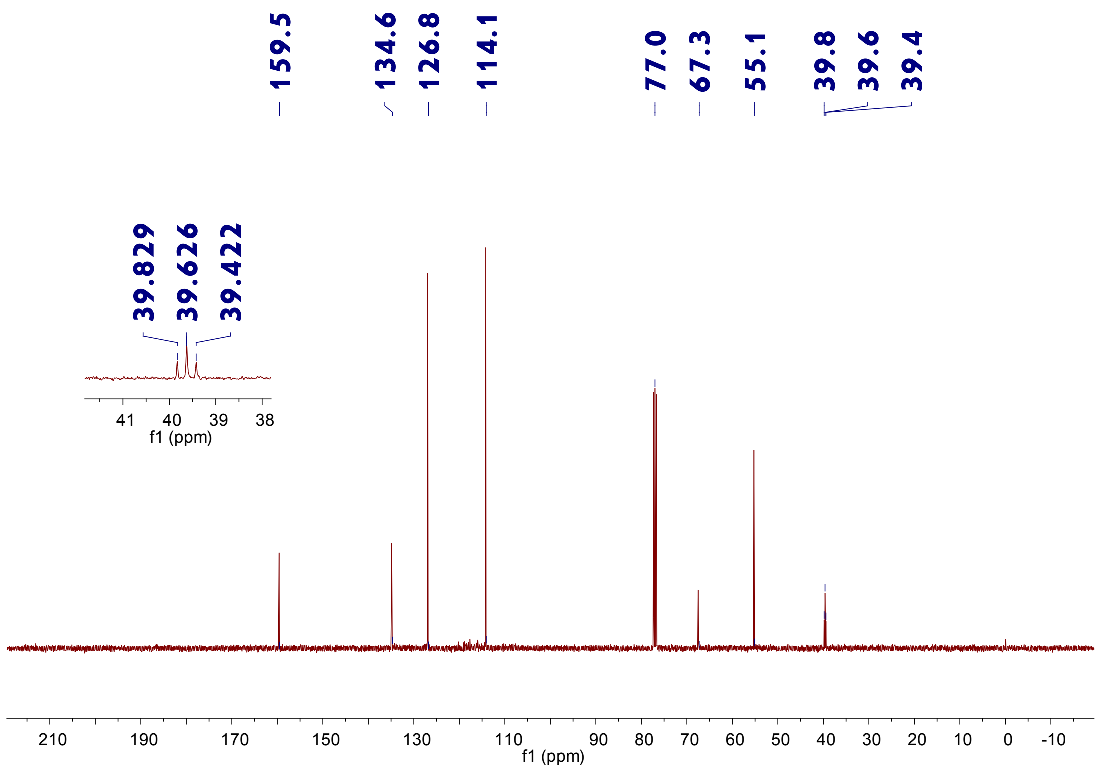


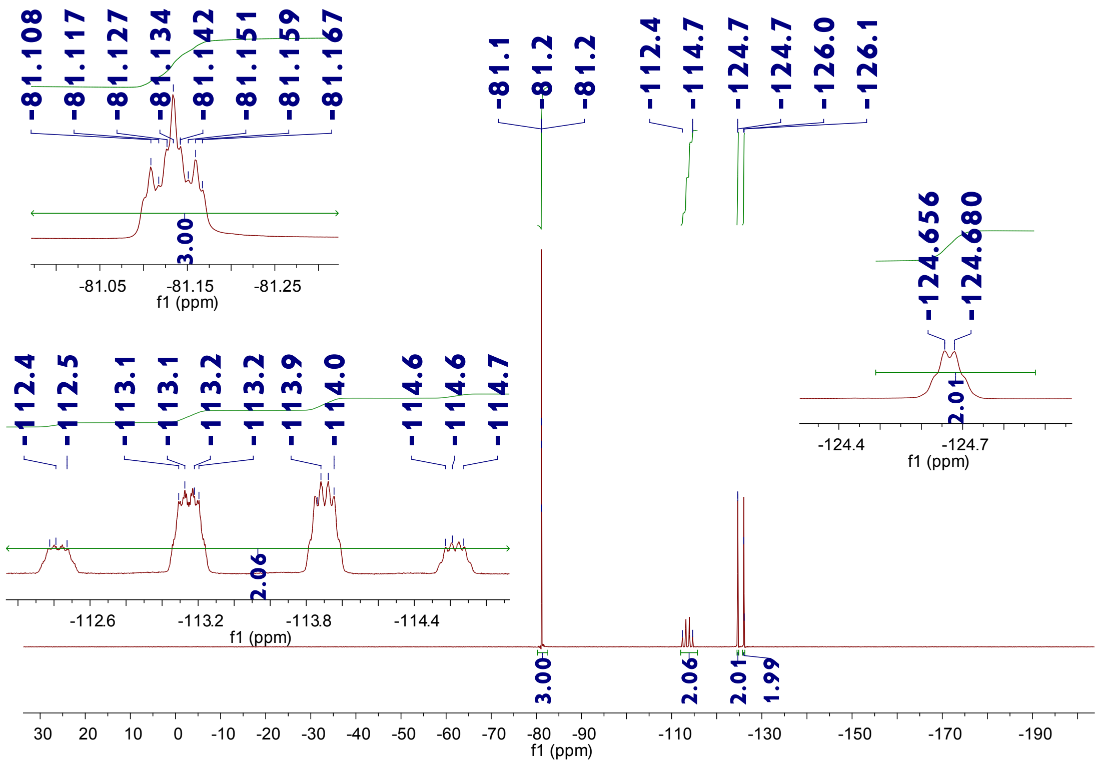

125.8
125.4
127.0 126.0 125.0
f1 (ppm)
151.5
139.7
125.8
125.4
77.0
67.7
39.9
39.7
39.5
34.6
31.3
39.867
39.663
39.459
41 39
f1 (ppm)
240 220 200 180 160 140 120 100 80 60 40 20 0 -10 -30
f1 (ppm)


-81.181
-81.206
-81.232
3.00
-81.0 -81.2 -81.4
f1 (ppm)
-81.2
-81.2
-81.2
-112.3
-114.9
-124.7
-124.7
-126.0
-126.1
-124.688
-124.710
2.01
-124.4 -124.8
f1 (ppm)
-112.3
-112.4
-112.4
-113.1
-113.1
-114.1
-114.1
-114.8
-114.9
2.06
-112.5 -113.5 -114.5
f1 (ppm)
3.00
2.06
2.01
1.93
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

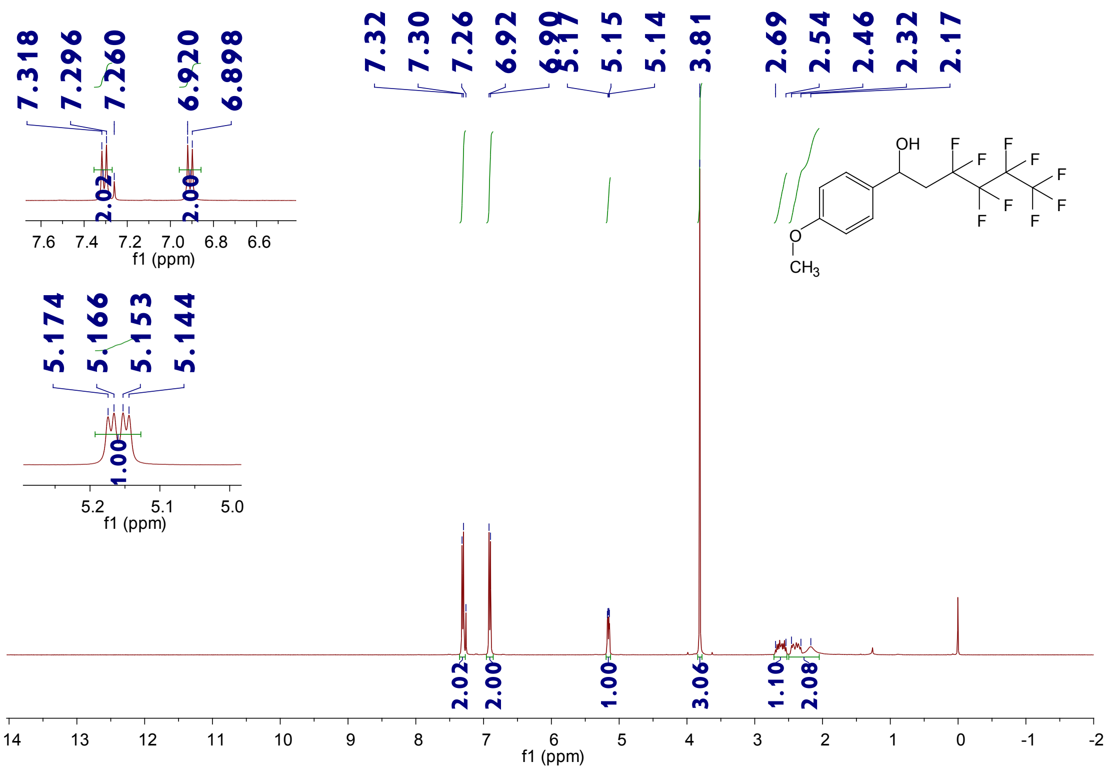
3f

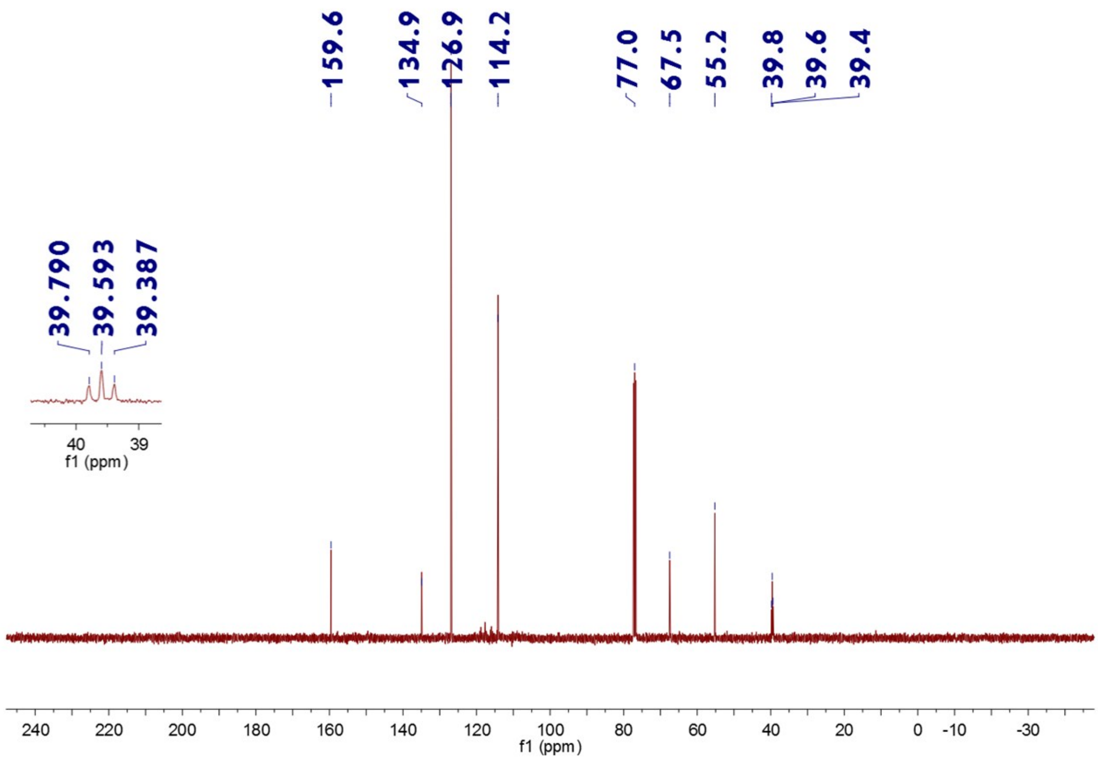

7.30
7.28
6.91
6.89
5.15
5.13
5.13
3.80
2.66
2.31
2.25
0.00
5.152
5.146
5.132
5.126
1.01
5.25
5.20
5.15
5.10
5.05
f1 (ppm)
7.301
7.281
6.907
6.887
1.99
2.01
7.4
7.2
7.0
6.8
f1 (ppm)
OH
F
O
CH3
1.99
2.01
1.01
3.00
1.10
1.10
1.02
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
f1 (ppm)

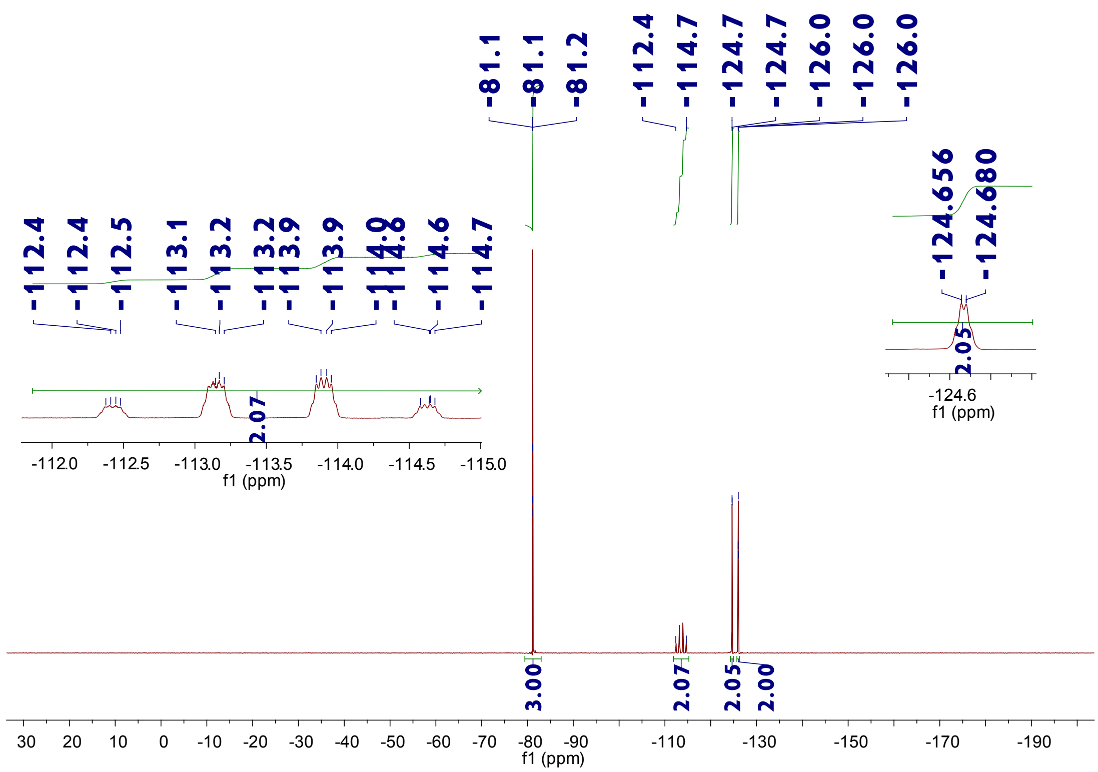

159.5
134.6
126.8
114.1
77.0
67.3
55.1
39.8
39.6
39.4
39.829
39.626
39.422
41
40
39
38
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)



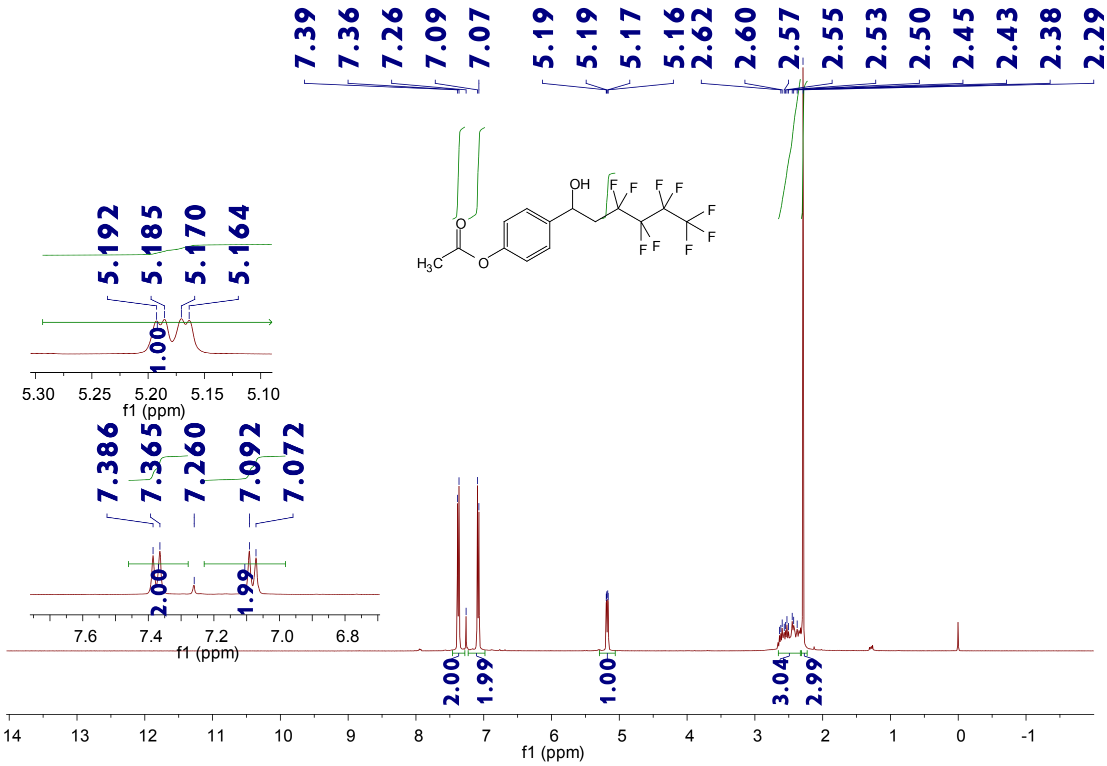
3f (under condition B)

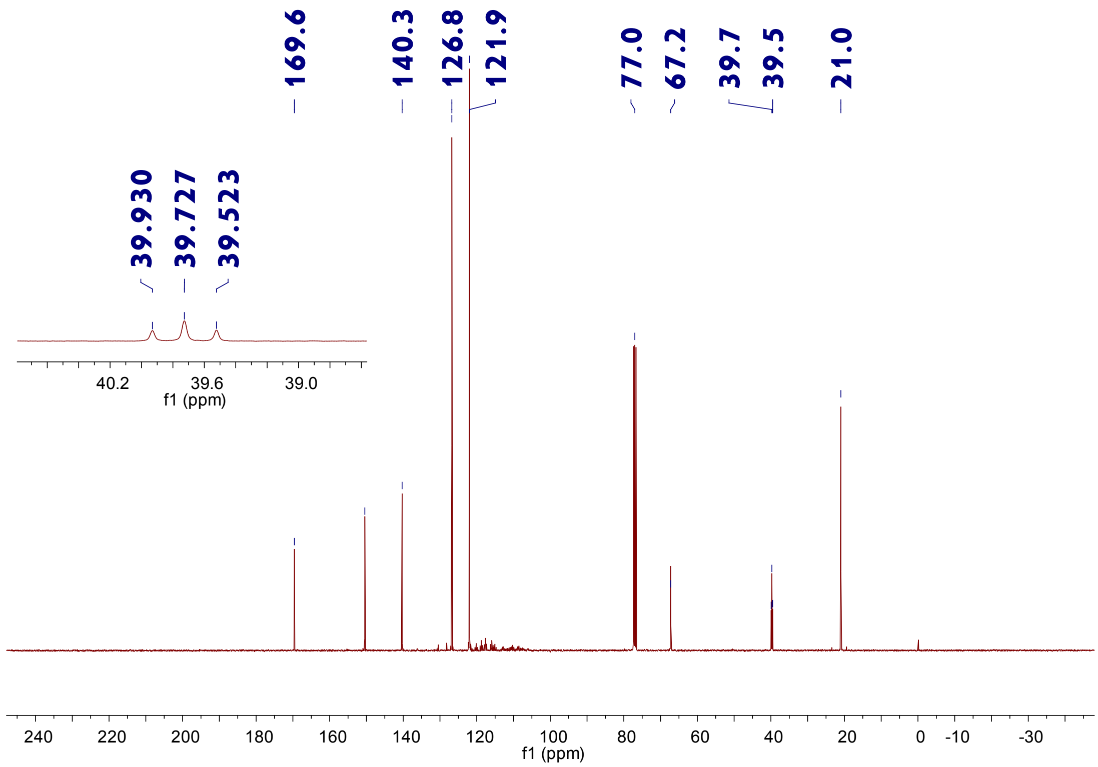


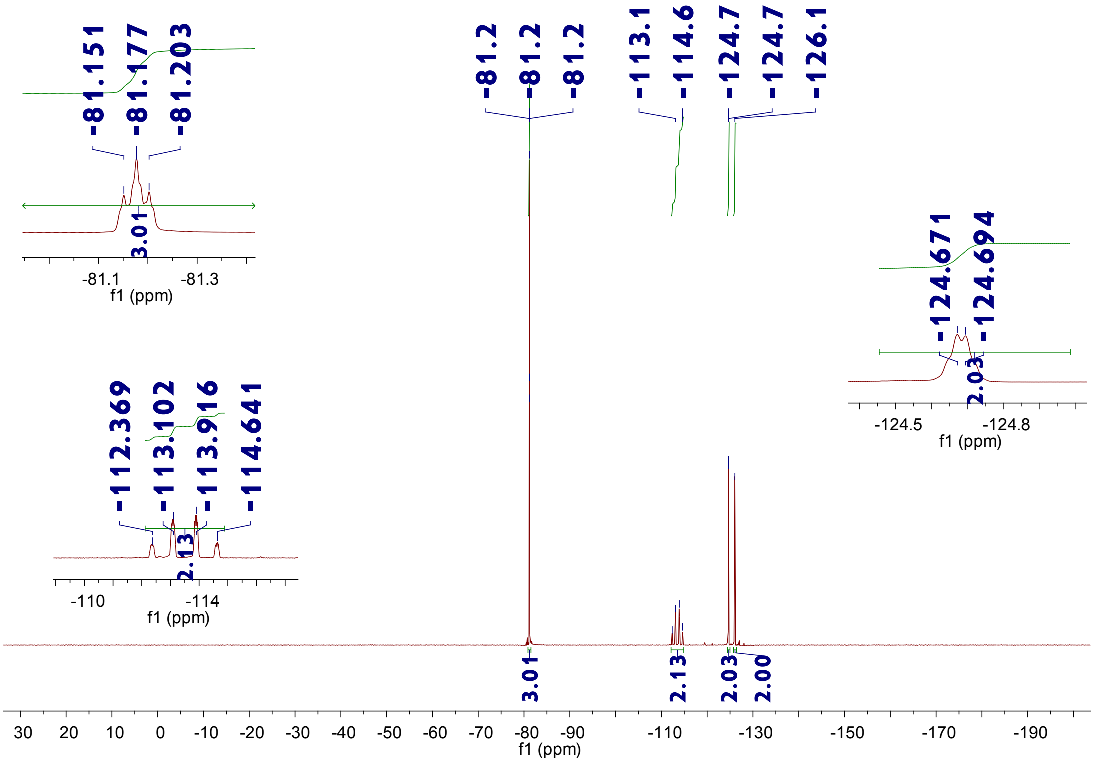

159.6
134.9
126.9
114.2
77.0
67.5
55.2
39.8
39.6
39.4
39.790
39.593
39.387
40
39
f1 (ppm)
240
220
200
180
160
140
120
100
80
60
40
20
0
-10
-30
f1 (ppm)


-81.1
-81.1
-81.2
-112.4
-114.7
-124.7
-124.7
-126.0
-126.0
-126.0
-112.4
-112.4
-112.5
-113.1
-113.2
-113.2
-113.9
-113.9
-114.0
-114.6
-114.7
2.07
-112.0
-112.5
-113.0
-113.5
-114.0
-114.5
-115.0
f1 (ppm)
-124.656
-124.680
2.05
-124.6
f1 (ppm)
3.00
2.07
2.05
2.00
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

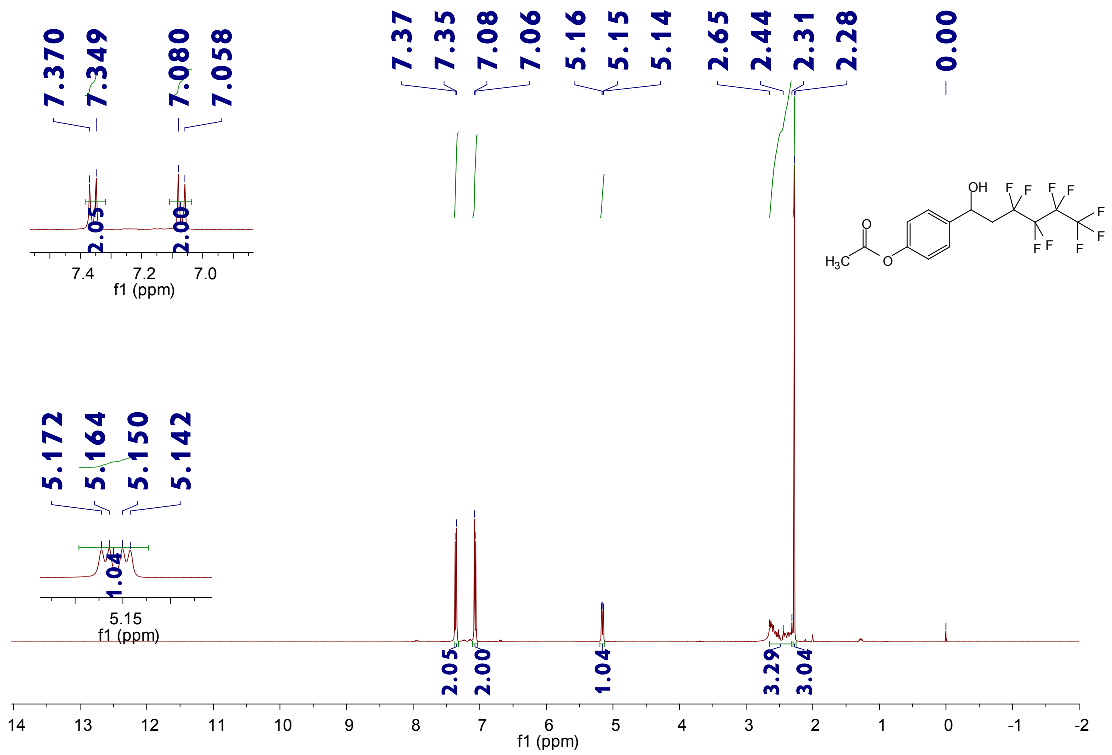
3g

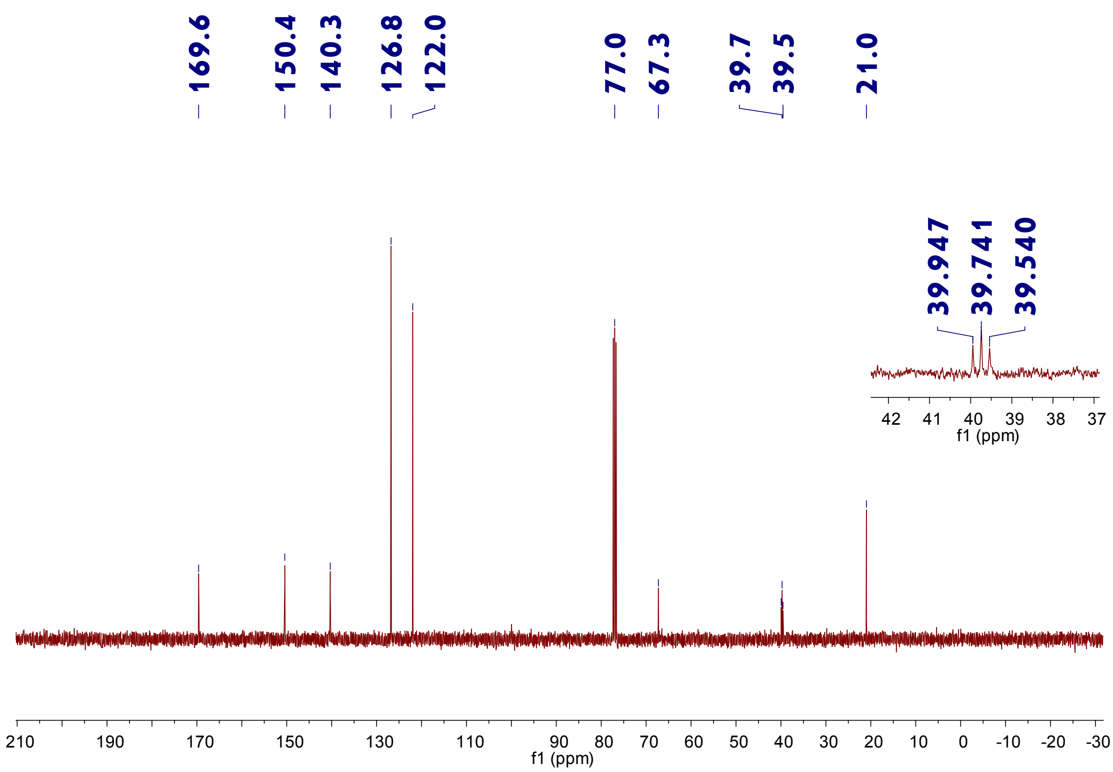


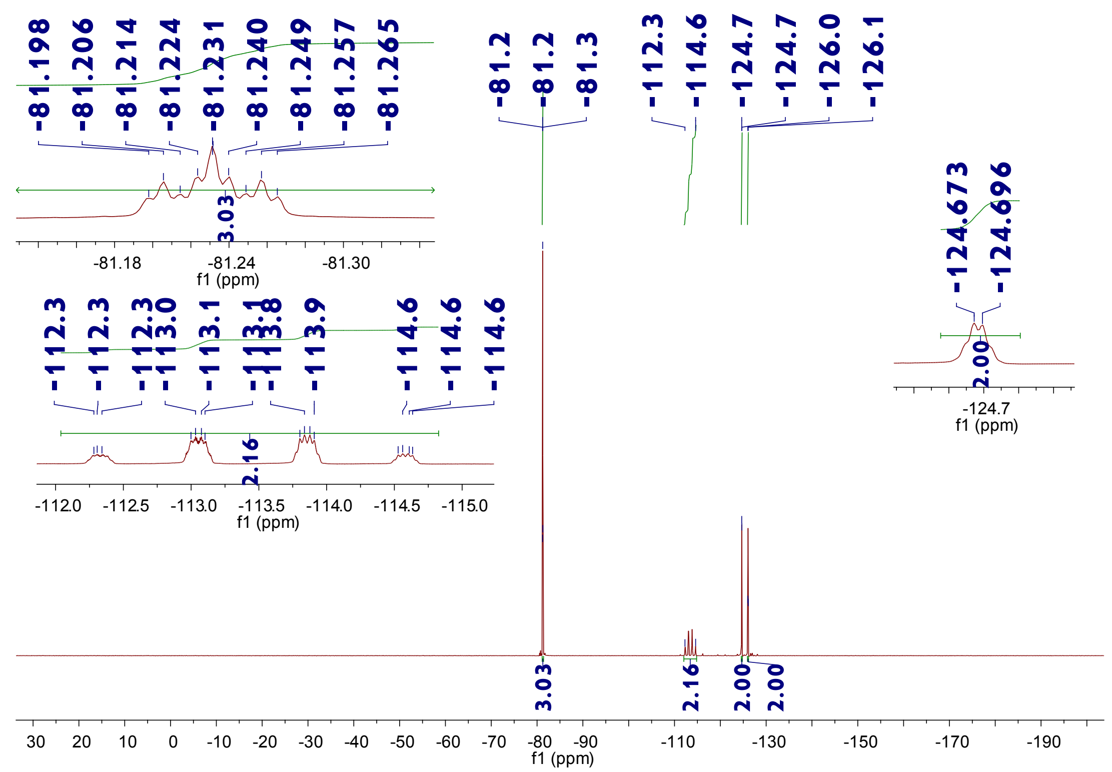




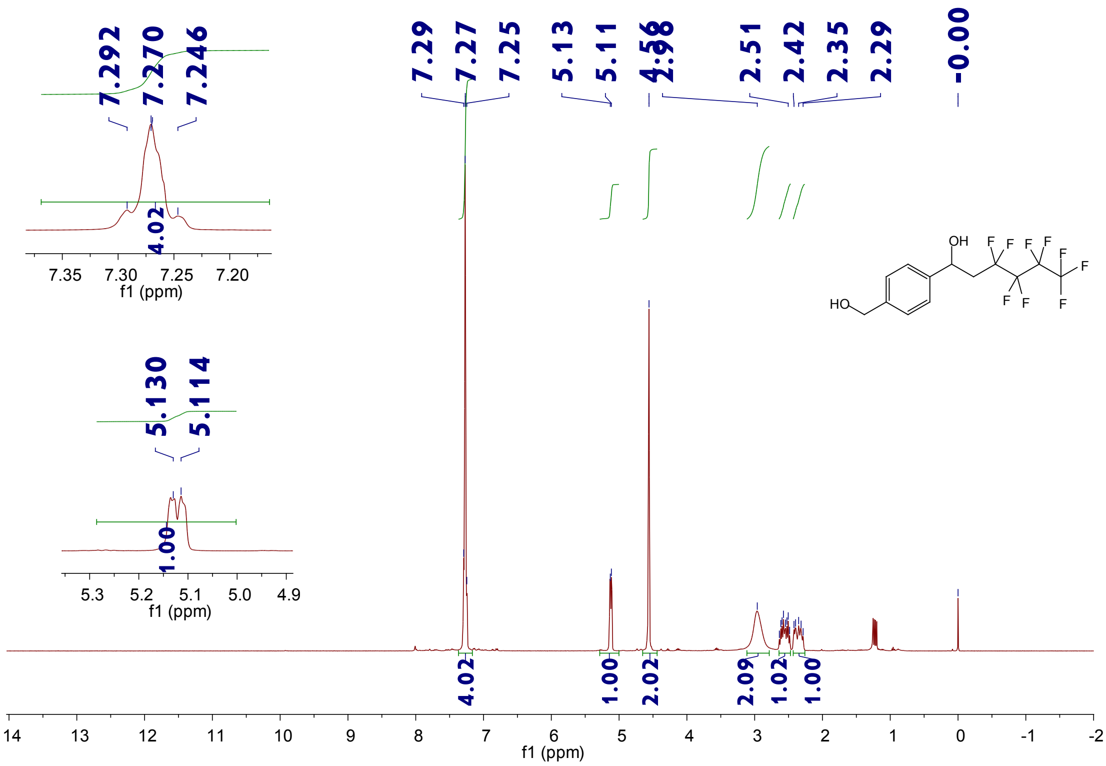
3g (under condition B)

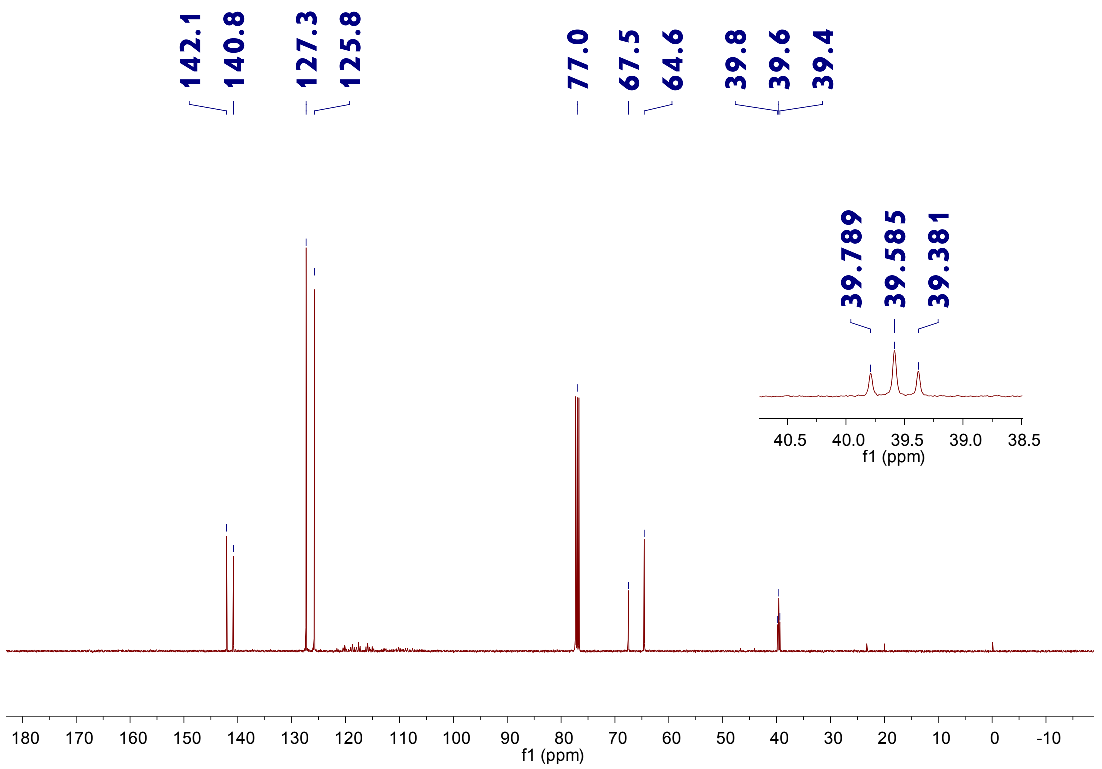


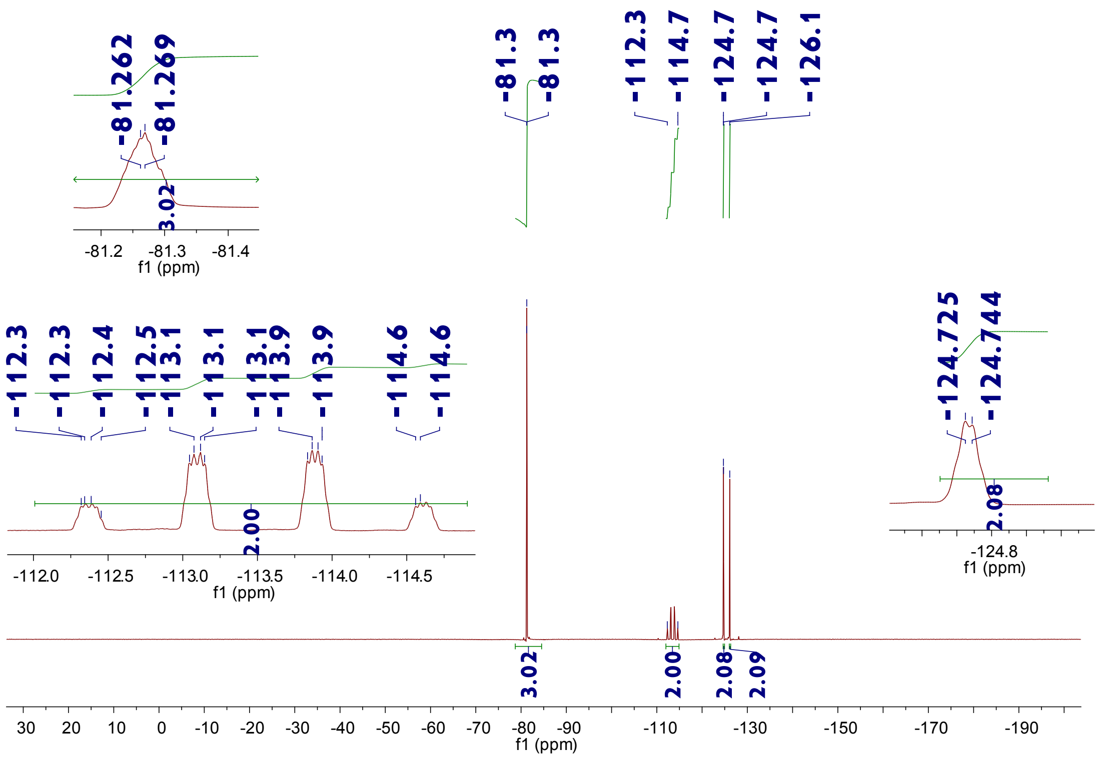

169.6
150.4
140.3
126.8
122.0
77.0
67.3
39.7
39.5
21.0
39.947
39.741
39.540
f1 (ppm)
f1 (ppm)


-81.198
-81.206
-81.214
-81.224
-81.231
-81.240
-81.249
-81.257
-81.265
-81.2
-81.2
-81.3
-112.3
-114.6
-124.7
-124.7
-126.0
-126.1
-124.673
-124.696
3.03
2.16
2.00
2.00
f1 (ppm)

3h

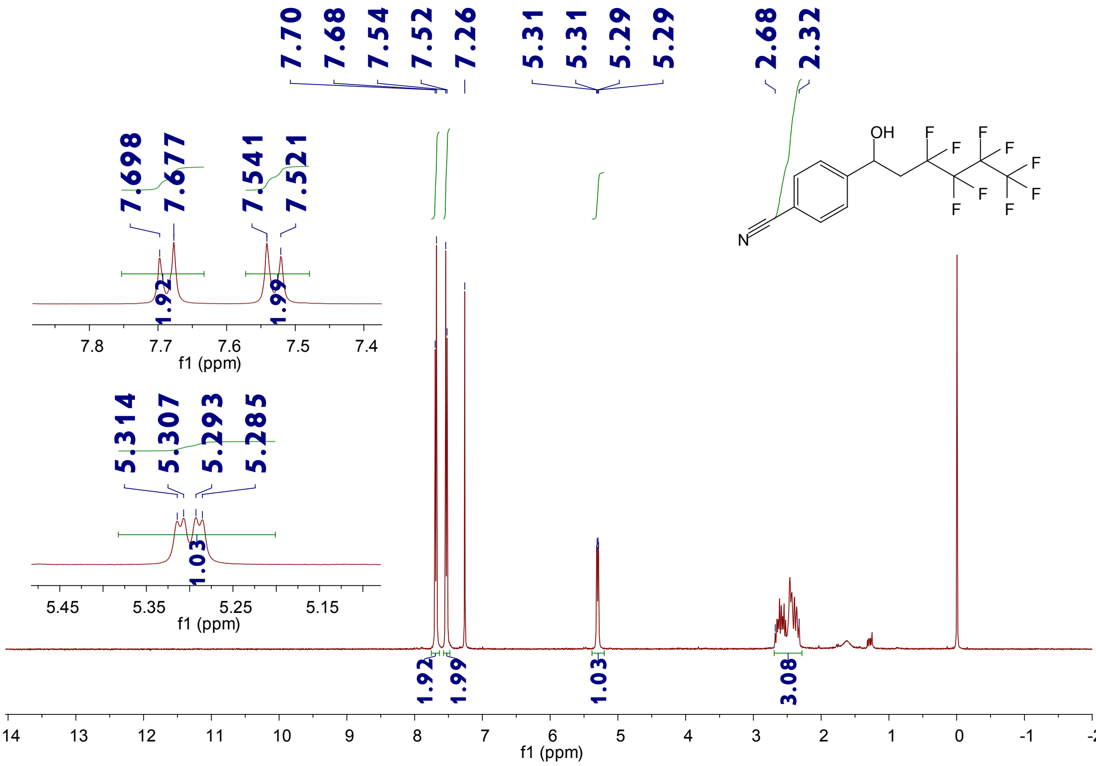


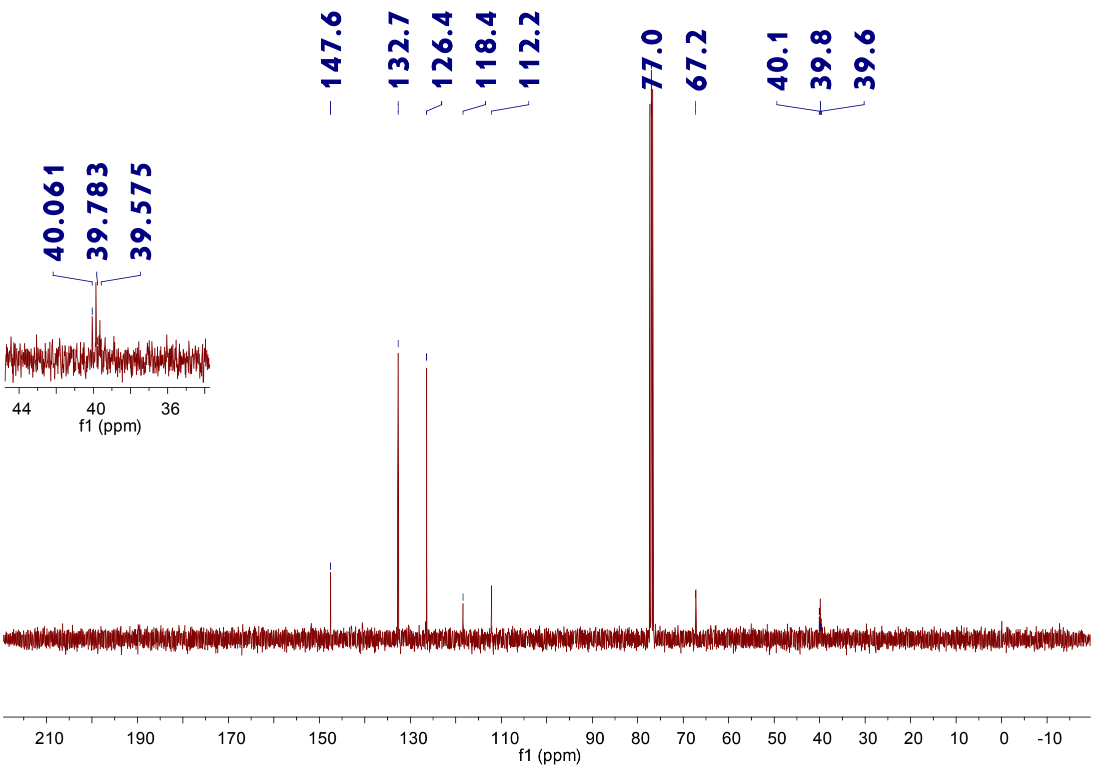


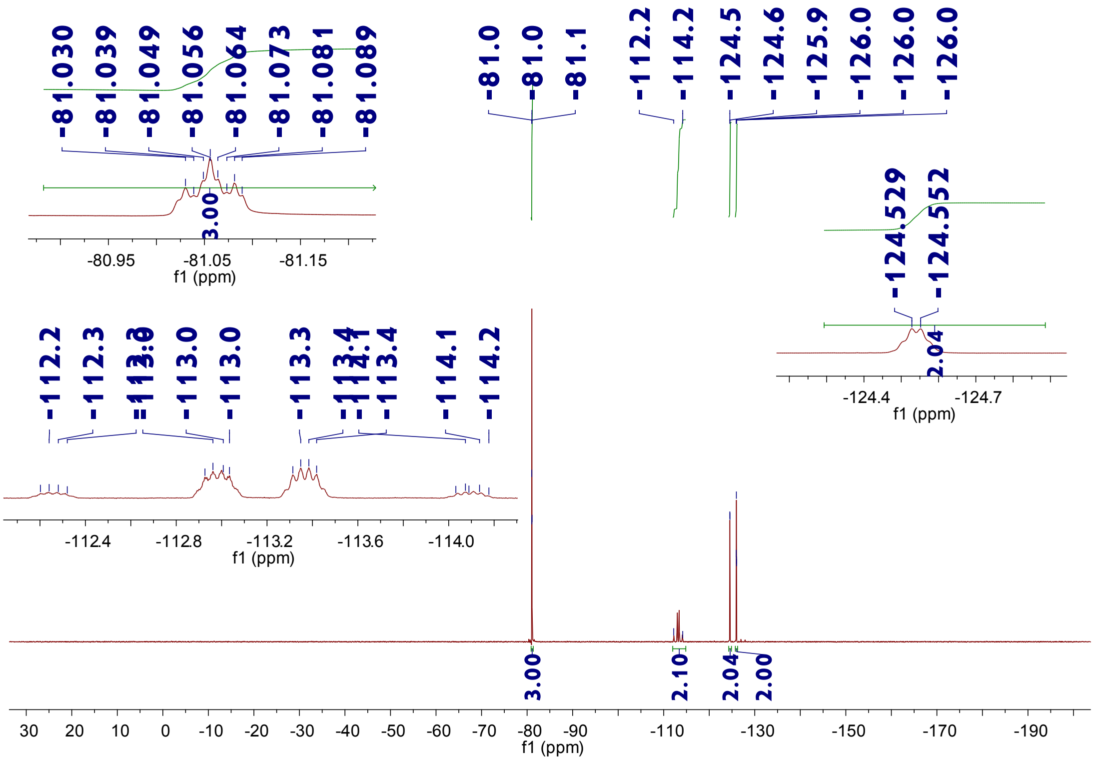


-81.262
-81.269
3.02
-81.2
-81.3
-81.4
f1 (ppm)
-81.3
-81.3
-112.3
-114.7
-124.7
-124.7
-126.1
-112.3
-112.3
-112.4
-112.5
-113.1
-113.1
-113.1
-113.9
-113.9
-114.6
-114.6
2.00
-112.0
-112.5
-113.0
-113.5
-114.0
-114.5
f1 (ppm)
-124.725
-124.744
2.08
-124.8
f1 (ppm)
3.02
2.00
2.08
2.09
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

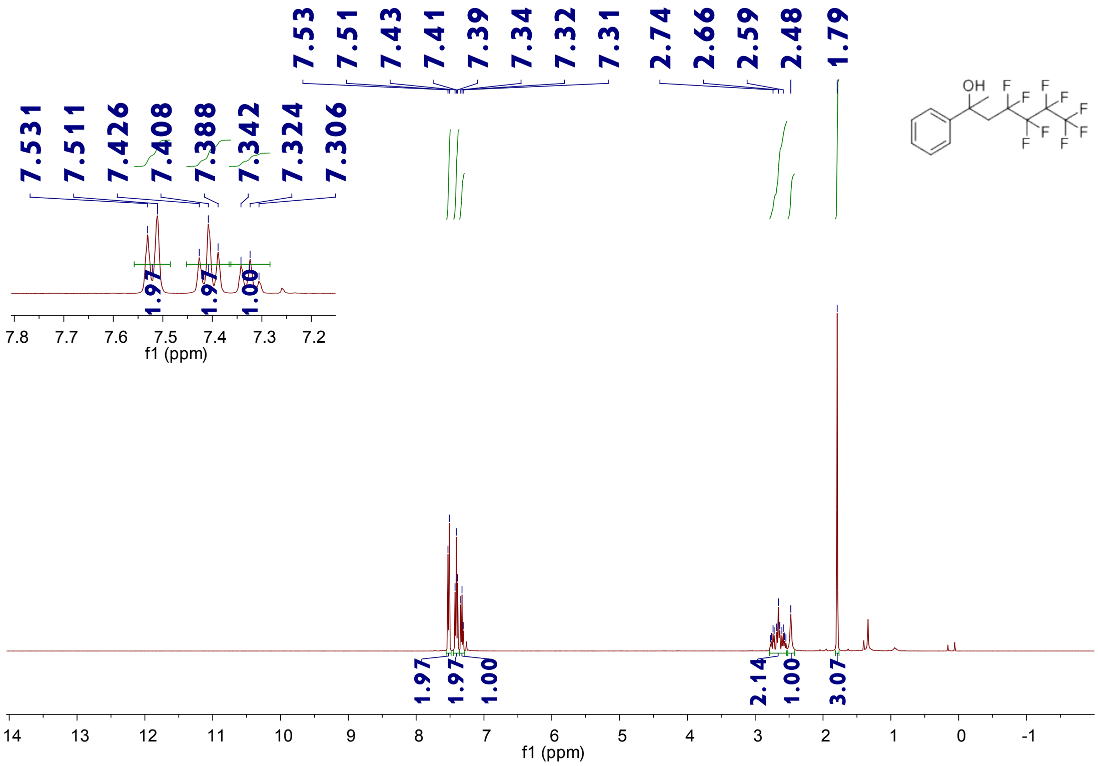
3i

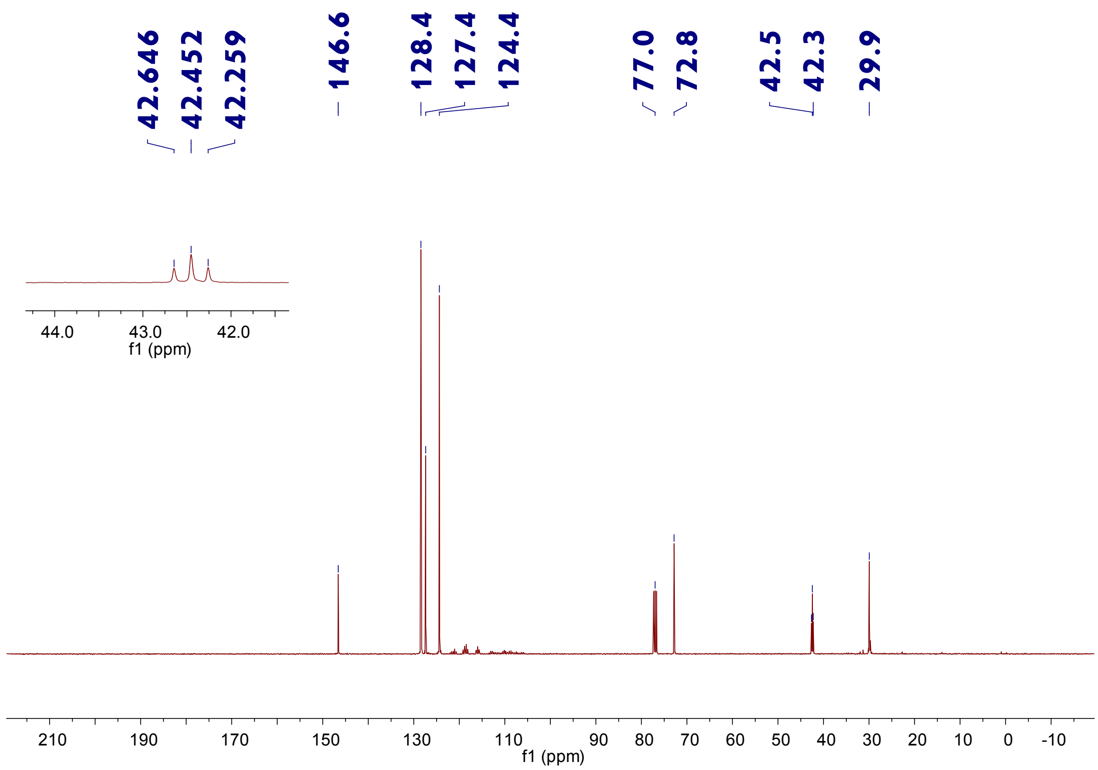

7.70
7.68
7.54
7.52
7.26
5.31
5.31
5.29
5.29
2.68
2.32
7.698
7.677
7.541
7.521
1.92
1.99
7.8
7.7
7.6
7.5
7.4
f1 (ppm)
5.314
5.307
5.293
5.285
1.03
5.45
5.35
5.25
5.15
f1 (ppm)
OH
F
F
F
F
F
F
F
F
F
N
1.92
1.99
1.03
3.08
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

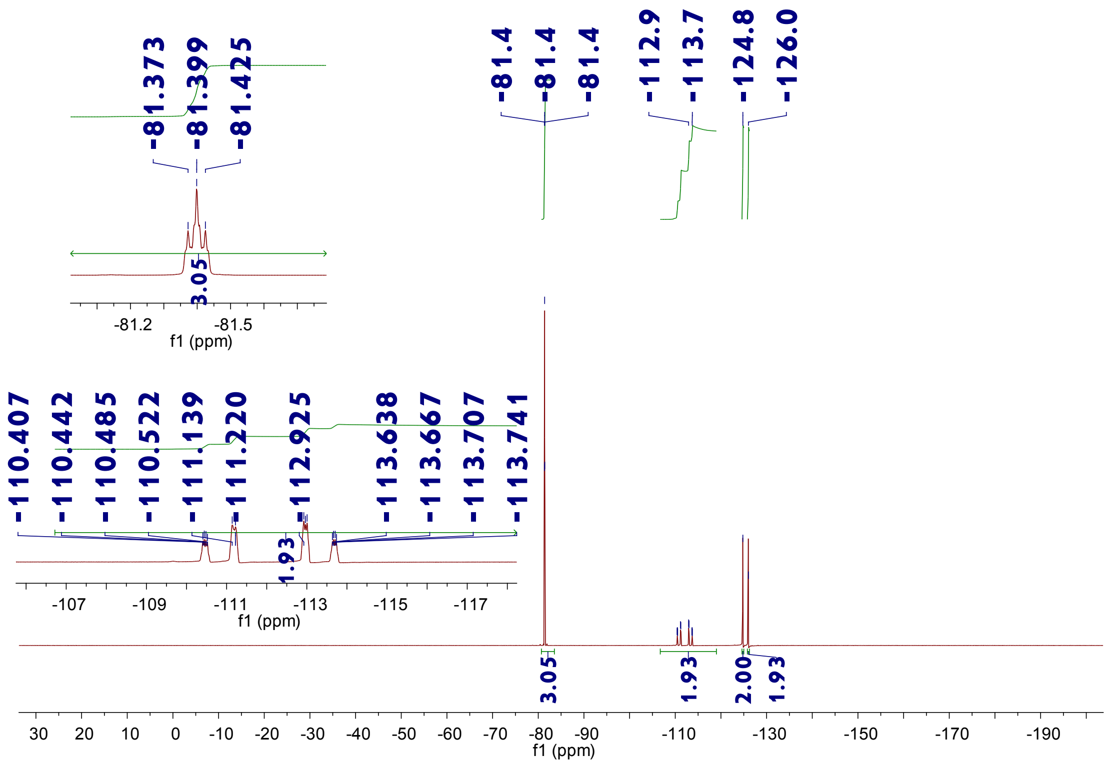

147.6
132.7
126.4
118.4
112.2
77.0
67.2
40.1
39.8
39.6
40.061
39.783
39.575
44
40
36
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


-81.030
-81.039
-81.049
-81.056
-81.064
-81.073
-81.081
-81.089
3.00
-80.95
-81.05
-81.15
f1 (ppm)
-81.0
-81.0
-81.1
-112.2
-114.2
-124.5
-124.6
-125.9
-126.0
-126.0
-126.0
-124.529
-124.552
2.04
-124.4
-124.7
f1 (ppm)
-112.2
-112.3
-113.0
-113.0
-113.3
-113.4
-113.4
-114.1
-114.2
-112.4
-112.8
-113.2
-113.6
-114.0
f1 (ppm)
3.00
2.10
2.04
2.00
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

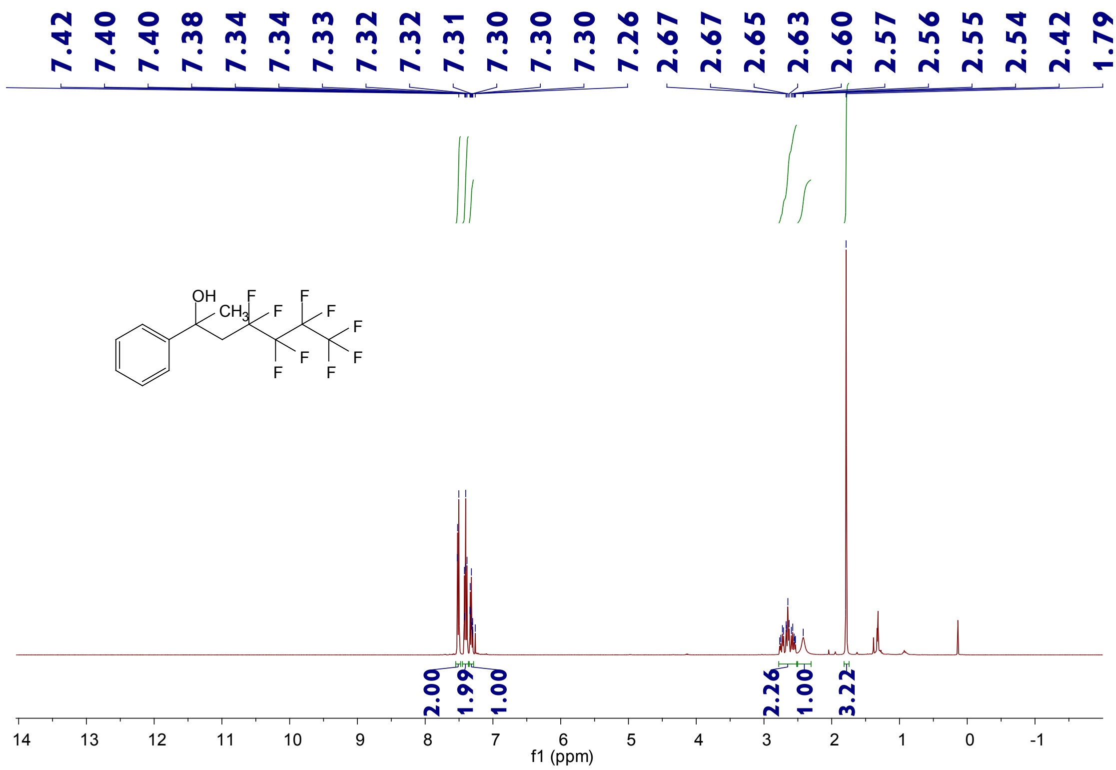
3j

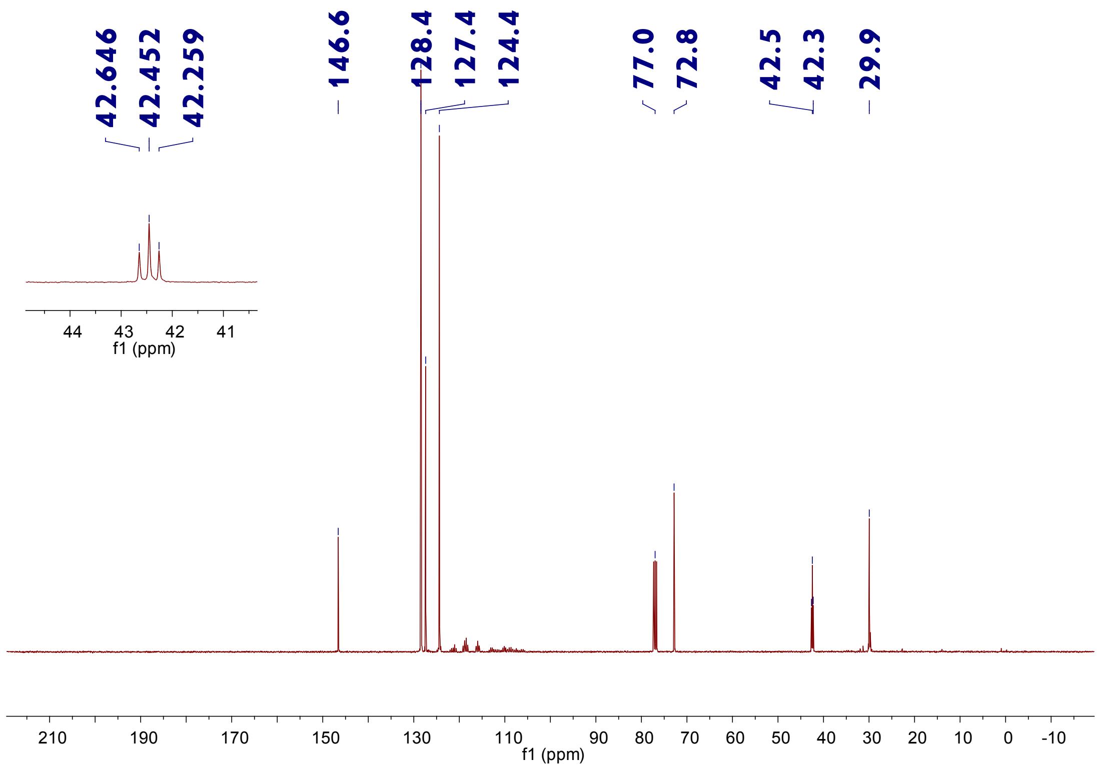

7.53 7.51 7.43 7.41 7.39 7.34 7.32 7.31 2.74 2.66 2.59 2.48 1.79
7.531 7.511 7.426 7.408 7.388 7.342 7.324 7.306
1.97 1.97 1.00
7.8 7.7 7.6 7.5 7.4 7.3 7.2
f1 (ppm)
OH F F F F F F F F F
1.97 1.97 1.00 2.14 1.00 3.07
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1
f1 (ppm)

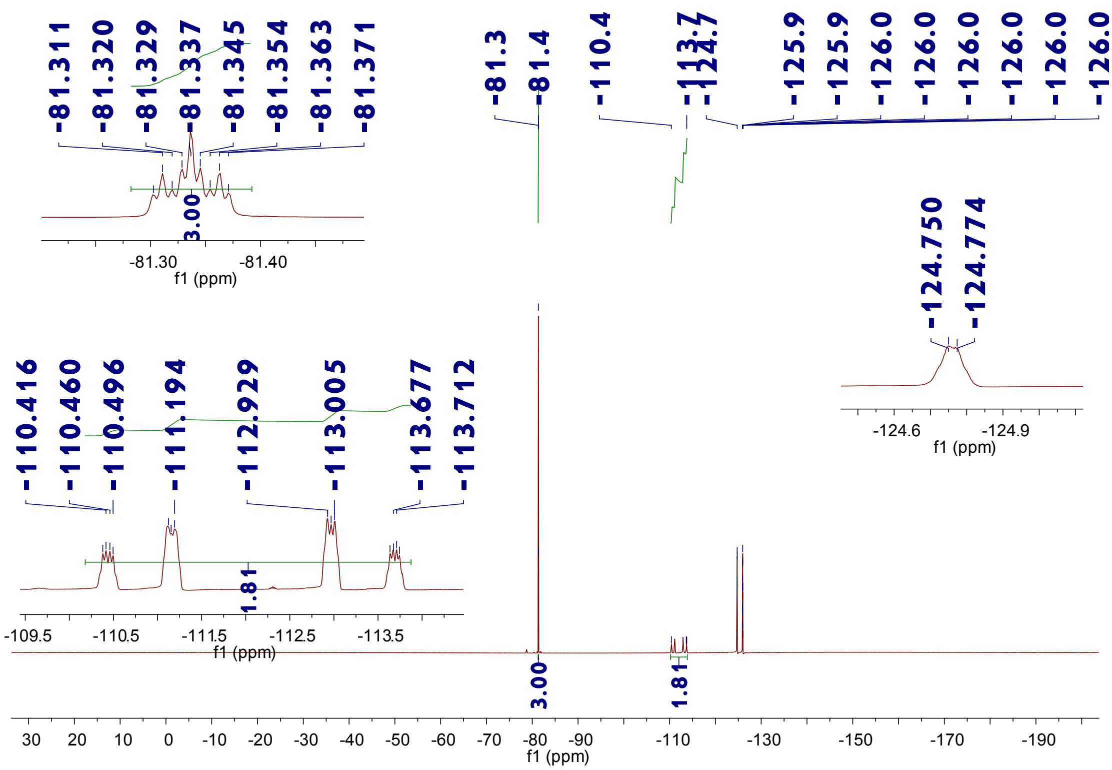

42.646 42.452 42.259
146.6 128.4 127.4 124.4 77.0 72.8 42.5 42.3 29.9
44.0 43.0 42.0
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



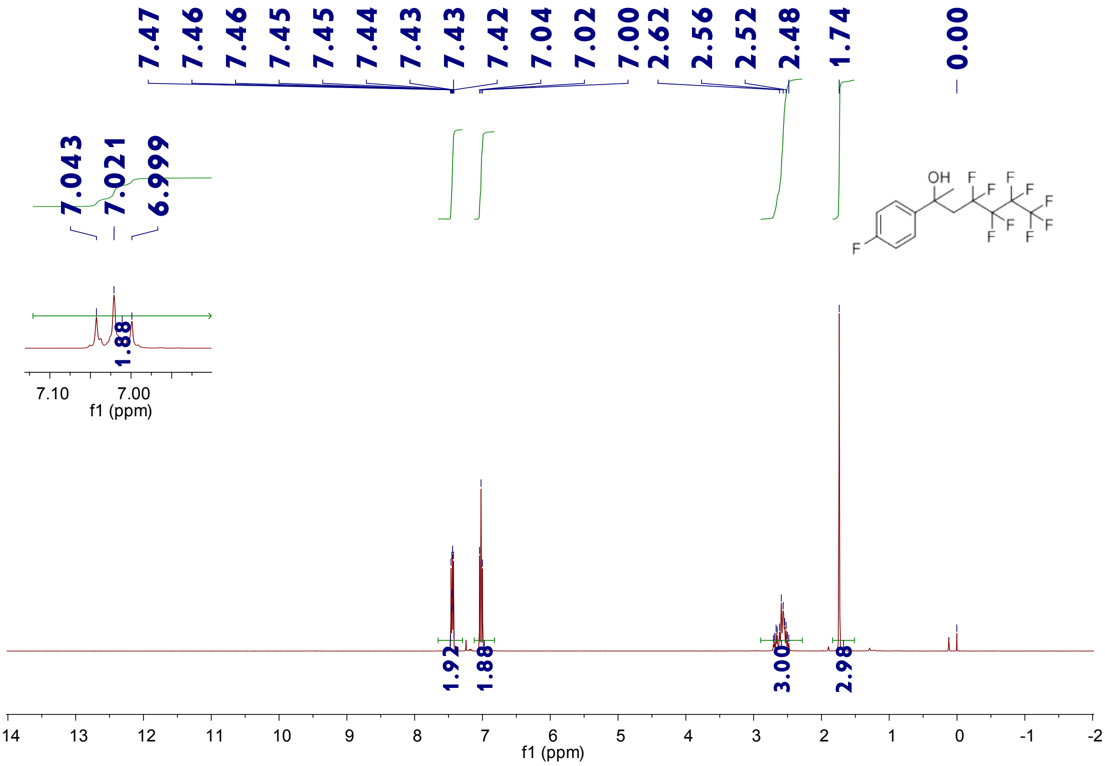
3j (under condition B)

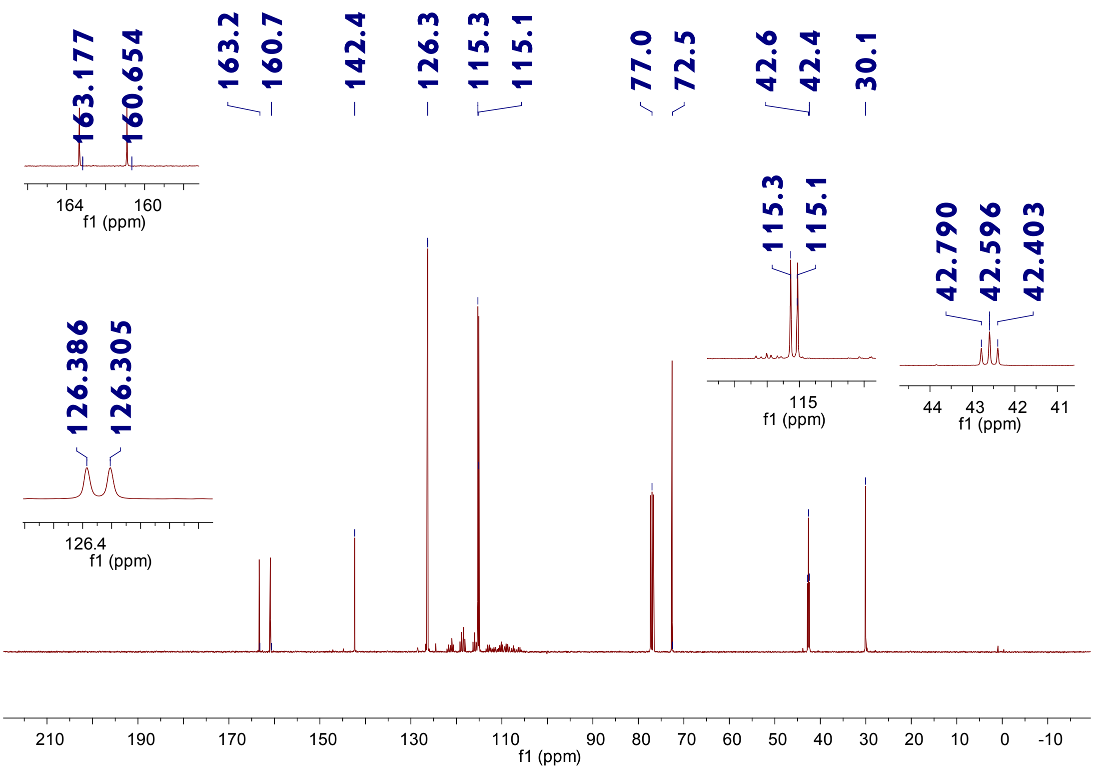


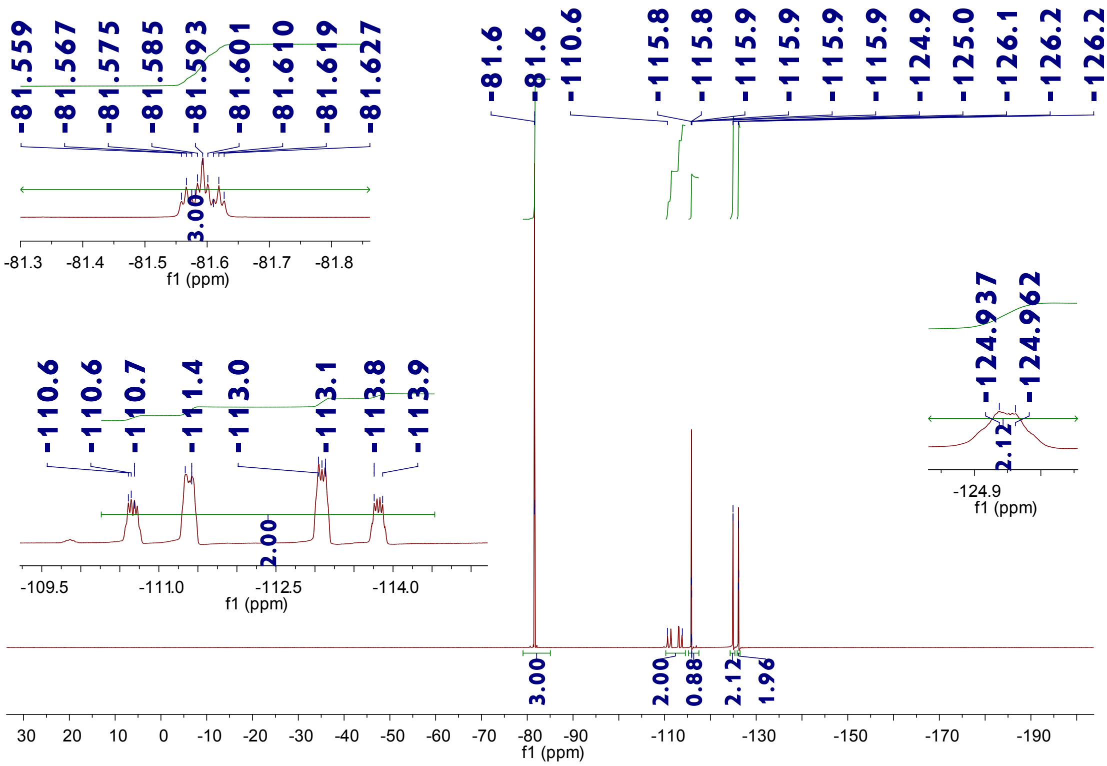

42.646
42.452
42.259
146.6
128.4
127.4
124.4
77.0
72.8
42.5
42.3
29.9
44 43 42 41
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


-81.311
-81.320
-81.329
-81.337
-81.345
-81.354
-81.363
-81.371
3.00
-81.30 -81.40
f1 (ppm)
-81.3
-81.4
-110.4
-113.7
-124.7
-125.9
-125.9
-126.0
-126.0
-126.0
-126.0
-126.0
-126.0
-124.750
-124.774
-124.6 -124.9
f1 (ppm)
-110.416
-110.460
-110.496
-111.194
-112.929
-113.005
-113.677
-113.712
1.81
-109.5 -110.5 -111.5 -112.5 -113.5
f1 (ppm)
3.00
1.81
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

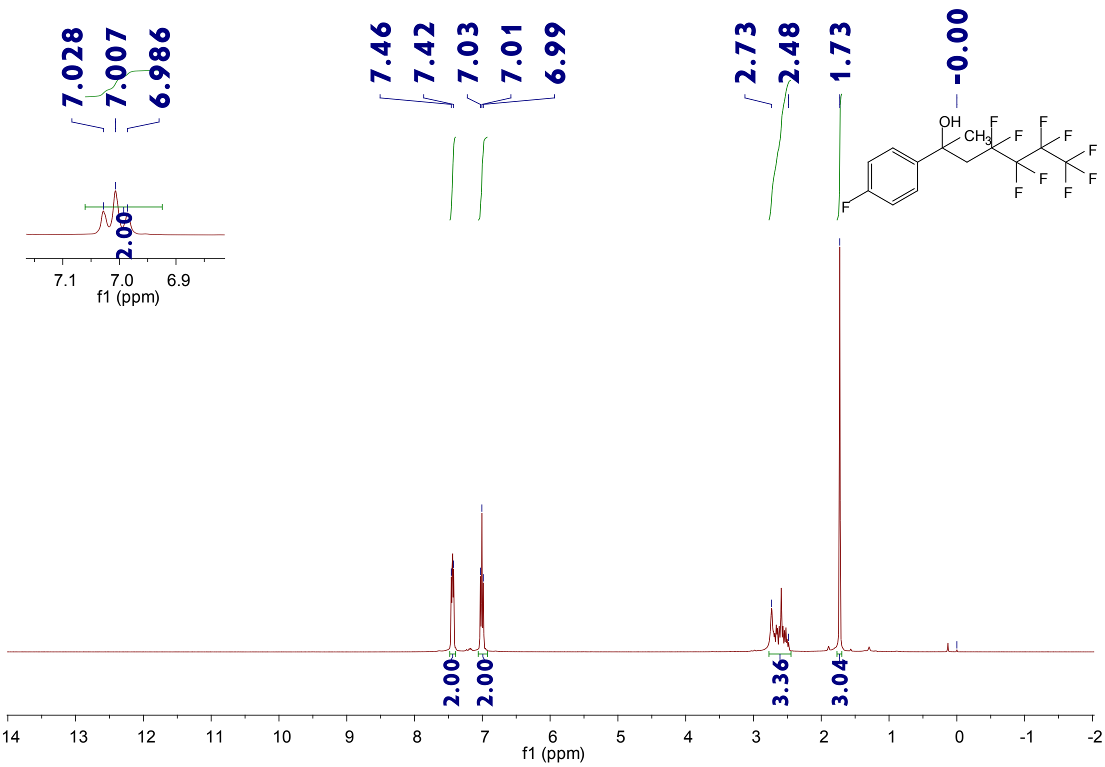
3k

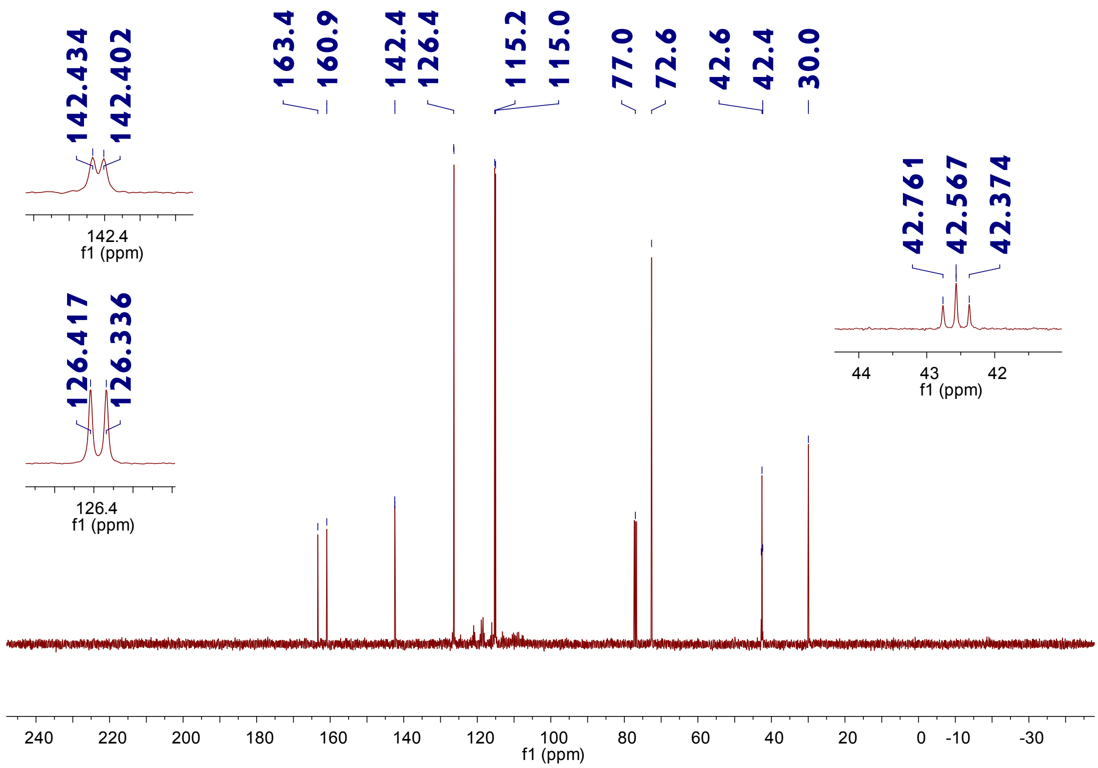

7.47
7.46
7.46
7.45
7.45
7.44
7.43
7.43
7.42
7.04
7.02
7.00
2.62
2.56
2.52
2.48
1.74
0.00
7.043
7.021
6.999
1.88
7.10
7.00
f1 (ppm)
1.92
1.88
3.00
2.98
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
f1 (ppm)

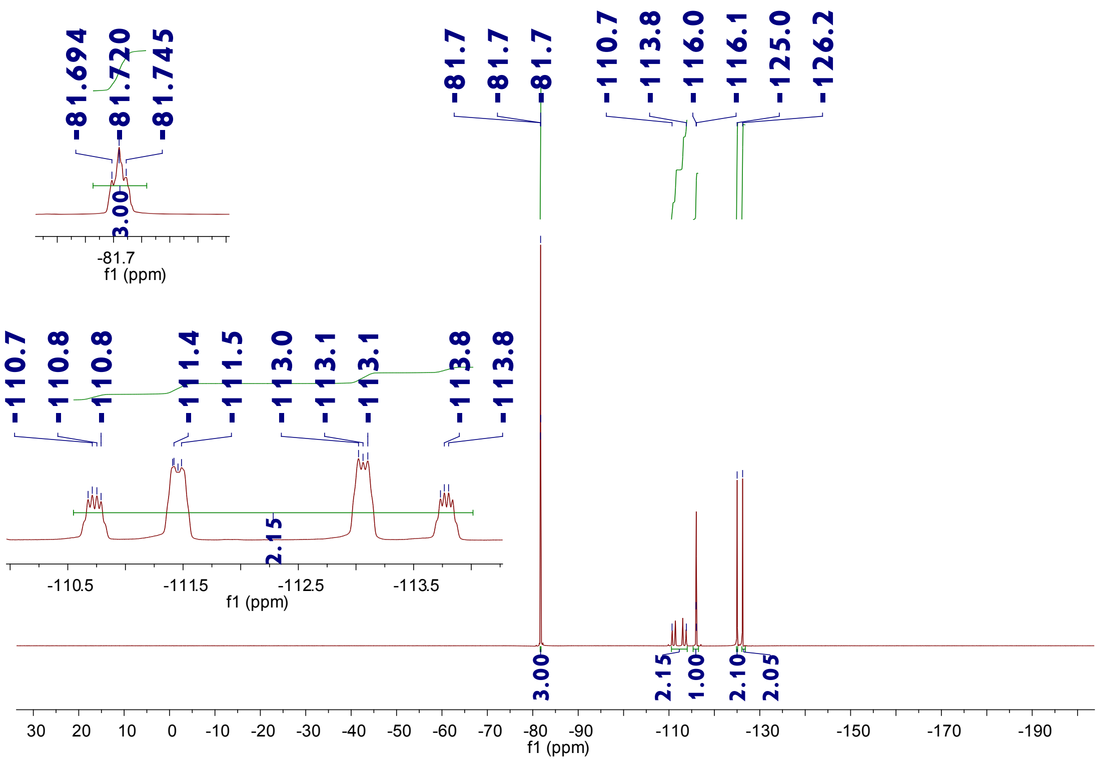

163.177
160.654
164
160
f1 (ppm)
163.2
160.7
142.4
126.3
115.3
115.1
77.0
72.5
42.6
42.4
30.1
115.3
115.1
115
f1 (ppm)
42.790
42.596
42.403
44
43
42
41
f1 (ppm)
126.386
126.305
126.4
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)



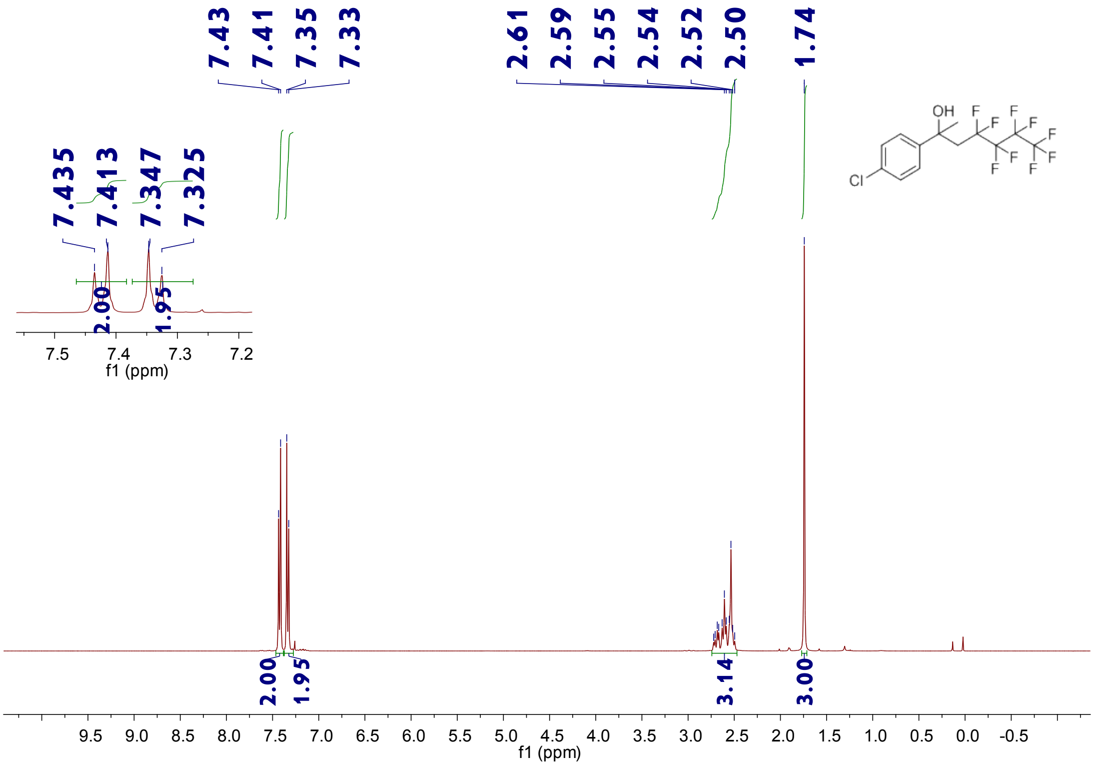
3k (under condition B)

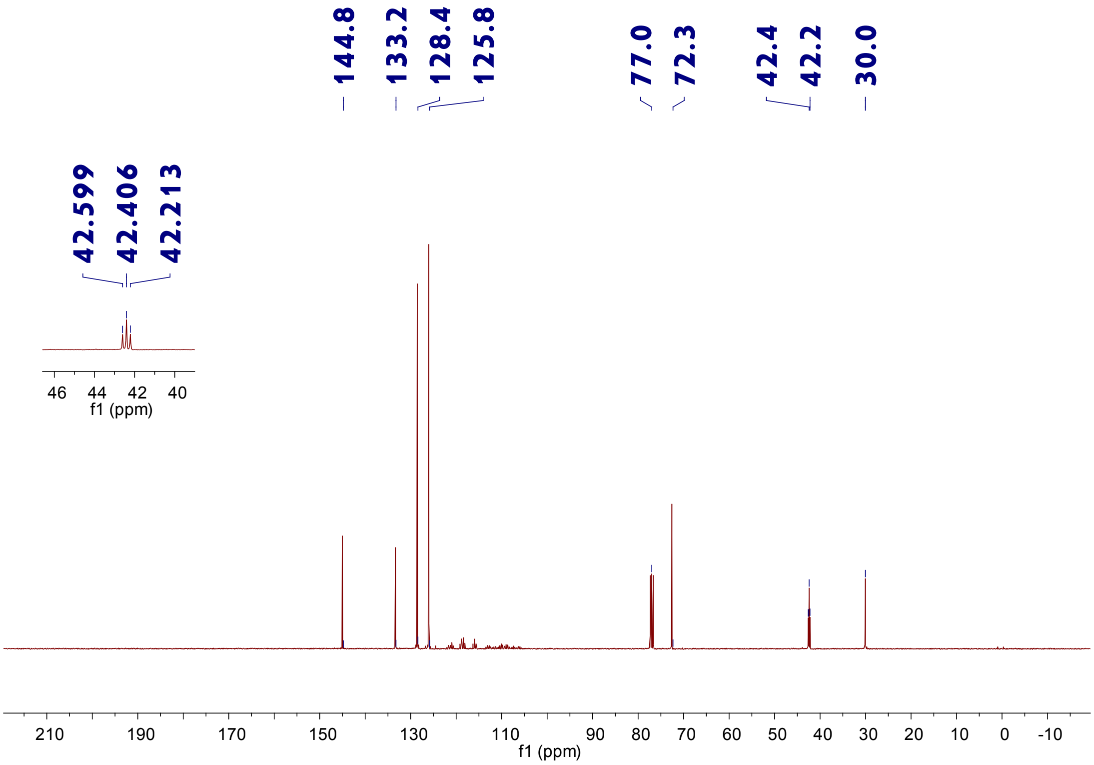


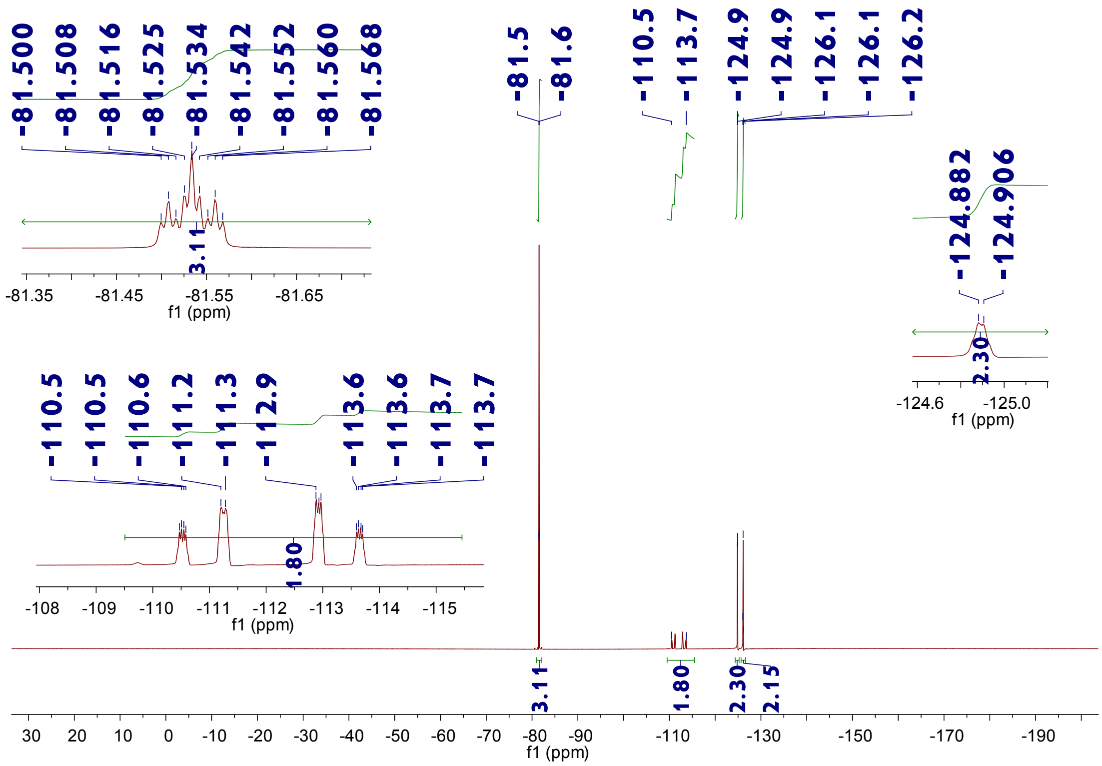

163.4
160.9
142.4
126.4
115.2
115.0
77.0
72.6
42.6
42.4
30.0
142.434
142.402
142.4
f1 (ppm)
126.417
126.336
126.4
f1 (ppm)
42.761
42.567
42.374
44
43
42
f1 (ppm)
240
220
200
180
160
140
120
100
80
60
40
20
0
-10
-30
f1 (ppm)


-81.7
-81.7
-81.7
-110.7
-113.8
-116.0
-116.1
-125.0
-126.2
-81.694
-81.720
-81.745
3.00
-81.7
f1 (ppm)
-110.7
-110.8
-110.8
-111.4
-111.5
-113.0
-113.1
-113.1
-113.8
-113.8
2.15
-110.5
-111.5
-112.5
-113.5
f1 (ppm)
3.00
2.15
1.00
2.10
2.05
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

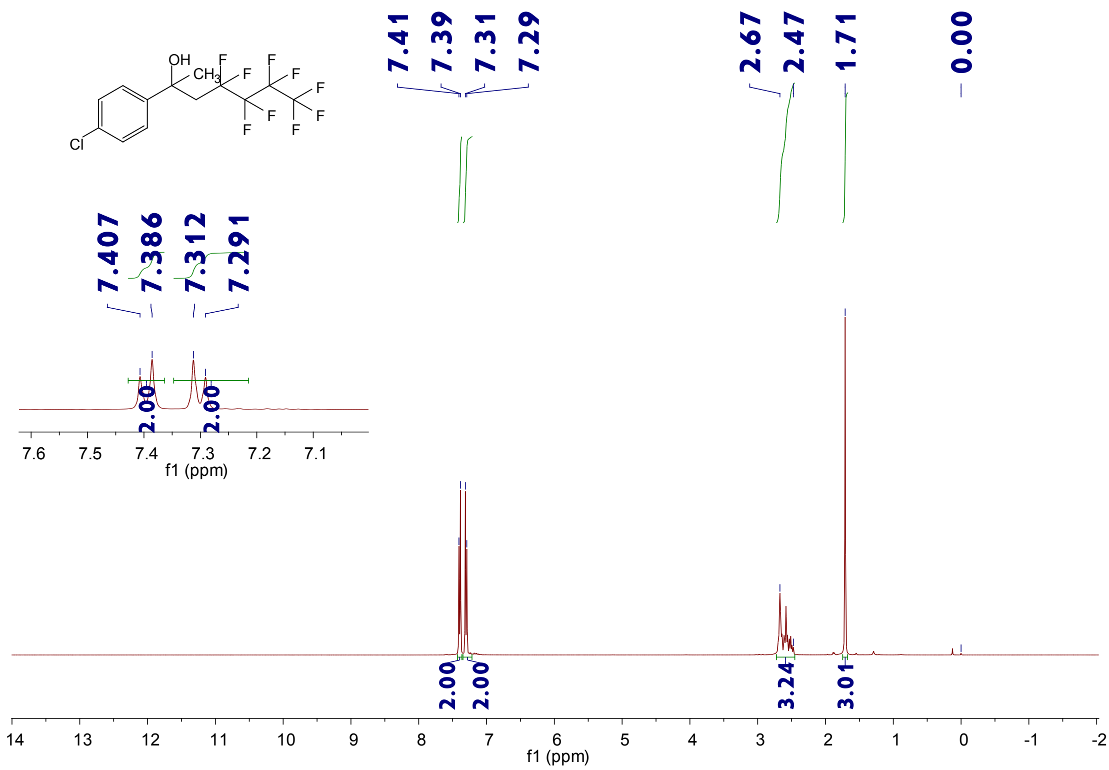
3l

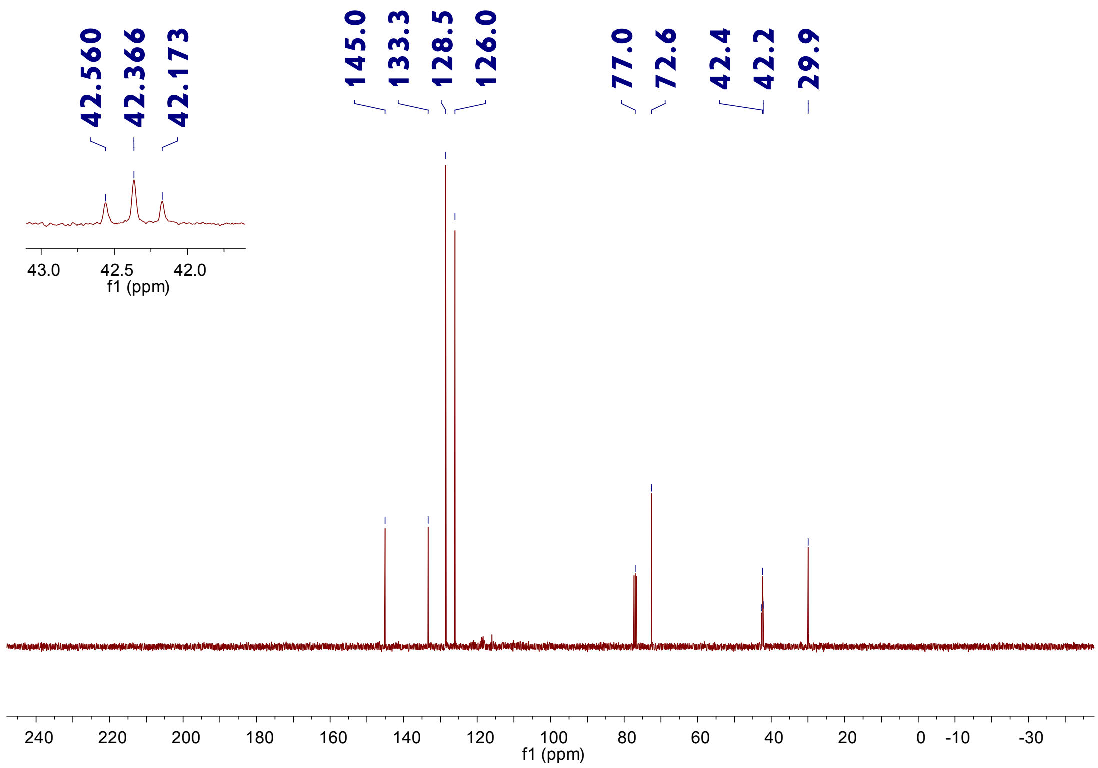

7.43
7.41
7.35
7.33
2.61
2.59
2.55
2.54
2.52
2.50
1.74
7.435
7.413
7.347
7.325
2.00
1.95
7.5 7.4 7.3 7.2
f1 (ppm)
OH
F
Cl
2.00
1.95
3.14
3.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


144.8
133.2
128.4
125.8
77.0
72.3
42.4
42.2
30.0
42.599
42.406
42.213
46 44 42 40
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

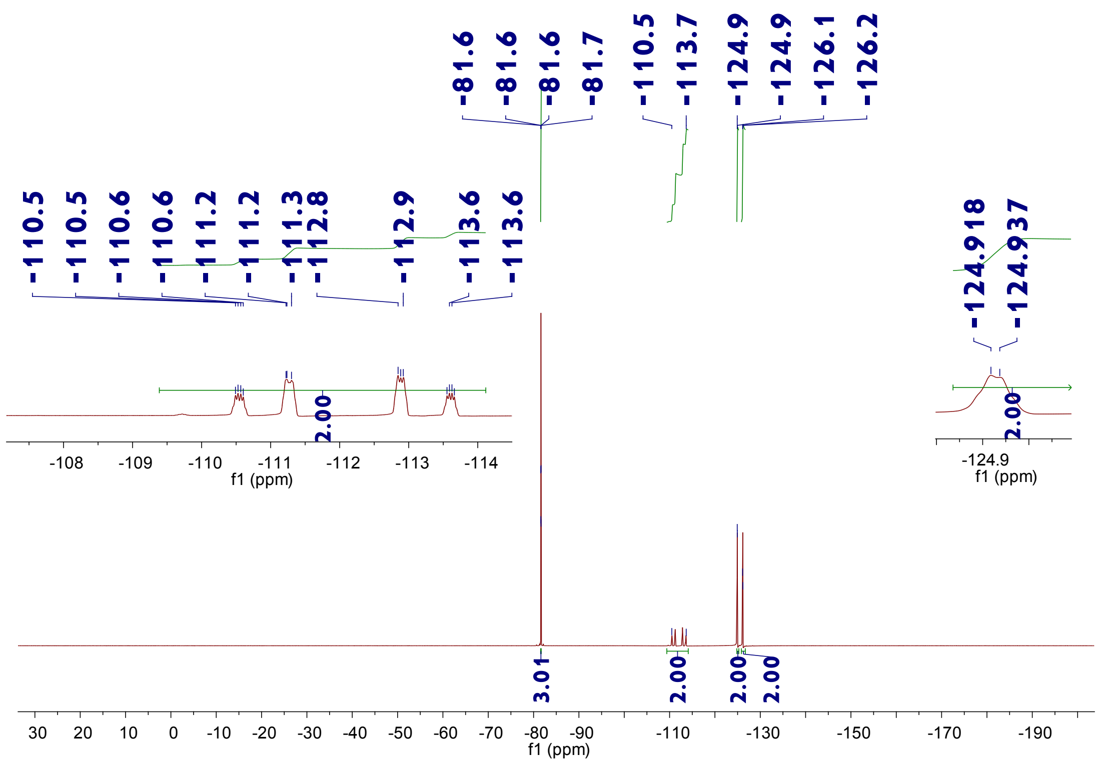


3l (under condition B)



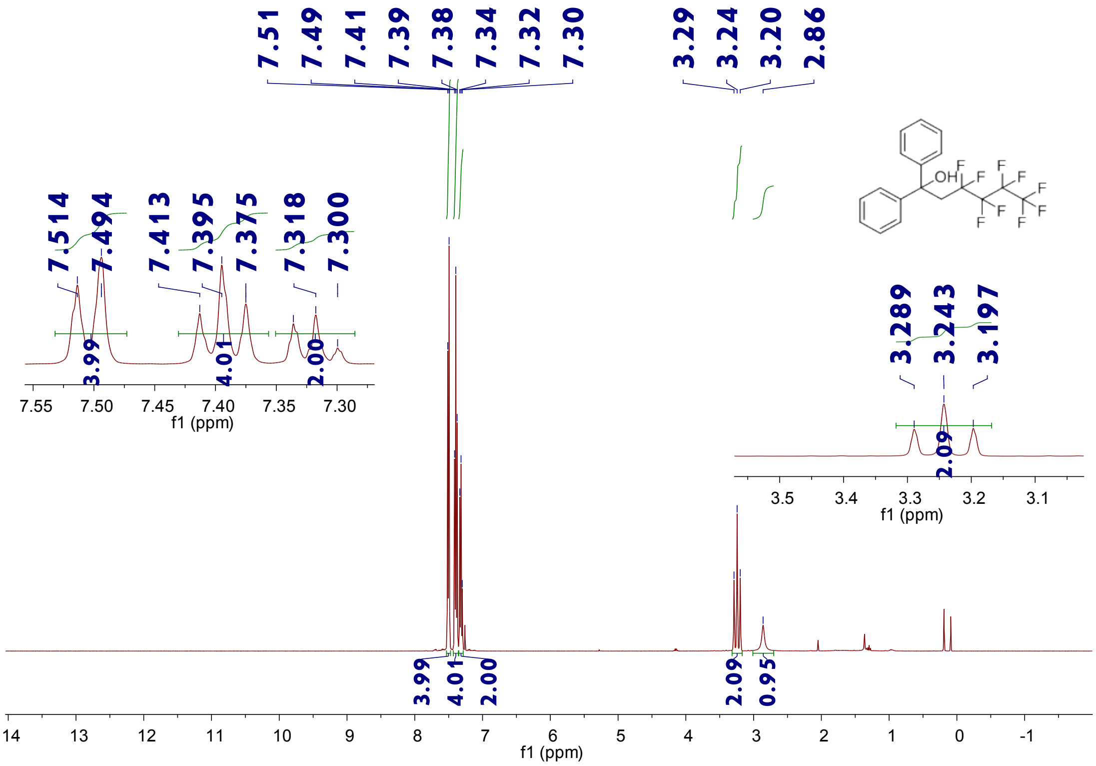


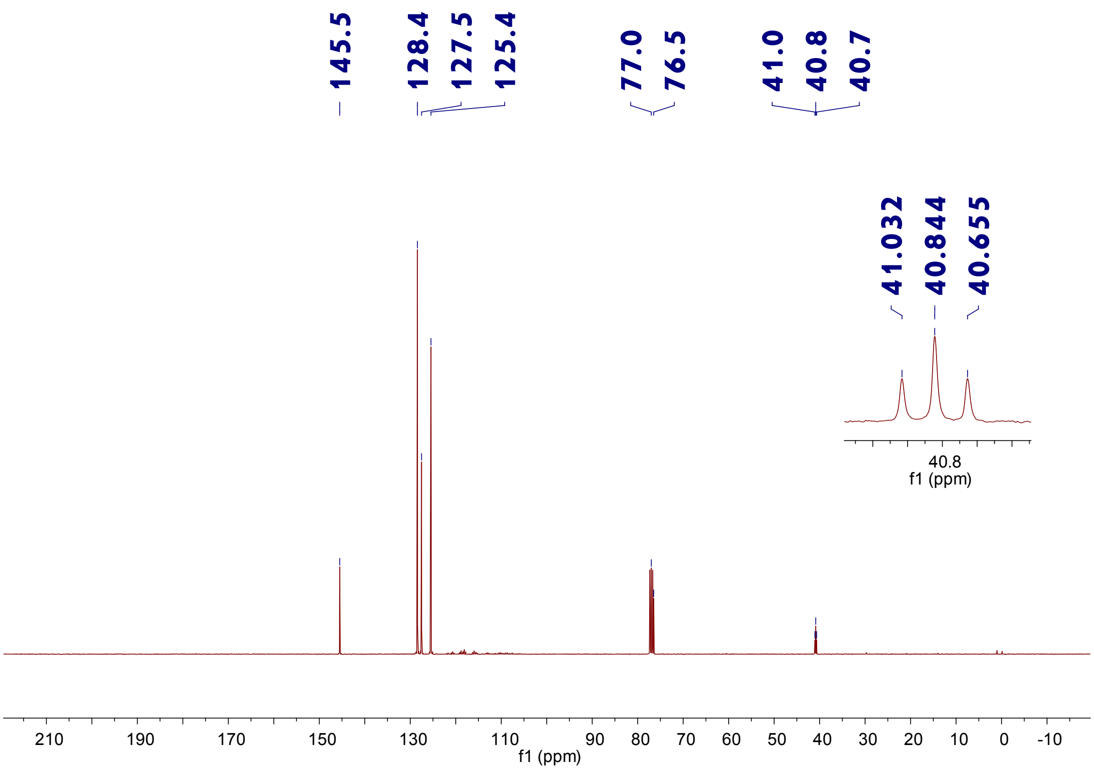
42.560
42.366
42.173
43.0
42.5
42.0
f1 (ppm)
145.0
133.3
128.5
126.0
77.0
72.6
42.4
42.2
29.9
240
220
200
180
160
140
120
100
80
60
40
20
0
-10
-30
f1 (ppm)

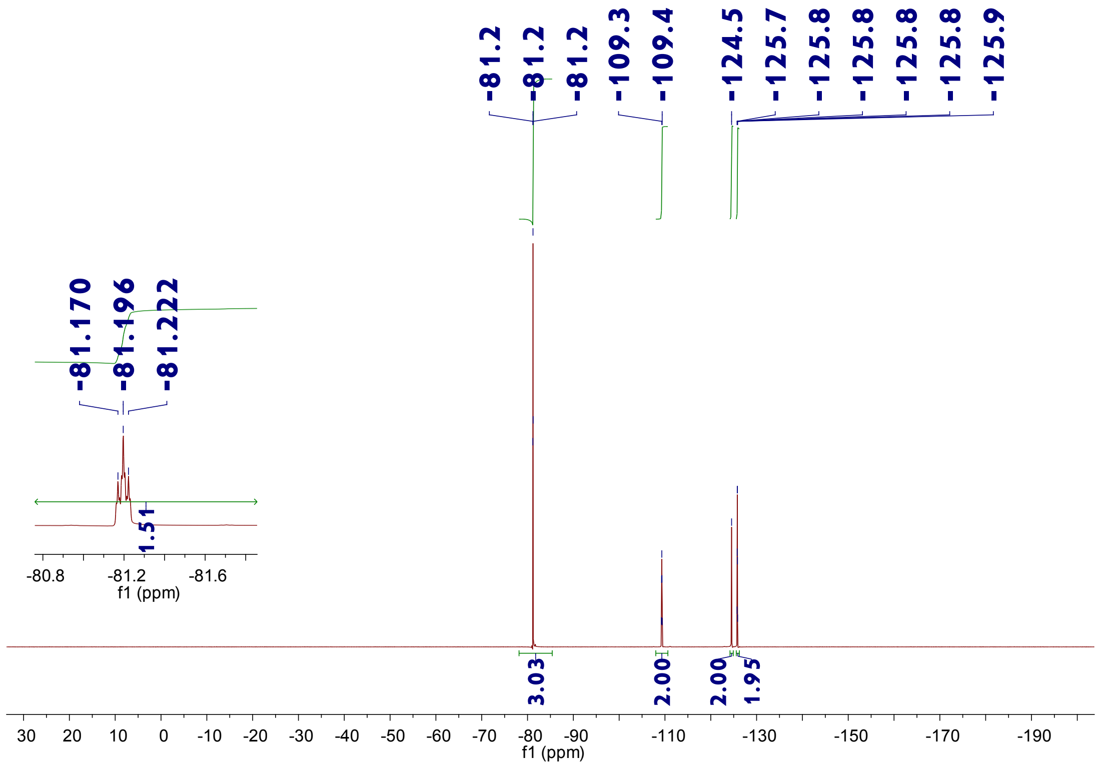


-81.6
-81.6
-81.6
-81.7
-110.5
-113.7
-124.9
-124.9
-126.1
-126.2
-110.5
-110.5
-110.6
-110.6
-111.2
-111.2
-111.3
-112.8
-112.9
-113.6
-113.6
2.00
-108
-109
-110
-111
-112
-113
-114
f1 (ppm)
-124.918
-124.937
2.00
-124.9
f1 (ppm)
3.01
2.00
2.00
2.00
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

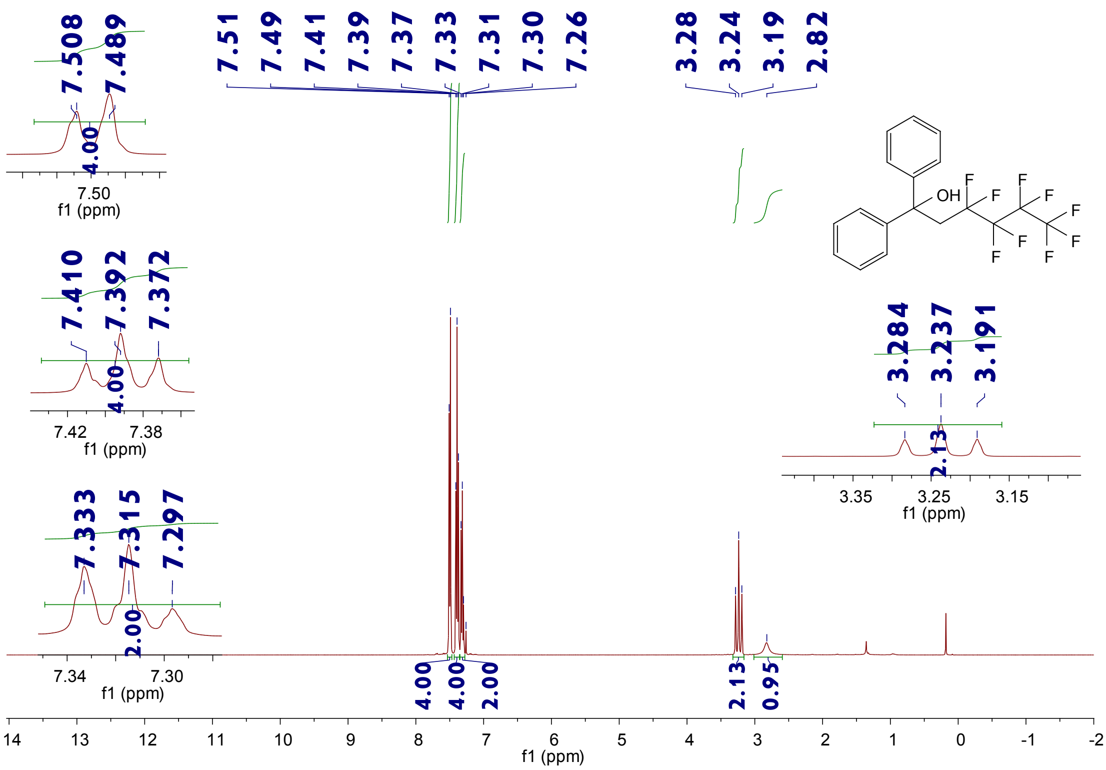
3m

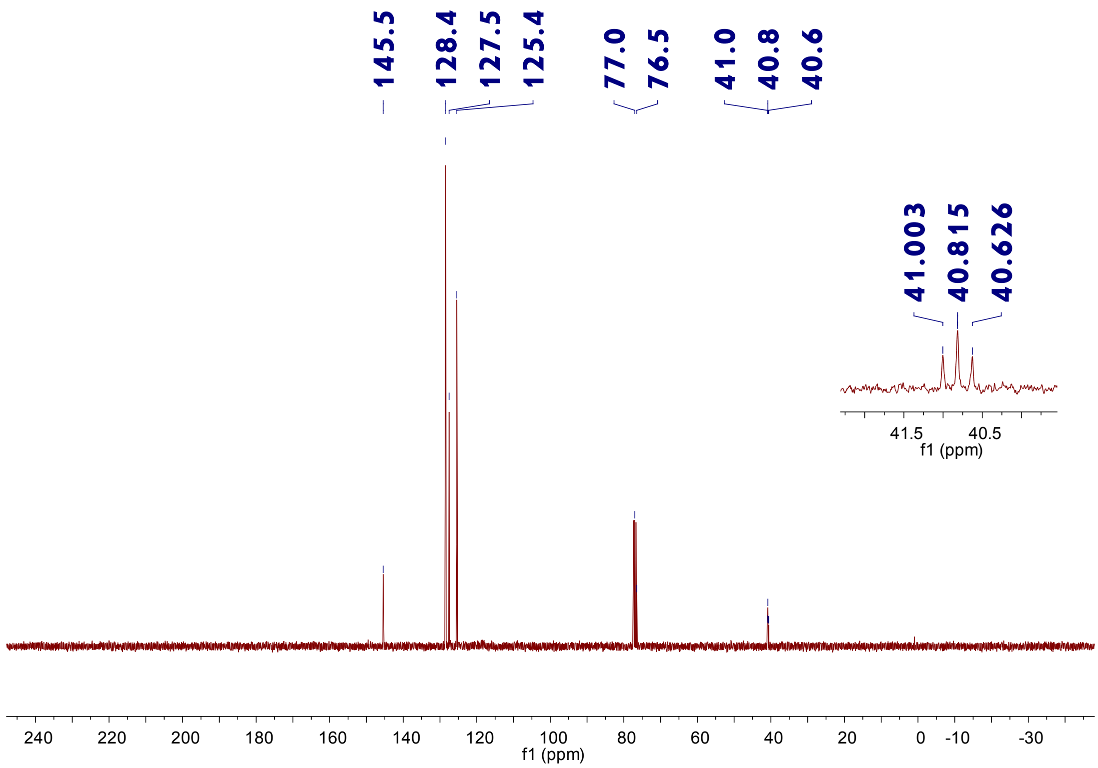

7.51
7.49
7.41
7.39
7.38
7.34
7.32
7.30
3.29
3.24
3.20
2.86
7.514
7.494
7.413
7.395
7.375
7.318
7.300
3.99
4.01
2.00
7.55 7.50 7.45 7.40 7.35 7.30
f1 (ppm)
OH
F
3.289
3.243
3.197
2.09
3.5 3.4 3.3 3.2 3.1
f1 (ppm)
3.99
4.01
2.00
2.09
0.95
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1
f1 (ppm)

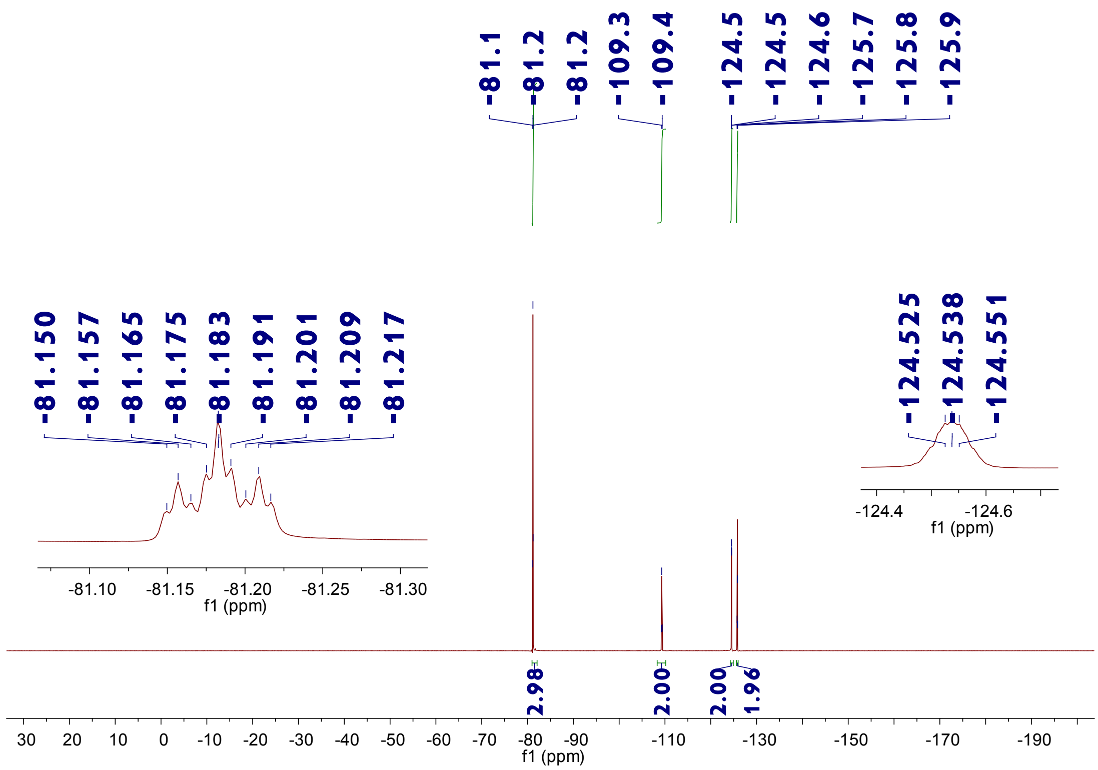

145.5
128.4
127.5
125.4
77.0
76.5
41.0
40.8
40.7
41.032
40.844
40.655
40.8
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



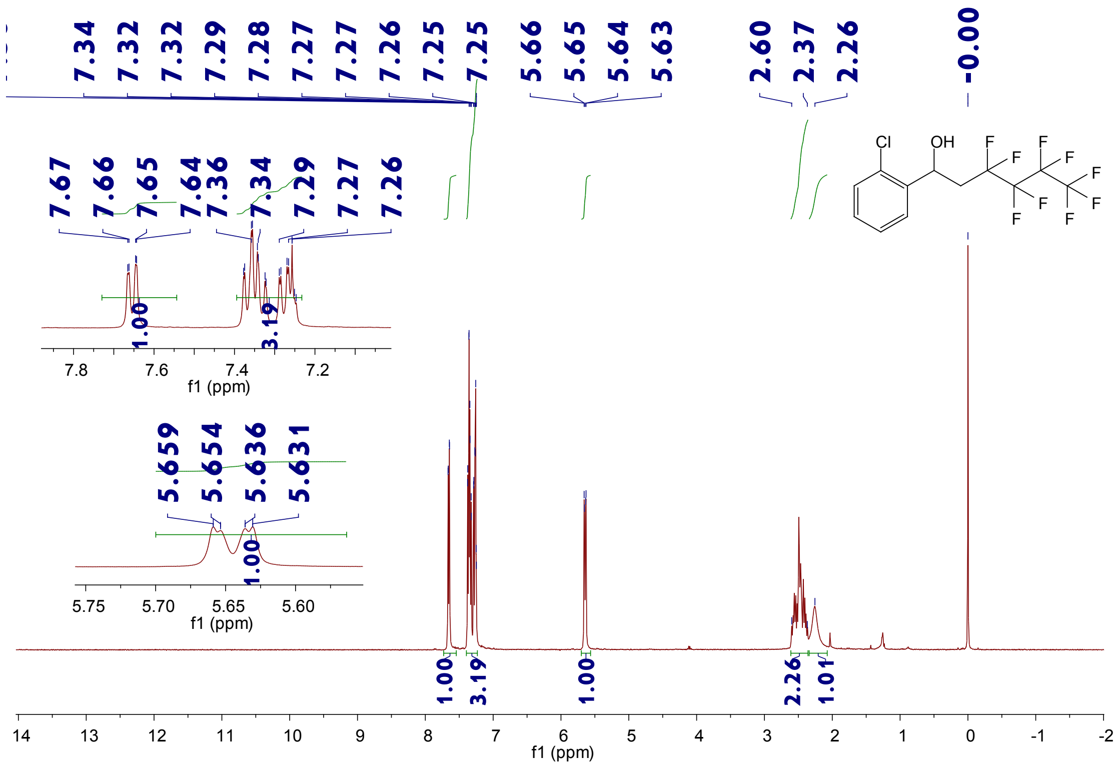
3m (under condition B)

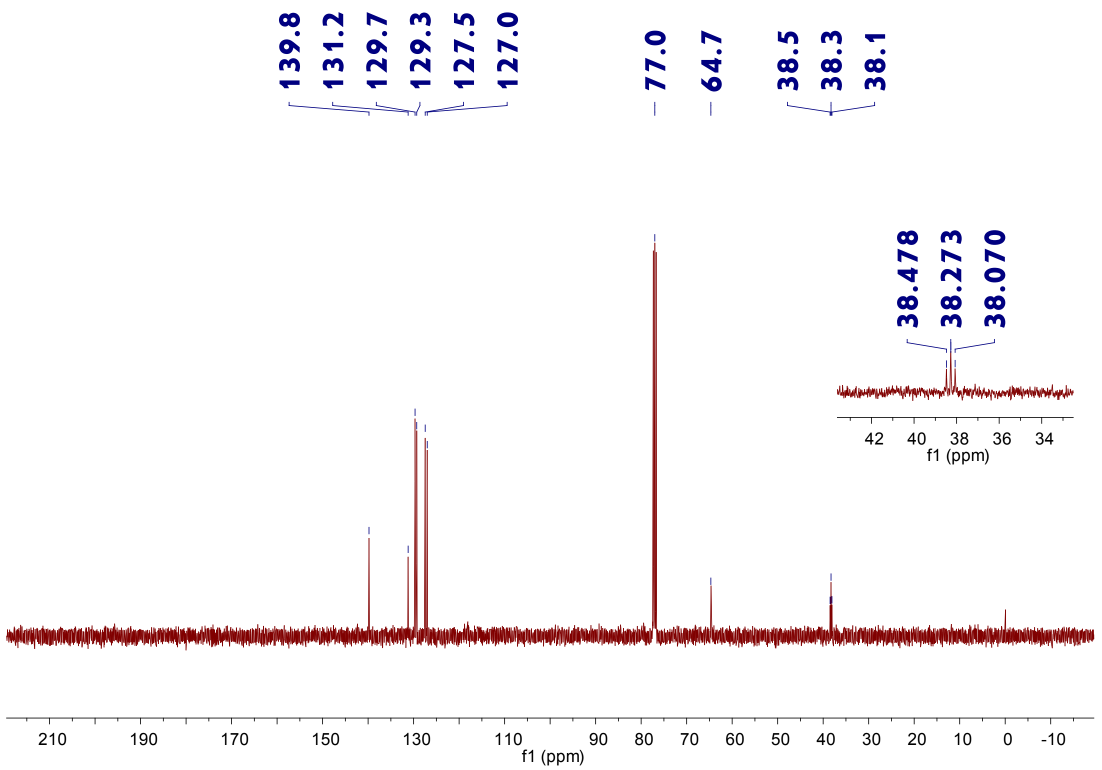


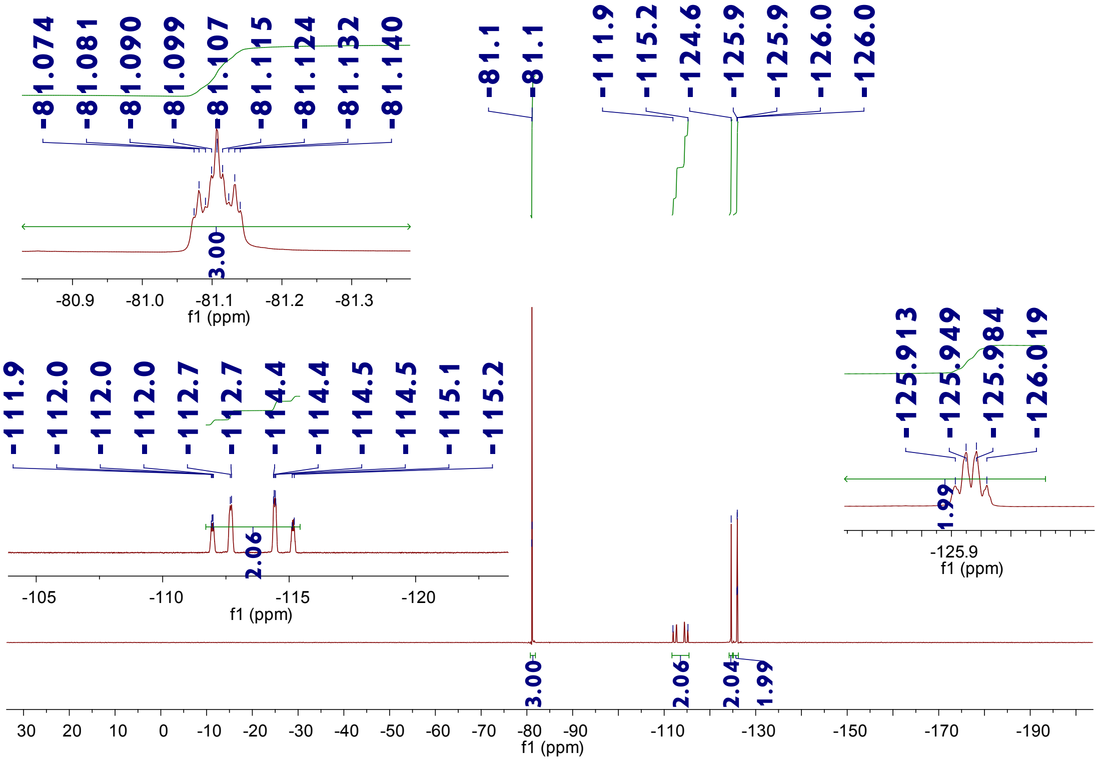

145.5
128.4
127.5
125.4
77.0
76.5
41.0
40.8
40.6
41.003
40.815
40.626
41.5
40.5
f1 (ppm)
240
220
200
180
160
140
120
100
80
60
40
20
0
-10
-30
f1 (ppm)


-81.1
-81.2
-81.2
-109.3
-109.4
-124.5
-124.5
-124.6
-125.7
-125.8
-125.9
-81.150
-81.157
-81.165
-81.175
-81.183
-81.191
-81.201
-81.209
-81.217
-81.10
-81.15
-81.20
-81.25
-81.30
f1 (ppm)
-124.525
-124.538
-124.551
-124.4
-124.6
f1 (ppm)
2.98
2.00
2.00
1.96
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

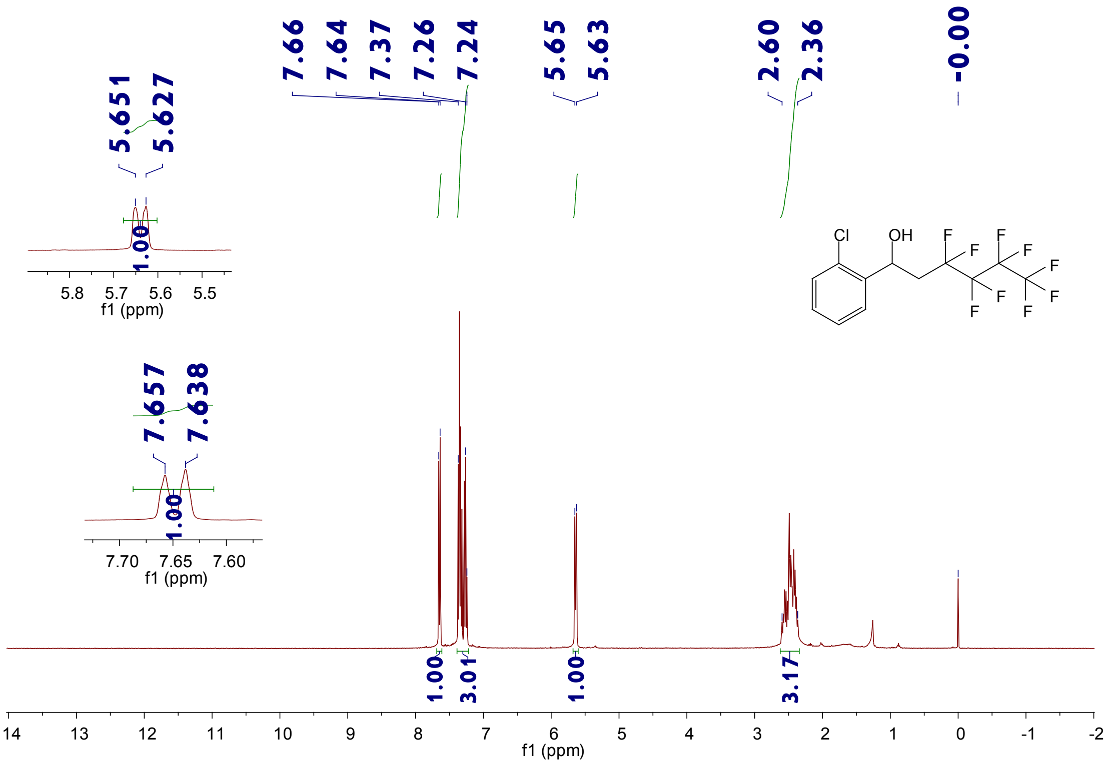
3n

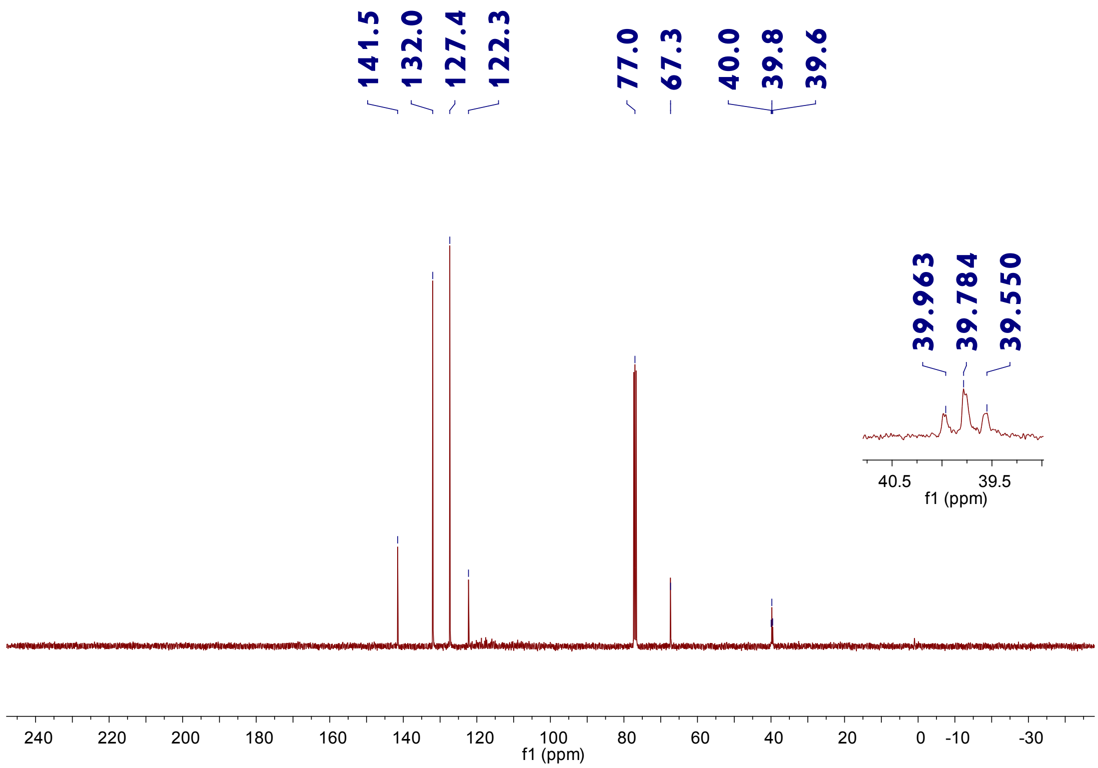

7.34 7.32 7.32 7.29 7.28 7.27 7.27 7.26 7.25 7.25
5.66 5.65 5.64 5.63
2.60 2.37 2.26
-0.00
7.67 7.66 7.65 7.64 7.36 7.34 7.29 7.27 7.26
1.00
3.19
7.8 7.6 7.4 7.2
f1 (ppm)
5.659 5.654 5.636 5.631
1.00
5.75 5.70 5.65 5.60
f1 (ppm)
Cl
OH
F
1.00 3.19 1.00 2.26 1.01
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

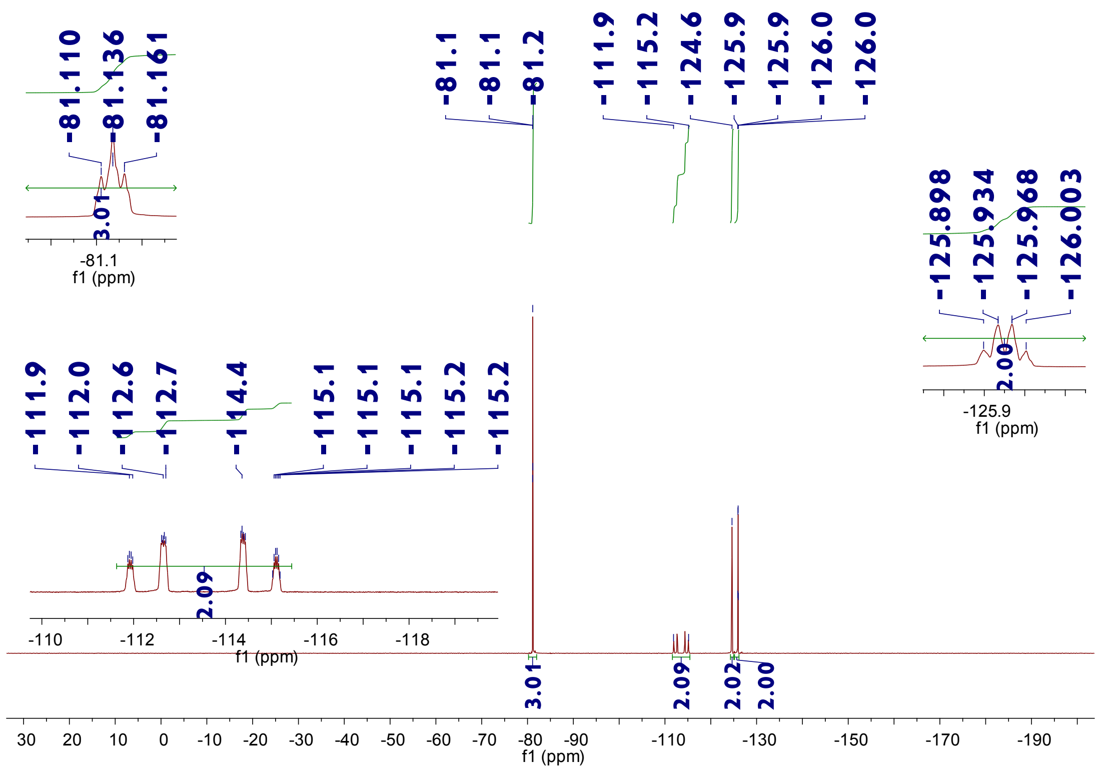

139.8 131.2 129.7 129.3 127.5 127.0
77.0
64.7
38.5 38.3 38.1
38.478 38.273 38.070
42 40 38 36 34
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



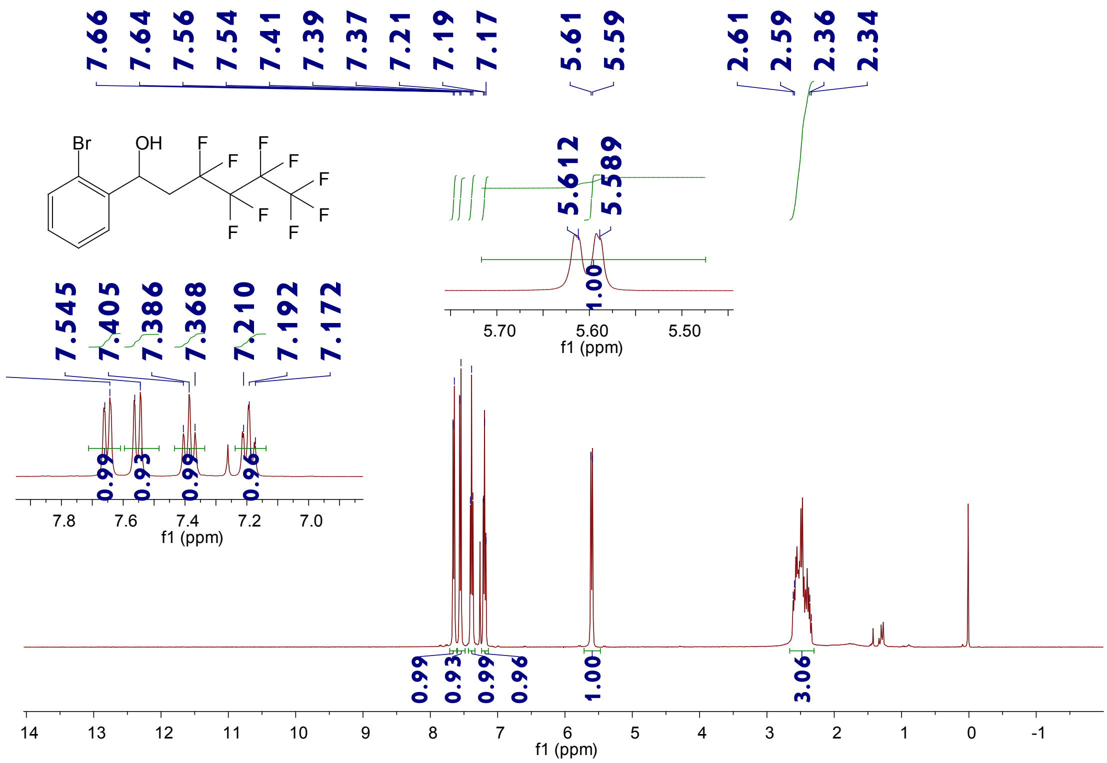
3n (under condition B)



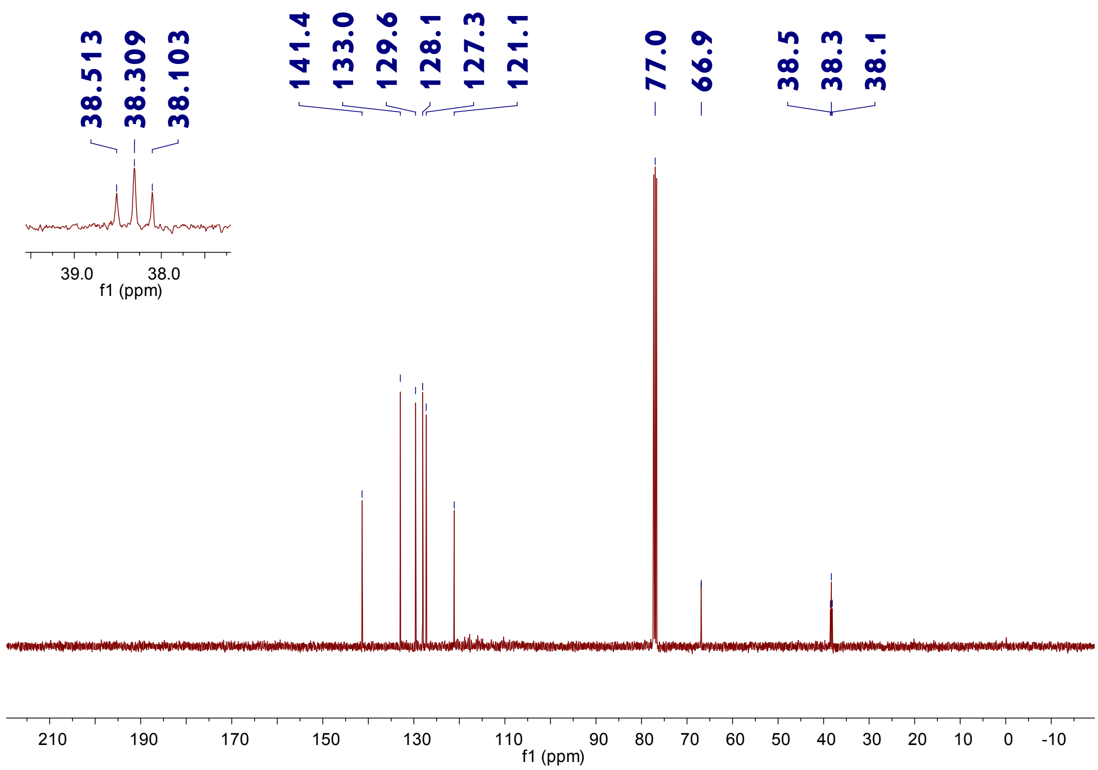

141.5
132.0
127.4
122.3
77.0
67.3
40.0
39.8
39.6
39.963
39.784
39.550
40.5
39.5
f1 (ppm)
240 220 200 180 160 140 120 100 80 60 40 20 0 -10 -30
f1 (ppm)


-81.110
-81.136
-81.161
3.01
-81.1
f1 (ppm)
-81.1
-81.1
-81.2
-111.9
-115.2
-124.6
-125.9
-125.9
-126.0
-126.0
-125.898
-125.934
-125.968
-126.003
2.00
-125.9
f1 (ppm)
-111.9
-112.0
-112.6
-112.7
-114.4
-115.1
-115.1
-115.1
-115.2
-115.2
2.09
-110 -112 -114 -116 -118
f1 (ppm)
3.01
2.09
2.02
2.00
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

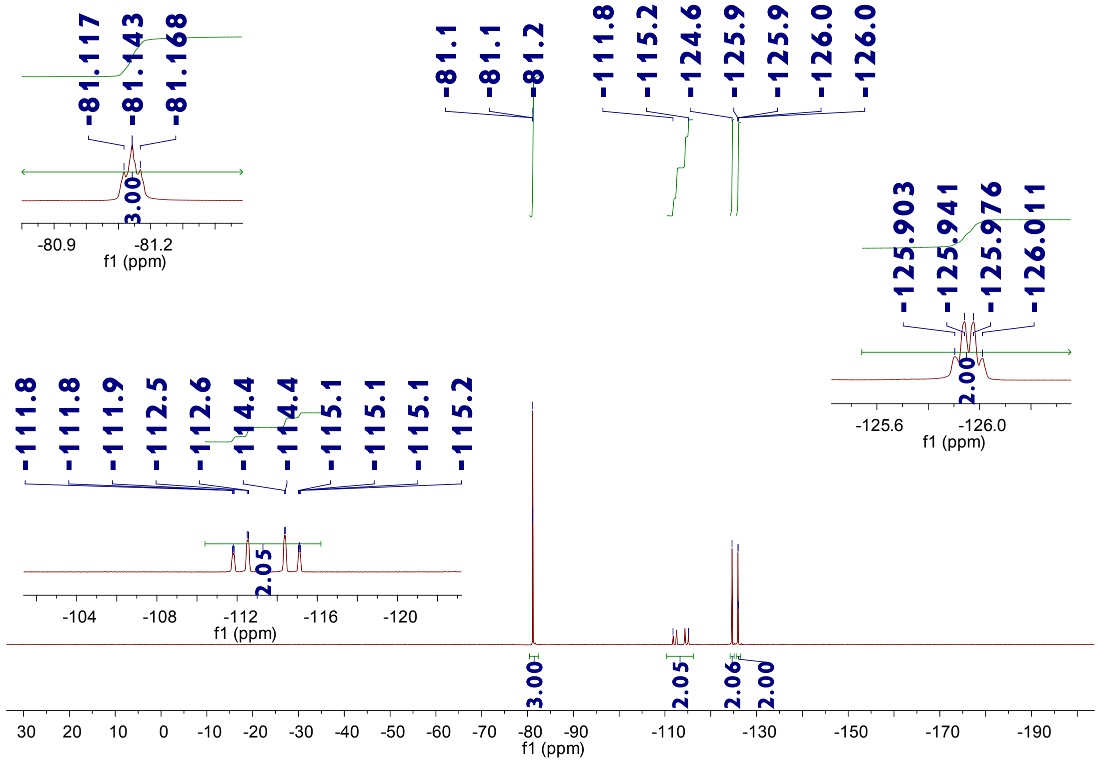
3o



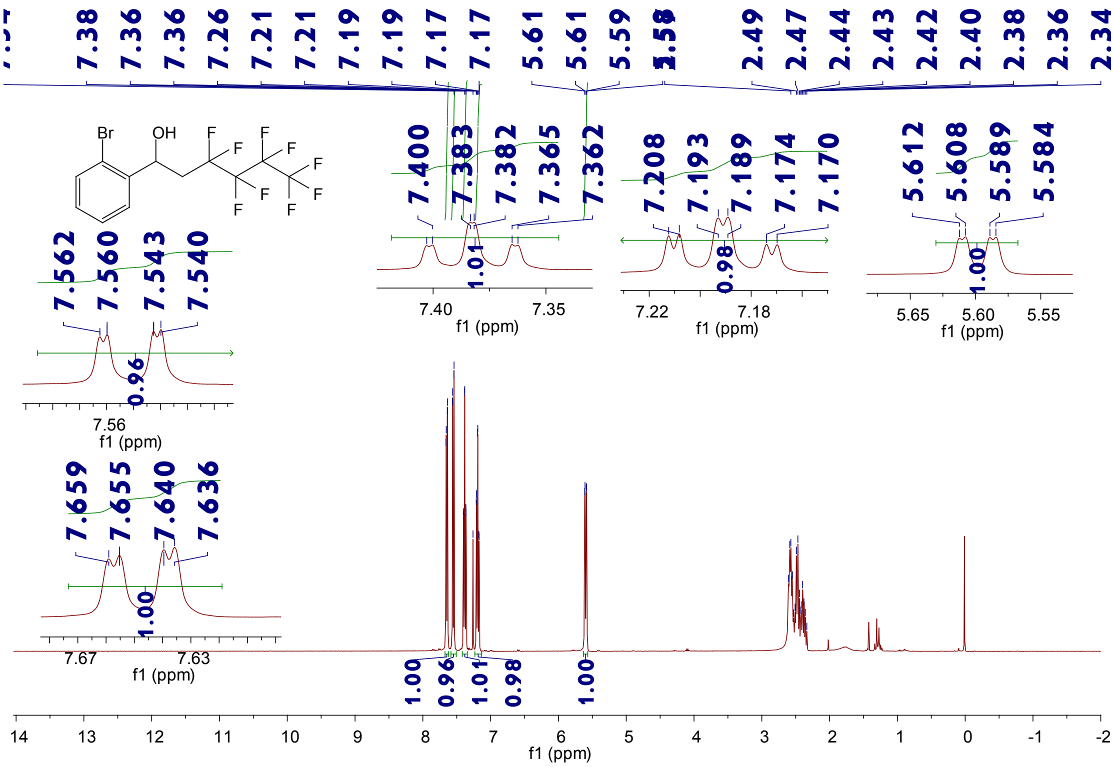
7.66
7.64
7.56
7.54
7.41
7.39
7.37
7.21
7.19
7.17
5.61
5.59
2.61
2.59
2.36
2.34
Br
OH
F
5.612
5.589
1.00
5.70
5.60
5.50
f1 (ppm)
7.545
7.405
7.386
7.368
7.210
7.192
7.172
0.99
0.93
0.99
0.96
7.8
7.6
7.4
7.2
7.0
f1 (ppm)
3.06
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
f1 (ppm)

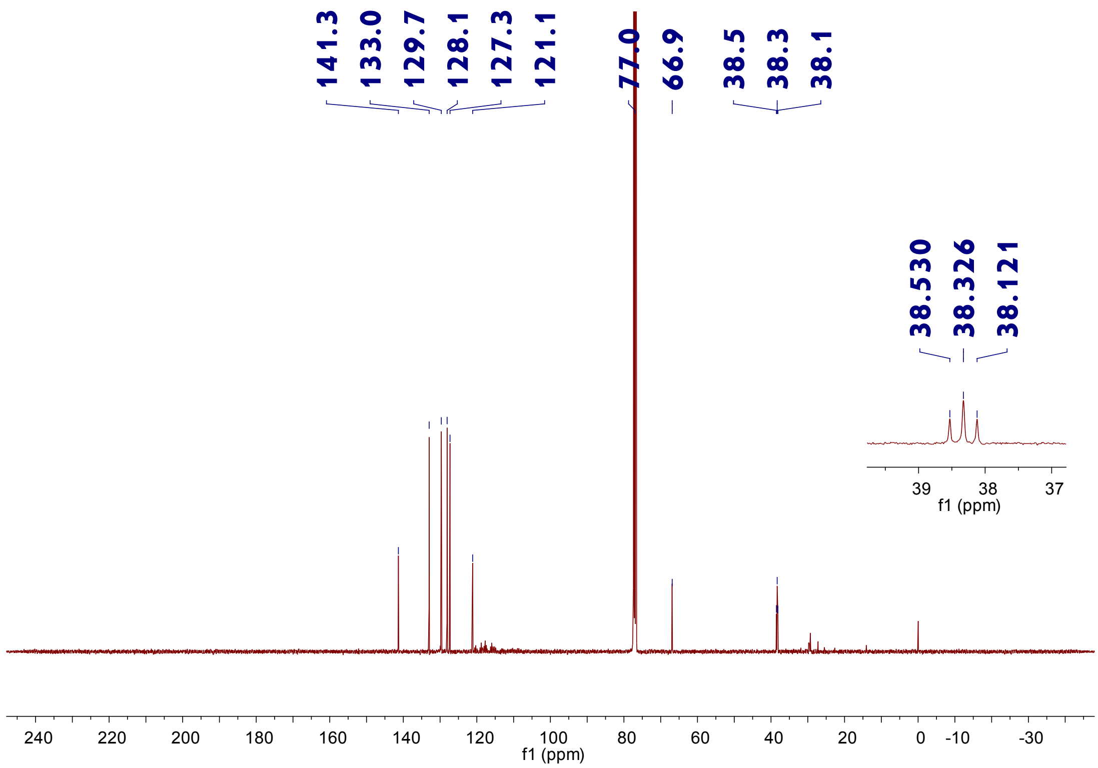


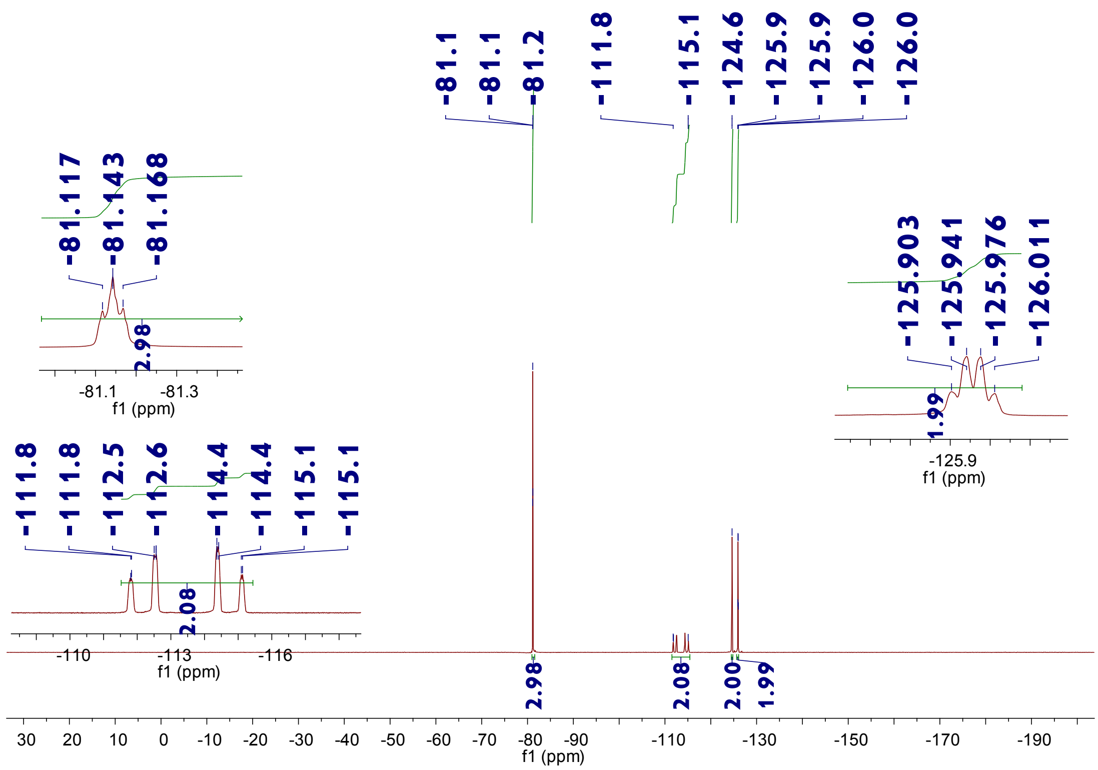
38.513
38.309
38.103
141.4
133.0
129.6
128.1
127.3
121.1
77.0
66.9
38.5
38.3
38.1
39.0
38.0
f1 (ppm)
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)



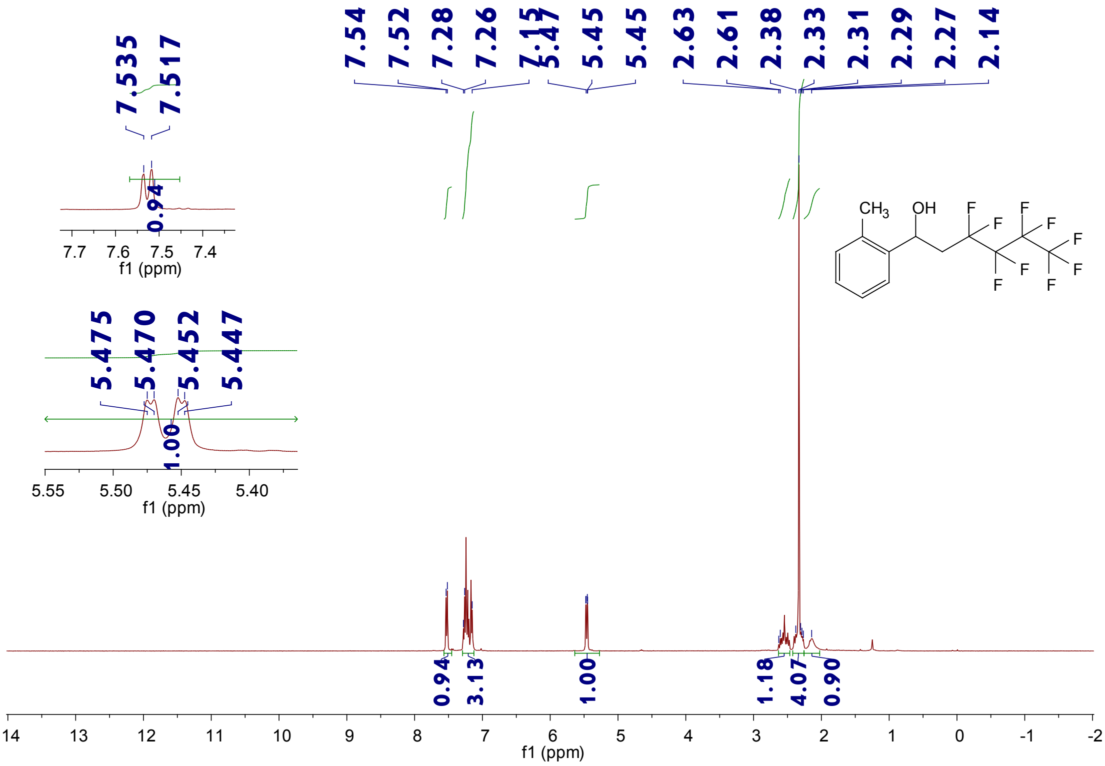
3o (under condition B)



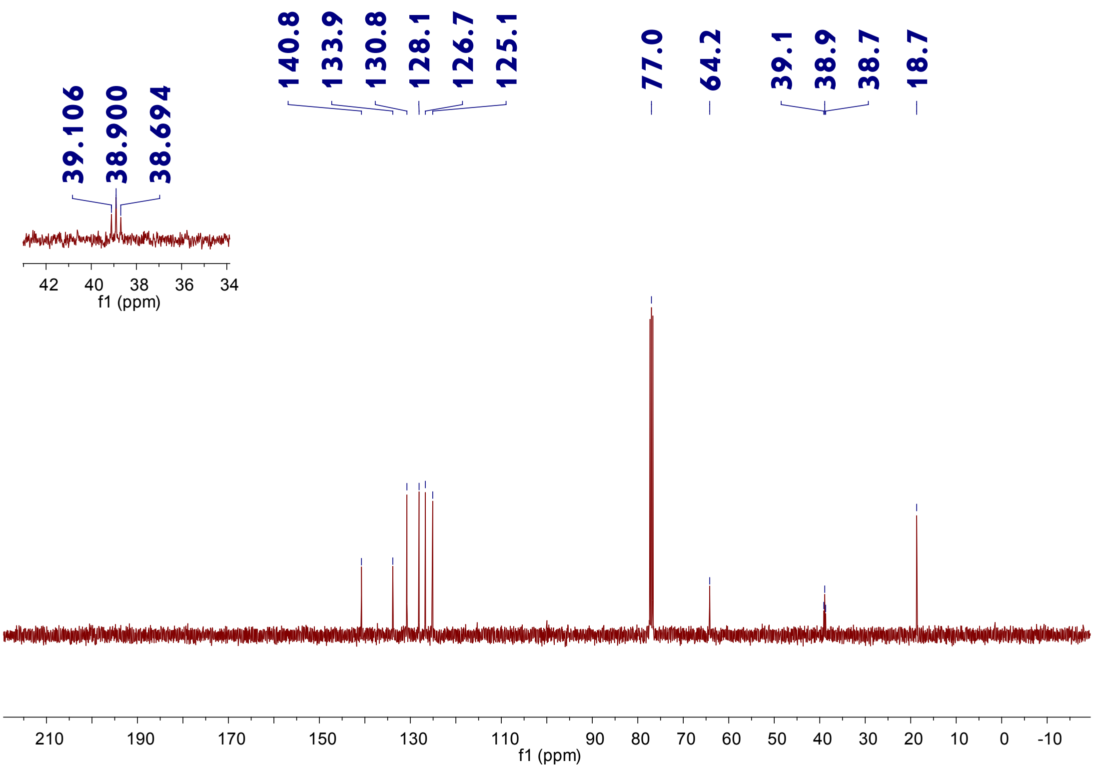

141.3
133.0
129.7
128.1
127.3
121.1
77.0
66.9
38.5
38.3
38.1
38.530
38.326
38.121
39
38
37
f1 (ppm)
240
220
200
180
160
140
120
100
80
60
40
20
0
-10
-30
f1 (ppm)


-81.1
-81.1
-81.2
-111.8
-115.1
-124.6
-125.9
-125.9
-126.0
-126.0
-81.117
-81.143
-81.168
2.98
-81.1
-81.3
f1 (ppm)
-125.903
-125.941
-125.976
-126.011
1.99
-125.9
f1 (ppm)
-111.8
-111.8
-112.5
-112.6
-114.4
-114.4
-115.1
-115.1
2.08
-110
-113
-116
f1 (ppm)
2.98
2.08
2.00
1.99
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

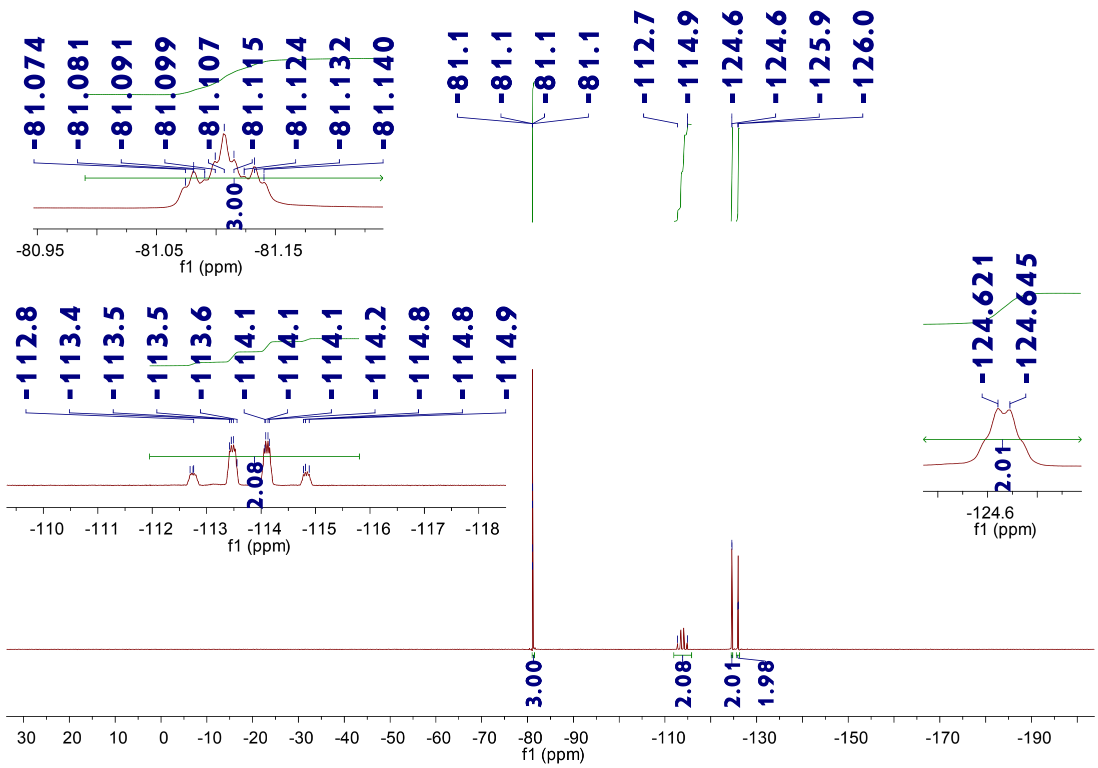
3p



7.535
7.517
0.94
7.7 7.6 7.5 7.4
f1 (ppm)
5.475
5.470
5.452
5.447
1.00
5.55 5.50 5.45 5.40
f1 (ppm)
7.54 7.52 7.28 7.26 7.15 5.47 5.45 5.45 2.63 2.61 2.38 2.33 2.31 2.29 2.27 2.14
CH3 OH F F F F F F F F F
0.94 3.13 1.00 1.18 4.07 0.90
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

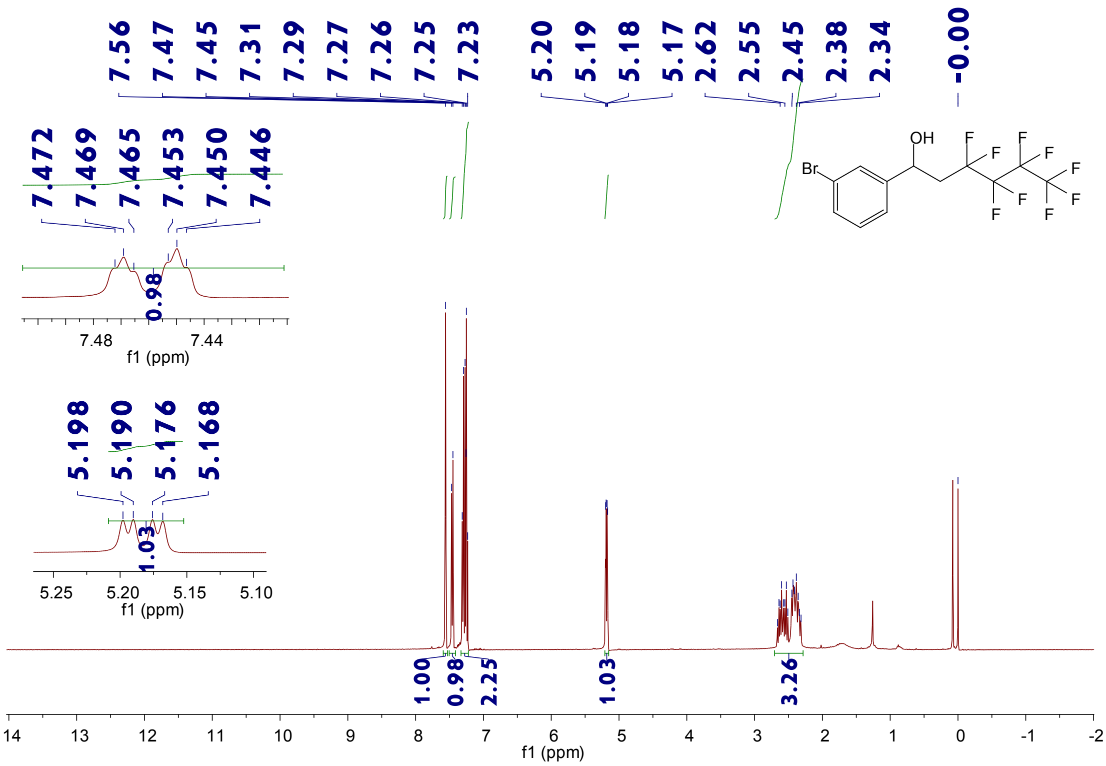


39.106
38.900
38.694
42 40 38 36 34
f1 (ppm)
140.8 133.9 130.8 128.1 126.7 125.1 77.0 64.2 39.1 38.9 38.7 18.7
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

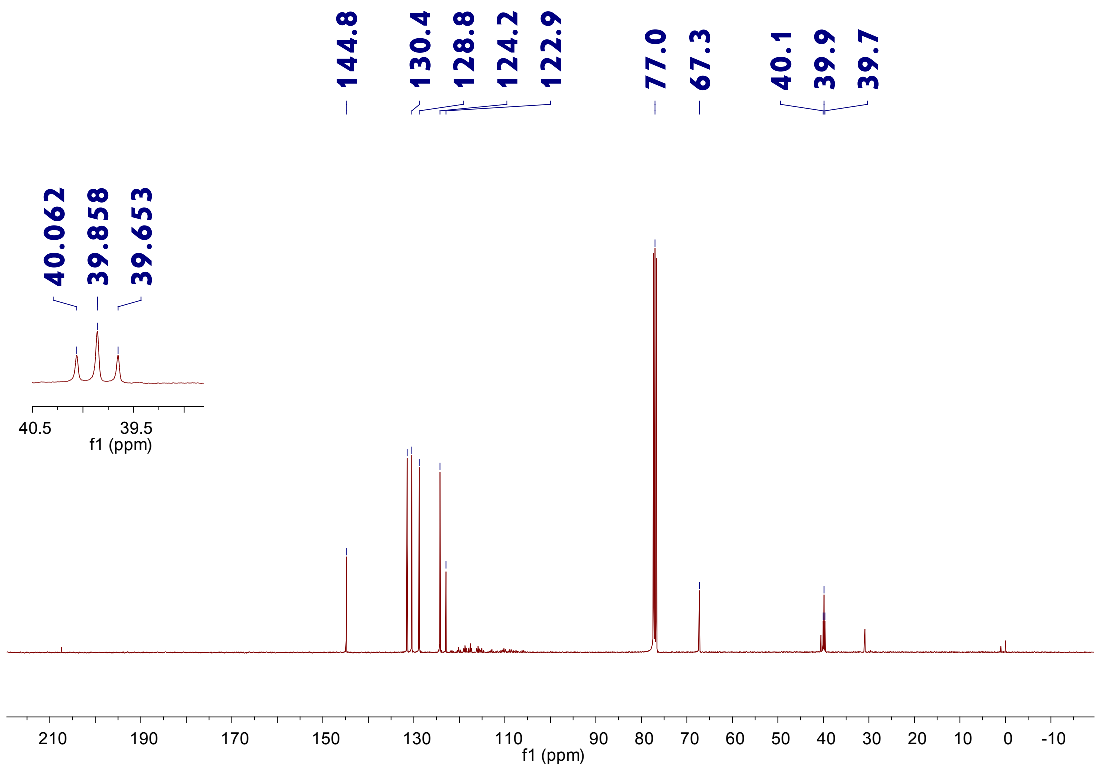


-81.074
-81.081
-81.091
-81.099
-81.107
-81.115
-81.124
-81.132
-81.140
3.00
-80.95
-81.05
-81.15
f1 (ppm)
-81.1
-81.1
-81.1
-81.1
-112.7
-114.9
-124.6
-124.6
-125.9
-126.0
-112.8
-113.4
-113.5
-113.5
-113.6
-114.1
-114.1
-114.1
-114.2
-114.8
-114.8
-114.9
2.08
-110 -111 -112 -113 -114 -115 -116 -117 -118
f1 (ppm)
-124.621
-124.645
2.01
-124.6
f1 (ppm)
3.00
2.08
2.01
1.98
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

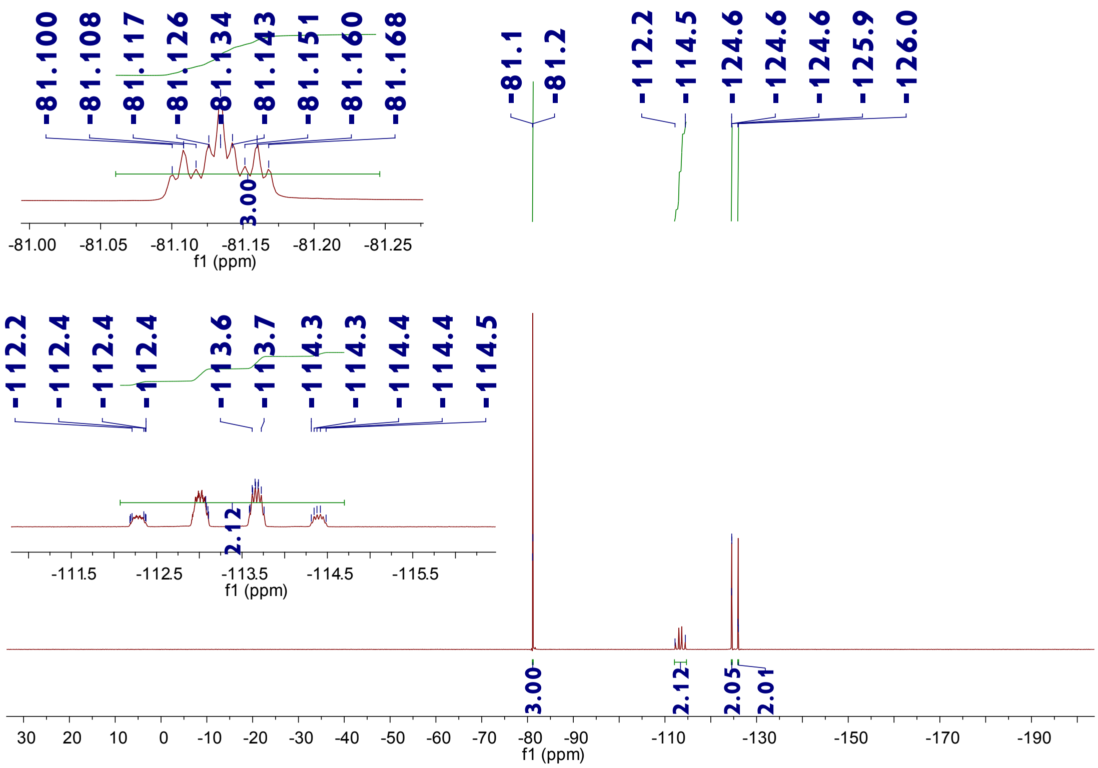
3q



7.56
7.47
7.45
7.31
7.29
7.27
7.26
7.25
7.23
5.20
5.19
5.18
5.17
2.62
2.55
2.45
2.38
2.34
-0.00
OH
Br
F
7.472
7.469
7.465
7.453
7.450
7.446
0.98
7.48
7.44
f1 (ppm)
5.198
5.190
5.176
5.168
1.03
5.25
5.20
5.15
5.10
f1 (ppm)
1.00
0.98
2.25
1.03
3.26
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

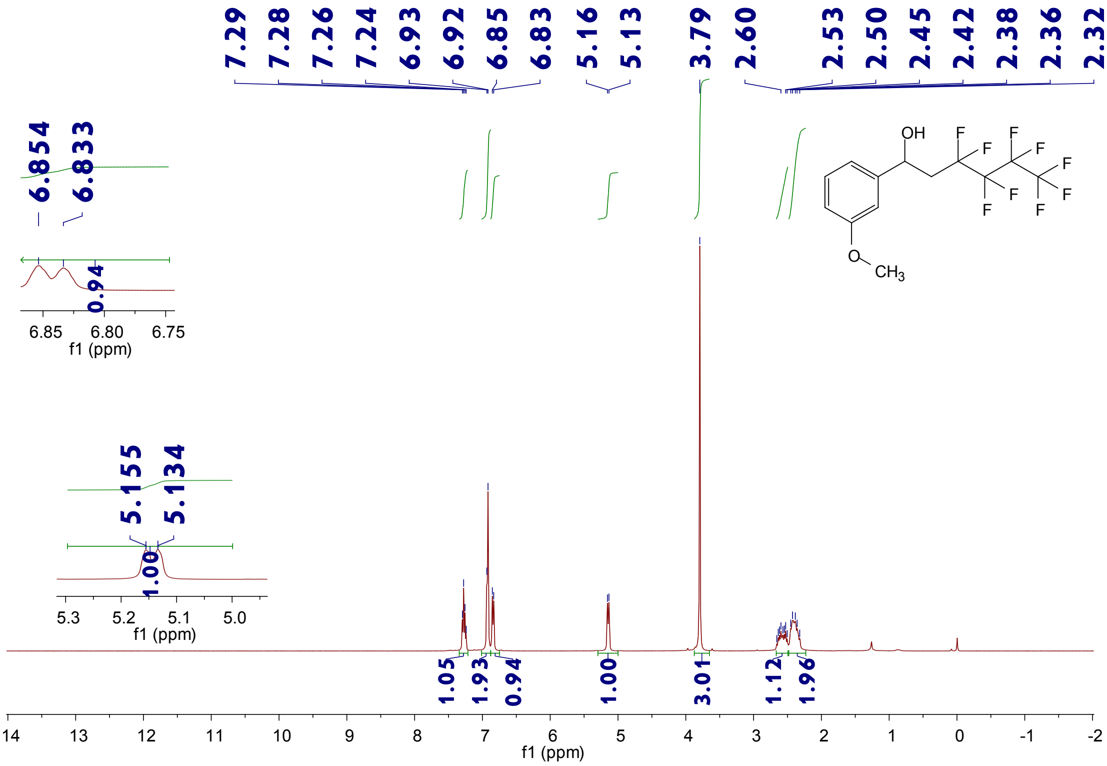


144.8
130.4
128.8
124.2
122.9
77.0
67.3
40.1
39.9
39.7
40.062
39.858
39.653
40.5
39.5
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

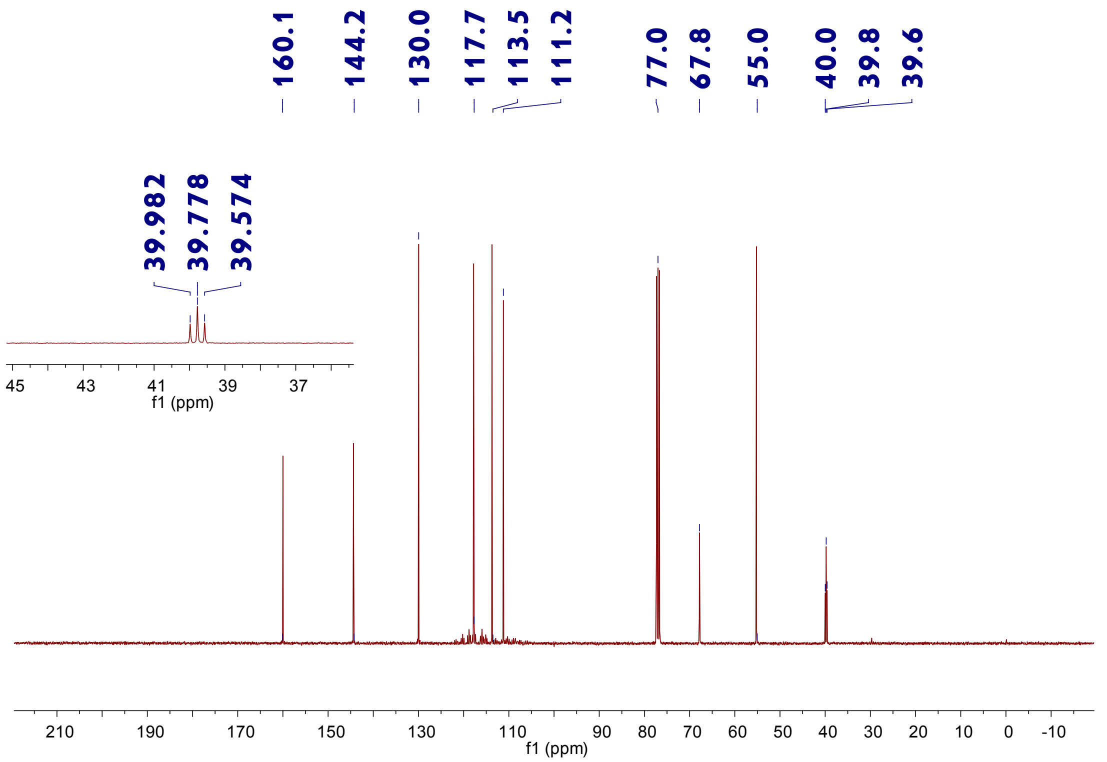


-81.100
-81.108
-81.117
-81.126
-81.134
-81.143
-81.151
-81.160
-81.168
3.00
-81.00 -81.05 -81.10 -81.15 -81.20 -81.25
f1 (ppm)
-81.1
-81.2
-112.2
-114.5
-124.6
-124.6
-124.6
-125.9
-126.0
-112.2
-112.4
-112.4
-112.4
-113.6
-113.7
-114.3
-114.3
-114.4
-114.4
-114.5
2.12
-111.5 -112.5 -113.5 -114.5 -115.5
f1 (ppm)
3.00
2.12
2.05
2.01
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

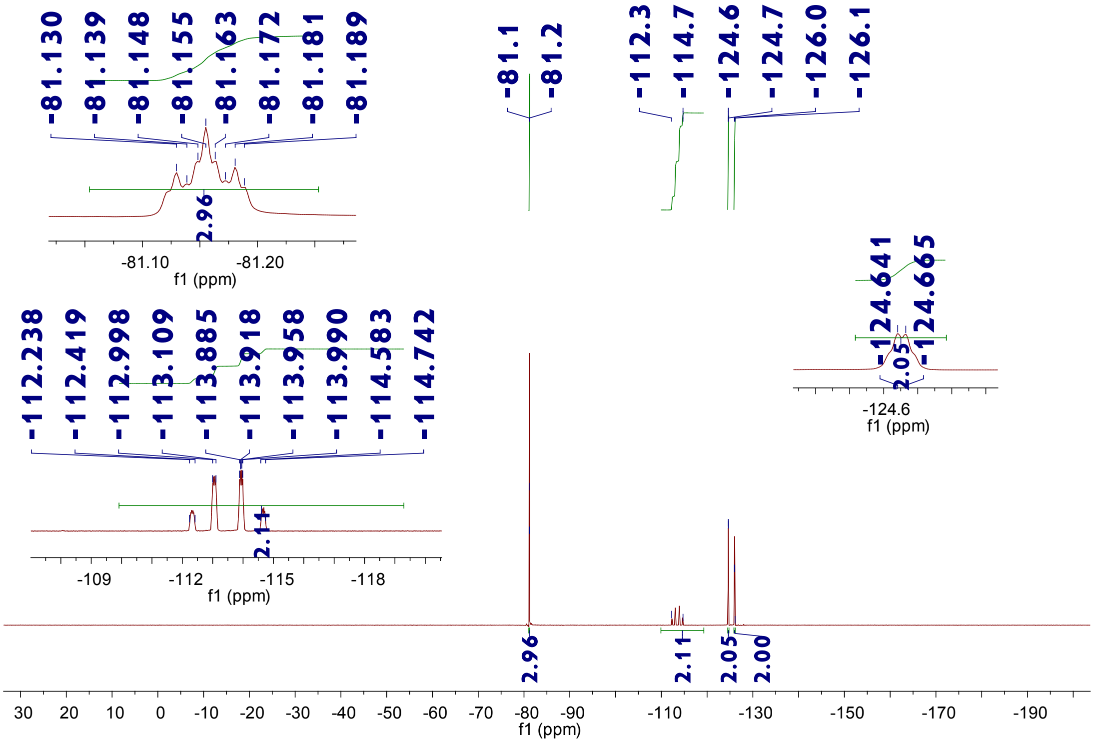
3r



7.29
7.28
7.26
7.24
6.93
6.92
6.85
6.83
5.16
5.13
3.79
2.60
2.53
2.50
2.45
2.42
2.38
2.36
2.32
6.854
6.833
0.94
6.85 6.80 6.75
f1 (ppm)
5.155
5.134
1.00
5.3 5.2 5.1 5.0
f1 (ppm)
OH
F
F
F
F
F
F
F
F
F
O
CH3
1.05
1.93
0.94
1.00
3.01
1.12
1.96
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

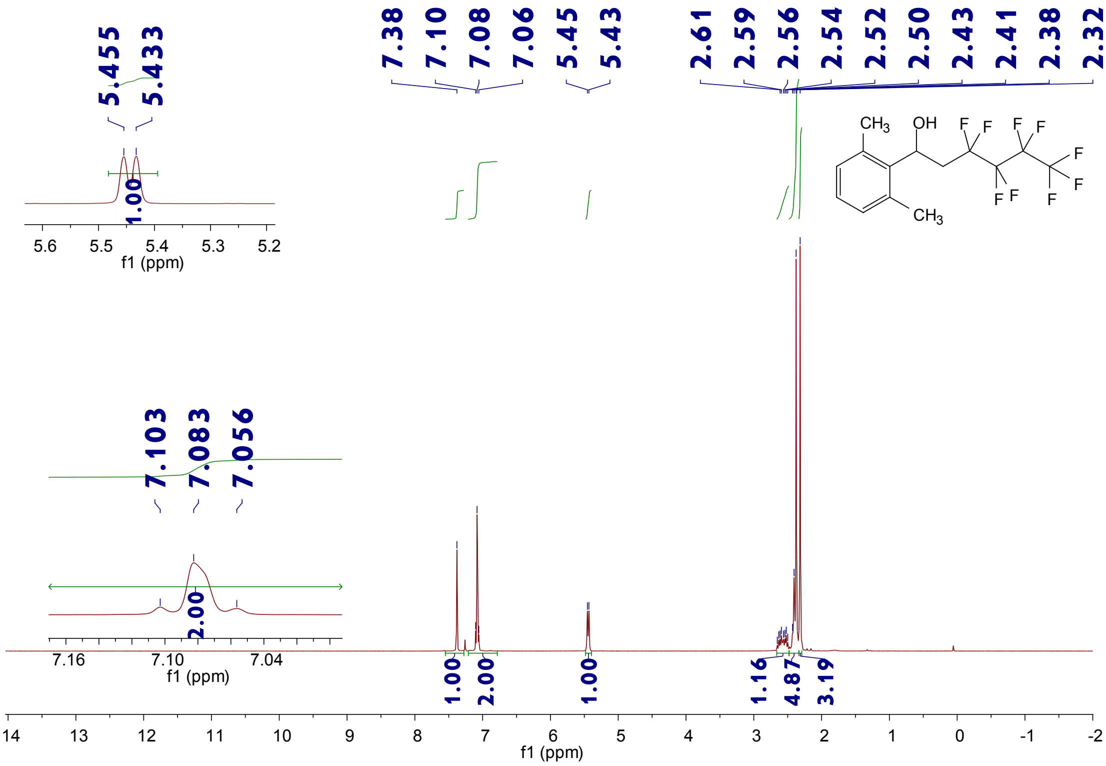


160.1
144.2
130.0
117.7
113.5
111.2
77.0
67.8
55.0
40.0
39.8
39.6
39.982
39.778
39.574
45 43 41 39 37
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

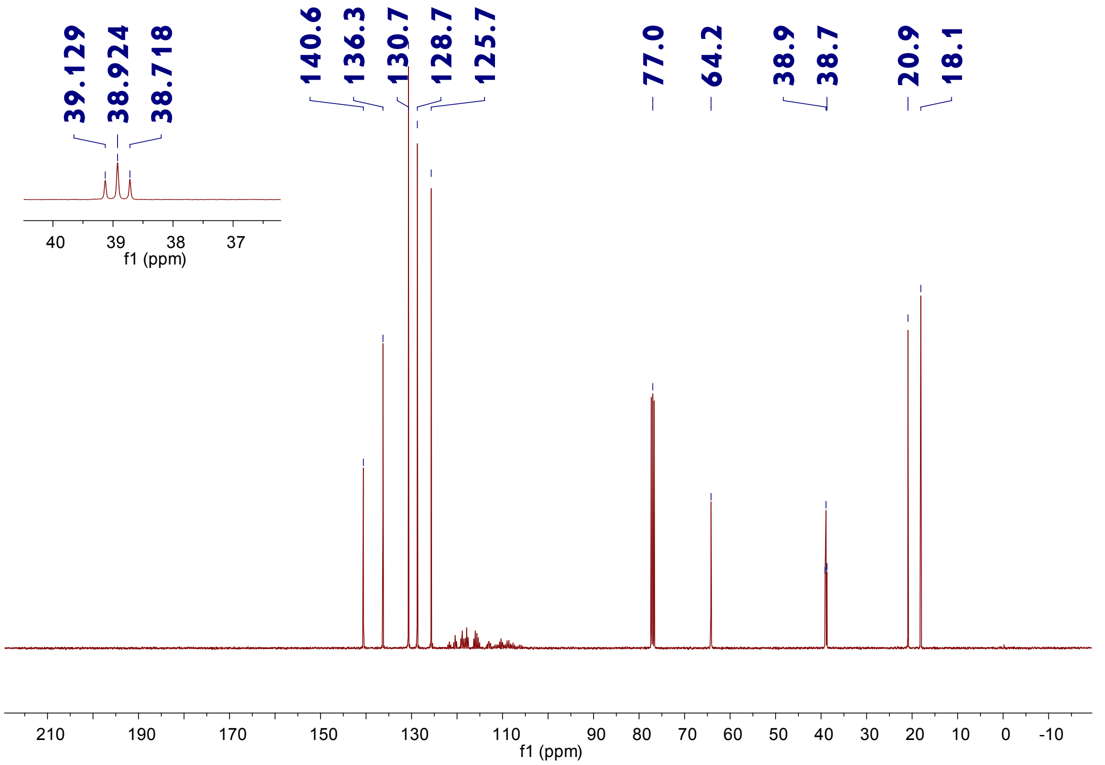


-81.130
-81.139
-81.148
-81.155
-81.163
-81.172
-81.181
-81.189
2.96
-81.10
-81.20
f1 (ppm)
-81.1
-81.2
-112.3
-114.7
-124.6
-124.7
-126.0
-126.1
-124.641
-124.665
2.05
-124.6
f1 (ppm)
-112.238
-112.419
-112.998
-113.109
-113.885
-113.918
-113.958
-113.990
-114.583
-114.742
2.11
-109
-112
-115
-118
f1 (ppm)
2.96
2.11
2.05
2.00
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

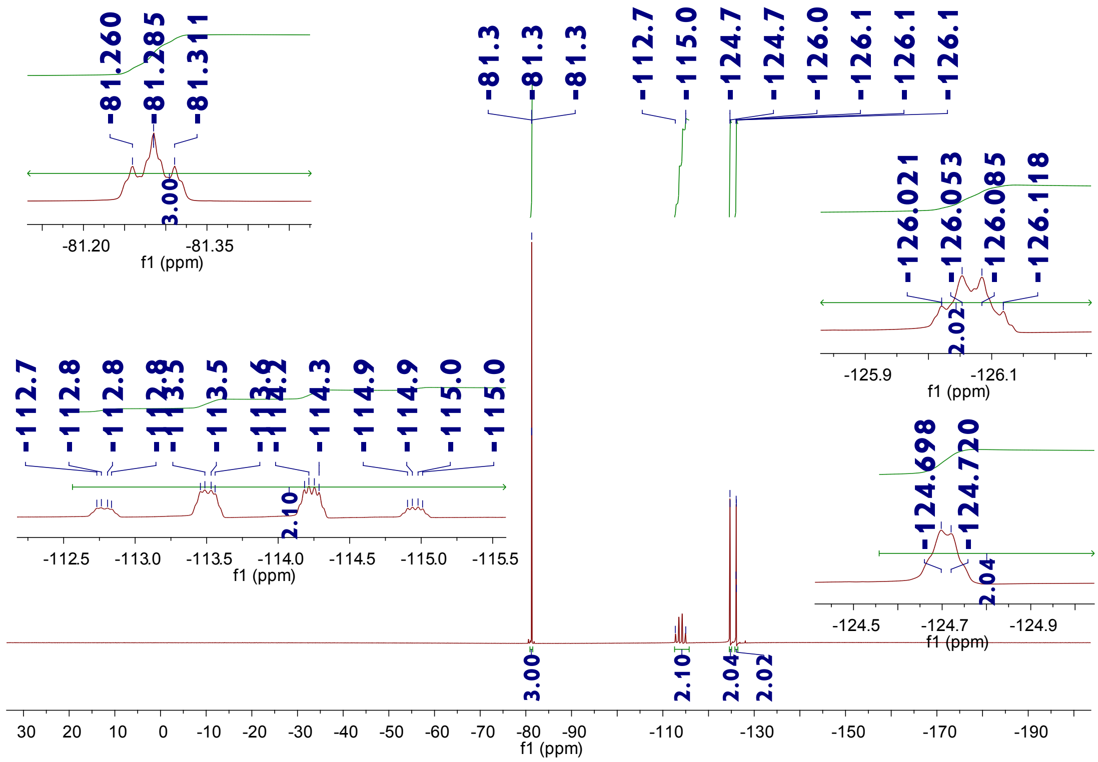
3s



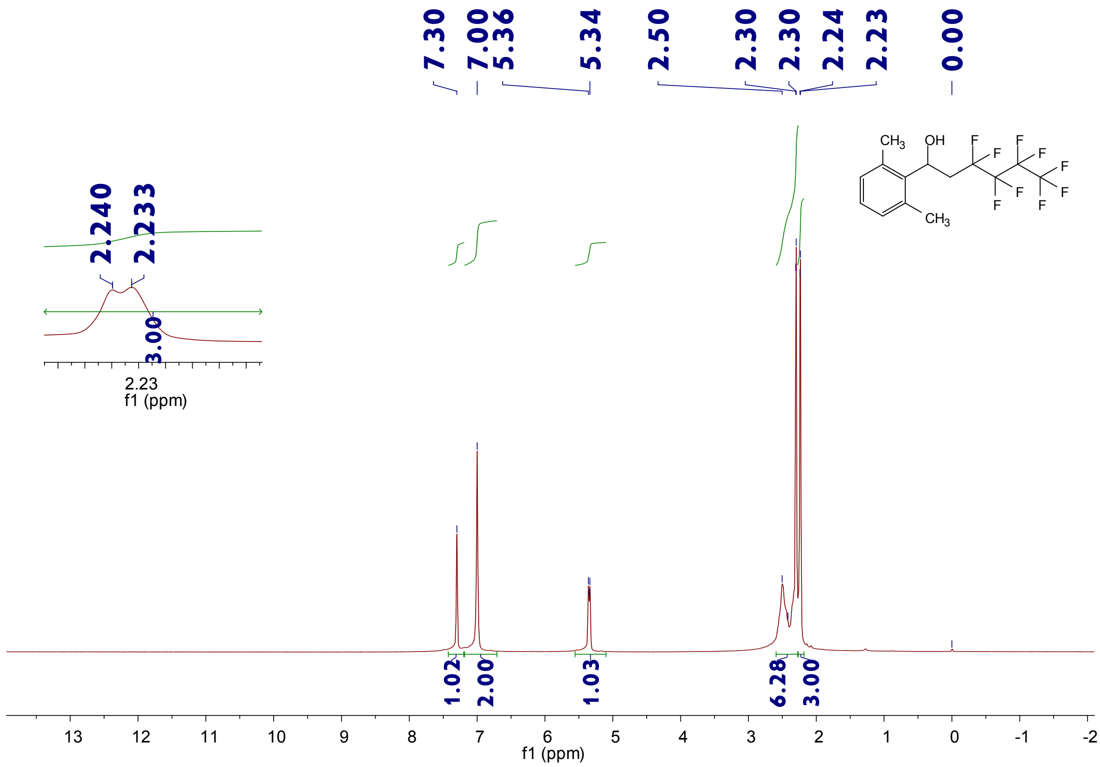
7.38
7.10
7.08
7.06
5.45
5.43
2.61
2.59
2.56
2.54
2.52
2.50
2.43
2.41
2.38
2.32
5.455
5.433
1.00
f1 (ppm)
7.103
7.083
7.056
2.00
1.00
2.00
1.00
1.16
4.87
3.19
CH3
OH
F
CH3
f1 (ppm)

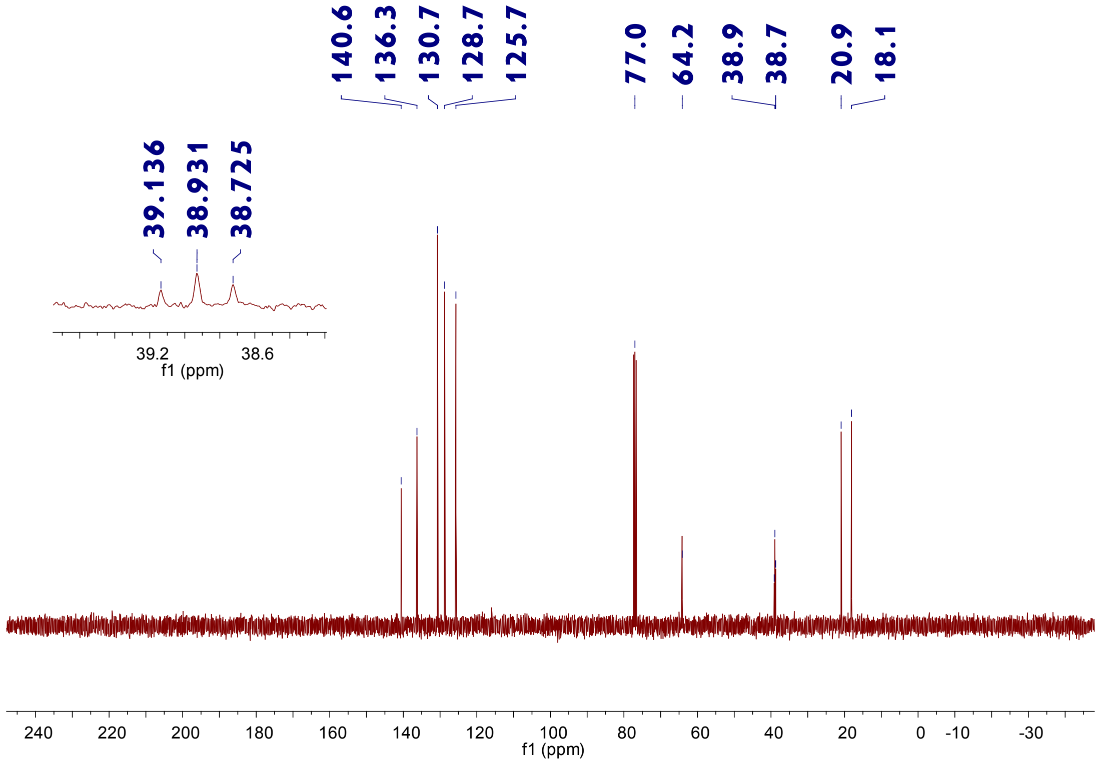


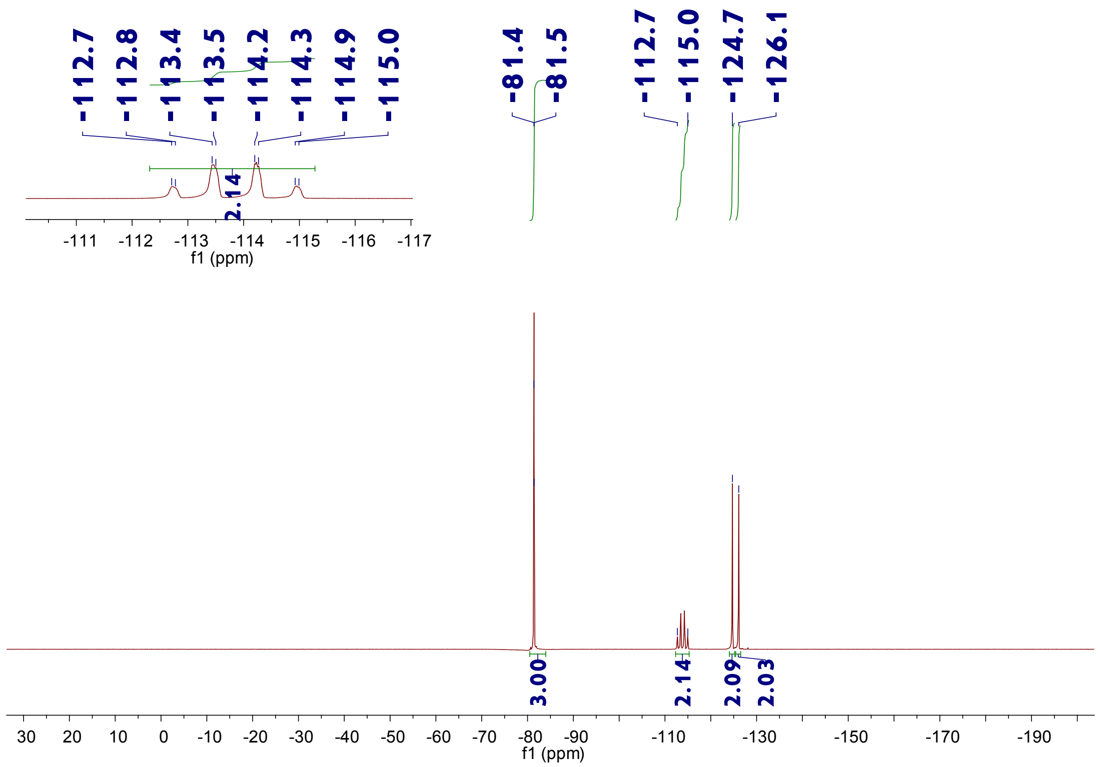
39.129
38.924
38.718
f1 (ppm)
140.6
136.3
130.7
128.7
125.7
77.0
64.2
38.9
38.7
20.9
18.1
f1 (ppm)



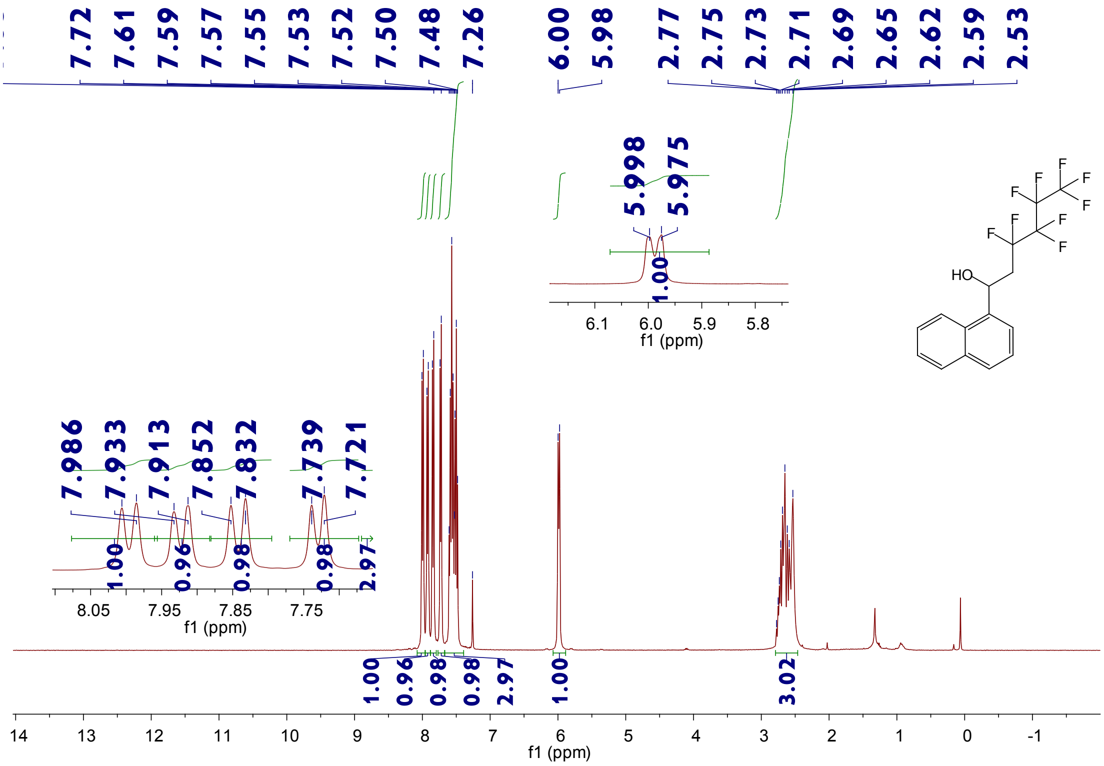
3s (under condition B)

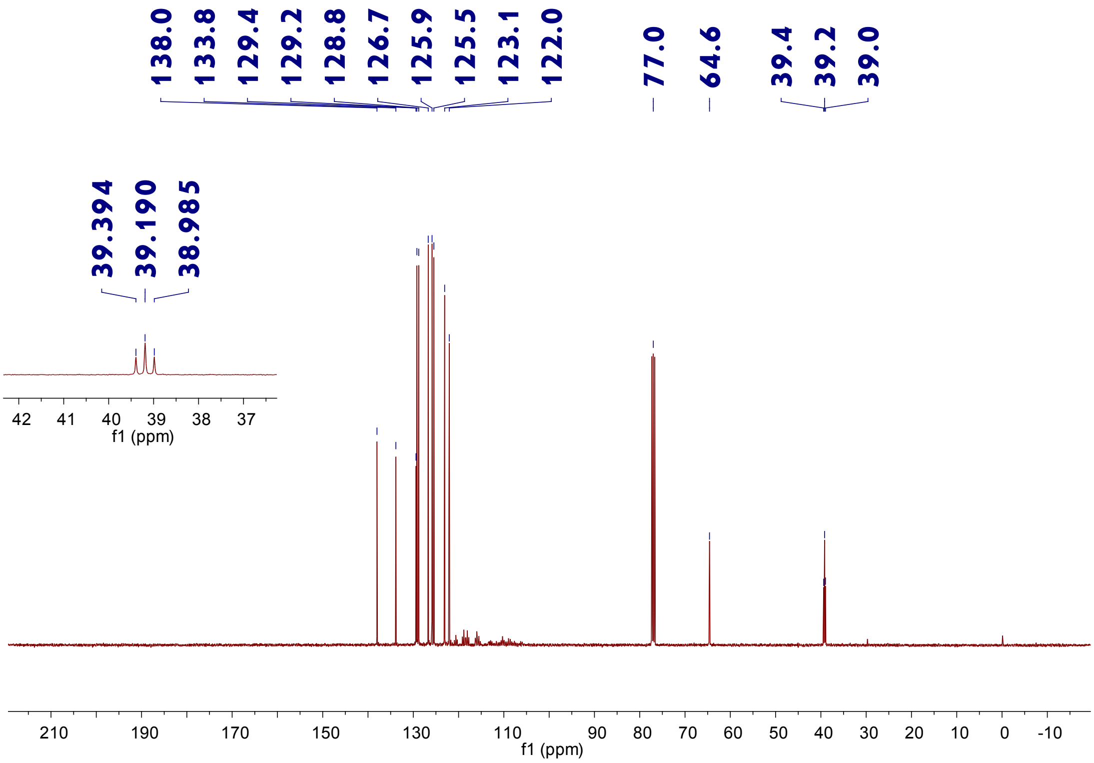


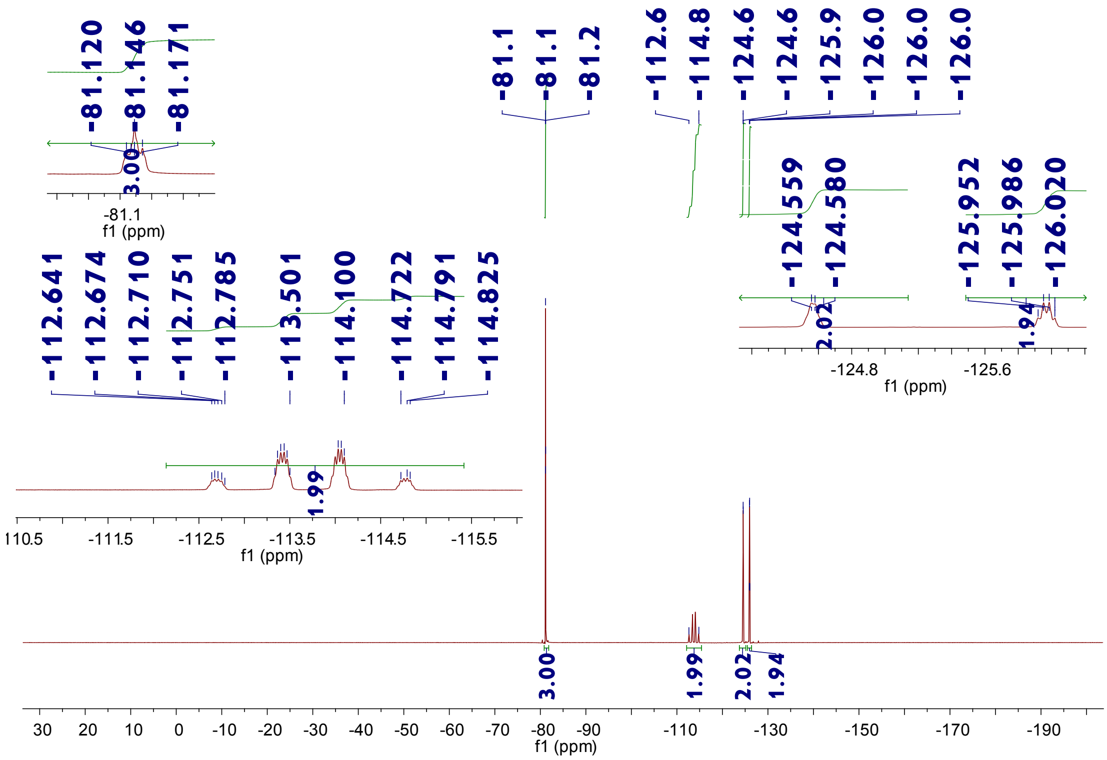

140.6
136.3
130.7
128.7
125.7
77.0
64.2
38.9
38.7
20.9
18.1
39.136
38.931
38.725
39.2
38.6
f1 (ppm)
240
220
200
180
160
140
120
100
80
60
40
20
0
-10
-30
f1 (ppm)


-112.7
-112.8
-113.4
-113.5
-114.2
-114.3
-114.9
-115.0
2.14
-111
-112
-113
-114
-115
-116
-117
f1 (ppm)
-81.4
-81.5
-112.7
-115.0
-124.7
-126.1
3.00
2.14
2.09
2.03
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

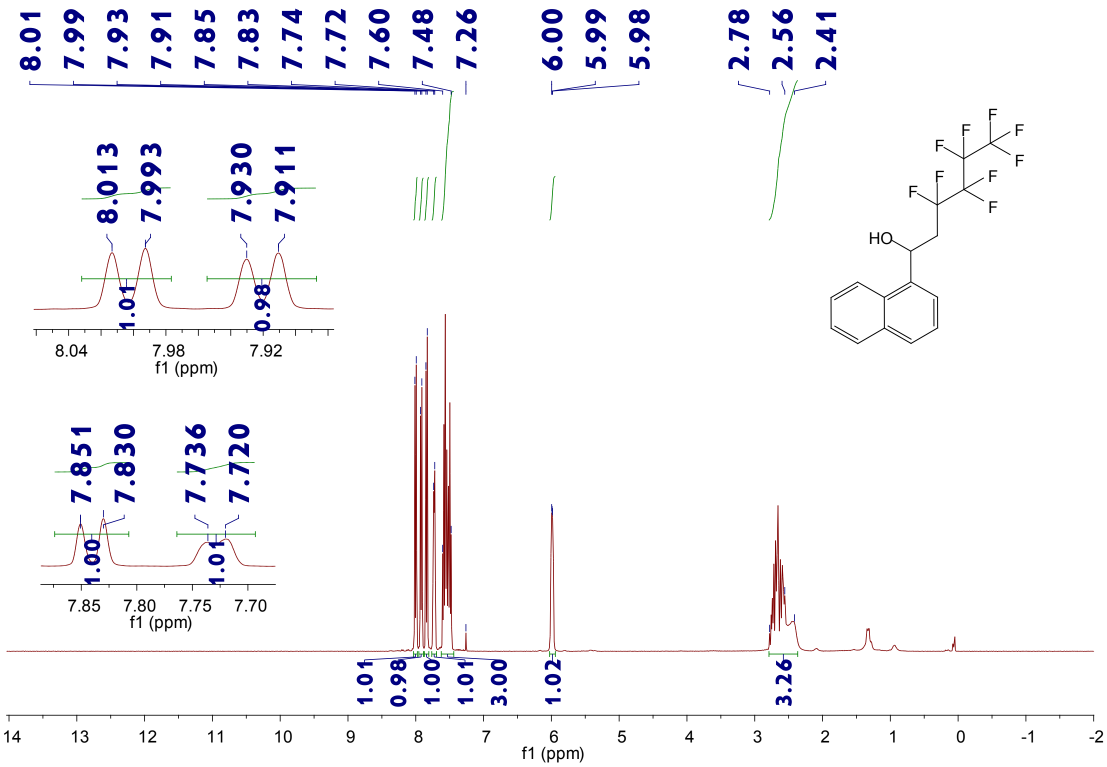
3t

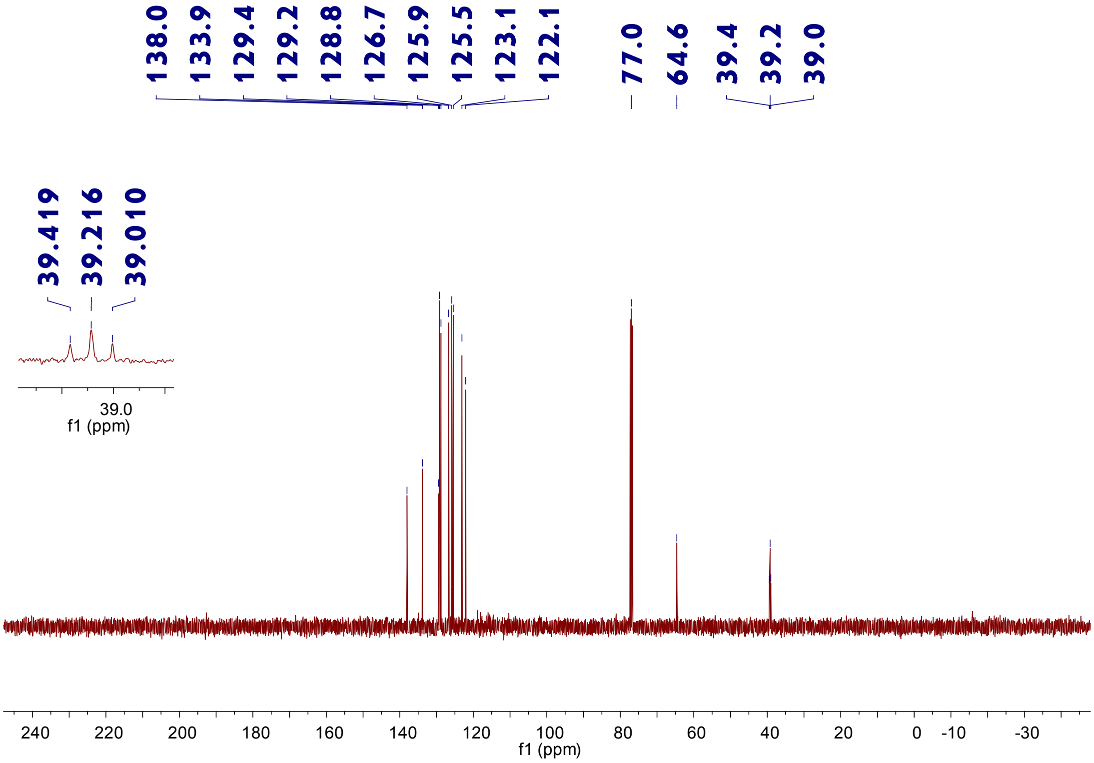

7.72
7.61
7.59
7.57
7.55
7.53
7.52
7.50
7.48
7.26
6.00
5.98
2.77
2.75
2.73
2.71
2.69
2.65
2.62
2.59
2.53
5.998
5.975
1.00
f1 (ppm)
7.986
7.933
7.913
7.852
7.832
7.739
7.721
1.00
0.96
0.98
0.98
2.97
f1 (ppm)
1.00
0.96
0.98
0.98
2.97
1.00
3.02
f1 (ppm)
HO
F

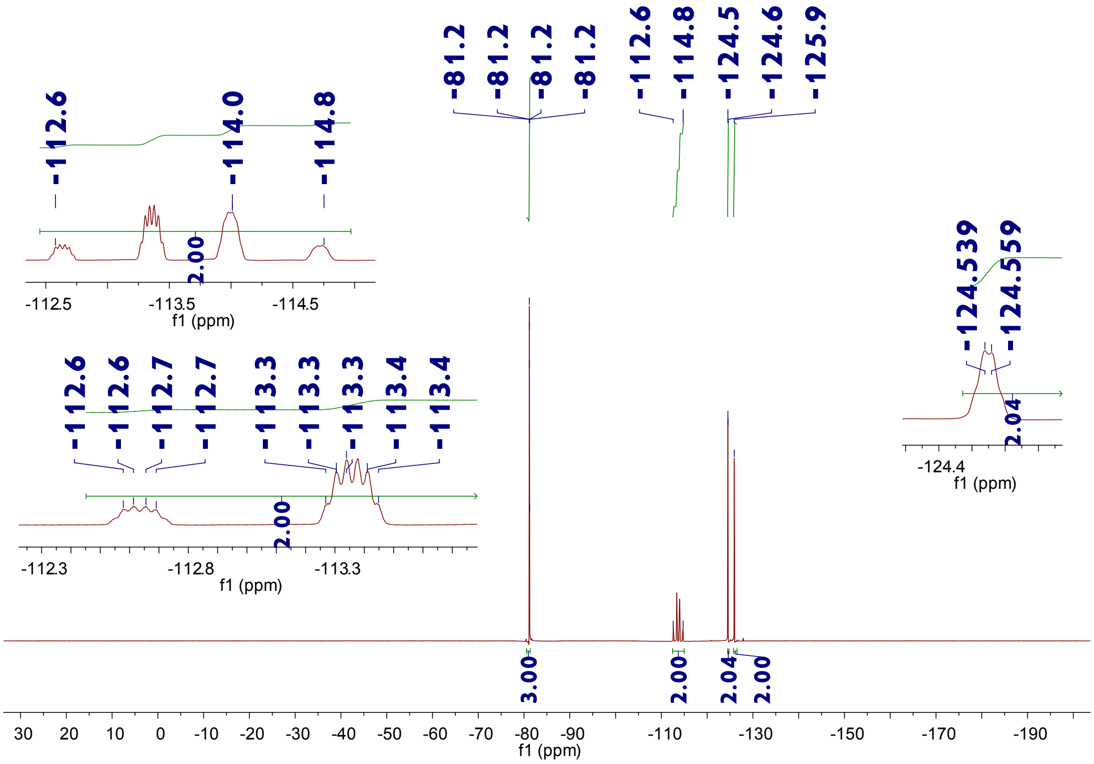

138.0
133.8
129.4
129.2
128.8
126.7
125.9
125.5
123.1
122.0
77.0
64.6
39.4
39.2
39.0
39.394
39.190
38.985
f1 (ppm)
f1 (ppm)



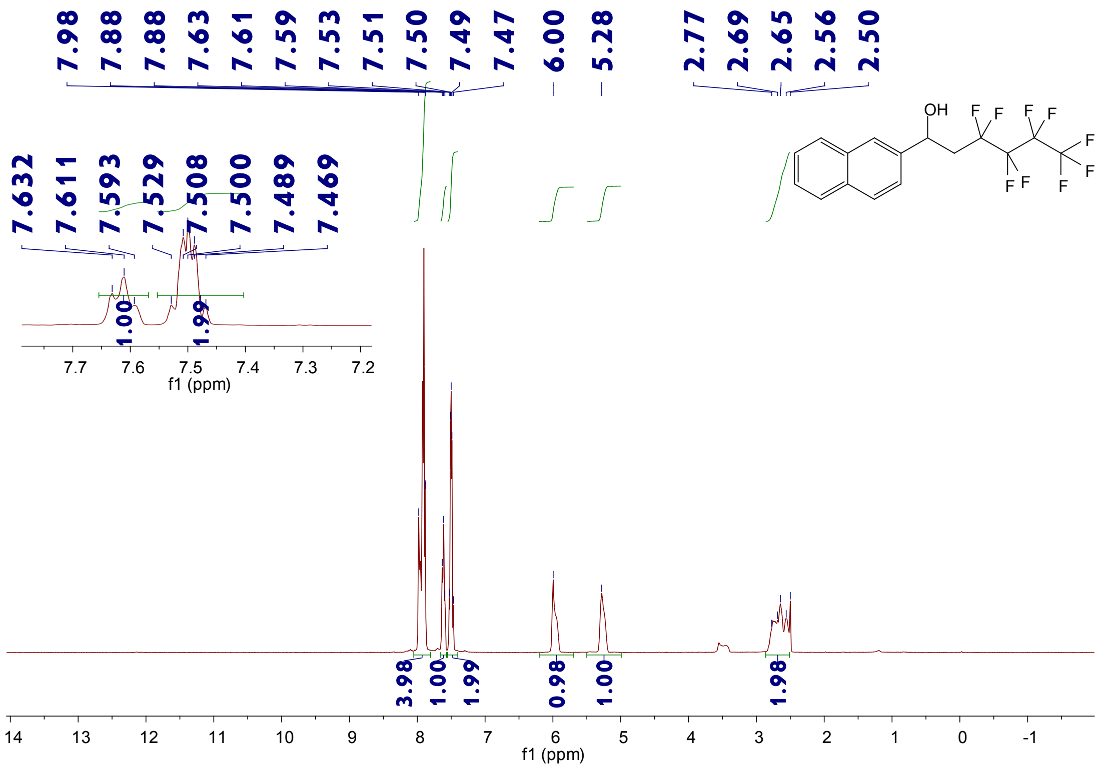
3t (under condition B)



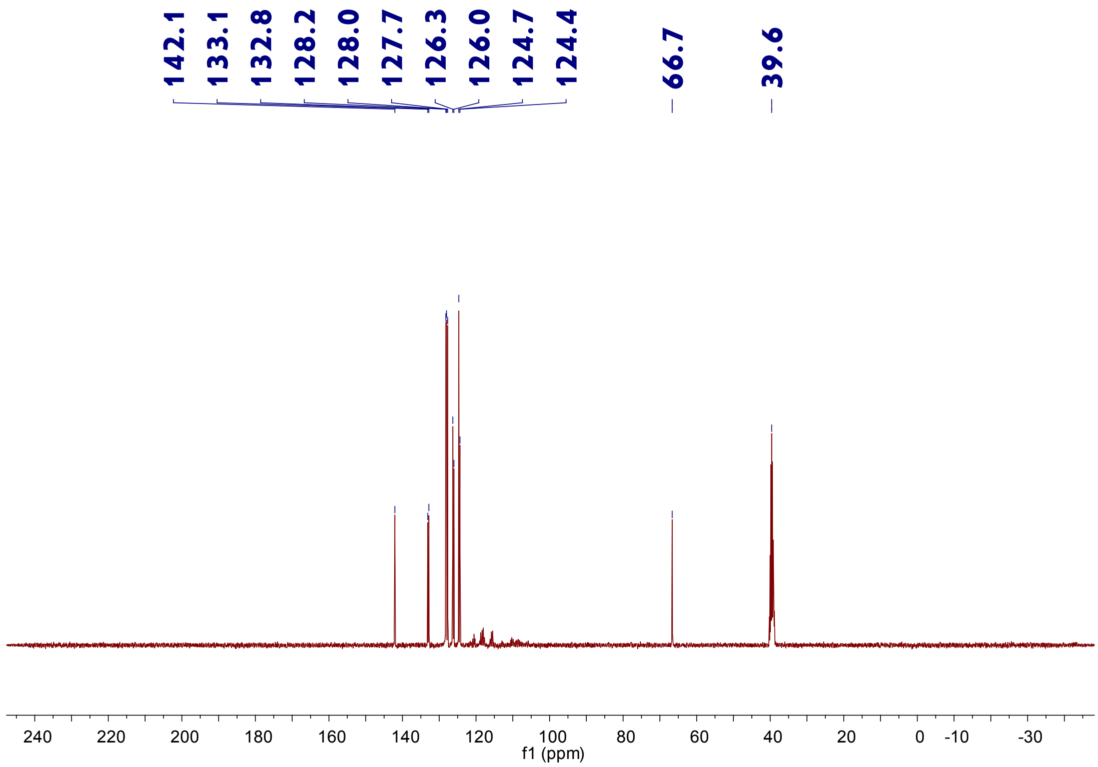

138.0
133.9
129.4
129.2
128.8
126.7
125.9
125.5
123.1
122.1
77.0
64.6
39.4
39.2
39.0
39.419
39.216
39.010
39.0
f1 (ppm)
240 220 200 180 160 140 120 100 80 60 40 20 0 -10 -30
f1 (ppm)


-81.2
-81.2
-81.2
-81.2
-112.6
-114.8
-124.5
-124.6
-125.9
-112.6
-114.0
-114.8
2.00
-112.5 -113.5 -114.5
f1 (ppm)
-112.6
-112.6
-112.7
-112.7
-113.3
-113.3
-113.3
-113.4
-113.4
2.00
-112.3 -112.8 -113.3
f1 (ppm)
-124.539
-124.559
2.04
-124.4
f1 (ppm)
3.00
2.00
2.04
2.00
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

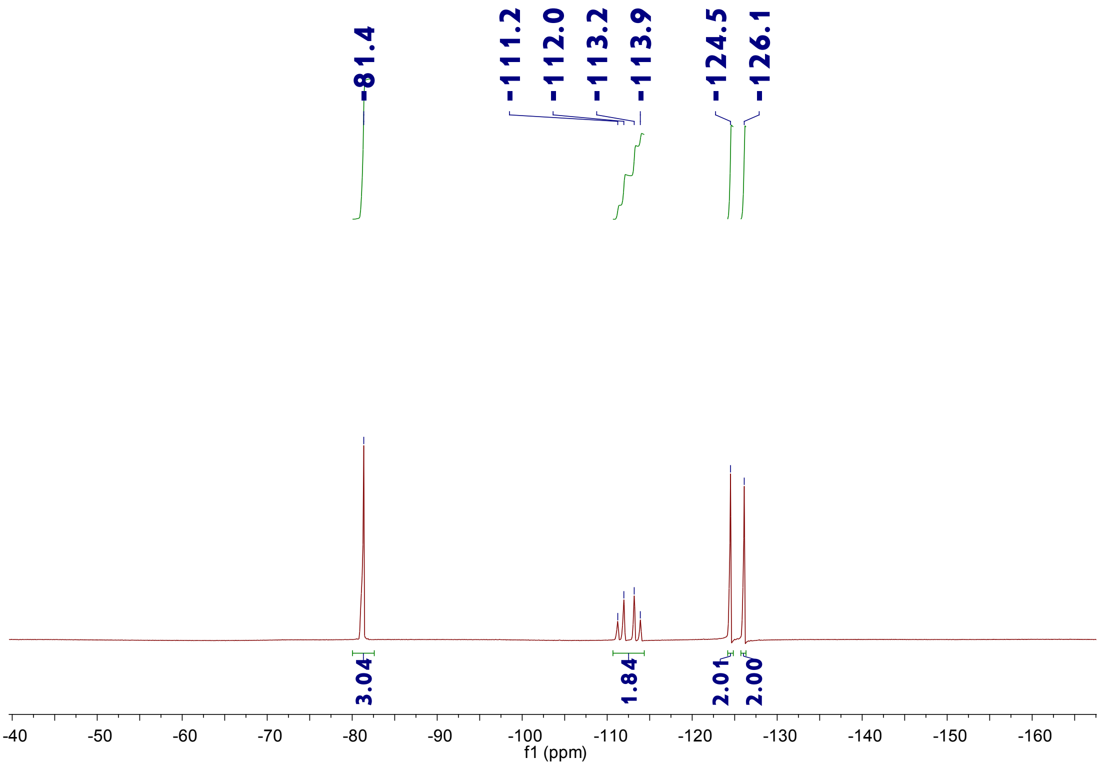
3u



7.98 7.88 7.88 7.63 7.61 7.59 7.53 7.51 7.50 7.49 7.47 6.00 5.28 2.77 2.69 2.65 2.56 2.50
7.632 7.611 7.593 7.529 7.508 7.500 7.489 7.469
1.00 1.99
7.7 7.6 7.5 7.4 7.3 7.2
f1 (ppm)
OH F F F F F F F F F
3.98 1.00 1.99 0.98 1.00 1.98
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1
f1 (ppm)

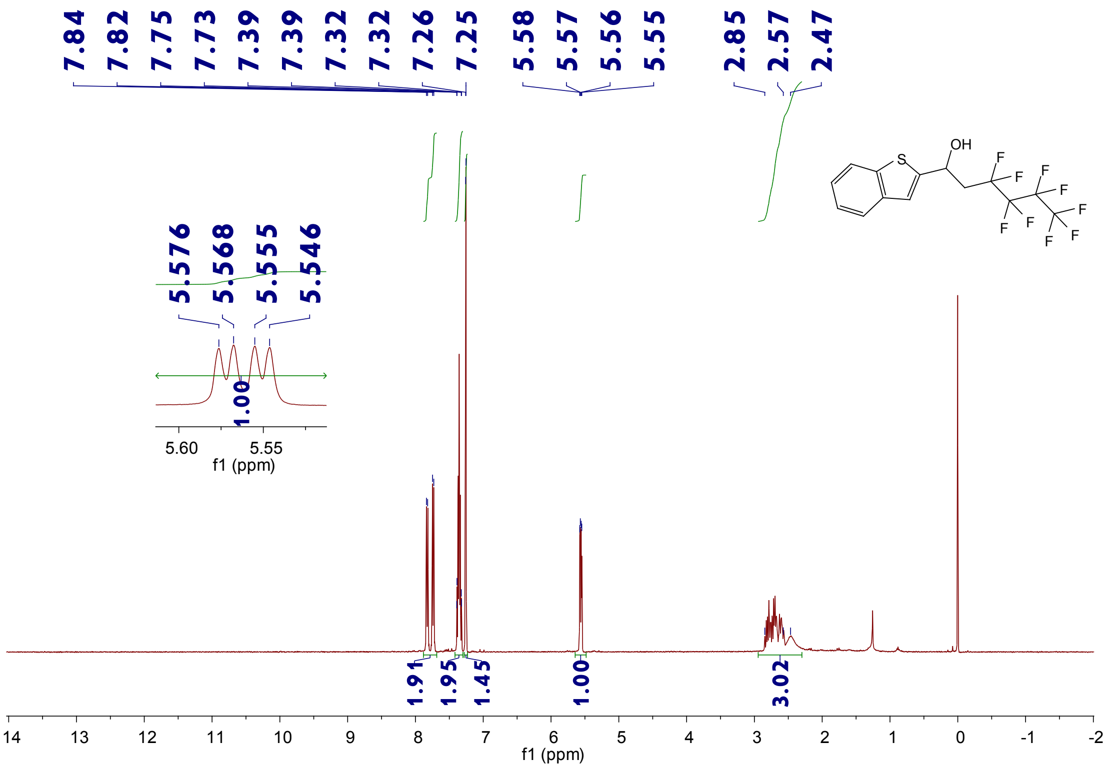


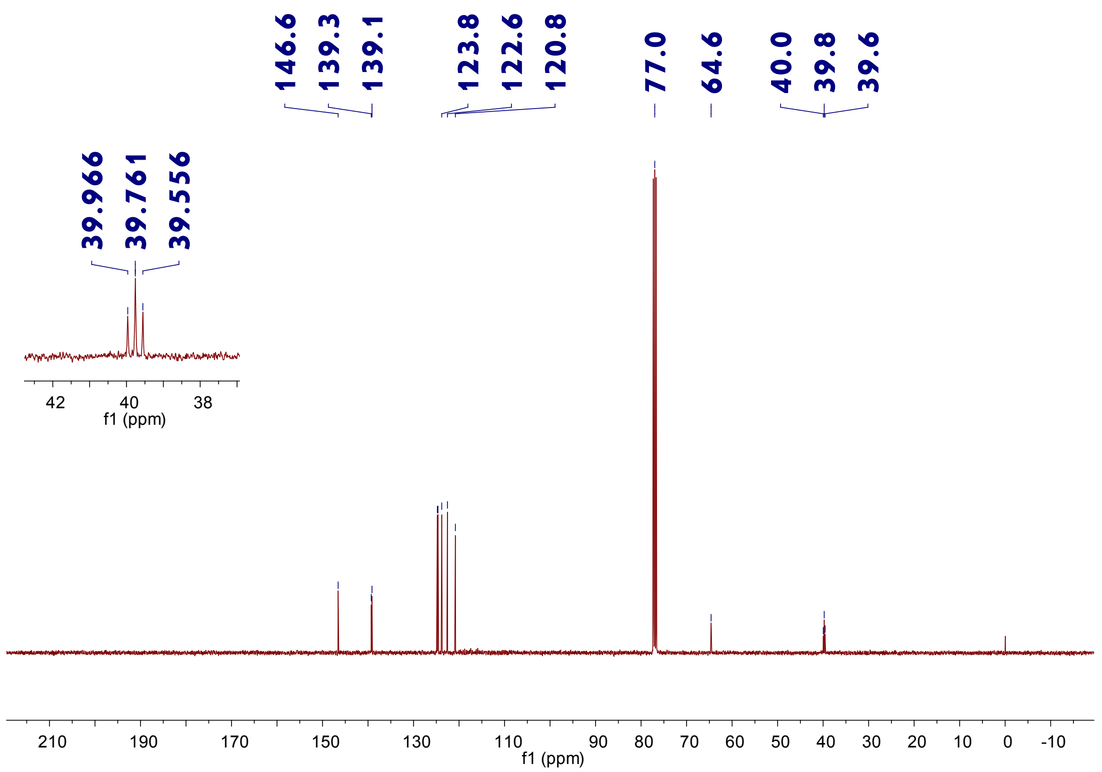
142.1 133.1 132.8 128.2 128.0 127.7 126.3 126.0 124.7 124.4 66.7 39.6
240 220 200 180 160 140 120 100 80 60 40 20 0 -10 -30
f1 (ppm)

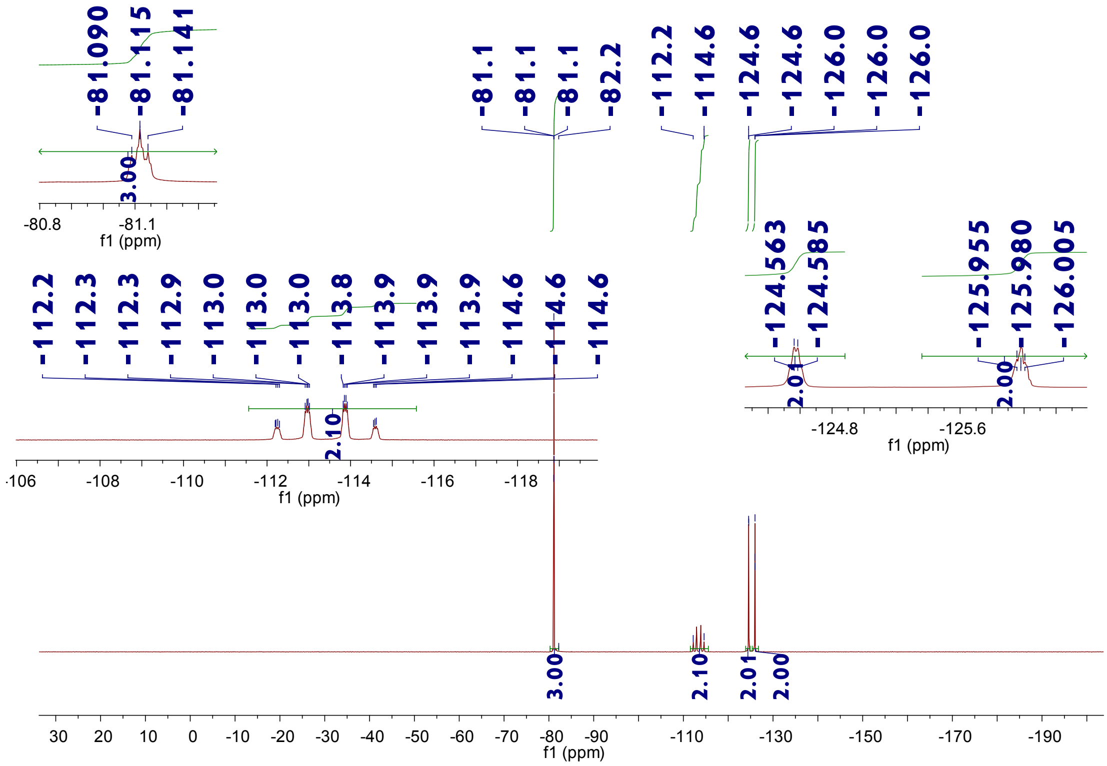


-81.4
-111.2
-112.0
-113.2
-113.9
-124.5
-126.1
3.04
1.84
2.01
2.00
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
f1 (ppm)

3v

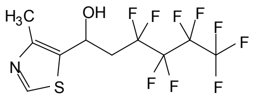

7.84 7.82 7.75 7.73 7.39 7.39 7.32 7.32 7.26 7.25 5.58 5.57 5.56 5.55 2.85 2.57 2.47
5.576 5.568 5.555 5.546
1.00
5.60 5.55
f1 (ppm)
S
OH
F F F F F F F F F
1.91 1.95 1.45 1.00 3.02
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

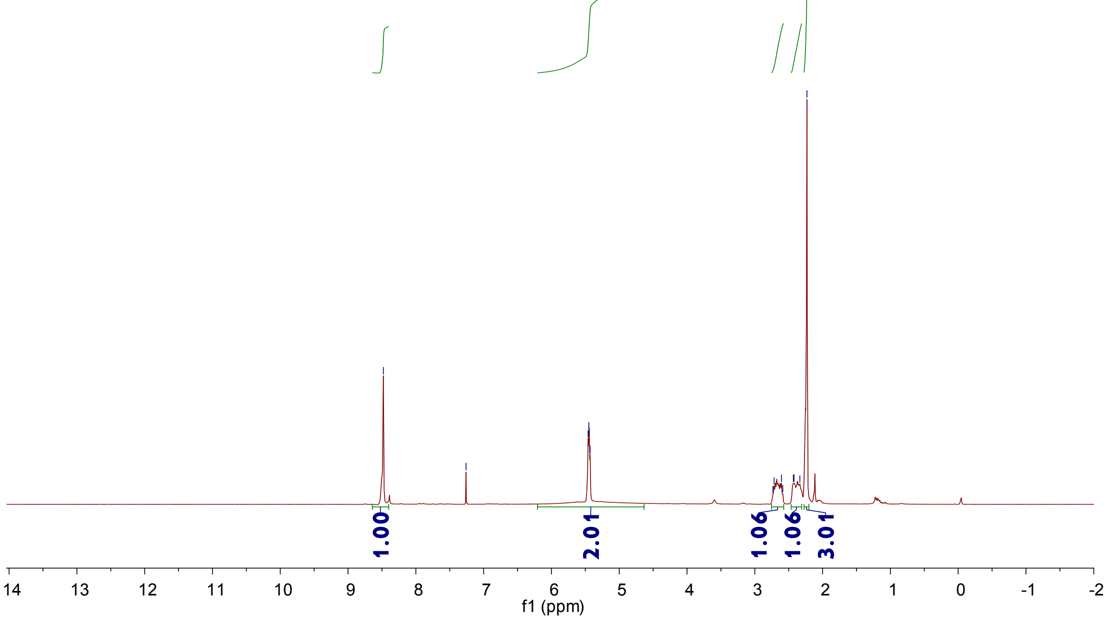

146.6 139.3 139.1 123.8 122.6 120.8 77.0 64.6 40.0 39.8 39.6
39.966 39.761 39.556
42 40 38
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

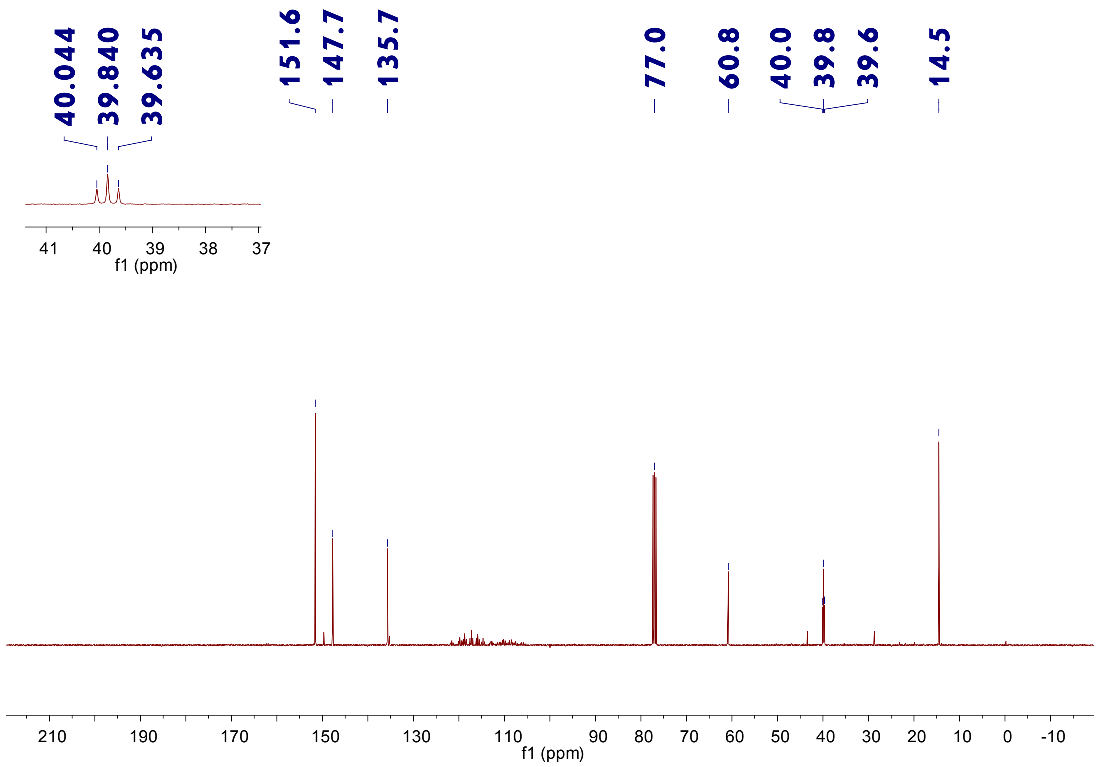


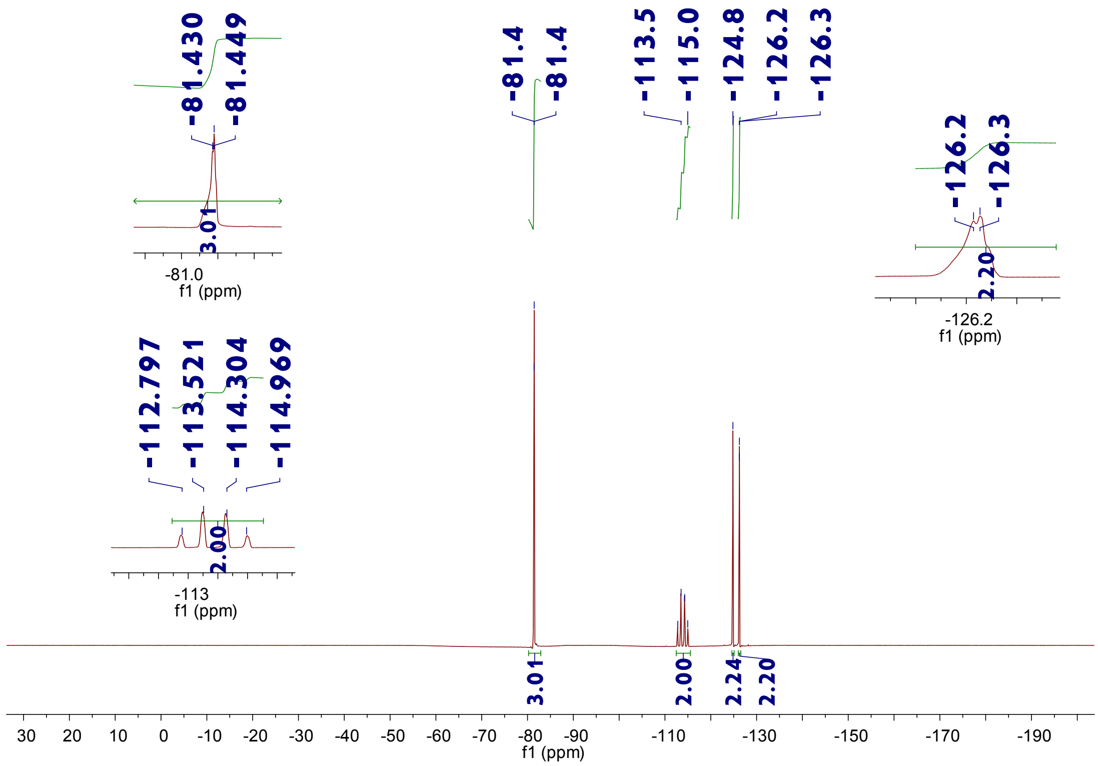
-81.090
-81.115
-81.141
3.00
-80.8
-81.1
f1 (ppm)
-81.1
-81.1
-81.1
-82.2
-112.2
-114.6
-124.6
-124.6
-126.0
-126.0
-126.0
-112.2
-112.3
-112.3
-112.9
-113.0
-113.0
-113.0
-113.8
-113.9
-113.9
-113.9
-114.6
-114.6
-114.6
2.10
-106
-108
-110
-112
-114
-116
-118
f1 (ppm)
-124.563
-124.585
-125.955
-125.980
-126.005
2.01
2.00
-124.8
-125.6
f1 (ppm)
3.00
2.10
2.01
2.00
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

3w


H3C
OH
F F F F F
F
N
S
F F F

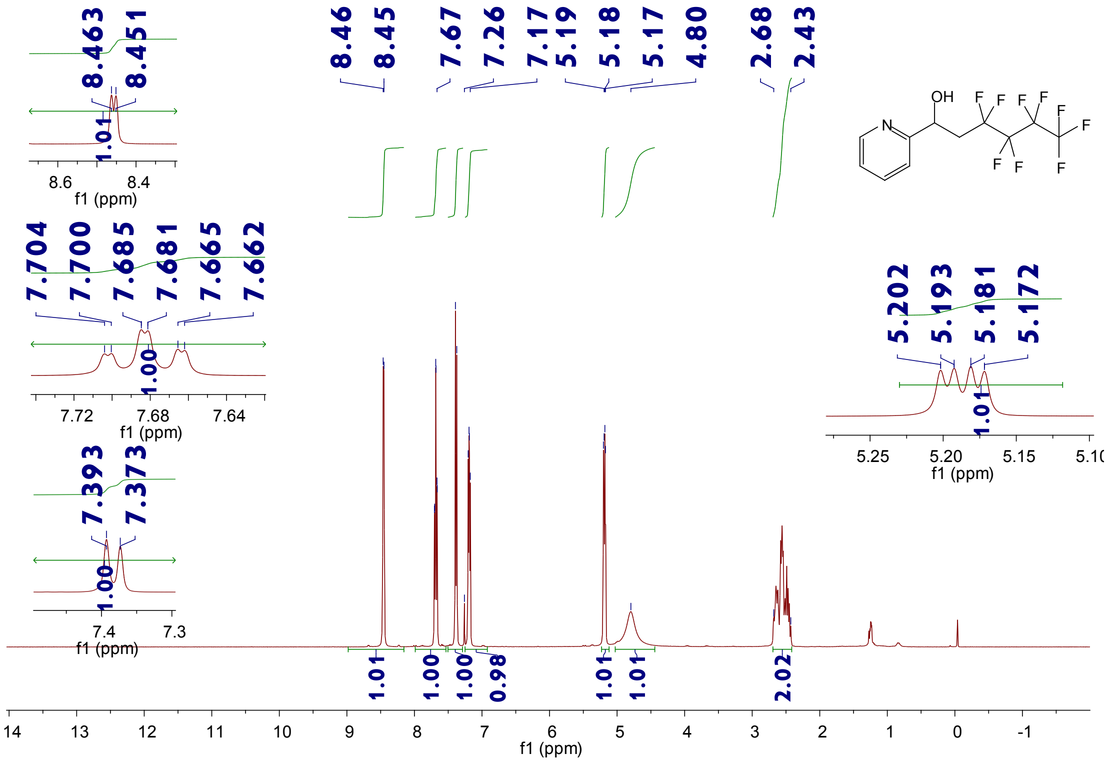

8.48
7.26
5.45
5.44
5.43
2.73
2.71
2.61
2.59
2.43
2.42
2.34
2.23
1.00
2.01
1.06
1.06
3.01
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

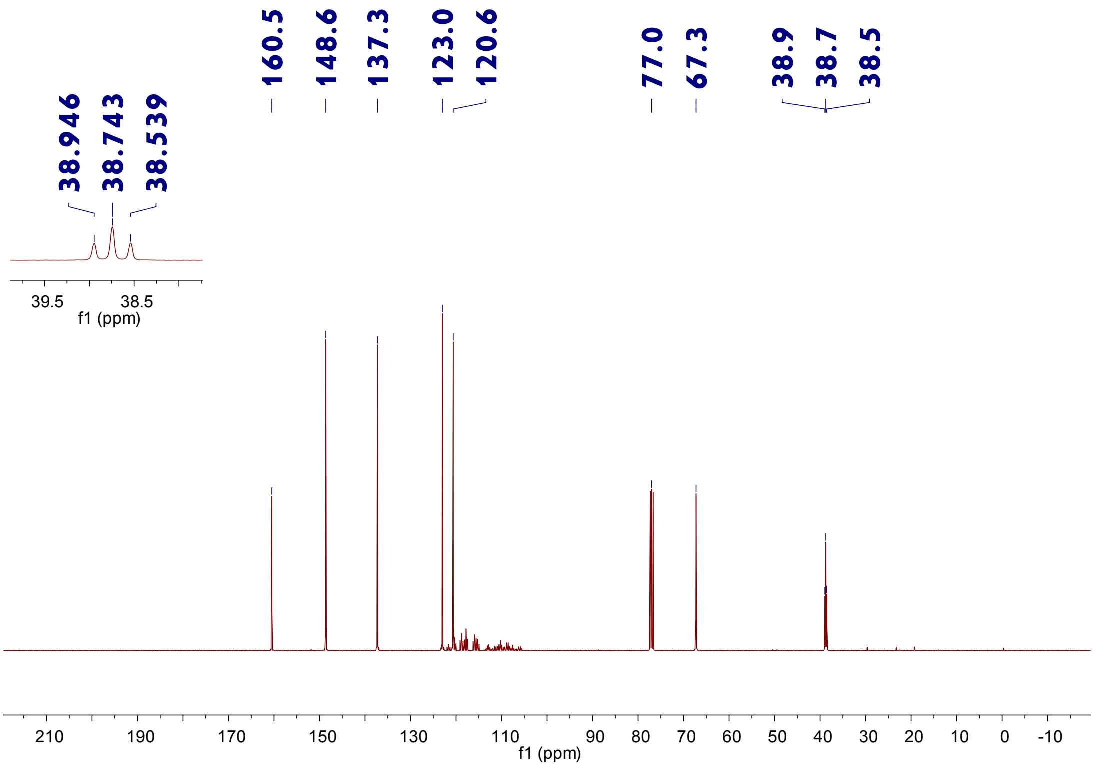

40.044
39.840
39.635
41 40 39 38 37
f1 (ppm)
151.6
147.7
135.7
77.0
60.8
40.0
39.8
39.6
14.5
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

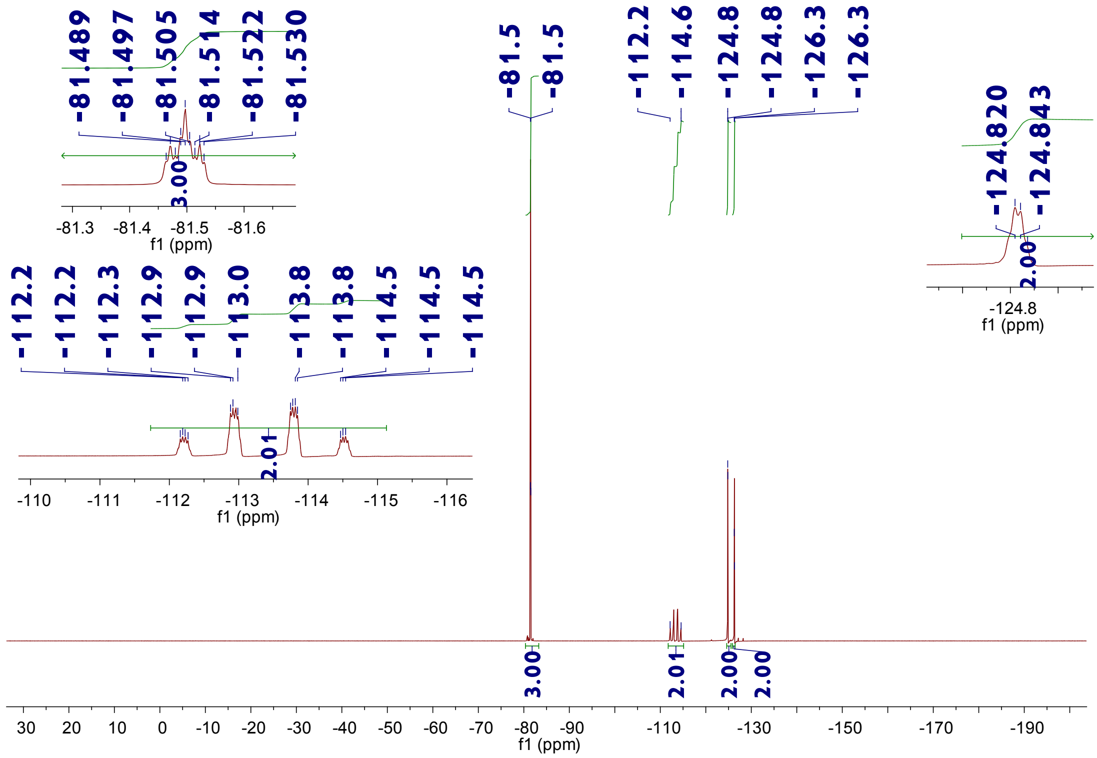


-81.430
-81.449
3.01
-81.0
f1 (ppm)
-81.4
-81.4
-113.5
-115.0
-124.8
-126.2
-126.3
-126.2
-126.3
2.20
-126.2
f1 (ppm)
-112.797
-113.521
-114.304
-114.969
2.00
-113
f1 (ppm)
3.01
2.00
2.24
2.20
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

3x

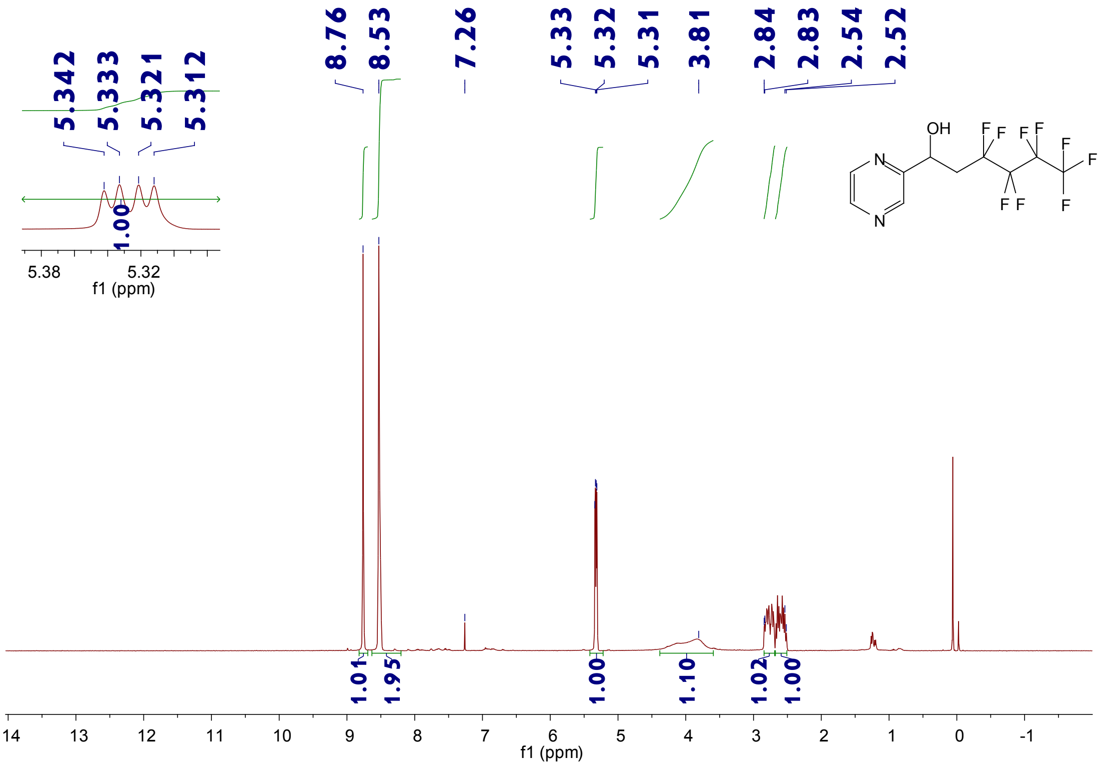

8.46
8.45
7.67
7.26
7.17
5.19
5.18
5.17
4.80
2.68
2.43
8.463
8.451
1.01
7.704
7.700
7.685
7.681
7.665
7.662
1.00
7.393
7.373
1.00
5.202
5.193
5.181
5.172
1.01
OH
N
F
1.01
1.00
1.00
0.98
1.01
1.01
2.02
f1 (ppm)

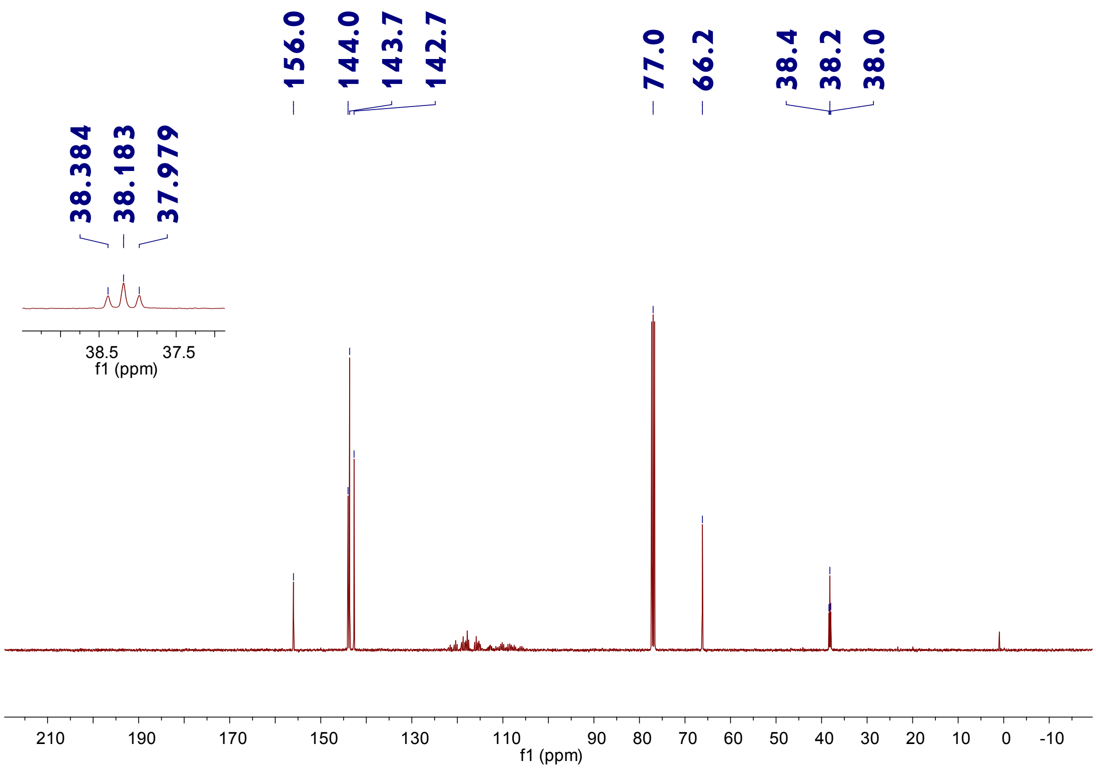

160.5
148.6
137.3
123.0
120.6
77.0
67.3
38.9
38.7
38.5
38.946
38.743
38.539
f1 (ppm)

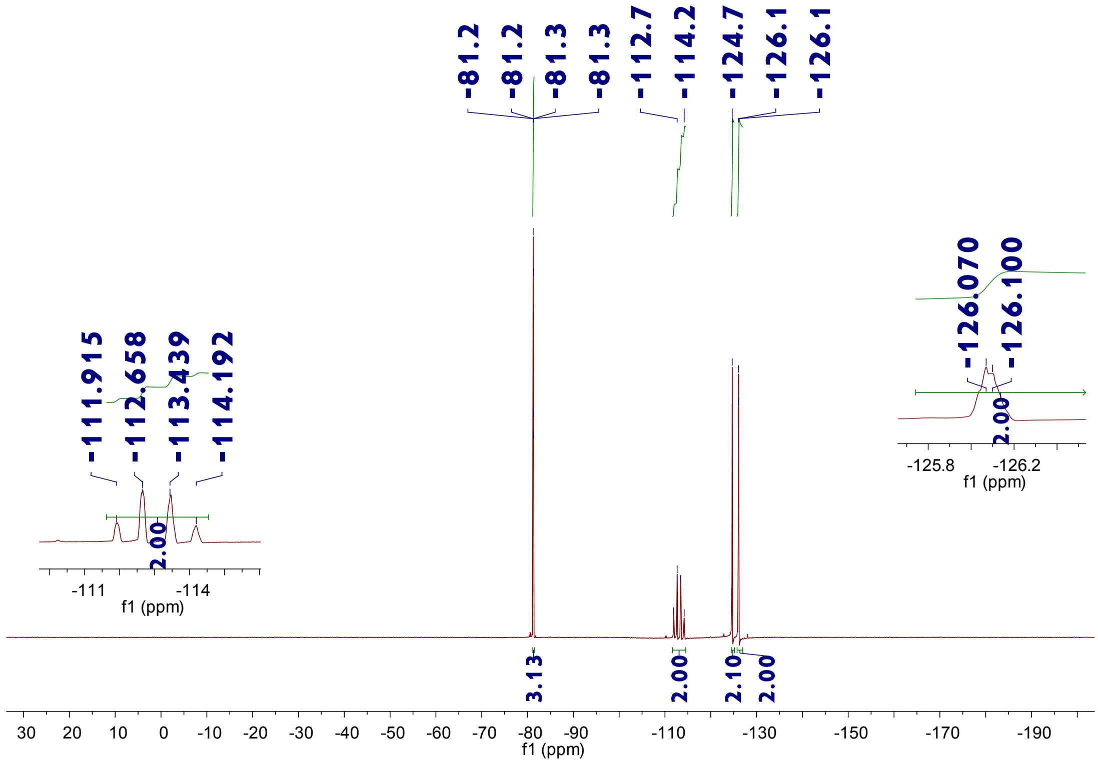


-81.5
-81.5
-112.2
-114.6
-124.8
-124.8
-126.3
-126.3
-81.489
-81.497
-81.505
-81.514
-81.522
-81.530
3.00
-81.3 -81.4 -81.5 -81.6
f1 (ppm)
-112.2
-112.2
-112.3
-112.9
-112.9
-113.0
-113.8
-113.8
-114.5
-114.5
-114.5
2.01
-110 -111 -112 -113 -114 -115 -116
f1 (ppm)
-124.820
-124.843
2.00
-124.8
f1 (ppm)
3.00
2.01
2.00
2.00
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

3y

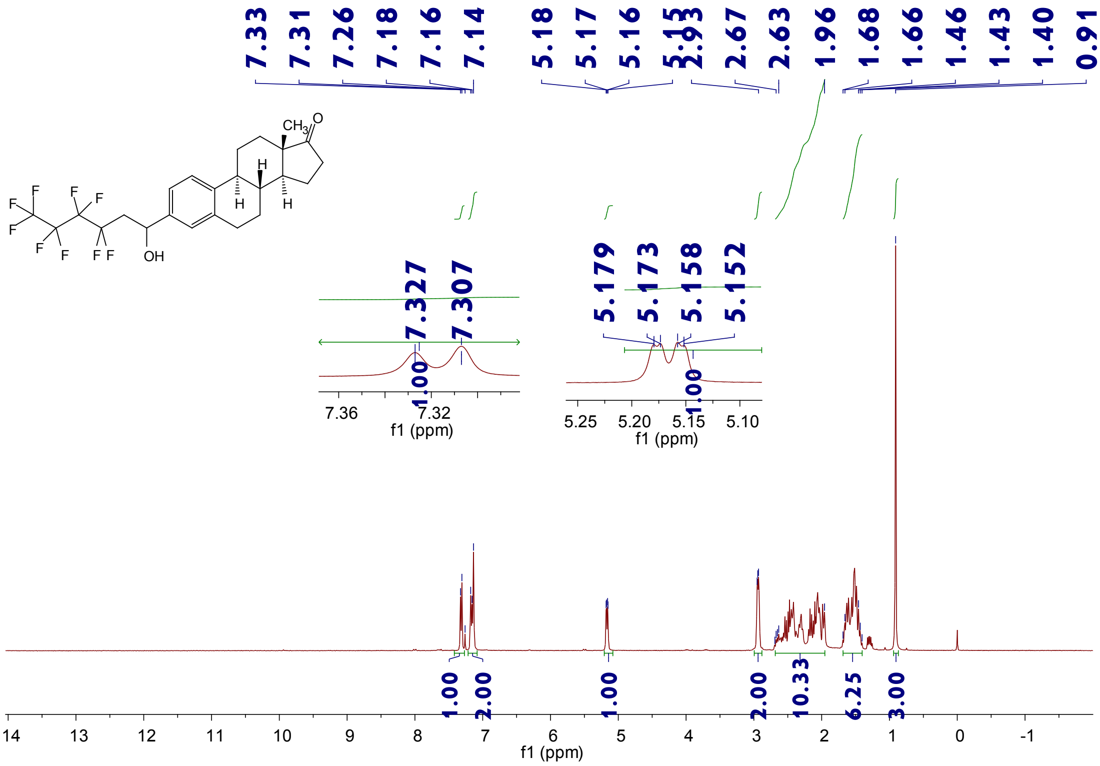

8.76
8.53
7.26
5.33
5.32
5.31
3.81
2.84
2.83
2.54
2.52
5.342
5.333
5.321
5.312
1.00
5.38
5.32
f1 (ppm)
OH
F F F F
F
F
F F F
N
N
1.01
1.95
1.00
1.10
1.02
1.00
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1
f1 (ppm)

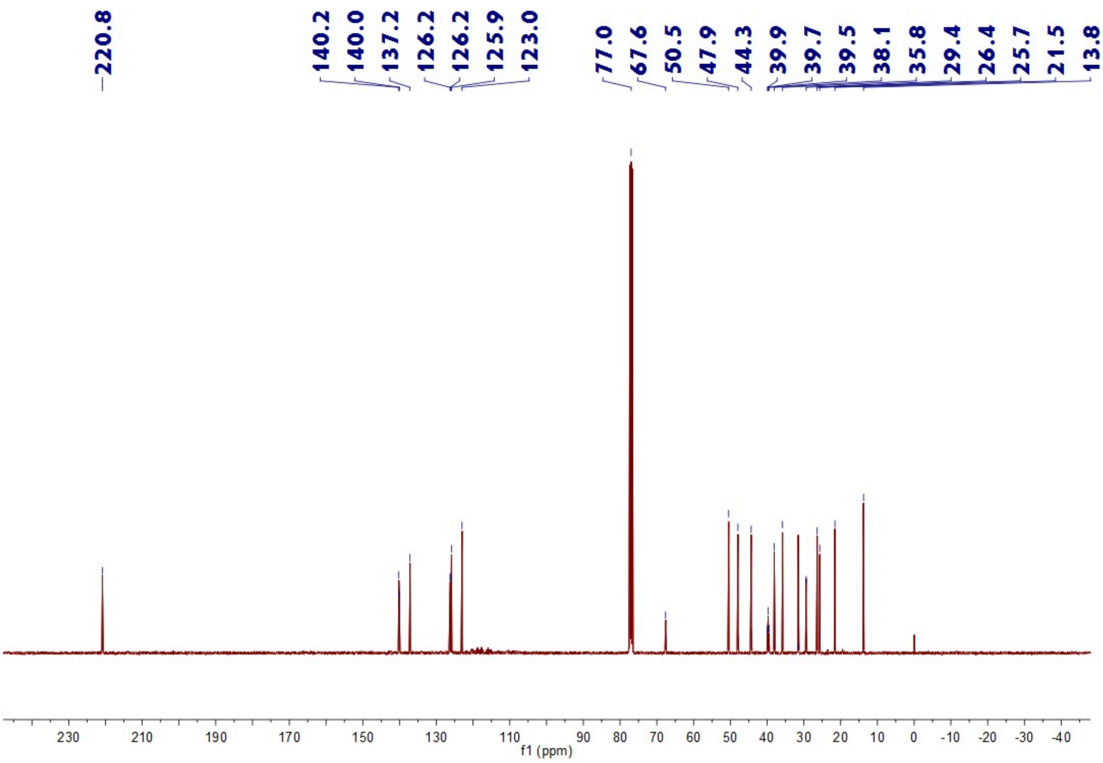

156.0
144.0
143.7
142.7
77.0
66.2
38.4
38.2
38.0
38.384
38.183
37.979
38.5
37.5
f1 (ppm)
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

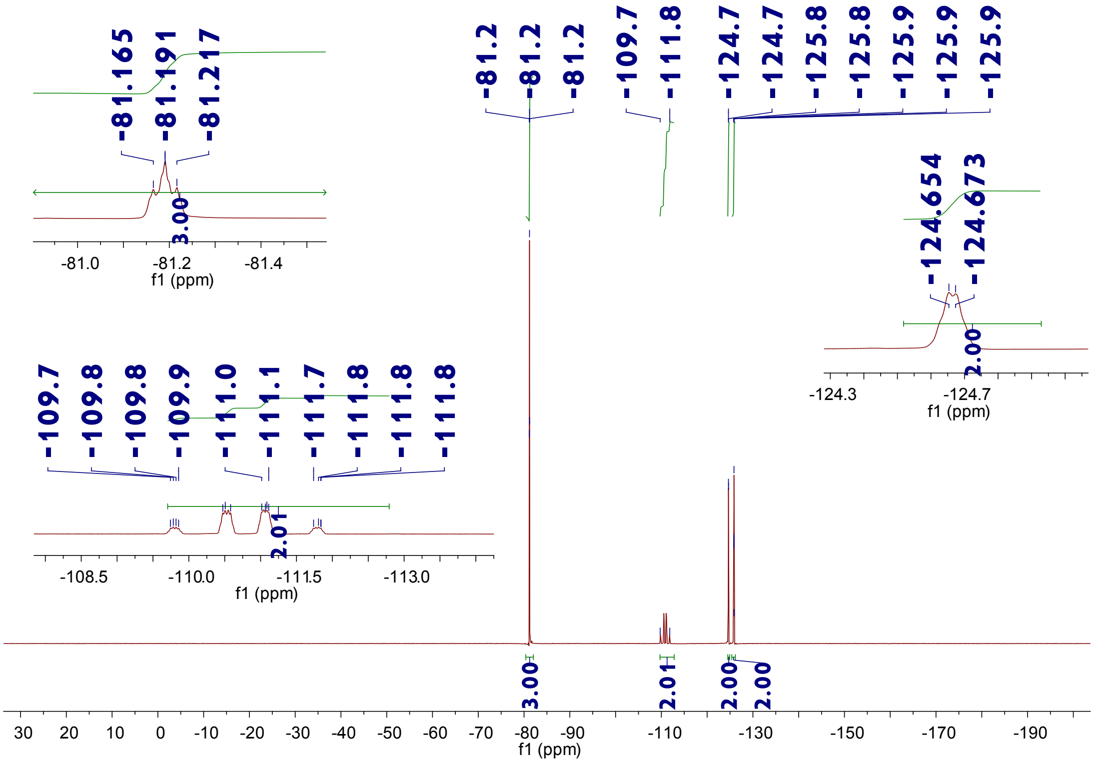


-81.2
-81.2
-81.3
-81.3
-112.7
-114.2
-124.7
-126.1
-126.1
-111.915
-112.658
-113.439
-114.192
2.00
-111
-114
f1 (ppm)
-126.070
-126.100
2.00
-125.8
-126.2
f1 (ppm)
3.13
2.00
2.10
2.00
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

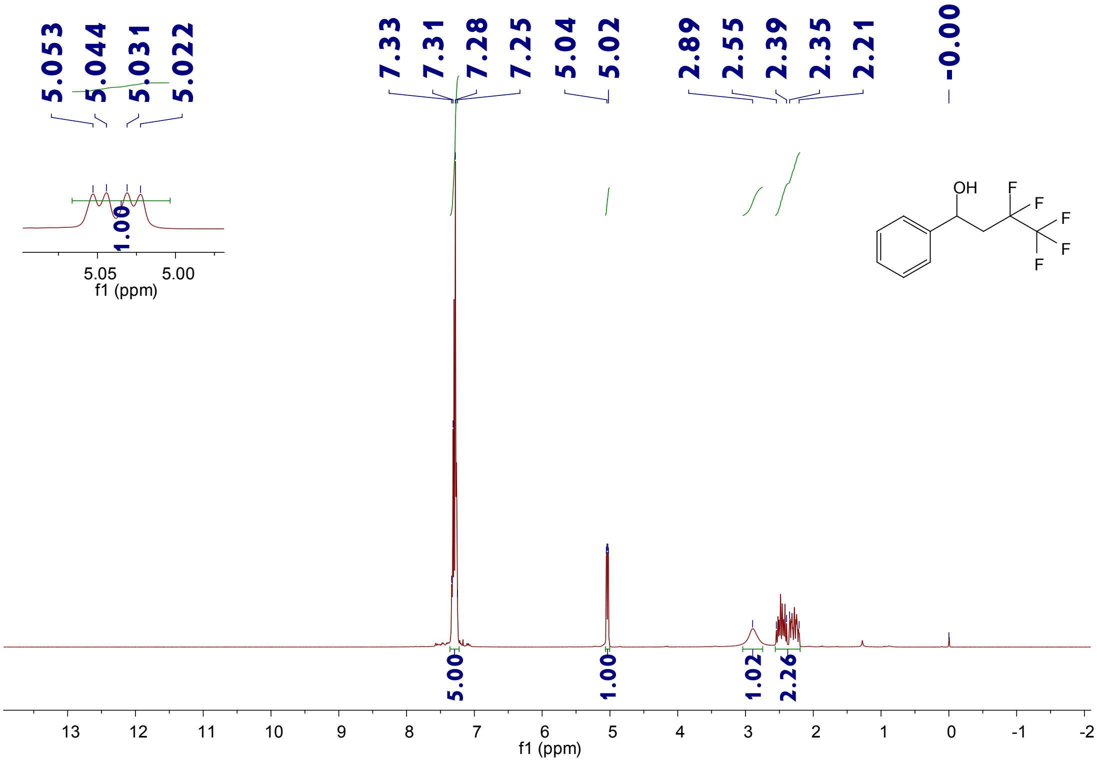
3z

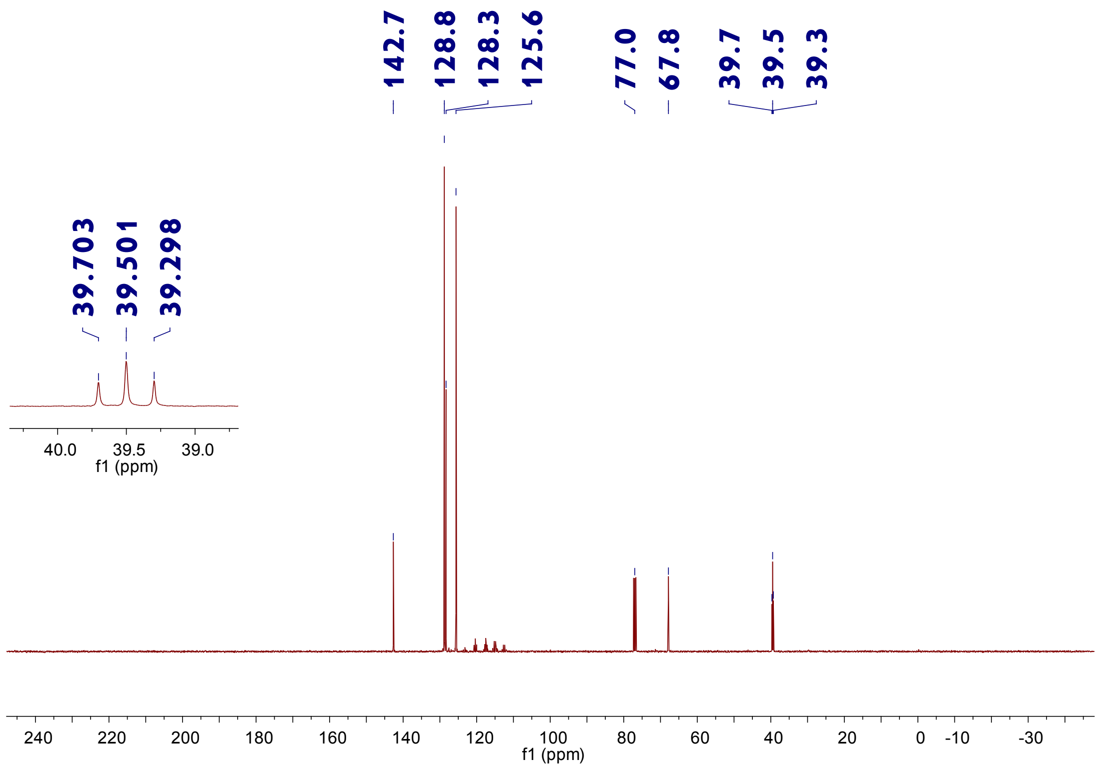


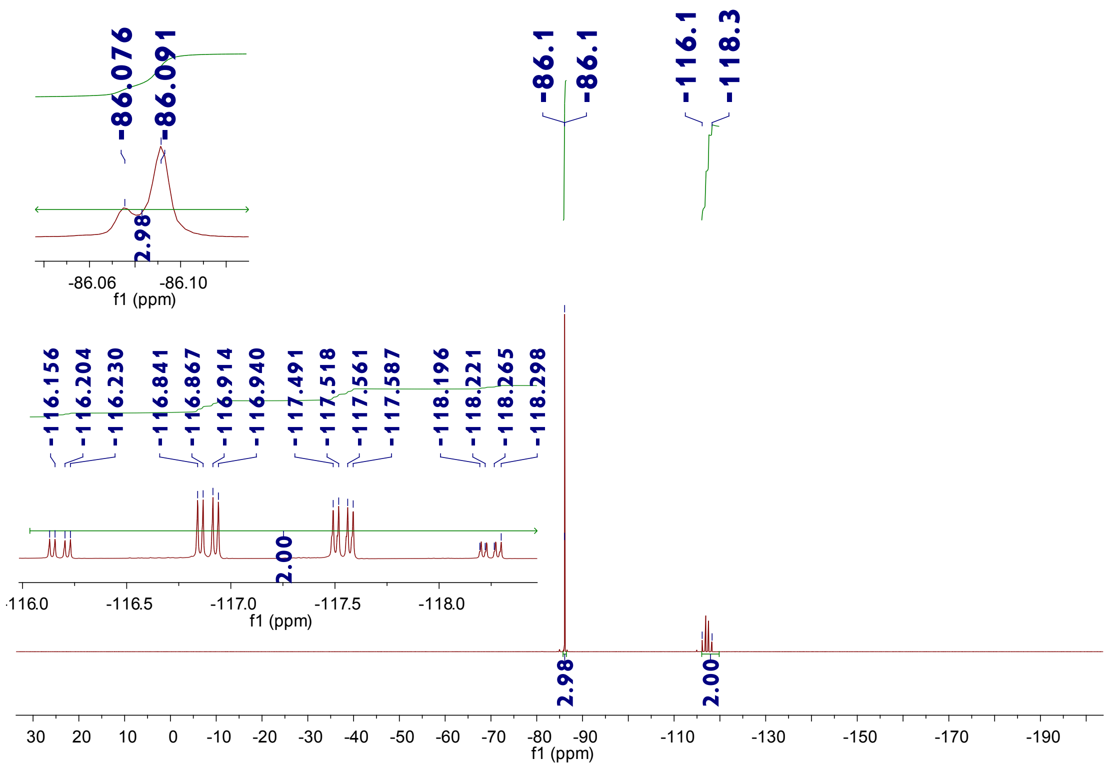



-81.165
-81.191
-81.217
3.00
-81.0
-81.2
-81.4
f1 (ppm)
-81.2
-81.2
-81.2
-109.7
-111.8
-124.7
-124.7
-125.8
-125.8
-125.9
-125.9
-125.9
-124.654
-124.673
2.00
-124.3
-124.7
f1 (ppm)
-109.7
-109.8
-109.8
-109.9
-111.0
-111.1
-111.7
-111.8
-111.8
-111.8
2.01
-108.5
-110.0
-111.5
-113.0
f1 (ppm)
3.00
2.01
2.00
2.00
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

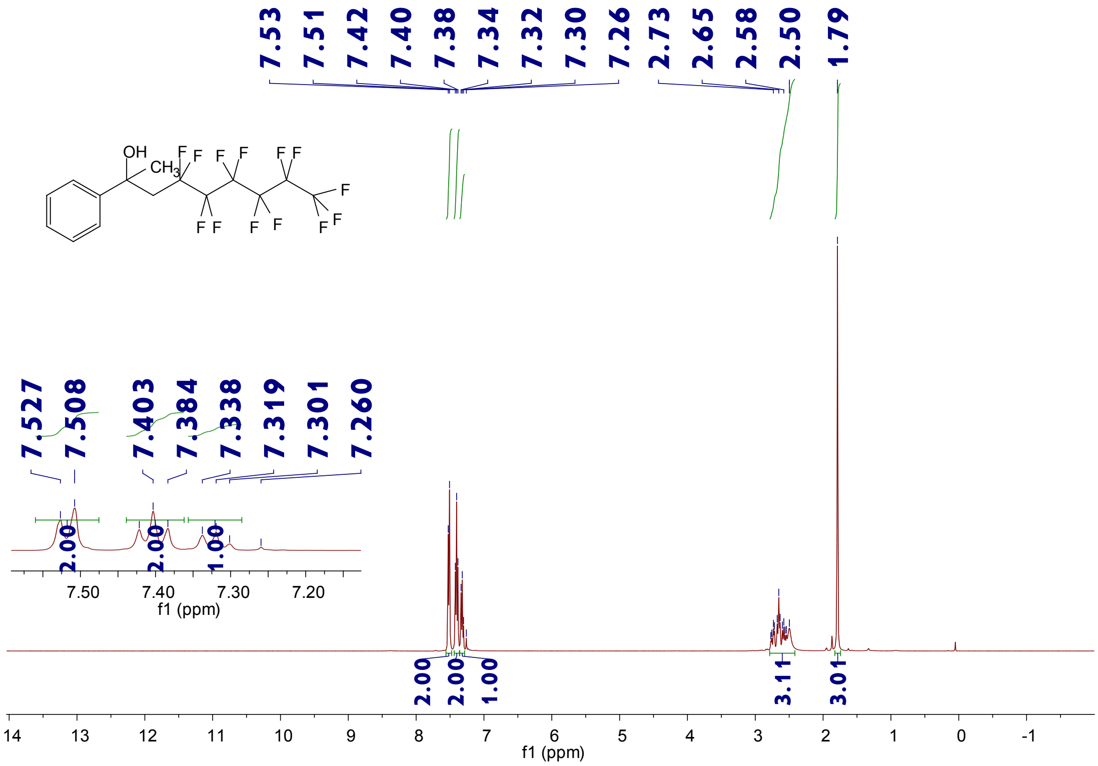
3aa


5.053
5.044
5.031
5.022
1.00
5.05
5.00
f1 (ppm)
7.33
7.31
7.28
7.25
5.04
5.02
2.89
2.55
2.39
2.35
2.21
-0.00
OH
F
F
F
F
F
5.00
1.00
1.02
2.26
13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

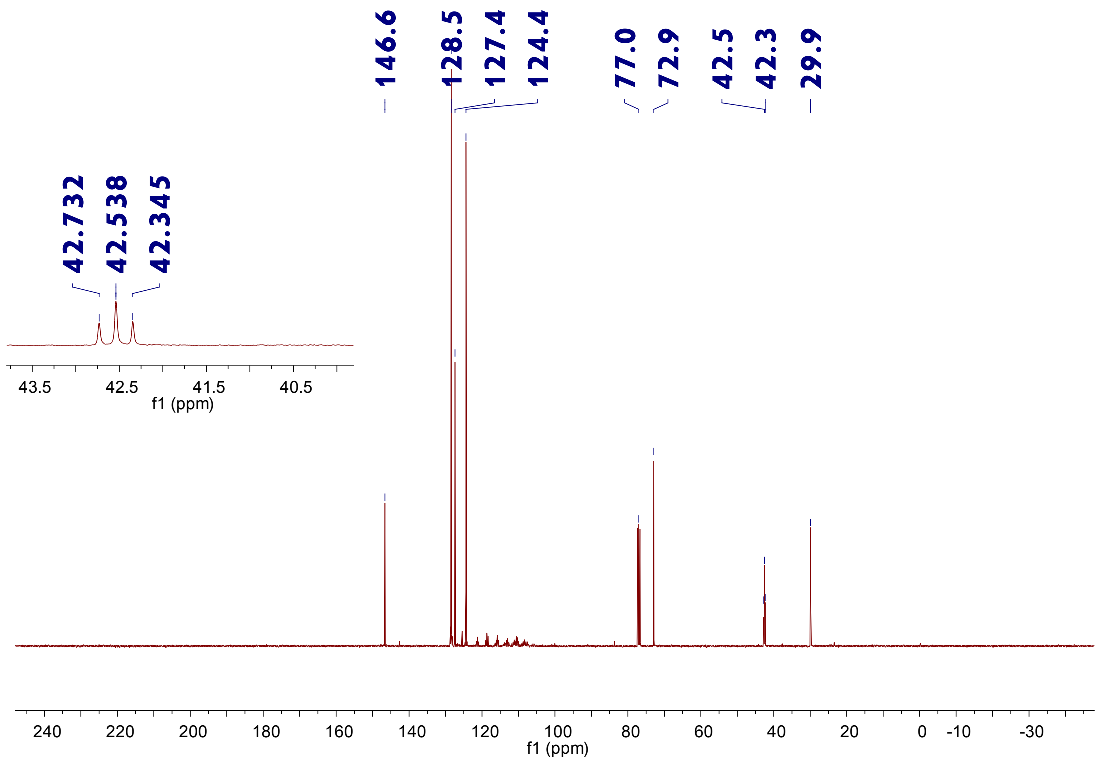

142.7
128.8
128.3
125.6
77.0
67.8
39.7
39.5
39.3
39.703
39.501
39.298
40.0
39.5
39.0
f1 (ppm)
240
220
200
180
160
140
120
100
80
60
40
20
0
-10
-30
f1 (ppm)


-86.1
-86.1
-116.1
-118.3
-86.076
-86.091
2.98
-86.06
-86.10
f1 (ppm)
-116.156
-116.204
-116.230
-116.841
-116.867
-116.914
-116.940
-117.491
-117.518
-117.561
-117.587
-118.196
-118.221
-118.265
-118.298
2.00
-116.0
-116.5
-117.0
-117.5
-118.0
f1 (ppm)
2.98
2.00
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

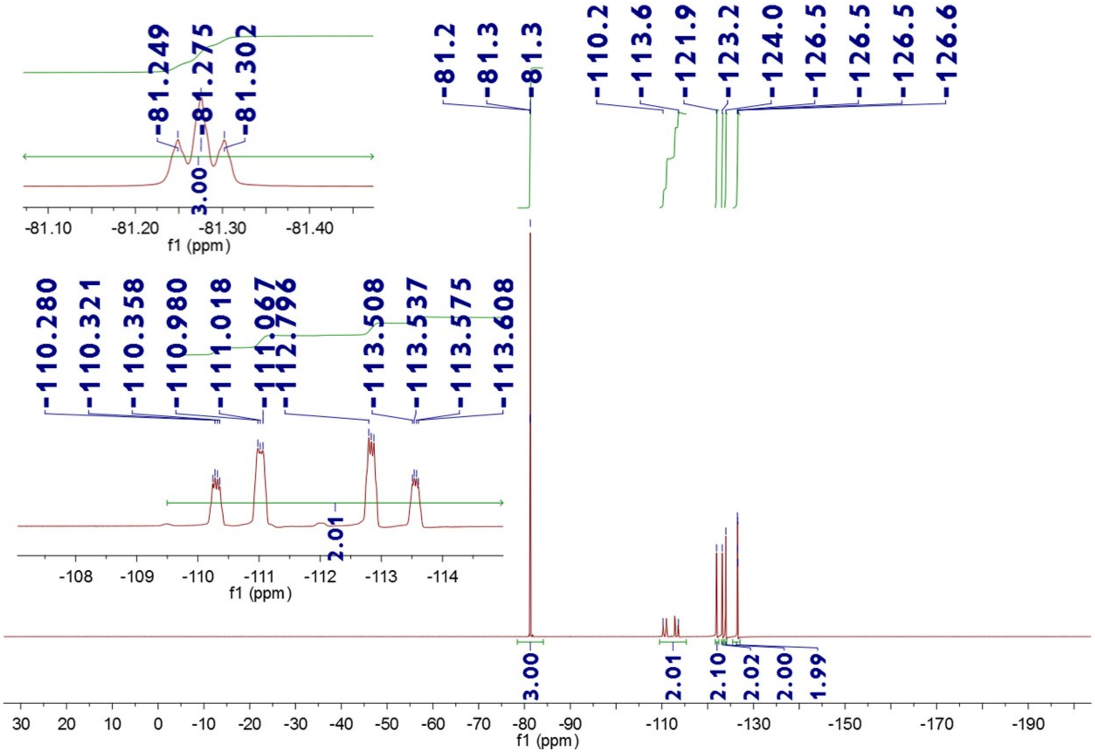
3ab



7.53 7.51 7.42 7.40 7.38 7.34 7.32 7.30 7.26 2.73 2.65 2.58 2.50 1.79
OH CH3 F F F F F F F F F F F F F
7.527 7.508 7.403 7.384 7.338 7.319 7.301 7.260
2.00 2.00 1.00
7.50 7.40 7.30 7.20
f1 (ppm)
2.00 2.00 1.00 3.11 3.01
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1
f1 (ppm)



146.6 128.5 127.4 124.4 77.0 72.9 42.5 42.3 29.9
42.732 42.538 42.345
43.5 42.5 41.5 40.5
f1 (ppm)
240 220 200 180 160 140 120 100 80 60 40 20 0 -10 -30
f1 (ppm)



-81.249
-81.275
-81.302
3.00
-81.10 -81.20 -81.30 -81.40
f1 (ppm)
-110.280
-110.321
-110.358
-110.980
-111.018
-111.067
-112.796
-113.508
-113.537
-113.575
-113.608
2.01
-108 -109 -110 -111 -112 -113 -114
f1 (ppm)
-81.2
-81.3
-81.3
-110.2
-113.6
-121.9
-123.2
-124.0
-126.5
-126.5
-126.5
-126.6
3.00
2.01
2.10
2.02
2.00
1.99
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)