Supporting Information

Catalyst-free radical fluorination of sulfonyl hydrazides in water

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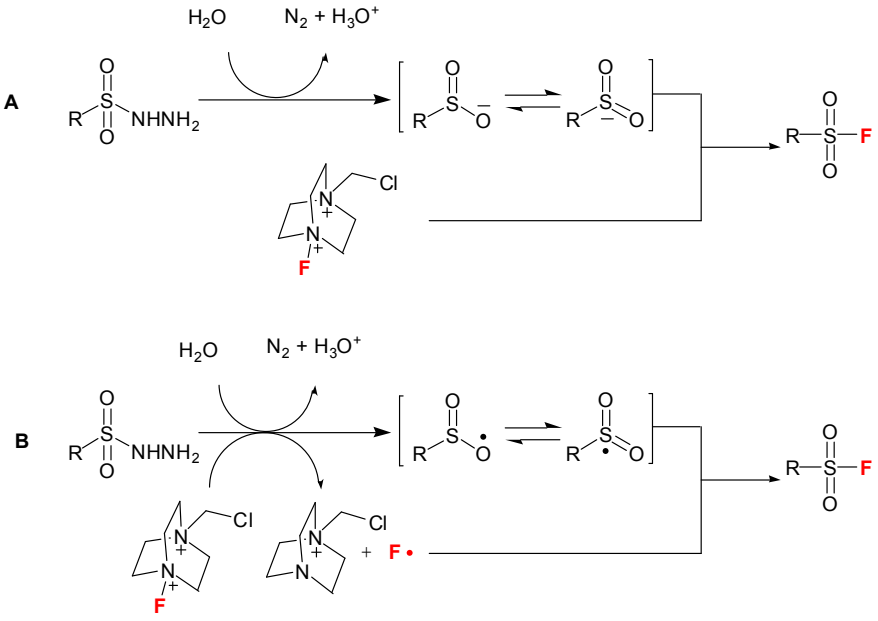
Contents:

General experimental procedures

Solvent of water (1.0 ml) was added to the mixture of 4-methylbenzenesulfonohydrazide (46.5mg, 0.25 mmol), Selectfluor (115.1 mg, 0.325 mmol) in a Schlenk tube. The reaction mixture was stirred at 60 °C for 14 h. After cooling to room temperature, 5 times the volume of EtOAc was added to the reaction mixture under vigorous stirring conditions. Then, the solvent of the organic phase was removed under vacuum and the residue was purified by flash column chromatography (petroleum ether/ethyl acetate = 8:1) to give the product as a white solid in 94% yield. Proton nuclear magnetic resonance (^{1}H NMR) spectra and carbon nuclear magnetic resonance (^{13}C NMR) spectra were recorded on a Bruker AC-400 FT (^{1}H NMR 400 MHz, ^{13}C NMR 100 MHz) using TMS as an internal reference. ^{19}F fluorine spectra were recorded on either a Bruker AC-400 FT (^{19}F NMR 376 MHz) using $CFCl_3$ as an external reference.

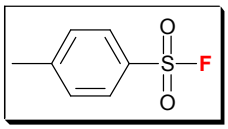
Two possible reaction pathways



Scheme S1 the possible processes for this fluorination.

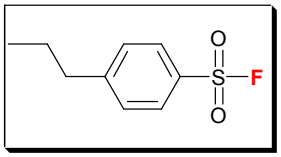
Characterization data of products 2a-2u

4-methyl-benzenesulfonyl fluoride **(2a)**



^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 7.89 (d, 8.0 Hz, 2H), 7.42 (d, 8.0 Hz, 2H), 2.49 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 147.2, 130.4, 130.3, 130.1, 128.6, 22.0; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.2. This compound was known.[1]

4-propyl-benzenesulfonyl fluoride (**2b**)

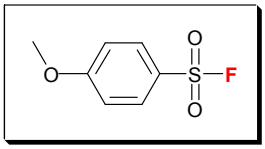


^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 7.91 (d, 8.0 Hz, 2H), 7.42 (d, 8.0 Hz, 2H), 2.71 (t, 7.8 Hz, 2H), 1.73-1.64 (m, 2H), 0.96 (t, 7.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 151.8, 130.5, 130.2, 129.8, 128.6, 38.2, 24.2, 13.8; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.3. This compound was known.[1]

4-*t*ert-butyl-benzenesulfonyl fluoride (**2c**)

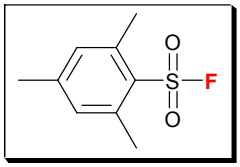
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 7.93 (d, 8.0 Hz, 2H), 7.63 (d, 8.0 Hz, 2H), 1.37 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 160.1, 130.2, 130.0, 128.5, 126.8, 35.7, 31.1; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.2. This compound was known.[1]

2-(4-Methoxyphenyl)-benzoxazole (**2d**)



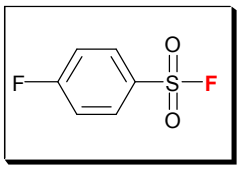
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 7.94 (d, 8.5 Hz, 2H), 7.06 (d, 8.5 Hz, 2H), 3.92 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 165.3, 131.0, 124.3, 124.1, 115.0, 56.0; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 67.3. This compound was known.[1]

2,4,6-trimethyl-benzenesulfonyl fluoride (**2e**)



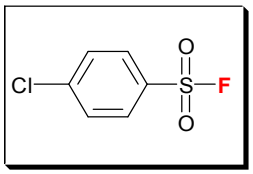
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 7.03 (s, 2H), 2.64 (d, 1.2 Hz, 6H), 2.35 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 145.2, 140.2, 132.0, 132.0, 129.3, 129.1, 22.5, 22.5, 21.3; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 68.2. This compound was known.[1]

4-fluoro-benzenesulfonyl fluoride (**2f**)



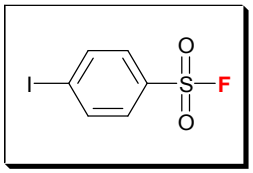
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 8.08-8.04 (m, 2H); 7.32 (t, 8.0 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 168.3, 165.7, 131.8, 131.7, 117.5, 117.3; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.8. This compound was known.[1]

4-chloro-benzenesulfonyl fluoride (**2g**)



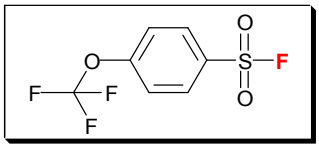
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 7.98-7.94 (m, 2H), 7.63-7.60 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 142.7, 131.5, 131.2, 130.1, 129.9; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.5. This compound was known.[1]

4-iodo-benzenesulfonyl fluoride (**2h**)



^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 8.01 (d, 8.0 Hz, 2H), 7.71 (d, 8.0 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 139.2, 132.9, 129.6, 104.2; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.2. This compound was known.[1]

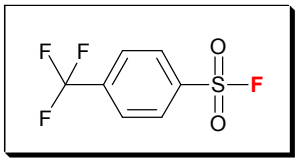
4-trifluoromethoxy-benzenesulfonyl fluoride (**2i**)



^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 8.09 (d, 8.0 Hz, 2H), 7.46 (8.0 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 154.3, 131.1, 130.9, 130.8, 124.0, 121.4, 121.2, 118.8, 116.2; ^{19}F NMR

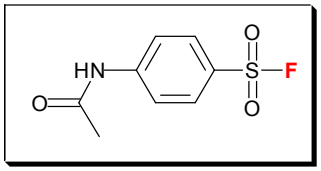
(376 MHz, $CDCl_3$): δ [ppm] = 66.5, -57.7. HRMS (M+) calcd for $C_7H_4F_4O_3S$: 243.9817 found 243.9811.

4-trifluoromethyl-benzenesulfonyl fluoride (**2j**)



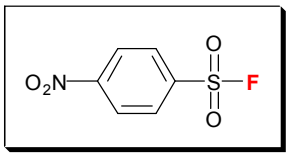
^1H NMR (400 MHz, $CDCl_3$): δ [ppm] = 8.17 (d, 8.0 Hz, 2H), 7.92 (d, 8.0 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 137.5, 137.2, 136.8, 129.3, 127.1, 127.1, 127.0, 127.0, 124.2, 121.5; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 65.9, -63.5. This compound was known.[2]

4-acetylamino-benzenesulfonyl fluoride (**2k**)



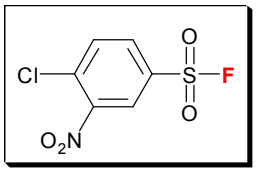
^1H NMR (400 MHz, $CDCl_3$): δ [ppm] = 7.96 (d, 8.8 Hz, 2H), 7.79 (d, 8.8 Hz, 2H), 7.57 (s, 1H), 2.25 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 168.8, 144.5, 130.2, 127.2, 119.5, 25.0; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.8. This compound was known.[1]

4-nitro-benzenesulfonyl fluoride (**2l**)



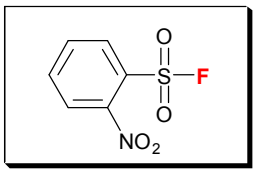
^1H NMR (400 MHz, $CDCl_3$): δ [ppm] = 8.49 (d, 8.4 Hz, 2H), 8.25 (d, 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 142.8, 131.7, 131.4, 130.3, 130.0; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.3. This compound was known.[1]

4-chloro-3-nitro-benzenesulfonyl fluoride (**2m**)



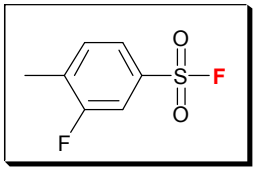
^1H NMR (400 MHz, $CDCl_3$): δ [ppm] = 8.52 (d, 2.0 Hz, 1H), 8.16-8.14 (m, 1H), 7.89 (d, 8.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 148.3, 135.5, 134.0, 133.0, 132.7, 132.3, 126.1; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 67.0. HRMS (M+) calcd for $C_6H_3ClFNO_4S$: 238.9455 found 238.9459.

2-nitro-benzenesulfonyl fluoride (**2n**)



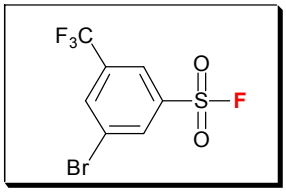
^{1}H NMR (400 MHz,$CDCl_3$): δ [ppm] = 8.88 (s, 1H), 8.65 (d, 8.0 Hz, 1H), 8.36 (d, 8.0 Hz, 1H), 7.94-7.90 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 148.6, 135.2, 134.9, 133.9, 131.5, 130.1, 124.0; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.5. This compound was known.[2]

3-fluoro-4-methyl-benzenesulfonyl fluoride (**2o**)



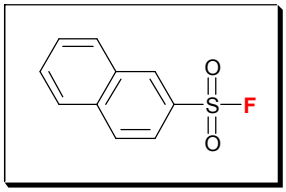
^{1}H NMR (400 MHz,$CDCl_3$): δ [ppm] = 7.72-7.70 (m, 1H), 7.65 (d, 8.0 Hz, 1H), 7.47 (t, 8.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 162.2, 159.7, 134.7, 134.5, 132.9, 132.9, 131.9, 131.9, 131.7, 131.6, 124.3, 124.2, 115.6, 115.4, 15.2, 15.2; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.3, -111.9. HRMS (M+) calcd for $C_7H_6F_2O_2S$: 192.0057 found 192.0065.

3-bromo-5-trifluoromethyl-benzenesulfonyl fluoride (**2p**)



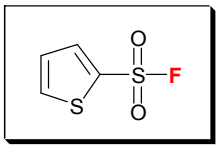
^{1}H NMR (400 MHz,$CDCl_3$): δ [ppm] = 8.34 (s, 1H), 8.20 (s, 1H), 8.16 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 136.0, 135.7, 135.6, 135.6, 135.6, 134.7, 134.4, 134.0, 133.7, 126.1, 124.6, 124.3, 124.3, 124.2, 124.2, 123.3, 120.6, 117.9; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.6, -63.1. This compound was known.[2]

naphthalene-2-sulfonyl fluoride (**2q**)



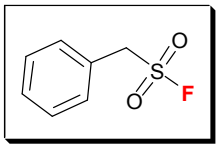
^{1}H NMR (400 MHz,$CDCl_3$): δ [ppm] = 8.62 (s, 1H), 8.08-8.02 (m, 2H), 7.99-7.92 (m, 2H), 7.78-7.68 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 136.2, 132.0, 131.1, 130.5, 130.2, 130.1, 129.8, 129.8, 128.5, 128.3, 122.3; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.3. This compound was known.[3]

thiophene-2-sulfonyl fluoride (**2r**)



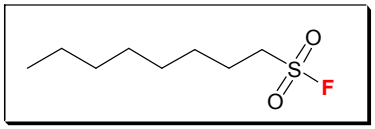
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 7.94 (d, 4.0 Hz, 1H), 7.90 (d, 4.8 Hz, 1H), 7.27 (t, 4.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 137.0, 136.6, 136.6, 131.8, 131.5, 128.3; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 71.8. This compound was known.[1]

phenyl-methanesulfonyl fluoride (**2s**)



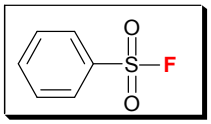
^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 7.47-7.43 (m, 5H), 4.60 (d, 3.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 130.8, 130.1, 129.5, 125.6, 57.1, 56.9; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 51.4. This compound was known.[4]

octanesulfonyl fluoride (**2t**)



^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 3.38-3.33 (m, 2H), 1.98-1.91 (m, 2H), 1.51-1.44 (m, 2H), 1.33-1.28 (m, 8H), 0.89 (t, 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 51.1, 50.9, 31.8, 29.0, 29.0, 28.0, 23.5, 22.7, 14.2; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 53.2. This compound was known.[5]

benzenesulfonyl fluoride (**2u**)



^{1}H NMR (400 MHz, $CDCl_3$): δ [ppm] = 8.20 (d, 6.8 Hz, 2H), 7.96 (t, 6.8 Hz, 1H), 7.82 (t, 6.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ [ppm] = 132.8, 130.3, 130.0, 126.9, 125.6; ^{19}F NMR (376 MHz, $CDCl_3$): δ [ppm] = 66.2. This compound was known.[1]

References:

[1] L. Matesic, N. A. Wyatt, B. H. Fraser, M. P. Roberts, T. Q. Pham, I. Greguric, *J. Org. Chem*., 2013, **78**, 112625.

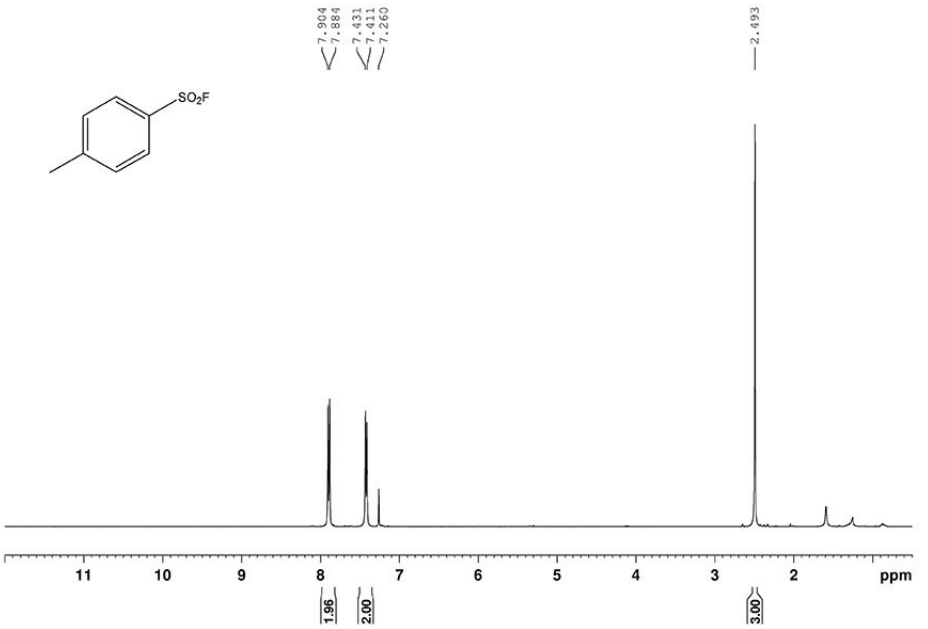
[2] G. Palumbo, R. Caputo, *Synthesis*, 1981, 888.

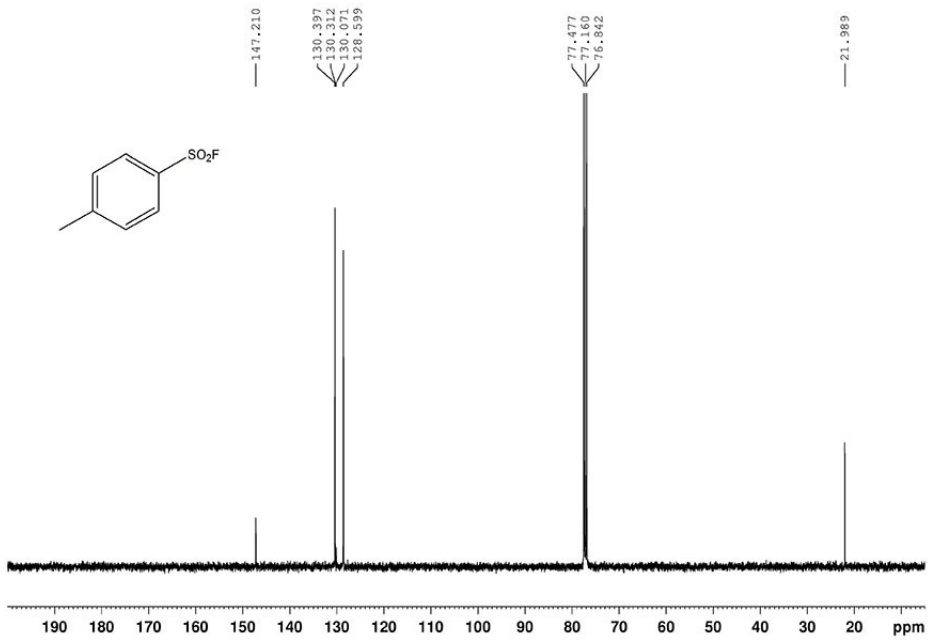
[3] D. N. Harpp, S. J. Bodzay, *Sulfur Lett*., 1987, 73.

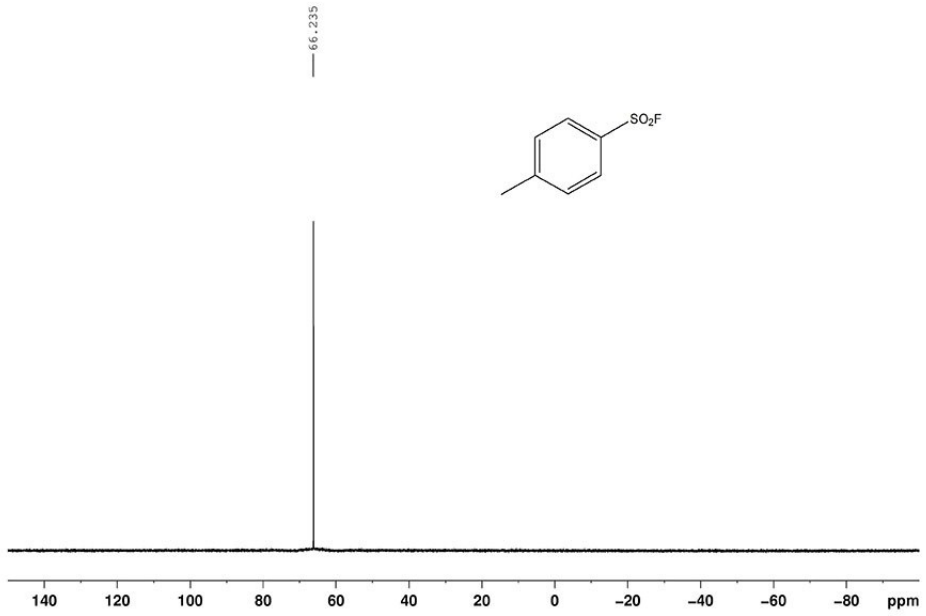
[4] M. Kirihara, S. Naito, Y. Nishimura, Y. Ishizuka, T. Iwai, H. Takeuchi, T. Ogata, H. Hanai, Y. Kinoshita, M. Kishida, K. Yamazaki, T. Noguchi, S. Yamashoji, *Tetrahedron*, 2014, **70**, 2464.

[5] J. Burdon, I. Farazmand,; M. Stacey, J. C. Tatlow, *J. Chem. Soc*.,1957, 2574.

^{1}H, ^{13}C and ^{19}F NMR spectra of products 2a-2u



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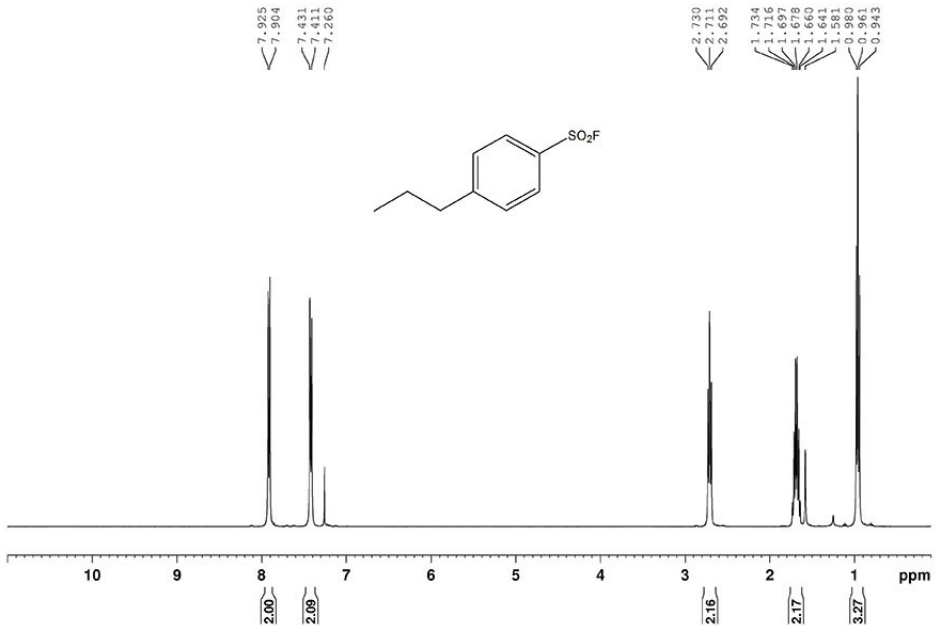
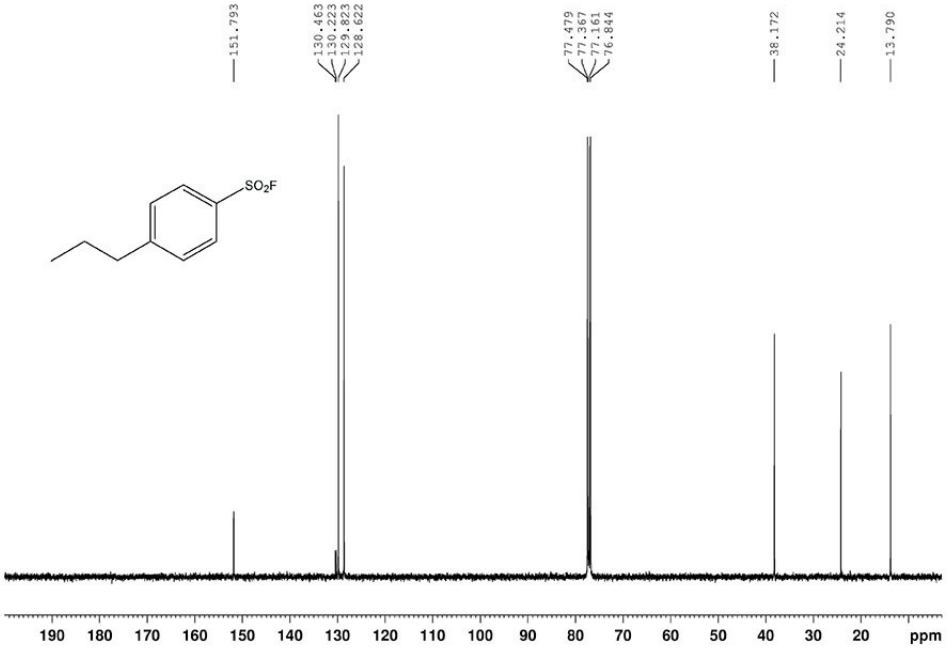
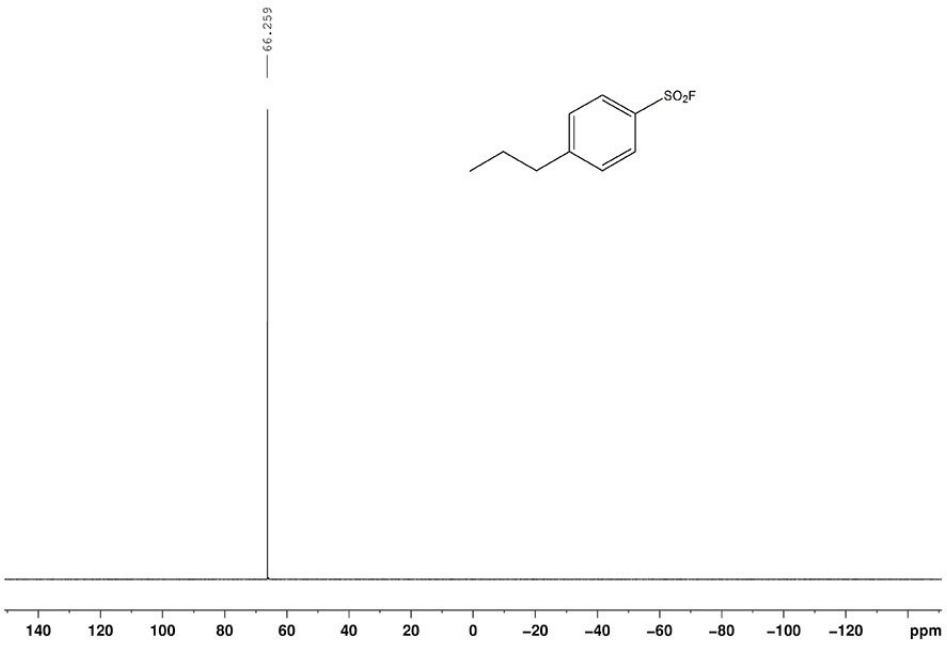
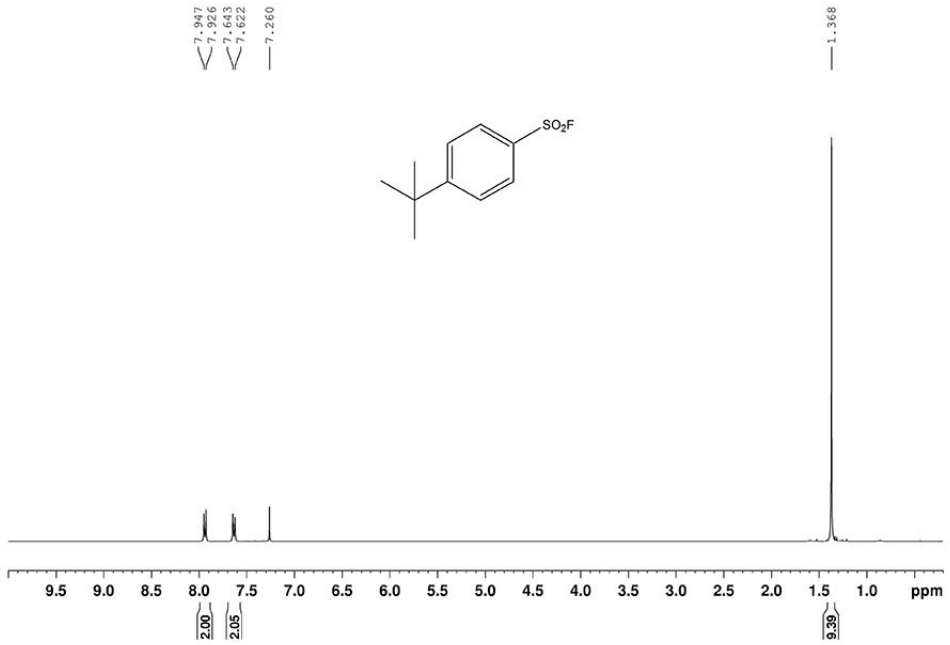
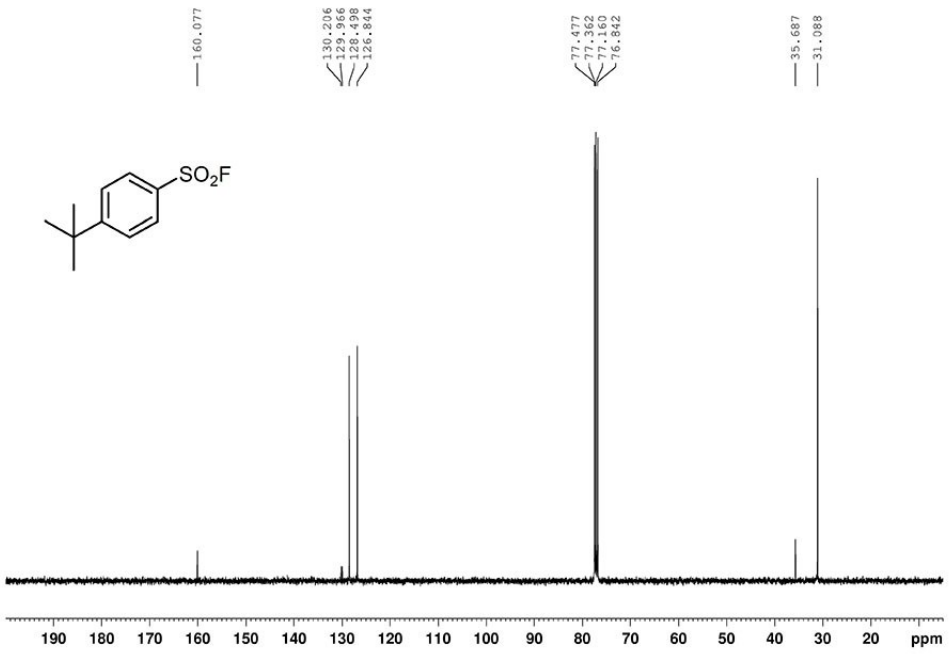
SO2F
140
120
100
80
60
40
20
0
-20
-40
-60
-80
ppm

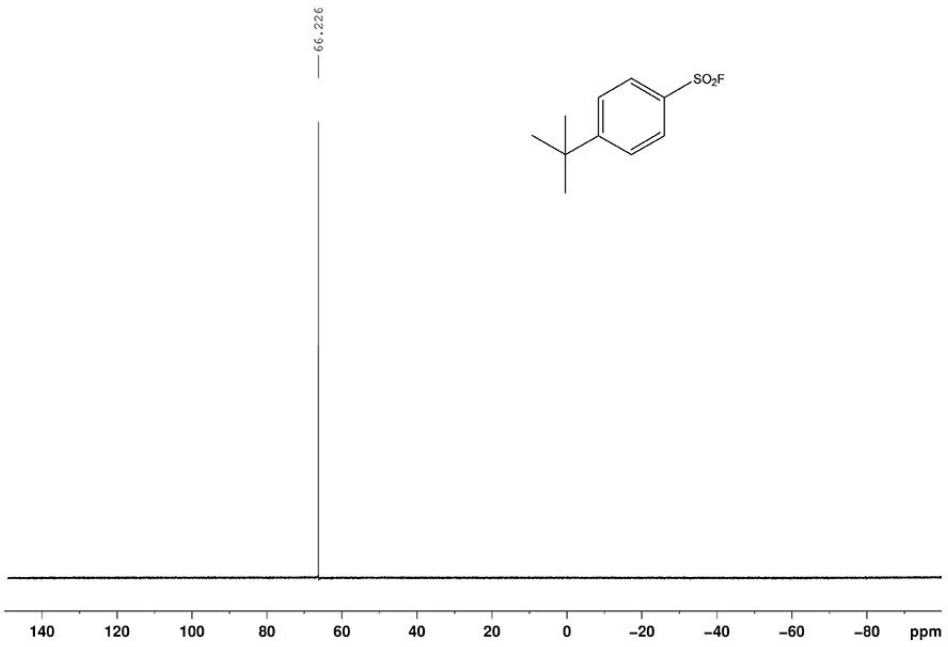

7.925
7.904
7.431
7.411
7.260
2.730
2.711
2.692
1.734
1.716
1.697
1.678
1.660
1.641
1.581
0.980
0.961
0.943
SO2F
10
9
8
7
6
5
4
3
2
1
ppm
2.00
2.09
2.16
2.17
3.27

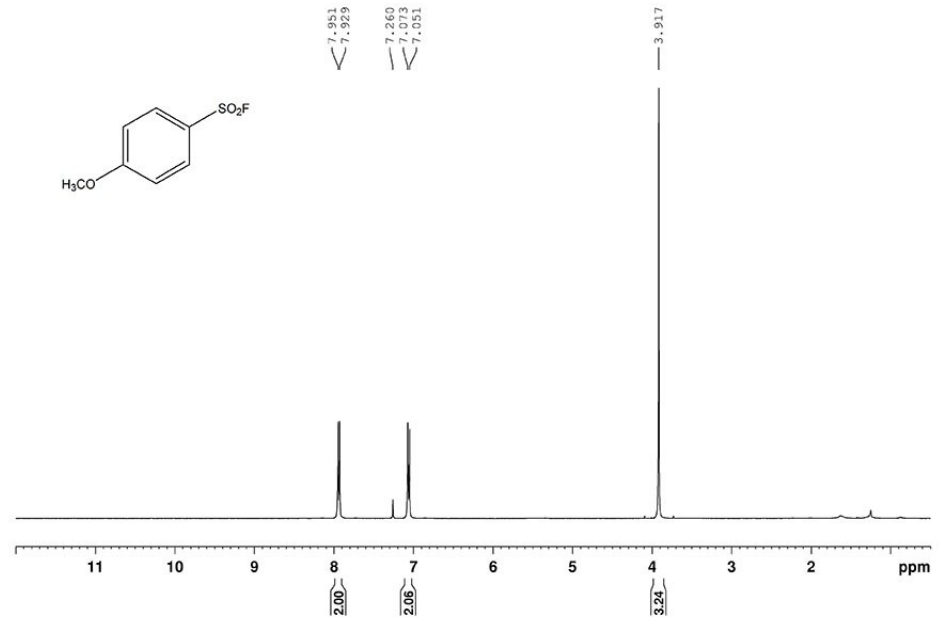

151.793
130.463
130.223
129.823
128.622
77.479
77.367
77.161
76.844
38.172
24.214
13.790
SO2F
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

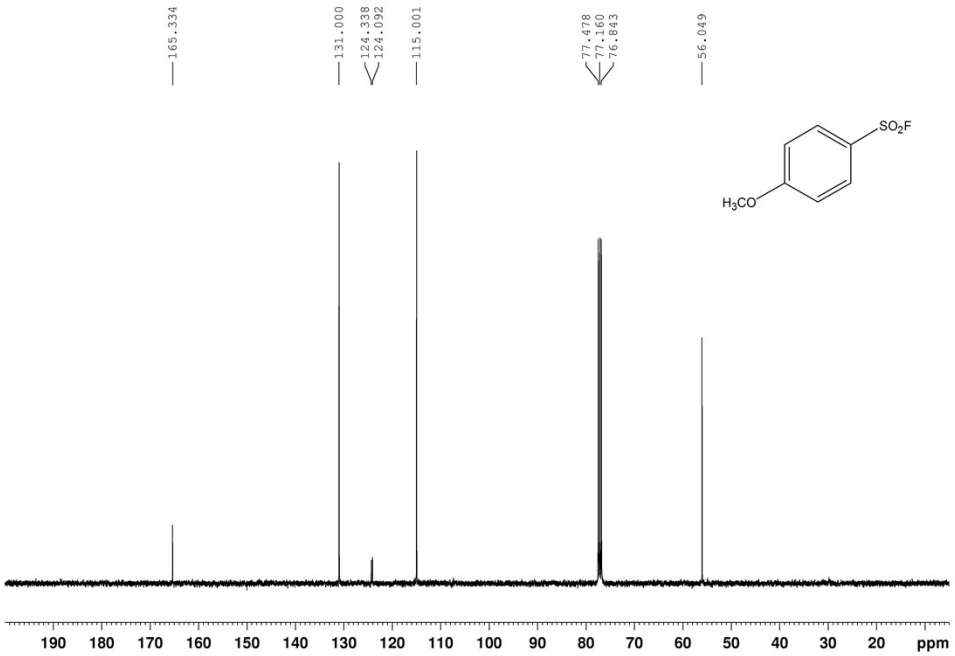

66.259
SO2F
140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 ppm

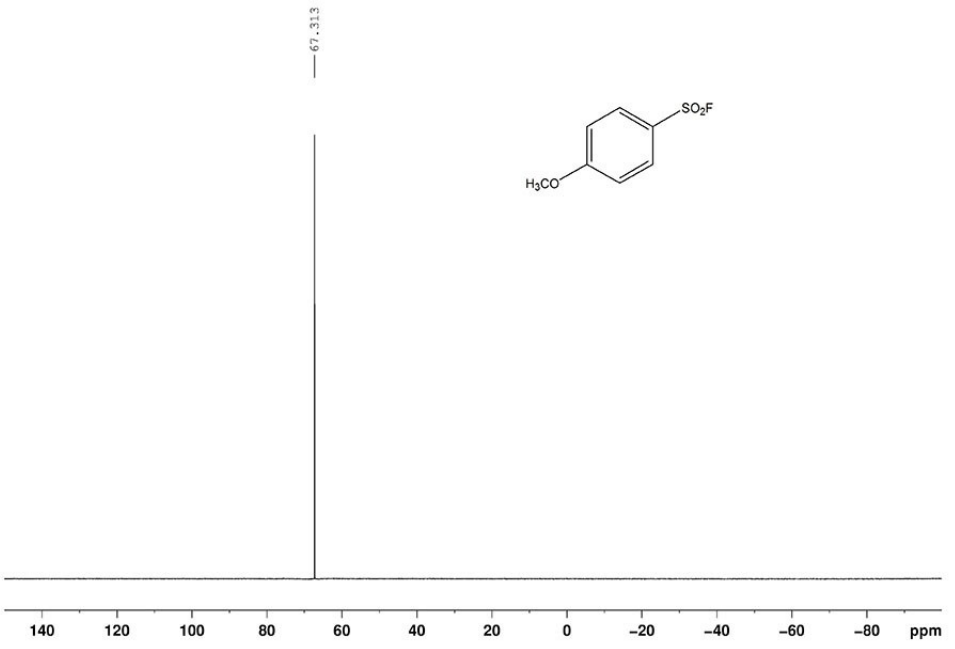

7.947
7.926
7.643
7.622
7.260
1.368
SO2F
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 ppm
2.00
2.05
9.39

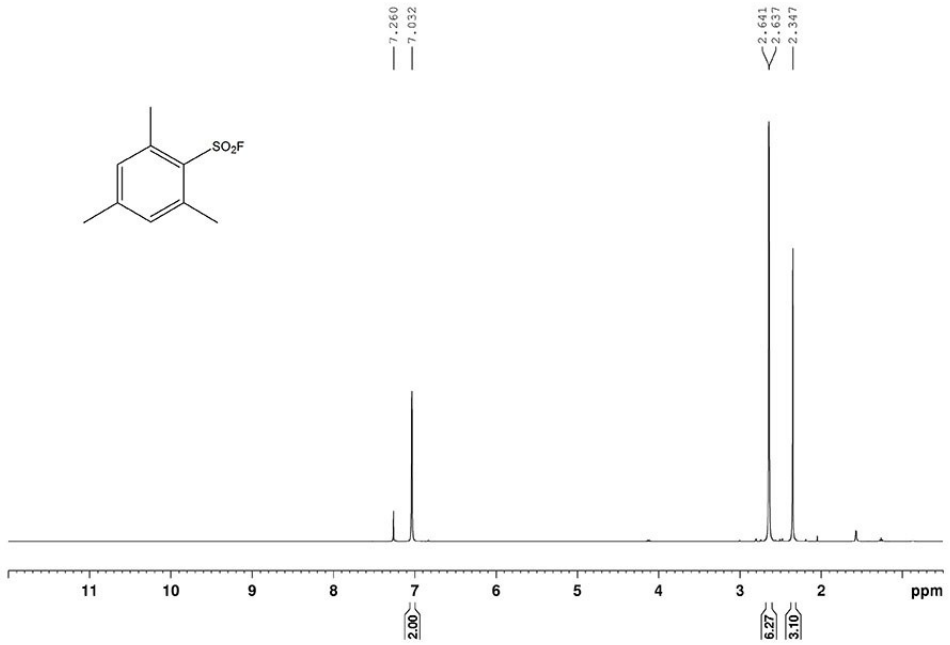

160.077
130.206
129.966
128.498
126.844
77.477
77.362
77.160
76.842
35.687
31.088
SO2F
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

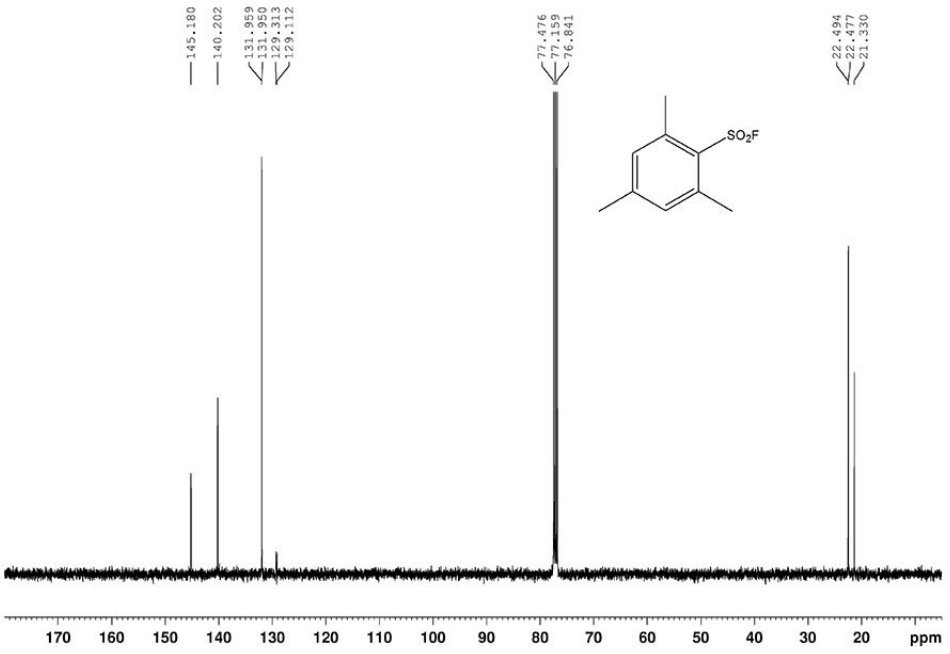

66.226
SO2F
140
120
100
80
60
40
20
0
-20
-40
-60
-80
ppm

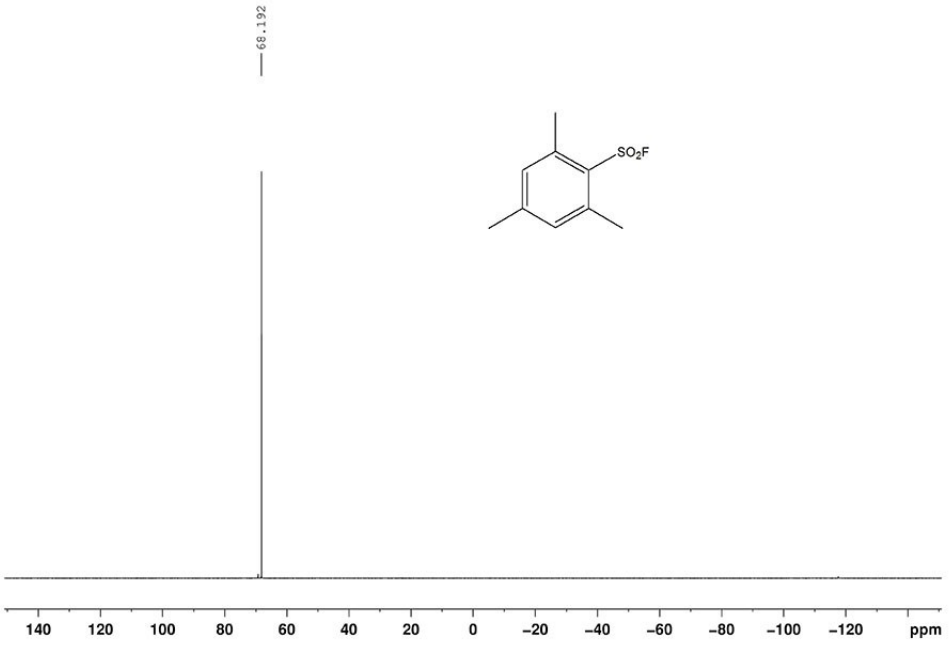

7.951
7.929
7.260
7.073
7.051
3.917
SO2F
H3CO
11
10
9
8
7
6
5
4
3
2
ppm
2.00
2.06
3.24

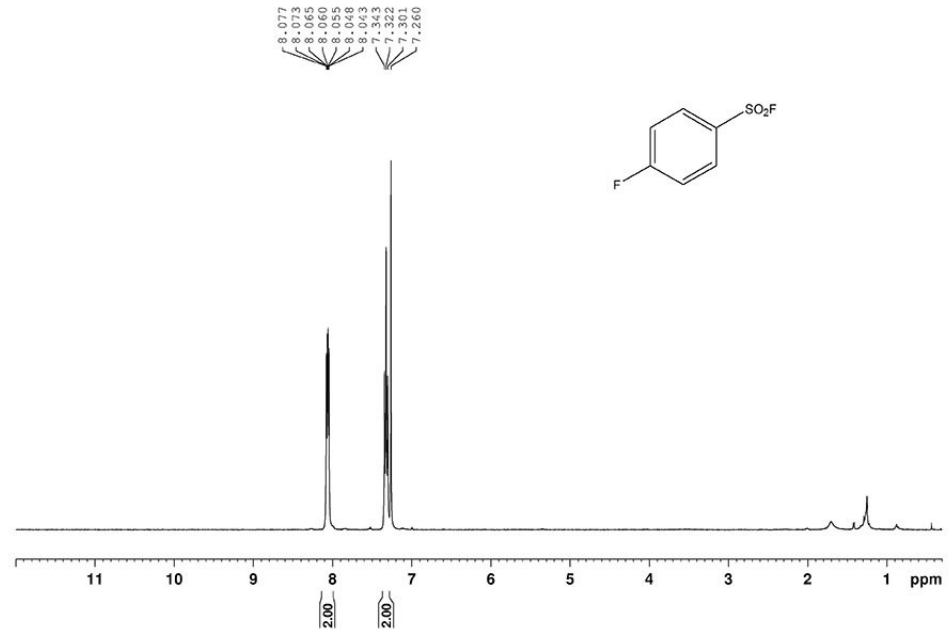

165.334
131.000
124.338
124.092
115.001
77.478
77.160
76.843
56.049
SO2F
H3CO
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

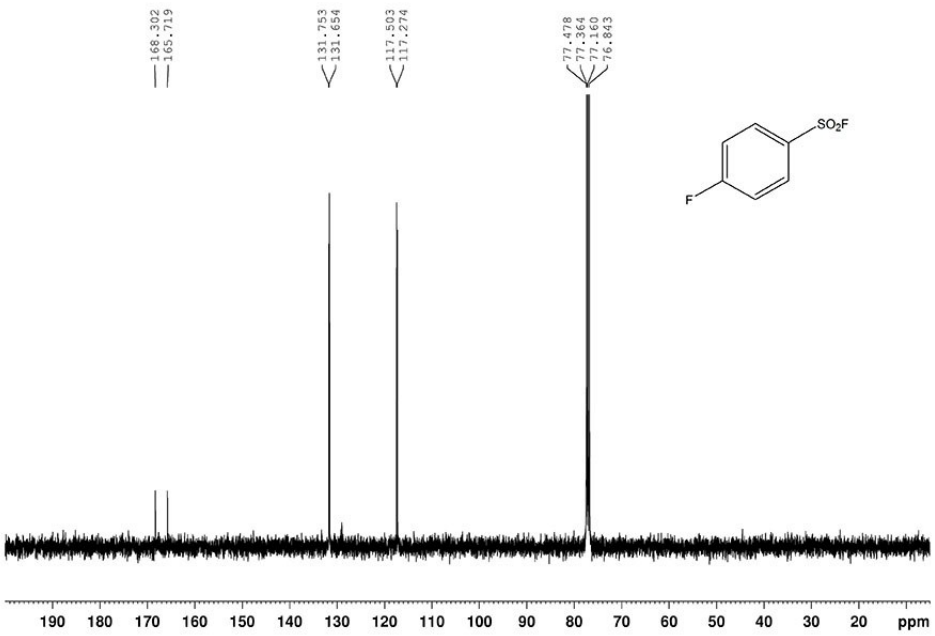

67.313
SO2F
H3CO
140 120 100 80 60 40 20 0 -20 -40 -60 -80 ppm

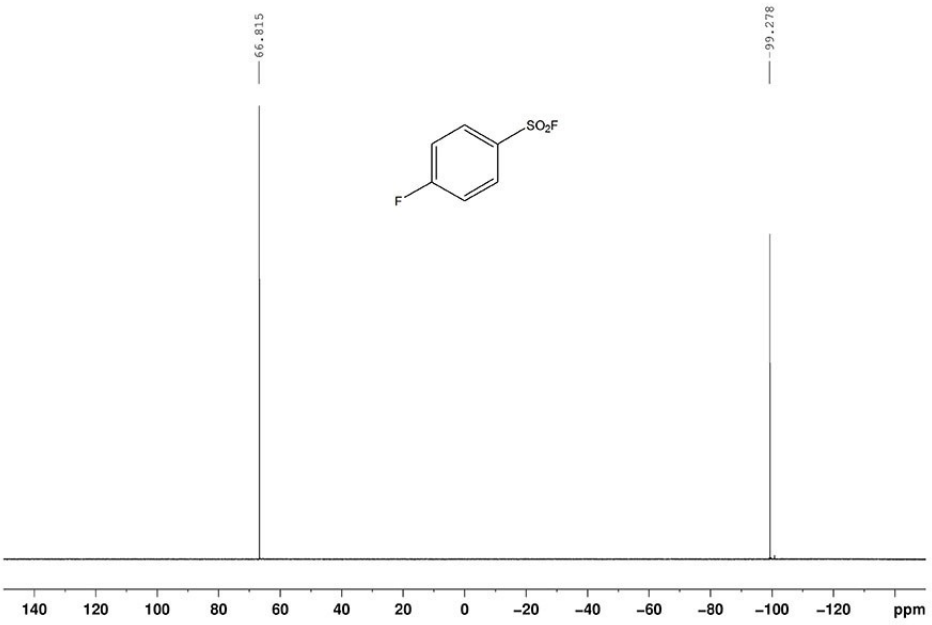

7.260
7.032
2.641
2.637
2.347
SO2F
11
10
9
8
7
6
5
4
3
2
ppm
2.00
6.27
3.10

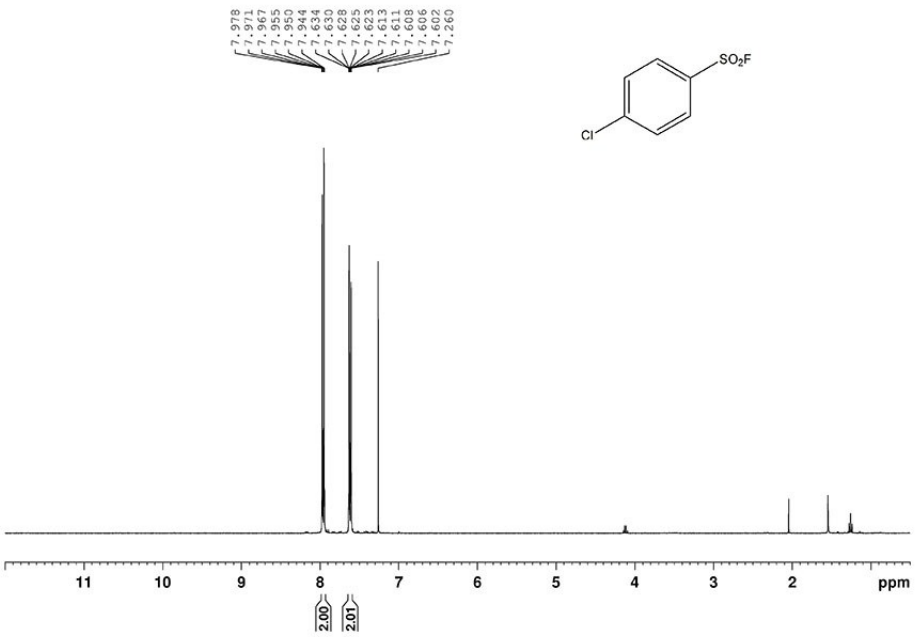

145.180
140.202
131.959
131.950
129.313
129.112
77.476
77.159
76.841
22.494
22.477
21.330
SO2F
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

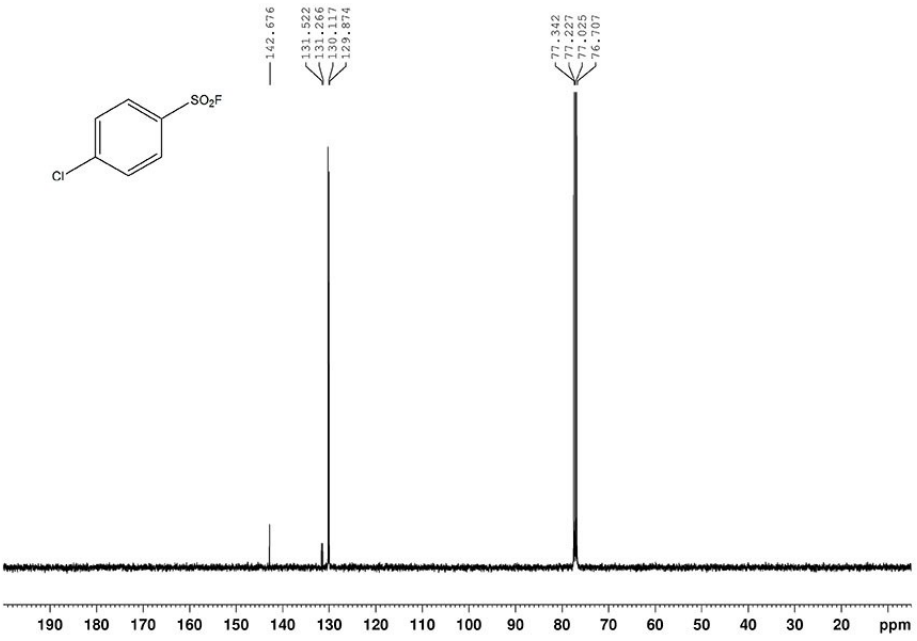

68.192
SO2F
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
ppm

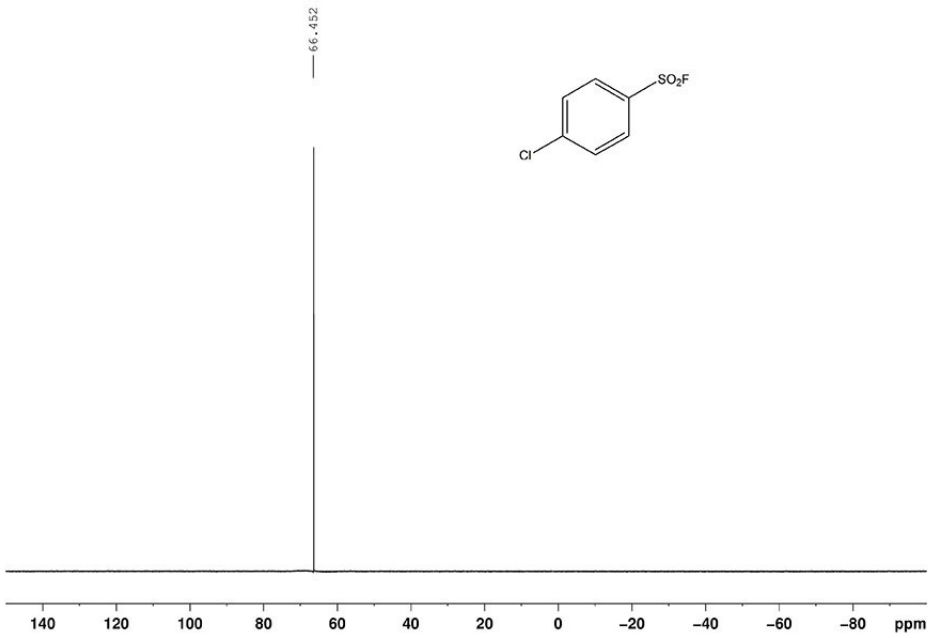

8.077
8.073
8.065
8.060
8.055
8.048
8.043
7.343
7.322
7.301
7.260
SO2F
F
11
10
9
8
7
6
5
4
3
2
1
ppm
2.00
2.00

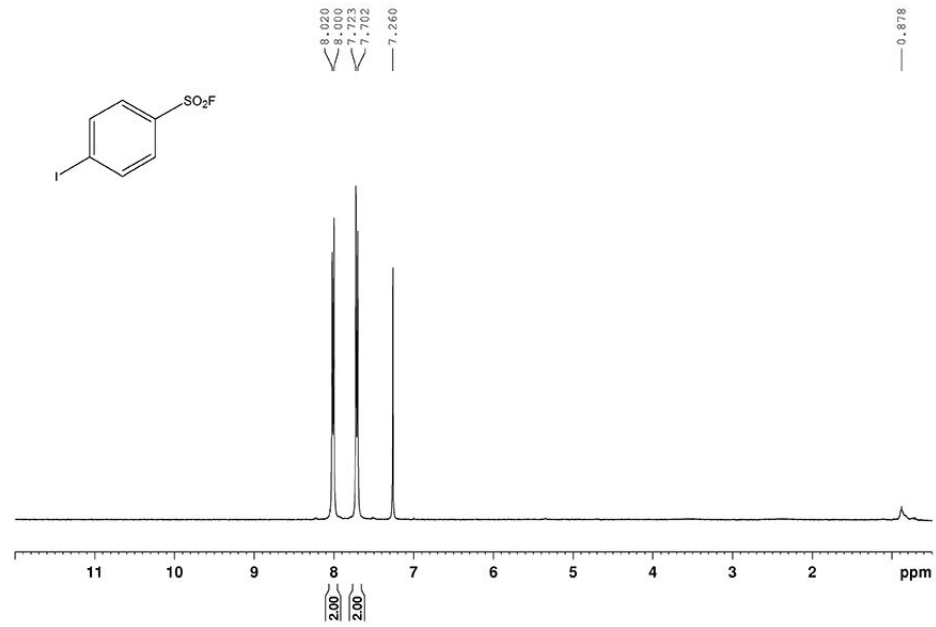

168.302
165.719
131.753
131.654
117.503
117.274
77.478
77.364
77.160
76.843
SO2F
F
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

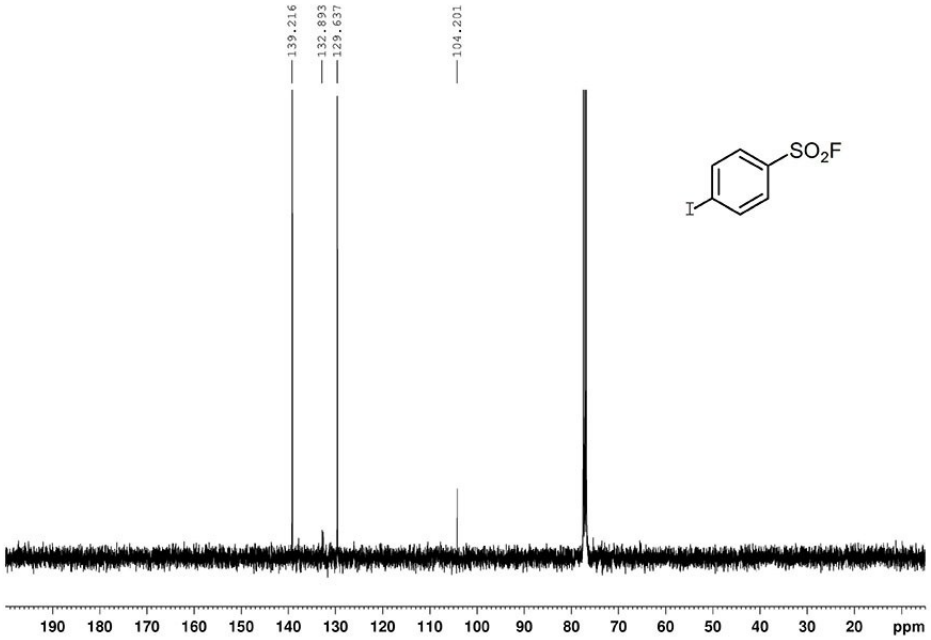

66.815
99.278
SO2F
F
140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 ppm

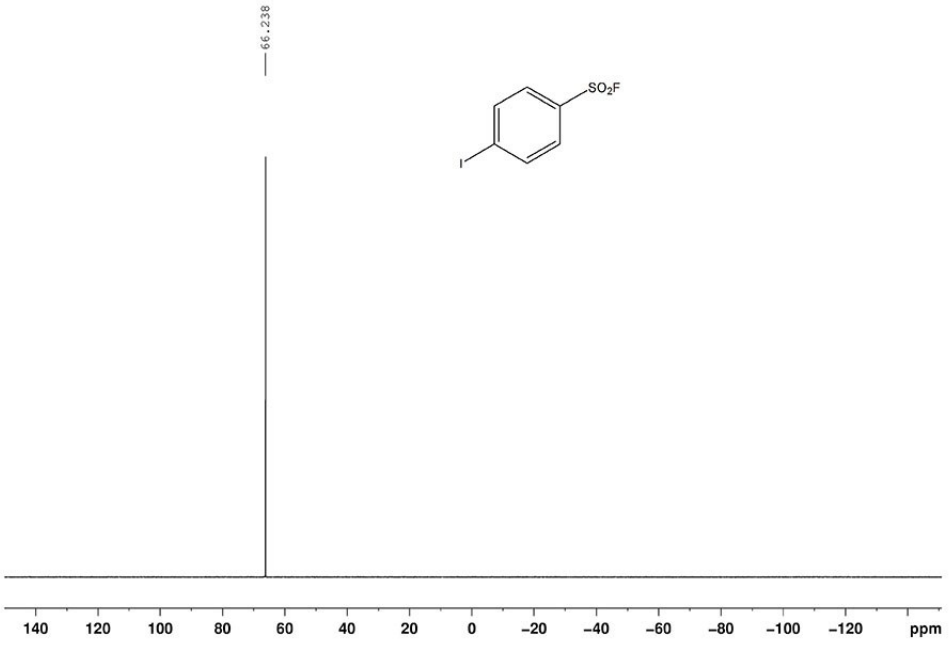

7.978
7.971
7.967
7.955
7.950
7.944
7.634
7.630
7.628
7.625
7.623
7.613
7.611
7.608
7.606
7.602
7.260
SO2F
Cl
11
10
9
8
7
6
5
4
3
2
ppm
2.00
2.01

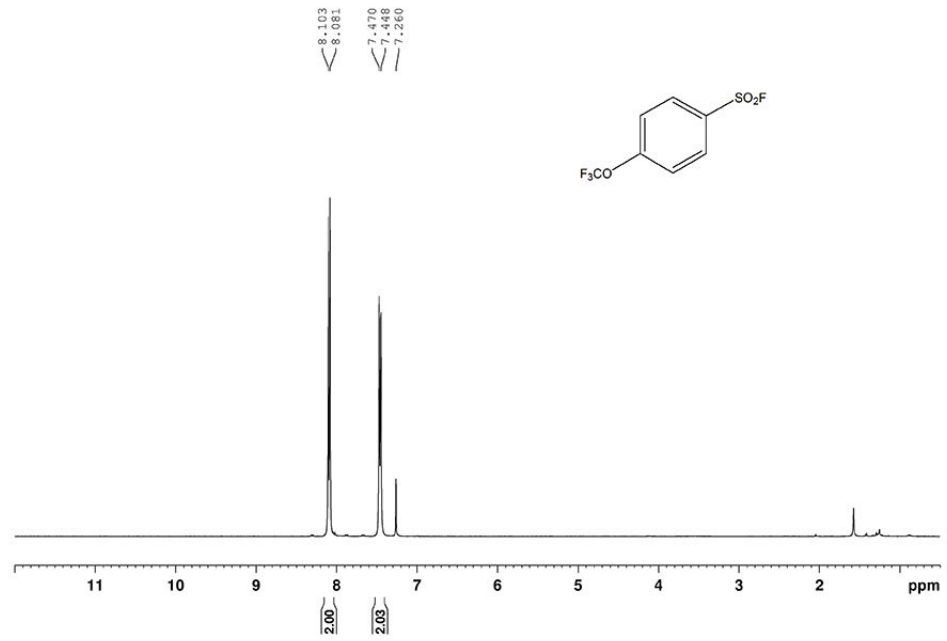

142.676
131.522
131.266
130.117
129.874
77.342
77.227
77.025
76.707
SO2F
Cl
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

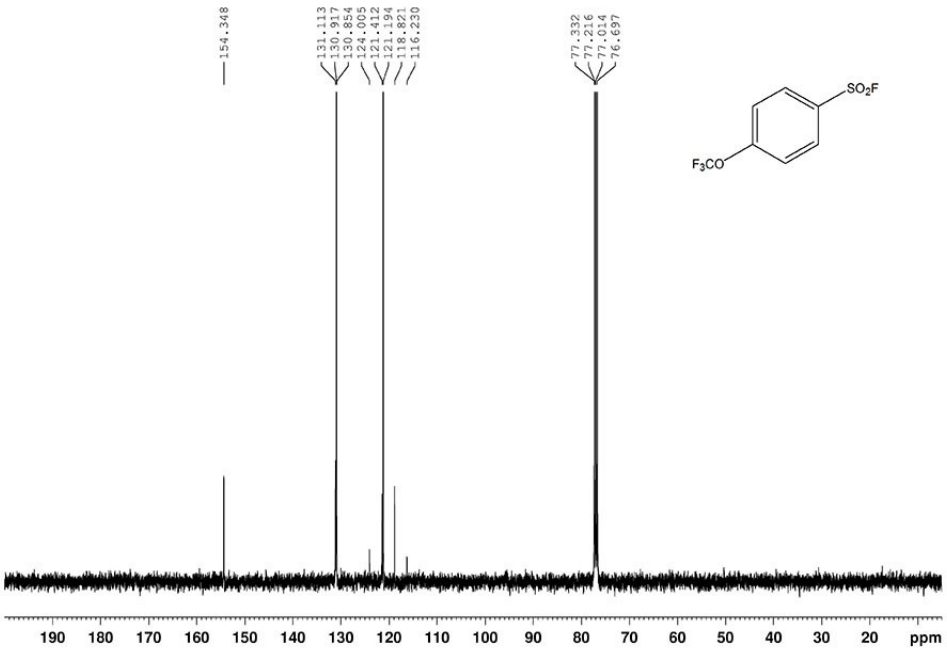

66.452
SO2F
Cl
140
120
100
80
60
40
20
0
−20
−40
−60
−80
ppm

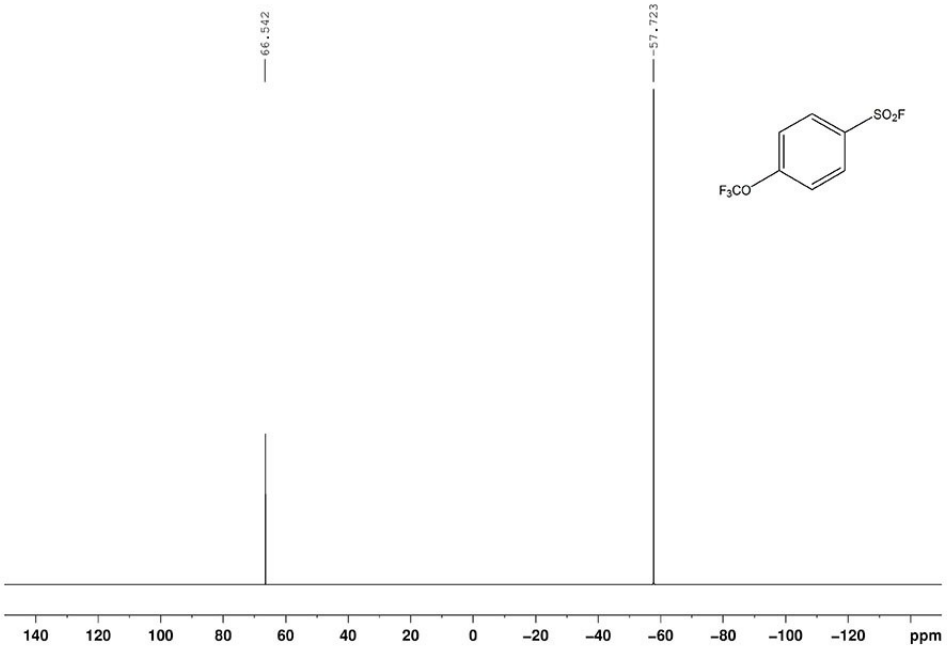

8.020
8.000
7.723
7.702
7.260
0.878
SO2F
I
11
10
9
8
7
6
5
4
3
2
ppm
2.00
2.00

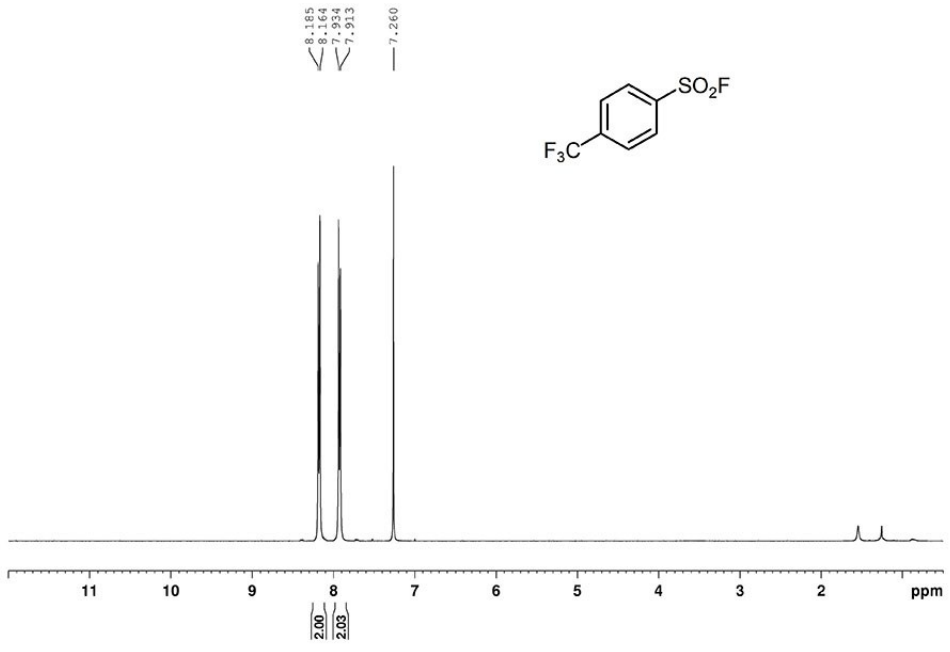

139.216
132.893
129.637
104.201
SO2F
I
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

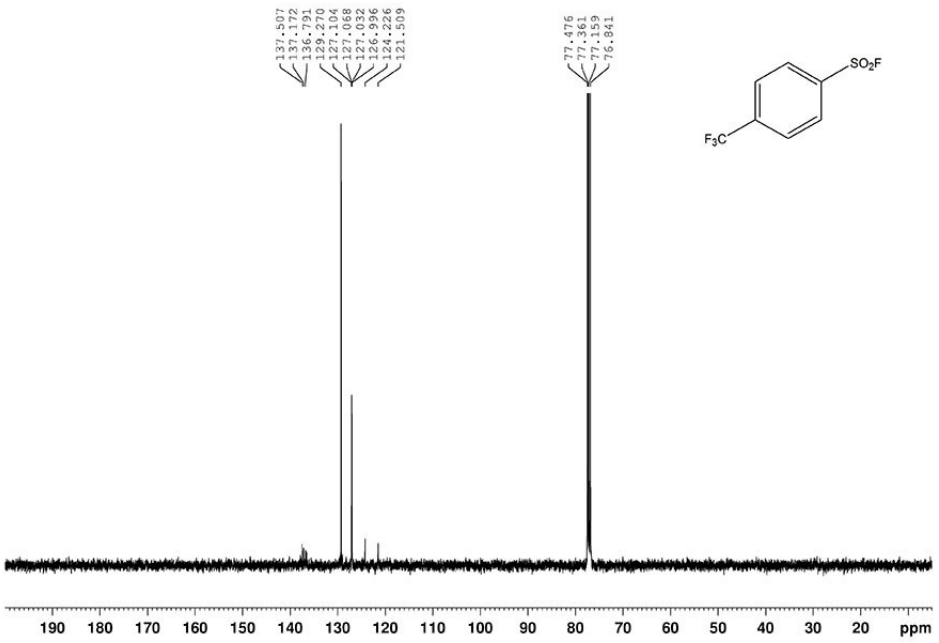

66.238
SO2F
I
140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 ppm

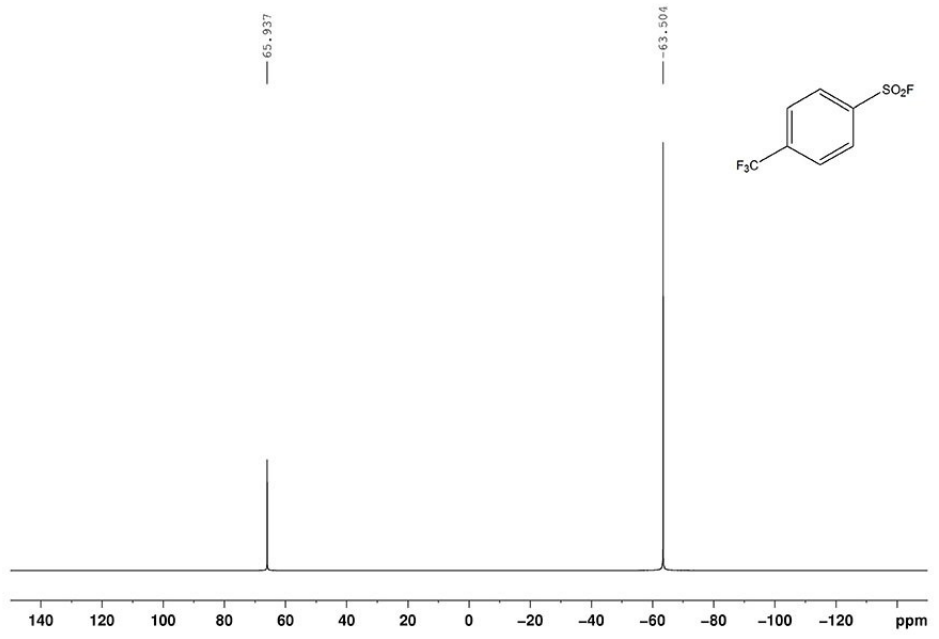

8.103
8.081
7.470
7.448
7.260
SO2F
F3CO
11
10
9
8
7
6
5
4
3
2
ppm
2.00
2.03

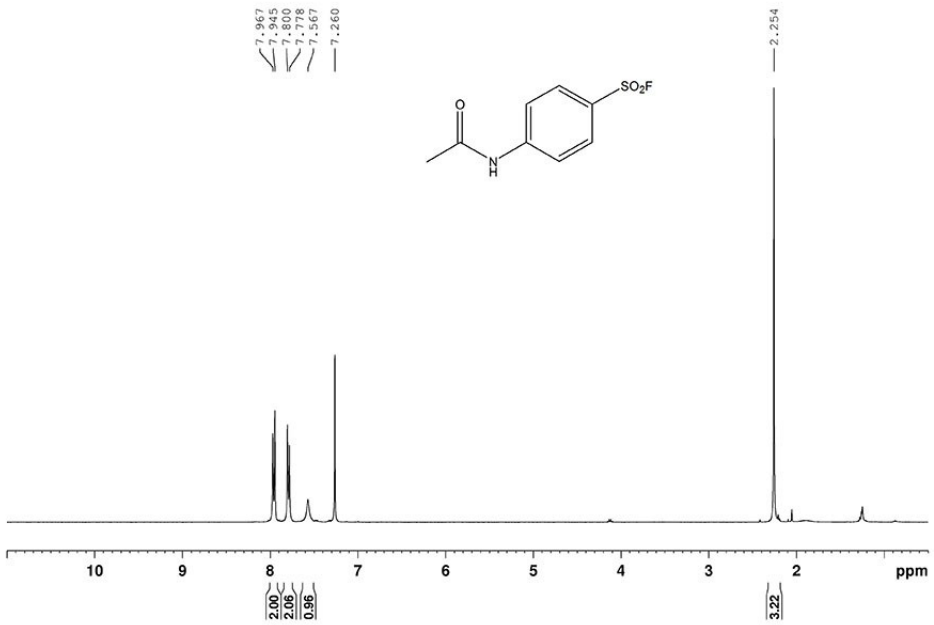

154.348
131.113
130.917
130.854
124.005
121.412
121.194
118.821
116.230
77.332
77.216
77.014
76.697
SO2F
F3CO
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

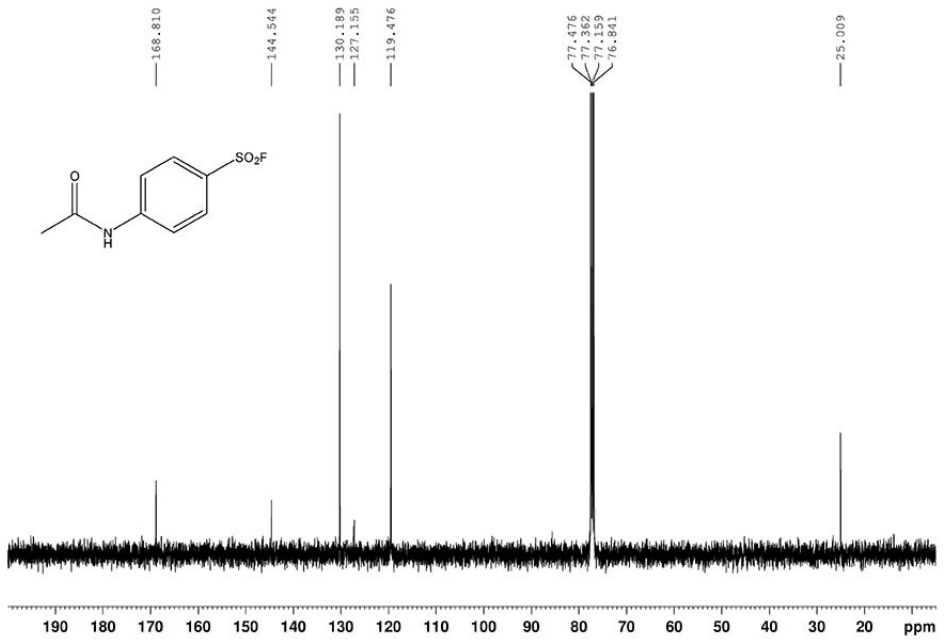

-66.542
-57.723
SO2F
F3CO
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
ppm

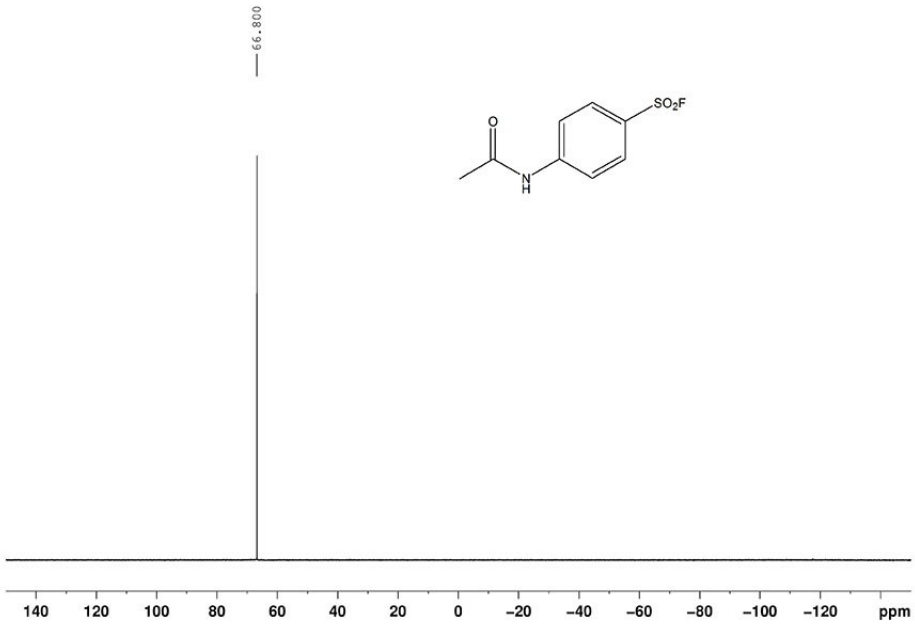

8.185
8.164
7.934
7.913
7.260
SO2F
F3C
11
10
9
8
7
6
5
4
3
2
ppm
2.00
2.03

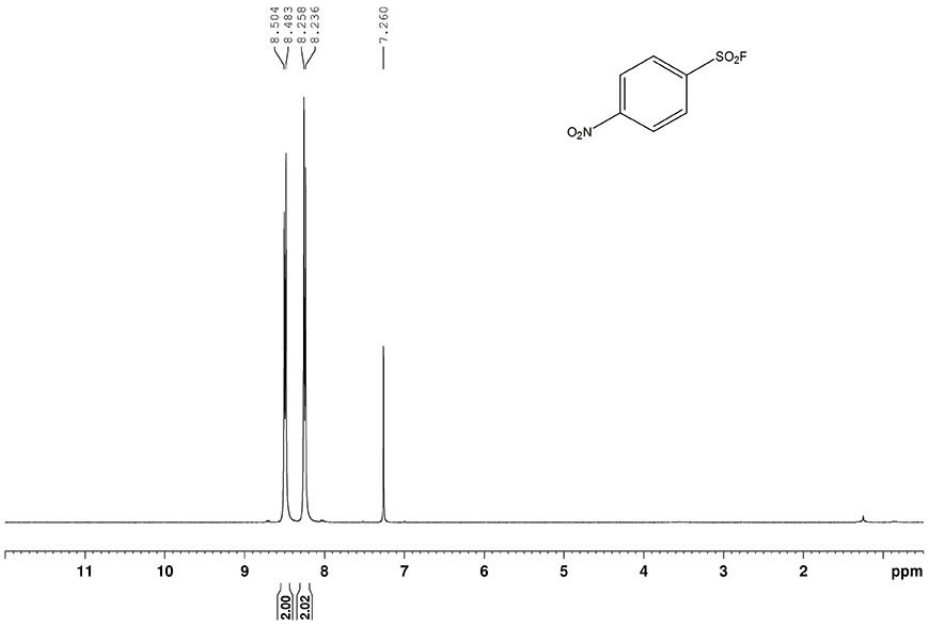

137.507
137.172
136.791
129.270
127.104
127.068
127.032
126.996
124.226
121.509
77.476
77.361
77.159
76.841
SO2F
F3C
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

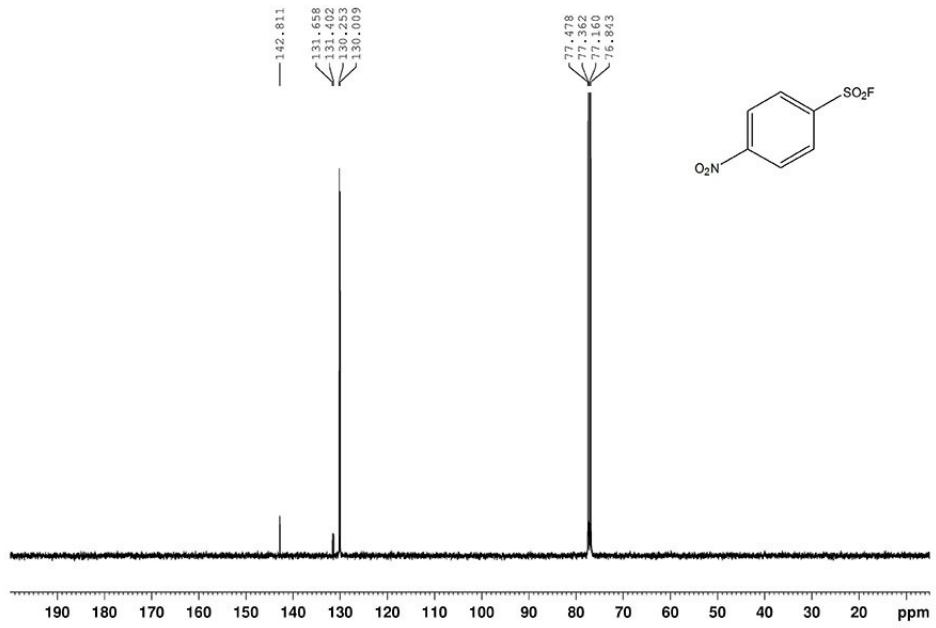

65.937
-63.504
SO2F
F3C
140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 ppm

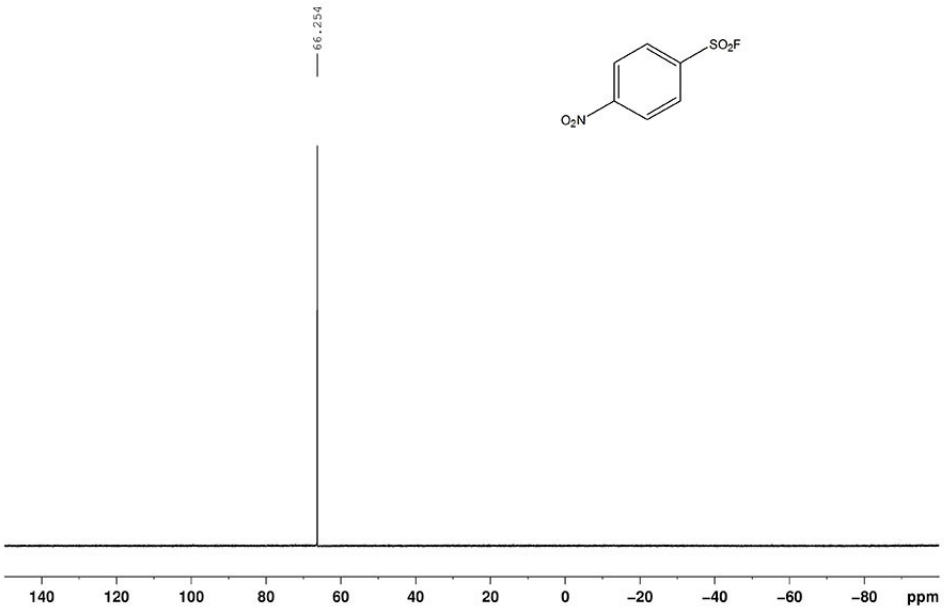

7.967
7.945
7.800
7.778
7.567
7.260
2.254
SO2F
O
N
H
10
9
8
7
6
5
4
3
2
ppm
2.00
2.06
0.96
3.22

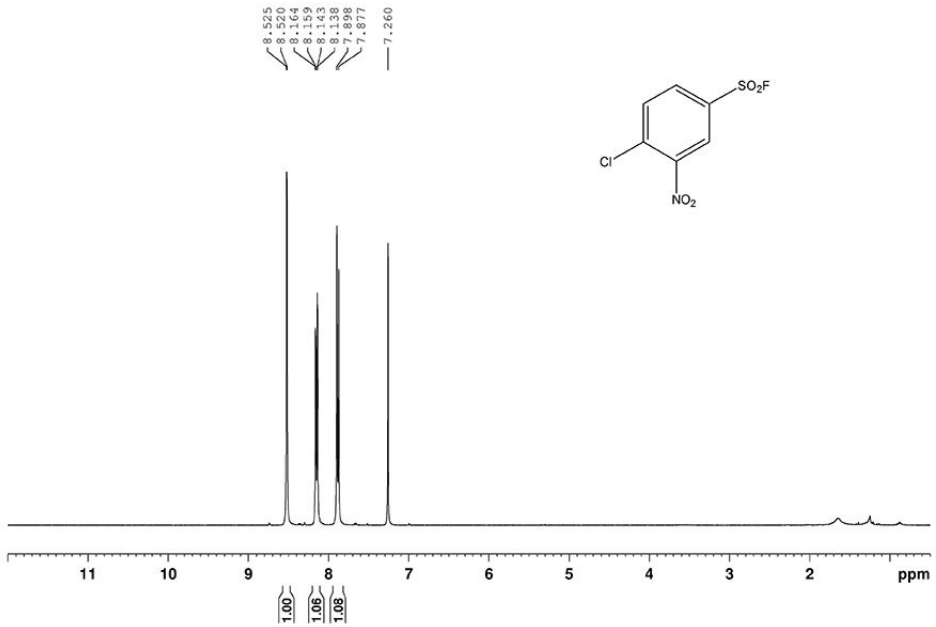

168.810
144.544
130.189
127.155
119.476
77.476
77.362
77.159
76.841
25.009
SO2F
O
N
H
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

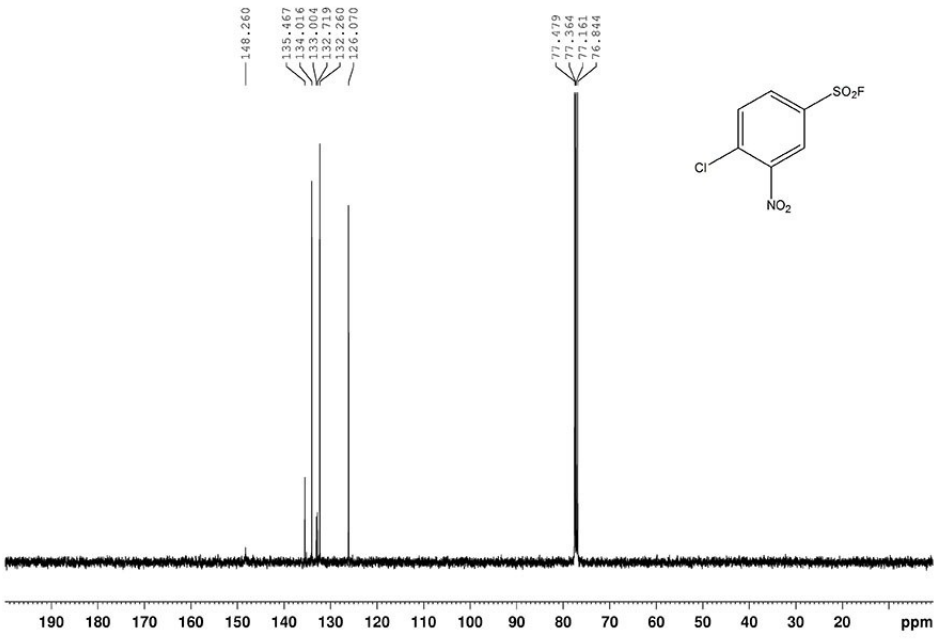

66.800
SO2F
O
N
H
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
ppm

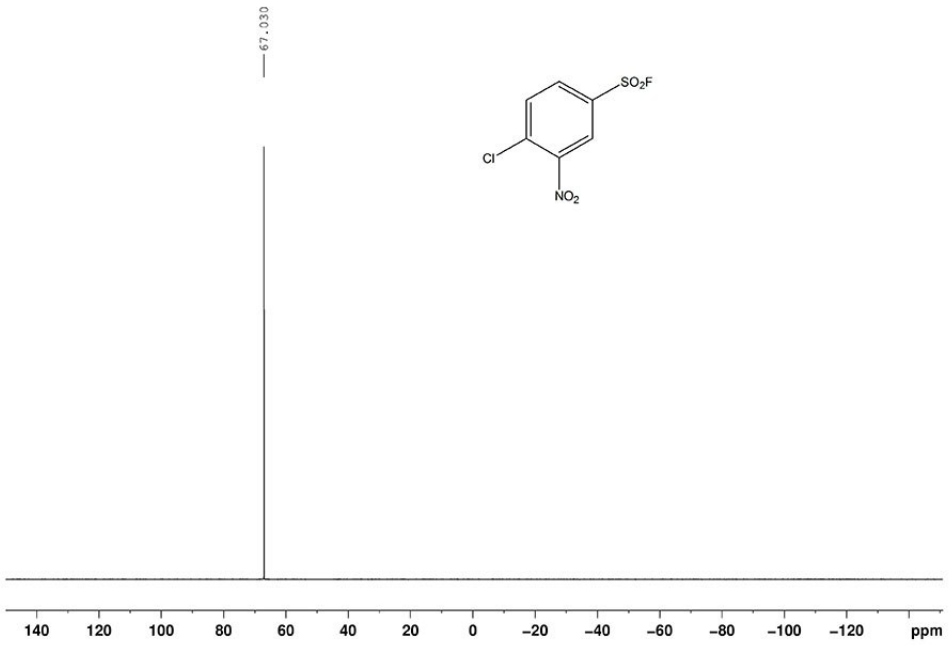

8.504
8.483
8.258
8.236
7.260
SO2F
O2N
11
10
9
8
7
6
5
4
3
2
ppm
2.00
2.02

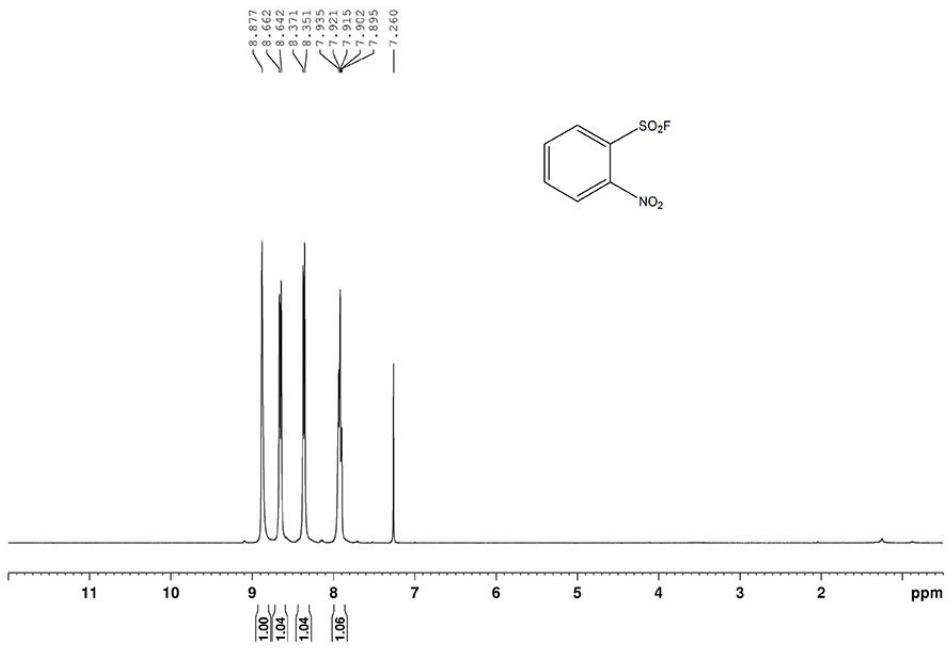

142.811
131.658
131.402
130.253
130.009
77.478
77.362
77.160
76.843
SO2F
O2N
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

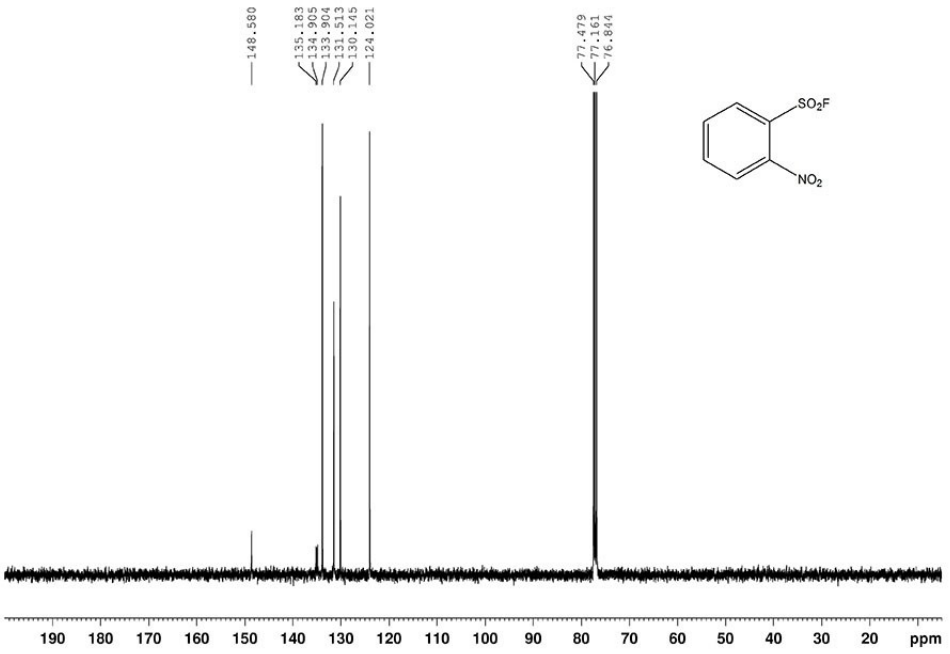

66.254
SO2F
O2N
140 120 100 80 60 40 20 0 −20 −40 −60 −80 ppm

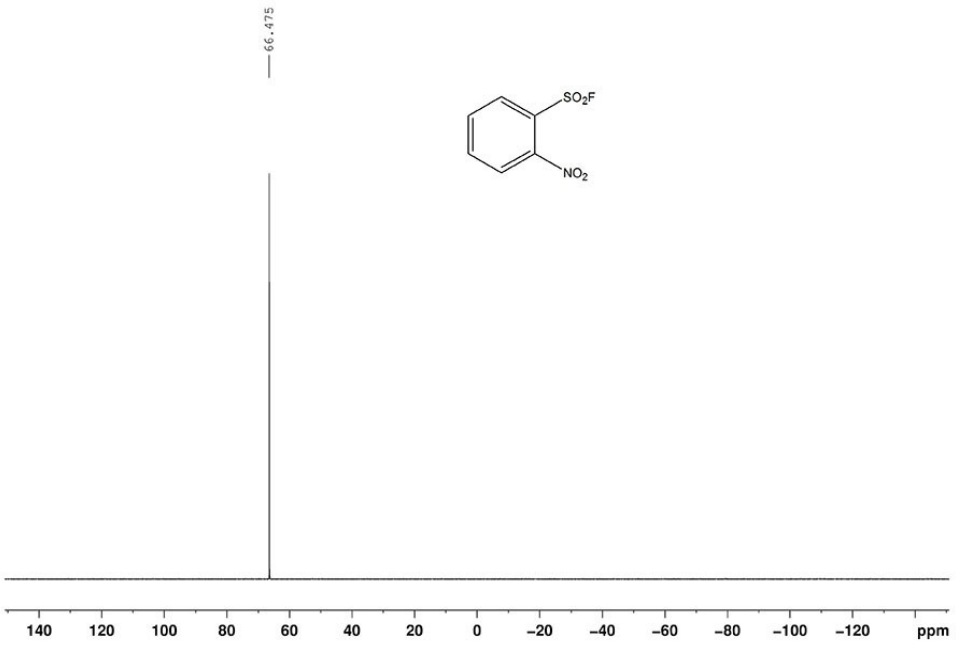

8.525
8.520
8.164
8.159
8.143
8.138
7.898
7.877
7.260
SO2F
Cl
NO2
11
10
9
8
7
6
5
4
3
2
ppm
1.00
1.06
1.08

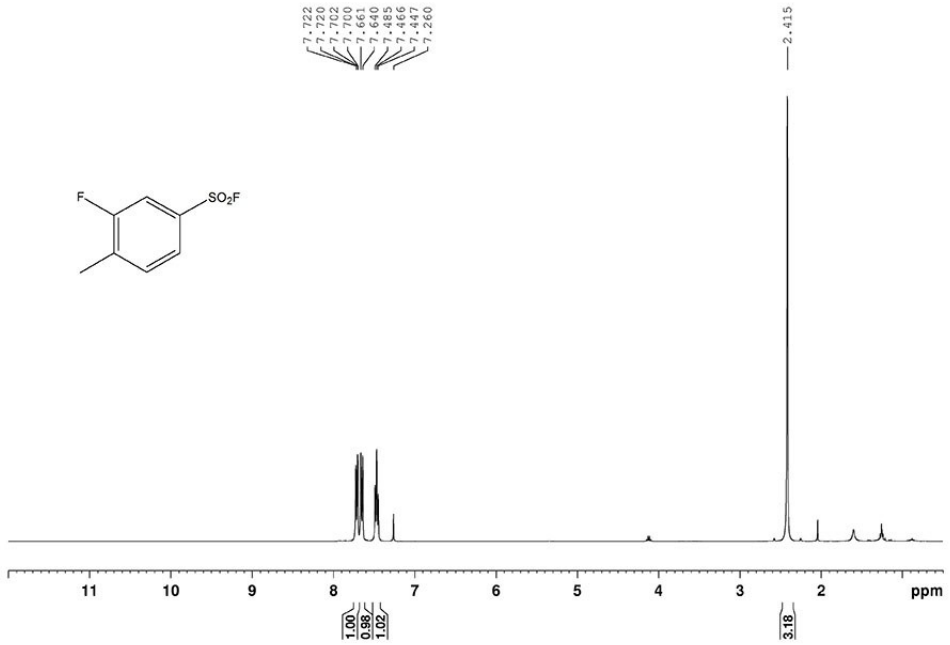

148.260
135.467
134.016
133.004
132.719
132.260
126.070
77.479
77.364
77.161
76.844
SO2F
Cl
NO2
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

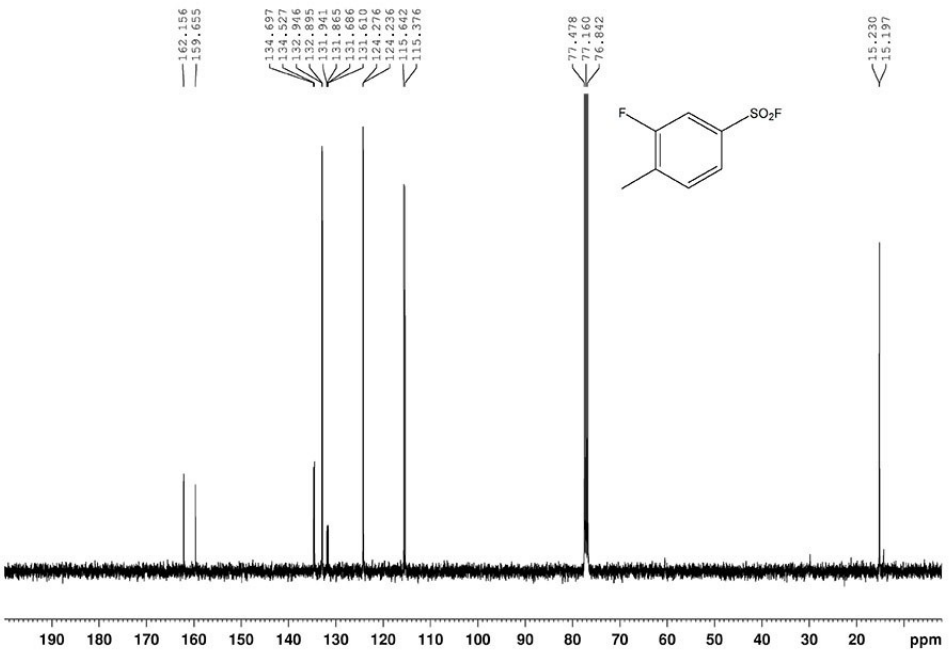

67.030
SO2F
Cl
NO2
140
120
100
80
60
40
20
0
−20
−40
−60
−80
−100
−120
ppm

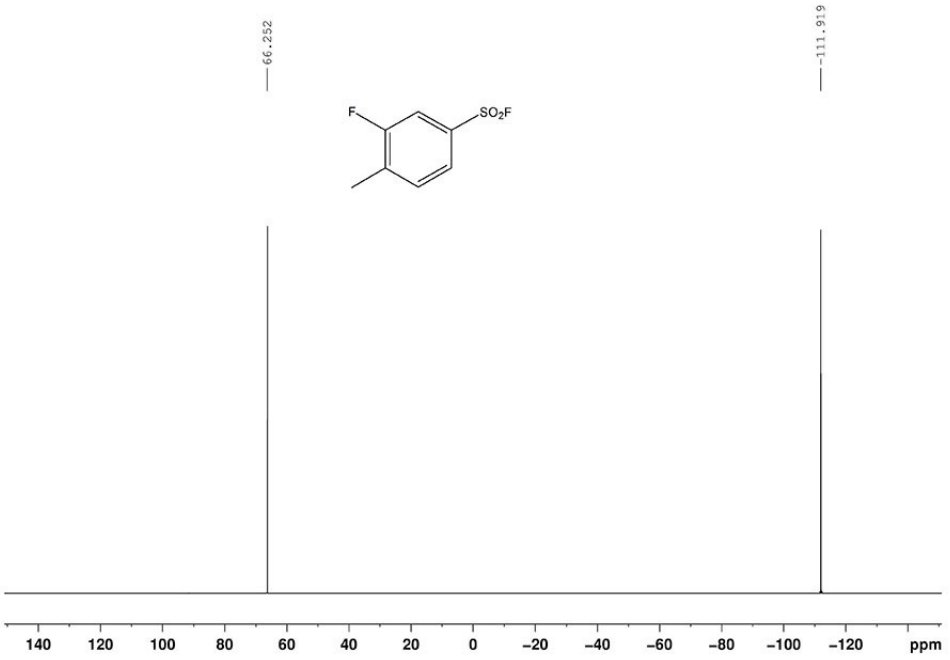

8.877
8.662
8.642
8.371
8.351
7.935
7.921
7.915
7.902
7.895
7.260
SO2F
NO2
11
10
9
8
7
6
5
4
3
2
ppm
1.00
1.04
1.04
1.06

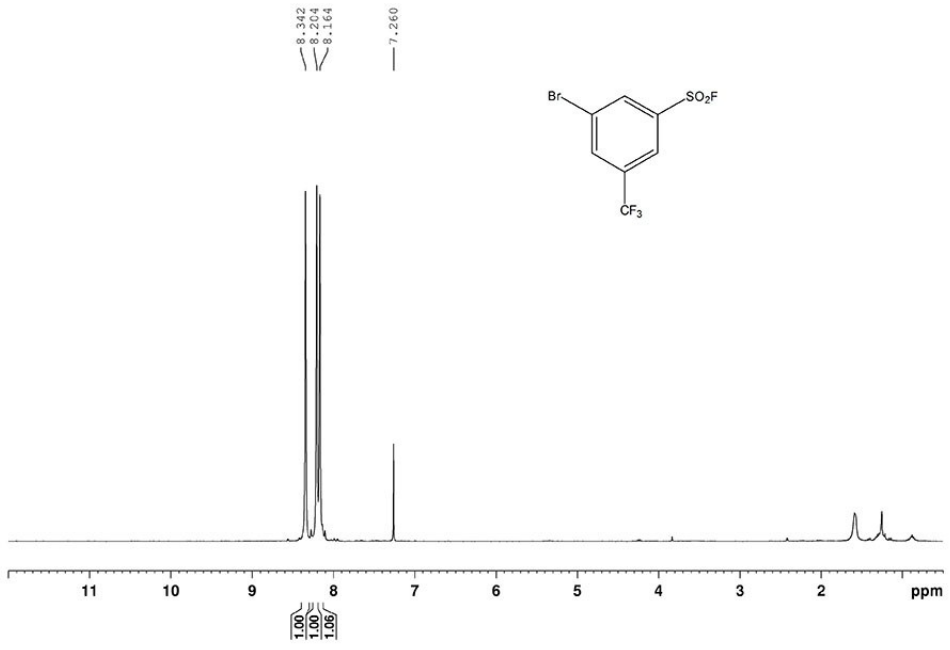

148.580
135.183
134.905
133.904
131.513
130.145
124.021
77.479
77.161
76.844
SO2F
NO2
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

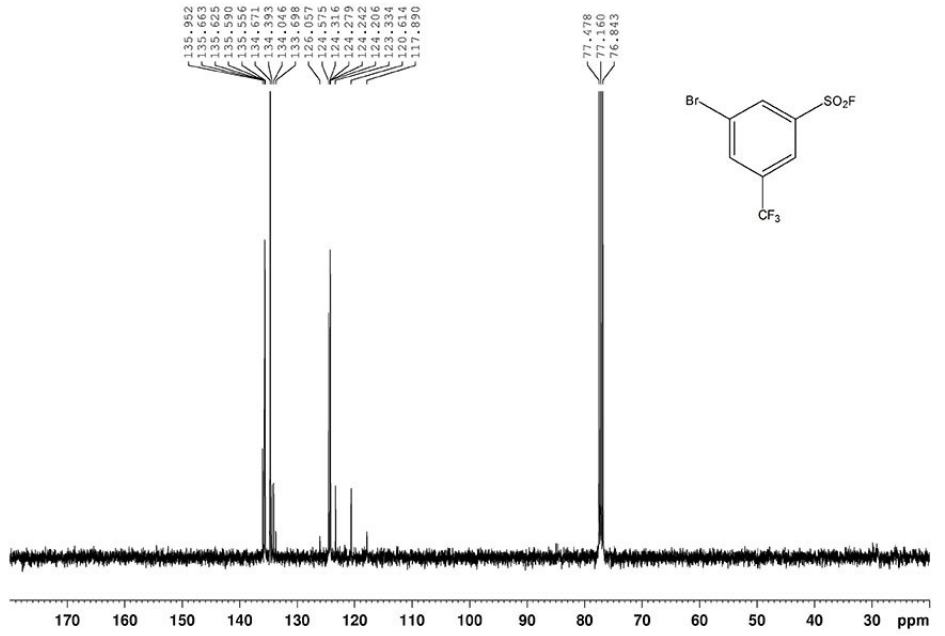

66.475
SO2F
NO2
140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 ppm

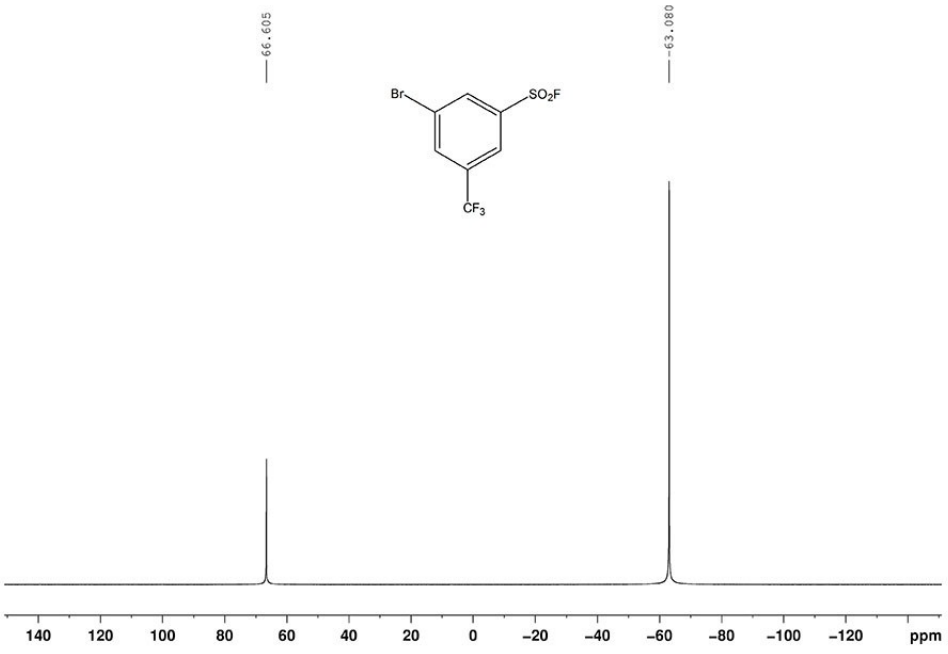

7.722
7.720
7.702
7.700
7.661
7.640
7.485
7.466
7.447
7.260
2.415
F
SO2F
11
10
9
8
7
6
5
4
3
2
ppm
1.00
0.98
1.02
3.18

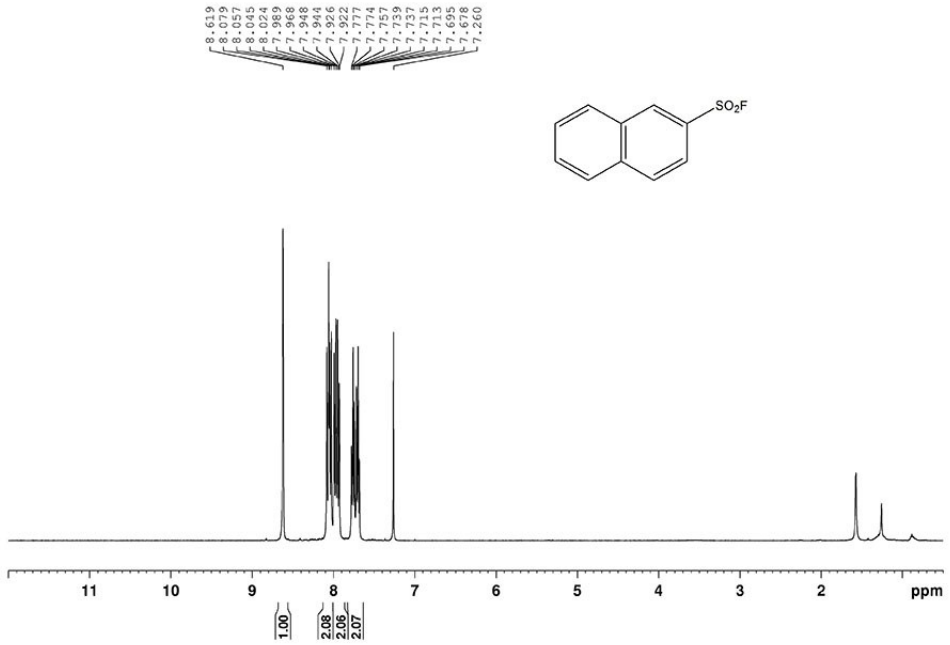

162.156
159.655
134.697
134.527
132.946
132.895
131.941
131.865
131.686
131.610
124.276
124.236
115.642
115.376
77.478
77.160
76.842
15.230
15.197
F
SO2F
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

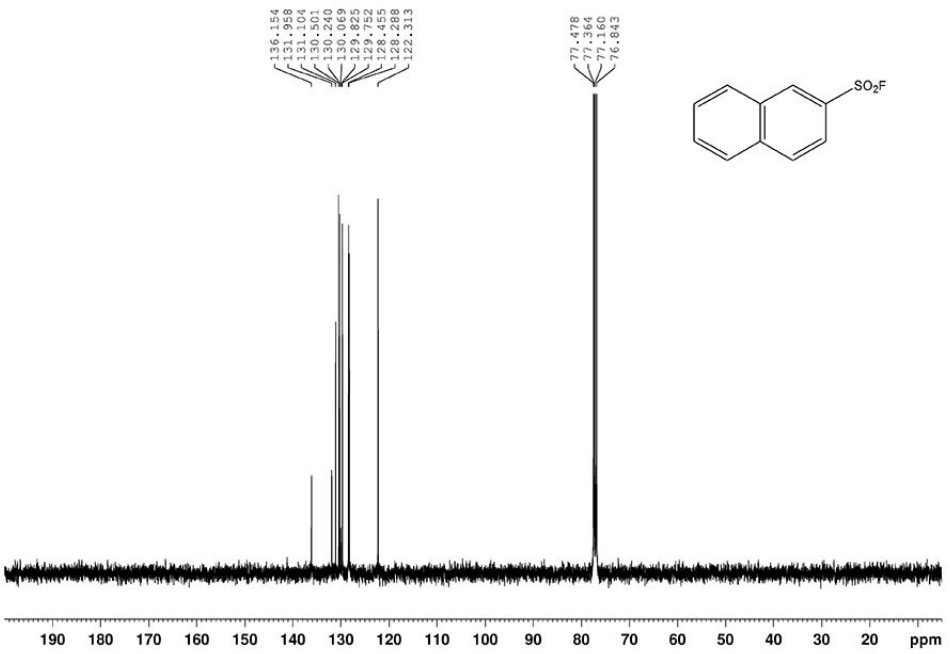

66.252
-111.919
F
SO2F
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
ppm

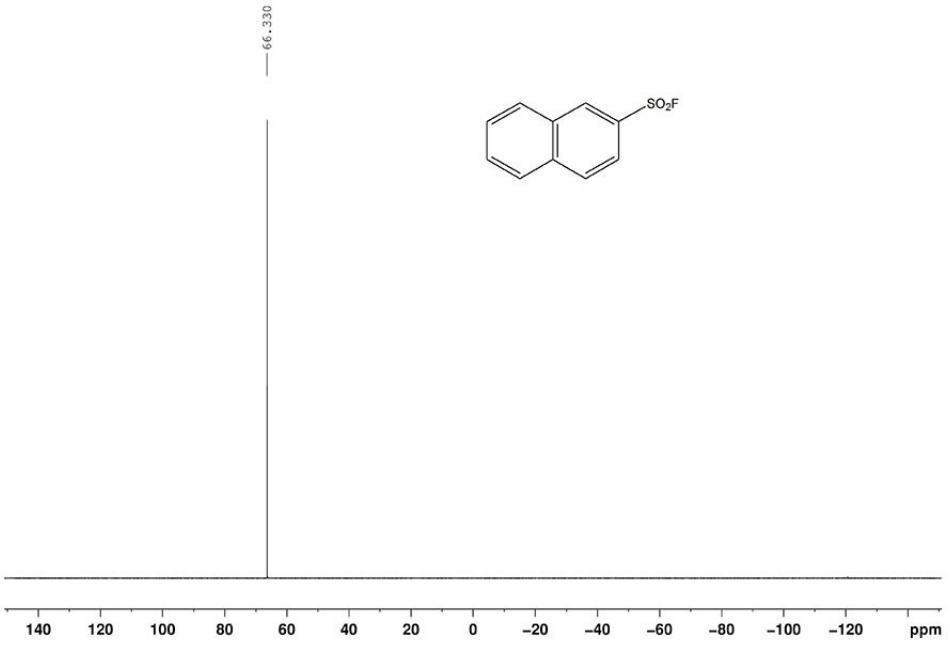

8.342
8.204
8.164
7.260
Br
SO2F
CF3
11
10
9
8
7
6
5
4
3
2
ppm
1.00
1.00
1.06

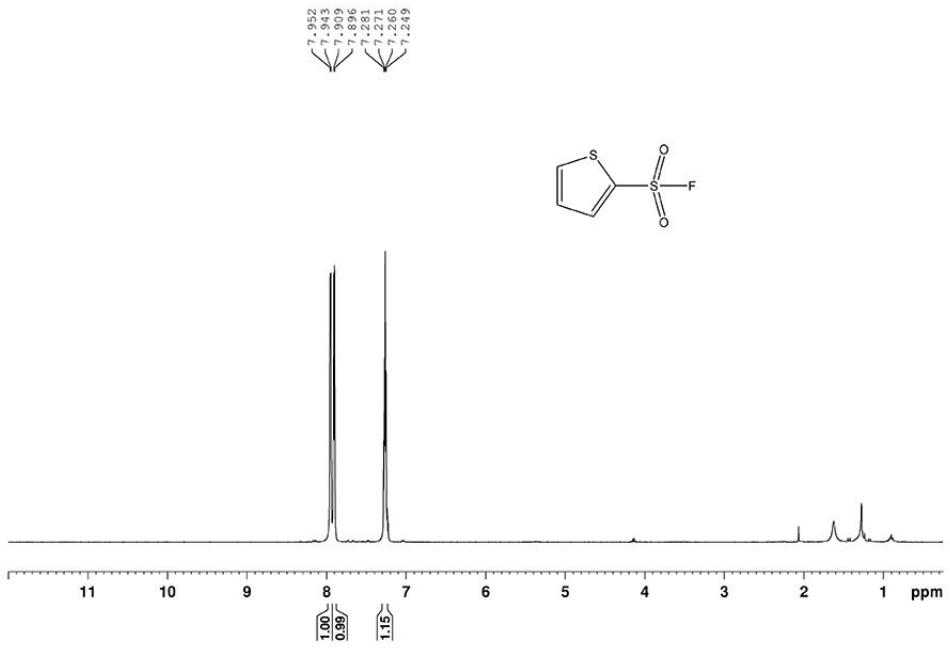

135.952
135.663
135.625
135.590
135.556
134.671
134.393
134.046
133.698
126.057
124.575
124.316
124.279
124.242
124.206
123.334
120.614
117.890
77.478
77.160
76.843
Br
SO2F
CF3
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 ppm

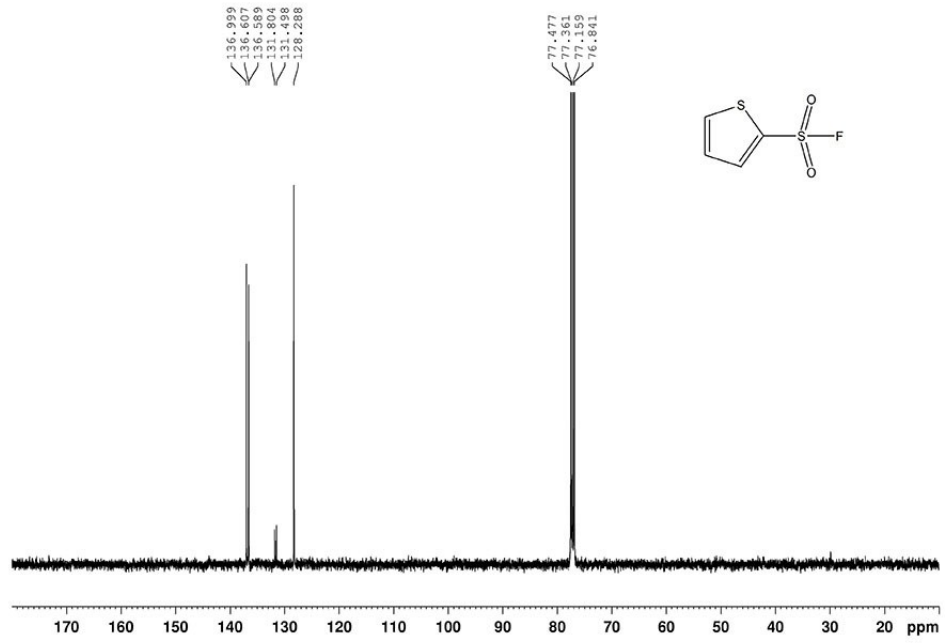

66.605
-63.080
Br
SO2F
CF3
140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 ppm

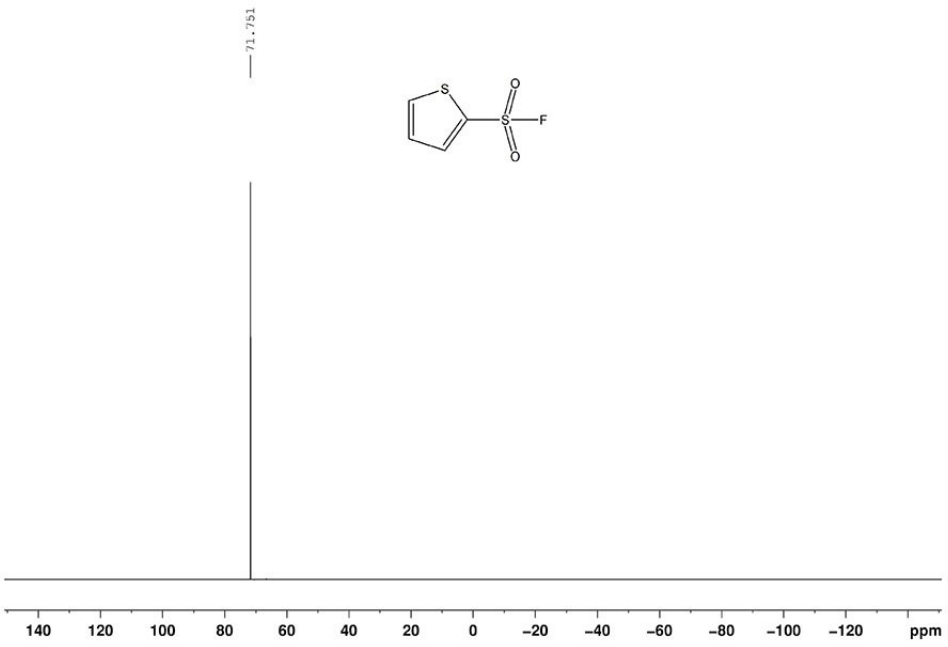

8.619
8.079
8.057
8.045
8.024
7.989
7.968
7.948
7.944
7.926
7.922
7.777
7.774
7.757
7.739
7.737
7.715
7.713
7.695
7.678
7.260
SO2F
11
10
9
8
7
6
5
4
3
2
ppm
1.00
2.08
2.06
2.07

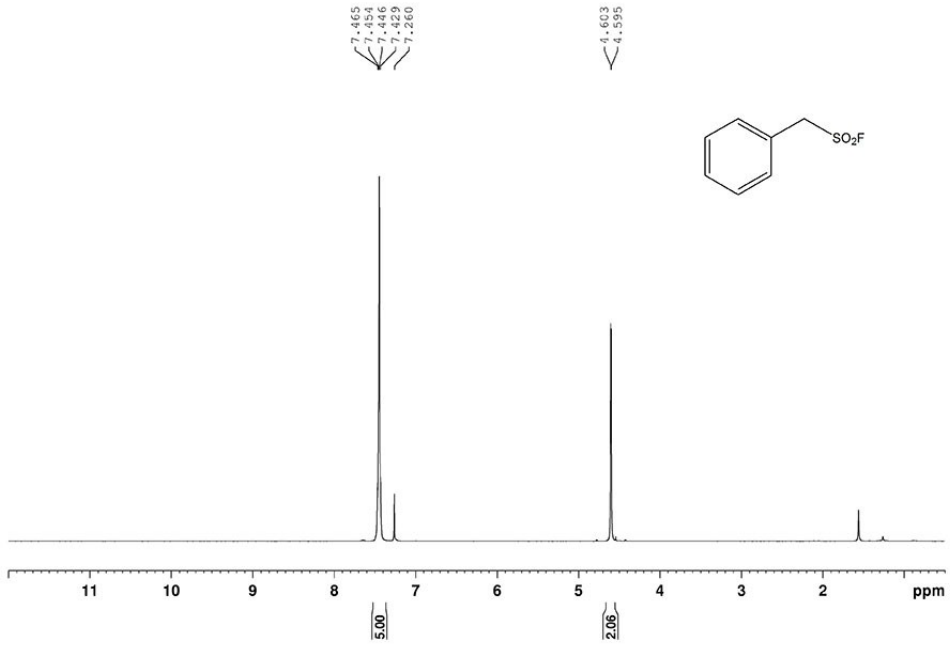

136.154
131.958
131.704
130.501
130.240
130.069
129.825
129.752
128.455
128.288
122.313
77.478
77.364
77.160
76.843
SO2F
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

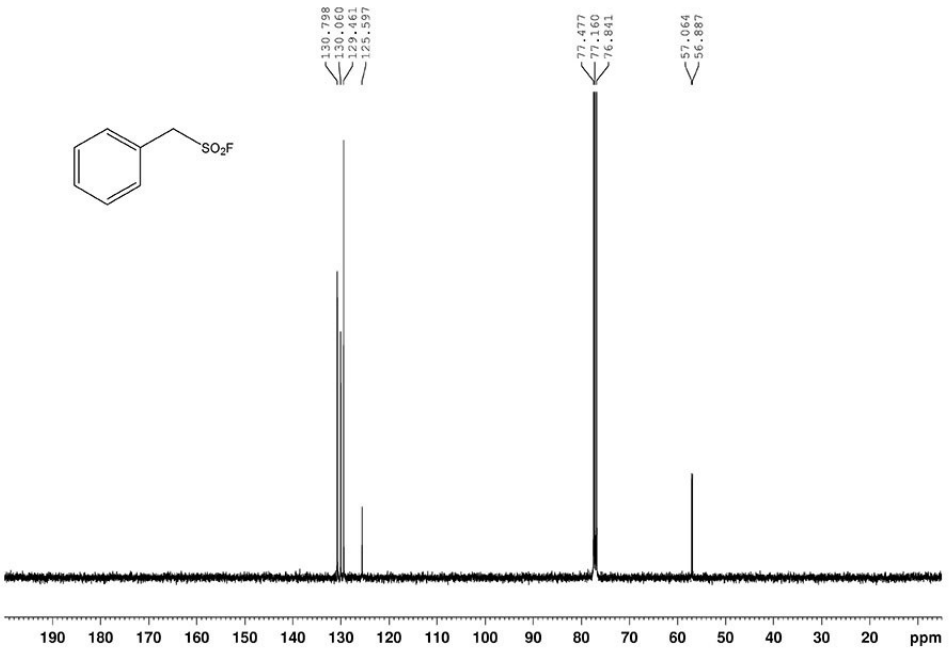

66.330
SO2F
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
ppm

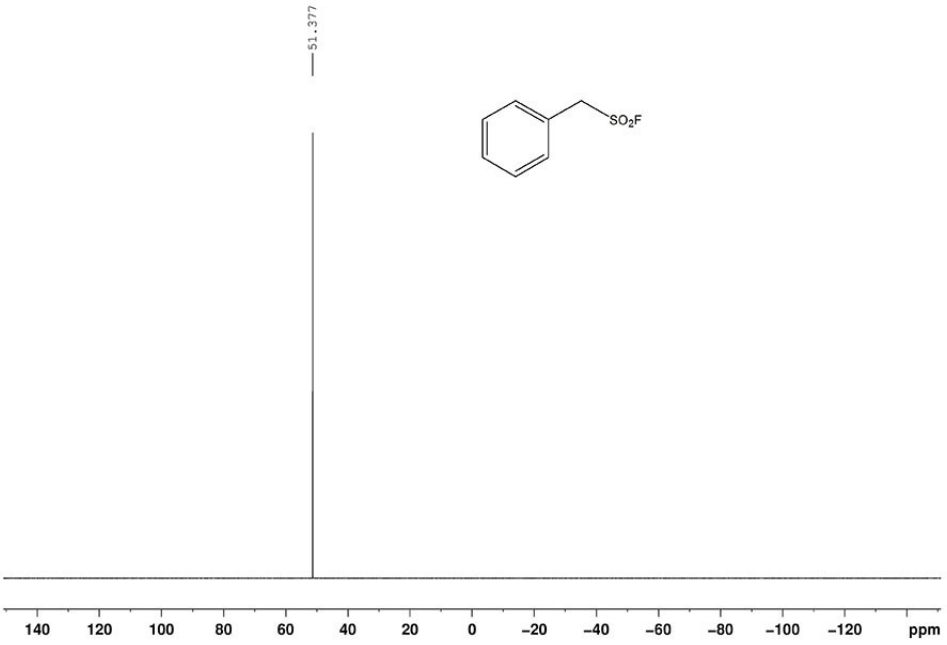

7.952
7.943
7.909
7.896
7.281
7.271
7.260
7.249
S
O
S
F
O
11
10
9
8
7
6
5
4
3
2
1
ppm
1.00
0.99
1.15

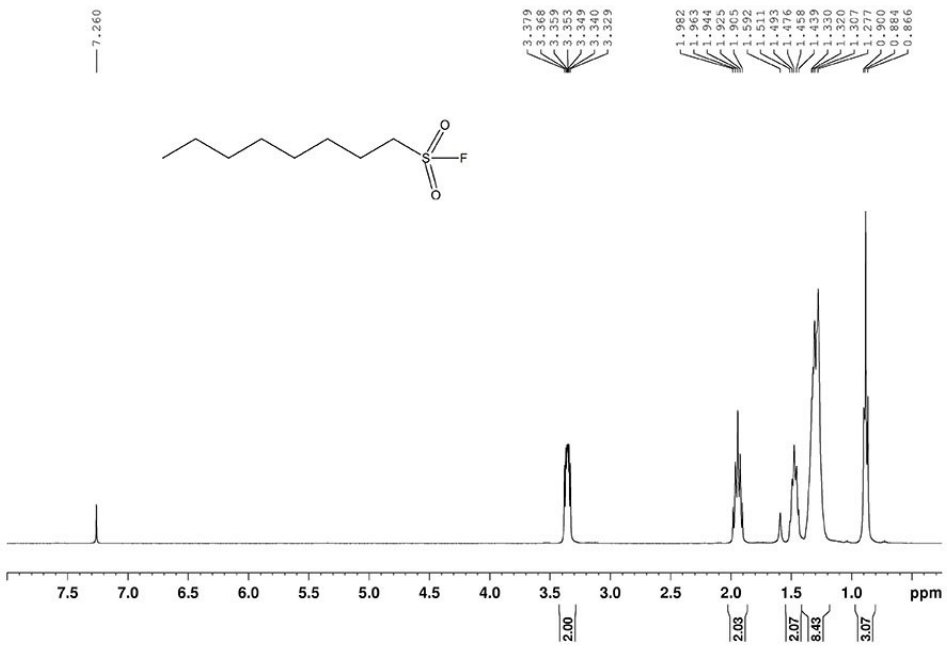

136.999
136.607
136.589
131.804
131.498
128.288
77.477
77.361
77.159
76.841
S
O
S
F
O
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

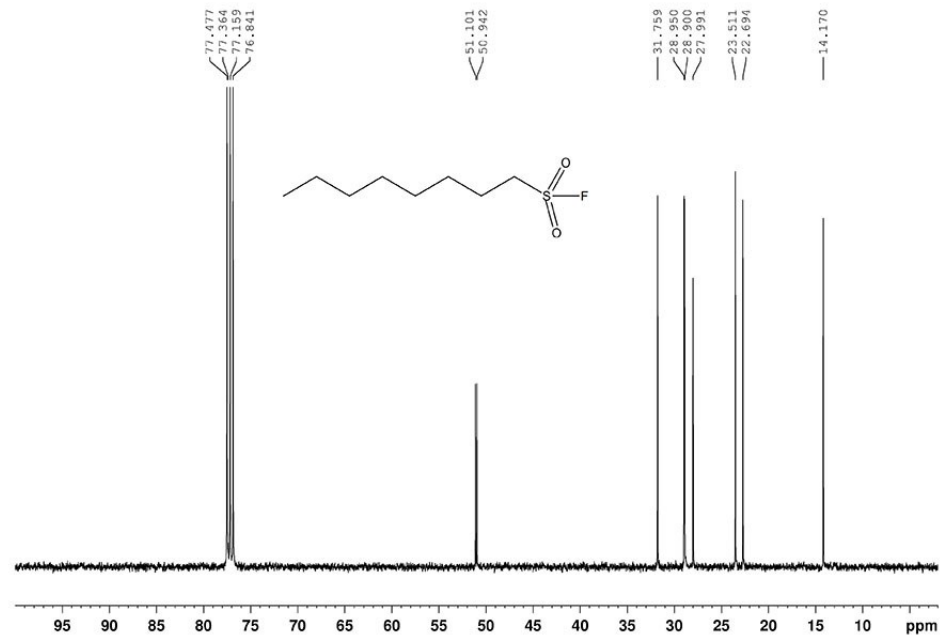

71.751
S
O
S
F
O
140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 ppm

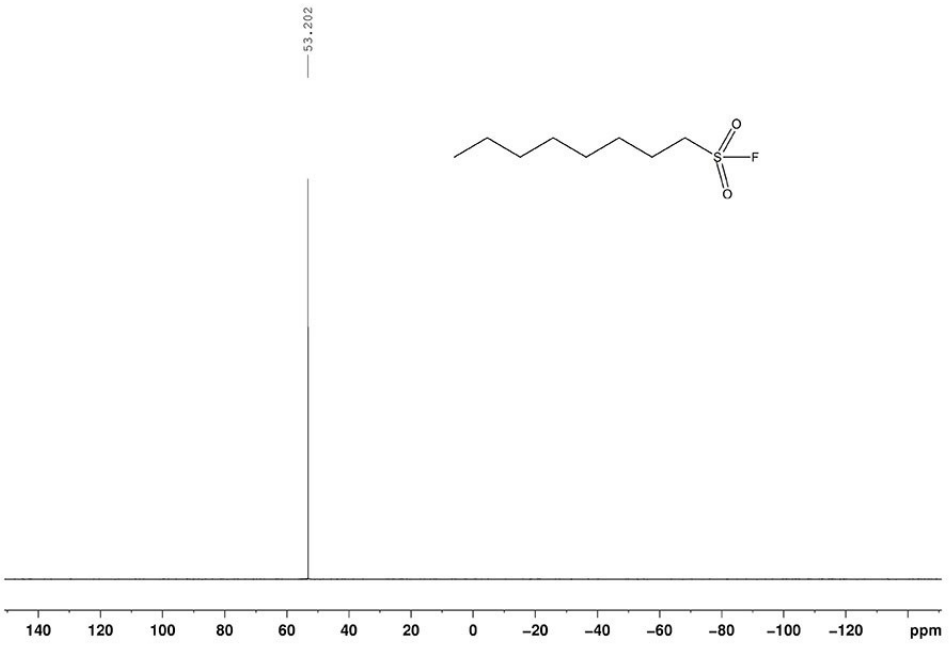

7.465
7.454
7.446
7.429
7.260
4.603
4.595
SO2F
11
10
9
8
7
6
5
4
3
2
ppm
5.00
2.06

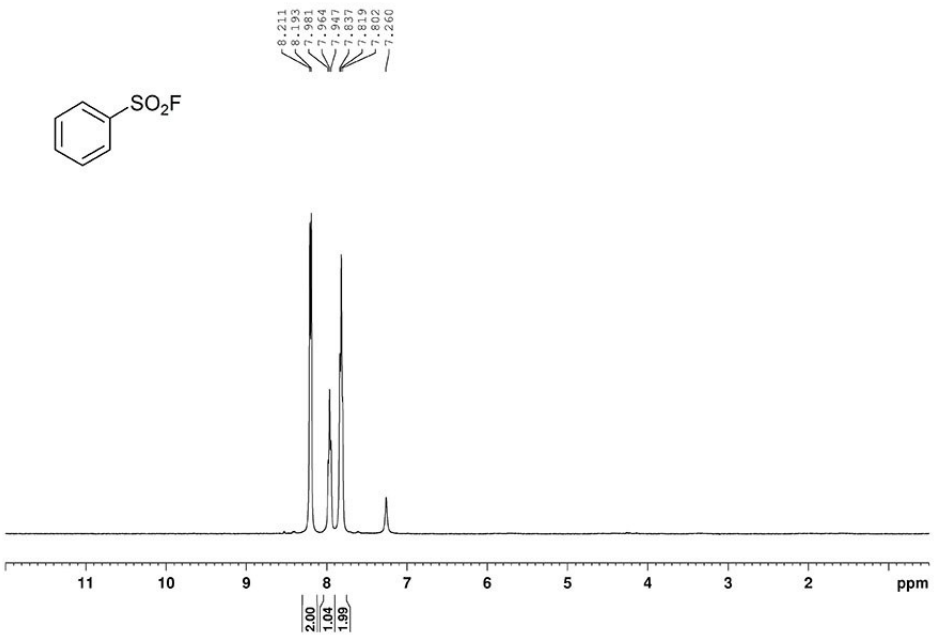

130.798
130.060
129.461
125.597
77.477
77.160
76.841
57.064
56.887
SO2F
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

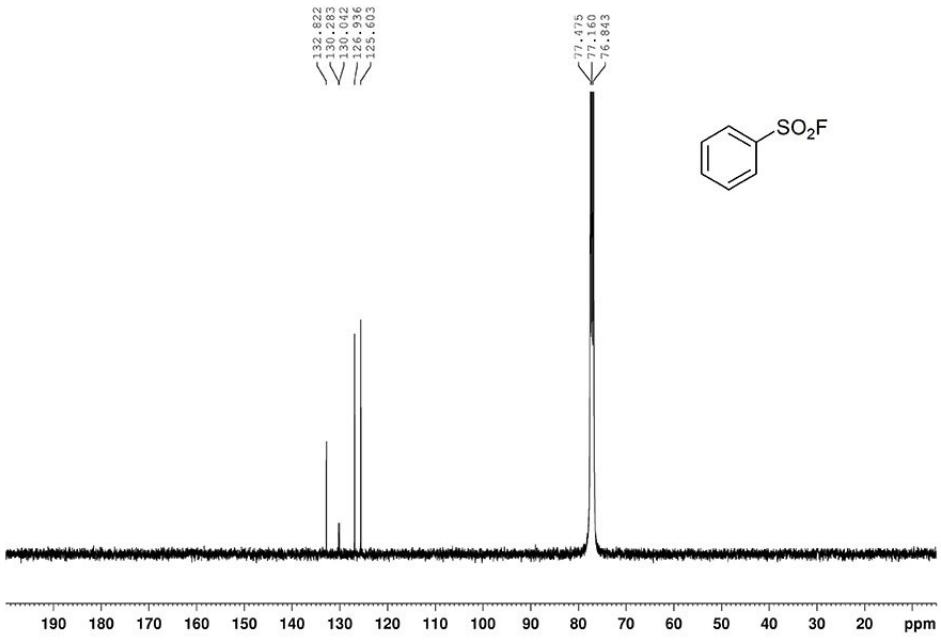

51.377
SO2F
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
ppm

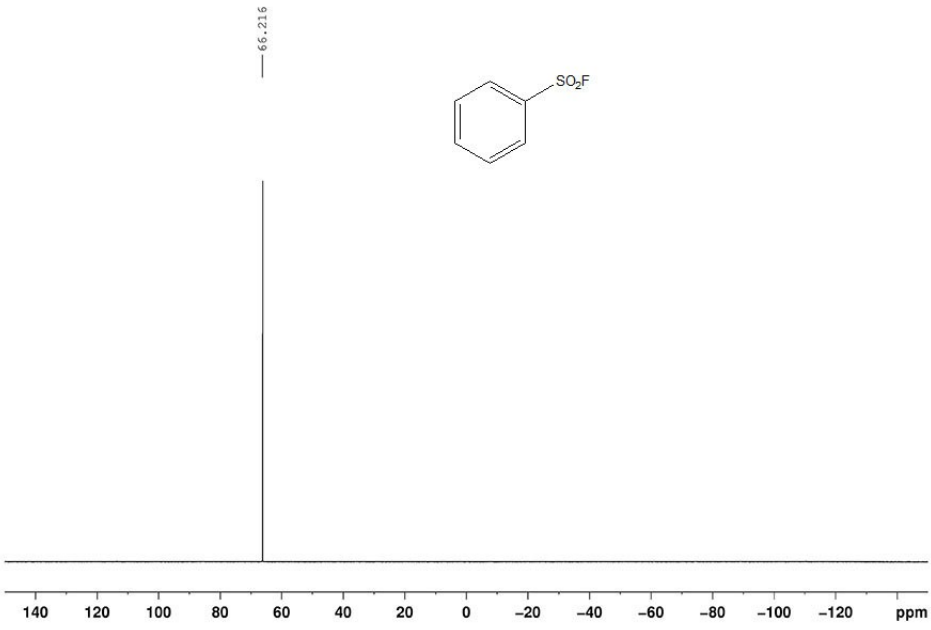

7.260
3.379
3.368
3.359
3.353
3.343
3.340
3.329
1.982
1.963
1.944
1.925
1.905
1.592
1.511
1.493
1.476
1.458
1.439
1.330
1.320
1.307
1.277
0.900
0.884
0.866
O
S
F
O
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
ppm
2.00
2.03
2.07
8.43
3.07


77.477
77.364
77.159
76.841
51.101
50.942
31.759
28.950
28.900
27.991
23.511
22.694
14.170
O
S
F
O
95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 ppm


53.202
O
S
F
O
140 120 100 80 60 40 20 0 −20 −40 −60 −80 −100 −120 ppm


8.211
8.193
7.981
7.964
7.947
7.837
7.819
7.802
7.260
SO2F
11
10
9
8
7
6
5
4
3
2
ppm
2.00
1.04
1.99


132.822
130.283
130.042
126.936
125.603
77.475
77.160
76.843
SO2F
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm


66.216
SO2F
140
120
100
80
60
40
20
0
−20
−40
−60
−80
−100
−120
ppm