Supporting Information

Regioselective C-H Chlorination: Towards the Sequential difunctionalization of Phenol Derivatives and Late-Stage Chlorination of Bioactive Compounds

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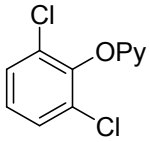
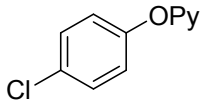
Characterization of Products in Details

2-(2,6-dichlorophenoxy)pyridine (3a)



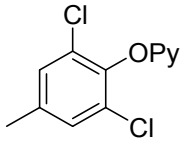
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded yellow liquid (40 mg, 83 % yield). **^{1}H NMR** (500 MHz, $CDCl_3$): δ 8.10 (d, *J* = 3.5 Hz, 1H), 7.73 (t, *J* = 7.0 Hz, 1H), 7.39 (d, *J* = 8.0 Hz, 2H), 7.14 (t, *J* = 8.5 Hz, 1H), 7.05 (d, *J* = 8.0 Hz, 1H), 7.00 (t, *J* = 6.0 Hz, 1H); **^{13}C NMR** (125 MHz, $CDCl_3$): δ 162.0, 147.4, 146.4, 139.6, 129.8, 128.8, 126.4, 118.7, 110.6; **HRMS** (TIC): calcd for $C_{11}H_8Cl_2NO$ $[M + H]^+$ 239.9978, found 239.9976.

2-(4-chlorophenoxy)pyridine (3a′)



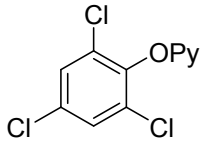
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded yellow liquid (37 mg, 90 % yield). **^{1}H NMR** (500 MHz, $CDCl_3$): δ 8.16 - 8.15 (m, 1H), 7.66 (t, *J* = 7.3 Hz, 1H), 7.33 (d, *J* = 8.6 Hz, 2H), 7.06 (d, *J* = 8.5 Hz, 2H), 6.97 (t, *J* = 5.6 Hz, 1H), 6.90 (d, *J* = 8.3 Hz, 1H); **^{13}C NMR** (125 MHz, $CDCl_3$): δ 163.4, 152.7, 147.6, 139.6, 129.8, 129.6, 122.6, 118.8, 111.7; **HRMS** (TIC): calcd for $C_{11}H_8ClNO$ $[M + H]^+$ 206.0367, found 206.0365.

2-(2,6-dichloro-4-methylphenoxy)pyridine (3b)



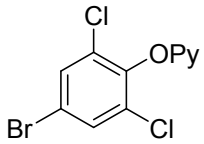
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded yellow liquid (35.1 mg, 69 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.03 (d, *J* = 4.5 Hz, 1H), 7.65 (t, *J* = 7.0 Hz, 1H), 7.13 (s, 2H), 6.97 - 6.91 (m, 2H), 2.26 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 161.1, 146.4, 142.9, 138.5, 135.7, 128.3, 128.1, 117.6, 109.6, 19.7; **HRMS** (TIC): calcd for $C_{12}H_{10}Cl_2NO$ $[M + H]^+$ 254.0134, found 254.0131.

2-(2,4,6-trichlorophenoxy)pyridine (3c)



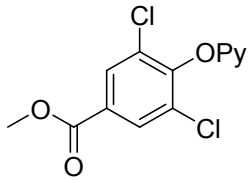
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded yellow liquid (35.1 mg, 69 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.08 (d, *J* = 4.5 Hz, 1H), 7.74 (t, *J* = 6.5 Hz, 1H), 7.40 (s, 2H), 7.08 - 7.01 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 161.7, 147.3, 145.4, 139.8, 131.0, 130.4, 128.7, 128.1, 121.7, 118.9, 110.7; **HRMS** (TIC): calcd for $C_{11}H_7Cl_3NO$ $[M + H]^+$ 273.9588 found 273.9591.

2-(4-bromo-2,6-dichlorophenoxy)pyridine (3d)



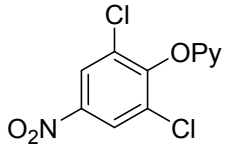
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded yellow liquid (59.6 mg, 94 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.09 (d, *J* = 4.5 Hz, 1H), 7.75 (t, *J* = 7.5 Hz, 1H), 7.55 (s, 2H), 7.07 (d, *J* = 8.0 Hz, 1H), 7.03 (t, *J* = 5.5 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 162.0, 147.4, 146.4, 139.6, 129.8, 128.8, 128.1, 126.4, 121.7, 118.7, 110.6; **HRMS** (TIC): calcd for $C_{11}H_7BrCl_2NO$ $[M + H]^+$ 317.9083, found 317.9085.

methyl 3,5-dichloro-4-(pyridin-2-yloxy)benzoate (3e)



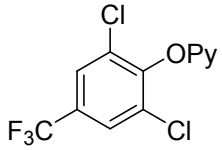
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a light yellow liquid (59.1 mg, 99 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.07 (s, 3H), 7.76 (t, *J* = 8.0 Hz, 1H), 7.09 (d, *J* = 8.0 Hz, 1H), 7.03 (t, *J* = 5.0 Hz, 1H), 3.95 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 164.6, 161.7, 150.2, 147.3, 139.9, 130.1, 130.0, 128.6, 119.1, 110.8, 52.7; **HRMS** (TIC): calcd for $C_{13}H_{10}Cl_2NO_3$ $[M + H]^+$ 298.0032, found 298.0030.

2-(2,6-dichloro-4-nitrophenoxy)pyridine (3f)



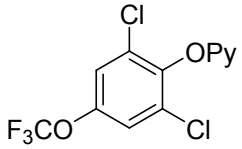
Following the general procedure, using 5:1 petroleum ether-EtOAc as the eluant afforded a white liquid (56.2 mg, 99 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.30 (s, 2H), 8.04 (d, *J* = 6.0 Hz, 1H), 7.80 (t, *J* = 8.5 Hz, 1H), 7.14 (d, *J* = 8.0 Hz, 1H), 7.07 (t, *J* = 7.0 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 161.4, 152.1, 147.2, 144.8, 140.1, 131.1, 124.2, 119.5, 110.8; **HRMS** (TIC): calcd for $C_{11}H_7Cl_2N_2O_3$ $[M + H]^+$ 284.9828, found 284.9825.

2-(2,6-dichloro-4-(trifluoromethyl)phenoxy)pyridine (3g)



Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a yellow liquid (56.2 mg, 92 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.07 (d, *J* = 5.0 Hz, 1H), 7.77 (t, *J* = 6.5 Hz, 1H), 7.67 (s, 2H), 7.11 (d, *J* = 8.0 Hz, 1H), 7.04 (t, *J* = 7.0 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 161.5, 149.5, 147.3, 140.0, 130.8, 128.9 (q, J_F= 33.8 Hz), 126.0 (q, J_F = 3.8 Hz), 122.7 (q, J_F = 271.2 Hz), 119.2, 110.8. ^{19}F NMR (470 MHz, $CDCl_3$): δ -62.6(s, 1F); **HRMS** (TIC): calcd for $C_{12}H_7Cl_2F_3NO$ $[M + H]^+$ 307.9852, found 307.9850.

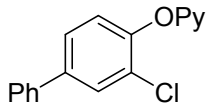
2-(2,6-dichloro-4-(trifluoromethoxy)phenoxy)pyridine (3h)



Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a light yellow liquid (59.3 mg, 92 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.09 (d, *J* = 6.5 Hz, 1H), 7.75 (t, *J* = 7.0 Hz, 1H), 7.30 (s, 2H), 7.08 (d, *J* = 8.5 Hz, 1H), 7.03 (t, *J* = 7.0 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 161.7, 147.3, 145.7 (q, J_F = 1.2 Hz), 145.5, 139.8, 130.6, 121.6, 120.3 (q, J_F = 256.2 Hz), 119.1, 110.7; ^{19}F NMR (470 MHz, $CDCl_3$): δ -58.1(s, 3F); **HRMS** (TIC): calcd for $C_{12}H_7Cl_2F_3NO_2$ [M

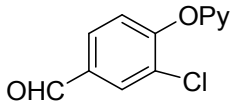
+ H]$^+$ 323.9801, found 323.9800.

2-((3-chloro-[1,1'-biphenyl]-4-yl)oxy)pyridine (3i)



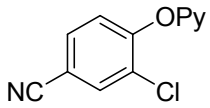
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded yellow liquid (45.6 mg, 81 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.13 (d, *J* = 6.0 Hz, 1H), 7.75 (t, *J* = 8.5 Hz, 1H), 7.60 - 7.54 (m, 4H), 7.46 - 7.37 (m, 4H), 7.10 - 7.01 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 172.2, 162.1, 147.4, 145.5, 140.0, 137.7, 138.3, 129.9, 129.0, 128.2, 127.4, 127.0, 121.5, 118.8, 110.7; **HRMS** (TIC): calcd for $C_{17}H_{13}ClNO$ [M + H]$^+$ 282.0680, found 282.0684.

3-chloro-4-(pyridin-2-yloxy)benzaldehyde (3j)



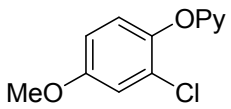
Following the general procedure, using 4:1 petroleum ether-EtOAc as the eluant afforded a light yellow liquid (21.3 mg, 46 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 9.96 (s, 1H), 8.16 (d, *J* = 3.0 Hz, 1H), 8.01 (s, 1H), 7.84 - 7.76 (m, 2H), 7.36 (d, *J* = 8.5 Hz, 1H), 7.09 - 7.06 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 189.8, 162.2, 154.9, 147.1, 140.4, 133.6, 131.4, 129.2, 128.3, 123.7, 119.5, 111.8; **HRMS** (TIC): calcd for $C_{12}H_9ClNO_2$ [M + H]$^+$ 234.0317, found 234.0315.

3-chloro-4-(pyridin-2-yloxy)benzonitrile (3k)



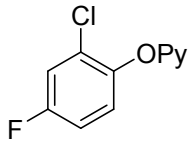
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a white liquid (23.3 mg, 51 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.14 (d, *J* = 3.5 Hz, 1H), 7.79 - 7.76 (m, 2H), 7.61 - 7.59 (m, 1H), 7.32 (d, *J* = 8.5 Hz, 1H), 7.09 - 7.07 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 162.0, 154.0, 147.4, 140.0, 134.3, 131.7, 128.3, 124.2, 119.6, 117.4, 111.8, 109.6; **HRMS** (TIC): calcd for $C_{12}H_8ClN_2O$ [M + H]$^+$ 231.0320, found 231.0321.

2-(2-chloro-4-methoxyphenoxy)pyridine (3l).



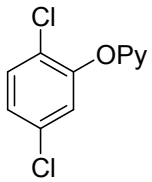
Following the general procedure, using 5:1 petroleum ether-EtOAc as the eluant afforded a yellow liquid (29.4 mg, 63 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.14 (d, J = 4.0 Hz, 1H), 7.68 (t, J = 7.5 Hz, 1H), 7.13 (d, J = 9.0 Hz, 1H), 7.01 (s, 1H), 6.98 - 6.93 (m, 2H), 6.85 (d, J = 8.5 Hz, 1H), 3.80 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 162.4, 156.8, 147.4, 140.0, 139.5, 129.8, 118.6, 114.5, 110.7, 110.5, 102.0, 55.9; **HRMS** (TIC): calcd for $C_{12}H_{11}ClNO_2$ $[M + H]^+$ 236.0473, found 236.0470.

2-(2-chloro-4-fluorophenoxy)pyridine (3m)



Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a yellow liquid (51.4 mg, 76 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.18 - 8.12 (m, 1H), 7.72 - 7.66 (m, 1H), 7.23 - 7.17 (m, 1H), 7.10 - 6.97 (m, 3H), 6.90 (d, J = 8.5 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 163.3 (d, J_F = 98.8 Hz), 160.4 (d, J_F = 22.5 Hz), 158.5 (d, J_F = 26.2 Hz), 147.5 (d, J_F = 26.2 Hz), 139.5 (d, J_F = 15.0 Hz), 124.7 (d, J_F = 10.0 Hz), 122.7 (d, J_F = 8.8 Hz), 118.6 (d, J_F = 20.0 Hz), 117.6 (d, J_F = 26.2 Hz), 116.2 (d, J_F = 22.5 Hz), 111.2 (d, J_F = 46.2 Hz); ^{19}F NMR (470 MHz, $CDCl_3$): δ -118.5(s, 1F); **HRMS** (TIC): calcd for $C_{11}H_8ClFNO$ $[M + H]^+$ 224.0273, found 224.0275.

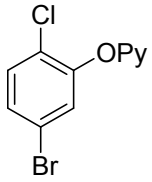
2-(2,5-dichlorophenoxy)pyridine (3n)



Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded yellow liquid (38.1 mg, 80 % yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.26 - 8.21 (m, 1H), 7.73 (d, J = 8.4 Hz, 1H), 7.54 - 7.26 (m, 3H), 7.04 - 6.95 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 162.5, 150.4, 147.5, 139.8, 133.0, 131.1, 128.3, 126.2, 124.2, 119.0, 111.3; **HRMS** (TIC): calcd for $C_{11}H_8Cl_2NO$ $[M + H]^+$ 239.9978, found

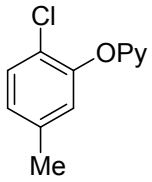
239.9976.

2-(5-bromo-2-chlorophenoxy)pyridine (3o)



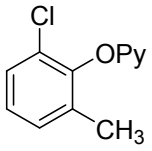
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded yellow liquid (49.7 mg, 88 % yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.19 (s, 1H), 7.77 (t, *J* =7.2 Hz, 1H), 7.42 (s, 1H), 7.39 - 7.34 (m, 2H), 7.06 - 7.04 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 162.5, 150.3, 147.5, 139.8, 131.5, 129.1, 127.0, 126.6, 120.4, 119.1, 111.5; **HRMS** (TIC): calcd for $C_{11}H_8BrClNO$ $[M + H]^+$ 283.9473, found 283.9474.

2-(2-chloro-5-methylphenoxy)pyridine (3p)



Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a yellow liquid (34.8 mg, 79 % yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.27 - 8.22 (m, 1H), 7.73 (d, *J* = 8.4 Hz, 1H), 7.41 - 7.32 (m, 1H), 7.09 - 7.02 (m, 3H), 6.95 (d, *J* = 8.0 Hz, 1H), 2.43 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 162.1, 148.4, 146.5, 138.4, 137.2 129.1, 125.9, 123.3, 123.1, 117.4, 110.0, 20.0; **HRMS** (TIC): calcd for $C_{12}H_{11}ClNO$ $[M + H]^+$ 220.0524, found 220.0523.

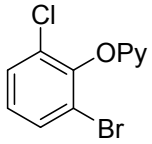
2-(2-chloro-6-methylphenoxy)pyridine (3q)



Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded yellow liquid (35.5 mg, 81 % yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.17 (s, 1H), 7.74 (t, *J* = 8.0 Hz, 1H), 7.35 (d, *J* = 8.0 Hz, 1H), 7.30 (s, 1H), 7.16 - 7.12 (m, 1H), 7.01 - 6.99 (m, 2H), 2.23 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 161.5, 147.0,

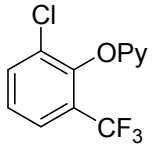
146.5, 138.5, 132.7, 128.4, 126.9, 126.8, 124.9, 117.2, 109.2, 15.8; **HRMS** (TIC): calcd for $C_{12}H_{11}ClNO$ $[M + H]^+$ 220.0524, found 220.0523.

2-(2-bromo-6-chlorophenoxy)pyridine (3r)



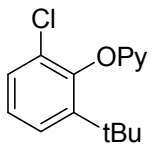
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded yellow liquid (40.1 mg, 71 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.10 (d, J = 4.5 Hz, 1H), 7.74 (t, J = 7.0 Hz, 1H), 7.55 (d, J = 8.5 Hz, 1H), 7.43 (d, J = 8.0 Hz, 1H), 7.09 - 6.99 (m, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 161.9, 147.5, 147.3, 139.6, 131.8, 129.7, 129.5, 126.9, 118.9, 118.7, 110.7; **HRMS** (TIC): calcd for $C_{11}H_8BrClNO$ $[M + H]^+$ 283.9473, found 283.9474.

2-(2-chloro-6-(trifluoromethyl)phenoxy)pyridine (3s)



Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded yellow liquid (25.7 mg, 47 % yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.14 (s, 1H), 7.79 (t, J = 7.2 Hz, 1H), 7.70 (t, J = 8.4 Hz, 2H), 7.38 - 7.32 (m, 2H), 7.12 (d, J = 8.0 Hz, 1H), 7.06 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 163.1, 151.8, 147.5, 139.6, 138.4, 132.9, 127.1 (q, J_F = 5.0 Hz), 124.5, 123.6, 123.0 (q, J_F = 151.2 Hz), 119.0; ^{19}F NMR (470 MHz, $CDCl_3$): δ -61.8(s, 3F); **HRMS** (TIC): calcd for $C_{12}H_8ClF_3NO$ $[M + H]^+$ 274.0241, found 274.0240.

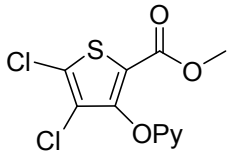
2-(2-(tert-butyl)-6-chlorophenoxy)pyridine (3t)



Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a brown liquid (40.1 mg, 77 % yield). ^{1}H NMR (500 MHz, DMSO-d_6): δ 8.17 (d, J = 4.5 Hz, 1H), 7.85 (t, J = 7.5 Hz, 1H), 7.41 (d, J = 7.5 Hz, 1H), 7.22 (d, J = 7.5 Hz, 1H), 7.15 - 7.10 (m, 2H), 7.01 - 6.91 (m, 1H), 1.31 (s, 9H); ^{13}C NMR (125

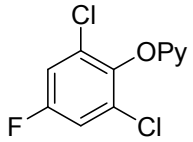
MHz, $CDCl_3$): δ 162.0, 147.1, 146.6, 143.7, 138.3, 128.0, 127.4, 124.9, 124.6, 116.9, 109.7, 34.3, 29.5, 28.2, 17.4; **HRMS** (TIC): calcd for $C_{15}H_{17}ClNO$ $[M + H]^+$ 262.0993, found 262.0990.

methyl-4,5-dichloro-3-(pyridin-2-yloxy)thiophene-2-carboxylate (3u)



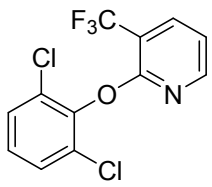
Following the general procedure, using 8:1 petroleum ether-EtOAc as the eluant afforded a brown liquid (42.3.3 mg, 70 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.01 (d, J = 5.0 Hz, 1H), 7.66 (t, J = 6.5 Hz, 1H), 7.33 (s, 1H), 7.00 (d, J = 8.5 Hz, 1H), 6.93 (t, J = 7.0 Hz, 1H), 3.65 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 161.5, 159.4, 148.7, 146.2, 138.6, 123.5, 121.4, 118.6, 117.8, 109.8, 51.1; **HRMS** (TIC): calcd for $C_{11}H_8Cl_2NO_3S$ $[M + H]^+$ 303.9597, found 303.9595.

2-(2,6-dichloro-4-fluorophenoxy)pyridine (3v)



Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a light yellow liquid (48.4 mg, 92 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.00 (d, J = 4.0 Hz, 1H), 7.66 (t, J = 7.0 Hz, 1H), 7.08 (t, J = 8.0Hz, 2H), 6.99 - 6.92 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 160.8, 158.7, 156.7, 146.2, 142.1, 138.7, 129.3 (d, J_F= 12.5 Hz), 117.9, 115.2 (d, J_F= 25.0 Hz), 109.6; ^{19}F NMR (470 MHz, $CDCl_3$): δ -113.9(s, 1F); **HRMS** (TIC): calcd for $C_{11}H_7Cl_2FNO$ $[M + H]^+$ 257.9883, found 257.9885.

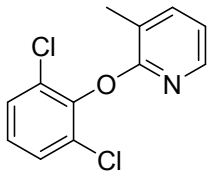
2-(2,6-dichlorophenoxy)-3-(trifluoromethyl)pyridine (5a)



Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a yellow liquid (14.1 mg, 23 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.25

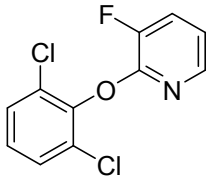
(d, J = 4.5 Hz, 1H), 8.01 (d, J = 8.0 Hz, 1H), 7.49 (d, J = 7.0 Hz, 1H), 7.42 - 7.33 (m, 1H), 7.25 - 7.22 (m, 1H), 7.11 - 7.09 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 159.6, 150.7, 149.0, 137.1 (q, J_F= 5.0 Hz), 130.6, 128.1 (q, J_F= 108.8 Hz), 127.9, 126.7, 120.0 (q, J_F= 271.2 Hz), 117.9; ^{19}F NMR (470 MHz, $CDCl_3$): δ -63.4(s, 3F); **HRMS** (TIC): calcd for $C_{12}H_7Cl_2F_3NO$ $[M + H]^+$ 307.9852, found 307.9850.

2-(2,6-dichlorophenoxy)-3-methylpyridine (5b)



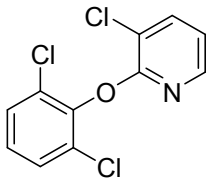
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a yellow liquid (41.1 mg, 81 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.81 (d, J = 5.0 Hz, 1H), 7.45 (d, J = 7.5 Hz, 1H), 7.30 (d, J = 8.0 Hz, 2H), 7.04 (t, J = 8.0 Hz, 1H), 6.84 - 6.82 (m, 1H) , 2.35 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 159.3, 145.9, 143.4, 138.7, 128.7, 127.6, 125.1, 119.8, 117.8, 14.8; **HRMS** (TIC): calcd for $C_{12}H_{10}Cl_2NO$ $[M + H]^+$ 254.0134, found 254.0131.

2-(2,6-dichlorophenoxy)-3-fluoropyridine (5c)



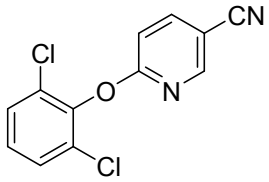
Following the general procedure, using 10:1 petroleum ether-EtOAc as the eluant afforded a light yellow liquid (40.8 mg, 79 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.84 (s, 1H), 7.26 - 7.18 (m, 1H), 7.11 (t, J = 8.5 Hz, 3H), 7.00 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 155.7 (d, J_F = 6.2 Hz), 150.6 (d, J_F = 200.0 Hz), 144.0 (d, J_F = 75 Hz), 143.1, 129.9 (d, J_F = 45 Hz), 126.8 (d, J_F = 81.2 Hz), 124.4 (d, J_F = 8.8 Hz), 123.4 (d, J_F = 31.2 Hz), 118.8 (d, J_F = 18.8 Hz); ^{19}F NMR (470 MHz, $CDCl_3$): δ -137.7(s, 1F); **HRMS** (TIC): calcd for $C_{11}H_7Cl_2FNO$ $[M + H]^+$ 257.9883, found 257.9885.

3-chloro-2-(2,6-dichlorophenoxy)pyridine (5d)



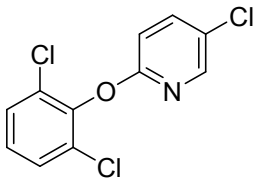
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a light yellow liquid (40.1 mg, 73 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.96 (d, *J* = 3.5 Hz, 1H), 7.79 (d, *J* = 9.0 Hz, 1H), 7.40 (d, *J* = 8.0 Hz, 2H), 7.17 (t, *J* = 8.0 Hz, 1H), 7.01 - 6.98 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 157.3, 146.3, 144.9, 139.5, 129.6, 128.8, 126.7, 119.8, 118.3; **HRMS** (TIC): calcd for $C_{11}H_7Cl_3NO$ $[M + H]^+$ 273.9588, found 273.9591.

6-(2,6-dichlorophenoxy)nicotinonitrile (5e)



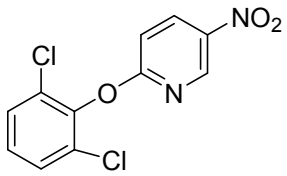
Following the general procedure, using 5:1 petroleum ether-EtOAc as the eluant afforded a yellow liquid (40.4 mg, 76 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.40 (d, *J* = 2.0 Hz, 1H), 7.99 (d, *J* = 6.5 Hz, 1H), 7.42 (d, *J* = 8.0 Hz, 2H), 7.22 - 7.19 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 163.7, 151.9, 142.6, 129.4, 128.9, 127.2, 122.0, 120.9, 116.5, 111.5; **HRMS** (TIC): calcd for $C_{12}H_7Cl_2N_2O$ $[M + H]^+$ 264.9930, found 264.9927.

5-chloro-2-(2,6-dichlorophenoxy)pyridine (5f)



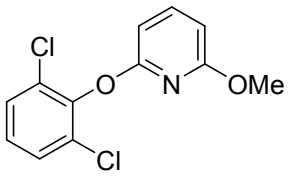
Following the general procedure, using 15:1 petroleum ether-EtOAc as the eluant afforded a light yellow liquid (53.3 mg, 98 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.03 (d, *J* = 2.0 Hz, 1H), 7.71 - 7.68 (m, 1H), 7.39 (d, *J* = 8.0 Hz, 2H), 7.16 (t, *J* = 8.0 Hz, 1H), 7.03 (d, *J* = 9.0 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 160.3, 146.1, 145.7, 139.6, 129.7, 128.8, 126.7, 126.3, 111.7; **HRMS** (TIC): calcd for $C_{11}H_7Cl_3NO$ $[M + H]^+$ 273.9588, found 273.9591.

2-(2,6-dichlorophenoxy)-5-nitropyridine (5g)



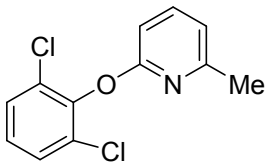
Following the general procedure, using 5:1 petroleum ether-EtOAc as the eluant afforded a light yellow liquid (18.7 mg, 33 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.98 (d, *J* = 2.5 Hz, 1H), 8.55 (d, *J* = 6..0 Hz, 1H), 7.43 (d, *J* = 8.5 Hz, 2H), 7.24 - 7.21 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 164.8, 145.6, 144.8, 141.0, 135.3, 129.3, 128.9, 127.3, 111.0; **HRMS** (TIC): calcd for $C_{11}H_7Cl_2N_2O_3$ $[M + H]^+$ 284.9828, found 284.9825.

2-(2,6-dichlorophenoxy)-6-methoxypyridine (5h)



Following the general procedure, using 2:1 petroleum ether-EtOAc as the eluant afforded a yellow liquid (35.0 mg, 65 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.06 (d, *J* = 3.5 Hz, 1H), 7.60 (t, *J* = 7.5 Hz, 1H), 7.05 (d, *J* = 9.0 Hz, 1H), 6.93 (d, *J* = 3.0 Hz, 2H), 6.90 - 6.76 (m, 2H), 3.72 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.0, 154.9, 153.6, 140.7, 129.2, 124.8, 121.1, 110.6, 109.2, 54.6; **HRMS** (TIC): calcd for $C_{12}H_{10}Cl_2NO_2$ $[M + H]^+$ 270.0083, found 270.0084.

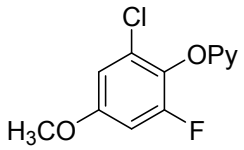
2-(2,6-dichlorophenoxy)-6-methylpyridine (5i)



Following the general procedure, using 5:1 petroleum ether-EtOAc as the eluant afforded a yellow liquid (36.6 mg, 68 % yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.56 (t, *J* = 7.2 Hz, 1H), 7.41 (t, *J* = 6.4 Hz, 2H), 7.22 - 7.15 (m, 3H), 6.90 (d, *J* = 6.8 Hz, 1H), 6.60 (d, *J* = 8.0 Hz, 1H), 2.50 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 161.3, 154.4, 139.7, 129.7, 124.9, 124.6, 122.1, 120.2, 109.4, 22.4; **HRMS** (TIC): calcd for

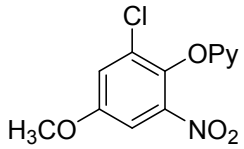
$C_{12}H_{10}Cl_2NO$ $[M + H]^+$ 254.0134, found 254.0131.

2-(2-chloro-6-fluoro-4-methoxyphenoxy)pyridine (7a)



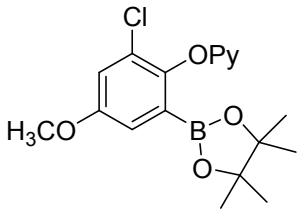
A 25 mL Schlenk tube equipped with a stir bar was charged with 3l (0.2 mmol), NFSI (3.0 equiv), $Pd(OAc)_2$ (10 mol %), EtOAc (2.0 mL), 110 °C, under N_2, 6 h, using 10:1 petroleum ether -EtOAc as the eluant afforded a light yellow liquid (26.7 mg, 53 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.12 (d, J = 4.5 Hz, 1H), 7.72 (t, J = 7.5 Hz, 1H), 7.05 - 7.00 (m, 2H), 6.95 (s, 1H), 6.82 - 6.68 (m, 1H), 3.80 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 163.2, 155.8, 146.3 (d, J_F = 3.8 Hz), 138.6 (d, J_F = 7.5 Hz), 134.5, 128.7 (d, J_F = 23.8 Hz), 127.4, 117.7 (d, J_F = 15.0 Hz), 113.5, 109.6 (d, J_F = 27.5 Hz), 101.0 (d, J_F = 22.5 Hz), 54.9; ^{19}F NMR (470 MHz, $CDCl_3$): δ -123.4 (s, 1F); **HRMS** (TIC): calcd for $C_{12}H_{10}ClFNO_2$ $[M + H]^+$ 254.0379, found 254.0382.

2-(2-chloro-4-methoxy-6-nitrophenoxy)pyridine (7b)



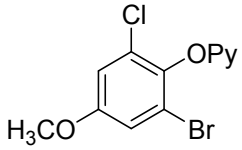
A 25 mL Schlenk tube equipped with a stir bar was charged with 3l (0.2 mmol), $AgNO_2$ (2.0 equiv), $Pd(OAc)_2$ (10 mol %), $K_2S_2O_8$ (2.0 equiv), DCE (2.0 mL), 110 °C, under N_2, 48 h, using 5:1 petroleum ether- EtOAc as the eluant afforded a light yellow liquid (35.3 mg, 68 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.06 (d, J = 4.5 Hz, 1H), 7.60 (t, J = 8.0 Hz, 1H), 7.05 (d, J = 9.0 Hz, 1H), 6.93 - 6.87 (m, 2H), 6.78 - 6.76 (m, 1H), 3.72 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 161.2, 155.8, 146.4, 138.9, 138.5, 128.8, 124.4, 117.6, 113.5, 112.5, 109.5, 54.9; **HRMS** (TIC): calcd for $C_{12}H_{10}ClN_2O_4$ $[M + H]^+$ 281.0324, found 281.0323.

2-(2-chloro-4-methoxy-6-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenoxy)pyridine (7c)



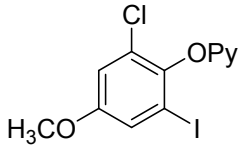
A 25 mL Schlenk tube equipped with a stir bar was charged with 3l (0.2 mmol), B_2pin_2 (2.0 equiv), Cp*Rh(III) (5 mol %), PCy_3 (30 mol %), EtOAc (2.0 mL), 100 °C, under N_2, 24 h, using 10:1 petroleum ether-EtOAc as the eluant afforded a light yellow liquid (41.1 mg, 57 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.05 (d, *J* = 4.5 Hz, 1H), 7.66 (t, *J* = 8.5 Hz, 1H), 6.96 - 6.92 (m, 2H), 6.88 (s, 2H), 3.74 (s, 3H), 1.51 (s, 6H), 1.18 (s, 6H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 162.3, 156.8, 147.5, 140.0, 139.5, 129.8, 126.1, 125.4, 118.6, 114.5, 113.6, 110.6, 83.5, 65.6, 56.7, 55.9, 25.0, 24.6; **HRMS** (TIC): calcd for $C_{18}H_{22}BClNO_4$ $[M + H]^+$ 362.1325, found 362.1323.

2-(2-bromo-6-chloro-4-methoxyphenoxy)pyridine (7d)



A 25 mL Schlenk tube equipped with a stir bar was charged with 3l (0.2 mmol), NBS (3.0 equiv), $Pd(OAc)_2$ (10 mol %), TsOH (10 mol %), EtOAc (2.0 mL), 110 °C, under N_2, 6 h using 10:1 petroleum ether-EtOAc as the eluant afforded a light yellow liquid (32.3 mg, 52 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.11 (s, 1H), 7.71 (t, *J* = 8.0 Hz, 1H), 7.04 - 6.98 (m, 2H), 6.94 (s, 2H), 3.80 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 162.3, 156.8, 147.4, 139.9, 139.5, 129.8, 125.4, 118.6, 114.5, 111.0, 110.6, 55.9; **HRMS** (TIC): calcd for $C_{12}H_{10}BrClNO_2$ $[M + H]^+$ 313.9578, found 313.9580.

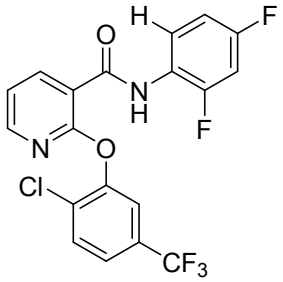
2-(2-chloro-6-iodo-4-methoxyphenoxy)pyridine (7e)



A 25 mL Schlenk tube equipped with a stir bar was charged with 3l (0.2 mmol), NIS (3.0 equiv), $Pd(OAc)_2$ (10 mol %), TsOH (10 mol %), EtOAc (2.0 mL), 110 °C, under N_2, 6 h, using 10:1 petroleum ether-EtOAc as the eluant afforded a light yellow liquid

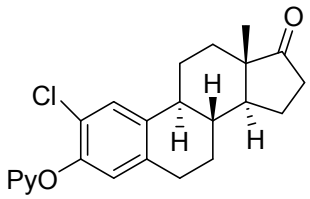
(25.3 mg, 35 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.05 (d, J = 5.0 Hz, 1H), 7.66 (t, J = 7.5 Hz, 1H), 6.97 - 6.93 (m, 2H), 6.88 (s, 2H), 3.74 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 163.4, 157.2, 147.5, 143.3, 139.4, 127.8, 124.4, 118.3, 115.6, 113.7, 110.8, 55.8; **HRMS** (TIC): calcd for $C_{12}H_{11}ClINO_2$ $[M + H]^+$ 361.9439, found 361.9437.

2-(2-chloro-5-(trifluoromethyl)phenoxy)-N-(2,4-difluorophenyl)nicotinamide (8a)



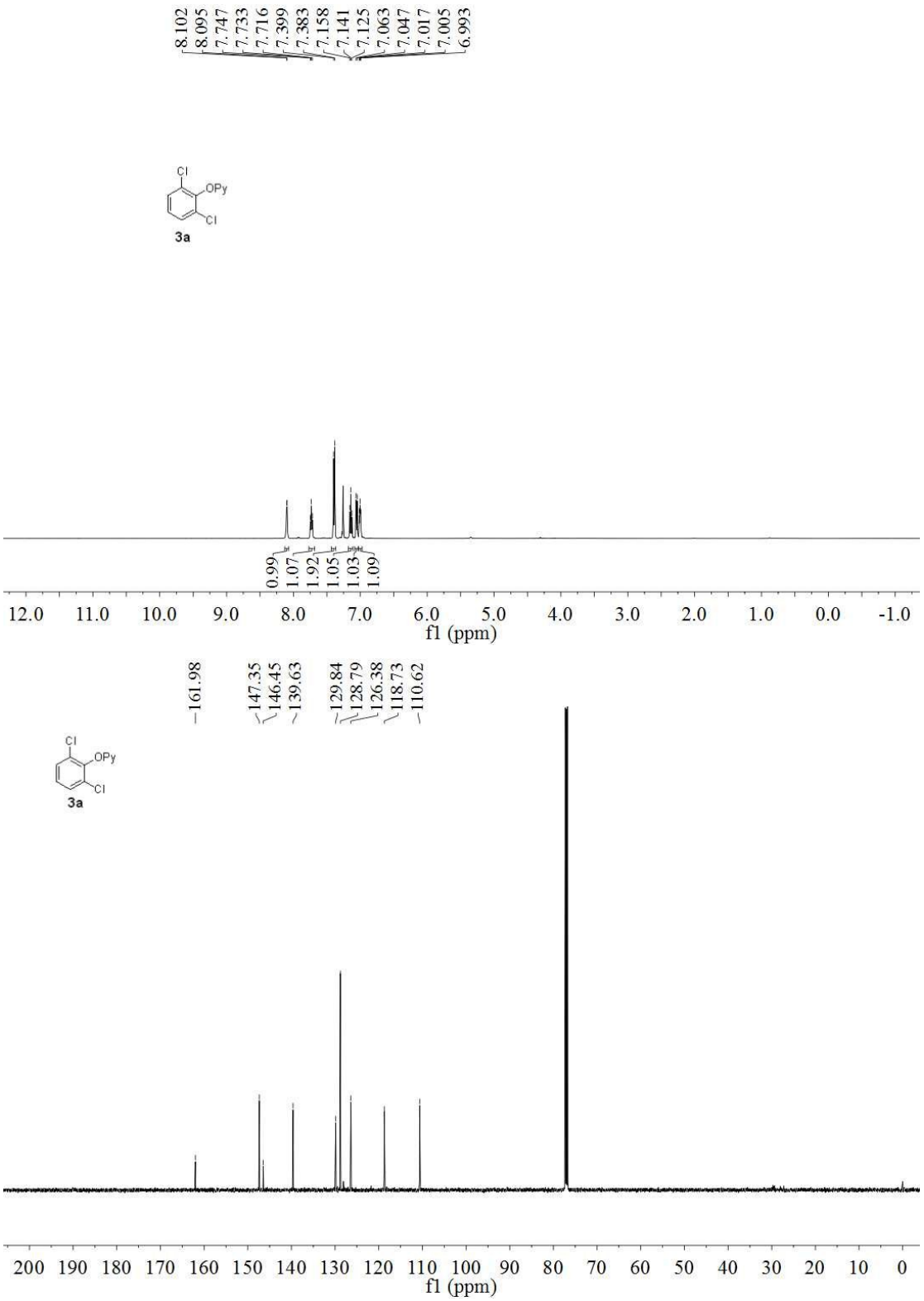
Following the general procedure, using 8:1 petroleum ether-EtOAc as the eluant afforded a light brown liquid (80.7 mg, 94 % yield). ^{1}H NMR (500 MHz, $CDCl_3$): δ 9.82 (s, 1H), 8.71-8.69 (m, 1H), 8.52 - 8.47 (m, 1H), 8.24 - 8.22 (m, 1H), 7.68 - 7.55 (m, 3H), 7.29 - 7.26 (m, 1H), 6.95 - 6.87 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 161.0, 158.8 (dd, J_F = 245.0, 11.2 Hz), 158.6, 152.9 (dd, J_F = 246.2, 11.2 Hz), 150.4, 148.5, 142.9, 131.4, 131.2, 130.6 (q, J_F = 33.8 Hz), 124.2, 123.9 (q, J_F = 3.8 Hz), 123.1 (d, J_F = 7.5 Hz), 122.8 (dd, J_F = 10.0, 3.8 Hz), 122.0 (q, J_F = 3.8 Hz), 120.4, 116.6, 111.3 (dd, J_F = 21.2, 3.8 Hz), 103.6 (dd, J_F = 26.2, 23.8 Hz); ^{19}F NMR (470 MHz, $CDCl_3$): δ -125.3 (s, 1F), -114.5 (s, 1F), -62.5 (s, 3F). **HRMS** (TIC): calcd for $C_{19}H_{11}ClF_5N_2O_2$ $[M + H]^+$ 429.0424, found 429.0423.

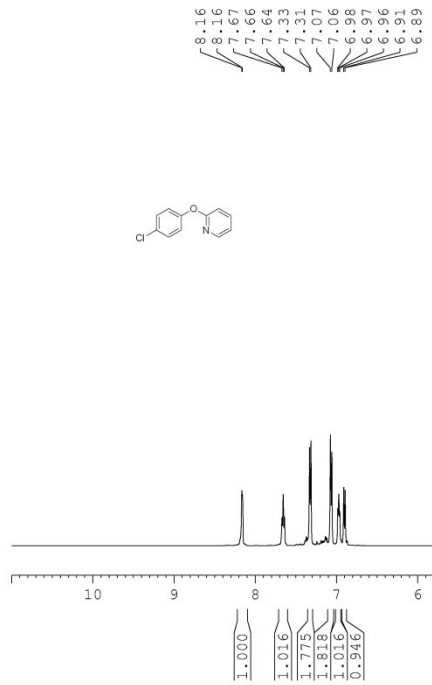
(8R,9S,13S,14S)-2-chloro-8,9,13,14-tetramethyl-3-(pyridin-2-yloxy)-6,7,8,9,11,12,13,14,15,16-decahydro-17H-cyclopenta[a]phenanthren-17-one (8b)

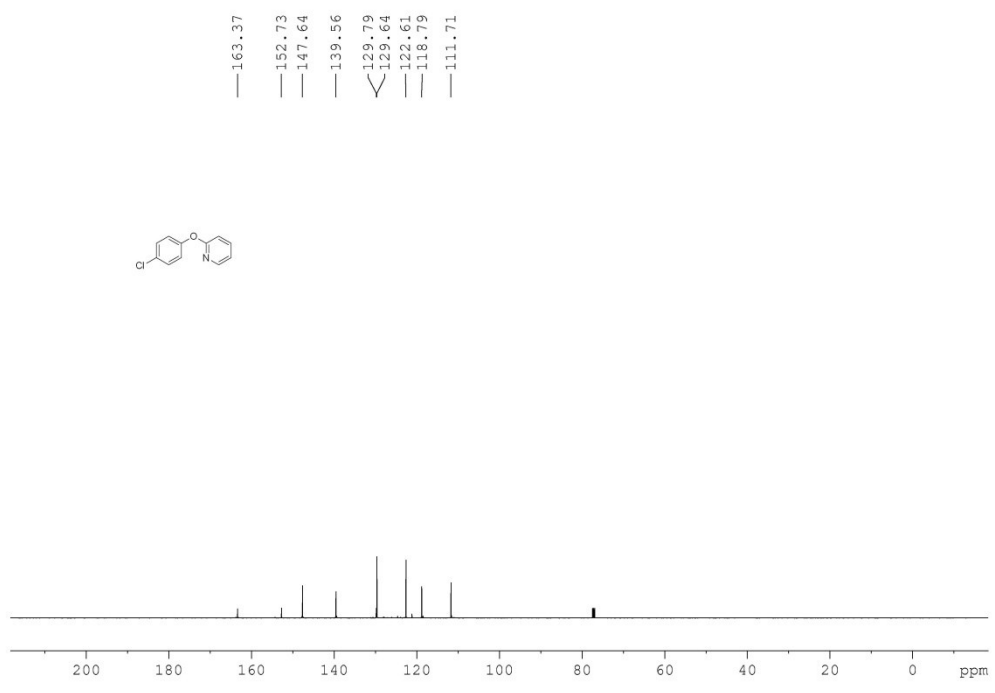


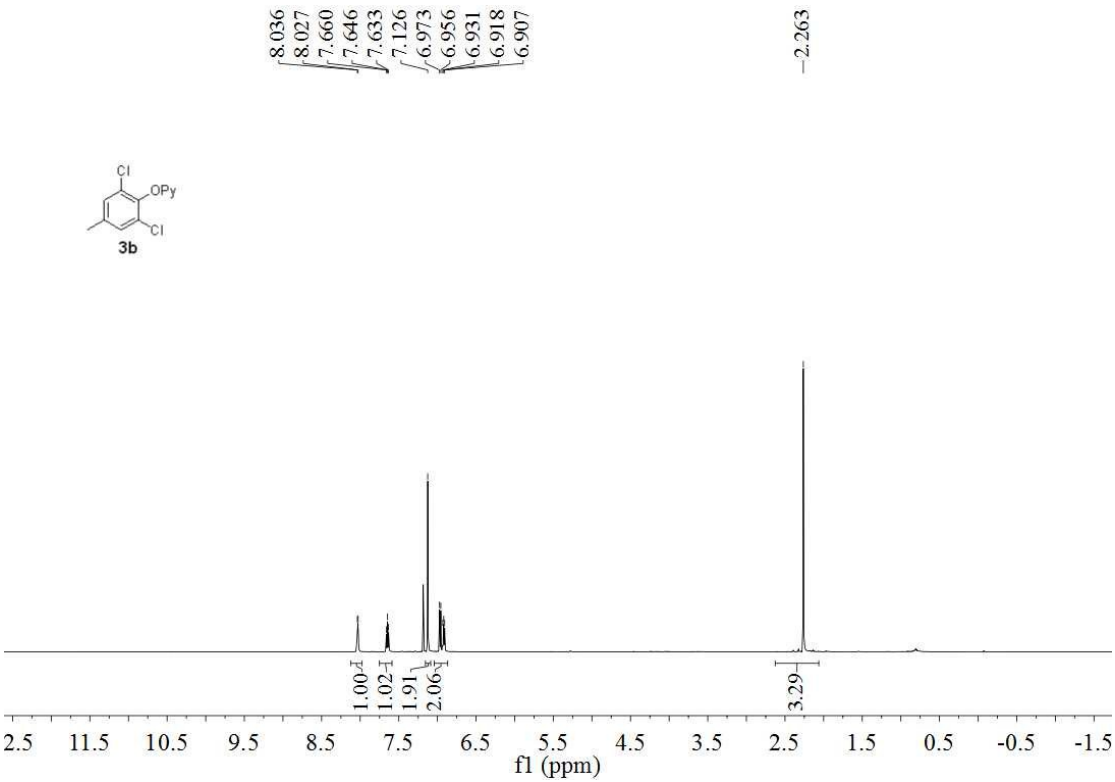
Following the general procedure, using 10:1 petroleum ether-EtOAc as the eluant afforded a yellow liquid (46.5 mg, 55 % yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.22 (s, 1H), 7.77 (t, J = 6.8 Hz, 1H), 7.39 (s, 1H), 7.05 - 7.01 (m, 3H), 3.06 - 3.03 (m, 1H),

2.93 (s, 2H), 2.59 - 2.52 (m, 1H), 2.46 - 2.41 (m, 2H), 2.19 - 2.09 (m, 2H), 1.94 - 1.90 (m, 2H), 1.74 - 1.52 (m, 4H), 1.30 (s, 1H), 1.17 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 205.6, 162.9, 147.4, 147.2, 139.9, 137.4, 136.3, 127.4, 124.3, 123.8, 118.5, 111.2, 82.9, 47.3, 45.8, 45.7, 43.8, 36.5, 32.3, 28.7, 26.2, 25.2, 15.8; **HRMS** (TIC): calcd for $C_{26}H_{31}ClNO_2$ $[M + H]^+$ 424.2038, found 424.2039.


8.102
8.095
7.747
7.733
7.716
7.399
7.383
7.158
7.141
7.125
7.063
7.047
7.017
7.005
6.993
Cl
OPy
Cl
3a
0.99
1.07
1.92
1.05
1.03
1.09
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)
161.98
147.35
146.45
139.63
129.84
128.79
126.38
118.73
110.62
Cl
OPy
Cl
3a
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


8.16
8.16
7.67
7.66
7.64
7.33
7.31
7.07
7.06
6.98
6.97
6.96
6.91
6.89
Cl
O
N
10
9
8
7
6
5
4
3
2
1
0
ppm
1.000
1.016
1.775
1.818
1.016
0.946


163.37
152.73
147.64
139.56
129.79
129.64
122.61
118.79
111.71
Cl
O
N
200
180
160
140
120
100
80
60
40
20
0
ppm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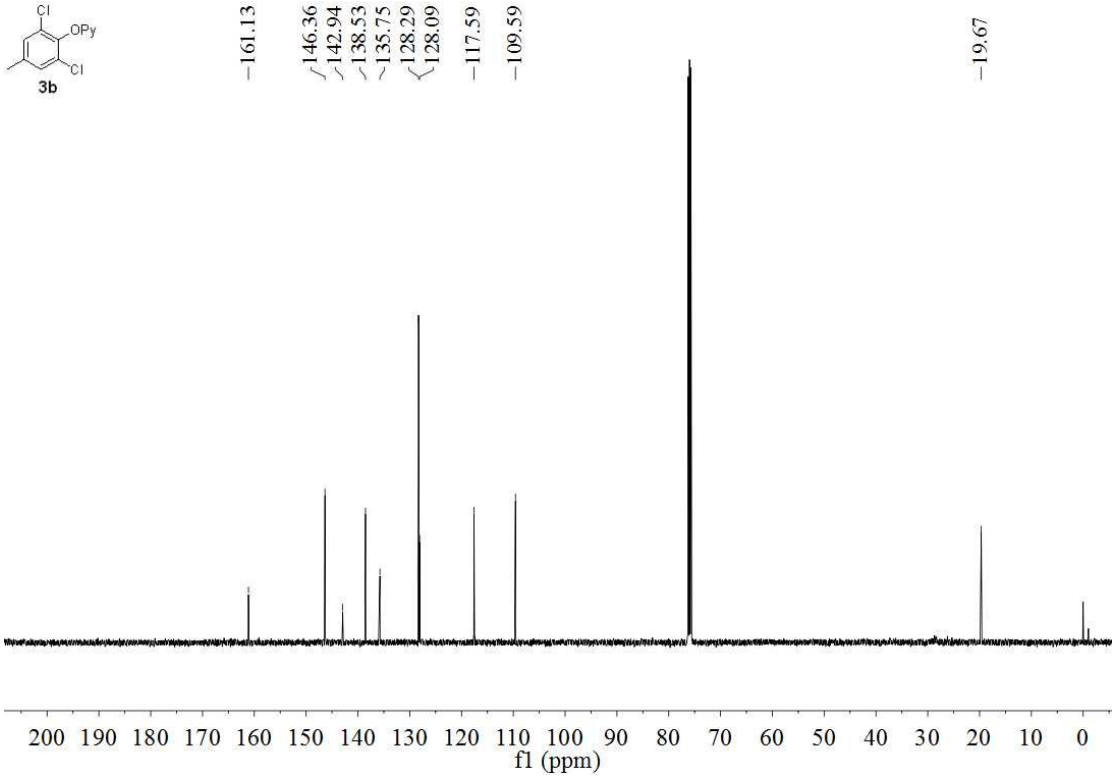
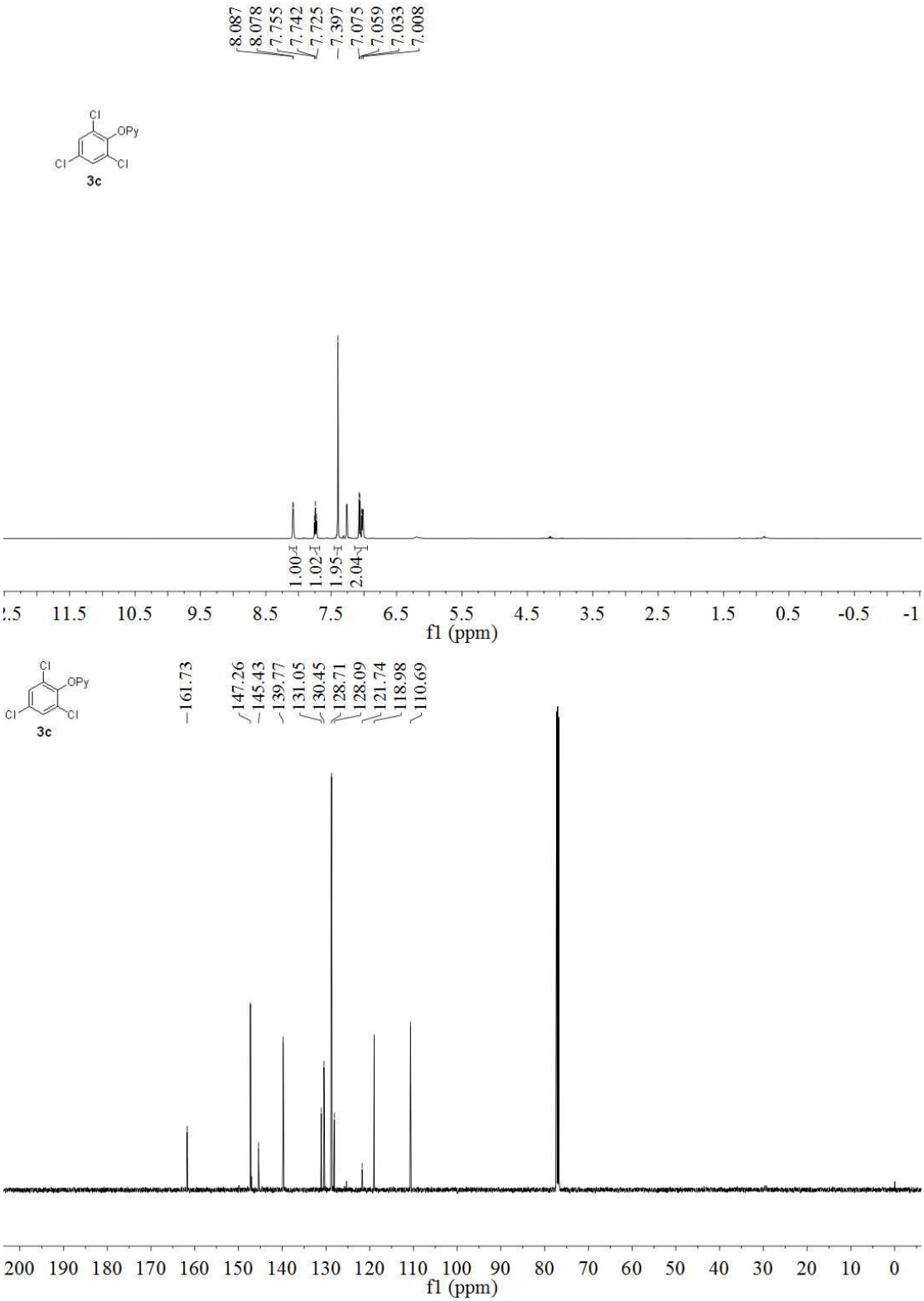
8.027
7.660
7.646
7.633
7.126
6.973
6.956
6.931
6.918
6.907
2.263
Cl
OPy
Cl
3b
1.00
1.02
1.91
2.06
3.29
2.5 11.5 10.5 9.5 8.5 7.5 6.5 5.5 4.5 3.5 2.5 1.5 0.5 -0.5 -1.5
f1 (ppm)


Cl
OPy
Cl
3b
161.13
146.36
142.94
138.53
135.75
128.29
128.09
117.59
109.59
19.67
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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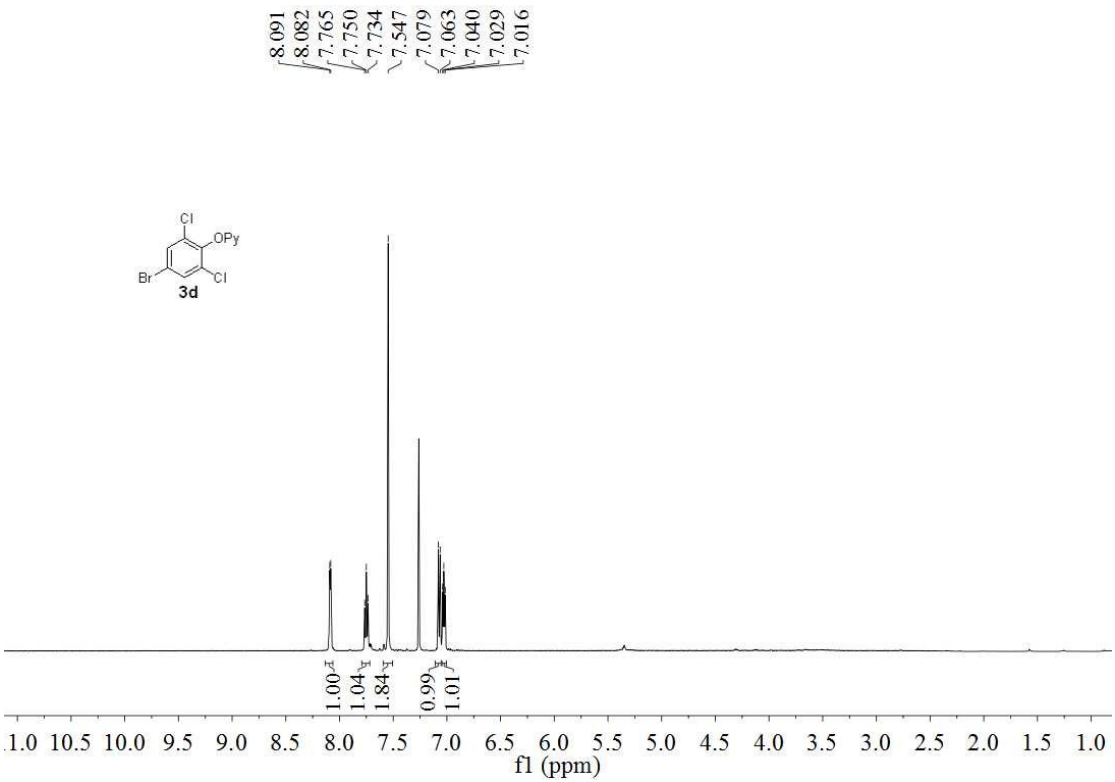
8.078
7.755
7.742
7.725
7.397
7.075
7.059
7.033
7.008
Cl
OPy
Cl
Cl
3c
1.00
1.02
1.95
2.04
f1 (ppm)
161.73
147.26
145.43
139.77
131.05
130.45
128.71
128.09
121.74
118.98
110.69
f1 (ppm)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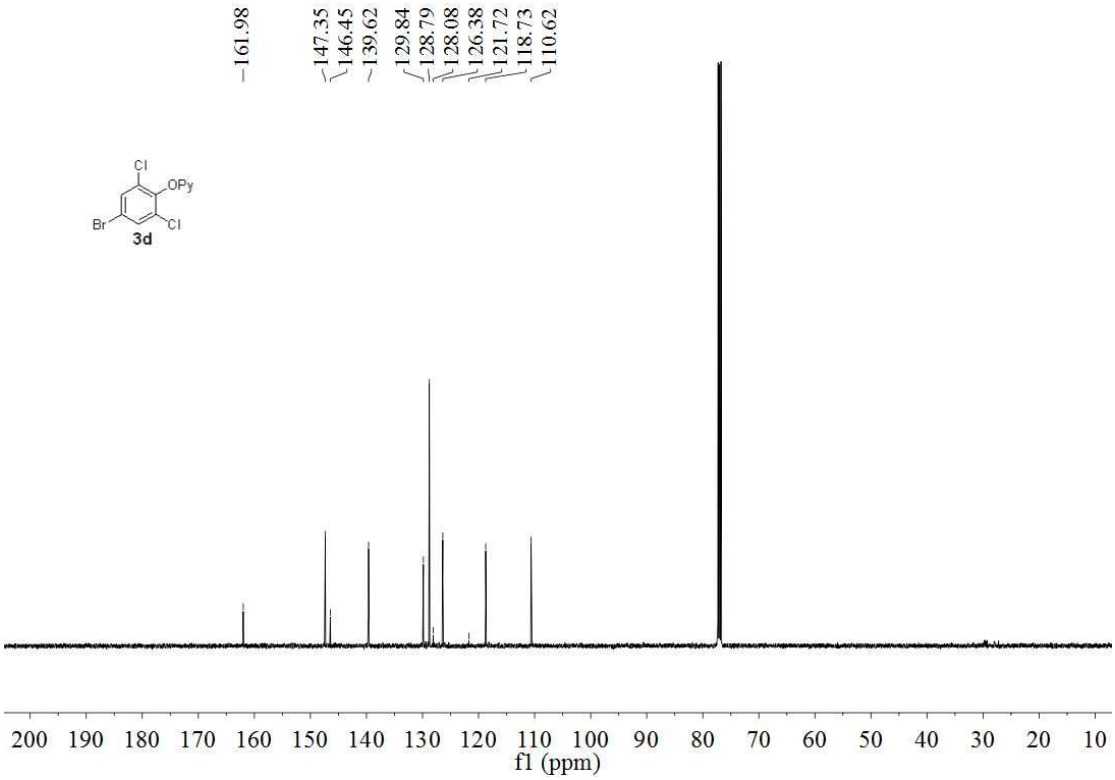
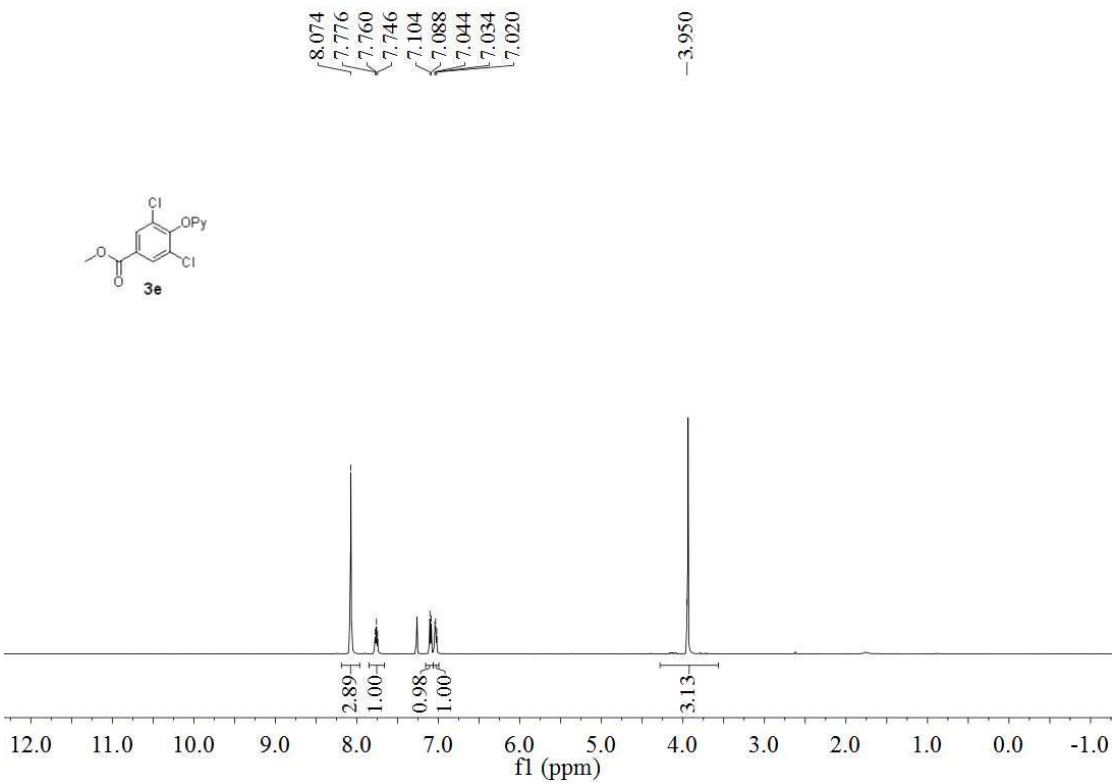
8.082
7.765
7.750
7.734
7.547
7.079
7.063
7.040
7.029
7.016
Cl
OPy
Br
Cl
3d
1.00
1.04
1.84
0.99
1.01
1.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
f1 (ppm)


161.98
147.35
146.45
139.62
129.84
128.79
128.08
126.38
121.72
118.73
110.62
Cl
OPy
Br
Cl
3d
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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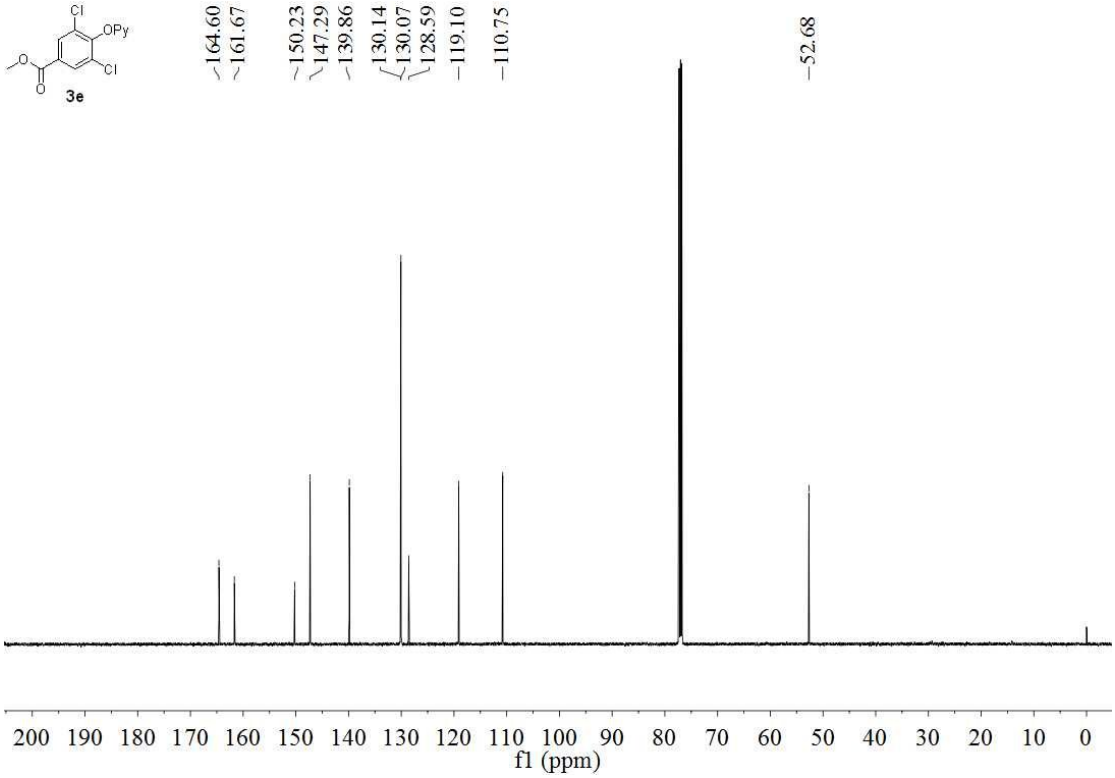
7.776
7.760
7.746
7.104
7.088
7.044
7.034
7.020
3.950
Cl
OPy
Cl
3e
2.89
1.00
0.98
1.00
3.13
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)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OPy
Cl
3e
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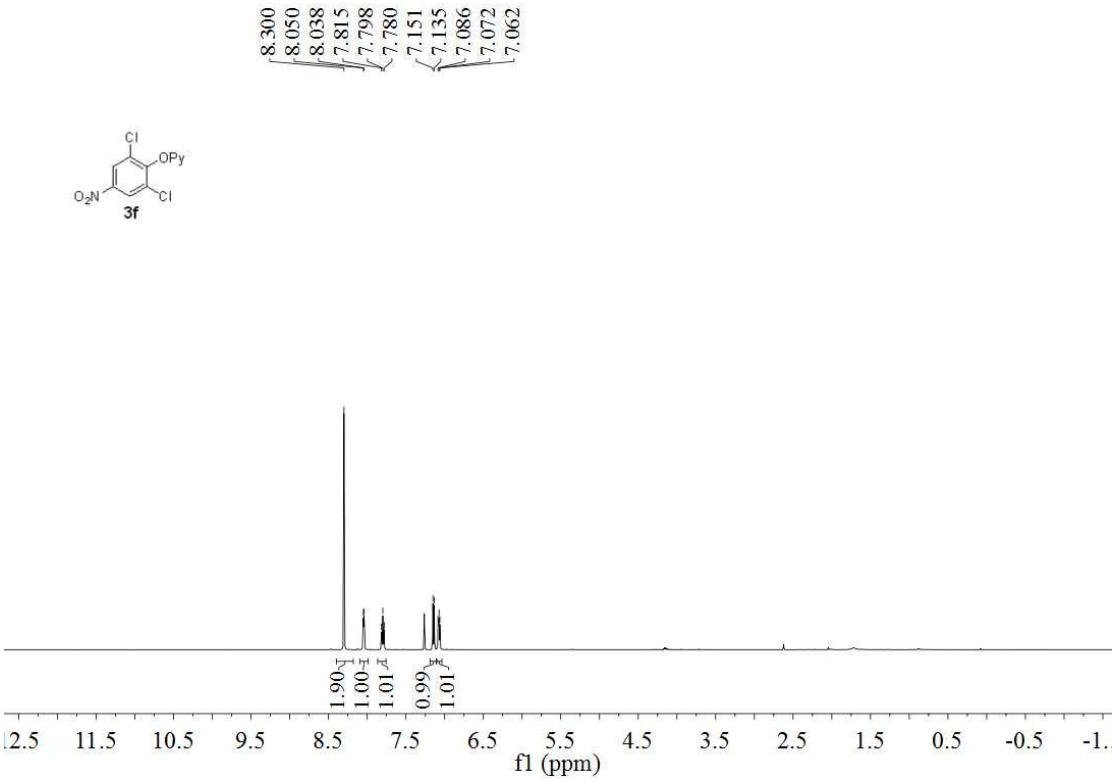
161.67
150.23
147.29
139.86
130.14
130.07
128.59
119.10
110.75
52.68
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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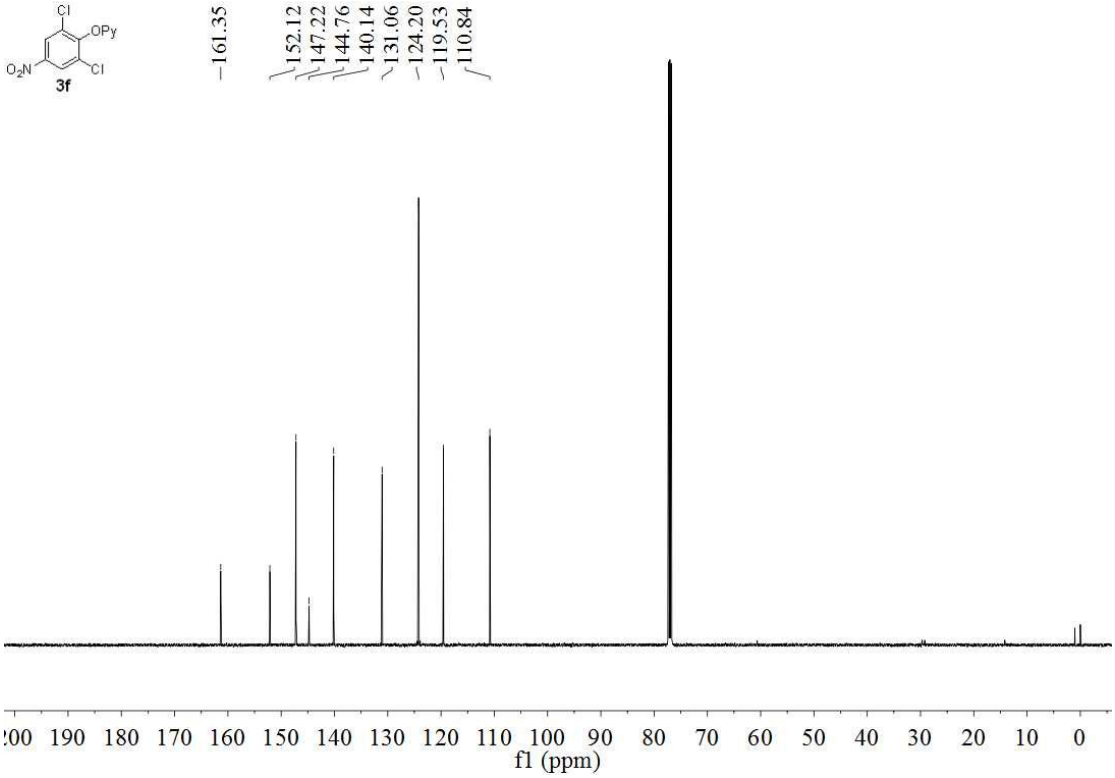
8.038
7.815
7.798
7.780
7.151
7.135
7.086
7.072
7.062
Cl
OPy
O2N
Cl
3f
1.90
1.00
1.01
0.99
1.01
f1 (ppm)


Cl
OPy
O2N
Cl
3f
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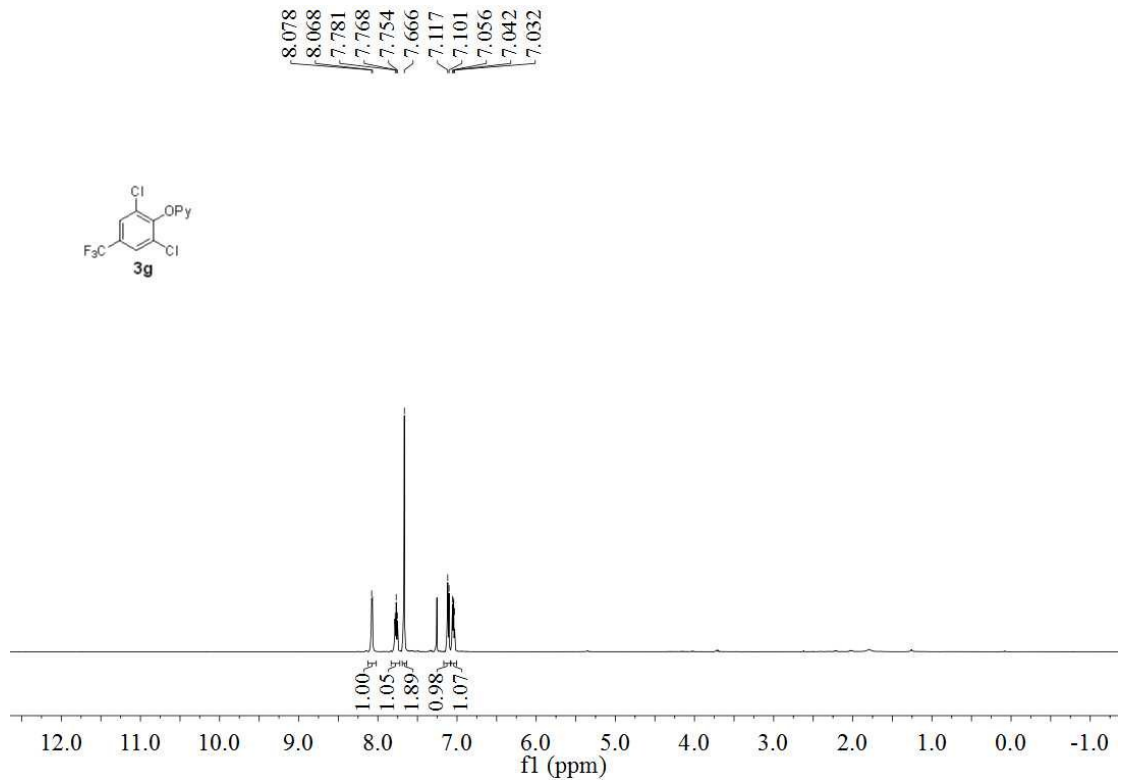
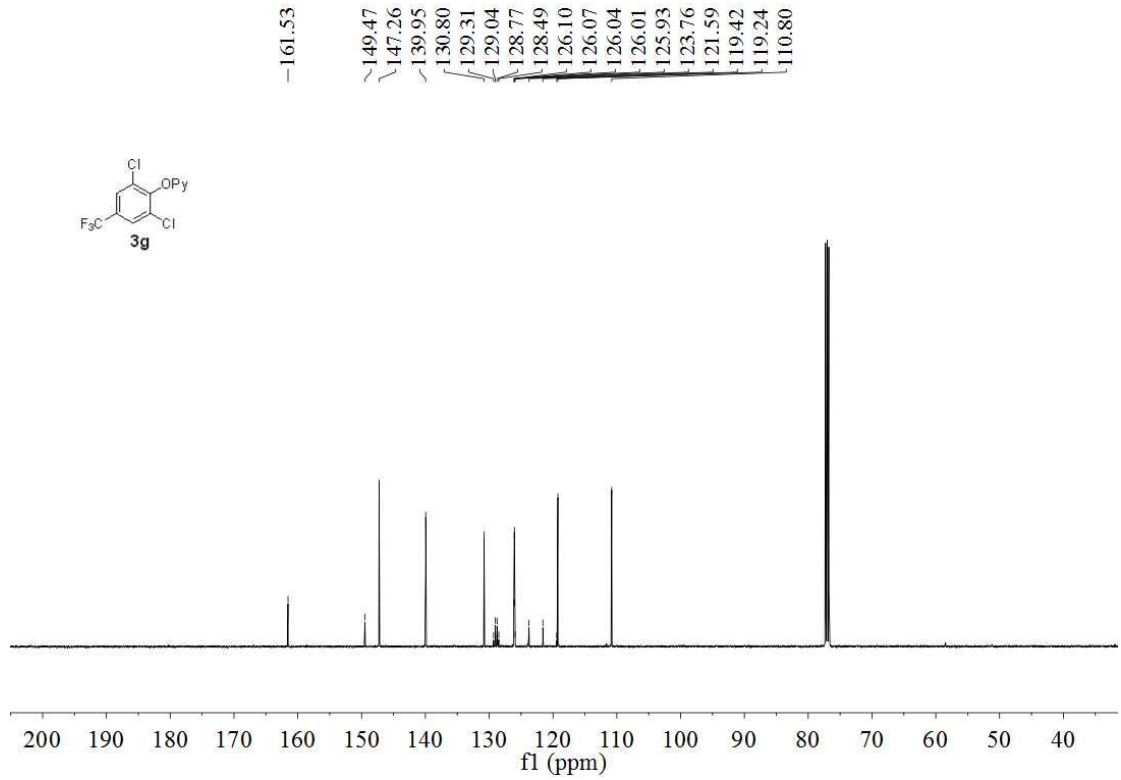
152.12
147.22
144.76
140.14
131.06
124.20
119.53
110.84
f1 (ppm)


8.078
8.068
7.781
7.768
7.754
7.666
7.117
7.101
7.056
7.042
7.032
Cl
OPy
F3C
Cl
3g
1.00
1.05
1.89
0.98
1.07
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)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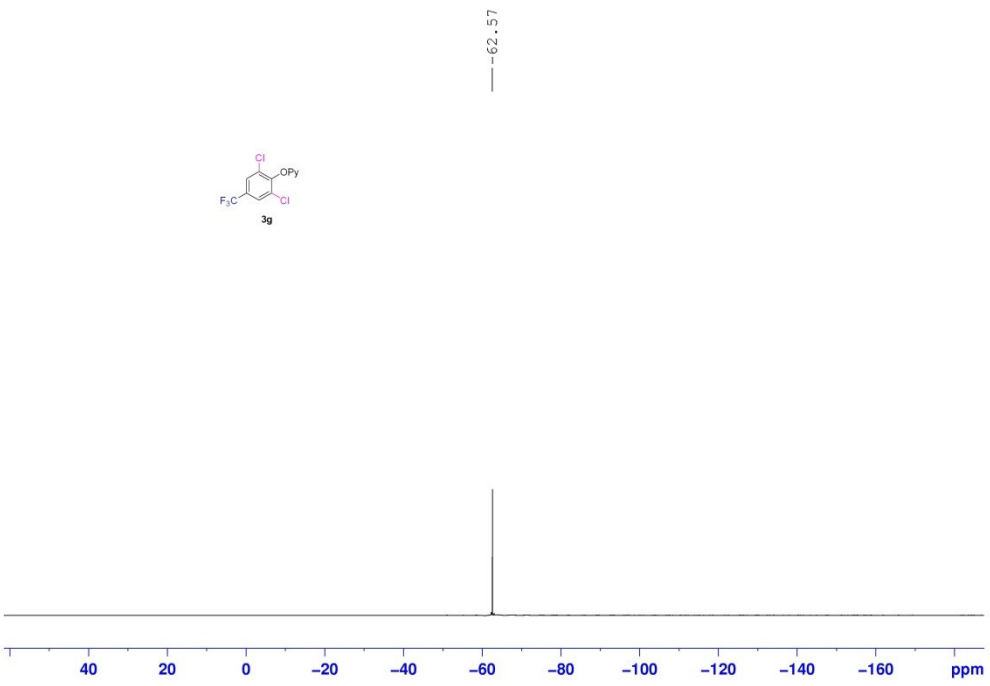
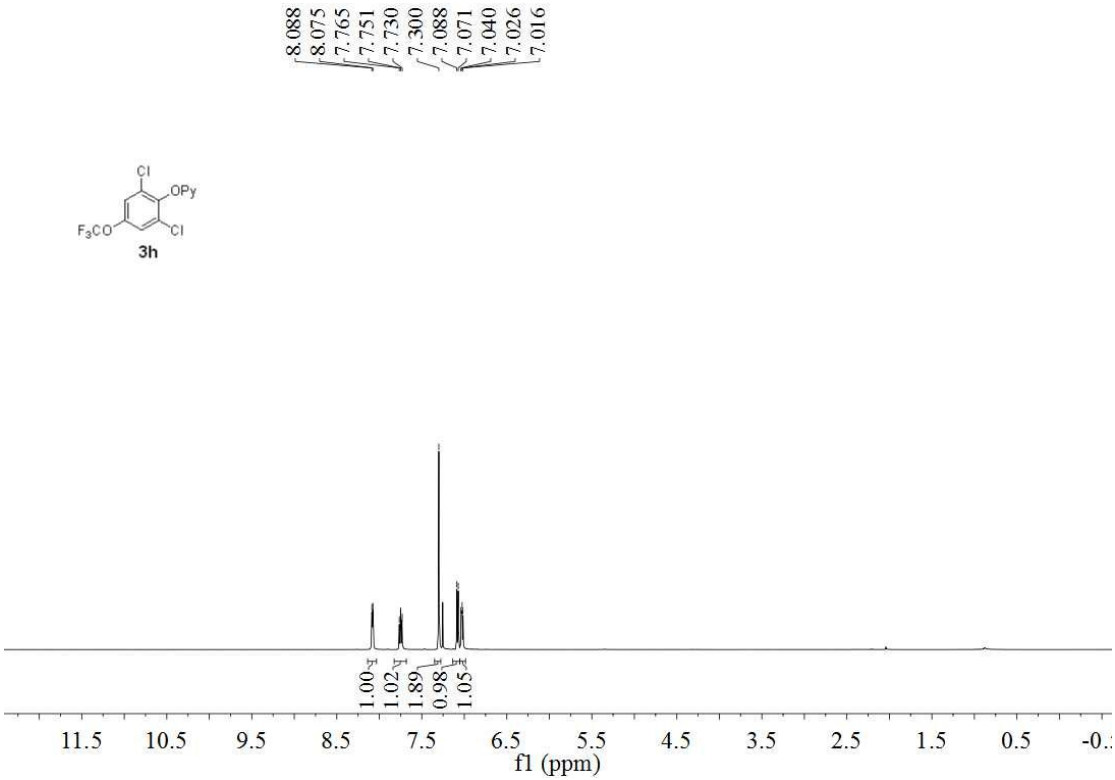
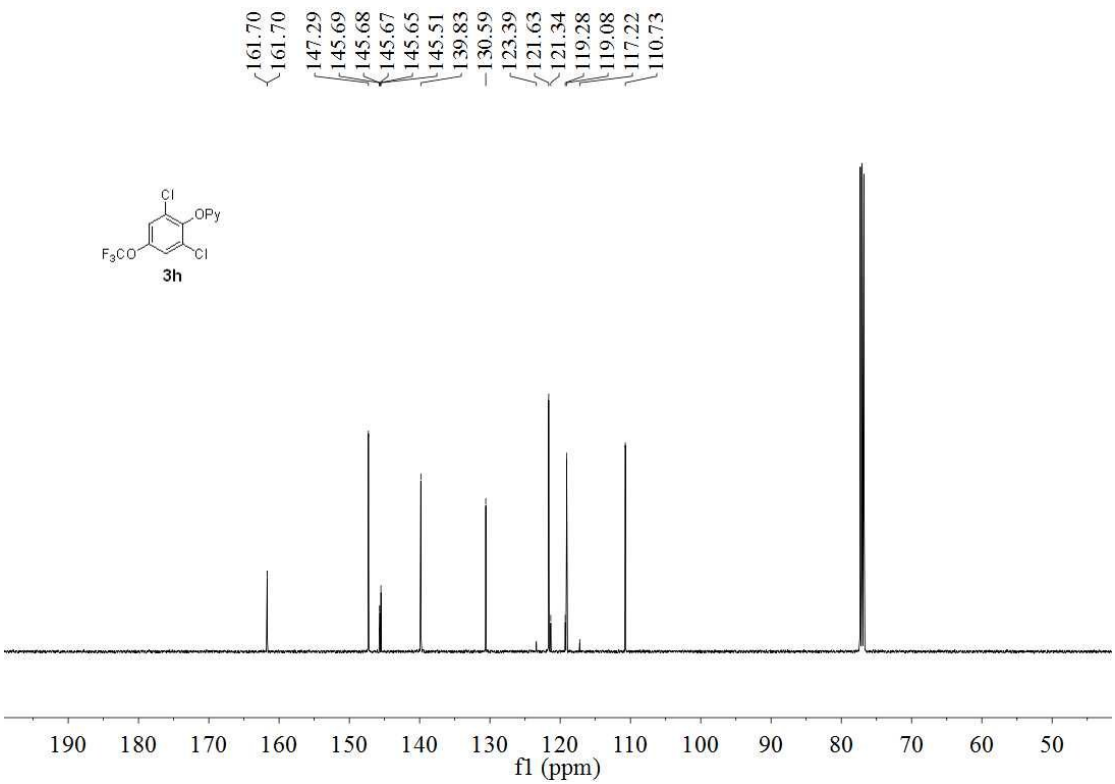
147.26
139.95
130.80
129.31
129.04
128.77
128.49
126.10
126.07
126.04
126.01
125.93
123.76
121.59
119.42
119.24
110.80
Cl
OPy
F3C
Cl
3g
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
f1 (ppm)


-62.57
Cl
OPy
F3C
Cl
3g
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
ppm


8.088
8.075
7.765
7.751
7.730
7.300
7.088
7.071
7.040
7.026
7.016
Cl
OPy
F3CO
Cl
3h
1.00
1.02
1.89
0.98
1.05
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)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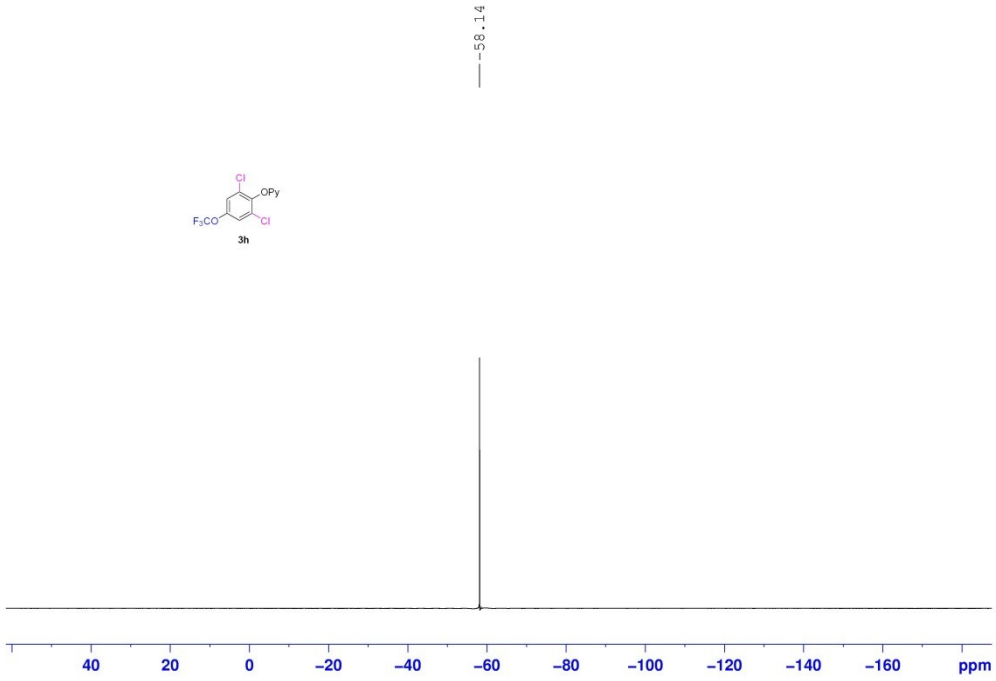
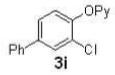
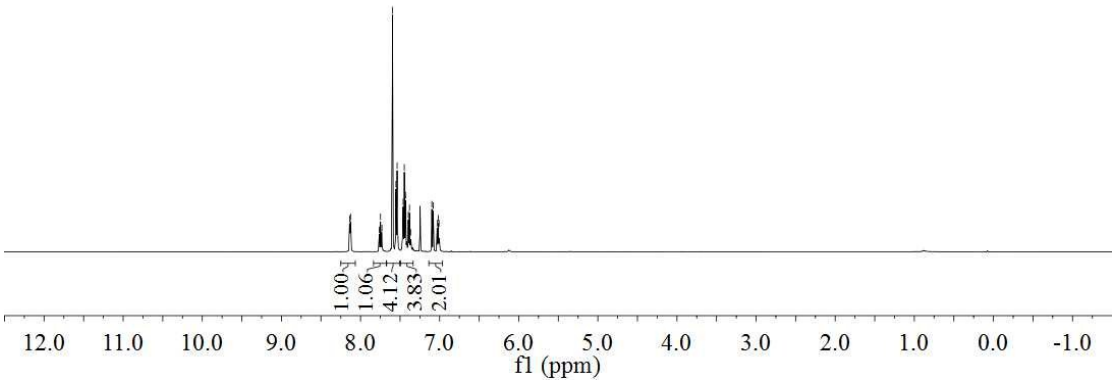
161.70
147.29
145.69
145.68
145.67
145.65
145.51
139.83
130.59
123.39
121.63
121.34
119.28
119.08
117.22
110.73
Cl
OPy
F3CO
Cl
3h
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
f1 (ppm)

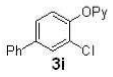

-58.14
Cl
OPy
F3CO
Cl
3h
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
ppm

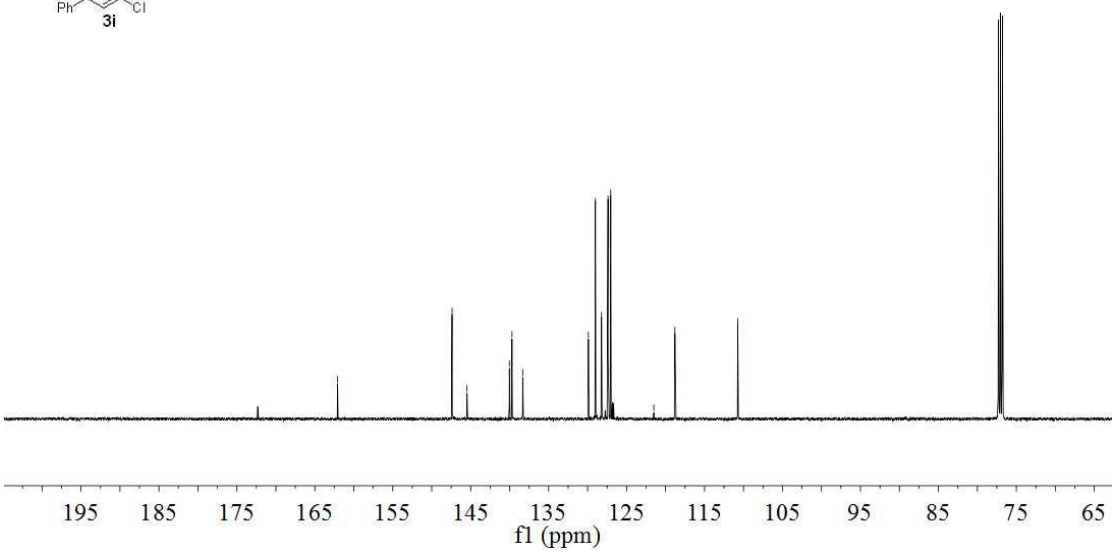

8.138
8.126
7.764
7.747
7.729
7.596
7.552
7.537
7.461
7.447
7.431
7.396
7.381
7.366
7.098
7.082
7.031
7.018
7.008

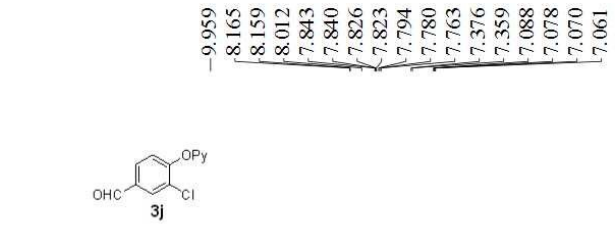

OPy
Ph
Cl
3i


1.00
1.06
4.12
3.83
2.01
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)


172.25
162.08
147.39
145.48
140.04
139.70
138.33
129.90
129.01
128.22
127.38
127.04
121.51
118.80
110.74


OPy
Ph
Cl
3i


195
185
175
165
155
145
135
125
115
105
95
85
75
65
f1 (ppm)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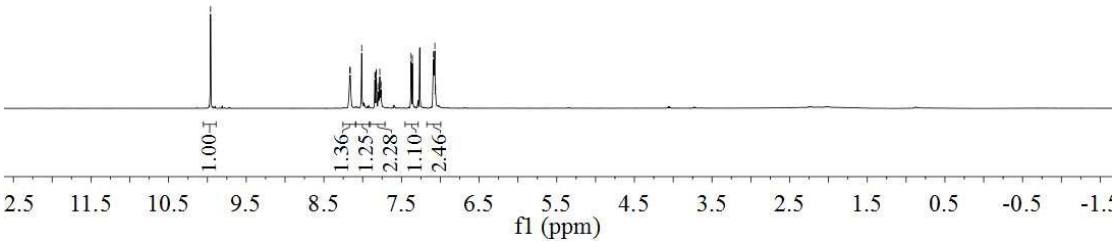
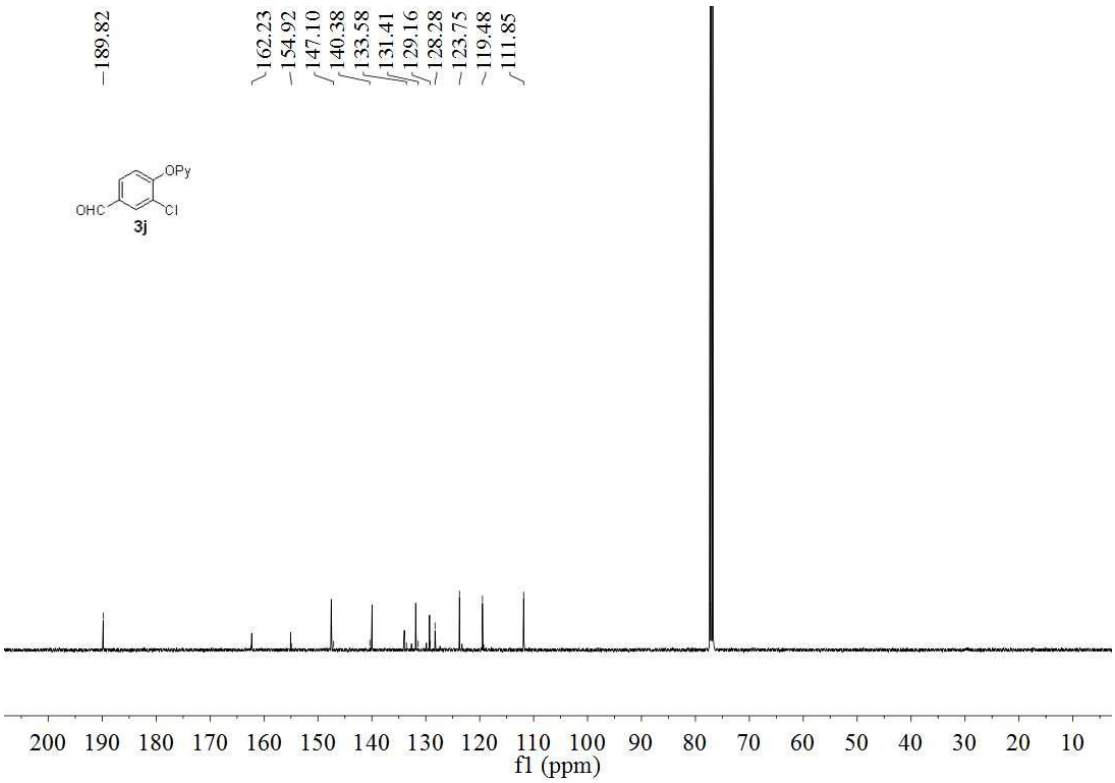
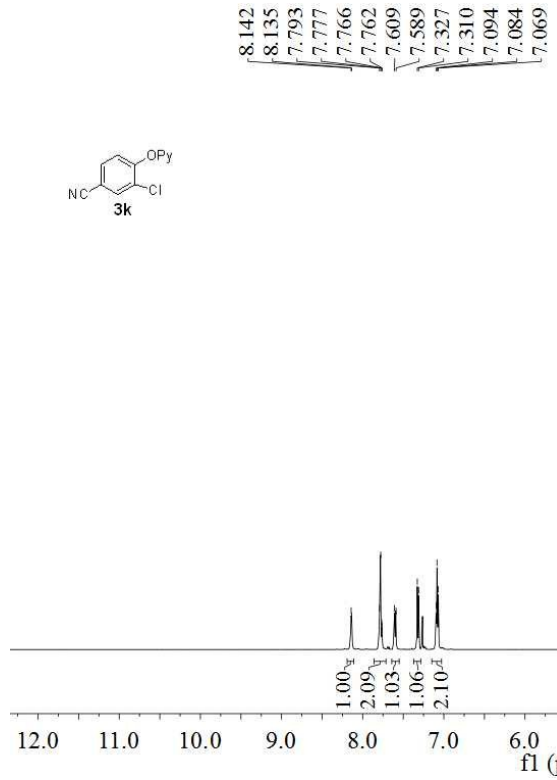
7.840
7.826
7.823
7.794
7.780
7.763
7.376
7.359
7.088
7.078
7.070
7.061
OPy
OHC
Cl
3j


1.00
1.36
1.25
2.28
1.10
2.46
2.5
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)


189.82
162.23
154.92
147.10
140.38
133.58
131.41
129.16
128.28
123.75
119.48
111.85
OPy
OHC
Cl
3j
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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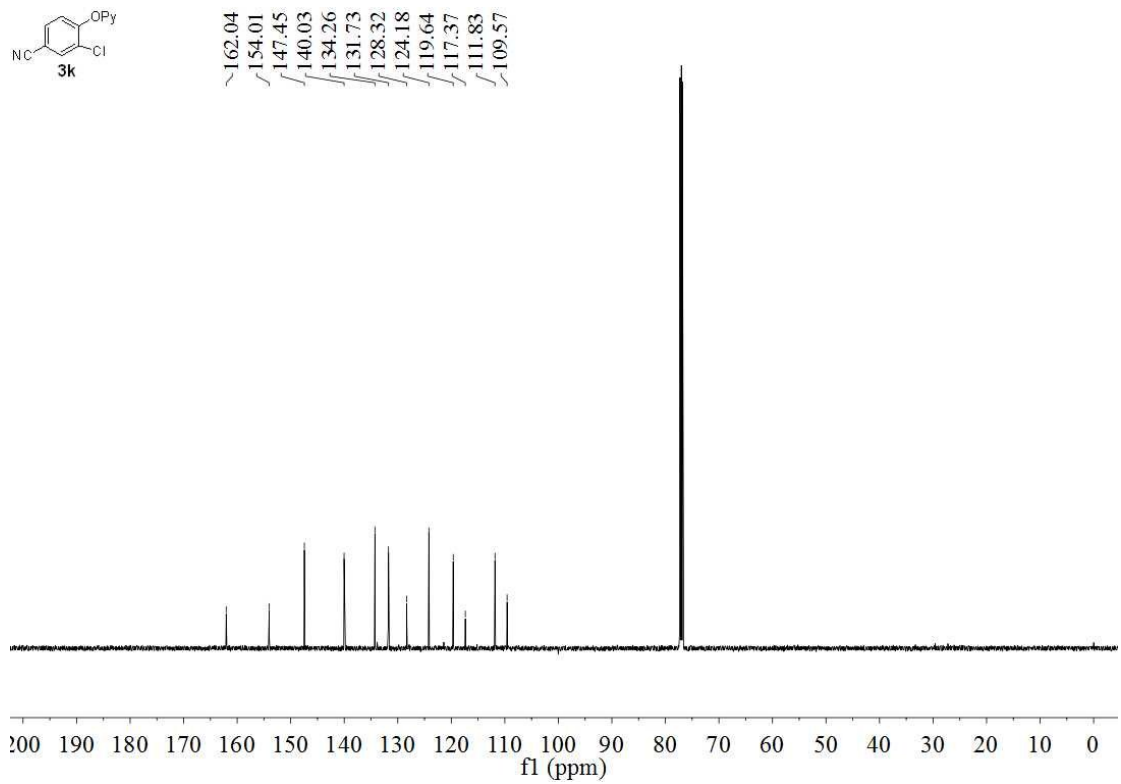
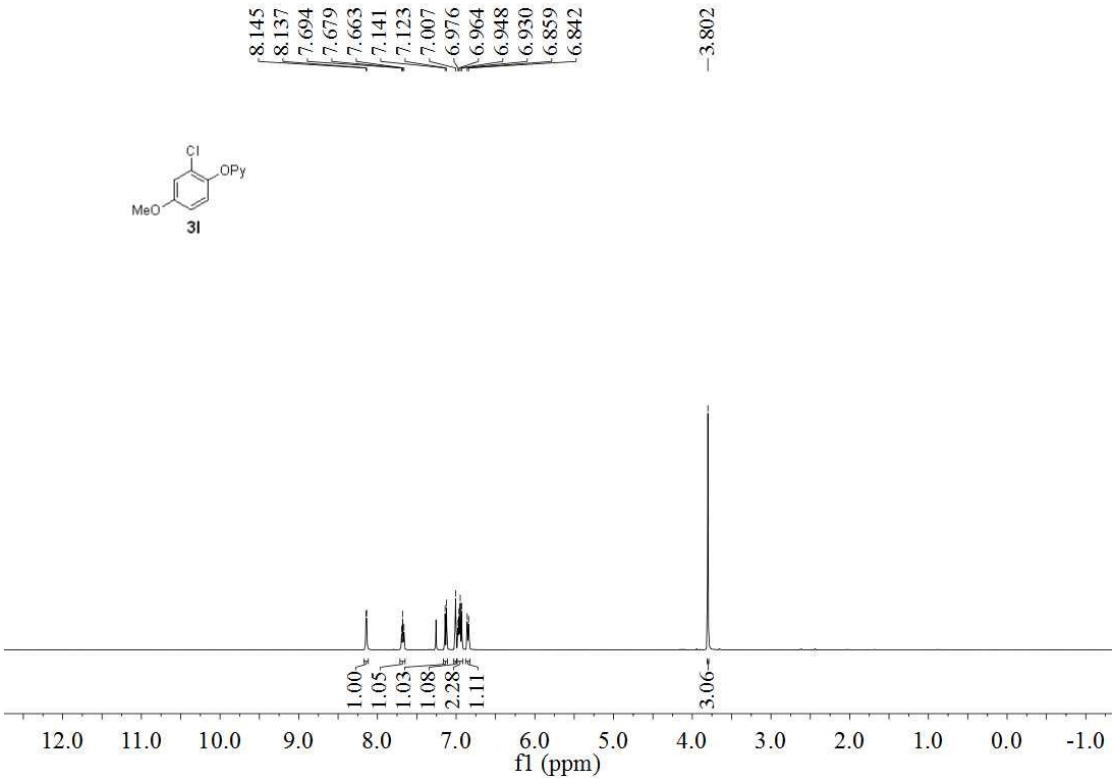
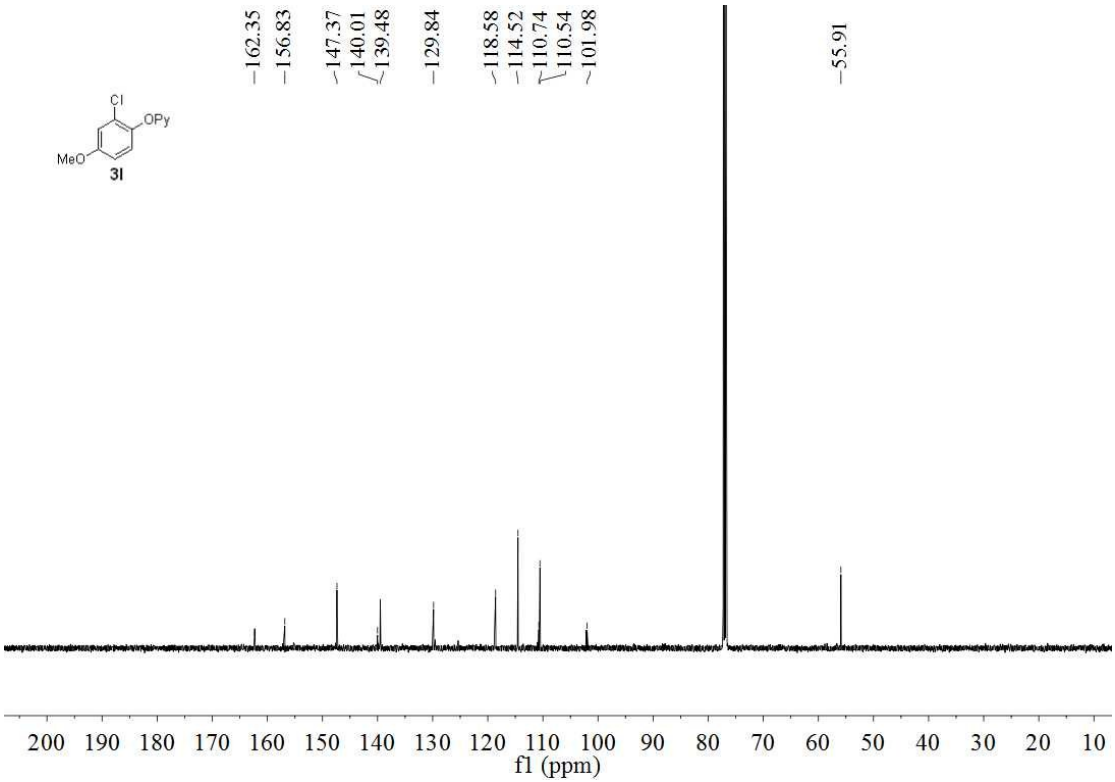
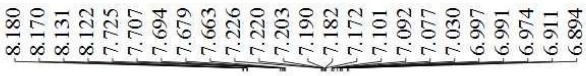
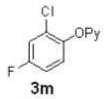
7.609
7.589
7.327
7.310
7.094
7.084
7.069
OPy
NC
Cl
3k
1.00
2.09
1.03
1.06
2.10
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)


OPy
NC
Cl
3k
162.04
154.01
147.45
140.03
134.26
131.73
128.32
124.18
119.64
117.37
111.83
109.57
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

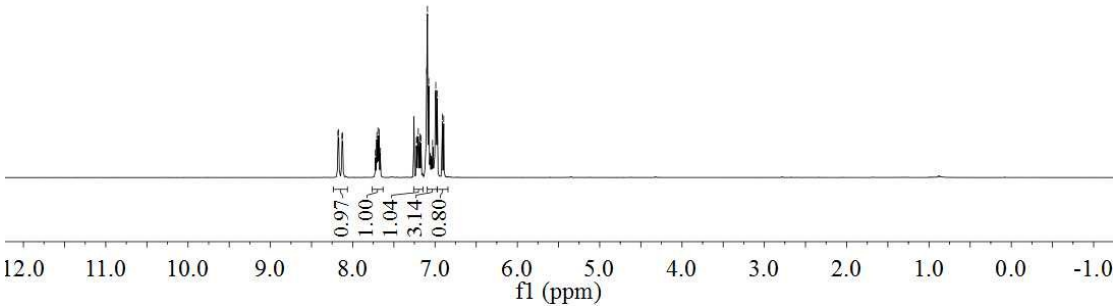

8.145
8.137
7.694
7.679
7.663
7.141
7.123
7.007
6.976
6.964
6.948
6.930
6.859
6.842
3.802
Cl
OPy
MeO
3l
1.00
1.05
1.03
1.08
2.28
1.11
3.06
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)


162.35
156.83
147.37
140.01
139.48
129.84
118.58
114.52
110.74
110.54
101.98
55.91
Cl
OPy
MeO
3l
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


8.180
8.170
8.131
8.122
7.725
7.707
7.694
7.679
7.663
7.226
7.220
7.203
7.190
7.182
7.172
7.101
7.092
7.077
7.030
6.997
6.991
6.974
6.911
6.894


Cl
OPy
F

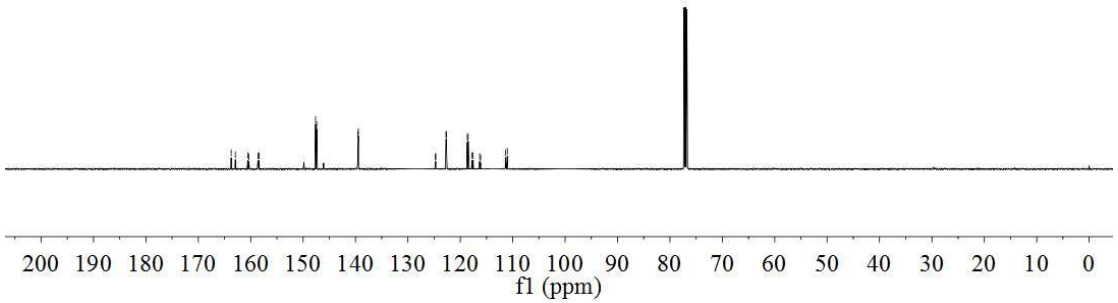
3m


0.97
1.00
1.04
3.14
0.80
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)


163.72
162.93
160.55
160.37
158.62
158.41
147.62
147.41
139.57
139.45
124.76
124.68
122.74
122.67
118.66
118.50
117.76
117.55
116.31
116.13
111.40
111.03


Cl
OPy
F

3m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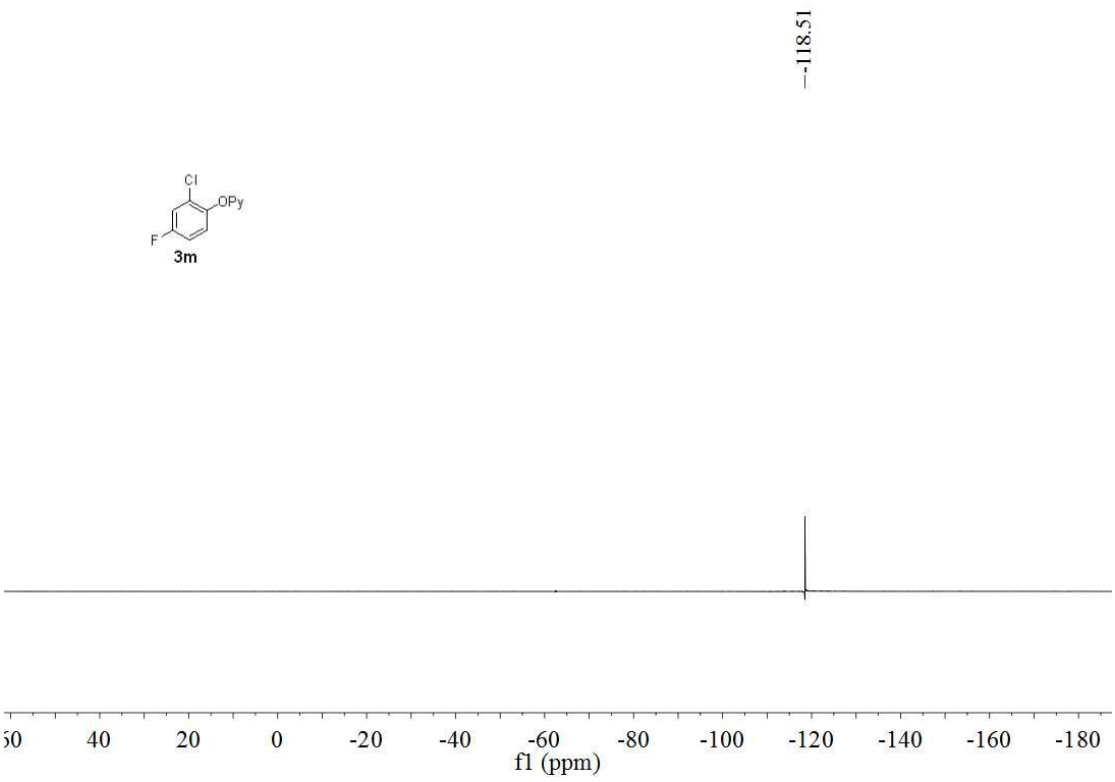
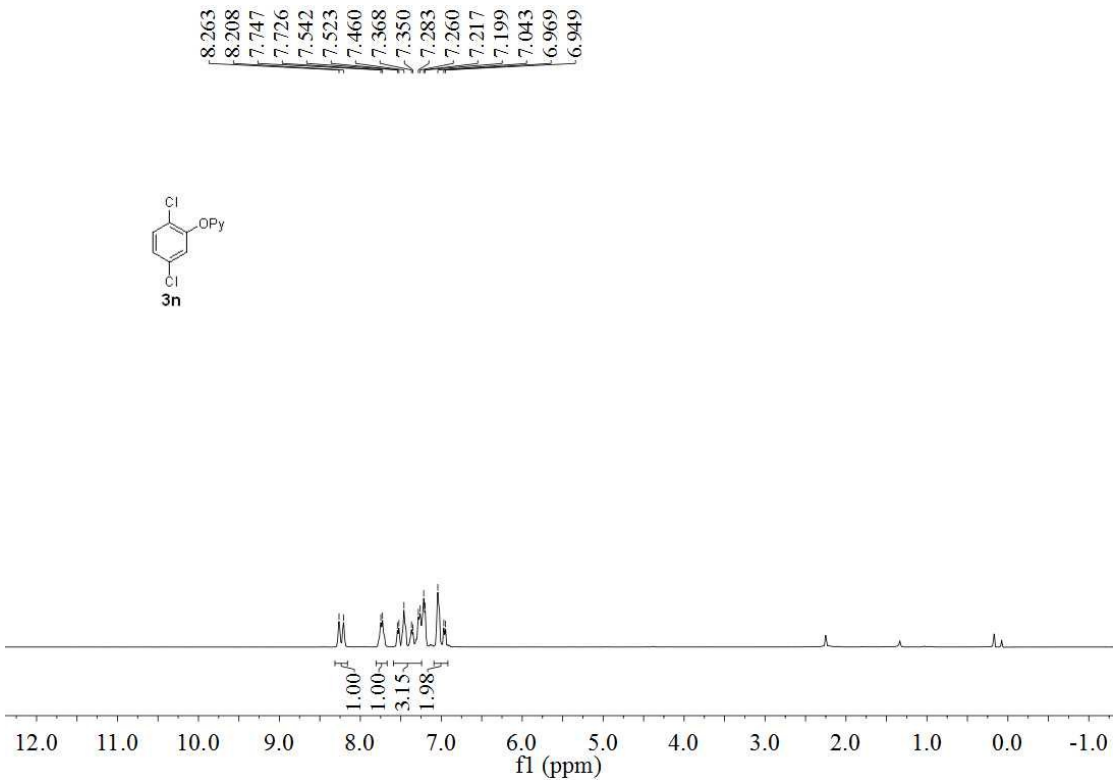
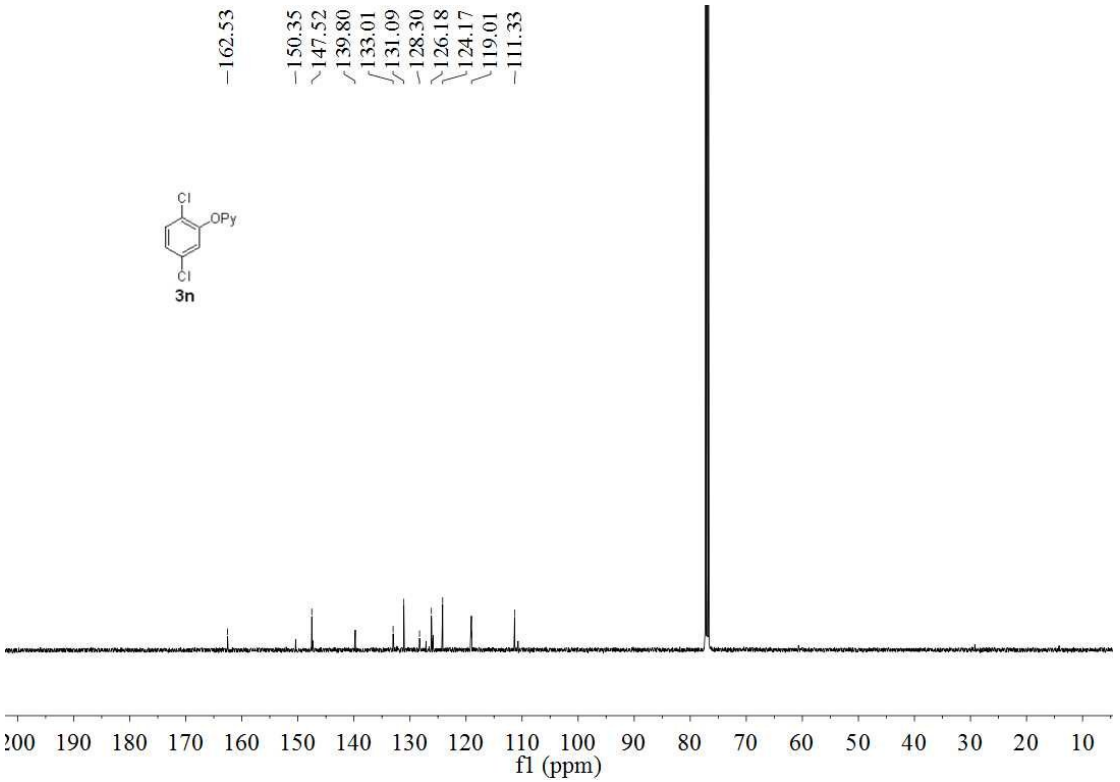
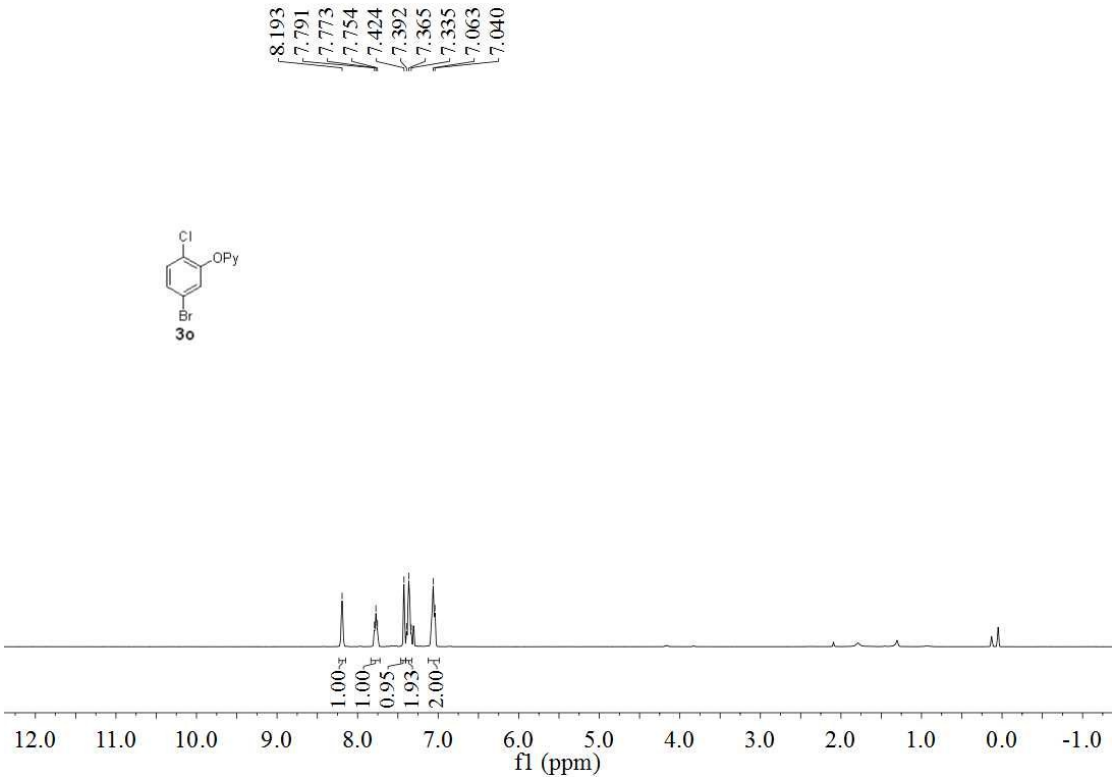
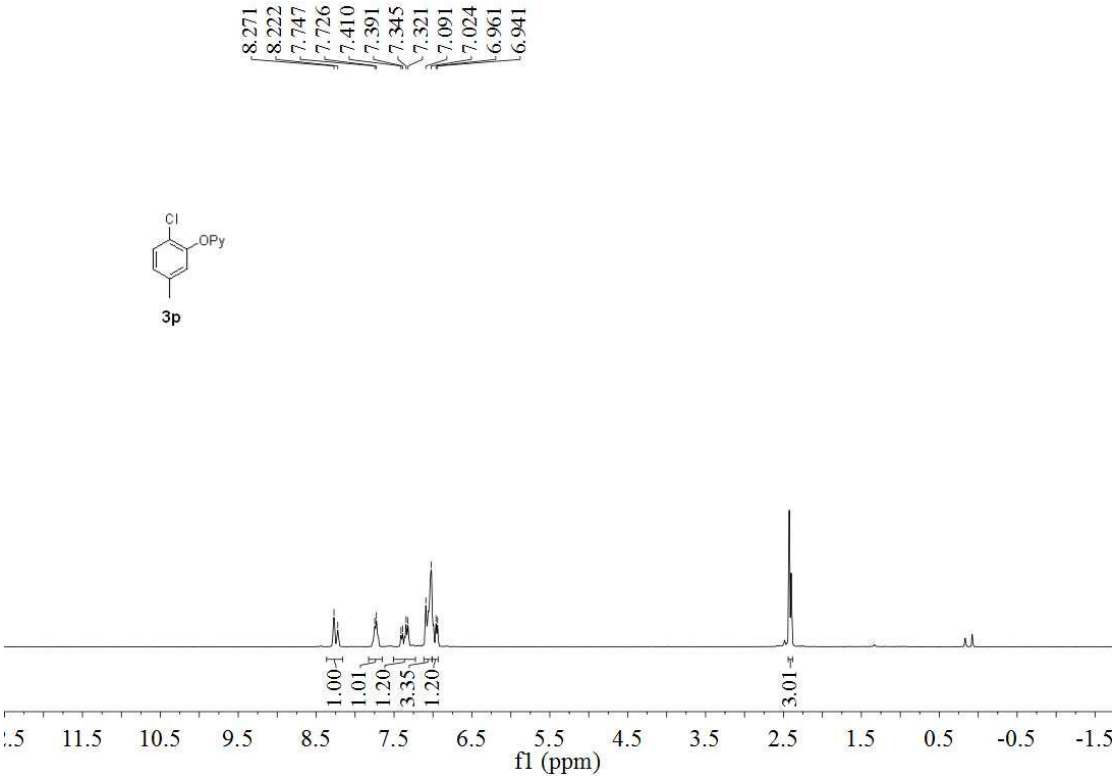
f1 (ppm)

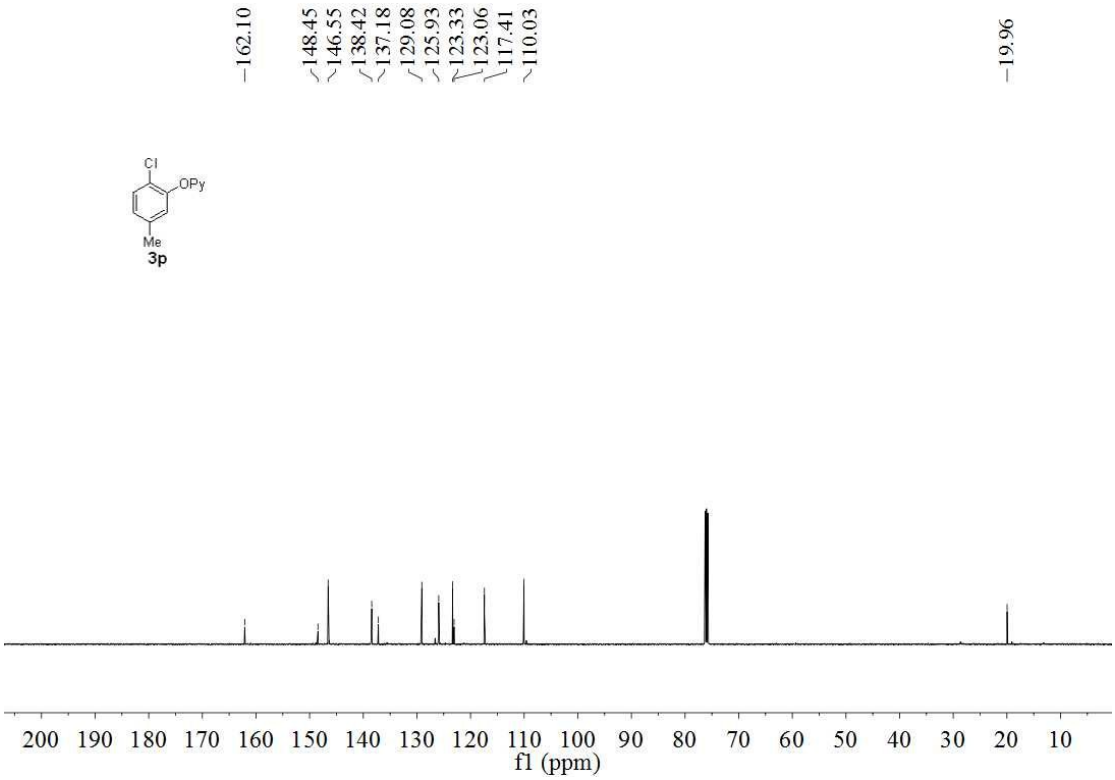

-118.51
Cl
OPy
F
3m
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
f1 (ppm)

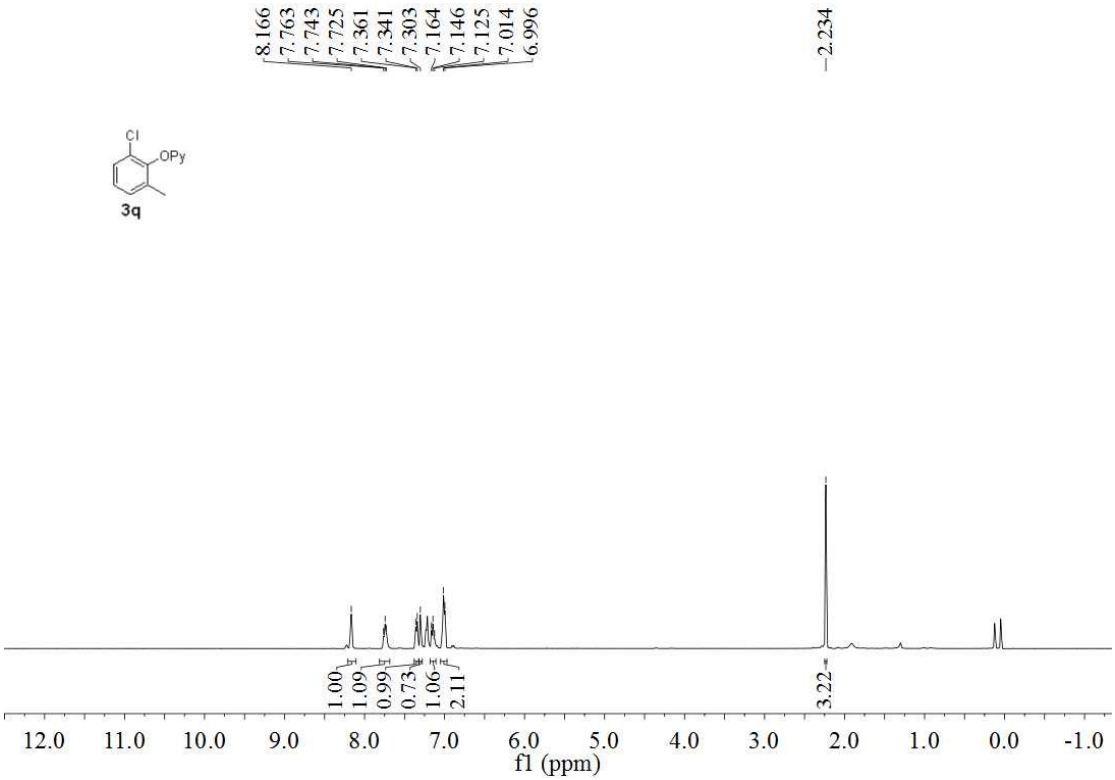

8.263
8.208
7.747
7.726
7.542
7.523
7.460
7.368
7.350
7.283
7.260
7.217
7.199
7.043
6.969
6.949
Cl
OPy
Cl
3n
1.00
1.00
3.15
1.98
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)

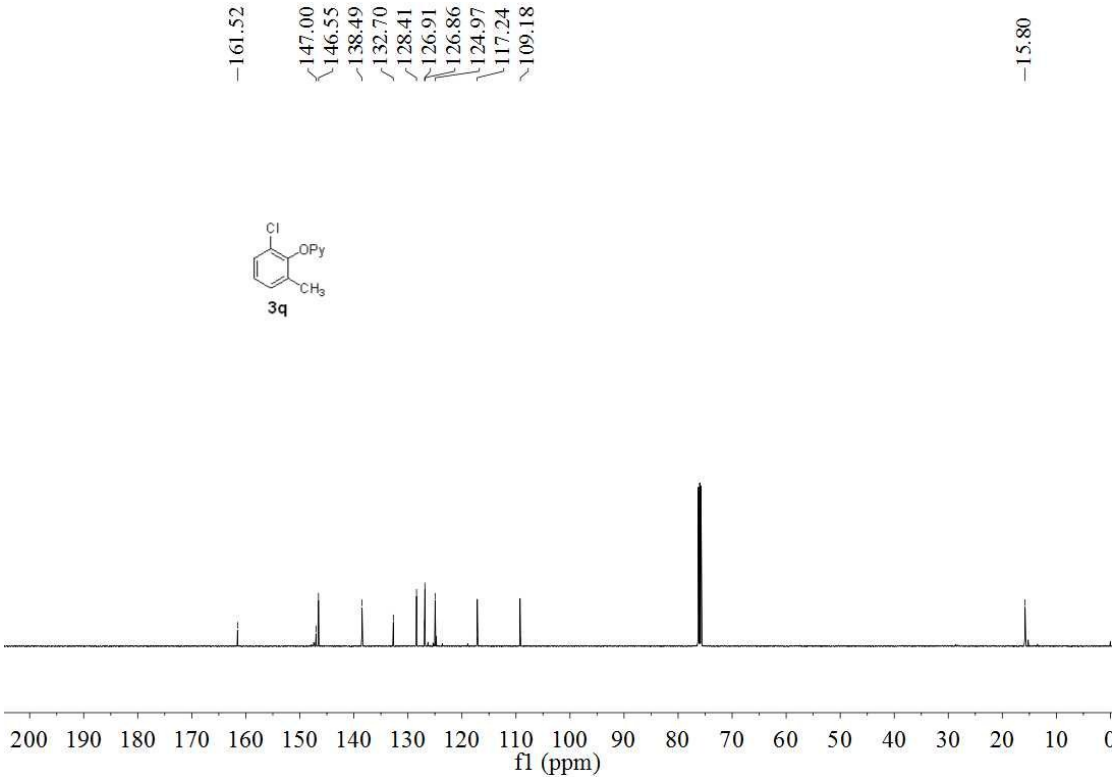

162.53
150.35
147.52
139.80
133.01
131.09
128.30
126.18
124.17
119.01
111.33
Cl
OPy
Cl
3n
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

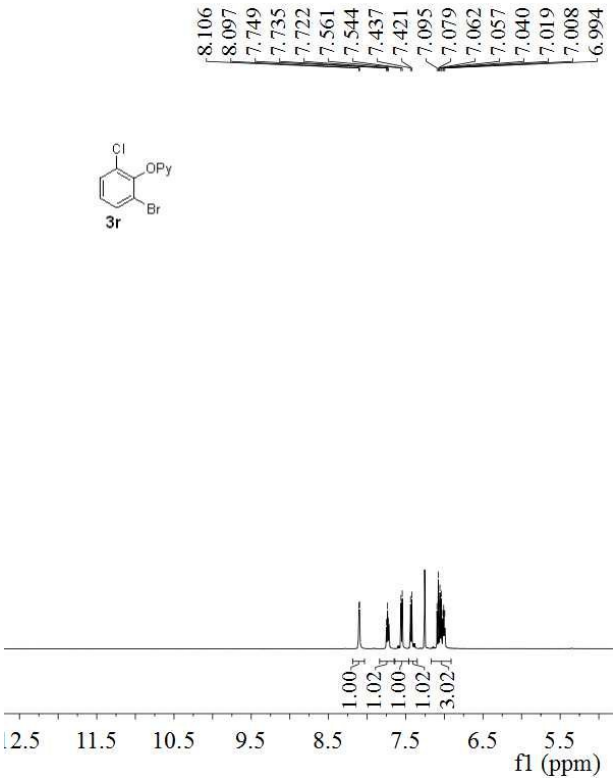

8.193
7.791
7.773
7.754
7.424
7.392
7.365
7.335
7.063
7.040
Cl
OPy
Br
3o
1.00
1.00
0.95
1.93
2.00
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)
162.52
150.31
147.50
139.80
131.49
129.14
127.05
126.59
120.42
119.07
111.46
Cl
OPy
Br
3o
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

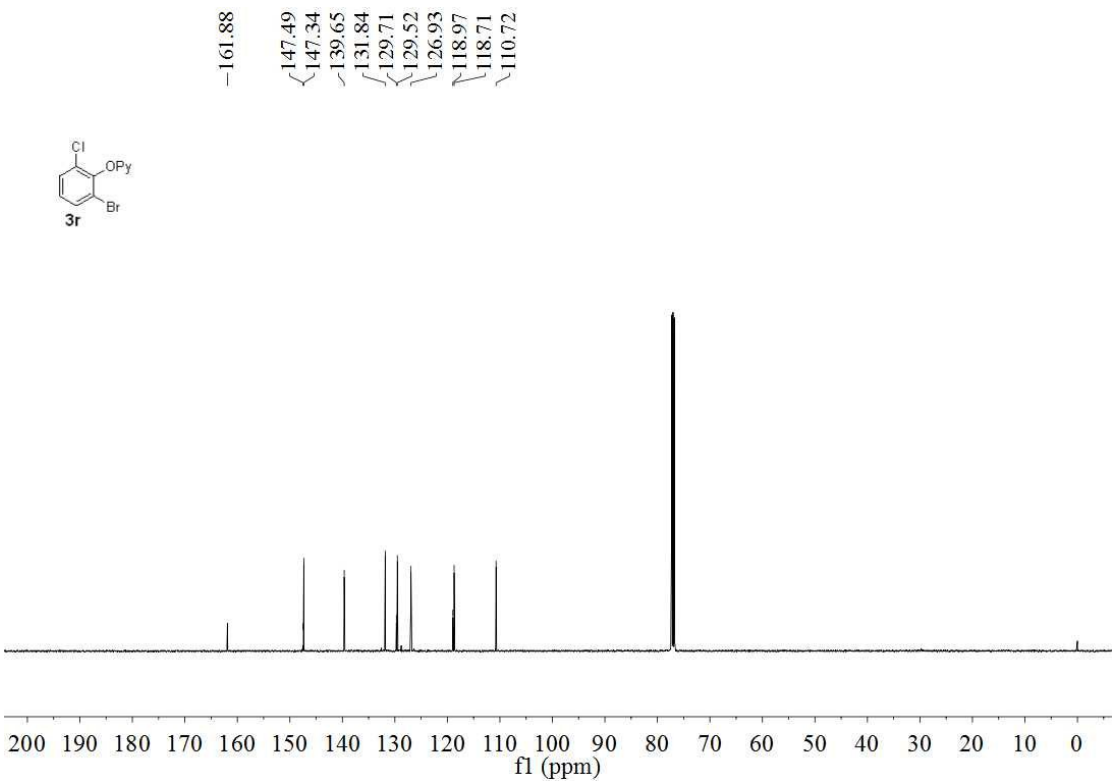

8.271
8.222
7.747
7.726
7.410
7.391
7.345
7.321
7.091
7.024
6.961
6.941
Cl
OPy
3p
1.00
1.01
1.20
3.35
1.20
3.01
f1 (ppm)

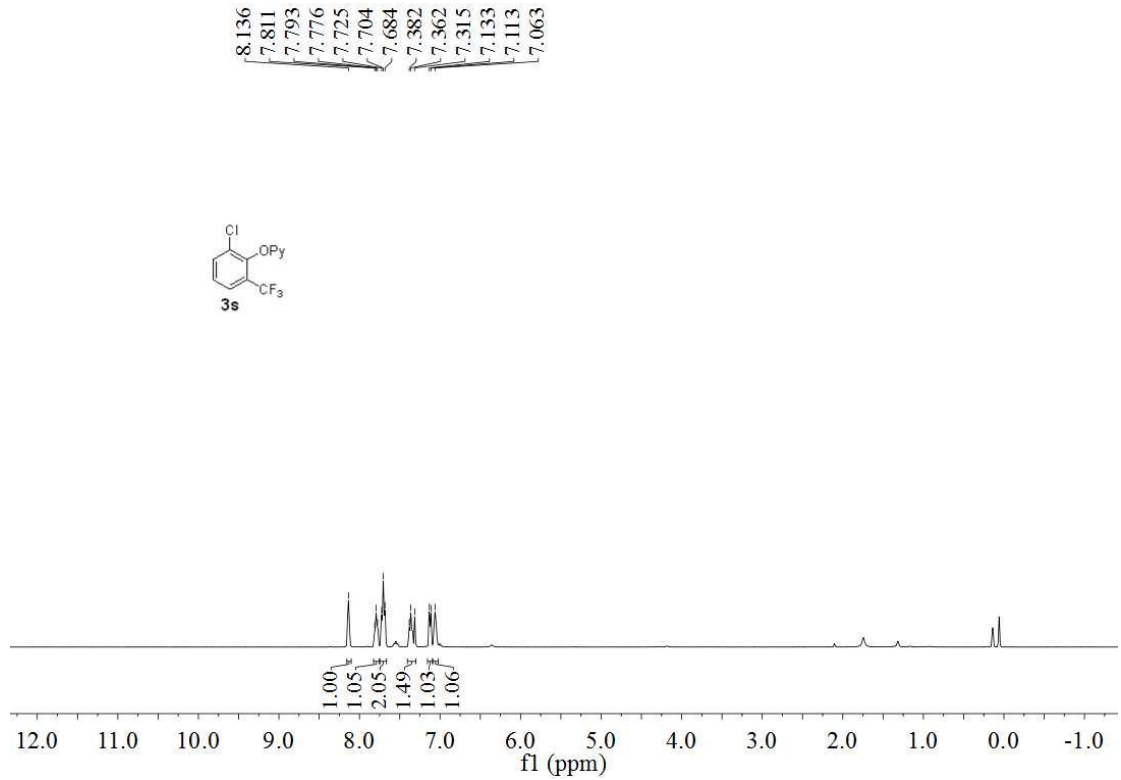

162.10
148.45
146.55
138.42
137.18
129.08
125.93
123.33
123.06
117.41
110.03
19.96
Cl
OPy
Me
3p
f1 (ppm)

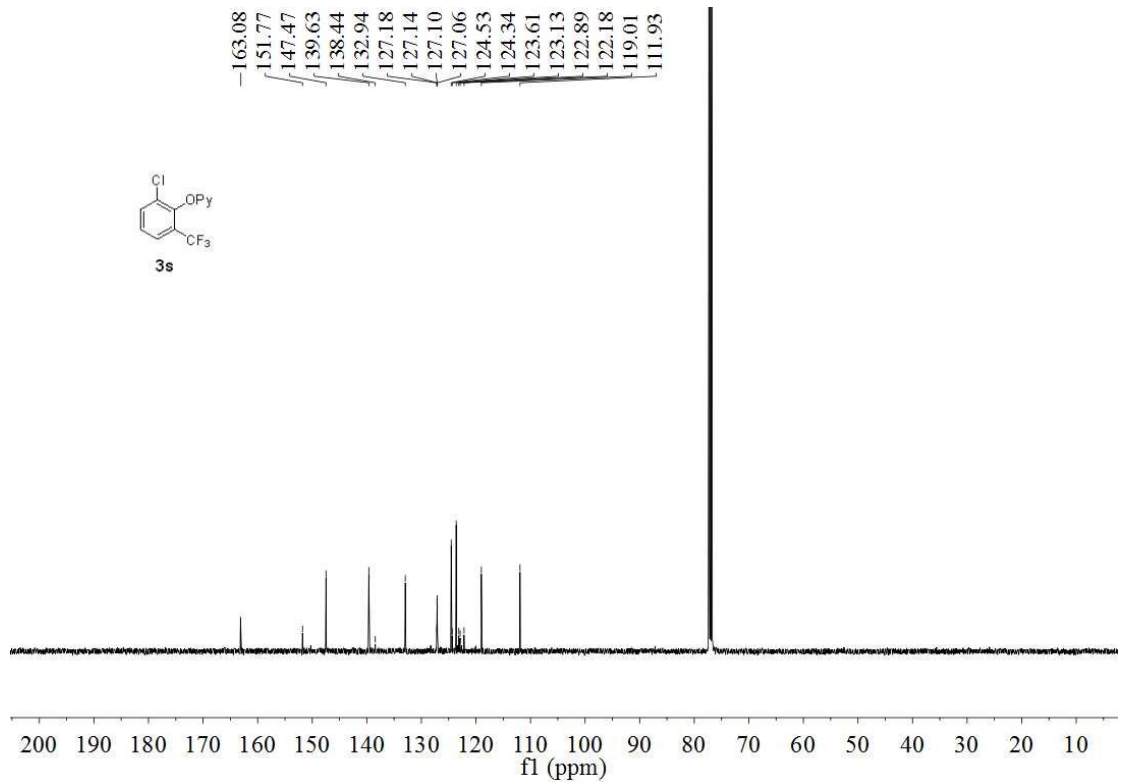

8.166
7.763
7.743
7.725
7.361
7.341
7.303
7.164
7.146
7.125
7.014
6.996
2.234
Cl
OPy
3q
1.00
1.09
0.99
0.73
1.06
2.11
3.22
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)

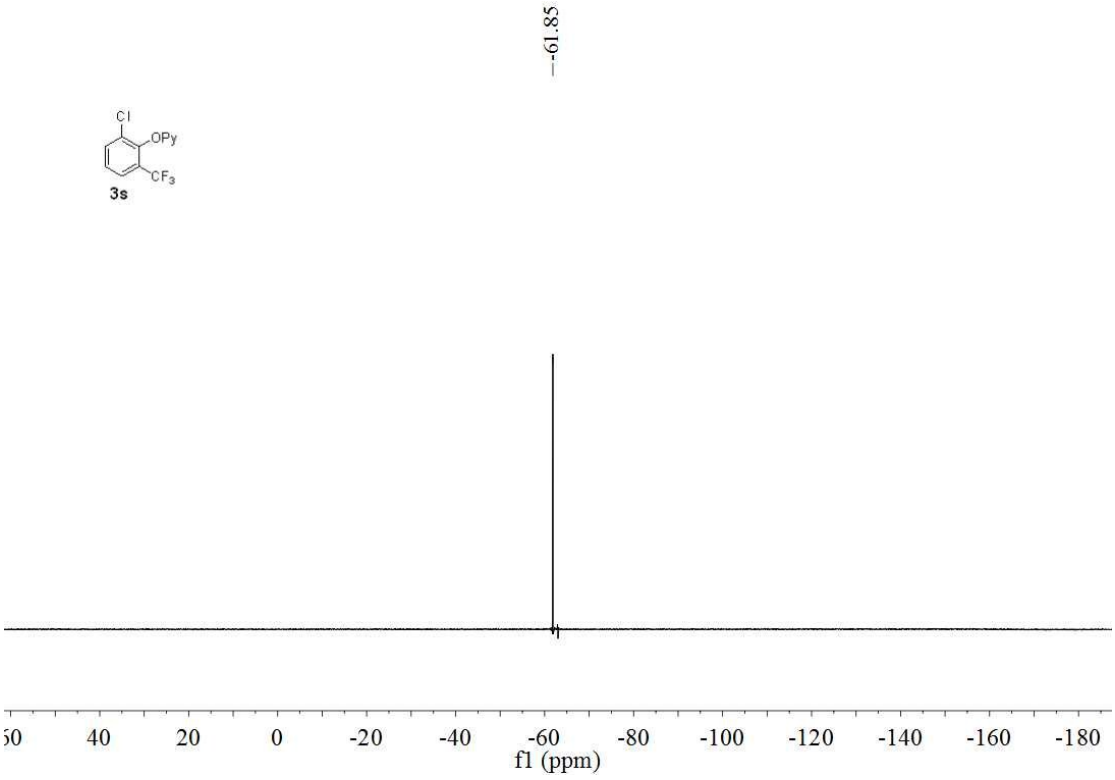

161.52
147.00
146.55
138.49
132.70
128.41
126.91
126.86
124.97
117.24
109.18
15.80
Cl
OPy
CH3
3q
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

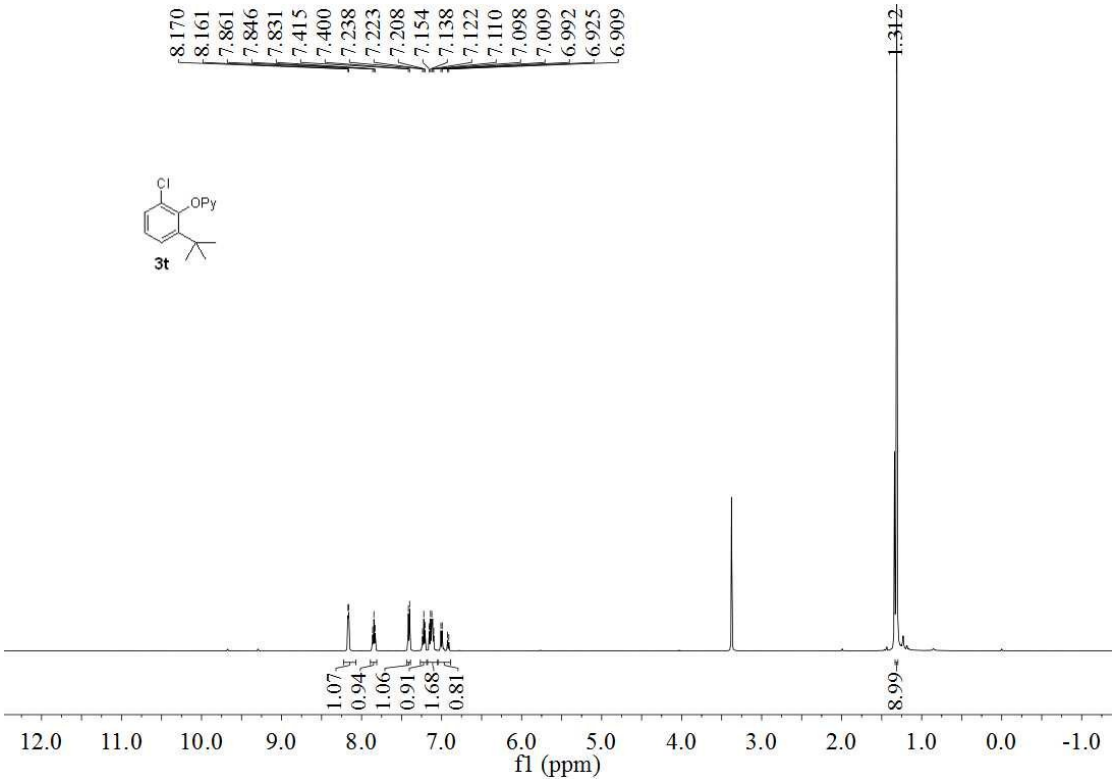

8.106
8.097
7.749
7.735
7.722
7.561
7.544
7.437
7.421
7.095
7.079
7.062
7.057
7.040
7.019
7.008
6.994
Cl
OPy
Br
3r
1.00
1.02
1.00
1.02
3.02
f1 (ppm)

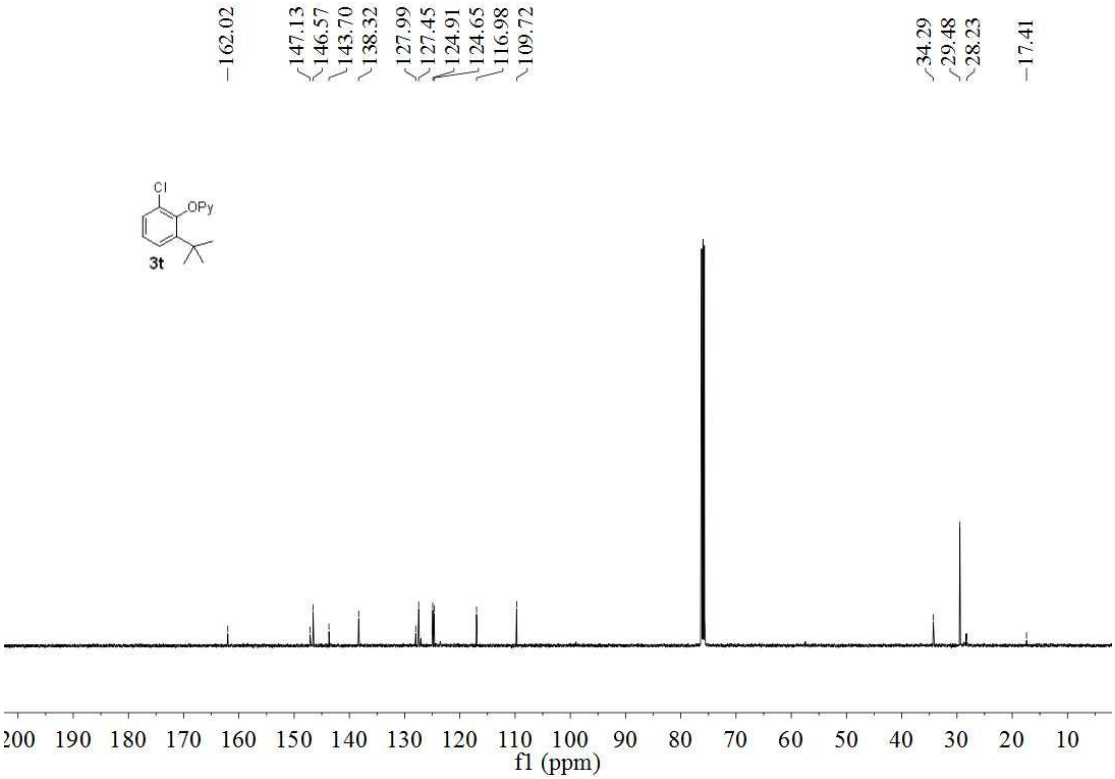

161.88
147.49
147.34
139.65
131.84
129.71
129.52
126.93
118.97
118.71
110.72
Cl
OPy
Br
3r
f1 (ppm)

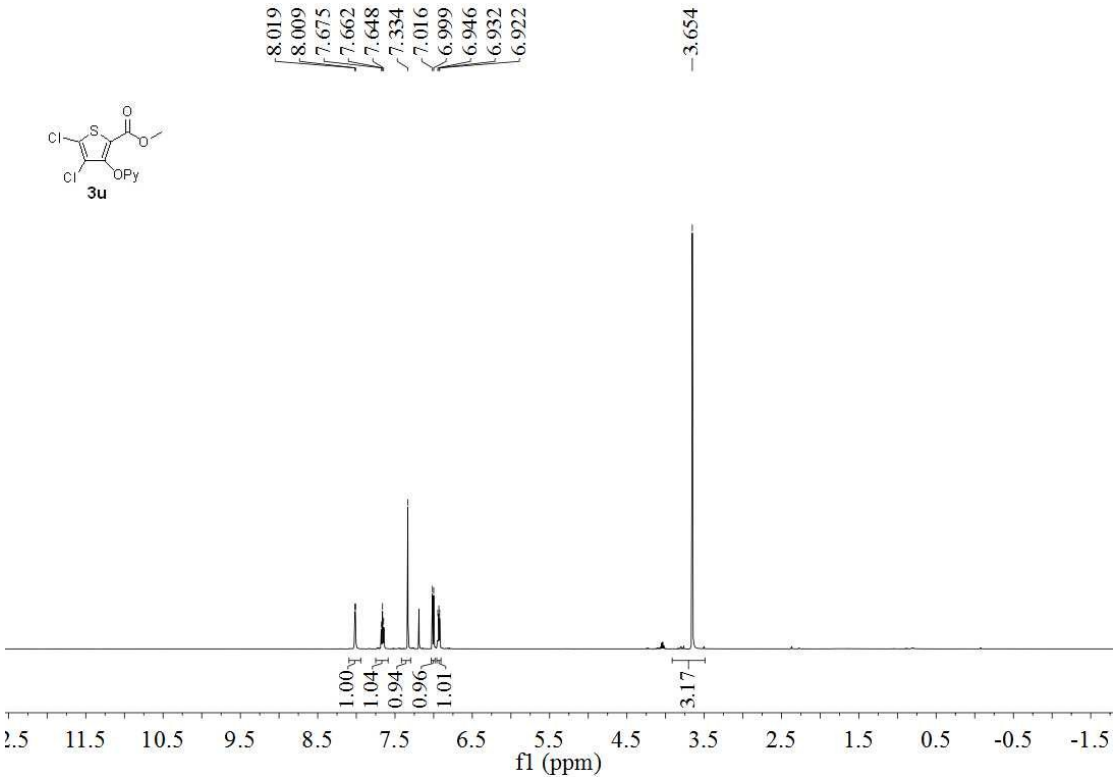

8.136
7.811
7.793
7.776
7.725
7.704
7.684
7.382
7.362
7.315
7.133
7.113
7.063
Cl
OPy
CF3
3s
1.00
1.05
2.05
1.49
1.03
1.06
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)

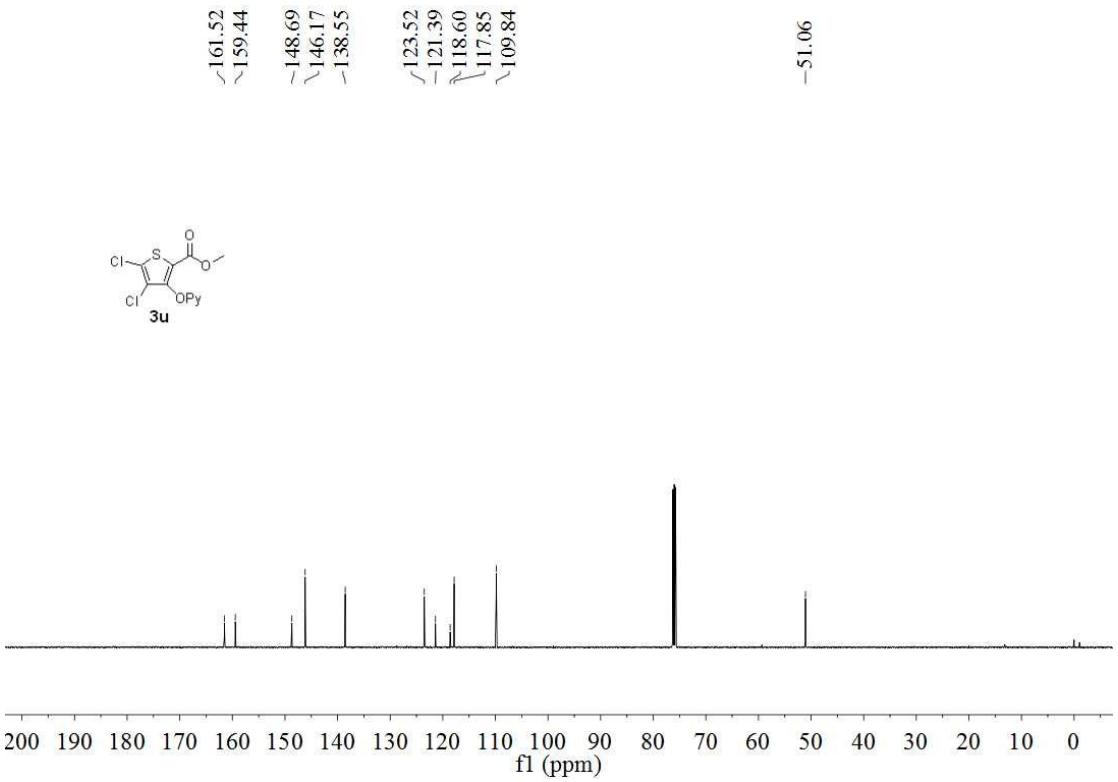

163.08
151.77
147.47
139.63
138.44
132.94
127.18
127.14
127.10
127.06
124.53
124.34
123.61
123.13
122.89
122.18
119.01
111.93
Cl
OPy
CF3
3s
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

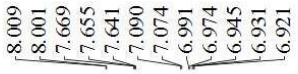

-61.85
Cl
OPy
CF3
3s
50
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
f1 (ppm)


8.170
8.161
7.861
7.846
7.831
7.415
7.400
7.238
7.223
7.208
7.154
7.138
7.122
7.110
7.098
7.009
6.992
6.925
6.909
1.312
Cl
OPy
3t
1.07
0.94
1.06
0.91
1.68
0.81
8.99
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)


162.02
147.13
146.57
143.70
138.32
127.99
127.45
124.91
124.65
116.98
109.72
34.29
29.48
28.23
17.41
Cl
OPy
3t
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

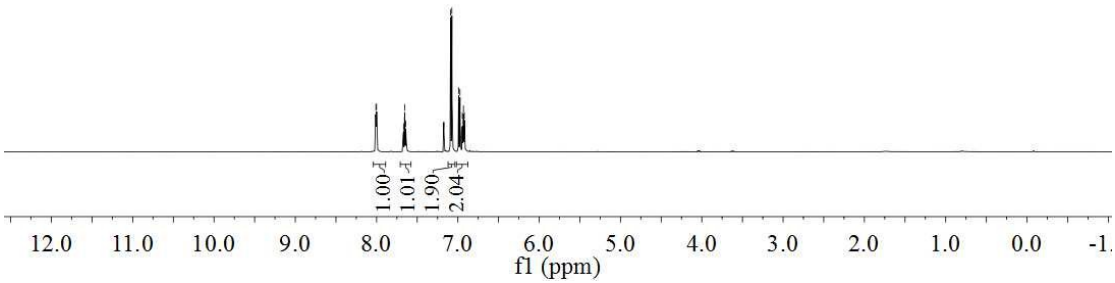

8.019
8.009
7.675
7.662
7.648
7.334
7.016
6.999
6.946
6.932
6.922
3.654
3u
1.00
1.04
0.94
0.96
1.01
3.17
f1 (ppm)


161.52
159.44
148.69
146.17
138.55
123.52
121.39
118.60
117.85
109.84
51.06
3u
f1 (ppm)

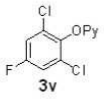

8.009
8.001
7.669
7.655
7.641
7.090
7.074
6.991
6.974
6.945
6.931
6.921


Cl
OPy
F
Cl

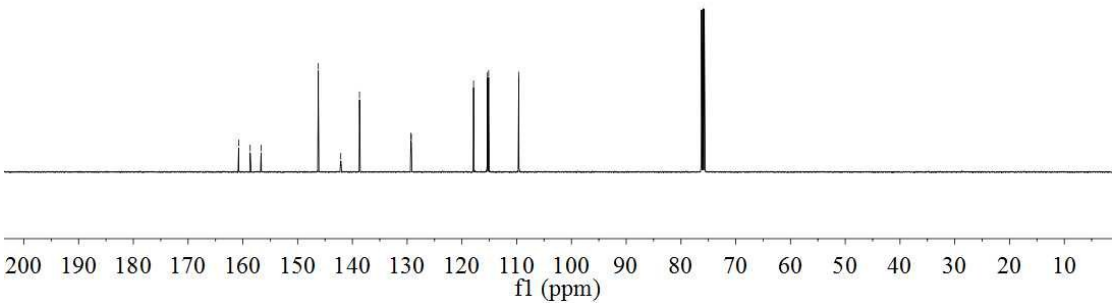
3v


1.00
1.01
1.90
2.04
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

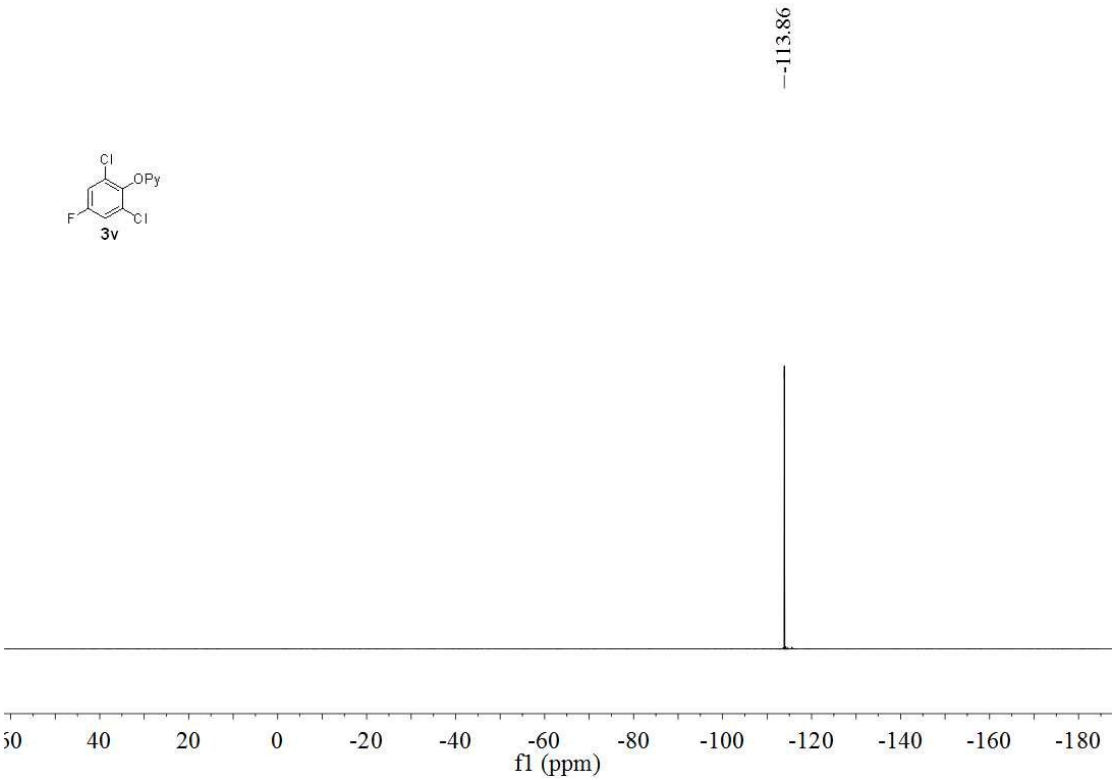

160.77
158.67
156.68
146.22
142.13
138.70
129.33
129.23
117.88
115.33
115.13
109.61

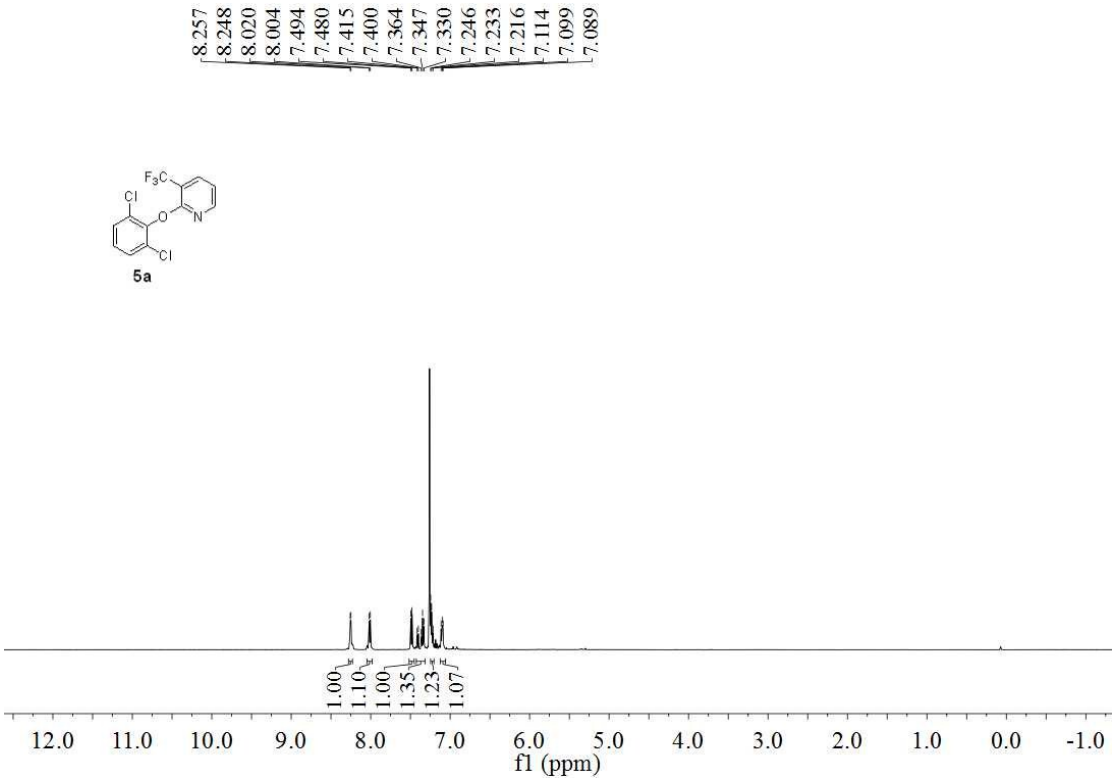

Cl
OPy
F
Cl

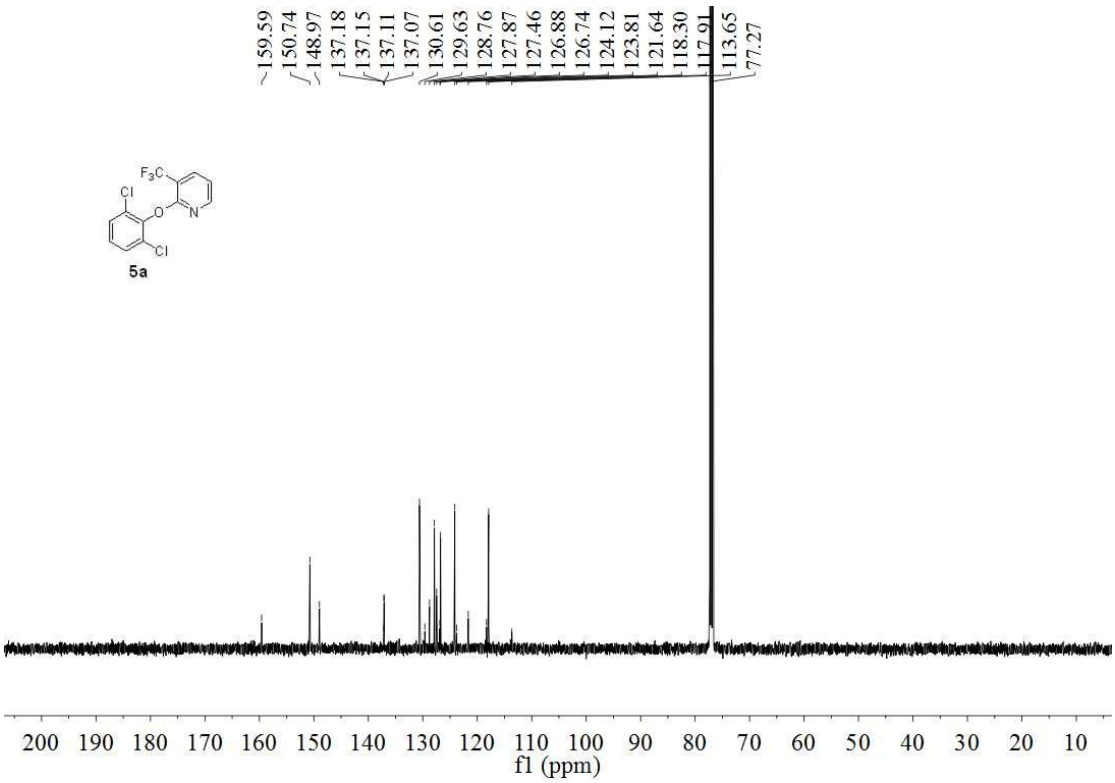
3v

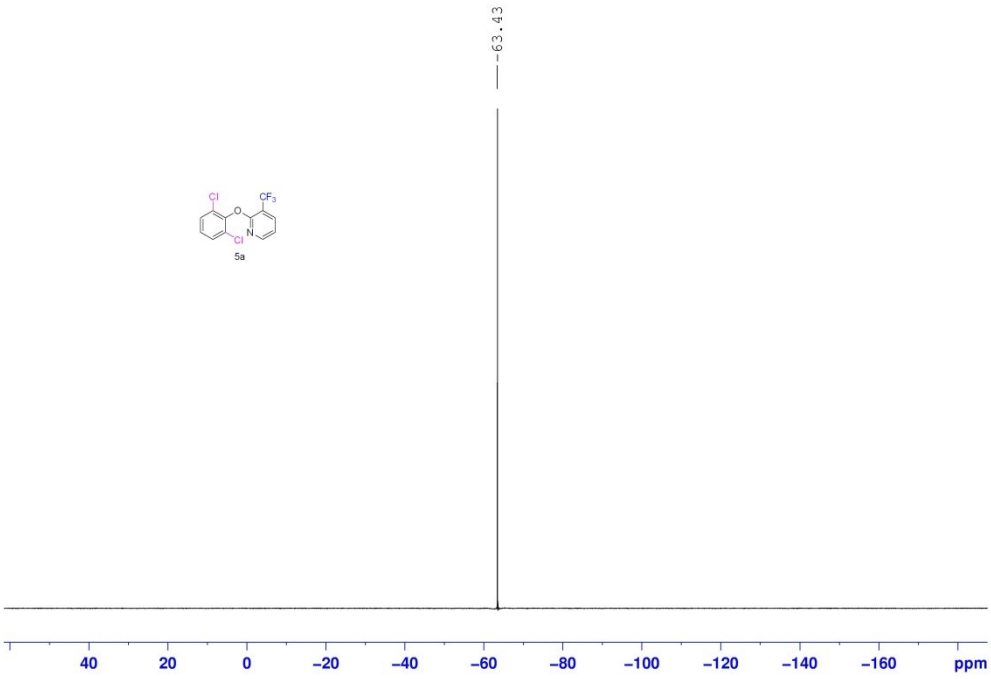

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

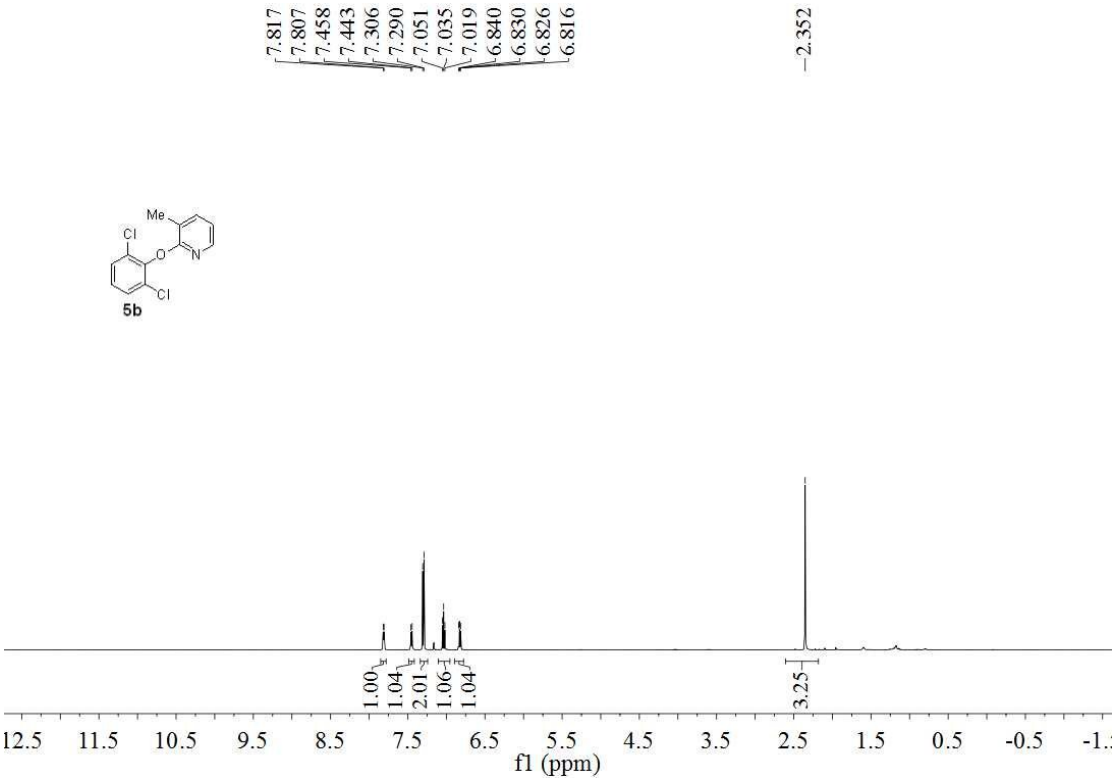
3v

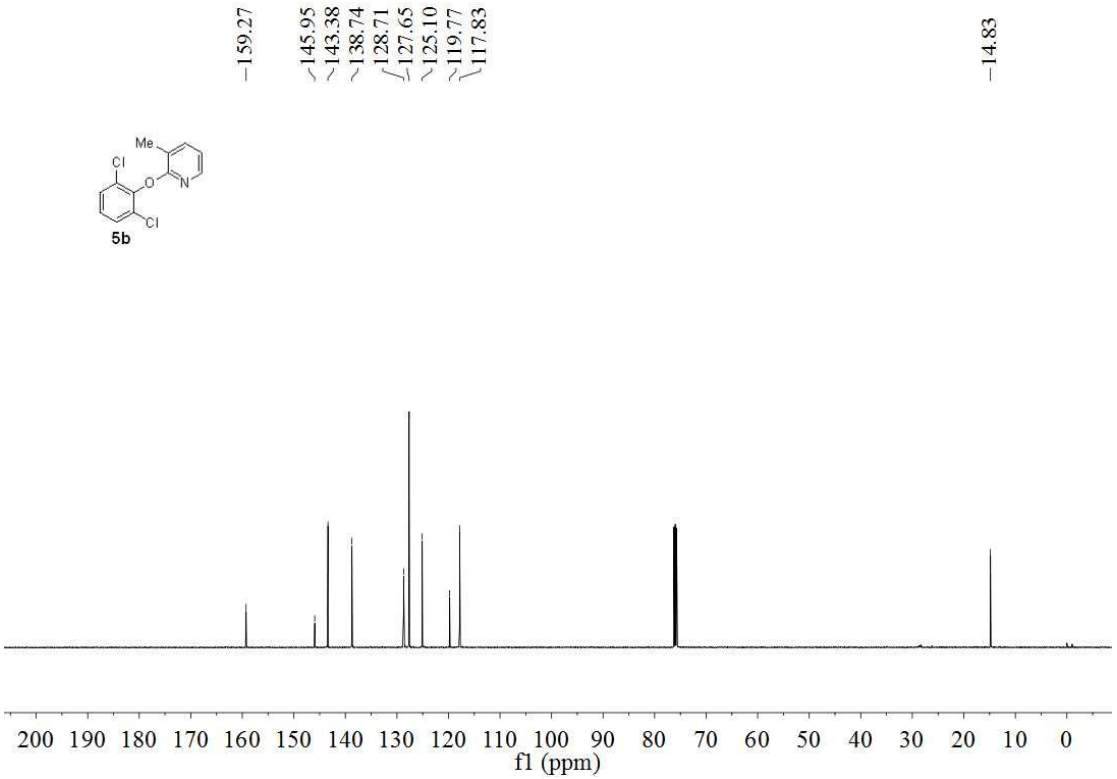


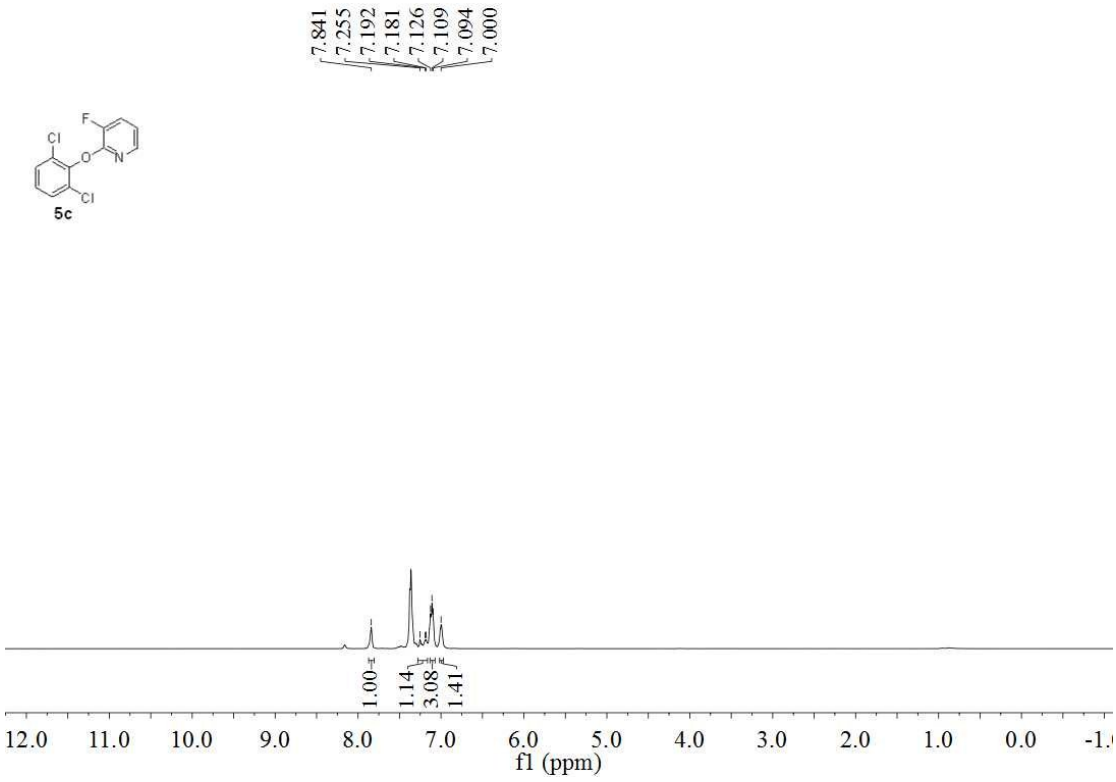

8.257
8.248
8.020
8.004
7.494
7.480
7.415
7.400
7.364
7.347
7.330
7.246
7.233
7.216
7.114
7.099
7.089
F3C
Cl
O
N
Cl
5a
1.00
1.10
1.00
1.35
1.23
1.07
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)

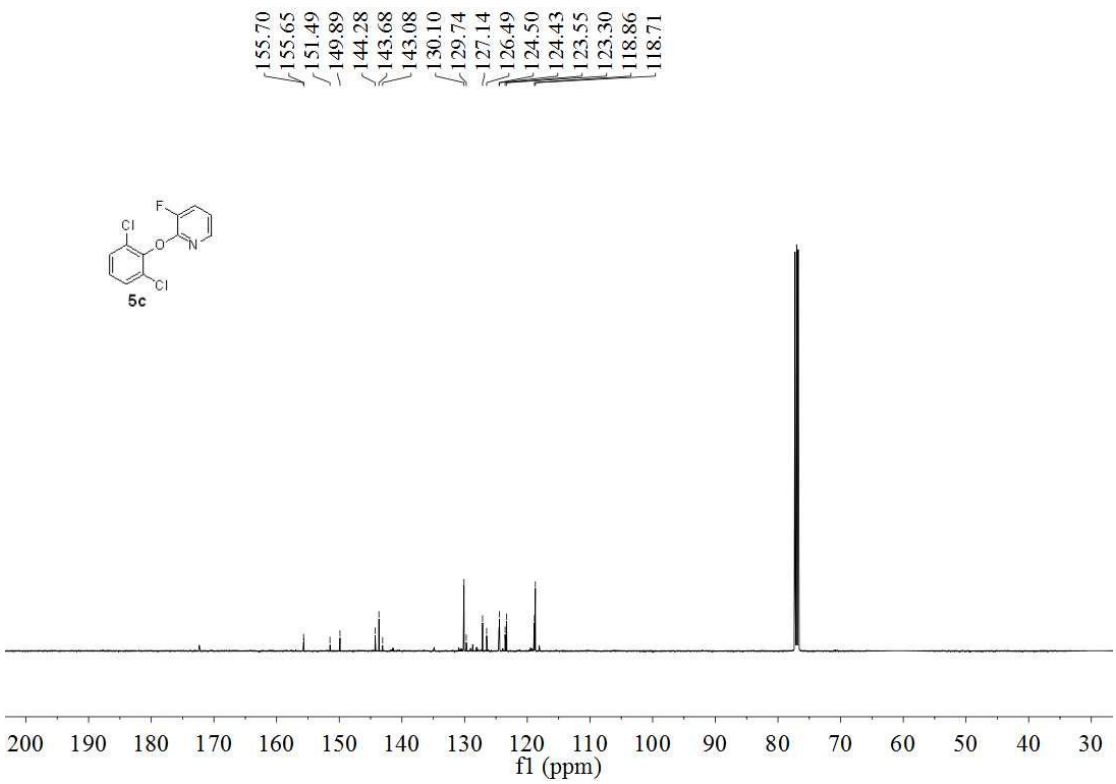

159.59
150.74
148.97
137.18
137.15
137.11
137.07
130.61
129.63
128.76
127.87
127.46
126.88
126.74
124.12
123.81
121.64
118.30
117.91
113.65
77.27
F3C
Cl
O
N
Cl
5a
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

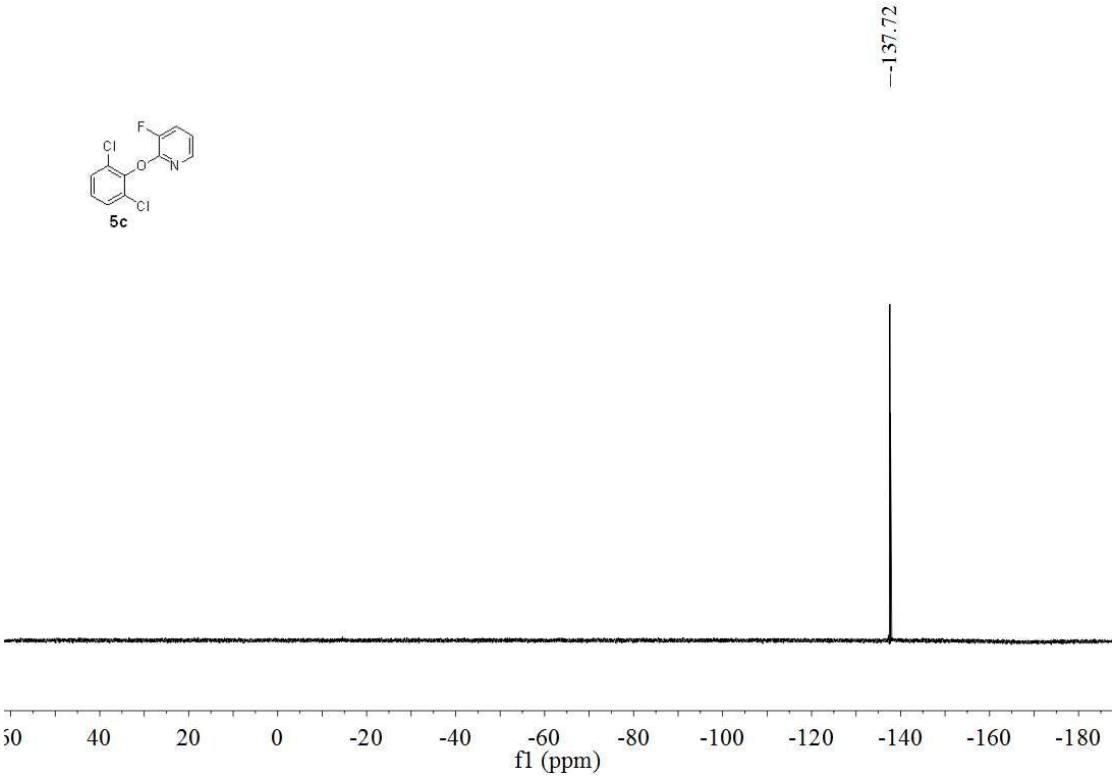

-63.43
Cl
CF3
O
N
Cl
5a
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
ppm

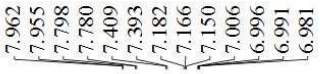

7.817
7.807
7.458
7.443
7.306
7.290
7.051
7.035
7.019
6.840
6.830
6.826
6.816
2.352
Me
Cl
O
N
Cl
5b
1.00
1.04
2.01
1.06
1.04
3.25
12.5 11.5 10.5 9.5 8.5 7.5 6.5 5.5 4.5 3.5 2.5 1.5 0.5 -0.5
f1 (ppm)

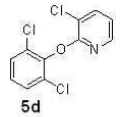

159.27
145.95
143.38
138.74
128.71
127.65
125.10
119.77
117.83
14.83
Me
Cl
O
N
Cl
5b
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.841
7.255
7.192
7.181
7.126
7.109
7.094
7.000
F
Cl
O
N
Cl
5c
1.00
1.14
3.08
1.41
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

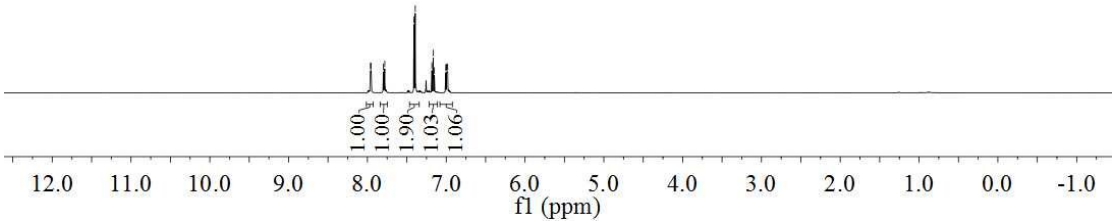

155.70
155.65
151.49
149.89
144.28
143.68
143.08
130.10
129.74
127.14
126.49
124.50
124.43
123.55
123.30
118.86
118.71
F
Cl
O
N
Cl
5c
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
f1 (ppm)


-137.72
F
Cl
O
N
Cl
5c
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
f1 (ppm)

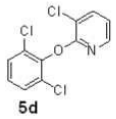

7.962
7.955
7.798
7.780
7.409
7.393
7.182
7.166
7.150
7.006
6.996
6.991
6.981


Cl
Cl
O
N
Cl

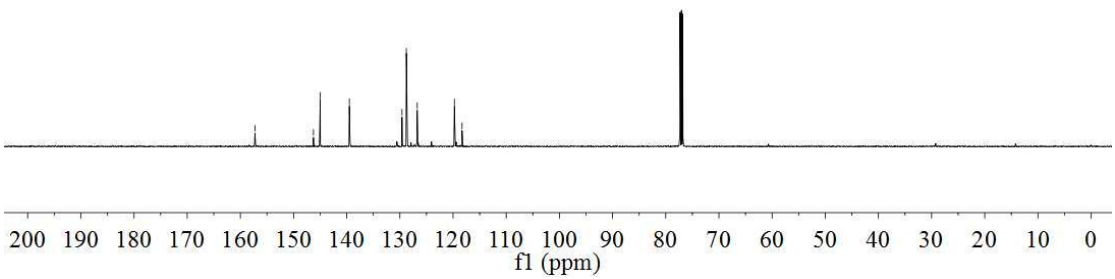
5d

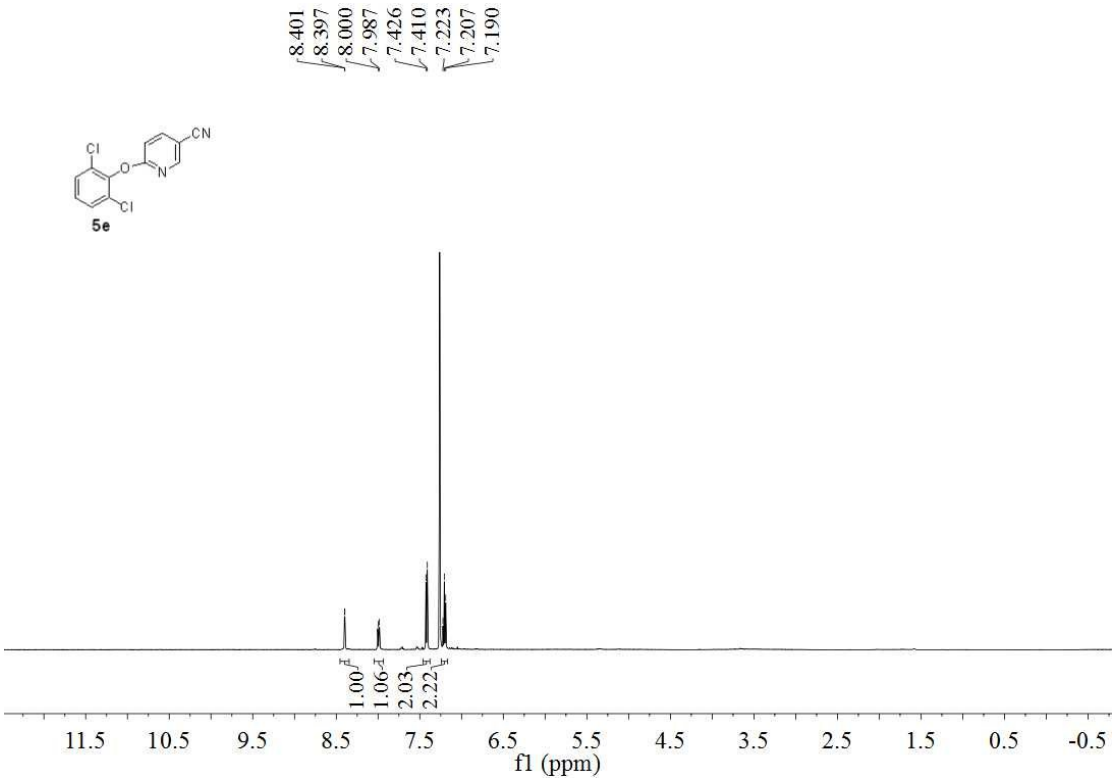

1.00
1.00
1.90
1.03
1.06
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
f1 (ppm)

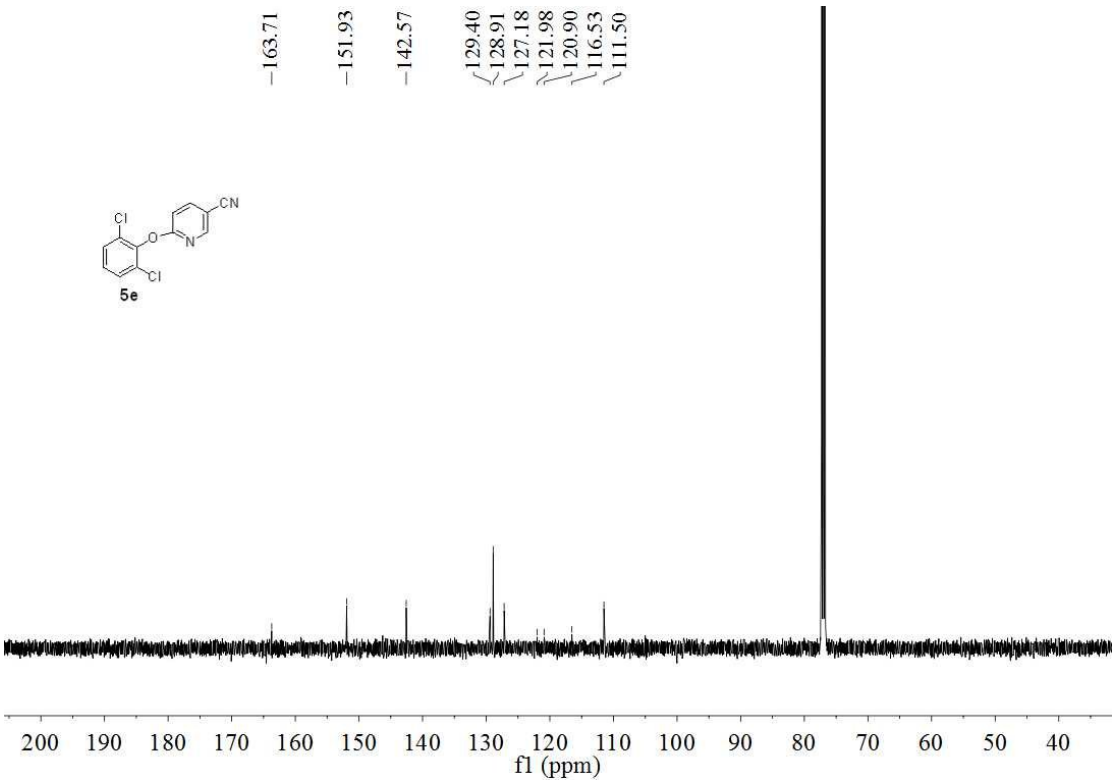

157.27
146.26
144.98
139.51
129.60
128.78
126.74
119.75
118.31

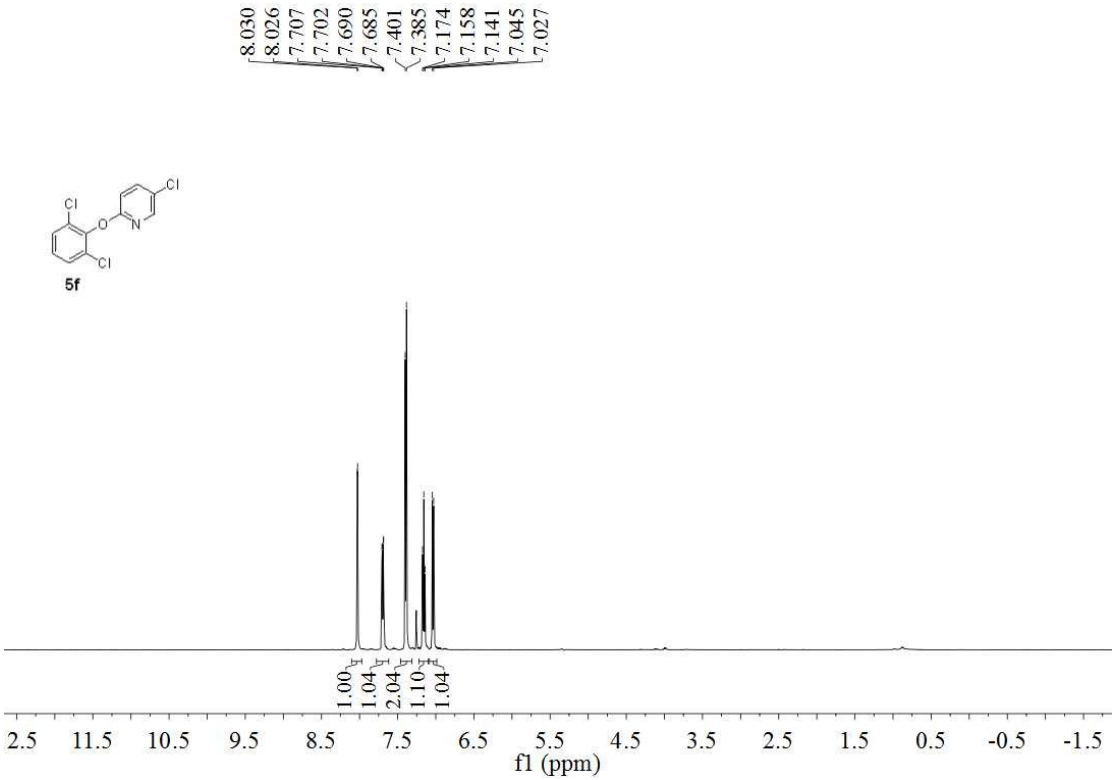

Cl
Cl
O
N
Cl

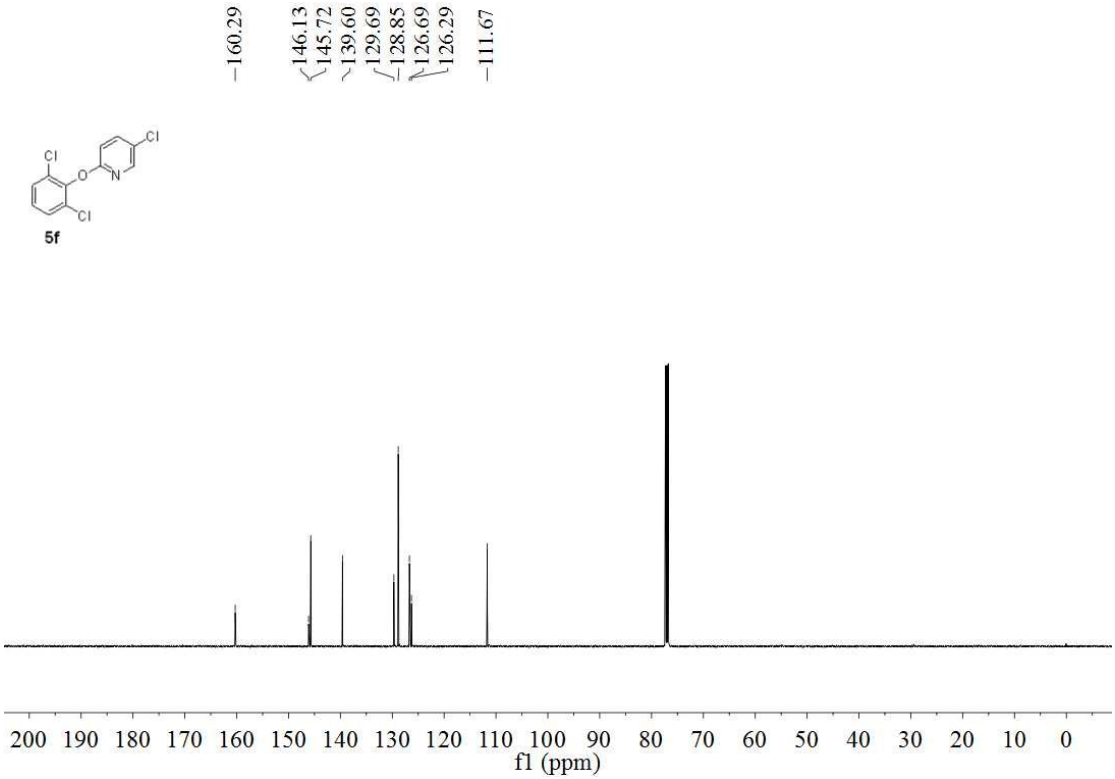
5d

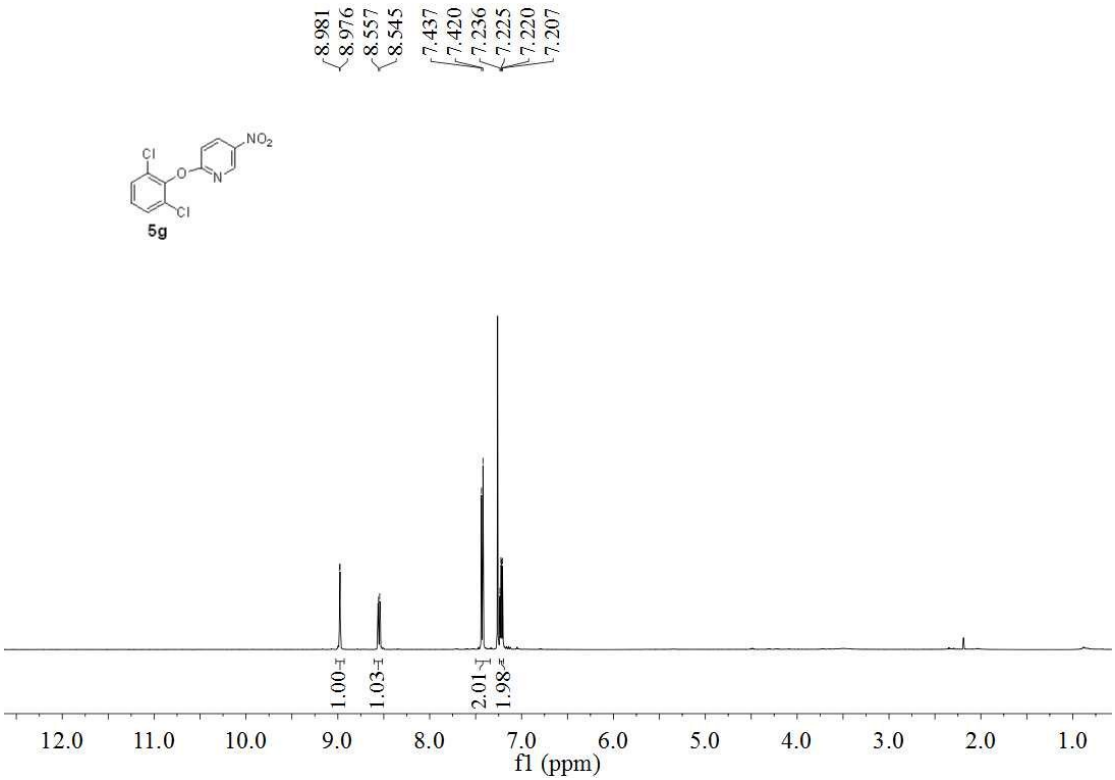

200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

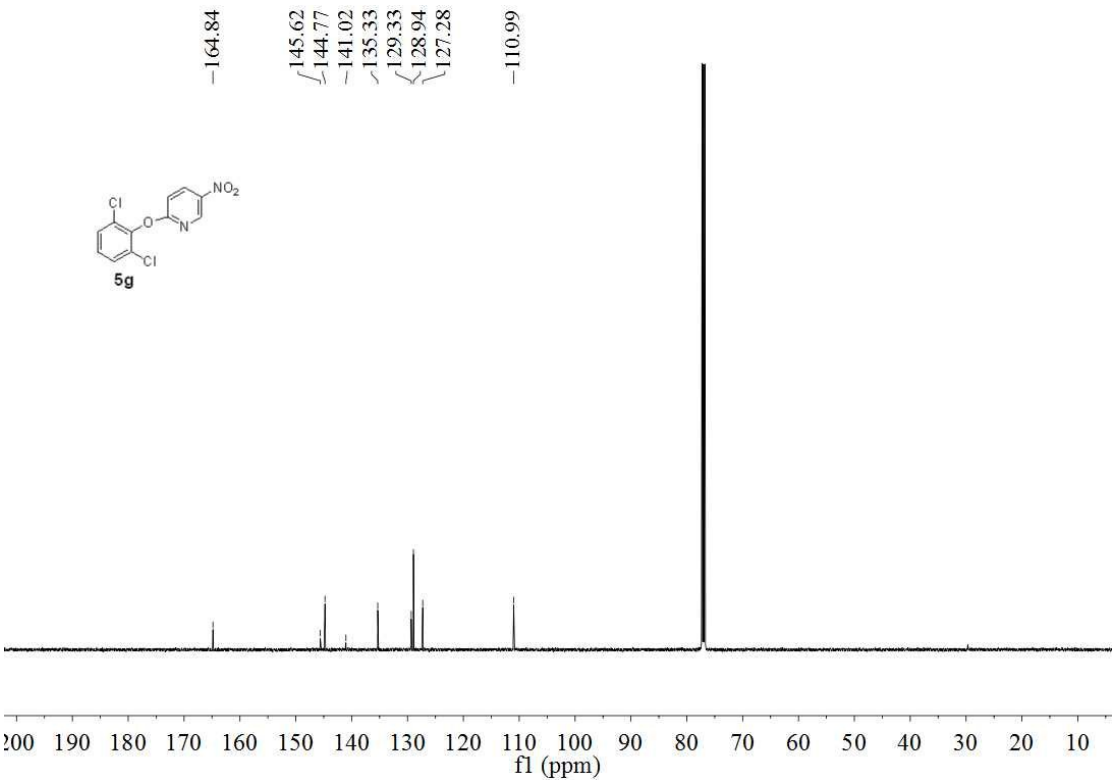

8.401
8.397
8.000
7.987
7.426
7.410
7.223
7.207
7.190
Cl
O
N
CN
Cl
5e
1.00
1.06
2.03
2.22
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

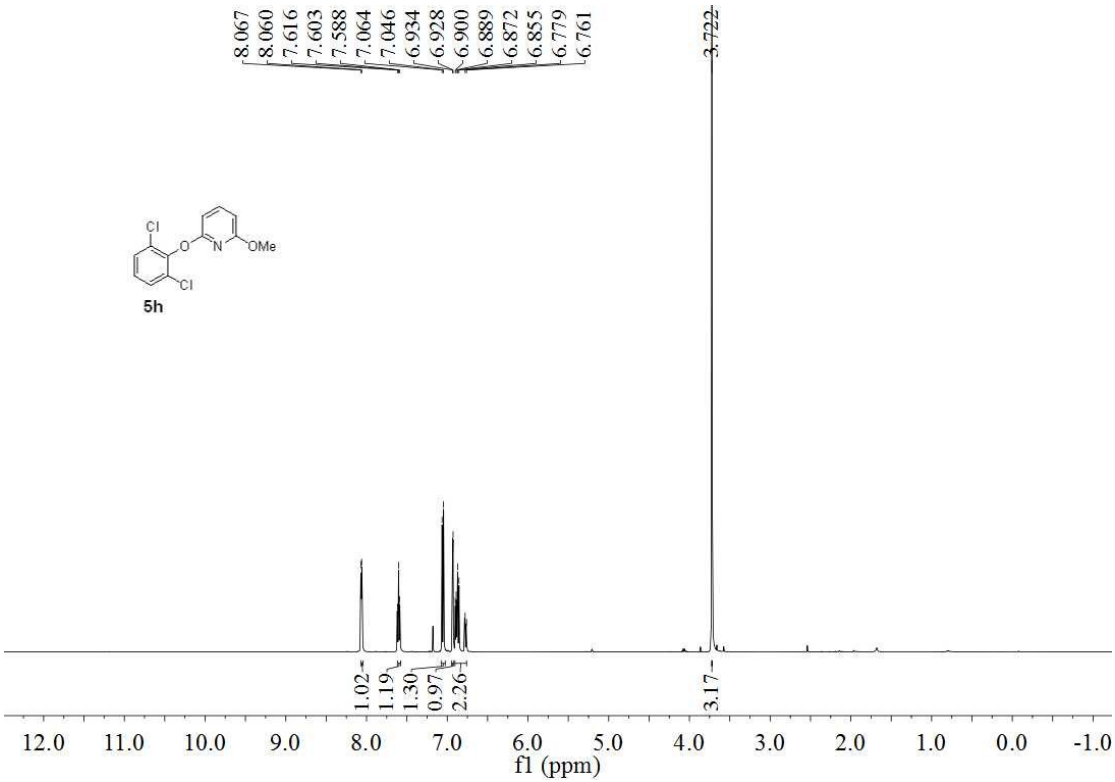

163.71
151.93
142.57
129.40
128.91
127.18
121.98
120.90
116.53
111.50
Cl
O
N
CN
Cl
5e
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
f1 (ppm)

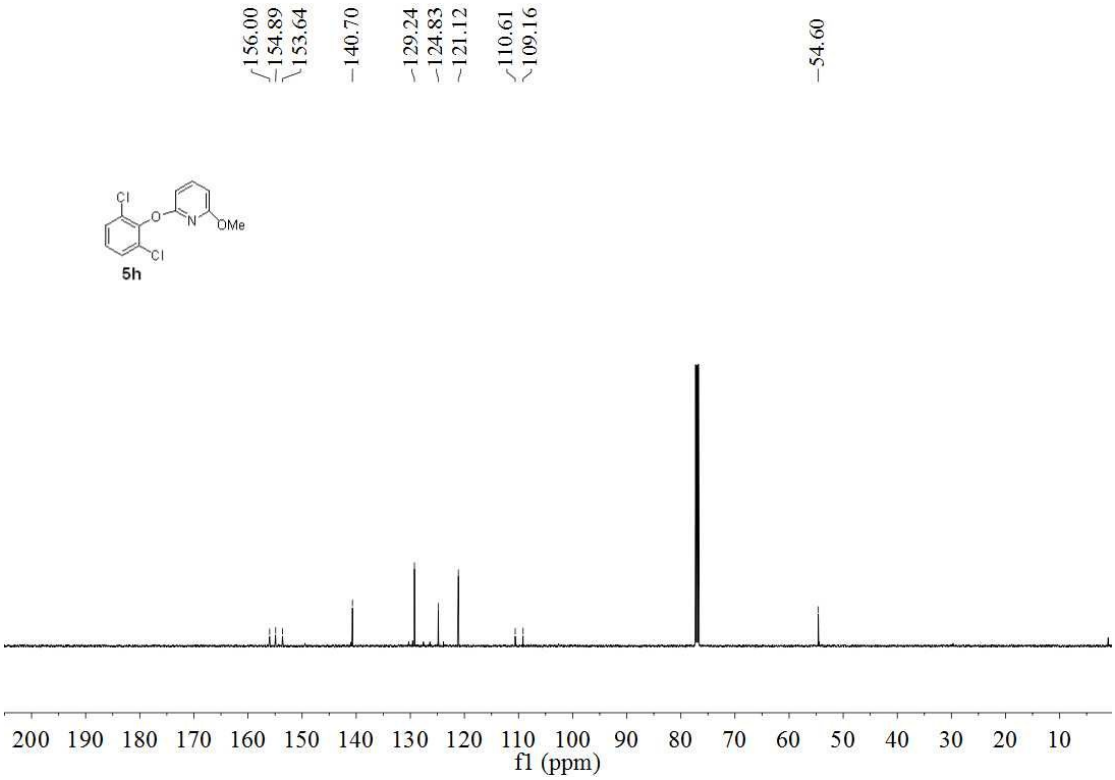

8.030
8.026
7.707
7.702
7.690
7.685
7.401
7.385
7.174
7.158
7.141
7.045
7.027
5f
1.00
1.04
2.04
1.10
1.04
2.5 11.5 10.5 9.5 8.5 7.5 6.5 5.5 4.5 3.5 2.5 1.5 0.5 -0.5 -1.5
f1 (ppm)

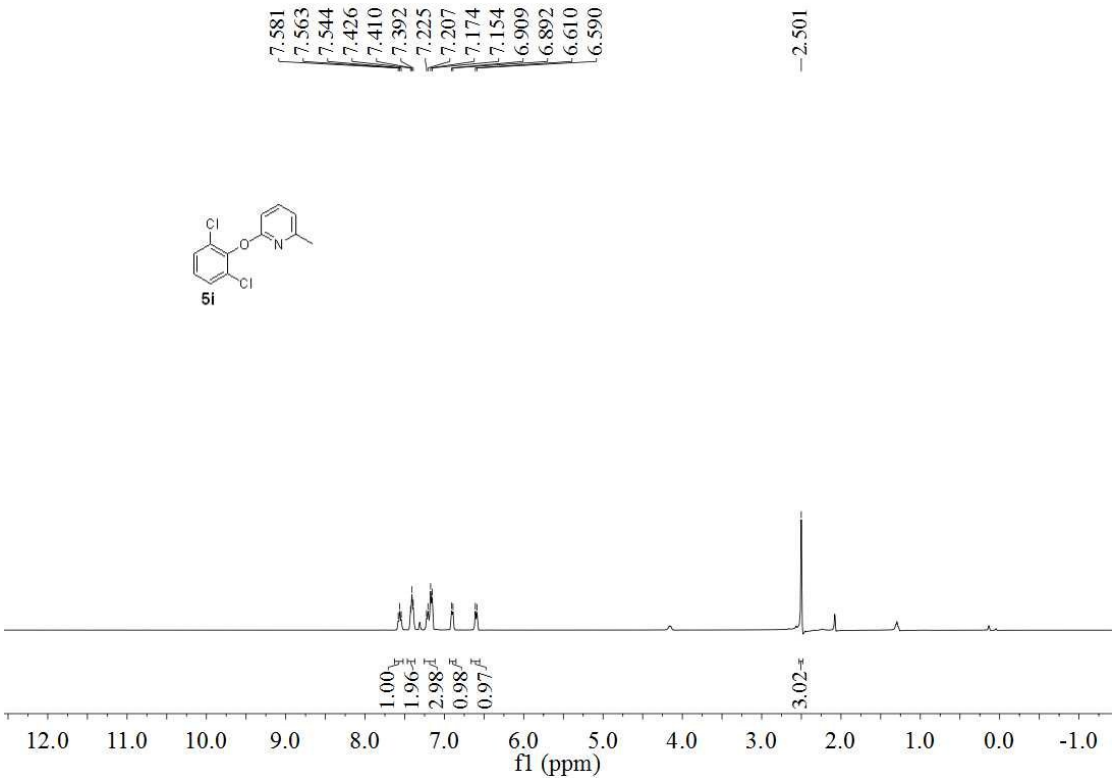

160.29
146.13
145.72
139.60
129.69
128.85
126.69
126.29
111.67
5f
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

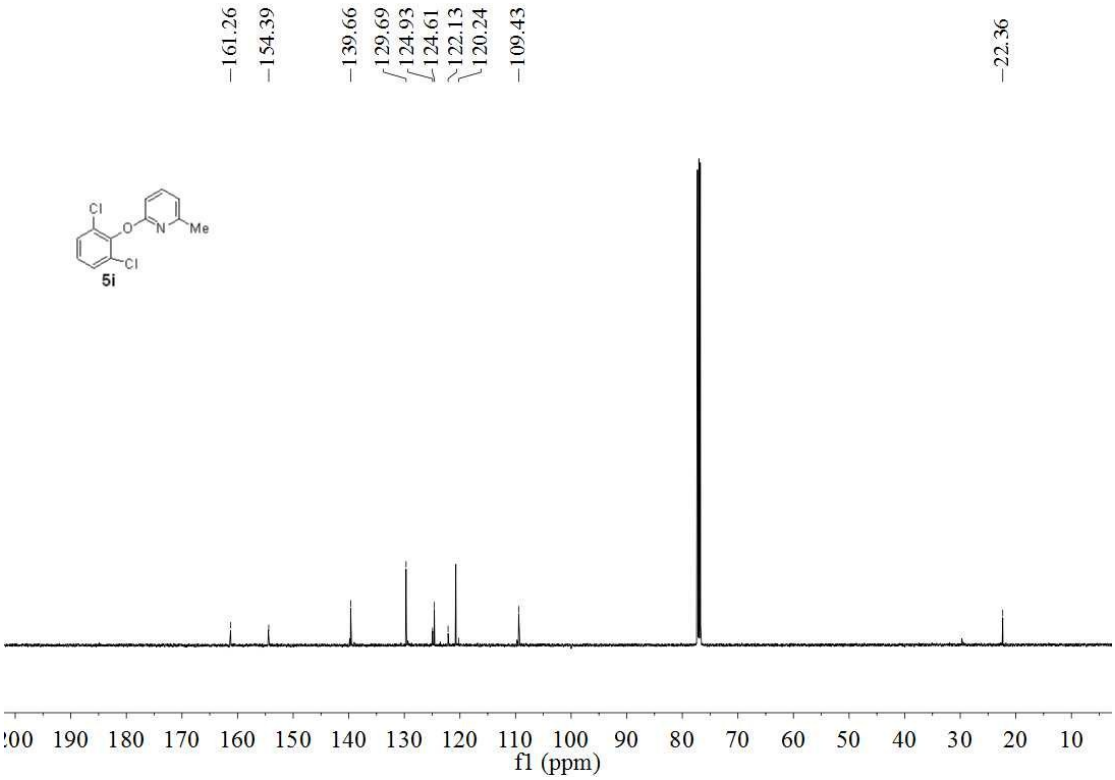

8.981
8.976
8.557
8.545
7.437
7.420
7.236
7.225
7.220
7.207
Cl
O
N
NO2
Cl
5g
1.00
1.03
2.01
1.98
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
f1 (ppm)


164.84
145.62
144.77
141.02
135.33
129.33
128.94
127.28
110.99
Cl
O
N
NO2
Cl
5g
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

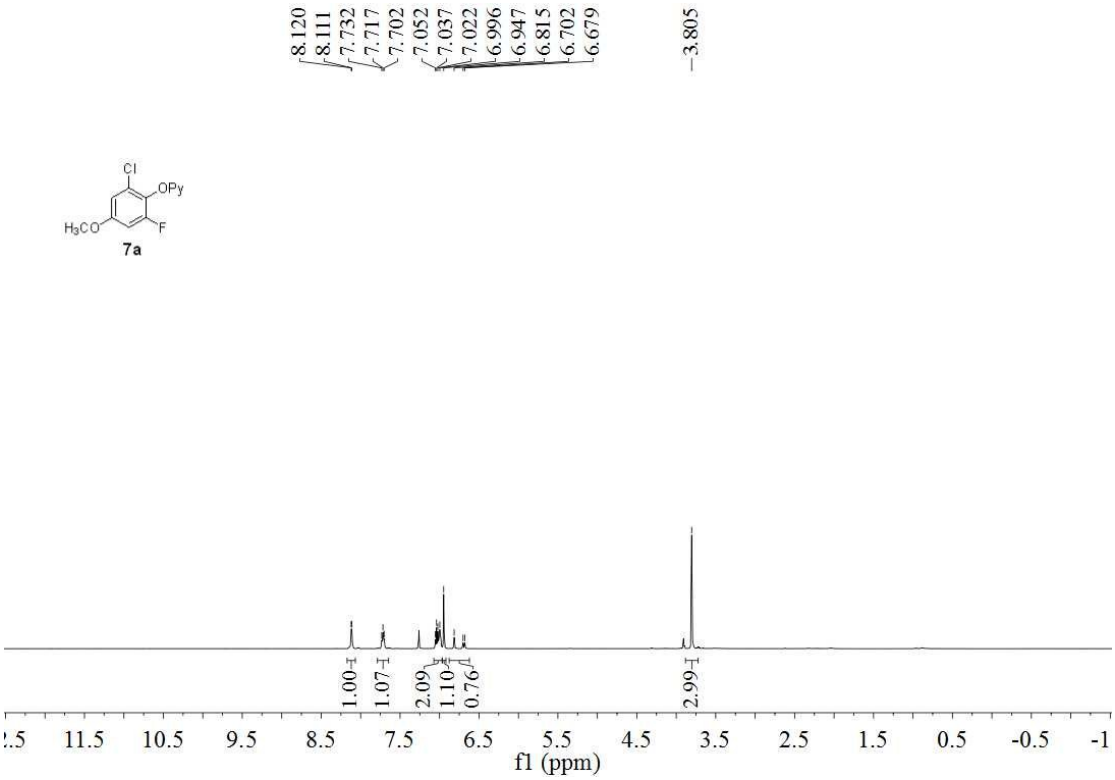

8.067
8.060
7.616
7.603
7.588
7.064
7.046
6.934
6.928
6.900
6.889
6.872
6.855
6.779
6.761
3.722
Cl
O
N
OMe
Cl
5h
1.02
1.19
1.30
0.97
2.26
3.17
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)


156.00
154.89
153.64
140.70
129.24
124.83
121.12
110.61
109.16
54.60
Cl
O
N
OMe
Cl
5h
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

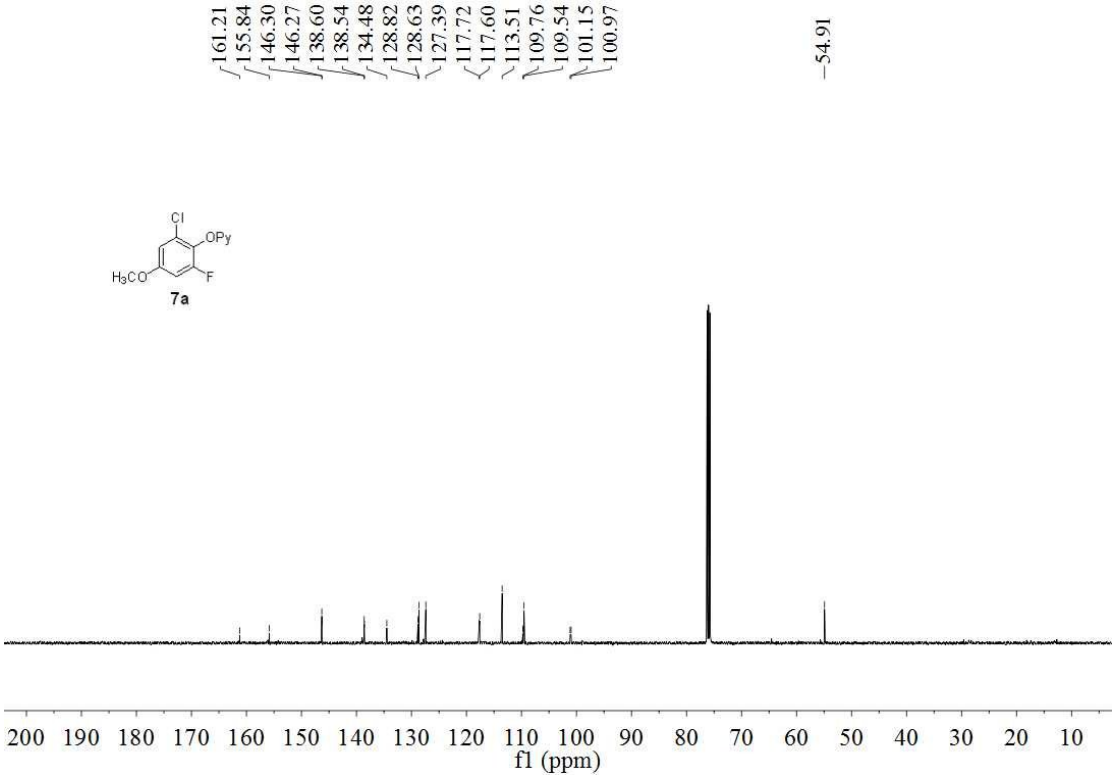

7.581
7.563
7.544
7.426
7.410
7.392
7.225
7.207
7.174
7.154
6.909
6.892
6.610
6.590
2.501
Cl
O
N
Cl
5i
1.00
1.96
2.98
0.98
0.97
3.02
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)


161.26
154.39
139.66
129.69
124.93
124.61
122.13
120.24
109.43
22.36
Cl
O
N
Me
Cl
5i
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

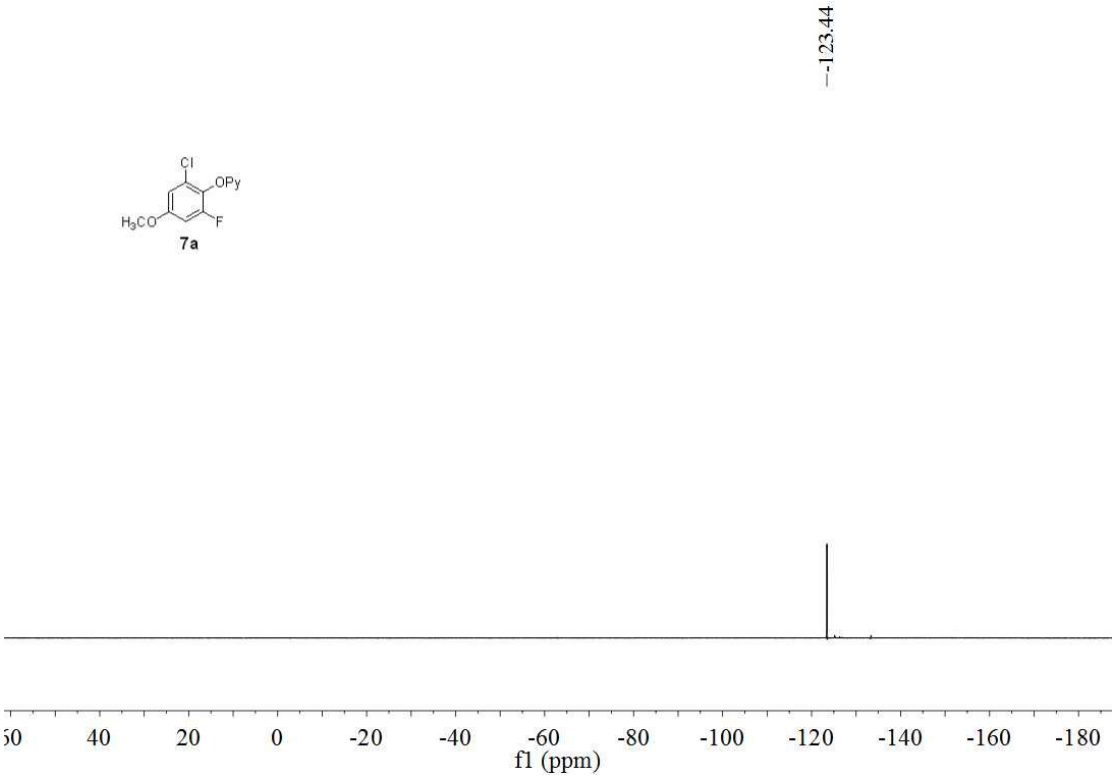
Cl
OPy
H3CO
F
7a

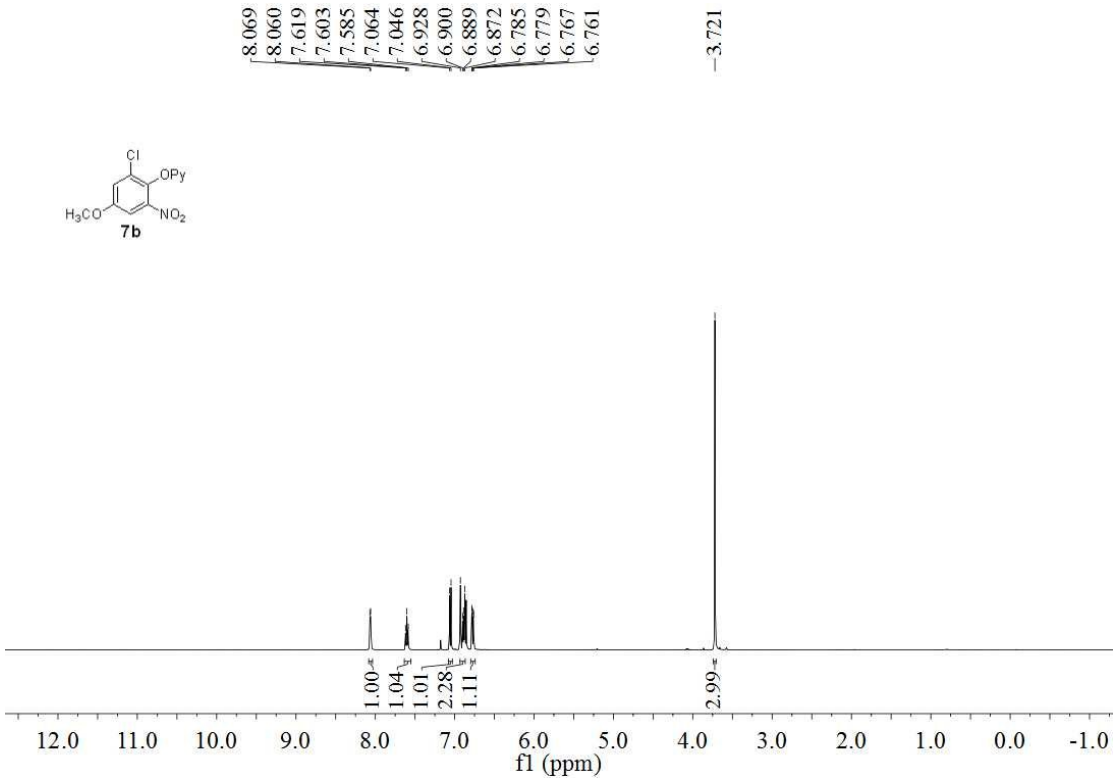

8.120
8.111
7.732
7.717
7.702
7.052
7.037
7.022
6.996
6.947
6.815
6.702
6.679
3.805
1.00
1.07
2.09
1.10
0.76
2.99
f1 (ppm)

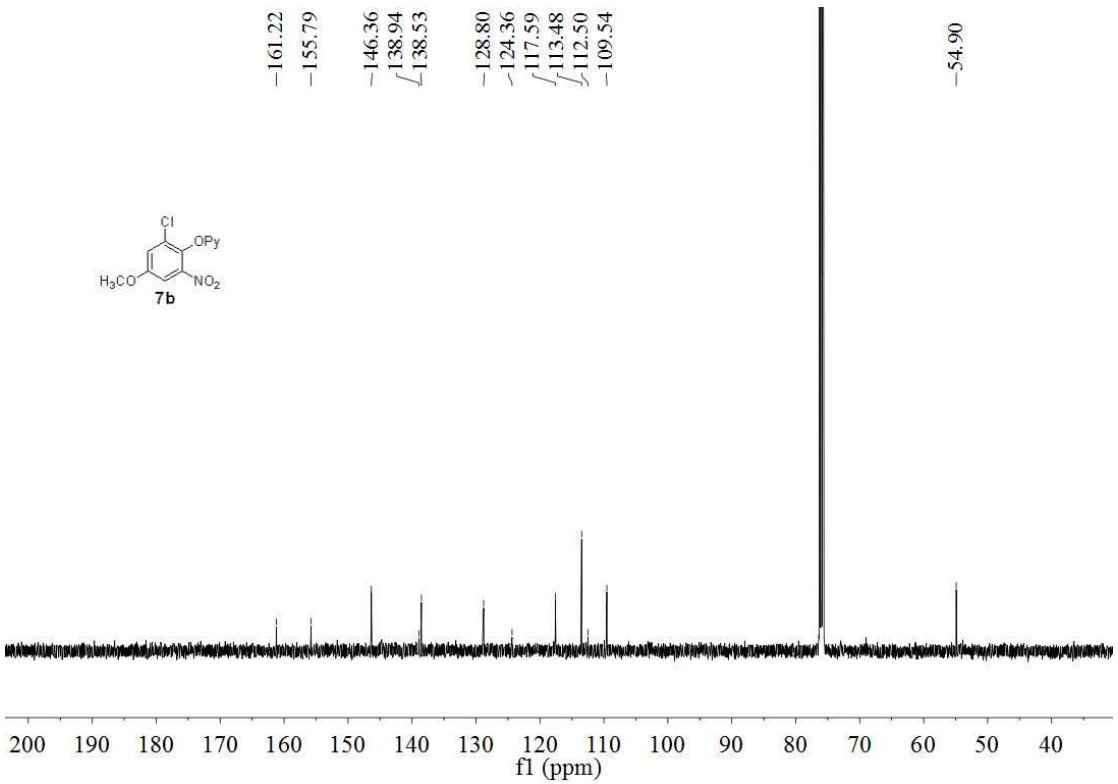
Cl
OPy
H3CO
F
7a

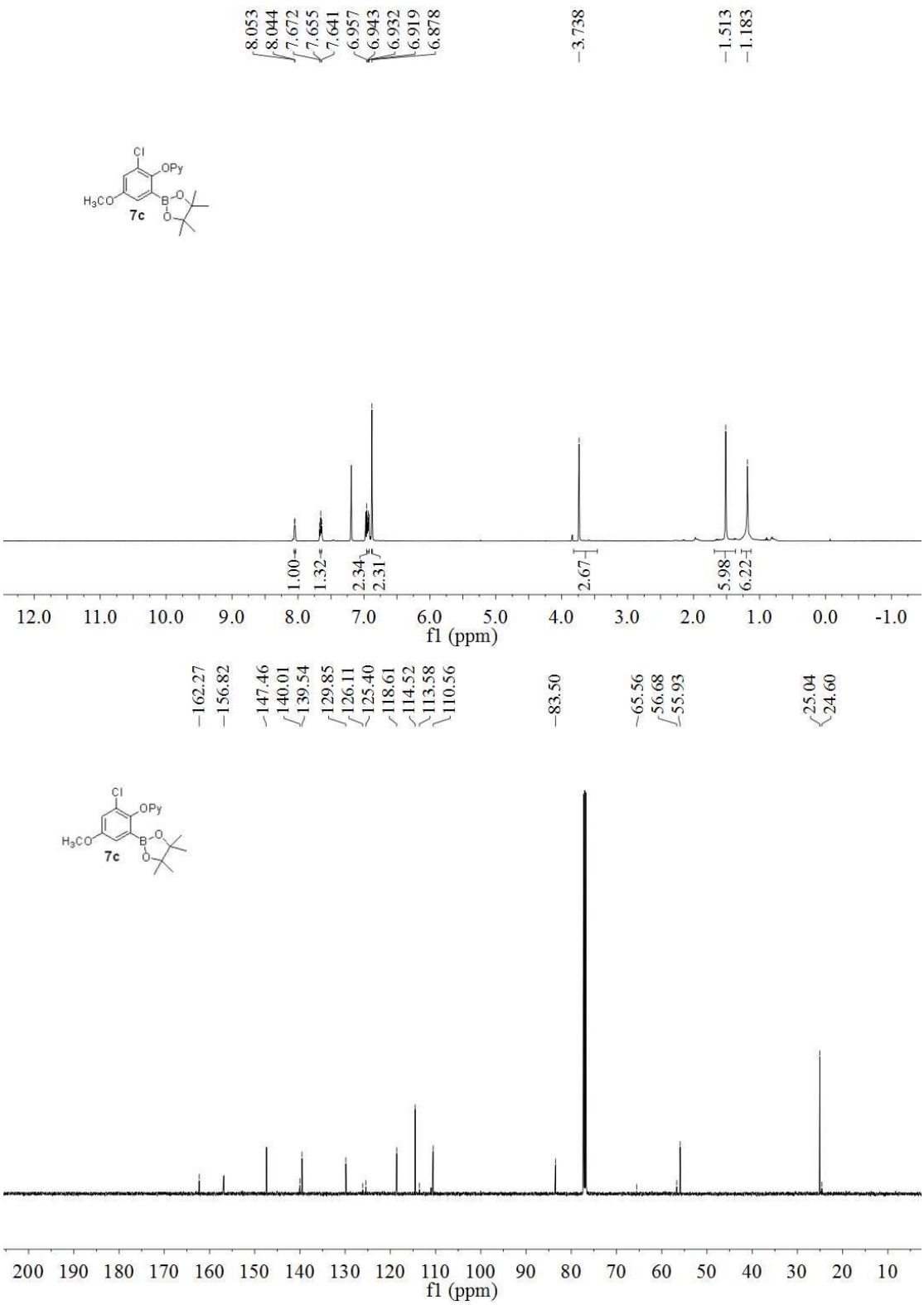

161.21
155.84
146.30
146.27
138.60
138.54
134.48
128.82
128.63
127.39
117.72
117.60
113.51
109.76
109.54
101.15
100.97
54.91
f1 (ppm)

7a



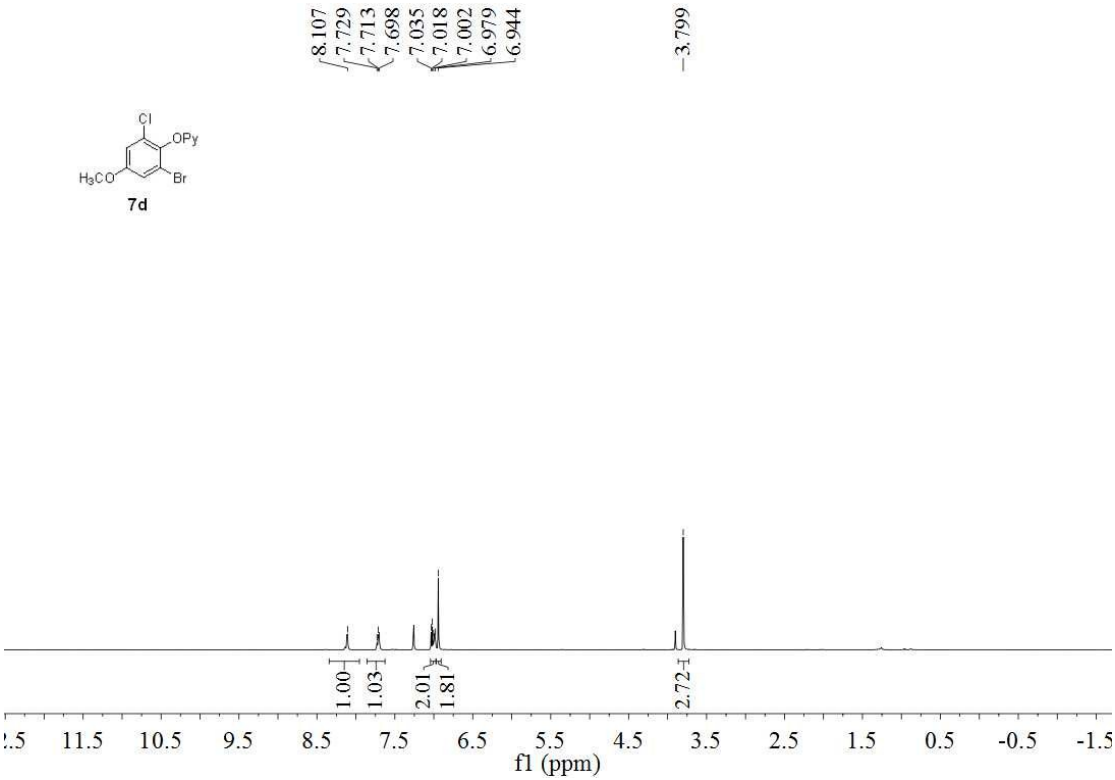

8.069
8.060
7.619
7.603
7.585
7.064
7.046
6.928
6.900
6.889
6.872
6.785
6.779
6.767
6.761
3.721
Cl
OPy
H3CO
NO2
7b
1.00
1.04
1.01
2.28
1.11
2.99
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)

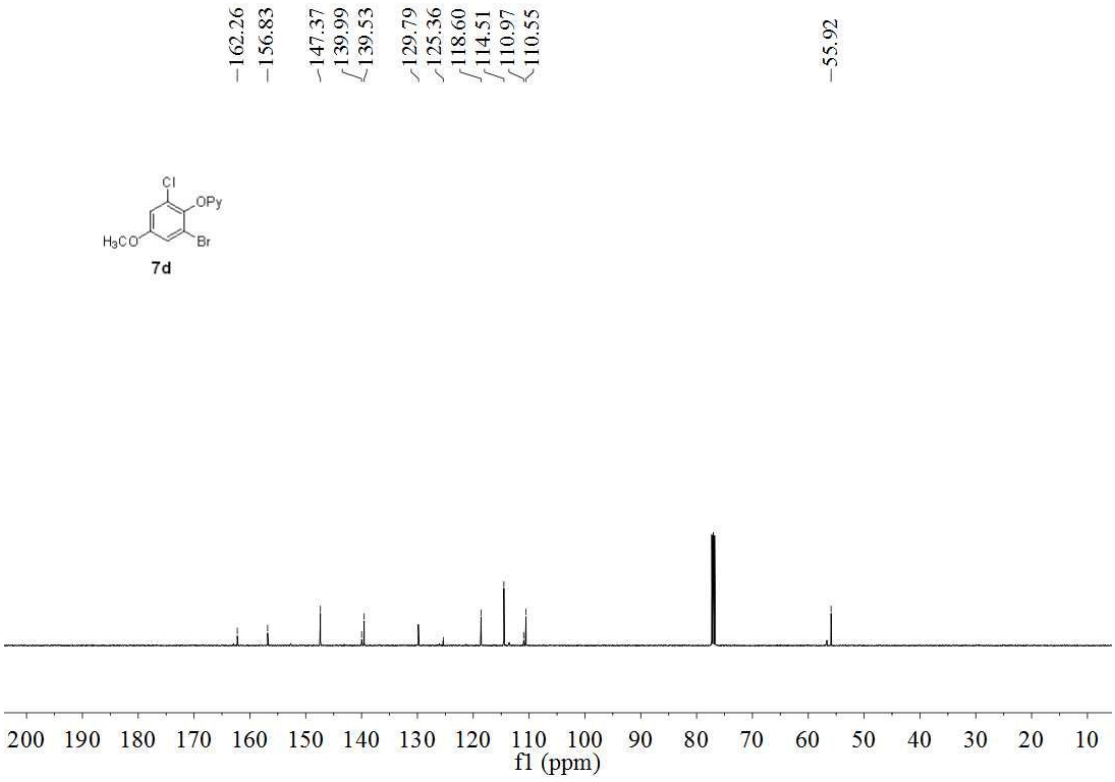

161.22
155.79
146.36
138.94
138.53
128.80
124.36
117.59
113.48
112.50
109.54
54.90
Cl
OPy
H3CO
NO2
7b
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40
f1 (ppm)


8.053
8.044
7.672
7.655
7.641
6.957
6.943
6.932
6.919
6.878
3.738
1.513
1.183
Cl
OPy
H3CO
B
O
7c
1.00
1.32
2.34
2.31
2.67
5.98
6.22
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)
162.27
156.82
147.46
140.01
139.54
129.85
126.11
125.40
118.61
114.52
113.58
110.56
83.50
65.56
56.68
55.93
25.04
24.60
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

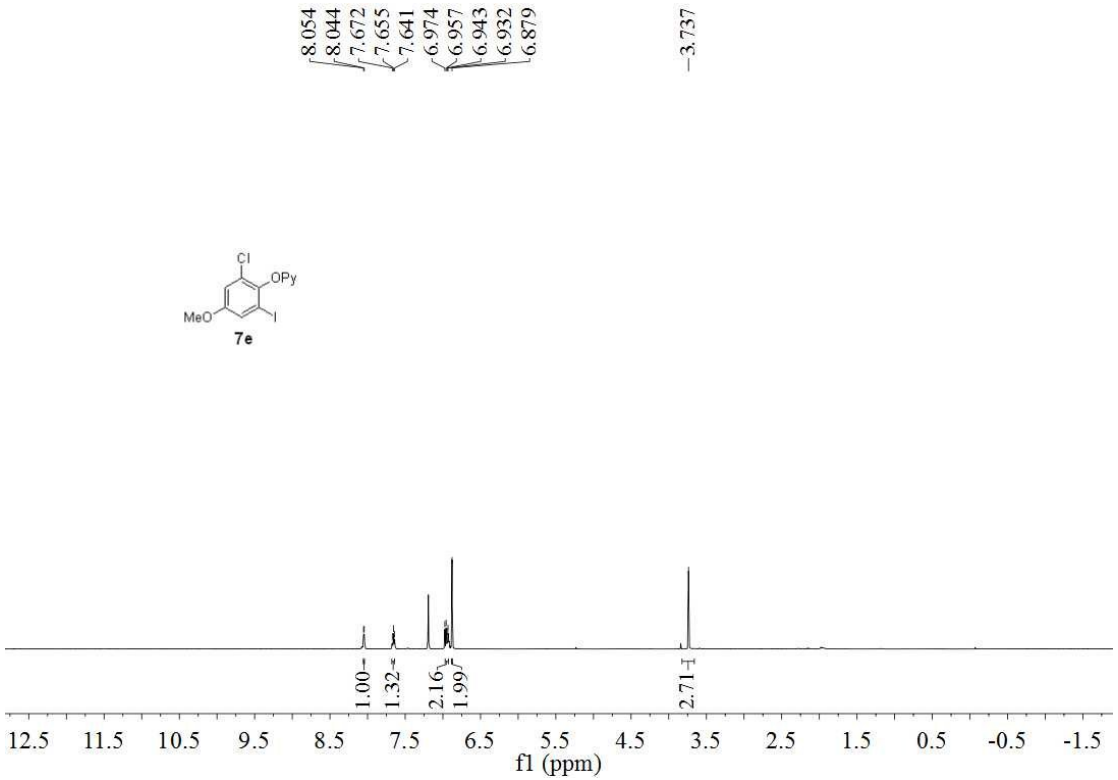
Cl
OPy
H3CO
Br

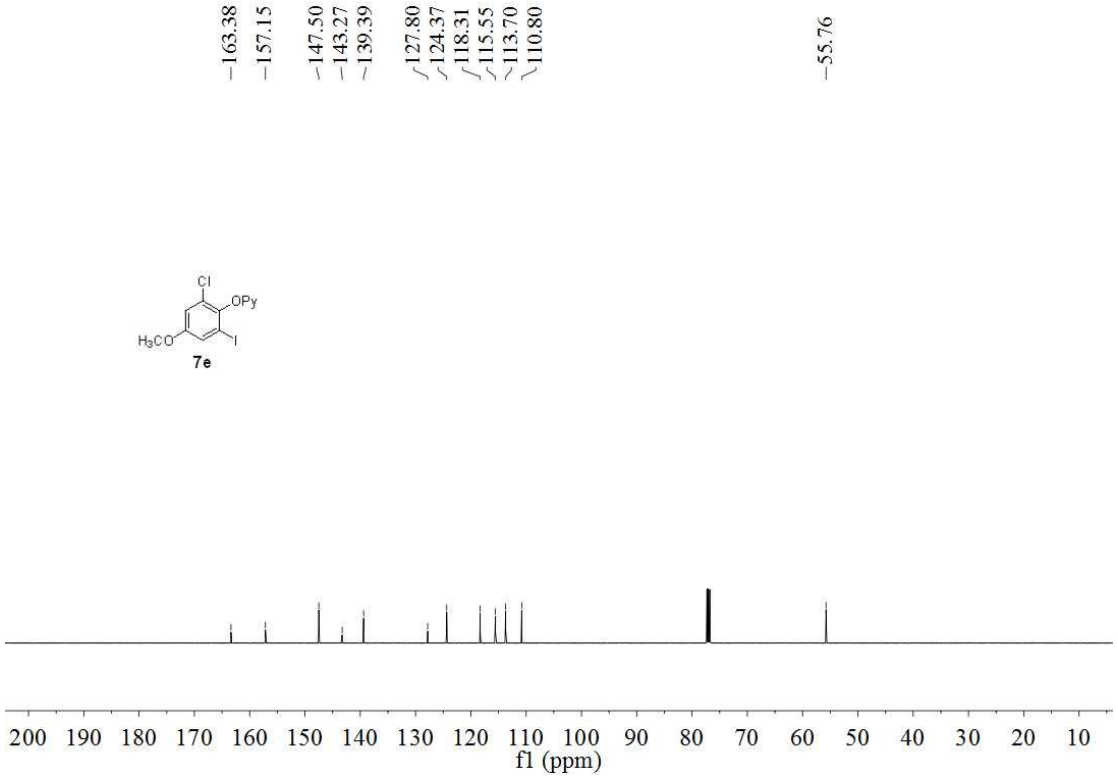
7d

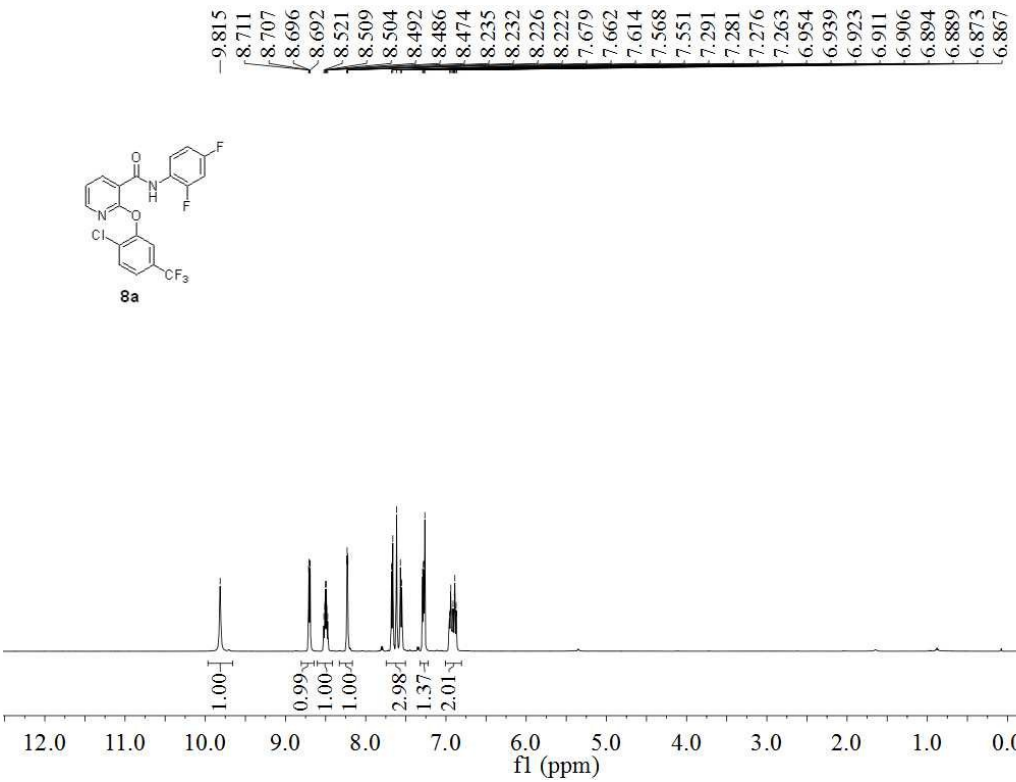

8.107
7.729
7.713
7.698
7.035
7.018
7.002
6.979
6.944
3.799
1.00
1.03
2.01
1.81
2.72
f1 (ppm)

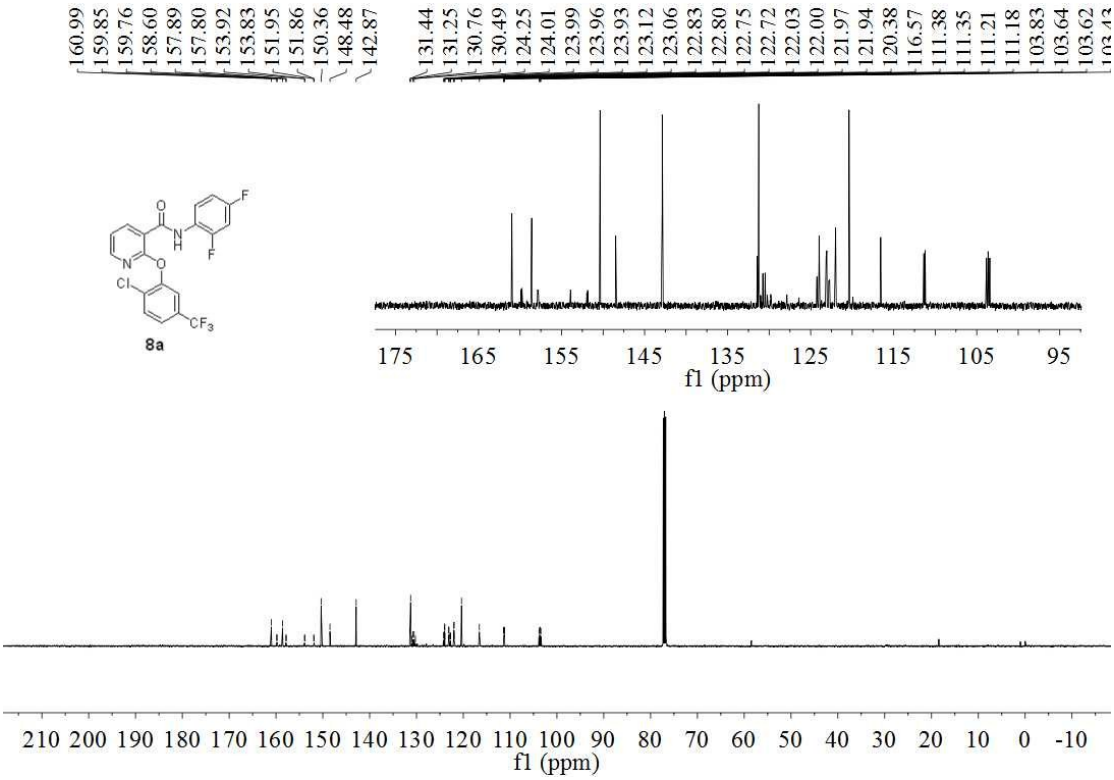

162.26
156.83
147.37
139.99
139.53
129.79
125.36
118.60
114.51
110.97
110.55
55.92
f1 (ppm)

7d

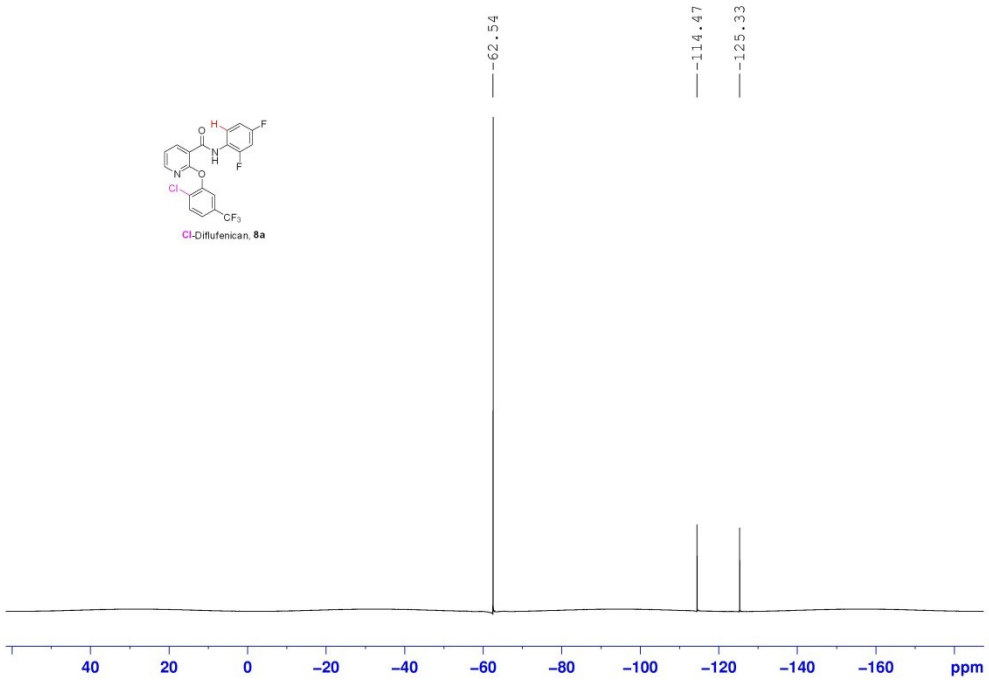

8.054
8.044
7.672
7.655
7.641
6.974
6.957
6.943
6.932
6.879
3.737
Cl
OPy
MeO
I
7e
1.00
1.32
2.16
1.99
2.71
12.5 11.5 10.5 9.5 8.5 7.5 6.5 5.5 4.5 3.5 2.5 1.5 0.5 -0.5 -1.5
f1 (ppm)

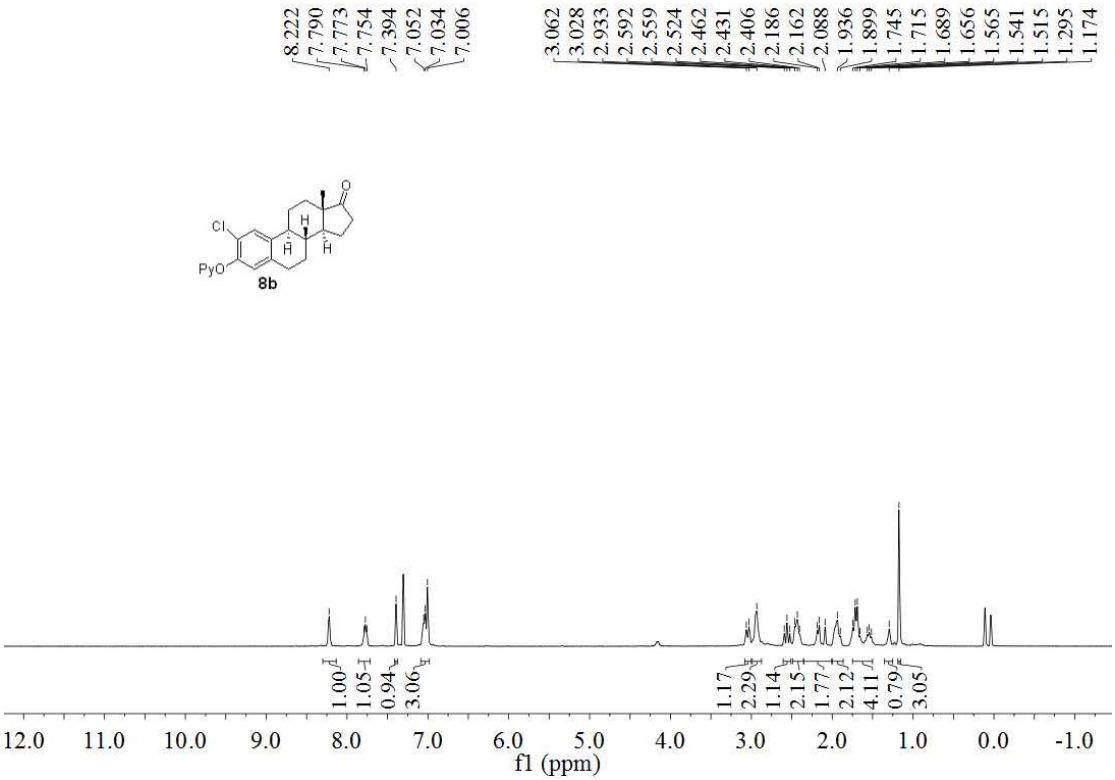

163.38
157.15
147.50
143.27
139.39
127.80
124.37
118.31
115.55
113.70
110.80
55.76
Cl
OPy
H3CO
I
7e
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

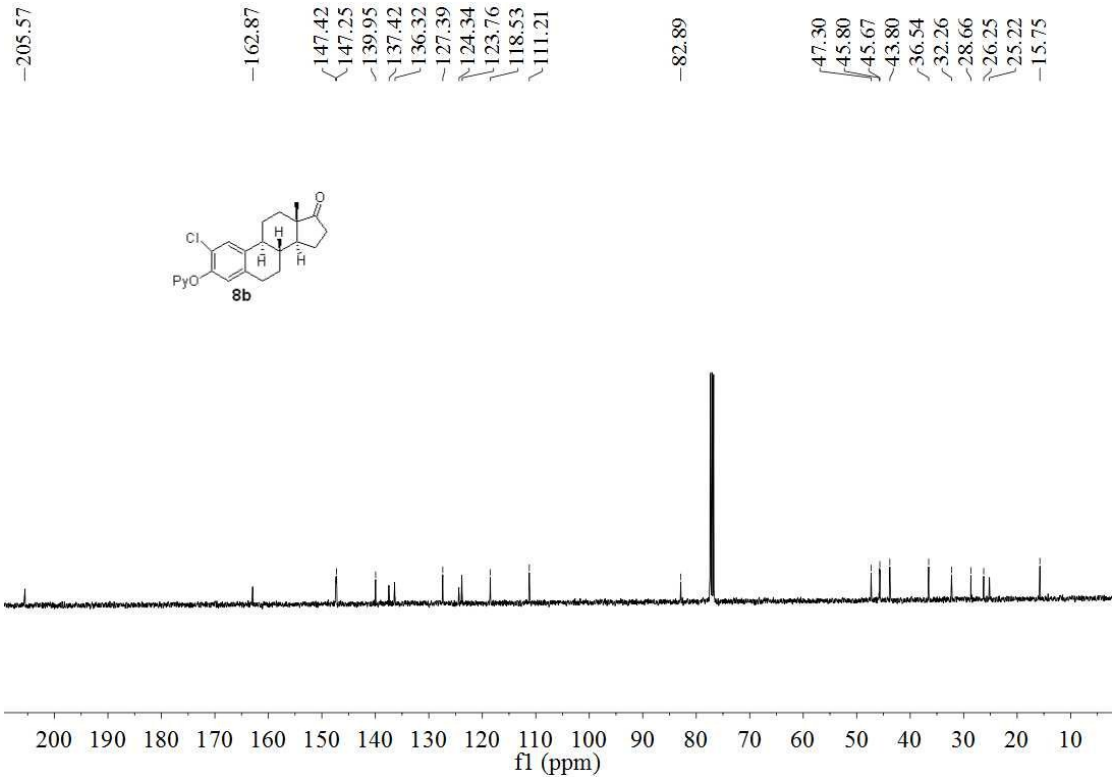

9.815
8.711
8.707
8.696
8.692
8.521
8.509
8.504
8.492
8.486
8.474
8.235
8.232
8.226
8.222
7.679
7.662
7.614
7.568
7.551
7.291
7.281
7.276
7.263
6.954
6.939
6.923
6.911
6.906
6.894
6.889
6.873
6.867
8a
1.00
0.99
1.00
1.00
2.98
1.37
2.01
f1 (ppm)


160.99
159.85
159.76
158.60
157.89
157.80
153.92
153.83
151.95
151.86
150.36
148.48
142.87
131.44
131.25
130.76
130.49
124.25
124.01
123.99
123.96
123.93
123.12
123.06
122.83
122.80
122.75
122.72
122.03
122.00
121.97
121.94
120.38
116.57
111.38
111.35
111.21
111.18
103.83
103.64
103.62
8a
f1 (ppm)

f1 (ppm)


-62.54
-114.47
-125.33
Cl-Diflufenican, 8a
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
ppm


8.222
7.790
7.773
7.754
7.394
7.052
7.034
7.006
3.062
3.028
2.933
2.592
2.559
2.524
2.462
2.431
2.406
2.186
2.162
2.088
1.936
1.899
1.745
1.715
1.689
1.656
1.565
1.541
1.515
1.295
1.174
Cl
PyO
H
O
8b
1.00
1.05
0.94
3.06
1.17
2.29
1.14
2.15
1.77
2.12
4.11
0.79
3.05
12.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.0
f1 (ppm)


205.57
162.87
147.42
147.25
139.95
137.42
136.32
127.39
124.34
123.76
118.53
111.21
82.89
47.30
45.80
45.67
43.80
36.54
32.26
28.66
26.25
25.22
15.75
Cl
PyO
H
O
8b
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)