Supporting information

Electrochemical fluoromethylation triggered lactonizations of alkenes under semi-aqueous conditions

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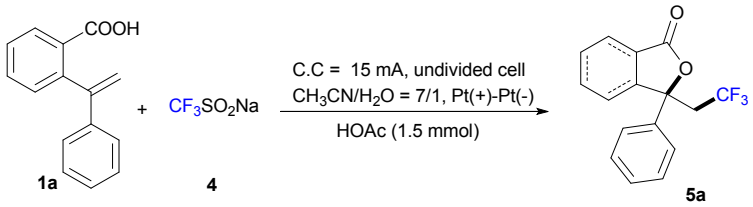
Part I Experimental Section

1.1 General information

^{1}H NMR and ^{13}C NMR were recorded on a Bruker-400MHz Spectrometer (^{1}H NMR: 400MHz, ^{13}C NMR: 100MHz, ^{19}F NMR: 376MHz) using TMS as internal reference. All the ^{13}C NMR spectra are obtained in ^{13}C{H} experiments. The chemical shifts (δ) and coupling constants (*J*) were expressed in ppm and Hz respectively. The abbreviations used for explaining the multiplicities were as follows: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad. High resolution mass spectra (HRMS) were measured using electrospray ionization (ESI) and the time-of-flight (TOF) mass analyzer. Commercially available compounds were used without further purification. Substrate **1a-1r** were prepared according to the literature procedures.[1] CF_2HSO_2Na was prepared according to the literature procedures.[2]

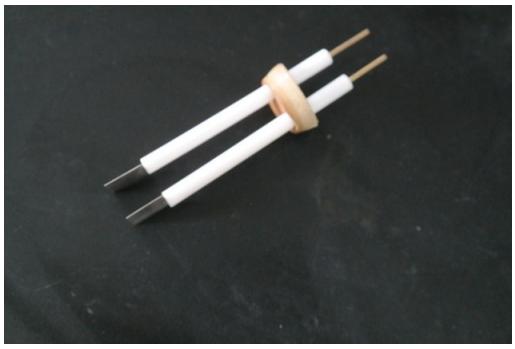
1.2 General procedure for electrochemical carboxyfluoromethylation

5a as an example

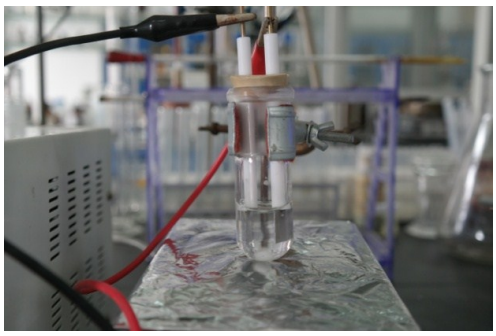


An undivided cell was equipped with a magnet stirrer, platinum plate (1.5×1.5 cm^2) electrode, as the working electrode and counter electrode (the electrolysis setup is shown in Fig. S1). The substrate 2-(1-phenylvinyl)benzoic acid **1a** (112 mg, 0.5 mmol), CF_3SO_2Na (195 mg, 1.25 mmol) and additive HOAc (86 μL, 1.5 mmol) was added to the solvent CH_3CN/H_2O (7/1 mL). The resulting mixture was allowed to stir and electrolyze at constant current conditions (*J* = 6.7 mA/cm^2) at room temperature for 3 hours. Then the volatile solvent was removed with a rotary evaporator and water was added (10 mL). The resulting mixture was extracted with ethyl acetate (10*3 mL). The combined organic layer was dried over Na_2SO_4 and concentrated in vacuum. The residue was purified by column chromatography (EA/PE = 1/15-1/10) on silica gel to afford the desired product **5a** in 93 % yield.

graphite plate electrode (15*15*2 mm^3)



platinum plate electrode (15*15*0.3 mm^3)



experiment apparatus (d: 24 mm, h: 80 mm)

Figure S1. Electrolysis setup

1.3 CV and control experiments

1.3.1 CV experiments

The electrochemical analysis was demonstrated with Ag wire as a reference electrode, which is not a stable reference electrode. CVs can be calibrated using ferrocene as an external reference. (Figure S2) $E_0(Fc/Fc^+) = (0.128-0.065)/2 = 0.0315V$.

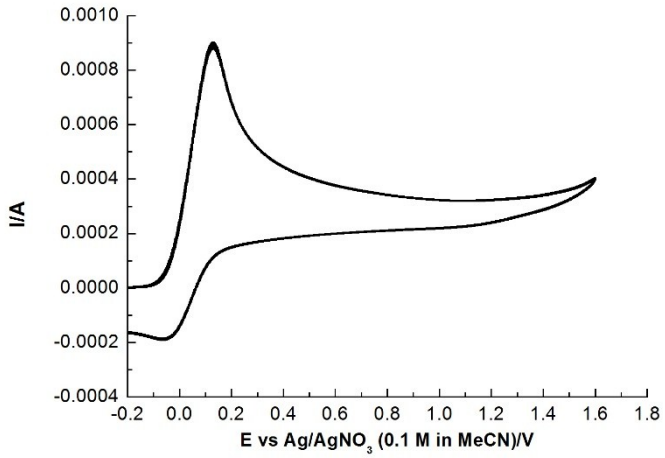


Figure S2. Cyclic voltammograms of ferrocene in 0.1 M $LiClO_4/CH_3CN$, using Pt wire working electrode, glassy carbon, and $Ag/AgNO_3$ (0.1 M in CH_3CN) as counter and reference electrodes at 100 mV/s scan rate.

The cyclic voltammetric experiments were performed as shown below (Figure S3). All potentials reported here vs. Fc/Fc^+ were obtained by comparing the potentials measured vs. the Ag/Ag^+ electrode with $E_0(Fc/Fc^+)$ (Figure S4).

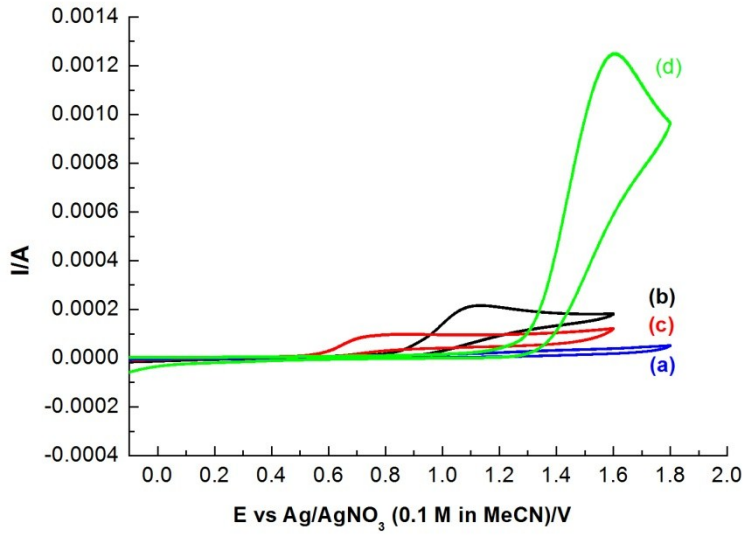


Figure S3. Cyclic voltammograms of substrates in 0.1 M $LiClO_4/CH_3CN$, using Pt wire working electrode, glassy carbon, and $Ag/AgNO_3$ (0.1 M in CH_3CN) as counter and reference electrodes at 100 mV/s scan rate: (a) background ($LiClO_4$ 0.1M in CH_3CN), (b) CF_3SO_2Na (5 mmol/L), (c) CF_2HSO_2Na (5 mmol/L), (d) **1a** (5 mmol/L).

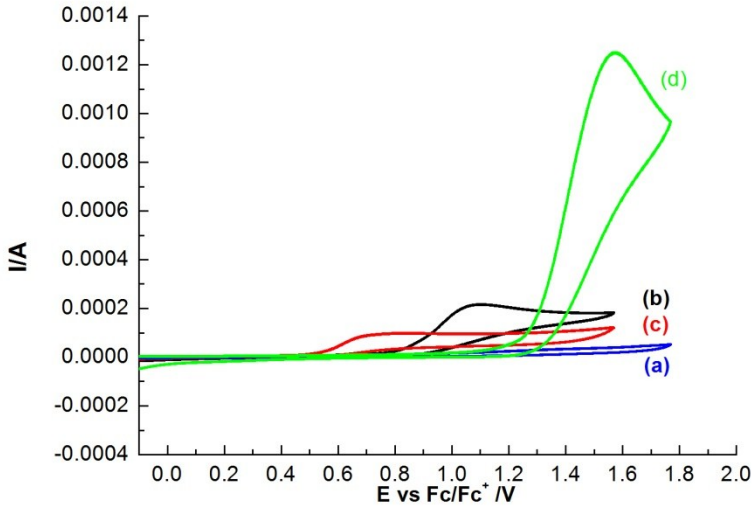


Figure S4. Cyclic voltammograms of substrates: (a) background ($LiClO_4$ 0.1M in CH_3CN), (b) CF_3SO_2Na (5 mmol/L), (c) CF_2HSO_2Na (5 mmol/L), (d) **1a** (5 mmol/L).

The CV experiments which were carried out in CH_3CN with HOAc as the additive were shown in Figure S5. The results showed that CF_2HSO_2Na and CF_3SO_2Na are much easier to be electrochemically oxidized than alkene moiety.

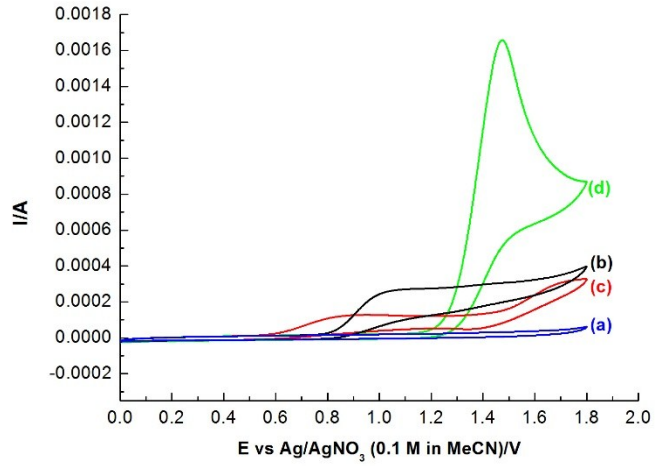


Figure S5. Cyclic voltammograms of substrates: (a) background (0.1M $LiClO_4$ in CH_3CN with 15 mmol/L HOAc as the additive), (b) CF_3SO_2Na (5 mmol/L), (c) CF_2HSO_2Na (5 mmol/L), (d) **1a** (5 mmol/L).

The CV experiments which were carried out in CH_3CN/H_2O were shown in Figure S6. The results showed that CF_2HSO_2Na and CF_3SO_2Na have the oxidation potential of 0.8 V and 1.2 V, respectively. However, alkene moiety is oxidatively inactive at the range of 0-1.2 V.

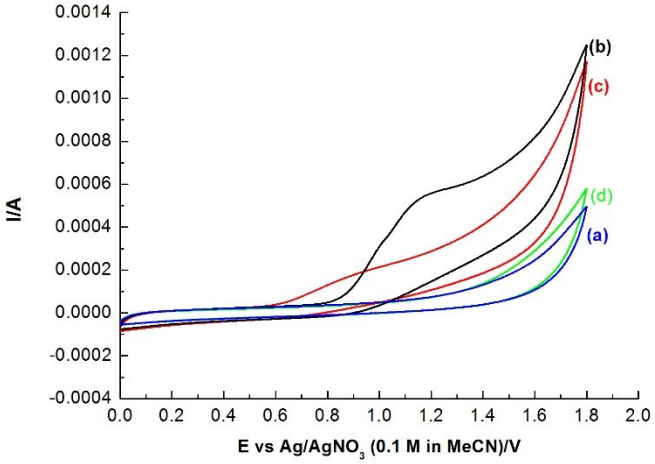
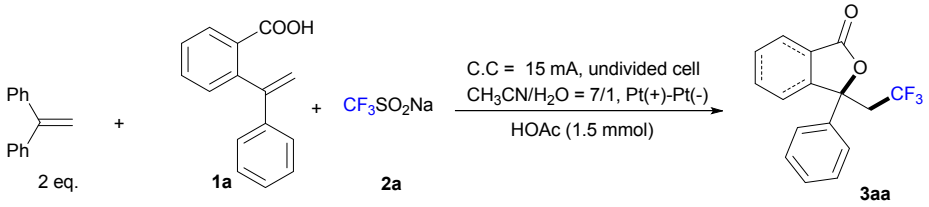


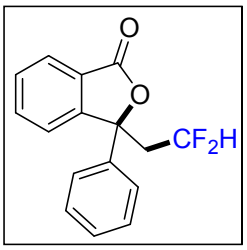
Figure S6. Cyclic voltammograms of substrates: (a) background (0.1M $LiClO_4$ in CH_3CN/H_2O (7/1, V/V)), (b) CF_3SO_2Na (5 mmol/L), (c) CF_2HSO_2Na (5 mmol/L), (d) **1a** (5 mmol/L).

1.3.2 Radical trapping reaction

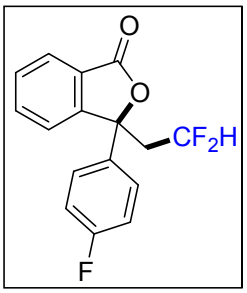


An undivided cell was equipped with a magnet stirrer, platinum plate (1.5×1.5 cm^2) electrode, as the working electrode and counter electrode. The substrate 2-(1-phenylvinyl)benzoic acid **1a** (112 mg, 0.5 mmol), CF_3SO_2Na (195 mg, 1.25 mmol) , additive HOAc (86 μL, 1.5 mmol) and the radical scavenger 1,1-diphenylethylene (180mg, 1.0mmol) was added to the solvent CH_3CN/H_2O (7/1 mL). The resulting mixture was allowed to stir and electrolyze at constant current conditions (J = 6.7 mA/cm^2) at room temperature for 3 hours. When we detected the reaction with TLC, we found no any desired product was observed, which suggest that the reaction involved a radical pathway.

1.4 Characterization data of products

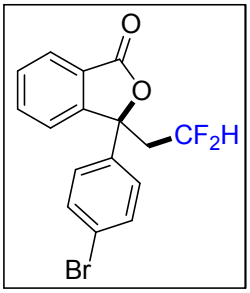


3-(2,2-Difluoroethyl)-3-phenylisobenzofuran-1(3*H*)-one (**3a**): White solid in 61% yield, 84 mg; m.p. 105-107 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.92-7.90 (d, J = 7.6 Hz, 1H), 7.72-7.68 (t, J = 7.3 Hz, 1H), 7.61-7.59 (d, J = 7.7 Hz, 1H), 7.56-7.50 (m, 3H), 7.41-7.37 (t, J = 7.4 Hz, 2H), 7.34-7.31 (t, J = 7.2 Hz, 1H), 5.93-5.63 (tt, J_{F-H} = 55.4 Hz, J = 4.5 Hz, 1H), 3.11-3.03 (m, 1H), 2.87-2.76 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.0, 151.5, 139.2, 134.6, 129.7, 129.0, 128.7, 126.2, 124.7, 124.6, 122.4, 114.3 (t, J_{F-C} = 238.9 Hz), 85.9 (t, J_{F-C} = 6.1 Hz), 44.0 (t, J_{F-C} = 22.3 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -113.2 (dd, J = 506.8 Hz, 291.4 Hz); HRMS (ESI) m/z calcd for $C_{16}H_{12}F_2O_2$ $[M+H]^+$ 275.0878, found 275.0874.

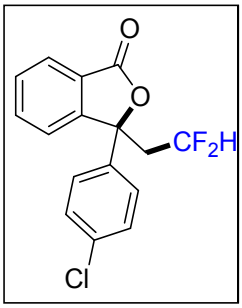


3-(2,2-Difluoroethyl)-3-(4-fluorophenyl)isobenzofuran-1(3*H*)-one (**3b**): Colorless oil in 63% yield,

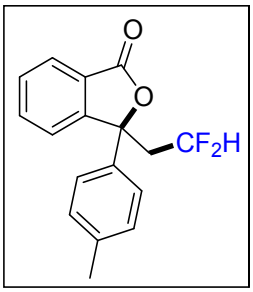
92 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.94-7.92 (d, *J* = 8.1 Hz, 1H), 7.75-7.71 (t, *J* = 7.5 Hz, 1H), 7.59-7.55 (t, *J* = 7.1 Hz, 2H), 7.51-7.47 (m, 2H), 7.09-7.05 (t, *J* = 8.6 Hz, 2H), 5.91-5.64 (tt, $J_{F\text{-}H}$ = 55.4 Hz, *J* = 4.6 Hz, 1H), 3.09-3.01 (m, 1H), 2.82-2.77 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.8, 162.7 (d, $J_{F\text{-}C}$ = 247.5 Hz), 151.3, 135.1 (d, $J_{F\text{-}C}$ = 3.2 Hz), 134.7, 129.9, 126.7 (d, $J_{F\text{-}C}$ = 8.3 Hz), 126.3, 124.7, 122.4, 116.0 (d, $J_{F\text{-}C}$ = 21.7 Hz), 114.2 (t, $J_{F\text{-}C}$ = 239.0 Hz), 85.5 (t, $J_{F\text{-}C}$ = 6.2 Hz), 44.1 (t, $J_{F\text{-}C}$ = 22.4 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -112.8, -113.2 (dd, *J* = 499.7 Hz, 291.9 Hz); HRMS (ESI) m/z calcd for $C_{16}H_{11}F_3O_2$ $[M+H]^+$ 293.0784, found 293.0787.



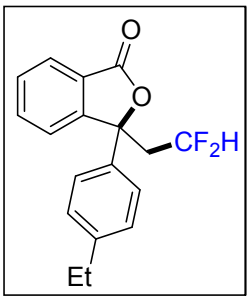
3-(4-Bromophenyl)-3-(2,2-difluoroethyl)isobenzofuran-1(3*H*)-one (**3c**): Colorless oil in 67% yield, 118 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.93-7.91 (m, 1H), 7.40-7.70 (m, 1H), 7.59-7.55 (m, 2H), 7.53-7.50 (m, 2H), 7.40-7.37 (m, 2H), 5.93-5.65 (tt, $J_{F\text{-}H}$ = 55.4 Hz, *J* = 4.6 Hz, 1H), 3.08-3.03 (m, 1H), 2.79-2.75 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.7, 151.1, 138.3, 134.8, 132.2, 129.9, 129.0, 126.4, 124.6, 123.0, 122.2, 114.1 (t, $J_{F\text{-}C}$ = 239.2 Hz), 85.4 (t, $J_{F\text{-}C}$ = 6.2 Hz), 43.9 (t, $J_{F\text{-}C}$ = 22.4 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -113.2 (dd, *J* = 472.3 Hz, 292.5 Hz); HRMS (ESI) m/z calcd for $C_{16}H_{11}BrF_2O_2$ $[M+H]^+$ 352.9983, found 352.9985.



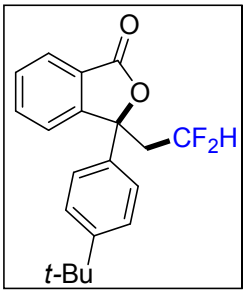
3-(4-Chlorophenyl)-3-(2,2-difluoroethyl)isobenzofuran-1(3*H*)-one (**3d**): Colorless oil in 76% yield, 117 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.93-7.91 (d, *J* = 7.6 Hz, 1H), 7.74-7.70 (t, *J* = 7.6 Hz, 1H), 7.60-7.55 (m, 2H), 7.48-7.45 (m, 2H), 7.38-7.32 (m, 2H), 5.94-5.64 (tt, $J_{F\text{-}H}$ = 55.4 Hz, *J* = 4.6 Hz, 1H), 3.13-3.01 (m, 1H), 2.85-2.73 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.7, 151.1, 137.7, 134.8, 134.7, 129.9, 129.1, 126.3, 126.1, 124.5, 122.3, 114.1 (t, $J_{F\text{-}C}$ = 239.2 Hz), 85.3 (t, $J_{F\text{-}C}$ = 6.1 Hz), 43.8 (t, $J_{F\text{-}C}$ = 22.4 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -113.2 (dd, *J* = 473.8 Hz, 291.8 Hz); HRMS (ESI) m/z calcd for $C_{16}H_{11}ClF_2O_2$ $[M+H]^+$ 309.0488, found 309.0490.



3-(2,2-Difluoroethyl)-3-(*p*-tolyl)isobenzofuran-1(3*H*)-one (**3e**): Colorless oil in 64% yield, 92 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.91-7.89 (d, *J* = 7.6 Hz, 1H), 7.71-7.67 (m, 1H), 7.58-7.52 (m, 2H), 7.39-7.37 (d, *J* = 8.3 Hz, 2H), 7.20-7.18 (d, *J* = 8.2 Hz, 2H), 5.91-5.63 (tt, J_{F-H} = 55.5 Hz, *J* = 4.6 Hz, 1H), 3.10-3.02 (m, 1H), 2.84-2.77 (m, 1H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.1, 151.7, 138.7, 136.2, 134.6, 129.7, 129.6, 126.1, 124.8, 124.5, 122.4, 114.4 (t, J_{F-C} = 238.9 Hz), 85.9 (t, J_{F-C} = 6.1 Hz), 44.01 (t, J_{F-C} = 22.3 Hz), 20.9; ^{19}F NMR (376 MHz, $CDCl_3$): -113.1 (dd, *J* = 511.7 Hz, 291.4 Hz); HRMS (ESI) m/z calcd for $C_{17}H_{14}F_2O_2$ $[M+H]^+$ 289.1035, found 289.1038.

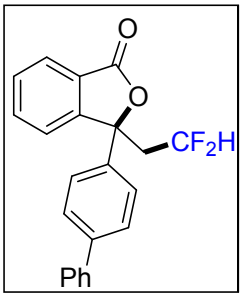


3-(2,2-Difluoroethyl)-3-(4-ethylphenyl)isobenzofuran-1(3*H*)-one (**3f**): Colorless oil in 61% yield, 92 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.92-7.90 (d, *J* = 7.6 Hz, 1H), 7.72-7.68 (t, *J* = 7.5 Hz, 1H), 7.59-7.52 (m, 2H), 7.42-7.39 (d, *J* = 8.3 Hz, 2H), 7.22-7.20 (d, *J* = 8.2 Hz, 2H), 5.91-5.63 (tt, J_{F-H} = 55.5 Hz, *J* = 4.5 Hz, 1H), 3.10-3.04 (m, 1H), 2.83-2.78 (m, 1H), 2.66-2.60 (q, *J* = 7.6 Hz, 2H), 1.22-1.19 (t, *J* = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.1, 151.7, 144.9, 136.4, 134.6, 129.6, 128.5, 126.2, 124.8, 124.6, 122.5, 114.4 (t, J_{F-C} = 238.9 Hz), 86.0 (t, J_{F-C} = 6.2 Hz), 44.1 (t, J_{F-C} = 22.3 Hz), 28.3, 15.3; ^{19}F NMR (376 MHz, $CDCl_3$): -113.1 (dd, *J* = 521.9 Hz, 291.8 Hz); HRMS (ESI) m/z calcd for $C_{17}H_{14}F_2O_2$ $[M+H]^+$ 289.1035, found 289.1038.

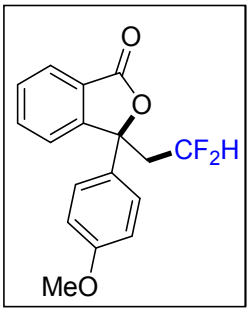


3-(4-(*tert*-Butyl)phenyl)-3-(2,2-difluoroethyl)isobenzofuran-1(3*H*)-one (**3g**): White solid in 66% yield, 109 mg; m.p. 154-156 ºC; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.91-7.90 (d, *J* = 7.6 Hz, 1H), 7.72-7.68 (t, *J* = 7.5 Hz, 1H), 7.61-7.59 (d, *J* = 7.7 Hz, 1H), 7.56-7.52 (t, *J* = 7.5 Hz, 1H), 7.46-7.38 (m, 4H), 5.90-

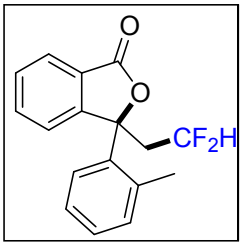
5.62 (tt, $J_{F\text{-}H}$ = 55.5 Hz, J = 4.5 Hz, 1H), 3.10-3.05 (m, 1H), 2.84-2.79 (m, 1H), 1.29 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.1, 151.8, 151.6, 136.2, 134.5, 129.6, 126.1, 125.9, 124.9, 124.4, 122.5, 114.4 (t, $J_{F\text{-}C}$ = 238.9 Hz), 85.9 (t, $J_{F\text{-}C}$ = 6.2 Hz), 44.0 (t, $J_{F\text{-}C}$ = 22.2 Hz), 34.5, 31.2; ^{19}F NMR (376 MHz, $CDCl_3$): -113.2 (dd, J = 526.4 Hz, 291.4 Hz); HRMS (ESI) m/z calcd for $C_{20}H_{20}F_2O_2$ $[M+H]^+$ 331.1504, found 331.1500.



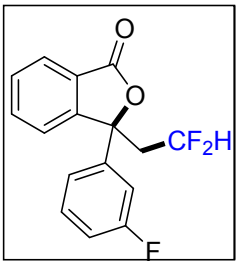
3-([1,1'-Biphenyl]-4-yl)-3-(2,2-difluoroethyl)isobenzofuran-1(3*H*)-one (**3h**): White solid in 57% yield, 99 mg; m.p. 73-75 ºC; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.94-7.92 (d, J = 7.6 Hz, 1H), 7.74-7.70 (t, J = 7.5 Hz, 1H), 7.63-7.53 (m, 8H), 7.45-7.41 (t, J = 7.5 Hz, 2H), 7.37-7.33 (t, J =7.2 Hz, 1H), 5.97-5.67 (tt, $J_{F\text{-}H}$ = 55.4 Hz, J = 4.5 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.0, 151.5, 141.7, 139.9, 138.1, 134.7, 129.8, 128.9, 127.74, 127.69, 127.0, 126.3, 125.1, 124.8, 122.4, 114.3 (t, $J_{F\text{-}C}$ = 239.0 Hz), 85.8 (t, $J_{F\text{-}C}$ = 6.2 Hz), 44.1 (t, $J_{F\text{-}C}$ = 22.2 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -113.1 (dd, J = 497.8 Hz, 291.4 Hz); HRMS (ESI) m/z calcd for $C_{20}H_{20}F_2O_2$ $[M+H]^+$ 351.1191, found 351.1194.



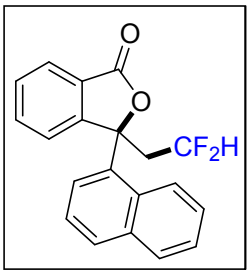
3-(2,2-Difluoroethyl)-3-(4-methoxyphenyl)isobenzofuran-1(3*H*)-one (**3i**): Colorless oil in 56% yield, 85 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.92-7.90 (d, J = 7.5 Hz, 1H), 7.72-7.68 (t, J = 7.5 Hz, 1H), 7.57-7.53 (t, J = 7.7 Hz, 2H), 7.41-7.39 (d, J = 8.8 Hz, 2H), 6.90-6.88 (d, J = 8.8 Hz, 2H), 5.90-5.62 (tt, $J_{F\text{-}H}$ = 55.5 Hz, J = 4.5 Hz, 1H), 3.78 (s, 3H), 3.09-3.04 (m, 1H), 2.81-2.77 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.1, 159.8, 151.7, 134.6, 131.1, 129.6, 126.18, 126.16, 124.9, 122.5, 114.4 (t, $J_{F\text{-}C}$ = 238.9 Hz), 114.3, 85.9 (t, $J_{F\text{-}C}$ = 6.1 Hz), 55.3, 44.0 (t, $J_{F\text{-}C}$ = 22.2 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -113.1 (dd, J = 527.9 Hz, 291.4 Hz); HRMS (ESI) m/z calcd for $C_{17}H_{14}F_2O_3$ $[M+H]^+$ 305.0984, found 305.0980.



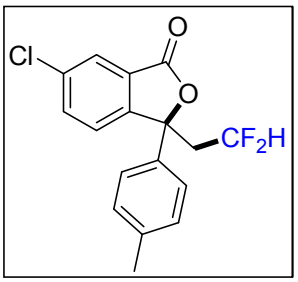
3-(2,2-Difluoroethyl)-3-(*o*-tolyl)isobenzofuran-1(3*H*)-one (**3j**): Colorless oil in 50% yield, 72 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.95-7.91 (t, *J* = 7.5 Hz, 1H), 7.77-7.73 (m, 1H), 7.61-7.53 (m, 2H), 7.36-7.34 (d, *J* = 7.8 Hz, 1H), 7.27-7.15 (m, 3H), 5.85-5.55 (tt, $J_{F\text{-}H}$ = 55.4 Hz, *J* = 4.5 Hz, 1H), 3.30-3.18 (m, 1H), 2.87-2.75 (m, 1H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.1, 150.5, 137.0, 135.7, 134.2, 133.6, 129.7, 129.0, 126.4, 126.0, 125.9, 123.7, 114.3 (t, $J_{F\text{-}C}$ = 238.9 Hz), 87.5 (t, $J_{F\text{-}C}$ = 6.2 Hz), 43.8 (t, $J_{F\text{-}C}$ = 22.2 Hz), 21.8; ^{19}F NMR (376 MHz, $CDCl_3$): -113.1 (dd, *J* = 553.8 Hz, 291.4 Hz); HRMS (ESI) m/z calcd for $C_{17}H_{14}F_2O_3$ $[M+H]^+$ 289.1035, found 289.1036.



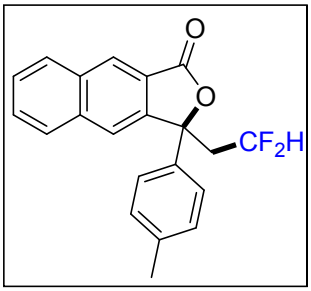
3-(2,2-Difluoroethyl)-3-(3-fluorophenyl)isobenzofuran-1(3*H*)-one (**3k**): Colorless oil in 79% yield, 115 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.93-7.92 (d, *J* = 7.6 Hz, 1H), 7.75-7.71 (m, 1H), 7.62-7.54 (m, 2H), 7.40-7.31 (m, 2H), 7.25-7.22 (m, 1H), 7.05-7.00 (m, 1H), 5.95-5.65 (tt, $J_{F\text{-}H}$ = 55.4 Hz, *J* = 4.6 Hz, 1H), 3.13-3.00 (m, 1H), 2.85-2.73 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.7, 162.9 (d, $J_{F\text{-}C}$ = 246.4 Hz), 151.0, 141.8 (d, $J_{F\text{-}C}$ = 7.0 Hz), 134.8, 130.7 (d, $J_{F\text{-}C}$ = 8.2 Hz), 129.9, 126.3, 124.5, 122.3, 120.2 (d, $J_{F\text{-}C}$ = 3.0 Hz), 115.7 (d, $J_{F\text{-}C}$ = 20.9 Hz), 114.1 (t, $J_{F\text{-}C}$ = 239.1 Hz), 112.1 (d, $J_{F\text{-}C}$ = 23.6 Hz), 85.2 (t, $J_{F\text{-}C}$ = 5.1 Hz), 44.0 (t, $J_{F\text{-}C}$ = 22.5 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -110.7, -113.3 (dd, *J* = 486.9 Hz, 292.2 Hz); HRMS (ESI) m/z calcd for $C_{16}H_{11}F_3O_2$ $[M+H]^+$ 293.0784, found 293.0786.



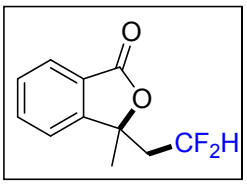
3-(2,2-Difluoroethyl)-3-(naphthalen-1-yl)isobenzofuran-1(3*H*)-one (**3l**): Colorless oil in 57% yield, 93 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.74-8.71 (d, *J* = 8.7 Hz, 1H), 8.02-7.97 (m, 1H), 7.93-7.88 (m, 1H), 7.87-7.80 (m, 3H), 7.68-7.63 (m, 2H), 7.58-7.54 (m, 1H), 7.39-7.37 (dd, *J* = 7.3 Hz, 1.1 Hz, 1H), 7.31-7.27 (t, *J* = 7.8 Hz, 1H), 5.86-5.58 (tt, $J_{F\text{-}H}$ = 55.4 Hz, *J* = 4.6 Hz, 1H), 3.67-3.62 (m, 1H), 2.92-2.87 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.7, 149.9, 135.1, 133.9, 133.7, 130.8, 130.5, 130.0, 129.4, 127.0, 126.6, 126.4, 126.1, 125.1,125.0, 124.2, 122.2, 114.2 (t, $J_{F\text{-}C}$ = 239.2 Hz), 88.2 (t, $J_{F\text{-}C}$ = 6.0 Hz), 43.9 (t, $J_{F\text{-}C}$ = 22.0 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -113.5 (dd, *J* = 491.1 Hz, 292.5 Hz); HRMS (ESI) m/z calcd for $C_{20}H_{14}F_2O_2$ $[M+H]^+$ 325.1035, found 325.1036.



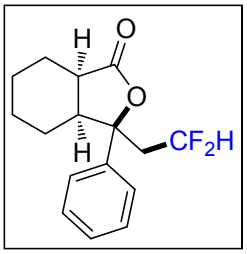
6-Chloro-3-(2,2-difluoroethyl)-3-(*p*-tolyl)isobenzofuran-1(3*H*)-one (**3m**): Colorless oil in 63% yield, 102 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84-7.82 (d, *J* = 8.1 Hz, 1H), 7.53-7.49 (m, 2H), 7.36-7.34 (m, 2H), 7.22-7.20 (m, 2H), 5.95-5.67 (tt, J_{F-H} = 55.4 Hz, *J* = 4.6 Hz, 1H), 3.09-3.03 (m, 1H), 2.82-2.77 (m, 1H), 2.34 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.0, 153.5, 141.4, 139.0, 135.6, 134.8, 130.4, 129.9, 127.3, 124.4, 122.8, 114.2 (t, J_{F-C} = 239.1 Hz), 85.5 (t, J_{F-C} = 4.9 Hz), 43.7 (t, J_{F-C} = 22.4 Hz), 21.0; ^{19}F NMR (376 MHz, $CDCl_3$): -113.3 (dd, *J* = 530.5 Hz, 292.2 Hz); HRMS (ESI) m/z calcd for $C_{17}H_{13}ClF_2O_2$ $[M+H]^+$ 323.0645, found 323.0648.



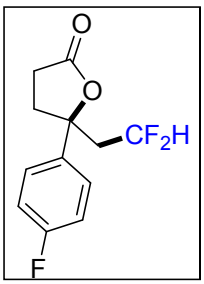
3-(2,2-Difluoroethyl)-3-(*p*-tolyl)naphtho[2,3-*c*]furan-1(3*H*)-one (**3n**): Colorless oil in 56% yield, 95 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.49 (s, 1H), 8.04-8.02 (d, *J* = 8.2 Hz, 1H), 7.96-7.94 (d, *J* = 9.6 Hz, 2H), 7.68-7.64 (m, 1H), 7.61-7.57 (m, 1H), 7.47-7.45 (d, *J* = 8.2 Hz, 2H), 7.21-7.19 (d, *J* = 8.2 Hz, 2H), 5.96-5.68 (tt, J_{F-H} = 55.5 Hz, *J* = 4.5 Hz, 1H), 3.19-3.11 (m, 1H), 2.92-2.87 (m, 1H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.0, 145.4, 138.6, 136.9, 136.4, 133.2, 129.9, 129.7, 129.3, 128.5, 127.7, 127.4, 124.6, 122.6, 121.5, 114.5 (t, J_{F-C} = 239.1 Hz), 86.1 (t, J_{F-C} = 6.1 Hz), 44.6 (t, J_{F-C} = 22.2 Hz), 20.9; ^{19}F NMR (376 MHz, $CDCl_3$): -113.1 (dd, *J* = 436.5 Hz, 291.4 Hz); HRMS (ESI) m/z calcd for $C_{21}H_{16}F_2O_2$ $[M+H]^+$ 339.1191, found 339.1195.



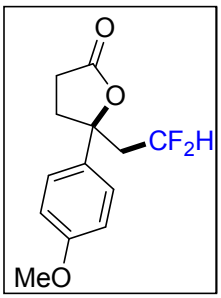
3-(2,2-Difluoroethyl)-3-methylisobenzofuran-1(3*H*)-one (**3o**): Colorless oil in 46% yield, 49 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.91-7.89 (d, *J* = 7.7 Hz, 1H), 7.74-7.70 (t, *J* = 7.5 Hz, 1H), 7.59-7.55 (t, *J* = 7.5 Hz, 1H), 7.46-7.44 (d, *J* = 7.7 Hz, 1H), 6.02-5.72 (tt, J_{F-H} = 55.6 Hz, *J* = 4.6 Hz, 1H), 2.68-2.55 (m, 1H), 2.46-2.33 (m, 1H), 1.71 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.0, 152.6, 134.5, 129.6, 126.1, 125.1, 121.1, 114.5 (t, J_{F-C} = 238.3 Hz), 83.5 (t, J_{F-C} = 5.8 Hz), 43.7 (t, J_{F-C} = 21.8 Hz), 26.3; ^{19}F NMR (376 MHz, $CDCl_3$): -113.3 (dd, *J* = 352.3 Hz, 291.4 Hz); HRMS (ESI) m/z calcd for $C_{11}H_{10}F_2O_2$ $[M+H]^+$ 213.0722, found 213.0721.



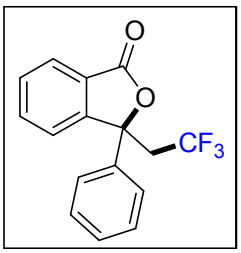
(3R,3aS,7aR)-3-(2,2-Difluoroethyl)-3-phenylhexahydroisobenzofuran-1(3*H*)-one (**3p**): Colorless oil in 38% yield, 53 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.43-7.40 (m, 4H), 7.39-7.33 (m, 1H), 5.88-5.60 (tt, J_{F-H} = 55.7 Hz, J = 4.4 Hz, 1H), 2.61-2.46 (m, 2H), 2.32-2.24 (m, 2H), 2.11-2.07 (m, 1H), 1.93-1.86 (m, 3H), 1.47-1.43 (m, 1H), 1.32-1.25 (m, 2H), 1.22-1.16 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.1, 141.3, 128.9, 128.1, 123.8, 115.1 (t, J_{F-C} = 238.6 Hz), 85.93 (t, J_{F-C} = 5.5 Hz), 54.4, 44.0, 38.5 (t, J_{F-C} = 22.1 Hz), 26.1, 25.6, 25.3, 25.2; ^{19}F NMR (376 MHz, $CDCl_3$): -111.3 (dd, J = 364.7 Hz, 288.4 Hz); HRMS (ESI) m/z calcd for $C_{16}H_{18}F_2O_2$ $[M+H]^+$ 281.1348, found 281.1350.



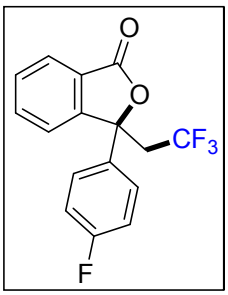
5-(2,2-Difluoroethyl)-5-(4-fluorophenyl)dihydrofuran-2(3*H*)-one (**3q**): Colorless oil in 42% yield, 51 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.38-7.34 (m, 2H), 7.12-7.06 (m, 2H), 5.87-5.57 (tt, J_{F-H} = 55.5 Hz, J = 4.6 Hz, 1H), 2.66-2.41 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.2, 162.4 (d, J_{F-C} = 246.5 Hz), 137.1 (d, J_{F-C} = 3.2 Hz), 126. 4 (d, J_{F-C} = 8.2 Hz), 115.9 (d, J_{F-C} = 21.6 Hz), 114.5 (t, J_{F-C} = 238.2 Hz), 84.8 (t, J_{F-C} = 5.9 Hz), 45.9 (t, J_{F-C} = 21.6 Hz), 35.0, 27.9; ^{19}F NMR (376 MHz, $CDCl_3$): -113.4, -113.9 (dd, J = 325.6 Hz, 291.8 Hz); HRMS (ESI) m/z calcd for $C_{12}H_{11}F_3O_2$ $[M+H]^+$ 245.0784, found 245.0786.



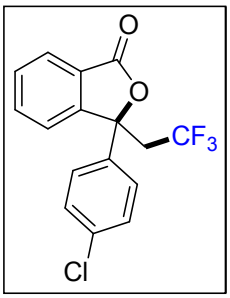
5-(2,2-Difluoroethyl)-5-(4-methoxyphenyl)dihydrofuran-2(3*H*)-one (**3r**): Colorless oil in 40% yield, 51 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.30-7.28 (d, J = 8.8 Hz, 2H), 6.94-6.91 (d, J = 8.8 Hz, 2H), 5.82-5.54 (tt, J_{F-H} = 55.6 Hz, J = 4.7 Hz, 1H), 3.82 (s, 3H), 2.61-2.43 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 175.6, 159.5, 132.9, 125.8, 114.8 (t, J_{F-C} = 238.0 Hz), 114.3, 85.2 (t, J_{F-C} = 5.9 Hz), 55.3, 46.1 (t, J_{F-C} = 21.6 Hz), 34.8, 28.1; ^{19}F NMR (376 MHz, $CDCl_3$): -114.0 (dd, J = 349.7 Hz, 291.0 Hz); HRMS (ESI) m/z calcd for $C_{13}H_{14}F_2O_3$ $[M+H]^+$ 257.0984, found 257.0981.



3-Phenyl-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5a**): White solid in 93% yield, 136 mg; m.p. 137-139 ºC; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.93-7.92 (d, *J* = 7.7 Hz, 1H), 7.74-7.70 (m, 1H), 7.65-7.63 (d, *J* = 7.8 Hz, 1H), 7.59-7.52 (m, 3H), 7.42-7.32 (m, 3H), 3.37-3.28 (m, 1H), 3.21-3.13 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.8, 150.2, 139.1, 134.4, 129.9, 129.0, 128.9, 126.2, 125.2, 124.6, 124.3 (q, $J_{F\text{-}C}$ = 277.1 Hz), 122.8, 84.8 (q, $J_{F\text{-}C}$ = 2.1 Hz), 43.24 (q, $J_{F\text{-}C}$ = 27.8 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -60.5; HRMS (ESI) m/z calcd for $C_{16}H_{11}F_3O_2$ $[M+H]^+$ 293.0784, found 293.0787.

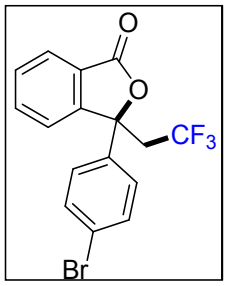


3-(4-Fluorophenyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5b**): Colorless oil in 70% yield, 109 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.94-7.92 (d, *J* = 7.6 Hz, 1H), 7.76-7.72 (m, 1H), 7.64-7.57 (m, 2H), 7.54-7.49 (m, 2H), 7.10-7.06 (m, 2H), 3.35-3.26 (m, 1H), 3.18-3.09 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.5, 162.8 (d, $J_{F\text{-}C}$ = 247.5 Hz), 149.9, 134.9 (d, $J_{F\text{-}C}$ = 3.3 Hz), 134.5, 130.0, 126.8 (d, $J_{F\text{-}C}$ = 8.5 Hz), 126.3, 125.2, 124.1 (q, $J_{F\text{-}C}$ = 277.0 Hz), 122.7, 116.1-115.9 (d, $J_{F\text{-}C}$ = 21.8 Hz), 84.4 (q, $J_{F\text{-}C}$ = 2.1 Hz), 43.4 (q, $J_{F\text{-}C}$ = 28.0 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -60.5, -112.6; HRMS (ESI) m/z calcd for $C_{16}H_{10}F_4O_2$ $[M+H]^+$ 311.0690, found 311.0692.

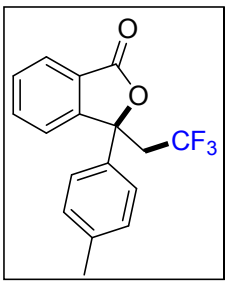


3-(4-Chlorophenyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5c**): Colorless oil in 89% yield, 145 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.94-7.92 (d, *J* = 7.6 Hz, 1H), 7.75-7.71 (m, 1H), 7.63-7.57 (m, 2H), 7.49-7.47 (d, *J* = 8.8 Hz, 2H), 7.38-7.35 (d, *J* = 8.7 Hz, 2H), 3.36-3.25 (m, 1H), 3.17-3.05 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.4, 149.8, 137.6, 135.0, 134.6, 130.1, 129.2, 126.4, 126.2, 125.1, 124.1 (q, $J_{F\text{-}C}$ = 277.1 Hz), 122.6, 84.2 (q, $J_{F\text{-}C}$ = 2.3 Hz), 43.2 (q, $J_{F\text{-}C}$ = 28.0 Hz); ^{19}F NMR (376

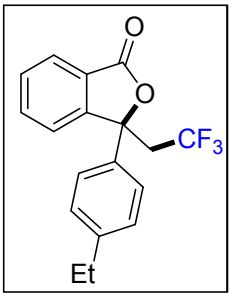
MHz, $CDCl_3$): -60.4; HRMS (ESI) m/z calcd for $C_{16}H_{10}F_3ClO_2$ $[M+H]^+$ 327.0394, found 327.0390.



3-(4-Bromophenyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5d**): Colorless oil in 73% yield, 135 mg; ^1H NMR (400 MHz, $CDCl_3$): δ 7.94-7.92 (d, *J* = 7.6 Hz, 1H), 7.75-7.71 (m, 1H), 7.63-7.57 (m, 2H), 7.54-7.51 (m, 2H), 7.44-7.40 (m, 2H), 3.34-3.25 (m, 1H), 3.17-3.05 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.4, 149.8, 138.1, 134.6, 132.2, 130.1, 126.40, 126.36, 125.0, 124.1 (q, J_{F-C} = 277.1 Hz), 123.2, 122.6, 84.3 (q, J_{F-C} = 2.0 Hz), 43.1 (q, J_{F-C} = 28.0 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -60.4; HRMS (ESI) m/z calcd for $C_{16}H_{10}BrF_3O_2$ $[M+H]^+$ 370.9889, found 370.9894.

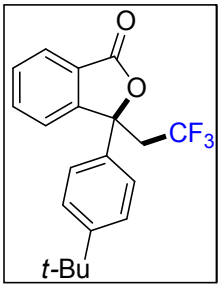


3-(*p*-Tolyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5e**): Colorless oil in 80% yield, 123 mg; ^1H NMR (400 MHz, $CDCl_3$): δ 7.91-7.90 (d, *J* = 7.6 Hz, 1H), 7.72-7.68 (m, 1H), 7.64-7.62 (d, *J* = 7.7 Hz, 1H), 7.57-7.53 (t, J = 7.5 Hz, 1H), 7.41-7.39 (d, *J* = 8.3 Hz, 2H), 7.19-7.17 (d, *J* = 8.1 Hz, 2H), 3.36-3.30 (m, 1H), 3.18-3.12 (m, 1H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.9, 150.3, 138.8, 136.1, 134.3, 129.7, 129.6, 126.1, 125.1, 124.5, 124.3 (q, J_{F-C} = 277.1 Hz), 122.8, 84.8 (q, J_{F-C} = 2.1 Hz), 43.1 (q, J_{F-C} = 27.8 Hz), 20.9; ^{19}F NMR (376 MHz, $CDCl_3$): -60.4; HRMS (ESI) m/z calcd for $C_{17}H_{13}F_3O_2$ $[M+H]^+$ 307.0940, found 307.0936.

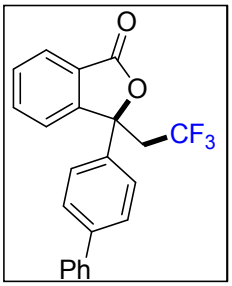


3-(4-Ethylphenyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5f**): Colorless oil in 81% yield, 130 mg; ^1H NMR (400 MHz, $CDCl_3$): δ 7.92-7.90 (d, *J* = 7.6 Hz, 1H), 7.73-7.69 (m, 1H), 7.63-7.62 (d, *J* = 7.7 Hz, 1H), 7.58-7.54 (t, *J* = 7.5 Hz, 1H), 7.43-7.41 (d, *J* = 8.4 Hz, 2H), 7.22-7.20 (d, *J* = 8.3 Hz,

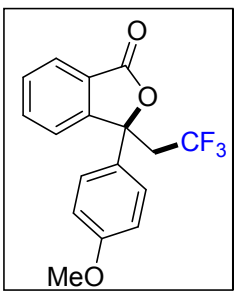
2H), 3.36-3.29 (m, 1H), 3.18-3.12 (m, 1H), 2.66-2.60 (q, *J* = 7.6 Hz, 2H), 1.22-1.19 (t, *J* = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.8, 150.3, 145.1, 136.4, 134.3, 129.8, 128.5, 126.1, 125.3, 124.7, 124.3 (q, $J_{F\text{-}C}$ = 277.1 Hz), 122.8, 84.9 (q, $J_{F\text{-}C}$ = 2.5 Hz), 43.2 (q, $J_{F\text{-}C}$ = 27.9 Hz), 28.3, 15.3; ^{19}F NMR (376 MHz, $CDCl_3$): -60.5; HRMS (ESI) m/z calcd for $C_{18}H_{15}F_3O_2$ $[M+H]^+$ 321.1097, found 321.1092.



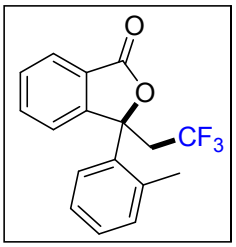
3-(4-(*tert*-Butyl)phenyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5g**): White solid in 82% yield, 143 mg; m.p. 138-140 ºC ; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.92-7.90 (d, *J* = 7.6 Hz, 1H), 7.73-7.69 (m, 1H), 7.65-7.63 (d, *J* = 7.8 Hz, 1H), 7.58-7.54 (m, 1H), 7.45-7.38 (m, 4H), 3.36-3.30 (m, 1H), 3.19-3.13 (m, 1H), 1.29 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.8, 152.0, 150.2, 136.1, 134.2, 126.1, 125.9, 125.4, 124.4, 124.3 (q, $J_{F\text{-}C}$ = 277.0 Hz), 122.9, 84.8 (q, $J_{F\text{-}C}$ = 2.2 Hz), 43.2 (q, $J_{F\text{-}C}$ = 27.7 Hz), 34.5, 31.1; ^{19}F NMR (376 MHz, $CDCl_3$): -60.5; HRMS (ESI) m/z calcd for $C_{20}H_{19}F_3O_2$ $[M+H]^+$ 349.1410, found 349.1413.



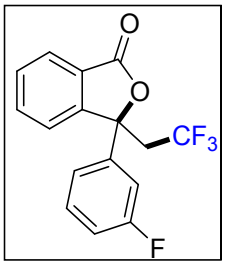
3-([1,1'-biphenyl]-4-yl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5h**): White solid in 76% yield, 140 mg; m.p. 132-134 ºC ; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.95-7.93 (d, *J* = 7.6 Hz, 1H), 7.75-7.72 (t, *J* = 7.4 Hz, 1H), 7.68-7.67 (d, *J* = 7.7 Hz, 1H), 7.64-7.54 (m, 7H), 7.45-7.41 (t, *J* = 7.4 Hz, 2H), 7.37-7.34 (t, *J* = 7.2 Hz, 1H), 3.41-3.34 (m, 1H), 3.22-3.16 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.7, 150.1, 141.8, 139.9, 138.0, 134.4, 129.9, 128.9, 127.8, 127.7, 127.1, 126.3, 125.3, 125.1, 124.1 (q, $J_{F\text{-}C}$ = 247.0 Hz), 122.8, 84.7 (q, $J_{F\text{-}C}$ = 2.3 Hz), 43.2 (q, $J_{F\text{-}C}$ = 27.8 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -60.4; HRMS (ESI) m/z calcd for $C_{22}H_{15}F_3O_2$ $[M+H]^+$ 369.1097, found 369.1099.



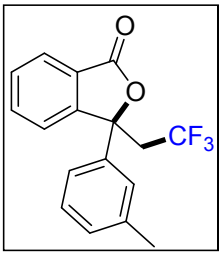
3-(4-Methoxyphenyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5i**): White solid in 73% yield, 118 mg; m.p. 77-79 ºC ; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.93-7.91 (d, *J* = 7.6 Hz, 1H), 7.73-7.69 (t, *J* = 7.5 Hz, 1H), 7.62-7.55 (m, 2H), 7.43-7.40 (m, 2H), 6.90-6.87 (m, 2H), 3.79 (s, 3H), 3.35-3.29 (m, 1H), 3.16-3.10 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.8, 159.9, 150.3, 134.3, 131.0, 129.8, 126.2, 125.4, 124.3 (q, $J_{F\text{-}C}$ = 277.2 Hz), 122.8, 114.3, 84.8 (q, $J_{F\text{-}C}$ = 2.6 Hz), 55.3, 43.2 (q, $J_{F\text{-}C}$ = 27.7 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -60.5; HRMS (ESI) m/z calcd for $C_{17}H_{13}F_3O_3$ $[M+H]^+$ 323.2859, found 323.2854.



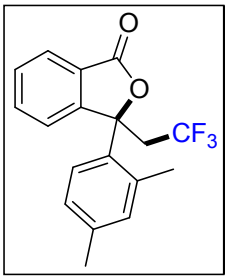
3-(*o*-Tolyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5j**): White solid in 65% yield, 100 mg; m.p. 87-89 ºC; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.95-7.94 (d, *J* = 7.6 Hz, 1H), 7.80-7.76 (t, *J* = 7.4 Hz, 1H), 7.66-7.59 (m, 2H), 7.33-7.31 (d, *J* = 7.9 Hz, 1H), 7.25-7.24 (m, 2H), 7.15-7.13 (m, 1H), 3.54-3.47 (m, 1H), 3.15-3.09 (m, 1H), 2.56 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.8, 149.5, 137.1, 135.6, 133.9, 133.7, 129.9, 129.1, 126.4, 126.3, 126.1, 125.8, 124.3 (q, $J_{F\text{-}C}$ = 277.2 Hz), 124.2, 86.4 (q, $J_{F\text{-}C}$ = 2.1 Hz), 42.6 (q, $J_{F\text{-}C}$ = 27.5 Hz), 21.8; ^{19}F NMR (376 MHz, $CDCl_3$): -60.2; HRMS (ESI) m/z calcd for $C_{17}H_{13}F_3O_2$ $[M+H]^+$ 307.0940, found 307.0942.



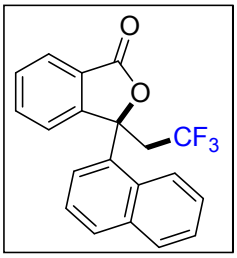
3-(3-Fluorophenyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5k**): Colorless oil in 62% yield, 96 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.95-7.93 (d, *J* = 7.6 Hz, 1H), 7.76-7.72 (m, 1H), 7.65-7.63 (d, *J* = 7.8 Hz, 1H), 7.61-7.58 (d, *J* = 7.5 Hz, 1H), 7.41-7.33 (m, 2H), 7.26-7.23 (m, 1H), 7.07-7.02 (m, 1H), 3.34-3.26 (m, 1H), 3.17-3.09 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.4, 162.9 (d, $J_{F\text{-}C}$ = 246.6 Hz), 149.7, 141.6 (d, $J_{F\text{-}C}$ = 7.0 Hz), 134.6, 130.8 (d, $J_{F\text{-}C}$ = 8.2 Hz), 130.1, 126.4, 125.1, 124.1 (q, $J_{F\text{-}C}$ = 277.1 Hz), 122.7, 120.3 (d, $J_{F\text{-}C}$ = 3.0 Hz), 115.9 (d, $J_{F\text{-}C}$ = 21.1 Hz), 112.3 (d, $J_{F\text{-}C}$ = 23.8 Hz), 84.1 (q, $J_{F\text{-}C}$ = 2.1 Hz), 43.3 (q, $J_{F\text{-}C}$ = 28.2 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -60.5, -110.6; HRMS (ESI) m/z calcd for $C_{16}H_{10}F_4O_2$ $[M+H]^+$ 311.0690, found 311.0692.



3-(*m*-Tolyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5l**): White solid in 71% yield, 109 mg; m.p. 98-100 ºC; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.93-7.91 (d, *J* = 7.7 Hz, 1H), 7.73-7.69 (m, 1H), 7.65-7.63 (d, *J* = 7.7 Hz, 1H), 7.58-7.54 (d, *J* = 7.4 Hz, 1H), 7.33-7.31 (m, 2H), 7.29-7.25 (m, 1H), 7.16-7.14 (d, *J* = 7.3 Hz, 1H), 3.36-3.30 (m, 1H), 3.19-3.12 (m, 1H), 2.35 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.9, 150.3, 139.1, 138.9, 134.3, 129.8, 129.6, 128.9, 126.1, 125.2, 124.3 (q, J_{F-C} = 277.1 Hz), 122.8, 121.6, 84.8 (q, J_{F-C} = 2.2 Hz), 43.2 (q, J_{F-C} = 27.8 Hz), 21.5; ^{19}F NMR (376 MHz, $CDCl_3$): -60.5; HRMS (ESI) m/z calcd for $C_{17}H_{13}F_3O_2$ $[M+H]^+$ 307.0940, found 307.0946.

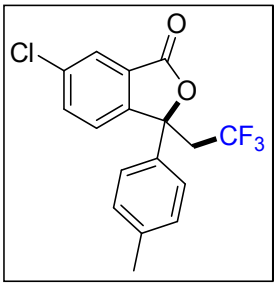


3-(2,4-Dimethylphenyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5m**): Colorless oil in 64% yield, 102 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.96-7.94 (d, *J* = 7.5 Hz, 1H), 7.79-7.75 (m, 1H), 7.63-7.59 (m, 2H), 7.19-7.17 (d, *J* = 8.1 Hz, 1H), 7.06 (s, 1H), 6.94-6.92 (d, *J* = 8.0 Hz, 1H), 3.52-3.45 (m, 1H), 3.14-3.07 (m, 1H), 2.51 (s, 3H), 2.29 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.8, 149.7, 139.1, 137.0, 134.5, 133.8, 132.8, 129.8, 126.5, 126.4, 126.1, 124.3 (q, J_{F-C} = 277.1 Hz), 124.2, 86.4 (q, J_{F-C} = 2.2 Hz), 42.7 (q, J_{F-C} = 27.4 Hz), 21.7, 20.7; ^{19}F NMR (376 MHz, $CDCl_3$): -60.2; HRMS (ESI) m/z calcd for $C_{18}H_{15}F_3O_2$ $[M+H]^+$ 321.1097, found 321.1099.

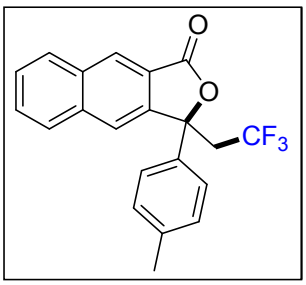


3-(Naphthalen-1-yl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5n**): White solid in 66% yield, 113 mg; m.p. 163-165 ºC; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.79-8.77 (d, *J* = 8.7 Hz, 1H), 8.02-8.00 (d, *J* = 7.6 Hz, 1H), 7.91-7.81 (m, 4H), 7.69-7.65 (m, 2H), 7.58-7.53 (m, 1H), 7.40-7.38 (m, 1H), 7.32-7.27 (m, 1H), 4.07-3.92 (m, 1H), 3.18-3.06 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.4, 149.1, 135.1, 133.6, 133.3, 131.0, 130.5, 130.1, 129.4, 127.2, 126.61, 126.56, 126.2, 126.0, 125.2, 125.1, 124.3 (q, J_{F-C} = 277.3 Hz), 124.1, 86.8 (q, J_{F-C} = 2.2 Hz), 42.9 (q, J_{F-C} = 27.4 Hz); ^{19}F NMR (376 MHz,

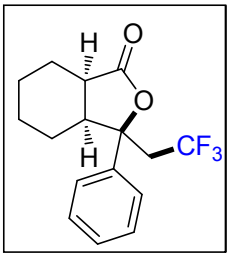
$CDCl_3$): -60.4; HRMS (ESI) m/z calcd for $C_{20}H_{13}F_3O_2$ $[M+H]^+$ 343.0940, found 343.0942.



6-Chloro-3-(*p*-tolyl)-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3*H*)-one (**5o**): White solid in 69% yield, 118 mg; m.p. 146-148 ºC; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85-7.83 (d, *J* = 8.1 Hz, 1H), 7.57 (d, *J* = 1.2 Hz, 1H), 7.54-7.51 (dd, *J* = 8.2 Hz, 1.6 Hz, 1H), 7.37-7.35 (d, *J* = 8.4 Hz, 2H), 7.22-7.20 (d, *J* = 8.1 Hz, 2H), 3.34-3.28 (m, 1H), 3.17-3.11 (m, 1H), 2.34 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.7, 152.1, 141.1, 139.2, 135.6, 130.6, 129.8, 127.3, 124.4, 124.1 (q, J_{F-C} = 255.2 Hz), 123.7, 123.1, 84.4 (q, J_{F-C} = 2.1 Hz), 42.9 (J_{F-C} = 27.9 Hz), 21.0; ^{19}F NMR (376 MHz, $CDCl_3$): -60.4; HRMS (ESI) m/z calcd for $C_{17}H_{12}ClF_3O_2$ $[M+H]^+$ 341.0551, found 341.0554.

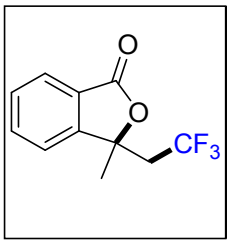


3-(*p*-Tolyl)-3-(2,2,2-trifluoroethyl)naphtho[2,3-*c*]furan-1(3*H*)-one (**5p**): Colorless oil in 63% yield, 112 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.49 (s, 1H), 8.05-8.03 (d, *J* = 8.2 Hz, 1H), 8.01 (s, 1H), 7.97-7.95 (d, *J* = 8.2 Hz, 1H), 7.69-7.65 (m, 1H), 7.62-7.58 (m, 1H), 7.49-7.47 (d, *J* = 8.3 Hz, 2H), 7.21-7.19 (d, *J* = 8.1 Hz, 2H), 3.44-3.38 (m, 1H), 3.28-3.21 (m, 1H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.8, 144.2, 138.8, 136.8, 136.2, 133.3, 129.9, 129.6, 129.3, 128.5, 127.7, 127.4, 124.6, 124.4 (q, J_{F-C} = 277.2 Hz), 122.9, 121.9, 84.9 (q, J_{F-C} = 2.2 Hz), 43.8 (q, J_{F-C} = 27.7 Hz), 21.0; ^{19}F NMR (376 MHz, $CDCl_3$): -60.1; HRMS (ESI) m/z calcd for $C_{21}H_{15}F_3O_2$ $[M+H]^+$ 357.1097, found 357.1096.

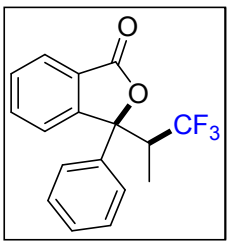


(3R,3aS,7aR)-3-Phenyl-3-(2,2,2-trifluoroethyl)hexahydroisobenzofuran-1(3*H*)-one (**5q**): Colorless oil in 53% yield, 79mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.44-7.32 (m, 5H), 2.89-2.74 (m, 2H), 2.31-2.24 (m, 1H), 2.15-2.11 (m, 1H), 1.94-1.88 (m, 3H), 1.49-1.40 (m, 1H), 1.32-1.16 (m, 4H); ^{13}C

NMR (100 MHz, $CDCl_3$): δ 174.8, 141.3, 128.7, 128.0, 125.1 (q, $J_{F\text{-}C}$ = 277.0 Hz), 123.6, 84.6 (q, $J_{F\text{-}C}$ = 1.9 Hz), 54.9, 43.7, 37.6 (q, $J_{F\text{-}C}$ = 27.7 Hz), 26.1, 25.6, 25.2; ^{19}F NMR (376 MHz, $CDCl_3$): -59.0; HRMS (ESI) m/z calcd for $C_{16}H_{17}F_3O_2$ $[M+H]^+$ 299.1253, found 299.1256.



3-methyl-3-(2,2,2-trifluoroethyl)isobenzofuran-1(3H)-one (**5r**): Colorless oil in 42% yield, 79 mg; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (d, *J* = 7.6 Hz, 1H), 7.73 (dd, *J* = 10.9, 4.2 Hz, 1H), 7.58 (t, *J* = 7.5 Hz, 1H), 7.48 (d, *J* = 7.7 Hz, 1H), 2.92-2.83 (m, 1H), 2.82-2.66 (m, 1H), 1.77 (d, *J* = 15.1 Hz, 3H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -61.05 (t, *J* = 10.3 Hz). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.9, 151.7, 134.5, 129.9, 126.1, 125.5, 124.7 (q, *J* = 270 Hz), 121.6, 82.6, 43.1 (q, *J* = 29 Hz), 26.6. HRMS (ESI) m/z calcd for $C_{11}H_{10}F_3O_2$ $[M+H]^+$ 231.0627, found 231.0633.



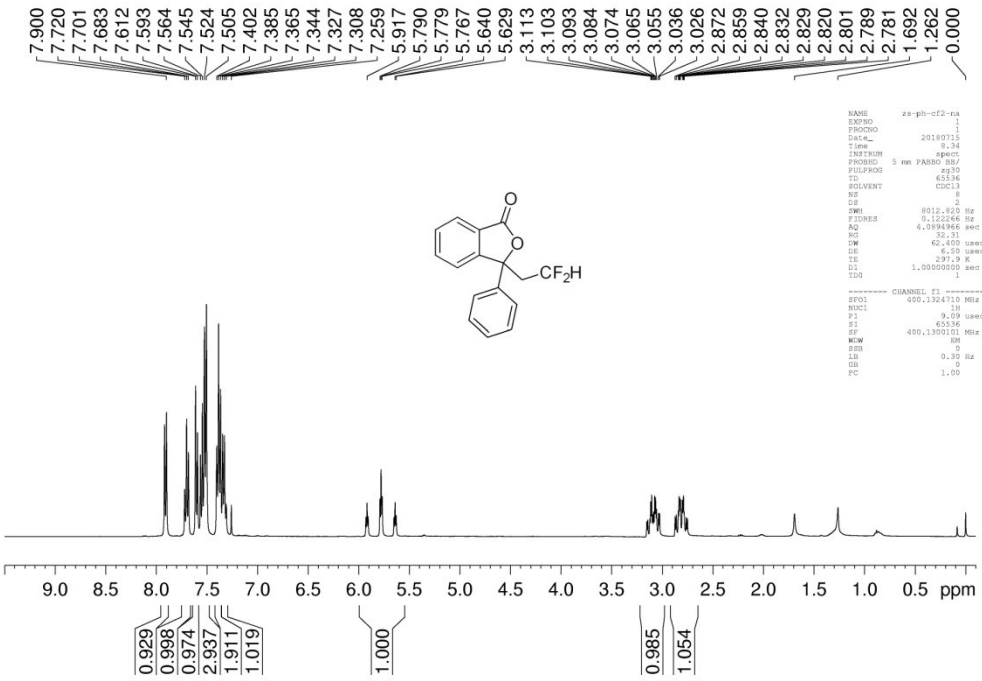
3-phenyl-3-(1,1,1-trifluoropropan-2-yl)isobenzofuran-1(3*H*)-one (**5s**): White foam in 69% yield, 64 mg; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.87-7.85 (d, *J* = 7.6 Hz, 1H), 7.69-7.63 (m, 2H), 7.58-7.56 (d, *J* = 7.6 Hz, 2H), 7.51-7.48 (t, *J* = 7.3 Hz, 1H), 7.41-7.37 (t, *J* = 7.6 Hz, 2H), 7.34-7.30 (t, *J* = 7.3 Hz, 1H), 3.47-3.39 (m, 1H), 1.25-1.23 (d, *J* = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.1, 151.0, 139.6, 134.2, 129.5, 129.1, 128.5, 127.6, 125.9, 124.6, 124.2, 123.7 (q, $J_{F\text{-}C}$ = 270.4 Hz), 123.0, 87.7, 46.1 (q, $J_{F\text{-}C}$ = 24.8 Hz), 10.1 (q, $J_{F\text{-}C}$ = 2.6 Hz); ^{19}F NMR (376 MHz, $CDCl_3$): -65.2; HRMS (ESI) m/z calcd for $C_{17}H_{13}F_3O_2$ $[M+H]^+$ 307.0940, found 307.0944.

1.5. Reference

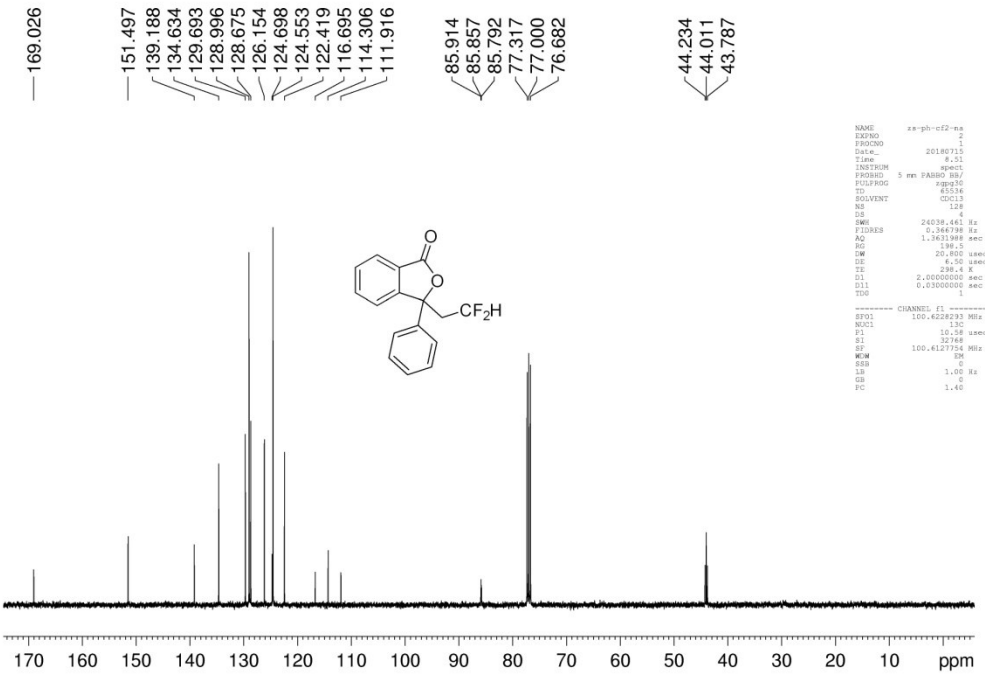
1. J. Xie, Y.-W. Wang, L.-W. Qi, B. Zhang, *Org. Lett.* **2017**, *19*, 1148.
2. Q. Yan, L.-Q. Jiang, W.-B. Yi, Q.-R. Liu, W. Zhang, *Adv. Synth. Catal.* **2017**, *359*, 2471.

Part II NMR Spectra

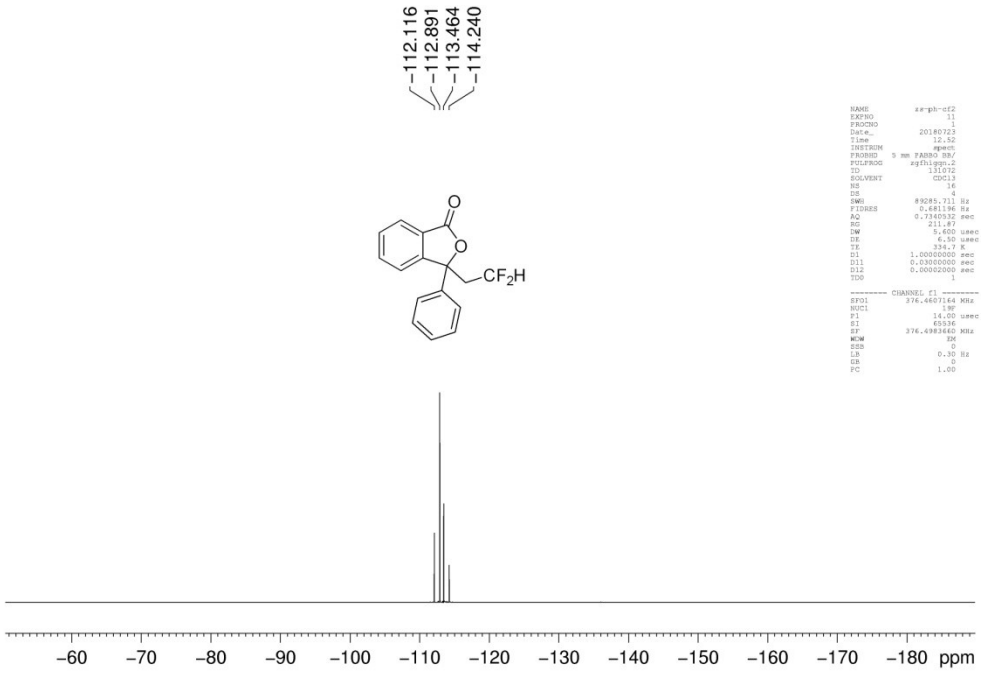
3a ^{1}H NMR:



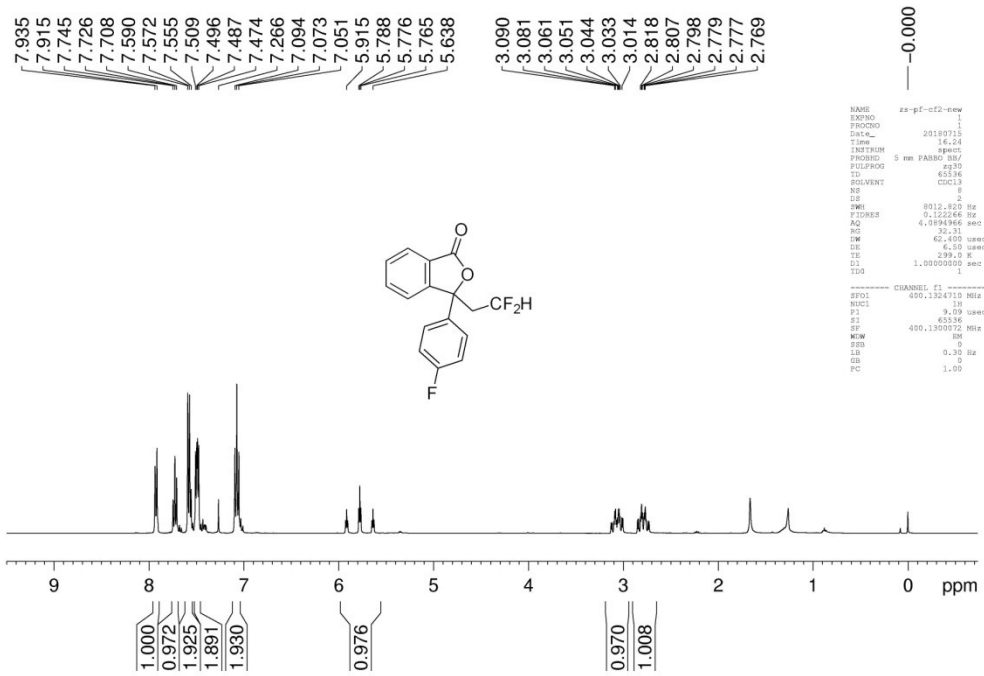
3a ^{13}C NMR:



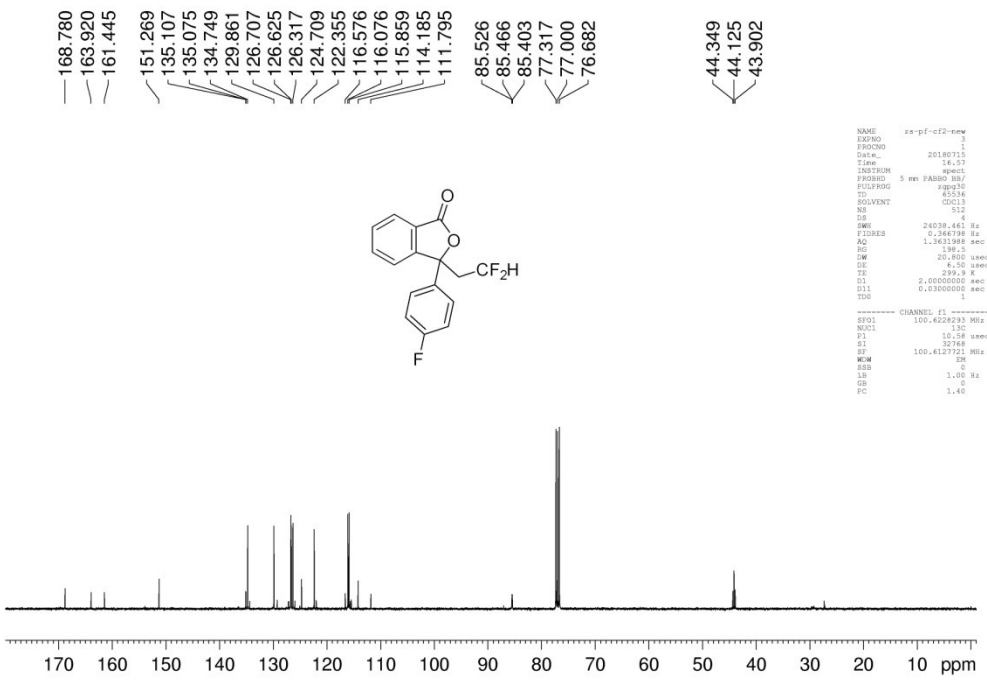
3a ^{19}F NMR:



3b ^{1}H NMR:



3b ^{13}C NMR:



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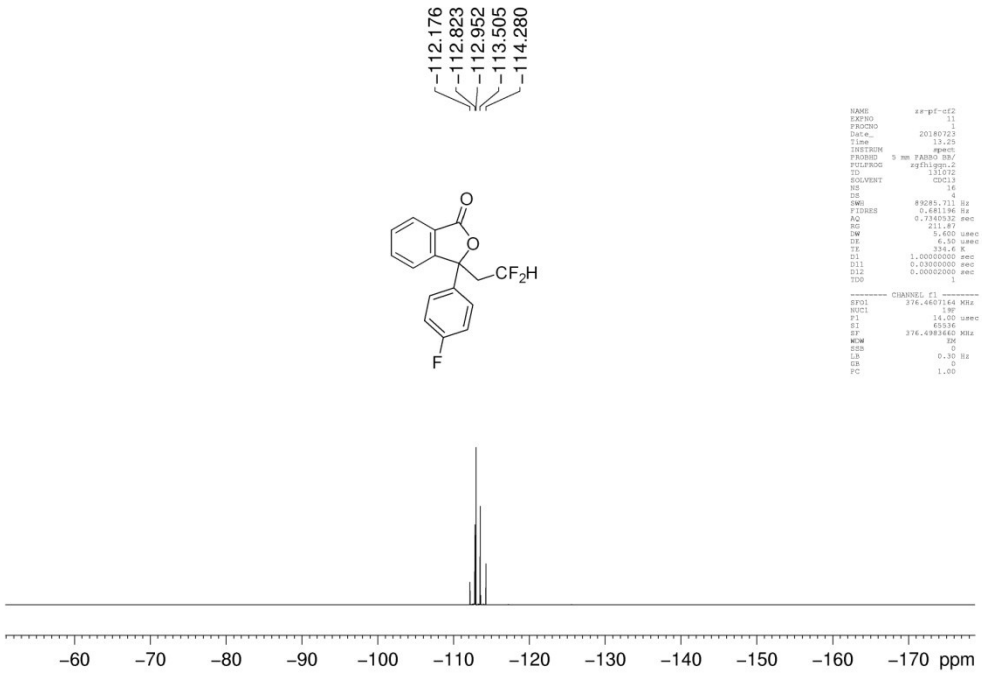

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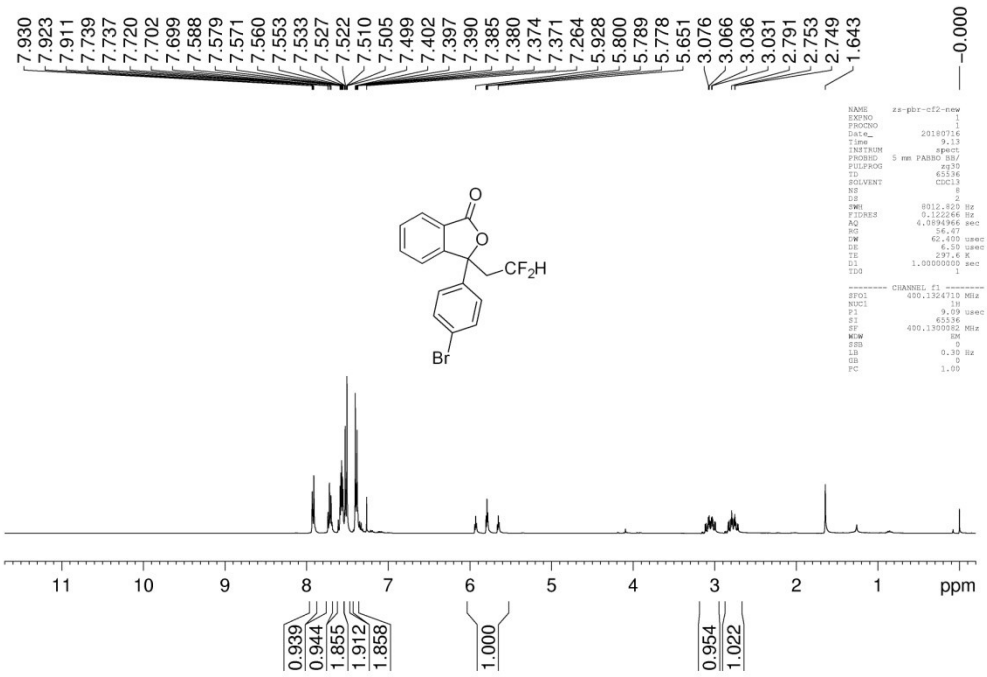

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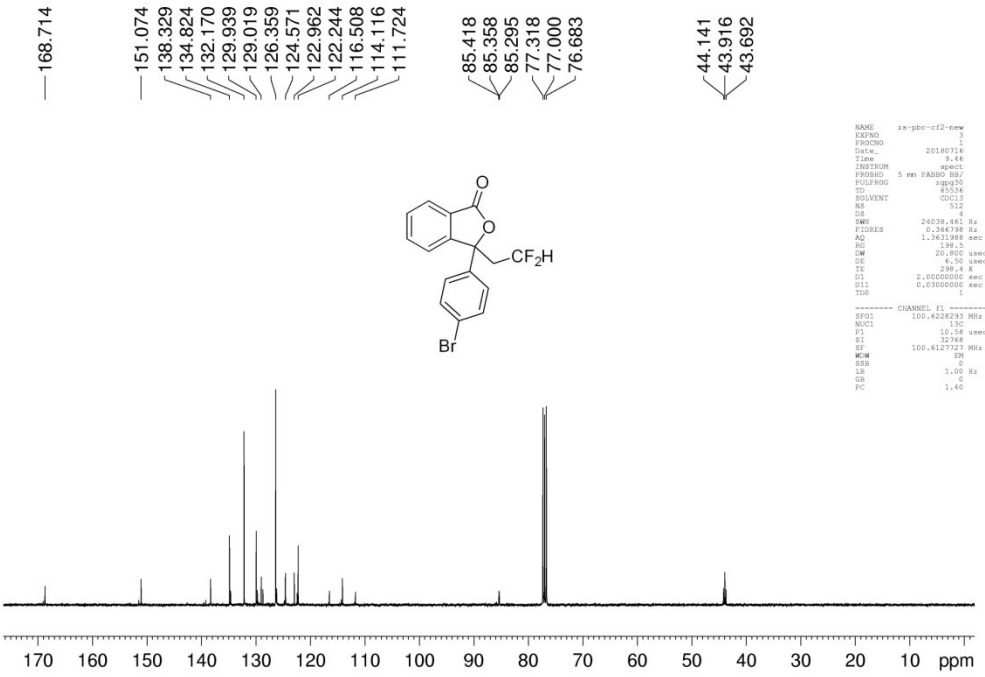
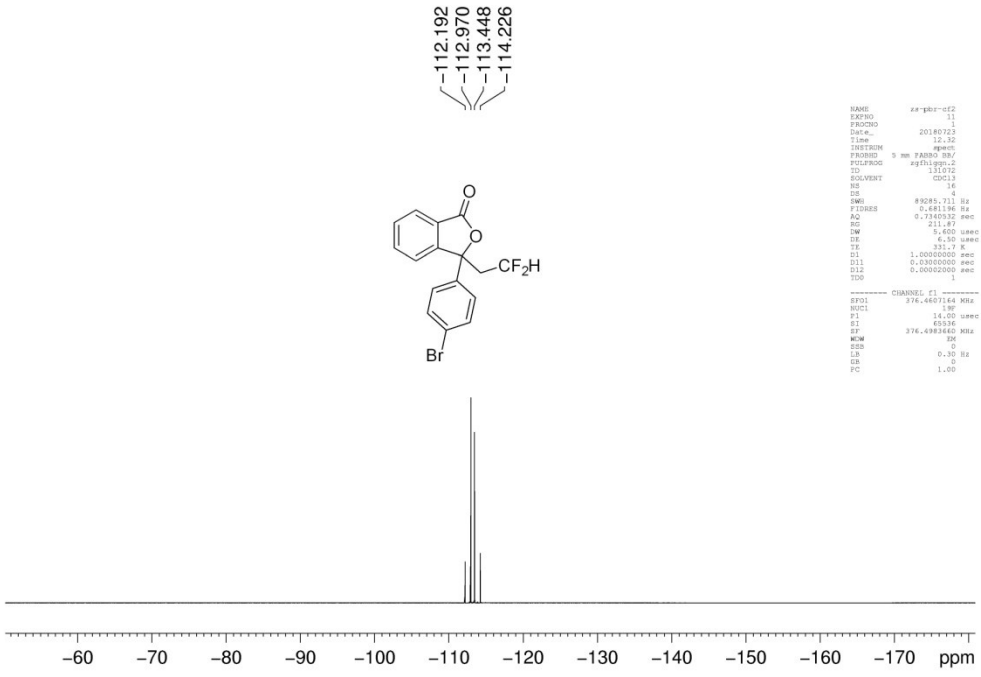
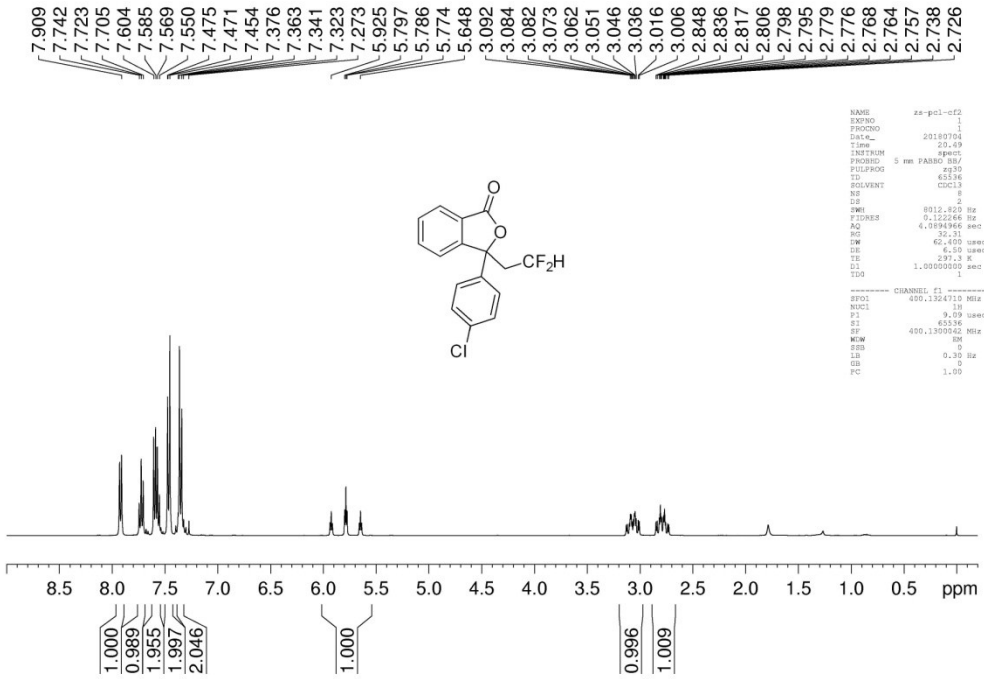


3c ^{19}F NMR:



3d ^{1}H NMR:



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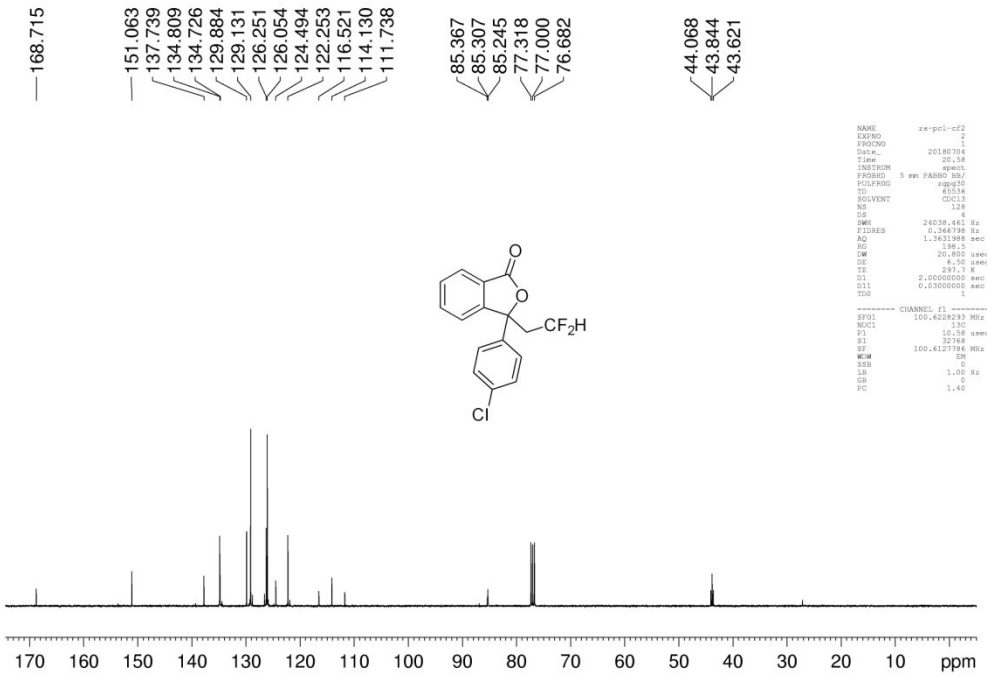
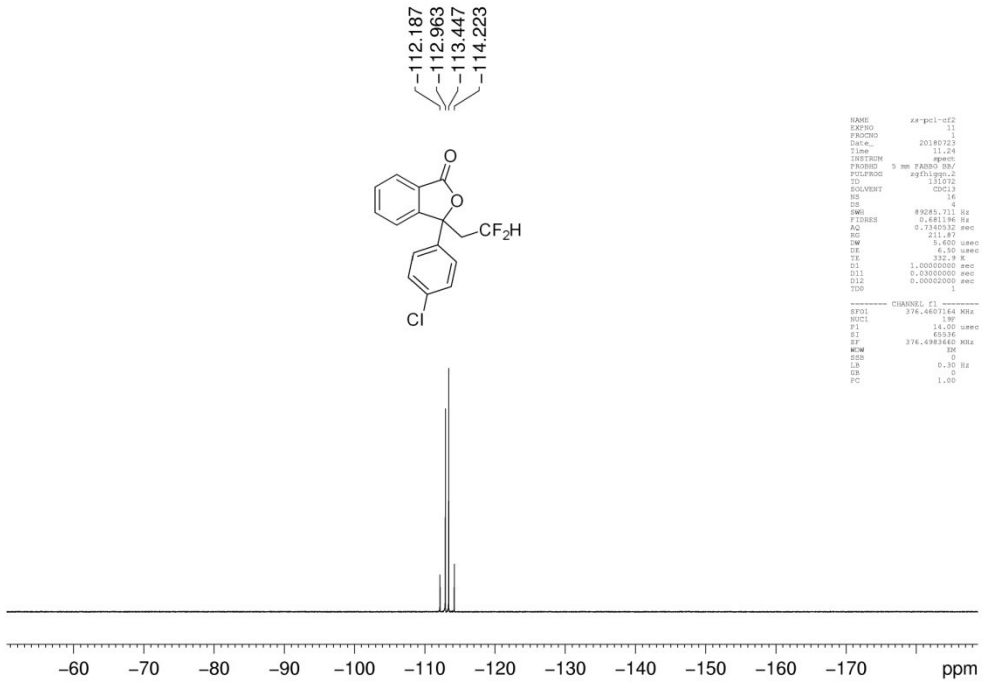
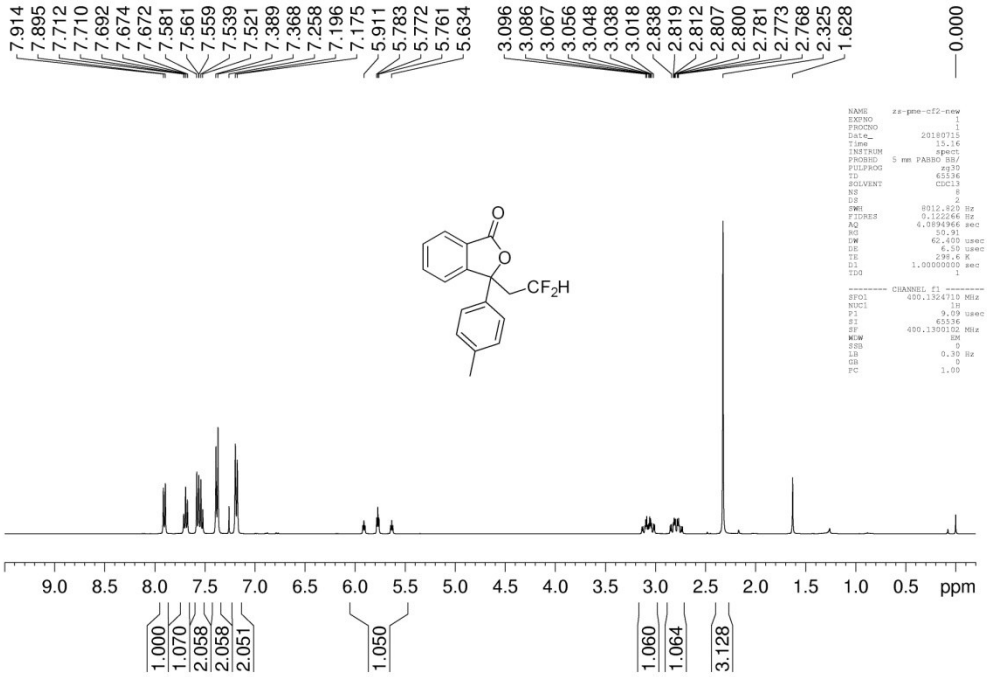

168.715
151.063
137.739
134.809
134.726
129.884
129.131
126.251
126.054
124.494
122.253
116.521
114.130
111.738
85.367
85.307
85.245
77.318
77.000
76.682
44.068
43.844
43.621
O
O
CF2H
Cl
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

3d ^{19}F NMR:


-112.187
-112.963
-113.447
-114.223
O
O
CF2H
Cl
-60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 ppm

3e ^{1}H NMR:



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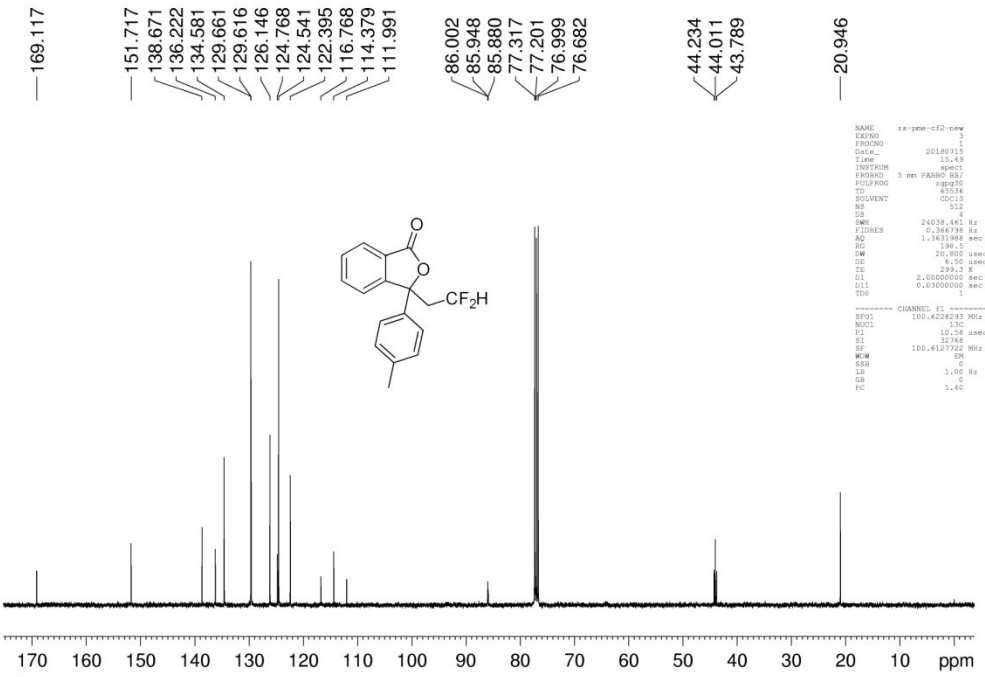

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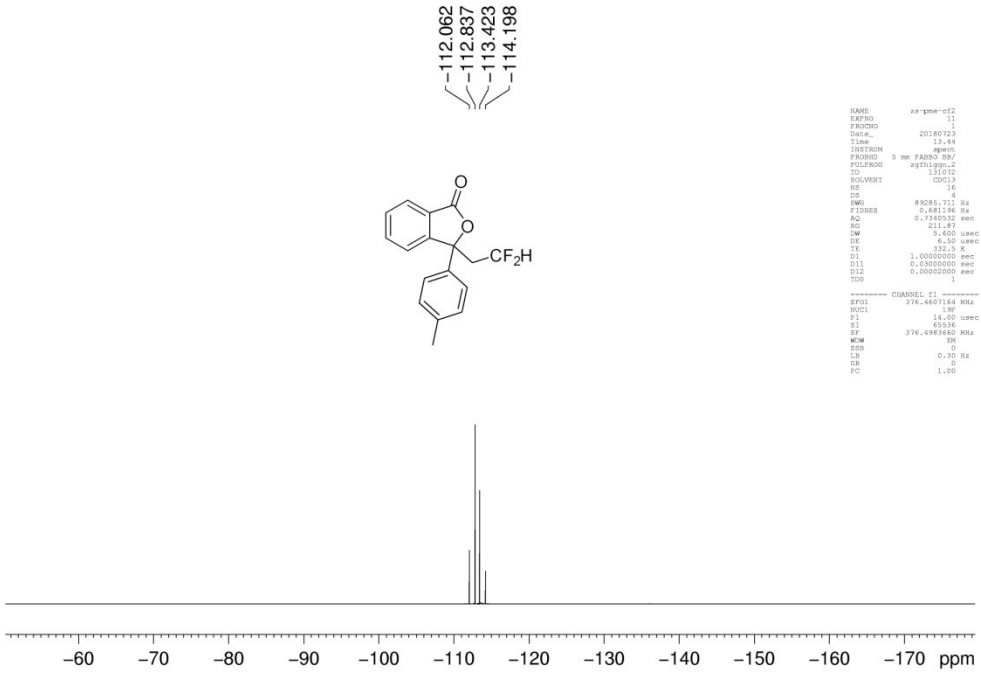

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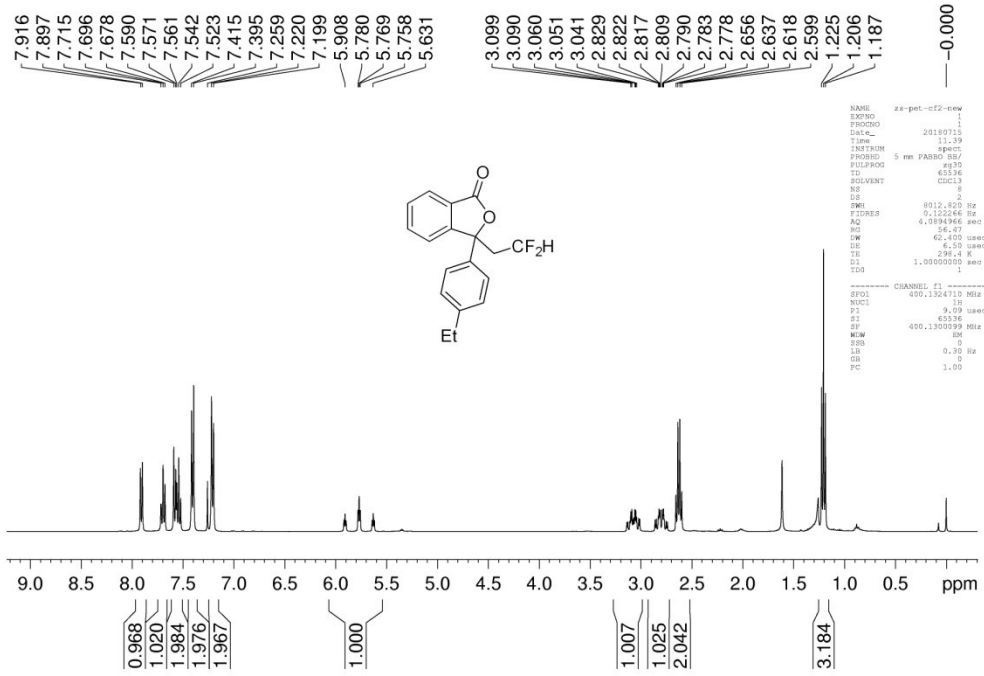

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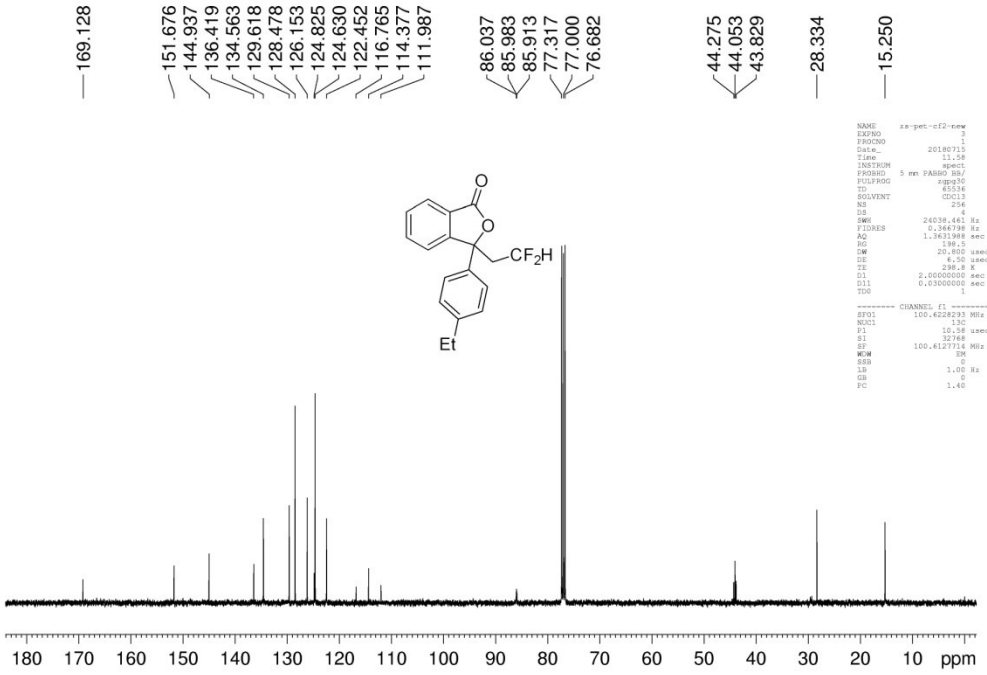

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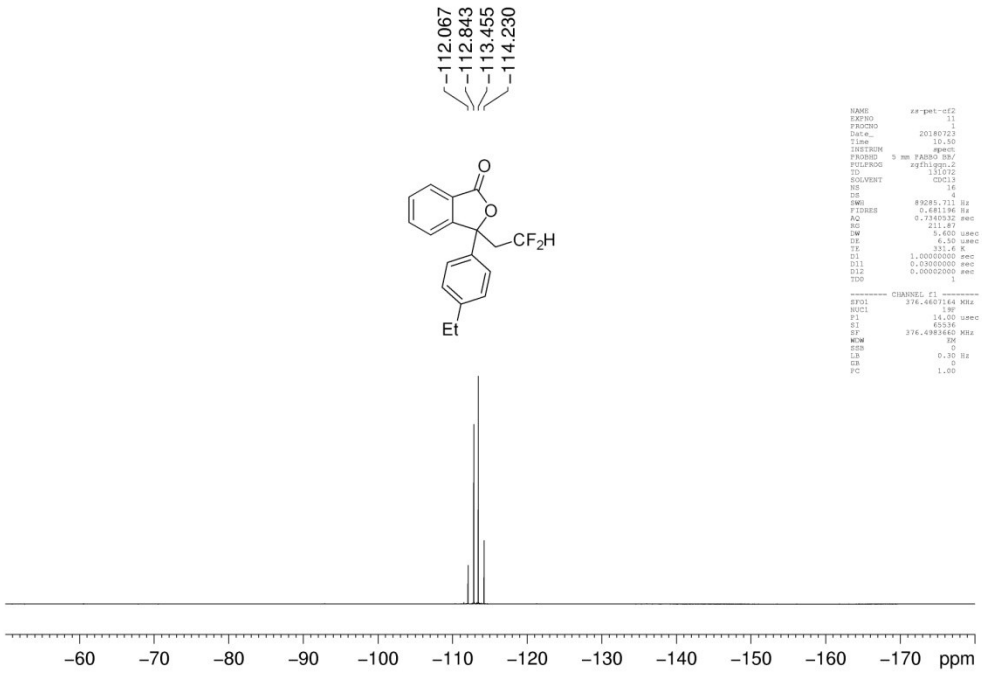

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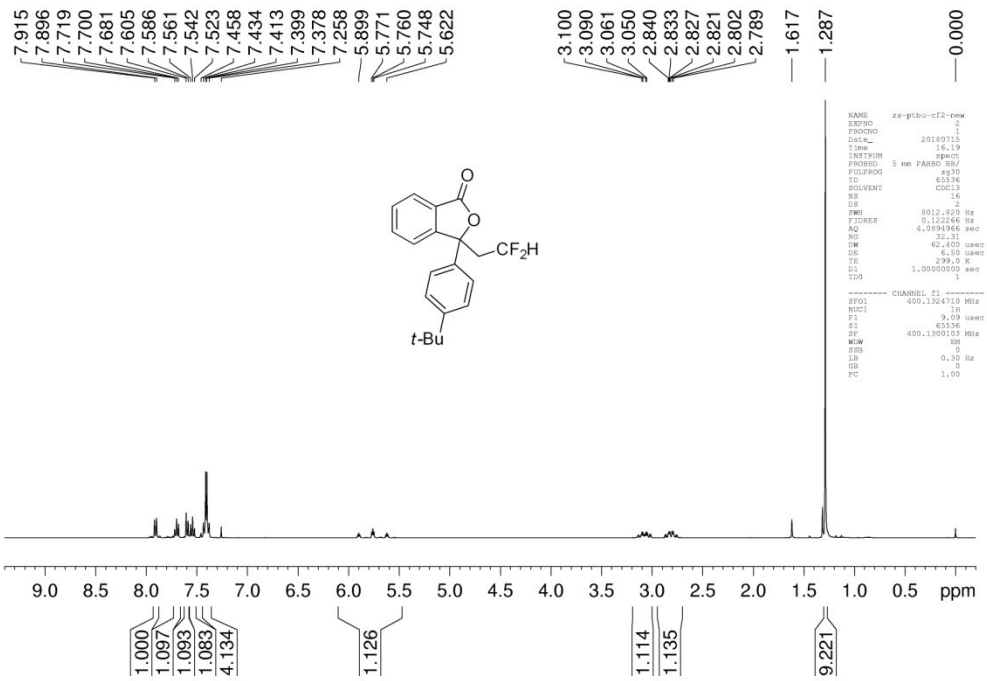

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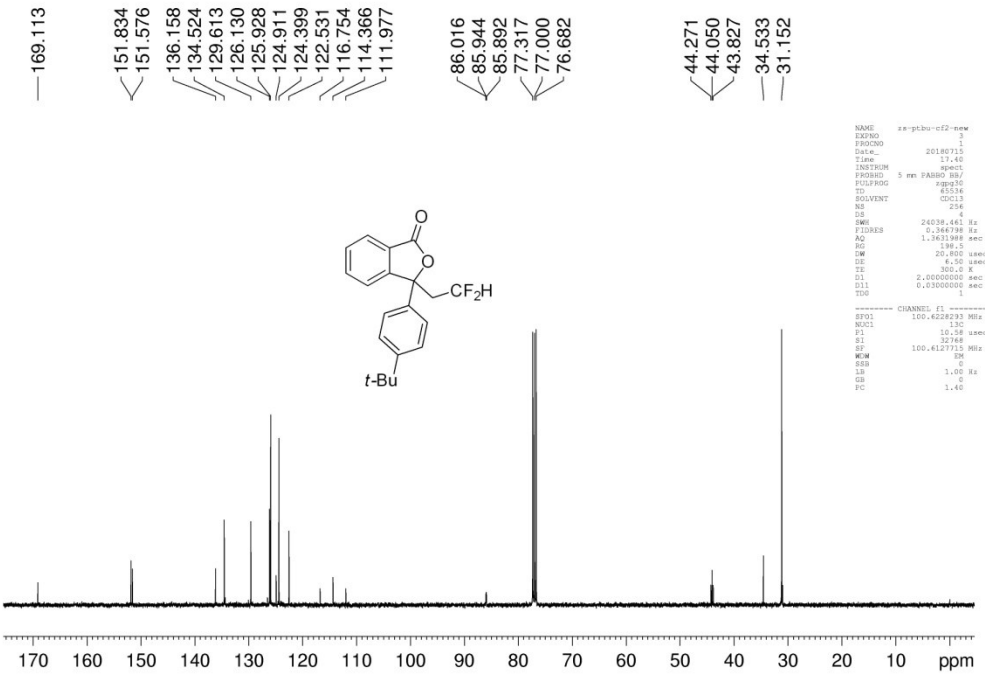

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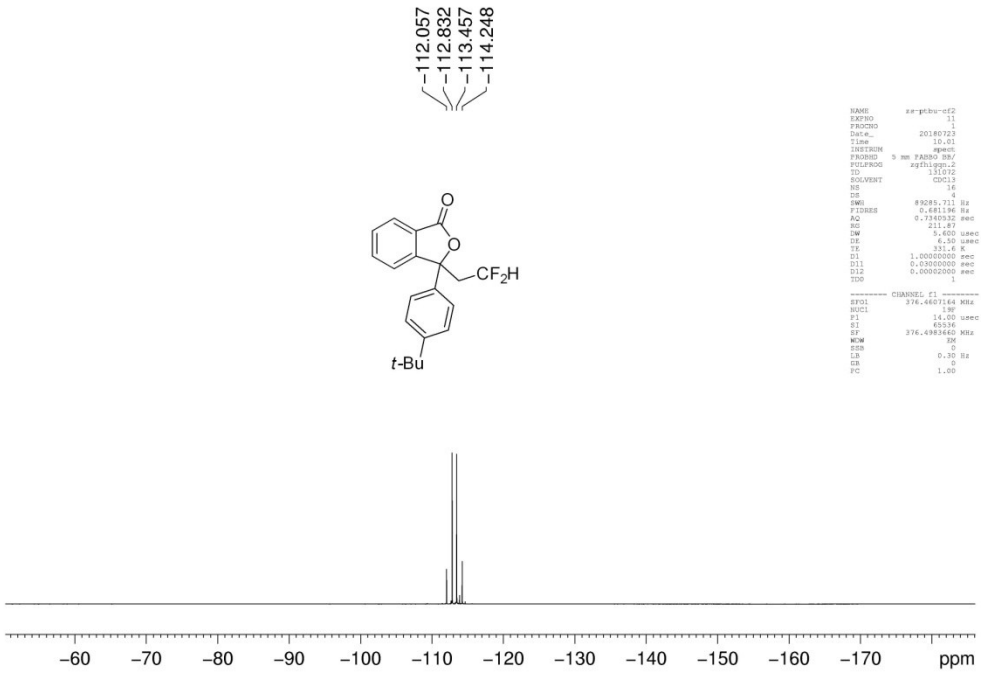

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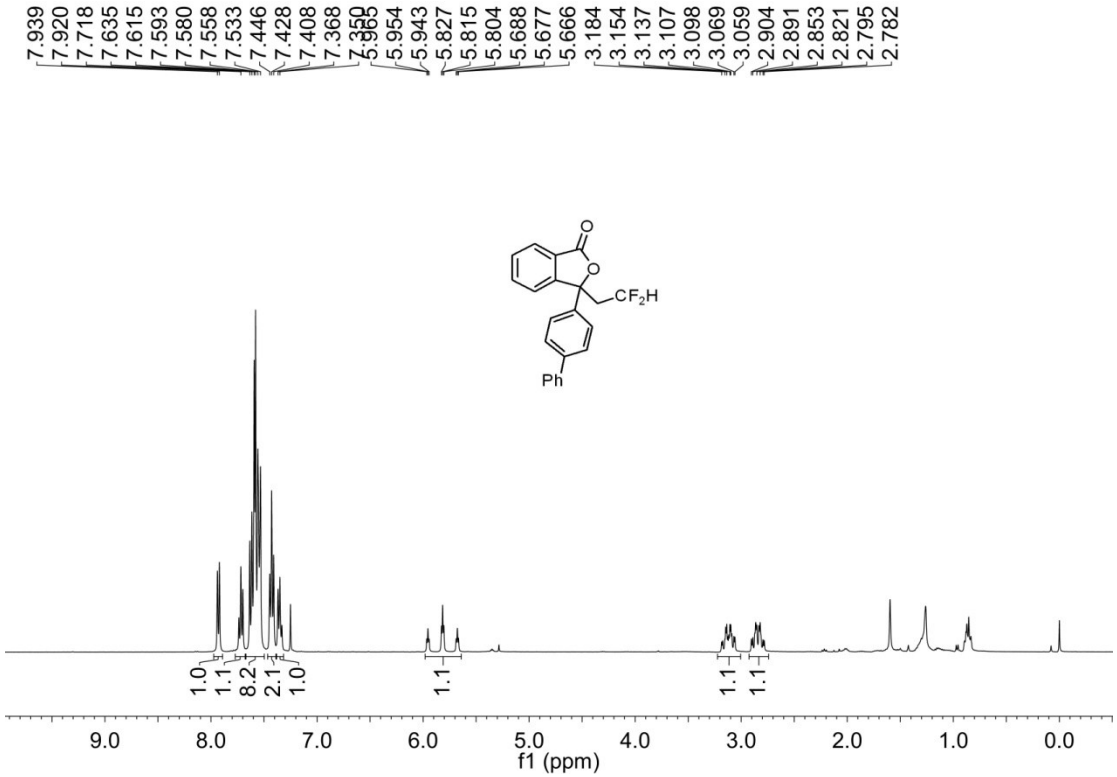

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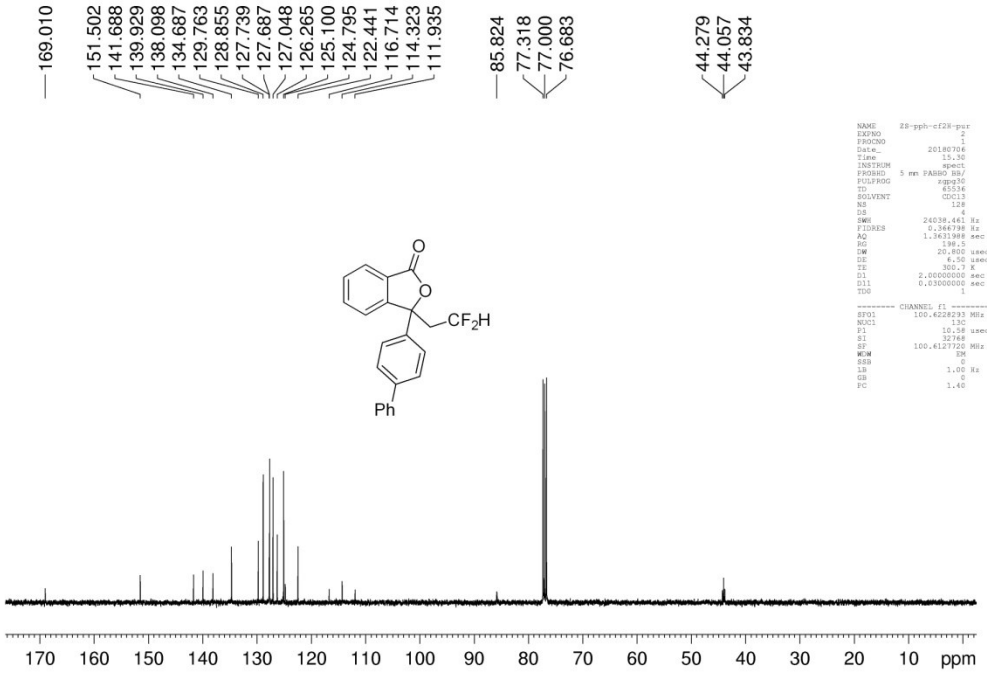

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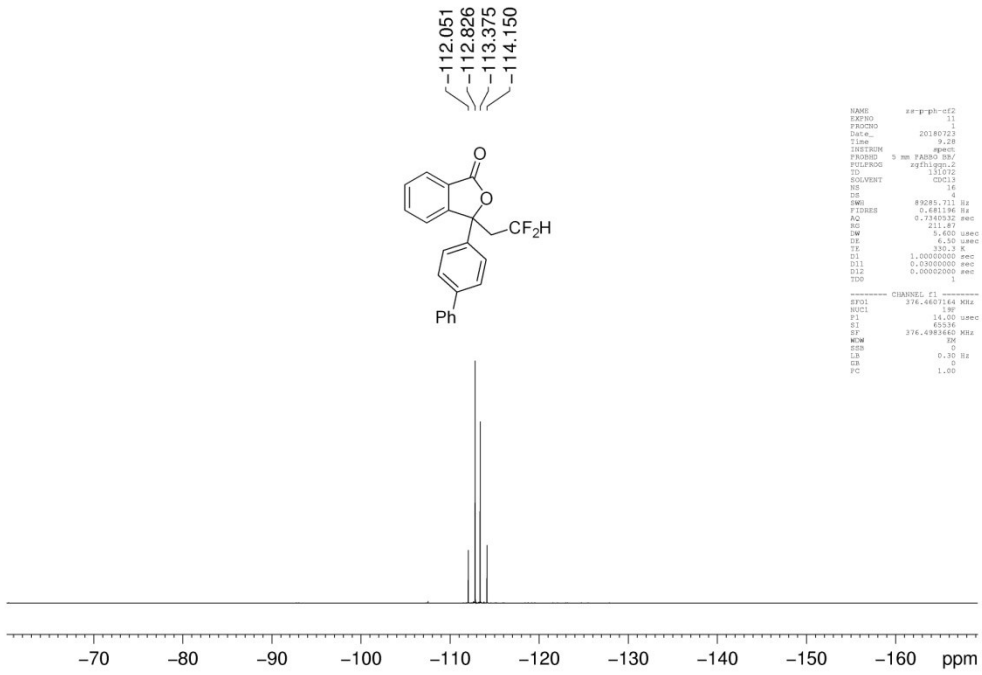

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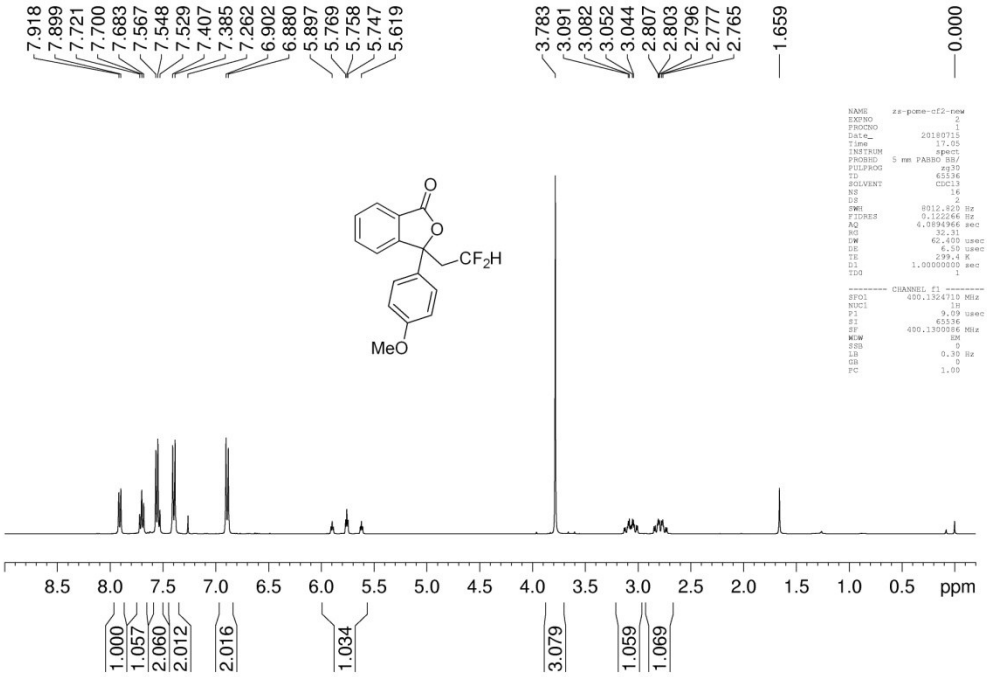

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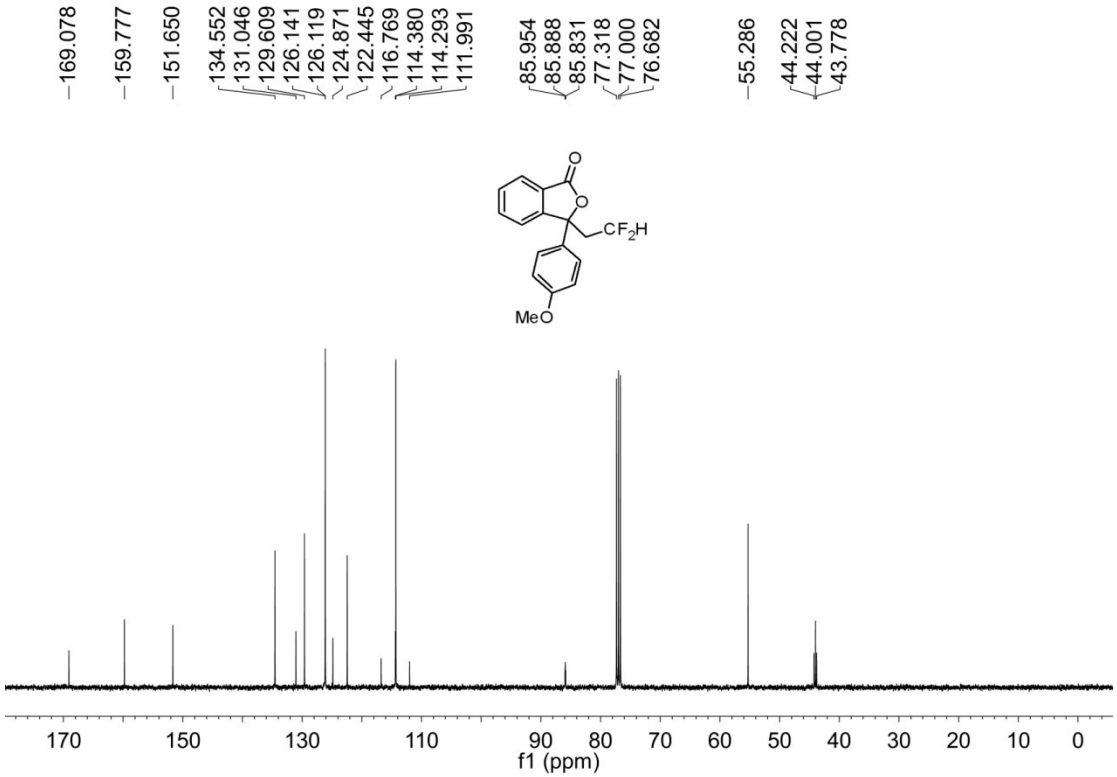

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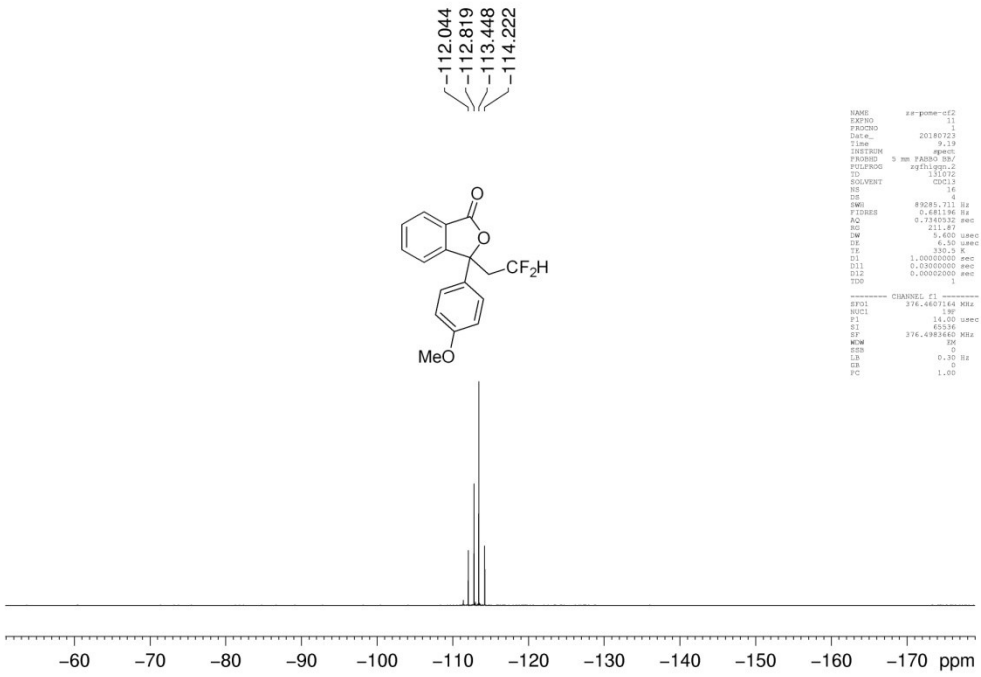

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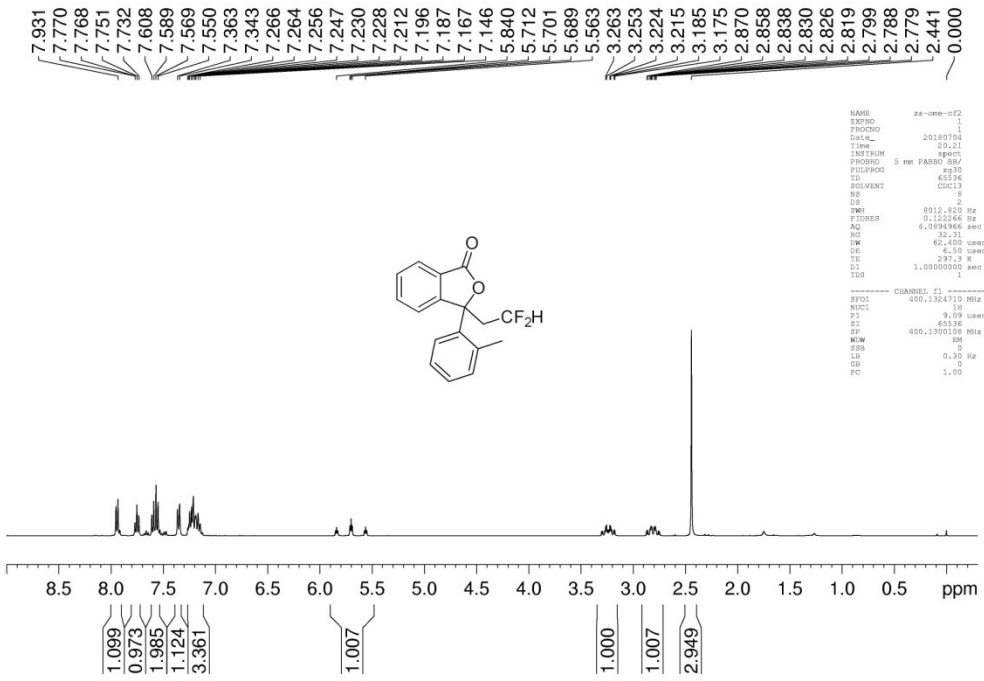

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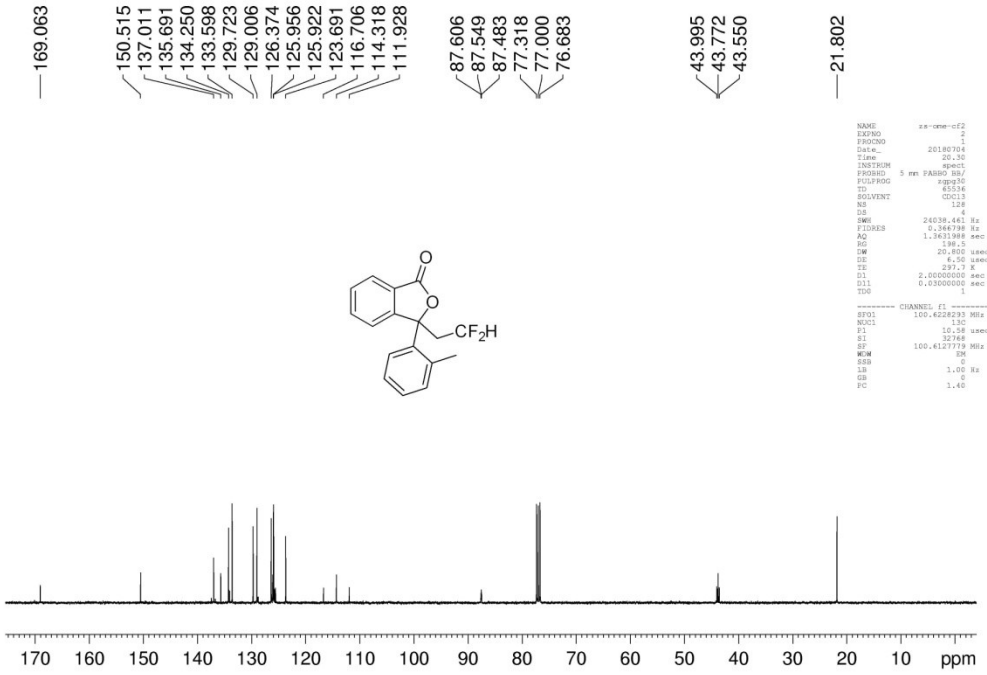

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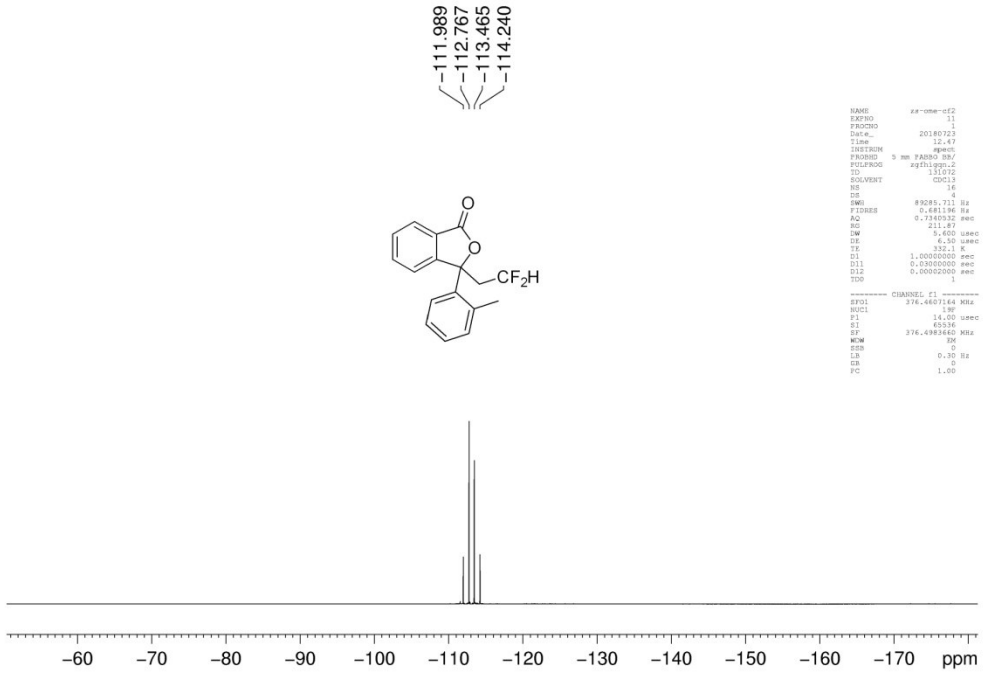

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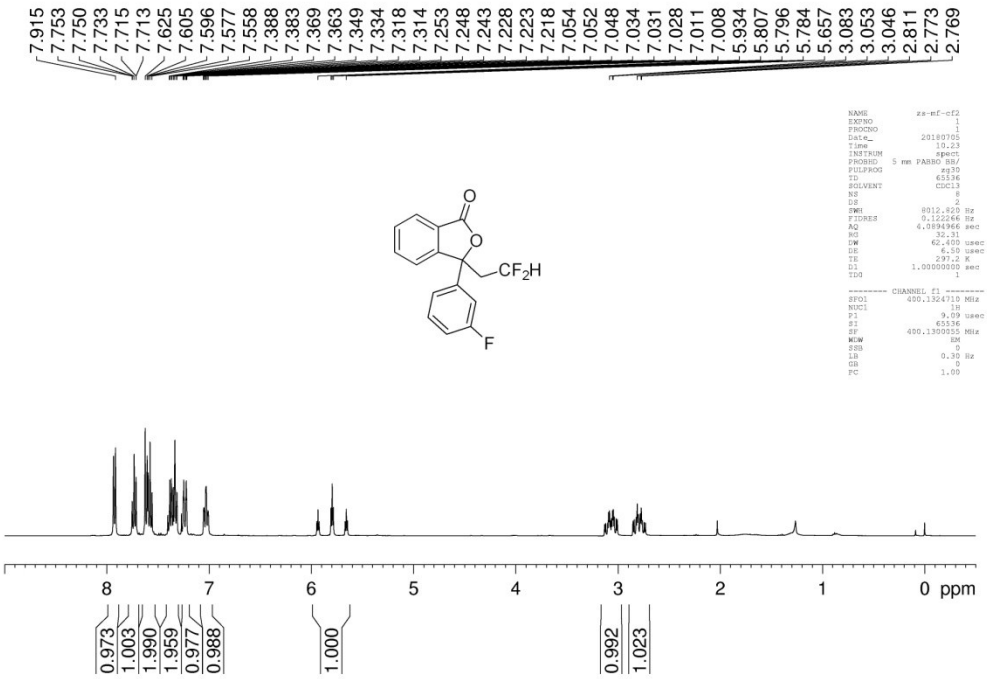

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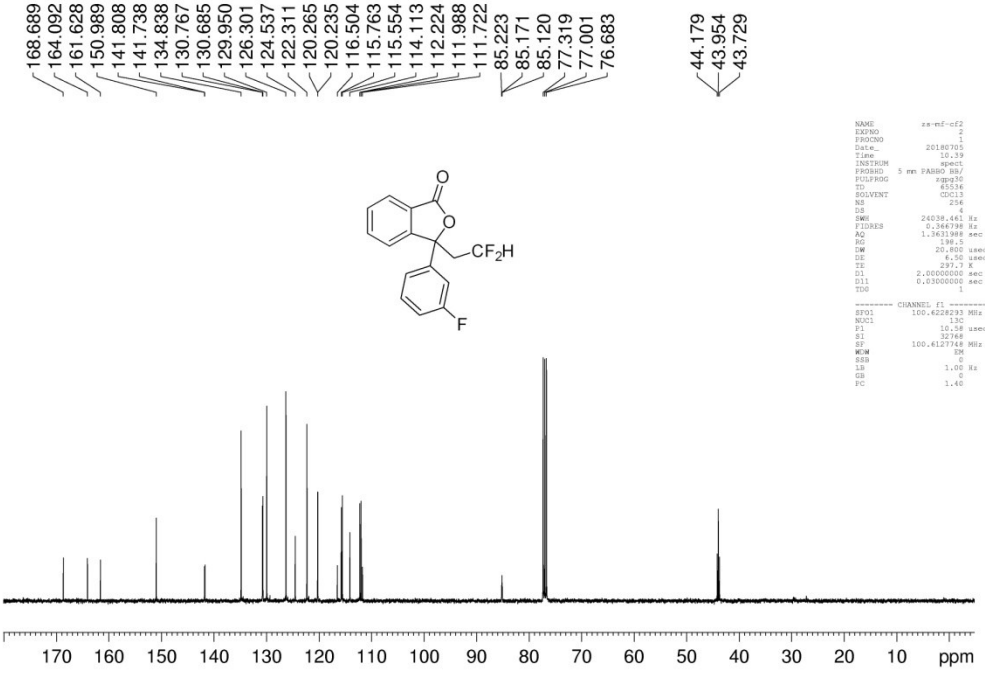

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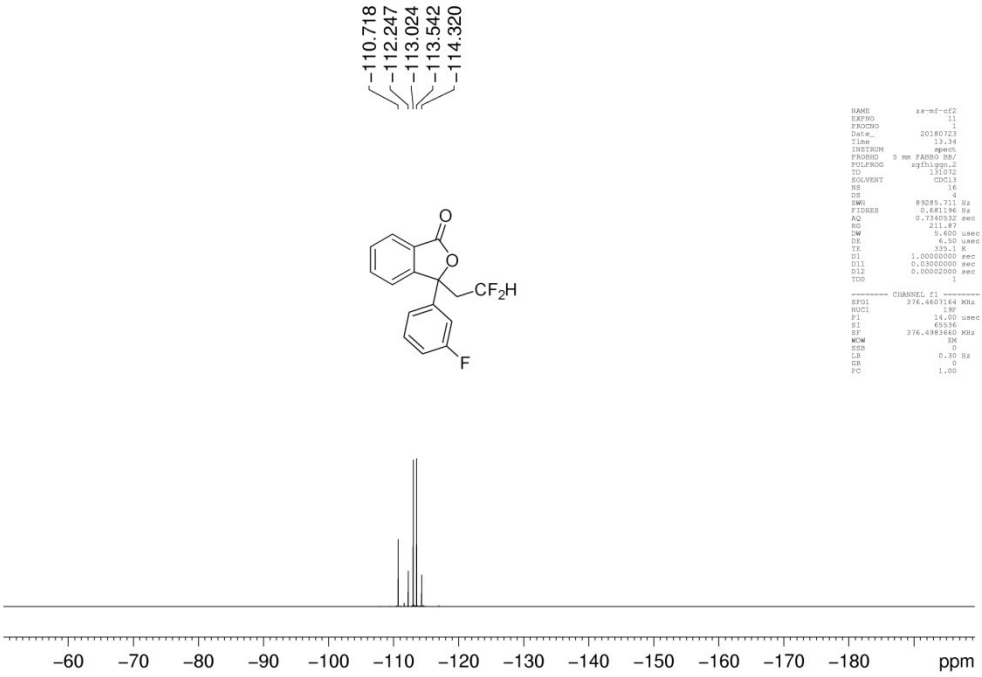

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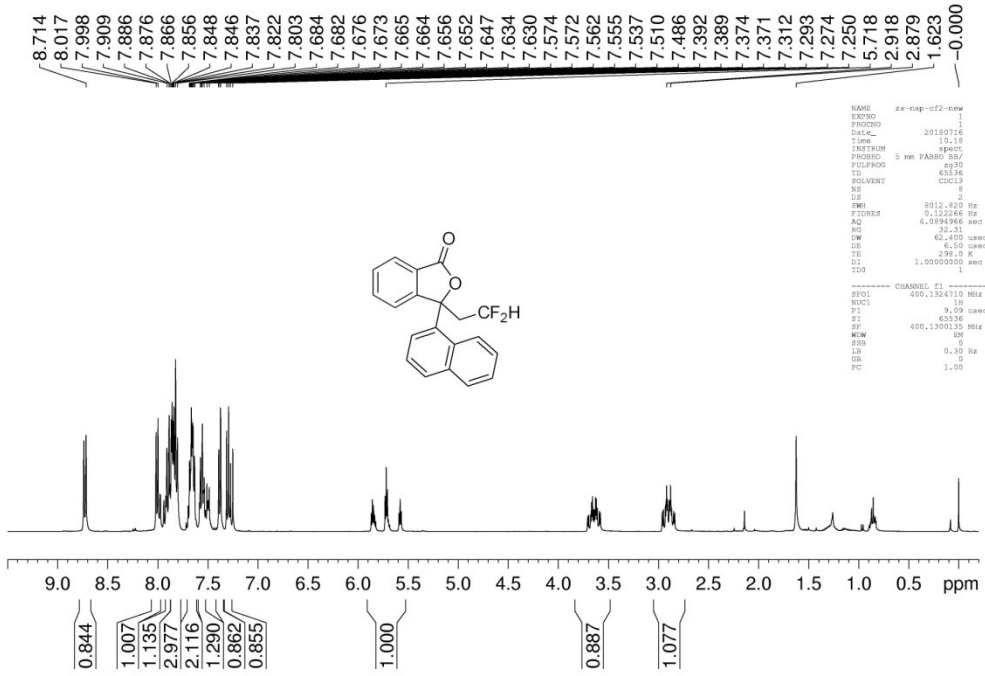

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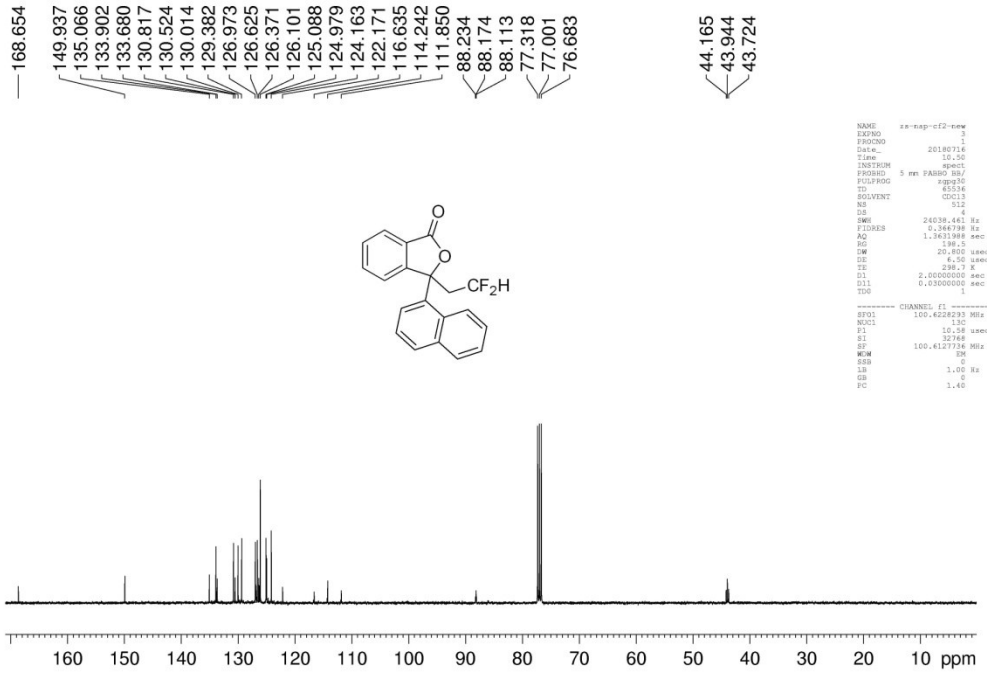

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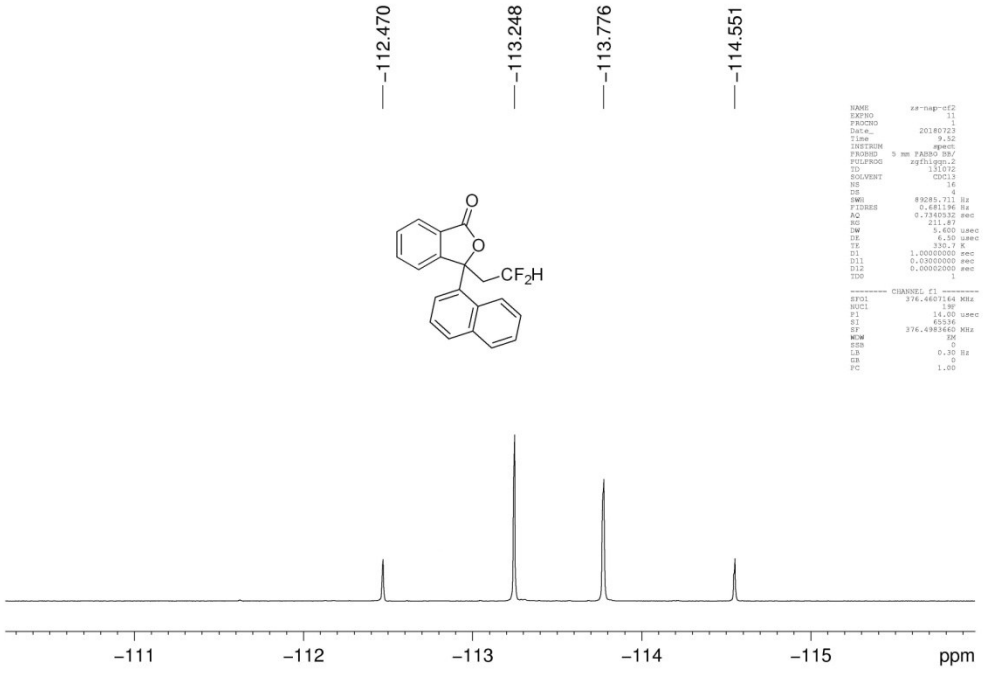

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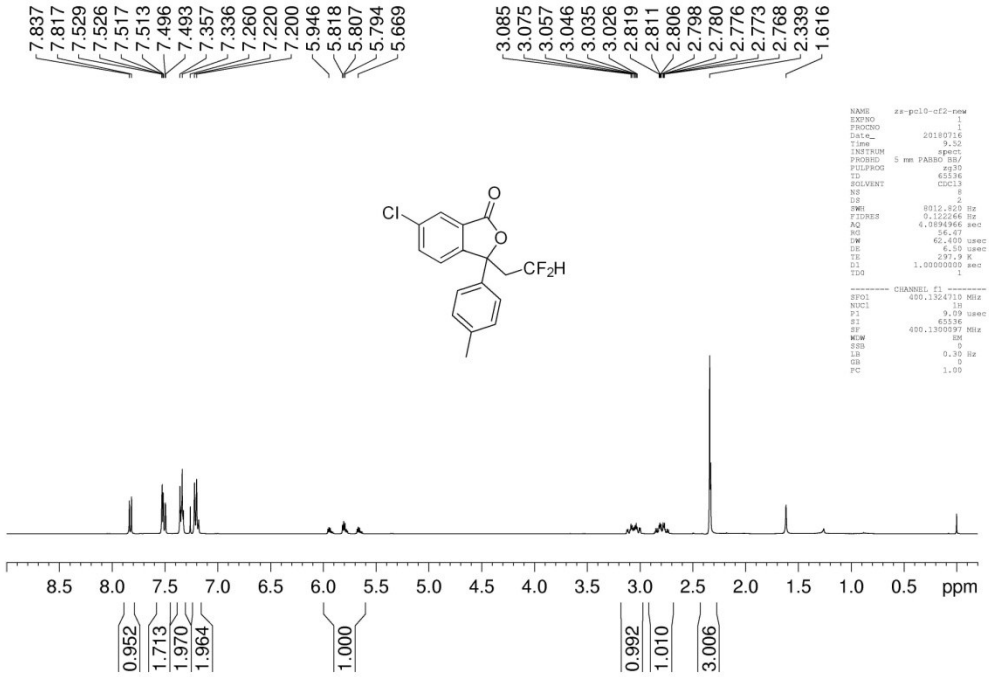

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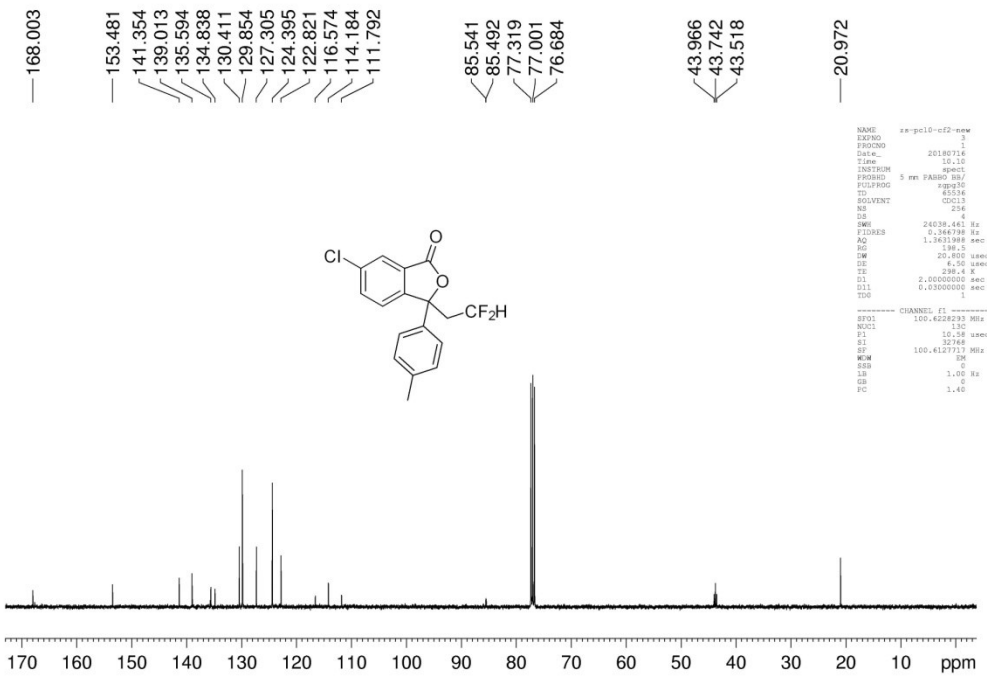

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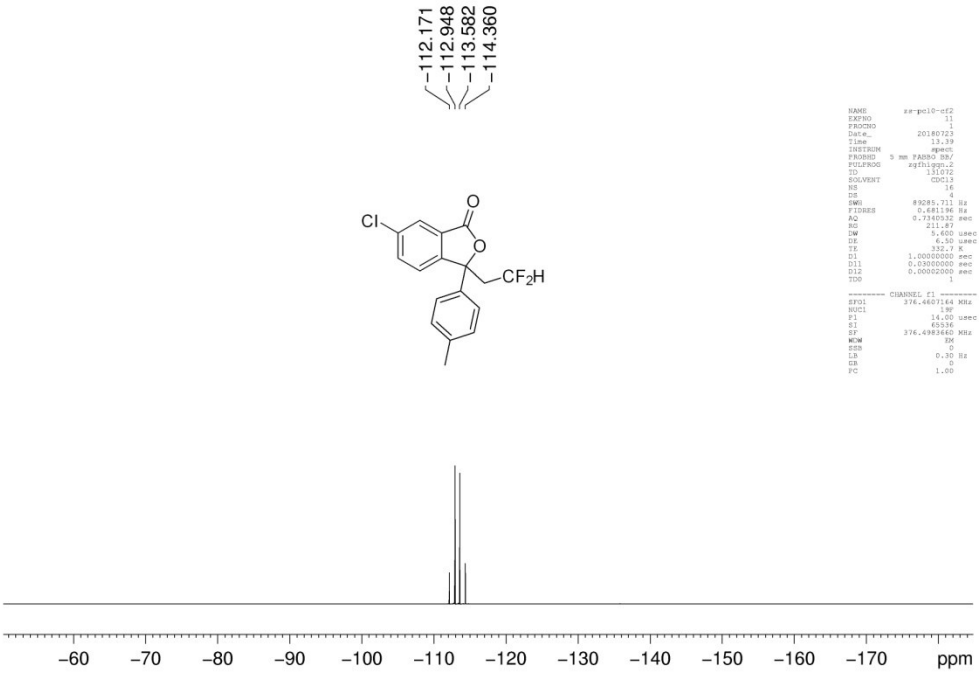

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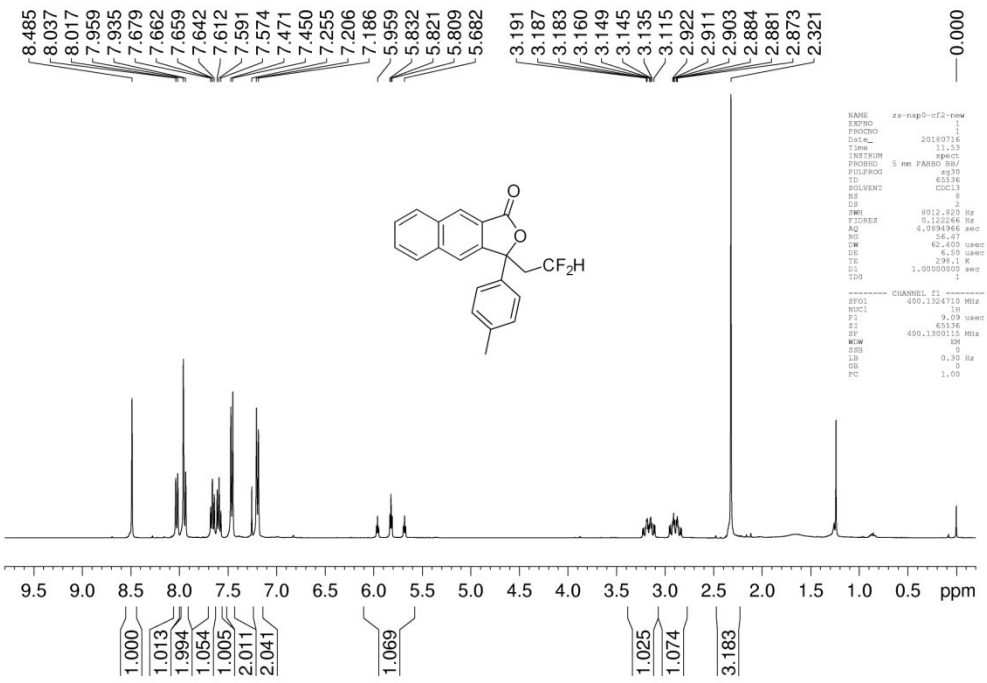

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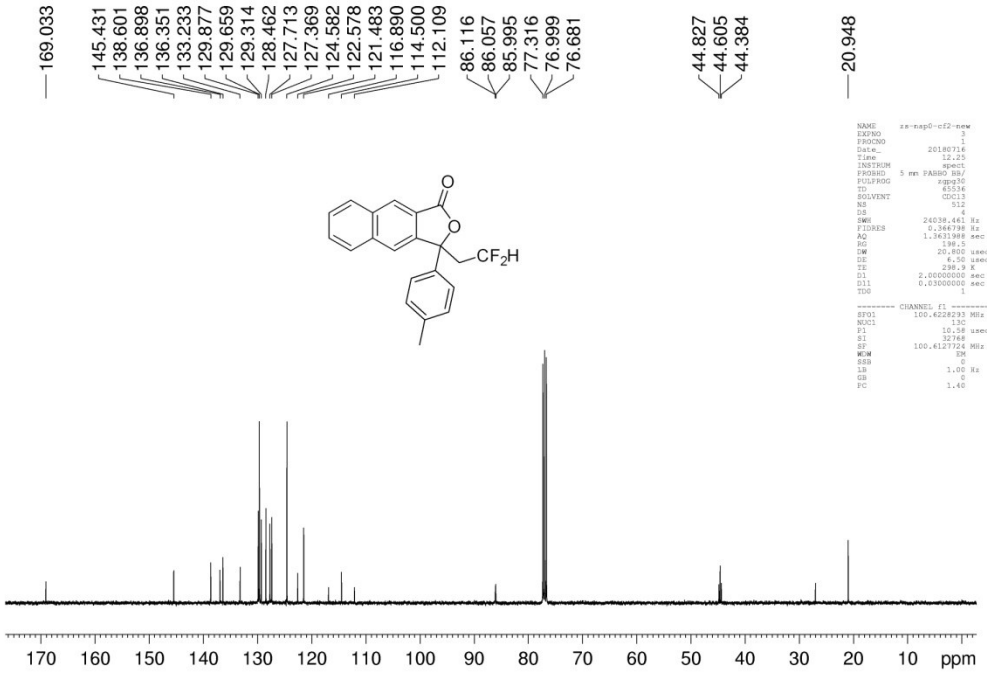

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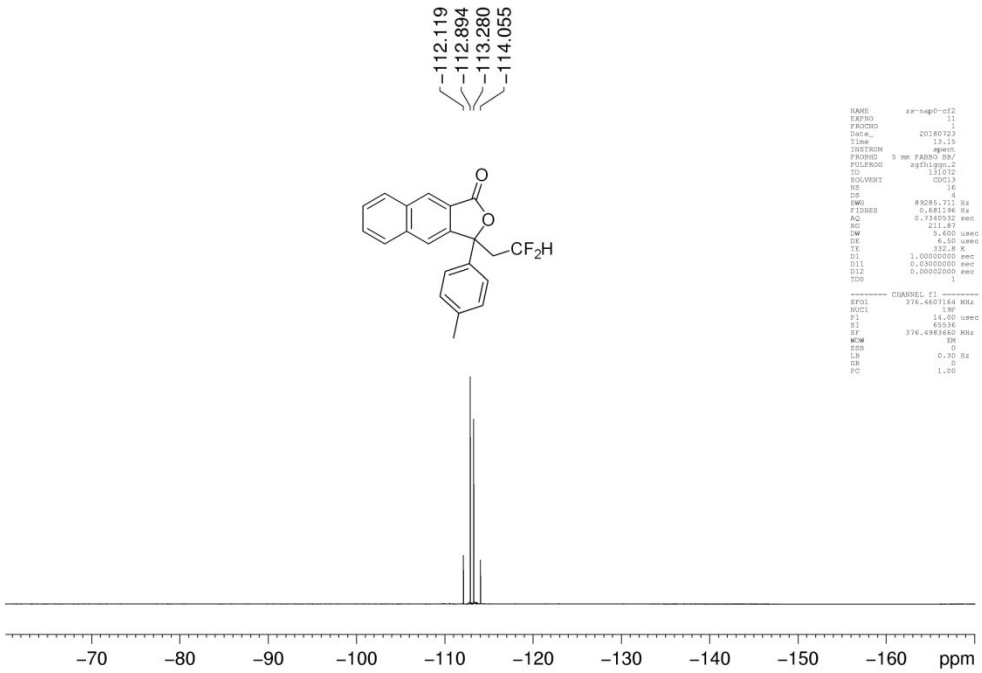

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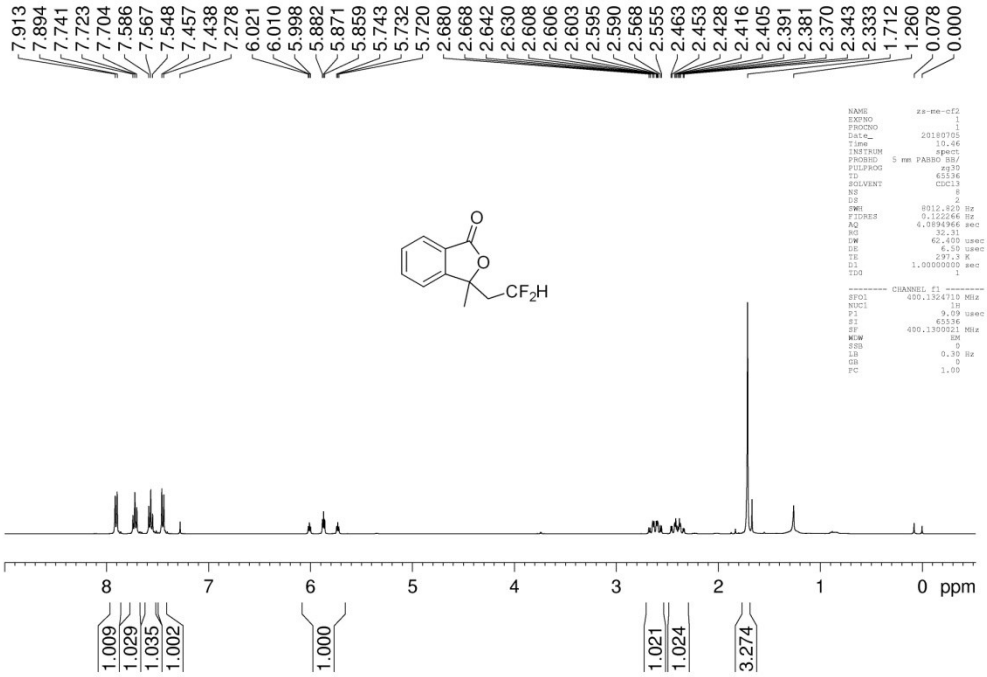
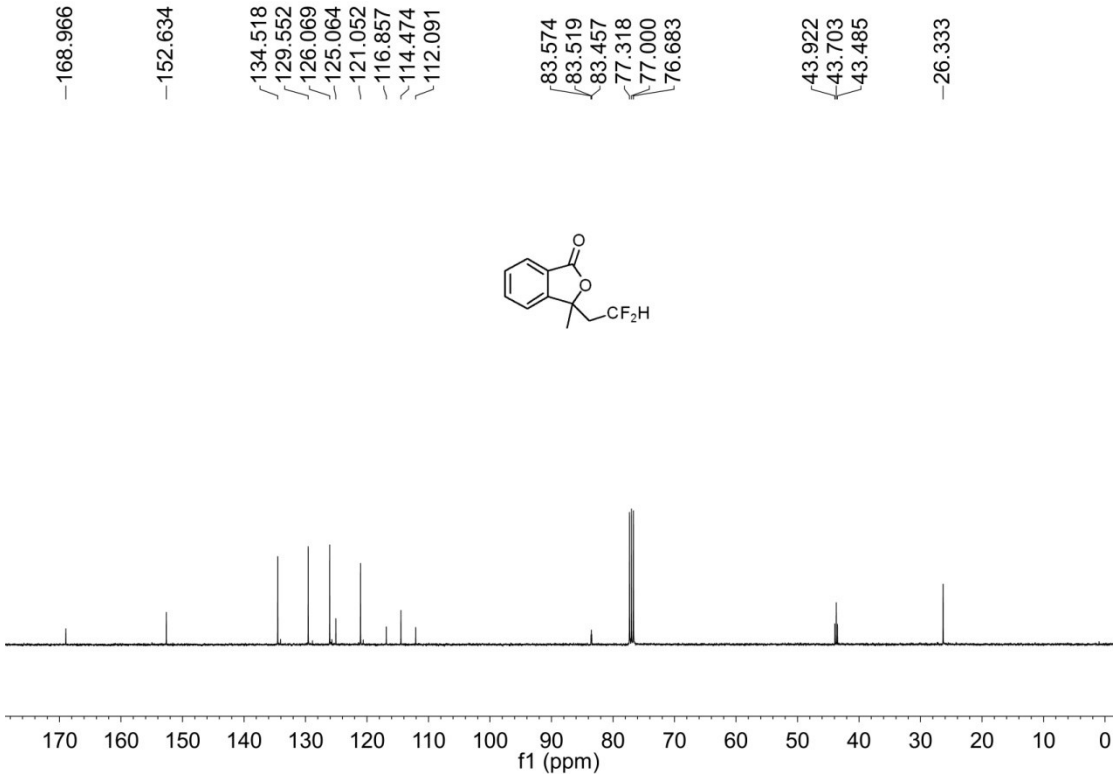


3o ^{13}C NMR:



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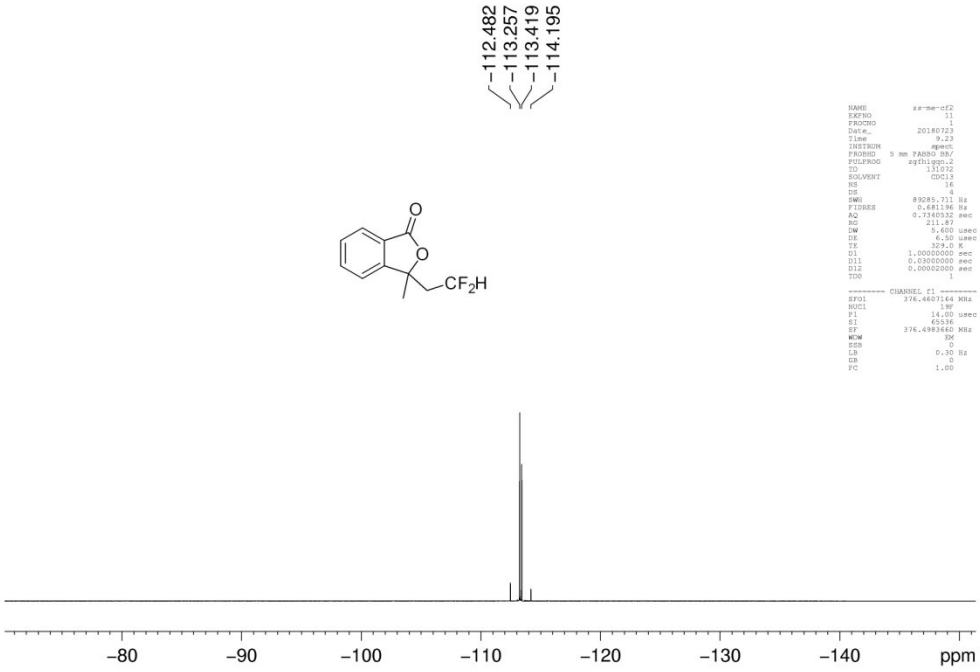

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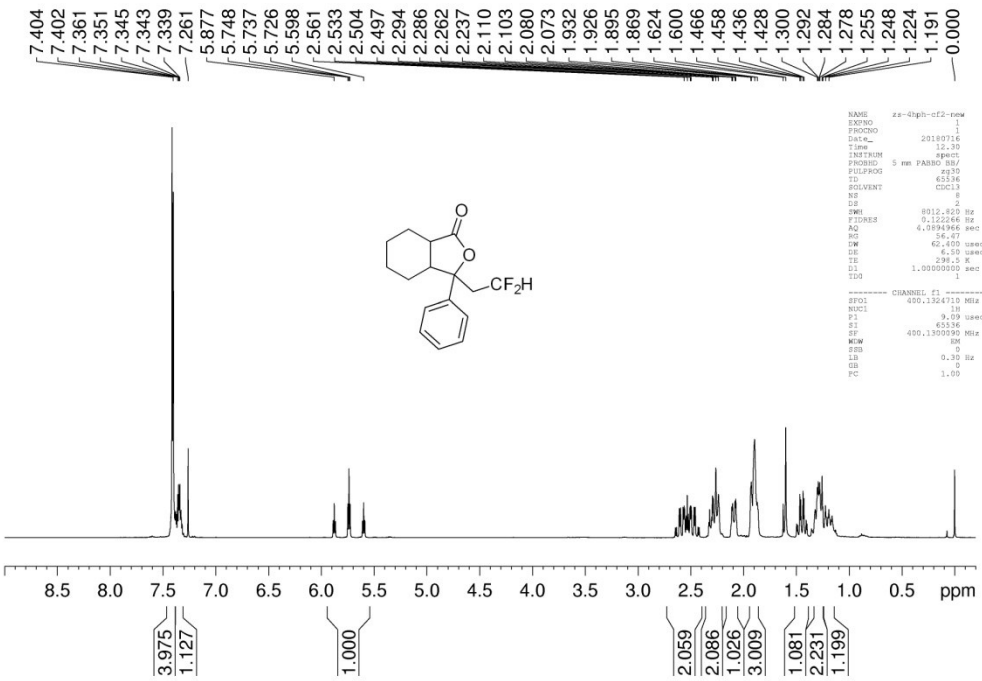

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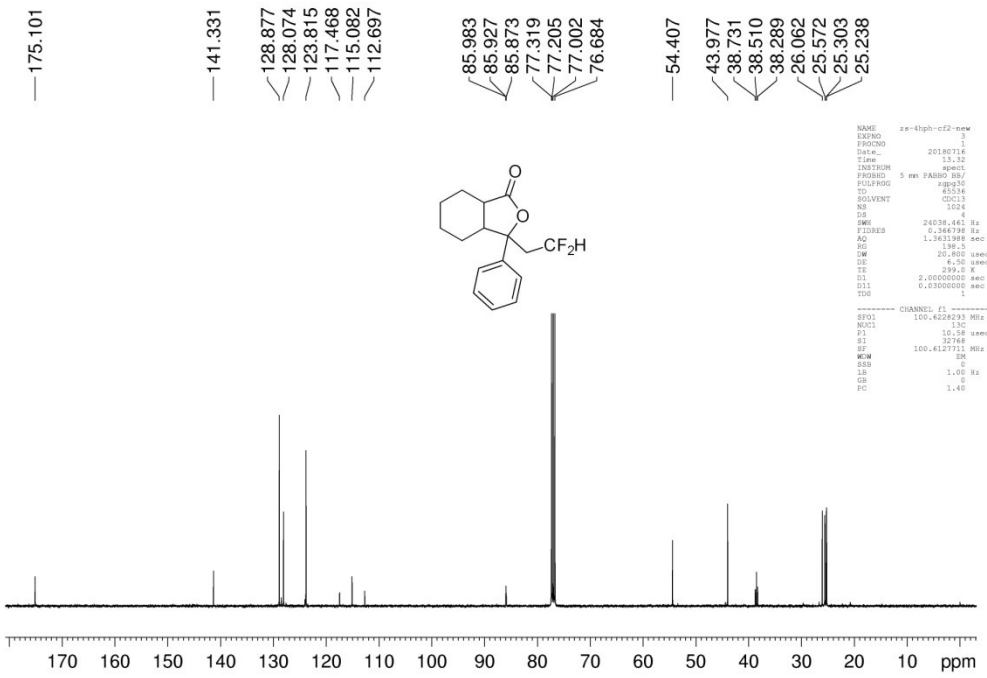
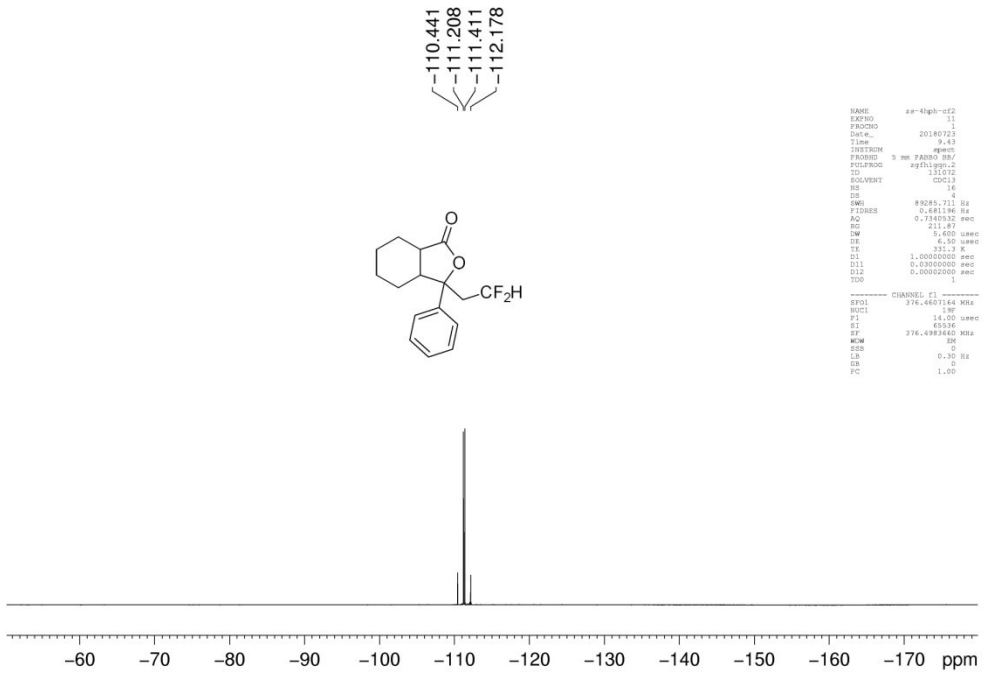


3p ^{19}F NMR:



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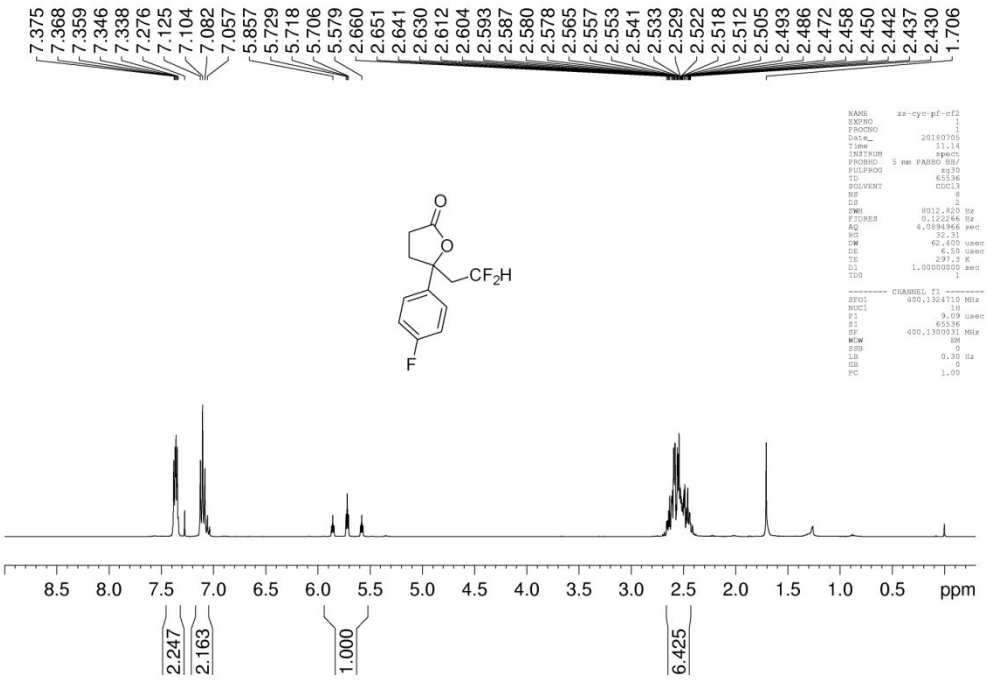

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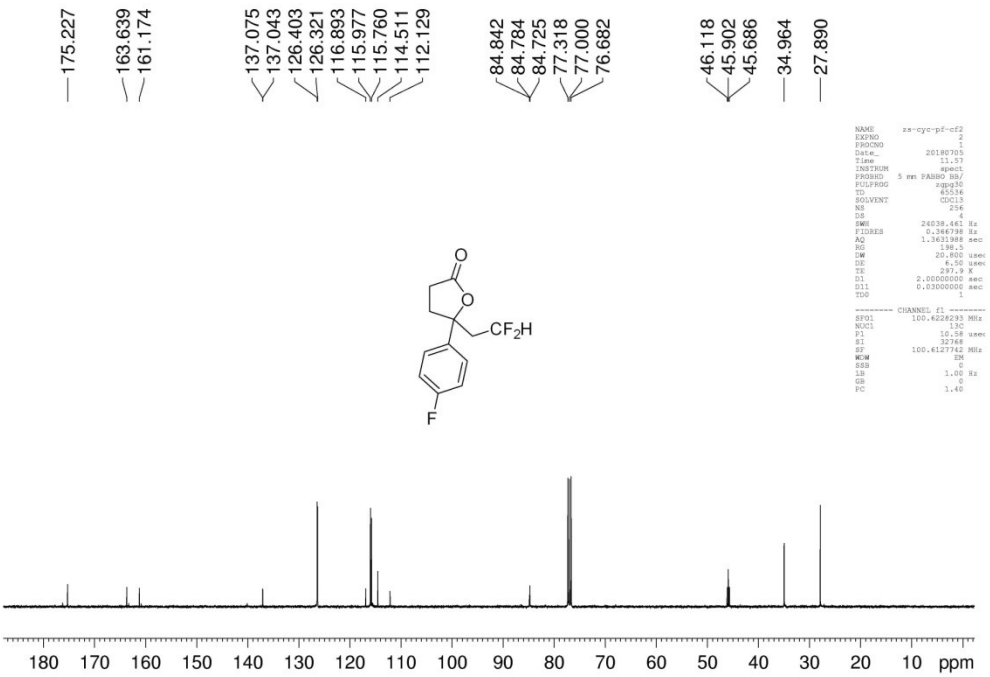
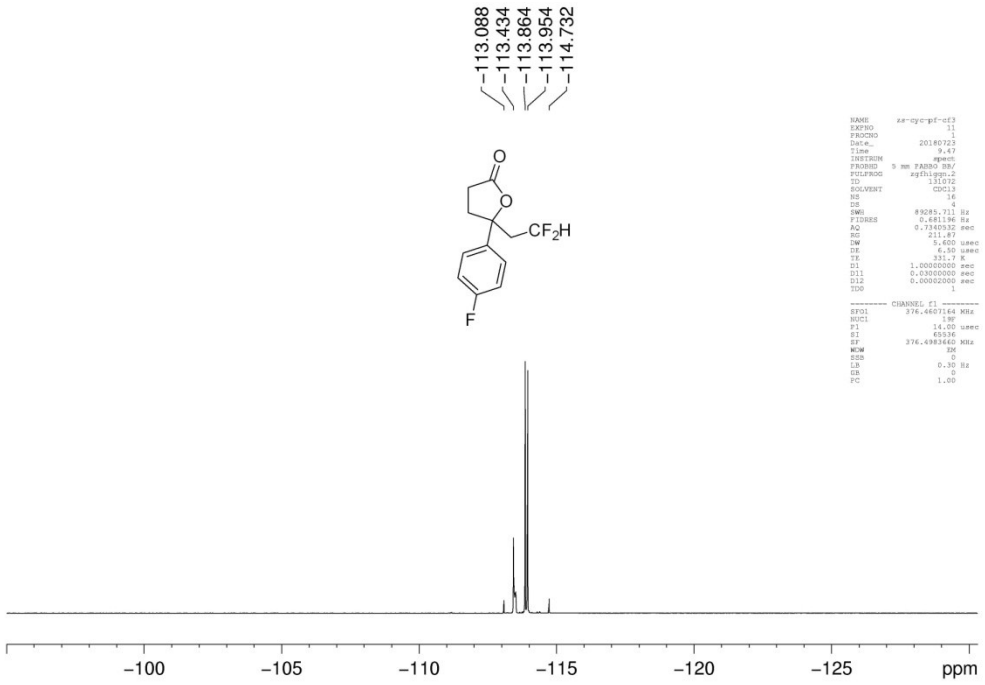
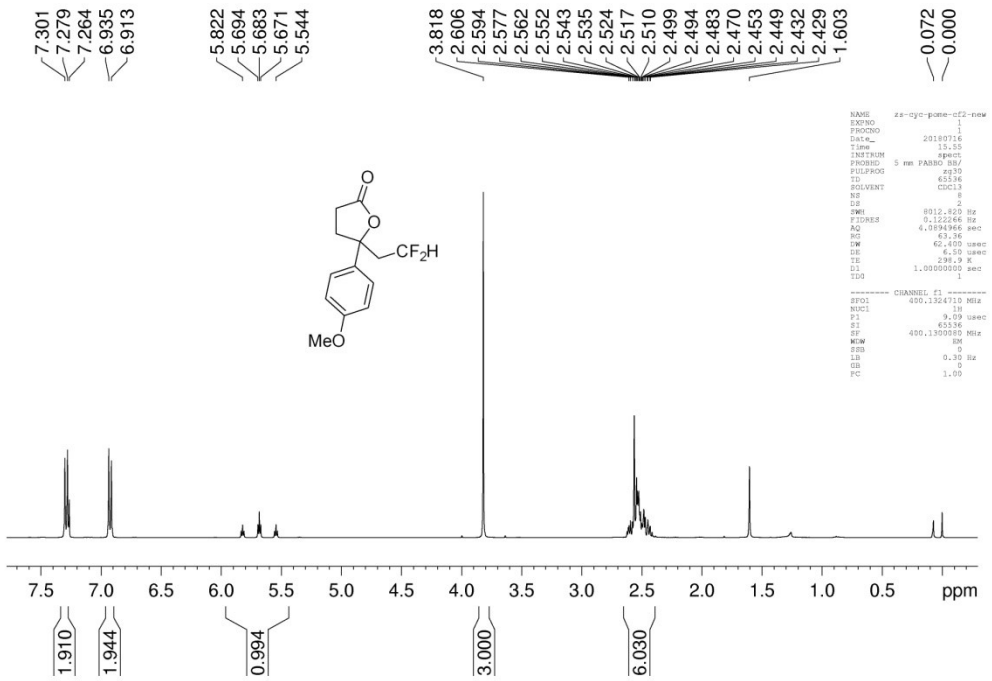


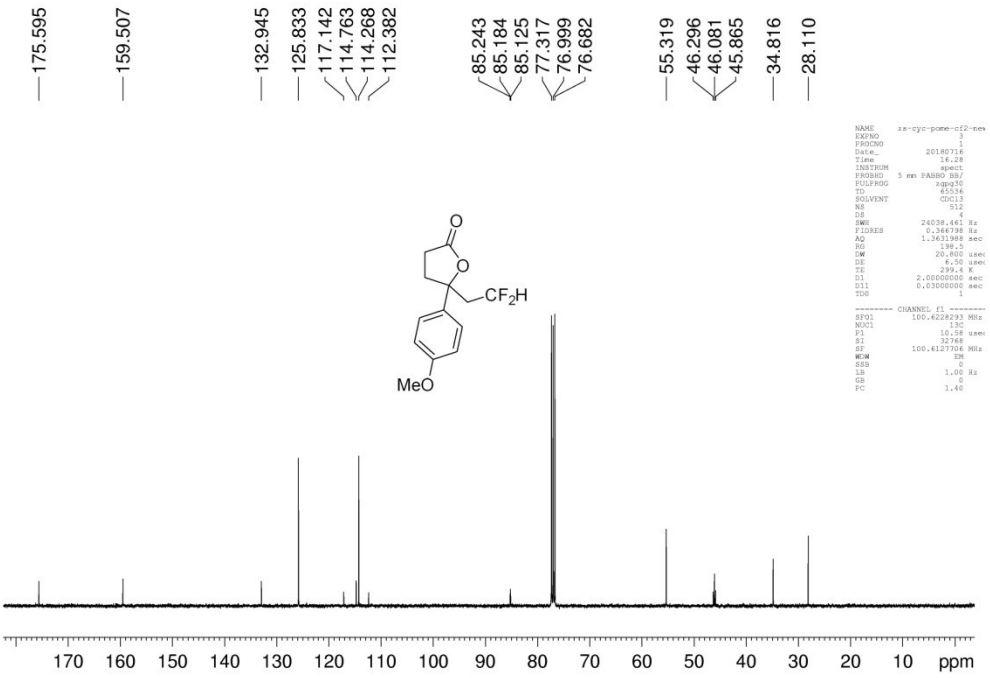
3q ^{19}F NMR:



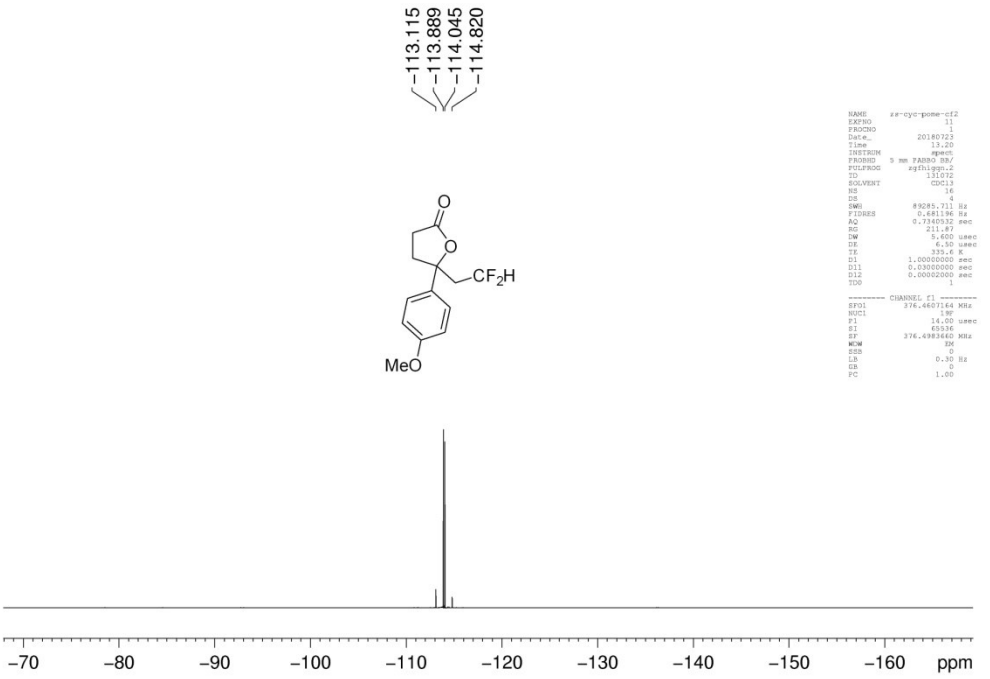
3r ^{1}H NMR:



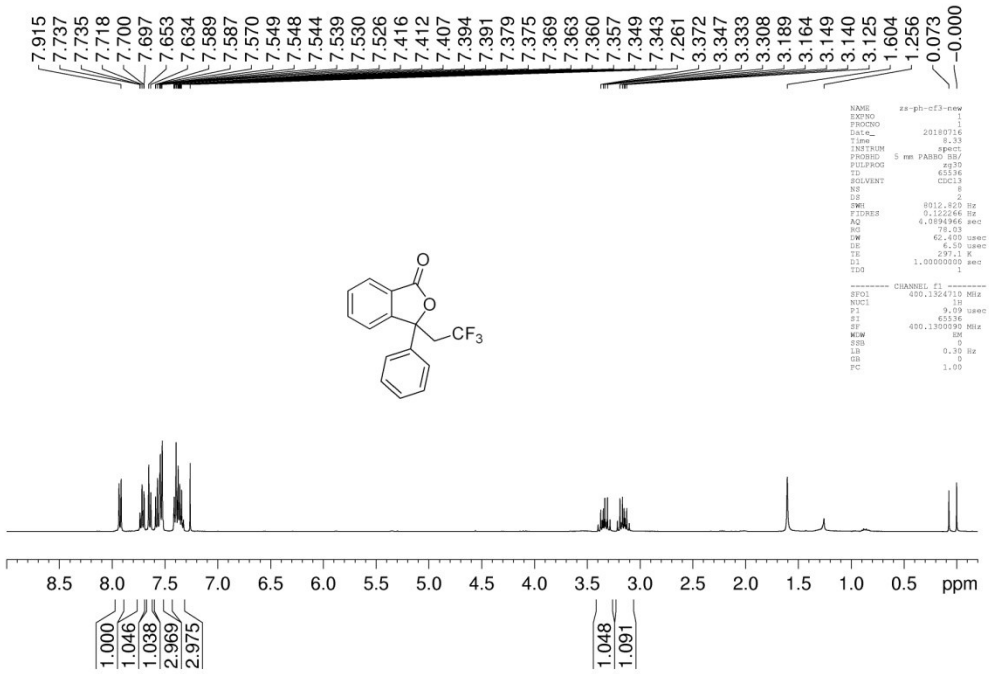
3r ^{13}C NMR:


175.595
159.507
132.945
125.833
117.142
114.763
114.268
112.382
85.243
85.184
85.125
77.317
76.999
76.682
55.319
46.296
46.081
45.865
34.816
28.110
O
O
CF2H
MeO
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

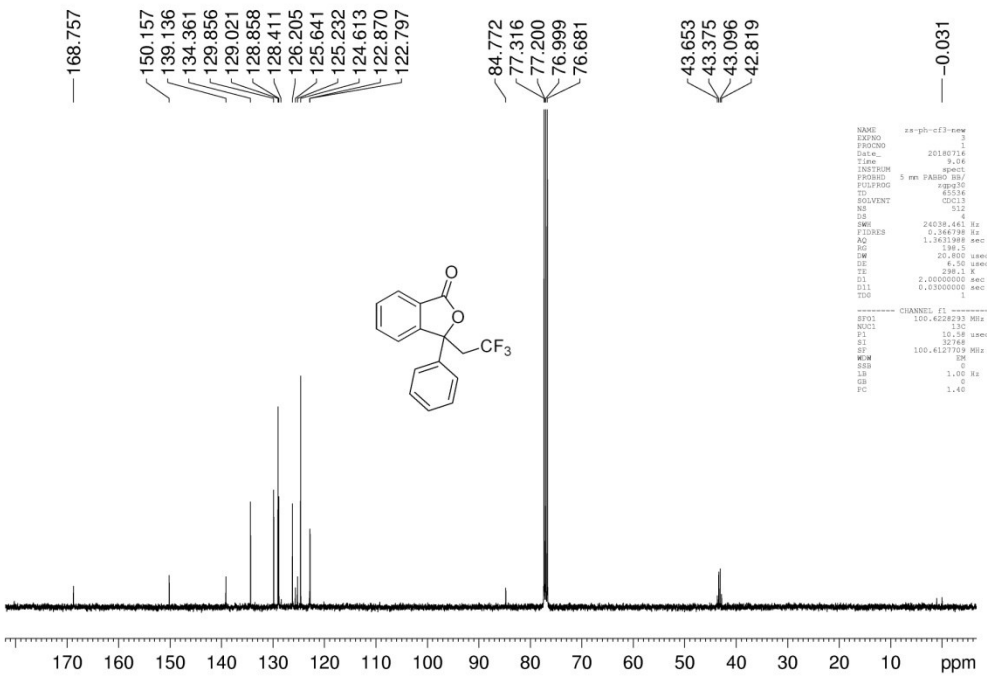
3r ^{19}F NMR:


-113.115
-113.889
-114.045
-114.820
O
O
CF2H
MeO
−70 −80 −90 −100 −110 −120 −130 −140 −150 −160 ppm

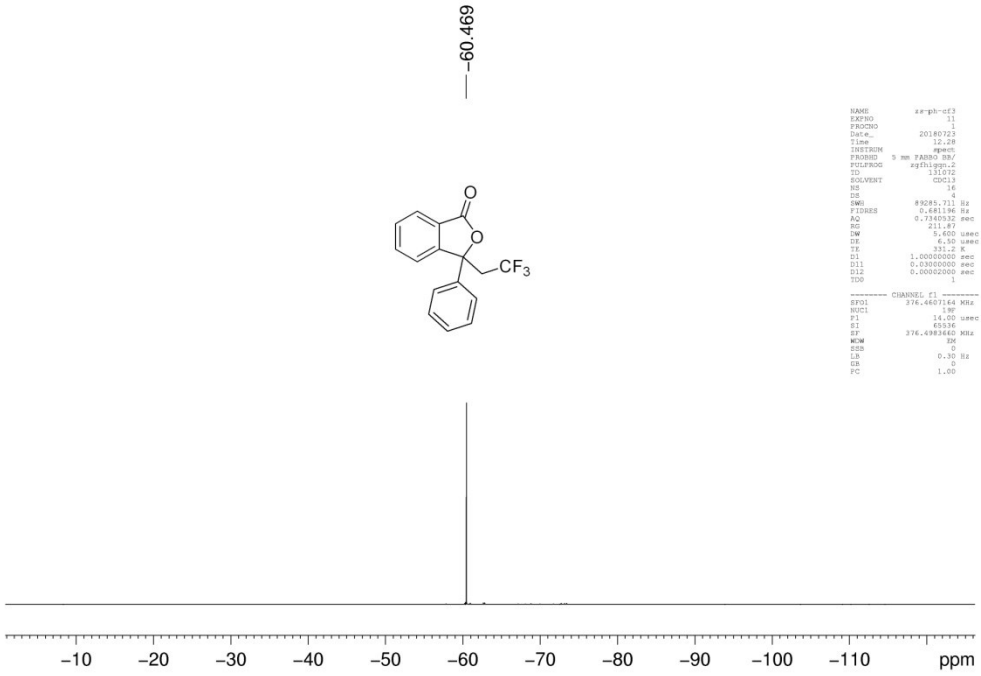
5a ^{1}H NMR:



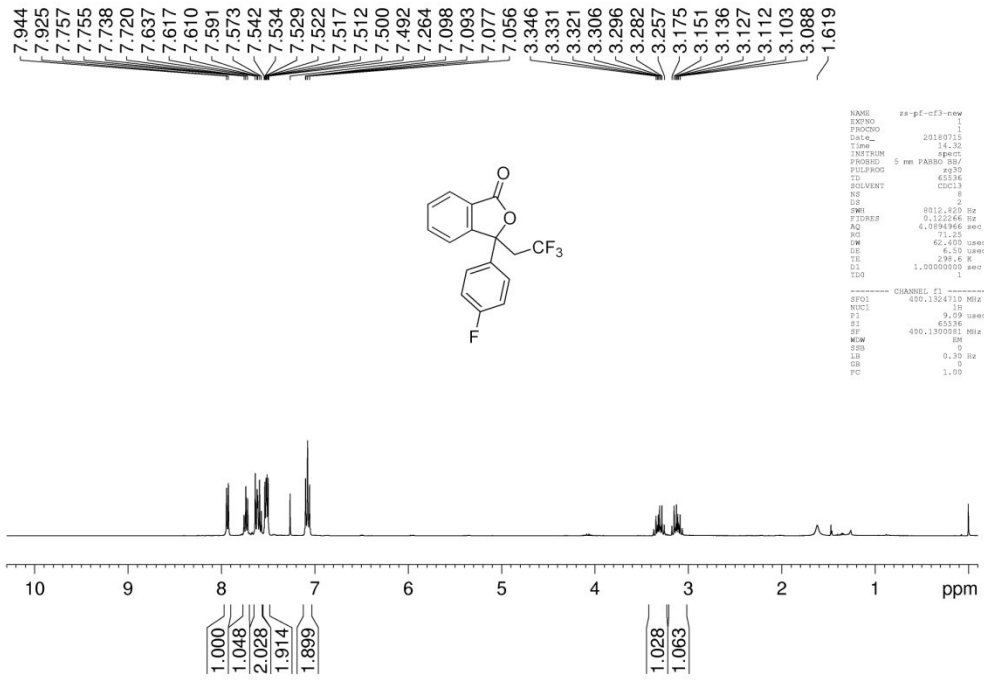
5a ^{13}C NMR:



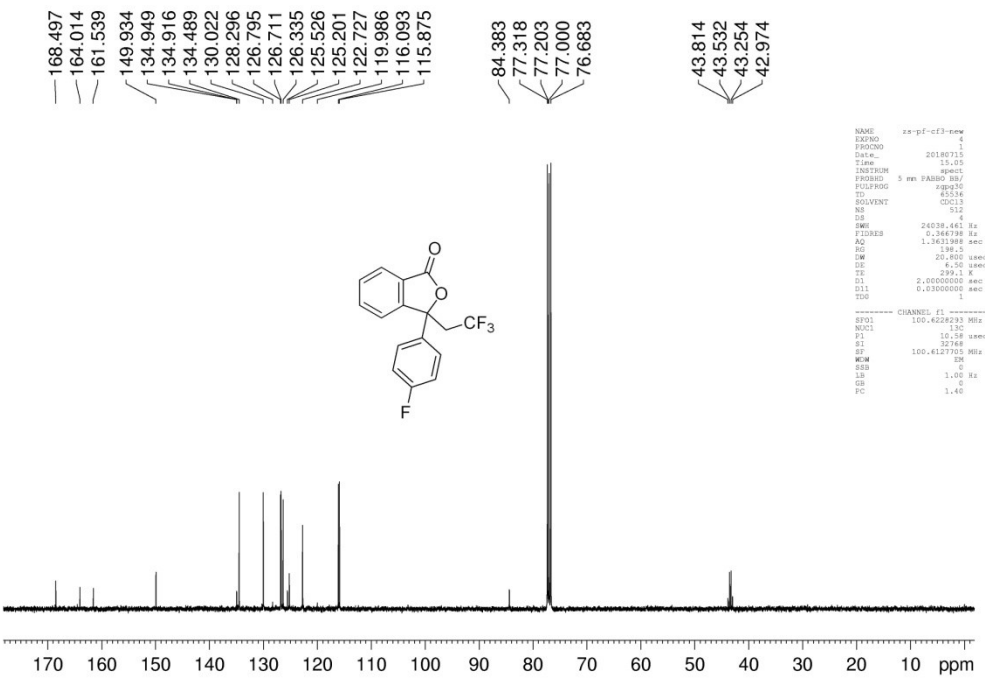
5a ^{19}F NMR:



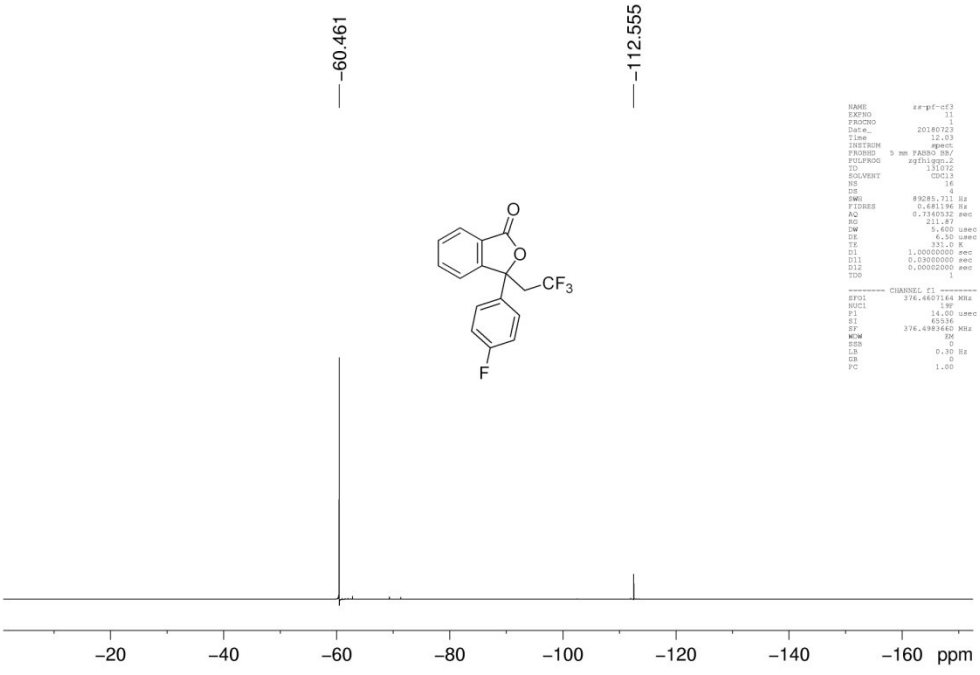
5b ^{1}H NMR:



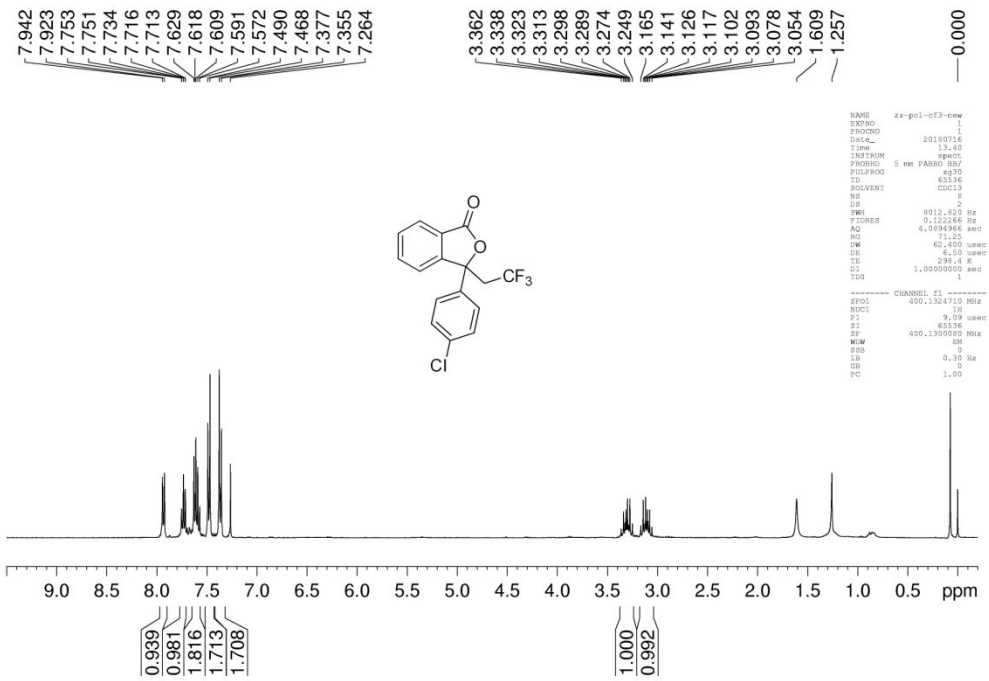
5b ^{13}C NMR:


168.497
164.014
161.539
149.934
134.949
134.916
134.489
130.022
128.296
126.795
126.711
126.335
125.526
125.201
122.727
119.986
116.093
115.875
84.383
77.318
77.203
77.000
76.683
43.814
43.532
43.254
42.974
O
O
CF3
F
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

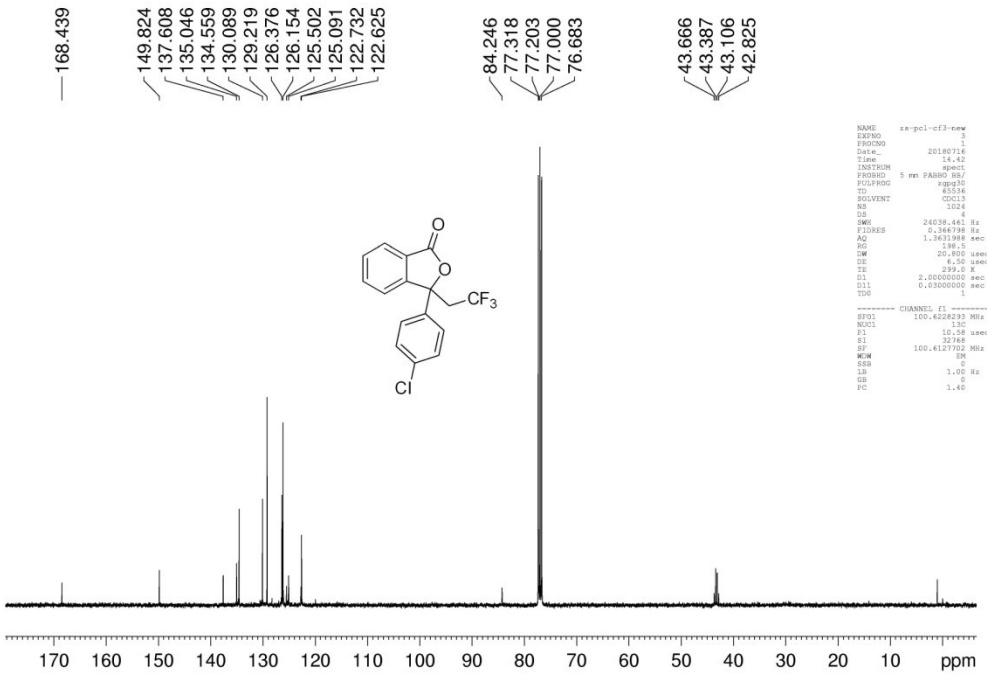
5b ^{19}F NMR:


-60.461
-112.555
O
O
CF3
F
−20 −40 −60 −80 −100 −120 −140 −160 ppm

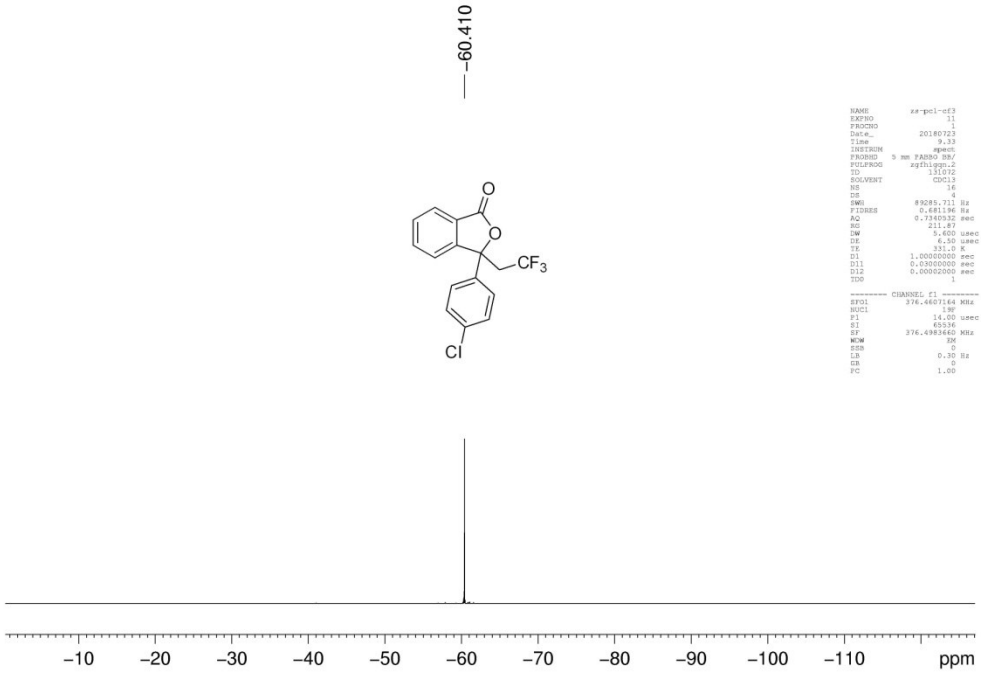
5c ^{1}H NMR:



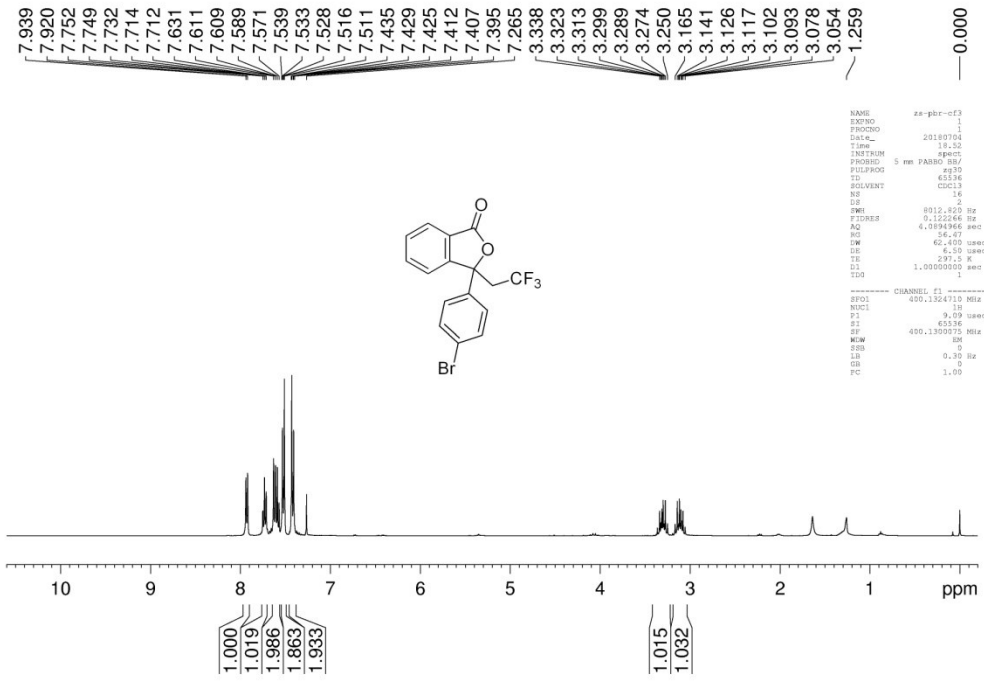
5c ^{13}C NMR:



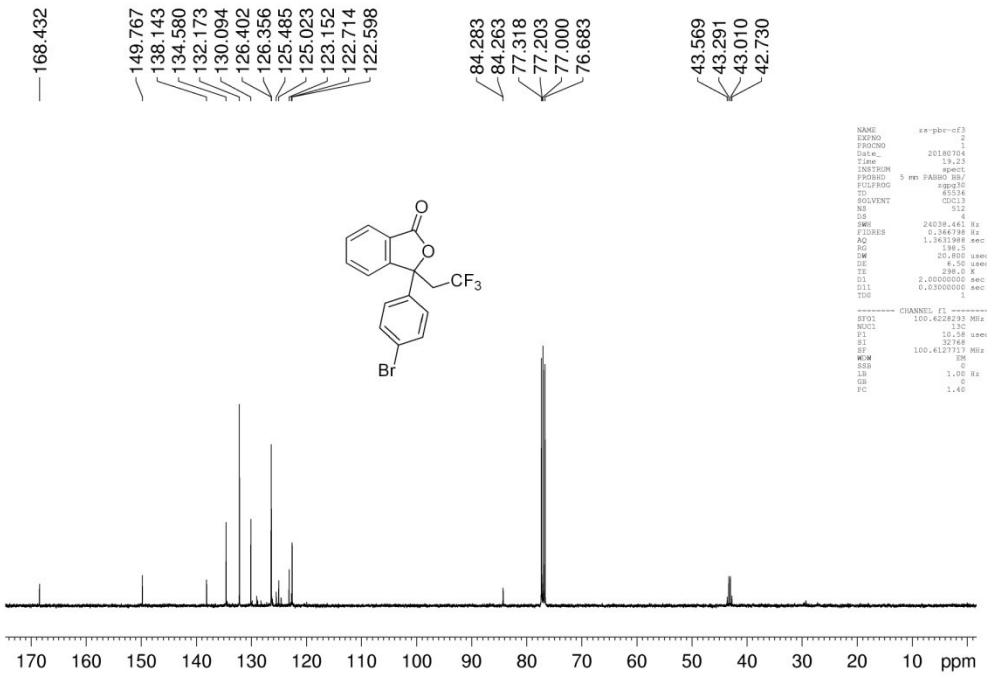
5c ^{19}F NMR:



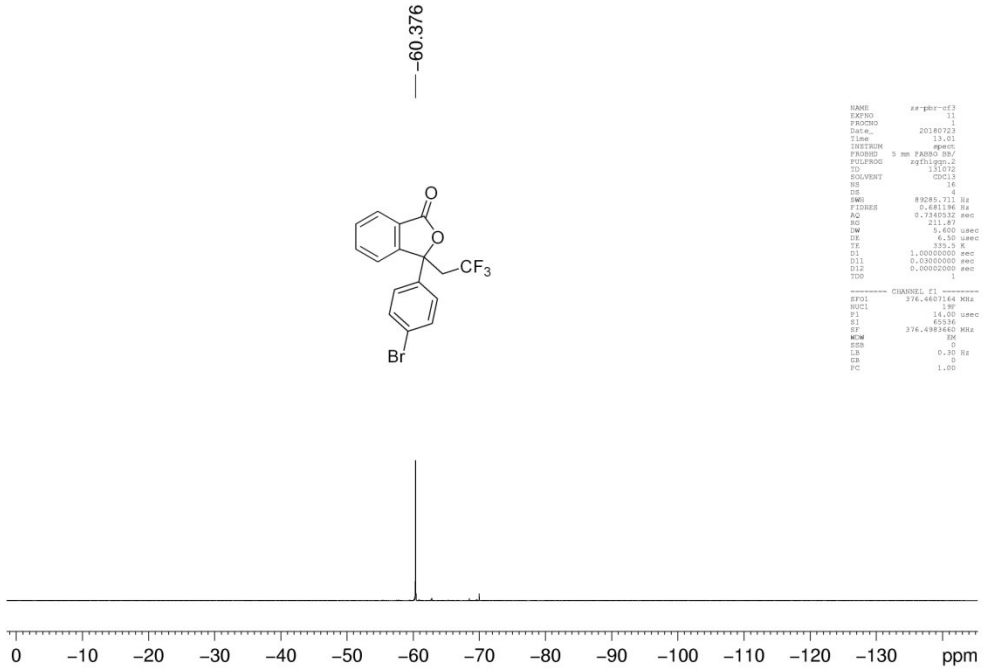
5d ^{1}H NMR:



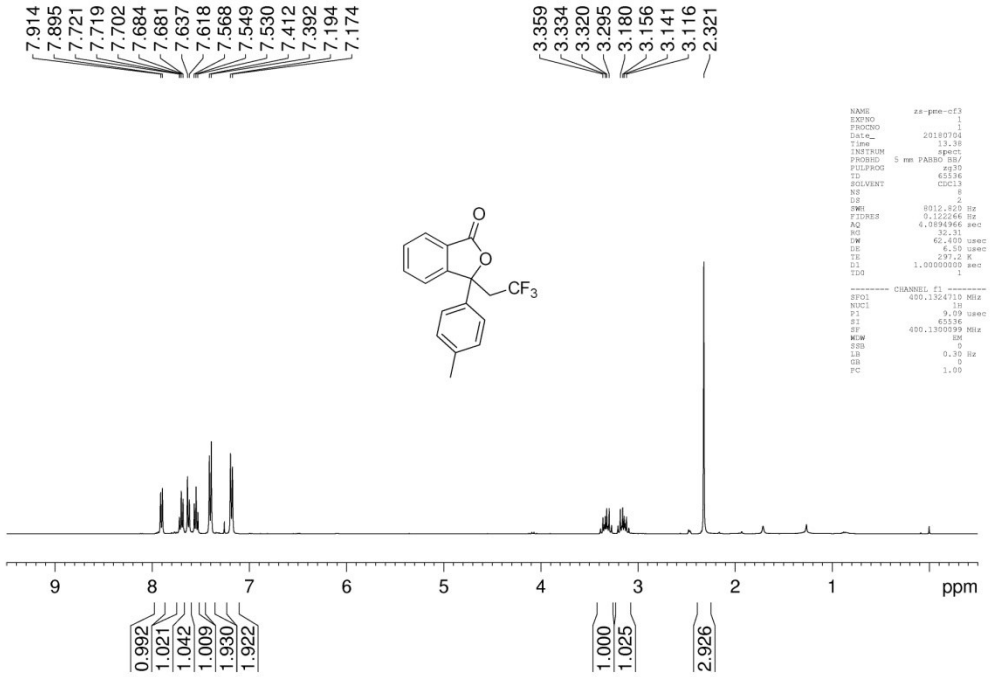
5d ^{13}C NMR:



5d ^{19}F NMR:



5e ^{1}H NMR:



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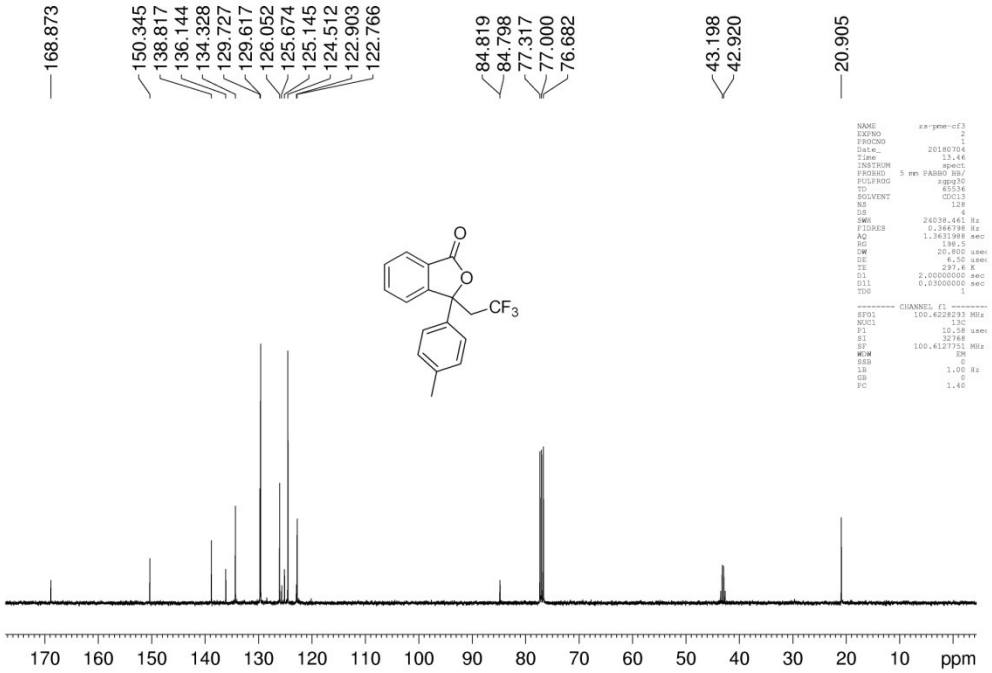

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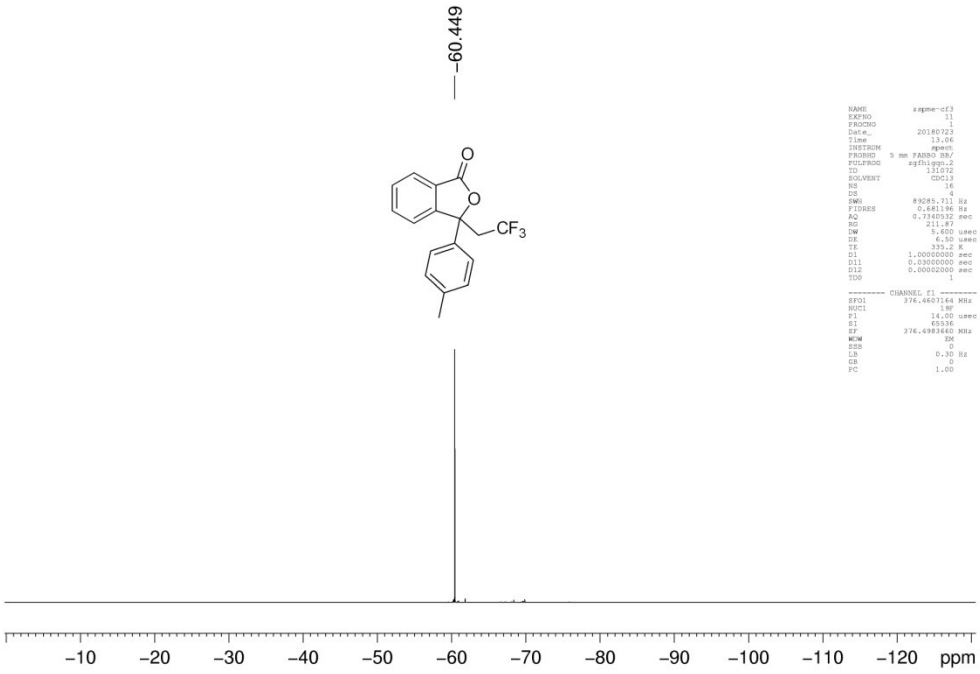
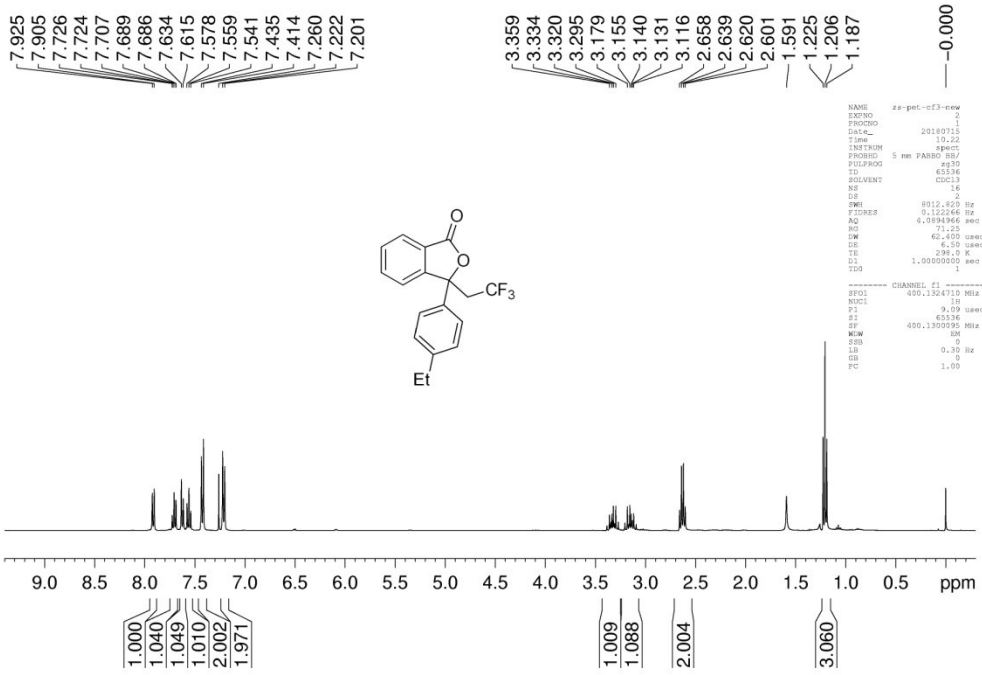
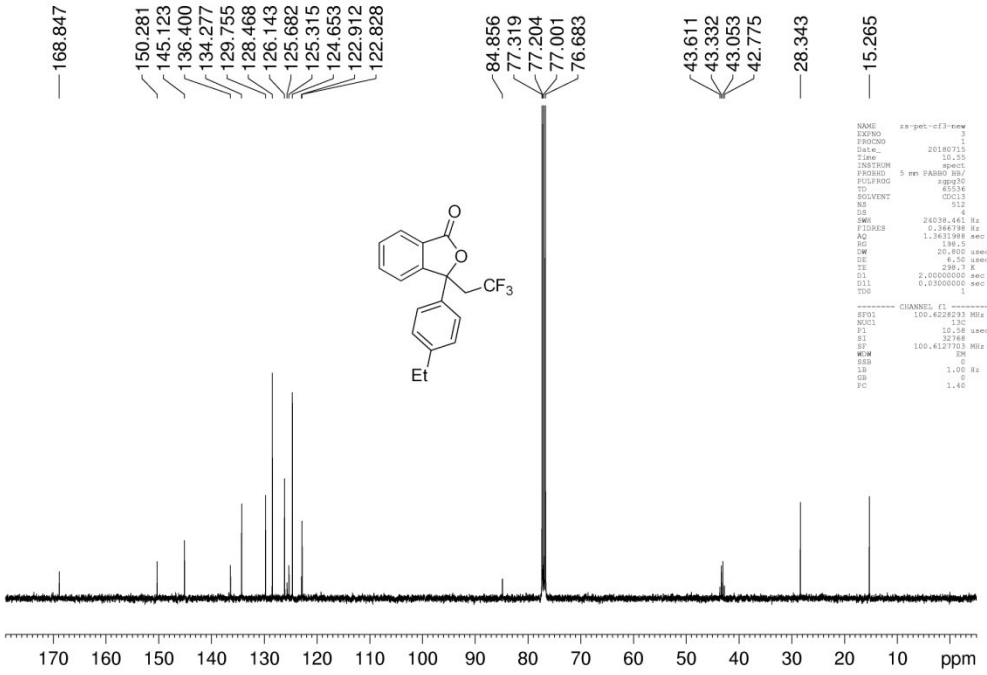

-60.449
O
O
CF3
NAME xspme-cf3
EXPNO 11
PROCNO 1
Date_ 20180723
Time 13.06
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgfhigqn.2
TD 131072
SOLVENT CDCl3
NS 16
DS 4
SWH 89285.711 Hz
FIDRES 0.681196 Hz
AQ 0.7340532 sec
RG 211.87
DW 5.600 usec
DE 6.50 usec
TE 335.2 K
D1 1.00000000 sec
D11 0.03000000 sec
D12 0.00002000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 376.4607164 MHz
NUC1 19F
P1 14.00 usec
SI 65536
SF 376.4983460 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
-10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 ppm

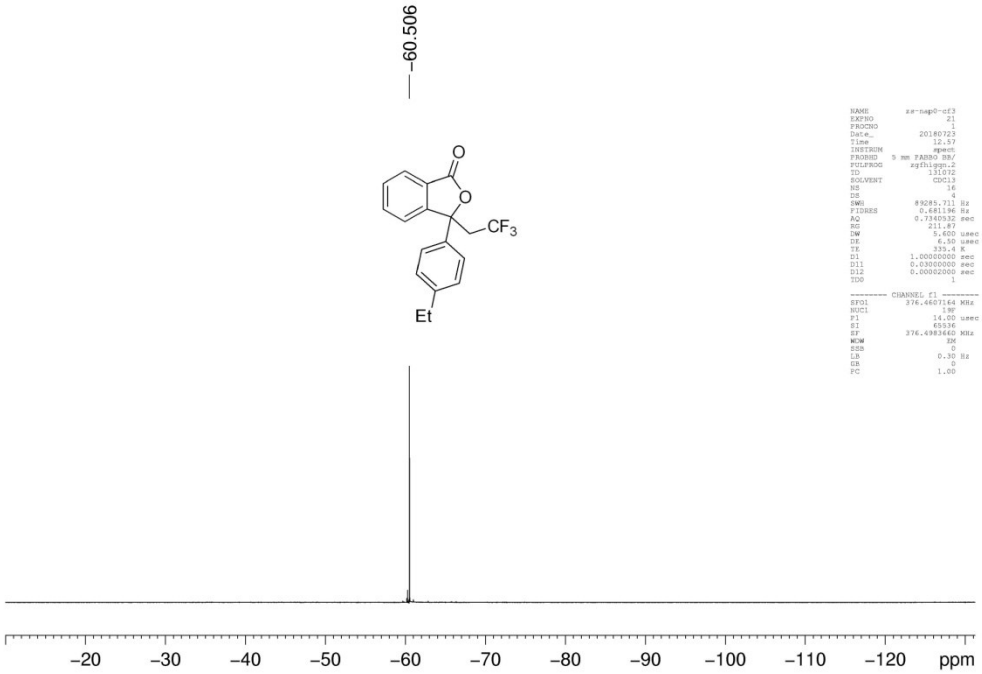
5f ^{1}H NMR:


7.925
7.905
7.726
7.724
7.707
7.689
7.686
7.634
7.615
7.578
7.559
7.541
7.435
7.414
7.260
7.222
7.201
3.359
3.334
3.320
3.295
3.179
3.155
3.140
3.131
3.116
2.658
2.639
2.620
2.601
1.591
1.225
1.206
1.187
-0.000
O
O
CF3
Et
NAME zs-pet-cf3-new
EXPNO 2
PROCNO 1
Date_ 20180715
Time 10.22
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 71.25
DW 62.400 usec
DE 6.50 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 400.1324710 MHz
NUC1 1H
P1 9.09 usec
SI 65536
SF 400.1300095 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
1.000
1.040
1.049
1.010
2.002
1.971
1.009
1.088
2.004
3.060

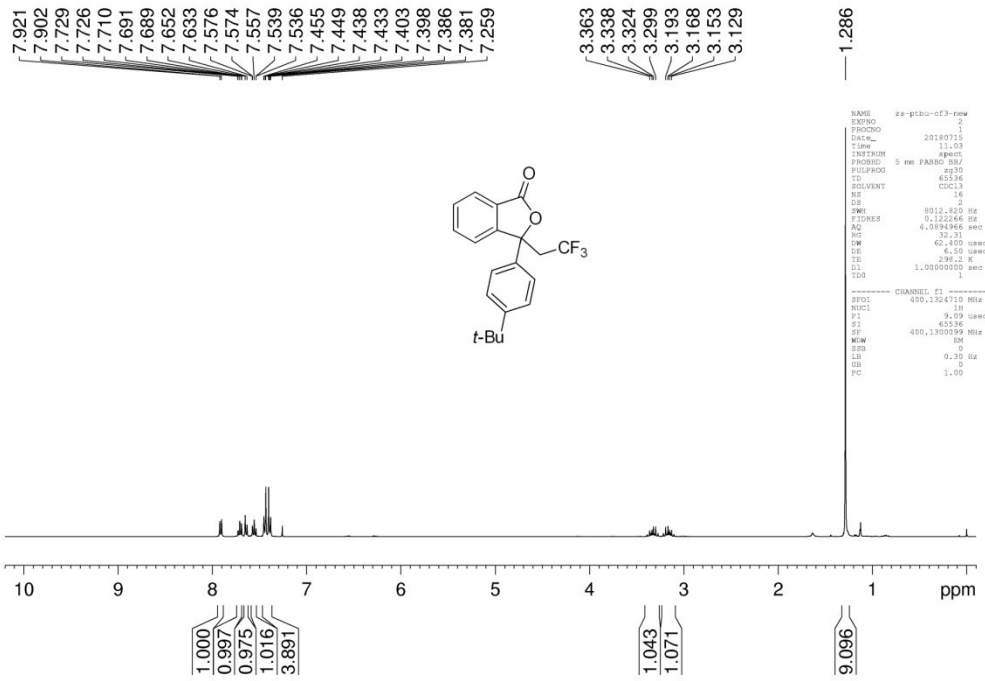
5f ^{13}C NMR:



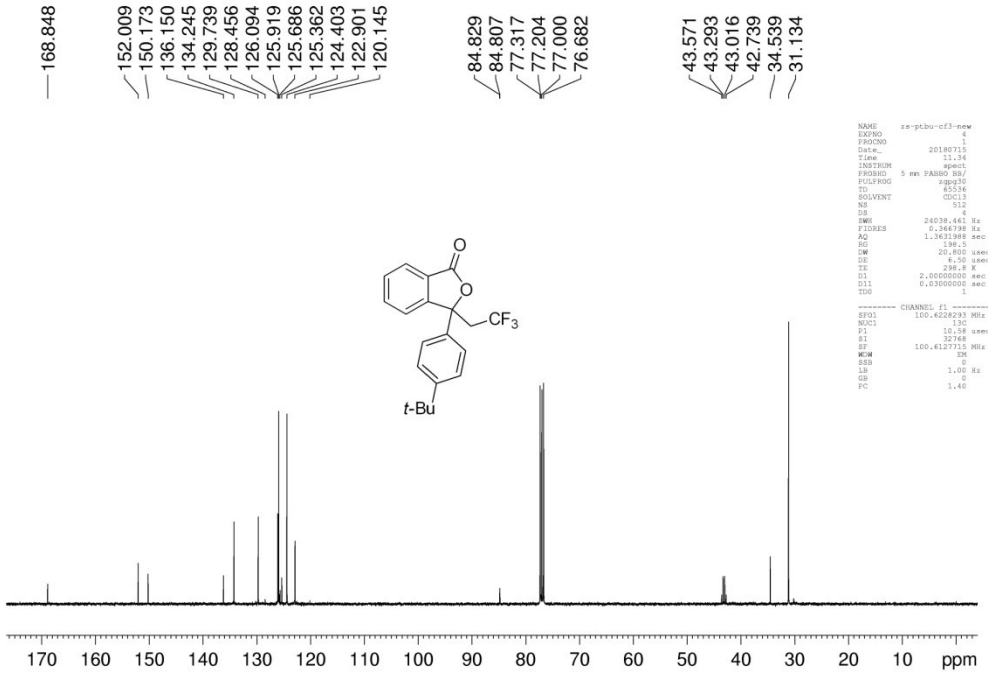
5f ^{19}F NMR:



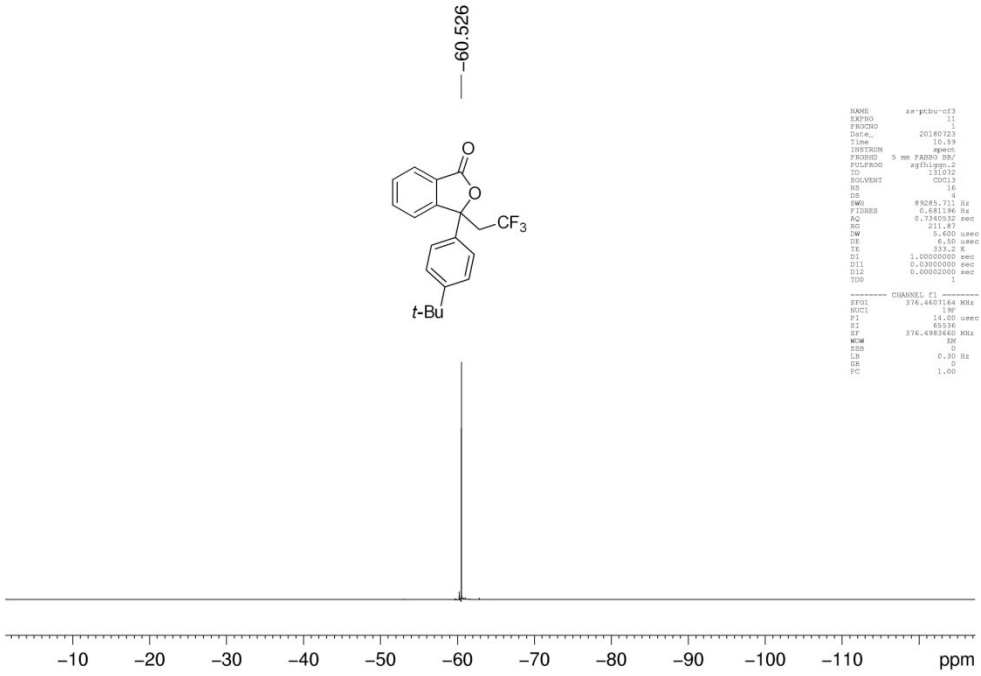
5g ^{1}H NMR:



5g ^{13}C NMR:



5g ^{19}F NMR:



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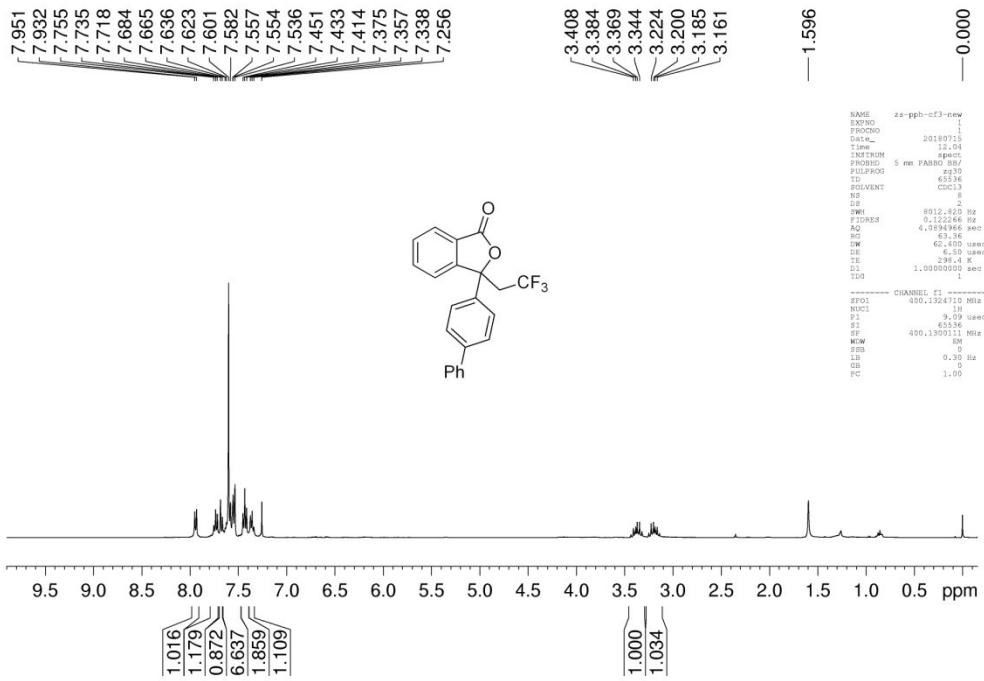

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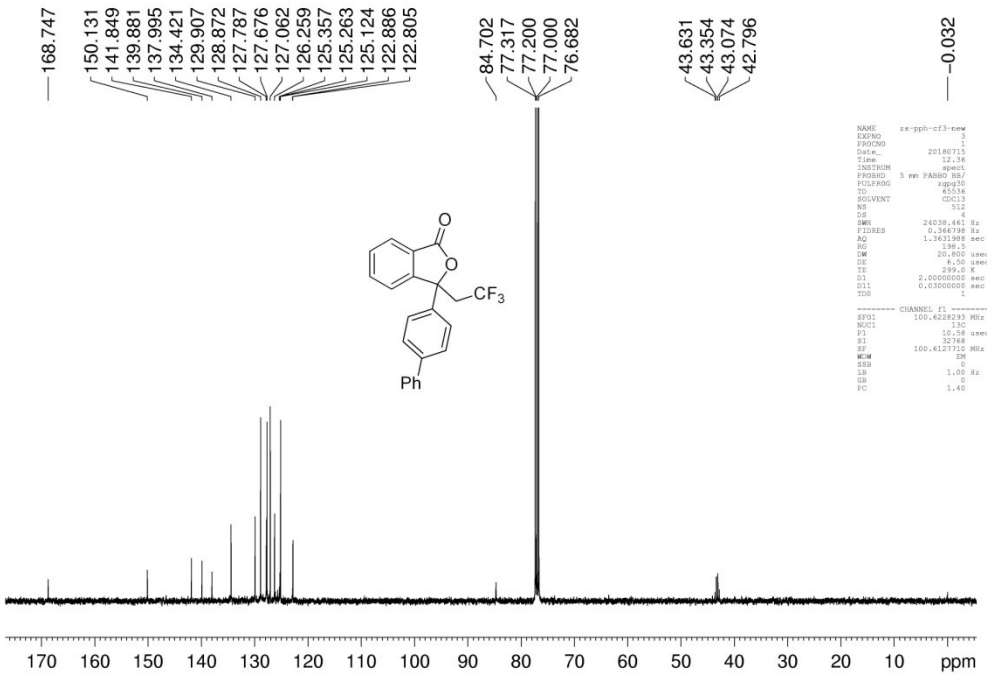
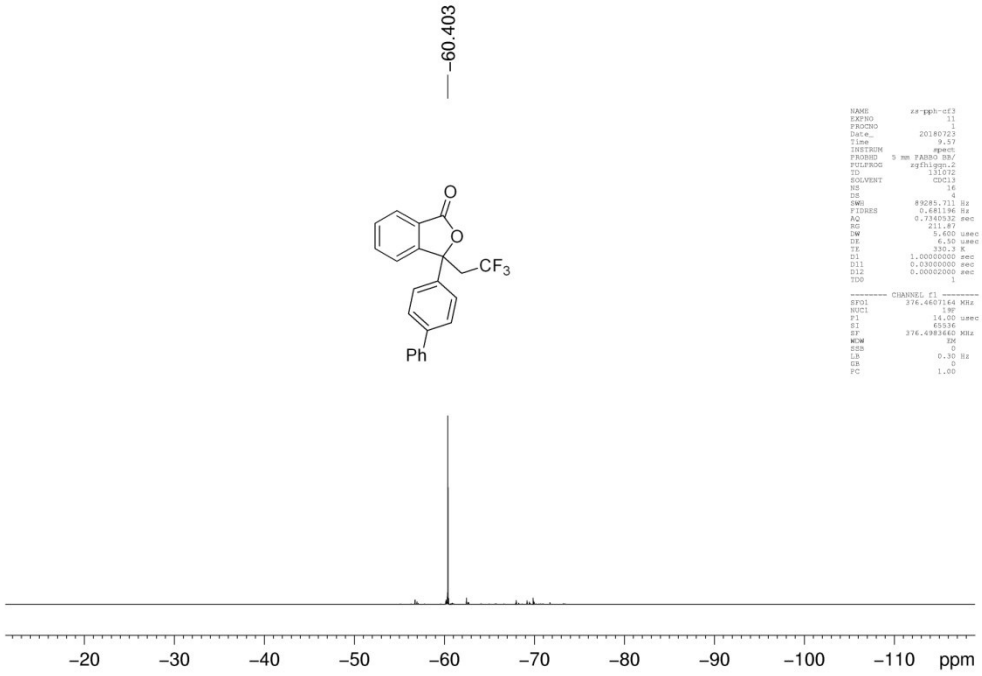
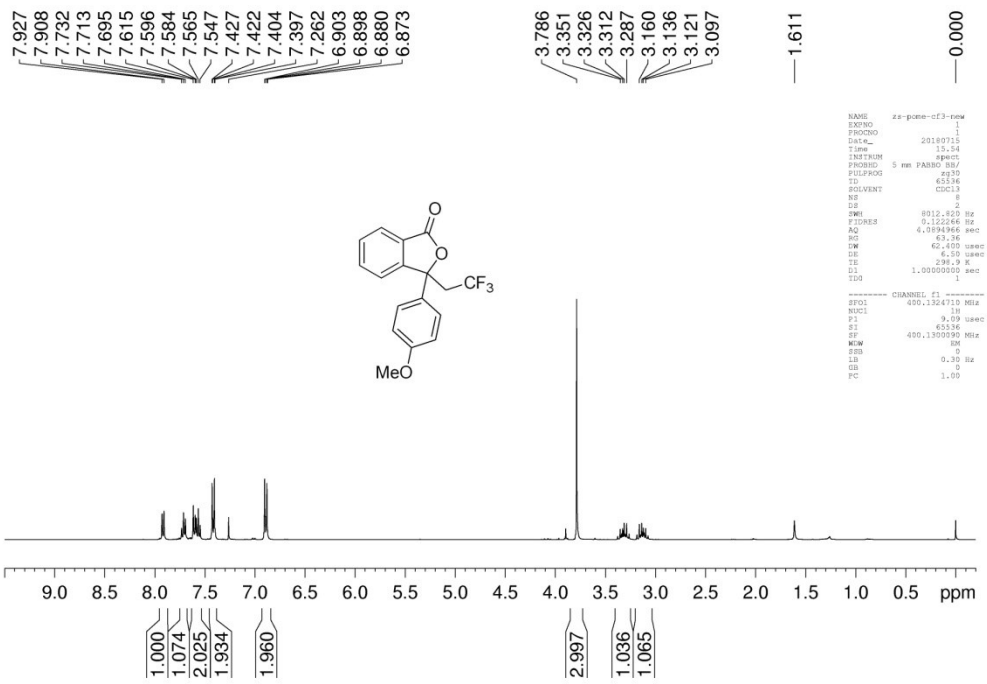


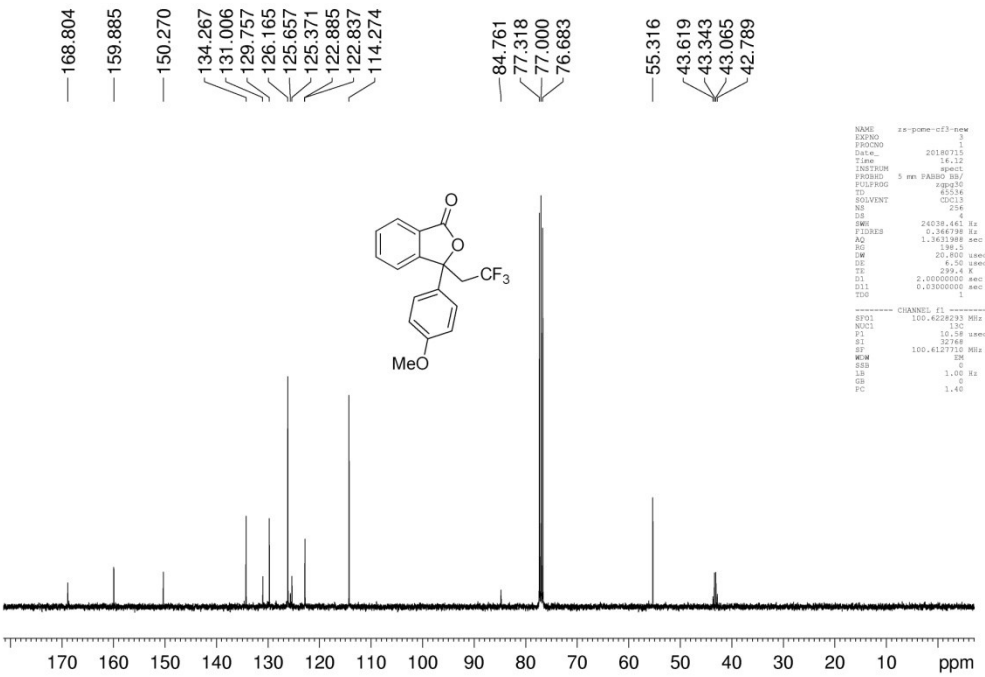
5h ^{19}F NMR:



5i ^{1}H NMR:



5i ^{13}C NMR:



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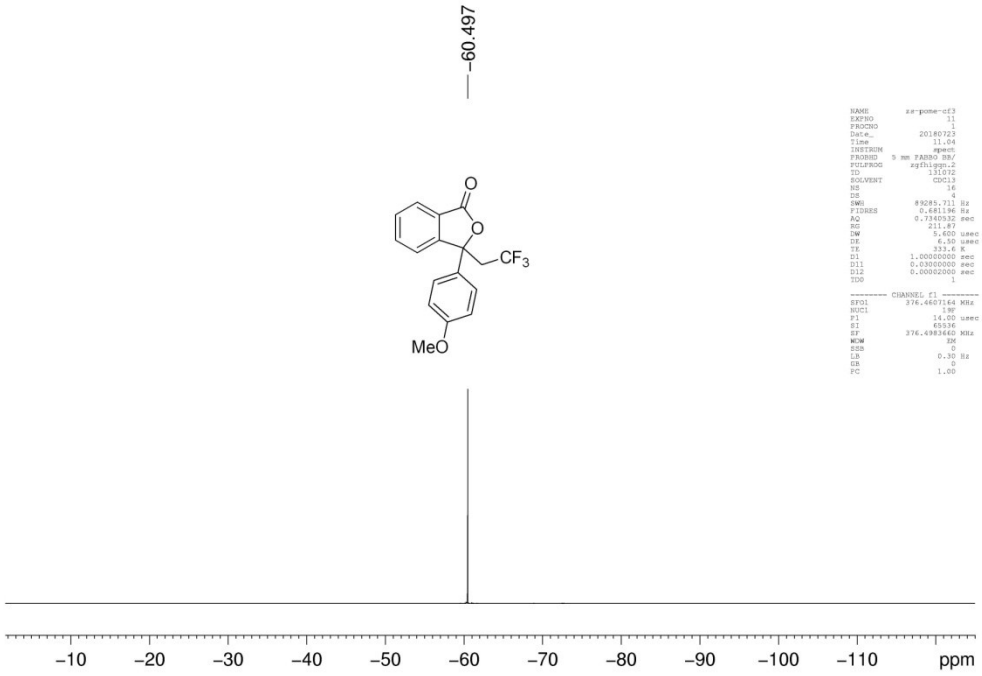

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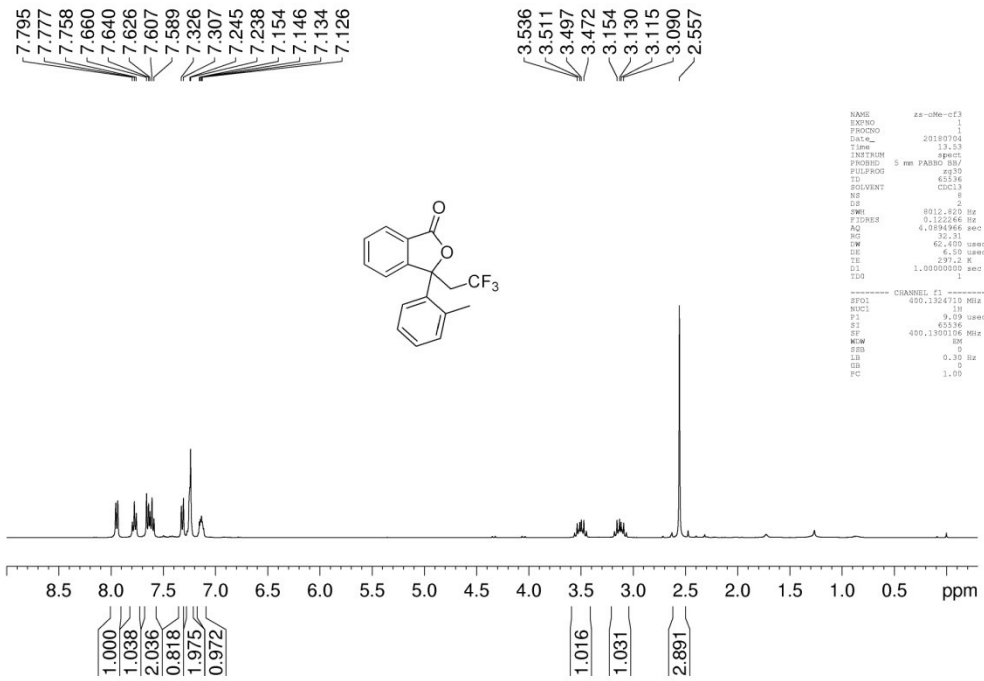

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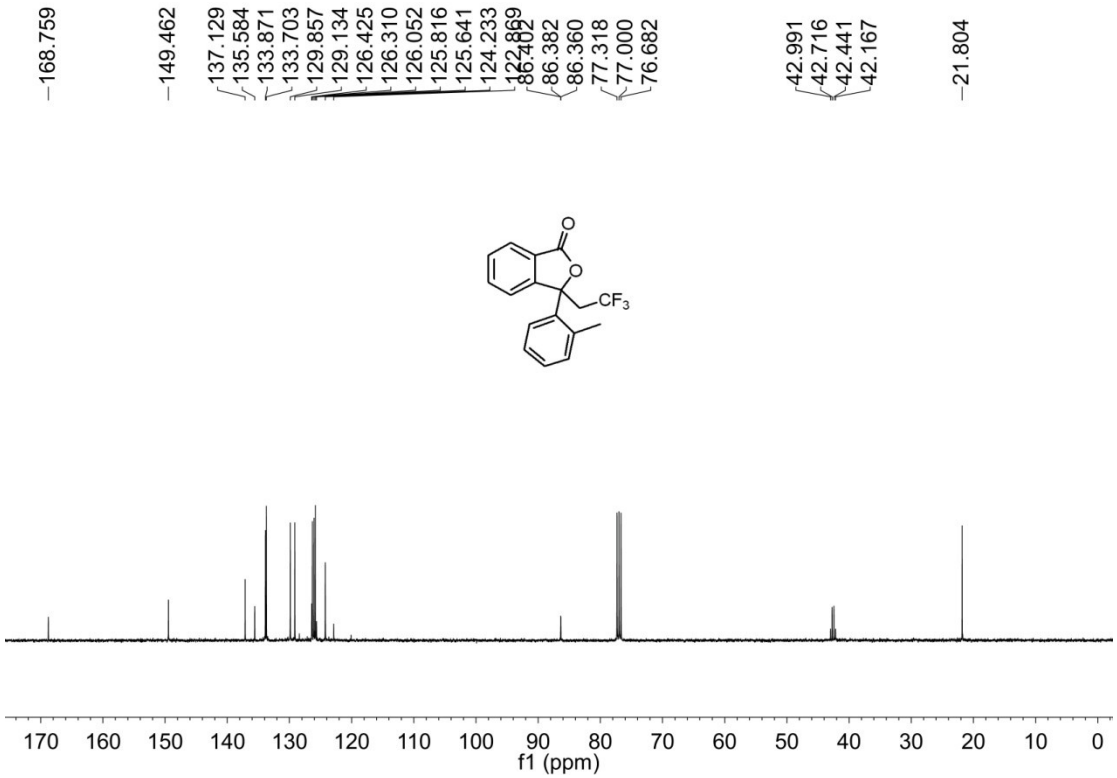
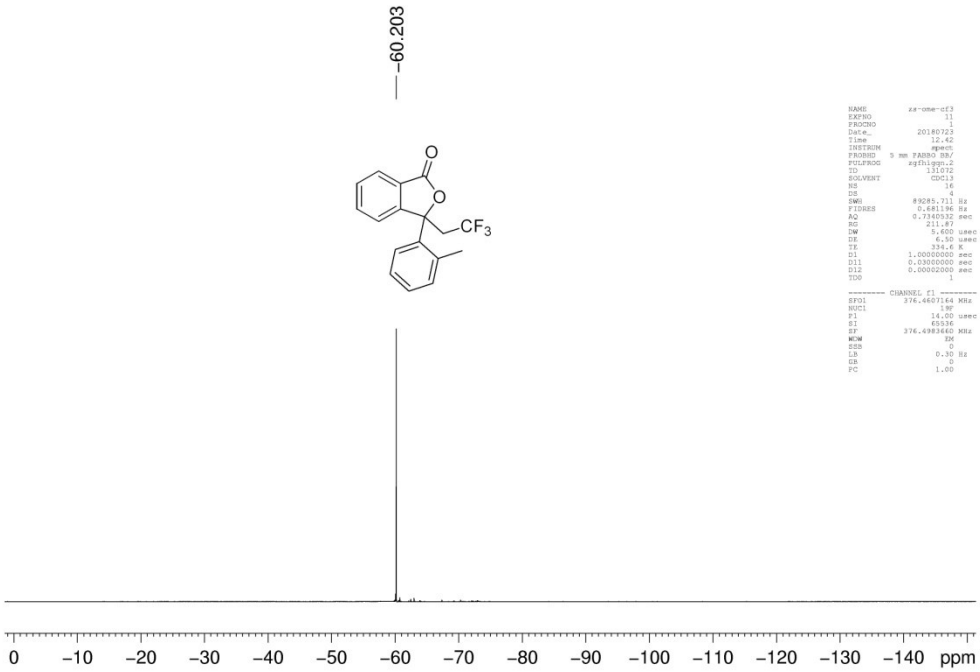
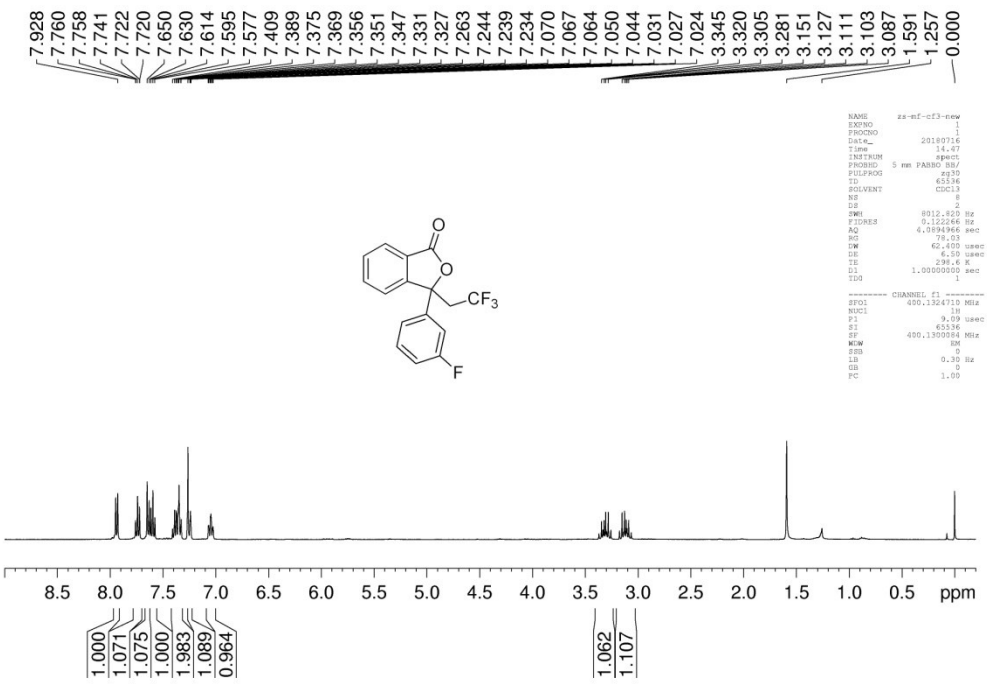


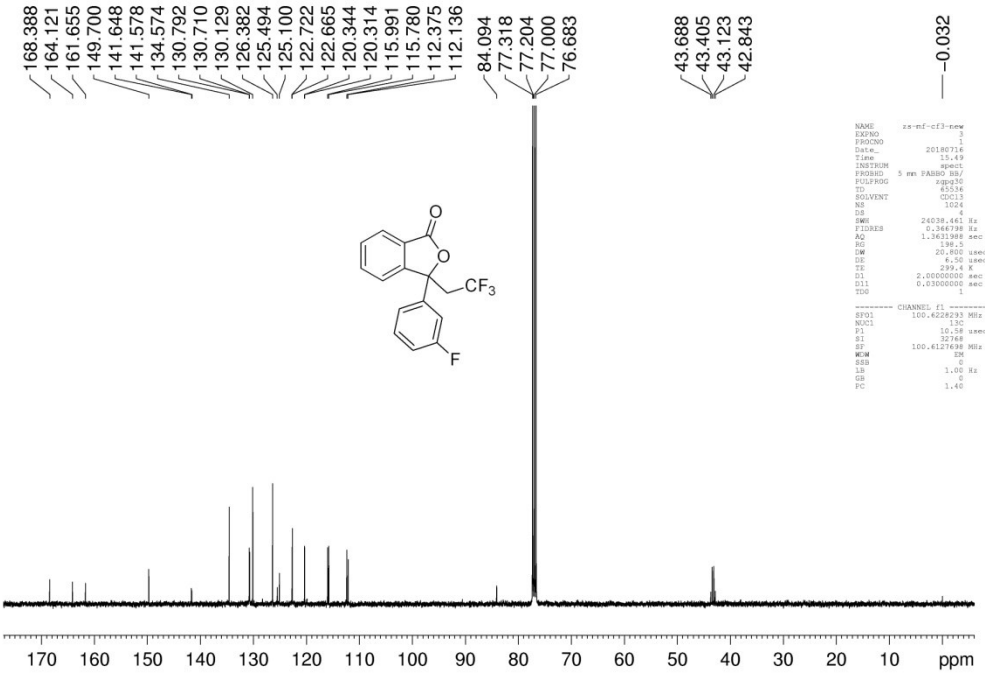
5j ^{19}F NMR:



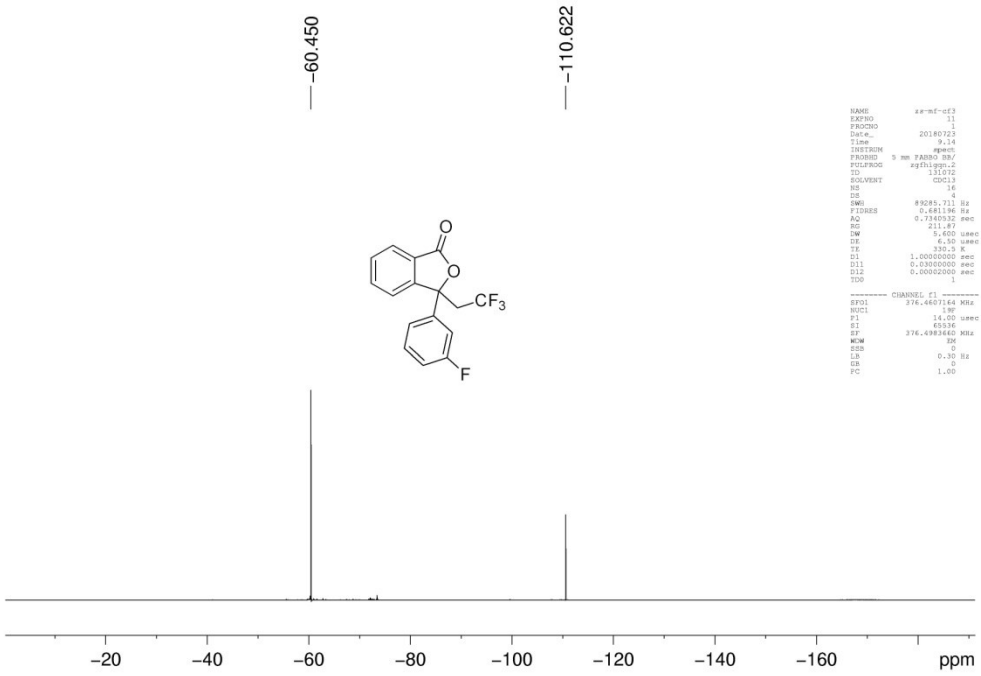
5k ^{1}H NMR:



5k ^{13}C NMR:



5k ^{19}F NMR:



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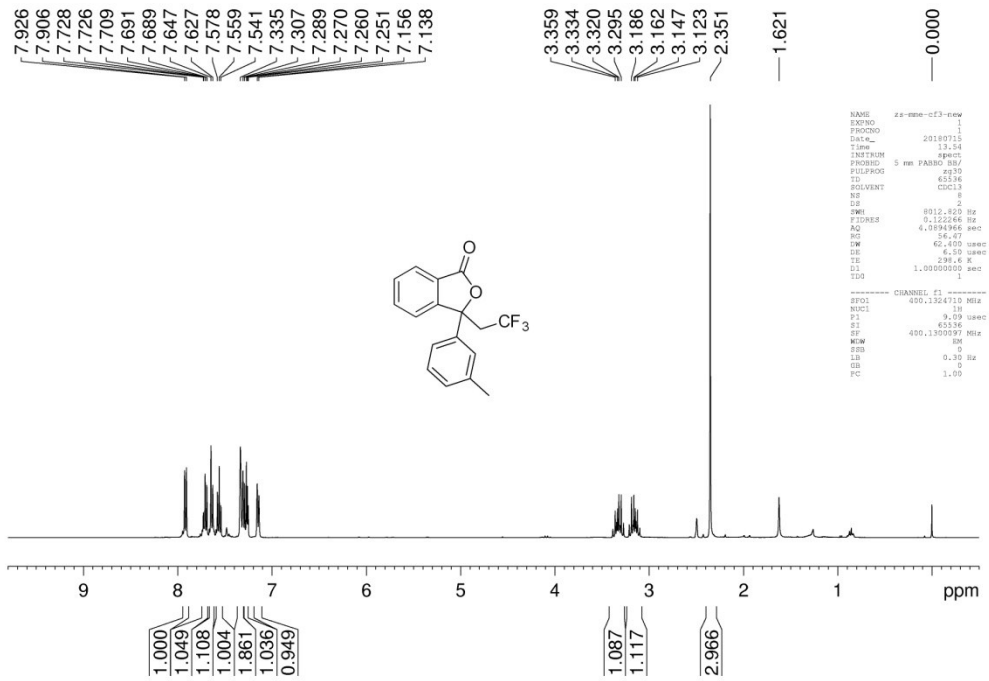

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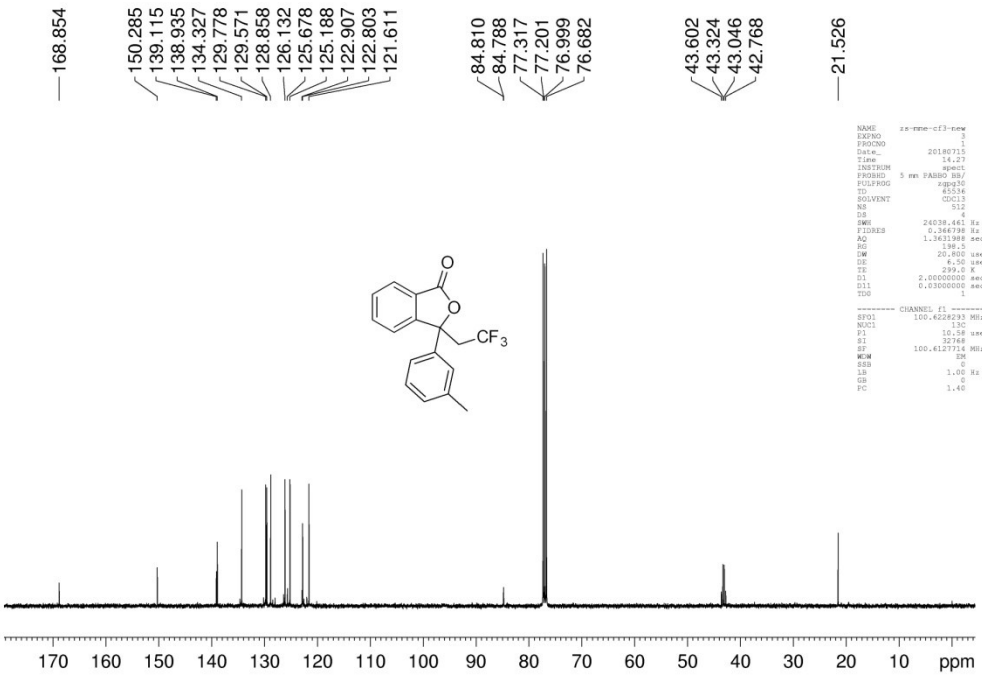
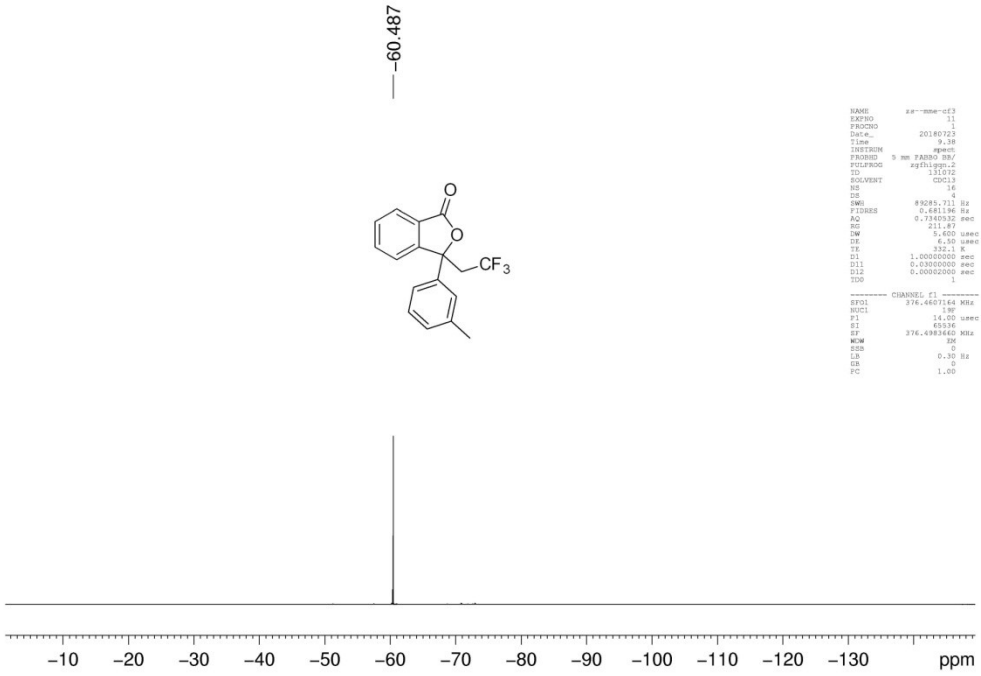
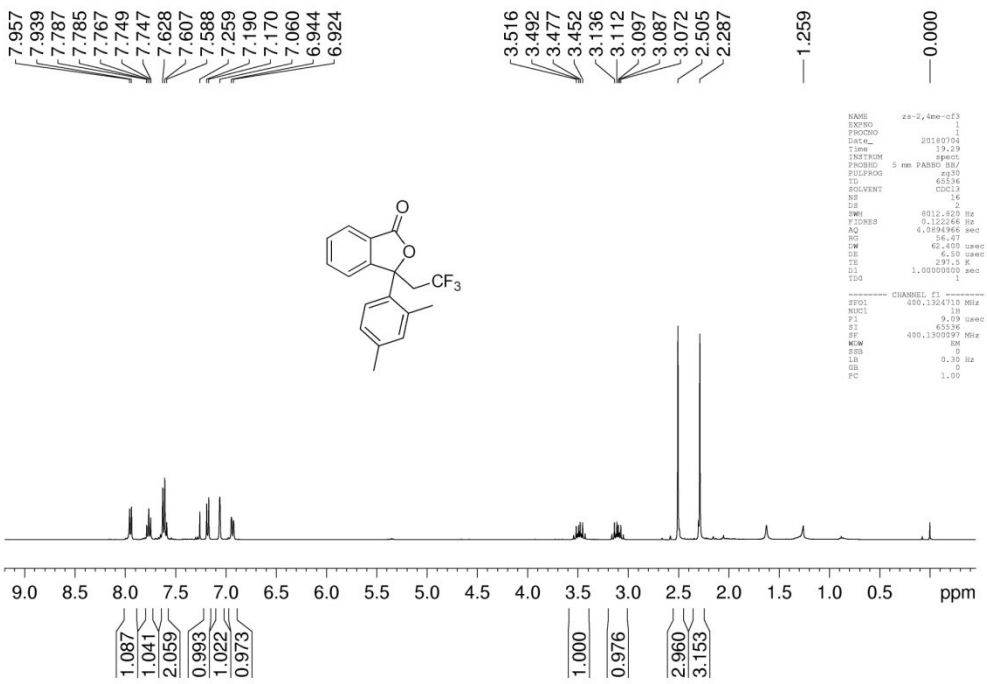


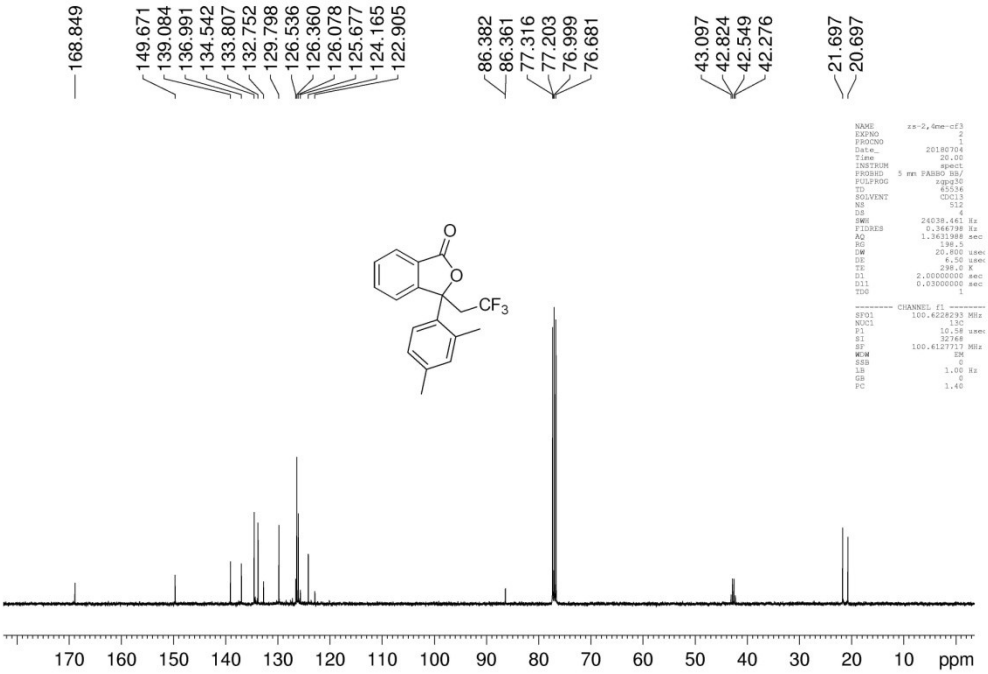
5l ^{19}F NMR:



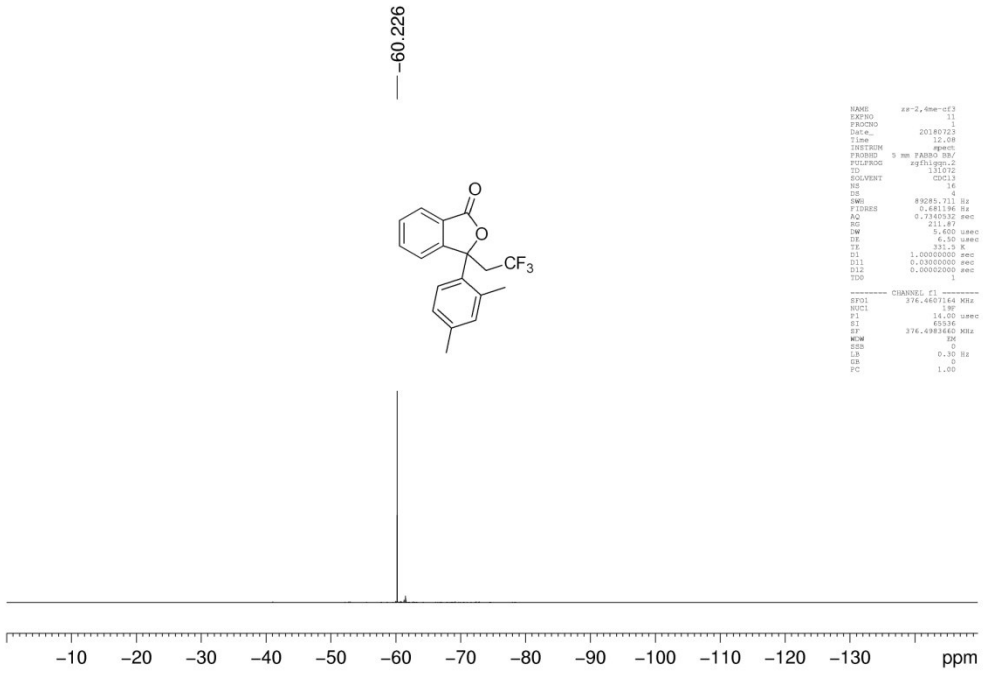
5m ^{1}H NMR:



5m ^{13}C NMR:



5m ^{19}F NMR:



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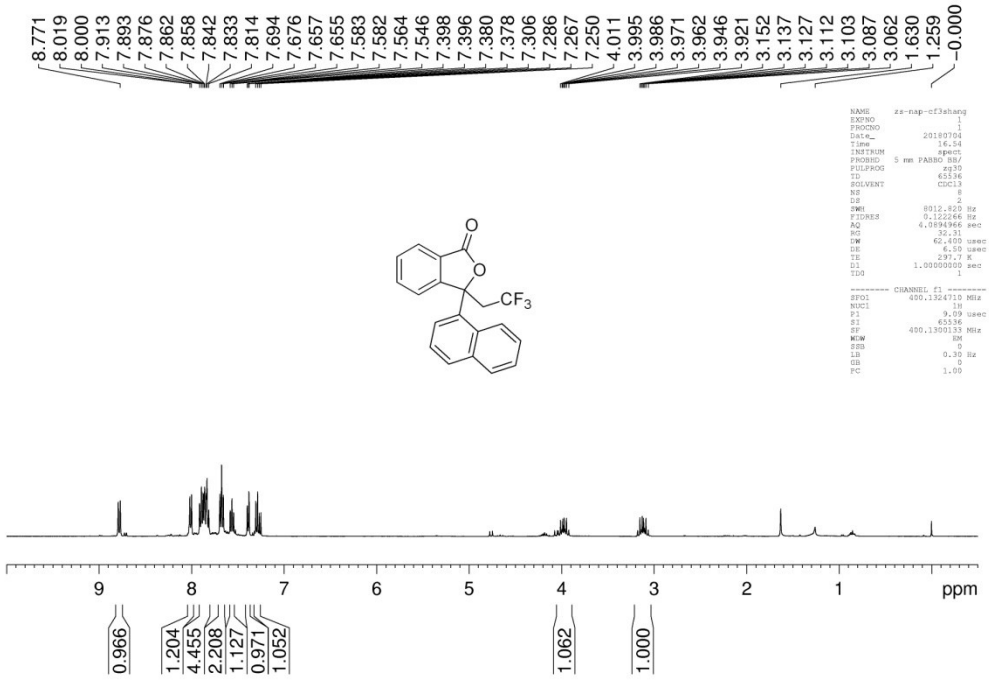

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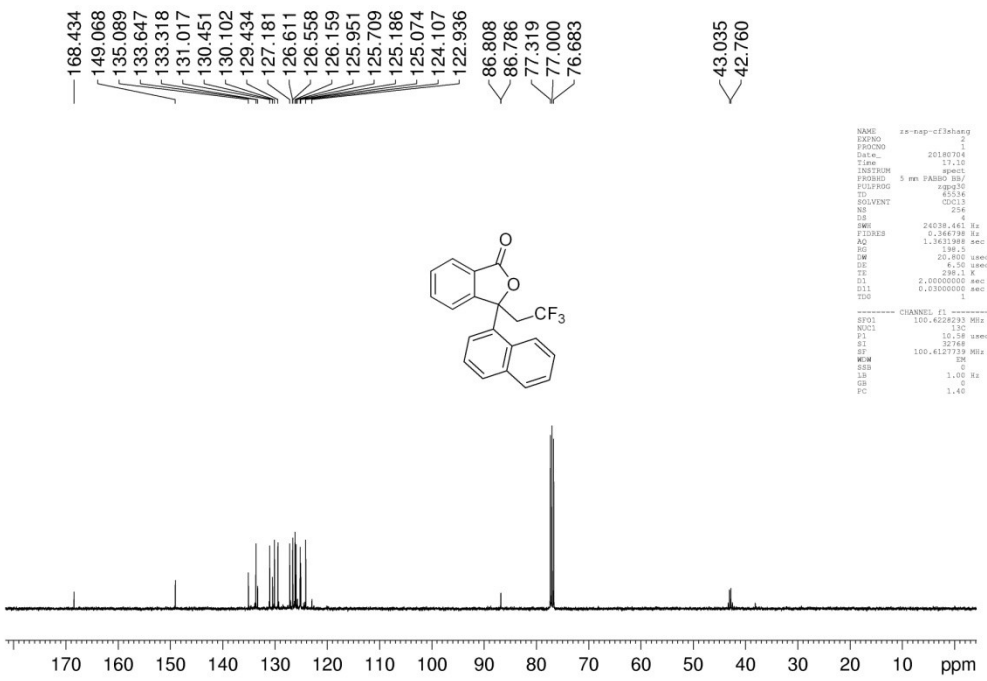
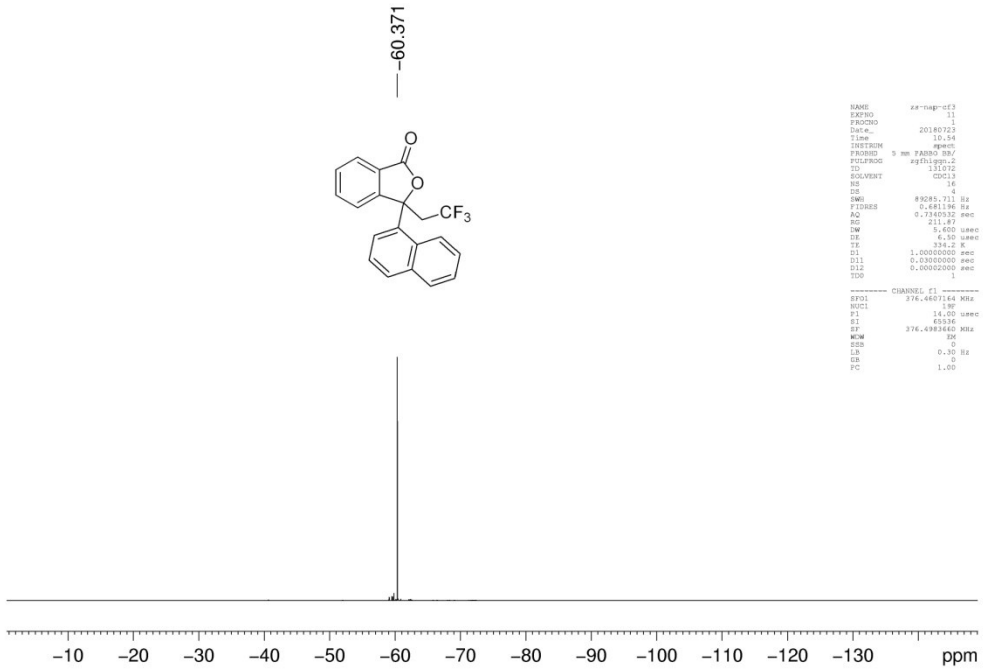
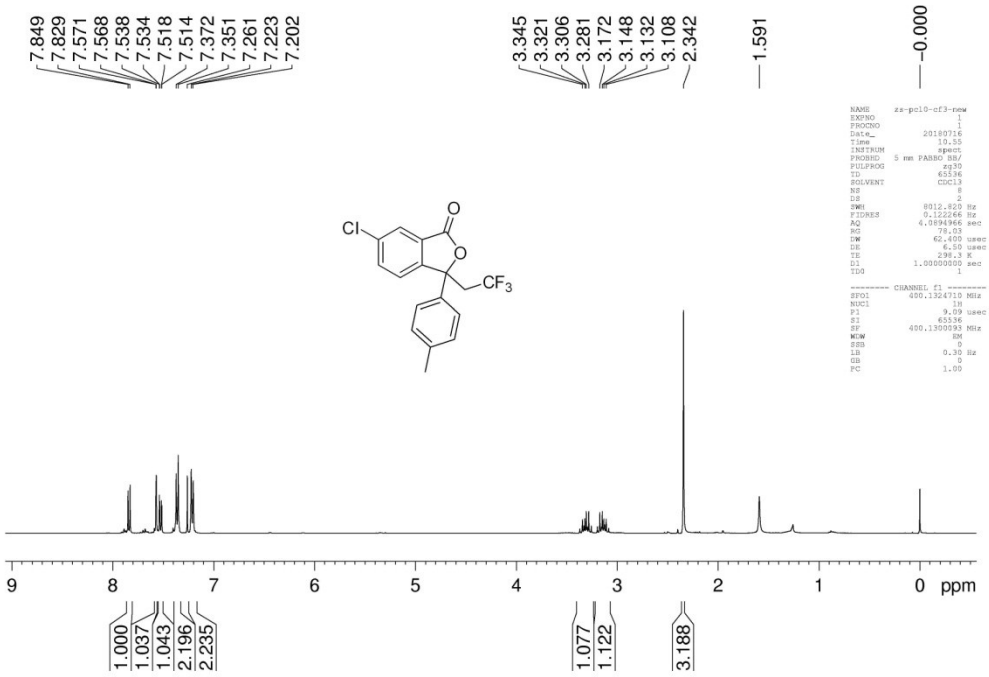


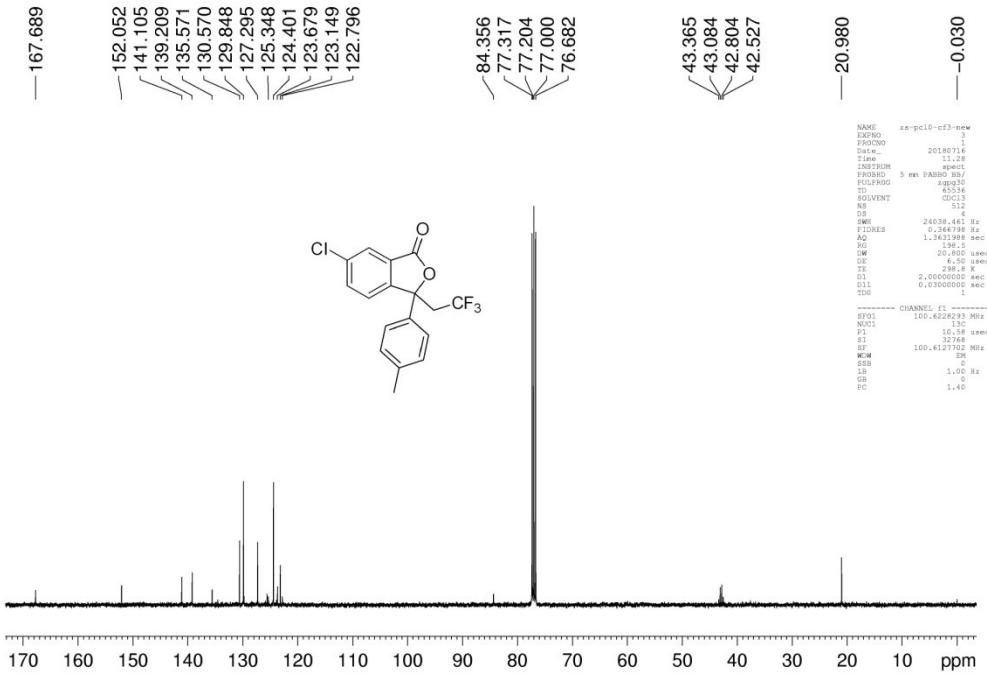
5n ^{19}F NMR:



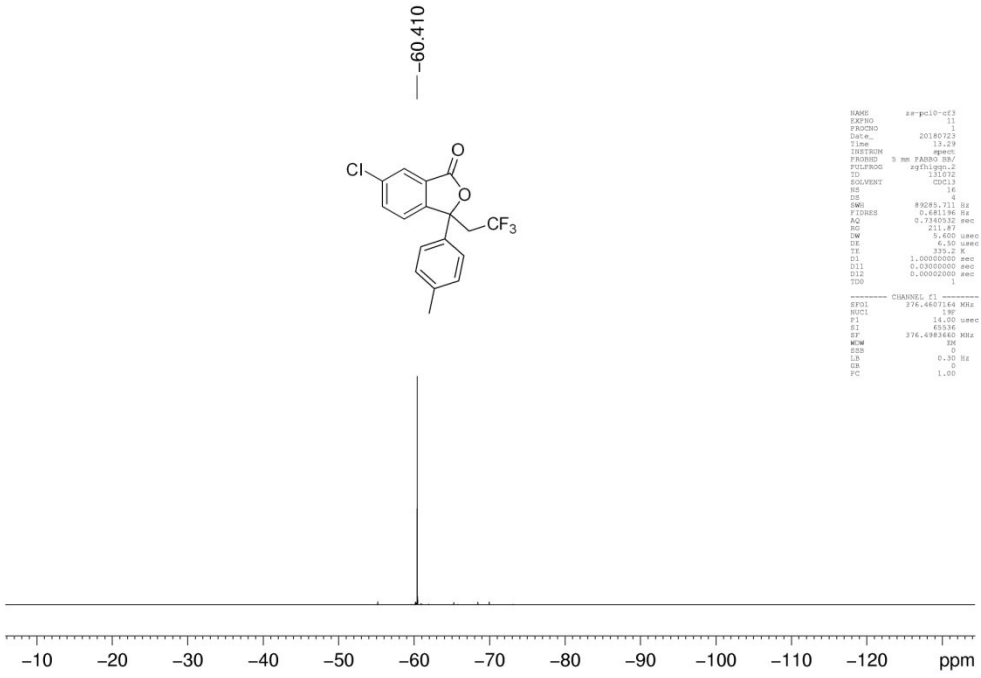
5o ^{1}H NMR:



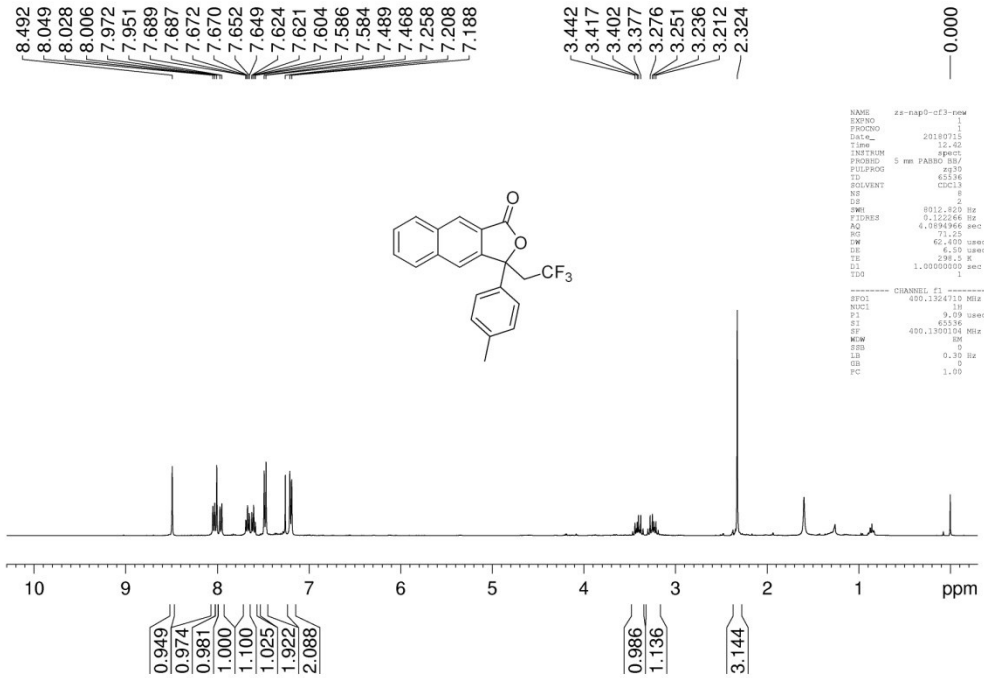
5o ^{13}C NMR:



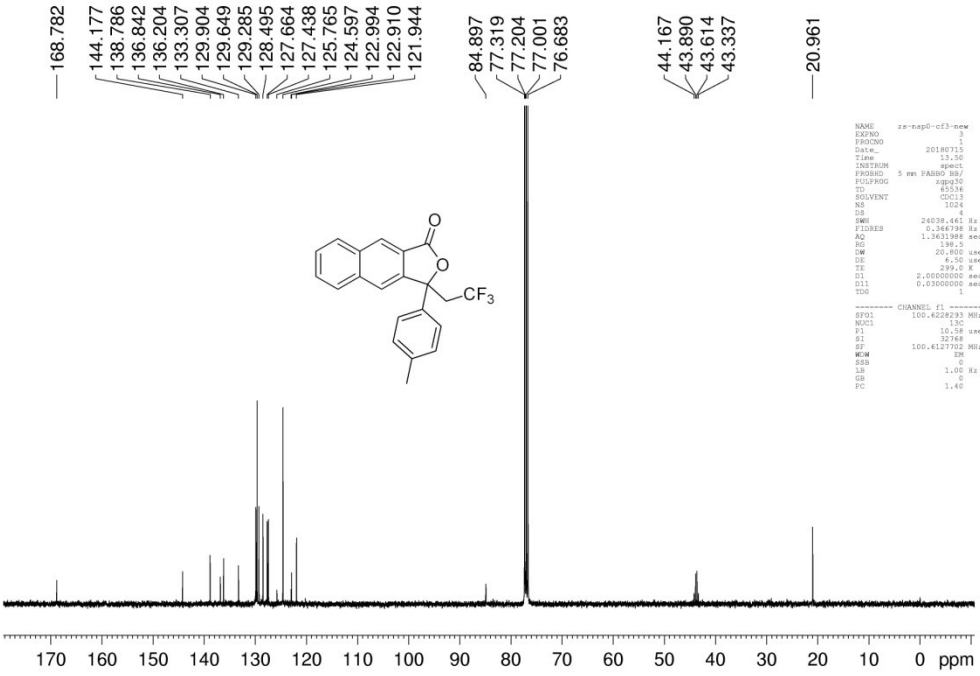
5o ^{19}F NMR:



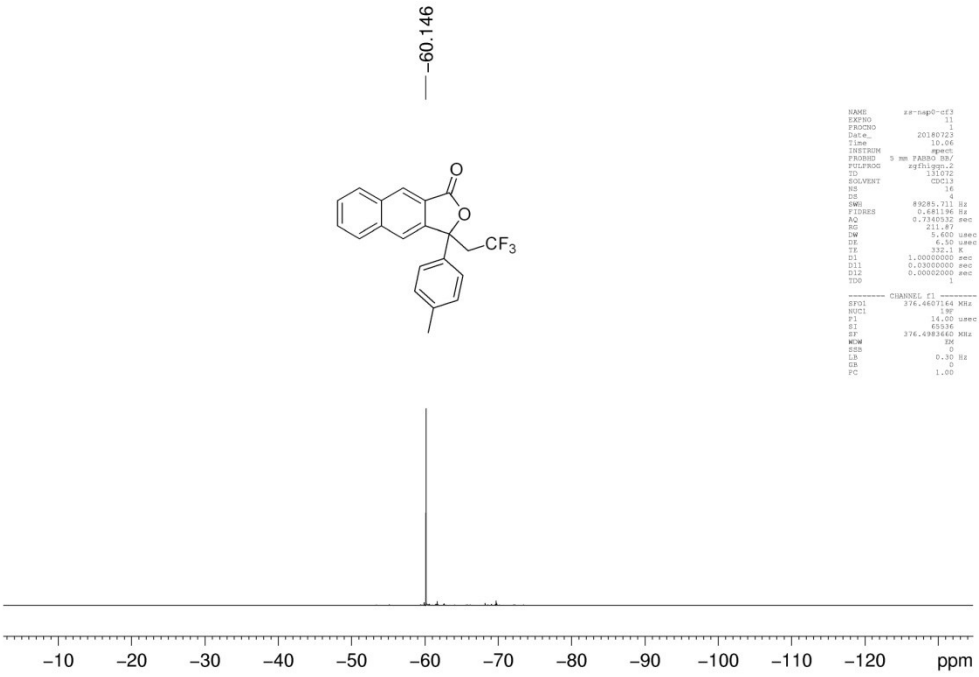
5p ^{1}H NMR:



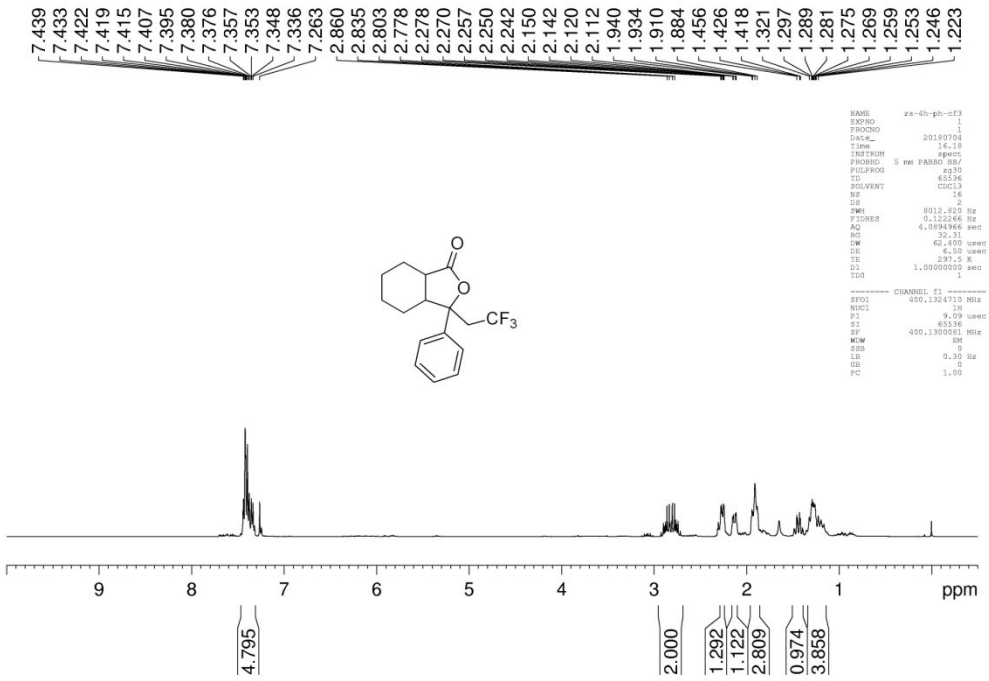
5p ^{13}C NMR:



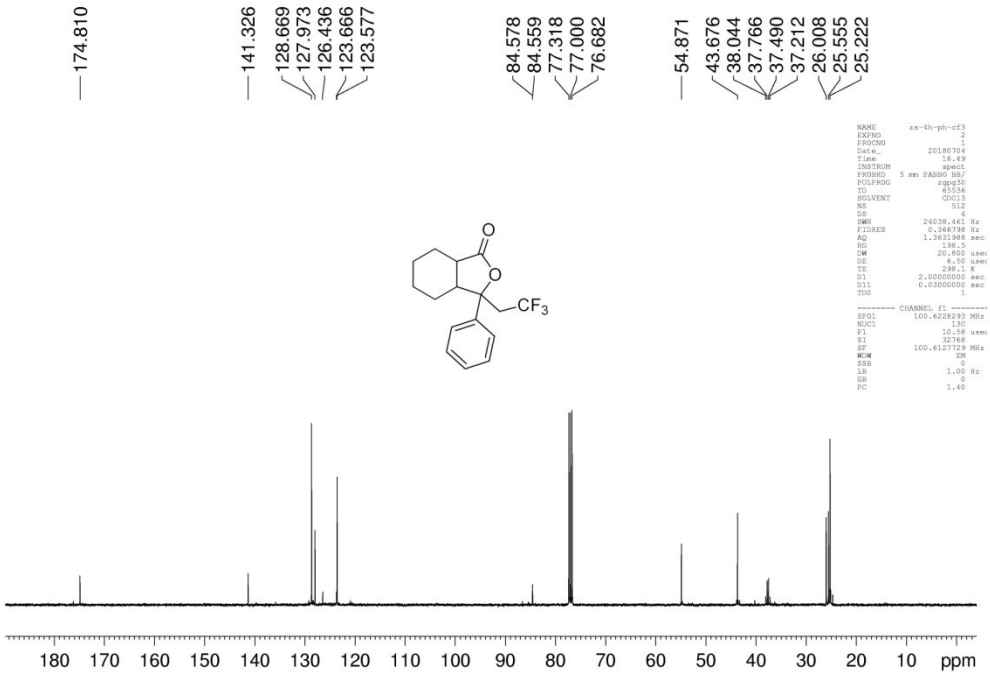
5p ^{19}F NMR:



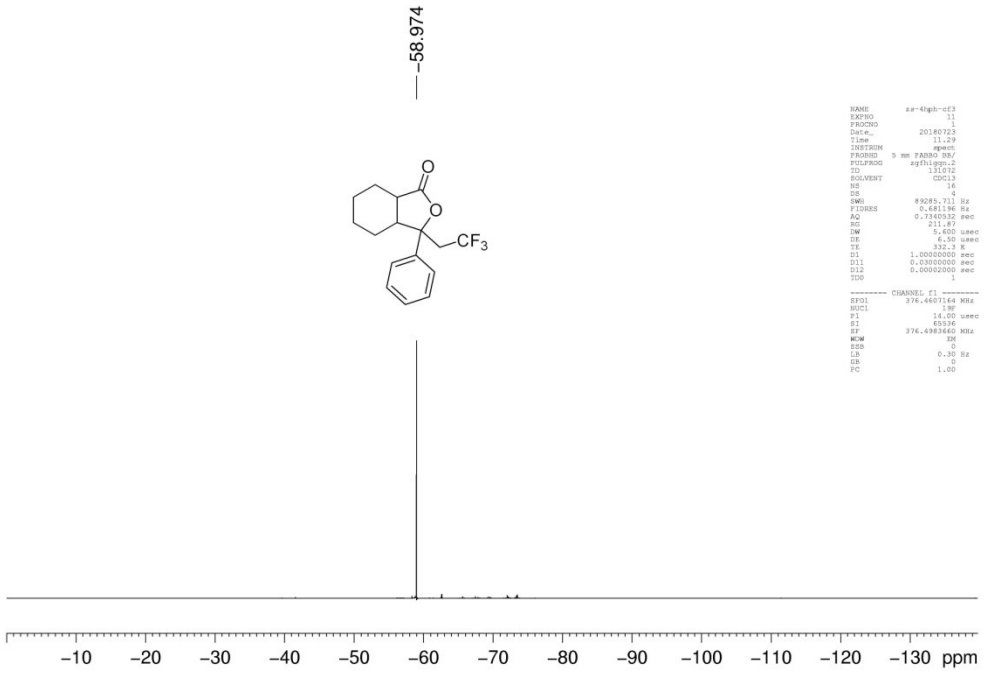
5q ^{1}H NMR:



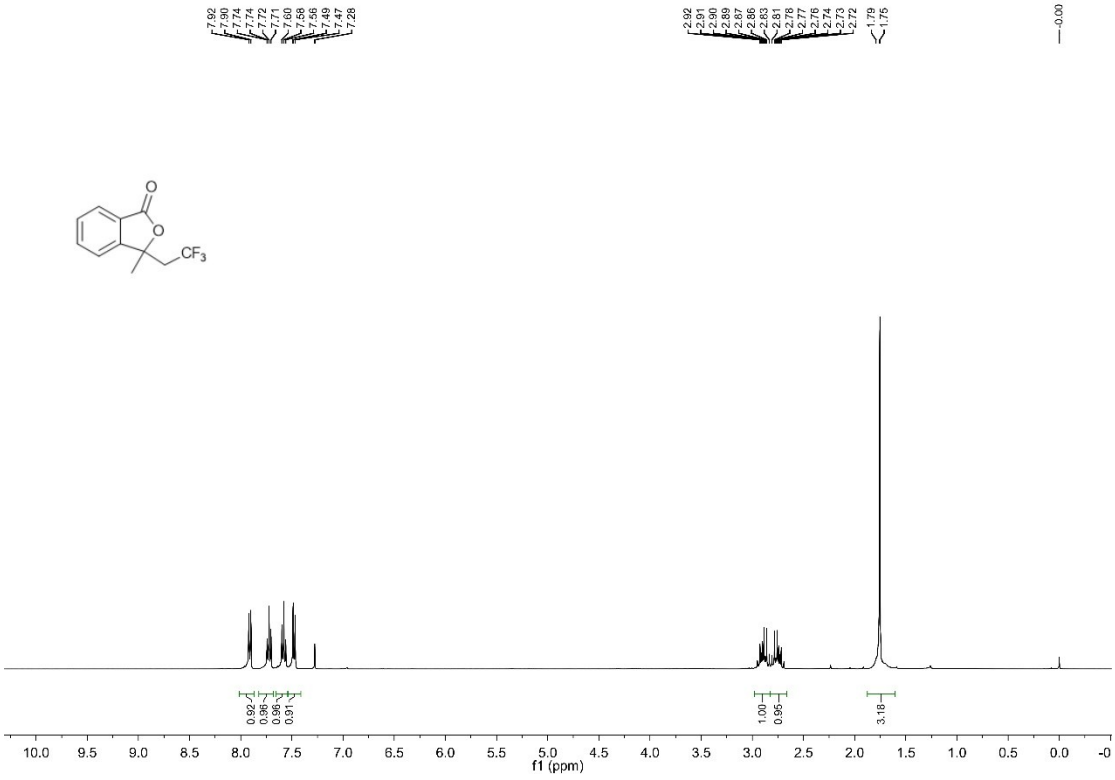
5q ^{13}C NMR:



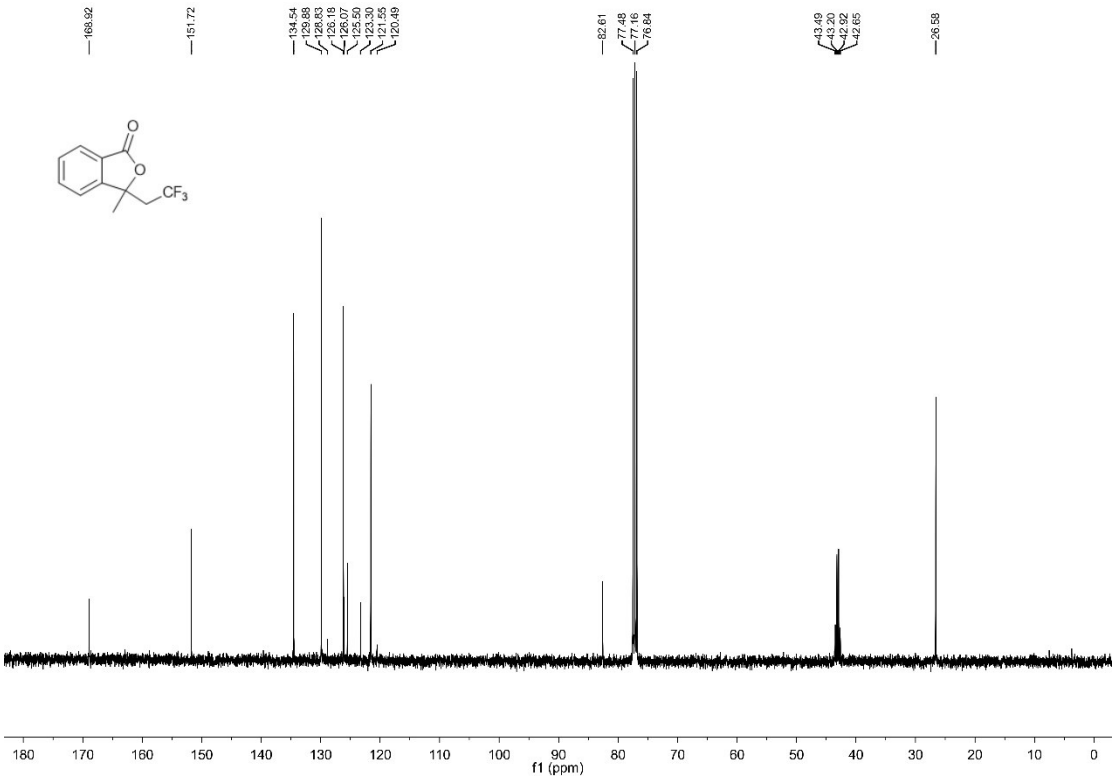
5q ^{19}F NMR:



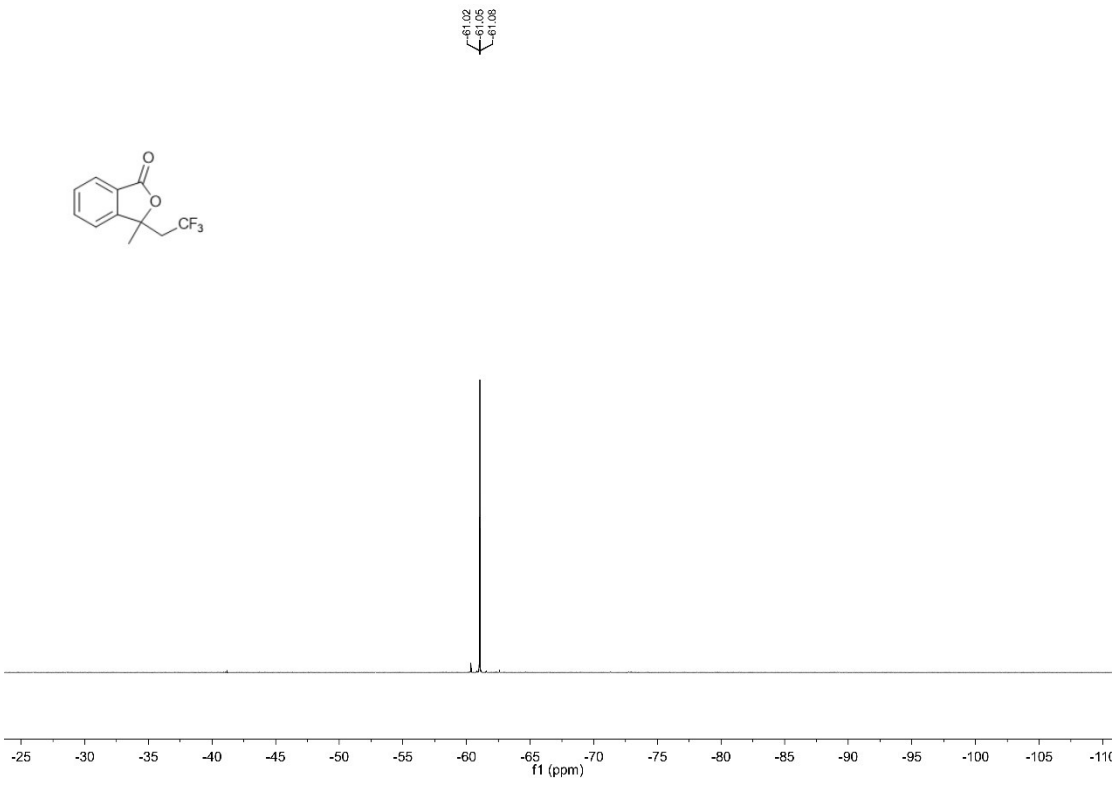
5r ^{1}H NMR:



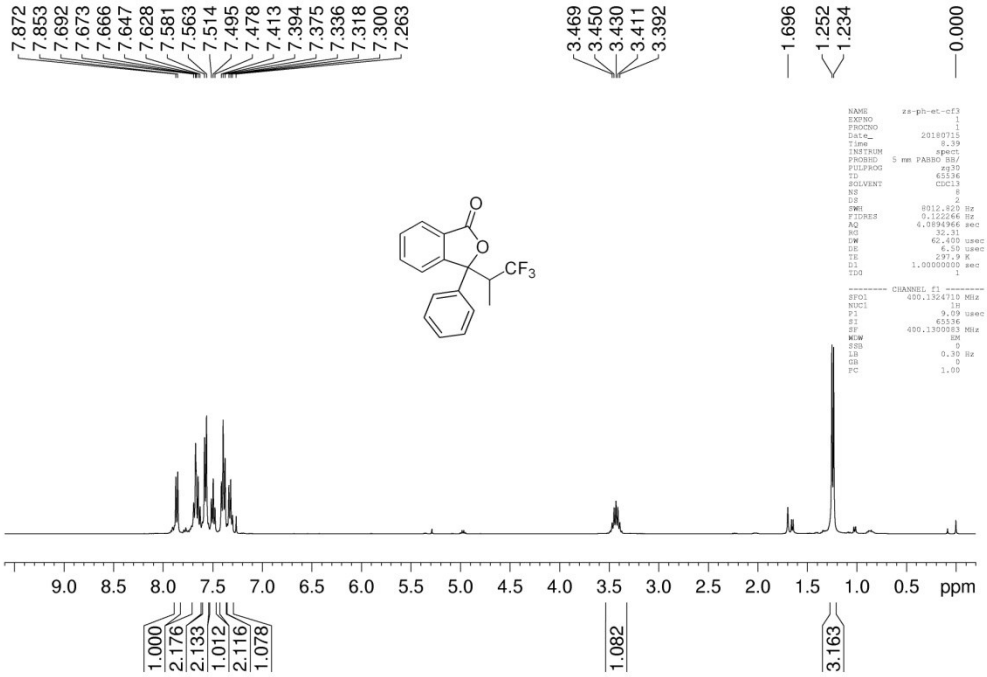
5r ^{13}C NMR:


168.92
151.72
134.54
129.88
128.83
126.18
126.07
125.50
123.30
121.55
120.49
82.61
77.48
77.16
76.84
43.49
43.20
42.92
42.65
26.58
O
O
CF3
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

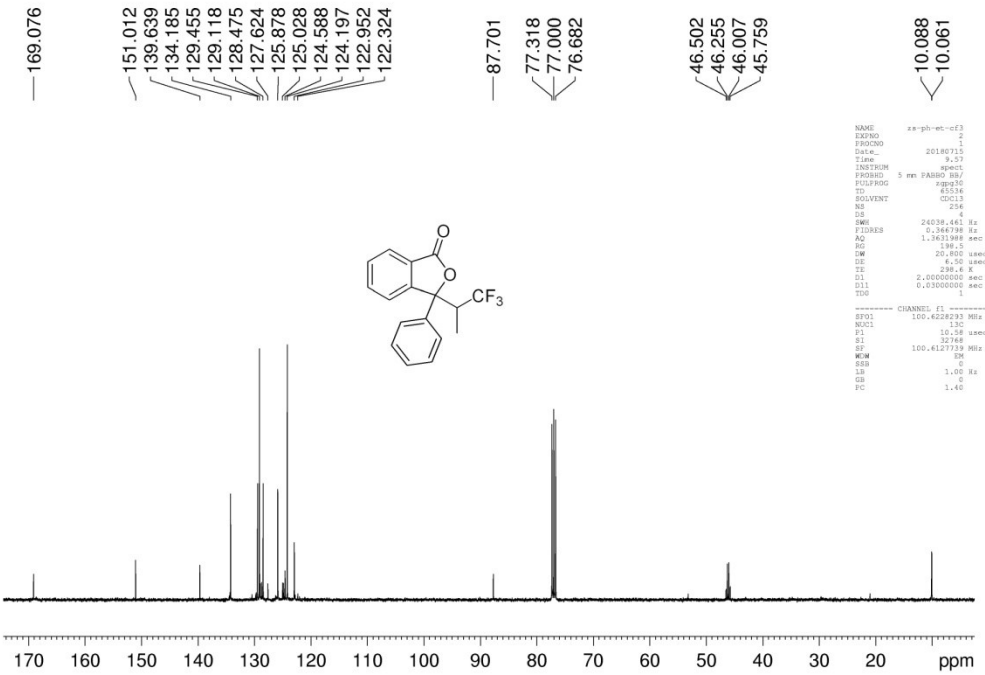
5r ^{19}F NMR:


-61.02
-61.05
-61.08
O
O
CF3
-25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100 -105
f1 (ppm)

5s ^{1}H NMR:



5s ^{13}C NMR:



5s ^{19}F NMR: