Supporting Information

Catalytic cascade aldol–cyclization of tertiary ketone enolates for enantioselective synthesis of keto-esters with C-F quaternary stereogenic center

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page

1. General information 2
2. General synthetic procedures and experimental methods 2
2.1. General procedures for the preparation of **racemic-7** for HPLC analysis 2
2.2. General procedures for asymmetric detrifluoroacetylative cascade reaction 2
2.3. General procedures for the SDE tests 3
2.3.1. Achiral gravity-driven column chromatography SDE tests 3
3. Characterization data of products **7** 3
3.1. Characterization data of products **7** 3
4. X-ray crystallography 13
4.1 X-ray crystallography for **7ca** 13
5. NMR spectra 14
5.1. NMR spectra of products **7** 14
6. HPLC spectra 58
6.1. HPLC spectra of products 7 58
6.2. HPLC spectra of achiral gravity-driven column chromatography SDE tests 80

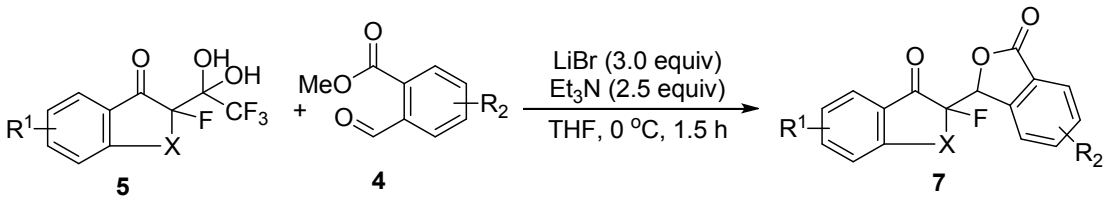
1. General information

All commercial reagents were used without additional purification unless otherwise specified. Solvents were purified and dried according to standard methods prior to use. All reactions were carried out under a nitrogen atmosphere with dry, freshly distilled solvents under anhydrous conditions, unless otherwise noted. All experiments were monitored by thin layer chromatography (TLC) using UV light as visualizing agent. TLC was performed on pre-coated silica gel plated. Column chromatography was performed using silica gel 60 (300-400 mesh).

^{1}H NMR (400 MHz), ^{13}C NMR (101 MHz) and ^{19}F NMR (376 MHz) were measured on a Bruker AVANCE III-400 spectrometer. Chemical shifts are reported in ppm (δ) relative to internal tetramethylsilane (TMS, δ 0.0 ppm) or with the solvent reference relative to TMS employed as the internal standard. Data are reported as follows: chemical shift (multiplicity [singlet (s), doublet (d), triplet (t), quartet (q) and multiplet (m)], coupling constants [Hz], integration). Melting points are uncorrected. Values of optical rotation were measured on Rudolph Automatic Polarimeter A21101 at the wavelength of the sodium D-line (589 nm). Infrared spectra were obtained on Bruker Vector 22 in KBr pellets. HRMS were recorded on a LTQ-Orbitrap XL (Thermofisher, U. S. A.). HPLC analysis was performed on Shimadzu SPD-20A using Daicel Chiralpak IC Column.

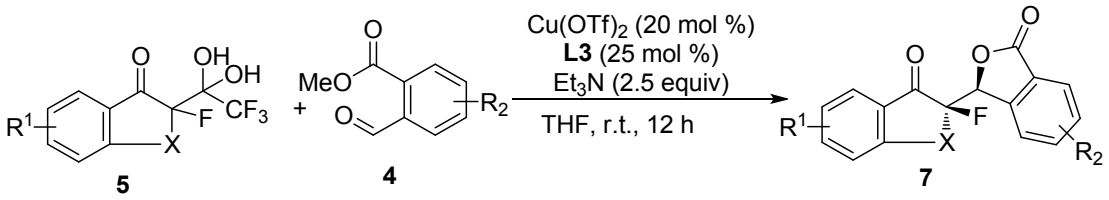
2. General synthetic procedures and experimental methods

2.1. General procedures for the preparation of **racemic-7** for HPLC analysis



To a solution of *α*-fluorinated gem-diols **5** (0.1 mmol), methyl *o*-formylbenzoate **4** (0.2 mmol, 2.0 equiv), and LiBr (0.3 mmol, 3.0 equiv) in THF (2 mL), was added Et_3N (0.25 mmol, 2.5 equiv) dropwise at 0 °C. After 1.5 h, the reaction was quenched with saturated aqueous NH_4Cl (5 mL) followed by H_2O (20 mL). The organic layer was taken and the aqueous layer was extracted with EtOAc (2 × 20 mL). The combined organic layers were washed with H_2O (2 × 50 mL) and brine solution (1 × 50 mL) and dried with anhydrous Na_2SO_4, filtered and the solvent was removed to give the crude product, which was purified by column chromatography to afford the corresponding products **racemic-7**.

2.2. General procedures for asymmetric detrifluoroacetylative cascade reaction



The bisoxazoline ligand **L3** (6.7 mg, 0.025 mmol) and $Cu(OTf)_2$ (7.2 mg, 0.020 mmol) were dissolved in 0.4 mL of anhydrous THF under argon at room temperature and stirred for 2 h. Then, the *α*-fluorinated gem-diols **5** (0.1mmol) dissolved in 0.3 mL of THF was added, and the solution was stirred for an additional minute followed by addition of 0.2 mmol of methyl *o*-formylbenzoate **4** (2.0 equiv) dissolved in 0.3 mL of THF. The mixture was stirred for another 10 minutes. Finally, Et_3N (25.6 mg, 0.25 mmol, 2.5 equiv) was added dropwise. The mixture was stirred until the *α*-fluorinated gem-diols **5** disappeared (monitored by TLC). The solvent was removed under reduced pressure, and the residue was purified by silica gel column chromatography (PE:EA = 7:1) to afford products **7**.

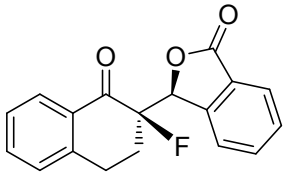
2.3. General procedures for the SDE tests

2.3.1. Achiral gravity-driven column chromatography SDE tests

28.7 mg of compound **7aa** (white solid, 8:92 dr, 92% ee) was used as the starting sample for the gravity-driven column chromatography SDE tests over achiral silica gel (45 g, 300-400 mesh) with the mixed solvent system ether acetate-petroleum ether in the ratio 1:15 as the eluent. Column flow rates were targeted to 40 mL/h amounting to total elution times of several hours. Finally 12 × 10 mL aliquots were collected, chiral HPLC analysis of the collected fractions showed that the early eluting fractions were enantiomerically enriched in comparison to the starting sample while the later eluting fractions were enantiomerically depleted. The ee values of the first and last fractions were 94% and 90%.

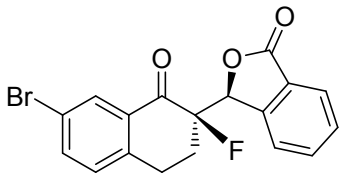
3. Characterization data of products 7

3.1. Characterization data of products **7**



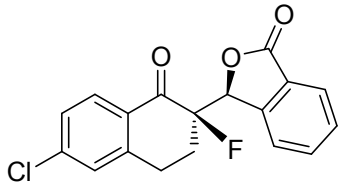
(S)-3-((R)-2-fluoro-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-one (7aa)
Pale yellow solid, 27.2 mg (92% yield), 92:8 dr, 92% ee, m.p. 140 – 142 °C. [α]20 D = -118.6 (c = 0.12, CH_2Cl_2). ^1H NMR (400 MHz, $CDCl_3$) δ 8.11 (dd, *J* = 7.8, 0.8 Hz, 1H), 7.93 (d, *J* = 7.5 Hz, 1H), 7.62- 7.53 (m, 3H), 7.38 (t, *J* = 7.6 Hz, 2H), 7.24 (d, *J* = 7.7 Hz, 1H), 6.25 (d, *J* = 8.8 Hz, 1H),

3.30 – 3.22 (m, 1H), 2.83 (dt, *J* = 17.1, 4.5 Hz, 1H), 2.45 (ddt, *J* = 14.5, 10.0, 4.5 Hz, 1H), 1.75 (dddd, *J* = 36.6, 14.6, 10.9, 5.1 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -161.27 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.5 (d, *J* = 18.6 Hz), 170.0, 144.6 (d, *J* = 6.8 Hz), 143.9, 135.0, 134.6, 130.8, 130.1, 129.0, 128.6, 127.5, 126.5 (d, *J* = 1.9 Hz), 126.2, 124.1, 93.6 (d, *J* = 184.7 Hz), 81.1 (d, *J* = 25.0 Hz), 27.7 (d, *J* = 22.8 Hz), 24.1 (d, *J* = 5.5 Hz). IR (cm^{-1}): 1776, 1698, 1290, 1219, 1065, 761, 733.HRMS (TOF MS ESI): calcd for $C_{18}H_{13}FO_3Na^+$ $[M+Na]^+$ 319.0741, found 319.0743. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (70:30 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



(S)-3-((R)-7-bromo-2-fluoro-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-one (7ba)

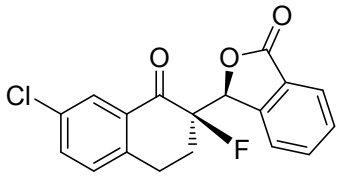
White solid, 26.7 mg (71% yield), 94:6 dr, 94% ee, m.p. 155 – 156 °C. [α]20 D = -173.7 (c = 0.11, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 (d, *J* = 2.1 Hz, 1H), 7.93 (d, *J* = 7.5 Hz, 1H), 7.66 – 7.60 (m, 2H), 7.57 (d, *J* = 7.4 Hz, 1H), 7.38 (d, *J* = 7.6 Hz, 1H), 7.14 (d, *J* = 8.2 Hz, 1H), 6.21 (d, *J* = 8.5 Hz, 1H), 3.23 – 3.14 (m, 1H), 2.82 (dt, *J* = 17.3, 4.6 Hz, 1H), 2.52 – 2.39 (m, 1H), 1.74 (dddd, *J* = 36.4, 14.7, 10.8, 5.1 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ-161.47 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.4 (d, *J* = 18.9 Hz), 169.9, 144.4 (d, *J* = 6.6 Hz), 142.6, 137.8, 134.7, 132.2, 131.2, 130.8, 130.2, 126.4 (d, *J* = 1.8 Hz), 126.3, 124.1, 121.4, 93.2 (d, *J* = 185.0 Hz), 80.9 (d, *J* = 25.1 Hz), 27.6 (d, *J* = 22.8 Hz), 23.7 (d, *J* = 5.6 Hz). IR (cm^{-1}): 1761, 1707, 1054, 1013, 727, 661. HRMS (TOF MS ESI): calcd for $C_{18}H_{12}BrFO_3Na^+$ $[M+Na]^+$ 396.9846, found 396.9804. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (70:30 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



(S)-3-((R)-6-chloro-2-fluoro-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-one (7ca)

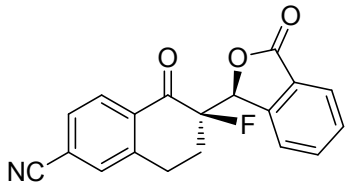
White solid, 30.3 mg (92% yield), 94:6 dr, 94% ee, m.p. 129 – 130 °C. [α]20 D = -76.1 (c = 0.09, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (d, *J* = 8.5 Hz, 1H), 7.93 (d, *J* = 7.4 Hz, 1H), 7.65 – 7.52 (m, 2H), 7.42 – 7.31 (m, 2H), 7.26 – 7.25 (m, 1H), 6.21 (d, *J* = 8.4 Hz, 1H), 3.30 – 3.17 (m, 1H), 2.83 (dt, *J* = 17.2, 4.5 Hz, 1H), 2.51 – 2.39 (m, 1H), 1.76 (dddd, *J* = 36.2, 14.7, 10.8, 5.1 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -161.25 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.5 (d, *J* = 18.8 Hz), 170.0, 145.4, 144.5 (d, *J* = 6.6 Hz), 141.7, 134.7, 130.2, 130.2, 129.2, 128.9, 128.1, 126.4 (d, *J* = 1.8 Hz), 126.2, 124.1, 93.3 (d, *J* = 184.7 Hz), 81.0 (d, *J* = 25.3 Hz), 27.7 (d, *J* = 22.8 Hz), 24.0 (d, *J* = 5.6 Hz). IR (cm^{-1}): 1773, 1690, 1286, 930, 690, 645. HRMS (TOF MS ESI): calcd for $C_{18}H_{12}ClFO_3Na^+$ $[M+Na]^+$ 353.0351, found 353.0322. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (80:20

hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



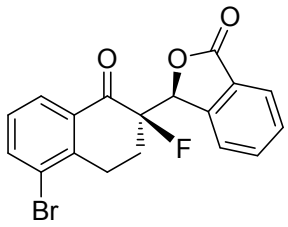
(S)-3-((R)-7-chloro-2-fluoro-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-one (7da)

White solid, 29.2 mg (88% yield), 94:6 dr, 94% ee, m.p. 126 – 128 °C. [α]20 D = -206.9 (c = 0.12, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (d, *J* = 2.3 Hz, 1H), 7.94 (d, *J* = 7.5 Hz, 1H), 7.63 (td, *J* = 7.5, 1.1 Hz, 1H), 7.57(t, *J* = 7.4 Hz, 1H), 7.51 (dd, *J* = 8.2, 2.3 Hz, 1H), 7.38 (d, *J* = 7.6 Hz, 1H), 7.21 (d, *J* = 8.3 Hz, 1H), 6.22 (d, *J* = 8.5 Hz, 1H), 3.27 – 3.15 (m, 1H), 2.84 (dt, *J* = 17.2, 4.5 Hz, 1H), 2.52 – 2.40 (m, 1H), 1.75 (dddd, *J* = 36.3, 14.7, 10.7, 5.1 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -161.49 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.5 (d, *J* = 18.9 Hz), 169.9, 144.5 (d, *J* = 6.6 Hz), 142.1, 135.0, 134.7, 133.7, 131.9, 130.6, 130.2, 128.1, 126.4 (d, *J* = 1.8 Hz), 126.2, 124.0, 93.2 (d, *J* = 184.9 Hz), 80.9 (d, *J* = 25.2 Hz), 27.7 (d, *J* = 22.8 Hz), 23.7 (d, *J* = 5.6 Hz),. IR (cm^{-1}): 1759, 1705, 1210, 939, 833, 728, 647.HRMS (TOF MS ESI): calcd for $C_{18}H_{12}ClFO_3Na^+$ $[M+Na]^+$ 353.0351, found 353.0321. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (70:30 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



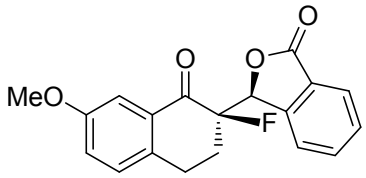
(R)-6-fluoro-5-oxo-6-((S)-3-oxo-1,3-dihydroisobenzofuran-1-yl)-5,6,7,8-tetrahydronaphthalene-2-carbonitrile (7ea)

Pale yellow solid, 15.8 mg (49% yield), 86:14 dr, 93% ee, m.p. 129 – 131 °C. [α]20 D = -75.0 (c = 0.10, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (d, *J* = 8.1 Hz, 1H), 7.94 (d, *J* = 7.5 Hz, 1H), 7.66 – 7.56 (m, 4H), 7.41 (d, *J* = 7.6 Hz, 1H), 6.16 (d, *J* = 7.7 Hz, 1H), 3.37 – 3.22 (m, 1H), 2.97 (dt, *J* = 17.4, 4.7 Hz, 1H), 2.53 (qd, *J* = 9.5, 4.6 Hz, 1H), 1.99 – 1.77 (m, 1H),; ^{19}F NMR (376 MHz, $CDCl_3$) δ -162.10 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.5 (d, *J* = 19.2 Hz), 169.7, 144.4 (d, *J* = 5.9 Hz), 144.3, 134.8, 133.5, 132.9, 130.6, 130.3, 129.2, 126.4, 126.3, 124.0, 118.0, 117.6, 93.2 (d, *J* = 185.1 Hz), 80.7 (d, *J* = 25.8 Hz), 28.0 (d, *J* = 22.7 Hz), 24.0 (d, *J* = 6.0 Hz),. IR (cm^{-1}): 1771, 1692, 1052, 920, 734, 721. HRMS (TOF MS ESI): calcd for $C_{19}H_{12}FNO_3Na^+$ $[M+Na]^+$ 344.0693, found 344.0694. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (90:10 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



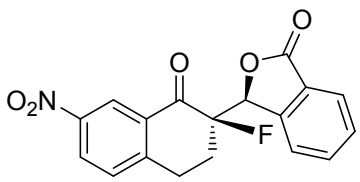
(S)-3-((R)-5-bromo-2-fluoro-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-one (7fa)

White solid, 33.6 mg (90% yield), 85:15 dr, 95% ee, m.p. 123 – 125 ^{o}C. [α]20 D = -50.0 (c = 0.10, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (dd, *J* = 7.9, 1.1 Hz, 1H), 7.94 (d, *J* = 7.5 Hz, 1H), 7.82 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.64 (td, *J* = 7.5, 1.2 Hz, 1H), 7.57 (t, *J* = 7.3 Hz, 1H), 7.44 (d, *J* = 7.6 Hz, 1H), 7.30 – 7.27 (m, 1H), 6.17 (d, *J* = 8.5 Hz, 1H), 3.17 – 3.04 (m, 2H), 2.55-2.46 (m, 1H), 1.92 – 1.75 (m, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -162.77 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.9 (d, *J* = 19.1 Hz), 169.9, 144.5 (d, *J* = 6.1 Hz), 142.7, 138.8, 134.6, 132.6, 130.2, 128.5, 127.9, 126.5 (d, *J* = 1.7 Hz), 126.2, 124.9, 124.1, 92.8 (d, *J* = 185.2 Hz), 80.7 (d, *J* = 25.2 Hz), 27.3 (d, *J* = 22.8 Hz), 25.0 (d, *J* = 5.8 Hz). IR (cm^{-1}): 1771, 1710, 1052, 922, 738. HRMS (TOF MS ESI): calcd for $C_{18}H_{12}BrFO_3Na^+$ $[M+Na]^+$ 396.9846, found396.9821. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (80:20 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



(S)-3-((R)-2-fluoro-7-methoxy-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-one(7ga)

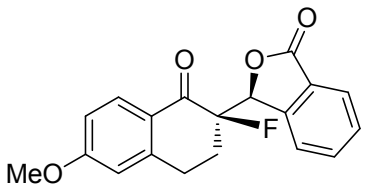
White solid, 26.0 mg (80% yield), 92:8 dr, 92% ee, m.p. 122 – 124 ^{o}C. [α]20 D = -166.7 (c = 0.10, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 7.4 Hz, 1H), 7.65 – 7.50 (m, 3H), 7.39 (d, *J* = 7.6 Hz, 1H), 7.19 – 7.08 (m, 2H), 6.22 (d, *J* = 8.8 Hz, 1H), 3.86 (s, 3H), 3.26 – 3.09 (m, 1H), 2.77 (dt, *J* = 16.9, 4.6 Hz, 1H), 2.44 (qd, *J* = 9.3, 4.5 Hz, 1H), 1.87 – 1.65 (m, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -161.50 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.3 (d, *J* = 18.7 Hz), 170.0, 158.8, 144.6 (d, *J* = 6.6 Hz), 136.5, 134.4, 131.4, 130.1, 130.0, 126.4 (d, *J* = 1.8 Hz), 126.0, 123.9, 123.6, 109.9, 93.4 (d, *J* = 184.7 Hz), 81.0 (d, *J* = 25.2 Hz), 55.6, 27.9 (d, *J* = 22.7 Hz), 23.3 (d, *J* = 5.5 Hz).IR (cm^{-1}): 767, 1700, 1289, 1067, 735. HRMS (TOF MS ESI): calcd for $C_{19}H_{15}FO_4Na^+$ $[M+Na]^+$ 349.0847, found 349.0825. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (70:30 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



(S)-3-((R)-2-fluoro-7-nitro-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-

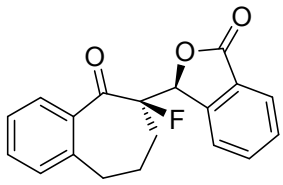
one(7ha)

Pale yellow solid, 17.0 mg (50% yield), 95:5 dr, 92% ee, m.p. 154 – 156 °C. [α]20 D = -173.3 (c = 0.15, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.89 (d, *J* = 2.4 Hz, 1H), 8.37 (dd, *J* = 8.5, 2.5 Hz, 1H), 7.94 (d, *J* = 7.5 Hz, 1H), 7.65 (td, *J* = 7.5, 1.1 Hz, 1H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.48 (d, *J* = 8.5 Hz, 1H), 7.43 (d, *J* = 7.7 Hz, 1H), 6.20 (d, *J* = 7.7 Hz, 1H), 3.44 – 3.27 (m, 1H), 3.06 (dt, *J* = 17.9, 4.6 Hz, 1H), 2.59 – 2.51 (m, 1H), 1.97 – 1.74 (m, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -161.78 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 188.9 (d, *J* = 19.3 Hz), 169.7, 150.1, 147.5, 144.3 (d, *J* = 6.0 Hz), 134.8, 131.6, 130.6, 130.4, 128.6, 126.4, 126.3, 124.1, 123.8, 93.0 (d, *J* = 185.0 Hz), 80.6 (d, *J* = 25.6 Hz), 27.7 (d, *J* = 22.8 Hz), 24.5 (d, *J* = 5.9 Hz). IR (cm^{-1}): 1767, 1704, 1344, 1091, 1008, 734. HRMS (TOF MS ESI): calcd for $C_{18}H_{12}FNO_5Na^+$ $[M+Na]^+$ 364.0592, found 364.0571. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (90:10 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



(S)-3-((R)-2-fluoro-6-methoxy-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-one (7ia)

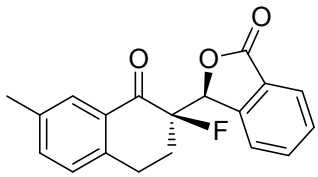
White solid, 21.5 mg (66% yield), 87:13 dr, 78% ee, m.p. 107 – 109 °C. [α]20 D = -131.3 (c = 0.13, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09 (d, *J* = 8.8 Hz, 1H), 7.92 (d, *J* = 7.4 Hz, 1H), 7.65 – 7.47 (m, 2H), 7.37 (d, *J* = 7.6 Hz, 1H), 6.89 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.66 (d, *J* = 2.1 Hz, 1H), 6.27 (d, *J* = 9.0 Hz, 1H), 3.86 (s, 3H), 3.27 – 3.13 (m, 1H), 2.74 (dt, *J* = 17.0, 4.4 Hz, 1H), 2.40 (ddt, *J* = 14.6, 10.3, 4.4 Hz, 1H), 1.76 – 1.56 (m, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -160.12 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 188.8 (d, *J* = 18.3 Hz), 170.1, 164.9, 146.5, 144.6 (d, *J* = 7.2 Hz), 134.5, 131.1, 129.9, 126.4 (d, *J* = 2.0 Hz), 126.0, 124.2, 124.1, 114.4, 112.4, 93.4 (d, *J* = 184.3 Hz), 81.3 (d, *J* = 24.9 Hz), 55.6, 27.4 (d, *J* = 22.9 Hz), 24.3 (d, *J* = 5.1 Hz). IR (cm^{-1}): 1763, 1682, 1596, 1262, 1219, 922, 729. HRMS (TOF MS ESI): calcd for $C_{19}H_{15}FO_4Na^+$ $[M+Na]^+$ 349.0847, found 349.0831. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (70:30 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



(S)-3-((R)-6-fluoro-5-oxo-6,7,8,9-tetrahydro-5H-benzo[7]annulen-6-yl)isobenzofuran-1(3H)-one (7ja)

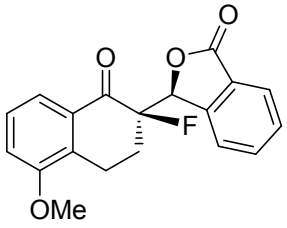
White solid, 28.8 mg (93% yield), 97:3 dr, 96% ee, m.p. 149 – 151 °C. [α]20 D = 26.5 (c = 0.10, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (d, *J* = 7.4 Hz, 1H), 7.73 – 7.65 (m, 1H), 7.57 (t, *J* = 7.6 Hz, 2H), 7.45 – 7.35 (m, 2H), 7.28 – 7.25 (m, 1H), 7.19 (d, *J* = 7.5 Hz, 1H), 5.97 (d, *J* = 15.9 Hz, 1H), 3.14 (dd, *J* = 16.3, 11.2 Hz, 1H), 2.96 (dd, *J* = 16.6, 7.3 Hz, 1H), 2.46 – 2.15 (m, 3H),

1.91 (tdd, *J* = 16.8, 7.7, 4.0 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -164.79 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 200.7 (d, *J* = 28.9 Hz), 169.6, 144.6, 141.3 (d, *J* = 2.1 Hz), 136.8, 134.1, 132.0, 130.0, 129.7, 129.1, 127.5, 126.7, 126.0, 123.5, 100.3 (d, *J* = 191.1 Hz), 81.0 (d, *J* = 26.3 Hz), 33.8 (d, *J* = 2.4 Hz), 32.9 (d, *J* = 21.5 Hz), 23.6. IR (cm^{-1}): 1769, 1681, 1596, 1280, 995, 622. HRMS (TOF MS ESI): calcd for $C_{19}H_{15}FO_3Na^+$ $[M+Na]^+$ 333.0897, found 333.0880. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (70:30 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



(S)-3-((R)-2-fluoro-7-methyl-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-one (7la)

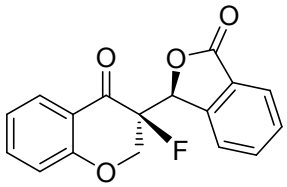
White solid, 25.0 mg (81% yield), 92:8 dr, 91% ee, m.p. 140 – 142 °C. [α]20 D = -180.0 (c = 0.10, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.4 Hz, 2H), 7.62 – 7.52 (m, 2H), 7.37 (t, *J* = 7.9 Hz, 2H), 7.13 (d, *J* = 7.8 Hz, 1H), 6.24 (d, *J* = 8.9 Hz, 1H), 3.28 – 3.11 (m, 1H), 2.78 (dt, *J* = 17.0, 4.5 Hz, 1H), 2.49 – 2.40 (m, 1H), 2.39 (s, 3H), 1.81 – 1.63 (m, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -161.16 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.7 (d, *J* = 18.6 Hz), 170.1, 144.7 (d, *J* = 6.9 Hz), 141.0, 137.3, 136.1, 134.6, 130.6, 130.0, 128.9, 128.5, 126.5 (d, *J* = 1.9 Hz), 126.1, 124.1, 93.6 (d, *J* = 184.7 Hz), 81.2 (d, *J* = 24.9 Hz), 27.7 (d, *J* = 22.8 Hz), 23.7 (d, *J* = 5.4 Hz), 21.1. IR (cm^{-1}): 1763, 1693, 1055, 1018, 732. HRMS (TOF MS ESI): calcd for $C_{19}H_{15}FO_3Na^+$ $[M+Na]^+$ 333.0897, found 333.0889. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (90:10 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



(S)-3-((R)-2-fluoro-5-methoxy-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-one (7ma)

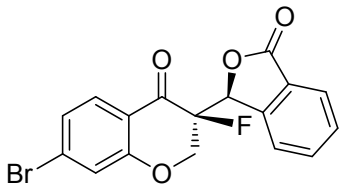
White solid, 17.2 mg (53% yield), 90:10 dr, 91% ee, m.p. 157 – 159 °C. [α]20 D = -88.2 (c = 0.10, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 7.5 Hz, 1H), 7.70 (d, *J* = 7.9 Hz, 1H), 7.61 (td, *J* = 7.5, 0.9 Hz, 1H), 7.54 (t, *J* = 7.4 Hz, 1H), 7.43 (d, *J* = 7.6 Hz, 1H), 7.34 (t, *J* = 8.0 Hz, 1H), 7.07 (d, *J* = 8.1 Hz, 1H),3.85 (s, 3H), 2.96 (dd, *J* = 9.3, 5.1 Hz, 2H), 2.45 (ddt, *J* = 14.5, 9.5, 4.7 Hz, 1H), 1.83 – 1.64 (m, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -162.26 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.9 (d, *J* = 18.8 Hz), 170.1, 156.8, 144.7 (d, *J* = 7.3 Hz), 134.5, 132.9, 131.7, 130.0, 127.8, 126.6 (d, *J* = 1.8 Hz), 126.2, 124.2, 119.9, 115.6, 93.4 (d, *J* = 185.1 Hz), 81.0 (d, *J* = 25.0 Hz), 55.9, 27.1 (d, *J* = 22.8 Hz), 18.2 (d, *J* = 5.8 Hz). IR (cm^{-1}): 1774, 1711, 1266, 1216, 930, 731, 634. HRMS (TOF MS ESI): calcd for $C_{19}H_{15}FO_4Na^+$ $[M+Na]^+$ 349.0847, found 349.0844. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak

IC column (80:20 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



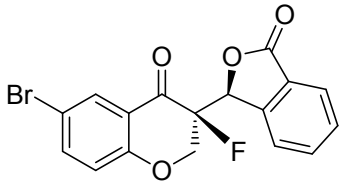
(R)-3-fluoro-3-((S)-3-oxo-1,3-dihydroisobenzofuran-1-yl)chroman-4-one (7na)

Yellow solid, 27.9 mg (94% yield), 95:5 dr, 84% ee, m.p. 125 – 126 °C. [α]20 D = -174.0 (c = 0.19, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 – 7.90 (m, 2H), 7.63 – 7.51 (m, 3H), 7.40 (d, *J* = 7.4 Hz, 1H), 7.15 – 7.07 (m, 1H), 6.94 (d, *J* = 8.4 Hz, 1H), 6.10 (d, *J* = 10.5 Hz, 1H), 4.63 (dd, *J* = 13.1, 11.0 Hz, 1H), 4.25 (dd, *J* = 27.8, 13.1 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -167.46 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 185.0 (d, *J* = 18.3 Hz), 169.4, 161.2, 143.5 (d, *J* = 5.7 Hz), 137.7, 134.7, 130.5, 128.0, 126.4, 126.1, 123.7, 122.8, 119.6, 118.3, 90.0 (d, *J* = 192.0 Hz), 79.0 (d, *J* = 25.0 Hz), 68.7 (d, *J* = 25.8 Hz). IR (cm^{-1}): 1771, 1697, 1466, 1218, 1047, 767, 735. HRMS (TOF MS ESI): calcd for $C_{17}H_{11}FO_4Na^+$ $[M+Na]^+$ 321.0534, found 321.0533. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (80:20 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



(R)-7-bromo-3-fluoro-3-((S)-3-oxo-1,3-dihydroisobenzofuran-1-yl)chroman-4-one (7oa)

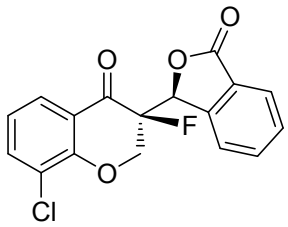
White solid, 27.7 mg (74% yield), 94:6 dr, 85% ee, m.p. 141 – 142 °C. [α]20 D = -109.0 (c = 0.18, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.1 Hz, 1H), 7.79 (d, *J* = 8.5 Hz, 1H), 7.69 – 7.53 (m, 2H), 7.41 (d, *J* = 7.4 Hz, 1H), 7.26 – 7.23 (m, 1H), 7.17 (d, *J* = 1.7 Hz, 1H), 6.07 (d, *J* = 9.8 Hz, 1H), 4.66 (dd, *J* = 13.2, 11.2 Hz, 1H), 4.25 (dd, *J* = 28.5, 13.2 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -167.18 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 184.2 (d, *J* = 18.7 Hz), 169.3, 161.2, 143.4 (d, *J* = 5.5 Hz), 134.8, 132.6, 130.6, 129.1, 126.6, 126.5, 126.0, 123.7, 121.6, 118.4, 89.7 (d, *J* = 191.9 Hz), 78.8 (d, *J* = 25.1 Hz), 69.2 (d, *J* = 25.6 Hz). IR (cm^{-1}): 1767, 1705, 1286, 1009, 701, 607.HRMS (TOF MS ESI): calcdfor $C_{17}H_{10}BrFO_4Na^+$ $[M+Na]^+$ 398.9639, found 398.9612. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (80:20 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



(R)-6-bromo-3-fluoro-3-((S)-3-oxo-1,3-dihydroisobenzofuran-1-yl)chroman-4-one (7pa)

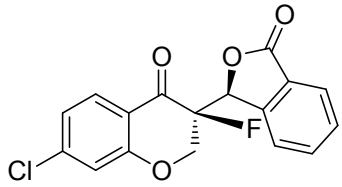
White solid, 26.6 mg (71% yield), 95:5 dr, 86% ee, m.p. 155 – 157 °C. [α]20 D = -155.4 (c = 0.13, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04 (d, *J* = 2.3 Hz, 1H), 7.95 (d, *J* = 7.3 Hz, 1H),7.66 –

7.57 (m, 3H), 7.40 (d, *J* = 7.5 Hz, 1H), 6.86 (d, *J* = 8.9 Hz, 1H), 6.08 (d, *J* = 10.0 Hz, 1H), 4.65 (dd, *J* = 13.1, 11.3 Hz, 1H), 4.23 (dd, *J* = 28.7, 13.2 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -167.14 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 184.6 (d, *J* = 18.1 Hz), 168.9, 160.2, 143.5 (d, *J* = 1.0 Hz), 140.3, 134.8, 130.6, 130.3, 130.3, 126.3, 124.4 (d, *J* = 2.0 Hz), 120.7, 120.4, 115.6, 89.1 (d, *J* = 193.2 Hz), 76.9 (d, *J* = 28.0 Hz), 69.1 (d, *J* = 27.5 Hz). IR (cm^{-1}): 1780, 1705, 1598, 1474, 1279, 1017, 832, 733.HRMS (TOF MS ESI): calcd for $C_{17}H_{10}BrFO_4Na^+$ $[M+Na]^+$ 398.9639, found 398.9636.The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (90:10 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



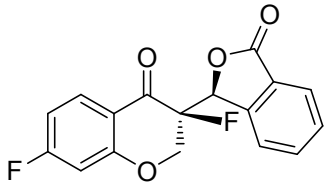
(R)-8-chloro-3-fluoro-3-((S)-3-oxo-1,3-dihydroisobenzofuran-1-yl)chroman-4-one (7qa)

Pale yellow solid, 19.8 mg (60% yield), 95:5 dr, 90% ee, m.p. 166 – 167 °C. [α]20 D = -90.7 (c = 0.09, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.96 (d, *J* = 6.9 Hz, 1H), 7.86 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.69 – 7.54 (m, 3H), 7.43 (d, *J* = 7.4 Hz, 1H), 7.07 (t, *J* = 7.9 Hz, 1H), 6.07 (d, *J* = 9.9 Hz, 1H), 4.79 (dd, *J* = 13.2, 11.0 Hz, 1H), 4.38 (dd, *J* = 28.4, 13.2 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -168.18 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 184.2 (d, *J* = 18.8 Hz), 169.1, 156.5, 143.3 (d, *J* = 5.2 Hz), 137.6, 134.6, 130.5, 126.4, 126.4, 126.0 (d, *J* = 1.3 Hz), 123.5, 123.2, 122.8, 120.7, 89.4 (d, *J* = 192.3Hz), 78.5 (d, *J* = 25.1 Hz), 69.4 (d, *J* = 25.6 Hz). IR (cm^{-1}): 1760, 1717, 1033, 1024, 722, 712. HRMS (TOF MS ESI): calcd for $C_{17}H_{10}ClFO_4Na^+$ $[M+Na]^+$ 355.0144, found 355.0121. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (80:20 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



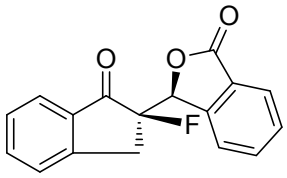
(R)-7-chloro-3-fluoro-3-((S)-3-oxo-1,3-dihydroisobenzofuran-1-yl)chroman-4-one (7ra)

White solid, 20.3 mg (61% yield), 96:4 dr, 90% ee, m.p. 134 – 136 °C. [α]20 D = -137.7 (c = 0.14, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.95 (d, *J* = 7.0 Hz, 1H), 7.88 (d, *J* = 8.5 Hz, 1H), 7.68 – 7.54 (m, 2H), 7.41 (d, *J* = 7.4 Hz, 1H), 7.09 (dd, *J* = 8.5, 1.8 Hz, 1H), 6.98 (d, *J* = 1.8 Hz, 1H), 6.07 (d, *J* = 9.8 Hz, 1H), 4.66 (dd, *J* = 13.2, 11.2 Hz, 1H), 4.26 (dd, *J* = 28.5, 13.2 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -167.13 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 184.0 (d, *J* = 18.6 Hz), 169.3, 161.4, 144.0, 143.4 (d, *J* = 5.5 Hz), 134.8, 130.6, 129.2, 126.5, 126.0 (d, *J* = 1.4 Hz), 123.8, 123.7, 118.5, 118.1, 89.7 (d, *J* = 191.8 Hz), 78.8 (d, *J* = 25.1 Hz), 69.2 (d, *J* = 25.7 Hz). IR (cm^{-1}): 1769, 1707, 1606, 1039, 711, 690. HRMS (TOF MS ESI): calcd for $C_{17}H_{10}ClFO_4Na^+$ $[M+Na]^+$ 355.0144, found 355.0114. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (80:20 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



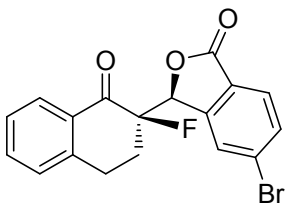
(R)-3,7-difluoro-3-((S)-3-oxo-1,3-dihydroisobenzofuran-1-yl)chroman-4-one (7sa)

White solid, 24.8 mg (78% yield), 84:16 dr, 73% ee, m.p. 165 – 167 °C. [α]20 D = -157.1 (c = 0.11, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04 – 7.87 (m, 2H), 7.70 – 7.52 (m, 2H), 7.41 (d, *J* = 7.4 Hz, 1H), 6.92 – 6.77 (m, 1H), 6.64 (dd, *J* = 9.5, 2.0 Hz, 1H), 6.09 (d, *J* = 9.9 Hz, 1H), 4.71 – 4.61 (m, 1H), 4.25 (dd, *J* = 28.8, 13.2 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -96.64 (s, 1F), -166.87 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 183.4 (d, *J* = 18.4 Hz), 169.2, 168.4 (d, *J* = 258.0 Hz), 162.9 (d, *J* = 14.0 Hz), 143.3 (d, *J* = 5.7 Hz), 134.6, 130.6 (d, *J* = 11.7 Hz), 130.4, 126.4, 125.9, 123.6, 116.4 (d, *J* = 2.3 Hz), 111.5 (d, *J* = 23.1 Hz), 105.1 (d, *J* = 24.9 Hz), 89.6 (d, *J* = 191.6 Hz), 78.8 (d, *J* = 25.1 Hz), 69.2 (d, *J* = 25.6 Hz). IR (cm^{-1}): 1766, 1692, 1260, 1043, 1021, 862, 719. HRMS (TOF MS ESI): calcd for $C_{17}H_{10}F_2O_4Na^+$ $[M+Na]^+$ 339.0439, found 339.0415. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (80:20 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



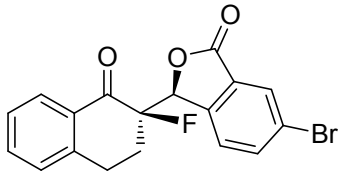
(S)-3-((R)-2-fluoro-1-oxo-2,3-dihydro-1H-inden-2-yl)isobenzofuran-1(3H)-one(7ta)

White solid, 26.0 mg (92% yield), 91:9 dr, 59% ee, m.p. 175 – 176 °C. [α]20 D = -84.7 (c = 0.14, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (dd, *J* = 6.0, 2.5 Hz, 1H), 7.81 (d, *J* = 7.7 Hz, 1H), 7.62 (t, *J* = 7.3 Hz, 1H), 7.53 (dd, *J* = 5.2, 3.5 Hz, 2H), 7.42 (t, *J* = 7.5 Hz, 1H), 7.37 – 7.20 (m, 2H), 6.03 (d, *J* = 9.7 Hz, 1H), 3.36 (dd, *J* = 24.3, 18.3 Hz, 1H), 3.15 – 3.00 (m, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -155.51 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.9 (d, *J* = 16.6 Hz), 169.6, 151.0 (d, *J* = 2.6 Hz), 143.4 (d, *J* = 6.7 Hz), 137.1, 134.5, 134.3, 130.3, 128.7, 126.8, 126.5 (d, *J* = 1.7 Hz), 126.2, 125.1, 123.6, 96.6 (d, *J* = 192.2 Hz), 80.8 (d, *J* = 28.5 Hz), 34.7 (d, *J* = 24.6 Hz). IR (cm^{-1}): 1771, 1718, 1285, 1214, 907, 742. HRMS (TOF MS ESI): calcd for $C_{17}H_{11}FO_3Na^+$ $[M+Na]^+$ 305.0584, found 305.0587. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (90:10 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



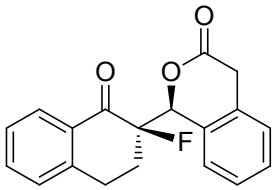
(S)-5-bromo-3-((R)-2-fluoro-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-one(7ab)

White solid, 25.7 mg (69% yield), 80:20 dr, 84% ee, m.p. 134 – 136 °C. [α]20 D = -18.5 (c = 0.11, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09 (d, *J* = 7.8 Hz, 1H), 7.79 – 7.68 (m, 2H), 7.58 (dd, *J* = 14.4, 7.4 Hz, 2H), 7.39 (t, *J* = 7.6 Hz, 1H), 7.27 (d, *J* = 6.9 Hz, 1H), 6.15 (d, *J* = 7.9 Hz, 1H), 3.38 – 3.23 (m, 1H), 2.90 (dt, *J* = 17.2, 4.3 Hz, 1H), 2.48 (qd, *J* = 8.9, 4.1 Hz, 1H), 1.95 – 1.72 (m, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -162.26 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.2 (d, *J* = 18.9 Hz), 168.9, 146.5 (d, *J* = 6.2 Hz), 143.6, 135.1, 133.6, 130.5, 129.9, 128.9, 128.6, 127.5, 127.4, 127.2, 125.4 (d, *J* = 1.7 Hz), 93.2 (d, *J* = 184.6 Hz), 80.4 (d, *J* = 26.0 Hz), 28.0 (d, *J* = 22.7Hz), 24.0 (d, *J* = 5.5 Hz). IR (cm^{-1}): 1764, 1686, 1049, 1009, 916, 764. HRMS (TOF MS ESI): calcd for $C_{18}H_{12}BrFO_3Na^+$ $[M+Na]^+$ 396.9846, found 396.9817.The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (90:10 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



(S)-6-bromo-3-((R)-2-fluoro-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isobenzofuran-1(3H)-one(7ac)

White solid, 28.7 mg (77% yield), 87:13 dr, 88% ee, m.p. 123 – 124°C. [α]20 D = -95.6 (c = 0.09, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (dd, *J* = 7.9, 1.0 Hz, 1H), 8.05 (d, *J* = 1.7 Hz, 1H), 7.72 (dd, *J* = 8.2, 1.8 Hz, 1H), 7.56 (td, *J* = 7.5, 1.4 Hz, 1H), 7.38 (t, *J* = 7.6 Hz, 1H), 7.31 (d, *J* = 8.2 Hz, 1H), 7.27 – 7.25 (m, 1H), 6.15 (d, *J* = 8.1 Hz, 1H), 3.34 – 3.20 (m, 1H), 2.88 (dt, *J* = 17.1, 4.5 Hz, 1H), 2.47 (ddt, *J* = 14.5, 10.0, 4.5 Hz, 1H), 1.80 (dddd, *J* = 37.1, 14.5, 10.9, 5.2 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -161.87 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.2 (d, *J* = 18.7 Hz), 168.3, 143.7, 143.4 (d, *J* = 6.6 Hz), 137.5, 135.1, 130.5, 129.0, 128.9, 128.5, 128.4 (d, *J* = 1.9 Hz), 127.4, 125.6, 124.2, 93.2 (d, *J* = 184.8 Hz), 81.0 (d, *J* = 26.1 Hz), 28.0 (d, *J* = 22.7 Hz), 24.0 (d, *J* = 5.5 Hz). IR (cm^{-1}): 1778, 1707, 1208, 1124, 1009, 920. HRMS (TOF MS ESI): calcd for $C_{18}H_{12}BrFO_3Na^+$ $[M+Na]^+$ 396.9846, found 396.9815. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (90:10 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).



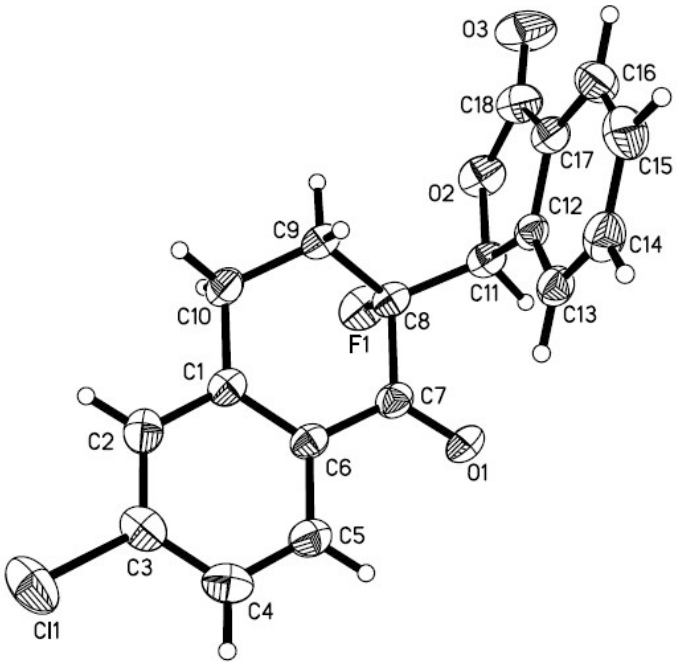
(S)-1-((R)-2-fluoro-1-oxo-1,2,3,4-tetrahydronaphthalen-2-yl)isochroman-3-one (7ae)

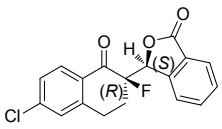
White solid, 25.9 mg (84% yield), 87:13 dr, 94% ee, m.p. 237 – 239 °C. [α]20 D = -17.9 (c = 0.16, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12 (d, *J* = 7.9 Hz, 1H), 7.60 – 7.56 (m, 1H), 7.45 – 7.20 (m, 6H), 5.77 (d, *J* = 25.7 Hz, 1H),4.10 (d, *J* = 19.8 Hz, 1H), 3.67 (dd, *J* = 19.8, 4.4 Hz, 1H), 3.44 – 3.19 (m, 2H), 2.55 – 2.31 (m, 2H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -169.48 (s, 1F); ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.3 (d, *J* = 17.8 Hz), 169.2, 141.1, 134.6, 132.5, 131.4, 129.6, 129.0 (d, *J* = 1.8 Hz), 128.9, 128.3, 127.7, 127.3 (d, *J* = 1.4 Hz), 127.1, 126.1, 97.8 (d, *J* = 193.5 Hz), 80.3 (d, *J*

= 22.9 Hz), 35.3 (d, *J* = 7.6 Hz), 30.1 (d, *J* = 21.4 Hz), 26.4 (d, *J* = 10.5 Hz). IR (cm^{-1}): 1746, 1694, 1383, 1055, 1031, 758, 729. HRMS (TOF MS ESI): calcd for $C_{19}H_{15}FONa^+$ $[M+Na]^+$ 333.0897, found 333.0885. The dr and ee values were determined by chiral stationary phase HPLC analysis using a Daicel Chiralpak IC column (90:10 hexanes/*i*-PrOH at 1.0 mL/min, λ = 254 nm).

4. X-ray crystallography

4.1 X-ray crystallography for **7ca** (CCDC number: 1470631)

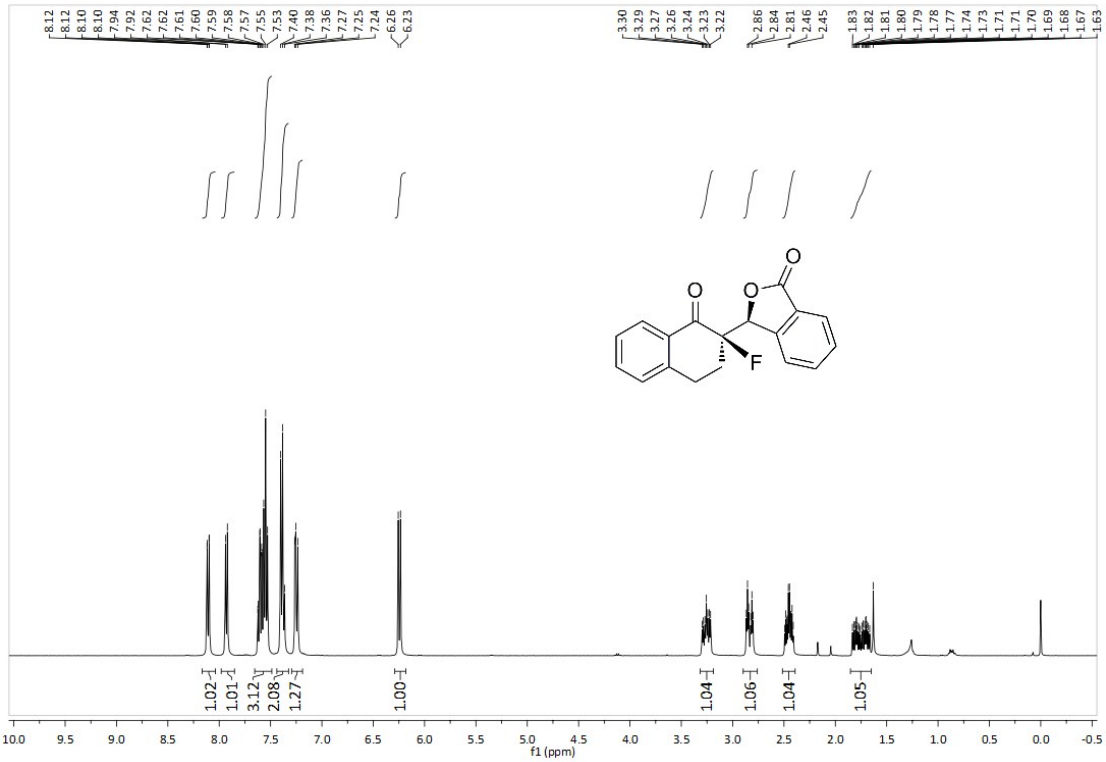




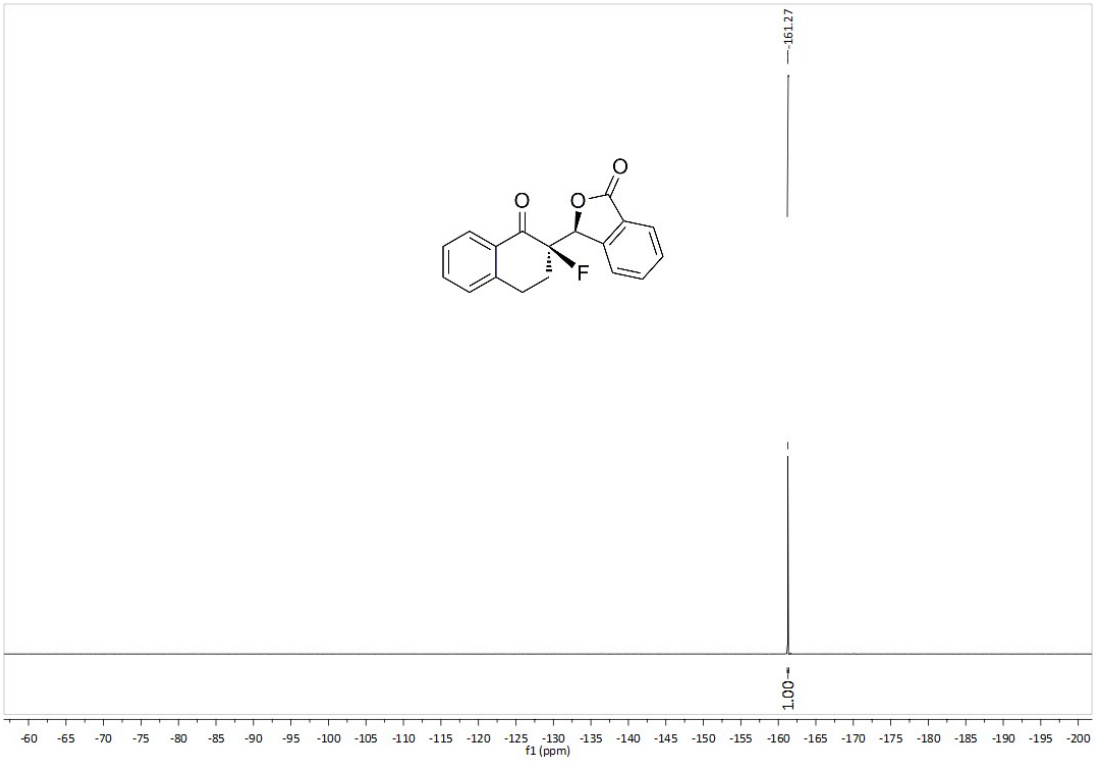
5. NMR spectra

5.1. NMR spectra of products **7**

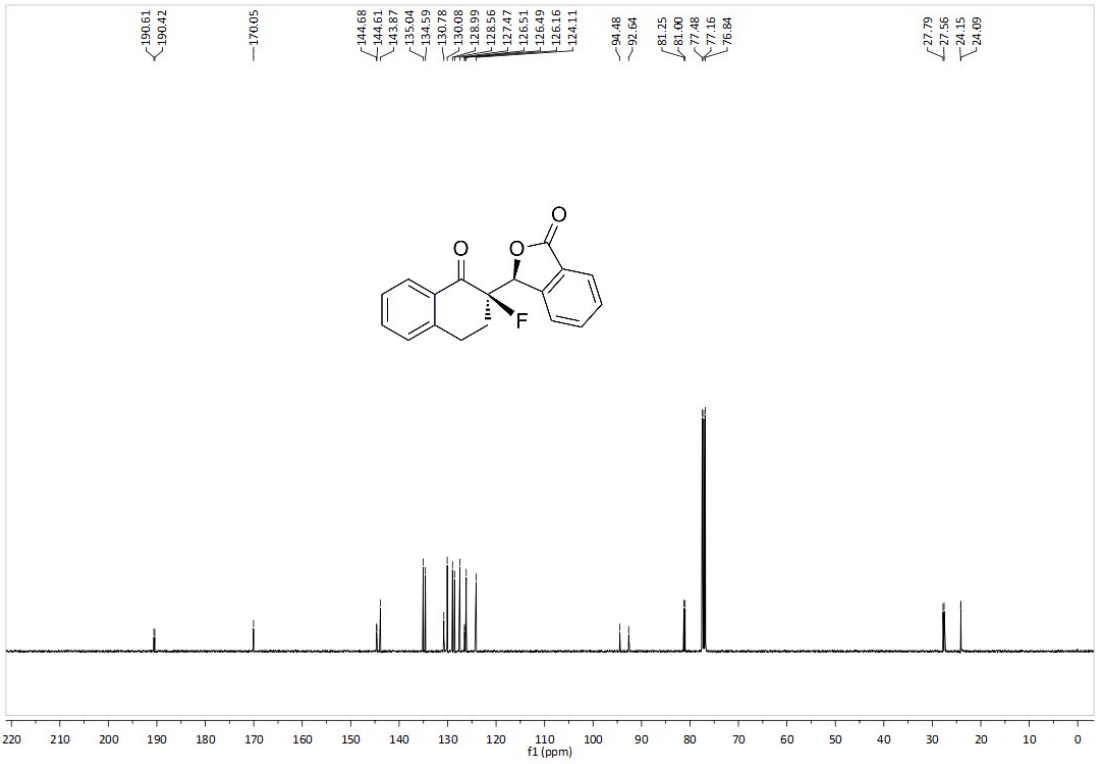
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7aa**



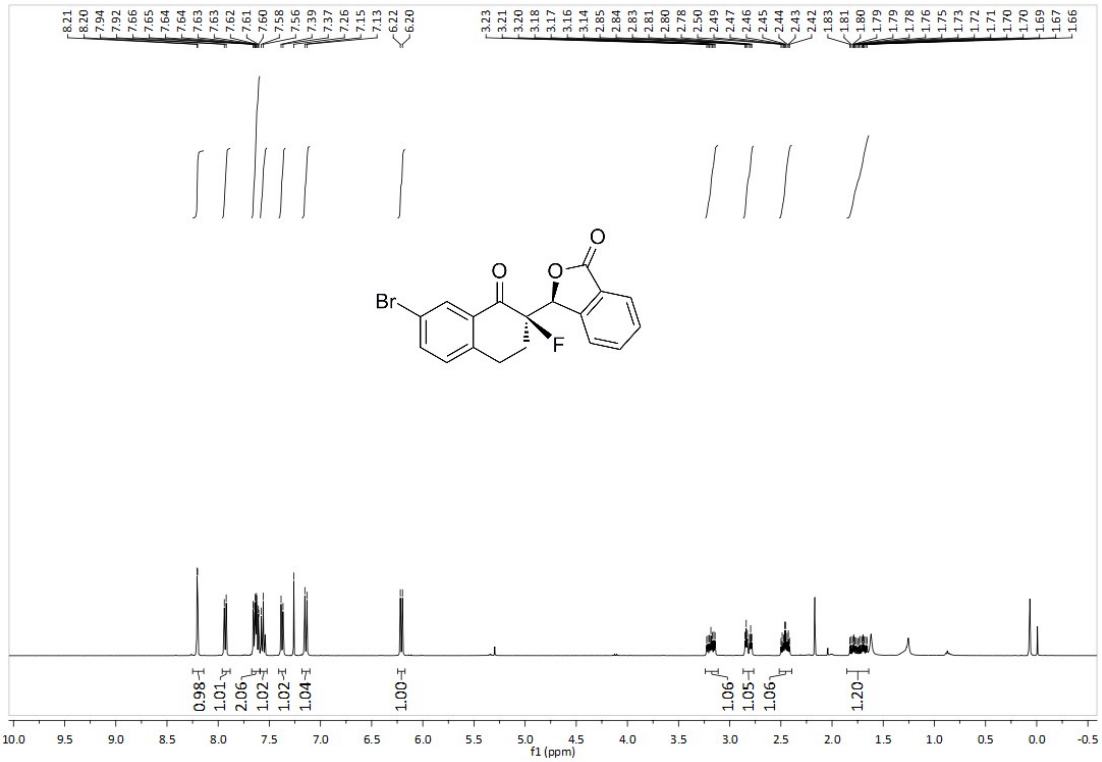
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7aa**



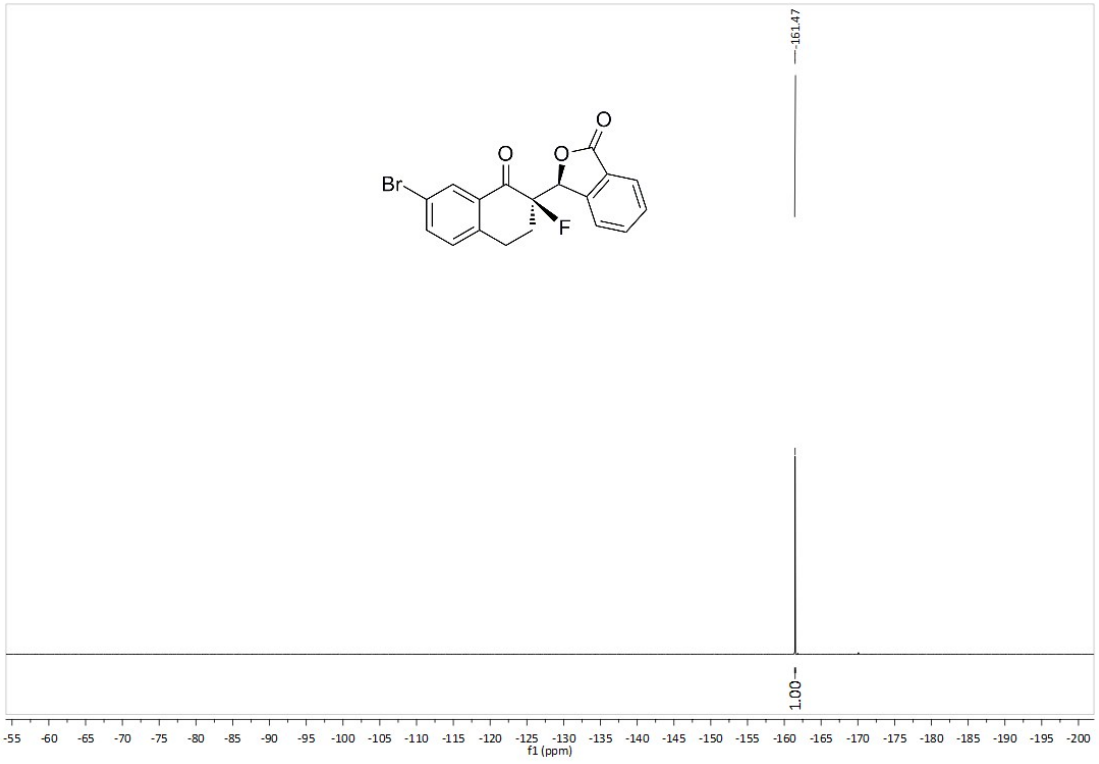
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7aa**



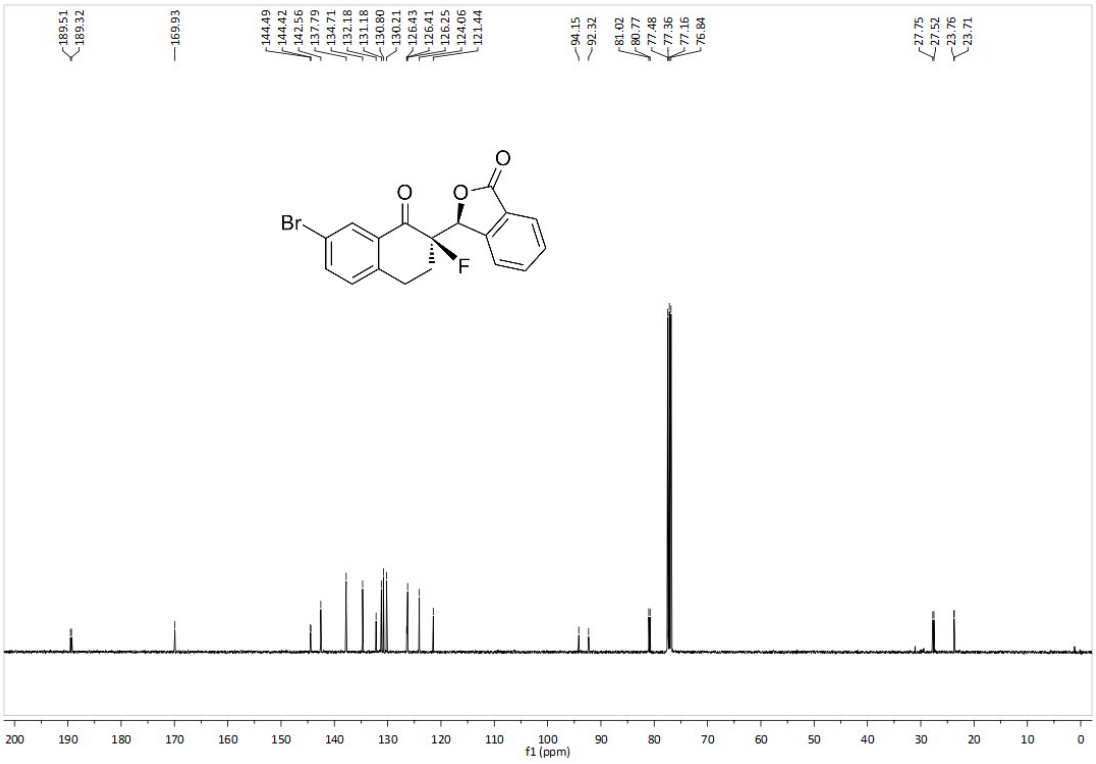
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ba**



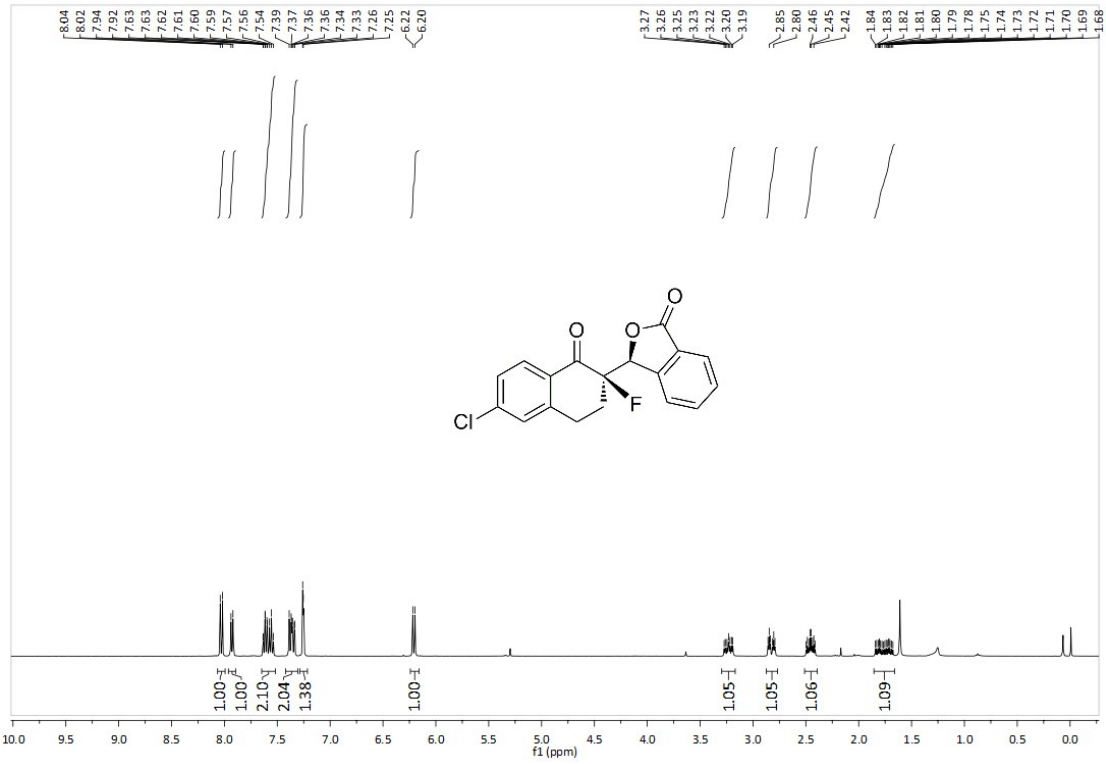
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ba**



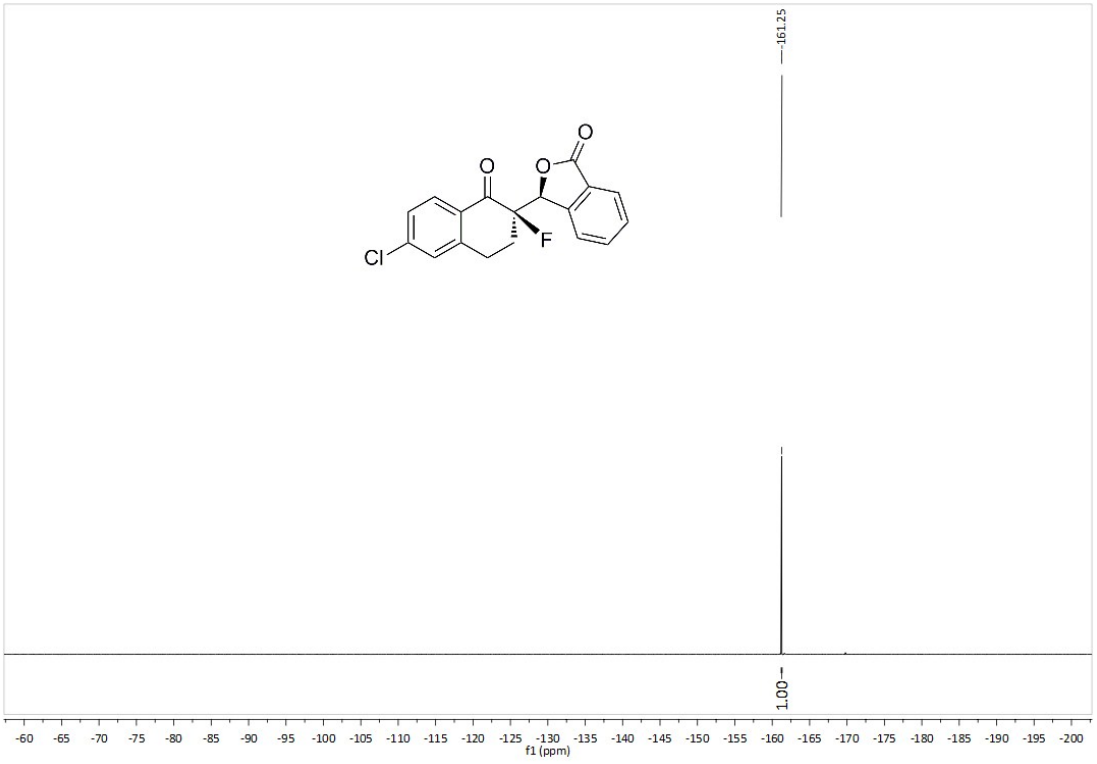
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ba**



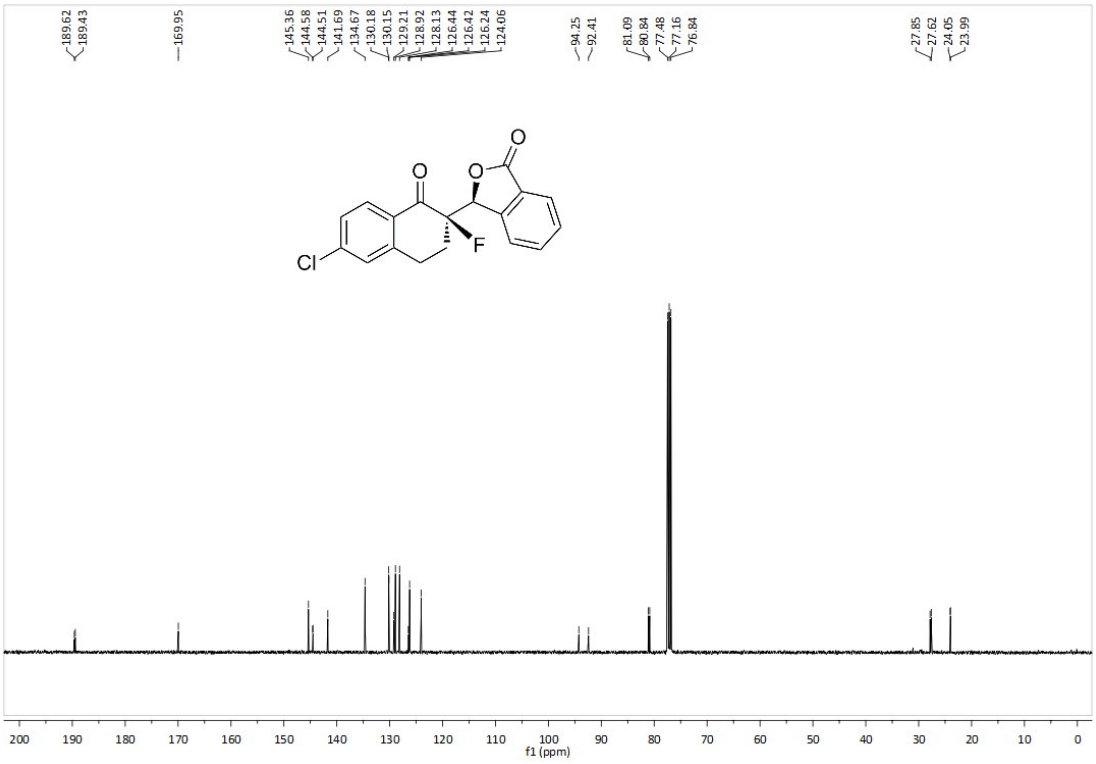
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ca**



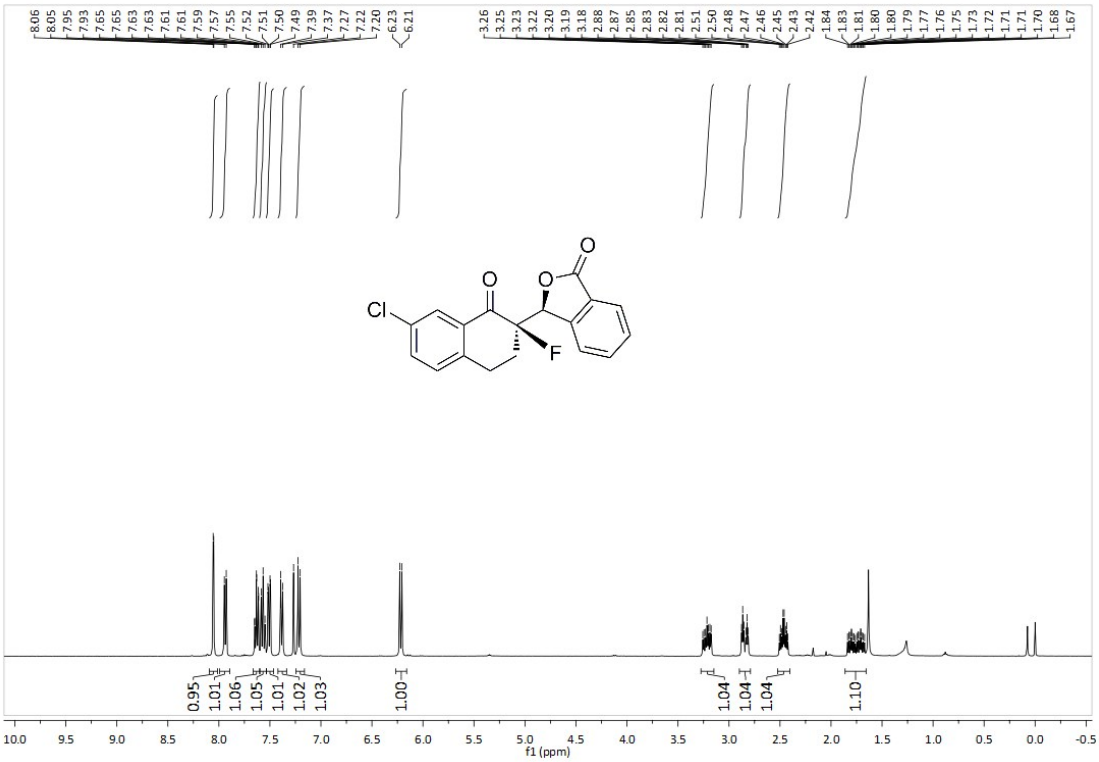
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ca**



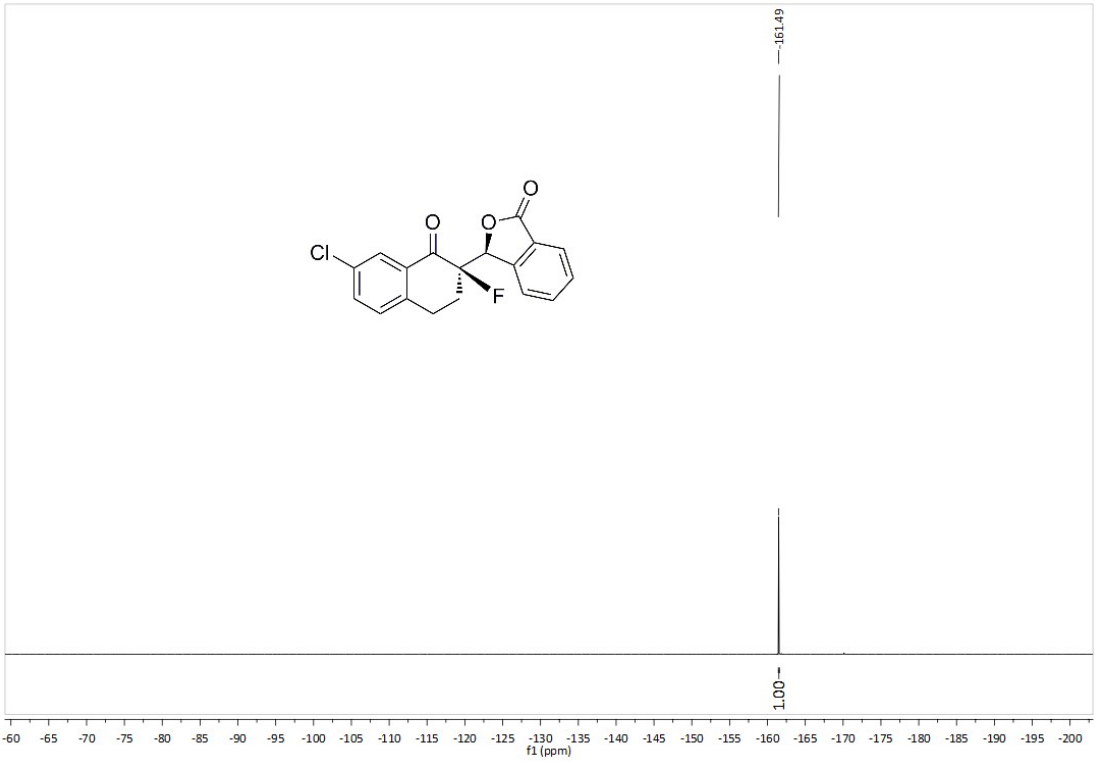
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ca**



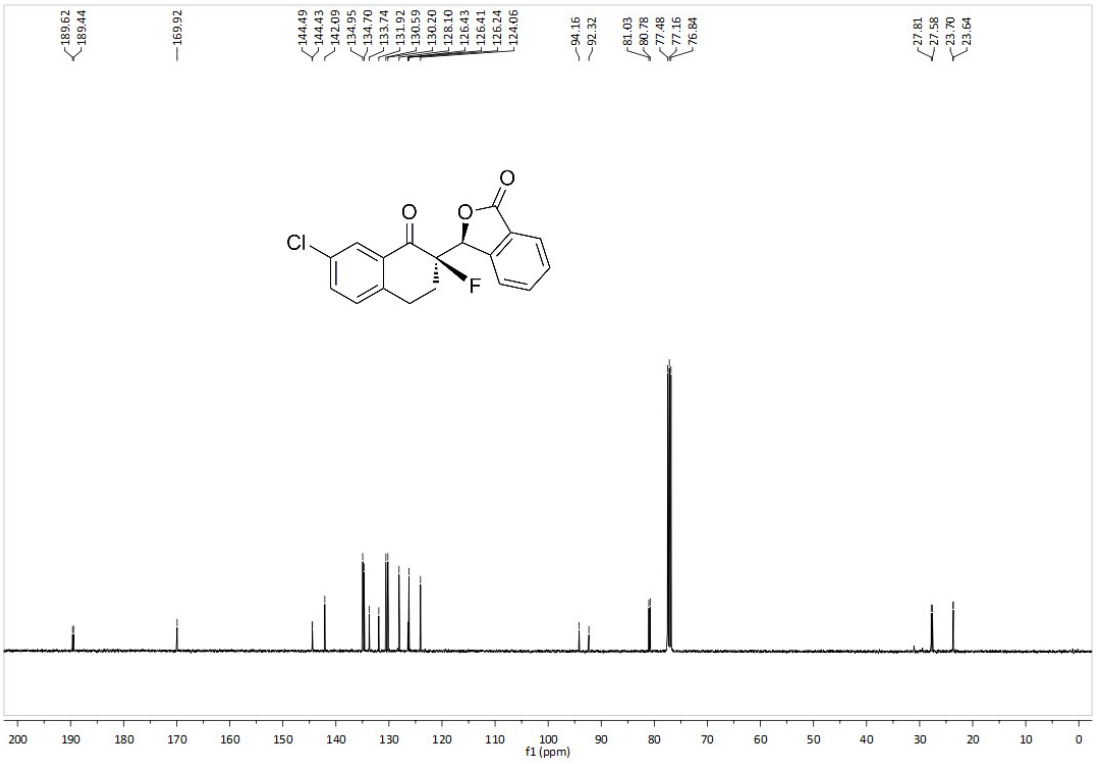
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7da**



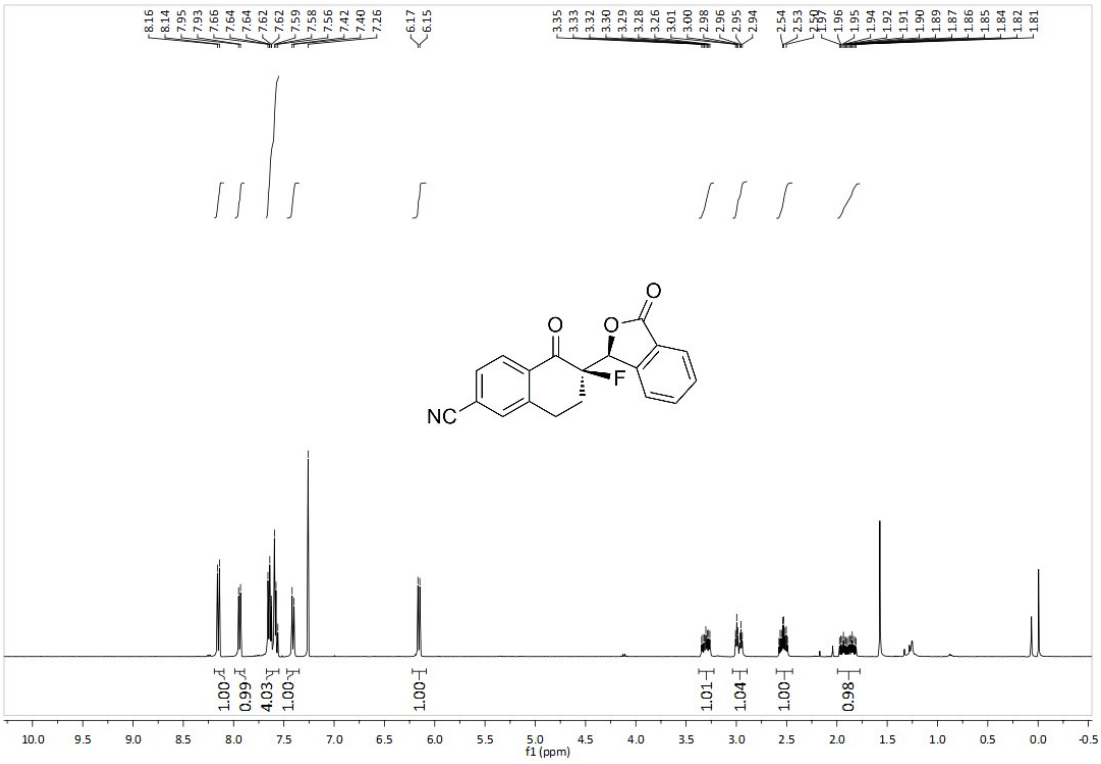
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7da**



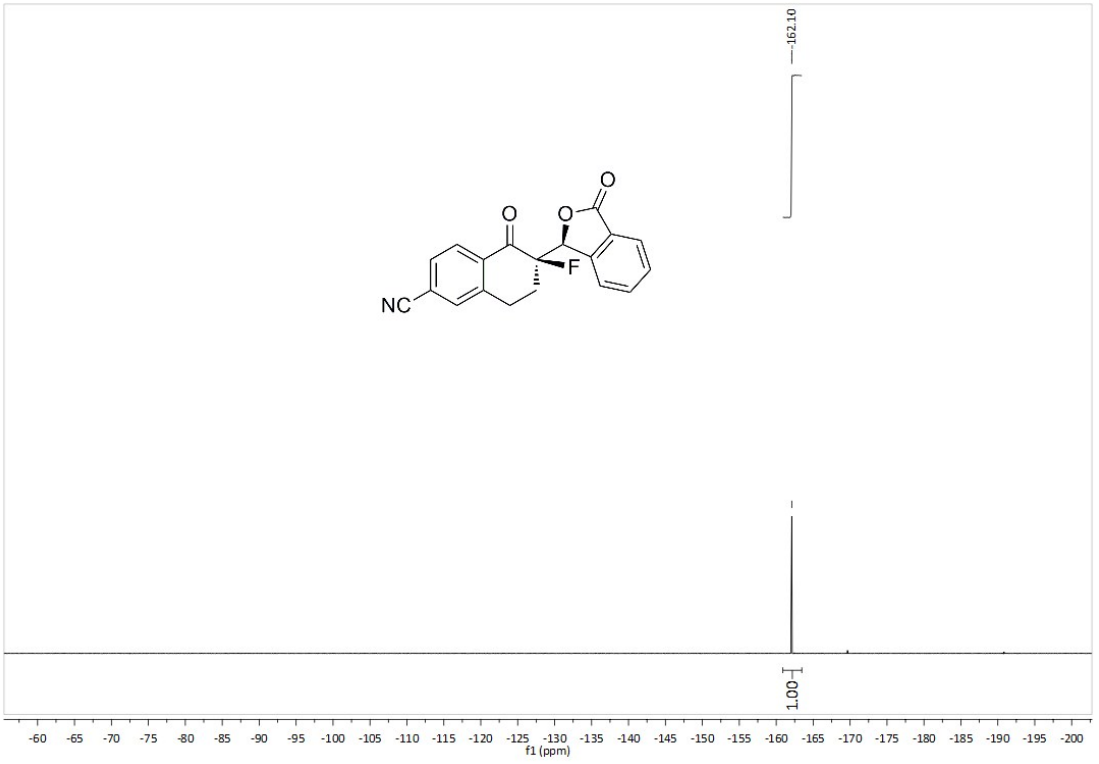
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7da**



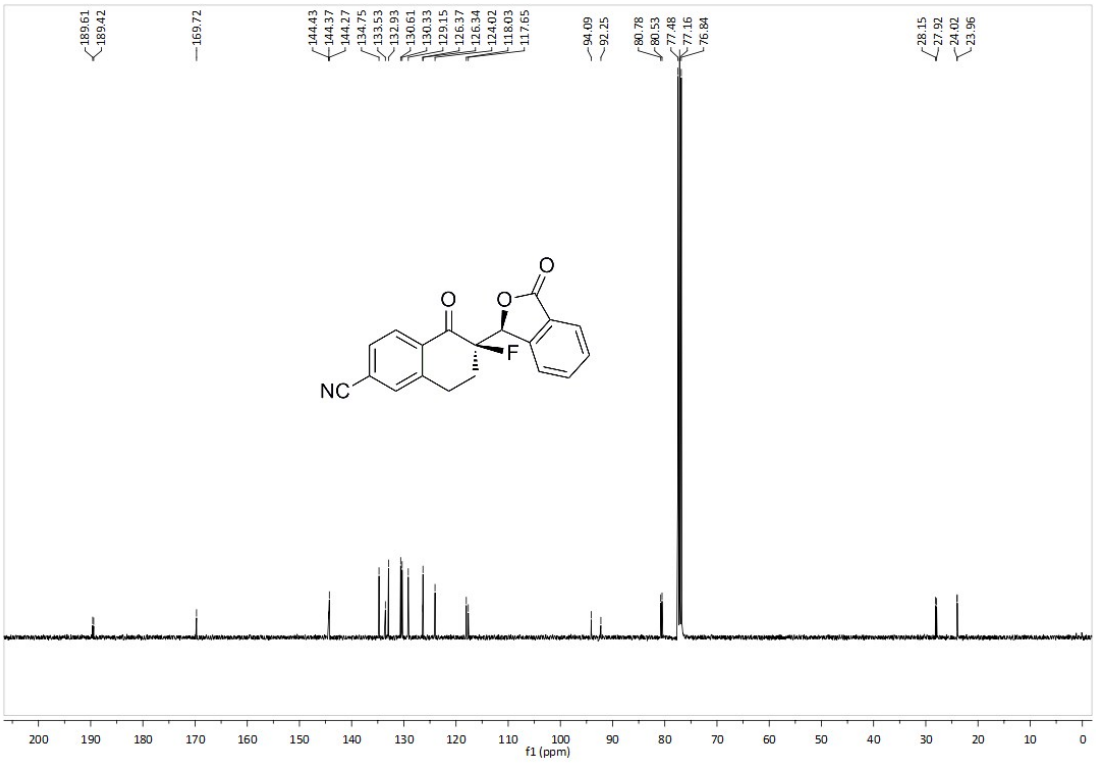
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ea**



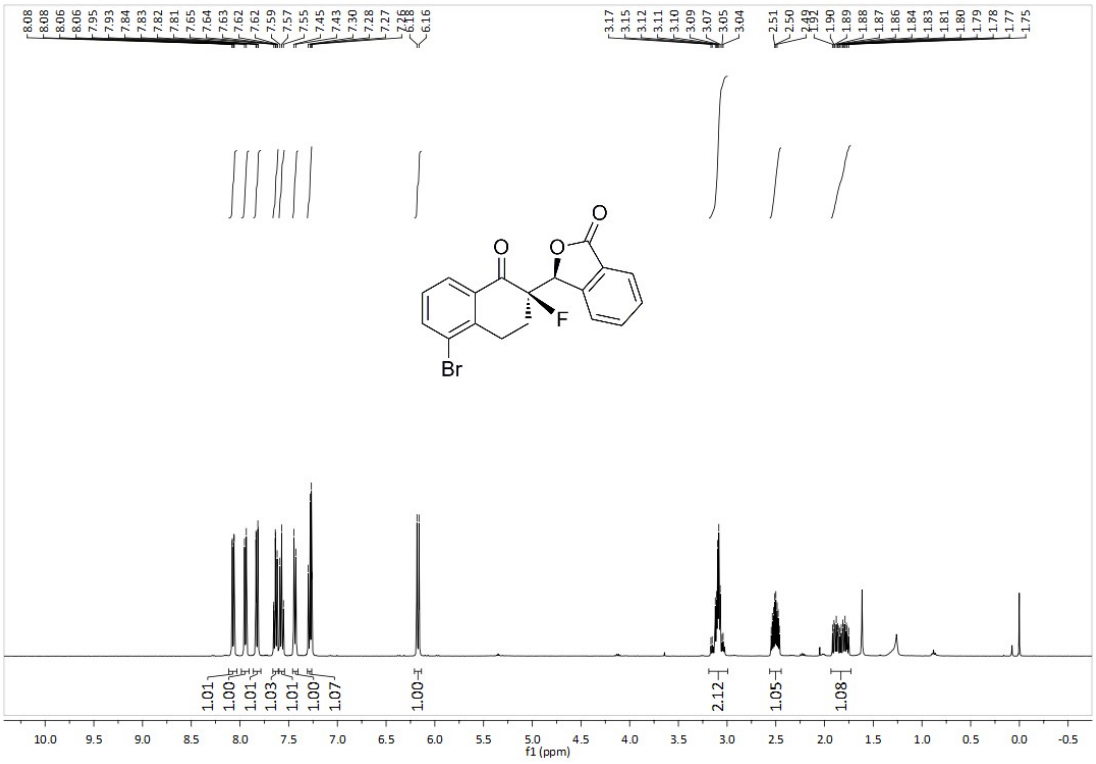
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ea**



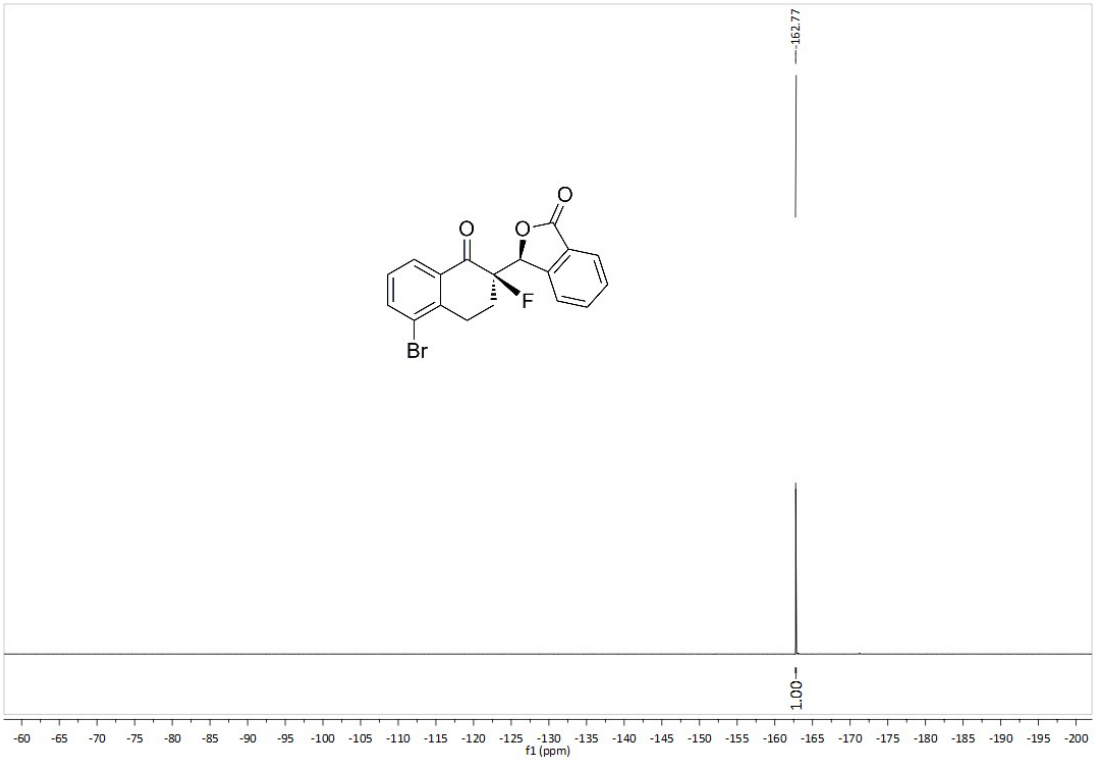
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ea**



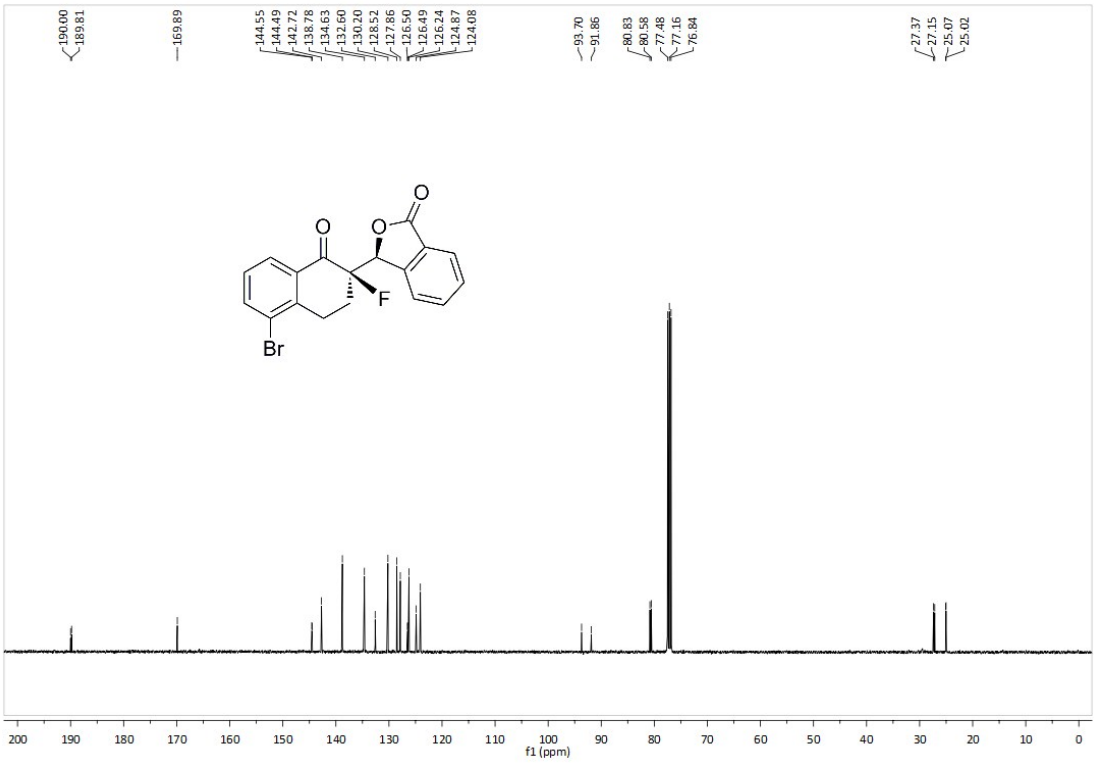
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7fa**



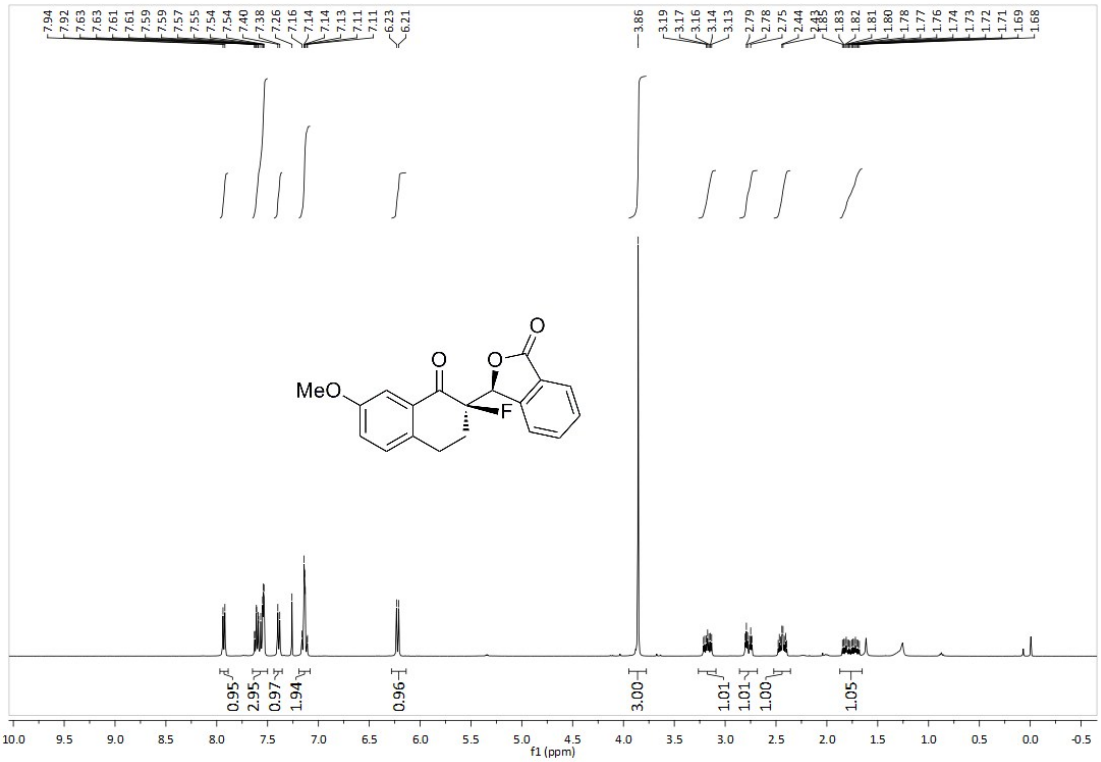
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7fa**



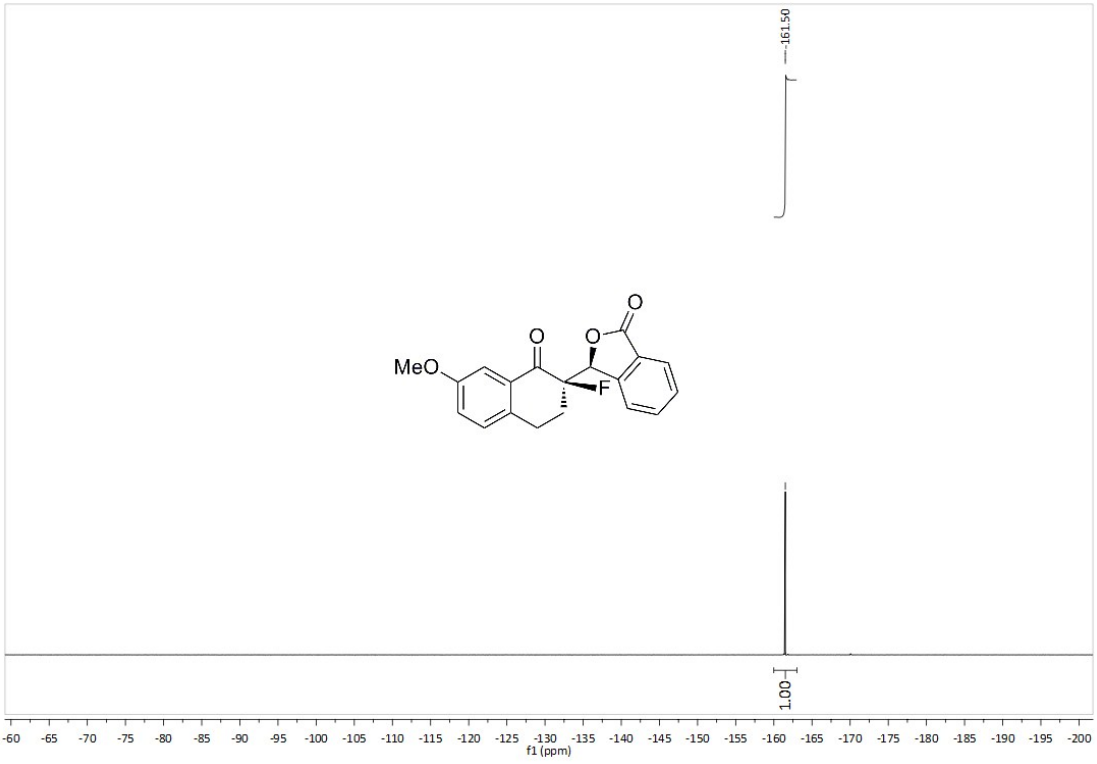
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7fa**



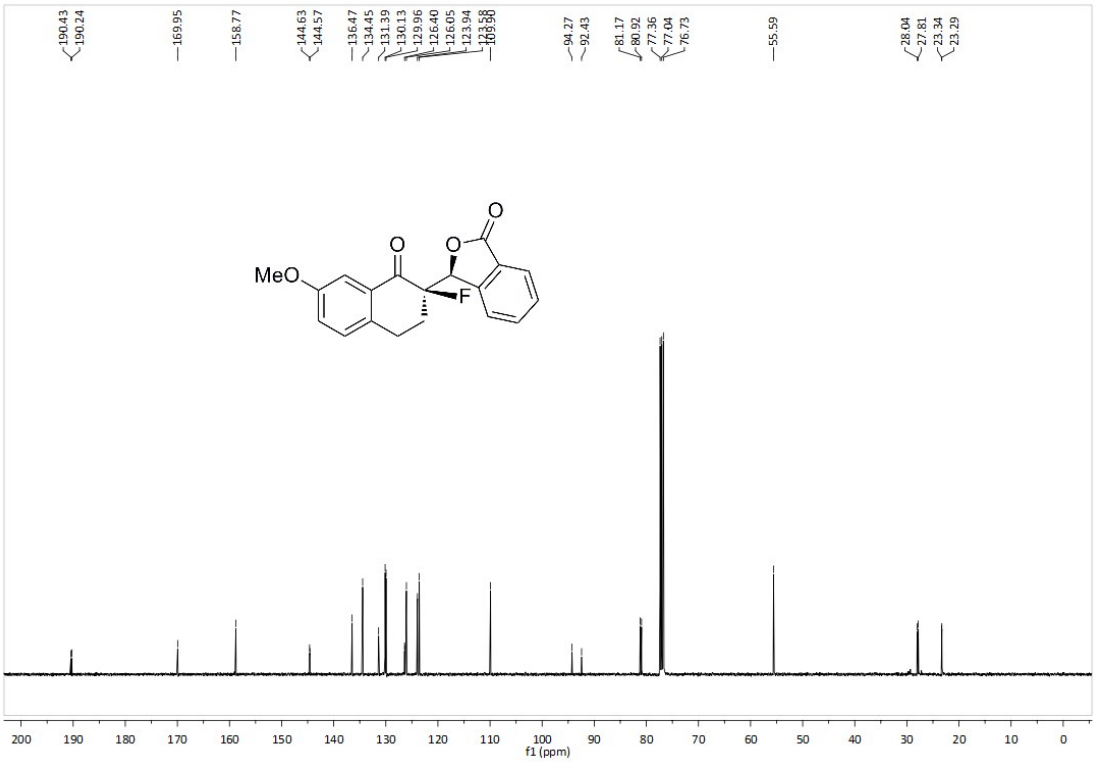
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ga**



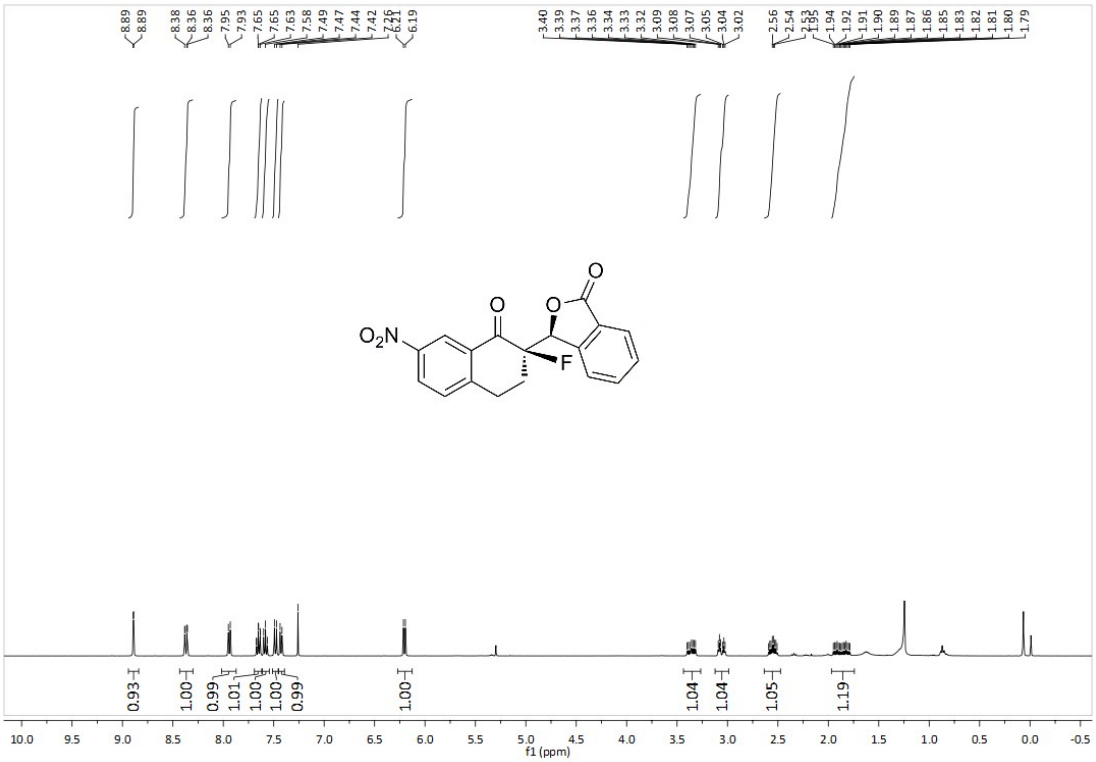
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ga**



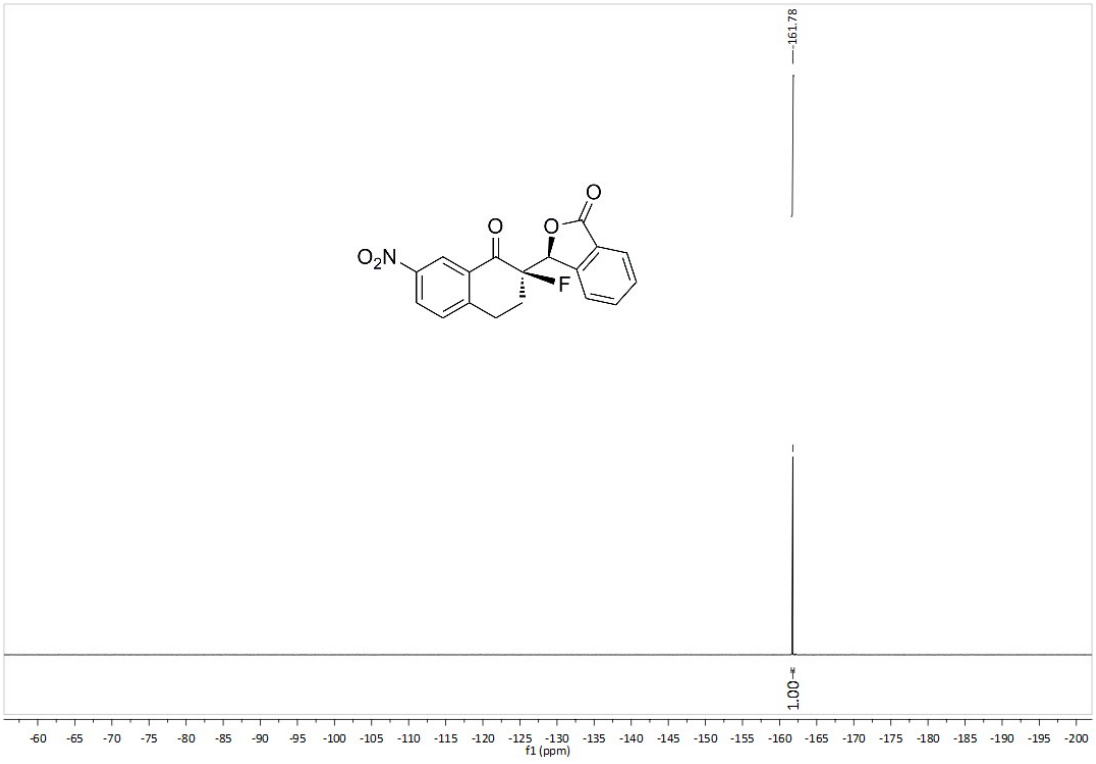
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ga**



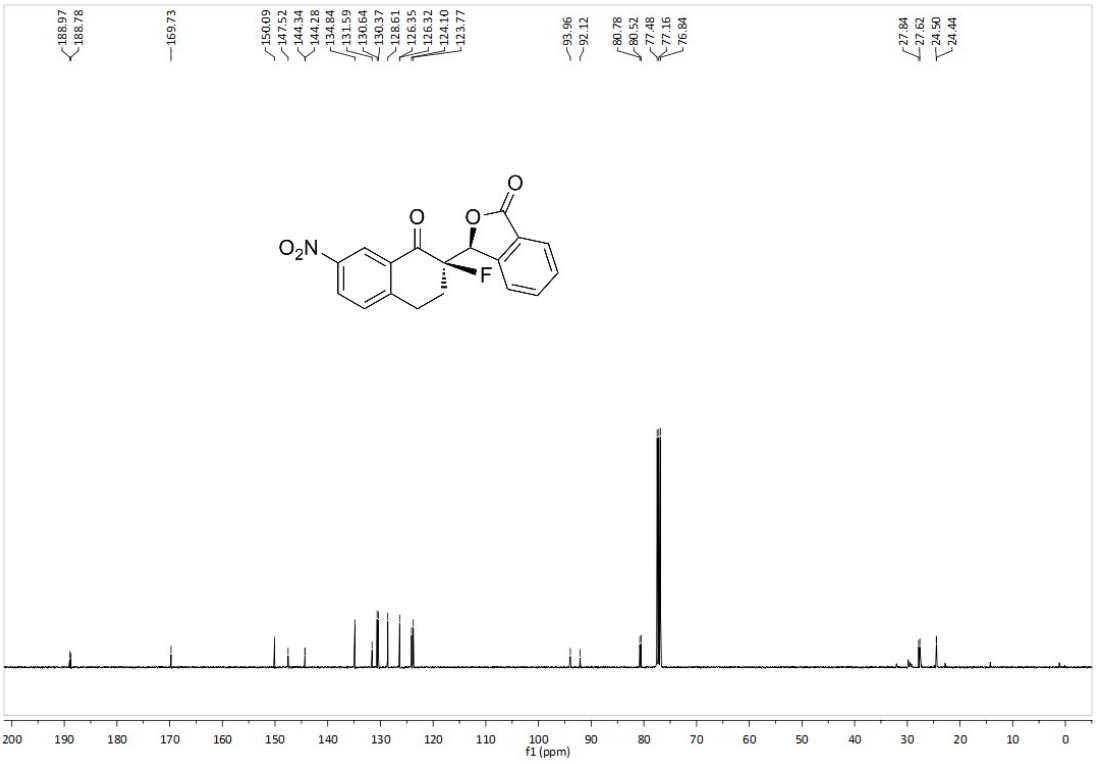
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ha**



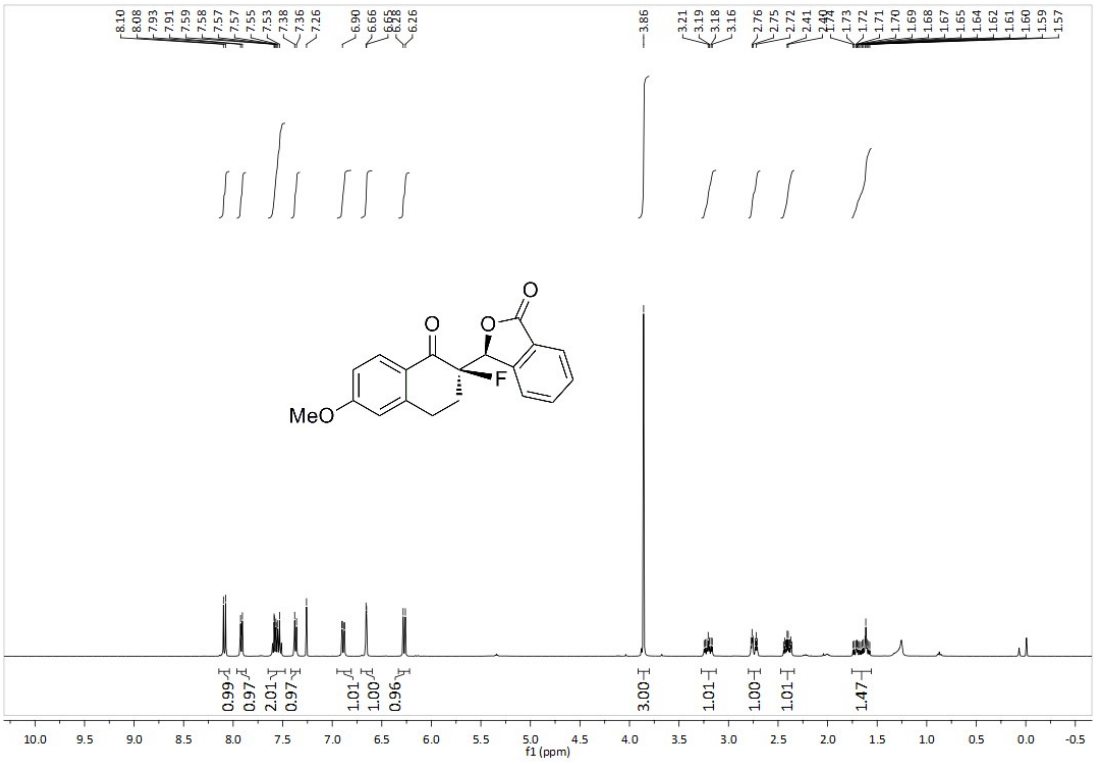
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ha**



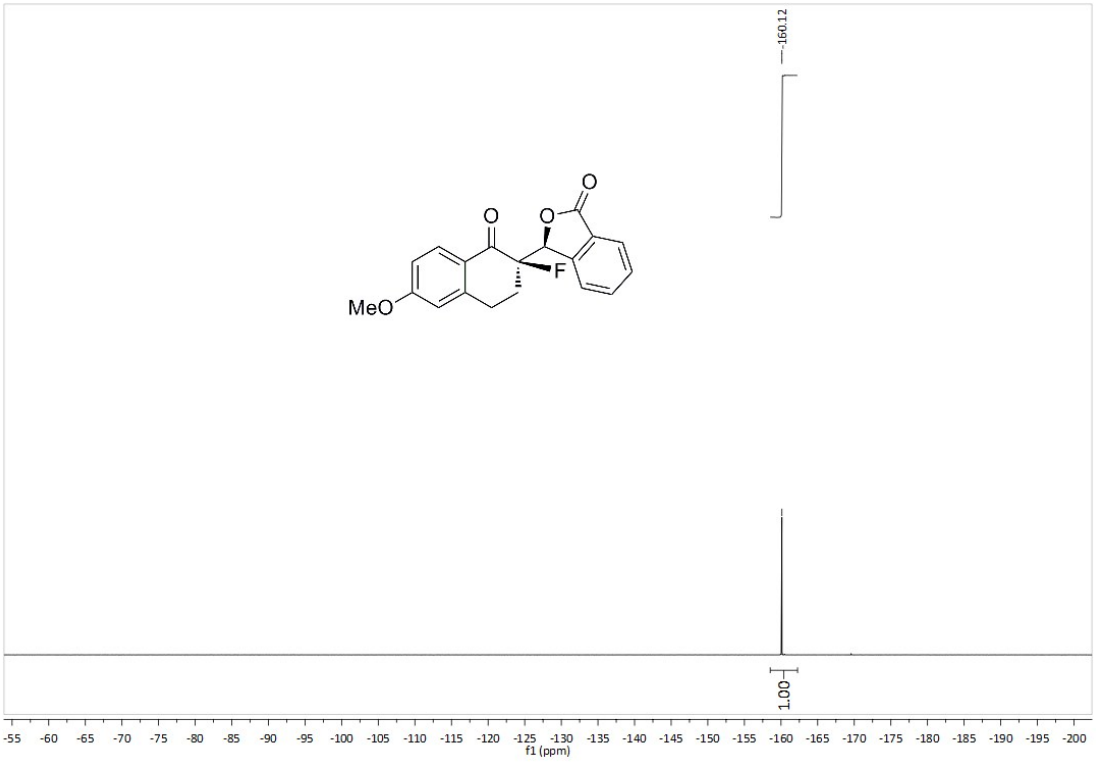
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ha**



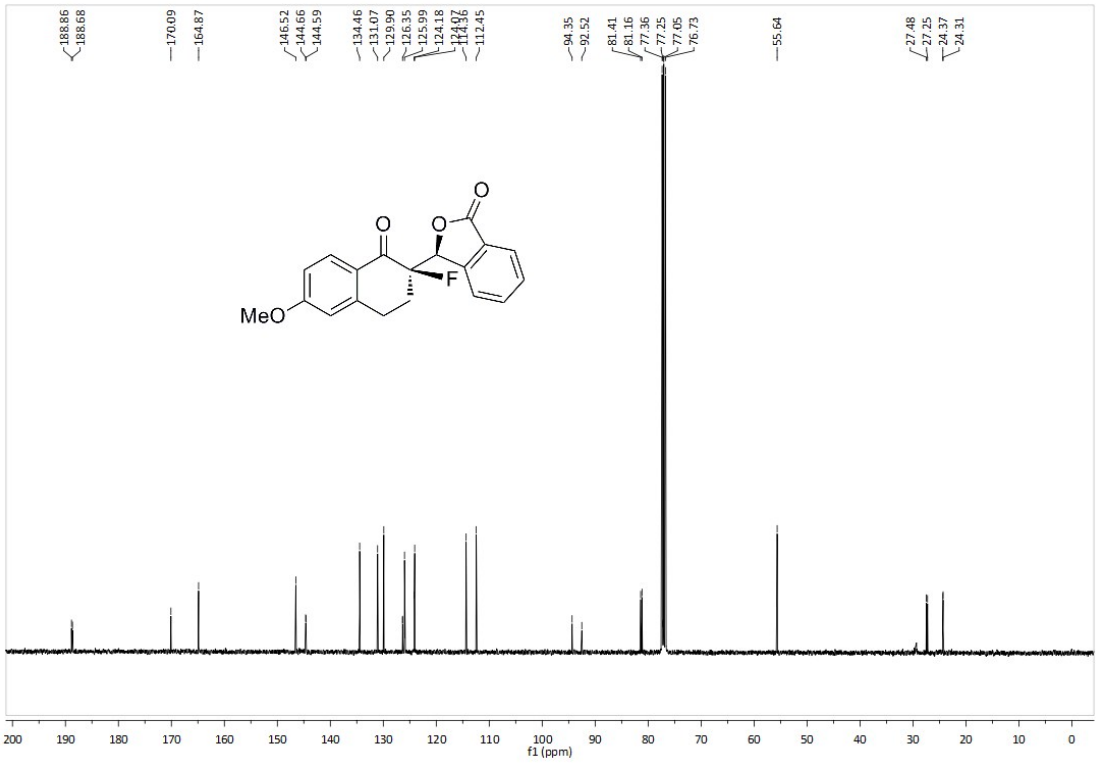
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ia**



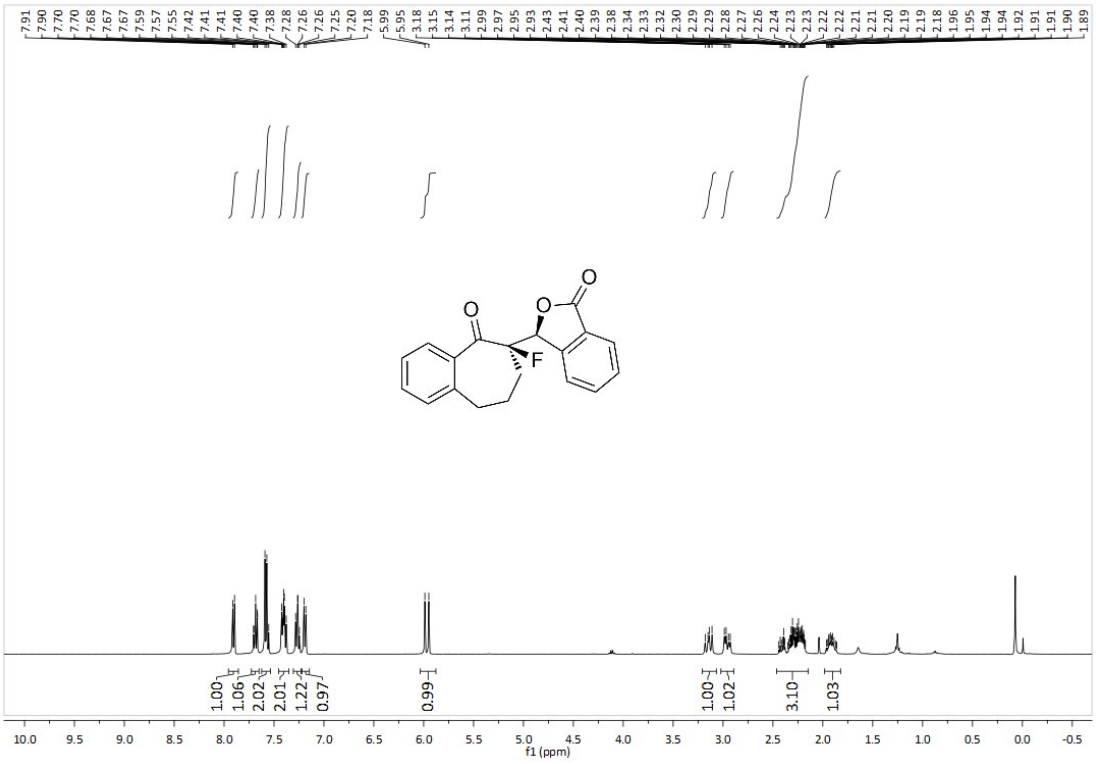
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ia**



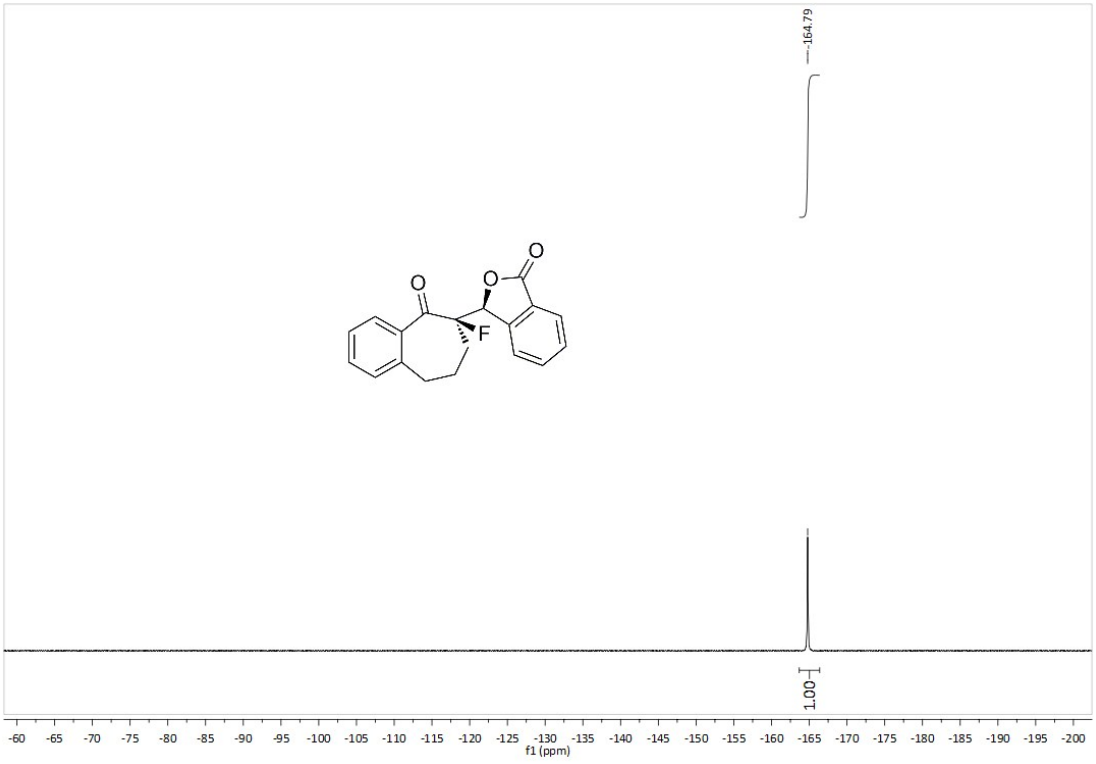
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ia**



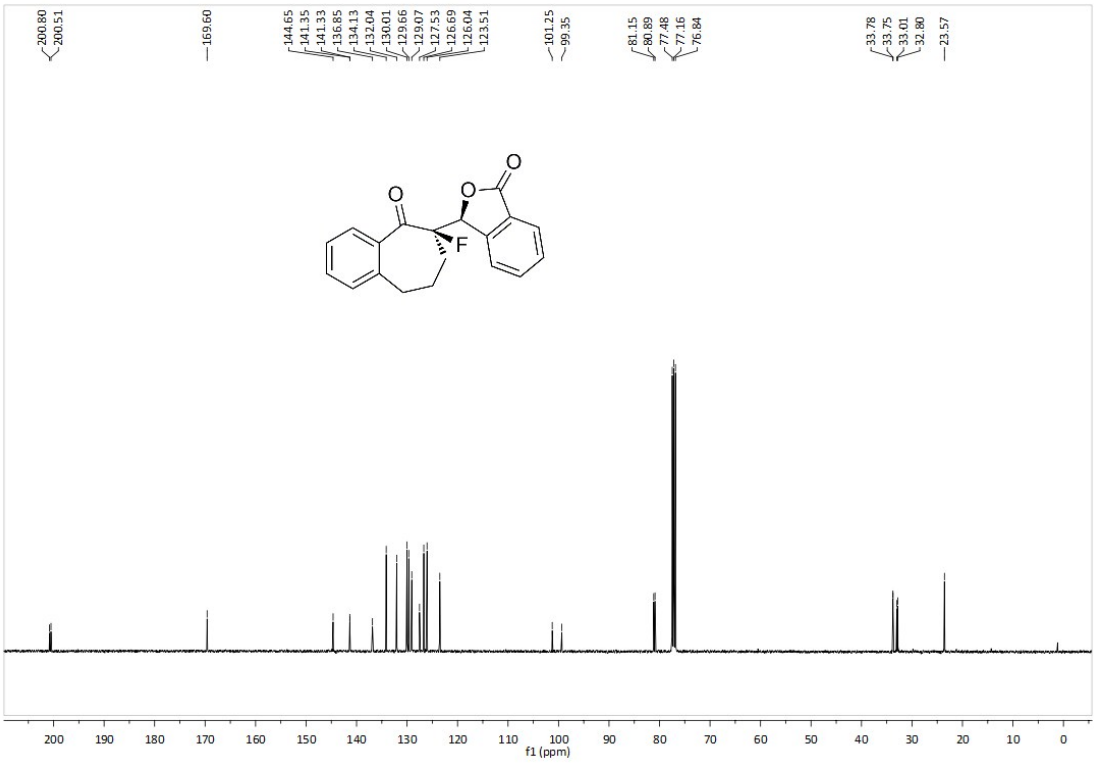
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ja**



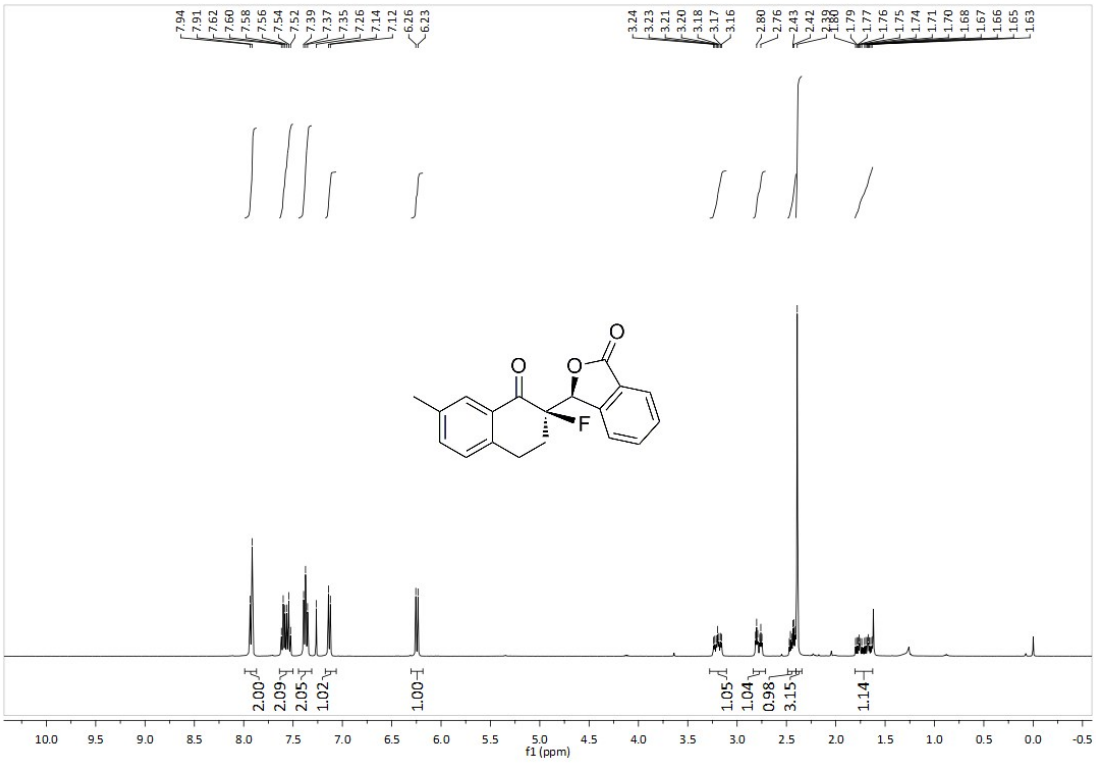
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ja**



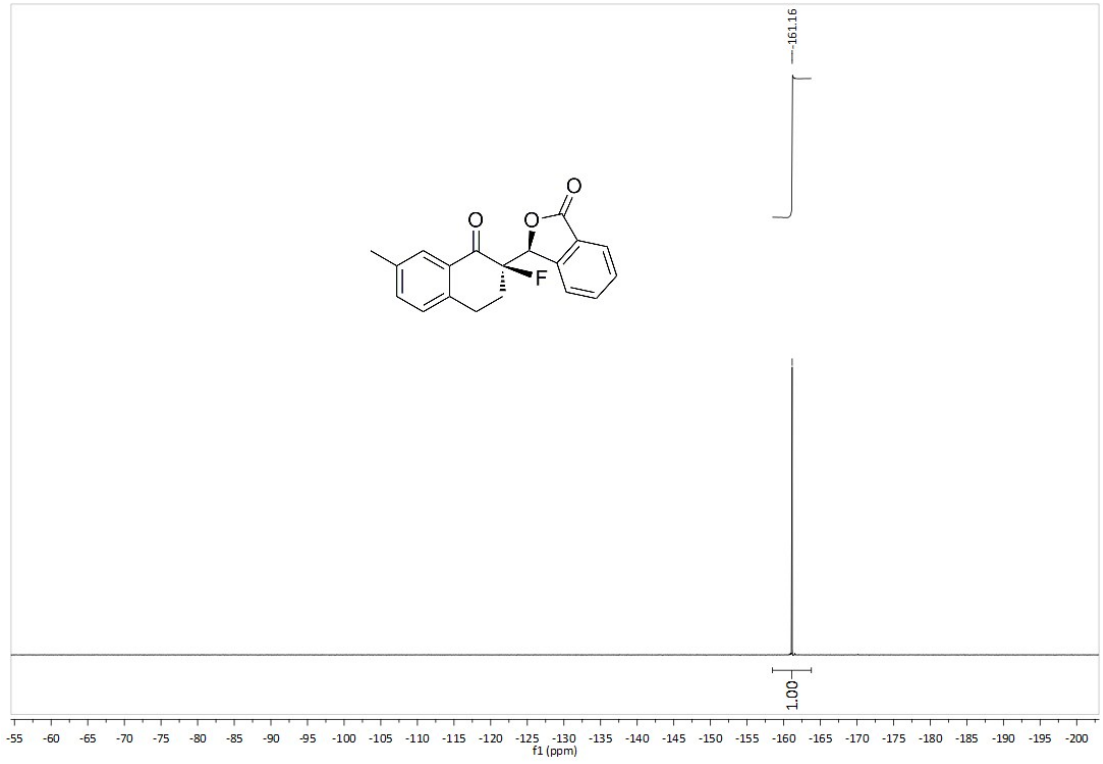
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ja**



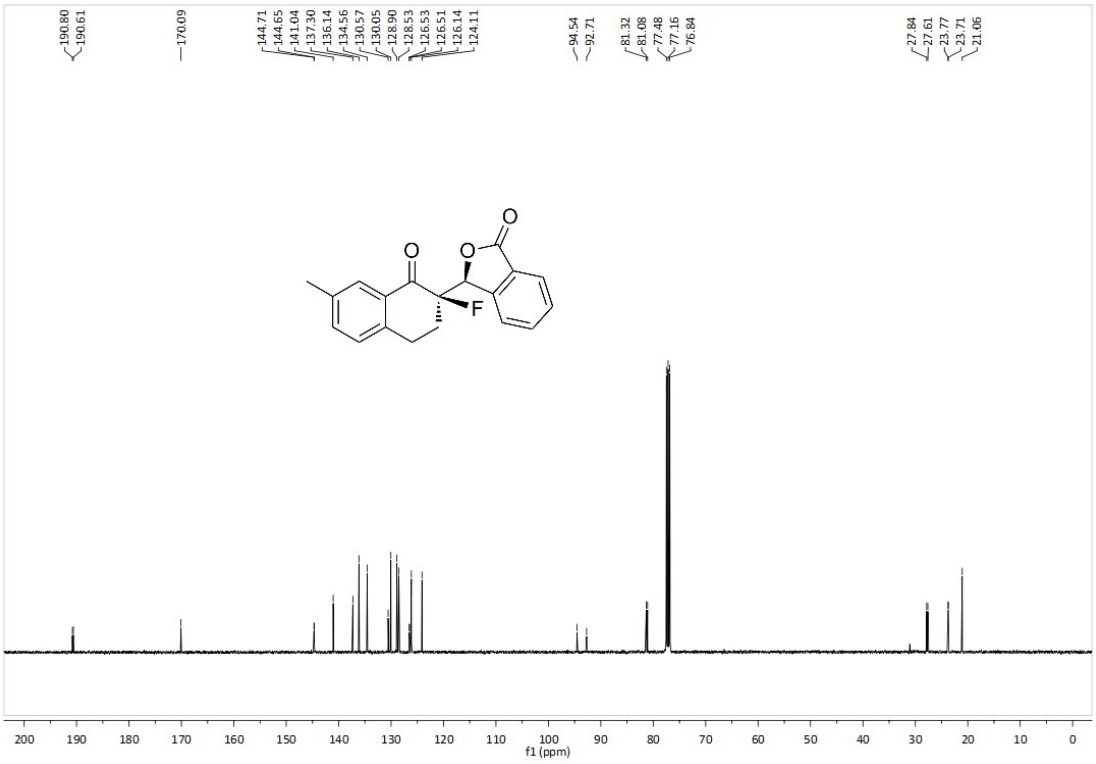
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7la**



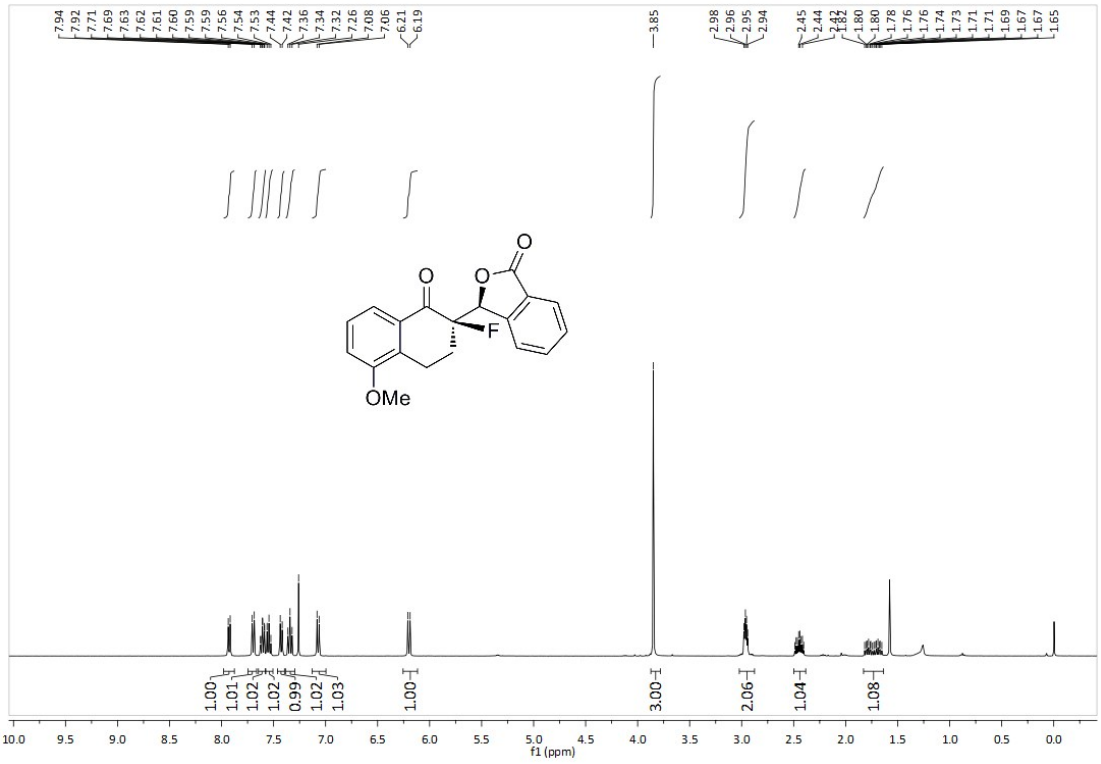
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7la**



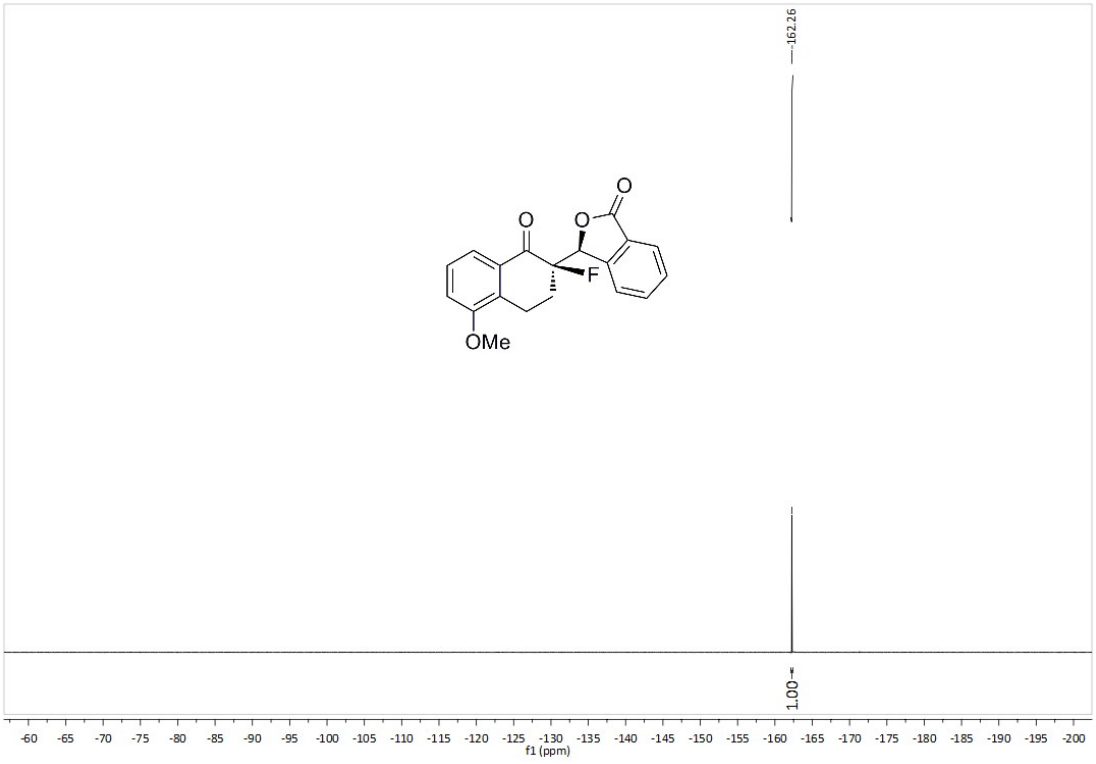
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7la**



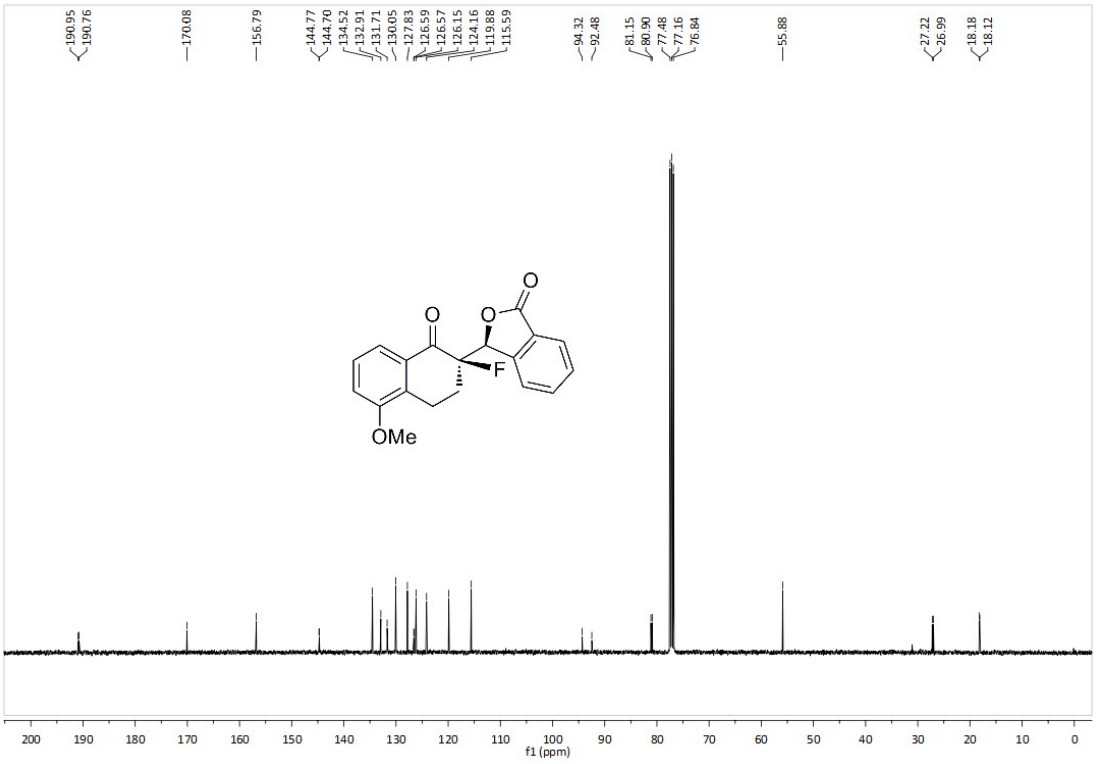
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ma**



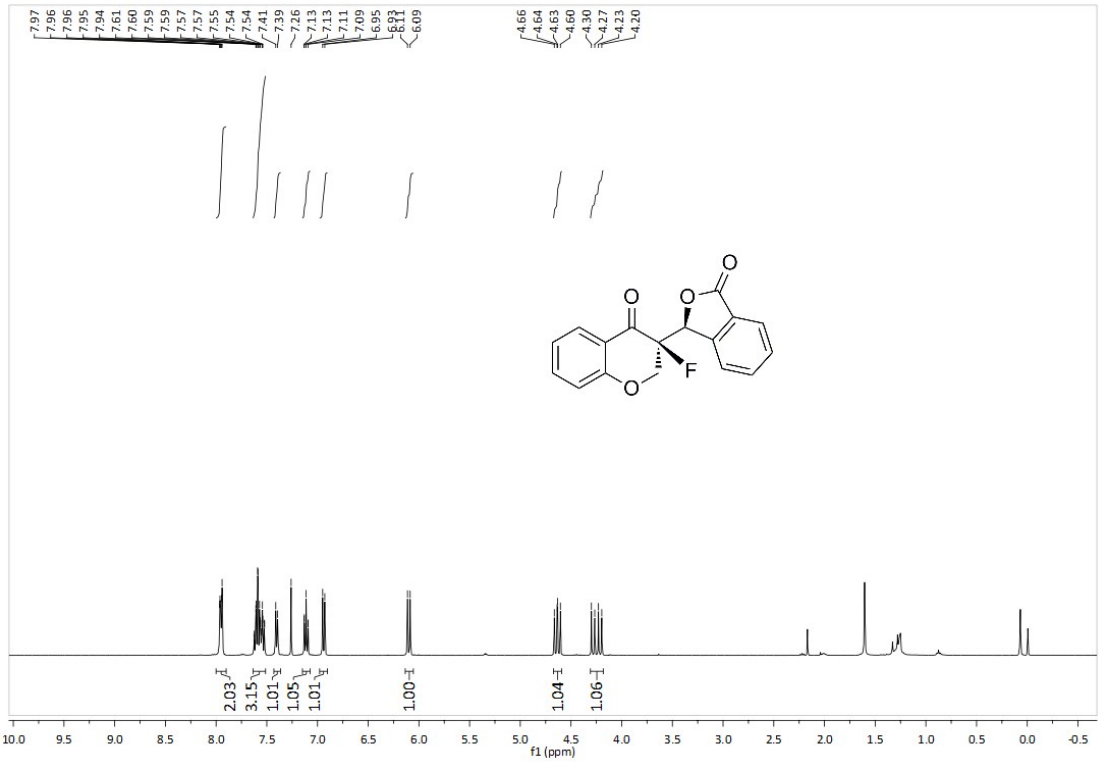
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ma**



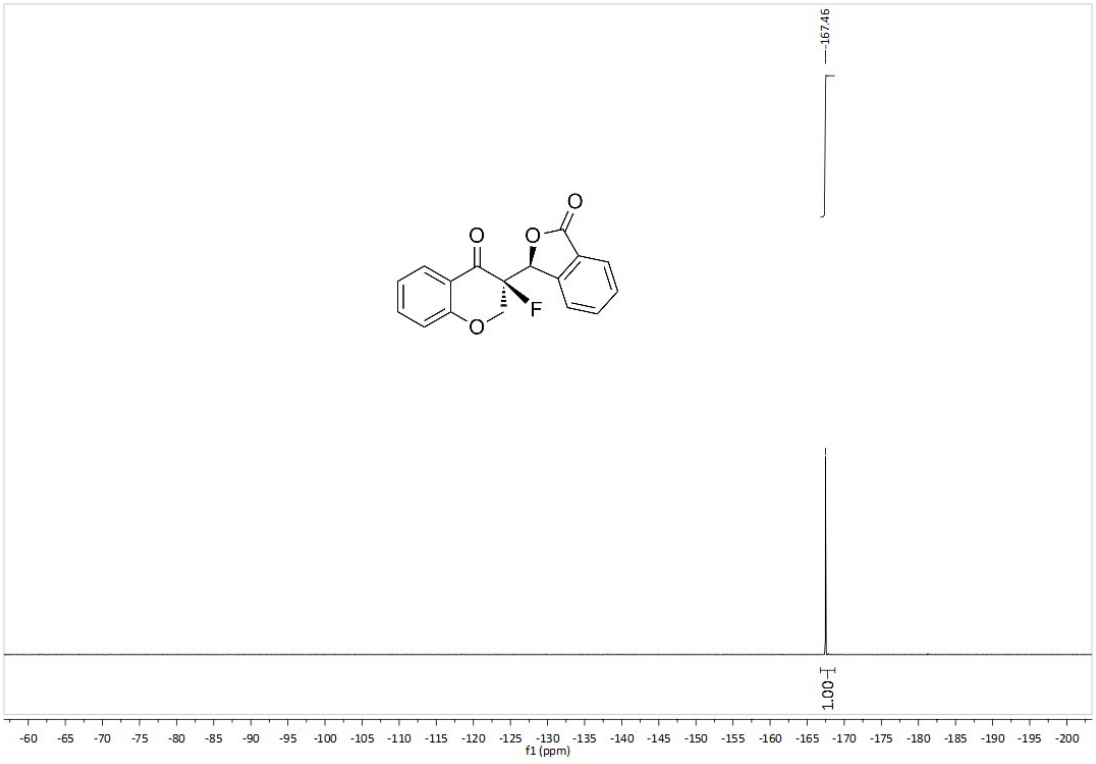
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ma**



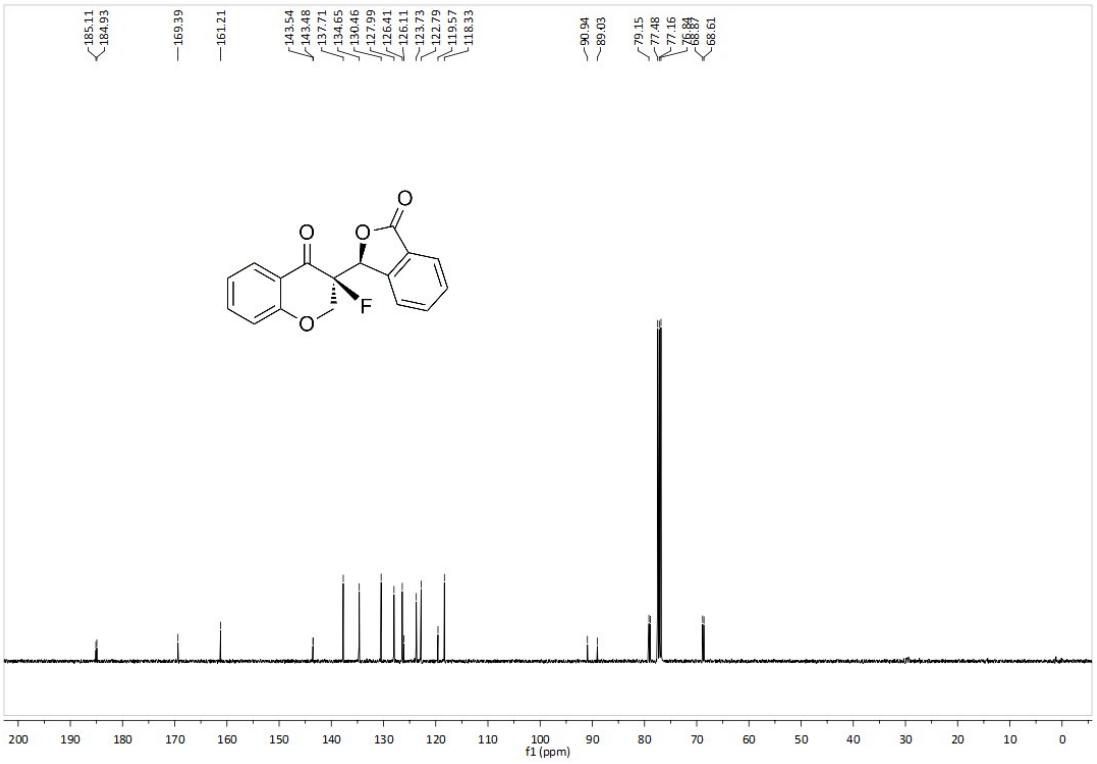
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7na**



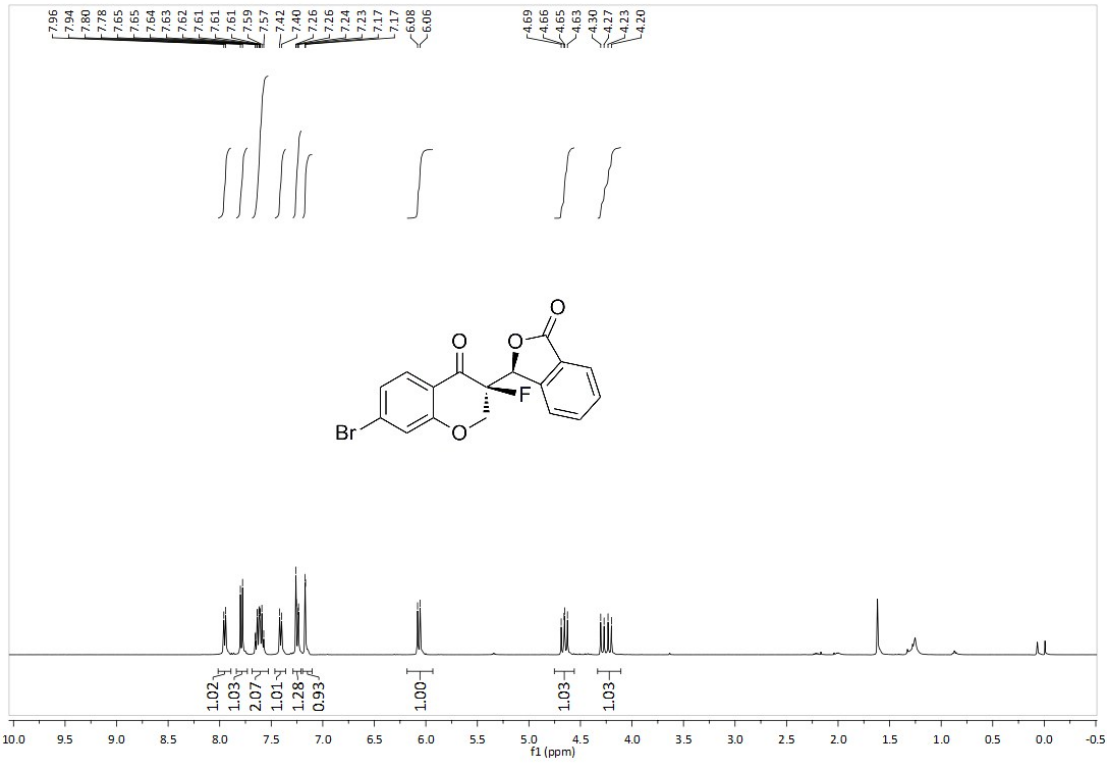
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7na**



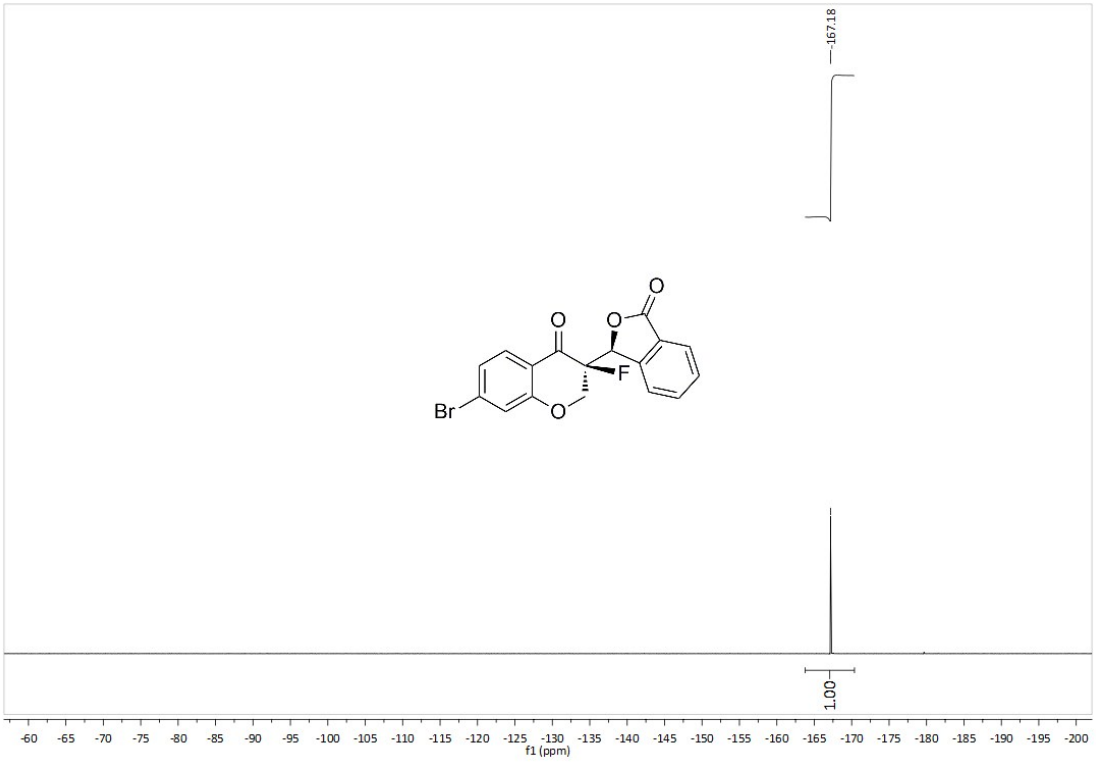
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7na**



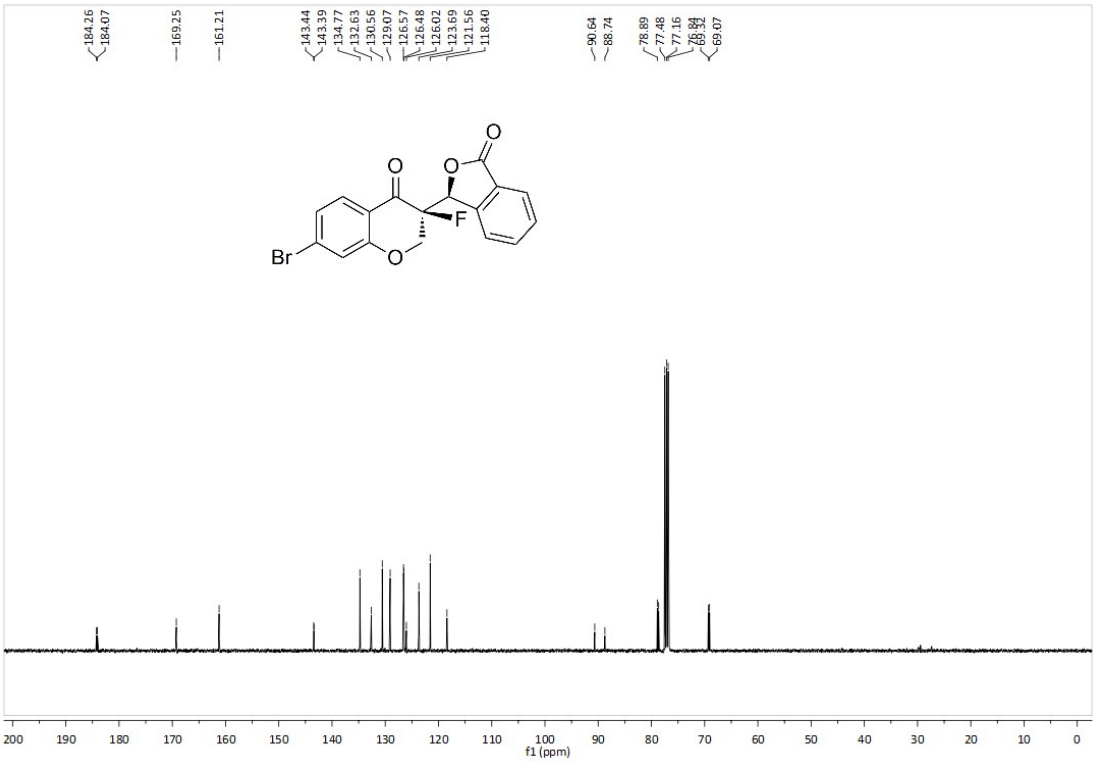
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7oa**



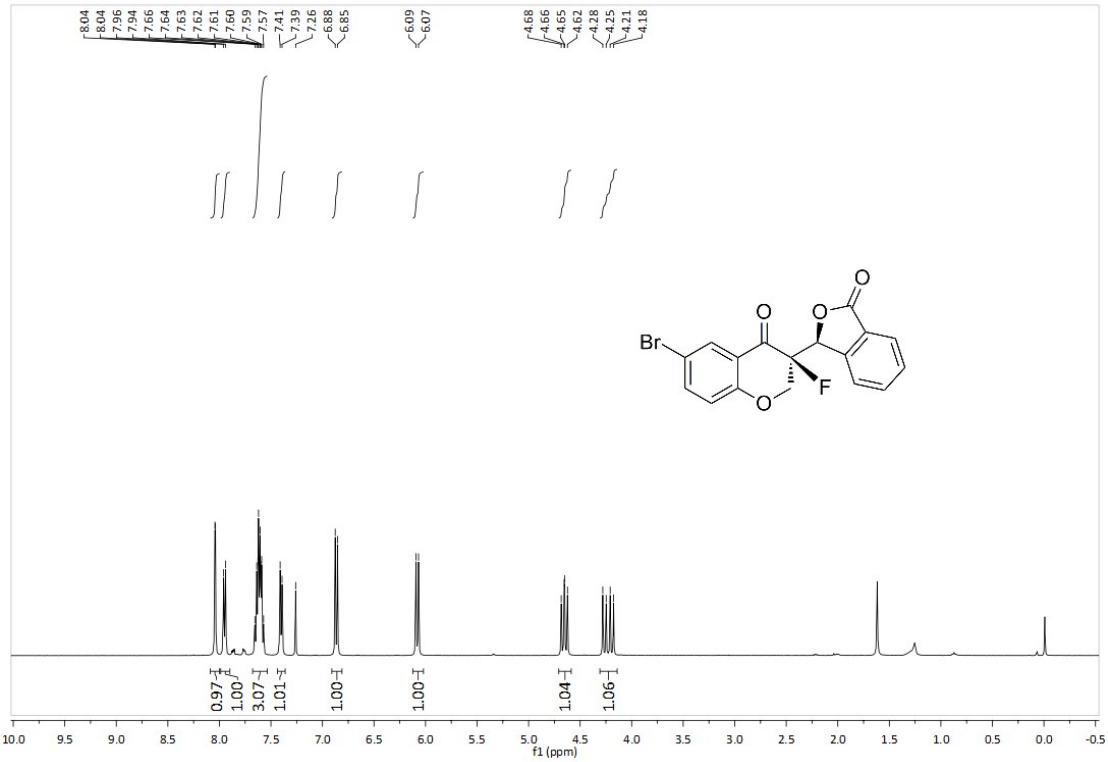
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7oa**



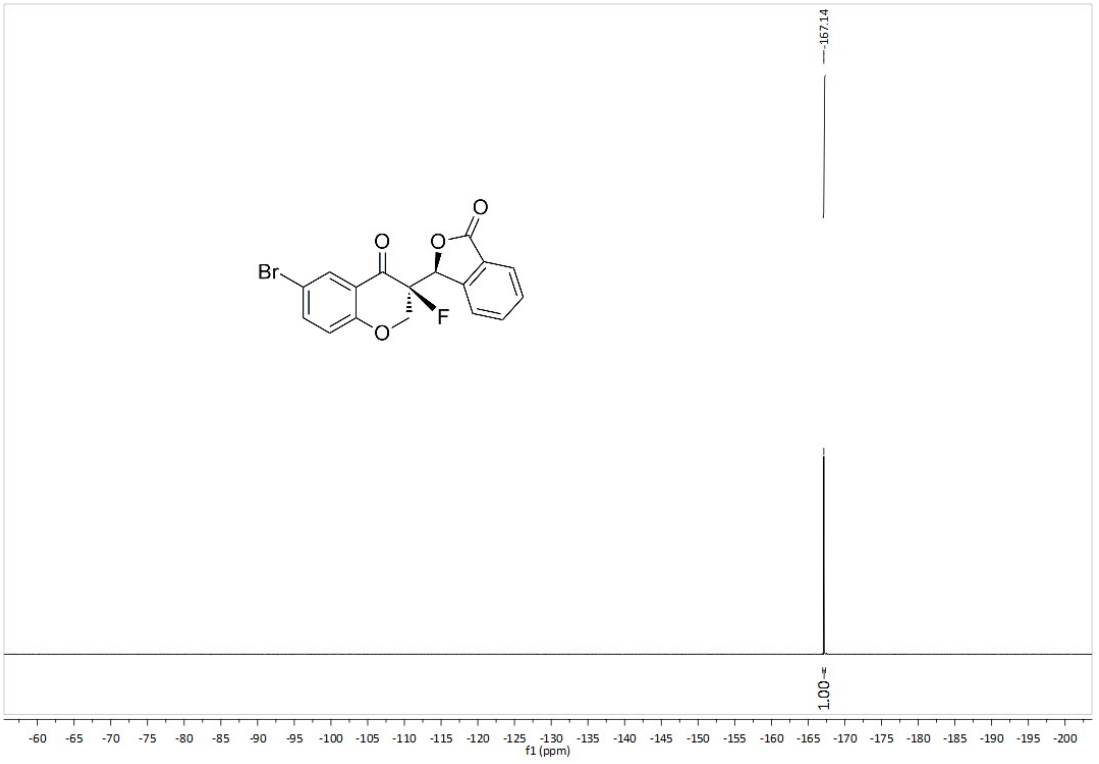
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7oa**



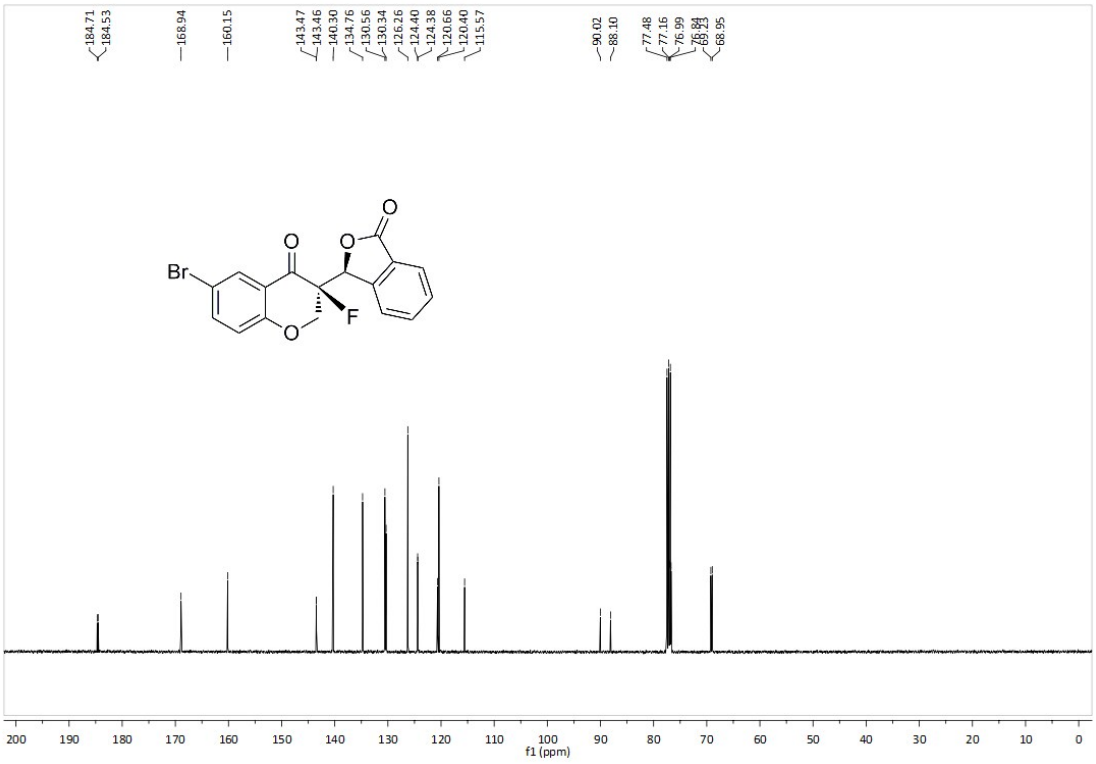
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7pa**



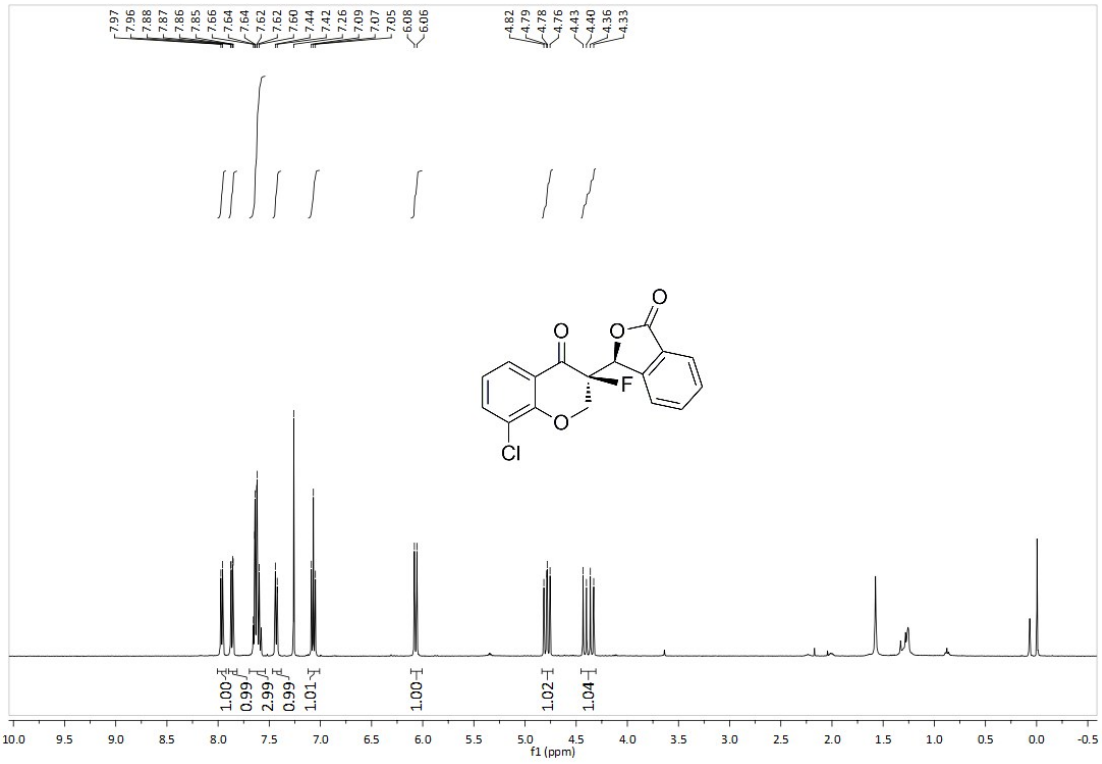
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7pa**



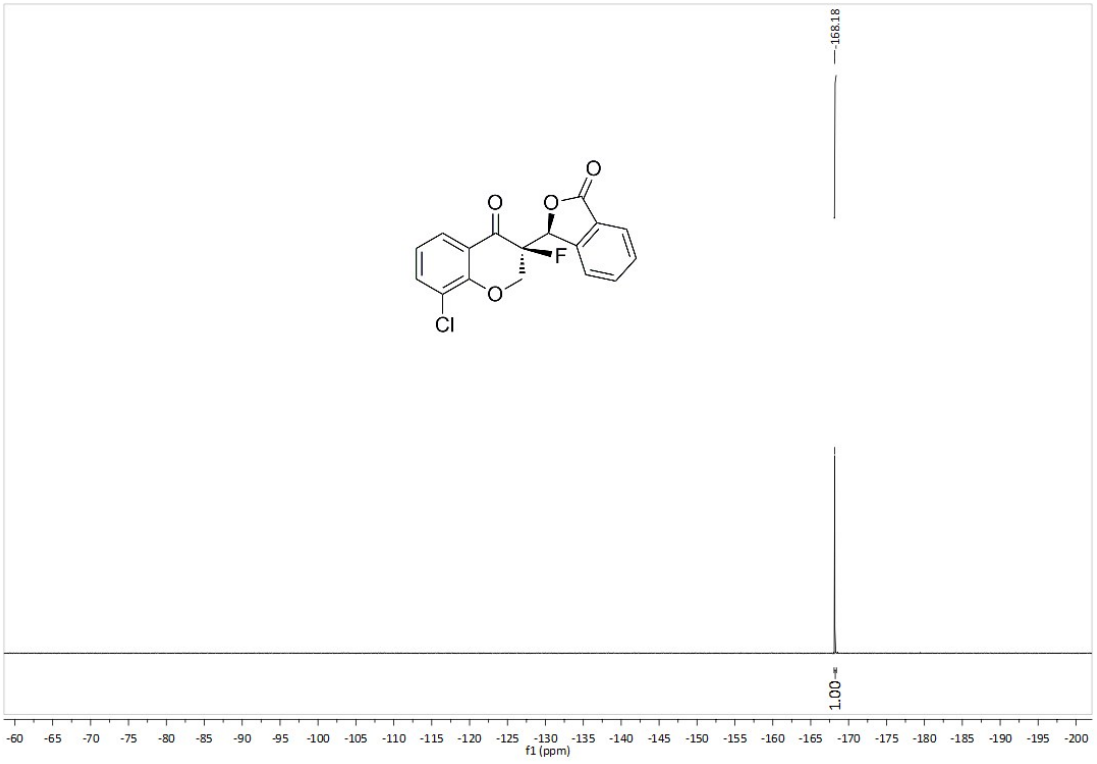
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7pa**



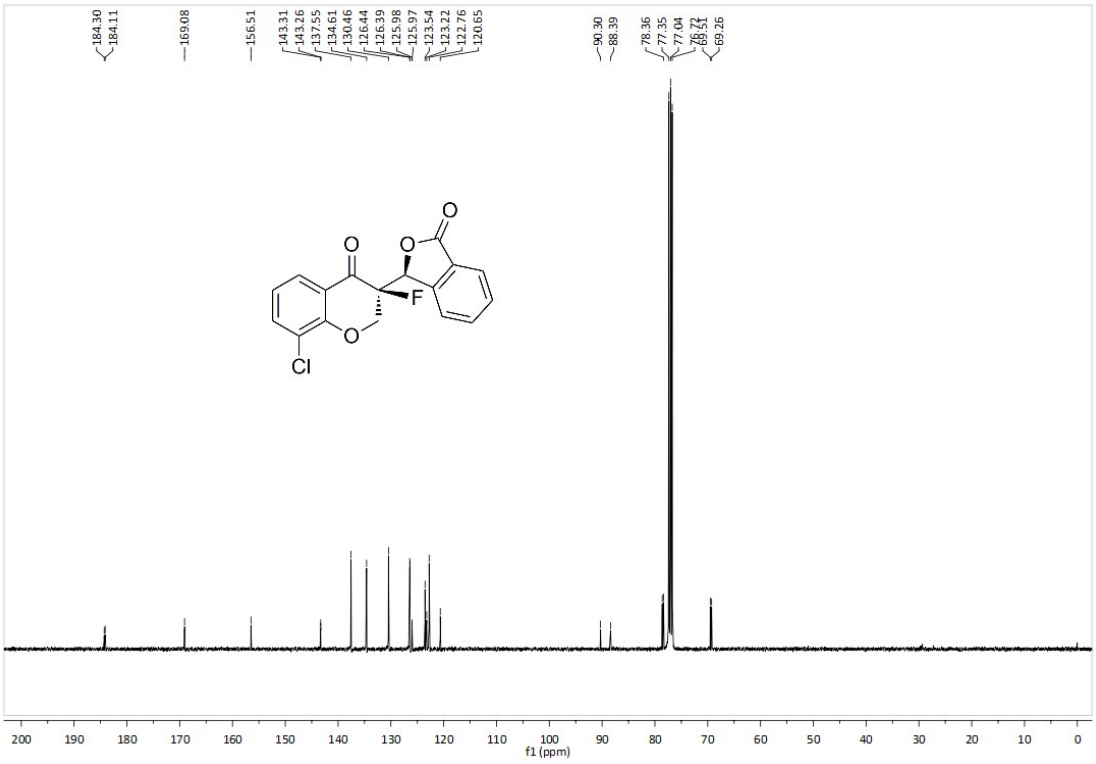
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7qa**



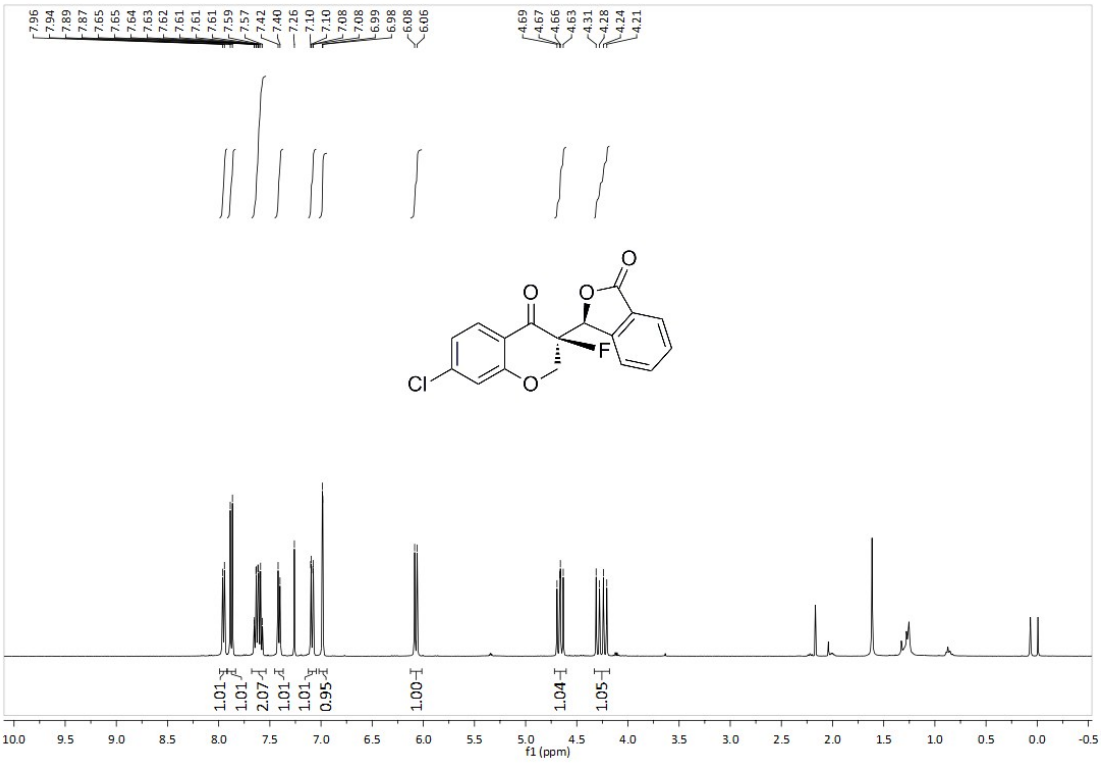
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7qa**



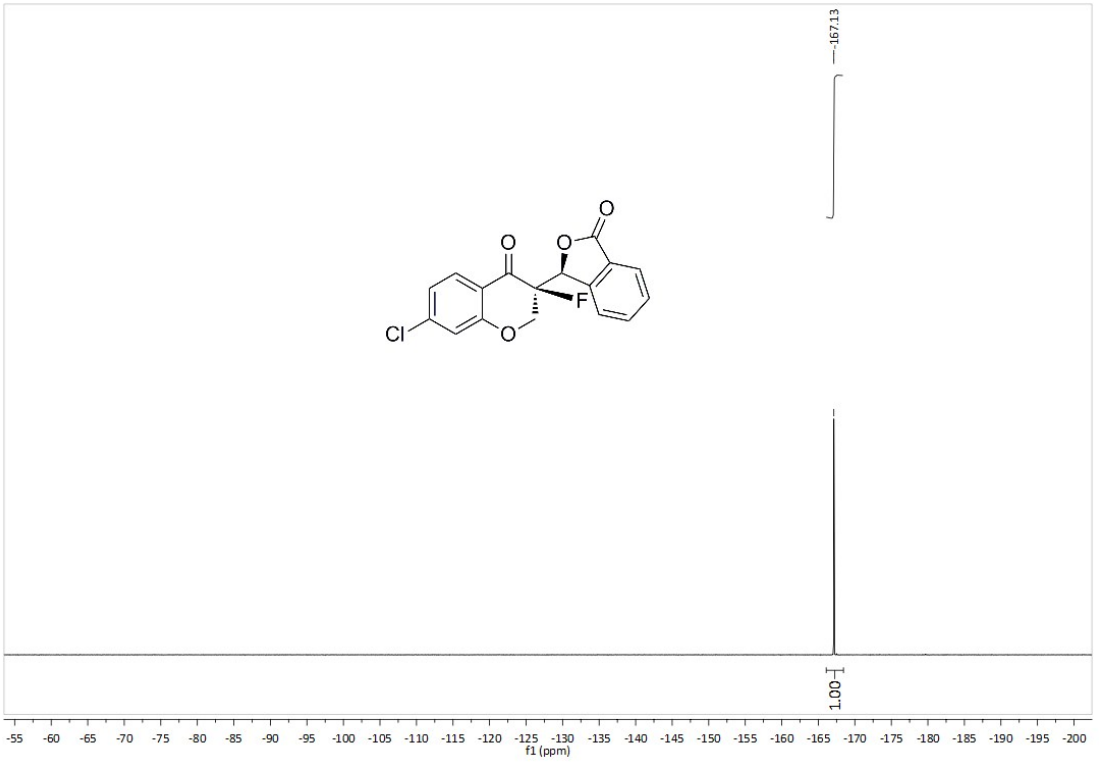
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7qa**



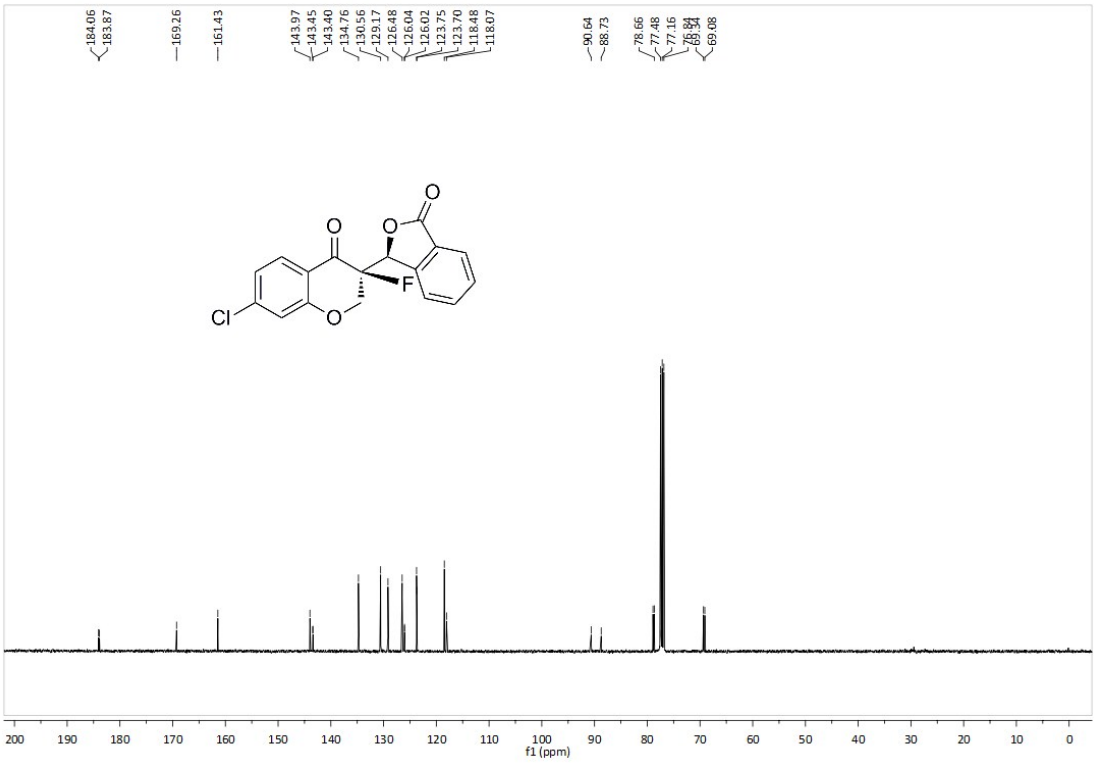
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ra**



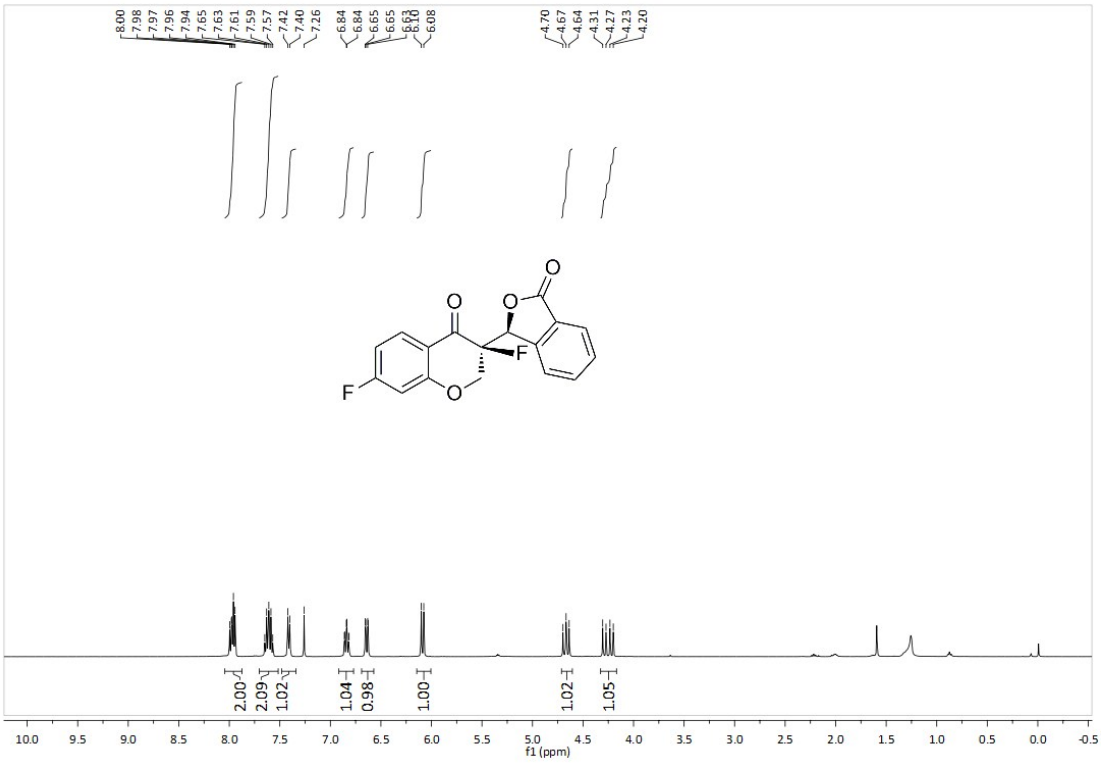
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ra**



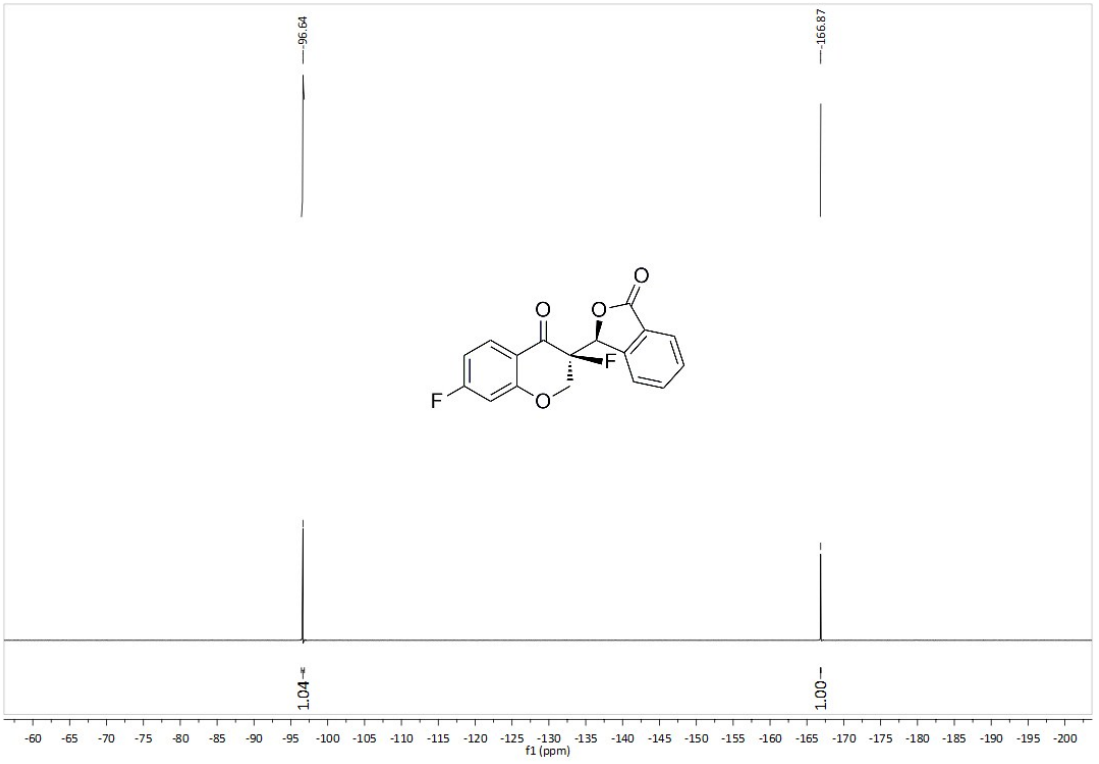
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ra**



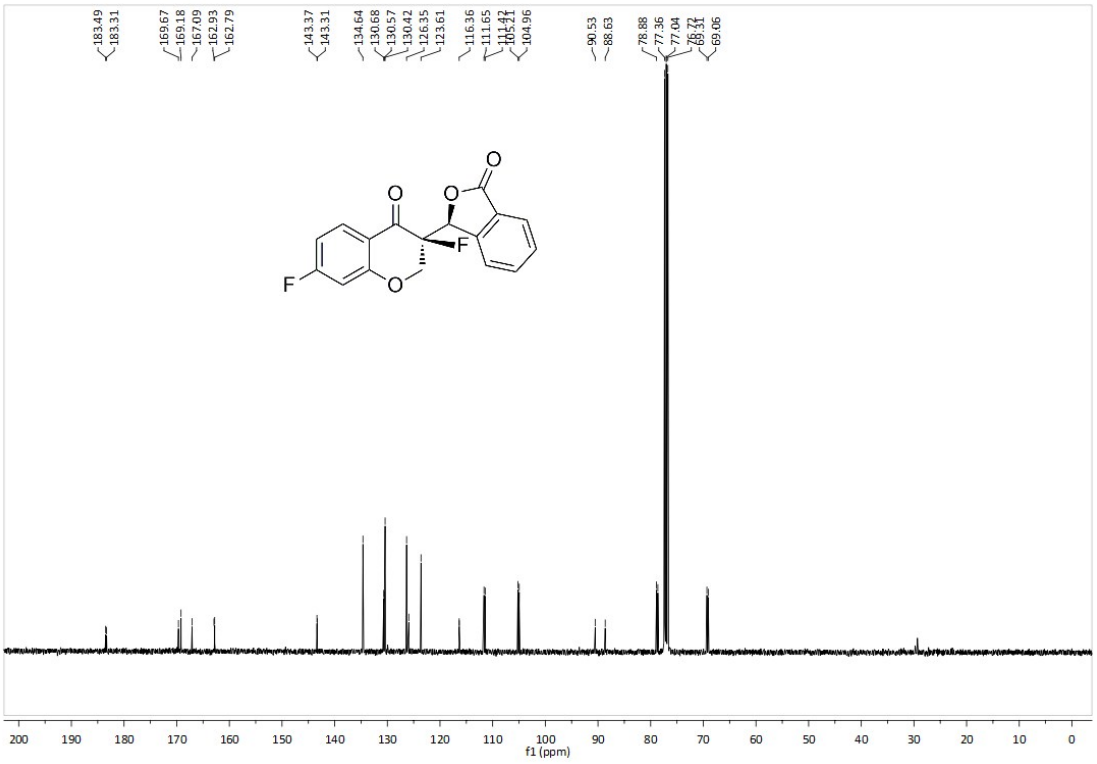
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7sa**



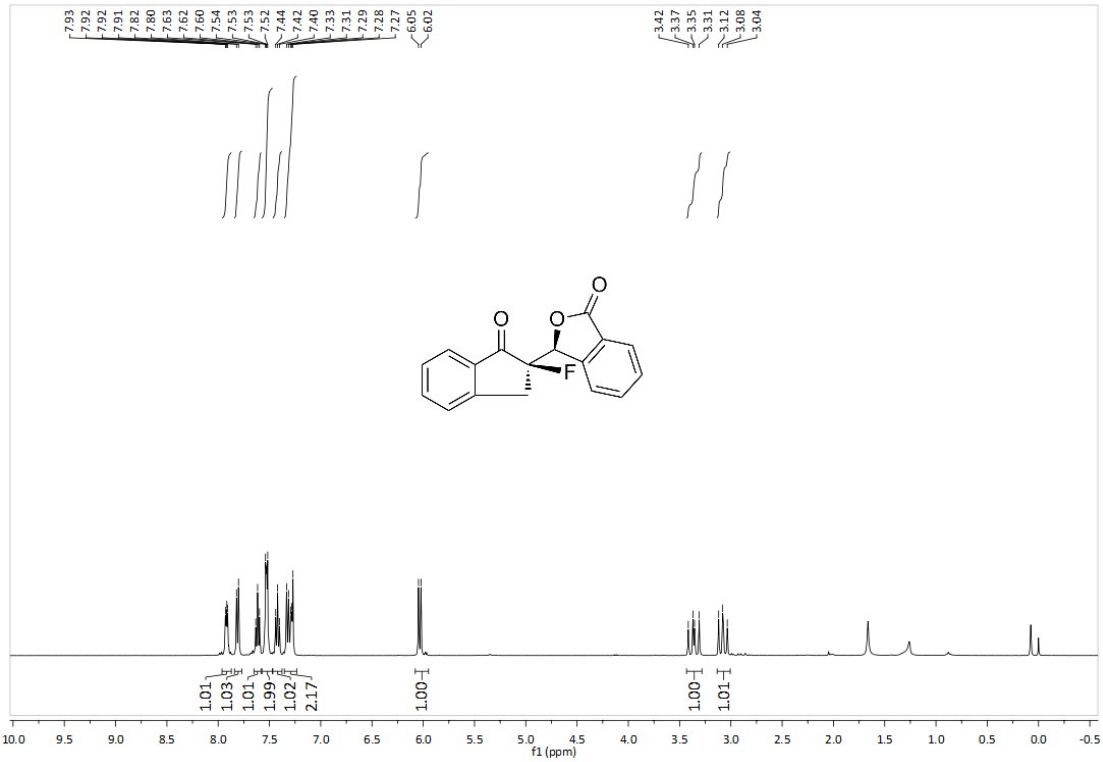
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7sa**



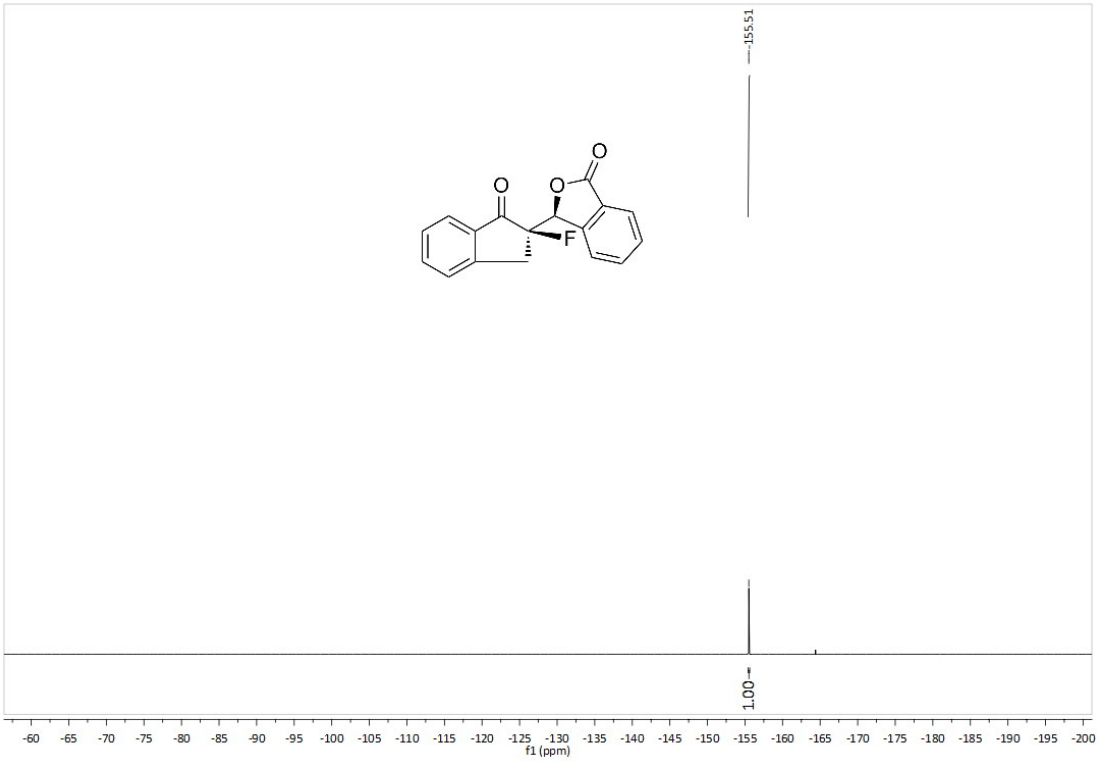
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7sa**



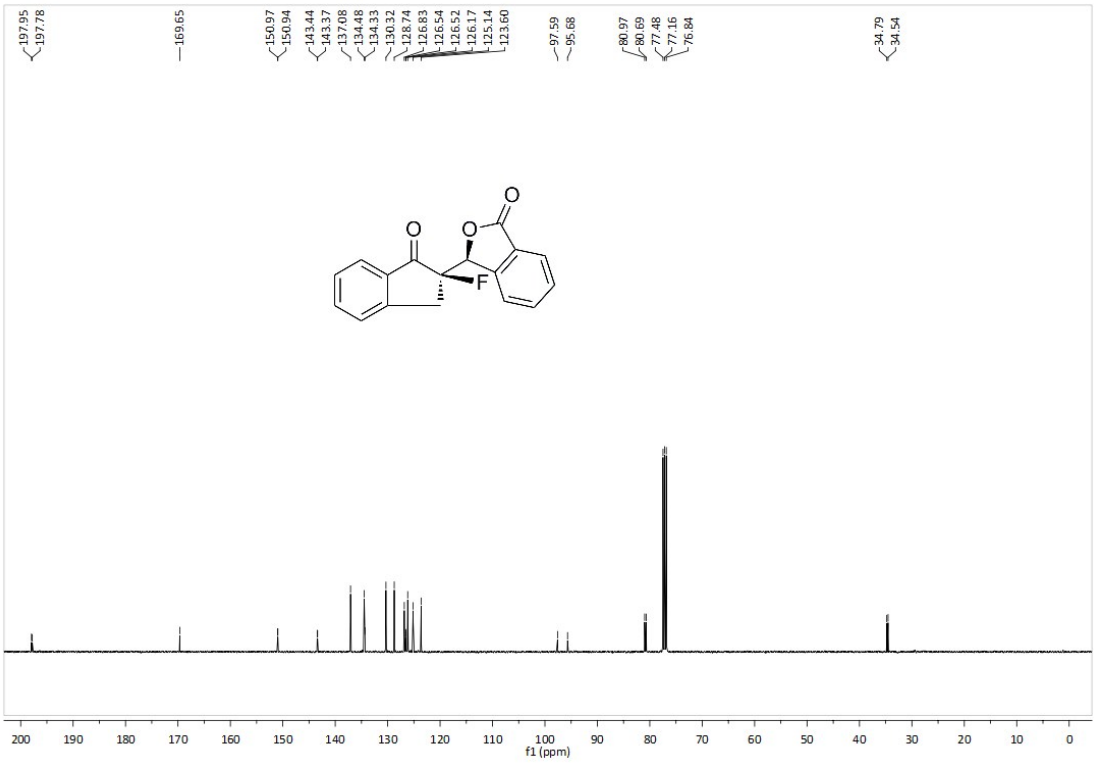
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ta**



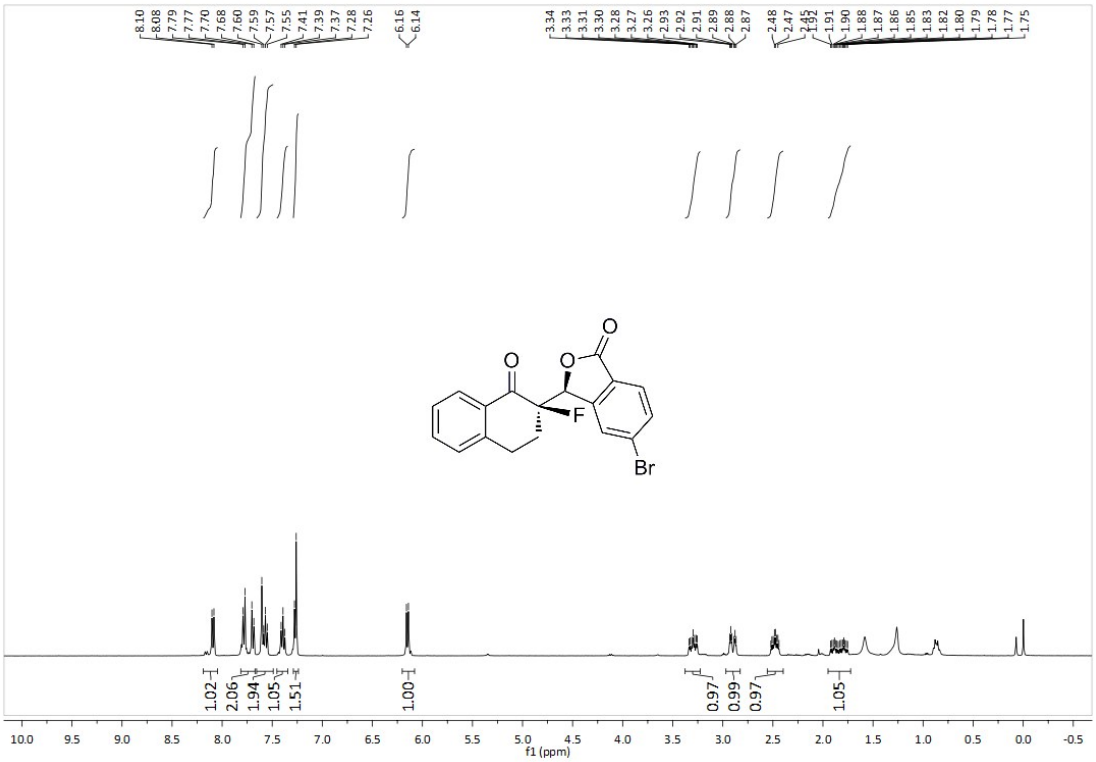
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ta**



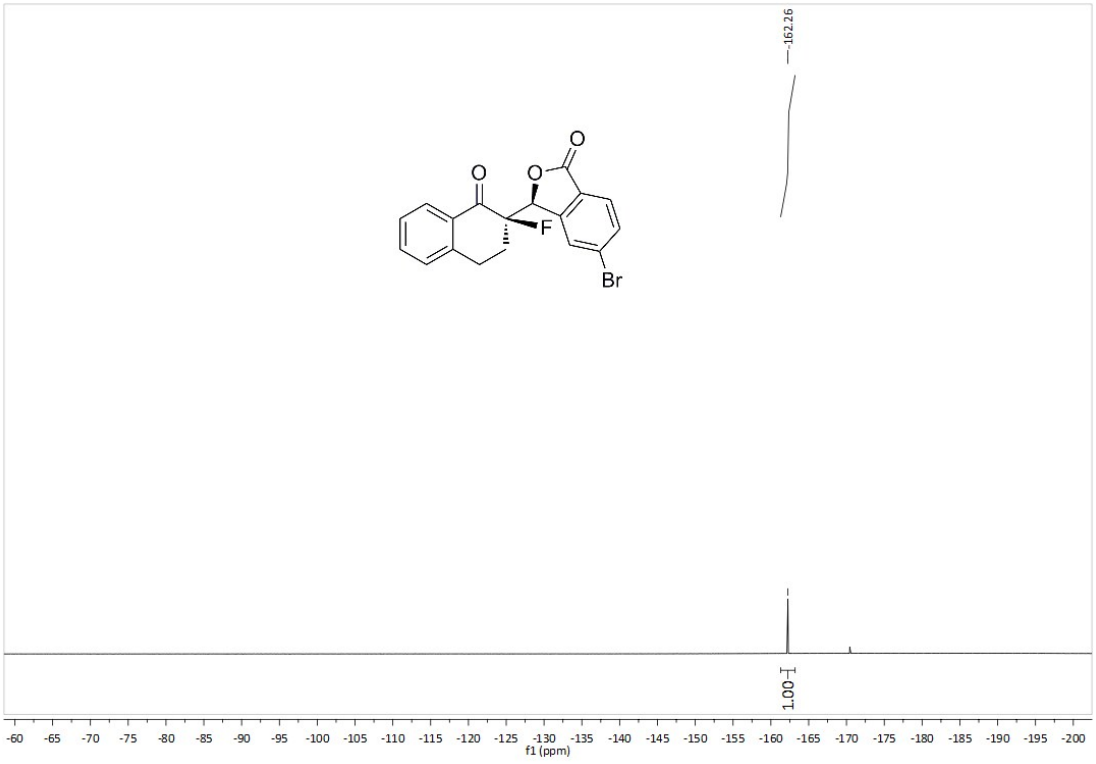
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ta**



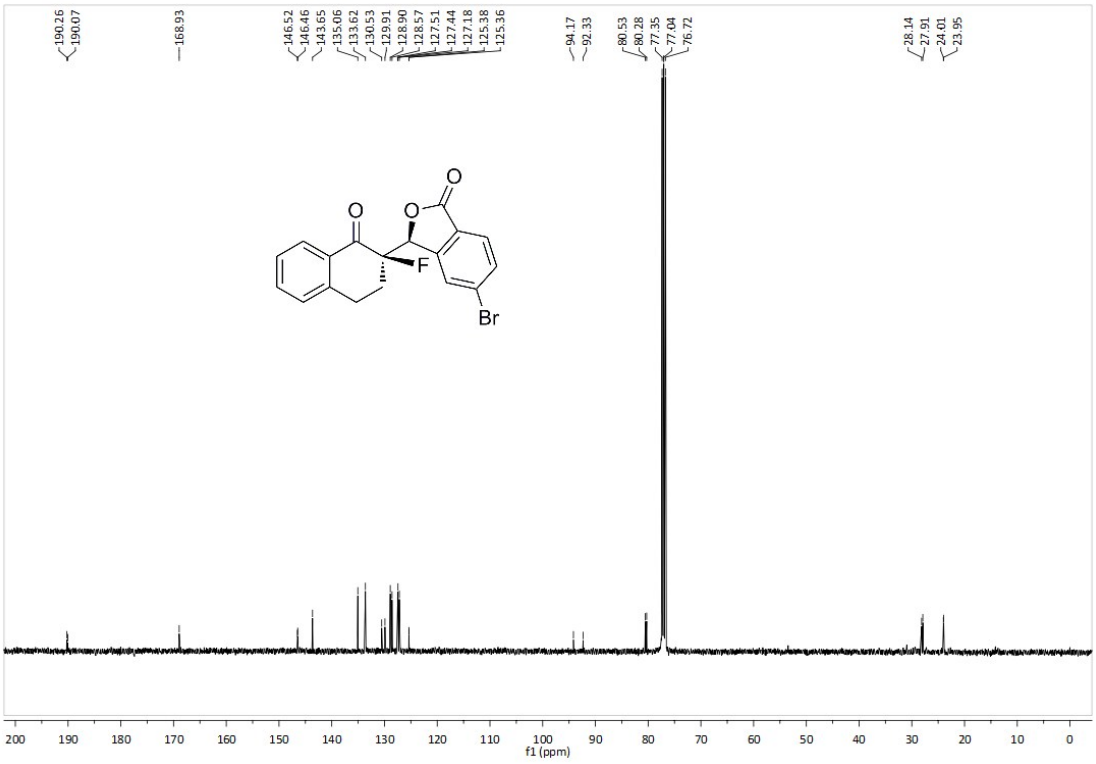
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ab**



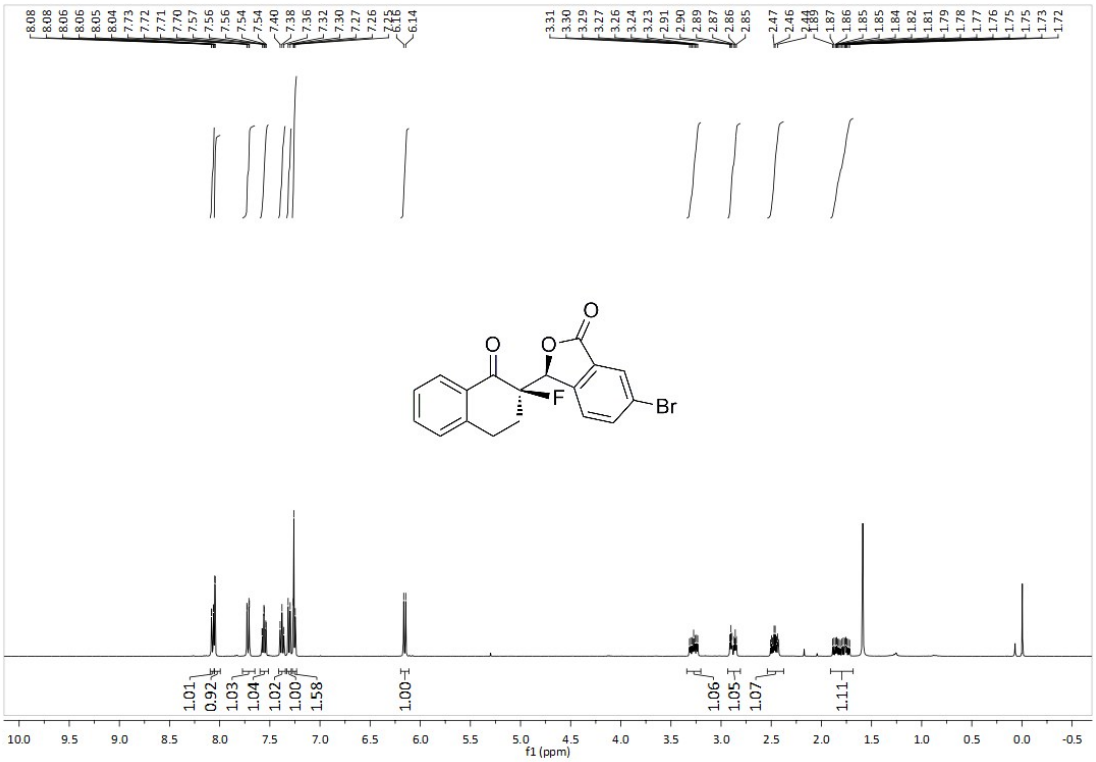
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ab**



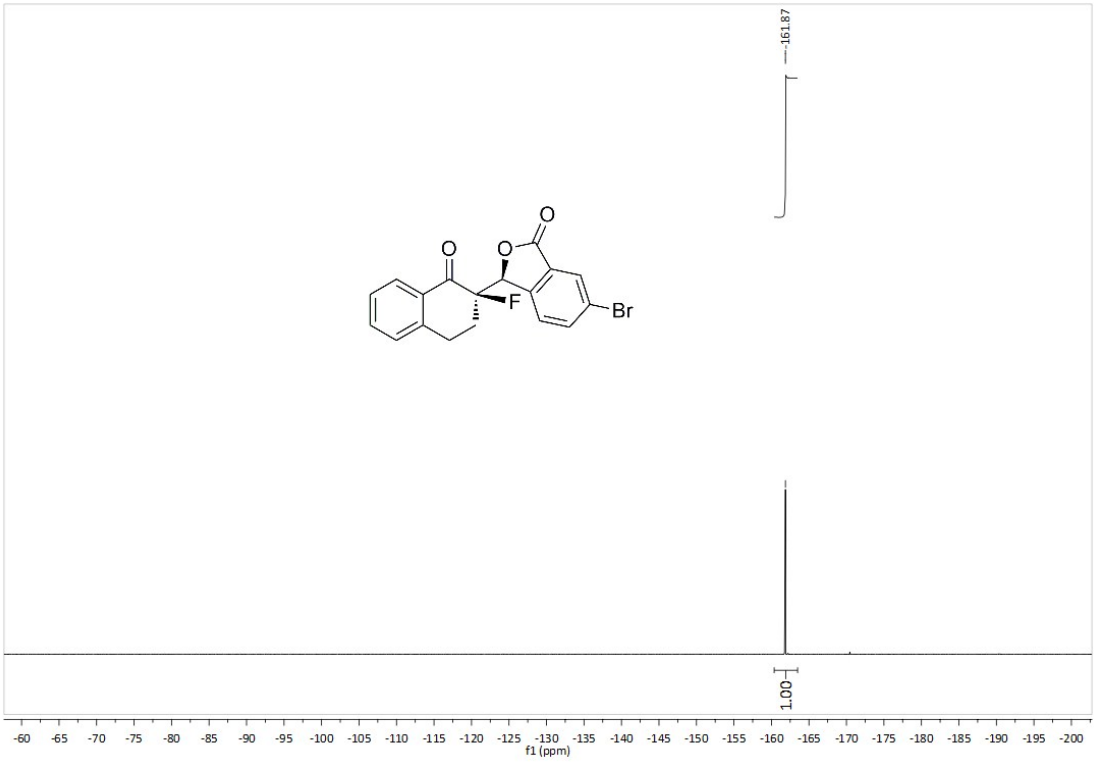
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ab**



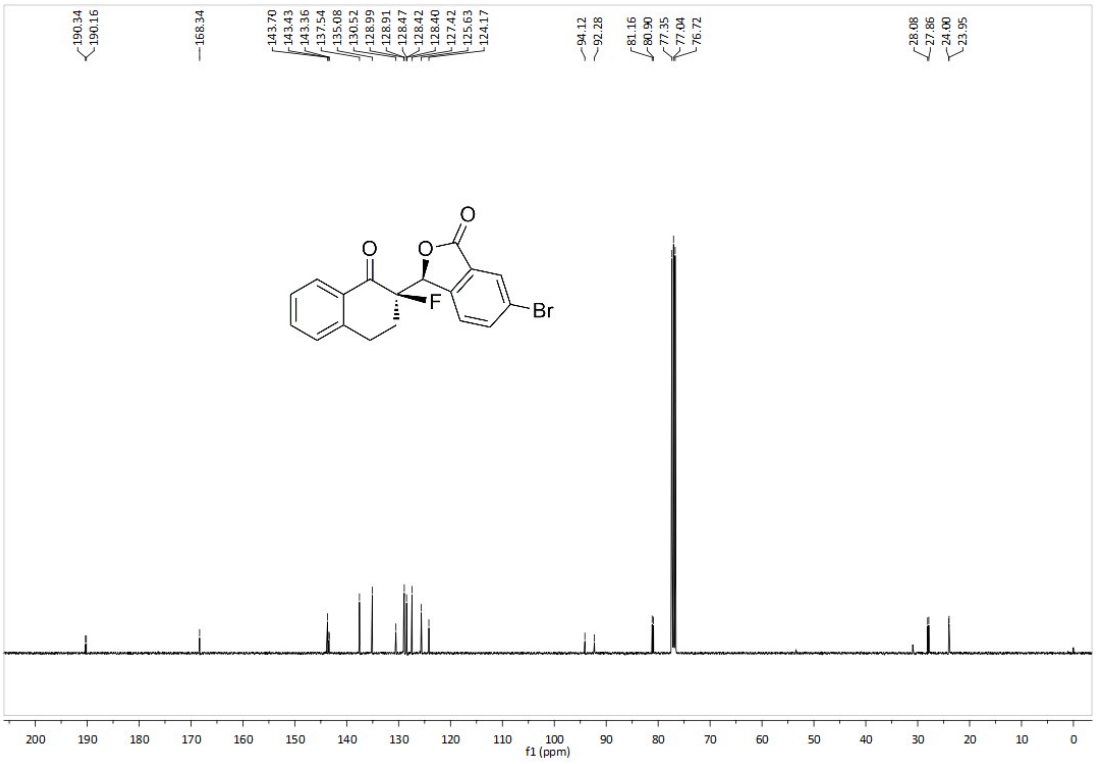
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ac**



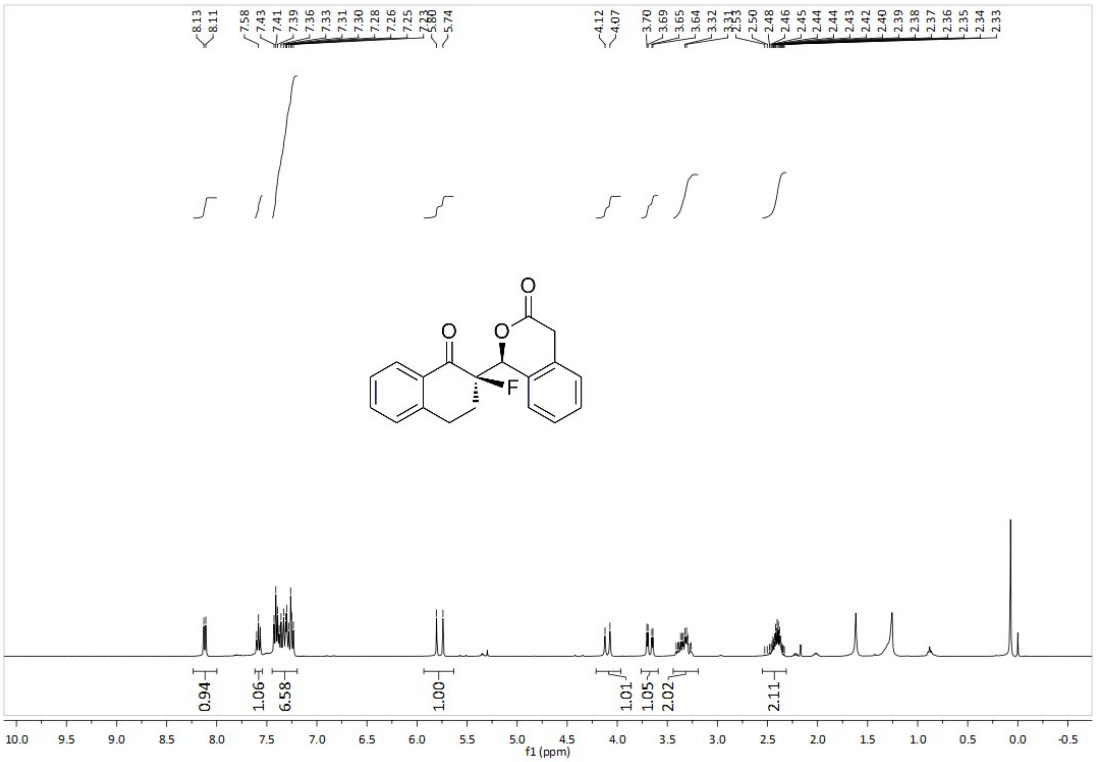
^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ac**



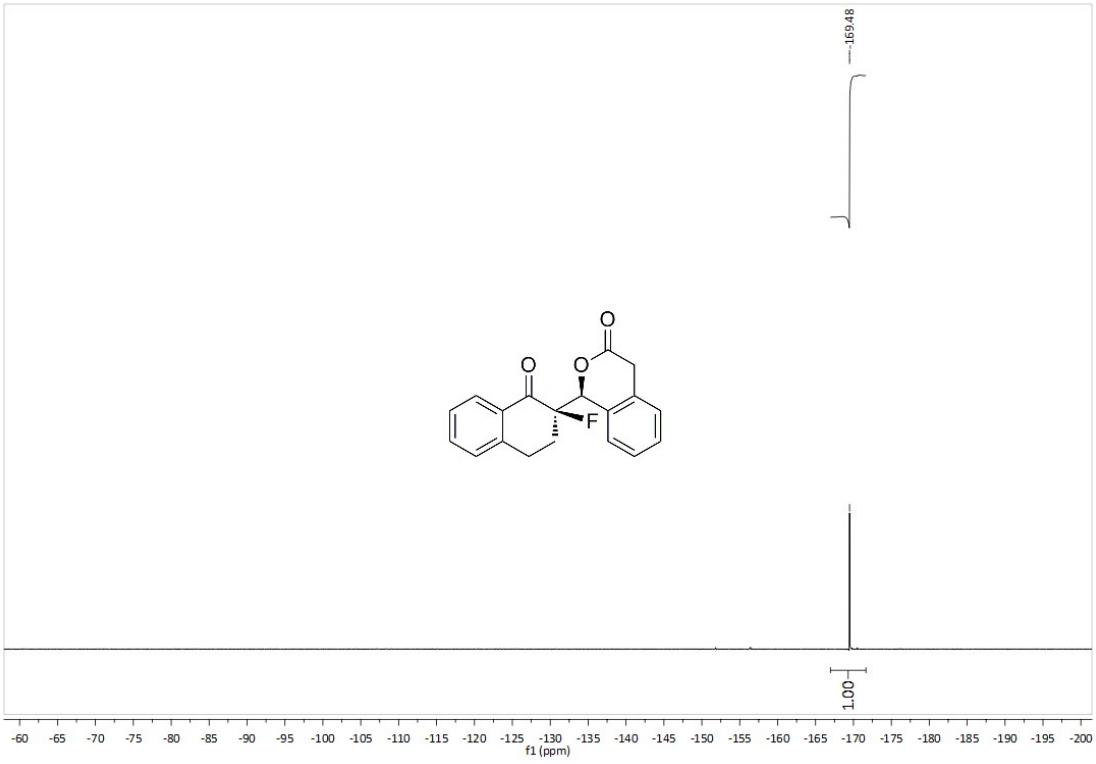
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ac**



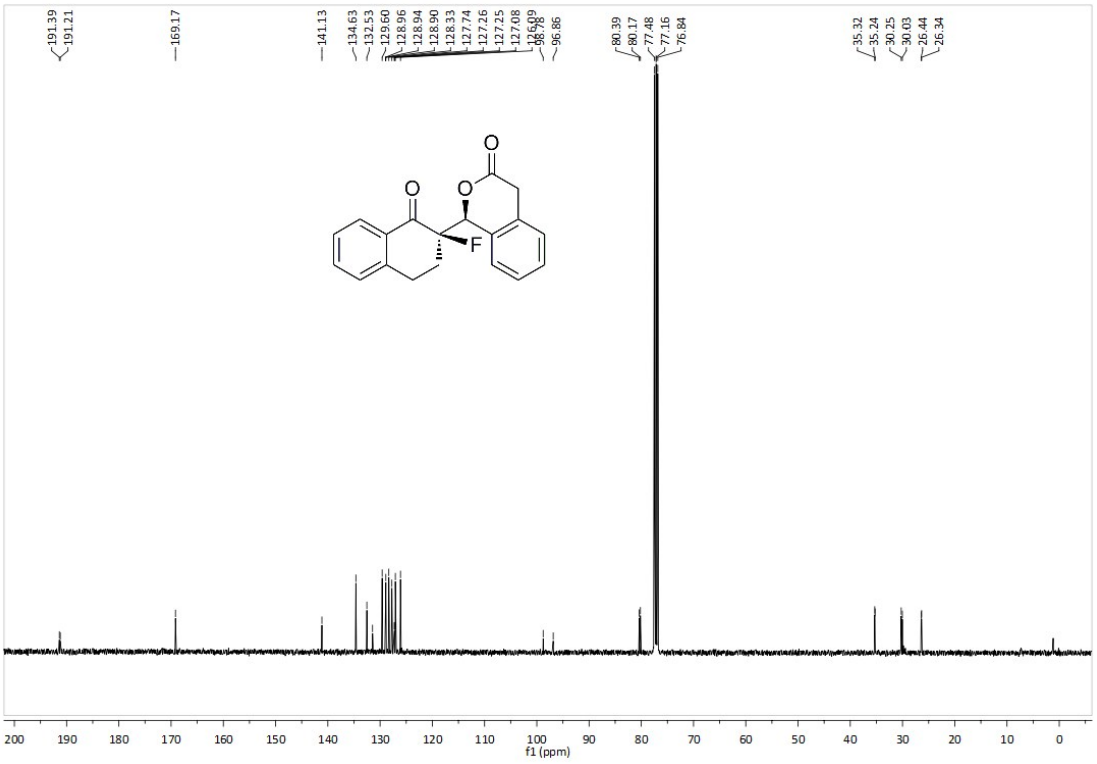
^{1}H NMR (400 MHz, $CDCl_3$) spectra of **7ae**



^{19}F NMR (376 MHz, $CDCl_3$) spectra of **7ae**



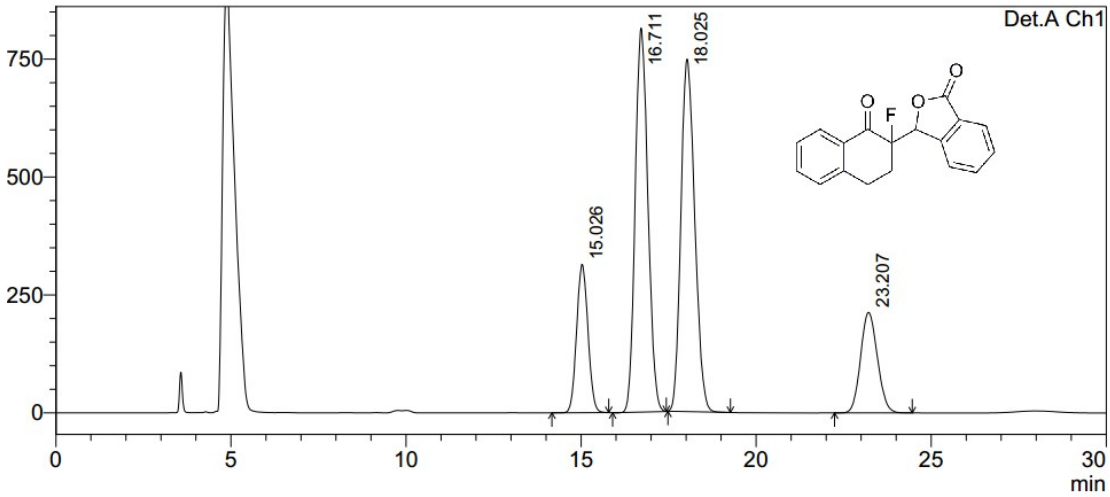
^{13}C NMR (101 MHz, $CDCl_3$) spectra of **7ae**



6. HPLC spectra

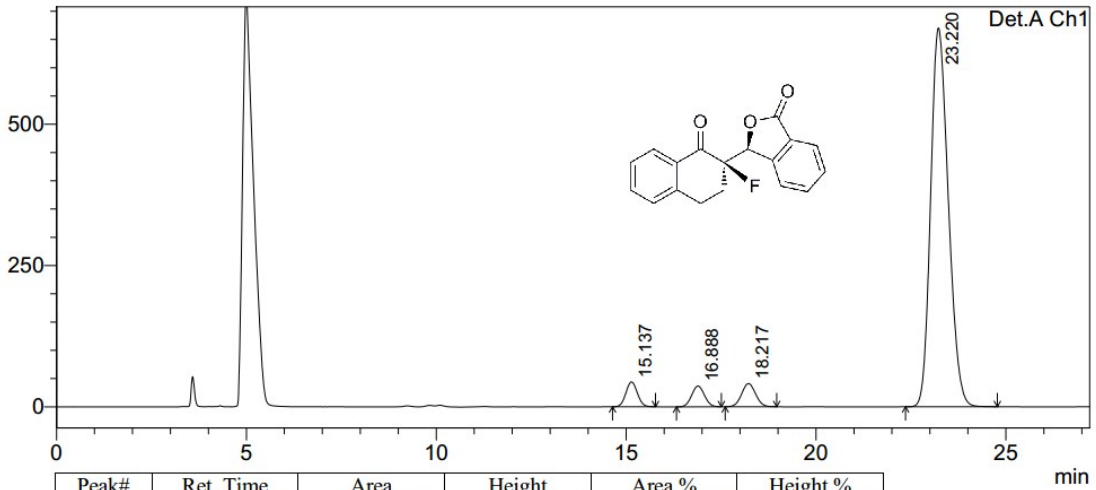
6.1. HPLC spectra of products **7**

HPLC spectra of **racemic-7aa**



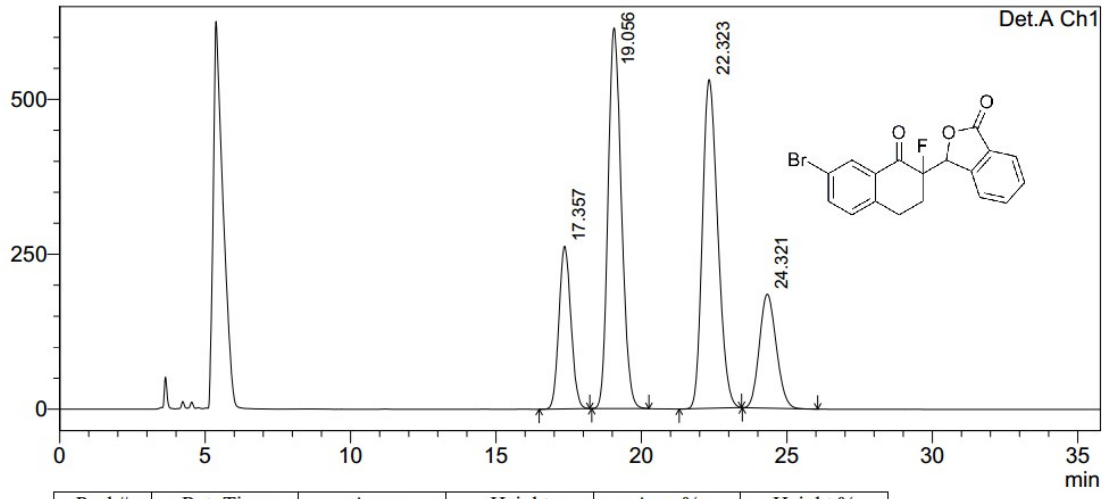
Peak#	Ret. Time	Area	Height	Area %	Height %
1	15.026	7110949	314569	12.828	15.056
2	16.711	20601845	814276	37.166	38.973
3	18.025	20597781	747312	37.158	35.768
4	23.207	7121724	213151	12.848	10.202
Total		55432299	2089309	100.000	100.000

HPLC spectra of product **7aa**



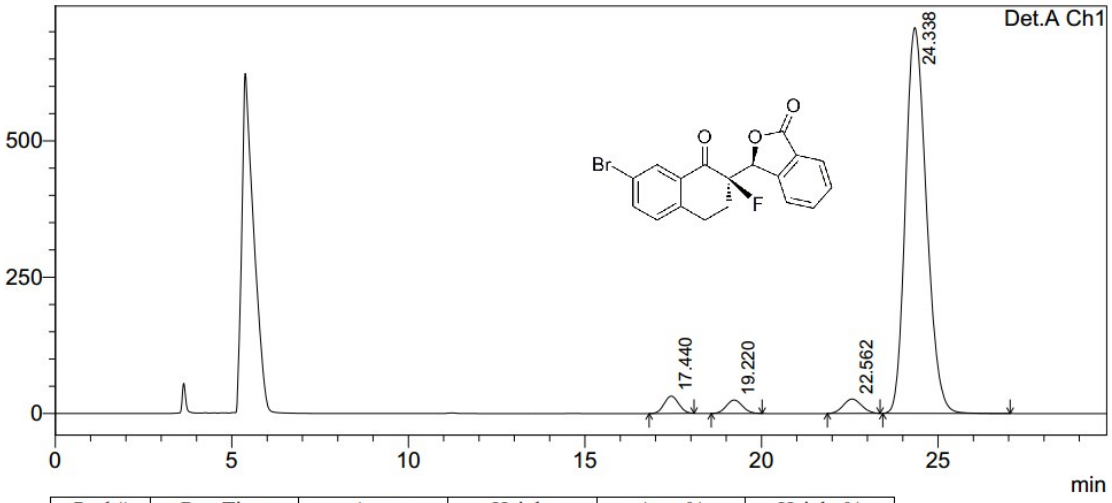
Peak#	Ret. Time	Area	Height	Area %	Height %
1	15.137	925649	43936	3.773	5.548
2	16.888	860962	36681	3.509	4.632
3	18.217	1052211	41151	4.289	5.196
4	23.220	21694544	670206	88.429	84.625
Total		24533365	791973	100.000	100.000

HPLC spectra of **racemic-7ba**



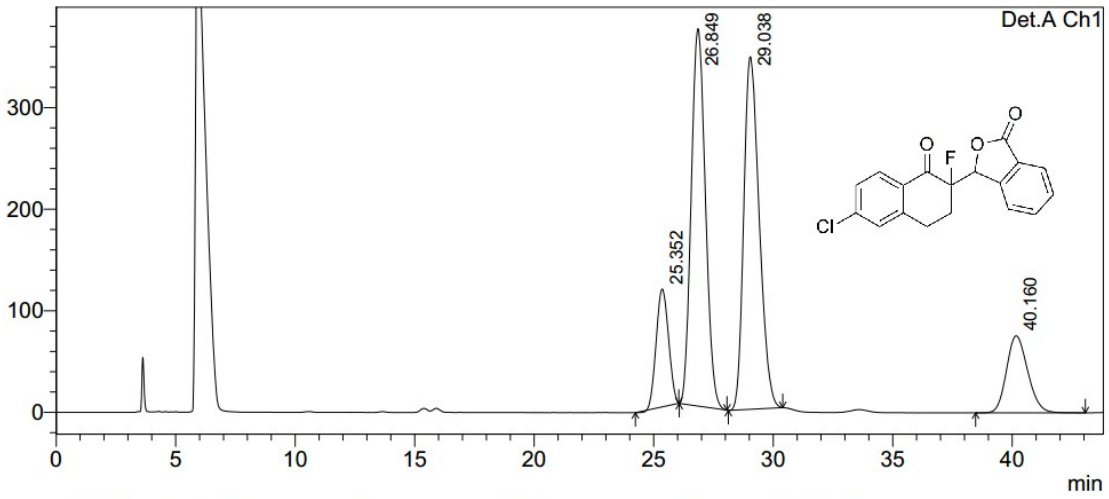
Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.357	7524359	262529	13.907	16.497
2	19.056	19615250	614314	36.254	38.604
3	22.323	19525541	530630	36.089	33.345
4	24.321	7439370	183862	13.750	11.554
Total		54104520	1591335	100.000	100.000

HPLC spectra of product **7ba**



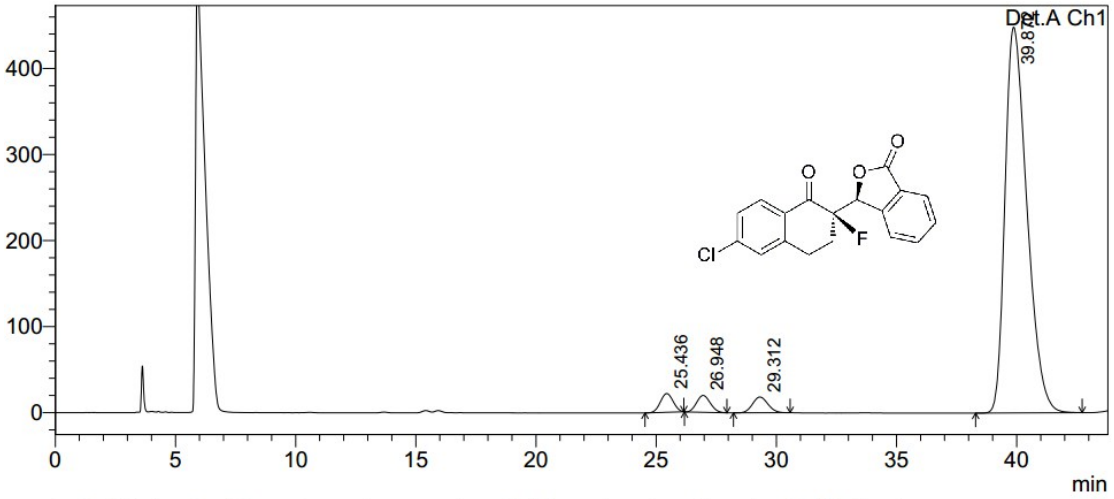
Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.440	914749	31861	2.871	4.031
2	19.220	783442	24662	2.459	3.120
3	22.562	947469	26334	2.974	3.332
4	24.338	29210621	707482	91.695	89.516
Total		31856282	790339	100.000	100.000

HPLC spectra of **racemic-7ca**



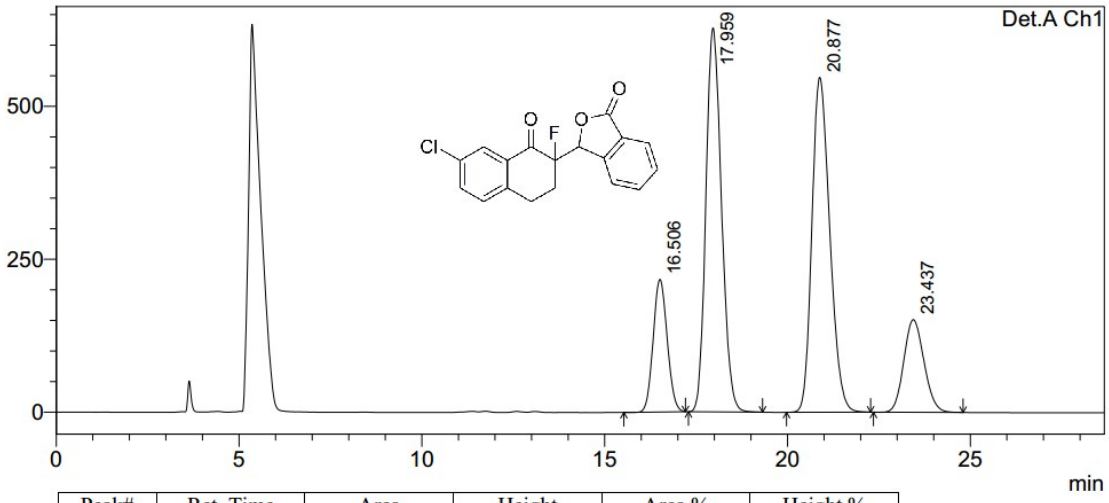
Peak#	Ret. Time	Area	Height	Area %	Height %
1	25.352	4158972	116091	10.455	12.748
2	26.849	15334506	371646	38.548	40.809
3	29.038	15603467	347150	39.224	38.119
4	40.160	4683716	75806	11.774	8.324
Total		39780660	910693	100.000	100.000

HPLC spectra of product **7ca**



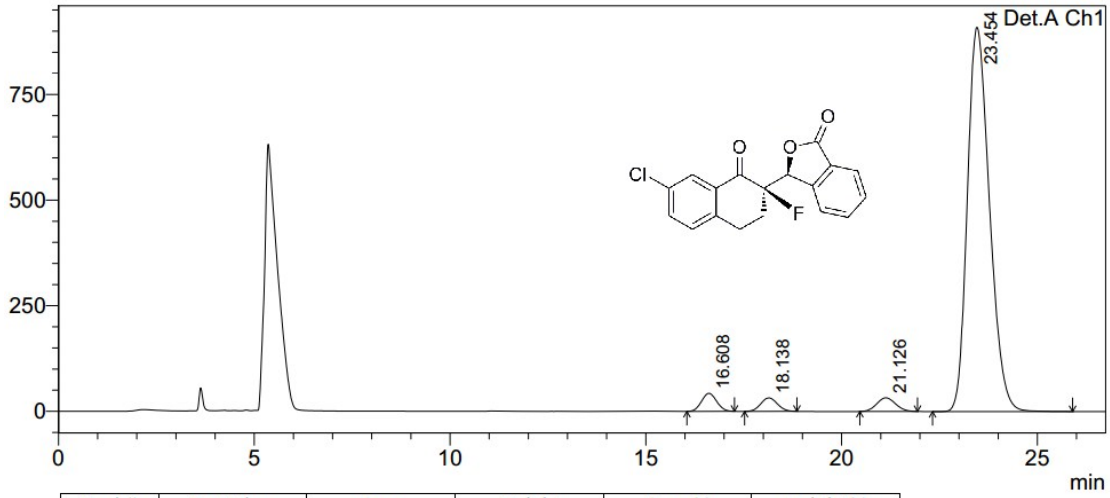
Peak#	Ret. Time	Area	Height	Area %	Height %
1	25.436	805921	21804	2.614	4.290
2	26.948	776056	19579	2.518	3.853
3	29.312	819332	18334	2.658	3.608
4	39.872	28424101	448465	92.210	88.249
Total		30825409	508182	100.000	100.000

HPLC spectra of **racemic-7da**



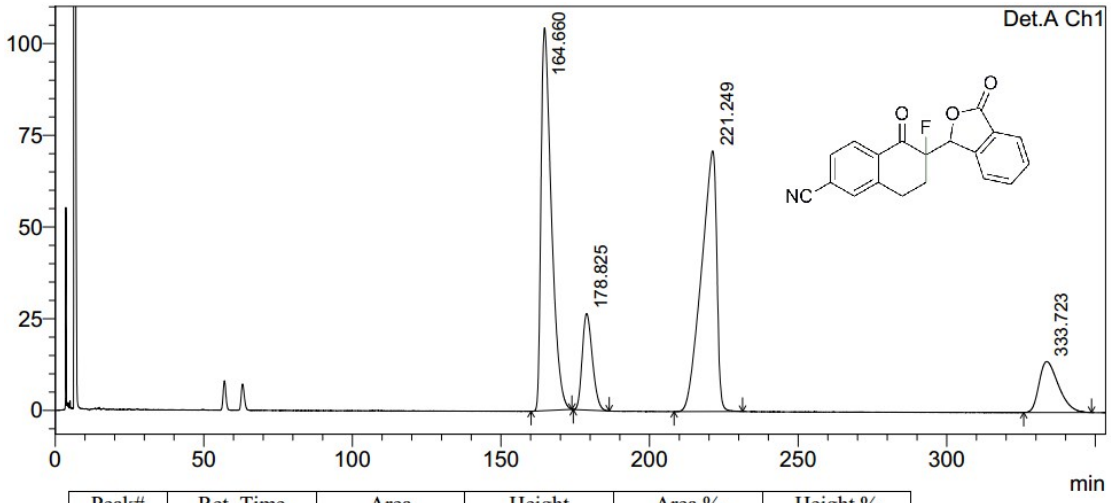
Peak#	Ret. Time	Area	Height	Area %	Height %
1	16.506	5782457	216961	11.858	14.054
2	17.959	18567620	627719	38.077	40.662
3	20.877	18592295	547411	38.128	35.460
4	23.437	5820386	151643	11.936	9.823
Total		48762757	1543734	100.000	100.000

HPLC spectra of product **7da**



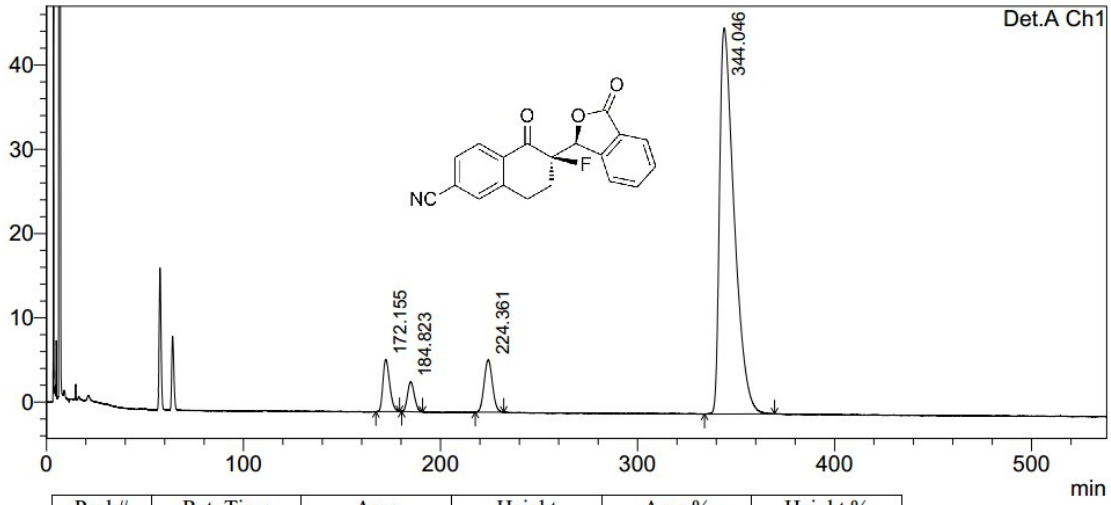
Peak#	Ret. Time	Area	Height	Area %	Height %
1	16.608	1146182	42648	2.948	4.194
2	18.138	943411	32018	2.426	3.149
3	21.126	1081562	32328	2.782	3.179
4	23.454	35712532	909796	91.845	89.477
Total		38883687	1016790	100.000	100.000

HPLC spectra of **racemic-7ea**



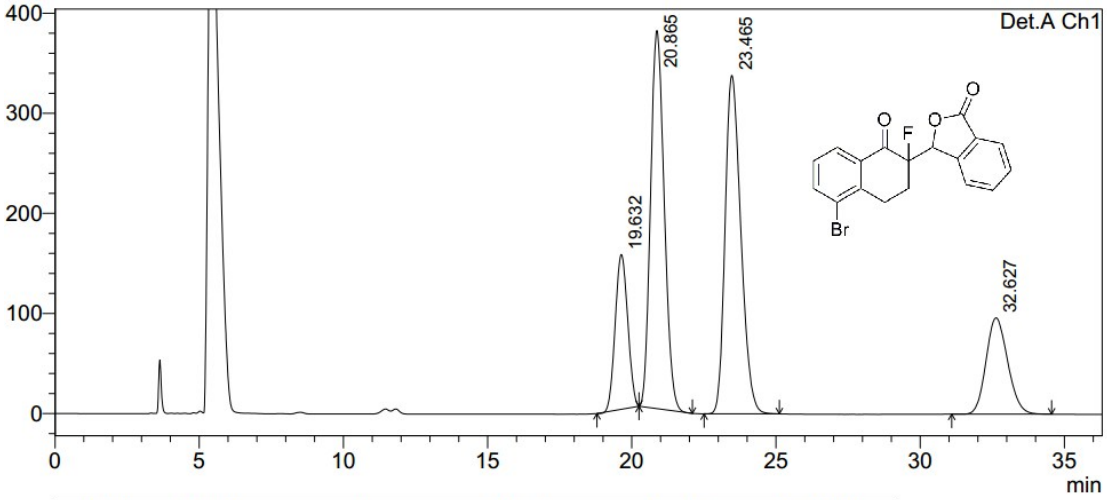
Peak#	Ret. Time	Area	Height	Area %	Height %
1	164.660	25296084	104336	39.924	48.393
2	178.825	6252006	26322	9.867	12.209
3	221.249	25487894	71043	40.226	32.951
4	333.723	6324989	13900	9.982	6.447
Total		63360972	215601	100.000	100.000

HPLC spectra of product **7ea**



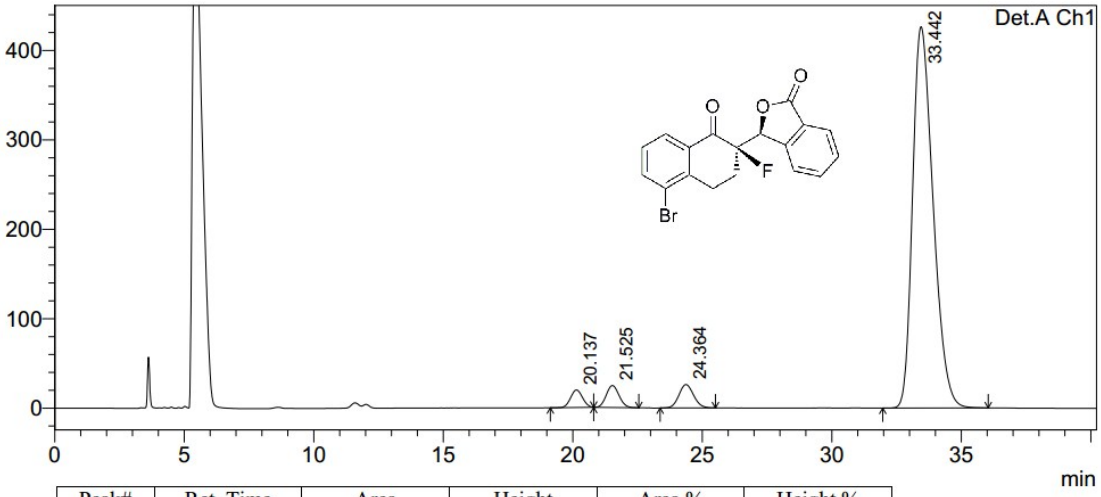
Peak#	Ret. Time	Area	Height	Area %	Height %
1	172.155	1472698	6188	5.303	10.017
2	184.823	867834	3559	3.125	5.762
3	224.361	1814438	6214	6.533	10.058
4	344.046	23618198	45817	85.040	74.164
Total		27773168	61779	100.000	100.000

HPLC spectra of **racemic-7fa**



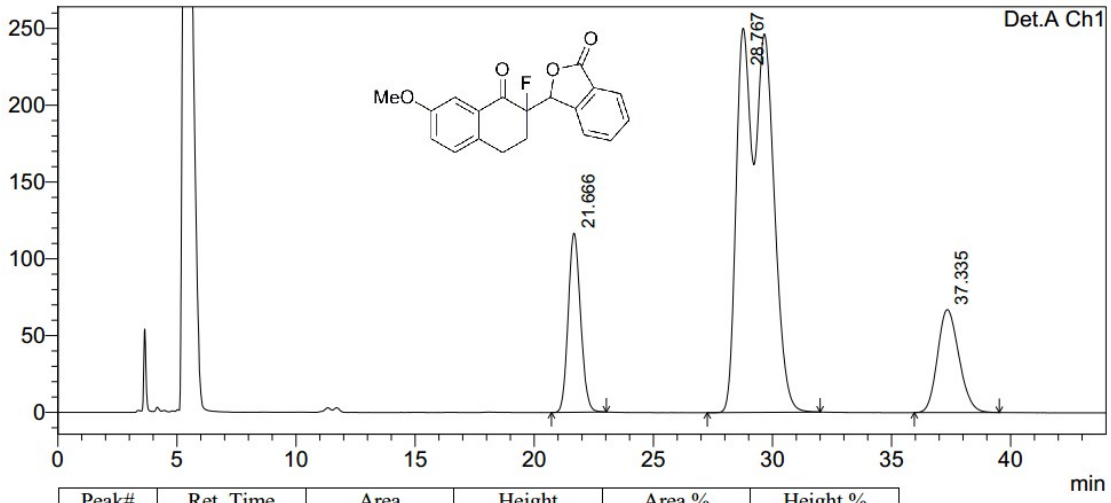
Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.632	4650142	154735	13.303	16.003
2	20.865	12451455	377783	35.621	39.071
3	23.465	12840531	338203	36.734	34.978
4	32.627	5012959	96188	14.341	9.948
Total		34955088	966909	100.000	100.000

HPLC spectra of product **7fa**



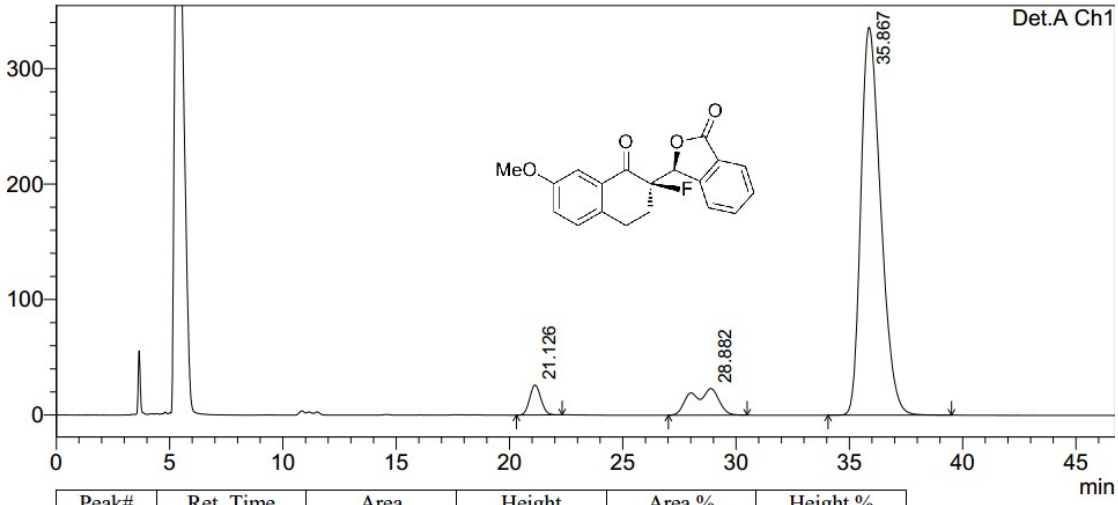
Peak#	Ret. Time	Area	Height	Area %	Height %
1	20.137	628020	19606	2.418	3.948
2	21.525	844129	24581	3.250	4.949
3	24.364	1022548	26077	3.937	5.251
4	33.442	23475051	426401	90.394	85.853
Total		25969749	496666	100.000	100.000

HPLC spectra of **racemic-7ga**



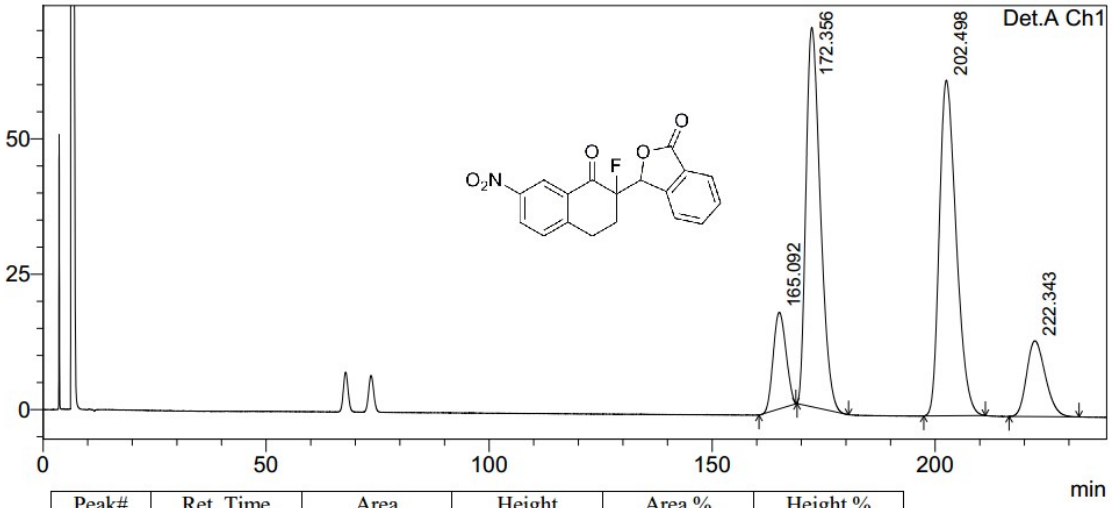
Peak#	Ret. Time	Area	Height	Area %	Height %
1	21.666	4193880	116659	13.081	26.889
2	28.767	23670003	250157	73.829	57.659
3	37.335	4196672	67038	13.090	15.452
Total		32060554	433854	100.000	100.000

HPLC spectra of product **7ga**



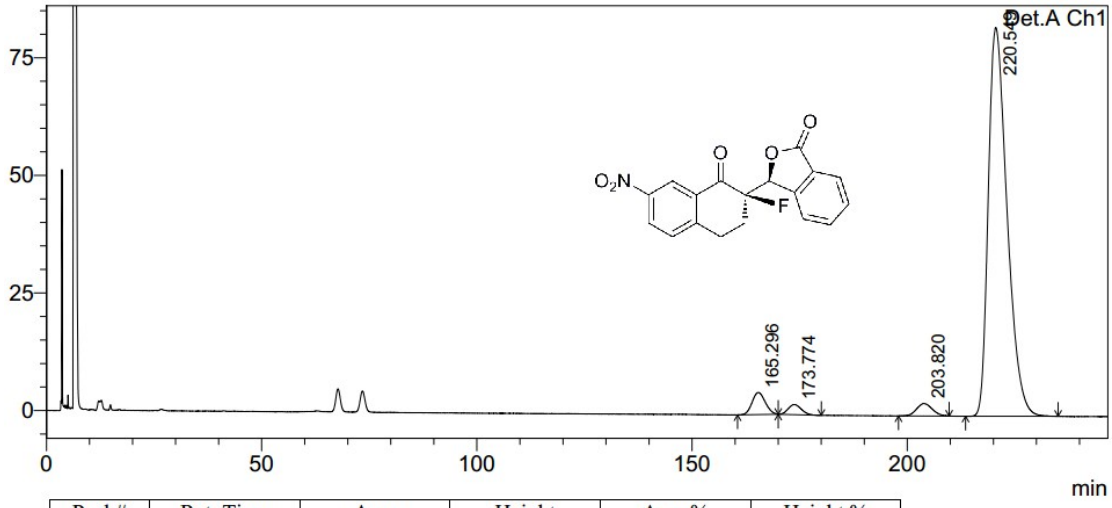
Peak#	Ret. Time	Area	Height	Area %	Height %
1	21.126	895579	25977	3.837	6.745
2	28.882	1937690	23071	8.301	5.991
3	35.867	20510337	336059	87.863	87.264
Total		23343606	385107	100.000	100.000

HPLC spectra of **racemic-7ha**



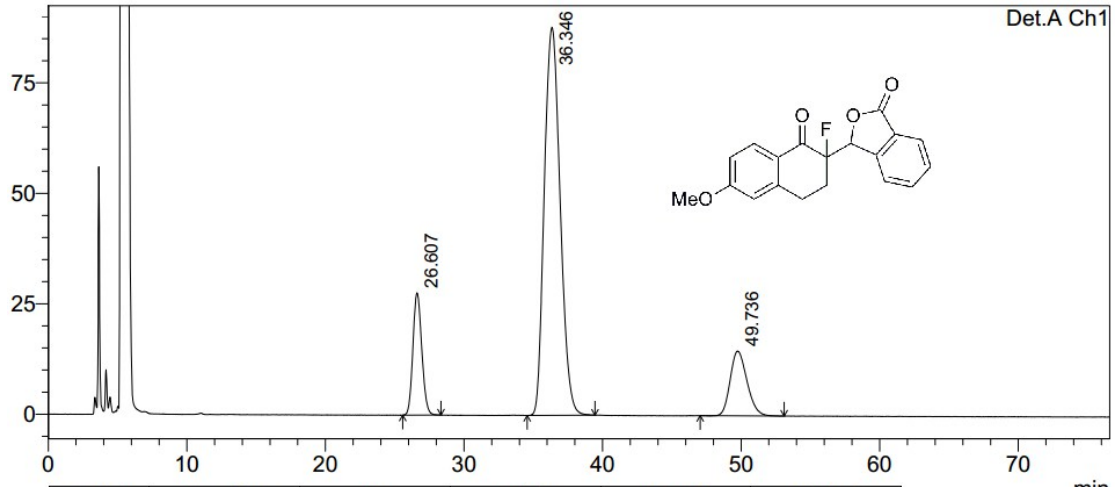
Peak#	Ret. Time	Area	Height	Area %	Height %
1	165.092	3538427	17837	8.939	10.885
2	172.356	15653218	70060	39.546	42.756
3	202.498	16308681	61969	41.202	37.818
4	222.343	4082244	13996	10.313	8.541
Total		39582570	163862	100.000	100.000

HPLC spectra of product **7ha**



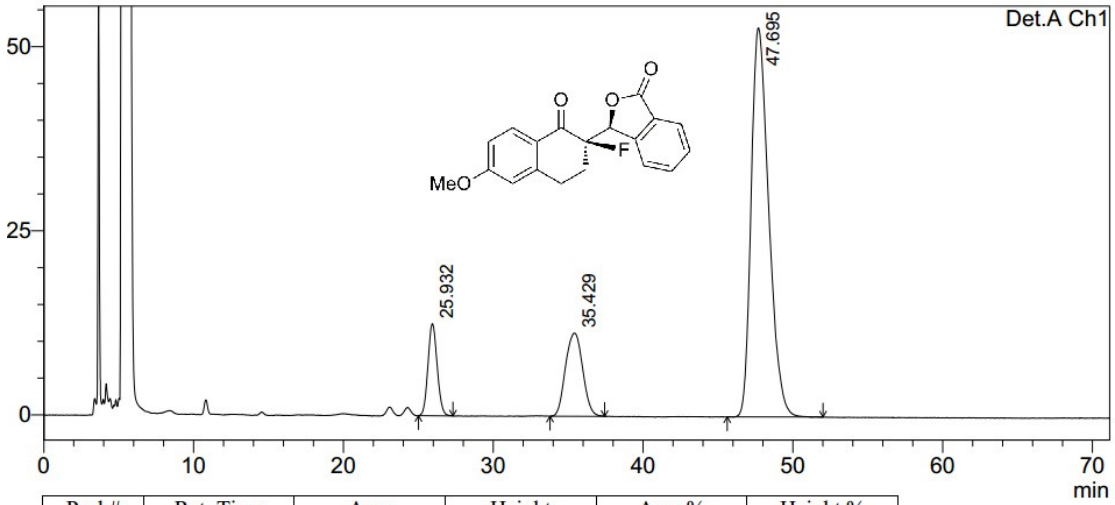
Peak#	Ret. Time	Area	Height	Area %	Height %
1	165.296	999206	4695	3.679	5.094
2	173.774	449063	2160	1.653	2.344
3	203.820	676673	2666	2.491	2.892
4	220.549	25038317	82657	92.177	89.671
Total		27163259	92178	100.000	100.000

HPLC spectra of **racemic-7ia**



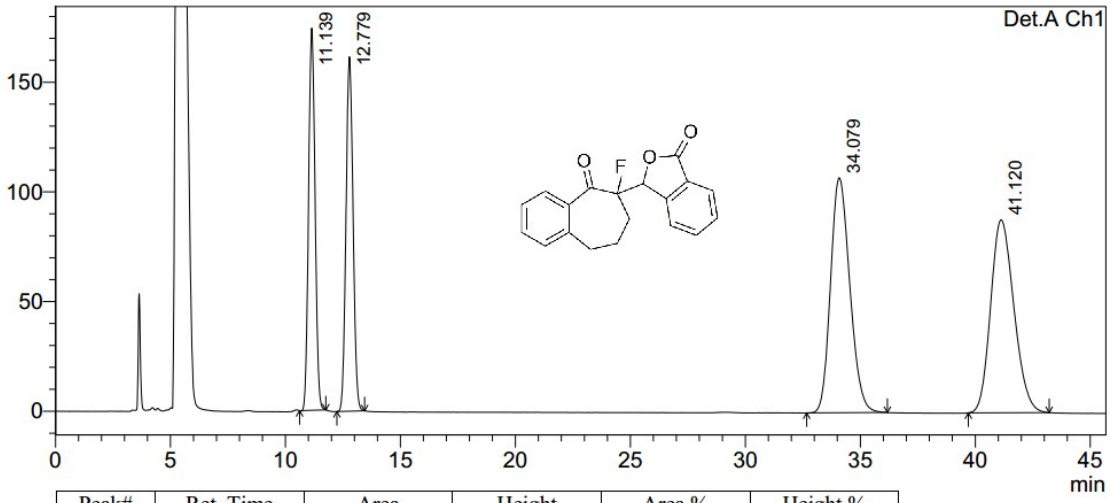
Peak#	Ret. Time	Area	Height	Area %	Height %
1	26.607	1234483	27680	13.056	21.273
2	36.346	6987370	87786	73.899	67.468
3	49.736	1233479	14650	13.045	11.259
Total		9455332	130116	100.000	100.000

HPLC spectra of product **7ia**



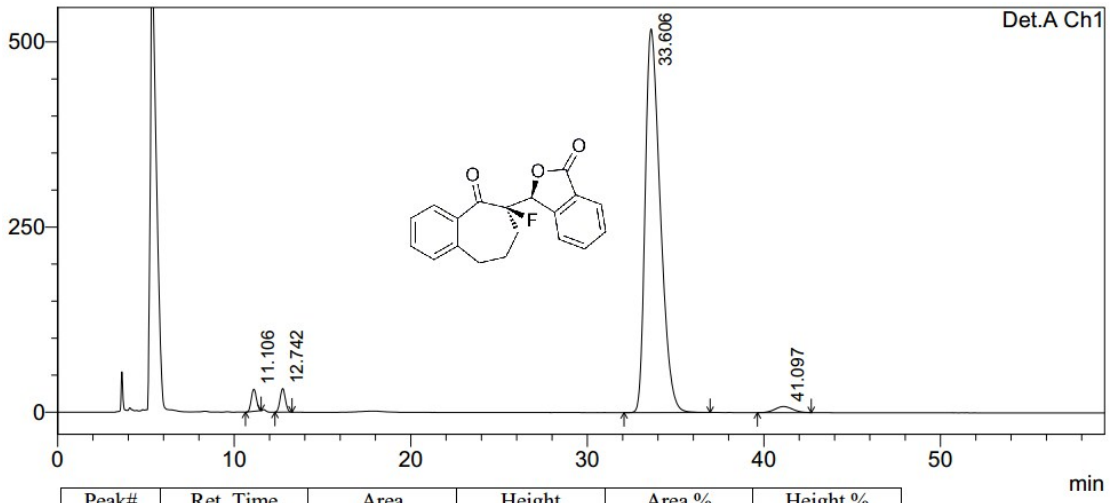
Peak#	Ret. Time	Area	Height	Area %	Height %
1	25.932	533589	12502	9.299	16.322
2	35.429	901214	11283	15.705	14.730
3	47.695	4303414	52812	74.996	68.947
Total		5738217	76597	100.000	100.000

HPLC spectra of **racemic-7ja**



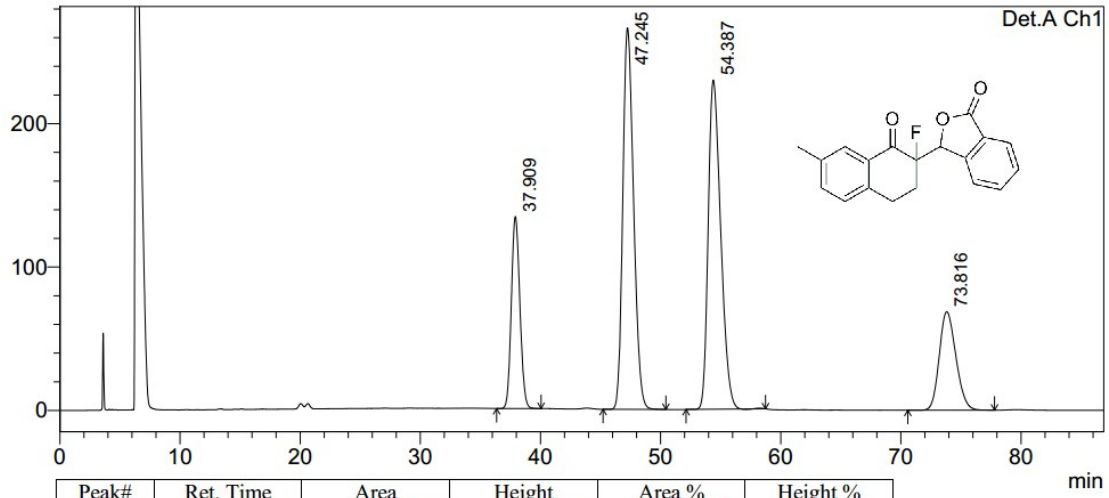
Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.139	3429166	174313	17.767	32.824
2	12.779	3440343	161592	17.825	30.429
3	34.079	6239219	107166	32.327	20.180
4	41.120	6191646	87976	32.080	16.567
Total		19300373	531048	100.000	100.000

HPLC spectra of product **7ja**



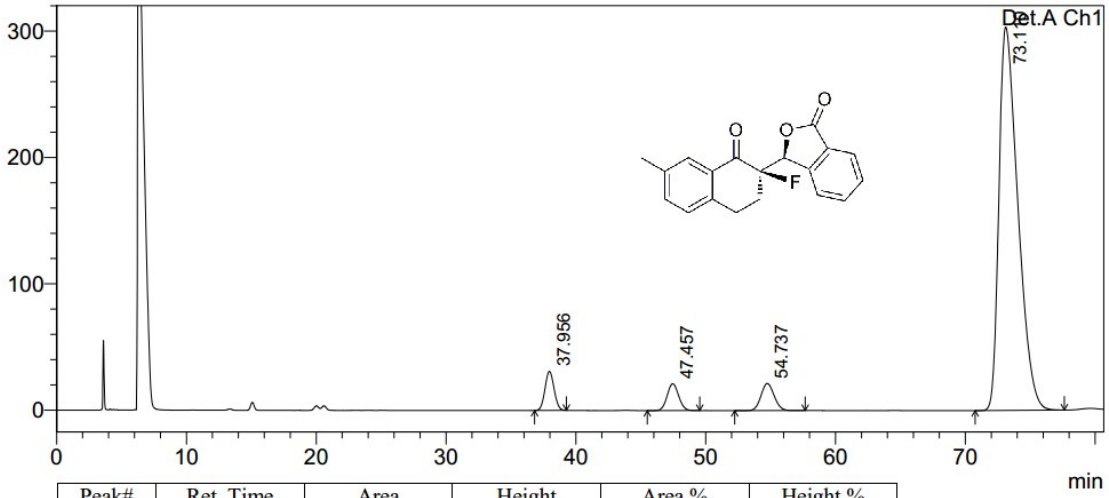
Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.106	607662	29870	1.865	5.080
2	12.742	671365	31856	2.061	5.417
3	33.606	30723266	518095	94.311	88.107
4	41.097	574333	8211	1.763	1.396
Total		32576627	588032	100.000	100.000

HPLC spectra of **racemic-7la**



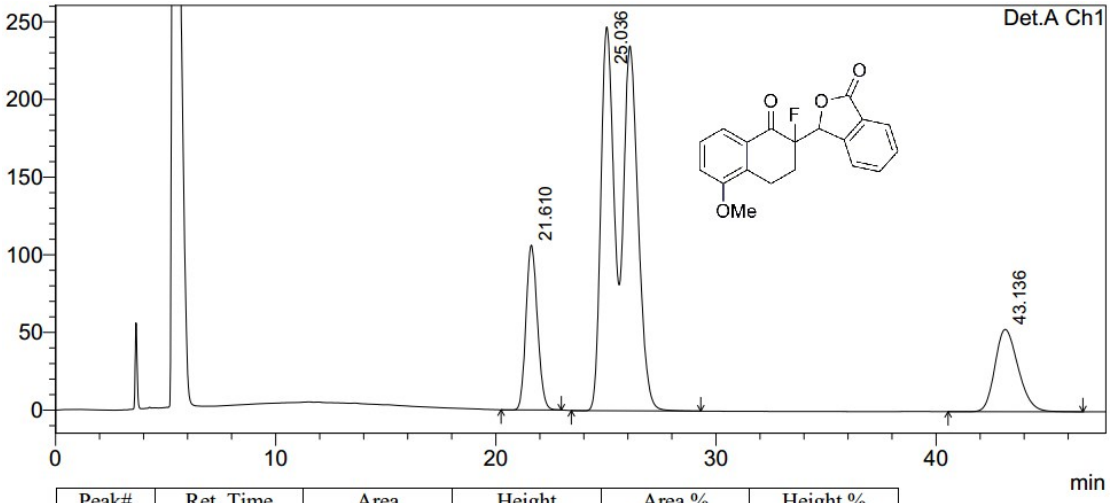
Peak#	Ret. Time	Area	Height	Area %	Height %
1	37.909	6597831	133959	14.240	19.186
2	47.245	16565779	266059	35.754	38.105
3	54.387	16566279	229525	35.755	32.873
4	73.816	6603393	68683	14.252	9.837
Total		46333282	698227	100.000	100.000

HPLC spectra of product **7la**



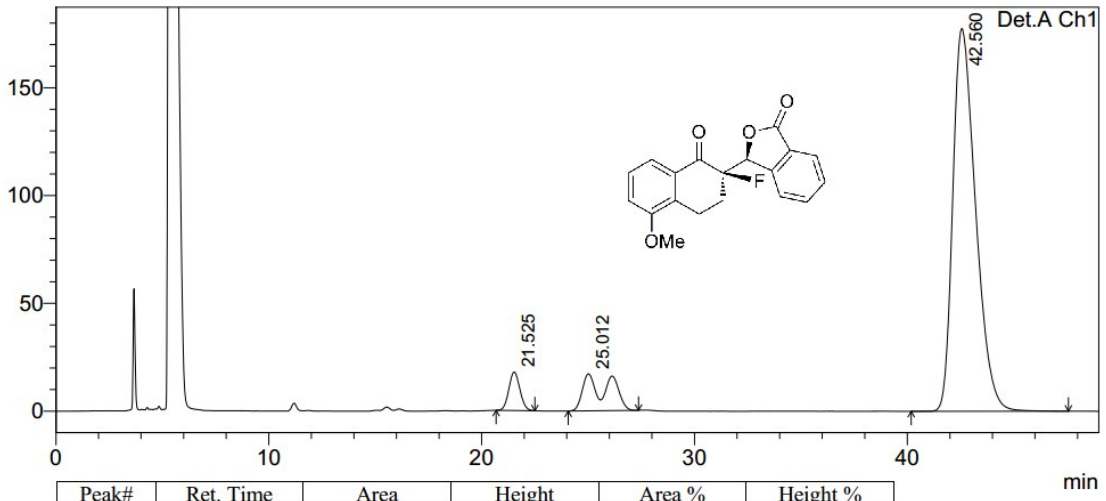
Peak#	Ret. Time	Area	Height	Area %	Height %
1	37.956	1512808	30941	4.314	8.205
2	47.457	1308546	21277	3.732	5.642
3	54.737	1500702	21430	4.280	5.683
4	73.110	30741926	303442	87.674	80.470
Total		35063982	377089	100.000	100.000

HPLC spectra of **racemic-7ma**



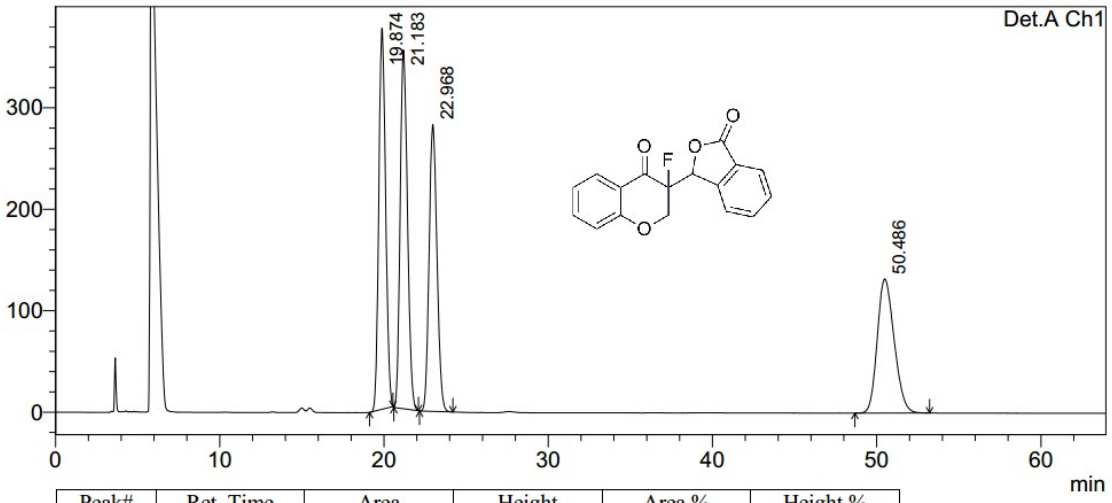
Peak#	Ret. Time	Area	Height	Area %	Height %
1	21.610	3827081	106093	13.346	26.120
2	25.036	20964146	247125	73.109	60.842
3	43.136	3884073	52958	13.545	13.038
Total		28675300	406176	100.000	100.000

HPLC spectra of product **7ma**



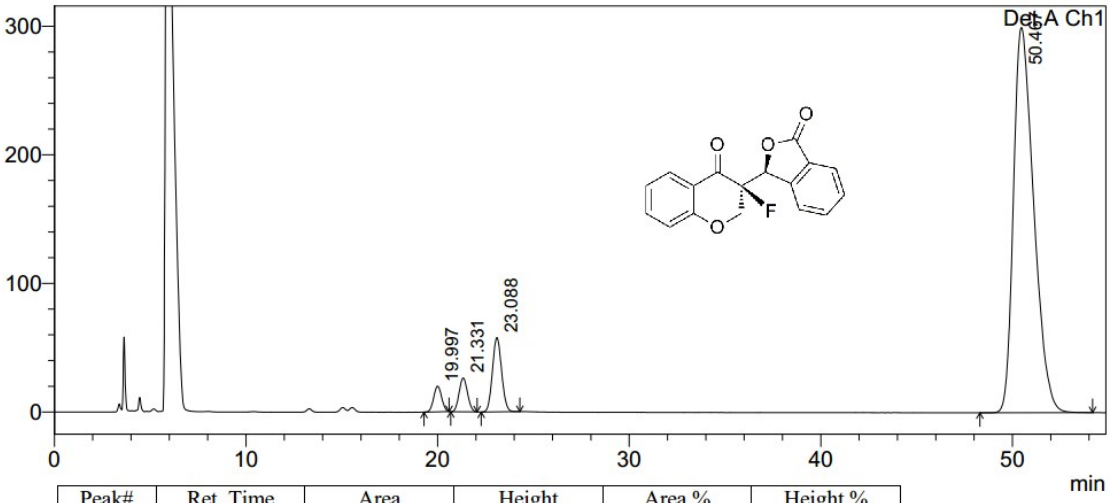
Peak#	Ret. Time	Area	Height	Area %	Height %
1	21.525	645718	17819	4.230	8.386
2	25.012	1417605	17141	9.286	8.067
3	42.560	13202355	177517	86.484	83.547
Total		15265679	212476	100.000	100.000

HPLC spectra of **racemic-7na**



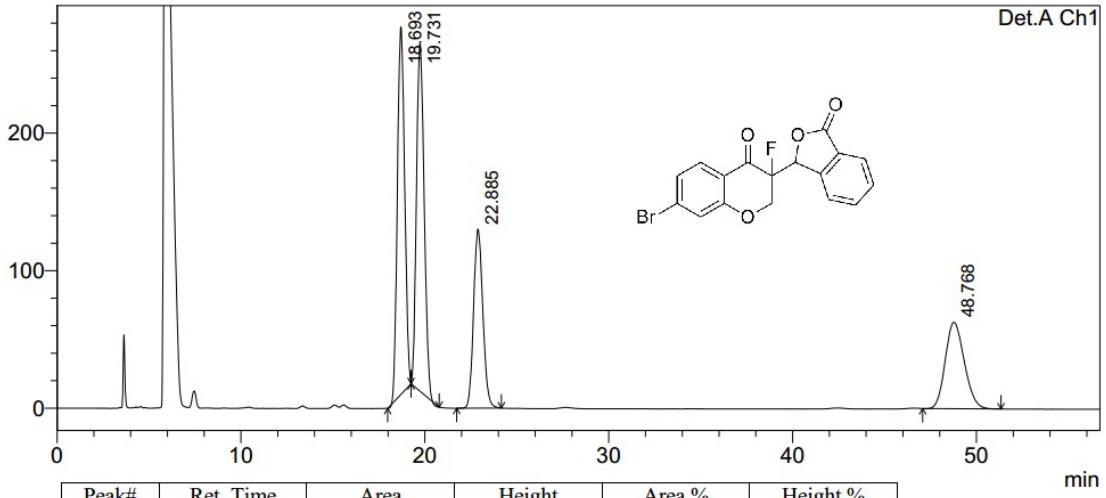
Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.874	10873273	375746	26.737	32.830
2	21.183	10901355	353790	26.806	30.912
3	22.968	9432620	282808	23.195	24.710
4	50.486	9459813	132179	23.262	11.549
Total		40667061	1144523	100.000	100.000

HPLC spectra of product **7na**



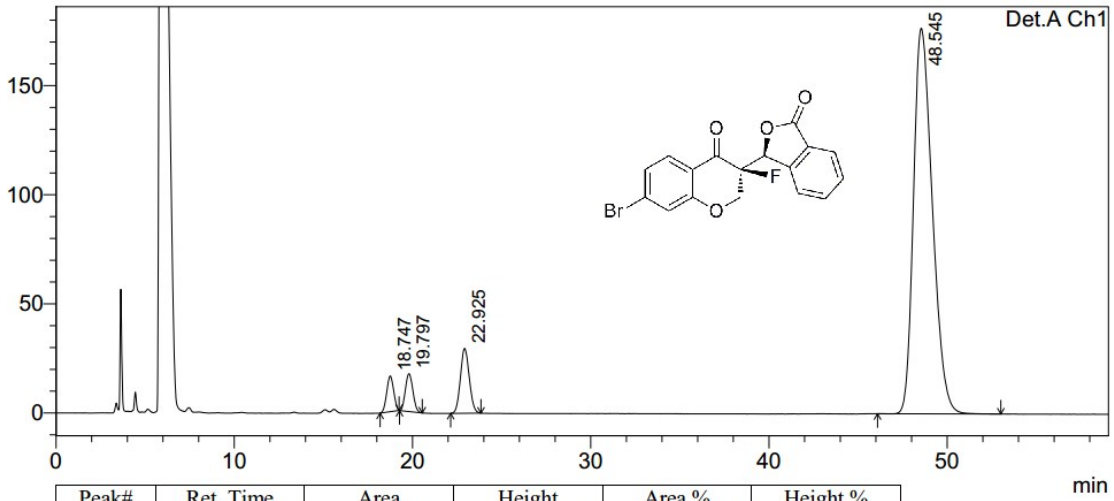
Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.997	580276	20010	2.290	4.956
2	21.331	807324	26302	3.186	6.515
3	23.088	1922871	57802	7.588	14.317
4	50.467	22029472	299626	86.936	74.212
Total		25339942	403741	100.000	100.000

HPLC spectra of **racemic-7oa**



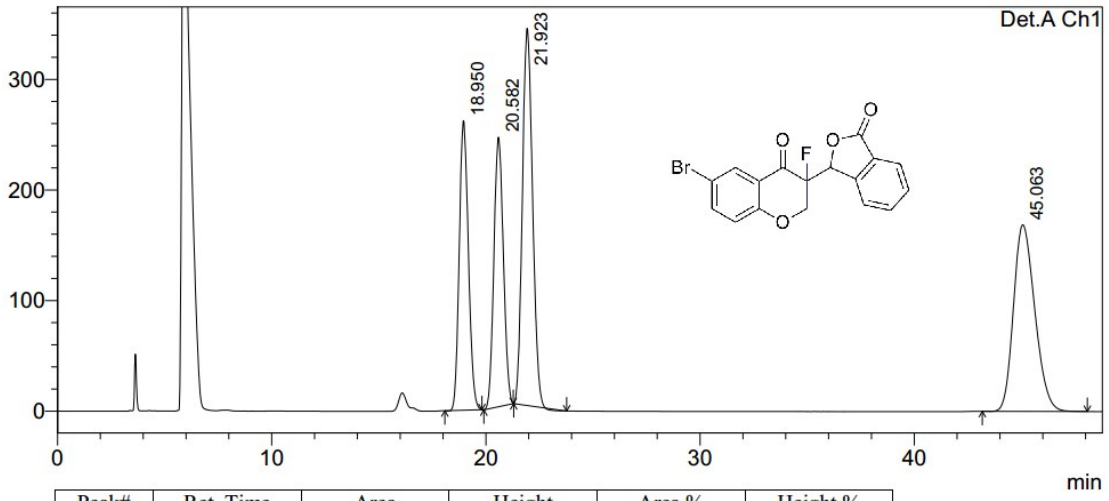
Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.693	7349221	267265	30.928	37.478
2	19.731	7312336	252697	30.773	35.436
3	22.885	4575537	130312	19.255	18.274
4	48.768	4525214	62843	19.044	8.812
Total		23762307	713116	100.000	100.000

HPLC spectra of product **7oa**



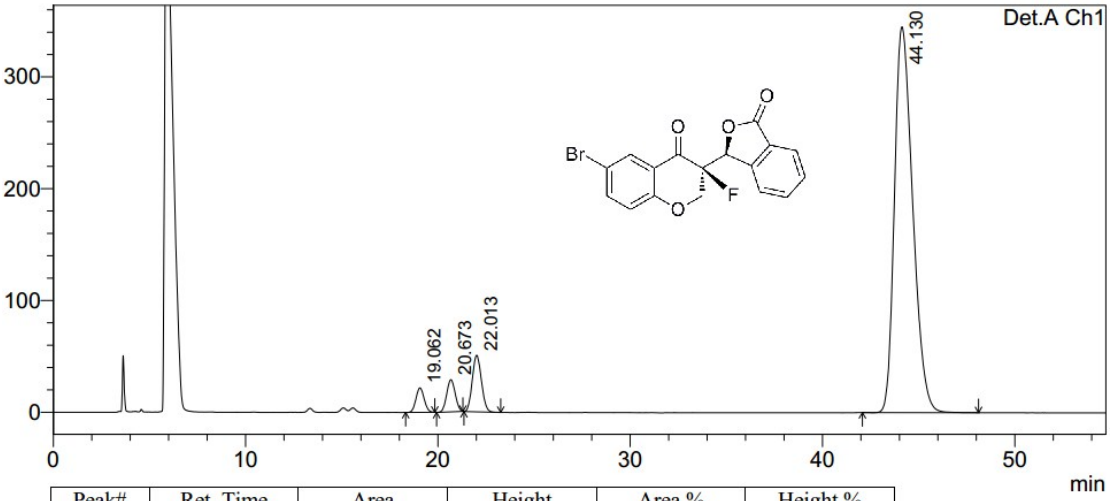
Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.747	447591	16338	2.987	6.805
2	19.797	505878	17356	3.376	7.229
3	22.925	1033012	29706	6.894	12.373
4	48.545	12997752	176690	86.743	73.593
Total		14984233	240089	100.000	100.000

HPLC spectra of **racemic-7pa**



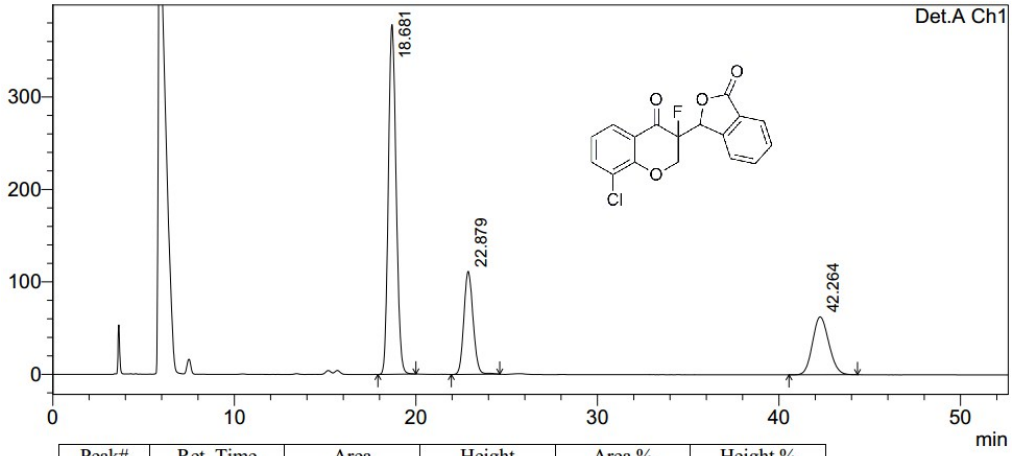
Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.950	7779148	261898	20.362	25.789
2	20.582	7506962	243839	19.650	24.011
3	21.923	11240438	341079	29.422	33.586
4	45.063	11677615	168731	30.566	16.615
Total		38204162	1015547	100.000	100.000

HPLC spectra of product **7pa**



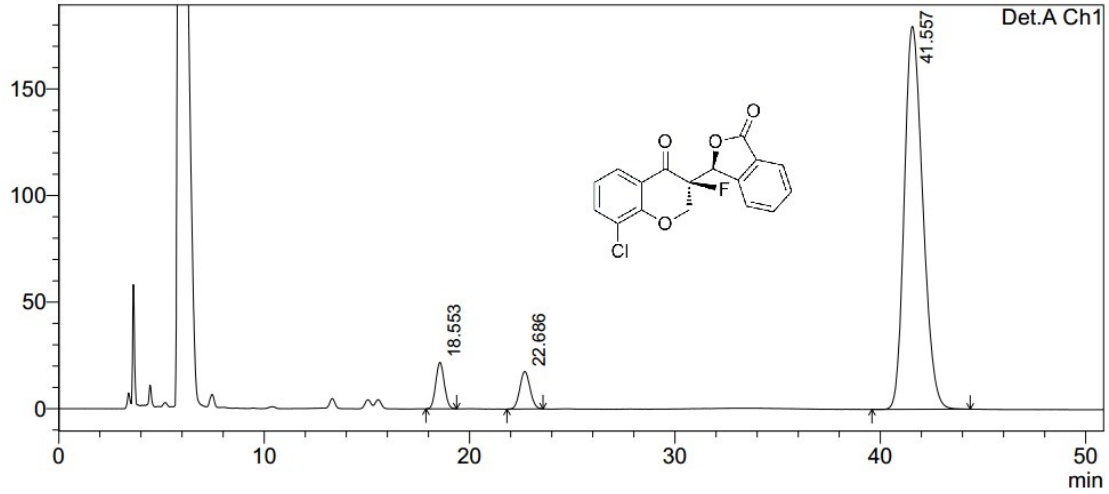
Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.062	652468	21927	2.514	4.911
2	20.673	882382	28764	3.400	6.443
3	22.013	1672043	50647	6.443	11.344
4	44.130	22743560	345119	87.642	77.302
Total		25950453	446458	100.000	100.000

HPLC spectra of **racemic-7qa**



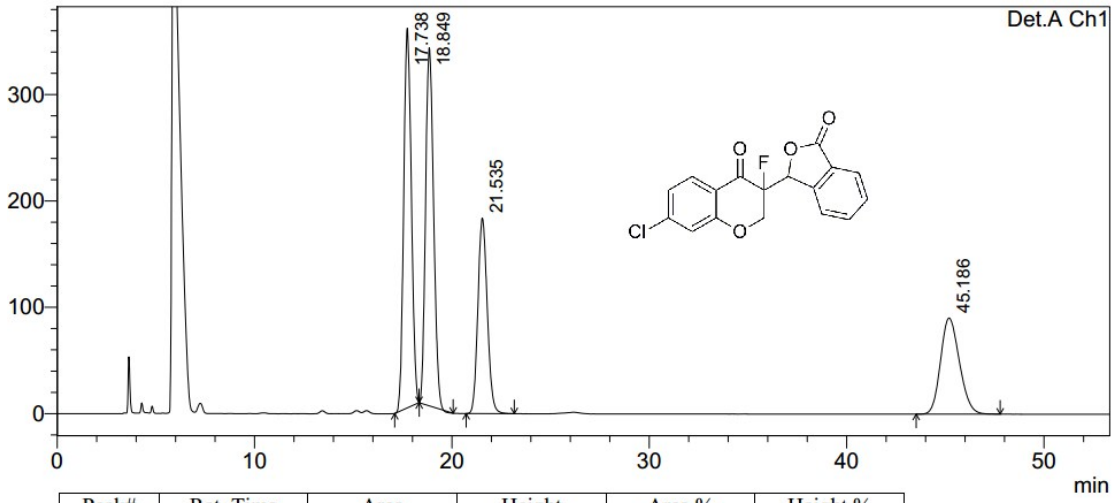
Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.681	11241808	378267	58.875	68.494
2	22.879	3937536	111389	20.621	20.169
3	42.264	3915008	62609	20.503	11.337
Total		19094351	552265	100.000	100.000

HPLC spectra of product **7qa**



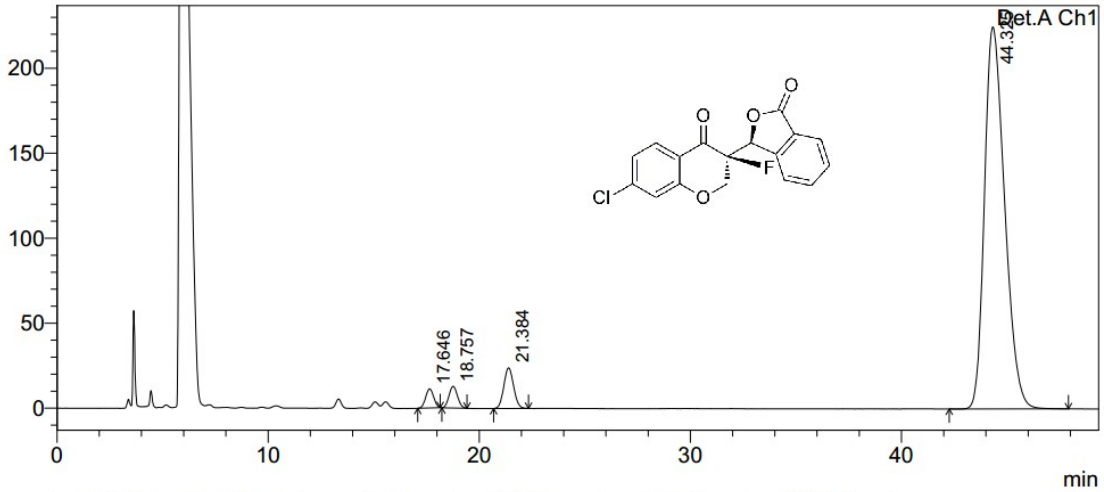
Peak#	Ret. Time	Area	Height	Area %	Height %
1	18.553	632753	21795	5.083	9.951
2	22.686	606742	17567	4.874	8.021
3	41.557	11208757	179663	90.043	82.028
Total		12448252	219025	100.000	100.000

HPLC spectra of **racemic-7ra**



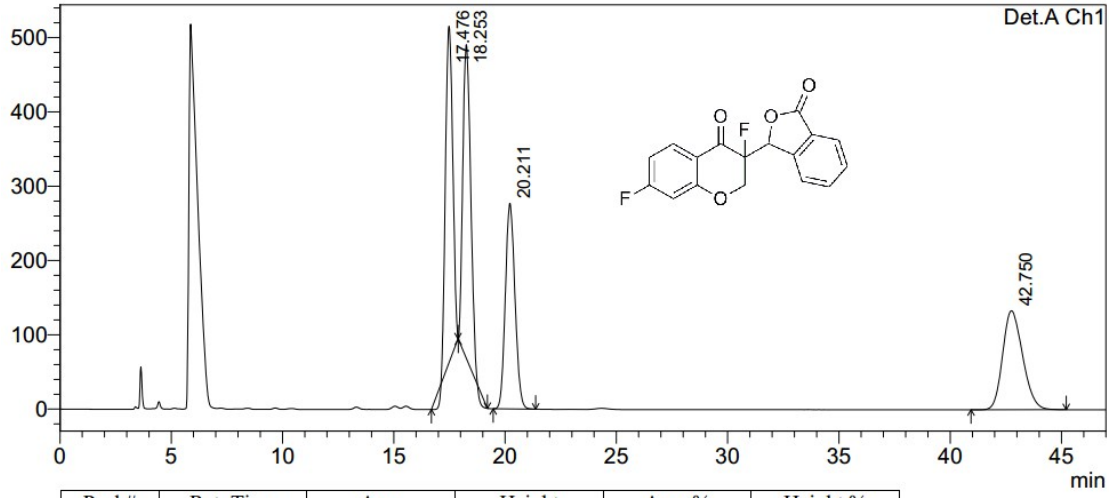
Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.738	9584514	356973	30.705	36.883
2	18.849	9536322	336658	30.551	34.784
3	21.535	6077352	183824	19.470	18.993
4	45.186	6016410	90394	19.274	9.340
Total		31214600	967850	100.000	100.000

HPLC spectra of product **7ra**



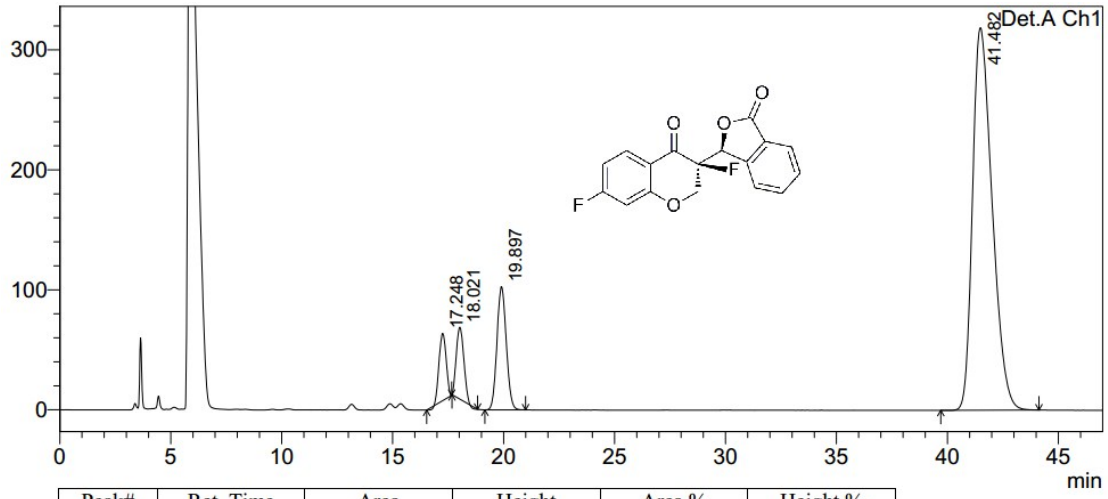
Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.646	295037	11213	1.805	4.113
2	18.757	357023	12753	2.185	4.678
3	21.384	767893	23902	4.699	8.767
4	44.325	14921844	224755	91.311	82.442
Total		16341797	272623	100.000	100.000

HPLC spectra of **racemic-7sa**



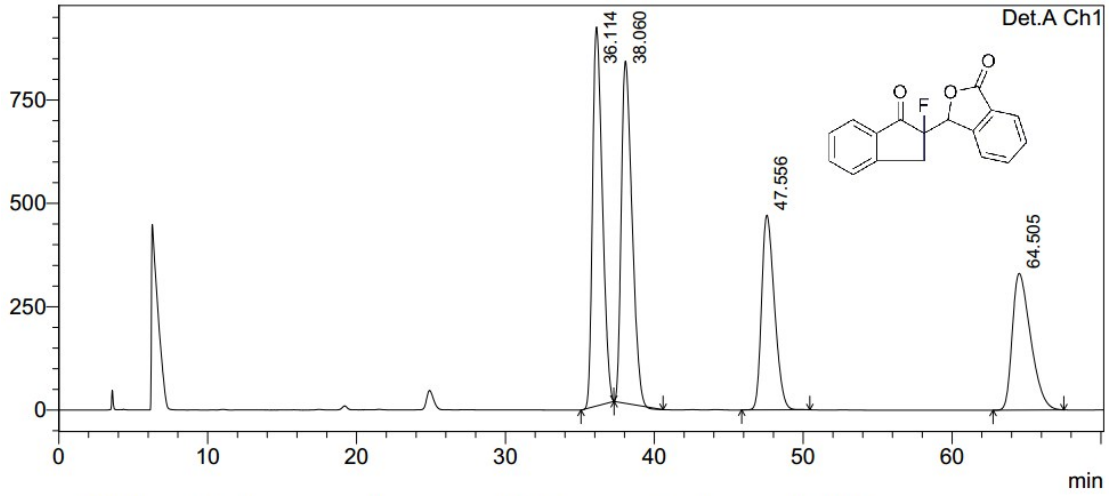
Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.476	10051319	453356	27.298	35.292
2	18.253	10090175	421402	27.404	32.804
3	20.211	8339358	276678	22.649	21.538
4	42.750	8339620	133154	22.649	10.365
Total		36820472	1284589	100.000	100.000

HPLC spectra of product **7sa**



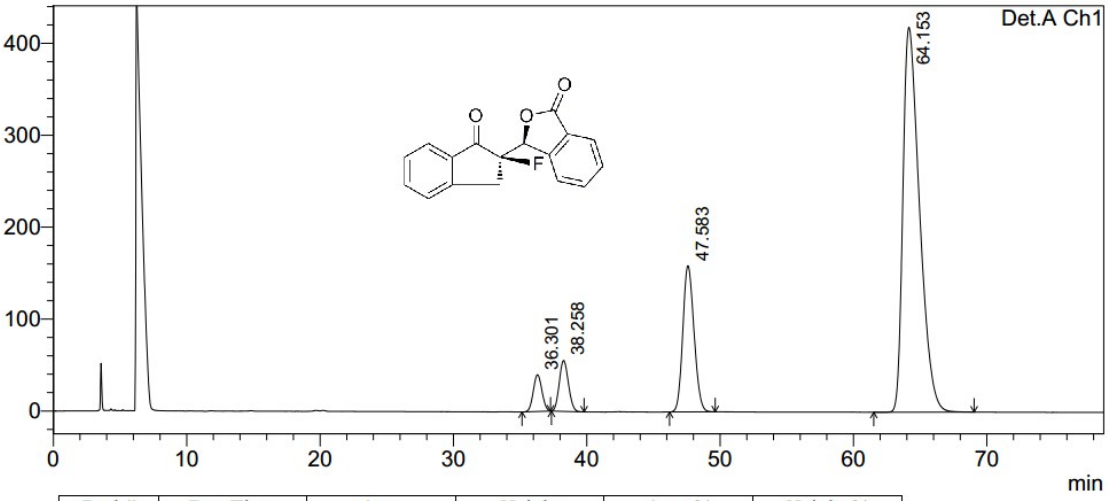
Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.248	1245547	56093	4.933	10.437
2	18.021	1405595	59841	5.567	11.134
3	19.897	3006928	102711	11.909	19.111
4	41.482	19591937	318803	77.592	59.318
Total		25250007	537448	100.000	100.000

HPLC spectra of **racemic-7ta**



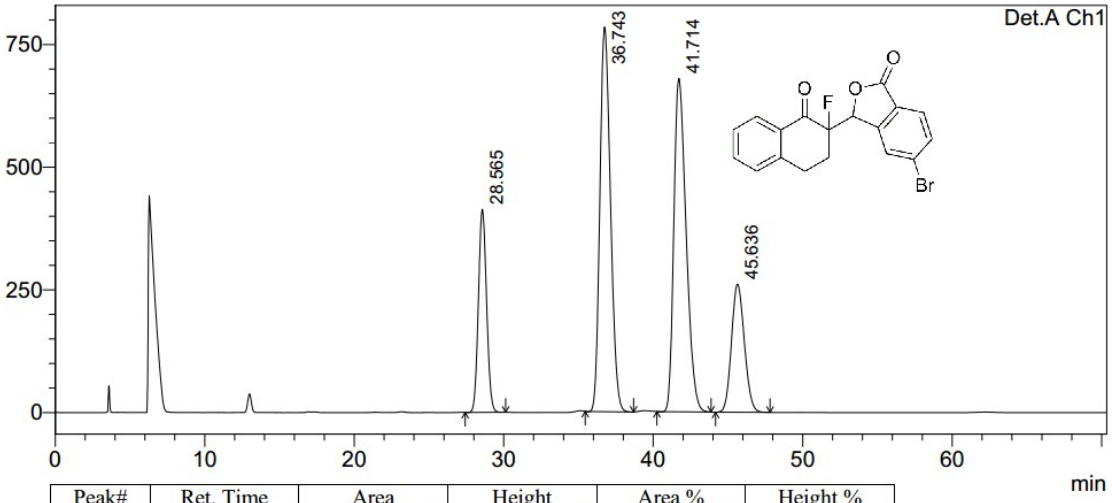
Peak#	Ret. Time	Area	Height	Area %	Height %
1	36.114	41830207	917239	29.904	36.007
2	38.060	41468918	828078	29.645	32.507
3	47.556	28323854	471348	20.248	18.503
4	64.505	28260431	330758	20.203	12.984
Total		139883409	2547423	100.000	100.000

HPLC spectra of product **7ta**



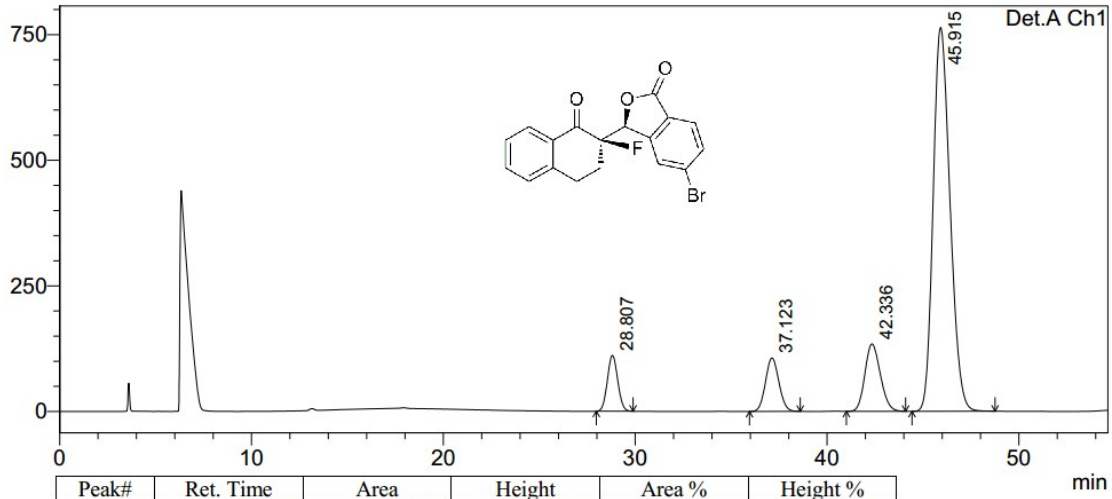
Peak#	Ret. Time	Area	Height	Area %	Height %
1	36.301	1805698	39997	3.616	5.942
2	38.258	2643831	55396	5.295	8.230
3	47.583	9290539	158994	18.605	23.622
4	64.153	36195222	418692	72.484	62.205
Total		49935290	673079	100.000	100.000

HPLC spectra of **racemic-7ab**



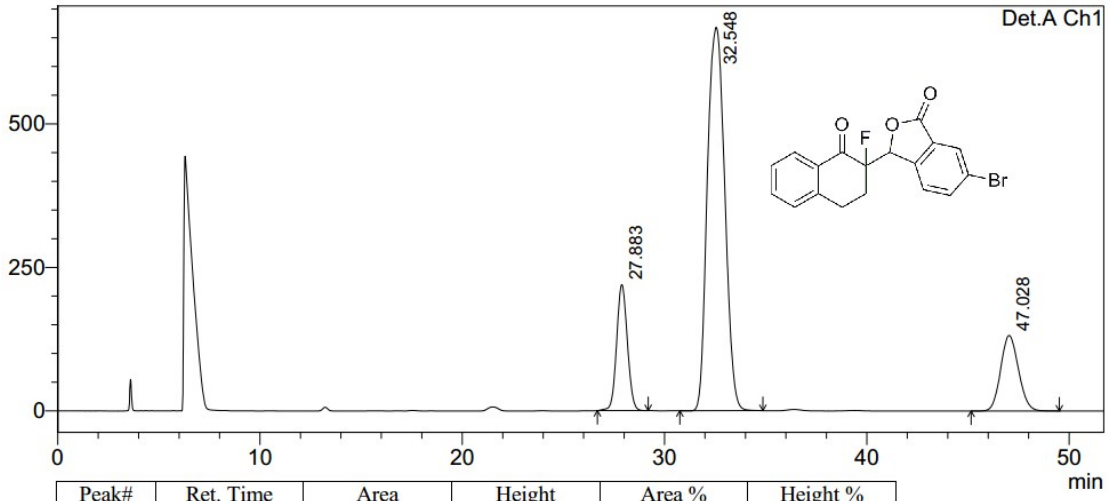
Peak#	Ret. Time	Area	Height	Area %	Height %
1	28.565	15680393	414001	14.441	19.360
2	36.743	38561760	784077	35.513	36.667
3	41.714	38677147	679397	35.620	31.771
4	45.636	15664604	260912	14.426	12.201
Total		108583905	2138387	100.000	100.000

HPLC spectra of product **7ab**



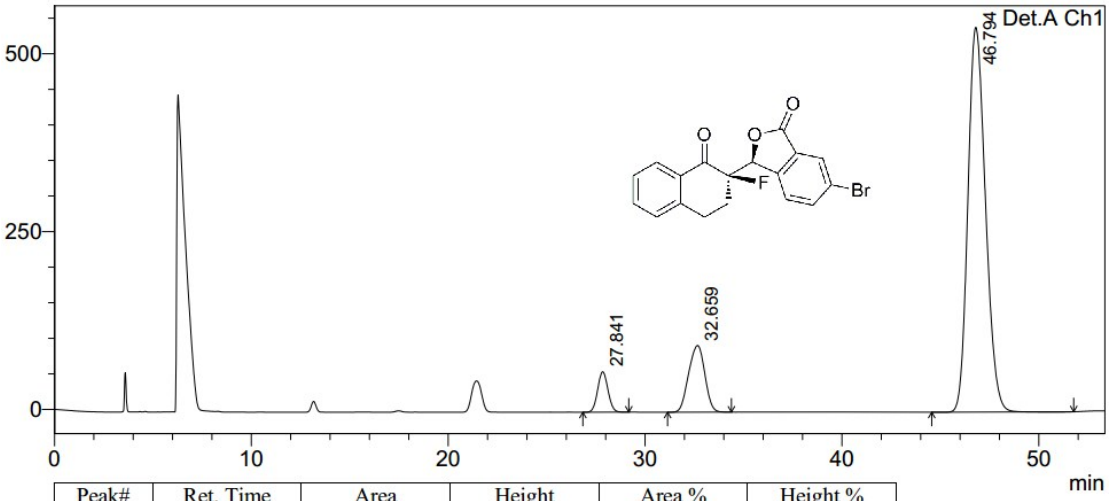
Peak#	Ret. Time	Area	Height	Area %	Height %
1	28.807	4189176	111177	6.595	9.964
2	37.123	5168771	106357	8.137	9.532
3	42.336	7525040	134174	11.846	12.025
4	45.915	46640533	764107	73.422	68.480
Total		63523520	1115814	100.000	100.000

HPLC spectra of **racemic-7ac**



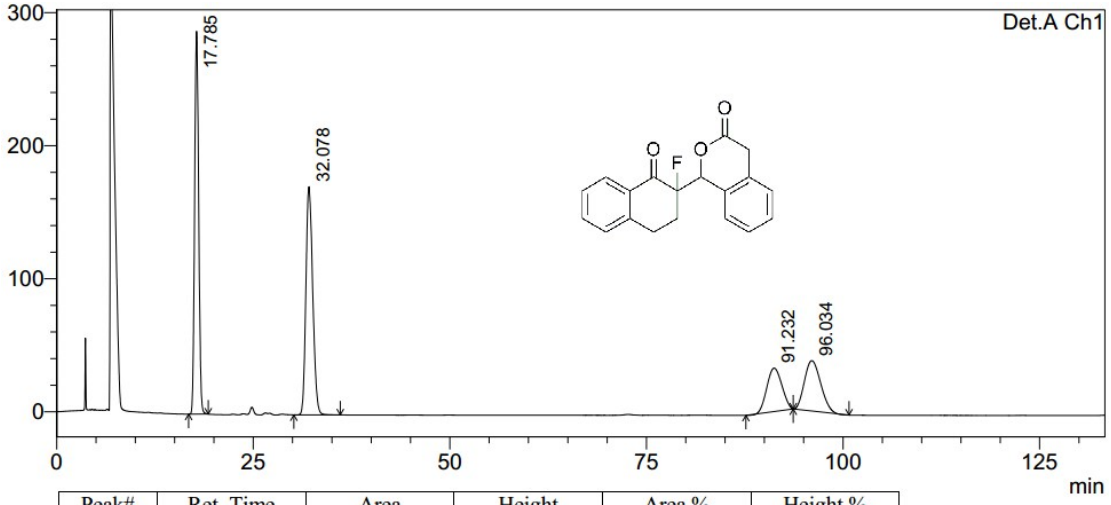
Peak#	Ret. Time	Area	Height	Area %	Height %
1	27.883	8079936	219484	14.390	21.537
2	32.548	40003000	667978	71.242	65.545
3	47.028	8067948	131654	14.368	12.918
Total		56150885	1019116	100.000	100.000

HPLC spectra of product **7ac**



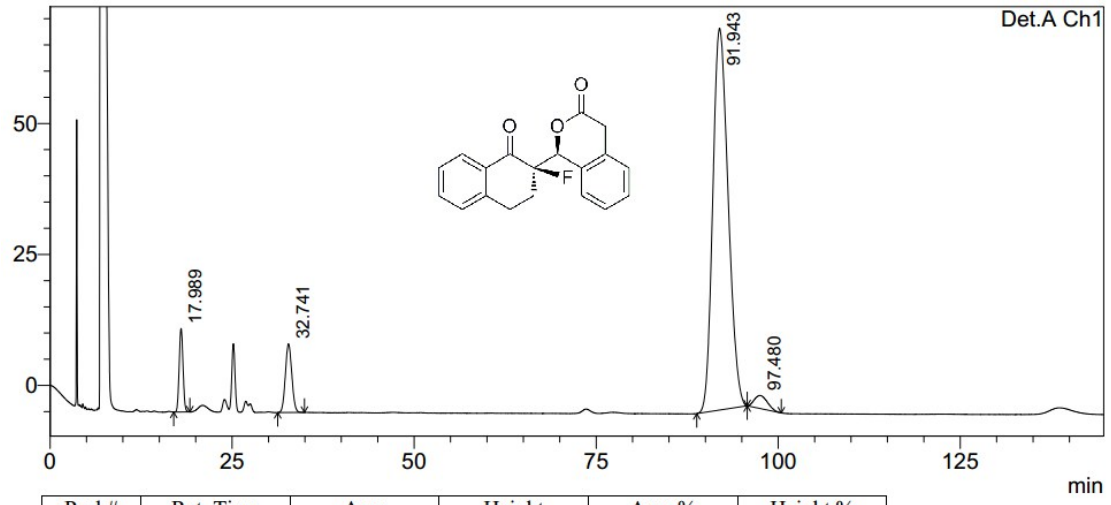
Peak#	Ret. Time	Area	Height	Area %	Height %
1	27.841	2071965	56822	5.066	8.215
2	32.659	5347125	93823	13.074	13.565
3	46.794	33480903	541031	81.860	78.220
Total		40899992	691676	100.000	100.000

HPLC spectra of **racemic-7ae**



Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.785	10320346	287788	33.944	54.320
2	32.078	10358719	171598	34.070	32.389
3	91.232	4299475	32588	14.141	6.151
4	96.034	5425744	37829	17.845	7.140
Total		30404283	529802	100.000	100.000

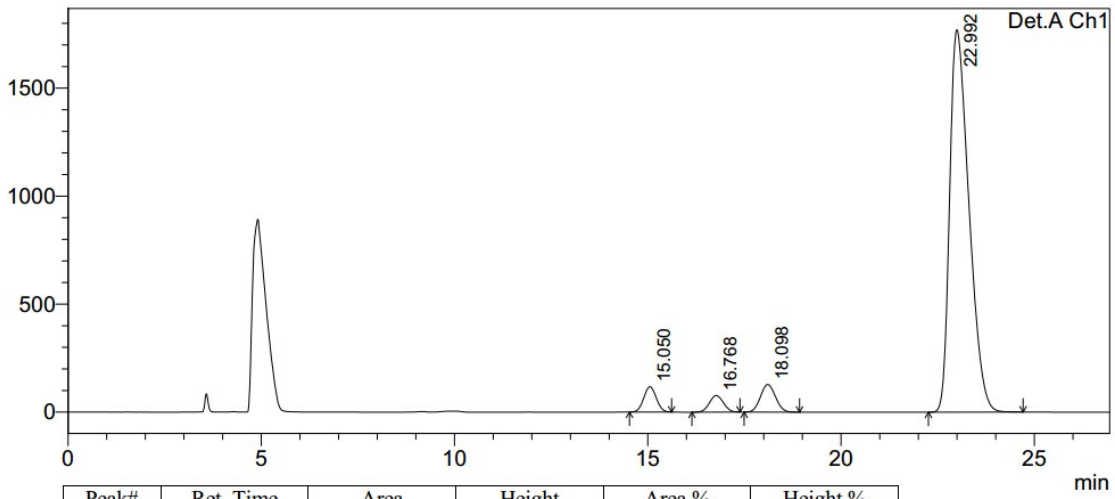
HPLC spectra of product **7ae**



Peak#	Ret. Time	Area	Height	Area %	Height %
1	17.989	587129	15957	4.729	15.280
2	32.741	807254	13111	6.501	12.555
3	91.943	10712393	72887	86.275	69.796
4	97.480	309758	2474	2.495	2.369
Total		12416534	104429	100.000	100.000

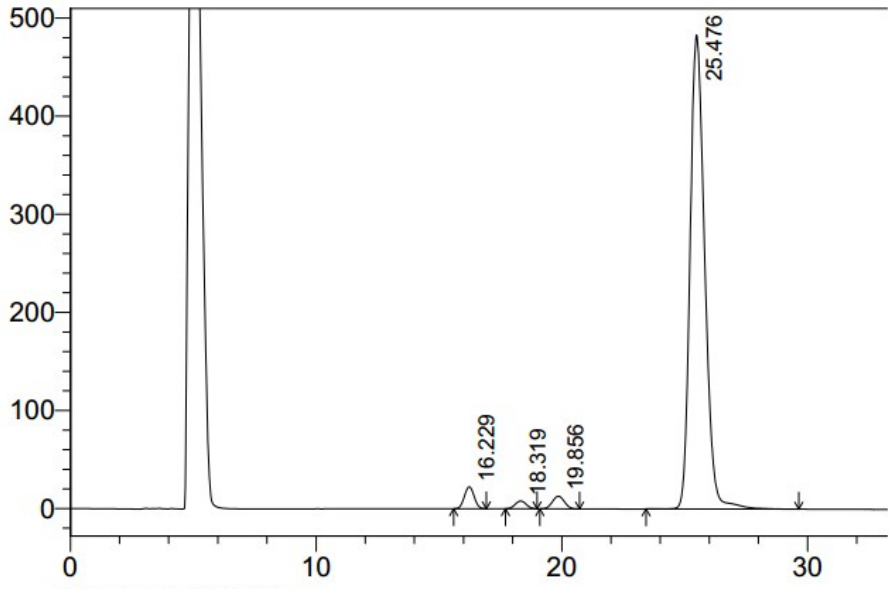
6.2. HPLC spectra of achiral gravity-driven column chromatography SDE tests

HPLC spectraof the starting sample:



Peak#	Ret. Time	Area	Height	Area %	Height %
1	15.050	2639815	117085	3.801	5.597
2	16.768	1941459	76822	2.795	3.673
3	18.098	3453548	127688	4.972	6.104
4	22.992	61424176	1770220	88.432	84.626
Total		69458999	2091815	100.000	100.000

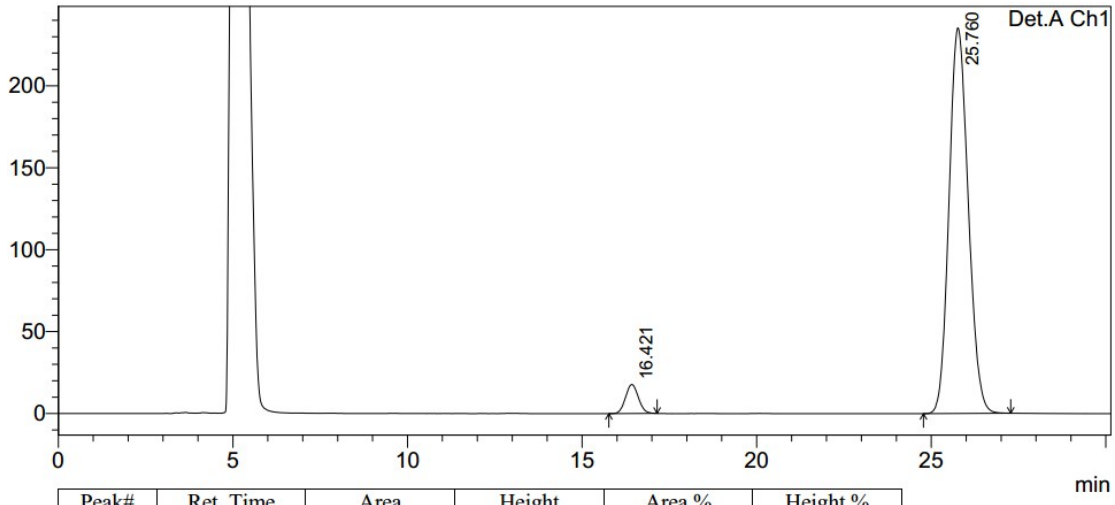
HPLC spectra of the first fraction:



Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	16.229	617653	22317	2.892	4.240
2	18.319	248862	7902	1.165	1.501
3	19.856	438669	12863	2.054	2.444
4	25.476	20048648	483305	93.888	91.816
Total		21353832	526387	100.000	100.000

HPLC spectra of the last fraction:



Peak#	Ret. Time	Area	Height	Area %	Height %
1	16.421	454769	17705	4.814	6.997
2	25.760	8991111	235341	95.186	93.003
Total		9445880	253046	100.000	100.000