Supplementary Information (SI) for Organic & Biomolecular Chemistry.
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Supporting Information

Visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes to synthesize CF_3-functionalized 1,4-naphthoquinones

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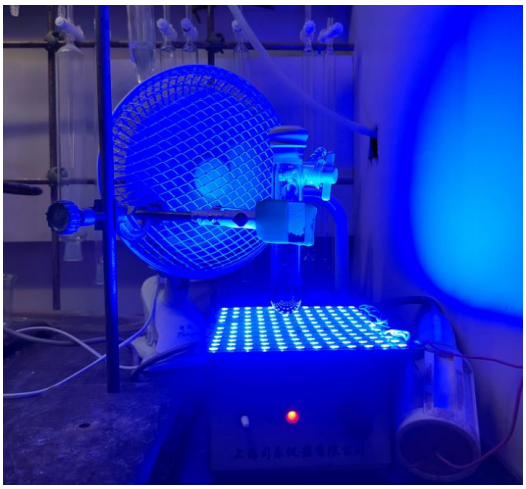
1. General remarks

Proton nuclear magnetic resonance (^{1}H NMR) spectra, carbon nuclear magnetic resonance (^{13}C NMR) spectra and ^{19}F fluorine spectra (^{19}F NMR) were recorded on a JEOL ECZ600R/S3 (^{1}H NMR 600 MHz, ^{13}C NMR 150 MHz, ^{19}F NMR 564 MHz). GC and MS samples were recorded on an Agilent 7890A-5975C GC-MS system. HRMS was recorded on a MicroMass Waters Xevo G2-XS QTof. UV−vis spectra were recorded on a UV-vis 2550 spectroscope (Shimadzu). Fluminescence quenching experiments were recorded on Hitachi High-Tech Fluorescence Spectrophotometer F-7000. For visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes: a blue LEDs panel (40W, 450-470 nm, Hangzhou Jiadeng Precise Light Source LTD) was used, and the distance from the light source to the irradiation glass tube is about 2 cm. Reactants **1** and **2** were readily prepared according to previous experimental procedures (*J. Org. Chem*., 2011, **76**, 5264-5273; *J. Org. Chem.*, 2022, **87**, 14763-14777) and NMR spectroscopic data were consisted with those data.

2. Typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes



To an oven-dried 10 mL glass tube was added 2-amino-1,4-naphthoquinones **2** (0.10 mmol, 1.0 equiv.), Togni reagent **3** (0.175 mmol, 1.75 equiv.), and Na_3PO_4 (0.15 mmol, 1.5 equiv.). The tube was evacuated and back-filled with nitrogen under reduced pressure, which was repeated three times. DMF (1 mL) and alkenes **1** (0.15 mmol, 1.5 equiv.) were successively added to the reaction mixture via a syringe. The resulting mixture was stirred at room temperature (external temperature of the glass tube) for 24 h with 40W blue LEDs (450-470 nm) irradiation until the reaction completion. Water (5 mL) was added to the reaction mixture, the resulting reaction mixture was extracted with EtOAc, and the organic phase was dried with Na_2SO_4 and then concentrated under reduced pressure. The obtained residue was further purified

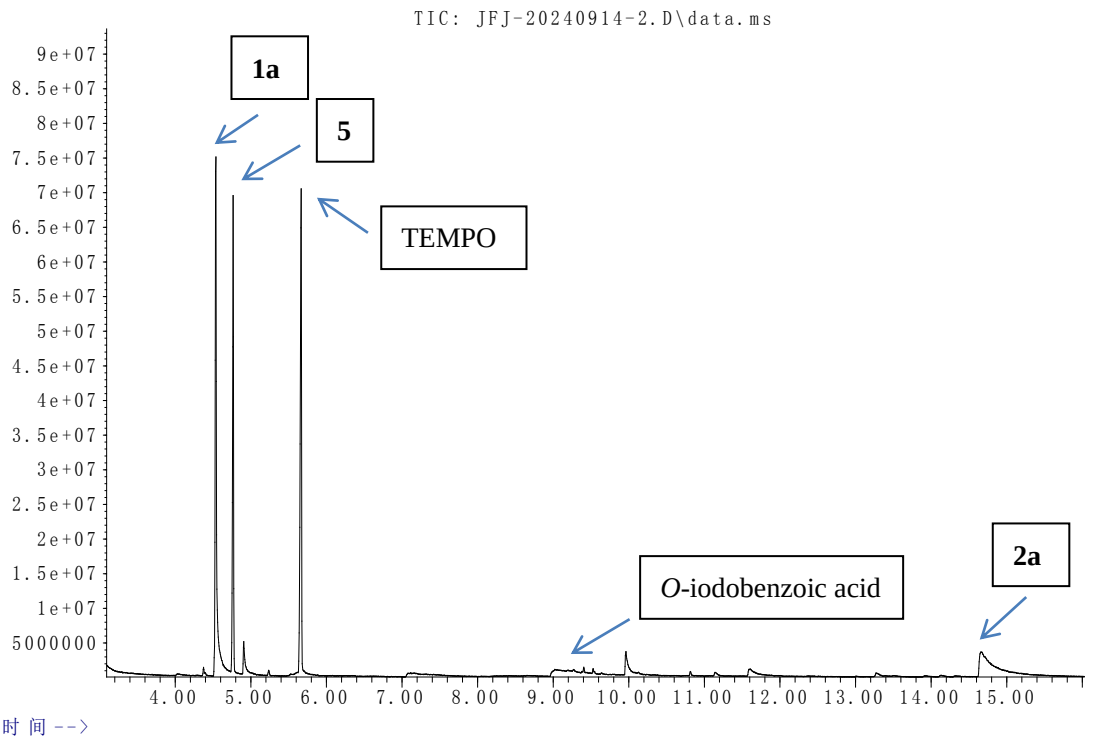
by flash column chromatography using petroleum ether/ethyl acetate as eluant to afford the products **4**.

3. Scale-up experiment procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes

To an oven-dried 100 mL glass tube was added 2-phenylamino-1,4-naphthoquinone **2a** (5 mmol, 1.0 equiv.), Togni reagent **3** (8.75 mmol, 1.75 equiv.), and Na_3PO_4 (7.5 mmol, 1.5 equiv.). The tube was evacuated and back-filled with nitrogen under reduced pressure, which was repeated three times. DMF (40 mL) and 4-methylstyrene **1a** (7.5 mmol, 1.5 equiv.) were successively added to the reaction mixture via a syringe. The resulting mixture was stirred at room temperature (external temperature of the glass tube) for 48 h with 40W blue LEDs (450-470 nm) irradiation. Water (200 mL) was added to the reaction mixture, the resulting reaction mixture was extracted with EtOAc, and the organic phase was dried with Na_2SO_4 and then concentrated under reduced pressure. The obtained residue was further purified by flash column chromatography using petroleum ether/ethyl acetate as eluant to afford the product **4aa** (1.4g, 64%).

4. GC-MS detection for compounds 5, 6 and 7

(1) GC-MS detection for compound **5**


丰 度
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1a
5
TEMPO
O-iodobenzoic acid
2a
时 间 -->
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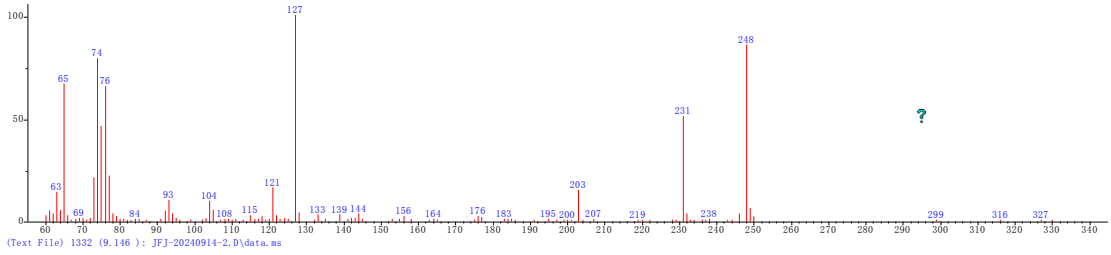
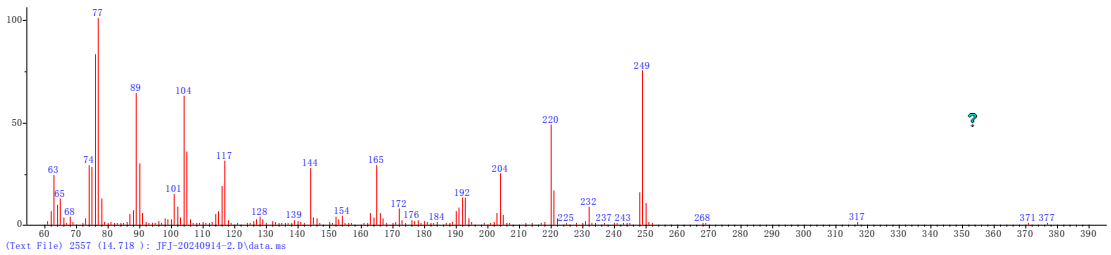
1a

5

TEMPO

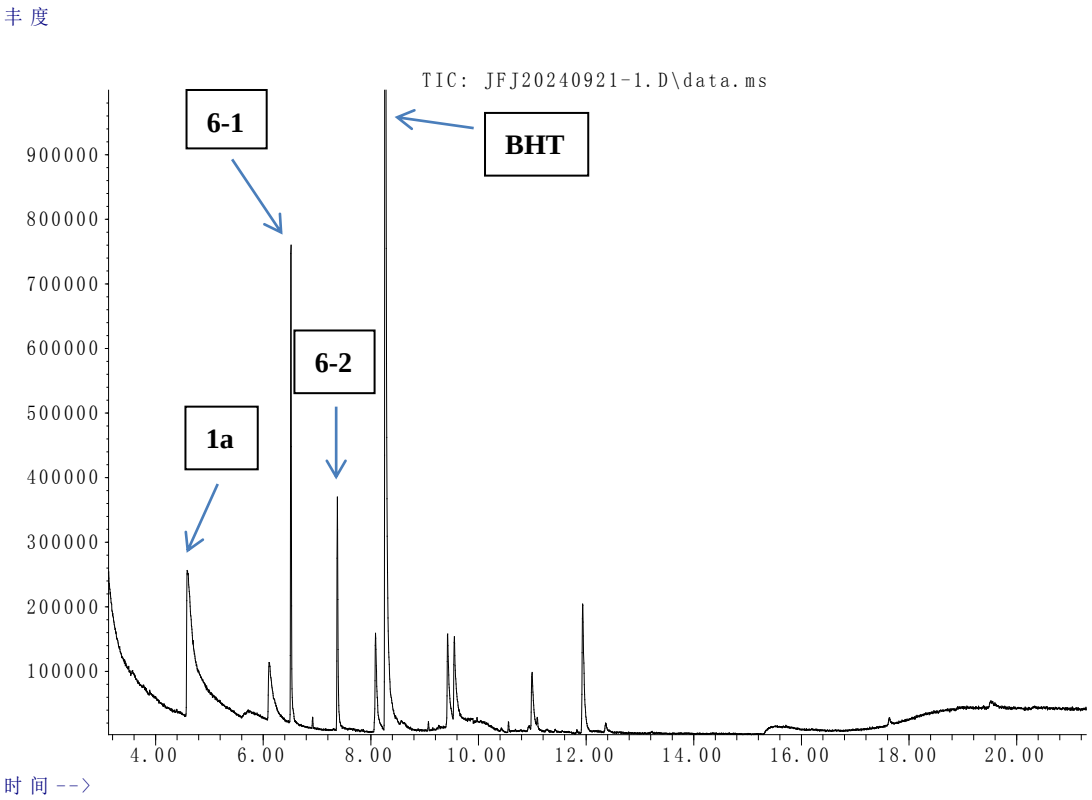


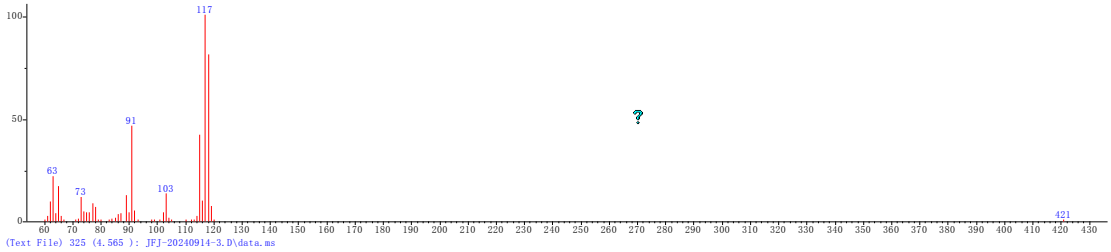
O-iodobenzoic acid



2a

(2) GC-MS detection for compound **6**

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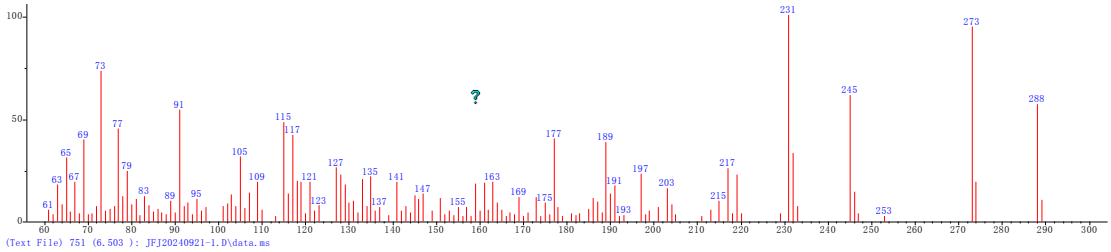
1a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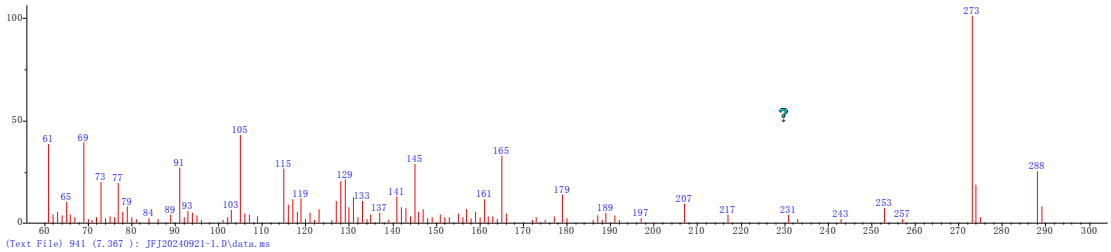
6-1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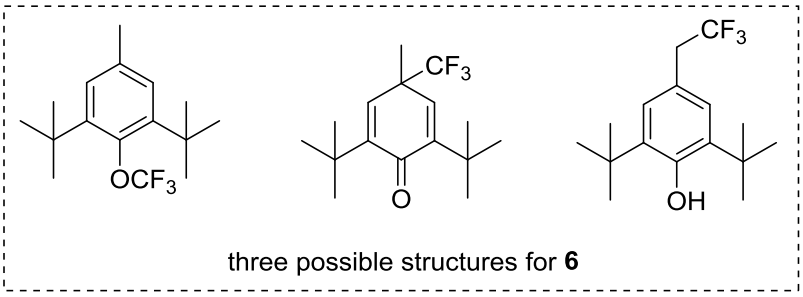
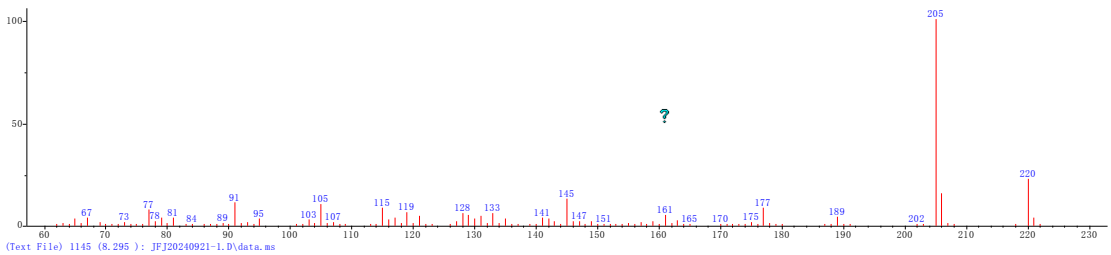
6-2


OCF3
CF3
O
CF3
OH
three possible structures for 6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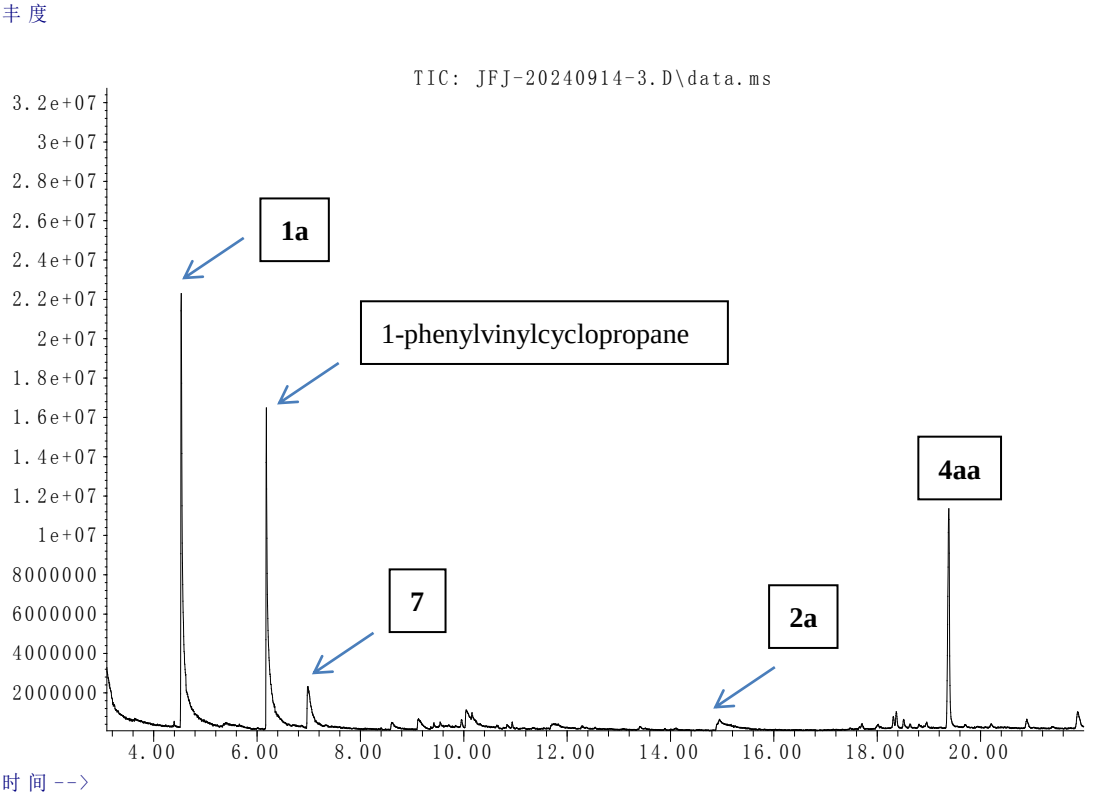
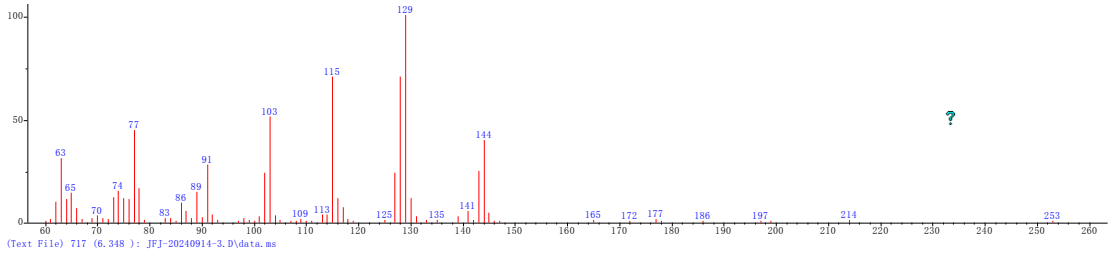
BHT

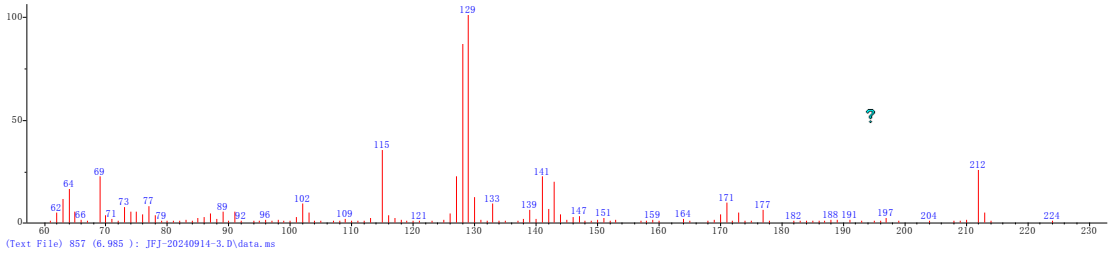
(3) GC-MS detection for compound **7**



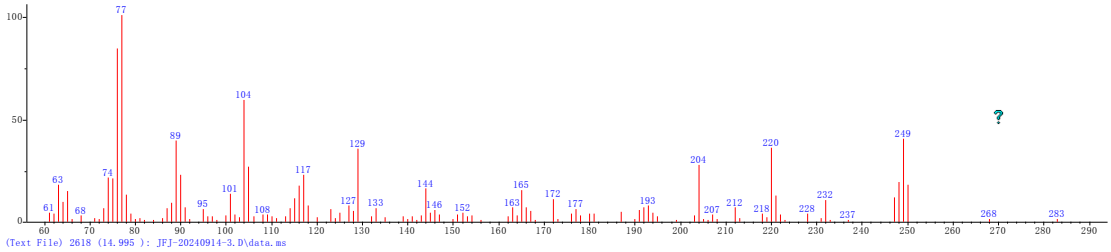
1a



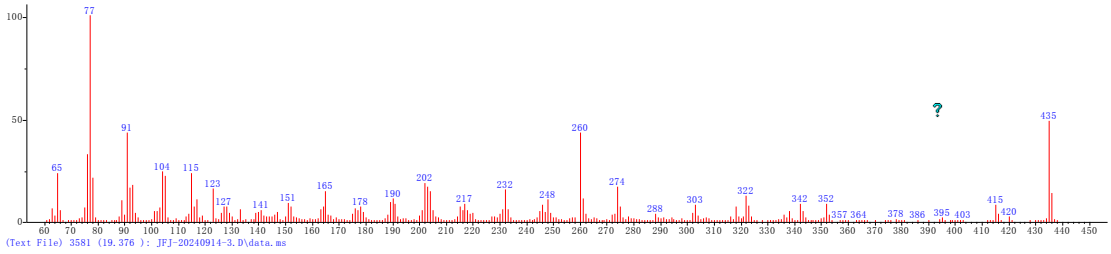
1-phenylvinylcyclopropane



7



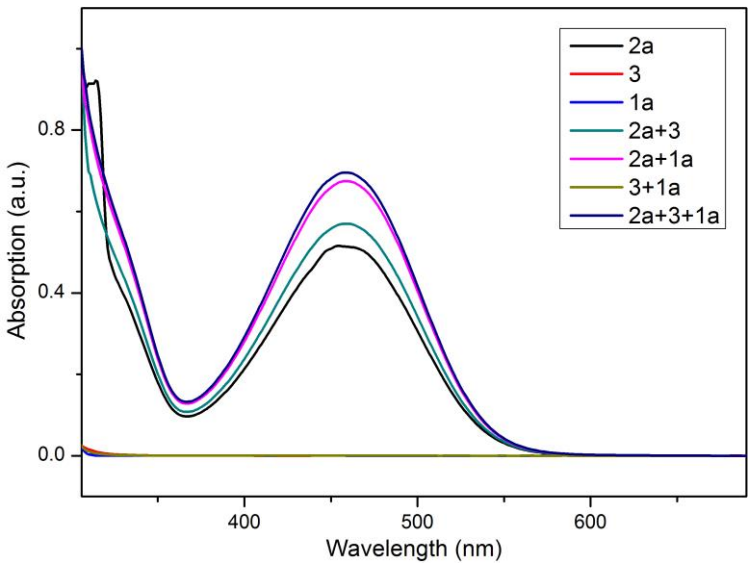
2a



4aa

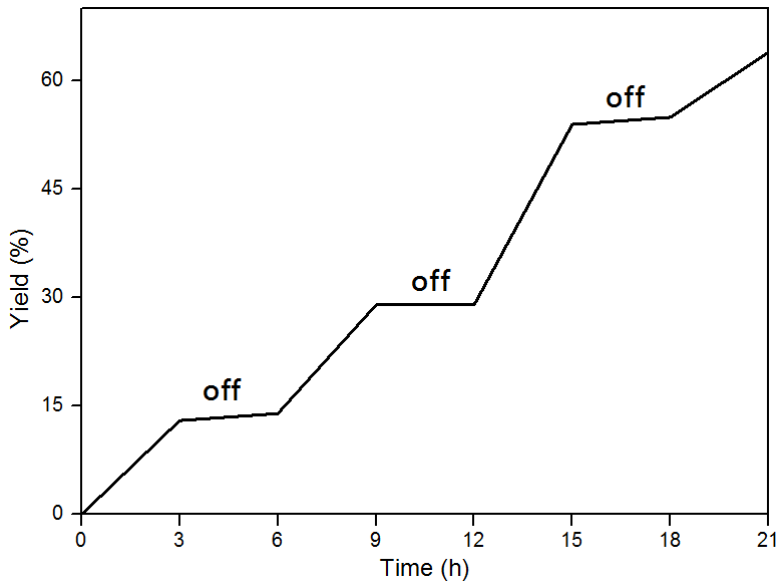
5. UV-vis analysis of substrates

The UV-vis spectra of **2a** and its mixture **2a+3**, **2a+1a** **2a+3+1a** showed a typical absorption of blue light with the maximum peak of 460 nm, which indicated the spectra were not shifted. The results excluded the possibility of an electron-donor-acceptor (EDA) complex (Figure 2A). In addition, **2a** could act as an photosensitizer under the radiation of blue light.



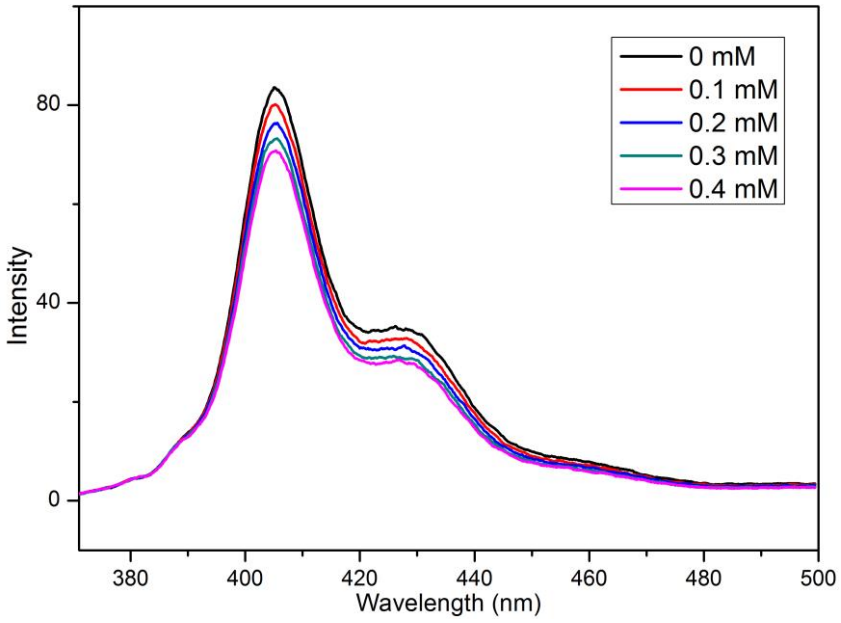
6. "Light/dark" irradiation experiments for the reaction

To an oven-dried 10 mL glass tube was added 2-amino-1,4-naphthoquinones **2** (0.10 mmol, 1.0 equiv.), Togni reagent **3** (0.175 mmol, 1.75 equiv.), and Na_3PO_4 (0.15 mmol, 1.5 equiv.). The tube was evacuated and back-filled with nitrogen under reduced pressure, which was repeated three times. DMF (1 mL) and alkenes **1** (0.15 mmol, 1.5 equiv.) were successively added to the reaction mixture via a syringe. The resulting mixture was stirred at room temperature with 40W blue LEDs (450-470 nm) irradiation. Once the mixture was stirred for 3 hours, 30 μL of the reaction mixture was taken out via a syringe. The mixture was monitored by ^{19}F NMR using 1-bromo-4-fluorobenzene as an internal standard. The resulting mixture in the tube continued to be stirred at dark for 3 h, and 30 μL of the reaction mixture was taken out via a syringe. The mixture was monitored by ^{19}F NMR using 1-bromo-4-fluorobenzene as an internal standard. The above process was repeated for several times. The following figure showed that the yield of **4aa** was obviously increased upon irradiating the reaction with blue LEDs. In contrast, the increase of the yield of **4aa** was not observed upon performing the reaction in the dark. These results indicated that continuous visible light irradiation was necessary for the alkenyltrifluoromethylation of alkenes.

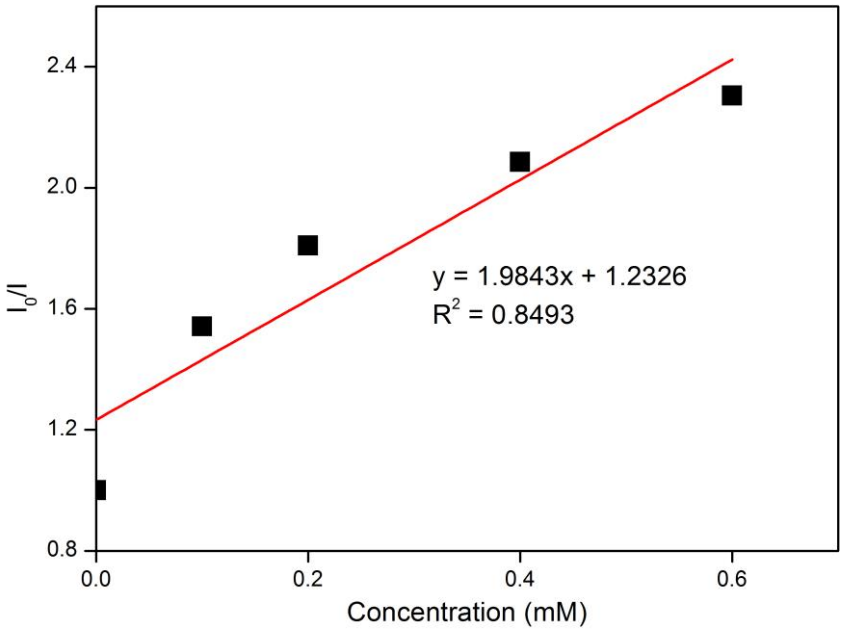


7. Fluorescence quenching experiments

Fluorescence measurements for freshly prepared **2a** stock solutions in DMF were performed with an excitation irradiation of λ_{ex} = 360 nm and observed for a fluorescence emission of around λ_{em} = 405 nm and an excitation as well as measuring bandwidth of 5 nm. The following fluorescence data were received with measurements of **2a** stock solutions of c = 1 $\times 10^{-4}$ M containing **3** in a range of c = 1×10^{-4} M, 2×10^{-4} M, 3×10^{-4} M, 4×10^{-4} M.

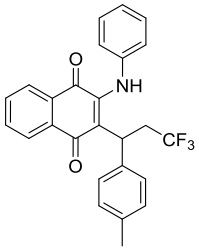


The plot shows an obvious quenching of the excited state of **2a** when using **3** as a quencher. Stern-Volmer quenching plot for **2a** using **3** as a quencher were obtained.



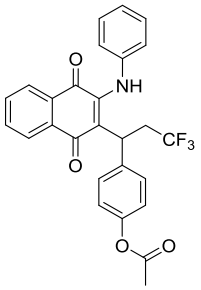
8. Characterization data of products

2-(phenylamino)-3-(3,3,3-trifluoro-1-(p-tolyl)propyl)naphthalene-1,4-dione **(4aa)**



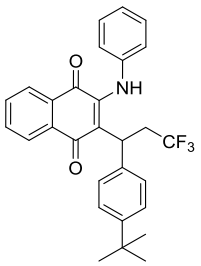
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 33.1mg, 76%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.11-8.09 (dd, J = 7.8, 1.1 Hz, 1H), 8.06-8.05 (dd, J = 7.8, 1.2 Hz, 1H), 7.74-7.71 (td, J = 7.7, 1.2 Hz, 1H), 7.64-7.62 (td, J = 7.7, 1.1 Hz, 1H), 7.52 (s, 1H), 7.23-7.20 (t, J = 7.8 Hz, 2H), 7.15-7.12 (t, J = 7.8 Hz, 1H), 7.05-6.99 (m, 6H), 4.16-4.14 (t, J = 7.0 Hz, 1H), 3.15-2.99 (m, 2H), 2.28 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.2, 182.8, 144.0, 140.2, 137.2, 136.3, 134.9, 133.6, 132.6, 130.1, 129.6, 129.1, 128.0, 126.9 (q, J_{CF} = 275.3 Hz), 126.6, 126.3, 125.9, 123.7, 120.3, 37.3 (q, J_{CF} = 27.0 Hz), 37.1, 21.1; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.0 (t, J = 11.0 Hz, 3F).[1]

4-(1-(1,4-dioxo-3-(phenylamino)-1,4-dihydronaphthalen-2-yl)-3,3,3-trifluoropropyl)phenyl acetate **(4ab)**



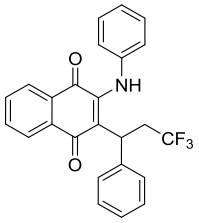
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 8:1) to offer the product. Red brown solid (mixed small amounts of oil); 21.5 mg, 45%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.09-8.07 (td, J = 7.7, 1.1 Hz, 1H), 7.75-7.73 (td, J = 7.7, 1.1 Hz, 1H), 7.66-7.63 (td, J = 7.8, 1.1 Hz, 1H), 7.56 (s, 1H), 7.20-7.18 (t, J = 7.8 Hz, 2H), 7.13-7.11 (t, J = 7.7 Hz, 1H), 7.04-7.03 (d, J = 8.4 Hz, 2H), 7.00-6.99 (d, J = 8.5 Hz, 2H), 6.89-6.87 (d, J = 8.5 Hz, 2H), 4.11-4.08 (t, J = 7.2 Hz, 1H), 3.17-3.08 (m, 1H), 2.97-2.88 (m, 1H), 2.25 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.3, 182.7, 169.5, 149.3, 144.4, 139.9, 137.8, 135.0, 133.6, 132.7, 130.0, 129.6, 129.2, 126.6, 126.5 (q, J_{CF} = 272.8 Hz), 126.4, 126.2, 124.0, 121.3, 119.0, 37.7 (q, J_{CF} = 27.0 Hz), 37.3, 21.2; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.2 (t, J = 10.8 Hz, 3F).[1]

2-(1-(4-(tert-butyl)phenyl)-3,3,3-trifluoropropyl)-3-(phenylamino)naphthalene-1,4-di one (**4ac**)



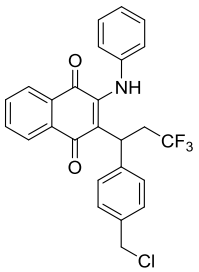
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 36.7 mg, 77%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.11-8.10 (dd, J = 7.7, 1.1 Hz, 1H), 8.07-8.05 (dd, J = 7.7, 1.1 Hz, 1H), 7.74-7.72 (td, J = 7.6, 1.1 Hz, 1H), 7.65-7.62 (td, J = 7.7, 1.1 Hz, 1H), 7.48 (s, 1H), 7.20-7.19 (d, J = 8.5 Hz, 2H), 7.17-7.14 (t, J = 8.3 Hz, 2H), 7.11-7.09 (t, J = 7.7 Hz, 1H), 7.01-6.99 (m, 4H), 4.15-4.13 (t, J = 7.1 Hz, 1H), 3.20-3.10 (m, 1H), 3.02-2.92 (m, 1H), 1.27 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.2, 182.8, 149.4, 144.2, 140.1, 137.0, 134.9, 133.6, 132.6, 130.1, 129.4, 127.7, 126.8 (q, J_{CF} = 273.6 Hz), 126.6, 126.3, 125.8, 125.2, 123.8, 120.4, 37.4 (q, J_{CF} = 27.2 Hz), 37.1, 34.4, 31.4; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.1 (t, J = 10.9 Hz, 3F).[1]

2-(phenylamino)-3-(3,3,3-trifluoro-1-phenylpropyl)naphthalene-1,4-dione (**4ad**)



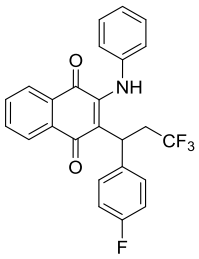
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 30.0 mg, 72%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.11-8.09 (dd, J = 7.7, 0.9 Hz, 1H), 8.07-8.06 (dd, J = 7.7, 0.9 Hz, 1H), 7.75-7.75 (td, J = 7.7, 1.1 Hz, 1H), 7.66-7.63 (td, J = 7.7, 1.0 Hz, 1H), 7.53 (s, 1H), 7.20-7.10 (m, 6H), 7.07-7.06 (d, J = 8.3 Hz, 2H), 7.02-7.01 (d, J = 8.4 Hz, 2H), 4.16-4.13 (t, J = 7.1 Hz, 1H), 3.18-3.08 (m, 1H), 3.04-2.95 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.2, 182.7, 144.3, 140.2, 140.0, 134.9, 133.6, 132.6, 130.1, 129.5, 128.3, 128.1, 126.8 (q, J_{CF} = 272.3 Hz), 126.7, 126.6, 126.4, 126.0, 123.9, 119.7, 37.6, 37.5 (q, J_{CF} = 27.0 Hz); ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.1 (t, J = 11.1 Hz, 3F).[1]

2-(1-(4-(chloromethyl)phenyl)-3,3,3-trifluoropropyl)-3-(phenylamino)naphthalene-1, 4-dione (**4ae**)



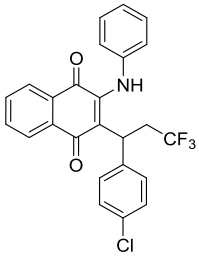
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 26.2 mg, 56%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.09-8.07 (t, J = 7.8 Hz, 2H), 7.76-7.73 (t, J = 7.8 Hz, 1H), 7.67-7.64 (t, J = 7.7 Hz, 1H), 7.57 (s, 1H), 7.20-7.17 (m, 4H), 7.14-7.11 (t, J = 7.5 Hz, 1H), 7.06-7.04 (d, J = 8.0 Hz, 2H), 7.02-7.01 (d, J = 7.9 Hz, 2H), 4.51 (s, 2H), 4.12-4.10 (t, J = 6.9 Hz, 1H), 3.12-2.94 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.2, 182.7, 144.4, 140.6, 139.9, 135.8, 135.0, 133.6, 132.7, 130.0, 129.6, 128.6, 128.5, 126.6, 126.5 (q, J_{CF} = 274.7 Hz), 126.4, 126.2, 124.0, 119.0, 46.1, 37.4 (q, J_{CF} = 27.0 Hz), 37.4; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.2 (t, J = 10.9 Hz, 3F).[1]

2-(phenylamino)-3-(3,3,3-trifluoro-1-(4-fluorophenyl)propyl)naphthalene-1,4-dione (**4af**)



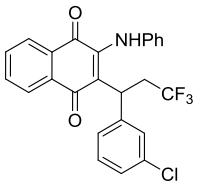
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 30.3 mg, 69%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.10-8.06 (m, 2H), 7.76-7.73 (td, J = 7.8, 1.1 Hz, 1H), 7.66-7.64 (td, J = 7.7, 1.1 Hz, 1H), 7.59 (s, 1H), 7.21-7.18 (m, 2H), 7.15-7.12 (t, J = 7.7 Hz, 1H), 7.02-7.00 (m, 4H), 6.87-6.84 (t, J = 8.5 Hz, 2H), 4.10-4.07 (t, J = 7.2 Hz, 1H), 3.12-3.03 (m, 1H), 3.00-2.91 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.2, 182.7, 161.6 (d, J_{CF} = 244.2 Hz), 144.3, 139.9, 136.0 (d, J_{CF} = 2.7 Hz), 135.0, 133.6, 132.7, 130.0, 129.8 (d, J_{CF} = 7.5 Hz), 129.6, 126.6, 126.6 (q, J_{CF} = 274.4 Hz), 126.4, 126.2, 124.1, 119.1, 115.0 (d, J_{CF} = 21.2 Hz), 37.7 (q, J_{CF} = 27.0 Hz), 37.1; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.2 (t, J = 11.0 Hz, 3F), -116.2--116.3 (m, 1F).[1]

2-(1-(4-chlorophenyl)-3,3,3-trifluoropropyl)-3-(phenylamino)naphthalene-1,4-dione **(4ag)**



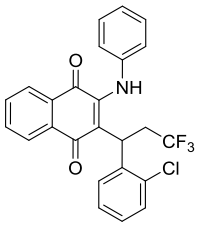
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 29.1 mg, 64%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.09-8.07 (m, 2H), 7.76-7.73 (td, J = 7.8, 1.1 Hz, 1H), 7.67-7.64 (td, J = 7.8, 1.1 Hz, 1H), 7.60 (s, 1H), 7.21-7.18 (m, 2H), 7.16-7.12 (m, 3H), 7.02-7.01 (d, J = 7.7 Hz, 2H), 6.99-6.97 (m, 2H), 4.08-4.05 (t, J = 7.1 Hz, 1H), 3.10-3.01 (m, 1H), 2.99-2.90 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.2, 182.6, 144.4, 139.8, 138.8, 135.1, 133.6, 132.7, 132.4, 129.9, 129.6, 129.5, 128.4, 126.6 (q, J_{CF} = 272.6 Hz), 126.6, 126.5, 126.3, 124.2, 118.6, 37.5 (q, J_{CF} = 27.0 Hz), 37.1; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.2 (t, J = 10.9 Hz, 3F).[1]

2-(1-(3-chlorophenyl)-3,3,3-trifluoropropyl)-3-(phenylamino)naphthalene-1,4-dione **(4ah)**



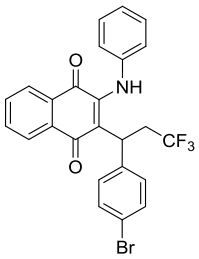
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 27.3 mg, 60%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.10-8.07 (m, 2H), 7.77-7.74 (td, J = 7.7, 1.1 Hz, 1H), 7.67-7.64 (td, J = 7.8, 1.1 Hz, 1H), 7.61 (s, 1H), 7.25-7.14 (m, 3H), 7.13-7.09 (m, 2H), 7.02-7.01 (d, J = 7.7 Hz, 2H), 6.97-6.95 (m, 2H), 4.08-4.06 (t, J = 7.0 Hz, 1H), 3.16-3.07 (m, 1H), 2.94-2.85 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.1, 182.6, 144.7, 142.4, 139.8, 135.1, 134.0, 133.6, 132.7, 129.9, 129.54, 129.46, 128.4, 126.8, 126.7, 126.6 (q, J_{CF} = 271.2 Hz), 126.5, 126.3, 124.4, 118.2, 37.6 (q, J_{CF} = 27.1 Hz), 37.5; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.2 (t, J = 10.9 Hz, 3F).[1]

2-(1-(2-chlorophenyl)-3,3,3-trifluoropropyl)-3-(phenylamino)naphthalene-1,4-dione (**4ai**)



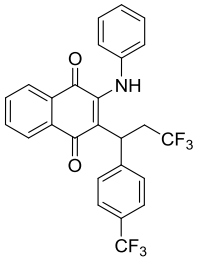
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 21.8 mg, 48%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.16-8.15 (d, J = 7.7 Hz, 1H), 8.10-8.09 (d, J = 7.7 Hz, 1H), 7.79-7.76 (td, J = 7.8, 1.1 Hz, 1H), 7.69-7.66 (td, J = 7.8, 1.1 Hz, 1H), 7.62 (s, 1H), 7.46-7.44 (d, J = 7.7 Hz, 1H), 7.18-7.15 (m, 1H), 7.14-7.11 (m, 2H), 7.08-7.05 (t, J = 7.2 Hz, 1H), 7.00-6.97 (t, J = 7.1 Hz, 2H), 6.79-6.78 (d, J = 7.7 Hz, 2H), 4.32-4.30 (dd, J = 9.8, 4.5 Hz, 1H), 3.35-3.26 (m, 1H), 2.83-2.74 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.8, 182.5, 145.2, 139.3, 136.6, 135.0, 134.7, 133.7, 132.7, 130.7, 130.1, 129.4, 129.1, 128.4 (q, J_{CF} = 273.6 Hz), 128.2, 126.7, 126.5, 125.8, 123.5, 117.0, 36.8, 35.2 (q, J_{CF} = 27.2 Hz); ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.4 (t, J = 10.9 Hz, 3F).[1]

2-(1-(4-bromophenyl)-3,3,3-trifluoropropyl)-3-(phenylamino)naphthalene-1,4-dione **(4aj)**



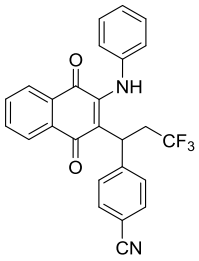
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 29.4 mg, 59%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.09-8.07 (d, J = 7.7 Hz, 2H), 7.76-7.73 (t, J = 7.8 Hz, 1H), 7.67-7.64 (t, J = 7.7 Hz, 1H), 7.61 (s, 1H), 7.30-7.28 (d, J = 8.6 Hz, 2H), 7.22-7.19 (t, J = 7.8 Hz, 2H), 7.16-7.14 (t, J = 7.7 Hz, 1H), 7.03-7.01 (d, J = 7.8 Hz, 2H), 6.94-6.92 (d, J = 7.6 Hz, 2H), 4.06-4.03 (t, J = 7.0 Hz, 1H), 3.08-2.90 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.1, 182.6, 144.4, 139.8, 139.4, 135.1, 133.6, 132.7, 131.3, 129.9, 129.6, 126.6 (q, J_{CF} = 275.0 Hz), 126.6, 126.5, 126.3, 124.2, 120.5, 118.5, 37.5 (q, J_{CF} = 27.1 Hz), 37.2; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.2 (t, J = 10.9 Hz, 3F).[1]

2-(phenylamino)-3-(3,3,3-trifluoro-1-(4-(trifluoromethyl)phenyl)propyl)naphthalene-1,4-dione (**4ak**)



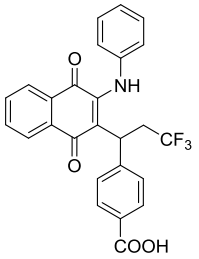
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 23.0 mg, 47% yield; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.10-8.08 (dt, J = 7.7, 1.0 Hz, 2H), 7.77-7.74 (td, J = 7.7, 1.1 Hz, 1H), 7.68-7.65 (m, 2H), 7.43-7.42 (d, J = 7.6 Hz, 2H), 7.19-7.13 (m, 5H), 7.03-7.01 (d, J = 7.7 Hz, 2H), 4.15-4.13 (t, J = 7.0 Hz, 1H), 3.12-2.94 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.1, 182.5, 144.7, 144.5, 139.7, 135.1, 133.5, 132.8, 129.9, 129.6, 128.9 (q, J_{CF} = 32.2 Hz), 128.4, 126.6, 126.5, 126.4 (q, J_{CF} = 274.8 Hz), 125.2, 125.1, 124.3, 124.1 (q, J_{CF} = 276.2 Hz), 117.9, 37.5, 37.4 (q, J_{CF} = 27.0 Hz); ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -62.4 (s, 3F), -64.2 (t, J = 10.9 Hz, 3F).[1]

4-(1-(1,4-dioxo-3-(phenylamino)-1,4-dihydronaphthalen-2-yl)-3,3,3-trifluoropropyl)benzonitrile (**4al**)



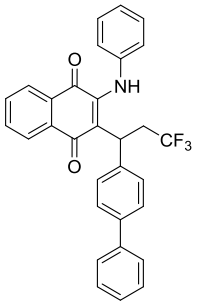
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 10:1) to offer the product. Red brown solid (mixed small amounts of oil); 24.9 mg, 54%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.10-8.07 (m, 2H), 7.77-7.75 (td, J = 7.7, 1.1 Hz, 1H), 7.68-7.66 (m, 2H), 7.47-7.45 (d, J = 8.3 Hz, 2H), 7.20-7.15 (m, 5H), 7.03-7.02 (d, J = 7.2 Hz, 2H), 4.12-4.10 (t, J = 7.0 Hz, 1H), 3.08-2.92 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.0, 182.4, 146.0, 144.9, 139.6, 135.2, 133.5, 132.9, 132.0, 129.9, 129.7, 128.9, 126.7, 126.64, 126.60, 126.3 (q, J_{CF} = 269.4 Hz), 124.5, 118.9, 117.7, 110.4, 37.7 (q, J_{CF} = 2.8 Hz), 37.7 (q, J_{CF} = 26.8 Hz); ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.2 (t, J = 11.0 Hz, 3F); HRMS (ESI) m/z: $[M+H]^+$ calcd. for $C_{26}H_{18}F_3N_2O_2$ 447.1320; found 447.1325.

4-(1-(1,4-dioxo-3-(phenylamino)-1,4-dihydronaphthalen-2-yl)-3,3,3-trifluoropropyl)benzoic acid (**4am**)



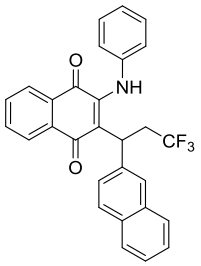
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 4:1) to offer the product. Red solid (mixed small amounts of oil); 22.3 mg, 48%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.10-8.09 (d, J = 7.8 Hz, 2H), 7.92-7.91 (d, J = 7.7 Hz, 2H), 7.77-7.74 (td, J = 7.7, 1.0 Hz, 1H), 7.68-7.65 (m, 2H), 7.19-7.12 (m, 5H), 7.03-7.01 (d, J = 8.2 Hz, 2H), 4.16-4.14 (t, J = 7.2 Hz, 1H), 3.15-3.05 (m, 1H), 3.01-2.92 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.1, 182.5, 171.7, 146.7, 144.8, 142.0, 139.7, 135.1, 133.5, 132.8, 132.1, 130.2, 129.9, 129.6, 128.2, 126.9 (q, J_{CF} = 275.6 Hz), 126.7, 126.5, 124.4, 117.7, 37.7, 37.5 (q, J_{CF} = 27.2 Hz); ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.2 (t, J = 10.9 Hz, 3F); HRMS (ESI) m/z: $[M+H]^+$ calcd. for $C_{26}H_{19}F_3NO_4$ 466.1266; found 466.1272.

2-(1-([1,1'-biphenyl]-4-yl)-3,3,3-trifluoropropyl)-3-(phenylamino)naphthalene-1,4-dione (**4an**)



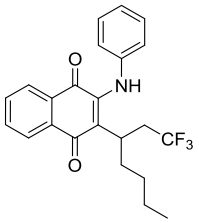
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 32.3 mg, 65%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.13-8.12 (d, J = 7.7 Hz, 1H), 8.09-8.08 (d, J = 7.7 Hz, 1H), 7.76-7.74 (t, J = 7.7 Hz, 1H), 7.67-7.64 (t, J = 7.7 Hz, 1H), 7.59 (s, 1H), 7.56-7.54 (d, J = 7.9 Hz, 2H), 7.44-7.40 (m, 4H), 7.33-7.31 (t, J = 7.7 Hz, 1H), 7.21-7.19 (t, J = 7.6 Hz, 2H), 7.16-7.12 (m, 3H), 7.06-7.05 (d, J = 7.6 Hz, 2H), 4.20-4.18 (t, J = 7.1 Hz, 1H), 3.21-3.12 (m, 1H), 3.08-2.99 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.3, 182.7, 144.3, 140.8, 140.0, 139.5, 139.3, 135.0, 133.6, 132.7, 130.1, 129.5, 128.8, 128.5, 127.3, 127.1, 127.0, 126.7 (q, J_{CF} = 273.2 Hz), 126.6, 126.4, 126.1, 124.0, 119.5, 37.5 (q, J_{CF} = 27.0 Hz), 37.3; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.1 (t, J = 10.9 Hz, 3F).[1]

2-(phenylamino)-3-(3,3,3-trifluoro-1-(naphthalen-2-yl)propyl)naphthalene-1,4-dione (**4ao**)



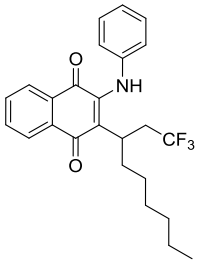
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 28.7 mg, 61%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.13-8.12 (d, J = 7.7 Hz, 1H), 8.09-8.07 (d, J = 7.7 Hz, 1H), 7.76-7.73 (m, 2H), 7.72-7.70 (m, 1H), 7.67-7.64 (m, 2H), 7.59 (s, 1H), 7.49 (s, 1H), 7.43-7.39 (m, 2H), 7.20-7.18 (dd, J = 8.6, 1.8 Hz, 1H), 7.15-7.09 (m, 3H), 7.04-7.03 (d, J = 7.3 Hz, 2H), 4.33-4.31 (t, J = 7.0 Hz, 1H), 3.27-3.17 (m, 1H), 3.14-3.05 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.3, 182.7, 144.3, 140.0, 137.7, 135.0, 133.6, 133.3, 132.7, 132.3, 130.1, 129.5, 128.0, 127.9, 127.5, 126.8, 126.7, 126.6 (q, J_{CF} = 276.3 Hz), 126.5, 126.4, 126.04, 126.02, 125.8, 124.0, 119.5, 37.7, 37.5 (q, J_{CF} = 27.0 Hz); ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.1 (t, J = 11.0 Hz, 3F).[1]

2-(phenylamino)-3-(1,1,1-trifluoroheptan-3-yl)naphthalene-1,4-dione (**4ap**)



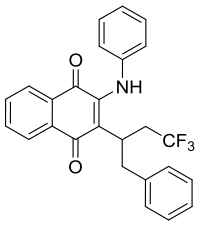
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 23.3 mg, 58%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.07-8.05 (m, 2H), 7.74-7.71 (td, J = 7.7, 1.0 Hz, 1H), 7.65-7.62 (td, J = 7.7, 1.0 Hz, 1H), 7.37-7.33 (m, 3H), 7.23-7.20 (t, J = 7.6 Hz, 1H), 7.13-7.12 (d, J = 7.7 Hz, 2H), 2.67-2.58 (m, 2H), 2.39-2.29 (m, 1H), 1.88-1.82 (m, 1H), 1.52-1.46 (m, 1H), 1.18-1.01 (m, 3H), 0.79-0.77 (t, J = 7.5 Hz, 3H), 0.55-0.48 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.3, 182.8, 144.2, 144.4, 141.1, 134.8, 133.7, 132.5, 130.1, 129.6, 127.2 (q, J_{CF} = 267.5 Hz), 126.31, 126.29, 125.9, 124.2, 122.1, 35.7 (q, J_{CF} = 26.8 Hz), 32.9, 32.2, 30.2, 22.8, 14.0; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.9 (t, J = 11.0 Hz, 3F).[1]

2-(phenylamino)-3-(1,1,1-trifluorononan-3-yl)naphthalene-1,4-dione (**4aq**)



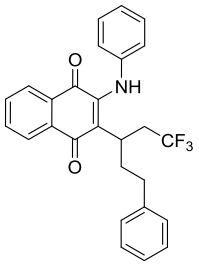
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 22.7 mg, 53%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.07-8.05 (m, 2H), 7.74-7.71 (td, J = 7.7, 1.1 Hz, 1H), 7.65-7.62 (td, J = 7.8, 1.1 Hz, 1H), 7.36-7.33 (m, 3H), 7.22-7.20 (t, J = 7.9 Hz, 1H), 7.13-7.12 (d, J = 7.8 Hz, 2H), 2.67-2.58 (m, 2H), 2.38-2.28 (m, 1H), 1.88-1.82 (m, 1H), 1.61-1.46 (m, 1H), 1.24-1.18 (m, 2H), 1.16-1.04 (m, 5H), 0.85-0.83 (t, J = 7.1 Hz, 3H), 0.58-0.52 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.3, 182.8, 144.4, 141.1, 134.8, 133.7, 132.5, 130.1, 129.6, 127.0 (q, J_{CF} = 276.3 Hz), 126.32, 126.29, 126.0, 124.2, 122.1, 35.6 (q, J_{CF} = 26.8 Hz), 32.8, 32.5, 31.8, 29.3, 28.0, 22.7, 14.2; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.9 (t, J = 10.8 Hz, 3F).[1]

2-(phenylamino)-3-(4,4,4-trifluoro-1-phenylbutan-2-yl)naphthalene-1,4-dione (**4ar**)



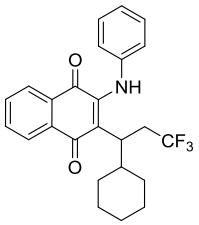
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 22.2 mg, 51%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.12-8.10 (dd, J = 7.7, 1.1 Hz, 1H), 8.07-8.05 (dd, J = 7.7, 1.1 Hz, 1H), 7.77-7.75 (td, J = 7.7, 1.1 Hz, 1H), 7.67-7.64 (td, J = 7.7, 1.2 Hz, 1H), 7.41-7.38 (m, 2H), 7.28-7.25 (m, 2H), 7.13-7.11 (m, 5H), 6.59-6.58 (m, 2H), 3.20-3.09 (m, 2H), 2.93-2.90 (dd, J = 8.1, 5.7 Hz, 1H), 2.75-2.65 (m, 1H), 2.23-2.14 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.4, 182.5, 144.9, 141.2, 139.2, 134.9, 133.8, 132.6, 130.0, 129.9, 129.0, 128.3, 127.0 (q, J_{CF} = 276.3 Hz), 126.4, 126.1, 124.2, 120.3, 37.2, 34.9 (q, J_{CF} = 27.0 Hz), 34.1; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.6 (t, J = 10.8 Hz, 3F).[1]

2-(phenylamino)-3-(1,1,1-trifluoro-5-phenylpentan-3-yl)naphthalene-1,4-dione (**4as**)



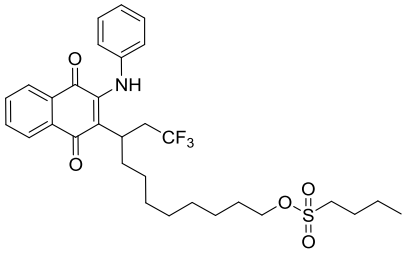
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 19.8 mg, 44%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.08-8.04 (m, 2H), 7.74-7.71 (td, J = 7.7, 1.1 Hz, 1H), 7.66-7.63 (td, J = 7.7, 1.2 Hz, 1H), 7.40-7.37 (m, 2H), 7.34 (s, 1H), 7.28-7.25 (t, J = 7.8 Hz, 1H), 7.23-7.21 (m, 2H), 7.14-7.10 (m, 3H), 7.05-7.04 (d, J = 7.5 Hz, 2H), 2.75-2.61 (m, 2H), 2.49-2.34 (m, 2H), 2.24-2.18 (m, 1H), 1.95-1.83 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.2, 182.7, 144.5, 141.7, 141.1, 134.8, 133.6, 132.6, 130.0, 129.7, 128.4, 128.3, 126.9 (t, J_{CF} = 246.2 Hz), 126.3, 126.1, 125.9, 124.3, 121.3, 35.8 (q, J_{CF} = 26.8 Hz), 34.3, 34.0, 32.7; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.8 (t, J = 10.9 Hz, 3F). [2]

2-(1-cyclohexyl-3,3,3-trifluoropropyl)-3-(phenylamino)naphthalene-1,4-dione (**4at**)



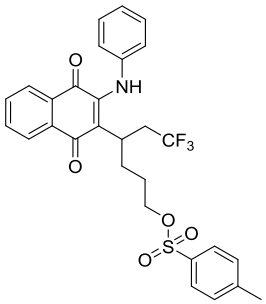
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 20:1) to offer the product. Red brown solid (mixed small amounts of oil); 23.4 mg, 55%, dr = 9: 1; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.05-8.04 (d, J = 7.8 Hz, 2H), 7.73-7.70 (td, J = 7.8, 1.1 Hz, 1H), 7.64-7.61 (td, J = 7.7, 1.0 Hz, 1H), 7.38-7.35 (t, J = 7.9 Hz, 2H), 7.33 (s, 1H), 7.27-7.26 (d, J = 7.9 Hz, 1H), 7.16-7.15 (d, J = 7.6 Hz, 2H), 2.89-2.79 (m, 1H), 2.55-2.50 (m, 1H), 2.28-2.19 (m, 1H), 1.76-1.74 (m, 1H), 1.65-1.57 (m, 5H), 1.45-1.43 (d, J = 12.5 Hz, 1H), 1.15-1.05 (m, 2H), 1.00-0.93 (m, 1H), 0.89-0.80 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.4, 182.2, 145.7, 140.6, 134.7, 133.9, 133.6, 132.5, 129.4, 127.3 (t, J_{CF} = 240.2 Hz), 126.6, 126.4, 126.1, 120.7, 41.2, 37.3, 35.3 (q, J_{CF} = 26.5 Hz), 31.9, 30.9, 26.8, 26.5; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.3 (t, J = 10.7 Hz, 3F); -63.7 (t, J = 10.8 Hz, 0.3F).[2]

9-(1,4-dioxo-3-(phenylamino)-1,4-dihydronaphthalen-2-yl)-11,11,11-trifluoroundecyl butane-1-sulfonate (**4au**)



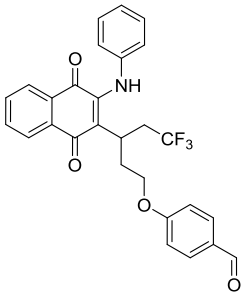
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 8:1) to offer the product. Red oil; 21.9 mg, 37%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.07-8.04 (m, 2H), 7.74-7.71 (td, J = 7.7, 1.0 Hz, 1H), 7.65-7.63 (td, J = 7.7, 0.9 Hz, 1H), 7.36-7.33 (m, 3H), 7.22-7.20 (t, J = 7.6 Hz, 1H), 7.13-7.11 (d, J = 7.5 Hz, 2H), 4.19-4.17 (t, J = 6.7 Hz, 2H), 3.08-3.06 (m, 2H), 2.65-2.58 (m, 2H), 2.38-2.30 (m, 1H), 1.85-1.80 (m, 3H), 1.72-1.68 (m, 2H), 1.50-1.43 (m, 3H), 1.36-1.32 (m, 2H), 1.25-1.20 (m, 3H), 1.19-1.14 (m, 2H), 1.12-1.04 (m, 2H), 0.95-0.93 (t, J = 7.5 Hz, 3H), 0.58-0.52 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.3, 182.8, 144.4, 141.1, 134.8, 133.7, 132.5, 130.0, 129.6, 127.1 (q, J_{CF} = 268.4 Hz), 126.3, 126.0, 124.2, 122.0, 69.8, 35.7 (q, J_{CF} = 26.9 Hz), 32.8, 32.5, 29.5, 29.32, 29.31, 29.1, 28.0, 25.52, 25.49, 21.5, 13.6; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.9 (t, J = 11.2 Hz, 3F); HRMS (ESI) m/z: $[M+Na]^+$ calcd. for $C_{31}H_{38}F_3NNaO_5S$ 616.2320; found 616.2324.

4-(1,4-dioxo-3-(phenylamino)-1,4-dihydronaphthalen-2-yl)-6,6,6-trifluorohexyl 4-methylbenzenesulfonate (**4av**)



This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 8:1) to offer the product. Red brown solid (mixed small amounts of oil); 19.5 mg, 35% yield; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.08-8.07 (dd, J = 7.7, 1.1 Hz, 1H), 8.04-8.02 (dd, J = 7.7, 1.0 Hz, 1H), 7.75-7.72 (m, 3H), 7.67-7.64 (td, J = 7.7, 1.1 Hz, 1H), 7.41 (s, 1H), 7.36-7.31 (m, 4H), 7.23-7.20 (t, J = 7.8 Hz, 1H), 7.10-7.09 (d, J = 7.5 Hz, 2H), 3.87-3.78 (m, 2H), 2.59-2.52 (m, 2H), 2.41 (s, 3H), 2.31-2.19 (m, 1H), 1.83-1.76 (m, 1H), 1.55-1.50 (m, 1H), 1.42-1.36 (m, 1H), 0.98-0.91 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.1, 182.6, 144.9, 144.6, 140.7, 134.9, 133.6, 133.1, 132.6, 129.9, 129.8, 127.9, 126.7 (q, J_{CF} = 273.7 Hz), 126.4, 126.3, 124.3, 120.3, 70.2, 35.6 (q, J_{CF} = 26.7 Hz), 32.1, 28.3, 27.4, 21.7; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.0 (t, J = 10.9 Hz, 3F); HRMS (ESI-TOF): calcd. for $C_{29}H_{26}F_3NNaO_5S$ $[M+Na]^+$ 580.1381, found 580.1377.

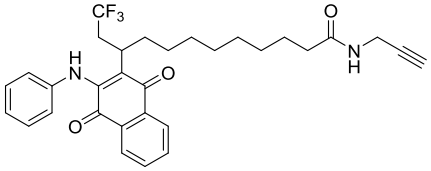
4-((3-(1,4-dioxo-3-(phenylamino)-1,4-dihydronaphthalen-2-yl)-5,5,5-trifluoropentyl)oxy)benzaldehyde (**4aw**)



This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 16.3 mg, 33%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 9.85 (s, 1H), 8.07-8.05 (t, J = 7.8 Hz, 2H), 7.78-7.74 (m, 3H), 7.67-7.65 (t, J = 7.7 Hz, 1H), 7.35-7.32 (m, 3H), 7.21-7.18 (t, J = 7.6 Hz, 1H), 7.06-7.05 (d, J = 7.7 Hz, 2H), 6.78-6.77 (d, J = 7.7 Hz, 2H), 3.73-3.67 (m, 2H), 3.02-2.98 (m, 1H), 2.72-2.57 (m, 2H), 2.38-2.32 (m, 1H), 2.19-2.14 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 190.9, 184.2, 182.4, 163.7, 144.8, 140.9, 135.0,

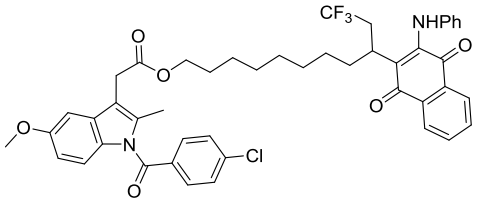
133.6, 132.8, 132.0, 130.1, 130.0, 129.7, 126.7 (q, J_{CF} = 277.2 Hz), 126.5, 126.4, 126.2, 124.0, 120.6, 114.7, 66.8, 36.2 (q, J_{CF} = 27.1 Hz), 31.6, 30.0; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.6 (t, J = 11.0 Hz, 3F); HRMS (ESI) m/z: $[M+Na]^+$ calcd. for $C_{28}H_{22}F_3NNaO_4$ 516.1399; found 516.1400.

10-(1,4-dioxo-3-(phenylamino)-1,4-dihydronaphthalen-2-yl)-12,12,12-trifluoro-N-(prop-2-yn-1-yl)dodecanamide (**4ax**)



This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 5:1) to offer the product. Red solid (mixed small amounts of oil); 22.6 mg, 42%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.06-8.03 (m, 2H), 7.73-7.71 (td, J = 7.7, 1.1 Hz, 1H), 7.65-7.62 (td, J = 7.7, 1.1 Hz, 1H), 7.37-7.32 (m, 3H), 7.21-7.19 (t, J = 7.6 Hz, 1H), 7.12-7.11 (m, 2H), 5.74 (s, 1H), 4.04-4.03 (dd, J = 5.2, 2.5 Hz, 2H), 2.66-2.56 (m, 2H), 2.38-2.30 (m, 1H), 2.21 (t, J = 2.6 Hz, 1H), 2.17-2.15 (t, J = 7.6 Hz, 2H), 1.89-1.79 (m, 1H), 1.62-1.57 (m, 2H), 1.50-1.45 (m, 1H), 1.28-1.21 (m, 3H), 1.20-1.13 (m, 3H), 1.11-1.00 (m, 3H), 0.57-0.50 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.3, 182.8, 172.8, 144.4, 141.1, 134.8, 133.7, 132.5, 130.0, 129.6, 127.1 (q, J_{CF} = 274.5 Hz), 126.3, 126.0, 124.2, 122.0, 79.8, 71.6, 36.5, 35.7 (q, J_{CF} = 27.1 Hz), 32.8, 32.5, 29.5, 29.3, 29.2, 27.9, 25.6; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.9 (t, J = 10.8 Hz, 3F); HRMS (ESI) m/z: $[M+Na]^+$ calcd. for $C_{31}H_{33}F_3N_2NaO_3$ 561.2341; found 561.2346.

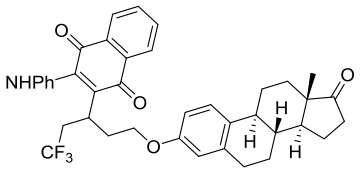
9-(1,4-dioxo-3-(phenylamino)-1,4-dihydronaphthalen-2-yl)-11,11,11-trifluoroundecyl 2-(1-(4-chlorobenzoyl)-5-methoxy-2-methyl-1H-indol-3-yl)acetate (**4ay**)



This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 2:1) to offer the product. Red solid (mixed small amounts of oil); 36.6 mg, 45%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.06-8.04 (td, J = 7.7, 1.1 Hz, 2H), 7.73-7.71 (td, J = 7.7, 1.0 Hz, 1H), 7.64-7.62 (m, 3H), 7.45-7.43 (m, 2H), 7.37 (s, 1H), 7.34-7.32 (t, J = 7.6 Hz, 2H), 7.20-7.18 (t, J = 7.5 Hz, 1H), 7.12-7.11 (d, J = 7.9 Hz, 2H), 6.95 (d, J = 2.5 Hz, 1H), 6.86-6.84 (d, J = 7.7 Hz, 1H), 6.65-6.63 (dd, J = 7.6, 2.5 Hz, 1H), 4.08-4.06 (t, J = 6.8 Hz, 2H), 3.81 (s, 3H), 3.64 (s, 2H), 2.65-2.58 (m, 2H), 2.37-2.30 (m, 4H), 1.86-1.81

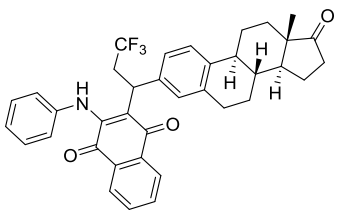
(m, 1H), 1.60-1.56 (m, 2H), 1.50-1.45 (m, 1H), 1.25-1.22 (m, 2H), 1.20-1.15 (m, 2H), 1.14-1.02 (m, 5H), 0.58-0.50 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.2, 182.8, 171.1, 168.4, 156.1, 144.4, 141.1, 139.3, 136.0, 134.8, 134.0, 133.7, 132.5, 131.3, 130.9, 130.8, 130.1, 129.6, 129.2, 127.1 (q, J_{CF} = 273.8 Hz), 126.3, 125.9, 124.1, 122.0, 115.0, 112.8, 111.7, 101.4, 65.2, 55.8, 35.7 (q, J_{CF} = 27.0 Hz), 32.8, 32.5, 30.5, 29.6, 29.4, 29.3, 28.7, 28.0, 25.9, 13.5; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.9 (t, J = 10.9 Hz, 3F); HRMS (ESI) m/z: $[M+Na]^+$ calcd. for $C_{46}H_{44}ClF_3N_2NaO_6$ 835.2738; found 835.2731.

2-(phenylamino)-3-(1,1,1-trifluoro-5-(((8R,9S,13S,14S)-13-methyl-17-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6H-cyclopenta[a]phenanthren-3-yl)oxy)pentan-3-yl)naphthalene-1,4-dione (**4az**)



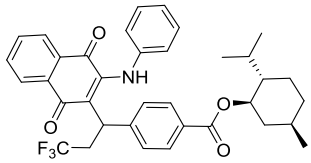
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 8:1) to offer the product. Red brown solid (mixed small amounts of oil); 23.7 mg, 37%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.07-8.06 (d, J = 7.6 Hz, 1H), 8.03-8.02 (d, J = 7.7 Hz, 1H), 7.75-7.72 (td, J = 7.6, 1.1 Hz, 1H), 7.66-7.63 (t, J = 7.7 Hz, 1H), 7.34-7.30 (m, 3H), 7.19-7.16 (t, J = 7.4 Hz, 1H), 7.15-7.13 (d, J = 8.6 Hz, 1H), 7.03-7.02 (d, J = 7.9 Hz, 2H), 6.54-6.52 (dd, J = 8.6, 2.4 Hz, 1H), 6.45-6.43 (m, 1H), 3.68-3.58 (m, 2H), 3.12-3.03 (m, 1H), 2.87-2.79 (m, 2H), 2.75-2.66 (m, 1H), 2.64-2.58 (m, 1H), 2.52-2.47 (m, 1H), 2.39-2.36 (m, 1H), 2.33-2.28 (m, 1H), 2.24-2.10 (m, 3H), 2.06-1.93 (m, 3H), 1.65-1.35 (m, 6H), 0.90 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 221.1, 184.3, 182.2, 156.5, 144.9, 141.2, 137.8, 134.7, 133.6, 132.7, 132.3, 130.4, 129.6, 126.9 (q, J_{CF} = 268.4 Hz), 126.4, 126.3, 125.6, 123.7, 121.8, 122.2, 114.6, 112.1, 66.1, 50.5, 48.1, 44.0, 38.4, 36.3 (q, J_{CF} = 26.7 Hz), 36.0, 32.0, 31.7, 30.2, 29.7, 26.6, 26.00, 25.98, 21.7, 14.0; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.7 (t, J = 10.9 Hz, 3F); HRMS (ESI) m/z: $[M+Na]^+$ calcd. for $C_{39}H_{38}F_3NNaO_4$ 664.2651; found 664.2651.

2-(phenylamino)-3-(3,3,3-trifluoro-1-((8R,9S,13S,14S)-13-methyl-17-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6H-cyclopenta[a]phenanthren-3-yl)propyl)naphthalene-1,4-dione (**4ba**)



This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 10:1) to offer the product. Red brown solid (mixed small amounts of oil); 40.6 mg, 68%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.09-8.03 (m, 2H), 7.73-7.70 (m, 1H), 7.64-7.61 (m, 1H), 7.48-7.47 (d, J = 4.2 Hz, 1H), 7.23-7.19 (m, 2H), 7.15-7.10 (m, 2H), 7.05-7.01 (m, 2H), 6.92-6.90 (m, 1H), 6.75-6.73 (m, 1H), 4.15-4.13 (m, 1H), 3.15-2.97 (m, 2H), 2.81-2.78 (m, 2H), 2.50-2.45 (m, 1H), 2.37-2.33 (m, 1H), 2.24-2.20 (m, 1H), 2.15-2.09 (m, 1H), 2.05-2.01 (m, 1H), 1.98-1.91 (m, 2H), 1.64-1.32 (m, 6H), 0.88 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 221.1, 184.22, 184.19, 182.79, 182.77, 144.1, 144.0, 140.30, 140.28, 138.1, 137.64, 137.62, 136.34, 136.31, 134.9, 133.6, 132.6, 130.1, 129.5, 129.4, 128.7, 126.7 (q, J_{CF} = 270.2 Hz), 126.6, 126.3, 125.8, 125.7, 125.48, 125.47, 125.3, 123.8, 120.8, 120.7, 50.6, 48.1, 44.4, 44.3, 38.19, 38.17, 37.1 (q, J_{CF} = 26.8 Hz), 37.0, 35.9, 31.7, 29.5, 26.6, 25.7, 21.7, 13.9; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.9--64.0 (m, 3F); HRMS (ESI) m/z: $[M+Na]^+$ calcd. for $C_{37}H_{34}F_3NNaO_3$ 620.2388; found 620.2391.

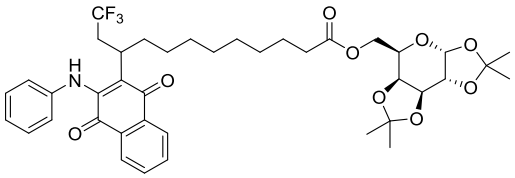
(1R,2S,5R)-2-isopropyl-5-methylcyclohexyl
4-(1-(1,4-dioxo-3-(phenylamino)-1,4-dihydronaphthalen-2-yl)-3,3,3-trifluoropropyl)benzoate (**4ca**)



This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 8:1) to offer the product. Red brown solid (mixed small amounts of oil); 33.2 mg, 55%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.08-8.06 (m, 2H), 7.87-7.85 (dd, J = 7.7, 0.9 Hz, 2H), 7.75-7.72 (m, 1H), 7.66-7.63 (m, 2H), 7.22-7.11 (m, 5H), 7.06-7.02 (m, 2H), 4.90-4.85 (m, 1H), 4.16-4.13 (q, J = 6.9 Hz, 1H), 3.10-2.97 (m, 2H), 2.09-2.07 (d, J = 12.4 Hz, 1H), 1.95-1.89 (m, 1H), 1.71-1.69 (d, J = 12.0 Hz, 2H), 1.54-1.48 (m, 2H), 1.13-1.02 (m, 2H), 0.93-0.87 (m, 7H), 0.76-0.74 (m, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.02, 184.00, 182.6, 166.0, 145.5, 144.5, 144.4, 139.8, 139.7, 135.1, 133.5, 132.7, 129.95, 129.92, 129.7, 129.62, 129.56, 129.19, 129.16, 128.02, 127.97, 126.7 (q, J_{CF} = 274.5 Hz), 126.6, 126.5, 126.4, 124.23, 124.19, 118.3, 118.2, 74.8, 47.3, 41.0, 37.49, 37.45, 37.2 (q, J_{CF} = 26.8 Hz), 37.1 (q, J_{CF} = 26.9 Hz), 34.4, 31.5, 26.6, 26.5, 23.69, 23.68, 22.1, 20.9, 16.60, 16.58; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.1--64.2 (m, 3F); HRMS (ESI) m/z: $[M+Na]^+$ calcd. for $C_{36}H_{36}F_3NNaO_4$ 626.2494; found 626.2496.

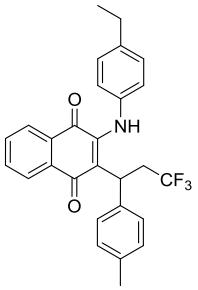
((3aR,5R,5aS,8aS,8bR)-2,2,7,7-tetramethyltetrahydro-5H-bis([1,3]dioxolo)[4,5-b:4',5'-d]pyran-5-yl)methyl
10-(1,4-dioxo-3-(phenylamino)-1,4-dihydronaphthalen-2-yl)-12,12,12-trifluorododeca

noate (**4da**)



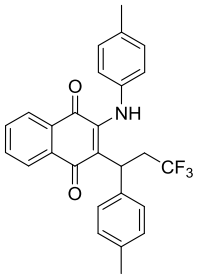
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 3:1) to offer the product. Red oil; 20.8 mg, 28%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.07-8.04 (m, 2H), 7.74-7.71 (td, J = 7.7, 1.1 Hz, 1H), 7.65-7.62 (td, J = 7.7, 1.2 Hz, 1H), 7.36-7.33 (m, 3H), 7.22-7.19 (t, J = 7.9 Hz, 1H), 7.12-7.11 (d, J = 7.6 Hz, 2H), 5.53-5.52 (d, J = 5.0 Hz, 1H), 4.61-4.59 (dd, J = 7.9, 1.9 Hz, 1H), 4.31-4.28 (m, 2H), 4.23-4.21 (dd, J = 7.8, 1.9 Hz, 1H), 4.17-4.14 (m, 1H), 4.01-3.99 (m, 1H), 2.67-2.57 (m, 2H), 2.32-2.30 (t, J = 7.5 Hz, 3H), 1.86-1.80 (m, 1H), 1.61-1.56 (m, 2H), 1.49-1.46 (m, 4H), 1.43 (s, 3H), 1.32 (s, 3H), 1.31 (s, 3H), 1.27-1.01 (m, 9H), 0.58-0.50 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.2, 182.8, 173.9, 144.4, 141.1, 134.8, 133.7, 132.5, 130.0, 129.6, 127.1 (q, J_{CF} = 275.6 Hz), 126.3, 126.0, 124.2, 122.0, 109.7, 108.8, 96.4, 71.2, 70.8, 70.5, 66.1, 63.3, 35.6 (q, J_{CF} = 27.2 Hz), 34.3, 32.8, 32.5, 29.6, 29.35, 29.32, 29.1, 26.1, 26.0, 25.05, 25.03, 24.6; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -63.9 (t, J = 11.0 Hz, 3F); HRMS (ESI) m/z: $[M+Na]^+$ calcd. for $C_{40}H_{48}F_3NNaO_9$ 766.3179; found 766.3178.

2-((4-ethylphenyl)amino)-3-(3,3,3-trifluoro-1-(p-tolyl)propyl)naphthalene-1,4-dione (**4ea**)



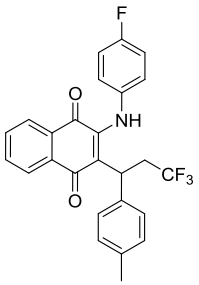
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 33.3 mg, 72%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.10-8.08 (d, J = 7.7 Hz, 1H), 8.06-8.04 (d, J = 7.8 Hz, 1H), 7.73-7.70 (td, J = 7.7, 1.1 Hz, 1H), 7.64-7.61 (td, J = 7.7, 1.1 Hz, 1H), 7.50 (s, 1H), 7.03-7.02 (d, J = 7.8 Hz, 2H), 6.99-6.95 (m, 6H), 4.14-4.12 (t, J = 7.0 Hz, 1H), 3.09-2.99 (m, 2H), 2.61-2.57 (q, J = 7.6 Hz, 2H), 2.27 (s, 3H), 1.21-1.18 (t, J = 7.5 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.2, 182.9, 144.4, 142.4, 137.6, 137.4, 136.1, 134.8, 133.7, 132.5, 130.1, 128.92, 128.91, 128.0, 126.7 (q, J_{CF} = 269.5 Hz), 126.5, 126.3, 124.2, 119.4, 37.3 (q, J_{CF} = 27.0 Hz), 36.9, 28.5, 21.1, 15.7; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.0 (t, J = 11.0 Hz, 3F).[1]

2-(p-tolylamino)-3-(3,3,3-trifluoro-1-(p-tolyl)propyl)naphthalene-1,4-dione (**4fa**)



This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 30.5 mg, 68%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.08-8.04 (m, 2H), 7.73-7.70 (td, J = 7.7, 1.1 Hz, 1H), 7.64-7.61 (td, J = 7.7, 1.2 Hz, 1H), 7.48 (s, 1H), 7.01-6.93 (m, 8H), 4.16-4.13 (t, J = 7.0 Hz, 1H), 3.13-2.96 (m, 2H), 2.29 (s, 3H), 2.27 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.1, 182.9, 144.3, 137.5, 137.4, 136.1, 136.0, 134.8, 133.7, 132.5, 130.0, 128.9, 127.9, 126.7 (q, J_{CF} = 275.6 Hz), 126.5, 126.3, 124.1, 119.4, 37.3 (q, J_{CF} = 27.1 Hz), 36.8, 21.1, 21.0; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.0 (t, J = 11.2 Hz, 3F).[1]

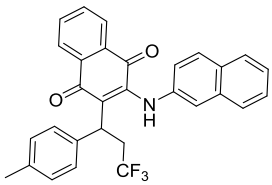
2-((4-fluorophenyl)amino)-3-(3,3,3-trifluoro-1-(p-tolyl)propyl)naphthalene-1,4-dione (**4ga**)



This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 25.8 mg, 57%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.10-8.08 (d, J = 7.7 Hz, 1H), 8.07-8.06 (d, J = 7.7 Hz, 1H), 7.75-7.72 (td, J = 7.7, 1.0 Hz, 1H), 7.66-7.63 (td, J = 7.7, 0.9 Hz, 1H), 7.42 (s, 1H), 7.00-6.96 (m, 4H), 6.93-6.92 (d, J = 7.9 Hz, 2H), 6.86-6.83 (t, J = 8.0 Hz, 2H), 4.07-4.05 (t, J = 7.0 Hz, 1H), 3.19-3.09 (m, 1H), 2.92-2.83 (m, 1H), 2.27 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.2, 182.6, 160.7 (d, J_{CF} = 244.5 Hz), 144.5, 137.0, 136.3, 136.0 (d, J_{CF} = 2.9 Hz), 135.0, 133.6, 132.7, 130.0, 129.1, 127.8, 126.7 (q, J_{CF} = 276.2 Hz), 126.6, 126.4, 126.0 (d, J_{CF} = 8.4 Hz), 119.5, 116.2 (d, J_{CF} = 22.8 Hz), 37.7 (q, J_{CF} = 27.0 Hz), 37.0, 21.0; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.3 (t, J = 10.9 Hz, 3F), -115.5--115.6 (m, 1F).[1]

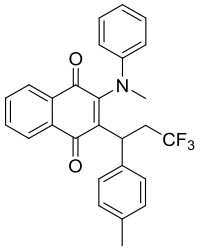
2-(naphthalen-2-ylamino)-3-(3,3,3-trifluoro-1-(p-tolyl)propyl)naphthalene-1,4-dione

(**4ha**)



This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 35.4 mg, 73%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.14-8.13 (d, J = 7.6 Hz, 1H), 8.10-8.08 (d, J = 7.6 Hz, 1H), 7.77-7.74 (m, 2H), 7.71-7.70 (d, J = 7.8 Hz, 1H), 7.67-7.64 (t, J = 7.6 Hz, 2H), 7.41-7.36 (m, 2H), 7.34-7.33 (d, J = 7.9 Hz, 1H), 7.22-7.20 (dd, J = 7.7, 0.9 Hz, 1H), 6.89-6.86 (m, 4H), 4.17-4.14 (m, 1H), 3.26-3.15 (m, 1H), 2.87-2.78 (m, 1H), 2.23 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 184.3, 182.8, 144.3, 137.4, 136.9, 136.3, 134.9, 133.7, 133.6, 132.7, 131.2, 130.1, 129.5, 129.0, 127.9, 127.6, 127.4, 126.9 (q, J_{CF} = 273.4 Hz), 126.7, 126.5, 126.4, 125.7, 122.6, 120.8, 120.4, 37.9 (q, J_{CF} = 27.2 Hz), 37.7, 21.0; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.2 (t, J = 10.9 Hz, 3F).[1]

2-(methyl(phenyl)amino)-3-(3,3,3-trifluoro-1-(p-tolyl)propyl)naphthalene-1,4-dione (**4ia**)



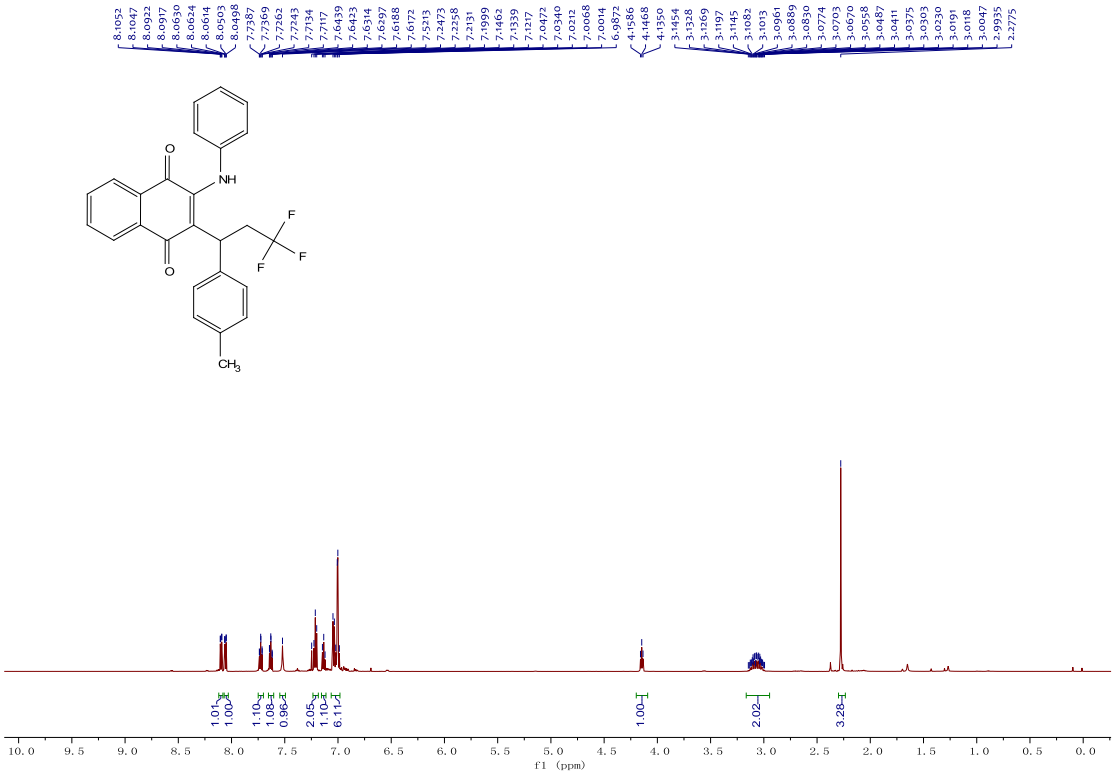
This compound was prepared according to typical reaction procedure for visible light-driven and substrate-promoted alkenyltrifluoromethylation of alkenes and purified by column chromatography (petroleum ether/ethyl acetate = 15:1) to offer the product. Red brown solid (mixed small amounts of oil); 14.8 mg, 33%; ^{1}H NMR (600 MHz, $CDCl_3$): δ [ppm] = 8.12-8.11 (dd, J = 7.6, 1.0 Hz, 1H), 7.96-7.94 (dd, J = 7.7, 1.0 Hz, 1H), 7.74-7.67 (m, 2H), 7.22-7.19 (t, J = 7.8 Hz, 4H), 7.05-7.04 (d, J = 8.0 Hz, 2H), 6.88-6.85 (tt, J = 7.7, 1.0 Hz, 1H), 6.68-6.67 (dd, J = 7.6, 0.9 Hz, 2H), 4.79-4.76 (dd, J = 8.2, 6.1 Hz, 1H), 3.51-3.41 (m, 1H), 3.13 (s, 3H), 2.98-2.89 (m, 1H), 2.28 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$): δ [ppm] = 186.1, 182.0, 150.5, 148.3, 146.4, 137.1, 136.1, 134.1, 133.9, 132.6, 131.8, 129.4, 129.3, 128.6, 126.9 (q, J_{CF} = 274.7 Hz), 126.71, 126.65, 119.7, 114.4, 39.8, 38.5, 37.2 (q, J_{CF} = 27.0 Hz), 21.1; ^{19}F NMR (564 MHz, $CDCl_3$): δ [ppm] = -64.3 (t, J = 11.0 Hz, 3F).[1]

References:

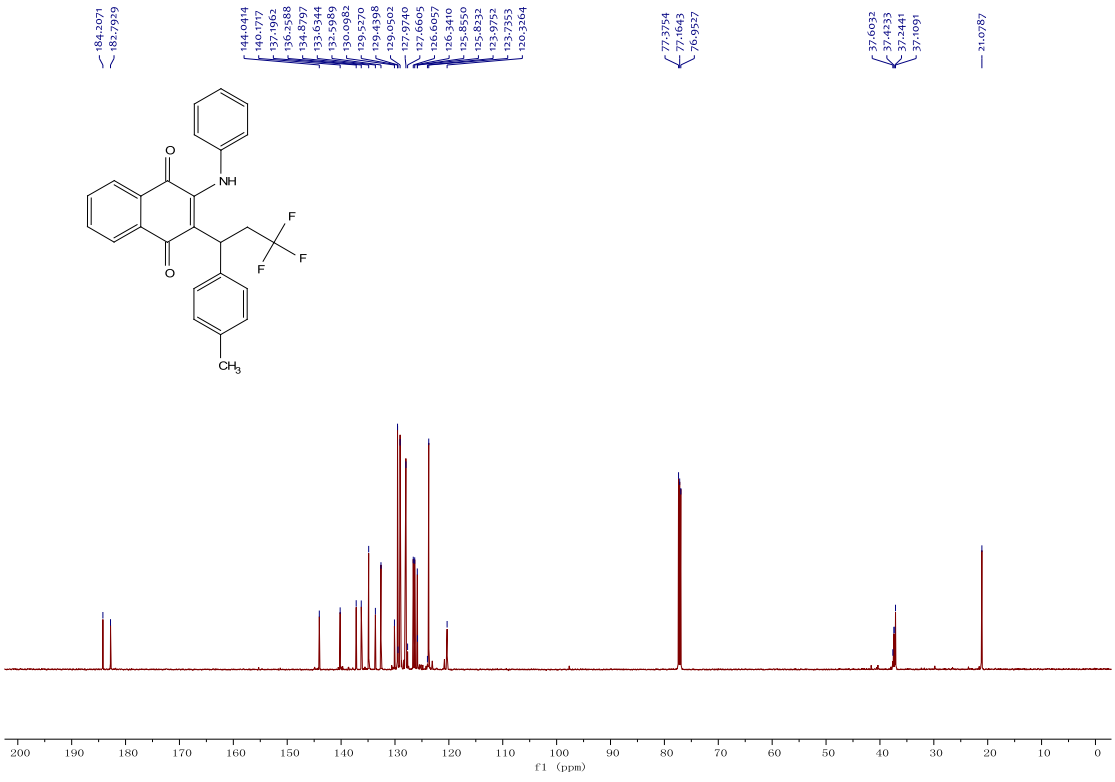
[1] L. Tang, F. Yang, S. Zhang, G. Lv, Q. Zhou, L. Zheng, *J. Org. Chem.*, 2022, **87**, 7274.

[2] Q. Wang, B. Wang, H. Deng, Y. Shangguang, Y. Lin, Y. Zhang, Z. Zhang, Y.

9. NMR Spectra of products

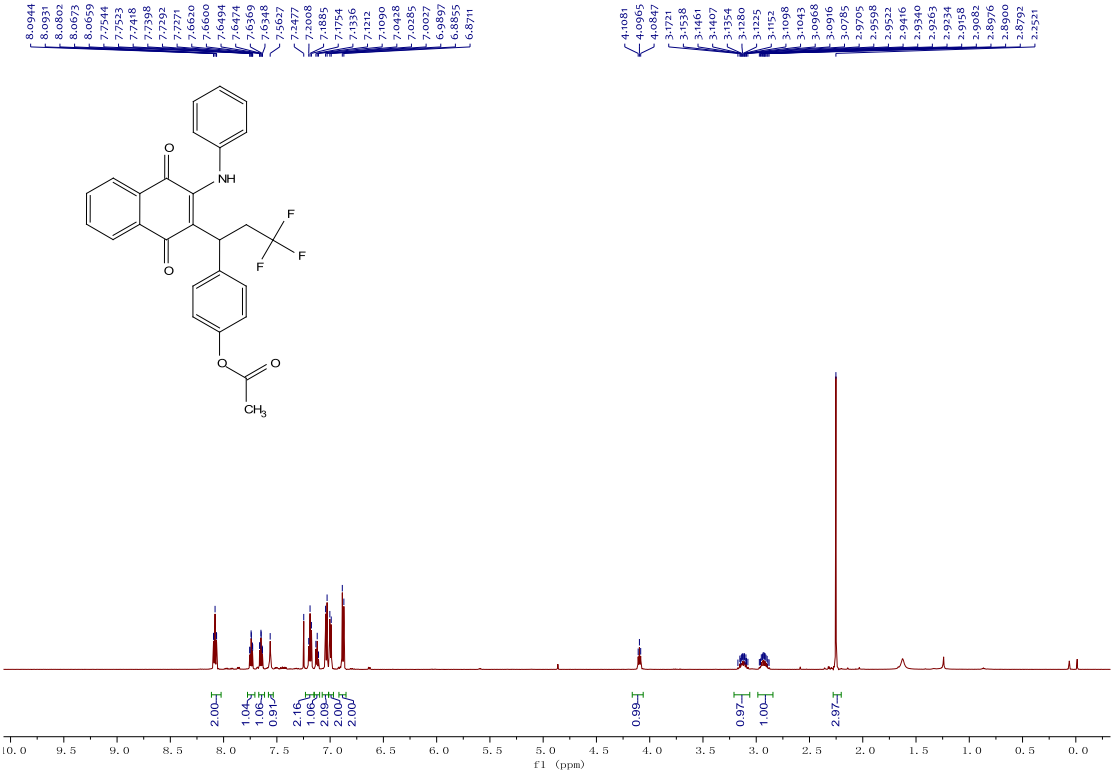


^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4aa**

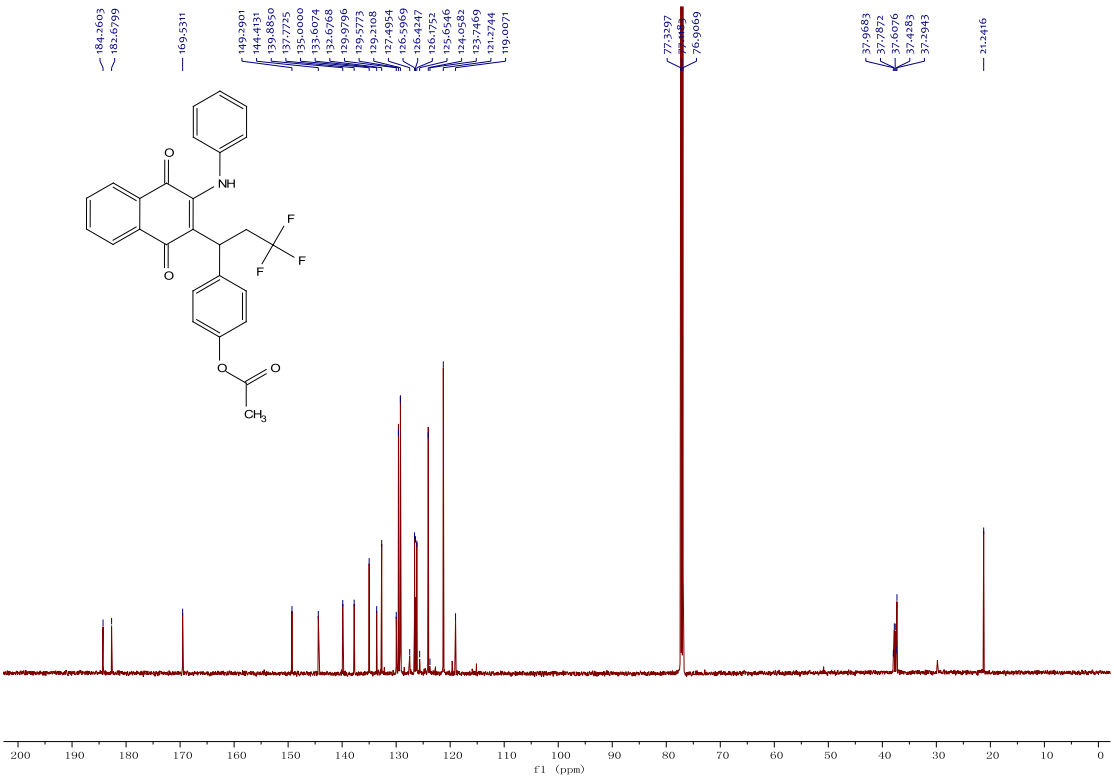


^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4aa**

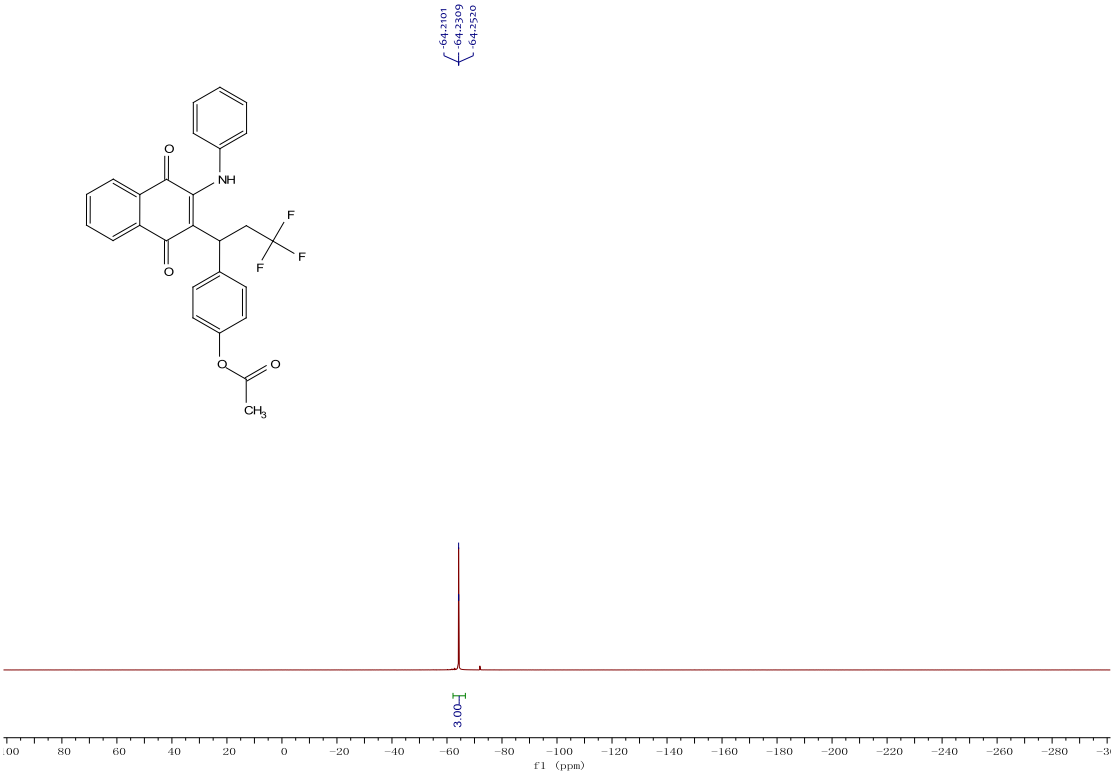
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4aa**



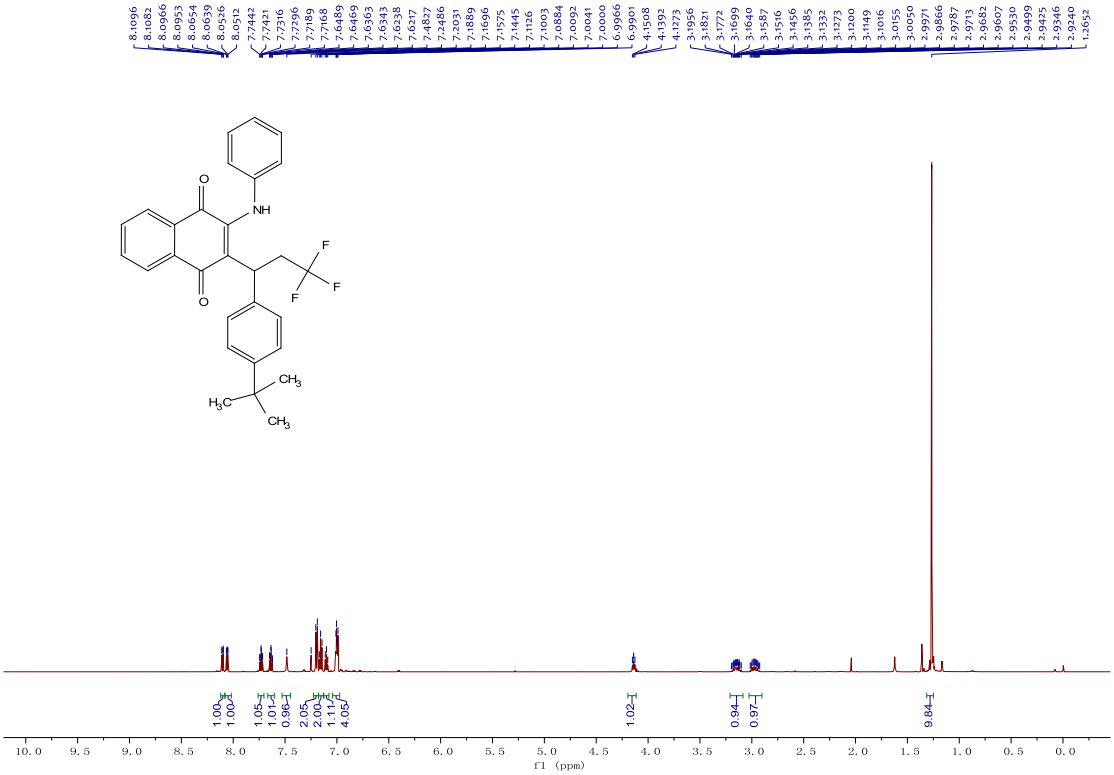
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ab**



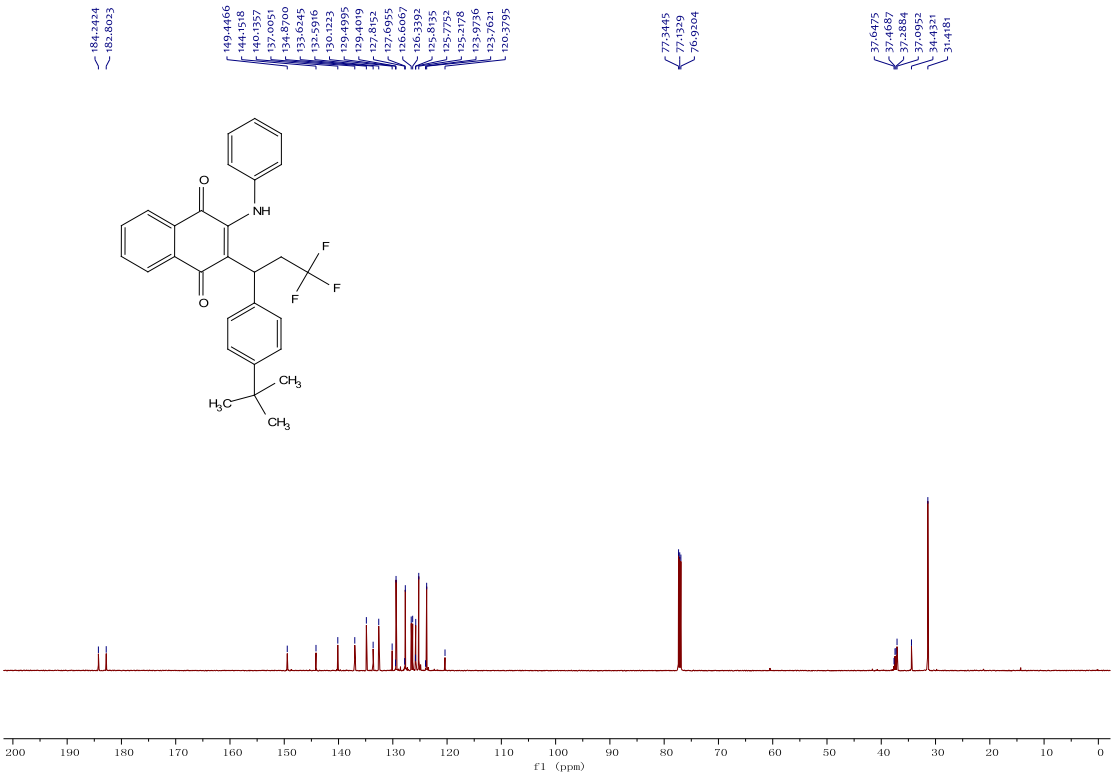
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ab**



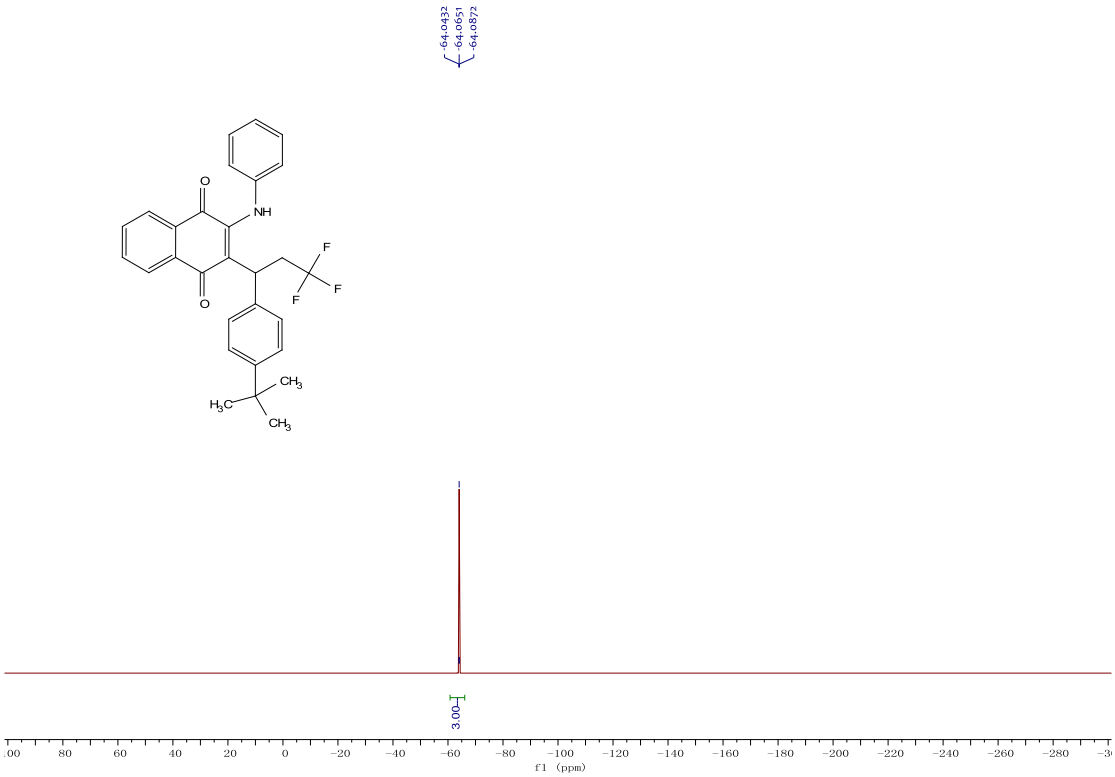
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ab**



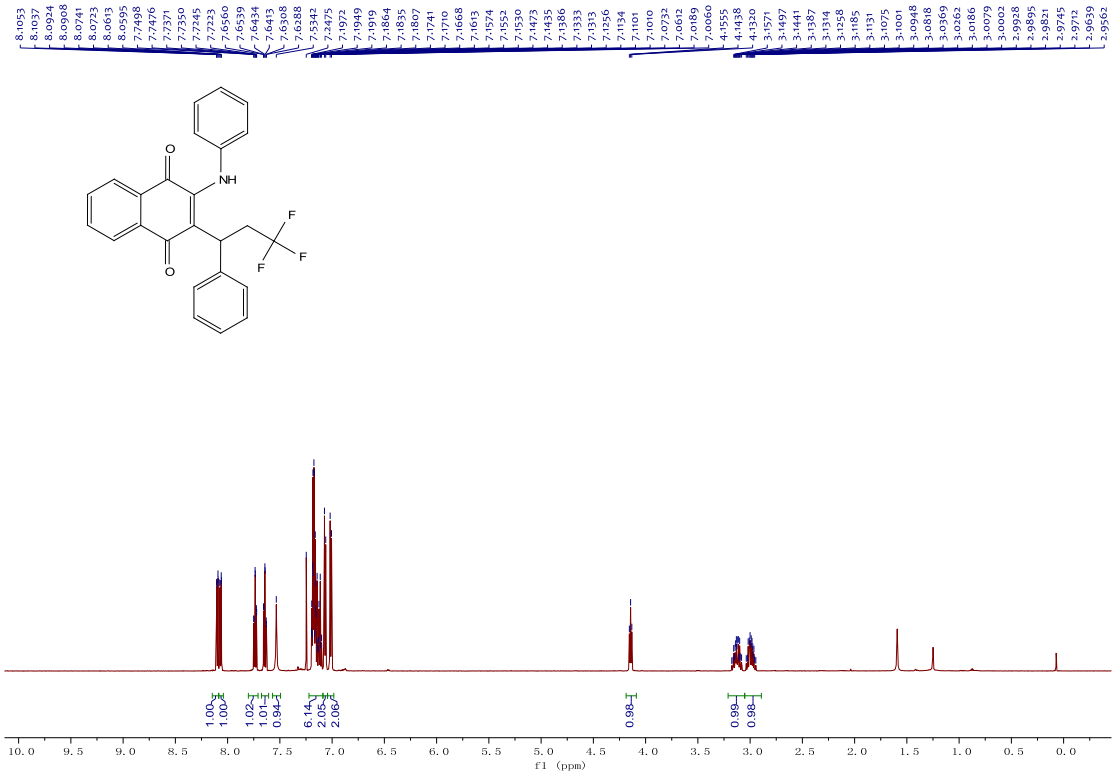
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ac**



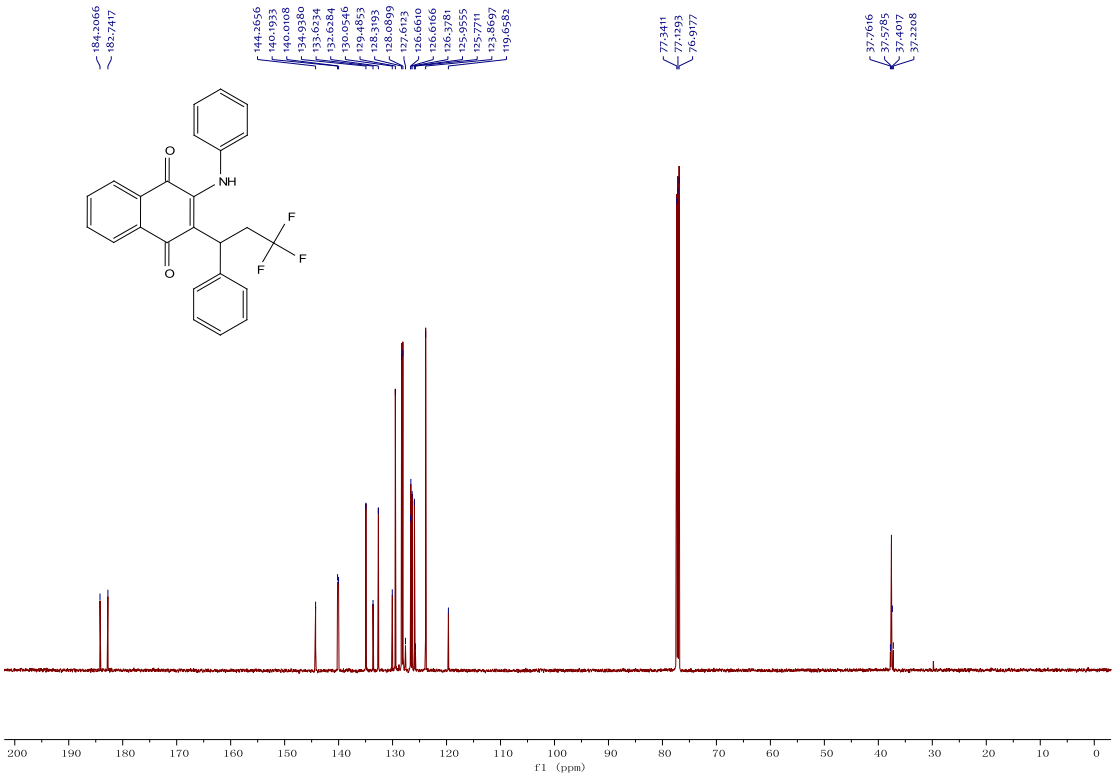
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ac**



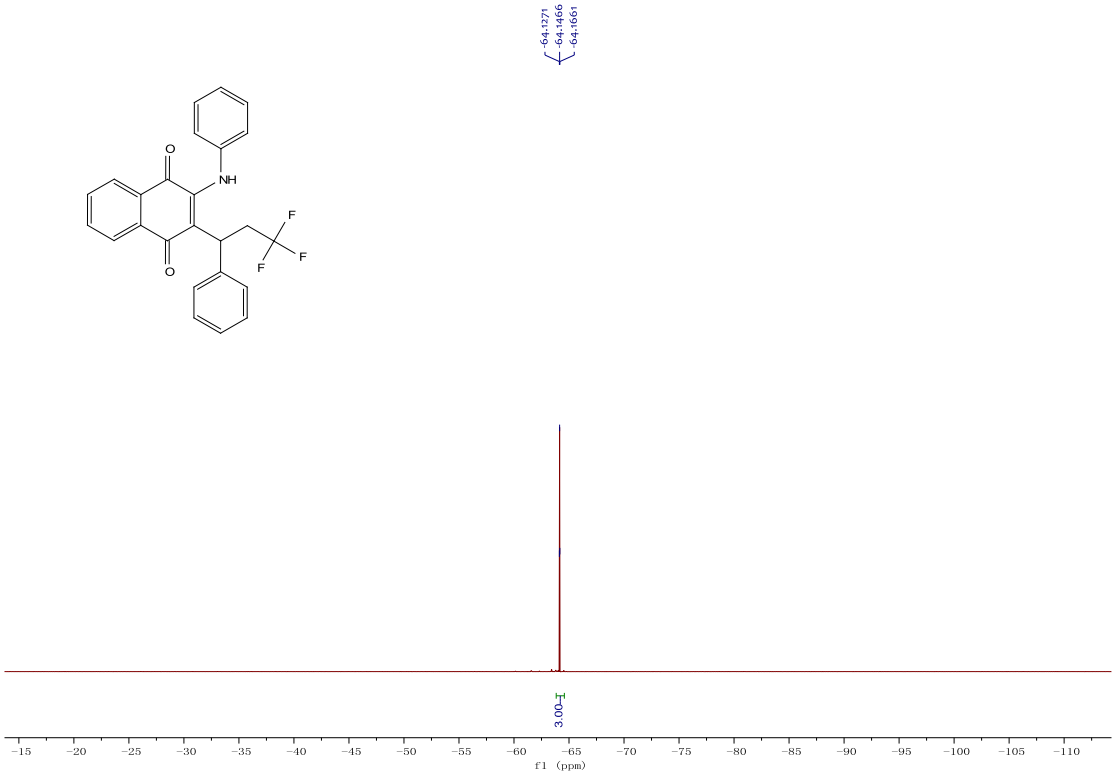
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ac**



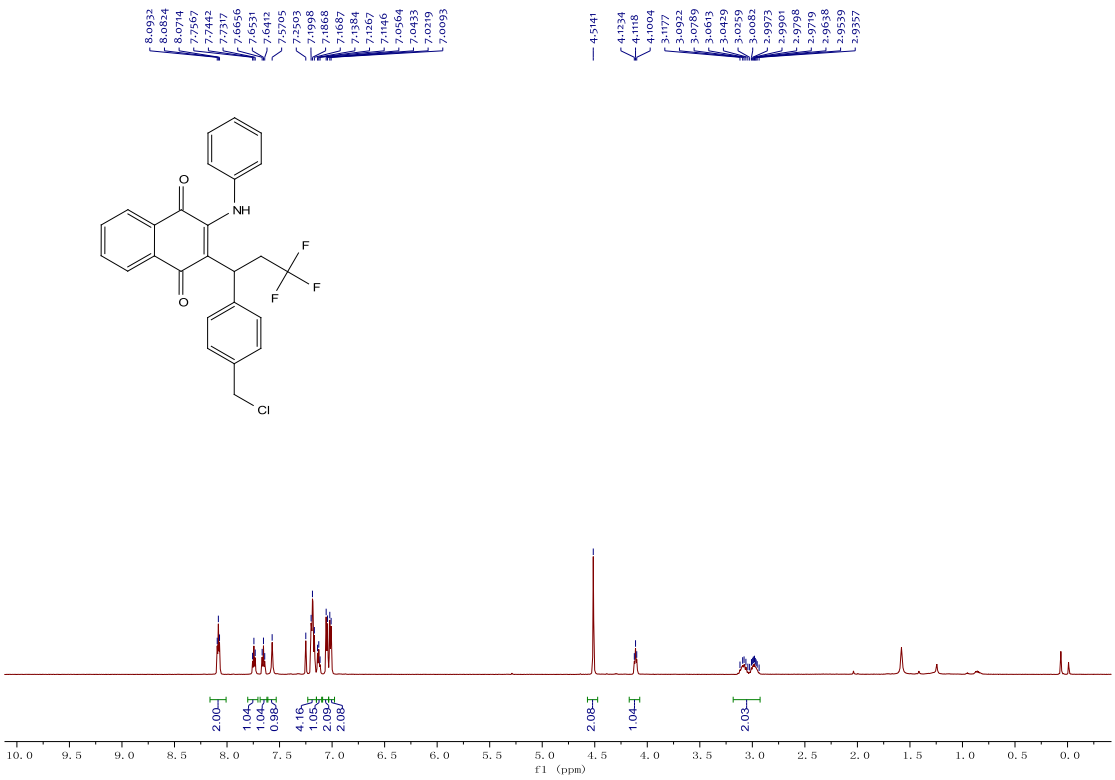
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ad**



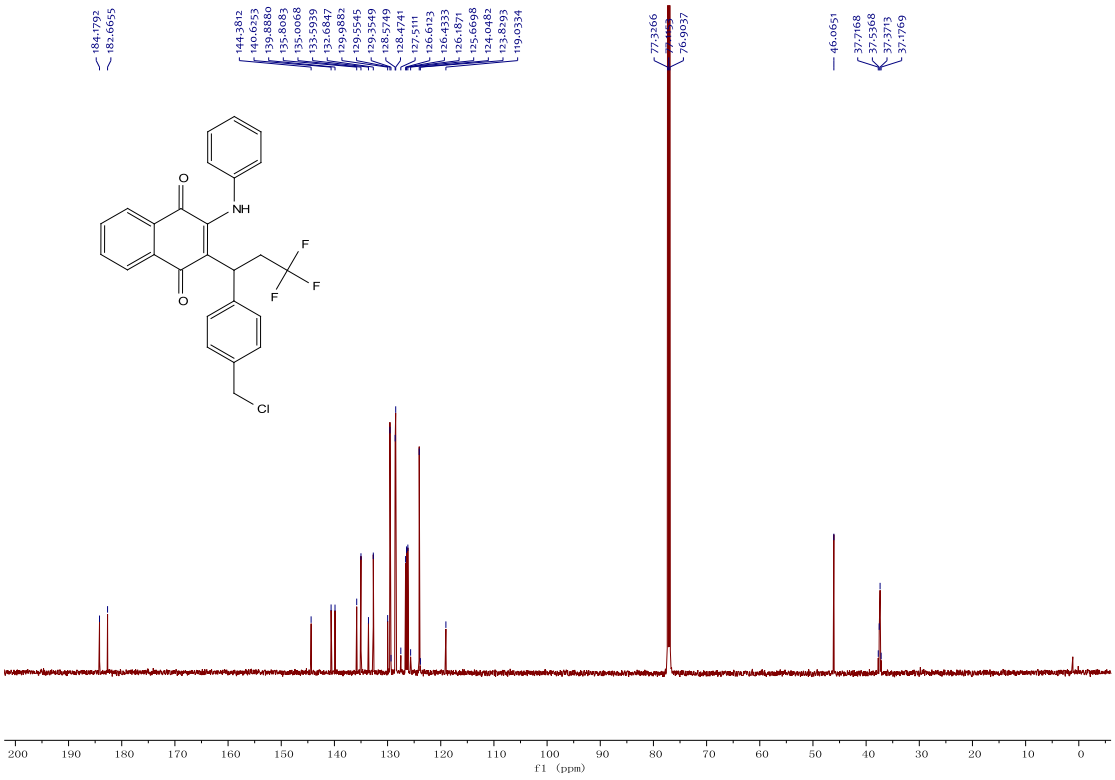
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ad**



^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ad**

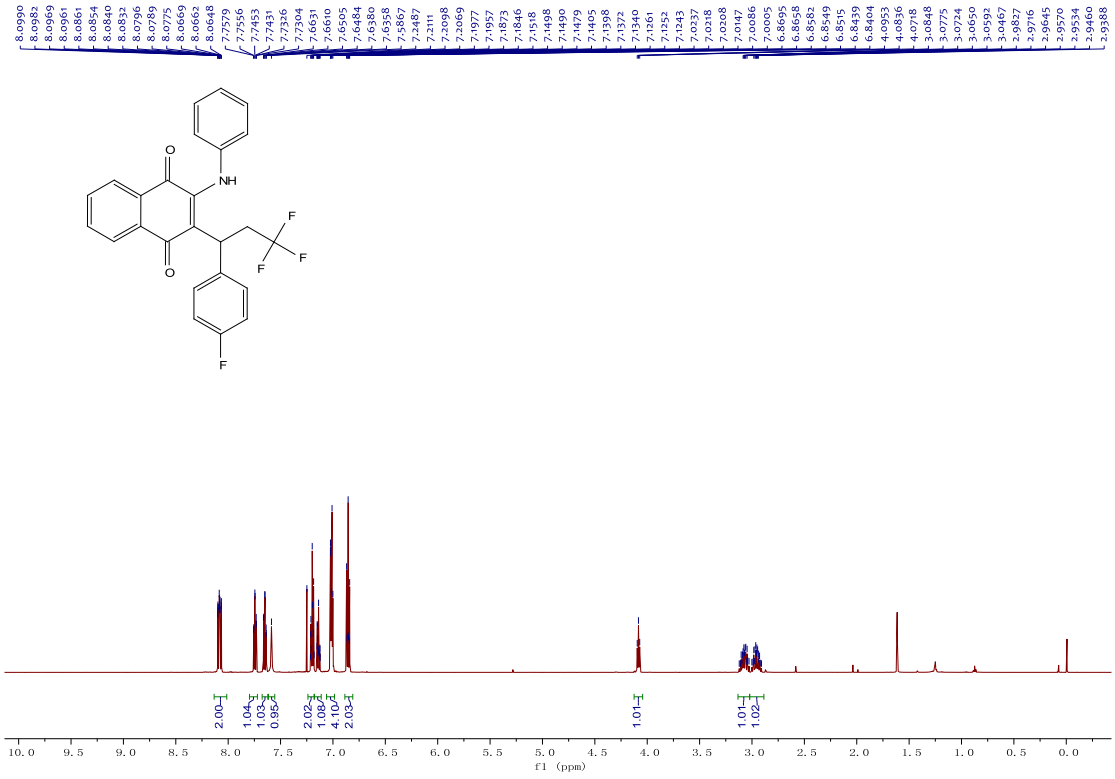


^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ae**

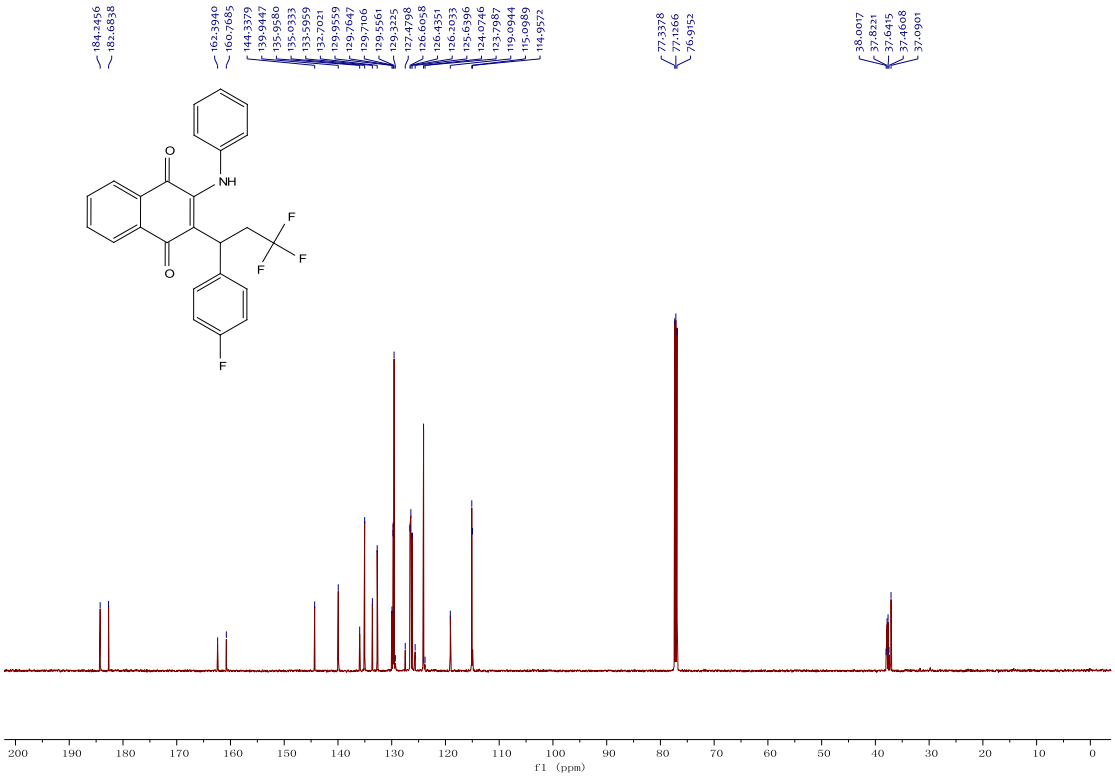


^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ae**

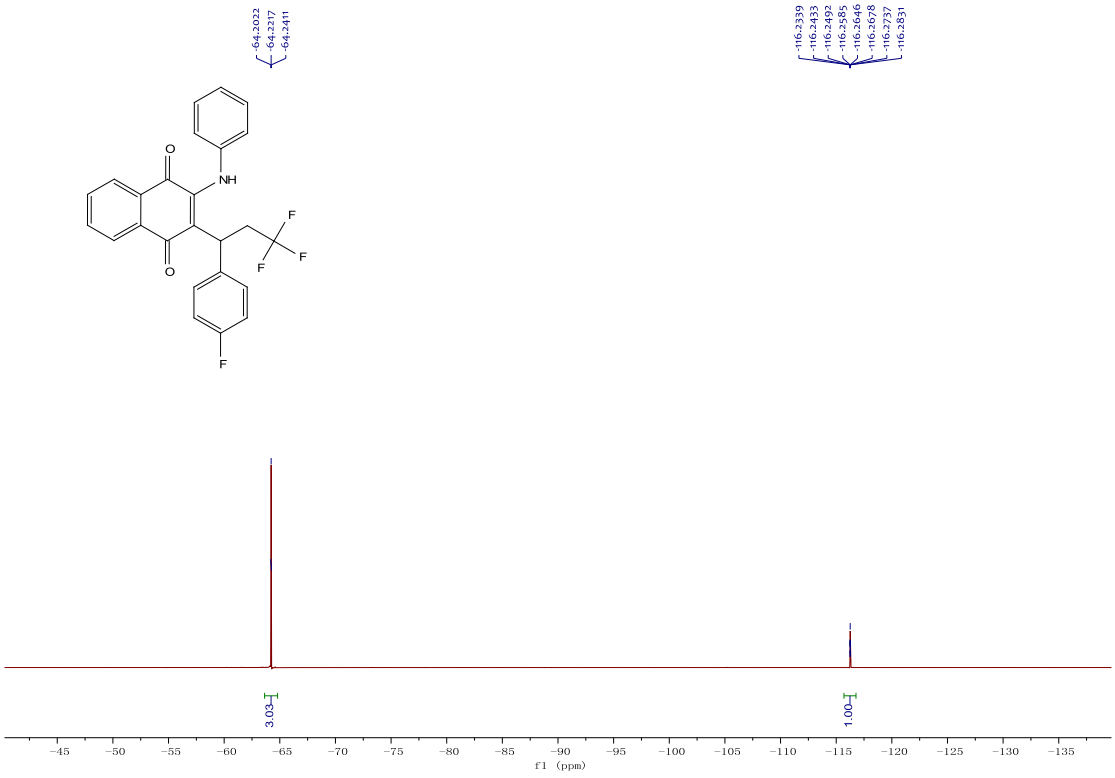
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ae**



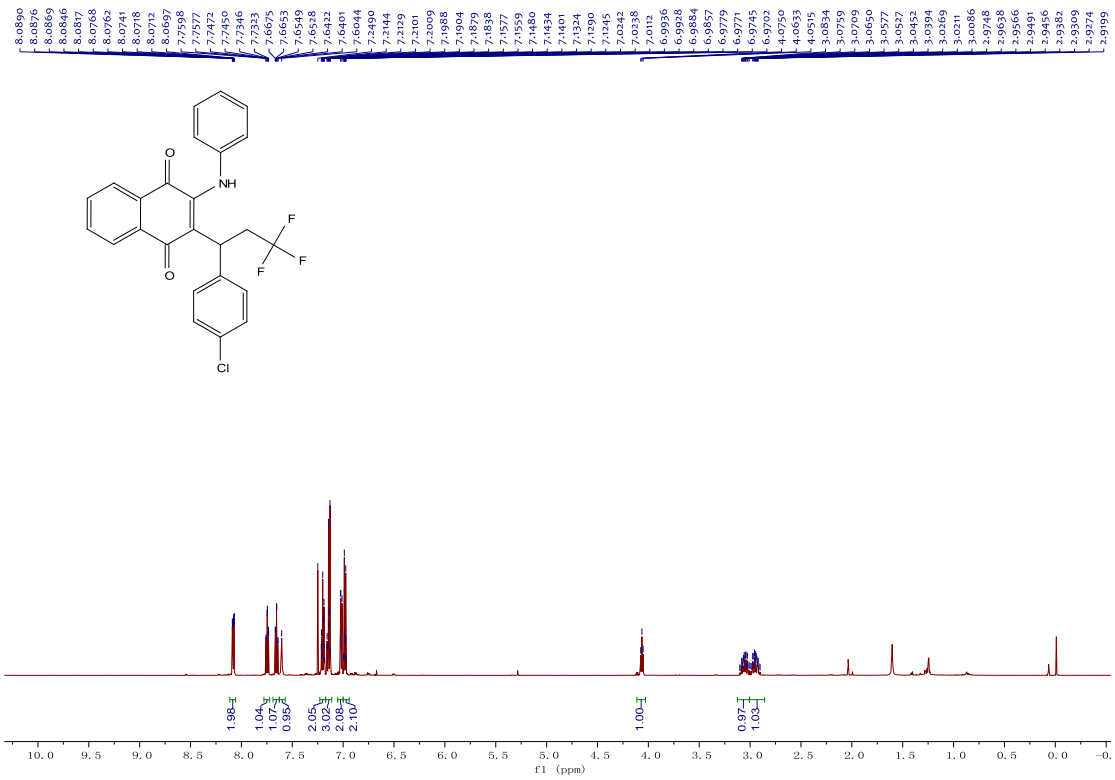
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4af**



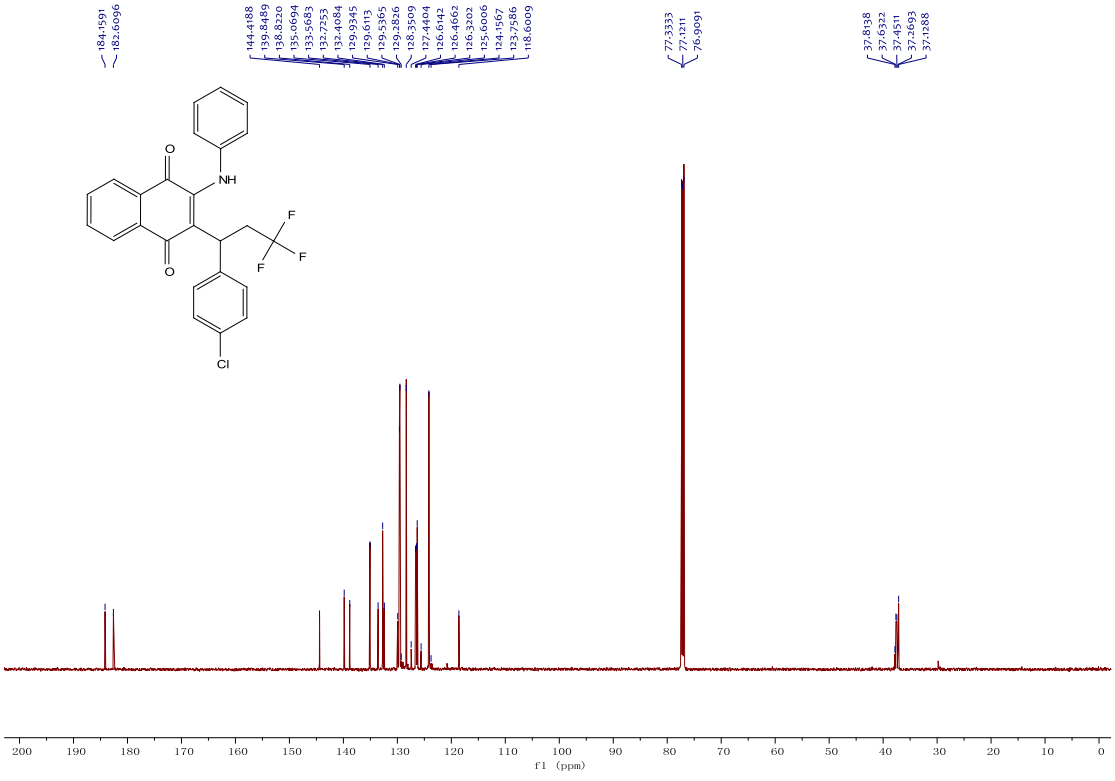
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4af**



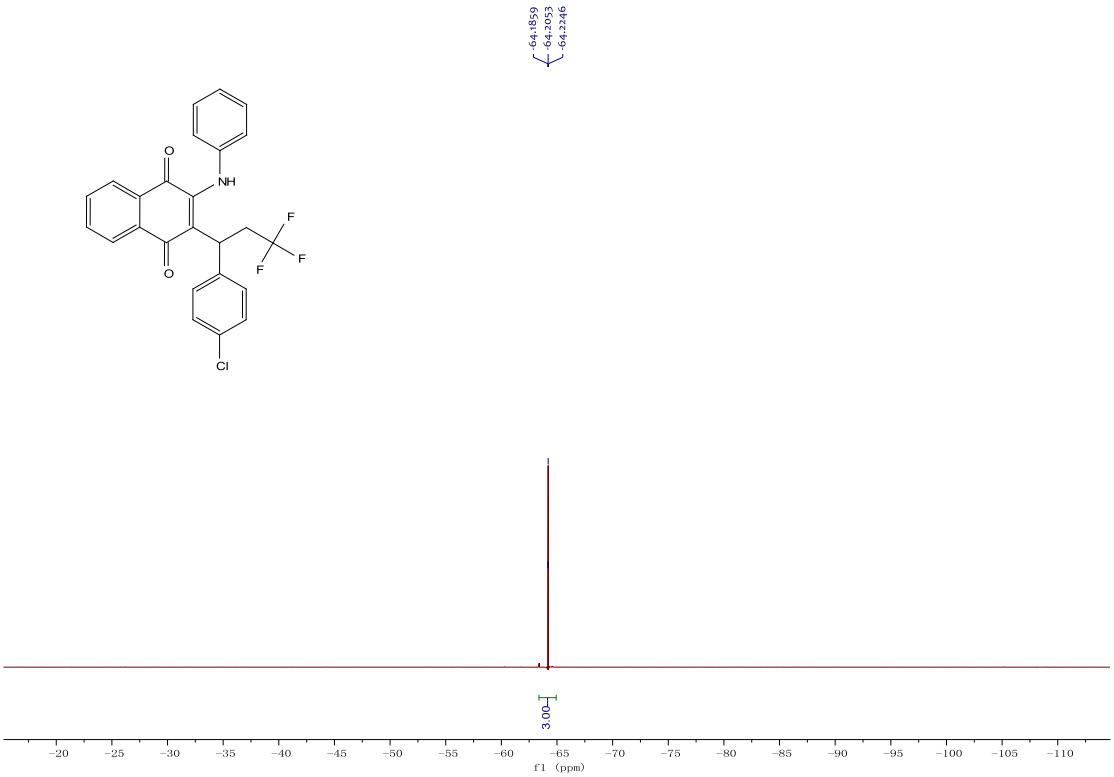
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4af**



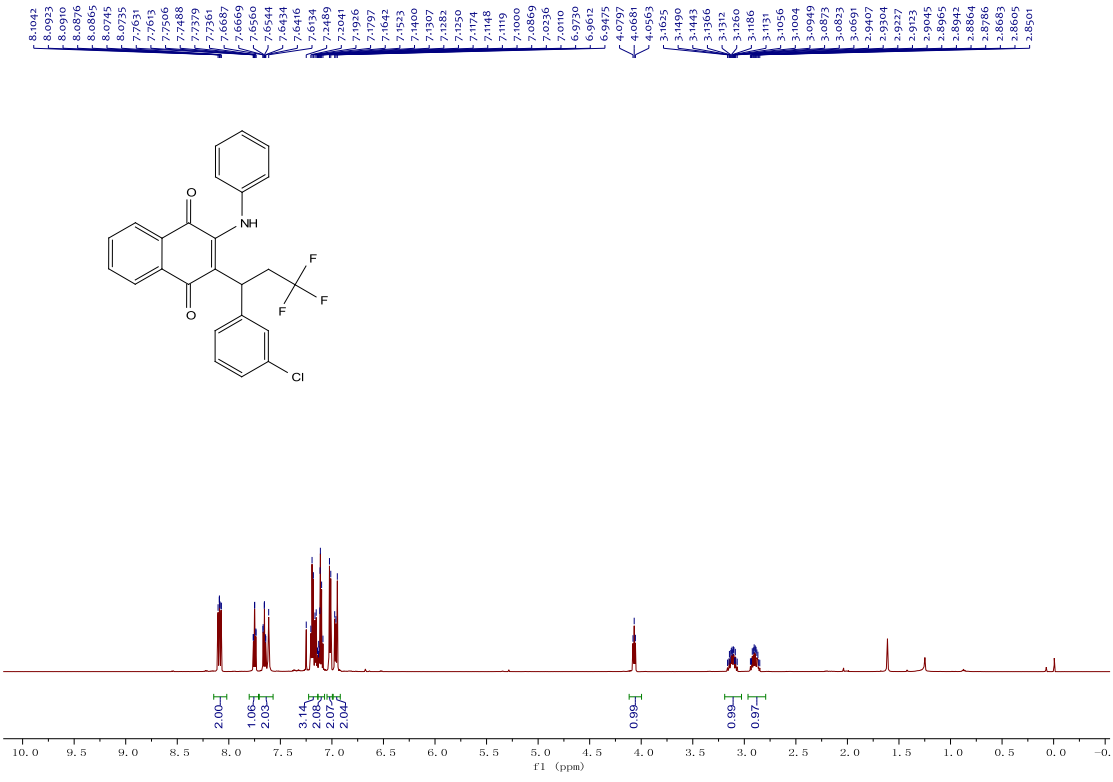
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ag**



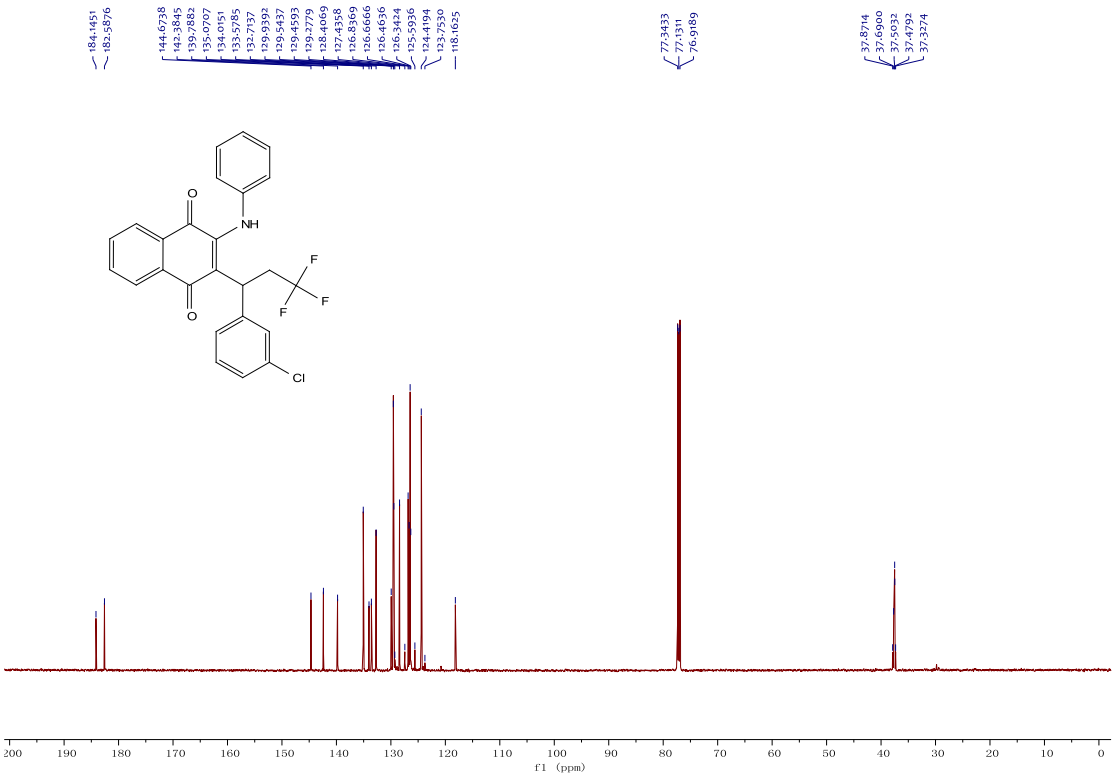
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ag**



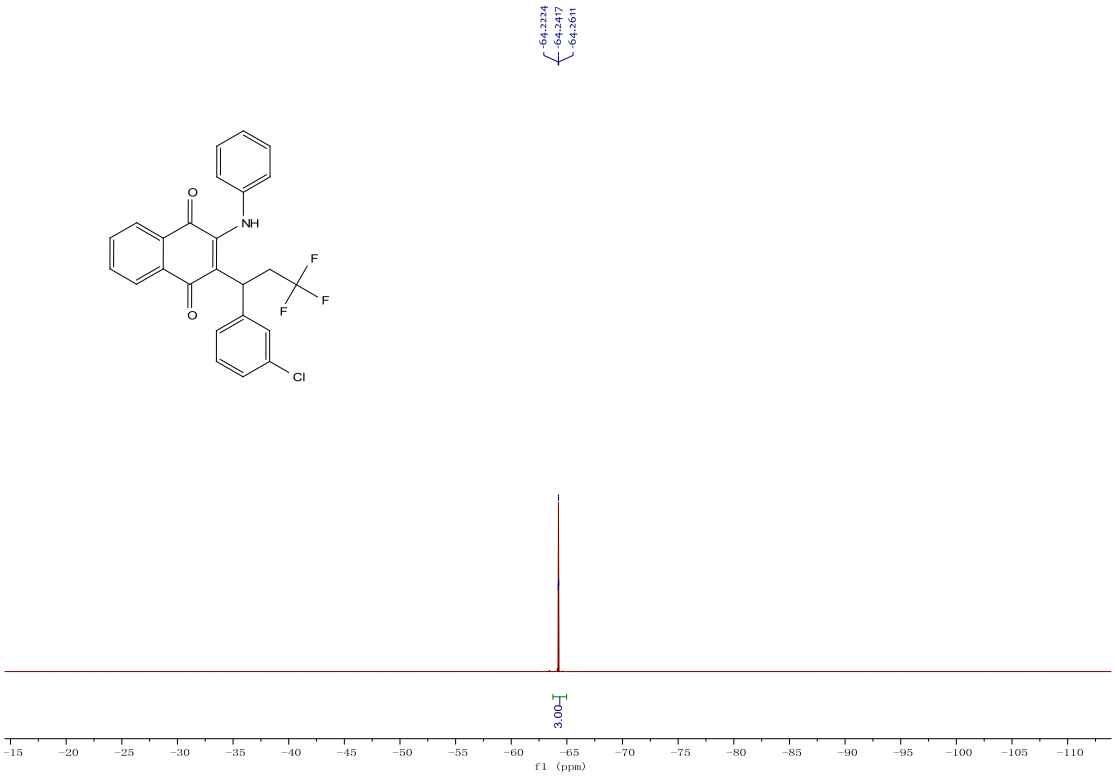
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ag**



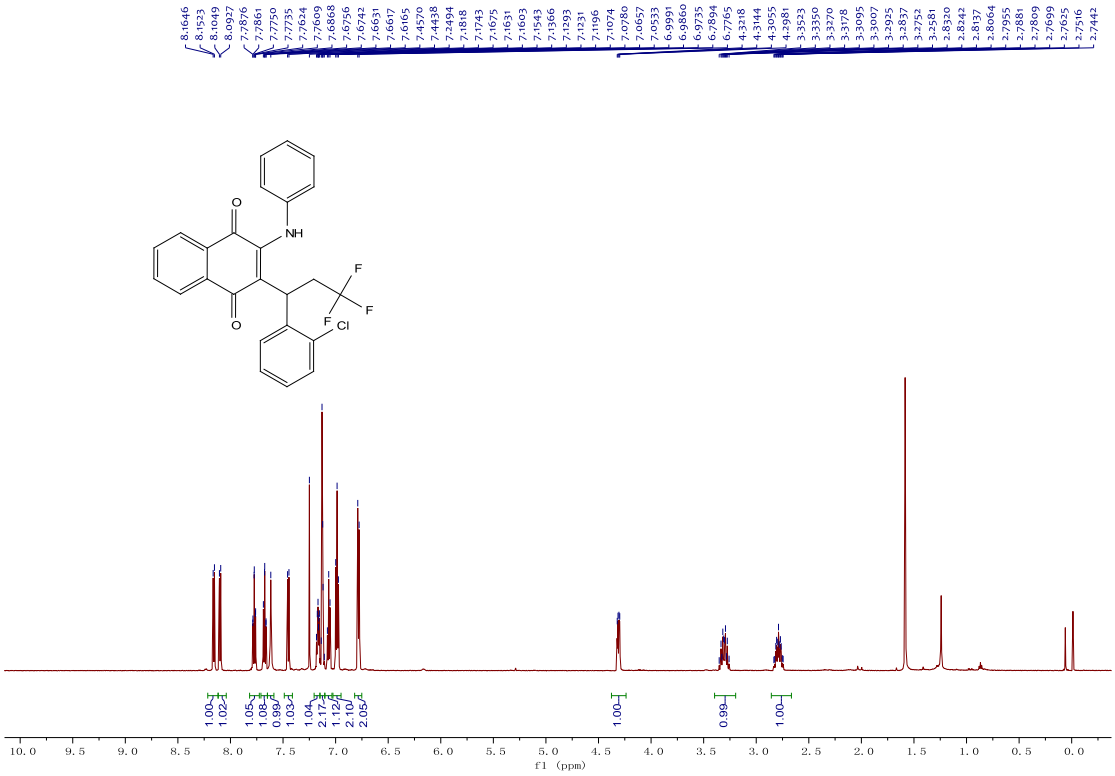
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ah**



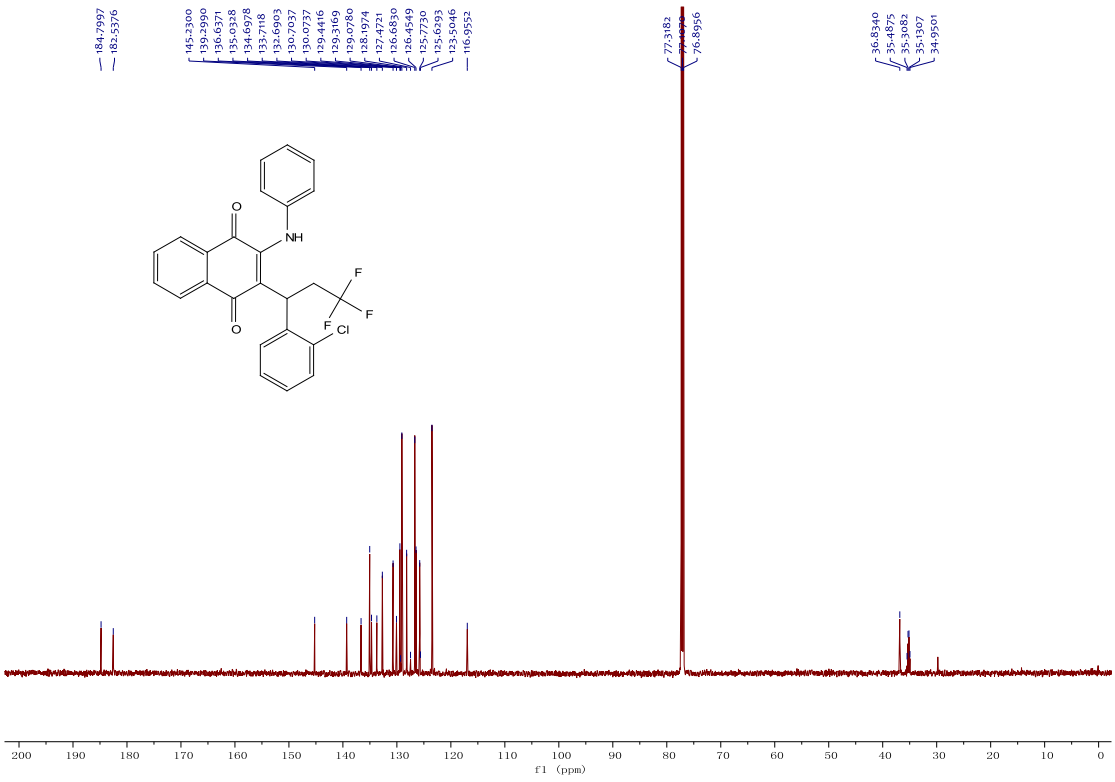
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ah**



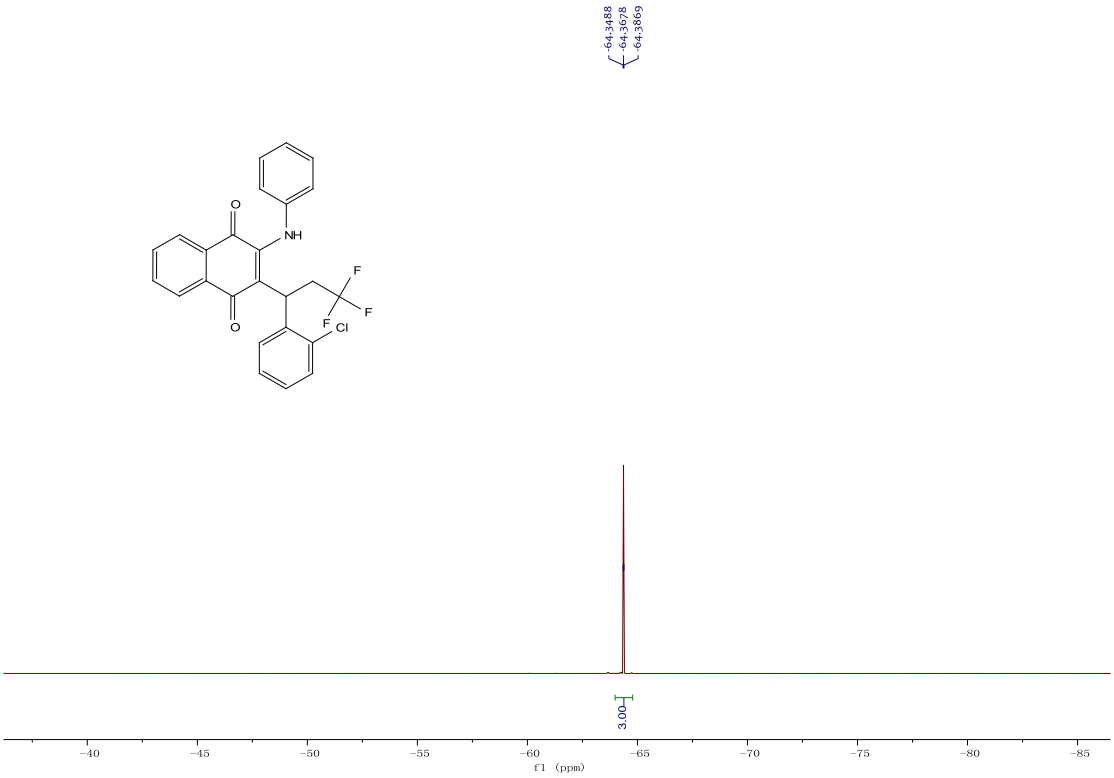
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ah**



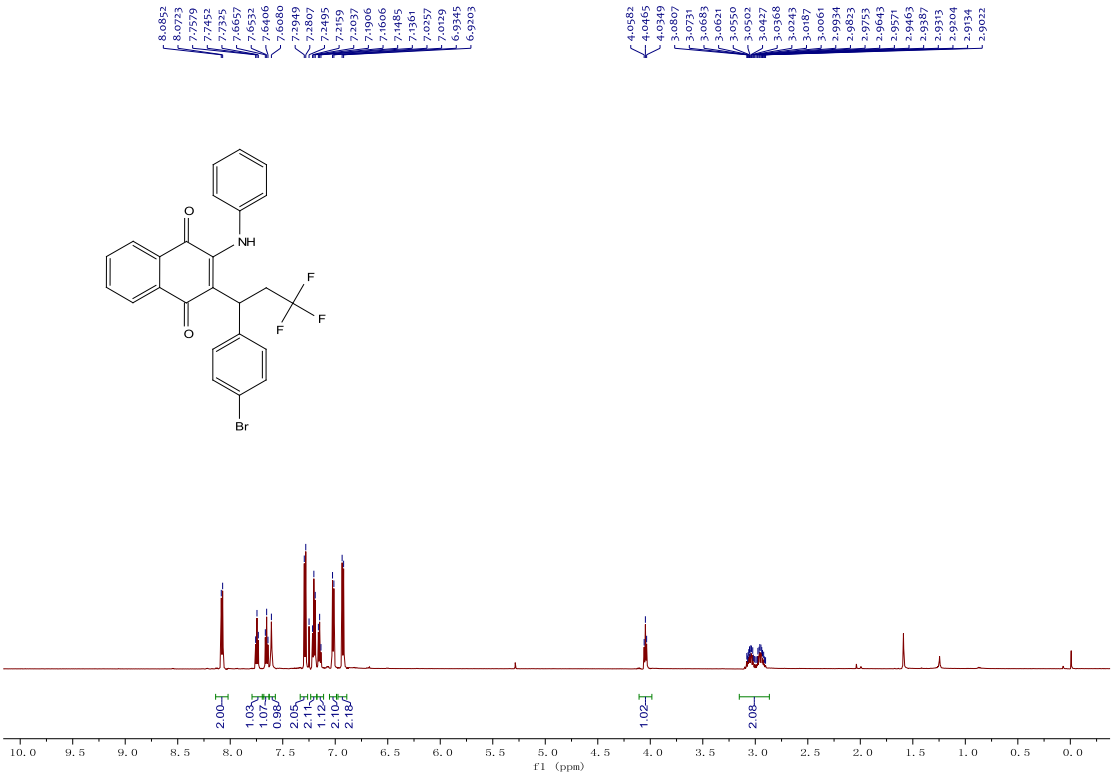
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ai**



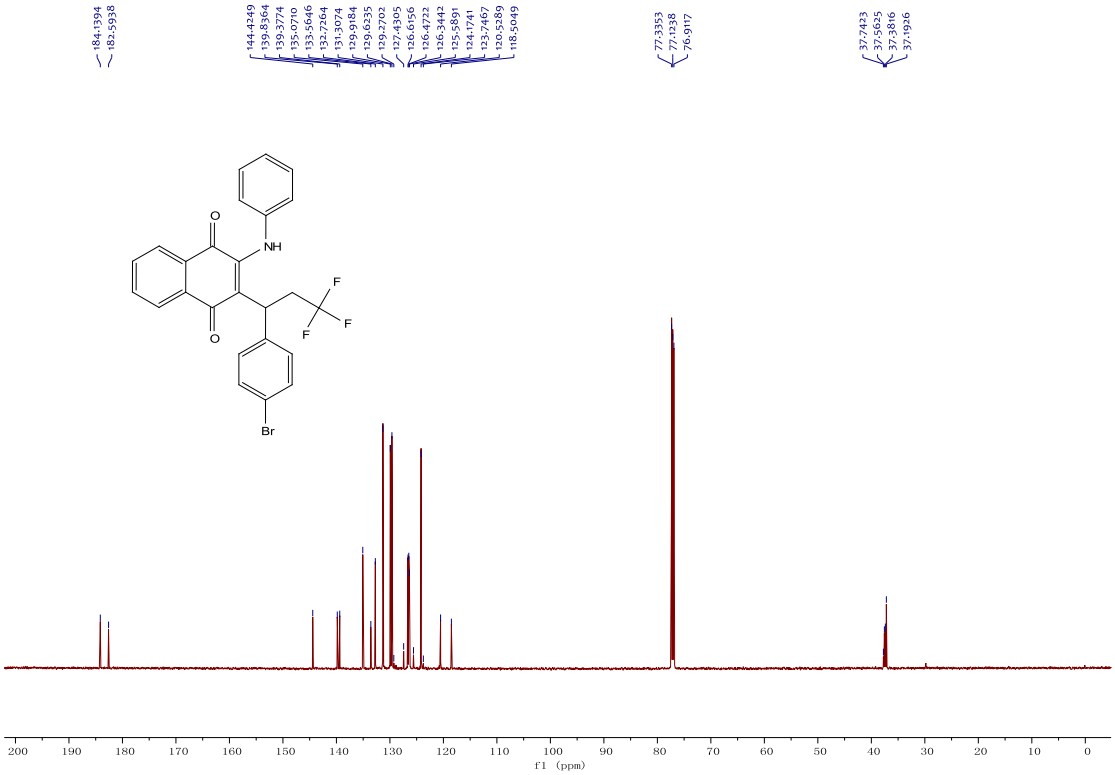
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ai**



^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ai**

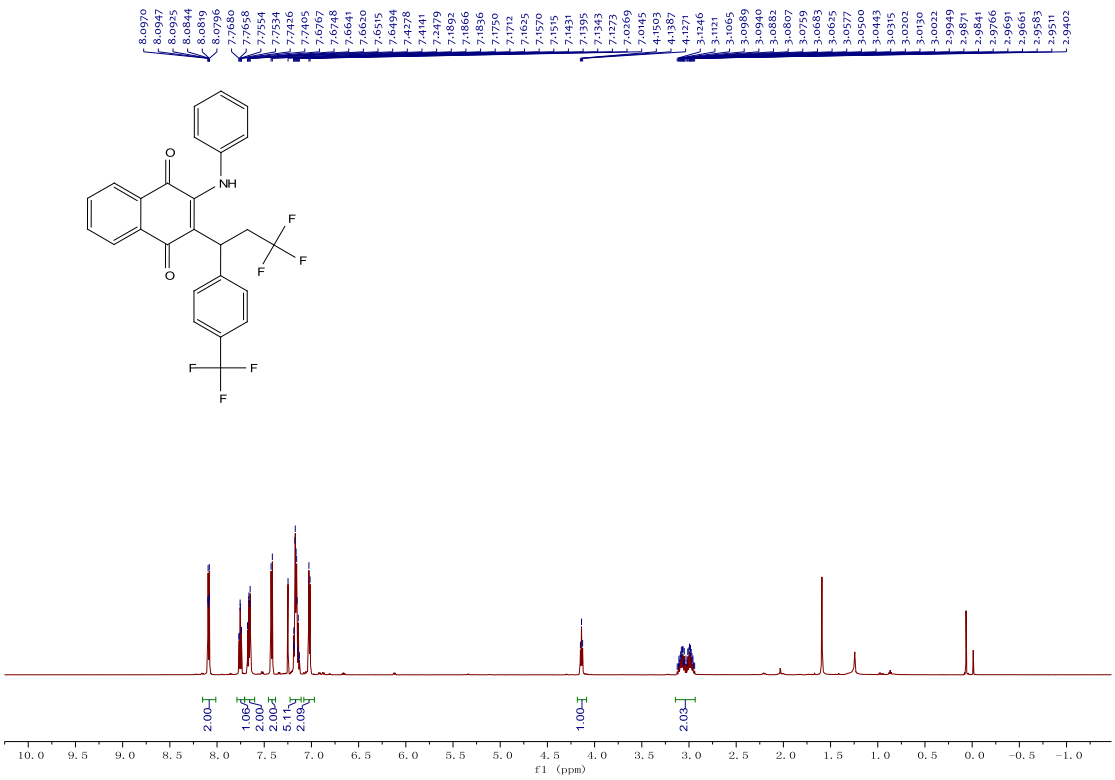


^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4aj**

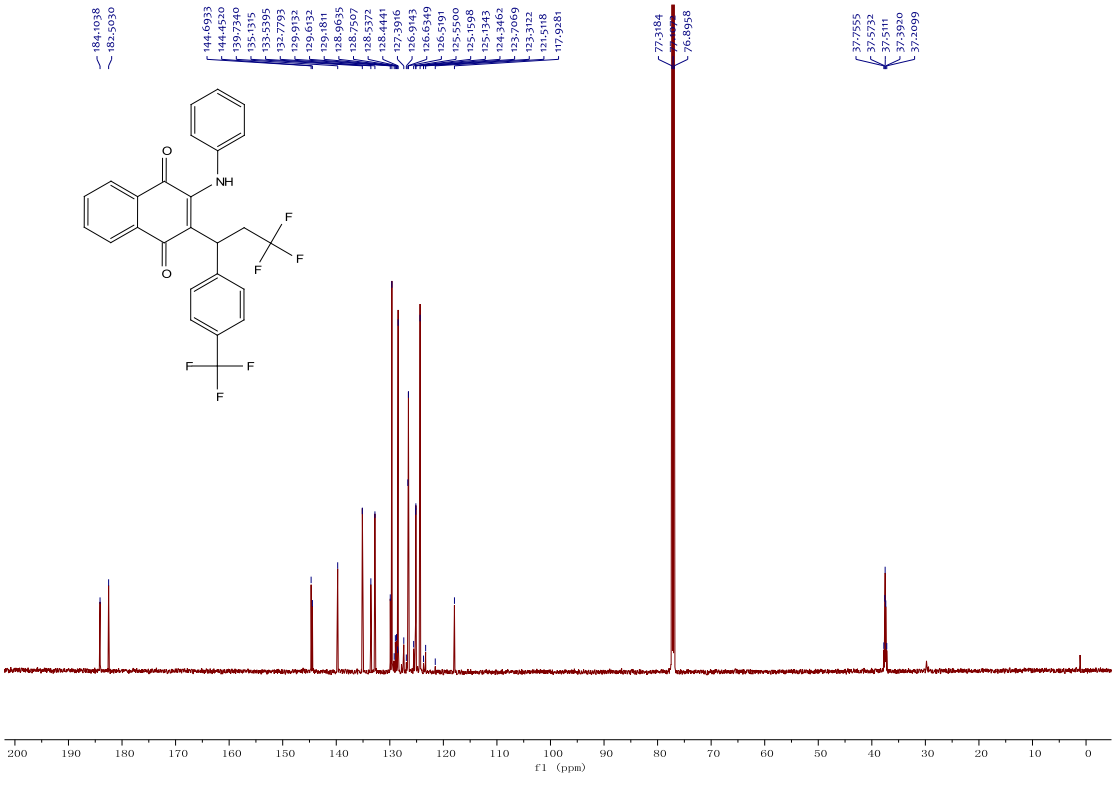


^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4aj**

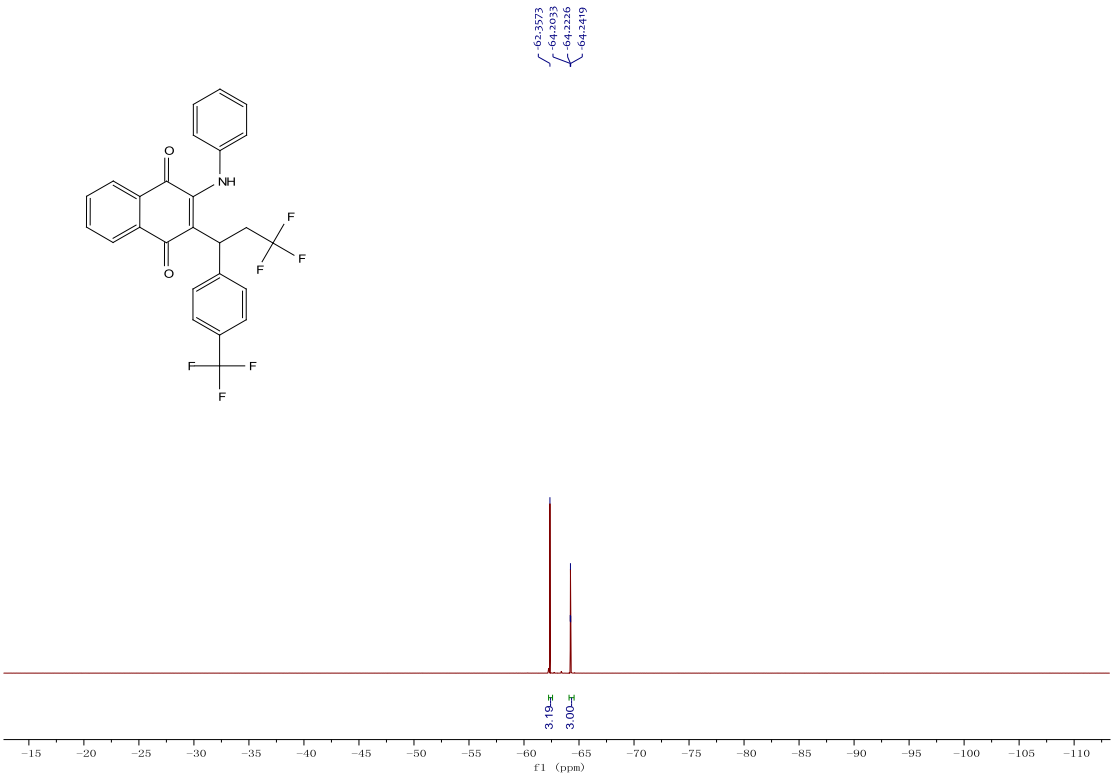
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4aj**



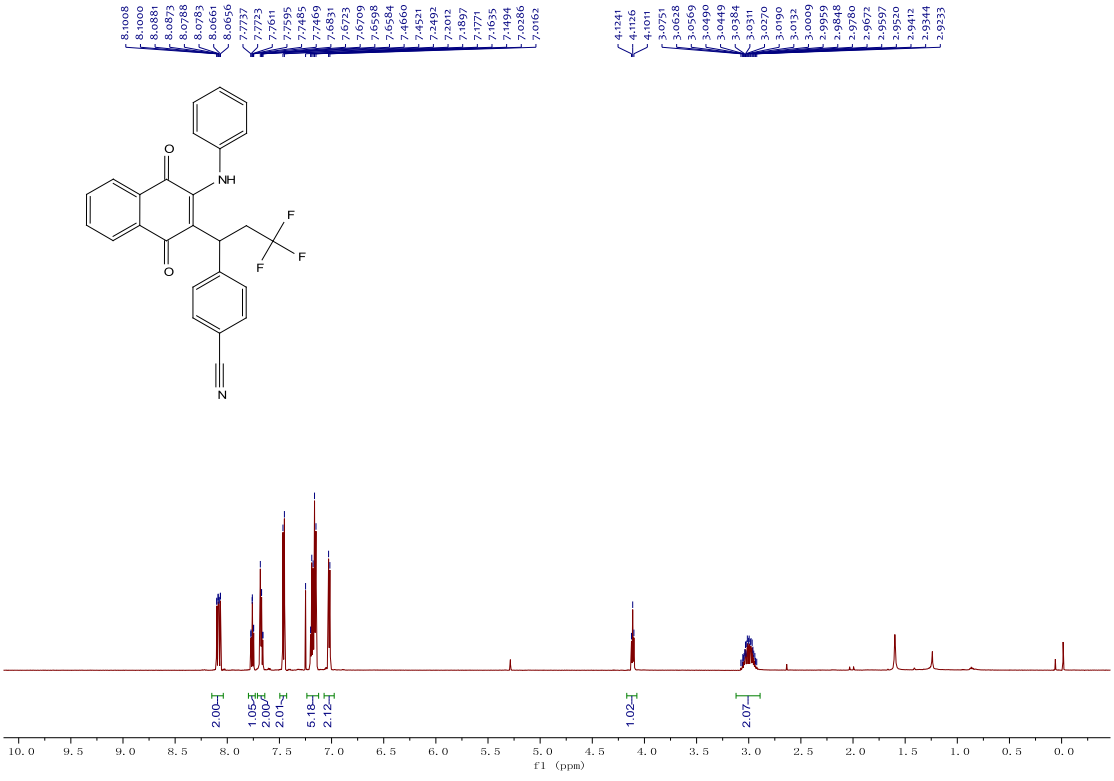
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ak**



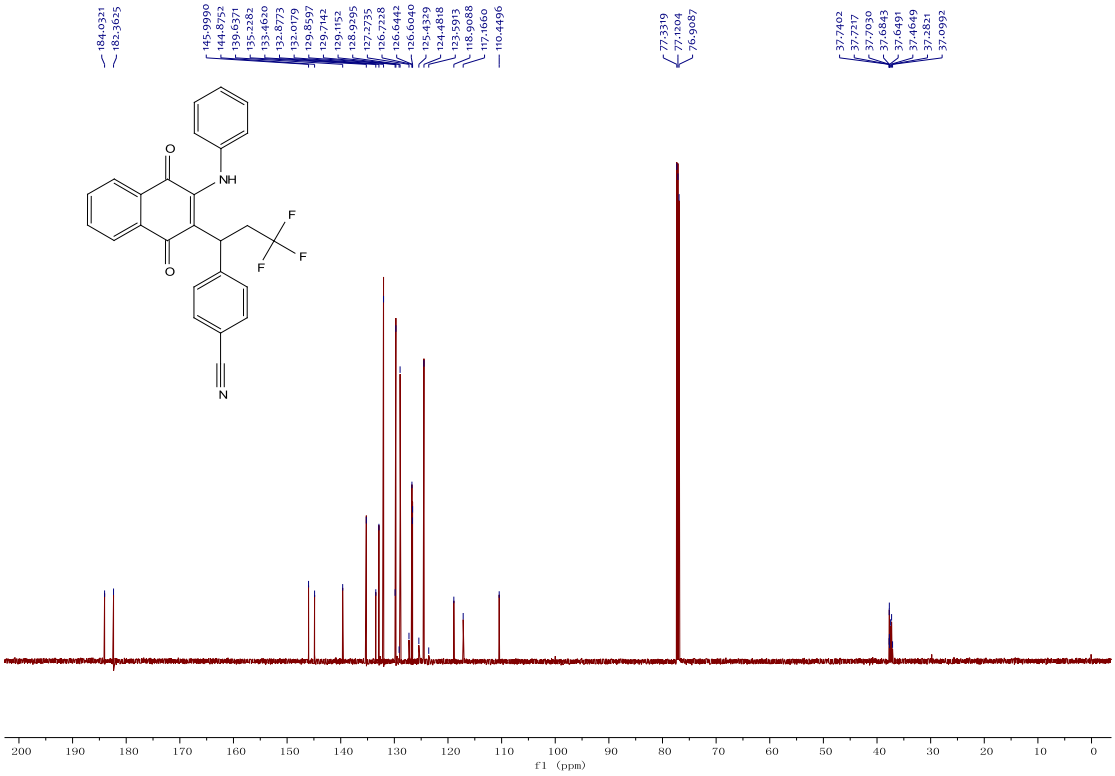
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ak**



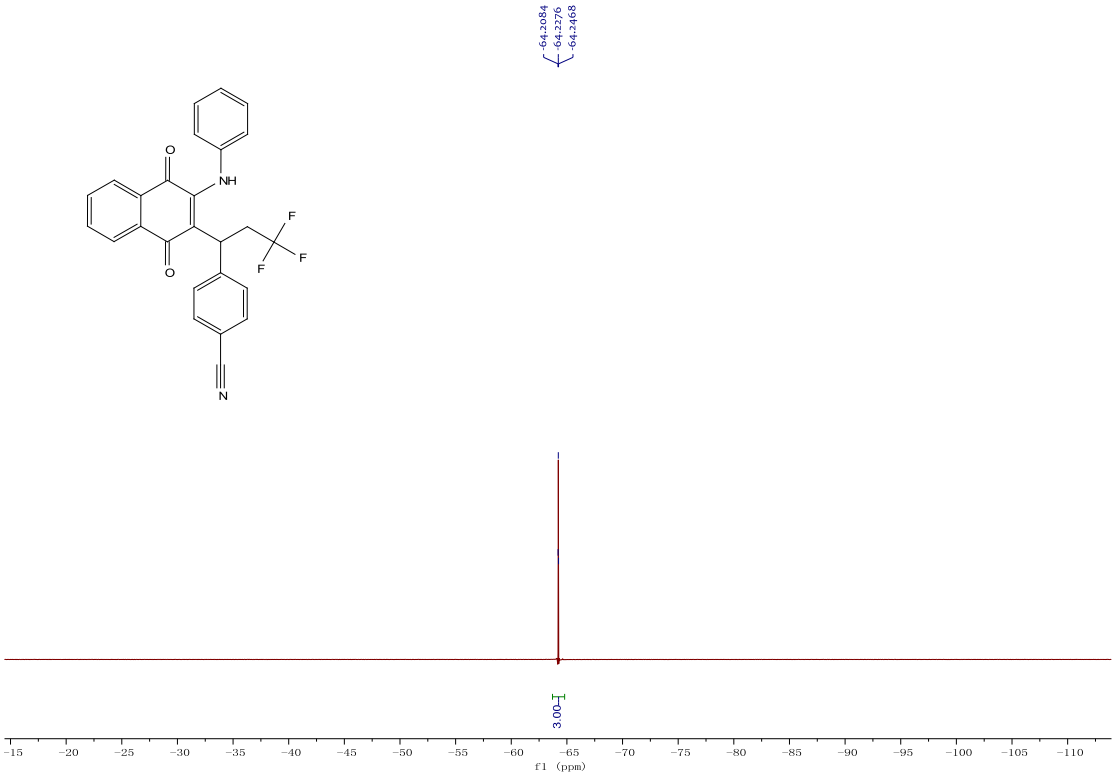
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ak**



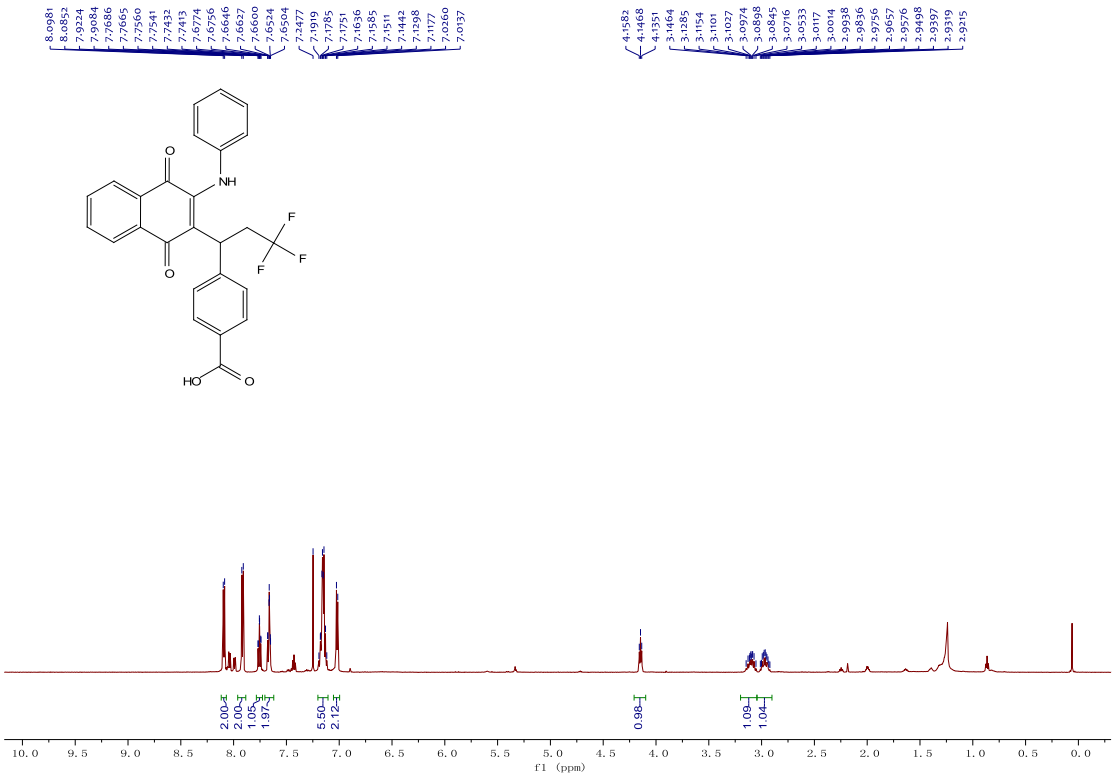
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4al**



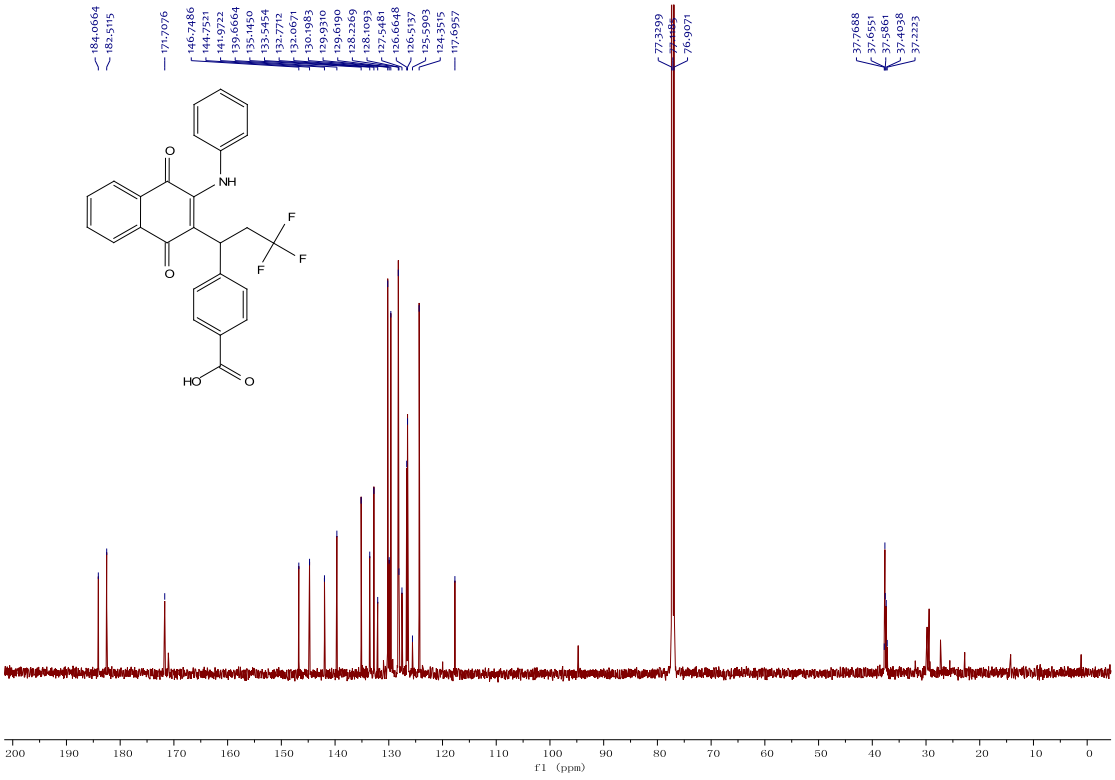
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4al**



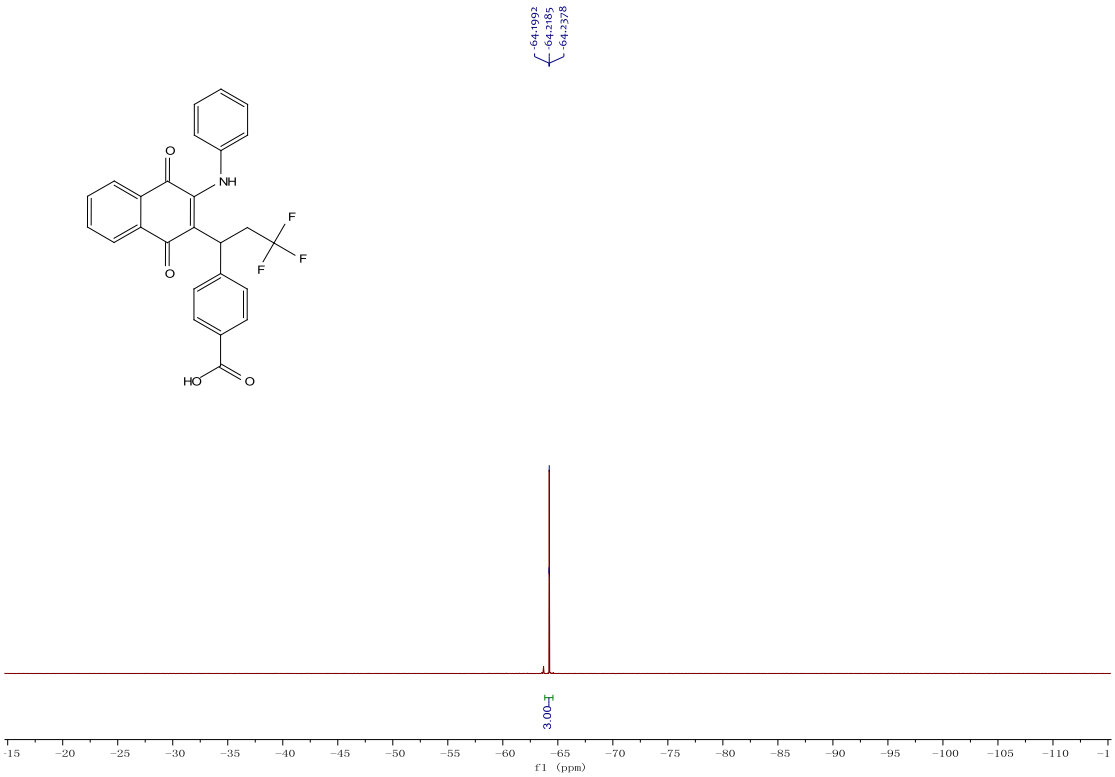
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4al**



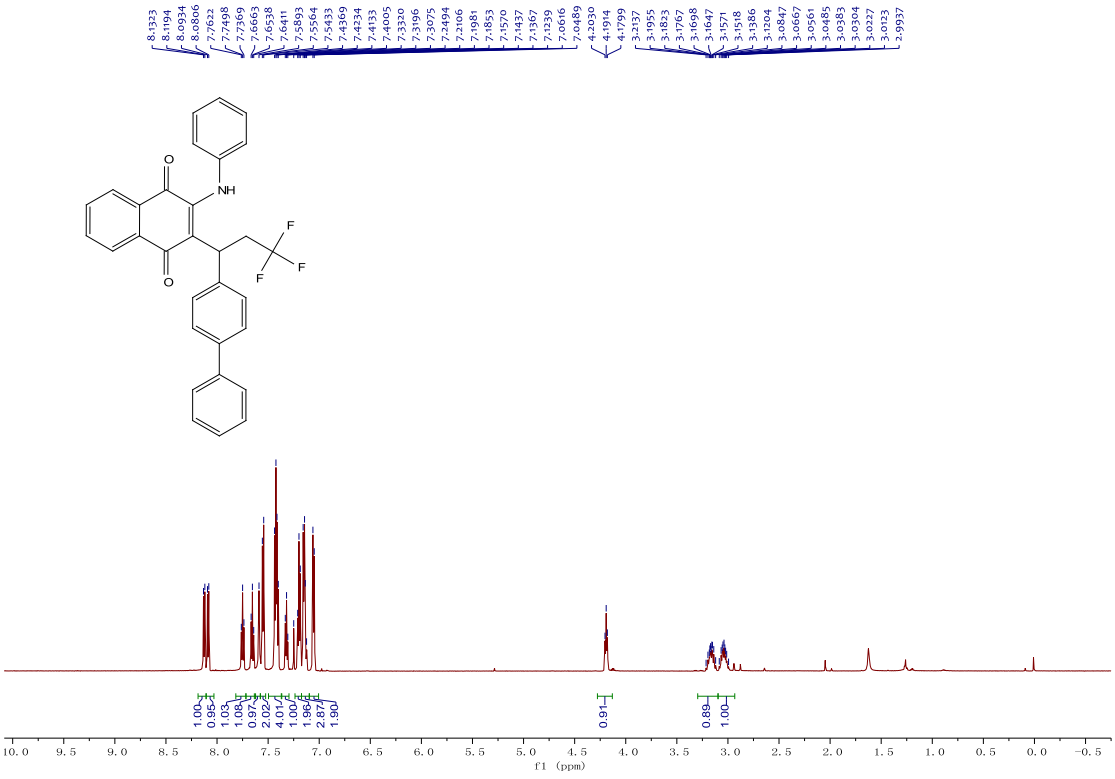
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4am**



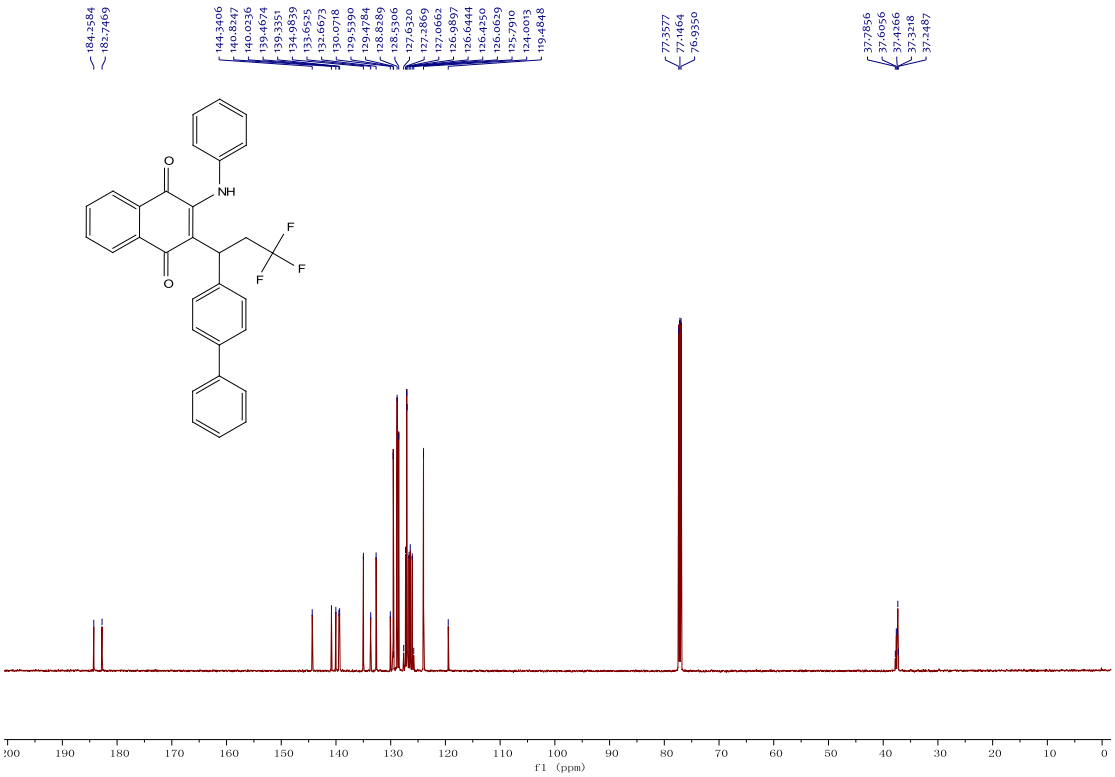
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4am**



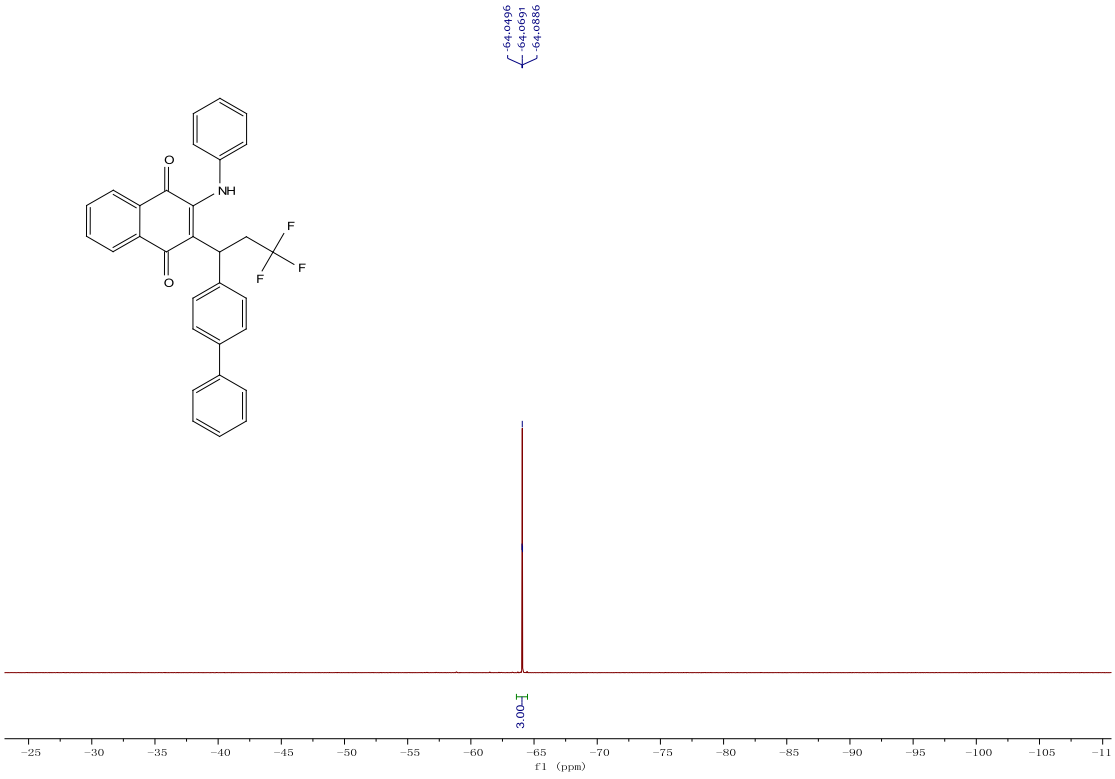
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4am**



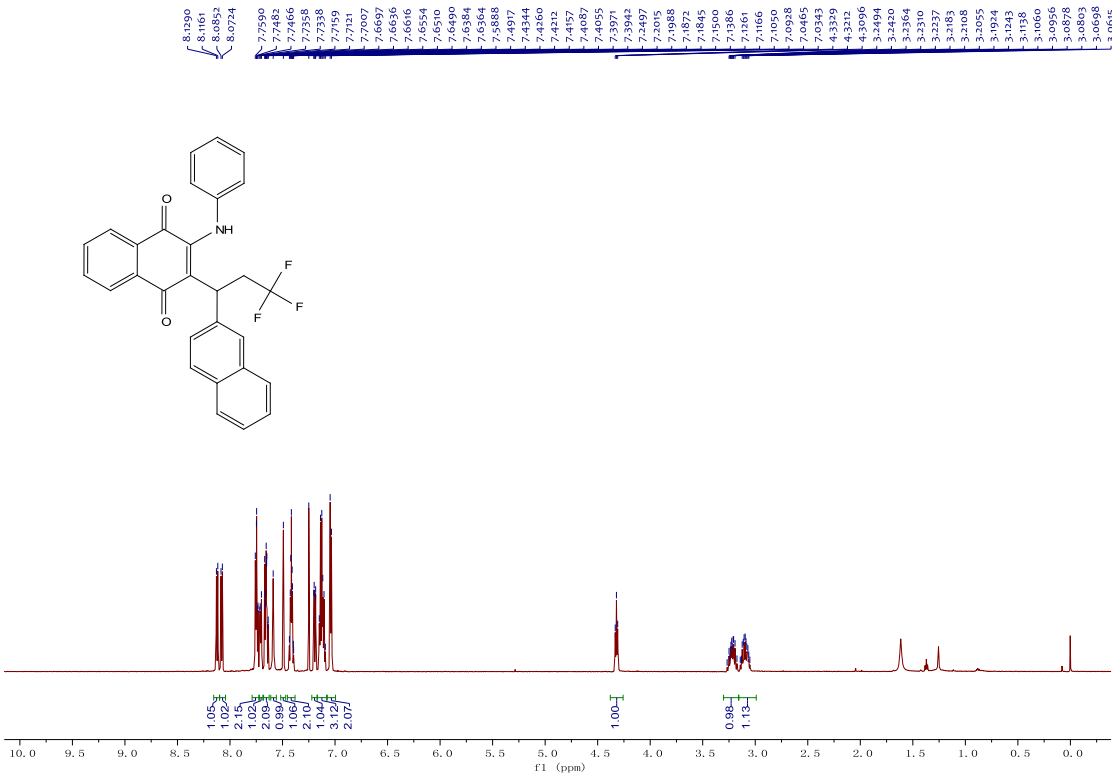
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4an**



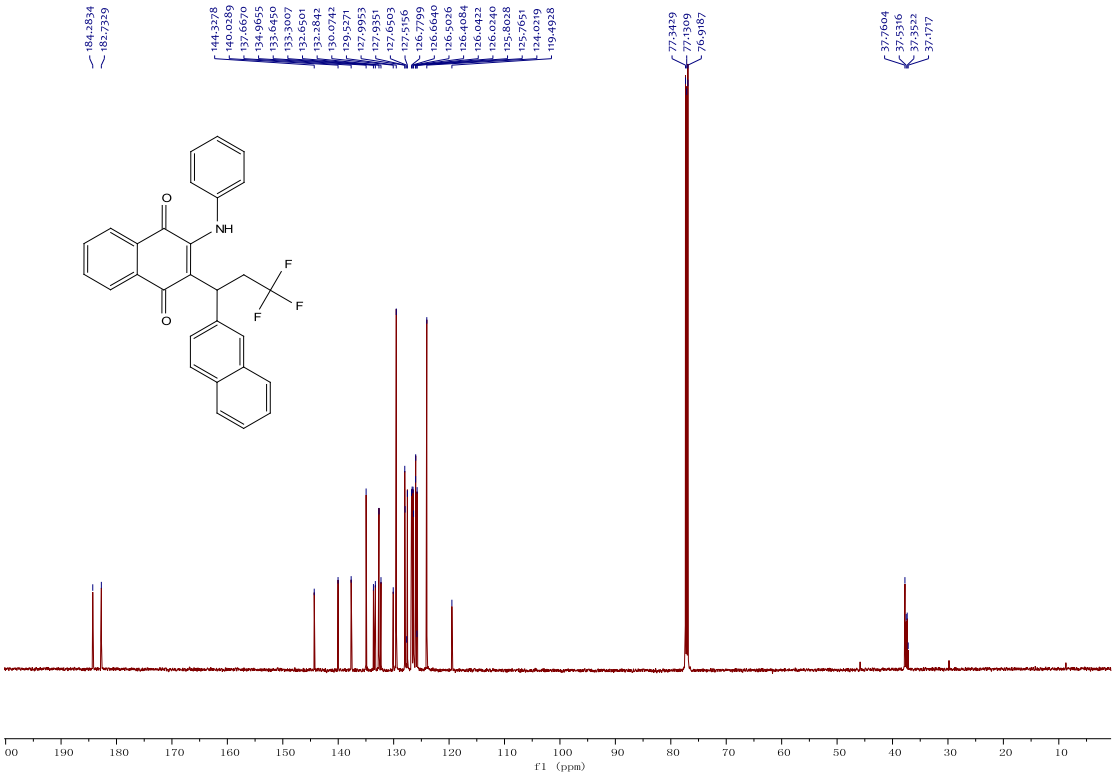
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4an**



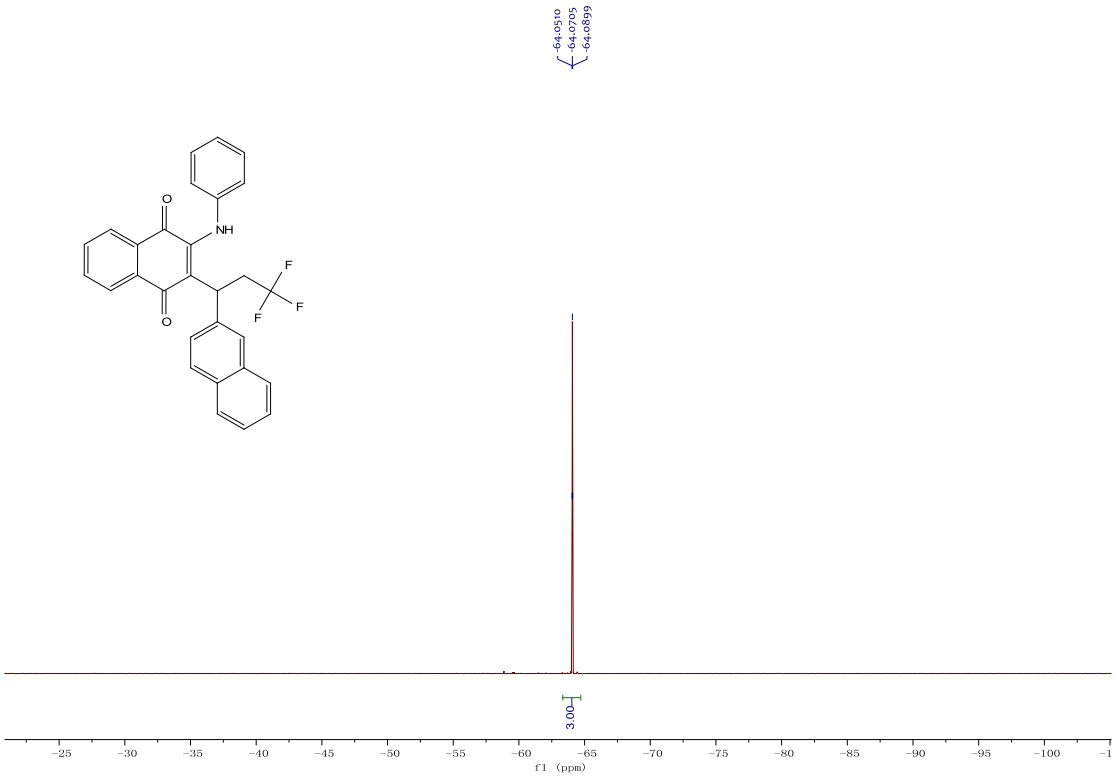
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4an**



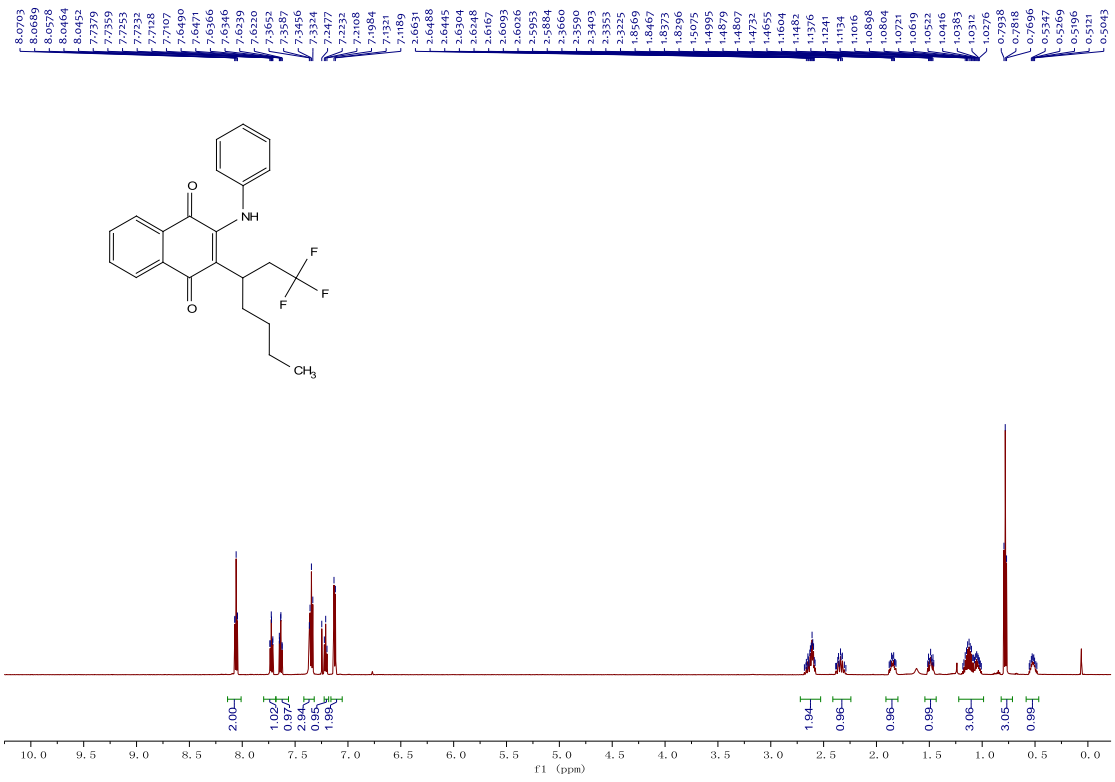
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ao**



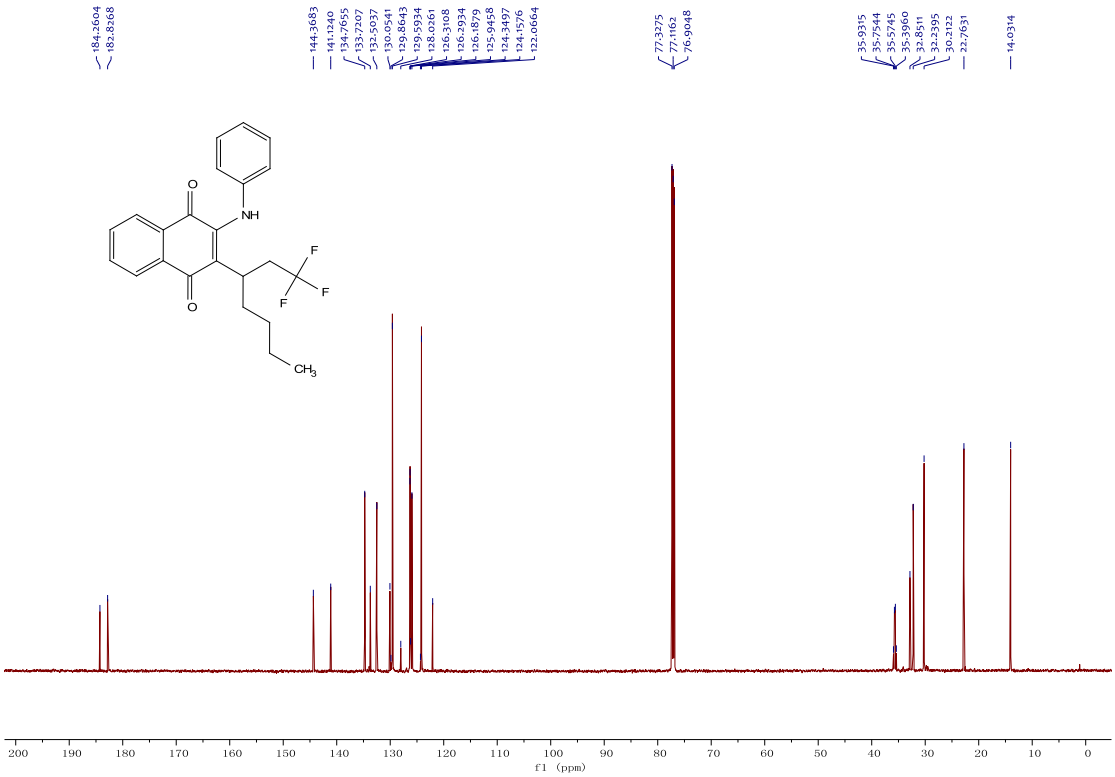
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ao**



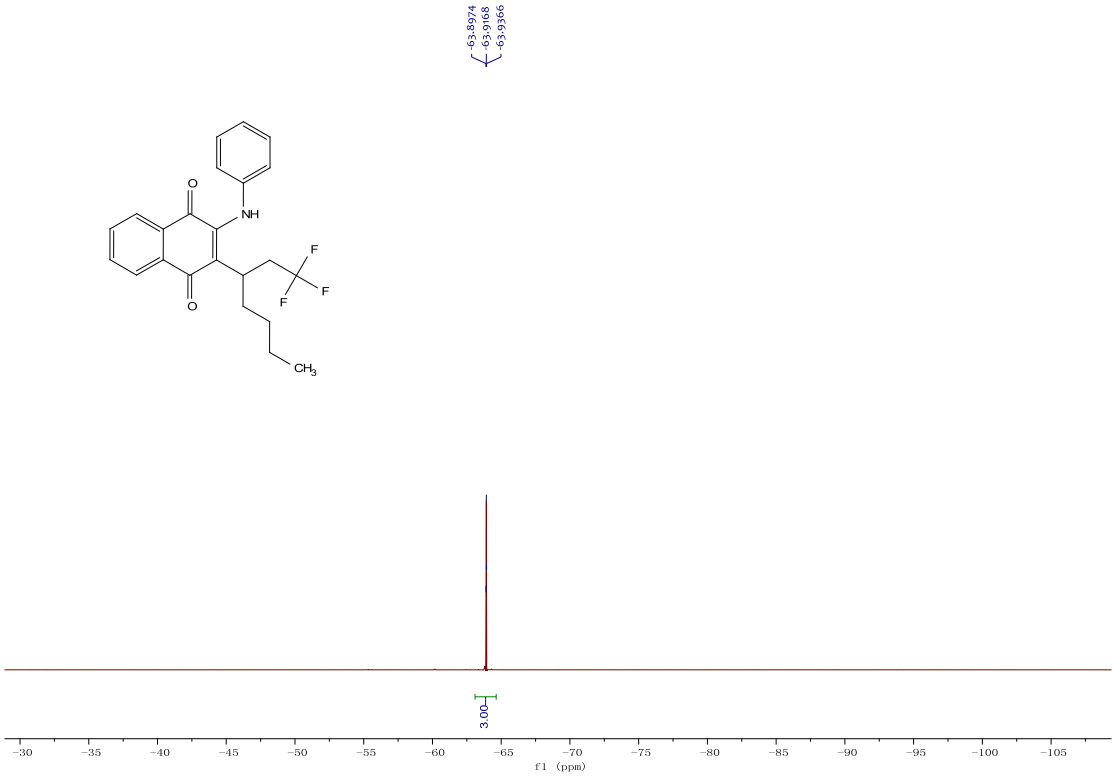
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ao**



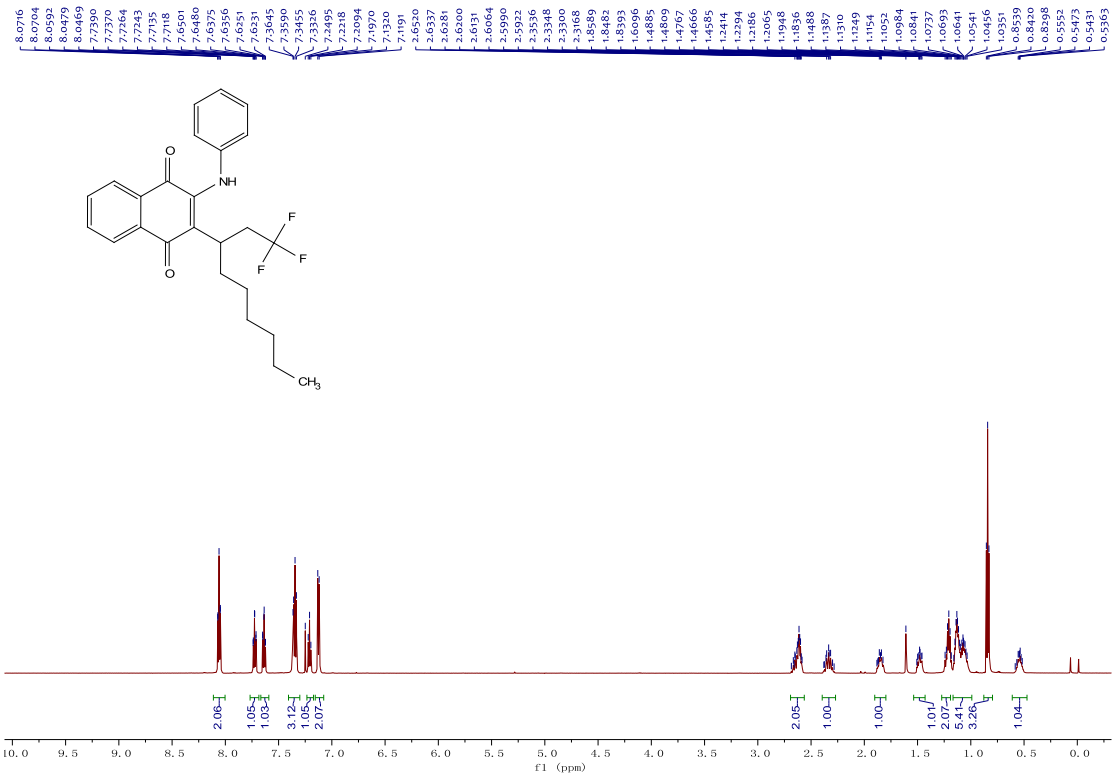
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ap**



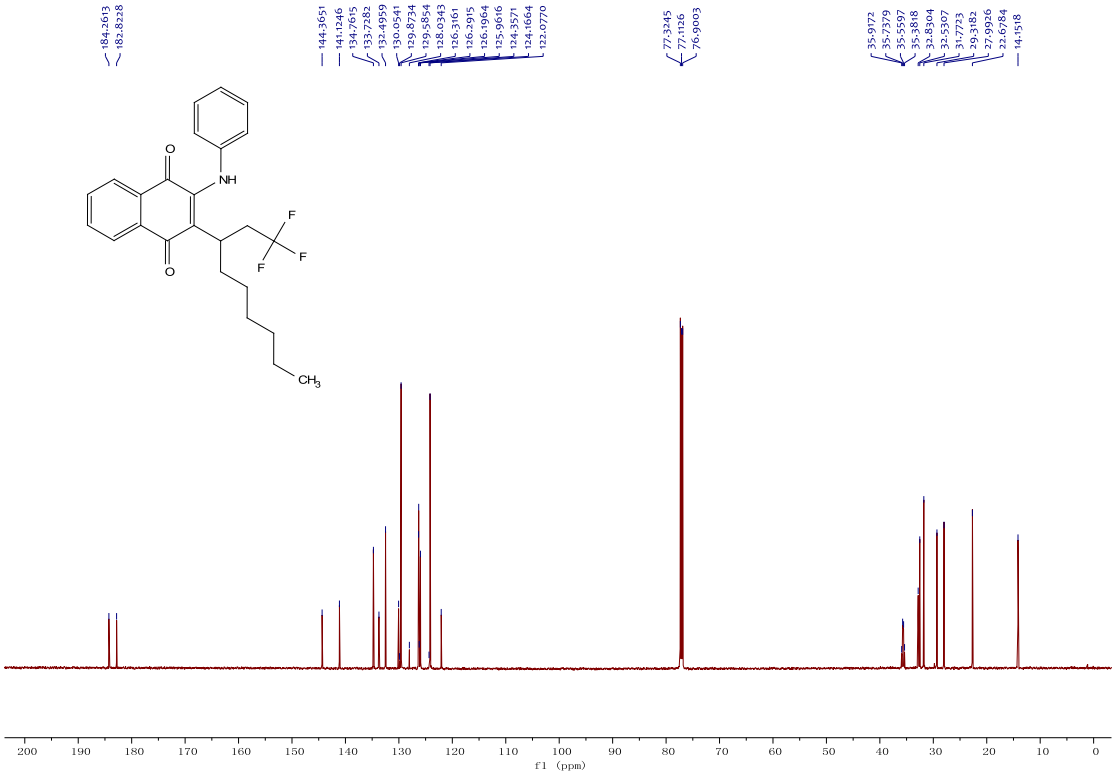
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ap**



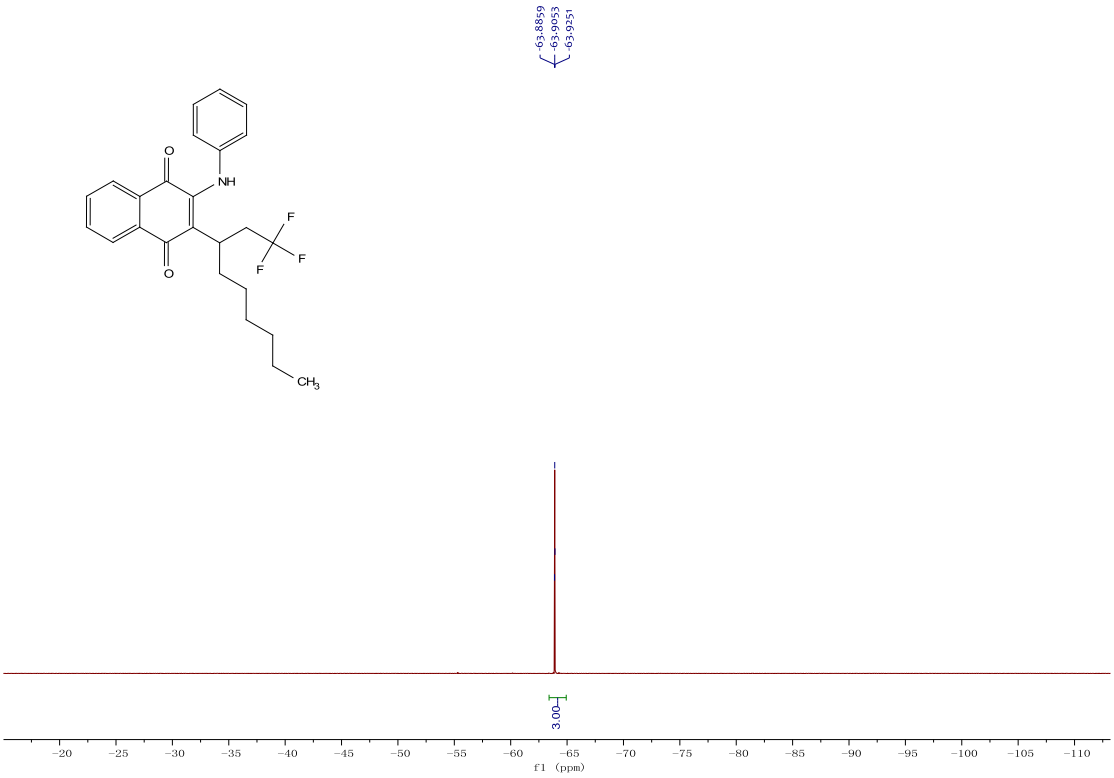
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ap**



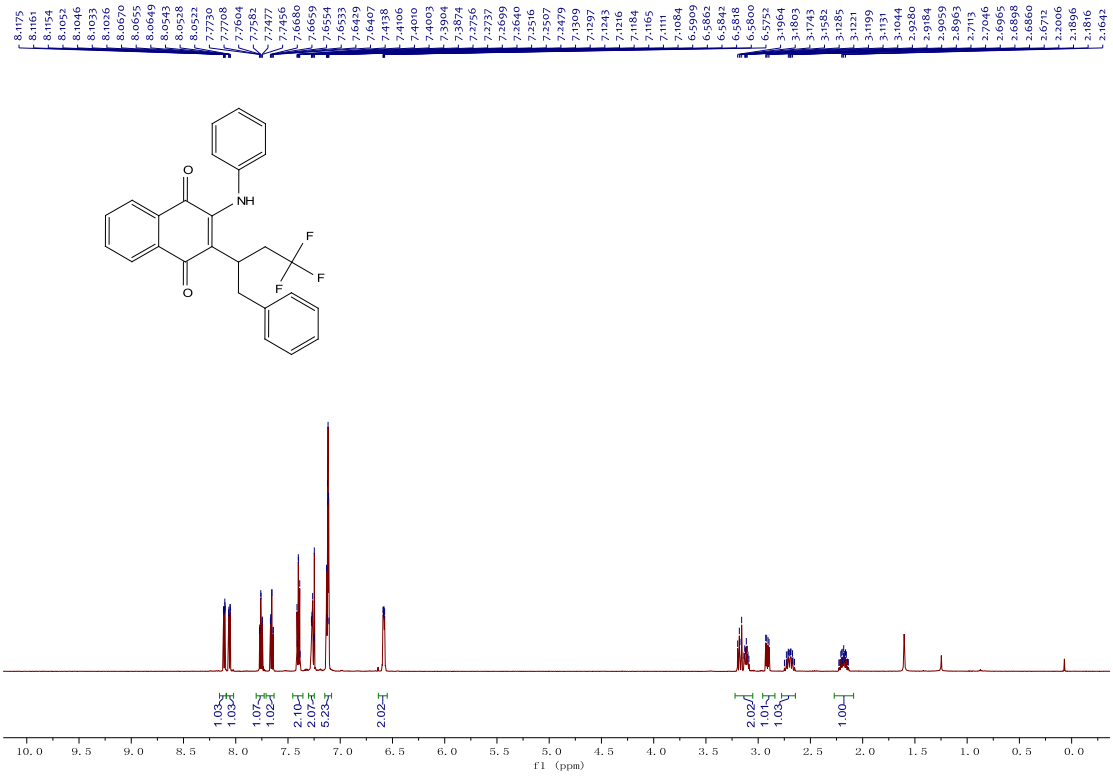
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4aq**



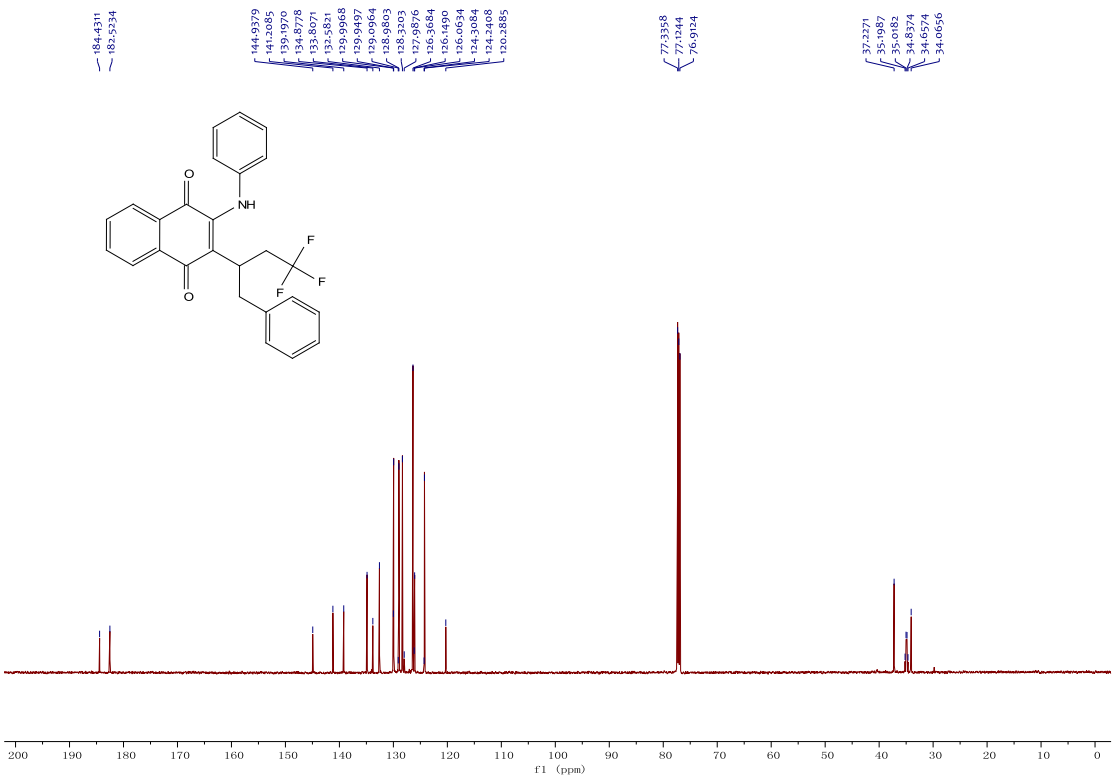
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4aq**



^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4aq**

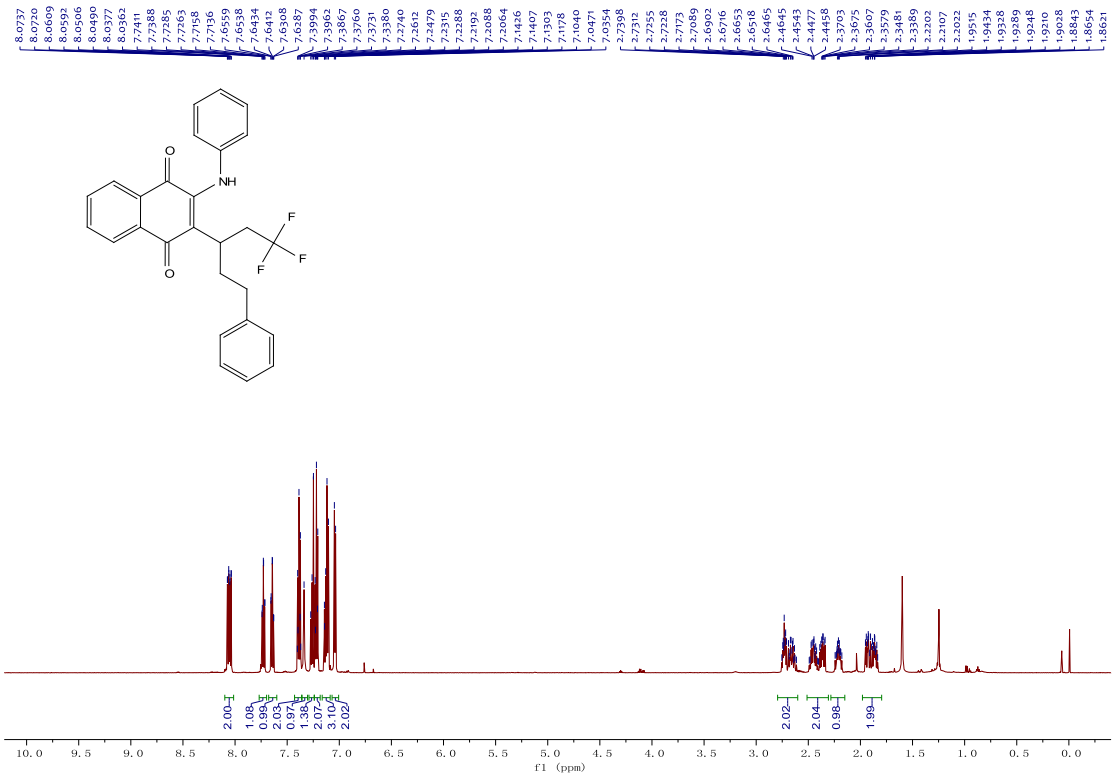


^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ar**

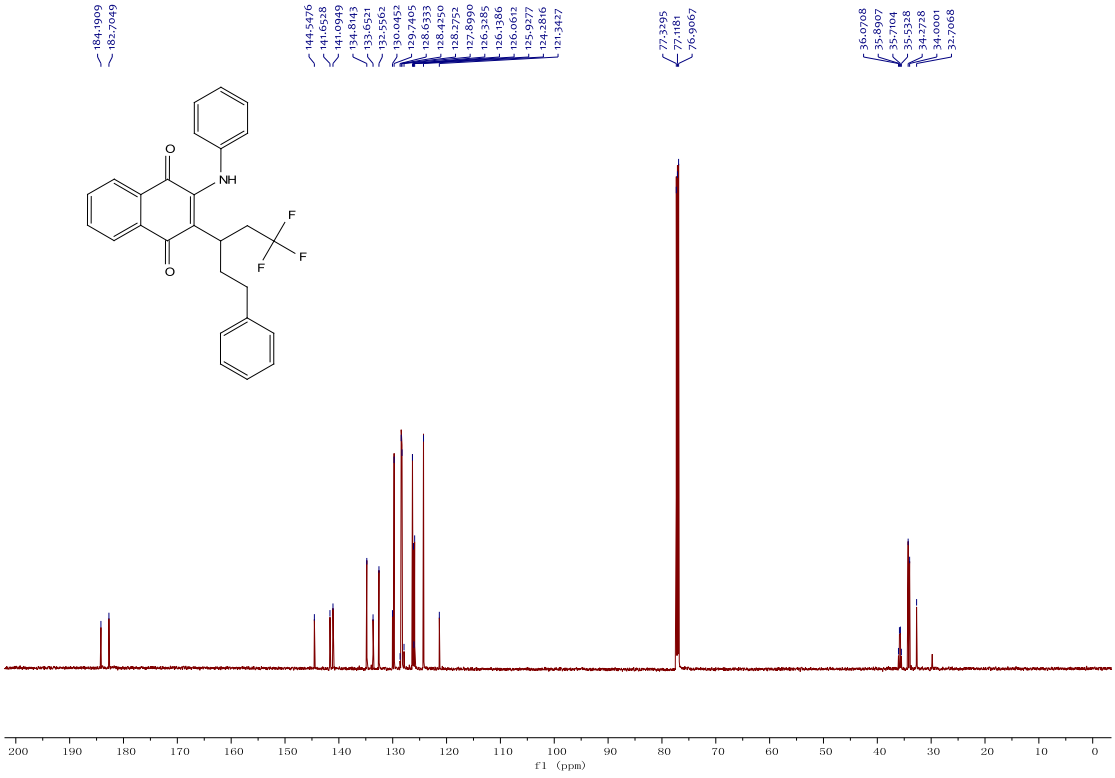


^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ar**

^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ar**

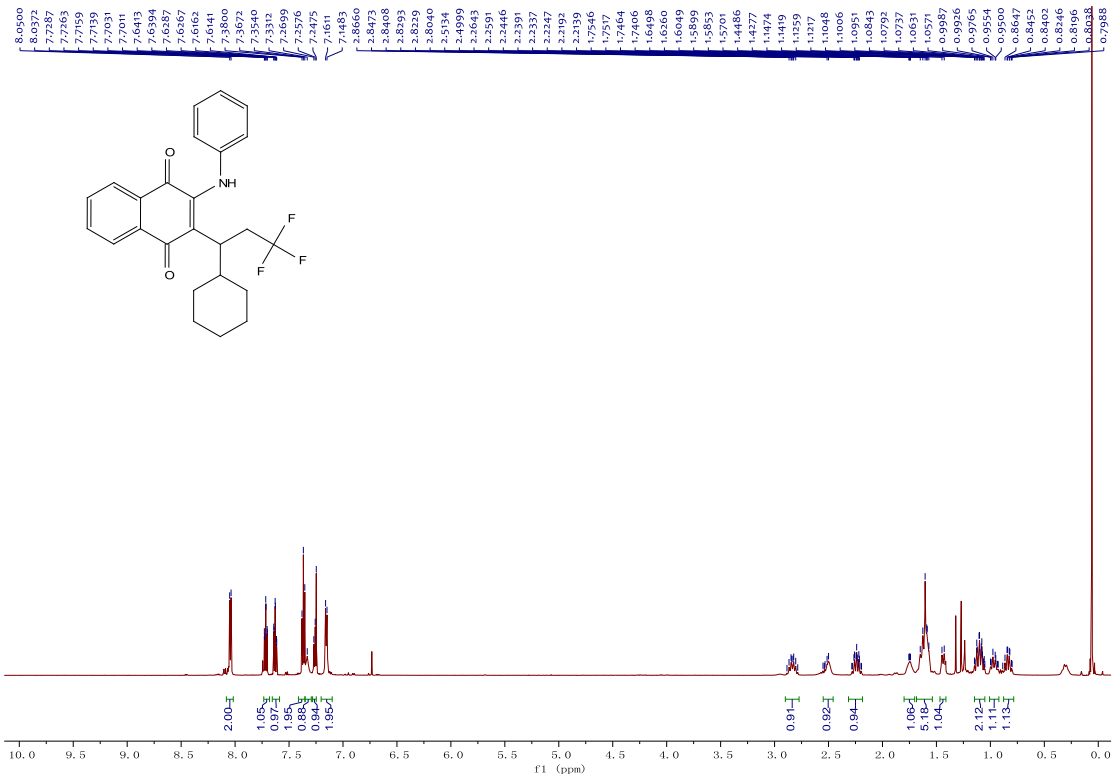


^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4as**

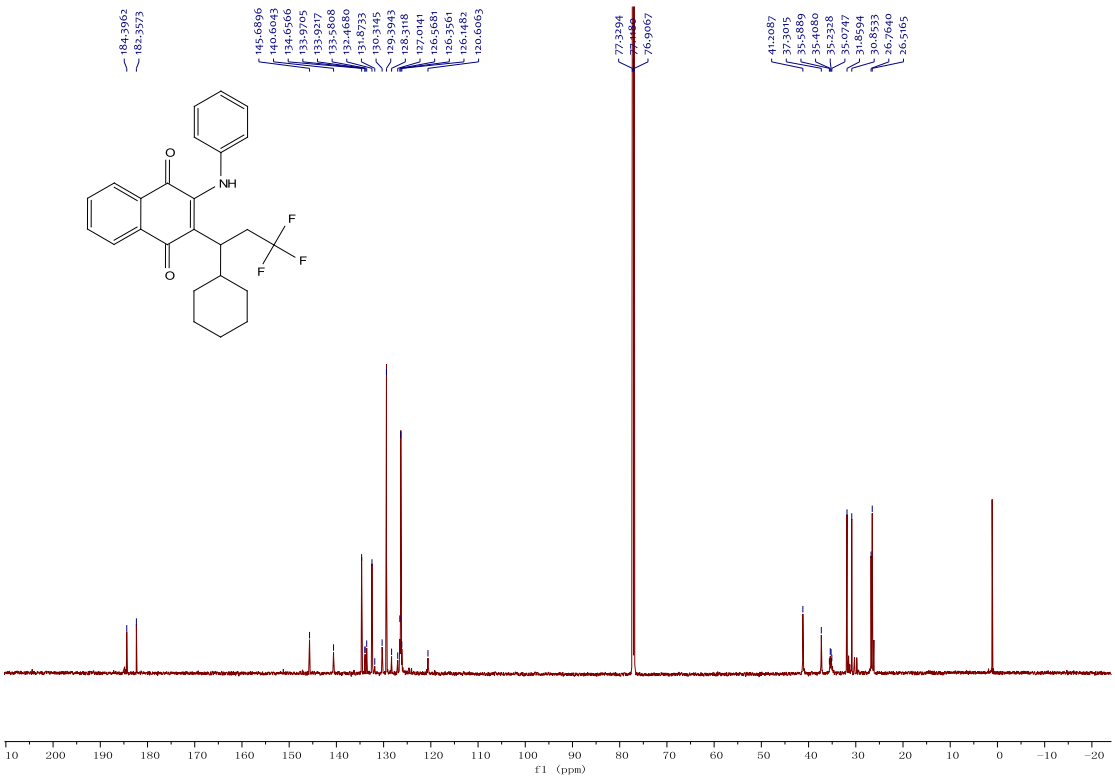


^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4as**

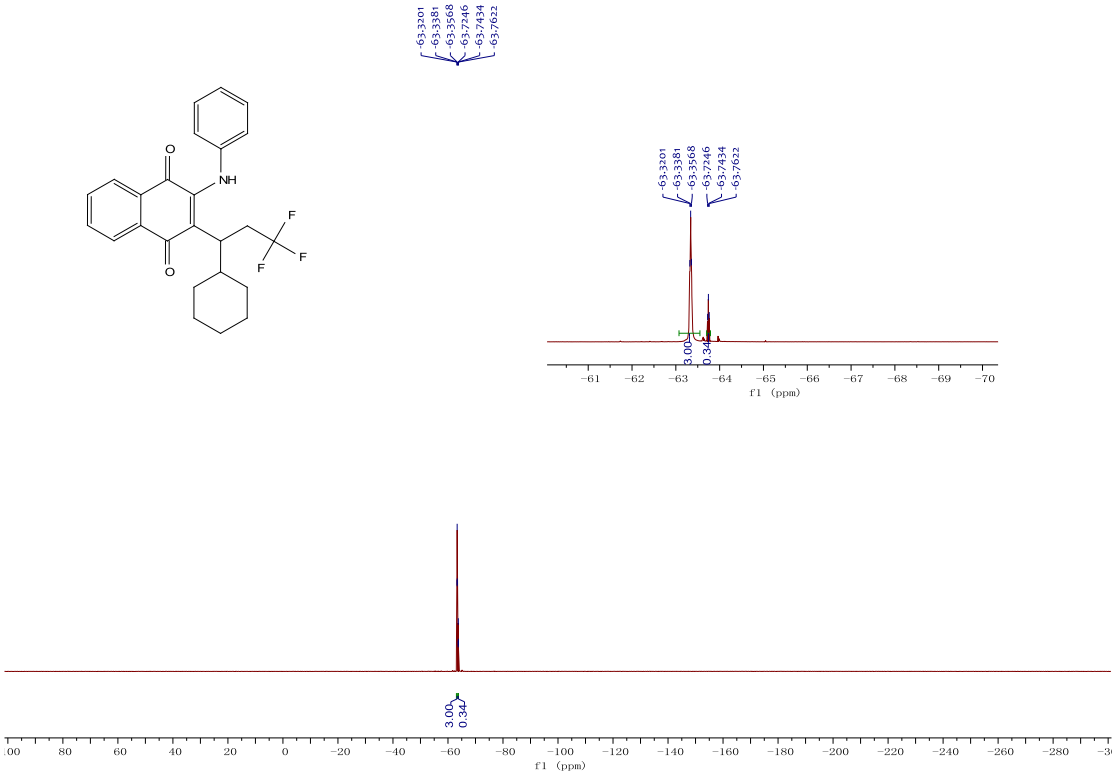
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4as**



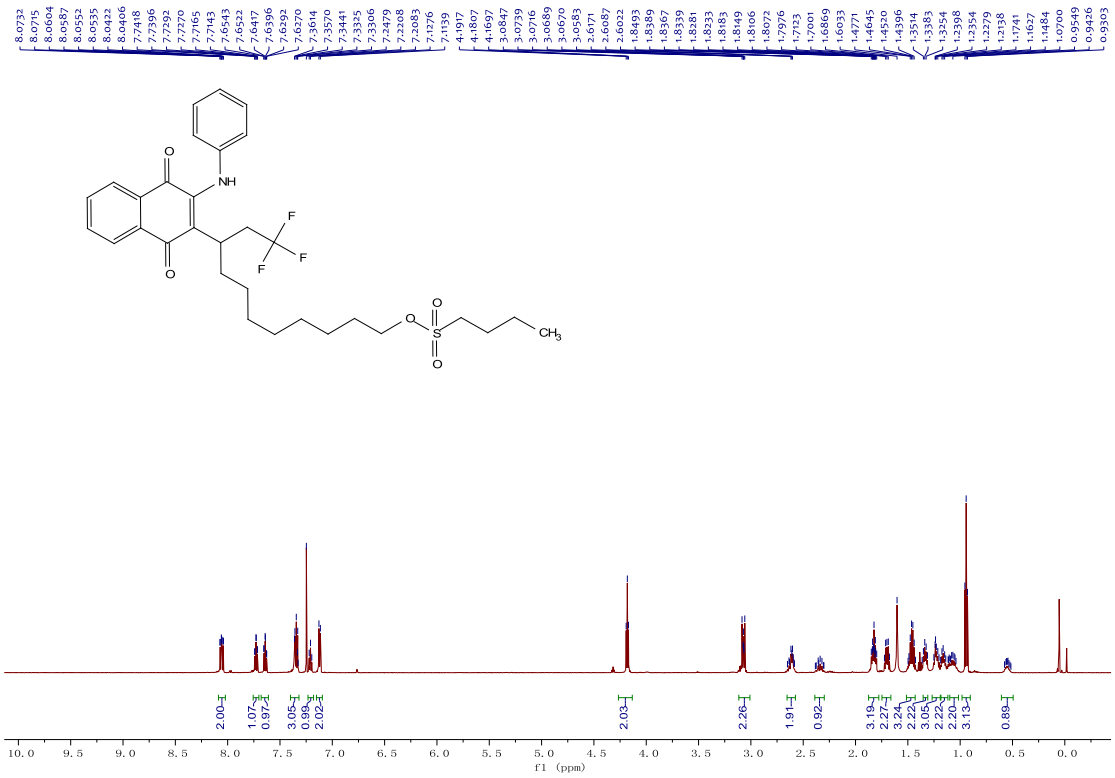
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4at**



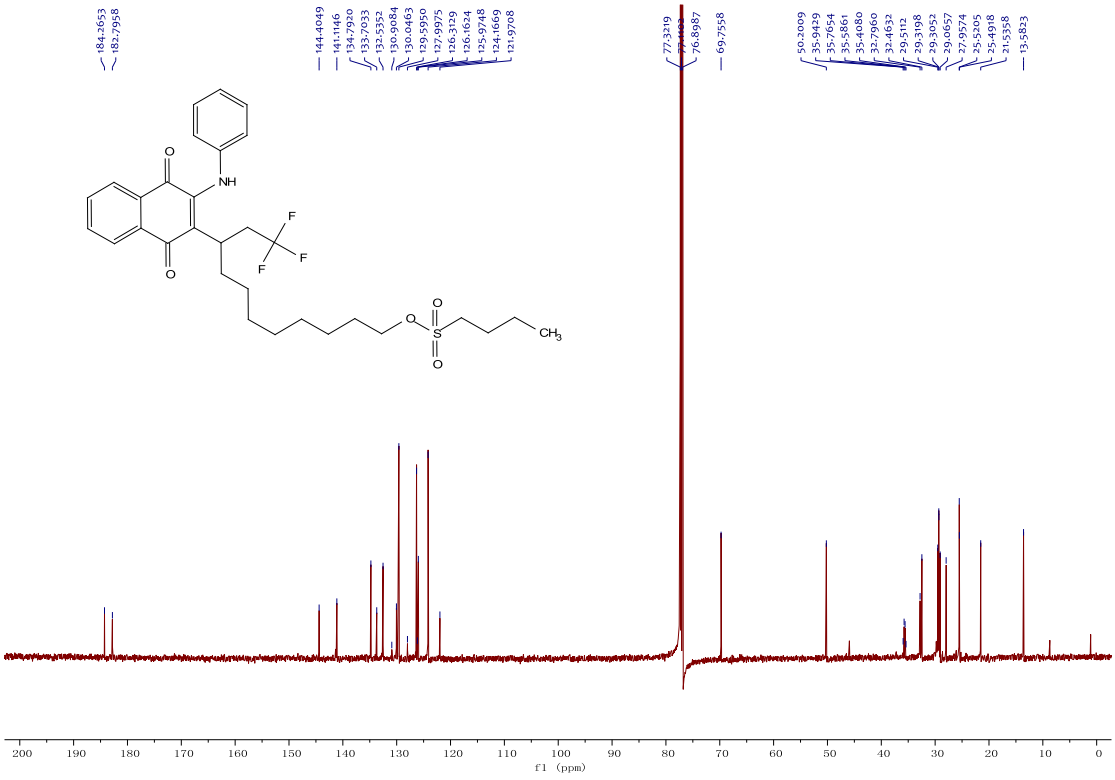
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4at**



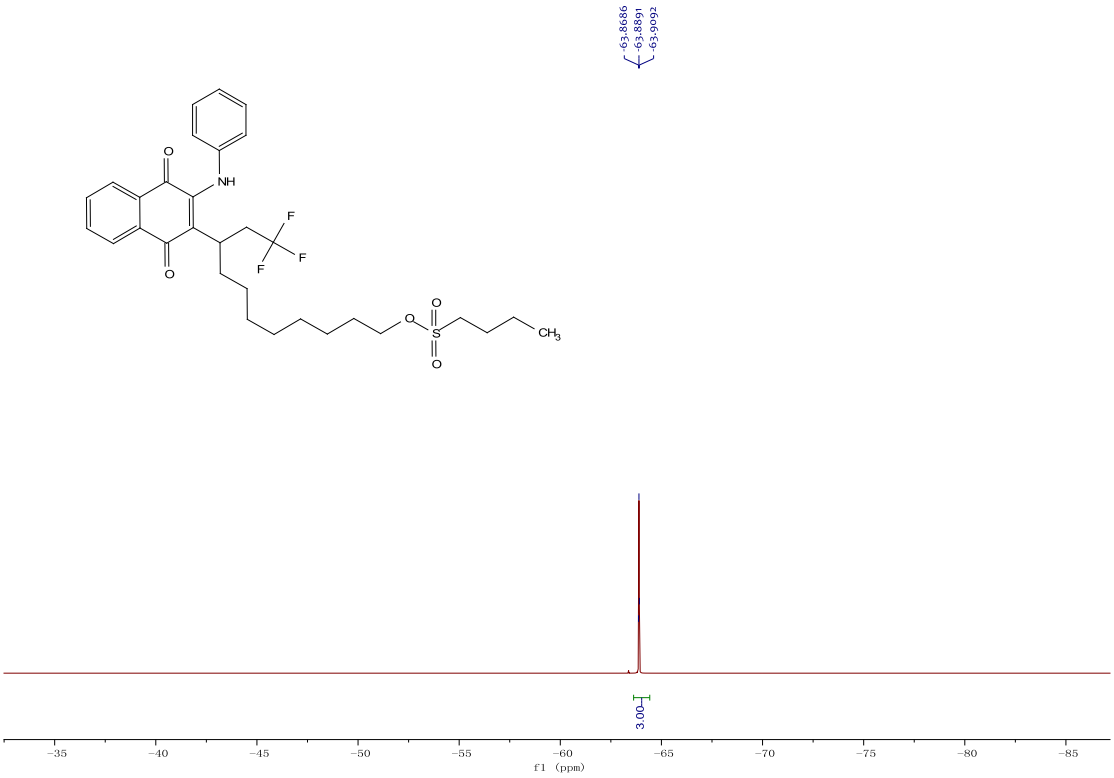
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4at**



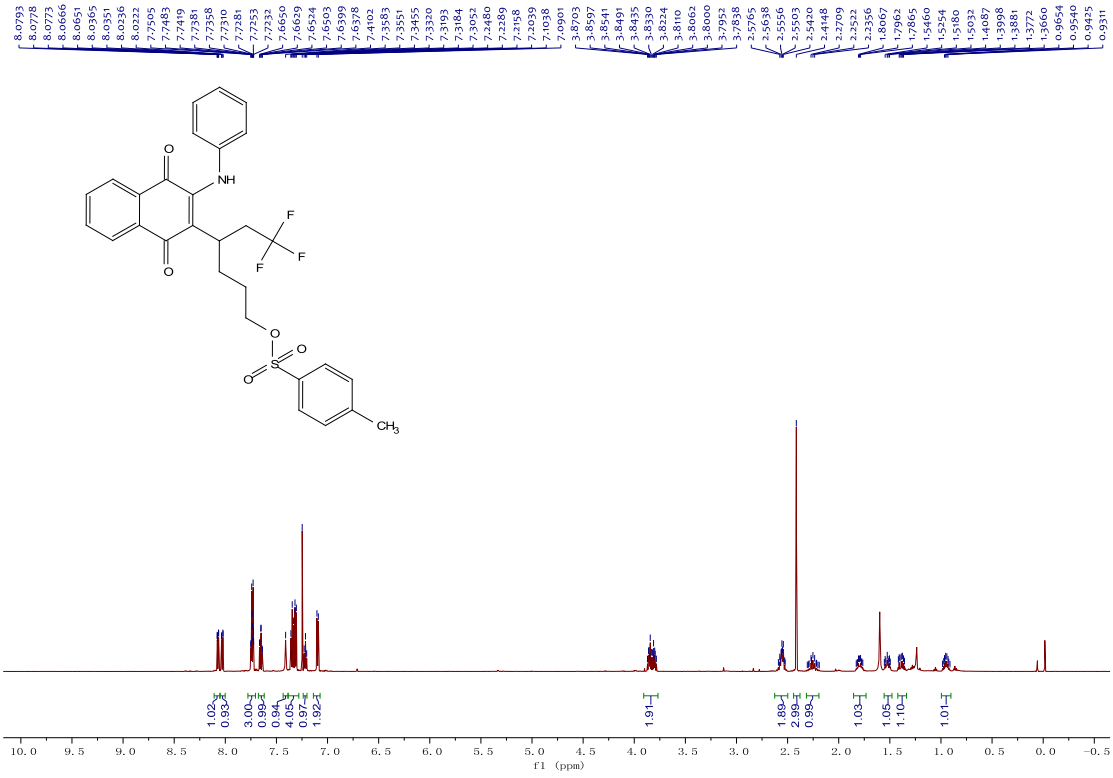
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4au**



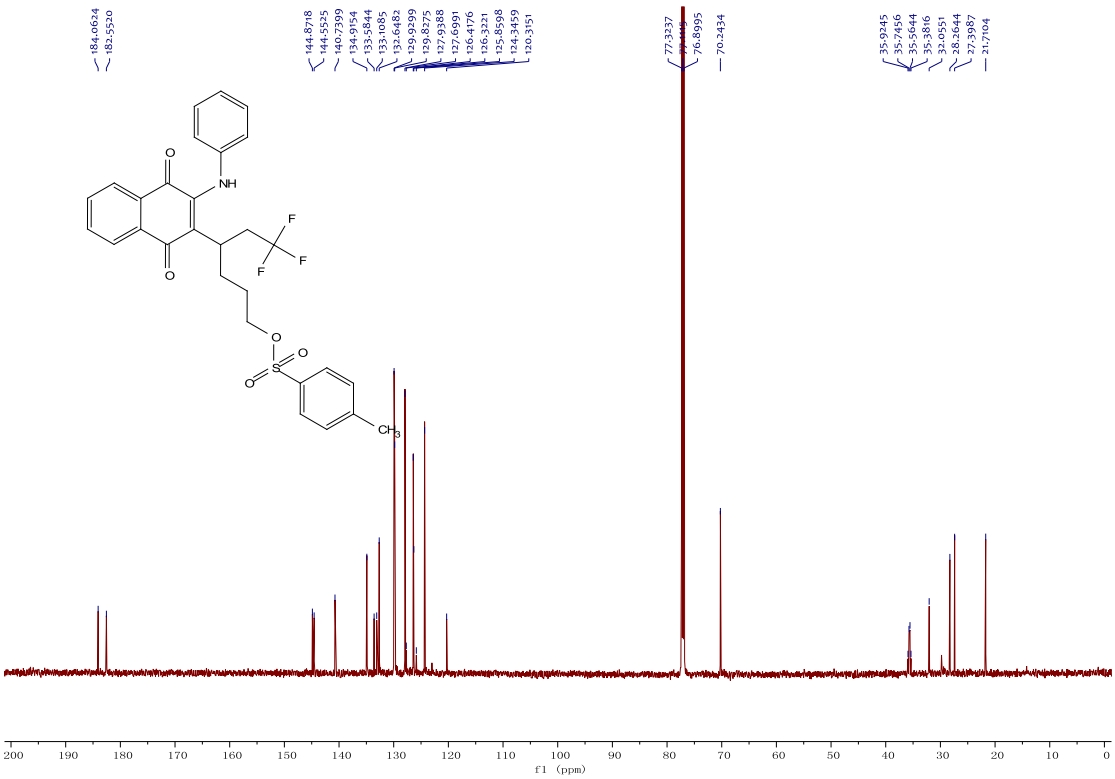
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4au**



^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4au**

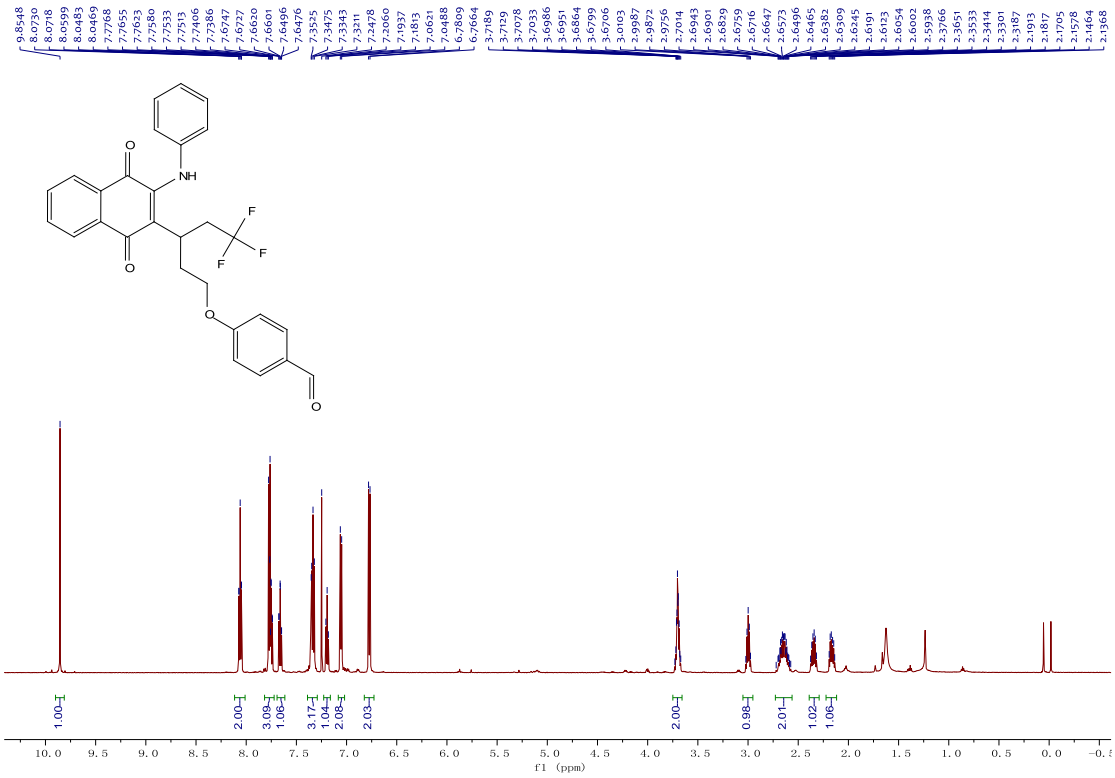


^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4av**

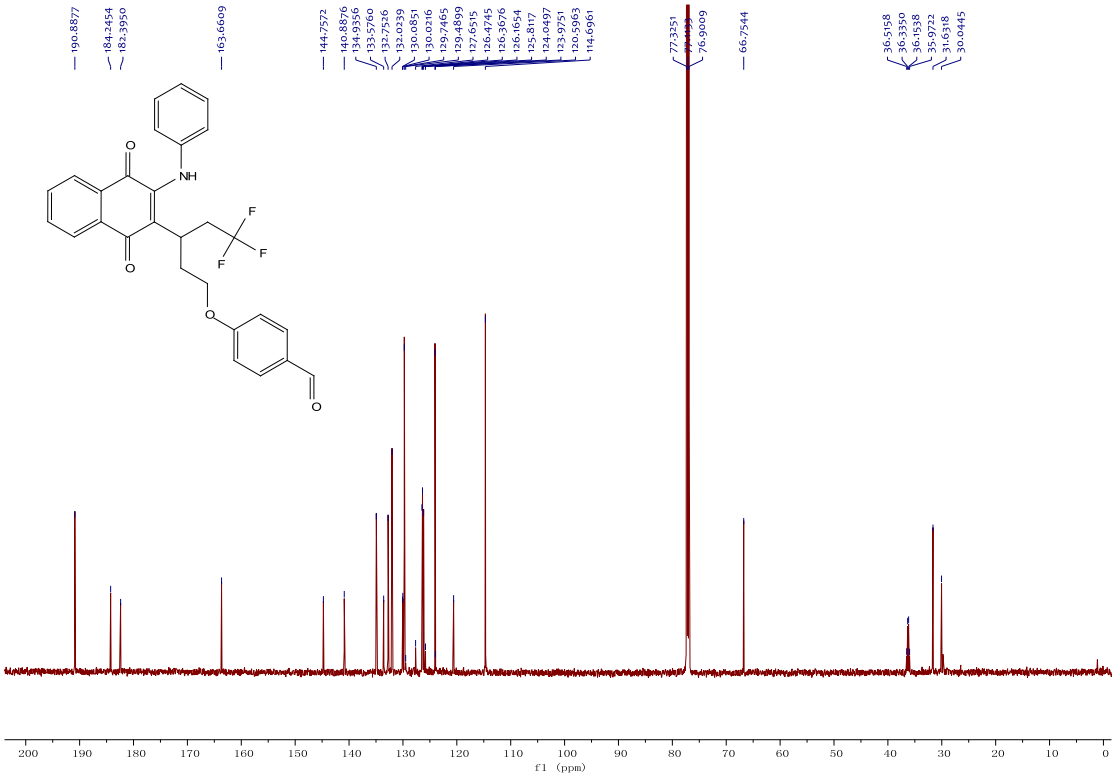


^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4av**

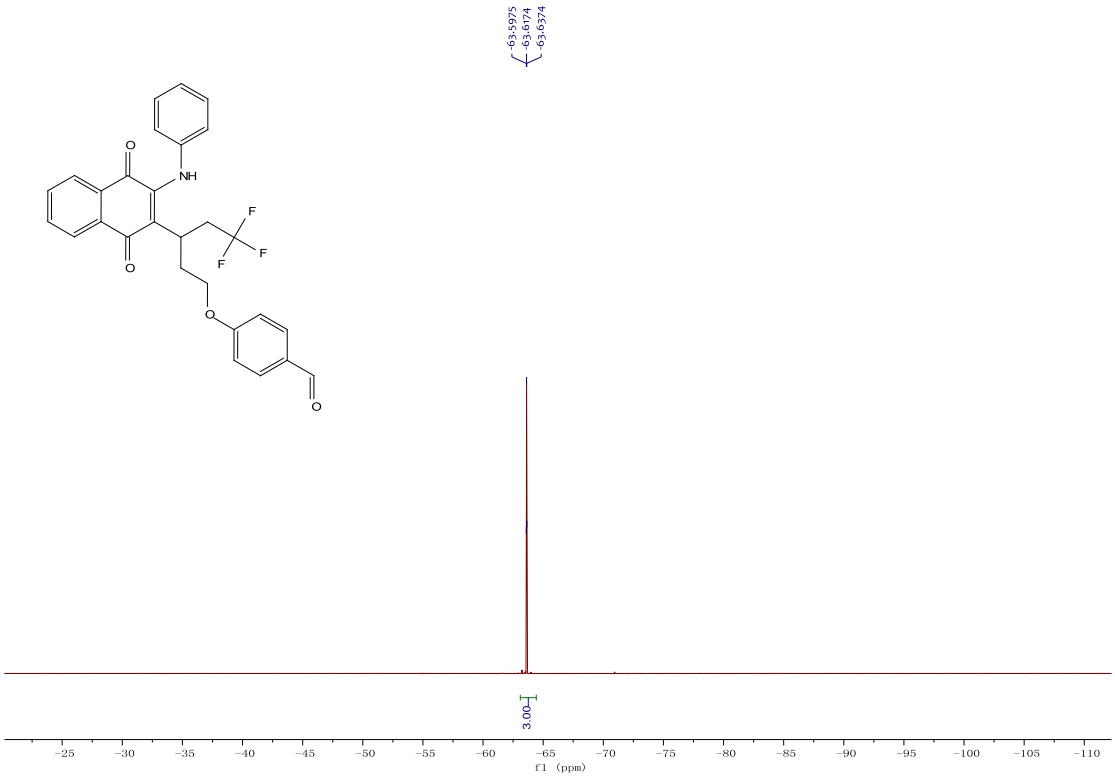
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4av**



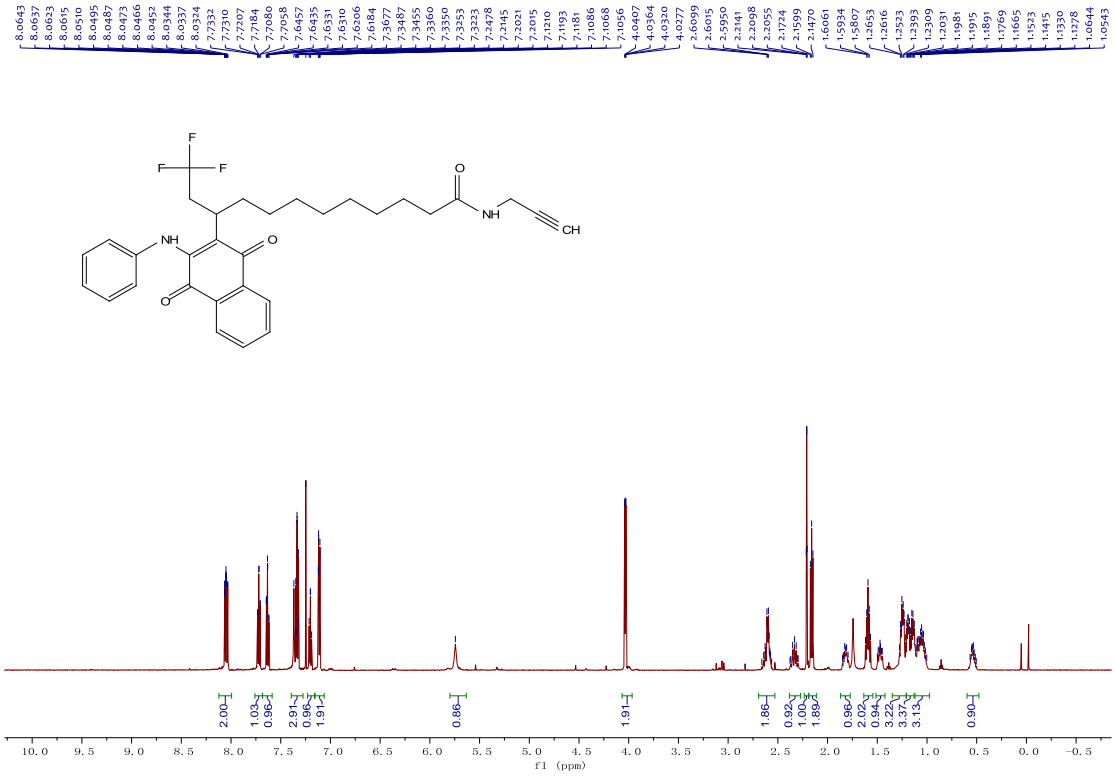
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4aw**



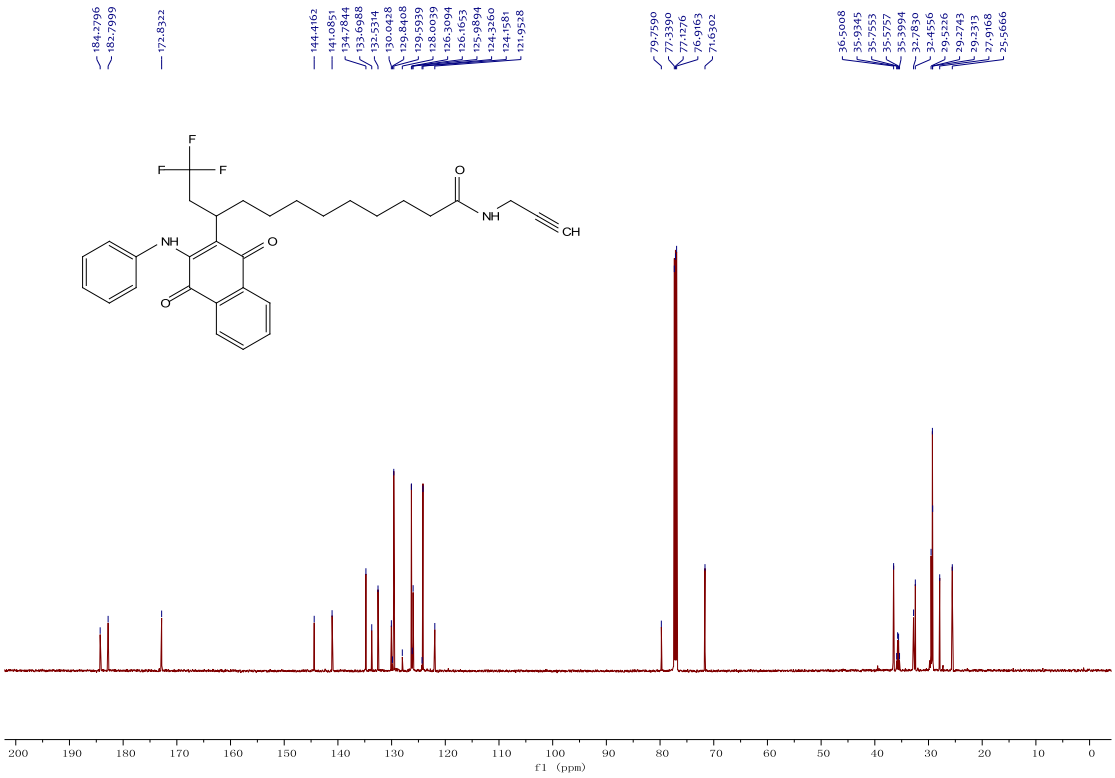
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4aw**



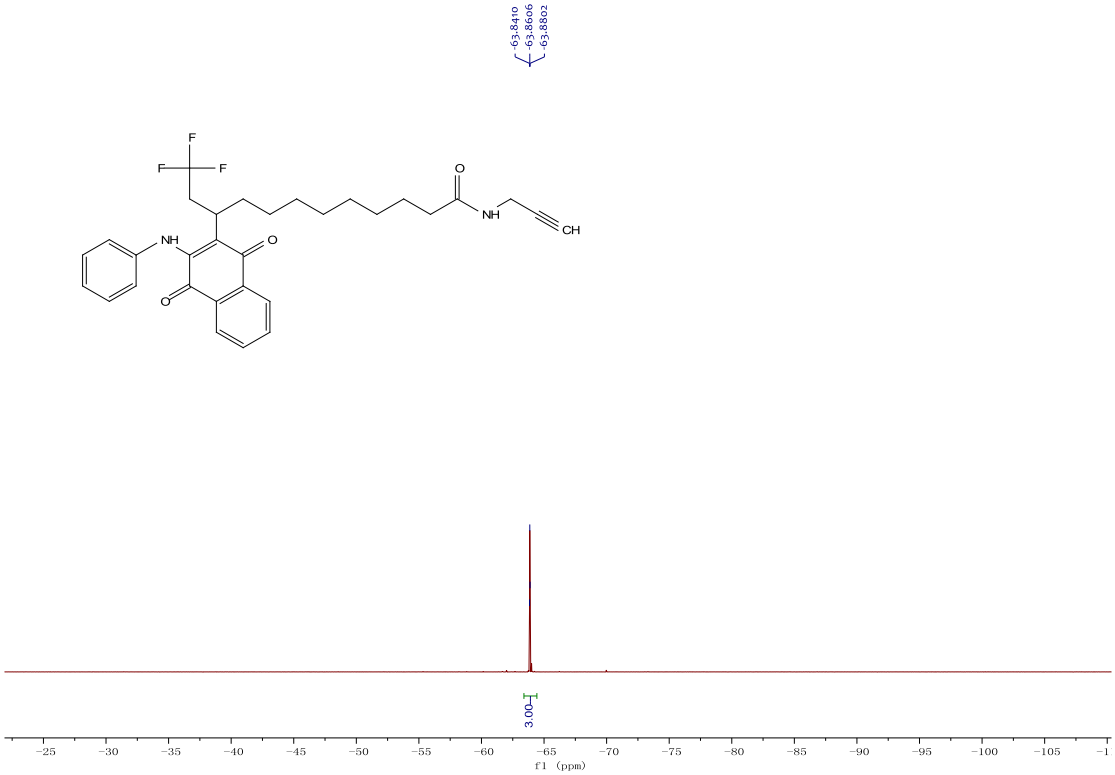
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4aw**



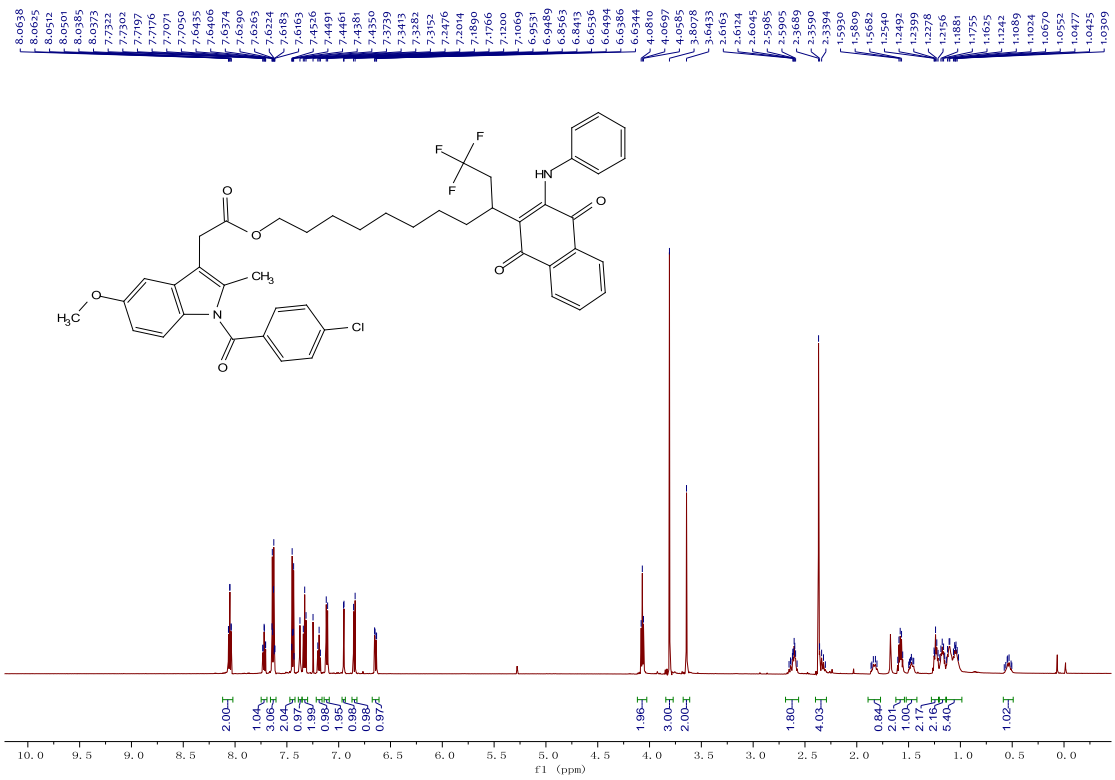
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ax**



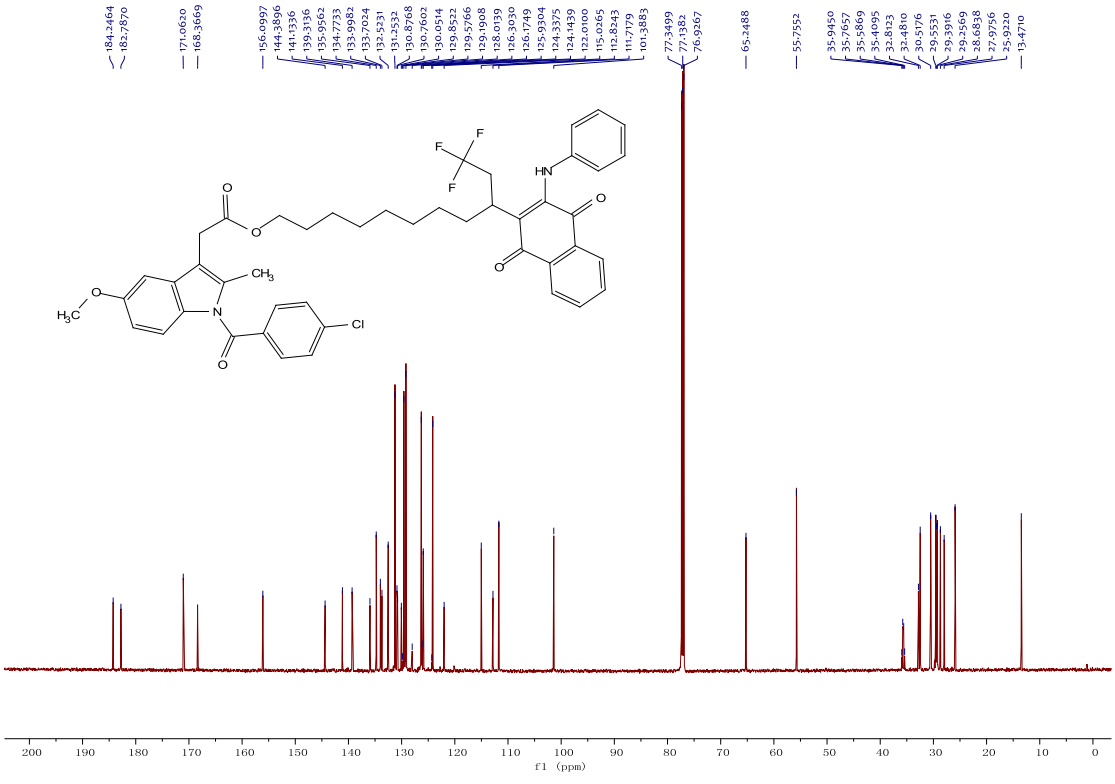
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ax**



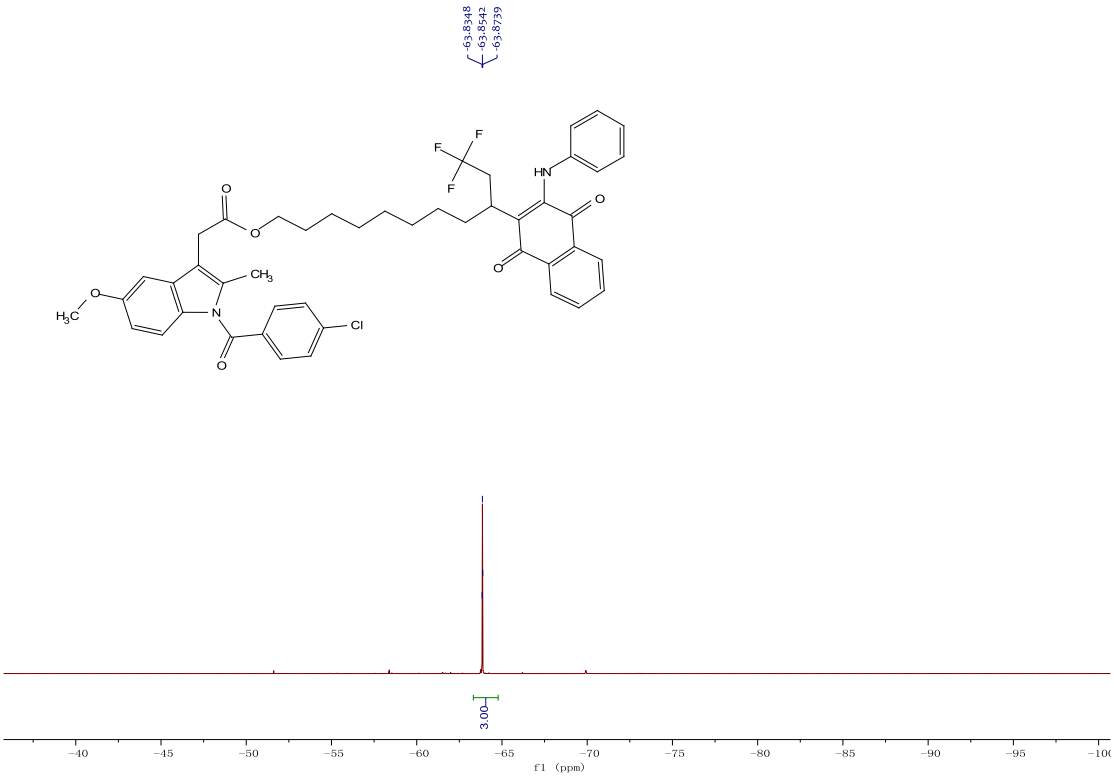
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ax**



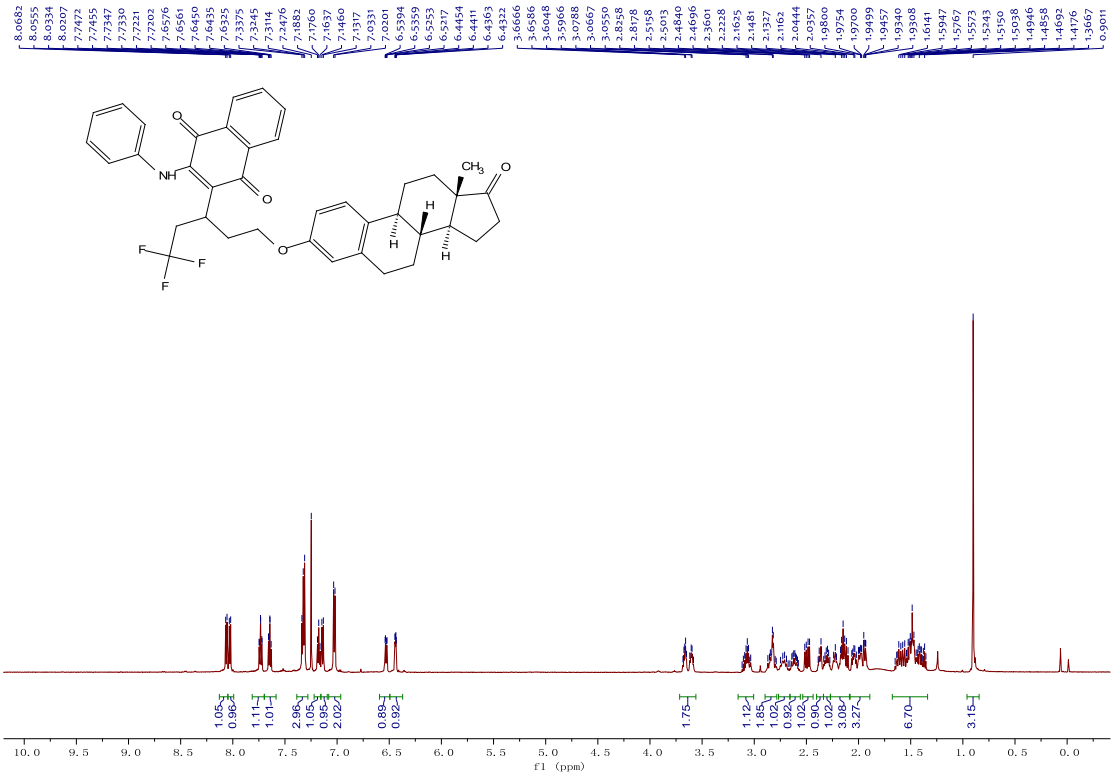
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ay**



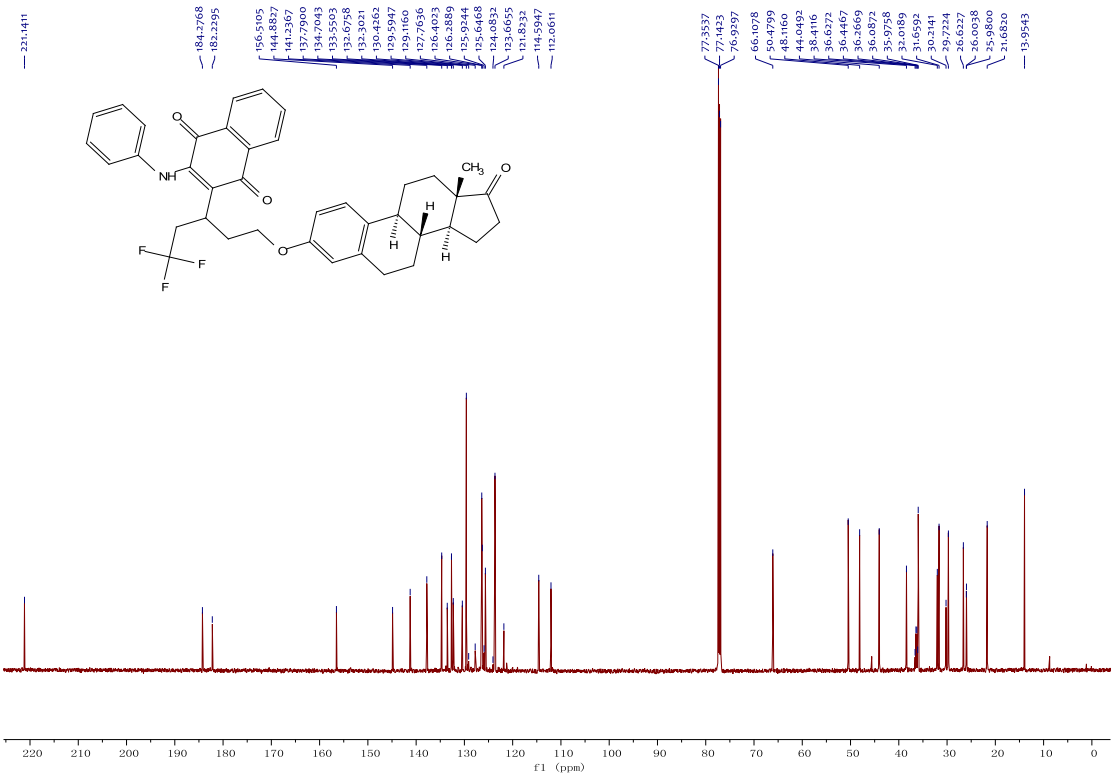
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ay**



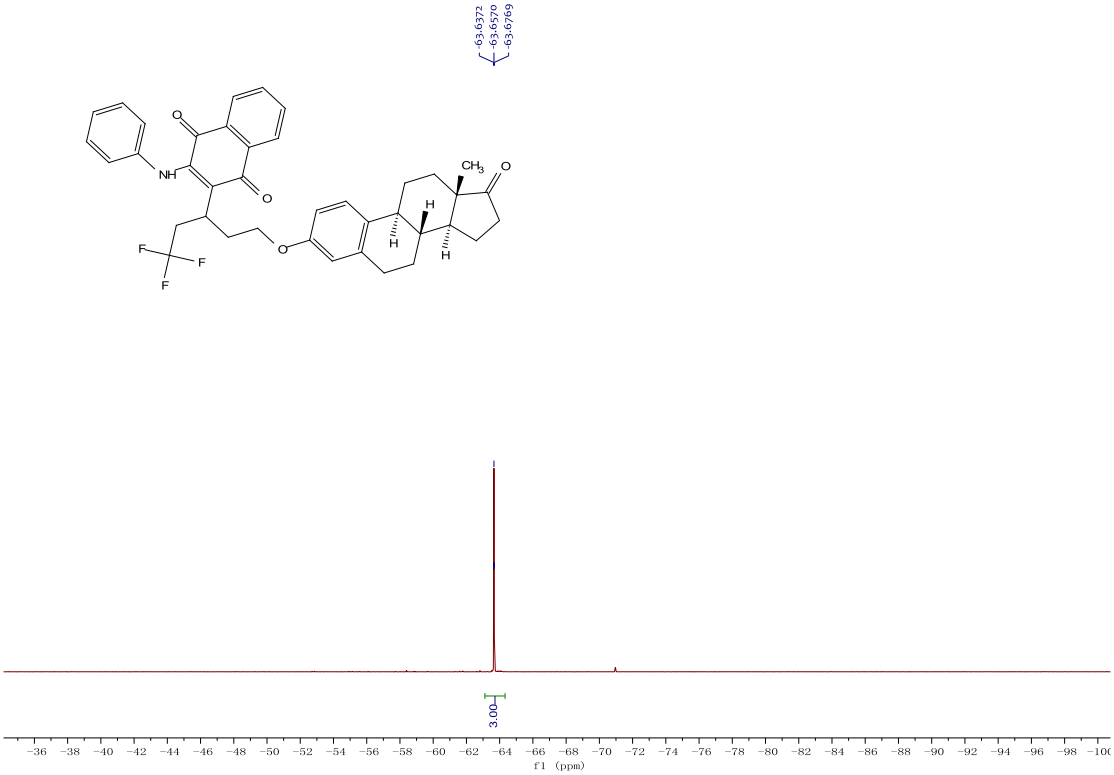
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ay**



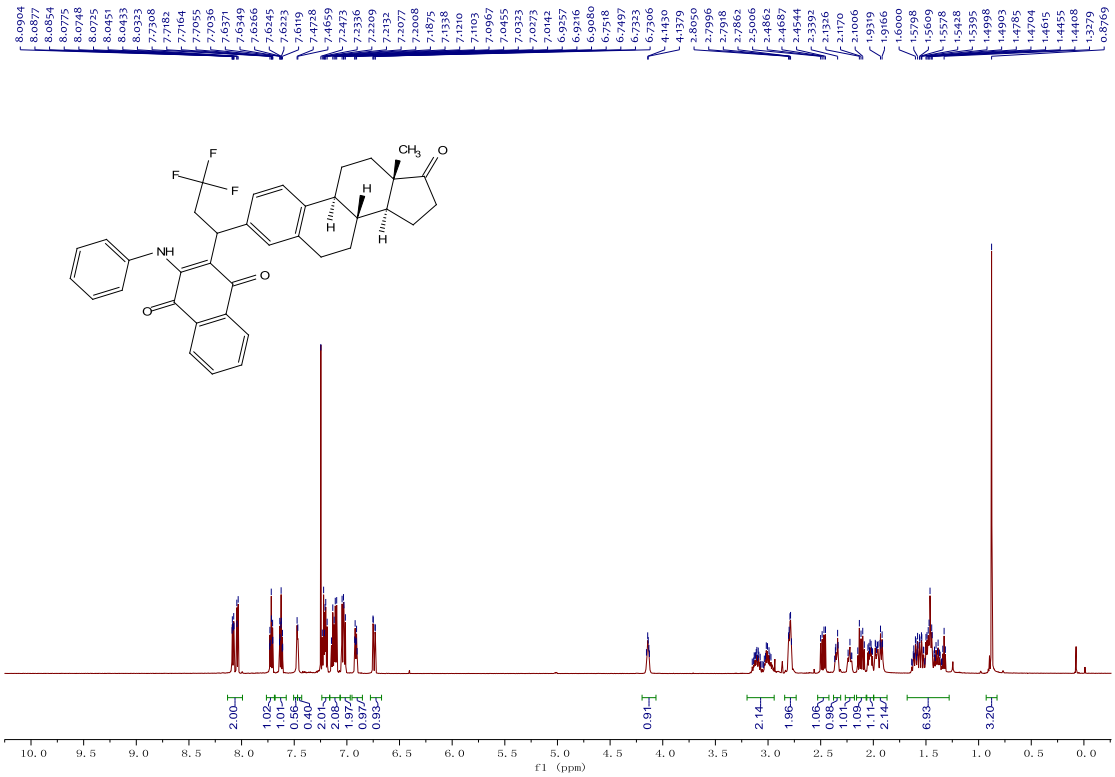
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4az**



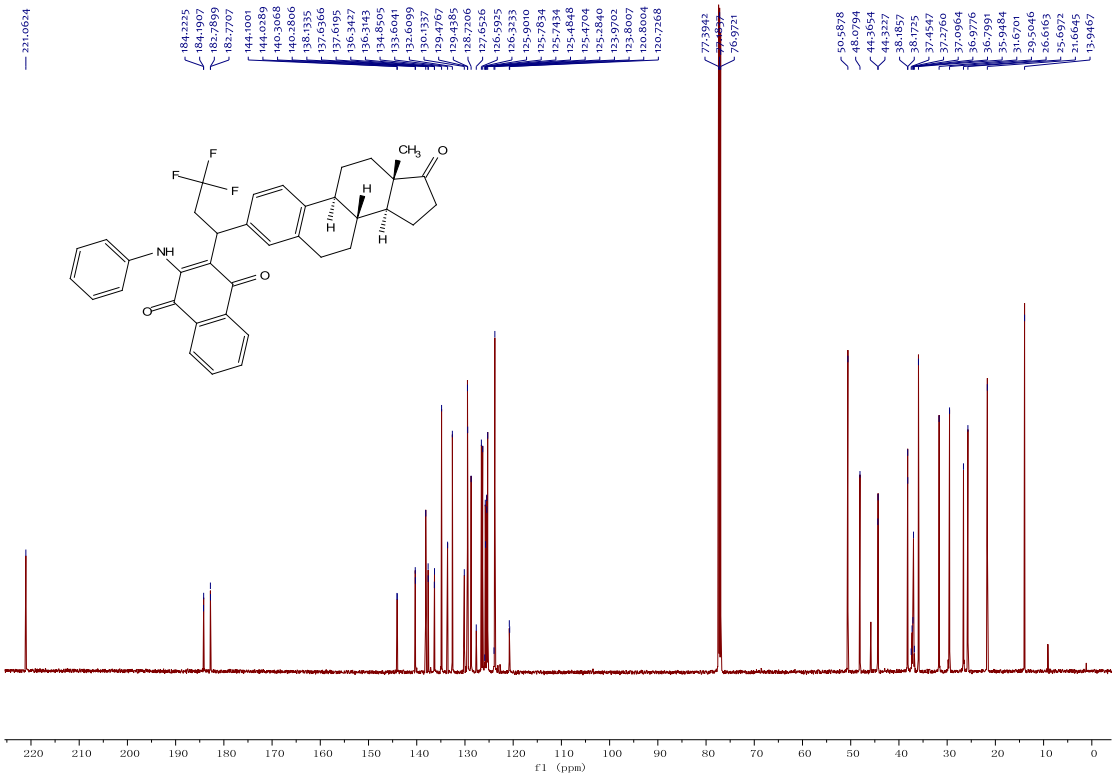
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4az**



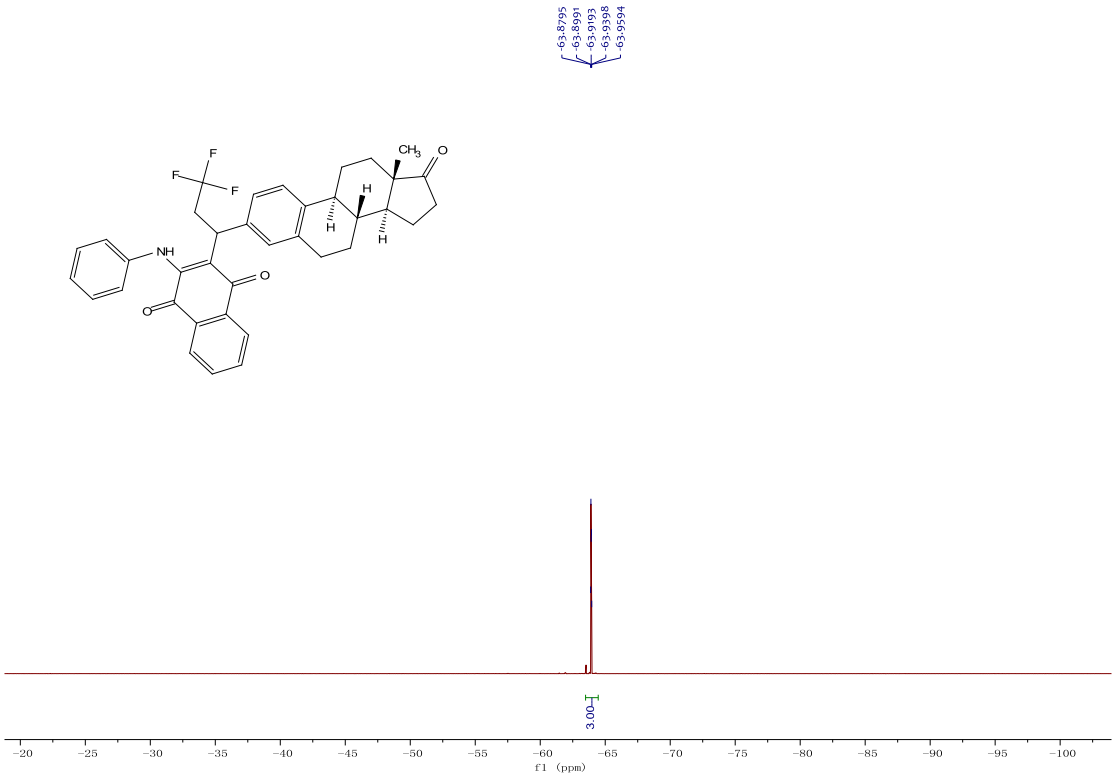
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4az**



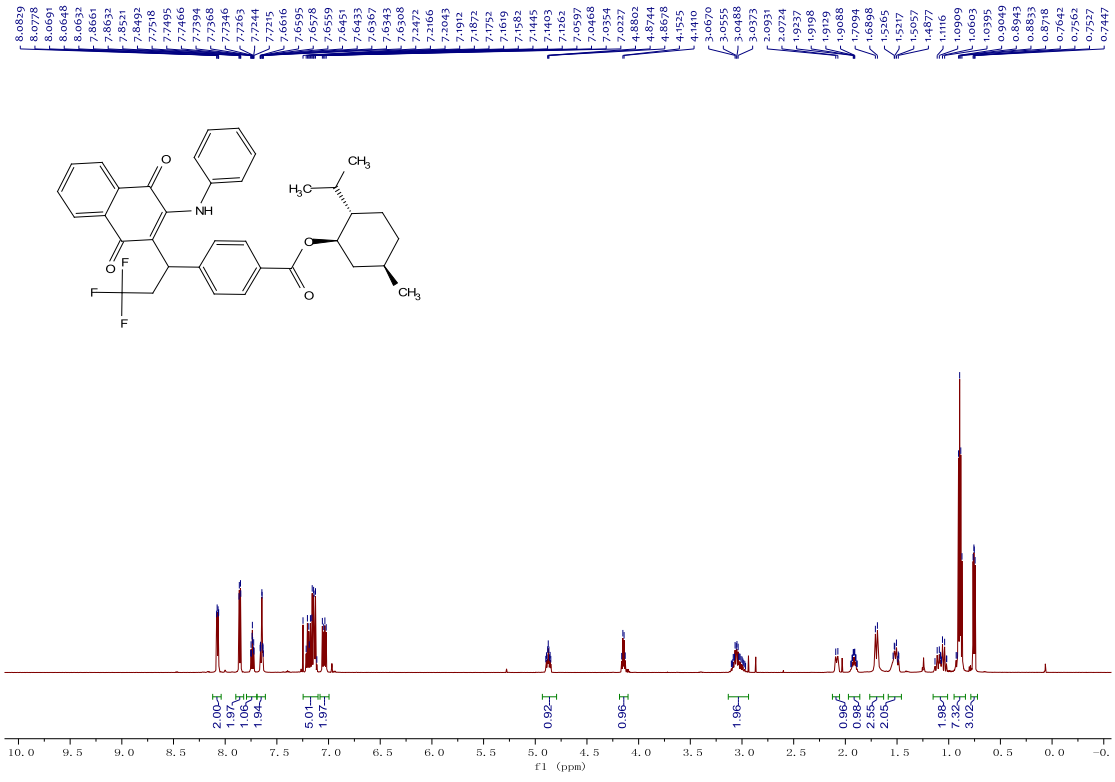
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ba**



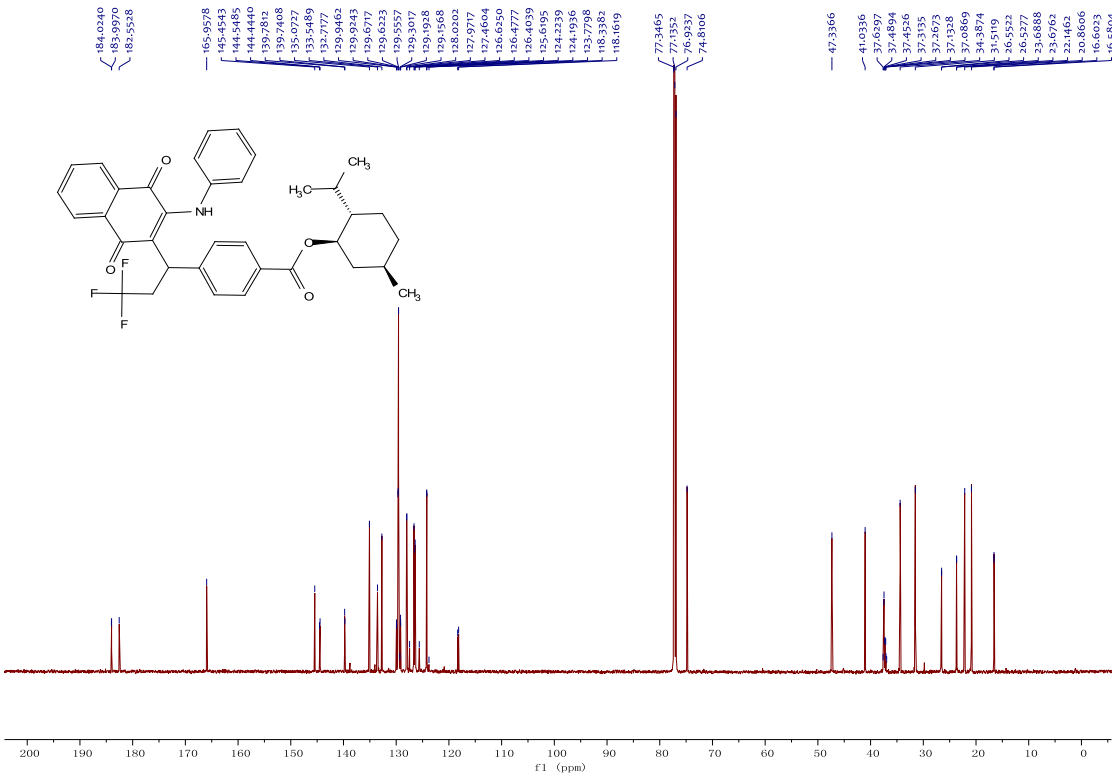
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ba**



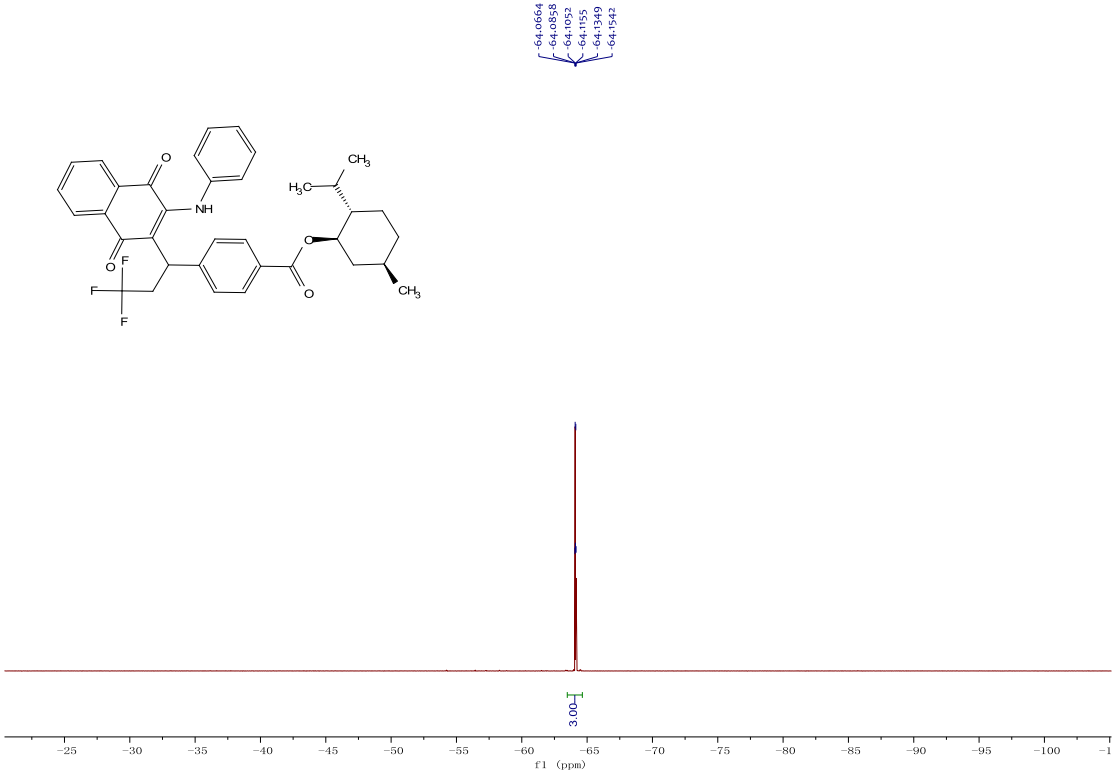
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ba**



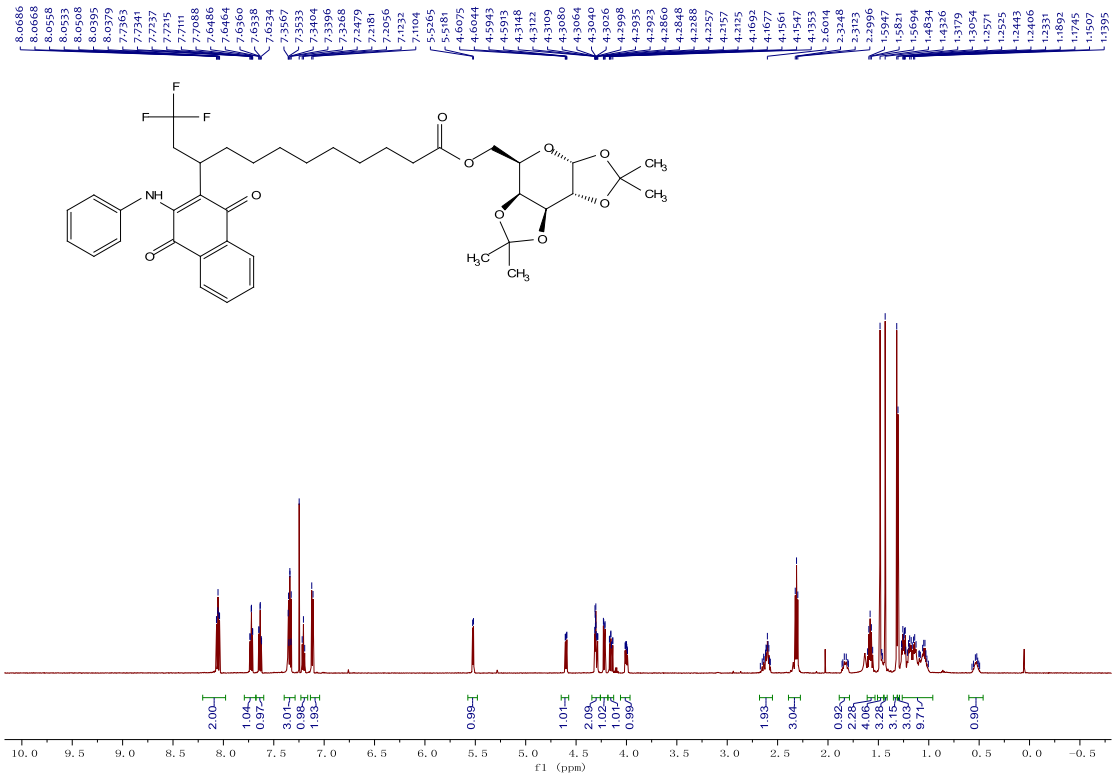
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ca**



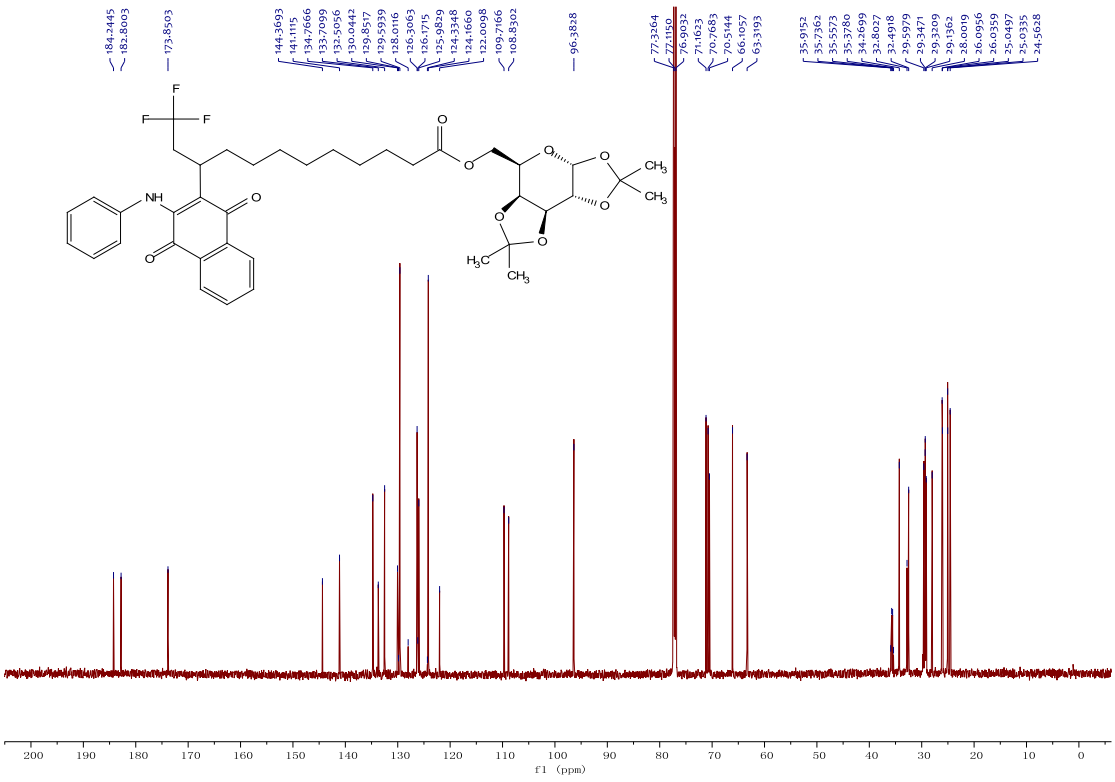
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ca**



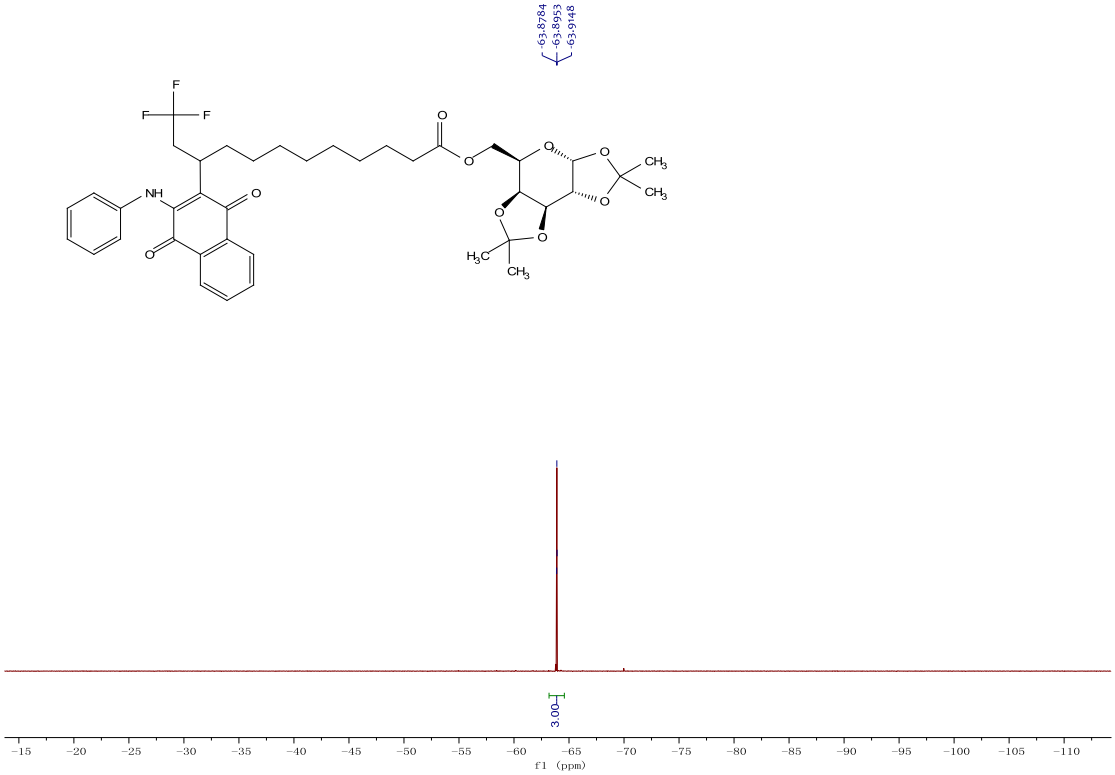
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ca**



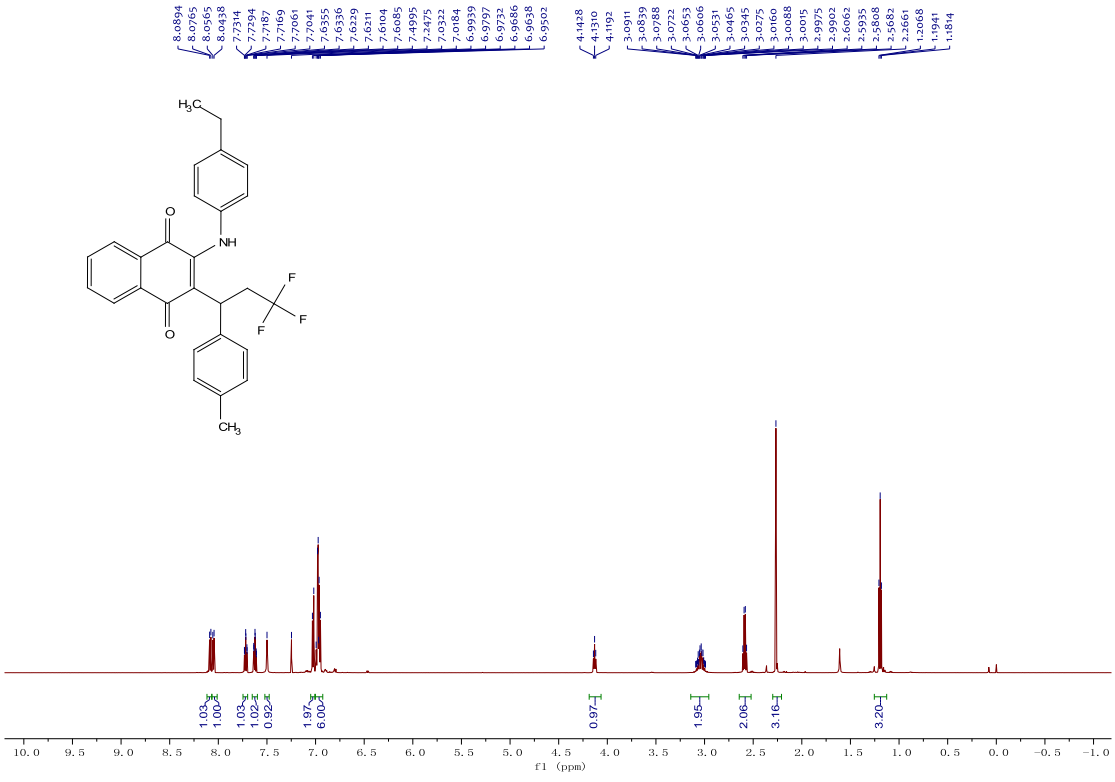
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4da**



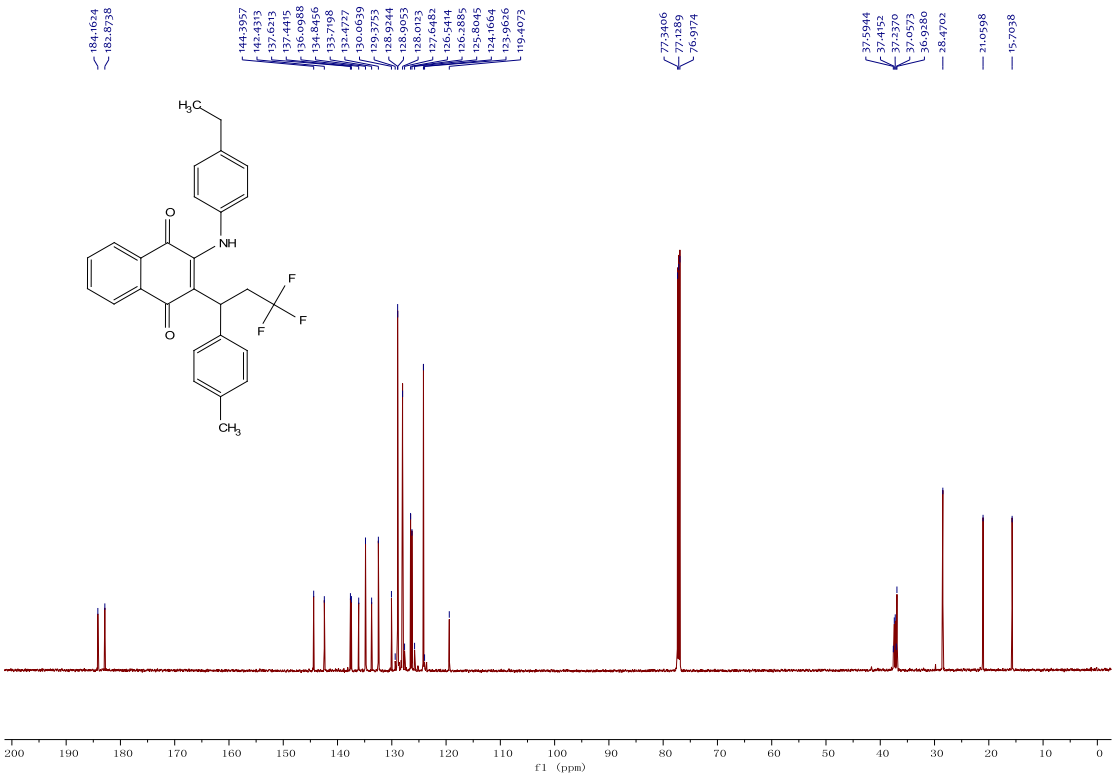
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4da**



^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4da**

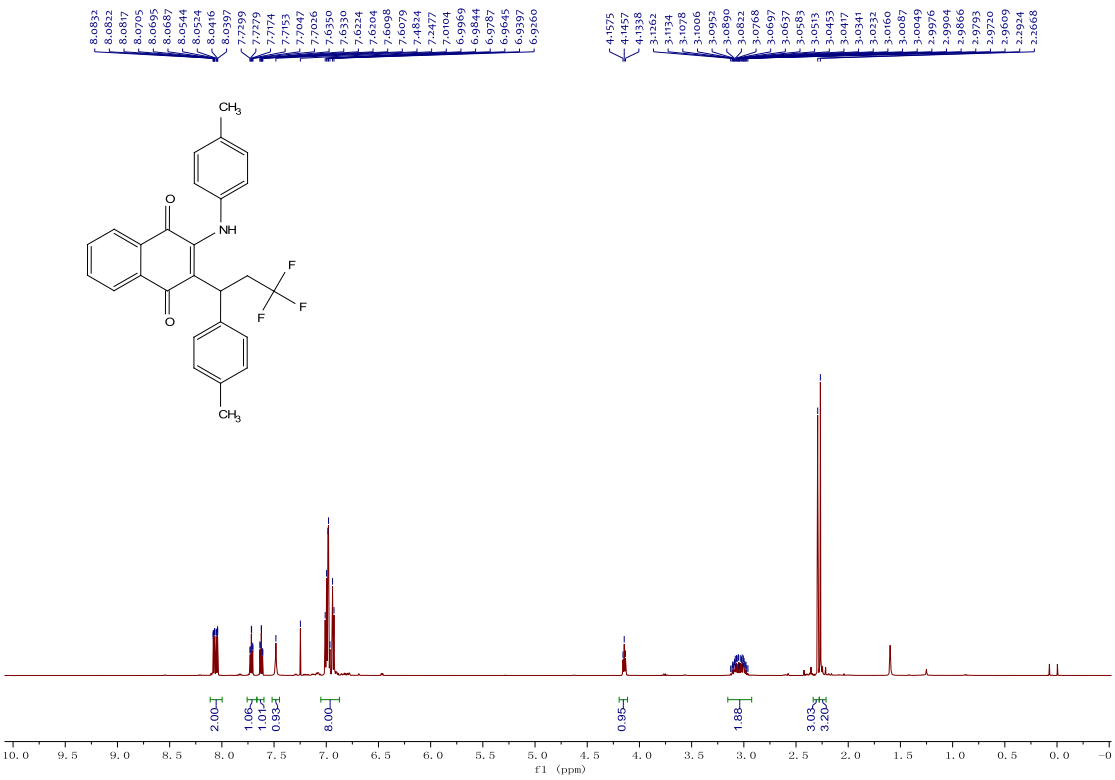


^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ea**

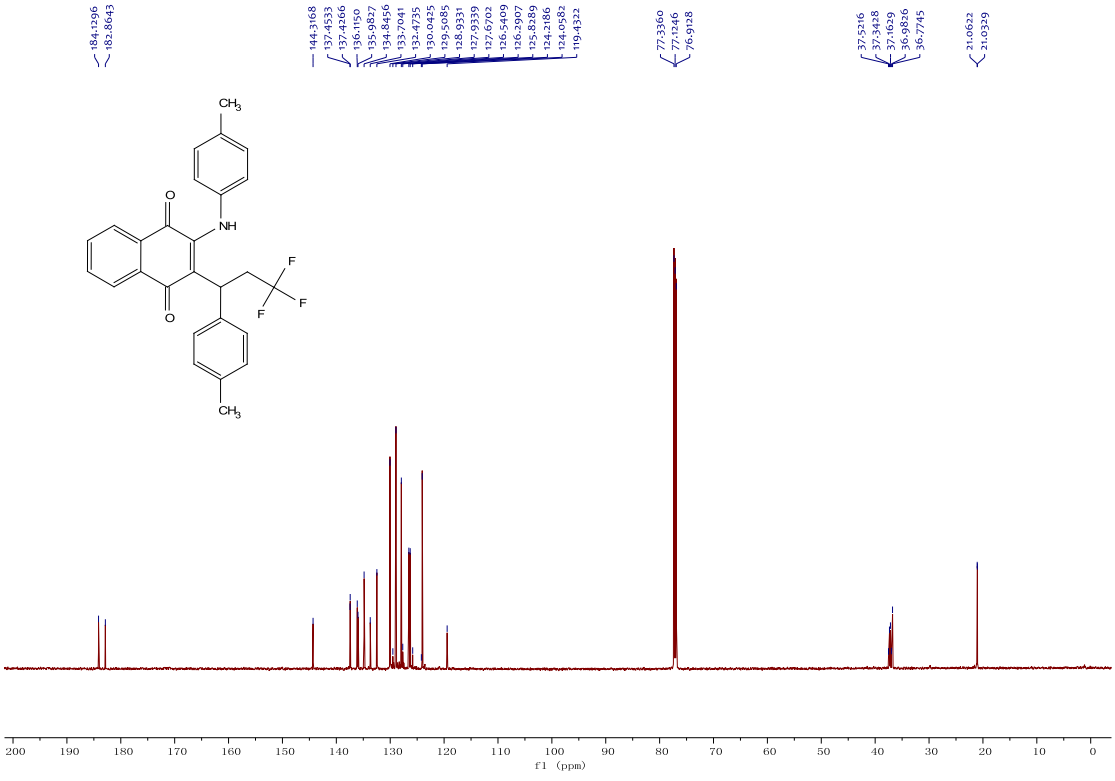


^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ea**

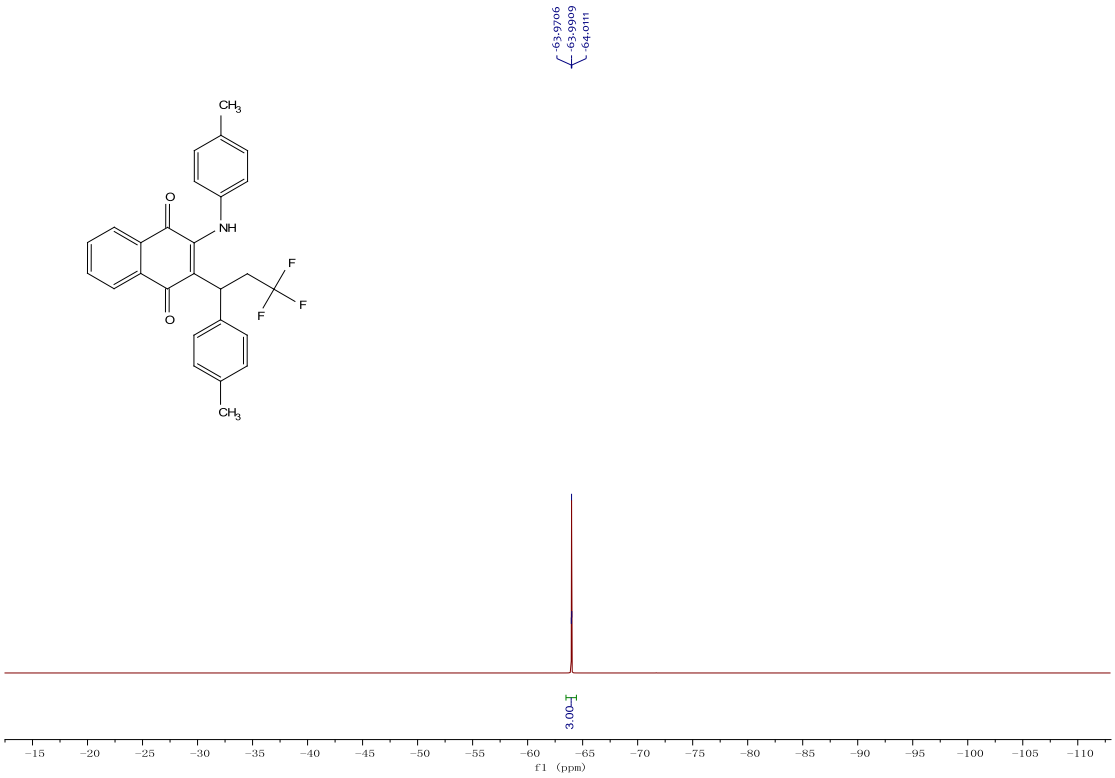
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ea**



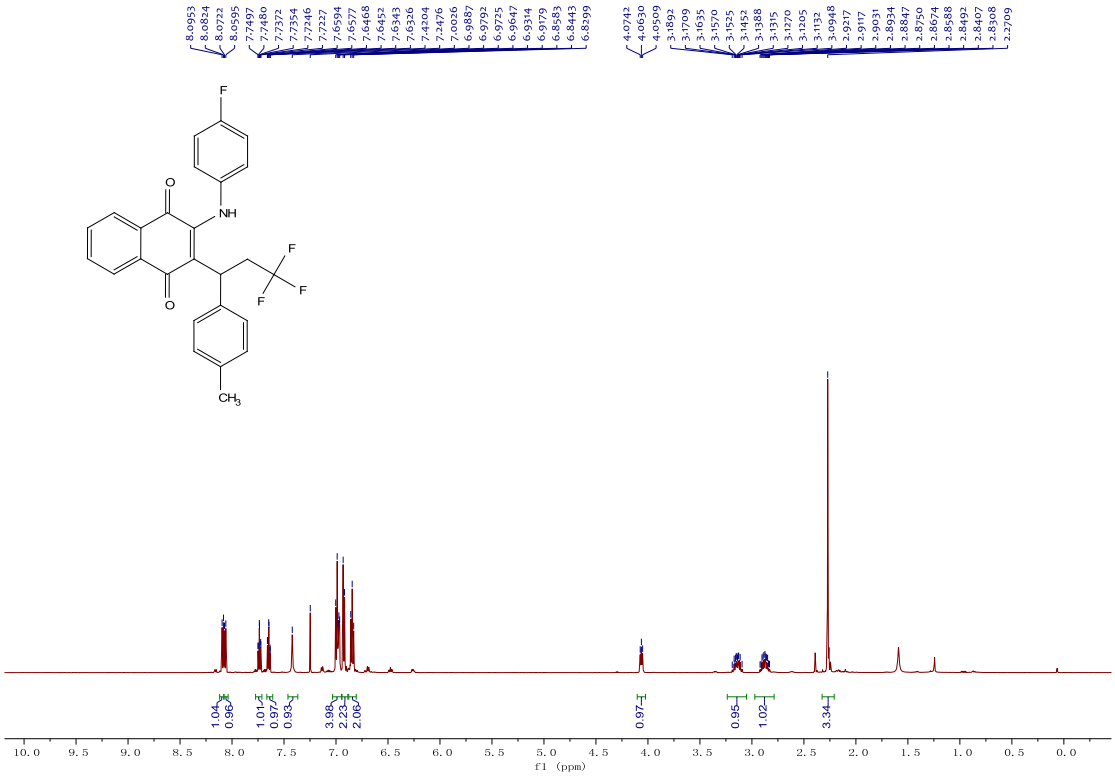
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4fa**



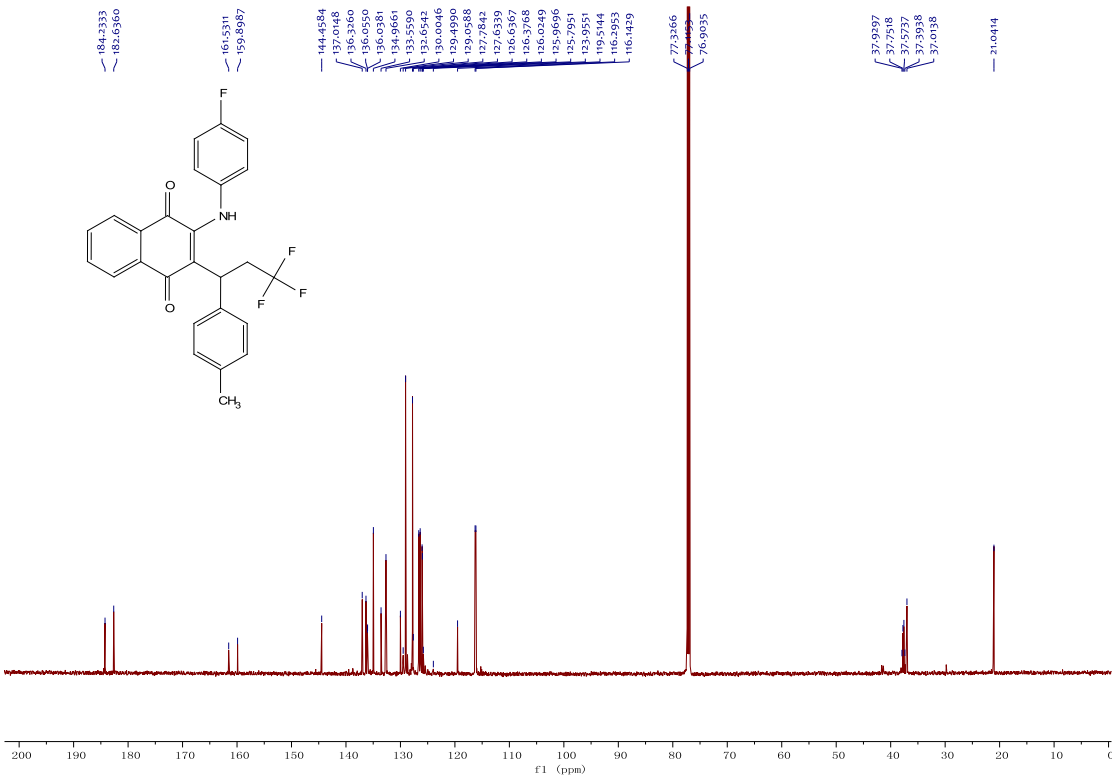
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4fa**



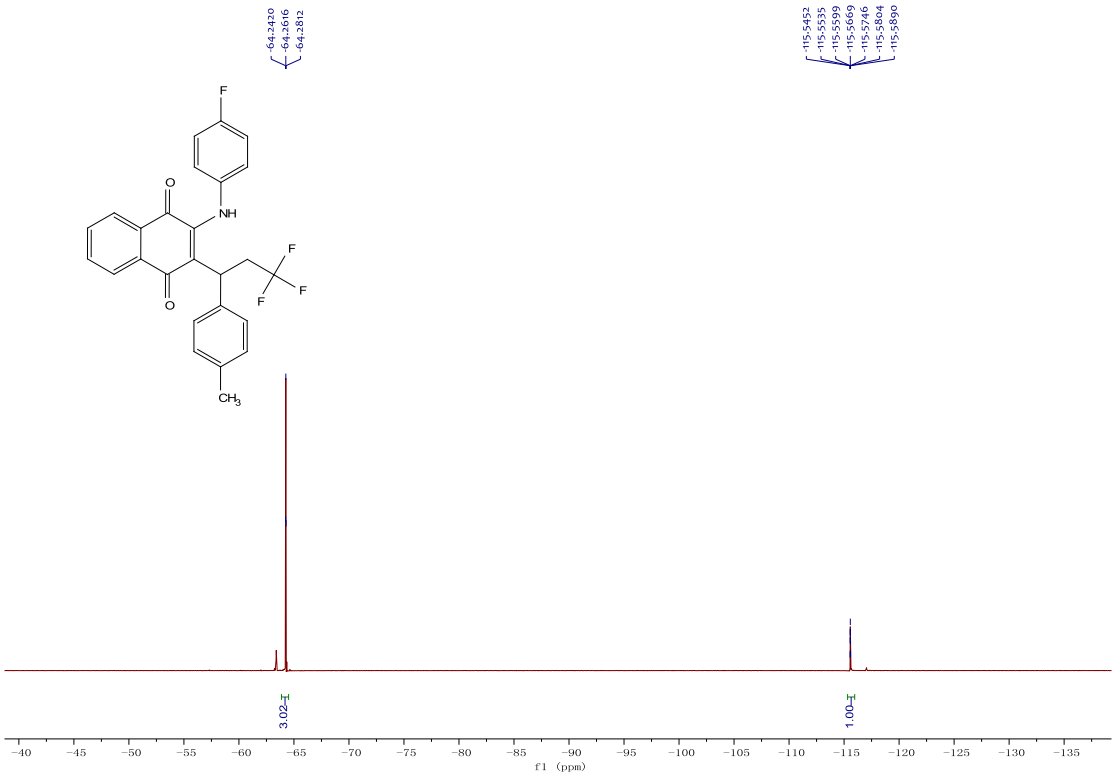
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4fa**



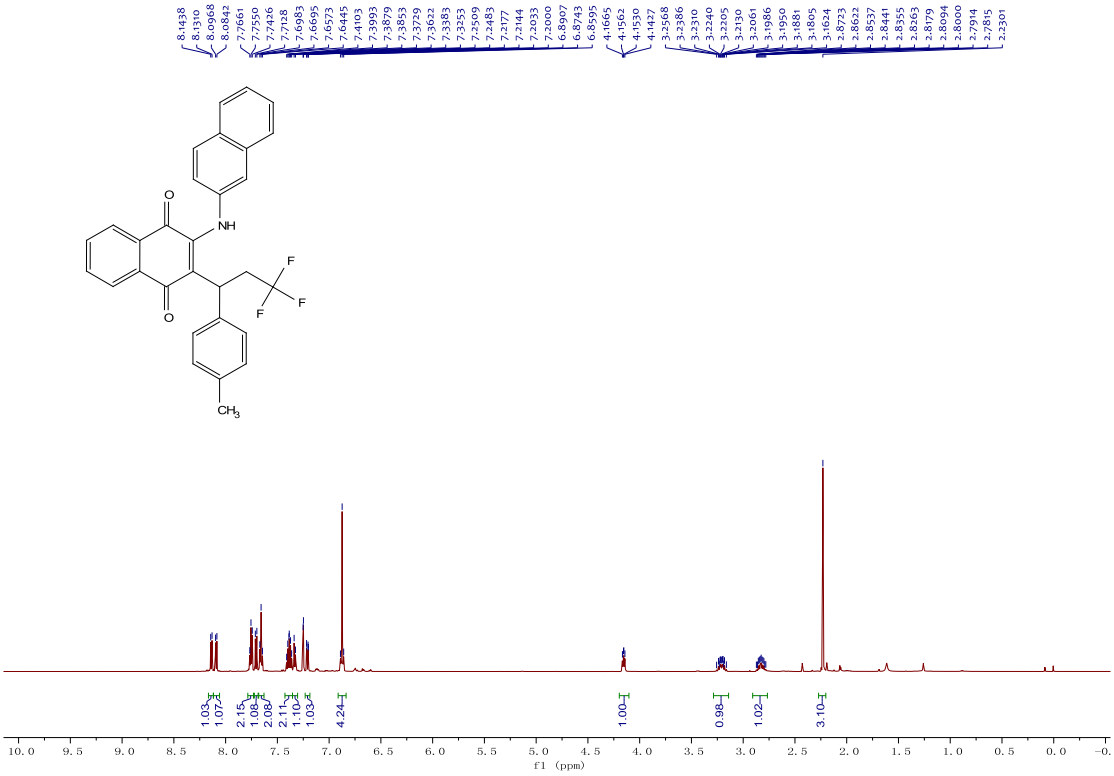
^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ga**



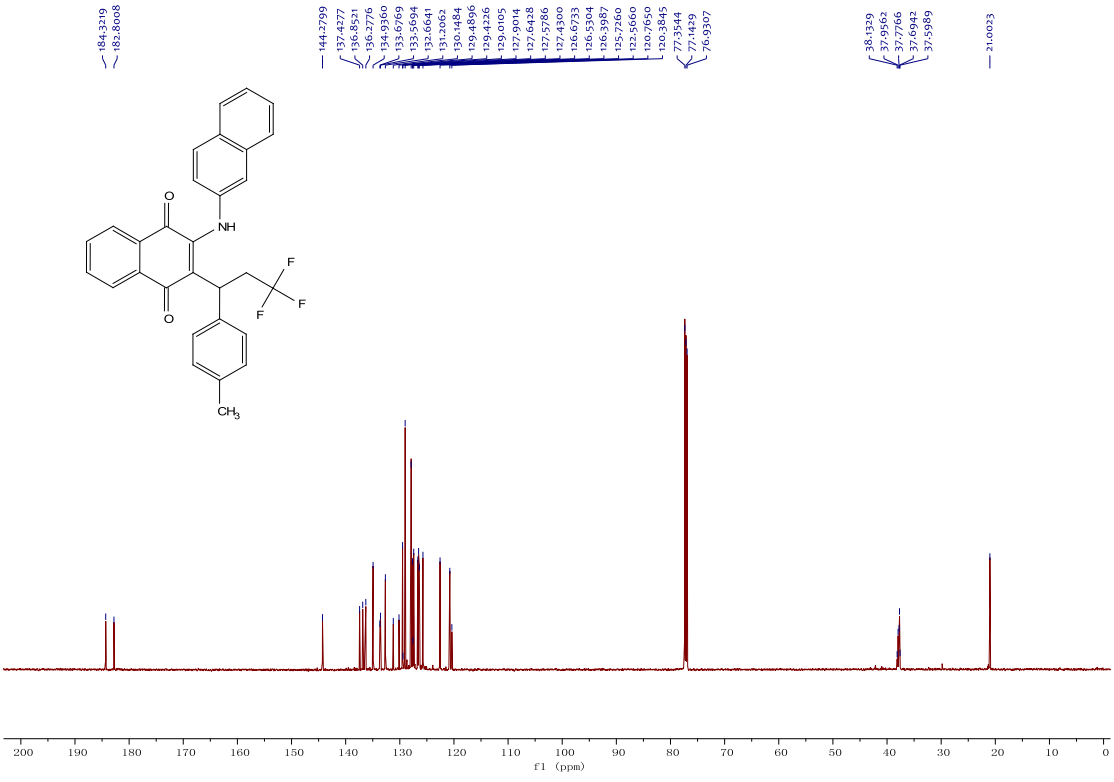
^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ga**



^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ga**

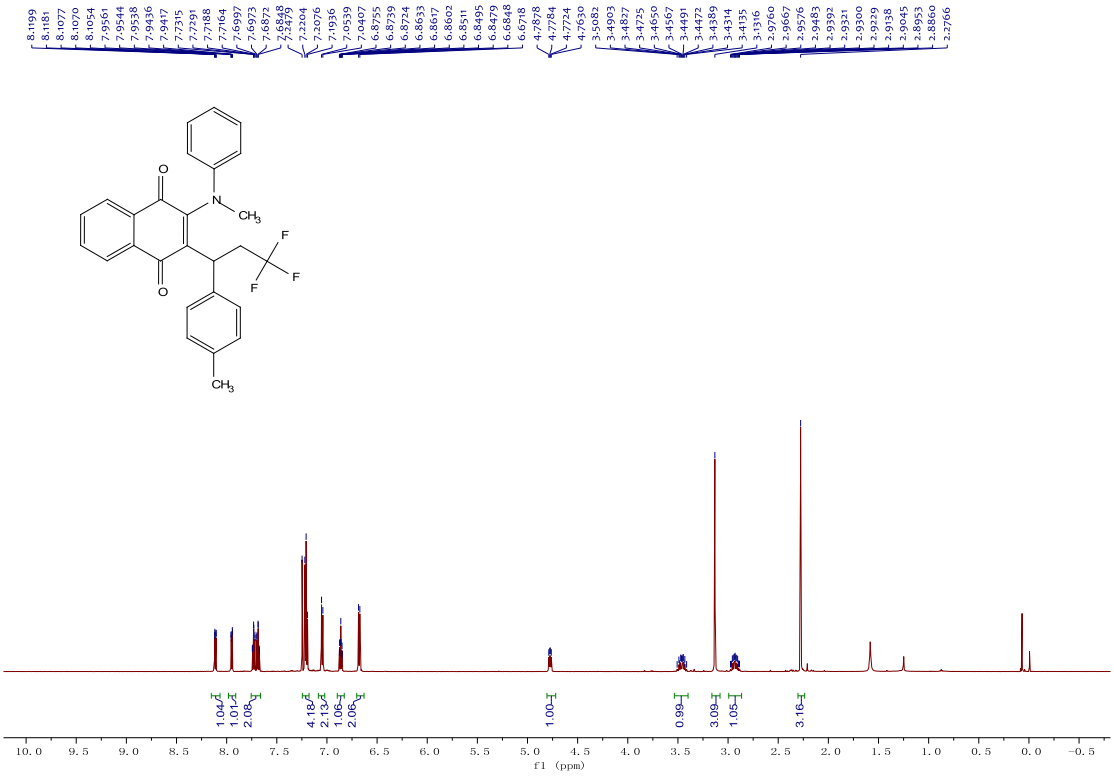


^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ha**

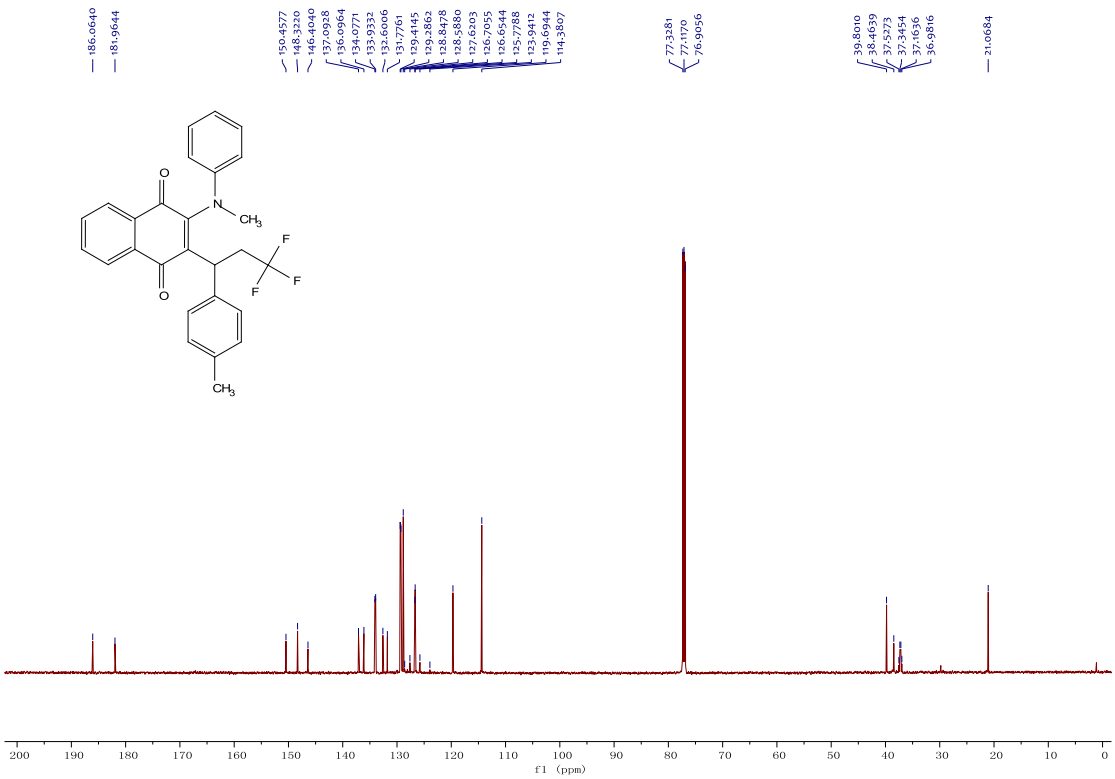


^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ha**

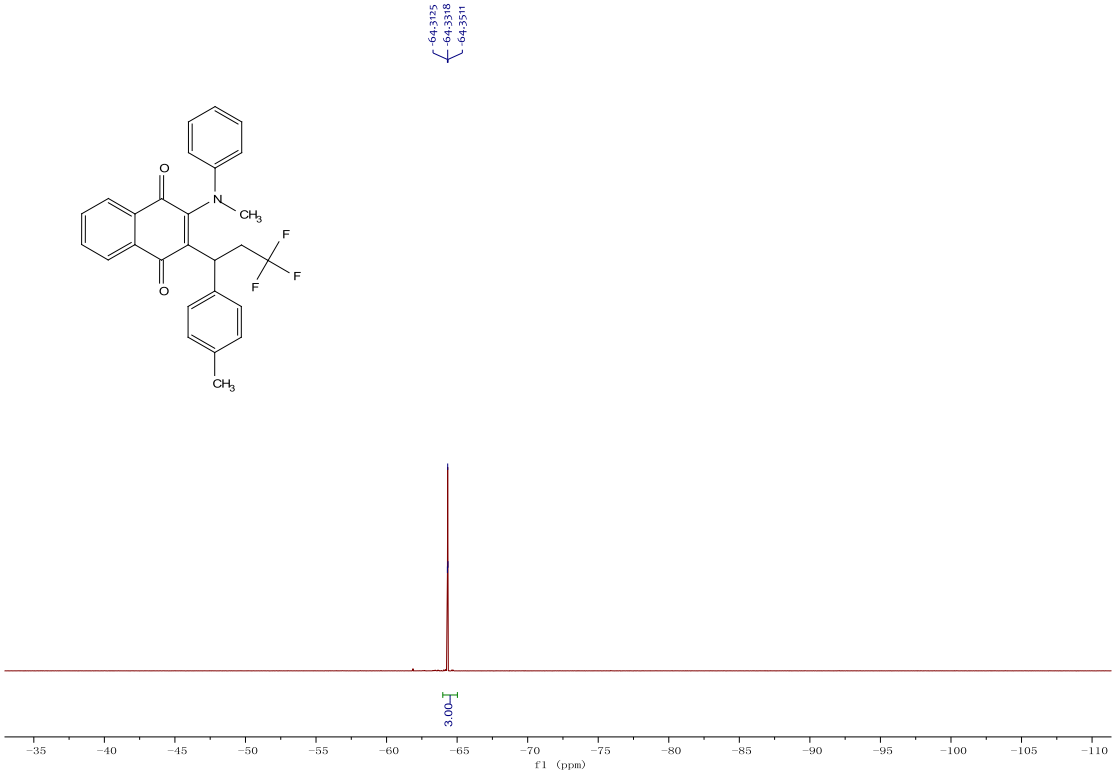
^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ha**



^{1}H NMR spectrum (600 MHz, $CDCl_3$) of **4ia**



^{13}C NMR spectrum (150 MHz, $CDCl_3$) of **4ia**



^{19}F NMR spectrum (564 MHz, $CDCl_3$) of **4ia**