Supporting Information

Palladium-Catalyzed Decarboxylative Domino Synthesis of Fused Quinolin-2(1*H*)-one Scaffolds Containing Perfluoroalkyl Unit

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Supporting Information Placeholder

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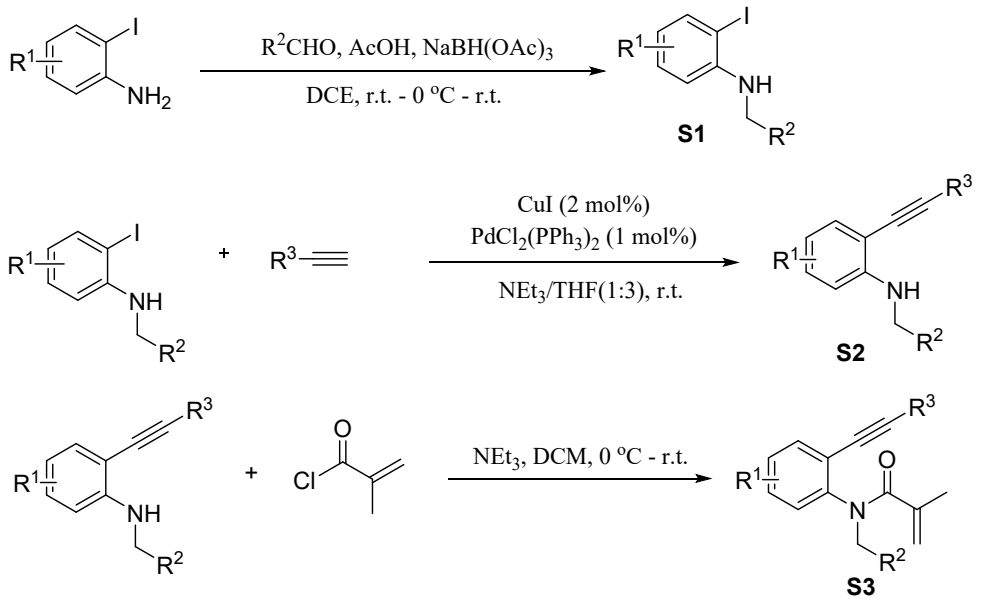
1. General experimental information

Unless otherwise noted, all reactions were carried out under nitrogen atmosphere. All commercially available reagents were used without further purification. All of the solvents were treated according to known methods. Column chromatography was performed on silica gel (200-400 mesh). ^{1}H NMR (400 MHz) chemical shifts were reported in ppm (δ) relative to tetramethylsilane (TMS) with the solvent resonance employed as the internal standard. ^{13}C NMR (100 MHz) chemical shifts were reported in ppm (δ) from tetramethylsilane (TMS) with the solvent resonance as the internal standard and ^{19}F NMR at (377 MHz) chemical shifts were reported in ppm (δ) relative to tetramethylsilane (TMS) with the solvent resonance employed as the internal standard. Data were reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublets, td = triplet of doublets, qd = quartet of doublets, m = multiplet), coupling constants (Hz) and integration. HRMS measurements were obtained on a TOF analyzer.

2. General procedure for the synthesis of substrates[1,2]

1a-h, 1n-1q, 1s (ref. 1)



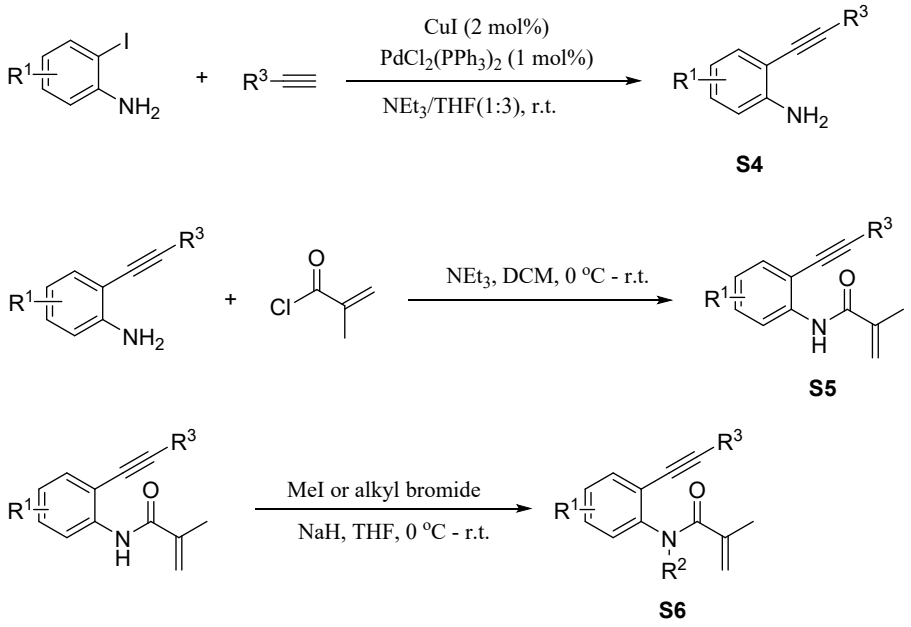
General procedure for synthesis of **S1**: To a 15 mL oven-dried tube charged with 2-iodoaniline (5.0 mmol, 1.0 equiv), aldehyde (6.0 mmol, 1.2 equiv) and dry 1,2-dichloroethane (8.0 mL) was added glacial acetic acid (30.0 μL, 0.5 mmol, 10 mol%) at room temperature. The reaction was stirred at room temperature for 1 h. Then $NaBH(OAc)_3$ (2.1 g, 10.0 mmol, 2.0 equiv) was added for portions at 0 °C. The mixture was allowed to stir at room temperature for 12 h. The resulting reaction mixture was cooled to 0 °C and water (2.0 mL) was added. The residue was extracted with ethyl acetate twice and the combined organic phase was dried over anhydrous Na_2SO_4, filtrated and concentrated. The resulting crude mixture was purified by flash chromatography using petroleum ether / ethyl acetate = 50:1 as eluent.

General procedure for synthesis of **S2**: To a suspension of $PdCl_2(PPh_3)_2$ (0.1 mmol, 1 mol%) and CuI (0.2 mmol, 2 mol%) in a mixture of THF (30.0 mL) and Et_3N (10.0 mL) was added **S1** (10.0 mmol) and alkyne (12.0 mmol, 1.2 equiv). The reaction was allowed to react at room temperature for 12 h. Then, the crude mixture was filtered through a shot pad of Celite and washed with CH_2Cl_2 (10.0 mL) for three times, and the combined organic layer was concentrated under reduced pressure. The resulting mixture was purified by flash chromatography using petroleum ether / ethyl acetate = 50:1 as eluent.

General procedure for the synthesis of substrates **S3**: To a stirred solution of **S2** (1.0 equiv) in

CH_2Cl_2 (5.0 mL) was added methacryloyl chloride (1.5 equiv) and Et_3N (2.0 equiv) at 0 °C. The resulted mixture was stirred at room temperature for 12 h. Then, the reaction was quenched by saturated $NaHCO_3$ solution and the reaction mixture was extracted with CH_2Cl_2 for three times. The combined organic layer was dried over anhydrous Na_2SO_4 and concentrated in vacuo. The resulting crude mixture was purified by flash chromatography using petroleum ether / ethyl acetate = 10:1 as eluent.

1i-m (ref. 2)



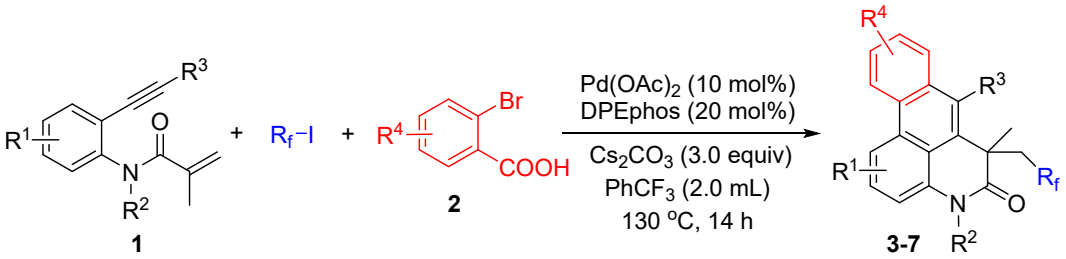
General procedure for synthesis of **S4**: To a suspension of $PdCl_2(PPh_3)_2$ (0.1 mmol, 1 mol%) and CuI (0.2 mmol, 2 mol%) in a mixture of THF (30.0 mL) and Et_3N (10.0 mL) was added 2-iodoaniline (10.0 mmol) and alkyne (12.0 mmol, 1.2 equiv). The reaction was allowed to react at room temperature for 12 h. Then, the crude mixture was filtered through a shot pad of Celite and washed with CH_2Cl_2 (10.0 mL) for three times, and the combined organic layer was concentrated under reduced pressure. The resulting mixture was purified by flash chromatography using petroleum ether / ethyl acetate = 50:1 as eluent.

General procedure for synthesis of **S5**: To a stirred solution of **S4** (1.0 equiv) in CH_2Cl_2 (5.0 mL) was added methacryloyl chloride (1.5 equiv) and Et_3N (2.0 equiv) at 0 °C. The resulted mixture was stirred at room temperature for 12 h. Then, the reaction was quenched by saturated $NaHCO_3$ solution and the reaction mixture was extracted with CH_2Cl_2 for three times. The combined organic

layer was dried over anhydrous Na_2SO_4 and concentrated in vacuo. The resulting crude mixture was purified by flash chromatography using petroleum ether / ethyl acetate = 20:1 as eluent.

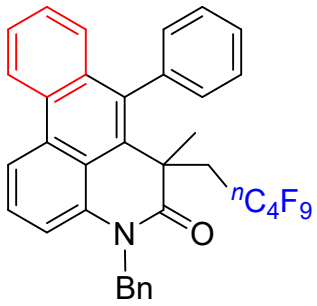
General procedure for the synthesis of substrates **S6**: To a solution of NaH (2.0 equiv) in THF (5.0 mL) at 0 °C was added a solution of **S5** (1.0 equiv) in THF dropwise and the reaction mixture was stirred for 30 min. Then, iodomethane or alkyl bromide (1.5 equiv) was added and the reaction mixture was stirred at room temperature. Upon completion, the reaction was quenched by water and extracted with CH_2Cl_2 for three times. The combined organic layer was washed with brine and dried over anhydrous Na_2SO_4. The solvent was removed under vacuum and the residue was purified by a flash column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 as eluent.

3. General procedure for synthesis of fused quinolin-2(1H)-one products (3aa-qa, 3sa, 4a-c, 5ab-ai, 6aj, 7a-e)

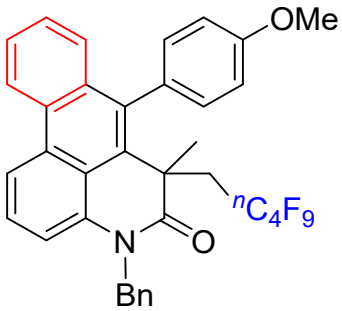


1,7-enyne **1** (0.2 mmol, 1.0 equiv), *o*-bromobenzoic acid **2** (0.4 mmol, 2.0 equiv), $Pd(OAc)_2$ (4.5 mg, 10 mol%), DPEphos (21.5 mg, 20 mol%), Cs_2CO_3 (195.0 mg, 0.6 mmol, 3.0 equiv), and perfluoroalkyl iodide (1.2 mmol, 6.0 equiv) were added to an oven-dried tube (15.0 mL) which was then placed under vacuum and refilled with nitrogen three times. $PhCF_3$ (2.0 mL) was added into the tube via syringe and the tube was sealed and stirred at 130 °C (oil bath) for 14 h. Upon the reaction was completed, the resulting mixture was purified by silica gel column using chromatography (petroleum ether / ethyl acetate = 20:1) to obtain products (**3aa-qa, 3sa, 4a-c, 5ab-ai, 6aj, 7a-e**).

4. Characterization data of products (3aa-qa, 3sa, 4a-c, 5ab-ai, 6aj, 7a-e)

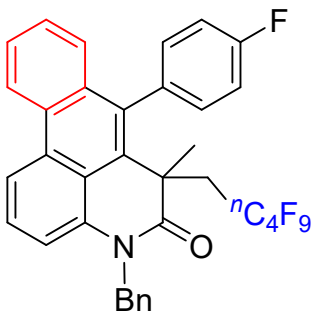


4-benzyl-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-4*H*-naphtho[3,2,1-*de*]quinolin-5(6*H*)-one (3aa). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 91.9 mg, 71% yield; mp 154.8-156.0 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.68 (d, J = 8.4 Hz, 1H), 8.45 (d, J = 8.4 Hz, 1H), 7.61 (d, J = 7.3 Hz, 1H), 7.55 (m, 4H), 7.50 (d, J = 6.5 Hz, 1H), 7.41 – 7.36 (m, 2H), 7.34 (d, J = 4.4 Hz, 4H), 7.30 – 7.26 (m, 1H), 7.16 (d, J = 7.9 Hz, 1H), 6.94 (d, J = 8.5 Hz, 1H), 5.45 (dd, J = 42.3, 14.4 Hz, 2H), 3.26 (dd, J = 34.7, 15.3 Hz, 1H), 3.13 – 2.94 (m, 1H), 1.91 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 139.9, 137.8, 136.6, 136.3, 134.0, 133.4, 131.99, 131.96, 131.1, 129.8, 129.2, 128.9, 128.25, 128.18, 127.9, 127.6, 127.32, 127.27, 127.1, 126.9, 126.5, 122.8, 118.0, 117.8, 112.6, 47.9, 45.3, 39.7 (t, J = 18.1 Hz), 31.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.99 (s, 3F), -108.88 – -110.15 (m, 1F), -110.98 – -112.17 (m, 1F), -123.33 – -125.42 (m, 2F), -125.87 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{35}H_{24}F_9NNaO^+$: 668.1606; found: 668.1615.

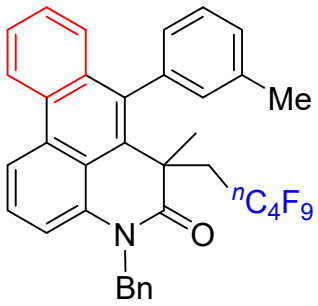


4-benzyl-7-(4-methoxyphenyl)-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-4*H*-naphtho[3,2,1-*de*]quinolin-5(6*H*)-one (3ba). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 74.6 mg, 55% yield; mp 212.5-213.7 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.71 (d, J = 8.4 Hz, 1H), 8.49 (d, J = 8.5 Hz, 1H), 7.63 (t, J = 7.6 Hz, 1H), 7.55 (t, J = 8.1 Hz, 1H), 7.43 (m, 2H), 7.37 (d, J = 4.4 Hz, 4H), 7.30 (dd, J = 7.4, 3.6 Hz, 2H),

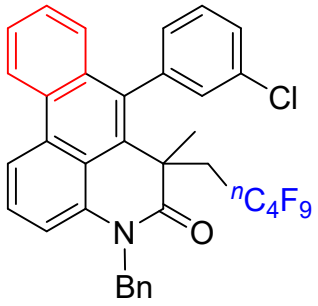
7.18 (d, J = 7.9 Hz, 1H), 7.15 – 7.09 (m, 2H), 7.03 (d, J = 8.4 Hz, 1H), 5.47 (dd, J = 43.6, 14.5 Hz, 2H), 4.00 (s, 3H), 3.30 (dd, J = 34.6, 15.0 Hz, 1H), 3.11 (m, 1H), 1.96 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.4, 159.4, 137.6, 136.6, 136.3, 134.5, 134.4, 133.1, 133.0, 131.6, 131.0, 130.2, 129.3, 128.9, 127.6, 127.3, 127.0, 126.9, 126.5, 122.8, 117.95, 117.90, 113.6, 113.3, 112.6, 55.5, 47.8, 45.3, 39.6 (t, J = 18.1 Hz), 32.0; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.98 (s, 3F), -108.90 – -110.15 (m, 1F), -110.70 – -112.39 (m, 1F), -124.35 (dd, 2F), -125.84 (d, J = 9.9 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{36}H_{26}F_9NNaO_2^+$: 698.1712; found: 698.1721.



4-benzyl-7-(4-fluorophenyl)-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-4*H*-naphtho[3,2,1-*de*]quinolin-5(6*H*)-one (3ca). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 84.5 mg, 64% yield; mp 190.8-192.0 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.69 (d, J = 8.4 Hz, 1H), 8.46 (d, J = 8.4 Hz, 1H), 7.61 (t, J = 7.5 Hz, 1H), 7.53 (t, J = 8.1 Hz, 1H), 7.49 – 7.45 (m, 1H), 7.42 (t, J = 7.7 Hz, 1H), 7.35 (d, J = 4.3 Hz, 5H), 7.31 – 7.23 (m, 3H), 7.17 (d, J = 7.9 Hz, 1H), 6.93 (d, J = 8.4 Hz, 1H), 5.45 (dd, J = 40.8, 14.9 Hz, 2H), 3.32 (dd, J = 34.8, 15.3 Hz, 1H), 2.97 (m, 1H), 1.91 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.1, 162.6 (d, J = 248.7 Hz), 136.7, 136.4 (d, J = 20.3 Hz), 135.7 (d, J = 3.7 Hz), 135.1 (d, J = 7.7 Hz), 134.0, 133.6, 131.1, 130.3, 129.3, 128.9, 127.4 (d, J = 20.5 Hz), 127.2, 127.0, 126.5, 122.9, 118.0, 117.7, 115.4, 115.3, 115.2, 115.1, 112.7, 47.9, 45.3, 39.7 (t, J = 18.1 Hz), 32.0; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.97 (s, 3F), -108.96 – -110.15 (m, 1F), -111.01 – -112.35 (m, 1F), -113.21 (s, 1F), -123.34 – -125.39 (m, 2F), -125.82 (d, J = 11.1 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{35}H_{23}F_{10}NNaO^+$: 686.1512; found: 686.1517.

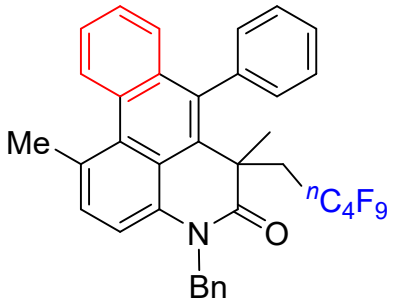


4-benzyl-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-(*m*-tolyl)-4*H*-naphtho[3,2,1-*de*]quinolin-5(6*H*)-one (3da). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 85.9 mg, 65% yield; mp 171.2-172.4 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.67 (d, J = 8.4 Hz, 1H), 8.45 (d, J = 8.4 Hz, 1H), 7.59 (t, J = 7.6 Hz, 1H), 7.51 (t, J = 8.1 Hz, 1H), 7.45 – 7.38 (m, 2H), 7.35 (s, 1H), 7.33 (d, J = 4.3 Hz, 4H), 7.29 (s, 1H), 7.26 (s, 1H), 7.16 (dd, J = 13.2, 7.7 Hz, 2H), 6.97 (d, J = 8.4 Hz, 1H), 5.43 (dd, J = 52.4, 15.2 Hz, 2H), 3.36 – 2.82 (m, 2H), 2.44 (s, 3H), 1.91 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 139.7, 138.0, 137.9, 136.6, 136.3, 134.0, 132.7, 131.0, 130.5, 129.7, 129.2, 128.9, 128.8, 127.8, 127.7, 127.3, 127.0 126.9, 126.5, 122.8, 118.0, 117.8, 112.6, 47.8, 45.3, 39.5 (t, J = 17.7 Hz), 32.0, 21.4; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.02 (s, 3F), -109.08 – -110.29 (m, 1F), -110.86 – -112.03 (m, 1F), -123.47 – -125.47 (m, 2F), -125.88 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{36}H_{26}F_9NNaO^+$: 682.1763; found: 682.1761.

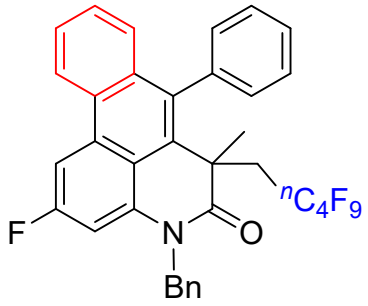


4-benzyl-7-(3-chlorophenyl)-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-4H-naphtho[3,2,1-*de*]quinolin-5(6*H*)-one (3ea). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 78.4 mg, 58% yield; mp 145.6-146.8 ℃; ^{1}H NMR (400 MHz, CDCl3) δ 8.69 (d, J = 8.3 Hz, 1H), 8.45 (d, J = 8.3 Hz, 1H), 7.64 – 7.58 (m, 1H), 7.54 (t, J = 8.2 Hz, 2H), 7.51 – 7.46 (m, 2H), 7.45 – 7.39 (m, 1H), 7.35 – 7.32 (m, 4H), 7.30 – 7.27 (m, 2H), 7.16 (d, J = 7.8 Hz, 1H), 6.93 (d, J = 8.0 Hz, 1H), 5.44 (dd, J = 43.5, 15.0 Hz, 2H), 3.31

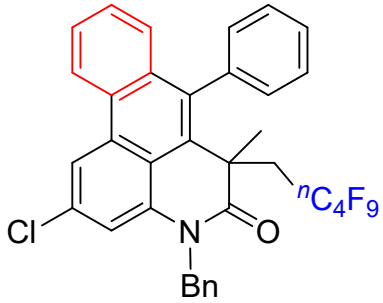
(dd, J = 34.8, 15.3 Hz, 1H), 3.06 – 2.82 (m, 1H), 1.89 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 141.8, 136.5, 136.4, 136.2, 134.6, 133.5, 132.12, 132.08, 131.6, 131.2, 130.1, 129.3, 129.2, 129.0, 128.5, 127.6, 127.32, 127.29, 127.1, 126.5, 122.9, 118.0, 117.6, 112.8, 47.9, 45.2, 39.7 (t, J = 18.4 Hz), 32.0; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.98 (s, 3F), -109.14 – -110.21 (m, 1F), -111.19 – -112.38 (m, 1F), -123.99 – -124.76 (m, 2F), -125.83 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{35}H_{23}ClF_9NNaO^+$: 702.1217; found: 702.1224.



4-benzyl-1,6-dimethyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-4*H*-naphtho[3,2,1-*de*]quinolin-5(6*H*)-one (3fa). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 59.7 mg, 45% yield; mp 145.1-146.3 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.63 (d, J = 8.5 Hz, 1H), 7.52 (dt, J = 9.4, 7.5 Hz, 4H), 7.47 (d, J = 6.5 Hz, 1H), 7.36 (t, J = 7.2 Hz, 3H), 7.32 (d, J = 4.5 Hz, 4H), 7.24 (d, J = 4.9 Hz, 1H), 7.07 (d, J = 8.2 Hz, 1H), 6.99 (d, J = 8.4 Hz, 1H), 5.41 (dd, J = 59.6, 16.1 Hz, 2H), 3.22 (dd, J = 34.9, 15.5 Hz, 1H), 3.10 – 3.03 (m, 1H), 3.00 (s, 3H), 1.85 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.9, 139.9, 137.5, 136.7, 134.8, 134.2, 133.4, 132.1, 131.5, 131.4, 130.0, 129.9, 129.7, 128.9, 128.2, 128.1, 127.9, 127.6, 127.2, 126.8, 126.6, 126.4, 124.9, 119.3, 112.3, 47.8, 45.2, 39.7 (t, J = 18.2 Hz), 31.7, 26.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.00 (s, 3F), -108.91 – -110.13 (m, 1F), -111.11 – -112.46 (m, 1F), -123.53 – -125.42 (m, 2F), -125.86 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{36}H_{26}F_9NNaO^+$: 682.1763; found: 682.1761.

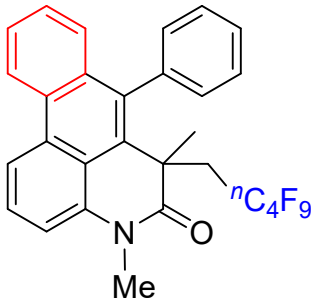


4-benzyl-2-fluoro-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-4*H*-naphtho[3,2,1-*de*]quinolin-5(6*H*)-one (3ga). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 74.1 mg, 56% yield; mp 159.4-160.6 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 (d, J = 8.4 Hz, 1H), 8.04 (dd, J = 10.4, 2.1 Hz, 1H), 7.63 – 7.52 (m, 4H), 7.45 (d, J = 5.2 Hz, 1H), 7.41 (d, J = 8.0 Hz, 1H), 7.37 – 7.29 (m, 6H), 6.92 (d, J = 8.5 Hz, 2H), 5.39 (dd, J = 53.0, 15.7 Hz, 2H), 3.21 (dd, J = 34.6, 15.1 Hz, 1H), 3.11 – 2.94 (m, 1H), 1.88 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.5, 161.7 (d, J = 244.2 Hz), 139.6, 138.7, 138.6, 136.9, 135.9, 134.3, 133.5, 132.8, 132.7, 132.0, 129.5, 129.1, 128.8 (d, J = 4.2 Hz), 128.4, 128.2 (d, J = 23.6 Hz), 127.7, 127.6, 127.0, 126.6, 122.9, 114.7, 102.5 (d, J = 22.7 Hz), 102.1, 48.1, 45.3, 39.8 (t, J = 17.5 Hz), 31.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.99 (s, 3F), -108.94 – -110.05 (m, 1F), -110.95 – -112.19 (m, 2F), -123.44 – -125.40 (m, 2F), -125.87 (d, J = 9.9 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{35}H_{23}F_{10}NNaO^+$: 686.1512; found: 686.1521.

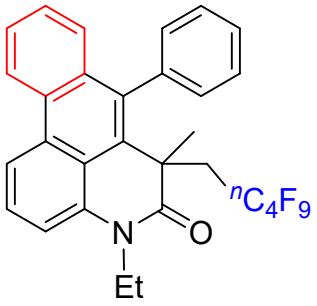


4-benzyl-2-chloro-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-4*H*-naphtho[3,2,1-*de*]quinolin-5(6*H*)-one (3ha). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 88.7 mg, 65% yield; mp 160.6-161.8 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.58 (d, J = 8.4 Hz, 1H), 8.39 (d, J = 1.7 Hz, 1H), 7.60 (t, J = 7.6 Hz, 1H), 7.54 (t, J = 5.3 Hz, 3H), 7.45 (s, 1H), 7.40 (t, 1H), 7.34 (m, 5H), 7.30 – 7.27 (m, 1H), 7.13 (d, J = 1.7 Hz, 1H), 6.92 (d, J = 8.4 Hz, 1H), 5.39 (dd, J = 51.9, 16.0 Hz, 2H), 3.20 (dd, J = 34.5, 15.2

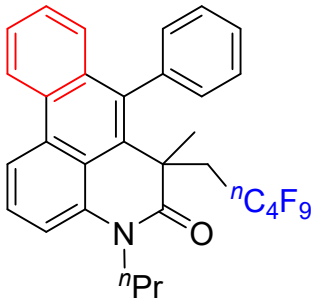
Hz, 1H), 3.08 – 2.90 (m, 1H), 1.87 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.4, 139.5, 138.0, 137.8, 135.9, 134.3, 133.5, 133.4, 132.1, 131.9, 129.4, 129.1, 128.41, 128.35, 128.3, 128.0, 127.7, 127.6, 127.2, 126.7, 122.8, 117.3, 116.3, 113.0, 48.0, 45.2, 39.8 (t, J = 18.7 Hz), 31.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.99 (s, 3F), -108.18 – -110.12 (m, 1F), -110.60 – -112.31 (m, 1F), -123.32 – -125.35 (m, 2F), -125.87 (d, J = 12.5 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{35}H_{23}ClF_9NNaO^+$: 702.1217; found: 702.1216.



4,6-dimethyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-4*H*-naphtho[3,2,1-*de*]quinolin-5(6*H*)-one (3ia). The product was purified by column chromatography (petroleum ether / ethyl acetate = 10:1); White solid, 83.5 mg, 73% yield; mp 204.5-205.7 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.69 (d, J = 8.3 Hz, 1H), 8.49 (d, J = 8.3 Hz, 1H), 7.66 (t, J = 8.1 Hz, 1H), 7.61 – 7.56 (m, 1H), 7.54 – 7.49 (m, 3H), 7.42 – 7.38 (m, 1H), 7.37 – 7.34 (m, 2H), 7.23 (d, J = 8.1 Hz, 1H), 6.92 (d, J = 8.4 Hz, 1H), 3.59 (s, 3H), 3.12 (dd, J = 35.1, 15.1 Hz, 1H), 3.03 – 2.87 (m, 1H), 1.79 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.8, 139.9, 137.7, 137.3, 134.0, 133.5, 131.8, 130.9, 130.0, 129.2, 128.21, 128.17, 127.9, 127.6, 127.4, 127.1, 126.9, 122.8, 117.9, 117.7, 111.3, 44.9, 40.0 (t, J = 18.2 Hz), 31.4, 31.1; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.02 (s, 3F), -109.41 – -110.92 (m, 1F), -112.33 – -113.79 (m, 1F), -124.43 (s, 2F), -125.57 – -126.80 (m, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{29}H_{20}F_9NNaO^+$: 592.1293; found: 592.1300.

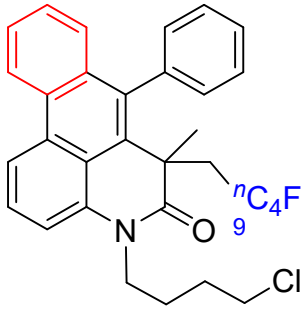


4-ethyl-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (3ja). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 71.0 mg, 61% yield; mp 164.1-165.3 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.70 (d, J = 8.3 Hz, 1H), 8.48 (d, J = 8.3 Hz, 1H), 7.68 (t, J = 8.2 Hz, 1H), 7.62 – 7.56 (m, 1H), 7.51 (m, 3H), 7.43 – 7.33 (m, 3H), 7.25 (s, 1H), 6.90 (d, J = 8.4 Hz, 1H), 4.51 – 4.32 (m, 1H), 4.10 – 3.95 (m, 1H), 3.11 (dd, J = 35.0, 15.2 Hz, 1H), 3.01 – 2.86 (m, 1H), 1.79 (s, 3H), 1.37 (t, J = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.1, 140.0, 137.6, 135.9, 134.0, 133.5, 131.8, 131.2, 130.1, 129.2, 128.2, 127.9, 127.5, 127.4, 127.0, 126.8, 122.8, 117.7, 111.2, 44.8, 40.1 (t, J = 17.7 Hz), 38.6, 31.4, 11.5; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.04 (s, 3F), -109.55 – -110.57 (m, 1F), -111.84 – -113.01 (m, 1F), -124.30 – -124.63 (m, 2F), -125.89 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{30}H_{22}F_9NNaO^+$: 606.1450; found: 606.1456.

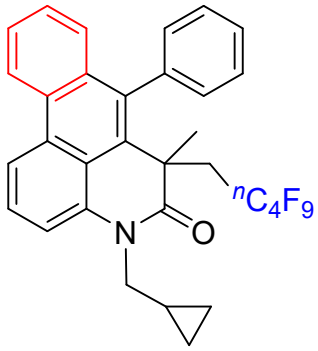


6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-4-propyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (3ka). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 75.6mg, 63% yield; mp 120.8-122.0 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.70 (d, J = 8.3 Hz, 1H), 8.48 (d, J = 8.3 Hz, 1H), 7.67 (t, J = 8.2 Hz, 1H), 7.62 – 7.56 (m, 1H), 7.54 – 7.48 (m, 3H), 7.43 – 7.38 (m, 1H), 7.38 – 7.34 (m, 2H), 7.21 (d, J = 7.9 Hz, 1H), 6.90 (d, J = 8.0 Hz, 1H), 4.28 – 4.12 (m, 1H), 4.04 – 3.91 (m, 1H), 3.12 (dd, J = 34.9, 15.1 Hz, 1H), 3.02 – 2.86 (m, 1H), 1.87 – 1.71 (m, 5H), 1.07 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100

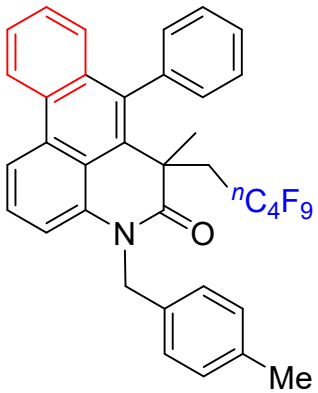
MHz, $CDCl_3$) δ 172.3, 140.0, 137.6, 136.2, 134.0, 133.5, 131.9, 131.2, 130.1, 129.2, 128.2, 128.1, 127.9, 127.5, 127.4, 127.0, 126.8, 122.8, 117.9, 117.7, 111.4, 45.3, 44.9, 40.0 (t, J = 18.1 Hz), 31.5, 19.4, 11.5.; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.02 (s, 3F), -109.27 – -110.71 (m, 1F), -111.63 – -113.30 (m, 1F), -124.16 – -124.96 (m, 2F), -125.91 (d, J = 12.4 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{31}H_{24}F_9NNaO^+$: 620.1606; found: 620.1610.



4-(4-chlorobutyl)-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (3la). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); Yellow oil, 83.5 mg, 65% yield; ^1H NMR (400 MHz, $CDCl_3$) δ 8.70 (d, J = 8.4 Hz, 1H), 8.50 (d, J = 8.5 Hz, 1H), 7.68 (t, J = 8.1 Hz, 1H), 7.60 (dd, J = 8.1, 7.1 Hz, 1H), 7.56 – 7.50 (m, 3H), 7.46 – 7.39 (m, 1H), 7.39 – 7.33 (m, 2H), 7.24 (d, J = 8.0 Hz, 1H), 6.92 (d, J = 8.5 Hz, 1H), 4.45 – 3.91 (m, 2H), 3.65 (d, J = 2.7 Hz, 2H), 3.12 (dd, J = 34.7, 14.6 Hz, 1H), 3.04 – 2.86 (m, 1H), 1.97 (d, J = 5.5 Hz, 4H), 1.80 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.5, 139.9, 137.7, 136.0, 134.0, 133.5, 131.9, 131.3, 129.8, 129.2, 128.21, 128.16, 127.9, 127.6, 127.4, 127.1, 126.9, 122.8, 117.9, 111.3, 44.9, 44.6, 42.8, 40.0 (t, J = 17.7 Hz), 31.5, 30.1, 23.7; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.02 (s, 3F), -109.04 – -110.70 (m, 1F), -111.61 – -113.35 (m, 1F), -124.01 – -124.95 (m, 2F), -125.89 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{32}H_{25}ClF_9NNaO^+$: 668.1373; found: 668.1382.

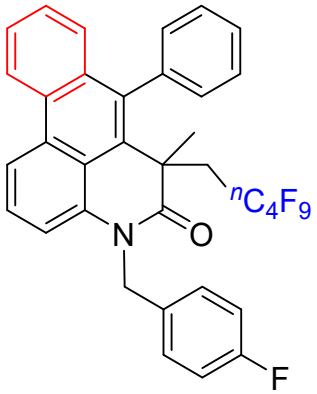


4-(cyclopropylmethyl)-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (3ma). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 69.7 mg, 57% yield; mp 148.6-149.8 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.70 (d, J = 8.3 Hz, 1H), 8.49 (d, J = 8.3 Hz, 1H), 7.69 (t, J = 8.2 Hz, 1H), 7.62 – 7.56 (m, 1H), 7.54 – 7.50 (m, 3H), 7.42 (d, J = 7.9 Hz, 2H), 7.39 – 7.33 (m, 2H), 6.90 (d, J = 8.4 Hz, 1H), 4.24 – 4.00 (m, 2H), 3.13 (dd, J = 35.0, 15.2 Hz, 1H), 3.02 – 2.86 (m, 1H), 1.79 (s, 3H), 1.35 – 1.28 (m, 1H), 0.62 – 0.41 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.7, 140.0, 137.6, 136.5, 134.0, 133.5, 131.9, 131.2, 130.1, 129.2, 128.2, 128.1, 127.9, 127.5, 127.3, 127.0, 126.8, 122.8, 117.7, 111.8, 47.2, 45.0, 40.0 (t, J = 18.5 Hz), 31.5, 9.0, 4.3, 3.8; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.03 (s), -109.20 – -110.30 (m), -111.30 – -112.62 (m), -123.56 – -125.55 (m), -125.90 (s); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{32}H_{24}F_9NNaO^+$: 632.1606; found: 632.1614.

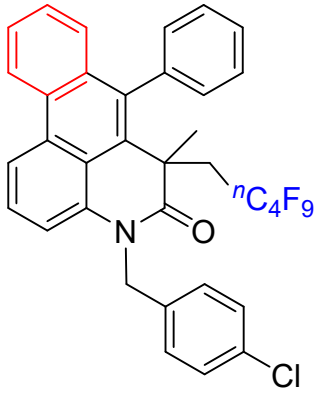


4-(3,5-dimethoxyphenyl)-1,3-dimethyl-3-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)cyclopenta[*de*]quinoline-2,5(1*H*,3*H*)-dione (3na). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 83.5 mg, 63% yield; mp 209.7-210.9 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.68 (d, J = 8.3 Hz, 1H), 8.45 (d, J = 8.4 Hz,

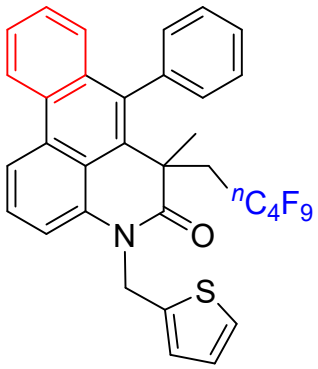
1H), 7.62 – 7.56 (m, 2H), 7.55 – 7.51 (m, 3H), 7.51 – 7.48 (m, 1H), 7.38 (t, J = 7.3 Hz, 2H), 7.23 (d, J = 7.9 Hz, 2H), 7.19 – 7.12 (m, 3H), 6.93 (d, J = 8.5 Hz, 1H), 5.50 – 5.33 (m, 2H), 3.25 (dd, J = 34.7, 15.3 Hz, 1H), 3.13 – 2.87 (m, 1H), 2.33 (s, 3H), 1.90 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.2, 139.9, 137.7, 136.9, 136.4, 134.0, 133.53, 133.46, 132.0, 131.0, 129.8, 129.6, 129.2, 128.23, 128.17, 127.9, 127.6, 127.3, 127.0, 126.9, 126.5, 122.8, 117.9, 117.8, 112.7, 47.6, 45.3, 39.7 (t, J = 17.8 Hz), 31.9, 21.2; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.99 (t, J = 9.4 Hz, 3F), -108.77 – -110.08 (m, 1F), -110.89 – -112.39 (m, 1F), -123.29 – -125.43 (m, 2F), -125.86 (dd, J = 26.1, 12.0 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{36}H_{26}F_9NNaO^+$: 682.1763; found: 682.1769.



4-(4-fluorobenzyl)-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (3oa). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 85.7 mg, 65% yield; mp 100.1-101.3 ℃ ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.69 (d, J = 8.3 Hz, 1H), 8.47 (d, J = 8.3 Hz, 1H), 7.63 – 7.57 (m, 2H), 7.57 – 7.54 (m, 3H), 7.52 – 7.48 (m, 1H), 7.43 – 7.36 (m, 2H), 7.32 (dd, J = 8.5, 5.3 Hz, 2H), 7.13 (d, J = 7.8 Hz, 1H), 7.03 (t, J = 8.7 Hz, 2H), 6.95 (d, J = 8.3 Hz, 1H), 5.40 (s, 2H), 3.25 (dd, J = 34.7, 15.2 Hz, 1H), 3.14 – 2.97 (m, 1H), 1.91 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 162.1 (d, J = 245.3 Hz), 139.8, 137.9, 136.2, 134.0, 133.4, 132.29, 132.26, 131.9 (d, J = 3.3 Hz), 131.1, 129.6, 129.2, 128.3, 128.2 (d, J = 8.7 Hz), 128.0, 127.6, 127.3, 127.1, 127.0, 122.8, 118.1, 117.8, 115.8 (d, J = 21.6 Hz), 112.4, 47.3, 45.3, 39.7 (t, J = 18.0 Hz), 31.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.99 (t, J = 8.4 Hz, 3F), -109.37 (d, J = 273.3 Hz, 1F), -111.59 (d, J = 273.4 Hz, 1F), -115.52 (d, J = 4.1 Hz, 1F), -123.24 – -125.56 (m, 2F), -125.86 (d, J = 12.4 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{35}H_{23}F_{10}NNaO^+$: 686.1512; found: 686.1519.

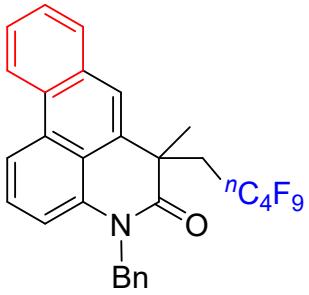


4-(4-chlorobenzyl)-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (3pa). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 84.7 mg, 62% yield; mp 123.8-125.0 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.69 (d, J = 8.4 Hz, 1H), 8.47 (d, J = 8.5 Hz, 1H), 7.61 (t, J = 7.7 Hz, 1H), 7.57 – 7.53 (m, 4H), 7.48 (d, J = 6.1 Hz, 1H), 7.42 – 7.35 (m, 2H), 7.33 – 7.26 (m, 4H), 7.08 (d, J = 7.9 Hz, 1H), 6.94 (d, J = 8.5 Hz, 1H), 5.39 (s, 2H), 3.23 (dd, J = 34.6, 15.2 Hz, 1H), 3.13 – 2.94 (m, 1H), 1.89 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.4, 139.8, 137.9, 136.1, 135.2, 134.0, 133.4, 133.1, 132.0, 131.1, 129.6, 129.2, 129.1, 128.3, 128.2, 128.03, 127.97, 127.6, 127.3, 127.2, 127.0, 122.8, 118.2, 117.8, 112.4, 47.3, 45.3, 39.7 (t, J = 17.4 Hz), 31.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.98 (s, 3F), -108.69 – -110.15 (m, 1F), -110.96 – -112.41 (m, 1F), -123.27 – -125.52 (m, 2F), -125.86 (d, J = 9.4 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{35}H_{23}ClF_9NNaO^+$: 702.1217; found: 702.1224.

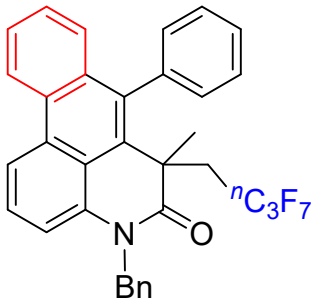


6-**methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-4-(thiophen-2-ylmethyl)-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (3qa).** The product was purified by column chromatography (petroleum ether / ethyl acetate = 10:1); White solid, 70.0 mg, 54% yield; mp 133.2-134.4 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.68 (d, J = 8.4 Hz, 1H), 8.48 (d, J = 8.4 Hz, 1H),

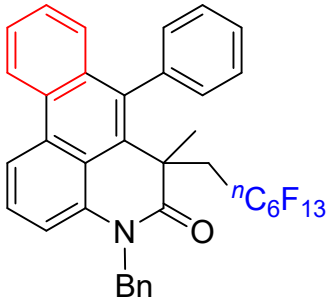
7.61 (dd, J = 16.5, 8.3 Hz, 2H), 7.54 (t, J = 6.6 Hz, 3H), 7.46 (d, J = 5.8 Hz, 1H), 7.42 – 7.32 (m, 3H), 7.22 (d, J = 5.0 Hz, 1H), 7.13 (d, J = 3.1 Hz, 1H), 6.98 – 6.94 (m, 1H), 6.92 (d, J = 8.5 Hz, 1H), 5.54 (dd, J = 43.9, 15.6 Hz, 2H), 3.21 (dd, J = 34.6, 15.1 Hz, 1H), 3.08 – 2.90 (m, 1H), 1.86 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.8, 139.8, 139.2, 137.8, 136.0, 134.0, 133.4, 131.9, 131.2, 129.6, 129.2, 128.24, 128.16, 127.9, 127.6, 127.3, 127.1, 126.9, 126.8, 126.2, 125.2, 122.8, 118.1, 117.9, 111.9, 45.2, 43.2, 39.7 (t, J = 18.0 Hz), 31.6; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.97 (d, J = 1.6 Hz, 3F), -108.87 – -110.56 (m, 1F), -110.87 – -112.39 (m, 1F), -123.54 – -125.55 (m, 2F), -125.84 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{33}H_{22}F_9NNaOS^+$: 674.1171; found: 674.1180.



4-benzyl-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-4*H*-naphtho[3,2,1-*de*]quinolin-5(6*H*)-one (3sa). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); Yellow oil, 47.1 mg, 41% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.68 – 8.59 (m, 1H), 8.38 (d, J = 8.4 Hz, 1H), 7.90 (dd, J = 6.4, 2.8 Hz, 1H), 7.77 (s, 1H), 7.70 – 7.60 (m, 2H), 7.51 (t, J = 8.1 Hz, 1H), 7.34 – 7.28 (m, 5H), 7.10 (d, J = 7.9 Hz, 1H), 5.45 (s, 2H), 3.75 (dd, J = 32.4, 15.6 Hz, 1H), 3.14 – 2.85 (m, 1H), 1.87 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.8, 136.6, 136.0, 133.1, 131.8, 131.0, 129.2, 129.0, 128.4, 127.5, 127.3, 127.1, 126.5, 124.4, 123.2, 118.0, 117.2, 112.2, 47.0, 44.2, 40.9 (t, J = 19.5 Hz), 34.8; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.03 (t, J = 9.1 Hz, 3F), -105.44 (d, J = 281.2 Hz, 1F), -111.37 (d, J = 272.8 Hz, 1F), -123.18 – -125.35 (m, 2F), -125.54 – -126.27 (m, 2F); HRMS (ESI-TOF) m/z: $[M+H]^+$ Calcd. for $C_{29}H_{21}F_9NO^+$: 570.1474; found: 570.1470.

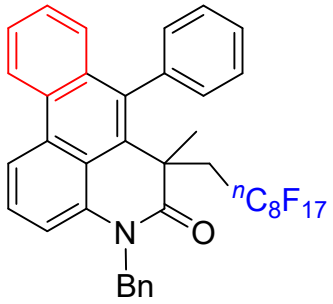


4-benzyl-6-(2,2,3,3,4,4,4-heptafluorobutyl)-6-methyl-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (4a). The product was purified by column chromatography (petroleum ether / ethyl acetate = 30:1); White solid, 76.7 mg, 64% yield; mp 190.1-191.3 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.68 (d, J = 8.4 Hz, 1H), 8.45 (d, J = 8.4 Hz, 1H), 7.57 (m, 5H), 7.50 – 7.45 (m, 1H), 7.38 (t, J = 7.3 Hz, 2H), 7.33 (d, J = 4.3 Hz, 4H), 7.29 – 7.25 (m, 1H), 7.15 (d, J = 7.9 Hz, 1H), 6.93 (d, J = 8.4 Hz, 1H), 5.43 (dd, J = 61.7, 15.2 Hz, 2H), 3.23 (dd, J = 34.7, 15.2 Hz, 1H), 3.10 – 2.92 (m, 1H), 1.90 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 139.9, 137.8, 136.6, 136.3, 134.0, 133.5, 132.0, 131.1, 129.8, 129.2, 128.9, 128.3, 128.2, 127.9, 127.6, 127.32, 127.28, 127.1, 126.9, 126.6, 122.8, 118.0, 117.8, 112.6, 47.9, 45.3, 39.6 (t, J = 17.5 Hz), 31.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.26 (d, J = 1.4 Hz, 3F), -108.92 – -110.96 (m, 1F), -111.69 – -114.62 (m, 1F), -126.11 – -129.95 (m, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{34}H_{24}F_7NNaO^+$: 618.1638; found: 618.1646.

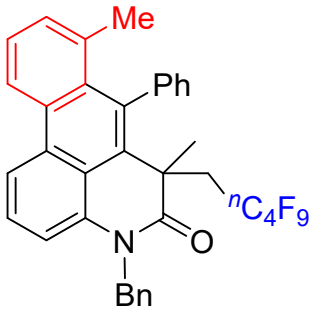


4-benzyl-6-methyl-7-phenyl-6-(2,2,3,3,4,4,5,5,6,6,7,7,7-tridecafluoroheptyl)-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (4b). The product was purified by column chromatography (petroleum ether / ethyl acetate = 40:1); White solid, 100.5 mg, 67% yield; mp 208.7-209.9 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.69 (d, J = 8.4 Hz, 1H), 8.46 (d, J = 8.4 Hz, 1H), 7.63 – 7.56 (m, 3H), 7.55 – 7.50 (m, 3H), 7.39 (t, J = 7.5 Hz, 2H), 7.35 (d, J = 4.3 Hz, 4H), 7.30 – 7.27 (m, 1H), 7.17 (d, J = 7.9 Hz, 1H), 6.96 (d, J = 8.5 Hz, 1H), 5.46 (dd, J = 47.0, 15.4 Hz, 2H), 3.28 (dd, J = 34.8, 15.1

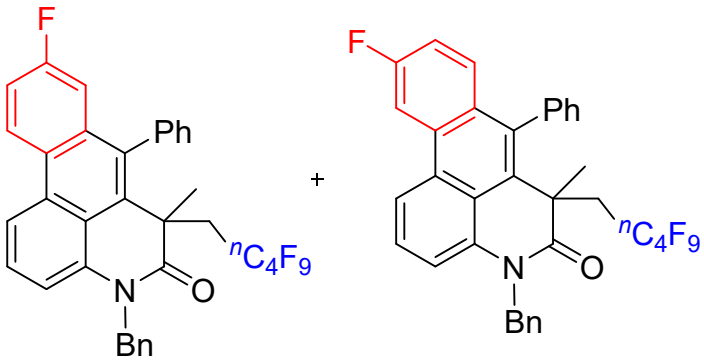
Hz, 1H), 3.15 – 2.95 (m, 1H), 1.92 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 139.9, 137.8, 136.6, 136.4, 134.0, 133.5, 132.0, 131.1, 129.8, 129.3, 128.9, 128.3, 128.2, 127.9, 127.6, 127.32, 127.28, 127.1, 126.9, 126.6, 122.8, 118.0, 117.9, 112.6, 47.9, 45.3, 39.8 (t, J = 18.0 Hz), 31.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.80 (t, J = 9.3 Hz, 3F), -108.59 – -109.77 (m, 1F), -110.62 – -111.90 (m, 1F), -121.69 (s, 2F), -122.77 (s, 2F), -123.30 – -123.74 (m, 2F), -126.12 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{34}H_{24}F_{13}NNaO^+$: 768.1543; found: 768.1552.



4-benzyl-6-(2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-heptadecafluorononyl)-6-methyl-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (4c). The product was purified by column chromatography (petroleum ether / ethyl acetate = 30:1); White solid, 110.4 mg, 65% yield; mp 221.5-222.7 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.68 (d, J = 8.3 Hz, 1H), 8.45 (d, J = 8.3 Hz, 1H), 7.62 – 7.57 (m, 1H), 7.56 – 7.51 (m, 4H), 7.51 – 7.46 (m, 1H), 7.41 – 7.35 (m, 2H), 7.33 (d, J = 4.4 Hz, 4H), 7.26 – 7.23 (m, 1H), 7.14 (d, J = 7.8 Hz, 1H), 6.92 (d, J = 8.0 Hz, 1H), 5.43 (dd, J = 46.0, 15.1 Hz, 2H), 3.24 (dd, J = 34.7, 15.1 Hz, 1H), 3.10 – 2.89 (m, 1H), 1.89 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 139.9, 137.8, 136.6, 136.4, 134.0, 133.5, 132.0, 131.1, 129.8, 129.3, 128.9, 128.3, 128.2, 127.9, 127.6, 127.33, 127.28, 127.1, 126.9, 126.6, 122.8, 118.0, 117.8, 112.6, 47.9, 45.3, 39.8 (t, J = 14.7 Hz), 31.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.76 (d, J = 8.2 Hz, 3F), -108.55 – -110.01 (m, 1F), -110.66 – -112.27 (m, 1F), -121.30 – -122.10 (m, 6F), -122.70 (s, 2F), -123.31 – -123.75 (m, 2F), -126.07 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{39}H_{24}F_{17}NNaO^+$: 868.1479; found: 868.1487.

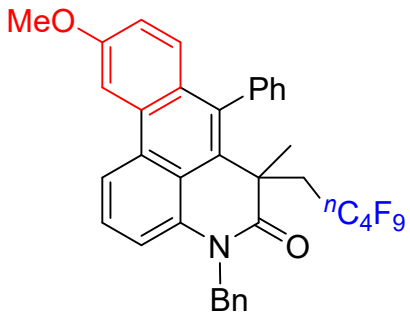


4-benzyl-6,8-dimethyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (5ab)[3]. The product was purified by column chromatography (petroleum ether / ethyl acetate = 30:1); White solid, 81.4 mg, 62% yield; mp 176.4-177.6 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.60 (d, J = 8.3 Hz, 1H), 8.39 (d, J = 8.4 Hz, 1H), 7.54 – 7.47 (m, 3H), 7.47 – 7.40 (m, 4H), 7.35 – 7.30 (m, 4H), 7.27 (d, J = 3.4 Hz, 1H), 7.25 – 7.22 (m, 1H), 7.10 (d, J = 7.8 Hz, 1H), 5.40 (q, J = 16.3 Hz, 2H), 3.28 – 3.02 (m, 1H), 2.90 – 2.70 (m, 1H), 1.79 (s, 3H), 1.67 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.9, 141.6, 138.6, 137.1, 136.6, 135.8, 135.3, 133.5, 132.9, 131.6, 131.0, 130.7, 128.9, 128.6, 127.5, 127.3, 127.2, 126.9, 126.6, 122.1, 118.8, 117.8, 112.3, 48.0, 46.2, 39.9 (t, J = 17.9 Hz), 32.3, 25.5; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.02 (s. 3F), -109.42 – -110.78 (m, 1F), -111.08 – -112.51 (m, 1F), -123.38 – -125.43 (m, 2F), -125.86 (d, J = 7.2 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{36}H_{26}F_9NNaO^+$: 682.1763; found: 682.1771.

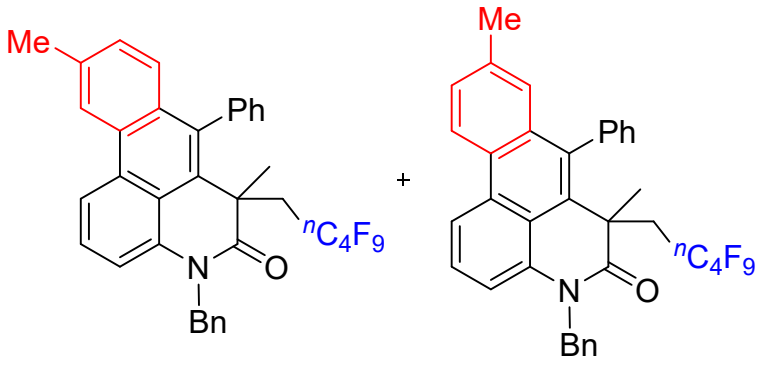


4-benzyl-9-fluoro-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one and 4-benzyl-10-fluoro-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (5ac and 5ac')[4,5]. The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 72.1 mg (5ac:5ac' = 4:1), 54% yield; mp 158.1-159.3 °C; ^{1}H NMR (400 MHz,

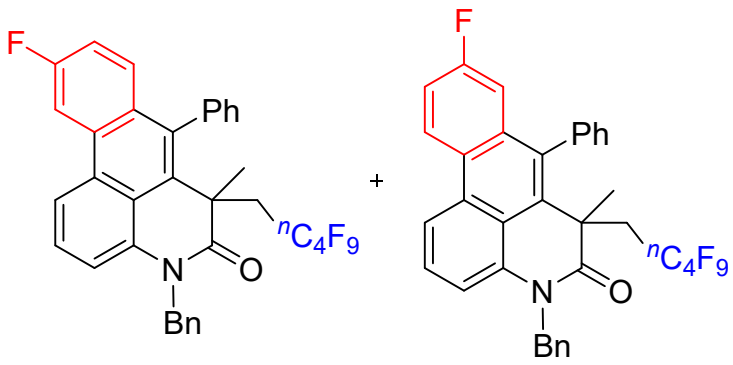
$CDCl_3$) δ 8.65 (dd, J = 9.2, 5.6 Hz, 0.2H), 8.35 (d, J = 8.5 Hz, 0.2H), 8.32 – 8.23 (m, 1.6H), 7.58 – 7.51 (m, 4H), 7.47 (d, J = 6.0 Hz, 1H), 7.37 – 7.31 (m, 5H), 7.29 – 7.24 (m, 1H), 7.16 (dd, J = 9.4, 5.0 Hz, 1H), 7.14 – 7.09 (m, 1H), 6.92 (dd, J = 9.3, 5.9 Hz, 0.8H), 6.54 (dd, J = 11.6, 2.6 Hz, 0.2H), 5.43 (dd, J = 45.5, 15.1 Hz, 2H), 3.24 (dd, J = 34.6, 15.2 Hz, 1H), 3.11 – 2.89 (m, 1H), 1.89 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.2, 161.7 (d, J = 247.0 Hz), 139.7, 136.5, 136.4, 133.4, 133.3, 131.8, 130.8, 130.4 (d, J = 4.3 Hz), 130.2 (d, J = 8.7 Hz), 129.0, 128.6, 128.4, 128.3, 128.2, 128.0, 127.8, 127.4 (d, J = 8.9 Hz), 126.5, 125.4, 125.3, 118.3, 118.1, 117.8, 116.1 (d, J = 23.5 Hz), 113.2, 112.5, 112.1, 111.9, 107.7 (d, J = 22.6 Hz), 47.9, 45.2, 39.7 (t, J = 17.9 Hz), 31.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.99 (s, 3F), -108.89 – -110.20 (m, 1F), -110.91 – -112.27 (m, 1F), -112.75 – -113.03 (m, 0.2F), -113.59 (d, J = 3.9 Hz, 0.8F), -123.32 – -125.59 (m, 2F), -125.85 (d, J = 13.1 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{35}H_{23}F_{10}NNaO^+$: 686.1512; found: 686.1520.



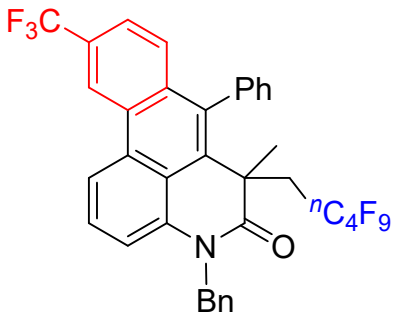
4-benzyl-10-methoxy-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (5ad)[5]. The product was purified by column chromatography (petroleum ether / ethyl acetate = 10:1); White solid, 98.8 mg, 73% yield; mp 207.6-208.8 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.58 (d, J = 9.2 Hz, 1H), 8.33 (d, J = 8.4 Hz, 1H), 7.58 – 7.51 (m, 3H), 7.48 (m, 2H), 7.39 – 7.35 (m, 1H), 7.32 (d, J = 4.4 Hz, 4H), 7.25 – 7.20 (m, 2H), 7.07 (d, J = 7.8 Hz, 1H), 6.24 (d, J = 2.6 Hz, 1H), 5.56 – 5.28 (m, 2H), 3.58 (s, 3H), 3.23 (dd, J = 34.7, 15.4 Hz, 1H), 3.10 – 2.93 (m, 1H), 1.89 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 158.4, 140.1, 137.2, 136.7, 136.4, 135.6, 133.4, 132.0, 131.1, 130.3, 128.9, 128.3, 128.1, 127.4, 127.2, 126.6, 124.5, 123.8, 117.5, 117.2, 116.8, 111.7, 108.2, 55.0, 47.8, 45.3, 39.7 (t, J = 18.6 Hz), 31.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.00 (s, 3F), -108.88 – -110.09 (m, 1F), -111.04 – -112.40 (m, 1F), -123.44 – -125.38 (m, 2F), -125.87 (d, J = 10.7 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{36}H_{26}F_9NNaO_2^+$: 698.1712; found: 698.1719.



4-benzyl-6,10-dimethyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one and 4-benzyl-6,9-dimethyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (5ae and 5ae')[3,5]. The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 76.7 mg (5ae:5ae' = 1:1), 58% yield; mp 183.1-184.3 ℃;^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (d, J = 8.6 Hz, 0.5H), 8.40 (s, 0.5H), 8.37 (d, J = 8.4 Hz, 0.5H), 8.33 (d, J = 8.3 Hz, 0.5H), 7.52 – 7.39 (m, 6H), 7.37 – 7.30 (m, 1H), 7.30 – 7.27 (m, 3H), 7.23 – 7.12 (m, 2H), 7.05 (t, J = 8.0 Hz, 1H), 6.76 (d, J = 8.6 Hz, 0.5H), 6.62 (s, 0.5H), 5.36 (dd, J = 40.9, 15.0 Hz, 2H), 3.18 (dd, J = 34.7, 15.1 Hz, 1H), 3.03 – 2.87 (m, 1H), 2.49 (s, 1.5H), 2.25 (s, 1.5H), 1.83 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 140.1, 139.9, 137.7, 137.5, 136.8, 136.74, 136.68, 136.3, 134.1, 133.5, 133.4, 132.0, 131.9, 131.1, 130.7, 129.7, 129.3, 128.9, 128.75, 128.68, 128.20, 128.16, 128.1, 127.9, 127.5, 127.25, 127.22, 127.1, 126.6, 122.8, 122.5, 118.01, 117.96, 117.8, 117.5, 112.5, 112.2, 47.9, 47.8, 45.33, 45.25, 39.8 (t, J = 17.4 Hz), 31.93, 31.90, 21.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.99 (s, 3F), -109.52 (d, J = 272.3 Hz, 1F), -110.92 – -112.41 (m, 1F), -123.40 – -125.42 (m, 2F), -125.85 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{36}H_{26}F_9NNaO^+$: 682.1763; found: 682.1771.

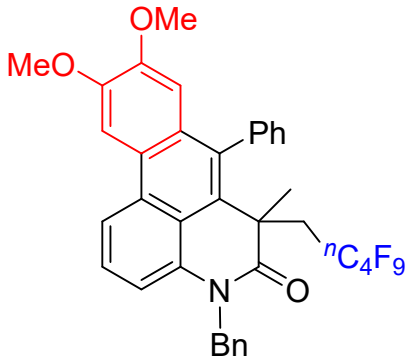


4-benzyl-10-fluoro-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one and 4-benzyl-9-fluoro-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (5ac' and 5ac)[4,5]. The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 86.8 mg (5af:5af' = 5.7:1), 65% yield; mp 151.8-153.0 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.65 (dd, J = 9.2, 5.7 Hz, 0.85H), 8.35 (d, J = 8.4 Hz, 0.85H), 8.29 – 8.20 (m, 0.3H), 7.58 – 7.51 (m, 4H), 7.45 (d, J = 6.1 Hz, 1H), 7.38 – 7.30 (m, 7H), 7.13 (d, J = 7.9 Hz, 1H), 6.94 – 6.87 (m, 0.15H), 6.53 (dd, J = 11.6, 2.6 Hz, 0.85H), 5.66 – 5.11 (m, 2H), 3.24 (dd, J = 34.9, 15.5 Hz, 1H), 3.08 – 2.91 (m, 1H), 1.88 (d, J = 2.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.1, 161.6 (d, J = 246.1 Hz), 139.4, 136.5, 135.7 (d, J = 8.2 Hz), 133.3, 131.8, 131.2, 130.8, 129.0, 128.6, 128.4, 128.2, 127.8, 127.3, 126.5, 125.9, 125.3 (d, J = 8.7 Hz), 118.1, 117.8, 117.4, 116.1 (d, J = 23.9 Hz), 113.2, 112.5, 112.0 (d, J = 22.9 Hz), 47.9, 45.3, 39.7 (t, J = 17.9 Hz), 31.8; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.99 (s, 3F), -108.73 – -110.19 (m, 1F), -111.07 – -112.55 (m, 1F), -112.91 (d, J = 4.6 Hz, 0.85F), -113.62 (s, 0.15F), -123.33 – -125.55 (m, 2F), -125.87 (d, J = 12.1 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{35}H_{23}F_{10}NNaO^+$: 644.0866; found: 644.0875.

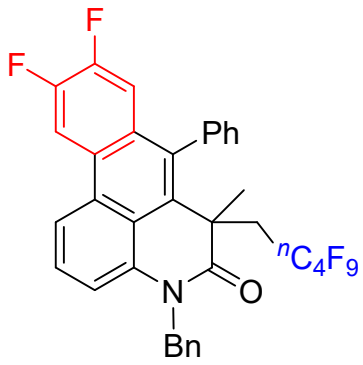


4-benzyl-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-10-(trifluoromethyl)-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (5ag)[4]. The product was purified by column

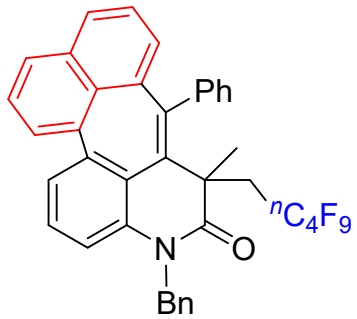
chromatography (petroleum ether / ethyl acetate = 10:1); White solid, 76.7 mg, 54% yield; mp 152.4-153.6 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.77 (d, J = 8.8 Hz, 1H), 8.45 (d, J = 8.3 Hz, 1H), 7.77 (dd, J = 8.7, 1.5 Hz, 1H), 7.60 – 7.54 (m, 4H), 7.47 (d, J = 4.8 Hz, 1H), 7.37 – 7.32 (m, 5H), 7.29 – 7.27 (m, 1H), 7.23 – 7.18 (m, 2H), 5.52 – 5.34 (m, 2H), 3.26 (dd, J = 34.9, 15.3 Hz, 1H), 3.10 – 2.92 (m, 1H), 1.90 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.1, 138.8, 137.7, 136.6, 136.3, 133.5, 133.3, 131.8 (d, J = 3.5 Hz), 131.4 (d, J = 32.9 Hz), 130.4, 129.0, 128.8, 128.5, 128.2, 127.9, 127.4, 125.2 (d, J = 264.9 Hz), 124.8 (d, J = 4.5 Hz), 122.72, 122.70, 118.6, 118.3, 113.6, 47.9, 45.4, 39.7 (t, J = 17.6 Hz), 31.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -62.50 (s, 3F), -80.98 (s, 3F), -108.43 – -110.16 (m, 1F), -110.63 – -112.58 (m, 1F), -123.67 – -124.97 (m, 2F), -125.85 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{36}H_{23}F_{12}NNaO^+$: 736.1480; found: 736.1488.



4-benzyl-9,10-dimethoxy-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (5ah). The product was purified by column chromatography (petroleum ether / ethyl acetate = 5:1); White solid, 87.3 mg, 62% yield; mp 189.3-190.5 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.28 (d, J = 8.4 Hz, 1H), 7.98 (s, 1H), 7.60 – 7.57 (m, 1H), 7.56 – 7.52 (m, 3H), 7.48 (t, J = 8.1 Hz, 1H), 7.41 – 7.38 (m, 1H), 7.35 (d, J = 4.9 Hz, 4H), 7.32 – 7.26 (m, 1H), 7.09 (d, J = 7.9 Hz, 1H), 6.26 (s, 1H), 5.45 (dd, J = 40.5, 14.5 Hz, 2H), 4.09 (s, 3H), 3.58 (s, 3H), 3.28 (dd, J = 34.7, 15.1 Hz, 1H), 3.13 – 2.91 (m, 1H), 1.93 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 149.6, 149.4, 140.4, 136.9, 136.7, 136.4, 133.3, 131.80, 131.77, 130.3, 129.4, 128.9, 128.21, 128.18, 128.0, 127.8, 127.2, 126.8, 126.5, 124.3, 117.5, 117.3, 111.5, 107.6, 103.0, 56.0, 55.2, 47.8, 45.2, 39.7 (t, J = 17.9 Hz), 32.0; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.98 (t, J = 9.0 Hz, 3F), -109.58 (dd, J = 273.2, 32.4 Hz, 1F), -110.87 – -112.63 (m, 1F), -123.08 – -125.33 (m, 2F), -125.82 (dd, J = 26.6, 13.1 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{37}H_{22}F_9NNaO_3^+$: 728.1818; found: 728.1823.

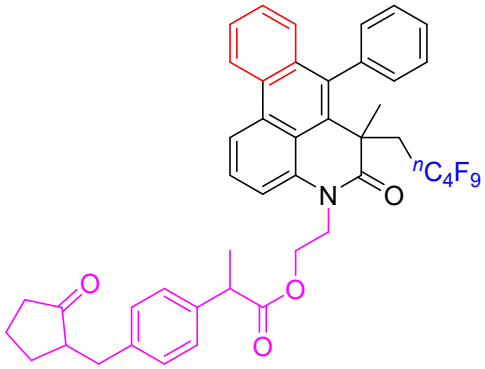


4-benzyl-9,10-difluoro-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,6-dihydro-1*H*-naphtho[3,2,1-*de*]quinolin-5(4*H*)-one (5ai). The product was purified by column chromatography (petroleum ether / ethyl acetate = 20:1); White solid, 79.5 mg, 58% yield; mp 147.1-148.3 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (dd, J = 12.2, 8.0 Hz, 1H), 8.18 (d, J = 8.3 Hz, 1H), 7.61 – 7.55 (m, 3H), 7.52 (t, J = 8.1 Hz, 1H), 7.46 (d, J = 6.2 Hz, 1H), 7.37 – 7.32 (m, 5H), 7.29 – 7.26 (m, 1H), 7.16 (d, J = 7.9 Hz, 1H), 6.67 (dd, J = 12.9, 8.4 Hz, 1H), 5.44 (dd, J = 46.5, 15.2 Hz, 2H), 3.26 (dd, J = 34.9, 15.3 Hz, 1H), 3.09 – 2.86 (m, 1H), 1.89 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.1, 150.3 (dd, J = 250.1, 14.4 Hz), 150.0 (dd, J = 248.7, 13.7 Hz), 139.2, 136.7, 136.5, 136.4, 133.2, 131.7 (d, J = 3.3 Hz), 131.53, 131.48, 130.6, 130.1 (d, J = 3.5 Hz), 129.0, 128.8, 128.5, 128.3, 127.8, 127.4, 126.5, 117.9, 117.8, 114.7 (d, J = 18.7 Hz), 112.9, 110.4 (d, J = 18.3 Hz), 47.9, 45.3, 39.7 (t, J = 17.7 Hz), 31.8; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.99 (s, 3F), -108.53 – -110.27 (m, 1F), -110.79 – -112.59 (m, 1F), -123.34 – -125.40 (m, 2F), -125.85 (d, J = 11.5 Hz, 2F), -135.98 (dd, J = 18.8, 10.6 Hz, 1F), -136.43 – -136.87 (m, 1F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{35}H_{22}F_{11}NNaO^+$: 704.1418; found: 704.1426.



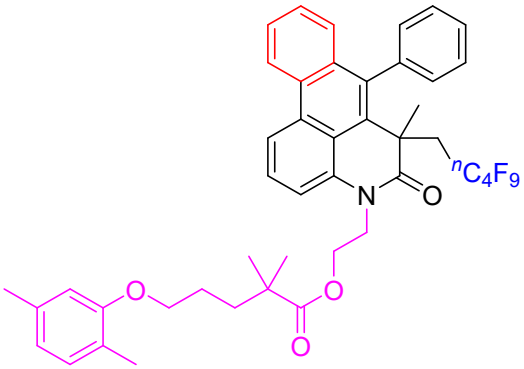
4-benzyl-6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-7-phenyl-2,4-dihydro-1*H*-naphtho[1',8':4,5,6]cyclohepta[1,2,3-*de*]quinolin-5(6*H*)-one (6aj). The product was purified by

column chromatography (petroleum ether / ethyl acetate = 15:1); White oil, 72.6 mg, 52% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, J = 7.9 Hz, 1H), 7.60 (d, J = 7.0 Hz, 1H), 7.57 – 7.50 (m, 2H), 7.40 – 7.32 (m, 4H), 7.31 – 7.26 (m, 3H), 7.25 – 7.22 (m, 2H), 7.22 – 7.15 (m, 1H), 7.10 (t, J = 7.7 Hz, 1H), 6.97 (d, J = 8.1 Hz, 1H), 6.73 (d, J = 7.4 Hz, 1H), 6.67 (d, J = 7.9 Hz, 1H), 6.52 (d, J = 7.3 Hz, 1H), 5.46 (d, J = 16.3 Hz, 1H), 5.10 (d, J = 16.3 Hz, 1H), 2.71 (dd, J = 35.5, 15.1 Hz, 1H), 2.18 – 1.97 (m, 1H), 1.00 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.6, 147.9, 145.2, 141.9, 139.6, 137.7, 137.24, 137.17, 132.8, 132.7, 131.3, 131.2, 130.5, 129.3, 129.1, 129.0, 128.7, 128.0, 127.8, 127.61, 127.59, 127.55, 127.47, 126.50, 126.3, 124.8, 114.3, 48.1, 47.5, 38.7 (t, J = 19.6 Hz), 21.1; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.58 (s, 3F), -106.97 – -108.23 (m, 1F), -112.86 – -114.32 (m, 1F), -125.43 – -126.17 (m, 2F), -126.34 (s, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{39}H_{26}F_9NNaO^+$: 718.1763; found: 718.1771.

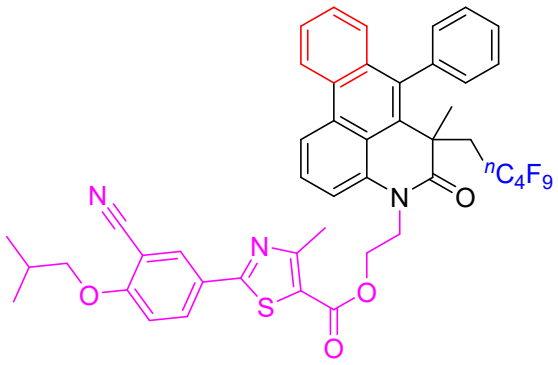


2-(6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-5-oxo-7-phenyl-5,6-dihydro-4*H*-naphtho[3,2,1-*de*]quinolin-4-yl)ethyl 2-(4-((2-oxocyclopentyl)methyl)phenyl)propanoate (7a). The product was purified by column chromatography (petroleum ether / ethyl acetate = 3:1); White solid, 79.7 mg, 48% yield; mp 78.3-79.5 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.70 (d, J = 8.4 Hz, 1H), 8.50 (d, J = 8.4 Hz, 1H), 7.67 – 7.56 (m, 2H), 7.52 (m, 3H), 7.39 (dd, J = 15.0, 7.7 Hz, 4H), 7.18 (d, J = 7.9 Hz, 2H), 7.08 (d, J = 7.9 Hz, 2H), 6.91 (d, J = 8.5 Hz, 1H), 4.58 – 4.27 (m, 4H), 3.76 – 3.61 (m, 1H), 3.21 – 2.84 (m, 3H), 2.51 – 2.41 (m, 1H), 2.32 (m, 2H), 2.17 – 2.01 (m, 2H), 1.98 – 1.87 (m, 1H), 1.77 (s, 3H), 1.75 – 1.67 (m, 1H), 1.57 – 1.50 (m, 1H), 1.47 (t, J = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 220.2, 174.9, 172.8, 139.8, 139.1, 138.2, 137.8, 136.2, 136.1, 133.9, 133.4, 131.8, 131.2, 129.6, 129.3, 129.2, 128.23, 128.16, 127.9, 127.65, 127.56, 127.5, 127.1, 127.0, 122.8, 118.1, 117.8, 111.6, 111.5, 60.7, 51.1, 51.0, 45.2, 44.9, 42.0, 41.8, 40.1 (t, J = 17.9 Hz), 38.3, 35.3, 31.4, 29.4, 20.6, 18.5; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.99 (s, 3F), -109.51 – -110.74 (m,

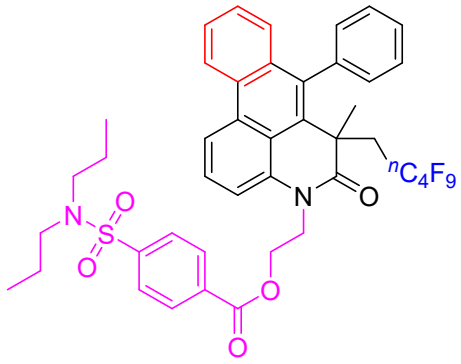
1F), -111.64 – -113.63 (m, 1F), -124.52 (s, 2F), -125.86 (d, J = 30.3 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{45}H_{38}F_9NNaO_4^+$: 850.2549; found: 850.2557.



2-(6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-5-oxo-7-phenyl-5,6-dihydro-4*H*-naphtho[3,2,1-*de*]quinolin-4-yl)ethyl 5-(2,5-dimethylphenoxy)-2,2-dimethylpentanoate (7b). The product was purified by column chromatography (petroleum ether / ethyl acetate = 10:1); White solid, 103.6 mg, 62% yield; mp 107.6-109.8 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.70 (d, J = 8.4 Hz, 1H), 8.51 (d, J = 8.4 Hz, 1H), 7.71 (t, J = 8.1 Hz, 1H), 7.61 (t, J = 7.5 Hz, 1H), 7.57 – 7.50 (m, 4H), 7.44 – 7.37 (m, 2H), 7.33 (d, J = 6.9 Hz, 1H), 7.00 (d, J = 7.4 Hz, 1H), 6.93 (d, J = 8.4 Hz, 1H), 6.65 (d, J = 7.4 Hz, 1H), 6.55 (s, 1H), 4.65 – 4.31 (m, 4H), 4.06 – 3.49 (m, 2H), 3.28 – 2.70 (m, 2H), 2.28 (s, 3H), 2.18 (s, 3H), 1.82 (s, 3H), 1.72 (s, 4H), 1.23 (d, J = 2.4 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 178.1, 172.7, 157.0, 139.9, 137.8, 136.6, 136.2, 134.0, 133.4, 131.8, 131.2, 130.4, 129.6, 129.2, 128.2, 128.1, 127.9, 127.6, 127.5, 127.1, 127.0, 123.7, 122.8, 120.8, 118.2, 117.8, 112.0, 111.7, 67.9, 60.6, 44.9, 42.3, 42.0, 40.1 (t, J = 17.7 Hz), 37.2, 31.4, 25.3, 25.2, 21.5, 15.9; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.97 (s, 3F), -109.06 – -111.27 (m, 1F), -111.45 – -113.99 (m, 1F), -124.47 (s, 2F), -125.40 – -126.53 (m, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{45}H_{42}F_9NNaO_4^+$: 854.2862; found: 854.2869.

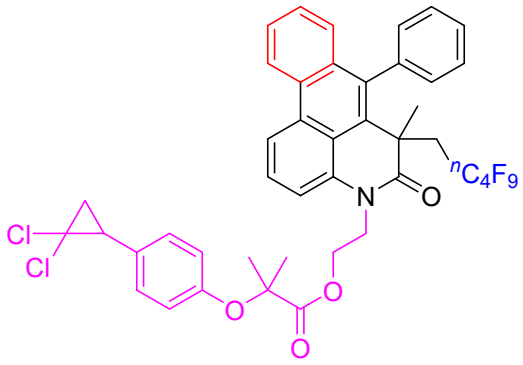


2-(6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-5-oxo-7-phenyl-5,6-dihydro-4*H*-naphtho[3,2,1-*de*]quinolin-4-yl)ethyl 2-(3-cyano-4-isobutoxyphenyl)-4-methylthiazole-5-carboxylat*e* (7c). The product was purified by column chromatography (petroleum ether / ethyl acetate = 5:1); White solid, 82.1 mg, 46% yield; mp 162.5-163.7 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.71 (d, J = 8.4 Hz, 1H), 8.52 (d, J = 8.4 Hz, 1H), 8.13 (d, J = 2.0 Hz, 1H), 8.02 (dd, J = 8.8, 2.0 Hz, 1H), 7.70 (t, J = 8.1 Hz, 1H), 7.61 (t, J = 7.6 Hz, 1H), 7.55 – 7.46 (m, 4H), 7.42 – 7.34 (m, 3H), 6.98 (d, J = 8.9 Hz, 1H), 6.91 (d, J = 8.5 Hz, 1H), 4.77 – 4.52 (m, 4H), 3.89 (d, J = 6.5 Hz, 2H), 3.25 – 2.86 (m, 2H), 2.73 (s, 3H), 2.30 – 2.14 (m, 1H), 1.80 (s, 3H), 1.09 (d, J = 6.7 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.9, 167.7, 162.7, 162.1, 162.0, 139.8, 137.9, 136.2, 134.0, 133.4, 132.7, 132.2, 131.8, 131.3, 129.6, 129.2, 128.3, 128.2, 127.9, 127.6, 127.5, 127.2, 127.0, 126.1, 122.9, 121.2, 118.2, 117.9, 115.5, 112.8, 111.5, 103.2, 75.9, 61.3, 44.9, 42.0, 40.2 (t, J = 17.7 Hz), 31.4, 28.3, 19.2, 17.6; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.00 (s, 3F), -109.46 – -111.03 (m, 1F), -111.43 – -113.29 (m, 1F), -123.34 – -124.96 (m, 2F), -125.77 – -125.99 (m, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{46}H_{37}F_9N_3O_4S^+$: 898.2356; found: 898.2365.



2-(6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-5-oxo-7-phenyl-5,6-dihydro-4*H*-naphtho[3,2,1-*de*]quinolin-4-yl)ethyl 4-(*N*,*N*-dipropylsulfamoyl)benzoate--methane (1/1) (7d). The product was purified by column chromatography (petroleum ether / ethyl acetate = 5:1); White

solid, 72.5 mg, 42% yield; mp 62.5-63.7 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.70 (d, J = 8.4 Hz, 1H), 8.52 (d, J = 8.4 Hz, 1H), 8.10 (d, J = 8.4 Hz, 2H), 7.84 (d, J = 8.4 Hz, 2H), 7.67 (t, J = 8.1 Hz, 1H), 7.61 (t, J = 7.6 Hz, 1H), 7.55 – 7.51 (m, 3H), 7.48 (d, J = 8.0 Hz, 1H), 7.42 – 7.33 (m, 3H), 6.92 (d, J = 8.4 Hz, 1H), 4.82 – 4.75 (m, 1H), 4.73 – 4.67 (m, 1H), 4.63 (t, J = 5.9 Hz, 2H), 3.15 – 3.05 (m, 5H), 3.05 – 2.90 (m, 1H), 1.80 (s, 3H), 1.54 (dd, J = 15.1, 7.5 Hz, 4H), 0.86 (t, J = 7.4 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.9, 165.4, 144.5, 139.8, 137.9, 136.1, 133.9, 133.4, 133.1, 131.7, 131.3, 130.4, 129.5, 129.1, 128.2, 128.1, 127.9, 127.6, 127.3, 127.2, 127.1, 127.0, 122.8, 118.3, 117.8, 111.3, 61.7, 50.0, 44.9, 41.9, 40.2 (t, J = 18.1 Hz), 31.4, 22.0, 11.2; ^{19}F NMR (377 MHz, $CDCl_3$) δ -81.03 (t, J = 9.4 Hz, 3F), -109.35 – -110.70 (m, 1F), -111.79 – -113.03 (m, 1F), -124.49 (s, 2F), -125.70 – -126.14 (m, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{44}H_{43}F_{10}N_2NaO_5S^+$: 905.2641; found: 905.2638.

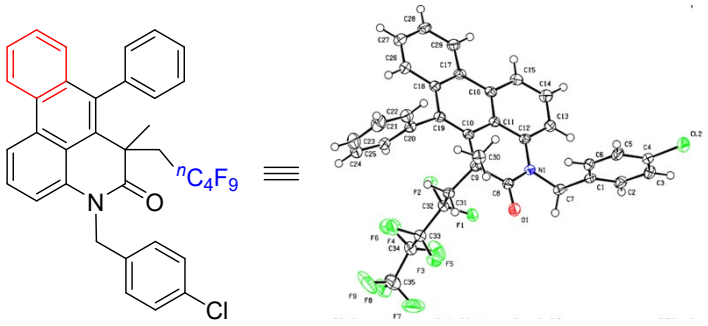


2-(6-methyl-6-(2,2,3,3,4,4,5,5,5-nonafluoropentyl)-5-oxo-7-phenyl-5,6-dihydro-4*H*-naphtho[3,2,1-*de*]quinolin-4-yl)ethyl 2-(4-(2,2-dichlorocyclopropyl)phenoxy)-2-methylpropanoate (7e). The product was purified by column chromatography (petroleum ether / ethyl acetate = 10:1); White solid, 99.6 mg, 57% yield; mp 168. °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.70 (d, J = 8.3 Hz, 1H), 8.49 (d, J = 8.4 Hz, 1H), 7.66 – 7.59 (m, 2H), 7.55 – 7.50 (m, 3H), 7.41 – 7.38 (m, 3H), 7.37 – 7.33 (m, 1H), 7.11 – 6.98 (m, 2H), 6.92 (d, J = 8.5 Hz, 1H), 6.84 – 6.76 (m, 2H), 4.57 – 4.33 (m, 4H), 3.17 – 2.89 (m, 2H), 2.78 – 2.70 (m, 1H), 1.89 – 1.81 (m, 1H), 1.79 (s, 3H), 1.68 (dd, J = 16.0, 8.4 Hz, 1H), 1.58 (d, J = 11.5 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.4, 172.8, 155.0, 139.8, 137.8, 136.0, 134.0, 133.4, 131.8, 131.2, 129.8, 129.7, 129.6, 129.2, 128.5, 128.4, 128.25, 128.17, 127.9, 127.6, 127.5, 127.2, 127.0, 122.8, 119.0, 118.9, 118.2, 117.7, 111.6, 79.3, 61.5, 60.9, 44.9, 41.8, 40.1 (t, J = 18.1 Hz), 34.9, 31.4, 25.9, 25.6, 25.4; ^{19}F NMR (377 MHz, $CDCl_3$) δ -80.98 (s, 3F), -109.35 – -110.98 (m, 1F), -111.72 – -113.25 (m, 1F), -124.51 (s,

2F), -125.87 (d, J = 14.7 Hz, 2F); HRMS (ESI-TOF) m/z: $[M+Na]^+$ Calcd. for $C_{43}H_{34}Cl_2F_9NNaO_4^+$: 892.1613; found: 892.1616.

5. X-ray crystal data for product 3pa (CCDC: 2377733)

Bruker Apex2 CCD was used for the crystal measurement and the ellipsoid contour is shown at 30% probability levels. Single crystals of compound **3pa** were obtained by slow evaporation of its hexane/dichloromethane solution.



3pa

X-ray structure of **3pa**
CCDC:2377733

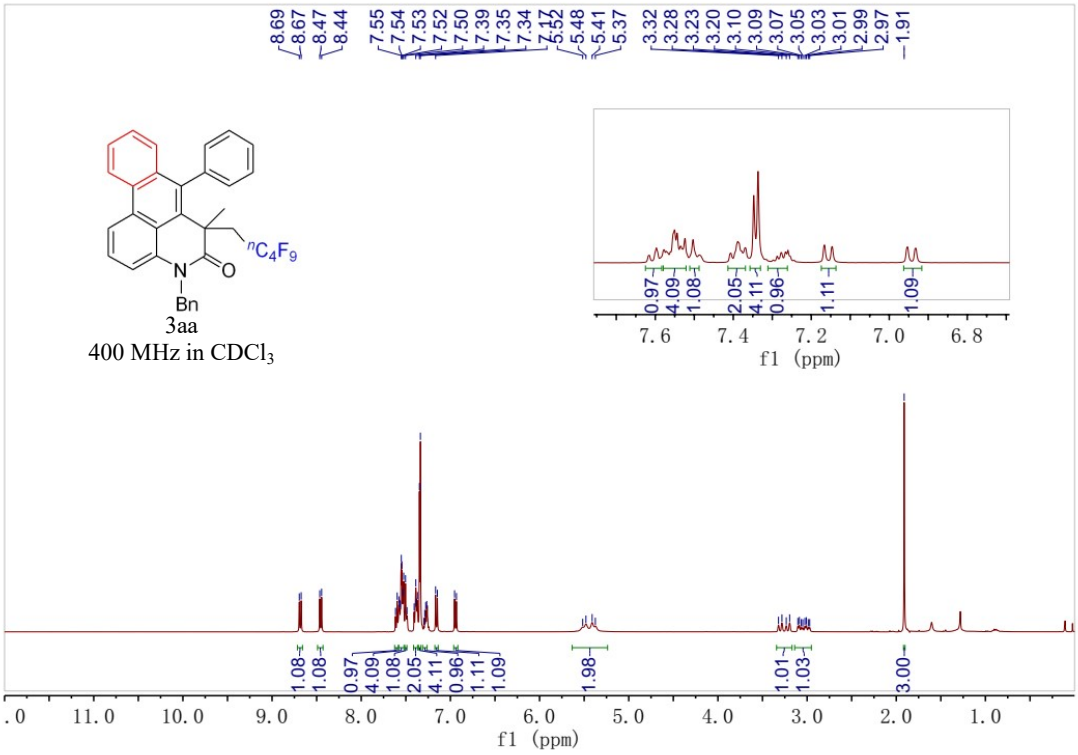
Compound	**3pa**
Empirical formula	$C_{35}H_{23}ClF_9NO$
Formula weight	679.99
Temperature/K	150
Crystal system	monoclinic
Space group	$P2_1$
a/Å	14.7922(7)
b/Å	6.2915(3)
c/Å	19.9389(10)
α/°	90
β/°	106.376(2)
γ/°	90
Volume/Å^3	1780.34(15)
Z	2
ρ_{calc}g/cm^3	1.268
μ/mm^{-1}	0.181
F(000)	692.0
Crystal size/mm^3	0.15 × 0.06 × 0.05
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	4.026 to 52.916
Index ranges	$-18 \le h \le 18$, $-7 \le k \le 7$, $-24 \le l \le 24$
Reflections collected	21018
Independent reflections	6682 [R_{int} = 0.0644, R_{sigma} = 0.0669]
Data/restraints/parameters	6682/1/425

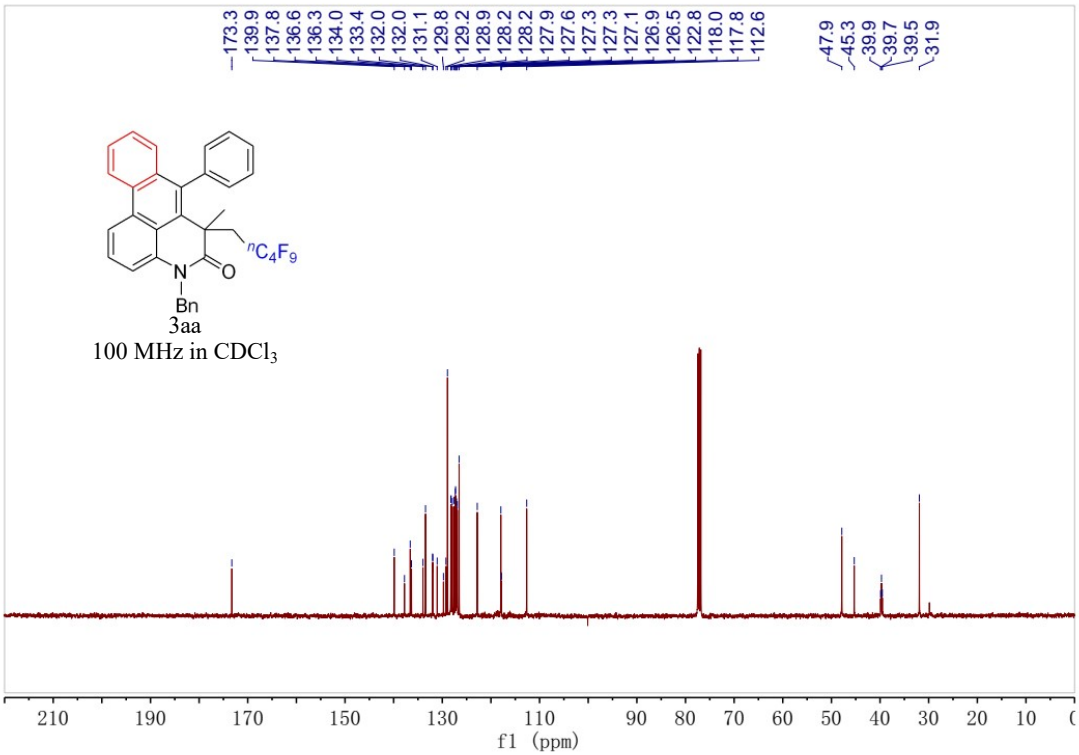
Goodness-of-fit on F^2	1.033
Final R indexes [I>=2σ (I)]	R_1 = 0.0442, wR_2 = 0.1017
Final R indexes [all data]	R_1 = 0.0581, wR_2 = 0.1090
Largest diff. peak/hole / e $Å^{-3}$	0.21/-0.25

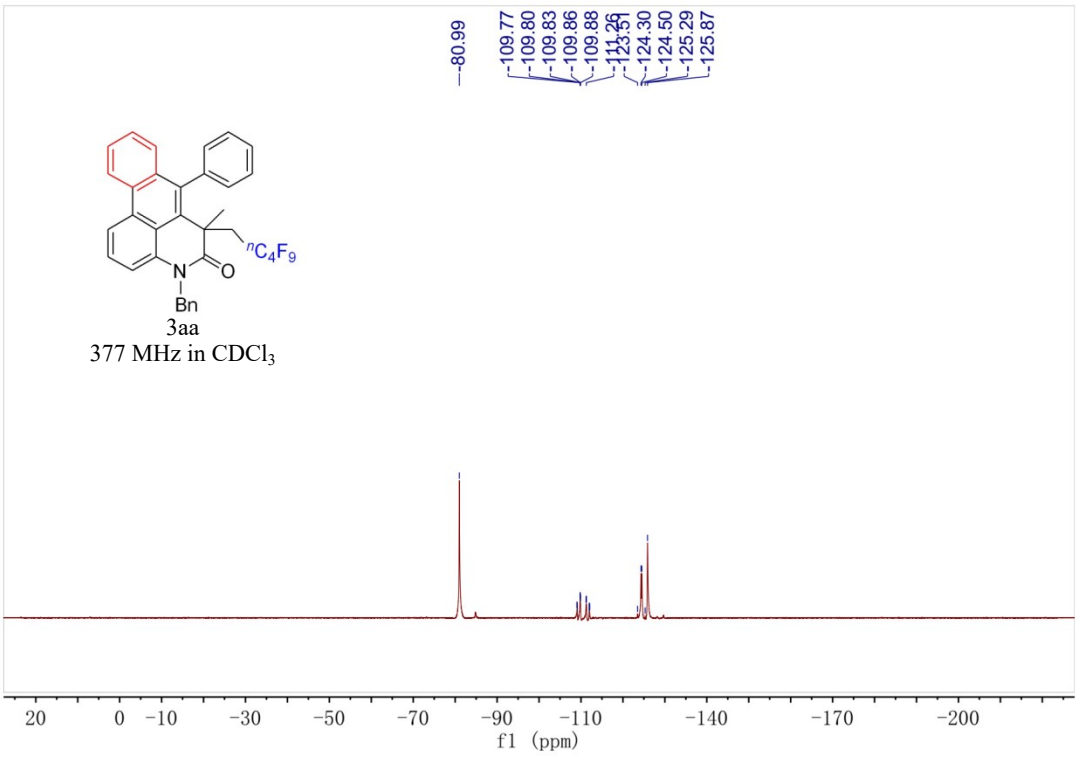
6. References

1. Xu, R.-R.; Fang, X.; Qi, X.; Wu, X.-F. Convenient synthesis of thioester-substituted oxindoles by palladium-catalyzed thiocarbonylative cyclization with sulfonyl chlorides as the sulfur source. *Chin. J. Chem.* **2023**, *41*, 188-192.
2. Li, Q.; Cai, Y.; Hu, Y.; Jin, H.; Chen, F.; Liu, Y.; Zhou, B. Nickel-catalyzed cyclization of 1,7-enynes for the selective synthesis of dihydrocyclobuta[*c*]quinolin-3-ones and benzo[*b*]azocin-2-ones. *Chem. Commun.* **2021**, *57*, 11657-11660.
3. Akhmetov, V.; Feofanov, M.; Sharapa, D. I.; Amsharov, K. Alumina-mediated π-Activation of Alkynes. *J. Am. Chem. Soc.* **2021**, *143*, 15420-15426.
4. Ito, S.; Fujimoto, H.; Tobisu, M. Non-stabilized vinyl anion equivalents from styrenes by *N*-heterocyclic carbene catalysis and its use in catalytic nucleophilic aromatic substitution. *J. Am. Chem. Soc.* **2022**, *144*, 6714-6718.
5. Matsushima, T.; Kobayashi, S.; Watanabe, S. Air-driven potassium iodide-mediated oxidative photocyclization of stilbene derivatives. *J. Org. Chem.* **2016**, *81*, 7799-7806.

7. ^{1}H, ^{13}C, ^{19}F NMR spectra of products (3aa-qa, 3sa, 4a-c, 5ab-ai, 6aj, 7a-e)







3aa
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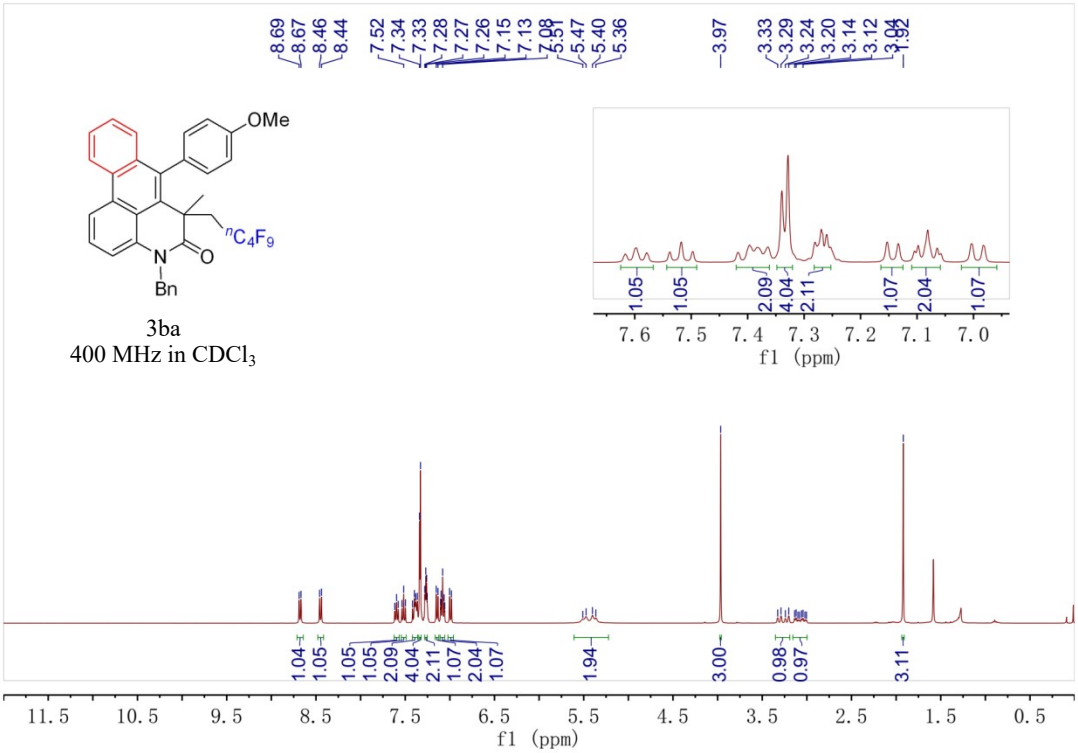
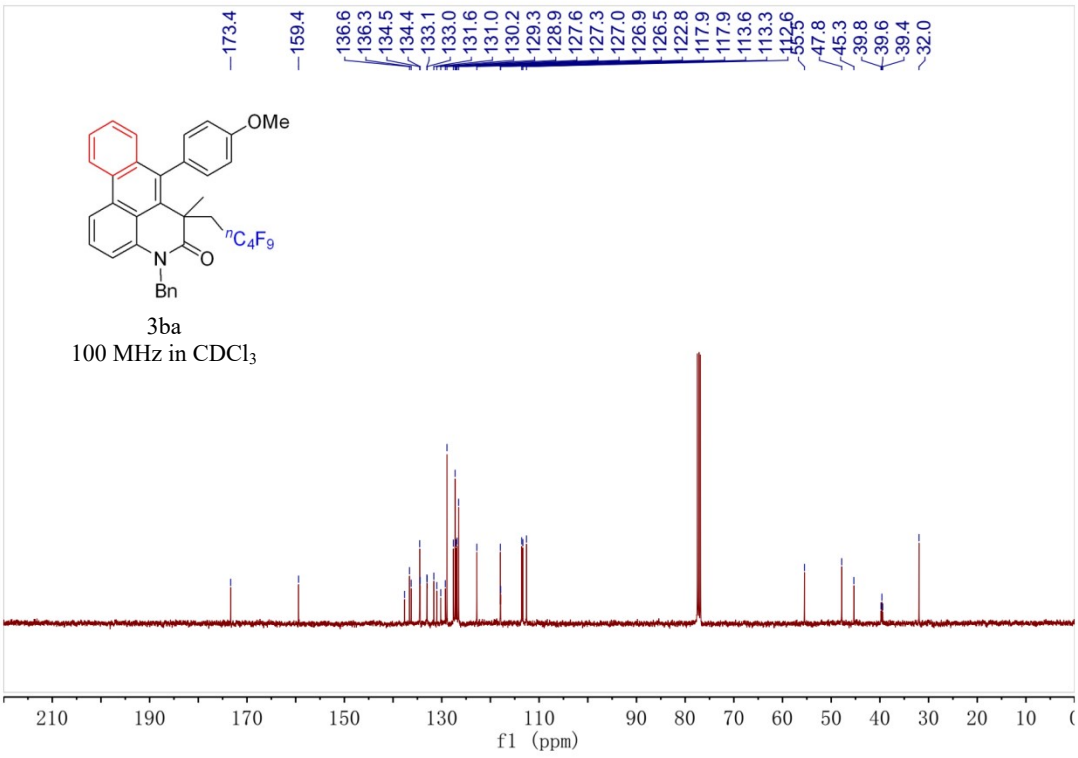


3ba
400 MHz in $CDCl_3$



3ba
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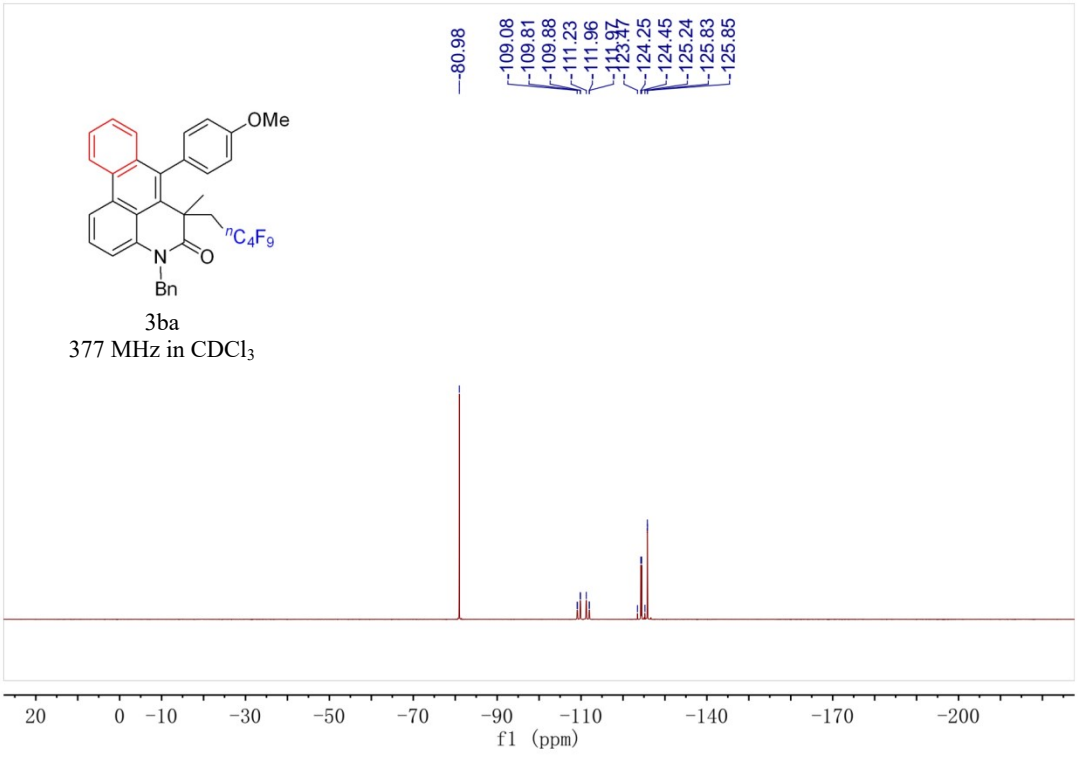

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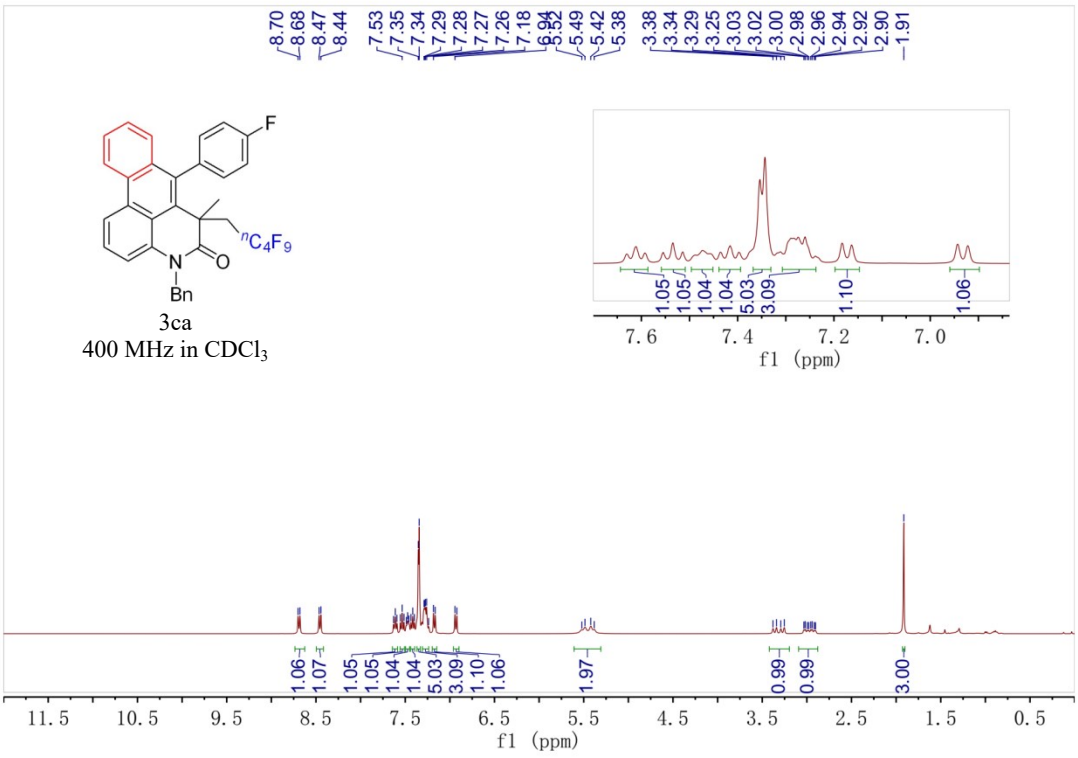

3ca
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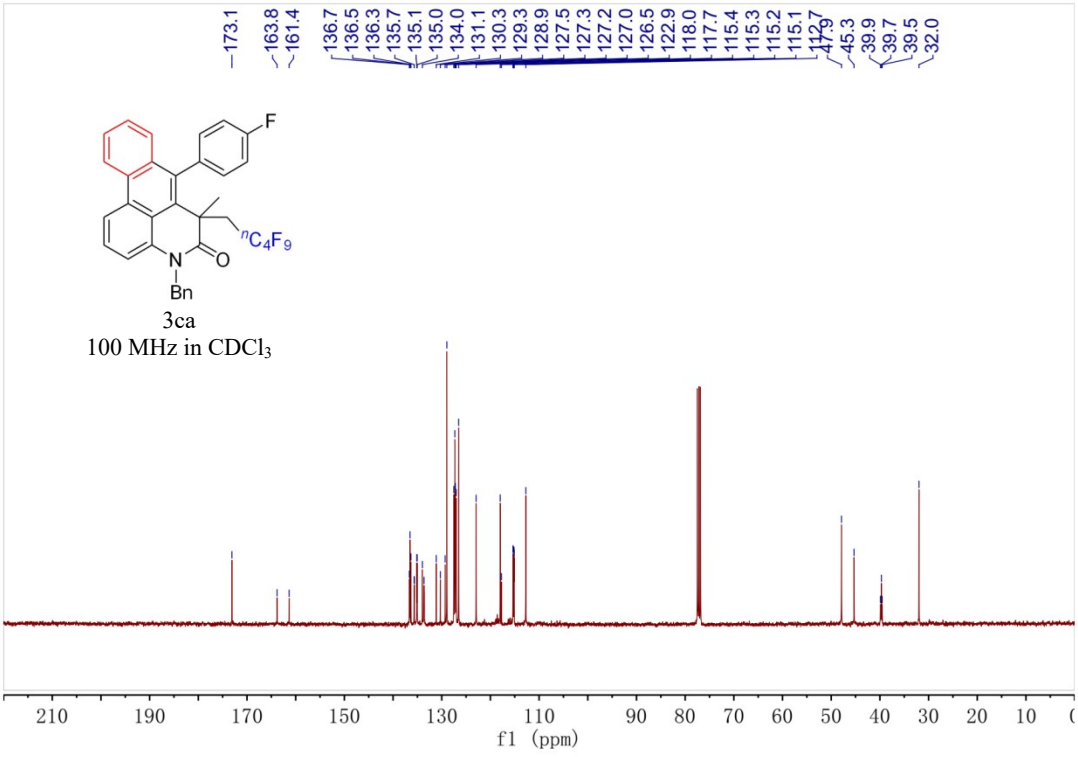

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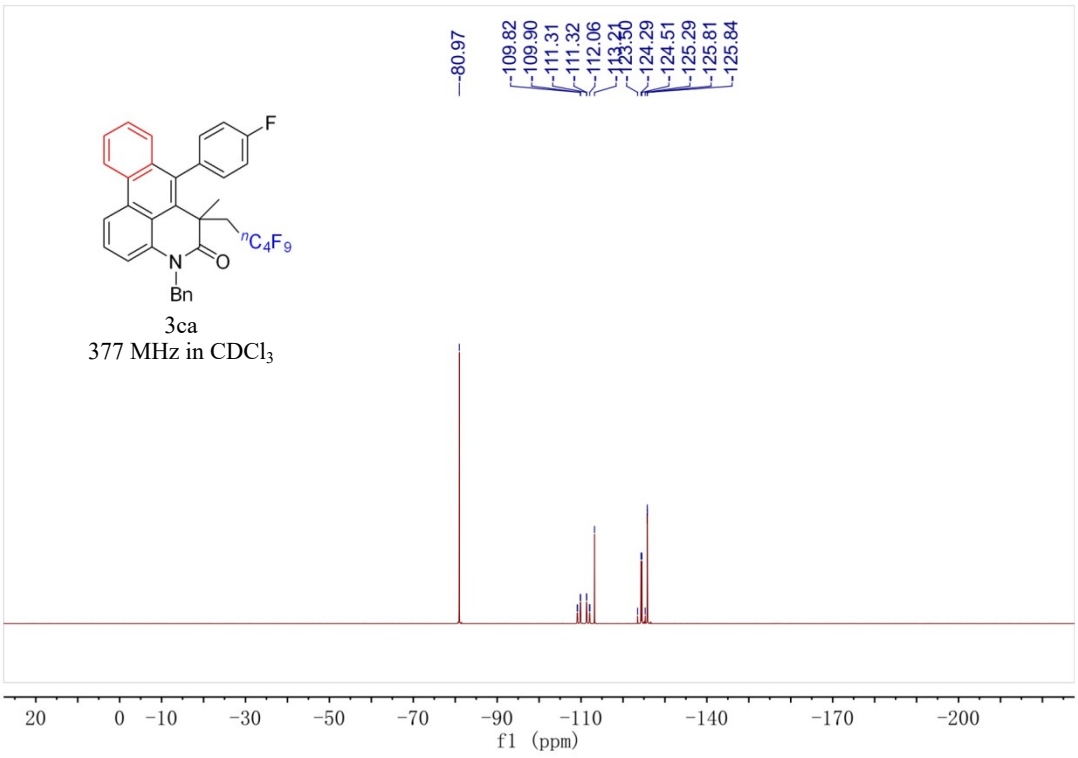

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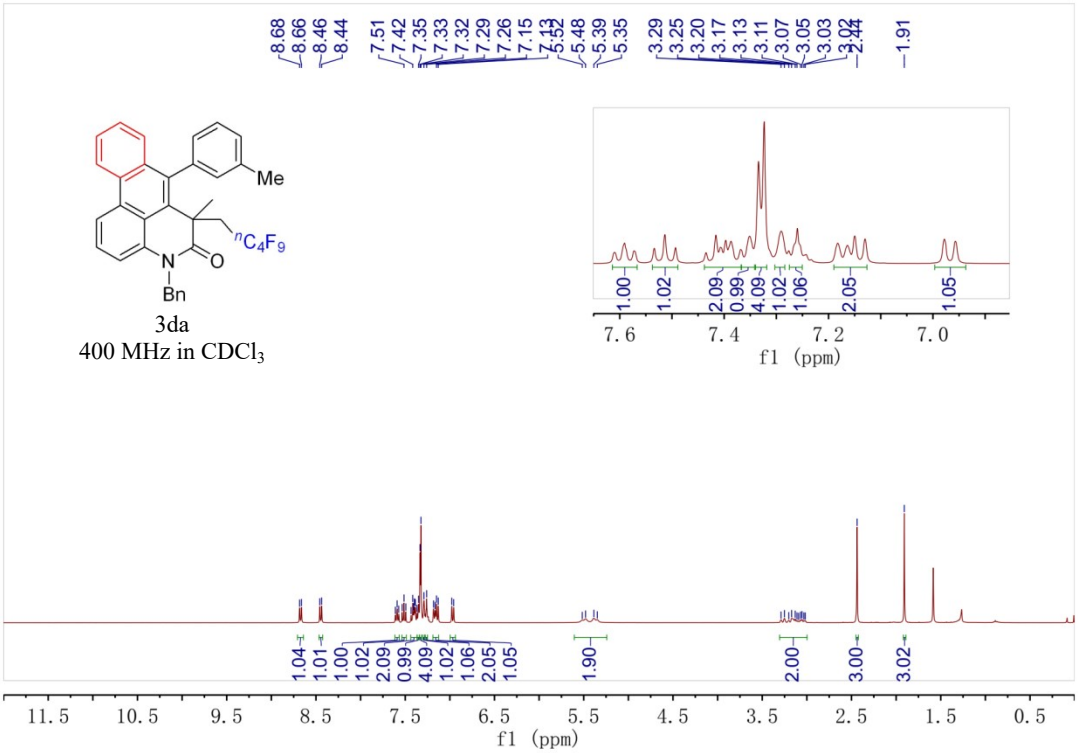

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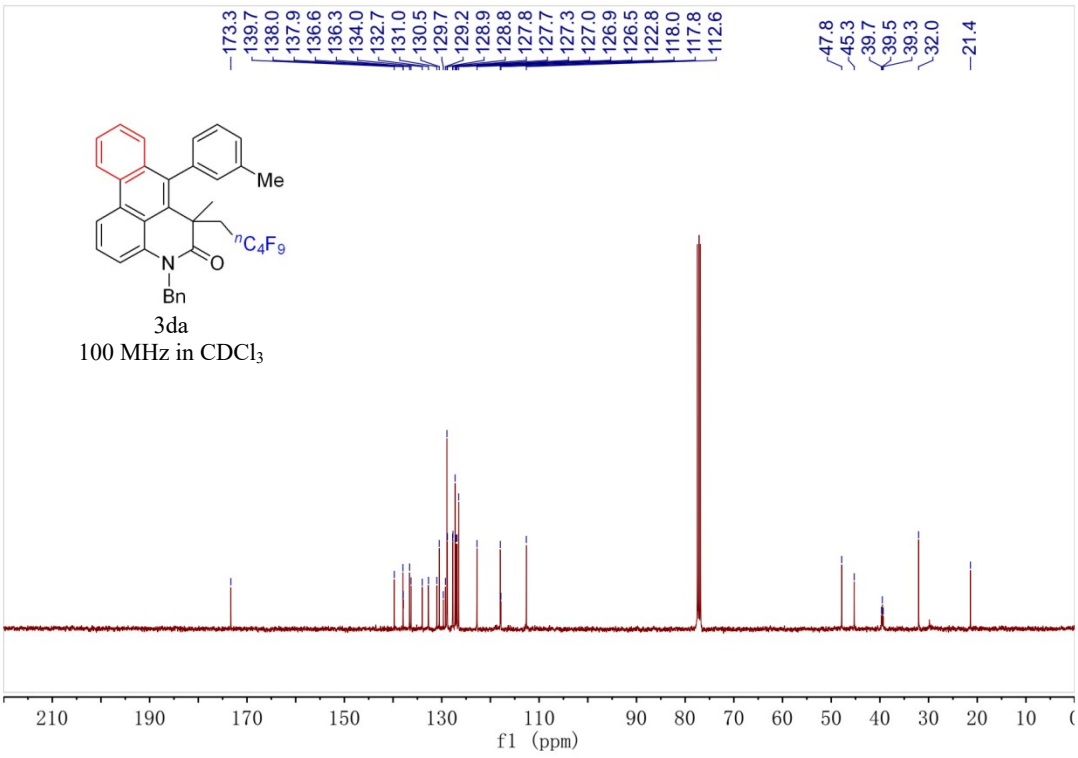

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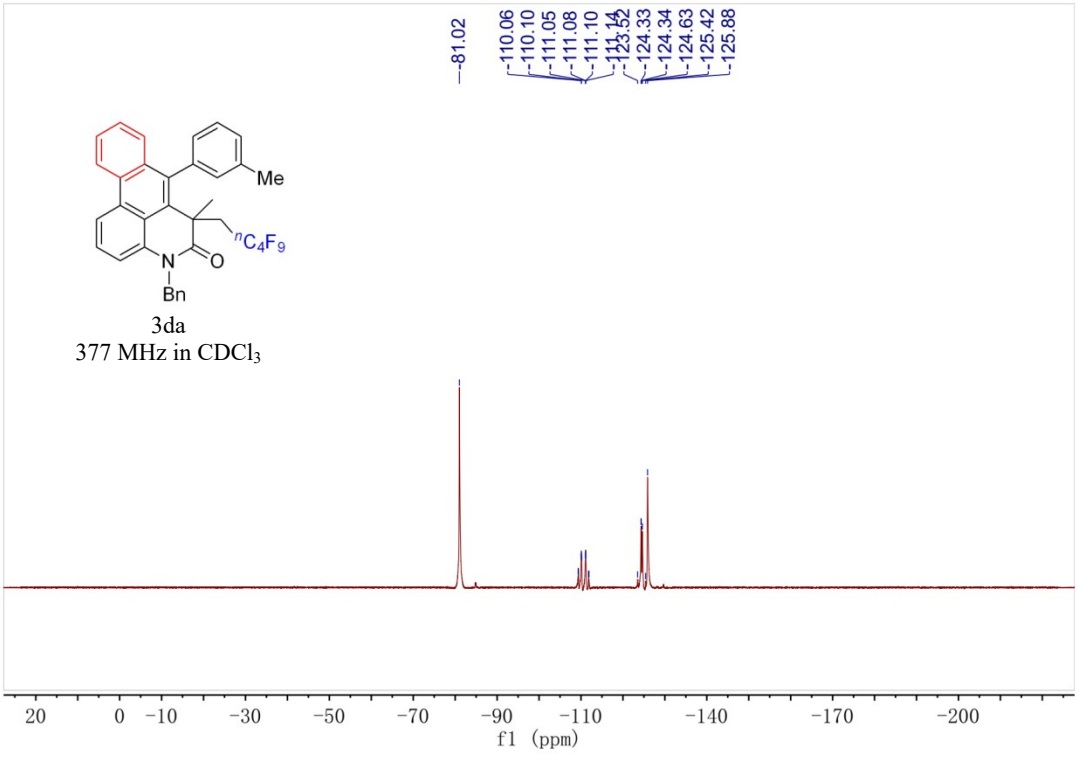

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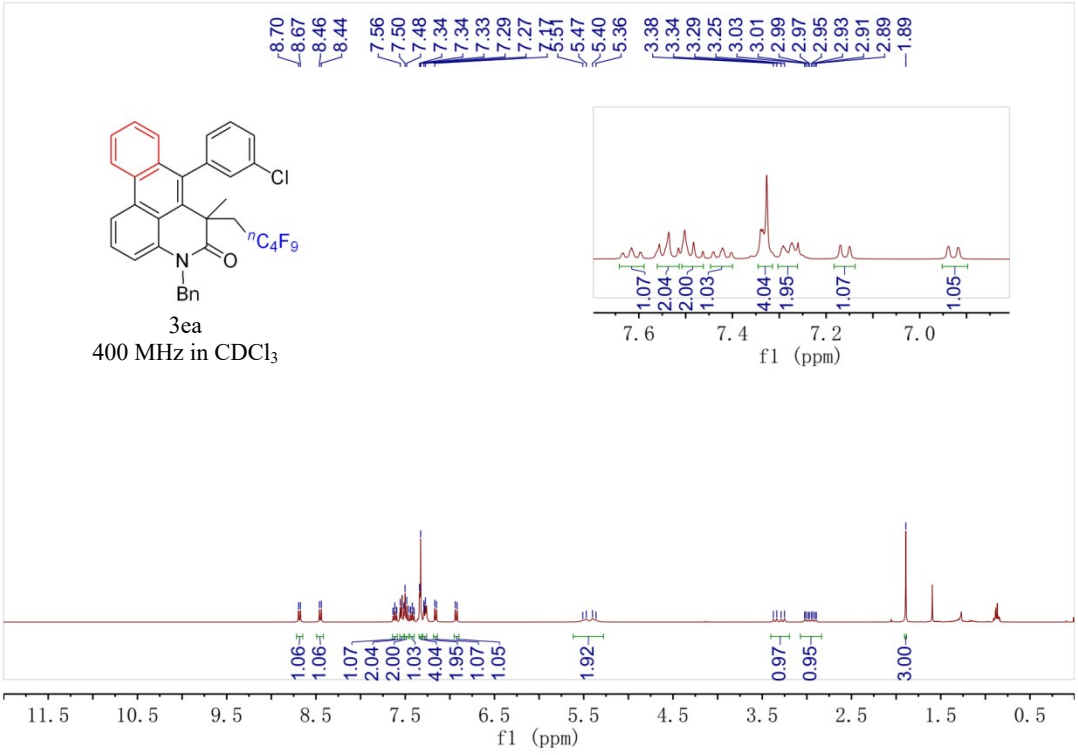

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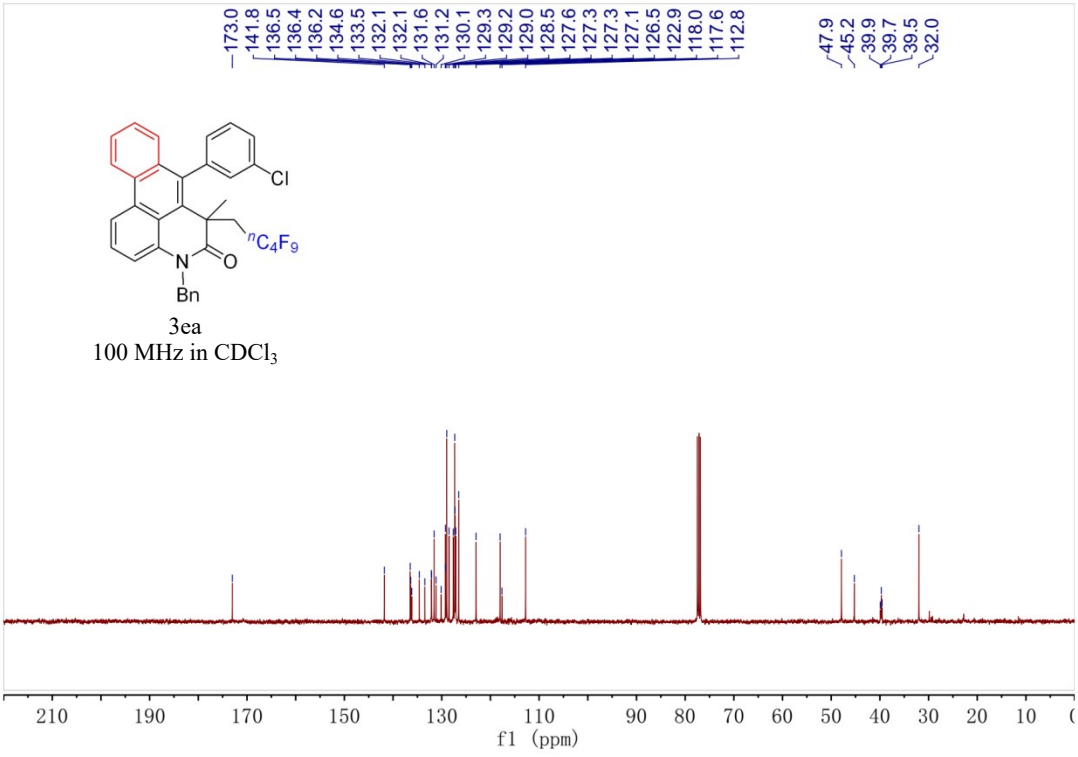

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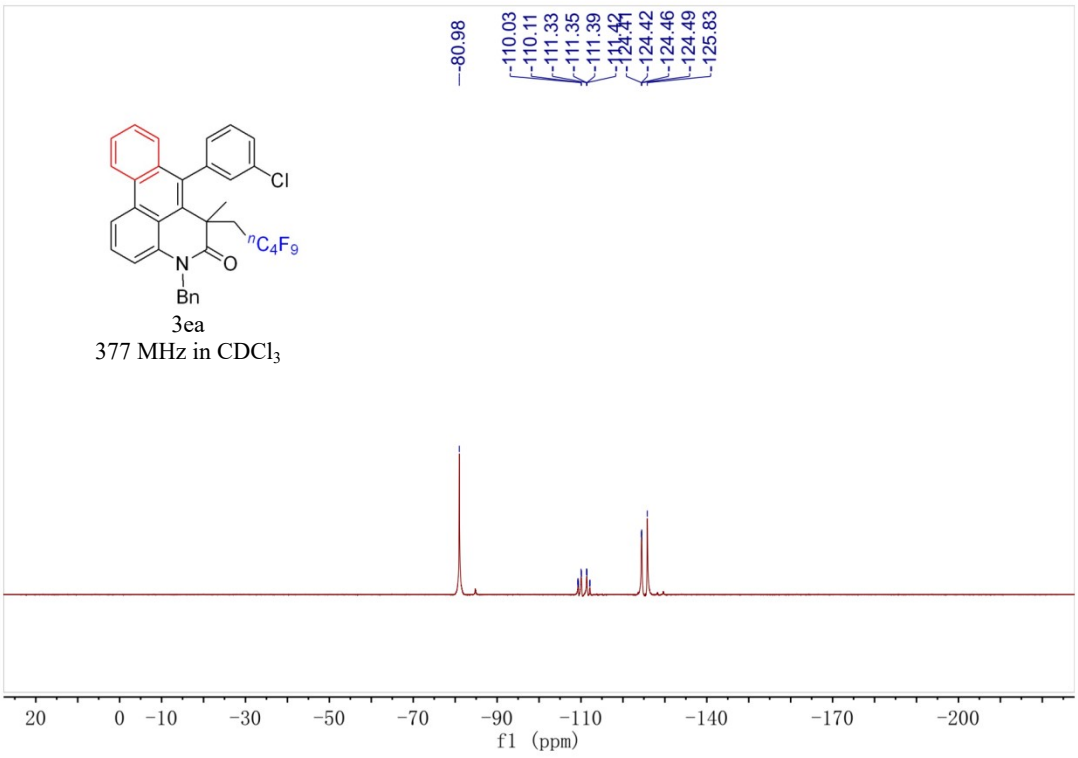

3ea
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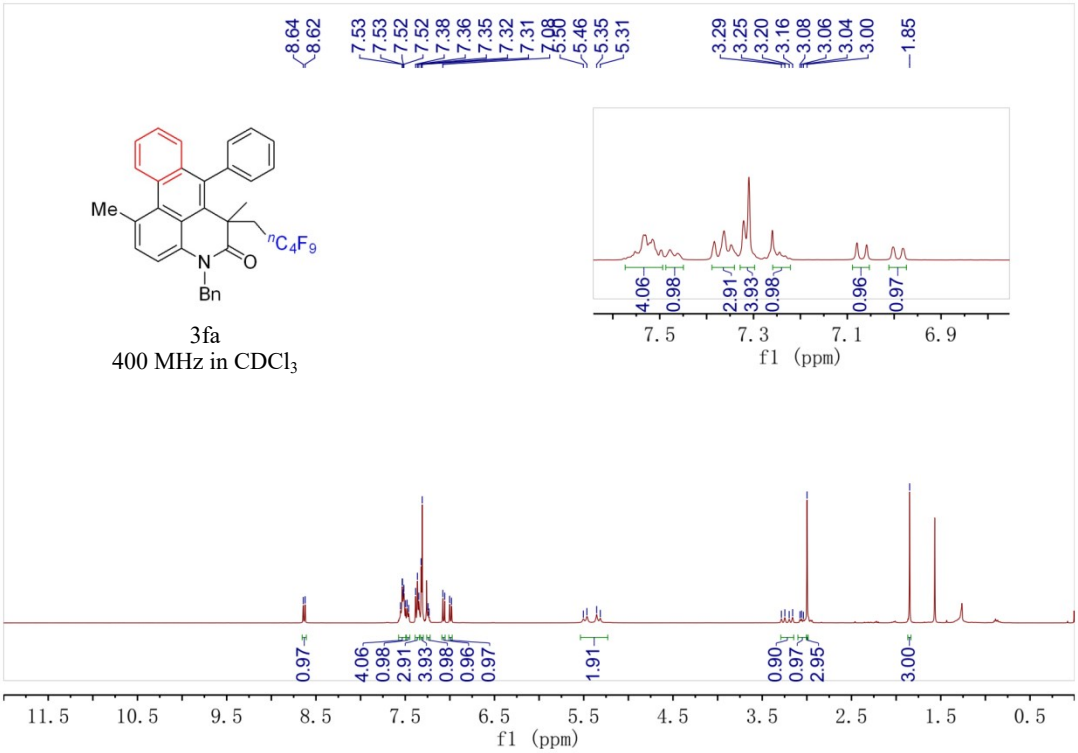

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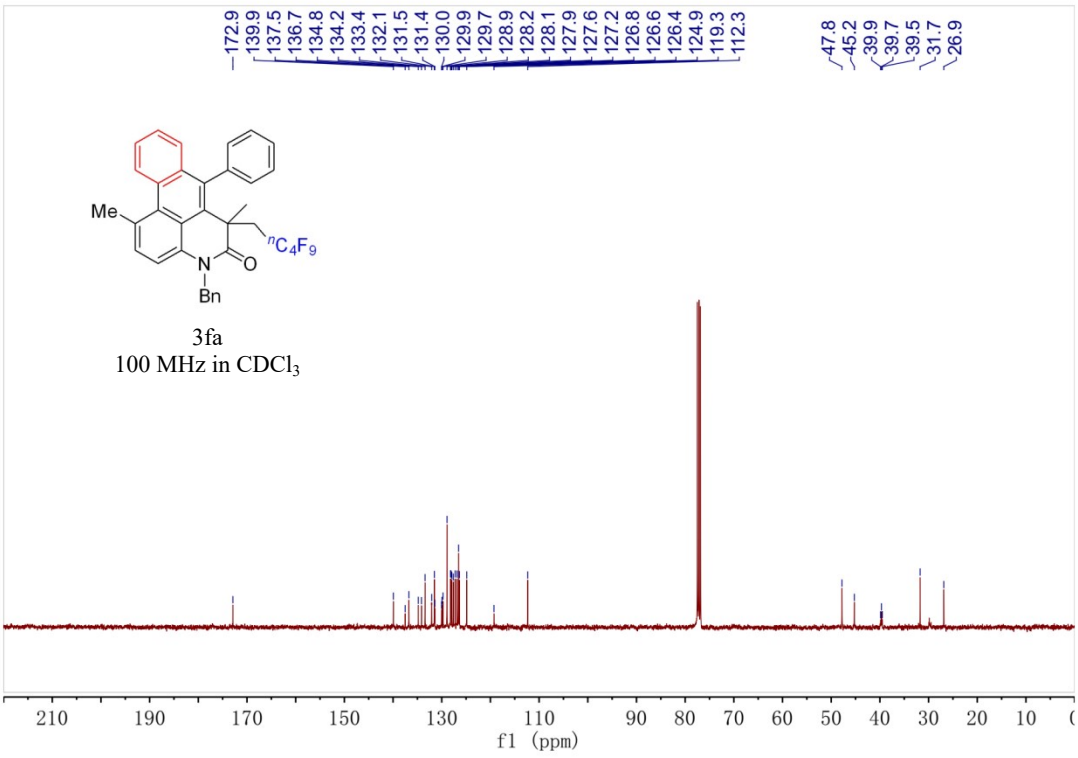

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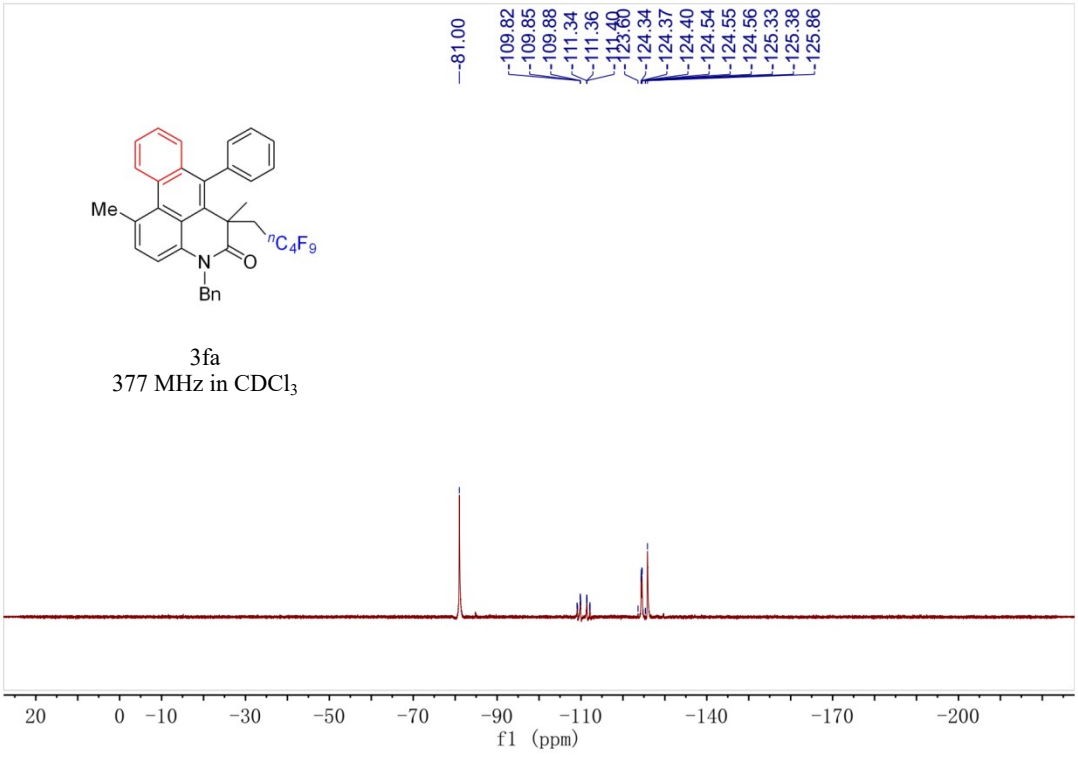

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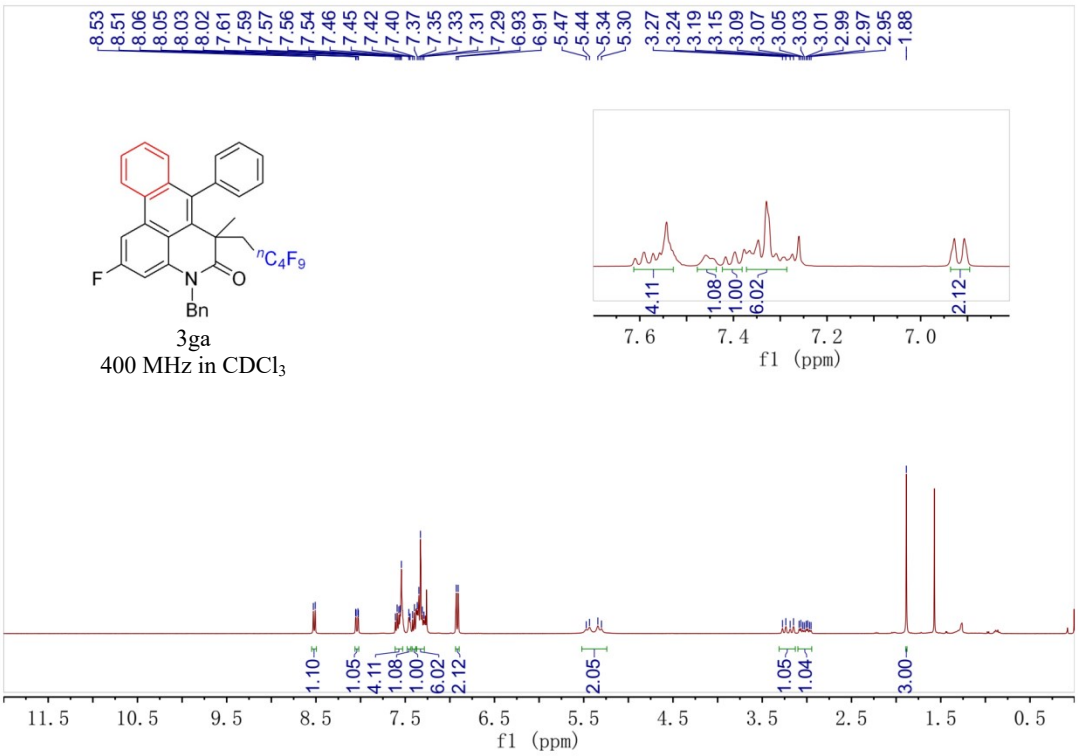

3ga
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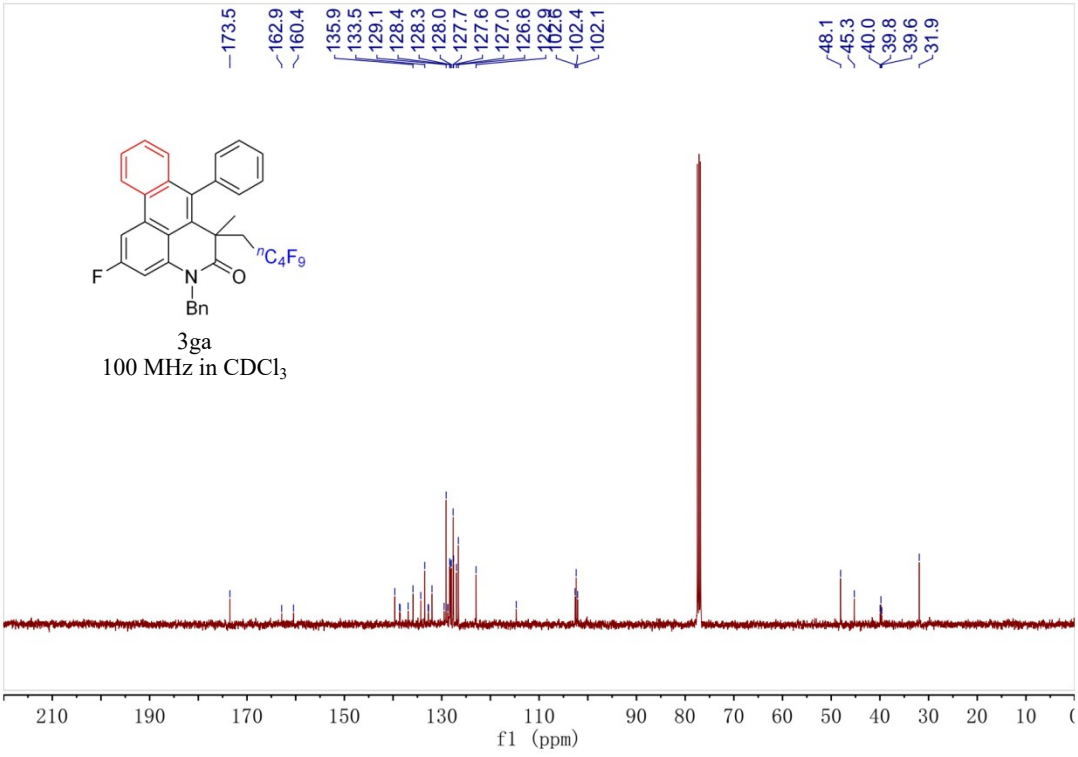

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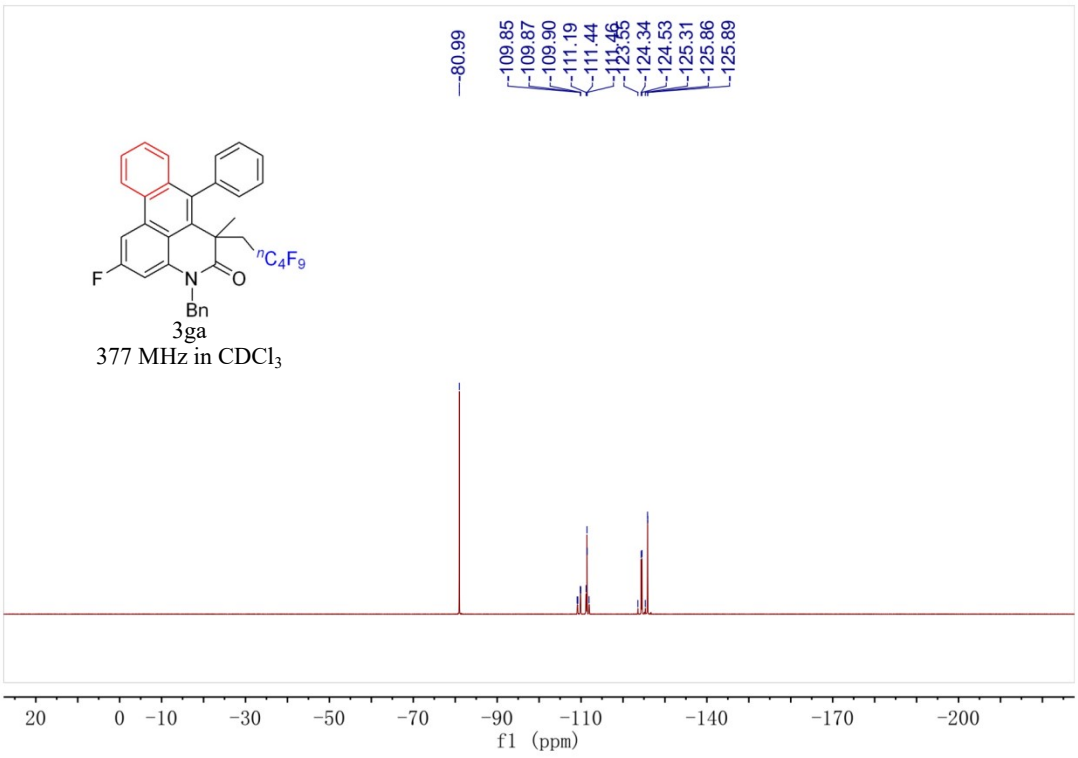

3ga

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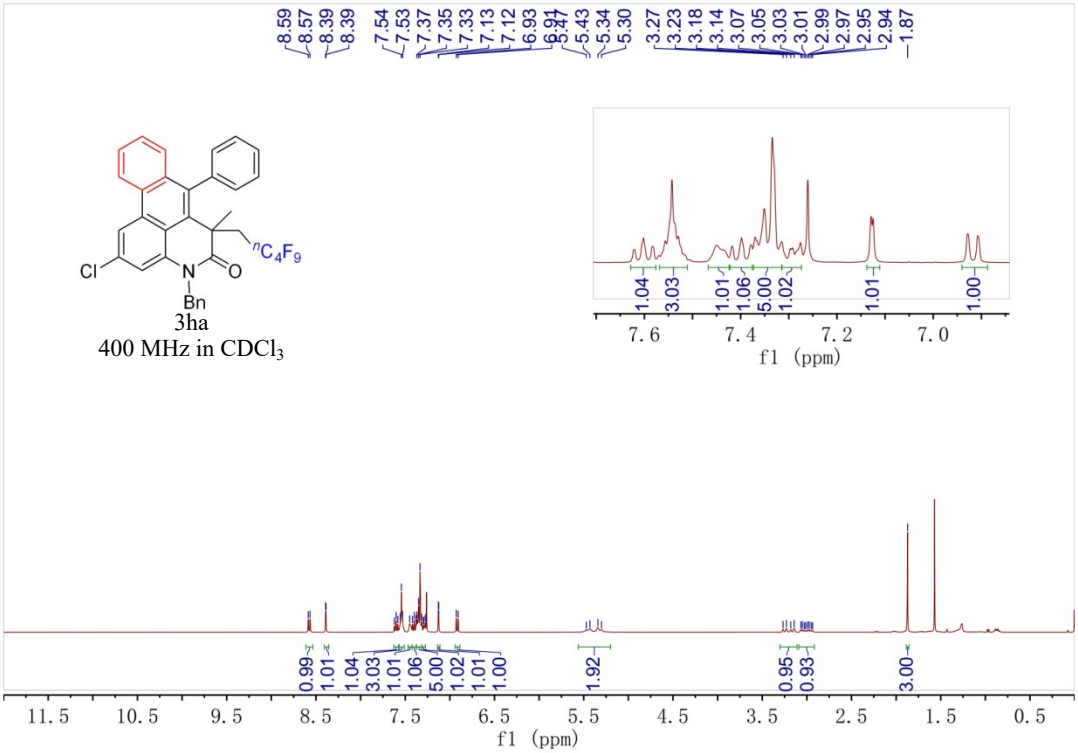

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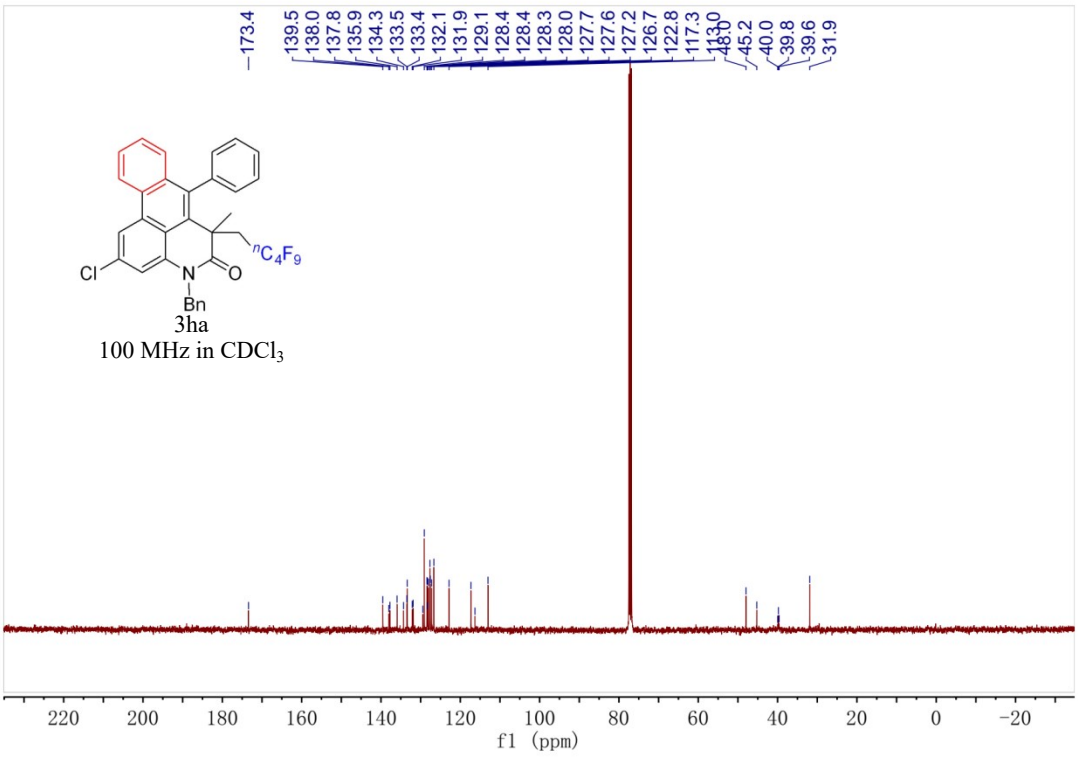

3ha

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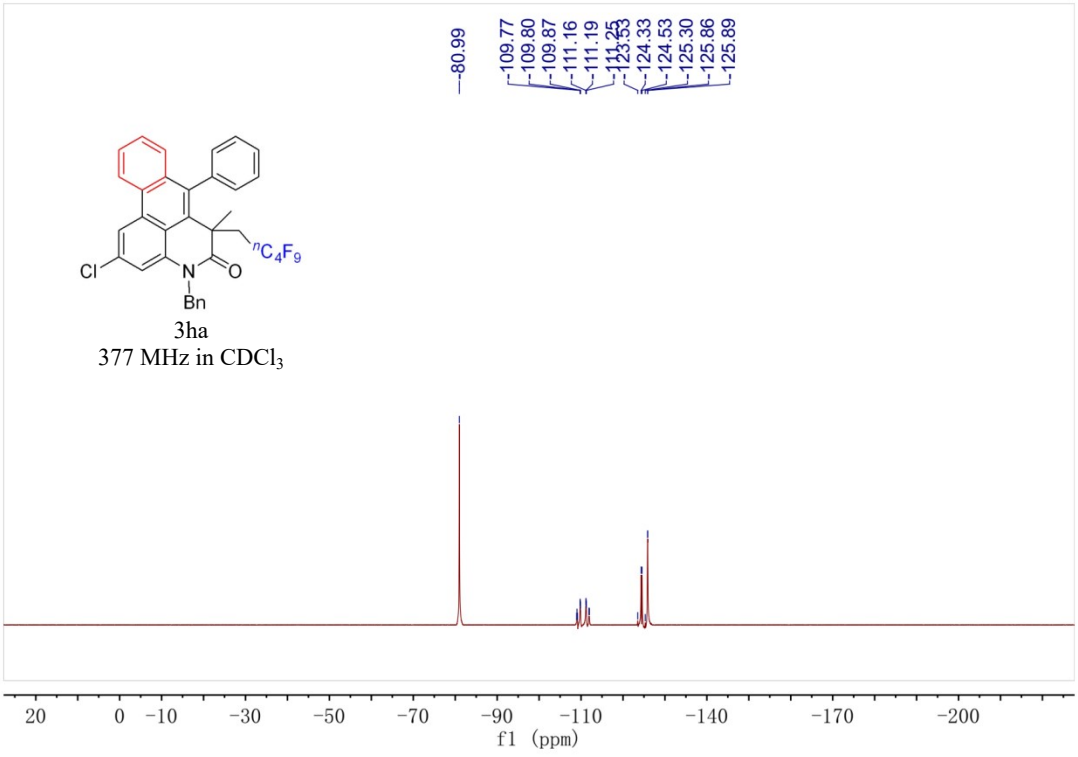

3ha

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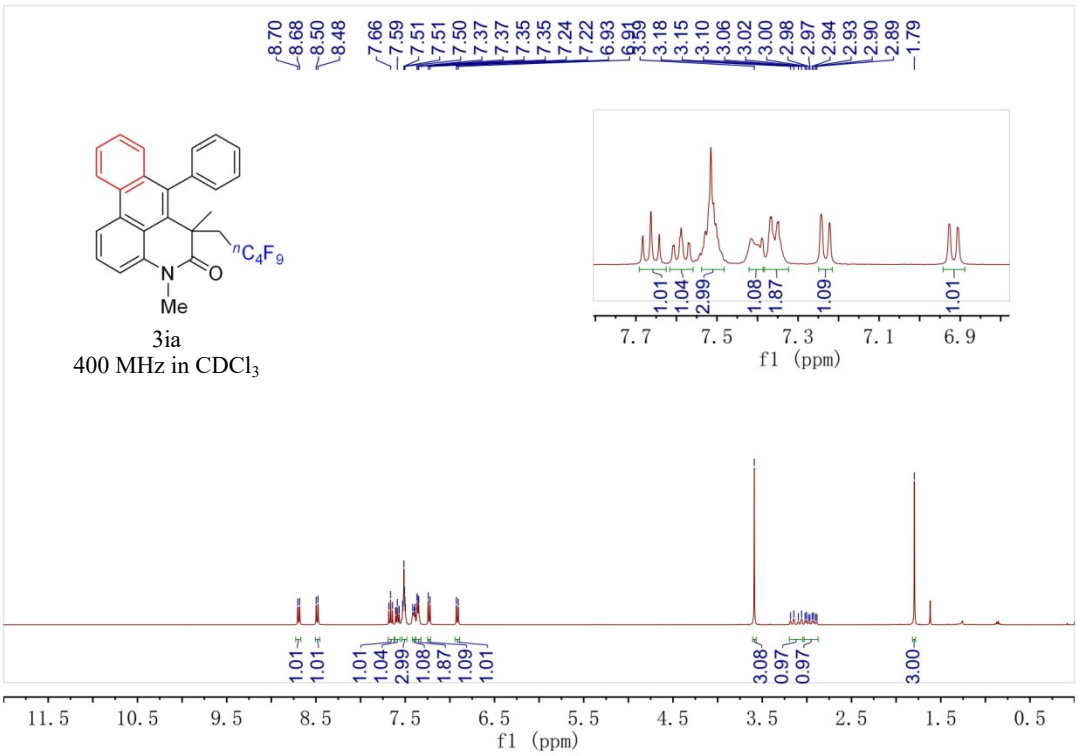

3ia
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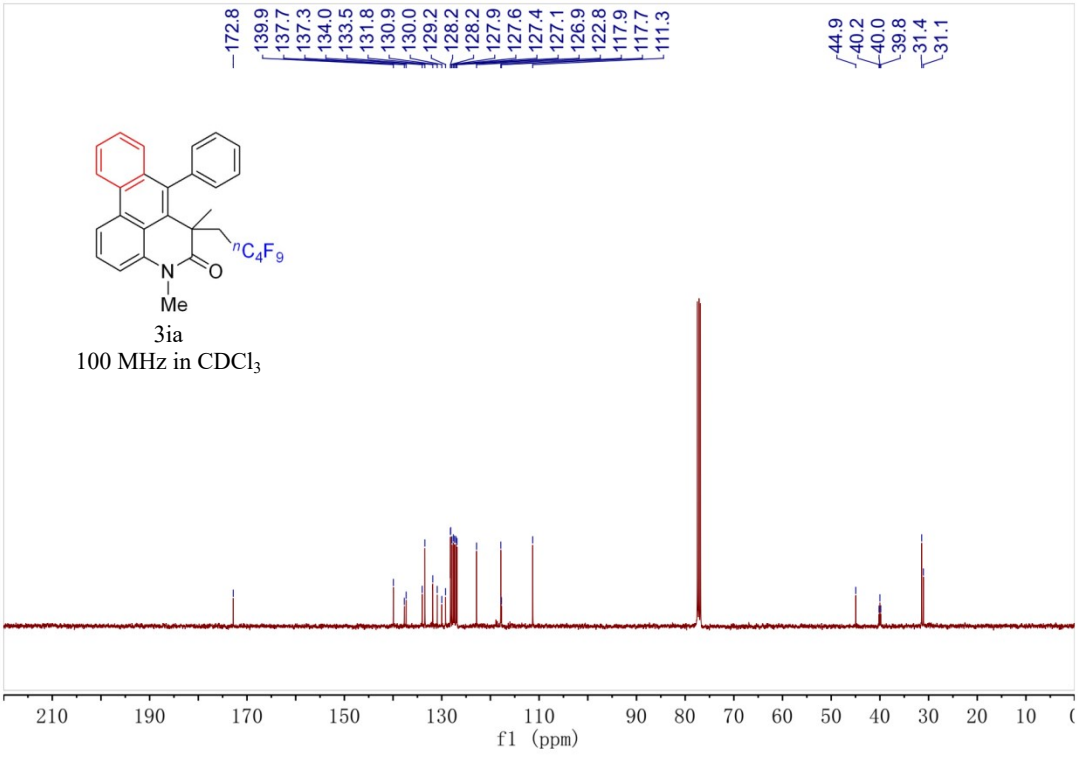

3ia
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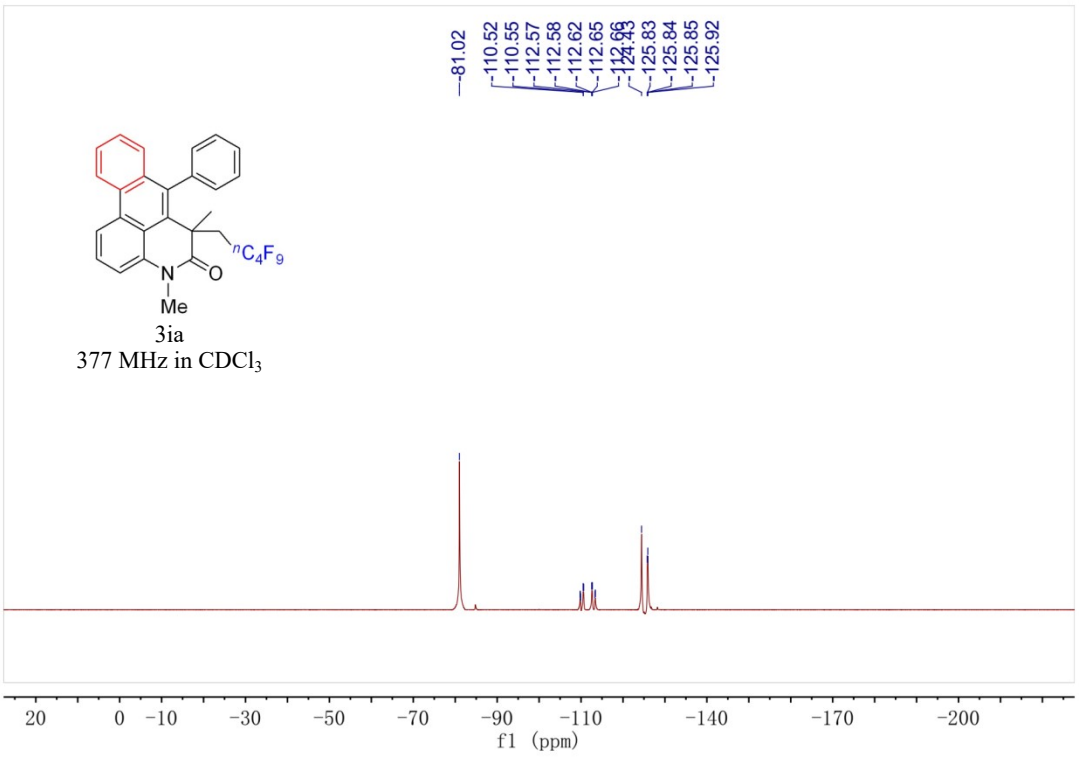

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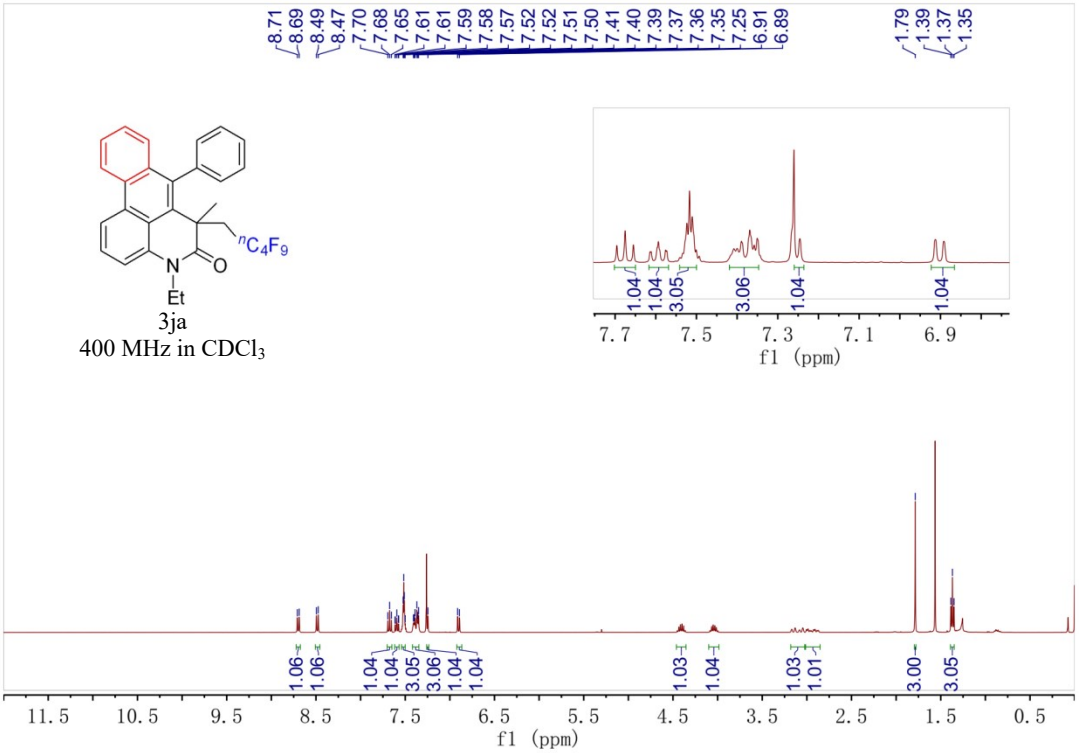

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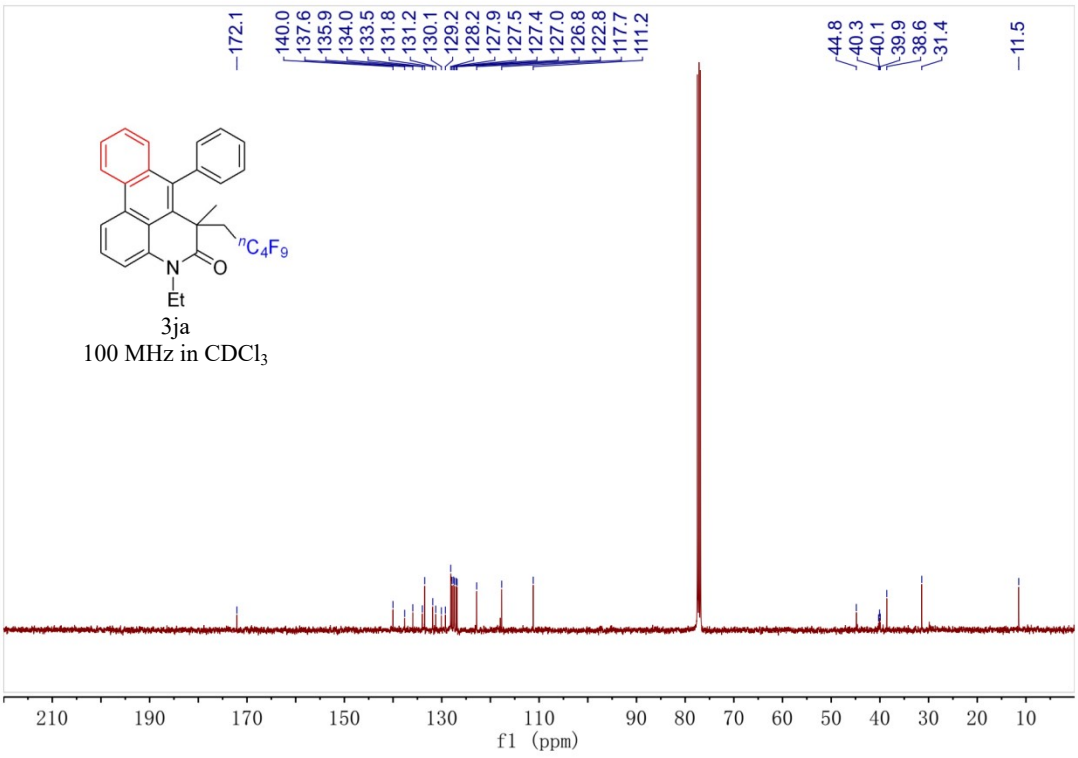

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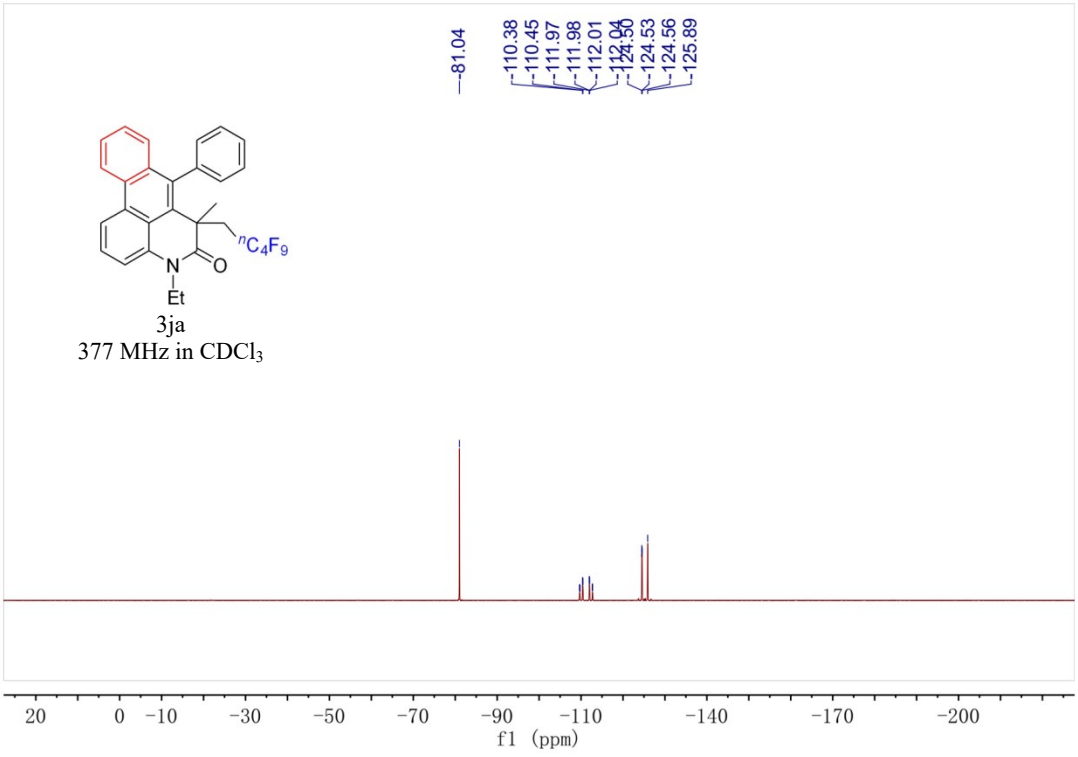

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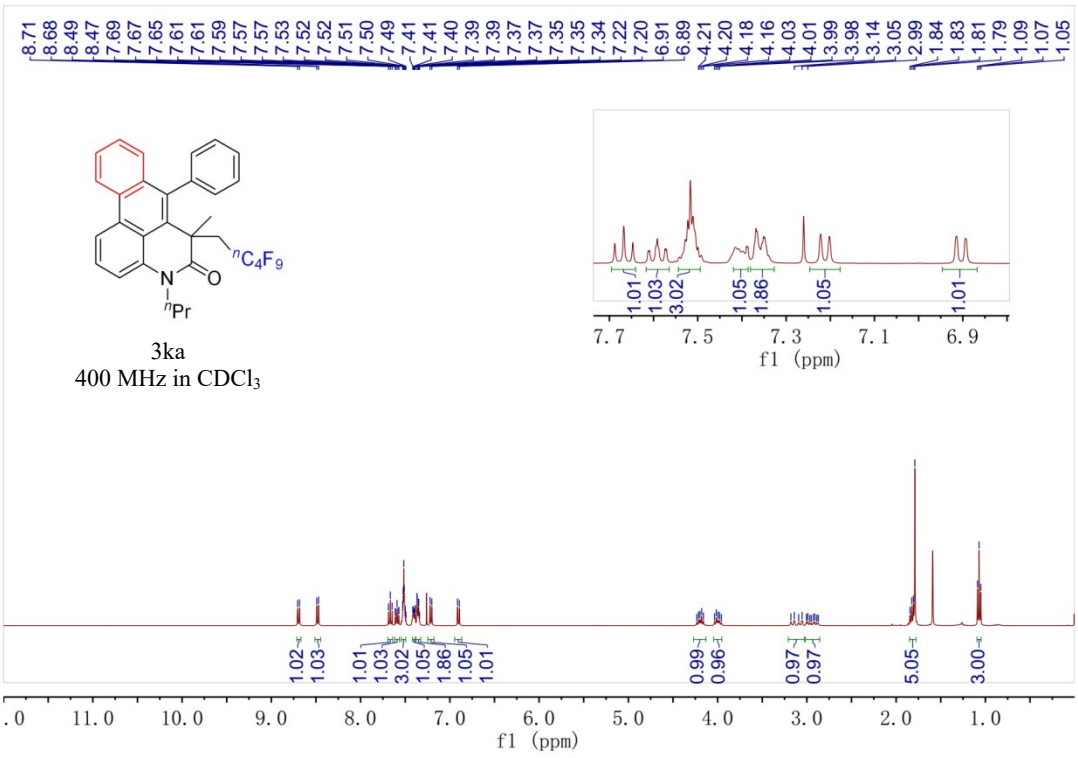

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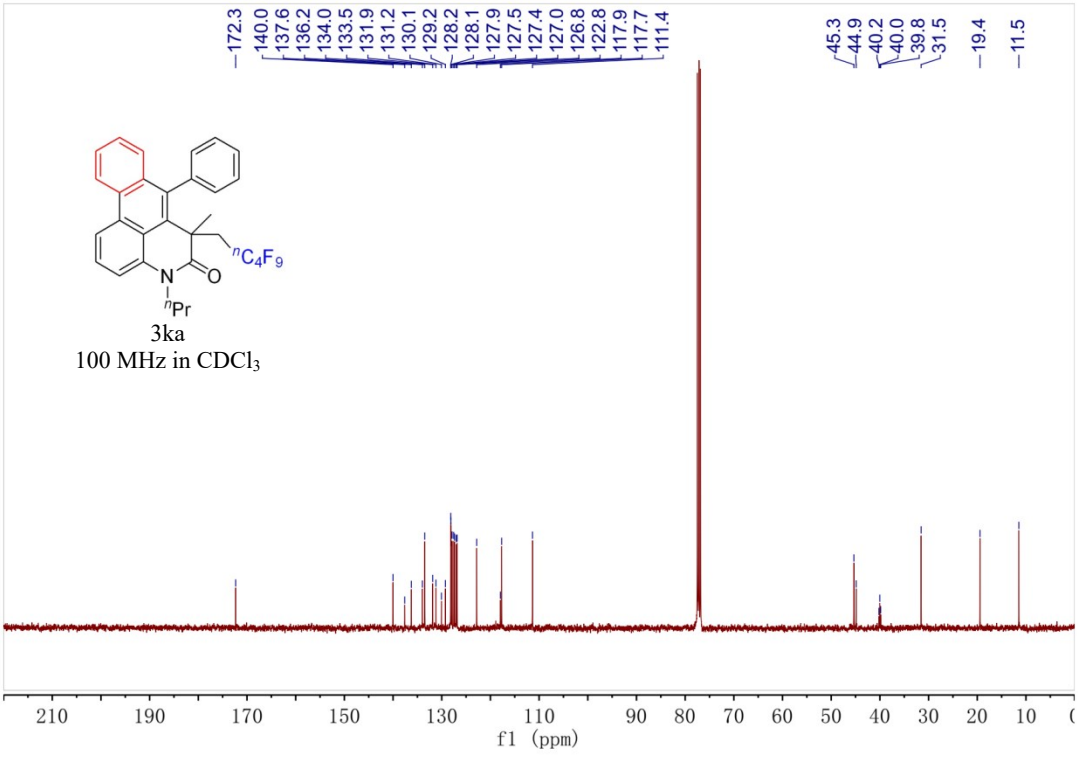

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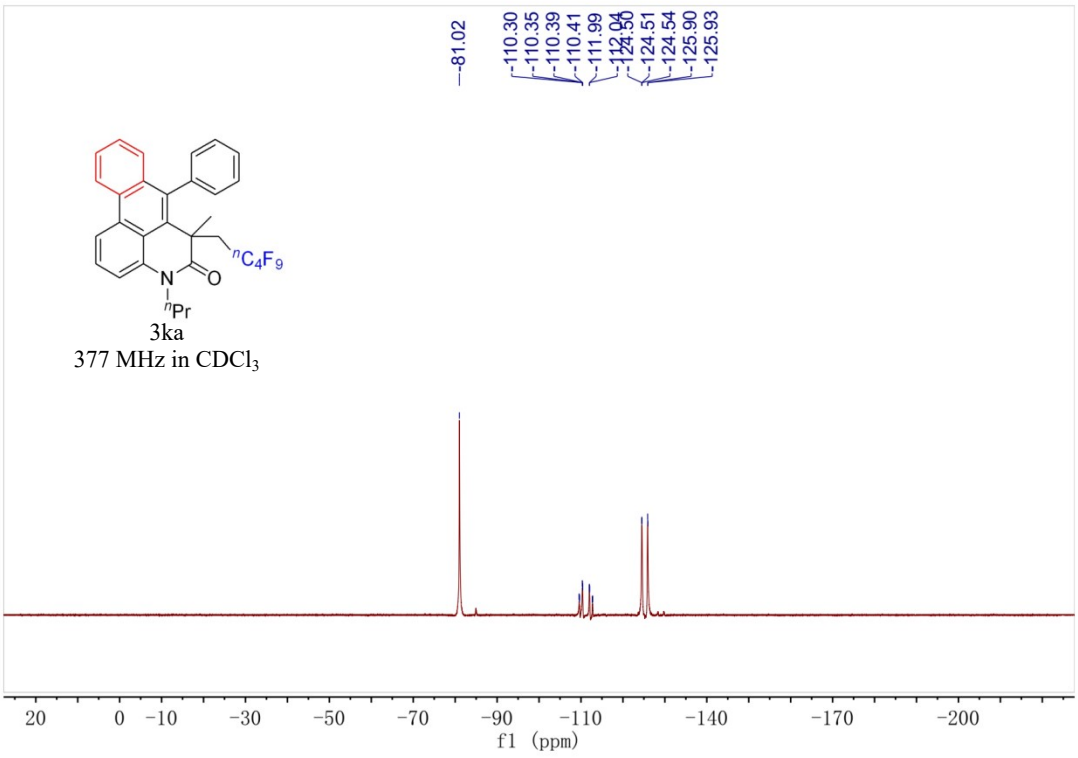

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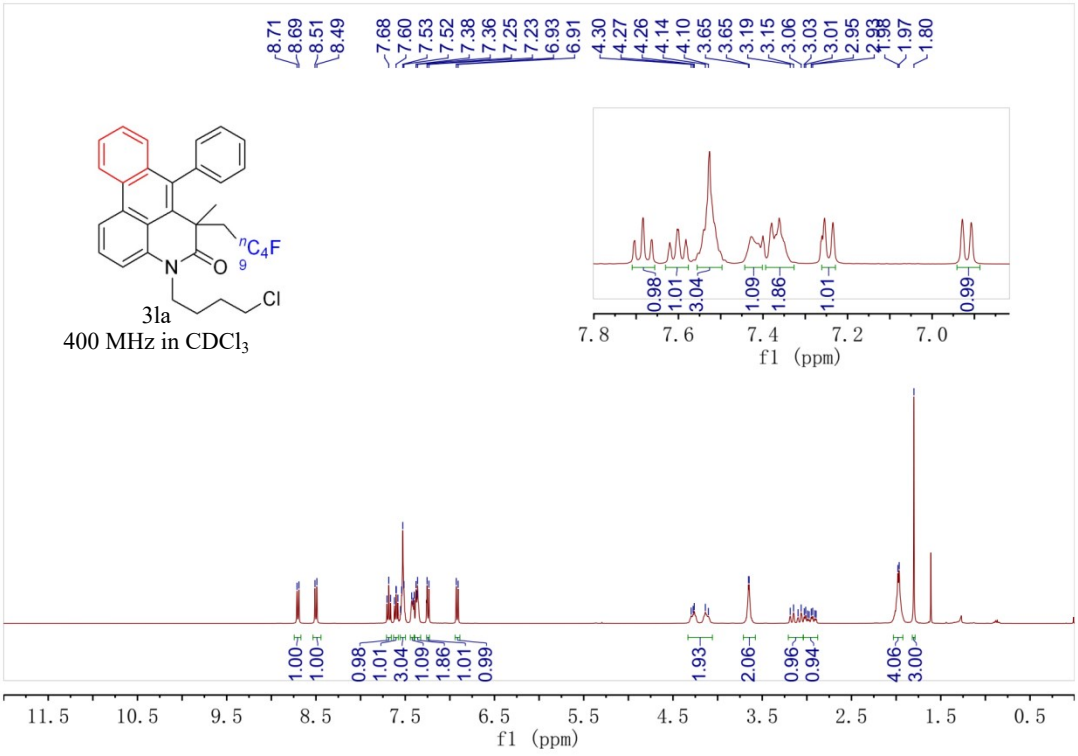

3la
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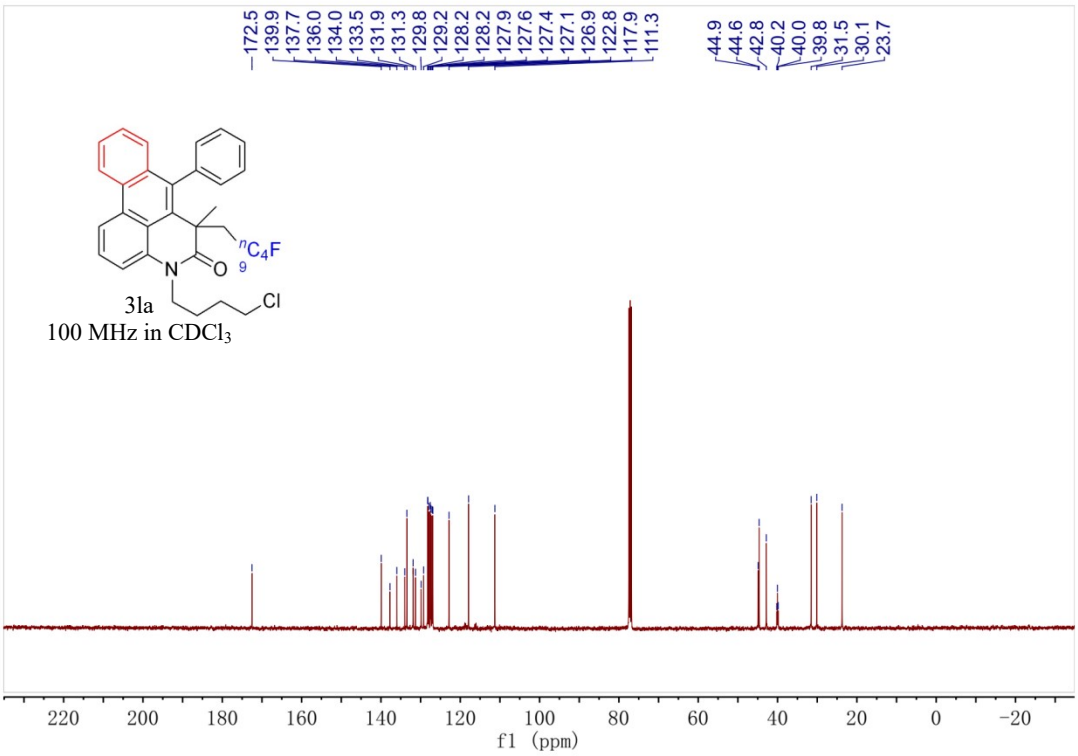
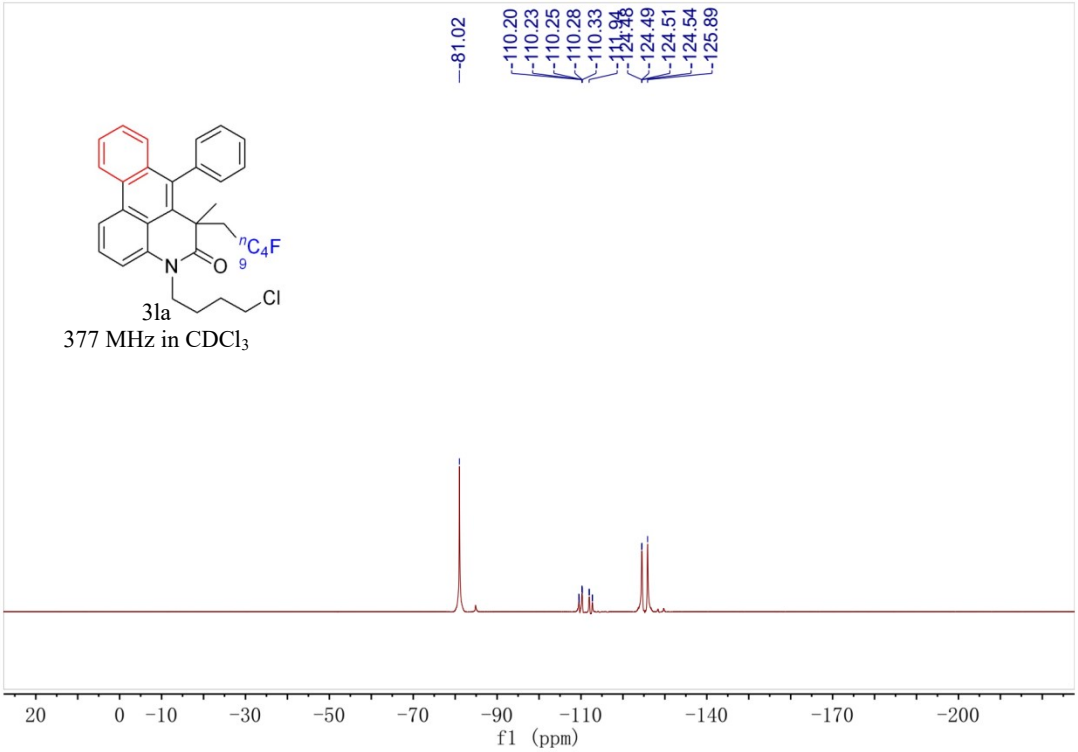
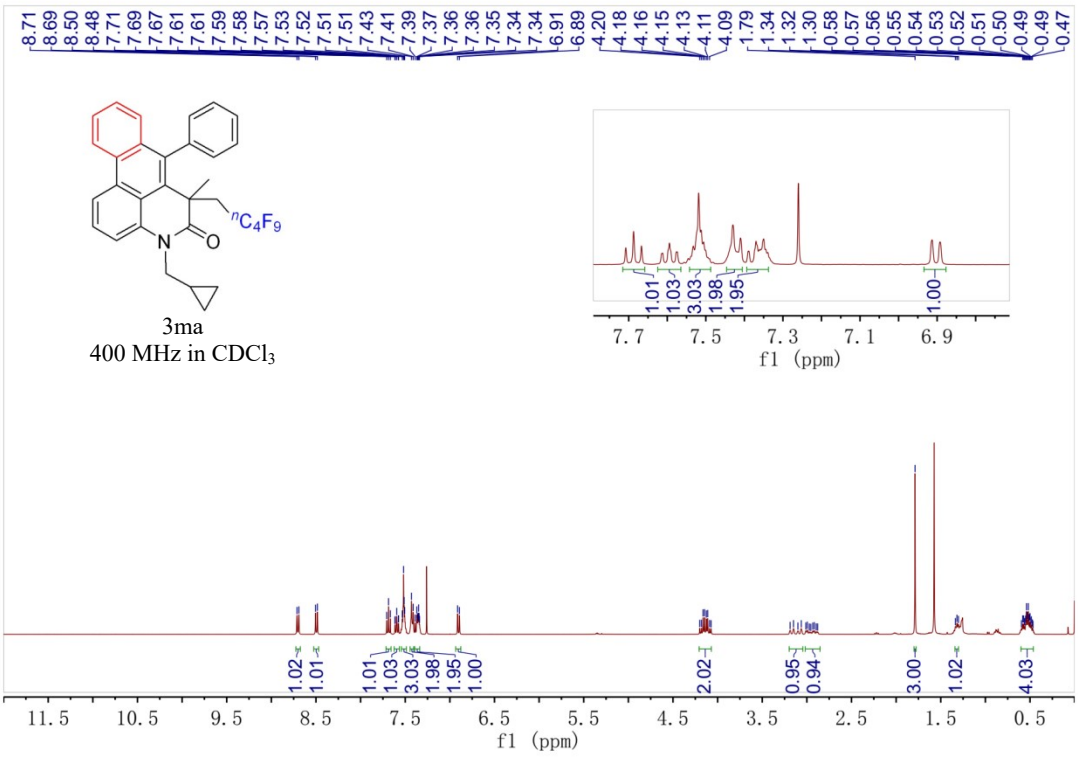
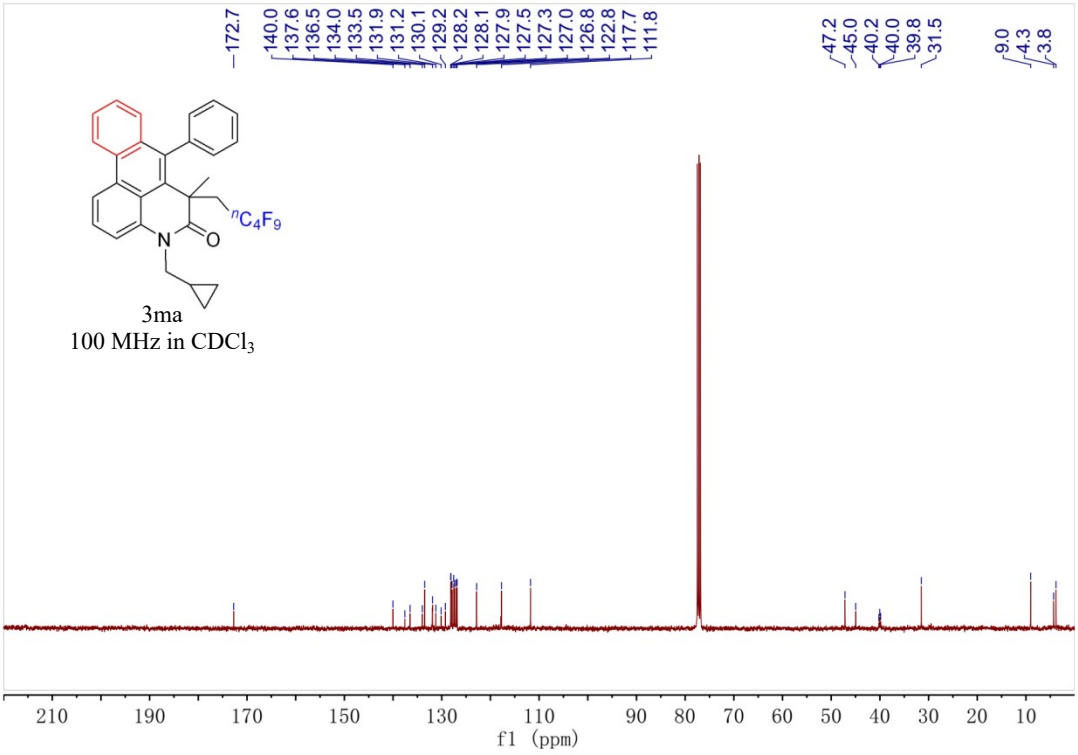

172.5
139.9
137.7
136.0
134.0
133.5
131.9
131.3
129.8
129.2
128.2
128.2
127.9
127.6
127.4
127.1
126.9
122.8
117.9
111.3
44.9
44.6
42.8
40.2
40.0
39.8
31.5
30.1
23.7
$^{n}C_4F_9$
N
O
Cl
3la
100 MHz in CDCl3
220
200
180
160
140
120
100
80
60
40
20
0
−20
f1 (ppm)


81.02
110.20
110.23
110.25
110.28
110.33
124.49
124.51
124.54
125.89
$^{n}C_4F_9$
N
O
Cl
3la
377 MHz in CDCl3
20
0
−10
−30
−50
−70
−90
−110
−140
−170
−200
f1 (ppm)



3ma
400 MHz in $CDCl_3$



3ma
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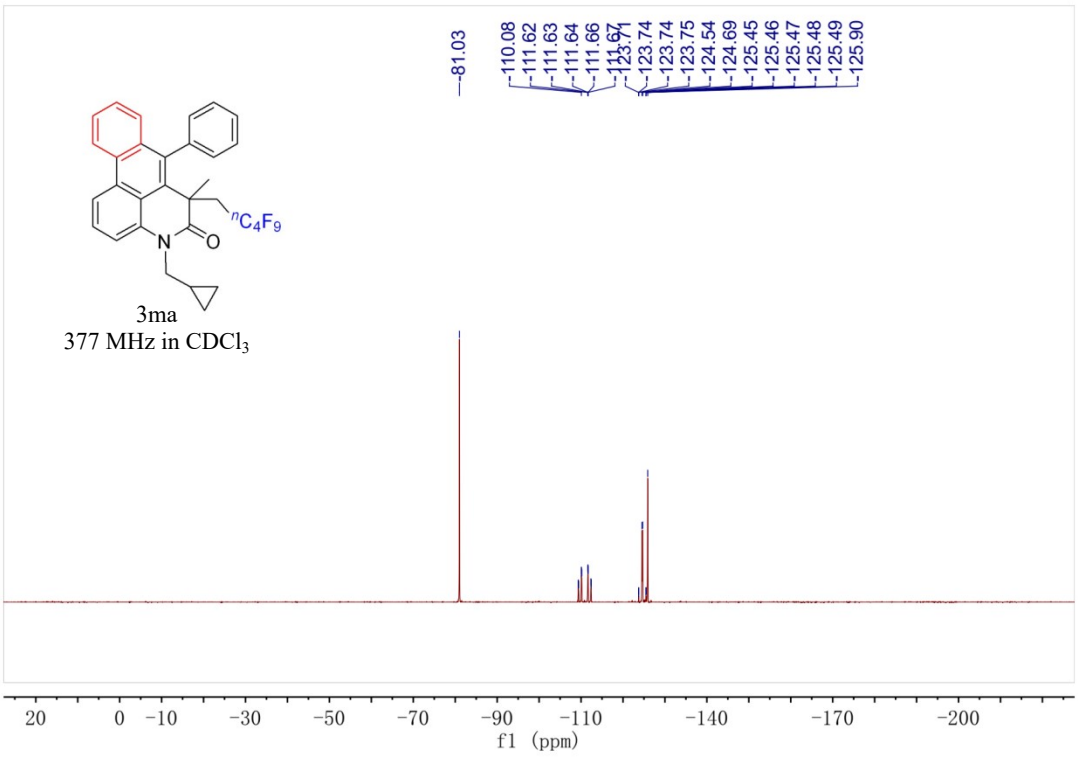
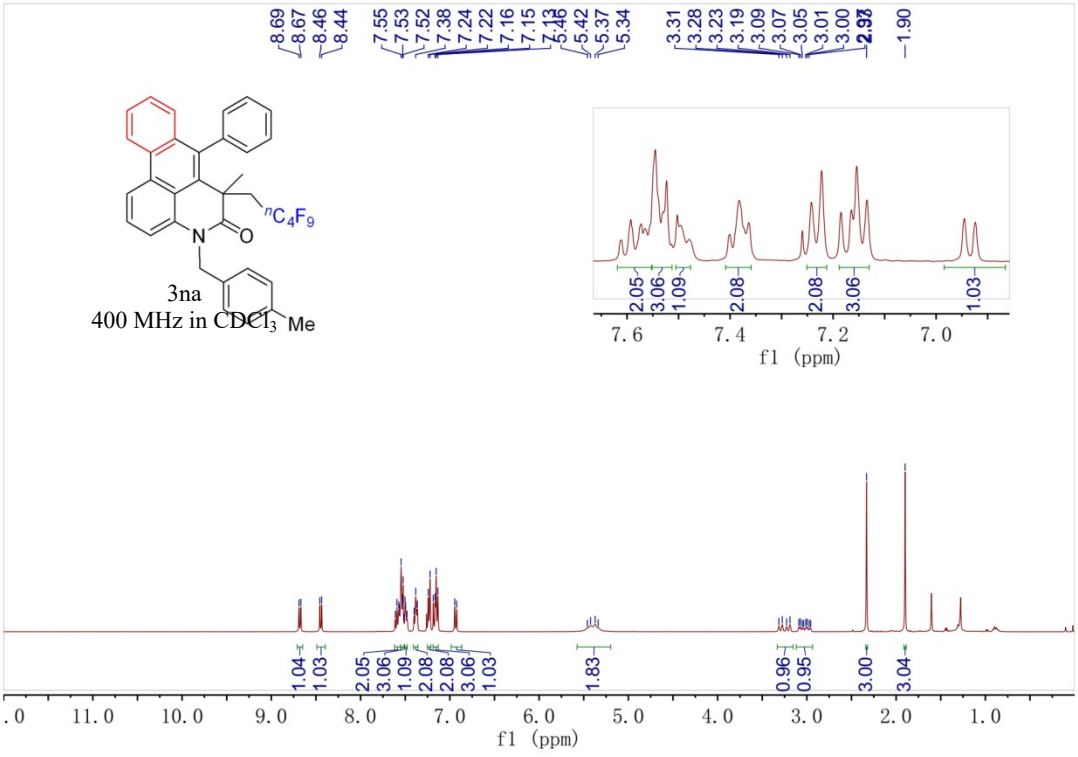
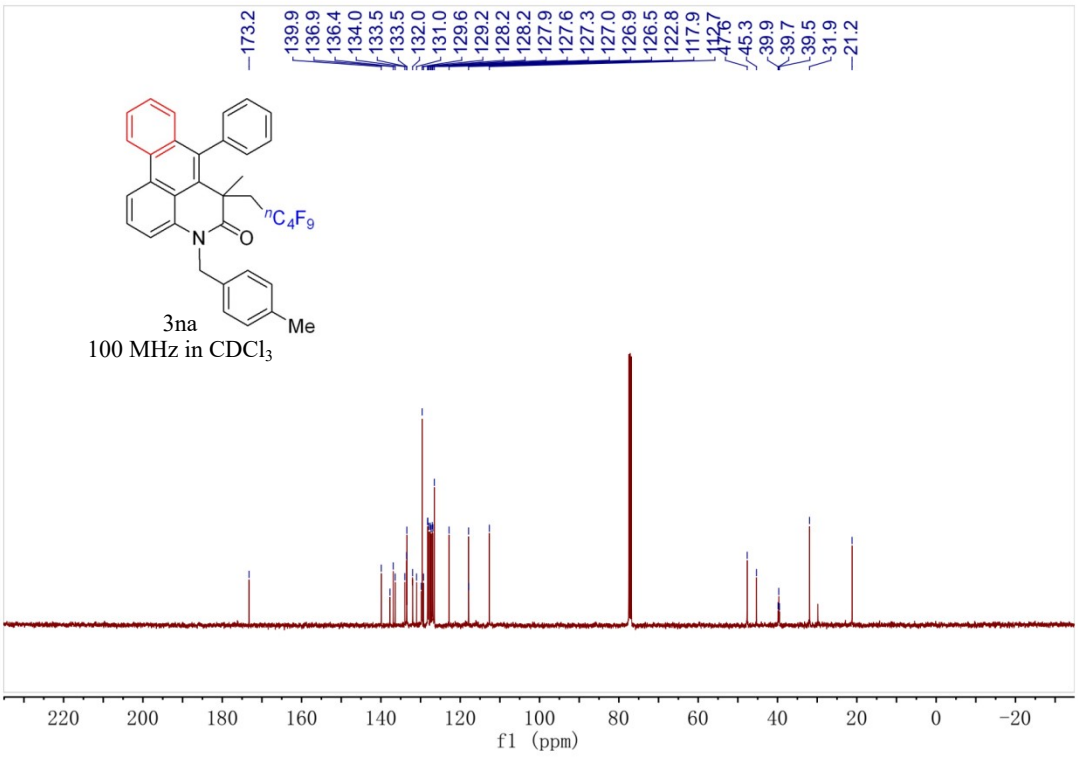
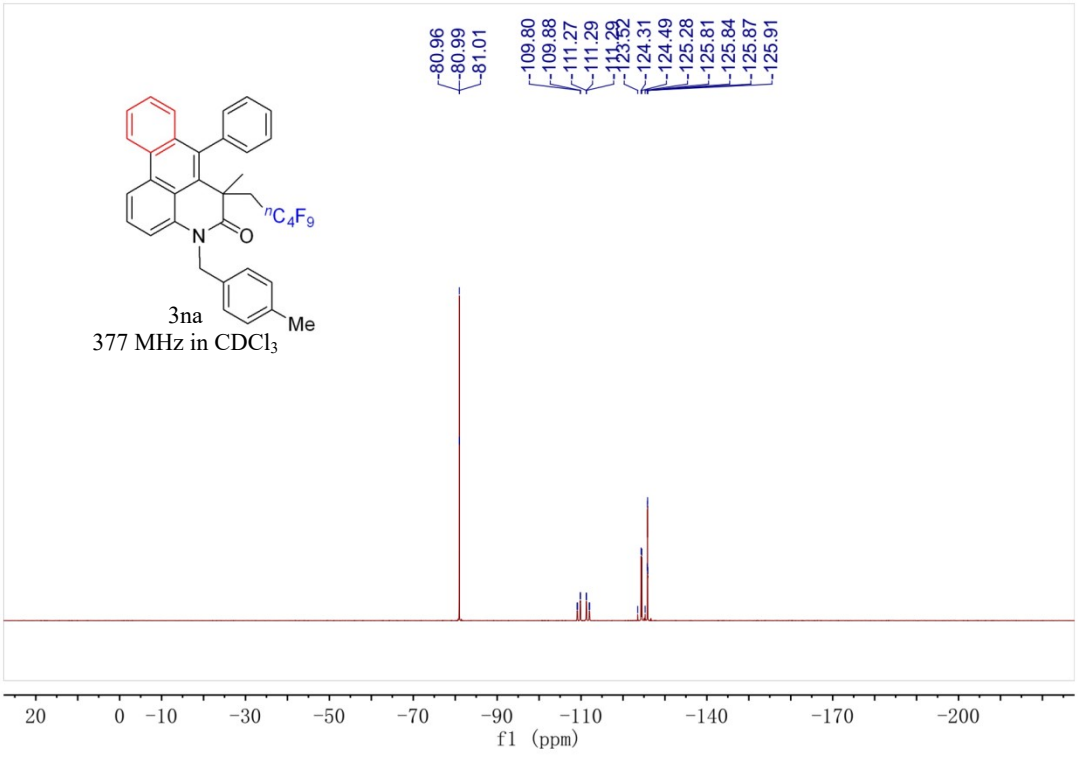


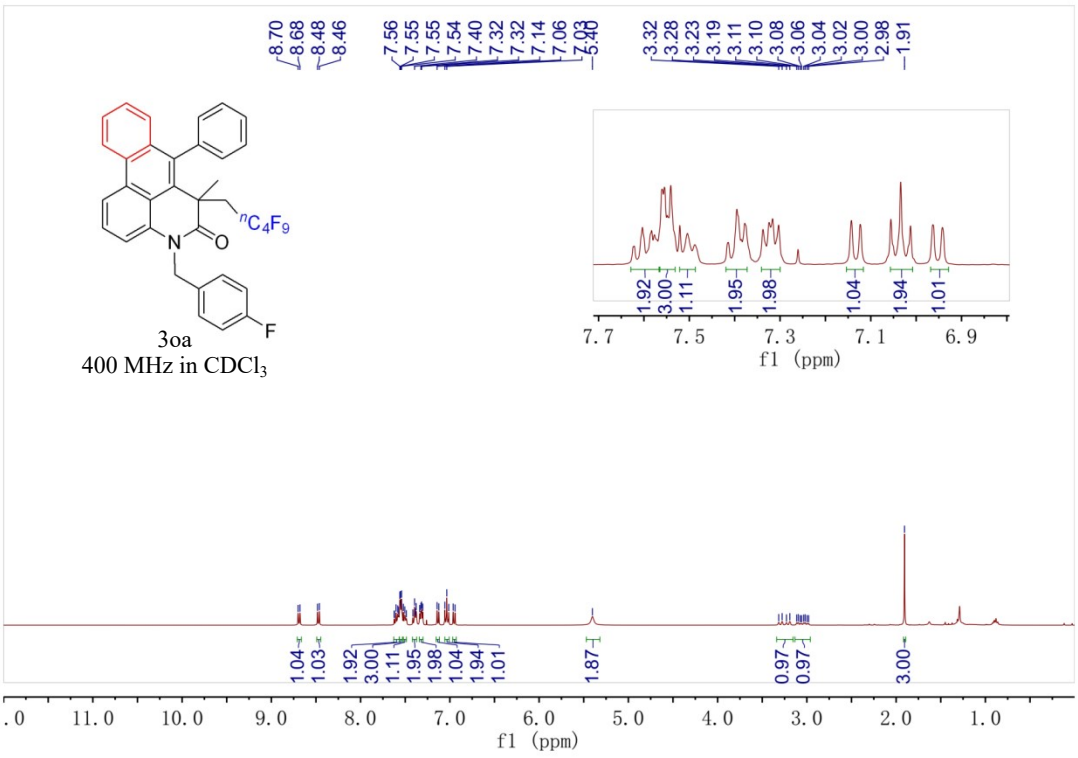
3ma
377 MHz in $CDCl_3$

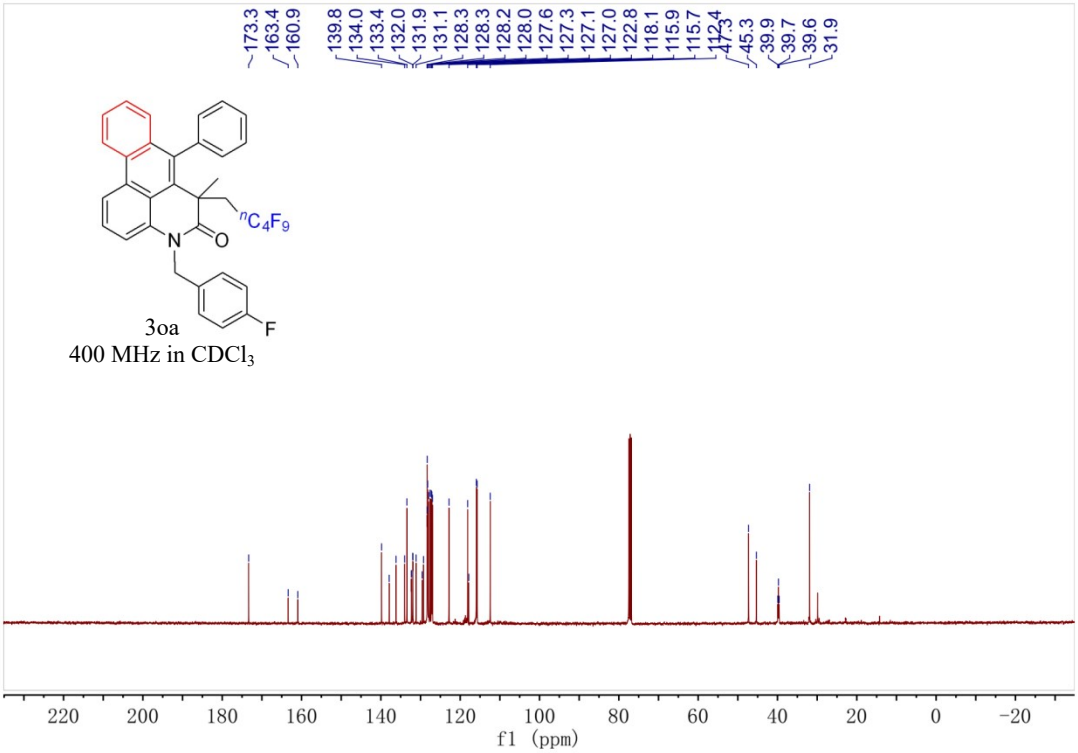


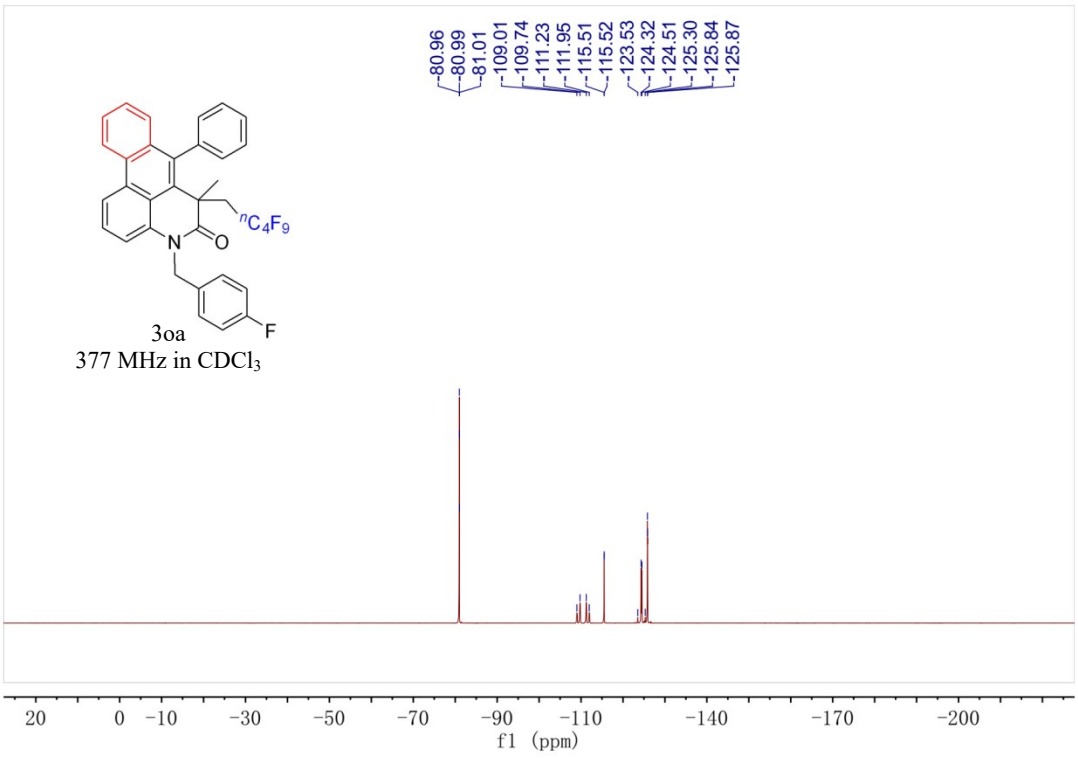
3na
400 MHz in $CDCl_3$


173.2
139.9
136.9
136.4
134.0
133.5
133.5
132.0
131.0
129.6
129.2
128.2
128.2
127.9
127.6
127.3
127.0
126.9
126.5
122.8
117.9
47.6
45.3
39.9
39.7
39.5
31.9
21.2
$^{n}C_4F_9$
N
O
Me
3na
100 MHz in $CDCl_3$
220
200
180
160
140
120
100
80
60
40
20
0
−20
f1 (ppm)

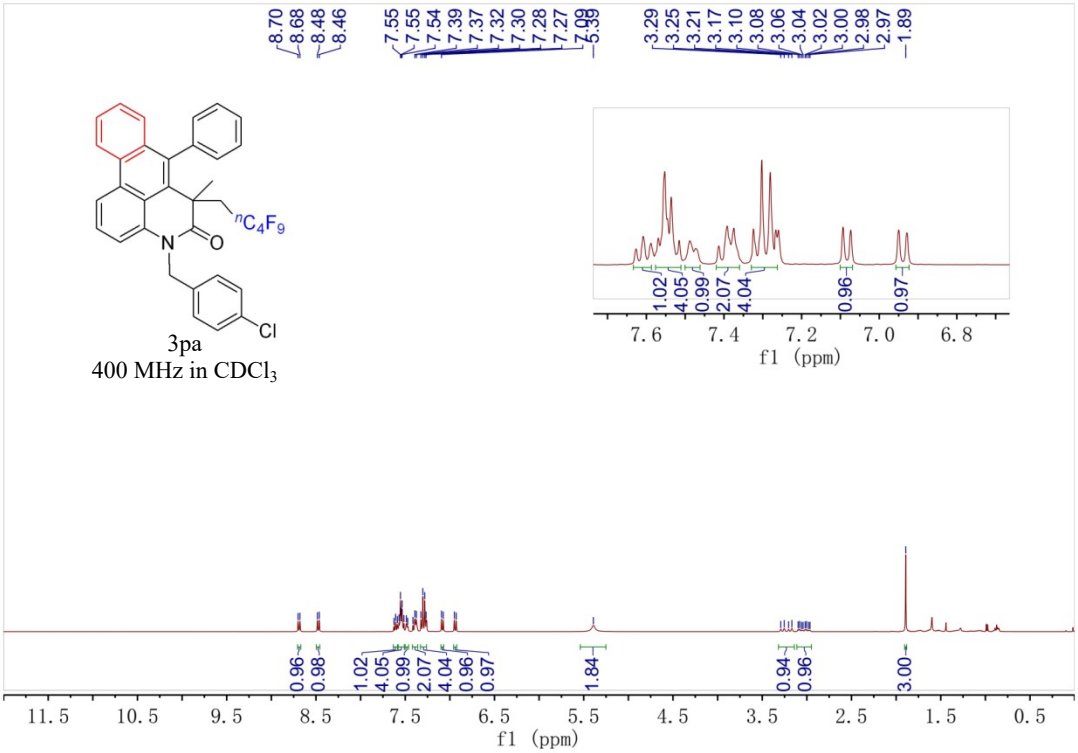

80.96
80.99
81.01
109.80
109.88
111.27
111.29
124.31
124.49
125.28
125.81
125.84
125.87
125.91
$^{n}C_4F_9$
N
O
Me
3na
377 MHz in $CDCl_3$
20
0
−10
−30
−50
−70
−90
−110
−140
−170
−200
f1 (ppm)


8.70
8.68
8.48
8.46
7.56
7.55
7.55
7.54
7.40
7.32
7.32
7.14
7.06
3.32
3.28
3.23
3.19
3.11
3.10
3.08
3.06
3.04
3.02
3.00
2.98
1.91
$^{n}C_4F_9$
N
O
F
3oa
400 MHz in $CDCl_3$
1.92
3.00
1.11
1.95
1.98
1.04
1.94
1.01
7.7
7.5
7.3
7.1
6.9
f1 (ppm)
1.04
1.03
1.92
3.00
1.11
1.95
1.98
1.04
1.94
1.01
1.87
0.97
0.97
3.00
.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
f1 (ppm)

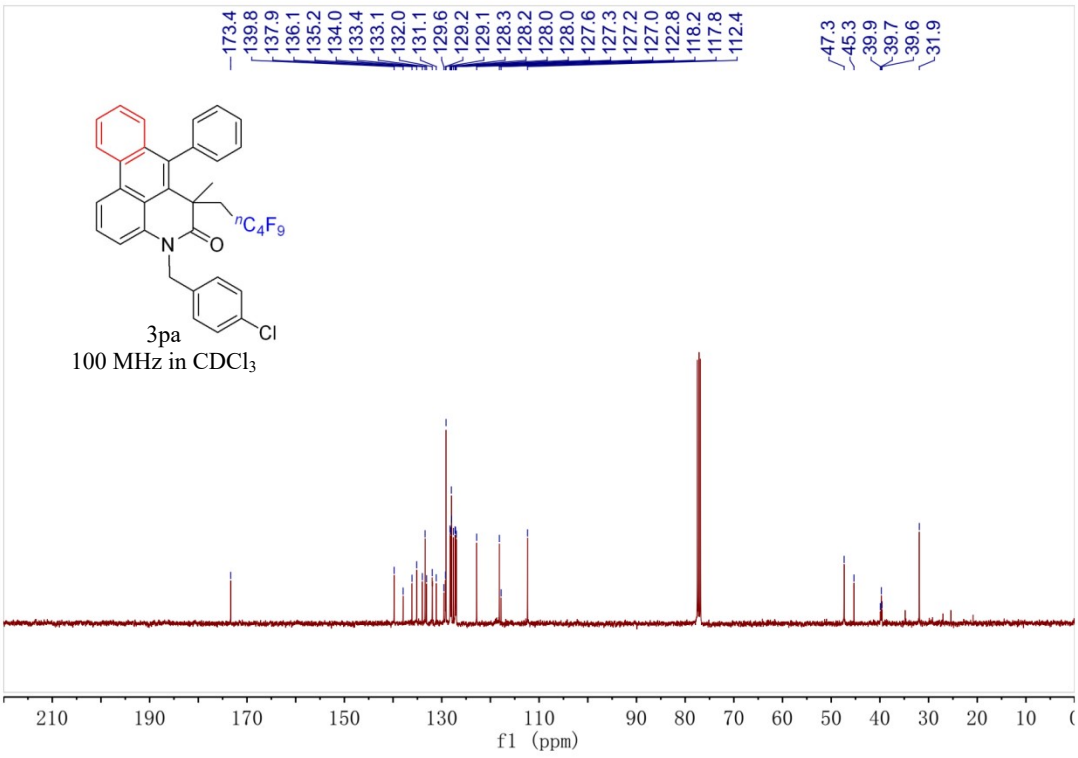

173.3
163.4
160.9
139.8
134.0
133.4
132.0
131.9
131.1
128.3
128.3
128.2
128.0
127.6
127.3
127.1
127.0
122.8
118.1
115.9
115.7
112.4
47.3
45.3
39.9
39.7
39.6
31.9
$^{n}C_4F_9$
N
O
F
3oa
400 MHz in $CDCl_3$
220
200
180
160
140
120
100
80
60
40
20
0
−20
f1 (ppm)



3oa
377 MHz in $CDCl_3$

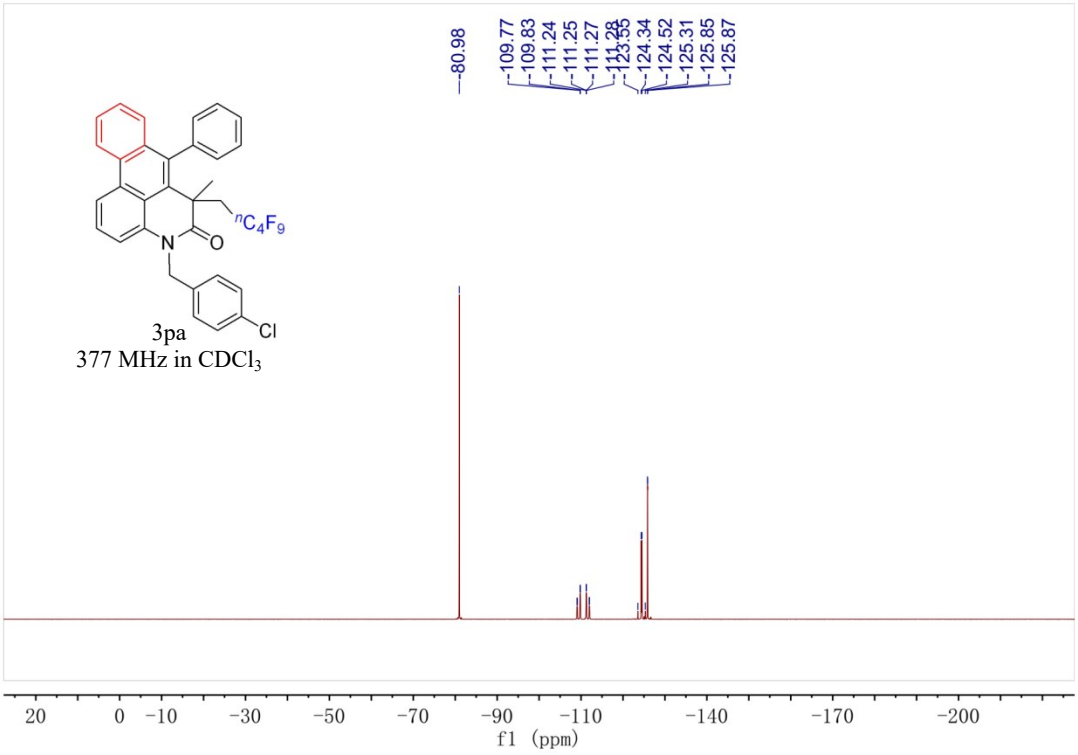


3pa
400 MHz in $CDCl_3$



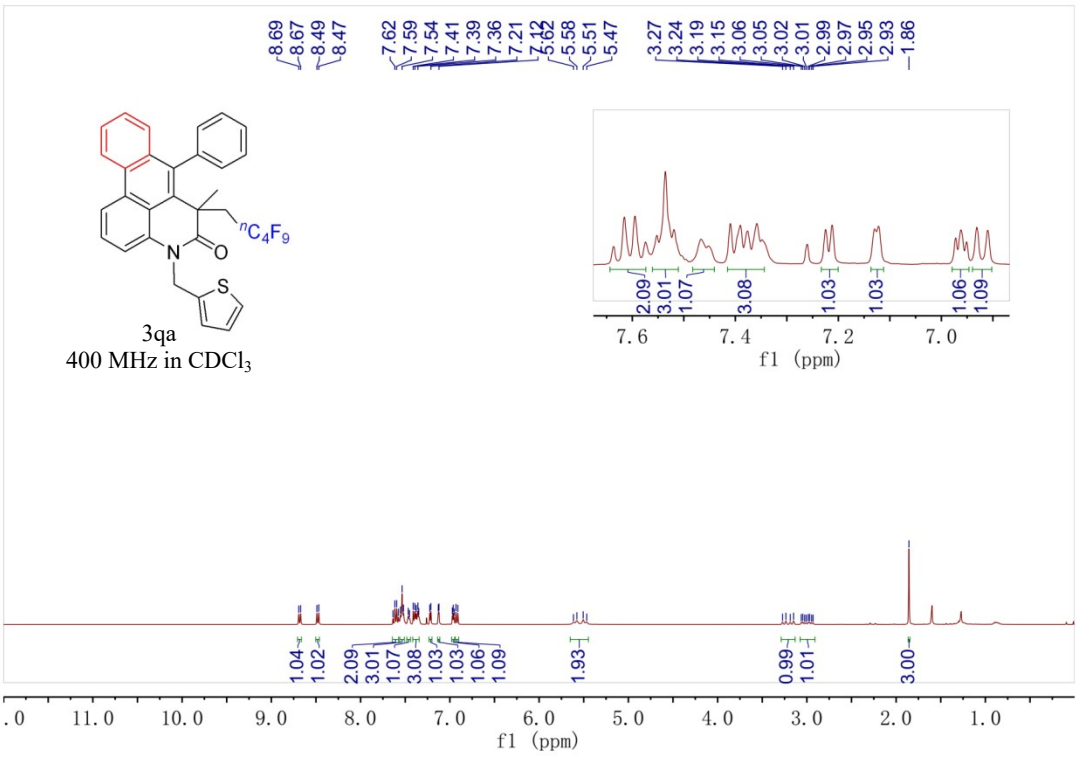
3pa

100 MHz in $CDCl_3$

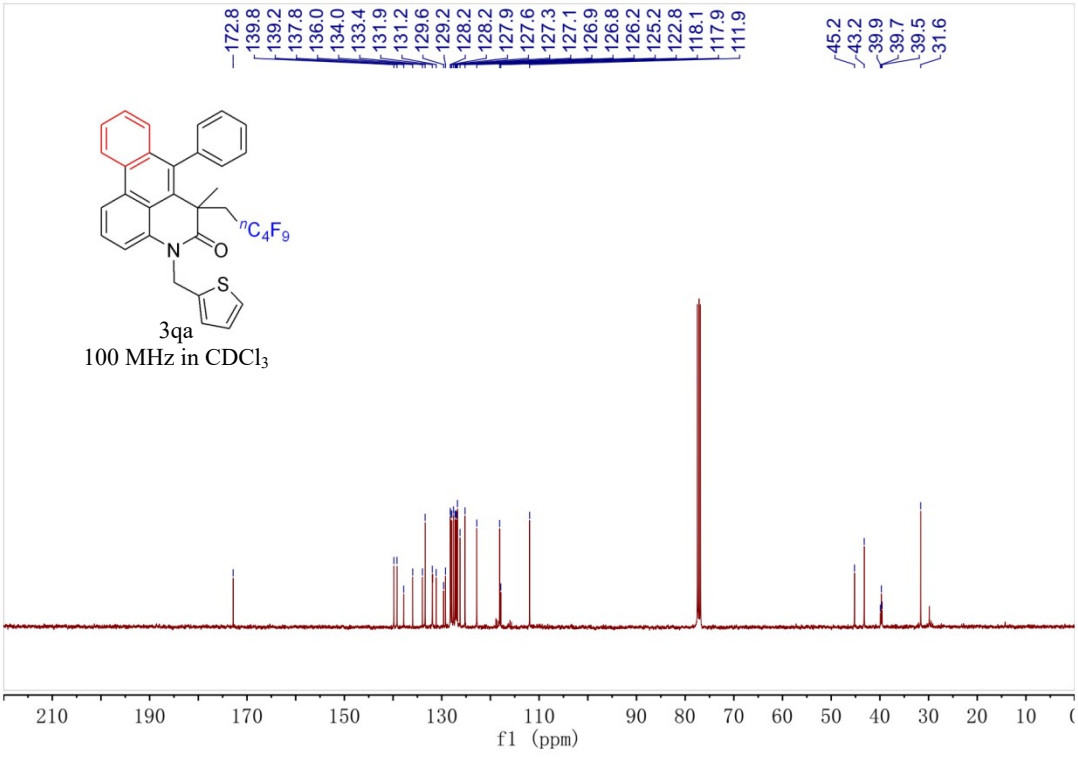


3pa

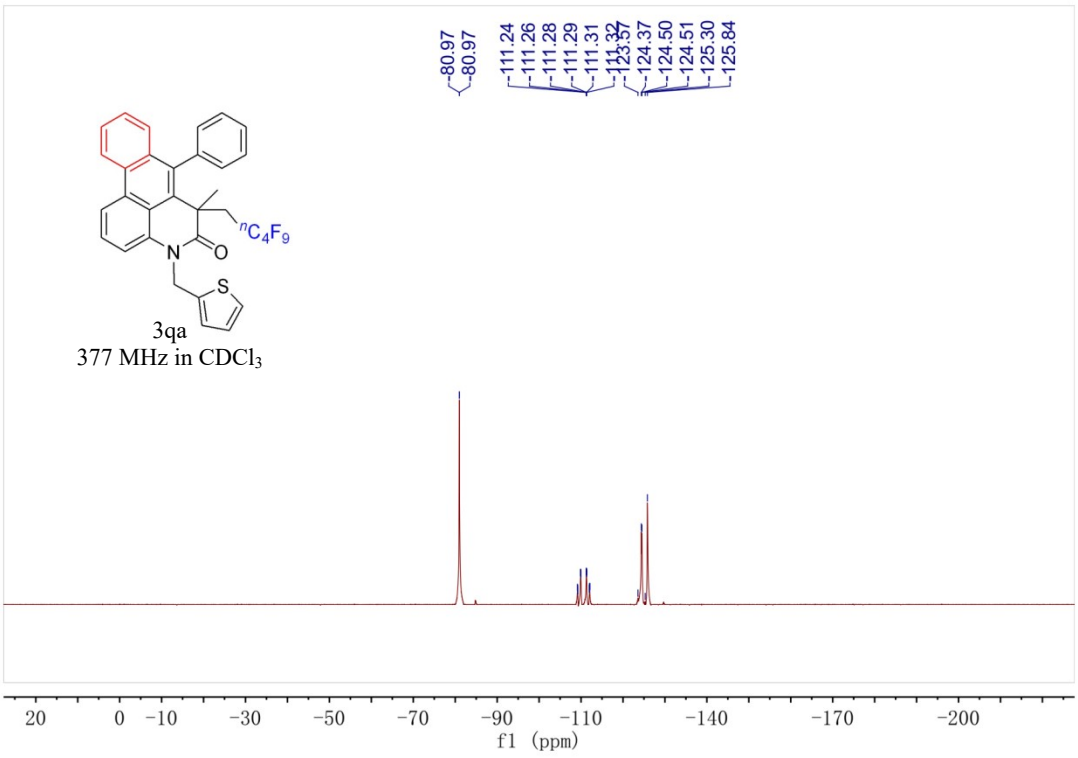
377 MHz in $CDCl_3$



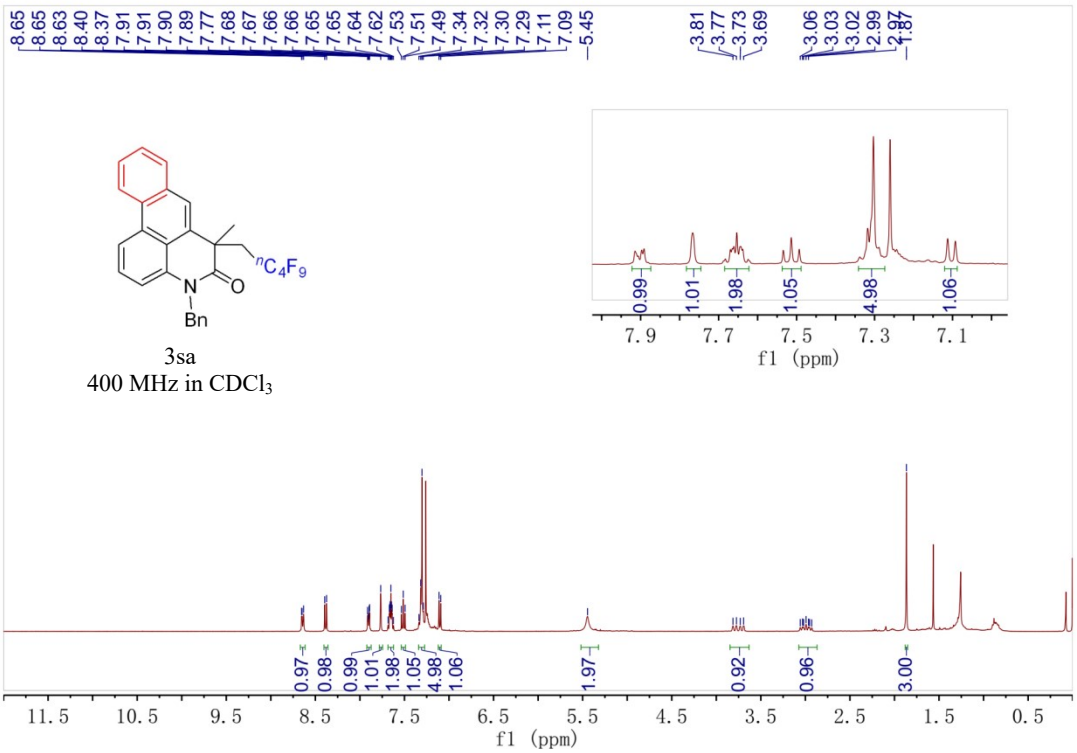
3qa
400 MHz in $CDCl_3$



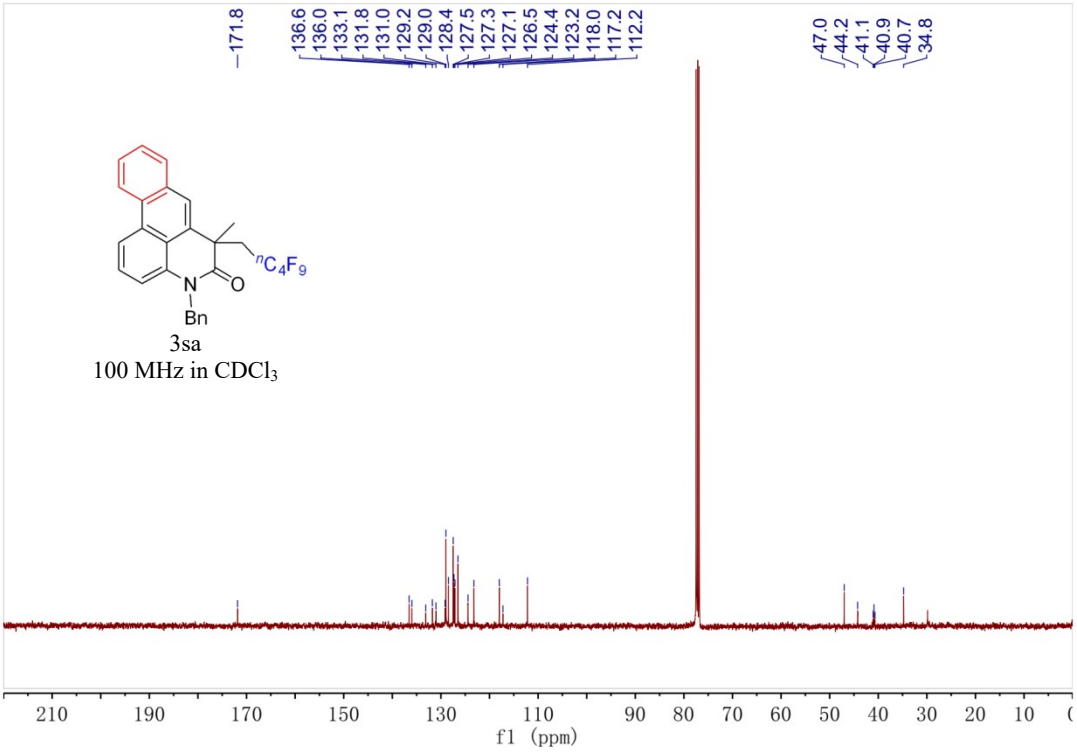
3qa
100 MHz in $CDCl_3$



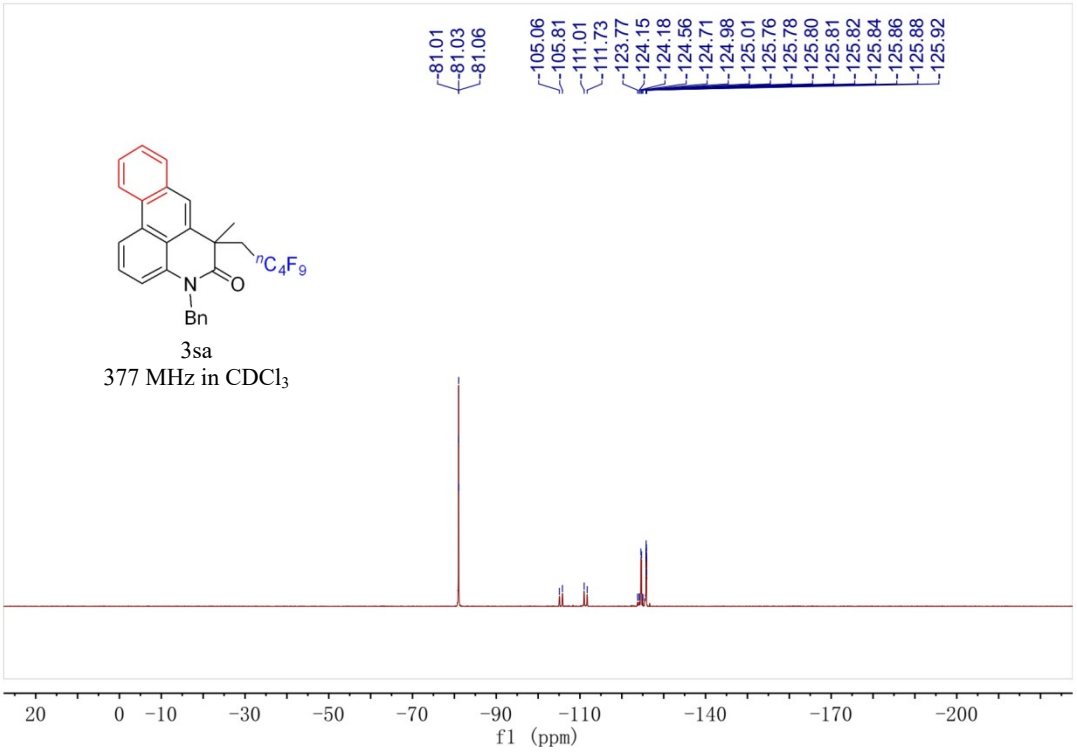
3qa
377 MHz in $CDCl_3$



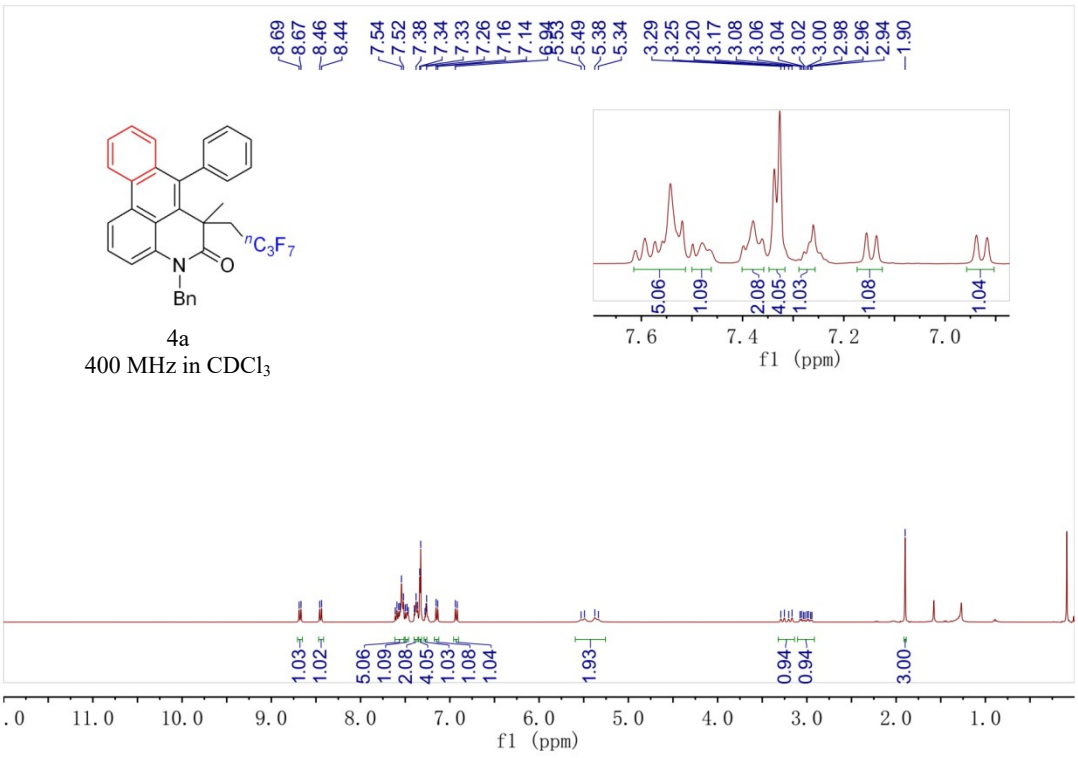
3sa
400 MHz in $CDCl_3$



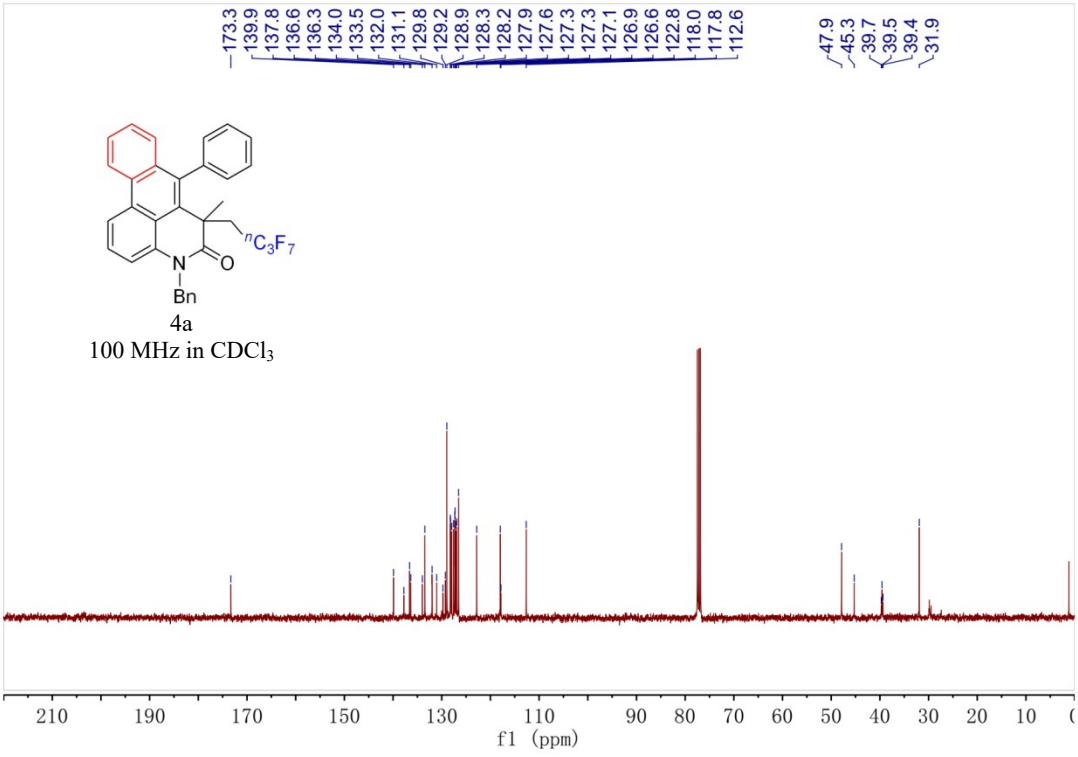
3sa
100 MHz in $CDCl_3$



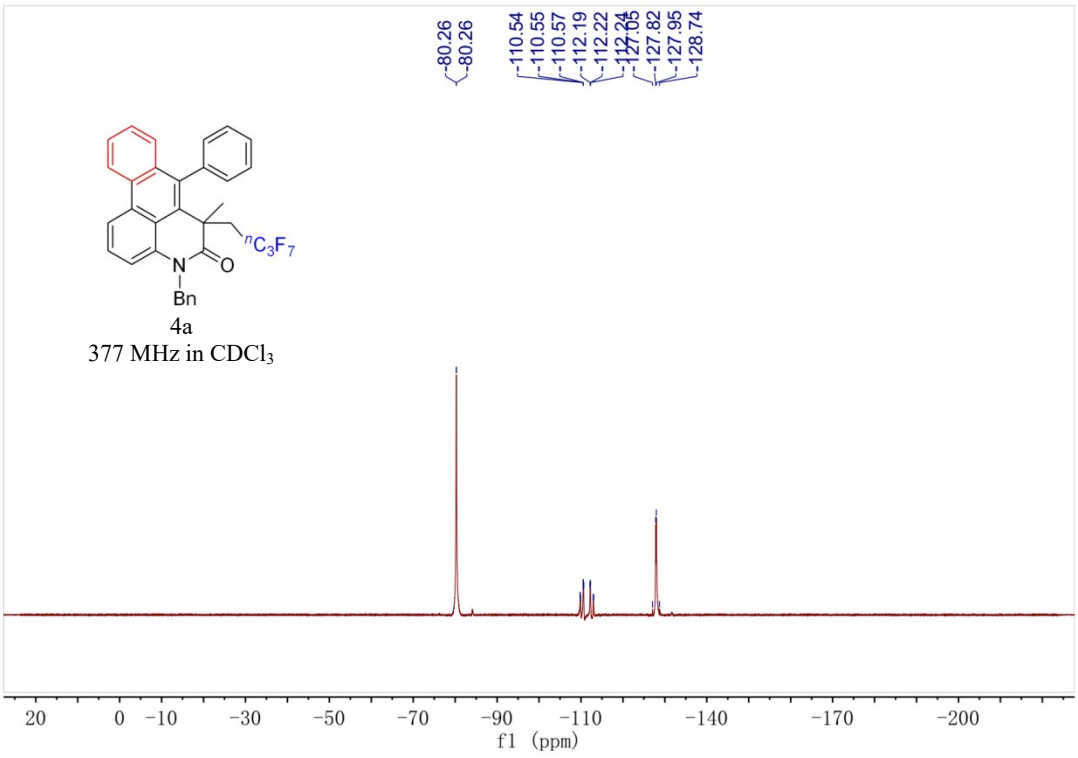
3sa
377 MHz in $CDCl_3$



4a
400 MHz in $CDCl_3$

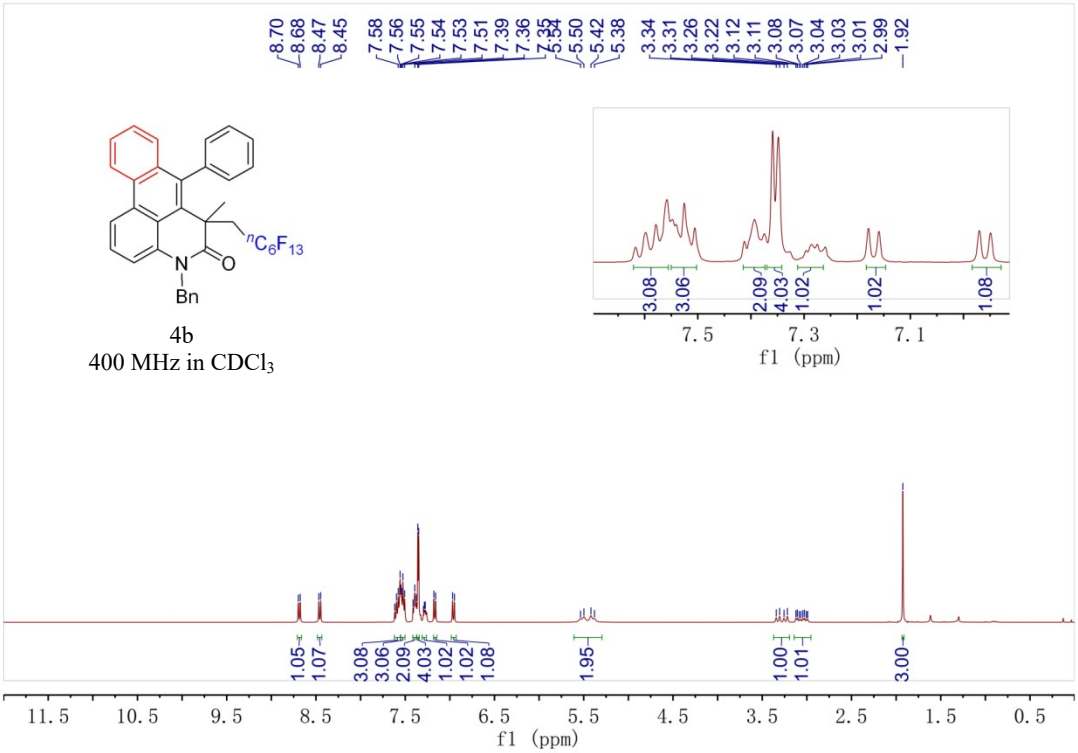


4a
100 MHz in $CDCl_3$



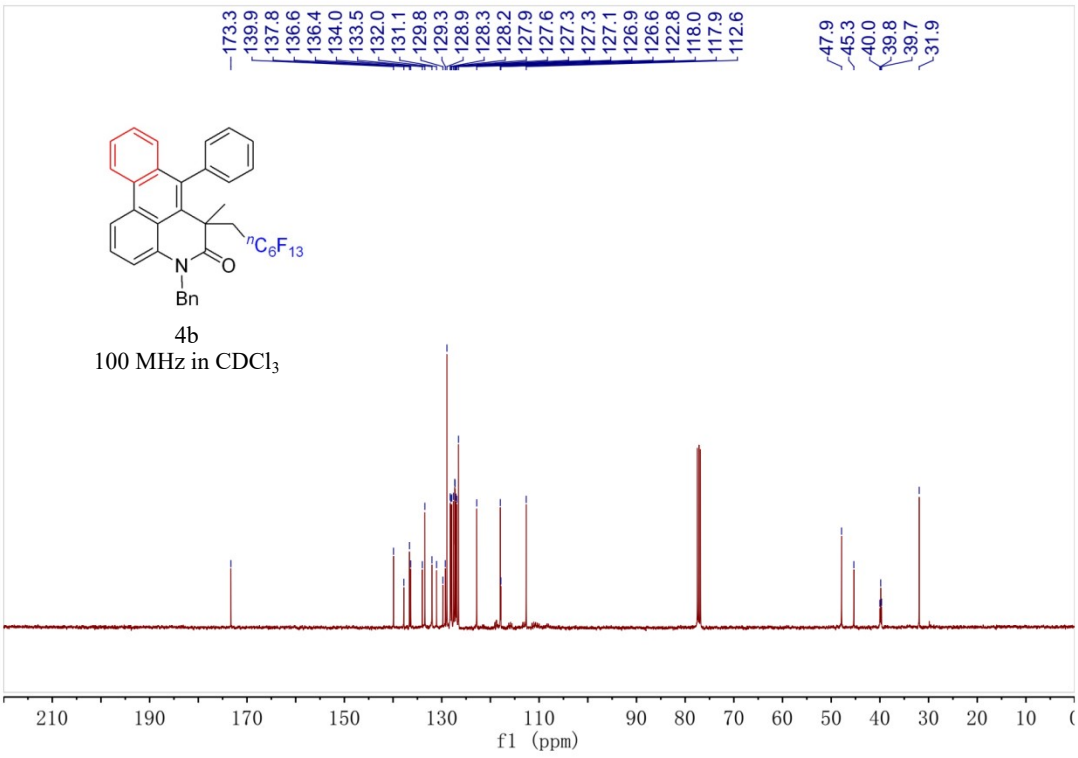
4a

377 MHz in $CDCl_3$

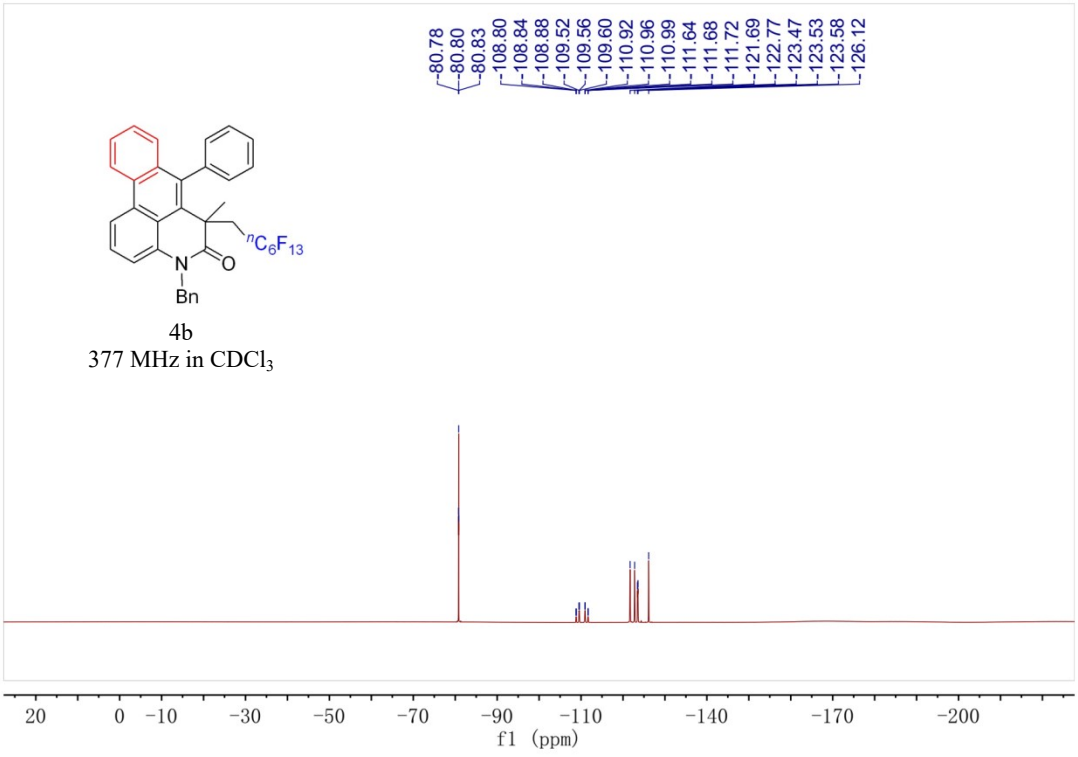


4b

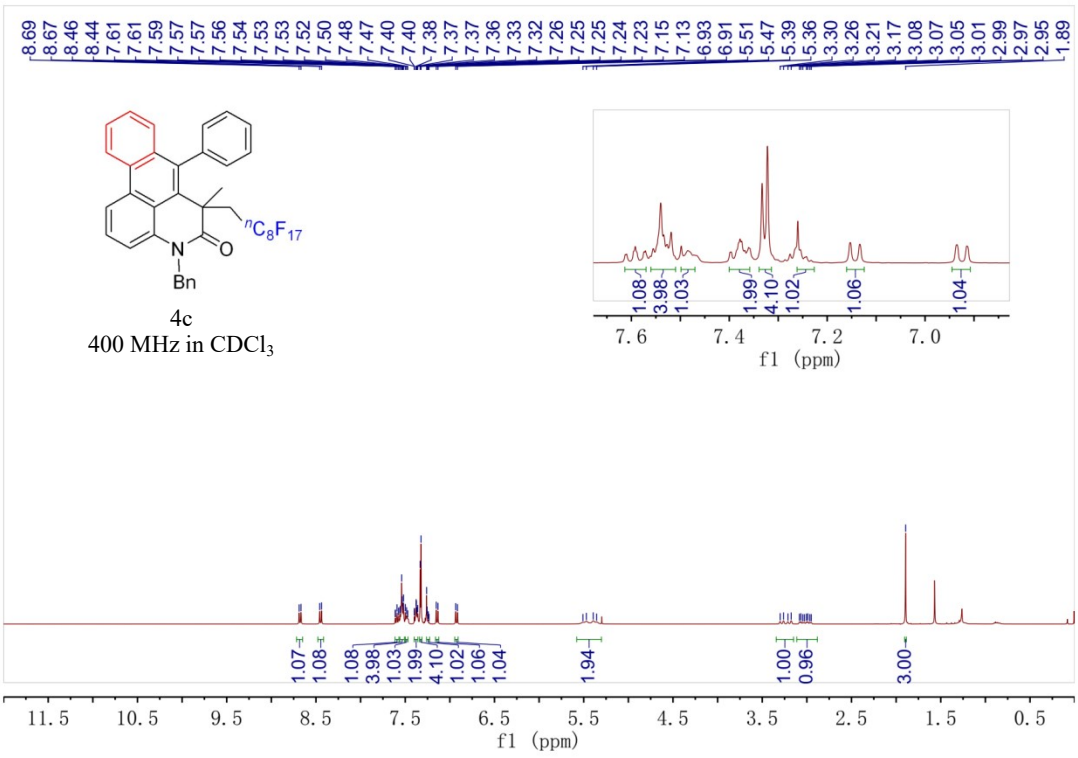
400 MHz in $CDCl_3$



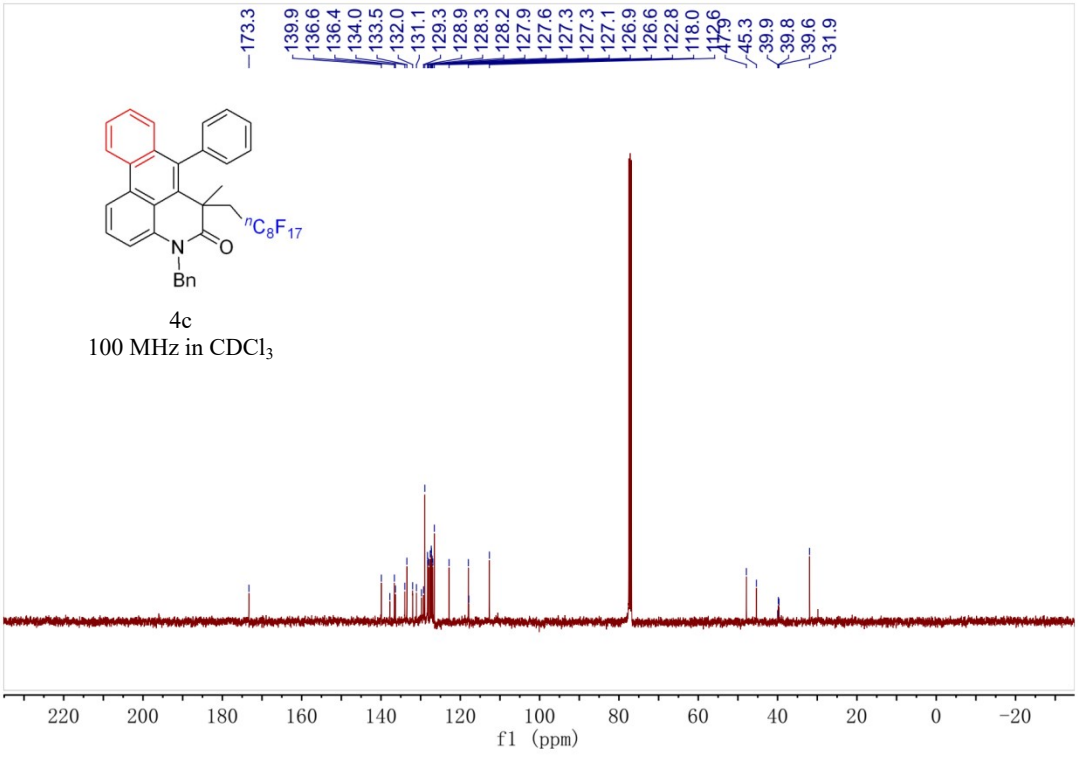
4b
100 MHz in $CDCl_3$



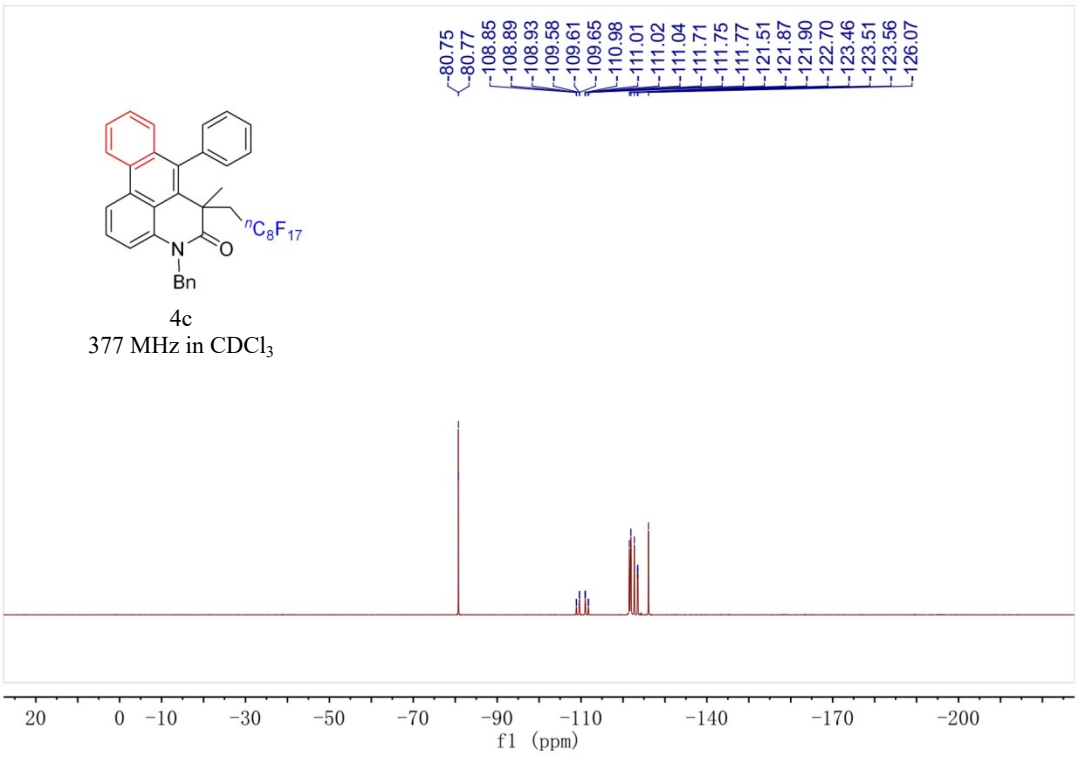
4b
377 MHz in $CDCl_3$



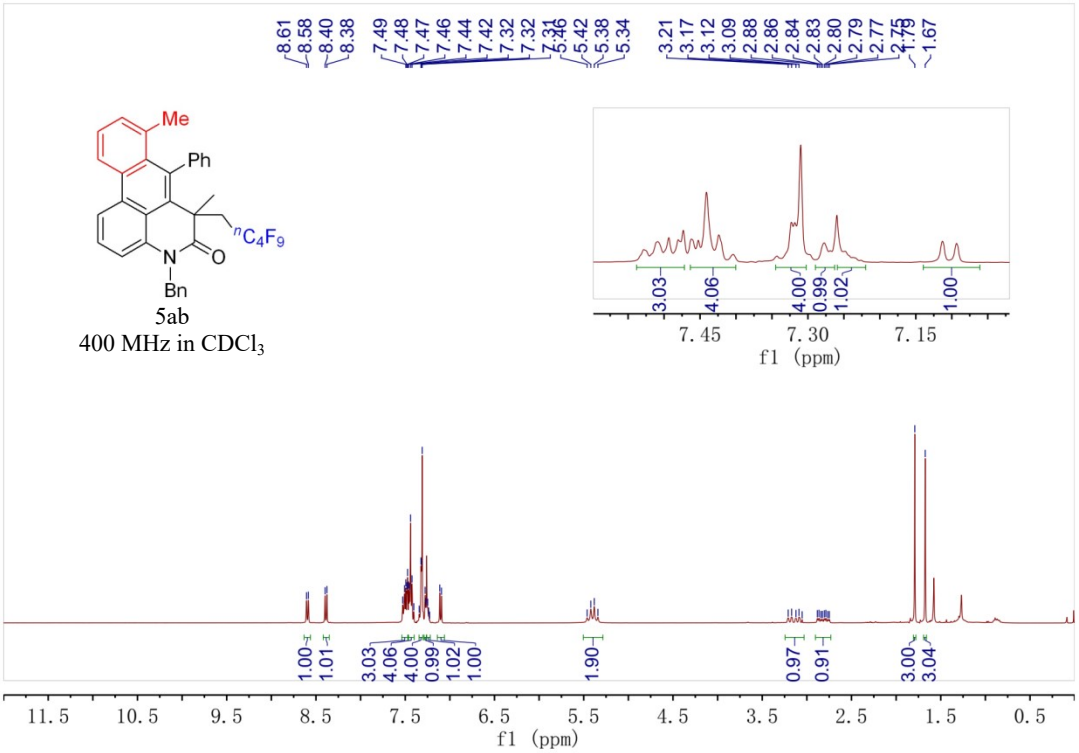
4c
400 MHz in $CDCl_3$



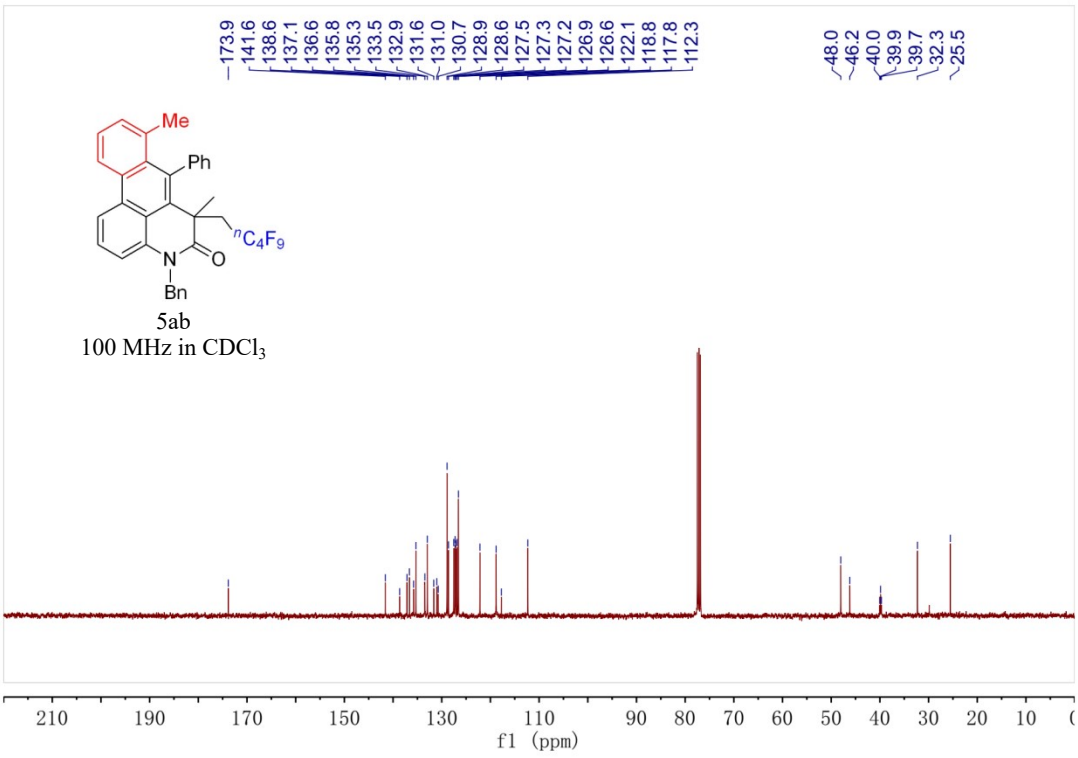
4c
100 MHz in $CDCl_3$



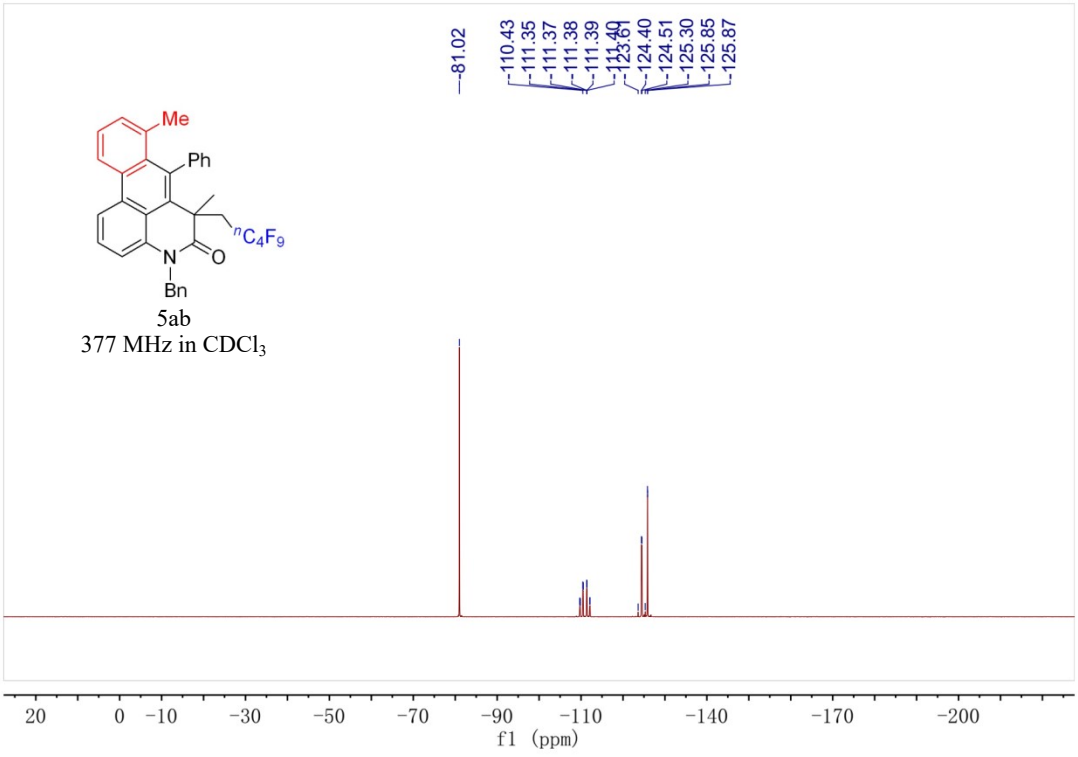
4c
377 MHz in $CDCl_3$



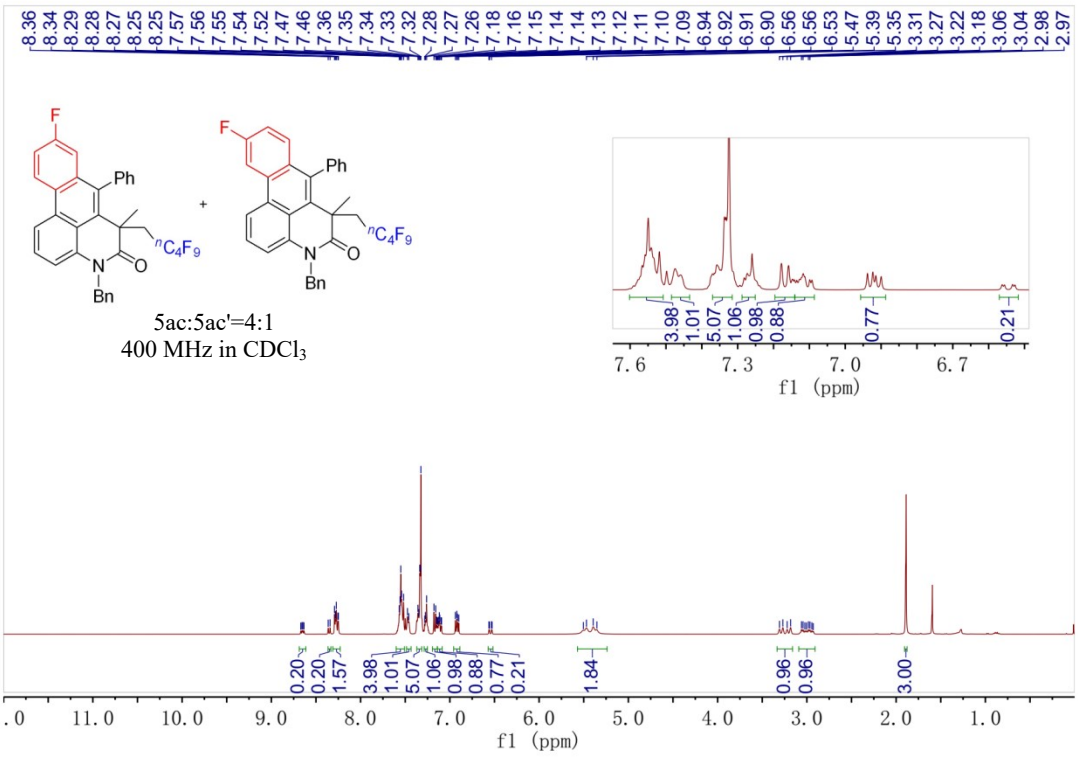
5ab
400 MHz in $CDCl_3$

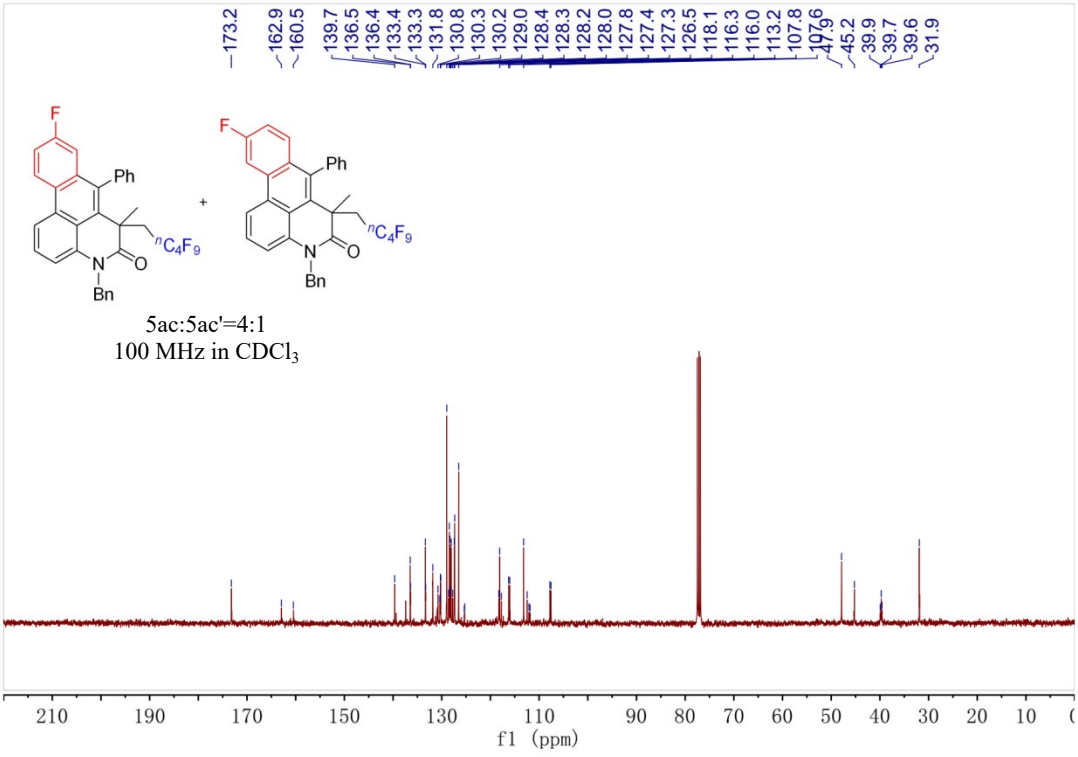


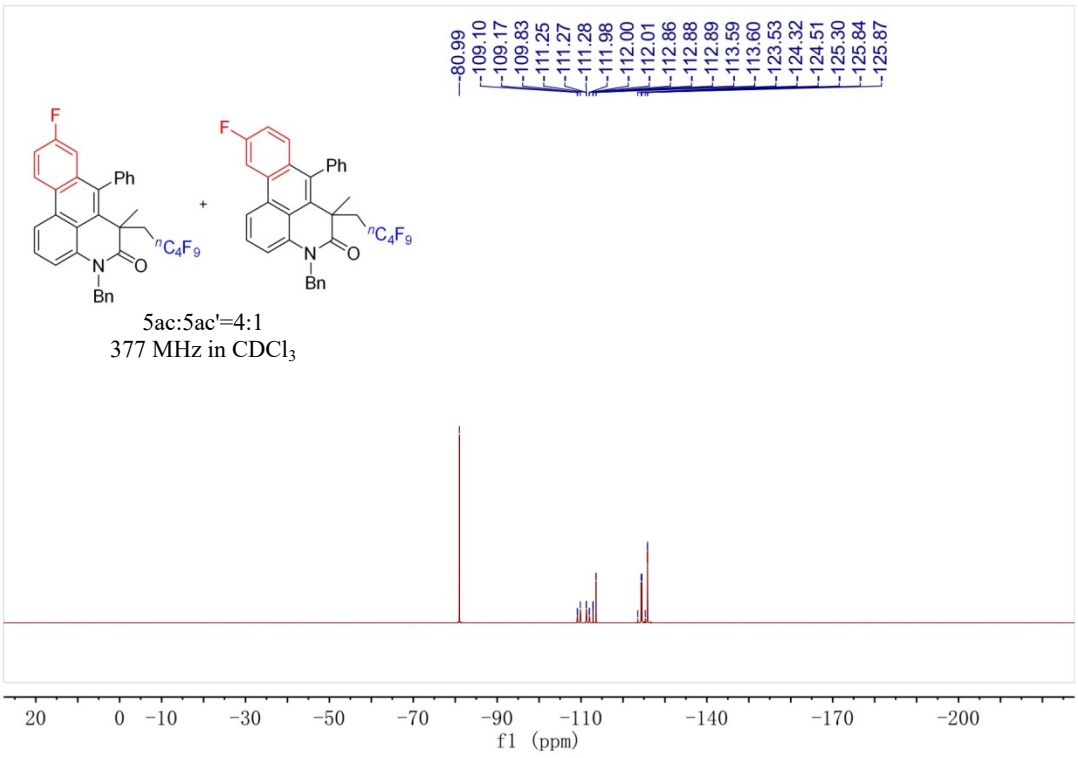
5ab
100 MHz in $CDCl_3$



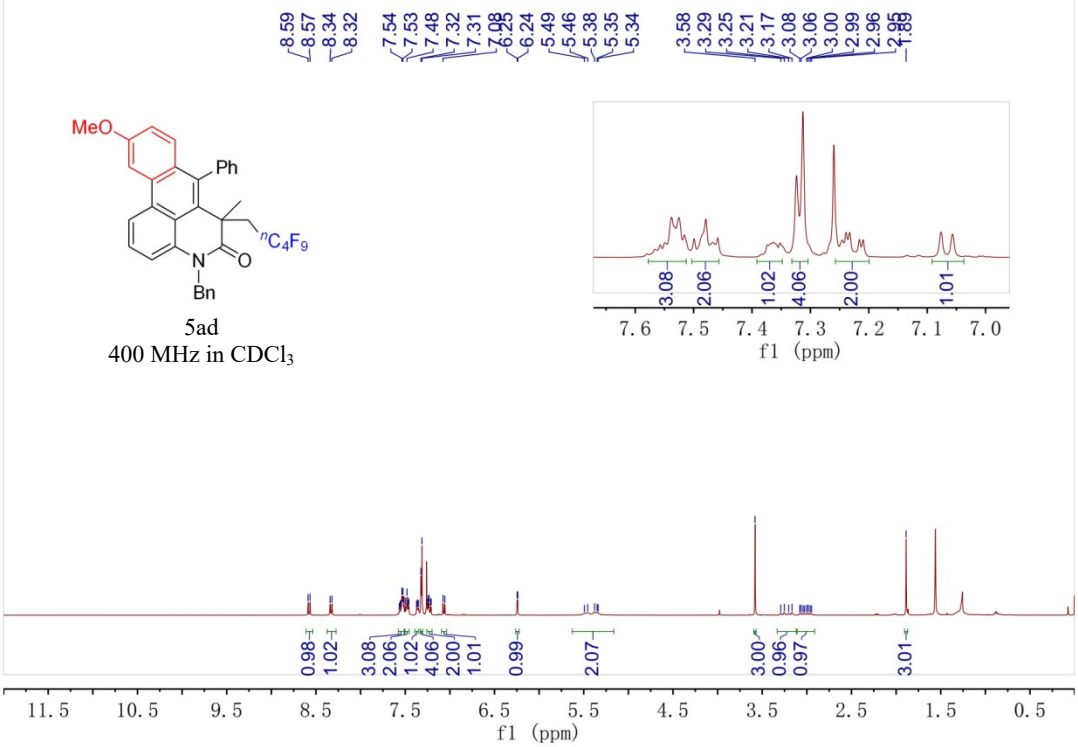
5ab
377 MHz in $CDCl_3$


8.36 8.34 8.29 8.28 8.27 8.25 8.25 7.57 7.56 7.55 7.54 7.52 7.47 7.46 7.36 7.35 7.34 7.33 7.32 7.28 7.27 7.26 7.18 7.16 7.15 7.14 7.14 7.13 7.12 7.11 7.10 7.09 6.94 6.92 6.91 6.90 6.56 6.56 6.53 5.47 5.39 5.35 3.31 3.27 3.22 3.18 3.06 3.04 2.98 2.97
F
Ph
nC4F9
N
O
Bn
5ac:5ac'=4:1
400 MHz in CDCl3
3.98 1.01 5.07 1.06 0.98 0.88 0.77 0.21
7.6 7.3 7.0 6.7
f1 (ppm)
0.20 0.20 1.57 3.98 1.01 5.07 1.06 0.98 0.88 0.77 0.21 1.84 0.96 0.96 3.00
11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0
f1 (ppm)

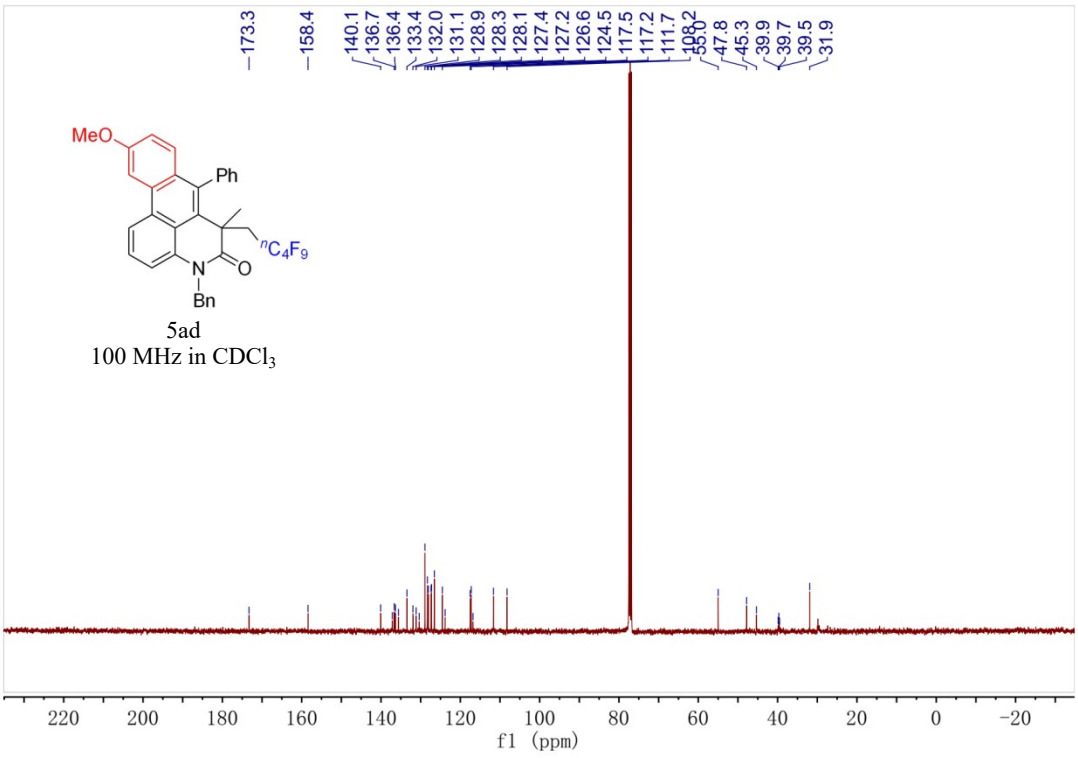

173.2 162.9 160.5 139.7 136.5 136.4 133.4 133.3 131.8 130.8 130.3 130.2 129.0 128.4 128.3 128.2 128.0 127.8 127.4 127.3 126.5 118.1 116.3 116.0 113.2 107.8 47.9 45.2 39.9 39.7 39.6 31.9
F
Ph
nC4F9
N
O
Bn
5ac:5ac'=4:1
100 MHz in CDCl3
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10
f1 (ppm)



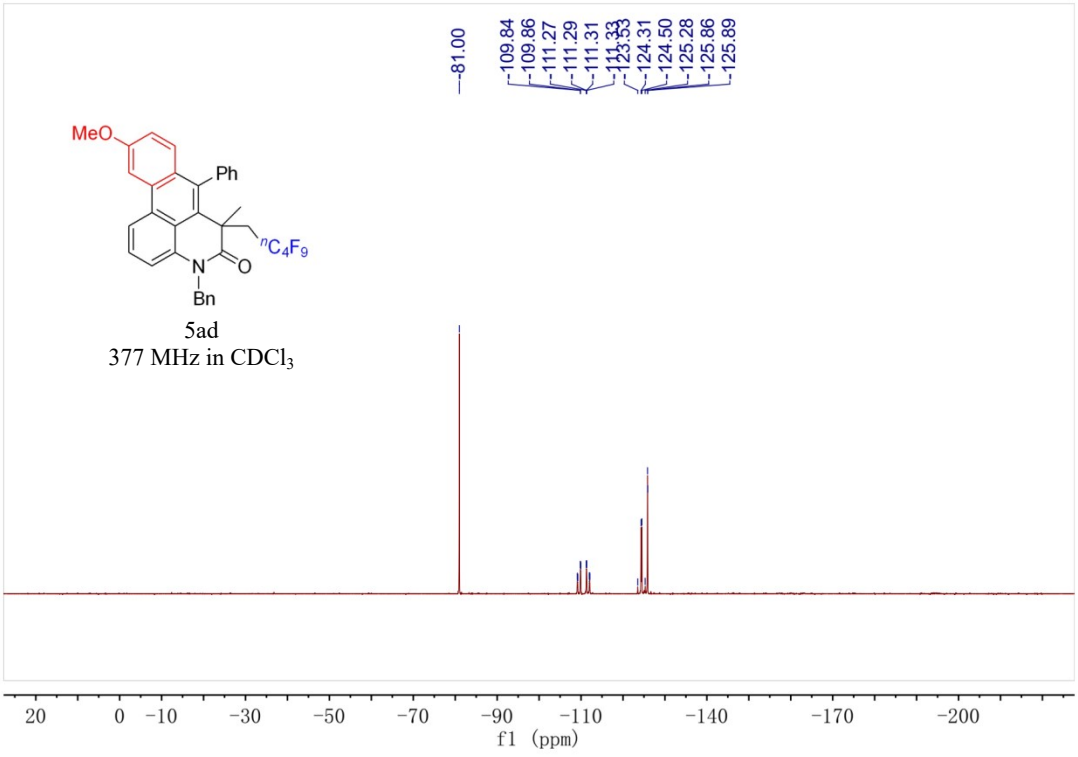
5ac:5ac'=4:1
377 MHz in $CDCl_3$



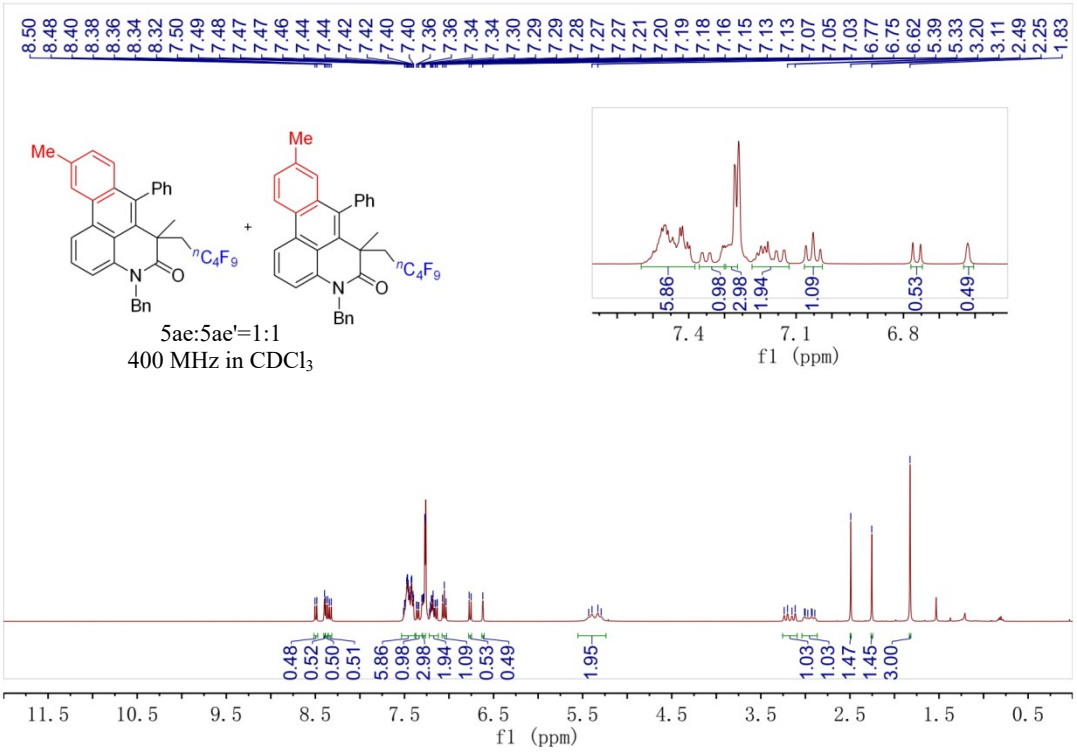
5ad
400 MHz in $CDCl_3$

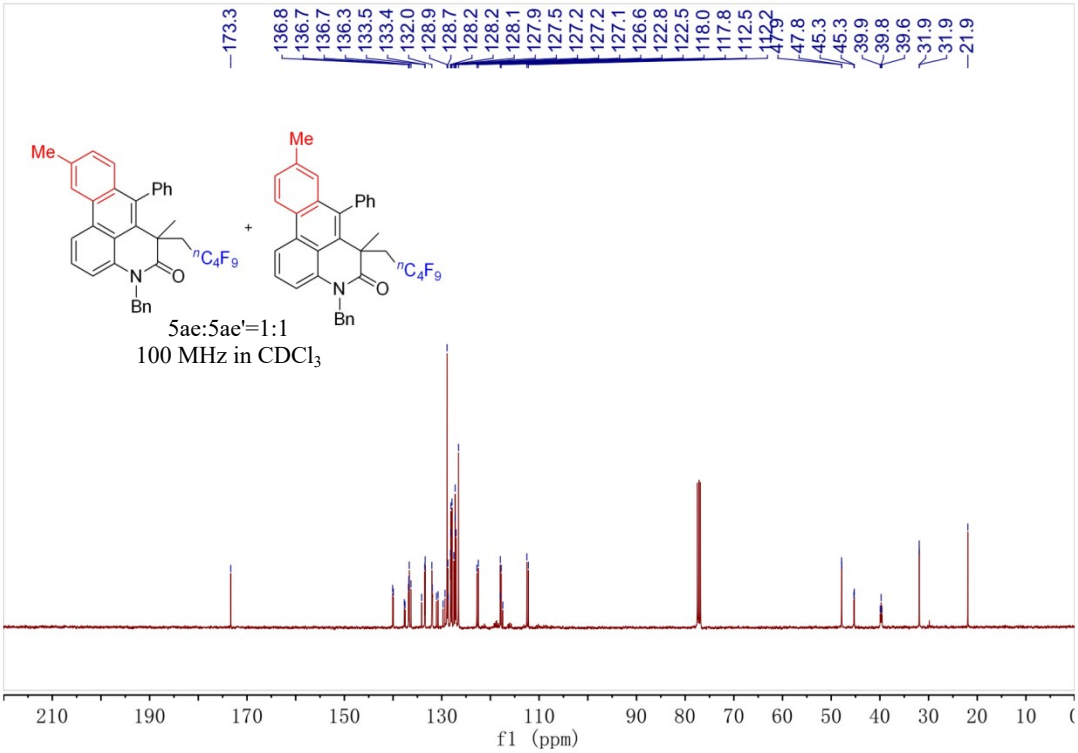


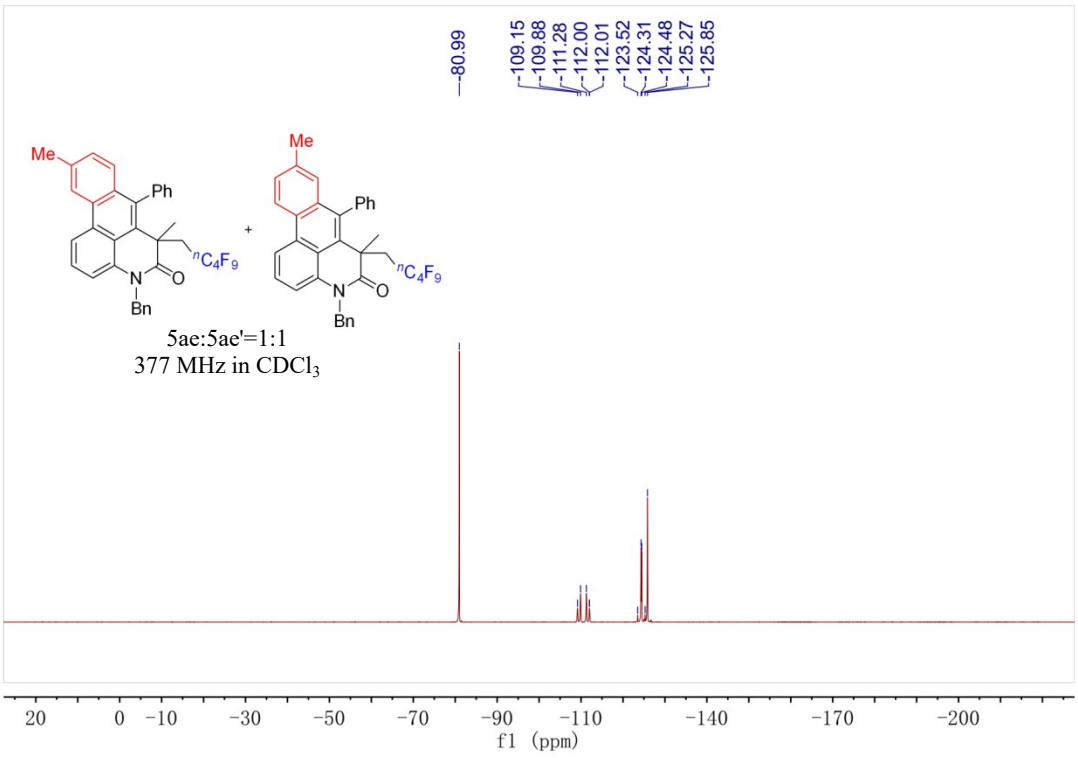
5ad
100 MHz in $CDCl_3$



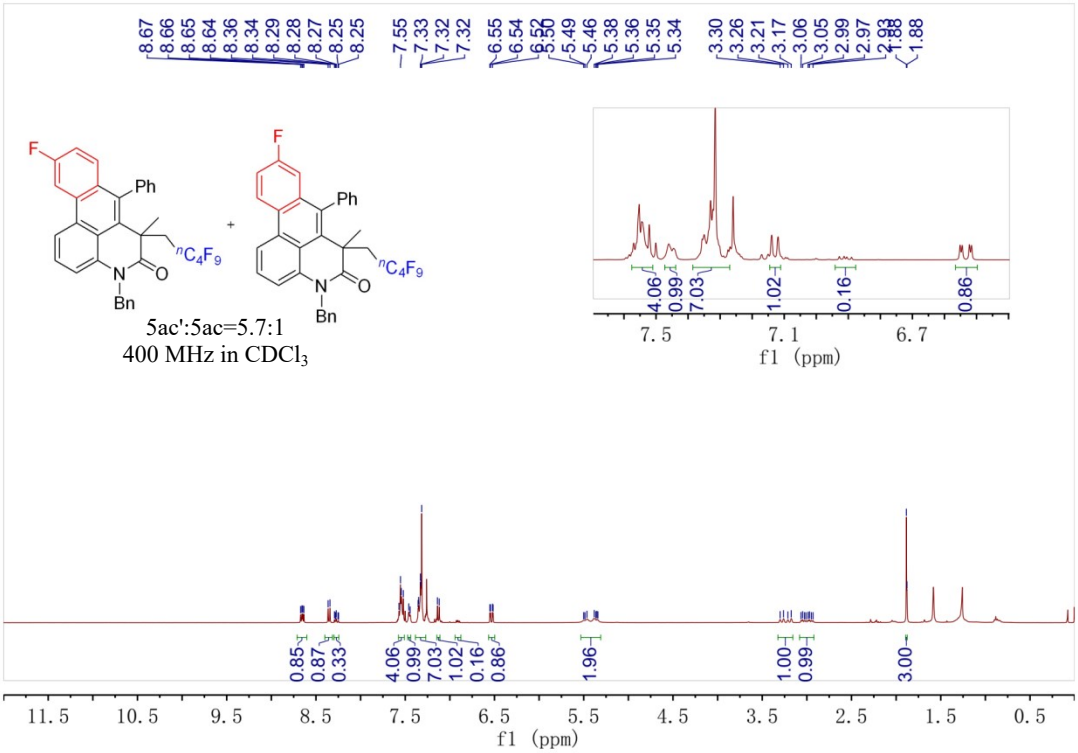
5ad
377 MHz in $CDCl_3$


Me
Ph
$^nC_4F_9$
N
O
Bn
5ae:5ae'=1:1
400 MHz in CDCl3
f1 (ppm)

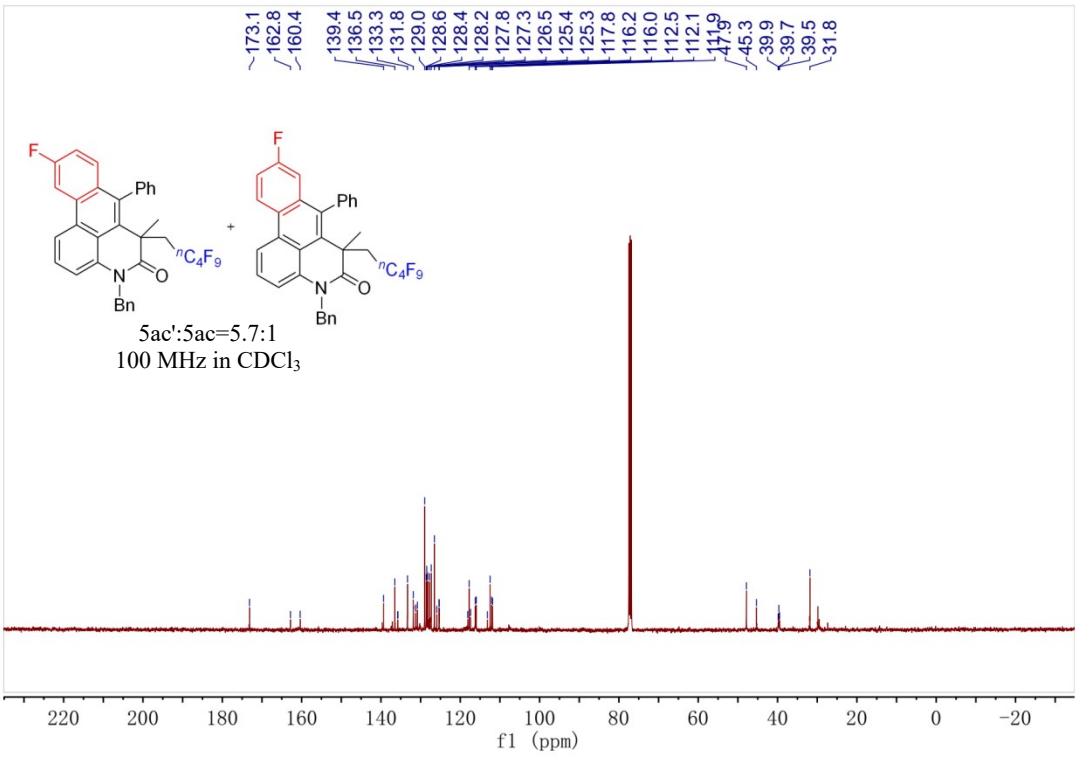

Me
Ph
$^nC_4F_9$
N
O
Bn
5ae:5ae'=1:1
100 MHz in CDCl3
f1 (ppm)



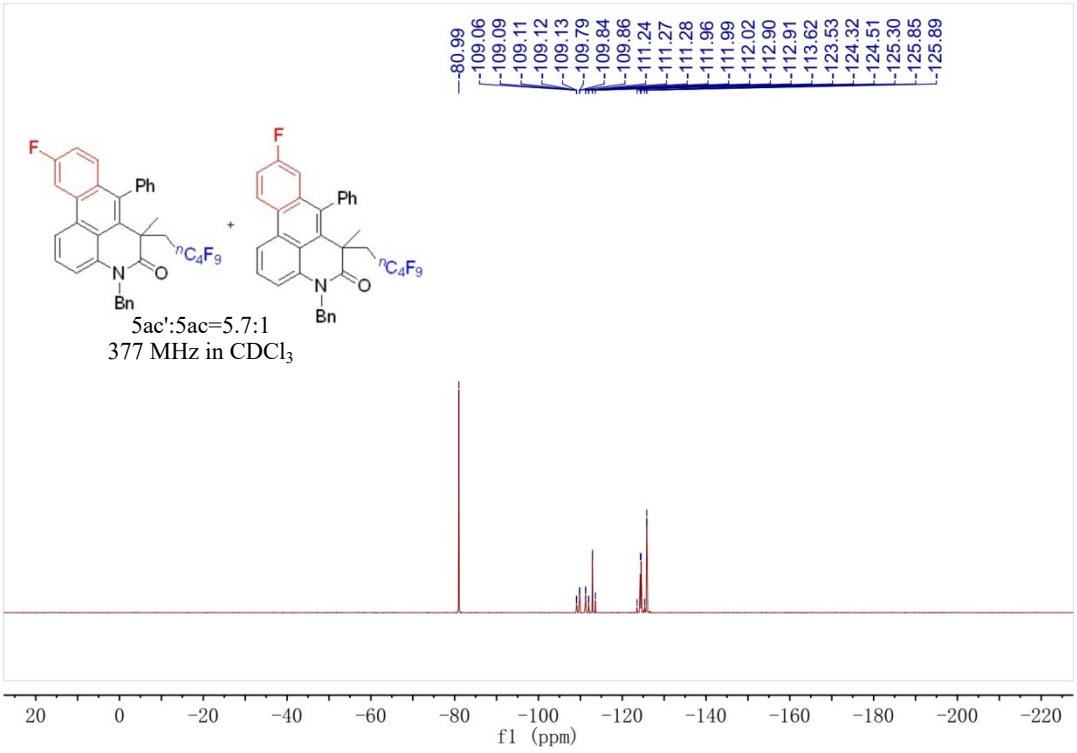
5ae:5ae'=1:1
377 MHz in $CDCl_3$



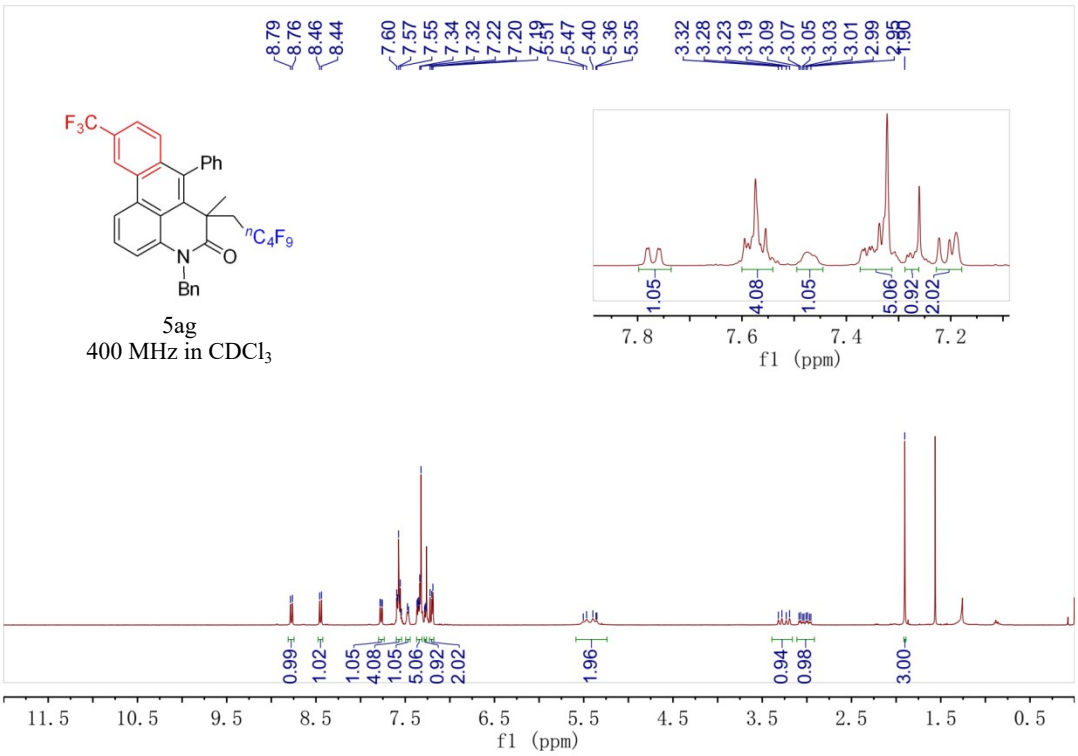
5ac':5ac=5.7:1
400 MHz in $CDCl_3$



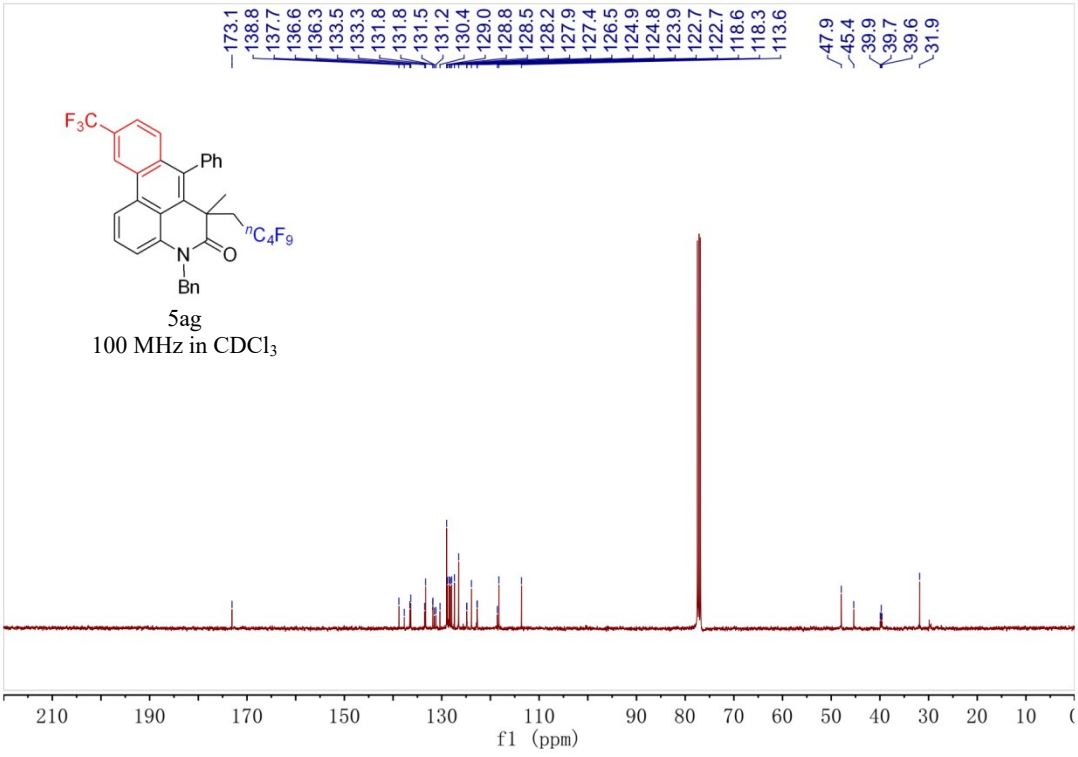
5ac':5ac=5.7:1
100 MHz in $CDCl_3$



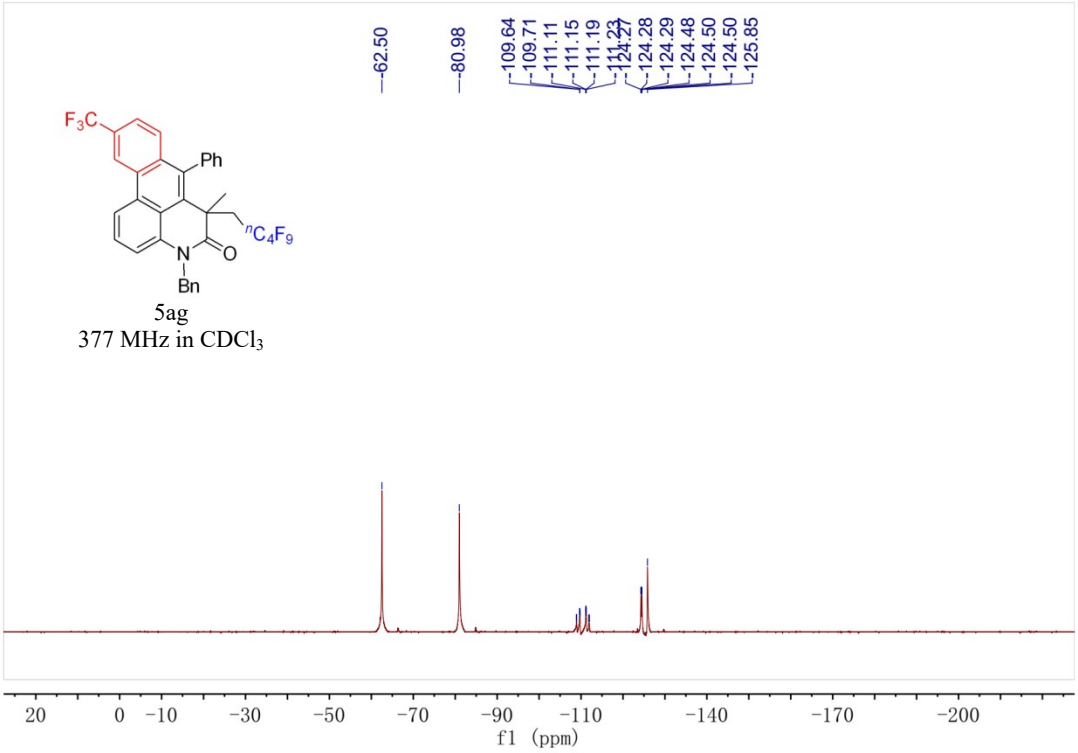
5ac':5ac=5.7:1
377 MHz in $CDCl_3$



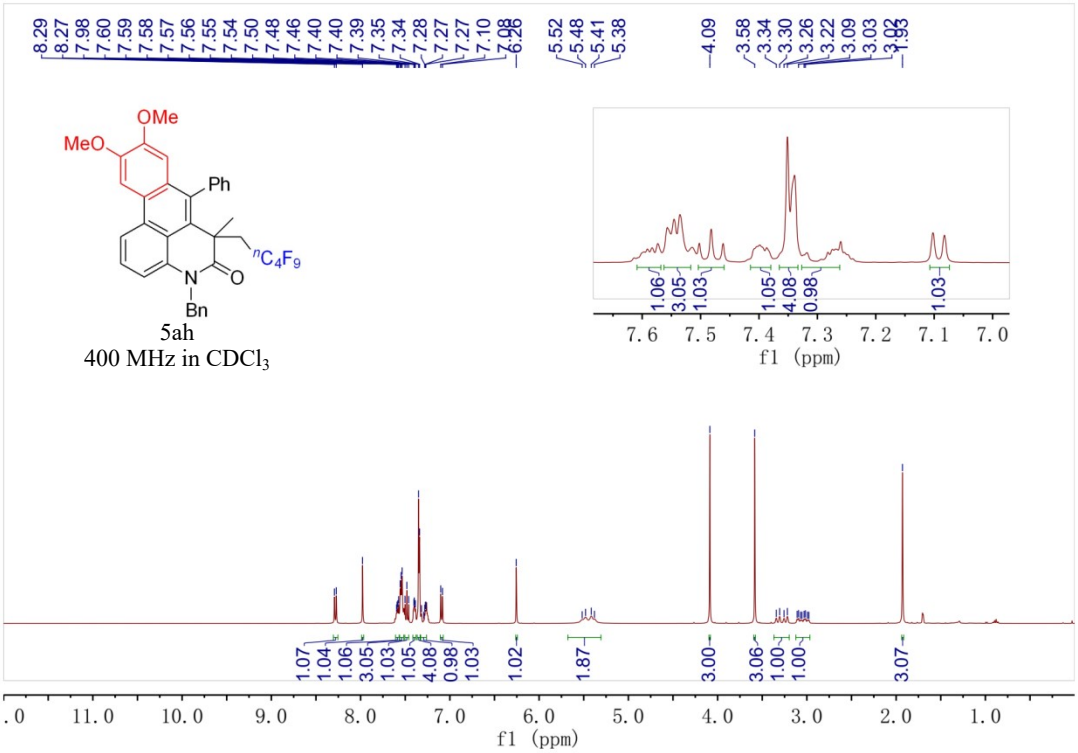
5ag
400 MHz in $CDCl_3$



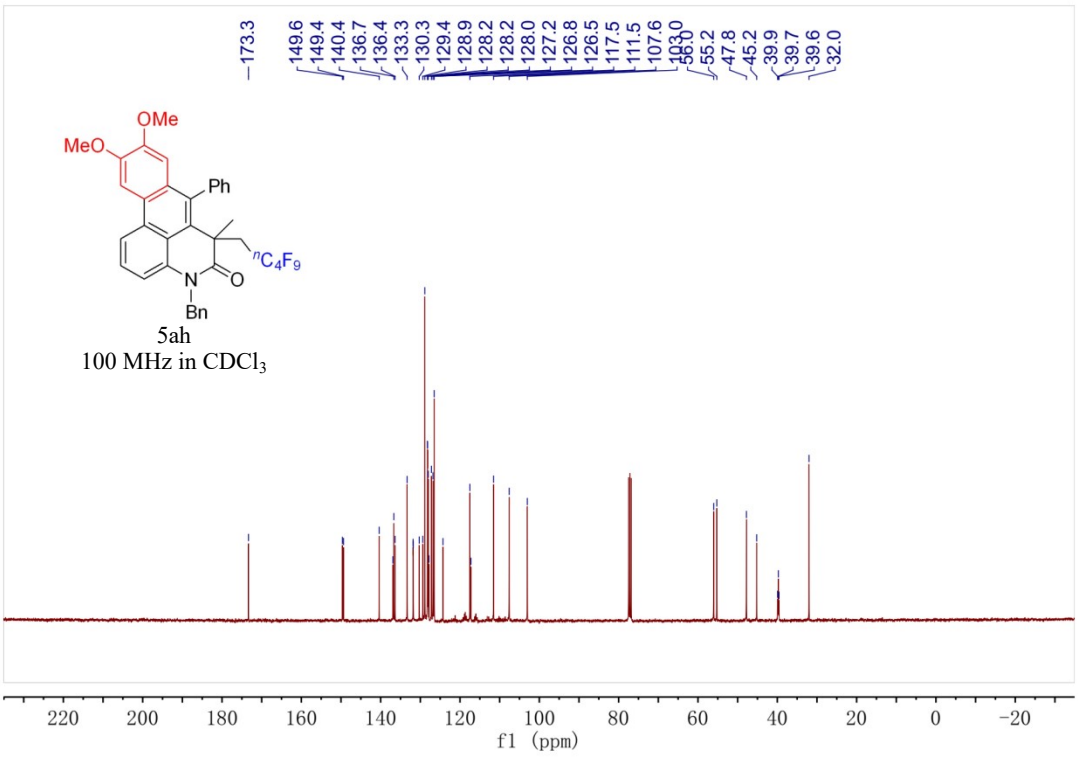
5ag
100 MHz in $CDCl_3$



5ag
377 MHz in $CDCl_3$

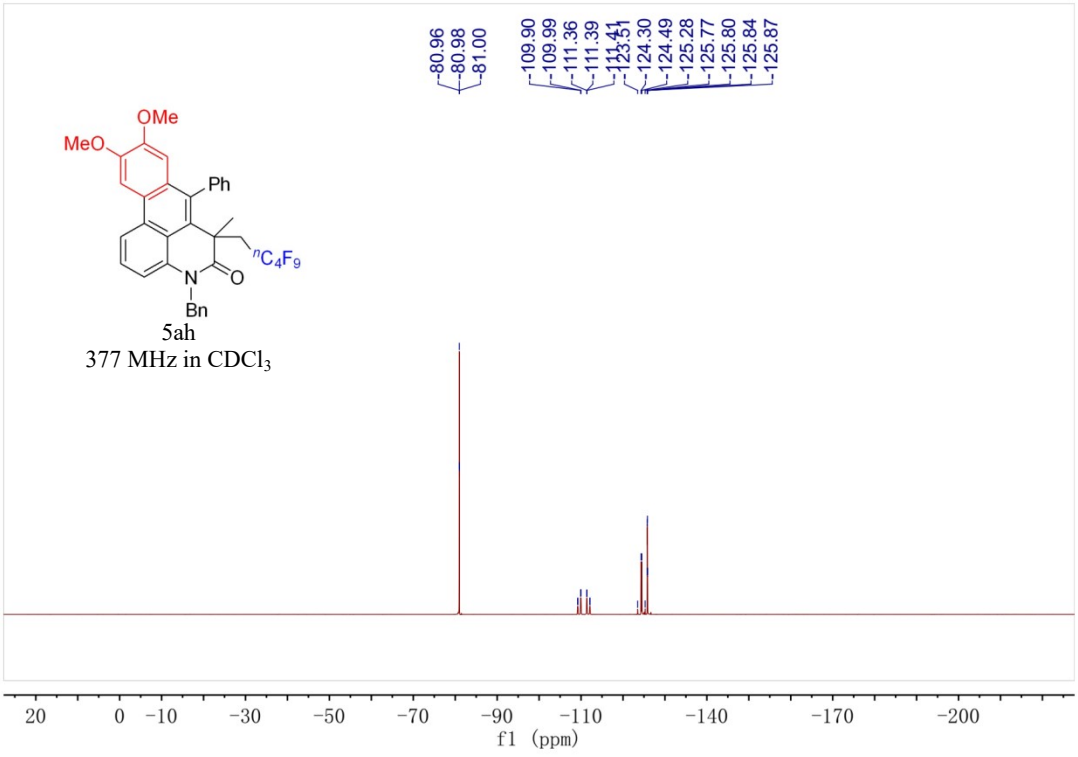


5ah
400 MHz in $CDCl_3$



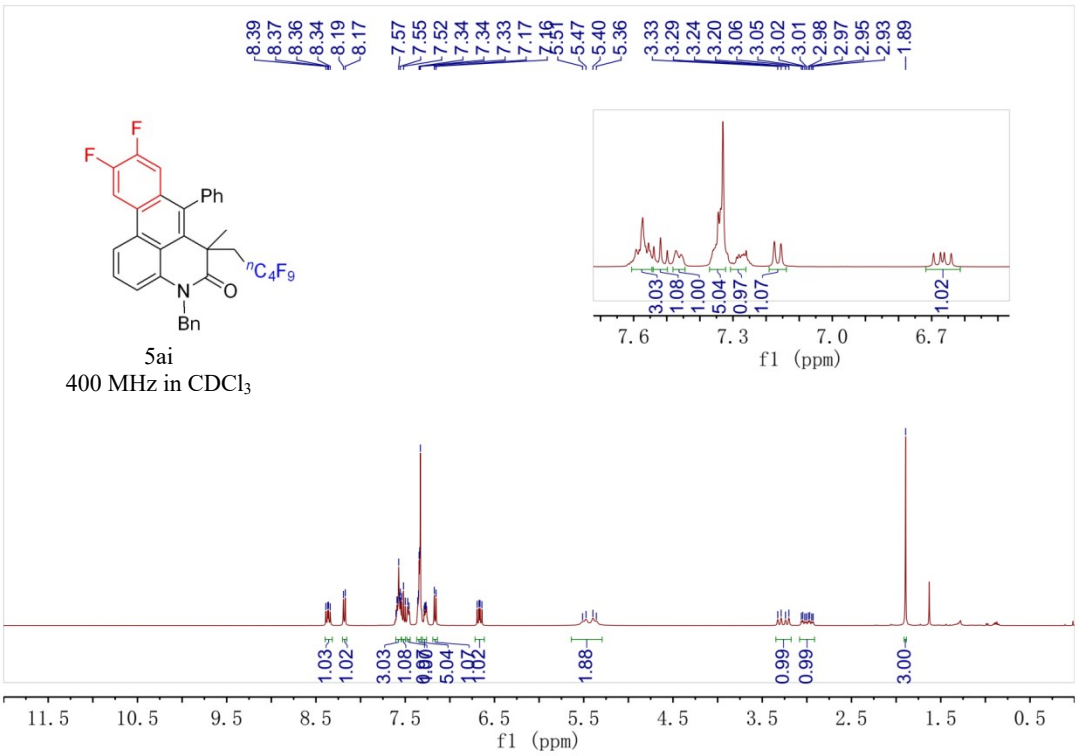
5ah

100 MHz in $CDCl_3$

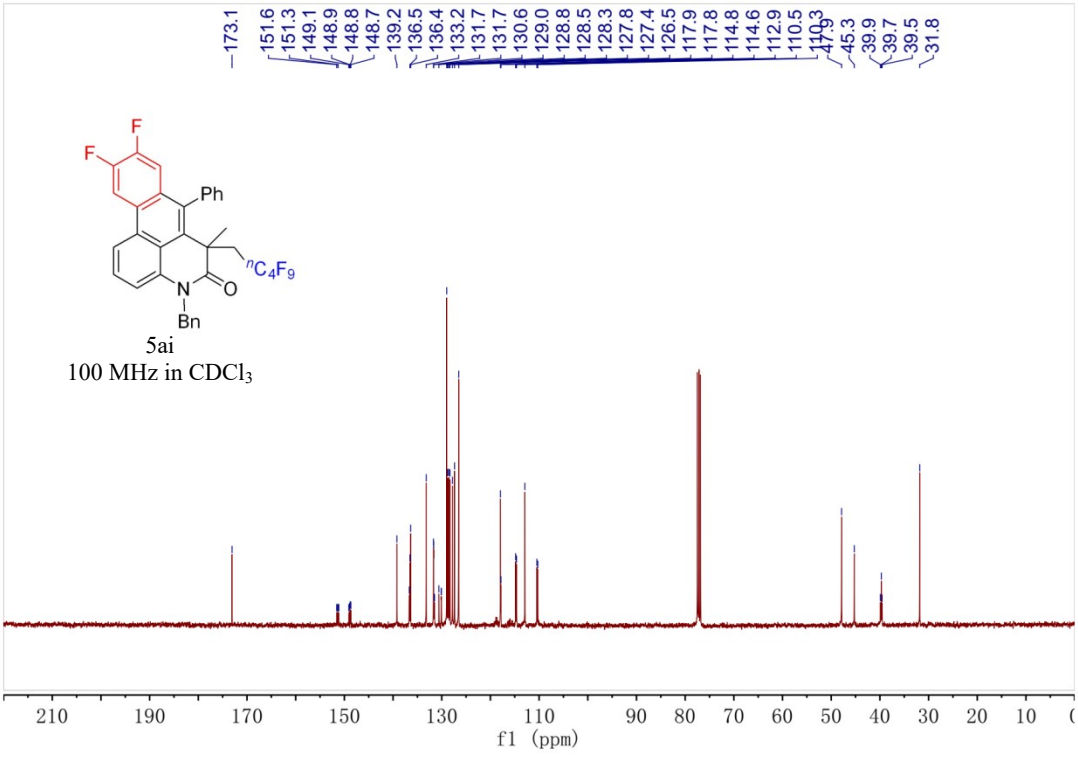


5ah

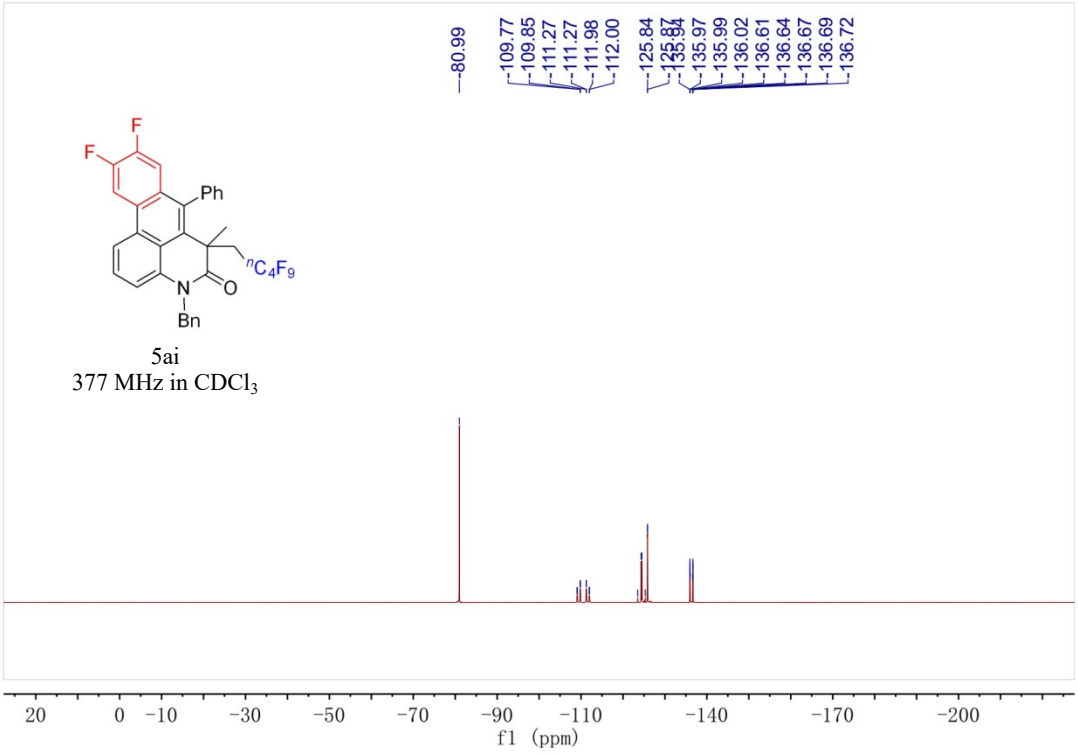
377 MHz in $CDCl_3$



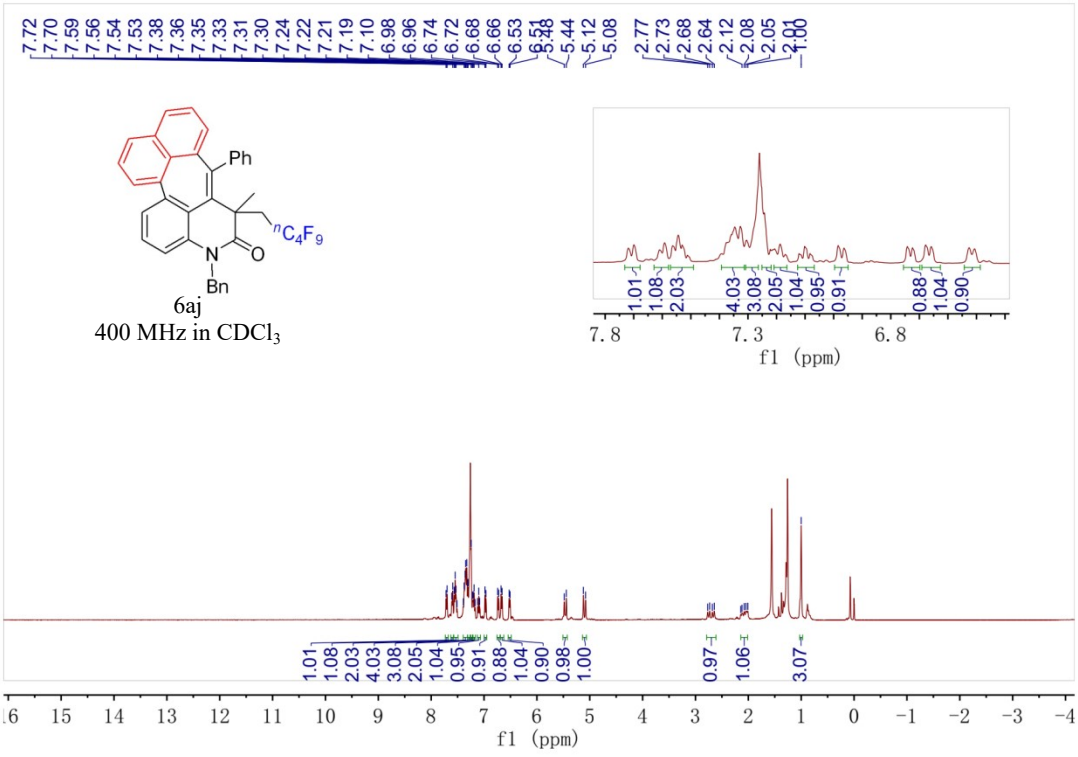
5ai
400 MHz in $CDCl_3$



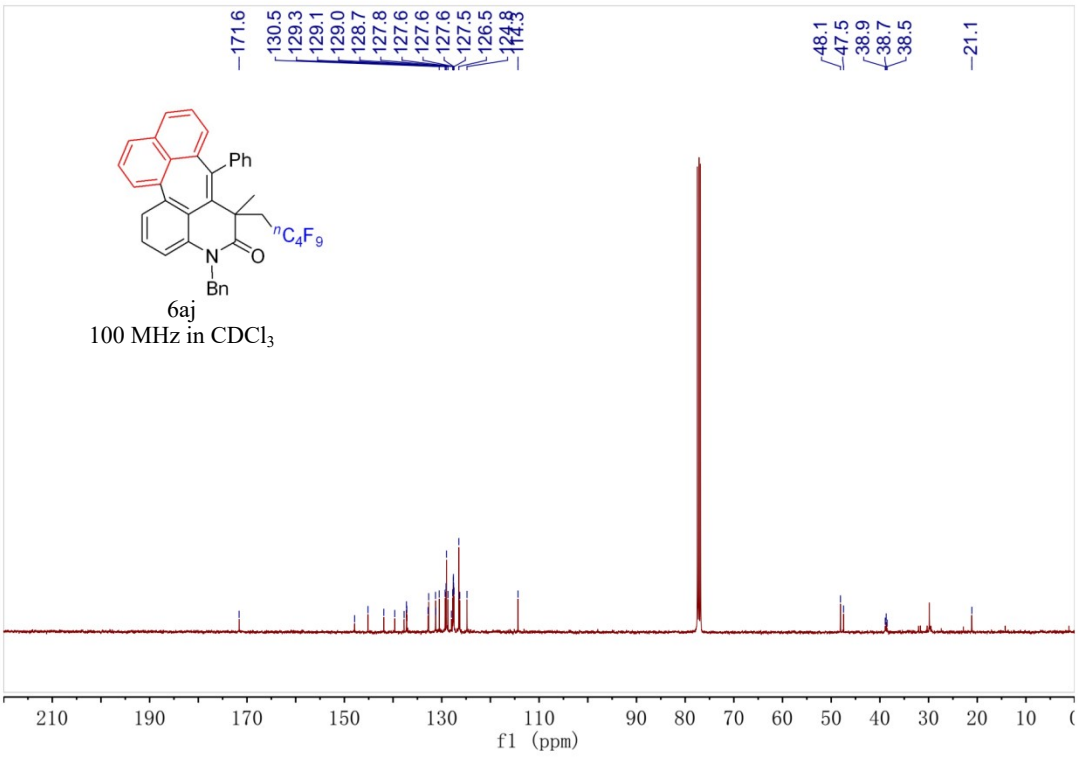
5ai
100 MHz in $CDCl_3$



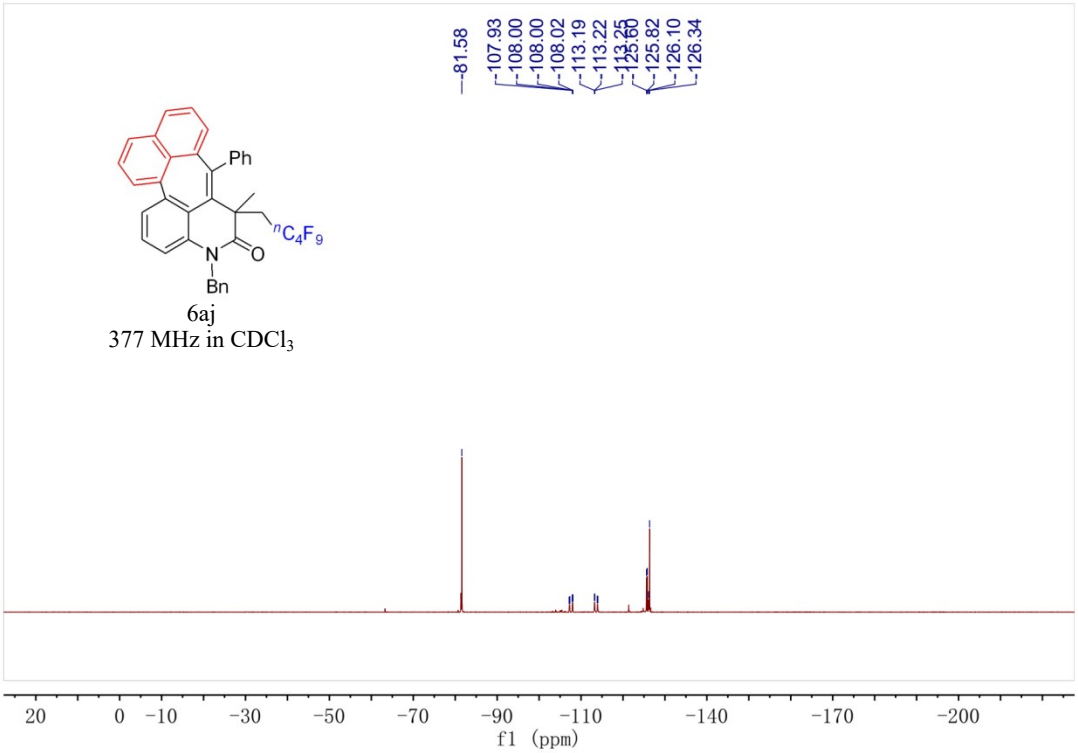
5ai
377 MHz in $CDCl_3$



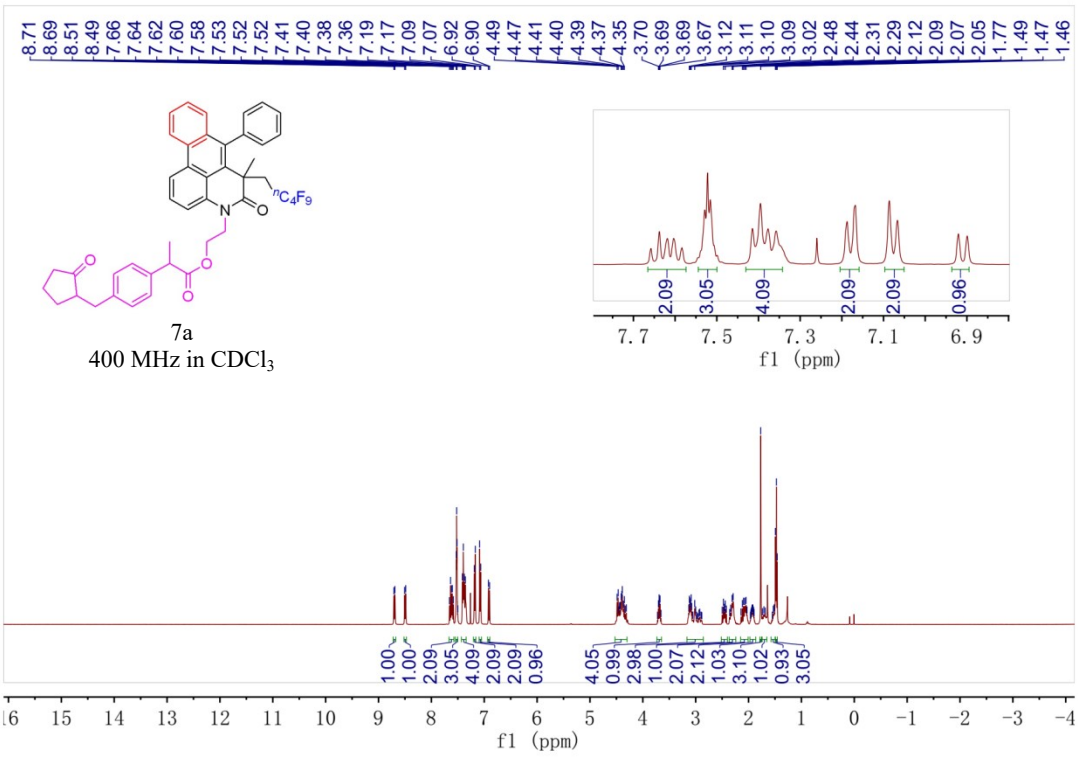
6aj
400 MHz in $CDCl_3$



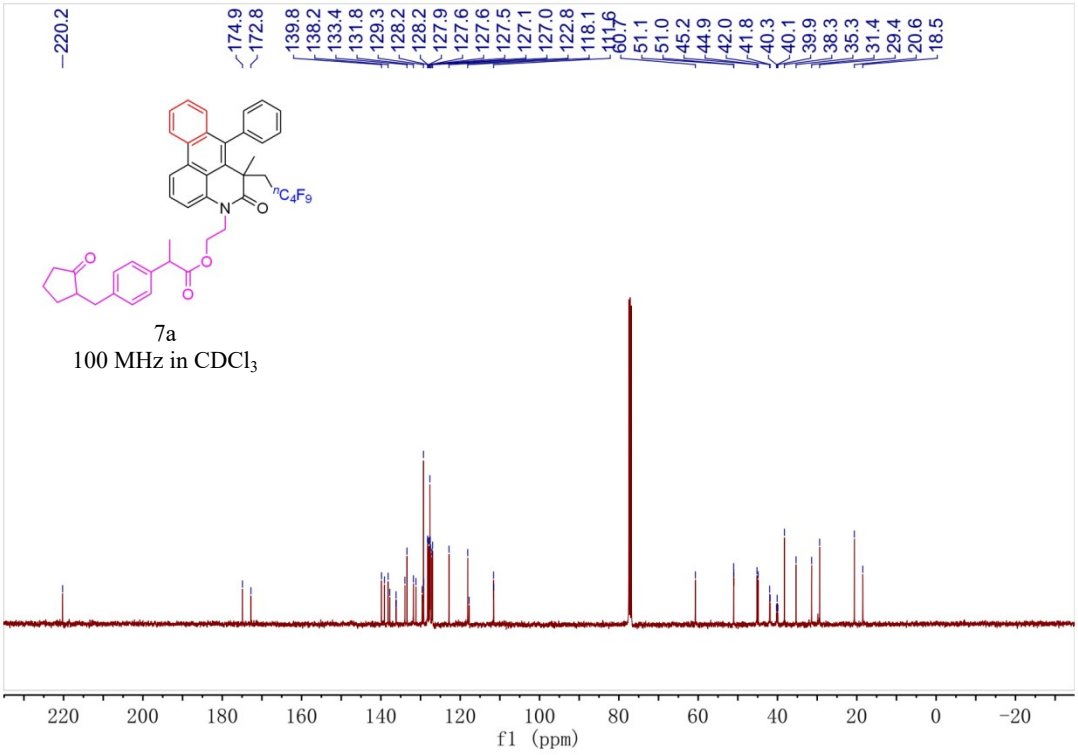
6aj
100 MHz in $CDCl_3$



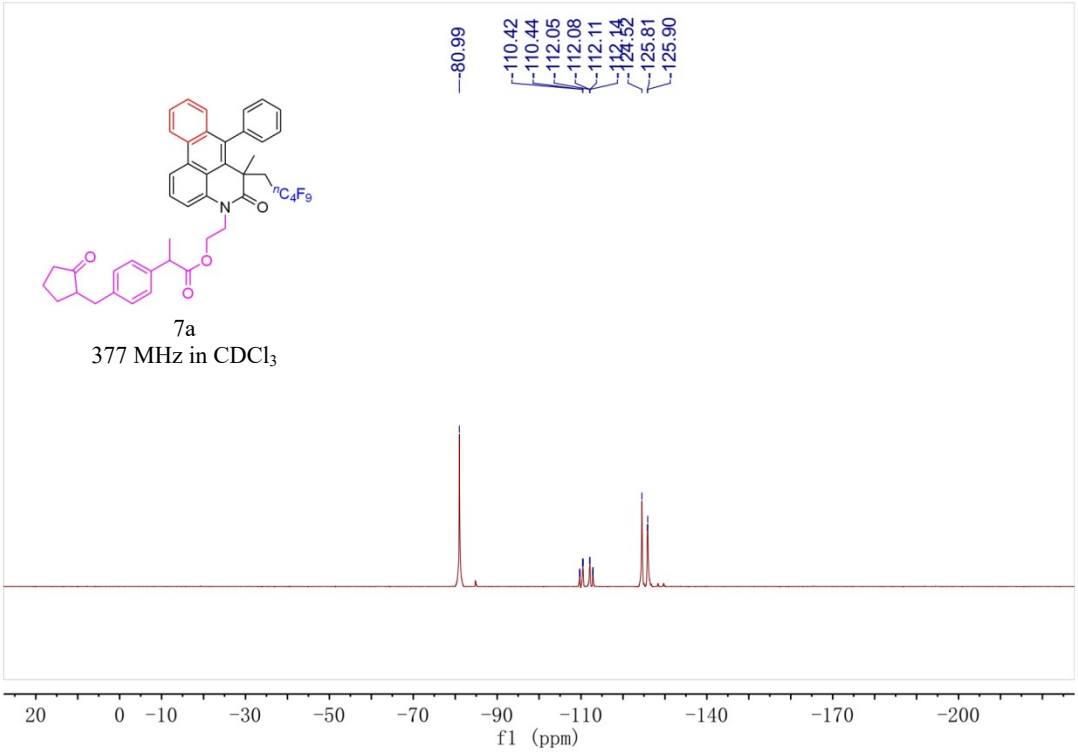
6aj
377 MHz in $CDCl_3$



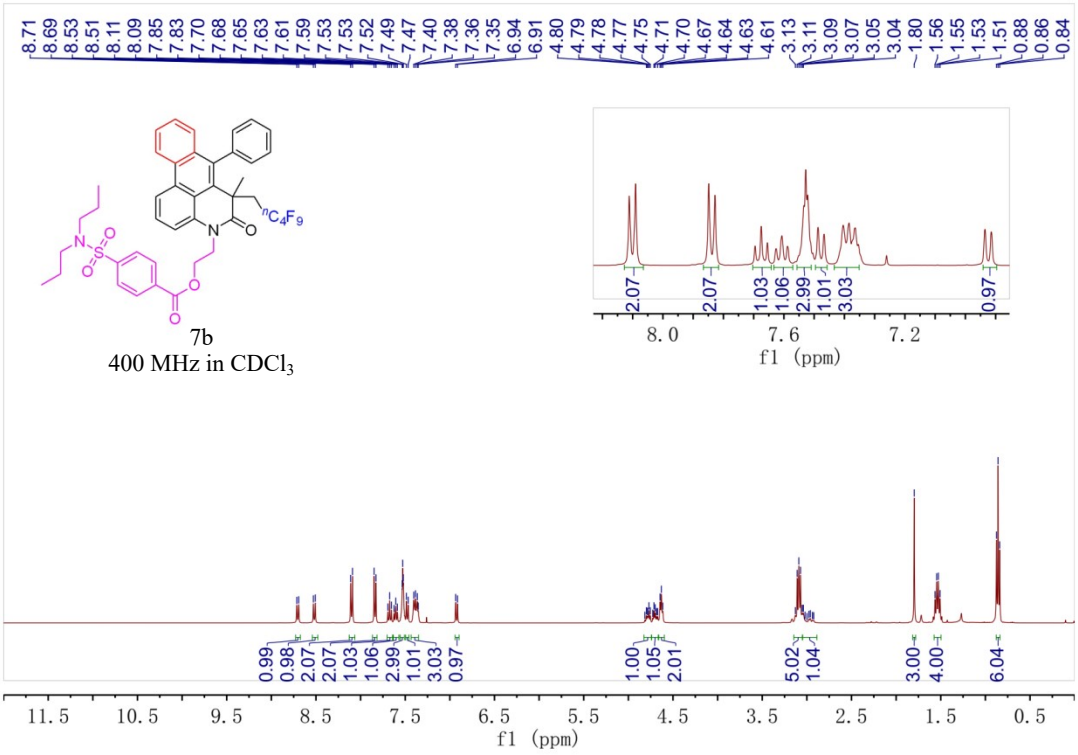
7a
400 MHz in $CDCl_3$



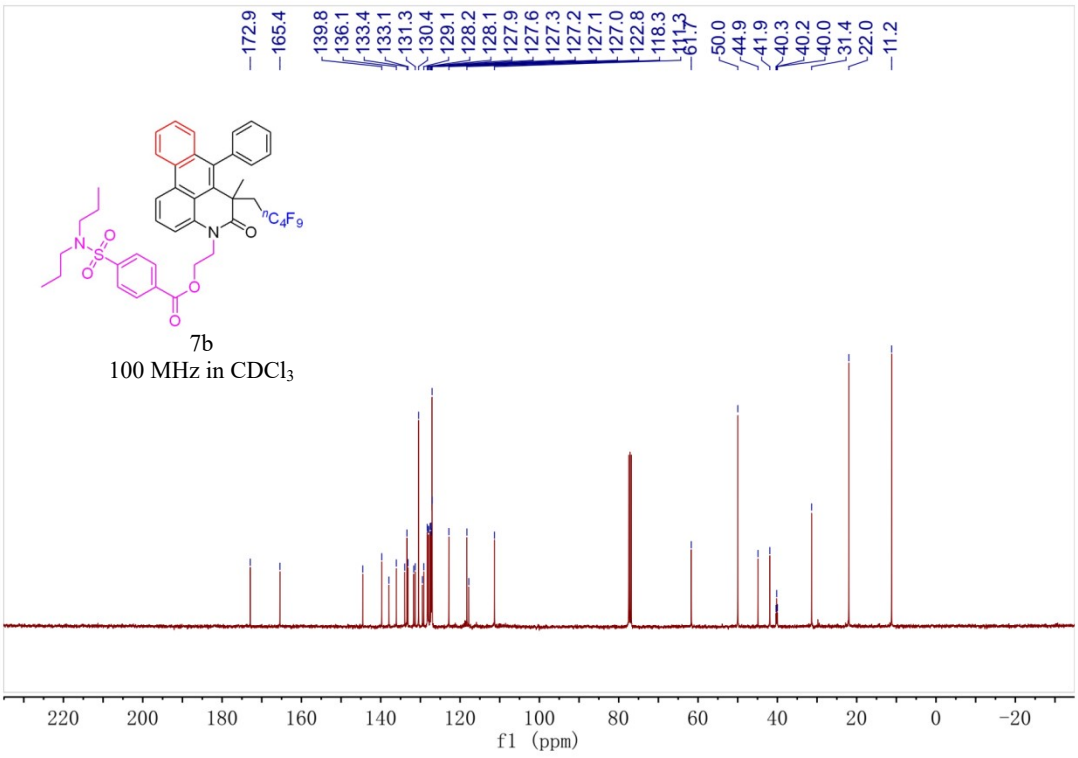
7a
100 MHz in $CDCl_3$



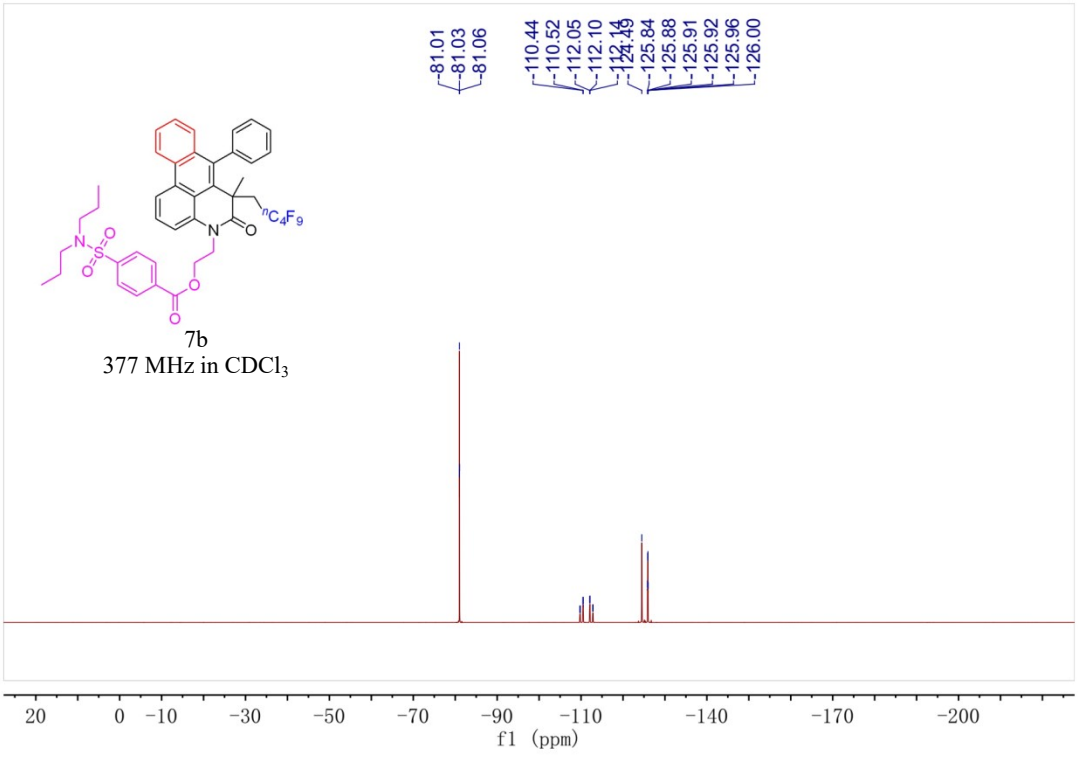
7a
377 MHz in $CDCl_3$



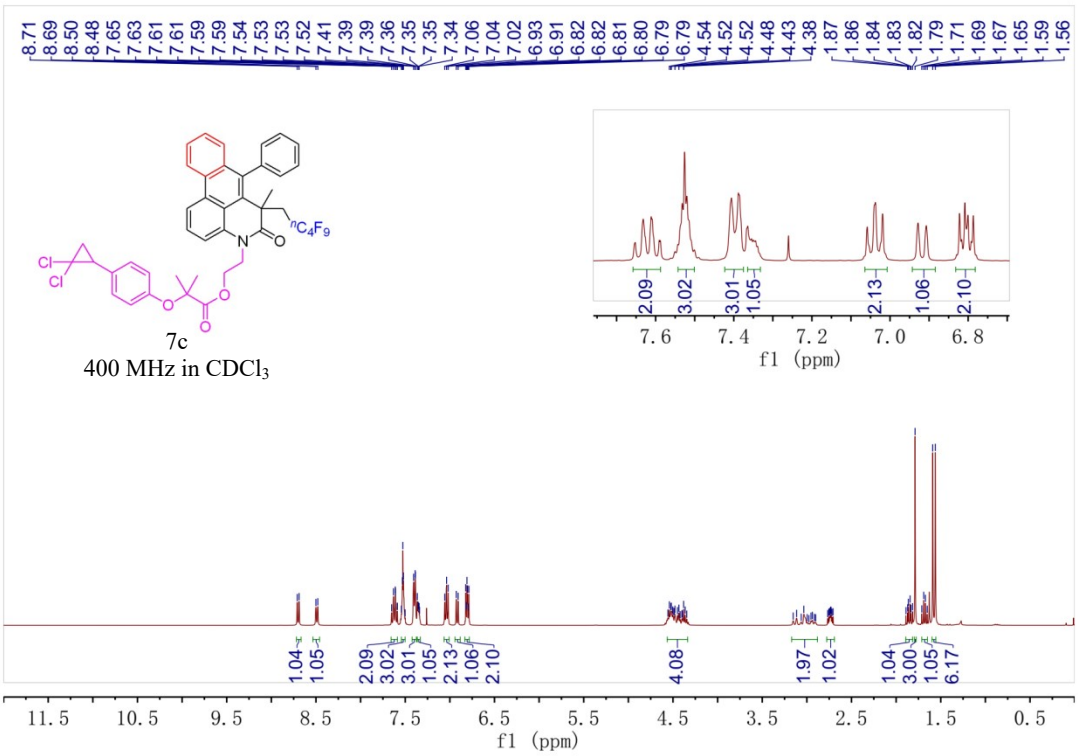
7b
400 MHz in $CDCl_3$



7b
100 MHz in $CDCl_3$

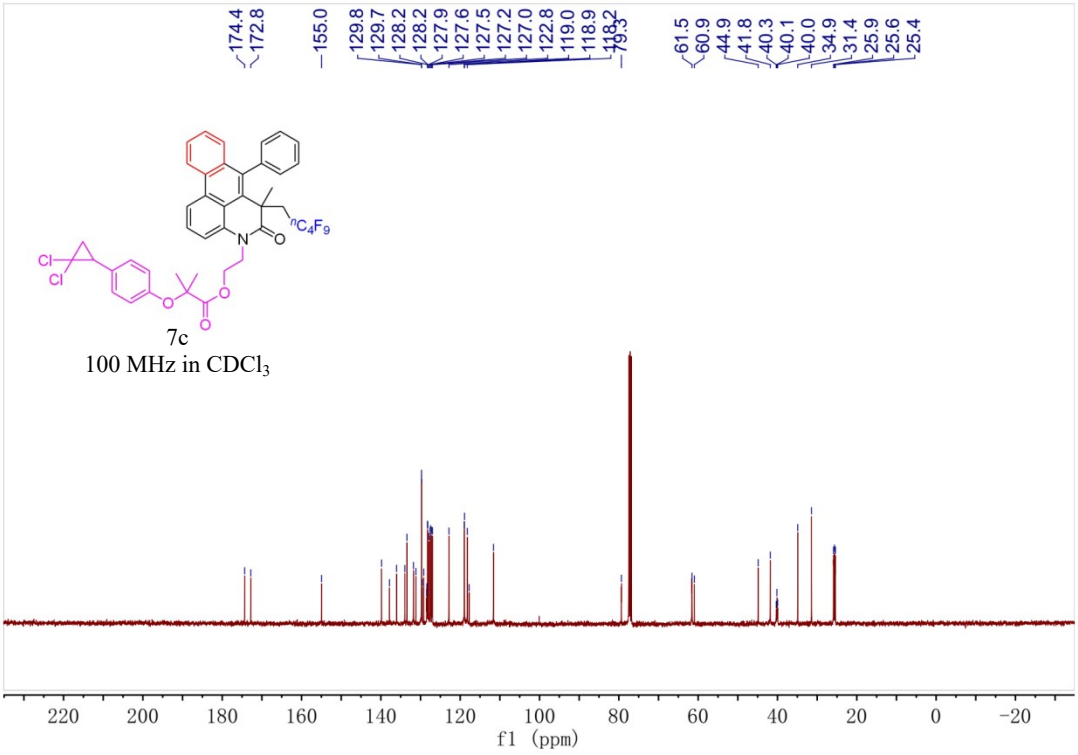


7b
377 MHz in $CDCl_3$



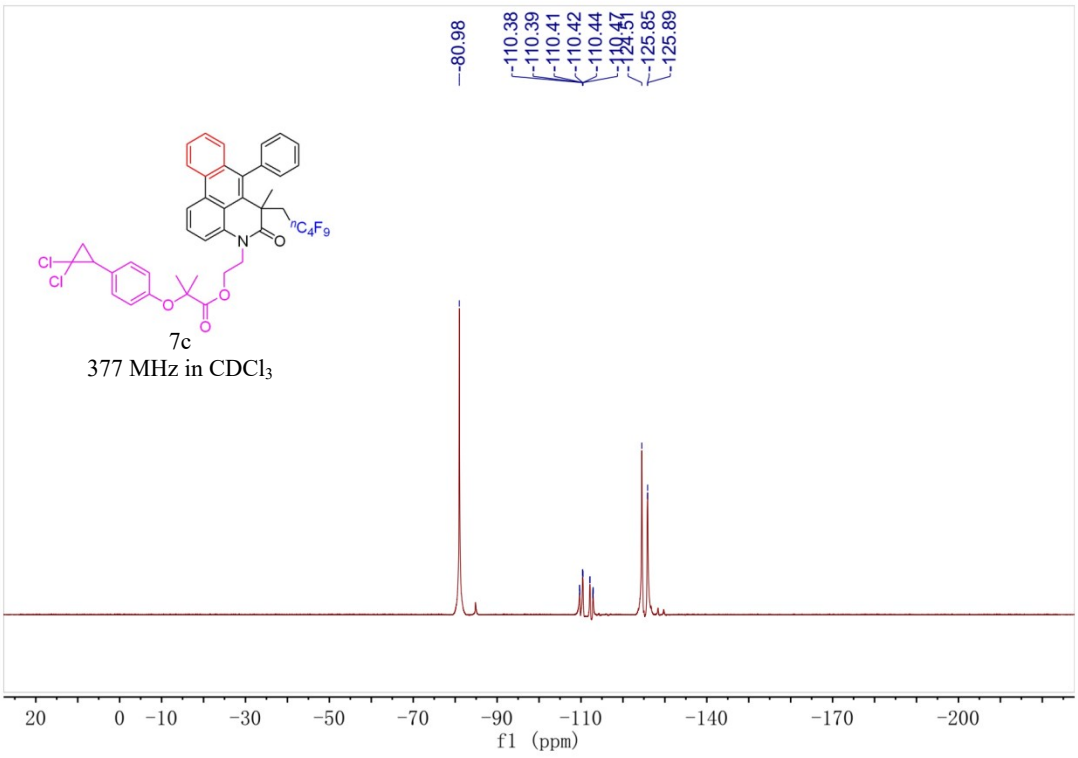
7c

400 MHz in $CDCl_3$



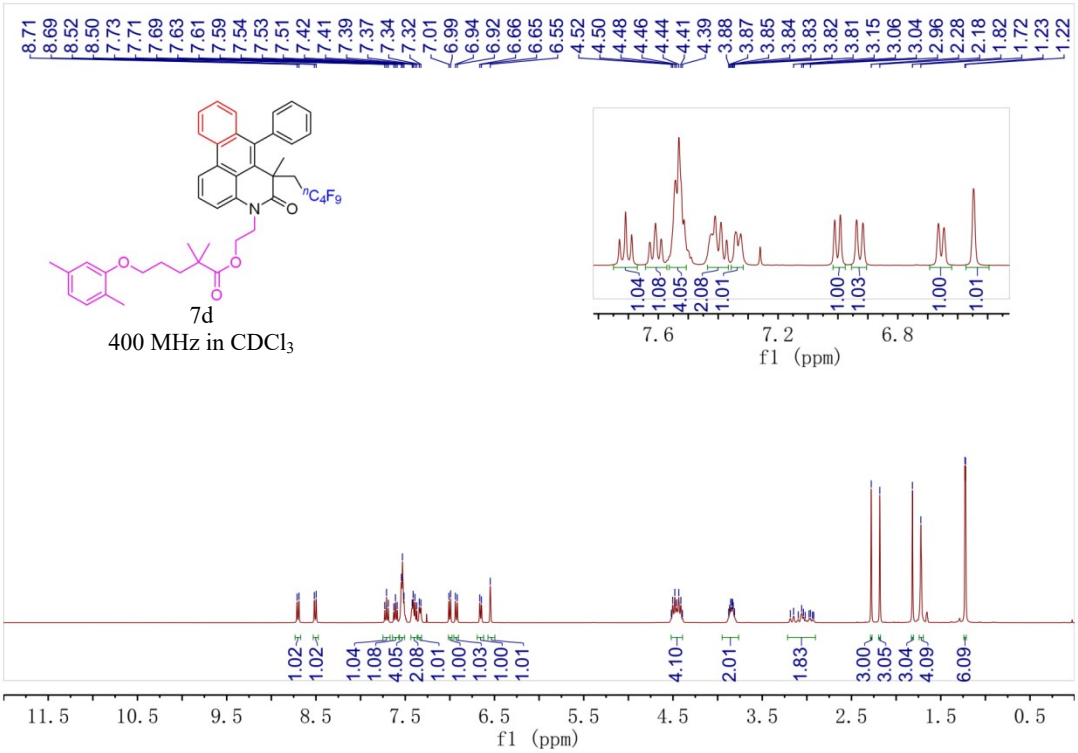
7c

100 MHz in $CDCl_3$



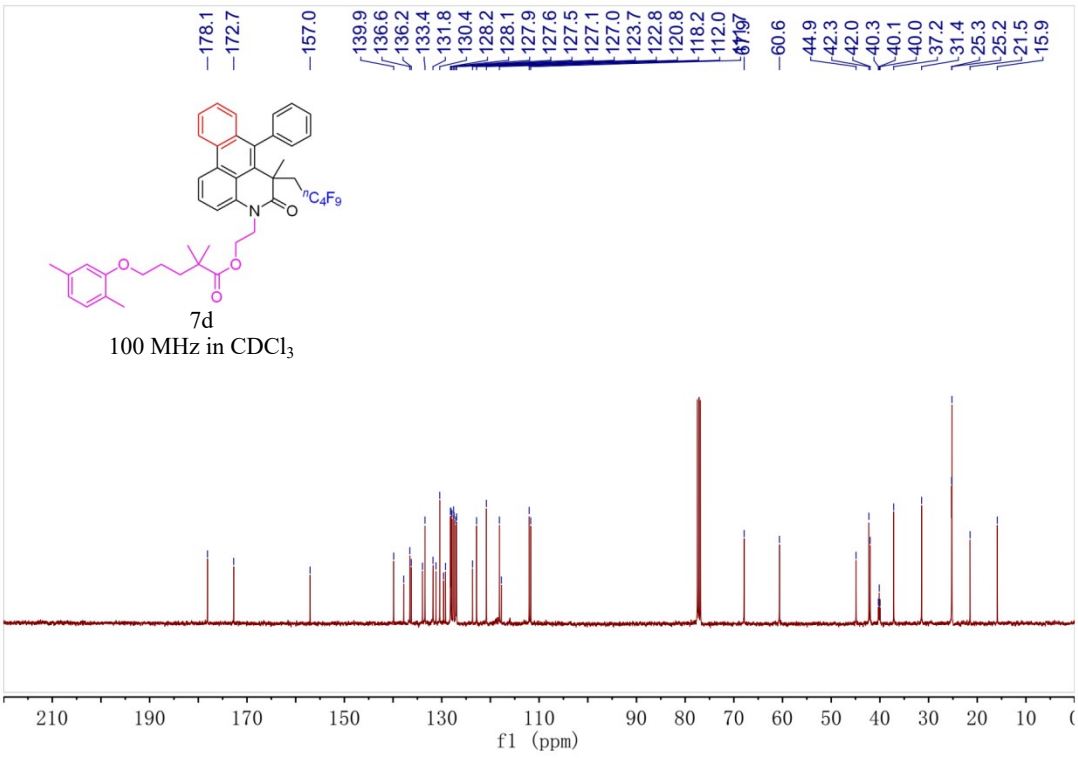
7c

377 MHz in $CDCl_3$

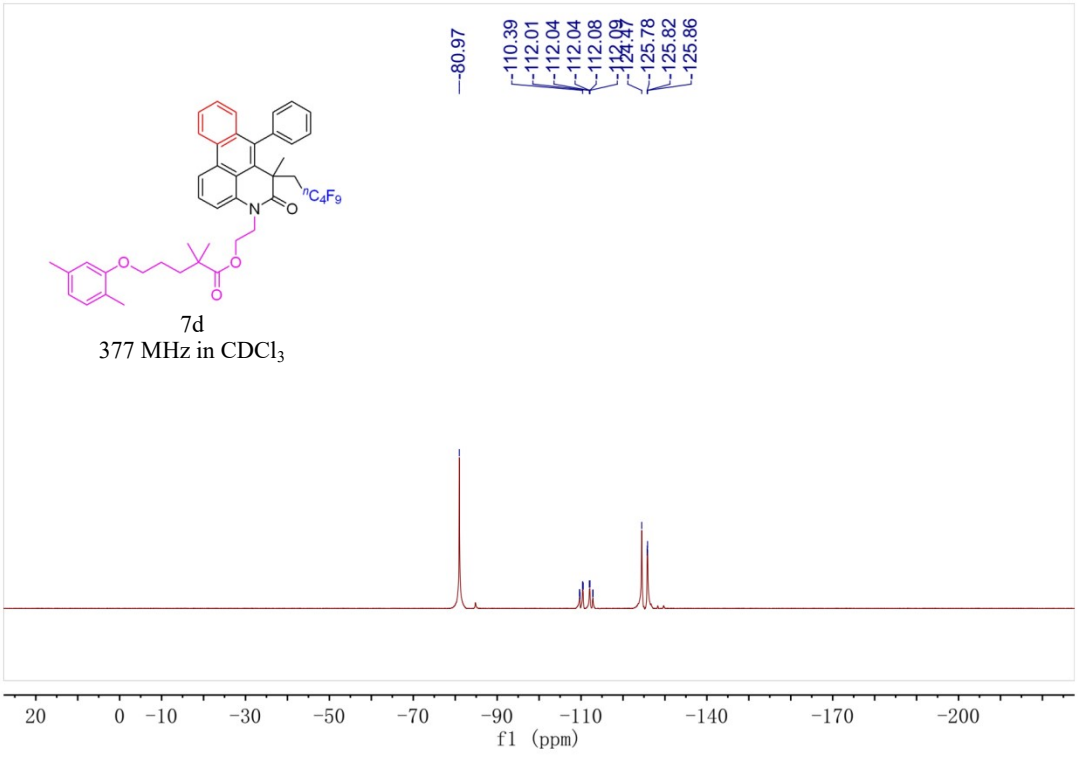


7d

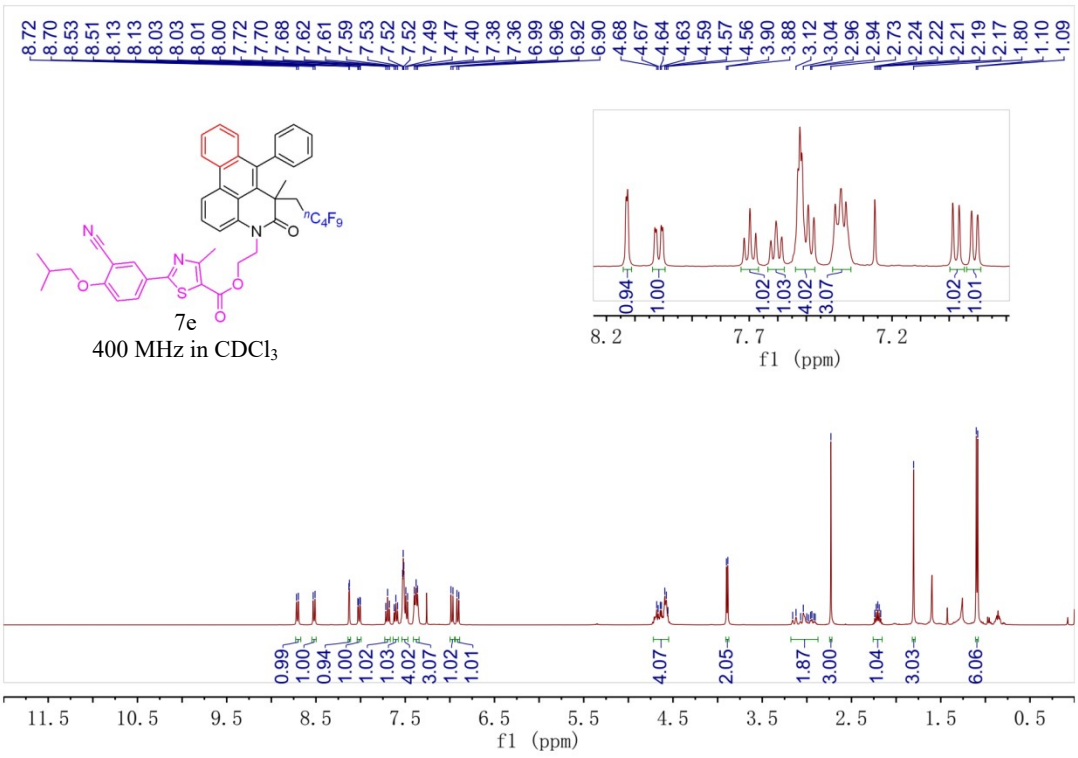
400 MHz in $CDCl_3$

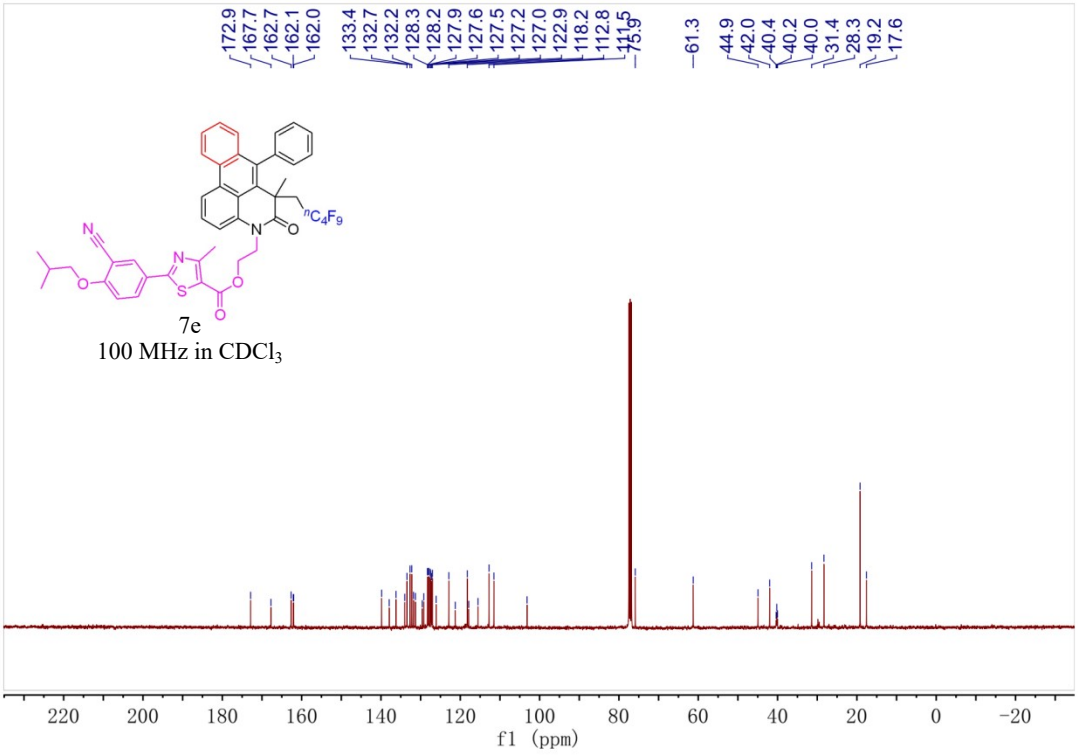


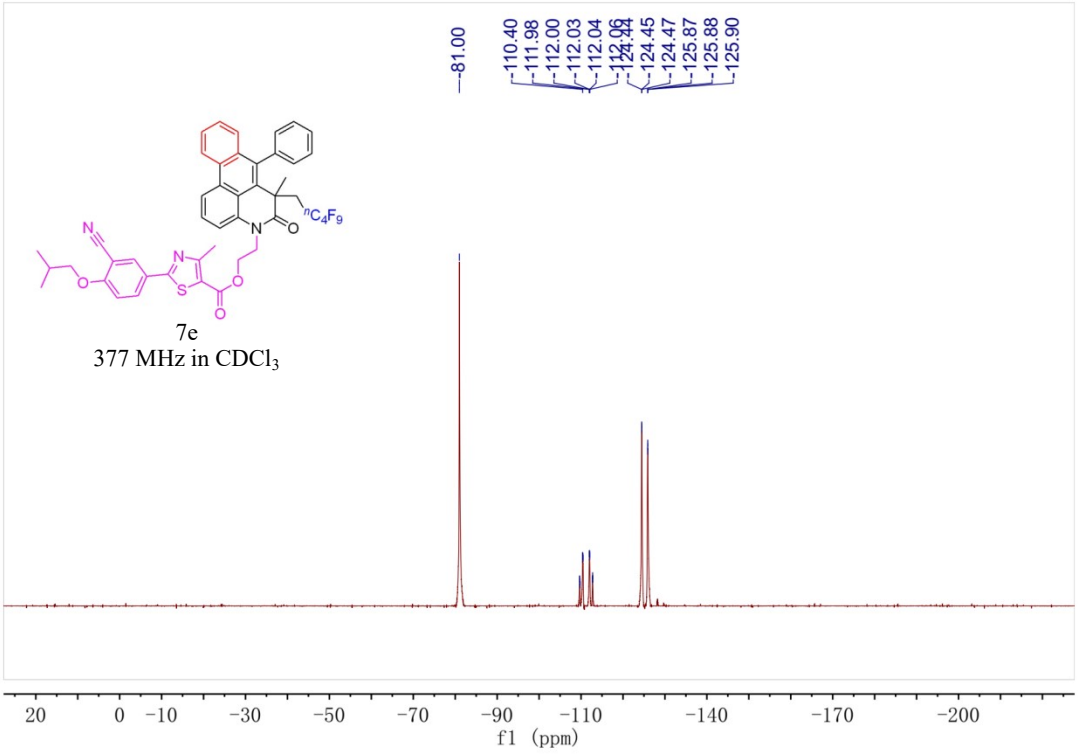
7d
100 MHz in $CDCl_3$



7d
377 MHz in $CDCl_3$


8.72 8.70 8.53 8.51 8.13 8.13 8.03 8.03 8.01 8.00 7.72 7.70 7.68 7.62 7.61 7.59 7.53 7.52 7.52 7.49 7.47 7.40 7.38 7.36 6.99 6.96 6.92 6.90 4.68 4.67 4.64 4.63 4.59 4.57 4.56 3.90 3.88 3.12 3.04 2.96 2.94 2.73 2.24 2.22 2.21 2.19 2.17 1.80 1.10 1.09
nC4F9
N
O
S
7e
400 MHz in CDCl3
0.94 1.00 1.02 1.03 4.02 3.07 1.02 1.01
8.2 7.7 7.2
f1 (ppm)
0.99 1.00 0.94 1.00 1.02 1.03 4.02 3.07 1.02 1.01 4.07 2.05 1.87 3.00 1.04 3.03 6.06
11.5 10.5 9.5 8.5 7.5 6.5 5.5 4.5 3.5 2.5 1.5 0.5
f1 (ppm)


172.9 167.7 162.7 162.1 162.0 133.4 132.7 132.2 128.3 128.2 127.9 127.6 127.5 127.2 127.0 122.9 118.2 112.8 111.5 75.9 61.3 44.9 42.0 40.4 40.2 40.0 31.4 28.3 19.2 17.6
nC4F9
N
O
S
7e
100 MHz in CDCl3
220 200 180 160 140 120 100 80 60 40 20 0 -20
f1 (ppm)



7e
377 MHz in $CDCl_3$