Construction of Hydrodibenzo[*b*,*d*]furan Frameworks from Morita–Baylis–Hillman Carbonates of Isatins and *o*-Hydroxy Enones via Palladium and Brønsted Base Relay Catalysis

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Supporting Information

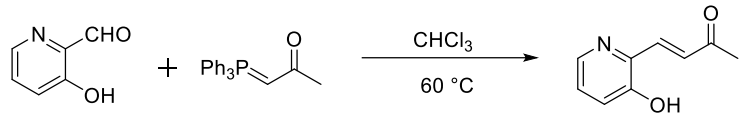
1. General methods

Unless otherwise noted, the reactions were carried out under ambient atmosphere; when the reactions required heating, the heat source was oil bath. ^{1}H NMR (400 or 600 MHz), ^{13}C NMR (100 or 150 MHz) and ^{19}F NMR (375 MHz) spectra were recorded on Varian INOVA-400/54, Agilent DD2-600/54 or Bruker Ascend^{TM} 400 instruments (Chemical shifts were reported in ppm from tetramethylsilane with the solvent resonance as the internal standard in $CDCl_3$ solution, unless otherwise noted). The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, dd = double doublet, m = multiplet and coupling constants (*J*) are reported in Hertz (Hz). High resolution mass spectra (HRMS) were recorded on a Waters SYNAPT G2 or Agilent G1969-85000 using a time-of-flight mass spectrometer equipped with electrospray ionization (ESI) source. X-ray diffraction experiments were carried out on an Agilent Gemini or Burker D8 Venture and the data obtained were deposited at the Cambridge Crystallographic Data Centre. In each case, diastereomeric ratio was determined by ^{1}H NMR analysis and enantiomeric excess was determined by HPLC (Agilent Technologies: 1220 Infinity II, 1200 Series, 1260 Infinity) analysis on a chiral column in comparison with authentic racemate, using a Daicel Chiralpak AD-H Column (250 × 4.6 mm). UV detection was monitored at 220 nm or 254 nm. Optical rotation was measured in $CHCl_3$ solution at 25 °C. Column chromatography was performed on silica gel (200-300 mesh) eluting with EtOAc and petroleum ether. TLC was performed on glass-backed silica plates. UV light, I_2, and solution of potassium permanganate were used to visualize products or starting materials. All chemicals were used without purification as commercially available unless otherwise noted. Petroleum ether and EtOAc were distilled. Experiments involving moisture and/or air sensitive components were performed under a positive pressure of argon in oven-dried glassware equipped with a rubber septum inlet. Toluene was freshly distilled from CaH_2 under an atmosphere of dry argon. Dried solvents reagents were transferred by oven-dried syringe.

2. Preparation and characterization of substrates

The Morita–Baylis–Hillman (MBH) carbonates **1**,[1] enones **2**[2] and (*E*)-4-methyl-*N*-(2-(3-oxobut-1-en-1-yl)phenyl)benzenesulfon-amide **5**[3] were prepared according to the literature procedures. Compounds **1a**–**n**,[1] **2a**–**g**, **2i**, **2l**,[2a] **2k**,[2b] **2m**,[2c] and **5**[3] are known compounds and the spectroscopic data were consistent with the literature report.

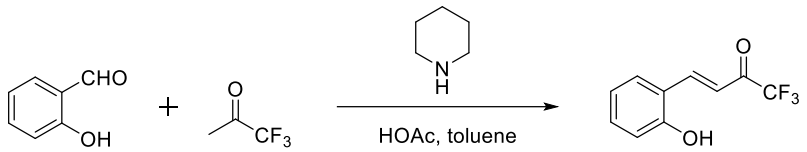
2.1 Procedure for preparation of substrate 2h



2h

To a flask equipped with a magnetic stirring bar and a reflux condenser were added 3-hydroxypicolinaldehyde (0.247 g, 2.01 mmol), 1-triphenylphosphoranylidene-2-propanone (0.770 g, 2.42 mmol), and $CHCl_3$ (5.0 mL), and the resultant mixture was heated at 60 ºC for 12 h. After completion (monitored by TLC, ethyl acetate/ petroleum ether = 1/3), the mixture was cooled to room temperature and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/2) to give the substrate **2h**: 0.231 g (1.42 mmol), as a yellow solid, 71% yield; mp 152–154 °C; ^{1}H NMR (400 MHz, DMSO-d_6) δ (ppm) 10.64 (s, 1H), 8.17–8.10 (m, 1H), 7.82 (d, J = 16.0 Hz, 1H), 7.33–7.25 (m, 2H), 7.08 (d, J = 16.0 Hz, 1H), 2.35 (s, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ (ppm) 198.7, 153.8, 141.4, 140.1, 136.9, 129.1, 126.5, 124.1, 28.1; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_9H_{10}NO_2^+$ 164.0706; Found 164.0704.

2.2 Procedure for preparation of substrate 2j



2j

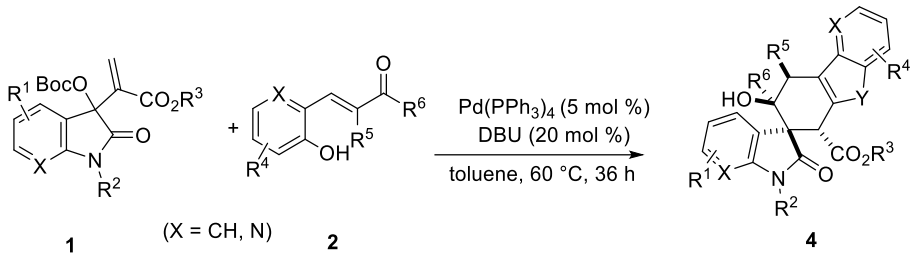
To a stirred solution of salicylaldehyde (1.12 g, 10.0 mmol), acetic acid (0.90 g, 15.0 mmol), and piperidine (0.85 g, 10.0 mmol) in dry toluene (10 mL) was added dropwise a solution of trifluoroacetone (4.49 g, 40.1 mmol) in dry toluene (10 mL) at 0 ºC. The mixture was stirred at 0 ºC for 2 h, and then stirred at room temperature for another 24 h. The reaction was quenched with saturated ammonium chloride aqueous solution. The organic layer was separated, washed with water and brine, dried over anhydrous Na_2SO_4. After concentration, the residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/12) to give the substrate **2j**: 0.735 g (3.39 mmol), as a colourless oil, 34% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.33–7.27 (m, 1H), 7.22–7.16 (m, 1H), 7.08–6.99 (m, 2H), 6.91 (d, J = 10.0 Hz, 1H), 5.89 (d, J = 10.0 Hz, 1H), 2.93 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 149.7, 130.7, 129.7, 127.5, 122.6, 121.8 (q, J = 283.6 Hz), 118.3, 116.6, 115.2, 93.63 (q, J = 34.1 Hz); ^{19}F NMR (375 MHz, $CDCl_3$) δ (ppm) –84.97; HRMS (ESI-TOF) m/z: $[M + H]^+$ Calcd for $C_{10}H_8F_3O_2^+$ 217.0471; Found 217.0462.

(1) Fan, X.; Yang, H.; Shi, M. *Adv. Synth. Catal.* **2017**, *359*, 49−57.

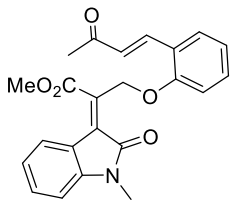
(2) (a) Song, X.; Yan, R.-J.; Du, W.; Chen, Y.-C. *Org. Lett.* **2020**, *22*, 7617−7621. (b) Gao, Y.-Q.; Hou, Y.; Chen, J.; Zhen, Y.; Xu, D.; Zhang, H.; Wei, H.; Xie, W. *Org. Biomol. Chem*. **2021**, *19*, 348–354. (c) Ackrill, T. D.; Sparkes, H. A.; Willis, C. L. *Org. Lett.* **2015**, *17*, 3884–3887.

(3) Kim, S.; Kang, K.-T.; Kim, S.-G. *Tetrahedron* **2014**, *70*, 5114–5121.

3. General procedure for synthesis of products 4

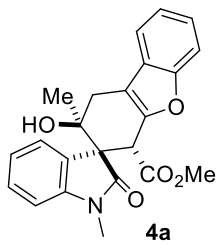


General procedure: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added MBH carbonate **1** (0.12 mmol, 1.2 equiv), enone **2** (0.1 mmol, 1.0 equiv), DBU (3.0 mg, 0.020 mmol, 20 mol %) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol, 5 mol %). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether) to give the product.


3a

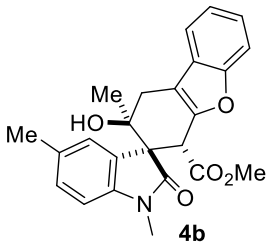
Synthesis of 3a: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl) but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 12 h, and monitored by TLC (EtOAc/petroleum ether = 1/6). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the product **3a**: 28.6 mg (0.0731 mmol), as a white solid, 73% yield; mp 124–126 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.86 (d, J = 16.4 Hz, 1H), 7.55 (d, J = 7.6 Hz, 1H), 7.42–7.29 (m, 3H), 7.07 (d, J = 8.4 Hz, 1H), 7.05–6.96 (m, 2H), 6.82 (d, J = 7.6 Hz, 1H), 6.72 (d, J = 16.8 Hz, 1H),

5.77 (s, 2H), 3.99 (s, 3H), 3.24 (s, 3H), 2.41 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 199.0, 166.9, 156.6, 143.8, 138.3, 131.9, 131.0, 128.0, 127.7, 125.7, 123.6, 123.0, 122.6, 121.6, 119.4, 112.6, 108.5, 64.5, 52.9, 27.4, 26.0; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{23}H_{21}NO_5Na^+$ 414.1312; Found 414.1317.



4a

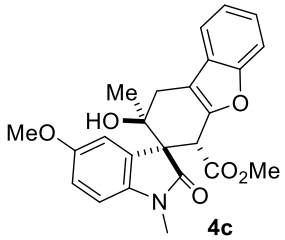
Synthesis of 4a: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/7) to give the product **4a**: 32.9 mg (0.0841 mmol), as a white solid, 84% yield; mp 161−163 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.46–7.40 (m, 2H), 7.26–7.13 (m, 3H), 6.98 (d, J = 7.6 Hz, 1H), 6.89–6.84 (m, 1H), 6.82 (d, J = 8.0 Hz, 1H), 4.66 (s, 1H), 4.45 (s, 1H), 3.25 (s, 3H), 3.18 (s, 3H), 2.88 (s, 2H), 0.94 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.5, 168.9, 155.7, 146.9, 144.2, 129.4, 127.7, 126.8, 125.3, 124.2, 123.3, 122.6, 119.1, 113.0, 111.6, 108.4, 73.4, 57.9, 52.0, 46.0, 32.2, 26.4, 25.0; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{23}H_{21}NO_5Na^+$ 414.1312; Found 414.1316.



4b

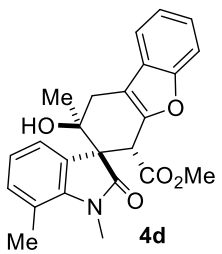
Synthesis of 4b: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1,5-dimethyl-2-oxoindolin-3-yl)acrylate **1b** (43.4 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/7) to give the product

4b: 30.8 mg (0.0760 mmol), as a white solid, 76% yield; mp 166–168 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.57–7.51 (m, 2H), 7.34–7.23 (m, 2H), 7.11 (d, *J* = 8.0 Hz, 1H), 6.87 (s, 1H), 6.79 (d, *J* = 8.0 Hz, 1H), 4.72 (s, 1H), 4.59 (s, 1H), 3.32 (s, 3H), 3.28 (s, 3H), 3.02–2.91 (m, 2H), 2.21 (s, 3H), 1.02 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.5, 168.9, 155.7, 146.9, 141.7, 133.0, 129.7, 127.8, 126.8, 125.9, 124.2, 122.5, 119.2, 113.0, 111.6, 108.1, 73.4, 57.8, 52.0, 45.9, 32.1, 26.4, 24.9, 21.2; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{23}NO_5Na^+$ 428.1468; Found 428.1466.



4c

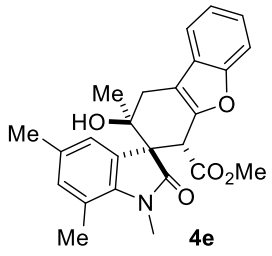
Synthesis of 4c: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-5-methoxy-1-methyl-2-oxoindolin-3-yl)acrylate **1c** (45.3 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the product **4c**: 32.5 mg (0.0771 mmol), as a white solid, 77% yield; mp 146–148 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.55–7.47 (m, 2H), 7.33–7.21 (m, 2H), 6.85–6.78 (m, 2H), 6.69 (s, 1H), 4.74 (s, 1H), 4.58 (s, 1H), 3.65 (s, 3H), 3.323 (s, 3H), 3.316 (s, 3H), 3.02–2.90 (m, 2H), 1.03 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.1, 168.9, 156.3, 155.7, 146.7, 137.6, 128.2, 127.7, 124.2, 122.5, 119.1, 113.5, 112.9, 112.8, 111.6, 108.6, 73.4, 58.1, 55.8, 52.1, 45.8, 32.0, 26.5, 24.9; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{23}NO_6Na^+$ 444.1418; Found 444.1420.



4d

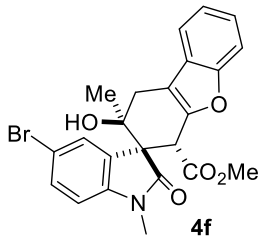
Synthesis of 4d: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1,7-dimethyl-2-oxoindolin-3-yl)acrylate **1d** (43.4 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC

(EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/7) to give the product **4d**: 28.4 mg (0.0700 mmol), as a white solid, 70% yield; mp 144–146 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.54–7.48 (m, 2H), 7.33–7.23 (m, 2H), 7.03 (d, *J* = 7.6 Hz, 1H), 6.92 (d, *J* = 7.2 Hz, 1H), 6.86–6.78 (m, 1H), 4.72 (s, 1H), 4.65 (s, 1H), 3.62 (s, 3H), 3.30 (s, 3H), 3.02–2.89 (m, 2H), 2.59 (s, 3H), 1.02 (s, 3H).^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 179.3, 169.0, 155.6, 146.9, 141.8, 133.1, 127.7, 127.3, 124.2, 123.15, 123.11, 122.5, 120.0, 119.1, 113.0, 111.5, 73.4, 57.1, 52.0, 46.2, 32.0, 29.9, 24.9, 19.2; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{23}NO_5Na^+$ 428.1468; Found 428.1466.



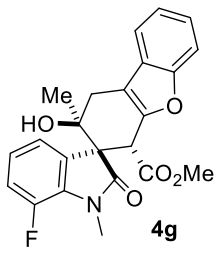
4e

Synthesis of 4e: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1,5,7-trimethyl-2-oxoindolin-3-yl)acrylate **1e** (45.1 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/8) to give the product **4e**: 34.4 mg (0.0820 mmol), as a white solid, 82% yield; mp 151–153 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.52 (d, *J* = 8.4 Hz, 2H), 7.36–7.24 (m, 2H), 6.84 (s, 1H), 6.72 (s, 1H), 4.70 (s, 2H), 3.59 (s, 3H), 3.31 (s, 3H), 3.01–2.85 (m, 2H), 2.54 (s, 3H), 2.14 (s, 3H), 1.01 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 179.3, 169.0, 155.7, 147.0, 139.4, 133.7, 132.7, 127.8, 127.5, 124.1, 123.7, 122.5, 119.6, 119.2, 113.0, 111.6, 73.5, 57.1, 52.0, 46.1, 32.0, 29.9, 25.0, 20.9, 19.0; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{25}H_{25}NO_5Na^+$ 442.1625; Found 442.1628.



4f

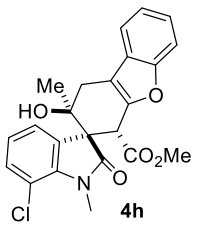
Synthesis of 4f: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(5-bromo-3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1f** (51.2 mg, 0.0999 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.100 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the product **4f**: 31.5 mg (0.0670 mmol), as a white solid, 67% yield; mp 167–169 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.53 (d, J = 7.7 Hz, 2H), 7.46 (d, J = 8.3 Hz, 1H), 7.36–7.26 (m, 2H), 7.16 (s, 1H), 6.80 (d, J = 8.3 Hz, 1H), 4.73 (s, 1H), 4.41 (s, 1H), 3.34 (s, 3H), 3.32 (s, 3H), 3.00–2.91 (m, 2H), 1.03 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.0, 168.8, 155.7, 146.4, 143.4, 132.4, 129.1, 128.2, 127.6, 124.4, 122.7, 119.3, 116.0, 112.8, 111.6, 109.8, 73.4, 58.1, 52.2, 46.1, 32.1, 26.5, 24.9; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{23}H_{20}{}^{79}BrNO_5Na^+$ 492.0417; Found 492.0411; $C_{23}H_{20}{}^{81}BrNO_5Na^+$ 494.0397; Found 494.0396.



4g

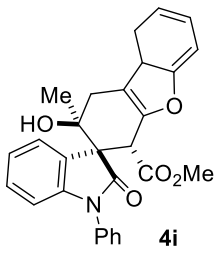
Synthesis of 4g: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-7-fluoro-1-methyl-2-oxoindolin-3-yl)acrylate **1g** (45.5 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/8) to give the product **4g**: 33.7 mg (0.0823 mmol), as a white solid, 82% yield; mp 156–158 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.57–7.47 (m, 2H), 7.36–7.25 (m, 2H), 7.09–6.99 (m, 1H), 6.94–6.84 (m, 2H), 4.74 (s, 1H), 4.45 (s, 1H), 3.55 (d, J = 2.8 Hz, 3H), 3.36 (s, 3H), 2.95 (s, 2H), 1.05 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.2, 168.8, 155.7, 147.8 (d, $^1J_{FC}$ = 242.8 Hz), 146.6, 130.9 (d, $^2J_{FC}$ = 8.3 Hz), 129.8

(d, $^4J_{FC}$ = 2.8 Hz), 127.6, 124.3, 123.8 (d, $^3J_{FC}$ = 6.4 Hz), 122.6, 121.1 (d, $^3J_{FC}$ = 3.2 Hz), 119.1, 117.4 (d, $^2J_{FC}$ = 19.0 Hz), 112.9, 111.6, 73.5, 58.1, 52.1, 46.1, 32.1, 29.0 (d, $^4J_{FC}$ = 6.1 Hz), 24.9; ^{19}F NMR (375 MHz, $CDCl_3$) δ (ppm) –135.6; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{23}H_{20}FNO_5Na^+$ 432.1218; Found 432.1216.



4h

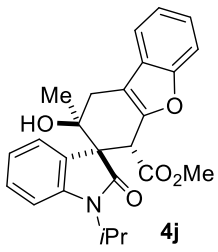
Synthesis of 4h: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-7-chloro-1-methyl-2-oxoindolin-3-yl)acrylate **1h** (45.8 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the product **4h**: 30.7 mg (0.0721 mmol), as a white solid, 72% yield; mp 130–132 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.51 (t, *J* = 7.6 Hz, 2H), 7.34–7.26 (m, 3H), 7.02–6.96 (m, 1H), 6.86 (t, *J* = 7.6 Hz, 1H), 4.74 (s, 1H), 4.48 (s, 1H), 3.72 (s, 3H), 3.37 (s, 3H), 3.00–2.87 (m, 2H), 1.04 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.9, 168.7, 155.6, 146.5, 140.0, 131.8, 129.6, 127.5, 124.4, 124.0, 123.7, 122.6, 119.1, 115.9, 112.9, 111.6, 73.5, 57.5, 52.2, 46.1, 32.0, 30.0, 24.9; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{23}H_{20}{}^{35}ClNO_5Na^+$ 448.0922; Found 448.0918; $C_{23}H_{20}{}^{37}ClNO_5Na^+$ 450.0893; Found 450.0895.



4i

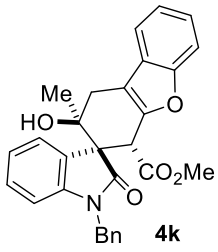
Synthesis of 4i: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-2-oxo-1-phenylindolin-3-yl)acrylate **1i** (49.1 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/8). After completion, the solvent was evaporated in vacuo. The residue

was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/10) to give the product **4i**: 37.3 mg (0.0823 mmol), as a white solid, 82% yield; mp 137–139 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.63–7.57 (m, 2H), 7.56–7.52 (m, 2H), 7.51–7.44 (m, 3H), 7.35–7.27 (m, 2H), 7.25–7.20 (m, 1H), 7.14 (d, *J* = 7.2 Hz, 1H), 6.98 (t, *J* = 7.6 Hz, 1H), 6.85 (d, *J* = 8.0 Hz, 1H), 4.84 (s, 1H), 4.50 (s, 1H), 3.37 (s, 3H), 3.11–2.92 (m, 2H), 1.22 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.2, 169.0, 155.7, 146.7, 144.2, 133.8, 129.9, 129.3, 128.8, 127.7, 126.6, 126.4, 125.5, 124.3, 123.7, 122.6, 119.1, 113.1, 111.6, 109.7, 73.7, 57.8, 52.2, 46.2, 32.2, 24.9; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{28}H_{23}NO_5Na^+$ 476.1468; Found 476.1465.



4j

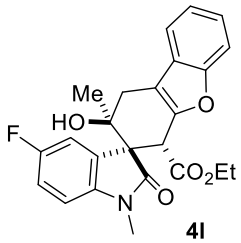
Synthesis of 4j: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-isopropyl-2-oxoindolin-3-yl)acrylate **1j** (45.1 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)-but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/8). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/12) to give the product **4j**: 31.1 mg (0.0741 mmol), as a white solid, 74% yield; mp 138–140 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.54–7.49 (m, 2H), 7.32–7.26 (m, 3H), 7.06 (m, 2H), 6.93 (t, *J* = 7.6 Hz, 1H), 4.77–4.68 (m, 2H), 4.66 (s, 1H), 3.29 (s, 3H), 2.95 (s, 2H), 1.57 (d, *J* = 7.2 Hz, 6H), 1.04 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.1, 168.9, 155.6, 146.9, 142.8, 129.1, 127.7, 127.1, 125.6, 124.2, 122.7, 122.5, 119.1, 113.0, 111.6, 109.9, 73.5, 57.1, 51.9, 45.8, 44.5, 32.1, 24.7, 19.3, 19.2; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{25}H_{25}NO_5Na^+$ 442.1625; Found 442.1627.



4k

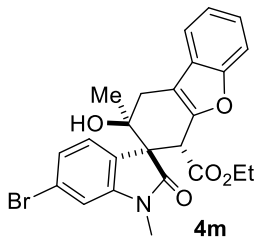
Synthesis of 4k: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(1-benzyl-3-((*tert*-butoxycarbonyl)oxy)-2-oxoindolin-3-yl)acrylate **1k** (50.8 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped,

evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/10). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/15) to give the product **4k**: 33.3 mg (0.0712 mmol), as a white solid, 71% yield; mp 134–136 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.56–7.49 (m, 2H), 7.47–7.42 (m, 2H), 7.41–7.34 (m, 2H), 7.33–7.21 (m, 4H), 7.07 (d, J = 7.6 Hz, 1H), 6.92 (t, J = 7.6 Hz, 1H), 6.88 (d, J = 7.6 Hz, 1H), 5.01 (s, 2H), 4.79 (s, 1H), 4.53 (s, 1H), 3.13 (s, 3H), 2.97 (s, 2H), 1.05 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.6, 168.9, 155.6, 146.9, 143.3, 135.4, 129.3, 128.9, 128.0, 127.6, 126.8, 125.5, 124.2, 123.3, 122.6, 119.1, 112.9, 111.6, 109.4, 73.7, 57.7, 51.9, 45.9, 44.4, 32.1, 25.0; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{29}H_{25}NO_5Na^+$ 490.1625; Found 490.1622.



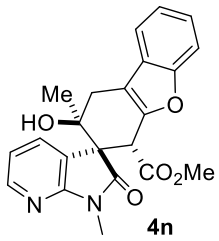
4l

Synthesis of 4l: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added ethyl 2-(3-((*tert*-butoxycarbonyl)oxy)-5-fluoro-1-methyl-2-oxo-indolin-3-yl)acrylate **1l** (45.5 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/7) to give the product **4l**: 30.9 mg (0.0730 mmol), as a white solid, 73% yield; mp 110–112 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.57–7.49 (m, 2H), 7.36–7.25 (m, 2H), 7.06–6.99 (m, 1H), 6.88–6.80 (m, 2H), 4.72 (s, 1H), 4.47 (s, 1H), 3.93–3.73 (m, 2H), 3.32 (s, 3H), 2.96 (s, 2H), 1.03 (s, 3H), 0.85 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.2, 168.2, 159.4 (d, $^{1}J_{FC}$ = 240.7 Hz), 155.7, 146.6, 140.3 (d, $^{4}J_{FC}$ = 2.0 Hz), 128.5 (d, $^{3}J_{FC}$ = 8.3 Hz), 127.6, 124.4, 122.7, 119.2, 115.7 (d, $^{2}J_{FC}$ = 23.4 Hz), 113.7 (d, $^{2}J_{FC}$ = 25.3 Hz), 112.8, 111.6, 108.9 (d, $^{3}J_{FC}$ = 8.2 Hz), 73.4, 61.1, 58.1, 45.7, 32.0, 26.6, 24.9, 13.7; ^{19}F NMR (375 MHz, $CDCl_3$) δ (ppm) –119.1; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{22}FNO_5Na^+$ 446.1374; Found 446.1371.



4m

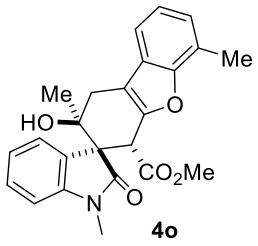
Synthesis of 4m: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added ethyl 2-(6-bromo-3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1m** (52.8 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/8) to give the product **4m**: 34.4 mg (0.0710 mmol), as a white solid, 71% yield; mp 165–167 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.51 (t, *J* = 7.2 Hz, 2H), 7.34–7.25 (m, 2H), 7.12–7.04 (m, 2H), 6.93 (d, *J* = 8.0 Hz, 1H), 4.71 (s, 1H), 4.34 (s, 1H), 3.84 (q, J = 7.2 Hz, 2H), 3.31 (s, 3H), 3.00–2.81 (m, 2H), 1.02 (s, 3H), 0.88 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.3, 168.2, 155.7, 146.7, 145.6, 127.5, 126.7, 126.0, 125.8, 124.3, 123.1, 122.6, 119.1, 112.8, 111.9, 111.6, 73.4, 61.2, 57.6, 45.6, 32.1, 26.5, 24.8, 13.8; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{22}{}^{79}BrNO_5Na^+$ 506.0574; Found506.0568; $C_{24}H_{22}{}^{81}BrNO_5Na^+$ 508.0553; Found 508.0553.



4n

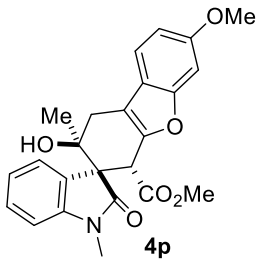
Synthesis of 4n: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxo-2,3-dihydro-1*H*-pyrrolo[2,3-*b*]pyridin-3-yl)acrylate **1n** (41.8 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (16.2 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/8). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/10) to give the product **4n**: 27.1 mg (0.0691 mmol), as a white solid, 69% yield; mp 177–179 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.24–8.21 (m, 1H), 7.51 (t, *J* = 7.2 Hz, 2H), 7.35–7.26 (m, 3H), 6.89–6.84 (m, 1H), 4.79 (s, 1H), 4.29 (s, 1H), 3.42 (s, 3H), 3.36 (s, 3H), 3.09–2.80 (m, 2H), 1.07 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.3, 168.7, 157.4, 155.7, 148.3, 146.3, 132.9, 127.4,

124.5, 122.7, 121.5, 119.1, 118.7, 112.8, 111.7, 73.4, 57.6, 52.2, 45.7, 32.3, 25.6, 25.0; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{22}H_{20}N_2O_5Na^+$ 415.1264; Found 415.1267.



4o

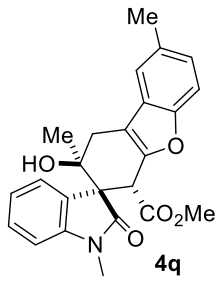
Synthesis of 4o: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-(2-hydroxy-3-methylphenyl)but-3-en-2-one **2b** (17.6 mg, 0.999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/7) to give the product **4o**: 35.7 mg (0.0881 mmol), as a white solid, 88% yield; mp 150–152 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.35–7.28 (m, 2H), 7.16 (t, *J* = 7.6 Hz, 1H), 7.11–7.05 (m, 2H), 6.95 (t, *J* = 7.2 Hz, 1H), 6.90 (d, *J* = 8.0 Hz, 1H), 4.74 (s, 1H), 4.51 (s, 1H), 3.34 (s, 3H), 3.26 (s, 3H), 2.95 (s, 2H), 2.51 (s, 3H), 1.02 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ (ppm) 178.6, 168.9, 154.7, 146.4, 144.1, 129.3, 127.1, 126.8, 125.4, 125.2, 123.2, 122.6, 121.7, 116.5, 113.1, 108.4, 73.37, 57.9, 51.9, 46.1, 32.2, 26.4, 24.9, 15.1; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{23}NO_5Na^+$ 428.1468; Found 428.1470.



4p

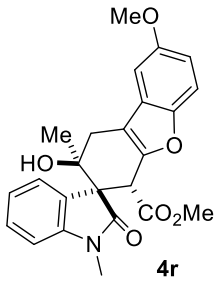
Synthesis of 4p: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-(2-hydroxy-4-methoxyphenyl)but-3-en-2-one **2c** (19.2 mg, 0.999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the product **4p**: 32.0 mg (0.0759 mmol), as a white solid, 76% yield; mp 141–143 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.36 (d, *J* = 8.8 Hz, 1H), 7.31 (t, *J* = 7.6 Hz, 1H), 7.10–7.04 (m, 2H), 6.96 (t, *J* = 7.6 Hz, 1H), 6.92–6.86 (m, 2H), 4.71 (s, 1H), 4.52 (brs, 1H), 3.85 (s, 3H), 3.34 (s, 3H), 3.27 (s,

3H), 2.92 (s, 2H), 1.01 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.6, 169.1, 158.0, 156.6, 145.6, 144.1, 129.4, 126.8, 125.4, 123.3, 121.1, 119.2, 112.8, 111.5, 108.4, 96.5, 73.4, 57.8, 55.8, 52.0, 46.0, 32.2, 26.4, 25.0; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{23}NO_6Na^+$ 444.1418; Found 444.1416.



4q

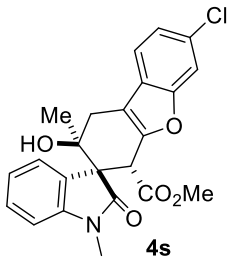
Synthesis of 4q: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-(2-hydroxy-5-methylphenyl)but-3-en-2-one **2d** (17.6 mg, 0.999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the product **4q**: 34.9 mg (0.0861 mmol), as a white solid, 86% yield; mp 170–172 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.39 (d, *J* = 8.4 Hz, 1H), 7.33–7.27 (m, 2H), 7.13–7.08 (m, 1H), 7.05 (d, *J* = 7.6 Hz, 1H), 6.94 (t, *J* = 7.6 Hz, 1H), 6.90 (d, *J* = 8.0 Hz, 1H), 4.72 (s, 1H), 4.51 (s, 1H), 3.33 (s, 3H), 3.26 (s, 3H), 2.93 (s, 2H), 2.46 (s, 3H), 1.02 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.6, 169.0, 154.1, 146.8, 144.1, 132.0, 129.4, 127.8, 126.8, 125.4, 125.3, 123.3, 119.0, 112.7, 111.1, 108.4, 73.4, 57.9, 52.0, 46.0, 32.2, 26.4, 25.0, 21.4; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{23}NO_5Na^+$ 428.1468; Found 428.1472.



4r

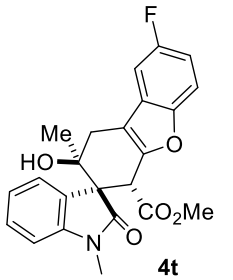
Synthesis of 4r: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-(2-hydroxy-5-methoxyphenyl)but-3-en-2-one **2e** (19.2 mg, 0.999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the product

4r: 27.4 mg (0.0650 mmol), as a white solid, 65% yield; mp 158–160 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.40 (d, *J* = 8.8 Hz, 1H), 7.34–7.28 (m, 1H), 7.07 (d, *J* = 7.2 Hz, 1H), 6.98–6.93 (m, 2H), 6.92–6.87 (m, 2H), 4.72 (s, 1H), 4.52 (s, 1H), 3.86 (s, 3H), 3.34 (s, 3H), 3.27 (s, 3H), 2.93 (s, 2H), 1.02 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.5, 169.0, 155.9, 150.6, 147.6, 144.1, 129.4, 128.2, 126.8, 125.3, 123.3, 113.1, 112.7, 112.0, 108.5, 102.0, 73.4, 57.8, 56.0, 52.0, 46.1, 32.2, 26.4, 25.0; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{23}NO_6Na^+$ 444.1418; Found 444.1413.



4s

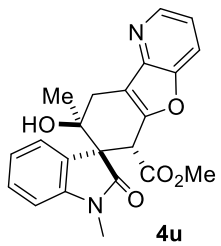
Synthesis of 4s: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-(4-chloro-2-hydroxyphenyl)but-3-en-2-one **2f** (19.7 mg, 0.100 mmol) , DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/7) to give the product **4s**: 36.2 mg (0.0850 mmol), as a white solid, 85% yield; mp 150–152 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.52 (d, *J* = 1.6 Hz, 1H), 7.44–7.38 (m, 1H), 7.35–7.29 (m, 1H), 7.27–7.22 (m, 1H), 7.05–7.01 (m, 1H), 6.97 (t, *J* = 7.6 Hz, 1H), 6.92 (d, *J* = 8.0 Hz, 1H), 4.71 (s, 1H), 4.53 (s, 1H), 3.34 (s, 3H), 3.27 (s, 3H), 2.93 (s, 2H), 1.02 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.4, 168.7, 155.7, 147.8, 144.1, 130.1, 129.5, 126.6, 126.4, 125.2, 123.3, 123.3, 119.6, 113.0, 112.2, 108.5, 73.4, 57.7, 52.1, 46.0, 32.0, 26.5, 24.9; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{23}H_{20}{}^{35}ClNO_5Na^+$ 448.0922; Found 448.0922; $C_{23}H_{20}{}^{37}ClNO_5Na^+$ 450.0893; Found 450.0898.



4t

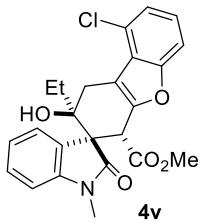
Synthesis of 4t: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-(5-fluoro-2-hydroxyphenyl)but-3-en-2-one **2g** (18.0 mg, 0.999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0

mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the product **4t**: 29.2 mg (0.0714 mmol), as a white solid, 71% yield; mp 190–192 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.46–7.41 (m, 1H), 7.32 (t, J = 7.6 Hz, 1H), 7.19–7.14 (m, 1H), 7.07–6.95 (m, 3H), 6.92 (d, J = 8.0 Hz, 1H), 4.73 (s, 1H), 4.52 (s, 1H), 3.34 (s, 3H), 3.28 (s, 3H), 2.98–2.85 (m, 2H), 1.03 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.4, 168.7, 159.2 (d, $^{1}J_{FC}$ = 236.8 Hz), 151.8, 148.8, 144.1, 129.5, 128.5 (d, $^{3}J_{FC}$ = 10.4 Hz), 126.6, 125.2, 123.4, 113.3 (d, $^{4}J_{FC}$ = 3.9 Hz), 112.2 (d, $^{3}J_{FC}$ = 9.6 Hz), 111.8 (d, $^{2}J_{FC}$ = 26.2 Hz), 108.5, 104.9 (d, $^{2}J_{FC}$ = 24.9 Hz), 73.3, 57.7, 52.1, 46.0, 32.1, 26.5, 24.9; ^{19}F NMR (375 MHz, $CDCl_3$) δ (ppm) –121.0; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{23}H_{20}FNO_5Na^+$ 432.1218; Found 432.1213.



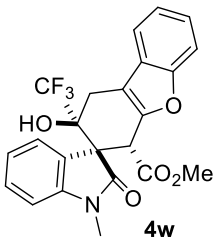
4u

Synthesis of 4u: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-(3-hydroxypyridin-2-yl)but-3-en-2-one **2h** (16.3 mg, 0.999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/3). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/3) to give the product **4u**: 27.9 mg (0.0711 mmol), as a white solid, 71% yield; mp 161–163 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.56–8.53 (m, 1H), 7.80–7.76 (m, 1H), 7.35–7.30 (m, 1H), 7.26–7.22 (m, 1H), 7.07 (d, J = 7.6 Hz, 1H), 6.97 (t, J = 7.6 Hz, 1H), 6.93 (d, J = 8.0 Hz, 1H), 4.78 (s, 1H), 4.50 (s, 1H), 3.35 (s, 3H), 3.29 (s, 3H), 3.21–3.01 (m, 2H), 1.05 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.3, 168.5, 151.5, 148.9, 147.0, 145.5, 144.1, 129.6, 126.5, 125.2, 123.4, 118.9, 118.3, 114.2, 108.5, 73.4, 57.8, 52.2, 46.2, 31.1, 26.5, 24.8; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{22}H_{20}N_2O_5Na^+$ 415.1264; Found 415.1263.



4v

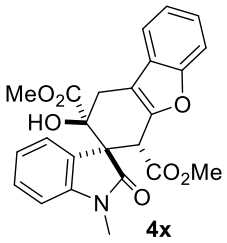
Synthesis of 4v: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-1-(2-chloro-6-hydroxyphenyl)pent-1-en-3-one **2i** (21.0 mg, 0.999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/7) to give the product **4v**: 35.6 mg (0.0809 mmol), as a white solid, 81% yield; mp 176–178 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.44–7.38 (m, 1H), 7.31 (t, *J* = 7.6 Hz, 1H), 7.23–7.17 (m, 2H), 7.08 (d, *J* = 7.2 Hz, 1H), 6.98 (t, *J* = 7.6 Hz, 1H), 6.90 (d, *J* = 7.6 Hz, 1H), 4.74 (s, 1H), 4.18 (s, 1H), 3.47 (d, *J* = 17.2 Hz, 1H), 3.32 (s, 3H), 3.26 (s, 3H), 2.96 (d, *J* = 17.2 Hz, 1H), 1.43–1.29 (m, 1H), 1.14–1.01 (m, 1H), 0.94 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ (ppm) 178.6, 168.6, 156.1, 147.8, 144.1, 129.3, 126.6, 126.1, 126.0, 125.4, 124.7, 123.3, 123.2, 112.8, 110.2, 108.4, 75.6, 57.9, 52.0, 46.3, 29.7, 29.5, 26.4, 6.9; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{22}{}^{35}ClNO_5Na^+$ 462.1079; Found 462.1071; $C_{24}H_{22}{}^{37}ClNO_5Na^+$ 464.1049; Found 464.1049.



4w

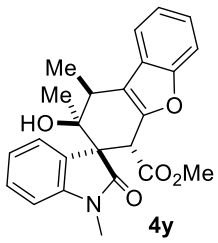
Synthesis of 4w: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-1,1,1-trifluoro-4-(2-hydroxyphenyl)but-3-en-2-one **2j** (21.6 mg, 0.999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/8). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/10) to give the product **4w**: 26.8 mg (0.0602 mmol), as a white solid, 60% yield; mp 221–223 °C; H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.57–7.50 (m, 2H), 7.40–7.28 (m, 3H), 7.08 (d, *J* = 7.2 Hz, 1H), 6.99 (t, *J* = 7.6 Hz, 1H), 6.93 (d, *J* = 8.0 Hz, 1H), 5.70 (s, 1H), 4.72 (s, 1H), 3.33 (s, 3H), 3.31–3.28 (m, 1H), 3.27–3.19 (m, 4H), 1.58 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 77.1, 167.6, 155.7, 145.6,

143.6, 130.0, 127.2, 125.7, 124.8, 124.3, 123.2 (q, $^1J_{FC}$ = 218 Hz), 123.4, 123.0, 119.1, 111.7, 110.6, 108.9, 52.6, 52.3, 47.5, 26.7, 26.0; ^{19}F NMR (375 MHz, $CDCl_3$) δ (ppm) −76.6; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{23}H_{18}F_3NO_5Na^+$ 468.1029; Found 468.1037.



4x

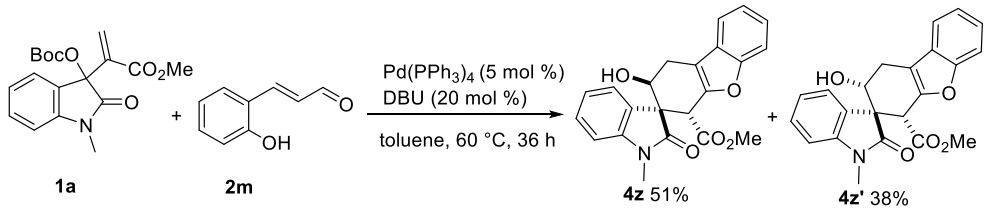
Synthesis of 4x: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), methyl (*E*)-4-(2-hydroxyphenyl)-2-oxobut-3-enoate **2k** (20.6 mg, 0.999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the product **4x**: 28.8 mg (0.0661 mmol), as a white solid, 66% yield; mp 186–188 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.56–7.50 (m, 2H), 7.37–7.27 (m, 3H), 7.10 (d, *J* = 7.2 Hz, 1H), 6.97 (t, *J* = 7.6 Hz, 1H), 6.87 (d, *J* = 8.0 Hz, 1H), 5.40 (s, 1H), 4.78 (s, 1H), 3.63–3.56 (m, 1H), 3.48 (s, 3H), 3.29 (d, *J* = 8.8 Hz, 6H), 3.19 (d, *J* = 17.6 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ (ppm) 177.2, 171.2, 168.2, 155.7, 145.9, 143.9, 129.8, 127.5, 125.8, 124.9, 124.5, 123.2, 122.7, 119.1, 111.7, 111.6, 108.3, 78.2, 55.1, 52.7, 52.1, 46.3, 28.1, 26.6; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{21}NO_7Na^+$ 458.1210; Found 458.1215.



4y

Synthesis of 4y: **General procedure**: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-(2-hydroxyphenyl)-3-methylbut-3-en-2-one **2l** (17.6 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/8) to give the product **4y**: 25.6 mg (0.0631 mmol), as a white solid, 63% yield; mp 149–151 °C; ^{1}H NMR (400 MHz, $CDCl_3$)

δ (ppm) 7.64 (d, *J* = 7.2 Hz, 1H), 7.45 (d, *J* = 7.6 Hz, 1H), 7.25–7.19 (m, 3H), 6.95 (d, *J* = 7.2 Hz, 1H), 6.90–6.80 (m, 2H), 4.72 (s, 1H), 4.41 (s, 1H), 3.26 (s, 3H), 3.20 (s, 3H), 3.19–3.13 (m, 1H), 1.52 (s, 3H), 0.93 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.8, 169.0, 155.7, 146.3, 144.1, 129.3, 127.3, 126.6, 125.8, 123.9, 123.2, 122.4, 120.8, 116.9, 111.8, 108.4, 75.2, 58.5, 52.0, 45.8, 35.8, 26.4, 21.5, 12.1; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{24}H_{23}NO_5Na^+$ 428.1468; Found 428.1468.



To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-3-(2-hydroxyphenyl)acrylaldehyde **2m** (14.8 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/3). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6 to 1/2) to give the products **4z** and **4z′** as separable diastereomers.

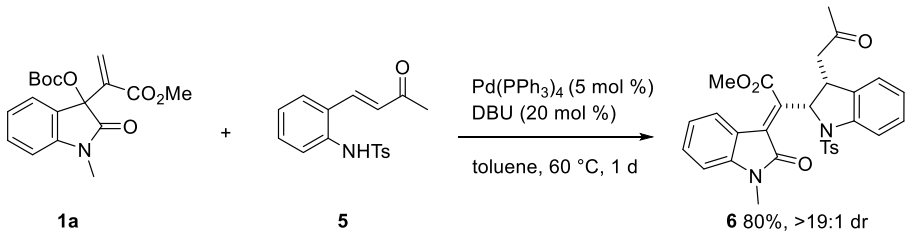
4z: 19.3 mg (0.0511 mmol), as a white solid, 51% yield; mp 215–217 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.56–7.51 (m, 2H), 7.36–7.27 (m, 3H), 7.09 (d, *J* = 7.2 Hz, 1H), 7.00–6.91 (m, 2H), 4.71 (s, 1H), 4.55 (s, 1H), 4.06 (s, 1H), 3.35 (s, 3H), 3.31 (s, 3H), 3.14–3.02 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.6, 168.8, 155.6, 146.3, 143.9, 129.6, 127.8, 125.9, 125.8, 124.4, 123.2, 122.6, 119.2, 112.0, 111.6, 108.6, 69.2, 54.3, 52.1, 43.7, 26.7, 25.7; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{22}H_{19}NO_5Na^+$ 400.1155; Found 400.1157.

4z′: 14.5 mg (0.0384 mmol), as a white solid, 38% yield; mp 114–116 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm)7.56–7.47 (m, 2H), 7.35–7.27 (m, 3H), 7.10 (d, *J* = 7.6 Hz, 1H), 6.97 (t, *J* = 7.6 Hz, 1H), 6.89 (d, *J* = 7.6 Hz, 1H), 4.60 (s, 1H), 4.55–4.46 (m, 1H), 3.30 (s, 3H), 3.26 (s, 3H), 3.24–3.17 (m, 1H), 2.97–2.87 (m, 1H), 2.28 (d, *J* = 7.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 177.5, 168.1, 156.0, 147.0, 145.1, 129.5, 127.1, 125.9, 124.7, 124.6, 122.8, 122.7, 119.2, 113.1, 111.7, 108.2, 71.4, 56.8, 52.0, 47.0, 26.7, 26.6; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{22}H_{19}NO_5Na^+$

400.1155; Found 400.1155.

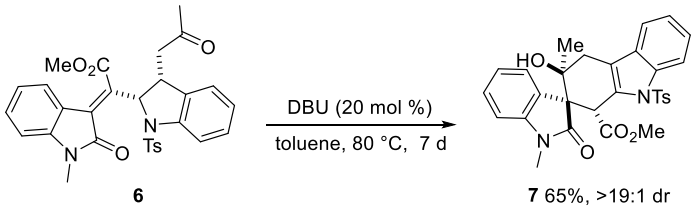
Procedure for synthesis of 4a on a 1.0 mmol scale: To an oven-dried 50 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (416.8 mg, 1.199 mmol), (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one **2a** (162.2 mg, 1.000 mmol), DBU (30.4 mg, 0.200 mmol) and $Pd(PPh_3)_4$ (57.8 mg, 0.0500 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (10.0 mL) was added via syringe. The mixture was stirred at 60 °C for 36 h, and monitored by TLC (EtOAc/petroleum ether = 1/5). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/7) to give the product **4a**: 321.1 mg (0.8203 mmol), as a white solid, 82% yield.

4. Procedure for synthesis of racemic 6 and 7



To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-methyl-*N*-(2-(3-oxobut-1-en-1-yl)phenyl)benzenesulfon-amide **5** (31.5 mg, 0.0999 mmol), DBU (3.0 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 1 day, and monitored by TLC (EtOAc/petroleum ether = 1/4). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/4) to give the product **6**: 43.6 mg (0.0801 mmol), as a yellow solid, 80% yield; mp 74–76 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ (ppm) 7.66 (d, *J* = 8.4 Hz, 2H), 7.62 (d, *J* =7.8 Hz, 1H), 7.35 (d, *J* = 7.2 Hz, 1H), 7.25–7.16 (m, 4H), 7.04 (d, *J* = 10.8 Hz, 1H), 7.02–6.95 (m, 2H), 6.84 (t, *J* = 8.4 Hz, 2H), 4.13–4.06 (m, 1H), 3.66 (s, 3H), 3.28 (s, 3H), 3.00–2.86 (m, 1H), 2.74–2.66 (m, 1H), 2.37 (s, 3H), 2.09 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ (ppm) 206.8, 166.82, 166.76, 144.3, 143.8, 140.9, 140.5, 136.0, 134.7, 130.8, 129.8, 127.9, 127.2,

125.7, 125.0, 124.2, 123.0, 122.5, 119.6, 116.2, 108.4, 61.4, 52.4, 44.3, 39.8, 30.4, 26.1, 21.6; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{30}H_{28}N_2O_6SNa^+$ 567.1560; Found 567.1559. wr

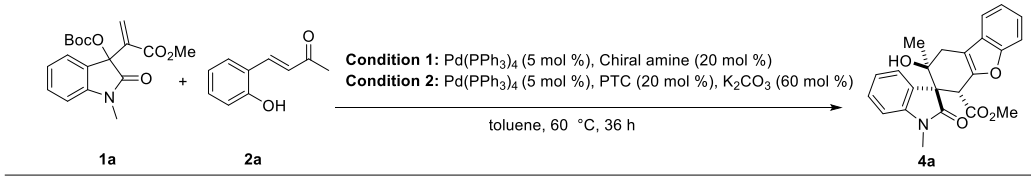


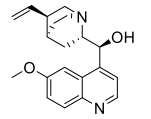
6 **7** 65%, >19:1 dr

To a solution of **6** (54.4 mg, 0.0999 mmol) in toluene (1.0 mL) was added DBU (3.0 mg, 0.020 mmol). The mixture was stirred at 80 °C for 7 days, and monitored by TLC (EtOAc/petroleum ether = 1/6). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the product **7**: 35.5 mg (0.0652 mmol), as a white solid, 65% yield; mp 242–244 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.01 (d, *J* = 8.0 Hz, 1H), 7.55 (d, *J* = 8.4 Hz, 2H), 7.39 (d, *J* = 7.6 Hz, 1H), 7.34–7.20 (m, 3H), 7.11 (d, *J* = 8.4 Hz, 2H), 7.02–6.86 (m, 3H), 4.97 (s, 1H), 4.57 (s, 1H), 3.37 (s, 3H), 3.18 (s, 3H), 3.06–2.82 (m, 2H), 2.26 (s, 3H), 1.01 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 178.9, 170.0, 144.5, 144.2, 137.5, 134.7, 130.8, 130.1, 129.6, 129.3, 126.9, 126.6, 125.8, 125.0, 123.8, 122.9, 119.5, 118.7, 115.5, 108.4, 72.7, 57.5, 51.7, 48.0, 32.3, 26.5, 24.9, 21.5; HRMS (ESI-TOF) m/z: $[M + Na]^+$ Calcd for $C_{30}H_{28}N_2O_6SNa^+$ 567.1560; Found 567.1565.

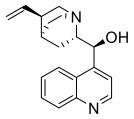
5. Detailed screening conditions of asymmetric cascade reaction and control experiments

Table S4.1. Detailed screening conditions for asymmetric synthesis of 4a

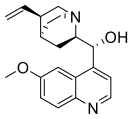




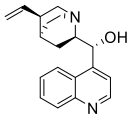
Condition 1
76%, 7 % ee



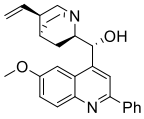
Condition 1
78%, 8% ee



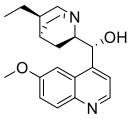
Condition 1
75%, –6 % ee



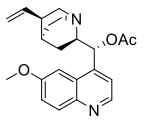
Condition 1
76% , –8% ee



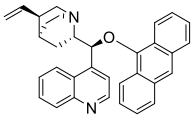
Condition 1
Conv. about 70%, –4 % ee



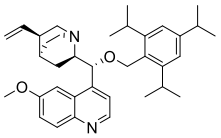
Condition 1
Conv. about 70%, –3 % ee



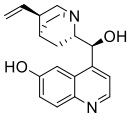
Condition 1
Conv. about 60%, –5% ee



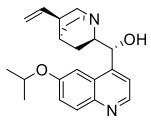
Condition 1
Conv. about 70%, –5 % ee



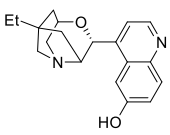
Condition 1
Conv. about 50%, –4 % ee



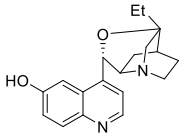
Condition 1
Conv. about 70%, –5 % ee



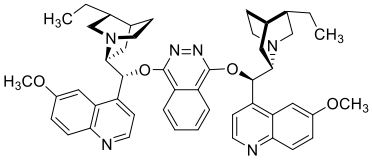
Condition 1
Conv. about 60%, –4 % ee



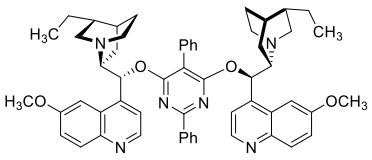
Condition 1
Conv. about 30%, 14 % ee



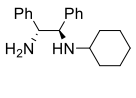
Condition 1
Conv. about 20%, 13 % ee



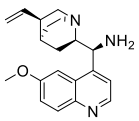
Condition 1
Conv. about 20%, 11 % ee



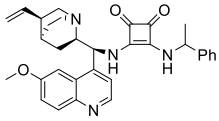
Condition 1
Conv. about 20%, 14 % ee



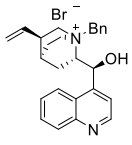
Condition 1
Conv. about 40%, –7 % ee



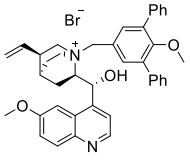
Condition 1
Conv. about 50%, 11 % ee



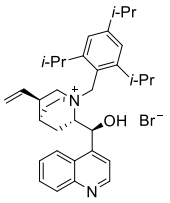
Condition 1
trace



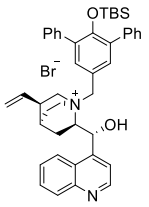
Condition 2
Conv. about 40%, –2 % ee



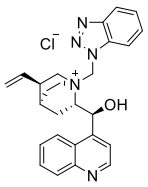
Condition 2
Conv. about 50%, –4 % ee



Condition 2
Conv. about 50%, 3 % ee



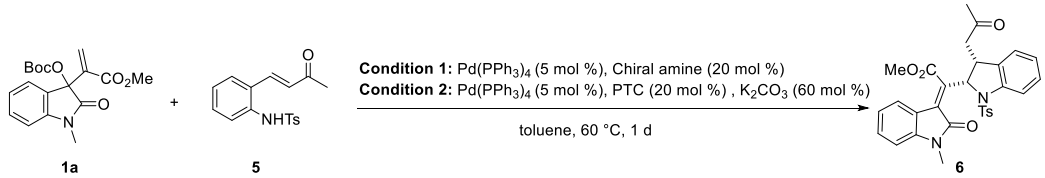
Condition 2
Conv. about 40%, –5 % ee

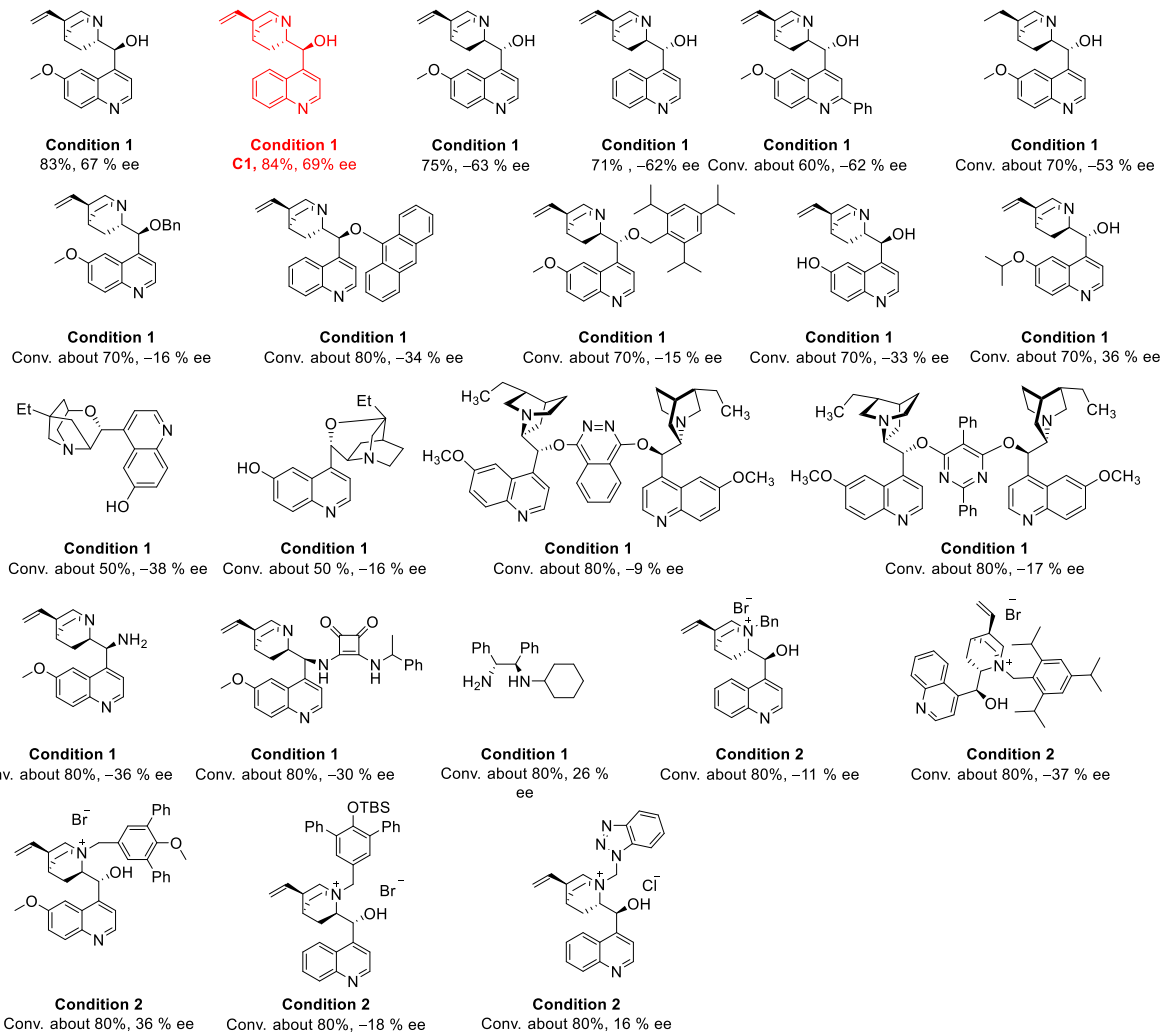


Condition 2
Conv. about 40%, 2 % ee

As summarized in Table S4.1, a number of chiral amines and phase transfer agents were screened, but poor enantiocontrol (<15% ee) was generally observed in the construction of benzo[*b*]furan framework **4a**.

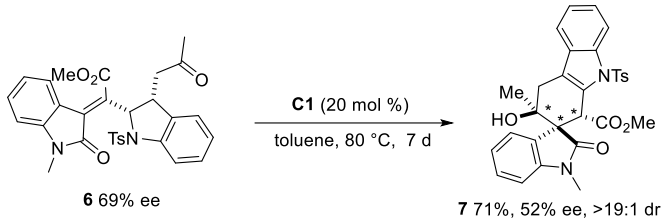
Table S4.2. Detailed screening conditions for asymmetric synthesis of 6



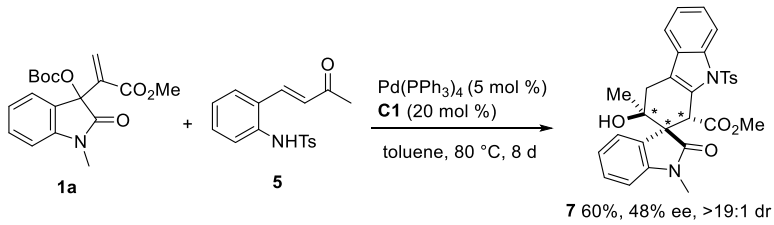


Asymmetric synthesis of 6: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl) acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-methyl-*N*-(2-(3-oxobut-1-en-1-yl)phenyl)benzene sulfonamide **5** (31.5 mg, 0.0999 mmol) , **C1** (5.9 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 60 °C for 1 day, and monitored by TLC (EtOAc/petroleum ether = 1/4). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/4) to give the product **6**: 45.8 mg (0.0841 mmol), as a yellow solid, 84% yield; $[\alpha]_D^{25} = -93.8$ ($c = 0.43$ in $CHCl_3$); 69% ee, determined by HPLC analysis (Daicel chiralpak AD-H, *i*-PrOH/*n*-hexane = 40/60, flow rate = 1.0

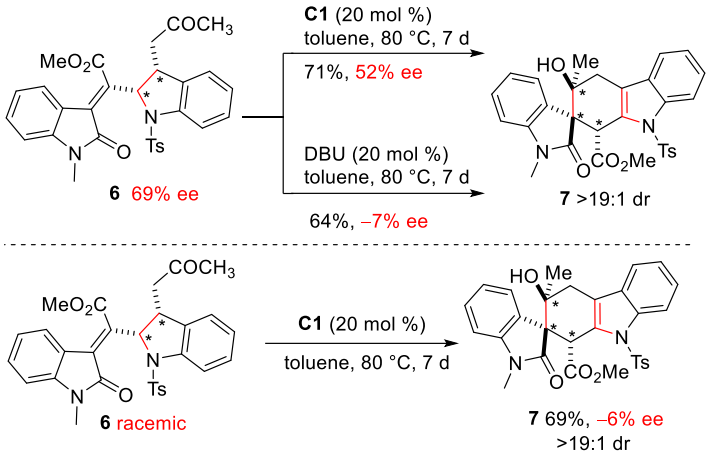
mL/min, l = 254 nm) t_R = 13.91 min (minor), t_R = 18.21 min (major).



Asymmetric synthesis of 7: To a solution of **6** (54.4 mg, 0.0999 mmol) in toluene (1.0 mL) was added **C1** (5.9 mg, 0.020 mmol). The mixture was stirred at at 80 °C for 7 days, and monitored by TLC (EtOAc/petroleum ether = 1/6). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the chiral product **7**: 38.7 mg (0.0711 mmol), as a white solid, 71% yield; $[\alpha]_D^{25}$ = +124.9 (*c* = 0.37 in $CHCl_3$); 52% ee, determined by HPLC analysis (Daicel chiralpak AD-H, *i*-PrOH/*n*-hexane = 40/60, flow rate = 1.0 mL/min, l = 254 nm) t_R = 18.28 min (major), t_R = 24.87 min (minor).



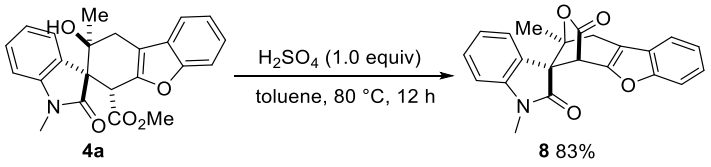
Asymmetric synthesis of 7 in one pot: To an oven-dried 10 mL Schlenk tube equipped with a magnetic stirring bar were added methyl 2-(3-((*tert*-butoxycarbonyl)oxy)-1-methyl-2-oxoindolin-3-yl)acrylate **1a** (41.6 mg, 0.120 mmol), (*E*)-4-methyl-*N*-(2-(3-oxobut-1-en-1-yl)phenyl)benzene sulfonamide **5** (31.5 mg, 0.0999 mmol) , **C1** (5.9 mg, 0.020 mmol) and $Pd(PPh_3)_4$ (5.8 mg, 0.0050 mmol). The tube was capped, evacuated and back-filled with argon for five times. Then degassed dry toluene (1.0 mL) was added via syringe. The mixture was stirred at 80 °C for 8 days, and monitored by TLC (EtOAc/petroleum ether = 1/6). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/6) to give the chiral product **7**: 32.7 mg (0.0600 mmol), as a white solid, 60% yield; 48% ee, determined by HPLC analysis (Daicel chiralpak AD-H, *i*-PrOH/*n*-hexane = 40/60, flow rate = 1.0 mL/min, l = 254 nm) t_R = 17.94 min (major), t_R = 24.51 min (minor).



In order to gain some insight into the reaction process, more experiments were conducted. As outlined above, treating enantioenriched product **6** (69% ee) with chiral **C1** at 80 °C delivered the indole **7** with a diminished ee value (52% ee), but using DBU provided product **7** with poor enantioselectivity and with the opposite configuration (–7% ee). Moreover, treating racemic substance **6** with **C1** afforded chiral product **7** with similar poor enantioselectivity and opposite configuration (–6% ee). These results implied that a racemization process would be involved in the cascade process of enantioenriched **6** via Brønsted base catalysis, and different Brønsted base resulted in apparent different extent of enantiopurity decrease.

6. Transformation of product 4a

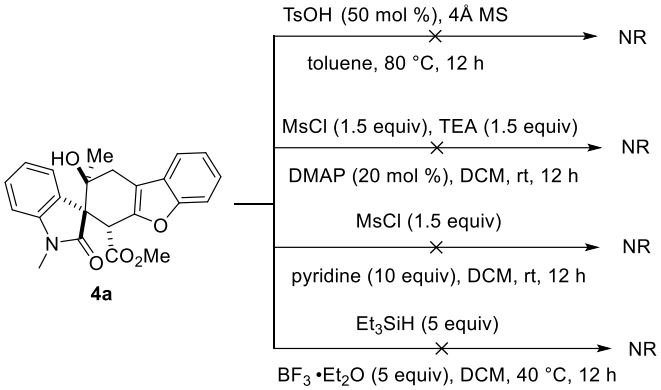
6.1 Lactonization of product 4a



To a solution of **4a** (49.8 mg, 0.127 mmol) in toluene (1.3 mL) was added concentrated sulfuric acid (12.5 mg, 0.127 mmol). The mixture was stirred at 80 °C for 12 h, and monitored by TLC (EtOAc/petroleum ether = 1/8). After completion, the solvent was evaporated in vacuo. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/8) to give the product **8**: 37.9 mg (0.106 mmol), as a white solid, 83% yield; mp 238–240 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 7.57–7.50 (m, 2H), 7.41–7.29 (m, 3H), 6.90 (d, J = 8.0 Hz, 1H), 6.81 (t, J = 7.6 Hz, 1H), 6.62 (d, J = 8.0 Hz, 1H), 3.97 (s, 1H), 3.29 (s, 3H), 3.20–3.08 (m, 2H), 1.43 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ (ppm) 174.6, 170.1, 155.7, 146.3, 144.9, 130.2, 126.4, 125.0, 124.9, 123.5, 123.2,

121.8, 119.2, 113.2, 112.1, 108.7, 86.7, 58.0, 47.7, 33.3, 26.4, 19.8; HRMS (ESI-TOF) m/z: [M + Na]$^+$ Calcd for $C_{22}H_{17}NO_4Na^+$ 382.1050; Found 382.1052.

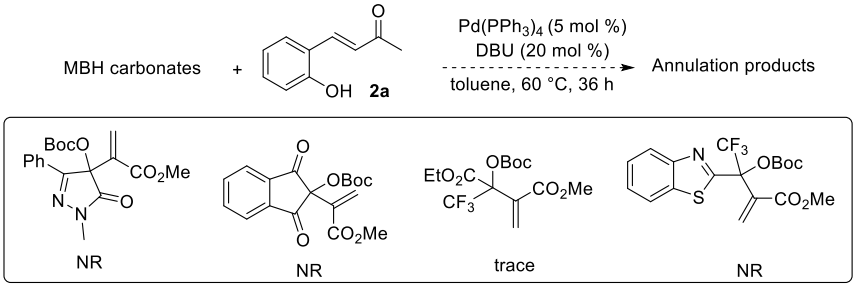
6.2 Attempts for dehydration reaction of product 4a



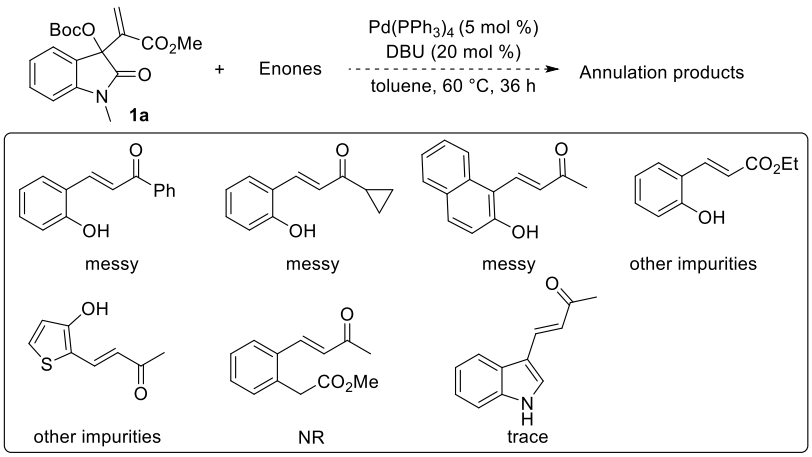
As mentioned above, the lactone product **8** was obtained by treating **4a** with concentrated H_2SO_4. We also tested the possible dehydration process with **4a** under diverse conditions. Unfortunately, no desired alkene product was formed, as summarized in the above scheme. Product **4a** was relatively stable under milder acidic conditions, and the attempts of mesylation of **4a** and subsequent elimination reaction also failed, probably due to steric hindrance.

7. Unsuccessful exploration of more substrates

7.1 Exploration of more MBH carbonates



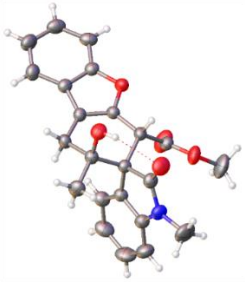
7.2 Exploration of more enones

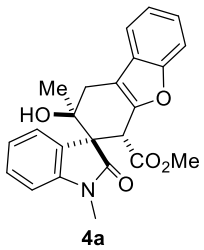


To further expand the substrate scope, more activated MBH carbonates were tested. Unfortunately, they generally showed low reactivity, and no obvious conversions were observed. Meanwhile, the outlined enones either gave complex reaction profiles or kept inert in the reaction.

8. Crystal data and structural refinement

Procedure for the recrystallization of 4a: To a 10 mL tube containing **4a** (35 mg) were added *n*-hexane (0.3 mL) and EtOAc (1.5 mL). The mixture was heated until a clear solution was formed, which was kept aside at room temperature to obtain crystals. The crystals were subjected for single crystal XRD to determine the relative configuration of racemic **4a**. The data were collected by an Agilent Gemini equipped with a Cu radiation source (Kα = 1.54184 Å) at 291.76 K. CCDC 2119385 (**4a**) contains the supplementary crystallographic data for this paper. These data can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif.





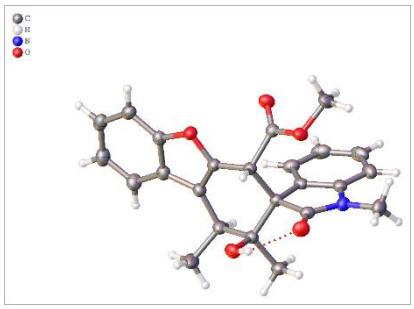
4a

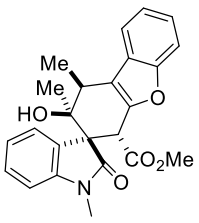
(ellipsoid contour probability 50%)

Identification code	**4a**
Empirical formula	$C_{23}H_{21}NO_5$
Formula weight	391.41
Temperature/K	291.76(18)
Crystal system	triclinic
Space group	P-1
a/Å	8.5908(4)
b/Å	10.6286(4)
c/Å	10.7126(4)
α/°	92.567(3)
β/°	101.413(4)
γ/°	96.618(4)
Volume/Å^3	950.11(7)

Z	2
ρ_{calc}g/cm^3	1.368
μ/mm^{-1}	0.795
F(000)	412.0
Crystal size/mm^3	0.7 × 0.65 × 0.55
Radiation	CuKα (λ = 1.54184)
2Θ range for data collection/°	8.396 to 143.028
Index ranges	-10 ≤ h ≤ 10, -13 ≤ k ≤ 13, -13 ≤ l ≤ 13
Reflections collected	14453
Independent reflections	3571 [R_{int} = 0.0652, R_{sigma} = 0.0325]
Data/restraints/parameters	3571/0/266
Goodness-of-fit on F^2	1.069
Final R indexes [I>=2σ (I)]	R_1 = 0.0659, wR_2 = 0.1657
Final R indexes [all data]	R_1 = 0.0695, wR_2 = 0.1718
Largest diff. peak/hole / e Å^{-3}	0.40/-0.66

Procedure for the recrystallization of 4y: To a 10 mL tube containing **4y** (40 mg) were added *n*-hexane (0.1 mL) and EtOAc (1.5 mL). The mixture was heated until a clear solution was formed, which was kept aside at room temperature to obtain crystals. The crystals were subjected for single crystal XRD to determine the relative configuration of racemic **4y**. The data were collected by an Agilent Gemini equipped with a Mo radiation source (Kα = 0.71073 Å) at 150.0 K. CCDC 2119395 (**4y**) contains the supplementary crystallographic data for this paper. These data can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif.





4y

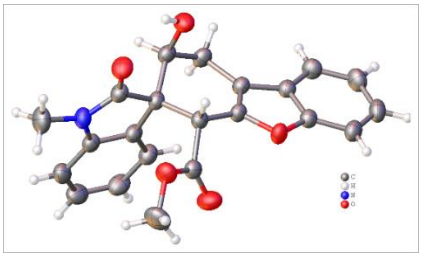
(ellipsoid contour probability 50%)

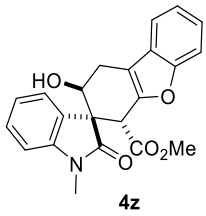
Identification code	**4y**
Empirical formula	$C_{24}H_{23}NO_5$

Formula weight	405.43
Temperature/K	150.0
Crystal system	triclinic
Space group	P-1
a/Å	9.8700(4)
b/Å	9.9973(4)
c/Å	10.1792(5)
α/°	93.621(2)
β/°	93.760(2)
γ/°	96.427(2)
Volume/Å^3	993.43(7)
Z	2
ρ_{calc}g/cm^3	1.355
μ/mm^{-1}	0.095
F(000)	428.0
Crystal size/mm^3	0.35 × 0.32 × 0.21
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	4.02 to 55.056
Index ranges	-12 ≤ h ≤ 12, -12 ≤ k ≤ 12, -13 ≤ l ≤ 13
Reflections collected	42813
Independent reflections	4571 [R_{int} = 0.0545, R_{sigma} = 0.0288]
Data/restraints/parameters	4571/0/277
Goodness-of-fit on F^2	1.043
Final R indexes [I>=2σ (I)]	R_1 = 0.0359, wR_2 = 0.0845
Final R indexes [all data]	R_1 = 0.0524, wR_2 = 0.0910
Largest diff. peak/hole / e Å^{-3}	0.26/-0.19

Procedure for the recrystallization of 4z: To a 10 mL tube containing **4z** (30 mg) were added *n*-hexane (0.5 mL) and EtOAc (2 mL). The mixture was heated until a clear solution was formed, which was kept aside at room temperature to obtain crystals. The crystals were subjected for single crystal XRD to determine the relative configuration of racemic **4z**. The data were collected by a Burker D8 Venture equipped with a Mo radiation source (Kα = 0.71073 Å) at 290.0 K. CCDC 2119386 (**4z**)

contains the supplementary crystallographic data for this paper. These data can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif.





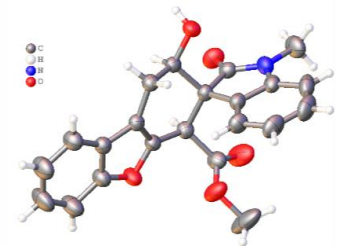
4z

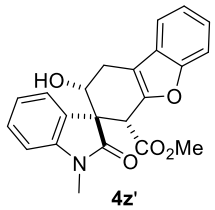
(ellipsoid contour probability 50%)

Identification code	**4z**
Empirical formula	$C_{22}H_{19}NO_5$
Formula weight	377.38
Temperature/K	290.0
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	8.2628(3)
b/Å	14.8800(5)
c/Å	14.9882(4)
α/°	90
β/°	104.5800(10)
γ/°	90
Volume/Å^3	1783.46(10)
Z	4
ρ_{calc}g/cm^3	1.405
μ/mm^{-1}	0.100
F(000)	792.0
Crystal size/mm^3	0.3 × 0.3 × 0.2
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	3.922 to 55.02
Index ranges	$-10 \le h \le 10$, $-19 \le k \le 19$, $-18 \le l \le 19$
Reflections collected	40344
Independent reflections	4092 [R_{int} = 0.0928, R_{sigma} = 0.0502]
Data/restraints/parameters	4092/0/256

Goodness-of-fit on F^2	1.025
Final R indexes [I>=2σ (I)]	R_1 = 0.0440, wR_2 = 0.1094
Final R indexes [all data]	R_1 = 0.0601, wR_2 = 0.1189
Largest diff. peak/hole / e $Å^{-3}$	0.27/-0.25

Procedure for the recrystallization of 4z′: To a 10 mL tube containing **4z′** (42 mg) were added *n*-hexane (0.8 mL) and EtOAc (2.5 mL). The mixture was heated until a clear solution was formed, which was kept aside at room temperature to obtain crystals. The crystals were subjected for single crystal XRD to determine the relative configuration of racemic **4z′**. The data were collected by a Burker D8 Venture equipped with a Mo radiation source (Kα = 0.71073 Å) at 290.0 K. CCDC 2119387 (**4z′**) contains the supplementary crystallographic data for this paper. These data can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif.



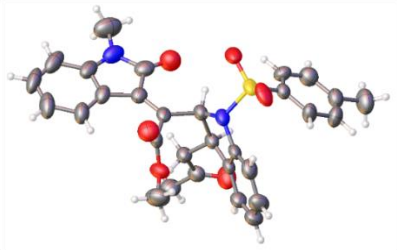


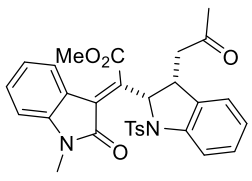
(ellipsoid contour probability 50%)

Identification code	**4z′**
Empirical formula	$C_{22}H_{19}NO_5$
Formula weight	377.38
Temperature/K	290.0
Crystal system	triclinic
Space group	P-1
a/Å	7.6460(3)
b/Å	9.0047(3)
c/Å	14.7060(5)
α/°	105.4244(10)
β/°	102.5959(11)
γ/°	95.9250(10)
Volume/$Å^3$	938.46(6)
Z	2
ρ_{calc}g/cm^3	1.336

μ/mm^{-1}	0.095
F(000)	396.0
Crystal size/mm^3	0.40 × 0.20 × 0.10
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	4.764 to 55.054
Index ranges	-9 ≤ h ≤ 9, -11 ≤ k ≤ 11, -19 ≤ l ≤ 19
Reflections collected	43793
Independent reflections	4291 [R_{int} = 0.0757, R_{sigma} = 0.0350]
Data/restraints/parameters	4291/0/256
Goodness-of-fit on F^2	1.037
Final R indexes [I>=2σ (I)]	R_1 = 0.0451, wR_2 = 0.1084
Final R indexes [all data]	R_1 = 0.0672, wR_2 = 0.1223
Largest diff. peak/hole / e Å^{-3}	0.24/-0.24

Procedure for the recrystallization of 6: To a 10 mL tube containing **6** (53 mg) were added *n*-hexane (1.0 mL) and EtOAc (4.0 mL). The mixture was heated until a clear solution was formed, which was kept aside at room temperature to obtain crystals. The crystals were subjected for single crystal XRD with to determine the relative configuration of racemic **6**. The data were collected by an Agilent Gemini equipped with a Cu radiation source (Kα = 1.54184 Å) at 295.4 K. CCDC 2119388 (**6**) contains the supplementary crystallographic data for this paper. These data can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif.





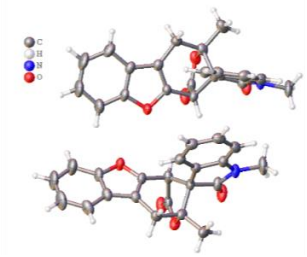
6

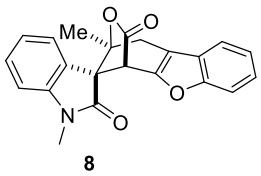
(ellipsoid contour probability 50%)

Identification code	**6**
Empirical formula	$C_{30}H_{28}N_2O_6S$
Formula weight	544.60
Temperature/K	295.4(4)
Crystal system	orthorhombic

Space group	Pbca
a/Å	8.3076(4)
b/Å	15.7413(11)
c/Å	40.773(2)
α/°	90
β/°	90
γ/°	90
Volume/Å^3	5332.0(5)
Z	8
ρ_{calc}g/cm^3	1.357
μ/mm^{-1}	1.479
F(000)	2288.0
Crystal size/mm^3	0.4 × 0.15 × 0.1
Radiation	CuKα (λ = 1.54184)
2Θ range for data collection/°	8.674 to 142.802
Index ranges	-10 ≤ h ≤ 5, -18 ≤ k ≤ 18, -49 ≤ l ≤ 45
Reflections collected	14781
Independent reflections	4968 [R_{int} = 0.0995, R_{sigma} = 0.0813]
Data/restraints/parameters	4968/0/356
Goodness-of-fit on F^2	1.059
Final R indexes [I>=2σ (I)]	R_1 = 0.1104, wR_2 = 0.2981
Final R indexes [all data]	R_1 = 0.1454, wR_2 = 0.3390
Largest diff. peak/hole / e Å^{-3}	0.63/-0.71

Procedure for the recrystallization of 8: To a 10 mL tube containing **8** (28 mg) were added *n*-hexane (1.0 mL) and EtOAc (2 mL). The mixture was heated until a clear solution was formed, which was kept aside at room temperature to obtain crystals. The crystals were subjected for single crystal XRD to determine the relative configuration of racemic **8**. The data were collected by an Agilent Gemini equipped with a Cu radiation source (Kα = 1.54178 Å) at 150.0 K. CCDC 2119389 (**8**) contains the supplementary crystallographic data for this paper. These data can be obtained free of charge via www.ccdc.cam.ac.uk/data_request/cif.



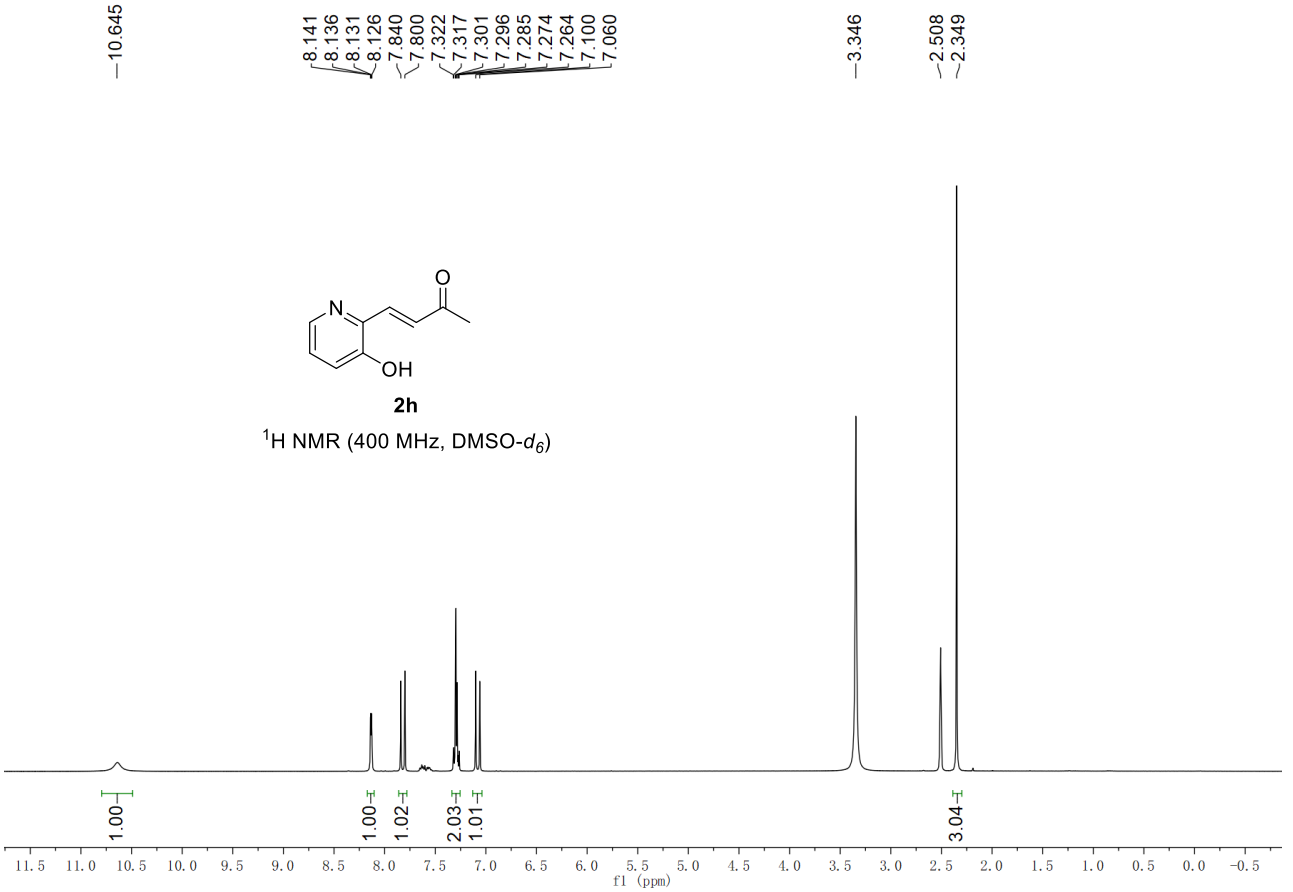


8

(ellipsoid contour probability 50%)

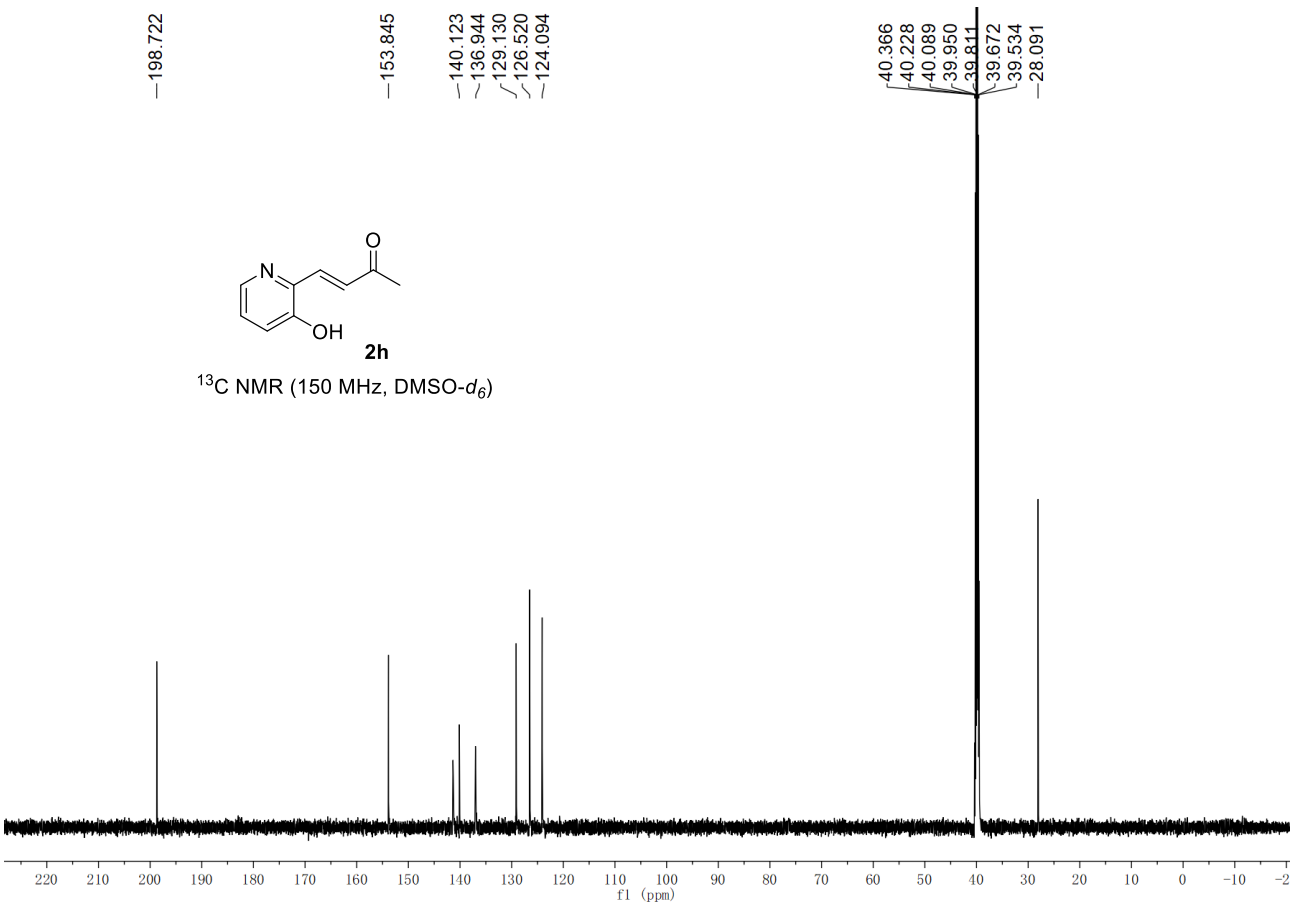
Identification code	**8**
Empirical formula	$C_{22}H_{17}NO_4$
Formula weight	359.36
Temperature/K	150.0
Crystal system	monoclinic
Space group	Cc
a/Å	18.7745(9)
b/Å	18.5044(8)
c/Å	10.6237(5)
α/°	90
β/°	107.614(3)
γ/°	90
Volume/Å^3	3517.8(3)
Z	8
ρ_{calc}g/cm^3	1.357
μ/mm-1	0.768
F(000)	1504.0
Crystal size/mm^3	0.38 × 0.09 × 0.08
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	6.872 to 137.018
Index ranges	-22 ≤ h ≤ 22, -19 ≤ k ≤ 22, -10 ≤ l ≤ 12
Reflections collected	15382
Independent reflections	5249 [R_{int} = 0.0667, R_{sigma} = 0.0506]
Data/restraints/parameters	5249/2/491
Goodness-of-fit on F^2	1.076
Final R indexes [I>=2σ (I)]	R_1 = 0.0407, wR_2 = 0.1044
Final R indexes [all data]	R_1 = 0.0458, wR_2 = 0.1065
Largest diff. peak/hole / e Å^{-3}	0.31/-0.24

9. NMR, HRMS spectra and HPLC chromatograms



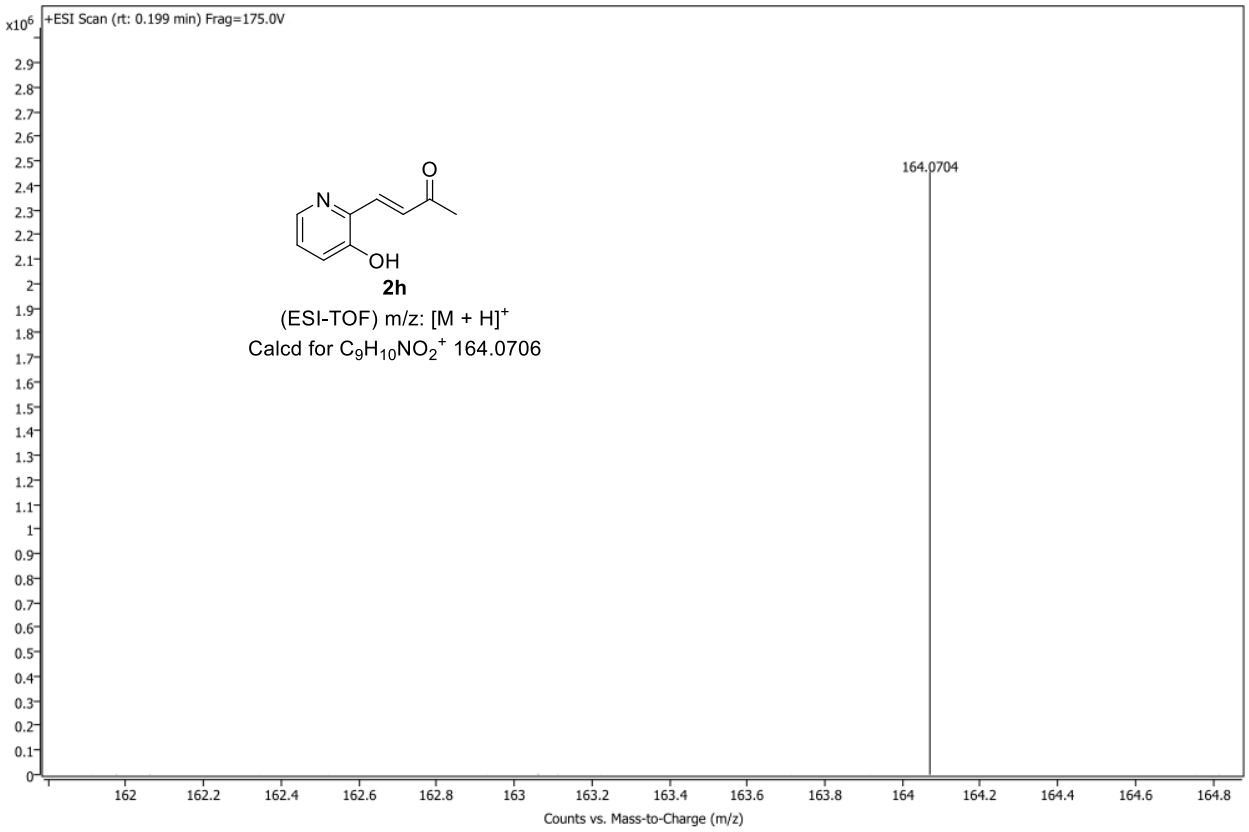
2h

^{1}H NMR (400 MHz, DMSO-d_6)



2h

^{13}C NMR (150 MHz, DMSO-d_6)



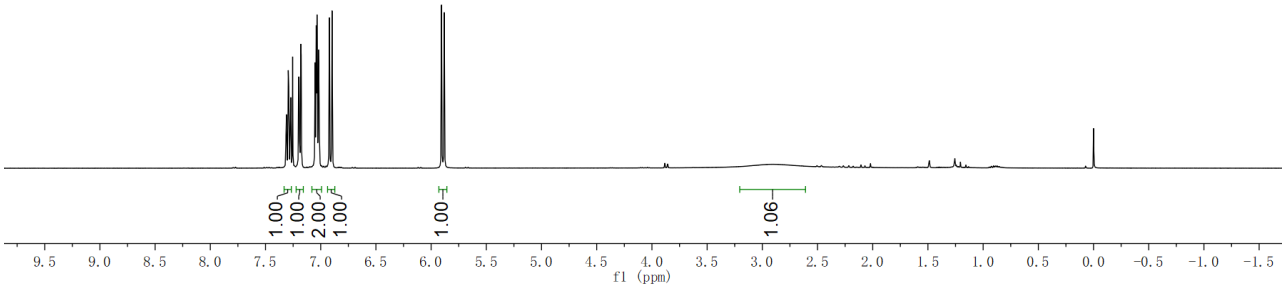
2h

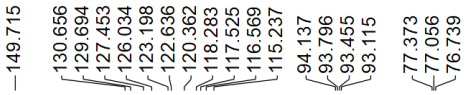
(ESI-TOF) m/z: $[M + H]^+$

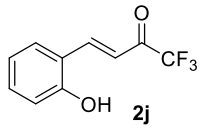
Calcd for $C_9H_{10}NO_2^+$ 164.0706

2j

^1H NMR (400 MHz, $CDCl_3$)

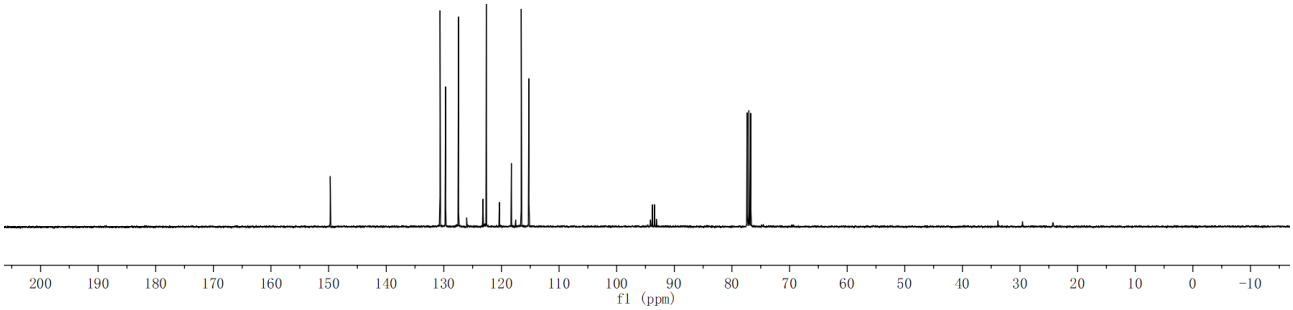


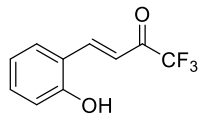




2j

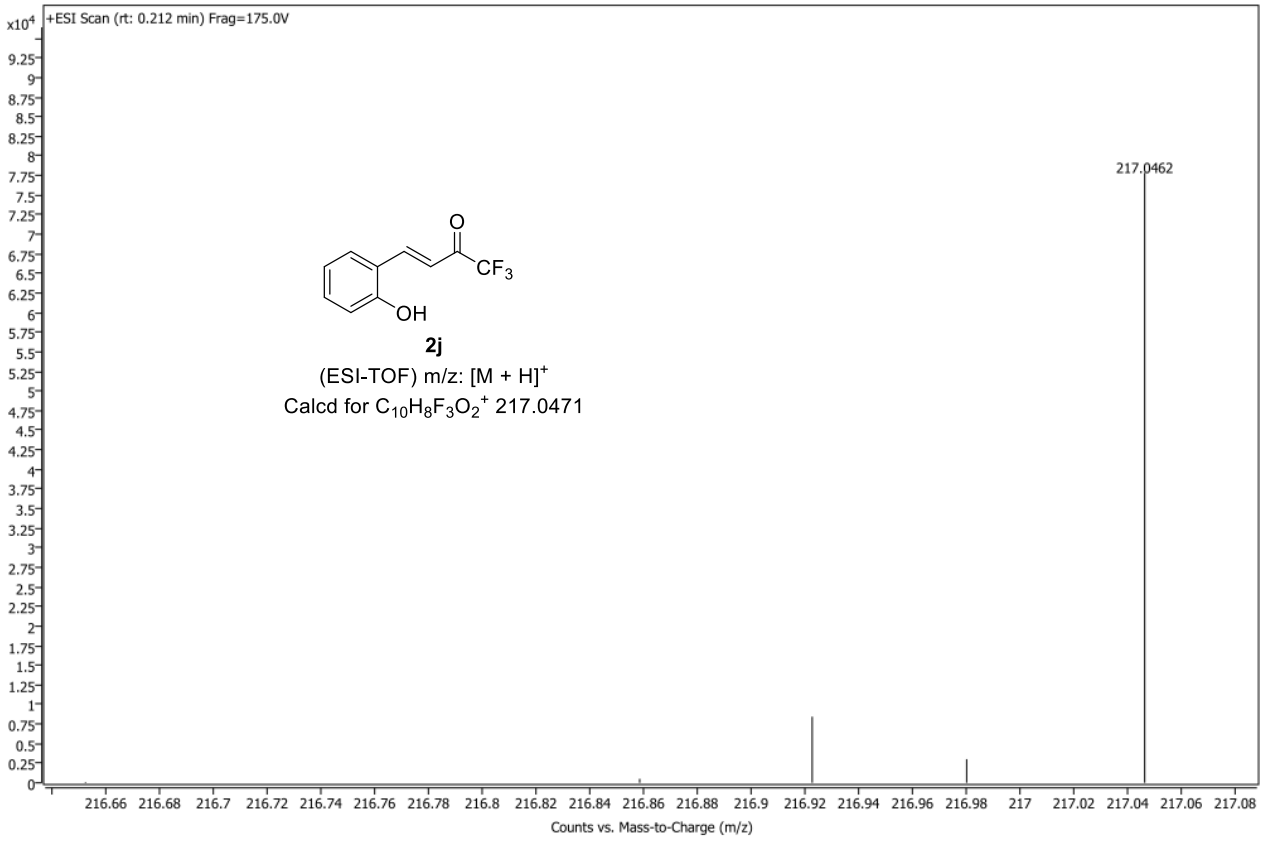
^{13}C NMR (100 MHz, $CDCl_3$)





2j

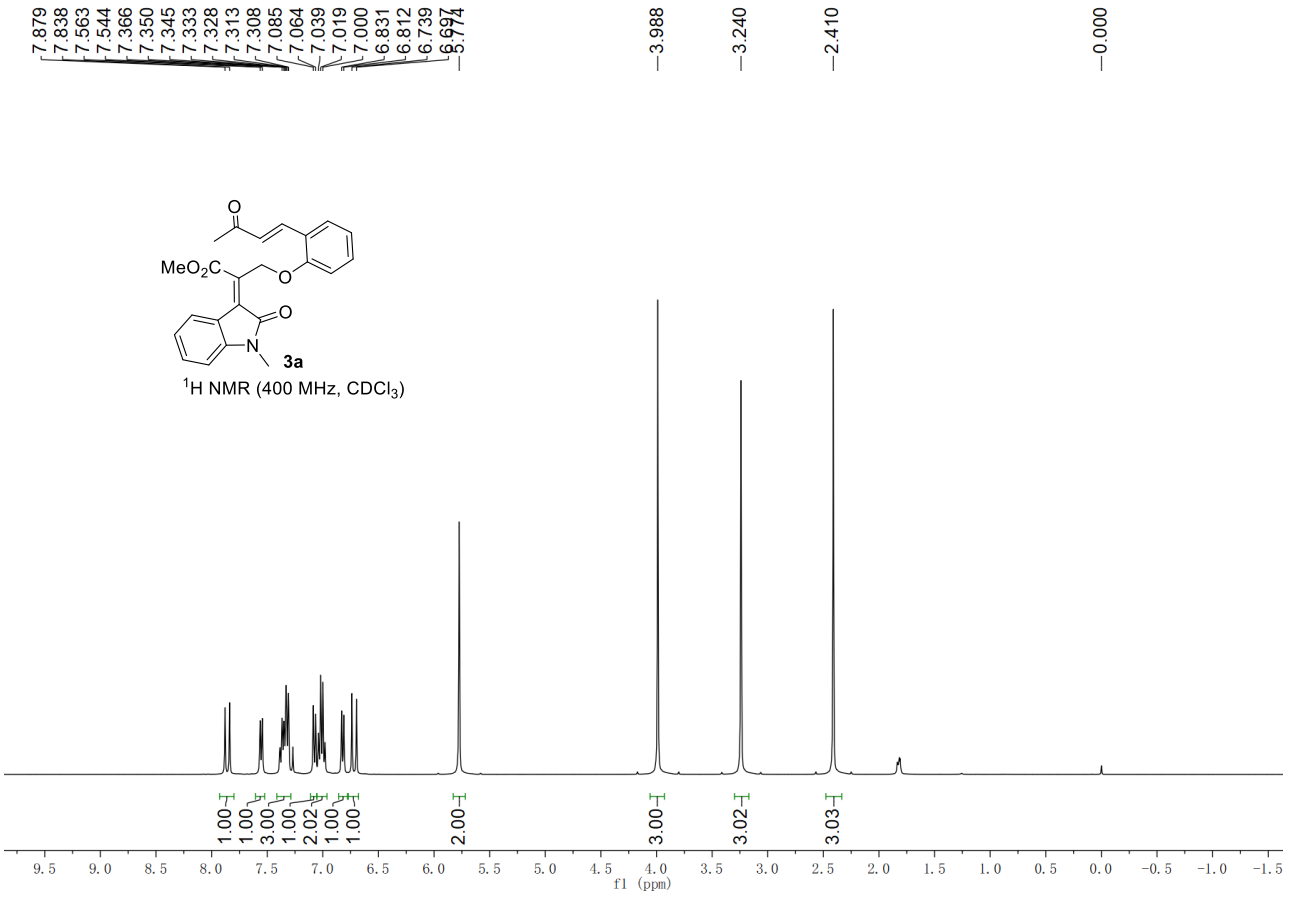
^{19}F NMR (375 MHz, $CDCl_3$)

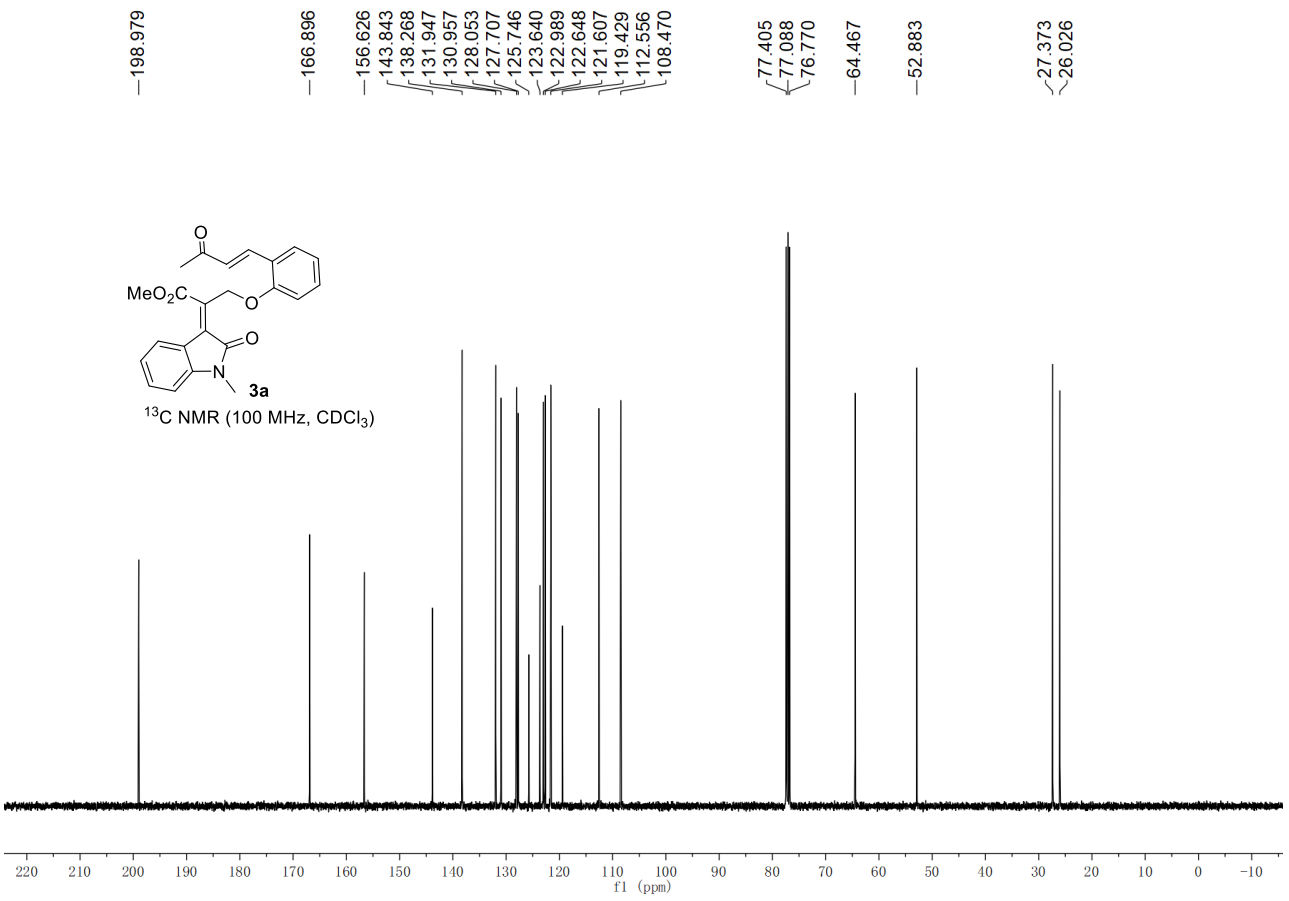


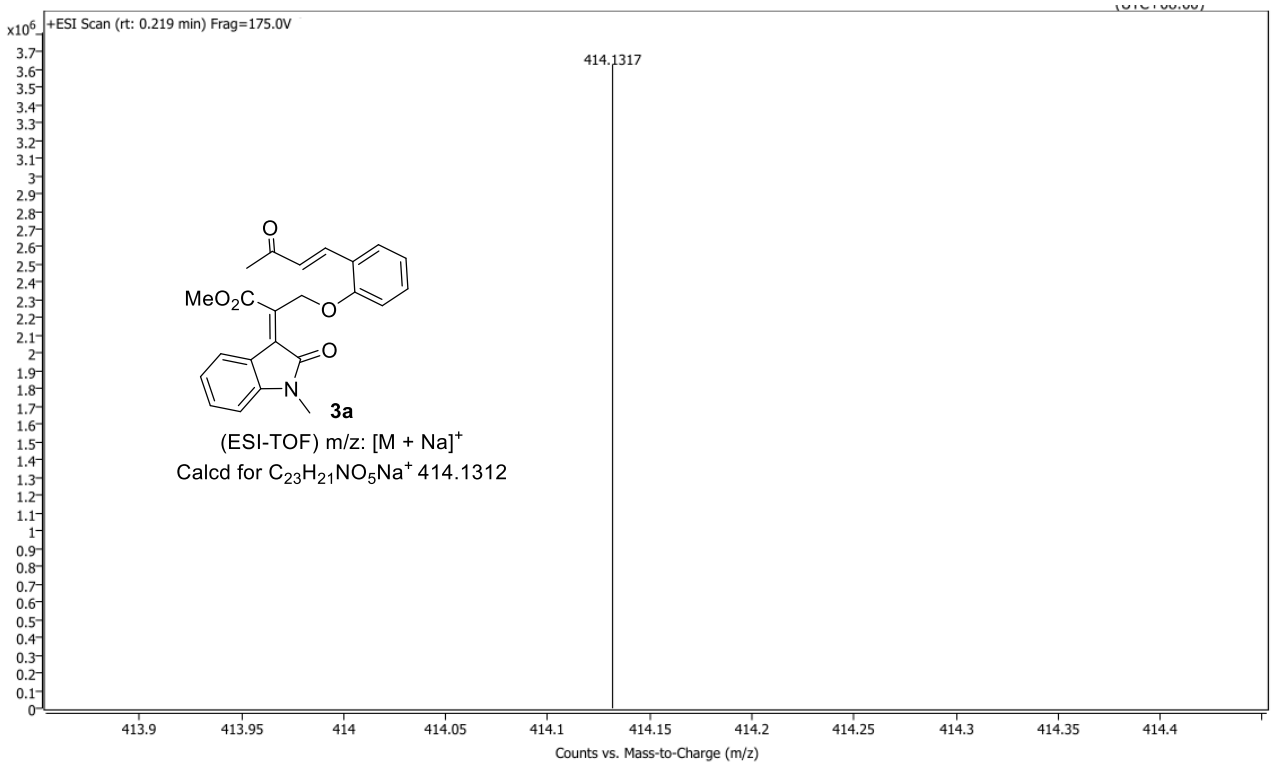
2j

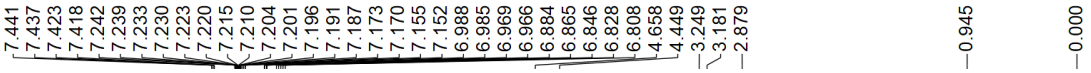
(ESI-TOF) m/z: $[M + H]^+$

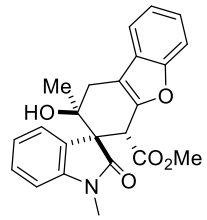
Calcd for $C_{10}H_8F_3O_2^+$ 217.0471


7.879
7.838
7.563
7.544
7.366
7.350
7.345
7.333
7.328
7.313
7.308
7.085
7.064
7.039
7.019
7.000
6.831
6.812
6.739
6.697
5.774
3.988
3.240
2.410
0.000
MeO2C
O
O
O
N
3a
1H NMR (400 MHz, CDCl3)
1.00
1.00
3.00
1.00
2.02
1.00
1.00
2.00
3.00
3.02
3.03
f1 (ppm)


198.979
166.896
156.626
143.843
138.268
131.947
130.957
128.053
127.707
125.746
123.640
122.989
122.648
121.607
119.429
112.556
108.470
77.405
77.088
76.770
64.467
52.883
27.373
26.026
MeO2C
O
O
O
N
3a
13C NMR (100 MHz, CDCl3)
f1 (ppm)

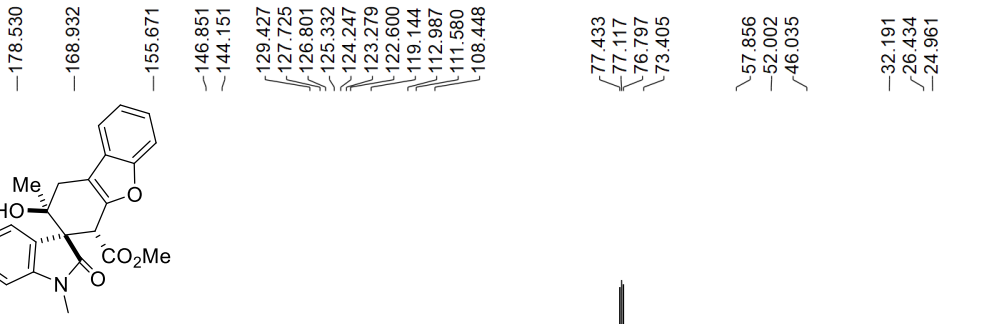

+ESI Scan (rt: 0.219 min) Frag=175.0V
x10^6
414.1317
MeO2C
O
O
O
N
3a
(ESI-TOF) m/z: [M + Na]+
Calcd for C23H21NO5Na+ 414.1312
Counts vs. Mass-to-Charge (m/z)





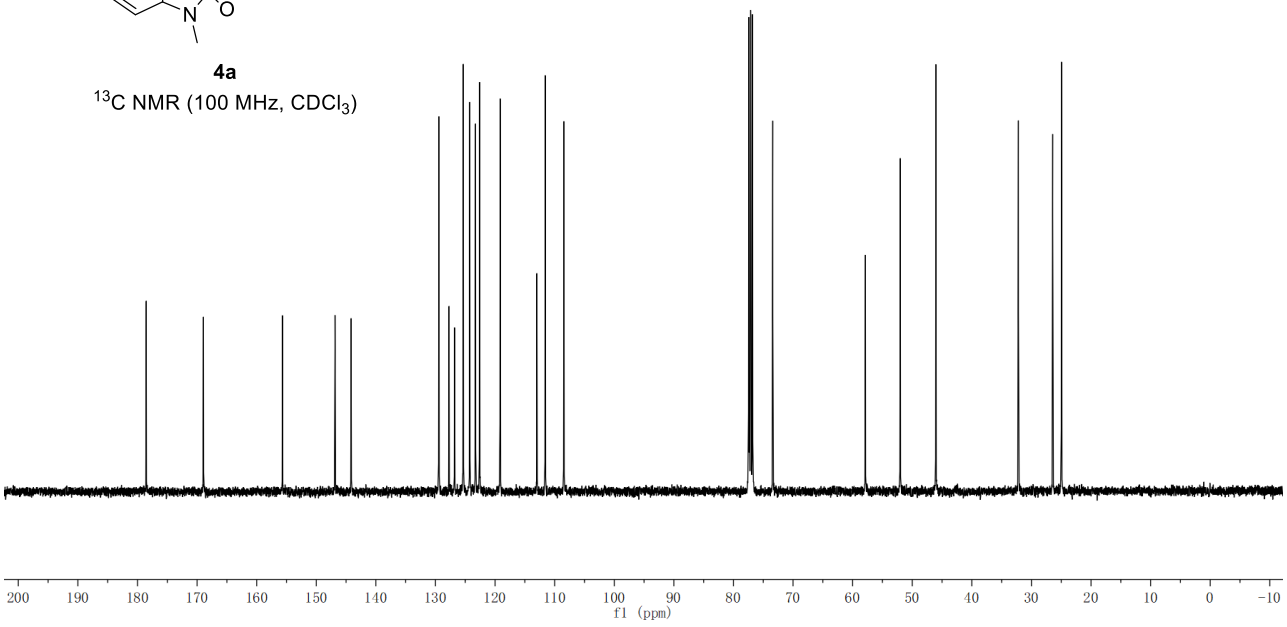
4a

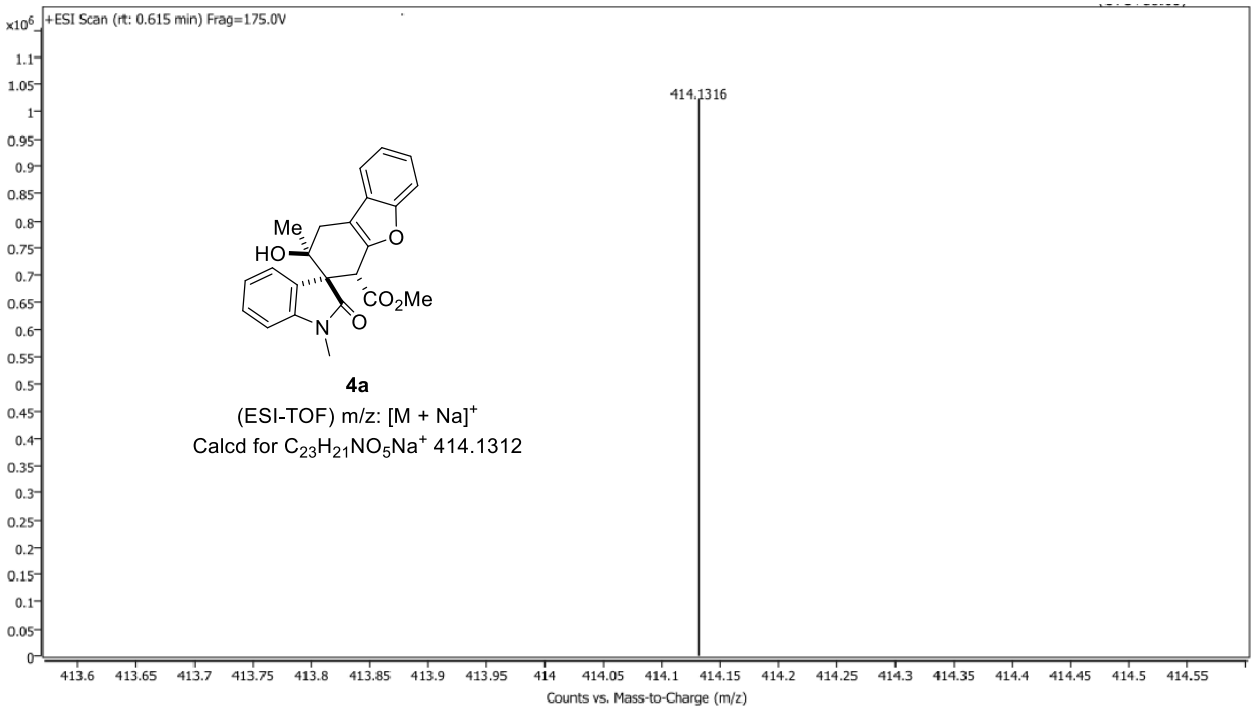
^{1}H NMR (400 MHz, $CDCl_3$)



4a

^{13}C NMR (100 MHz, $CDCl_3$)

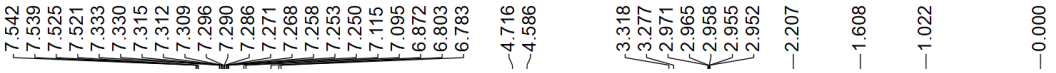


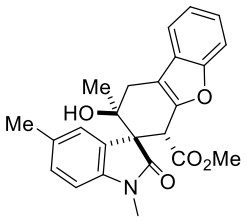


4a

(ESI-TOF) m/z: $[M + Na]^+$

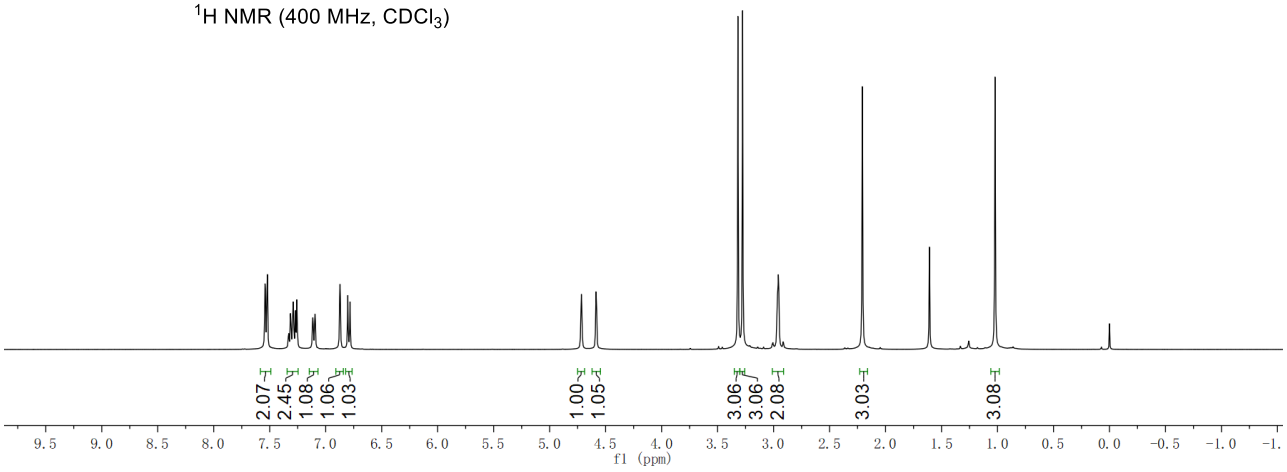
Calcd for $C_{23}H_{21}NO_5Na^+$ 414.1312

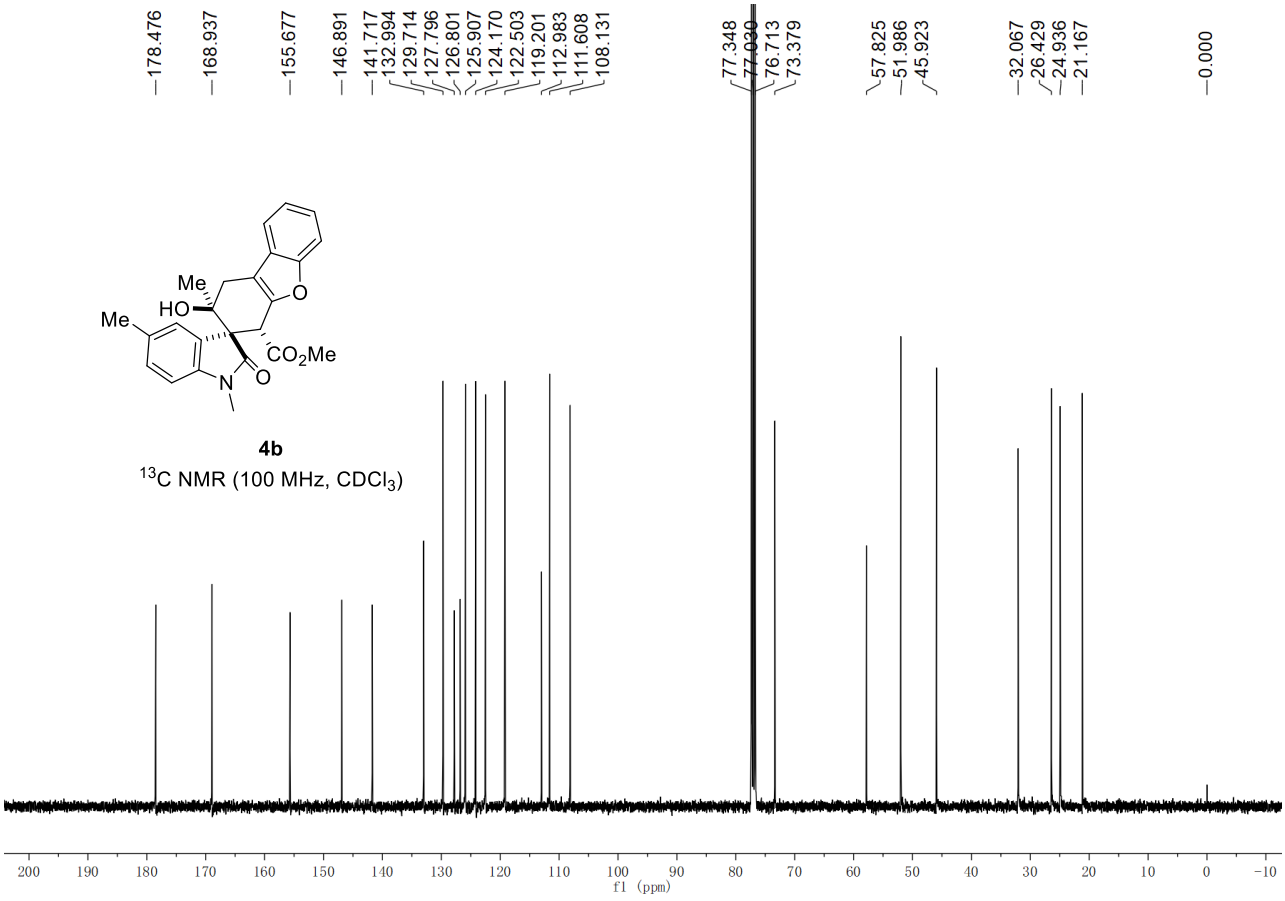




4b

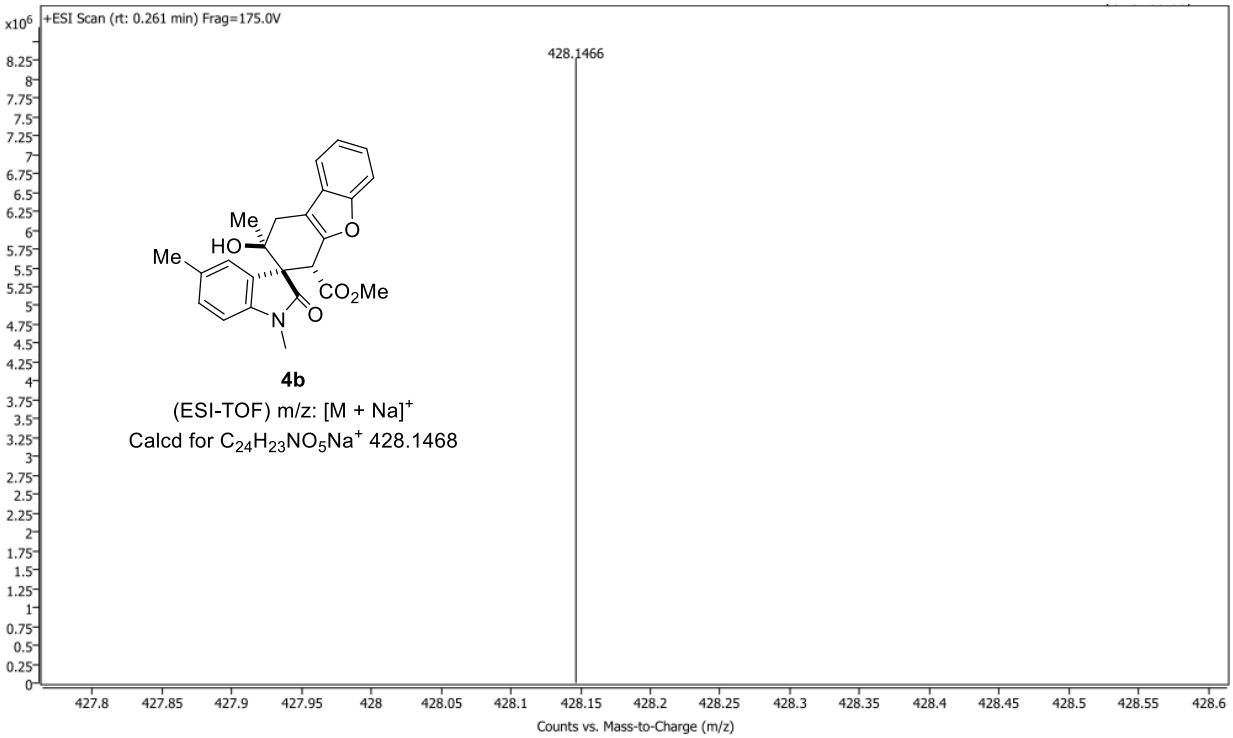
^{1}H NMR (400 MHz, $CDCl_3$)





4b

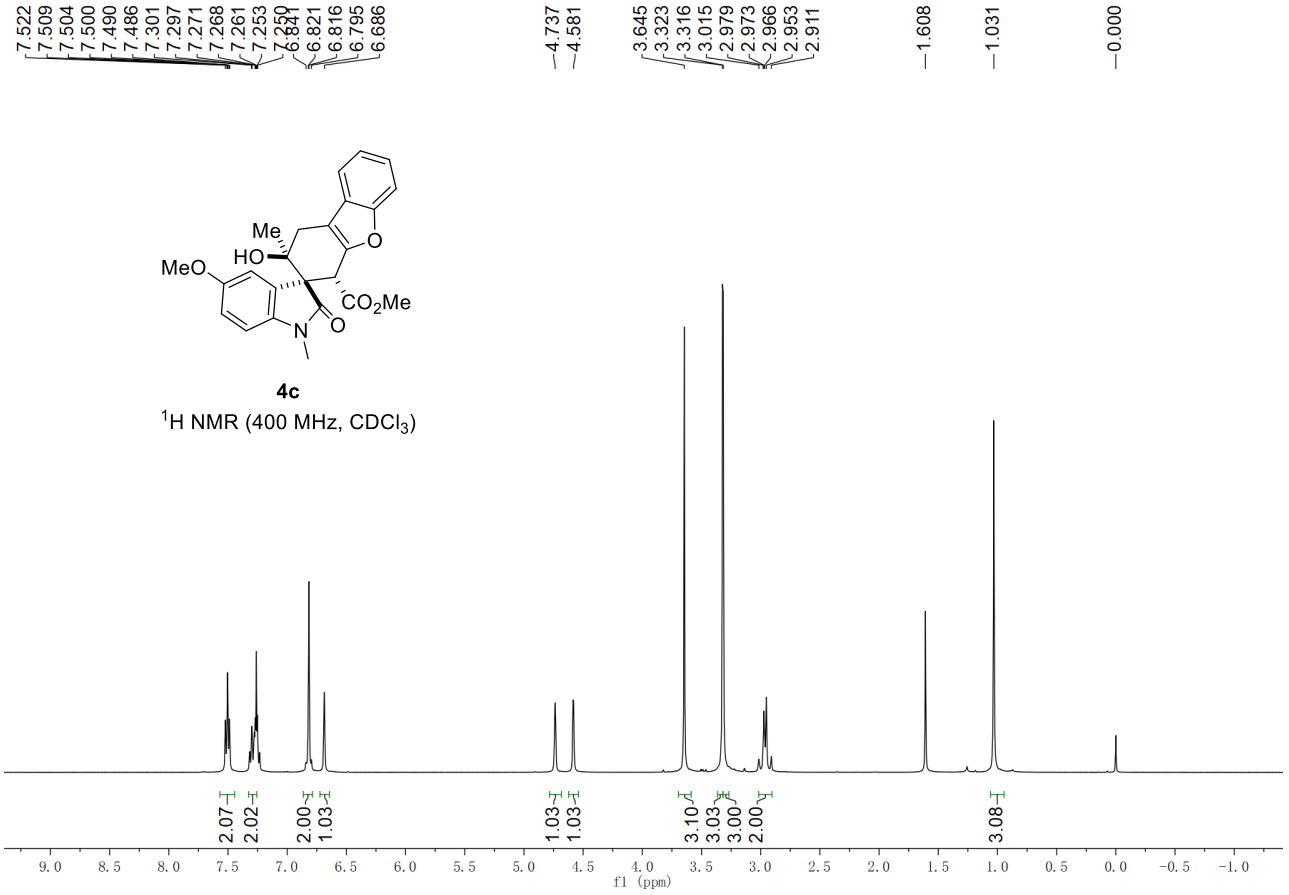
^{13}C NMR (100 MHz, $CDCl_3$)



4b

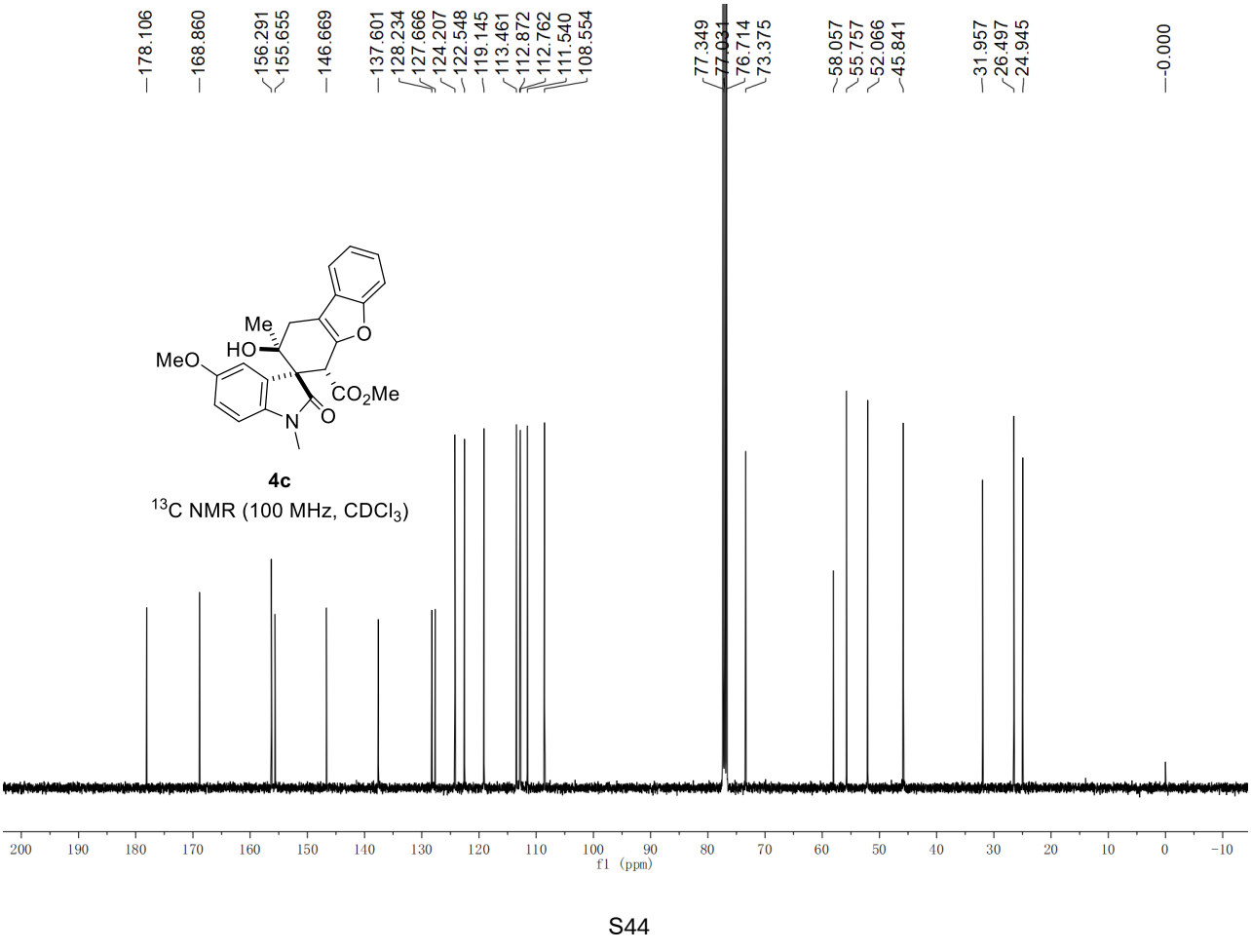
(ESI-TOF) m/z: $[M + Na]^+$

Calcd for $C_{24}H_{23}NO_5Na^+$ 428.1468



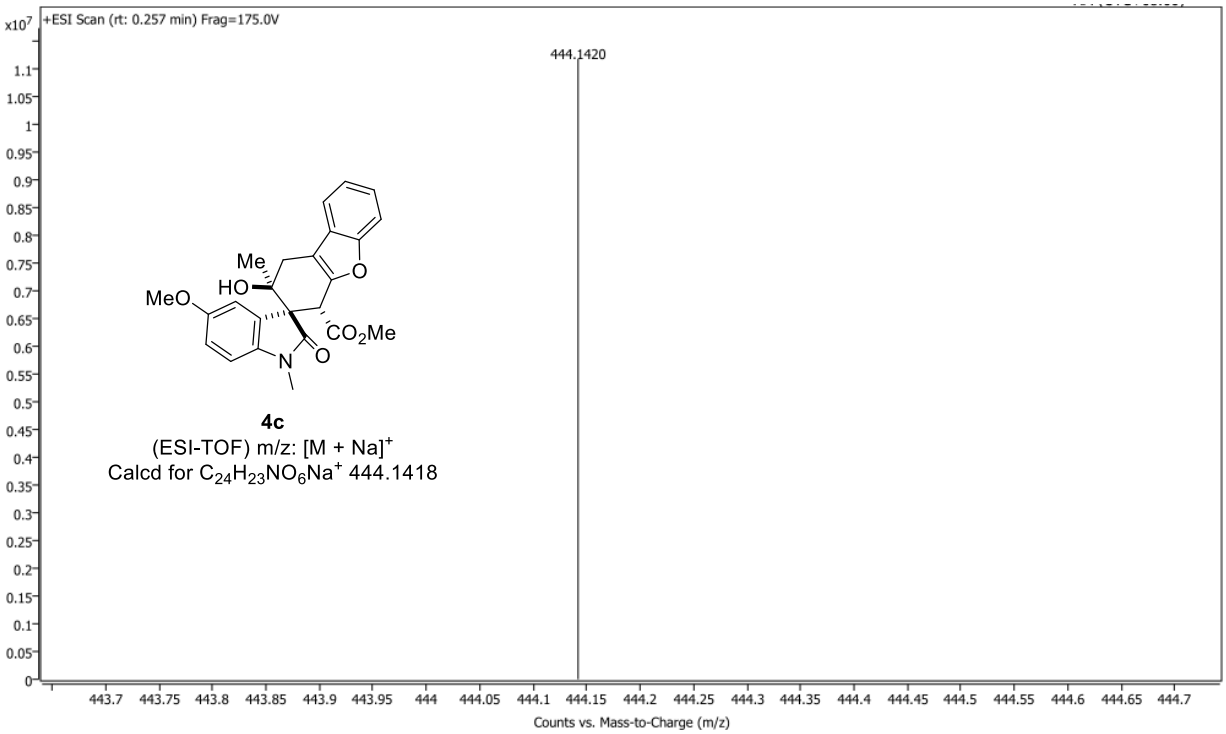
4c

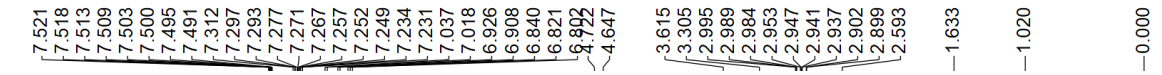
^{1}H NMR (400 MHz, $CDCl_3$)

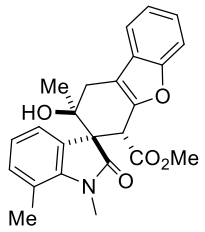


4c

^{13}C NMR (100 MHz, $CDCl_3$)

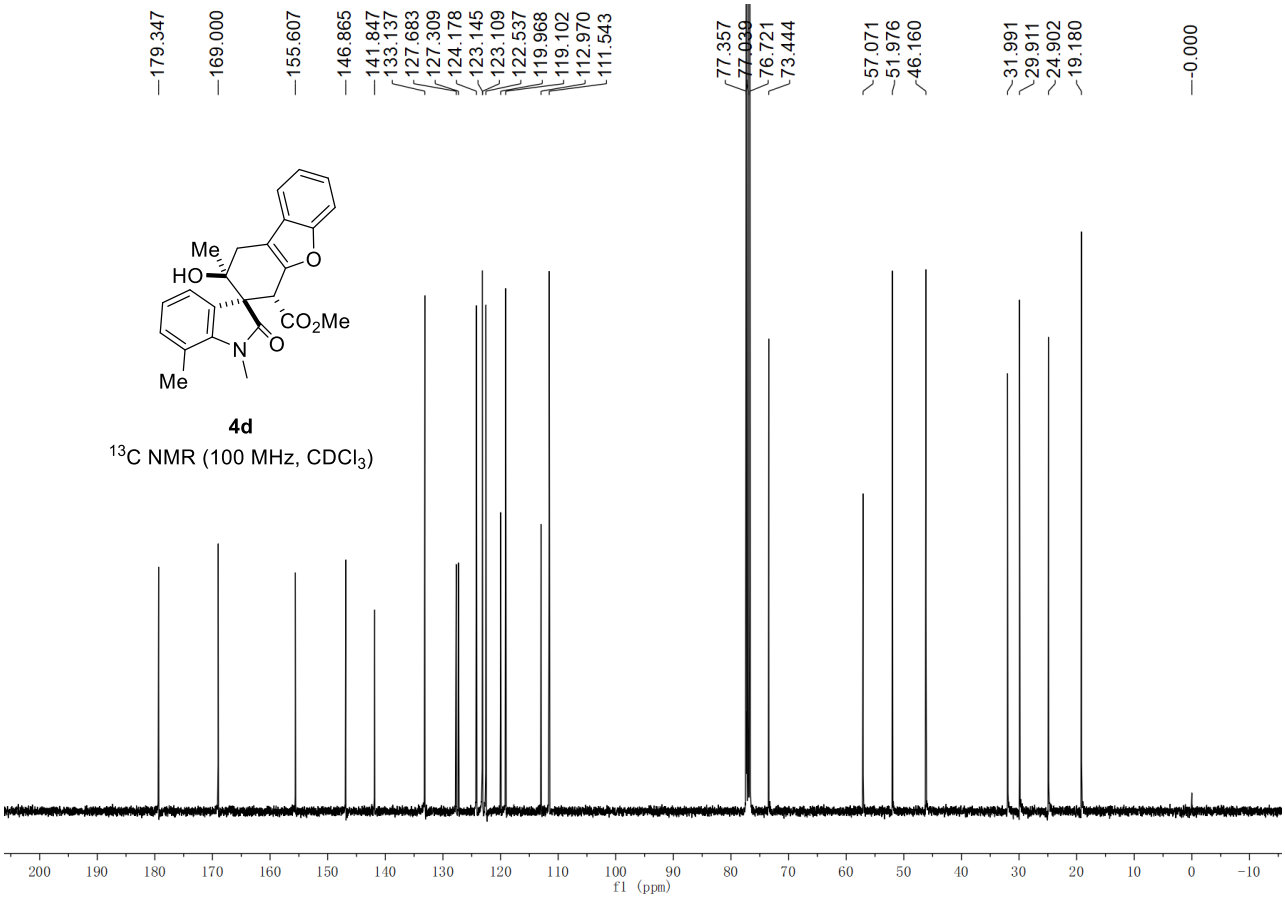

+ESI Scan (rt: 0.257 min) Frag=175.0V
x10^7
444.1420
Me
HO
MeO
O
CO2Me
N
O
4c
(ESI-TOF) m/z: [M + Na]+
Calcd for C24H23NO6Na+ 444.1418
Counts vs. Mass-to-Charge (m/z)





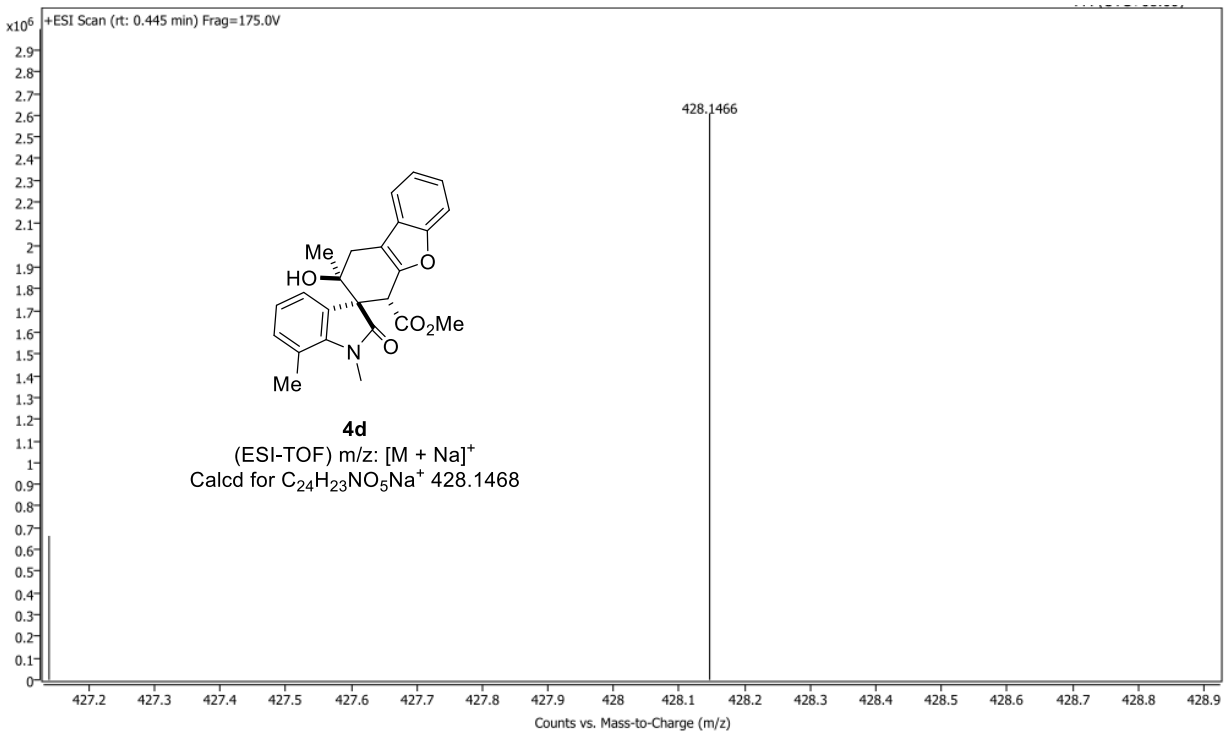
4d

^{1}H NMR (400 MHz, $CDCl_3$)



4d

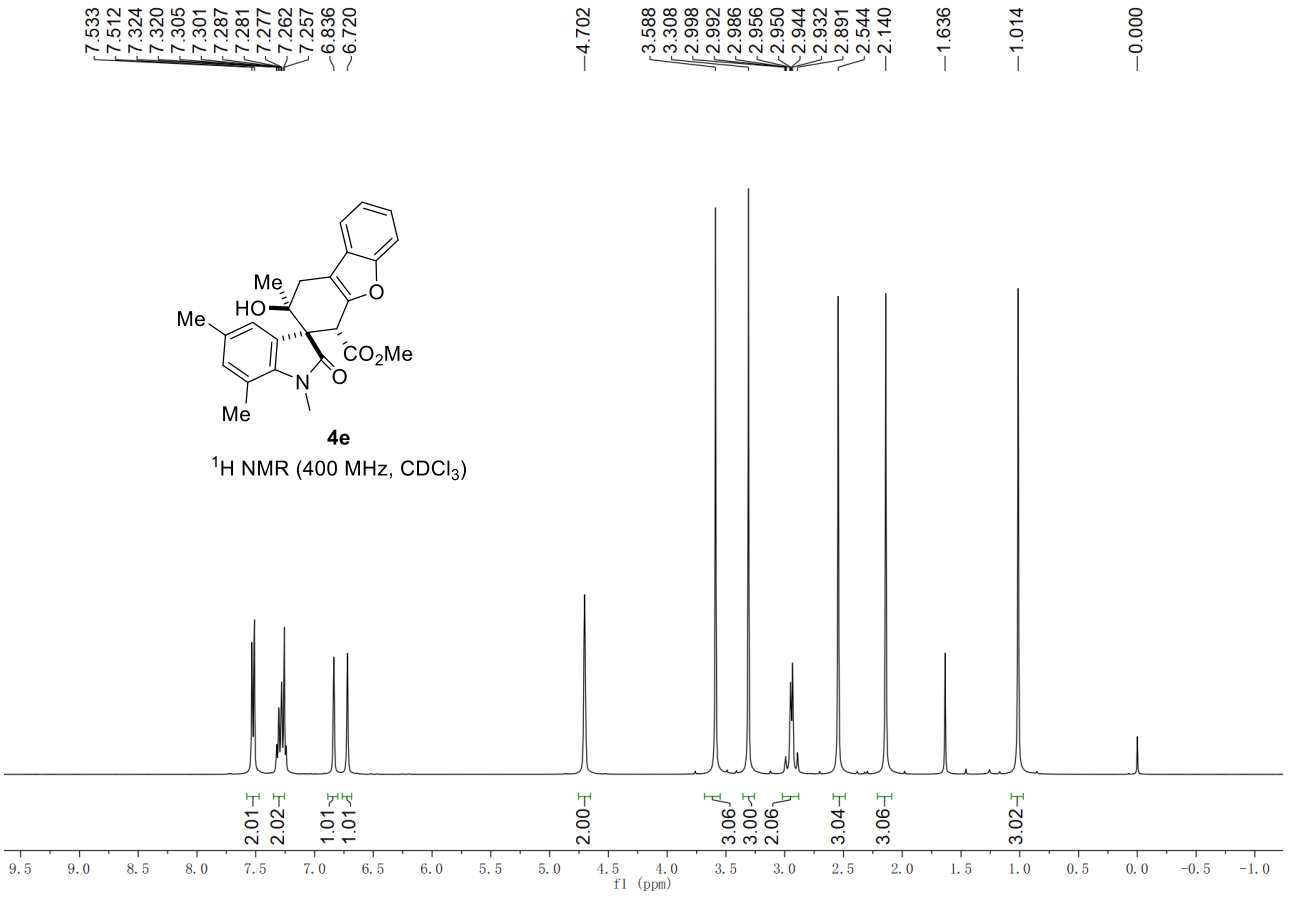
^{13}C NMR (100 MHz, $CDCl_3$)



4d

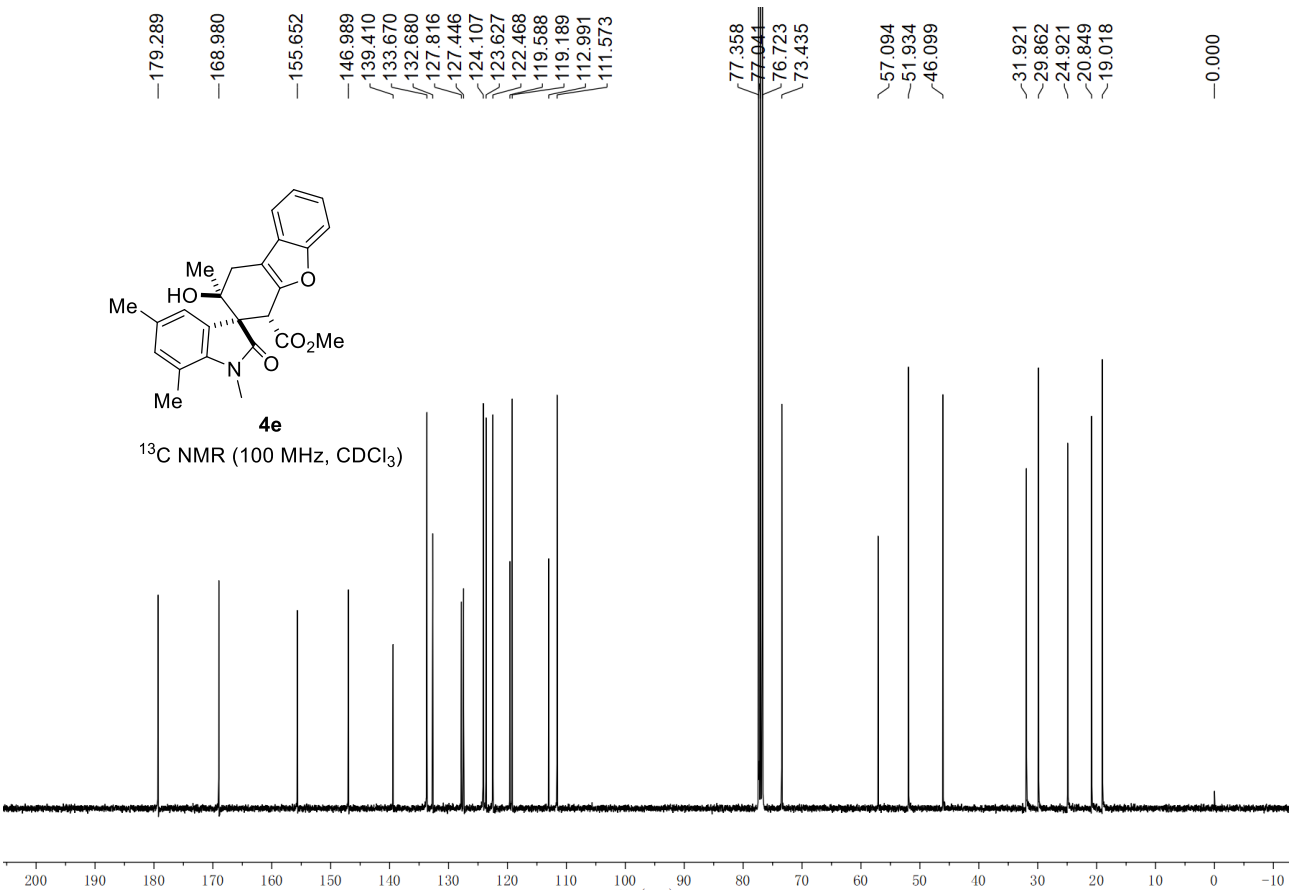
(ESI-TOF) m/z: $[M + Na]^+$

Calcd for $C_{24}H_{23}NO_5Na^+$ 428.1468



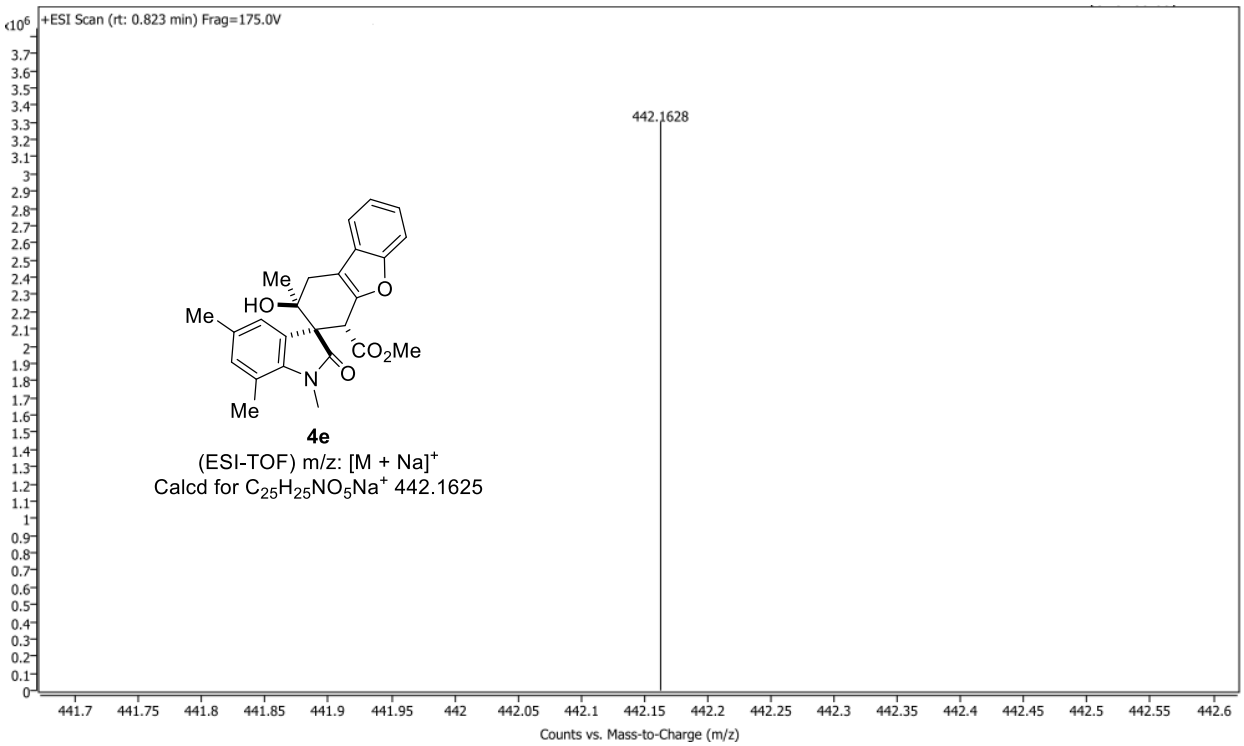
4e

^{1}H NMR (400 MHz, $CDCl_3$)



4e

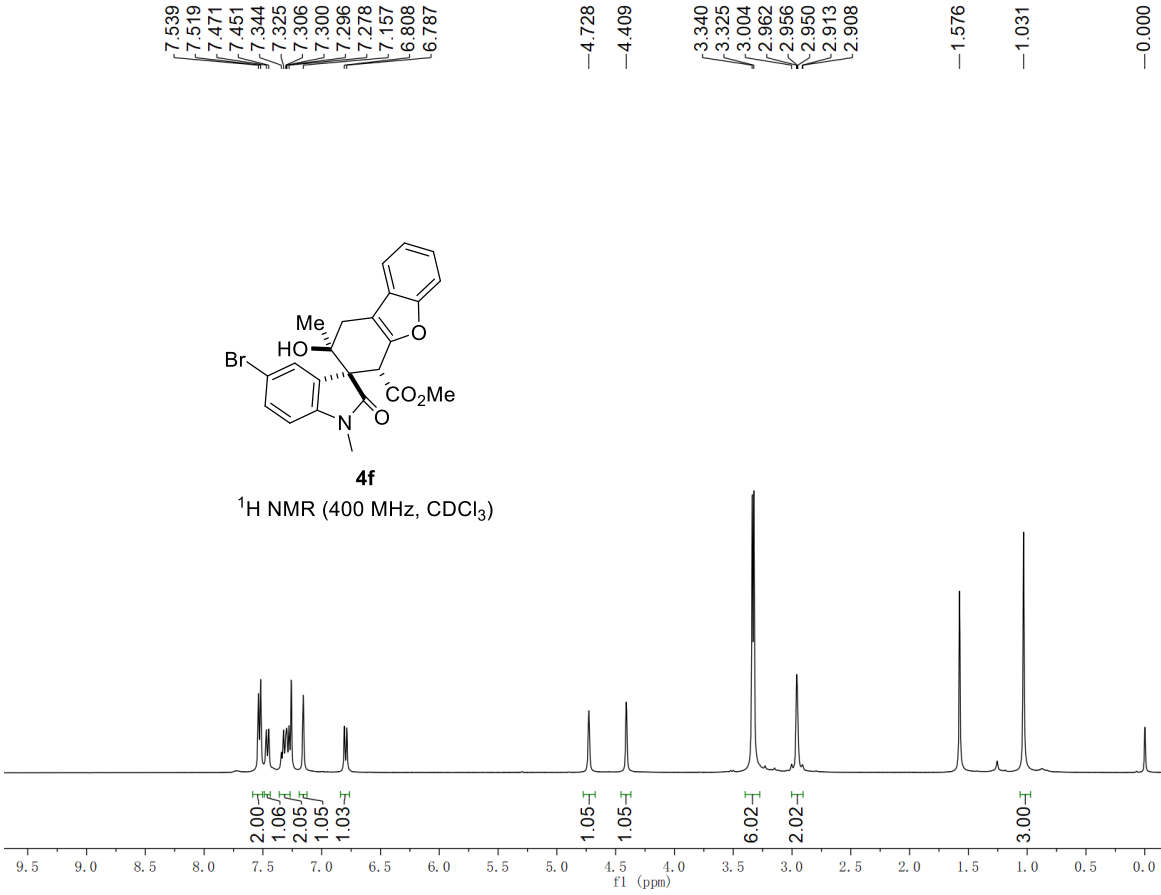
^{13}C NMR (100 MHz, $CDCl_3$)



4e

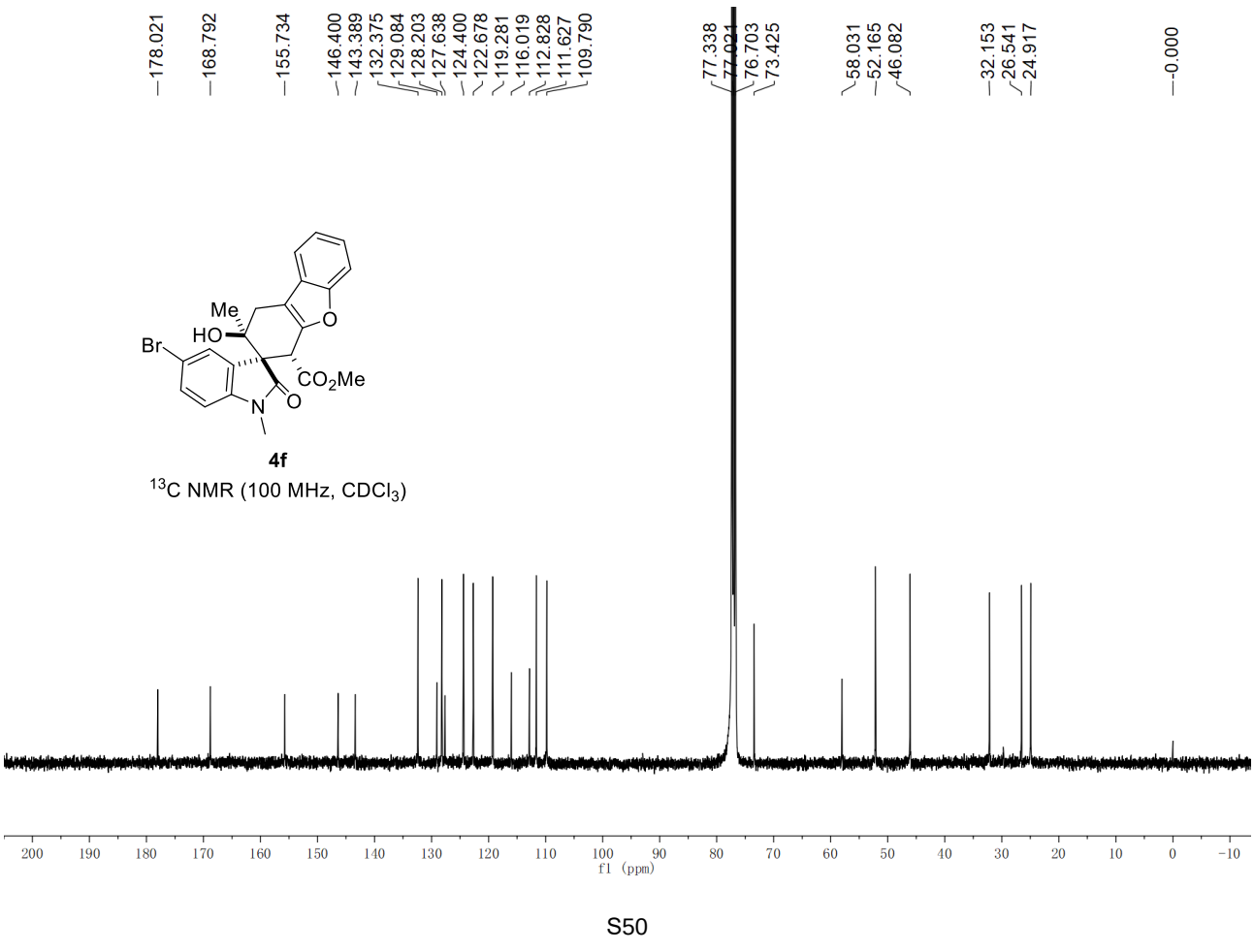
(ESI-TOF) m/z: $[M + Na]^+$

Calcd for $C_{25}H_{25}NO_5Na^+$ 442.1625



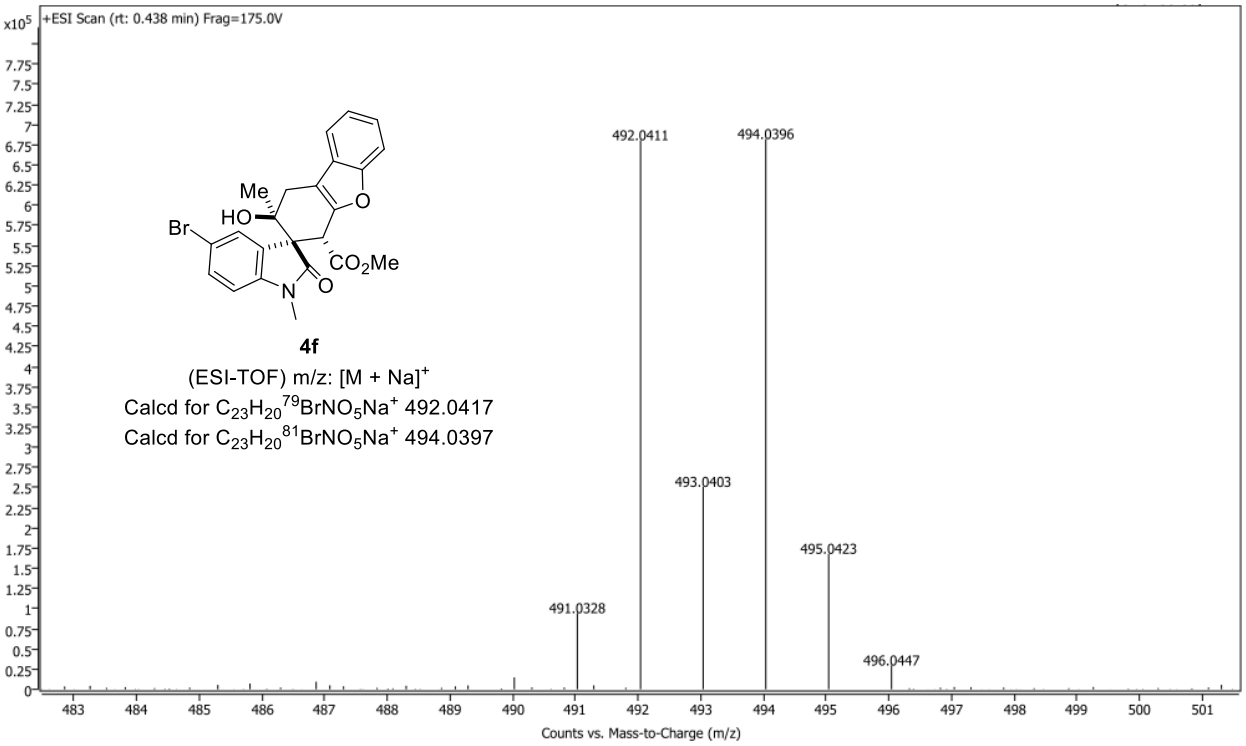
4f

^{1}H NMR (400 MHz, $CDCl_3$)



4f

^{13}C NMR (100 MHz, $CDCl_3$)

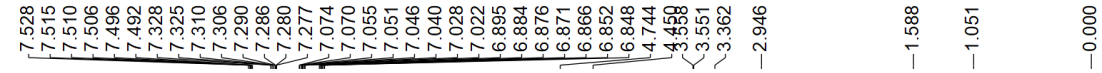


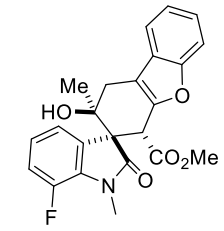
4f

(ESI-TOF) m/z: $[M + Na]^+$

Calcd for $C_{23}H_{20}{}^{79}BrNO_5Na^+$ 492.0417

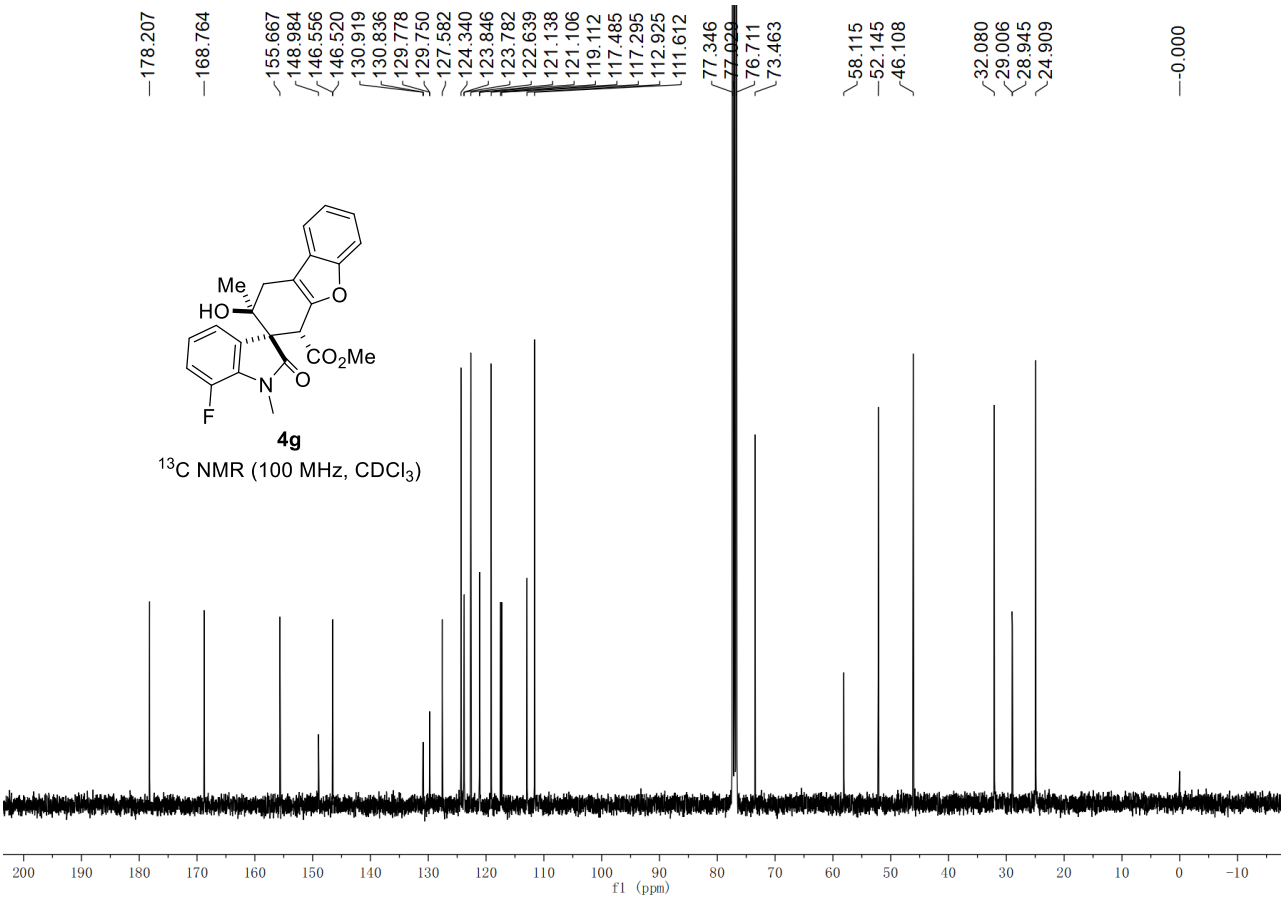
Calcd for $C_{23}H_{20}{}^{81}BrNO_5Na^+$ 494.0397





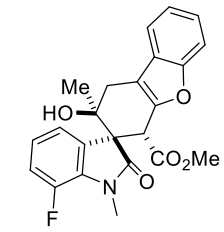
4g

^{1}H NMR (400 MHz, $CDCl_3$)



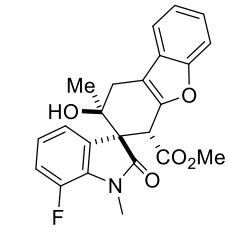
4g

^{13}C NMR (100 MHz, $CDCl_3$)



4g

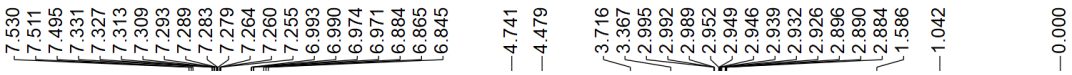
^{19}F NMR (375 MHz, $CDCl_3$)

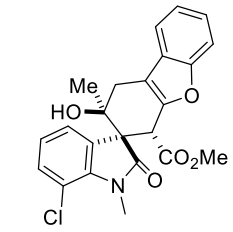


4g

(ESI-TOF) m/z: $[M + Na]^+$

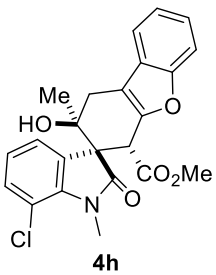
$C_{23}H_{20}FNO_5Na^+$ 432.1218





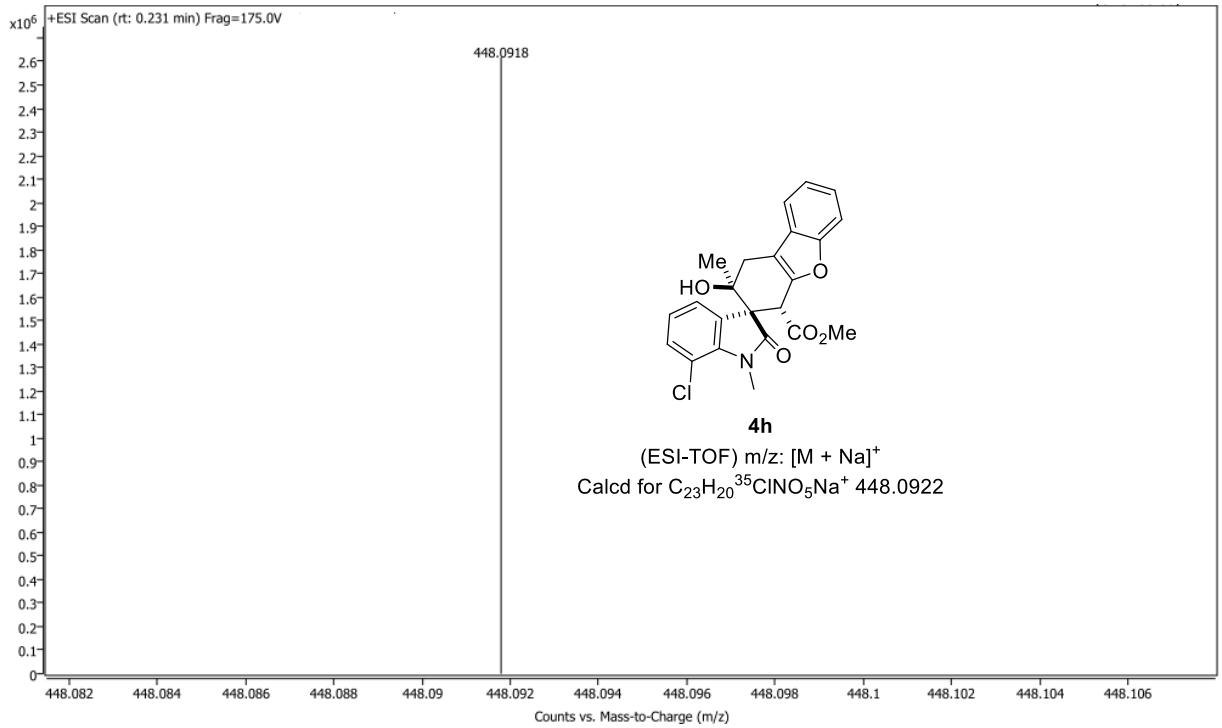
4h

^{1}H NMR (400 MHz, $CDCl_3$)



4h

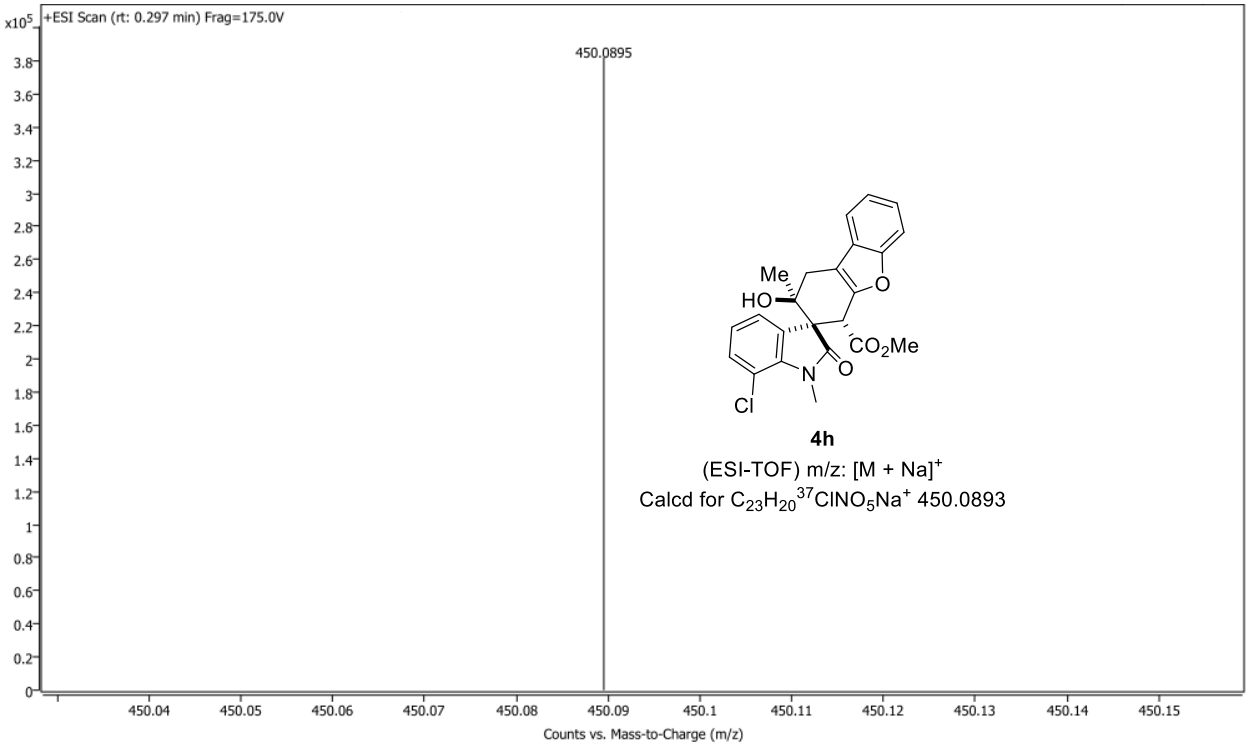
^{13}C NMR (100 MHz, $CDCl_3$)



4h

(ESI-TOF) m/z: $[M + Na]^+$

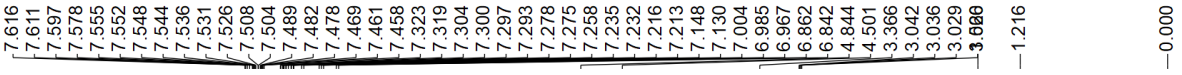
Calcd for $C_{23}H_{20}{}^{35}ClNO_5Na^+$ 448.0922

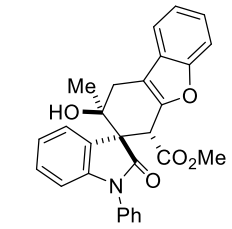


4h

(ESI-TOF) m/z: $[M + Na]^+$

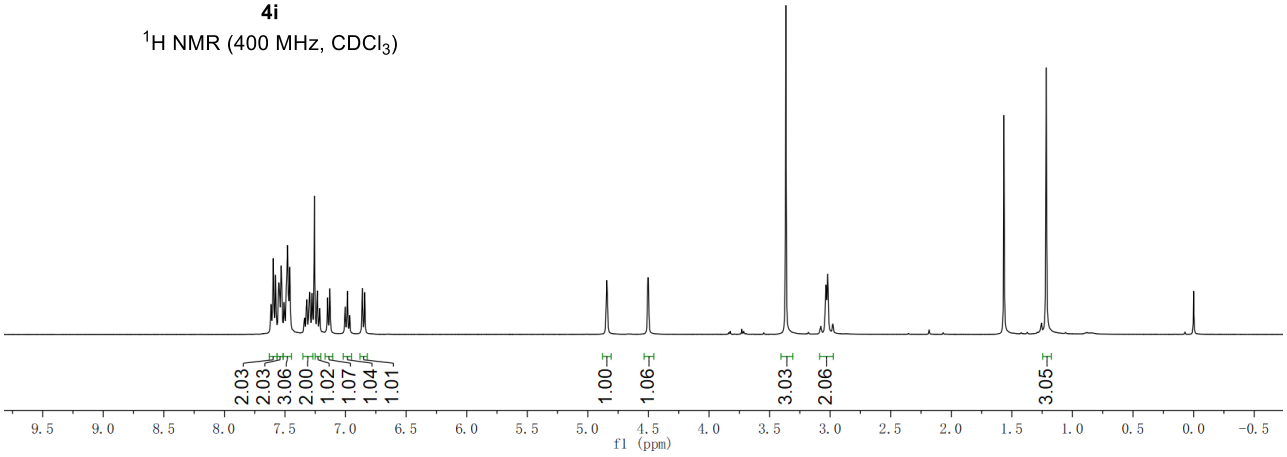
Calcd for $C_{23}H_{20}{}^{37}ClNO_5Na^+$ 450.0893

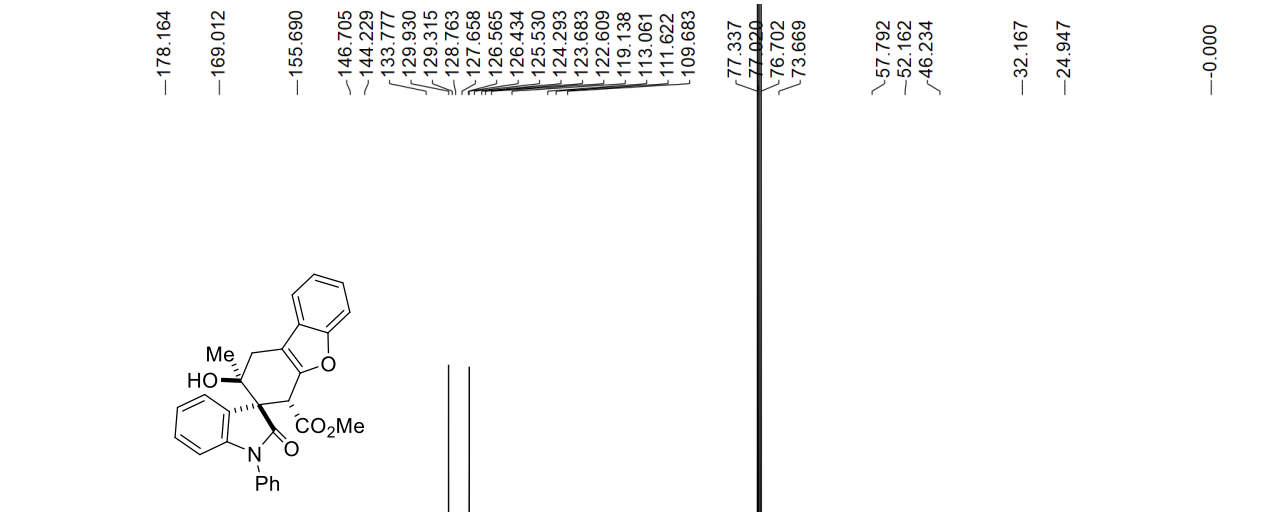




4i

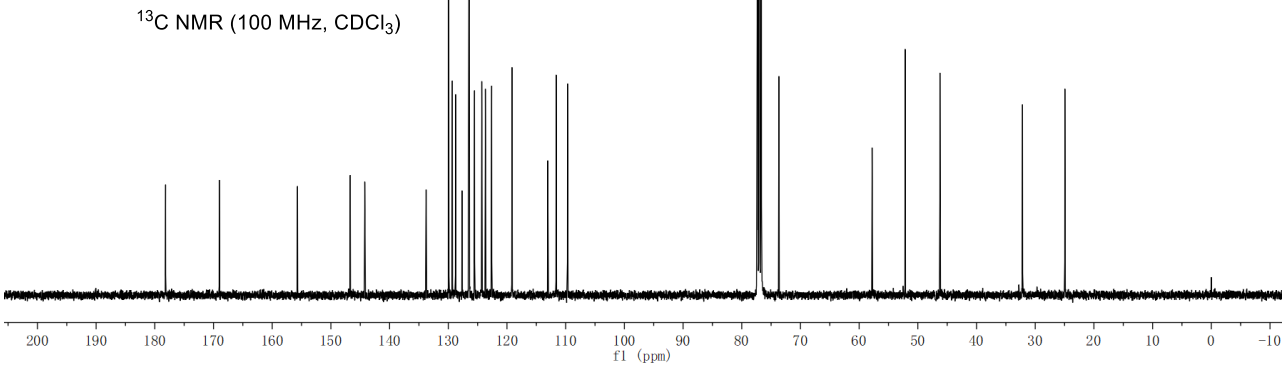
^{1}H NMR (400 MHz, $CDCl_3$)

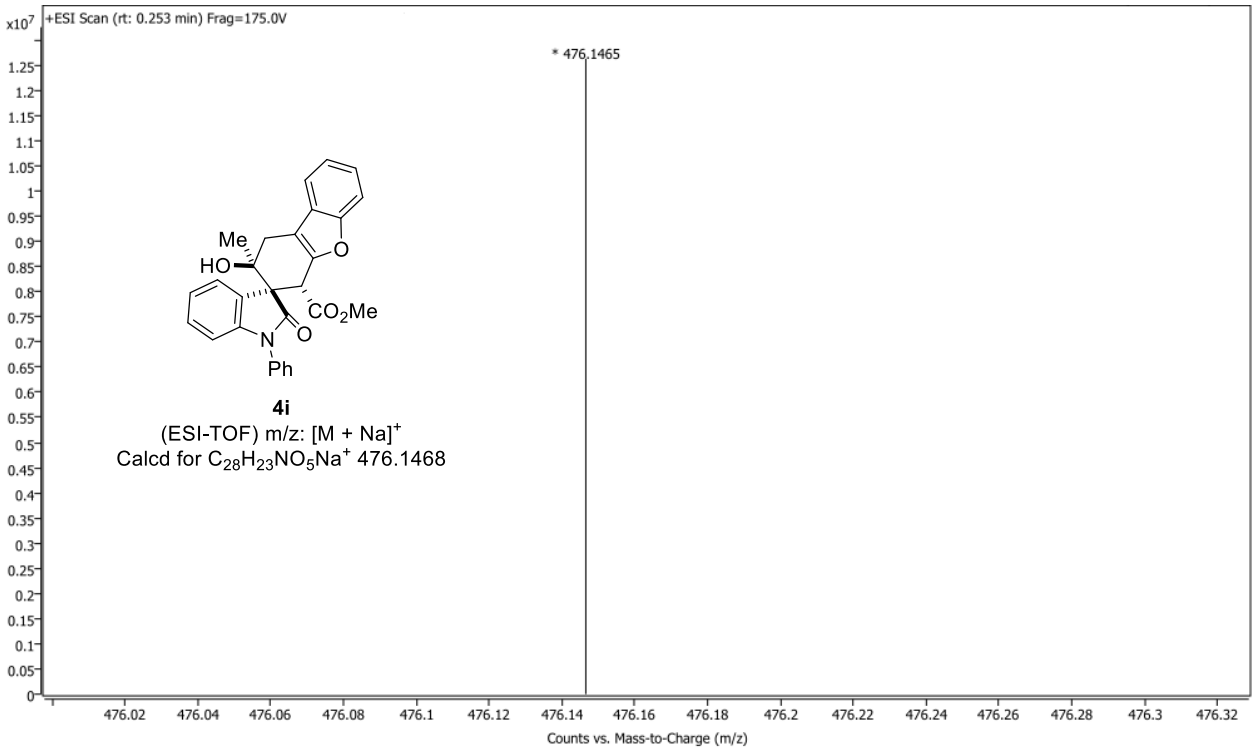




4i

^{13}C NMR (100 MHz, $CDCl_3$)

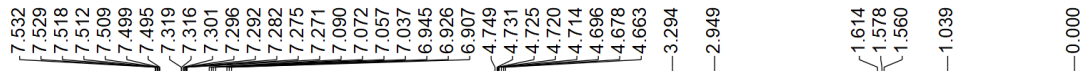


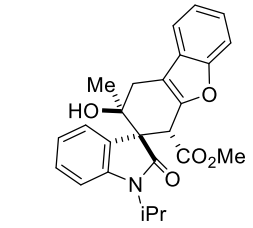


4i

(ESI-TOF) m/z: $[M + Na]^+$

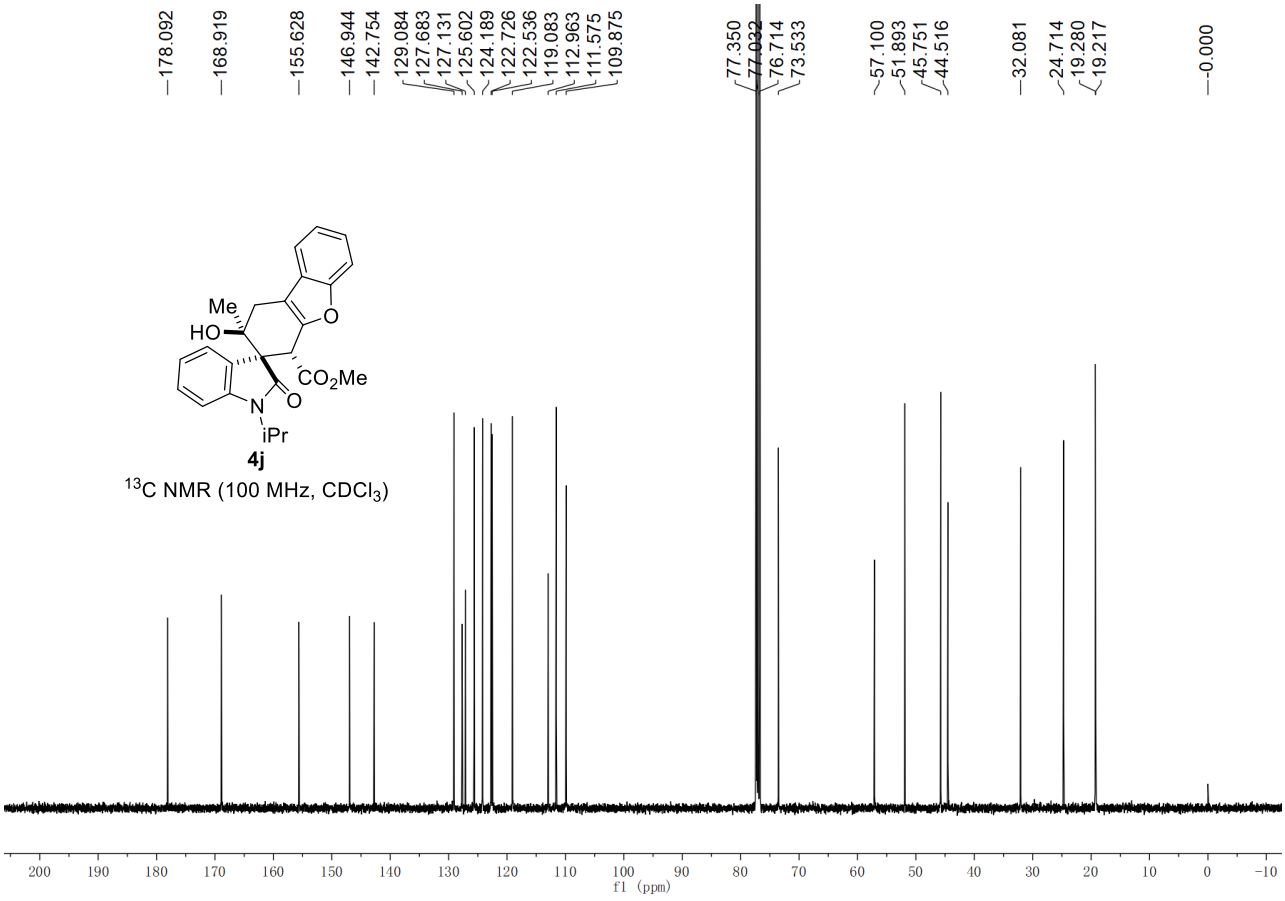
Calcd for $C_{28}H_{23}NO_5Na^+$ 476.1468





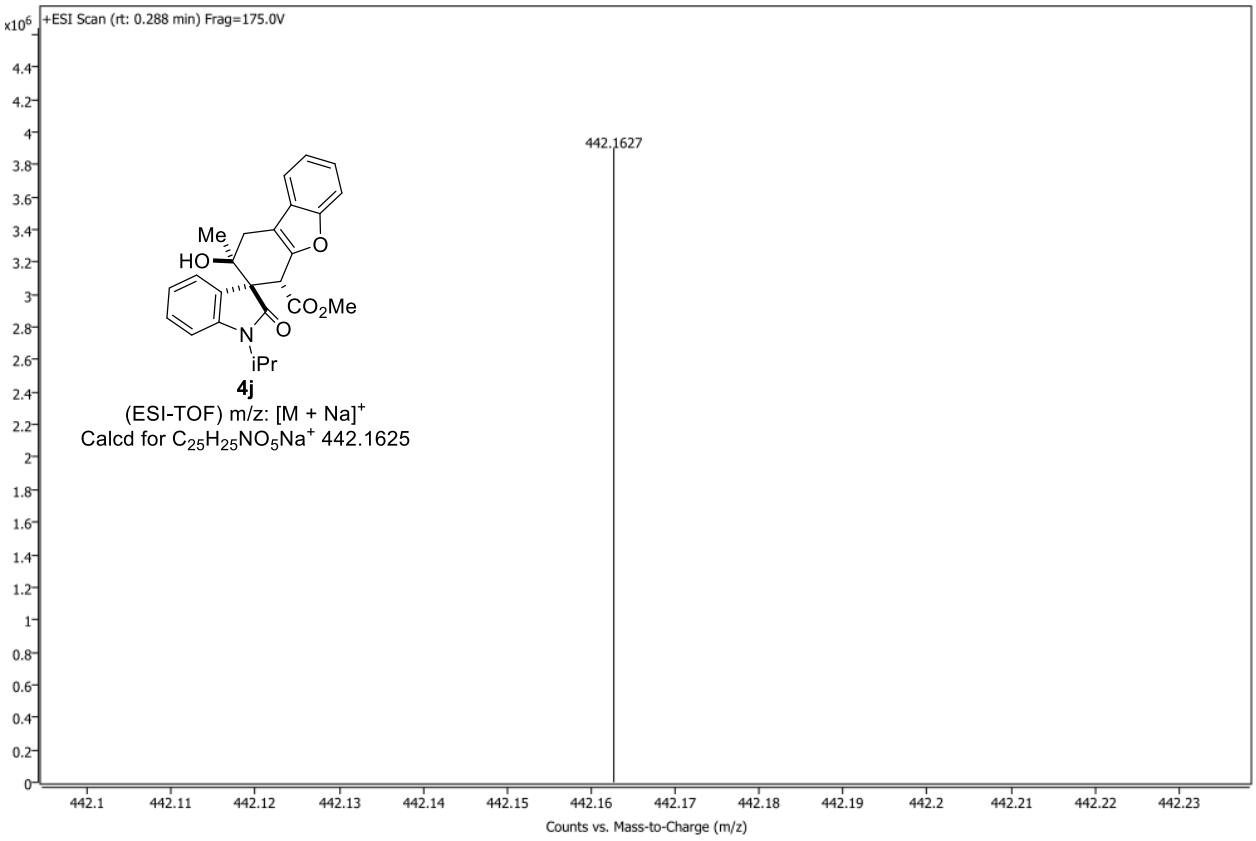
4j

^{1}H NMR (400 MHz, $CDCl_3$)



4j

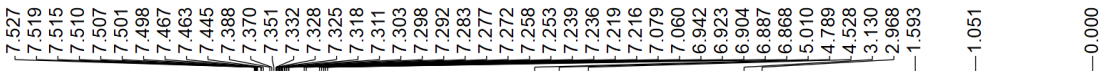
^{13}C NMR (100 MHz, $CDCl_3$)

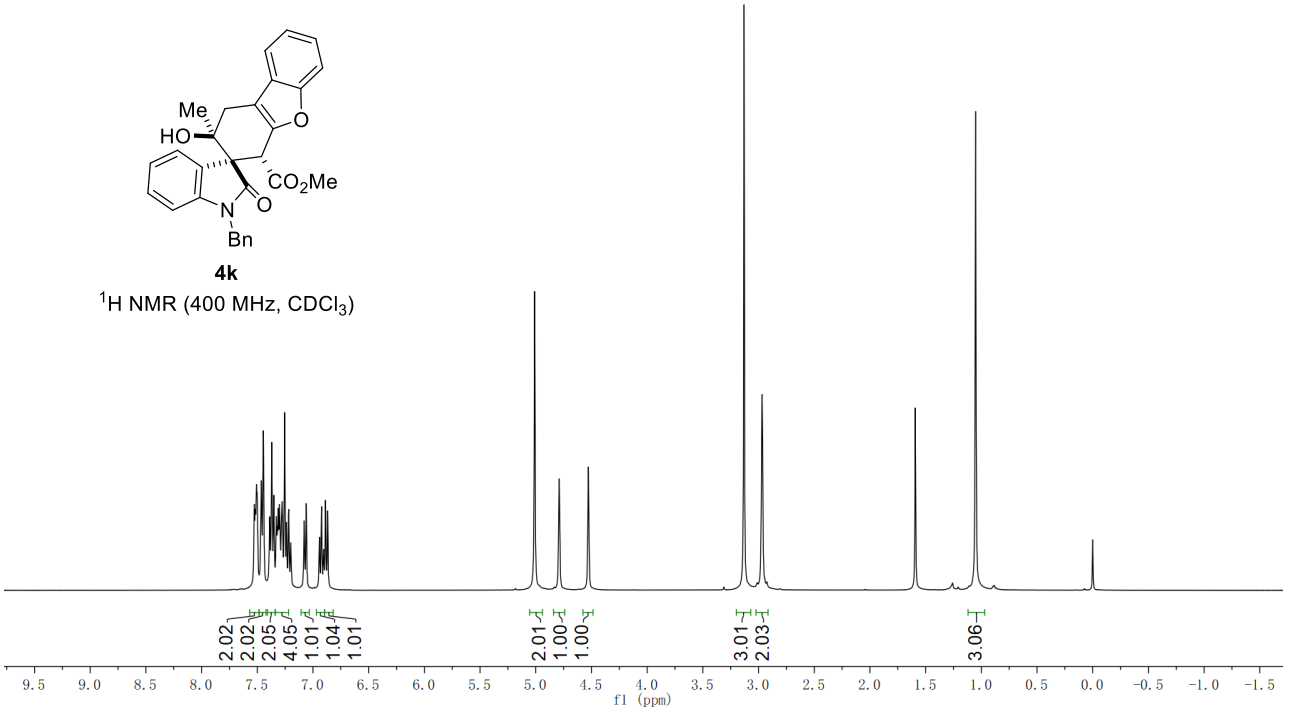


4j

(ESI-TOF) m/z: $[M + Na]^+$

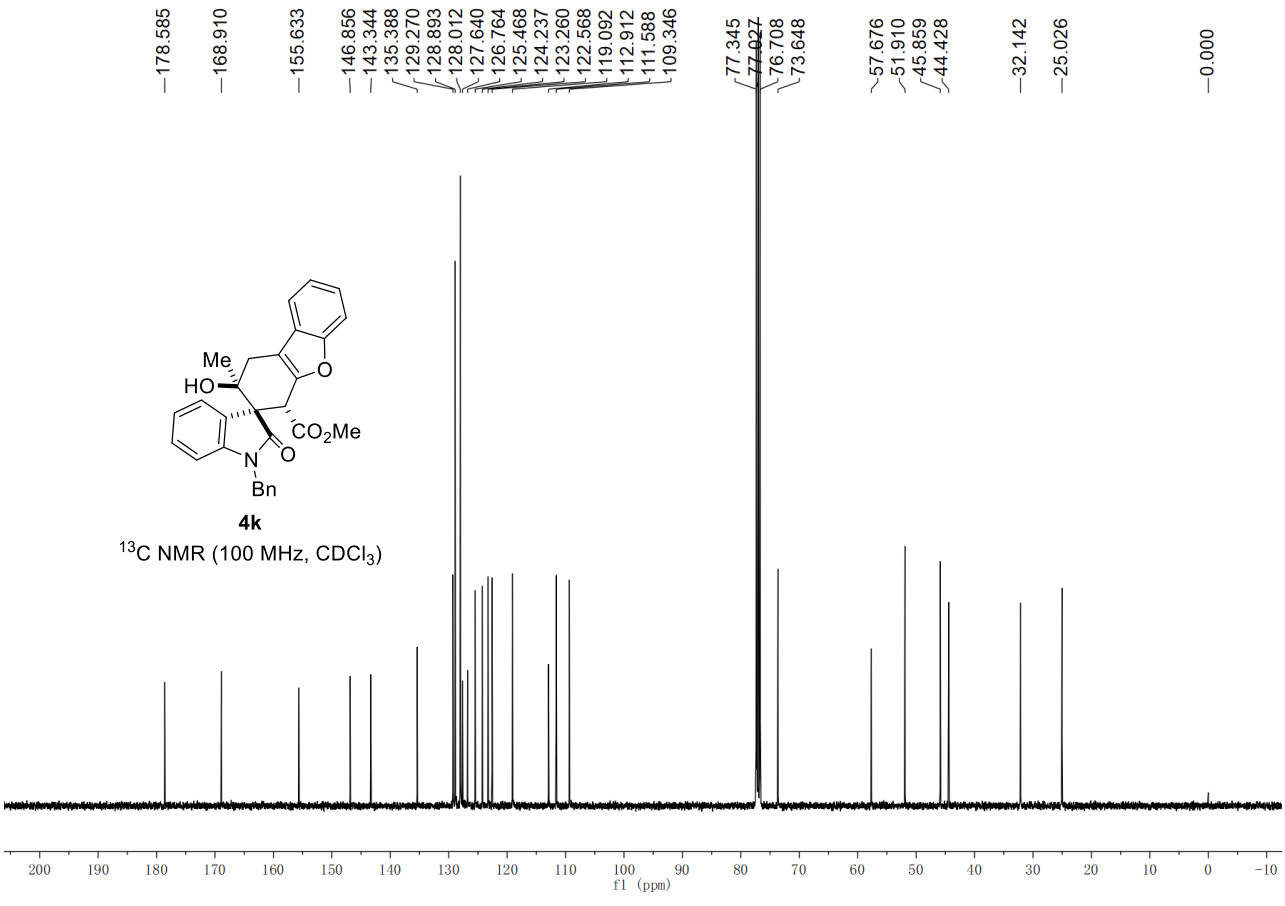
Calcd for $C_{25}H_{25}NO_5Na^+$ 442.1625





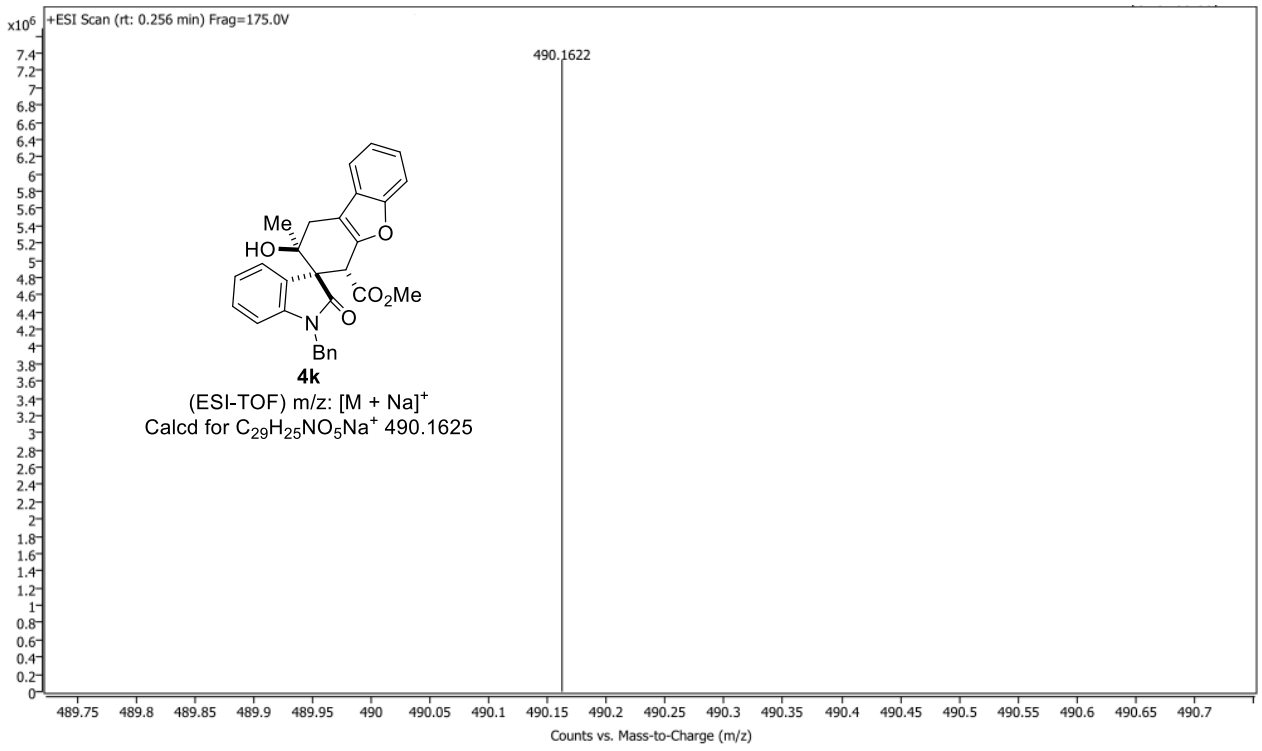
4k

^{1}H NMR (400 MHz, $CDCl_3$)



4k

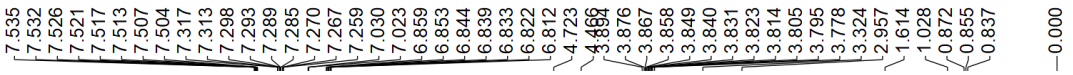
^{13}C NMR (100 MHz, $CDCl_3$)

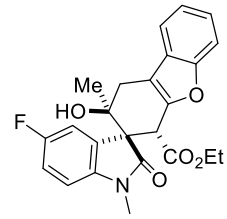


4k

(ESI-TOF) m/z: $[M + Na]^+$

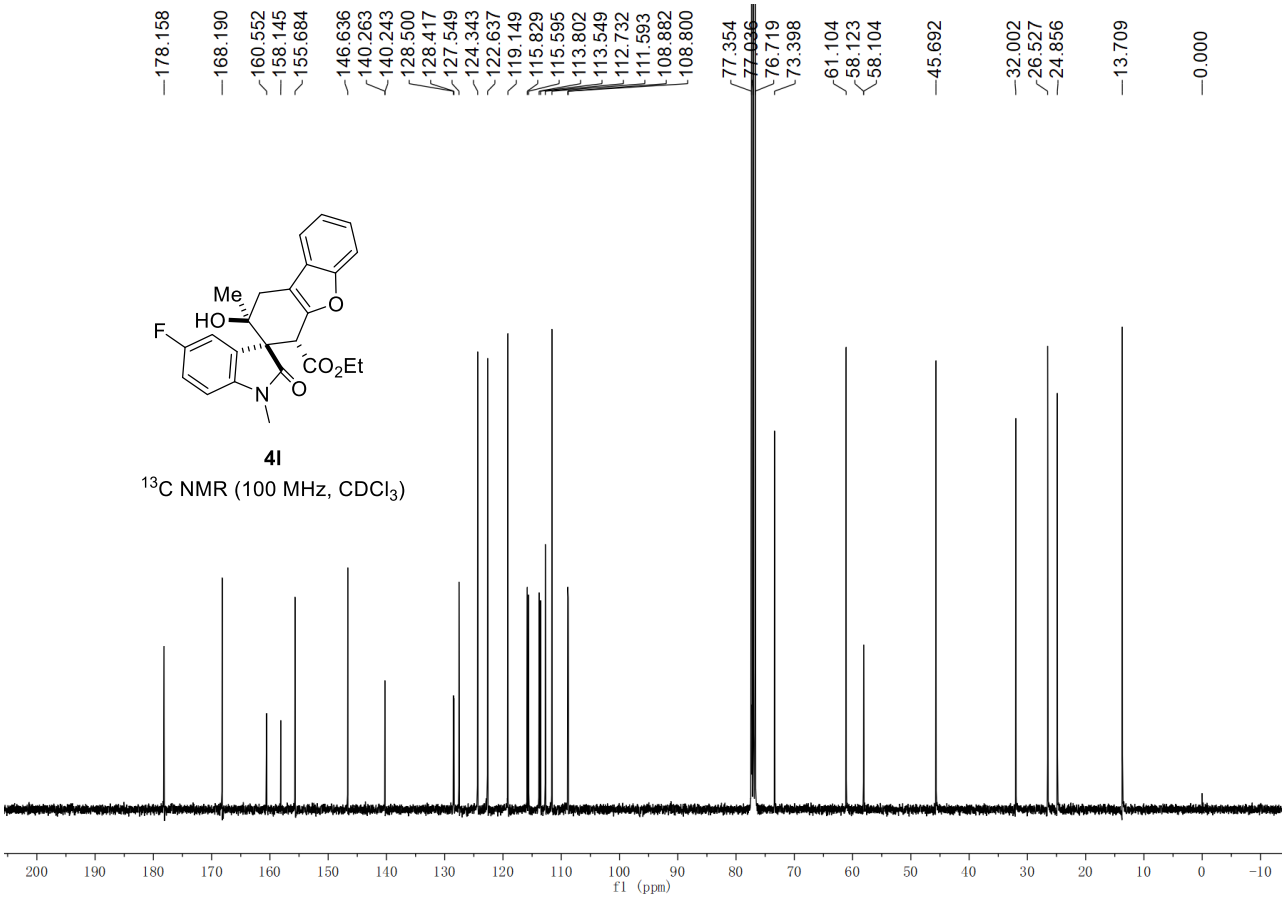
Calcd for $C_{29}H_{25}NO_5Na^+$ 490.1625





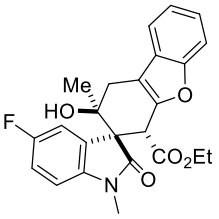
4l

^{1}H NMR (400 MHz, $CDCl_3$)



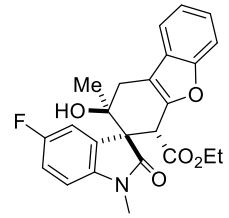
4l

^{13}C NMR (100 MHz, $CDCl_3$)



4l

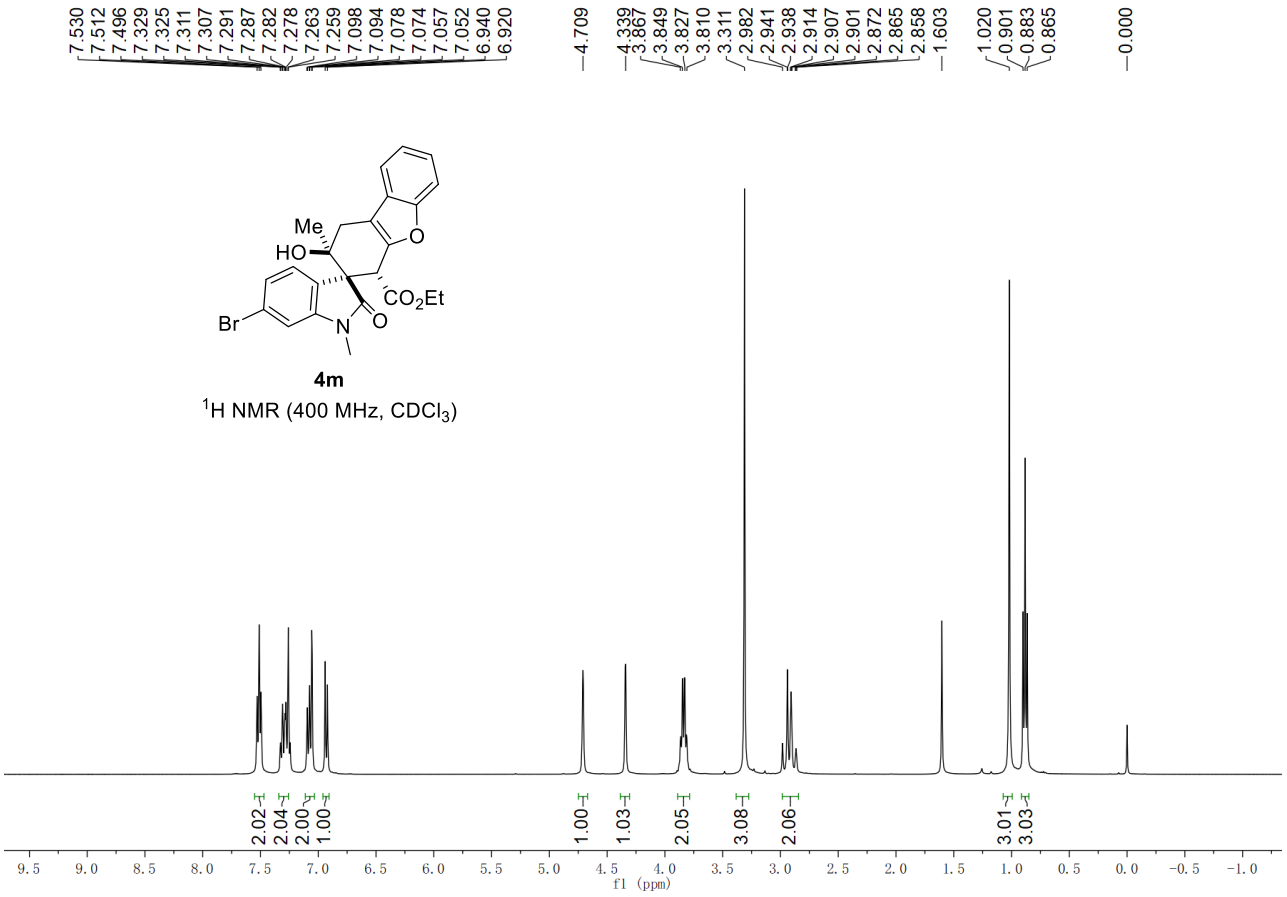
^{19}F NMR (375 MHz, $CDCl_3$)



4l

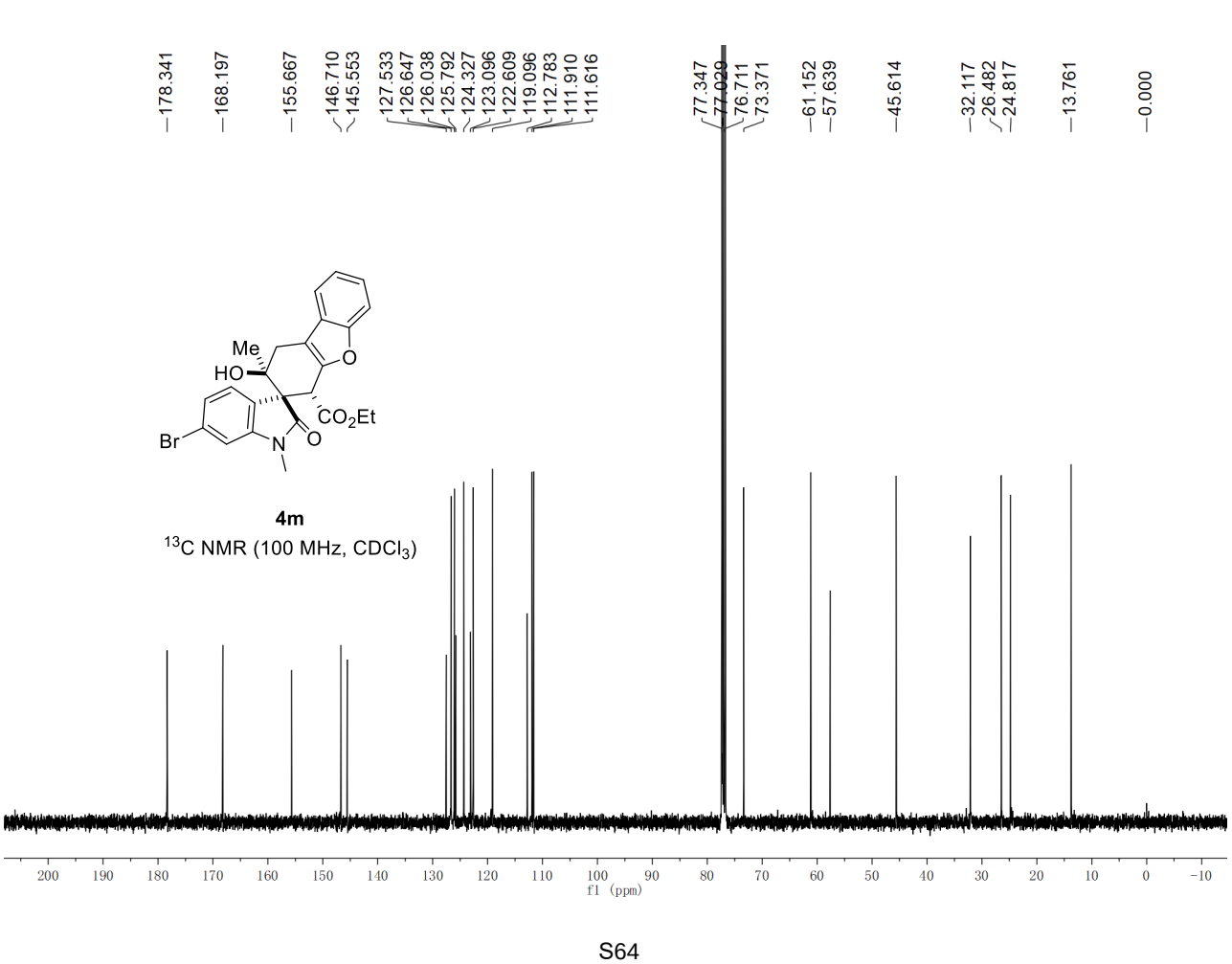
(ESI-TOF) m/z: $[M + Na]^+$

Calcd for $C_{24}H_{22}FNO_5Na^+$ 446.1374



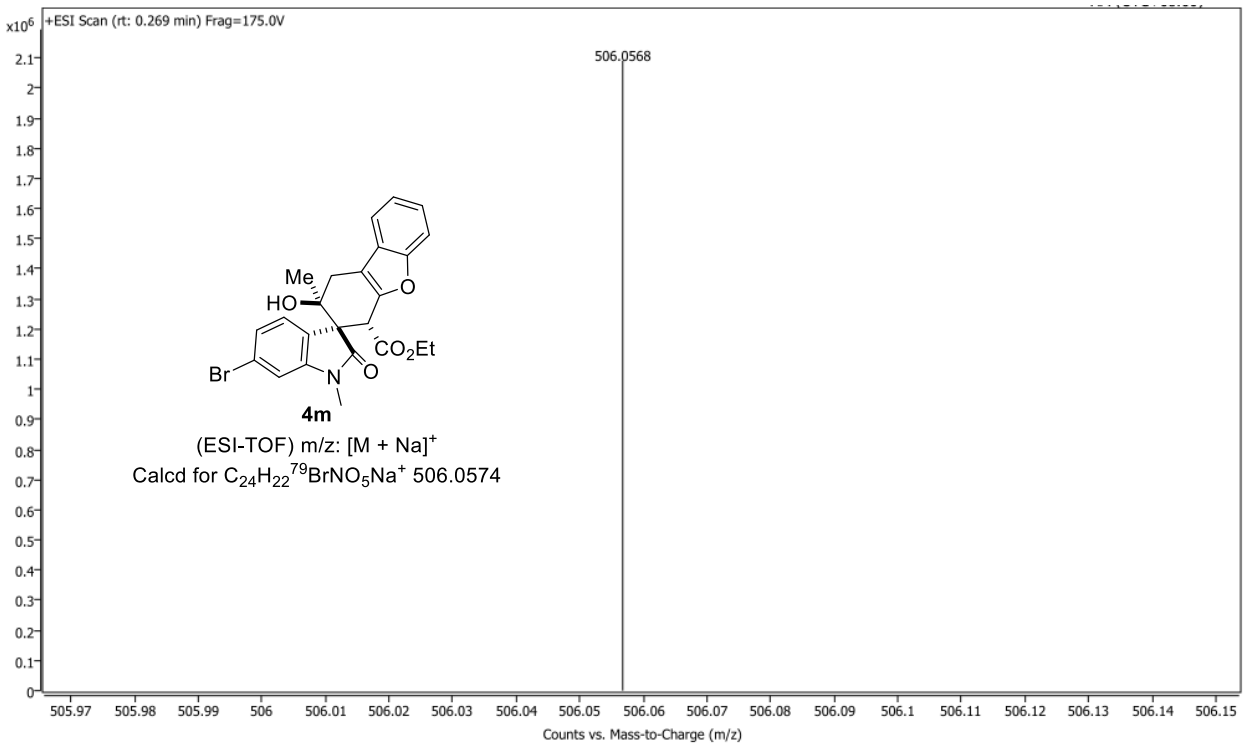
4m

^{1}H NMR (400 MHz, $CDCl_3$)



4m

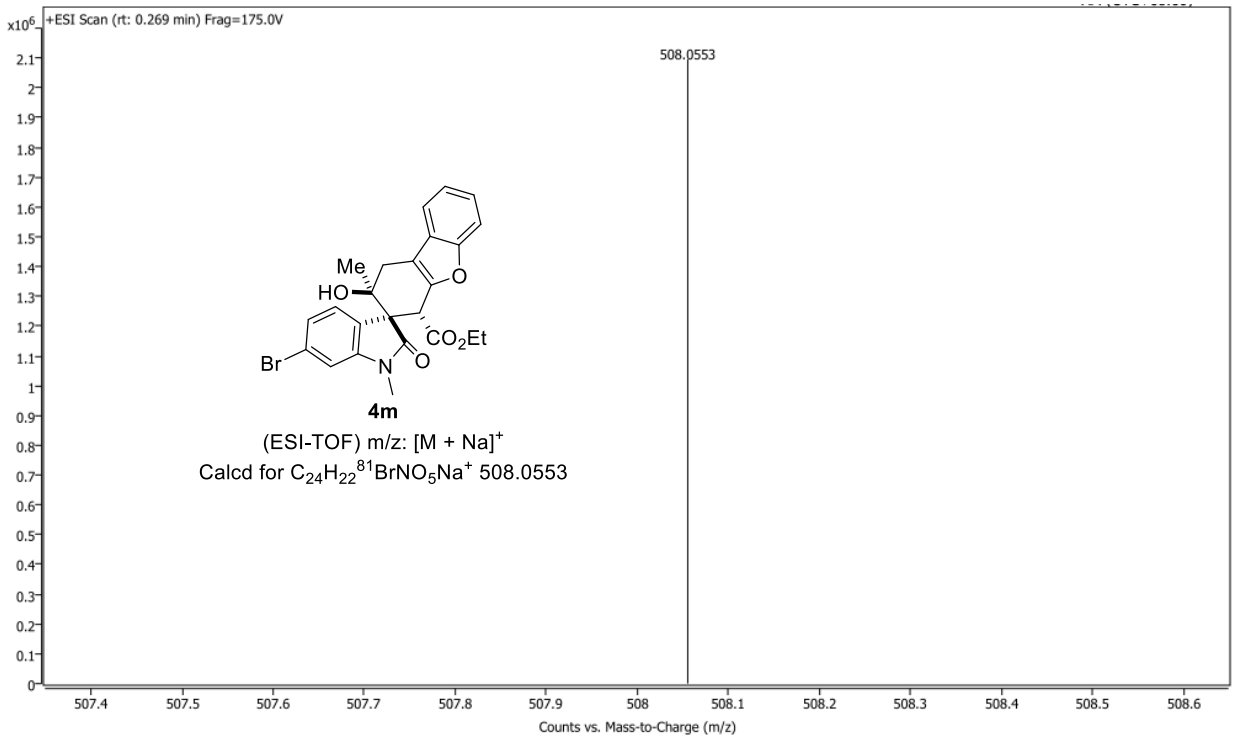
^{13}C NMR (100 MHz, $CDCl_3$)



4m

(ESI-TOF) m/z: $[M + Na]^+$

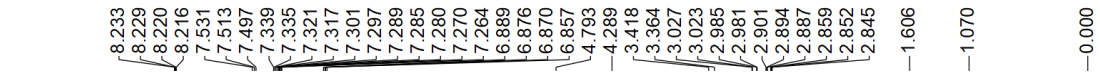
Calcd for $C_{24}H_{22}{}^{79}BrNO_5Na^+$ 506.0574



4m

(ESI-TOF) m/z: $[M + Na]^+$

Calcd for $C_{24}H_{22}{}^{81}BrNO_5Na^+$ 508.0553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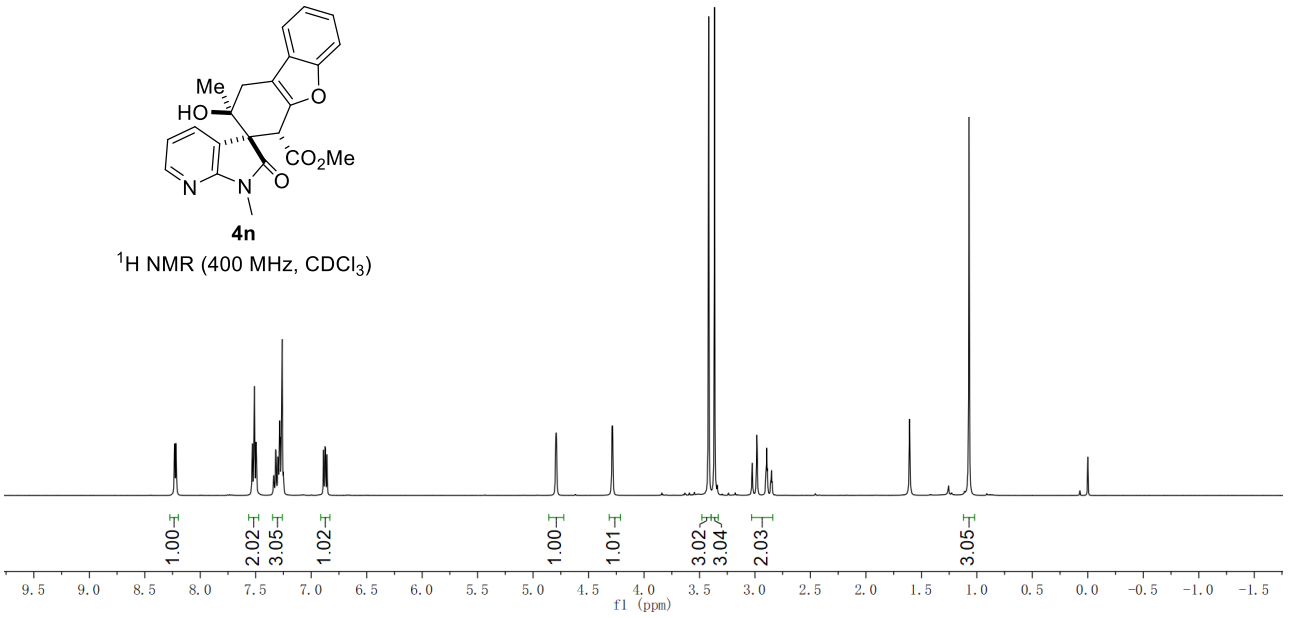
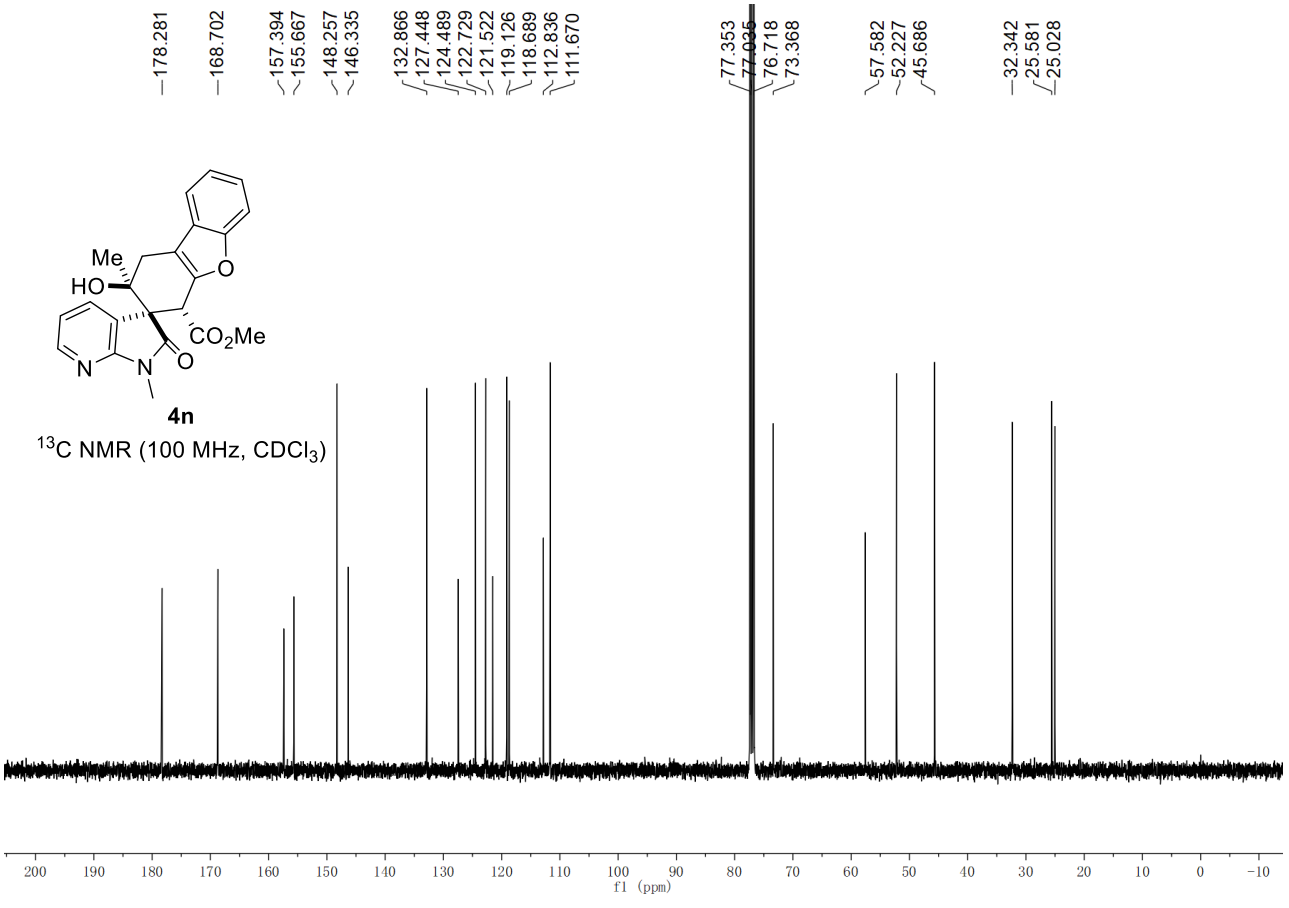
8.229
8.220
8.216
7.531
7.513
7.497
7.339
7.335
7.321
7.317
7.301
7.297
7.289
7.285
7.280
7.270
7.264
6.889
6.876
6.870
6.857
4.793
4.289
3.418
3.364
3.027
3.023
2.985
2.981
2.901
2.894
2.887
2.859
2.852
2.845
1.606
1.070
0.000


Me
HO
O
CO2Me
N
N
O
4n
1H NMR (400 MHz, CDCl3)
1.00
2.02
3.05
1.02
1.00
1.01
3.02
3.04
2.03
3.05
f1 (ppm)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157.394
155.667
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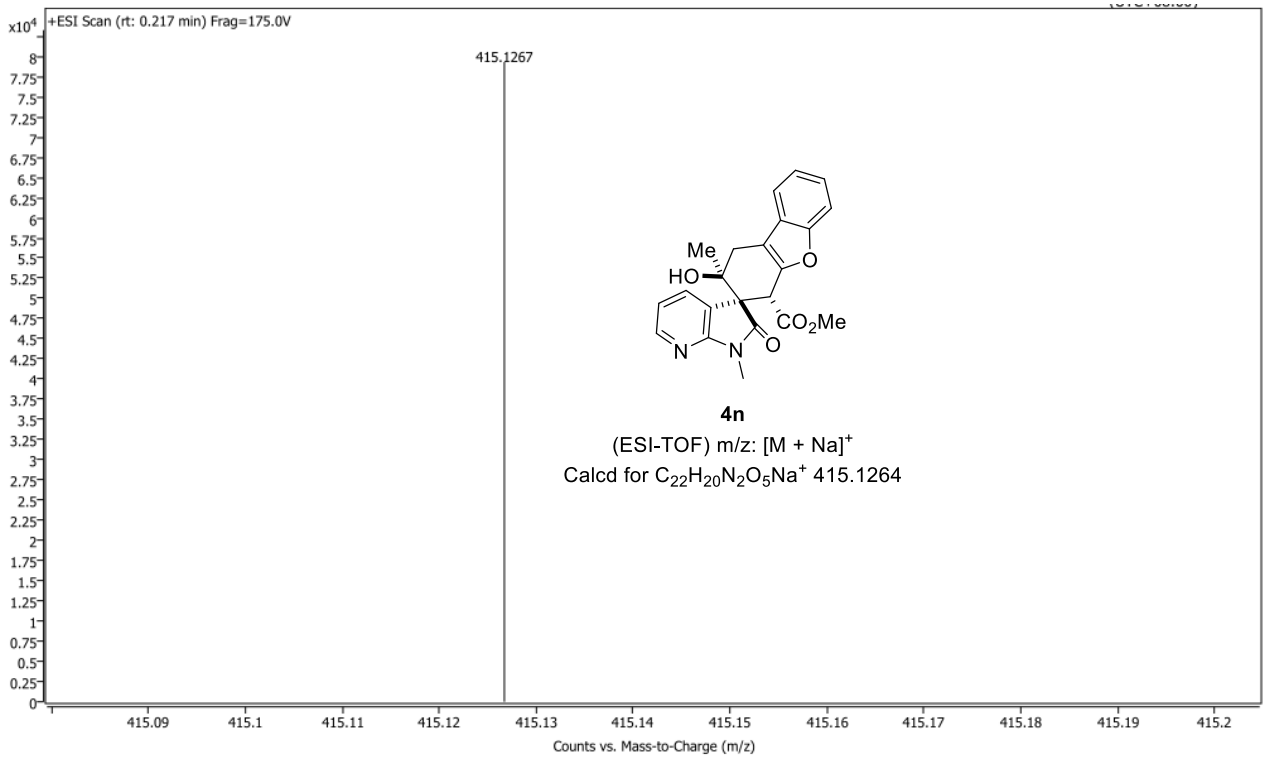
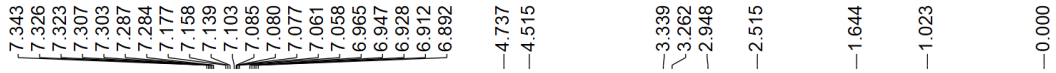
132.866
127.448
124.489
122.729
121.522
119.126
118.689
112.836
111.670
77.353
77.036
76.718
73.368
57.582
52.227
45.686
32.342
25.581
25.028
Me
HO
O
CO2Me
N
N
O
4n
13C NMR (100 MHz, CDCl3)
f1 (ppm)

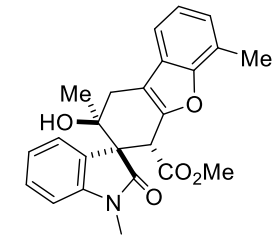


4n

(ESI-TOF) m/z: $[M + Na]^+$

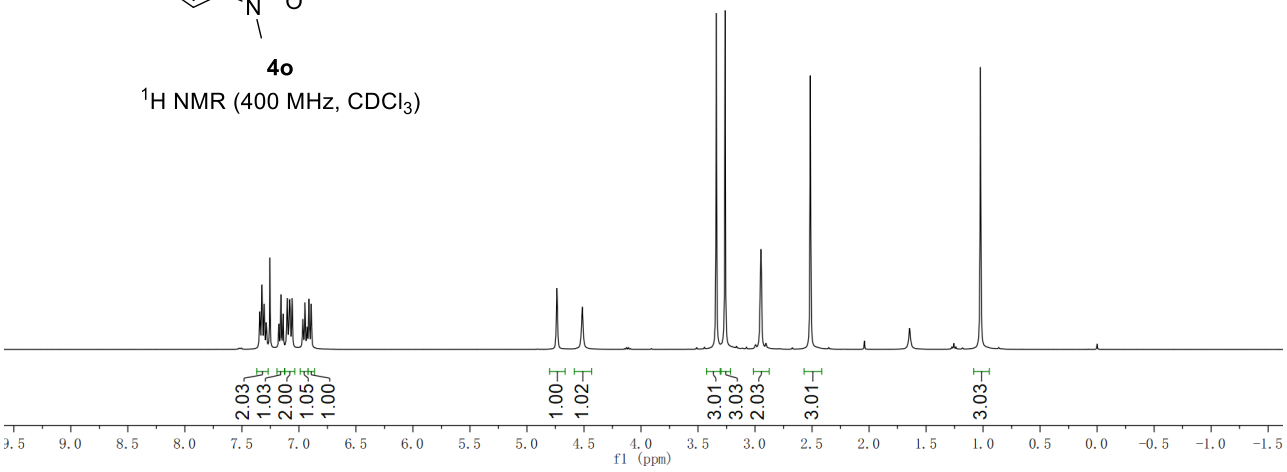
Calcd for $C_{22}H_{20}N_2O_5Na^+$ 415.1264

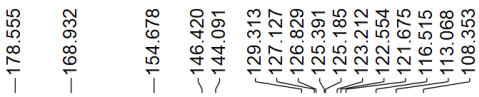


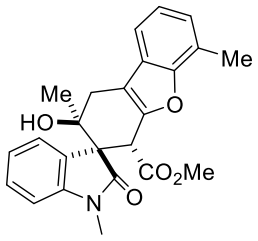


4o

^{1}H NMR (400 MHz, $CDCl_3$)

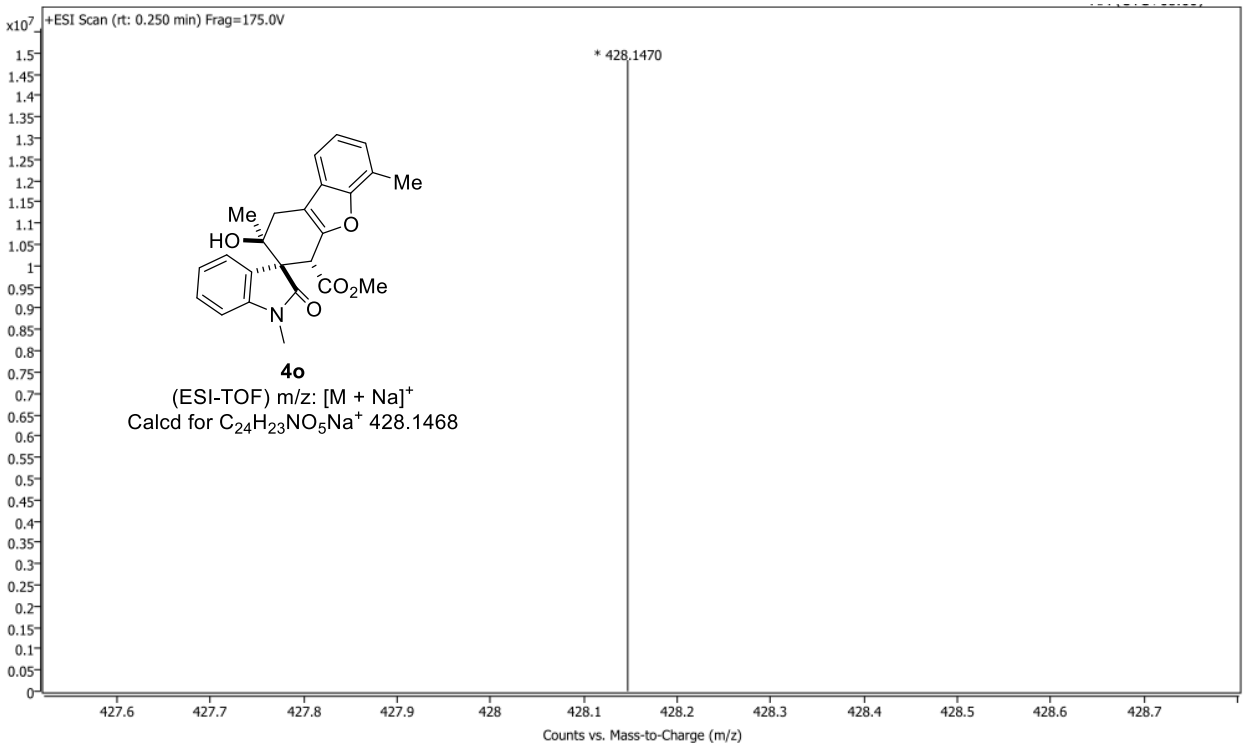






4o

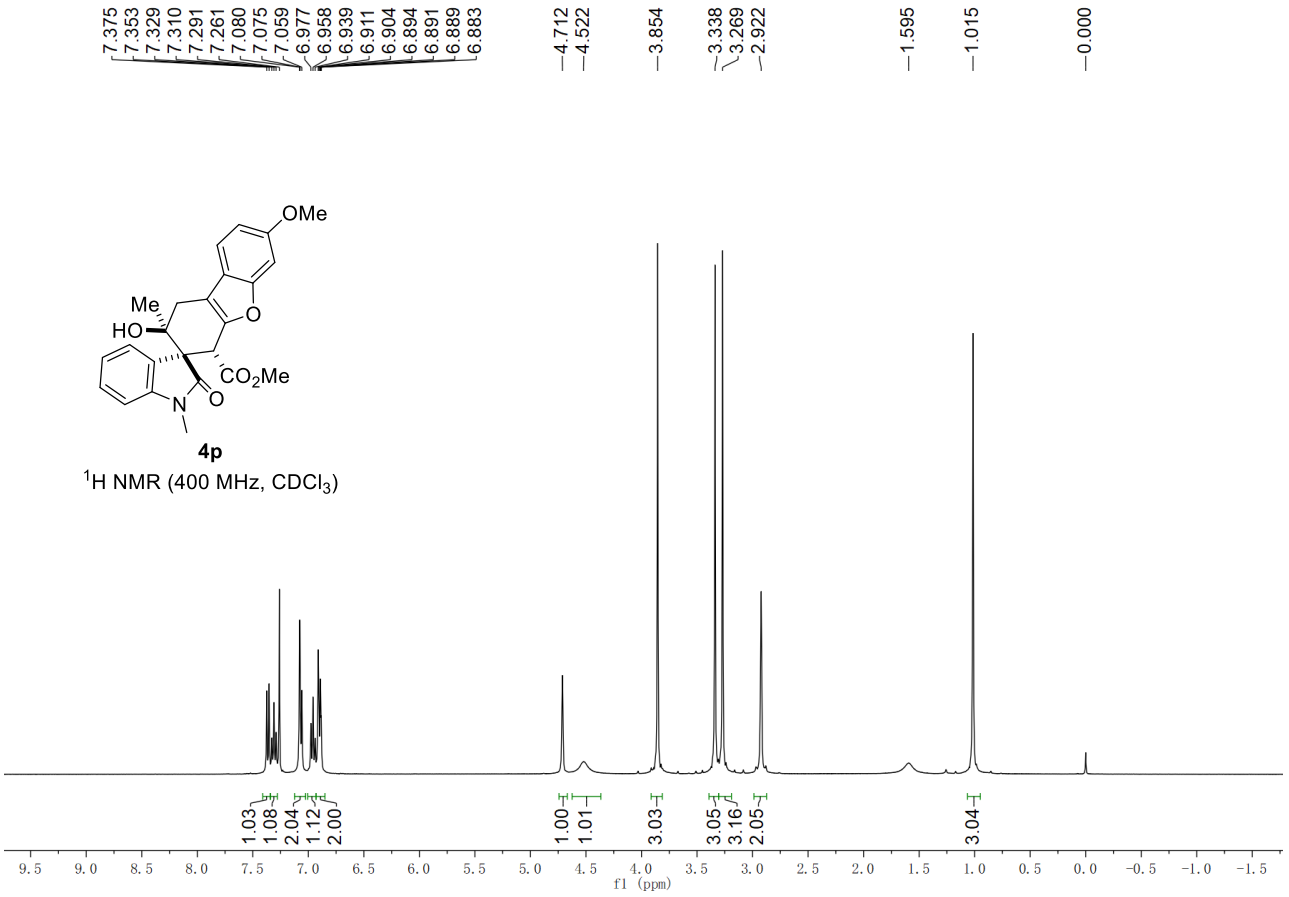
^{13}C NMR (150 MHz, $CDCl_3$)



4o

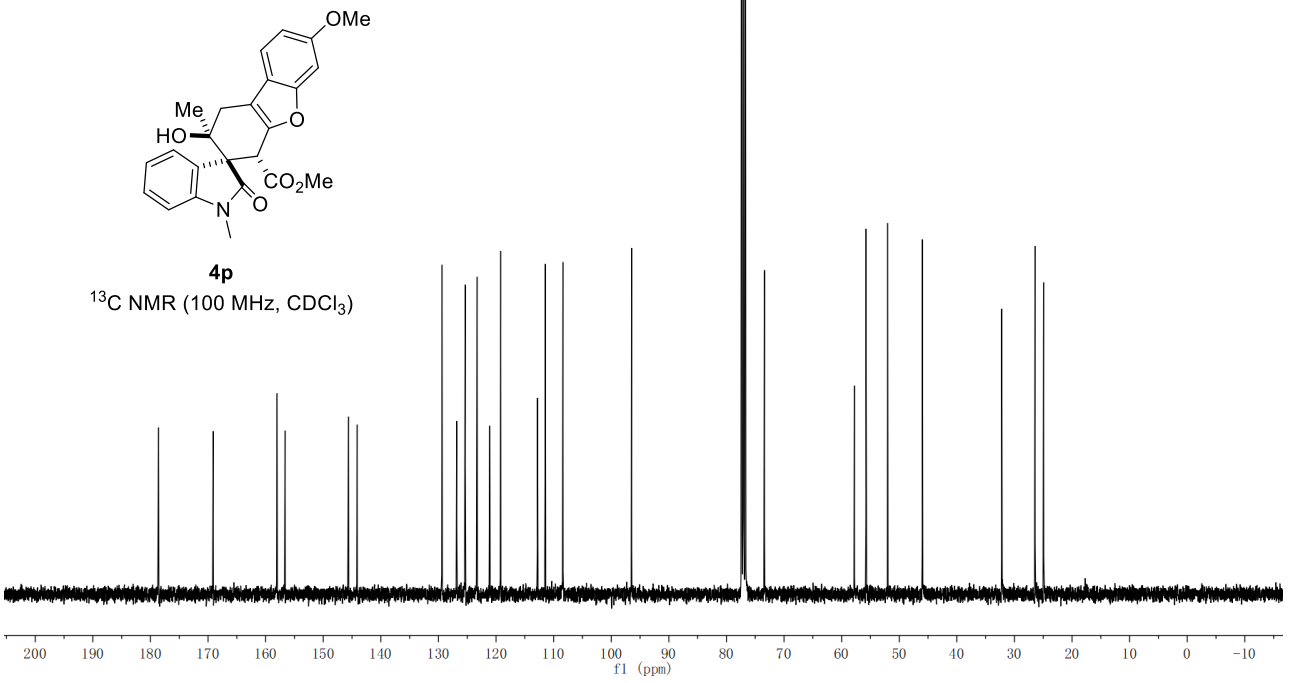
(ESI-TOF) m/z: $[M + Na]^+$

Calcd for $C_{24}H_{23}NO_5Na^+$ 428.1468



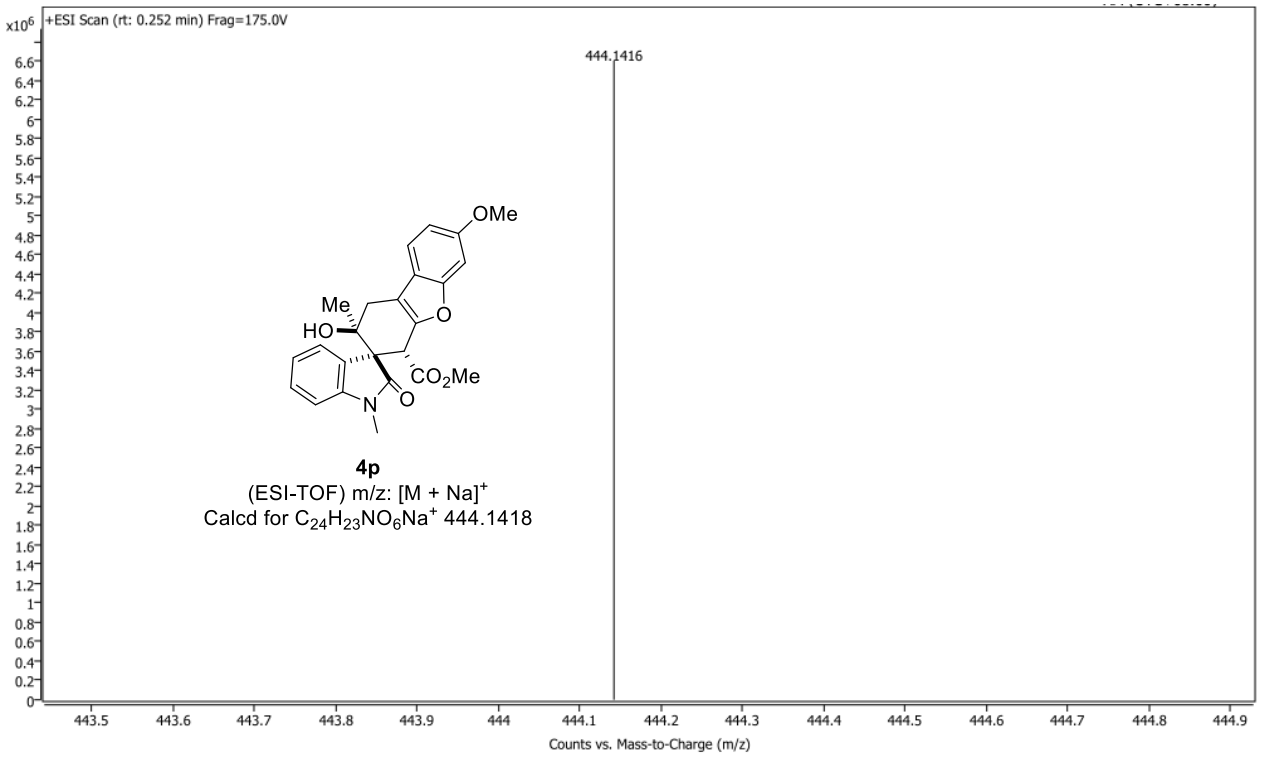
4p

^{1}H NMR (400 MHz, $CDCl_3$)



4p

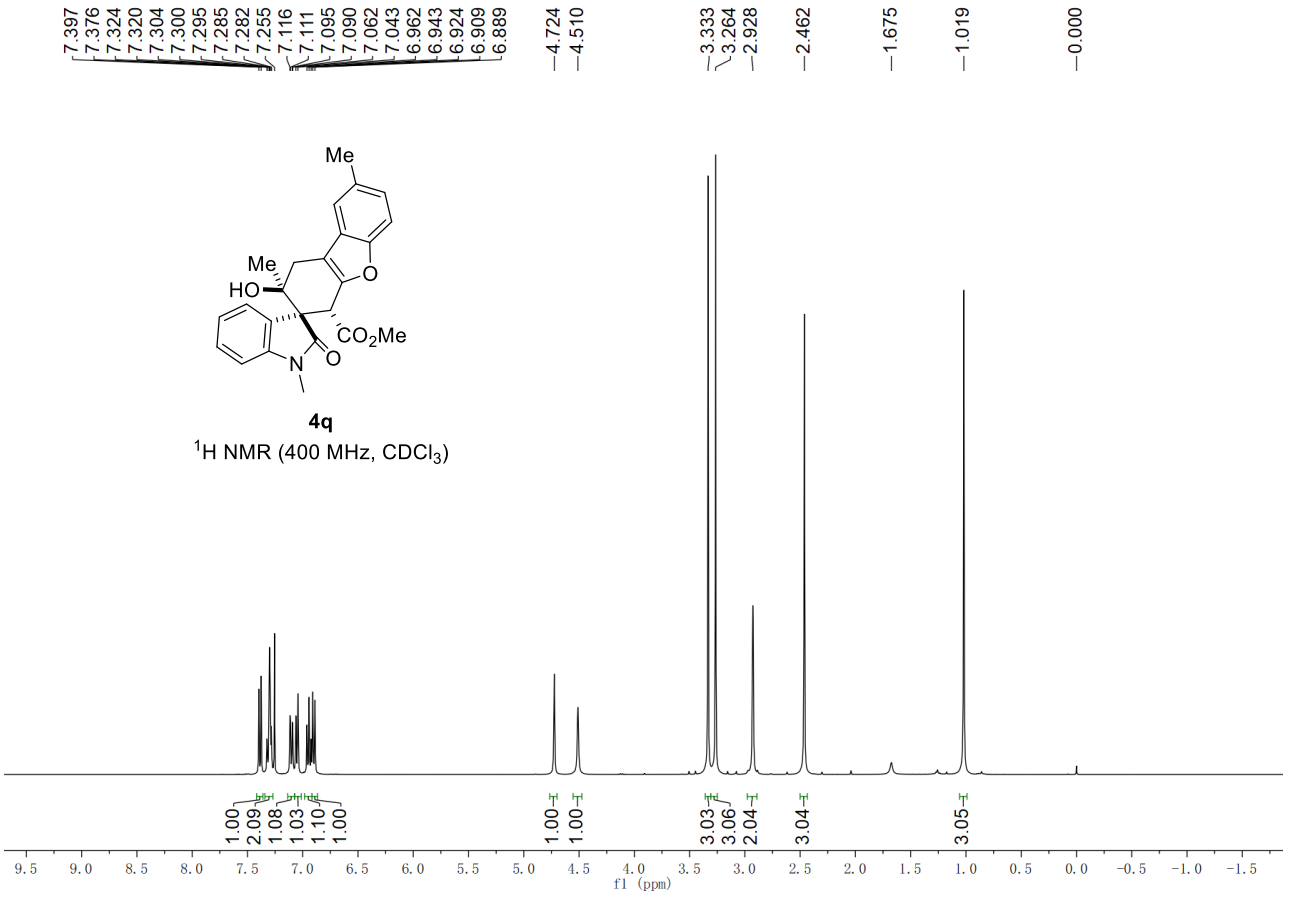
^{13}C NMR (100 MHz, $CDCl_3$)



4p

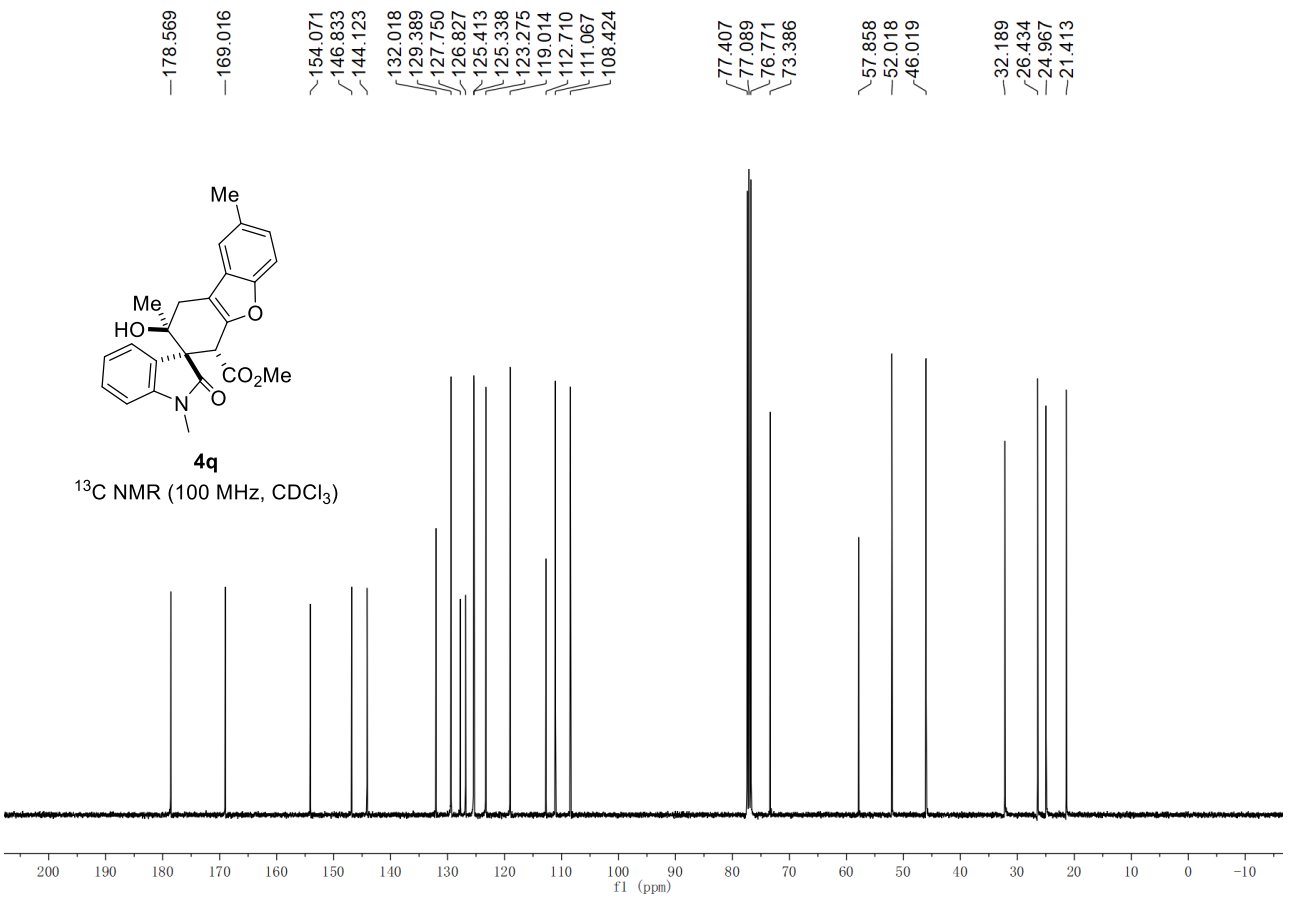
(ESI-TOF) m/z: $[M + Na]^+$

Calcd for $C_{24}H_{23}NO_6Na^+$ 444.1418



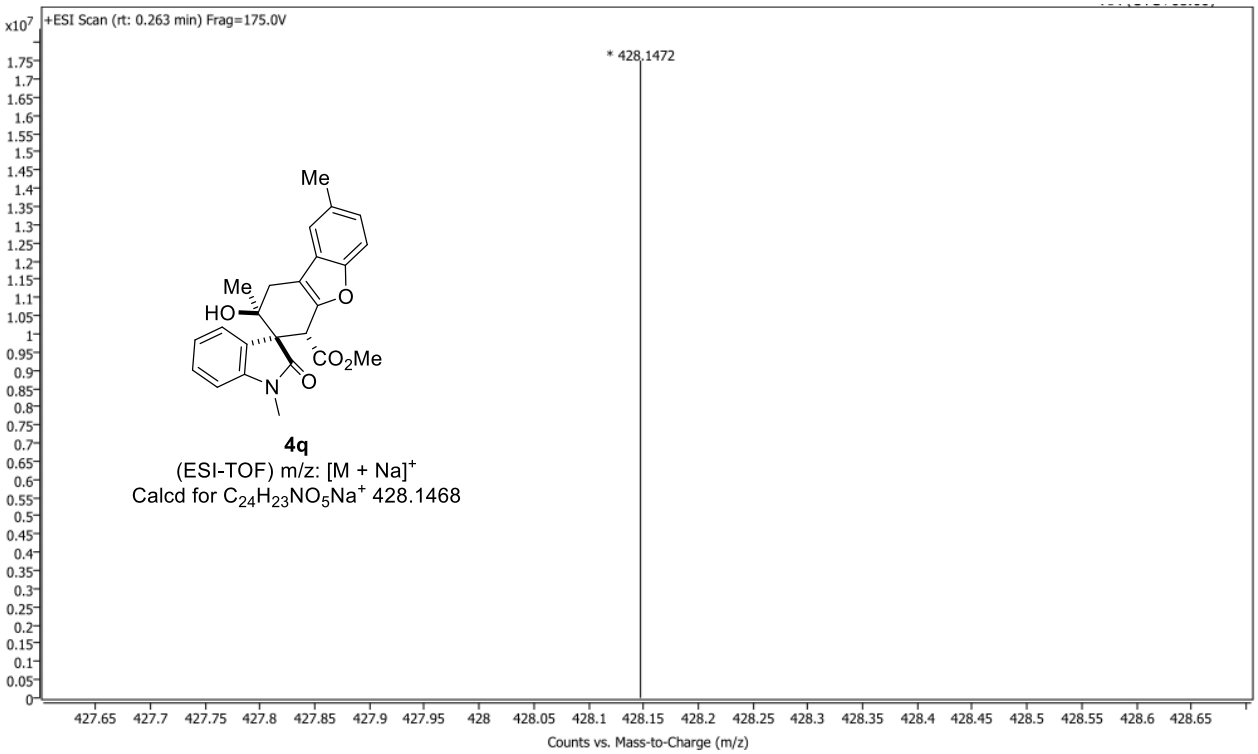
4q

^{1}H NMR (400 MHz, $CDCl_3$)



4q

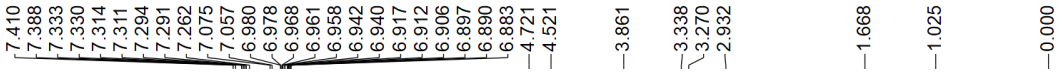
^{13}C NMR (100 MHz, $CDCl_3$)

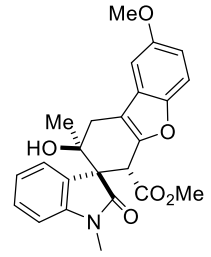


4q

(ESI-TOF) m/z: $[M + Na]^+$

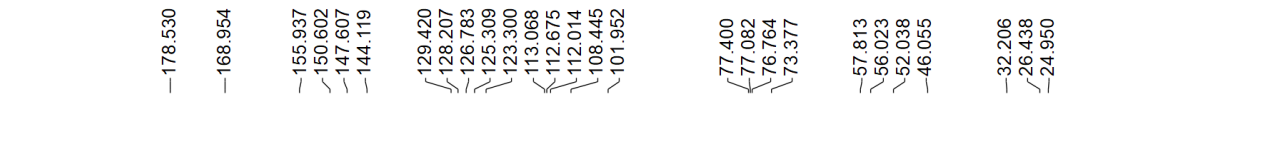
Calcd for $C_{24}H_{23}NO_5Na^+$ 428.1468

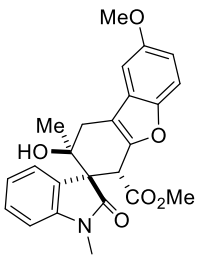




4r

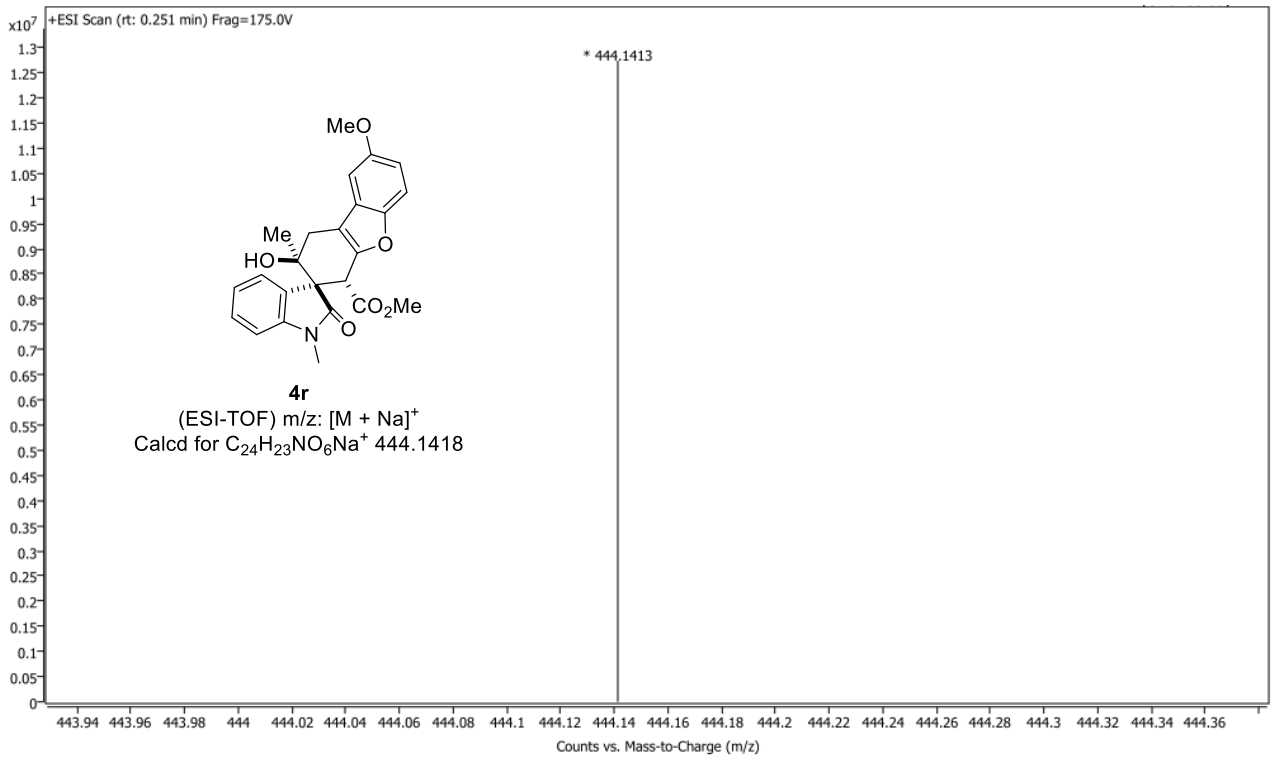
^{1}H NMR (400 MHz, $CDCl_3$)





4r

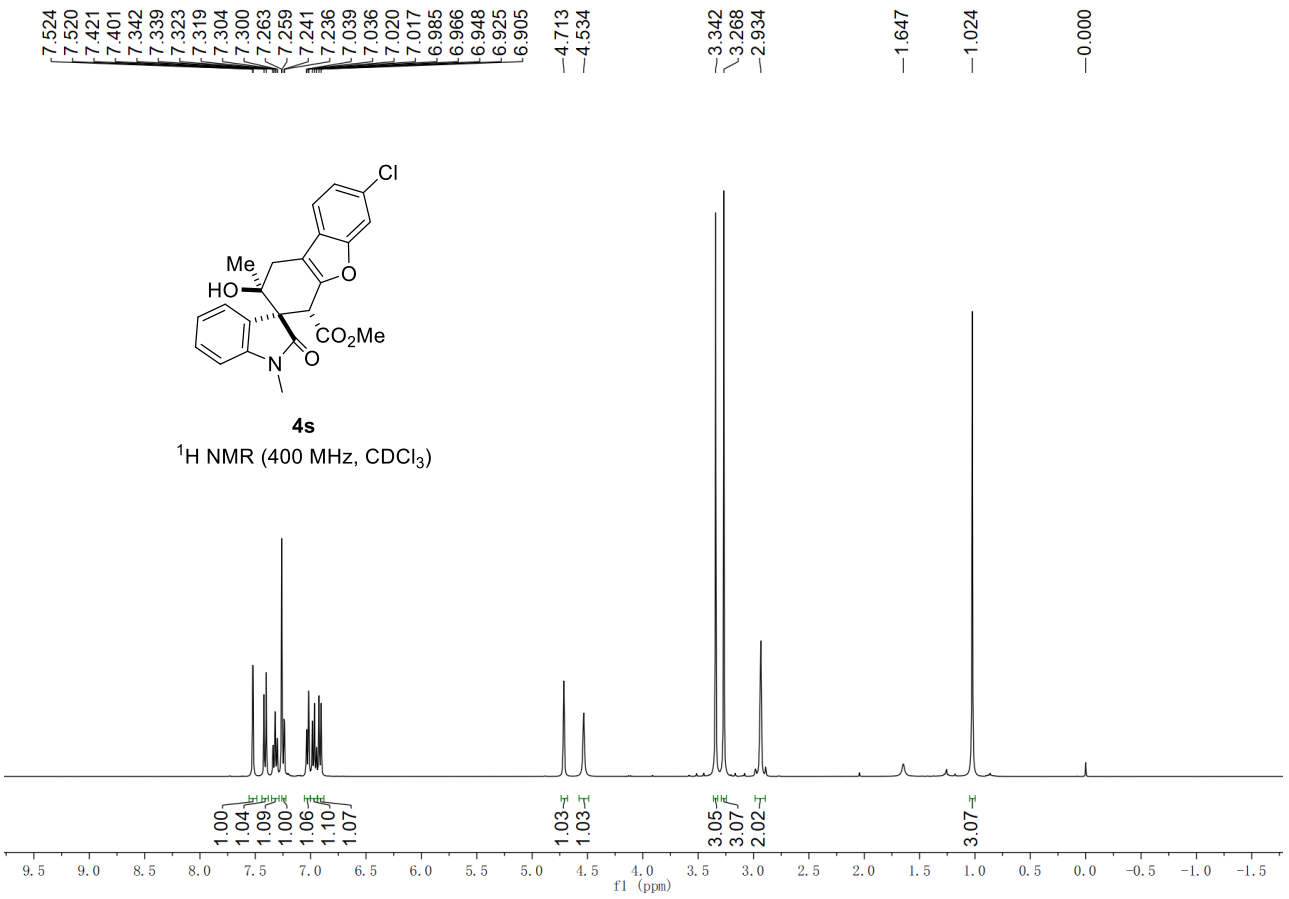
^{13}C NMR (100 MHz, $CDCl_3$)



4r

(ESI-TOF) m/z: $[M + Na]^+$

Calcd for $C_{24}H_{23}NO_6Na^+$ 444.1418


7.524
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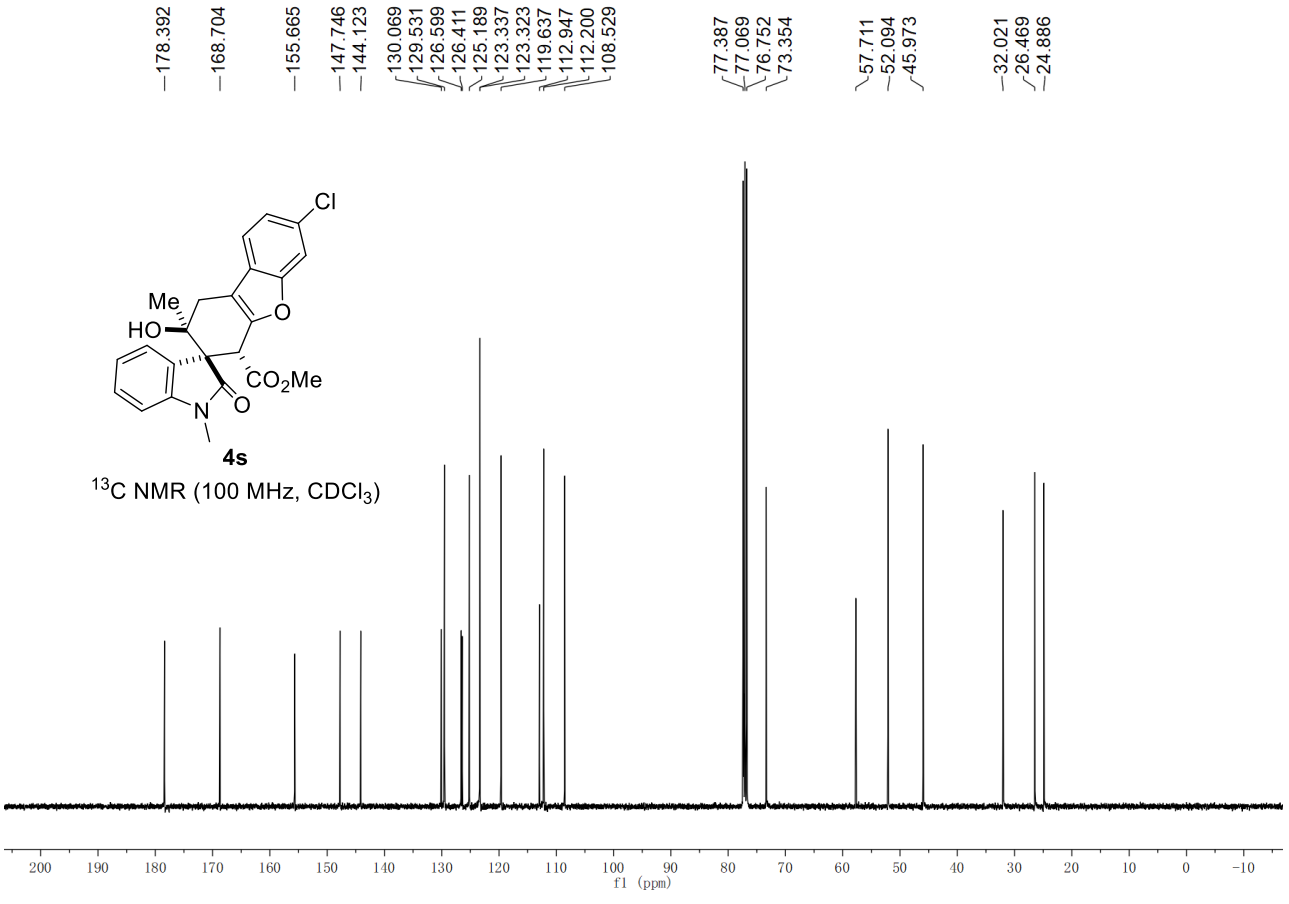
7.342
7.339
7.323
7.319
7.304
7.300
7.263
7.259
7.241
7.236
7.039
7.036
7.020
7.017
6.985
6.966
6.948
6.925
6.905
4.713
4.534
3.342
3.268
2.934
1.647
1.024
0.000
Cl
Me
HO
O
CO2Me
N
O
4s
1H NMR (400 MHz, CDCl3)
1.00
1.04
1.09
1.00
1.06
1.10
1.07
1.03
1.03
3.05
3.07
2.02
3.07
f1 (ppm)


178.392
168.704
155.665
147.746
144.123
130.069
129.531
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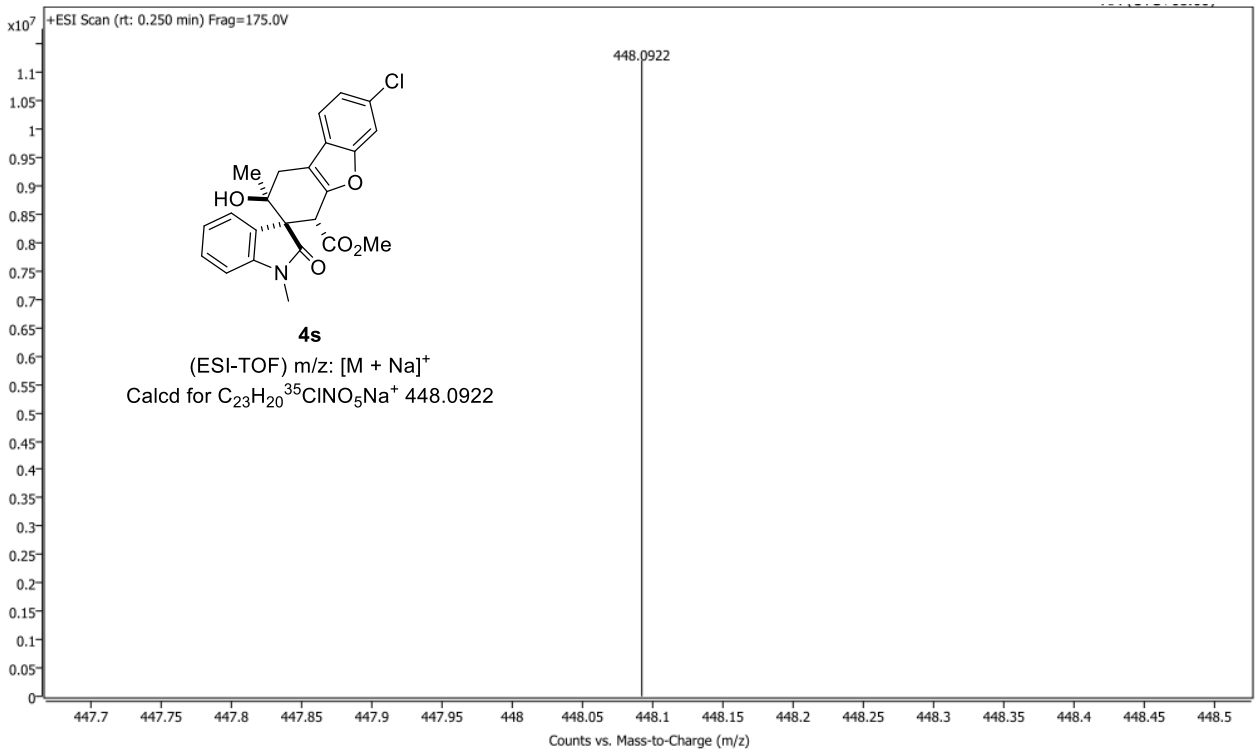
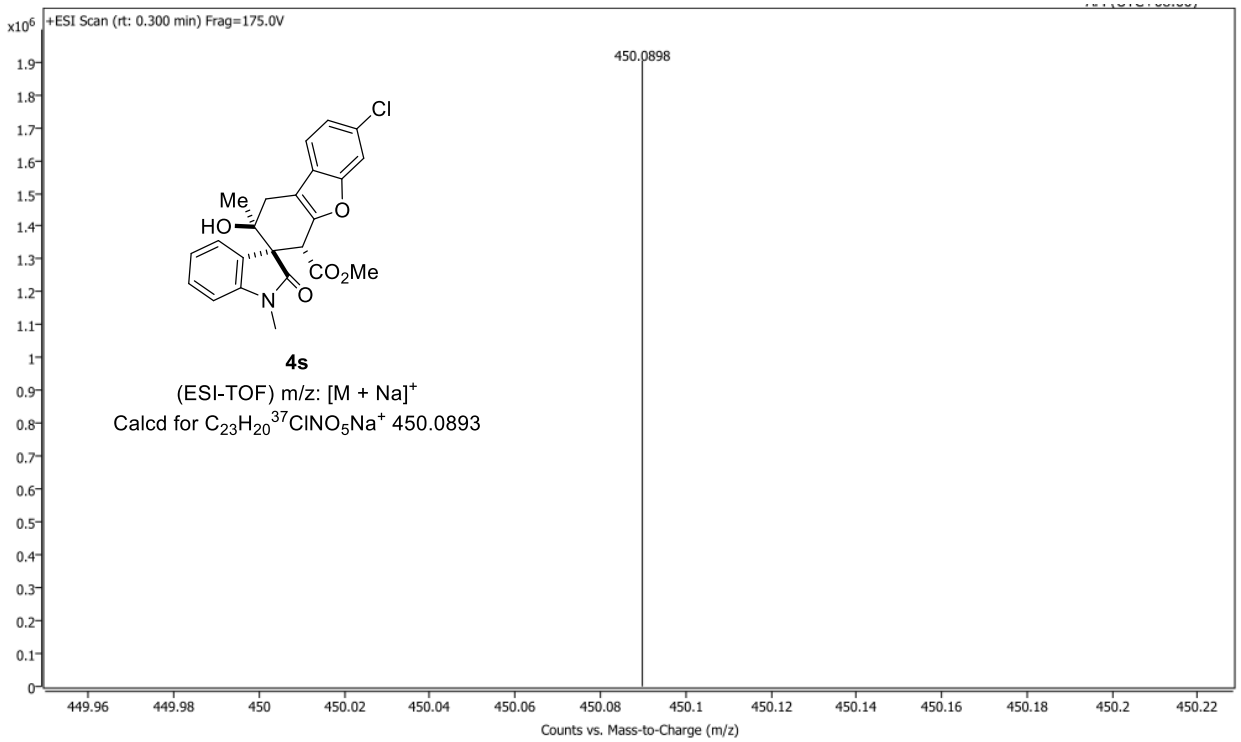
125.189
123.337
123.323
119.637
112.947
112.200
108.529
77.387
77.069
76.752
73.354
57.711
52.094
45.973
32.021
26.469
24.886
Cl
Me
HO
O
CO2Me
N
O
4s
13C NMR (100 MHz, CDCl3)
f1 (ppm)



4s

(ESI-TOF) m/z: $[M + Na]^+$

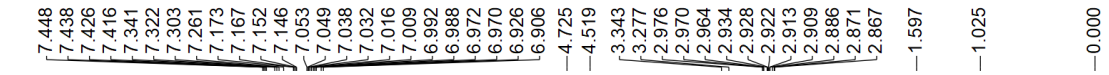
Calcd for $C_{23}H_{20}{}^{35}ClNO_5Na^+$ 448.0922

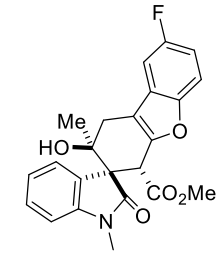


4s

(ESI-TOF) m/z: $[M + Na]^+$

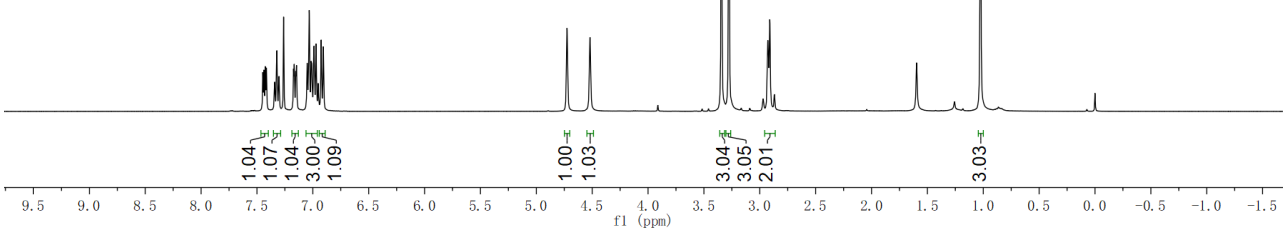
Calcd for $C_{23}H_{20}{}^{37}ClNO_5Na^+$ 450.0893

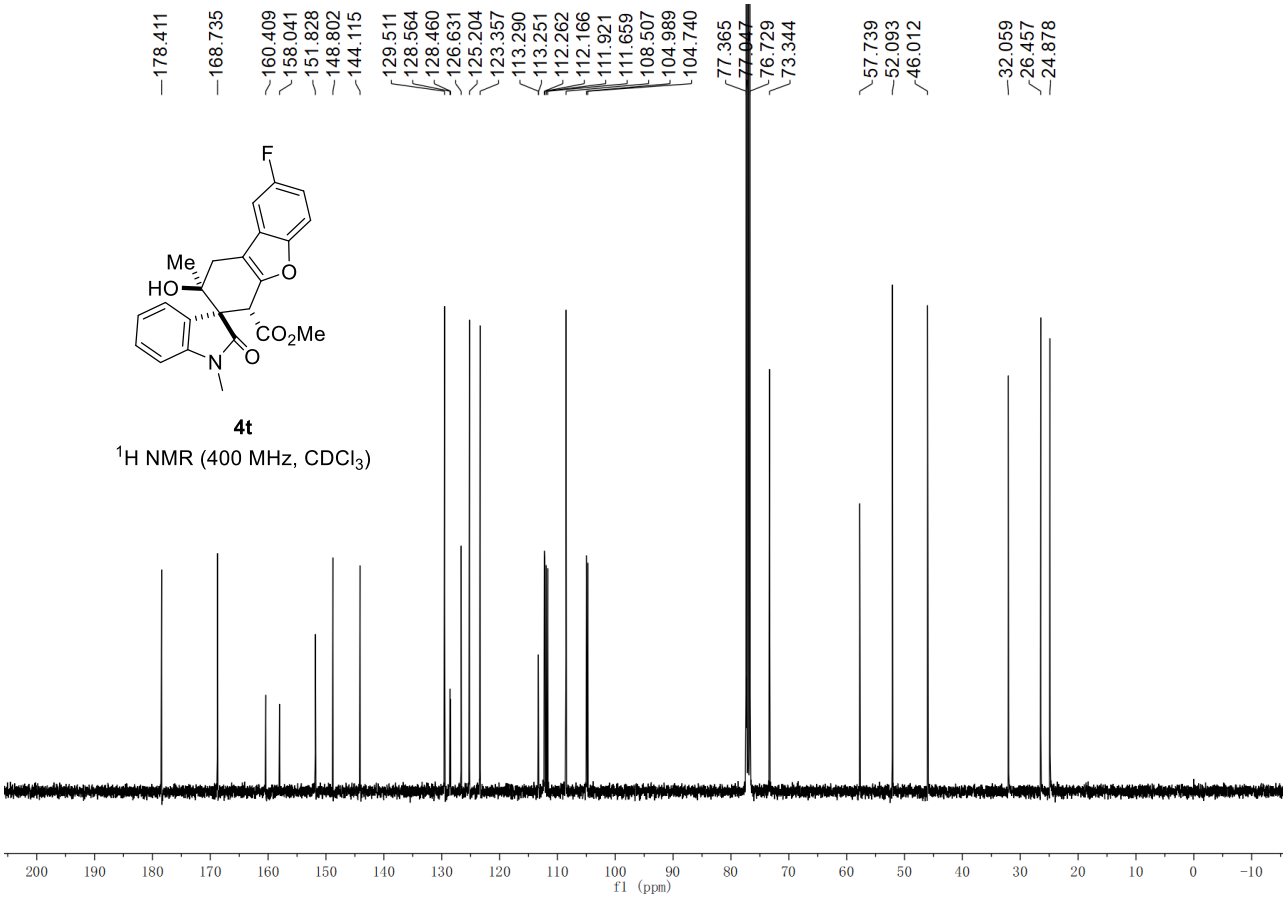




4t

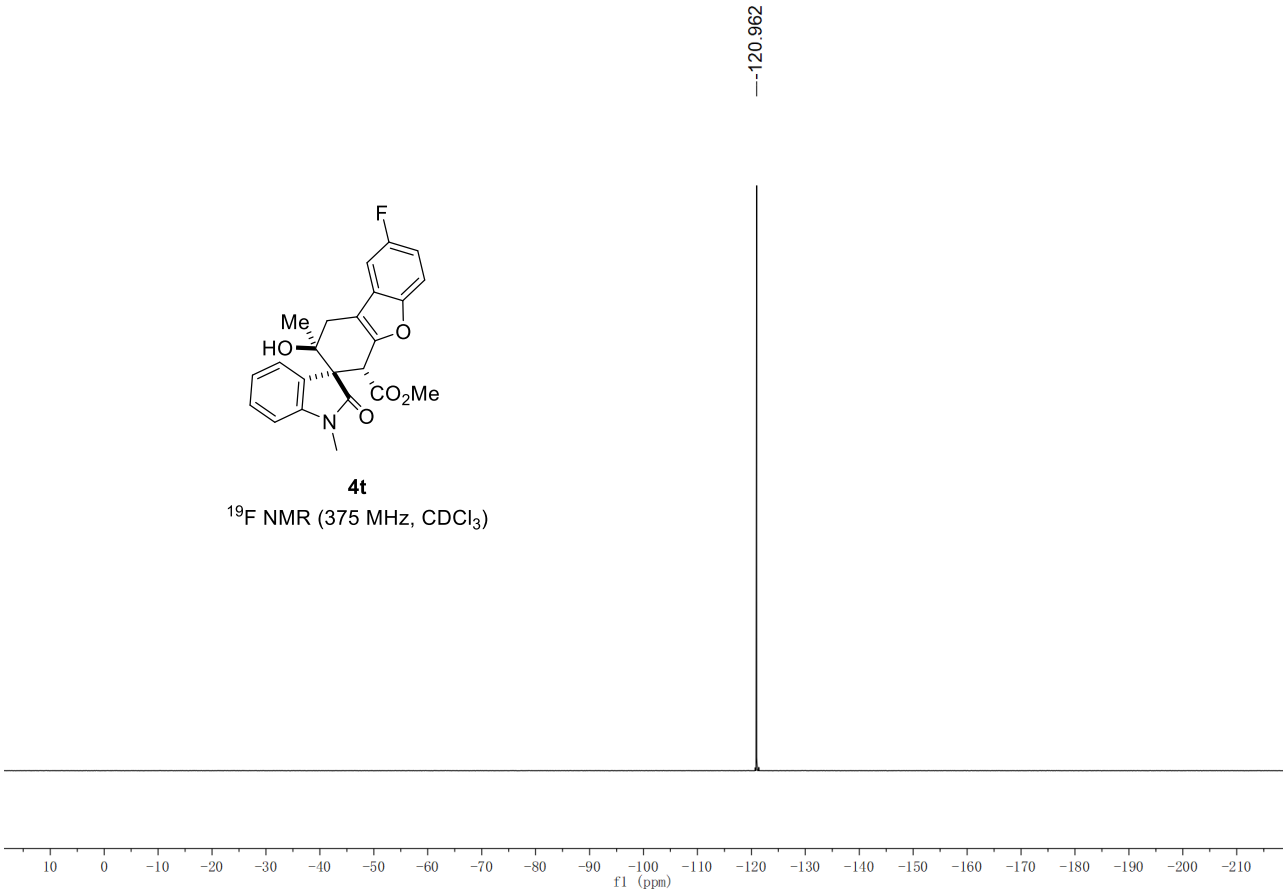
^{1}H NMR (400 MHz, $CDCl_3$)





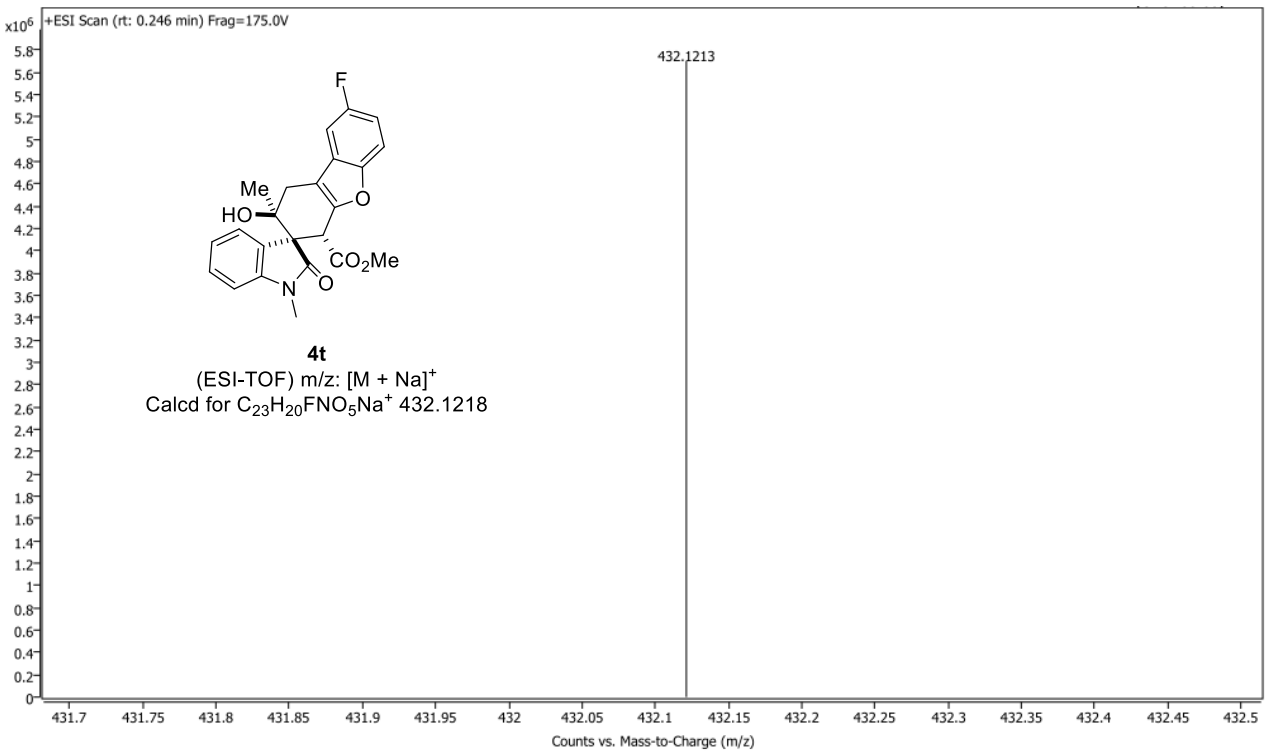
4t

^{1}H NMR (400 MHz, $CDCl_3$)



4t

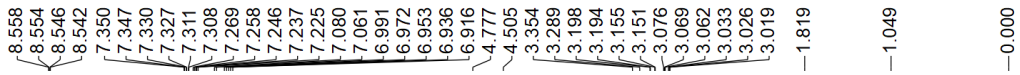
^{19}F NMR (375 MHz, $CDCl_3$)

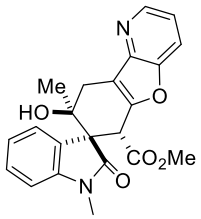


4t

(ESI-TOF) m/z: $[M + Na]^+$

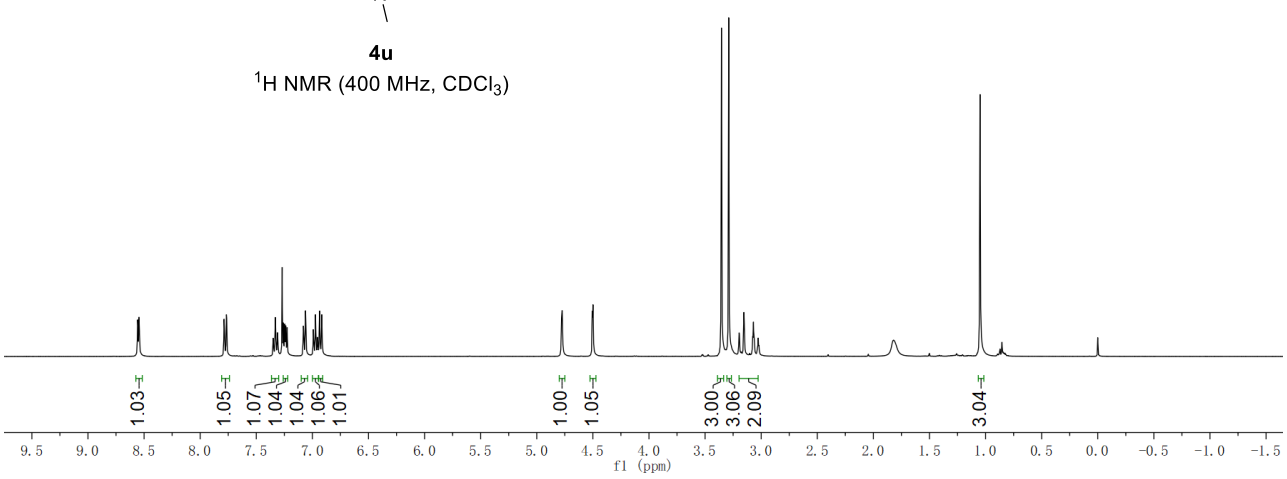
Calcd for $C_{23}H_{20}FNO_5Na^+$ 432.1218

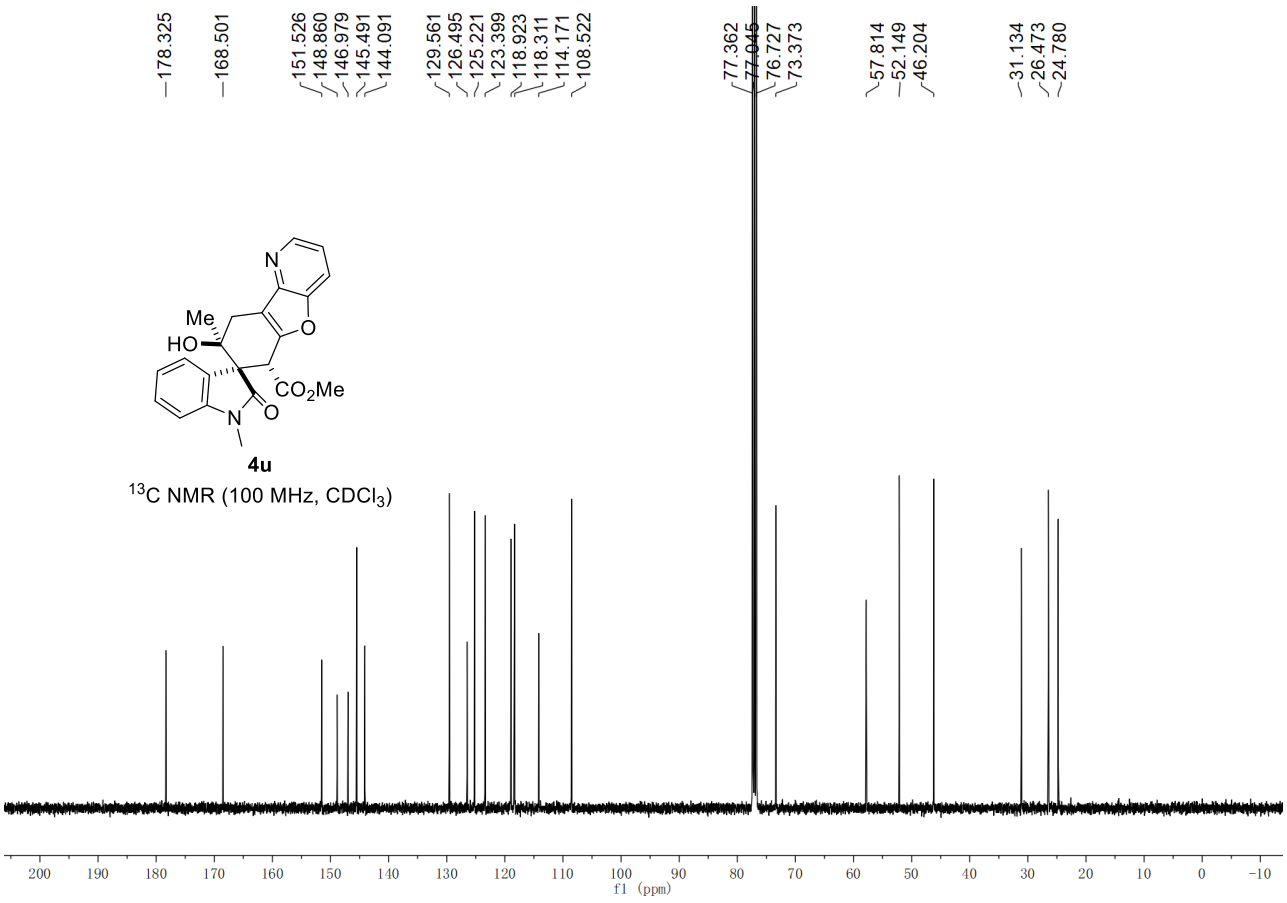




4u

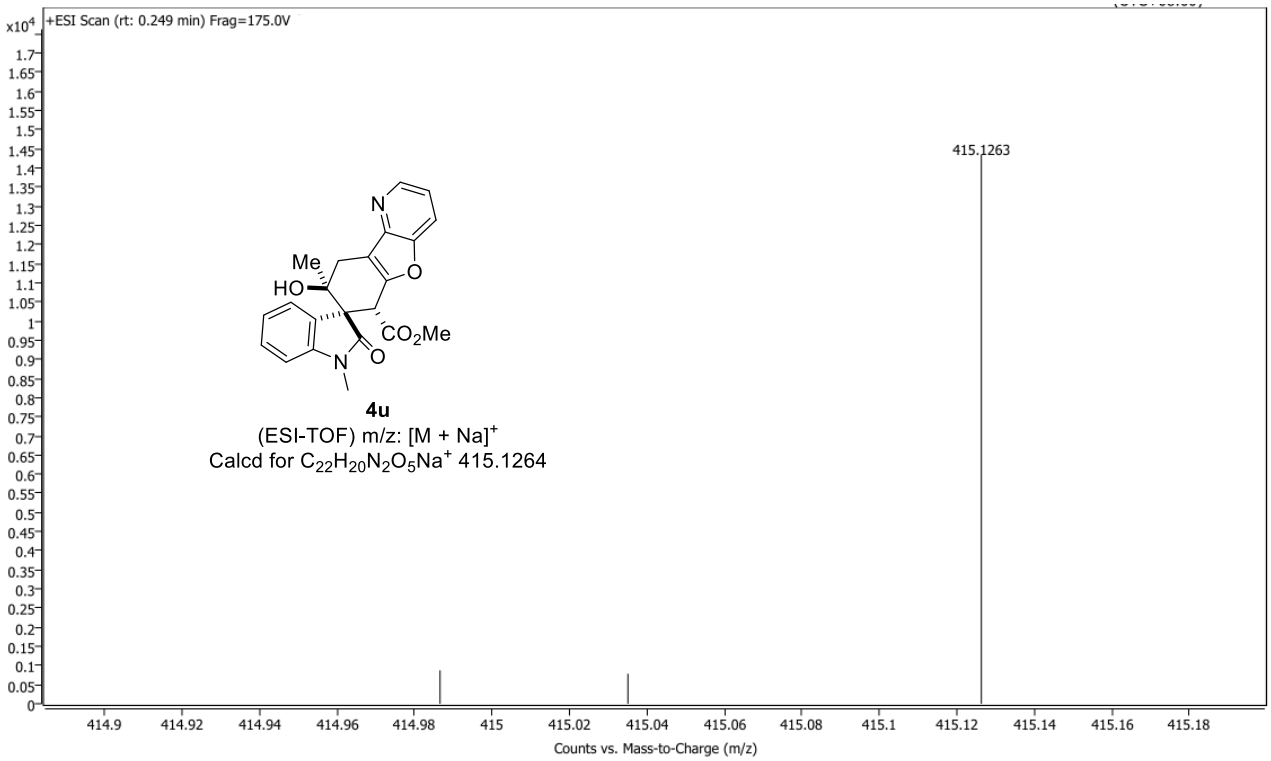
^{1}H NMR (400 MHz, $CDCl_3$)





4u

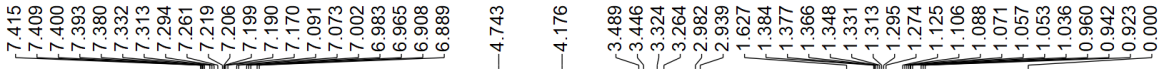
^{13}C NMR (100 MHz, $CDCl_3$)

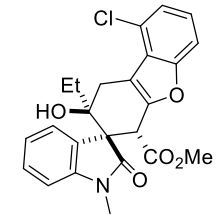


4u

(ESI-TOF) m/z: $[M + Na]^+$

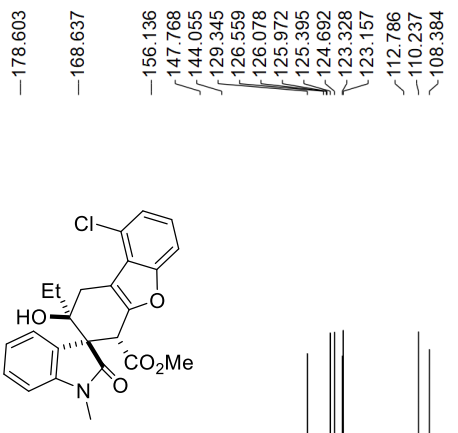
Calcd for $C_{22}H_{20}N_2O_5Na^+$ 415.1264





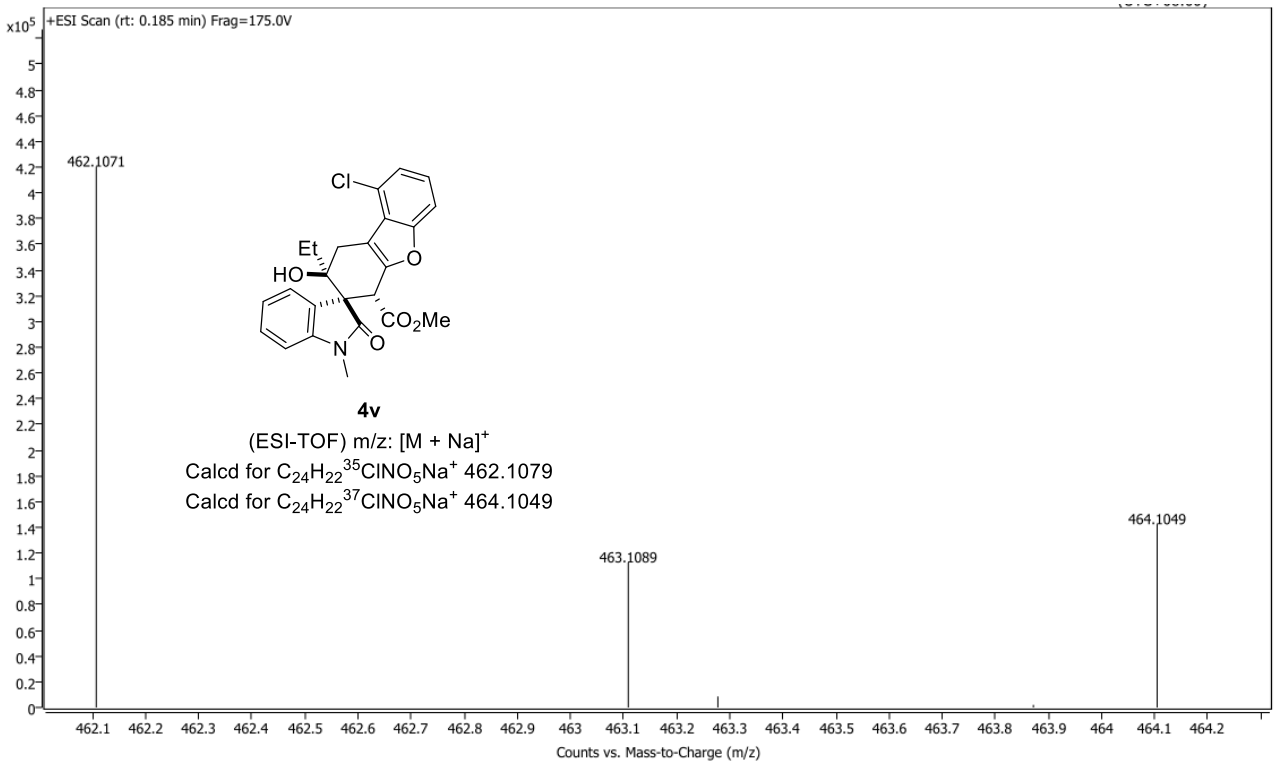
4v

^{1}H NMR (400 MHz, $CDCl_3$)



4v

^{13}C NMR (150 MHz, $CDCl_3$)

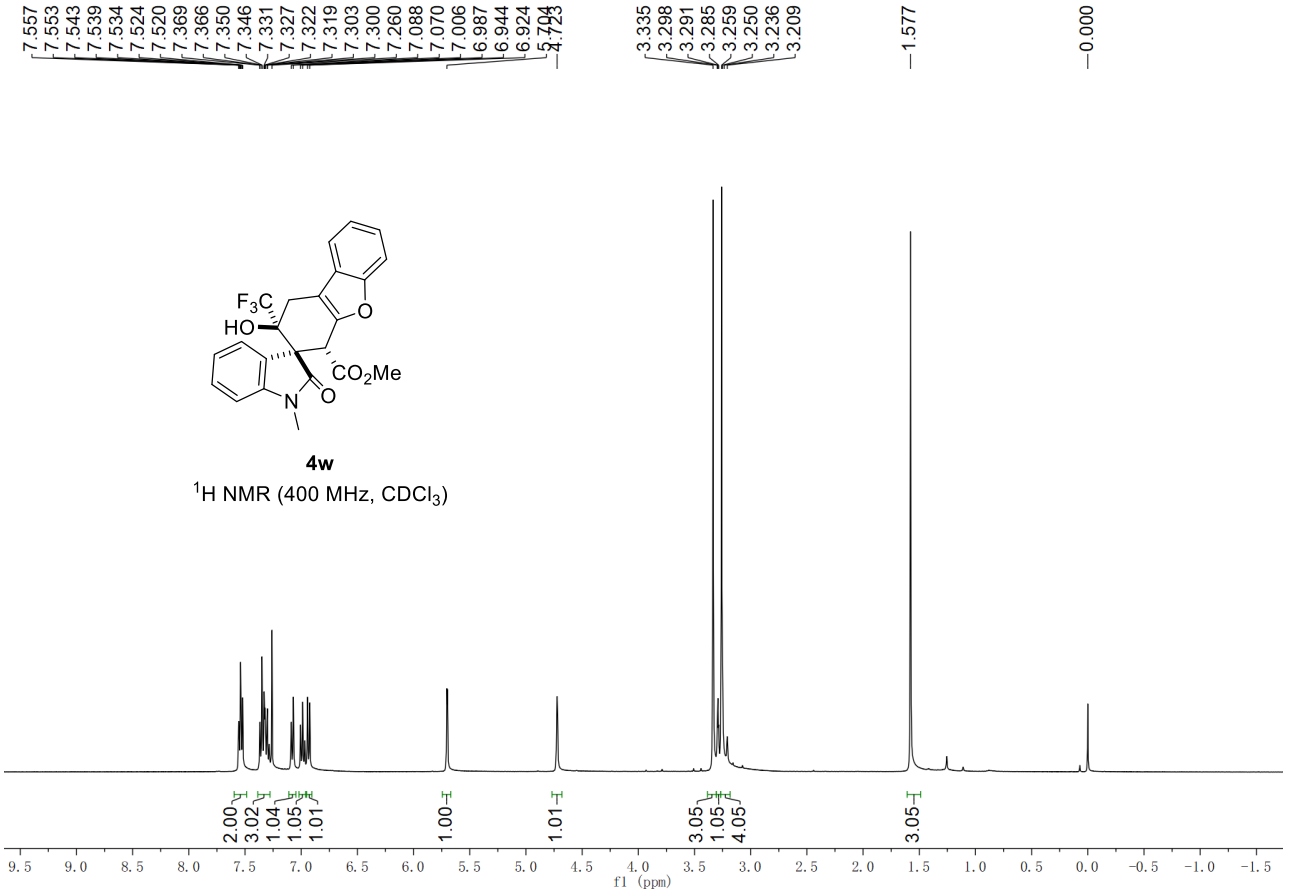


4v

(ESI-TOF) m/z: $[M + Na]^+$

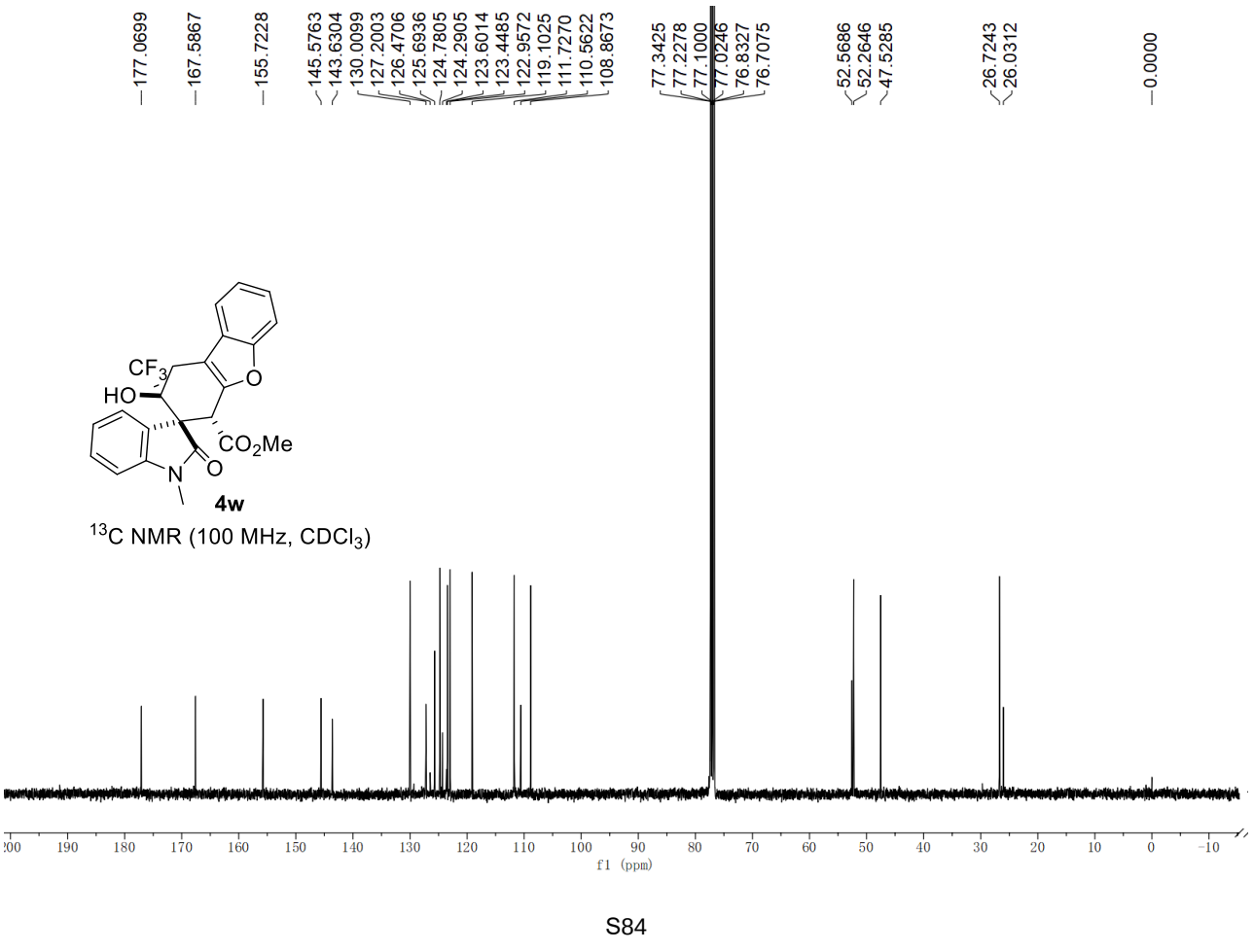
Calcd for $C_{24}H_{22}{}^{35}ClNO_5Na^+$ 462.1079

Calcd for $C_{24}H_{22}{}^{37}ClNO_5Na^+$ 464.1049



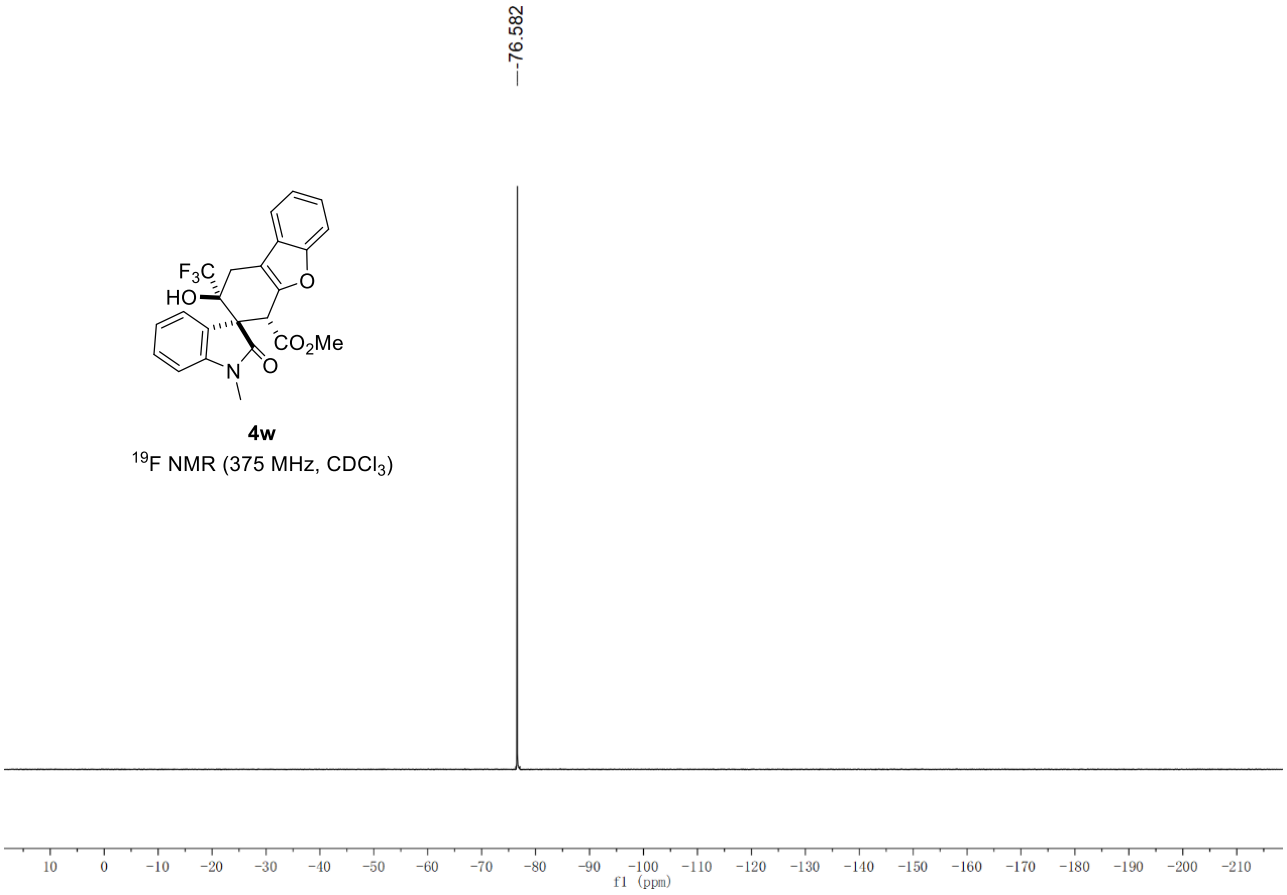
4w

^{1}H NMR (400 MHz, $CDCl_3$)



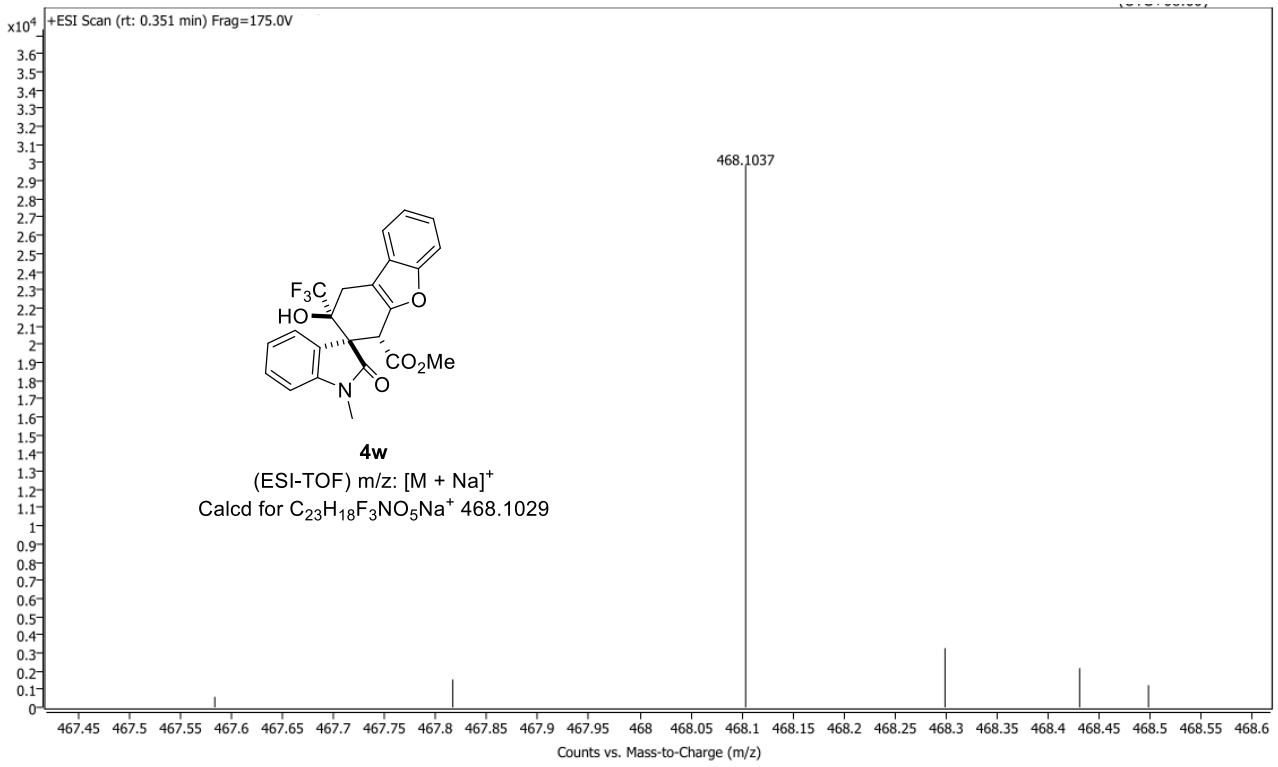
4w

^{13}C NMR (100 MHz, $CDCl_3$)



4w

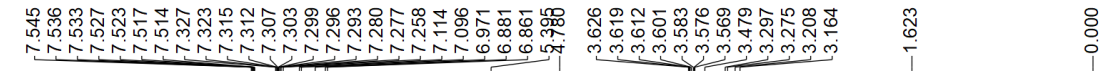
^{19}F NMR (375 MHz, $CDCl_3$)

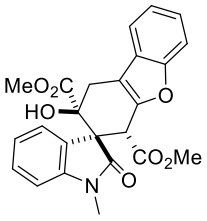


4w

(ESI-TOF) m/z: $[M + Na]^+$

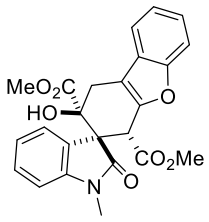
Calcd for $C_{23}H_{18}F_3NO_5Na^+$ 468.1029





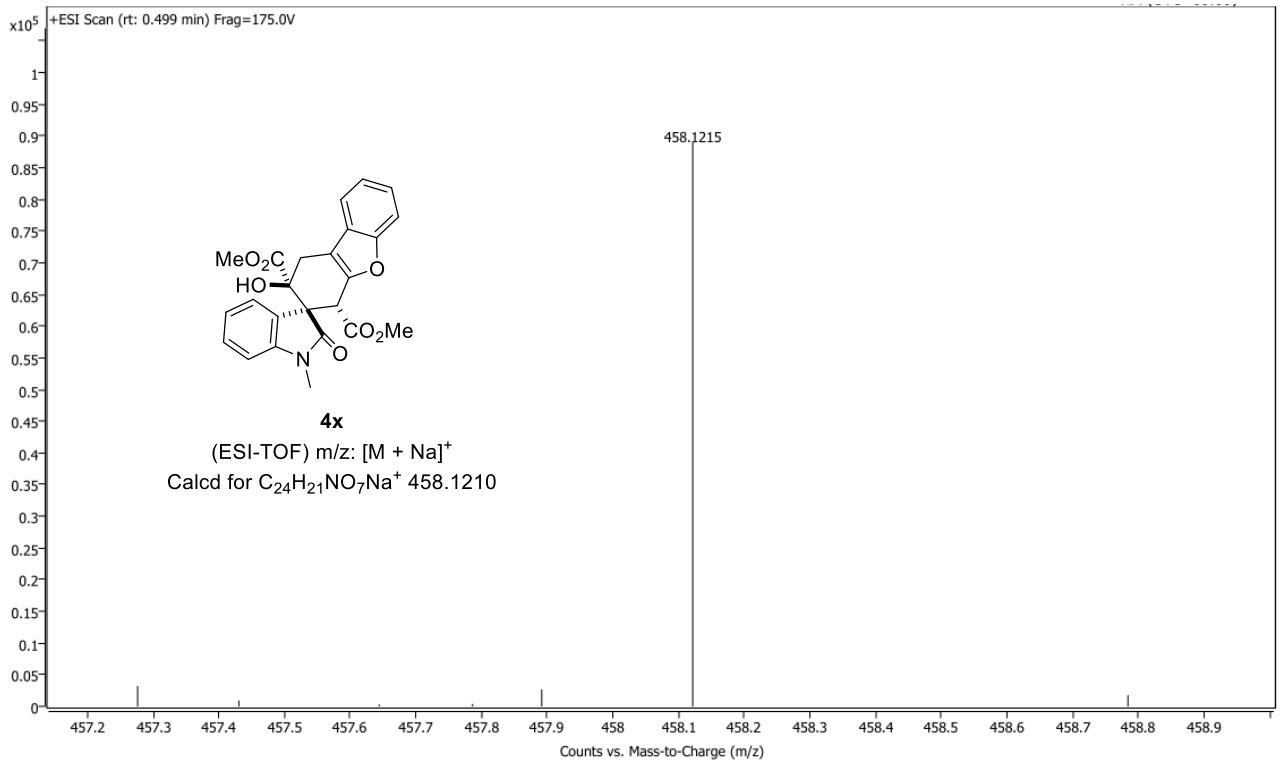
4x

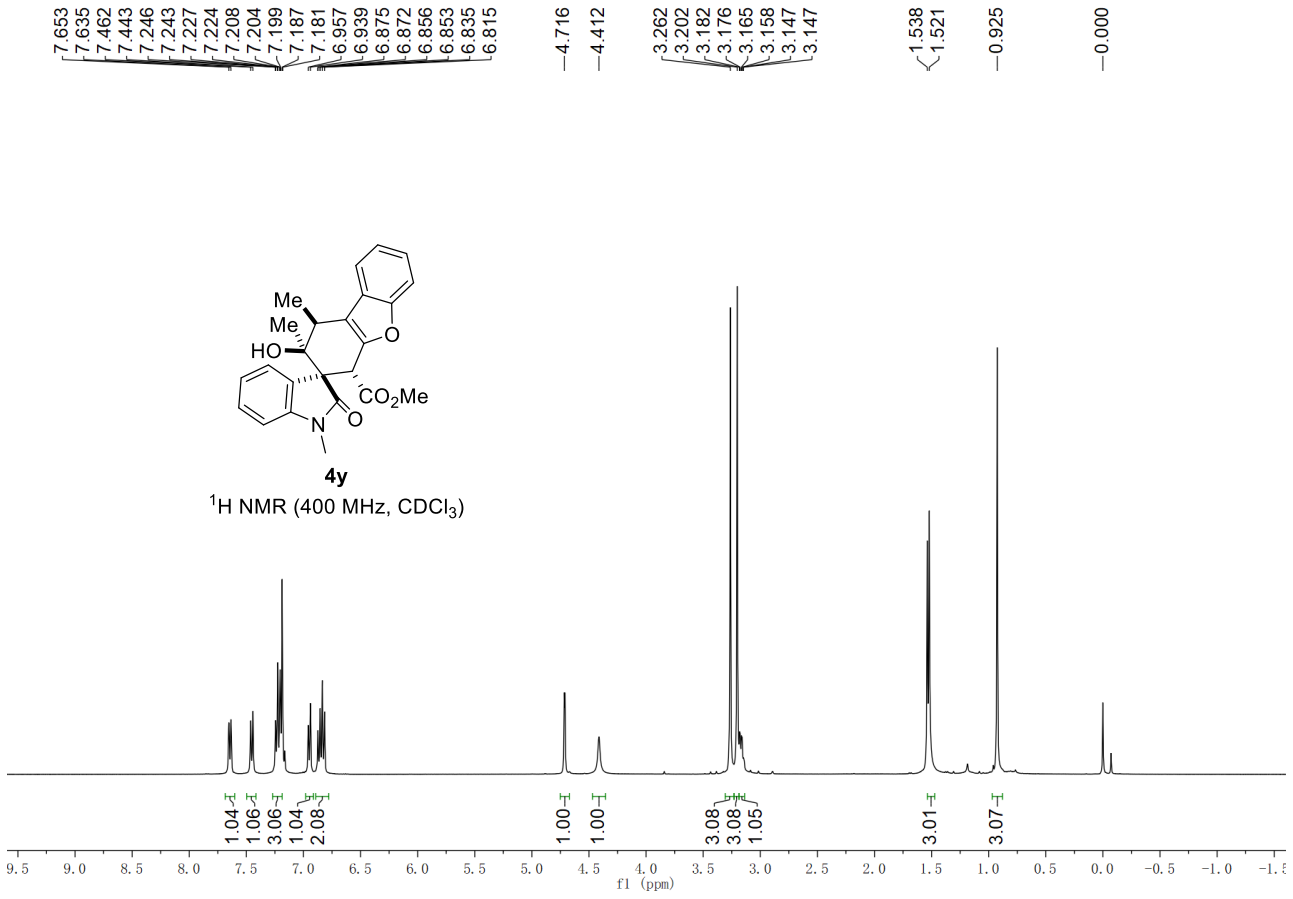
^{1}H NMR (400 MHz, $CDCl_3$)

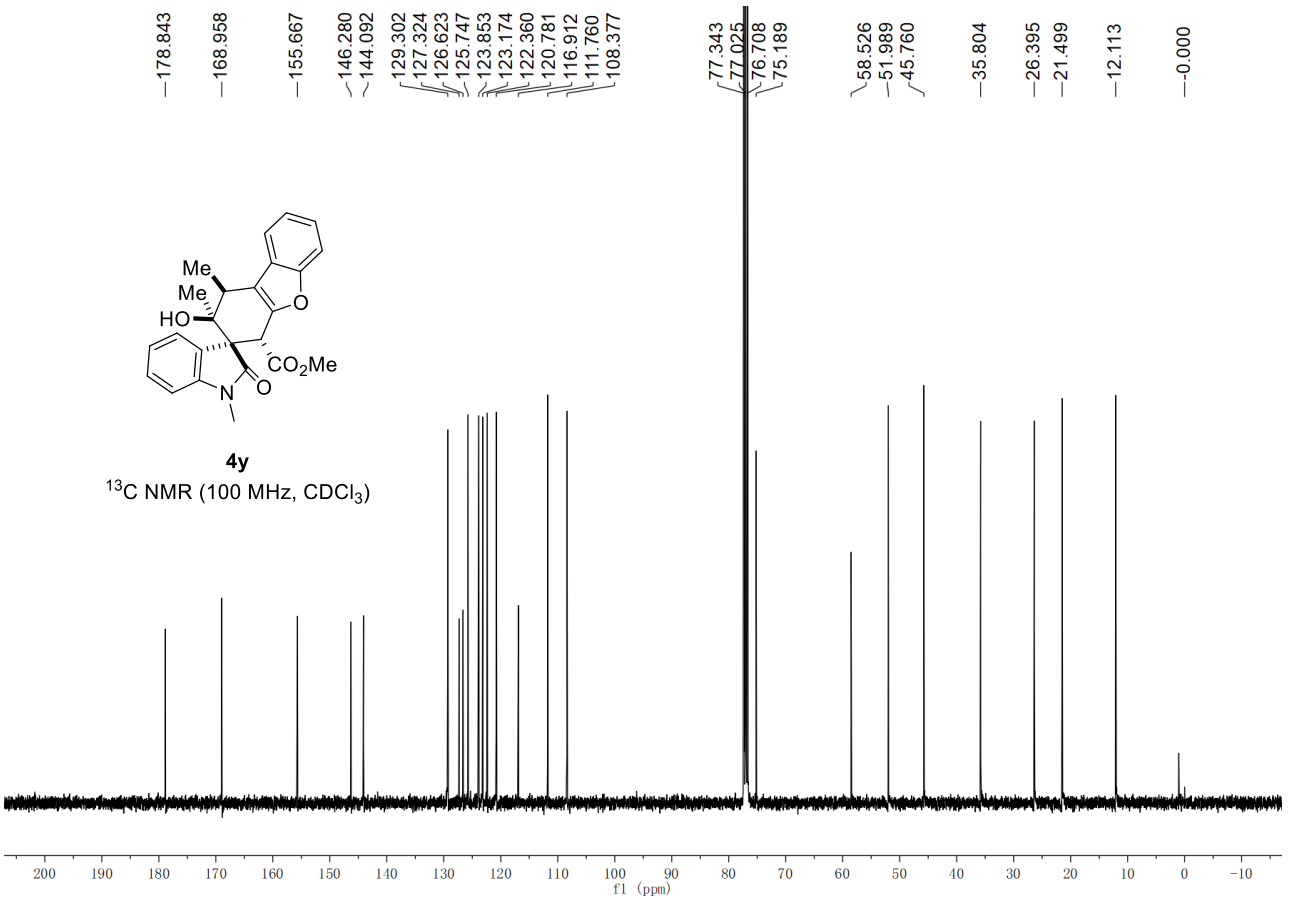


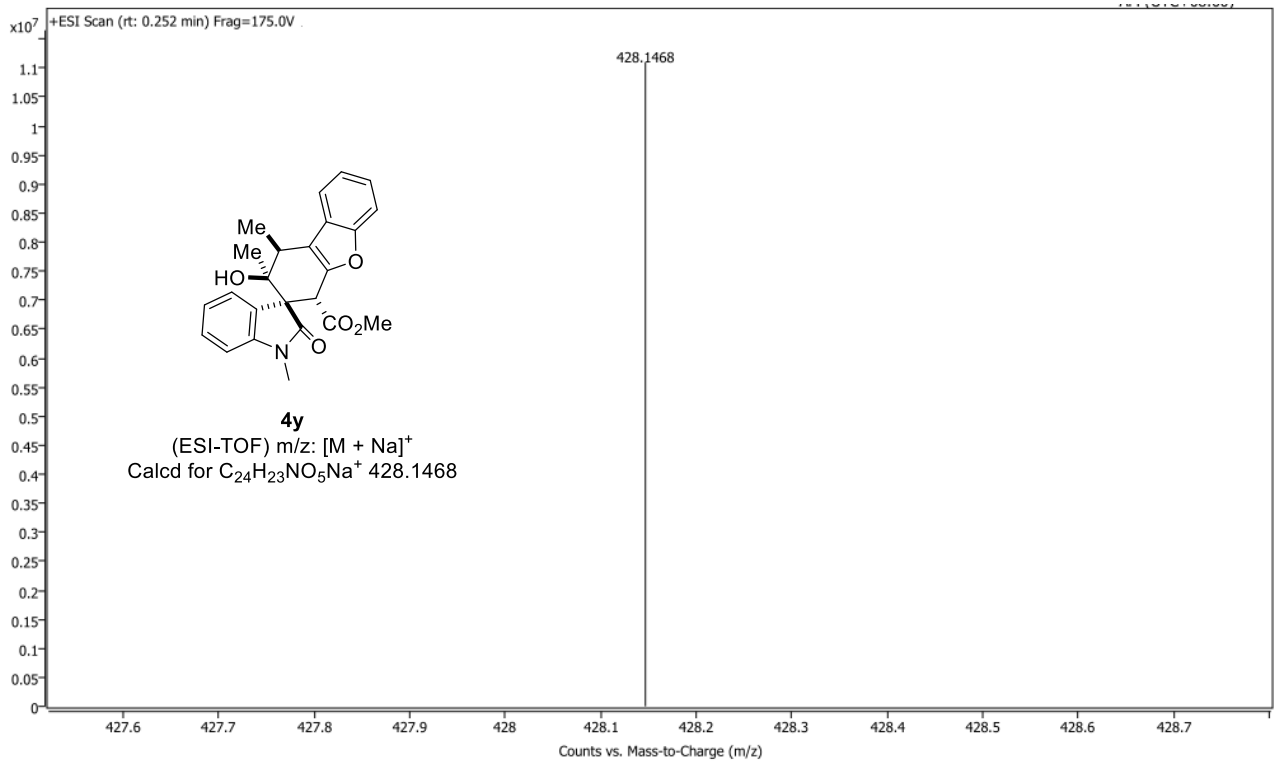
4x

^{13}C NMR (150 MHz, $CDCl_3$)


+ESI Scan (rt: 0.499 min) Frag=175.0V
x10^5
458.1215
MeO2C
HO
O
CO2Me
N
O
4x
(ESI-TOF) m/z: [M + Na]+
Calcd for C24H21NO7Na+ 458.1210
Counts vs. Mass-to-Charge (m/z)


7.653
7.635
7.462
7.443
7.246
7.243
7.227
7.224
7.208
7.204
7.199
7.187
7.181
6.957
6.939
6.875
6.872
6.856
6.853
6.835
6.815
4.716
4.412
3.262
3.202
3.182
3.176
3.165
3.158
3.147
3.147
1.538
1.521
0.925
0.000
Me
Me
HO
O
CO2Me
O
N
4y
1H NMR (400 MHz, CDCl3)
1.04
1.06
3.06
1.04
2.08
1.00
1.00
3.08
3.08
1.05
3.01
3.07
f1 (ppm)

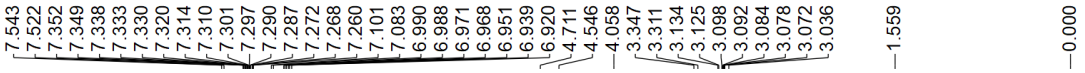

178.843
168.958
155.667
146.280
144.092
129.302
127.324
126.623
125.747
123.853
123.174
122.360
120.781
116.912
111.760
108.377
77.343
77.025
76.708
75.189
58.526
51.989
45.760
35.804
26.395
21.499
12.113
0.000
Me
Me
HO
O
CO2Me
O
N
4y
13C NMR (100 MHz, CDCl3)
f1 (ppm)

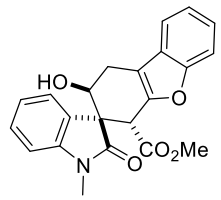


4y

(ESI-TOF) m/z: $[M + Na]^+$

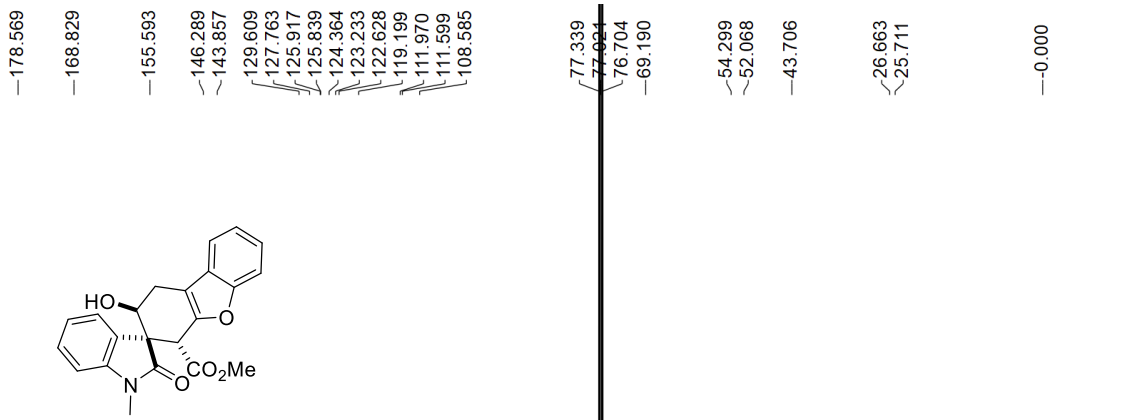
Calcd for $C_{24}H_{23}NO_5Na^+$ 428.1468





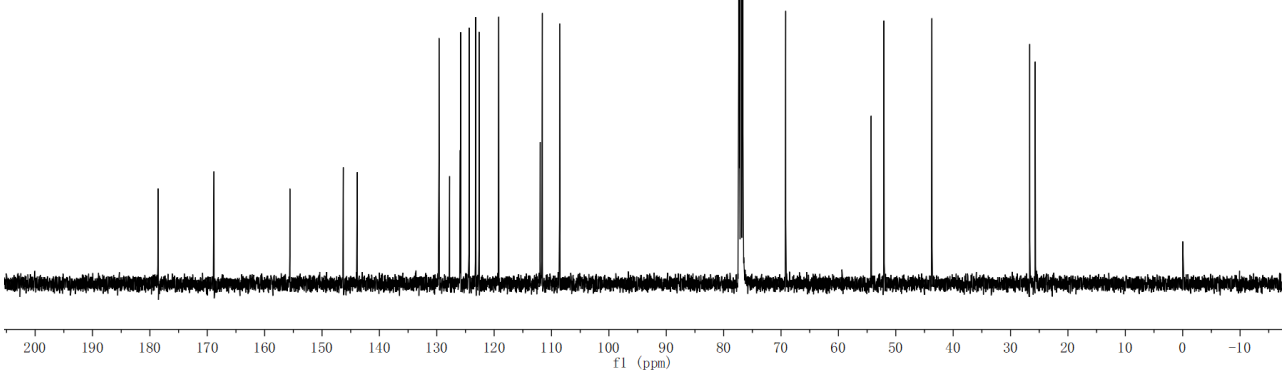
4z

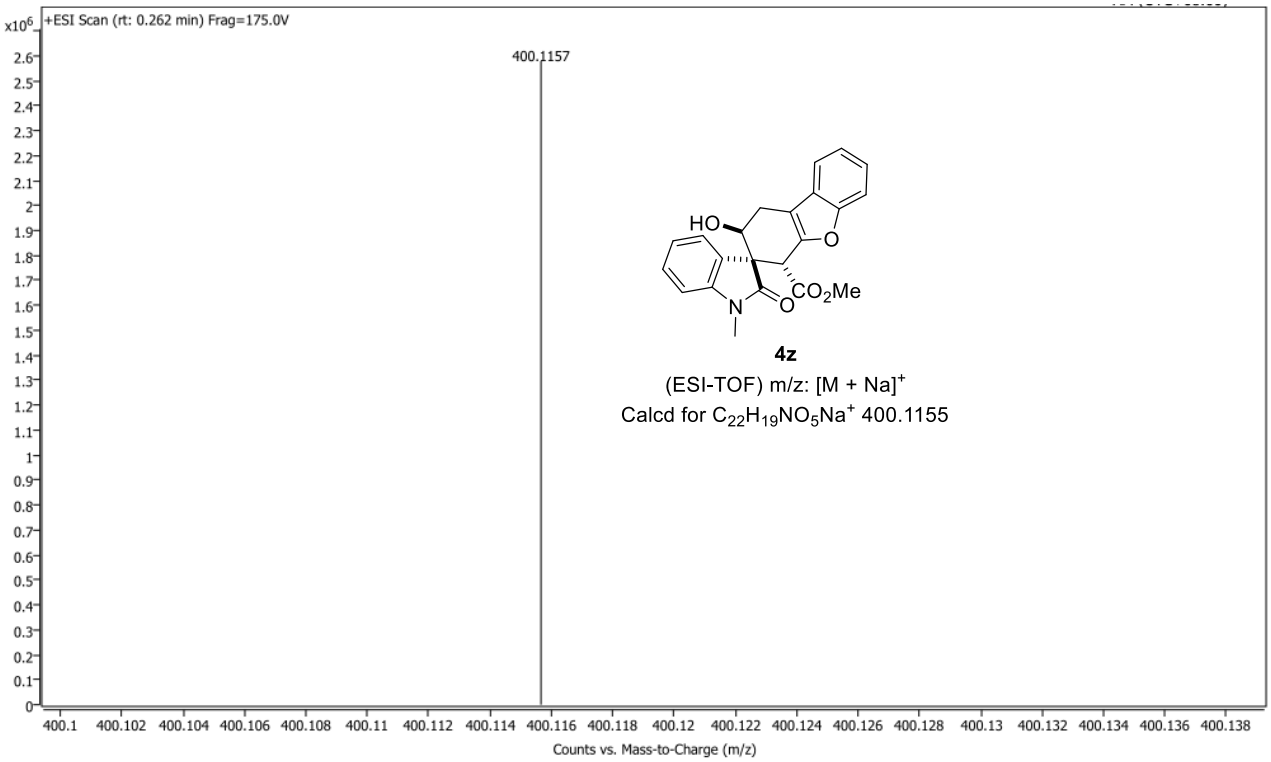
^{1}H NMR (400 MHz, $CDCl_3$)



4z

^{13}C NMR (100 MHz, $CDCl_3$)

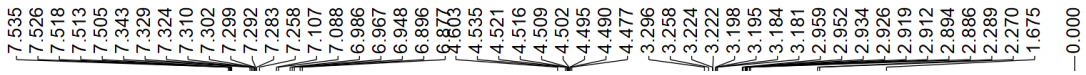


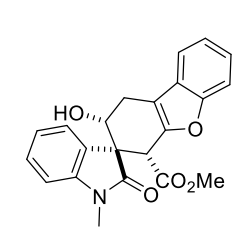


4z

(ESI-TOF) m/z: $[M + Na]^+$

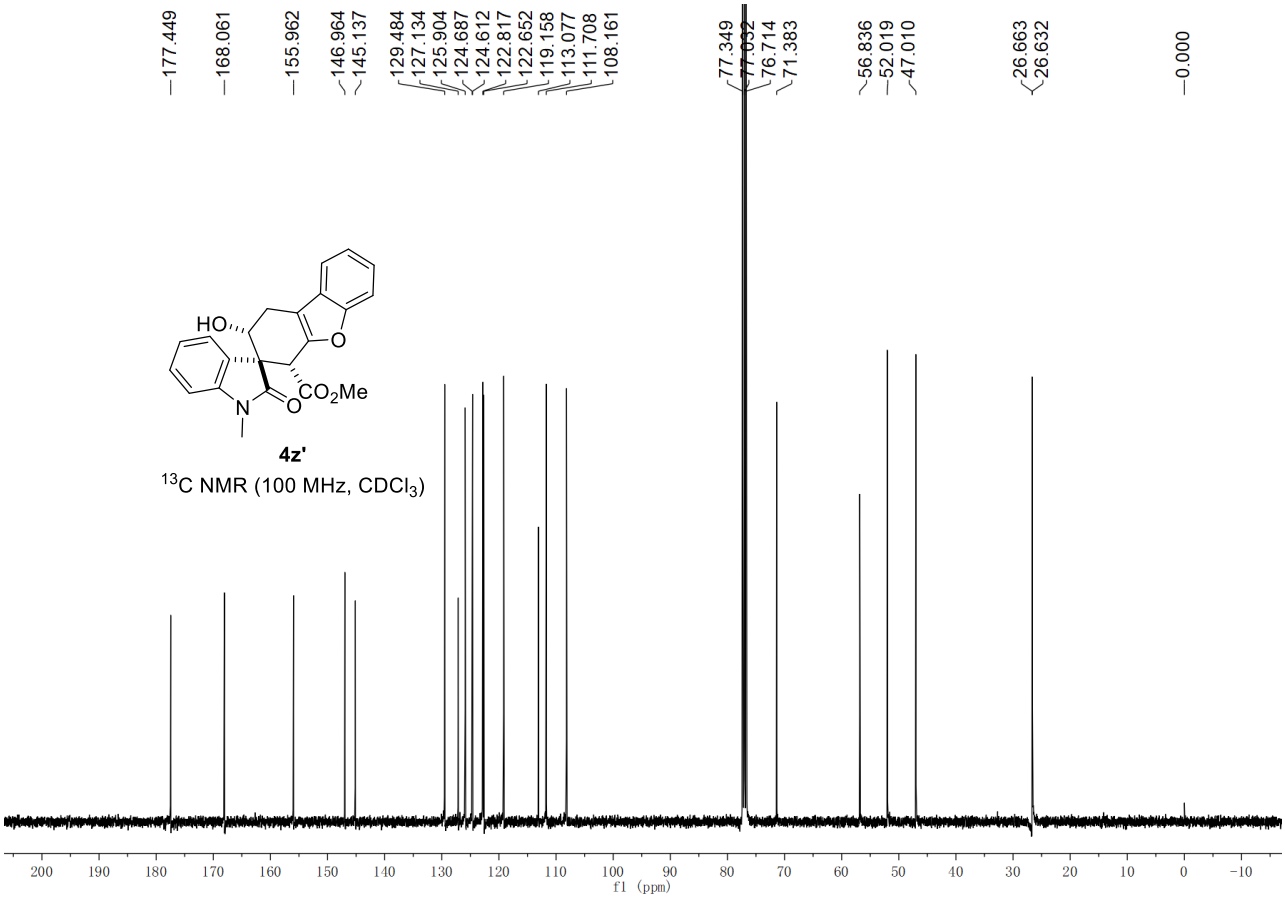
Calcd for $C_{22}H_{19}NO_5Na^+$ 400.1155





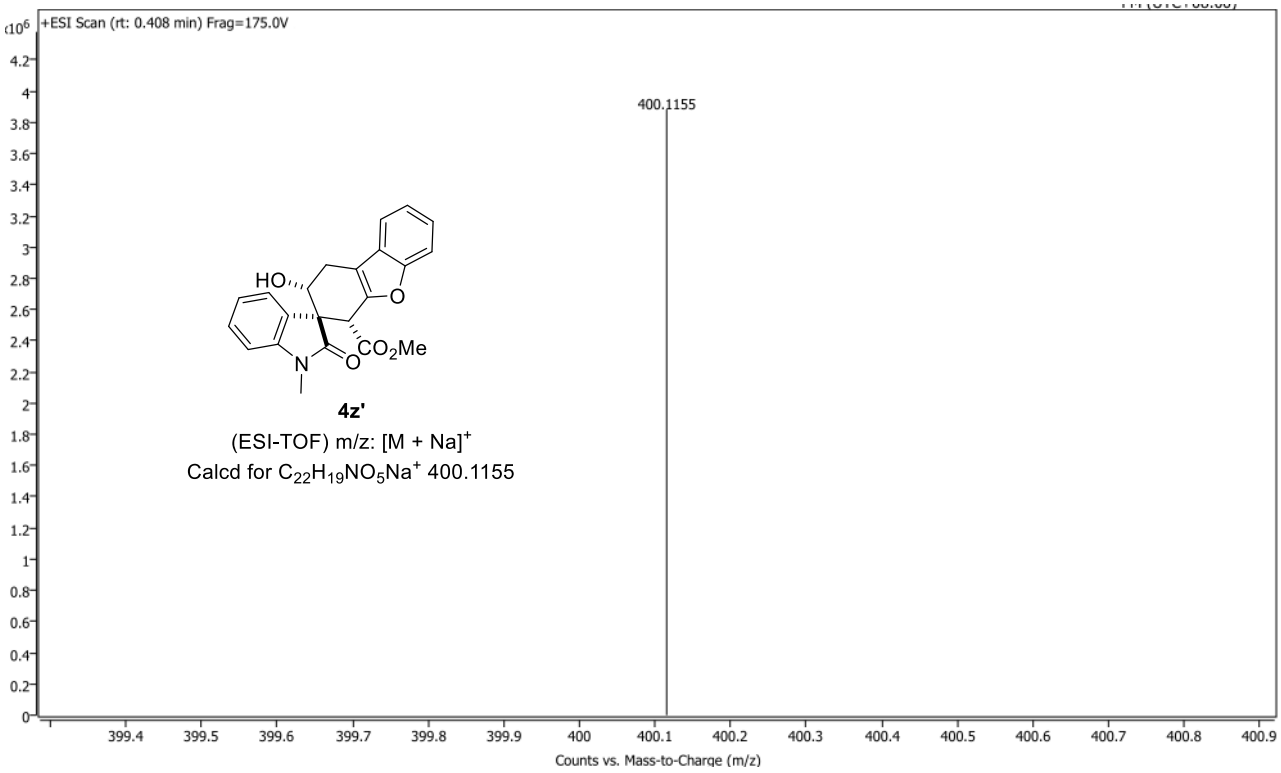
4z'

^{1}H NMR (400 MHz, $CDCl_3$)



4z'

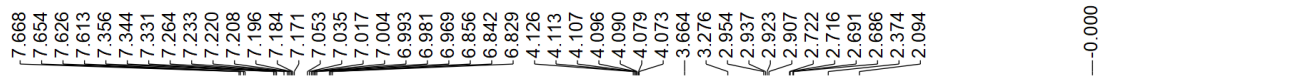
^{13}C NMR (100 MHz, $CDCl_3$)

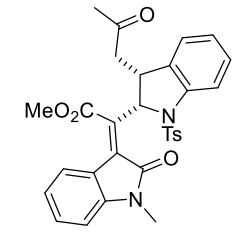


4z'

(ESI-TOF) m/z: $[M + Na]^+$

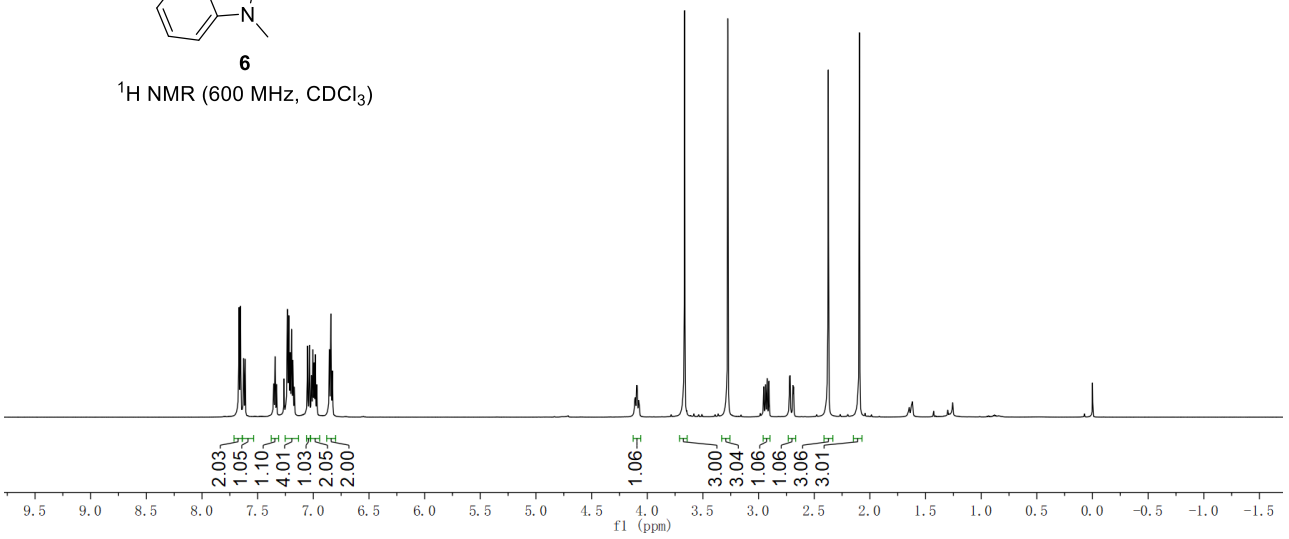
Calcd for $C_{22}H_{19}NO_5Na^+$ 400.1155

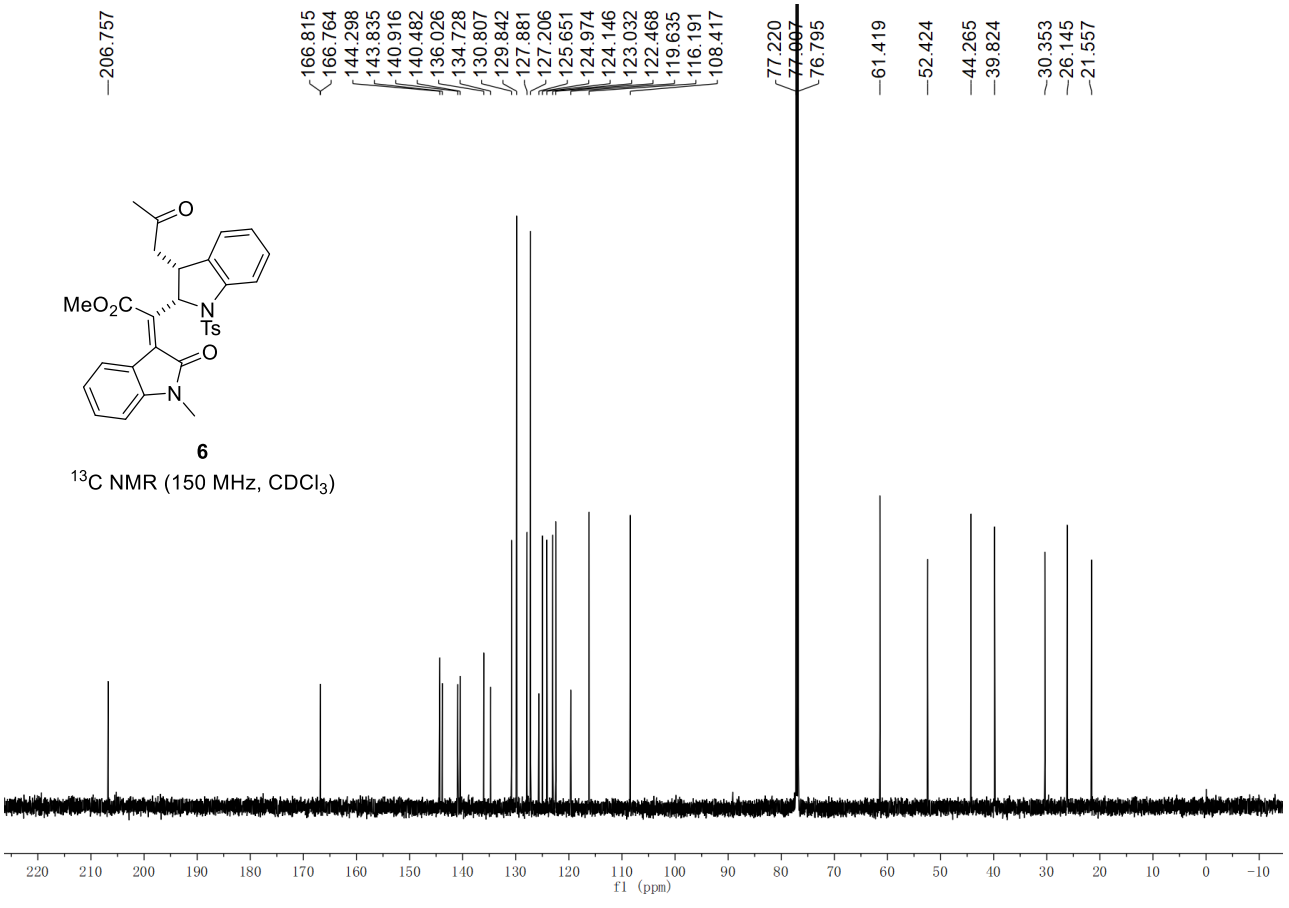




6

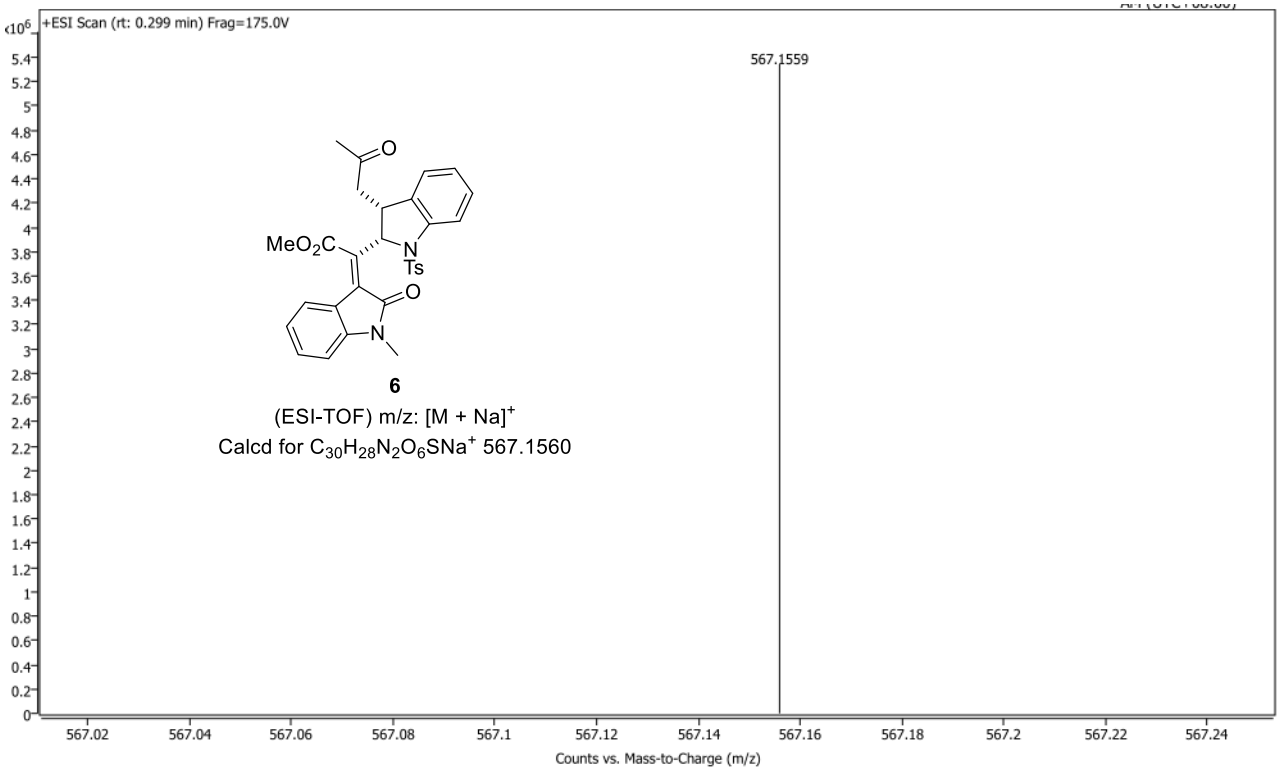
^{1}H NMR (600 MHz, $CDCl_3$)

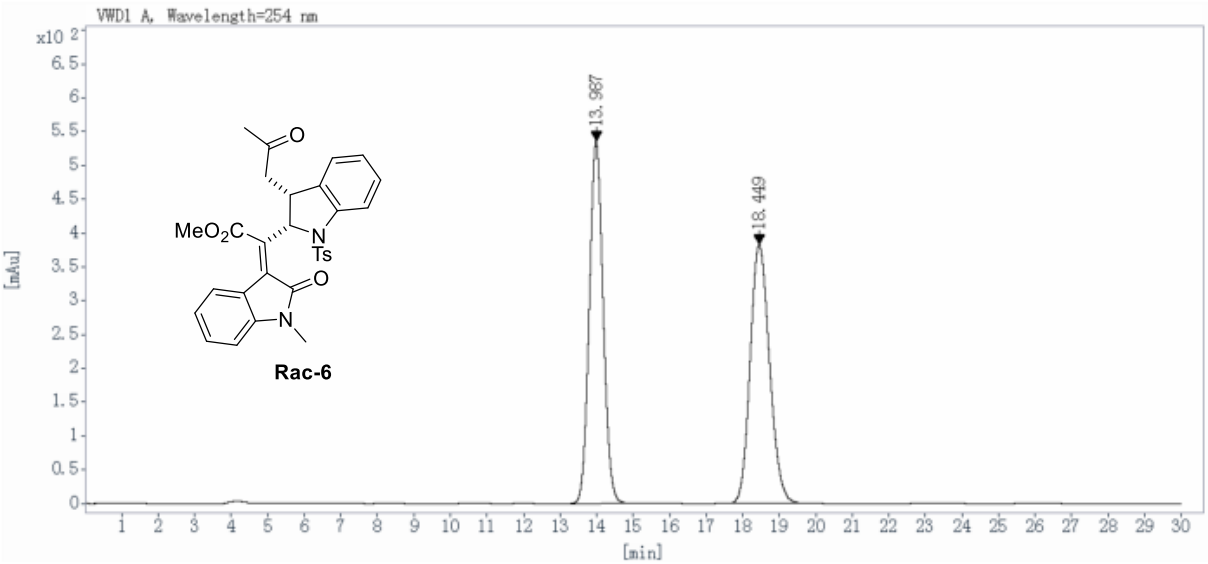




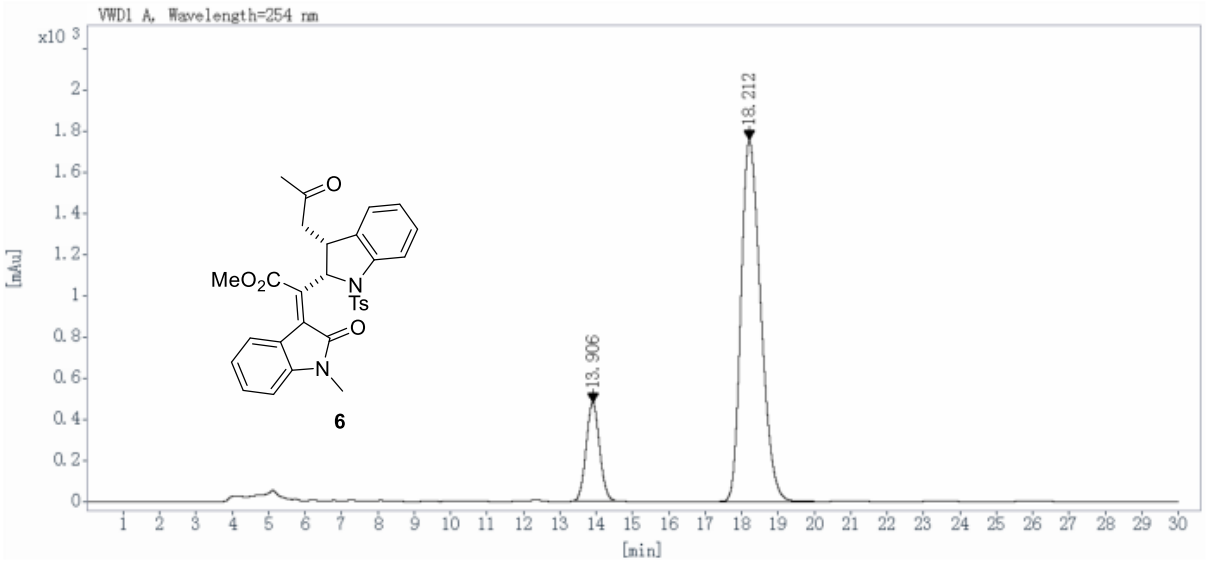
6

^{13}C NMR (150 MHz, $CDCl_3$)

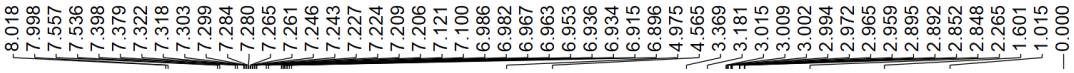

+ESI Scan (rt: 0.299 min) Frag=175.0V
x10^6
567.1559
MeO2C
N
Ts
O
O
N
6
(ESI-TOF) m/z: [M + Na]+
Calcd for C30H28N2O6SNa+ 567.1560
Counts vs. Mass-to-Charge (m/z)

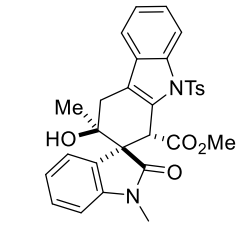


Ret Time [min]	Peak Type	Width [min]	Height [mAU]	Area [mAU*s]	Area [%]
13.987	BBA	0.41	535.4093	14097.6729	50.0330
18.449	BBA	0.57	382.3622	14079.0537	49.9670
			Totals:	28176.7266	100.0000



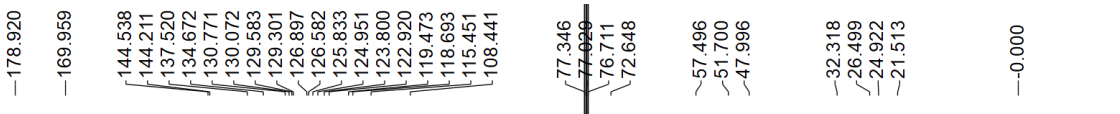
Ret Time [min]	Peak Type	Width [min]	Height [mAU]	Area [mAU*s]	Area [%]
13.906	BBA	0.40	478.2876	12183.7861	15.5854
18.212	BB	0.58	1755.5355	65990.7109	84.4146
			Totals:	78174.4971	100.0000

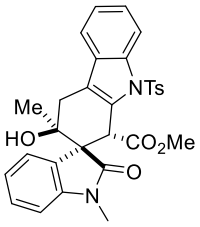




7

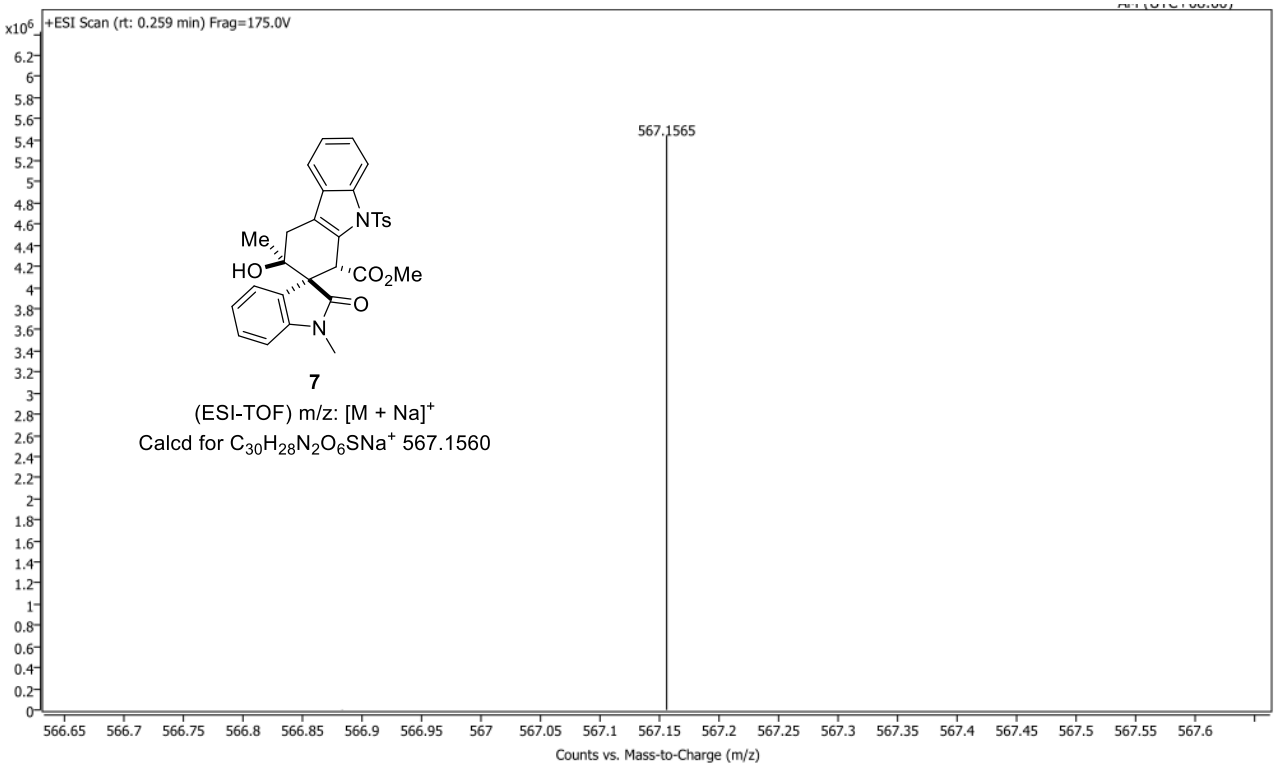
^{1}H NMR (400 MHz, $CDCl_3$)





7

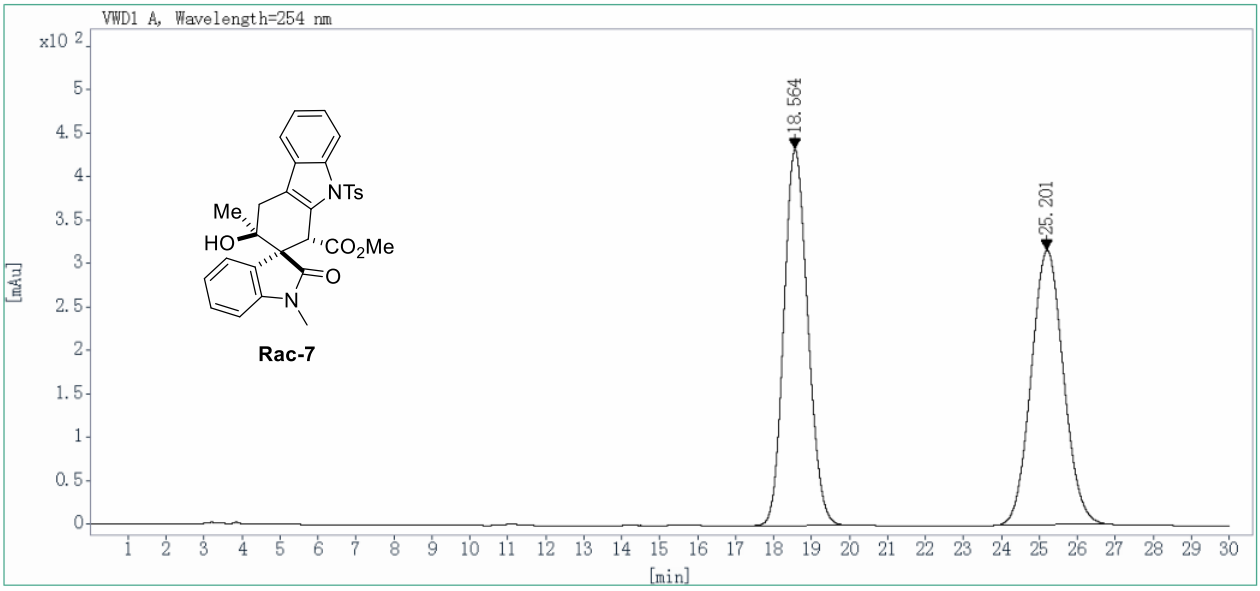
^{13}C NMR (100 MHz, $CDCl_3$)



7

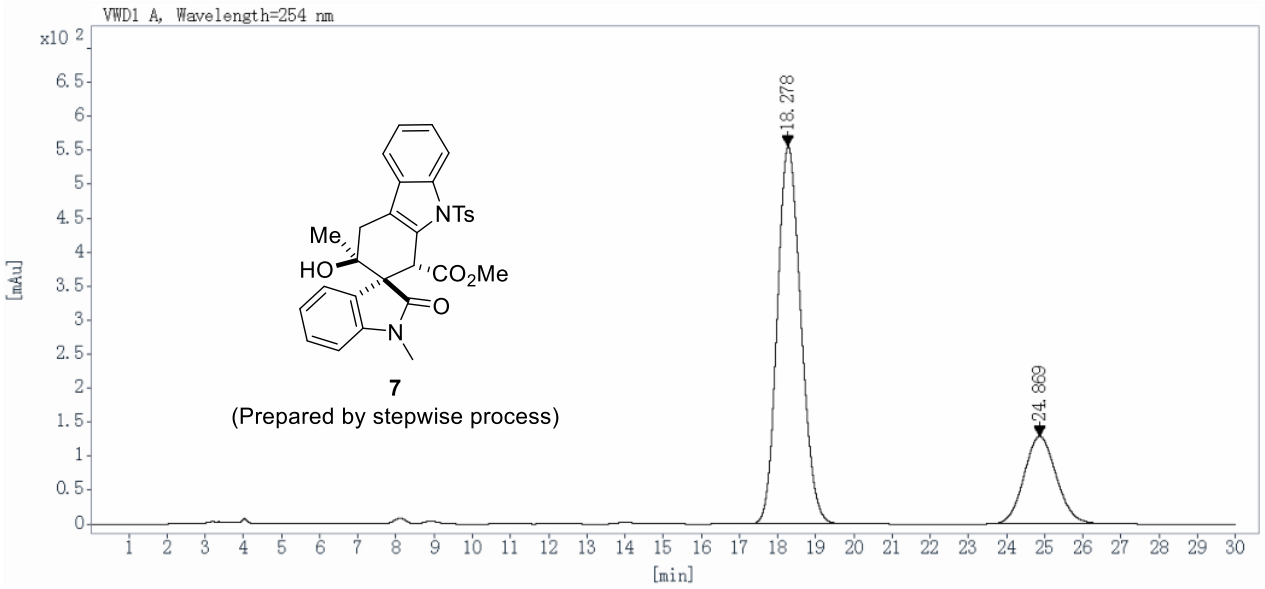
(ESI-TOF) m/z: $[M + Na]^+$

Calcd for $C_{30}H_{28}N_2O_6SNa^+$ 567.1560

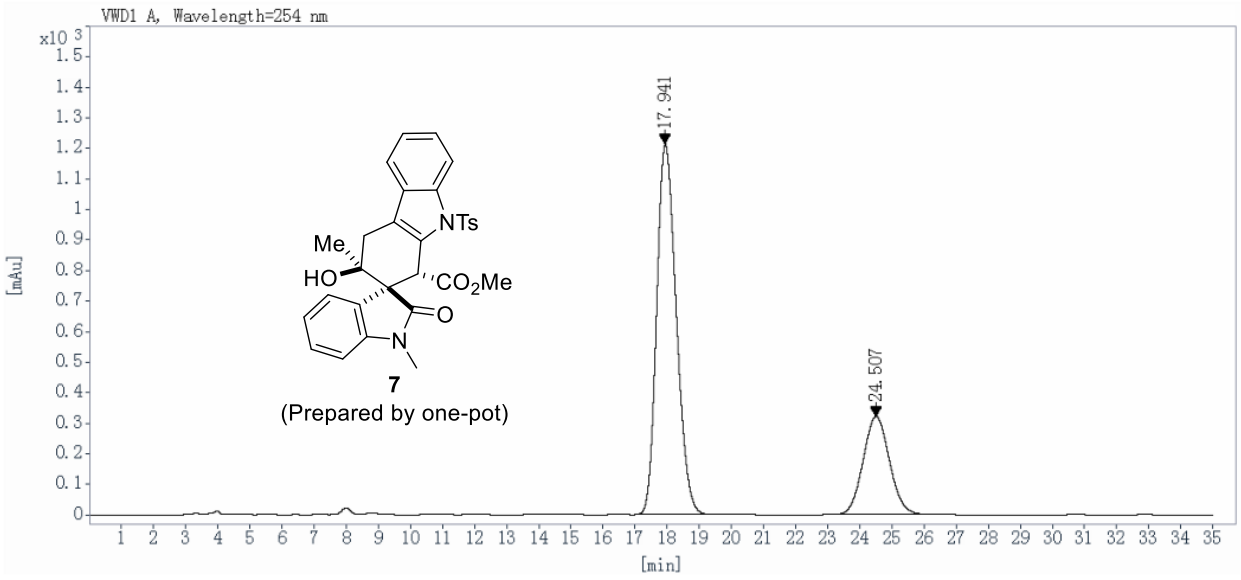


Rac-7

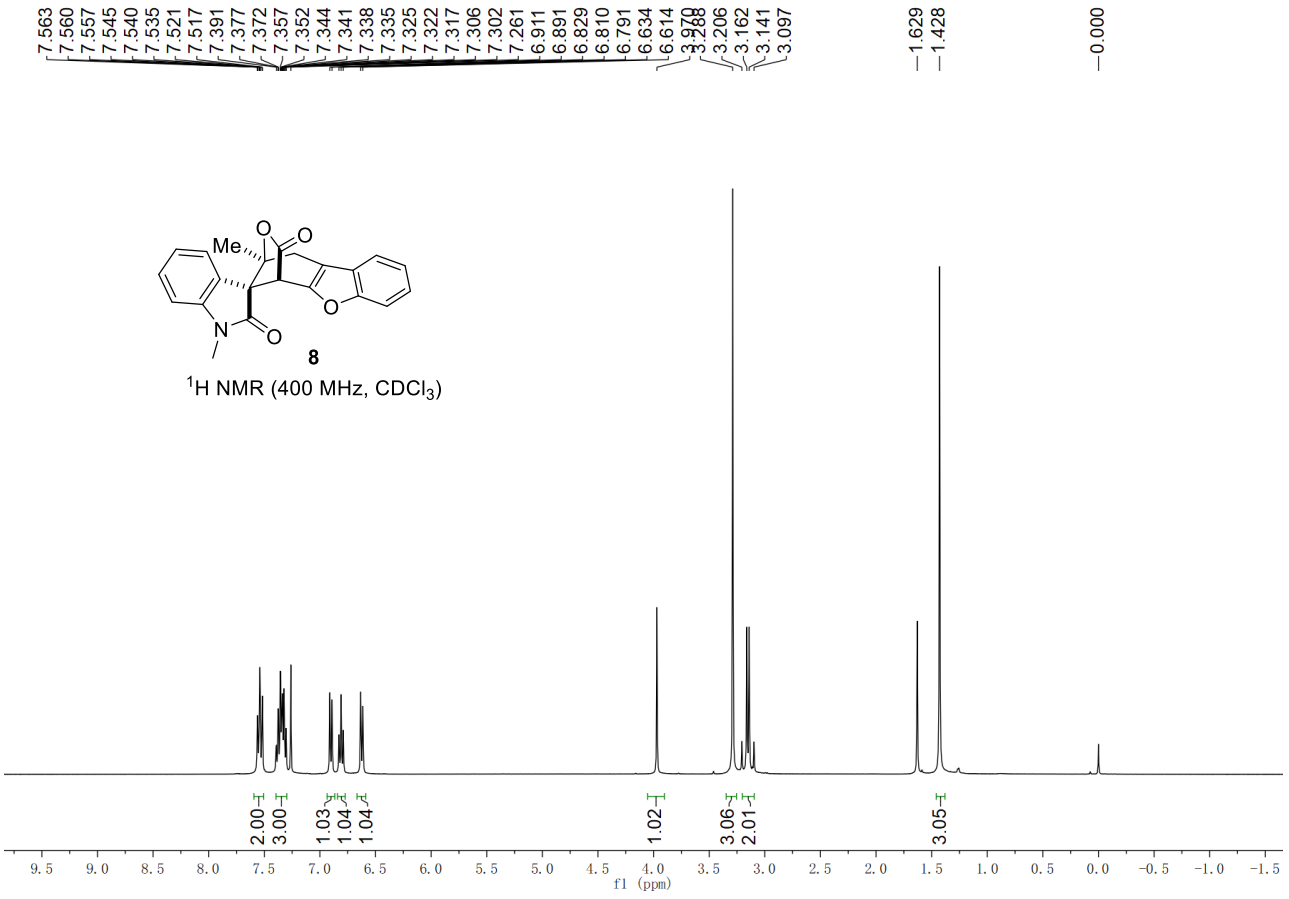
Ret Time [min]	Peak Type	Width [min]	Height [mAU]	Area [mAU*s]	Area [%]
18.564	BBA	0.68	433.2407	18918.8027	50.3947
25.201	BBA	0.92	315.8053	18622.4238	49.6053
			Totals:	37541.2266	100.0000

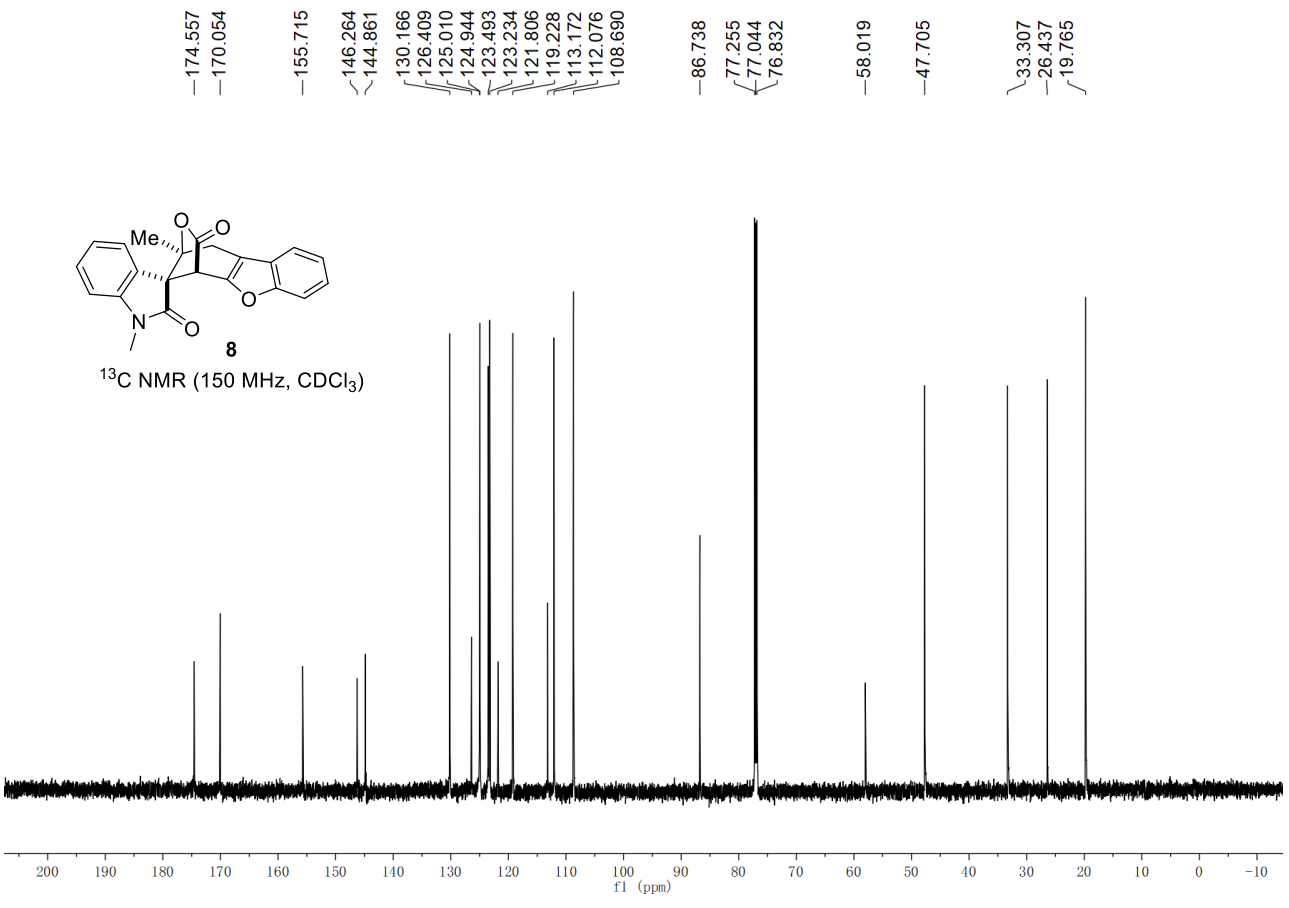


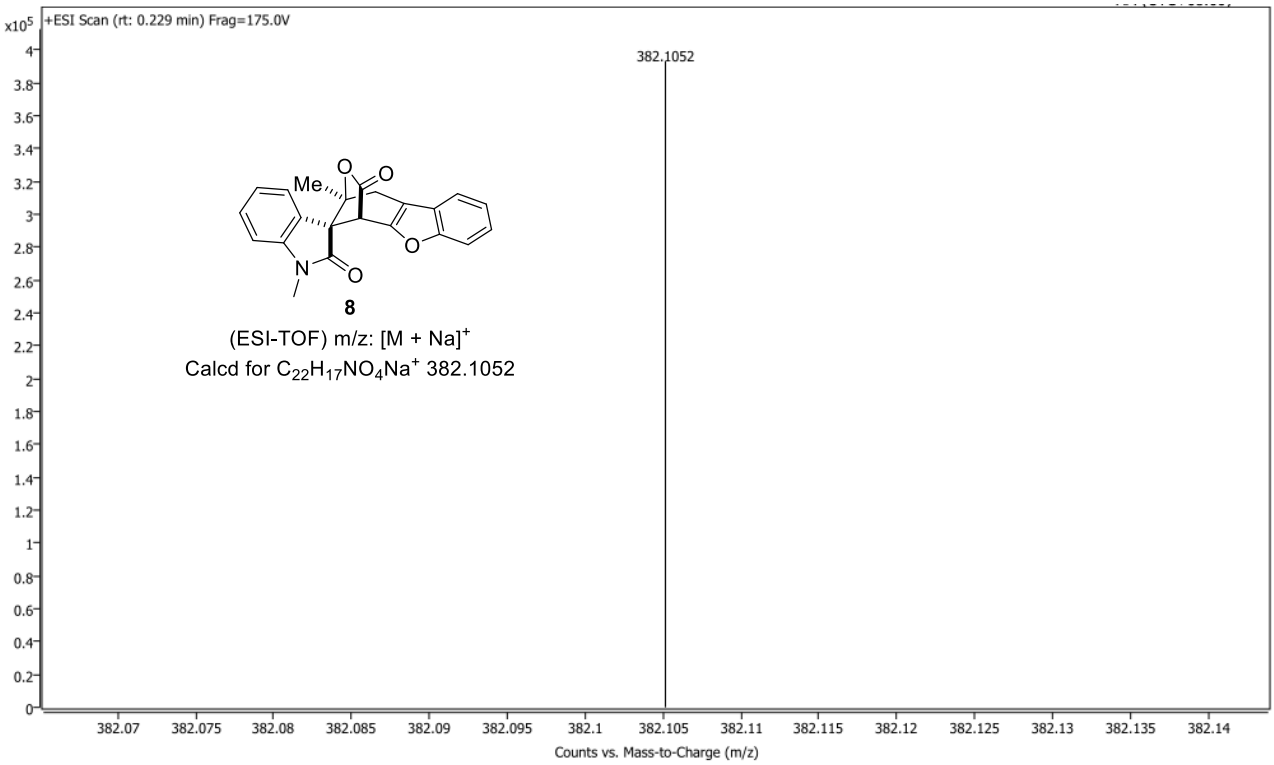
Ret Time [min]	Peak Type	Width [min]	Height [mAU]	Area [mAU*s]	Area [%]
18.278	BBA	0.67	555.2668	23853.9688	76.0245
24.869	BBA	0.91	128.4260	7522.7290	23.9755
			Totals:	31376.6978	100.0000



Ret Time [min]	Peak Type	Width [min]	Height [mAU]	Area [mAU*s]	Area [%]
17.941	BB	0.66	1212.3540	51276.4766	73.7829
24.507	BBA	0.89	320.8142	18219.9473	26.2171
			Totals:	69496.4238	100.0000


7.563
7.560
7.557
7.545
7.540
7.535
7.521
7.517
7.391
7.377
7.372
7.357
7.352
7.344
7.341
7.338
7.335
7.325
7.322
7.317
7.306
7.302
7.261
6.911
6.891
6.829
6.810
6.791
6.634
6.614
3.970
3.206
3.162
3.141
3.097
1.629
1.428
0.000
Me
O
O
N
O
O
8
1H NMR (400 MHz, CDCl3)
2.00
3.00
1.03
1.04
1.04
1.02
3.06
2.01
3.05
f1 (ppm)


174.557
170.054
155.715
146.264
144.861
130.166
126.409
125.010
124.944
123.493
123.234
121.806
119.228
113.172
112.076
108.690
86.738
77.255
77.044
76.832
58.019
47.705
33.307
26.437
19.765
Me
O
O
N
O
O
8
13C NMR (150 MHz, CDCl3)
f1 (ppm)



8

(ESI-TOF) m/z: $[M + Na]^+$

Calcd for $C_{22}H_{17}NO_4Na^+$ 382.1052