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Supporting Information for

Electrooxidative Tricyclic 6-7-6 Fused-System Domino Assembly to Allocolchicines by a Removable Radical Strategy

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1. General Remarks

NMR spectra were recorded on BRUKER AVANCE III 400 or BRUKER AVANCE III 600. $CDCl_3$ was used as the solvent. Chemical shifts were referenced relative to residual solvent signal ($CDCl_3$: ^1H NMR: δ 7.26 ppm, ^{13}C NMR: δ 77.16 ppm). The following abbreviations are used to describe peak patterns where appropriate: br = broad, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet. Coupling constants (*J*) are reported in Hertz (Hz). Electrospray-ionization (ESI) mass spectra were obtained on AB Sciex LC 30A-Triple TOF 4600 apparatus. All systems are equipped with time-of-flight (TOF) analyzers. Melting points were measured with micro melting point apparatus. Platinum electrodes (10 mm × 25 mm × 0.25 mm, 99.9%; obtained from ChemPur® Karlsruhe, Germany) and graphite felt (GF) electrodes (10 mm × 25 mm × 6 mm, SIGRACELL® GFA 6 EA, obtained from SGL Carbon, Wiesbaden, Germany) were connected using stainless steel adapters. CV studies were performed using a Metrohm Autolab PGSTAT204 workstation and Nova 2.1 software. Unless otherwise noted, some materials (or alternatively chemicals) obtained from commercial suppliers were used directly without further purification. Alkynones **1** were prepared according to the literatures.[1,2]

Table S–1. Scopes of Alkynones **1** and sodium sulfinate **2**.

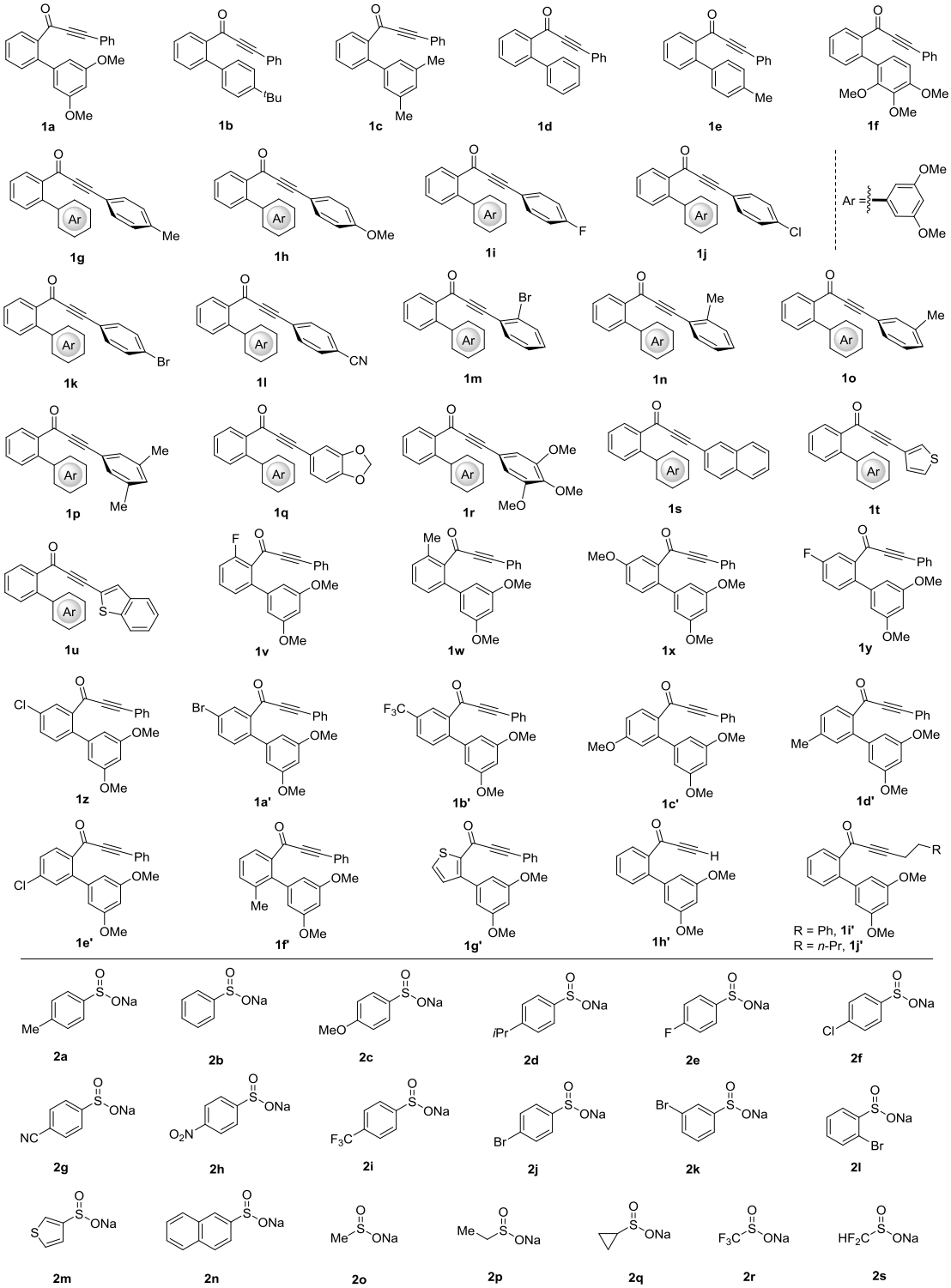
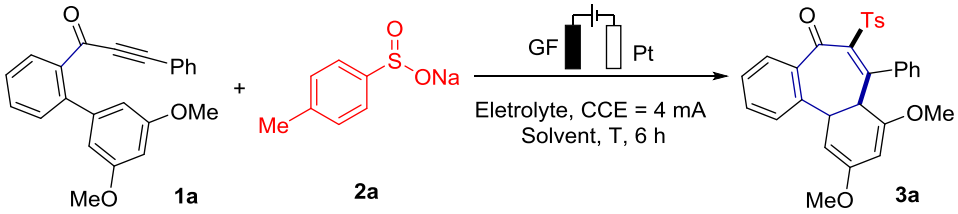


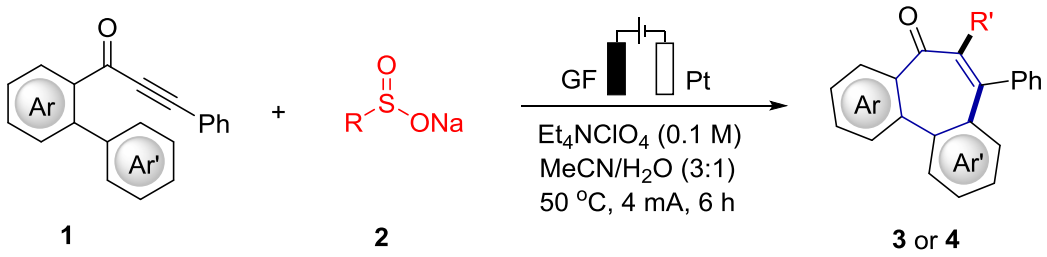
Table S–2. Optimization of the cascade cyclization/sulfonylation.[a]



Entry	Solvent	Eletrolyte	T / °C	Yield / %
1	EtOH/H_2O (3:1)	Et_4NClO_4	50	0
2	DMF/H_2O (3:1)	Et_4NClO_4	50	0
3	1,4-Dioxane/H_2O (3:1)	Et_4NClO_4	50	39
4	DCE/MeCN/H_2O (5:5:1)	Et_4NClO_4	50	37
5	MeCN/H_2O (3:1)	Et_4NClO_4	50	73
6	MeCN/H_2O (3:1)	*n*-Bu_4NI	50	32
7	MeCN/H_2O (3:1)	*n*-Bu_4NPF_6	50	56
8	MeCN/H_2O (3:1)	*n*-Bu_4NBF_4	50	64
9	MeCN/H_2O (3:1)	*n*-Bu_4NClO_4	50	43
10	MeCN/H_2O (3:1)	–	50	55
11[b]	MeCN/H_2O (3:1)	Et_4NClO_4	50	68
12	MeCN/H_2O (3:1)	Et_4NClO_4	25	0
13	MeCN/H_2O (3:1)	Et_4NClO_4	60	50
14[c]	MeCN/H_2O (3:1)	Et_4NClO_4	50	32
15[d]	MeCN/H_2O (3:1)	Et_4NClO_4	50	60
16[e]	MeCN/H_2O (3:1)	Et_4NClO_4	50	54
17[f]	MeCN/H_2O (3:1)	Et_4NClO_4	50	0
18[g]	MeCN/H_2O (3:1)	Et_4NClO_4	50	0

[a] Undivided cell, GF anode, Pt cathode, constant current = 4 mA, **1a** (0.30 mmol), **2a** (0.60 mmol, 2.0 equiv), eletrolyte (0.1 M), solvent (4 mL), under air, 6 h, 3.0 $Fmol^{-1}$. Yield of isolated products. [b] **2a** (0.60 mmol, 2.0 equiv). [c] CCE = 3 mA. [d] CCE = 6 mA. [e] GF(+)|Ni(−) instead of GF(+)|Pt(−). [f] Pt(+)|Pt(−) instead of GF(+)|Pt(−). [g] No electricity.

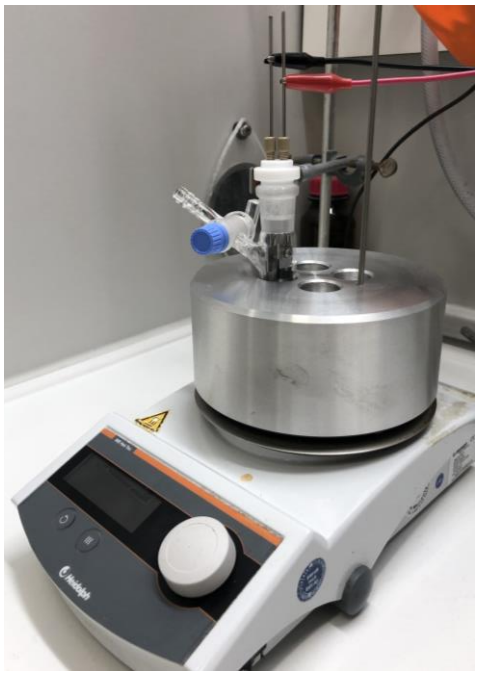
2. General Procedure for Cascade Cyclization/Sulfonylation.



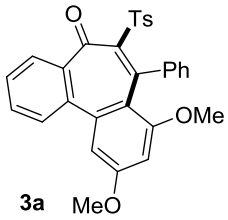
1 **2** **3** or **4**

The electrocatalysis was carried out in an undivided cell under air with a graphite felt (GF) anode (10 mm × 25 mm × 6 mm) and a platinum cathode (10 mm × 25 mm × 0.25 mm). Biarylynone **1** (0.3 mmol, 1.0 equiv), [R'SO_2Na (**2**, 0.6 mmol, 2.0 equiv) and Et_4NClO_4 (92 mg, 0.1 M) were dissolved in a mixture of MeCN /H_2O (3:1, 4 mL). Electrocatalysis was performed at 50 °C with a constant current of 4.0 mA maintained for 6 h. The GF anode was washed with ethyl acetate (3 × 5 mL) in an ultrasonic bath and transfered to the round bottom flask with the crude reaction solution. Silica was added to the flask and all volatiles were evaporated under vacuum. Purification was performed by flash column chromatography on silica gel using petroleum ether/ EtOAc as the eluent to give the corresponding products **3** or **4**.


lsr tools



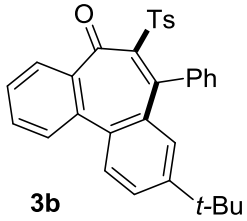
3. Characterization Data of All the Synthesized Products (3, 4 and 12)



3a

8,10-Dimethoxy-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3a)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3a** (108.6 mg, 73%) as a yellow oil. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.84 (d, J = 7.9 Hz, 1H), 7.66 (td, J = 7.6, 1.6 Hz, 1H), 7.55–7.50 (m, 2H), 7.17 (dd, J = 7.4, 7.4 Hz, 2H), 7.07 (d, J = 8.3 Hz, 3H), 6.92 (d, J = 8.1 Hz, 2H), 6.68 (d, J = 2.4 Hz, 1H), 6.30 (d, J = 2.4 Hz, 1H), 3.82 (s, 3H), 3.18 (s, 3H), 2.27 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.6, 161.3, 160.7, 146.9, 145.1, 143.5, 142.2, 140.3, 138.9, 138.3, 135.8, 131.2, 128.9, 128.8, 128.1, 128.0, 127.9, 126.8, 125.5, 118.3, 106.9, 99.6, 55.6, 55.6, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{25}O_5S$ $[M+H]^+$: 497.1417, found: 497.1398.

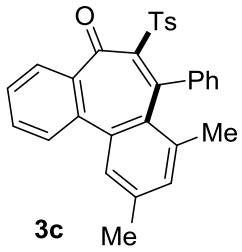


3b

9-(*tert*-Butyl)-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3b)

The general procedure was followed using **1b** (101.4 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3b** (69.4 mg, 47%) as a yellow solid. **M.p.**: 93–95 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.79 (d, J = 7.8 Hz, 1H), 7.67 (td, J = 7.7, 1.3 Hz, 1H), 7.61 (d, J = 8.4 Hz, 1H), 7.51 (dd, J = 7.5, 0.8 Hz, 1H), 7.49–7.43 (m, 4H), 7.38 (dd, J = 7.4, 7.4 Hz, 1H), 7.34 (dd, J = 7.6, 1.1 Hz, 1H), 7.16 (s, 1H), 7.12 (d, J = 8.1 Hz, 2H), 6.94 (d, J = 2.1 Hz, 1H), 2.38 (s, 3H), 1.08 (s, 9H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.8, 150.4, 150.0, 144.4, 144.1, 142.7, 138.7, 137.6, 135.6, 135.4, 134.5, 131.4, 130.8, 129.8, 129.2, 129.0, 128.9, 128.5, 127.4, 125.3, 34.6, 30.9, 21.7. **HR–MS** (ESI) *m/z* calc. for

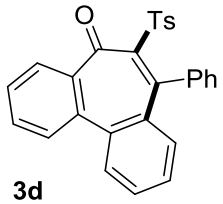
$C_{32}H_{29}O_3S$ $[M+H]^+$: 493.1832, found: 493.1814.



3c

8,10-Dimethyl-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3c)

The general procedure was followed using **1c** (93.0 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3c** (44.6 mg, 32%) as a yellow solid. **M.p.**: 107–109 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.83 (d, J = 7.7 Hz, 1H), 7.66 (td, J = 7.6, 1.8 Hz, 1H), 7.52–7.49 (m, 1H), 7.48 (dd, J = 7.5, 1.7 Hz, 1H), 7.23–7.20 (m, 2H), 7.08 (s, 3H), 6.88 (d, J = 8.4 Hz, 2H), 6.85 (s, 1H), 6.83 (d, J = 8.4 Hz, 2H), 2.32 (s, 3H), 2.23 (s, 3H), 1.73 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.3, 147.5, 145.3, 143.8, 143.6, 139.8, 139.6, 138.6, 138.3, 137.2, 136.9, 132.5, 131.7, 131.2, 129.2, 129.0, 128.8, 128.2, 128.0, 127.8, 127.4, 125.5, 23.2, 21.5, 21.3. **HR–MS** (EI) *m/z* calc. for $C_{30}H_{25}O_3S$ $[M+H]^+$: 465.1519, found: 465.1499.

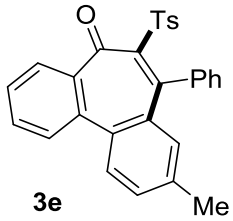


3d

7-Phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3d)

The general procedure was followed using **1d** (84.6 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3d** (32.7 mg, 25%) as a yellow solid. **M.p.**: 96–98 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.80 (d, J = 7.7 Hz, 1H), 7.70–7.66 (m, 2H), 7.53 (td, J = 7.5, 0.8 Hz, 2H), 7.46–7.43 (m, 4H), 7.38 (dd, J = 7.3, 7.3 Hz, 2H), 7.34 (dd, J = 7.6, 1.2 Hz, 1H), 7.23–7.20 (m, 2H), 7.13 (d, J = 8.2 Hz, 2H), 6.97 (dd, J = 8.1, 1.2 Hz, 1H), 2.38 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.6, 149.4, 144.7, 144.2, 143.3, 138.7, 138.4, 137.4, 135.5, 134.9, 132.7, 131.5, 131.2, 130.1, 129.3, 129.1, 128.9, 128.8, 128.7, 127.6,

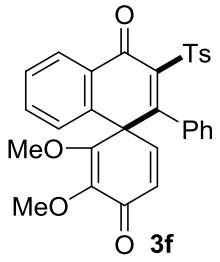
125.4, 21.7. **HR–MS** (ESI) *m/z* calc. for $C_{28}H_{21}O_3S$ $[M+H]^+$: 437.1206, found: 437.1191.



3e

9-Methyl-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3e)

The general procedure was followed using **1e** (88.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3e** (21.6 mg, 16%) as a yellow solid. **M.p.**: 190–192 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.80 (d, J = 7.9 Hz, 1H), 7.68 (td, J = 7.7, 1.3 Hz, 1H), 7.58 (d, J = 8.1 Hz, 1H), 7.52 (td, J = 7.5, 0.8 Hz, 2H), 7.45 (d, J = 8.3 Hz, 3H), 7.41 (dd, J = 7.3, 7.3 Hz, 1H), 7.34 (dd, J = 7.6, 1.1 Hz, 1H), 7.27 (d, J = 1.2 Hz, 1H), 7.18 (s. 1H), 7.14 (d, J = 8.1 Hz, 2H), 6.76 (s, 1H), 6.57 (s, 1H), 2.40 (s, 3H), 2.21 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.7, 149.6, 144.4, 144.1, 143.1, 138.7, 137.5, 137.4, 135.8, 135.5, 134.7, 132.9, 131.4, 131.2, 131.2, 129.2, 129.1, 128.8, 128.5, 128.5, 125.3, 21.7, 21.2. **HR–MS** (ESI) *m/z* calc. for $C_{29}H_{23}O_3S$ $[M+H]^+$: 451.1363, found: 451.1358.

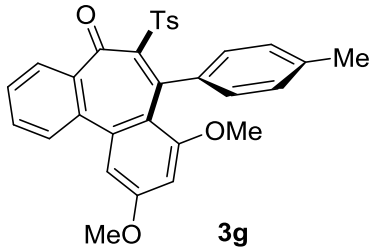


3f

(S)-2,3-dimethoxy-3'-tosyl-4'*H*-spiro[cyclohexane-1,1'-naphthalene]-2,5-diene-4,4'-dione (3f)

The general procedure was followed using **1f** (111.6 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3f** (61.4 mg, 40%) as a yellow solid. **M.p.**: 198–200 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.13 (dd, J = 7.9, 1.2 Hz, 1H), 7.86 (d, J = 8.3 Hz, 2H), 7.56 (td, J = 7.7, 1.5 Hz, 1H), 7.48 (td, J = 7.8, 1.2 Hz, 1H), 7.40 (td, J = 7.2, 1.2 Hz, 2H), 7.33 (td, J = 7.8, 2.4 Hz, 1H), 7.30 (d, J = 8.0 Hz, 2H), 7.25 (dt, J = 7.2, 1.2 Hz, 1H), 7.20

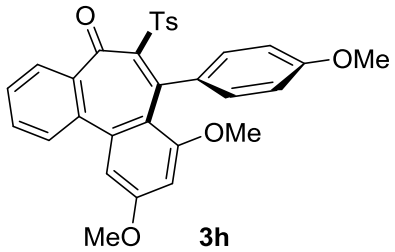
(d, *J* = 7.9 Hz, 1H), 7.15 (d, *J* = 6.8 Hz, 1H), 6.30 (q, *J* = 9.7 Hz, 2H), 3.81 (s, 3H), 3.41 (s, 3H), 2.41 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 183.9, 179.1, 162.3, 159.1, 144.5, 141.6, 140.9, 140.3, 138.7, 138.0, 134.1, 133.5, 130.1, 129.4, 129.2, 129.0, 128.0, 127.5, 127.4, 127.2, 127.0, 126.6, 61.3, 60.8, 57.3, 21.8. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{25}O_6S$ $[M+H]^+$: 513.1367, found: 513.1368.



3g

8,10-Dimethoxy-7-(*p*-tolyl)-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3g)

The general procedure was followed using **1g** (106.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3g** (94.9 mg, 62%) as a yellow solid. **M.p.**: 185–187 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 7.8 Hz, 1H), 7.65 (td, *J* = 7.7, 1.5 Hz, 1H), 7.52 (dd, *J* = 7.2, 7.2 Hz, 1H), 7.47 (dd, *J* = 7.5, 1.2 Hz, 1H), 7.13 (d, *J* = 8.3 Hz, 2H), 6.95 (d, *J* = 8.2 Hz, 2H), 6.88 (s, 2H), 6.68 (d, *J* = 2.4 Hz, 1H), 6.30 (d, *J* = 2.4 Hz, 1H), 3.82 (s, 3H), 3.21 (s, 3H), 2.29 (s, 6H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.8, 161.3, 160.8, 147.1, 145.2, 143.5, 142.0, 140.3, 139.1, 137.9, 135.9, 135.5, 131.1, 128.9, 128.7, 128.1, 128.0, 127.5, 125.5, 118.5, 106.8, 99.7, 55.7, 55.6, 21.6, 21.5. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{27}O_5S$ $[M+H]^+$: 511.1574, found: 511.1557.

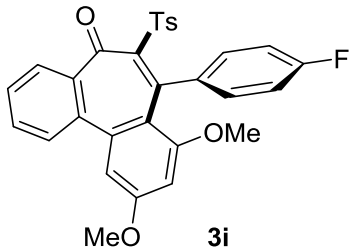


3h

8,10-Dimethoxy-7-(4-methoxyphenyl)-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3h)

The general procedure was followed using **1h** (111.6 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/

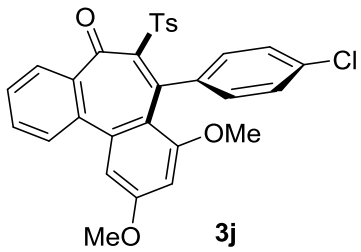
EtOAc = 3:1) yielded **3h** (131.0 mg, 83%) as a yellow oil. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.83 (d, J = 7.8 Hz, 1H), 7.64 (td, J = 7.7, 1.6 Hz, 1H), 7.51 (td, J = 7.5, 0.8 Hz, 1H), 7.47 (dd, J = 7.6, 1.5 Hz, 1H), 7.02 (d, J = 8.3 Hz, 2H), 6.90 (d, J = 8.1 Hz, 2H), 6.66 (d, J = 2.4 Hz, 1H), 6.59 (s, 2H), 6.30 (d, J = 2.4 Hz, 1H), 3.80 (s, 3H), 3.75 (s, 3H), 3.21 (s, 3H), 2.25 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.5, 161.2, 160.8, 159.5, 146.7, 145.1, 143.4, 141.7, 140.2, 138.9, 135.8, 131.1, 130.7, 128.8, 128.6, 128.1, 127.7, 125.4, 118.3, 112.2, 106.7, 99.5, 55.7, 55.5, 55.3, 21.5. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{27}O_6S$ $[M+H]^+$: 527.1523, found: 527.1501.



3i

7-(4-Fluorophenyl)-8,10-dimethoxy-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3i)

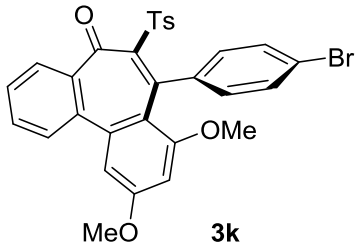
The general procedure was followed using **1i** (108.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3i** (84.8 mg, 55%) as a yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.84 (d, J = 7.8 Hz, 1H), 7.66 (td, J = 7.7, 1.4 Hz, 1H), 7.53 (dd, J = 7.2, 7.2 Hz, 1H), 7.46 (dd, J = 7.6, 1.1 Hz, 1H), 7.11 (d, J = 8.3 Hz, 2H), 6.99 (d, J = 8.2 Hz, 2H), 6.80 (s, 2H), 6.68 (d, J = 2.4 Hz, 1H), 6.30 (d, J = 2.4 Hz, 1H), 3.83 (s, 3H), 3.25 (s, 3H), 2.31 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.3, 162.5 (d, J = 247.8 Hz). 161.5, 160.6, 145.7, 145.0, 143.8, 142.4, 140.3, 138.8, 135.8, 134.3 (d, J = 3.3 Hz), 131.3, 129.0, 128.8, 128.2, 127.8, 125.5, 117.9, 115.1 (d, J = 22.0 Hz), 113.8 (d, J = 21.2 Hz), 106.9, 99.4, 55.6, 55.5, 21.5. **^{19}F NMR** (377 MHz, $CDCl_3$) δ –113.33. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{24}FO_5S$ $[M+H]^+$: 515.1323, found: 515.1313.



3j

7-(4-Chlorophenyl)-8,10-dimethoxy-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3j)

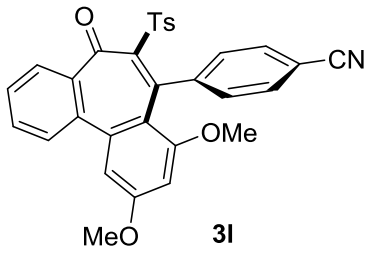
The general procedure was followed using **1j** (112.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3j** (119.3 mg, 75%) as a yellow solid. **M.p.**: 180–182 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.84 (d, J = 7.8 Hz, 1H), 7.66 (td, J = 7.7, 1.4 Hz, 1H), 7.53 (dd, J = 7.2, 7.2 Hz, 1H), 7.46 (dd, J = 7.6, 1.1 Hz, 1H), 7.11 (d, J = 8.3 Hz, 2H), 7.05 (s, 1H), 6.99 (d, J = 8.2 Hz, 2H), 6.68 (d, J = 2.4 Hz, 1H), 6.30 (d, J = 2.4 Hz, 1H), 3.83 (s, 3H), 3.25 (s, 3H), 2.31 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.2, 161.5, 160.5, 145.4, 145.0, 143.9, 142.6, 140.4, 138.8, 136.9, 135.8, 134.0, 131.3, 129.1, 129.0, 128.2, 127.9, 127.0, 125.5, 117.6, 106.9, 99.4, 55.6, 55.5, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{24}{}^{35}ClO_5S$ $[M+H]^+$: 531.1028, found: 531.0998.



3k

7-(4-Bromophenyl)-8,10-dimethoxy-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3k)

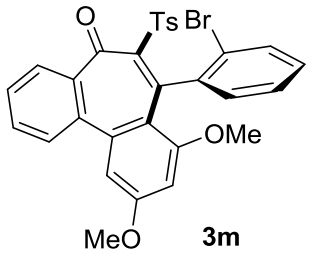
The general procedure was followed using **1k** (126.0 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3k** (99.9 mg, 58%) as a yellow solid. **M.p.**: 145–147 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (d, J = 7.7 Hz, 1H), 7.67 (td, J = 7.6, 1.5 Hz, 1H), 7.54 (td, J = 7.5, 1.0 Hz, 1H), 7.47 (dd, J = 7.6, 1.3 Hz, 1H), 7.20 (s, 2H), 7.11 (d, J = 8.4 Hz, 2H), 6.99 (d, J = 8.2 Hz, 2H), 6.68 (d, J = 2.4 Hz, 1H), 6.30 (d, J = 2.4 Hz, 1H), 3.83 (s, 3H), 3.26 (s, 3H), 2.32 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.2, 161.6, 160.5, 145.4, 145.0, 143.9, 142.7, 140.4, 138.8, 137.4, 135.8, 131.3, 129.9, 129.1, 128.9, 128.2, 128.0, 125.6, 122.3, 117.6, 107.0, 99.4, 55.6, 55.5, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{24}{}^{79}BrO_5S$ $[M+H]^+$: 575.0523, found: 575.0503.



3l

4-(8,10-Dimethoxy-5-oxo-6-tosyl-5*H*-dibenzo[a,c][7]annulen-7-yl)benzonitrile (3l)

The general procedure was followed using **1l** (110.1 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3l** (39.1 mg, 25%) as a yellow solid. **M.p.**: 82–84 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.84 (d, J = 7.7 Hz, 1H), 7.68 (td, J = 7.7, 1.4 Hz, 1H), 7.53 (td, J = 7.5, 0.9 Hz, 2H), 7.37 (dd, J = 7.6, 1.2 Hz, 2H), 7.23 (d, J = 8.3 Hz, 2H), 7.07 (d, J = 8.1 Hz, 2H), 6.70 (d, J = 2.4 Hz, 1H), 6.30 (d, J = 2.4 Hz, 1H), 3.85 (s, 3H), 3.24 (s, 3H), 2.36 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 192.9, 161.4, 161.0, 151.8, 146.0, 144.9, 143.0, 142.5, 140.5, 138.6, 137.9, 135.8, 133.5, 131.2, 128.8, 128.7, 128.3, 127.5, 125.7, 117.5, 107.1, 99.4, 55.7, 55.6, 21.4. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{24}NO_5S$ $[M+H]^+$: 522.1370, found: 522.1367.

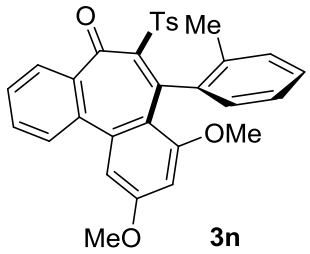


3m

7-(2-Bromophenyl)-8,10-dimethoxy-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3m)

The general procedure was followed using **1m** (126.0 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3m** (82.7 mg, 48%) as a yellow solid. **M.p.**: 175–177 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.77 (d, J = 7.8 Hz, 1H), 7.72 (d, J = 7.8 Hz, 1H), 7.65 (td, J = 7.7, 1.4 Hz, 1H), 7.53 (td, J = 7.5, 0.9 Hz, 1H), 7.48 (dd, J = 7.5, 1.3 Hz, 1H), 7.33–7.31 (m, 1H), 7.07–7.05 (m, 4H), 6.95 (d, J = 8.1 Hz, 2H), 6.65 (d, J = 2.4 Hz, 1H), 6.29 (d, J = 2.4 Hz, 1H), 3.81 (s, 3H), 3.28 (s, 3H), 2.30 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.2, 161.2, 159.8, 145.3, 144.8, 144.0, 143.9, 142.1, 137.8, 136.8, 136.6,

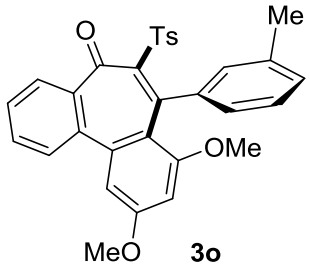
135.3, 132.0, 131.4, 129.5, 129.1, 128.6, 128.2, 128.0, 125.1, 124.7, 121.6, 116.2, 107.2, 98.9, 55.6, 55.3, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{24}{}^{79}BrO_5S$ $[M+H]^+$: 575.0523, found: 575.0523.



3n

8,10-Dimethoxy-7-(*o*-tolyl)-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3n)

The general procedure was followed using **1n** (106.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3n** (99.5 mg, 65%) as a yellow solid. **M.p.**: 230–232 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.77 (d, J = 7.6 Hz, 1H), 7.67 (td, J = 6.8, 1.2 Hz, 2H), 7.60 (d, J = 7.0 Hz, 1H), 7.53 (d, J = 6.9 Hz, 1H), 7.16 (dd, J = 7.4, 7.4 Hz, 1H), 7.09 (dd, J = 7.4, 7.4 Hz, 1H), 7.00 (d, J = 8.2 Hz, 2H), 6.91 (d, J = 8.2 Hz, 2H), 6.64 (dd, J = 10.5, 4.9 Hz, 2H), 6.29 (d, J = 2.4 Hz, 1H), 3.82 (s, 3H), 3.25 (s, 3H), 2.28 (s, 3H), 2.16 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.5, 161.1, 160.5, 147.3, 145.5, 143.6, 140.7, 138.6, 136.0, 135.5, 135.0, 133.4, 131.3, 129.4, 128.9, 128.3, 128.0, 127.9, 125.1, 123.8, 117.3, 107.0, 99.3, 55.6, 55.5, 21.6, 19.2. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{27}O_5S$ $[M+H]^+$: 511.1574, found: 511.1556.

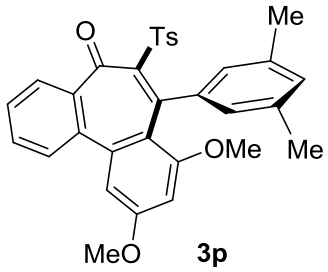


3o

8,10-Dimethoxy-7-(*m*-tolyl)-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3o)

The general procedure was followed using **1o** (106.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3o** (76.5 mg, 50%) as a yellow oil. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.88 (d, J = 7.8 Hz, 1H), 7.69 (td, J = 7.2, 1.8 Hz, 1H), 7.61–7.56 (m, 2H), 7.04 (s,

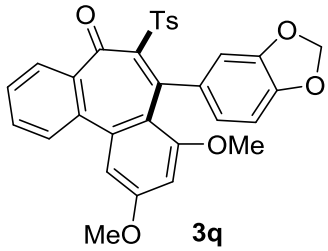
3H), 6.97 (d, *J* = 7.8 Hz, 1H), 6.93 (s, 2H), 6.72 (d, *J* = 2.4 Hz, 1H), 6.33 (d, *J* = 2.4 Hz, 1H), 3.85 (s, 3H), 3.21 (s, 3H), 2.28 (s, 3H), 2.08 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.6, 161.3, 160.8, 147.1, 145.1, 143.3, 142.2, 140.3, 139.2, 138.1, 136.2, 135.8, 131.2, 128.9, 128.8, 128.7, 128.2, 127.8, 126.7, 125.5, 118.3, 106.9, 99.7, 55.7, 55.6, 21.5, 21.2. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{27}O_5S$ $[M+H]^+$: 511.1574, found: 511.1561.



3p

7-(3,5-Dimethylphenyl)-8,10-dimethoxy-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3p)

The general procedure was followed using **1p** (111.0 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3p** (84.9 mg, 54%) as a yellow solid. **M.p.**: 200–202 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.8 Hz, 1H), 7.66 (td, *J* = 7.6, 1.6 Hz, 1H), 7.61 (dd, *J* = 7.6, 1.5 Hz, 1H), 7.55 (td, *J* = 7.6, 0.8 Hz, 1H), 7.08 (d, *J* = 8.2 Hz, 2H), 6.95 (d, *J* = 8.2 Hz, 2H), 6.78 (s, 1H), 6.70 (d, *J* = 2.4 Hz, 1H), 6.31 (d, *J* = 2.4 Hz, 1H), 3.82 (s, 3H), 3.19 (s, 3H), 2.29 (s, 3H), 2.12 (s, 6H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.8, 161.2, 160.9, 147.3, 145.2, 143.2, 142.1, 140.3, 139.4, 138.0, 135.8, 131.1, 129.5, 128.8, 128.8, 128.2, 127.8, 125.5, 118.4, 107.0, 99.8, 55.8, 55.6, 21.5, 21.1. **HR–MS** (ESI) *m/z* calc. for $C_{32}H_{29}O_5S$ $[M+H]^+$: 525.1730, found: 525.1707.

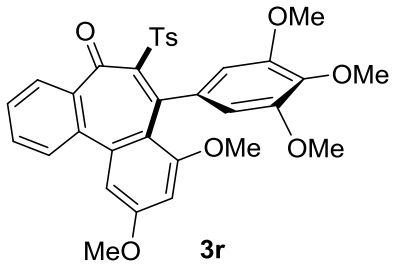


3q

7-(Benzo[*d*][1,3]dioxol-5-yl)-8,10-dimethoxy-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3q)

The general procedure was followed using **1q** (115.8 mg, 0.30 mmol) and **2a** (107.0

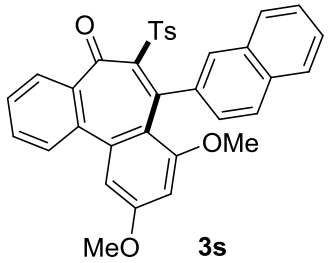
mg, 0.75 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3q** (90.7 mg, 56%) as a yellow solid. **M.p.**: 109–111 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.84 (d, J = 7.9 Hz, 1H), 7.71–7.65 (td, J = 6.6, 2.4 Hz, 1H), 7.57–7.54 (m, 2H), 7.17 (d, J = 8.1 Hz, 2H), 7.00 (d, J = 8.1 Hz, 2H), 6.71 (d, J = 2.4 Hz, 1H), 6.59 (d, J = 6.1 Hz, 2H), 6.35 (d, J = 2.3 Hz, 2H), 5.93 (s, 1H), 5.88 (s, 1H), 3.86 (s, 3H), 3.35 (s, 3H), 2.32 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.6, 161.4, 160.9, 147.5, 146.5, 146.2, 145.2, 143.6, 142.2, 140.4, 139.1, 135.9, 132.2, 131.2, 128.9, 128.8, 128.1, 128.0, 125.7, 118.0, 107.0, 106.8, 101.1, 99.5, 55.8, 55.6, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{25}O_7S$ $[M+H]^+$: 541.1316, found: 541.1293.



3r

8,10-Dimethoxy-6-tosyl-7-(3,4,5-trimethoxyphenyl)-5*H*-dibenzo[a,c][7]annulen-5-one (3r)

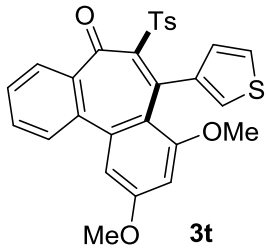
The general procedure was followed using **1r** (129.6 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3r** (54.5 mg, 31%) as a yellow solid. **M.p.**: 218–220 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (d, J = 7.8 Hz, 1H), 7.69 (td, J = 7.6, 1.8 Hz, 1H), 7.63–7.57 (m, 2H), 6.81 (d, J = 8.3 Hz, 2H), 6.76 (d, J = 8.4 Hz, 2H), 6.68 (d, J = 2.4 Hz, 1H), 6.31 (d, J = 2.4 Hz, 1H), 3.83 (s, 3H), 3.82 (s, 3H), 3.74–3.41 (m, 6H), 3.27 (s, 3H), 2.20 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.0, 161.8, 160.2, 144.8, 144.5, 144.5, 143.5, 143.1, 140.7, 138.6, 135.7, 131.6, 130.5, 129.4, 129.1, 128.3, 128.2, 125.6, 118.9, 116.9, 111.5, 107.2, 99.3, 55.7, 55.3, 21.7. **HR–MS** (ESI) *m/z* calc. $C_{33}H_{31}O_8S$ $[M+H]^+$: 587.1734, found: 587.1700.



3s

8,10-Dimethoxy-7-(naphthalen-2-yl)-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3s)

The general procedure was followed using **1s** (117.6 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3s** (90.1 mg, 55%) as a yellow solid. **M.p.**: 106–108 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92 (d, J = 7.9 Hz, 1H), 7.77 (d, J = 8.1 Hz, 1H), 7.72–7.68 (m, 1H), 7.61–7.55 (m, 3H), 7.45 (dd, J = 7.4, 7.4 Hz, 1H), 7.39 (s, 1H), 6.96 (d, J = 8.2 Hz, 2H), 6.74 (d, J = 2.4 Hz, 1H), 6.69 (d, J = 6.3 Hz, 2H), 6.28 (d, J = 2.4 Hz, 1H), 3.83 (s, 3H), 3.10 (s, 3H), 2.14 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.5, 161.4, 160.7, 146.7, 145.1, 143.6, 142.7, 140.3, 138.7, 135.8, 132.8, 132.2, 131.2, 128.9, 128.7, 128.2, 128.1, 127.8, 127.6, 126.3, 125.9, 125.6, 106.9, 99.5, 55.6, 55.6, 21.4. **HR–MS** (ESI) *m/z* calc. for $C_{34}H_{27}O_5S$ $[M+H]^+$: 547.1574, found: 547.1557.

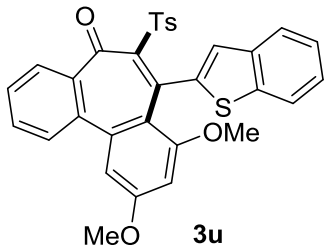


3t

8,10-Dimethoxy-7-(thiophen-3-yl)-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3t)

The general procedure was followed using **1t** (104.4 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3t** (45.2 mg, 30%) as a yellow solid. **M.p.**: 60–62 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.82 (d, J = 7.8 Hz, 1H), 7.66 (td, J = 8.8, 1.6 Hz, 1H), 7.57–7.50 (m, 3H), 7.05 (d, J = 8.3 Hz, 2H), 7.01–6.98 (m, 2H), 6.93 (s, 1H), 6.72 (dd, J = 4.5, 1.7 Hz, 1H), 6.67 (d, J = 2.4 Hz, 1H), 6.33 (d, J = 2.4 Hz, 1H), 3.84 (s, 3H), 3.30 (s, 3H), 2.27 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.2, 161.3, 161.0, 145.1, 143.5, 141.6, 140.1, 138.6, 138.2, 135.9, 131.2, 129.5, 128.9, 128.8, 128.2, 127.6, 127.5, 126.0,

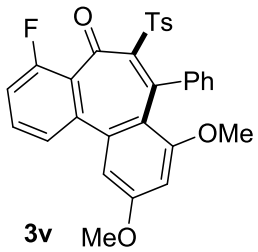
125.5, 123.3, 118.2, 106.8, 99.5, 55.9, 55.6, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{28}H_{23}O_5S_2$ $[M+H]^+$: 503.0982, found: 503.0974.



3u

7-(Benzo[*b*]Thiophen-2-yl)-8,10-dimethoxy-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3u)

The general procedure was followed using **1u** (119.4 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3u** (41.4 mg, 25%) as a yellow solid. **M.p.**: 88–90 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.86 (d, J = 7.8 Hz, 1H), 7.78 (d, J = 8.0 Hz, 1H), 7.70 (td, J = 7.8, 1.2 Hz, 1H), 7.67 (s, 1H), 7.63–7.58 (m, 2H), 7.52 (d, J = 8.1 Hz, 1H), 7.35 (td, J = 7.8, 1.2 Hz, 1H), 7.26–7.23 (m, 1H), 6.91 (d, J = 8.3 Hz, 2H), 6.68 (d, J = 2.4 Hz, 1H), 6.65 (d, J = 8.1 Hz, 2H), 6.34 (d, J = 2.4 Hz, 1H), 3.86 (s, 3H), 3.31 (s, 3H), 2.14 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 192.7, 161.7, 161.4, 144.8, 143.6, 143.6, 141.1, 140.6, 139.2, 139.1, 138.6, 137.9, 135.9, 131.3, 128.9, 128.8, 128.7, 128.4, 127.9, 125.8, 124.8, 124.5, 124.3, 121.7, 116.8, 107.1, 99.2, 55.9, 55.7, 21.5. **HR–MS** (ESI) *m/z* calc. for $C_{32}H_{25}O_5S_2$ $[M+H]^+$: 553.1138, found: 553.1128.

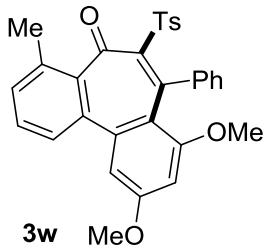


3v

4-Fluoro-8,10-dimethoxy-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3v)

The general procedure was followed using **1v** (108.0 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3v** (69.4 mg, 45%) as a yellow solid. **M.p.**: 196–198 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.67–7.62 (m, 2H), 7.28 (d, J = 8.2 Hz, 3H), 7.21 (d, J = 7.3 Hz,

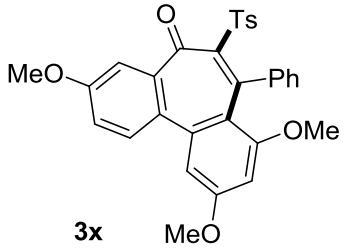
1H), 7.13 (dd, *J* = 7.2, 7.2 Hz, 2H), 7.04 (d, *J* = 8.1 Hz, 2H), 6.96 (s, 2H), 6.67 (d, *J* = 2.4 Hz, 1H), 6.33 (d, *J* = 2.3 Hz, 1H), 3.84 (s, 3H), 3.21 (s, 3H), 2.33 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 188.2, 161.4, 160.6, 156.2 (d, *J* = 257.6 Hz), 146.9, 143.8, 142.4, 139.4 (d, *J* = 2.5 Hz), 139.1, 138.4 (d, *J* = 2.3 Hz), 137.8, 132.5, 132.4 (d, *J* = 2.6 Hz), 132.3, 129.1, 128.1 127.9, 126.8, 124.1 (d, *J* = 3.5 Hz), 118.1, 116.1 (d, *J* = 21.2 Hz), 107.2, 99.9, 55.6, 55.6, 21.6. **^{19}F NMR** (377 MHz, $CDCl_3$) δ –115.86. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{24}FO_5S$ $[M+H]^+$: 515.1323, found: 515.1313.



3w

8,10-Dimethoxy-4-methyl-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3w)

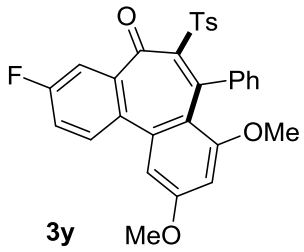
The general procedure was followed using **1w** (106.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3w** (99.5 mg, 65%) as a yellow solid. **M.p.**: 169–171 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 7.7 Hz, 1H), 7.53 (dd, *J* = 7.7, 7.7 Hz, 1H), 7.42 (d, *J* = 7.6 Hz, 1H), 7.15 (dd, *J* = 7.3, 7.3 Hz, 1H), 7.03 (s, 2H), 6.97 (d, *J* = 8.3 Hz, 2H), 6.88 (d, *J* = 8.2 Hz, 2H), 6.59 (d, *J* = 2.4 Hz, 1H), 6.27 (d, *J* = 2.4 Hz, 1H), 3.80 (s, 3H), 3.19 (s, 3H), 2.68 (s, 3H), 2.25 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 192.9, 161.1, 160.2, 146.6, 143.6, 143.3, 142.6, 141.1, 139.4, 137.7, 137.1, 135.2, 131.1, 130.5, 128.9, 127.8, 127.3, 126.6, 126.4, 118.2, 107.4, 99.4, 55.6, 55.5, 21.5, 19.0. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{27}O_5S$ $[M+H]^+$: 511.1574, found: 511.1559.



3x

3,8,10-Trimethoxy-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3x)

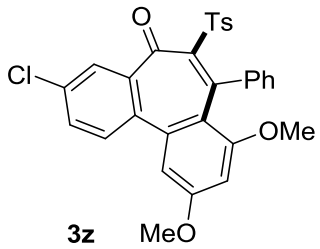
The general procedure was followed using **1x** (111.6 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3x** (88.4 mg, 56%) as a red oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.76 (d, *J* = 8.7 Hz, 1H), 7.23–7.13 (m, 5H), 7.09 (s, 1H), 6.98–6.95 (m, 4H), 6.64 (d, *J* = 2.4 Hz, 1H), 6.26 (d, *J* = 2.4 Hz, 1H), 3.88 (s, 3H), 3.82 (s, 3H), 3.16 (s, 3H), 2.29 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.5, 161.3, 160.9, 159.9, 147.2, 146.1, 143.6, 140.1, 139.0, 138.5, 129.7, 129.0, 128.6, 128.0, 128.0, 126.7, 118.6, 118.0, 108.9, 106.4, 99.1, 55.8, 55.6, 55.5, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{27}O_6S$ $[M+H]^+$: 527.1523, found: 527.1501.



3y

3-Fluoro-8,10-dimethoxy-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3y)

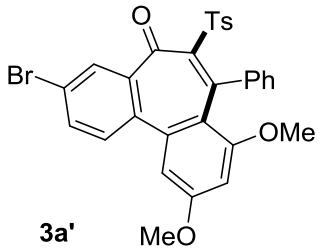
The general procedure was followed using **1y** (101.3 mg, 0.30 mmol) and **2a** (103.4 mg, 0.75 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3y** (78.6 mg, 51%) as a yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (dd, *J* = 8.7, 4.9 Hz, 1H), 7.33 (td, *J* = 8.4, 2.8 Hz, 1H), 7.17 (d, *J* = 8.3 Hz, 3H), 7.10 (dd, *J* = 7.9, 2.7 Hz, 3H), 6.99 (d, *J* = 8.1 Hz, 2H), 6.63 (d, *J* = 2.4 Hz, 1H), 6.30 (d, *J* = 2.4 Hz, 1H), 3.82 (s, 3H), 3.17 (s, 3H), 2.31 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 192.3, 162.6 (d, *J* = 252.3 Hz), 161.4, 160.9, 147.4, 146.4 (d, *J* = 6.8 Hz), 143.9, 141.6, 139.2, 138.7, 138.2, 132.1 (d, *J* = 3.3 Hz), 130.4 (d, *J* = 7.9 Hz), 129.1, 128.2, 128.1, 126.8, 118.3 (d, *J* = 21.7 Hz), 118.1, 112.3 (d, *J* = 23.4 Hz), 106.7, 99.6, 55.6, 55.6, 21.6. **^{19}F NMR** (377 MHz, $CDCl_3$) δ –111.56. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{24}FO_5S$ $[M+H]^+$: 515.1323, found: 515.1311.



3z

3-Chloro-8,10-dimethoxy-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3z)

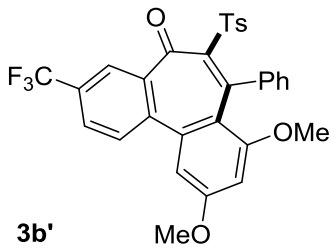
The general procedure was followed using **1z** (112.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3z** (71.6 mg, 45%) as a yellow solid. **M.p.**: 207–209 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.79 (d, J = 8.5 Hz, 1H), 7.60 (dd, J = 8.4, 2.3 Hz, 1H), 7.29 (d, J = 1.6 Hz, 1H), 7.27 (s, 1H), 7.24 (d, J = 7.3 Hz, 1H), 7.17 (s, 2H), 7.13 (d, J = 2.2 Hz, 1H), 7.08 (d, J = 8.1 Hz, 2H), 6.65 (d, J = 2.4 Hz, 1H), 6.34 (d, J = 2.4 Hz, 1H), 3.85 (s, 3H), 3.21 (s, 3H), 2.38 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 192.3, 161.5, 161.0, 147.3, 145.8, 144.2, 141.8, 139.1, 138.5, 138.4, 135.1, 134.3, 131.2, 129.5, 129.2, 128.5, 128.3, 126.9, 125.0, 118.3, 106.8, 99.9, 55.6, 55.6, 21.7. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{24}{}^{35}ClO_5S$ $[M+H]^+$: 531.1028, found: 531.1018.



3a'

3-Bromo-8,10-dimethoxy-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3a')

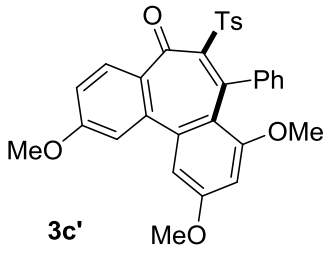
The general procedure was followed using **1a'** (126.0 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3a'** (91.3 mg, 53%) as a white solid. **M.p.**: 200–202 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.77–7.72 (m, 2H), 7.30–7.27 (m, 2H), 7.24 (d, J = 7.2 Hz, 1H), 7.21 (d, J = 1.7 Hz, 1H), 7.18 (s, 2H), 7.09 (d, J = 8.2 Hz, 2H), 6.65 (d, J = 2.3 Hz, 1H), 6.34 (d, J = 2.3 Hz, 1H), 3.84 (s, 3H), 3.20 (s, 3H), 2.39 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 192.1, 161.5, 161.0, 147.2, 145.8, 144.2, 141.7, 139.1, 138.3, 138.3, 134.7, 134.1, 129.7, 129.2, 128.5, 128.3, 127.8, 126.9, 123.1, 118.1, 106.7, 99.9, 55.6, 55.6, 21.7. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{24}{}^{79}BrO_5S$ $[M+H]^+$: 575.0523, found: 575.0509.



3b'

8,10-Dimethoxy-7-phenyl-6-tosyl-3-(trifluoromethyl)-5*H*-dibenzo[a,c][7]annulen-5-one (3b')

The general procedure was followed using **1b'** (123.0 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3b'** (59.2 mg, 35%) as a yellow solid. **M.p.**: 196–198 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.97 (d, J = 8.2 Hz, 1H), 7.86 (dd, J = 8.3, 1.4 Hz, 1H), 7.32 (s, 1H), 7.28 (d, J = 8.3 Hz, 2H), 7.24 (d, J = 7.3 Hz, 1H), 7.18 (s, 2H), 7.07 (d, J = 8.1 Hz, 2H), 6.67 (d, J = 2.4 Hz, 1H), 6.36 (d, J = 2.4 Hz, 1H). 3.84 (s, 3H), 3.21 (s, 3H), 2.35 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 192.5, 161.6, 161.0, 147.3, 145.0, 144.5, 142.1, 139.2, 138.7, 138.3, 138.2, 130.6 (q, J = 33.5 Hz), 129.3, 128.8, 128.6, 128.4, 127.8 (q, J = 3.0 Hz), 126.9, 123.6 (q, J = 273.3 Hz), 122.4 (q, J = 3.0 Hz), 118.5, 107.1, 100.4, 55.7, 21.6. **^{19}F NMR** (565 MHz, $CDCl_3$) δ –62.58. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{24}F_3O_5S$ $[M+H]^+$: 565.1291, found: 565.1272.

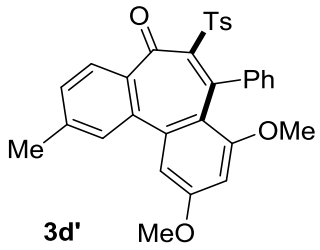


3c'

2,8,10-Trimethoxy-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3c')

The general procedure was followed using **1c'** (111.6 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3c'** (96.3 mg, 61%) as a yellow solid. **M.p.**: 213–215 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.39 (d, J = 8.5 Hz, 1H), 7.33 (d, J = 2.3 Hz, 1H), 7.20–7.11 (m, 4H), 7.08 (s, 1H), 7.03 (dd, J = 8.5, 2.4 Hz, 1H), 6.96 (d, J = 8.2 Hz, 2H), 6.67 (d, J = 2.4 Hz, 1H), 6.29 (d, J = 2.4 Hz, 1H), 3.95 (s, 3H), 3.81 (s, 3H), 3.16 (s, 3H),

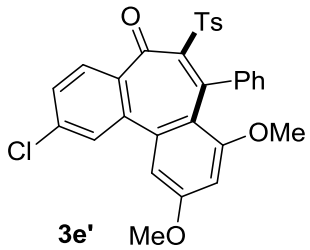
2.29 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 192.7, 161.8, 161.3, 160.8, 146.3, 143.5, 142.3, 140.1, 138.9, 138.7, 138.4, 137.9, 128.9, 128.0, 127.9, 127.6, 126.7, 118.3, 113.8, 113.6, 106.9, 99.5, 55.8, 55.6, 55.5, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{27}O_6S$ $[M+H]^+$: 527.1523, found: 527.1501.



3d'

8,10-Dimethoxy-2-methyl-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3d')

The general procedure was followed using **1d'** (106.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3d'** (91.8 mg, 60%) as a white solid. **M.p.**: 218–220 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.63 (s, 1H), 7.36 (dd, J = 7.5, 7.5 Hz, 2H), 7.16 (d, J = 7.2 Hz, 1H), 7.11 (d, J = 8.1 Hz, 4H), 6.94 (d, J = 8.1 Hz, 2H), 6.68 (d, J = 2.2 Hz, 1H), 6.29 (d, J = 2.2 Hz, 1H), 3.82 (s, 3H), 3.17 (s, 3H), 2.54 (s, 3H), 2.28 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.5, 161.3, 160.7, 146.6, 143.5, 142.8, 142.2, 141.6, 140.4, 139.0, 138.4, 135.9, 129.5, 128.9, 128.6, 127.9, 126.7, 125.5, 118.4, 106.8, 99.5, 55.6, 55.5, 21.9, 21.5. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{27}O_5S$ $[M+H]^+$: 511.1574, found: 511.1554.

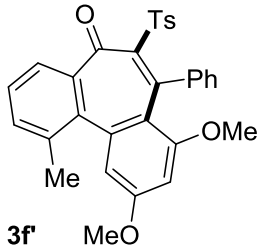


3e'

2-Chloro-8,10-dimethoxy-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3e')

The general procedure was followed using **1e'** (112.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3e'** (79.5 mg, 50%) as a yellow solid. **M.p.**: 227–229 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.85 (d, J = 1.9 Hz, 1H), 7.54 (dd, J = 8.2, 1.9 Hz, 1H),

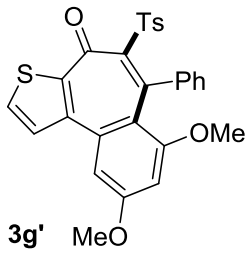
7.46 (d, *J* = 8.2 Hz, 1H), 7.28–7.12 (m, 3H), 7.09 (s, 2H), 7.01 (d, *J* = 8.1 Hz, 2H), 6.68 (d, *J* = 2.4 Hz, 1H), 6.34 (d, *J* = 2.4 Hz, 1H), 3.87 (s, 3H), 3.20 (s, 3H), 2.33 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 192.6, 161.5, 160.8, 147.0, 143.8, 143.4, 142.3, 138.9, 138.9, 138.1, 137.5, 137.2, 129.1, 128.8, 128.2, 128.1, 128.0, 127.0, 126.8, 118.4, 106.8, 100.1, 55.7, 55.6, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{24}{}^{35}ClO_5S$ $[M+H]^+$: 531.1028, found: 531.1008.



3f'

(*S*)-8,10-Dimethoxy-1-methyl-7-phenyl-6-tosyl-5*H*-dibenzo[a,c][7]annulen-5-one (3f')

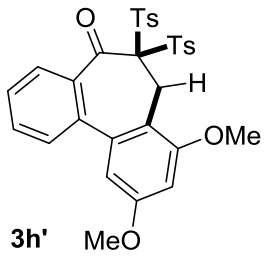
The general procedure was followed using **1f'** (106.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3f'** (53.6 mg, 35%) as a yellow solid. **M.p.**: 209–211 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.51 (d, *J* = 7.1 Hz, 1H), 7.38 (dd, *J* = 7.6, 7.6 Hz, 1H), 7.30 (d, *J* = 6.8 Hz, 1H), 7.18 (dd, *J* = 7.4, 7.4 Hz, 1H), 7.09 (dd, *J* = 7.5, 7.5 Hz, 2H), 6.99 (d, *J* = 8.3 Hz, 2H), 6.90 (d, *J* = 8.2 Hz, 2H), 6.50 (d, *J* = 2.4 Hz, 1H), 6.27 (d, *J* = 2.4 Hz, 1H), 3.77 (s, 3H), 3.26 (s, 3H), 2.59 (s, 3H), 2.28 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.5, 160.1, 160.0, 147.2, 146.6, 143.6, 143.5, 138.8, 138.6, 137.7, 136.0, 135.2, 133.8, 128.9, 128.0, 127.8, 126.8, 122.8, 118.0, 108.0, 99.2, 55.5, 55.5, 21.8, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{27}O_5S$ $[M+H]^+$: 511.1574, found: 511.1541.



3g'

7,9-Dimethoxy-6-phenyl-5-tosyl-4*H*-benzo[3,4]cyclohepta[1,2-b]thiophen-4-one (3g')

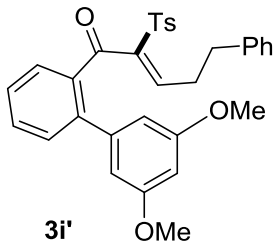
The general procedure was followed using **1g'** (104.4 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3g'** (90.4 mg, 60%) as a yellow oil. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.66 (d, J = 5.1 Hz, 1H), 7.61 (d, J = 5.1 Hz, 1H), 7.45 (d, J = 8.2 Hz, 2H), 7.23 (dd, J = 7.2, 7.2 Hz, 1H), 7.11 (d, J = 8.3 Hz, 3H), 6.84 (d, J = 2.4 Hz, 1H), 6.32 (d, J = 2.3 Hz, 1H), 3.87 (s, 3H), 3.12 (s, 3H), 2.36 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 184.1, 162.1, 161.9, 147.4, 143.9, 143.6, 140.9, 140.3, 139.8, 139.0, 135.7, 130.7, 129.1, 128.5, 128.1, 127.0, 119.0, 104.7, 99.7, 55.6, 55.5, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{28}H_{23}O_5S_2$ $[M+H]^+$: 503.0982, found: 503.0972.



3h'

8,10-Dimethoxy-6,6-ditosyl-6,7-dihydro-5*H*-dibenzo[a,c][7]annulen-5-one (3h')

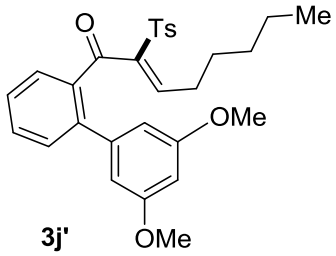
The general procedure was followed using **1h'** (79.8 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3h'** (34.6 mg, 20%) as a yellow solid. **M.p.**: 113–115 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.90 (dd, J = 7.8, 1.1 Hz, 1H), 7.78 (d, J = 8.1 Hz, 1H), 7.56 (td, J = 7.6, 1.6 Hz,1H), 7.51 (d, J = 8.2 Hz, 2H), 7.32 (d, J = 7.7 Hz, 1H), 7.16 (td, J = 8.4, 2.4 Hz, 5H), 6.95 (d, J = 8.2 Hz, 2H), 6.35 (d, J = 2.3 Hz, 1H), 5.36 (d, J = 13.5 Hz, 1H), 5.04 (d, J = 13.5 Hz, 1H), 3.92 (s, 3H), 3.66 (s, 3H), 2.36 (s, 3H), 2.27 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 188.7, 162.1, 161.8, 145.3, 144.3, 138.2, 136.8, 134.7, 134.5, 133.3, 130.3, 129.5, 129.1, 128.8, 128.5, 128.4, 128.3, 123.8, 108.8, 102.2, 99.4, 57.1, 55.5, 55.5, 21.7, 21.6. **HR–MS** (ESI) *m/z* calc. for $C_{31}H_{29}O_7S_2$ $[M+H]^+$: 577.1349, found: 577.1326.



3i'

(*Z*)-1-(3',5'-Dimethoxy-[1,1'-biphenyl]-2-yl)-5-phenyl-2-tosylpent-2-en-1-one (3i')

The general procedure was followed using **1i'** (111.0 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3i'** (47.3 mg, 30%) as a yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.63 (dd, J = 6.6, 6.6 Hz, 1H), 7.58 (d, J = 7.5 Hz, 1H), 7.51–7.48 (m, 4H), 7.32 (d, J = 8.1 Hz, 2H), 7.27 (d, J = 7.6 Hz, 2H), 7.21–7.18 (m, 3H), 6.93 (s, 1H), 6.57 (s, 1H), 6.49 (d, J = 1.9 Hz, 2H), 3.77 (s, 6H), 2.81–2.77 (m, 2H), 2.59–2.55 (m, 2H), 2.45 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 194.9, 161.2, 153.5, 145.1, 142.0, 141.2, 141.1, 140.2, 134.8, 131.9, 130.6, 130.1, 130.0, 129.0, 128.9, 128.6, 128.5, 128.1, 126.3, 107.7, 101.2, 55.6, 35.0, 30.4, 21.8. **HR–MS** (ESI) *m/z* calc. for $C_{32}H_{31}O_5S$ $[M+H]^+$: 527.1887, found: 527.1875.

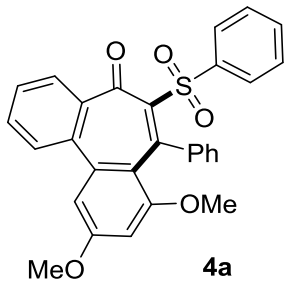


3j'

(*Z*)-1-(3',5'-Dimethoxy-[1,1'-biphenyl]-2-yl)-2-tosyloct-2-en-1-one (3j')

The general procedure was followed using **1j'** (100.9 mg, 0.30 mmol) and **2a** (107.0 mg, 0.60 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **3j'** (95.9 mg, 65%) as a yellow solid. **M.p.**: 89–91 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.60 (dd, J = 7.9, 1.2 Hz, 1H), 7.56 (td, J = 7.6, 1.3 Hz, 1H), 7.49–7.41 (m, 4H), 7.29 (d, J = 8.1 Hz, 2H), 6.84 (s, 1H), 6.55 (dd, J = 2.2, 2.2 Hz, 1H), 6.45 (d, J = 2.2 Hz, 2H), 3.77 (s, 6H), 2.54–2.48 (m, 2H), 2.43 (s, 3H), 1.27–1.17 (m, 6H), 0.81 (t, J = 6.8 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 195.0, 161.1, 154.8, 144.9, 142.0, 141.2, 140.3, 135.1, 131.8, 130.3, 130.0, 129.9, 128.9, 128.0, 107.7, 101.1, 55.6,

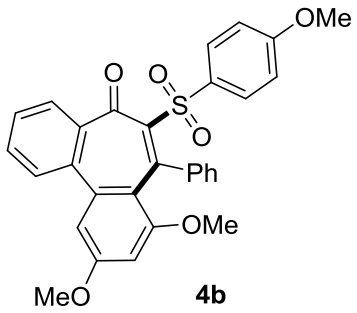
32.1, 28.7, 27.7, 22.2, 21.8, 14.0. **HR–MS** (ESI) *m/z* calc. for $C_{29}H_{33}O_5S$ $[M+H]^+$: 493.2043, found: 493.2036.



4a

8,10-Dimethoxy-7-phenyl-6-(phenylsulfonyl)-5*H*-dibenzo[a,c][7]annulen-5-one (4a)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2b** (147.6 mg, 0.90 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4a** (89.7 mg, 62%) as a yellow solid. **M.p.**: 203–205 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.85 (d, J = 7.8 Hz, 1H), 7.67 (td, J = 8.4, 2.0 Hz, 1H), 7.58–7.52 (m, 2H), 7.34–7.30 (m, 1H), 7.19–7.08 (m, 6H), 7.06 (s, 1H), 6.69 (d, J = 2.4 Hz, 1H), 6.30 (d, J = 2.4 Hz, 1H), 3.82 (s, 3H), 3.18 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.3, 161.4, 160.7, 147.2, 145.0, 141.9, 141.7, 140.3, 138.2, 135.8, 132.6, 131.3, 128.8, 128.3, 128.2, 128.0, 127.7, 126.9, 125.5, 118.2, 106.9, 99.6, 55.6, 55.6. **HR–MS** (ESI) *m/z* calc. for $C_{29}H_{23}O_5S$ $[M+H]^+$: 483.1261, found: 483.1246.

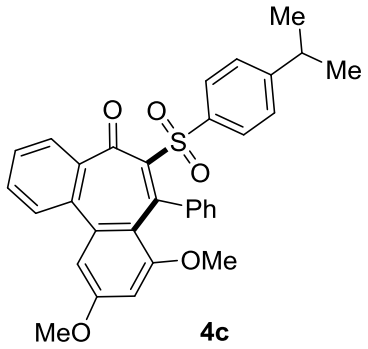


4b

8,10-Dimethoxy-6-((4-methoxyphenyl) sulfonyl)-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4b)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2c** (174.6 mg, 0.90 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4b** (92.2 mg, 60%) as a yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.84 (d, J = 7.8 Hz, 1H), 7.65 (td, J = 7.5, 1.9 Hz, 1H), 7.56–7.49 (m, 2H), 7.17 (dd, J = 7.2, 7.2 Hz, 2H), 7.09 (d, J = 9.0 Hz, 3H), 6.68 (d, J = 2.4 Hz, 1H), 6.58 (d, J = 9.0

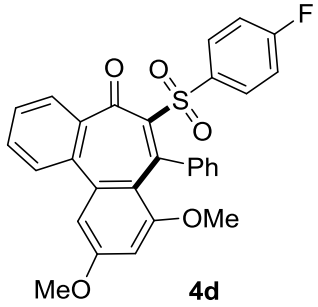
Hz, 2H), 6.29 (d, *J* = 2.4 Hz, 1H), 3.81 (s, 3H), 3.73 (s, 3H), 3.17 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.7, 162.9, 161.3, 160.7, 146.4, 145.1, 142.4, 140.2, 138.3, 135.8, 133.3, 131.2, 130.0, 128.7, 128.1, 128.0, 126.8, 125.4, 118.3, 113.5, 106.9, 99.6, 55.6, 55.6, 55.5. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{25}O_6S$ $[M+H]^+$: 513.1367, found: 513.1351.



4c

6-((4-Isopropylphenyl)sulfonyl)-8,10-dimethoxy-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4c)

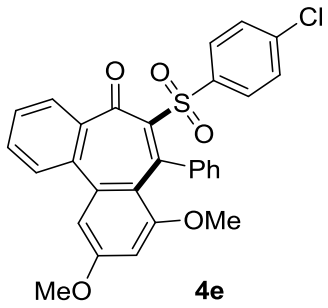
The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2d** (185.4 mg, 0.90 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4c** (89.6 mg, 57%) as a yellow solid. **M.p.**: 190–192 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.8 Hz, 1H), 7.67 (td, *J* = 7.7, 1.4 Hz, 1H), 7.53 (td, *J* = 7.6, 0.4 Hz, 1H), 7.46 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.15 (dd, *J* = 7.2, 7.2 Hz, 2H), 7.03 (d, *J* = 8.4 Hz, 3H), 6.93 (d, *J* = 8.4 Hz, 3H), 6.69 (d, *J* = 2.4 Hz, 1H), 6.30 (d, *J* = 2.4 Hz, 1H), 3.82 (s, 3H), 3.17 (s, 3H), 2.84–2.77 (m, 1H), 1.15 (dd, *J* = 6.9, 2.5 Hz, 6H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.5, 161.3, 160.7, 154.1, 146.6, 145.0, 142.2, 140.3, 138.8, 138.3, 135.9, 131.2, 128.7, 128.2, 128.0, 127.9, 126.8, 126.4, 125.5, 118.3, 106.9, 99.6, 55.6, 55.6, 34.2, 23.8, 23.5. **HR–MS** (ESI) *m/z* calc. for $C_{32}H_{29}O_5S$ $[M+H]^+$: 525.1730, found: 525.1708.



4d

6-((4-Fluorophenyl)sulfonyl)-8,10-dimethoxy-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4d)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2e** (163.8 mg, 0.90 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4d** (72.0 mg, 48%) as a yellow solid. **M.p.**: 185–187 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (d, J = 7.9 Hz, 1H), 7.70–7.66 (m, 1H), 7.57 (d, J = 4.2 Hz, 2H), 7.18 (dd, J = 7.3, 7.3 Hz, 1H), 7.13–7.02 (m, 4H), 6.76 (dd, J = 8.6, 8.6 Hz, 2H), 6.69 (d, J = 2.4 Hz, 1H), 6.31 (d, J = 2.4 Hz, 1H), 3.83 (s, 3H), 3.18 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.0, 164.9 (d, J = 255.5 Hz), 161.5, 160.7, 147.3, 144.9, 141.8, 140.3, 138.1, 137.7 (d, J = 3.0 Hz), 135.8, 131.4, 130.4 (d, J = 9.6 Hz), 128.9, 128.3, 128.2, 126.9, 125.4, 118.1, 115.4 (d, J = 22.7 Hz), 106.9, 99.6, 55.6, 55.5. **^{19}F NMR** (377 MHz, $CDCl_3$) δ –104.81. **HR–MS** (ESI) *m/z* calc. for $C_{29}H_{22}FO_5S$ $[M+H]^+$: 501.1167, found: 501.1147.

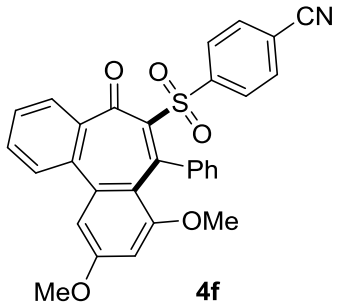


4e

6-((4-Chlorophenyl)sulfonyl)-8,10-dimethoxy-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4e)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2f** (103.4 mg, 0.75 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4e** (69.7 mg, 45%) as a yellow solid. **M.p.**: 205–207 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.85 (d, J = 7.9 Hz, 1H), 7.71–7.66 (m, 1H), 7.58 (d, J = 4.2 Hz, 2H), 7.20 (dd, J = 7.3, 7.3 Hz, 2H), 7.07 (d, J = 2.1 Hz, 1H), 7.06 (dd, J = 2.1, 2.1 Hz, 2H), 7.03 (dd, J = 2.1, 2.1 Hz, 2H), 6.69 (d, J = 2.4 Hz, 1H), 6.31 (d, J = 2.4 Hz, 1H), 3.84 (s, 3H), 3.19 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.0, 161.5, 160.8, 147.6, 144.9, 141.6, 140.4, 140.3, 139.2, 138.1, 135.9, 131.4, 129.1, 128.9, 128.5, 128.3, 128.2, 126.9, 125.5, 118.1, 106.9, 99.7, 55.6, 55.6. **HR–MS** (ESI) *m/z* calc. for $C_{29}H_{22}{}^{35}ClO_5$

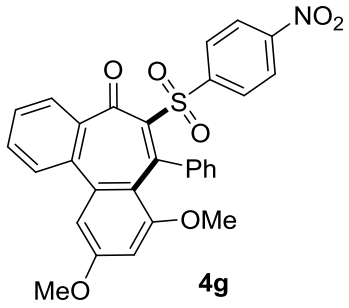
[M+H]$^+$: 517.0871, found: 517.0860.



4f

4-((8,10-Dimethoxy-5-oxo-7-phenyl-5*H*-dibenzo[a,c][7]annulen-6-yl)sulfonyl)benzonitrile (4f)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2g** (113.4 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4f** (45.6 mg, 30%) as a yellow solid. **M.p.**: 217–219 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 (d, J = 7.8 Hz, 1H), 7.72 (td, J = 6.4, 2.4 Hz, 1H), 7.63 (dd, J = 6.5, 6.5 Hz, 2H), 7.35 (d, J = 8.5 Hz, 2H), 7.19 (dd, J = 7.3, 7.3 Hz, 1H), 7.11 (d, J = 8.4 Hz, 3H), 7.07 (s, 1H), 6.70 (d, J = 2.3 Hz, 1H), 6.31 (d, J = 2.3 Hz, 1H), 3.84 (s, 3H), 3.20 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 192.3, 161.8, 160.8, 148.5, 146.0, 144.7, 140.8, 140.5, 138.0, 135.8, 132.0, 131.6, 129.1, 128.5, 128.5, 128.0, 127.1, 125.6, 117.7, 117.4, 115.9, 107.0, 99.7, 55,7, 55.6. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{22}NO_5S$ [M+H]$^+$: 508.1213, found: 508.1197.

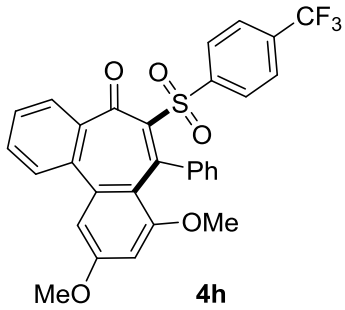


4g

8,10-Dimethoxy-6-((4-nitrophenyl)sulfonyl)-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4g)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2h** (125.4 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4g** (44.3 mg, 28%) as a yellow solid. **M.p.**: 210–212 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.88 (d, J = 8.9 Hz, 3H), 7.73 (td, J = 7.5, 1.8 Hz, 1H), 7.68–7.61

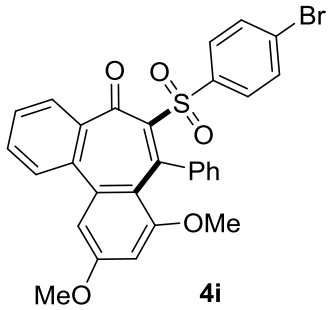
(m, 2H), 7.19 (dd, *J* = 6.5, 6.5 Hz, 3H), 7.06 (s, 2H), 6.71 (d, *J* = 2.4 Hz, 1H), 6.32 (d, *J* = 2.4 Hz, 1H), 3.85 (s, 3H), 3.20 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 192.3, 161.8, 160.8, 149.6, 148.7, 147.5, 144.8, 140.8, 140.5, 138.0, 135.8, 131.6, 129.1, 128.7, 128.6, 128.5, 127.1, 125.6, 123.4, 117.7, 107.0, 99.7, 55.7, 55.6. **HR–MS** (ESI) *m/z* calc. for $C_{29}H_{22}NO_7S$ $[M+H]^+$: 528.1112, found: 528.1091.



4h

8,10-Dimethoxy-7-phenyl-6-((4-(trifluoromethyl)phenyl)sulfonyl)-5*H*-dibenzo[a,c][7]annulen-5-one (4h)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2i** (139.2 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4h** (123.8 mg, 75%) as a yellow solid. **M.p.**: 174–176 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 7.9 Hz, 1H), 7.74–7.69 (td, *J* = 7.9, 2.0 Hz, 1H), 7.62–7.57 (m, 2H), 7.30 (d, *J* = 8.4 Hz, 2H), 7.16 (dd, *J* = 7.3, 7.3 Hz, 1H), 7.11 (d, *J* = 8.3 Hz, 2H), 7.03 (s, 1H), 6.71 (d, *J* = 2.4 Hz, 1H), 6.31 (d, *J* = 2.4 Hz, 1H), 3.82 (s, 3H), 3.18 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 192.5, 161.7, 160.7, 148.1, 145.1, 144.7, 141.1, 140.4, 138.0, 135.8, 133.8 (q, *J* = 32.9 Hz), 131.5, 128.9, 128.5, 128.3, 127.9, 126.9, 125.5, 125.3 (q, *J* = 3.6 Hz), 123.2 (q, *J* = 273.7 Hz), 117.8, 107.0, 99.6, 55.6, 55.5. **^{19}F NMR** (377 MHz, $CDCl_3$) δ –63.30. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{22}F_3O_5S$ $[M+H]^+$: 551.1135, found: 551.1109.

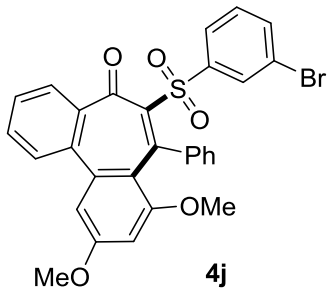


4i

6-((4-Bromophenyl)sulfonyl)-8,10-dimethoxy-7-phenyl-5*H*-

dibenzo[a,c][7]annulen-5-one (4i)

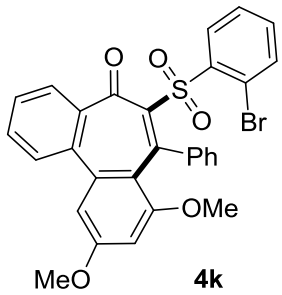
The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2j** (145.1 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4i** (70.6 mg, 42%) as a yellow solid. **M.p.**: 218–220 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.88 (d, J = 7.8 Hz, 1H), 7.73–7.69 (m, 1H), 7.60 (d, J = 4.2 Hz, 2H), 7.29–7.20 (m, 3H), 7.11 (s, 2H), 6.95 (d, J = 8.5 Hz, 2H), 6.72 (d, J = 2.0 Hz, 1H), 6.33 (d, J = 2.0 Hz, 1H), 3.86 (s, 3H), 3.22 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.0, 161.5, 160.7, 147.6, 144.9, 141.5, 140.8, 140.3, 138.1, 135.8, 131.5, 131.4, 129.1, 128.9, 128.3, 128.2, 127.8, 126.9, 125.5, 118.0, 106.9, 99.6, 55.6, 55.6. **HR–MS** (ESI) *m/z* calc. for $C_{29}H_{22}{}^{79}BrO_5S$ $[M+H]^+$: 561.0366, found: 561.0341.



4j

6-((3-Bromophenyl)sulfonyl)-8,10-dimethoxy-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4j)

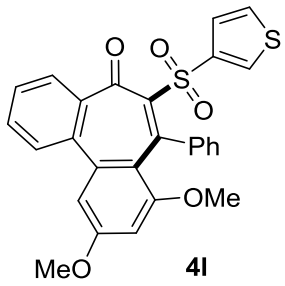
The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2k** (145.1 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4j** (50.4 mg, 30%) as a yellow solid. **M.p.**: 197–199 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (d, J = 7.9 Hz, 1H), 7.73–7.69 (m, 1H), 7.61 (d, J = 4.1 Hz, 2H), 7.42–7.37 (m, 1H), 7.22 (dd, J = 7.6, 7.6 Hz, 1H), 7.09 (m, 2H), 6.94–6.93 (m, 2H), 6.70 (d, J = 2.4 Hz, 1H), 6.31 (d, J = 2.4 Hz, 1H), 3.84 (s, 3H), 3.21 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 192.7, 161.6, 160.8, 147.9, 144.9, 143.5, 141.5, 140.5, 137.8, 135.9, 135.5, 131.5, 130.8, 129.8, 129.0, 128.5, 128.4, 127.0, 126.0, 125.6, 122.2, 118.1, 106.9, 99.7, 55.7, 55.6. **HR–MS** (ESI) *m/z* calc. for $C_{29}H_{22}{}^{79}BrO_5S$ $[M+H]^+$: 561.0366, found: 561.0345.



4k

6-((2-Bromophenyl)sulfonyl)-8,10-dimethoxy-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4k)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2l** (145.1 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4k** (97.4 mg, 58%) as a white solid. **M.p.**: 208–210 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.90 (d, J = 7.8 Hz, 1H), 7.66 (td, J = 7.7, 1.3 Hz, 1H), 7.61–7.59 (m, 1H), 7.51 (td, J = 7.5, 0.7 Hz, 1H), 7.41 (d, J = 7.0 Hz, 1H), 7.17–7.15 (m, 1H), 7.06–7.02 (m, 2H), 6.98–6.93 (m, 3H), 6.72 (d, J = 2.4 Hz, 1H), 6.32 (d, J = 2.4 Hz, 1H), 3.85 (s, 3H), 3.15 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 192.2, 161.4, 161.0, 145.4, 145.2, 140.8, 139.3, 139.1, 137.7, 137.0, 134.3, 133.4, 132.4, 131.5, 129.1, 128.3, 128.2, 127.1, 126.7, 126.2, 120.4, 117.7, 107.4, 99.6, 55.6, 55.4. **HR–MS** (ESI) *m/z* calc. for $C_{29}H_{22}{}^{79}BrO_5S$ $[M+H]^+$: 561.0366, found: 561.0359.

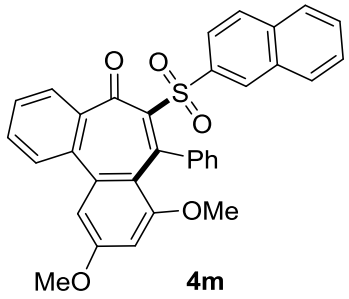


4l

8,10-Dimethoxy-7-phenyl-6-(thiophen-3-ylsulfonyl)-5*H*-dibenzo[a,c][7]annulen-5-one (4l)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2m** (102.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4l** (105.4 mg, 72%) as a yellow solid. **M.p.**: 190–192 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 (d, J = 7.8 Hz, 1H), 7.68 (td, J = 7.6, 1.6 Hz, 1H), 7.58–7.50 (m, 2H), 7.41 (dd, J = 5.0, 1.3 Hz, 1H), 7.26–7.18 (m, 3H), 6.93 (dd, J = 3.8, 1.3 Hz, 1H), 6.72–6.69 (m, 2H), 6.34 (d, J = 2.4 Hz, 1H), 3.85 (s, 3H), 3.23 (s, 3H). **^{13}C**

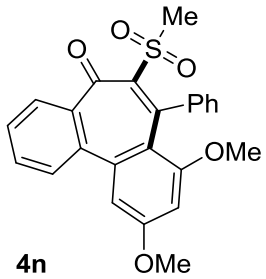
NMR (101 MHz, $CDCl_3$) δ 193.2, 161.5, 160.8, 147.3, 145.2, 142.7, 141.9, 140.3, 138.1, 135.8, 134.9, 133.8, 131.3, 128.8, 128.2, 126.9, 126.7, 125.3, 118.2, 106.9, 99.6, 55.6. **HR–MS** (ESI) *m/z* calc. for $C_{27}H_{21}O_5S_2$ $[M+H]^+$: 489.0825, found: 489.0811.



4m

8,10-Dimethoxy-6-(naphthalen-2-ylsulfonyl)-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4m)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2n** (128.4 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/EtOAc = 3:1) yielded **4m** (76.6mg, 48%) as a yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (d, J = 7.9 Hz, 1H), 7.72–7.69 (m, 2H), 7.63 (s, 1H), 7.60–7.51 (m, 5H), 7.47–7.45 (m, 1H), 7.05–6.98 (m, 2H), 6.68 (d, J = 2.4 Hz, 1H), 6.28 (d, J = 2.3 Hz, 1H), 3.81 (s, 3H), 3.15 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 193.2, 161.4, 160.7, 147.3, 145.0, 141.9, 140.3, 138.1, 137.9, 135.9, 134.5, 131.6, 131.3, 130.1, 129.4, 128.9, 128.8, 128.5, 128.3, 128.3, 128.2, 127.6, 127.2, 126.6, 125.6, 118.2, 106.9, 106.8, 99.6, 55.6, 55.5. **HR–MS** (ESI) *m/z* calc. for $C_{34}H_{25}O_5S$ $[M+H]^+$: 533.1417, found: 533.1404.

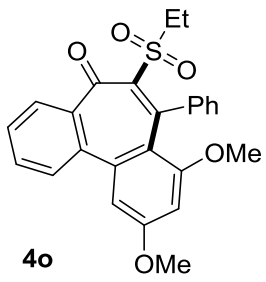


4n

8,10-Dimethoxy-6-(methylsulfonyl)-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4n)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2o** (61.2 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4n** (40.3 mg, 32%) as a yellow solid. **M.p.**: 202–204 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (d, J = 7.9 Hz, 1H), 7.65 (dd, J = 13.7, 3.1 Hz, 1H), 7.57–

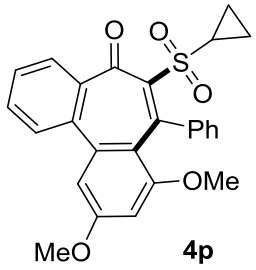
7.53 (m, 2H), 7.30 (s, 4H), 6.73 (d, *J* = 2.4 Hz, 1H), 6.37 (d, *J* = 2.4 Hz, 1H), 3.87 (s, 3H), 3.27 (s, 3H), 2.87 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 194.1, 161.5, 160.8, 146.9, 145.0, 140.5, 140.4, 138.4, 135.9, 131.5, 129.2, 128.5, 128.1, 127.3, 125.7, 118.0, 107.1, 99.8, 55.7, 45.9. **HR–MS** (ESI) *m/z* calc. for $C_{24}H_{21}O_5S$ $[M+H]^+$: 421.1104, found: 421.1088.



4o

6-(Ethylsulfonyl)-8,10-dimethoxy-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4o)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2p** (69.6 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4o** (52.1 mg, 40%) as a yellow solid. **M.p.**: 168–170 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 7.8 Hz, 1H), 7.63 (d, *J* = 16.7 Hz, 1H), 7.54 (d, *J* = 15.9 Hz, 2H), 7.29 (s, 4H), 6.72 (d, *J* = 2.4 Hz, 1H), 6.36 (d, *J* = 2.4 Hz, 1H), 3.86 (s, 3H), 3.29 (s, 3H), 2.78 (dd, *J* = 14.2, 7.4 Hz, 1H), 2.36 (dd, *J* = 14.2, 7.3 Hz, 1H), 0.80 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.4, 161.5, 160.6, 146.5, 144.6, 140.4, 138.9, 138.2, 135.7, 131.3, 129.0, 128.6, 128.0, 127.3, 125.6, 118.2, 106.8, 99.7, 55.7, 50.2, 6.6. **HR–MS** (ESI) *m/z* calc. for $C_{25}H_{23}O_5S$ $[M+H]^+$: 435.1261, found: 435.1244.

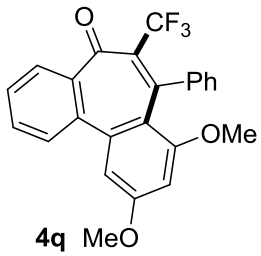


4p

6-(Cyclopropylsulfonyl)-8,10-dimethoxy-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4p)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2q** (76.8 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/

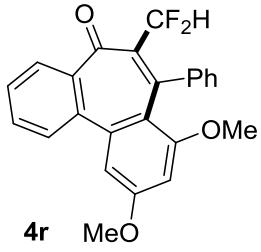
EtOAc = 3:1) yielded **4p** (40.1 mg, 30%) as a yellow solid. **M.p.**: 200–202 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (d, J = 7.9 Hz, 1H), 7.66–7.62 (m, 1H), 7.51 (d, J = 4.2 Hz, 2H), 7.29 (s, 4H), 6.72 (d, J = 2.4 Hz, 1H), 6.36 (d, J = 2.3 Hz, 1H), 3.86 (s, 3H), 3.29 (s, 3H), 1.94–1.88 (m, 1H), 1.29–1.25 (m, 1H), 0.87–0.80 (m, 1H), 0.58–0.51 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 193.5, 161.4, 160.7, 145.8, 144.8, 141.6, 140.3, 138.8, 135.9, 131.3, 128.8, 128.5, 128.1, 127.2, 125.6, 118.2, 106.9, 99.7, 55.6, 33.7, 6.8, 6.1. **HR–MS** (ESI) *m/z* calc. for $C_{26}H_{23}O_5S$ $[M+H]^+$: 447.1261, found: 447.1255.



4q

8,10-Dimethoxy-7-phenyl-6-(trifluoromethyl)-5*H*-dibenzo[a,c][7]annulen-5-one (4q)

The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2r** (140.4 mg, 0.9 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4q** (56.6 mg, 46%) as a yellow solid. **M.p.**: 150–152 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.94 (d, J = 7.9 Hz, 1H), 7.70 (dd, J = 7.5, 7.5 Hz, 1H), 7.56 (dd, J = 7.4, 7.4 Hz, 1H), 7.50 (d, J = 7.5 Hz, 1H), 7.29–7.28 (m, 3H), 7.22 (s, 2H), 6.76 (d, J = 2.1 Hz, 1H), 6.39 (d, J = 2.1 Hz, 1H), 3.88 (s, 3H), 3.26 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 195.2, 161.1, 160.6, 145.0 (q, J = 2.0 Hz), 145.0, 140.0, 139.9, 136.4, 131.6, 130.1 (q, J = 19.2 Hz), 128.9, 128.3, 128.0, 127.8, 127.2, 124.9, 121.6 (q, J = 276.3 Hz), 118.5, 106.9, 99.8, 55.6, 55.6. **^{19}F NMR** (565 MHz, $CDCl_3$) δ –52.63. **HR–MS** (ESI) *m/z* calc. for $C_{24}H_{18}F_3O_3$ $[M+H]^+$: 411.1203, found: 411.1195.

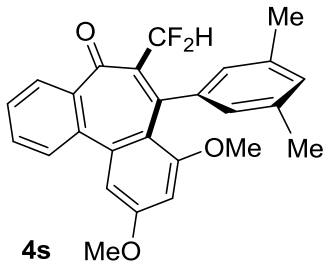


4r

6-(Difluoromethyl)-8,10-dimethoxy-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one

(4r)

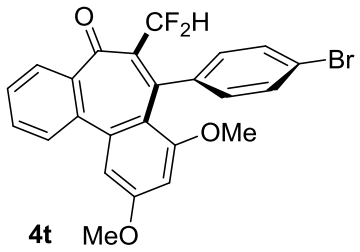
The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2s** (124.2 mg, 0.9 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4r** (67.0 mg, 57%) as a yellow solid. **M.p.**: 120–122 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89 (d, J = 7.8 Hz, 1H), 7.67–7.63 (m, 1H), 7.54–7.50 (m, 2H), 7.33–7.20 (m, 3H), 7.20 (s, 2H), 6.76 (d, J = 2.4 Hz, 1H), 6.38 (d, J = 2.3 Hz, 1H), 6.10 (t, J = 53.6 Hz, 1H), 3.87 (s, 3H), 3.25 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 196.0, 160.9, 160.2, 145.4, 144.1 (t, J = 9.3 Hz), 140.2, 139.5, 136.5, 133.4 (t, J = 20.2 Hz), 131.4, 128.9, 128.4, 128.1, 127.7, 125.3, 118.4, 112.6 (t, J = 236.8 Hz), 106.9, 99.6, 55.6, 55.6. **^{19}F NMR** (377 MHz, $CDCl_3$) δ –100.79 (d, J = 315.9 Hz), –114.66 (d, J = 315.9 Hz). **HR–MS** (ESI) *m/z* calc. for $C_{24}H_{19}F_2O_3$ $[M+H]^+$: 393.1297, found: 393.1274.



4s

6-(Difluoromethyl)-7-(3,5-dimethylphenyl)-8,10-dimethoxy-5*H*-dibenzo[a,c][7]annulen-5-one (4s)

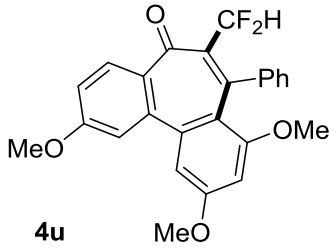
The general procedure was followed using **1p** (111.0 mg, 0.30 mmol) and **2s** (124.2 mg, 0.9 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4s** (54.2 mg, 43%) as a yellow solid. **M.p.**: 197–199 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89 (d, J = 7.9 Hz, 1H), 7.67–7.62 (m, 1H), 7.54–7.50 (m, 2H), 6.92 (s, 1H), 6.78 (s, 1H), 6.75 (d, J = 2.3 Hz, 1H), 6.39 (d, J = 2.2 Hz, 1H), 6.18 (t, J = 53.6 Hz, 1H), 3.87 (s, 3H), 3.27 (s, 3H), 2.27 (s, 6H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 196.2, 160.7, 160.4, 145.5, 144.5 (t, J = 9.3 Hz), 140.1, 139.3, 137.1, 136.5, 133.3 (t, J = 19.2 Hz), 131.3, 129.7, 128.8, 128.4, 126.1, 125.2, 118.7, 112.7 (t, J = 236.3 Hz), 106.9, 99.8, 55.8, 55.6, 21.3. **^{19}F NMR** (377 MHz, $CDCl_3$) δ –101.14 (d, J = 315.1 Hz), –114.66 (d, J = 315.2 Hz). **HR–MS** (ESI) *m/z* calc. for $C_{26}H_{23}F_2O_3$ $[M+H]^+$: 421.1610, found: 421.1597.



4t

7-(4-Bromophenyl)-6-(difluoromethyl)-8,10-dimethoxy-5*H*-dibenzo[a,c][7]annulen-5-one (4t)

The general procedure was followed using **1k** (126.0 mg, 0.30 mmol) and **2s** (124.2 mg, 0.9 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4t** (77.6 mg, 55%) as a yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.88 (d, J = 7.9 Hz, 1H), 7.67–7.63 (m, 1H), 7.52 (d, J = 4.2 Hz, 2H), 7.44 (d, J = 8.5 Hz, 2H), 7.07 (d, J = 7.7 Hz, 2H), 6.74 (d, J = 2.4 Hz, 1H), 6.38 (d, J = 2.3 Hz, 1H), 6.10 (t, J = 53.9 Hz, 1H), 3.87 (s, 3H), 3.31 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 195.7, 161.1, 160.0, 145.3, 142.9 (t, J = 9.2 Hz), 140.3, 138.5, 136.4, 133.7 (t, J = 20.2 Hz), 131.5, 130.9, 130.0, 129.0, 128.5, 125.3, 122.2, 117.7, 112.4 (t, J = 237.4 Hz), 106.9, 99.3, 55.6, 55.6. **^{19}F NMR** (377 MHz, $CDCl_3$) δ –100.45 (d, J = 317.4 Hz), –114.86 (d, J = 317.4 Hz). **HR–MS** (ESI) *m/z* calc. for $C_{24}H_{18}{}^{79}BrF_2O_3$ $[M+H]^+$: 471.0402, found: 471.0373.

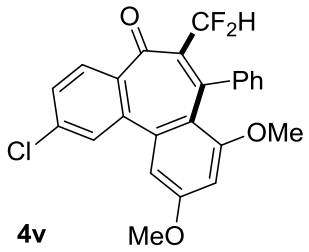


4u

6-(Difluoromethyl)-2,8,10-trimethoxy-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4u)

The general procedure was followed using **1c'** (111.6 mg, 0.30 mmol) and **2s** (124.2 mg, 0.9 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4u** (76.0 mg, 60%) as a yellow solid. **M.p.**: 205–207 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.51 (d, J = 8.5 Hz, 1H), 7.37 (d, J = 2.3 Hz, 1H), 7.31–7.28 (m, 3H), 7.19 (s, 2H), 7.03 (dd, J = 8.5, 2.4 Hz, 1H), 6.74 (d, J = 2.4 Hz, 1H), 6.37 (d, J =

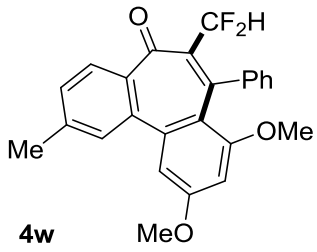
2.4 Hz, 1H), 6.09 (t, *J* = 54.0 Hz, 1H), 3.94 (s, 3H), 3.86 (s, 3H), 3.24 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 194.8, 162.0, 160.9, 143.8 (t, *J* = 9.4 Hz), 140.1, 139.6 139.1, 138.6, 133.6 (t, *J* = 19.2 Hz), 128.4, 128.0, 127.7, 127.7, 118.5, 114.2, 113.8, 112.8 (t, *J* = 237.4 Hz), 106.9, 99.6, 55.7, 55.6, 55.6. **^{19}F NMR** (377 MHz, $CDCl_3$) δ –100.86 (d, *J* = 315.9 Hz), –115.01 (d, *J* = 315.5 Hz). **HR–MS** (ESI) *m/z* calc. for $C_{25}H_{21}F_2O_4$ $[M+H]^+$: 423.1403, found: 423.1379.



4v

2-Chloro-6-(difluoromethyl)-8,10-dimethoxy-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4v)

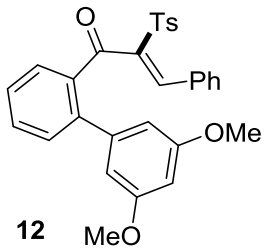
The general procedure was followed using **1e'** (112.8 mg, 0.30 mmol) and **2s** (124.2 mg, 0.9 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4v** (57.5 mg, 45%) as a yellow solid. **M.p.**: 180–182 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 (s, 1H), 7.50–7.42 (m, 2H), 7.31–7.26 (m, 3H), 7.18 (s, 2H), 6.71 (d, *J* = 2.3 Hz, 1H), 6.40 (d, *J* = 2.2 Hz, 1H), 6.10 (t, *J* = 53.9 Hz, 1H), 3.88 (s, 3H), 3.25 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 194.9, 161.1, 160.3, 144.4 (t, *J* = 9.3 Hz), 143.7, 139.2, 138.8, 138.2, 137.4, 133.4 (t, *J* = 20.2 Hz), 133.0, 128.9, 128.4, 128.2, 127.8, 126.9, 118.5, 114.0, 112.6 (t, *J* = 237.4 Hz), 106.7, 100.1, 55.7, 55.6. **^{19}F NMR** (377 MHz, $CDCl_3$) δ –100.50 (d, *J* = 317.4 Hz), –114.90 (d, *J* = 317.4 Hz). **HR–MS** (ESI) *m/z* calc. for $C_{24}H_{18}{}^{35}ClF_2O_3$ $[M+H]^+$: 427.0907, found: 427.0868.



4w

6-(Difluoromethyl)-8,10-dimethoxy-2-methyl-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (4w)

The general procedure was followed using **1d'** (106.8 mg, 0.30 mmol) and **2s** (124.2 mg, 0.9 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **4w** (75.5 mg, 62%) as a yellow solid. **M.p.**: 179–181 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.67 (s, 1H), 7.44 (d, J = 7.7 Hz, 1H), 7.34–7.26 (m, 4H), 7.18 (s, 2H), 6.74 (s, 1H), 6.37 (s, 1H), 6.08 (t, J = 54.0 Hz, 1H), 3.88 (s, 3H), 3.24 (s, 3H), 2.52 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 195.8, 160.9, 160.2, 144.0 (t, J = 9.4 Hz), 143.3, 141.8, 140.4, 140.0, 136.6, 133.6 (t, J = 20.2 Hz), 129.7, 129.0, 128.4, 128.0, 127.7, 118.6, 112.8 (t, J = 236.3 Hz), 106.9, 99.5, 55.6, 21.90. **^{19}F NMR** (377 MHz, $CDCl_3$) δ –100.88 (d, J = 315.8 Hz), –114.83 (d, J = 315.9 Hz). **HR–MS** (ESI) *m/z* calc. for $C_{25}H_{21}F_2O_3$ $[M+H]^+$: 407.1454, found: 407.1448.

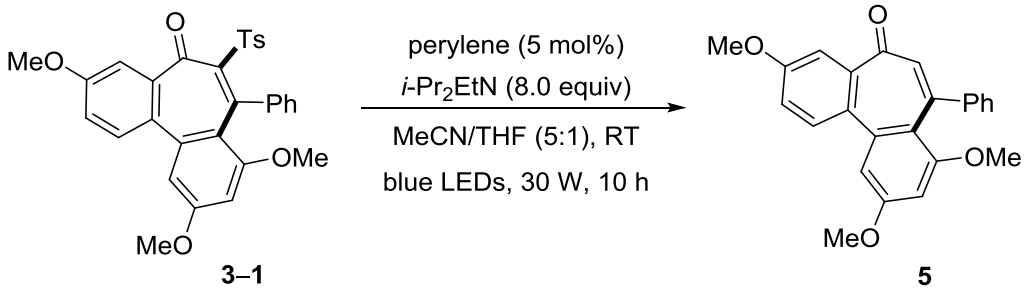


12

(*Z*)-1-(3',5'-Dimethoxy-[1,1'-biphenyl]-2-yl)-3-phenyl-2-tosylprop-2-en-1-one (12)

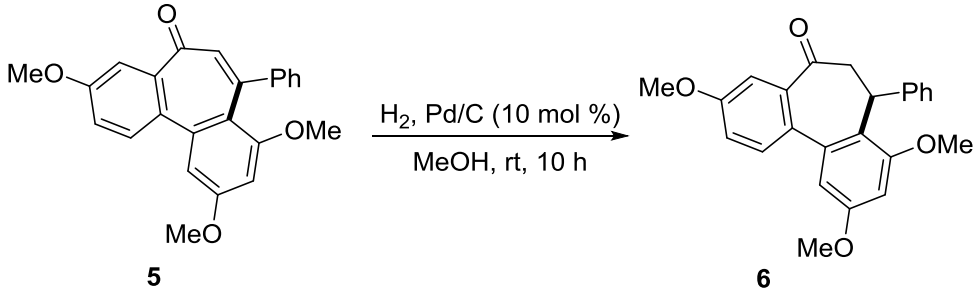
The general procedure was followed using **1a** (102.6 mg, 0.30 mmol) and **2a** (107.0 mg, 0.6 mmol). Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 3:1) yielded **12** （74.7 mg, 50%）as a yellow solid (This compound can be prepared under the standard condition without electricity). **M.p.**: 127–129 °C. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.42 (td, J = 7.6, 1.2 Hz, 1H), 7.33 (d, J = 7.3 Hz, 1H), 7.31 (d, J = 6.6 Hz, 1H), 7.24–7.21 (m, 4H), 7.17–7.11 (m, 4H), 7.05 (s, 1H), 6.88 (d, J = 7.2 Hz, 1H), 6.63 (dd, J = 2.2, 2.2 Hz, 1H), 6.47 (d, J = 2.2 Hz, 2H), 3.87 (s, 6H), 2.37 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 195.1, 161.2, 148.8, 144.6, 142.1, 141.3, 139.2, 134.3, 133.5, 131.6, 129.8, 129.6, 129.4, 129.4, 129.2, 129.0, 129.0, 127.7, 127.6, 107.8, 100.8, 55.6, 21.7. **HR–MS** (ESI) *m/z* calc. for $C_{30}H_{27}O_5S$ $[M+H]^+$: 499.1574, found: 499.1550.

4. Synthesis of NSC 51046 analogue 9 from product 3a



3,8,10-Trimethoxy-7-phenyl-5*H*-dibenzo[a,c][7]annulen-5-one (5)

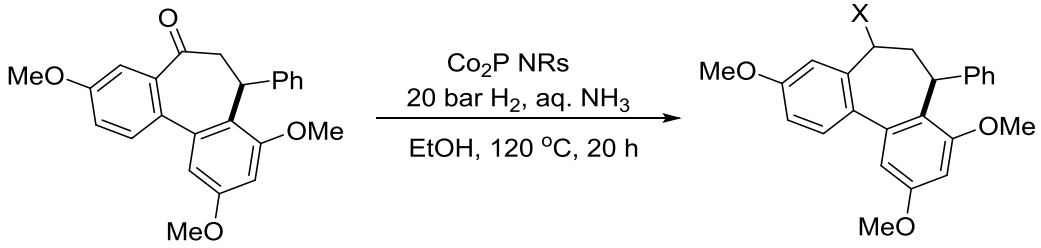
Compound **3-1** (1 mmol, 526.0 mg) was placed into a Schlenk tube, perylene (12.8 mg, 0.05 mmol) was added and the flask was evaculated and back filled with N_2. Then, *i*-Pr_2EtN (8.0 eq.) and the solvent mixture (10 mL) were added. The solution was kept stirring under irradiation of 30 W blue LEDs at room temperature for 10 h. Afterwards, the solution was diluted with CH_2Cl_2 and transferred to a round bottom flask. Silica was added to the flask and volatiles were evaporated under vacuum. The purification was performed by flash column chromatography on silica gel (petroleum ether/ EtOAc = 5:1) to obtain product **5** (275.3 mg, 74% yield) as a yellow oil.**^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89 (d, J = 9.5 Hz, 1H), 7.30–7.29 (m, 5H), 7.22–7.21 (m, 2H), 6.81 (d, J = 2.4 Hz, 1H), 6.64 (s, 1H), 6.47 (d, J = 2.4 Hz, 1H), 3.91 (d, J = 1.0 Hz, 6H), 3.36 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 196.0, 160.2, 159.8, 159.6, 146.0, 144.8, 144.3, 140.4, 131.8, 131.0, 130.7, 128.1, 127.4, 125.9, 118.9, 118.2, 109.8, 107.0, 99.0, 55.8, 55.7, 55.5. **HR–MS** (ESI) *m/z* calc. for $C_{24}H_{21}O_4$ $[M+H]^+$: 373.1435, found: 373.1436.



(*S*)-3,8,10-Trimethoxy-7-phenyl-6,7-dihydro-5*H*-dibenzo[a,c][7]annulen-5-one (6)

5 (0.3 mmol, 111.6 mg) was placed into a flask, MeOH (5 mL) was added and the solution was stirred until the solid was completely dissolved. Pd/C (10 mol %, 20 mg, 0.02 mmol) was added and the solution purged with H_2 three times. The solution was

kept stirring at room temperature for 10 h. Subsequently, the solution was diluted with CH_2Cl_2 and transferred to a round bottom flask. Silica was added to the flask and volatiles were evaporated under vacuum. The purification was performed by flash column chromatography on silica gel (petroleum ether/ EtOAc = 5:1) to obtain product **6** (72.9 mg, 65%) as a white solid (Pay attention! TLC shows that the polarities of the two compounds **5** and **6** are very similar). **M.p.**: 160–162 °C. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.13 (d, J = 8.6 Hz, 1H), 7.05 (d, J = 2.8 Hz, 1H), 6.98 (t, J = 7.6 Hz, 2H), 6.91 (t, J = 6.7 Hz, 3H), 6.86 (dd, J = 8.6, 2.8 Hz, 1H), 6.56 (dd, J = 11.6, 2.4 Hz, 2H), 5.16 (t, J = 3.6 Hz, 1H), 3.87 (s, 6H), 3.79 (d, J = 4.8 Hz, 1H), 3.75 (s, 3H), 3.23 (dd, J = 19.6, 3.6 Hz, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 204.3, 159.6, 158.7, 157.5, 141.4, 141.2, 139.3, 132.7, 131.6, 127.8, 126.8, 125.3, 123.3, 119.5, 111.9, 107.8, 97.8, 56.2, 55.6, 55.5, 49.7. **HR–MS** (ESI) *m/z* calc. for $C_{24}H_{23}O_4$ $[M+H]^+$: 375.1591, found: 375.1573.



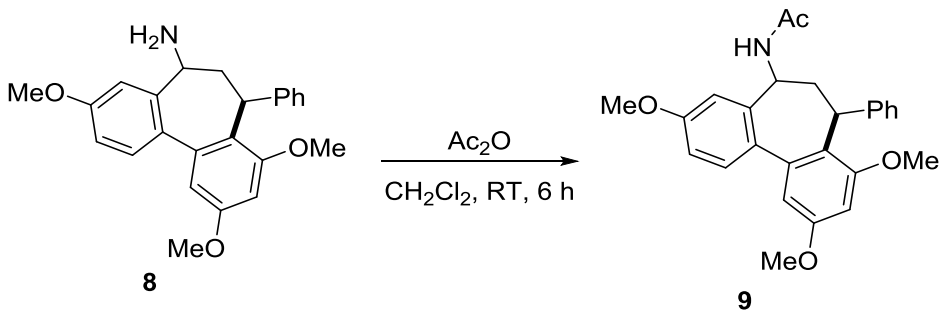
6

X = OH, **7**: 55%

X = NH_2, **8**: 40%

Co_2P NR powder (15 mg) was placed in a 50 mL stainless-steel autoclave with a Teflon inner cylinder, followed by addition of substrate (0.3 mmol), solvent (3 mL). The reaction mixture was stirred vigorously at 120 °C under 20 bar of H_2.[3a] The reaction progress was monitored by TLC until full consumption of the starting material. Neutral alumina was added to the flask and volatiles were evaporated under vacuum. The purification was performed by flash column chromatography using neutral alumina as stationary phase (dichloromethane/ methanol = 10:1) to obtain alcohol **7** (62.0 mg, 55% yield). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.21 (d, J = 2.2 Hz, 1H), 6.90–6.82 (m, 4H), 6.65 (d, J = 7.4 Hz, 2H), 6.61 (dd, J = 8.4, 2.5 Hz, 1H), 6.53 (d, J = 2.3 Hz, 1H), 6.39 (d, J = 2.4 Hz, 1H), 5.04 (d, J = 8.9 Hz, 1H), 4.85–4.80 (m, 1H), 3.90 (s, 3H), 3.82 (s, 6H), 2.94 (s, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.5, 159.1, 157.6, 145.0, 143.3, 141.9,

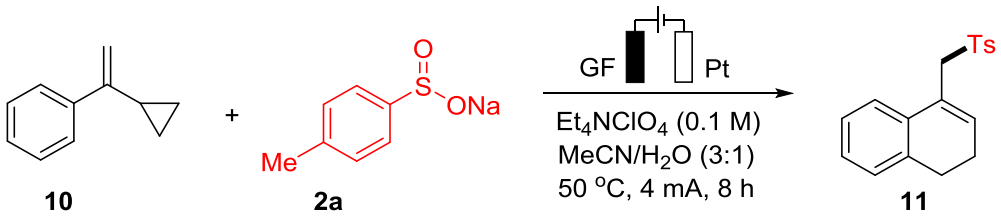
130.8, 129.5, 127.2, 126.9, 124.4, 123.8, 112.5, 108.0, 106.4, 97.4, 69.7, 56.1, 55.5, 55.4, 43.1, 33.7. **HR–MS** (ESI) *m/z* calc. for $C_{24}H_{25}O_4$ $[M+H]^+$: 377.1748, found: 377.1742. At the same time, amine **8** (45.0 mg,40%) was obtained as a yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31 (s, 1H), 7.11 (dd, J = 6.9, 6.9 Hz, 1H), 7.04 (dd, J = 6.8, 6.8 Hz, 1H), 6.90–6.82 (m, 2H), 6.62 (td, J = 8.4, 2.4 Hz, 1H), 6.55 (dd, J = 6.5, 2.4 Hz, 1H), 6.41 (t, J = 2.2 Hz, 1H), 4.29–4.24 (m, 2H), 3.92–3.75 (m, 9H), 3.21–3.13 (m, 1H), 3.03–2.83 (m, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.4, 158.2, 157.6, 144.1, 142.1, 132.1, 129.8, 127.4, 127.2, 127.0, 126.8, 124.9, 123.0, 112.5, 108.6, 99.0, 56.0, 55.7, 55.6, 55.5, 55.5, 29.8. **HR-MS** (ESI) *m/z* calc. for $C_{24}H_{26}NO_3$ $[M+H]^+$: 376.1907, found: 376.1894. (Pay attention! Compound **8** can also be obtained by reductive amination using $NaBH_3CN$ and NH_4OAc)[3b]



To a solution of amine **8** (56.4 mg, 0.15 mmol) in CH_2Cl_2 (5 mL) was added acetic anhydride (33 μL, 0.37 mmol) at 0 °C. The reaction was allowed to warm to room temperature and was then stirred for 6 h before concentration in vacuo. [4] The crude compound was purified by silica gel chromatography (petroleum ether/ EtOAc = 5:1) and the corresponding amide **9** (59.4 mg, 95%) was obtained as a yellow oil. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.98–6.92 (m, 3H), 6.92 (d, J = 6.4 Hz, 1H), 6.82 (t, J = 7.3 Hz, 3H), 6.69 (d, J = 7.0 Hz, 1H), 6.49 (s, 2H), 5.70 (m, 1H), 5.12 (m, 1H), 3.85 (s, 3H), 3.79 (s, 3H), 3.72 (s, 3H), 3.20 (m, 1H), 2.49 (m, 1H), 1.76 (s, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.7, 159.7, 159.3, 158.1, 144.4, 142.4, 140.8, 132.4, 130.5, 129.6, 127.3, 126.8, 124.8, 123.2, 113.0, 106.3, 98.2, 56.0, 55.5, 55.5, 51.8, 42.1, 23.6. **HR-MS** (ESI) *m/z* calc. for $C_{26}H_{28}NO_4$ $[M+H]^+$: 418.2013, found: 418.1999.

5. Mechanistic Studies

5.1 Radical Trapping Experiment



To a 25 mL Schlenk tube containing **10** (0.3 mmol, 1.0 equiv.), **2a** (0.3 mmol, 1.0 equiv.), Et_4NClO_4 (92 mg, 0.1 M) were added and subsequently dissolved in a mixture of MeCN /H_2O (3:1, 4 mL). Electrocatalysis was performed at 50 °C with a constant current of 4.0 mA maintained for 8 h. The GF anode was washed with ethyl acetate (3 × 5 mL) in an ultrasonic bath and transfered to the round bottom flask with the crude reaction solution. Silica was added to the flask and all volatiles were evaporated under vacuum. Purification by column chromatography on silica gel (petroleum ether/ EtOAc = 10:1) delivered product **11** (42.0 mg, 47%). **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.67 (d, J = 8.2 Hz, 2H), 7.21 (d, J = 7.9 Hz, 2H), 7.13–7.12 (m, 1H), 7.10–7.06 (m, 3H), 5.90 (t, J = 4.7 Hz, 1H), 4.20 (s, 2H), 2.69 (t, J = 8.1 Hz, 2H), 2.37 (s, 3H), 2.24–2.20 (m, 2H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 144.7, 136.0, 135.5, 134.9, 132.8, 129.5, 128.8, 127.7, 127.4, 126.4, 126.0, 123.3, 60.1, 27.8, 23.4, 21.7. This compound is known and the NMR data match previous reported.[5]

5.2 Cyclic Voltammetry

CV measurements were conducted with a CHI660D potentiostat. For all experiments, a glassy carbon working electrode (disk, diameter: 3 mm), a platinum wire counter electrode, and an Ag/AgCl reference electrode were employed. All cyclic voltammograms were obtained at room temperature with a scan rate of 100 mV/s. The CV of target molecule (10 mM) was performed in acetonitrile containing 50 mM $n$$Bu_4NPF_4$. Deviations from the general experimental setup were indicated in the respective figures and descriptions.

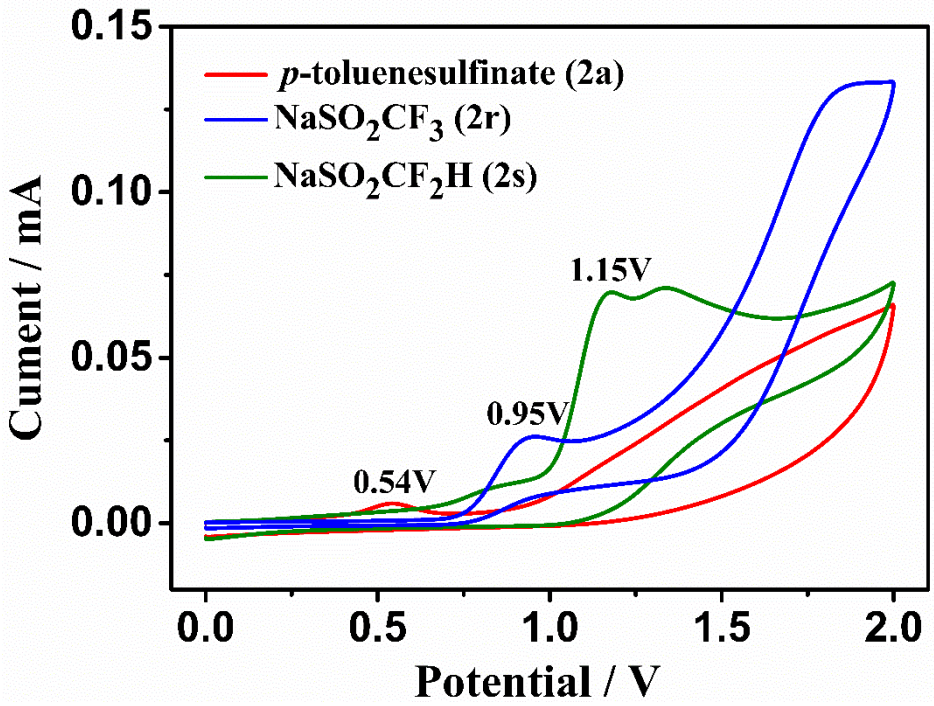


Figure S-1 Cyclic voltammograms.

6. References

[1] Y. Zhang, D. Guo, S. Ye, Z. Liu, G. Zhu, *Org. Lett*. **2017**, *19*, 1302–1305.

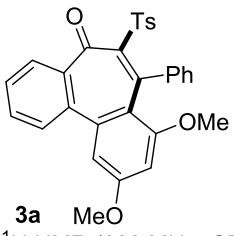
[2] Y. Yang, J. Zhang, B. Hu, M. Ji, S. Ye, G. Zhu, *Org. Lett.* **2018**, *20*, 2988–2992.

[3] (a) M. Sheng, S. Fujita, S. Yamaguchi, J. Yamasaki, K. Nakajima, S. Yamazoe, T.Mizugaki, T. Mitsudome, *JACS Au* **2021**, *1*, 501–507; (b) N. Sitnikov, J. Velder, L. Abodo, N. Cuvelier, J. Neudörfl, A. Prokop, G. Krause, A. R. Fedorov, H.-G. Schmalz, *Chem. Eur. J*. **2012**, *18*, 12096–12102.

[4] K. D. Collins, A. Rühling, F. Lied, F. Glorius, *Chem. Eur. J.* **2014**, *20*, 3800–3805.

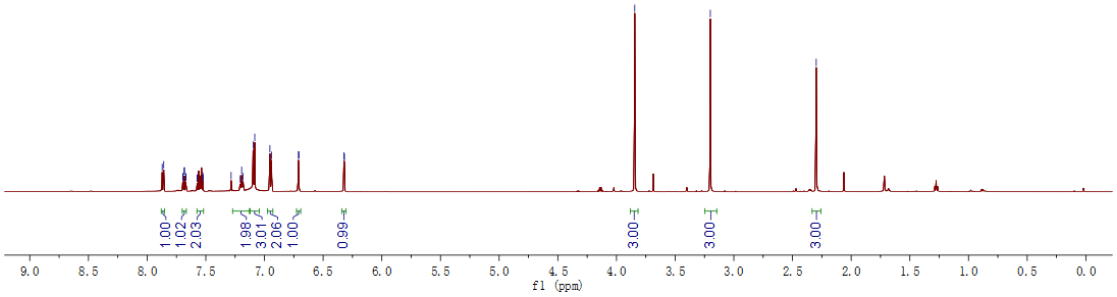
[5] P. Chen, Q. Zhou, Z. Chen, Y.-K. Liu, Y. Liang, K.-W. Tang, *Org. Biomol. Chem.* **2020**, *18*, 7345–7354.

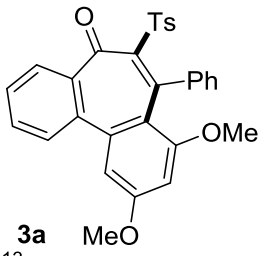
7. NMR Spectra



3a

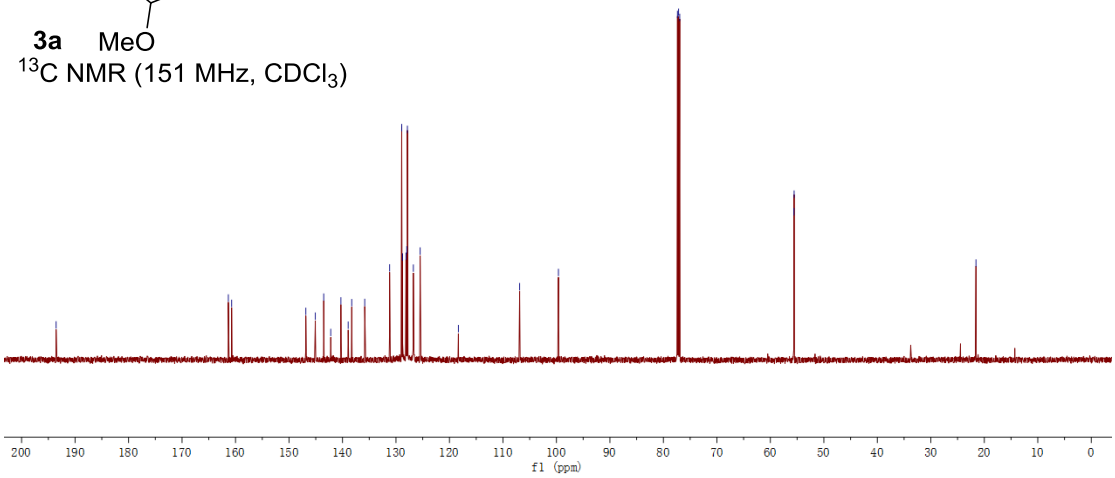
^{1}H NMR (600 MHz, $CDCl_3$)

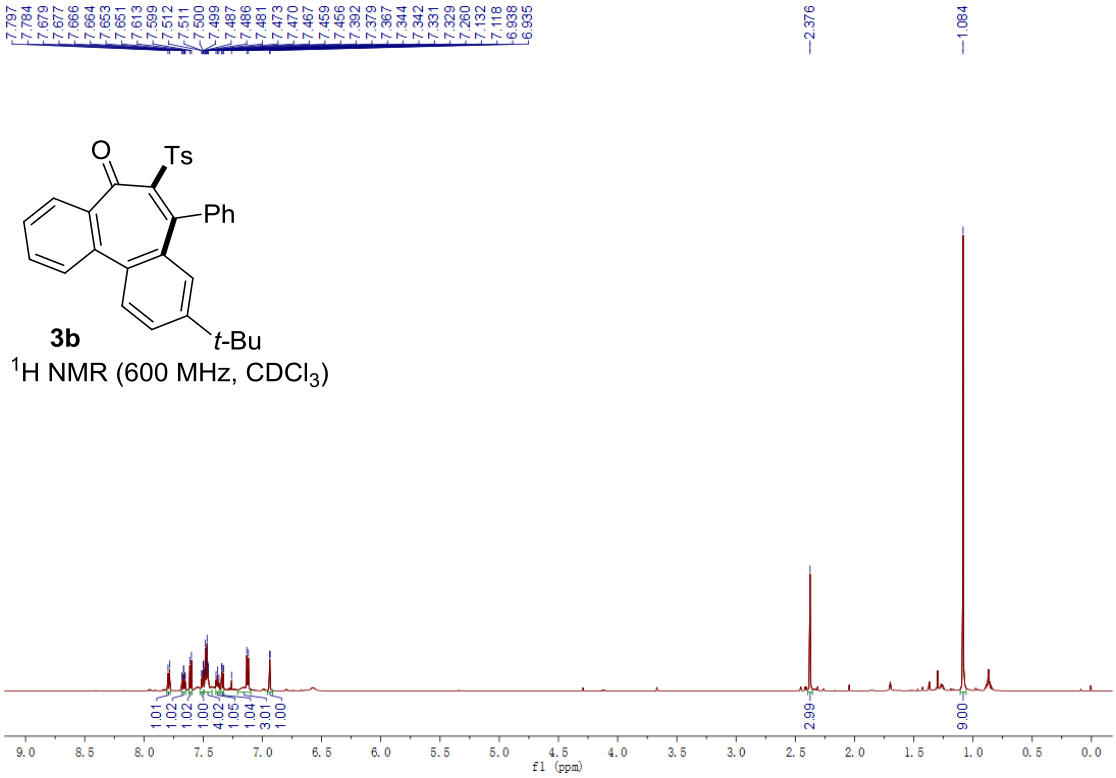




3a

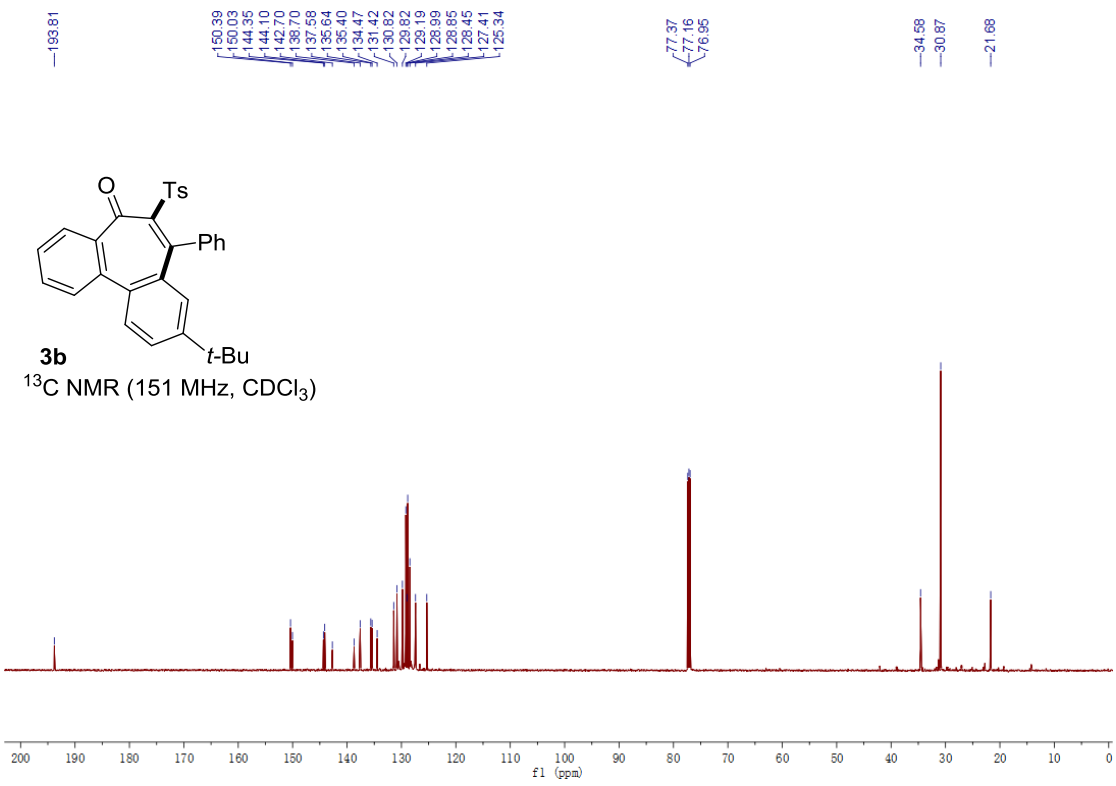
^{13}C NMR (151 MHz, $CDCl_3$)





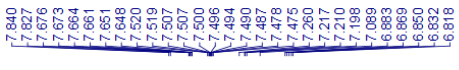
3b

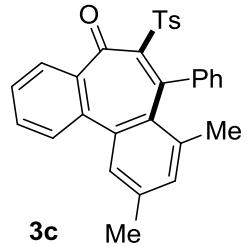
^{1}H NMR (600 MHz, $CDCl_3$)



3b

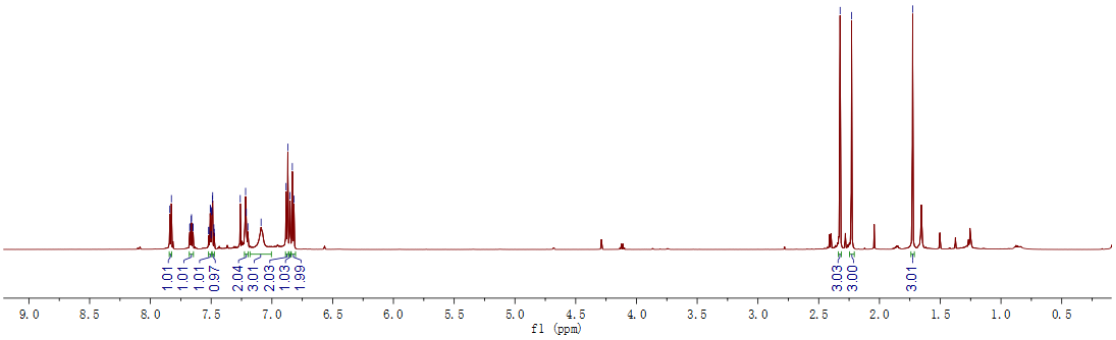
^{13}C NMR (151 MHz, $CDCl_3$)

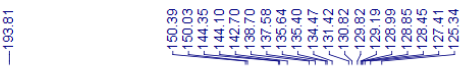


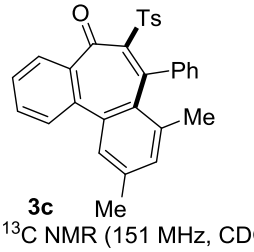


3c

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

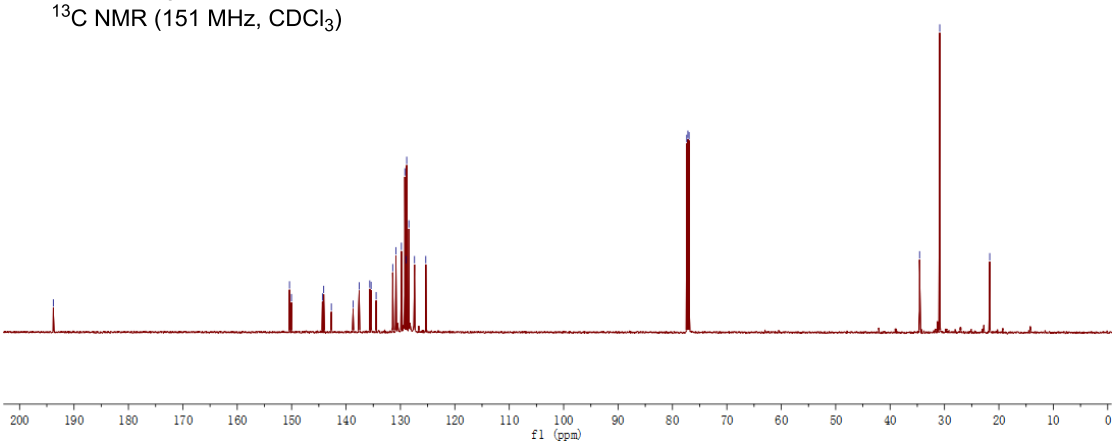


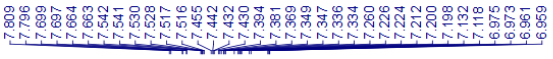


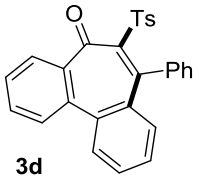


3c

^{13}C NMR (151 MHz, $CDCl_3$)

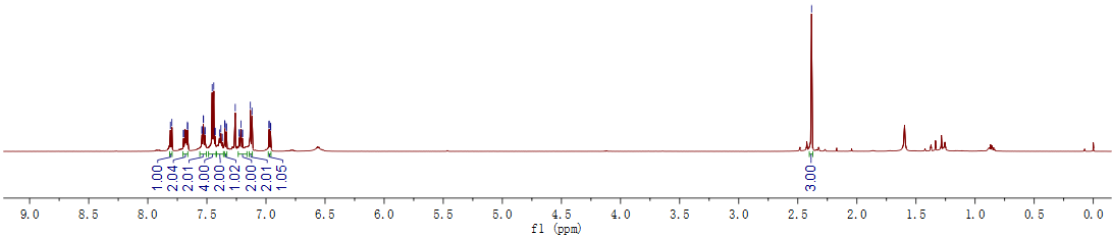


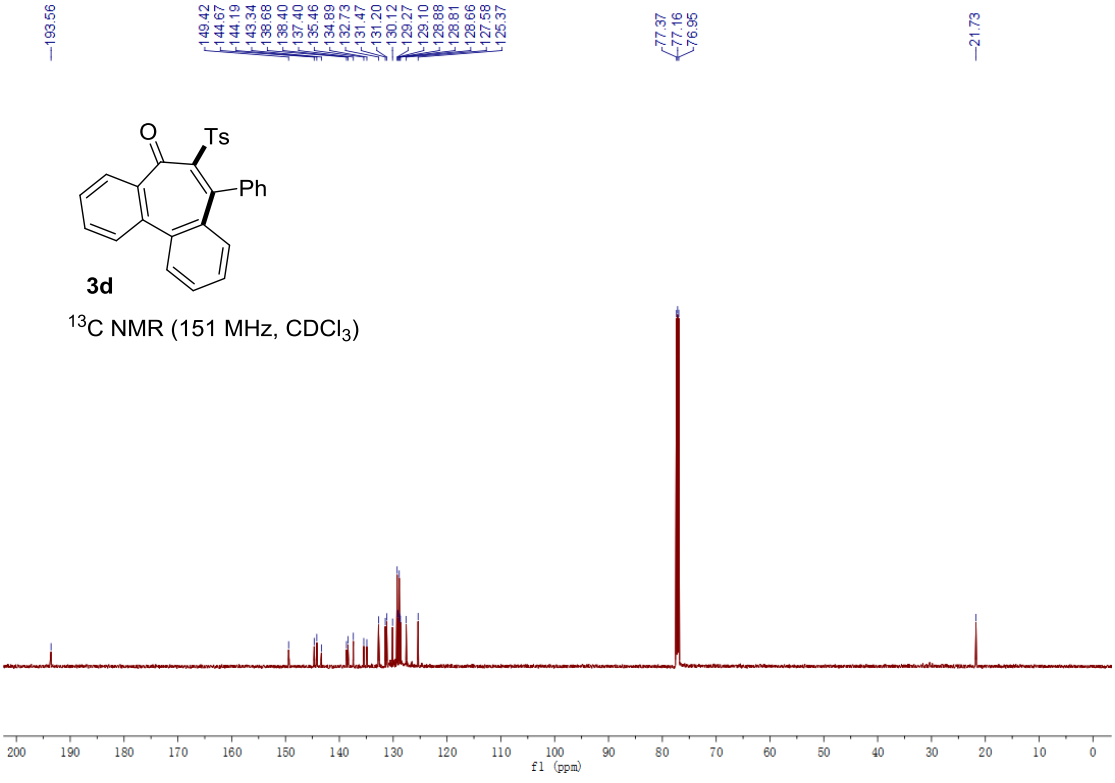




3d

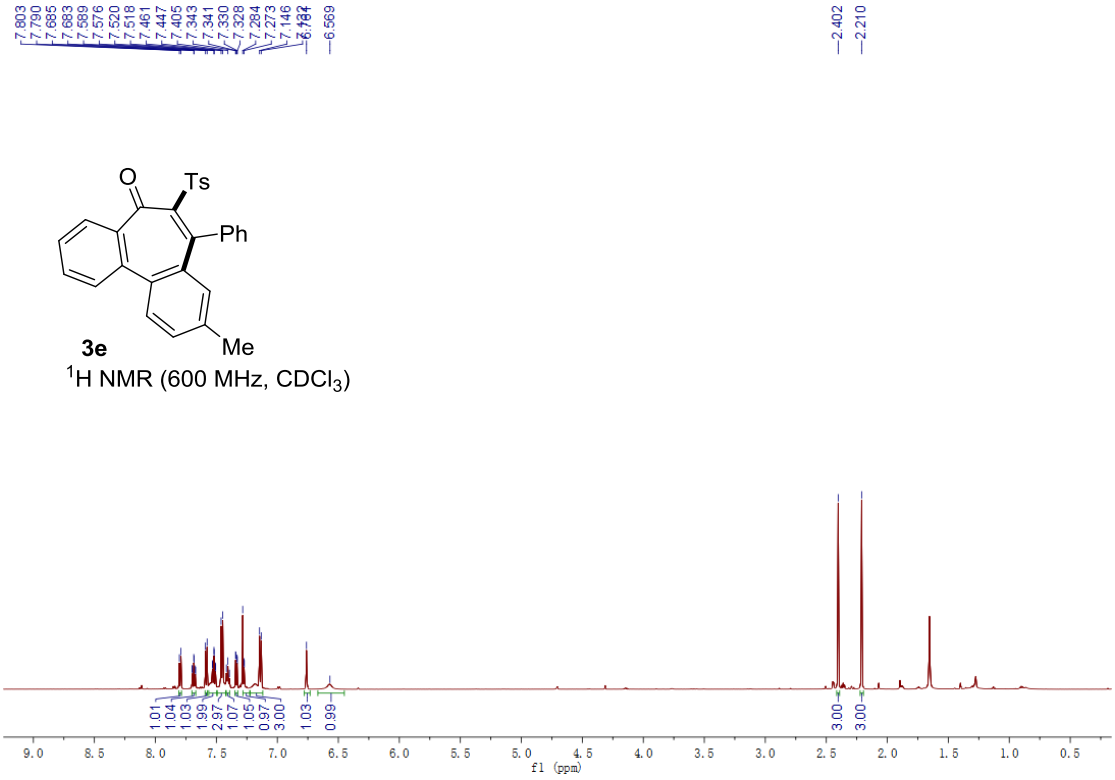
^{1}H NMR (600 MHz, $CDCl_3$)

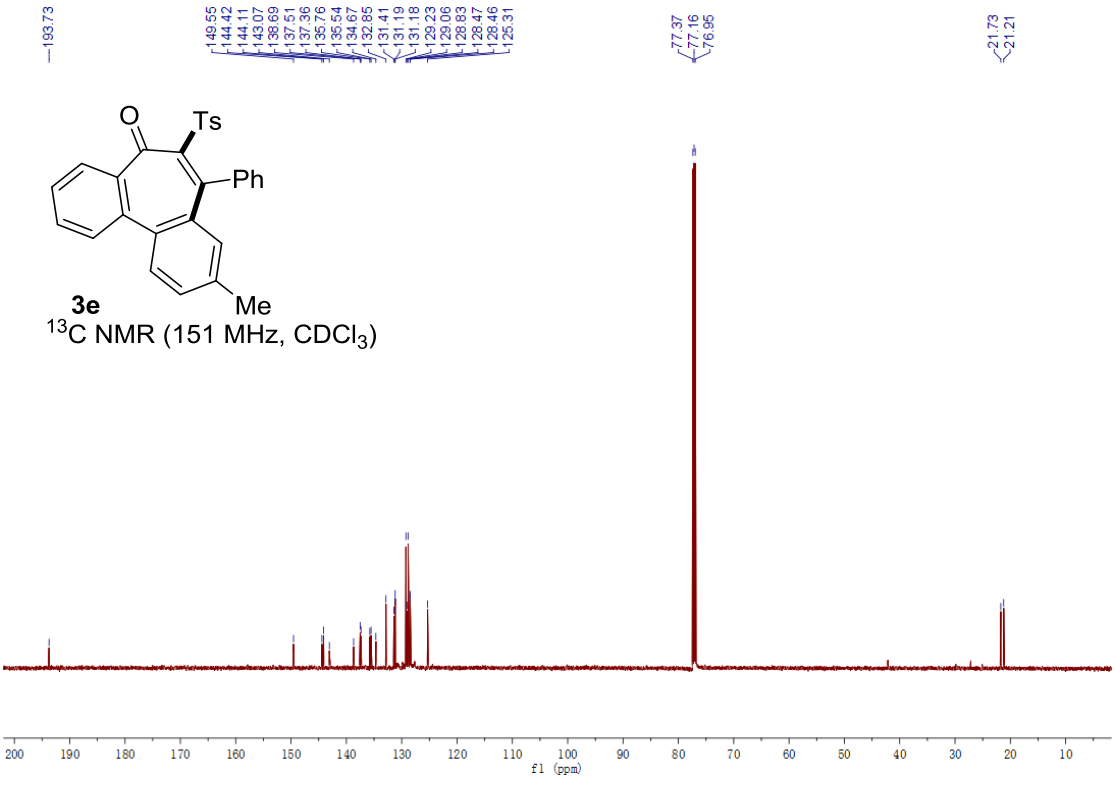


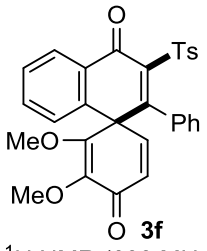


3d

^{13}C NMR (151 MHz, $CDCl_3$)

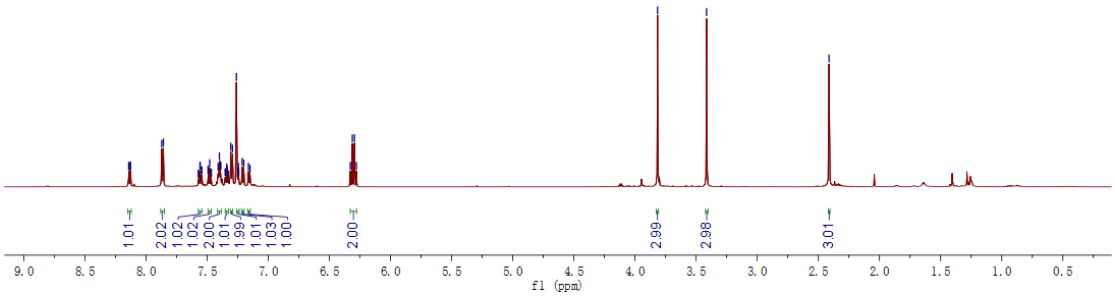

7.803
7.790
7.685
7.683
7.589
7.576
7.520
7.518
7.461
7.447
7.405
7.343
7.341
7.330
7.328
7.284
7.273
7.146
6.569
2.402
2.210
O
Ts
Ph
Me
3e
1H NMR (600 MHz, CDCl3)
1.01
1.04
1.03
1.99
2.97
1.07
1.05
0.97
3.00
1.03
0.99
3.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

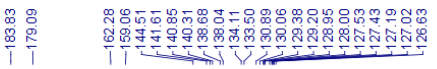

193.73
149.55
144.42
144.11
143.07
138.69
137.51
137.36
135.76
135.54
134.67
132.85
131.41
131.19
131.18
129.23
129.06
128.83
128.47
128.46
125.31
77.37
77.16
76.95
21.73
21.21
O
Ts
Ph
Me
3e
13C NMR (151 MHz, CDCl3)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

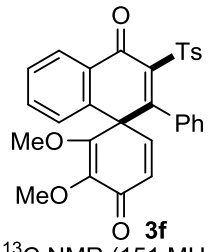


3f

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

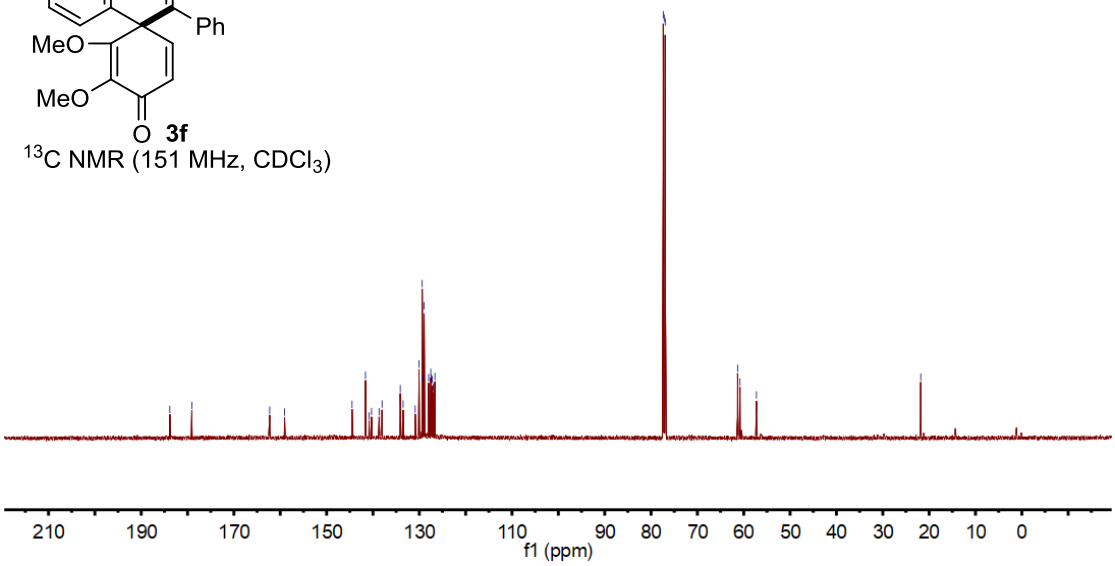






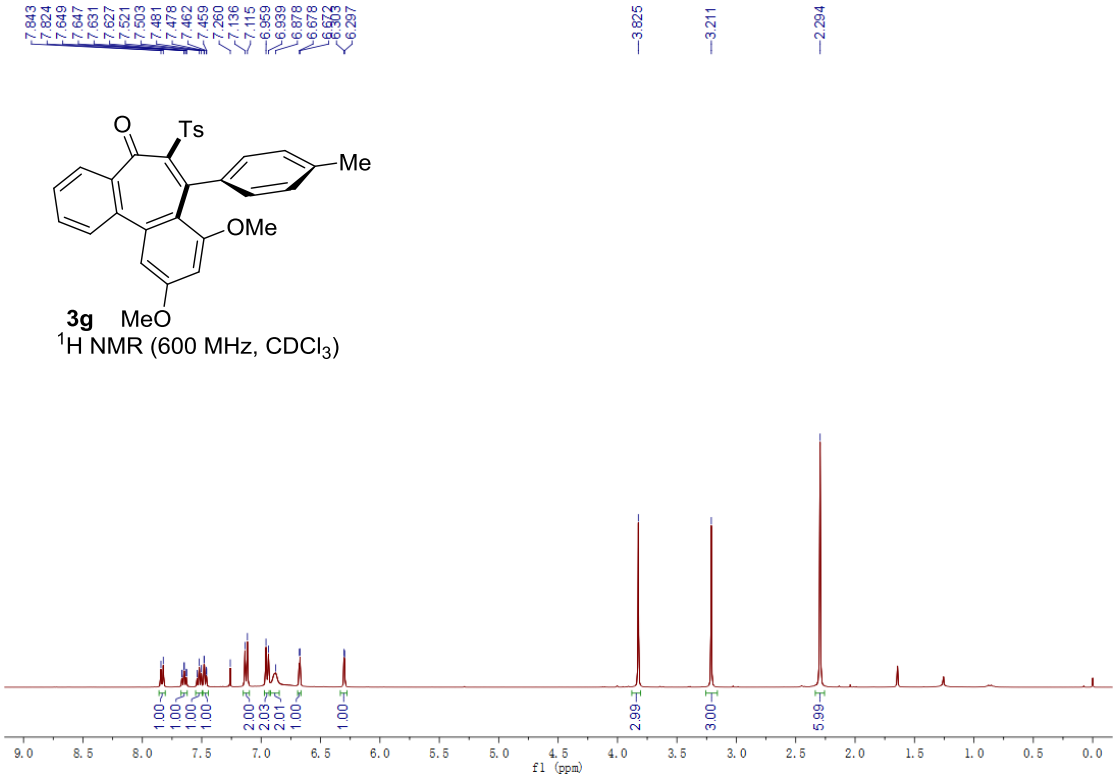
3f

^{13}C NMR (151 MHz, $CDCl_3$)



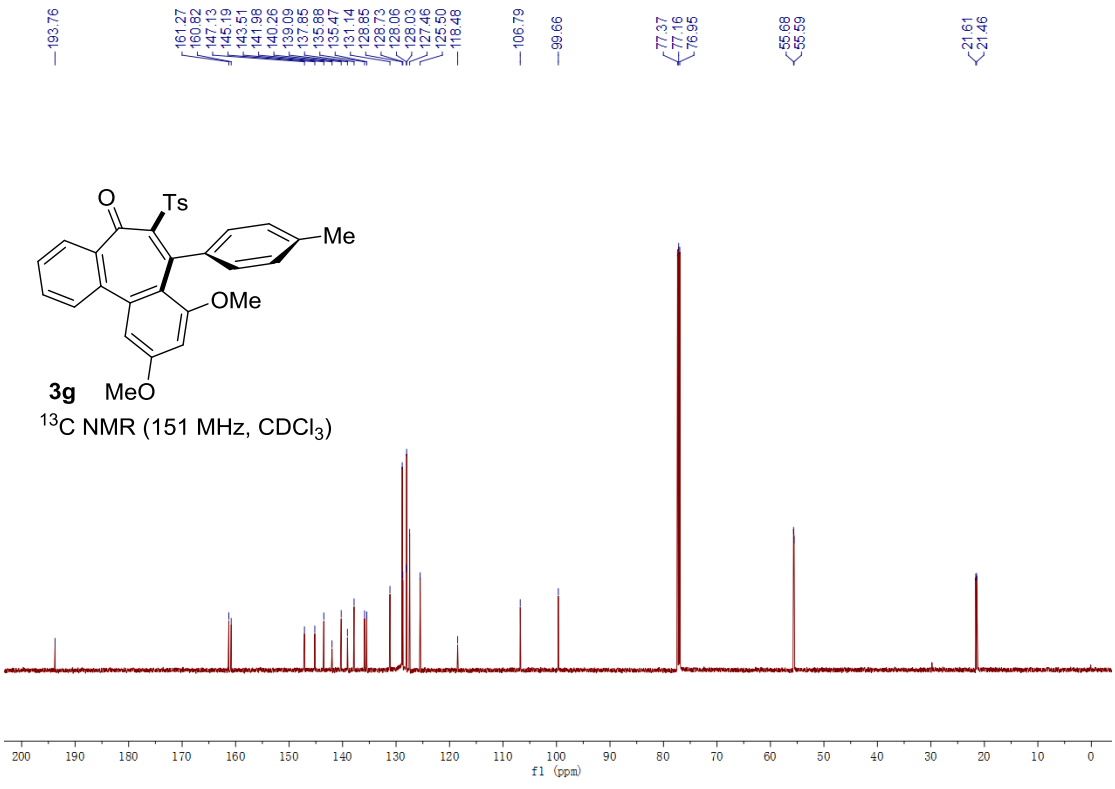
3g

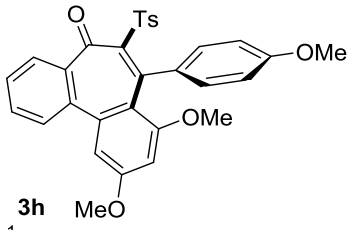
^{1}H NMR (600 MHz, $CDCl_3$)



3g

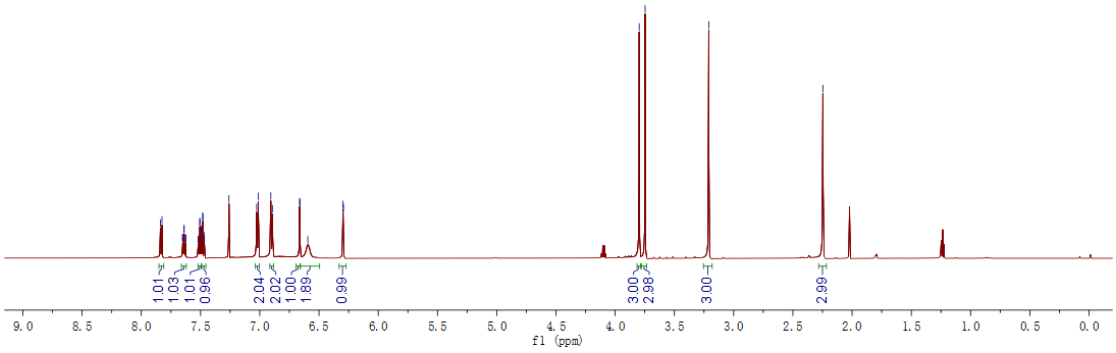
^{13}C NMR (151 MHz, $CDCl_3$)

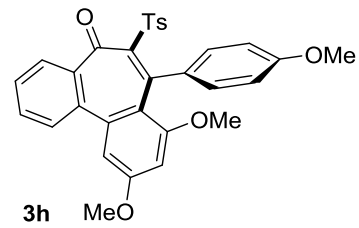




3h

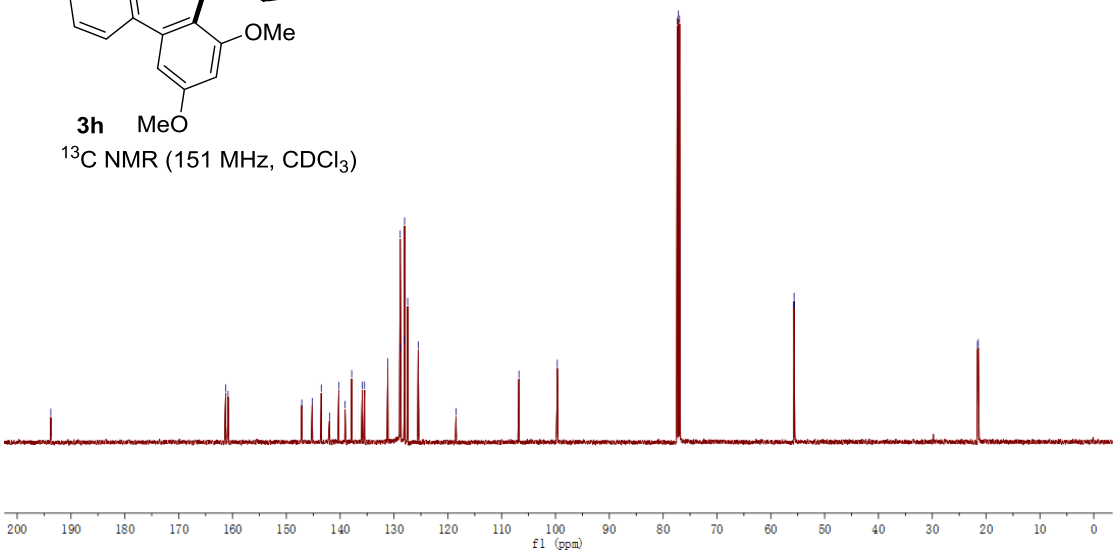
^{1}H NMR (600 MHz, $CDCl_3$)

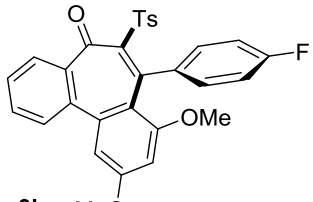




3h

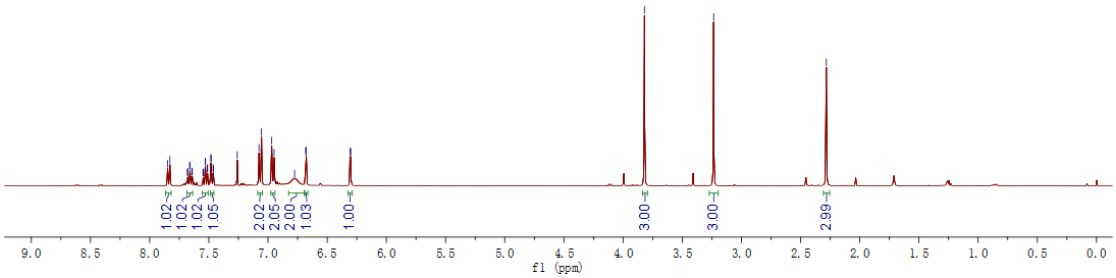
^{13}C NMR (151 MHz, $CDCl_3$)

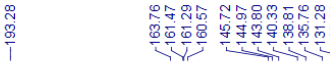


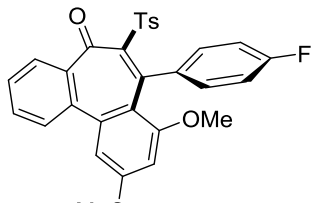


3i

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

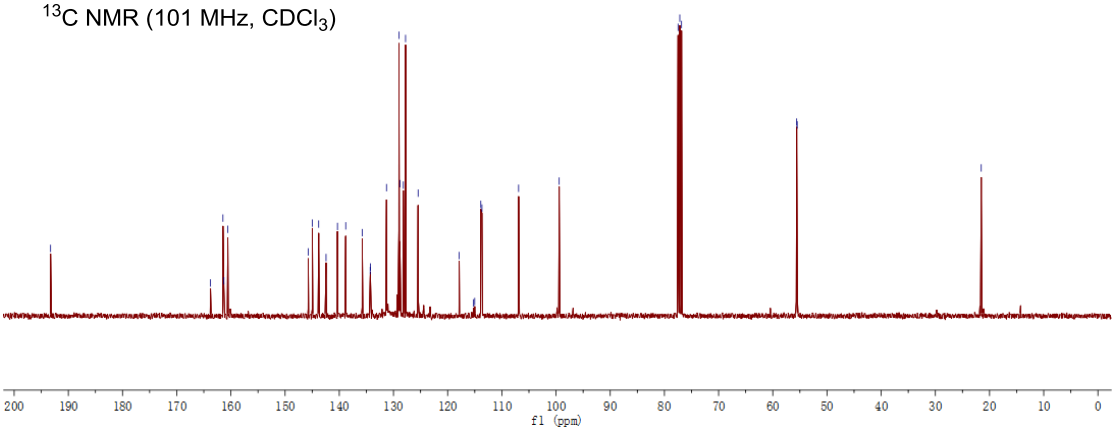






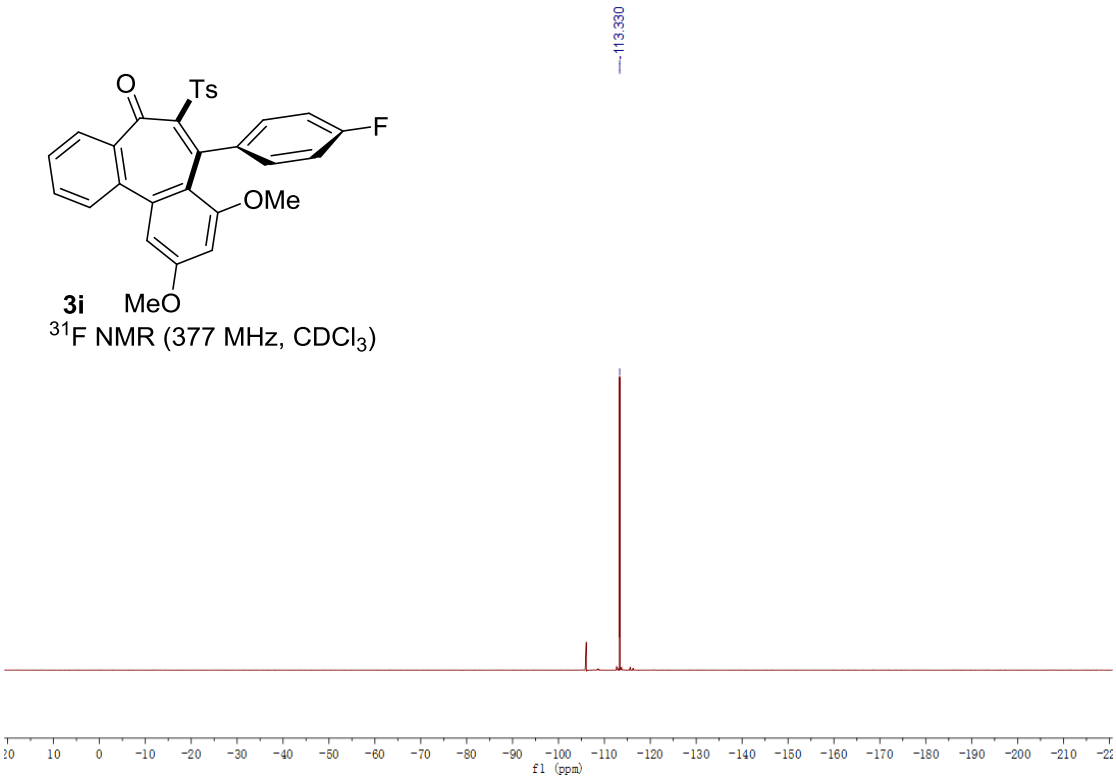
3i

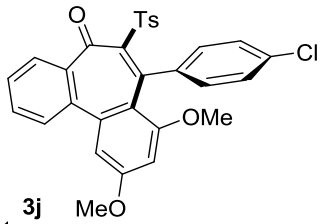
^{13}C NMR (101 MHz, $CDCl_3$)



3i

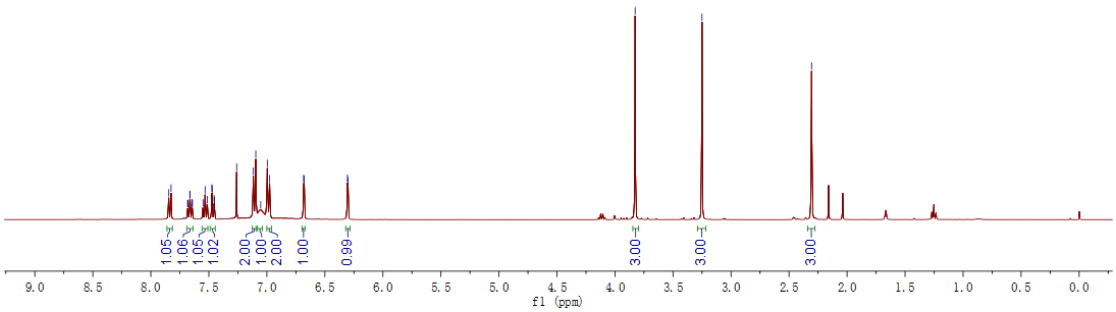
^{31}F NMR (377 MHz, $CDCl_3$)





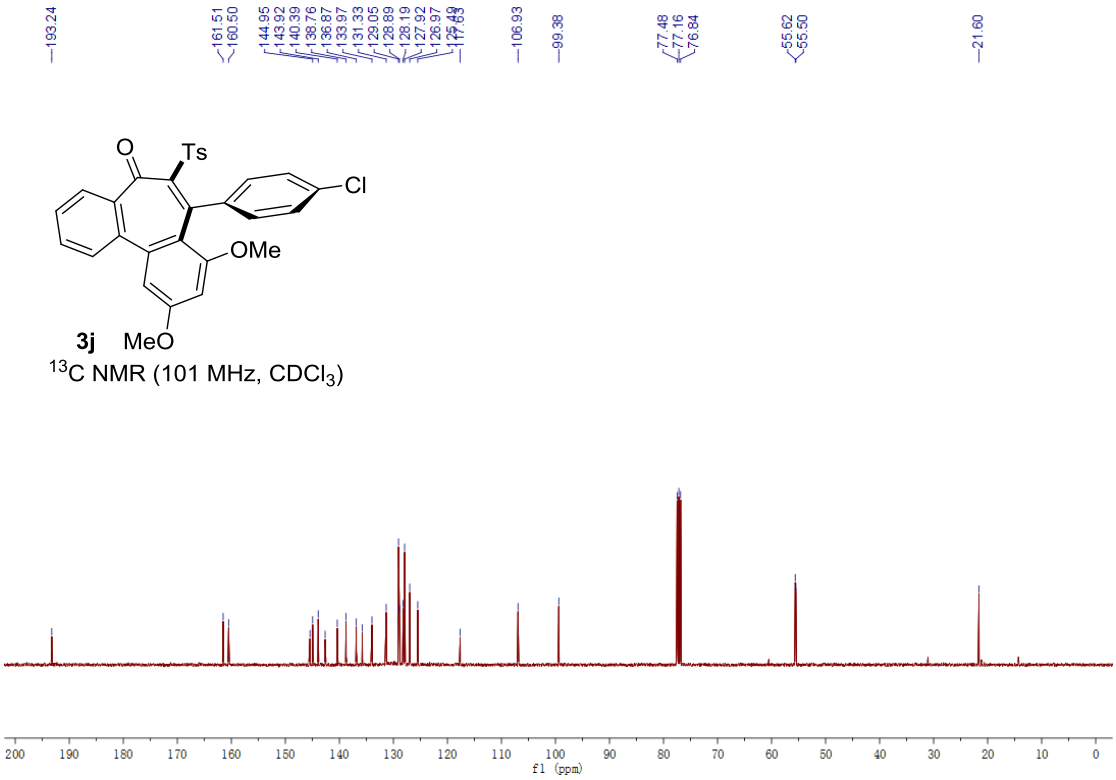
3j

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



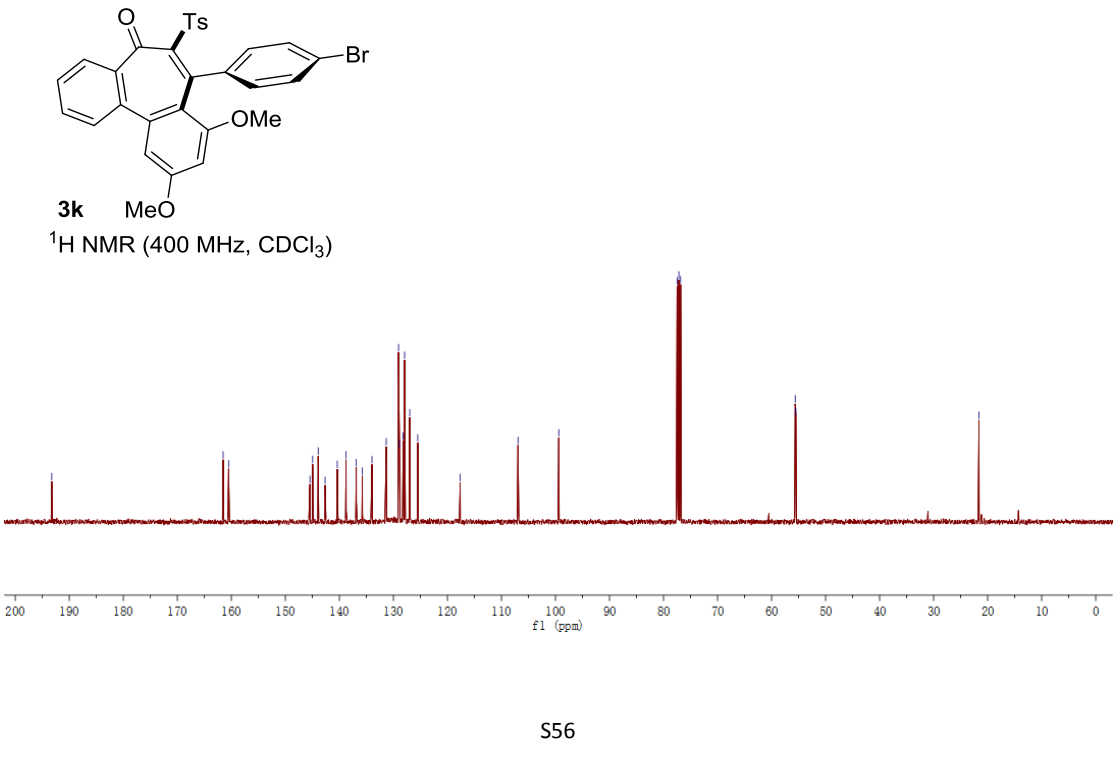
3j

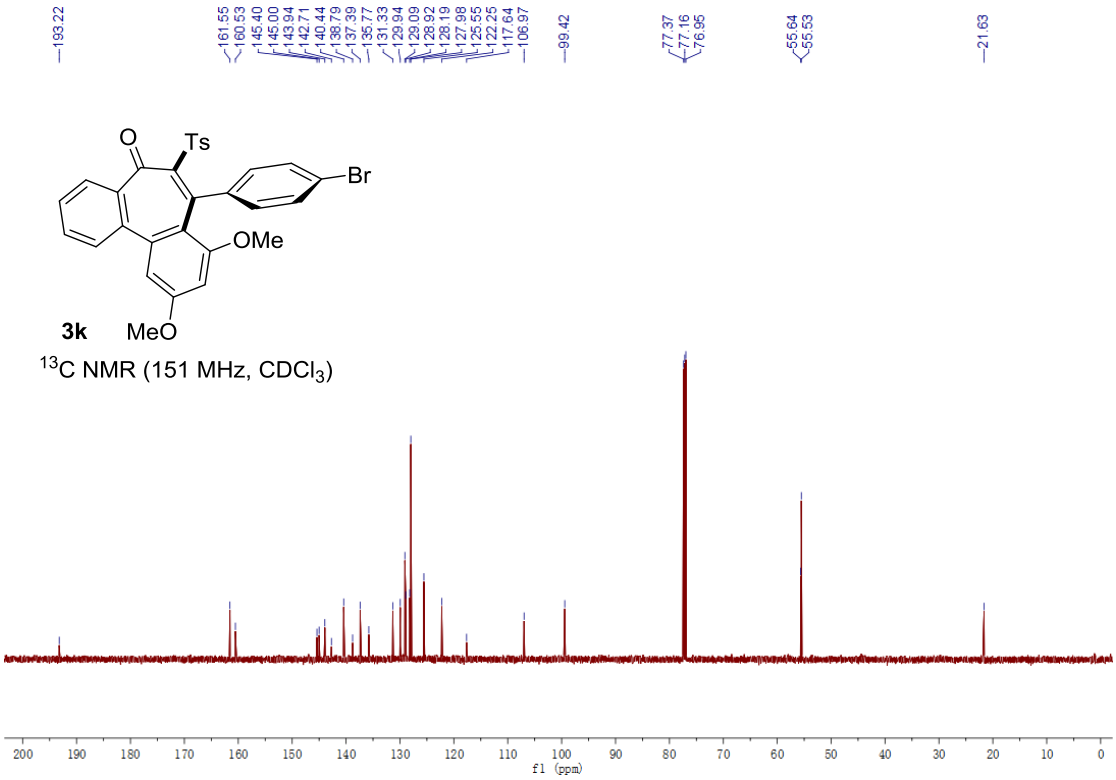
^{13}C NMR (101 MHz, $CDCl_3$)



3k

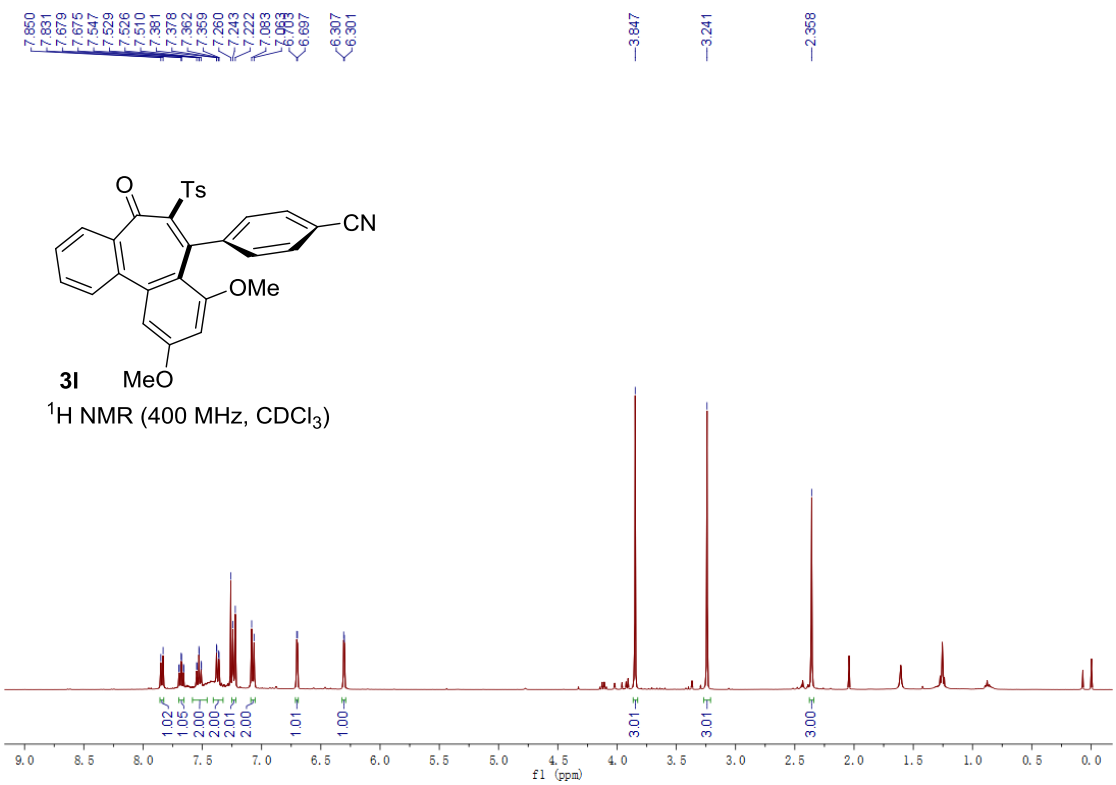
^{1}H NMR (400 MHz, $CDCl_3$)





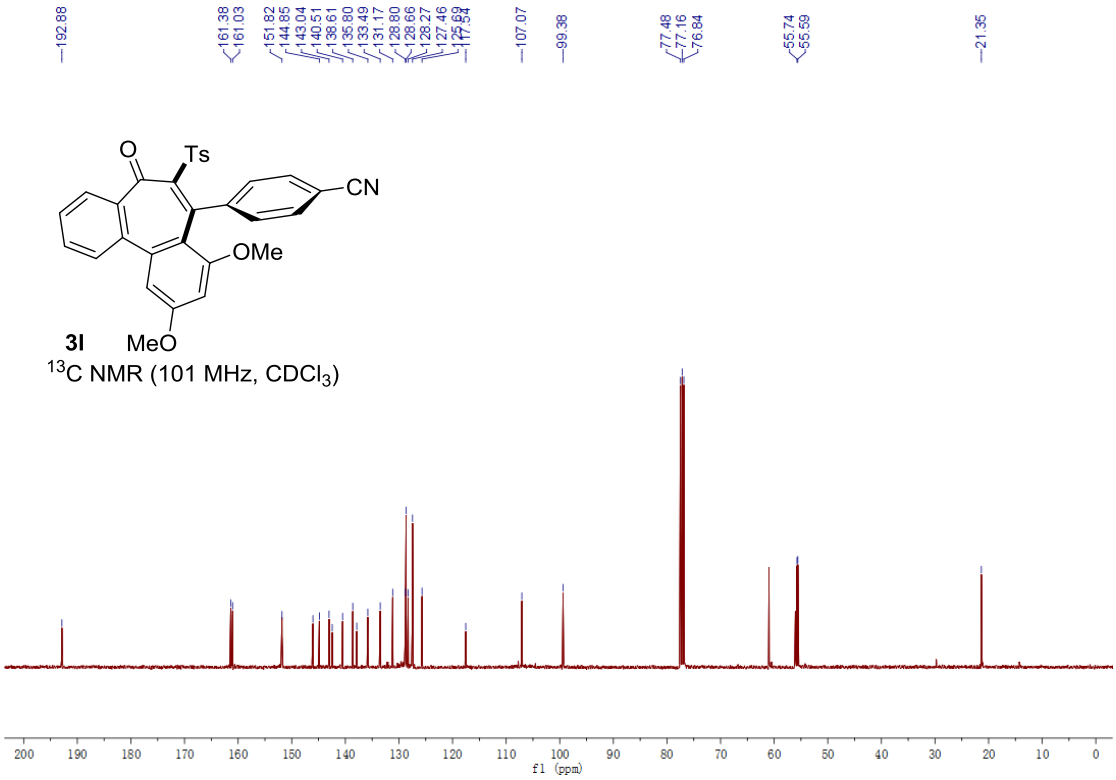
3k

^{13}C NMR (151 MHz, $CDCl_3$)



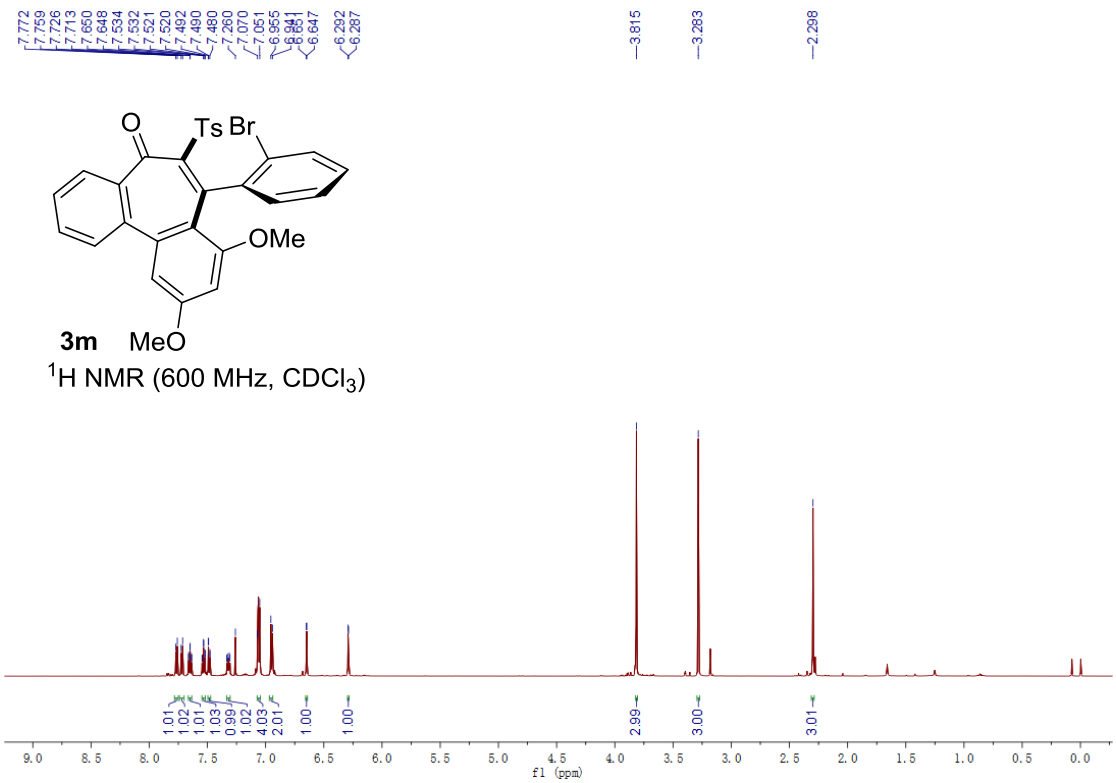
3l

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



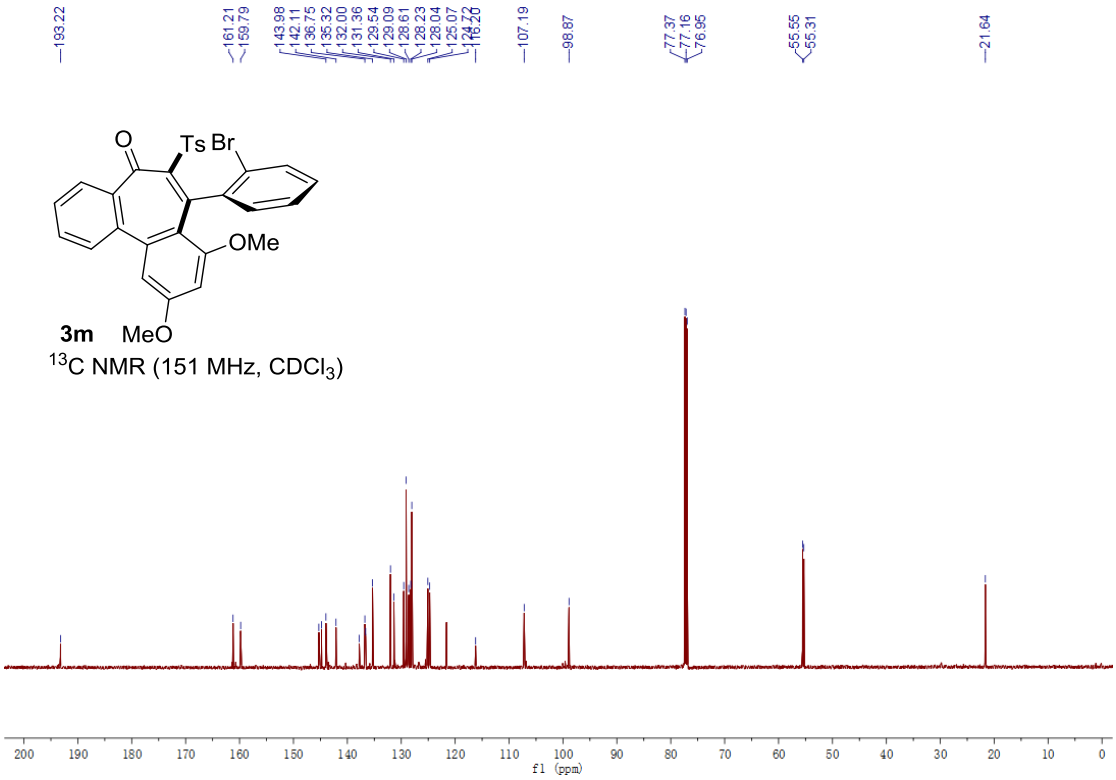
3l

^{13}C NMR (101 MHz, $CDCl_3$)



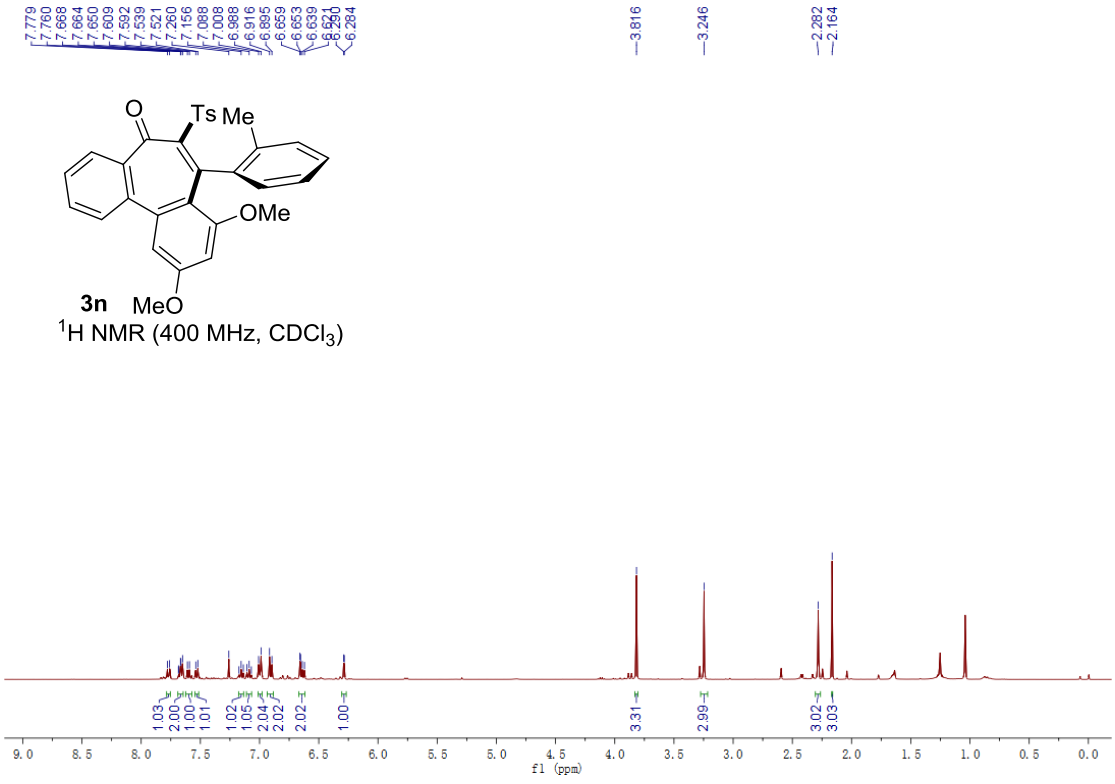
3m

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



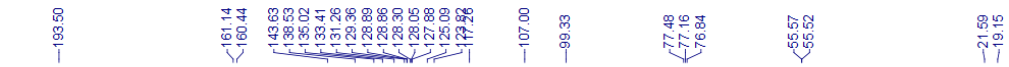
3m

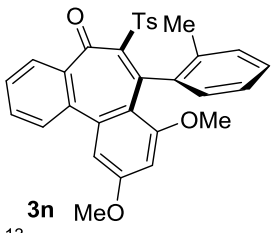
^{13}C NMR (151 MHz, $CDCl_3$)



3n

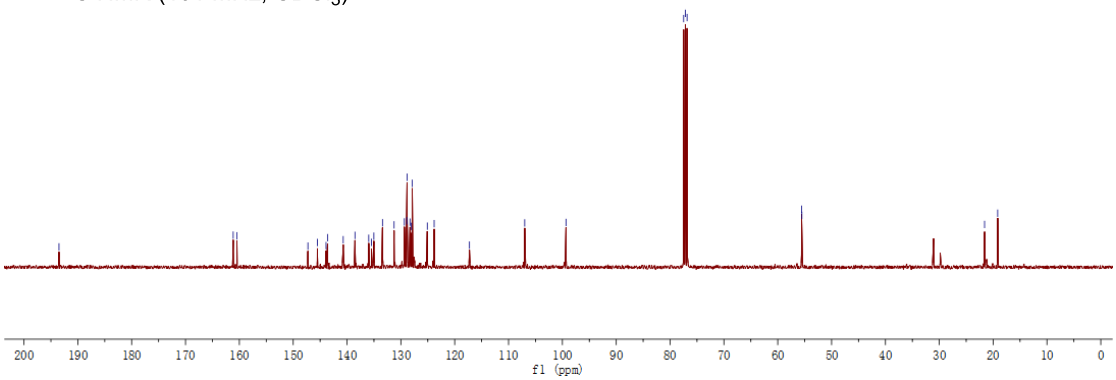
^{1}H NMR (400 MHz, $CDCl_3$)

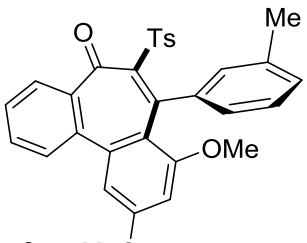




3n

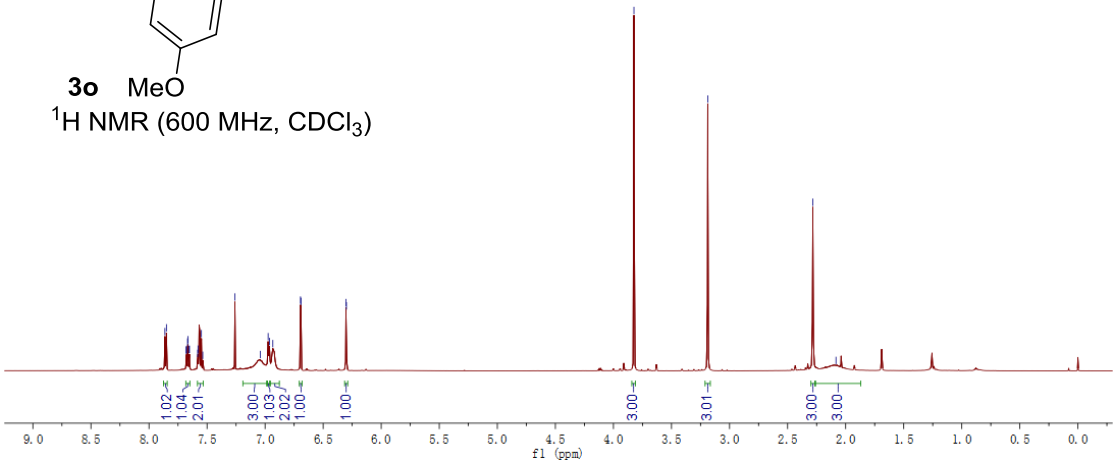
^{13}C NMR (101 MHz, $CDCl_3$)

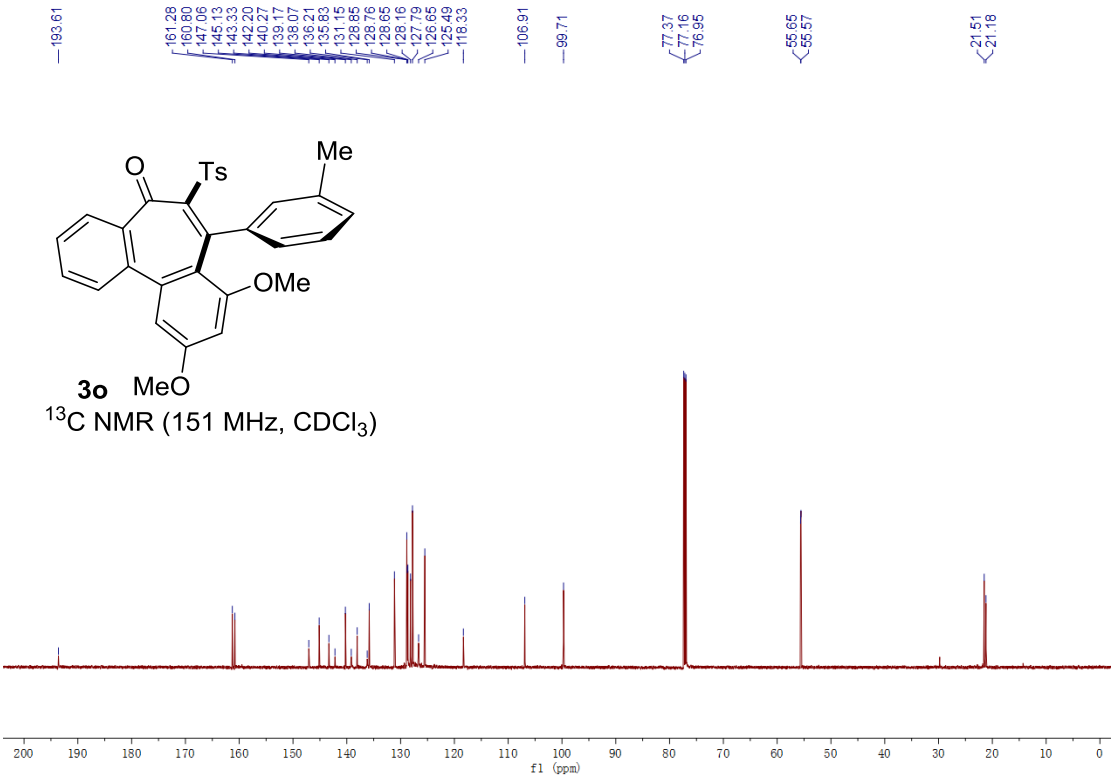




3o

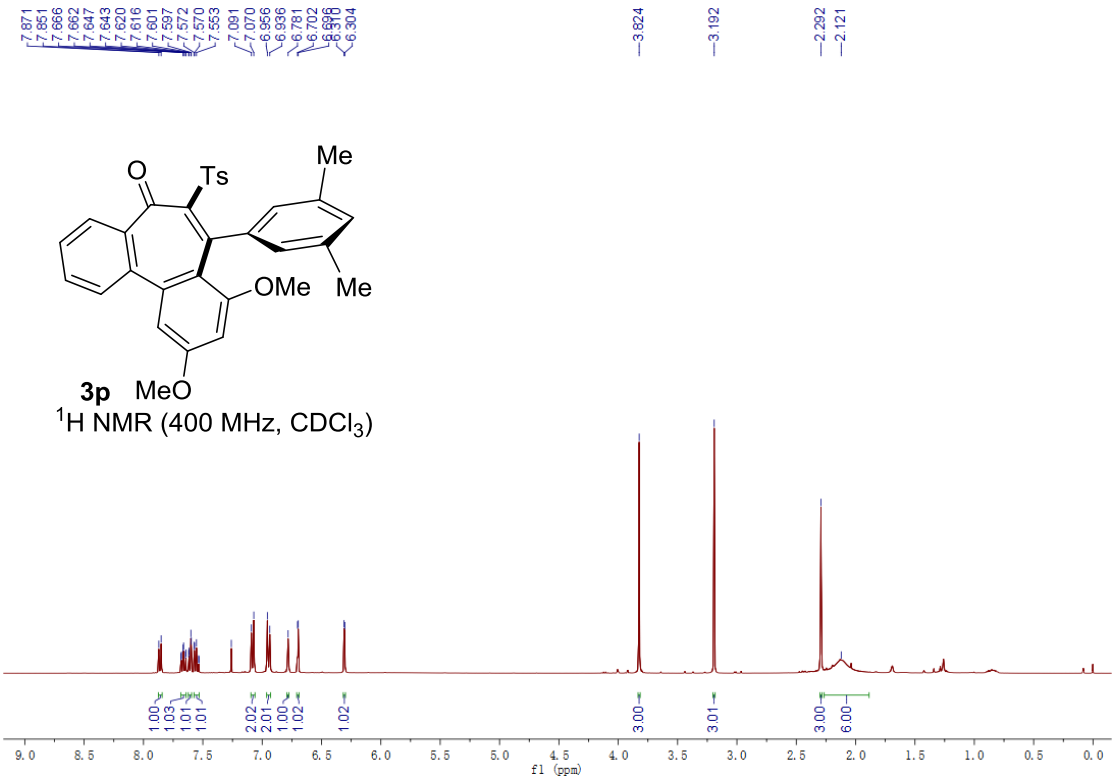
^{1}H NMR (600 MHz, $CDCl_3$)





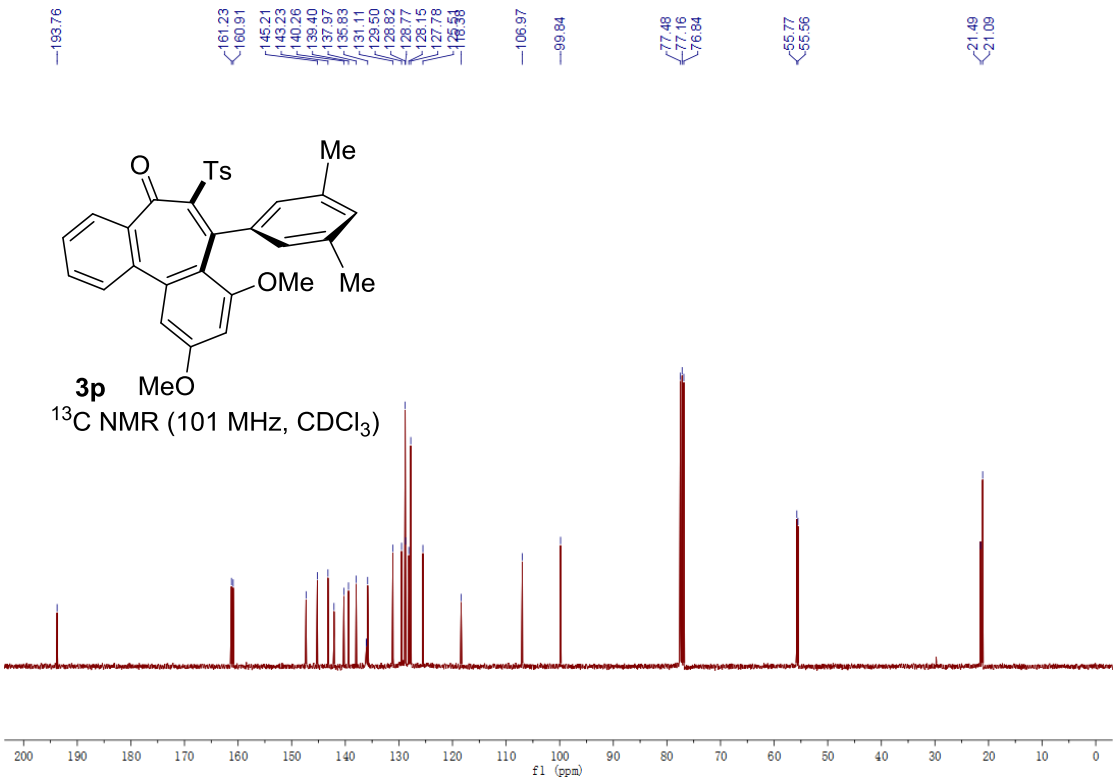
3o

^{13}C NMR (151 MHz, $CDCl_3$)



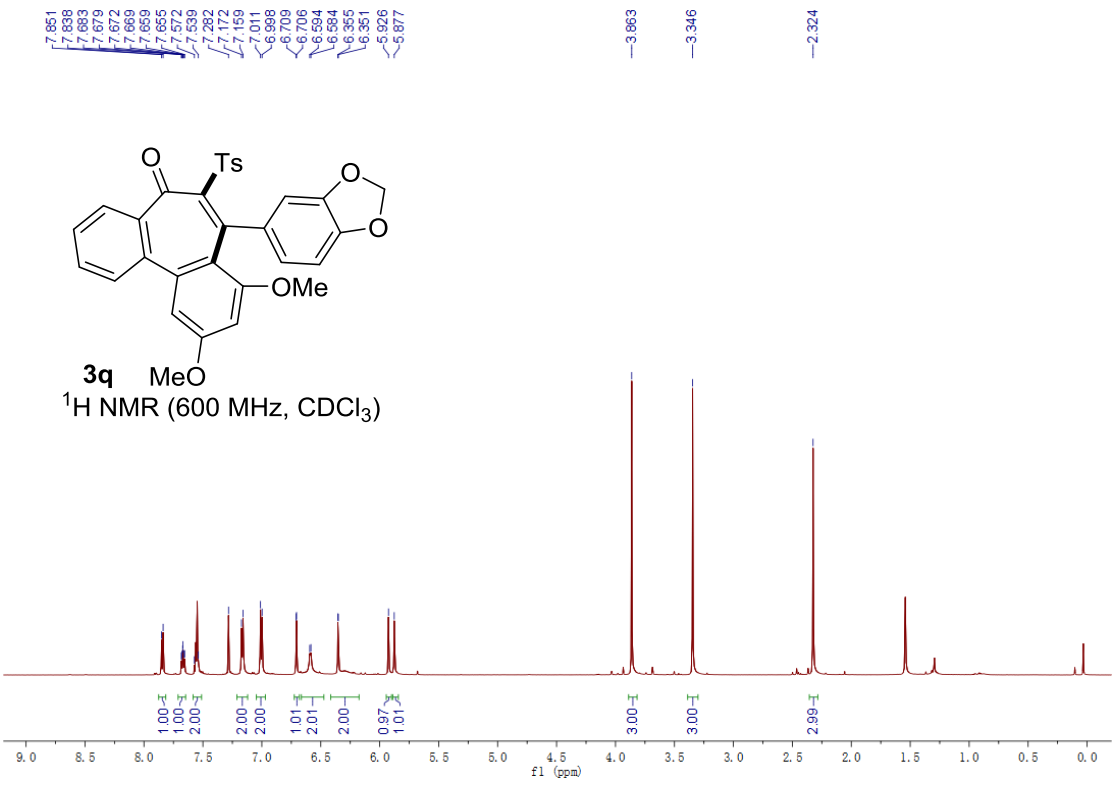
3p

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



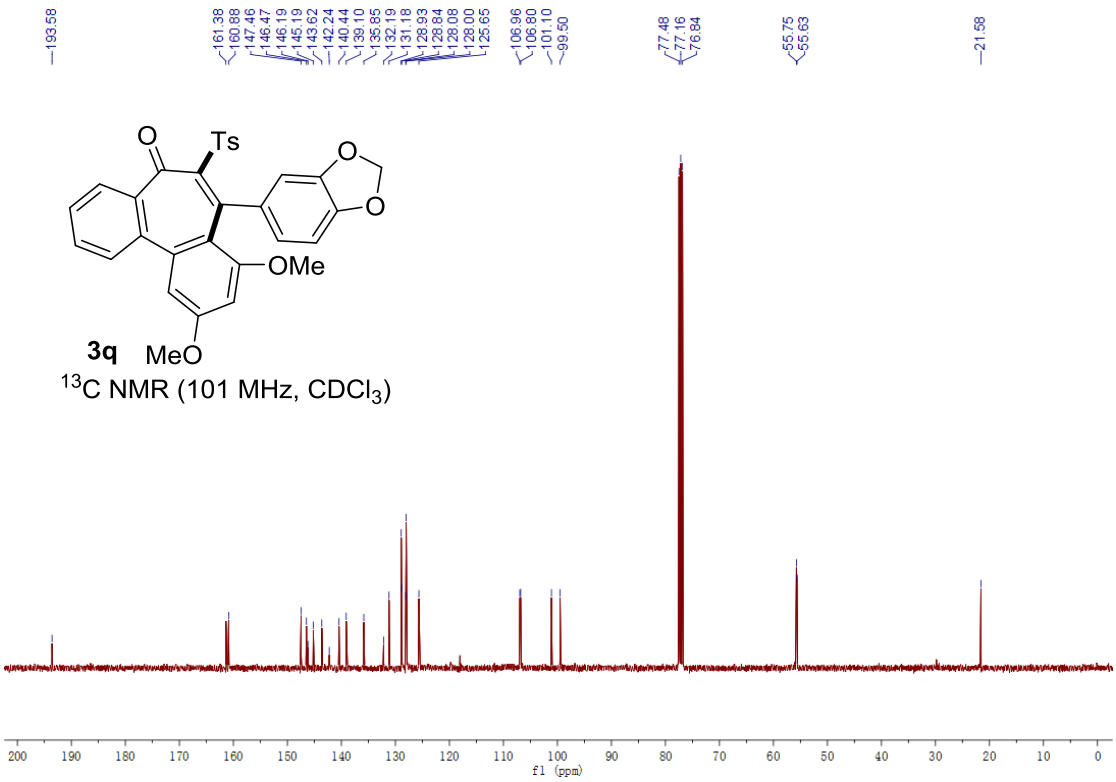
3p

^{13}C NMR (101 MHz, $CDCl_3$)



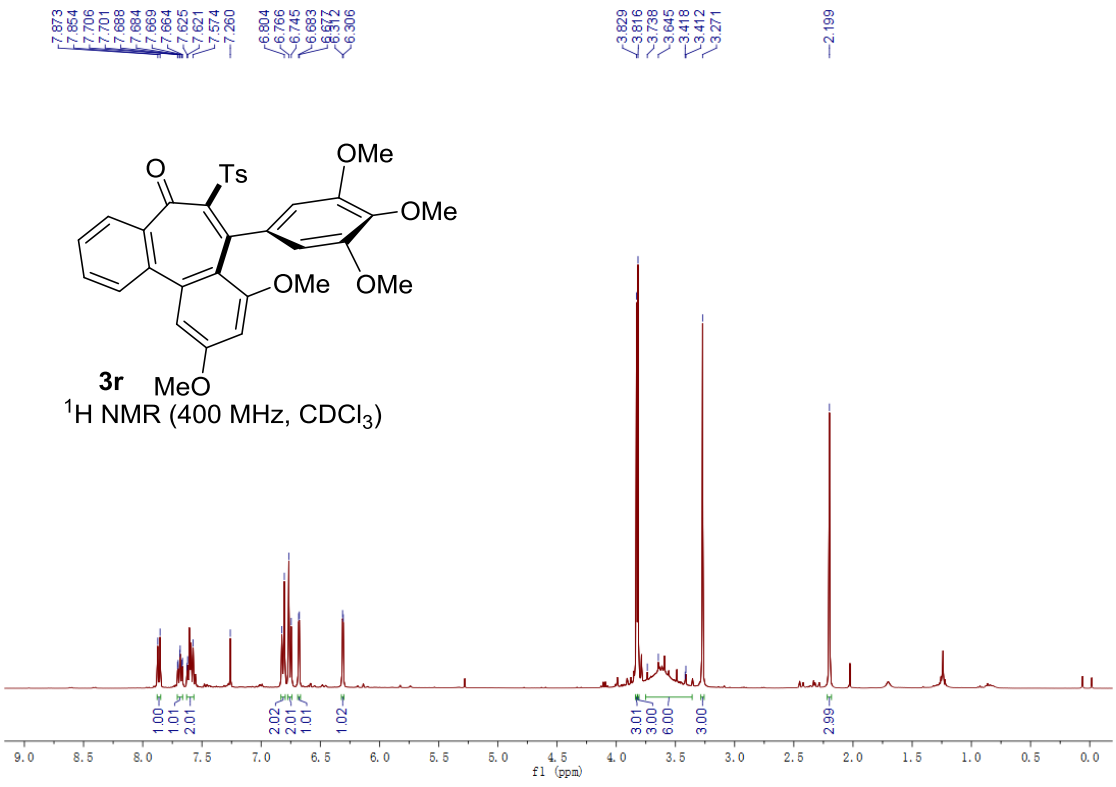
3q

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



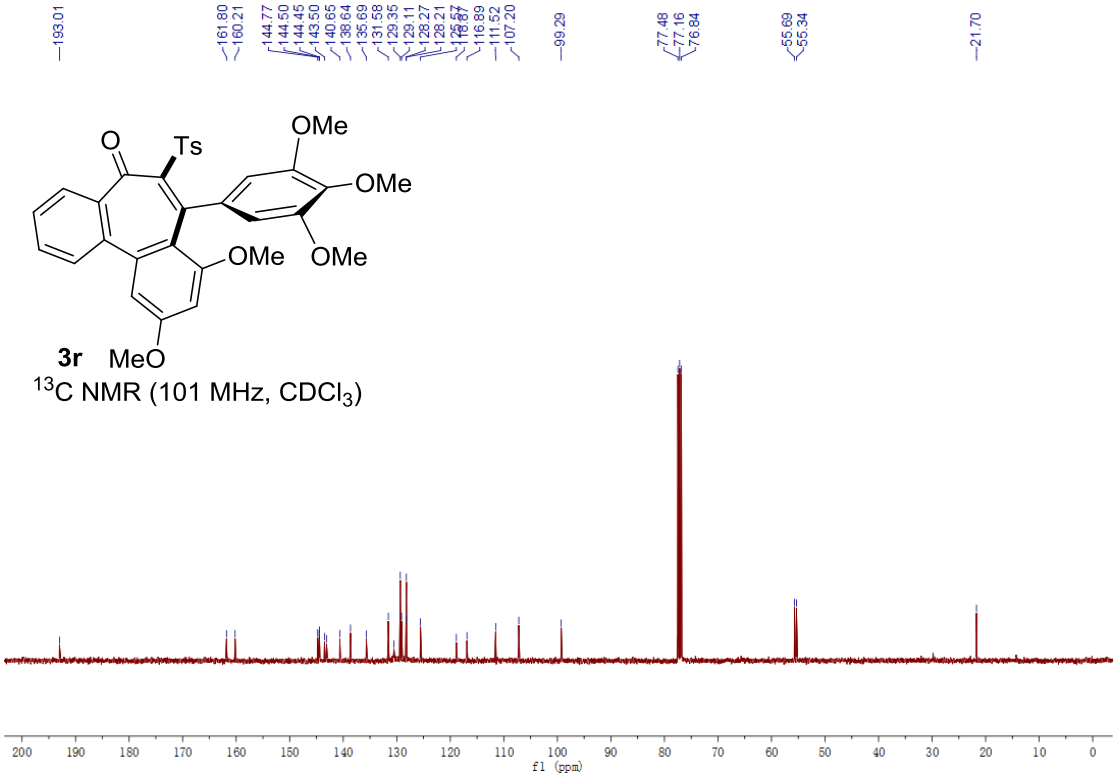
3q

^{13}C NMR (101 MHz, $CDCl_3$)



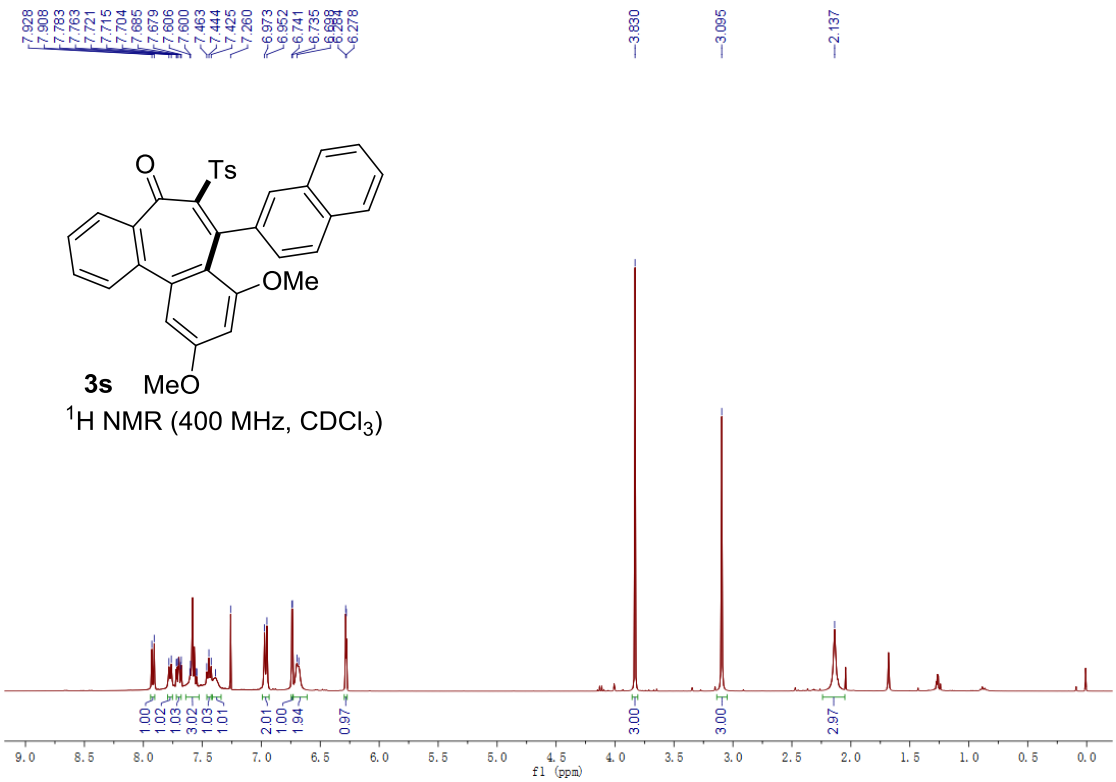
3r

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



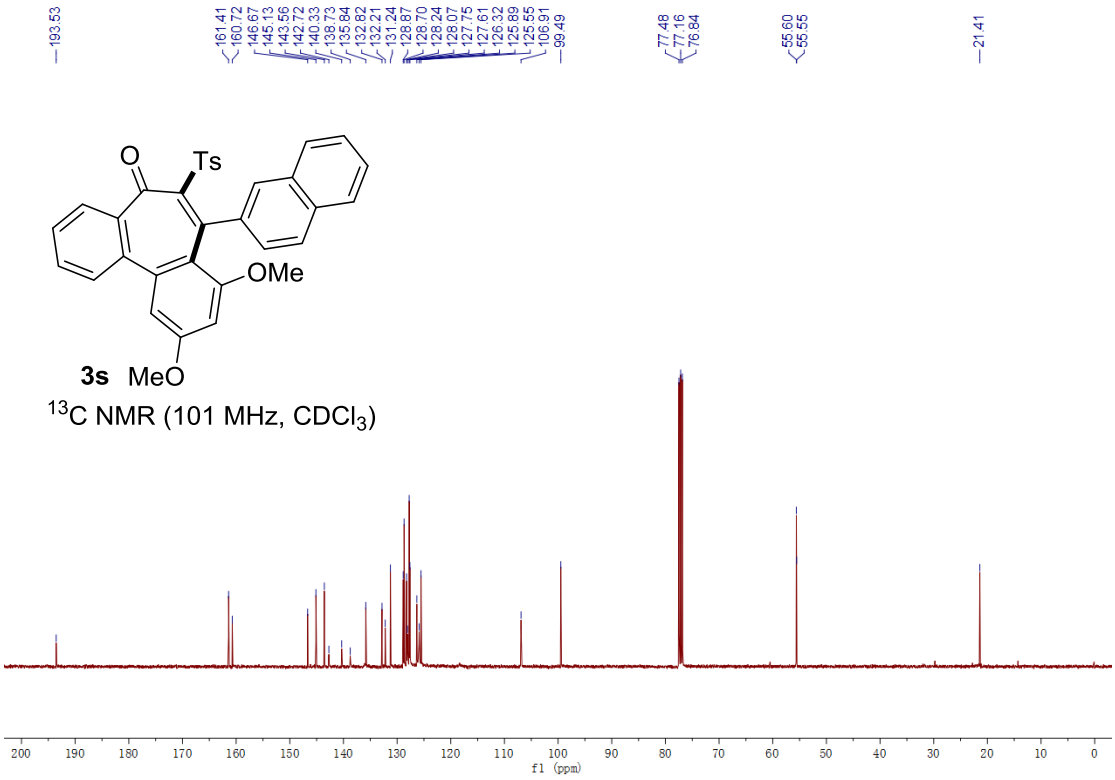
3r

^{13}C NMR (101 MHz, $CDCl_3$)



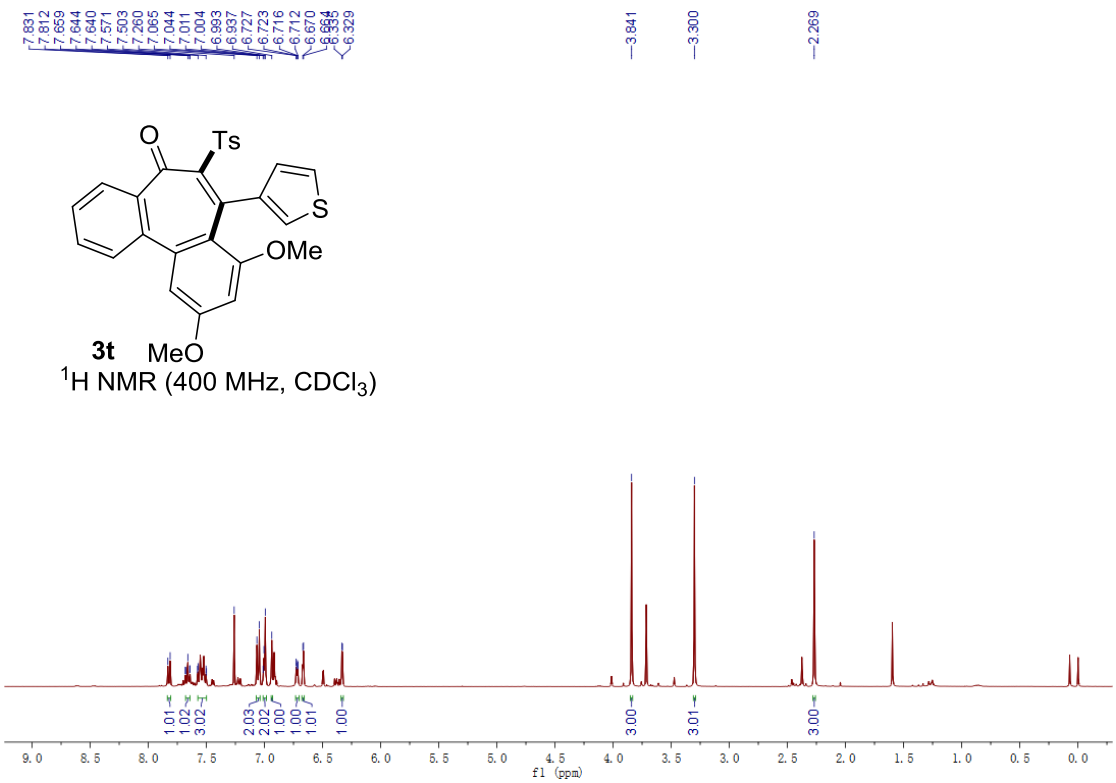
3s

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



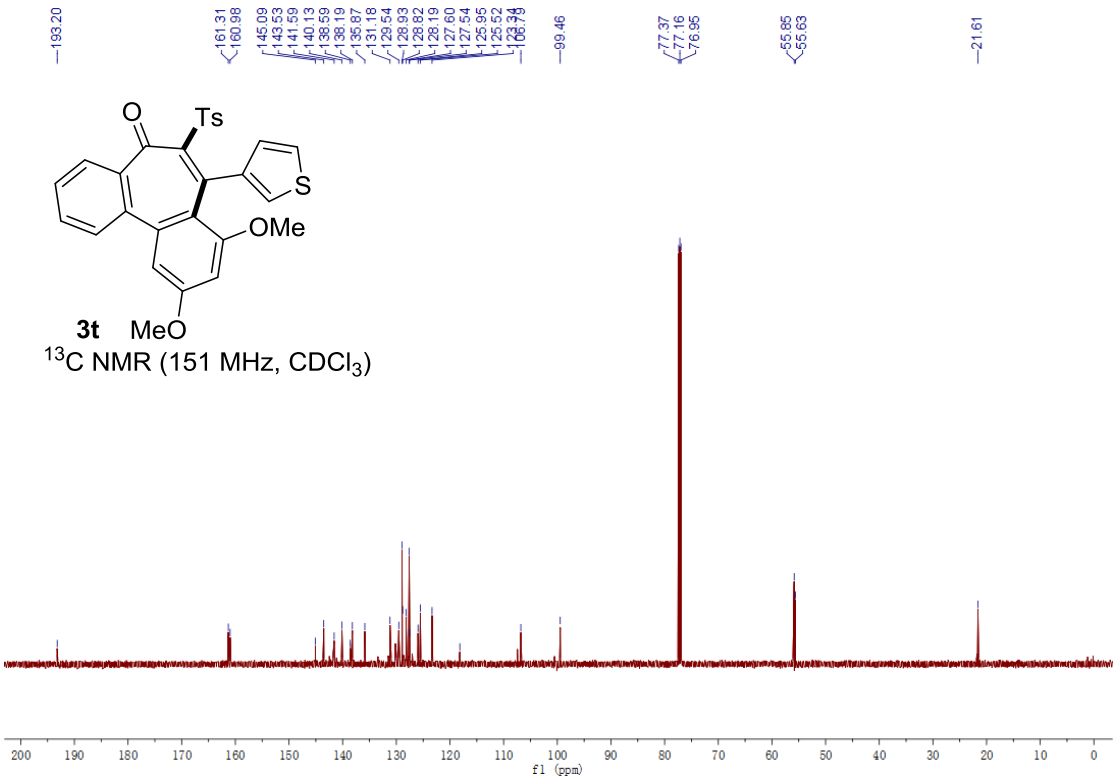
3s

^{13}C NMR (101 MHz, $CDCl_3$)



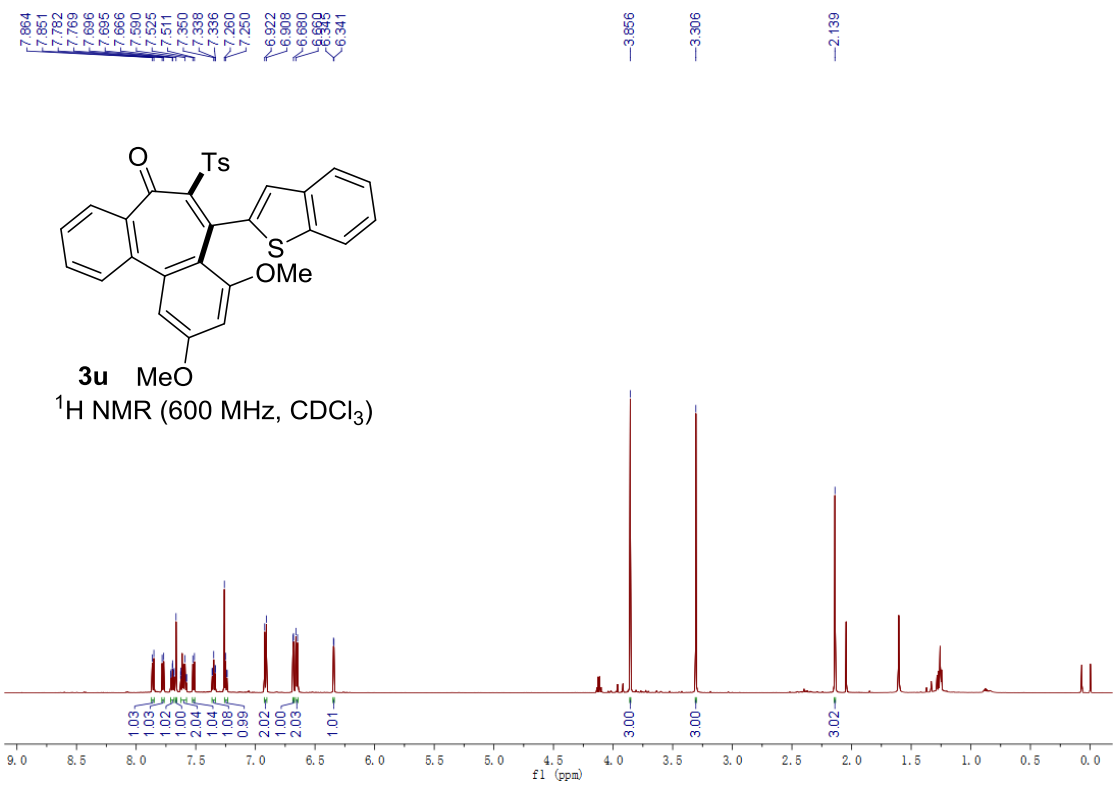
3t

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



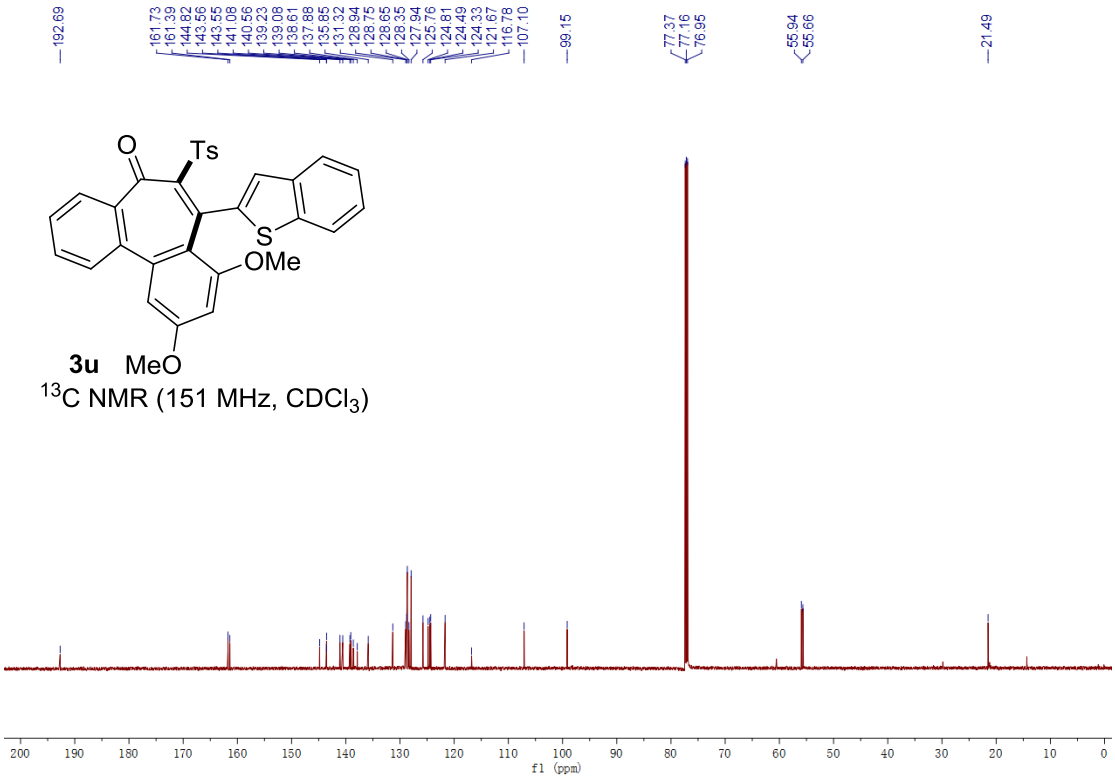
3t

^{13}C NMR (151 MHz, $CDCl_3$)



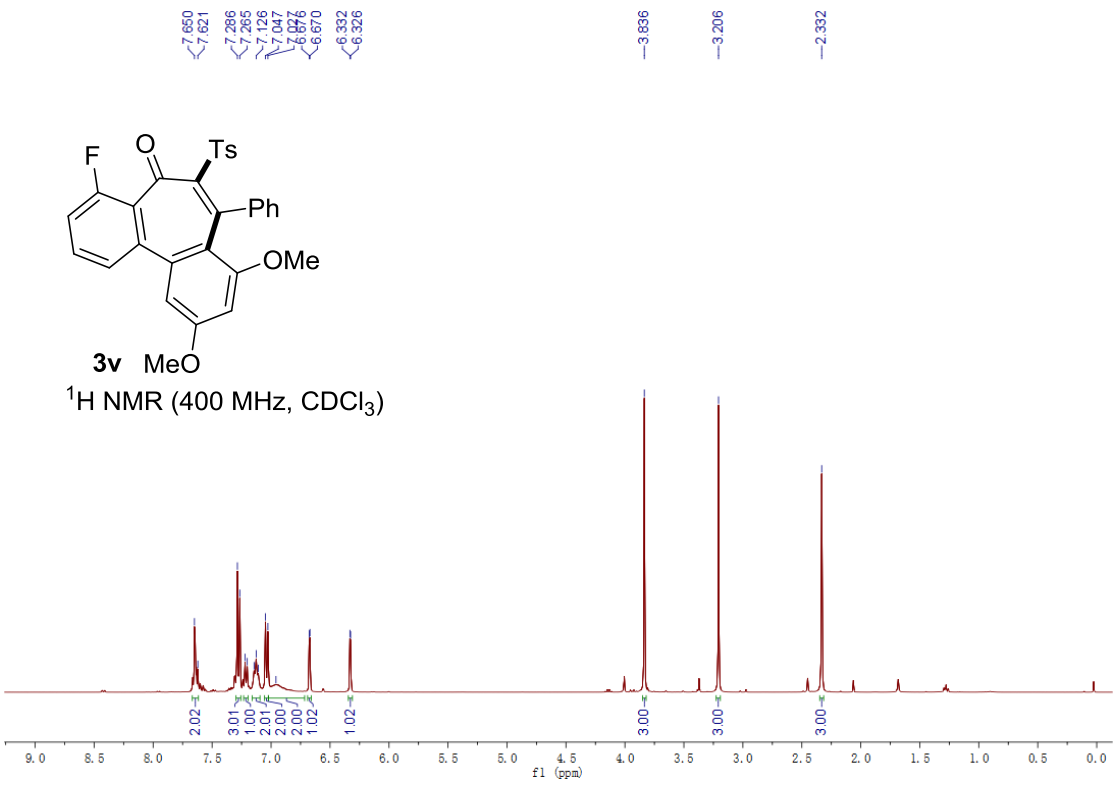
3u

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



3u

^{13}C NMR (151 MHz, $CDCl_3$)

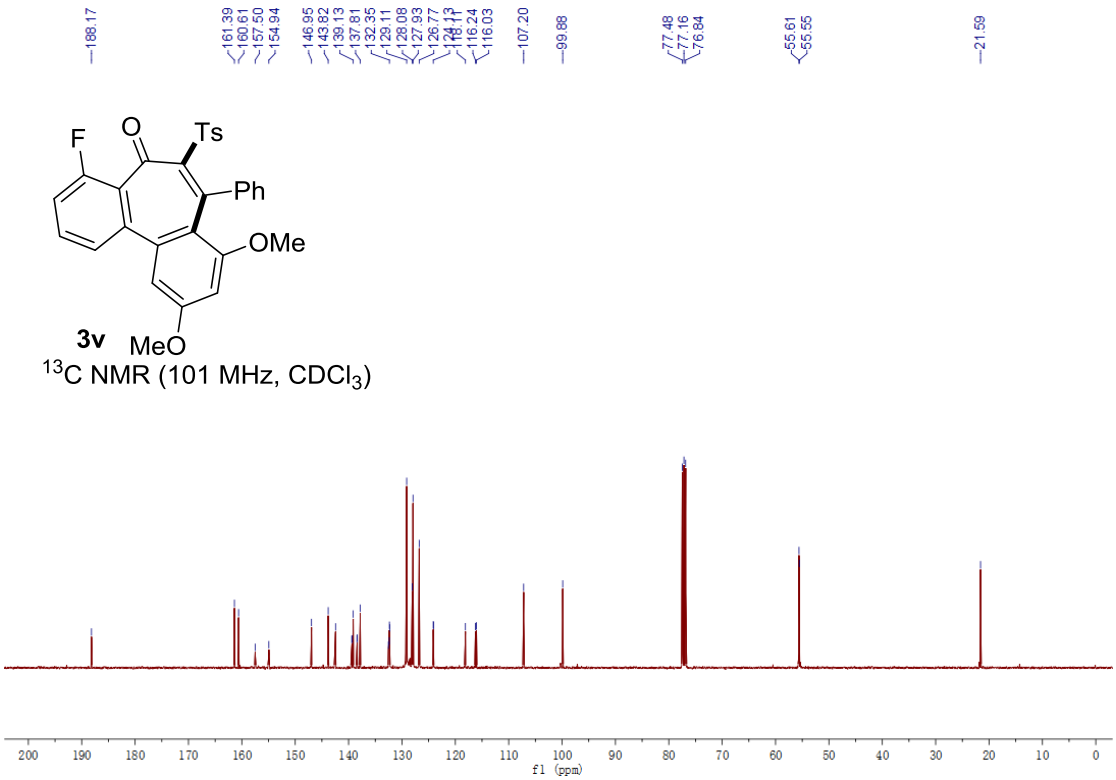


3v

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

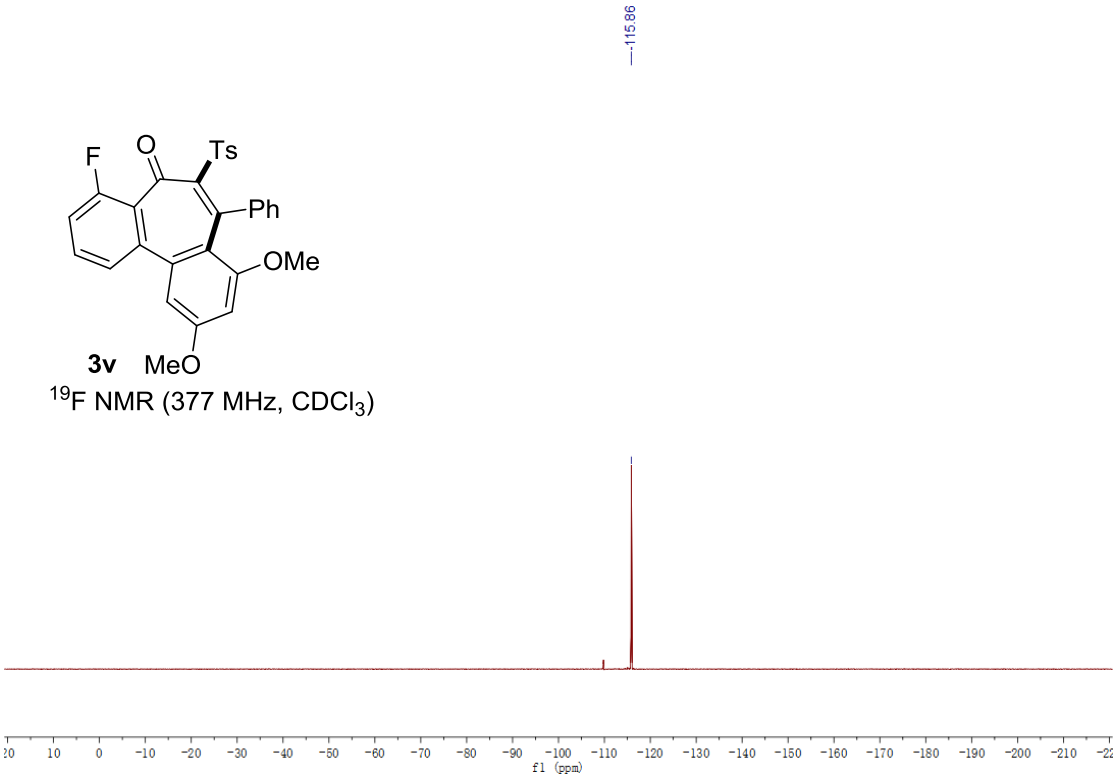
3v

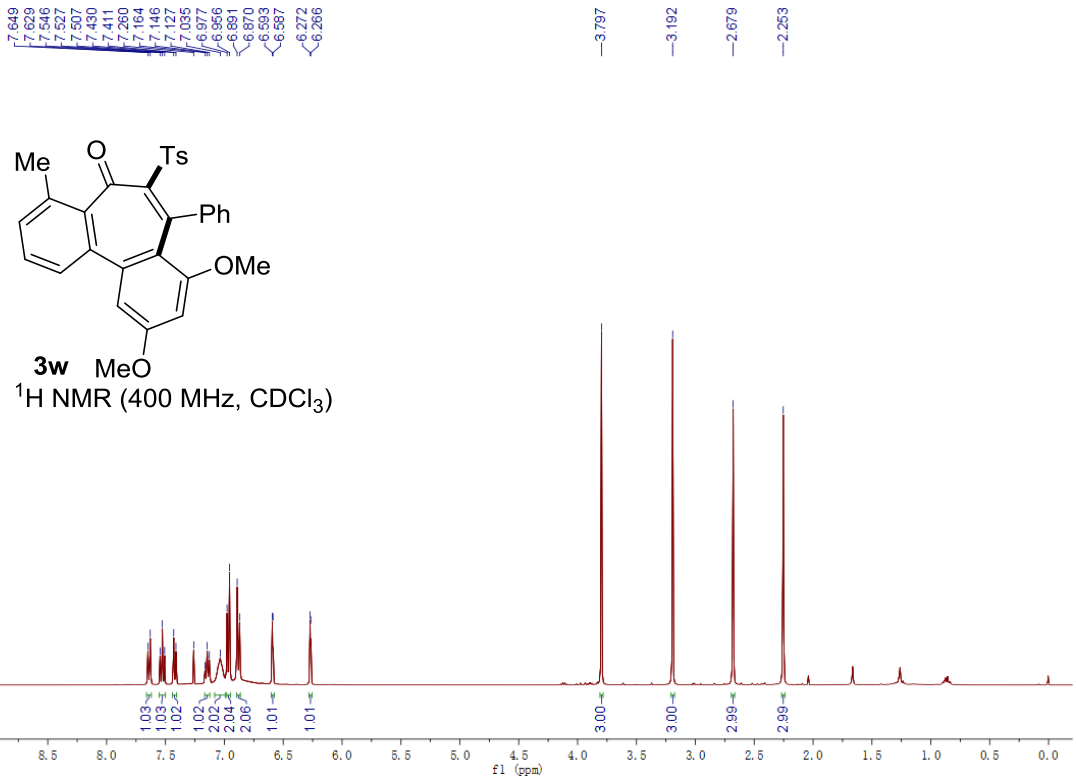
^{13}C NMR (101 MHz, $CDCl_3$)



3v

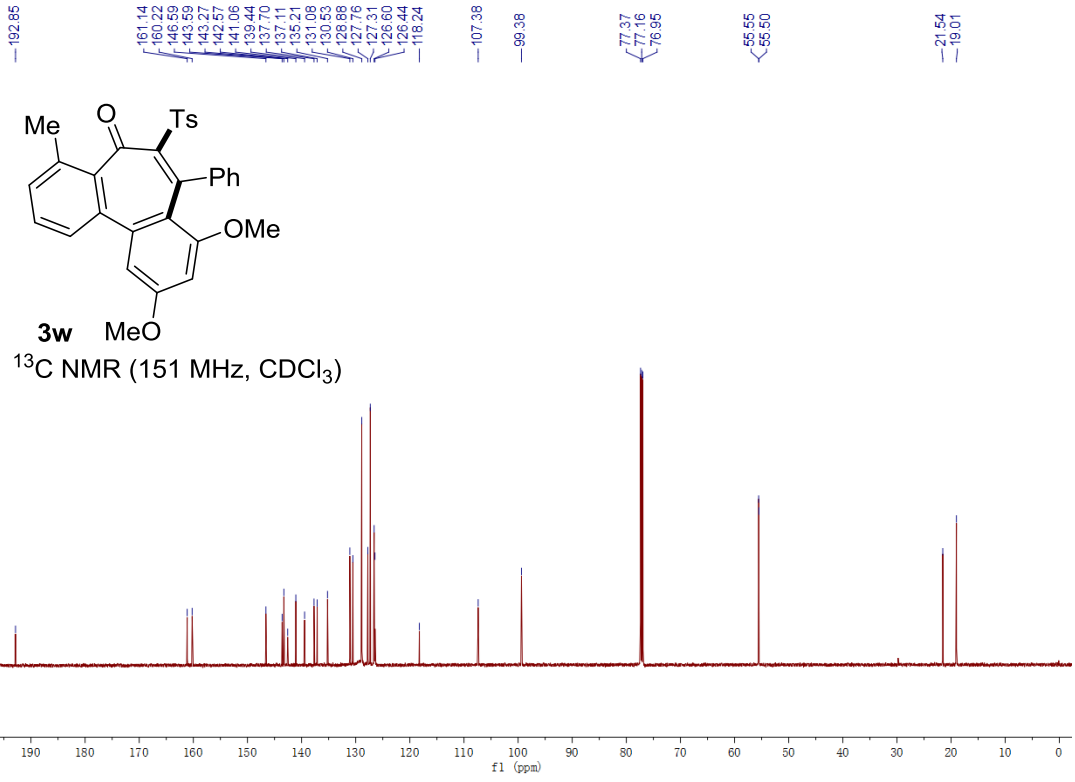
^{19}F NMR (377 MHz, $CDCl_3$)





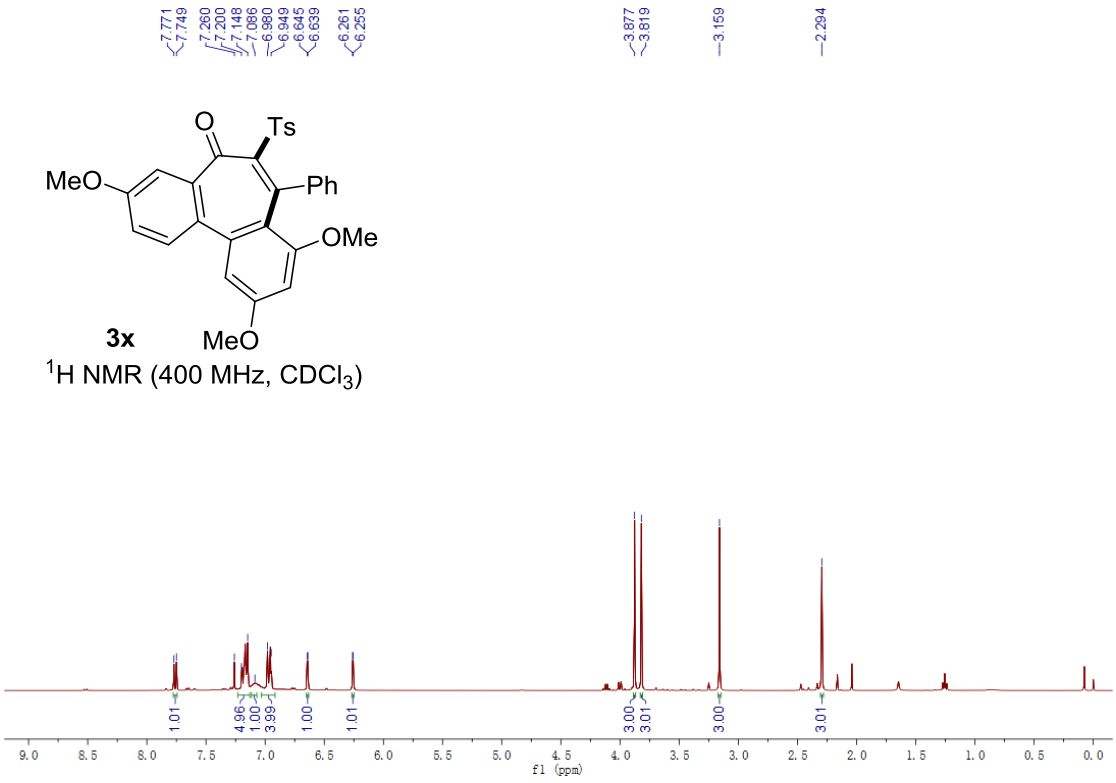
3w

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



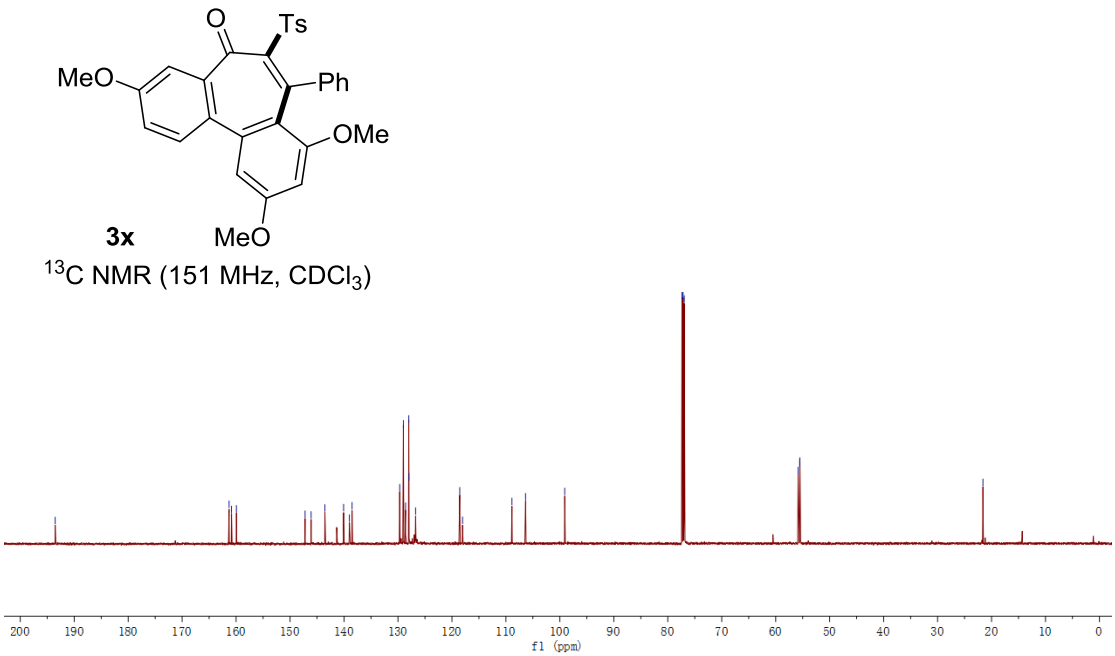
3w

^{13}C NMR (151 MHz, $CDCl_3$)



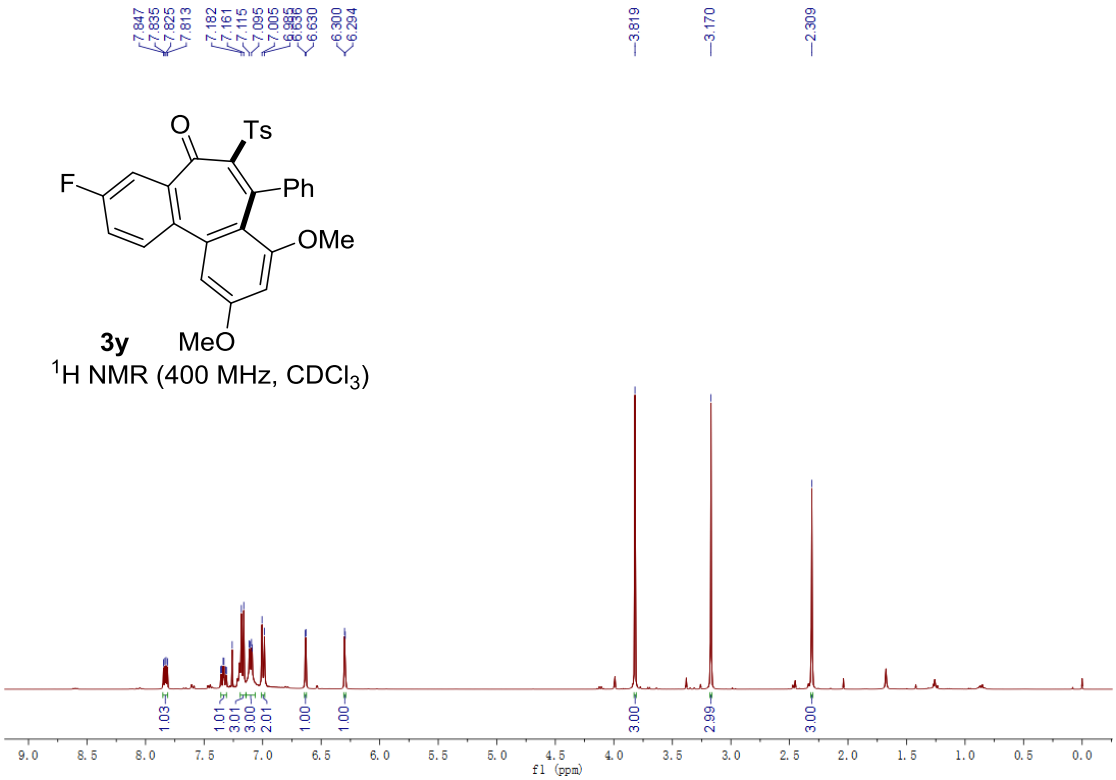
3x

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



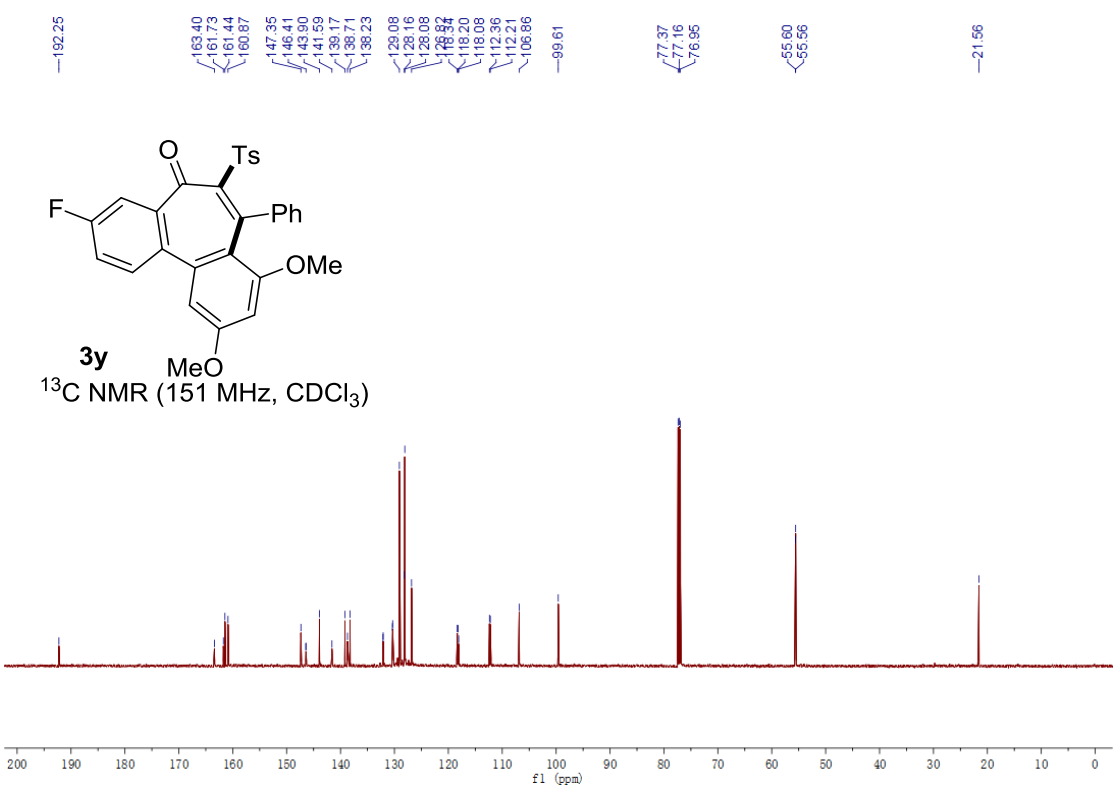
3x

^{13}C NMR (151 MHz, $CDCl_3$)



3y

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

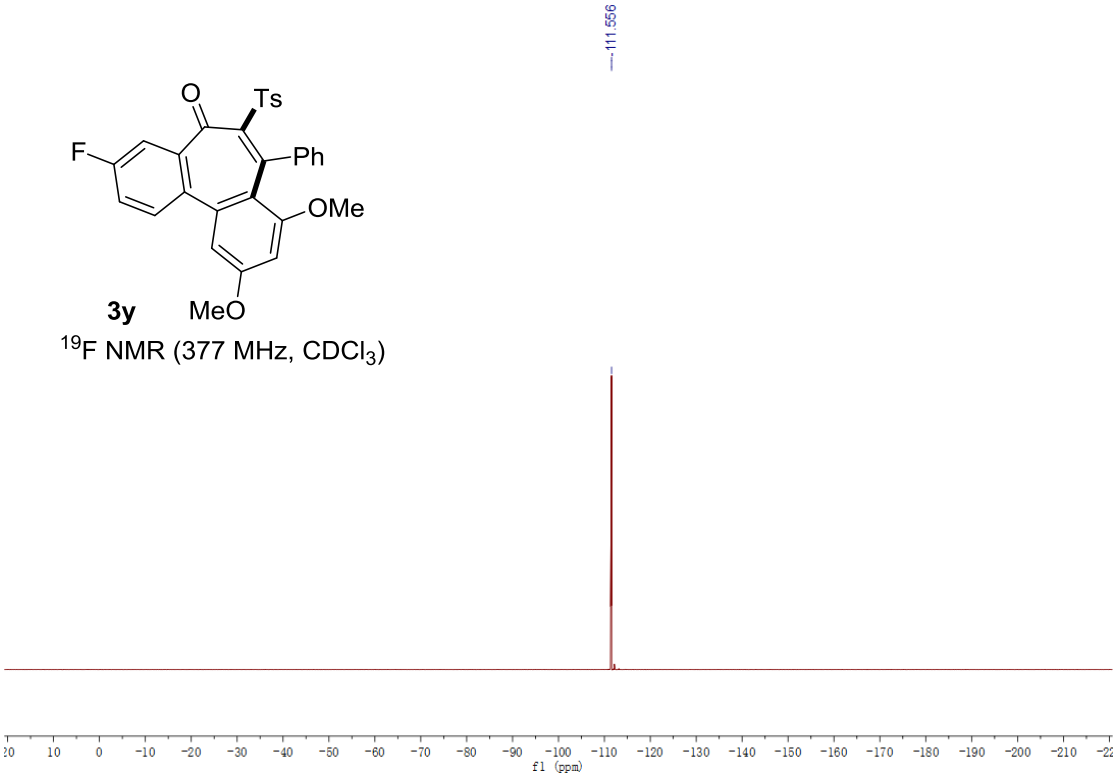


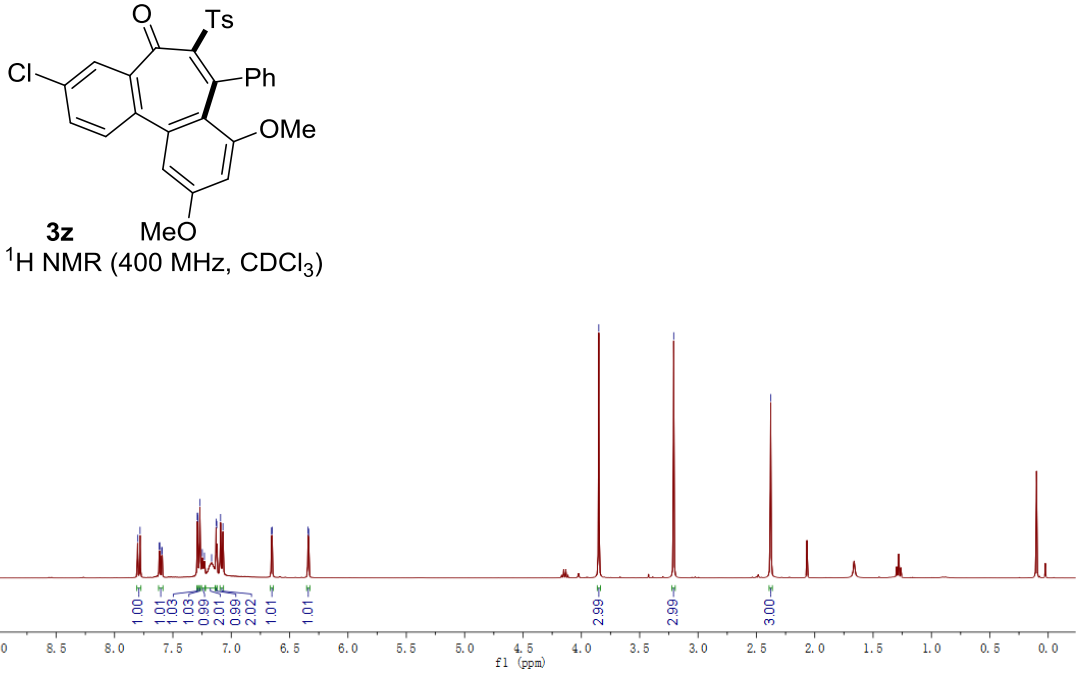
3y

^{13}C NMR (151 MHz, $CDCl_3$)

3y

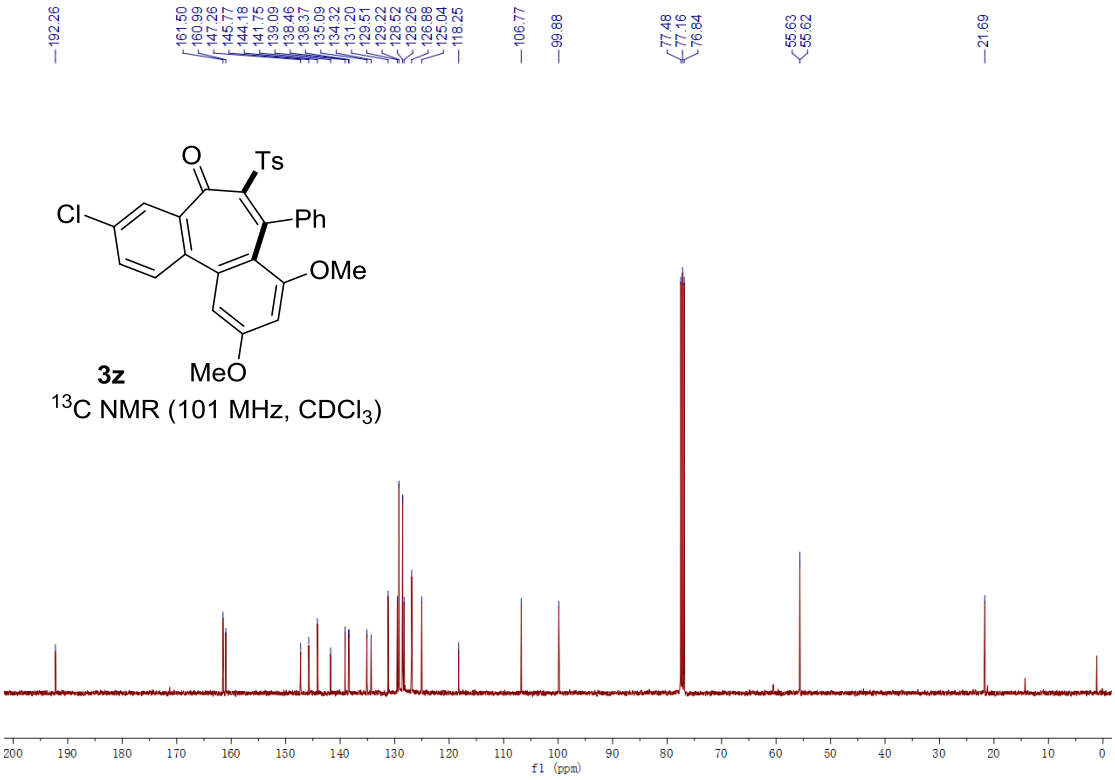
^{19}F NMR (377 MHz, $CDCl_3$)





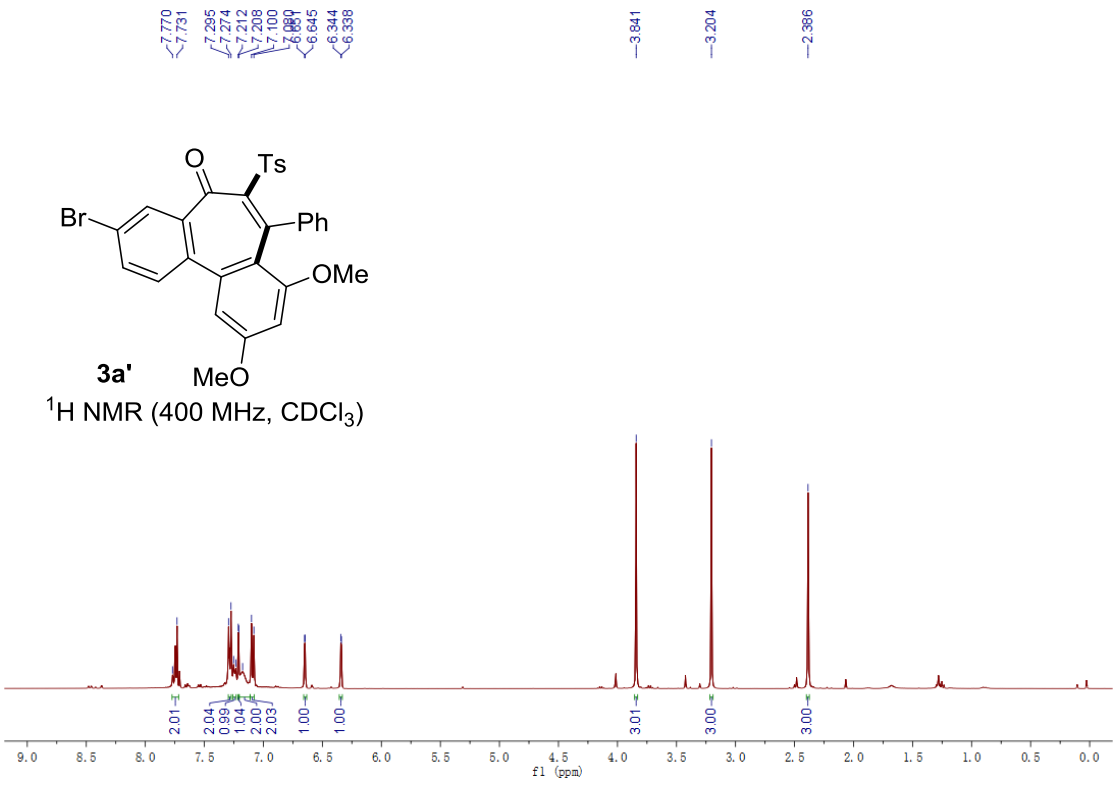
3z

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



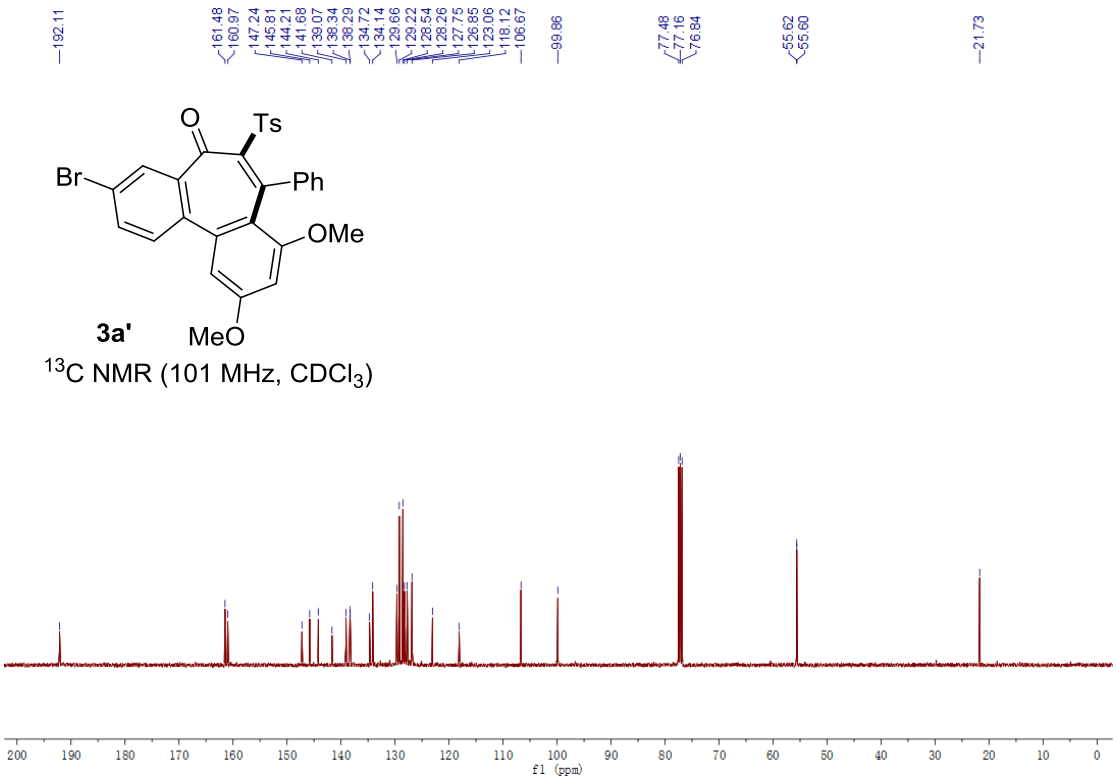
3z

^{13}C NMR (101 MHz, $CDCl_3$)

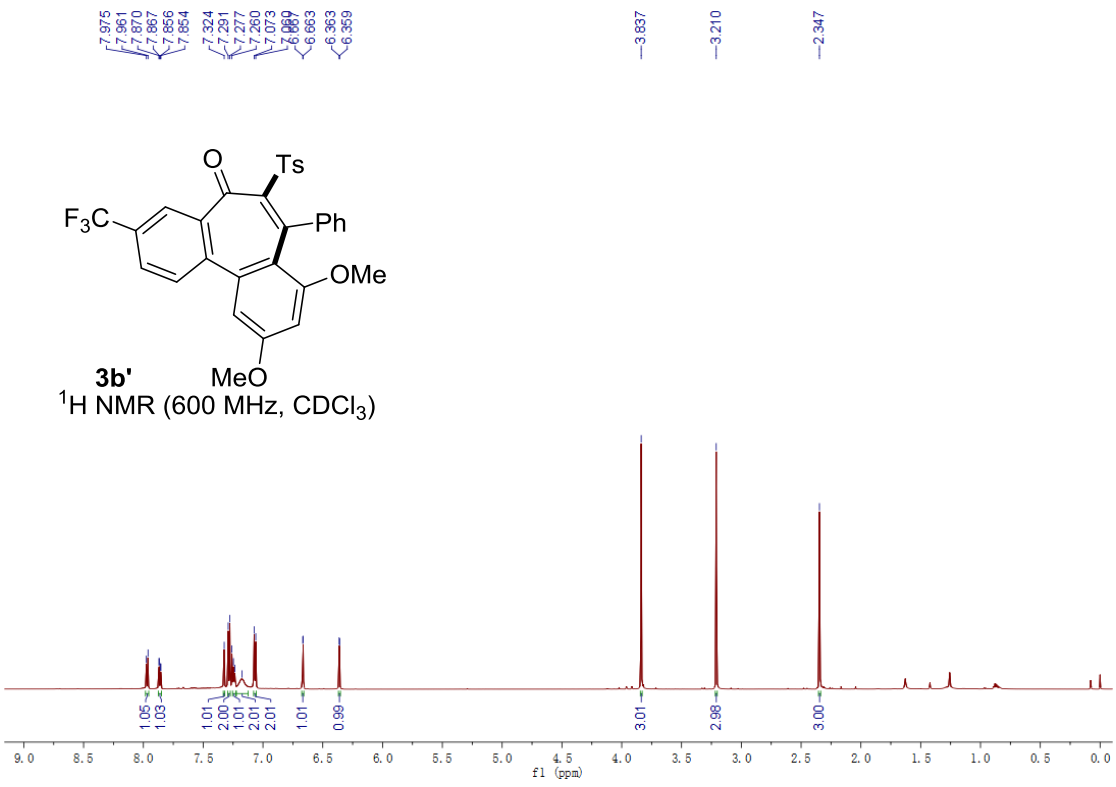


3a'

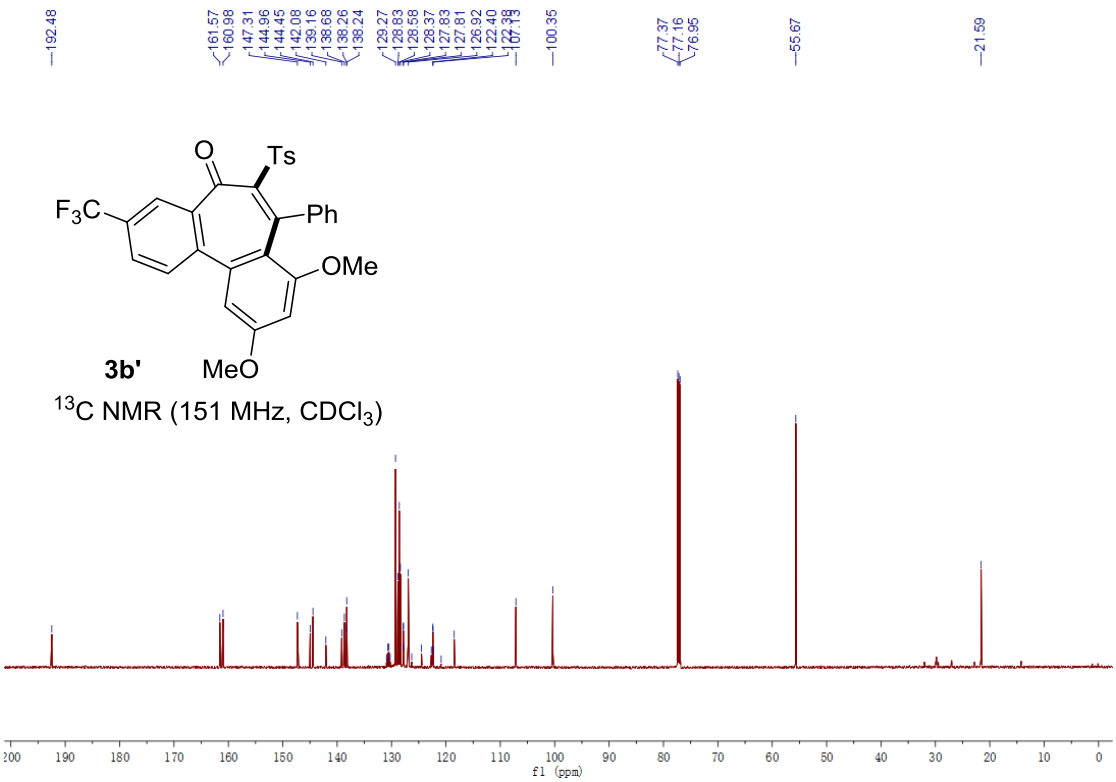
^{1}H NMR (400 MHz, $CDCl_3$)

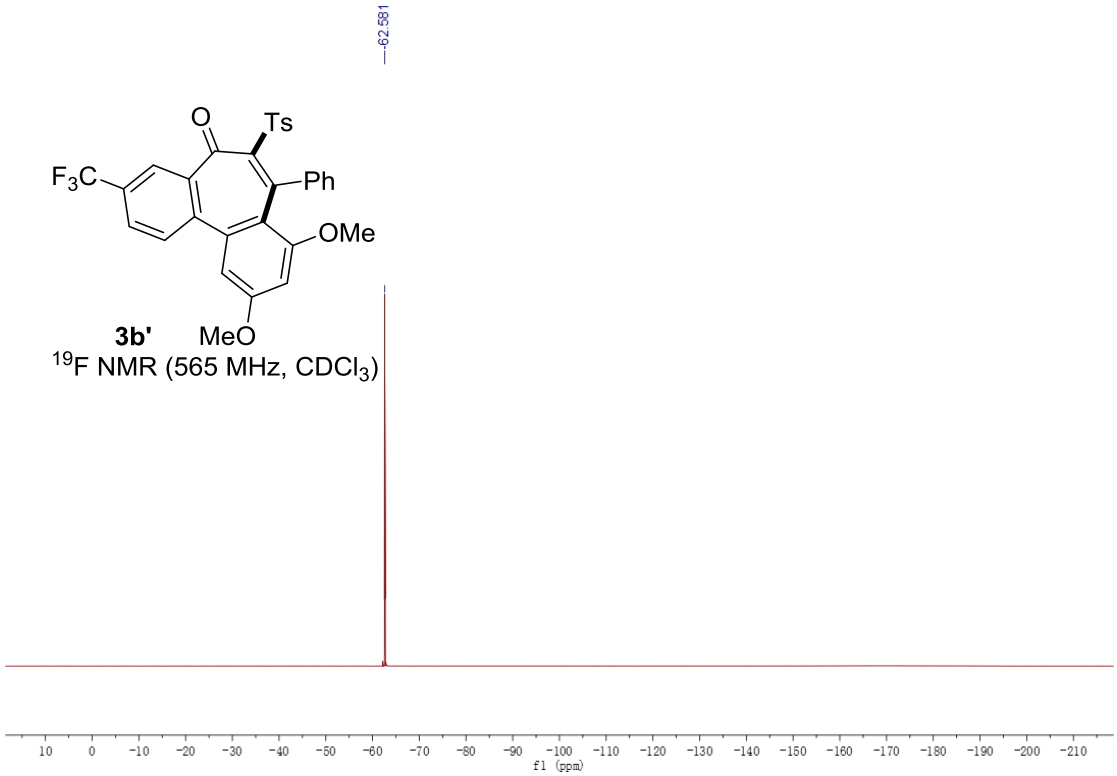


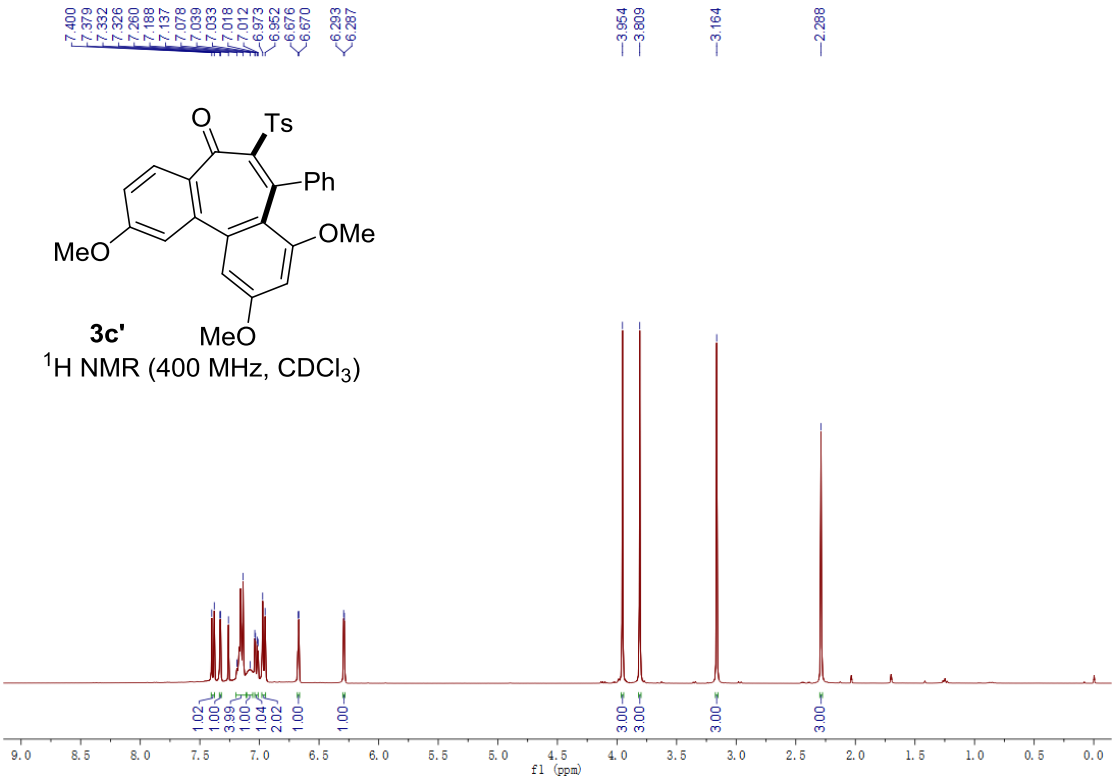
^{13}C NMR (101 MHz, $CDCl_3$)



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

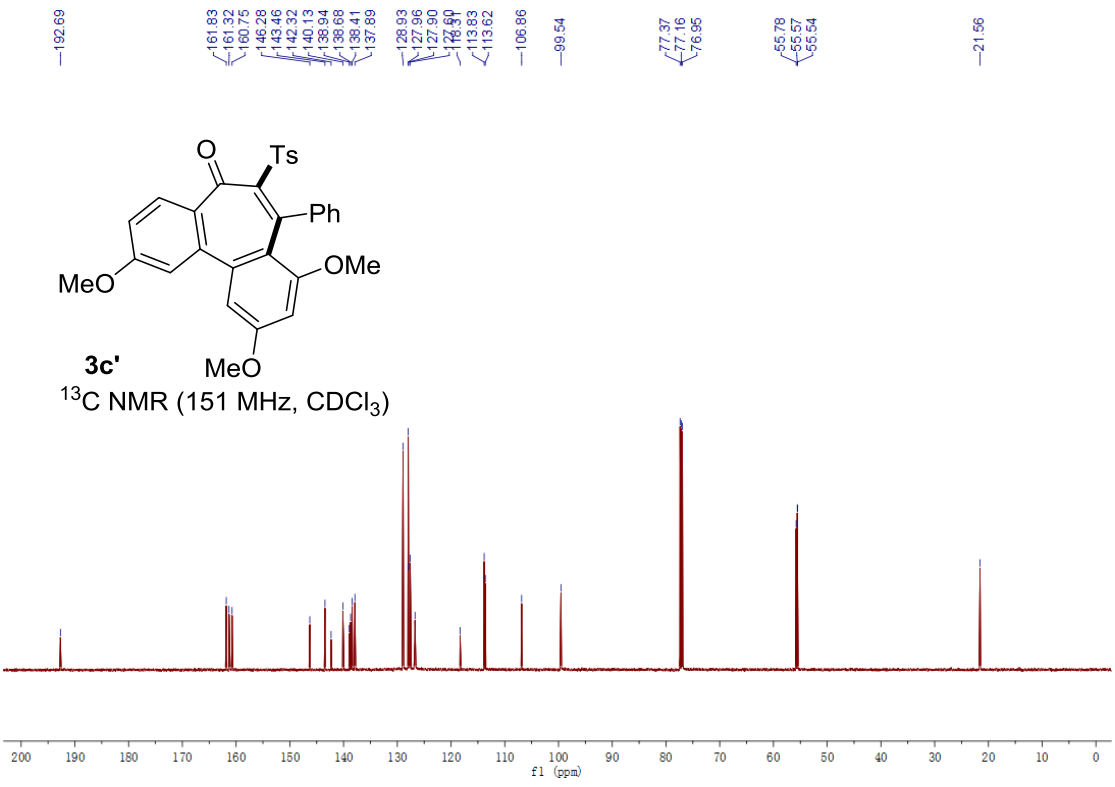

192.48
161.57
160.98
147.31
144.96
144.45
142.08
139.16
138.68
138.26
138.24
129.27
128.83
128.58
128.37
127.83
127.81
126.92
122.40
100.35
77.37
77.16
76.95
55.67
21.59
O
Ts
F3C
Ph
OMe
MeO
3b'
13C NMR (151 MHz, CDCl3)
f1 (ppm)


62.581
O
Ts
F3C
Ph
OMe
MeO
3b'
19F NMR (565 MHz, CDCl3)
f1 (ppm)



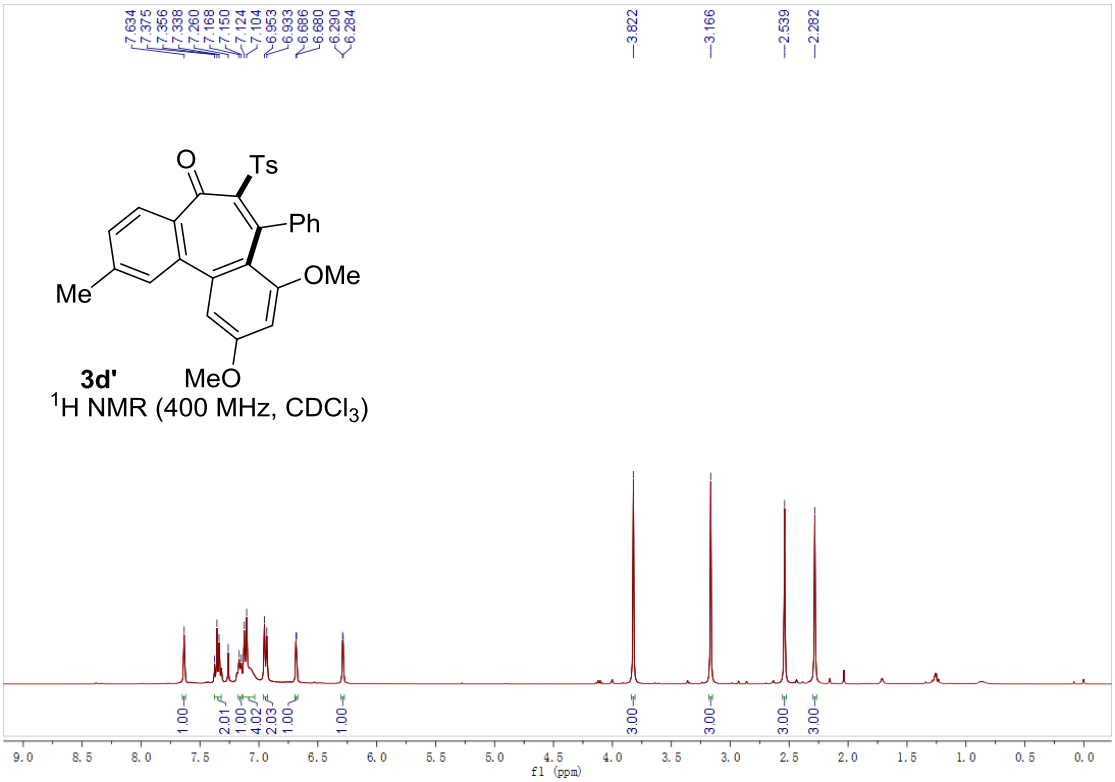
3c'

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



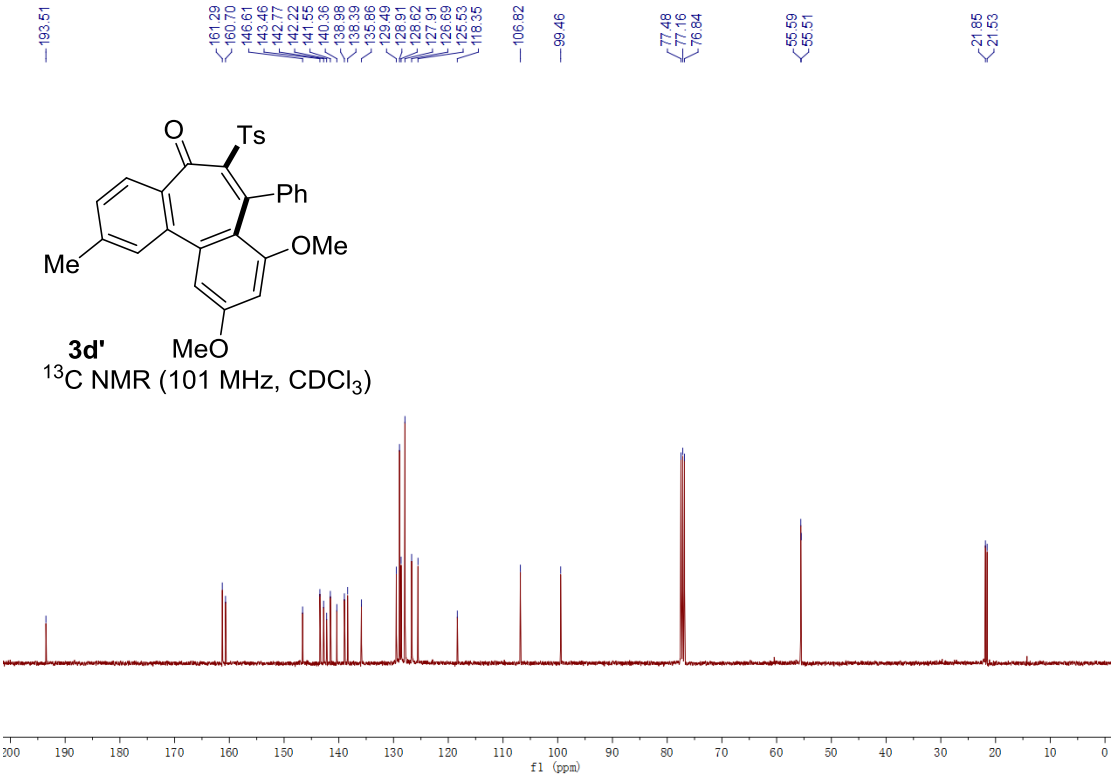
3c'

^{13}C NMR (151 MHz, $CDCl_3$)



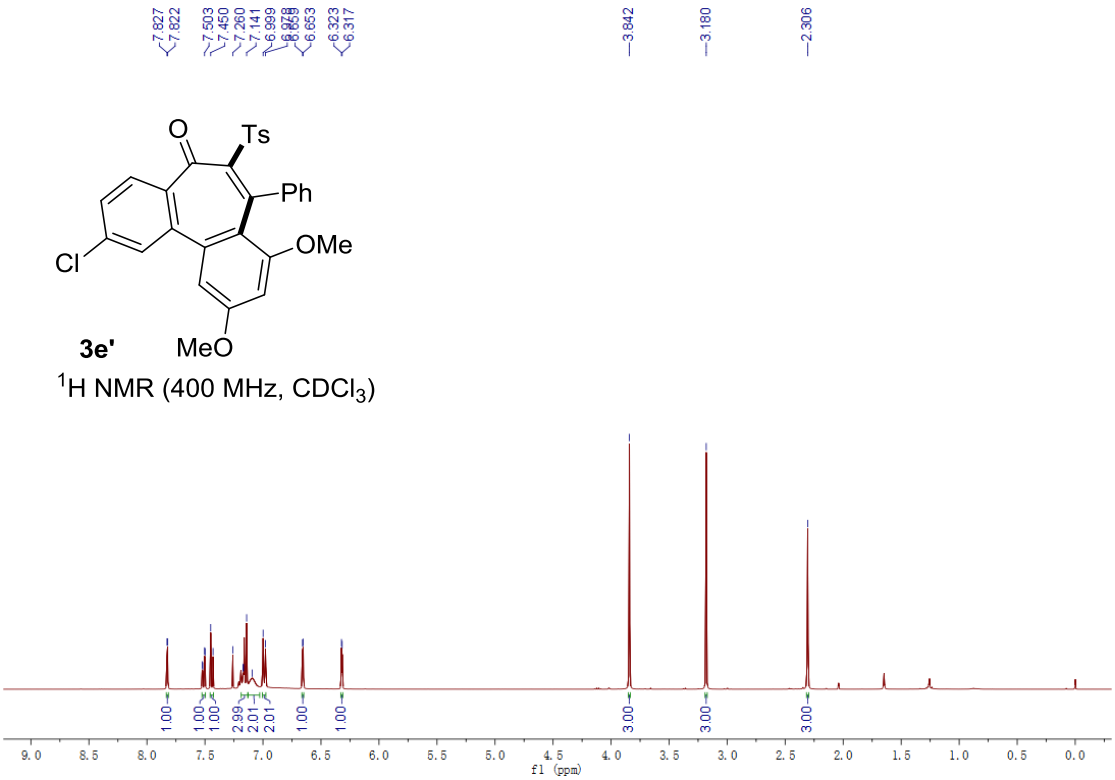
3d'

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



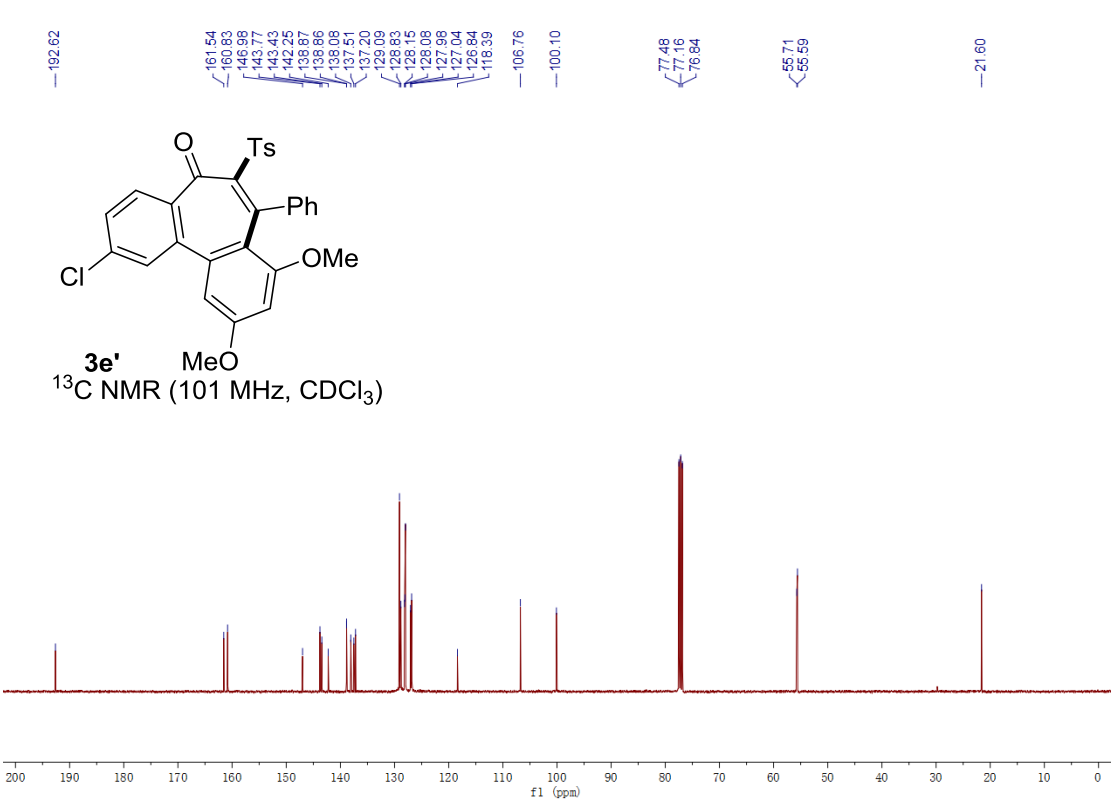
3d'

^{13}C NMR (101 MHz, $CDCl_3$)



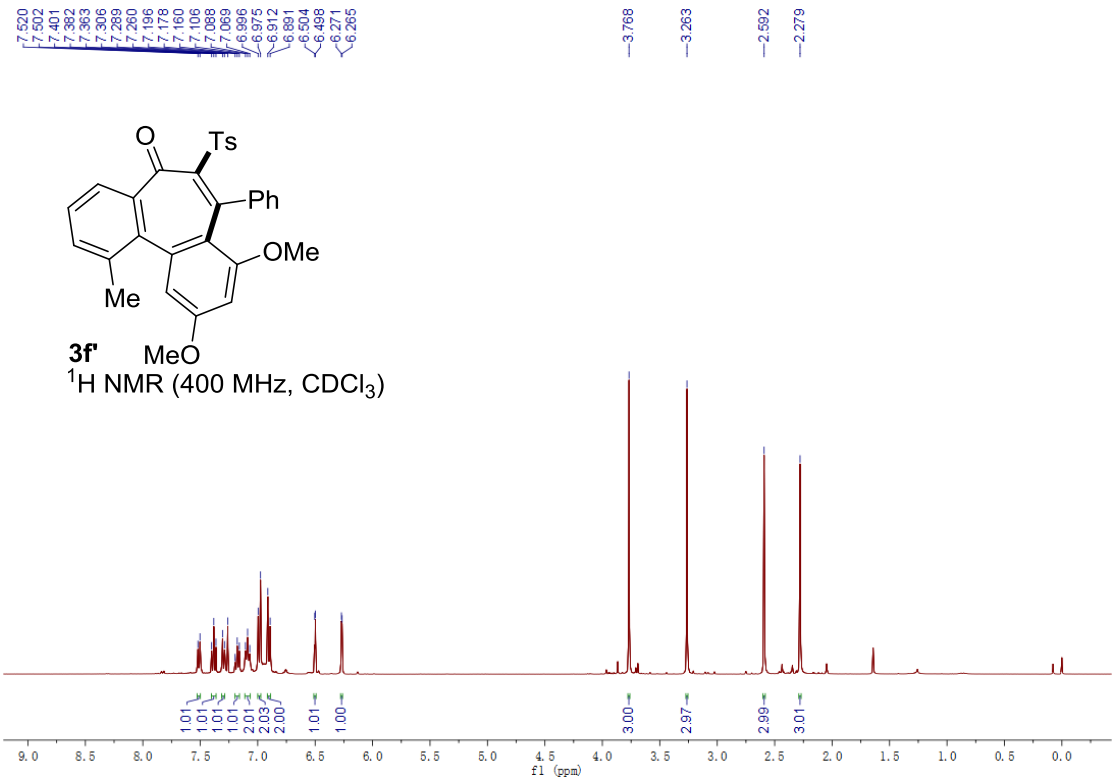
3e'

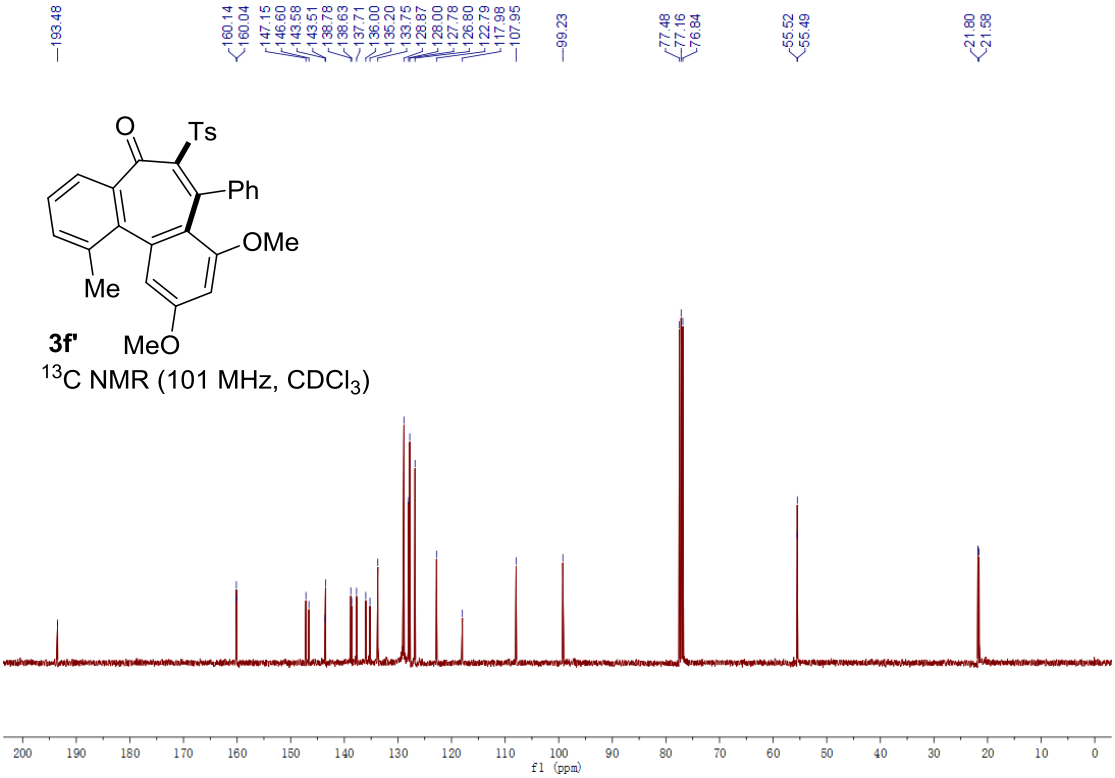
^{1}H NMR (400 MHz, $CDCl_3$)

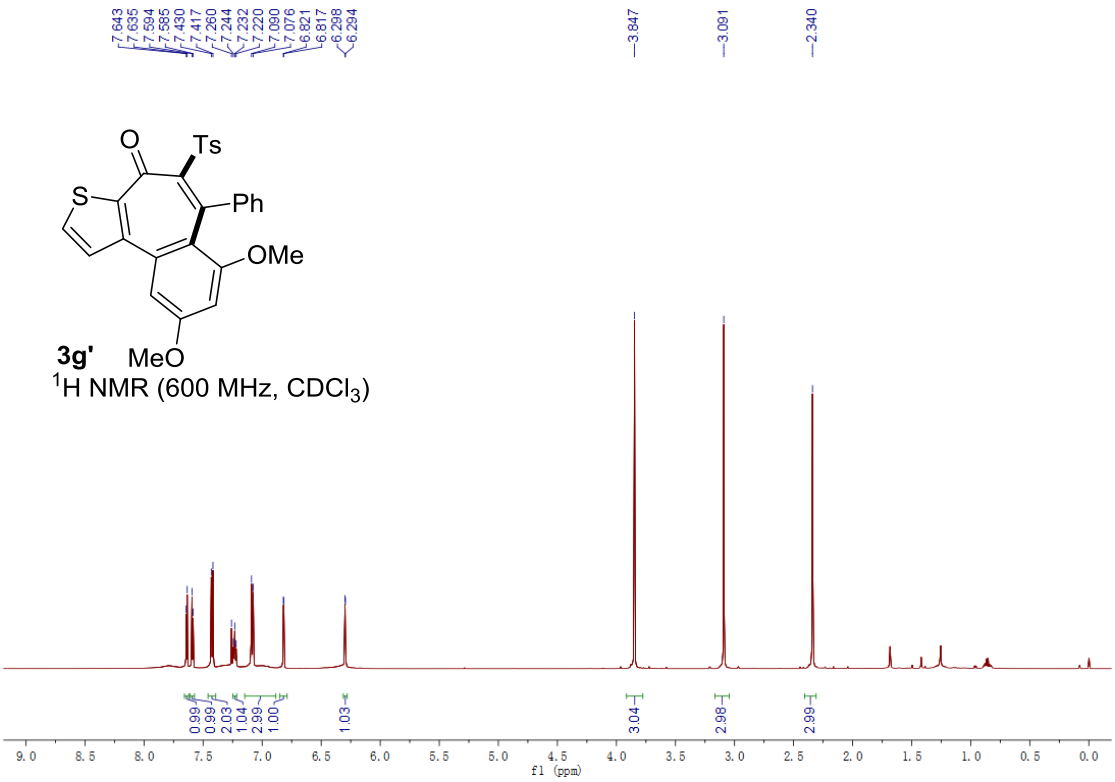


3e'

^{13}C NMR (101 MHz, $CDCl_3$)

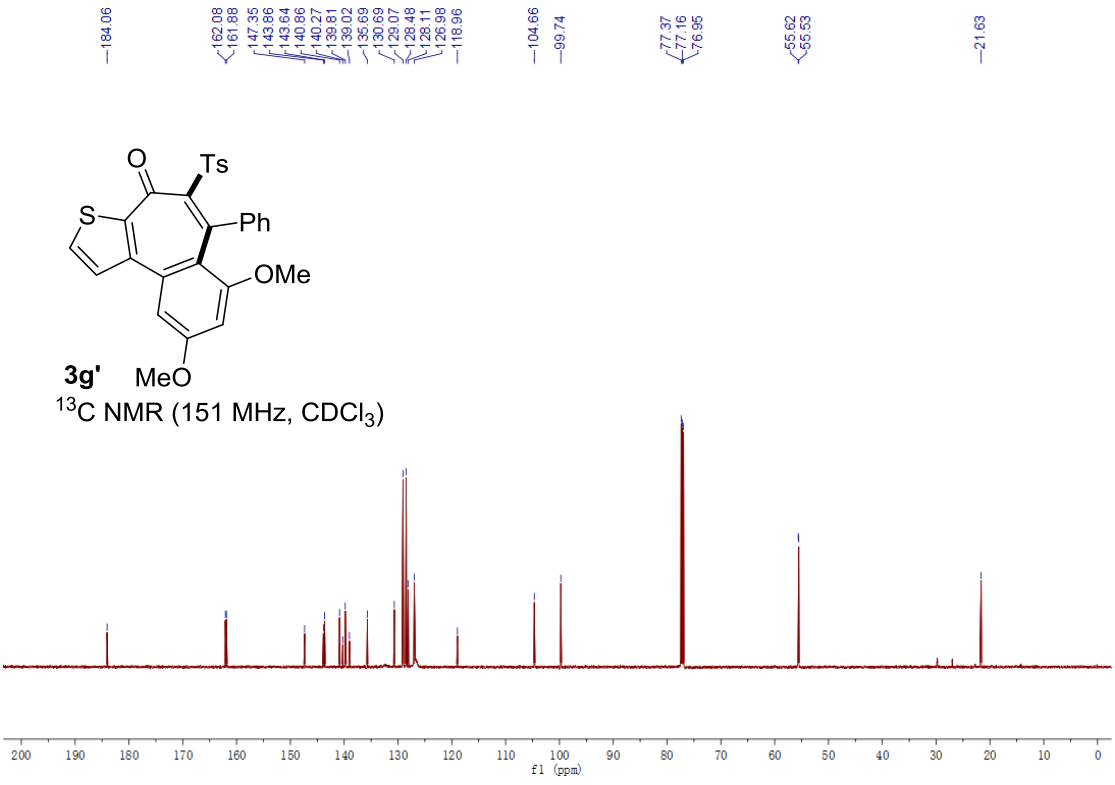

7.520
7.502
7.401
7.382
7.363
7.306
7.289
7.260
7.196
7.178
7.160
7.106
7.088
7.069
6.996
6.975
6.912
6.891
6.504
6.498
6.271
6.265
3.768
3.263
2.592
2.279
O
Ts
Ph
OMe
Me
MeO
3f'
1H NMR (400 MHz, CDCl3)
1.01
1.01
1.01
1.01
2.01
2.03
2.00
1.01
1.00
3.00
2.97
2.99
3.01
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


193.48
160.14
160.04
147.15
146.60
143.58
143.51
138.78
138.63
137.71
136.00
135.20
133.75
128.87
128.00
127.78
126.80
122.79
117.98
107.95
99.23
77.48
77.16
76.84
55.52
55.49
21.80
21.58
O
Ts
Ph
OMe
Me
MeO
3f'
13C NMR (101 MHz, CDCl3)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



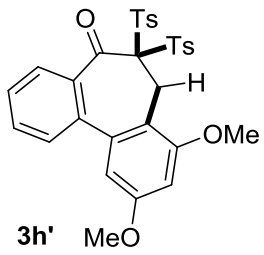
3g'

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



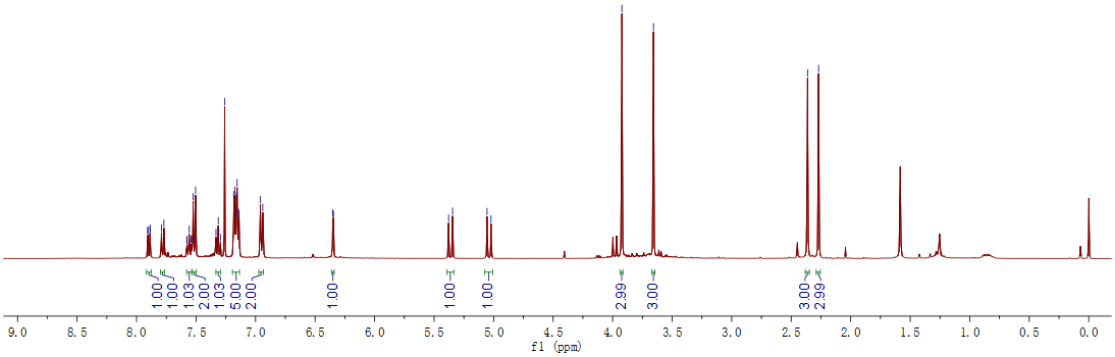
3g'

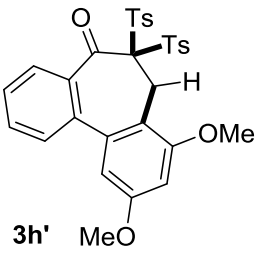
^{13}C NMR (151 MHz, $CDCl_3$)



3h'

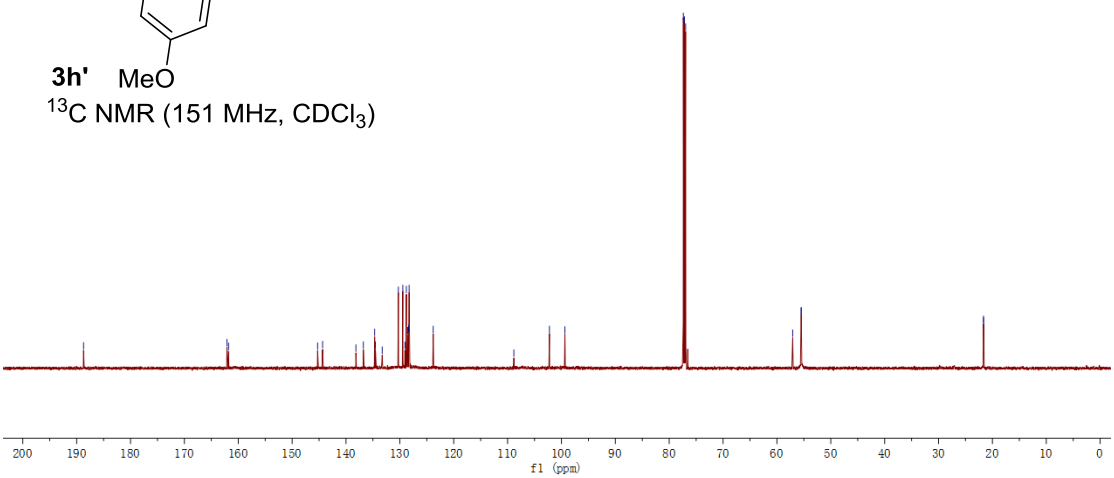
^{1}H NMR (400 MHz, $CDCl_3$)

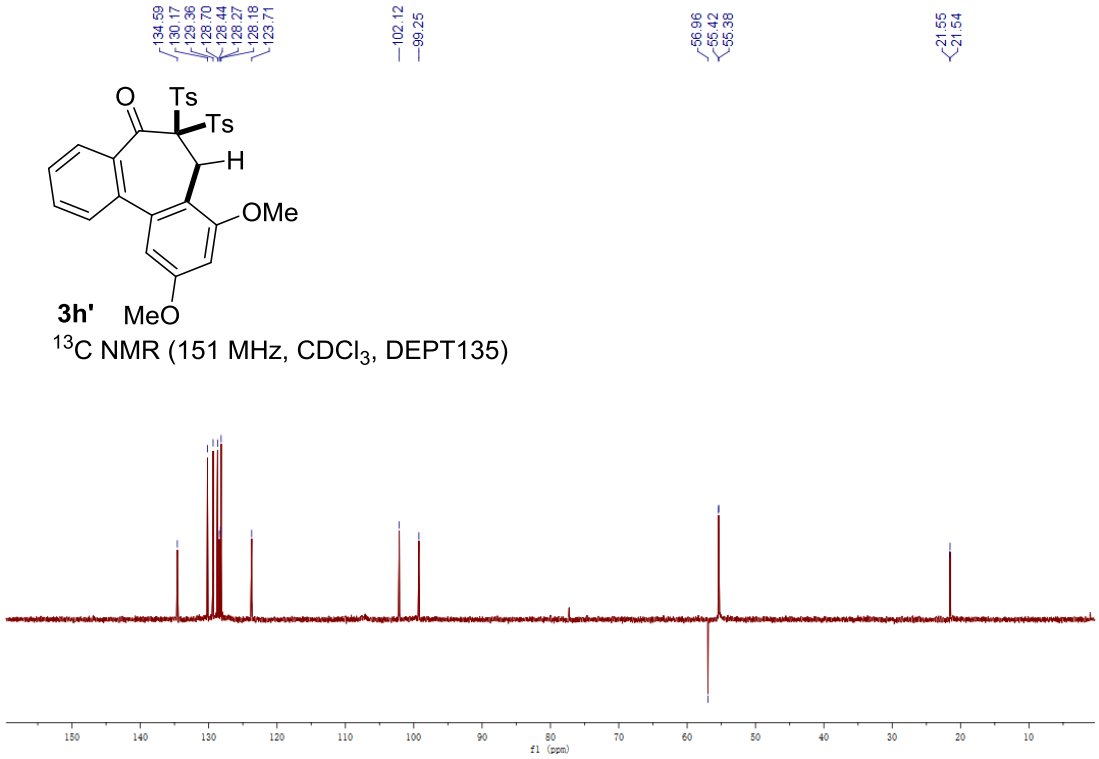




3h'

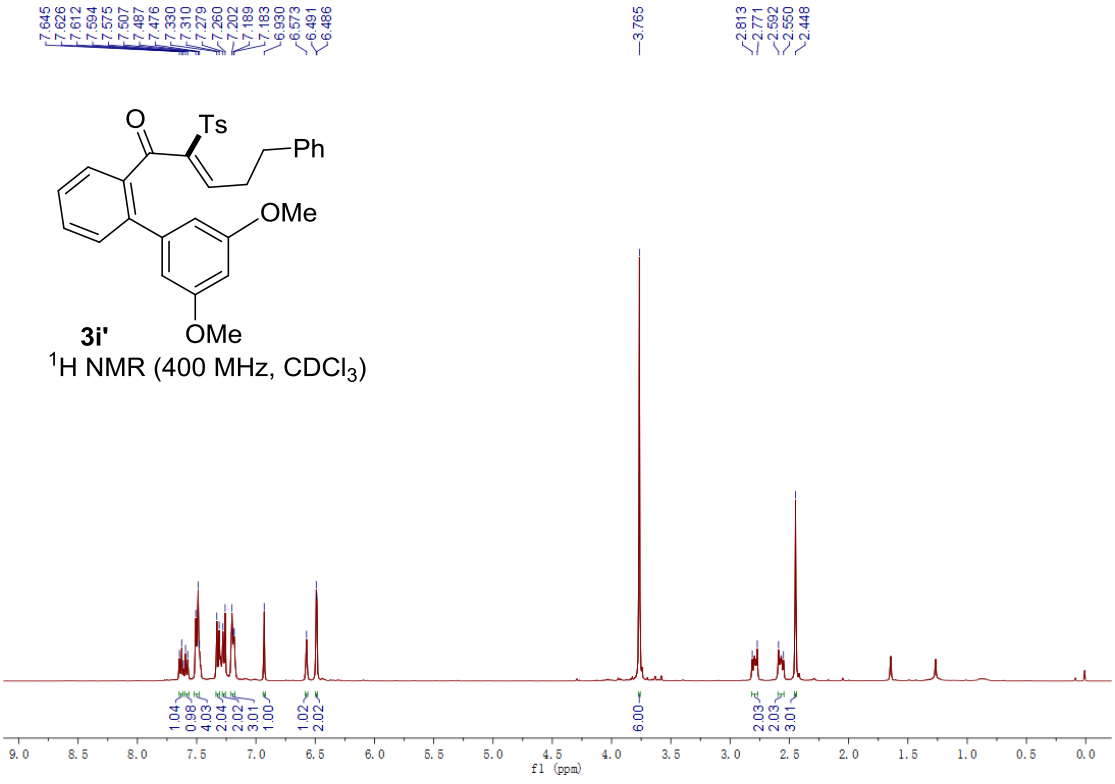
^{13}C NMR (151 MHz, $CDCl_3$)





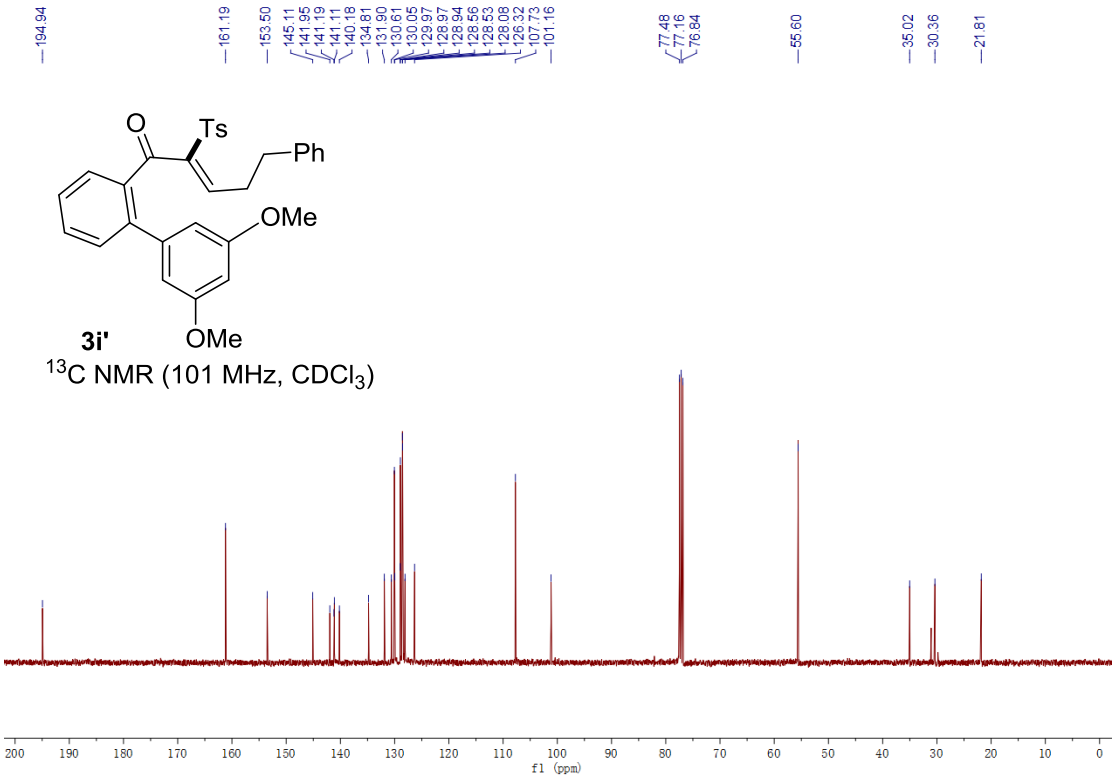
3h'

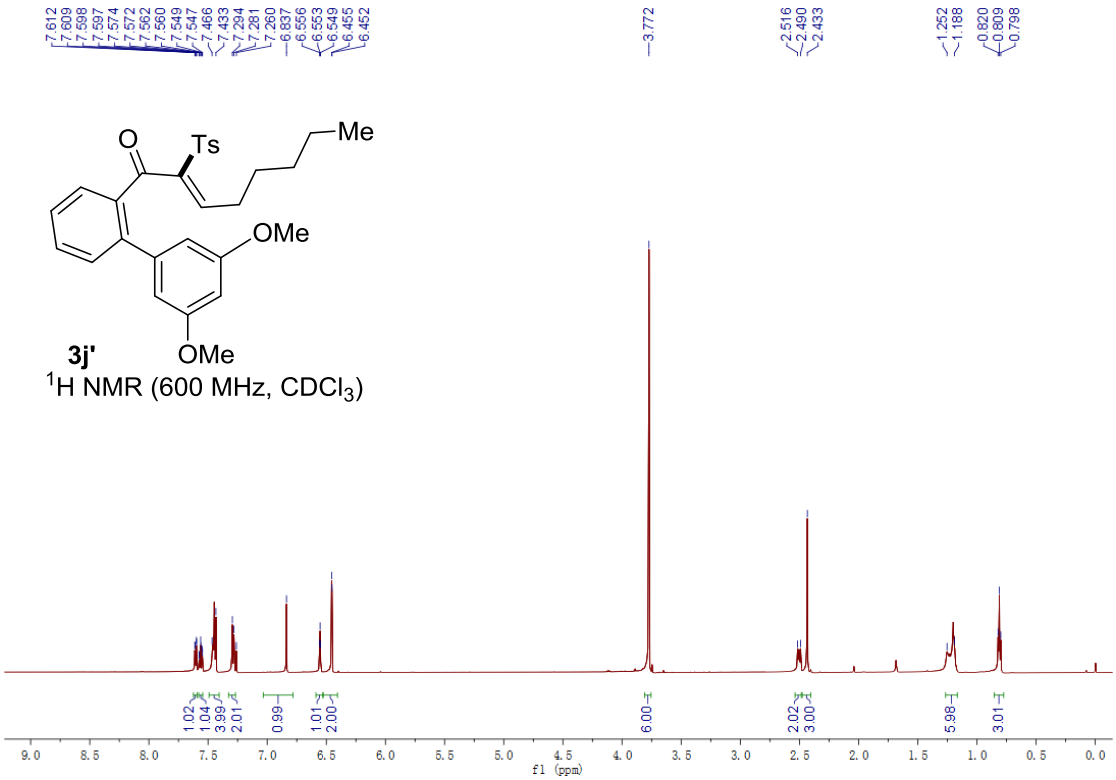
^{13}C NMR (151 MHz, $CDCl_3$, DEPT135)

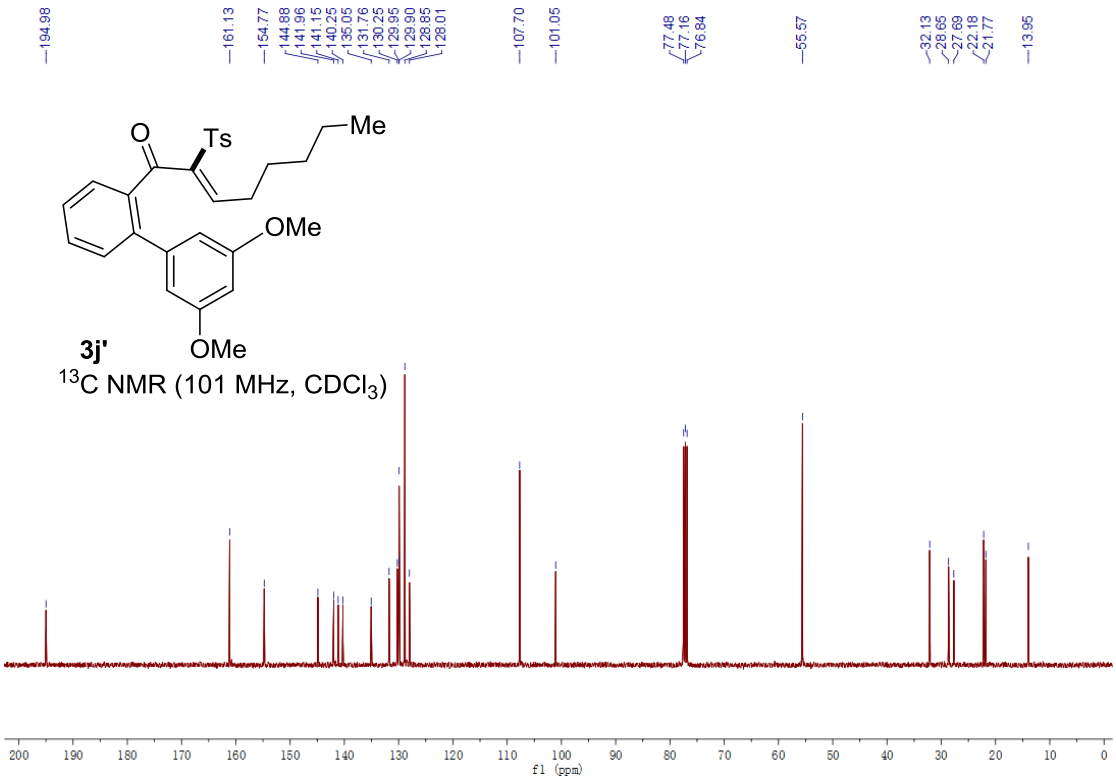


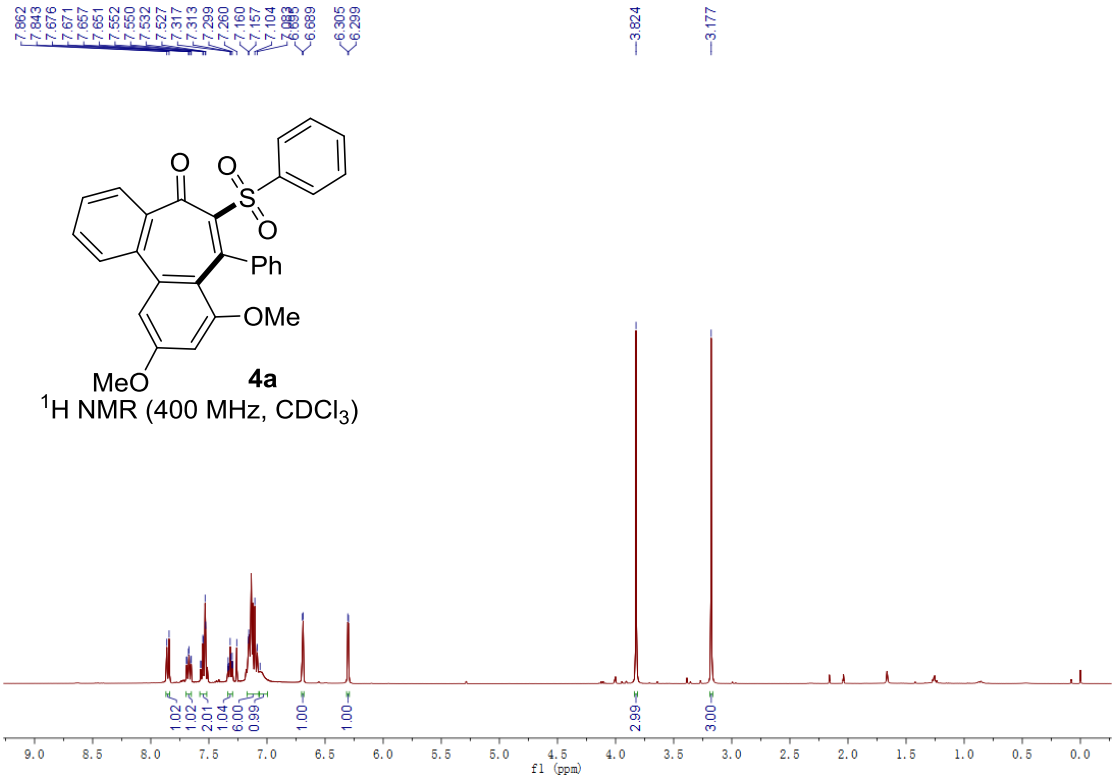
3i'

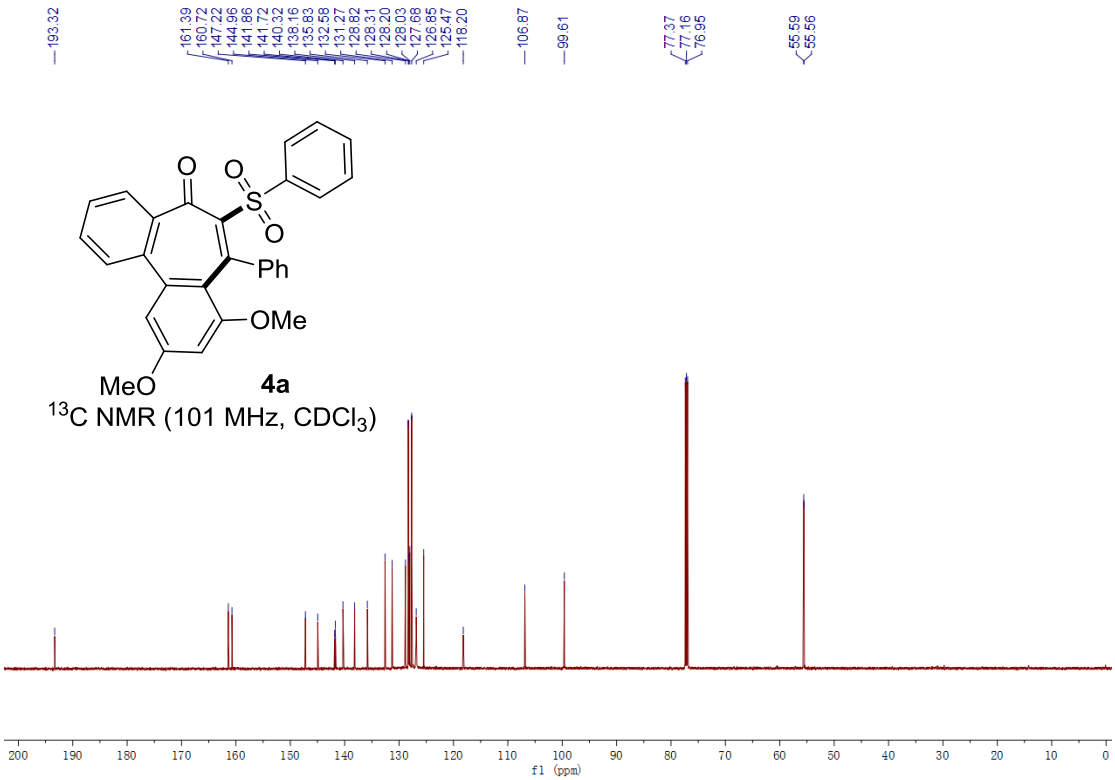
^{1}H NMR (400 MHz, $CDCl_3$)

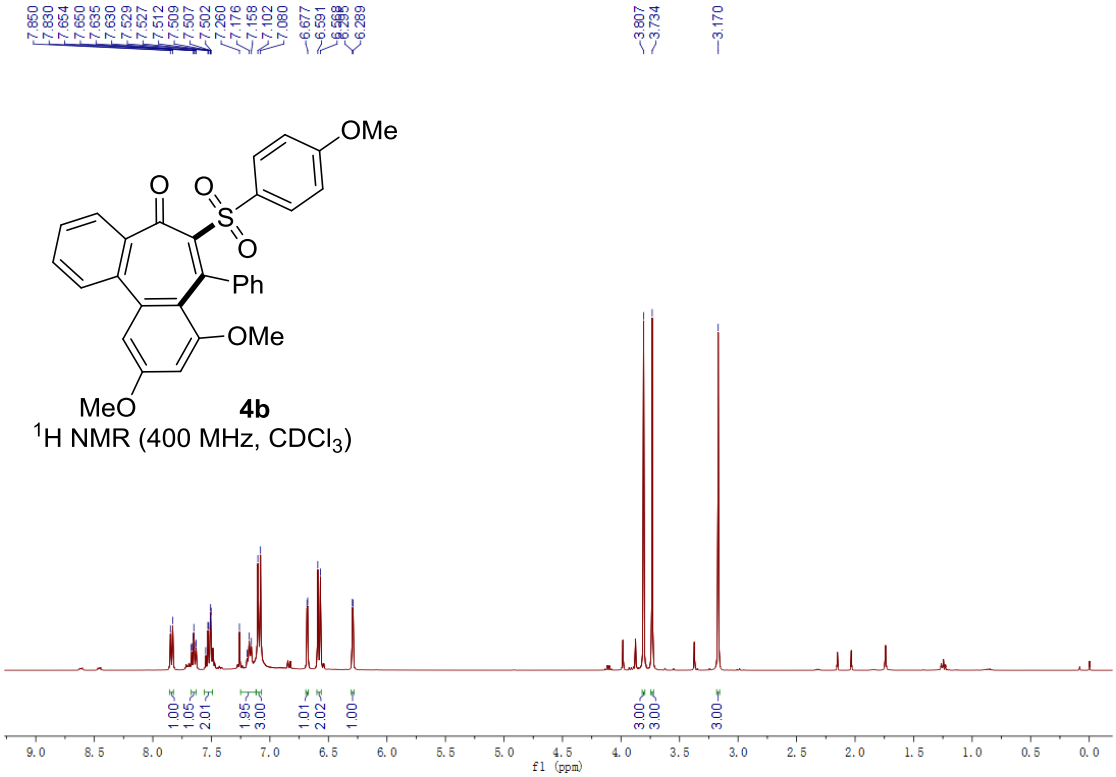

194.94
161.19
153.50
145.11
141.95
141.19
141.11
140.18
134.81
131.90
130.61
130.05
129.97
128.97
128.94
128.56
128.53
128.08
126.32
107.73
101.16
77.48
77.16
76.84
55.60
35.02
30.36
21.81
O
Ts
Ph
OMe
OMe
3i'
13C NMR (101 MHz, CDCl3)
f1 (ppm)

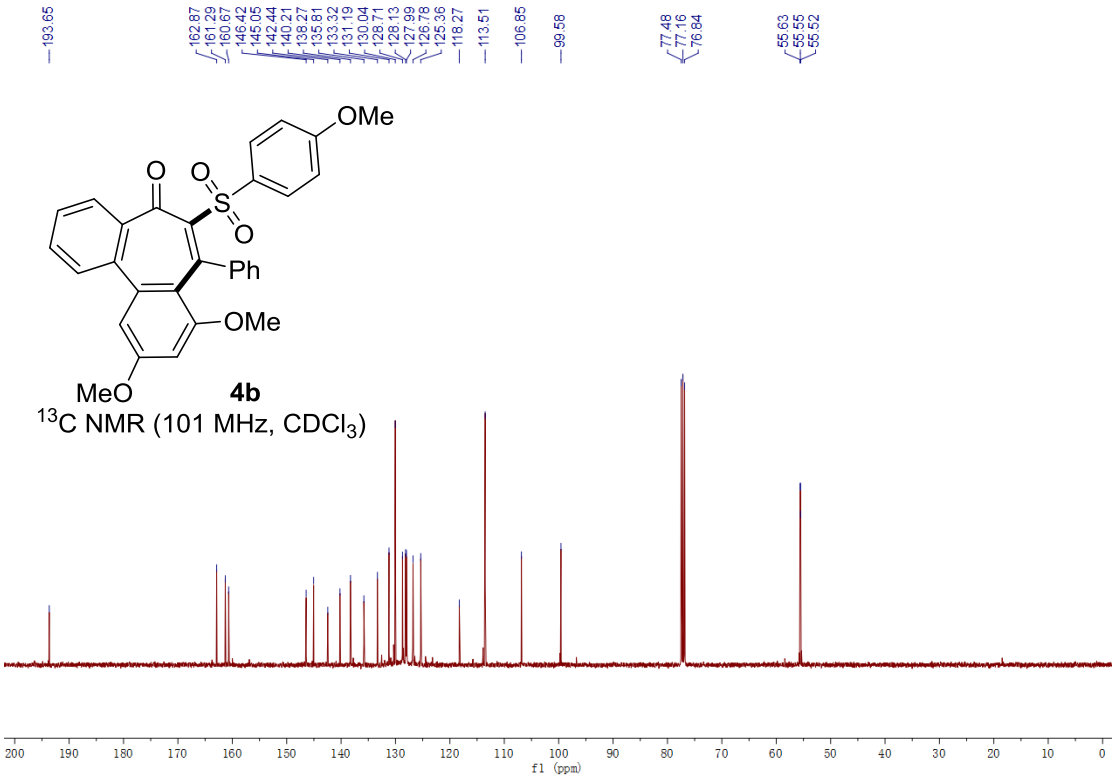

7.612
7.609
7.598
7.597
7.574
7.572
7.562
7.560
7.549
7.547
7.466
7.433
7.294
7.281
7.260
6.837
6.556
6.553
6.549
6.455
6.452
3.772
2.516
2.490
2.433
1.252
1.188
0.820
0.809
0.798
O
Ts
Me
OMe
OMe
3j'
1H NMR (600 MHz, CDCl3)
1.02
1.04
3.99
2.01
0.99
1.01
2.00
6.00
2.02
3.00
5.98
3.01
f1 (ppm)

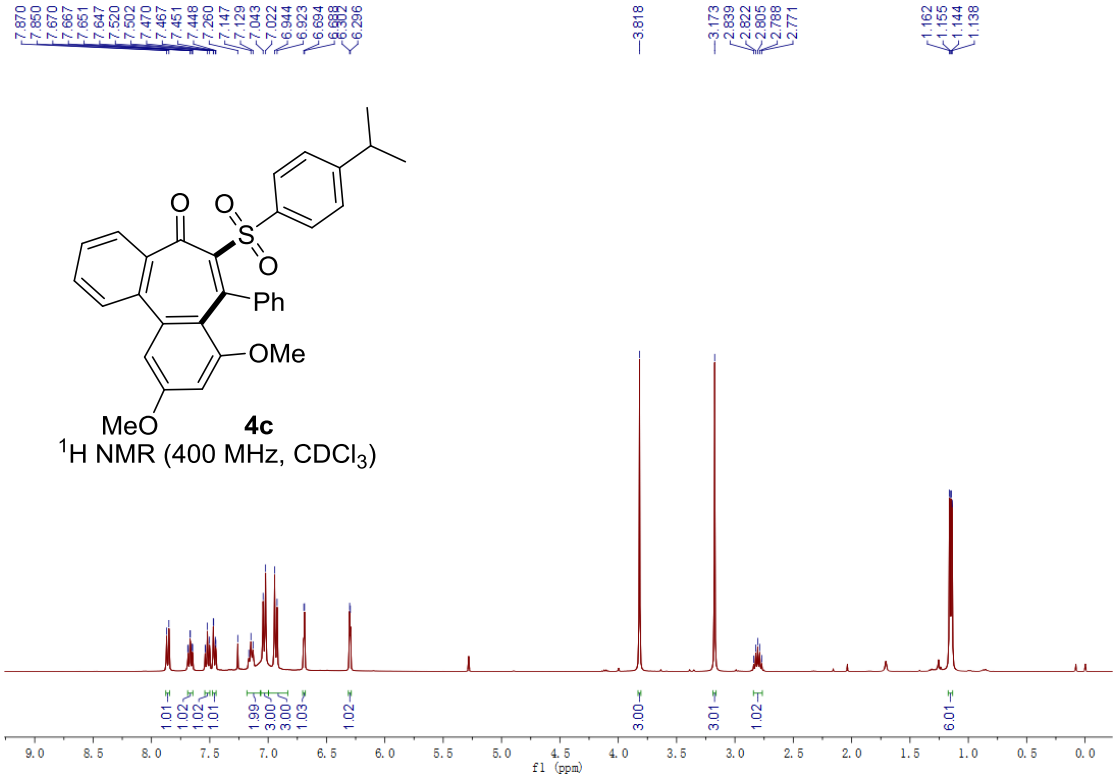

194.98
161.13
154.77
144.88
141.96
141.15
140.25
135.05
131.76
130.25
129.95
129.90
128.85
128.01
107.70
101.05
77.48
77.16
76.84
55.57
32.13
28.65
27.69
22.18
21.77
13.95
O
Ts
Me
OMe
OMe
3j'
13C NMR (101 MHz, CDCl3)
f1 (ppm)

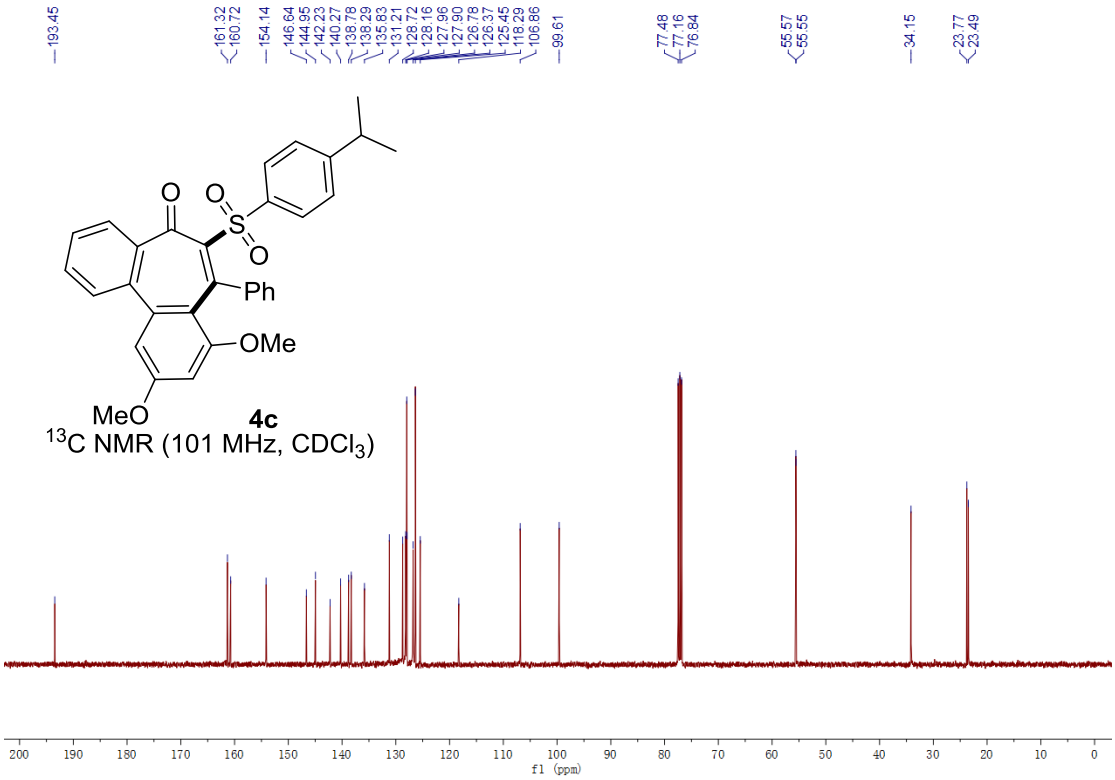

7.862
7.843
7.676
7.671
7.657
7.651
7.552
7.550
7.532
7.527
7.317
7.313
7.299
7.260
7.160
7.157
7.104
6.689
6.305
6.299
3.824
3.177
O
O
S
O
Ph
OMe
MeO
4a
1H NMR (400 MHz, CDCl3)
1.02
1.02
2.01
1.04
6.00
0.99
1.00
1.00
2.99
3.00
f1 (ppm)

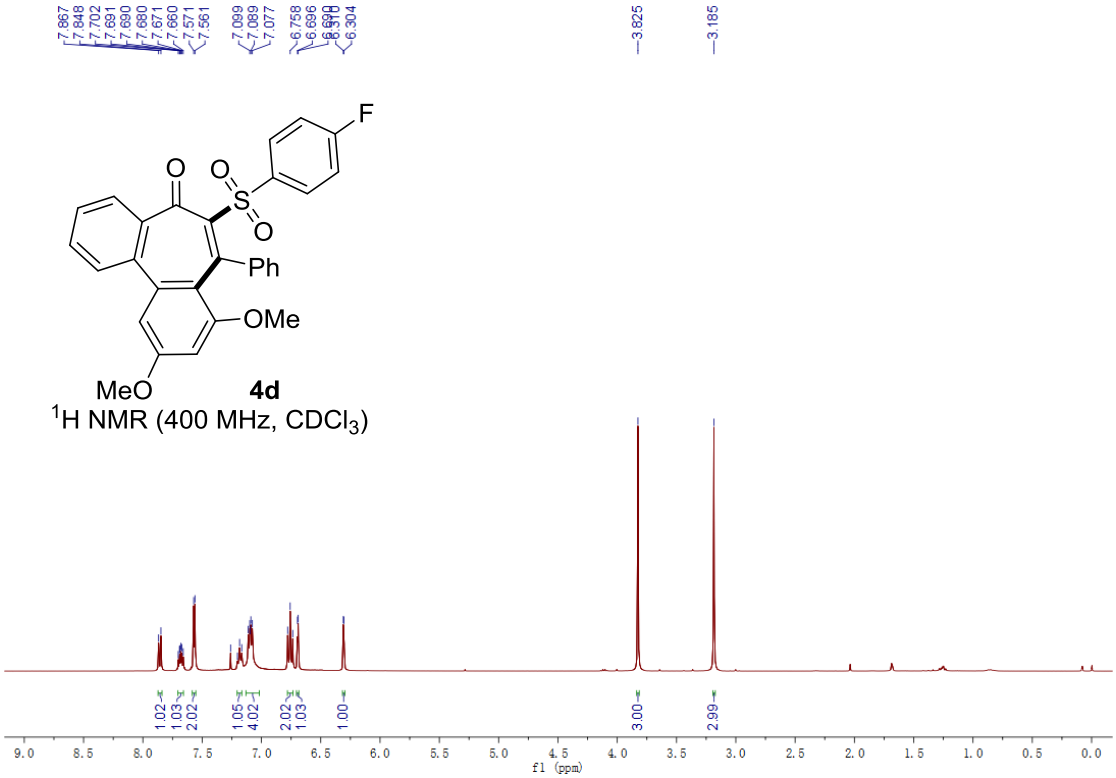

193.32
161.39
160.72
147.22
144.96
141.86
141.72
140.32
138.16
135.83
132.58
131.27
129.82
128.31
128.20
128.03
127.68
126.85
125.47
118.20
106.87
99.61
77.37
77.16
76.95
55.59
55.56
O
O
S
O
Ph
OMe
MeO
4a
13C NMR (101 MHz, CDCl3)
f1 (ppm)

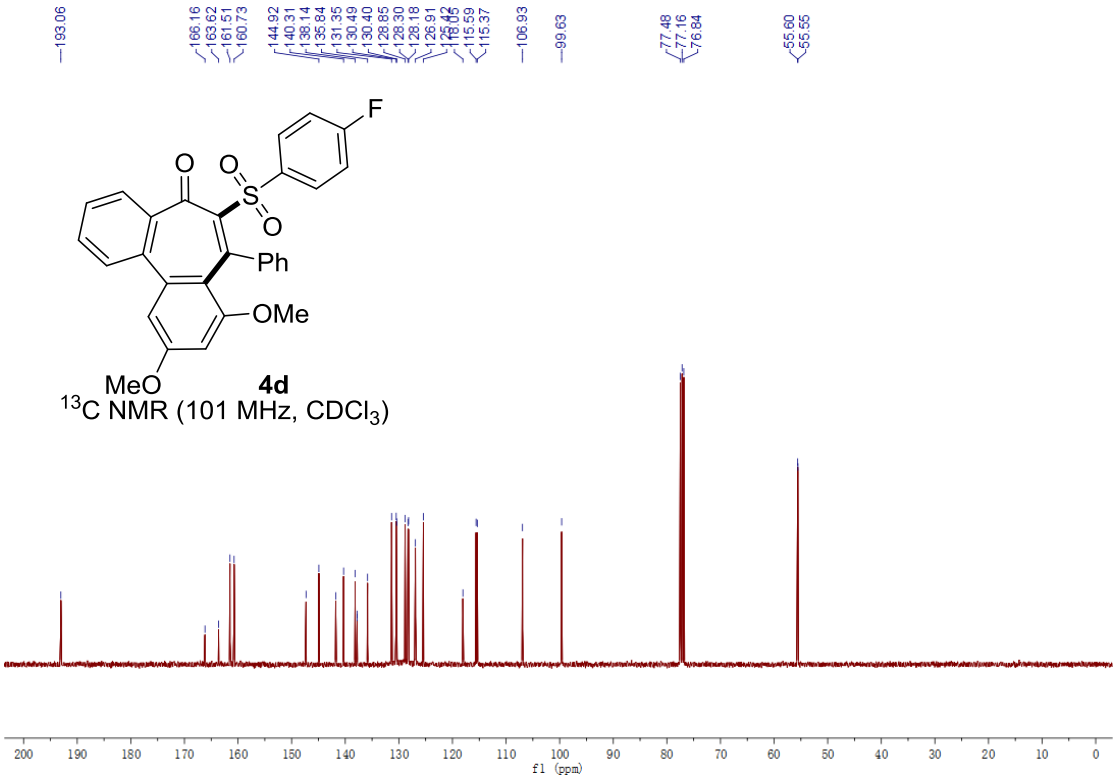

7.850
7.830
7.654
7.650
7.635
7.630
7.529
7.527
7.512
7.509
7.507
7.502
7.260
7.176
7.158
7.102
7.080
6.677
6.591
3.807
3.734
3.170
OMe
O
O
S
O
Ph
OMe
MeO
4b
1H NMR (400 MHz, CDCl3)
1.00
1.05
2.01
1.95
3.00
1.01
2.02
1.00
3.00
3.00
3.00
f1 (ppm)

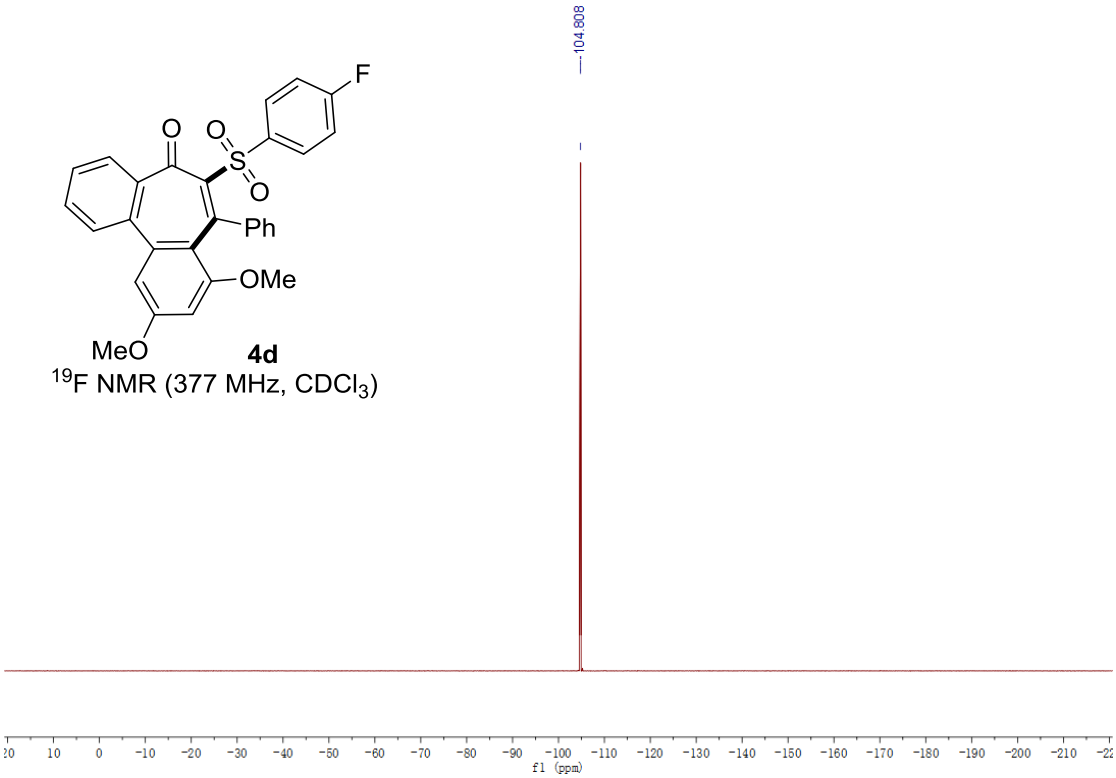

193.65
162.87
161.29
160.67
146.42
145.05
142.44
140.21
138.27
135.81
133.32
131.19
130.04
128.71
128.13
127.99
126.78
125.36
118.27
113.51
106.85
99.58
77.48
77.16
76.84
55.63
55.55
55.52
OMe
O
O
S
O
Ph
OMe
MeO
4b
13C NMR (101 MHz, CDCl3)
f1 (ppm)

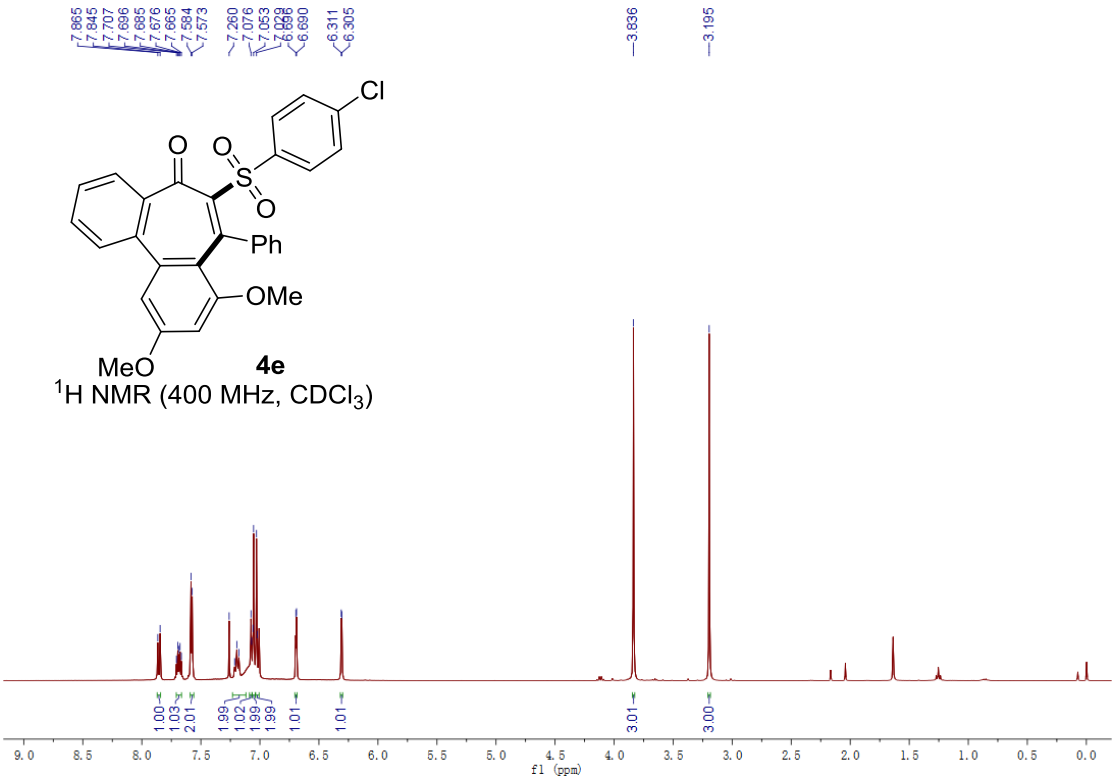

7.870
7.850
7.670
7.667
7.651
7.647
7.520
7.502
7.470
7.467
7.451
7.448
7.260
7.147
7.129
7.043
7.022
6.944
6.923
6.694
6.688
6.302
6.296
3.818
3.173
2.839
2.822
2.805
2.788
2.771
1.162
1.155
1.144
1.138
O
O
S
O
Ph
OMe
MeO
4c
1H NMR (400 MHz, CDCl3)
f1 (ppm)

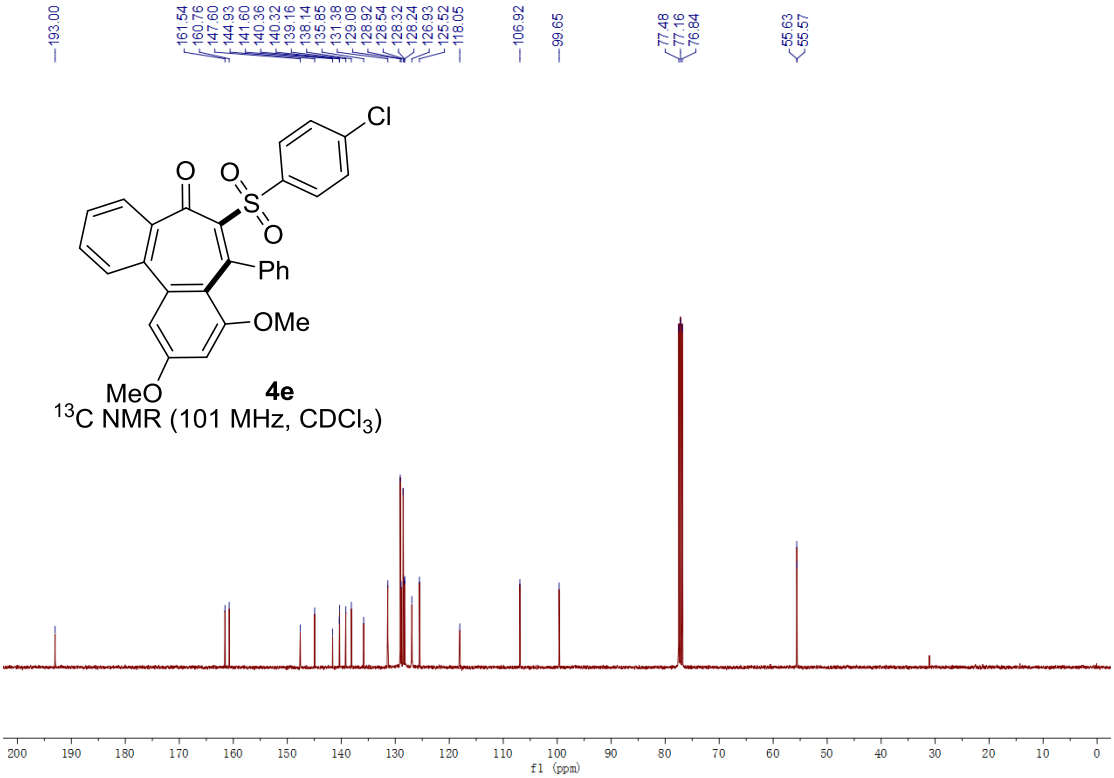

193.45
161.32
160.72
154.14
146.64
144.95
142.23
140.27
138.78
138.29
135.83
131.21
128.72
128.16
127.96
127.90
126.78
126.37
125.45
118.29
106.86
99.61
77.48
77.16
76.84
55.57
55.55
34.15
23.77
23.49
O
O
S
O
Ph
OMe
MeO
4c
13C NMR (101 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

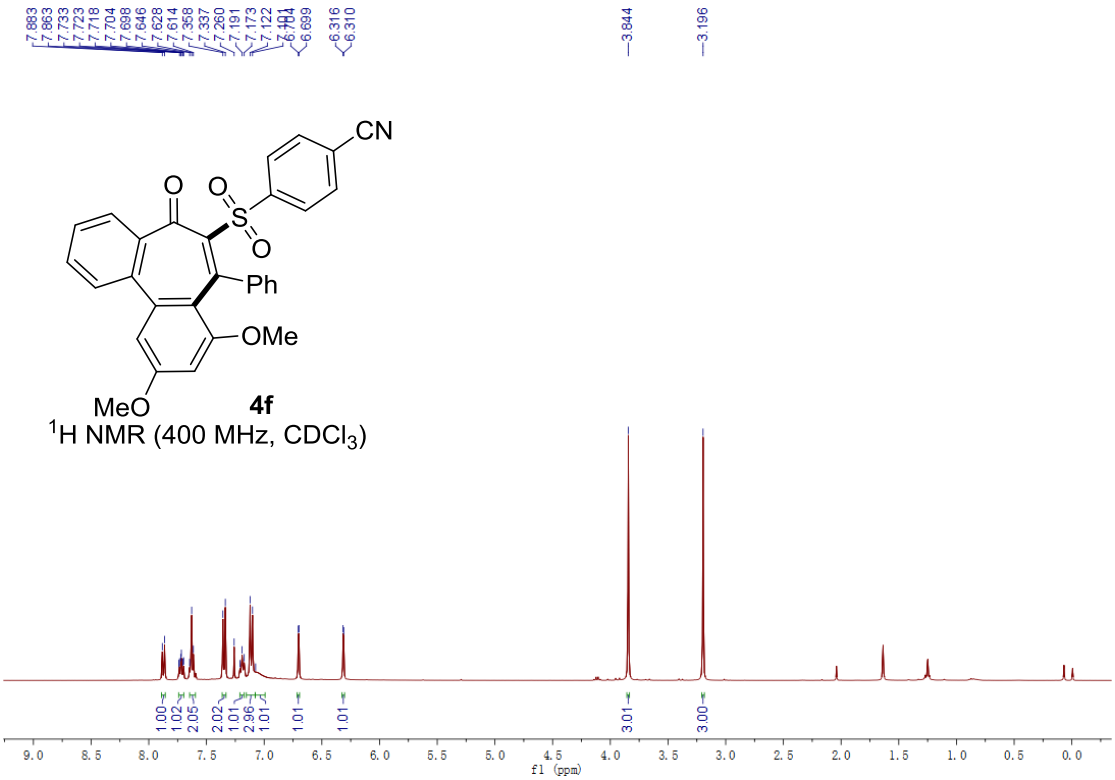

7.867
7.848
7.702
7.691
7.690
7.680
7.671
7.660
7.571
7.561
7.099
7.089
7.077
6.758
6.696
6.690
6.304
3.825
3.185
F
O
O
S
O
Ph
OMe
MeO
4d
1H NMR (400 MHz, CDCl3)
1.02
1.03
2.02
1.05
4.02
2.02
1.03
1.00
3.00
2.99
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

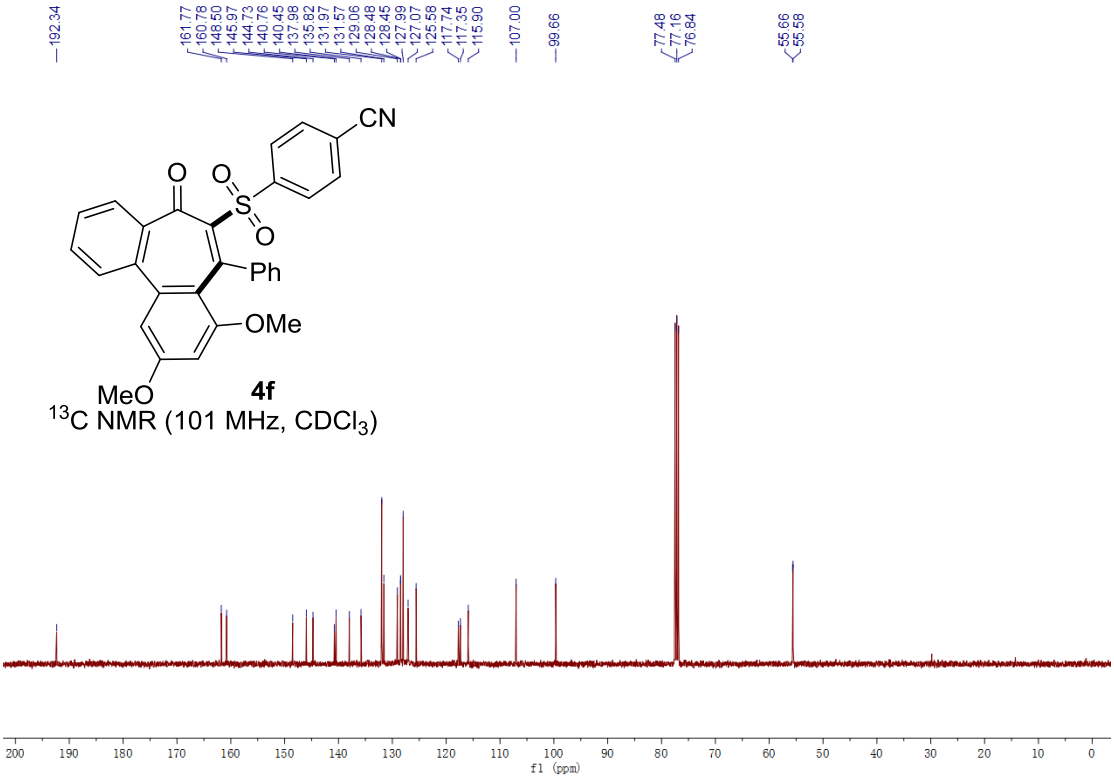

193.06
166.16
163.62
161.51
160.73
144.92
140.31
138.14
135.84
131.35
130.49
130.40
128.85
128.30
128.18
126.91
115.59
115.37
106.93
99.63
77.48
77.16
76.84
55.60
55.55
F
O
O
S
O
Ph
OMe
MeO
4d
^{13}C NMR (101 MHz, CDCl$_3$)
f1 (ppm)

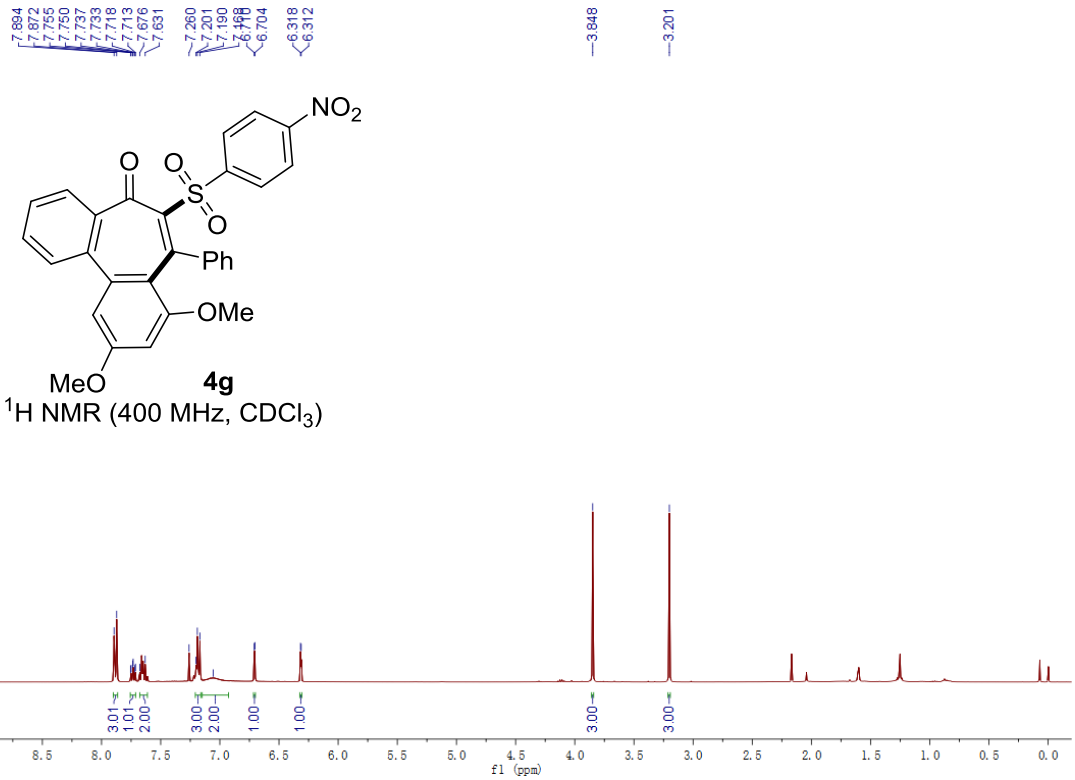

104.808
F
O
O
S
O
Ph
OMe
MeO
4d
^{19}F NMR (377 MHz, CDCl$_3$)
f1 (ppm)

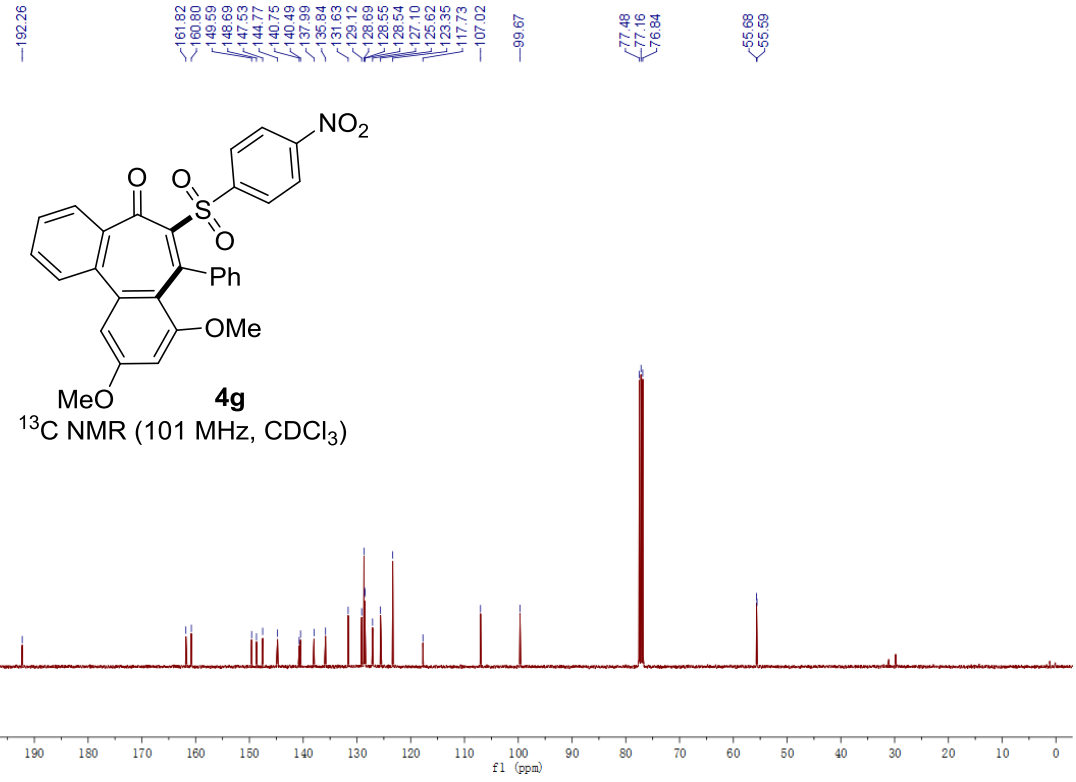

7.865
7.845
7.707
7.696
7.685
7.676
7.665
7.584
7.573
7.260
7.076
7.053
7.029
6.698
6.690
6.311
6.305
3.836
3.195
Cl
O
O
S
O
Ph
OMe
MeO
4e
1H NMR (400 MHz, CDCl3)
1.00
1.03
2.01
1.99
1.02
1.99
1.99
1.01
1.01
3.01
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

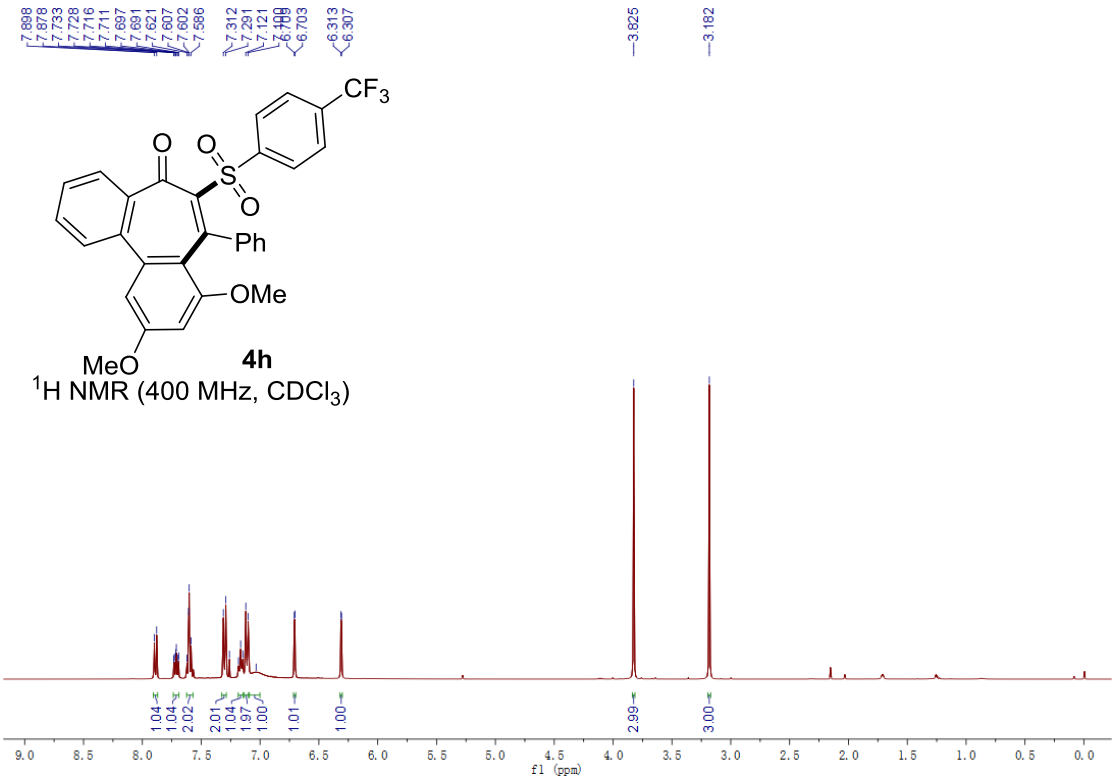

193.00
161.54
160.76
147.60
144.93
141.60
140.36
140.32
139.16
138.14
135.85
131.38
129.08
128.92
128.54
128.32
128.24
126.93
125.52
118.05
106.92
99.65
77.48
77.16
76.84
55.63
55.57
Cl
O
O
S
O
Ph
OMe
MeO
4e
13C NMR (101 MHz, CDCl3)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

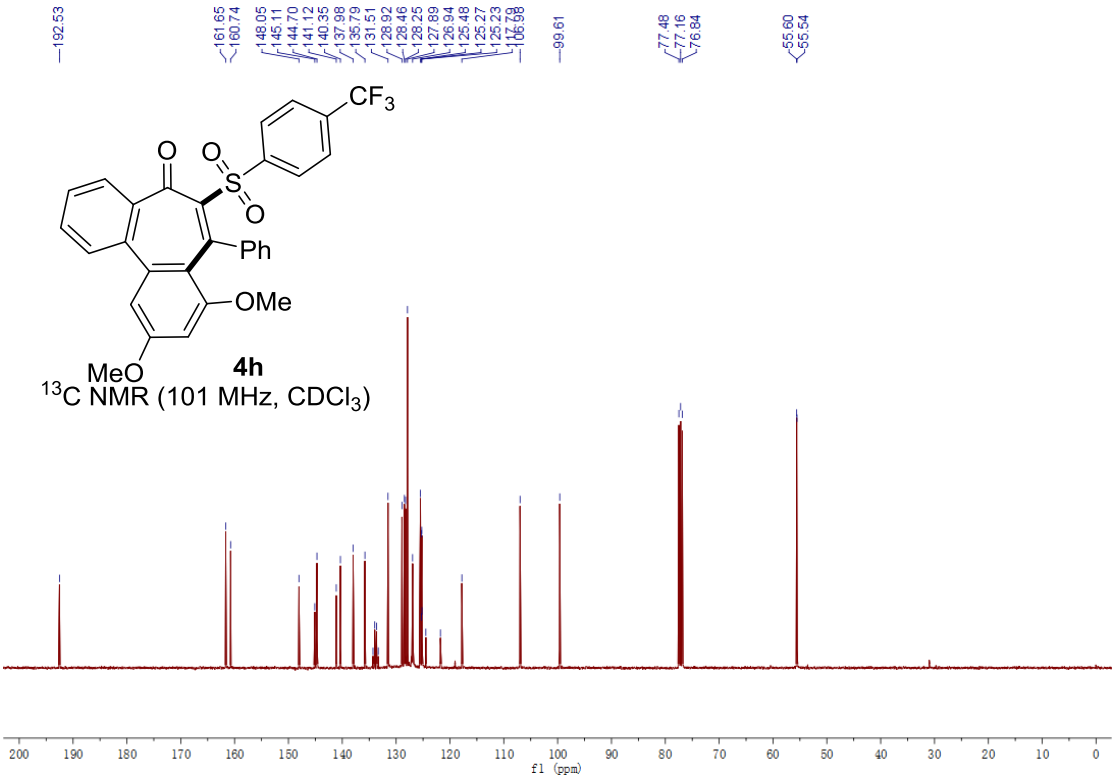

7.883
7.863
7.733
7.723
7.718
7.704
7.698
7.646
7.628
7.614
7.358
7.337
7.260
7.191
7.173
7.122
6.699
6.316
6.310
3.844
3.196
CN
O
O
S
O
Ph
OMe
MeO
4f
1H NMR (400 MHz, CDCl3)
1.00
1.02
2.05
2.02
1.01
2.96
1.01
1.01
1.01
3.01
3.00
f1 (ppm)


192.34
161.77
160.78
148.50
145.97
144.73
140.76
140.45
137.98
135.82
131.97
131.57
129.06
128.48
128.45
127.99
127.07
125.58
117.74
117.35
115.90
107.00
99.66
77.48
77.16
76.84
55.66
55.58
CN
O
O
S
O
Ph
OMe
MeO
4f
13C NMR (101 MHz, CDCl3)
f1 (ppm)


7.894
7.872
7.755
7.750
7.737
7.733
7.718
7.713
7.676
7.631
7.260
7.201
7.190
6.704
6.318
6.312
3.848
3.201
NO2
O
O
S
O
Ph
OMe
MeO
4g
1H NMR (400 MHz, CDCl3)
3.01
1.01
2.00
3.00
2.00
1.00
1.00
3.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

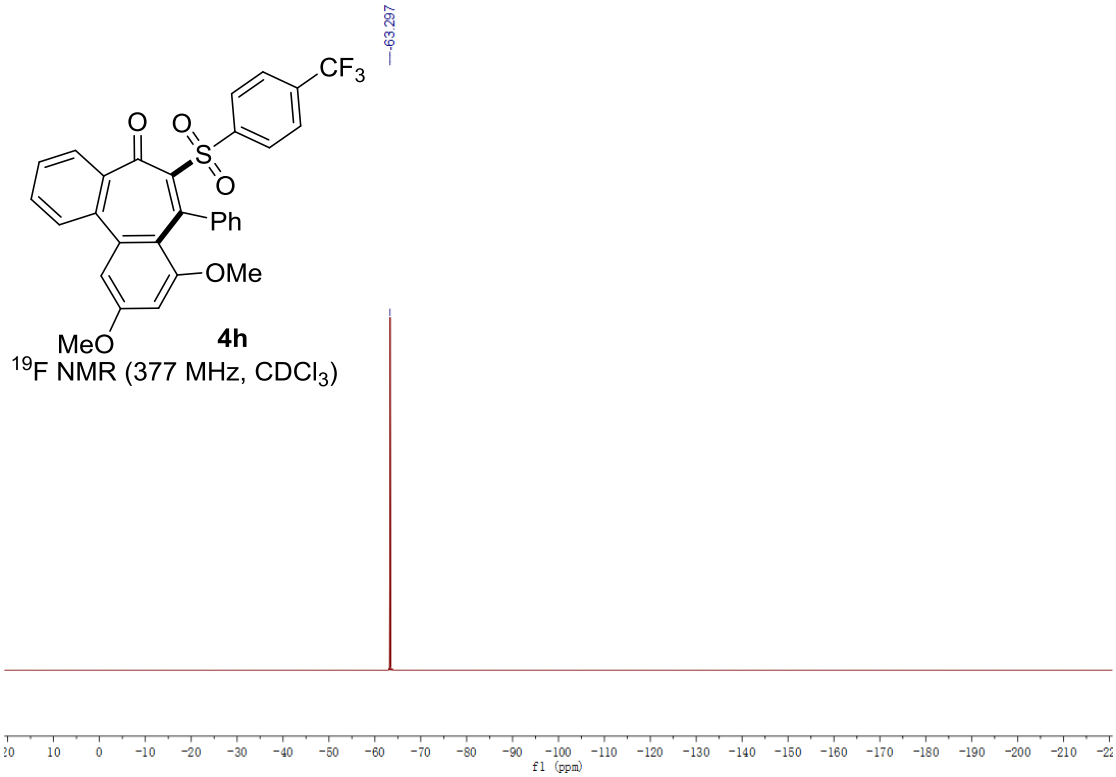

192.26
161.82
160.80
149.59
148.69
147.53
144.77
140.75
140.49
137.99
135.84
131.63
129.12
128.69
128.55
128.54
127.10
125.62
123.35
117.73
107.02
99.67
77.48
77.16
76.84
55.68
55.59
NO2
O
O
S
O
Ph
OMe
MeO
4g
13C NMR (101 MHz, CDCl3)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.898
7.878
7.733
7.728
7.716
7.711
7.697
7.691
7.621
7.607
7.602
7.586
7.312
7.291
7.121
6.703
6.313
6.307
3.825
3.182
CF3
O
O
S
O
Ph
OMe
MeO
4h
1H NMR (400 MHz, CDCl3)
1.04
1.04
2.02
2.01
1.04
1.97
1.00
1.01
1.00
2.99
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


192.53
161.65
160.74
148.05
145.11
144.70
141.12
140.35
137.98
135.79
131.51
128.92
128.46
128.25
127.89
126.94
125.48
125.27
125.23
117.59
116.98
99.61
77.48
77.16
76.84
55.60
55.54
CF3
O
O
S
O
Ph
OMe
MeO
4h
13C NMR (101 MHz, CDCl3)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

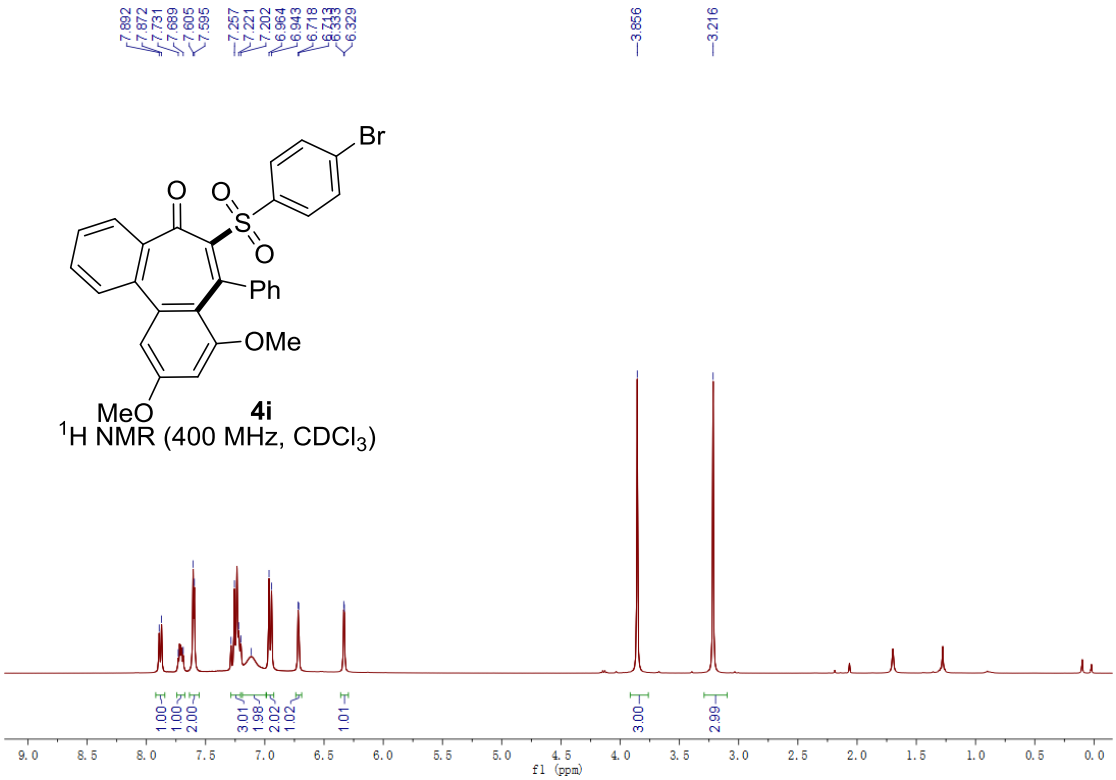
4h

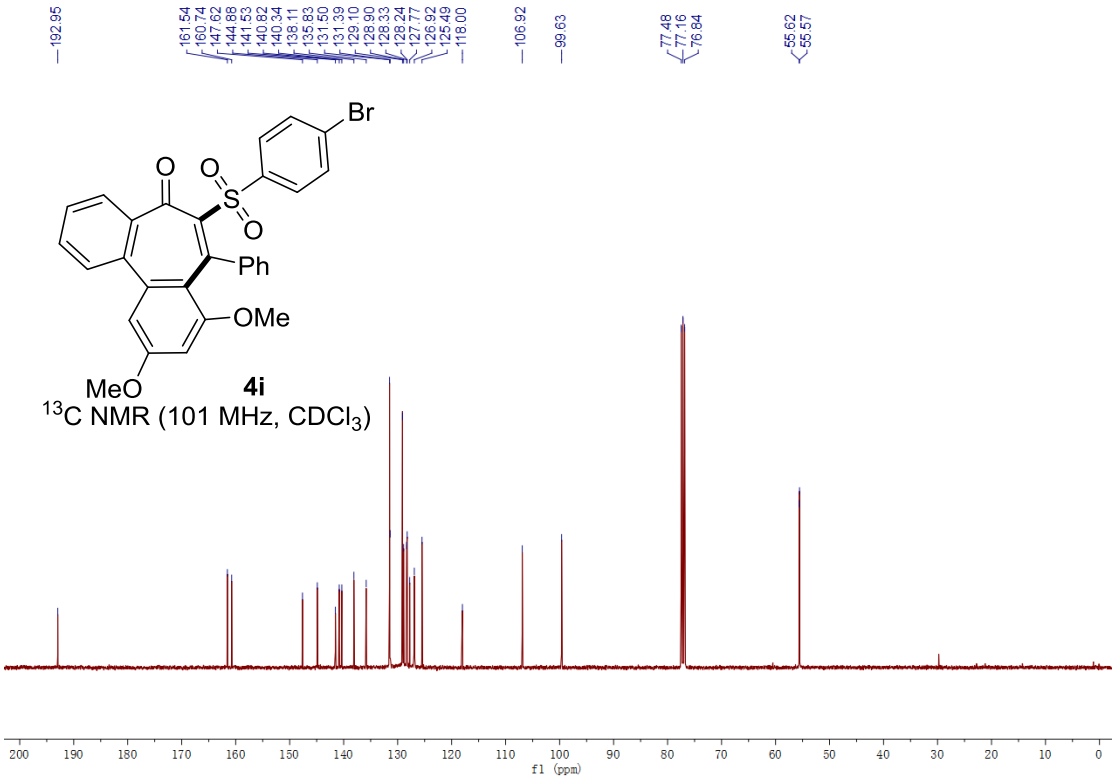
^{19}F NMR (377 MHz, $CDCl_3$)

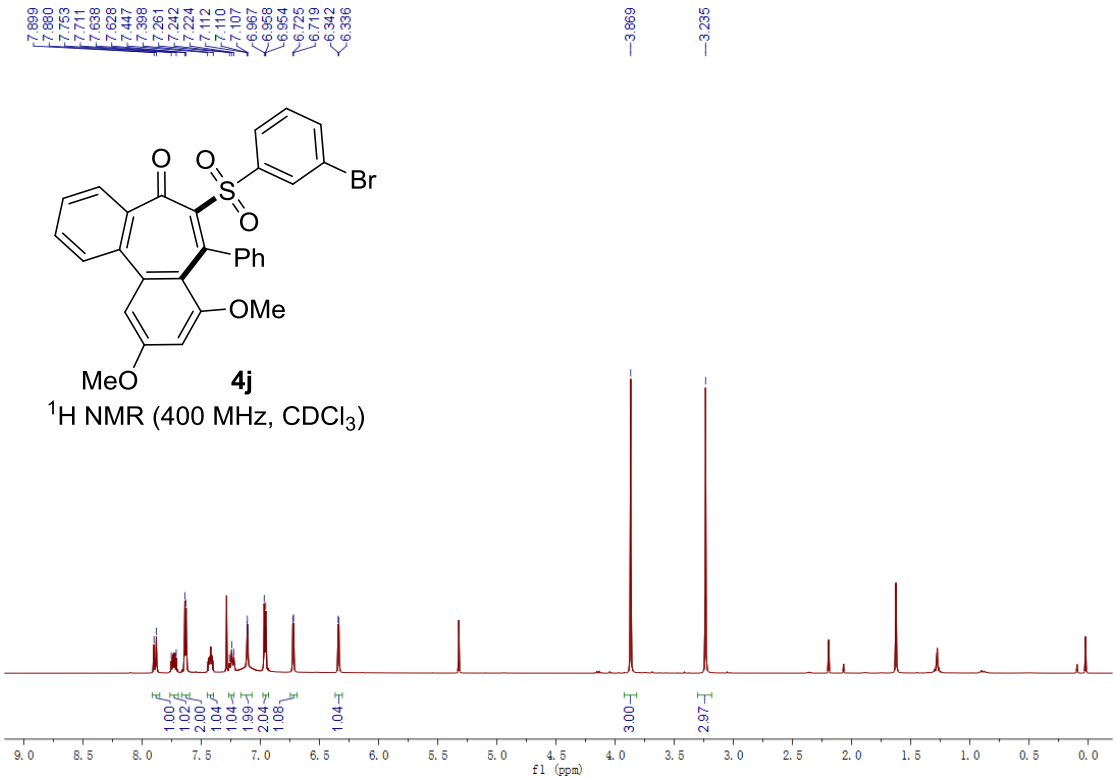


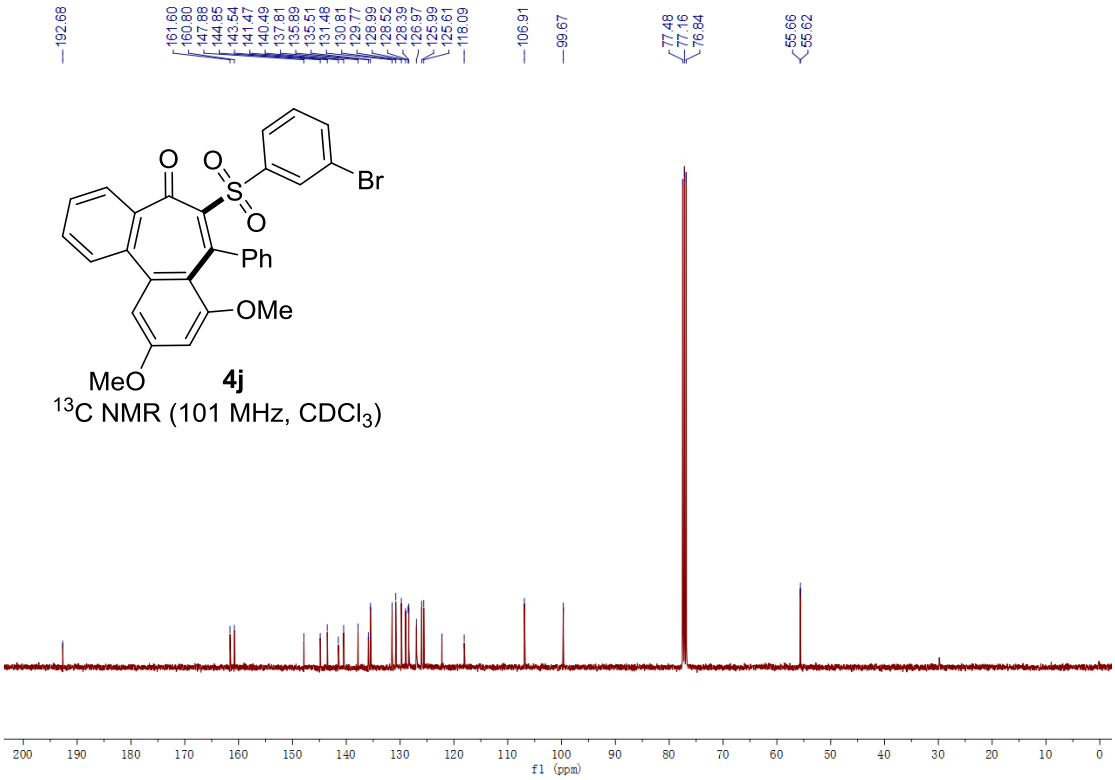
4i

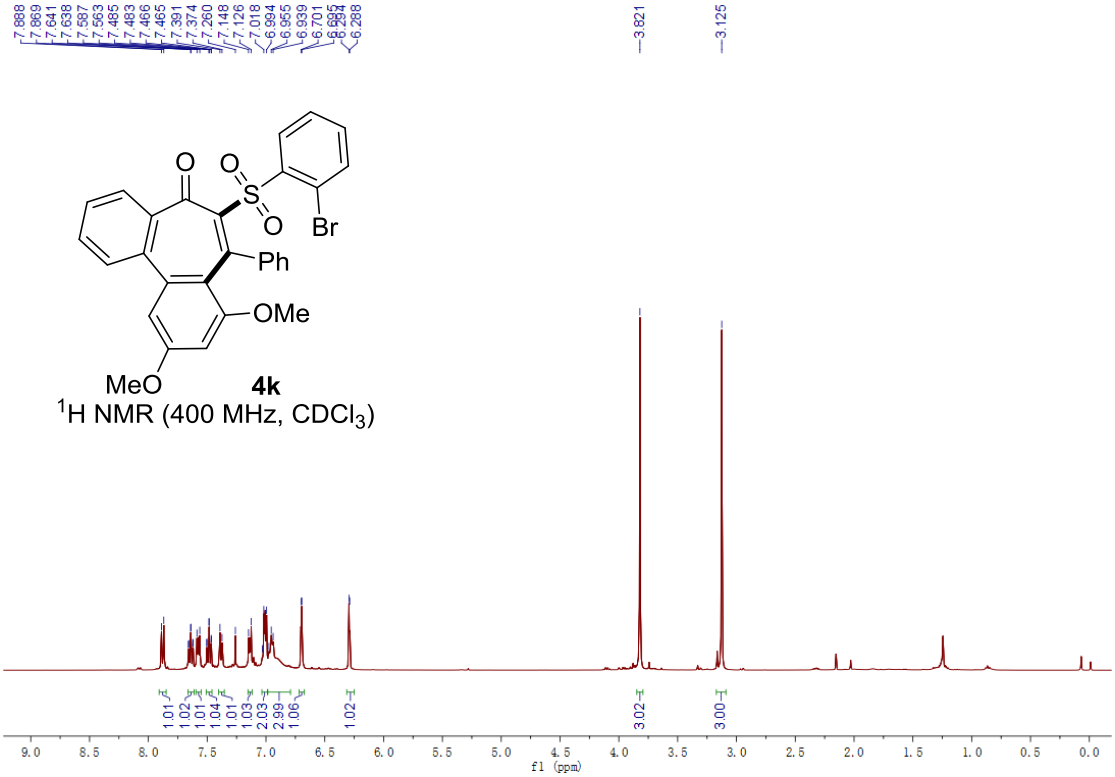
^{1}H NMR (400 MHz, $CDCl_3$)

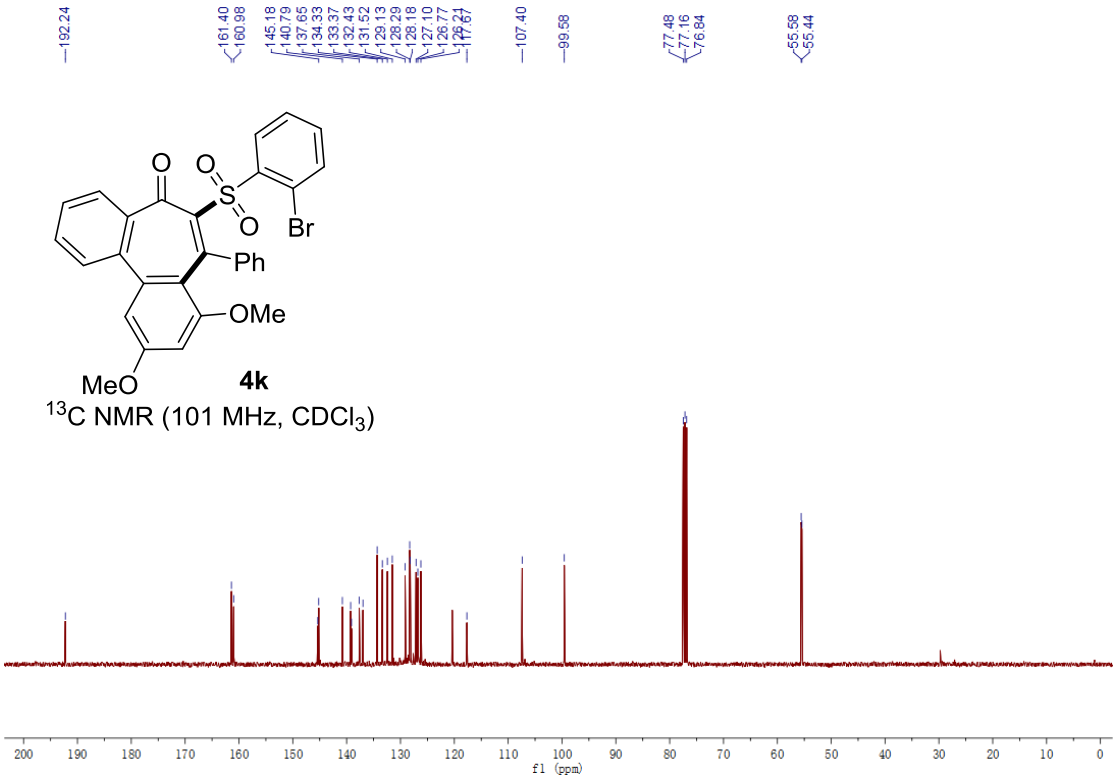


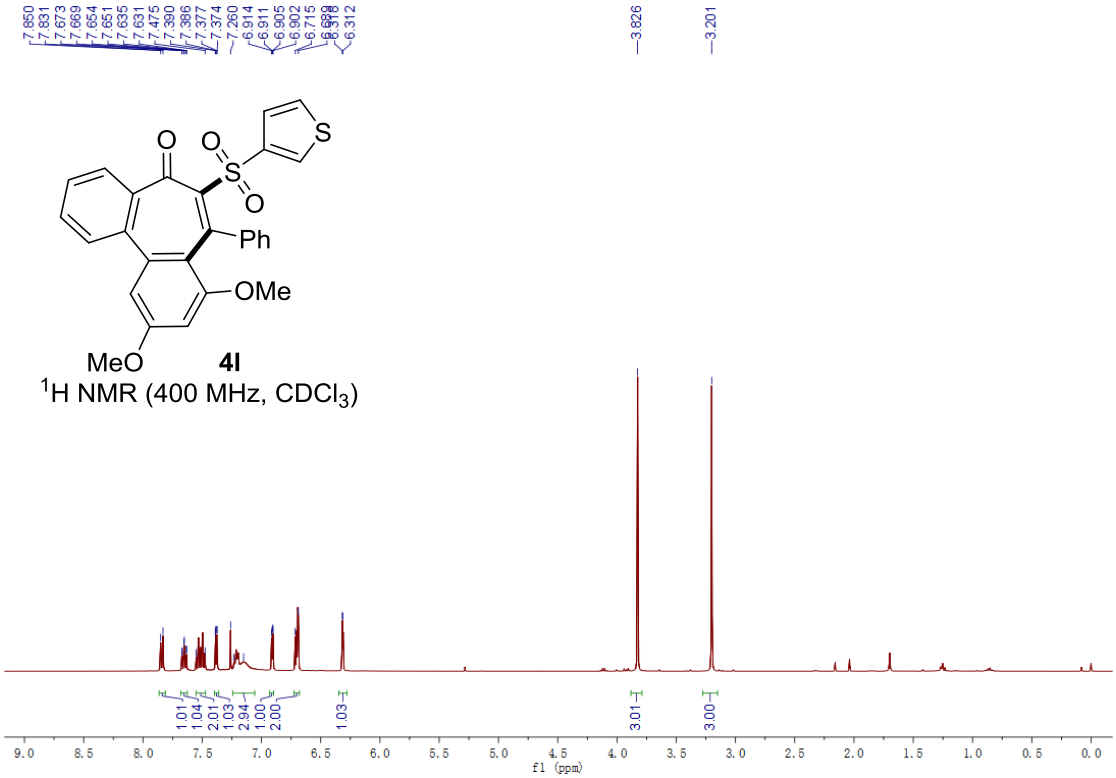

192.95
161.54
160.74
147.62
144.88
141.53
140.82
140.34
138.11
135.83
131.50
131.39
129.10
128.90
128.33
128.24
127.77
126.92
125.49
118.00
106.92
99.63
77.48
77.16
76.84
55.62
55.57
Br
O
O
S
O
Ph
OMe
MeO
4i
13C NMR (101 MHz, CDCl3)
f1 (ppm)

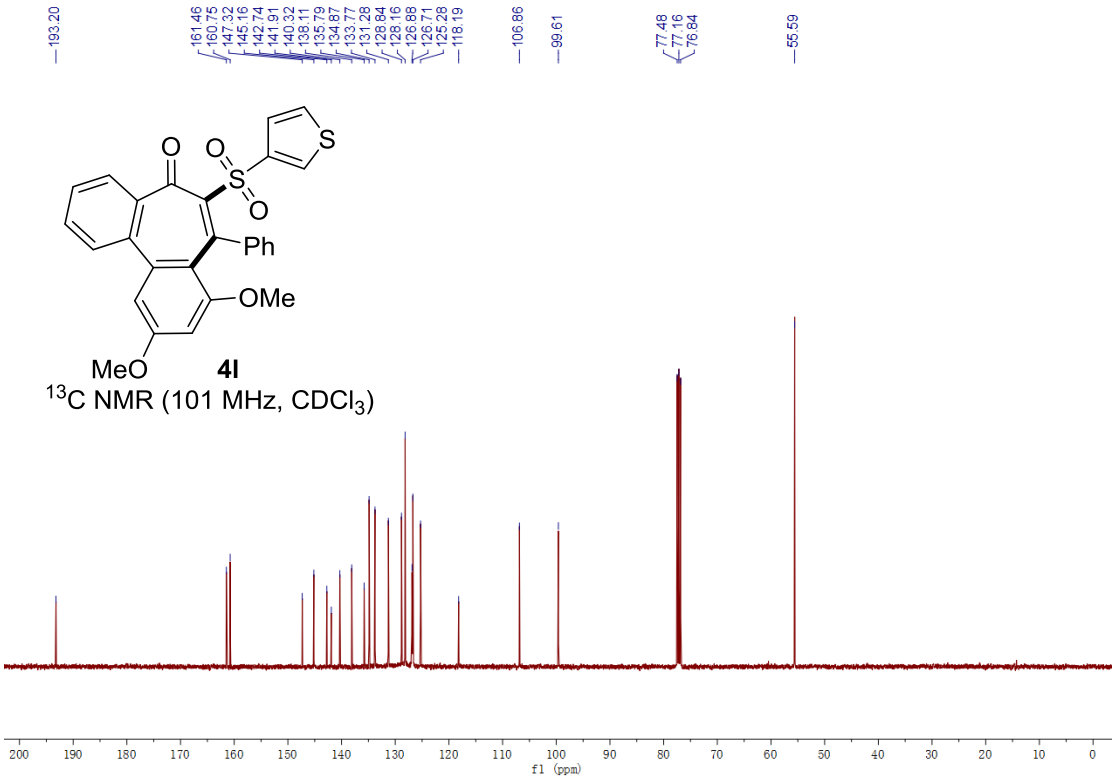

7.899
7.880
7.753
7.711
7.638
7.628
7.447
7.398
7.261
7.242
7.224
7.112
7.110
7.107
6.967
6.958
6.954
6.725
6.719
6.342
6.336
3.869
3.235
Br
O
O
S
O
Ph
OMe
MeO
4j
1H NMR (400 MHz, CDCl3)
1.00
1.02
2.00
1.04
1.04
1.99
2.04
1.08
1.04
3.00
2.97
f1 (ppm)

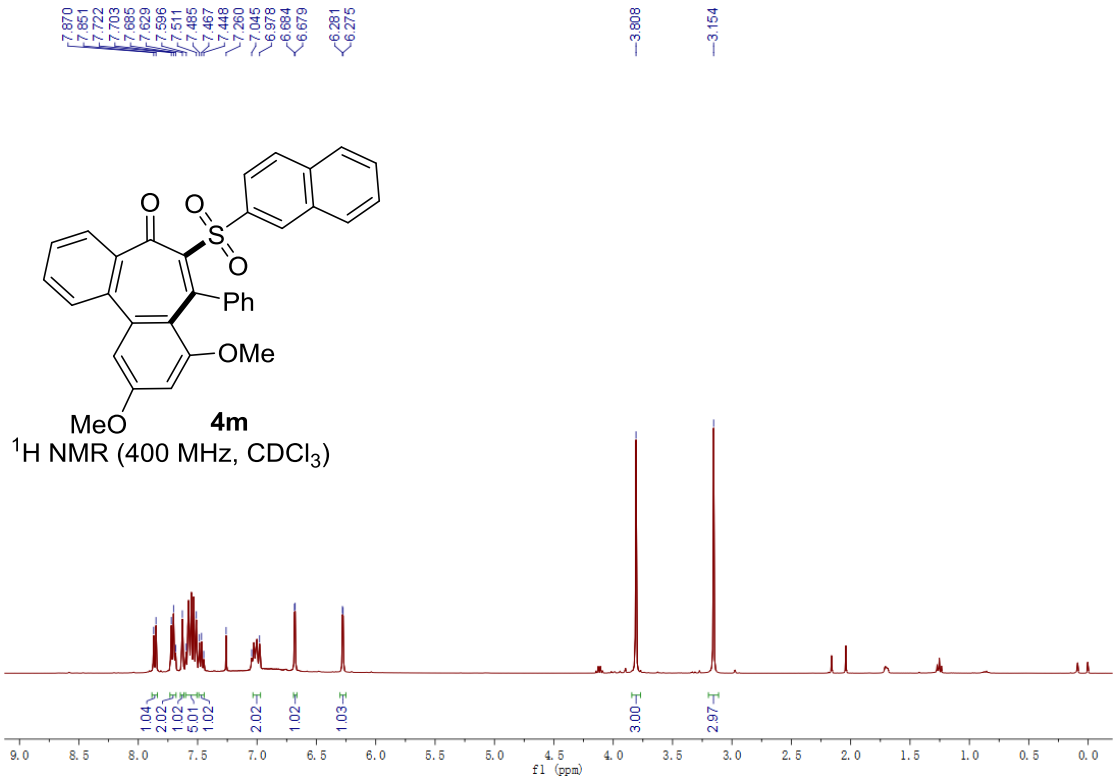

192.68
161.60
160.80
147.88
144.85
143.54
141.47
140.49
137.81
135.89
135.51
131.48
130.81
129.77
128.99
128.52
128.39
126.97
125.99
125.61
118.09
106.91
99.67
77.48
77.16
76.84
55.66
55.62
O
O
S
O
Br
Ph
OMe
MeO
4j
13C NMR (101 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

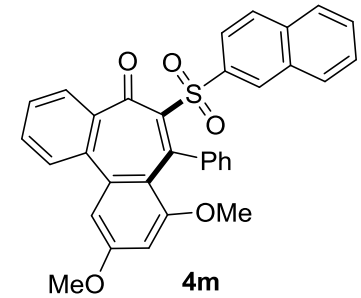

7.888
7.869
7.641
7.638
7.587
7.563
7.485
7.483
7.466
7.465
7.391
7.374
7.260
7.148
7.126
7.018
6.994
6.955
6.939
6.701
6.685
6.294
6.288
3.821
3.125
O
O
S
O
Br
Ph
OMe
MeO
4k
1H NMR (400 MHz, CDCl3)
1.01
1.02
1.01
1.04
1.01
1.03
2.03
2.99
1.06
1.02
3.02
3.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


192.24
161.40
160.98
145.18
140.79
137.65
134.33
133.37
132.43
131.52
129.13
128.29
128.18
127.10
126.77
107.40
99.58
77.48
77.16
76.84
55.58
55.44
O
O
S
O
Br
Ph
OMe
MeO
4k
13C NMR (101 MHz, CDCl3)
f1 (ppm)


7.850
7.831
7.673
7.669
7.654
7.651
7.635
7.631
7.475
7.390
7.386
7.377
7.374
7.260
6.914
6.911
6.905
6.902
6.715
6.698
6.312
3.826
3.201
O
O
S
O
S
Ph
OMe
MeO
4l
1H NMR (400 MHz, CDCl3)
1.01
1.04
2.01
1.03
2.94
1.00
2.00
1.03
3.01
3.00
f1 (ppm)

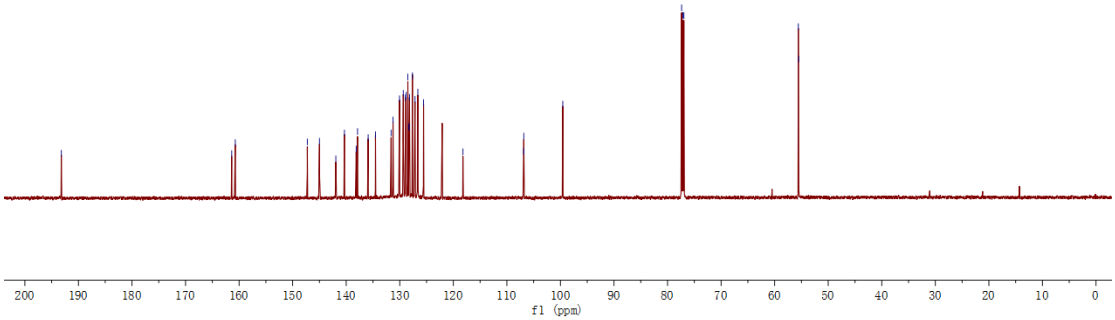

193.20
161.46
160.75
147.32
145.16
142.74
141.91
140.32
138.11
135.79
134.87
133.77
131.28
128.84
128.16
126.88
126.71
125.28
118.19
106.86
99.61
77.48
77.16
76.84
55.59
O
O
S
S
O
Ph
OMe
MeO
4l
13C NMR (101 MHz, CDCl3)
f1 (ppm)

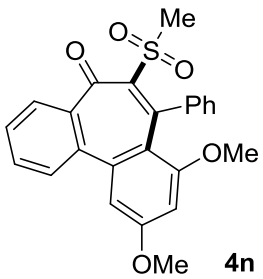

7.870
7.851
7.722
7.703
7.685
7.629
7.596
7.511
7.485
7.467
7.448
7.260
7.045
6.978
6.684
6.679
6.281
6.275
3.808
3.154
O
O
S
O
Ph
OMe
MeO
4m
1H NMR (400 MHz, CDCl3)
1.04
2.02
1.02
5.01
1.02
2.02
1.02
1.03
3.00
2.97
f1 (ppm)



4m

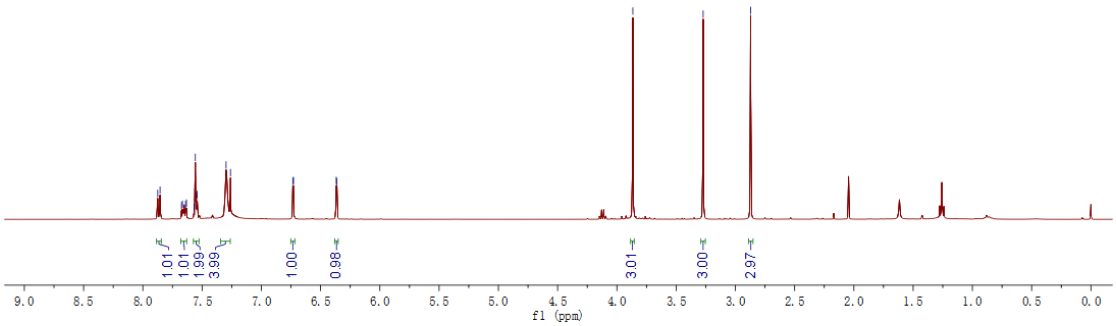
^{13}C NMR (101 MHz, $CDCl_3$)

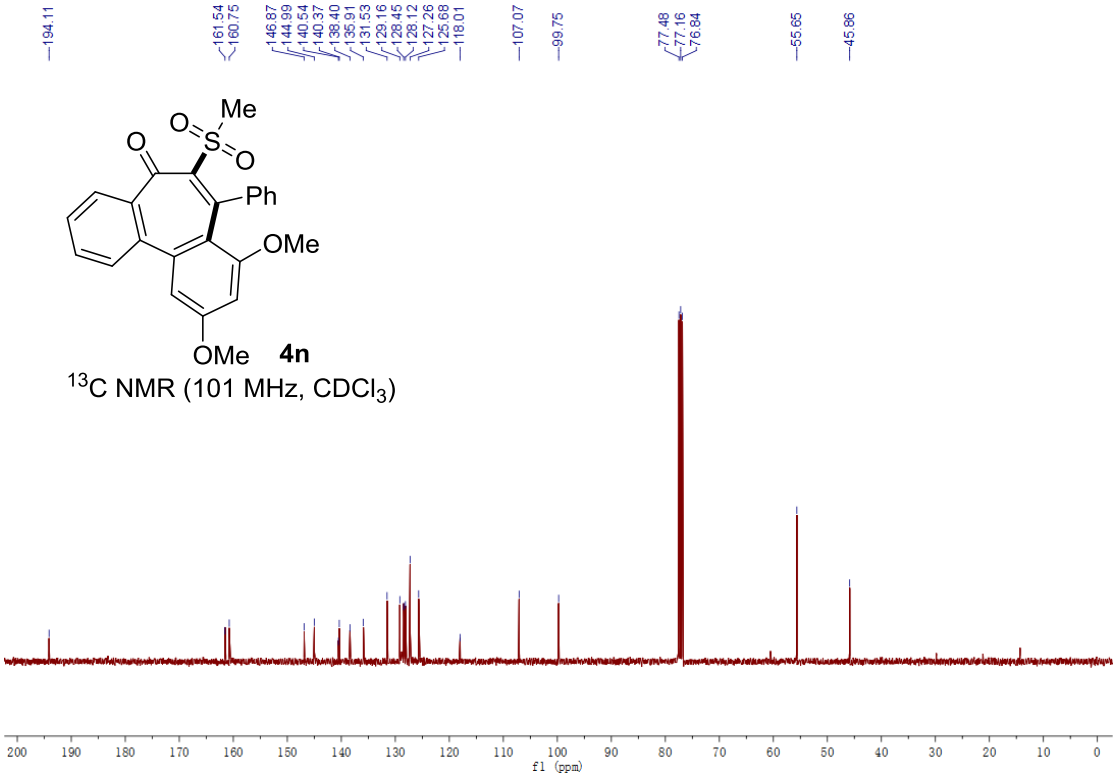


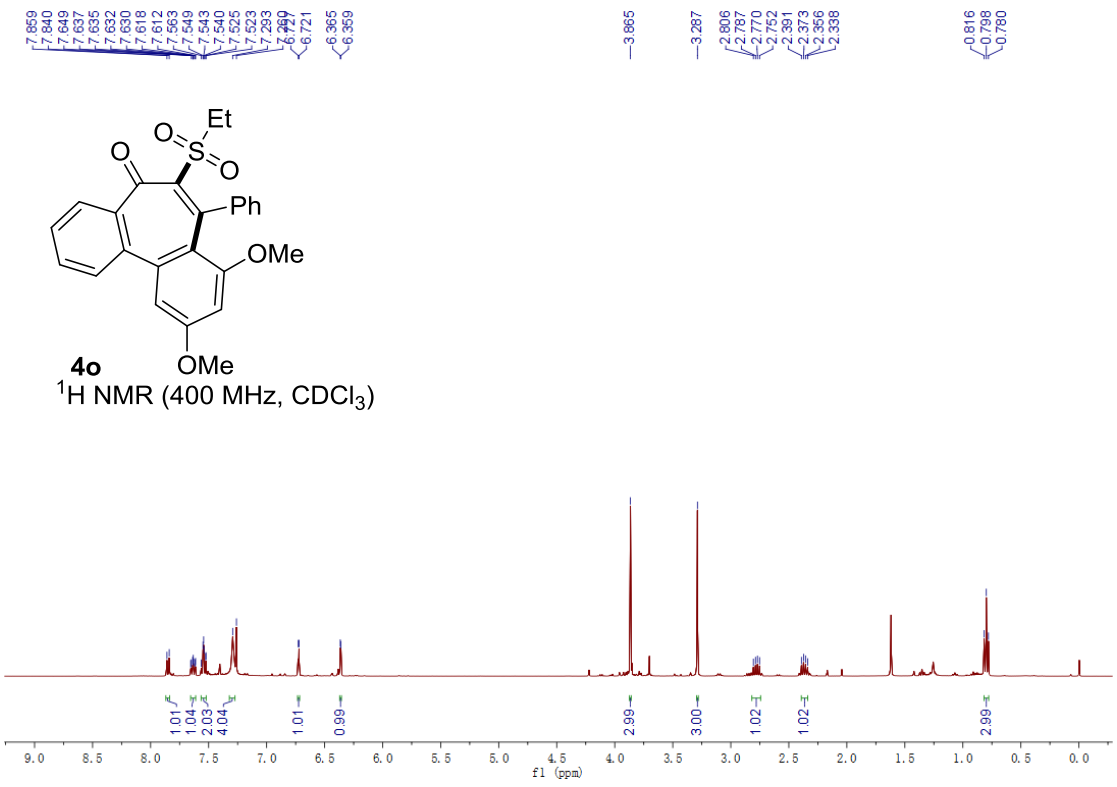


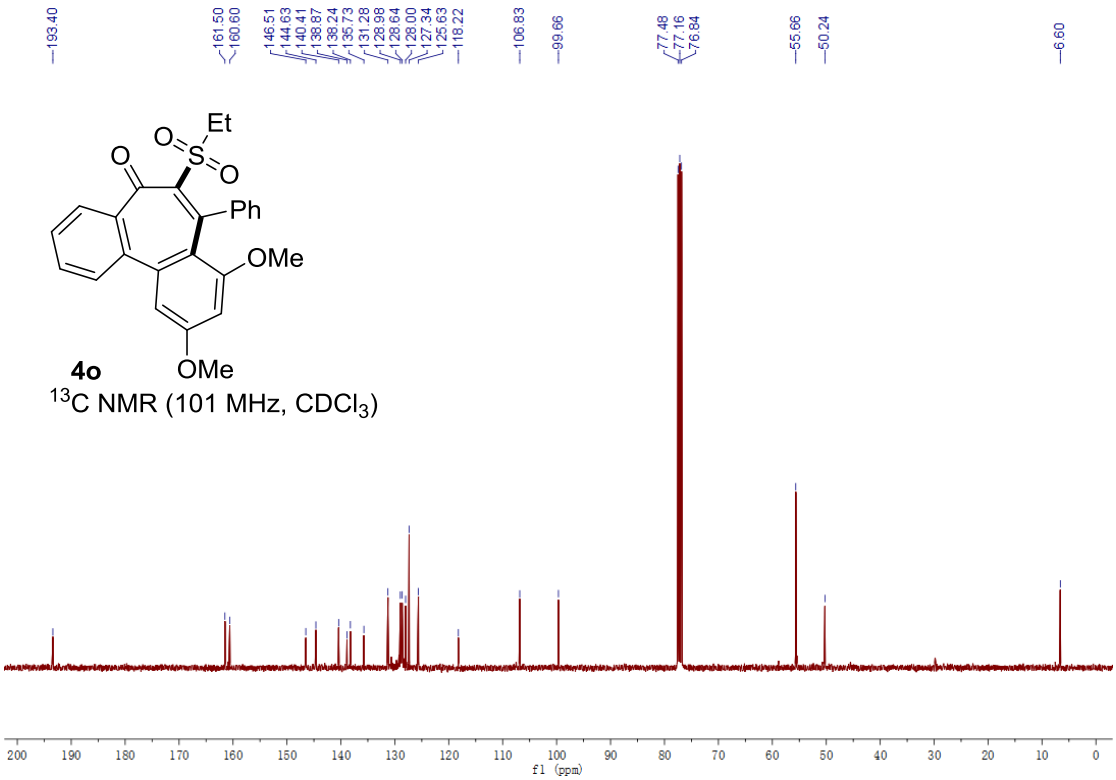
4n

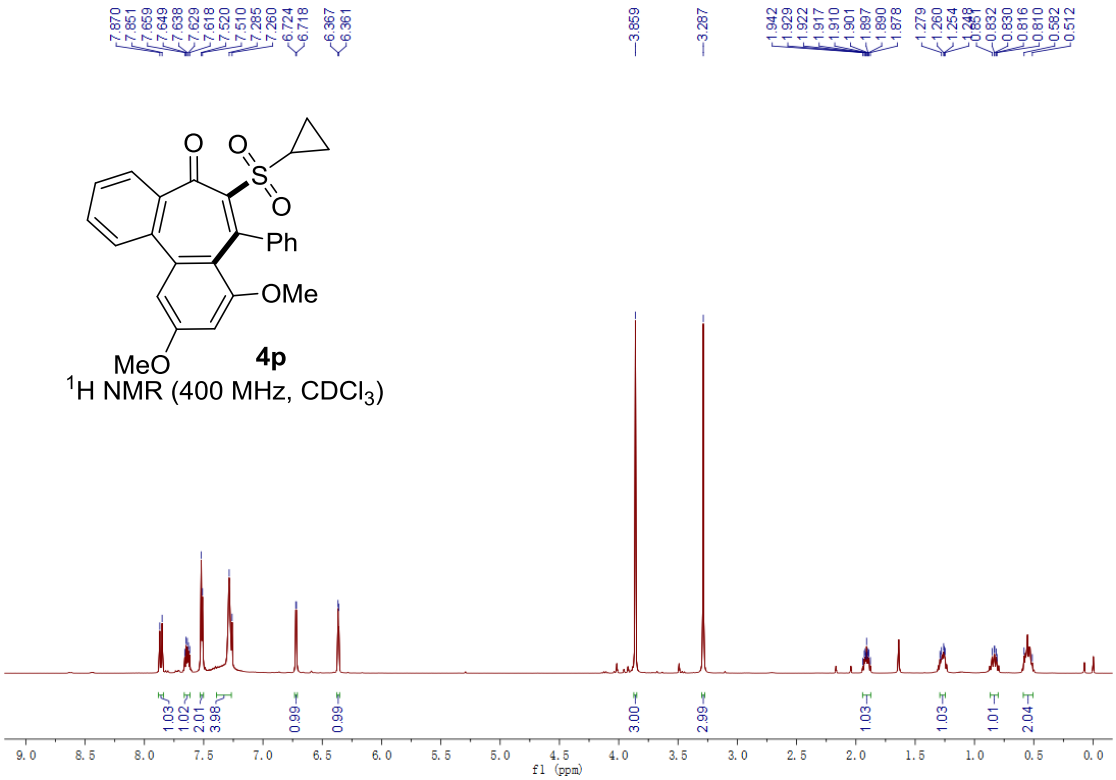
^{1}H NMR (400 MHz, $CDCl_3$)

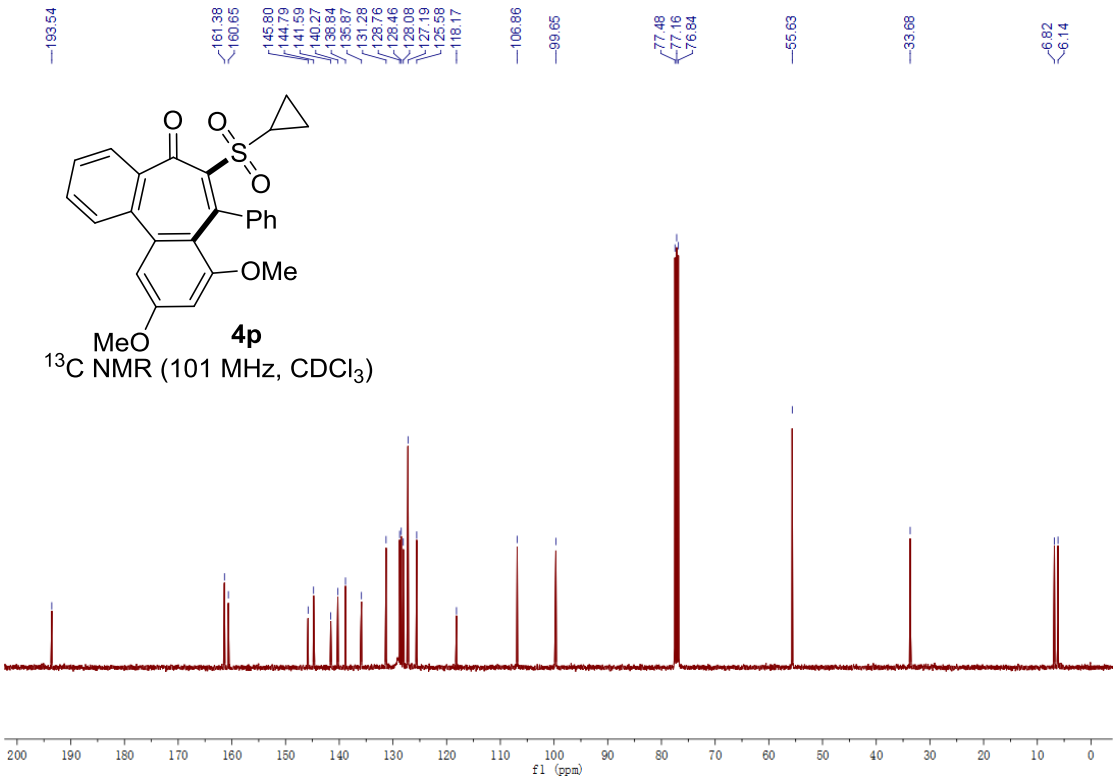


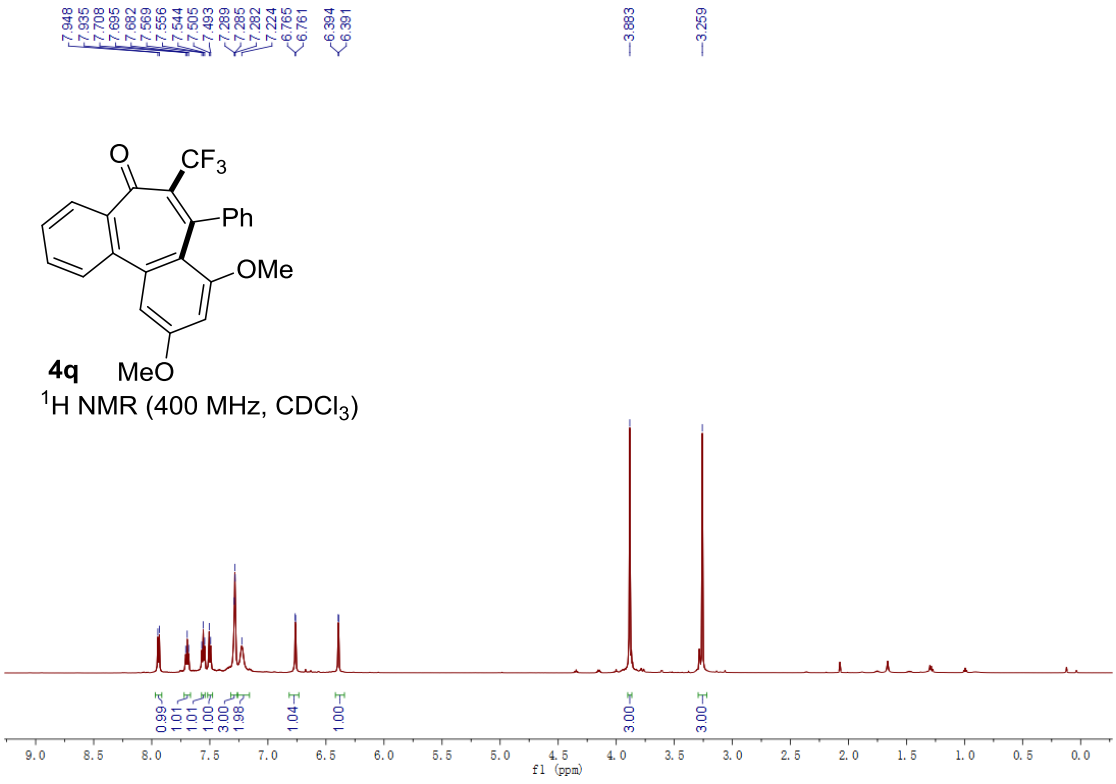

194.11
161.54
160.75
146.87
144.99
140.54
140.37
138.40
135.91
131.53
129.16
128.45
128.12
127.26
125.68
118.01
107.07
99.75
77.48
77.16
76.84
55.65
45.86
Me
O
S
O
O
Ph
OMe
OMe
4n
13C NMR (101 MHz, CDCl3)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

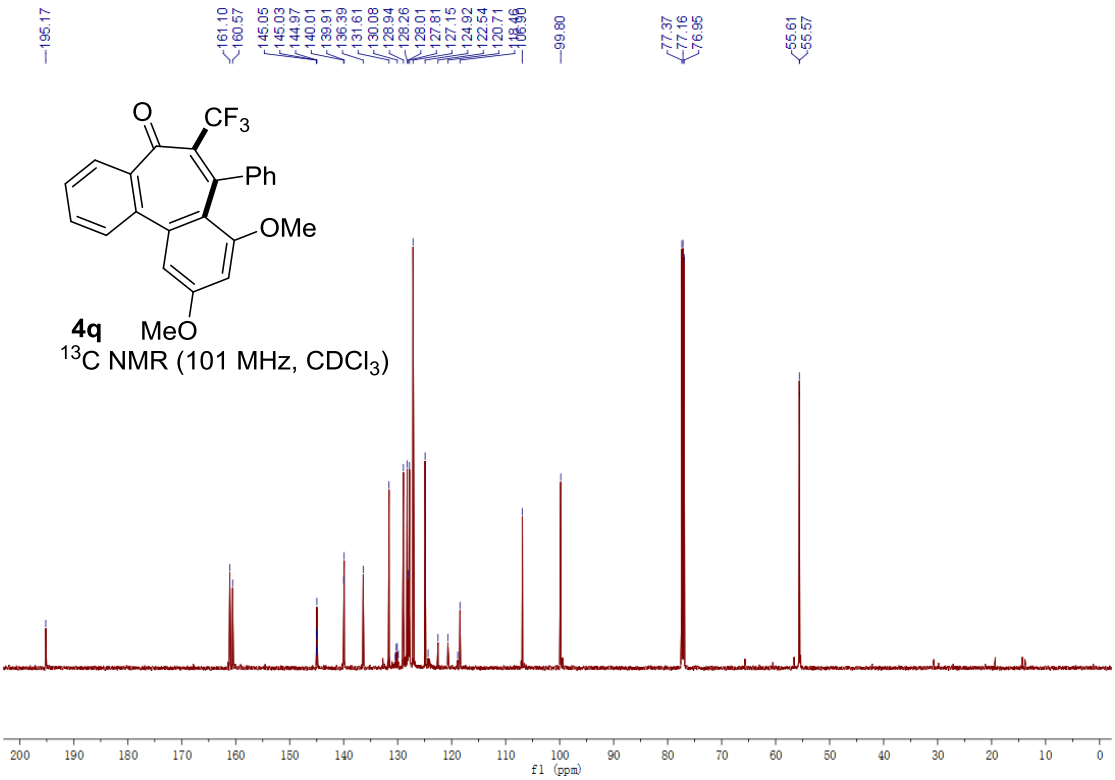

7.859
7.840
7.649
7.637
7.635
7.632
7.630
7.618
7.612
7.563
7.549
7.543
7.540
7.525
7.523
7.293
6.727
6.721
6.365
6.359
3.865
3.287
2.806
2.787
2.770
2.752
2.391
2.373
2.356
2.338
0.816
0.798
0.780
Et
O
S
O
O
Ph
OMe
OMe
4o
1H NMR (400 MHz, CDCl3)
1.01
1.04
2.03
4.04
1.01
0.99
2.99
3.00
1.02
1.02
2.99
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

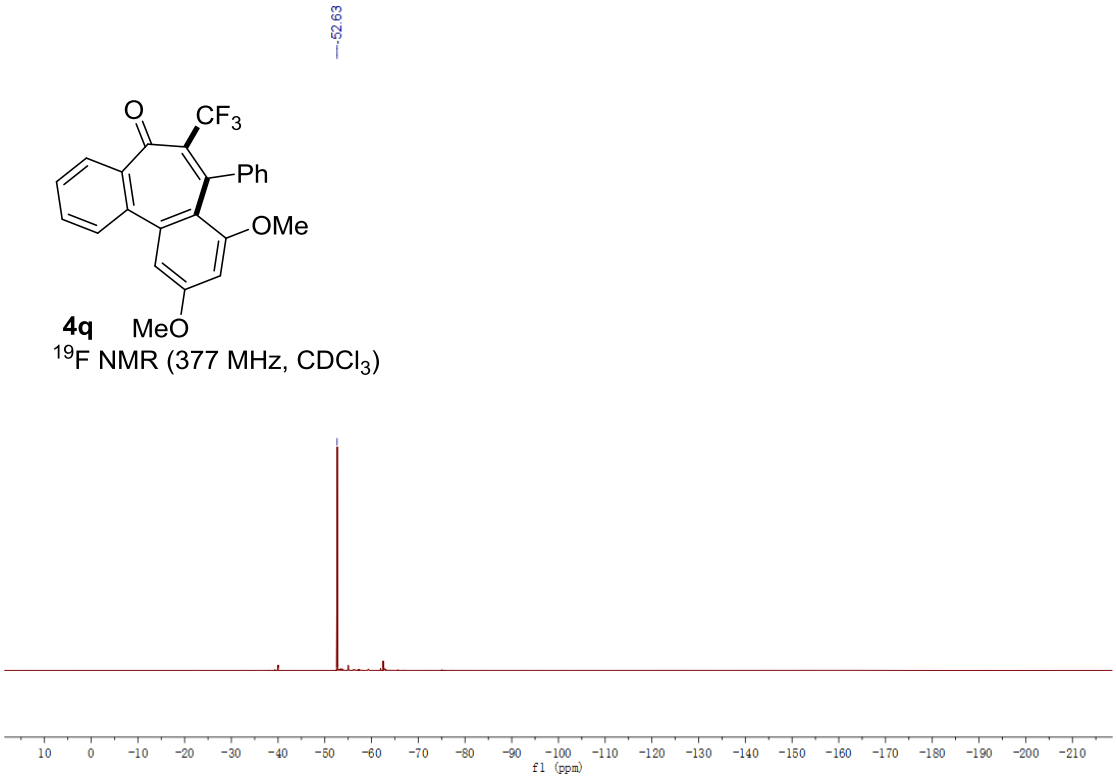

193.40
161.50
160.60
146.51
144.63
140.41
138.87
138.24
135.73
131.28
128.98
128.64
128.00
127.34
125.63
118.22
106.83
99.66
77.48
77.16
76.84
55.66
50.24
6.60
Et
O
S
O
O
Ph
OMe
OMe
4o
13C NMR (101 MHz, CDCl3)
f1 (ppm)

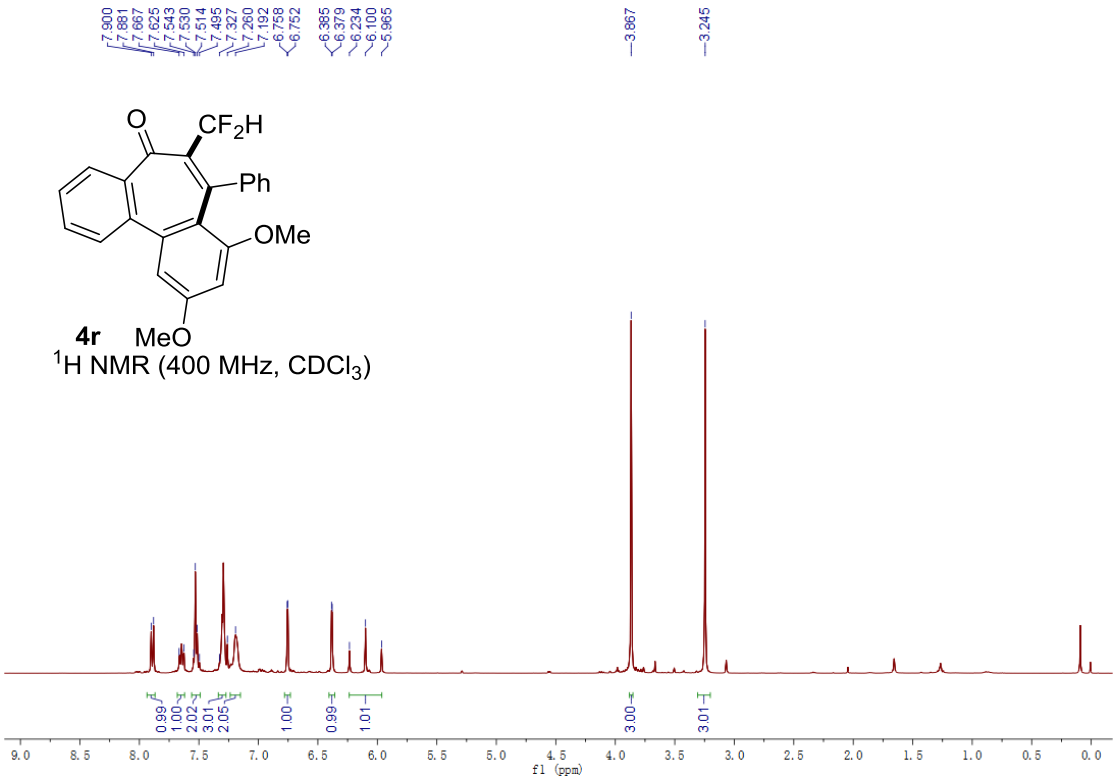

7.870
7.851
7.659
7.649
7.638
7.629
7.618
7.520
7.510
7.285
7.260
6.724
6.718
6.367
6.361
3.859
3.287
1.942
1.929
1.922
1.917
1.910
1.901
1.897
1.890
1.878
1.279
1.260
1.254
1.248
0.851
0.832
0.830
0.816
0.810
0.582
0.512
O
O
S
O
Ph
OMe
MeO
4p
1H NMR (400 MHz, CDCl3)
1.03
1.02
2.01
3.98
0.99
0.99
3.00
2.99
1.03
1.03
1.01
2.04
f1 (ppm)

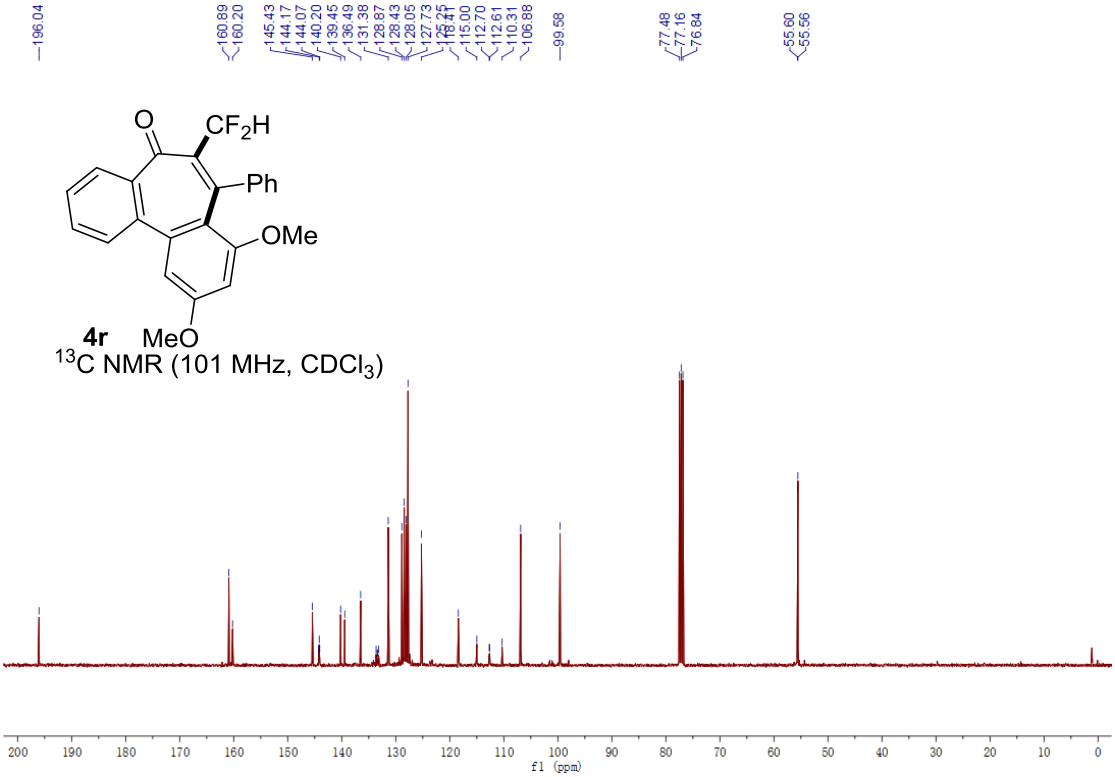

193.54
161.38
160.65
145.80
144.79
141.59
140.27
138.84
135.87
131.28
128.76
128.46
128.08
127.19
125.58
118.17
106.86
99.65
77.48
77.16
76.84
55.63
33.68
6.82
6.14
O
O
S
O
Ph
OMe
MeO
4p
13C NMR (101 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.948
7.935
7.708
7.695
7.682
7.569
7.556
7.544
7.505
7.493
7.289
7.285
7.282
7.224
6.765
6.761
6.394
6.391
3.883
3.259
O
CF3
Ph
OMe
MeO
4q
1H NMR (400 MHz, CDCl3)
0.99
1.01
1.01
1.00
3.00
1.98
1.04
1.00
3.00
3.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


195.17
161.10
160.57
145.05
145.03
144.97
140.01
139.91
136.39
131.61
130.08
128.94
128.26
128.01
127.81
127.15
124.92
122.54
120.71
99.80
77.37
77.16
76.95
55.61
55.57
O
CF3
Ph
OMe
MeO
4q
13C NMR (101 MHz, CDCl3)
f1 (ppm)

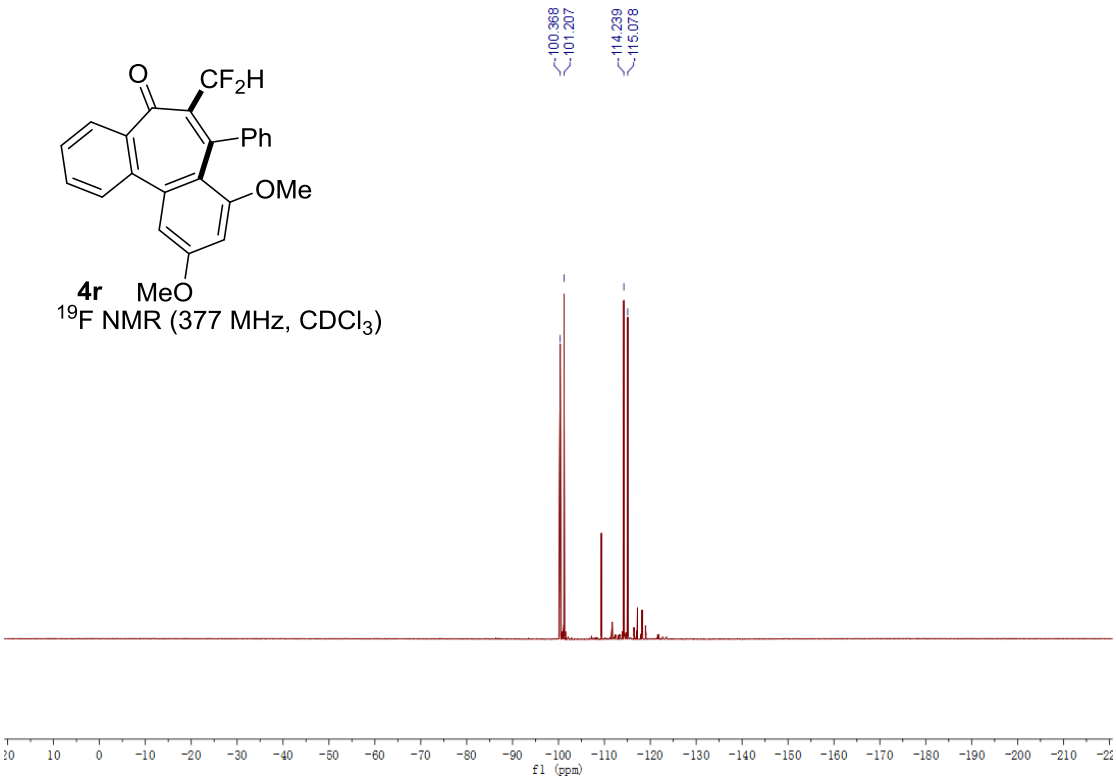

52.63
O
CF3
Ph
OMe
MeO
4q
19F NMR (377 MHz, CDCl3)
f1 (ppm)


7.900
7.881
7.667
7.625
7.543
7.530
7.514
7.495
7.327
7.260
7.192
6.758
6.752
6.385
6.379
6.234
6.100
5.965
3.867
3.245
O
CF2H
Ph
OMe
MeO
4r
1H NMR (400 MHz, CDCl3)
0.99
1.00
2.02
3.01
2.05
1.00
0.99
1.01
3.00
3.01
f1 (ppm)


196.04
160.89
160.20
145.43
144.17
144.07
140.20
139.45
136.49
131.38
128.97
128.43
128.05
127.73
115.00
112.70
112.61
110.31
106.88
99.58
77.48
77.16
76.84
55.60
55.56
O
CF2H
Ph
OMe
MeO
4r
13C NMR (101 MHz, CDCl3)
f1 (ppm)

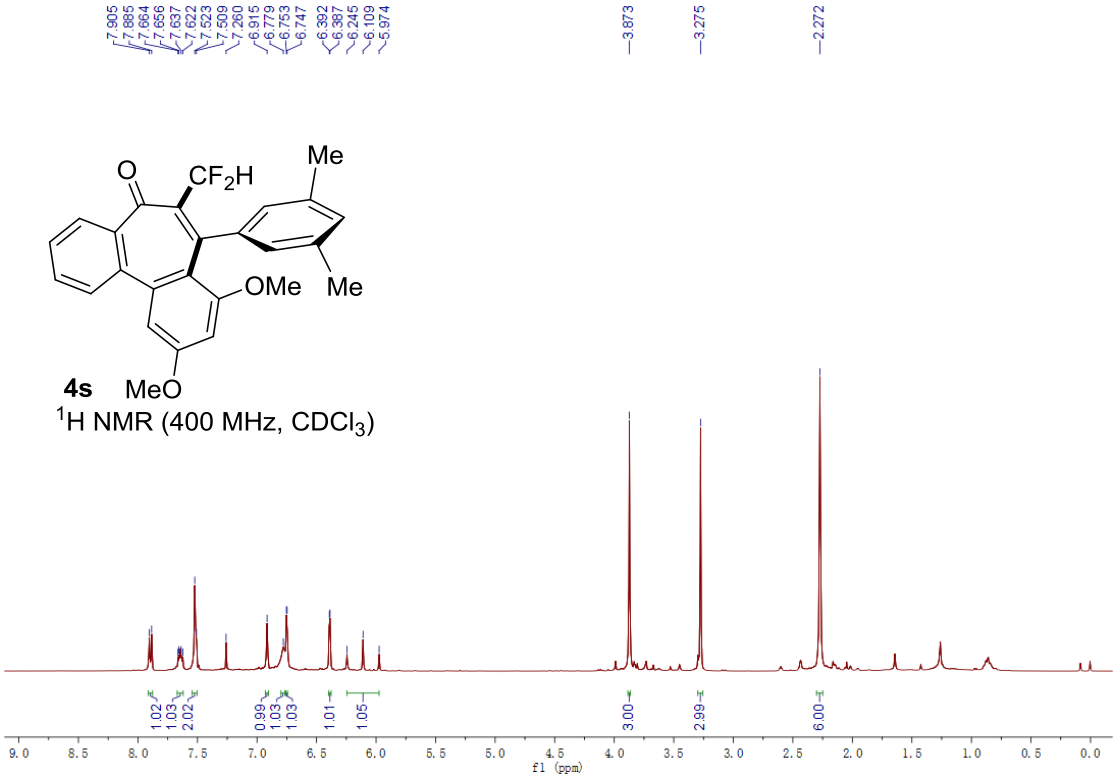
4r

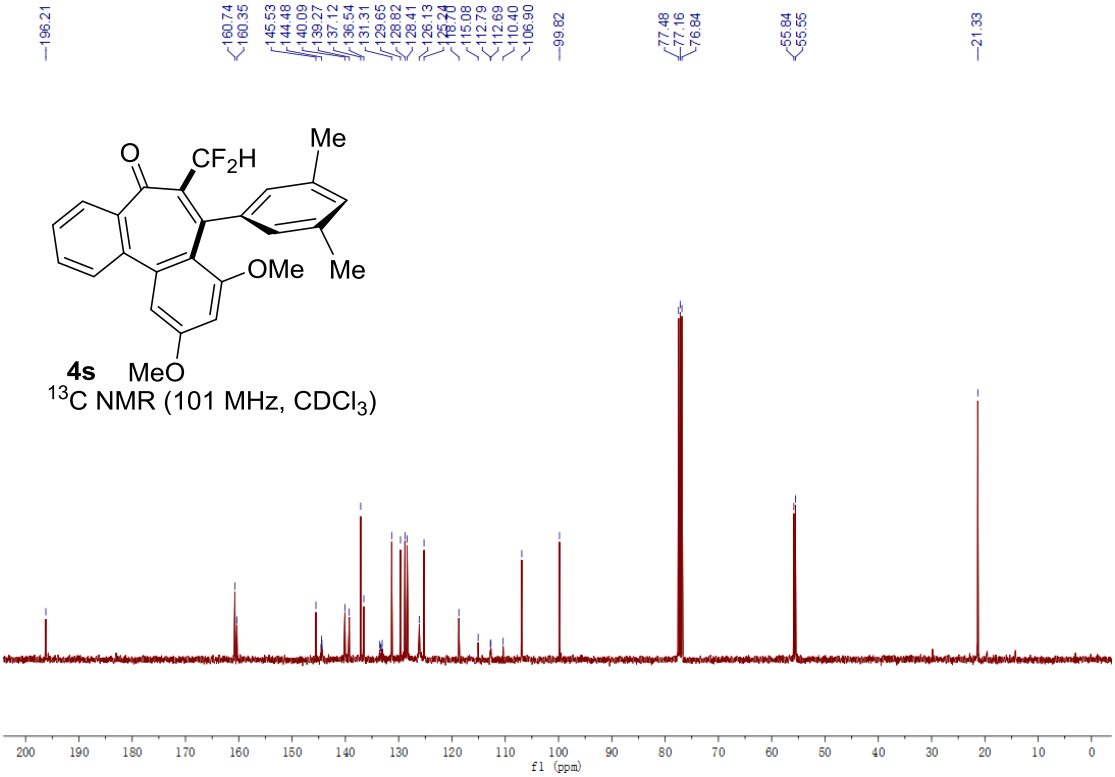
^{19}F NMR (377 MHz, $CDCl_3$)

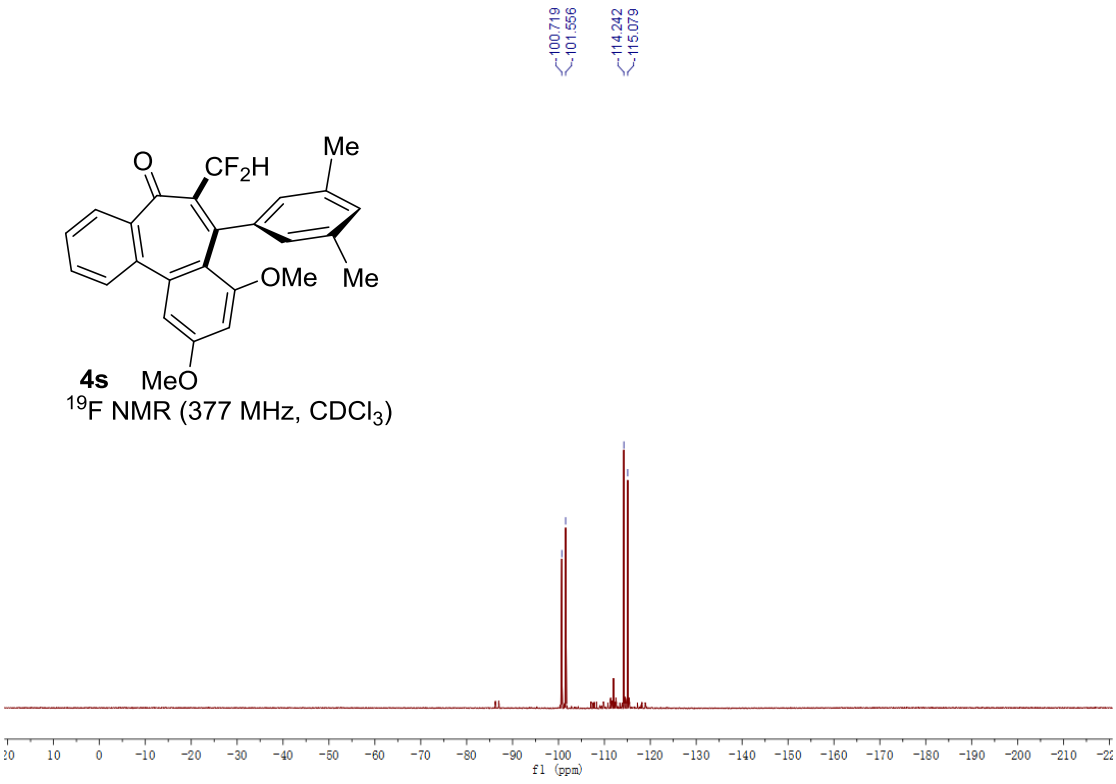


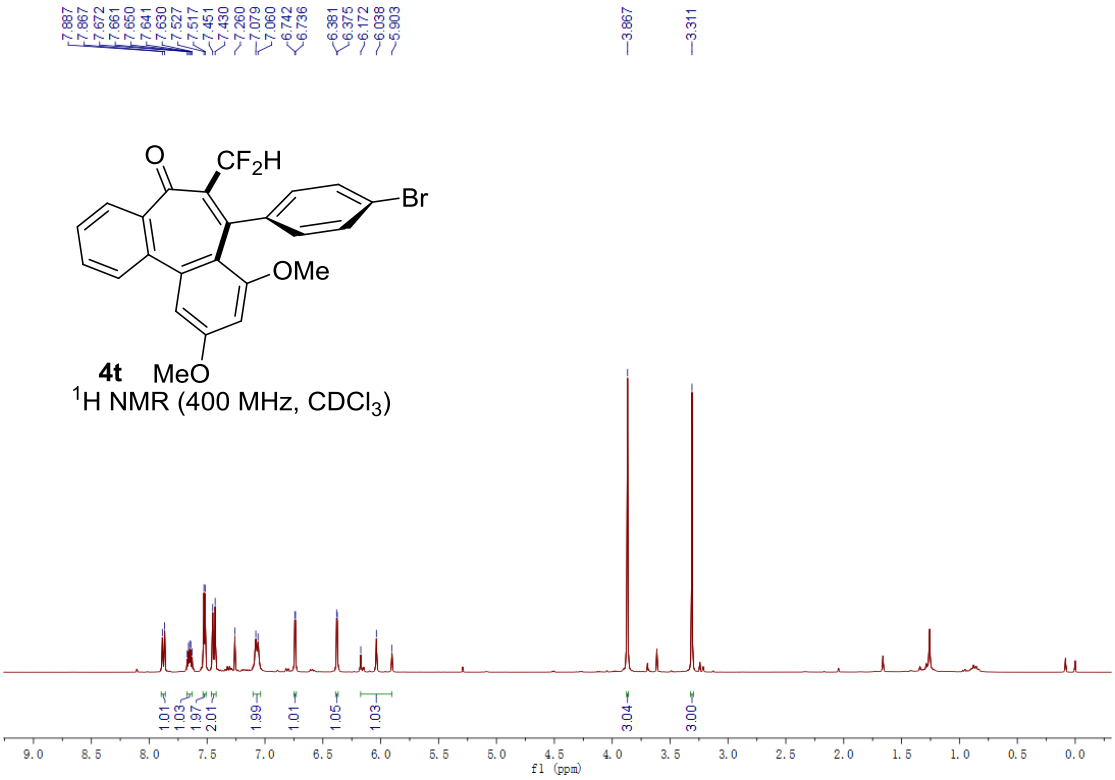
4s

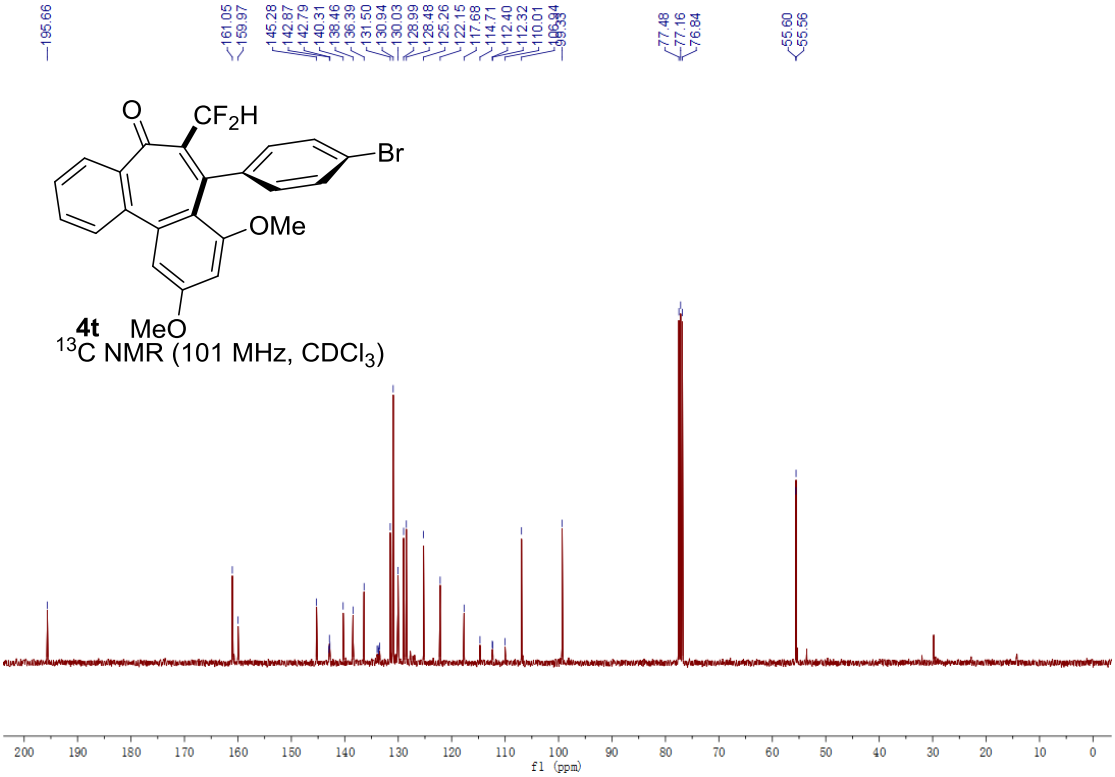
^{1}H NMR (400 MHz, $CDCl_3$)




196.21
160.74
160.35
145.53
144.48
140.09
139.27
137.12
136.54
131.31
129.65
128.82
128.41
126.13
115.08
112.79
112.69
110.40
106.90
99.82
77.48
77.16
76.84
55.84
55.55
21.33
O
CF2H
Me
OMe
Me
MeO
4s
13C NMR (101 MHz, CDCl3)
f1 (ppm)

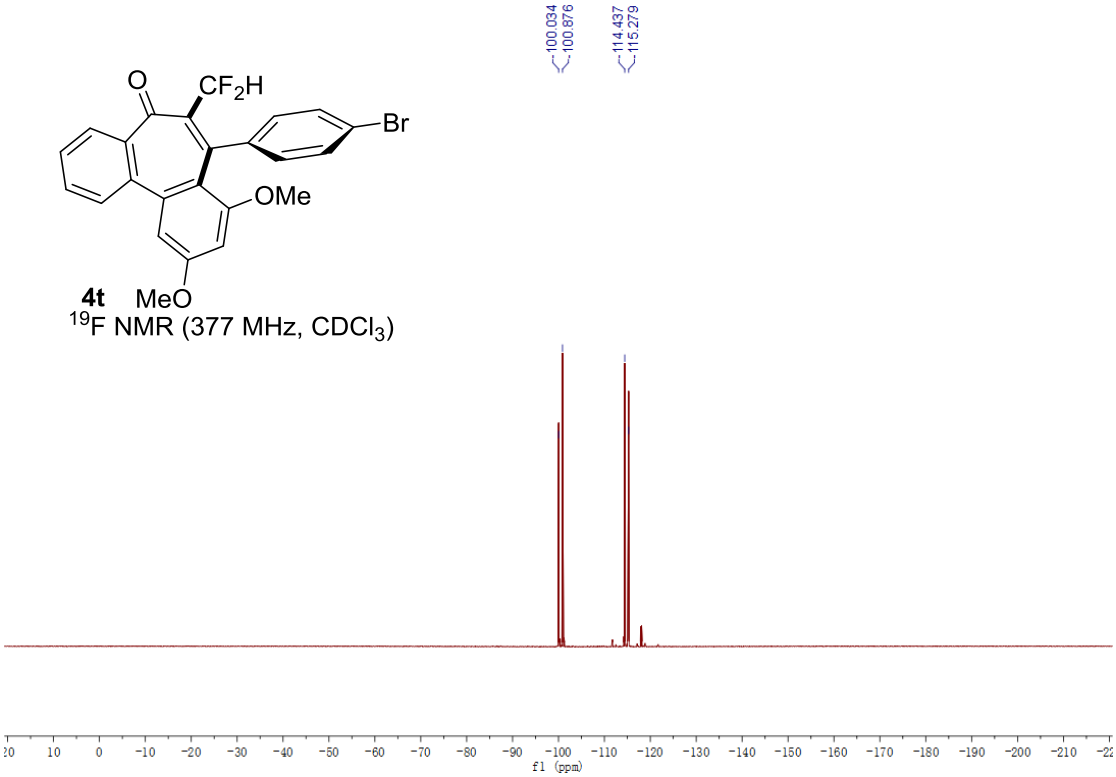

100.719
101.556
114.242
115.079
O
CF2H
Me
OMe
Me
MeO
4s
19F NMR (377 MHz, CDCl3)
f1 (ppm)


7.887
7.867
7.672
7.661
7.650
7.641
7.630
7.527
7.517
7.451
7.430
7.260
7.079
7.060
6.742
6.736
6.381
6.375
6.172
6.038
5.903
3.867
3.311
O
CF2H
Br
OMe
MeO
4t
1H NMR (400 MHz, CDCl3)
1.01
1.03
1.97
2.01
1.99
1.01
1.05
1.03
3.04
3.00
f1 (ppm)


195.66
161.05
159.97
145.28
142.87
142.79
140.31
138.46
136.39
131.50
130.94
130.03
128.99
128.48
125.26
122.15
117.68
114.71
112.40
112.32
110.01
77.48
77.16
76.84
55.60
55.56
O
CF2H
Br
OMe
MeO
4t
13C NMR (101 MHz, CDCl3)
f1 (ppm)

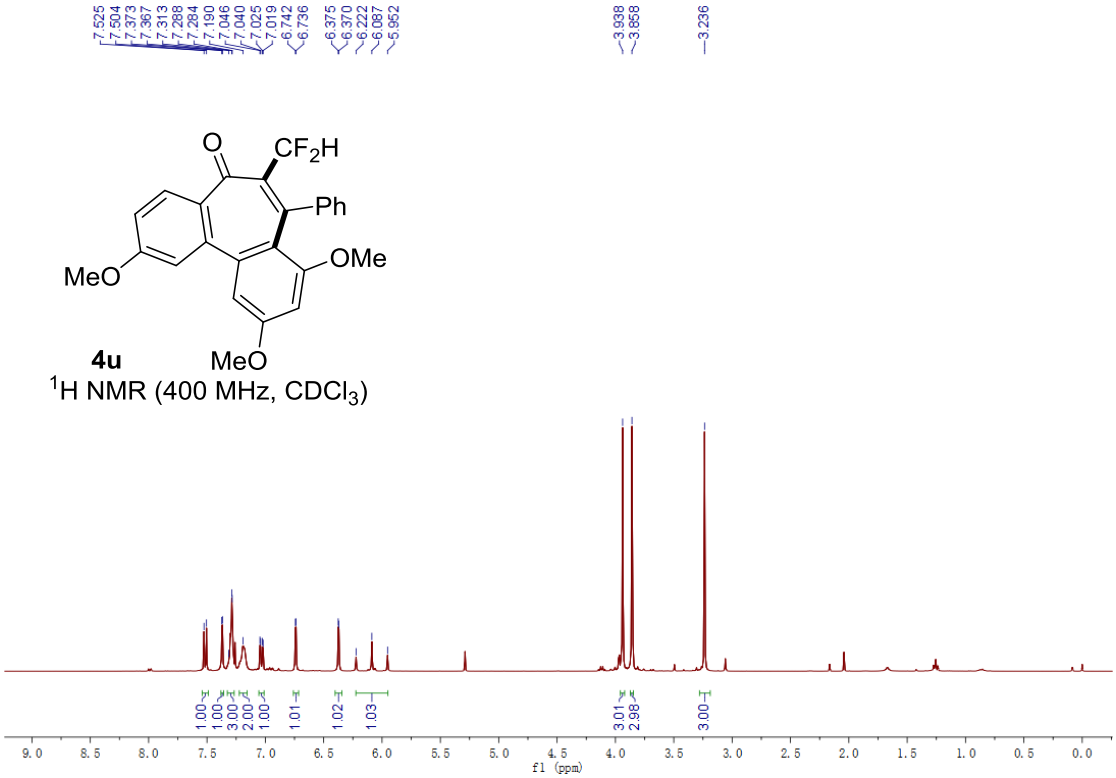
4t

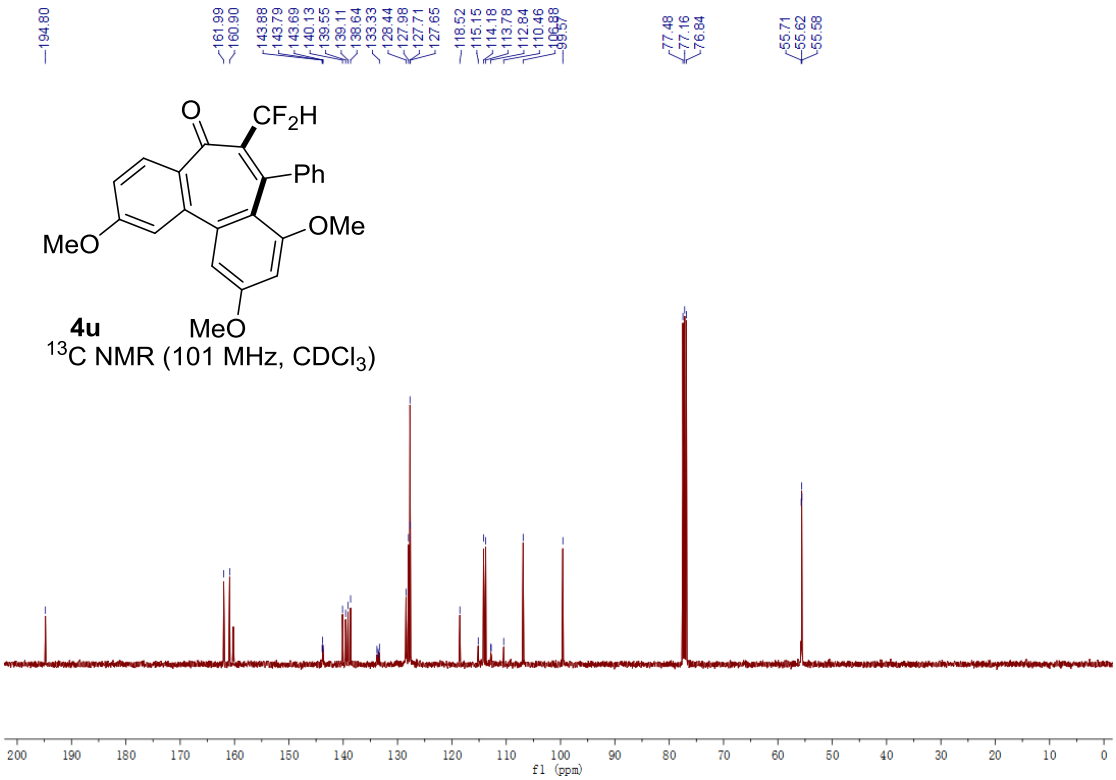
^{19}F NMR (377 MHz, $CDCl_3$)

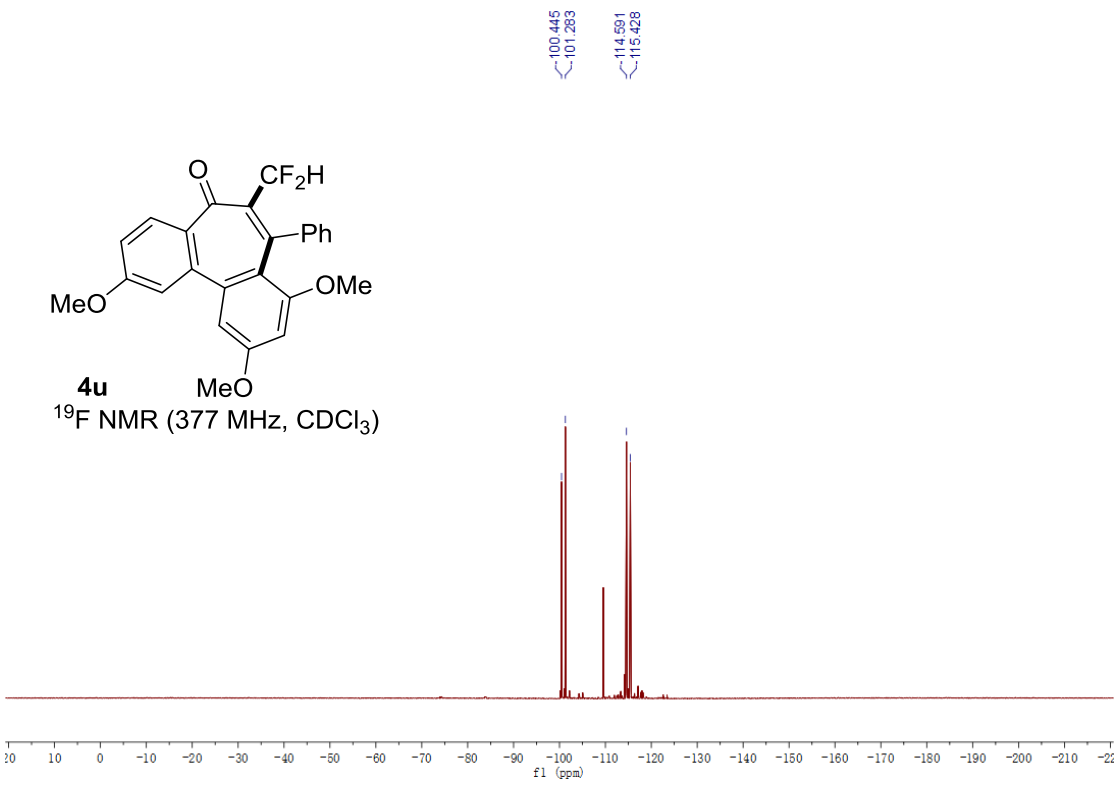


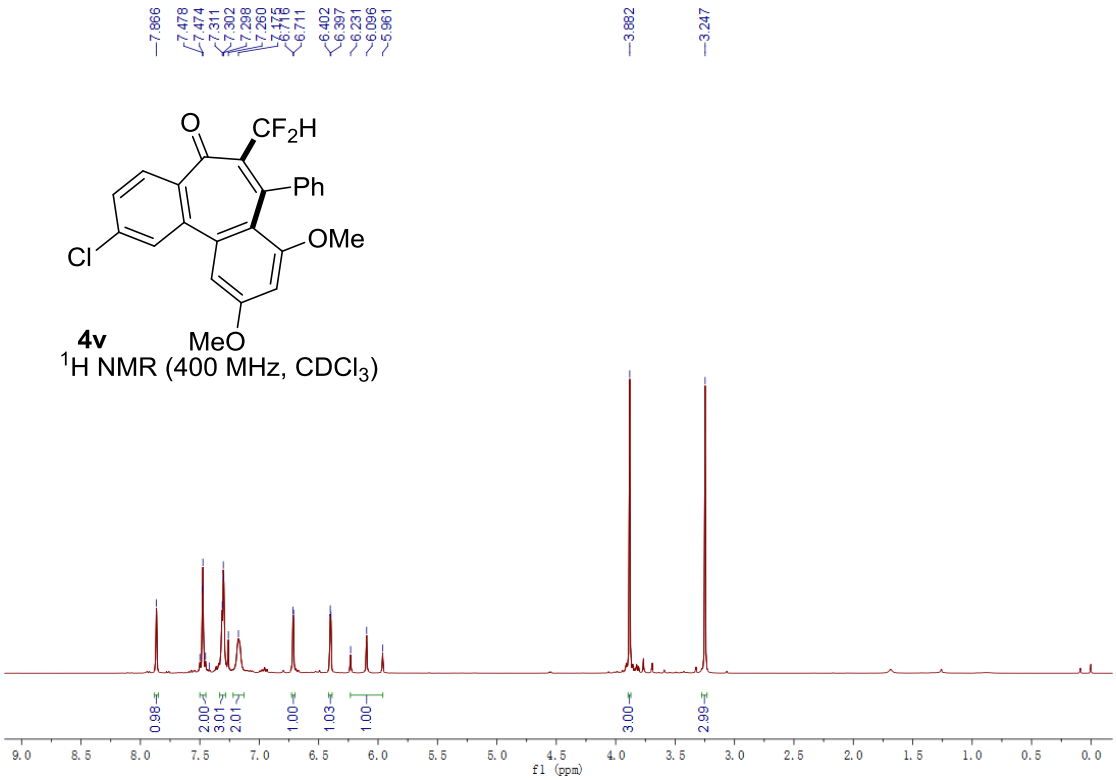
4u

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



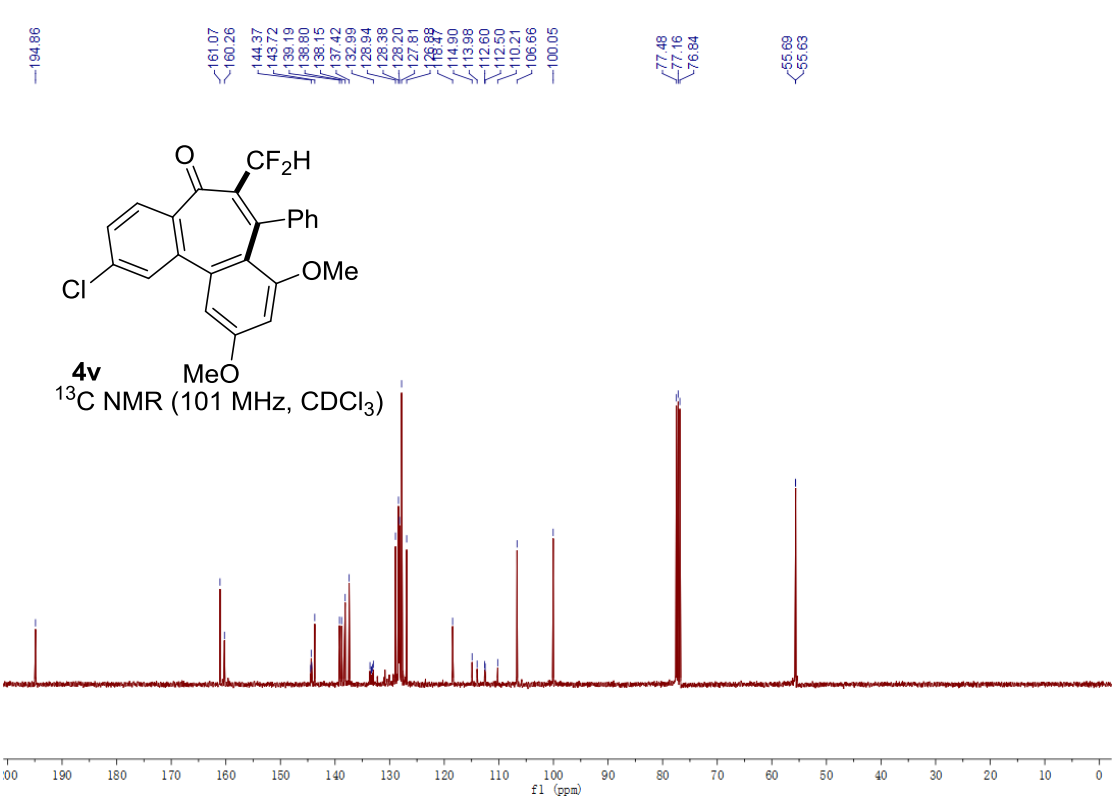

194.80
161.99
160.90
143.88
143.79
143.69
140.13
139.55
139.11
138.64
133.33
128.44
127.98
127.71
127.65
118.52
115.15
114.18
113.78
112.84
110.46
77.48
77.16
76.84
55.71
55.62
55.58
O
CF2H
Ph
OMe
MeO
MeO
4u
13C NMR (101 MHz, CDCl3)
f1 (ppm)


100.445
101.283
114.591
115.428
O
CF2H
Ph
OMe
MeO
MeO
4u
19F NMR (377 MHz, CDCl3)
f1 (ppm)



4v

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

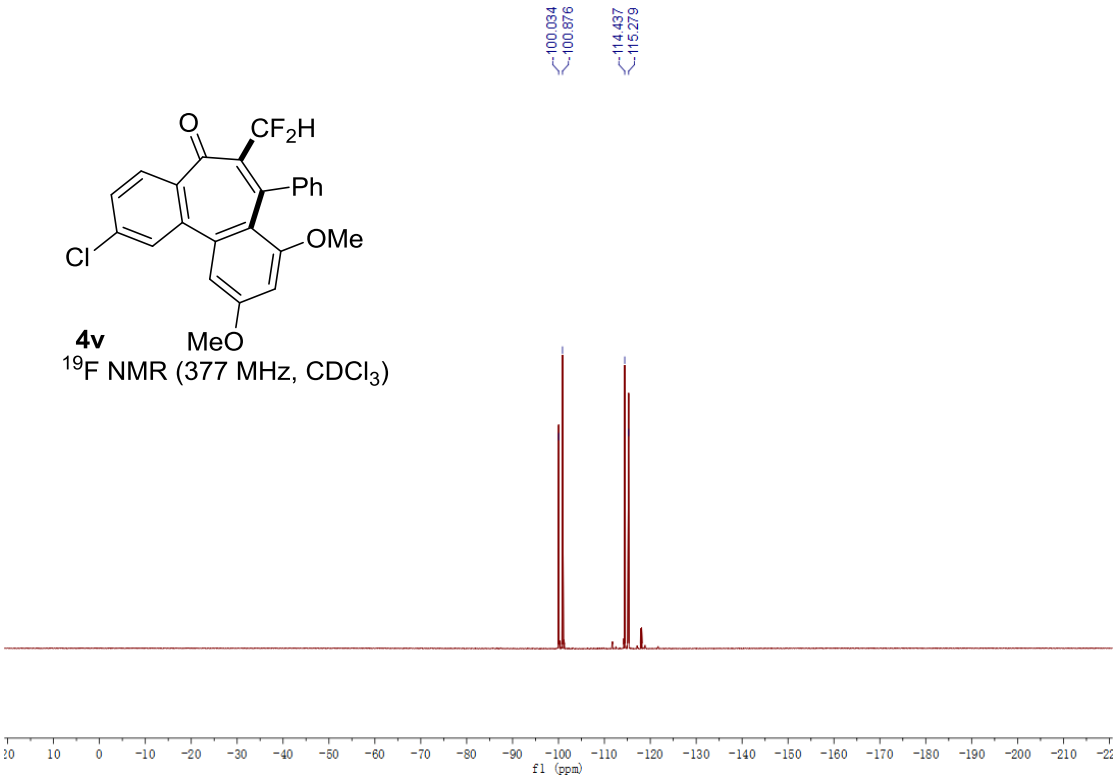


4v

^{13}C NMR (101 MHz, $CDCl_3$)

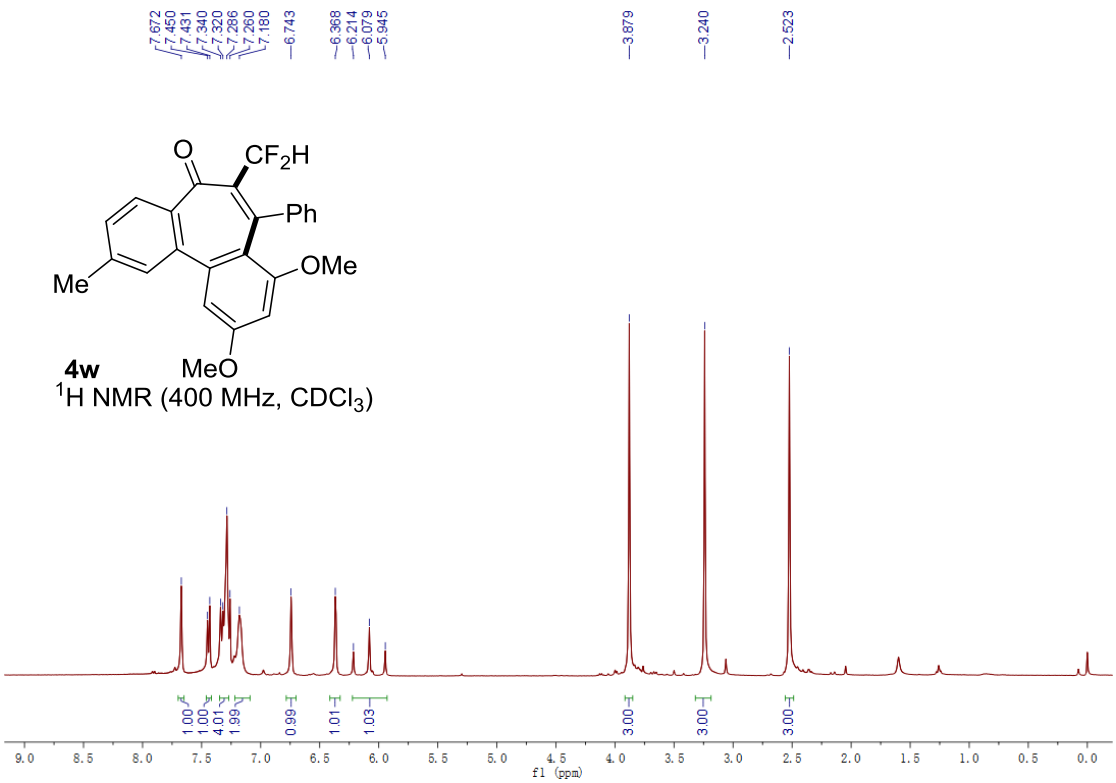
4v

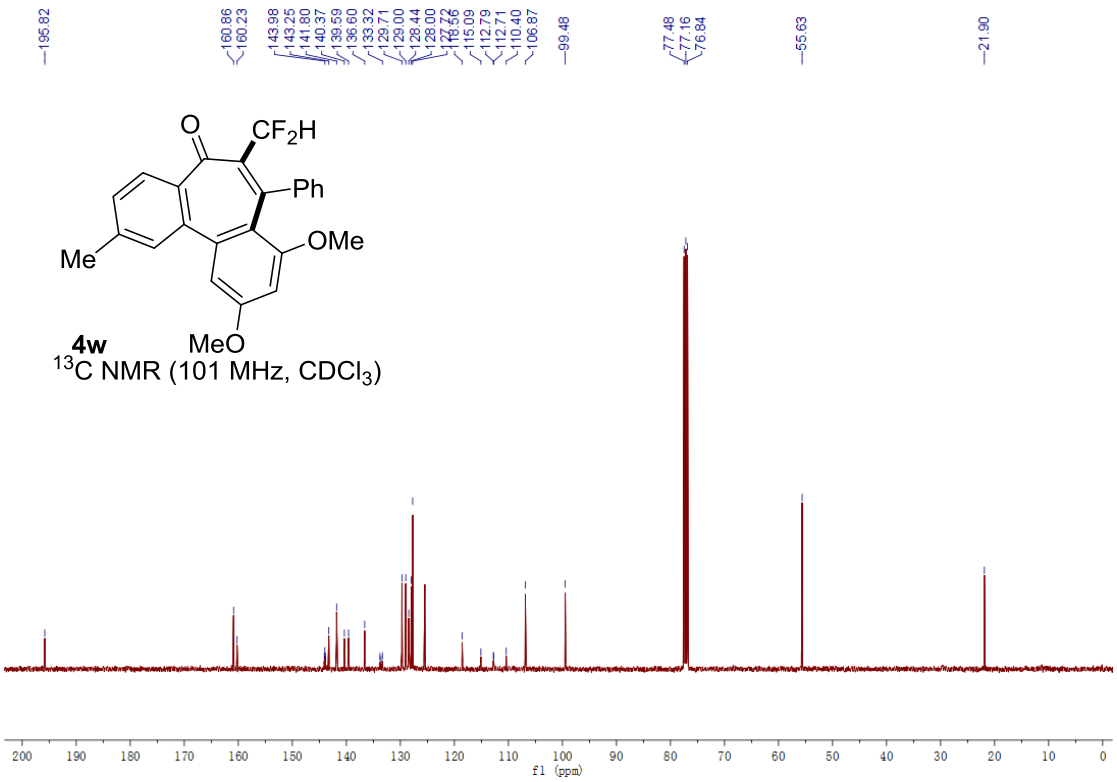
^{19}F NMR (377 MHz, $CDCl_3$)

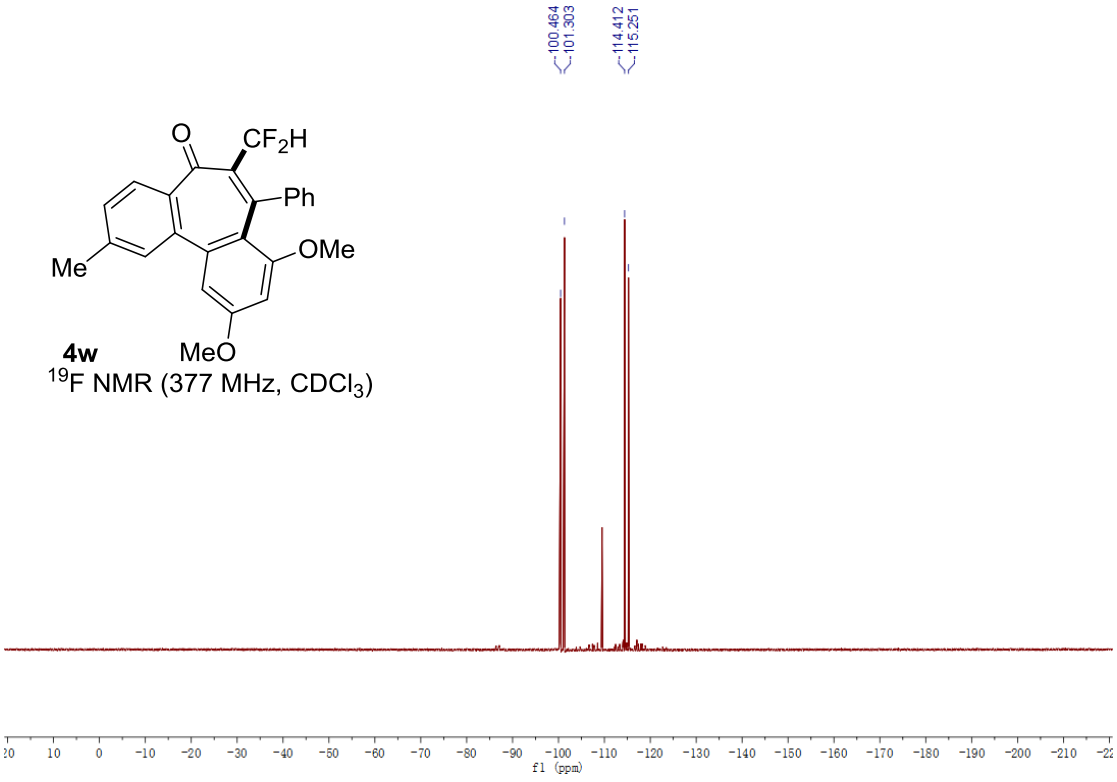


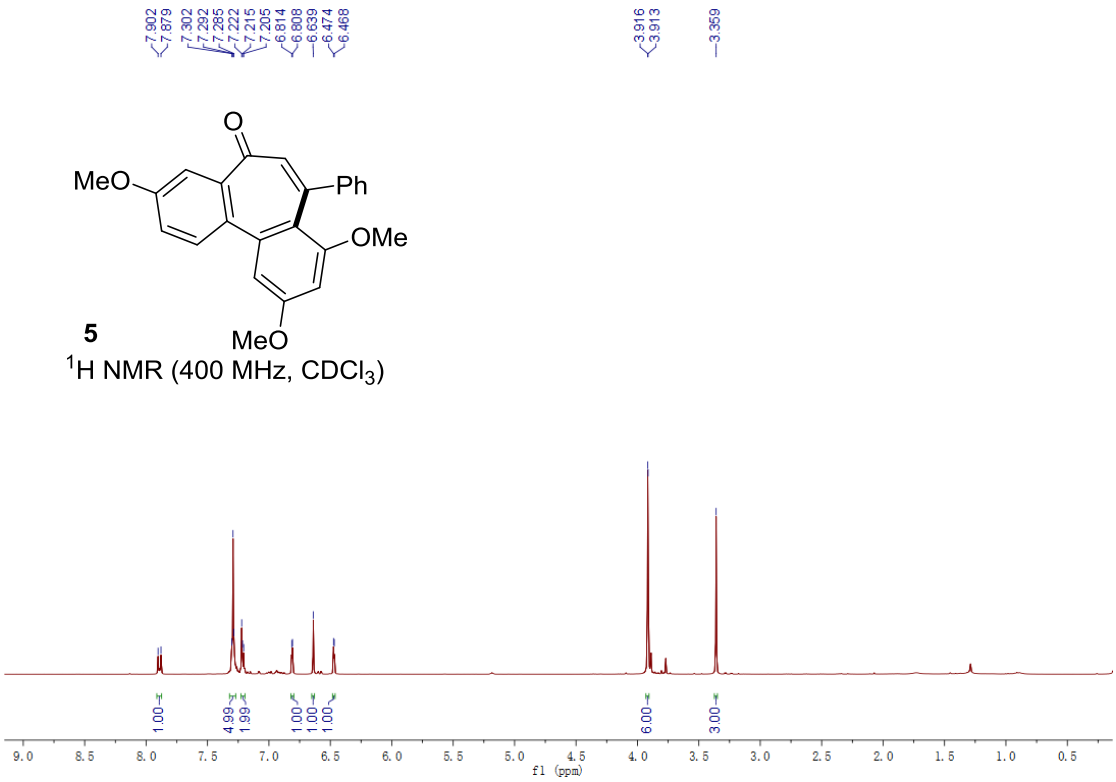
4w

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



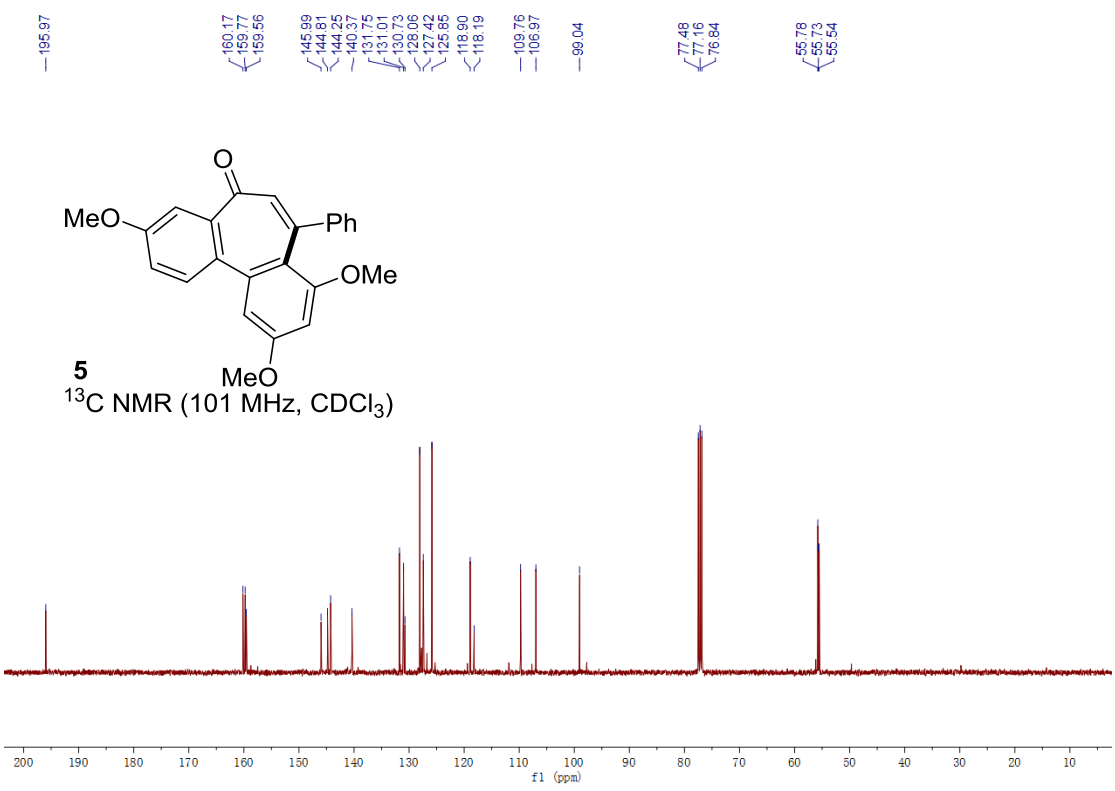

195.82
160.86
160.23
143.98
143.25
141.80
140.37
139.59
136.60
133.32
129.71
129.00
128.44
128.00
115.09
112.79
112.71
110.40
106.87
99.48
77.48
77.16
76.84
55.63
21.90
O
CF2H
Ph
OMe
Me
MeO
4w
13C NMR (101 MHz, CDCl3)
f1 (ppm)


100.464
101.303
114.412
115.251
O
CF2H
Ph
OMe
Me
MeO
4w
19F NMR (377 MHz, CDCl3)
f1 (ppm)



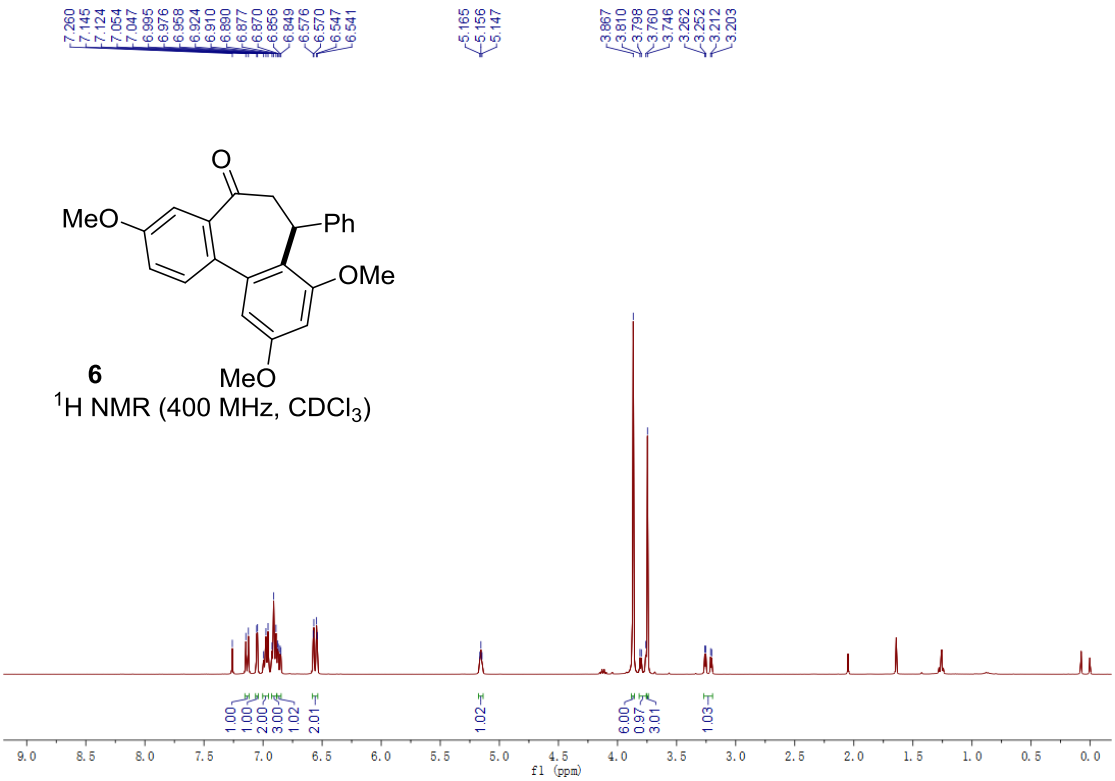
5

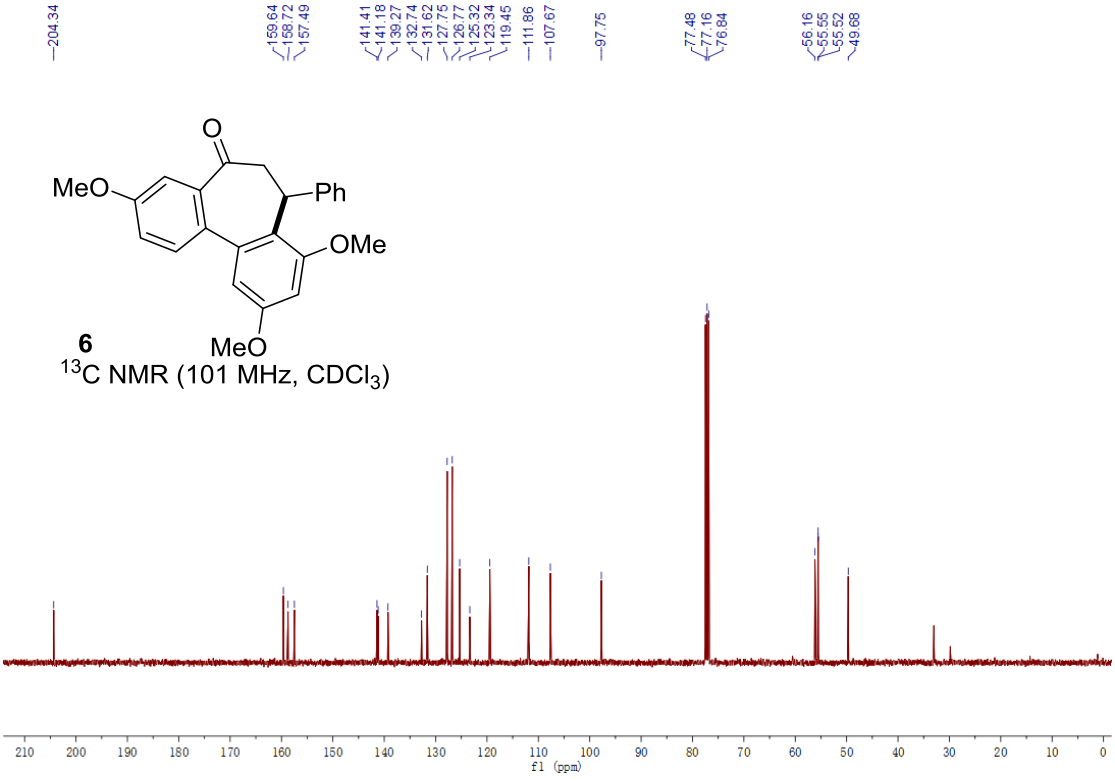
^{1}H NMR (400 MHz, $CDCl_3$)

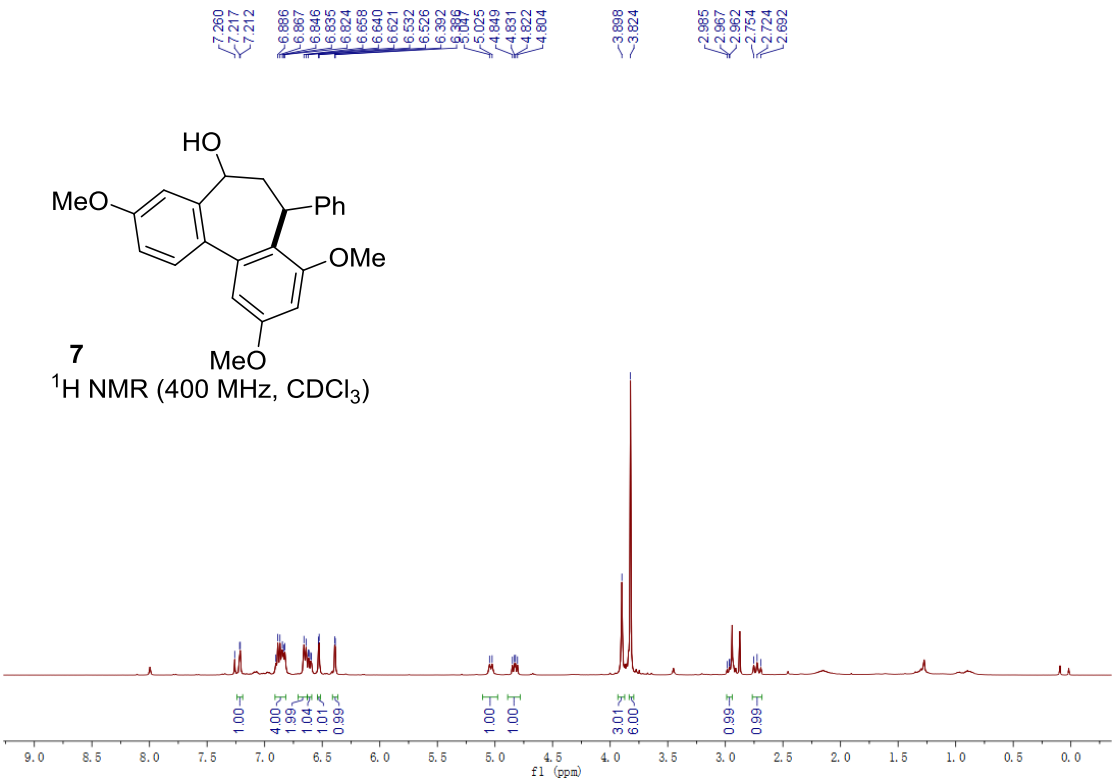


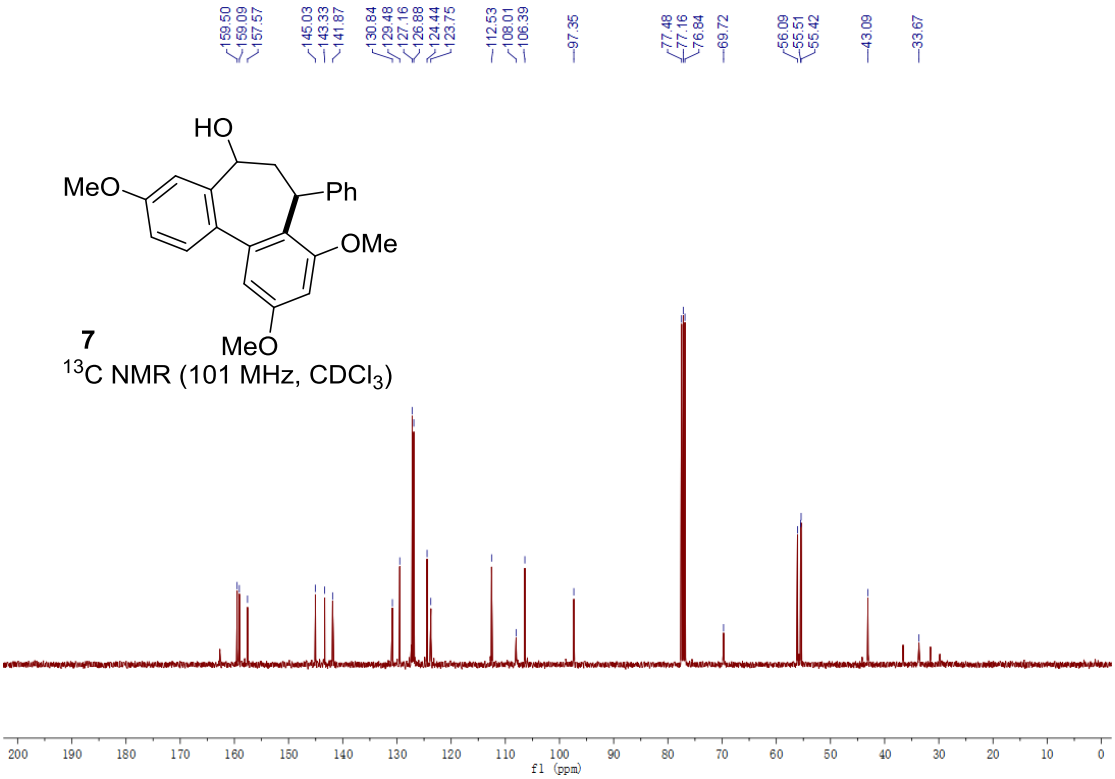
5

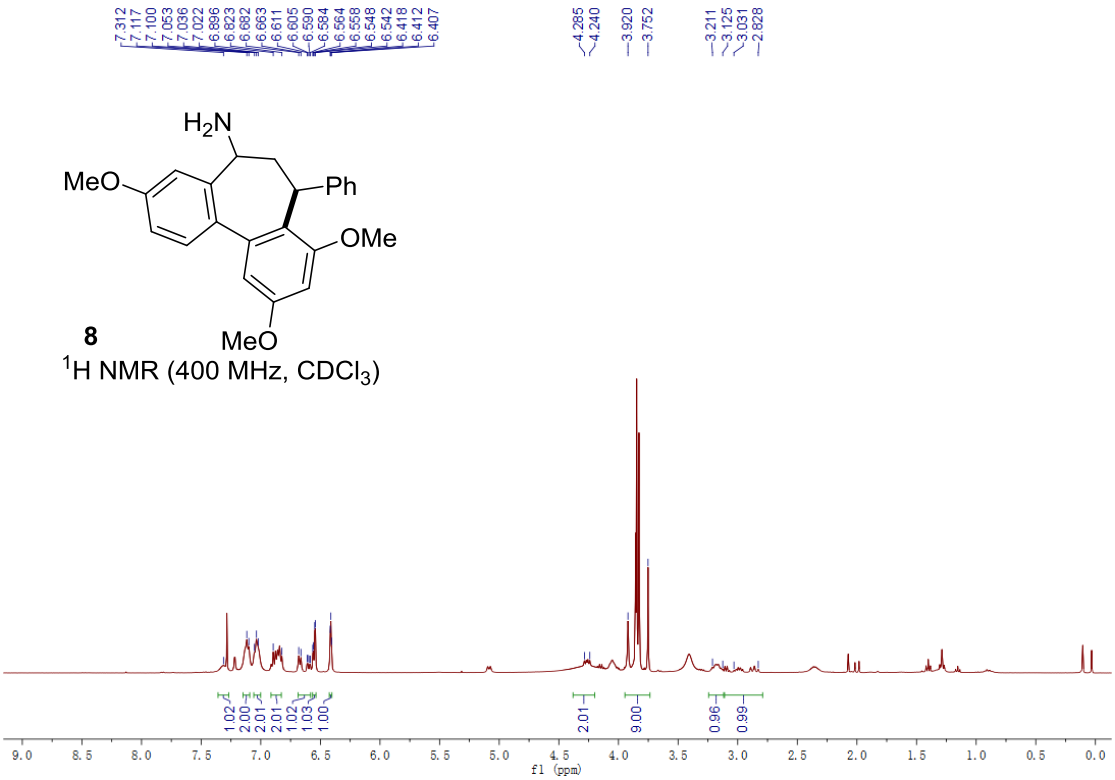
^{13}C NMR (101 MHz, $CDCl_3$)

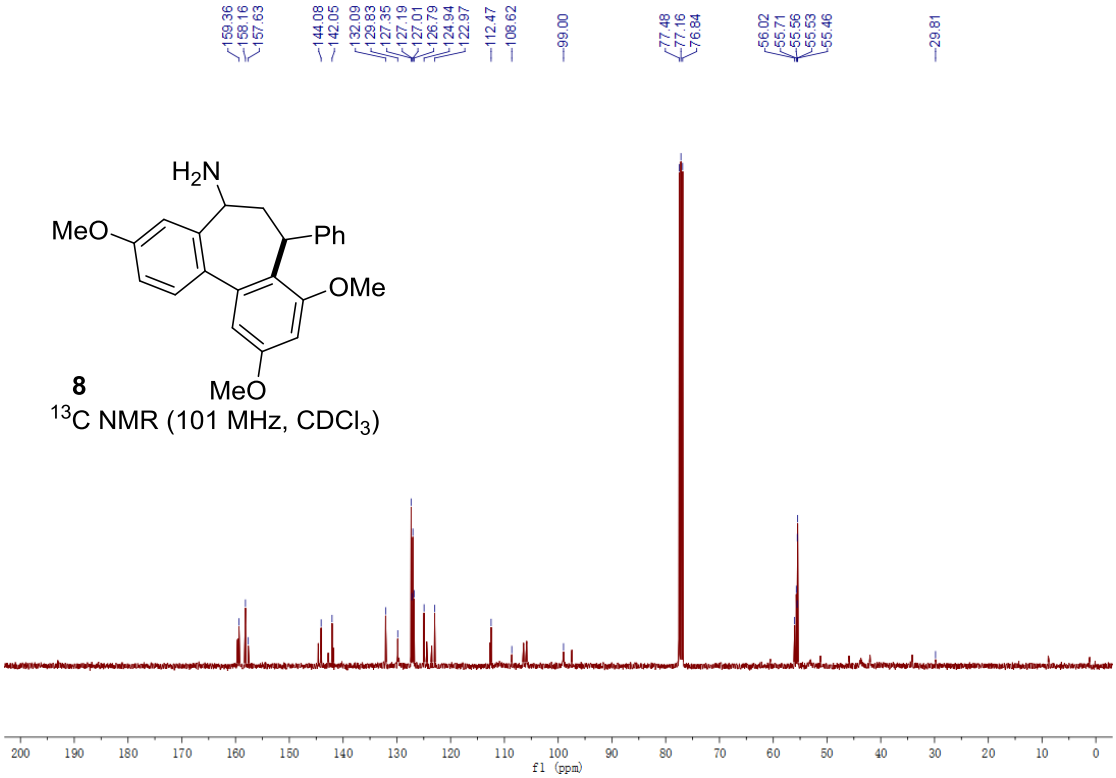

7.260
7.145
7.124
7.054
7.047
6.995
6.976
6.958
6.924
6.910
6.890
6.877
6.870
6.856
6.849
6.576
6.570
6.547
6.541
5.165
5.156
5.147
3.867
3.810
3.798
3.760
3.746
3.262
3.252
3.212
3.203
O
MeO
Ph
OMe
MeO
6
1H NMR (400 MHz, CDCl3)
1.00
1.00
2.00
3.00
1.02
2.01
1.02
6.00
0.97
3.01
1.03
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

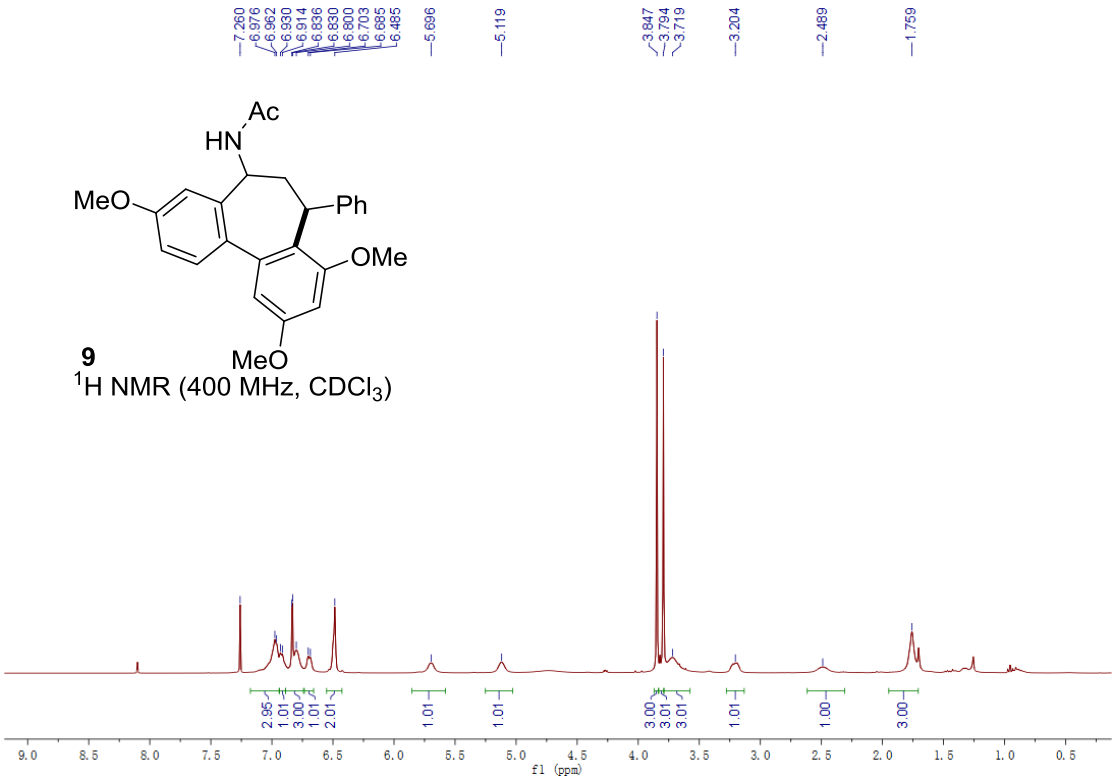

204.34
159.64
158.72
157.49
141.41
141.18
139.27
132.74
131.62
127.75
126.77
125.32
123.34
119.45
111.86
107.67
97.75
77.48
77.16
76.84
56.16
55.55
55.52
49.68
O
MeO
Ph
OMe
MeO
6
13C NMR (101 MHz, CDCl3)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

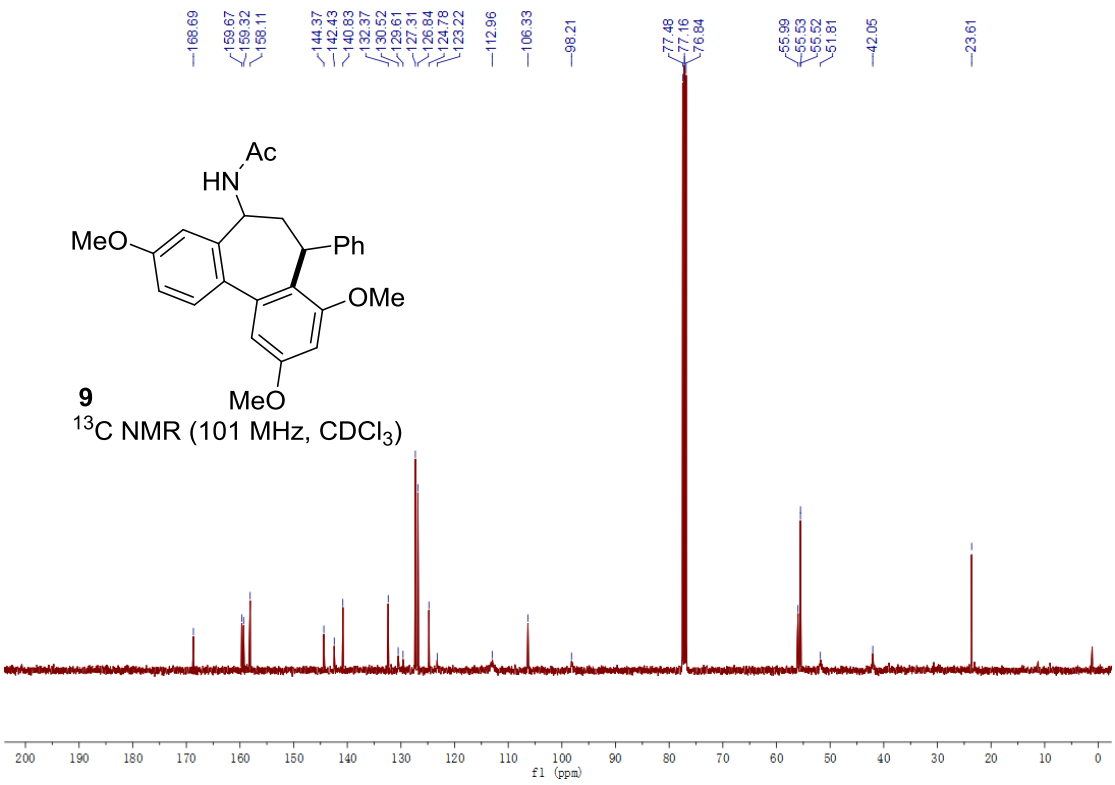

HO
MeO
Ph
OMe
MeO
7
1H NMR (400 MHz, CDCl3)
f1 (ppm)

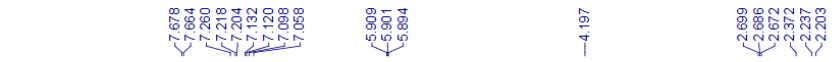

HO
MeO
Ph
OMe
MeO
7
13C NMR (101 MHz, CDCl3)
f1 (ppm)

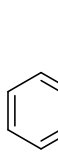

7.312
7.117
7.100
7.053
7.036
7.022
6.896
6.823
6.682
6.663
6.611
6.605
6.590
6.584
6.564
6.558
6.548
6.542
6.418
6.412
6.407
4.285
4.240
3.920
3.752
3.211
3.125
3.031
2.828
H2N
MeO
Ph
OMe
MeO
8
1H NMR (400 MHz, CDCl3)
1.02
2.00
2.01
2.01
1.02
1.03
1.00
2.01
9.00
0.96
0.99
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


159.36
158.16
157.63
144.08
142.05
132.09
129.83
127.35
127.19
127.01
126.79
124.94
122.97
112.47
108.62
99.00
77.48
77.16
76.84
56.02
55.71
55.56
55.53
55.46
29.81
H2N
MeO
Ph
OMe
MeO
8
13C NMR (101 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.260
6.976
6.962
6.930
6.914
6.836
6.830
6.800
6.703
6.685
6.485
5.696
5.119
3.847
3.794
3.719
3.204
2.489
1.759
Ac
HN
MeO
Ph
OMe
MeO
9
1H NMR (400 MHz, CDCl3)
2.95
1.01
3.00
1.01
2.01
1.01
1.01
3.00
3.01
3.01
1.01
1.00
3.00
f1 (ppm)

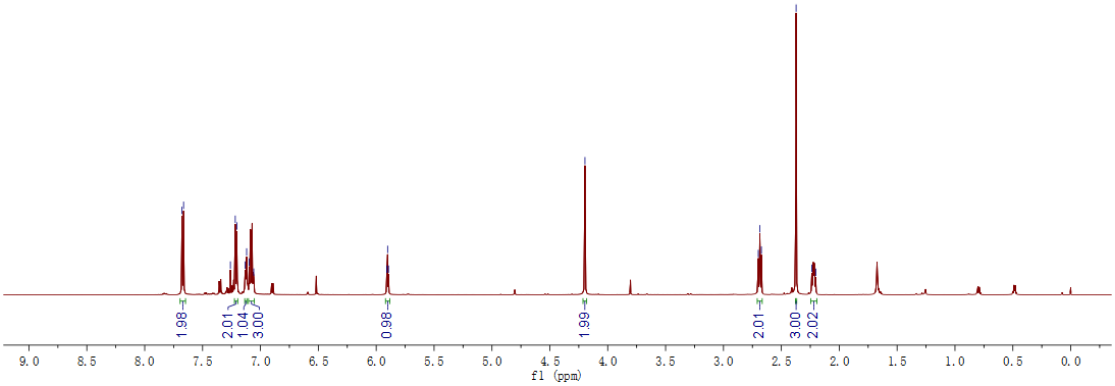

168.69
159.67
159.32
158.11
144.37
142.43
140.83
132.37
130.52
129.61
127.31
126.84
124.78
123.22
112.96
106.33
98.21
77.48
77.16
76.84
55.99
55.53
55.52
51.81
42.05
23.61
Ac
HN
MeO
Ph
OMe
MeO
9
13C NMR (101 MHz, CDCl3)
f1 (ppm)

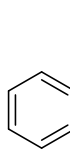




11

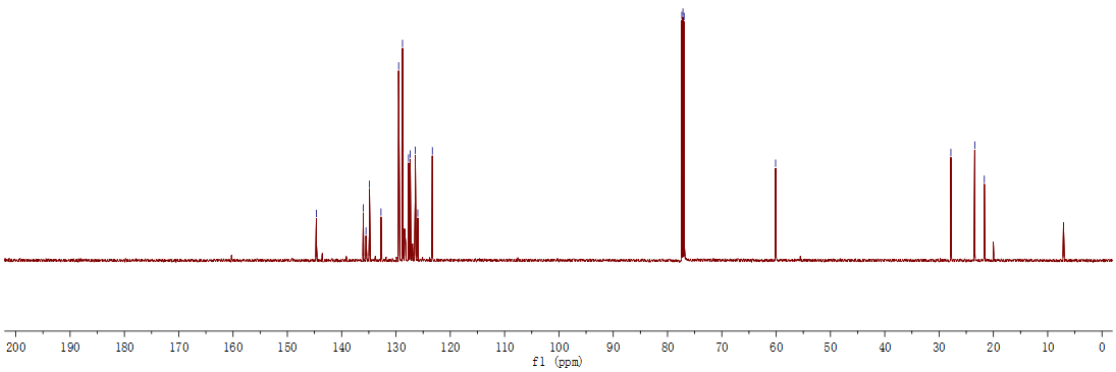
^{1}H NMR (600 MHz, $CDCl_3$)

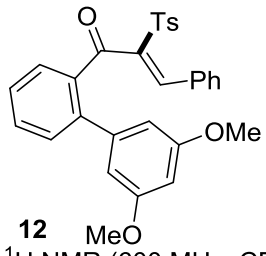




11

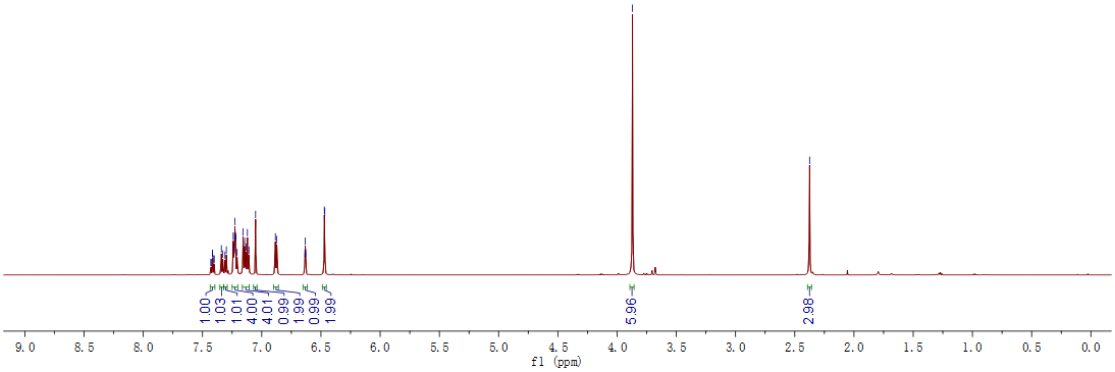
^{13}C NMR (151 MHz, $CDCl_3$)

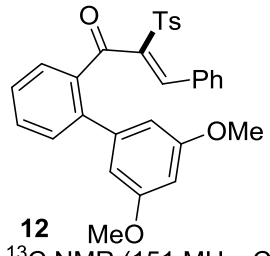




12

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





12

^{13}C NMR (151 MHz, $CDCl_3$)