

Supporting Information

Ligand-Controlled Regiodivergent π -Allyl Palladium Catalysis

Enables Switch between [3+2] and [3+3] Cycloadditions

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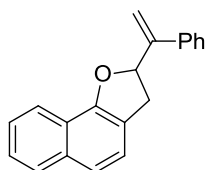
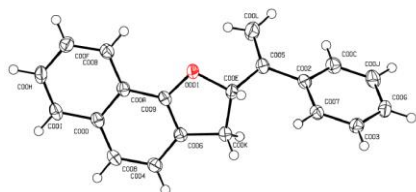
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1. General Information

Column chromatography was carried out on silica gel. ^1H NMR spectra were recorded on 400 MHz in CDCl_3 , ^{13}C NMR spectra were recorded on 100 MHz in CDCl_3 , and product **5g** ^{13}C NMR spectra used $\text{C}_3\text{D}_6\text{O}$ as solvent. Notably, some spectra worked with different nuclear magnetic resonance spectrometer. IR spectra were recorded on a FT-IR spectrometer and only major peaks are reported in cm^{-1} . All products were further characterized by high resolution mass spectra (HRMS), the HRMS was obtained on a Q-Exactive Hybrid Quadrupole-Orbitrap Mass Spectrometer. Copies of their ^1H NMR, ^{13}C NMR spectra are provided in the ESI. Unless otherwise noted, materials obtained from commercial suppliers were used without further purification.

2. X-ray Single Crystal Diffraction Data



4a

Bond precision: C-C = 0.0020 Å
 Cell: a=8.7455(6) b=9.5862(9) c=9.8123(10)
 alpha=63.15(1) beta=73.885(7) gamma=82.681(7)
 Temperature: 120 K

	Calculated	Reported
Volume	705.10(13)	705.10(12)
Space group	P -1	P -1
Hall group	-P 1	-P 1
Moiety formula	C ₂₀ H ₁₆ O	C ₂₀ H ₁₆ O
Sum formula	C ₂₀ H ₁₆ O	C ₂₀ H ₁₆ O
Mr	272.33	271.32
Dx, g cm ⁻³	1.283	1.278
Z	2	2
Mu (mm ⁻¹)	0.599	0.599
F ₀₀₀	288.0	286.0
F ₀₀₀ '	288.79	
h,k,lmax	10,11,12	10,11,12
Nref	2851	2743
Tmin,Tmax	0.750, 0.942	0.785, 1.000
Tmin'	0.658	

Correction method= # Reported T Limits: Tmin=0.785 Tmax=1.000

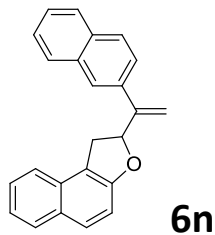
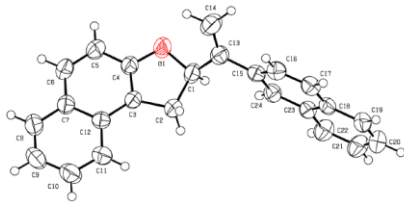
AbsCorr = MULTI-SCAN

Data completeness= 0.962 Theta(max)= 74.008

R(reflections)= 0.0515(2456) wR2(reflections)= 0.1495(2743)

S = 1.048 Npar= 195

The thermal ellipsoids are shown at 30% probability.



Bond precision: C-C = 0.0032 Å
 Cell: a=20.5655(10) b=6.0870(3) Wavelength=0.71073
 alpha=90 beta=98.487(5) c=27.2088(14)
 gamma=90

Temperature: 293 K

	Calculated	Reported
Volume	3368.8(3)	3368.7(3)
Space group	C 2/c	C 1 2/c 1
Hall group	-C 2yc	-C 2yc
Moiety formula	C ₂₄ H ₁₈ O	C ₂₄ H ₁₈ O
Sum formula	C ₂₄ H ₁₈ O	C ₂₄ H ₁₈ O
Mr	322.38	322.38
Dx, g cm ⁻³	1.271	1.271
Z	8	8
Mu (mm ⁻¹)	0.076	0.076
F ₀₀₀	1360.0	1360.0
F ₀₀₀ '	1360.55	
h,k,lmax	25,7,33	25,7,33
Nref	3326	3323
Tmin,Tmax	0.985, 0.989	0.981, 1.000
Tmin'	0.984	

Correction method= # Reported T Limits: Tmin=0.981 Tmax=1.000

AbsCorr = MULTI-SCAN

Data completeness= 0.999

Theta(max)= 26.020

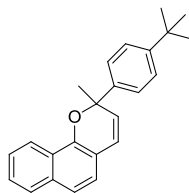
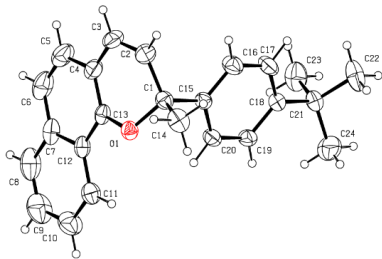
R(reflections)= 0.0549(2083)

wR2(reflections)= 0.1401(3323)

S = 1.075

Npar= 234

The thermal ellipsoids are shown at 30% probability.



5j

Bond precision: C-C = 0.0054 Å
 Cell: a=7.4217(15) b=11.0439(17) c=12.509(2)
 alpha=102.076(15) beta=98.045(16) gamma=106.355(16)

Temperature: 295 K

	Calculated	Reported
Volume	940.2(3)	940.2(3)
Space group	P -1	P -1
Hall group	:-P 1	-P 1
Moiety formula	C ₂₄ H ₂₄ O	C ₂₄ H ₂₄ O
Sum formula	C ₂₄ H ₂₄ O	C ₂₄ H ₂₄ O
Mr	328.43	328.43
Dx, g cm ⁻³	1.160	1.160
Z	2	2
Mu (mm ⁻¹)	0.069	0.069
F ₀₀₀	352.0	352.0
F ₀₀₀ '	352.14	
h,k,lmax	9,13,15	9,13,15
Nref	3706	3699
Tmin,Tmax	0.988, 0.992	0.893, 1.000
Tmin'	0.986	

Correction method= # Reported T Limits: Tmin=0.893 Tmax=1.000

AbsCorr = MULTI-SCAN

Data completeness= 0.998

Theta(max)= 26.020

R(reflections)= 0.0736(1577)

wR2(reflections)= 0.1909(3699)

S = 1.029

Npar= 230

The thermal ellipsoids are shown at 30% probability.

3. Table S1 Optimization of the [3+3] Cycloaddition Conditions

Table S1. Optimization of the [3+3] reaction conditions^{a,b}

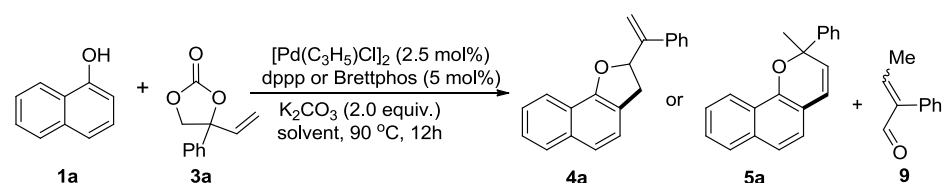
Entry	[Pd]	Ligand	Solvent	Yield (%) ^b	[4a:5a] ^c
1	[Pd(C ₃ H ₅)Cl] ₂	dppp	toluene	55	1:>20
2	[Pd(C ₃ H ₅)Cl] ₂	dppe	toluene	26	1:>20
3	[Pd(C ₃ H ₅)Cl] ₂	dppb	toluene	51	1:>20
4	[Pd(C ₃ H ₅)Cl] ₂	dppf	toluene	53	1:>20
5	[Pd(C ₃ H ₅)Cl] ₂	Cy-DPEphos	toluene	48	1:>20
6	[Pd(C ₃ H ₅)Cl] ₂	Triphos	toluene	33	1:3
7	Pd2(dba) ₃ ·CHCl ₃	dppp	toluene	47	1:>20
8	Pd(OAc) ₂	dppp	toluene	44	1:>20
9	[Pd(C ₃ H ₅)Cl] ₂	dppp	PhCF ₃	60	1:>20
10	[Pd(C ₃ H ₅)Cl] ₂	dppp	MeCN	18	1:>20
11	[Pd(C ₃ H ₅)Cl] ₂	dppp	DCE	54	1:>20
12^d	[Pd(C₃H₅)Cl]₂	dppp	PhCF₃	65	1:>20
13 ^e	[Pd(C ₃ H ₅)Cl] ₂	dppp	PhCF ₃	60	2:3

^aReactions were carried out using **1a** (0.2 mmol), **3a** (0.4 mmol), [Pd] (5.0 mol%), ligand (10.0 mol%), K₂CO₃ (2.0 equiv), solvent (2 ml), 90 °C, 12 h. ^bIsolated yields. ^cRegioselectivity determined by 1H-NMR analysis of crude reaction mixture. PhCF₃ = benzo-trifluoride. Triphos = Bis(2-diphenylphosphinoethyl)phenylphosphine. ^d[Pd] (2.5 mol%), ligand (5.0 mol%). ^e**1a** was replaced by 2-naphthol (**2a**).

As the formation of **5a** represents a new reaction, we further explored its reaction conditions (Table S1). We first investigated the effect of the bidentate ligand, yet no better results were obtained (entries 1–5). The tridentate ligand Triphos was used, but gave an unsatisfactory yield and regioselectivity (entry 6). Other palladium catalysts were tested along with dppp as ligand, but inferior performance was observed in contrast with [Pd(C₃H₅)Cl]₂ (entries 7–8). Subsequently, various solvents were explored (entries 9–11), PhCF₃ as the solvent slightly improved the yield. Notably, the adjustment of the catalyst/ligand loading ratio produced a higher yield (entry 12). Unfortunately, using 2-naphthol (**2a**) instead of 1-naphthol, showed a moderate yield but terrible regioselectivity (entry 13). The optimal conditions **B**: **1** (0.2 mmol), **3** (0.4 mmol), [Pd(C₃H₅)Cl]₂ (2.5 mol%), dppp (5.0 mol%), K₂CO₃ (2.0 equiv), PhCF₃ (2 ml), 90 °C, 12 h.

4. Table S2 Control Reactions

Control reactions for [3+2] and [3+3] cycloadditions.

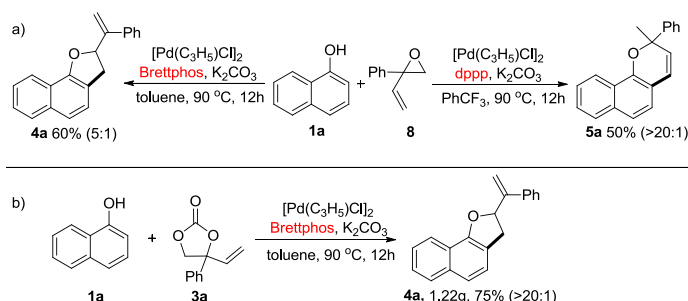


Entry	Variation from standard reaction condition	Yield[%]		
		4a	5a	9
1	without $[\text{Pd}(\text{C}_3\text{H}_5)\text{Cl}]_2$	0	0	0
2	without ligand	0	0	trace
3	without K_2CO_3	0	0	>95
4	without 1a	-	-	>95
5	1a added after 24h	0	0	>95
6	9 instead of 3a	0	0	-
7	25 °C instead of 90 °C, 24 h	trace	trace	-

The control reactions are shown in Table S2.

5. Diversification of This Protocol

Table S3. Diversification of this protocol



(Table S3, a) The reaction conditions: naphthols **1a** (0.20 mmol), 2-phenyl-2-vinyl-1,3-dioxolane **8** (0.4 mmol), $[\text{Pd}(\text{C}_3\text{H}_5)\text{Cl}]_2$ (2.5 mol%), ligand (5 mol%), K_2CO_3 (2 equiv.) and solvent (2 ml).

(Table S3, b) The scaled-up reaction conditions: 1-naphthol **1a** (6.0 mmol), VEC **3a** (12.0 mmol), $[\text{Pd}(\text{C}_3\text{H}_5)\text{Cl}]_2$ (2.5 mol%), ligand (5 mol%), K_2CO_3 (2 equiv.) and solvent (10 ml).

To demonstrate the diversity of this reaction, 2-phenyl-2-vinyl-1,3-dioxolane **8** was reacted with **1a** (Table S3, a). To our delight, the products **4a** and **5a** were carried out smoothly in acceptable yield. Another eminent advantage of this protocol is that the reaction could be scaled up to gram quantities, thus affording **4a** in a satisfied yield and high regioselectivity (Table S3, b).

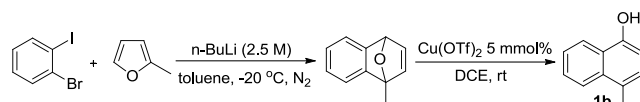
6. General Procedure

1) Synthesis of **4**, **5**, **6**

To a Schlenk tube were added naphthols **1** or **2** (0.20 mmol), VECs **3** (0.4 mmol),

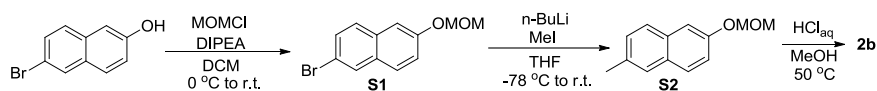
[Pd(C₃H₅)Cl]₂ (2.5 mol%), ligand (5 mol%), K₂CO₃ (2 equiv) and solvent (2 ml). Then the tube was charged by argon, and was stirred at 90 °C for 12 h. After the reaction was finished, the mixture was quenched by water and extracted with ethyl acetate twice. The combined organic phase was washed with brine and dried over Na₂SO₄. The concentrated residue was purified by column chromatography over silica gel using petroleum ether/ethyl acetate 100:1 to afford the desired products **4**, **5**, **6**. **Notably, the corresponding [3+2] and [3+3] cycloaddition products have same R_f value on the chromatography silica gel panel so the isolated **4**, **5**, **6** are mixture compounds.**

2) Synthesis of substrates **1b**, **1c-1e**, **2b**, **3**, **8**



The substrate **1b** was synthesized according to the references.¹

The substrates **1c-1e** were synthesized according to the reference.²



For the synthesis of **2b**: 6-bromo-2-naphthol (4.46 g, 20 mmol) was dissolved in CH₂Cl₂ (100 mL) and diisopropylethylamine (3.8 mL, 1.1 eq.) was added. The mixture was cooled to 0 °C and chloromethyl methyl ether (1.7 mL, 1.1 eq.) was slowly added. After stirring overnight at room temperature, the reaction was quenched by methanol. The mixture was extracted with CH₂Cl₂, washed with brine, dried over Na₂SO₄, and concentrated under reduced pressure to give a crude product, which was purified by column chromatography (*n*-hexane/EtOAc = 40/1) to afford **S1** as colorless oil (5.25 g, 98%).

A solution of **S1** (4.01 g, 15.0 mmol) in THF (100 mL) was cooled to -78 °C and *n*-BuLi (10.3 mL, 1.1 eq., 1.6 M in *n*-hexane) was slowly added. After stirring for 1 h at -78 °C, iodomethane (2.3 mL, 2.5 eq.) was slowly added and warmed to room temperature. After stirring for 1 h, the mixture was quenched by sat. NH₄Cl aq. The aqueous layer was extracted with EtOAc and the combined organic layers were washed with brine, dried over Na₂SO₄ and concentrated under reduced pressure to give a crude product, which was used without further purification. **S2** was dissolved in MeOH (50 mL), warmed to 50 °C and conc. HCl aq. (35%, 15 drops) was added. After stirring for 2 h, 50 mL of water was added and the aqueous layer was extracted with EtOAc. The combined organic layers were washed with brine, dried over Na₂SO₄, and concentrated under reduced pressure to give a crude product of **2b**, which was purified by column chromatography (*n*-hexane/EtOAc = 20/1) to afford **2b**.

The substrates **3** were synthesized according to the references.³

The substrate **8** was synthesized according to the reference.⁴

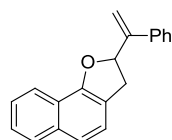
3) References for substrates synthesis

- (a) F. Peng, B. Fan, Z. Shao, X. Pu, P. Li, H. Zhang, *Synthesis*, 2008, **2008**, 3043; (b) H. Zhou, J. Li, H. Yang, C. Xia, G. Jiang, *Org. Lett.*, 2015, **17**, 4628.
- (a) W.-G. Lee, K. M. Frey, R. Gallardo-Macias, K. A. Spasov, M. Bollini, K. S. Anderson, W. L. Jorgensen, *ACS Med.Chem. Lett.*, 2014, **5**, 1259.

- 3 (a) W. Guo, L. Martínez-Rodríguez, R. Kuniyil, E. Martin, E. C. Escudero-Adán, F. Maseras, A. W. Kleij, *J. Am. Chem. Soc.*, 2016, **138**, 11970; (b) J. Yu, D. Wang, Y. Xu, Z. Wu, C. Zhu, *Adv. Synth. Catal.*, 2018, **360**, 744.
- 4 (a) B. M. Trost, B. S. Brown, E. J. McEachern, O. Kuhn, *Chem. Eur. J.*, 2003, **9**, 4442.

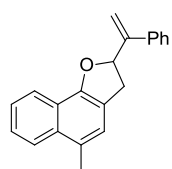
7. Spectral Data of Products

2-(1-phenylvinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4a**



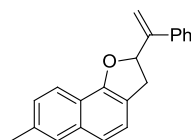
39.7mg, white solid, yield 73%, mp: 76-78 °C. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 8.06 (d, *J* = 8.8 Hz, 1H), 7.81 (d, *J* = 8.8 Hz, 1H), 7.48-7.42 (m, 4H), 7.41-7.29 (m, 4H), 7.24 (d, *J* = 9.2Hz, 1H), 5.91 (t, *J* = 9.2Hz, 1H), 5.55 (s, 1H), 5.46 (s, 1H), 3.58 (dd, *J* = 15.2 Hz, *J* = 10.0 Hz, 1H), 3.16 (dd, *J* = 15.2Hz, *J* = 10.0Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 154.8, 147.7, 138.6, 134.0, 128.5, 127.9, 126.8, 125.6, 125.4, 122.9, 121.5, 120.5, 120.3, 119.2, 113.1, 84.1, 36.9. IR (neat, cm⁻¹): 2922.6, 1630.8, 1597.3, 1518.3, 1276.2. HRMS (ESI): *m/z* calcd for C₂₀H₁₆O [M+H]⁺ 273.1274, found 273.1280.

5-methyl-2-(1-phenylvinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4b**



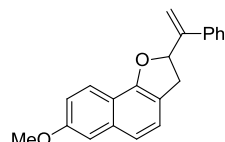
38.9mg, yellow oil, yield 68%. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 8.08 (dd, *J* = 9.6Hz, *J* = 6Hz, 1H), 7.93-7.91 (m, 1H), 7.49-7.42 (m, 4H), 7.35-7.28 (m, 3H), 7.09 (s, 1H), 5.87 (t, *J* = 7.6Hz, 1H), 5.54 (s, 1H), 5.44 (s, 1H), 3.53 (dd, *J* = 15.6Hz, *J* = 10.0Hz, 1H), 3.11 (dd, *J* = 15.6Hz, *J* = 10.0Hz, 1H), 2.59 (s, 3H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 153.4, 147.8, 138.7, 132.5, 128.5, 127.8, 126.8, 126.4, 125.5, 125.1, 124.5, 123.4, 121.9, 120.6, 118.5, 113.0, 83.7, 37.1, 19.1. IR (neat, cm⁻¹): 2928.7, 1631.1, 1597.4, 1494.9, 1443.8, 1365.7, 1261.2. HRMS (ESI): *m/z* calcd for C₂₁H₁₈O [M+H]⁺ 287.1430, found 287.1438.

7-methyl-2-(1-phenylvinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4c**



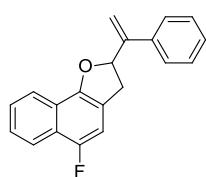
39.5mg, colorless oil, yield 69%. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 7.95 (d, *J* = 8.4Hz, 1H), 7.57 (s, 1H), 7.44-7.41 (m, 2H), 7.32-7.25 (m, 5H), 7.18 (d, *J* = 8.0Hz, 1H), 5.87 (t, *J* = 8.8Hz, 1H), 5.53 (s, 1H), 5.44 (s, 1H), 3.53 (dd, *J* = 15.2Hz, *J* = 9.6Hz, 1H), 3.11 (dd, *J* = 15.2Hz, *J* = 9.6Hz, 1H), 2.48 (s, 3H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 154.8, 147.7, 138.6, 135.2, 134.3, 128.5, 127.8, 127.6, 126.8, 125.3, 122.9, 121.3, 119.7, 118.7, 118.3, 113.0, 84.0, 36.9, 21.8. IR (neat, cm⁻¹): 2929.0, 1620.1, 1587.4, 1494.9, 1443.8, 1365.7, 1265.2. HRMS (ESI): *m/z* calcd for C₂₁H₁₈O [M+H]⁺ 287.1430, found 287.1439.

7-methoxy-2-(1-phenylvinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4d**



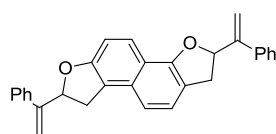
39.8mg, yellow oil, yield 69%. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 7.96 (d, *J* = 10.4Hz, 1H), 7.45-7.42 (m, 2H), 7.35-7.29 (m, 3H), 7.26-7.19 (m, 2H), 7.14-7.11 (m, 2H), 5.88 (t, *J* = 8.8Hz, 1H), 5.53 (s, 1H), 5.45 (s, 1H), 3.9 (s, 3H), 3.54 (dd, *J* = 15.2Hz, *J* = 10.0Hz, 1H), 3.12 (dd, *J* = 15.2Hz, *J* = 10.0Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 157.6, 115.0, 147.7, 138.6, 135.3, 128.5, 127.9, 126.8, 123.5, 123.1, 119.1, 118.1, 117.2, 115.9, 113.1, 106.0, 84.1, 55.2, 36.8. IR (neat, cm⁻¹): 2931.8, 1639.0, 1604.1, 1482.3, 1427.9, 1361.7, 1241.2. HRMS (ESI): *m/z* calcd for C₂₁H₁₈O₂ [M+H]⁺ 303.1380, found 303.1386.

5-fluoro-2-(1-phenylvinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4f**



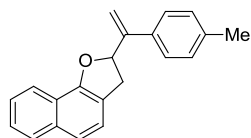
Regioselectivity 2:1, 38.1mg, colorless oil, yield 66%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.02 (d, $J = 7.6\text{Hz}$, 2H), 7.53-7.49 (m, 4H), 7.33-7.28 (m, 4H), 5.89 (t, $J = 8.8\text{Hz}$, 1H), 5.53 (s, 1H), 5.45 (s, 1H), 3.54 (dd, $J = 15.2\text{Hz}$, $J = 9.6\text{Hz}$, 1H), 3.12 (dd, $J = 15.2\text{Hz}$, $J = 9.6\text{Hz}$, 1H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 153.3 ($J = 243\text{Hz}$), 147.4, 145.7, 138.4, 128.5, 128.2, 128.0, 126.8, 126.4 ($J = 12\text{Hz}$), 126.8, 121.4 ($J = 1\text{Hz}$), 121.0 ($J = 4\text{Hz}$), 120.5, 113.4, 106.7 ($J = 23\text{Hz}$), 84.1, 37.1. IR (neat, cm^{-1}): 3061.5, 2927.6, 1630.1, 1599.8, 1404.7, 1261.7, 1061.8. HRMS (ESI): m/z calcd for $\text{C}_{20}\text{H}_{15}\text{FO}$ $[\text{M}+\text{H}]^+$ 291.1180, found 291.1184.

2,7-bis(1-phenylvinyl)-2,3,6,7-tetrahydronaphtho[1,2-*b*:6,5-*b'*]difuran **4g**



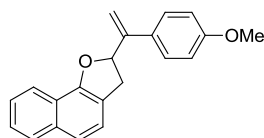
43.3mg, yellow oil, yield 52%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.96 (d, $J = 8.8\text{Hz}$, 1H), 7.46-7.42 (m, 4H), 7.35-7.30 (m, 6H), 7.20-7.17 (m, 2H), 6.97 (d, $J = 8\text{Hz}$, 1H), 5.87 (t, $J = 8.8\text{Hz}$, 2H), 5.53 (s, 1H), 5.52 (s, 1H), 5.46 (s, 1H), 5.45 (s, 1H), 3.64 (dd, $J = 15.2\text{Hz}$, $J = 10.0\text{Hz}$, 1H), 3.52 (dd, $J = 15.2\text{Hz}$, $J = 10.0\text{Hz}$, 1H), 3.25-3.18 (m, 1H), 3.12-3.06 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 157.0, 155.6, 147.6, 138.5, 131.5, 128.5, 128.4, 127.9, 127.8, 126.8, 123.9, 122.7, 118.2, 116.4, 116.3, 115.1, 113.1, 113.0, 11.4, 84.0, 83.9, 83.8, 83.7, 36.7, 35.4. IR (neat, cm^{-1}): 2925.4, 1640.0, 1599.4, 1494.9, 1444.9, 1244.7. HRMS (ESI): m/z calcd for $\text{C}_{30}\text{H}_{24}\text{O}_2$ $[\text{M}+\text{H}]^+$ 417.1849, found 417.1861.

2-(1-(*p*-tolyl)vinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4h**



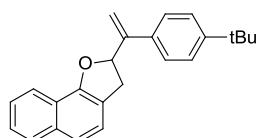
40.0mg, yellow solid, yield 70%, mp: 110-112°C. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.06 (d, $J = 7.6\text{Hz}$, 1H), 7.80 (d, $J = 8.8\text{Hz}$, 1H), 7.46-7.42 (m, 2H), 7.37-7.32 (m, 3H), 7.25-7.21 (m, 1H), 7.14 (d, $J = 8\text{Hz}$, 2H), 5.89 (t, $J = 8.8\text{Hz}$, 1H), 5.50 (m, 1H), 5.43 (s, 1H), 3.57 (dd, $J = 15.6\text{Hz}$, $J = 10.0\text{Hz}$, 1H), 3.14 (dd, $J = 15.6\text{Hz}$, $J = 10.0\text{Hz}$, 1H), 2.34 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 154.8, 147.4, 137.7, 135.6, 134.0, 129.2, 127.9, 126.6, 125.6, 125.3, 122.9, 121.4, 120.5, 120.3, 119.3, 112.3, 84.0, 37.0, 21.1. IR (neat, cm^{-1}): 2920.2, 1629.7, 1595.6, 1513.6, 1440.9, 1376.6, 1279.6. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{18}\text{O}$ $[\text{M}+\text{H}]^+$ 287.1430, found 287.1442.

2-(1-(4-methoxyphenyl)vinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4i**



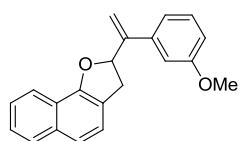
42.9mg, yellow solid, yield 71%, mp: 118-120 °C. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.05 (d, $J = 7.6\text{Hz}$, 1H), 7.80 (d, $J = 8.8\text{Hz}$, 1H), 7.45-7.41 (m, 2H), 7.38-7.35 (m, 3H), 7.24-7.21 (m, 1H), 6.85 (d, $J = 8.8\text{Hz}$, 1H), 5.86 (t, $J = 8.8\text{Hz}$, 1H), 5.46 (s, 1H), 5.38 (s, 1H), 3.78 (s, 3H), 3.56 (dd, $J = 15.6\text{Hz}$, $J = 10.0\text{Hz}$, 1H), 3.15 (dd, $J = 15.6\text{Hz}$, $J = 10.0\text{Hz}$, 1H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 159.4, 154.8, 146.9, 134.0, 130.9, 127.9, 127.8, 125.6, 125.3, 122.8, 121.4, 120.5, 120.3, 119.3, 113.9, 111.7, 84.2, 55.2, 36.9. IR (neat, cm^{-1}): 2922.5, 1606.5, 1512.7, 1440.6, 1377.3, 1283.5, 1249.2. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{18}\text{O}_2$ $[\text{M}+\text{H}]^+$ 303.1380, found 303.1388.

2-(1-(4-(*tert*-butyl)phenyl)vinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4j**



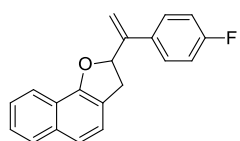
47.9mg, yellow solid, yield 73%, mp: 139-141 °C. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 8.06 (d, *J* = 7.6Hz, 1H), 7.79 (d, *J* = 8.8Hz, 1H), 7.45-7.40 (m, 2H), 7.39-7.33 (m, 5H), 7.23 (d, *J* = 8.0Hz, 1H), 5.89 (t, *J* = 8.8Hz, 1H), 5.50 (s, 1H), 5.45 (s, 1H), 3.57 (dd, *J* = 15.2Hz, 10.0Hz, 1H), 3.15 (dd, *J* = 15.2Hz, 10.0Hz, 1H), 1.31 (s, 9H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 154.8, 150.9, 147.3, 135.4, 134.0, 127.9, 126.3, 125.6, 125.4, 125.3, 122.9, 121.5, 120.5, 120.3, 119.3, 112.2, 84.0, 37.1, 34.5, 31.3. IR (neat, cm⁻¹): 2961.7, 1629.4, 1596.2, 1513.8, 1441.1, 1376.4, 1270.5, 1075.4. HRMS (ESI): *m/z* calcd for C₂₄H₁₄O [M+H]⁺ 329.1900, found 329.1910.

2-(1-(3-methoxyphenyl)vinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4k**



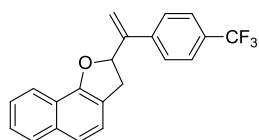
41.7mg, yellow oil, yield 63%. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 8.06 (d, *J* = 8.4Hz, 1H), 7.80 (d, *J* = 7.6Hz, 1H), 7.47-7.40 (m, 2H), 7.36 (d, *J* = 8.4Hz, 1H), 7.26-7.21 (m, 2H), 7.02 (d, *J* = 7.6Hz, 1H), 6.99 (d, *J* = 2.4Hz, 1H), 6.85-6.82 (m, 1H), 5.90-5.86 (m, 1H), 5.54 (d, *J* = 1.2Hz, 1H), 5.46 (s, 1H), 3.71 (s, 3H), 3.57 (dd, *J* = 15.2Hz, *J* = 10.0Hz, 1H), 3.14 (dd, *J* = 15.2Hz, *J* = 10.0Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 159.6, 154.7, 147.5, 140.0, 133.9, 129.5, 127.9, 125.6, 125.3, 122.8, 121.4, 120.4, 120.3, 119.3, 119.2, 113.3, 113.2, 112.6, 84.0, 55.1, 36.9. IR (neat, cm⁻¹): 3055.9, 2935.1, 1596.6, 1488.3, 1440.9, 1377.4, 1282.9, 1225.6. HRMS (ESI): *m/z* calcd for C₂₁H₁₈O₂ [M+H]⁺ 303.1380, found 303.1389.

2-(1-(4-fluorophenyl)vinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4m**



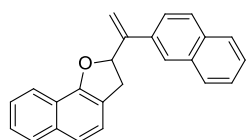
Regioselectivity 14:1, 41.2mg, yellow solid, yield 71%, mp: 108-110 °C. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 8.04 (d, *J* = 7.6Hz, 1H), 7.80 (d, *J* = 9.2Hz, 1H), 7.46-7.42 (m, 2H), 7.42-7.35 (m, 3H), 7.23 (d, *J* = 8Hz, 1H), 7.02-6.98 (m, 2H), 5.83 (t, *J* = 9.2Hz, 1H), 5.52 (s, 1H), 5.40 (s, 1H), 3.54 (dd, *J* = 15.6Hz, *J* = 10.0Hz, 1H), 3.12 (dd, *J* = 15.6Hz, *J* = 10.0Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 162.5(d, *J* = 242.6Hz,) 161.3, 154.6, 146.6, 134.5 (d, *J* = 3.3Hz), 134.0, 128.5 (d, *J* = 8.0Hz), 127.9, 125.7, 125.4, 122.8, 121.4, 120.5, 120.4, 119.2, 115.4 (d, *J* = 21.3Hz), 113.6, 84.2, 36.7. IR (neat, cm⁻¹): 2921.5, 1631.6, 1509.3, 1441.0, 1235.5, 1075.2. HRMS (ESI): *m/z* calcd for C₂₀H₁₅FO [M+H]⁺ 291.1180, found 291.1190.

2-(1-(4-(trifluoromethyl)phenyl)vinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4n**



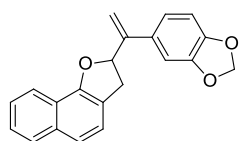
42.8mg, yellow solid, yield 63%, mp: 138-140 °C. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 8.04 (d, *J* = 7.6Hz, 1H), 7.81 (d, *J* = 8.8Hz, 1H), 7.58-7.51 (m, 4H), 7.46-7.44 (m, 2H), 7.43-7.37 (m, 1H), 7.24 (d, *J* = 8.4Hz, 1H), 5.86 (t, *J* = 9.2Hz, 1H), 5.63 (s, 1H), 5.51 (s, 1H), 3.56 (dd, *J* = 15.2Hz, 10.0Hz, 1H), 3.12 (dd, *J* = 15.2Hz, 10.0Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 154.5, 146.6, 142.1, 134.0, 129.9 (*J* = 33Hz), 127.9, 127.2, 126.7 (*J* = 292Hz), 125.8, 125.5, 125.4 (*J* = 4Hz), 122.8, 121.3, 120.6, 120.4, 119.0, 115.5, 83.8, 36.7. IR (neat, cm⁻¹): 2928.7, 1615.6, 1596.4, 1517.9, 1440.6, 1282.5, 1066.8. HRMS (ESI): *m/z* calcd for C₂₁H₁₅F₃O [M+H]⁺ 341.1148, found 341.1161.

2-(1-(naphthalen-2-yl)vinyl)-2,3-dihydronaphtho[1,2-*b*]furan **4o**



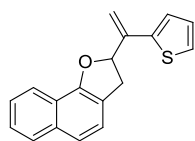
45.1mg, yellow solid, yield 70%, mp: 104-106 °C. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.10 (d, $J = 8\text{Hz}$, 1H), 7.85-7.78 (m, 5H), 7.61-7.58 (m, 1H), 7.47-7.45 (m, 4H), 7.38 (d, $J = 8\text{Hz}$, 1H), 7.25-7.21 (m, 1H), 6.04 (t, $J = 8.4\text{Hz}$, 1H), 5.65 (s, 1H), 5.60 (s, 1H), 3.63 (dd, $J = 15.6\text{Hz}$, $J = 10.0\text{Hz}$, 1H), 3.19 (dd, $J = 15.6\text{Hz}$, $J = 10.0\text{Hz}$, 1H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 154.7, 147.5, 135.9, 134.0, 133.3, 132.9, 128.2, 128.1, 127.9, 127.6, 126.3, 126.1, 125.7, 125.5, 125.4, 125.0, 122.9, 121.4, 120.5, 120.4, 119.2, 113.4, 83.8, 37.1. IR (neat, cm^{-1}): 2925.6, 1626.9, 1595.9, 1517.6, 1440.6, 1279.4. HRMS (ESI): m/z calcd for $\text{C}_{24}\text{H}_{18}\text{O}$ $[\text{M}+\text{H}]^+$ 323.1430, found 323.1440.

2-(1-(benzo[d][1,3]dioxol-5-yl)vinyl)-2,3-dihydronaphtho[1,2-b]furan 4p



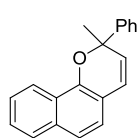
39.2mg, yellow solid, yield 62%, mp: 138-140 °C. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.06-8.04 (m, 1H), 7.81-7.79 (m, 1H), 7.47-7.42 (m, 2H), 7.37 (d, $J = 8\text{Hz}$, 1H), 7.26-7.22 (m, 1H), 6.95 (d, $J = 1.6\text{Hz}$, 1H), 6.92-6.89 (m, 1H), 6.77 (d, $J = 8\text{Hz}$, 1H), 5.94 (s, 2H), 5.82 (t, $J = 9.2\text{Hz}$, 1H), 5.47 (s, 1H), 5.36 (s, 1H), 3.56 (dd, $J = 15.2\text{Hz}$, $J = 10.0\text{Hz}$, 1H), 3.15 (dd, $J = 15.2\text{Hz}$, $J = 10.0\text{Hz}$, 1H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 154.7, 147.8, 147.3, 147.1, 133.9, 132.7, 127.9, 125.6, 125.3, 122.8, 121.4, 120.5, 120.3, 119.2, 108.2, 107.4, 101.1, 84.1, 36.9. IR (neat, cm^{-1}): 3056.7, 2917.4, 1596.2, 1503.3, 1442.2, 1278.6, 1039.2. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{16}\text{O}_3$ $[\text{M}+\text{H}]^+$ 317.1172, found 317.1184.

2-(1-(thiophen-2-yl)vinyl)-2,3-dihydronaphtho[1,2-b]furan 4q



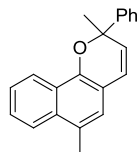
32.2mg, yellow oil, yield 58%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.06-8.03 (m, 1H), 7.82-7.80 (m, 1H), 7.47-7.42 (m, 2H), 7.41-7.38 (m, 1H), 7.27 (d, $J = 8\text{Hz}$, 1H), 7.22-7.19 (m, 1H), 7.06 (d, $J = 1.2\text{Hz}$, 1H), 7.05 (d, $J = 1.2\text{Hz}$, 1H), 6.97 (d, $J = 3.6\text{Hz}$, 1H), 6.95 (d, $J = 1.2\text{Hz}$, 1H), 5.81 (t, $J = 8.8\text{Hz}$, 1H), 5.55 (s, 1H), 5.42 (s, 1H), 3.68 (dd, $J = 15.2\text{Hz}$, $J = 10.0\text{Hz}$, 1H), 3.30 (dd, $J = 15.2\text{Hz}$, $J = 10.0\text{Hz}$, 1H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 154.7, 141.3, 141.1, 134.0, 127.9, 127.4, 125.7, 125.4, 124.9, 124.2, 122.8, 121.4, 120.5, 120.4, 119.3, 111.8, 84.0, 37.2. IR (neat, cm^{-1}): 3054.1, 2924.4, 1596.6, 1517.7, 1440.3, 1280.1. HRMS (ESI): m/z calcd for $\text{C}_{18}\text{H}_{14}\text{OS}$ $[\text{M}+\text{H}]^+$ 279.0838, found 279.0847.

2-methyl-2-phenyl-2H-benzo[h]chromene 5a



35.4mg, yellow oil, yield 65%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.25-8.22 (m, 1H), 7.71-7.69 (m, 1H), 7.45-7.38 (m, 2H), 7.33 (d, $J = 8.4\text{Hz}$, 1H), 7.17 (d, $J = 1.2\text{Hz}$, 1H), 7.14 (d, $J = 8.4\text{Hz}$, 1H), 7.06-7.05 (m, 1H), 6.89-6.86 (m, 1H), 6.61 (d, $J = 9.6\text{Hz}$, 1H), 5.92 (d, $J = 9.6\text{Hz}$, 1H), 1.99 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 148.1, 146.0, 134.5, 128.2, 128.1, 127.6, 127.2, 126.2, 125.5, 124.8, 124.6, 124.5, 123.3, 121.9, 120.2, 115.4, 79.4, 29.7. IR (neat, cm^{-1}): 2927.5, 1638.1, 1610.6, 1508.3, 1448.4, 1385.2, 1275.6. HRMS (ESI): m/z calcd for $\text{C}_{20}\text{H}_{16}\text{O}$ $[\text{M}+\text{H}]^+$ 273.1274, found 273.1278.

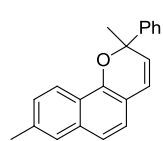
2,6-dimethyl-2-phenyl-2H-benzo[h]chromene 5b



32mg, yellow oil, yield 56%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.36 (d, $J = 9.6\text{Hz}$, 1H), 7.85 (d, $J = 9.2\text{Hz}$, 1H), 7.54 (d, $J = 7.6\text{Hz}$, 2H), 7.49-7.47 (m, 2H), 7.26 (d, $J = 15.2\text{Hz}$, 2H), 7.22-7.18 (m, 1H), 6.95 (s, 1H), 6.51 (d, $J = 9.6\text{Hz}$, 1H), 5.96 (d, $J = 9.6\text{Hz}$, 1H), 2.54 (s, 3H), 1.85 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 146.7, 146.2, 133.4, 131.7, 128.7, 128.2, 127.1, 126.1, 126.0,

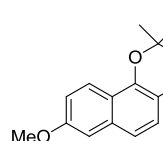
125.2, 125.0, 124.9, 124.1, 123.3, 122.4, 115.0, 79.2, 29.7, 18.7. IR (neat, cm^{-1}): 2927.5, 1640.1, 1601.6, 1508.3, 1448.4, 1383.2, 1275.0. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{18}\text{O}$ $[\text{M}+\text{H}]^+$ 287.1430, found 287.1439.

2,8-dimethyl-2-phenyl-2H-benzo[h]chromene 5c



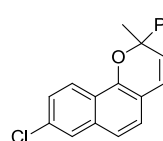
28.6mg, yellow oil, yield 50%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.22 (d, $J = 8.8\text{Hz}$, 1H), 7.55-7.53 (m, 2H), 7.30 (s, 1H), 7.29-7.25 (m, 3H), 7.23-7.19 (m, 2H), 7.06 (d, $J = 8.4\text{Hz}$, 1H), 6.53 (d, $J = 9.6\text{Hz}$, 1H), 5.94 (d, $J = 9.6\text{Hz}$, 1H), 2.48 (s, 3H), 1.85 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 148.3, 146.2, 135.9, 134.9, 128.2, 127.7, 127.1, 126.7, 125.5, 124.9, 124.6, 123.4, 121.9, 121.8, 119.6, 114.8, 79.4, 29.7, 21.7. IR (neat, cm^{-1}): 2927.5, 1640.1, 1601.6, 1508.3, 1448.4, 1383.2, 1275.0. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{18}\text{O}$ $[\text{M}+\text{H}]^+$ 287.1430, found 287.1440.

8-methoxy-2-methyl-2-phenyl-2H-benzo[h]chromene 5d



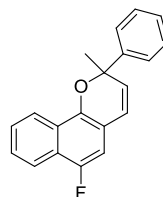
28.4mg, yellow oil, yield 50%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.23 (d, $J = 9.2\text{Hz}$, 1H), 7.54 (d, $J = 8.4\text{Hz}$, 1H), 7.30-7.26 (m, 2H), 7.21-7.19 (m, 2H), 7.14 (d, $J = 2.4\text{Hz}$, 1H), 7.07 (d, $J = 8.4\text{Hz}$, 1H), 7.03 (d, $J = 2.4\text{Hz}$, 1H), 6.53 (d, $J = 9.6\text{Hz}$, 1H), 5.92 (d, $J = 9.6\text{Hz}$, 1H), 3.90 (s, 3H), 1.85 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 158.1, 148.5, 146.2, 136.0, 128.2, 127.2, 127.1, 125.3, 124.9, 123.7, 123.3, 120.0, 119.0, 118.1, 113.9, 105.9, 79.4, 55.3, 29.7. IR (neat, cm^{-1}): 2931.1, 1618.8, 1572.2, 1481.7, 1439.2, 1372.1, 1267.5. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{18}\text{O}_2$ $[\text{M}+\text{H}]^+$ 303.1380, found 303.1387.

8-chloro-2-methyl-2-phenyl-2H-benzo[h]chromene 5e



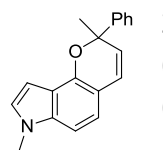
21.4mg, yellow oil, yield 35%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.25 (d, $J = 9.2\text{Hz}$, 1H), 7.69 (d, $J = 2\text{Hz}$, 1H), 7.53 (d, $J = 7.2\text{Hz}$, 1H), 7.41 (d, $J = 2\text{H}$, 1H), 7.39 (d, $J = 2\text{Hz}$, 1H), 7.30 (t, $J = 7.6\text{Hz}$, 2H), 7.23-7.21 (m, 1H), 7.13 (d, $J = 8\text{Hz}$, 1H), 6.55 (d, $J = 9.6\text{Hz}$, 1H), 5.99 (d, $J = 9.6\text{Hz}$, 1H), 1.87 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 148.3, 145.8, 135.2, 132.1, 128.7, 128.5, 128.3, 127.3, 126.4, 126.3, 125.8, 124.8, 123.7, 123.0, 122.9, 119.3, 115.8, 79.7, 29.6. IR (neat, cm^{-1}): 2927.0, 1611.6, 1589.0, 1493.2, 1446.8, 1384.0, 1264.0, 763.3. HRMS (ESI): m/z calcd for $\text{C}_{20}\text{H}_{15}\text{ClO}$ $[\text{M}+\text{H}]^+$ 307.0884, found 307.0891.

6-fluoro-2-methyl-2-phenyl-2H-benzo[h]chromene 5f



23.6mg, yellow oil, yield 41%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.31 ($J = 7.6\text{Hz}$, 1H), 7.97 ($J = 8.0\text{Hz}$, 1H), 7.55-7.48 (m, 4H), 7.29 (t, $J = 8\text{Hz}$, 2H), 7.21 (t, $J = 7.2\text{Hz}$, 1H), 6.81 (d, $J = 10.4\text{Hz}$, 1H), 6.51 (d, $J = 9.6\text{Hz}$, 1H), 6.04 (d, $J = 10.0\text{Hz}$, 1H), 1.86 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 152.9 ($J = 243\text{Hz}$), 145.7, 144.1, 129.1, 128.2, 127.3, 126.4, 125.4 ($J = 5\text{Hz}$), 124.8, 124.1 ($J = 18\text{Hz}$), 122.9, 121.9 ($J = 2\text{Hz}$), 114.9 ($J = 8\text{Hz}$), 107.4 ($J = 22\text{Hz}$), 79.3, 29.6. IR (neat, cm^{-1}): 3061.2, 2955.0, 1650.3, 1603.3, 1406.1, 1273.7, 1060.8. HRMS (ESI): m/z calcd for $\text{C}_{20}\text{H}_{15}\text{FO}$ $[\text{M}+\text{H}]^+$ 291.1180, found 291.1181.

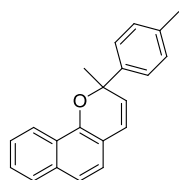
2,7-dimethyl-2-phenyl-2,7-dihydropyrano[2,3-e]indole 5g



24.8mg, yellow oil, yield 45%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.56-7.54 (m, 1H), 7.29-7.25 (m, 2H), 7.19-7.17 (m, 1H), 6.94 (d, $J = 3.2\text{ Hz}$, 1H), 6.84 (d, $J = 8\text{Hz}$, 1H), 6.78 (d, $J = 8.4\text{Hz}$, 1H), 6.65-6.64 (m, 1H), 6.53 (d, $J = 10\text{Hz}$, 1H), 5.81 (d, $J = 10\text{Hz}$, 1H), 3.70 (s, 3H), 1.82 (s, 3H). ^{13}C NMR (100 MHz,

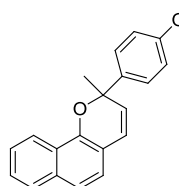
C₃D₆O; δ , ppm): 148.1, 147.3, 139.9, 129.7, 128.9, 127.9, 126.2, 125.9, 124.9, 121.6, 119.5, 112.5, 103.4, 98.6, 79.5, 33.2. IR (neat, cm⁻¹): 2930.0, 1605.6, 1590.0, 1488.2, 1445.0, 1384.0, 1264.0, 1120.0. HRMS (ESI): m/z calcd for C₁₉H₁₇NO [M+H]⁺ 277.1416, found 277.1405.

2-methyl-2-(*p*-tolyl)-2H-benzo[*h*]chromene **5h**



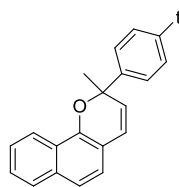
30.9mg, yellow oil, yield 54%. ¹H NMR (400 MHz, CDCl₃; δ , ppm): 8.31 (d, J = 8.4Hz, 1H), 7.70 (d, J = 8.0Hz, 1H), 7.46-7.41 (m, 4H), 7.30 (d, J = 8.4Hz, 1H), 7.11-7.07 (m, 1H), 6.55-6.52 (d, J = 9.6Hz, 1H), 5.95 (d, J = 10.0Hz, 1H), 2.26 (s, 3H), 1.85 (s, 3H). ¹³C NMR (100 MHz, CDCl₃; δ , ppm): 148.2, 143.1, 136.9, 134.5, 128.9, 128.2, 127.6, 126.1, 125.4, 124.8, 124.7, 124.5, 123.2, 121.9, 120.1, 115.5, 79.3, 29.6, 21.0. IR (neat, cm⁻¹): 2914.9, 1644.7, 1616.1, 1510.1, 1464.1, 1385.4, 1268.4. HRMS (ESI): m/z calcd for C₂₁H₁₈O [M+H]⁺ 287.1430, found 287.1440.

2-(4-methoxyphenyl)-2-methyl-2H-benzo[*h*]chromene **5i**



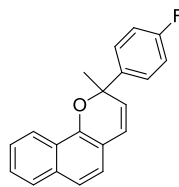
26.6mg, yellow oil, yield 44%. ¹H NMR (400 MHz, CDCl₃; δ , ppm): 8.29 (d, J = 8Hz, 1H), 7.70 (d, J = 7.6Hz, 1H), 7.48-7.41 (m, 4H), 7.31 (d, J = 8.4Hz, 1H), 7.11 (d, J = 8.4Hz, 1H), 6.81 (d, J = 8.8Hz, 1H), 6.55 (d, J = 10.0Hz, 1H), 5.94 (d, J = 9.6Hz, 1H), 3.72 (s, 3H), 1.85 (s, 3H). ¹³C NMR (100 MHz, CDCl₃; δ , ppm): 158.7, 148.2, 138.1, 134.5, 128.3, 127.6, 126.2, 126.1, 125.4, 124.8, 124.5, 123.2, 121.9, 120.1, 115.5, 113.6, 79.2, 55.2, 29.5. IR (neat, cm⁻¹): 2930.1, 1644.2, 1609.4, 1510.2, 1463.9, 1382.5, 1268.7, 1250.4. HRMS (ESI): m/z calcd for C₂₁H₁₈O₂ [M+H]⁺ 303.1380, found 303.1387.

2-(4-(*tert*-butyl)phenyl)-2-methyl-2H-benzo[*h*]chromene **5j**



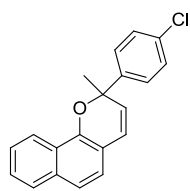
36.1mg, yellow solid, yield 55%, mp: 92-94 °C. ¹H NMR (400 MHz, CDCl₃; δ , ppm): 8.32 (d, J = 8.4Hz, 1H), 7.72 (d, J = 8.0Hz, 1H), 7.48-7.42 (m, 4H), 7.32-7.29 (m, 2H), 7.11 (d, J = 8.4Hz, 1H), 6.53 (d, J = 10.0Hz, 1H), 5.96 (d, J = 9.6Hz, 1H), 1.86 (s, 3H), 1.26 (s, 9H). ¹³C NMR (100 MHz, CDCl₃; δ , ppm): 149.9, 148.2, 143.0, 134.5, 128.3, 127.6, 126.1, 125.4, 125.2, 124.7, 124.6, 124.5, 123.0, 122.0, 120.1, 115.4, 79.4, 34.4, 31.3, 29.6. IR (neat, cm⁻¹): 2925.9, 1645.4, 1616.7, 1509.0, 1463.4, 1386.5, 1268.8, 1104.0. HRMS (ESI): m/z calcd for C₂₄H₂₄O [M+H]⁺ 329.1900, found 329.1911.

2-(4-fluorophenyl)-2-methyl-2H-benzo[*h*]chromene **5k**



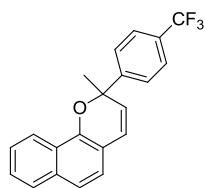
34.8mg, yellow oil, yield 60%. ¹H NMR (400 MHz, CDCl₃; δ , ppm): 8.30-8.28 (m, 1H), 7.73-7.70 (m, 1H), 7.52-7.47 (m, 4H), 7.52-7.40 (m, 1H), 7.32 (d, J = 8.0Hz, 1H), 7.11 (d, J = 8.4Hz, 1H), 6.97-6.93 (m, 2H), 6.57 (d, J = 9.6Hz, 1H), 5.93 (d, J = 9.6Hz, 1H), 1.84 (s, 3H). ¹³C NMR (100 MHz, CDCl₃; δ , ppm): 161.9 (J = 244Hz), 148.0, 141.7 (J = 3Hz), 134.6, 127.8, 127.7, 126.7 (J = 8Hz), 126.3, 125.6, 124.7, 124.5, 123.6, 121.8, 121.8, 120.4, 115.4, 115.0 (J = 21Hz), 78.9, 29.7. IR (neat, cm⁻¹): 2928.8, 1644.9, 1602.5, 1507.7, 1464.8, 1385.8, 1228.4, 1108.4. HRMS (ESI): m/z calcd for C₂₀H₁₅FO [M+H]⁺ 291.1180, found 291.1191.

2-(4-chlorophenyl)-2-methyl-2H-benzo[*h*]chromene **5l**



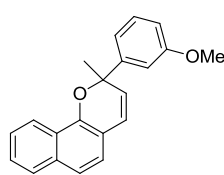
24.5mg, yellow oil, yield 40%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.29 (d, $J = 8.4\text{Hz}$, 1H), 7.73 (d, $J = 7.6\text{Hz}$, 1H), 7.49-7.46 (m, 3H), 7.33 (d, $J = 8.0\text{Hz}$, 1H), 7.24 (d, $J = 8.4\text{Hz}$, 1H), 7.12 (d, $J = 8.4\text{Hz}$, 1H), 6.59 (d, $J = 9.6\text{Hz}$, 1H), 5.95 (d, $J = 9.6\text{Hz}$, 1H), 1.85 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 148.0, 144.6, 134.6, 133.1, 128.4, 127.7, 127.5, 126.4, 126.3, 125.6, 124.6, 124.4, 123.8, 121.8, 120.5, 115.5, 78.9, 29.7. IR (neat, cm^{-1}): 2927.1, 1644.9, 1616.5, 1508.4, 1465.6, 1368.7, 1267.8. HRMS (ESI): m/z calcd for $\text{C}_{20}\text{H}_{15}\text{ClO}$ $[\text{M}+\text{H}]^+$ 307.0884, found 307.0894.

2-methyl-2-(4-(trifluoromethyl)phenyl)-2H-benzo[h]chromene 5m



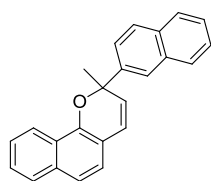
22.4mg, yellow solid, yield 33%, mp: 106-108 °C. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.32 (d, $J = 8.0\text{Hz}$, 1H), 7.74 (d, $J = 8.0\text{Hz}$, 1H), 7.65 (d, $J = 8.4\text{Hz}$, 2H), 7.54-7.50 (m, 2H), 7.48-7.43 (m, 2H), 7.34 (d, $J = 8.0\text{Hz}$, 1H), 7.12 (d, $J = 8.4\text{Hz}$, 1H), 6.60 (d, $J = 10.0\text{Hz}$, 1H), 5.98 (d, $J = 9.6\text{Hz}$, 1H), 1.87 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 150.1, 147.9, 134.6, 129.5 (q, $J = 32.3\text{Hz}$), 127.8, 127.2, 126.4, 125.7, 125.26 (q, $J = 3.7\text{Hz}$), 125.2, 124.6, 124.5, 124.1, 124.09 (q, $J = 271.0\text{Hz}$), 121.7, 120.7, 79.0, 29.8. IR (neat, cm^{-1}): 2928.6, 1645.6, 1618.2, 1509.3, 1465.5, 1387.9, 1269.1, 1078.6. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{15}\text{F}_3\text{O}$ $[\text{M}+\text{H}]^+$ 341.1148, found 341.1159.

2-(3-methoxyphenyl)-2-methyl-2H-benzo[h]chromene 5n



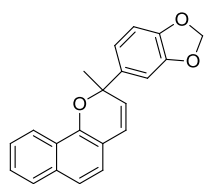
31.4mg, yellow oil, yield 52%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.34 (d, $J = 8.0\text{Hz}$, 1H), 7.71 (d, $J = 7.6\text{Hz}$, 1H), 7.49-7.40 (m, 2H), 7.31 (d, $J = 8.4\text{Hz}$, 1H), 7.20 (t, $J = 8.0\text{Hz}$, 1H), 7.13-7.09 (m, 3H), 6.74-7.71 (m, 1H), 6.55 (d, $J = 10.0\text{Hz}$, 1H), 5.97 (d, $J = 9.6\text{Hz}$, 1H), 3.69 (s, 3H), 1.86 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 159.4, 148.1, 147.8, 134.5, 129.2, 128.1, 127.7, 126.2, 125.5, 124.7, 124.5, 123.4, 121.8, 120.3, 117.2, 115.6, 112.3, 111.0, 79.3, 55.1, 29.7. IR (neat, cm^{-1}): 2931.0, 1644.0, 1600.3, 1508.5, 1450.9, 1385.7, 1289.8, 1268.7. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{18}\text{O}_2$ $[\text{M}+\text{H}]^+$ 303.1380, found 303.1387.

2-methyl-2-(naphthalen-2-yl)-2H-benzo[h]chromene 5o



33.5mg, yellow oil, yield 52%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.39 (d, $J = 8.4\text{Hz}$, 1H), 7.95 (d, $J = 1.2\text{Hz}$, 1H), 7.78-7.70 (m, 5H), 7.51-7.49 (m, 1H), 7.47-7.39 (m, 3H), 7.31 (d, $J = 8.4\text{Hz}$, 1H), 7.11 (d, $J = 8\text{Hz}$, 1H), 6.61 (d, $J = 10.0\text{Hz}$, 1H), 6.06 (d, $J = 10.0\text{Hz}$, 1H), 1.95 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 148.2, 143.2, 134.6, 132.9, 132.6, 128.2, 128.1, 128.0, 127.7, 127.5, 126.2, 126.0, 125.9, 125.5, 124.8, 124.5, 123.7, 123.6, 123.4, 121.9, 120.3, 115.6, 79.5, 29.5. IR (neat, cm^{-1}): 2927.4, 1633.0, 1589.8, 1515.1, 1437.6, 1377.1, 1244.7. HRMS (ESI): m/z calcd for $\text{C}_{24}\text{H}_{18}\text{O}$ $[\text{M}+\text{H}]^+$ 323.1430, found 323.1442.

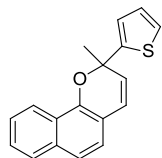
2-(benzo[d][1,3]dioxol-5-yl)-2-methyl-2H-benzo[h]chromene 5p



28.4mg, yellow oil, yield 45%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.28 (d, $J = 8.4\text{Hz}$, 1H), 8.71 (d, $J = 7.6\text{Hz}$, 1H), 7.48-7.39 (m, 2H), 7.31 (d, $J = 8.0\text{Hz}$, 1H), 7.13-7.08 (m, 2H), 7.01-6.99 (m, 1H), 6.70 (d, $J = 8.0\text{Hz}$, 1H), 6.57 (d, $J = 9.6\text{Hz}$, 1H), 5.92 (d, $J = 9.6\text{Hz}$, 1H), 5.88-5.86 (m, 2H), 1.84 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 148.1, 147.5,

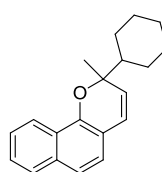
146.7, 140.1, 134.5, 128.0, 127.6, 126.2, 125.5, 124.7, 124.5, 123.4, 121.9, 120.2, 118.3, 115.5, 107.7, 106.1, 101.0, 79.2, 29.8. IR (neat, cm^{-1}): 2925.9, 1644.2, 1614.6, 1504.0, 1433.3, 1385.2, 1245.5, 1039.4. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{16}\text{O}_3$ $[\text{M}+\text{H}]^+$ 317.1172, found 317.1183.

2-methyl-2-(thiophen-2-yl)-2H-benzo[h]chromene **5q**



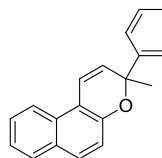
21.1mg, yellow oil, yield 38%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.25-8.22 (m, 1H), 7.71-7.69 (m, 1H), 7.45-7.39 (m, 2H), 7.33 (d, $J = 8.4\text{Hz}$, 1H), 7.18 (d, $J = 1.2\text{Hz}$, 1H), 7.17-7.13 (m, 1H), 7.06-7.05 (m, 1H), 6.89-6.86 (m, 1H), 6.61 (d, $J = 9.6\text{Hz}$, 1H), 5.92 (d, $J = 9.6\text{Hz}$, 1H), 1.99 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 149.8, 147.9, 134.6, 127.5, 127.3, 126.5, 126.3, 125.4, 125.1, 124.8, 124.4, 123.9, 123.8, 122.1, 120.4, 115.2, 77.5, 30.0. IR (neat, cm^{-1}): 2926.2, 1646.3, 1433.3, 1384.5, 1226.8. HRMS (ESI): m/z calcd for $\text{C}_{18}\text{H}_{14}\text{OS}$ $[\text{M}+\text{H}]^+$ 279.0838, found 279.0848.

2-cyclohexyl-2-methyl-2H-benzo[h]chromene **5r**



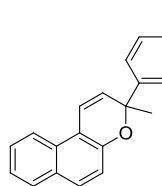
11.0 mg, colorless oil, yield 20%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.18-8.16 (m, 1H), 7.72-7.70 (m, 1H), 7.42-7.39 (m, 2H), 7.29 (d, $J = 8.4\text{Hz}$, 1H), 7.11 (d, $J = 8.4\text{Hz}$, 1H), 6.44 (d, $J = 10.0\text{Hz}$, 1H), 5.61 (d, $J = 10.0\text{Hz}$, 1H), 1.94 (m, 2H), 1.80-1.65 (m, 4H), 1.42 (s, 3H), 1.25-1.17 (m, 5H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 148.5, 134.4, 127.6, 127.5, 125.9, 125.1, 124.8, 124.6, 122.9, 121.9, 119.3, 115.0, 81.6, 47.5, 27.1, 27.0, 26.5, 23.7. IR (neat, cm^{-1}): 3051.1, 2927.8, 2852.5, 1596.6, 1509.4, 1384.3, 1271.2. HRMS (ESI): m/z calcd for $\text{C}_{20}\text{H}_{22}\text{O}$ $[\text{M}+\text{H}]^+$ 279.1743, found 279.1745.

3-methyl-3-phenyl-3H-benzo[f]chromene **5s**



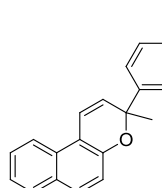
Regioselectivity 2:3, 32.6mg, colorless oil, yield 60%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.90 (d, $J = 8.4\text{Hz}$, 1H), 7.79 (d, $J = 8.4\text{Hz}$, 2H), 7.63 (d, $J = 8.8\text{Hz}$, 1H), 7.46-7.42 (m, 6H), 7.21 (d, $J = 2.8\text{Hz}$, 2H), 7.16-7.12 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 157.0, 147.7, 138.6, 129.6, 128.6, 128.3, 128.1, 127.9, 127.2, 126.5, 125.1, 123.5, 121.3, 118.9, 118.3, 113.9, 78.7, 29.2. IR (neat, cm^{-1}): 2928.2, 1631.5, 1599.2, 1494.7, 1445.3, 1375.0, 1242.2. HRMS (ESI): m/z calcd for $\text{C}_{20}\text{H}_{16}\text{O}$ $[\text{M}+\text{H}]^+$ 273.1274, found 273.1281.

3-methyl-3-(p-tolyl)-3H-benzof]chromene **5t**



Regioselectivity 10:1, 40.0mg, yellow solid, yield 70%, mp: 70-72 $^{\circ}\text{C}$. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.91 (d, $J = 8.4\text{Hz}$, 1H), 7.70 (d, $J = 8.0\text{Hz}$, 1H), 7.64 (d, $J = 9.2\text{Hz}$, 1H), 7.45-7.43 (m, 3H), 7.31-7.27 (m, 1H), 7.16-7.09 (m, 4H), 6.05-6.02 (m, 1H), 2.28 (s, 3H), 1.82 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 151.0, 142.9, 136.9, 129.8, 129.5, 129.3, 129.2, 128.8, 128.5, 126.6, 126.5, 125.1, 123.4, 121.3, 118.8, 118.3, 113.9, 78.6, 29.2, 21.0. IR (neat, cm^{-1}): 2924.4, 1633.6, 1590.1, 1514.3, 1462.1, 1382.0, 1243.0. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{18}\text{O}$ $[\text{M}+\text{H}]^+$ 287.1430, found 287.1436.

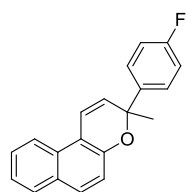
3-(4-methoxyphenyl)-3-methyl-3H-benzof]chromene **5u**



Regioselectivity 14:1, 39.9mg, yellow oil, yield 66%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.91 (d, $J = 8.4\text{Hz}$, 1H), 7.69 (d, $J = 8.4\text{Hz}$, 1H), 7.62 (d, $J = 8.8\text{Hz}$, 1H), 7.46 (d, $J = 8.8\text{Hz}$, 2H), 7.31-7.27 (m, 1H), 7.15-7.11 (m, 2H), 6.81 (d, $J = 8.8\text{Hz}$, 1H), 6.00 (d, $J = 10.0\text{Hz}$, 1H),

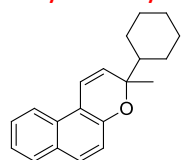
3.72 (s, 3H), 1.81 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 158.8, 151.0, 137.8, 129.8, 129.5, 129.2, 128.5, 126.5, 126.4, 123.4, 121.3, 118.8, 118.3, 113.9, 113.5, 78.4, 55.2, 29.0. IR (neat, cm^{-1}): 2930.1, 1633.4, 1609.2, 1510.7, 1440.5, 1382.7, 1246.3, 1032.5. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{18}\text{O}_2$ $[\text{M}+\text{H}]^+$ 303.1380, found 303.1388.

3-(4-fluorophenyl)-3-methyl-3H-benzo[f]chromene **5v**



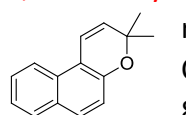
Regioselectivity 5:1, 38.9mg, yellow solid, yield 67%, mp: 80-82 °C. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.91 (d, $J = 8.4\text{Hz}$, 1H), 7.70 (d, $J = 8.4\text{Hz}$, 1H), 7.64 (d, $J = 8.8\text{Hz}$, 1H), 7.52-7.49 (m, 2H), 7.46-7.42 (m, 1H), 7.32-7.28 (m, 1H), 7.14 (d, $J = 10.0\text{Hz}$, 2H), 6.96 (t, $J = 8.8\text{Hz}$, 1H), 6.00 (d, $J = 10.0\text{Hz}$, 1H), 1.8 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 161.9 (d, $J = 245\text{Hz}$), 150.8, 141.5 (d, $J = 4\text{Hz}$), 129.8, 129.7, 129.2, 128.5, 128.0, 127.0 (d, $J = 8\text{Hz}$), 126.6, 123.6, 121.3, 119.3, 118.2, 114.9 (d, $J = 21\text{Hz}$), 113.9, 78.2, 29.3. IR (neat, cm^{-1}): 2928.5, 1633.8, 1602.2, 1507.9, 1462.9, 1382.5, 1233.6, 1093.5. HRMS (ESI): m/z calcd for $\text{C}_{20}\text{H}_{15}\text{FO}$ $[\text{M}+\text{H}]^+$ 291.1180, found 291.1189.

3-cyclohexyl-3-methyl-3H-benzo[f]chromene **5w**



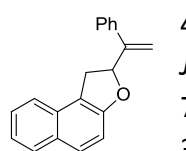
21.0mg, yellow oil, yield 38%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.93 ($J = 8.4\text{Hz}$, 1H), 7.72 (d, $J = 8.0\text{Hz}$, 1H), 7.62 (d, $J = 8.8\text{Hz}$, 1H), 7.47-7.43 (m, 1H), 7.31-7.28 (m, 1H), 7.05-7.02 (m, 2H), 5.70 (d, $J = 10.4\text{Hz}$, 1H), 1.92-1.87 (m, 2H), 1.77-1.64 (m, 5H), 1.39 (s, 3H), 1.19-1.15 (m, 4H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 151.3, 129.8, 129.2, 129.0, 128.5, 127.7, 126.4, 123.1, 121.1, 118.3, 113.4, 80.0, 47.1, 27.2, 26.9, 26.5, 26.47, 26.45, 23.3. IR (neat, cm^{-1}): 2928.7, 2854.2, 1590.9, 1515.1, 1449.9, 1382.7, 1096.0. HRMS (ESI): m/z calcd for $\text{C}_{20}\text{H}_{20}\text{O}$ $[\text{M}+\text{H}]^+$ 279.1743, found 279.1749.

3,3-dimethyl-3H-benzo[f]chromene **5x**



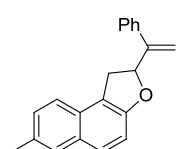
regioselectivity 3:1, 20.0mg, yellow oil, yield 48%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.93 (d, $J = 8.4\text{Hz}$, 1H), 7.73 (d, $J = 8.0\text{Hz}$, 1H), 7.64 (d, $J = 8.8\text{Hz}$, 1H), 7.46 (t, $J = 7.2\text{Hz}$, 1H), 7.31 (t, $J = 6.8\text{Hz}$, 1H), 7.06-7.00 (m, 2H), 5.71 (d, $J = 10.4\text{Hz}$, 1H), 1.48 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 150.9, 129.4, 129.3, 129.0, 128.5, 126.4, 123.3, 121.2, 118.4, 118.3, 113.7, 110.2, 76.0, 27.6. IR (neat, cm^{-1}): 3060.0, 2975.4, 1633.7, 1598.4, 1515.0, 1382.7, 1360.6. HRMS (ESI): m/z calcd for $\text{C}_{15}\text{H}_{14}\text{O}$ $[\text{M}+\text{H}]^+$ 211.1117, found 211.1122.

2-(1-phenylvinyl)-1,2-dihydronaphtho[2,1-b]furan **6a**



42mg, colorless oil, yield 77%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.80 (d, $J = 8.2\text{Hz}$, 1H), 7.71 (d, $J = 8.7\text{Hz}$, 1H), 7.49-7.41 (m, 4H), 7.38-7.29 (m, 4H), 7.21 (d, $J = 8.2\text{Hz}$, 1H), 5.91 (t, $J = 9.0\text{Hz}$, 1H), 5.53 (s, 1H), 5.47 (s, 1H), 3.69 (dd, $J = 15.4\text{Hz}$, $J = 10.2\text{Hz}$, 1H), 3.25 (dd, $J = 15.4\text{Hz}$, $J = 7.9\text{Hz}$, 1H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 157.0, 147.6, 138.5, 130.1, 129.3, 129.1, 128.7, 128.5, 127.9, 126.7, 126.6, 122.9, 122.6, 117.9, 113.1, 112.0, 84.1, 35.1. IR (neat, cm^{-1}): 2922.6, 1630.8, 1597.3, 1518.3, 1276.2. HRMS (ESI): m/z calcd for $\text{C}_{20}\text{H}_{16}\text{O}$ $[\text{M}+\text{H}]^+$ 273.1274, found 273.1280.

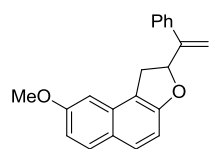
7-methyl-2-(1-phenylvinyl)-1,2-dihydronaphtho[2,1-b]furan **6b**



42.9mg, colorless oil, yield 75%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.60 (d, $J = 8.8\text{Hz}$, 1H), 7.56 (s, 1H), 7.45-7.43 (m, 2H), 7.38-7.31 (m, 4H), 7.24 (d, $J = 8.4\text{Hz}$, 1H), 7.15 (d, $J = 8.4\text{Hz}$, 1H), 5.85 (t, $J = 9.2\text{Hz}$, 1H),

5.52 (s, 1H), 5.45 (s, 1H), 3.64 (dd, $J = 15.2\text{Hz}, 10.0\text{Hz}$, 1H), 3.22 (dd, $J = 15.2\text{Hz}, 10.0\text{Hz}$, 1H), 2.44 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 156.4, 147.7, 138.6, 132.2, 129.6, 129.0, 128.9, 128.5, 128.3, 127.9, 127.6, 126.8, 122.5, 117.8, 113.1, 111.9, 84.0, 35.1, 21.5. IR (neat, cm^{-1}): 2935.1, 1636.2, 1601.0, 1495.6, 1253.2, 1020.3. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{18}\text{O}$ $[\text{M}+\text{H}]^+$ 287.1430, found 287.1438.

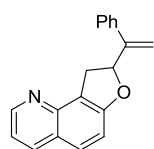
8-methoxy-2-(1-phenylvinyl)-1,2-dihydronaphtho[2,1-*b*]furan 6c



48.3mg, yellow solid, yield 80%, mp: 105-107 °C. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.66 (d, $J = 8.8\text{Hz}$, 1H), 7.60 (d, $J = 8.8\text{Hz}$, 1H), 7.46-7.44 (m, 2H), 7.34-7.30 (m, 3H), 7.04 (d, $J = 8.8\text{Hz}$, 1H), 6.93 (dd, $J = 8.8\text{Hz}, J = 1.6\text{Hz}$, 1H), 6.69 (d, $J = 2.4\text{Hz}$, 1H), 5.88 (t, $J = 8.8\text{Hz}$, 1H).

5.53(s, 1H), 5.46 (s, 1H), 3.82 (s, 3H), 3.61 (dd, $J = 15.2\text{Hz}, J = 10.0\text{Hz}$, 1H), 3.18 (dd, $J = 15.2\text{Hz}, J = 10.0\text{Hz}$, 1H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 158.5, 157.6, 147.7, 138.6, 132.0, 130.2, 128.8, 128.6, 127.9, 126.8, 124.7, 117.0, 115.6, 112.9, 109.4, 101.2, 83.9, 55.2, 35.2. IR (neat, cm^{-1}): 2932.1, 1632.2, 1601.0, 1495.6, 1252.1, 1028.8. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{18}\text{O}_2$ $[\text{M}+\text{H}]^+$ 303.1380, found 303.1387.

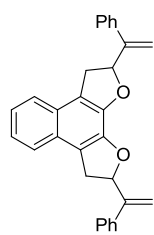
8-(1-phenylvinyl)-8,9-dihydrofuro[2,3-*h*]quinoline 6e



31.1mg, yellow solid, yield 57%, mp: 88-90 °C. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 8.83 (dd, $J = 4.4\text{Hz}, J = 1.7\text{Hz}$, 1H), 8.12 (dd, $J = 8.2\text{Hz}, J = 1.7\text{Hz}$, 1H), 7.71 (d, $J = 8.8\text{Hz}$, 1H), 7.48-7.46 (m, 2H), 7.39-7.32 (m, 3H), 7.30 (d, $J = 8.8\text{Hz}$, 1H), 7.24 (dd, $J = 8.2\text{Hz}, J = 4.3\text{Hz}$, 1H), 5.99 (t, $J = 9.0\text{Hz}$, 1H),

5.56 (s, 1H), 5.50 (s, 1H), 3.93 (dd, $J = 16\text{Hz}, J = 10.2\text{Hz}$, 1H), 3.51 (dd, $J = 16.0\text{Hz}, J = 7.9\text{Hz}$, 1H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 160.2, 150.7, 147.5, 145.7, 138.1, 136.6, 128.9, 128.5, 127.9, 126.8, 124.0, 119.8, 118.3, 112.9, 112.8, 84.8, 34.6. IR (neat, cm^{-1}): 2935.0, 1615.6, 1593.0, 1486.2, 1430.0, 1384.0, 1264.0. HRMS (ESI): m/z calcd for $\text{C}_{19}\text{H}_{15}\text{NO}$ $[\text{M}+\text{H}]^+$ 274.1226, found 274.1230.

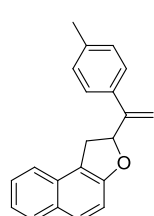
2,9-bis(1-phenylvinyl)-2,3,8,9-tetrahydronaphtho[2,1-*b*:3,4-*b'*]difuran 6f



51.6mg, white solid, yield 57%, mp: 72-74 °C. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.47-7.44 (m, 6H), 7.37-7.31 (m, 6H), 7.26-7.24 (m, 2H), 6.01-5.95 (m, 2H), 5.60 (d, $J = 8\text{Hz}$, 2H), 5.48 (s, 2H), 3.73-3.66 (m, 2H), 3.29-3.22 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 147.1, 143.7, 138.4, 128.5, 127.9, 126.8, 126.4, 123.7, 123.4, 120.1, 113.5, 113.4, 85.4, 35.5. IR (neat, cm^{-1}): 2925.5, 1632.6, 1599.0, 1495.3, 1440.6, 1287.5, 1028.8.

HRMS (ESI): m/z calcd for $\text{C}_{30}\text{H}_{24}\text{O}_2$ $[\text{M}+\text{H}]^+$ 417.1849, found 417.1864.

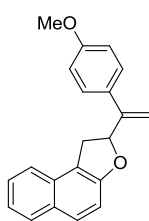
2-(1-(*p*-tolyl)vinyl)-1,2-dihydronaphtho[2,1-*b*]furan 6g



50.3mg, white solid, yield 88%, mp: 120-122 °C. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.77 (d, $J = 8.4\text{Hz}$, 1H), 7.68 (d, $J = 8.8\text{Hz}$, 1H), 7.45 (d, $J = 8.4\text{Hz}$, 1H), 7.40 (d, $J = 1.2\text{Hz}$, 1H), 7.38-7.37 (m, 2H), 7.34 (t, $J = 8\text{Hz}$, 1H), 7.28-7.26 (m, 1H), 7.24-7.13 (m, 1H), 5.86 (t, $J = 9.2\text{Hz}$, 1H), 5.48(s, 1H), 5.42

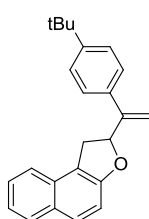
(s, 1H), 3.65 (dd, $J = 15.6\text{Hz}, J = 10.0\text{Hz}$, 1H), 3.23 (dd, $J = 15.2\text{Hz}, J = 8.0\text{Hz}$, 1H), 2.34 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 157.0, 147.4, 137.7, 135.6, 130.8, 129.3, 129.2, 129.1, 128.7, 126.6, 122.8, 122.6, 118.0, 112.3, 112.0, 84.1, 35.1, 21.1. IR (neat, cm^{-1}): 2920.4, 1631.0, 1600.8, 1520.0, 1464.8, 1377.4, 1257.3. HRMS (ESI): m/z calcd for $\text{C}_{21}\text{H}_{18}\text{O}$ $[\text{M}+\text{H}]^+$ 287.1430, found 287.1440.

2-(1-(4-methoxyphenyl)vinyl)-1,2-dihydronaphtho[2,1-*b*]furan 6h



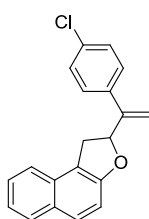
48.9mg, white solid, yield 81%, mp: 111-113 °C. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 7.79 (d, *J* = 8.0Hz, 1H), 7.69 (d, *J* = 8.8Hz, 1H), 7.47 (d, *J* = 8.0Hz, 1H), 7.42-7.37 (m, 3H), 7.29-7.25 (m, 1H), 7.19 (d, *J* = 8.8Hz, 1H), 6.87 (d, *J* = 8.8Hz, 1H), 5.85 (t, *J* = 9.2Hz, 1H), 5.44(s, 1H), 5.39 (s, 1H), 3.79 (s, 3H), 3.67 (dd, *J* = 15.2Hz, *J* = 10.0Hz, 1H), 3.25 (dd, *J* = 15.2Hz, *J* = 8.0Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 159.4, 157.0, 147.0, 130.9, 130.8, 129.3, 129.1, 128.7, 127.9, 126.6, 122.9, 122.7, 118.0, 113.9, 112.0, 111.8, 84.3, 55.2, 35.1. IR (neat, cm⁻¹): 2932.6, 1630.9, 1606.8, 1511.2, 1442.7, 1373.2, 1245.4, 1032.8. HRMS (ESI): *m/z* calcd for C₂₁H₁₈O₂ [M+H]⁺ 303.1380, found 303.1389.

2-(1-(4-(*tert*-butyl)phenyl)vinyl)-1,2-dihydronaphtho[2,1-*b*]furan 6i



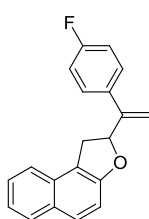
49.2mg, white solid, yield 75%, mp: 117-119 °C. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 7.78 (d, *J* = 8.4Hz, 1H), 6.69 (d, *J* = 8.8Hz, 1H), 7.46 (d, *J* = 8.0Hz, 1H), 7.40-7.35 (m, 5H), 7.28-7.25 (m, 1H), 7.20 (d, *J* = 9.2Hz, 1H), 5.88 (t, *J* = 9.2Hz, 1H), 5.48(s, 1H), 5.46 (s, 1H), 6.68 (dd, *J* = 15.6Hz, *J* = 10.0Hz, 1H), 3.26 (dd, *J* = 15.2Hz, *J* = 8.0Hz, 1H), 1.32 (s, 9H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 157.0, 150.9, 147.2, 135.4, 130.8, 129.3, 129.1, 128.7, 126.6, 126.3, 125.5, 122.8, 122.7, 118.0, 112.2, 112.0, 84.1, 35.2, 34.5, 31.3. IR (neat, cm⁻¹): 2961.8, 1631.1, 1601.5, 1520.3, 1464.7, 1365.1, 1248.8, 1133.2. HRMS (ESI): *m/z* calcd for C₂₄H₂₄O [M+H]⁺ 329.1900, found 329.1910.

2-(1-(4-chlorophenyl)vinyl)-1,2-dihydronaphtho[2,1-*b*]furan 6j



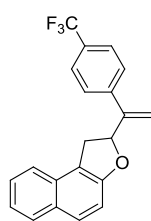
18.4mg, yellow solid, yield 30%, mp: 108-110 °C. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 7.80 (d, *J* = 8.0Hz, 1H), 7.71 (d, *J* = 8.8Hz, 1H), 7.49 (d, *J* = 8.4Hz, 2H), 7.44 (d, *J* = 1.2Hz, 1H), 7.38 (d, *J* = 8.8Hz, 2H), 7.32-7.30 (m, 3H), 7.19 (d, *J* = 8.8Hz, 1H), 5.84 (t, *J* = 9.2Hz, 1H), 5.55(s, 1H), 5.46 (s, 1H), 6.68 (dd, *J* = 15.6Hz, *J* = 10.0Hz, 1H), 3.24 (dd, *J* = 15.2Hz, *J* = 8.0Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 156.9, 146.6, 137.0, 133.9, 130.8, 129.4, 129.2, 128.7, 128.2, 126.7, 123.0, 122.6, 117.8, 114.1, 112.0, 84.1, 34.9. IR (neat, cm⁻¹): 2924.6, 1630.7, 1600.0, 1492.1, 1444.2, 1242.7. HRMS (ESI): *m/z* calcd for C₂₀H₁₅ClO [M+H]⁺ 307.0884, found 307.0895.

2-(1-(4-fluorophenyl)vinyl)-1,2-dihydronaphtho[2,1-*b*]furan 6k



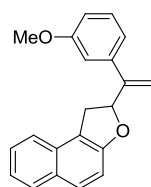
45.2mg, yellow solid, yield 78%, mp: 106-108 °C. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 7.79 (d, *J* = 8.0Hz, 1H), 7.70 (d, *J* = 8.8Hz, 1H), 7.47 (d, *J* = 8.4Hz, 1H), 7.42-7.39 (m, 3H), 7.30-7.26 (m, 1H), 7.21-7.17 (m, 1H), 7.04-7.00 (m, 2H), 5.82 (t, *J* = 9.2Hz, 1H), 5.51 (s, 1H), 5.41 (s, 2H), 3.65 (dd, *J* = 15.6Hz, *J* = 10.4Hz, 1H), 3.23 (dd, *J* = 15.6Hz, *J* = 8.4Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 162.5 (d, *J* = 246Hz), 156.9, 146.6, 134.5 (d, *J* = 4Hz), 130.8, 129.3, 129.2, 128.7, 128.5 (d, *J* = 8Hz), 126.7, 122.9, 122.6, 117.9, 115.4 (d, *J* = 21Hz). IR (neat, cm⁻¹): 2924.8, 1631.0, 1602.0, 1509.4, 1444.1, 1236.6. HRMS (ESI): *m/z* calcd for C₂₀H₁₅FO [M+H]⁺ 291.1180, found 291.1189.

2-(1-(4-(trifluoromethyl)phenyl)vinyl)-1,2-dihydronaphtho[2,1-*b*]furan 6l



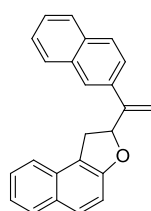
42.8mg, yellow solid, yield 63%, mp: 128-130 °C. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 7.80 (d, *J* = 8.4Hz, 1H), 7.71 (d, *J* = 8.8Hz, 1H), 7.61-7.54 (m, 4H), 7.49-7.42 (m, 2H), 7.31-7.28 (m, 1H), 7.19 (d, *J* = 8.8Hz, 1H), 5.87 (t, *J* = 9.6Hz, 1H), 5.63(s, 1H), 5.53 (s, 1H), 3.68 (dd, *J* = 15.6Hz, 10.0Hz, 1H), 3.23 (dd, *J* = 15.2Hz, *J* = 8.0Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 156.8, 146.6, 142.1, 130.7, 130.0 (q, *J* = 32Hz), 129.4, 129.3, 128.7, 127.2, 126.9, 125.5 (q, *J* = 4Hz), 124.1 (q, *J* = 271Hz), 123.0, 122.6, 117.7, 115.5, 112.0, 83.9, 34.9. IR (neat, cm⁻¹): 2925.2, 1631.2, 1600.5, 1521.0, 1444.4, 1243.5, 1067.4. HRMS (ESI): *m/z* calcd for C₂₁H₁₅F₃O [M+H]⁺ 341.1148, found 341.1158.

2-(1-(3-methoxyphenyl)vinyl)-1,2-dihydronaphtho[2,1-b]furan **6m**



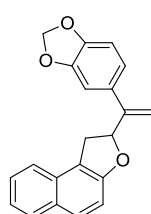
41.1mg, yellow oil, yield 68%. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 7.79 (d, *J* = 8.0Hz, 1H), 7.70 (d, *J* = 8.8Hz, 1H), 7.48 (d, *J* = 8.4Hz, 1H), 7.43-7.39 (m, 1H), 7.25-7.29 (m, 2H), 7.20 (d, *J* = 8.8Hz, 1H), 7.04 (d, *J* = 8.0Hz, 1H), 7.00-6.99 (m, 1H), 6.87-6.85 (m, 1H), 5.88 (t, *J* = 9.2Hz, 1H), 5.53(s, 1H), 5.47 (s, 1H), 3.76 (s, 3H), 3.69 (dd, *J* = 15.2Hz, *J* = 10.0Hz, 1H), 3.25 (dd, *J* = 15.2Hz, *J* = 8.0Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 159.6, 157.0, 147.5, 140.0, 130.8, 129.5, 129.3, 129.1, 128.7, 126.6, 122.9, 122.7, 119.2, 118.0, 113.4, 113.3, 112.6, 112.0, 84.1, 55.2, 35.0. IR (neat, cm⁻¹): 2936.2, 1631.0, 1599.0, 1487.8, 1429.9, 1376.3, 1288.5, 1048.3. HRMS (ESI): *m/z* calcd for C₂₁H₁₈O₂ [M+H]⁺ 303.1380, found 303.1388.

2-(1-(naphthalen-2-yl)vinyl)-1,2-dihydronaphtho[2,1-b]furan **6n**



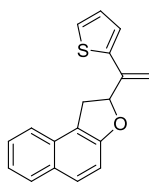
51.5mg, white solid, yield 80% mp: 145-147 °C. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 7.87 (s, 1H), 7.82-7.79 (m, 4H), 7.71 (d, *J* = 8.8Hz, 1H), 7.61-7.60 (m, 1H), 7.48-7.39 (m, 3H), 7.30-7.28 (m, 1H), 7.24-7.21 (m, 2H), 6.03 (t, *J* = 8.8Hz, 1H), 5.63(s, 1H), 5.60 (s, 1H), 3.73 (dd, *J* = 15.2Hz, 10.0Hz, 1H), 3.29 (dd, *J* = 15.2Hz, 8.0Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 157.0, 147.5, 135.8, 133.3, 132.9, 130.8, 129.3, 129.1, 128.7, 128.2, 127.6, 126.6, 126.3, 126.2, 125.5, 125.0, 122.9, 122.7, 117.9, 113.4, 112.0, 83.9, 35.2. IR (neat, cm⁻¹): 2929.7, 1629.4, 1598.7, 1520.0, 1442.4, 1257.4. HRMS (ESI): *m/z* calcd for C₂₄H₁₈O [M+H]⁺ 323.1430, found 323.1441.

2-(1-(benzo[d][1,3]dioxol-5-yl)vinyl)-1,2-dihydronaphtho[2,1-b]furan **6o**



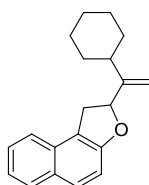
34.8mg, yellow oil, yield 55%. ¹H NMR (400 MHz, CDCl₃; δ, ppm): 7.79 (d, *J* = 8.0Hz, 1H), 7.70 (d, *J* = 8.8Hz, 1H), 7.48 (d, *J* = 8.0Hz, 1H), 7.43-7.39 (m, 1H), 7.30-7.26 (m, 1H), 7.19 (d, *J* = 8.8Hz, 1H), 6.96 (d, *J* = 2.0Hz, 1H), 6.93-6.91 (m, 1H), 6.78 (d, *J* = 8.0Hz, 1H), 5.94 (d, *J* = 1.6Hz, 2H), 5.81 (t, *J* = 8.8Hz, 1H), 5.45(s, 1H), 5.37 (s, 1H), 3.66 (dd, *J* = 15.2Hz, *J* = 10.0Hz, 1H), 3.25 (dd, *J* = 15.2Hz, *J* = 10.0Hz, 1H). ¹³C NMR (100 MHz, CDCl₃; δ, ppm): 156.9, 147.8, 147.4, 147.1, 132.6, 130.8, 129.3, 129.1, 128.7, 126.6, 122.9, 122.6, 120.3, 117.9, 112.5, 112.0, 108.3, 107.4, 101.1, 84.2, 35.0. IR (neat, cm⁻¹): 2900.3, 1631.0, 1602.2, 1503.3, 1443.0, 1241.1, 1039.3. HRMS (ESI): *m/z* calcd for C₂₁H₁₆O₃ [M+H]⁺ 317.1172, found 317.1182.

2-(1-(thiophen-2-yl)vinyl)-1,2-dihydronaphtho[2,1-b]furan **6p**



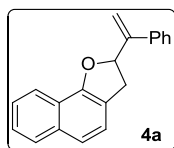
41.7mg, yellow oil, yield 75%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.80 (d, $J = 8.4\text{Hz}$, 1H), 7.70 (d, $J = 8.8\text{Hz}$, 1H), 7.51 (d, $J = 8.0\text{Hz}$, 1H), 7.44-7.41 (m, 1H), 7.31-7.27 (m, 1H), 7.22-7.19 (m, 2H), 7.08-7.06 (m, 1H), 6.99-6.97 (m, 1H), 5.79 (t, $J = 9.2\text{Hz}$, 1H), 5.55 (s, 1H), 5.41 (s, 1H), 3.78 (dd, $J = 15.6\text{Hz}$, $J = 10.0\text{Hz}$, 1H), 3.39 (dd, $J = 15.6\text{Hz}$, $J = 8.0\text{Hz}$, 1H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 156.9, 141.2, 141.0, 130.7, 129.3, 129.2, 128.7, 127.5, 126.7, 124.9, 124.2, 123.0, 122.7, 118.0, 112.0, 111.8, 84.0, 35.4. IR (neat, cm^{-1}): 2917.8, 1629.8, 1599.0, 1521.0, 1465.1, 1242.4. HRMS (ESI): m/z calcd for $\text{C}_{18}\text{H}_{14}\text{OS}$ $[\text{M}+\text{H}]^+$ 279.0838, found 279.0848.

2-(1-cyclohexylvinyl)-1,2-dihydronaphtho[2,1-b]furan 6q

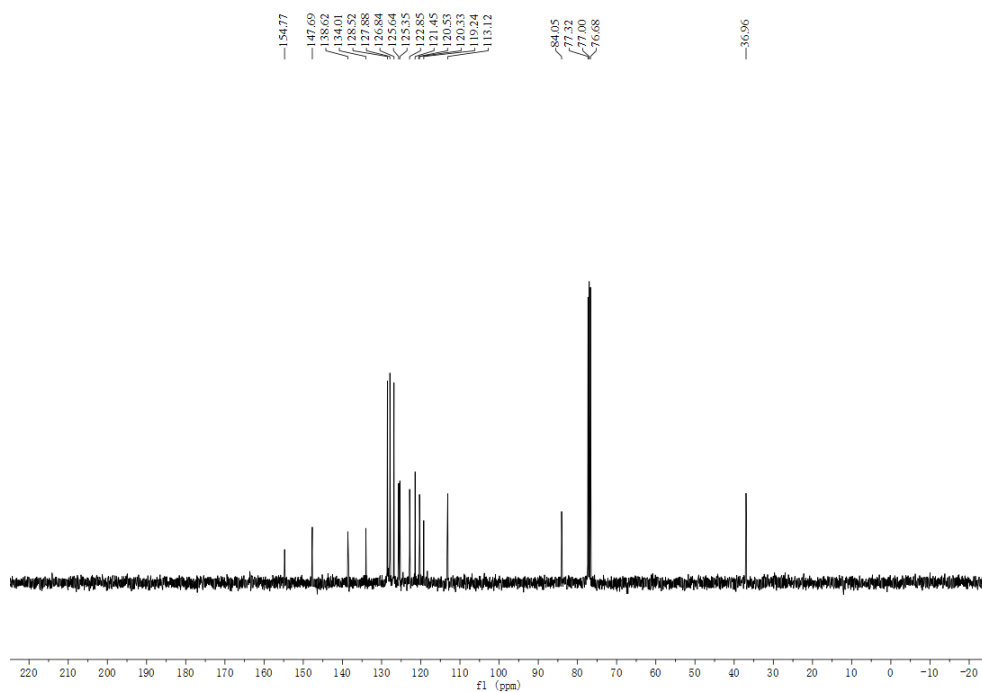
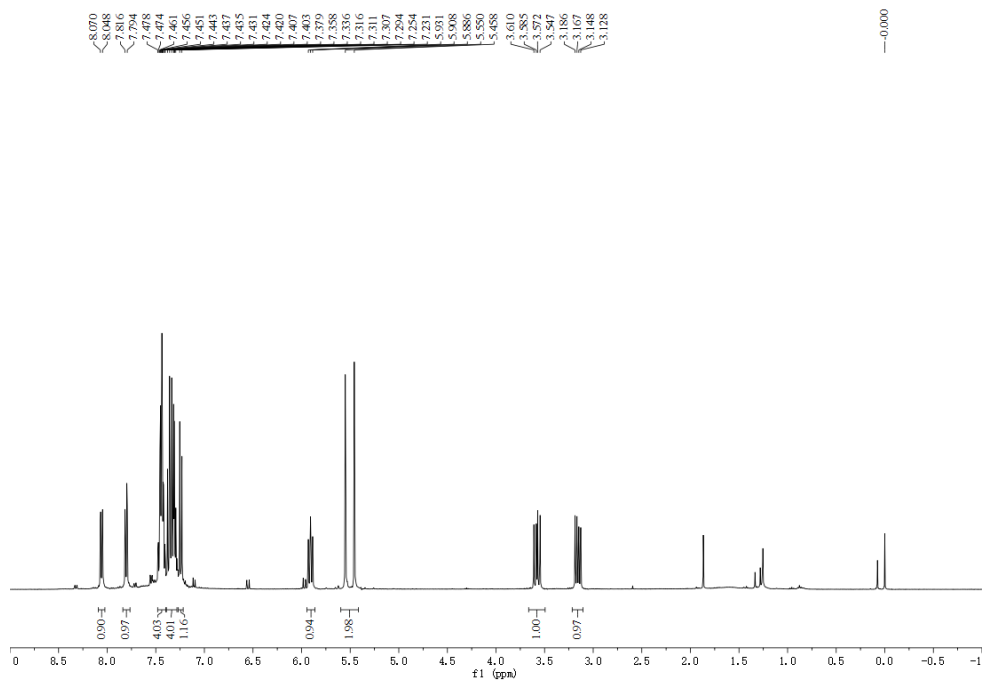


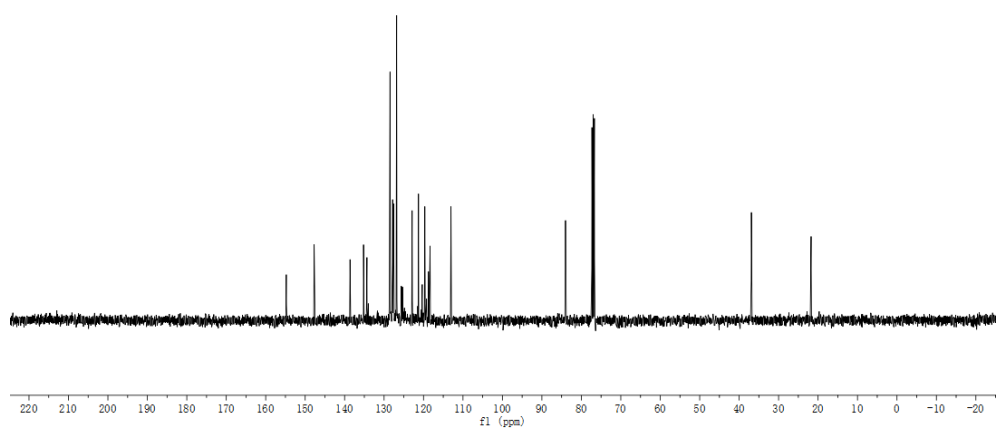
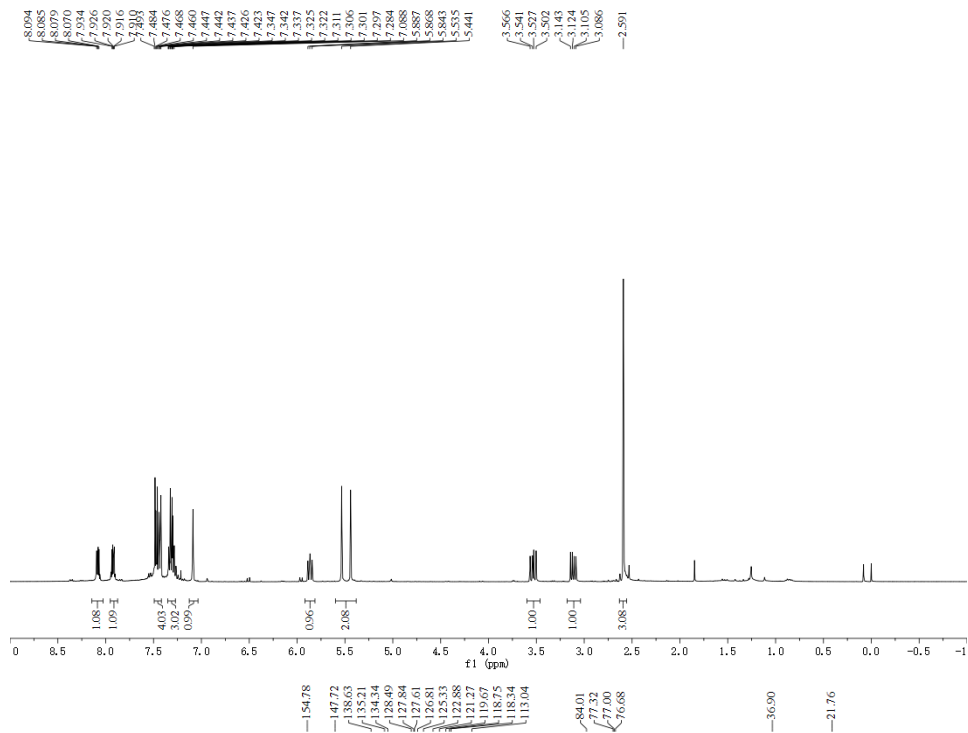
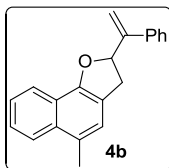
17.0mg, colorless oil, yield 31%. ^1H NMR (400 MHz, CDCl_3 ; δ , ppm): 7.80 (d, $J = 8.4\text{Hz}$, 1H), 7.69 (d, $J = 8.8\text{Hz}$, 1H), 7.57 (d, $J = 8.4\text{Hz}$, 1H), 7.46 (t, $J = 6.8\text{Hz}$, 1H), 7.30 (t, $J = 8.0\text{Hz}$, 1H), 7.14 (d, $J = 8.8\text{Hz}$, 1H), 5.41 (t, $J = 8.8\text{Hz}$, 1H), 5.20 (s, 1H), 4.98 (s, 1H), 3.66 (dd, $J = 15.2\text{Hz}$, $J = 10.0\text{Hz}$, 1H), 3.27 (dd, $J = 15.2\text{Hz}$, $J = 10.0\text{Hz}$, 1H), 2.05-2.01 (m, 1H), 1.89-1.68 (m, 5H), 1.32-1.24 (m, 5H). ^{13}C NMR (100 MHz, CDCl_3 ; δ , ppm): 157.3, 154.3, 130.8, 129.2, 128.9, 128.7, 126.6, 122.7, 122.6, 118.1, 112.0, 108.6, 85.3, 40.5, 35.0, 33.5, 33.2, 26.8, 26.2. IR (neat, cm^{-1}): 3058.7, 2924.9, 2851.7, 1631.3, 1600.9, 1499.7, 1240.8. HRMS (ESI): m/z calcd for $\text{C}_{20}\text{H}_{22}\text{O}$ $[\text{M}+\text{H}]^+$ 279.1743, found 279.1747.

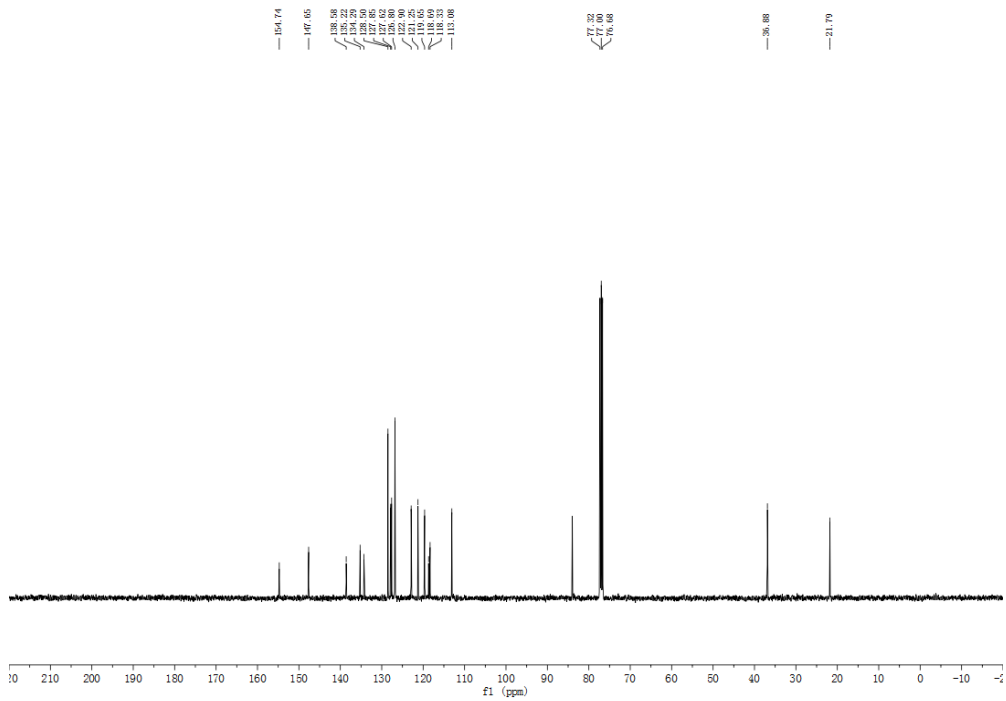
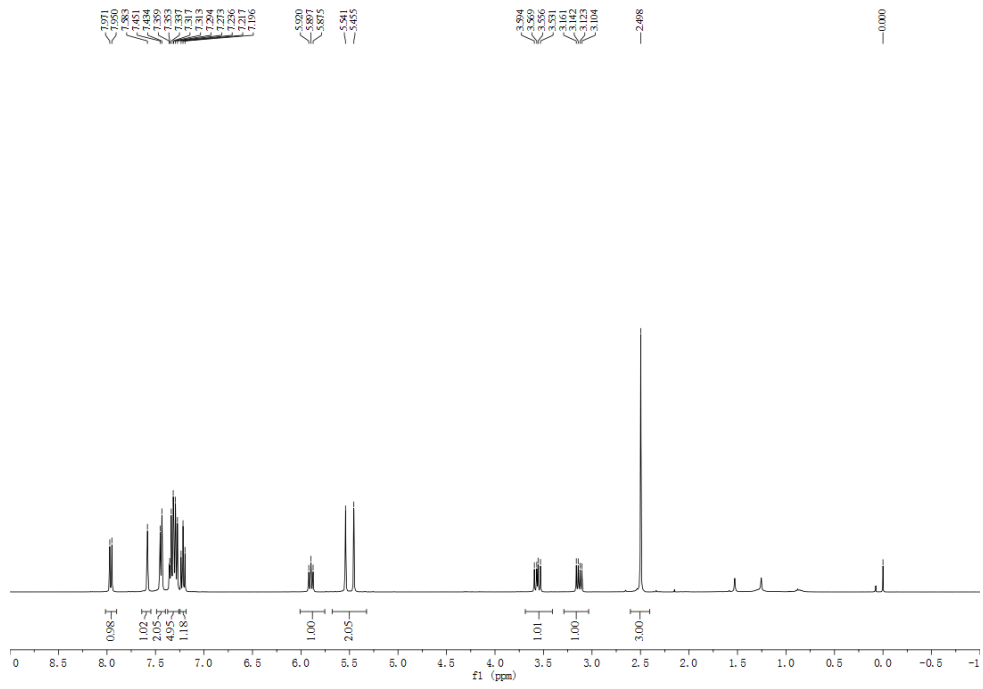
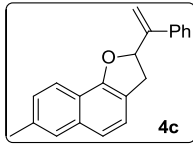
8. The Spectra of Products

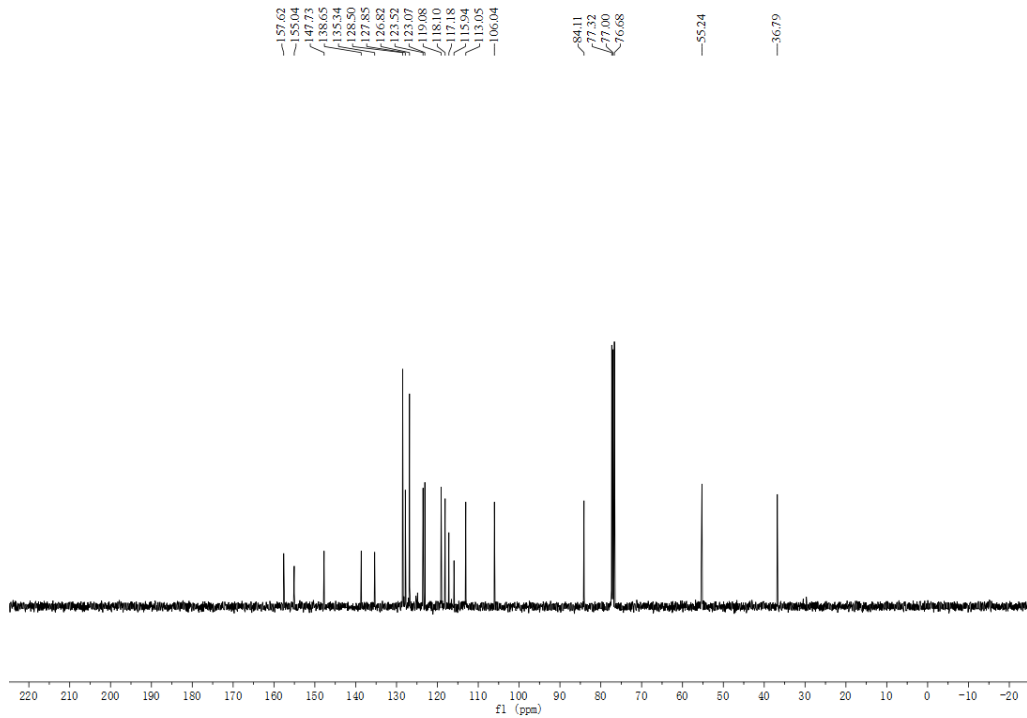
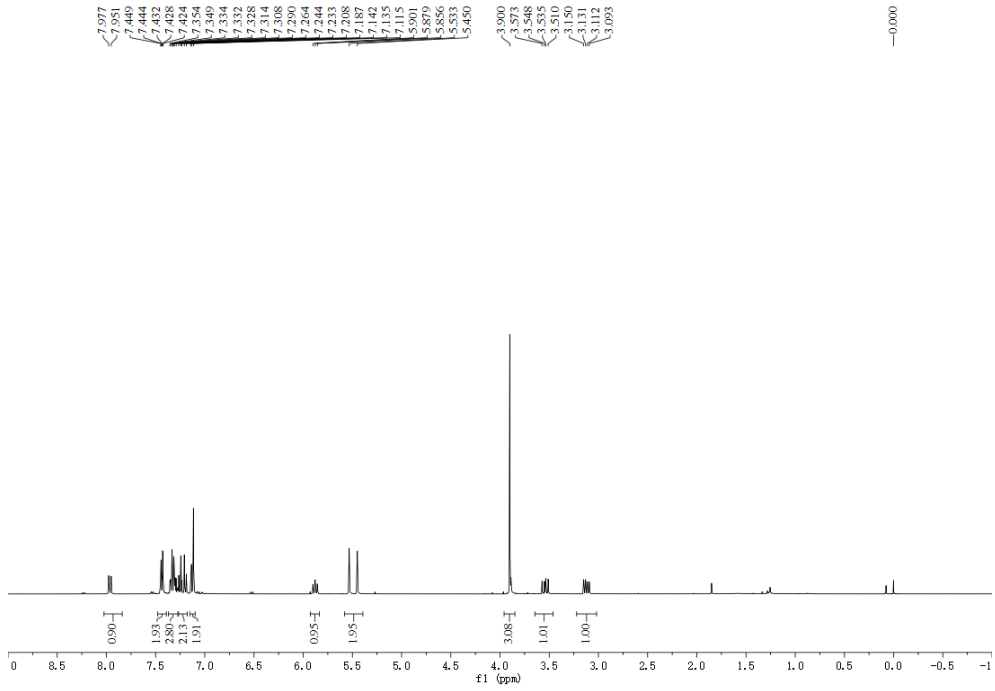
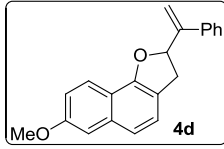


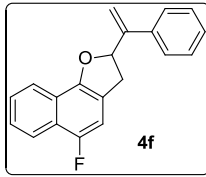
regioselectivity 25:1



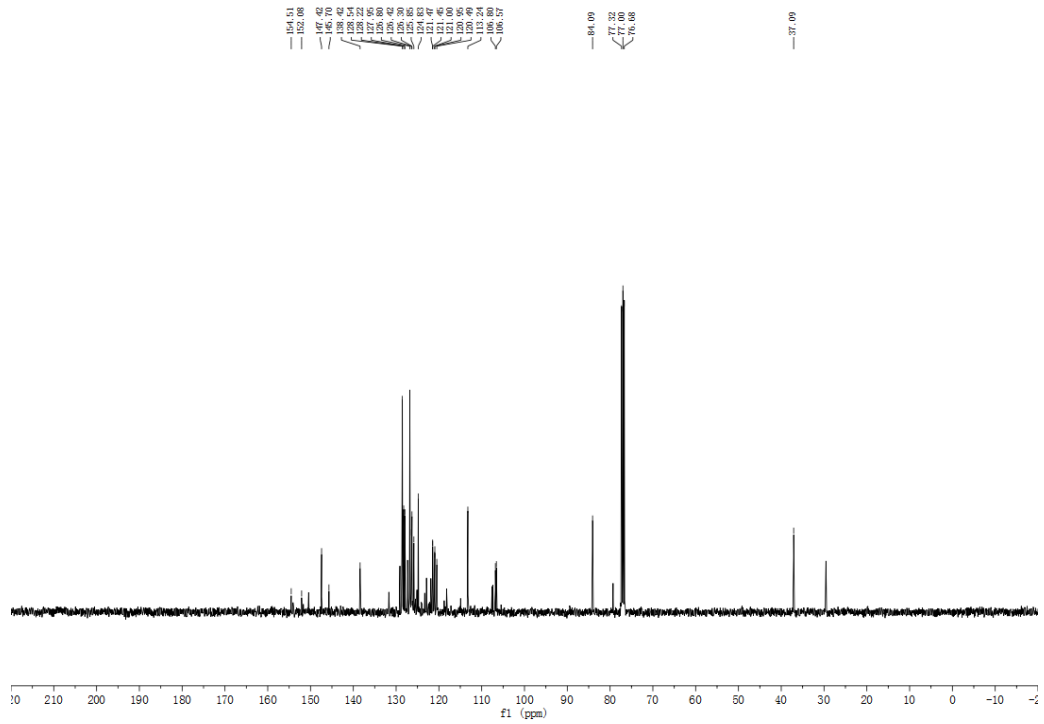
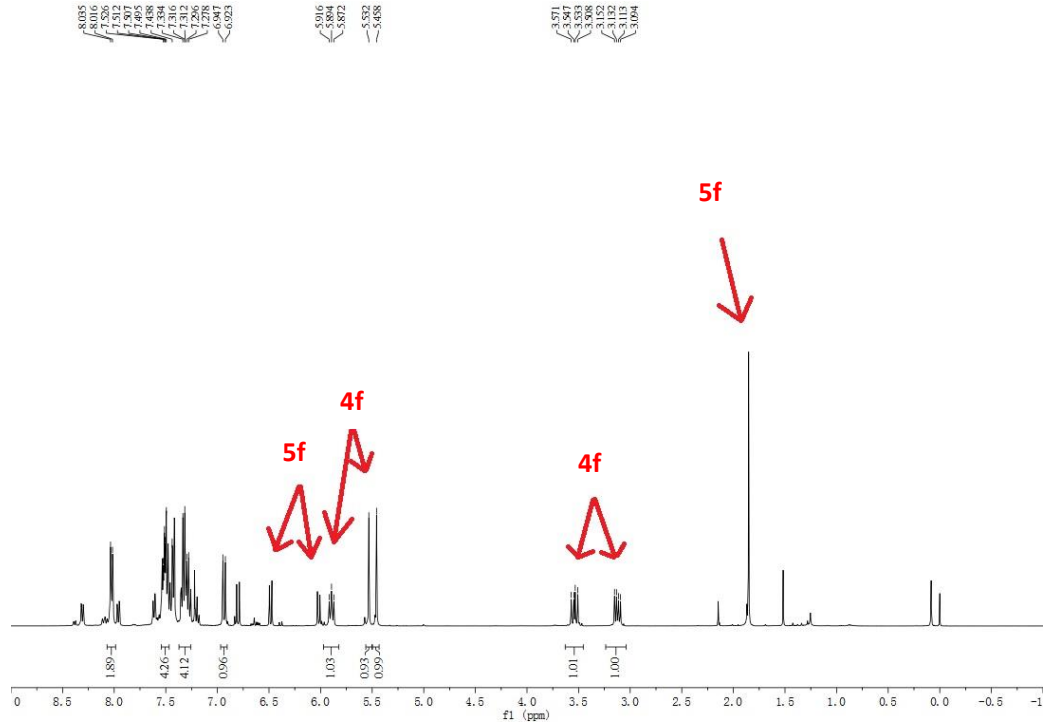


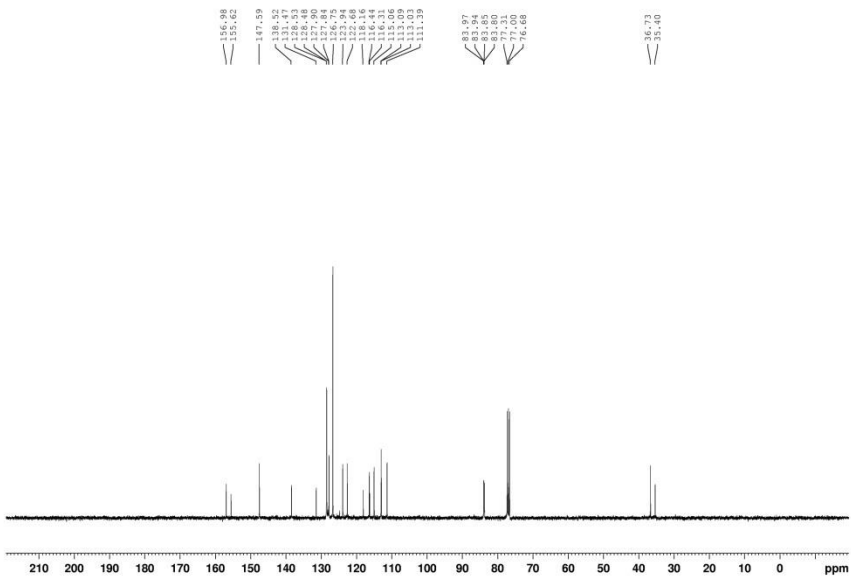
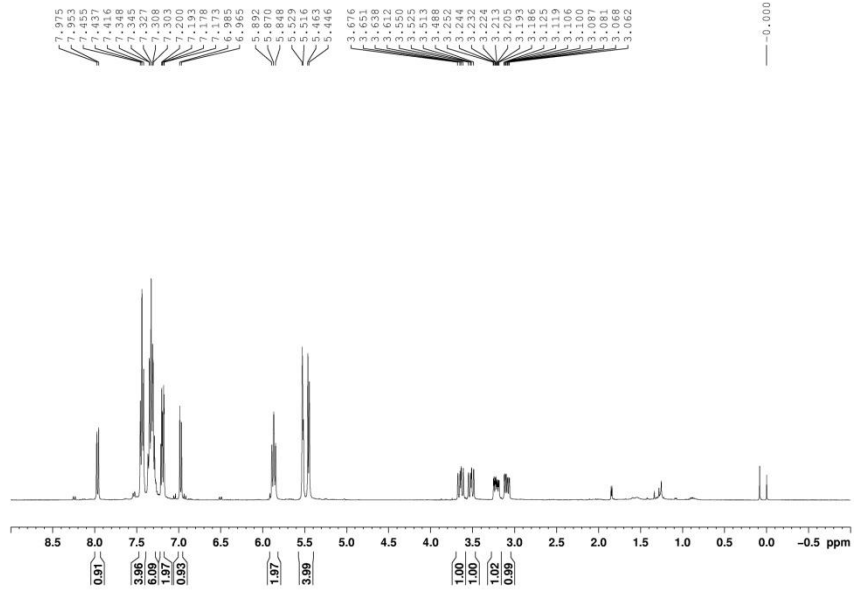
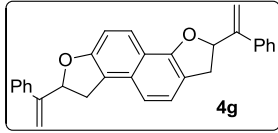


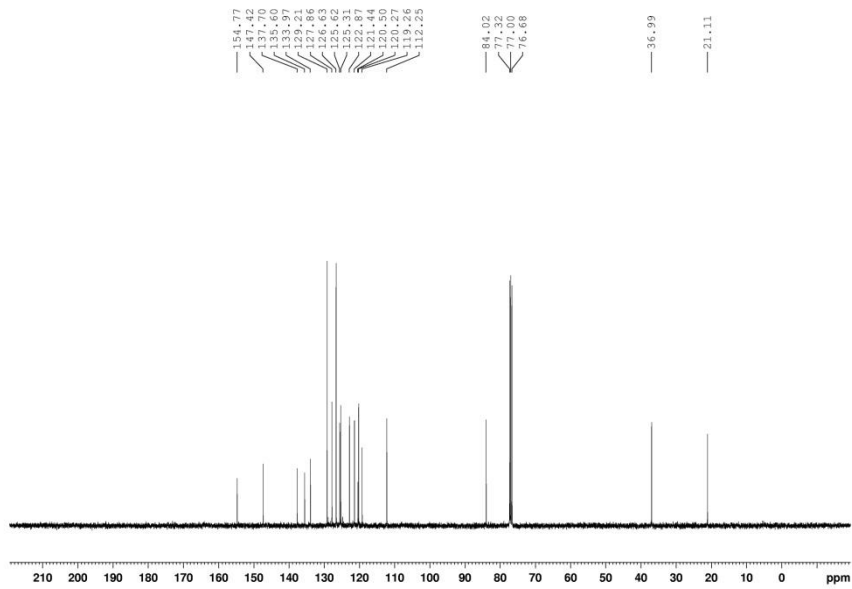
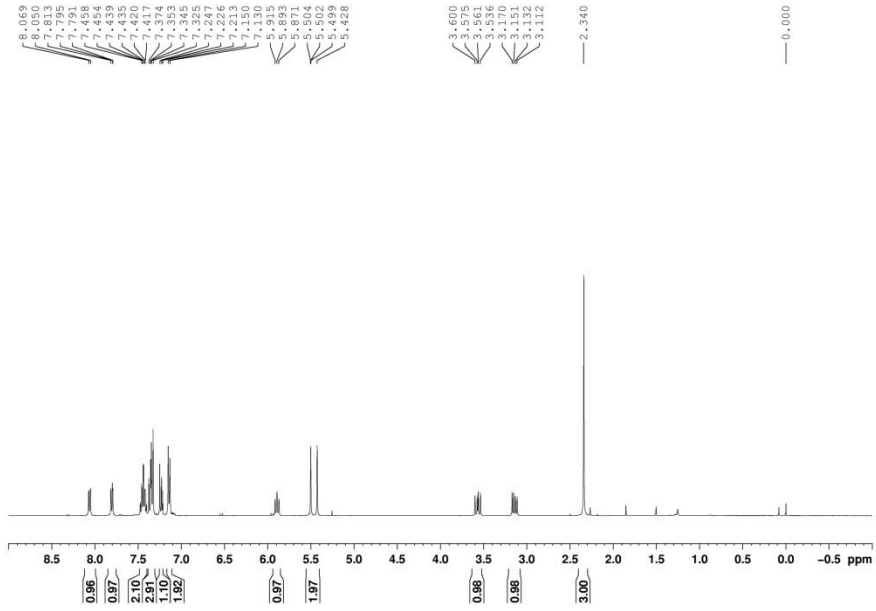
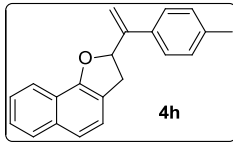


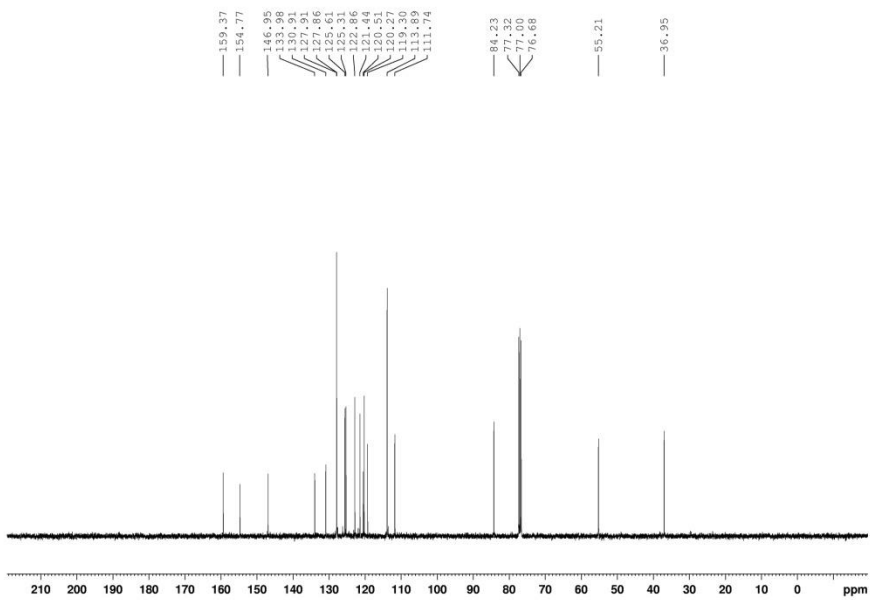
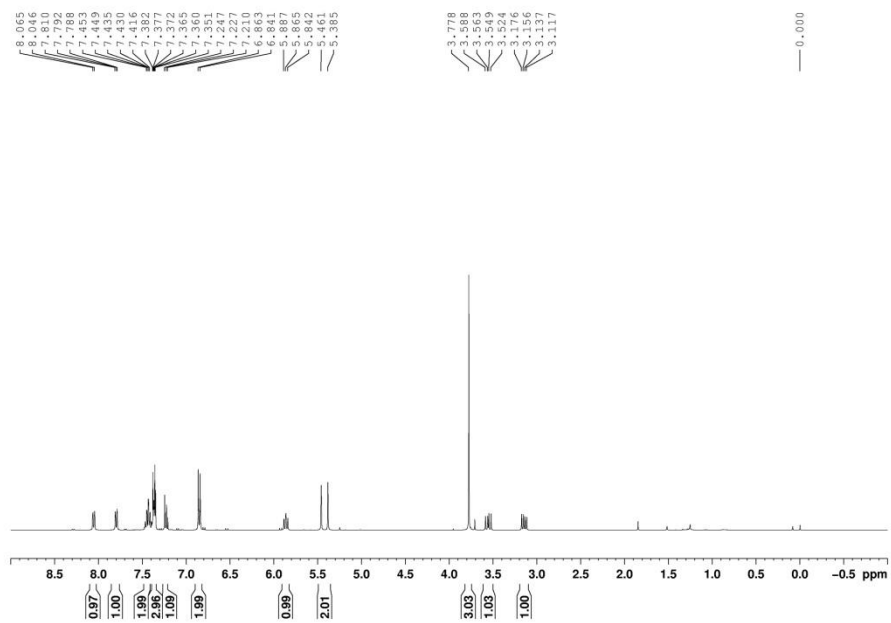
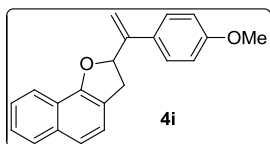


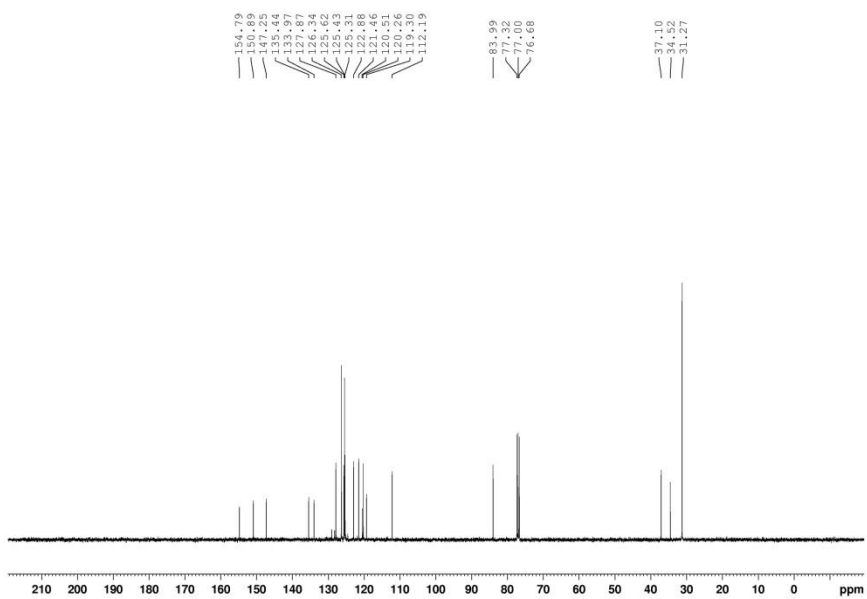
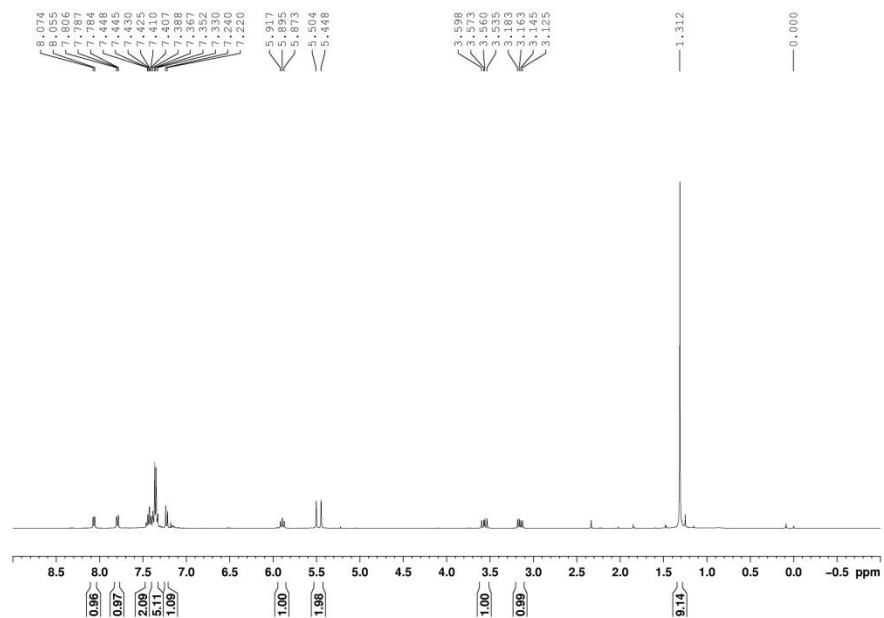
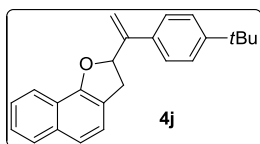
regioselectivity 2:1

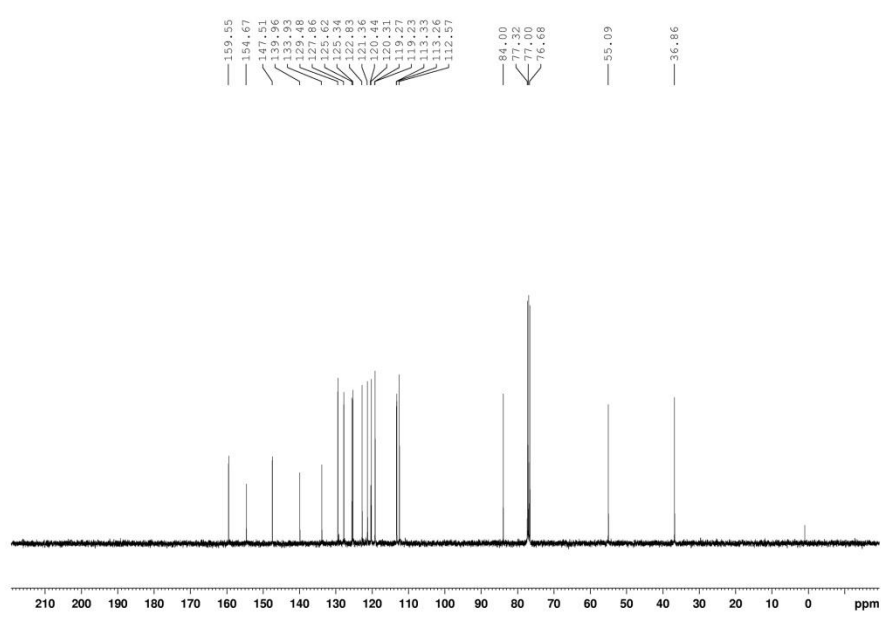
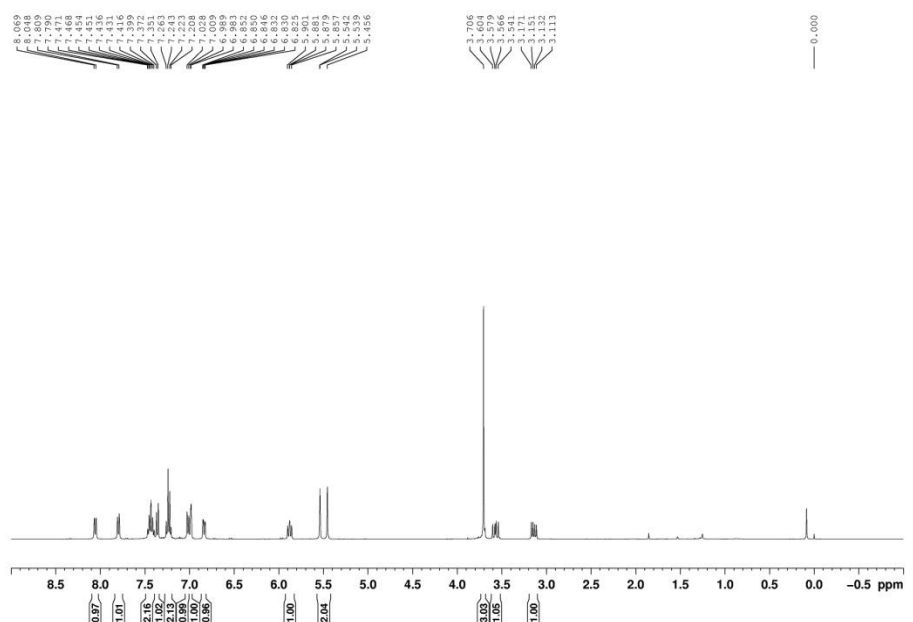
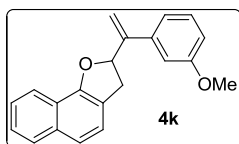


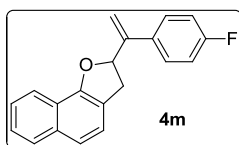




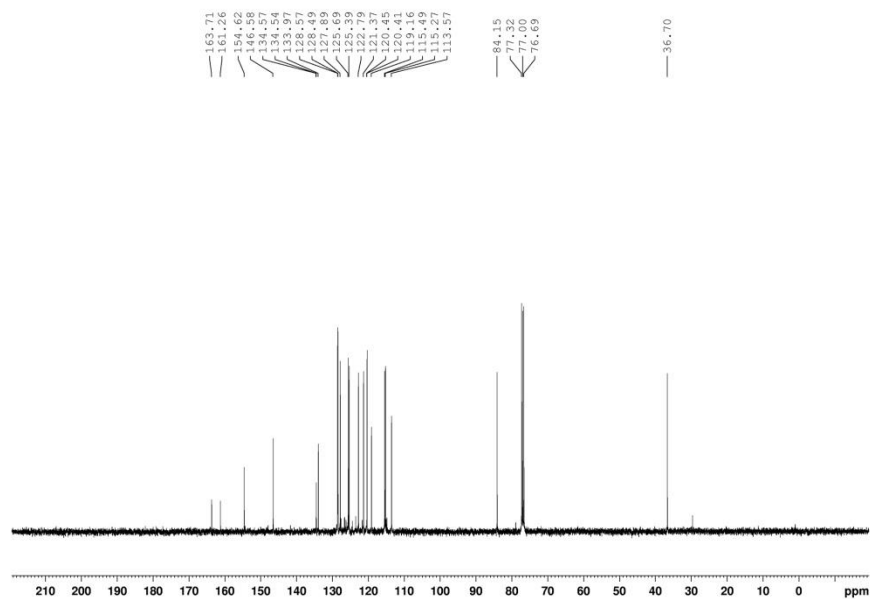
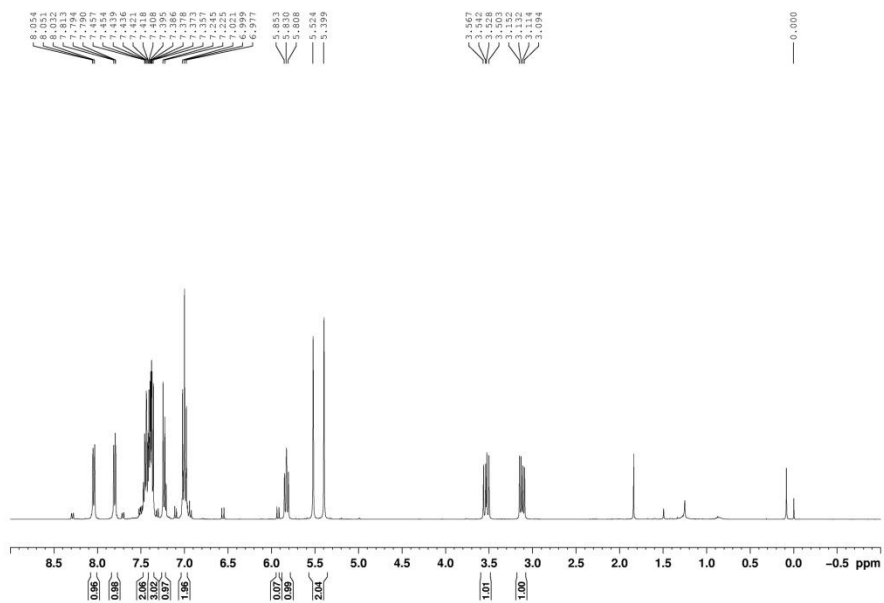


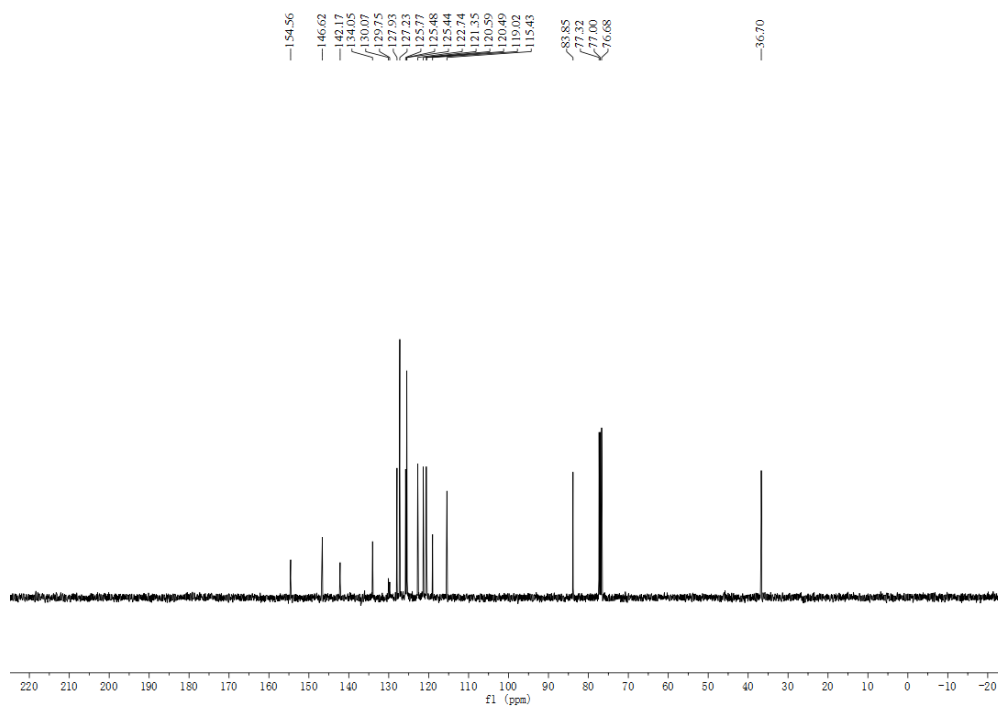
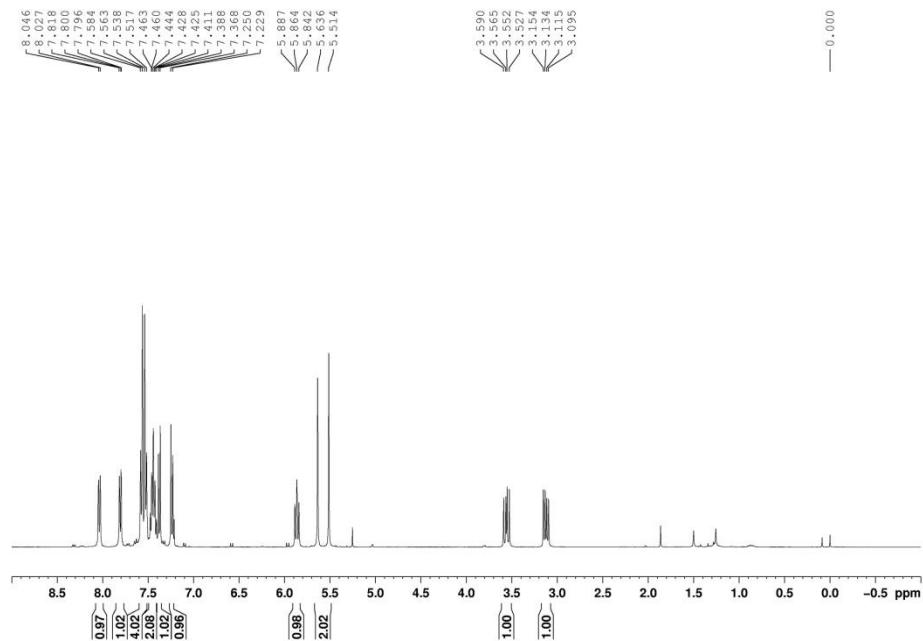
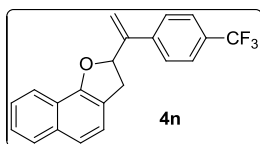


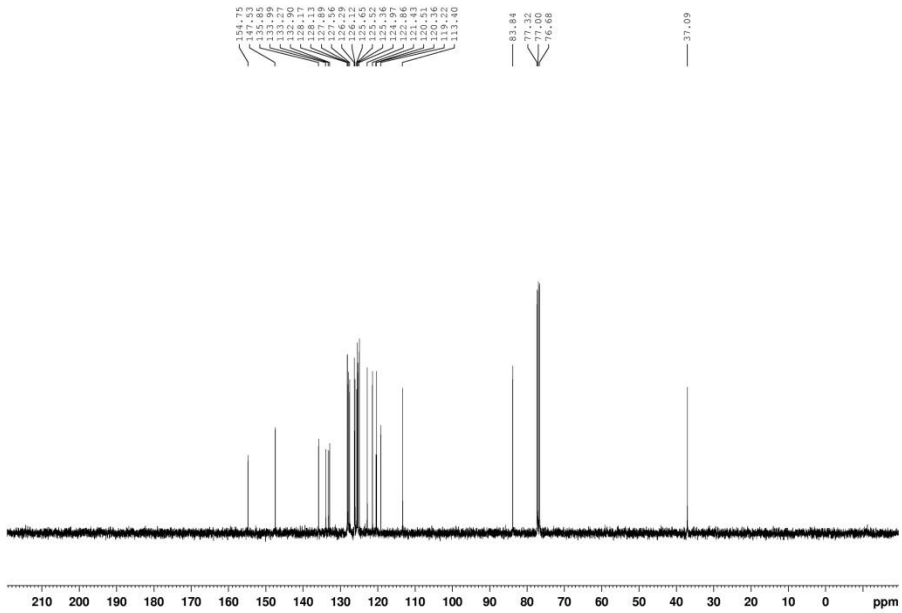
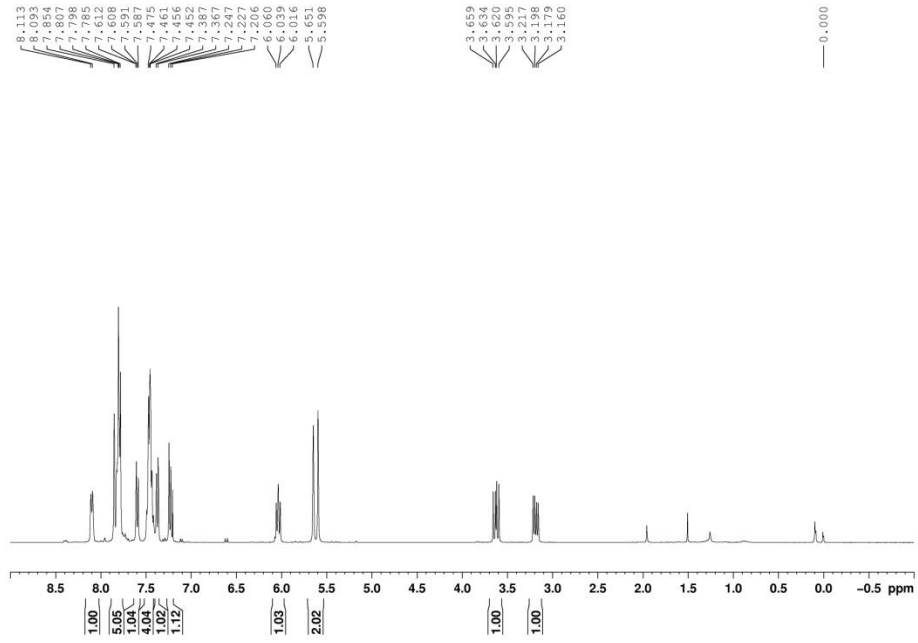
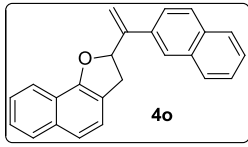


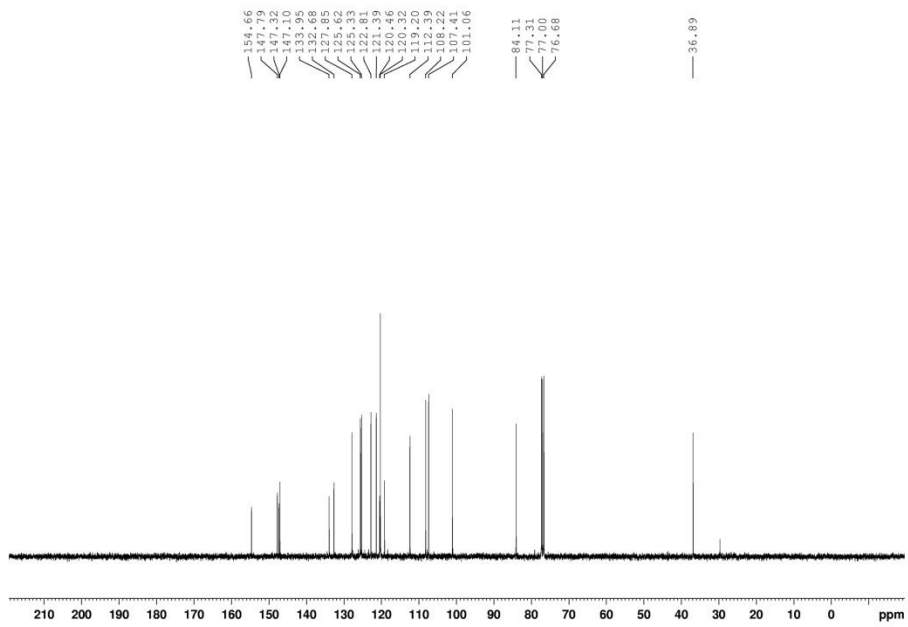
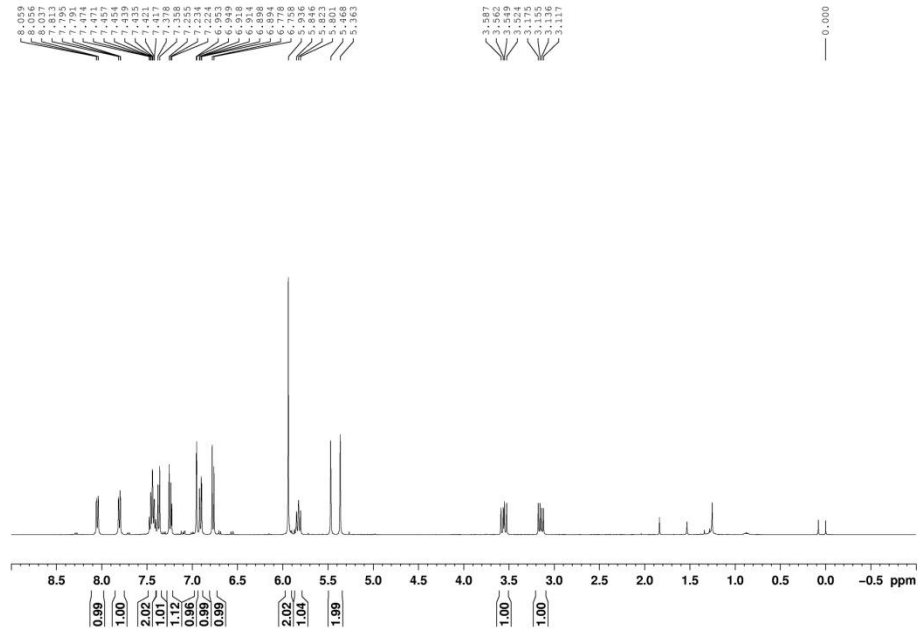
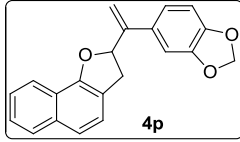


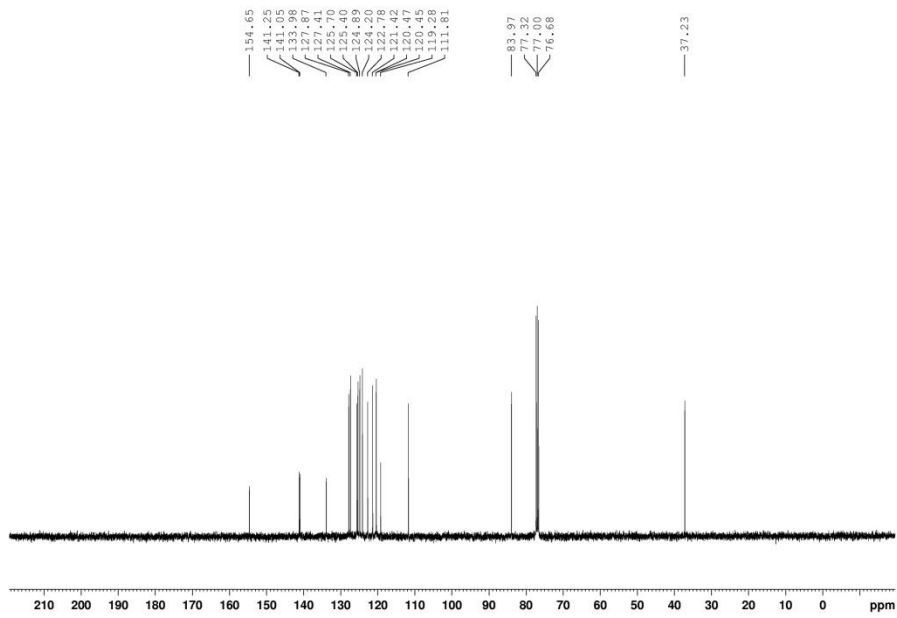
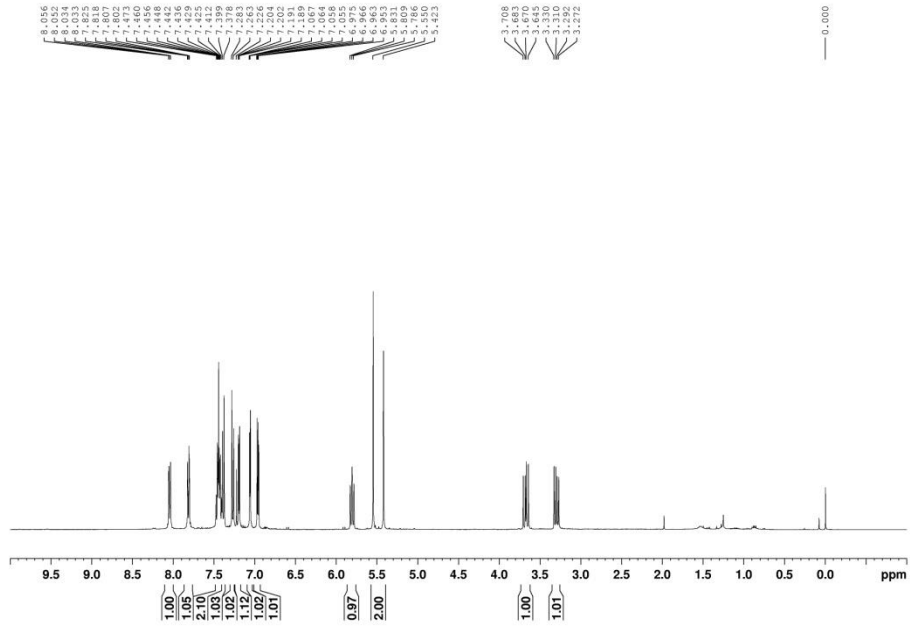
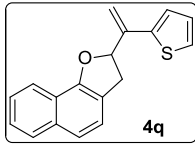
regioselectivity 14:1

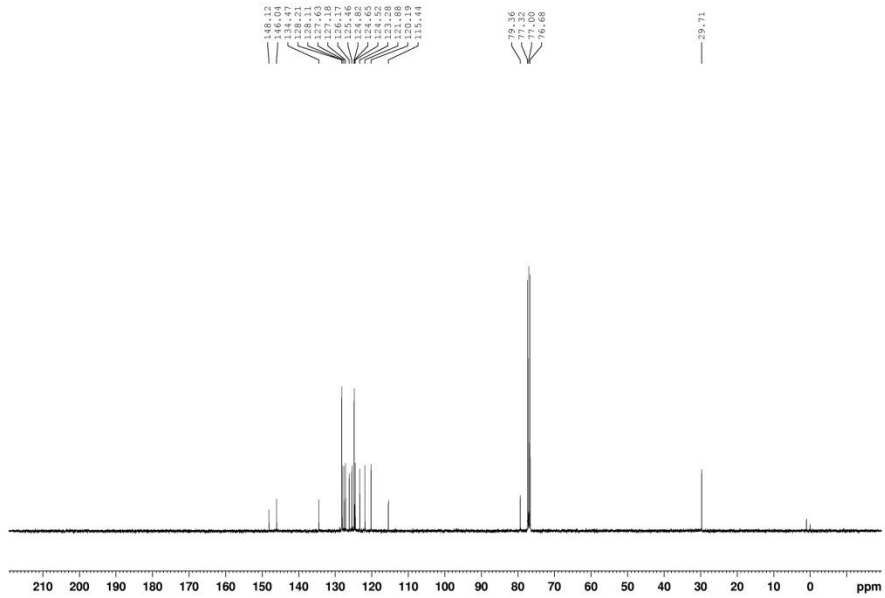
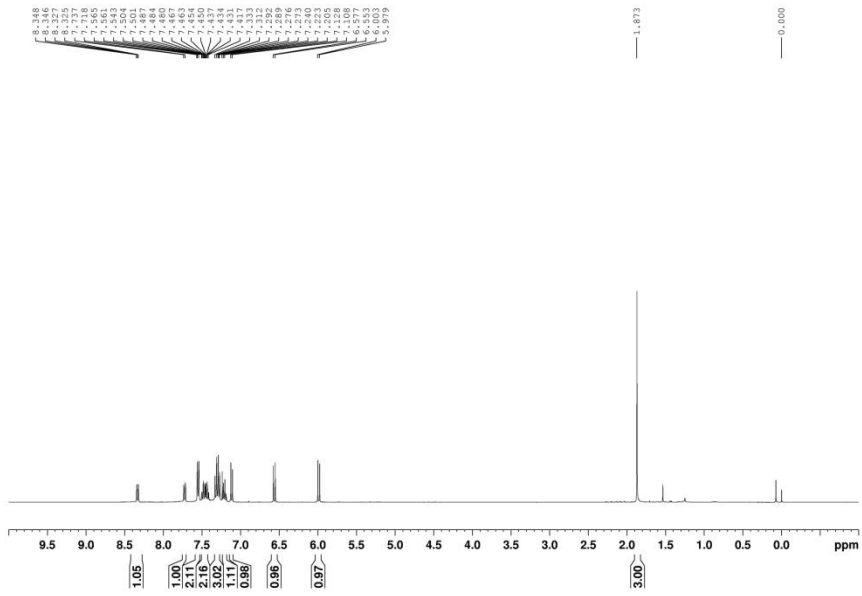
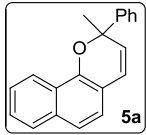


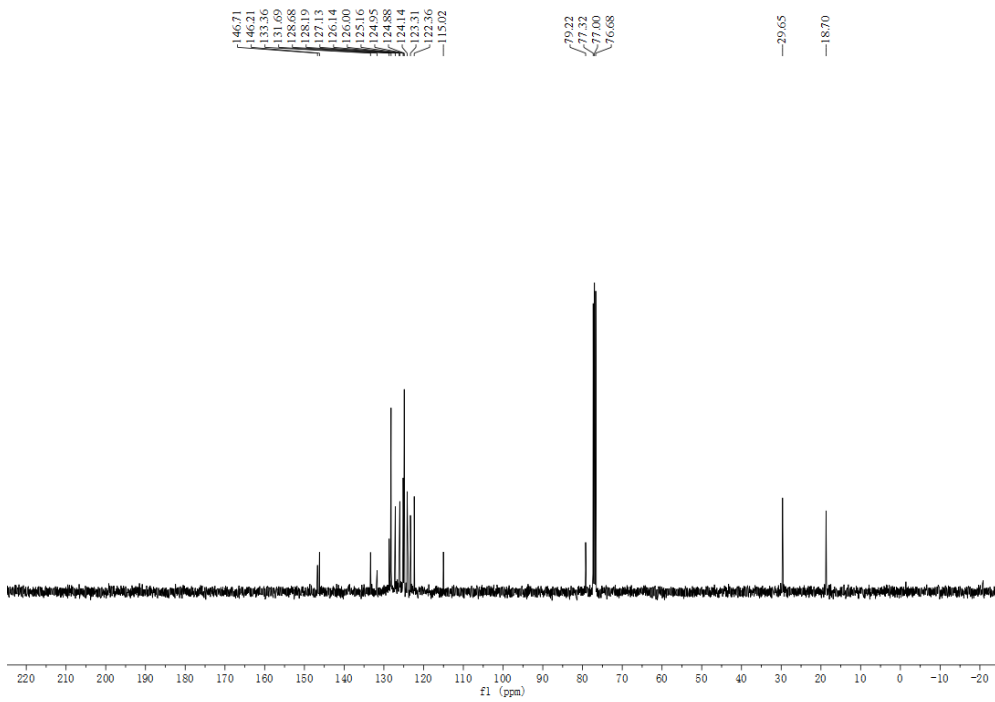
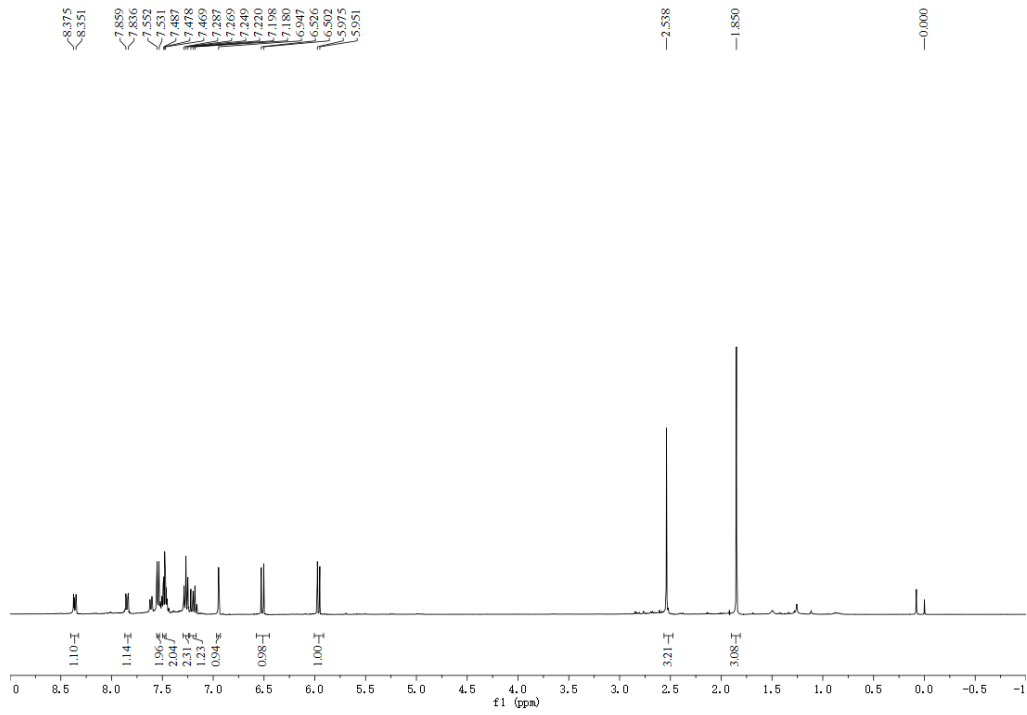
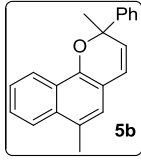


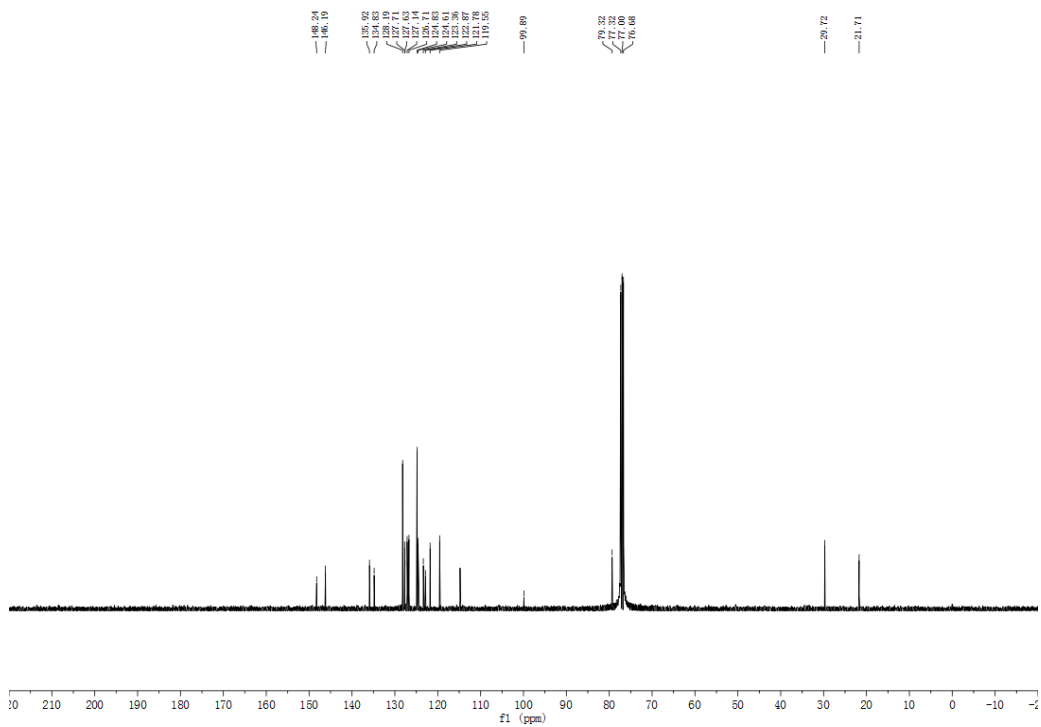
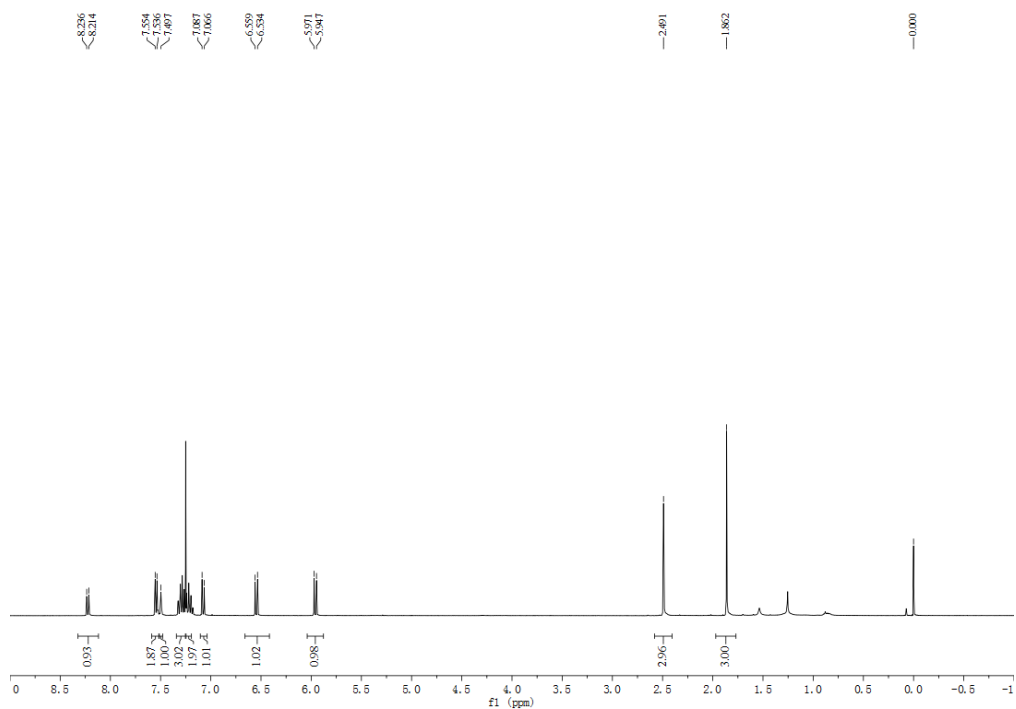
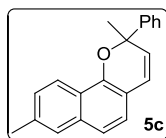


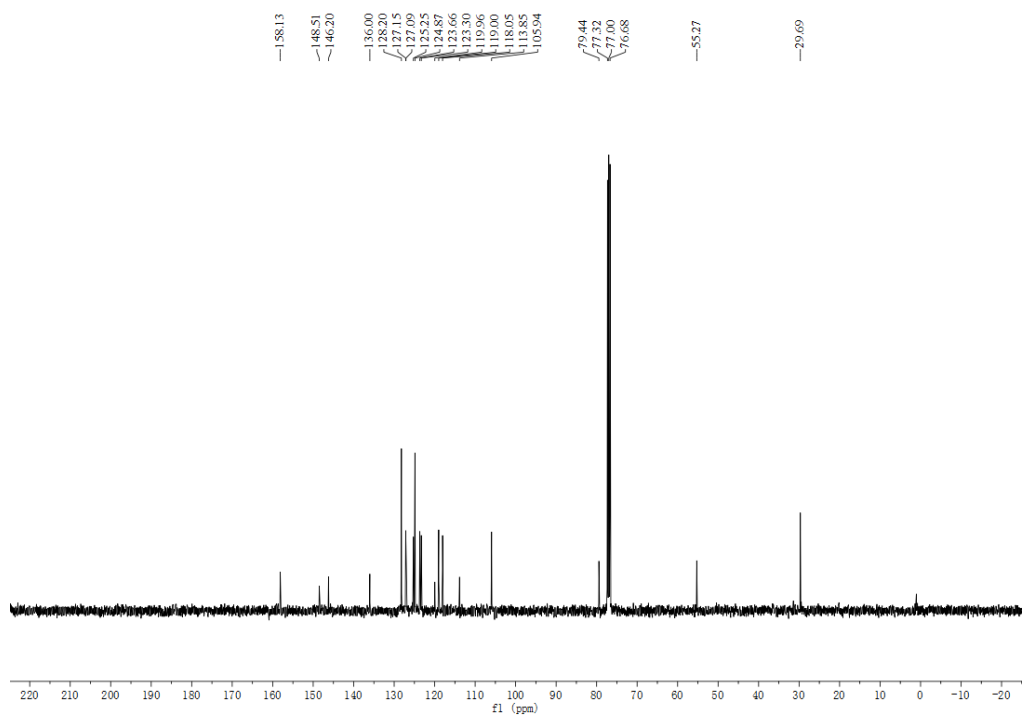
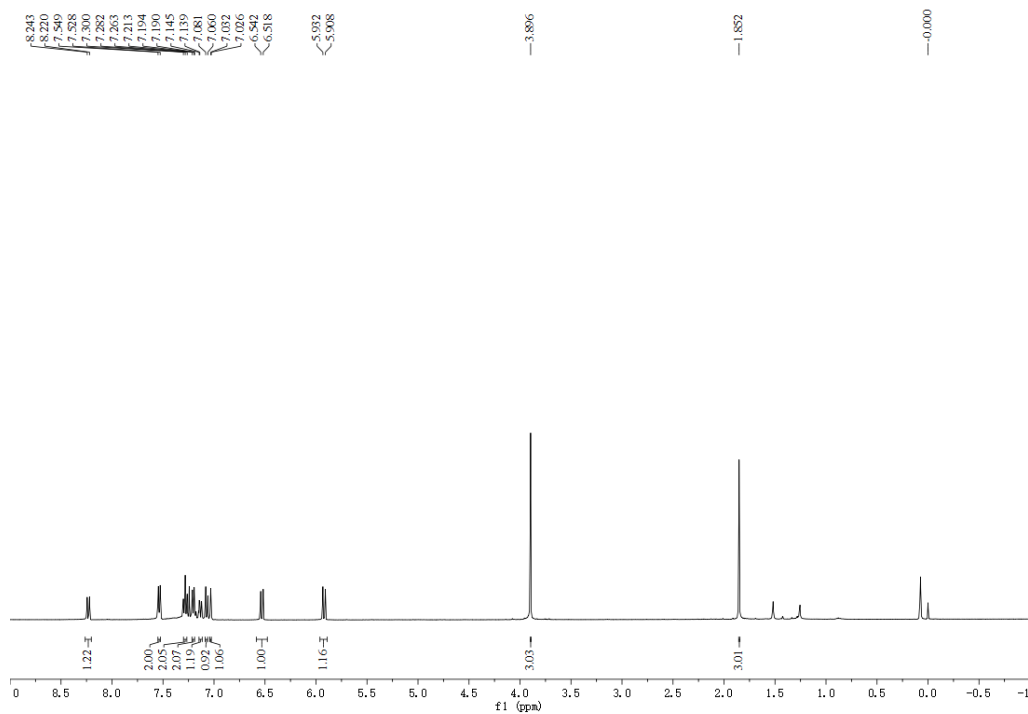
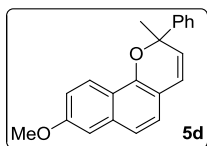


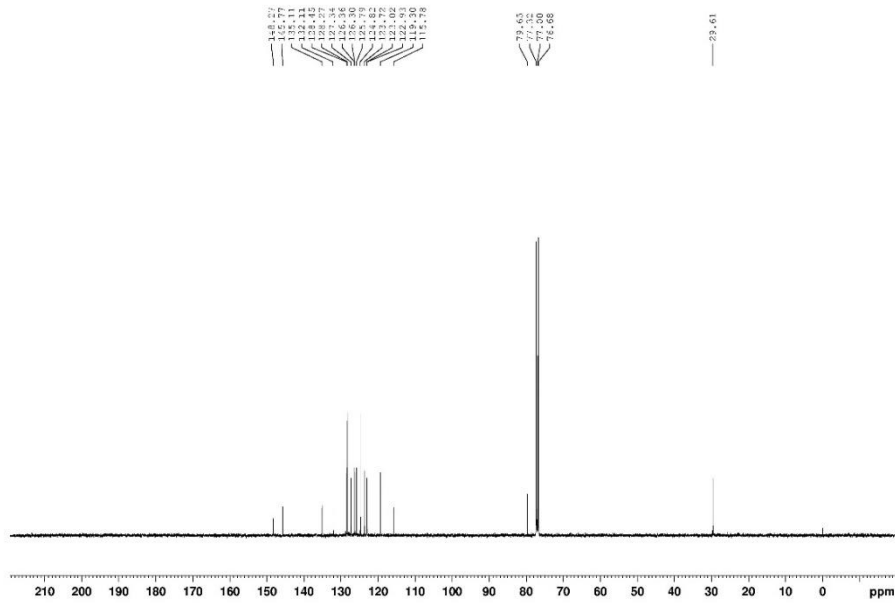
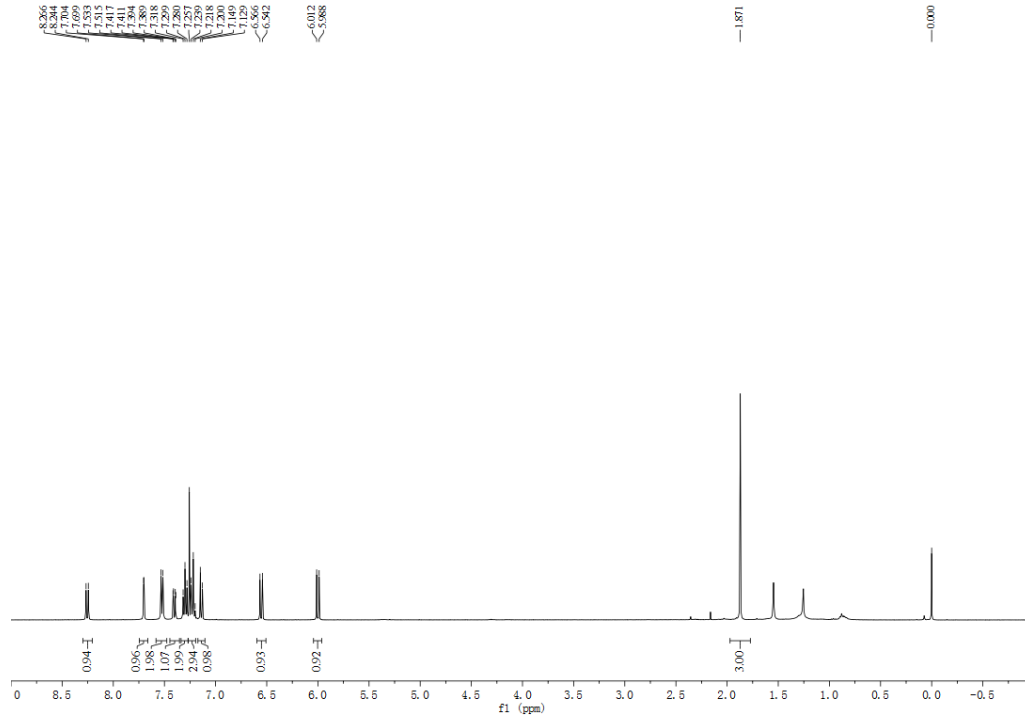
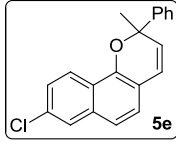


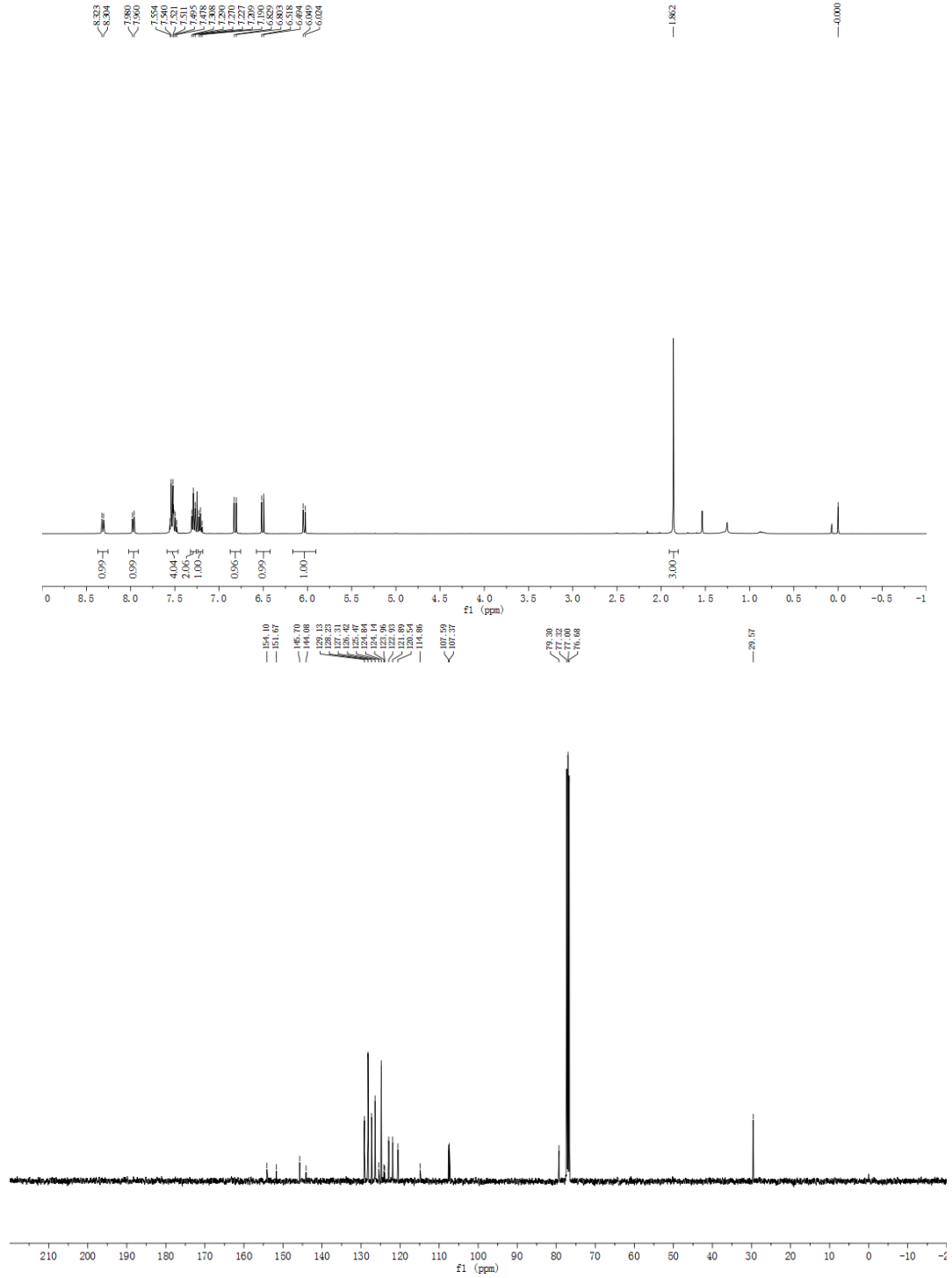
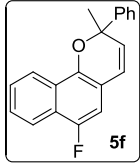


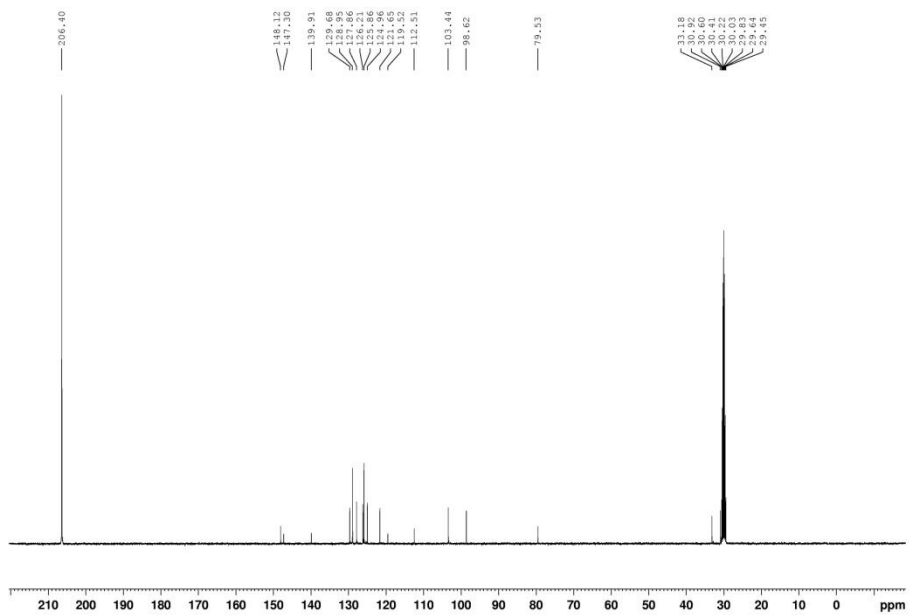
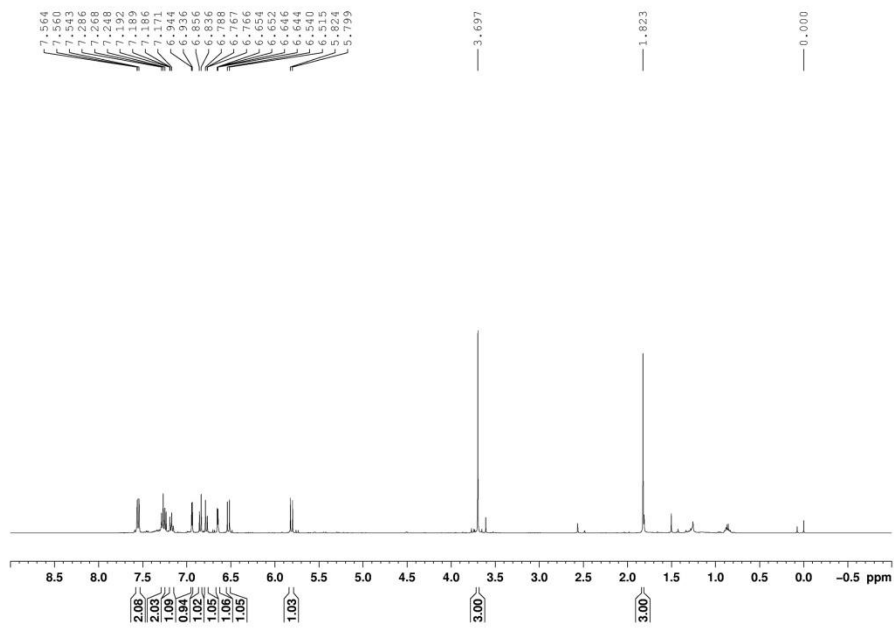
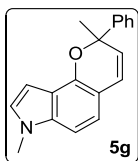


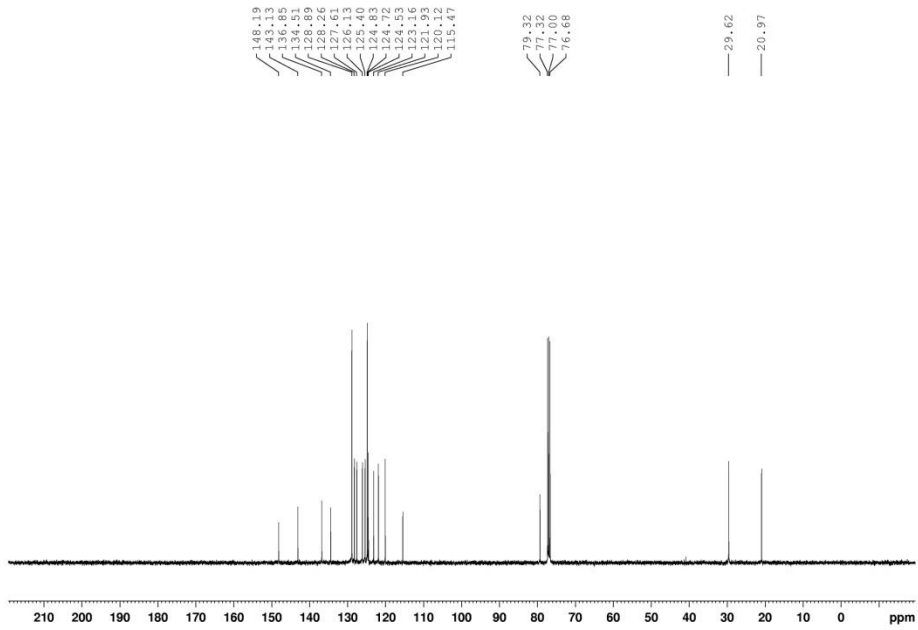
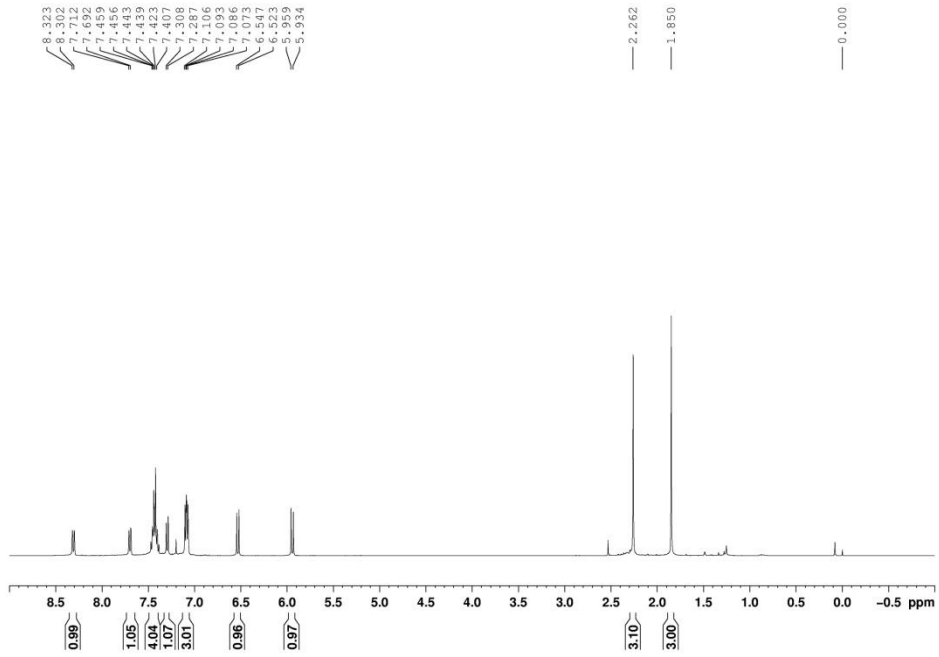
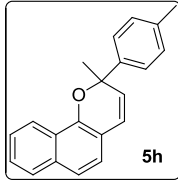


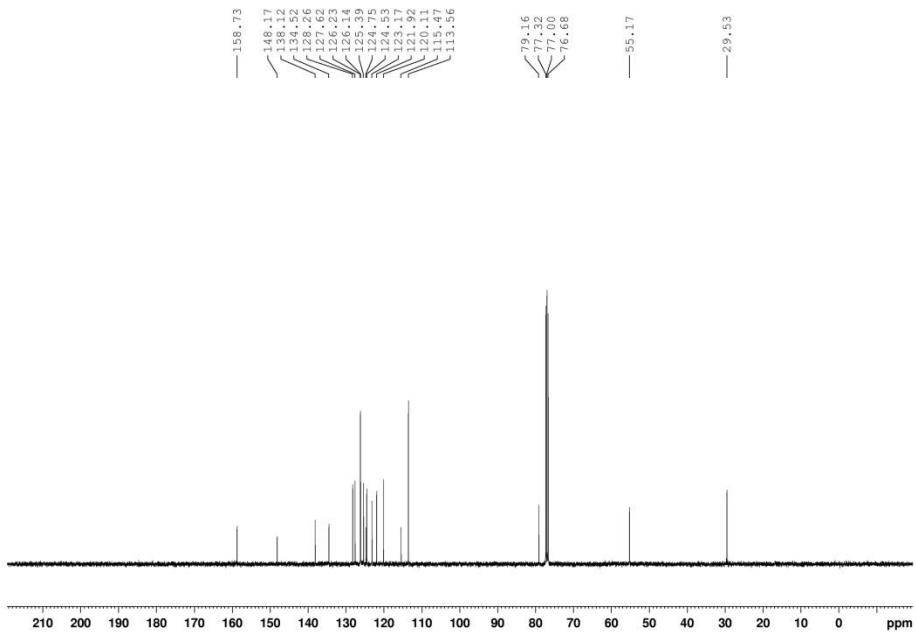
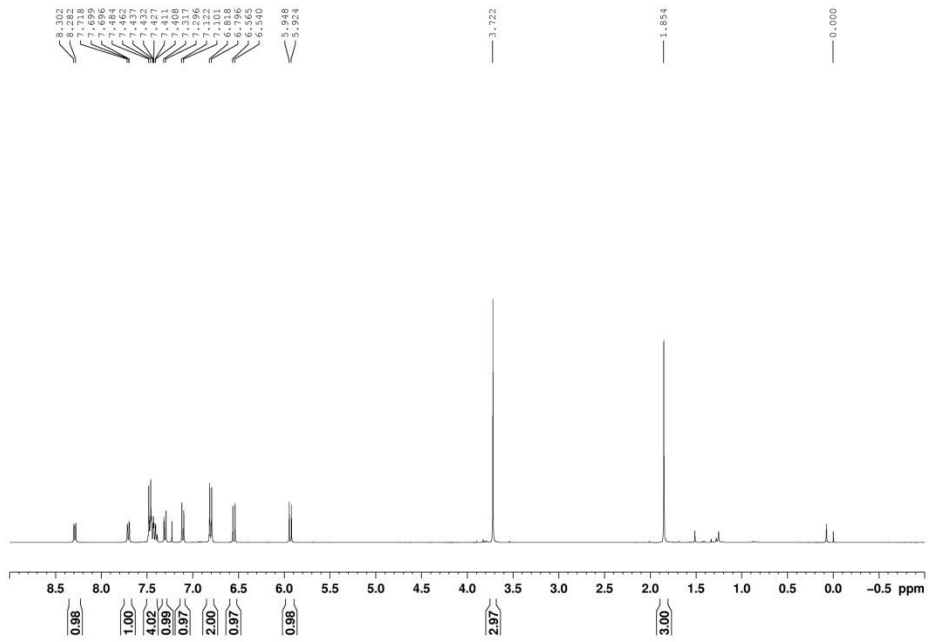
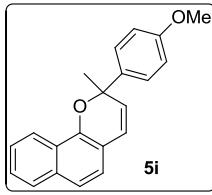


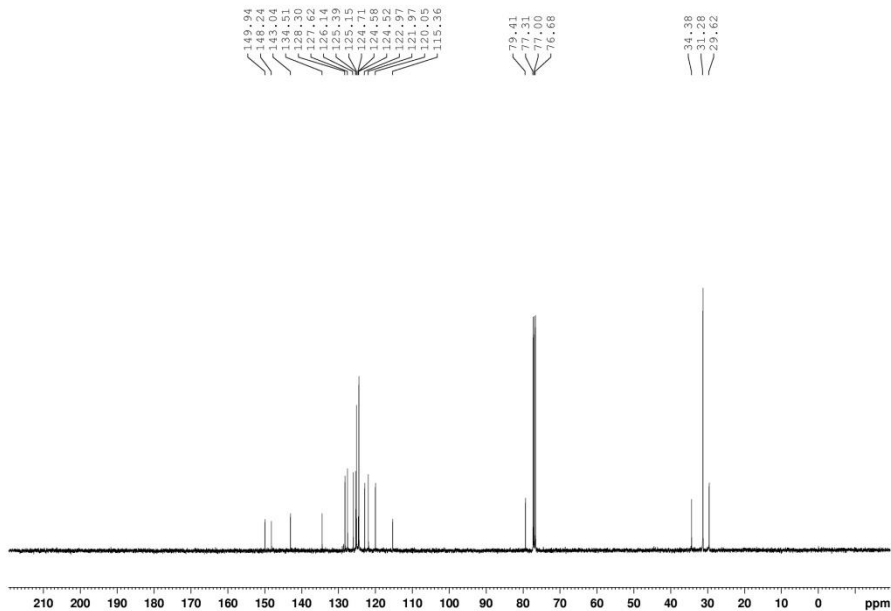
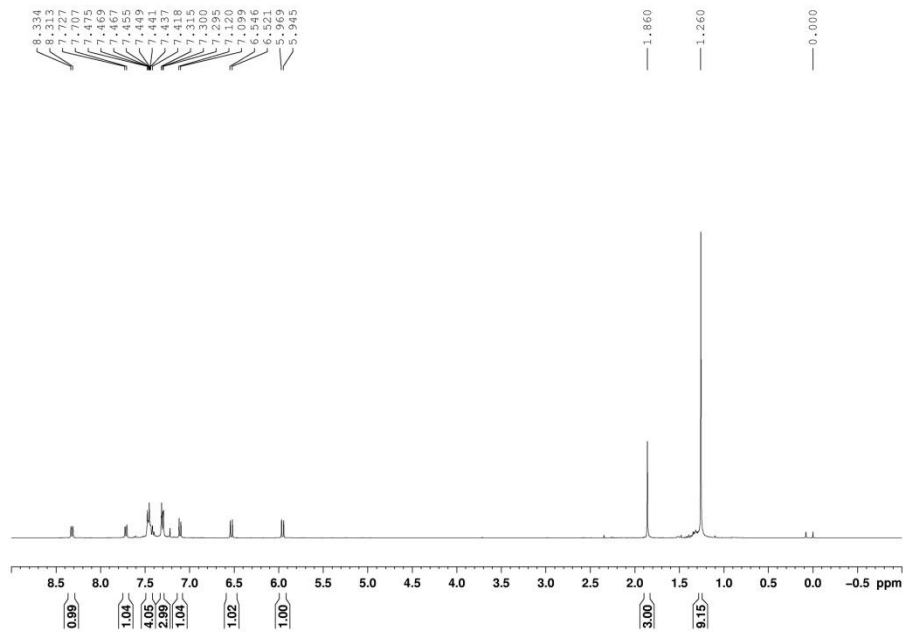
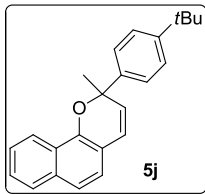


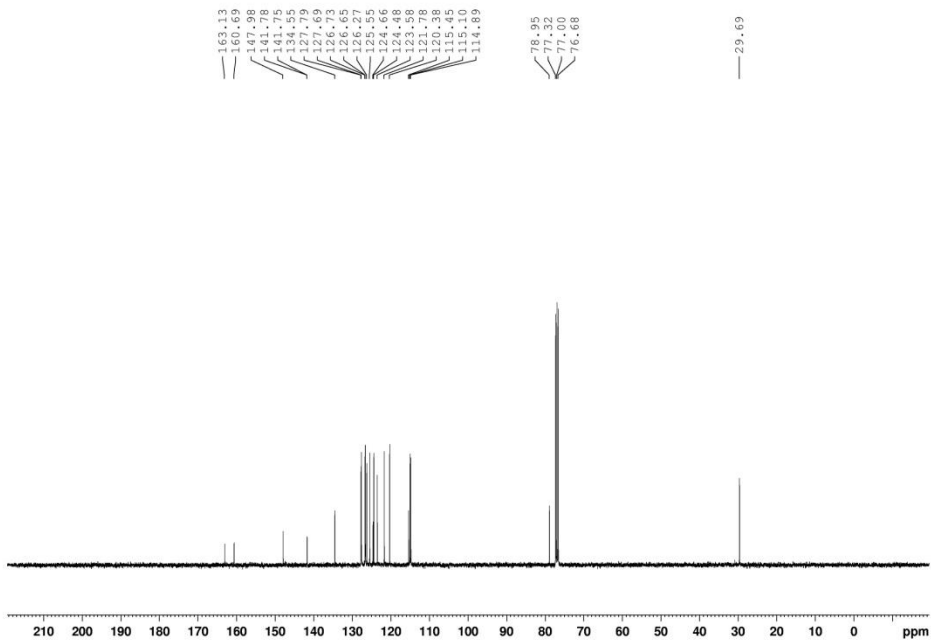
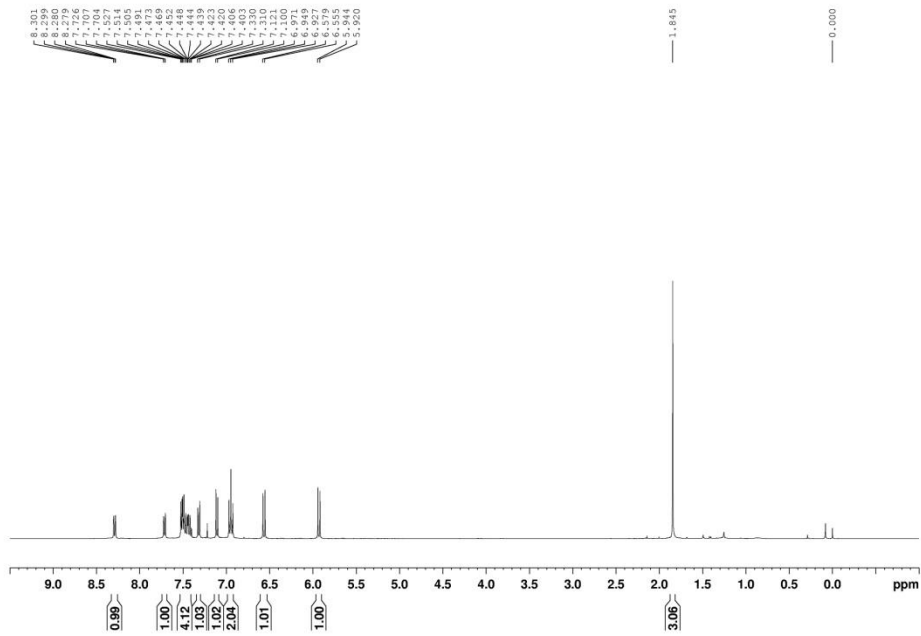
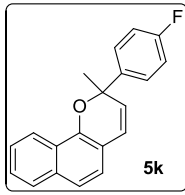


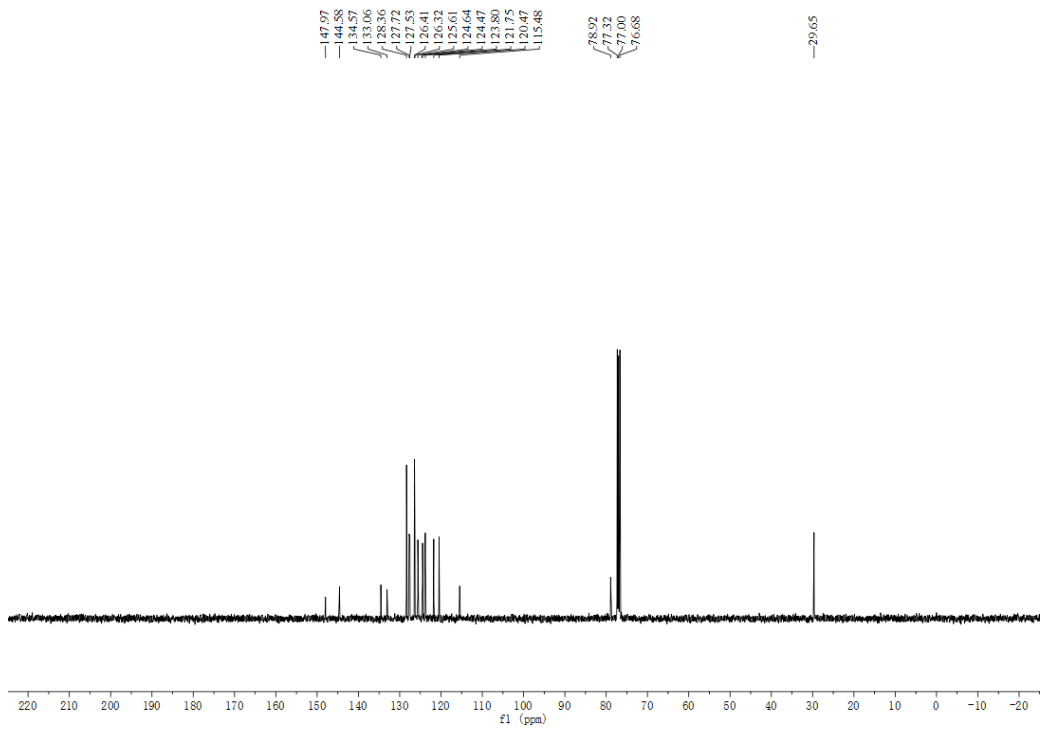
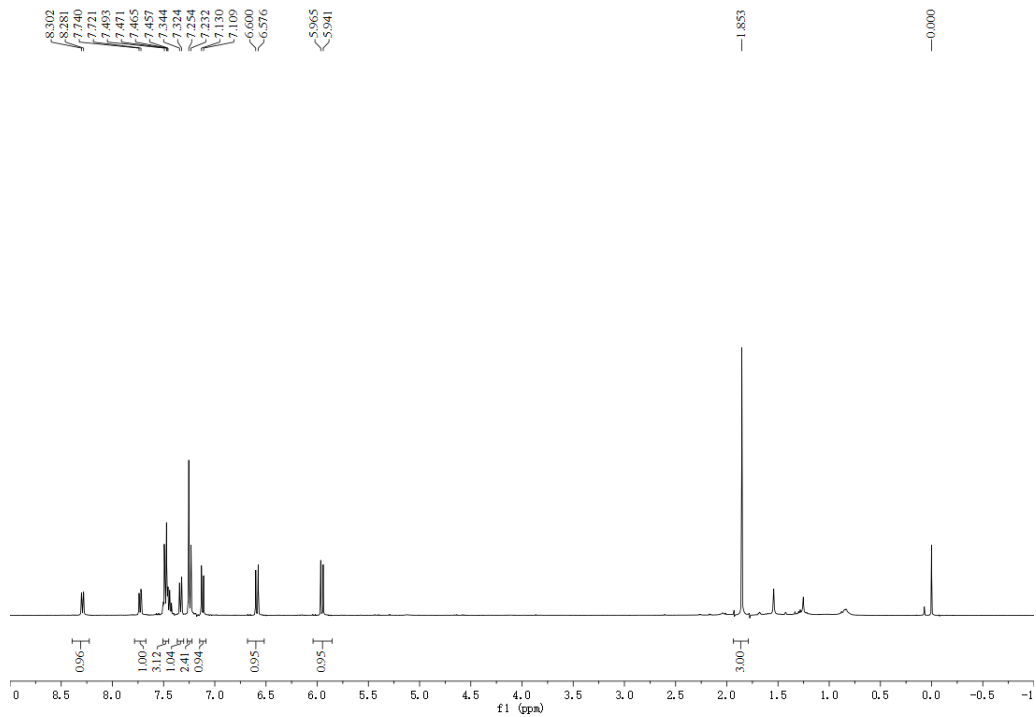
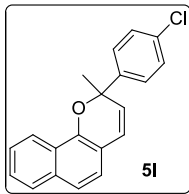


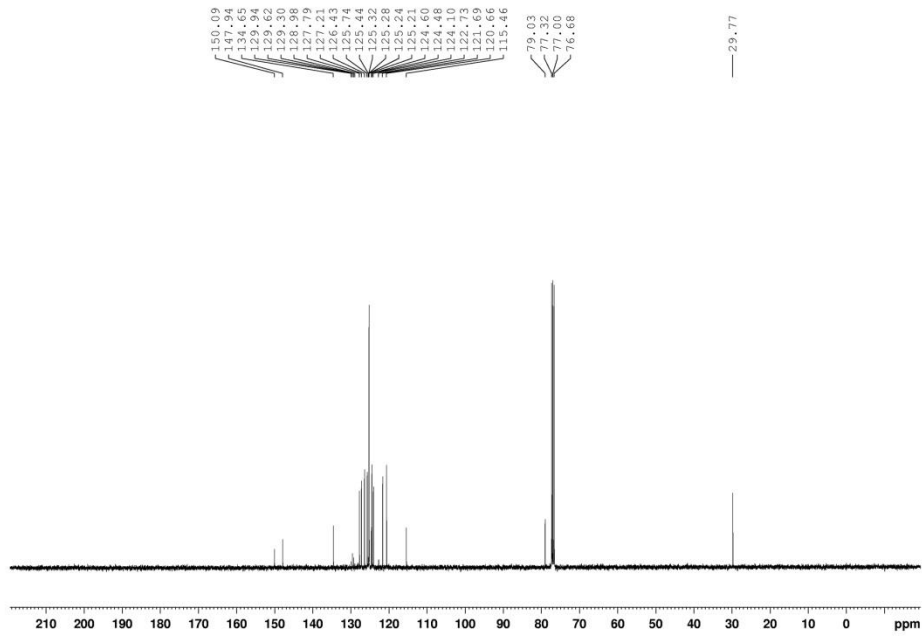
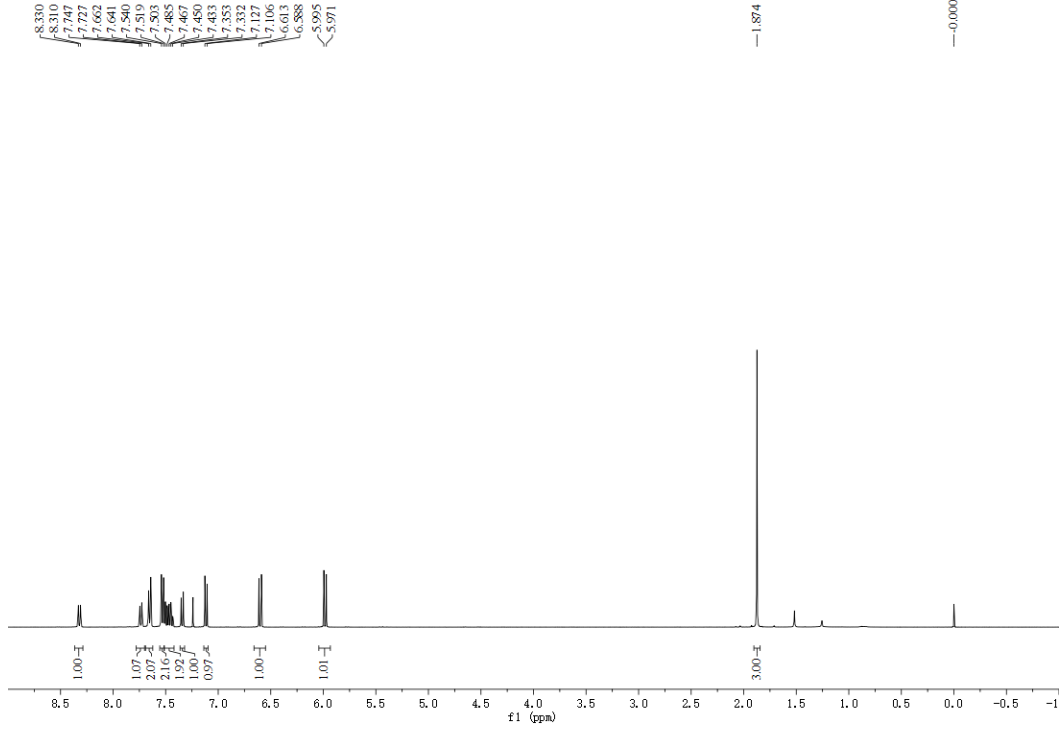
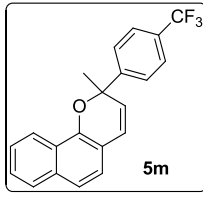


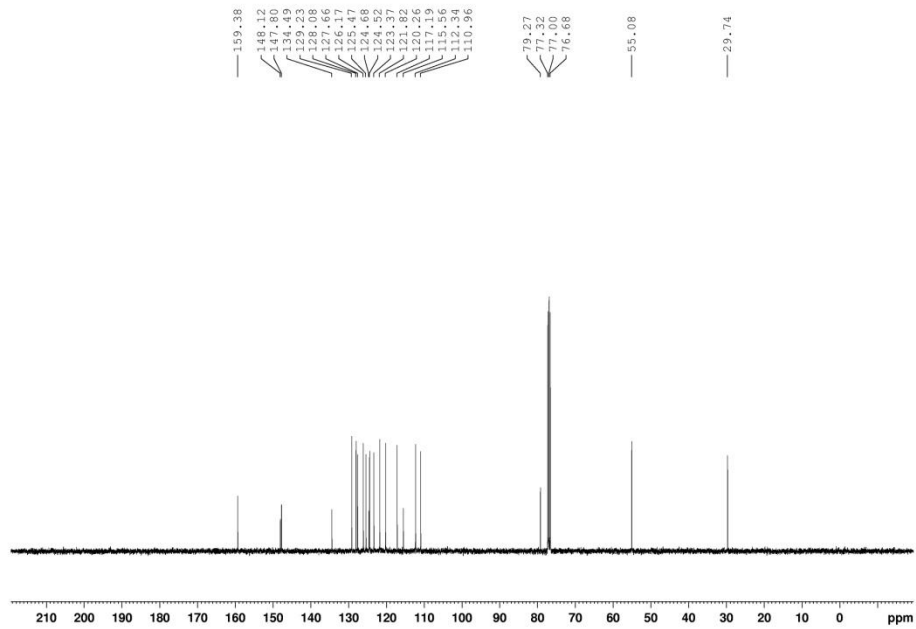
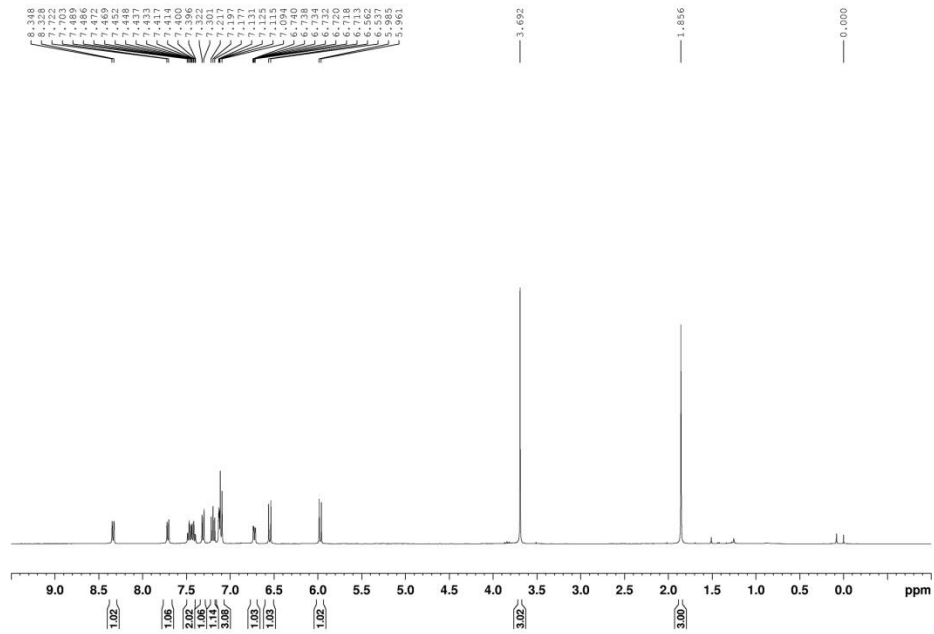
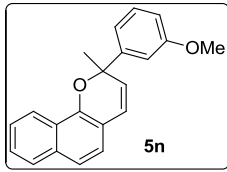


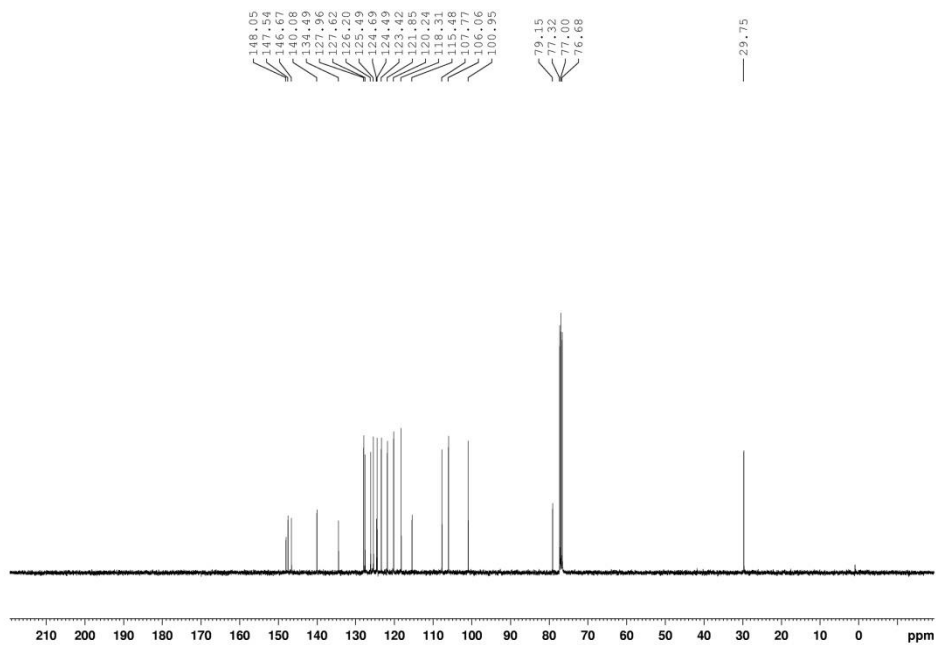
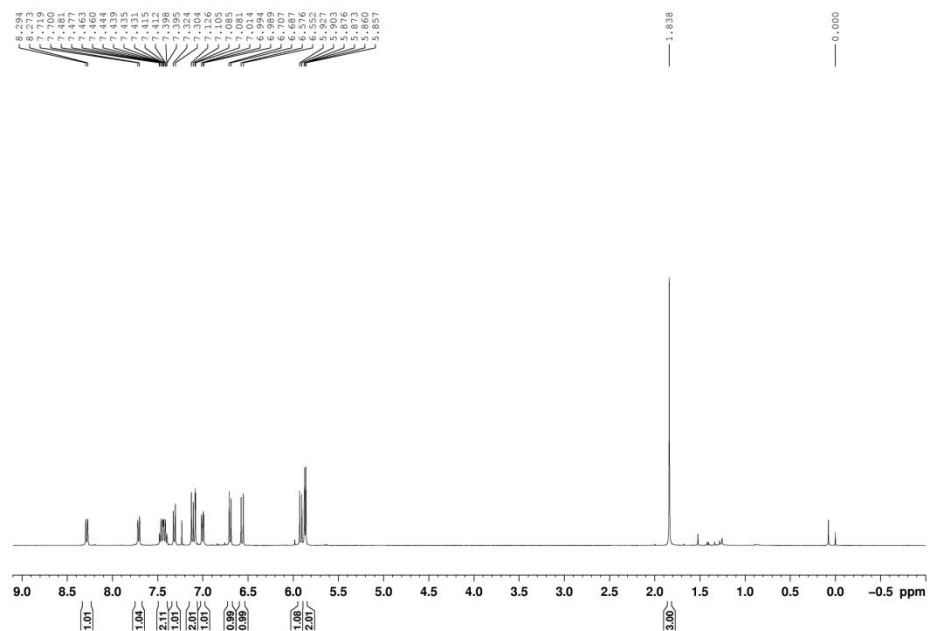
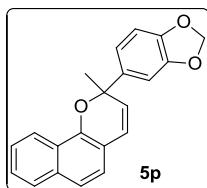


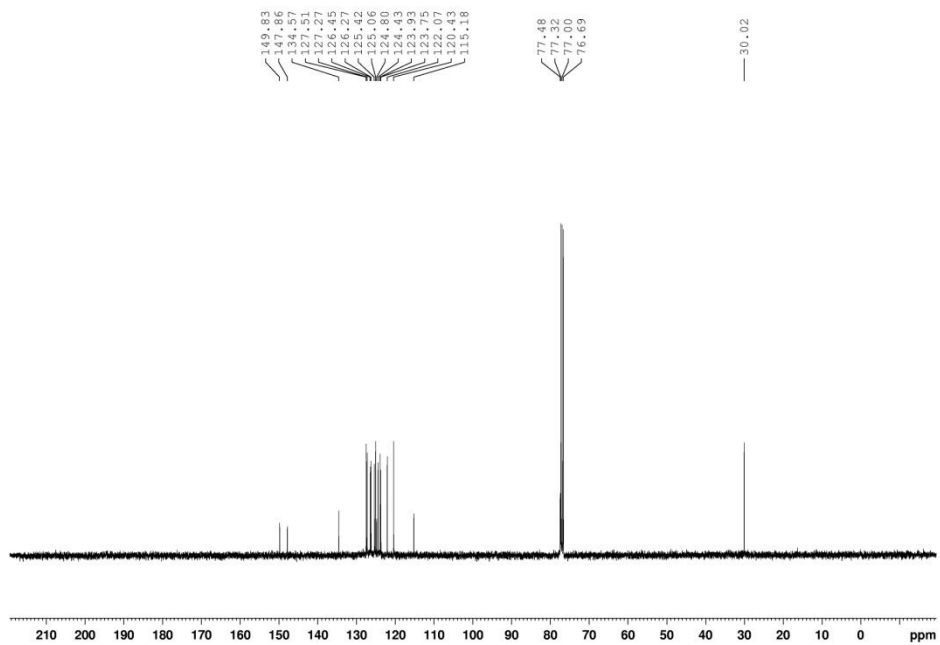
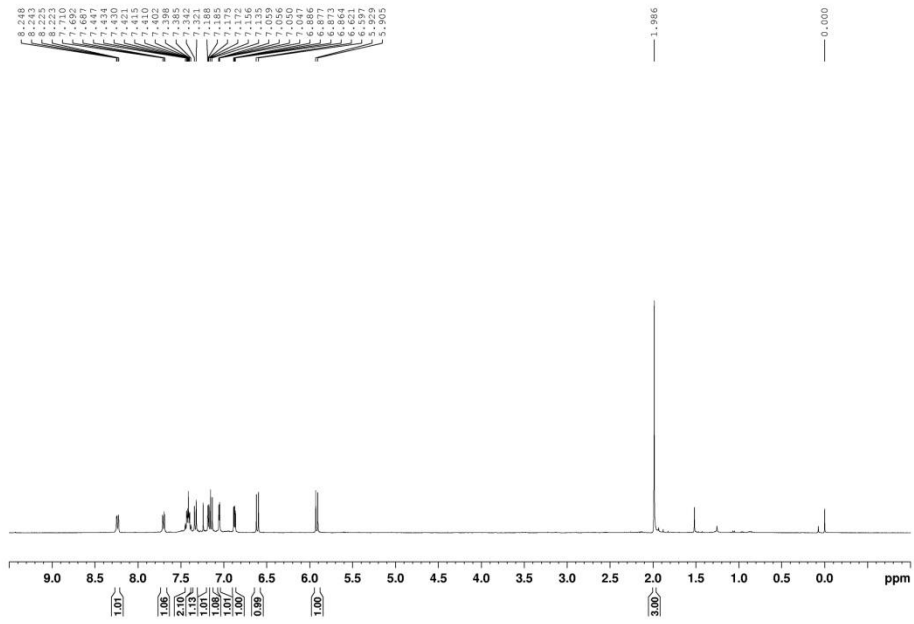
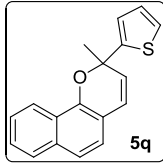


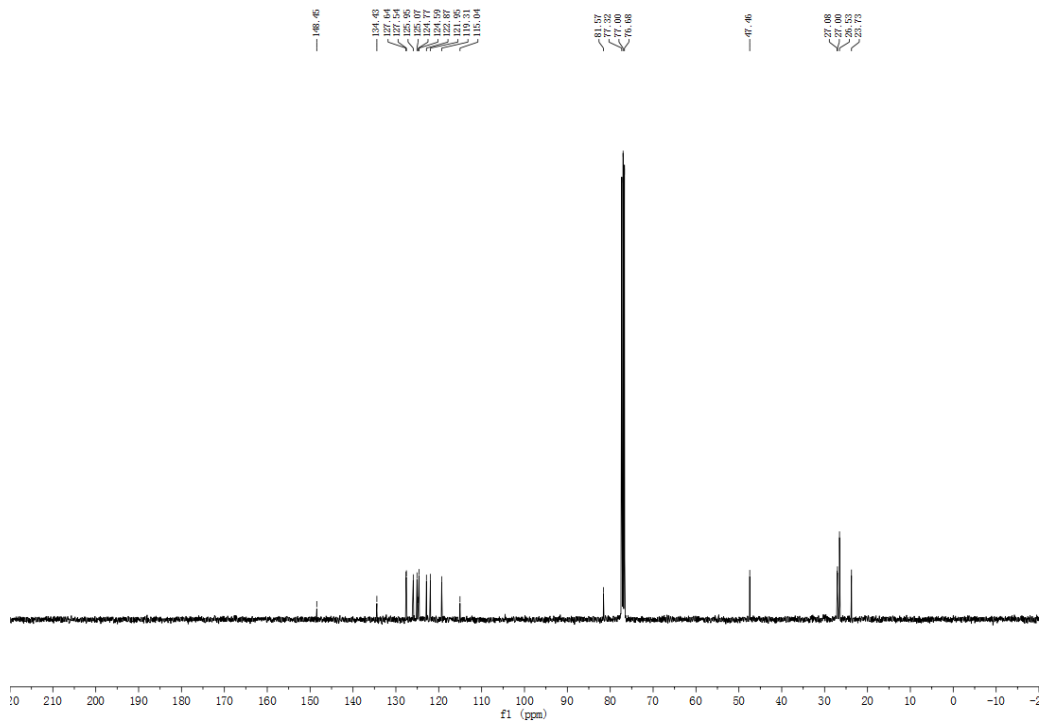
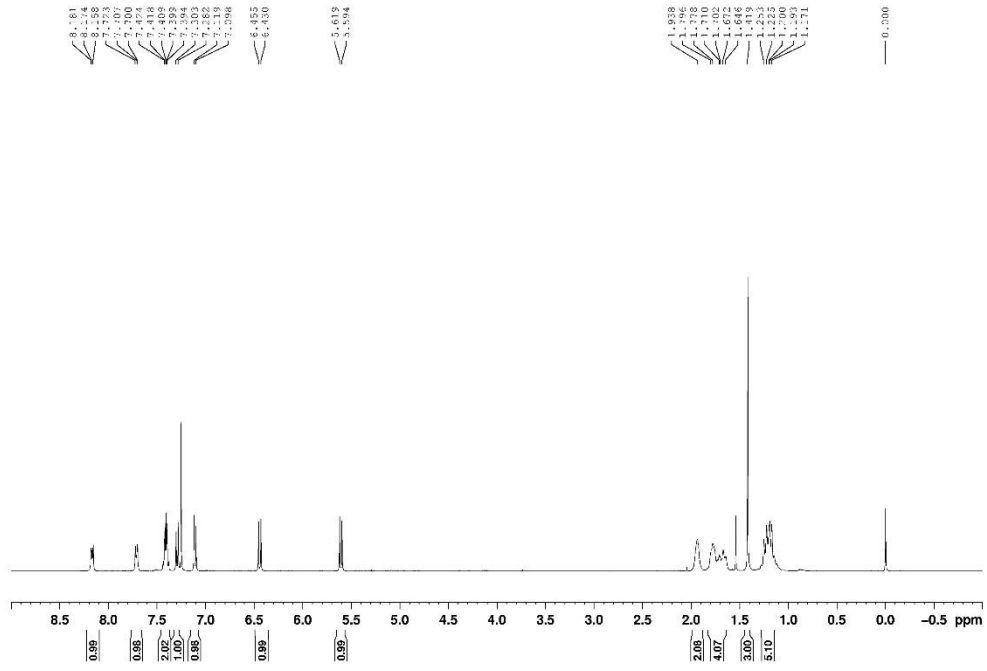
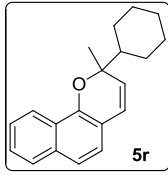


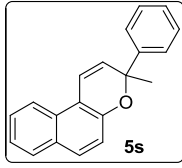




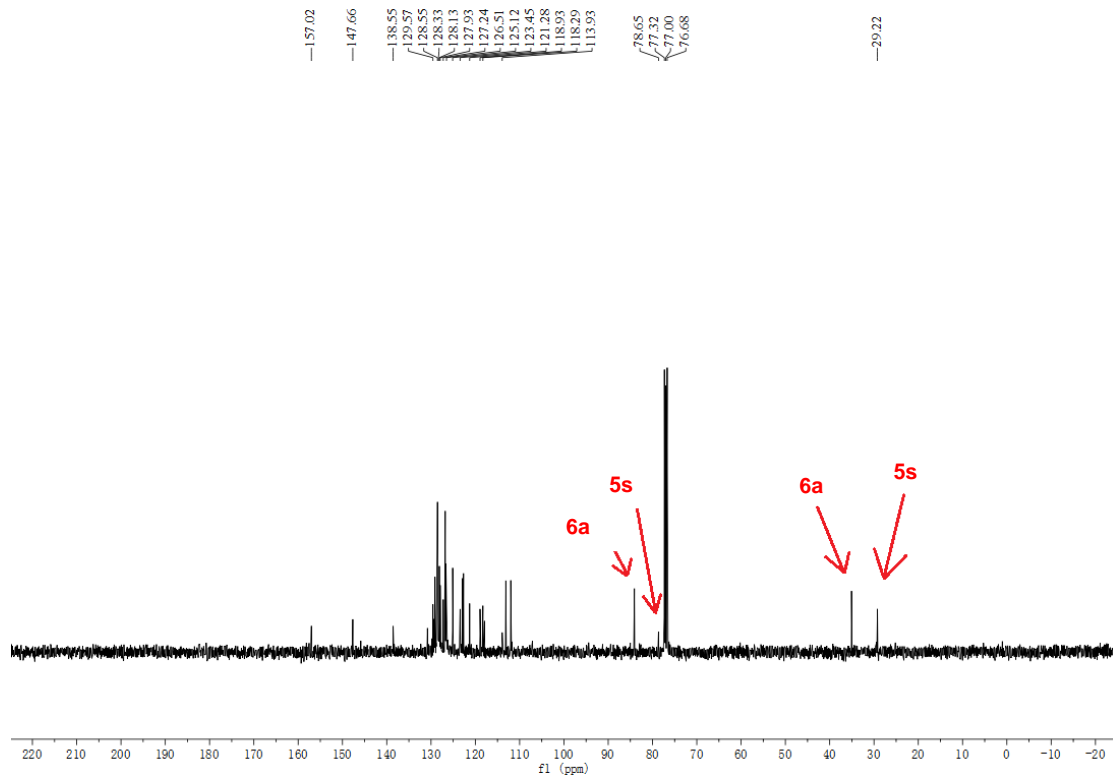
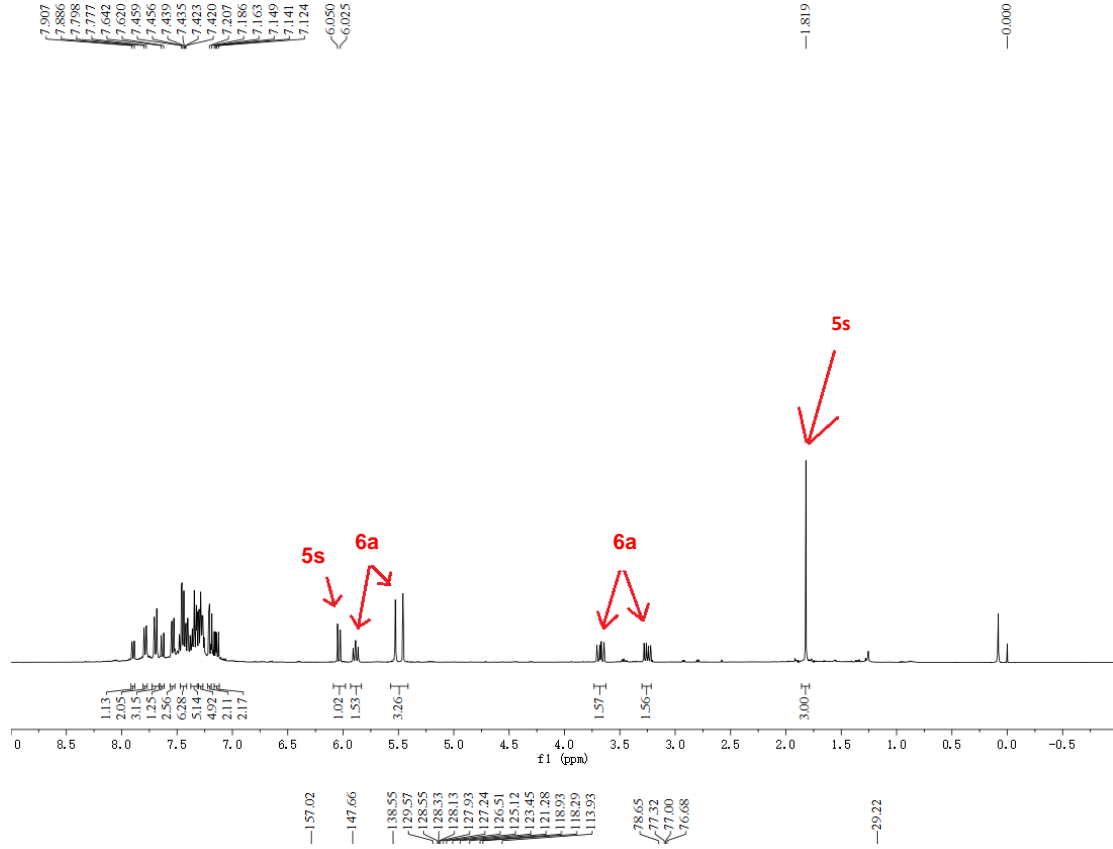


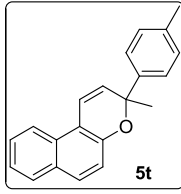




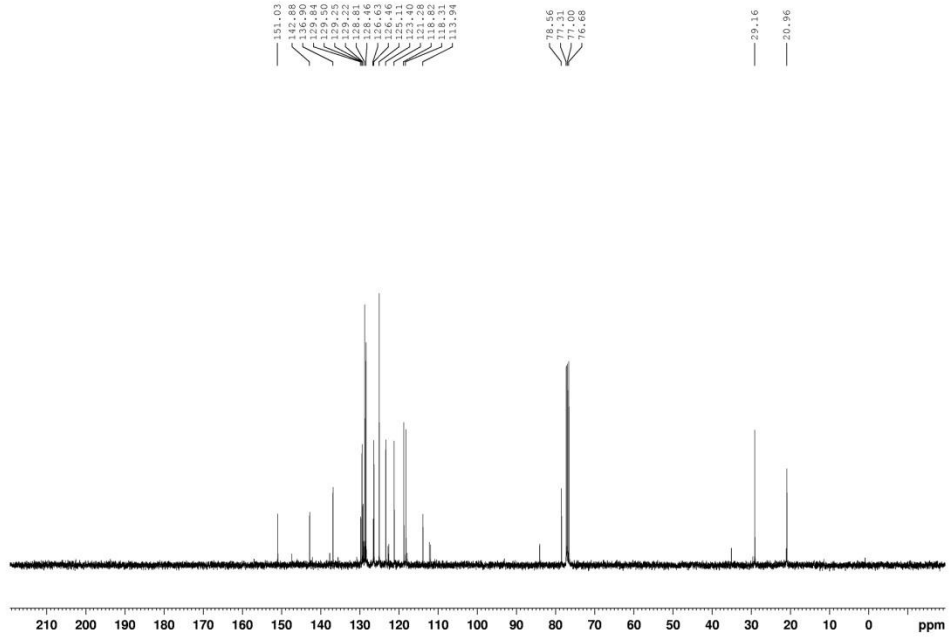
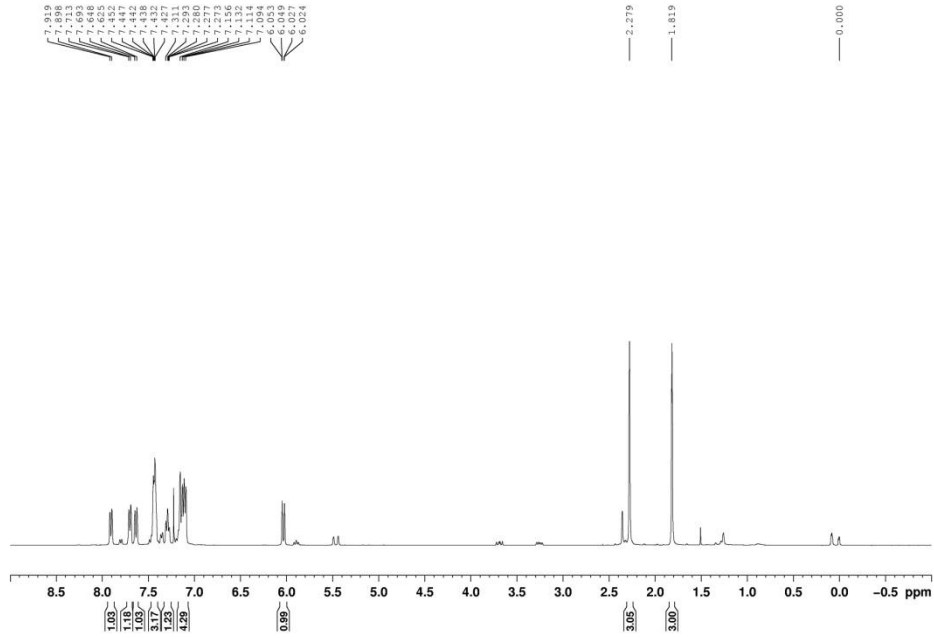


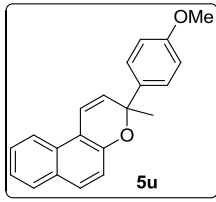
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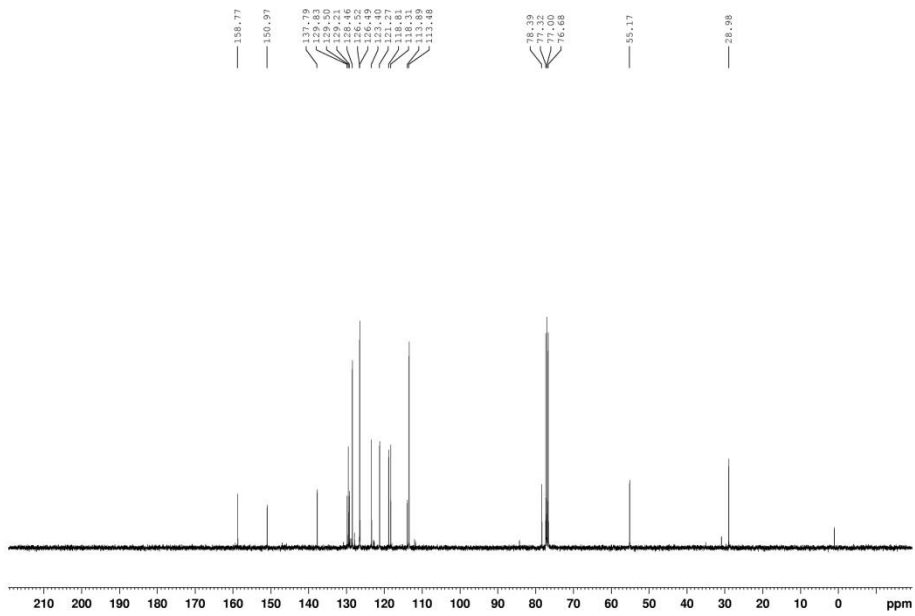
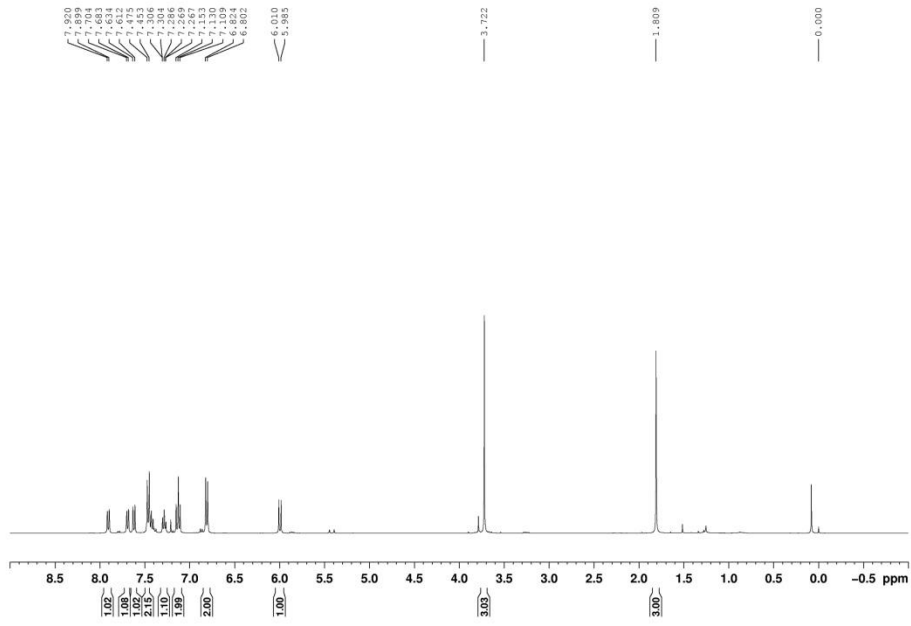


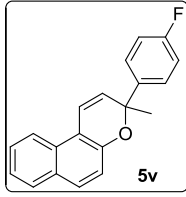
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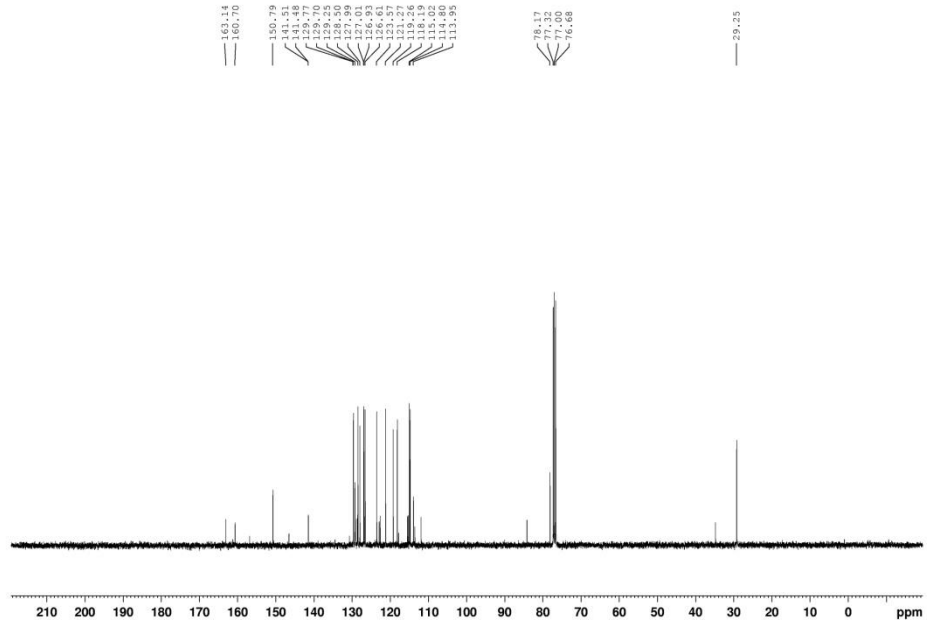
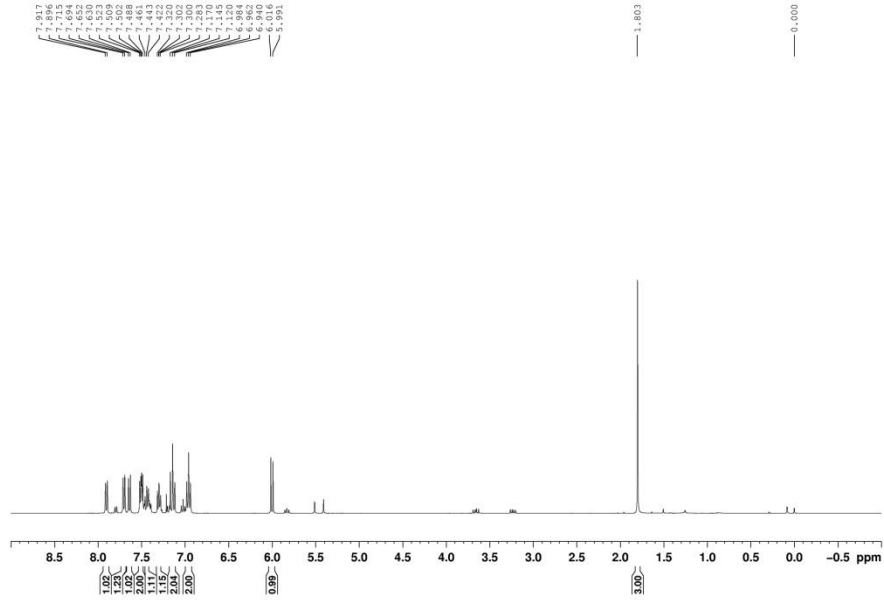


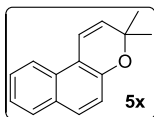
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regioselectivity 5:1





regioselectivity 3:1

