Platinum(II)-Catalyzed Asymmetric Ring-Opening Addition of Arylboronic Acids to Oxabenzonorbornadienes

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1. General

All flasks were flame-dried under a stream of nitrogen and cooled before use. Solvents and solutions were transferred with syringes and cannulae using standard inert atmosphere techniques. Proton nuclear magnetic resonance spectra (^{1}H NMR) spectra and carbon nuclear magnetic resonance spectra (^{13}C NMR) were recorded at 400 MHz and 100 MHz, respectively, using $CDCl_3$ as reference standard (δ 7.26 ppm) for ^{1}H NMR and (δ 77.04 ppm) for ^{13}C NMR. Data are represented in the following order: chemical shift (δ, ppm), integration, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), and coupling constant (*J*, Hz). Infrared (IR) spectra were obtained as a neat film on a NaCl plate. Data are presented as frequency of absorption (cm^{-1}). HRMS (ion trap) were recorded using APCI or ESI. Melting points are uncorrected. Optical rotations were measured using the sodium D line with spectra-grade $CHCl_3$ in a 1.0 dm cell. Data are reported as follows: $[\alpha]^{T\ °C}_{D}$ (*c* = g/100mL, solvent). The HPLC analysis was performed with a Chiralcel OD-H column or Chiralpak AD-H column.

2. Crystal structure and data of (1*S*,2*R*)-2-(4-*tert*-Butylphenyl)-1,2-dihydronaphthalen-1-ol (2m)

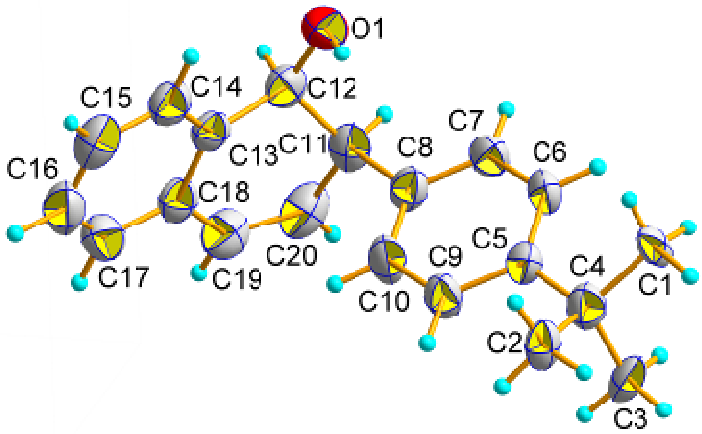


Table 1. Crystal data and structure refinement for 2m.

Identification code	**2m**
Empirical formula	$C_{20}H_{22}O$
Formula weight	278.38
Temperature	296(2) K
Wavelength	0.71073 Å
Crystal system	Monoclinic
Space group	P21
Unit cell dimensions	a = 6.1138(14) Å alpha = 90°.
	b = 11.409(3) Å beta = 95. 228(3)°.
	c = 11.578(3) Å gamma = 90°.
Volume	804.2(3) $Å^3$
Z	2
Calculated density	1.150 Mg/m^3

Absorption coefficient	0.069 mm^{-1}
F(000)	300.0
Crystal size	0.1 x 0.1 x 0.1 mm^3
Theta range for data collection	1.77 to 25.00°.
Limiting indices	-7<=h<=7, -13<=k<=12, -13<=l<=12
Reflections collected	3937
Independent reflections	2435 [R(int) = 0.0203]
Completeness to theta = 25.00°	99.2%
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	2435/1/194
Goodness-of-fit on F^2	1.047
Final R indices [I>2sigma(I)]	R1 = 0.0372, wR2 = 0.0921
R indices (all data)	R1 = 0.0490, wR2 = 0.0995
Largest diff. peak and hole	0.114 and -0.138 e.$Å^{-3}$

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters (Å^2 x 10^3) for 2m. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
C(1)	1948(6)	-2852(3)	-8455(3)	110.9(13)
C(2)	1342(5)	-4421(2)	-9917(3)	82.5(8)
C(3)	-1456(6)	-2868(2)	-9822(3)	91.3(9)
C(4)	209(4)	-3634.8(19)	-9087.2(18)	55.5(6)
C(5)	-1075(3)	-4346.3(17)	-8256.1(17)	45.2(5)
C(6)	-1300(4)	-3981.9(17)	-7128.2(18)	51.9(5)
C(7)	-2575(4)	-4593.4(17)	-6411.3(17)	50.4(5)
C(8)	-3674(3)	-5618.9(16)	-6767.0(17)	47.0(5)
C(9)	-2178(4)	-5368.1(18)	-8616.1(18)	55.5(6)
C(10)	-3445(4)	-5986.9(19)	-7891.6(19)	55.9(6)
C(11)	-5056(4)	-6268(2)	-5943.4(19)	55.6(6)
C(12)	-3851(4)	-7299.3(18)	-5311.4(18)	53.7(5)
C(13)	-3876(3)	-8395.2(18)	-6045.5(17)	46.4(5)
C(14)	-2143(4)	-9186(2)	-5981.1(19)	58.0(6)
C(15)	-2278(4)	-10224(2)	-6602(2)	67.2(7)
C(16)	-4156(5)	-10488(2)	-7279(2)	73.2(7)
C(17)	-5912(4)	-9719(2)	-7355(2)	65.7(7)
C(18)	-5781(3)	-8657.2(19)	-6756.9(18)	51.9(5)

C(19)	-7535(4)	-7775(2)	-6897(2)	62.0(6)
C(20)	-7204(4)	-6674(2)	-6537(2)	65.3(7)
O(1)	-1714(3)	-6992.9(15)	-4802.0(13)	69.7(5)

Table 3. Bond lengths [Å] and angles [°] for 2m.

C(5)-C(6)	1.389(3)
C(5)-C(9)	1.392(3)
C(5)-C(4)	1.529(3)
C(7)-H(7)	0.93
C(7)-C(6)	1.379(3)
C(7)-C(8)	1.393(3)
C(10)-H(10)	0.93
C(10)-C(9)	1.386(3)
C(10)-C(8)	1.387(3)
C(6)-H(6)	0.93
C(9)-H(9)	0.93
C(18)-C(13)	1.396(3)
C(18)-C(17)	1.394(3)
C(18)-C(19)	1.469(3)
O(1)-H(1)	0.82
O(1)-C(12)	1.427(3)
C(8)-C(11)	1.522(3)

C(15)-H(15)	0.93
C(15)-C(14)	1.383(3)
C(15)-C(16)	1.364(3)
C(12)-H(12)	0.98
C(12)-C(13)	1.511(3)
C(12)-C(11)	1.538(3)
C(13)-C(14)	1.389(3)
C(11)-H(11)	0.98
C(11)-C(20)	1.499(3)
C(14)-H(14)	0.93
C(4)-C(3)	1.539(4)
C(4)-C(2)	1.526(3)
C(4)-C(1)	1.524(3)
C(3)-H(3A)	0.96
C(3)-H(3B)	0.96
C(3)-H(3C)	0.96
C(2)-H(2A)	0.96
C(2)-H(2B)	0.96
C(2)-H(2C)	0.96
C(17)-H(17)	0.93
C(17)-C(16)	1.383(4)
C(16)-H(16)	0.93

C(19)-H(19)	0.93
C(19)-C(20)	1.333(3)
C(20)-H(20)	0.93
C(1)-H(1A)	0.96
C(1)-H(1B)	0.96
C(1)-H(1C)	0.96
C(6)-C(5)-C(9)	116.46(19)
C(6)-C(5)-C(4)	122.22(18)
C(9)-C(5)-C(4)	121.25(18)
C(6)-C(7)-H(7)	119
C(6)-C(7)-C(8)	122.08(19)
C(8)-C(7)-H(7)	119
C(9)-C(10)-H(10)	119.2
C(9)-C(10)-C(8)	121.59(19)
C(8)-C(10)-H(10)	119.2
C(5)-C(6)-H(6)	119.2
C(7)-C(6)-C(5)	121.62(18)
C(7)-C(6)-H(6)	119.2
C(5)-C(9)-H(9)	119.1
C(10)-C(9)-C(5)	121.86(19)
C(10)-C(9)-H(9)	119.1

C(13)-C(18)-C(19)	118.7(2)
C(17)-C(18)-C(13)	119.1(2)
C(17)-C(18)-C(19)	122.2(2)
C(12)-O(1)-H(1)	109.5
C(7)-C(8)-C(11)	120.24(18)
C(10)-C(8)-C(7)	116.39(19)
C(10)-C(8)-C(11)	123.36(18)
C(14)-C(15)-H(15)	120.2
C(16)-C(15)-H(15)	120.2
C(16)-C(15)-C(14)	119.7(2)
O(1)-C(12)-H(12)	105.6
O(1)-C(12)-C(13)	113.40(18)
O(1)-C(12)-C(11)	112.96(17)
C(13)-C(12)-H(12)	105.6
C(13)-C(12)-C(11)	112.68(17)
C(11)-C(12)-H(12)	105.6
C(18)-C(13)-C(12)	118.31(19)
C(14)-C(13)-C(18)	118.93(19)
C(14)-C(13)-C(12)	122.62(18)
C(8)-C(11)-C(12)	113.66(18)
C(8)-C(11)-H(11)	106.9
C(12)-C(11)-H(11)	106.9

C(20)-C(11)-C(8)	112.07(18)
C(20)-C(11)-C(12)	110.10(18)
C(20)-C(11)-H(11)	106.9
C(15)-C(14)-C(13)	121.3(2)
C(15)-C(14)-H(14)	119.4
C(13)-C(14)-H(14)	119.4
C(5)-C(4)-C(3)	107.3(2)
C(2)-C(4)-C(5)	111.88(19)
C(2)-C(4)-C(3)	107.6(2)
C(1)-C(4)-C(5)	112.63(19)
C(1)-C(4)-C(3)	109.2(3)
C(1)-C(4)-C(2)	108.0(2)
C(4)-C(3)-H(3A)	109.5
C(4)-C(3)-H(3B)	109.5
C(4)-C(3)-H(3C)	109.5
H(3A)-C(3)-H(3B)	109.5
H(3A)-C(3)-H(3C)	109.5
H(3B)-C(3)-H(3C)	109.5
C(4)-C(2)-H(2A)	109.5
C(4)-C(2)-H(2B)	109.5
C(4)-C(2)-H(2C)	109.5
H(2A)-C(2)-H(2B)	109.5

H(2A)-C(2)-H(2C)	109.5
H(2B)-C(2)-H(2C)	109.5
C(18)-C(17)-H(17)	119.7
C(16)-C(17)-C(18)	120.7(2)
C(16)-C(17)-H(17)	119.7
C(15)-C(16)-C(17)	120.3(2)
C(15)-C(16)-H(16)	119.9
C(17)-C(16)-H(16)	119.9
C(18)-C(19)-H(19)	119.2
C(20)-C(19)-C(18)	121.5(2)
C(20)-C(19)-H(19)	119.2
C(11)-C(20)-H(20)	118.8
C(19)-C(20)-C(11)	122.4(2)
C(19)-C(20)-H(20)	118.8
C(4)-C(1)-H(1A)	109.5
C(4)-C(1)-H(1B)	109.5
C(4)-C(1)-H(1C)	109.5
H(1A)-C(1)-H(1B)	109.5
H(1A)-C(1)-H(1C)	109.5
H(1B)-C(1)-H(1C)	109.5

Symmetry transformations used to generate equivalent atoms:

Table 4. Anisotropic displacement parameters ($Å^2$ x 10^3) for 2m. The anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2 a^{*2}U^{11} + ... + 2 h k a^* b^* U^{12}]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
C(1)	128(3)	119(3)	87(2)	-13.0(19)	18.9(19)	-80(2)
C(2)	93(2)	68.0(18)	92.8(19)	-0.6(14)	42.3(16)	-11.5(15)
C(3)	124(3)	65.0(18)	88.5(19)	26.7(16)	30.3(19)	9.4(18)
C(4)	68.8(14)	42.8(12)	56.4(12)	0.1(10)	13.4(11)	-11.2(11)
C(5)	54.5(12)	34.0(11)	46.7(11)	1.8(9)	2.5(9)	0.2(9)
C(6)	68.1(14)	33.8(10)	53.3(12)	-6.0(9)	2.7(10)	-7.3(10)
C(7)	66.5(14)	40.4(12)	44.8(12)	-6.6(9)	7.3(10)	0.4(10)
C(8)	57.0(13)	36.3(11)	48.8(11)	0.1(9)	10.7(9)	2.4(9)
C(9)	76.0(15)	46.6(13)	46.0(11)	-6.8(10)	16.8(10)	-13.0(12)
C(10)	74.7(15)	39.8(12)	54.9(12)	-6.8(10)	15.8(11)	-14.1(11)
C(11)	63.7(14)	49.4(13)	56.8(12)	-4(1)	21.9(11)	0.4(11)
C(12)	66.6(14)	50.8(13)	44.9(10)	6.4(10)	11.4(10)	-11.2(10)
C(13)	48.9(12)	46.9(12)	43.6(10)	10.0(9)	5.7(9)	-8.7(9)
C(14)	57.0(13)	57.6(14)	58.7(12)	14.6(11)	1.3(10)	-8.7(11)
C(15)	75.8(18)	51.9(15)	76.4(15)	13.5(12)	20.5(14)	5.3(13)
C(16)	99(2)	51.3(15)	71.4(15)	-2.5(12)	17.7(15)	-7.9(14)
C(17)	71.8(17)	62.2(15)	61.9(14)	0.5(12)	-0.8(12)	-20.2(13)
C(18)	54.0(13)	51.8(12)	50.5(11)	9.9(10)	7.1(10)	-10.2(10)

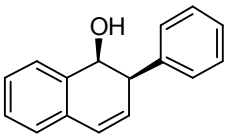
C(19)	43.2(12)	70.1(16)	73.1(14)	13.1(12)	7.9(11)	-8.0(11)
C(20)	54.4(15)	64.0(16)	80.7(15)	17.3(12)	23.7(12)	7.7(12)
O1	81.7(11)	67.6(11)	56.9(9)	4.6(8)	-9.5(8)	-22.2(9)

Table 5. Hydrogen coordinates (x 10^4) and isotropic displacement parameters (Å^2 x 10^3) for 2m.

	X	Y	Z	U(eq)
H(1)	-901	-6875	-5315	105
H(6)	-572	-3309	-6850	62
H(7)	-2706	-4312	-5667	60
H(9)	-2061	-5644	-9364	67
H(10)	-4159	-6665	-8166	67
H(11)	-5400	-5705	-5347	67
H(12)	-4707	-7490	-4661	64
H(14)	-867	-9015	-5512	70
H(15)	-1094	-10739	-6557	81
H(16)	-4256	-11188	-7692	88
H(17)	-7194	-9913	-7810	79
H(19)	-8908	-7989	-7244	74
H(20)	-8348	-6138	-6659	78
H(1A)	1248	-2278	-8007	166
H(1B)	2768	-2463	-9011	166

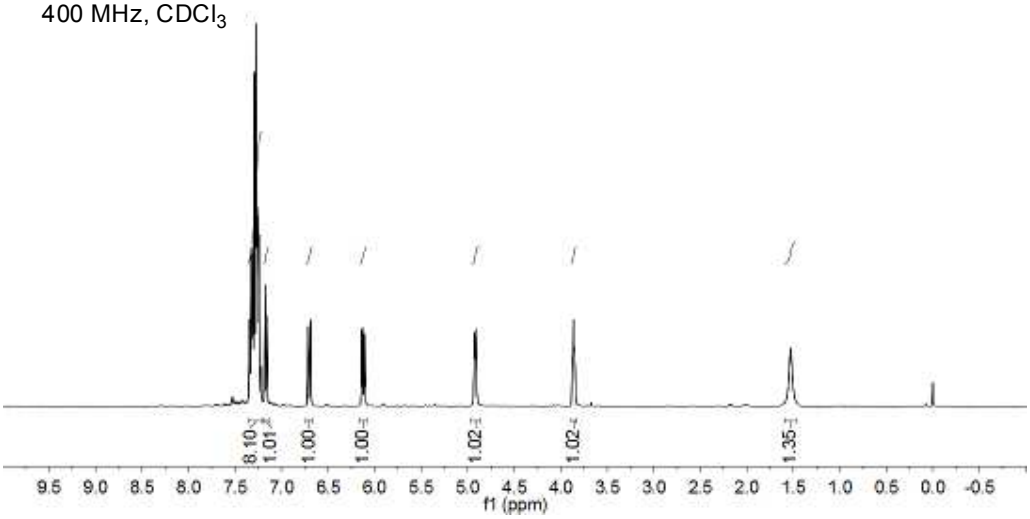
H(1C)	2924	-3321	-7950	166
H(2A)	2359	-4930	-9480	124
H(2B)	2120	-3944	-10427	124
H(2C)	261	-4883	-10365	124
H(3A)	-2591	-3355	-10194	137
H(3B)	-722	-2459	-10399	137
H(3C)	-2096	-2311	-9330	137

3. Copies of ^{1}H and ^{13}C NMR spectra of 2a–2g, 2i–2s, 3a–3f, 4a–4e, 5a–5e and ^{19}F NMR spectra of 2g



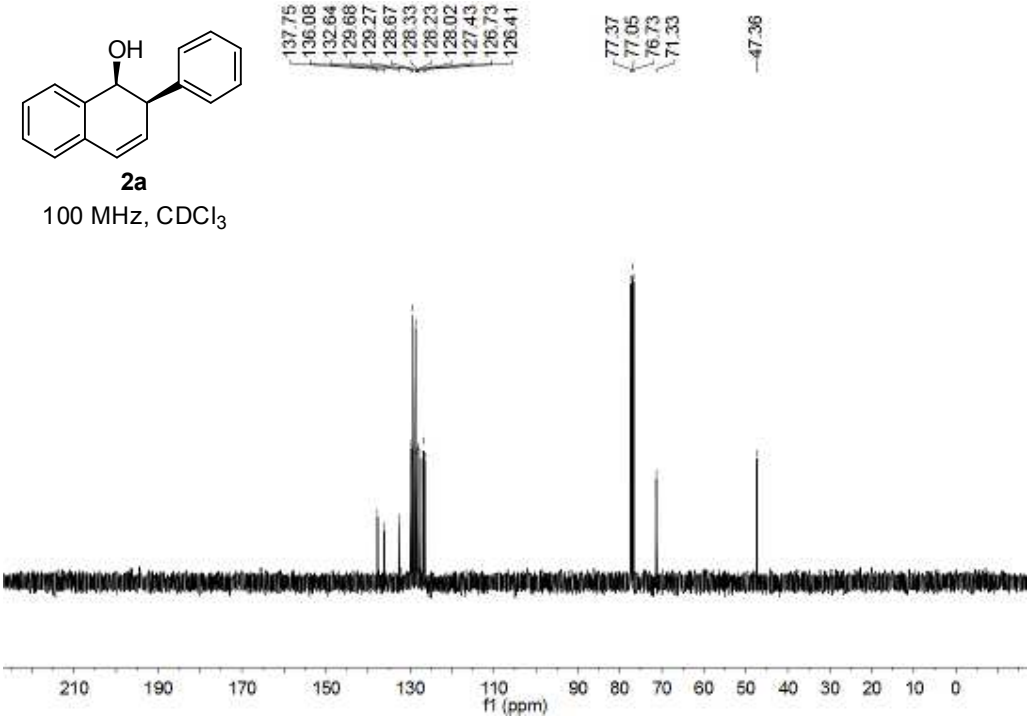
2a

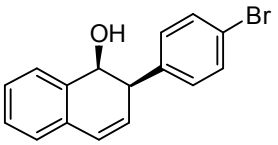
400 MHz, $CDCl_3$



2a

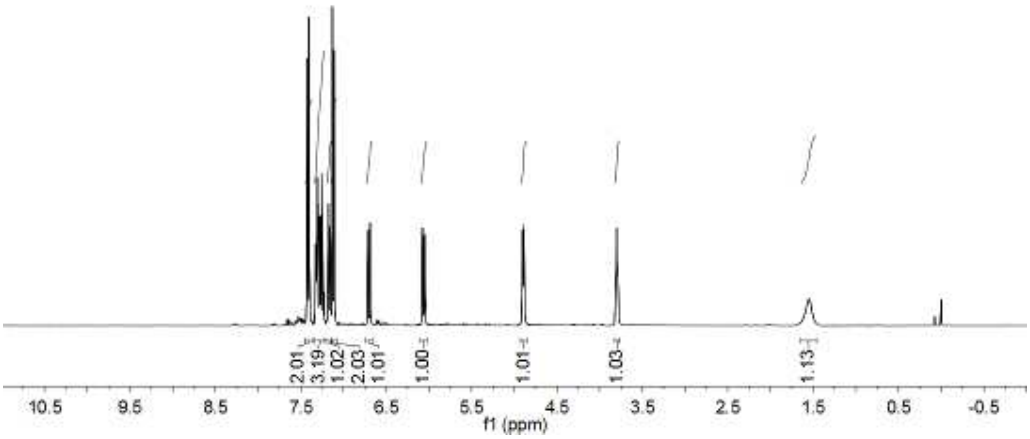
100 MHz, $CDCl_3$





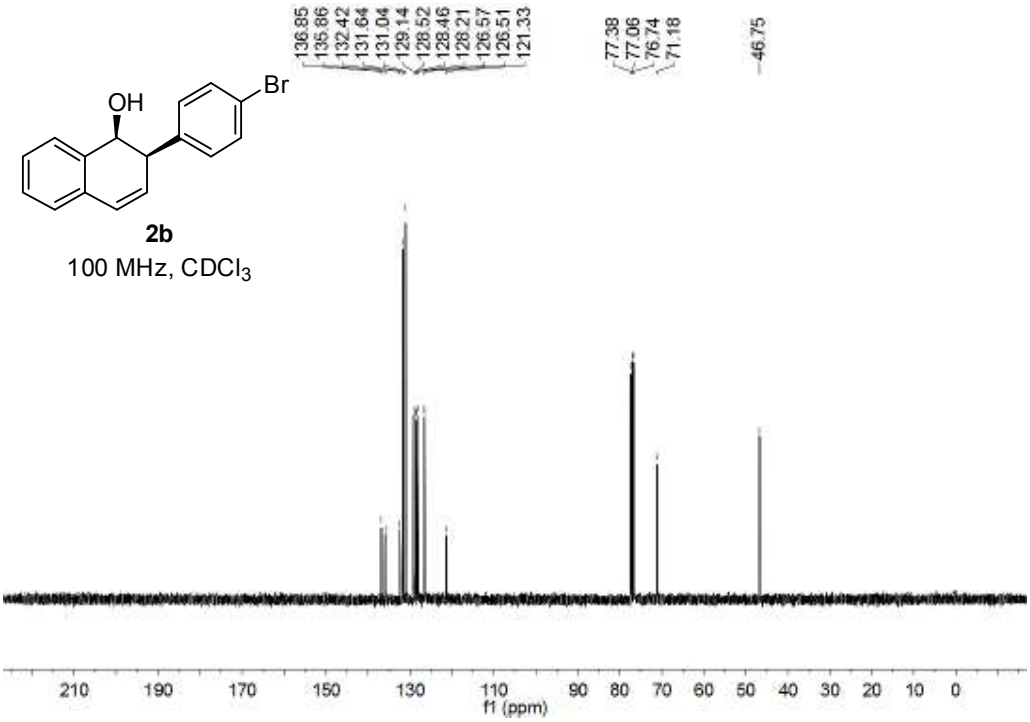
2b

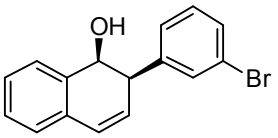
400 MHz, $CDCl_3$



2b

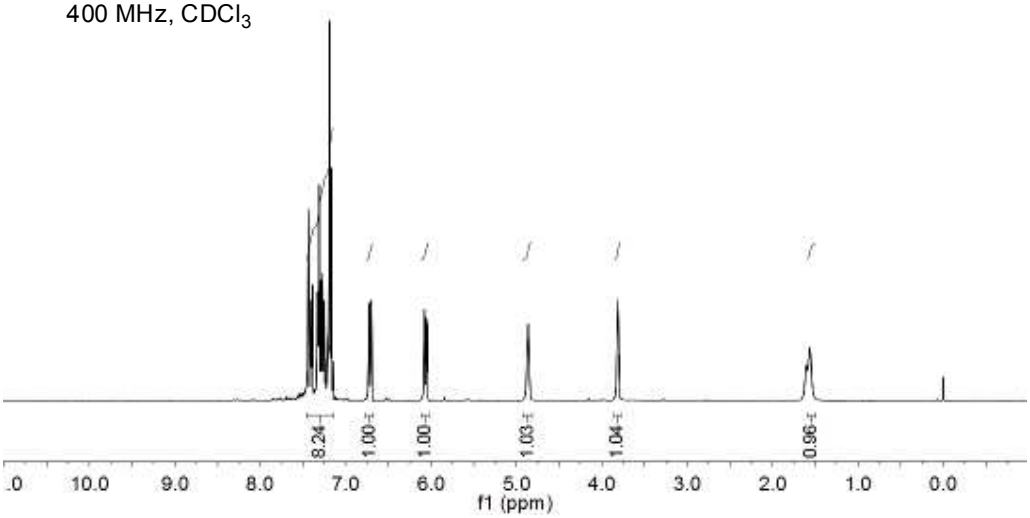
100 MHz, $CDCl_3$





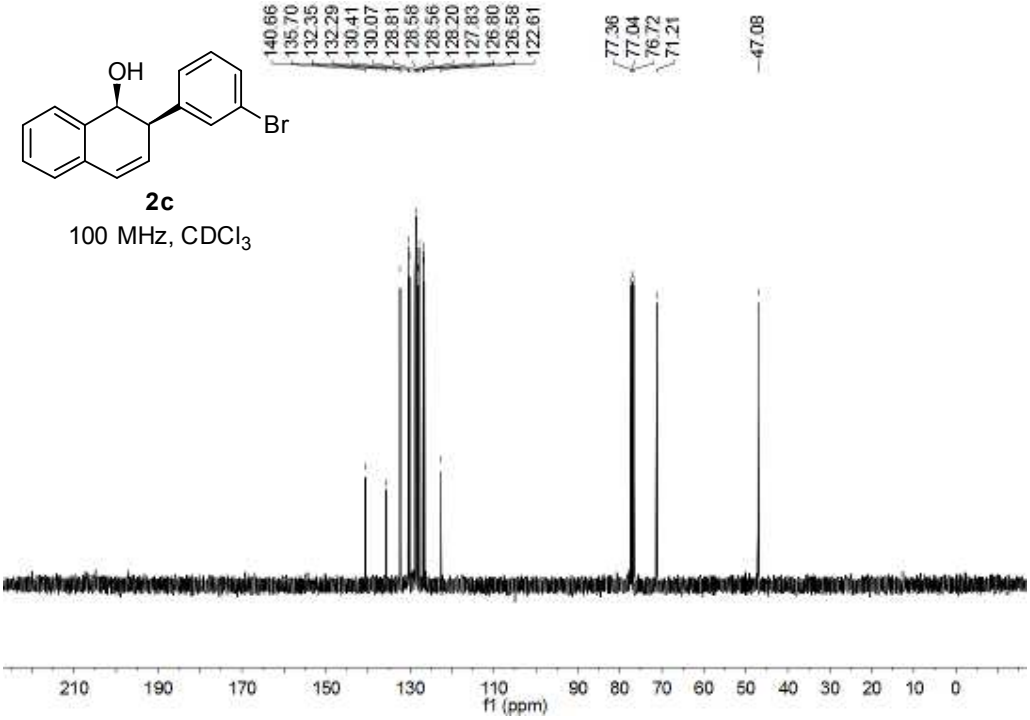
2c

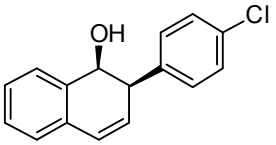
400 MHz, $CDCl_3$



2c

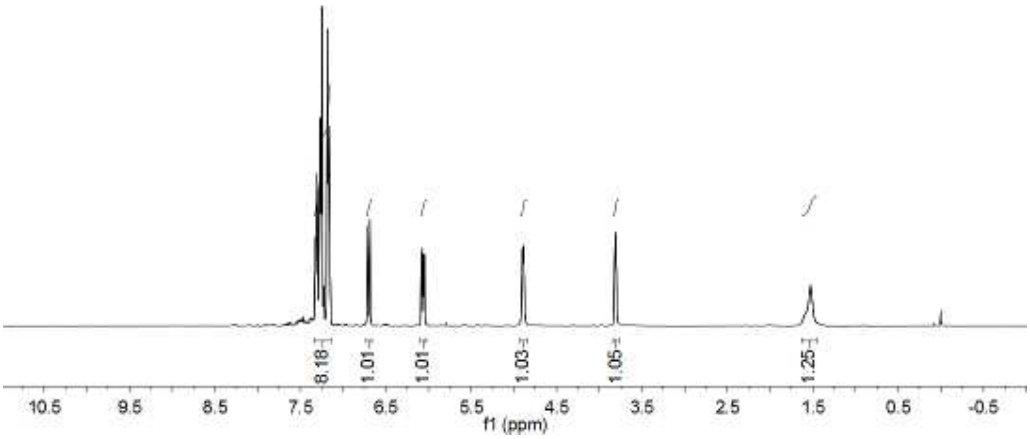
100 MHz, $CDCl_3$





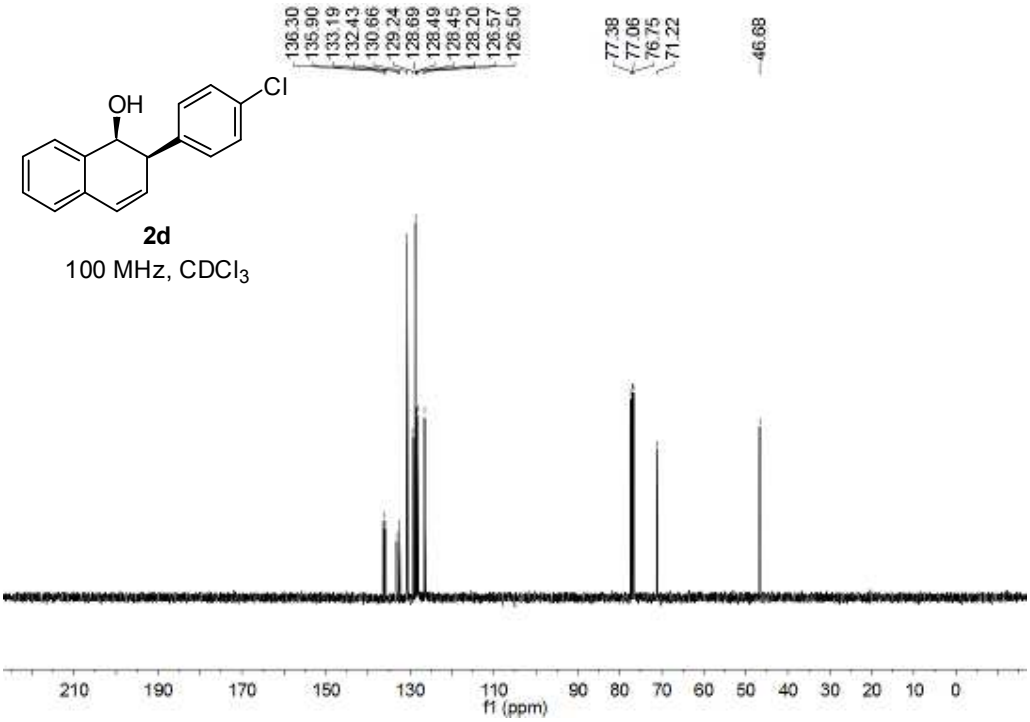
2d

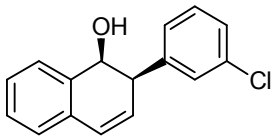
400 MHz, $CDCl_3$



2d

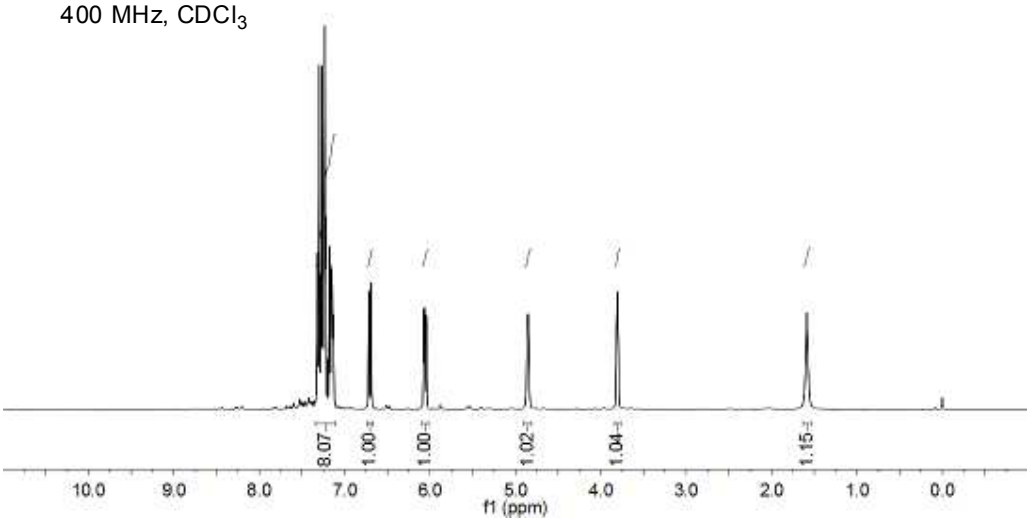
100 MHz, $CDCl_3$





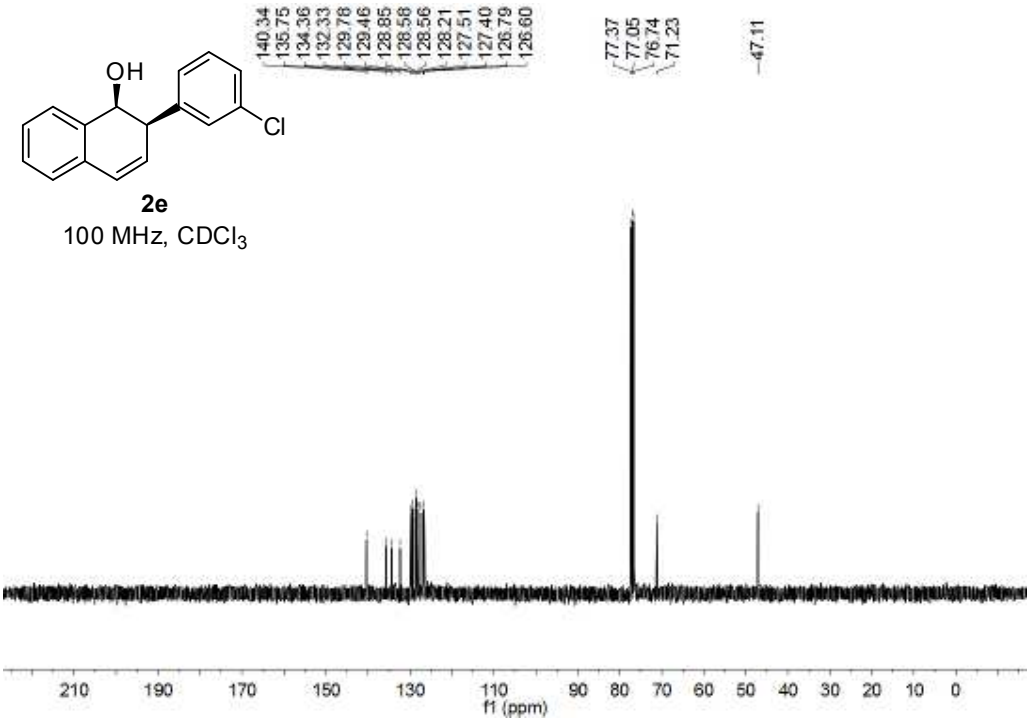
2e

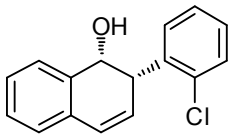
400 MHz, $CDCl_3$



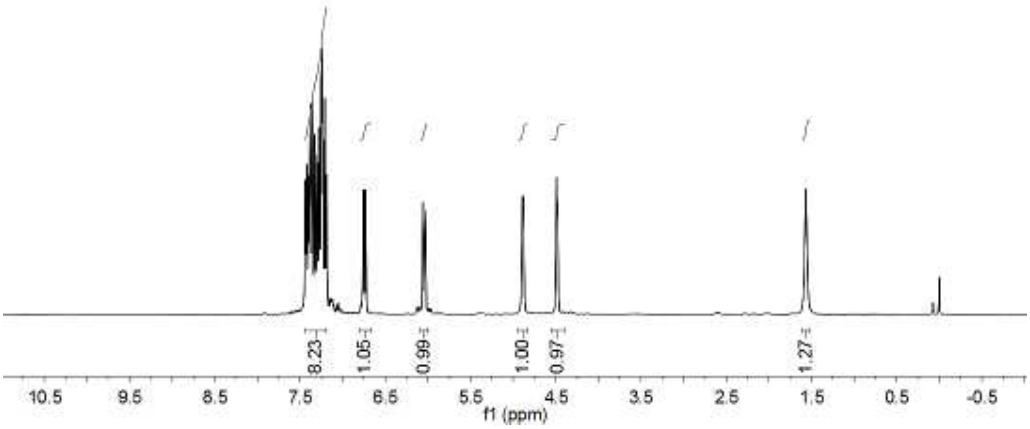
2e

100 MHz, $CDCl_3$

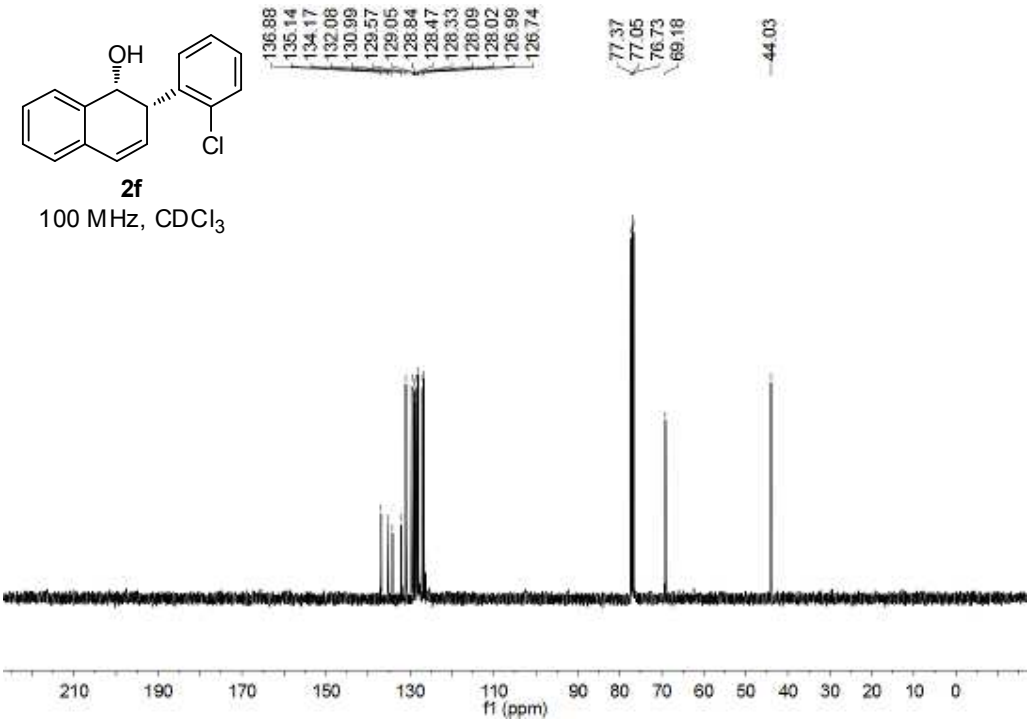


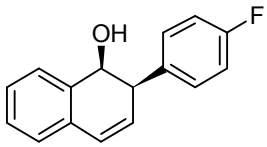


2f
400 MHz, $CDCl_3$

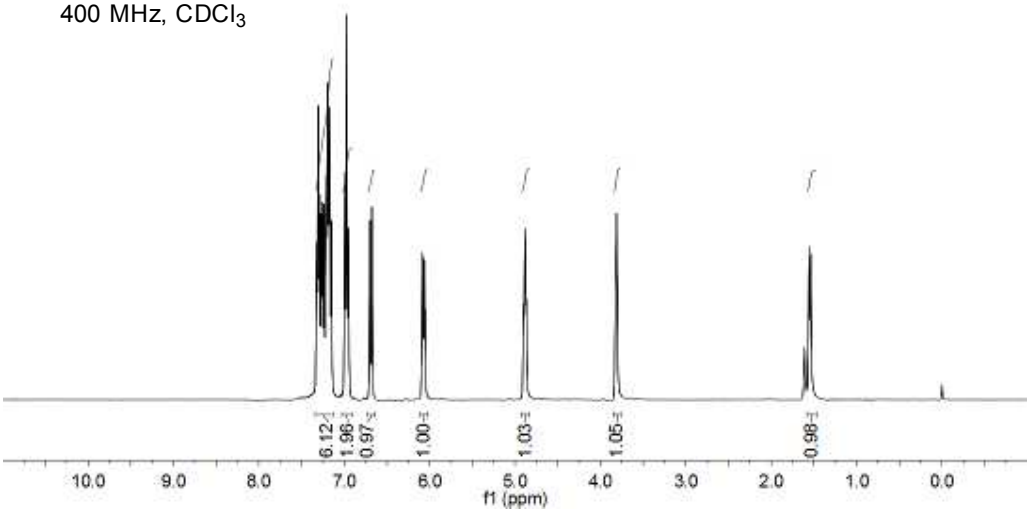


2f
100 MHz, $CDCl_3$

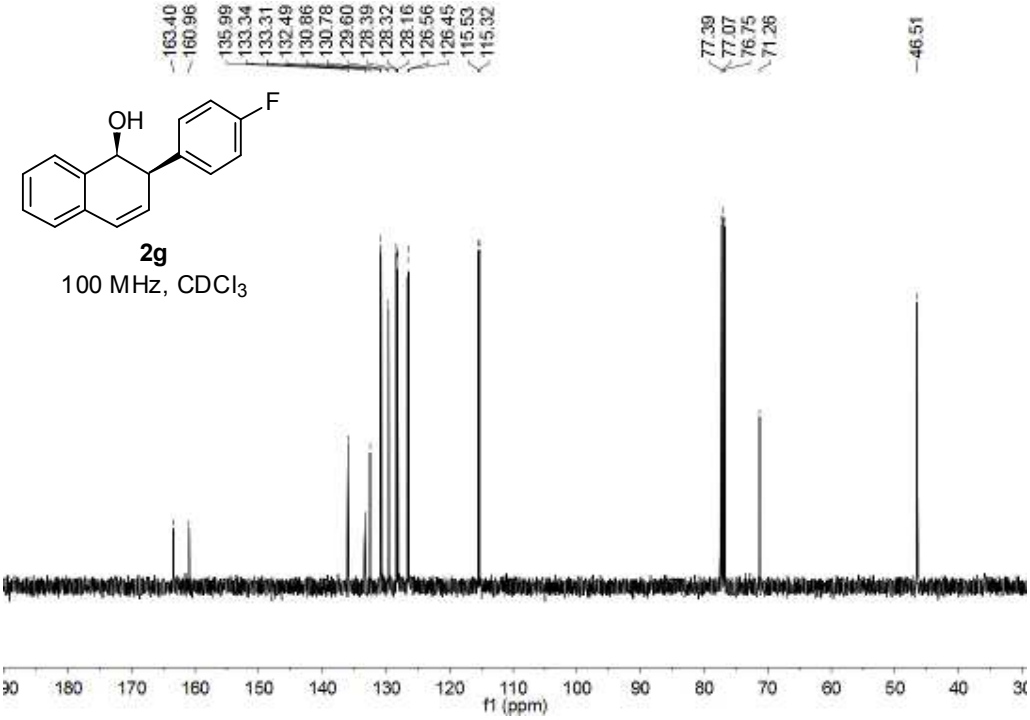


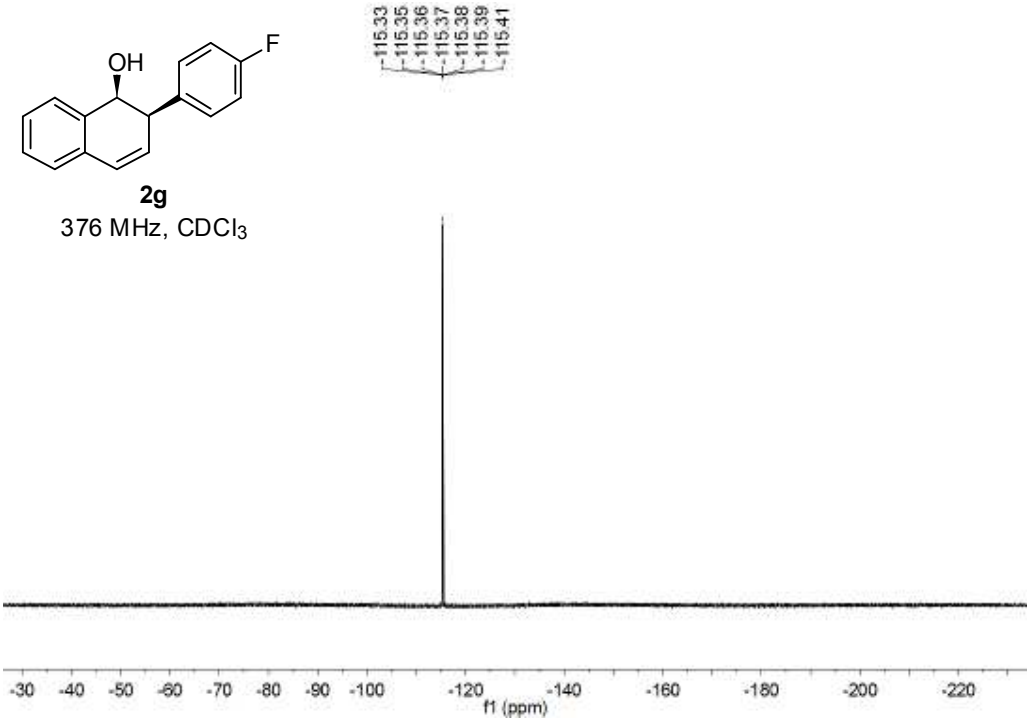


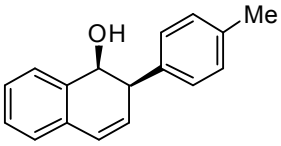
2g
400 MHz, $CDCl_3$



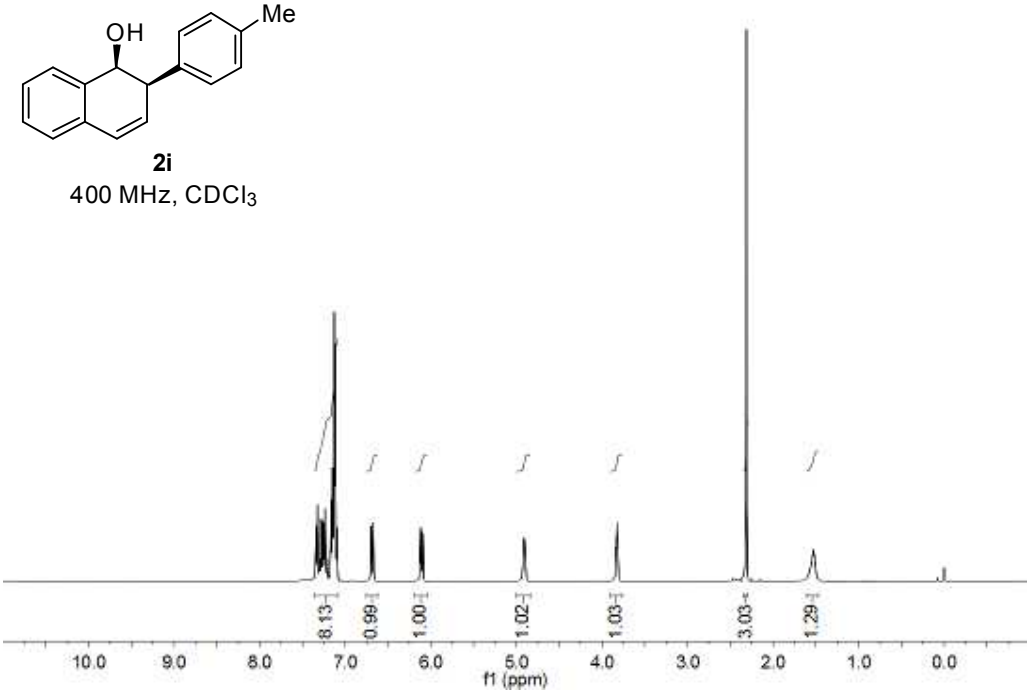
2g
100 MHz, $CDCl_3$



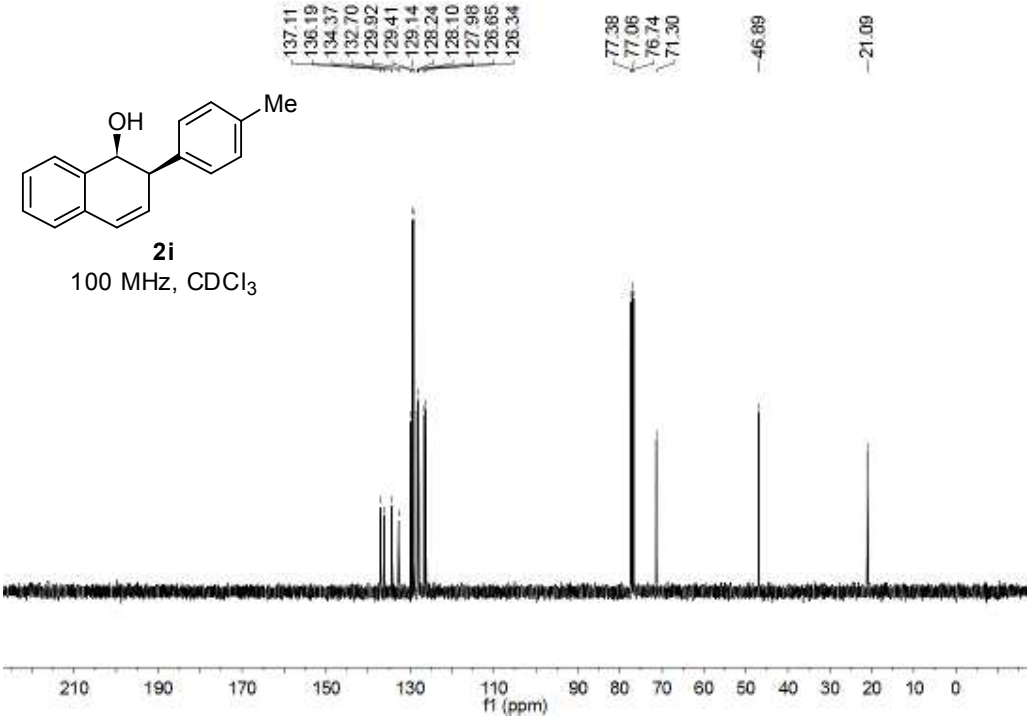

OH
F
-115.33
-115.35
-115.36
-115.37
-115.38
-115.39
-115.41
2g
376 MHz, CDCl3
-30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200 -220
f1 (ppm)

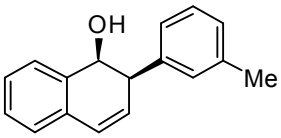


2i
400 MHz, $CDCl_3$

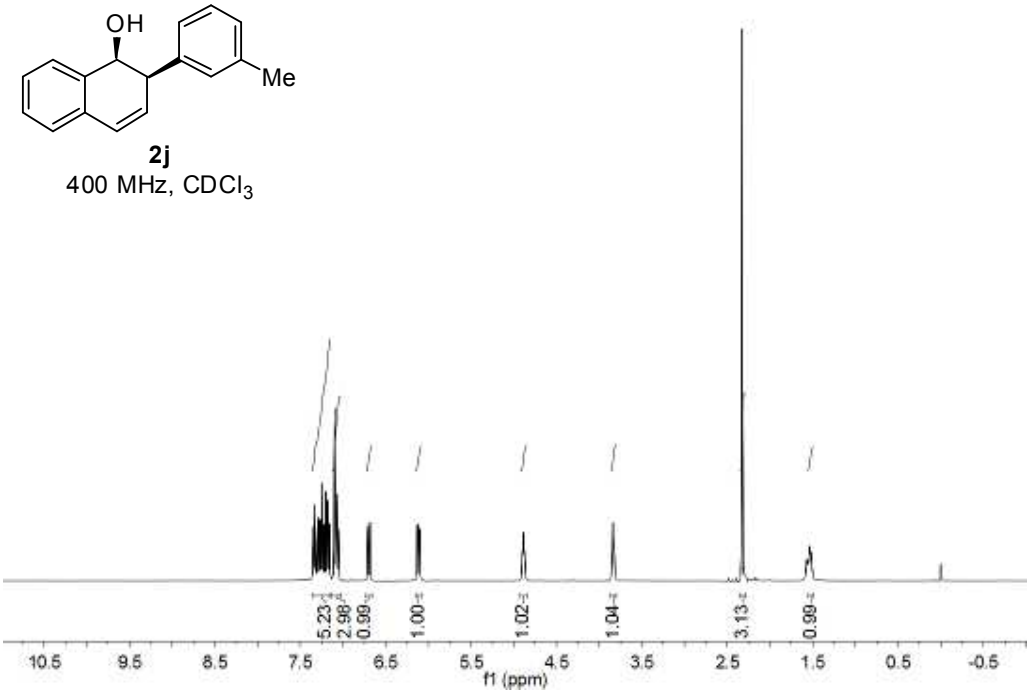


2i
100 MHz, $CDCl_3$

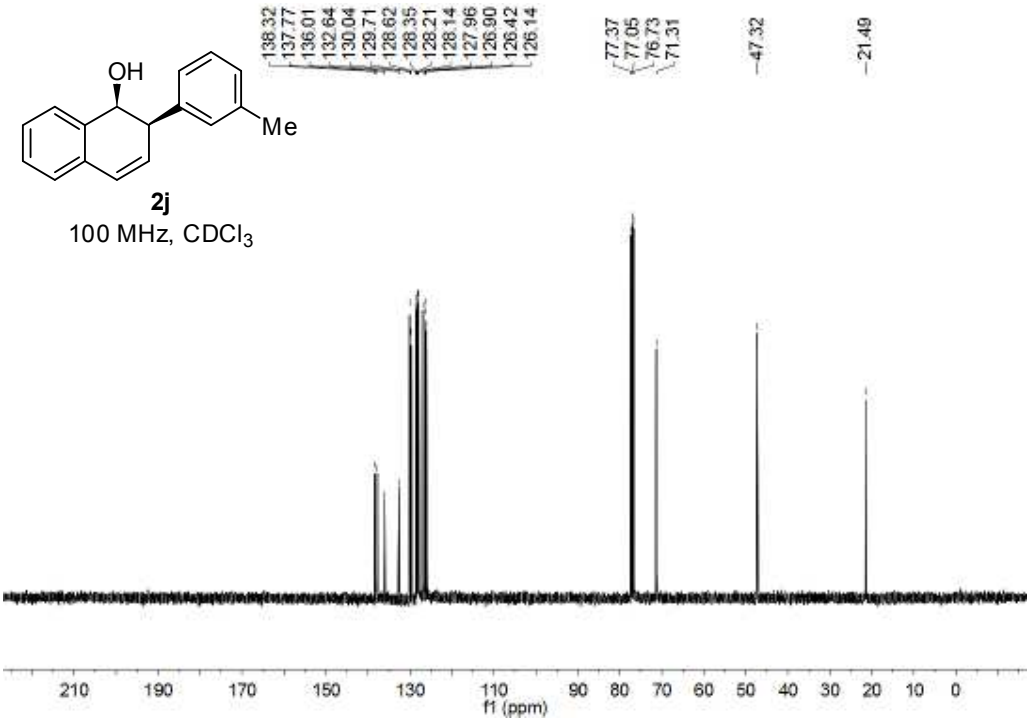


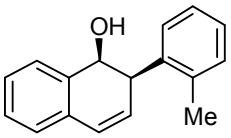


2j
400 MHz, $CDCl_3$

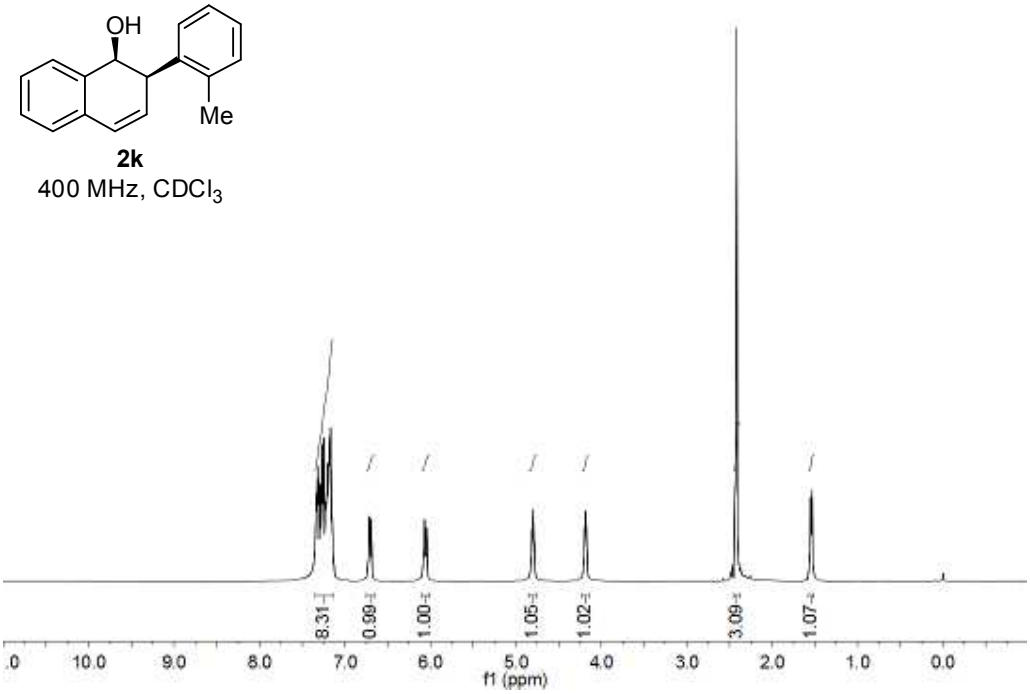


2j
100 MHz, $CDCl_3$

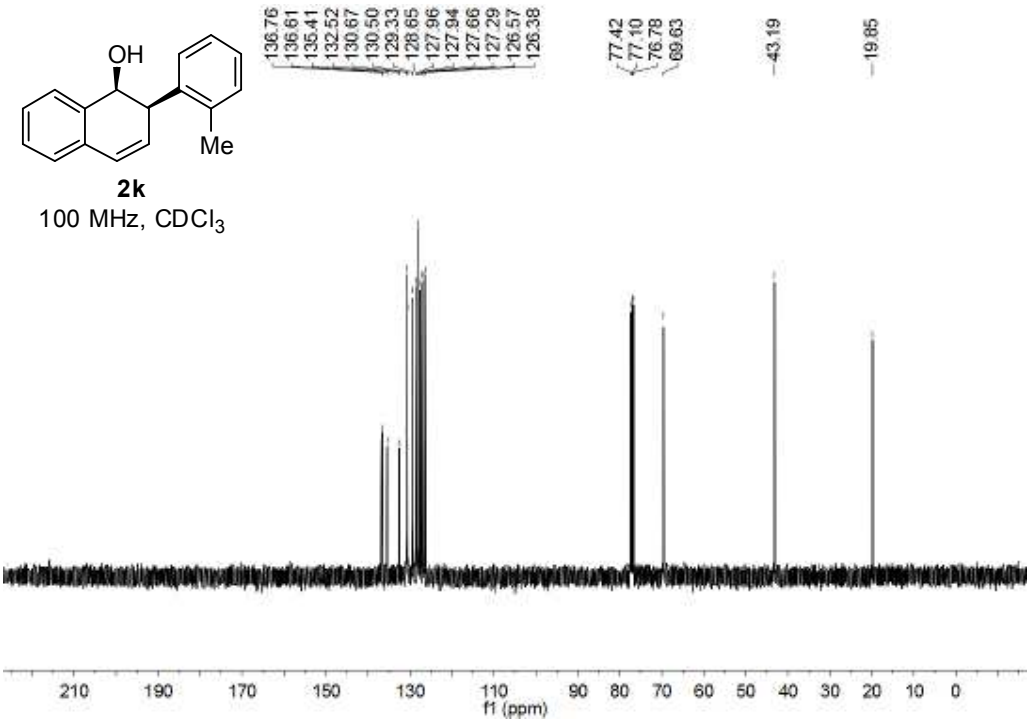


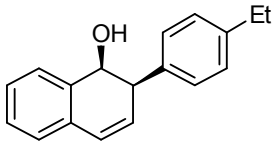


2k
400 MHz, $CDCl_3$



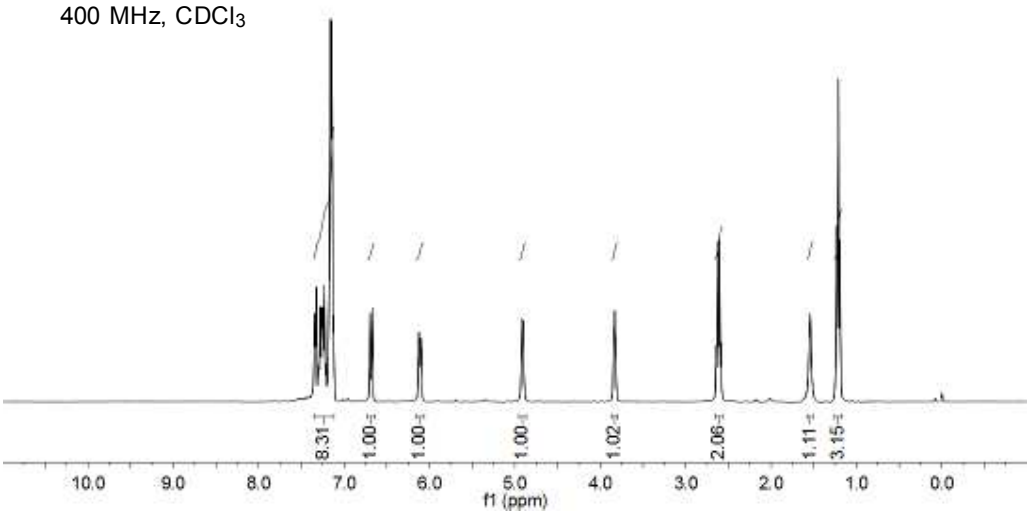
2k
100 MHz, $CDCl_3$





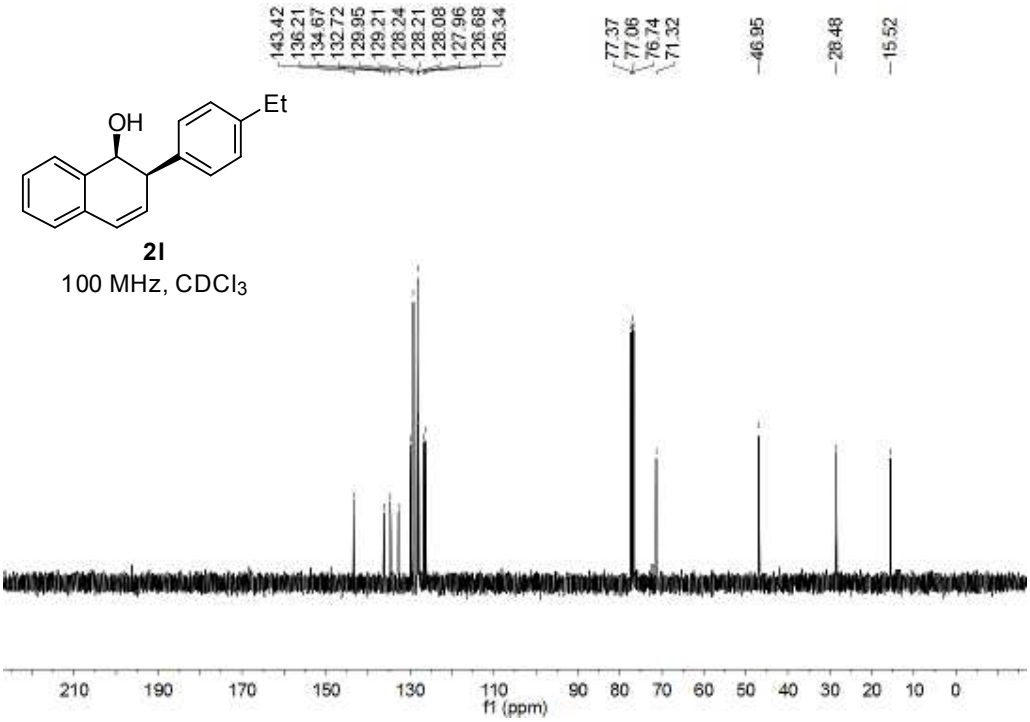
2l

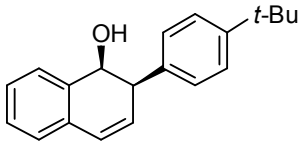
400 MHz, $CDCl_3$



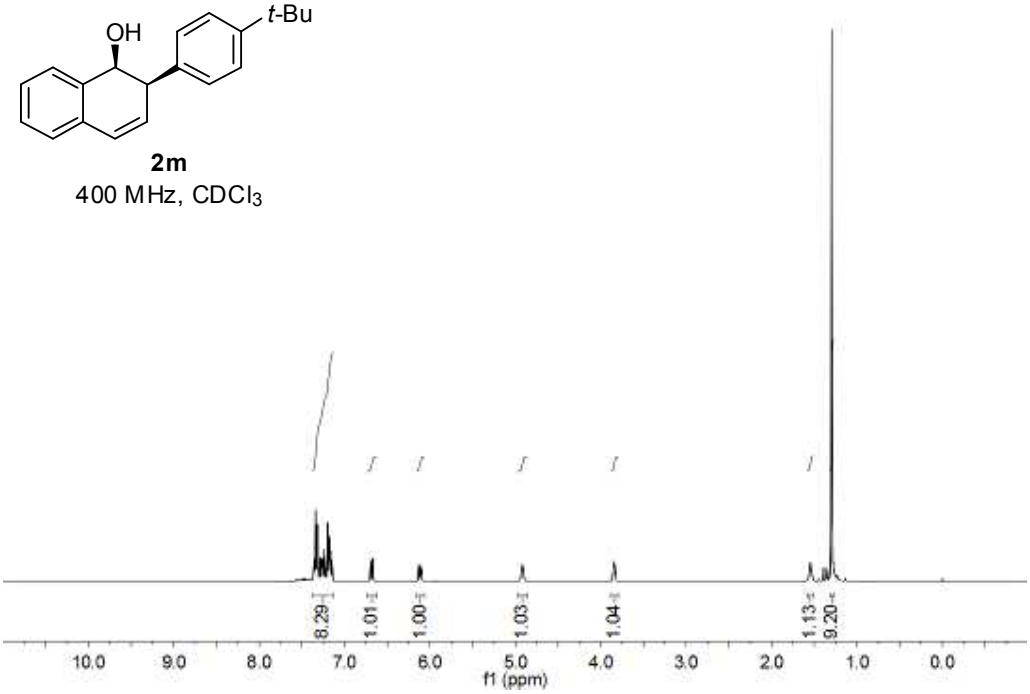
2l

100 MHz, $CDCl_3$

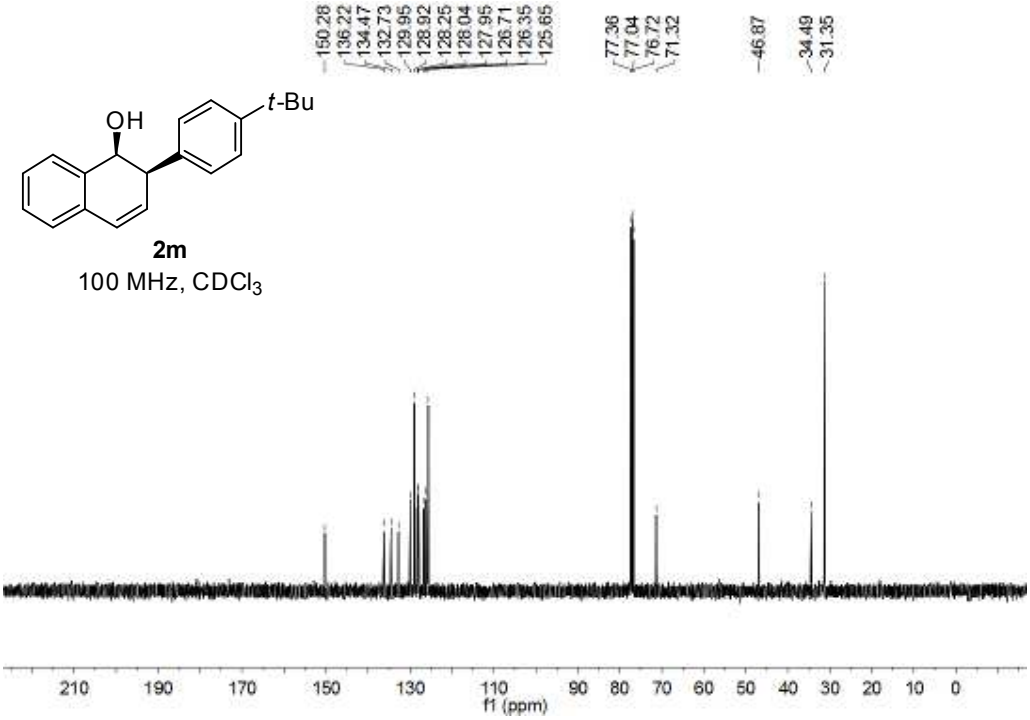


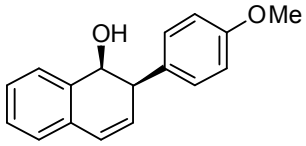


2m
400 MHz, $CDCl_3$



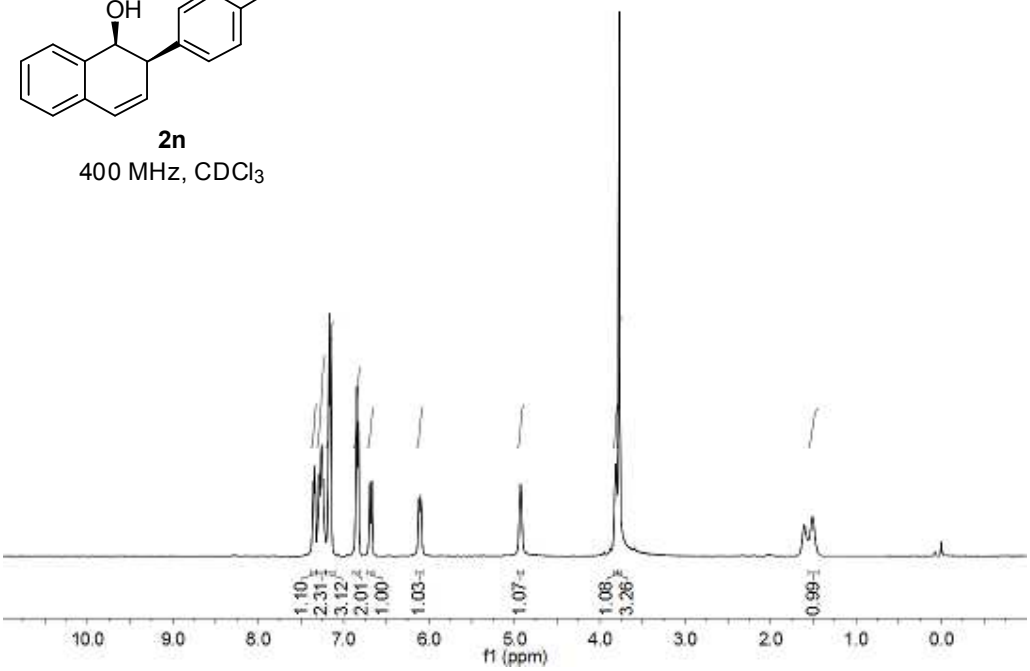
2m
100 MHz, $CDCl_3$

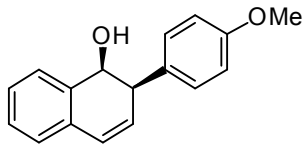




2n

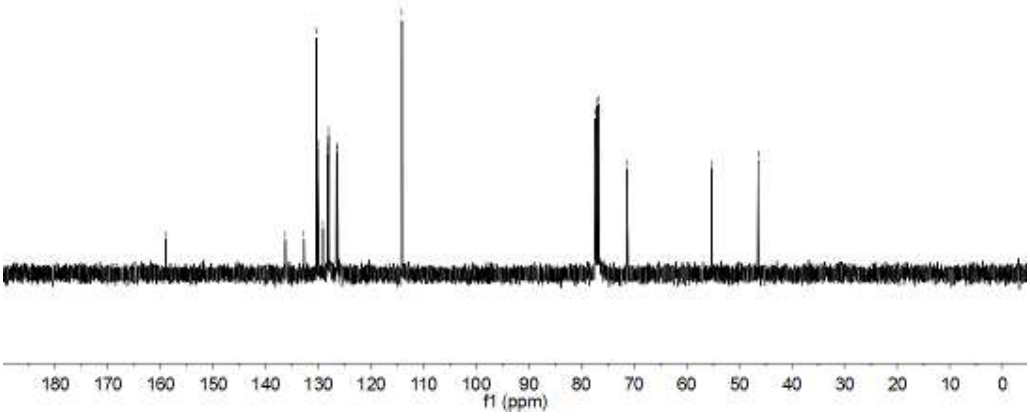
400 MHz, $CDCl_3$

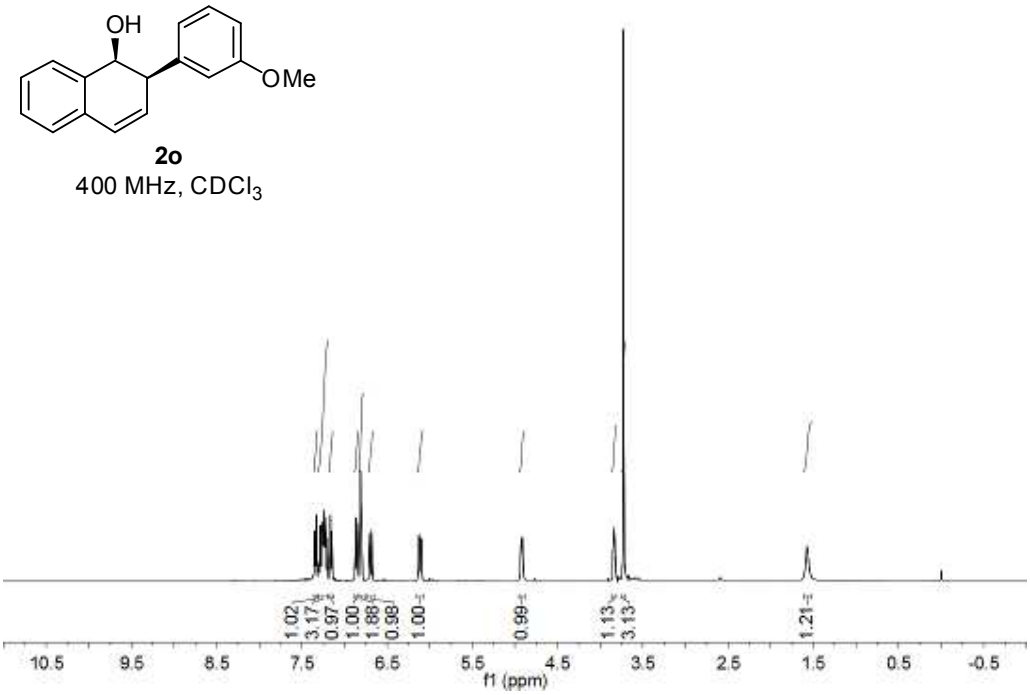


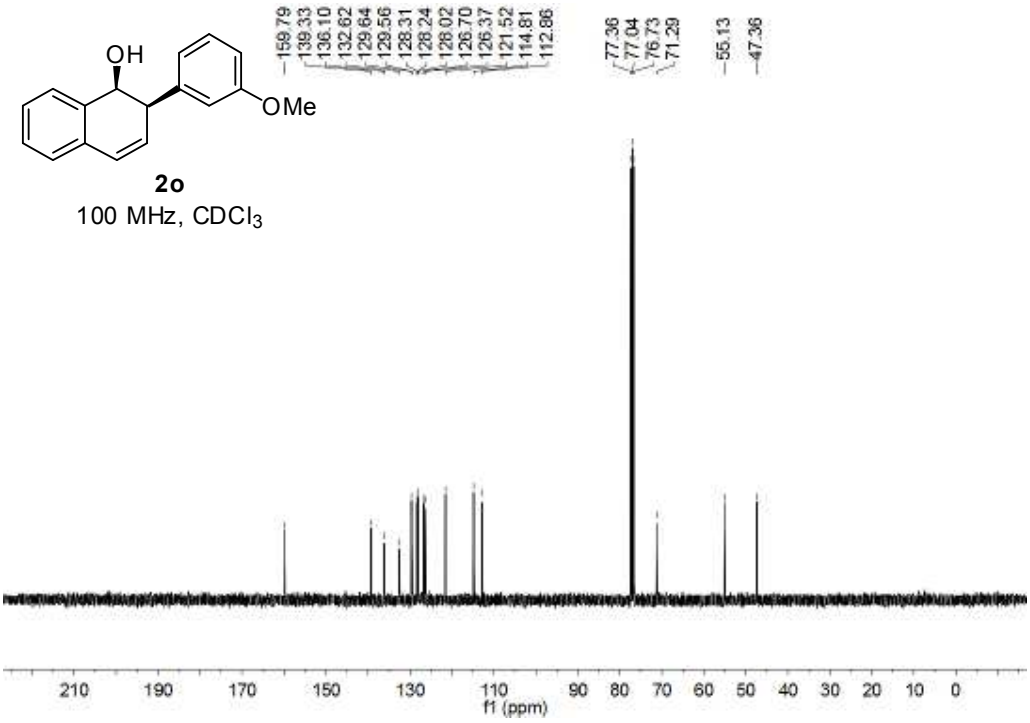


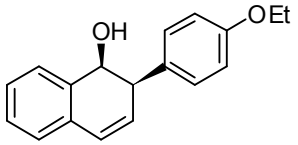
2n

100 MHz, $CDCl_3$

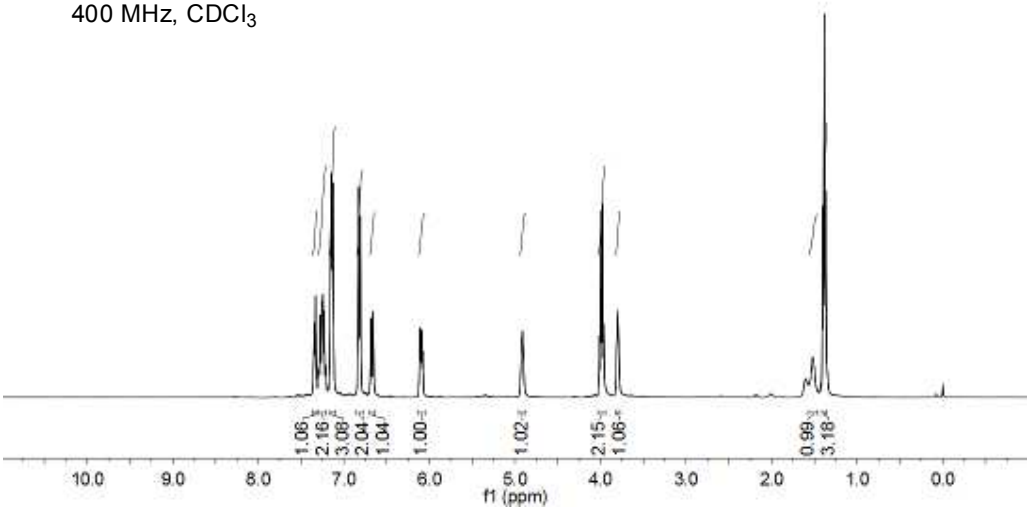



OH
OMe
2o
400 MHz, CDCl3
1.02
3.17
0.97
1.00
1.88
0.98
1.00
0.99
1.13
3.13
1.21
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

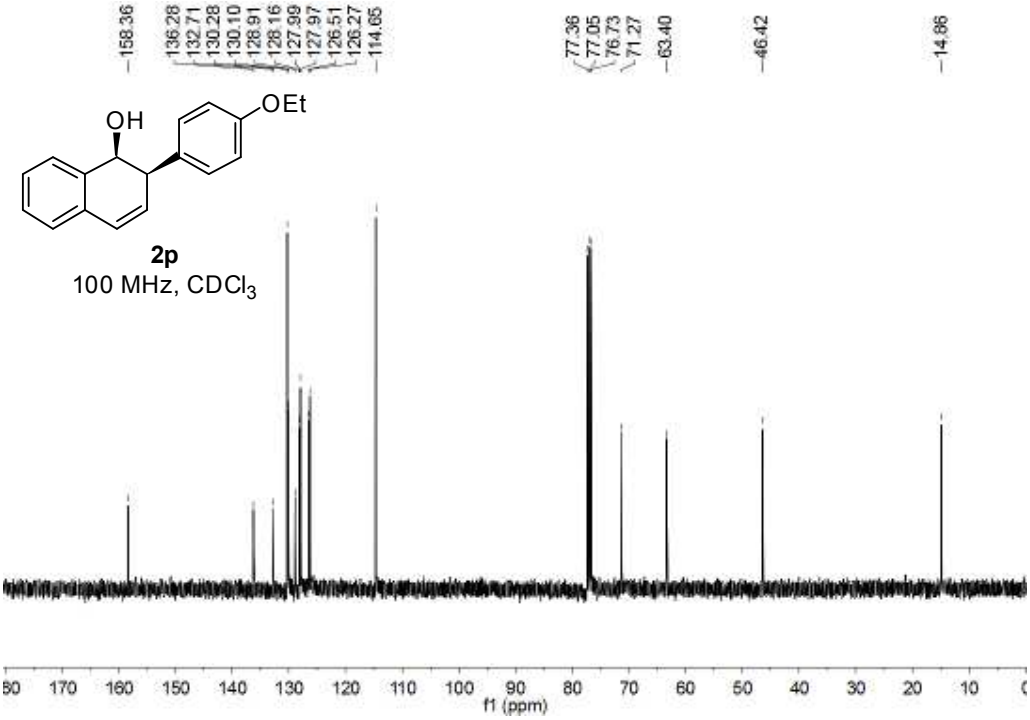

OH
OMe
2o
100 MHz, CDCl3
159.79
139.33
136.10
132.62
129.64
129.56
128.31
128.24
128.02
126.70
126.37
121.52
114.81
112.86
77.36
77.04
76.73
71.29
55.13
47.36
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

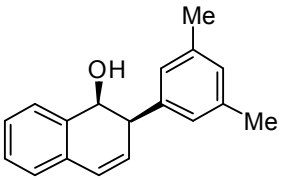


2p
400 MHz, $CDCl_3$

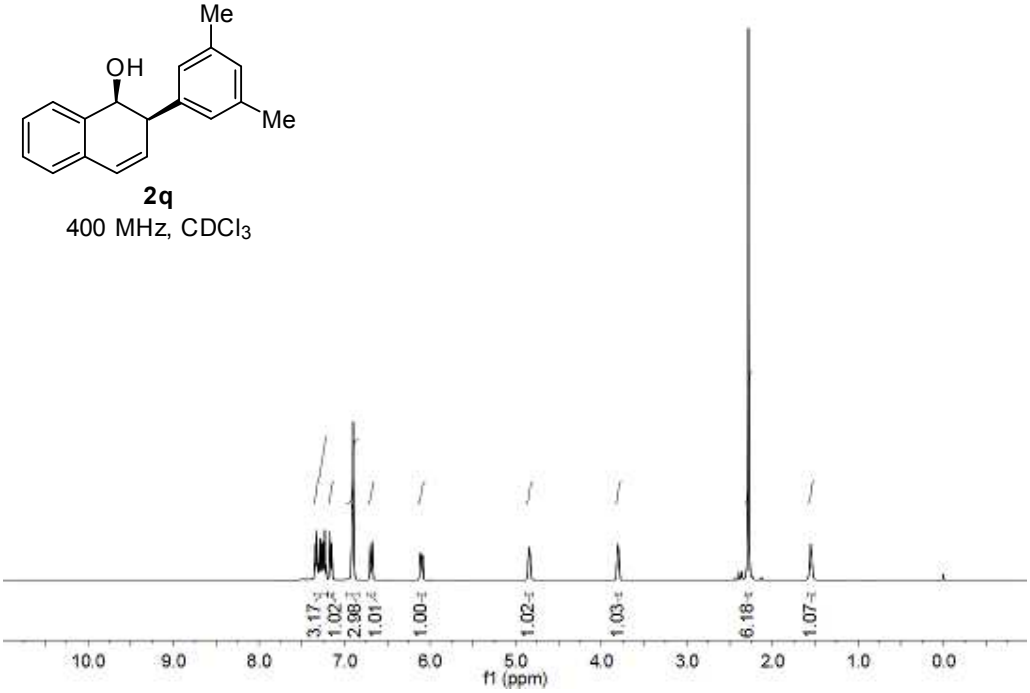


2p
100 MHz, $CDCl_3$

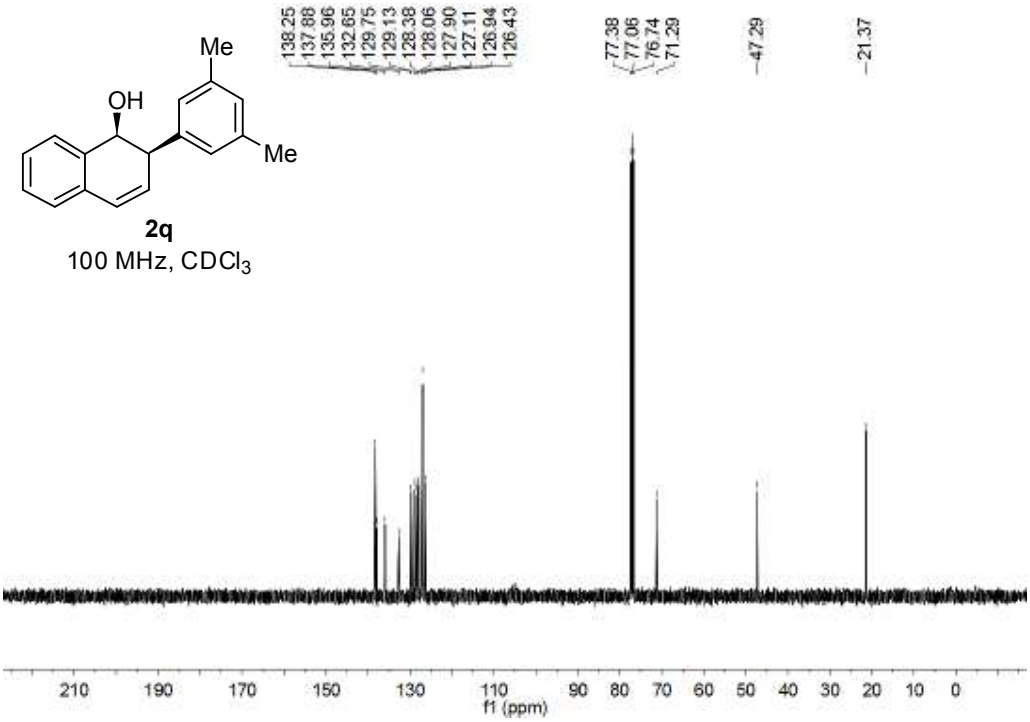


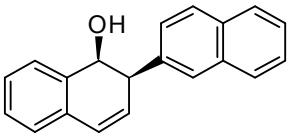


2q
400 MHz, $CDCl_3$



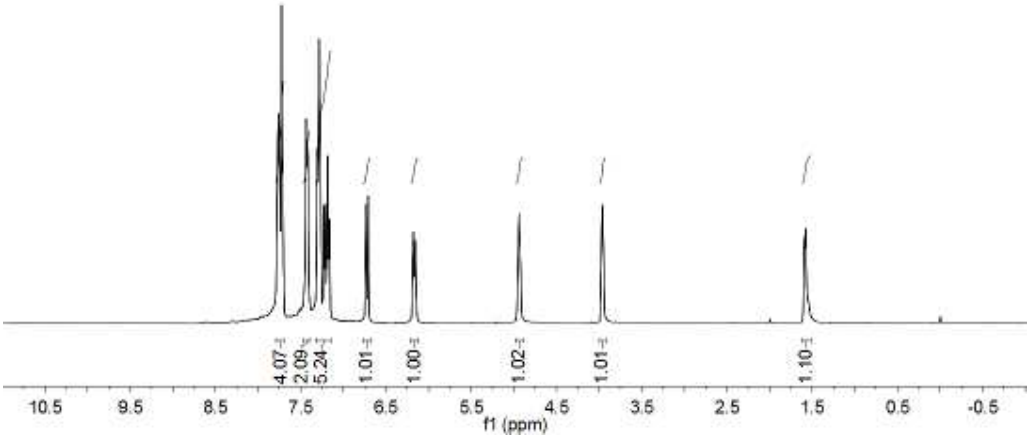
2q
100 MHz, $CDCl_3$





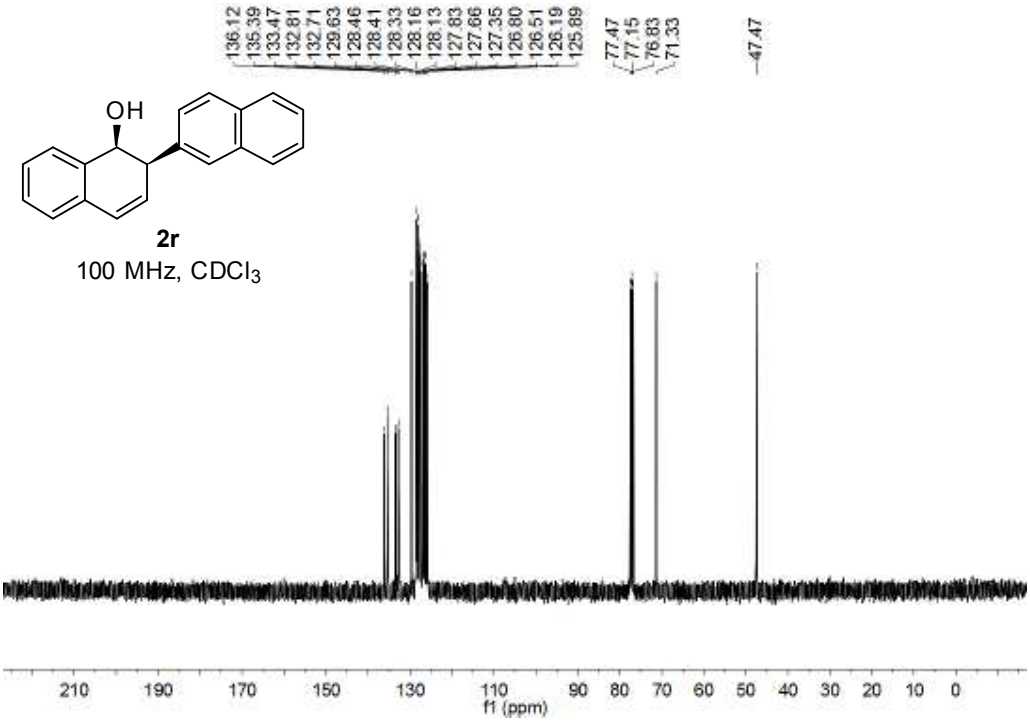
2r

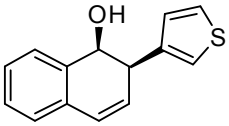
400 MHz, $CDCl_3$



2r

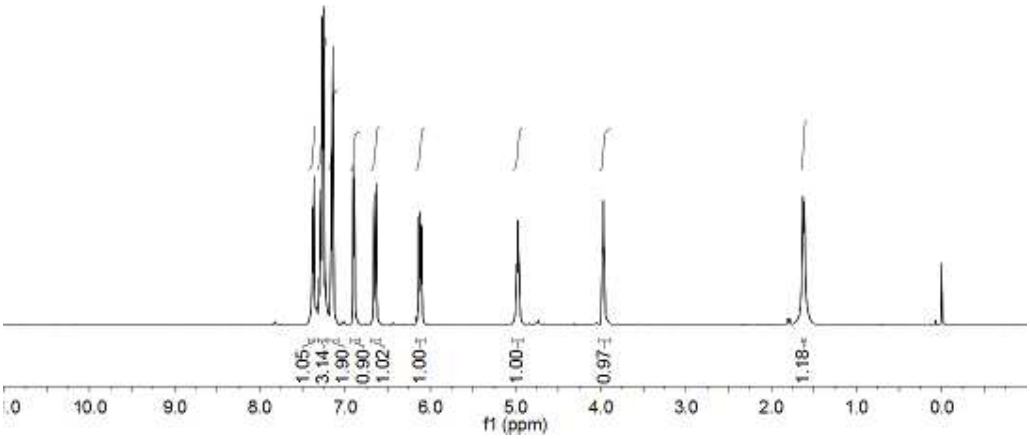
100 MHz, $CDCl_3$





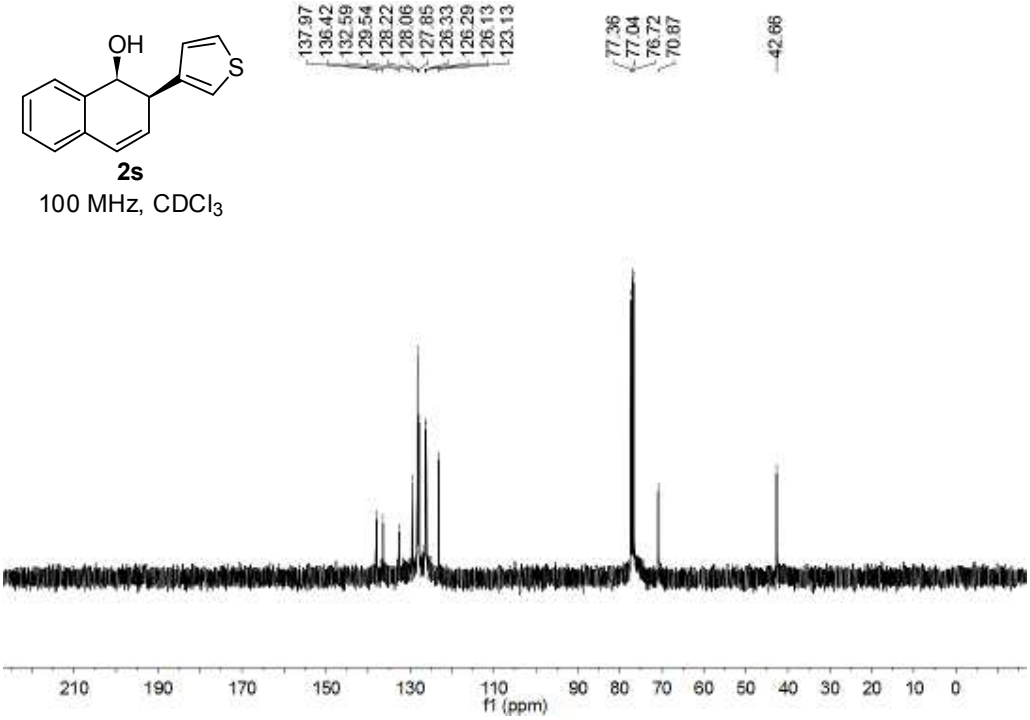
2s

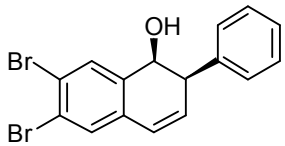
400 MHz, $CDCl_3$



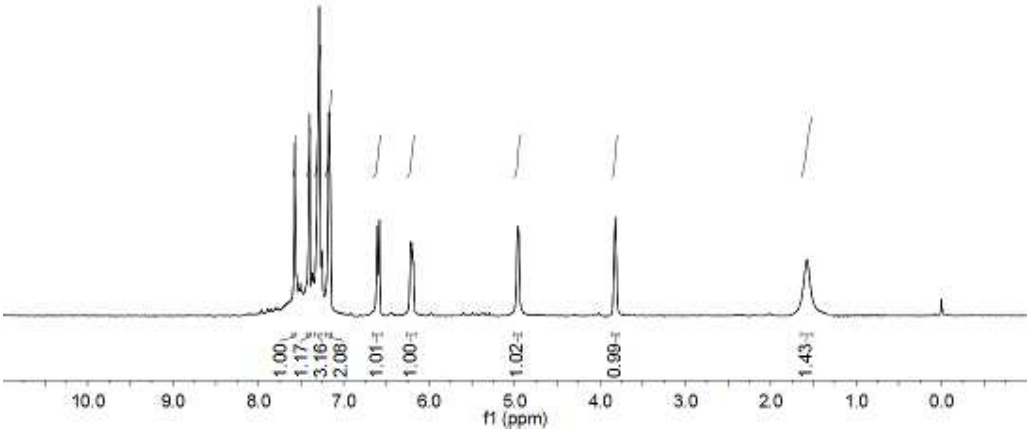
2s

100 MHz, $CDCl_3$

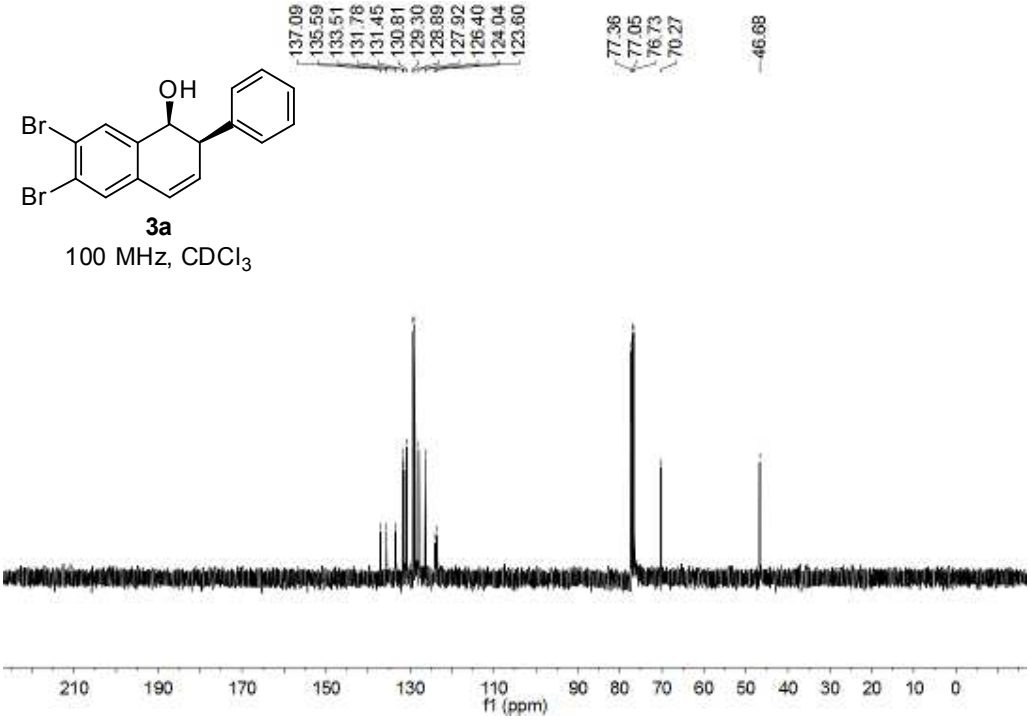


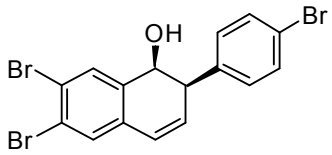


3a
400 MHz, $CDCl_3$



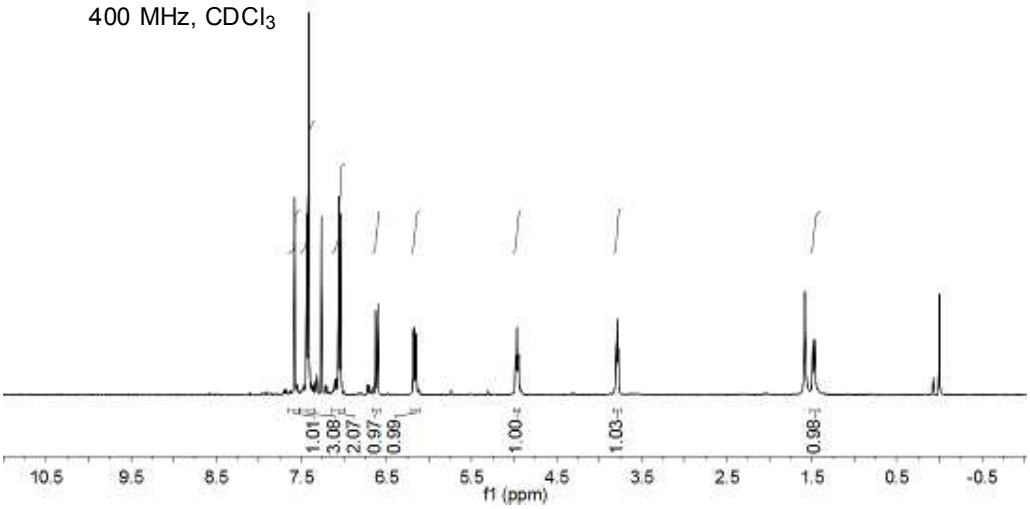
3a
100 MHz, $CDCl_3$





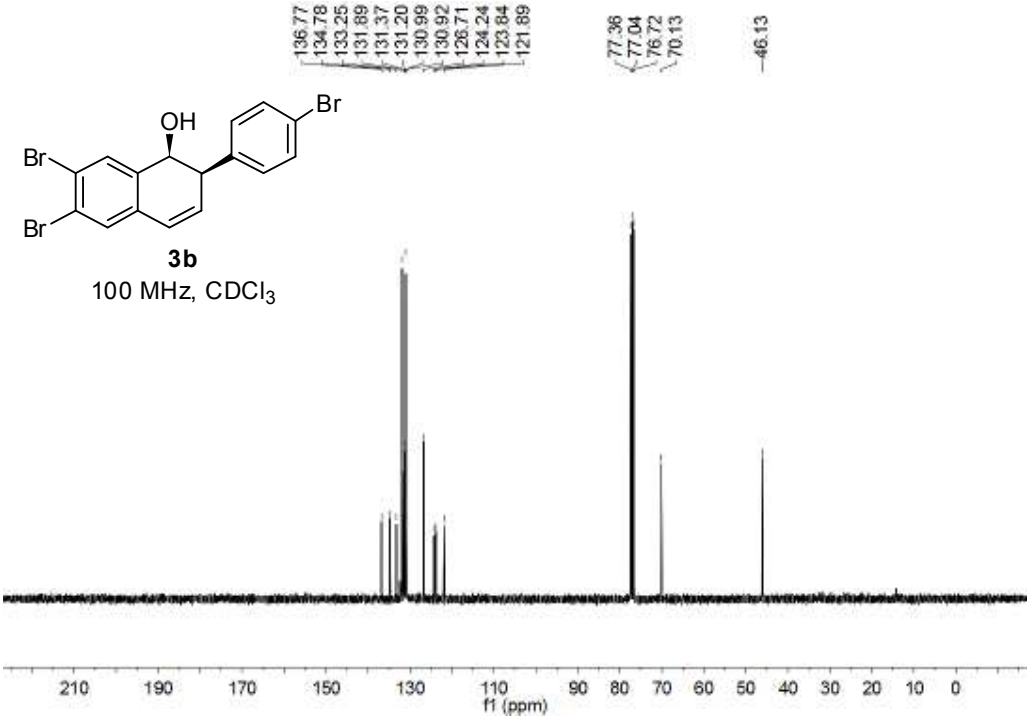
3b

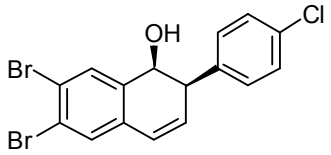
400 MHz, $CDCl_3$



3b

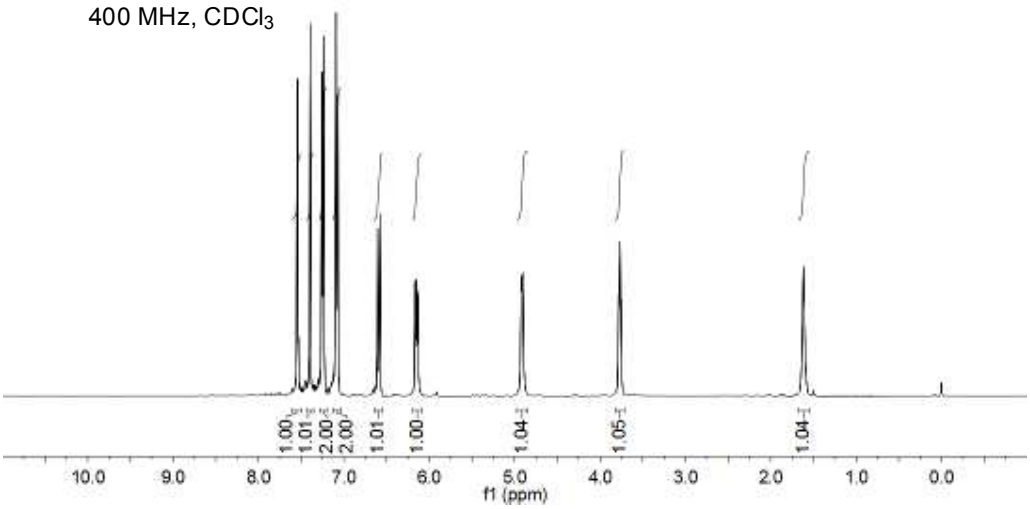
100 MHz, $CDCl_3$

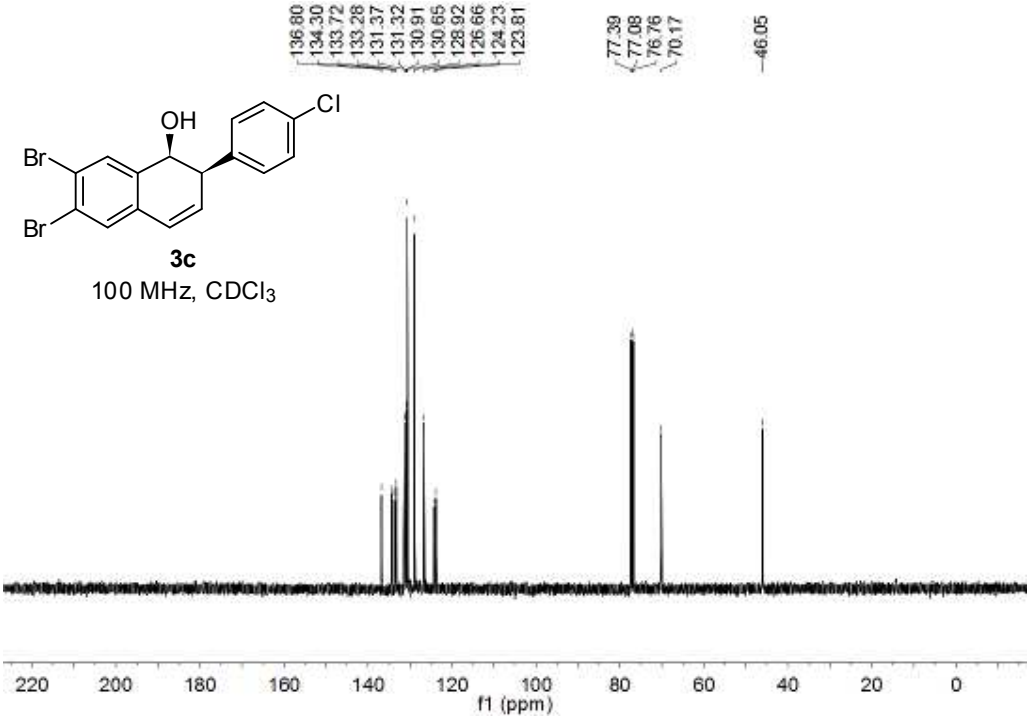




3c

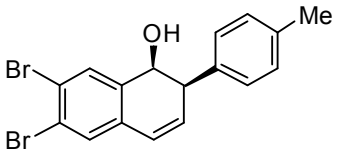
400 MHz, $CDCl_3$





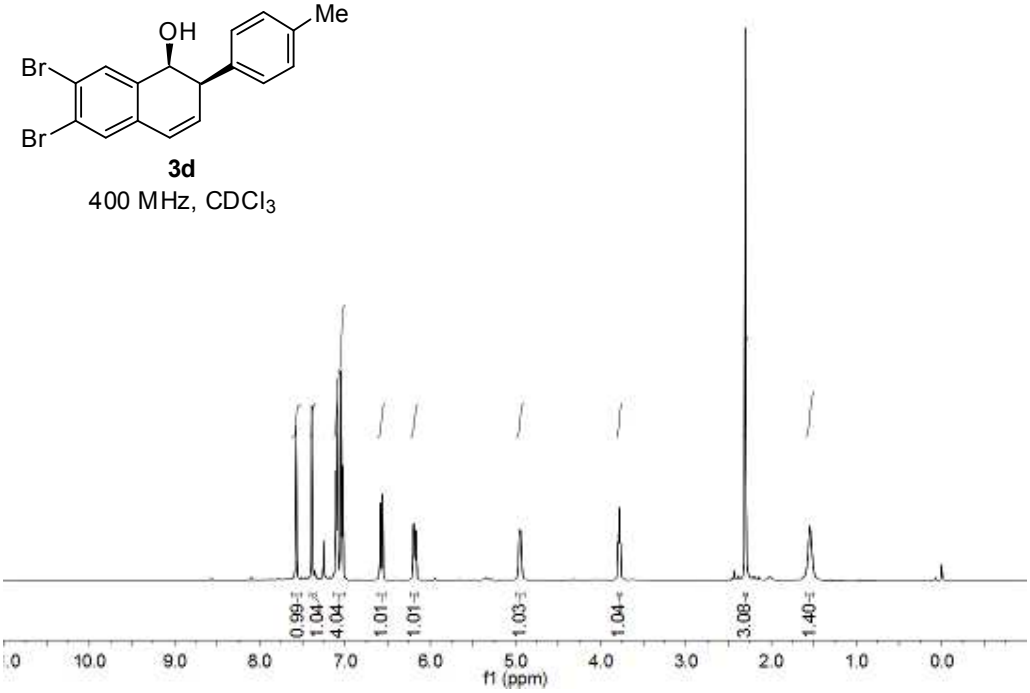
3c

100 MHz, $CDCl_3$



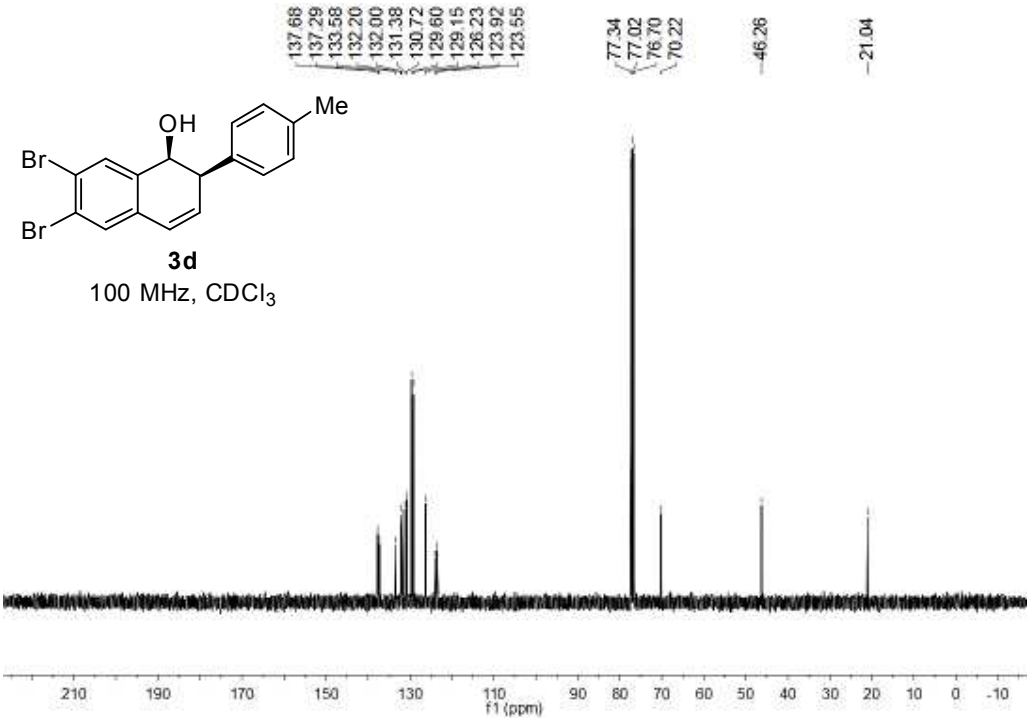
3d

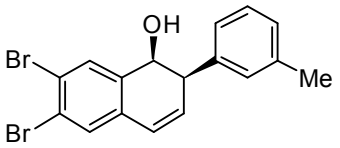
400 MHz, $CDCl_3$



3d

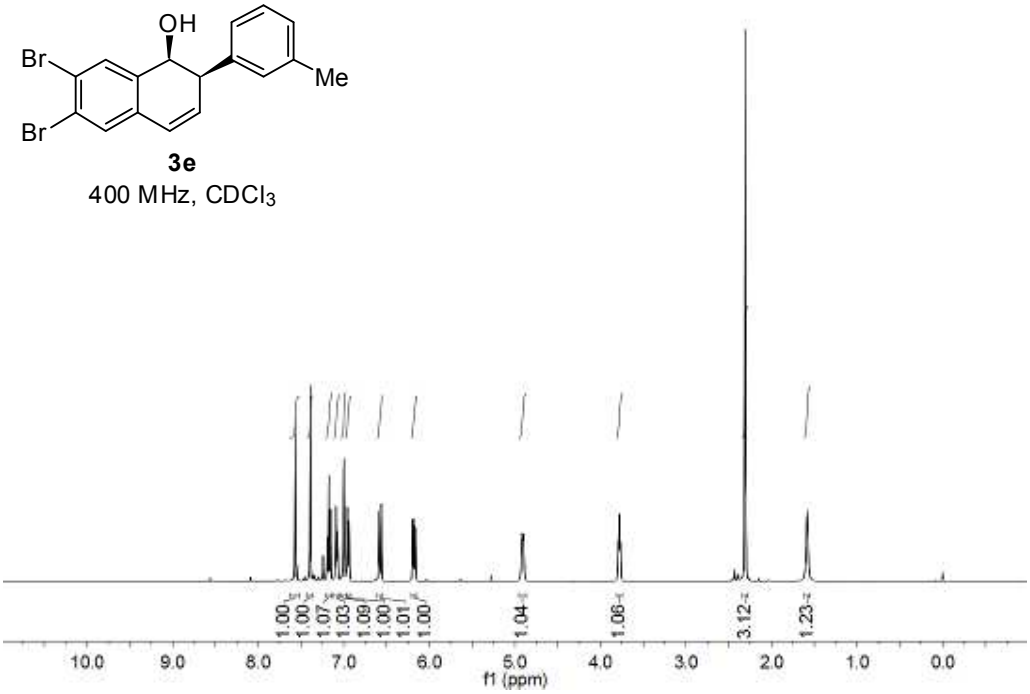
100 MHz, $CDCl_3$

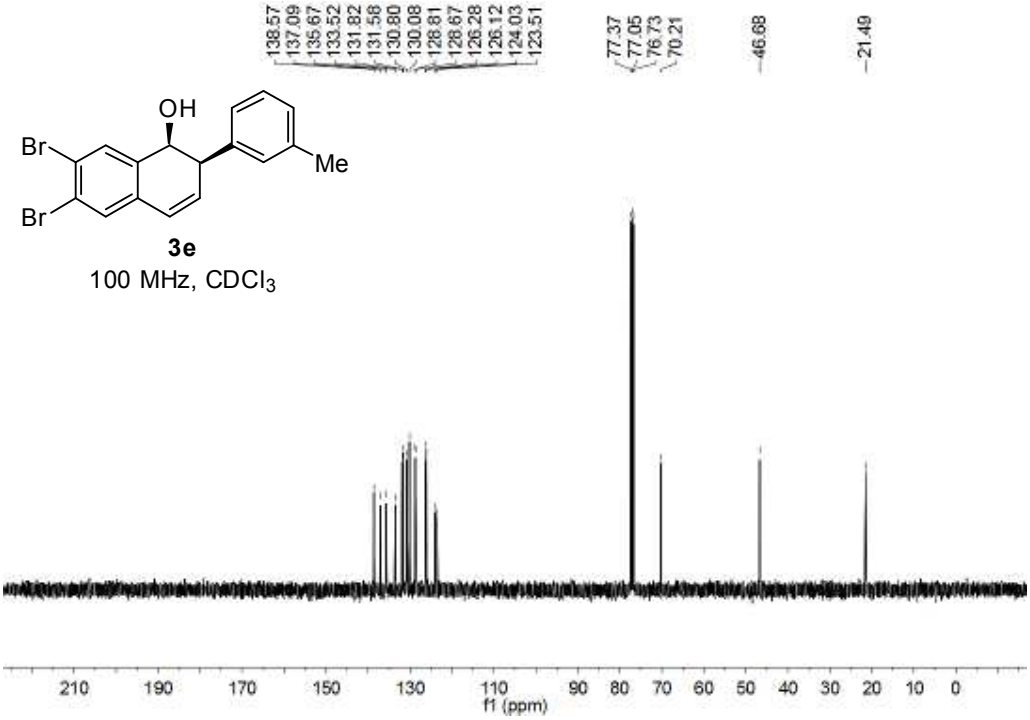




3e

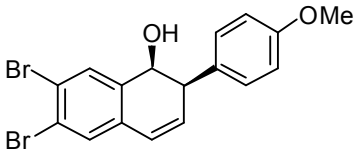
400 MHz, $CDCl_3$





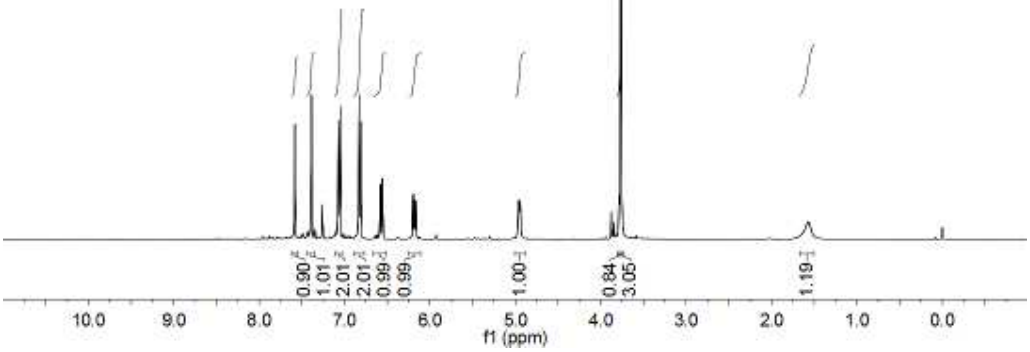
3e

100 MHz, $CDCl_3$



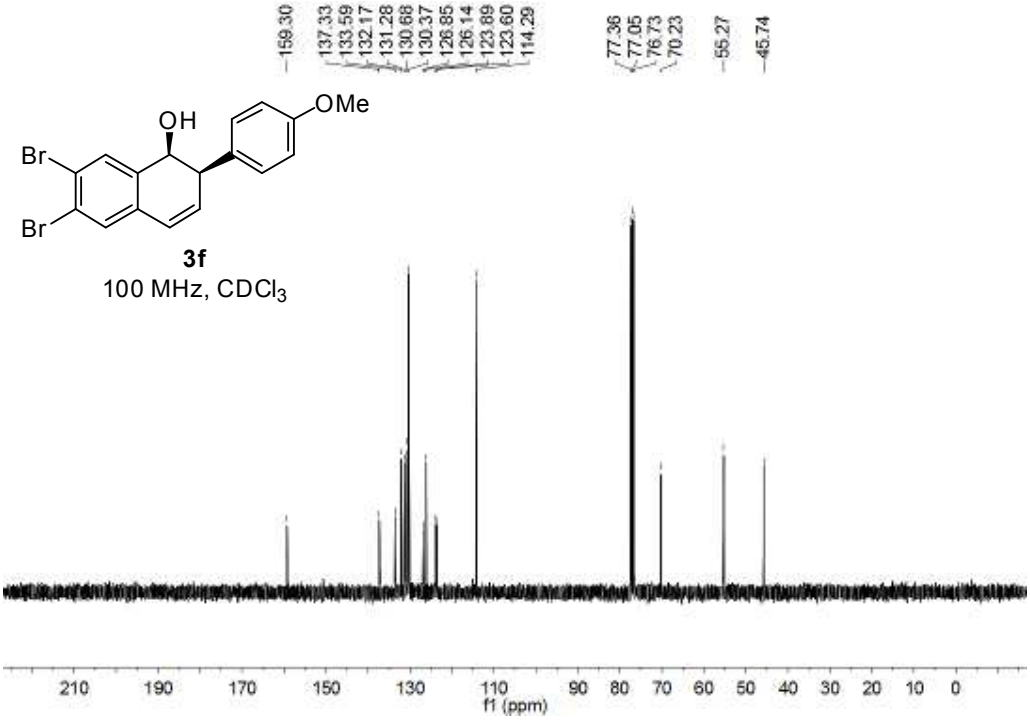
3f

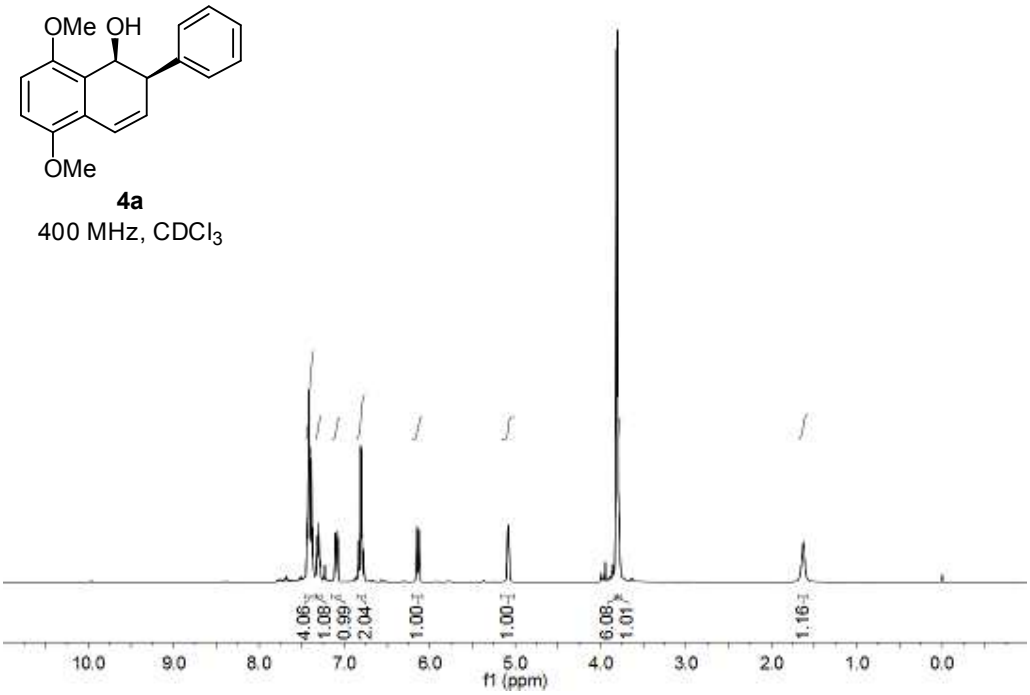
400 MHz, $CDCl_3$

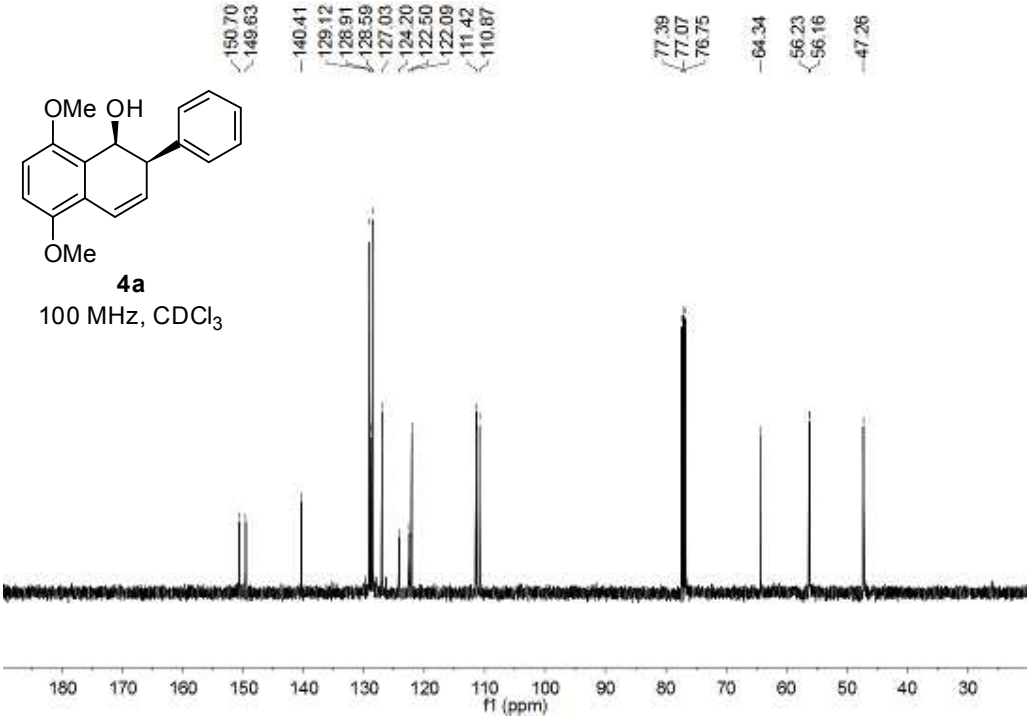


3f

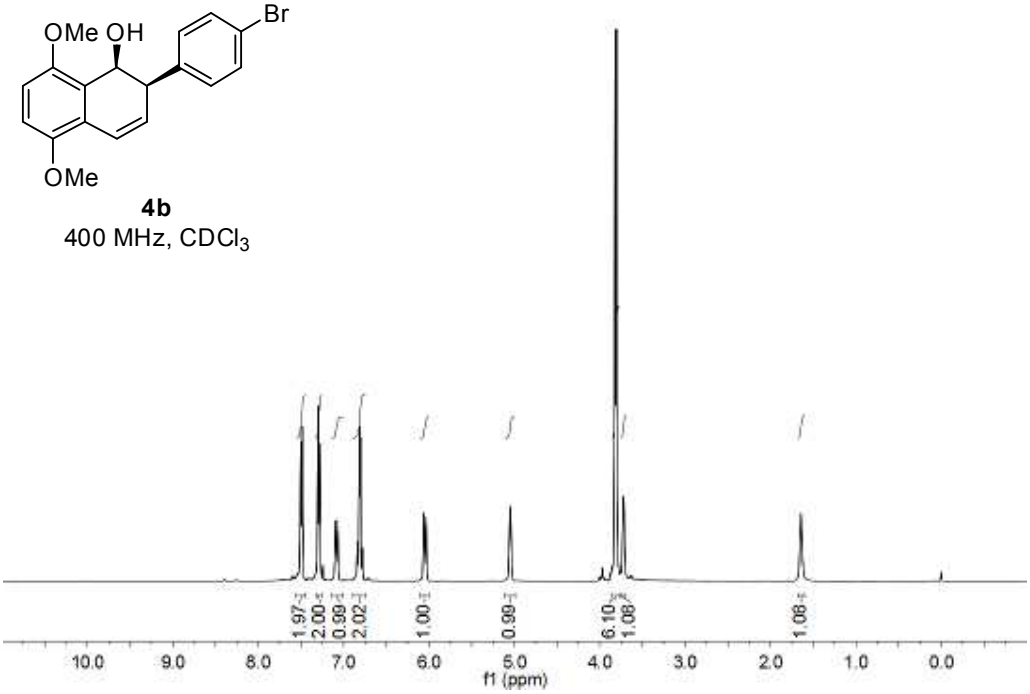
100 MHz, $CDCl_3$



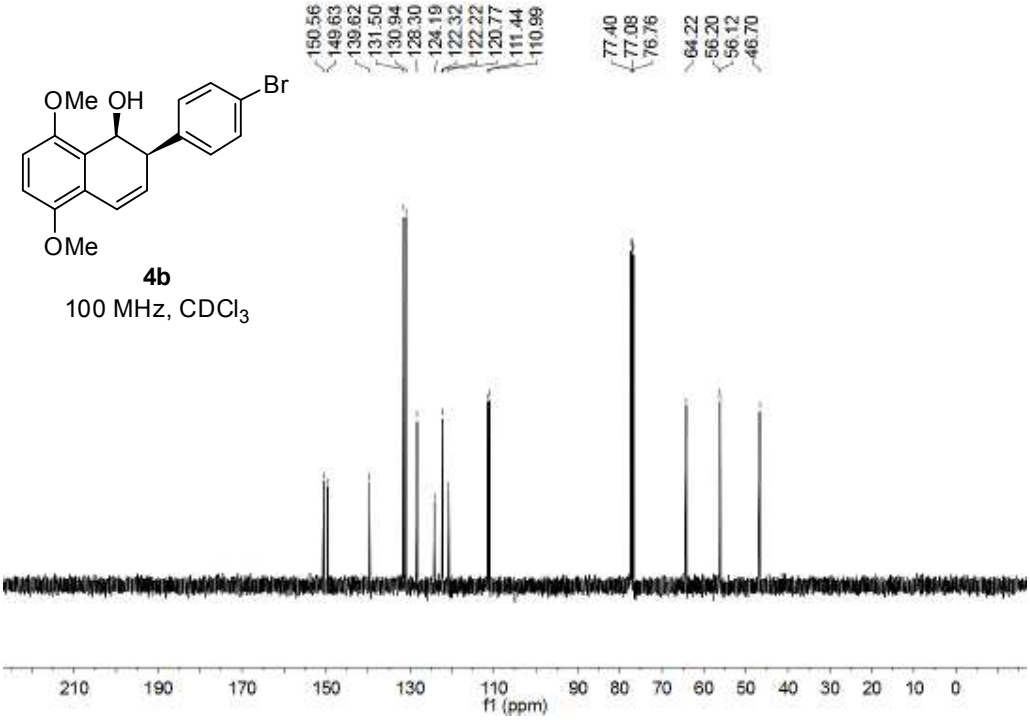

OMe OH
OMe
4a
400 MHz, CDCl3
4.06
1.08
0.99
2.04
1.00
1.00
6.08
1.01
1.16
10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

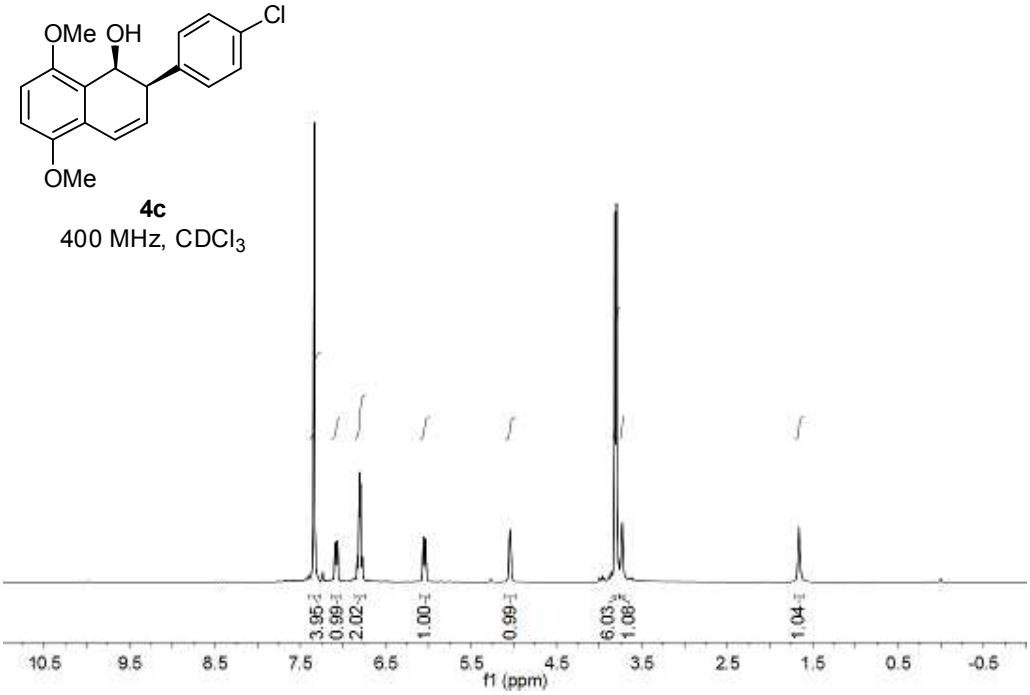

150.70
149.63
140.41
129.12
128.91
128.59
127.03
124.20
122.50
122.09
111.42
110.87
77.39
77.07
76.75
64.34
56.23
56.16
47.26
OMe OH
OMe
4a
100 MHz, CDCl3
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30
f1 (ppm)

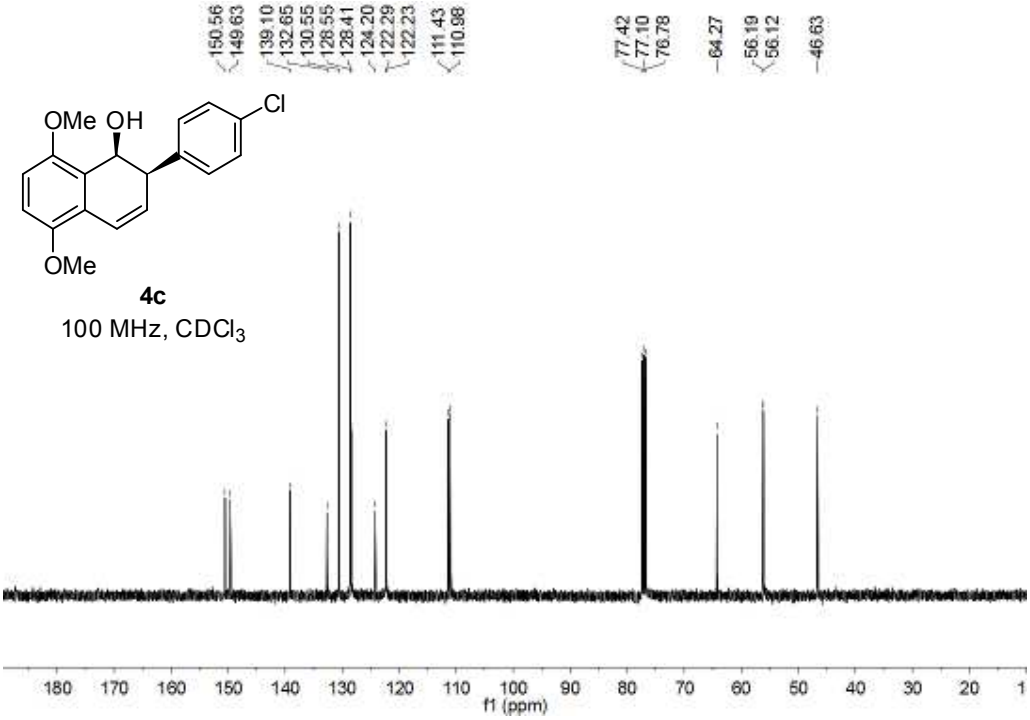
4b
400 MHz, $CDCl_3$

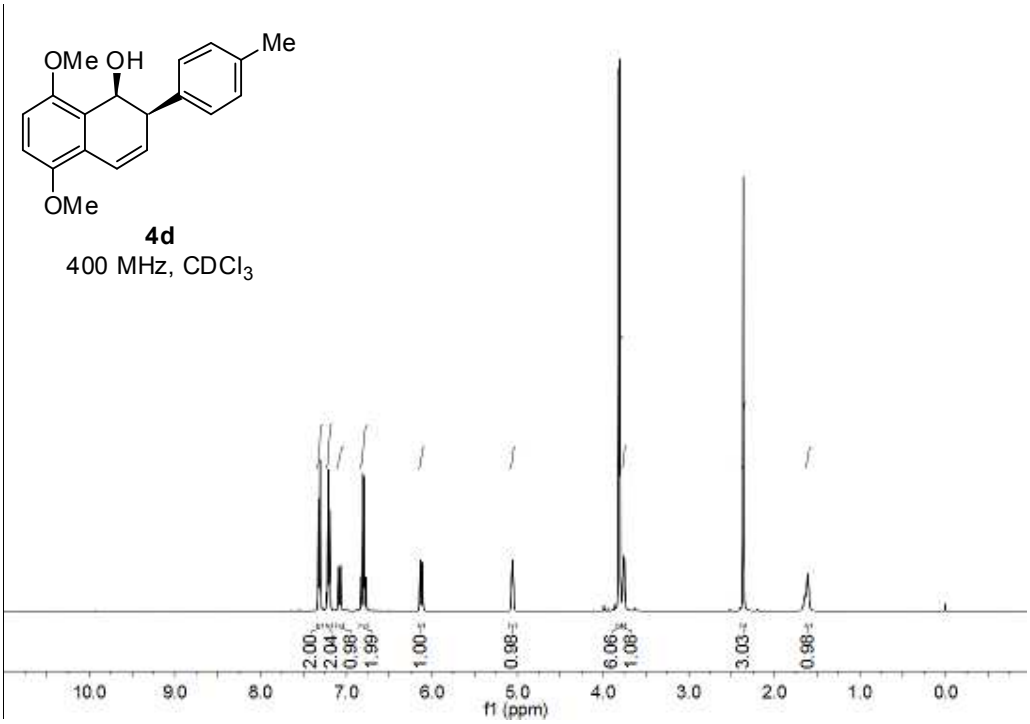


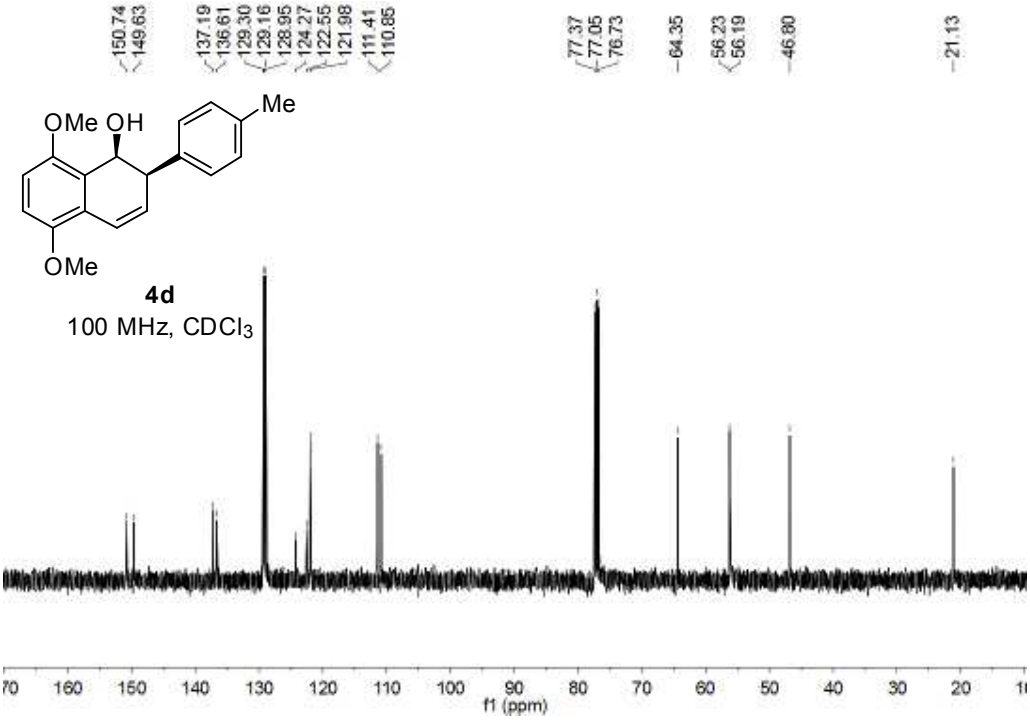
4b
100 MHz, $CDCl_3$

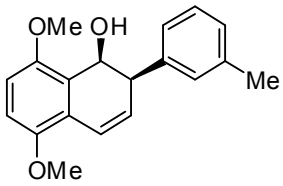



OMe OH
Cl
OMe
4c
400 MHz, CDCl3
3.95
0.99
2.02
1.00
0.99
6.03
1.08
1.04
10.5 9.5 8.5 7.5 6.5 5.5 4.5 3.5 2.5 1.5 0.5 -0.5
f1 (ppm)


150.56
149.63
139.10
132.65
130.55
128.55
128.41
124.20
122.29
122.23
111.43
110.98
77.42
77.10
76.78
64.27
56.19
56.12
46.63
OMe OH
Cl
OMe
4c
100 MHz, CDCl3
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 1
f1 (ppm)

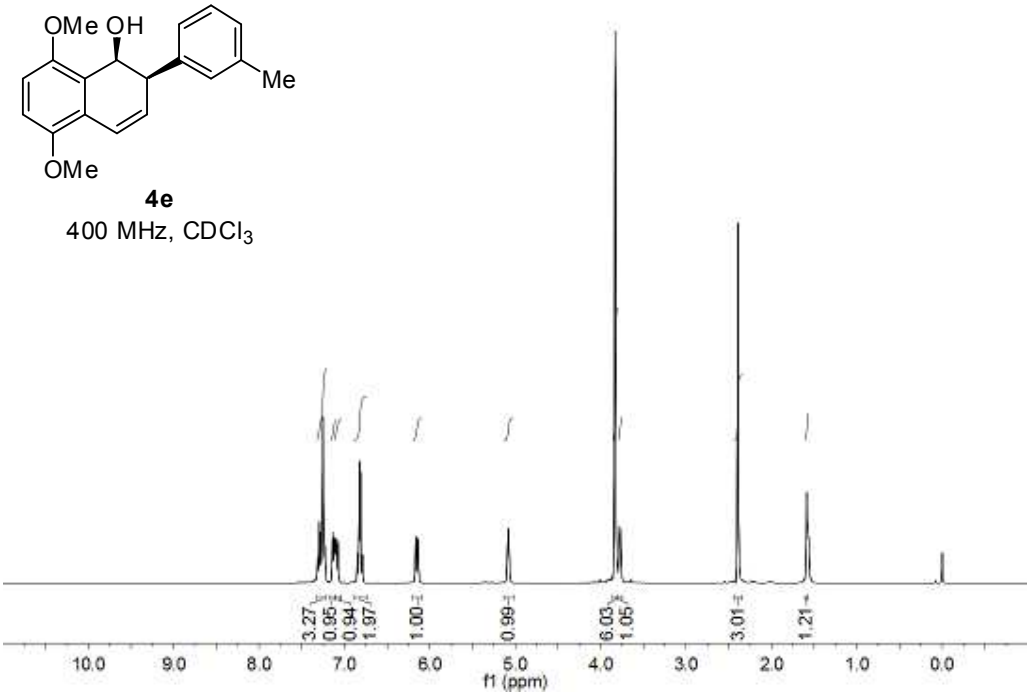

OMe OH
Me
OMe
4d
400 MHz, CDCl3
2.00
2.04
0.98
1.99
1.00
0.98
6.06
1.08
3.03
0.98
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

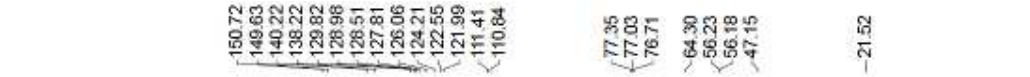

150.74
149.63
137.19
136.61
129.30
129.16
128.95
124.27
122.55
121.98
111.41
110.85
77.37
77.05
76.73
64.35
56.23
56.19
46.80
21.13
OMe OH
Me
OMe
4d
100 MHz, CDCl3
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
f1 (ppm)

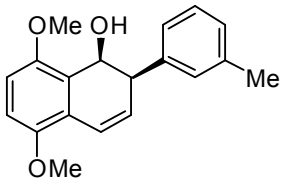


4e

400 MHz, $CDCl_3$

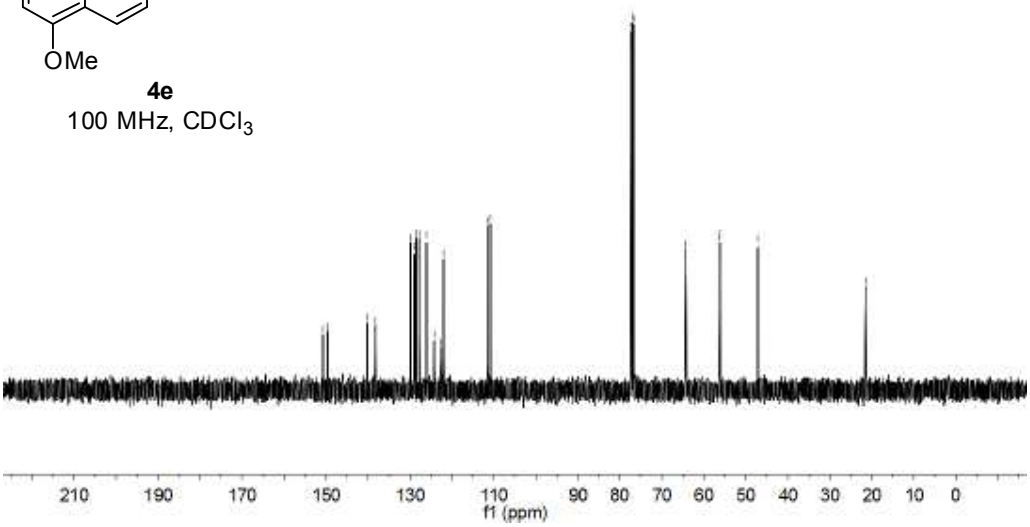


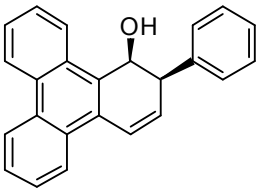




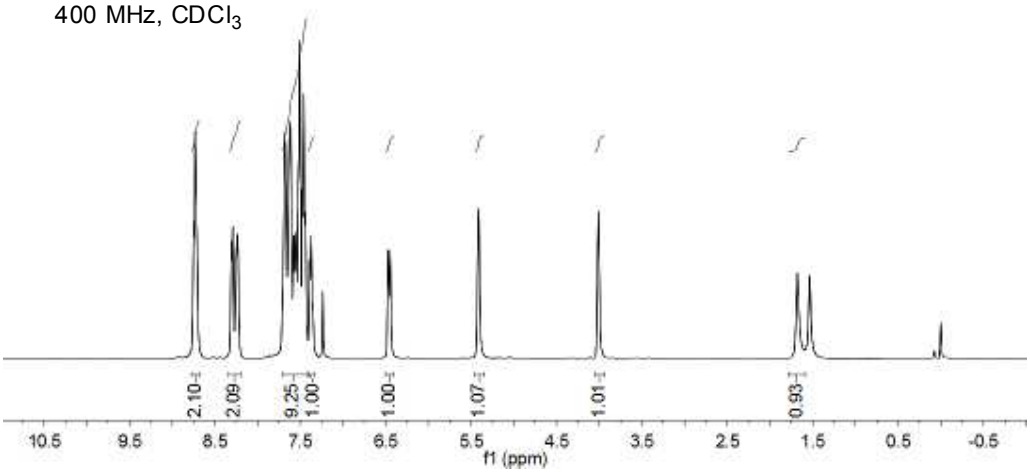
4e

100 MHz, $CDCl_3$

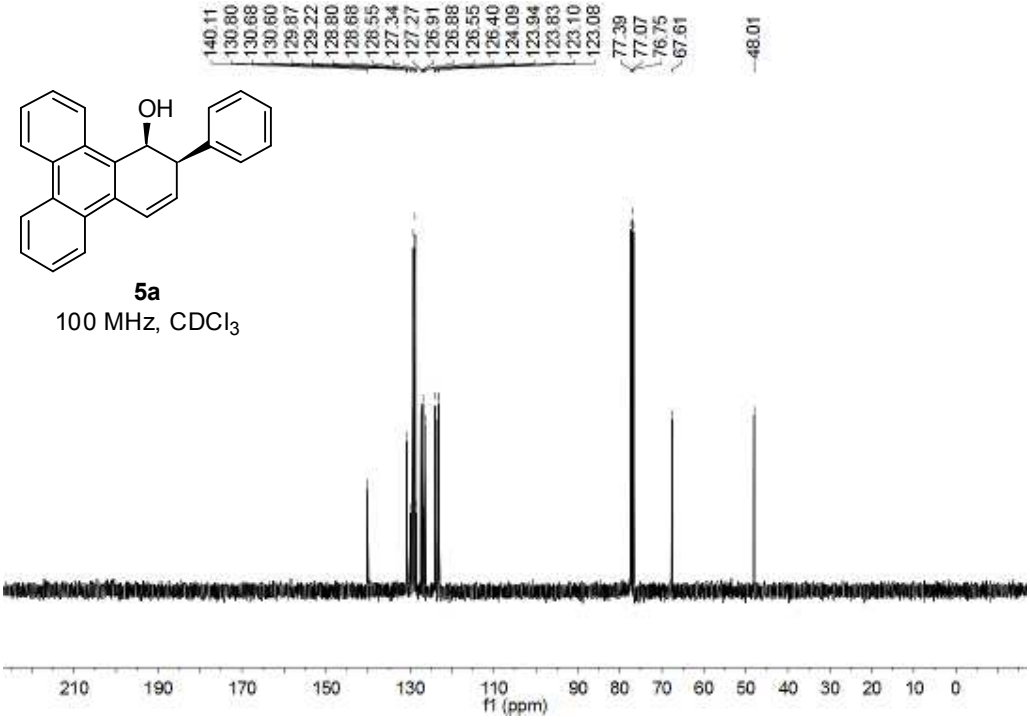


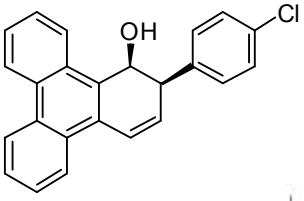


5a
400 MHz, $CDCl_3$

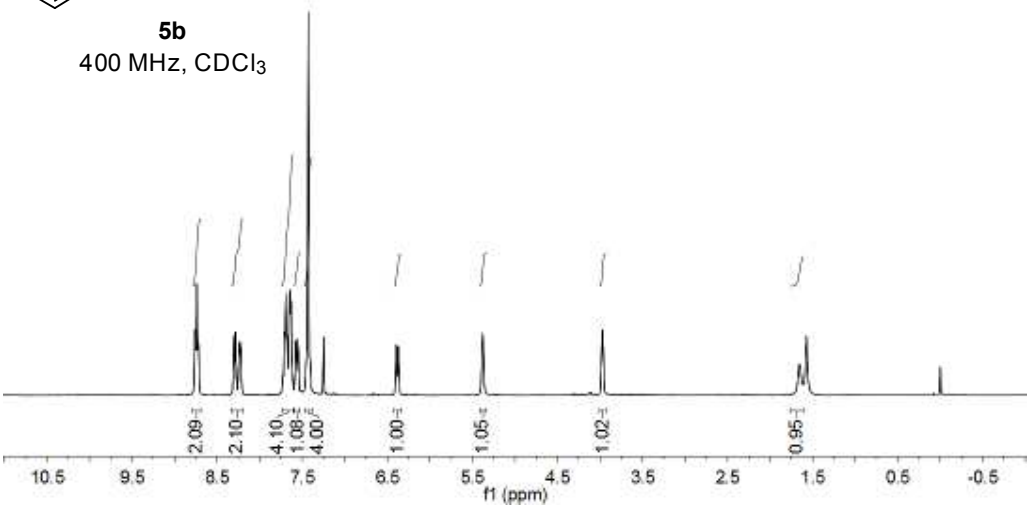


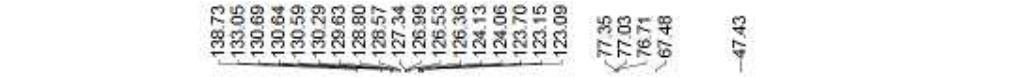
5a
100 MHz, $CDCl_3$

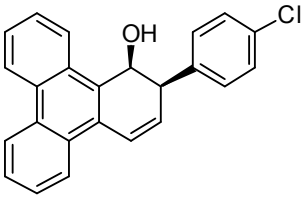




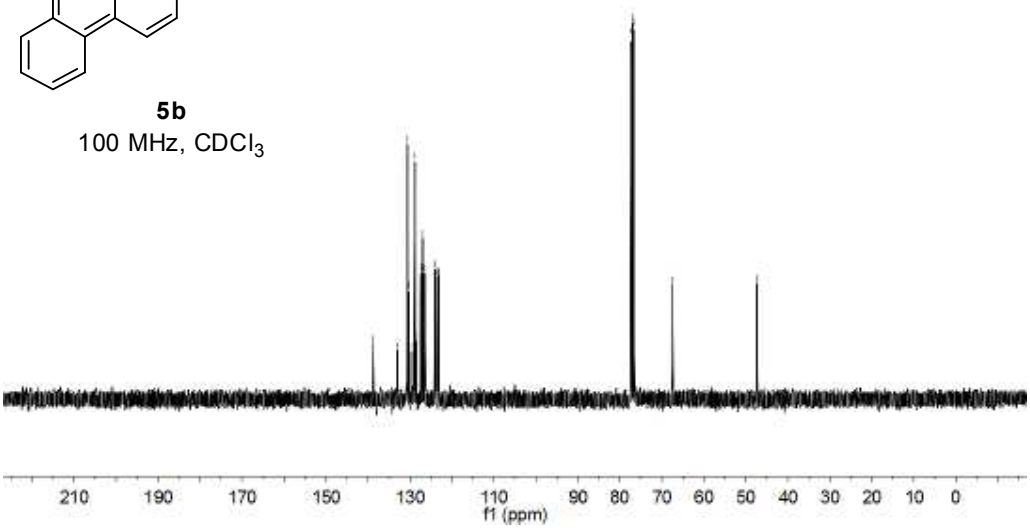
5b
400 MHz, $CDCl_3$

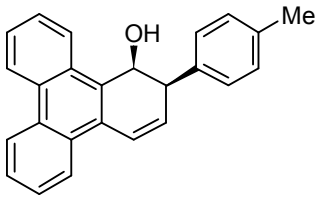




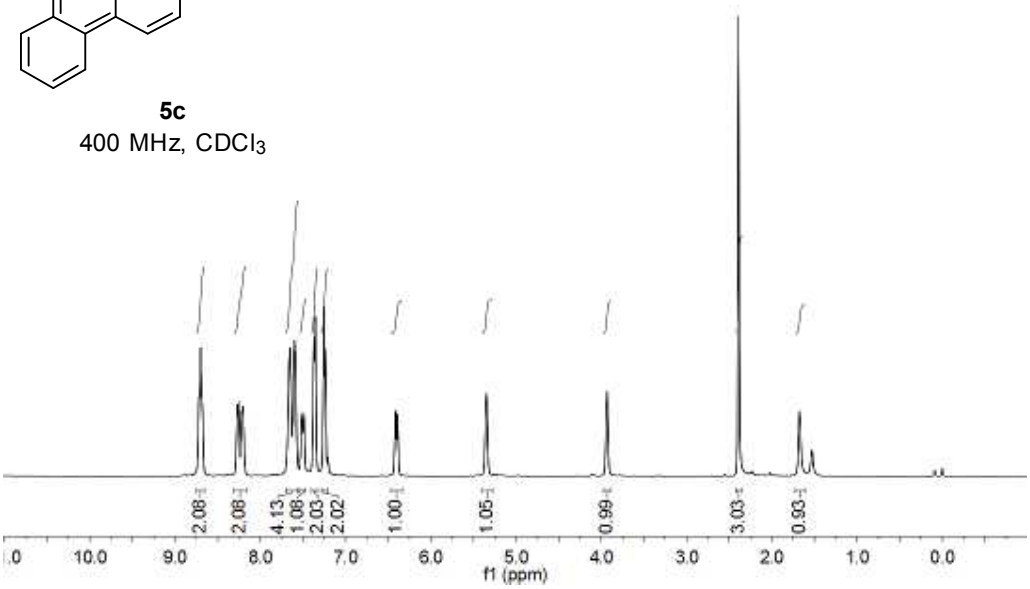


5b
100 MHz, $CDCl_3$

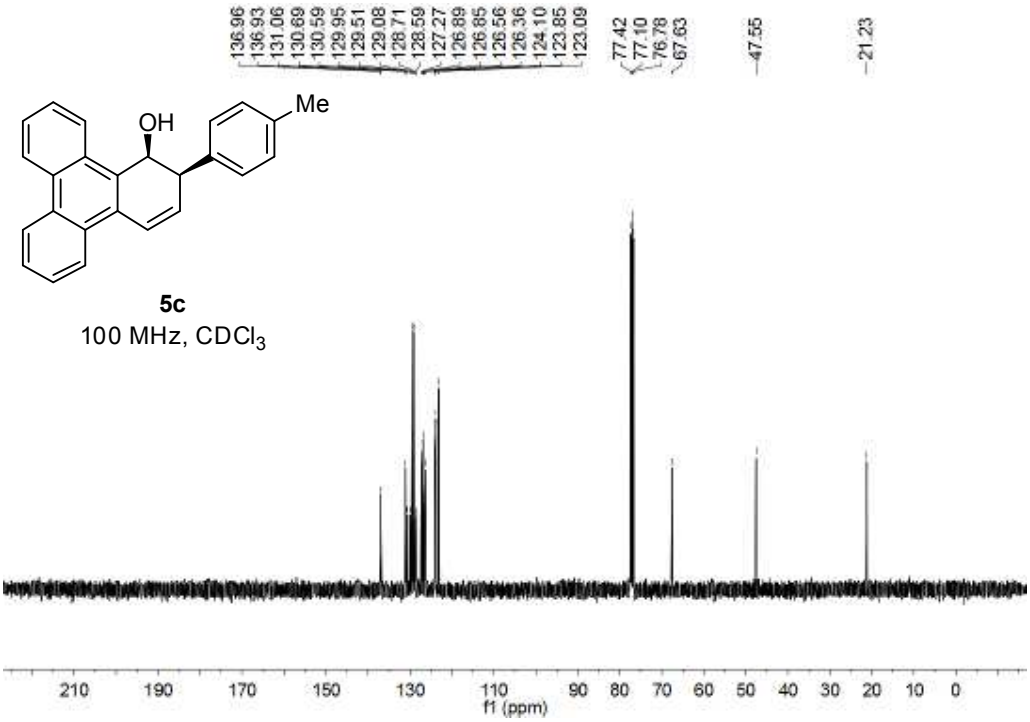


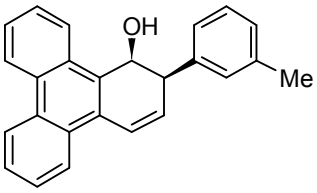


5c
400 MHz, $CDCl_3$

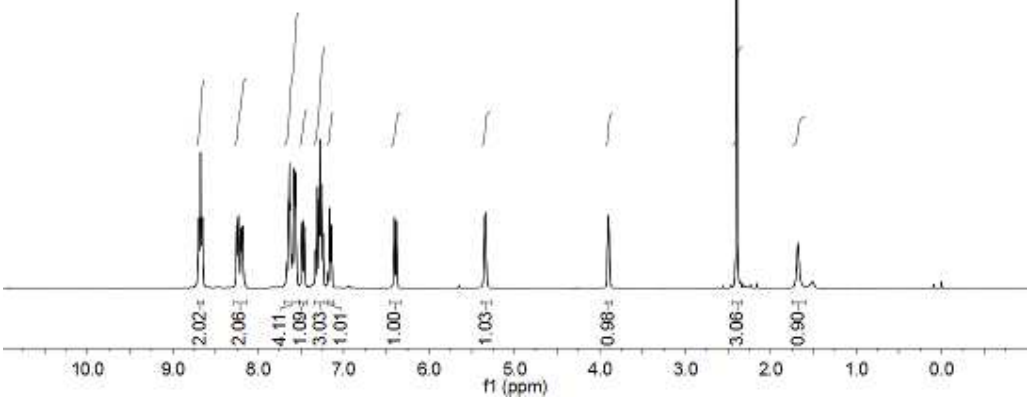


5c
100 MHz, $CDCl_3$

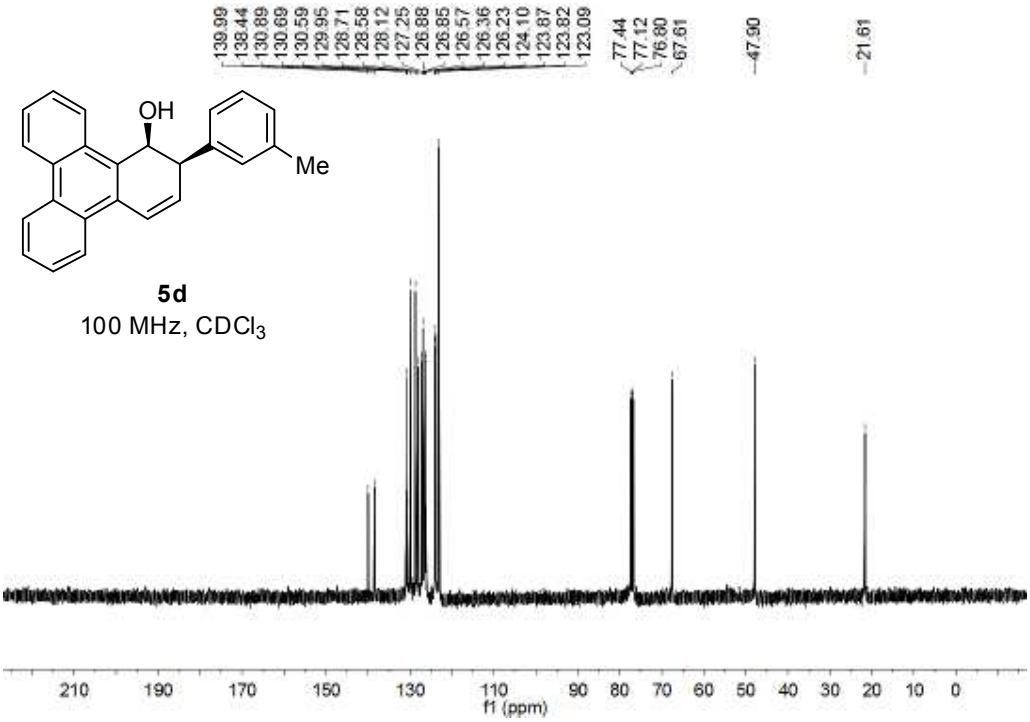


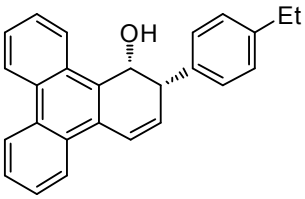


5d
400 MHz, $CDCl_3$



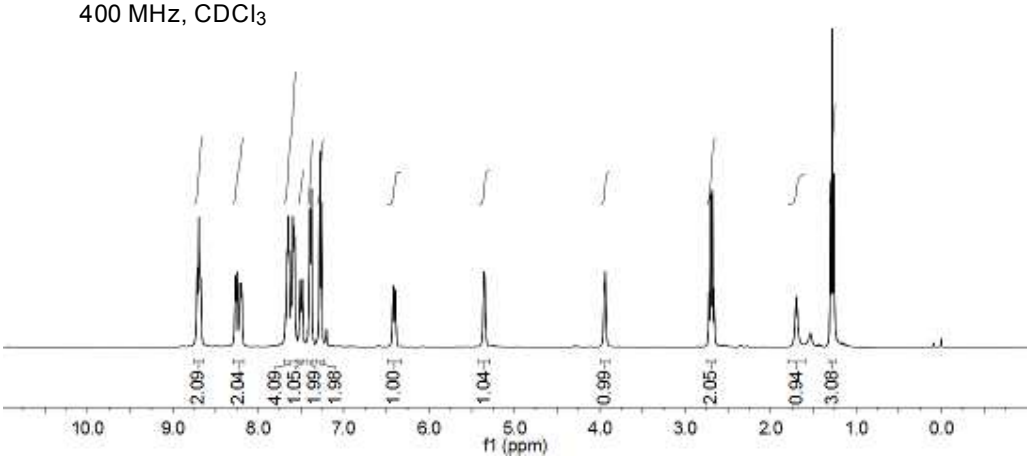
5d
100 MHz, $CDCl_3$

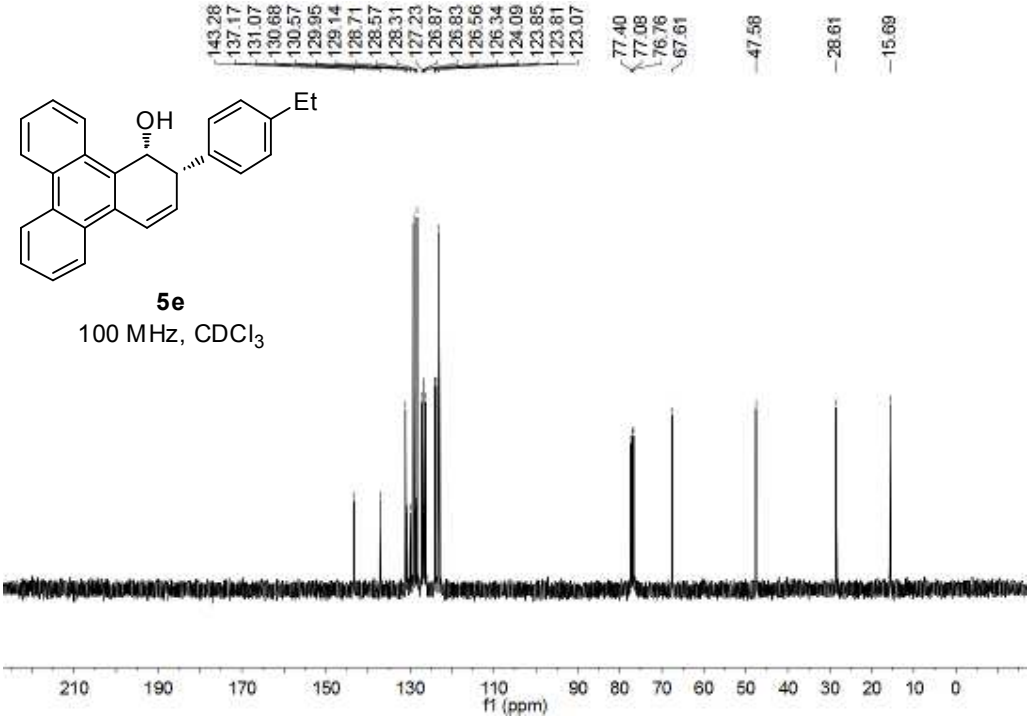




5e

400 MHz, $CDCl_3$



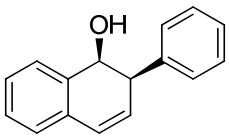


5e

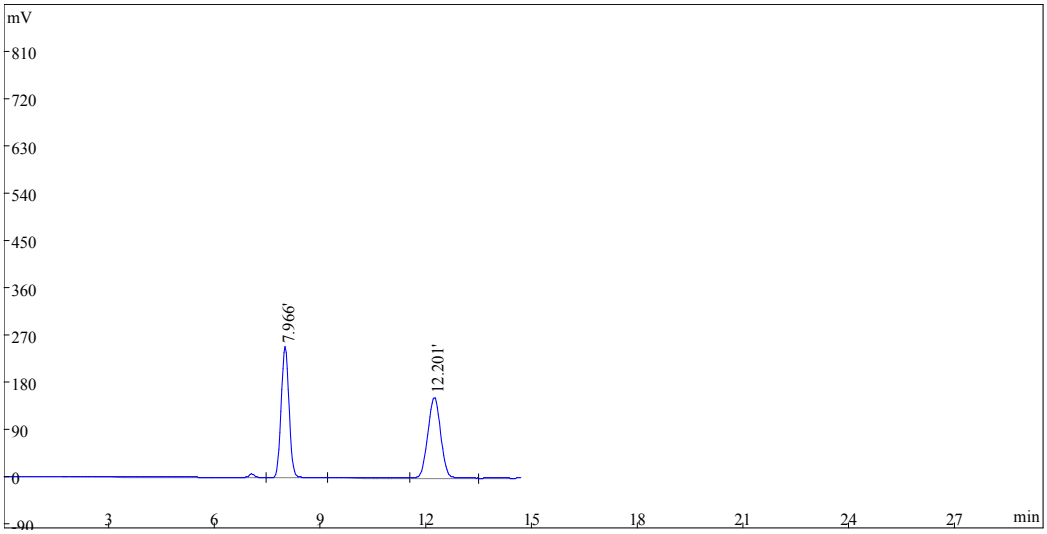
100 MHz, $CDCl_3$

4. The parts of copies of HPLC of 2a, 2i, 2l, 2m, 2n, 2o, 2p, 3e, 4e, and 5a

Sample	racemic-**2a**/ enantienriched-**2a**
Column	CHIRALCEL OD
Mobile phase	Hexane/2-Propanol = 90/10 (v/v)
Flow rate	1.0 mL/min
Detection	UV 254 nm

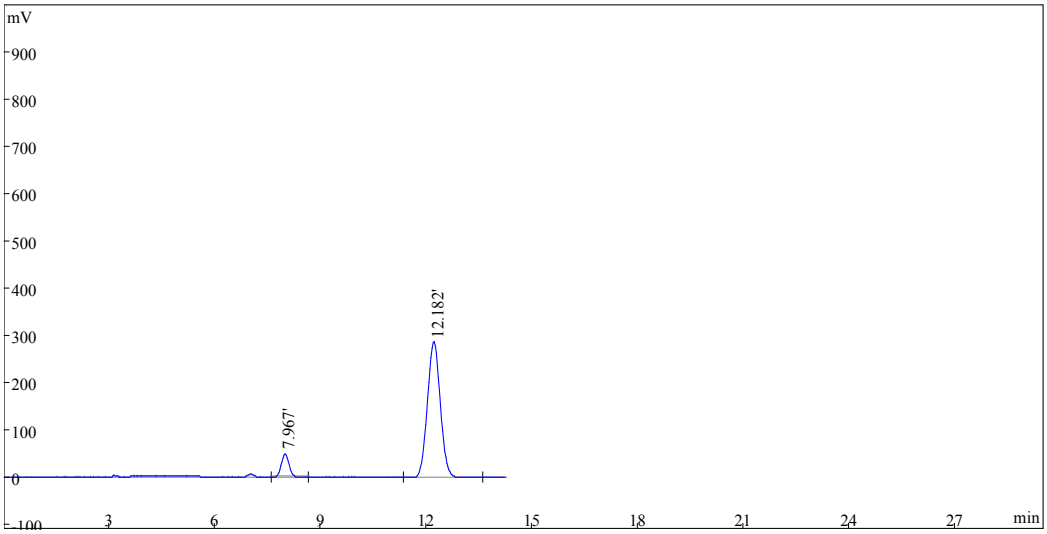


HPLC trace for racemic-**2a**.



Peak No.	Time (min)	Area (mV*s)	Area (%)
1	7.966	3981031	49.85
2	12.201	4005192	50.15

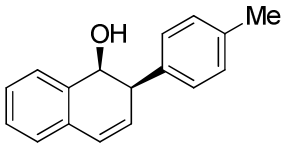
HPLC trace for enantienriched-**2a**.



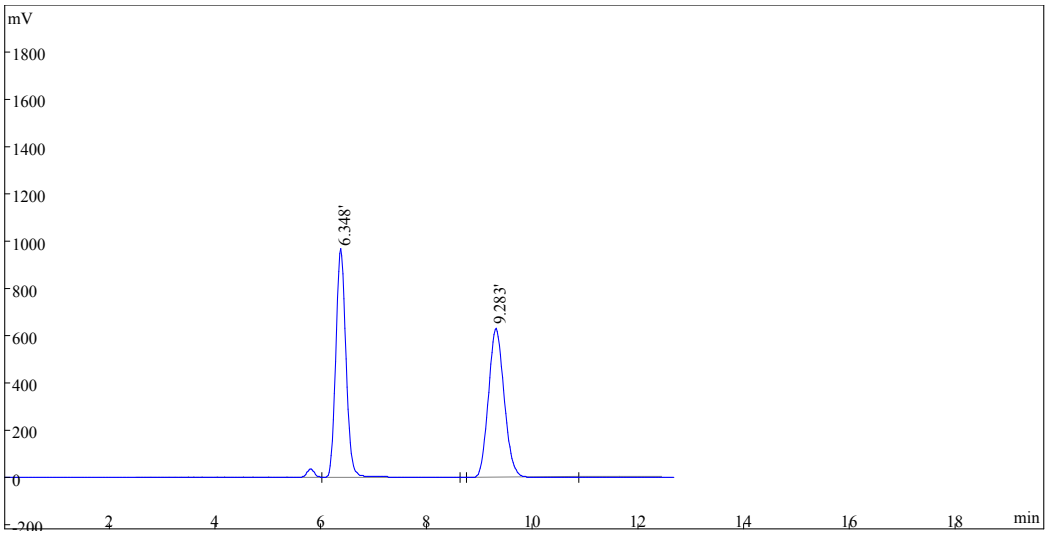
Peak No.	Time (min)	Area (mV*s)	Area (%)
1	7.967	750169	9.232
2	12.182	7375079	90.76

ee = 82%

Sample	racemic-**2i**/ enantienriched-**2i**
Column	CHIRALCEL OD
Mobile phase	Hexane/2-Propanol = 90/10 (v/v)
Flow rate	1.0 mL/min
Detection	UV 254 nm

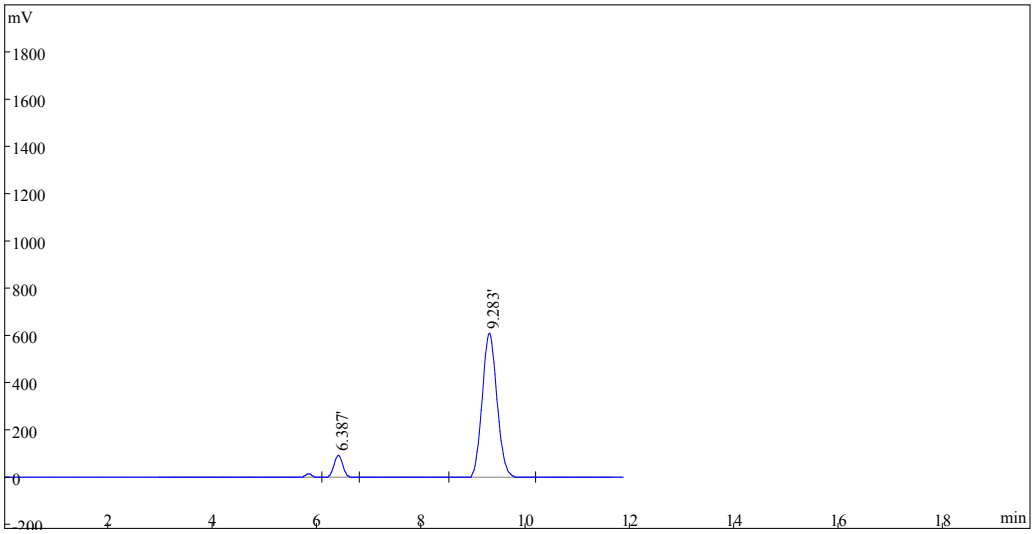


HPLC trace for racemic-**2i**.



Peak No.	Time (min)	Area (mV*s)	Area (%)
1	6.348	13231341	50.17
2	9.283	13143191	49.83

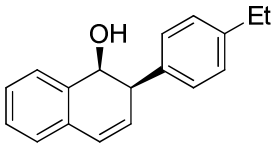
HPLC trace for enantienriched-**2i**.



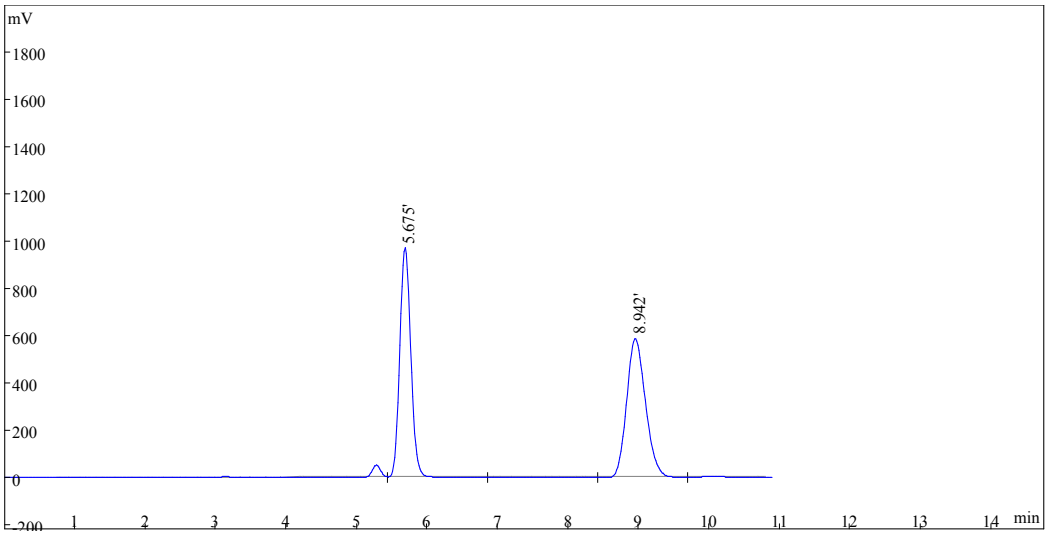
Peak No.	Time (min)	Area (mV*s)	Area (%)
1	6.387	1214550	9.049
2	9.283	12207699	90.95

ee = 82%

Sample	racemic-**2l**/ enantienriched-**2l**
Column	CHIRALCEL OD
Mobile phase	Hexane/2-Propanol = 90/10 (v/v)
Flow rate	1.0 mL/min
Detection	UV 254 nm

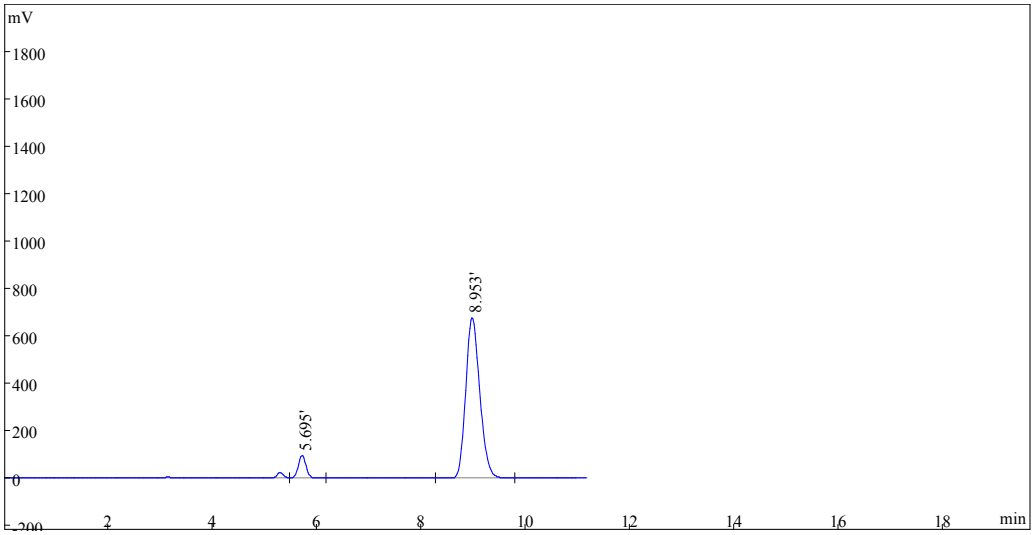


HPLC trace for racemic-**2l**.



Peak No.	Time (min)	Area (mV*s)	Area (%)
1	5.675	10690165	49.28
2	8.942	11001070	50.72

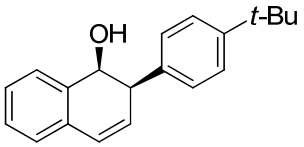
HPLC trace for enantienriched-**2l**.



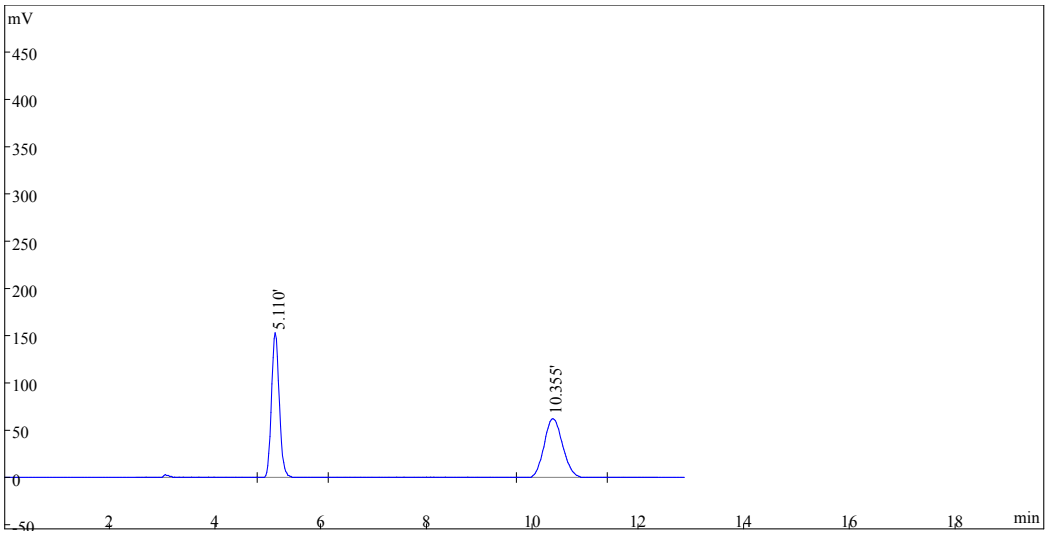
Peak No.	Time (min)	Area (mV*s)	Area (%)
1	5.695	1033428	7.488
2	8.953	12768805	92.52

ee = 85

Sample	racemic-**2m**/ enantienriched-**2m**
Column	CHIRALCEL OD
Mobile phase	Hexane/2-Propanol = 90/10 (v/v)
Flow rate	1.0 mL/min
Detection	UV 254 nm

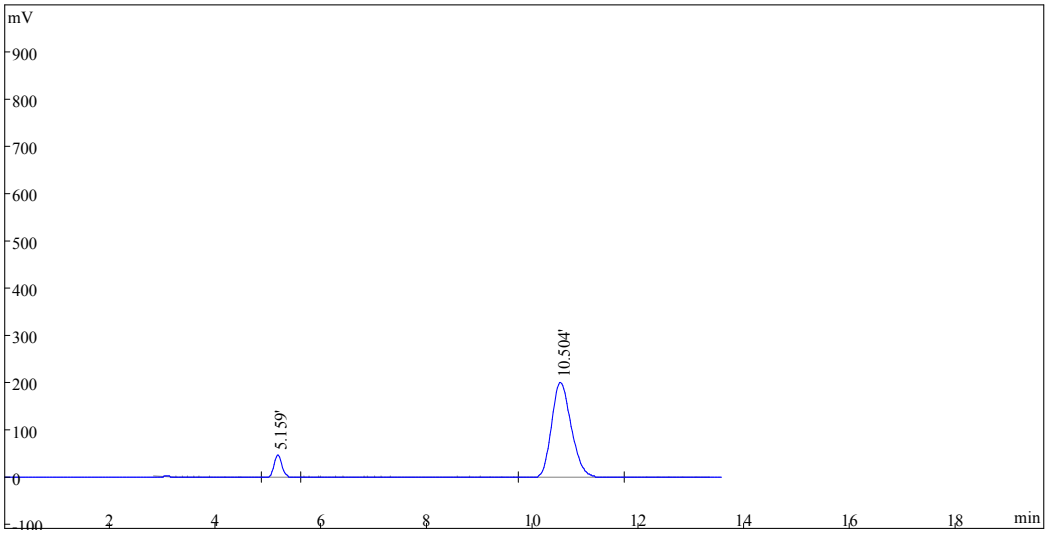


HPLC trace for racemic-**2m**.



Peak No.	Time (min)	Area (mV*s)	Area (%)
1	5.110	1596296	50.25
2	10.355	1580388	49.75

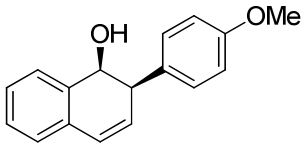
HPLC trace for enantienriched-**2m**.



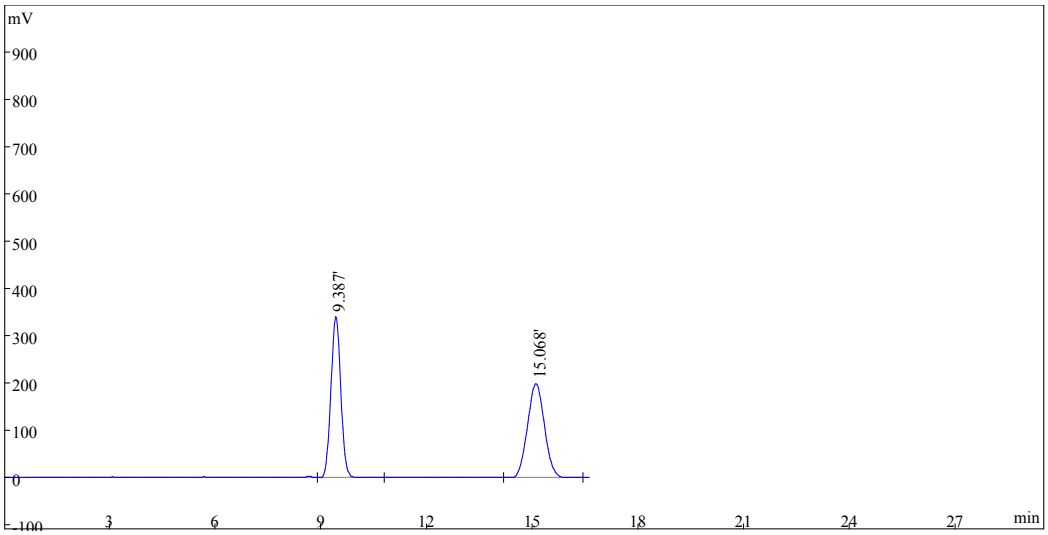
Peak No.	Time (min)	Area (mV*s)	Area (%)
1	5.159	513056	8.883
2	10.504	5262625	91.11

ee = 82%

Sample	racemic-**2n**/ enantienriched-**2n**
Column	CHIRALCEL OD
Mobile phase	Hexane/2-Propanol = 90/10 (v/v)
Flow rate	1.0 mL/min
Detection	UV 254 nm

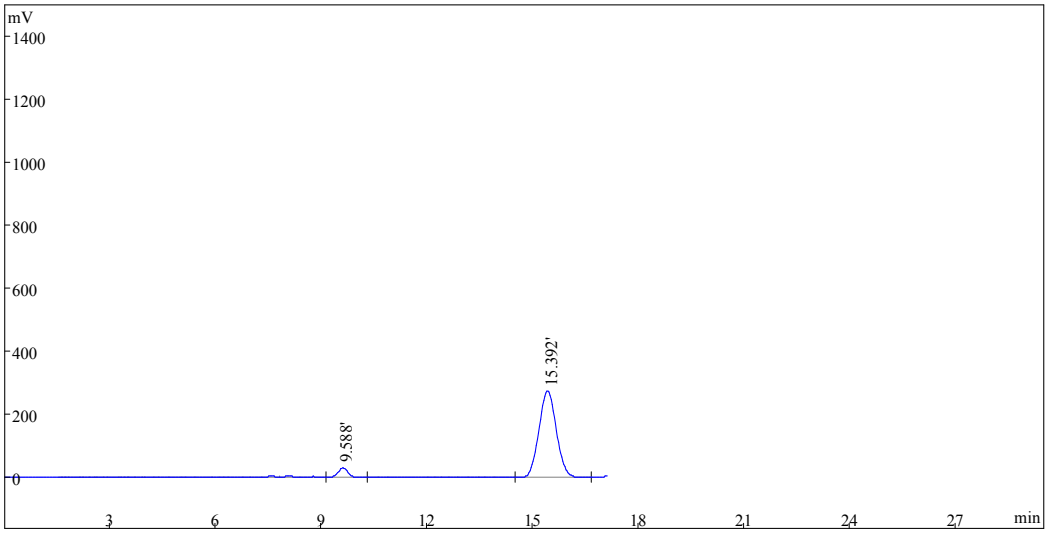


HPLC trace for racemic-**2n**.



Peak No.	Time (min)	Area (mV*s)	Area (%)
1	9.387	6735252	49.84
2	15.068	6777535	50.16

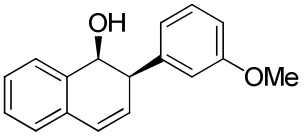
HPLC trace for enantienriched-**2n**.



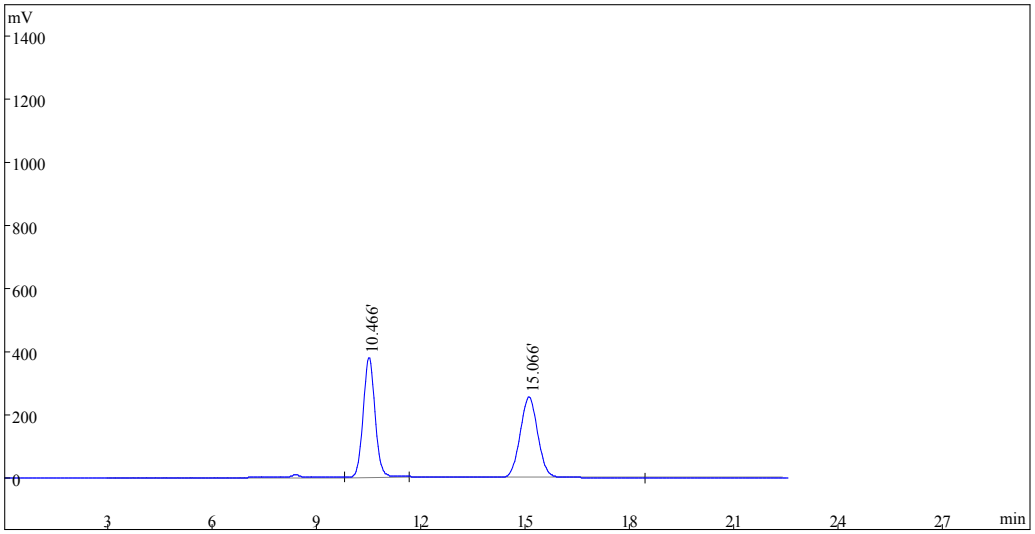
Peak No.	Time (min)	Area (mV*s)	Area (%)
1	9.588	649358	6.398
2	15.392	9499954	93.6

ee = 87%

Sample	racemic-**2o**/ enantienriched-**2o**
Column	CHIRALCEL OD
Mobile phase	Hexane/2-Propanol = 90/10 (v/v)
Flow rate	1.0 mL/min
Detection	UV 254 nm

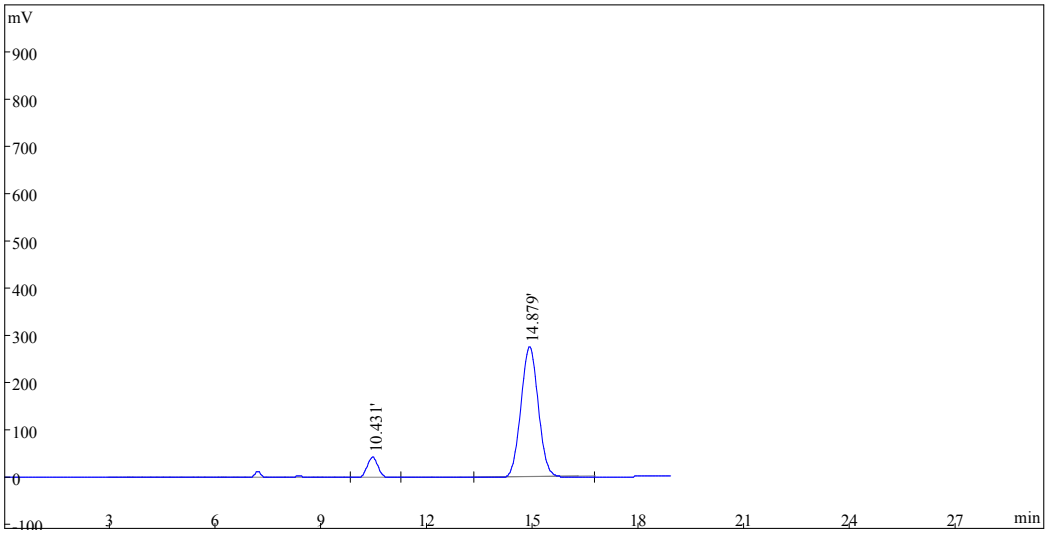


HPLC trace for racemic-**2o**.



Peak No.	Time (min)	Area (mV*s)	Area (%)
1	10.466	9476347	47.57
2	15.066	10445040	52.43

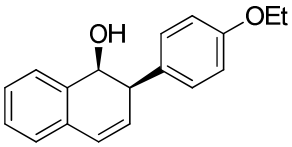
HPLC trace for enantienriched-**2o**.



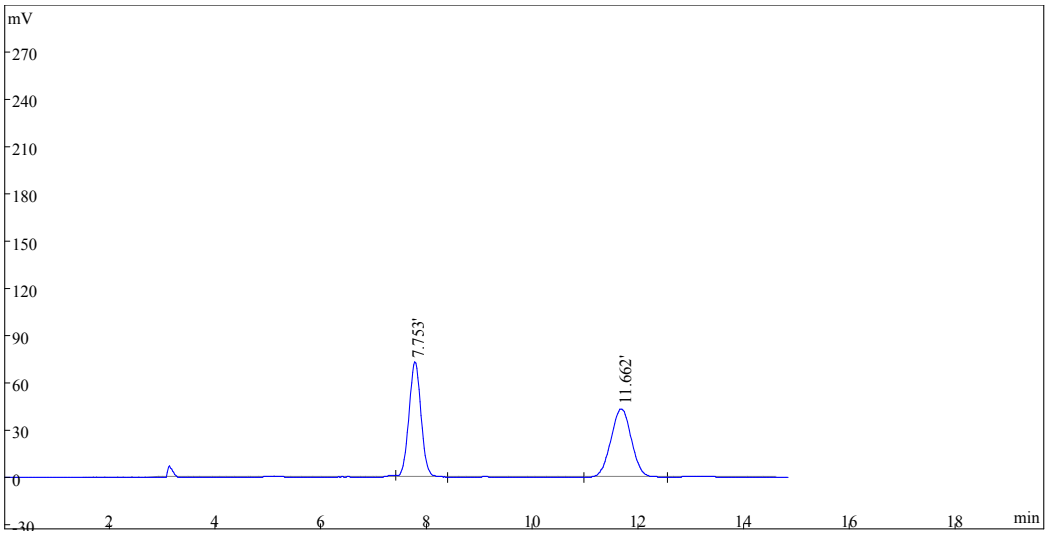
Peak No.	Time (min)	Area (mV*s)	Area (%)
1	10.431	1023578	9.682
2	14.879	9547575	90.31

ee = 81%

Sample	racemic-**2p**/ enantienriched-**2p**
Column	CHIRALCEL OD
Mobile phase	Hexane/2-Propanol = 90/10 (v/v)
Flow rate	1.0 mL/min
Detection	UV 254 nm

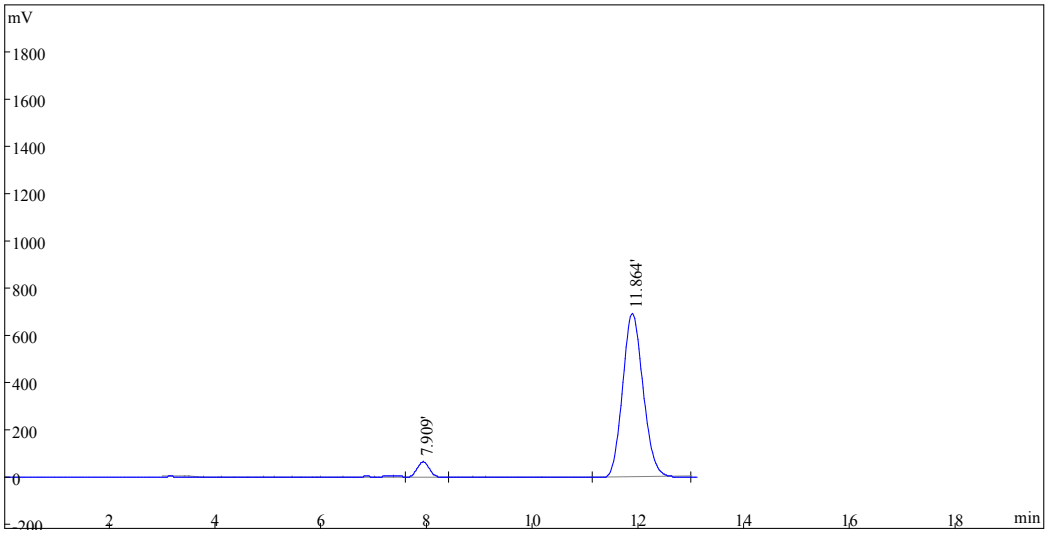


HPLC trace for racemic-**2p**.



Peak No.	Time (min)	Area (mV*s)	Area (%)
1	7.753	1190203	49.84
2	11.662	1197872	50.16

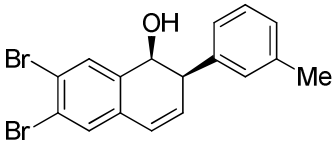
HPLC trace for enantienriched-**2p**.



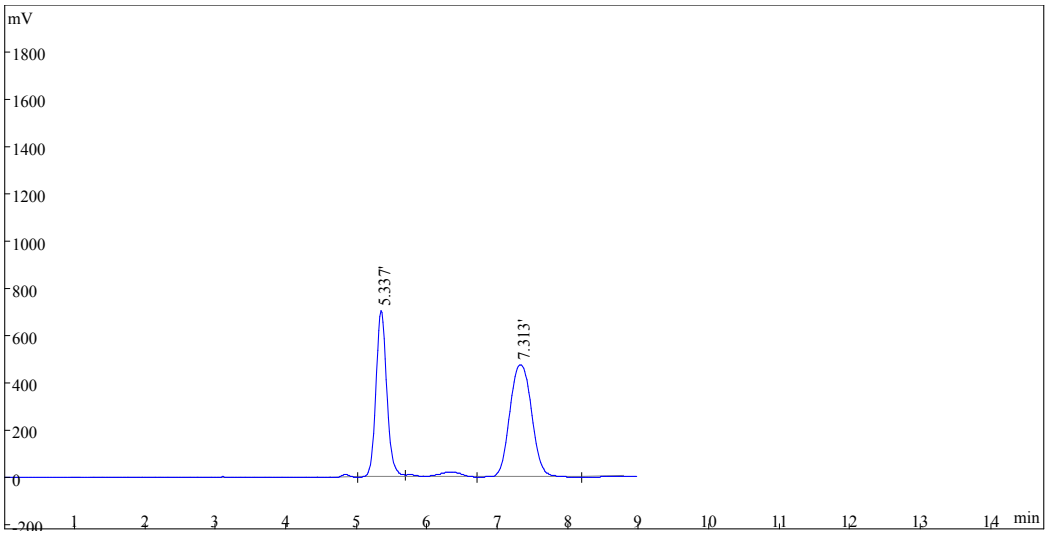
Peak No.	Time (min)	Area (mV*s)	Area (%)
1	7.909	1117201	5.627
2	11.864	18738155	94.38

ee = 89%

Sample	racemic-**3e**/ enantienriched-**3e**
Column	CHIRALCEL OD
Mobile phase	Hexane/2-Propanol = 90/10 (v/v)
Flow rate	1.0 mL/min
Detection	UV 254 nm

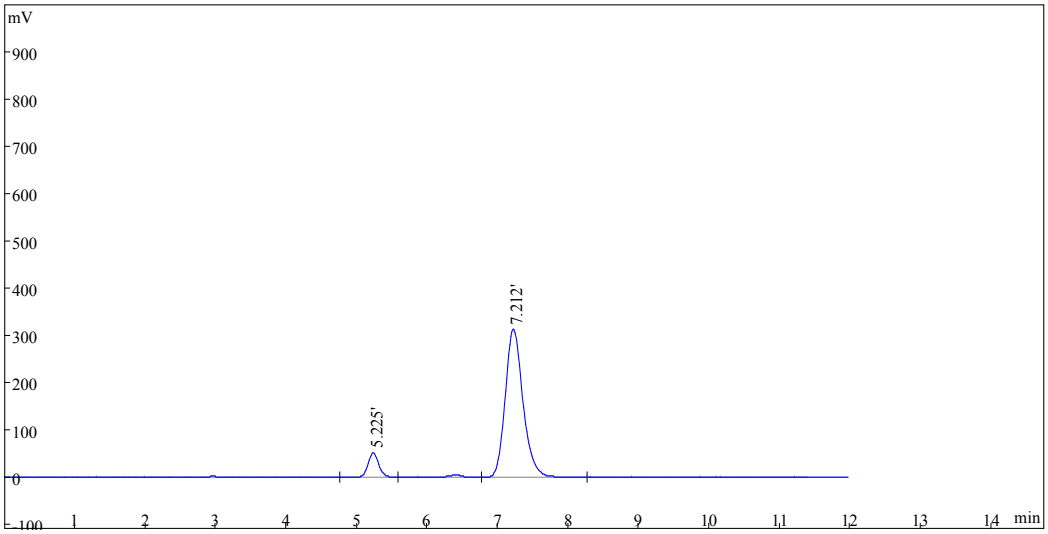


HPLC trace for racemic-**3e**.



Peak No.	Time (min)	Area (mV*s)	Area (%)
1	5.337	7649670	42.45
2	7.313	10368945	57.55

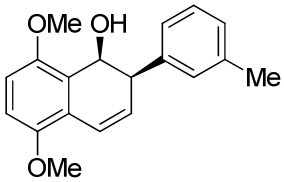
HPLC trace for enantienriched-**3e**.



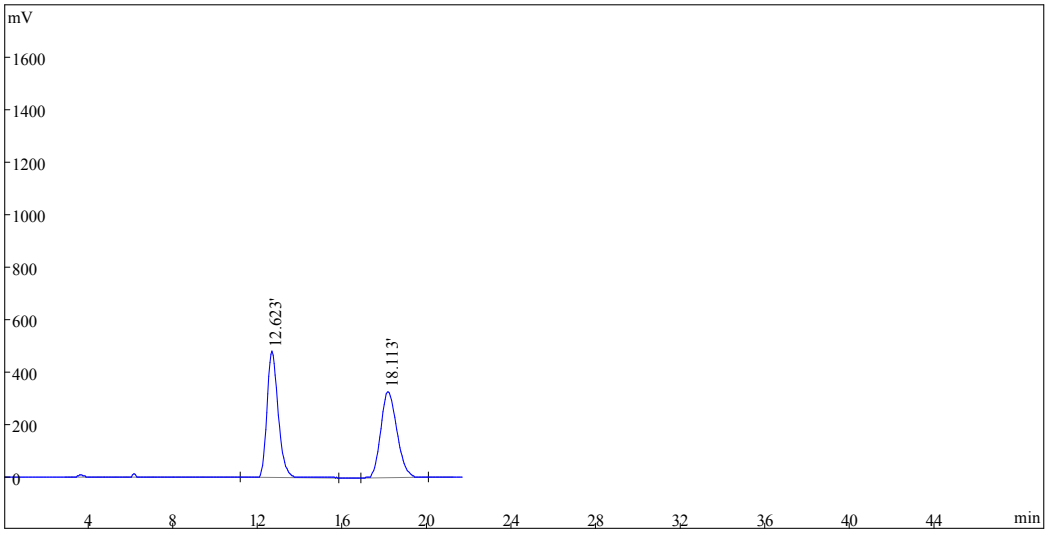
Peak No.	Time (min)	Area (mV*s)	Area (%)
1	5.225	594071	9.658
2	7.212	5557192	90.34

ee = 81%

Sample	racemic-**4e**/ enantienriched-**4e**
Column	CHIRALCEL OD
Mobile phase	Hexane/2-Propanol = 90/10 (v/v)
Flow rate	1.0 mL/min
Detection	UV 254 nm

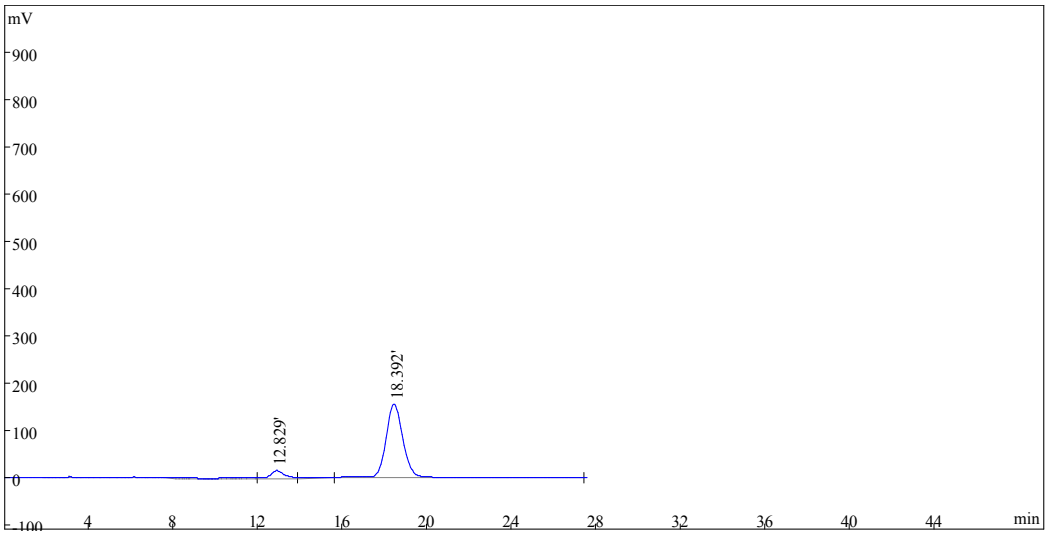


HPLC trace for racemic-**4e**.



Peak No.	Time (min)	Area (mV*s)	Area (%)
1	12.623	17963462	50.33
2	18.113	17731027	49.67

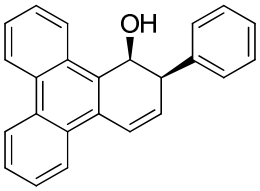
HPLC trace for enantienriched-**4e**.



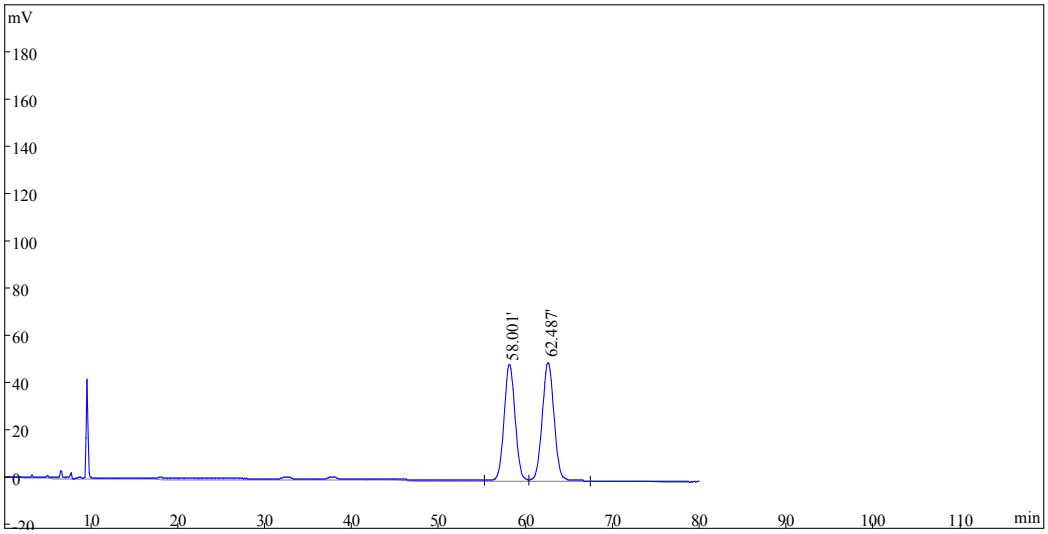
Peak No.	Time (min)	Area (mV*s)	Area (%)
1	12.829	935803	8.347
2	18.392	10276406	91.66

ee = 83%

Sample	racemic-**5a**/ enantienriched-**5a**
Column	CHIRALPAK AD
Mobile phase	Hexane/2-Propanol = 90/10 (v/v)
Flow rate	1.0 mL/min
Detection	UV 254 nm

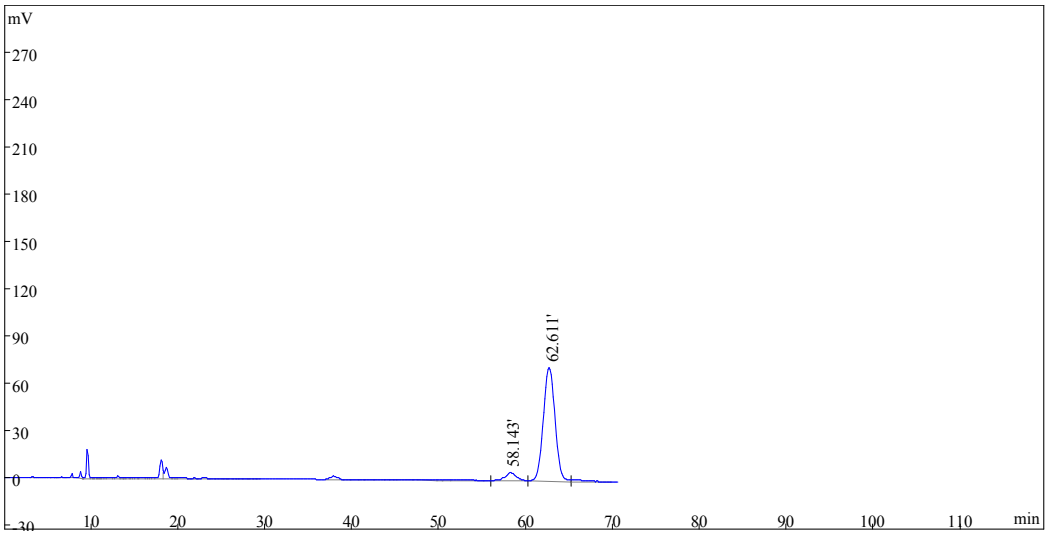


HPLC trace for racemic-**5a**.



Peak No.	Time (min)	Area (mV*s)	Area (%)
1	58.001	4440240	47.68
2	62.487	4871485	52.32

HPLC trace for enantienriched-**5a**.



Peak No.	Time (min)	Area (mV*s)	Area (%)
1	58.143	562837	7.564
2	62.611	6878030	92.43

ee = 85%