Supporting Information

1,6-Conjugated Addition Mediated [2+1] Annulation: Approach to Spiro[2.5]octa-4,7-dien-6-one

Zhenbo Yuan, Xinxin Fang, Xuanyi Li, Jie Wu, Hequan Yao, * and Aijun Lin *

State Key Laboratory of Natural Medicines and Department of Medicinal Chemistry,

China Pharmaceutical University, Nanjing 210009, P. R. *China.*

E-mail: ajlin@cpu.edu.cn, hyao@cpu.edu.cn

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Crystal structure of 4aa

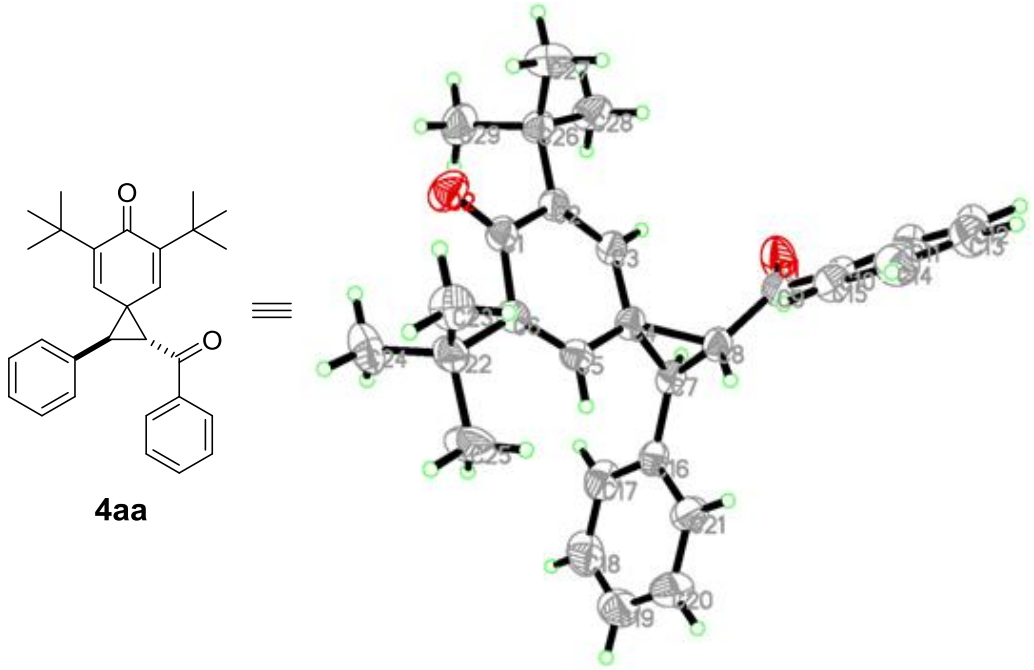


Figure S1. ORTEP plot of the crystal structure of 4aa (at 30% probability level).

X-ray crystallographic data of 4aa

CCDC number	1412107
Empirical formula	$C_{29}H_{32}O_2$
Formula weight	412.55
Temperature	296 K
Wavelength	0.71073 Å
Space group	P2(1)/c
Unit cell dimensions	a=13.417(2) Å =90°
	b=19.553(3) Å =108.595(3)°
	c=9.7821(16) Å =90°
Volume	2432.2(7) $Å^3$
Z	4
Density (calculated)	1.127 Mg/m3
F(000)	888.0
Completeness to theta = 25.010 °	99.8%
Absorption correction	MULTI-SCAN
Max. and min. transmission	0.985 and 0.981
R indices (all data)	R= 0.0467(2662) wR2(reflections)= 0.1470(4280)

Crystal structure of 4ma

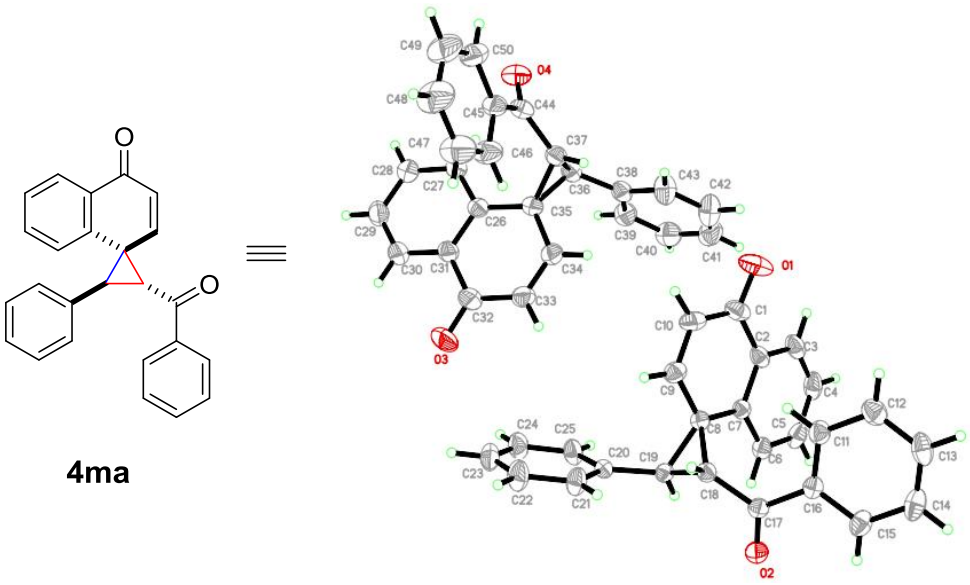
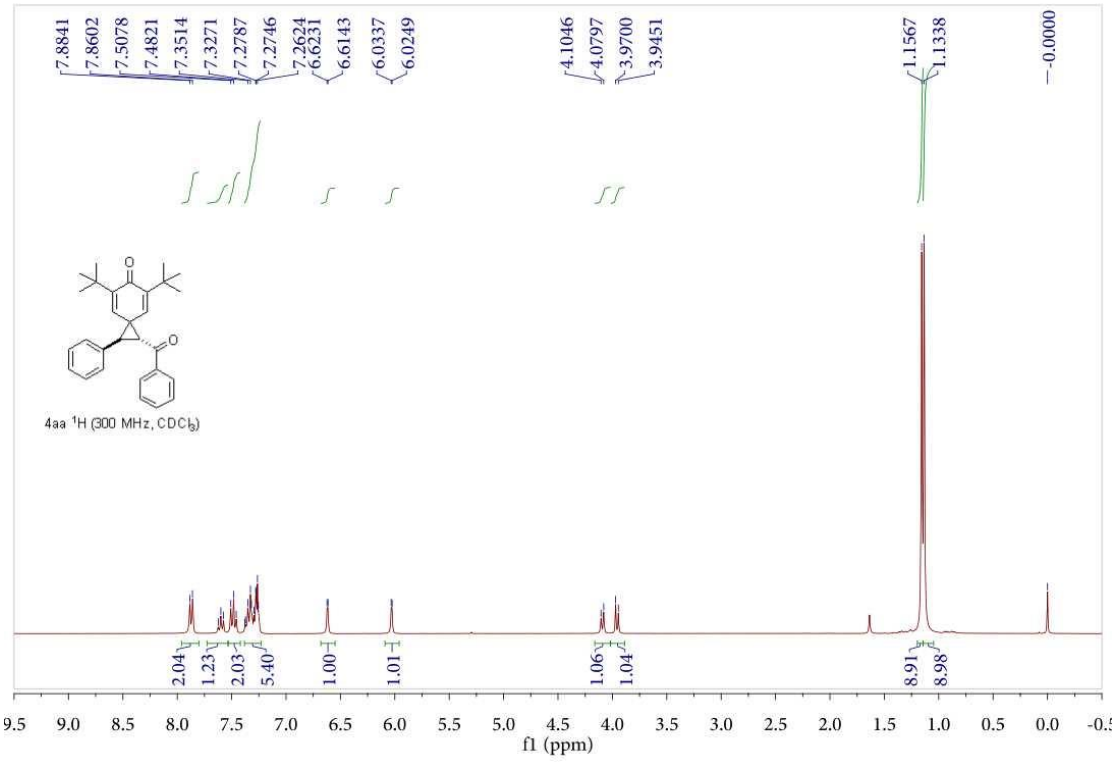


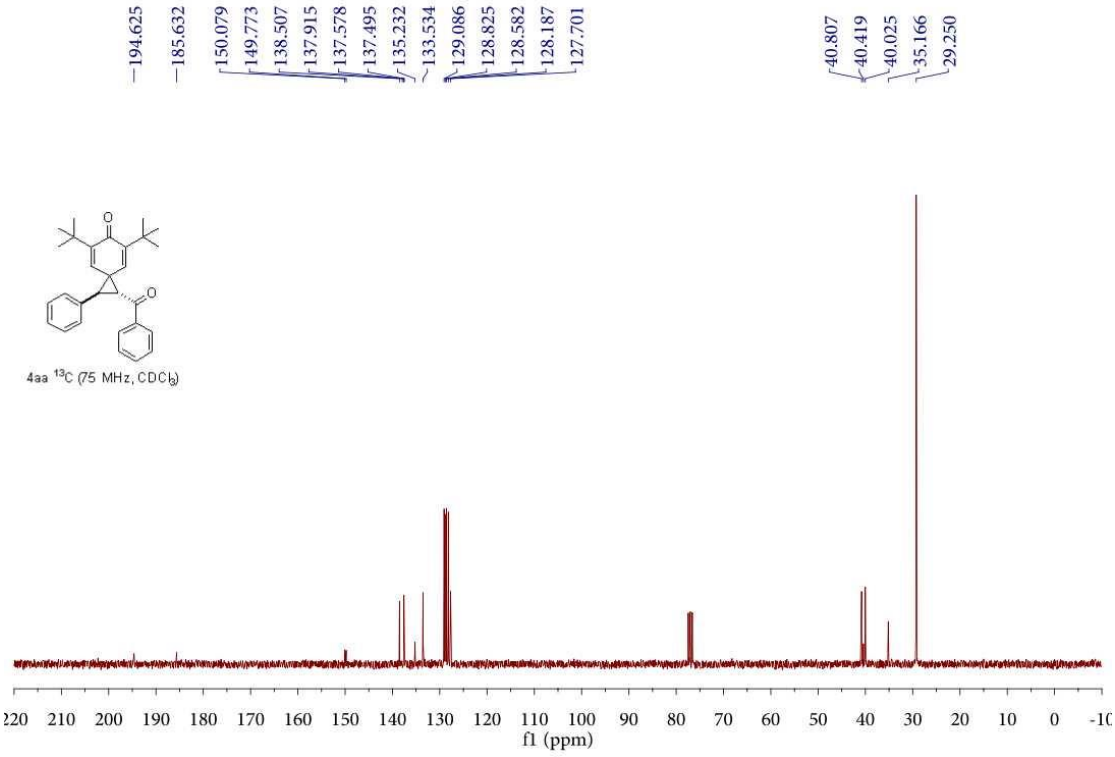
Figure S2. ORTEP plot of the crystal structure of 4ma (at 30% probability level).

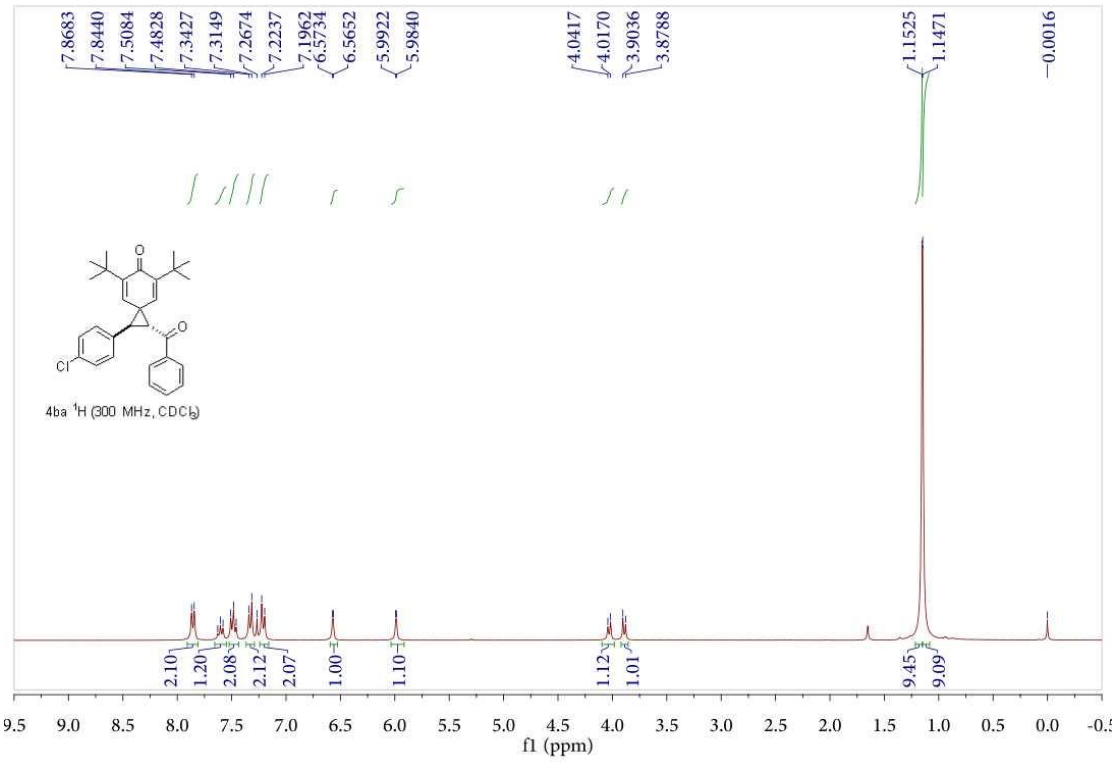
X-ray crystallographic data of 4ma

CCDC number	1427612	
Empirical formula	$C_{25}H_{18}O_2$	
Formula weight	350.39	
Temperature	296 K	
Wavelength	0.71073 Å	
Space group	C2/c	
Unit cell dimensions	a= 43.875(12)Å	=90°
	b= 8.776(2)Å	= 98.921(5)°
	c= 19.789(5)Å	=90°
Volume	7527(3) $Å^3$	
Z	16	
Density (calculated)	1.237 Mg/m3	
F(000)	2944.0	
Completeness to theta = 25.010 °	99.5%	
Absorption correction	MULTI-SCAN	
Max. and min. transmission	0.983 and 0.979	
R indices (all data)	R= 0.0778(3730) wR2= 0.1963(6616)	

[1]H and [13]C-NMR Spectra



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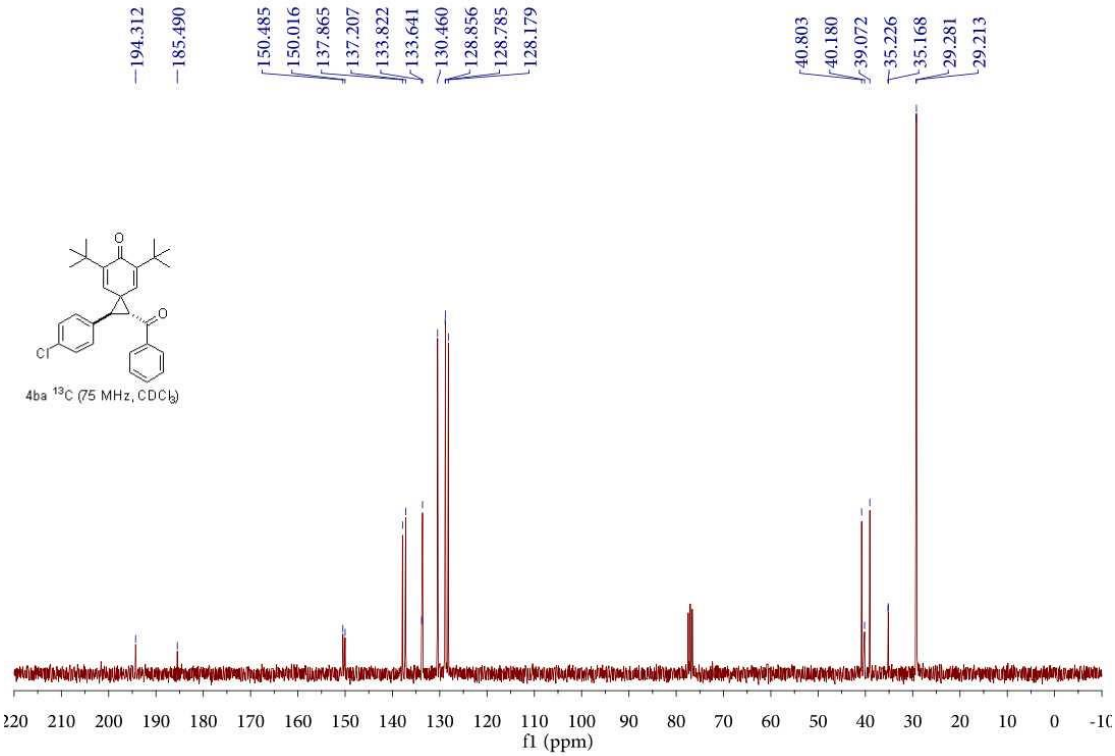
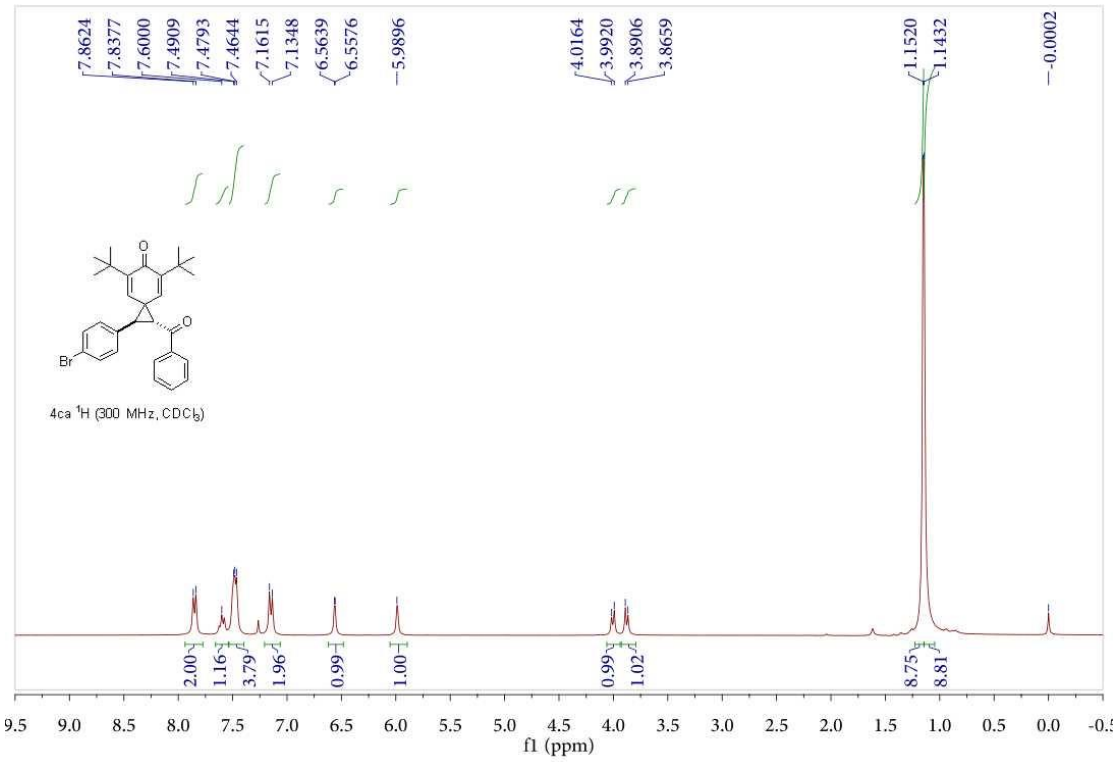
7.5084
7.4828
7.3427
7.3149
7.2674
7.2237
7.1962
6.5734
6.5652
5.9922
5.9840
4.0417
4.0170
3.9036
3.8788
1.1525
1.1471
0.0016
2.10
1.20
2.08
2.12
2.07
1.00
1.10
1.12
1.01
9.45
9.09
4ba ^{1}H (300 MHz, CDCl$_3$)
f1 (ppm)


194.312
185.490
150.485
150.016
137.865
137.207
133.822
133.641
130.460
128.856
128.785
128.179
40.803
40.180
39.072
35.226
35.168
29.281
29.213
4ba ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)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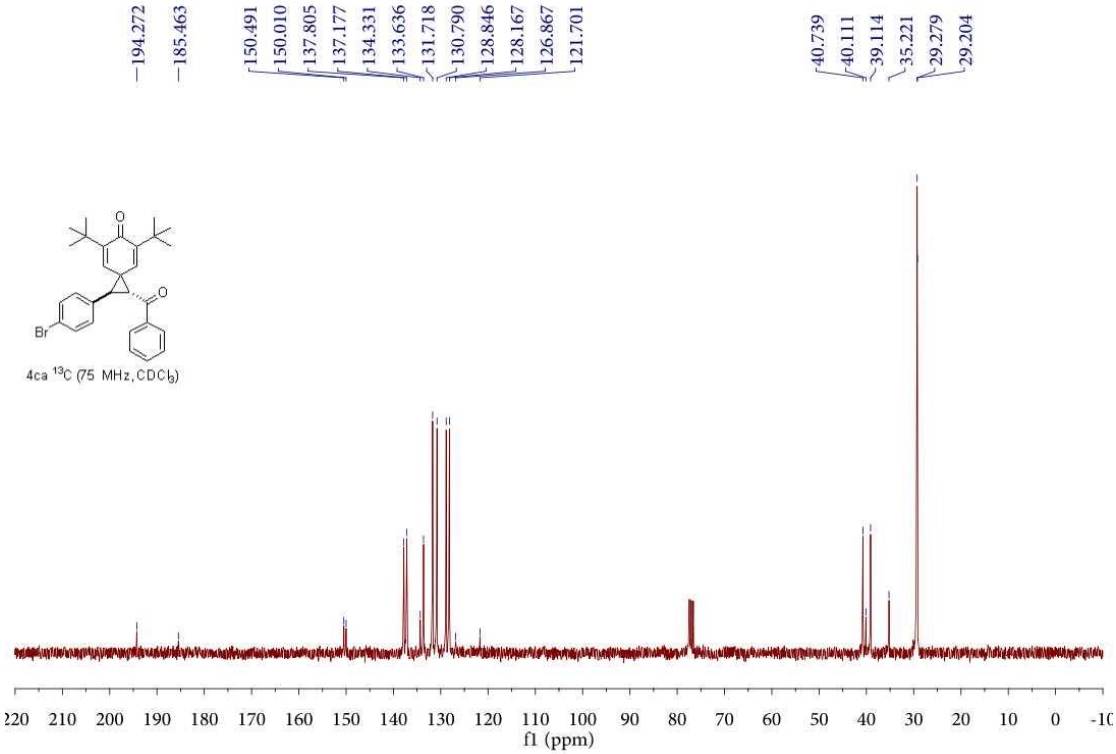
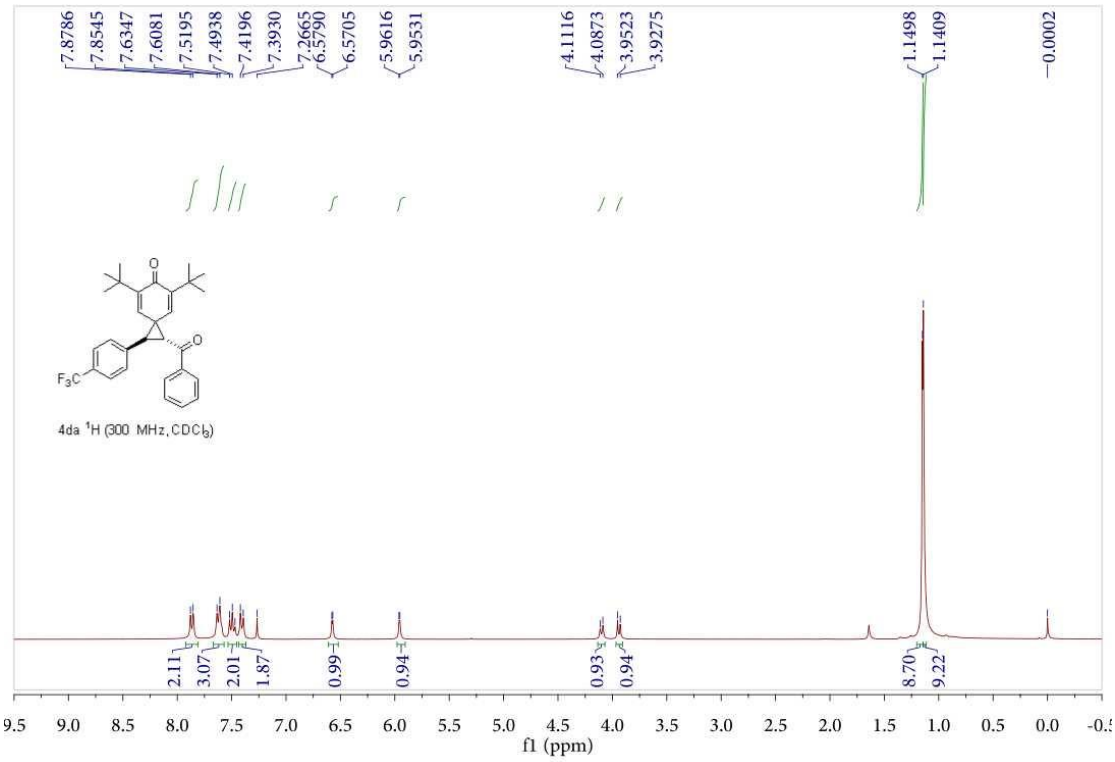
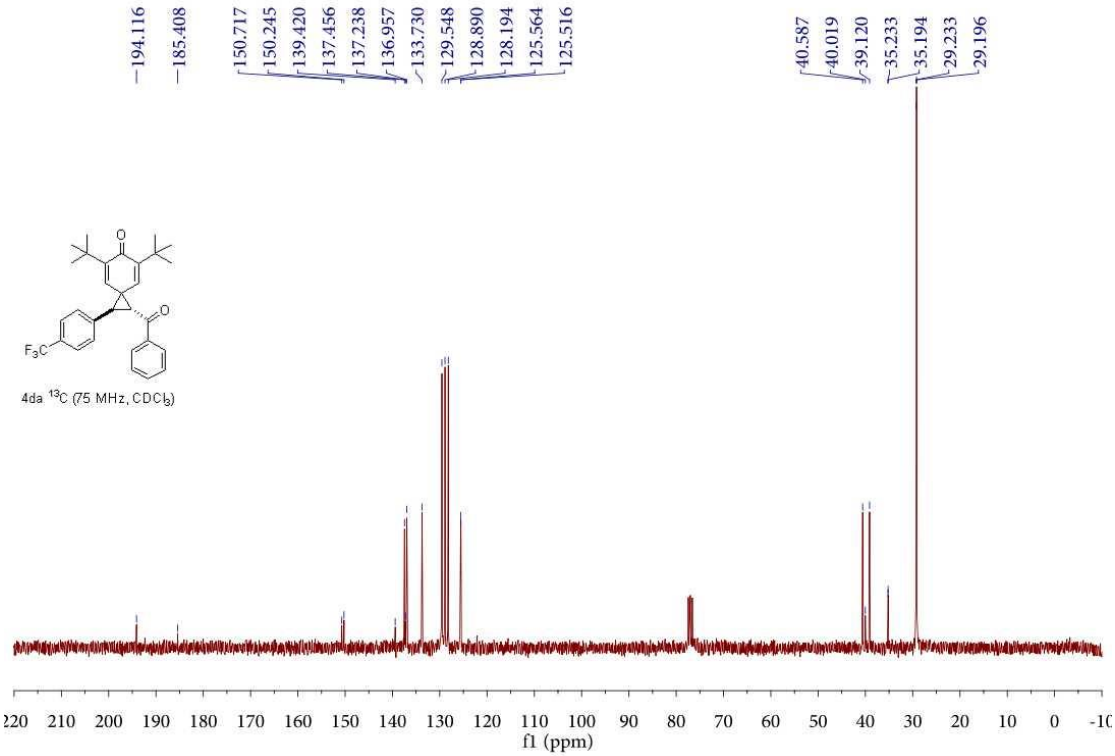
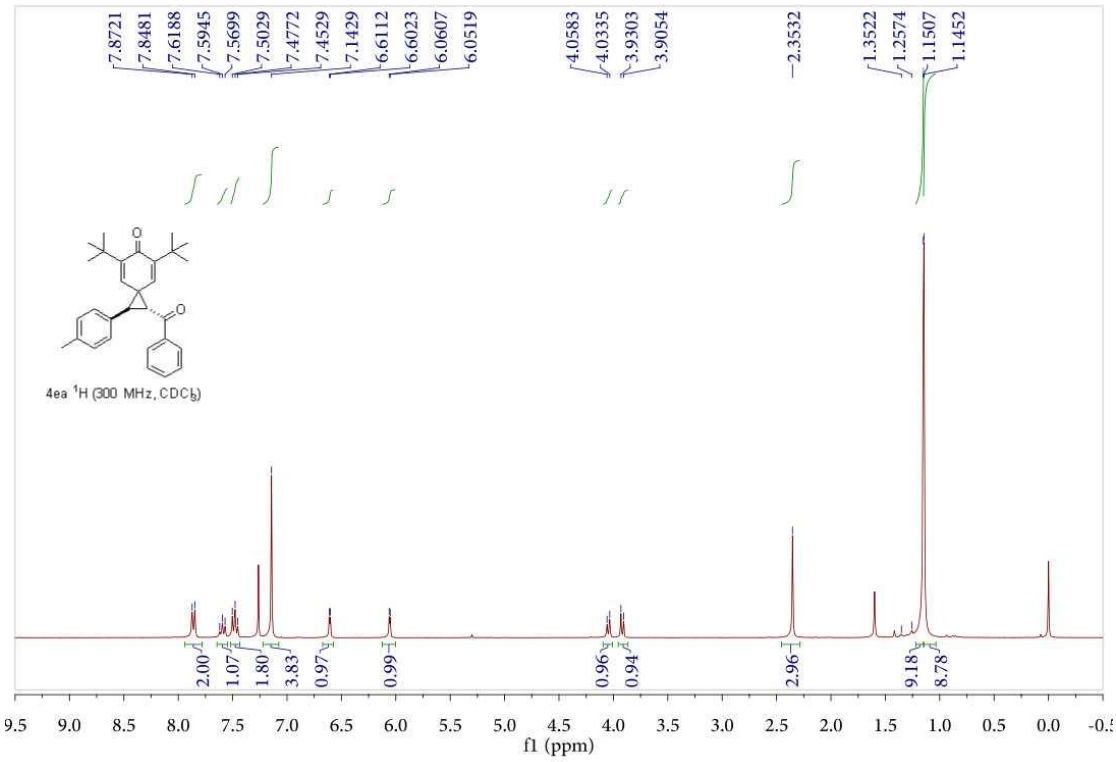
7.8377
7.6000
7.4909
7.4793
7.4644
7.1615
7.1348
6.5639
6.5576
5.9896
4.0164
3.9920
3.8906
3.8659
1.1520
1.1432
-0.0002
2.00
1.16
3.79
1.96
0.99
1.00
0.99
1.02
8.75
8.81
4ca ^{1}H (300 MHz, $CDCl_3$)
f1 (ppm)


194.272
185.463
150.491
150.010
137.805
137.177
134.331
133.636
131.718
130.790
128.846
128.167
126.867
121.701
40.739
40.111
39.114
35.221
29.279
29.204
4ca ^{13}C (75 MHz, $CDCl_3$)
f1 (ppm)


7.8786
7.8545
7.6347
7.6081
7.5195
7.4938
7.4196
7.3930
7.2665
6.5790
6.5705
5.9616
5.9531
4.1116
4.0873
3.9523
3.9275
1.1498
1.1409
0.0002
4da ^{1}H (300 MHz, $CDCl_3$)
2.11
3.07
2.01
1.87
0.99
0.94
0.93
0.94
8.70
9.22
f1 (ppm)


194.116
185.408
150.717
150.245
139.420
137.456
137.238
136.957
133.730
129.548
128.890
128.194
125.564
125.516
40.587
40.019
39.120
35.233
35.194
29.233
29.196
4da ^{13}C (75 MHz, $CDCl_3$)
f1 (ppm)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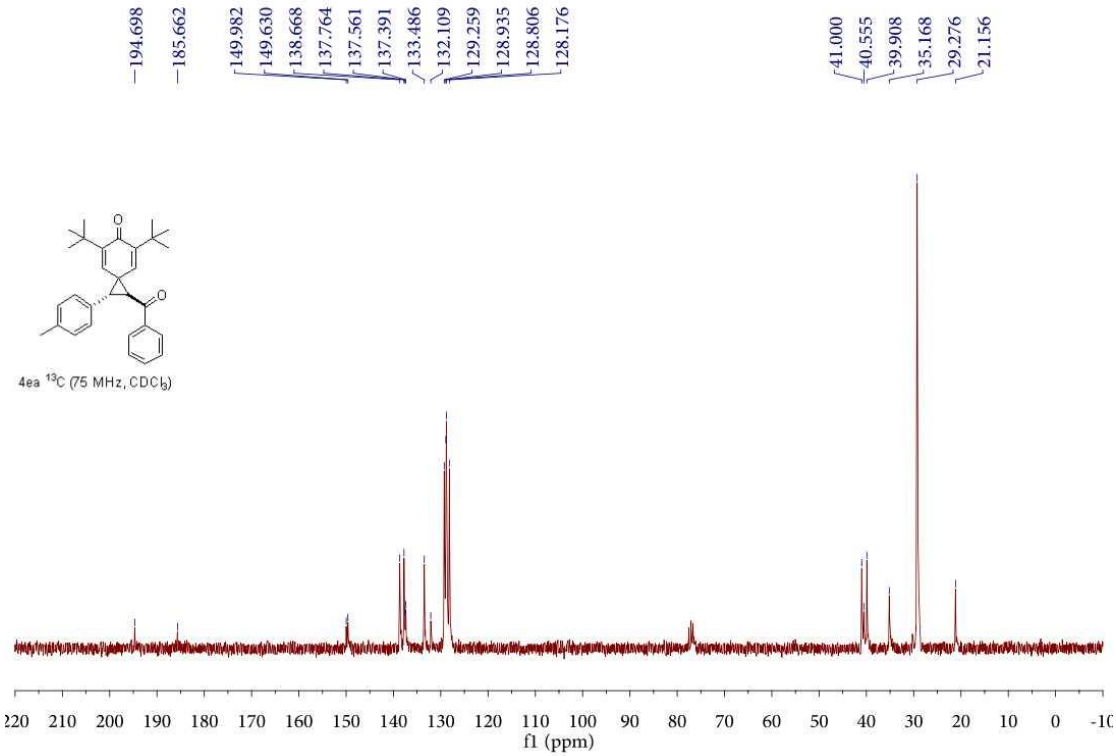
7.6188
7.5945
7.5699
7.5029
7.4772
7.4529
7.1429
6.6112
6.6023
6.0607
6.0519
4.0583
4.0335
3.9303
3.9054
2.3532
1.3522
1.2574
1.1507
1.1452
4ea ^{1}H (300 MHz, $CDCl_3$)
2.00
1.07
1.80
3.83
0.97
0.99
0.96
0.94
2.96
9.18
8.78
f1 (ppm)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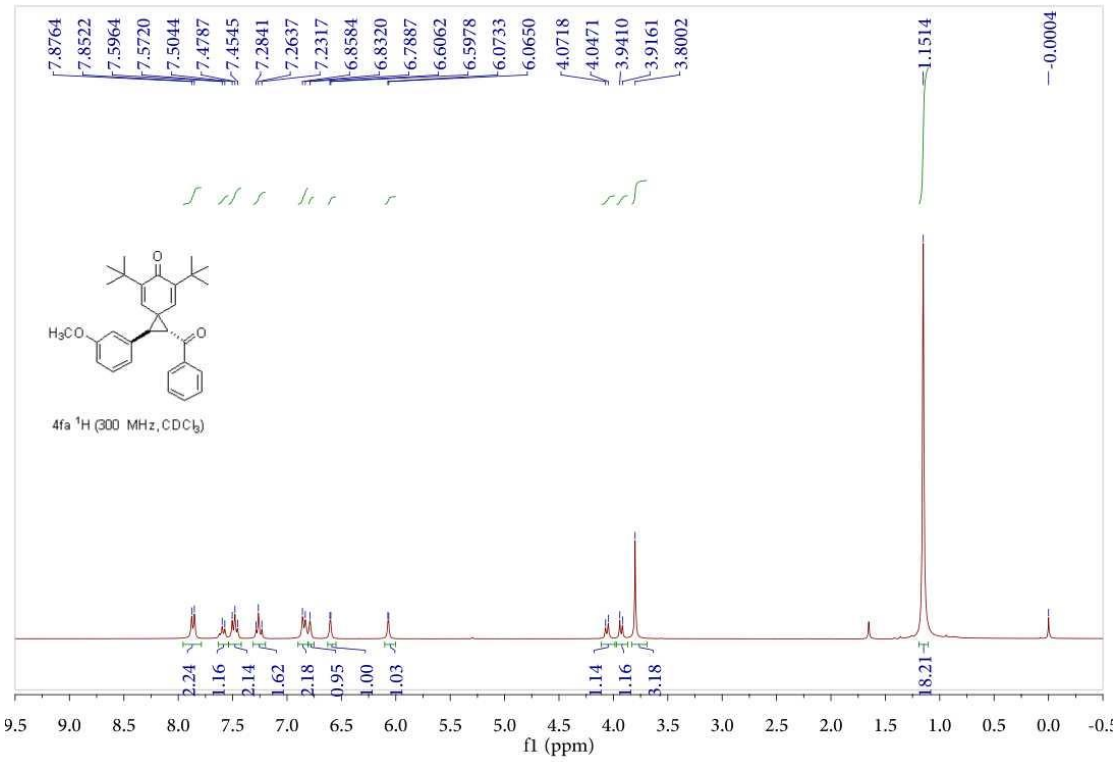
185.662
149.982
149.630
138.668
137.764
137.561
137.391
133.486
132.109
129.259
128.935
128.806
128.176
41.000
40.555
39.908
35.168
29.276
21.156
4ea ^{13}C (75 MHz, $CDCl_3$)
f1 (ppm)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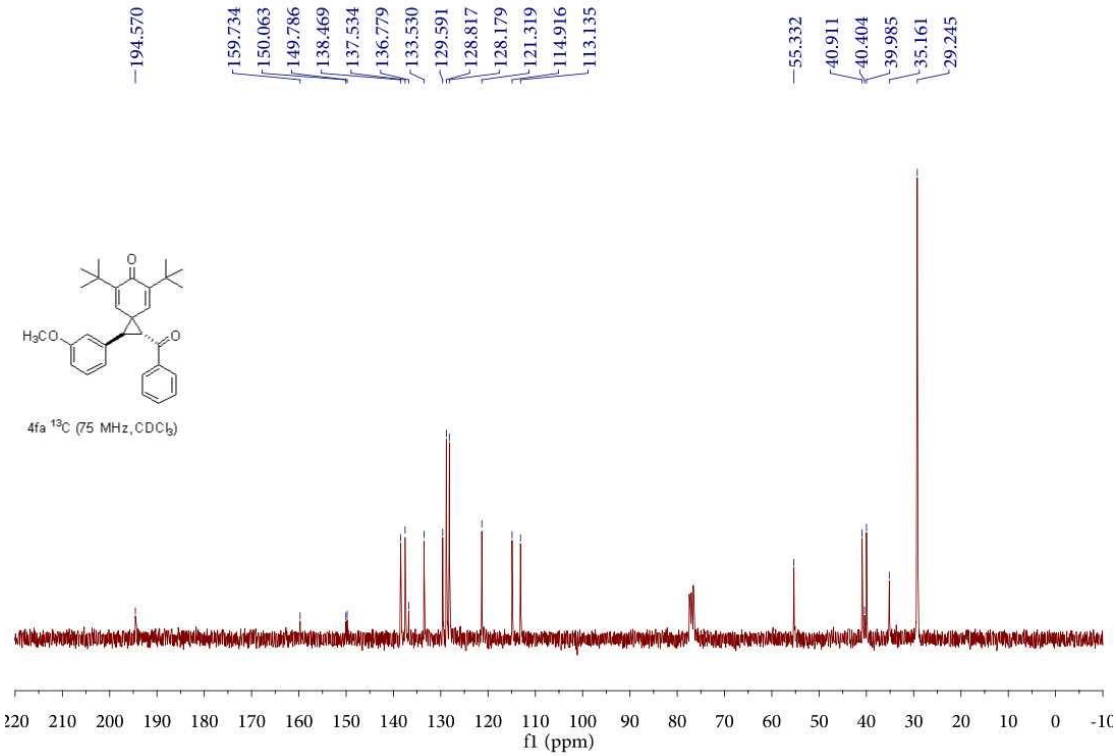
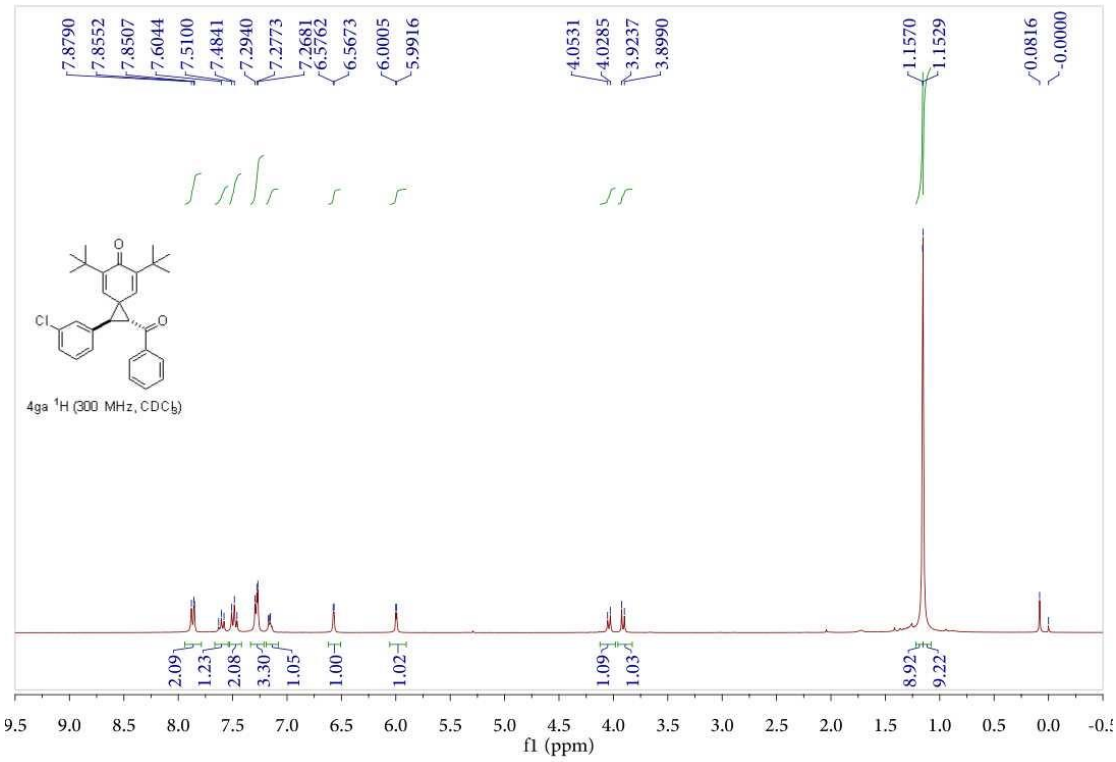
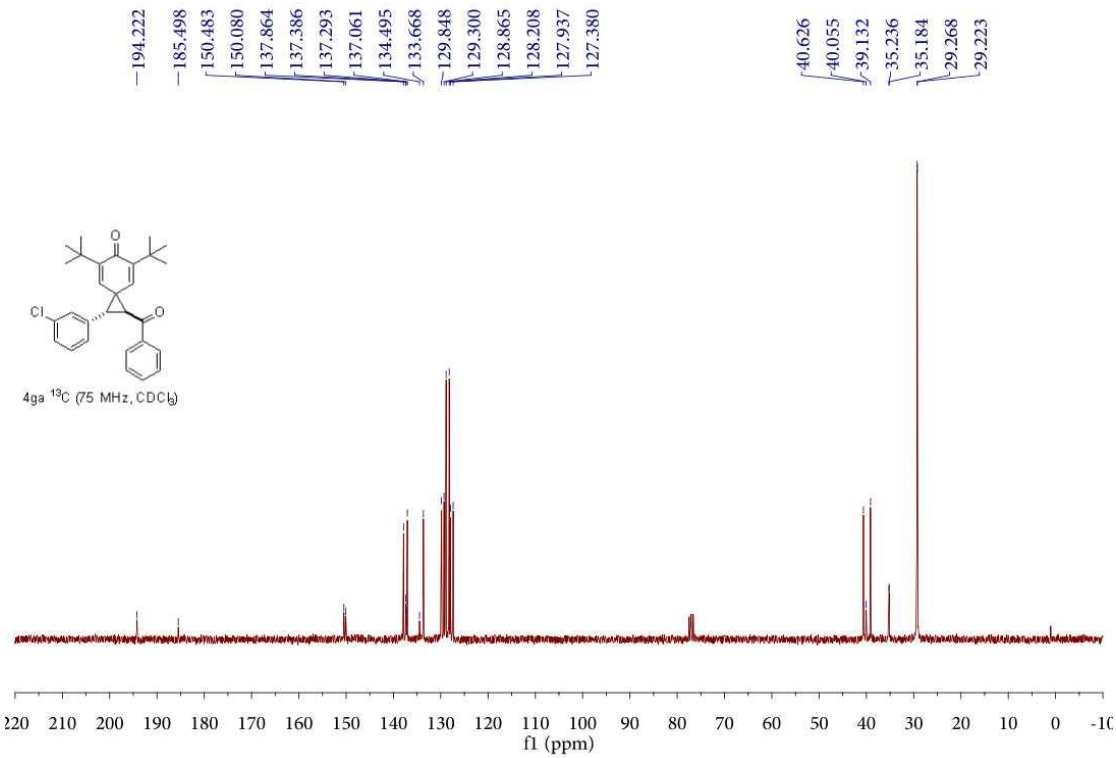
7.5964
7.5720
7.5044
7.4787
7.4545
7.2841
7.2637
7.2317
6.8584
6.8320
6.7887
6.6062
6.5978
6.0733
6.0650
4.0718
4.0471
3.9410
3.9161
3.8002
1.1514
-0.0004
2.24
1.16
2.14
1.62
2.18
0.95
1.00
1.03
1.14
1.16
3.18
18.21
H3CO
O
O
4fa 1H (300 MHz, CDCl3)
f1 (ppm)


194.570
159.734
150.063
149.786
138.469
137.534
136.779
133.530
129.591
128.817
128.179
121.319
114.916
113.135
55.332
40.911
40.404
39.985
35.161
29.245
H3CO
O
O
4fa 13C (75 MHz, CDCl3)
f1 (ppm)


7.8790
7.8552
7.8507
7.6044
7.5100
7.4841
7.2940
7.2773
7.2681
6.5762
6.5673
6.0005
5.9916
4.0531
4.0285
3.9237
3.8990
1.1570
1.1529
0.0816
-0.0000
2.09
1.23
2.08
3.30
1.05
1.00
1.02
1.09
1.03
8.92
9.22
f1 (ppm)
4ga ^{1}H (300 MHz, $CDCl_3$)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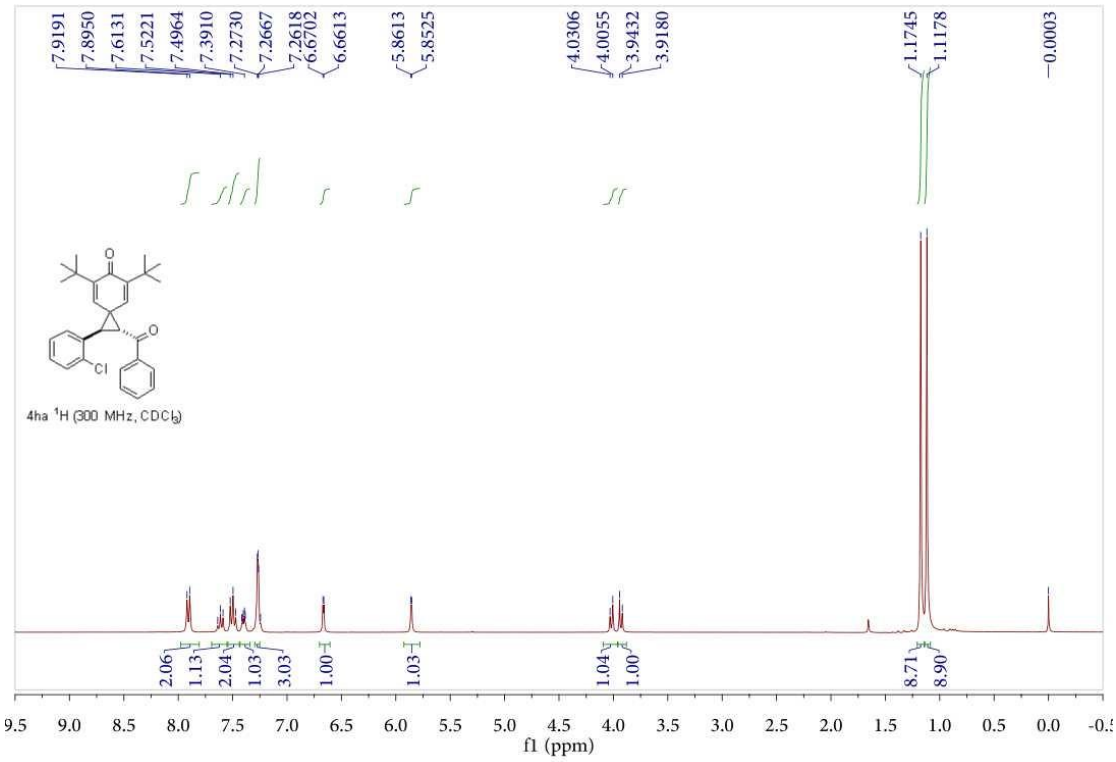
150.483
150.080
137.864
137.386
137.293
137.061
134.495
133.668
129.848
129.300
128.865
128.208
127.937
127.380
40.626
40.055
39.132
35.236
35.184
29.268
29.223
f1 (ppm)
4ga ^{13}C (75 MHz, $CDCl_3$)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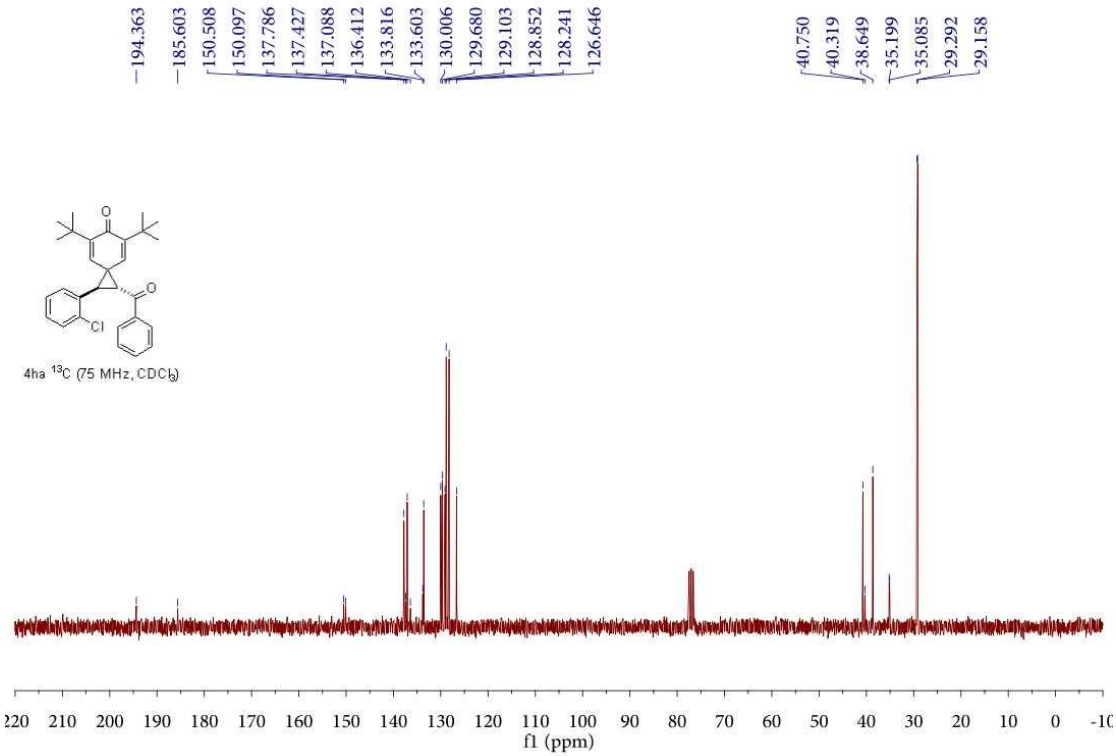
7.6131
7.5221
7.4964
7.3910
7.2730
7.2667
7.2618
6.6702
6.6613
5.8613
5.8525
4.0306
4.0055
3.9432
3.9180
1.1745
1.1178
0.0003
2.06
1.13
2.04
1.03
3.03
1.00
1.03
1.04
1.00
8.71
8.90
4ha ^{1}H (300 MHz, CDCl$_3$)
f1 (ppm)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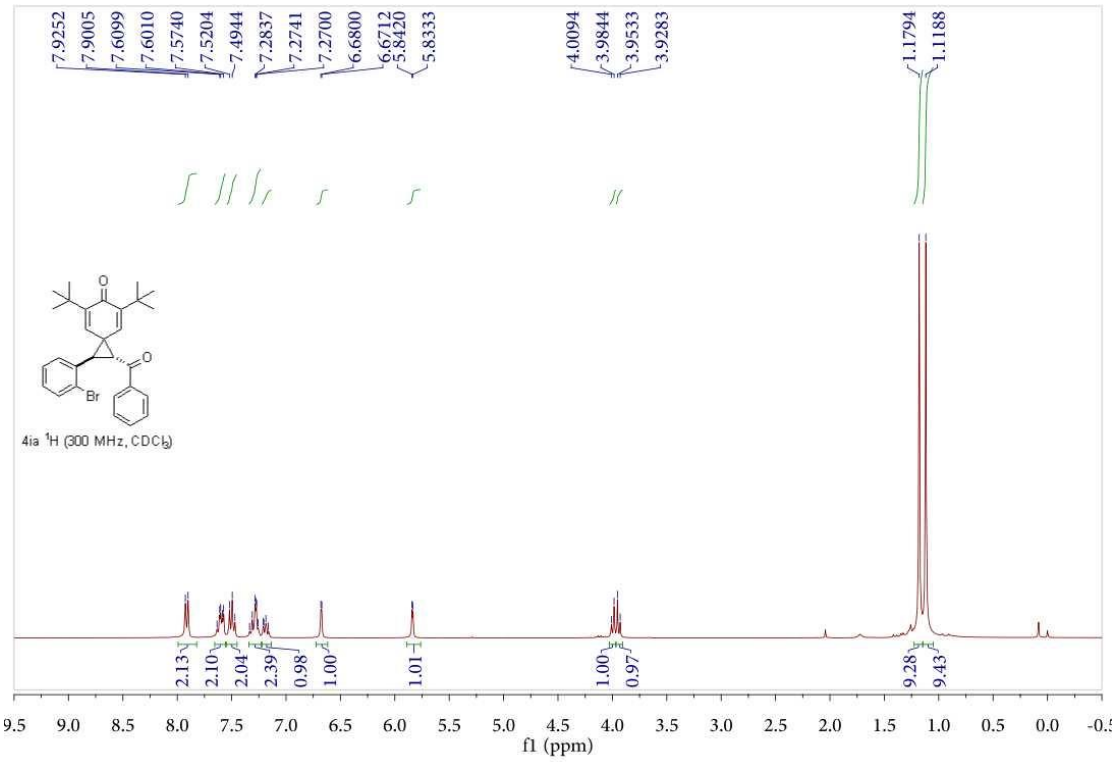
150.097
137.786
137.427
137.088
136.412
133.816
133.603
130.006
129.680
129.103
128.852
128.241
126.646
40.750
40.319
38.649
35.199
35.085
29.292
29.158
4ha ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)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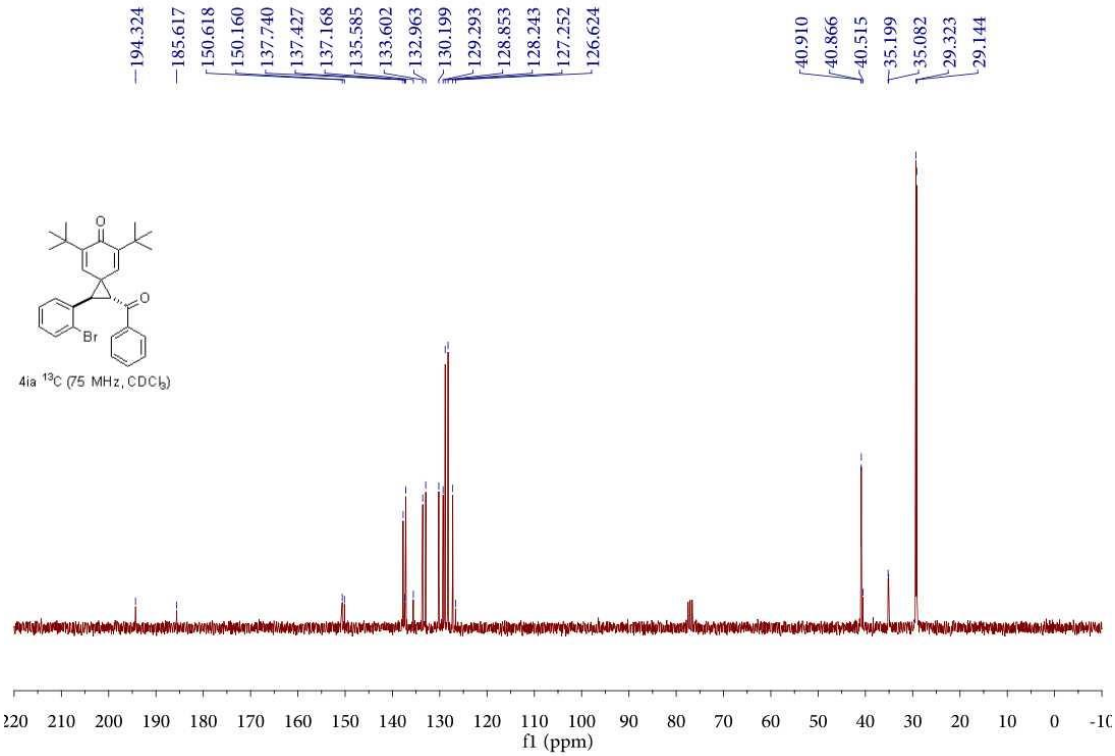
7.9005
7.6099
7.6010
7.5740
7.5204
7.4944
7.2837
7.2741
7.2700
6.6800
6.6712
5.8420
5.8333
4.0094
3.9844
3.9533
3.9283
1.1794
1.1188
Br
4ia ^{1}H (300 MHz, $CDCl_3$)
2.13
2.10
2.04
2.39
0.98
1.00
1.01
1.00
0.97
9.28
9.43
f1 (ppm)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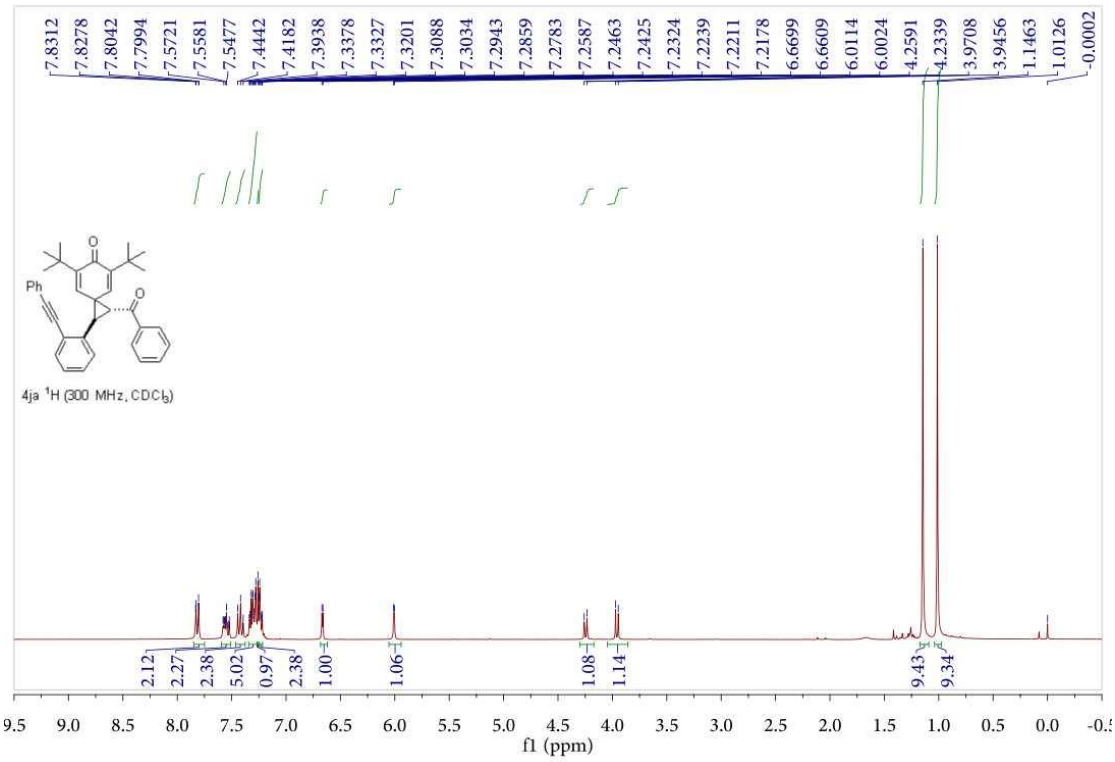
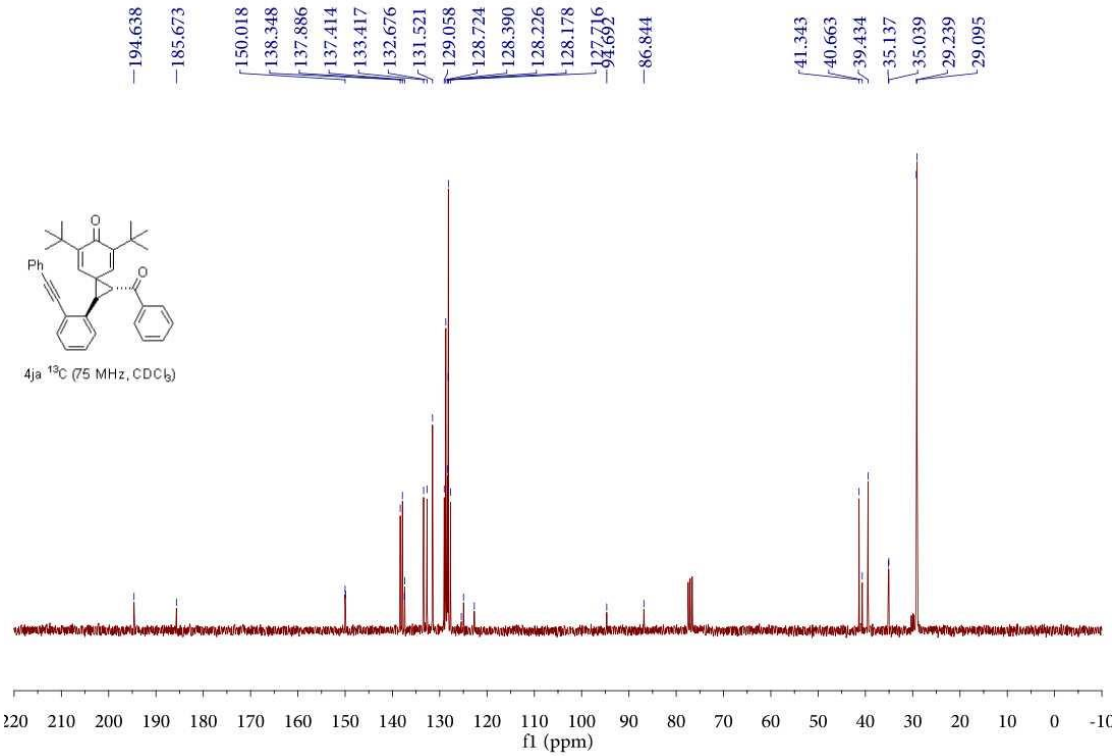
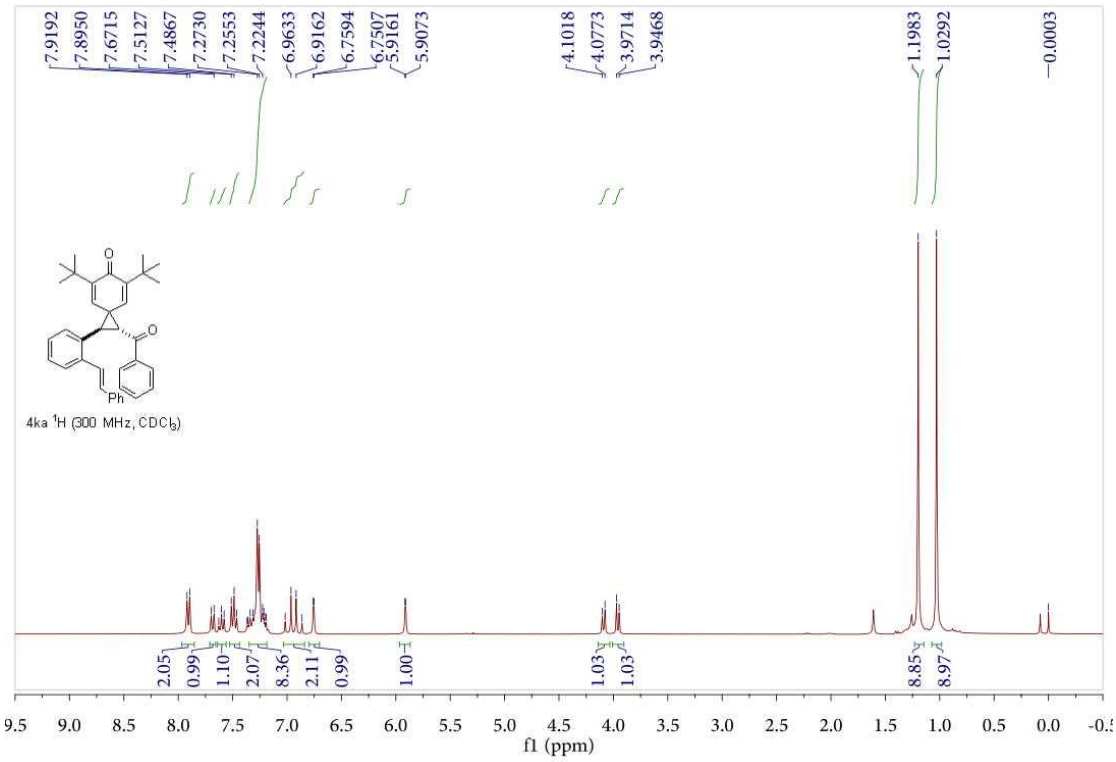
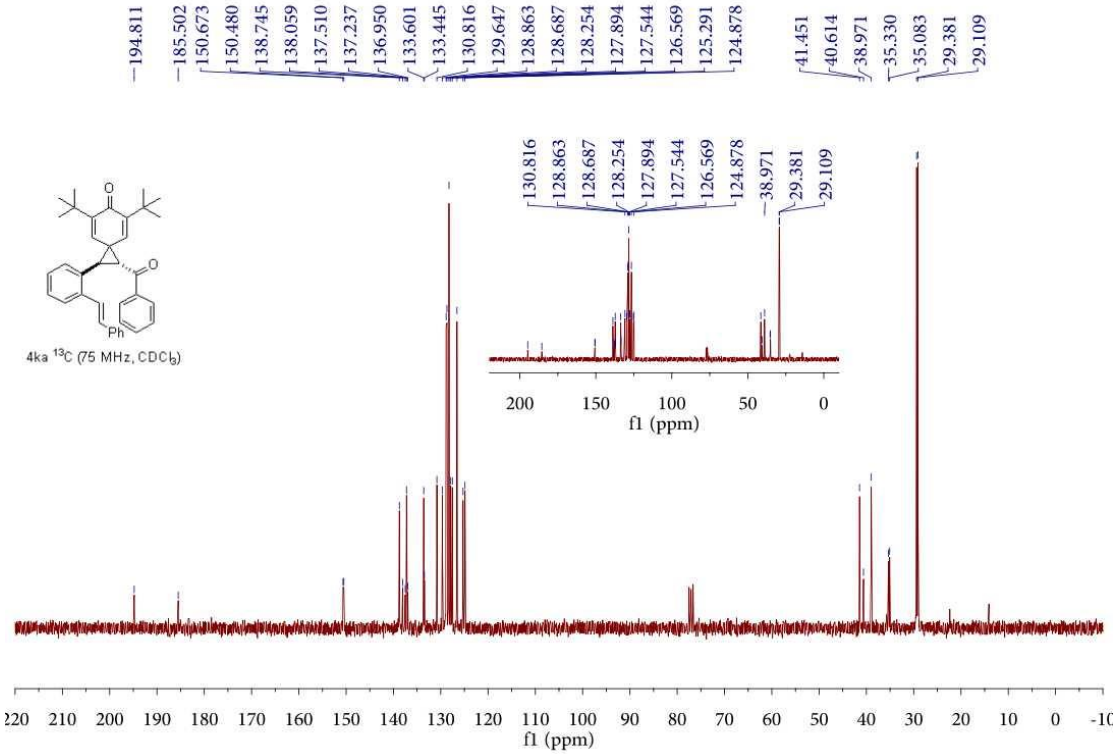
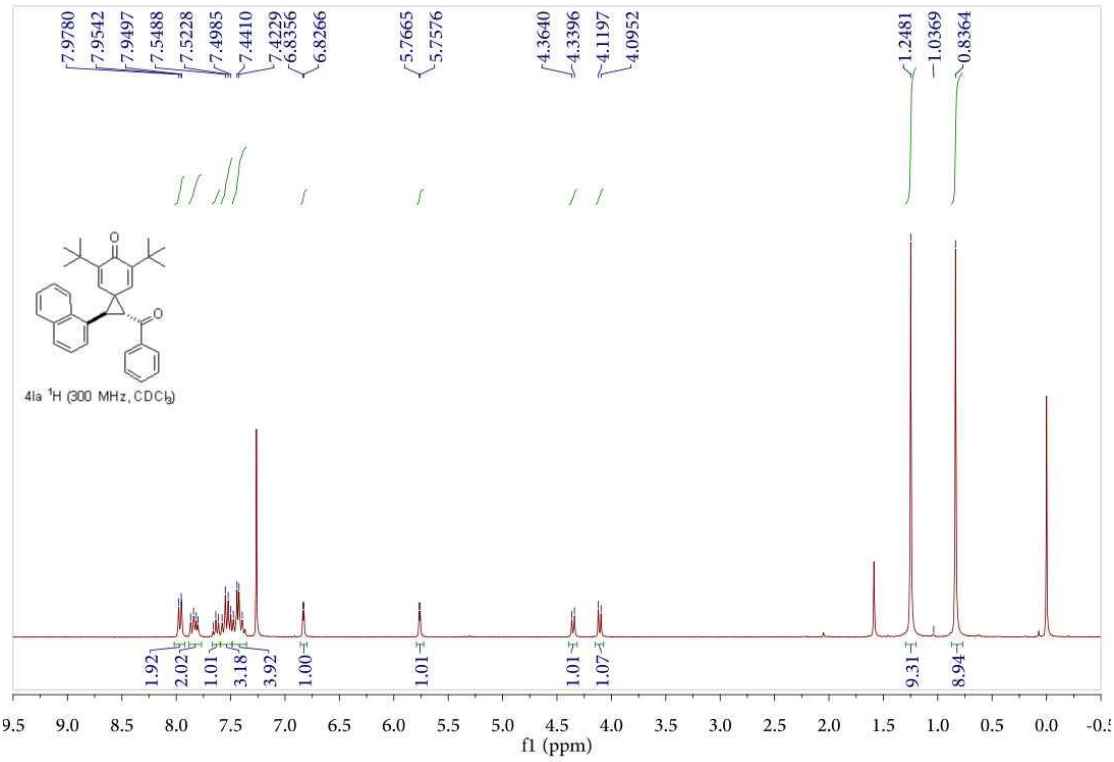
185.617
150.618
150.160
137.740
137.427
137.168
135.585
133.602
132.963
130.199
129.293
128.853
128.243
127.252
126.624
40.910
40.866
40.515
35.199
35.082
29.323
29.144
Br
4ia ^{13}C (75 MHz, $CDCl_3$)
f1 (ppm)

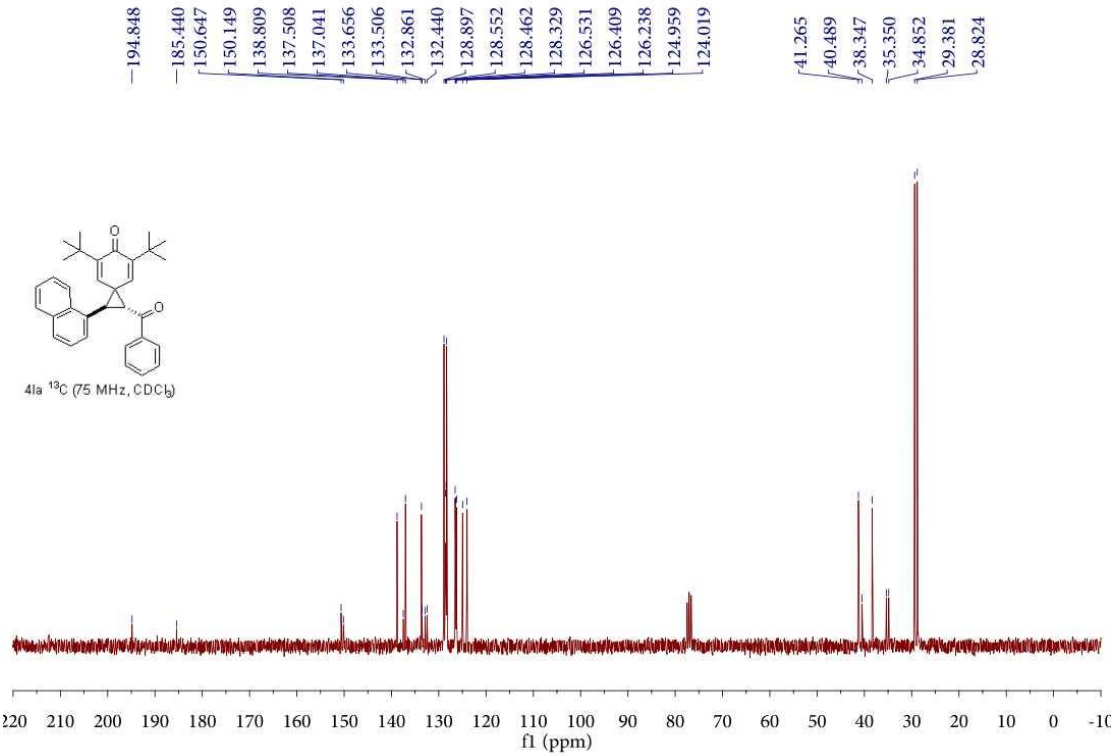

7.8312
7.8278
7.8042
7.7994
7.5721
7.5581
7.5477
7.4442
7.4182
7.3938
7.3378
7.3327
7.3201
7.3088
7.3034
7.2943
7.2859
7.2783
7.2587
7.2463
7.2425
7.2324
7.2239
7.2211
7.2178
6.6699
6.6609
6.0114
6.0024
4.2591
4.2339
3.9708
3.9456
1.1463
1.0126
-0.0002
Ph
O
O
4ja ^{1}H (300 MHz, $CDCl_3$)
2.12
2.27
2.38
5.02
0.97
2.38
1.00
1.06
1.08
1.14
9.43
9.34
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

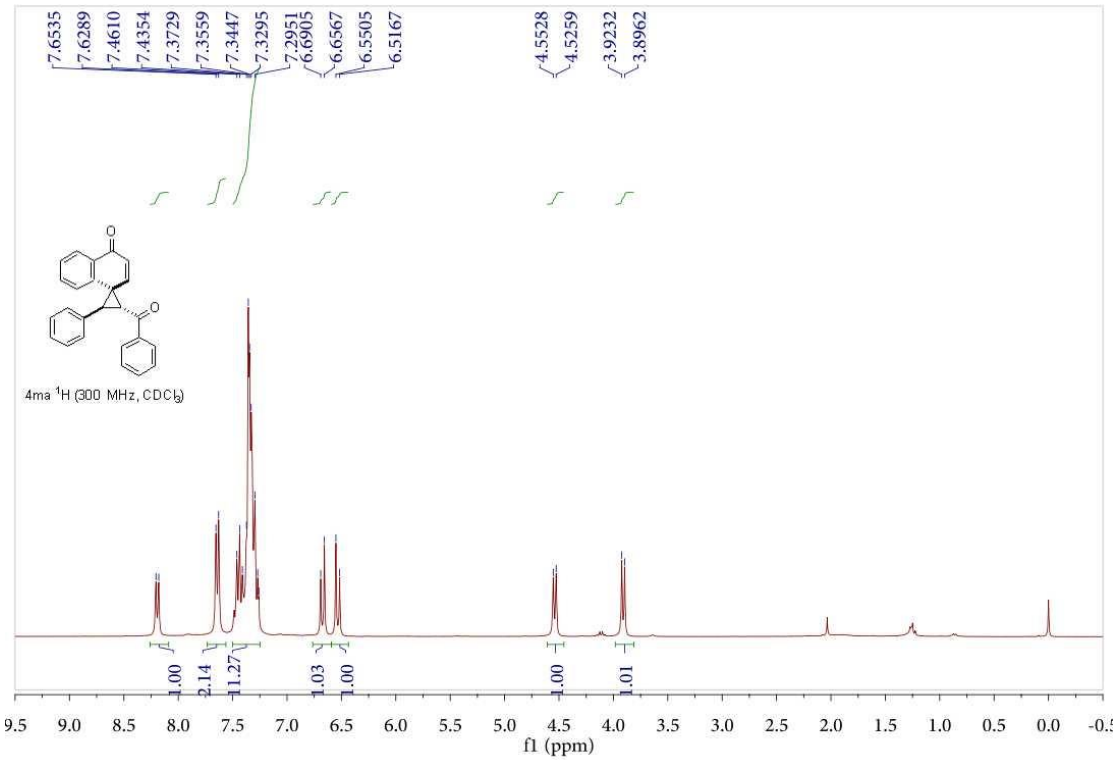

194.638
185.673
150.018
138.348
137.886
137.414
133.417
132.676
131.521
129.058
128.724
128.390
128.226
128.178
127.716
94.692
86.844
41.343
40.663
39.434
35.137
35.039
29.239
29.095
Ph
O
O
4ja ^{13}C (75 MHz, $CDCl_3$)
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

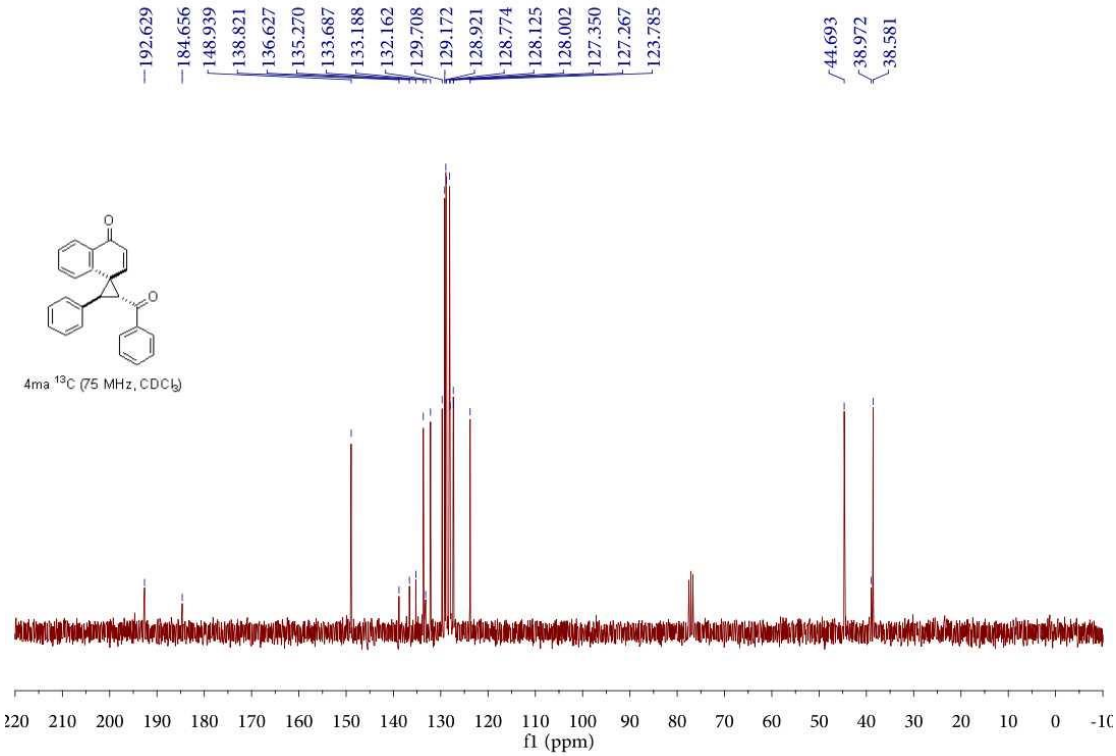

7.9192
7.8950
7.6715
7.5127
7.4867
7.2730
7.2553
7.2244
6.9633
6.9162
6.7594
6.7507
5.9161
5.9073
4.1018
4.0773
3.9714
3.9468
1.1983
1.0292
0.0003
4ka ^{1}H (300 MHz, CDCl$_3$)
2.05
0.99
1.10
2.07
8.36
2.11
0.99
1.00
1.03
1.03
8.85
8.97
f1 (ppm)

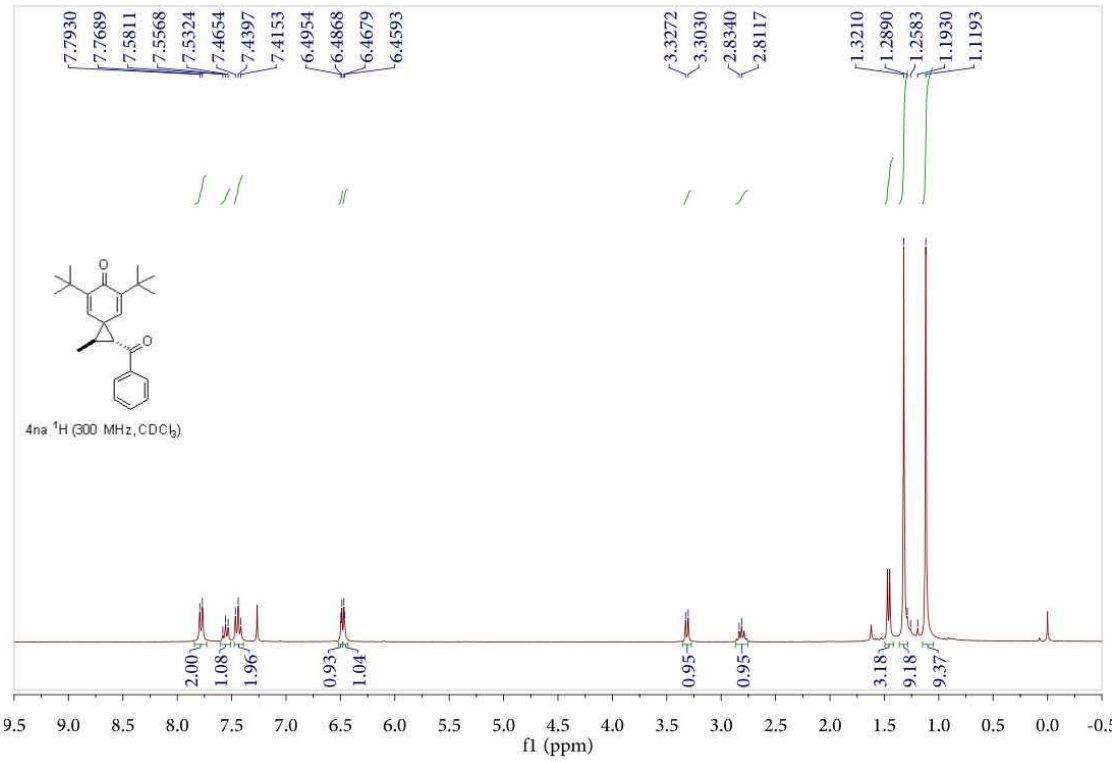

194.811
185.502
150.673
150.480
138.745
138.059
137.510
137.237
136.950
133.601
133.445
130.816
129.647
128.863
128.687
128.254
127.894
127.544
126.569
125.291
124.878
41.451
40.614
38.971
35.330
35.083
29.381
29.109
4ka ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)
f1 (ppm)

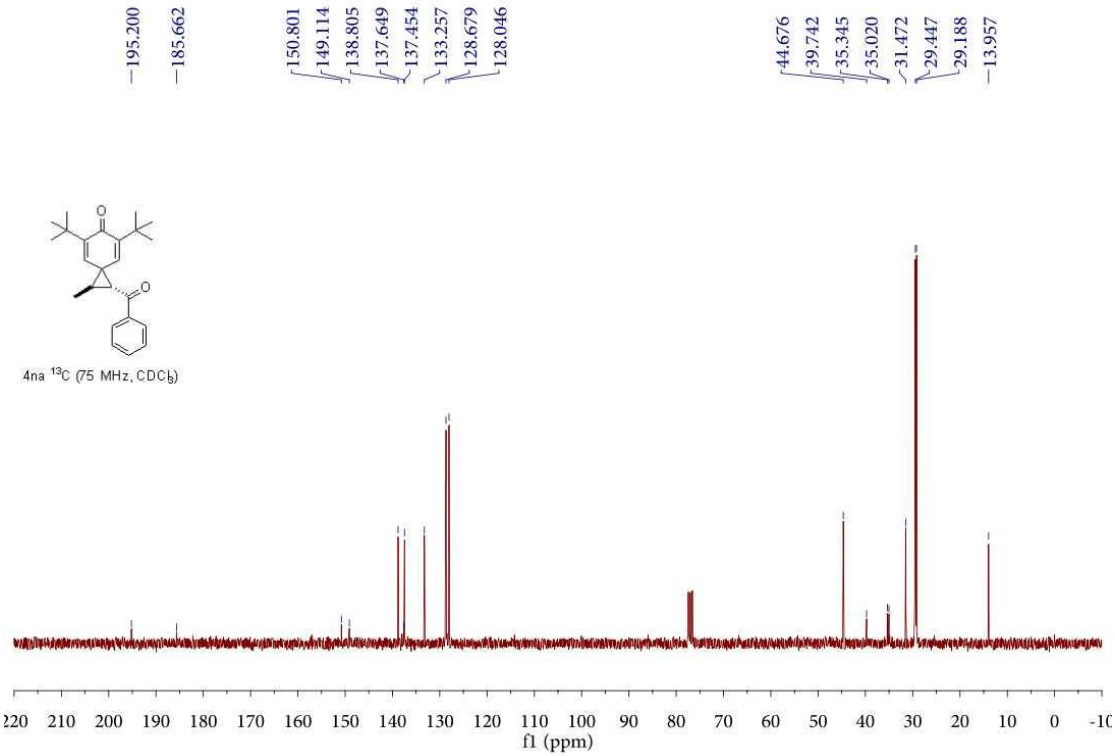

7.9780
7.9542
7.9497
7.5488
7.5228
7.4985
7.4410
7.4229
6.8356
6.8266
5.7665
5.7576
4.3640
4.3396
4.1197
4.0952
1.2481
1.0369
0.8364
4la ^{1}H (300 MHz, $CDCl_3$)
1.92
2.02
1.01
3.18
3.92
1.00
1.01
1.01
1.07
9.31
8.94
f1 (ppm)

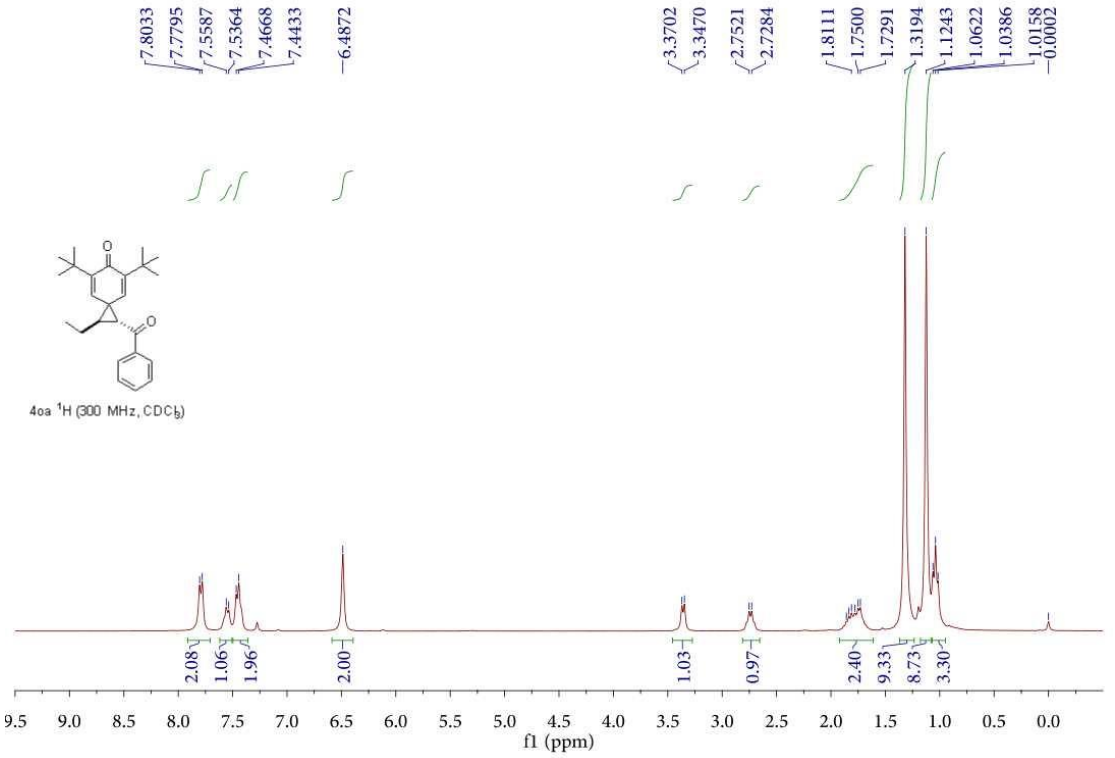

194.848
185.440
150.647
150.149
138.809
137.508
137.041
133.656
133.506
132.861
132.440
128.897
128.552
128.462
128.329
126.531
126.409
126.238
124.959
124.019
41.265
40.489
38.347
35.350
34.852
29.381
28.824
4la ^{13}C (75 MHz, $CDCl_3$)
f1 (ppm)


7.6535
7.6289
7.4610
7.4354
7.3729
7.3559
7.3447
7.3295
7.2951
6.6905
6.6567
6.5505
6.5167
4.5528
4.5259
3.9232
3.8962
4ma ^{1}H (300 MHz, CDCl$_3$)
1.00
2.14
11.27
1.03
1.00
1.00
1.01
f1 (ppm)

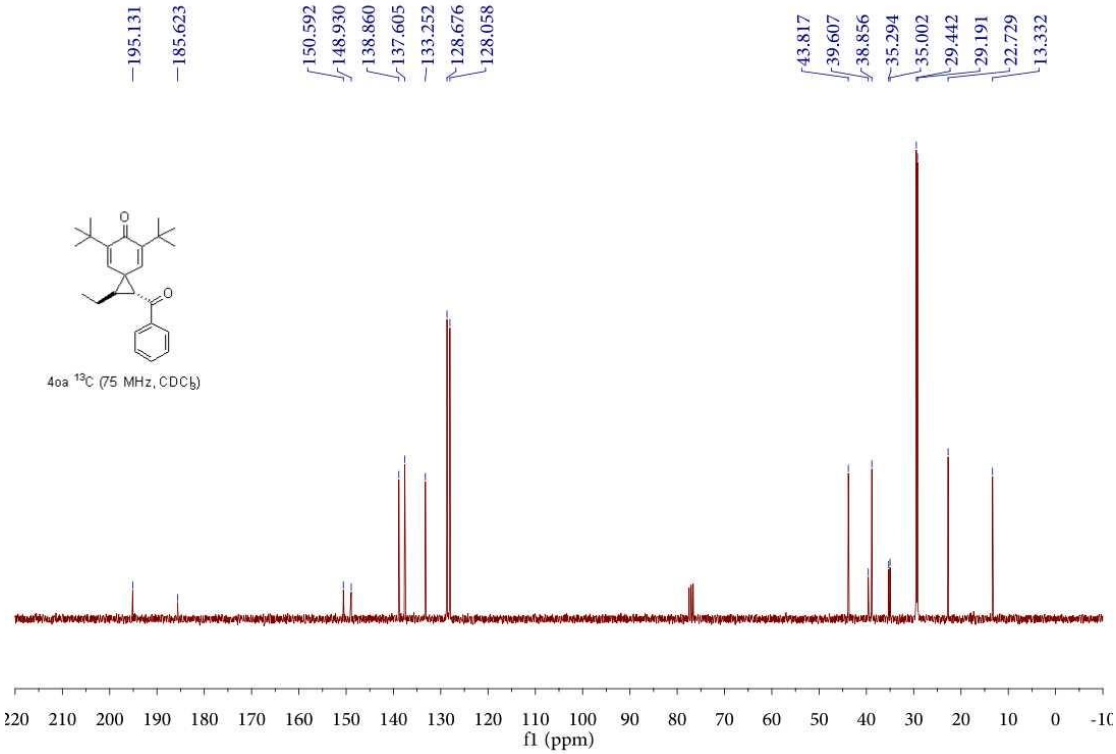

192.629
184.656
148.939
138.821
136.627
135.270
133.687
133.188
132.162
129.708
129.172
128.921
128.774
128.125
128.002
127.350
127.267
123.785
44.693
38.972
38.581
4ma ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)


7.7930
7.7689
7.5811
7.5568
7.5324
7.4654
7.4397
7.4153
6.4954
6.4868
6.4679
6.4593
3.3272
3.3030
2.8340
2.8117
1.3210
1.2890
1.2583
1.1930
1.1193
4na ¹H (300 MHz, CDCl₃)
2.00
1.08
1.96
0.93
1.04
0.95
0.95
3.18
9.18
9.37
f1 (ppm)

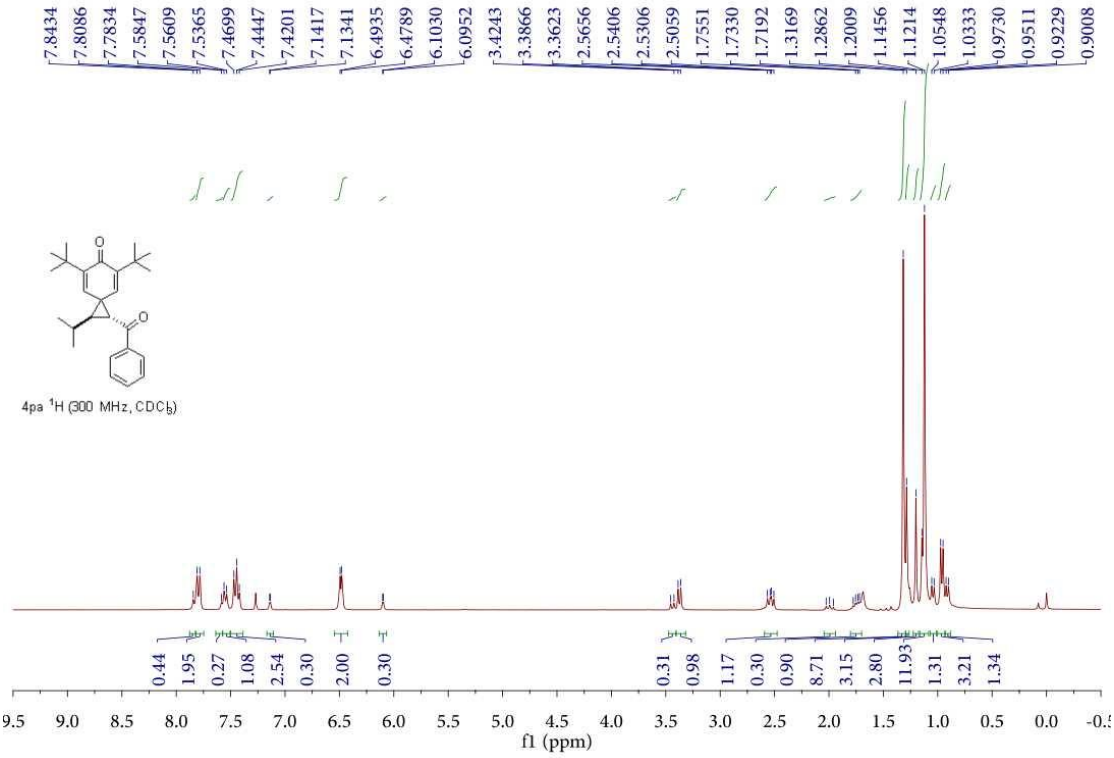

195.200
185.662
150.801
149.114
138.805
137.649
137.454
133.257
128.679
128.046
44.676
39.742
35.345
35.020
31.472
29.447
29.188
13.957
4na ¹³C (75 MHz, CDCl₃)
f1 (ppm)

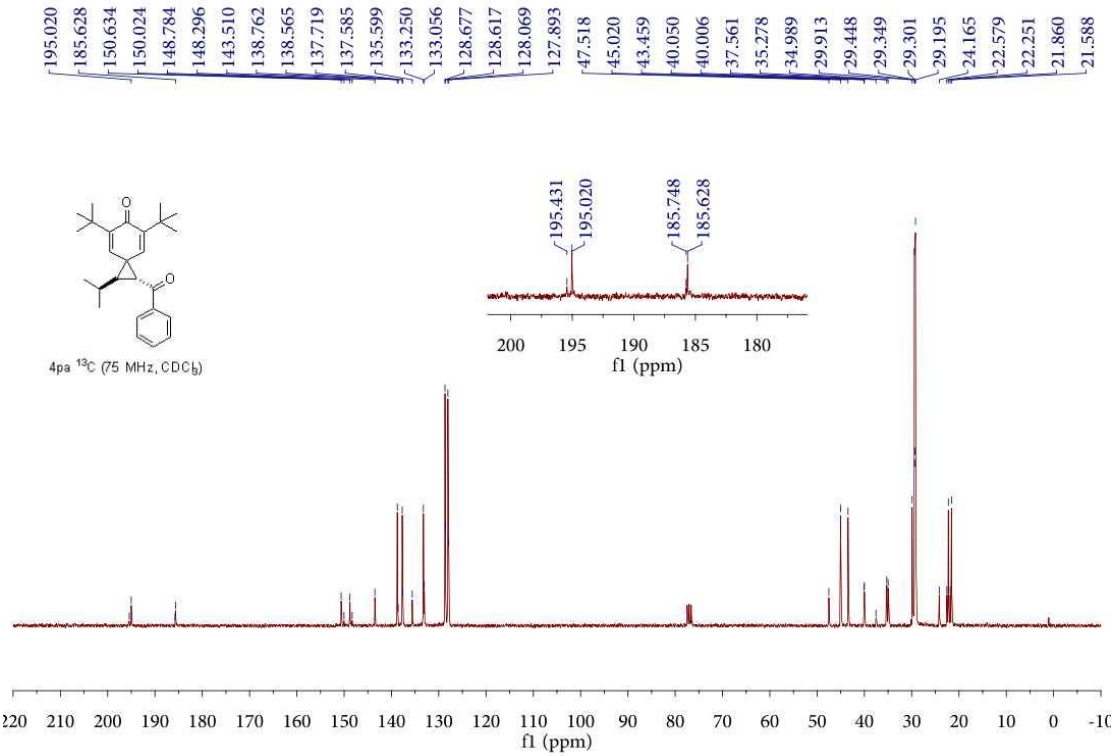


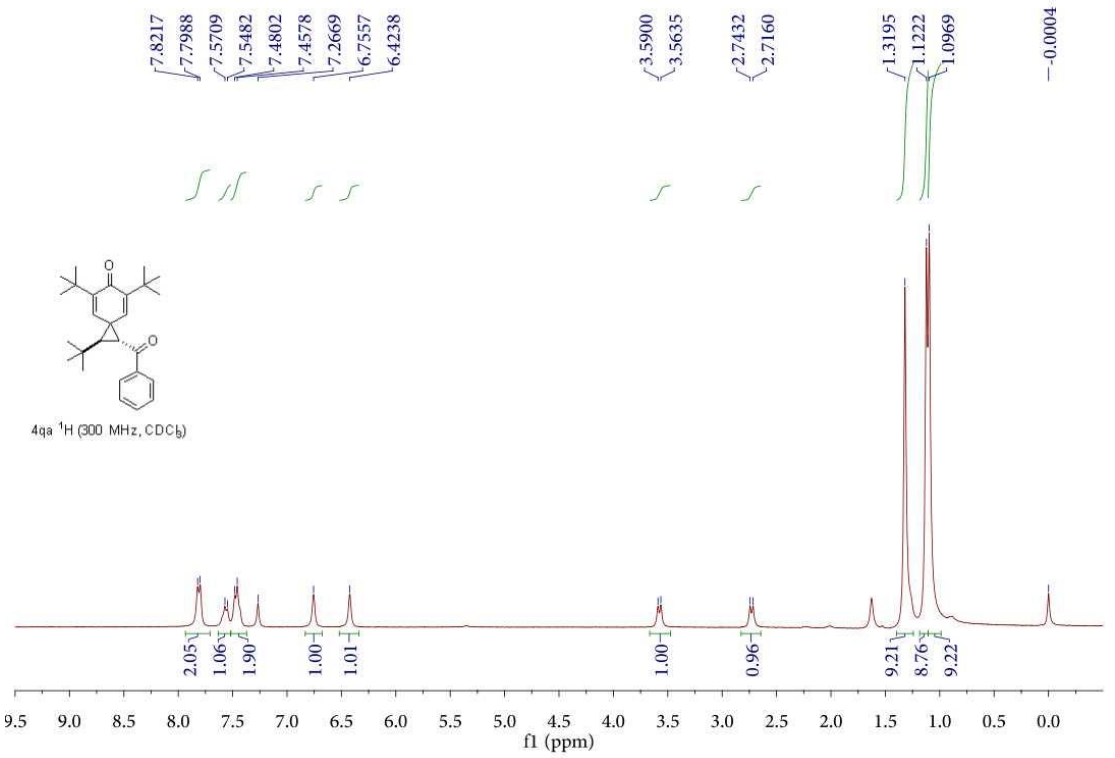
4oa ^{1}H (300 MHz, $CDCl_3$)

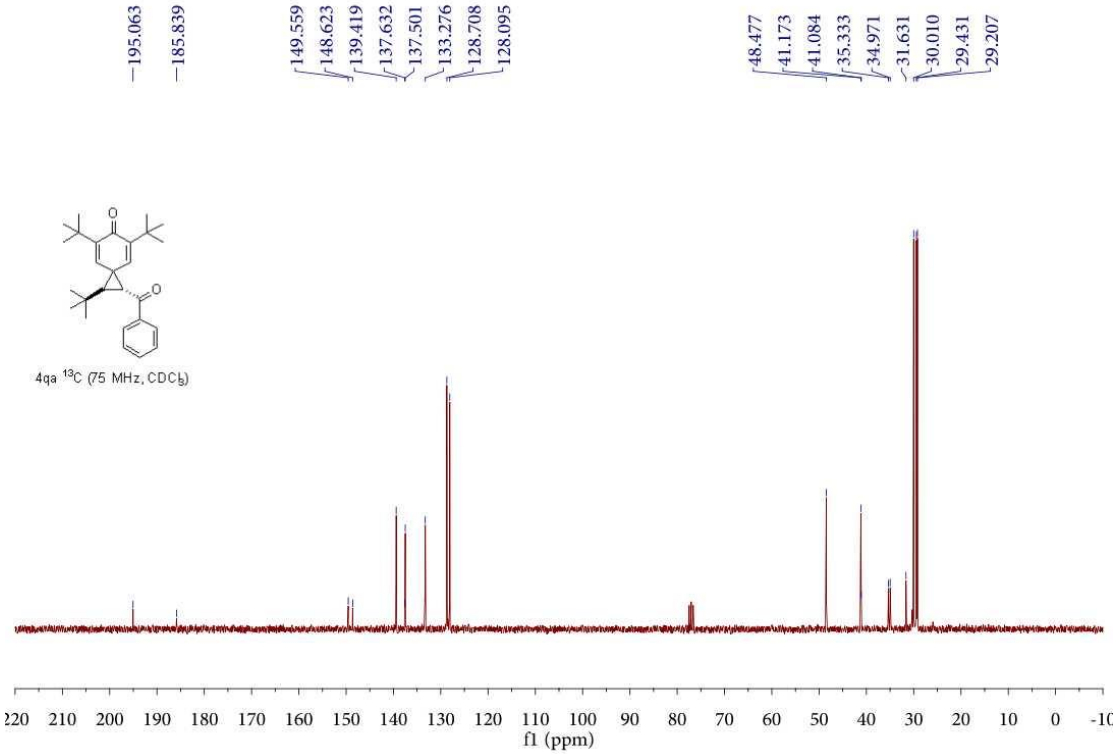


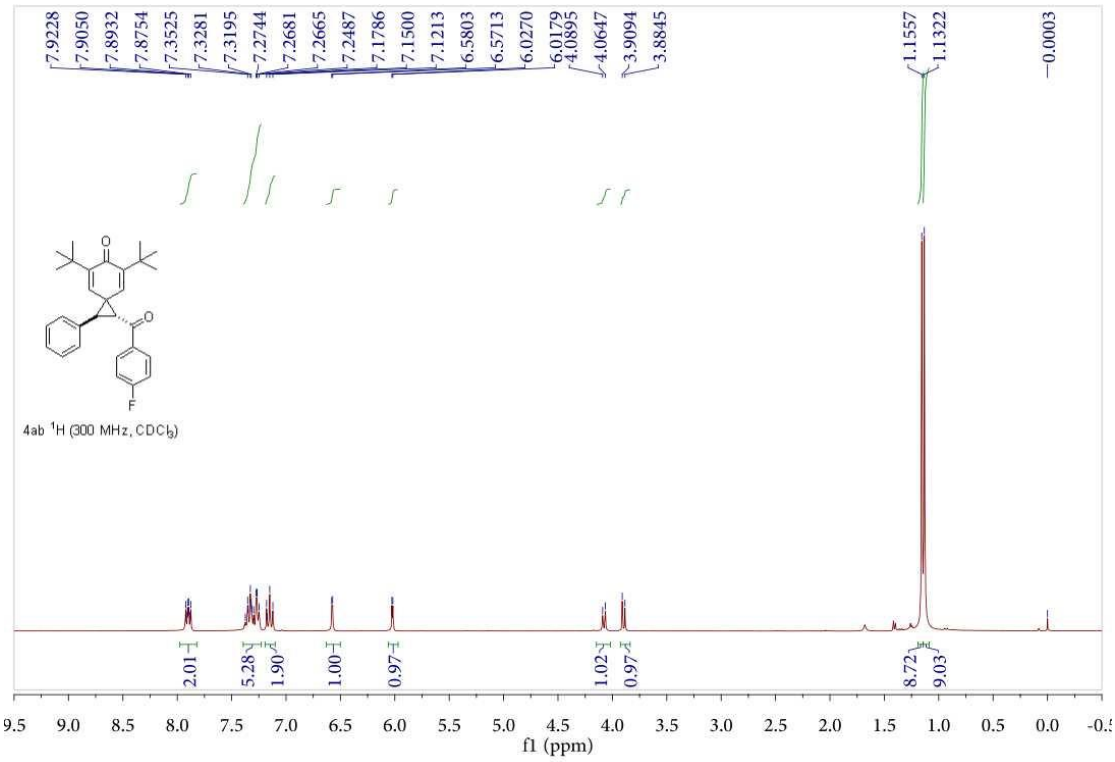
4oa ^{13}C (75 MHz, $CDCl_3$)

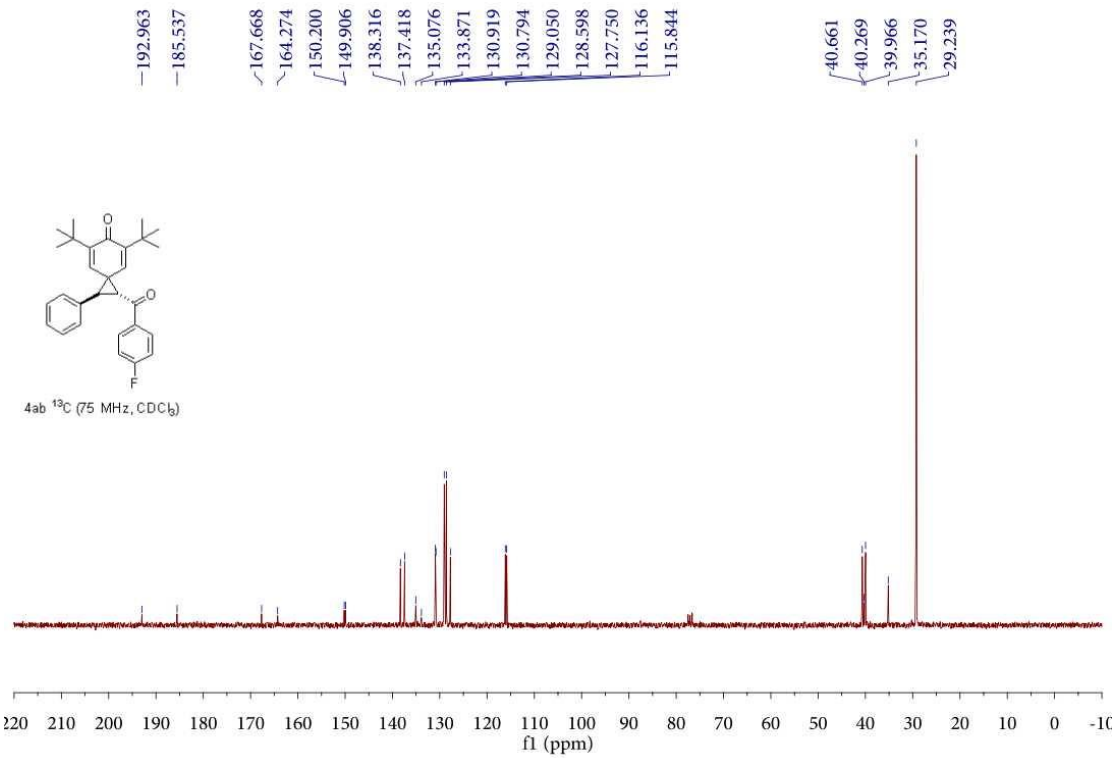

4pa ^{1}H (300 MHz, $CDCl_3$)
f1 (ppm)

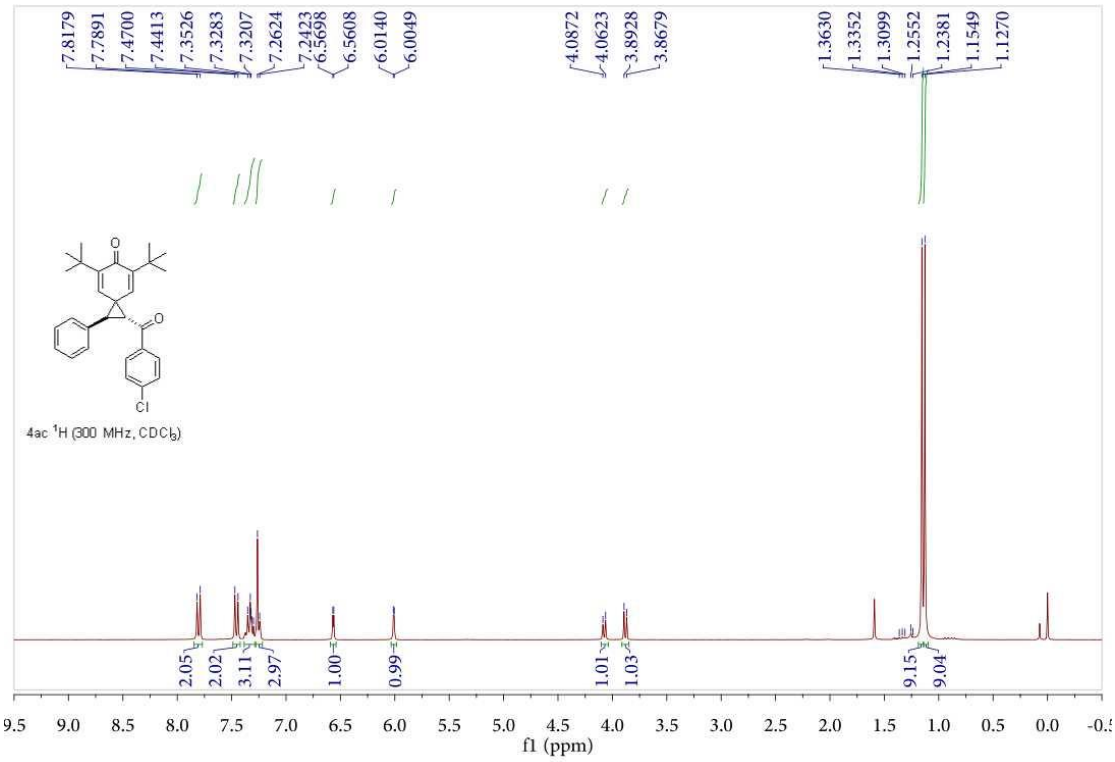

4pa ^{13}C (75 MHz, $CDCl_3$)
f1 (ppm)

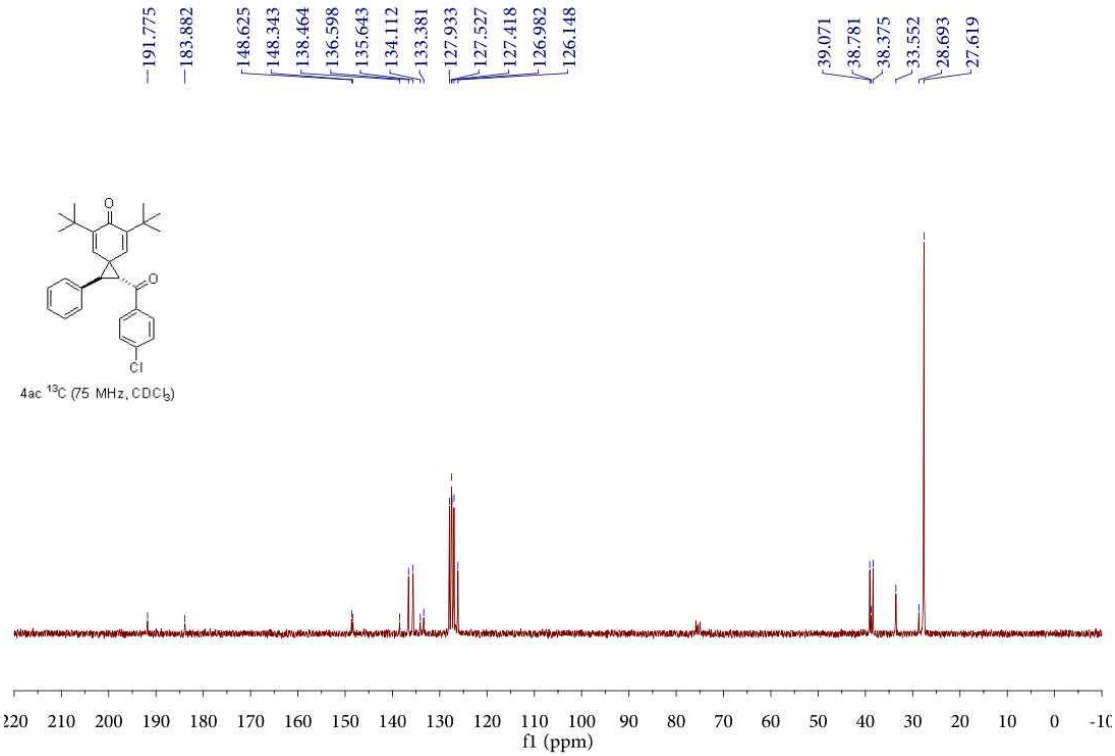

7.8217
7.7988
7.5709
7.5482
7.4802
7.4578
7.2669
6.7557
6.4238
3.5900
3.5635
2.7432
2.7160
1.3195
1.1222
1.0969
-0.0004
4qa ^{1}H (300 MHz, $CDCl_3$)
2.05
1.06
1.90
1.00
1.01
1.00
0.96
9.21
8.76
9.22
f1 (ppm)

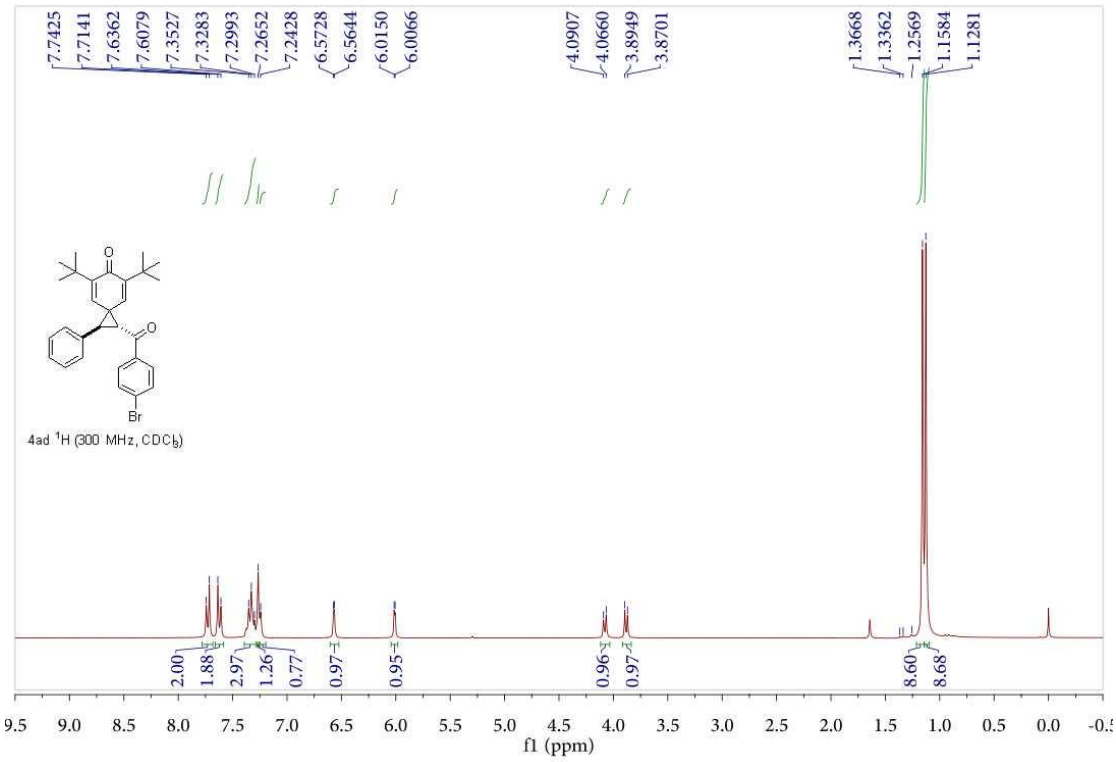

195.063
185.839
149.559
148.623
139.419
137.632
137.501
133.276
128.708
128.095
48.477
41.173
41.084
35.333
34.971
31.631
30.010
29.431
29.207
4qa ^{13}C (75 MHz, $CDCl_3$)
f1 (ppm)

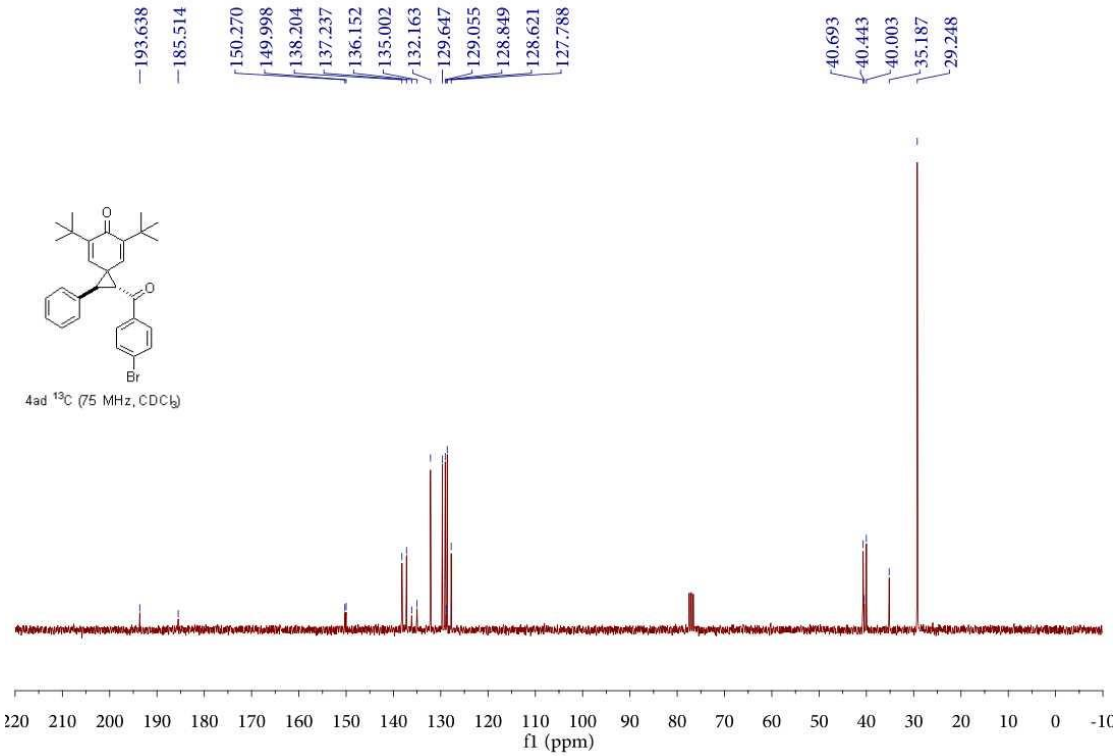

7.9228
7.9050
7.8932
7.8754
7.3525
7.3281
7.3195
7.2744
7.2681
7.2665
7.2487
7.1786
7.1500
7.1213
6.5803
6.5713
6.0270
6.0179
4.0895
4.0647
3.9094
3.8845
1.1557
1.1322
0.0003
2.01
5.28
1.90
1.00
0.97
1.02
0.97
8.72
9.03
4ab ^{1}H (300 MHz, CDCl$_3$)
f1 (ppm)

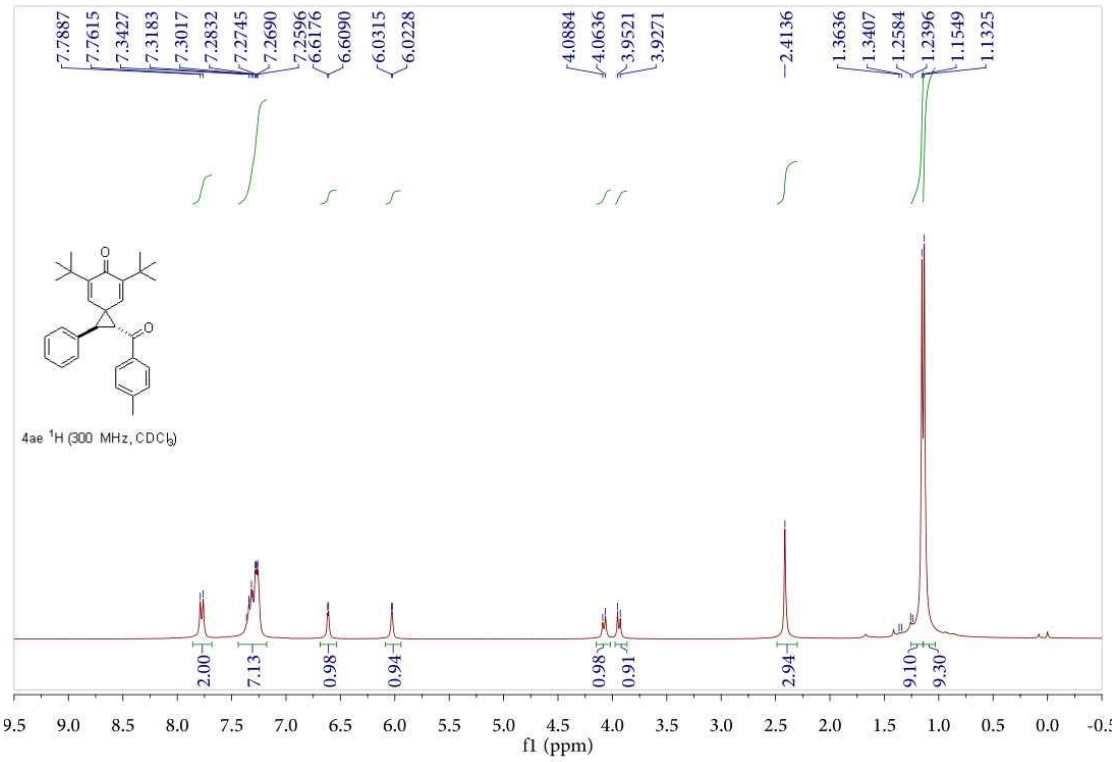

192.963
185.537
167.668
164.274
150.200
149.906
138.316
137.418
135.076
133.871
130.919
130.794
129.050
128.598
127.750
116.136
115.844
40.661
40.269
39.966
35.170
29.239
4ab ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)

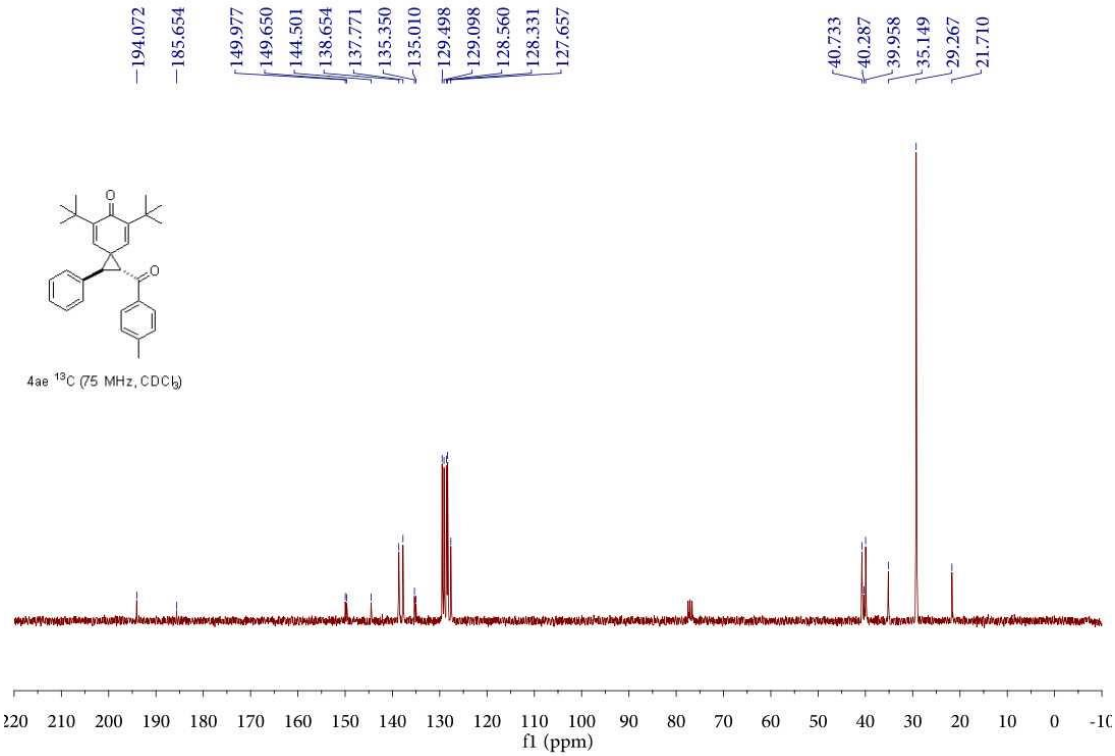

7.8179
7.7891
7.4700
7.4413
7.3526
7.3283
7.3207
7.2624
7.2423
6.5698
6.5608
6.0140
6.0049
4.0872
4.0623
3.8928
3.8679
1.3630
1.3352
1.3099
1.2552
1.2381
1.1549
1.1270
O
O
Cl
4ac ^{1}H (300 MHz, CDCl$_3$)
2.05
2.02
3.11
2.97
1.00
0.99
1.01
1.03
9.15
9.04
f1 (ppm)

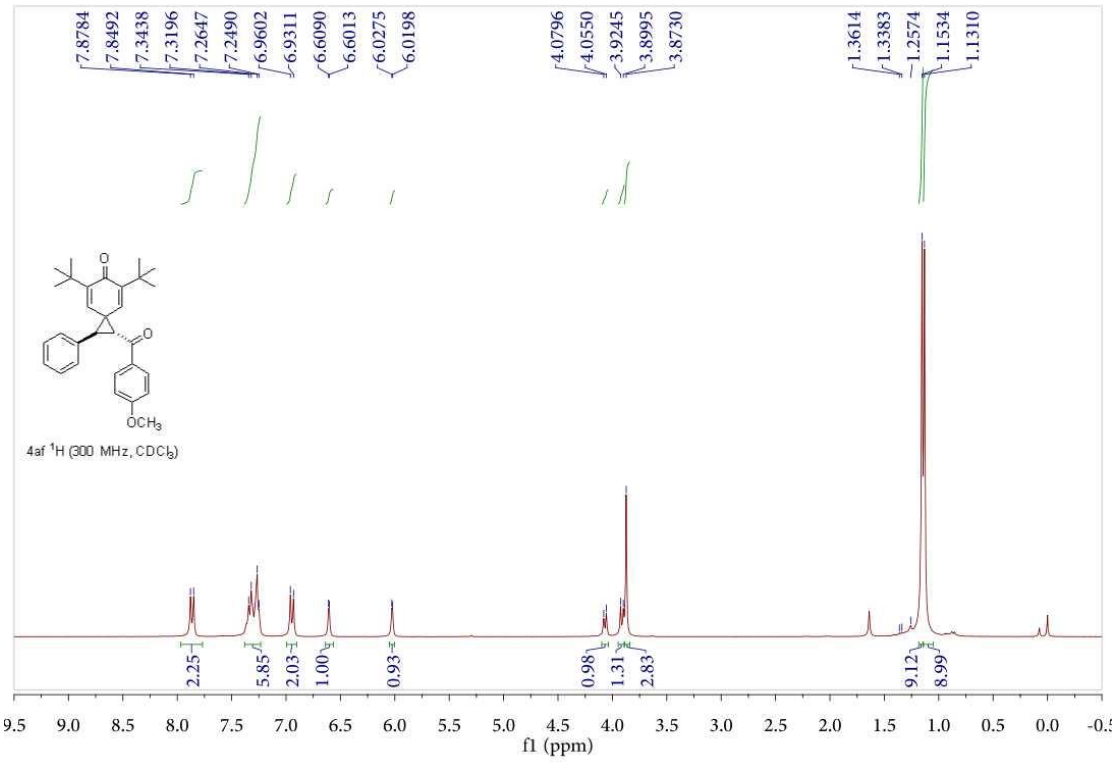

191.775
183.882
148.625
148.343
138.464
136.598
135.643
134.112
133.381
127.933
127.527
127.418
126.982
126.148
39.071
38.781
38.375
33.552
28.693
27.619
O
O
Cl
4ac ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)

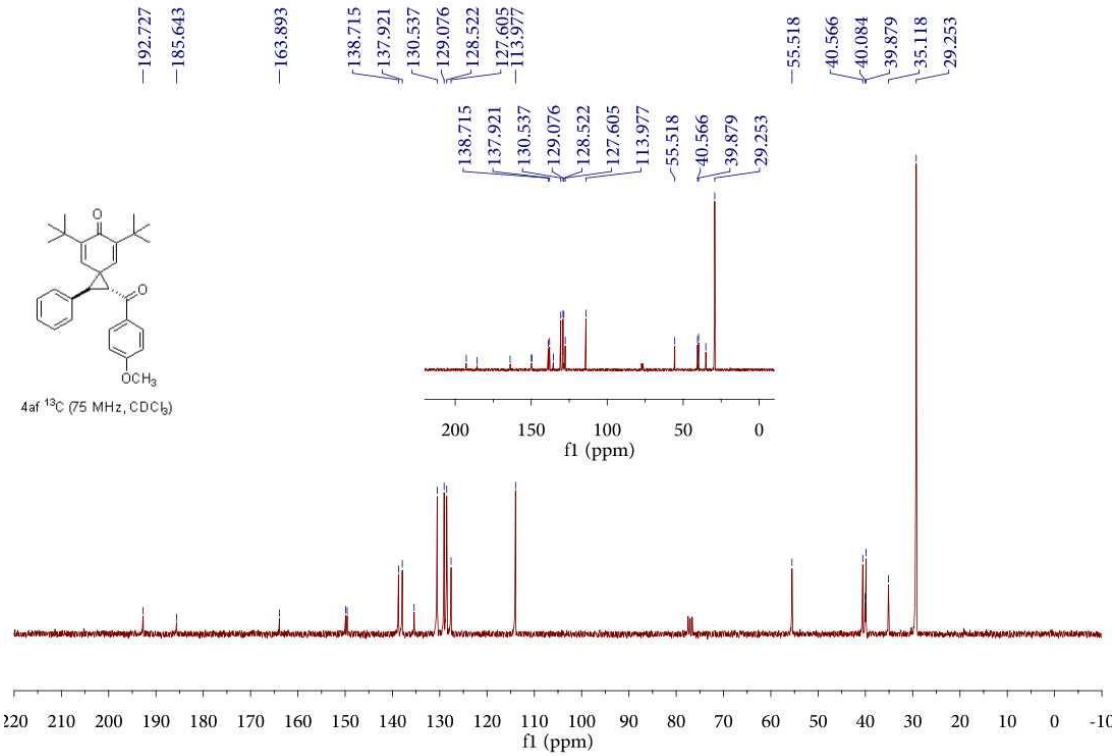

7.7425
7.7141
7.6362
7.6079
7.3527
7.3283
7.2993
7.2652
7.2428
6.5728
6.5644
6.0150
6.0066
4.0907
4.0660
3.8949
3.8701
1.3668
1.3362
1.2569
1.1584
1.1281
O
O
Br
4ad ^{1}H (300 MHz, CDCl$_3$)
2.00
1.88
2.97
1.26
0.77
0.97
0.95
0.96
0.97
8.60
8.68
f1 (ppm)

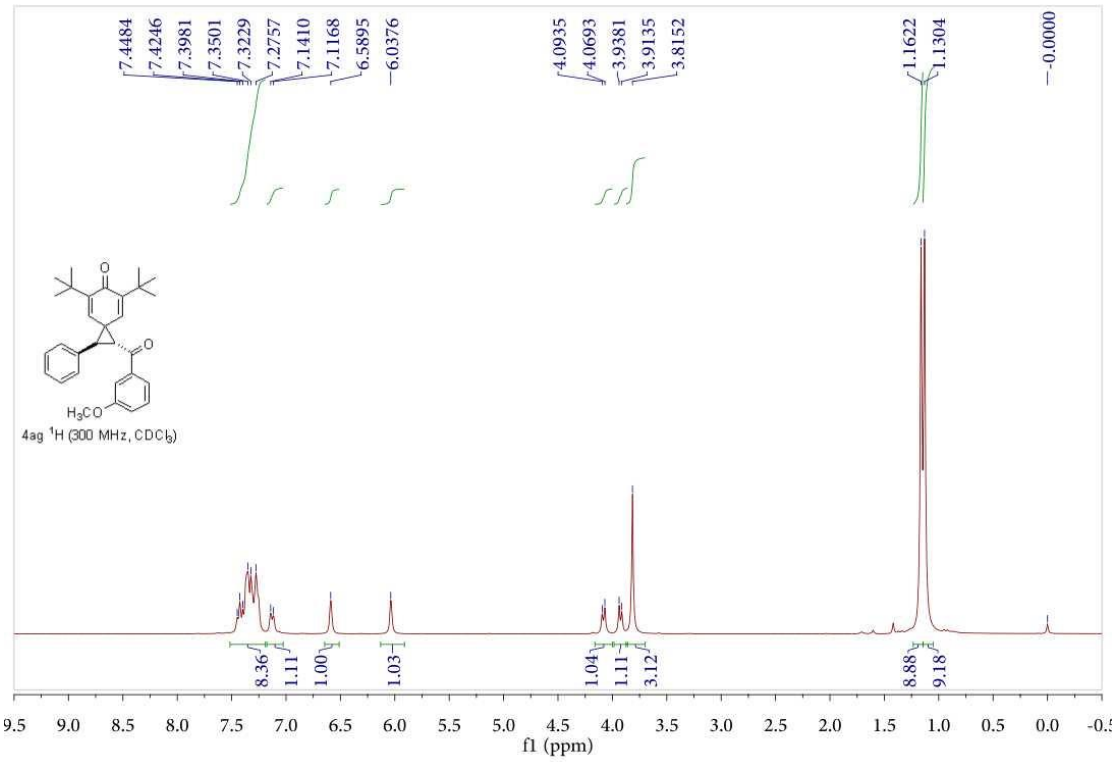

193.638
185.514
150.270
149.998
138.204
137.237
136.152
135.002
132.163
129.647
129.055
128.849
128.621
127.788
40.693
40.443
40.003
35.187
29.248
O
O
Br
4ad ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)

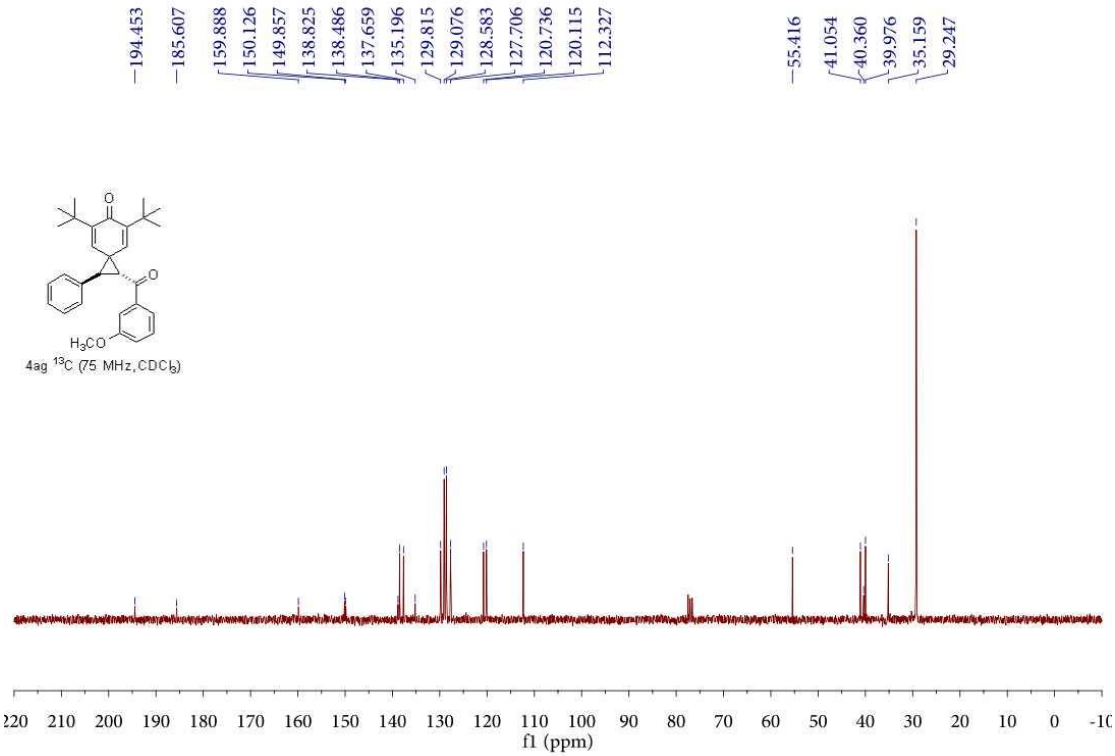

7.7887
7.7615
7.3427
7.3183
7.3017
7.2832
7.2745
7.2690
7.2596
6.6176
6.6090
6.0315
6.0228
4.0884
4.0636
3.9521
3.9271
2.4136
1.3636
1.3407
1.2584
1.2396
1.1549
1.1325
4ae ^{1}H (300 MHz, CDCl$_3$)
2.00
7.13
0.98
0.94
0.98
0.91
2.94
9.10
9.30
f1 (ppm)

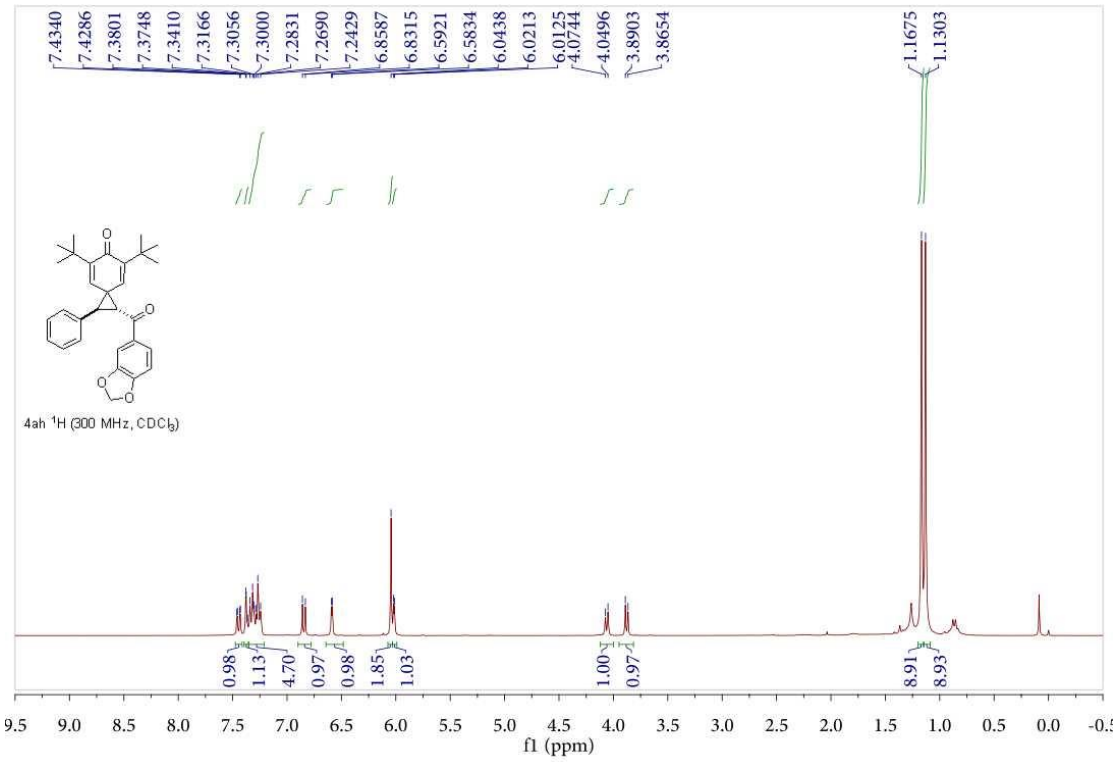

194.072
185.654
149.977
149.650
144.501
138.654
137.771
135.350
135.010
129.498
129.098
128.560
128.331
127.657
40.733
40.287
39.958
35.149
29.267
21.710
4ae ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)

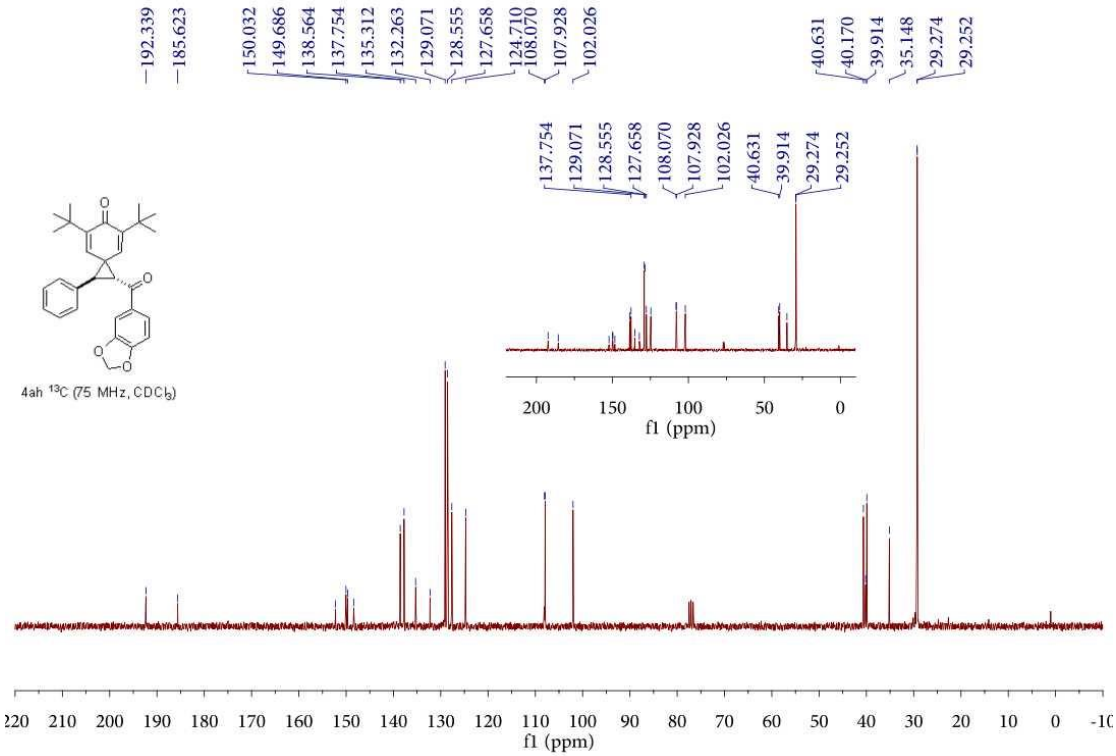

7.8784
7.8492
7.3438
7.3196
7.2647
7.2490
6.9602
6.9311
6.6090
6.6013
6.0275
6.0198
4.0796
4.0550
3.9245
3.8995
3.8730
1.3614
1.3383
1.2574
1.1534
1.1310
4af ^{1}H (300 MHz, CDCl$_3$)
2.25
5.85
2.03
1.00
0.93
0.98
1.31
2.83
9.12
8.99
f1 (ppm)

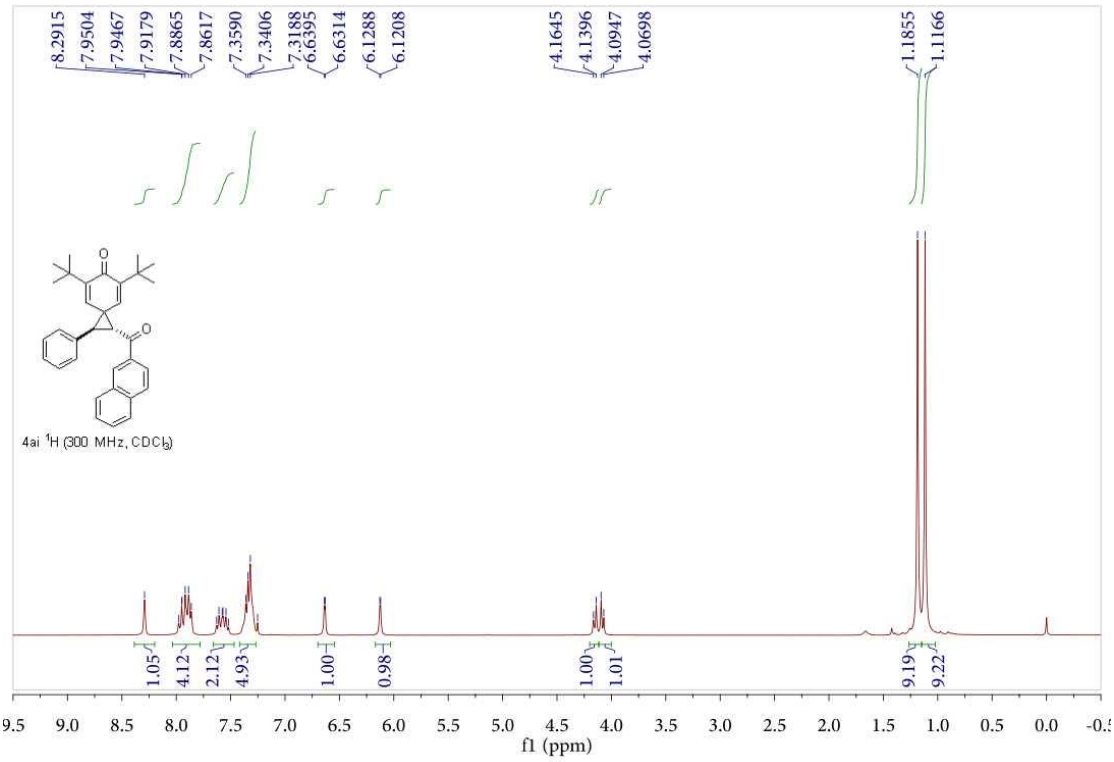

192.727
185.643
163.893
138.715
137.921
130.537
129.076
128.522
127.605
113.977
55.518
40.566
40.084
39.879
35.118
29.253
4af ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)

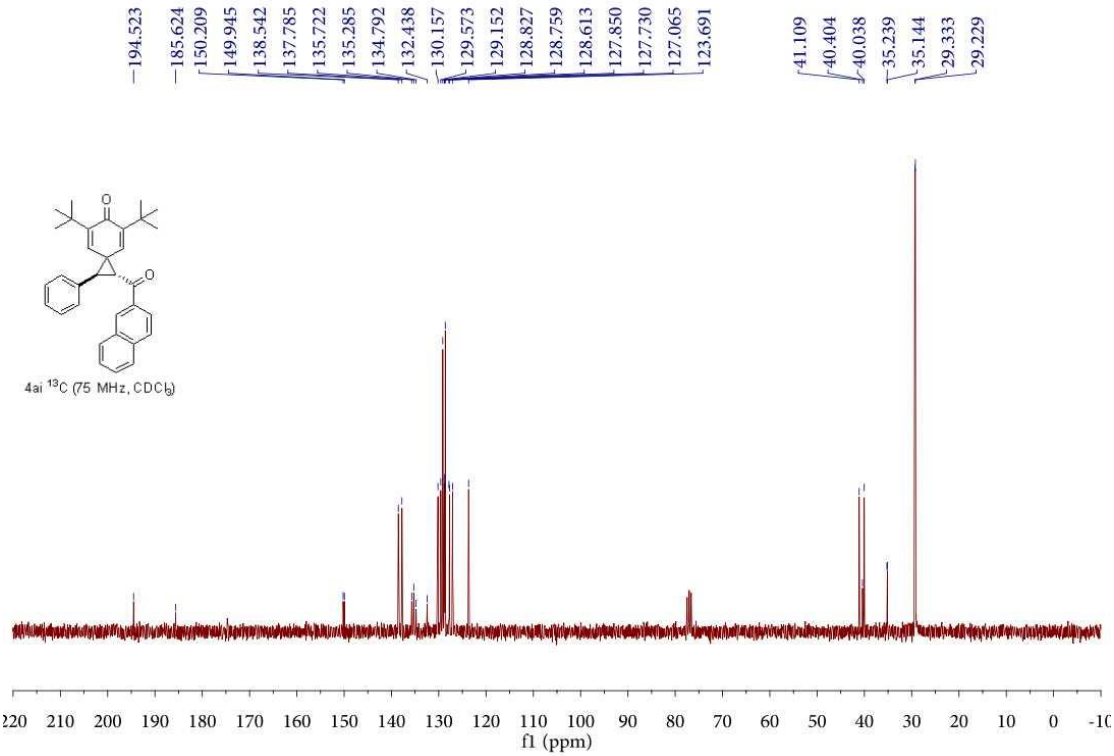

7.4484
7.4246
7.3981
7.3501
7.3229
7.2757
7.1410
7.1168
6.5895
6.0376
4.0935
4.0693
3.9381
3.9135
3.8152
1.1622
1.1304
-0.0000
4ag ^{1}H (300 MHz, CDCl$_3$)
8.36
1.11
1.00
1.03
1.04
1.11
3.12
8.88
9.18
f1 (ppm)

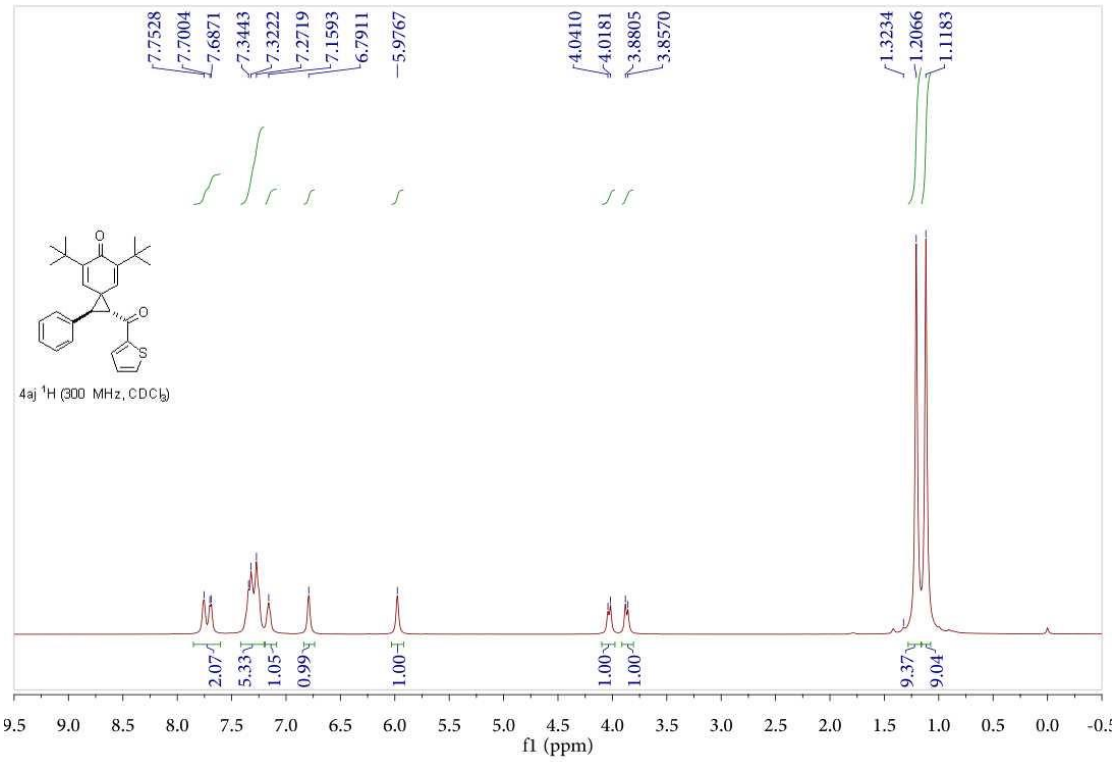

194.453
185.607
159.888
150.126
149.857
138.825
138.486
137.659
135.196
129.815
129.076
128.583
127.706
120.736
120.115
112.327
55.416
41.054
40.360
39.976
35.159
29.247
4ag ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)

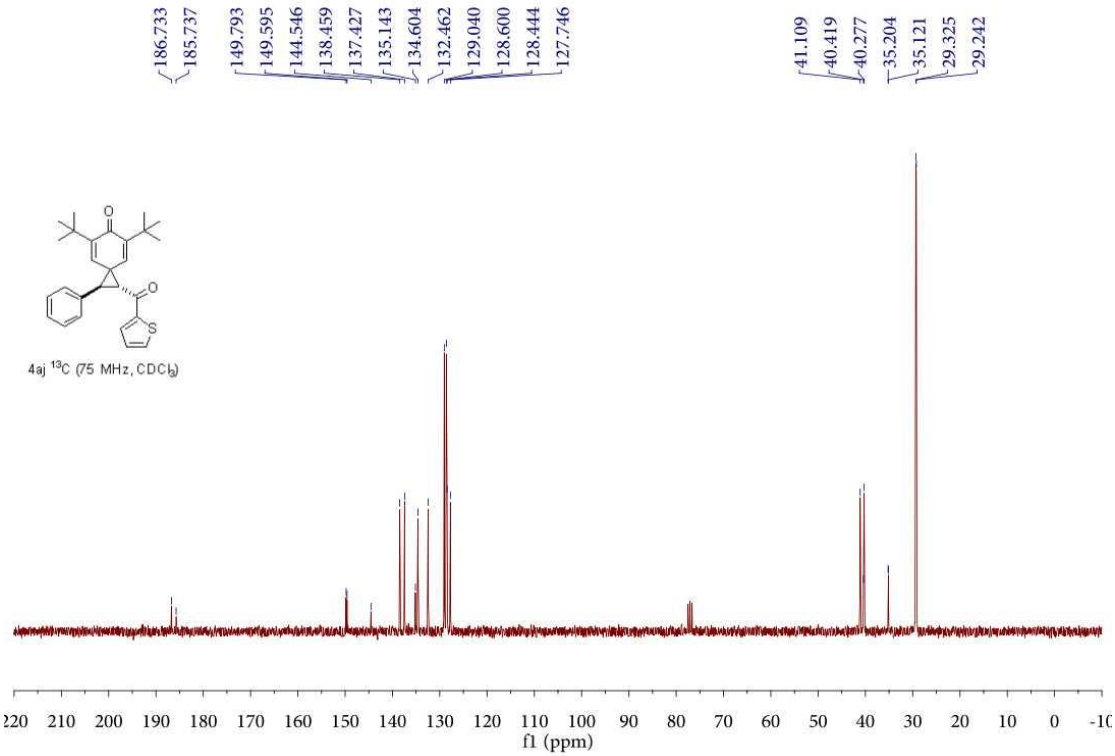

7.4340
7.4286
7.3801
7.3748
7.3410
7.3166
7.3056
7.3000
7.2831
7.2690
7.2429
6.8587
6.8315
6.5921
6.5834
6.0438
6.0213
6.0125
4.0744
4.0496
3.8903
3.8654
1.1675
1.1303
4ah 1H (300 MHz, CDCl3)
0.98
1.13
4.70
0.97
0.98
1.85
1.03
1.00
0.97
8.91
8.93
f1 (ppm)

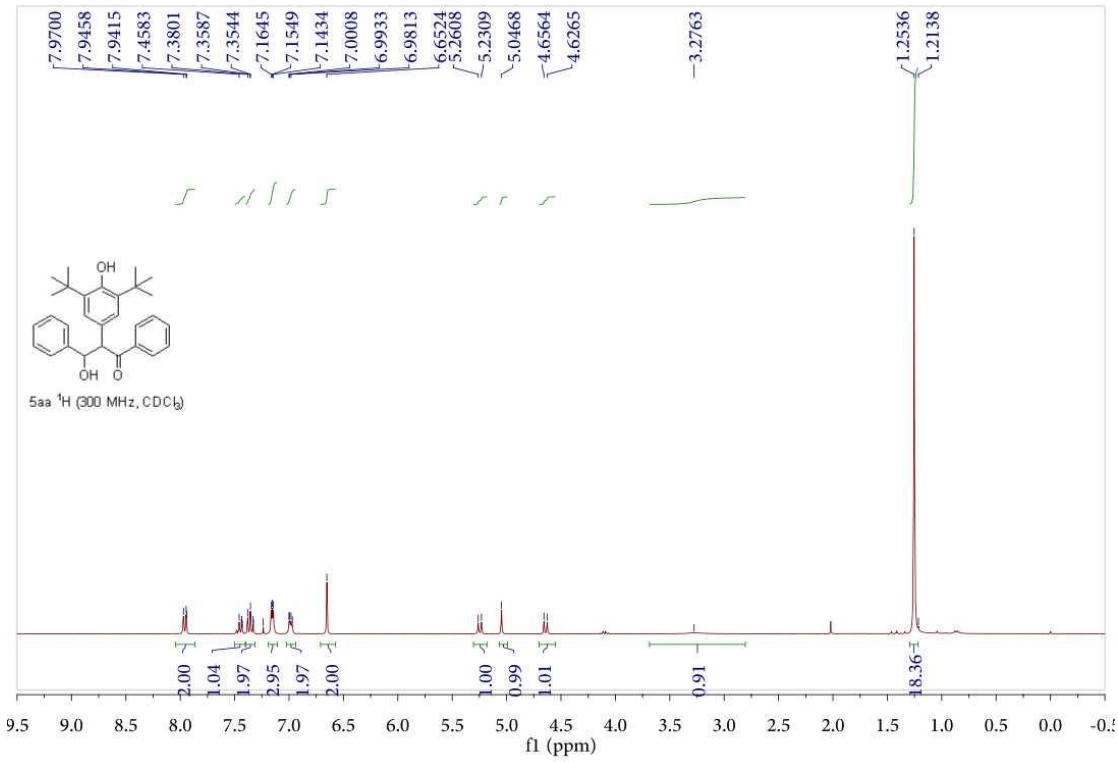

192.339
185.623
150.032
149.686
138.564
137.754
135.312
132.263
129.071
128.555
127.658
124.710
108.070
107.928
102.026
40.631
40.170
39.914
35.148
29.274
29.252
4ah 13C (75 MHz, CDCl3)
f1 (ppm)
f1 (ppm)

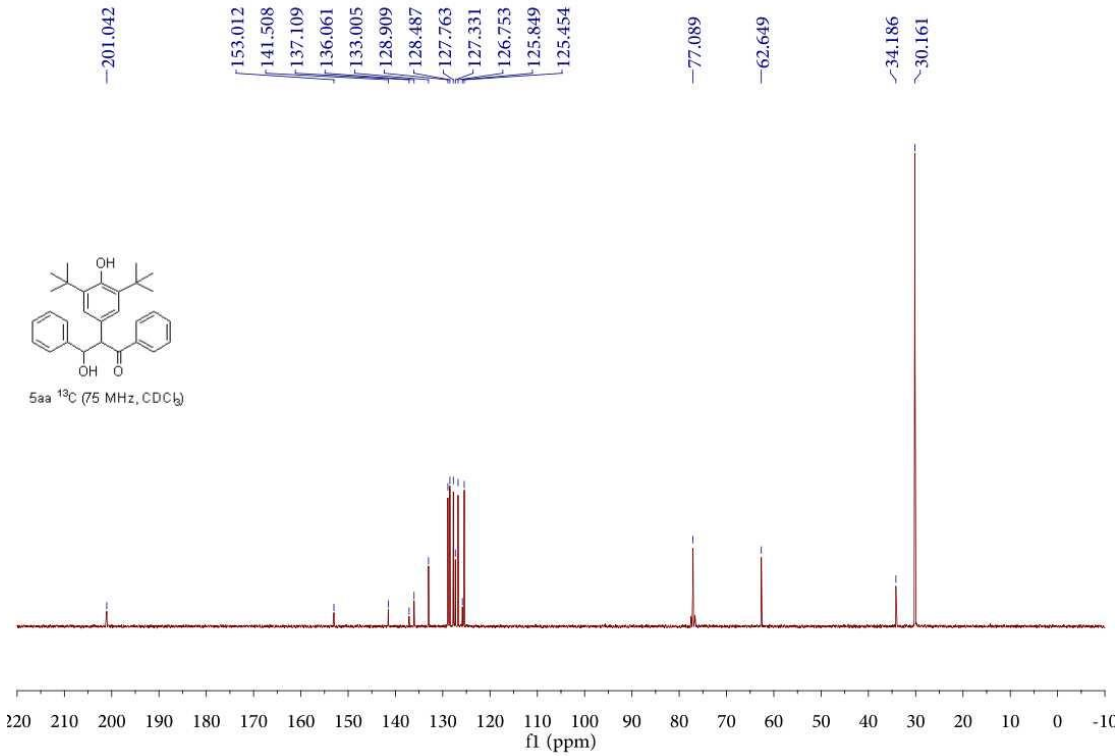

8.2915
7.9504
7.9467
7.9179
7.8865
7.8617
7.3590
7.3406
7.3188
6.6395
6.6314
6.1288
6.1208
4.1645
4.1396
4.0947
4.0698
1.1855
1.1166
4ai ^{1}H (300 MHz, CDCl$_3$)
1.05
4.12
2.12
4.93
1.00
0.98
1.00
1.01
9.19
9.22
f1 (ppm)

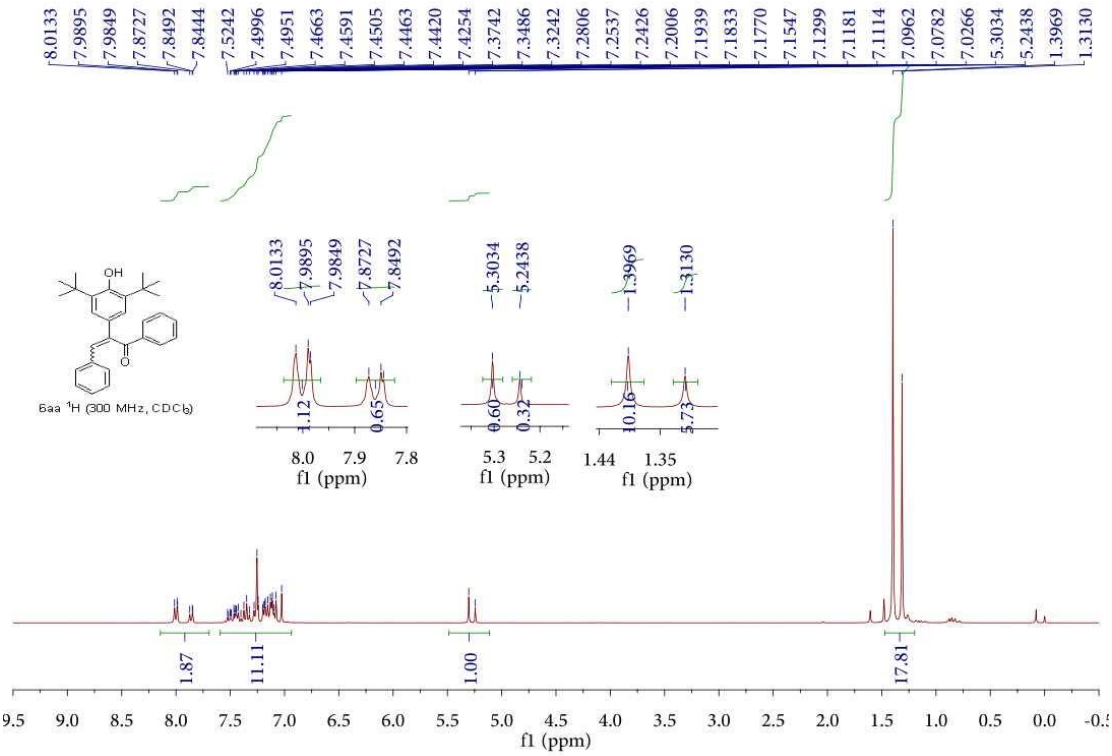

194.523
185.624
150.209
149.945
138.542
137.785
135.722
135.285
134.792
132.438
130.157
129.573
129.152
128.827
128.759
128.613
127.850
127.730
127.065
123.691
41.109
40.404
40.038
35.239
35.144
29.333
29.229
4ai ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)

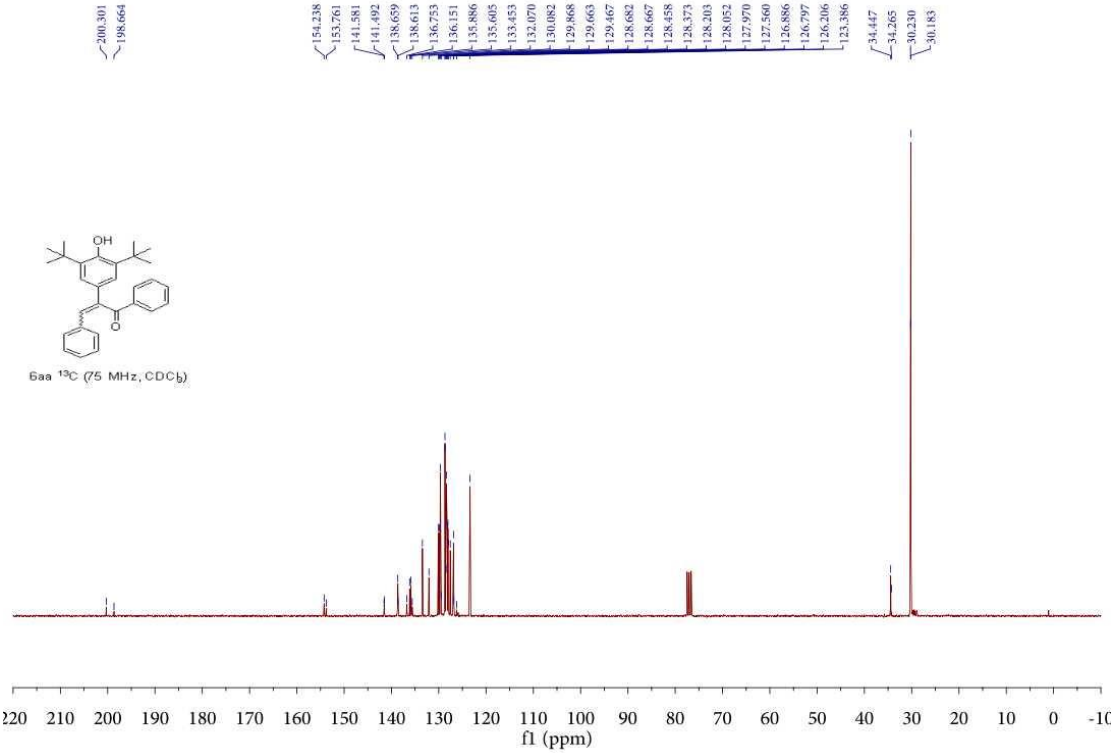

7.7528
7.7004
7.6871
7.3443
7.3222
7.2719
7.1593
6.7911
5.9767
4.0410
4.0181
3.8805
3.8570
1.3234
1.2066
1.1183
4aj ^{1}H (300 MHz, $CDCl_3$)
2.07
5.33
1.05
0.99
1.00
1.00
1.00
9.37
9.04
f1 (ppm)


186.733
185.737
149.793
149.595
144.546
138.459
137.427
135.143
134.604
132.462
129.040
128.600
128.444
127.746
41.109
40.419
40.277
35.204
35.121
29.325
29.242
4aj ^{13}C (75 MHz, $CDCl_3$)
f1 (ppm)


7.9700
7.9458
7.9415
7.4583
7.3801
7.3587
7.3544
7.1645
7.1549
7.1434
7.0008
6.9933
6.9813
6.6524
5.2608
5.2309
5.0468
4.6564
4.6265
3.2763
1.2536
1.2138
OH
OH
O
5aa ^{1}H (300 MHz, CDCl$_3$)
2.00
1.04
1.97
2.95
1.97
2.00
1.00
0.99
1.01
0.91
18.36
f1 (ppm)


201.042
153.012
141.508
137.109
136.061
133.005
128.909
128.487
127.763
127.331
126.753
125.849
125.454
77.089
62.649
34.186
30.161
OH
OH
O
5aa ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)


8.0133
7.9895
7.9849
7.8727
7.8492
7.8444
7.5242
7.4996
7.4951
7.4663
7.4591
7.4505
7.4463
7.4420
7.4254
7.3742
7.3486
7.3242
7.2806
7.2537
7.2426
7.2006
7.1939
7.1833
7.1770
7.1547
7.1299
7.1181
7.1114
7.0962
7.0782
7.0266
5.3034
5.2438
1.3969
1.3130
OH
O
6aa ^{1}H (300 MHz, CDCl$_3$)
1.12
0.65
0.60
0.32
10.16
5.73
8.0 7.9 7.8
f1 (ppm)
5.3 5.2
f1 (ppm)
1.44 1.35
f1 (ppm)
1.87
11.11
1.00
17.81
f1 (ppm)


200.301
198.664
154.238
153.761
141.581
141.492
138.659
138.613
136.733
136.151
135.886
135.685
133.453
132.070
130.082
129.868
129.663
129.467
128.682
128.667
128.458
128.373
128.203
128.052
127.970
127.560
126.886
126.797
126.206
123.386
34.447
34.265
30.230
30.183
OH
O
6aa ^{13}C (75 MHz, CDCl$_3$)
f1 (ppm)