Rapid Access to Cyclopentadienes Derivatives through Gold-Catalyzed Cycloisomerization of Ynamides with Cyclopropenes by Preferential Activation of Alkene over Alkyne

Xing Cheng,[a,b] Lei Zhu,[a] Meijun Lin, [a,b] Jianxin Chen,[b] and Xueliang Huang*[a]

[a]Key Laboratory of Coal to Ethylene Glycol and Its Related Technology, Fujian Institute of Research on the Structure of Matter, Chinese Academy of Sciences, Fuzhou, Fujian 350002, China

[b]College of Chemistry and Chemical Engineering Fujian Normal University, Fuzhou, Fujian 350007, China

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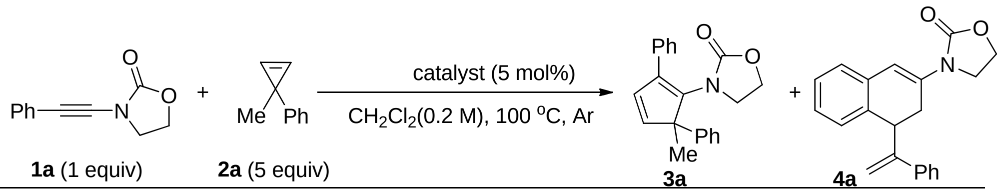
1. General information Section

Unless otherwise noted, all reactions were carried out with standard Schlenk techniques under argon. And all reagents were purchased from commercial suppliers without further purification. All solvents were distilled from appropriate drying agents prior to use. Reaction progress was monitored by thin layer chromatography (TLC) and components were visualized by observation under UV light at 254nm. Flash column chromatography was performed using silica gel 60 (200-300 mesh).

All ^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra were given on Bruker AV-III 400 in $CDCl_3$. Chemical shifts were reported in parts per million (ppm, δ), referenced to the peak of tetramethylsilane, defined at δ = 0.00 (^{1}H NMR), or the solvent peak of $CDCl_3$, defined at δ = 77.0 (^{13}C NMR); Data are reported as follows: chemical shift, multiplicity ((s = single, d = doublet, t = triplet, q = quartet, br = broad, m = multiplet), coupling constants were quoted in Hz (*J*). Splitting patterns that could not be interpreted or easily visualized were designated as multiplet (m) or broad (br). Pressed KBr disks for infrared spectra were recorded using a Bruker-VERTEX 70 FT-IR spectrometer. Wavelengths (ν) are reported in cm^{-1}. Melting points were recorded using a SGW Melting Point thermometer (X-4). High-resolution mass spectra were obtained using a Thermo Fisher Scientific LTQ FT Ultra.

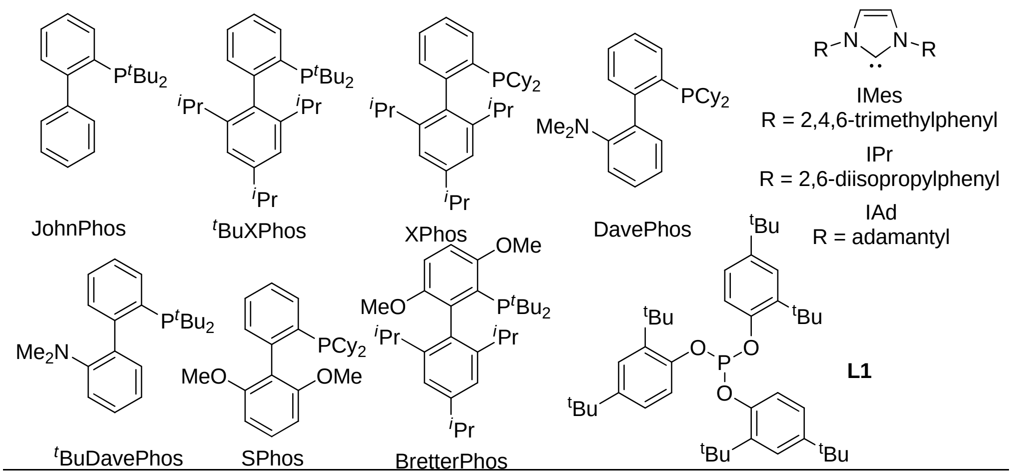
2. Representative Optimization Studies

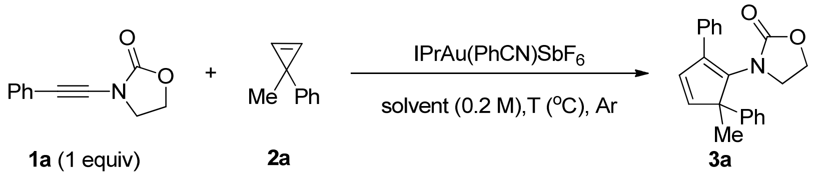
Table S1. Optimization of the reaction conditions



entry	catalyst	time (h)	yield of **3a** (%)[b]	yield of **4a** (%)[b]
1	$(4\text{-}CF_3C_6H_5)_3PAuNTf_2$	3	62	--
2	$^tBuXPhosAuNTf_2$	48	10	41
3	$^tBuDavePhosAuCl+AgNTf_2$	33	18	29
4	$IMeSAuCl+AgNTf_2$	2	82	--
5	$JohnPhosAuCl+AgNTf_2$	52	22	25
6	**L1**$AuNTf_2$	4	68[c]	--
7	$IPrAuNTf_2$	40	23[c]	--
8	PPh_3AuNTf_2	2	70[c]	--
9	$JohnPhosAu(MeCN)SbF_6$	1	47	25
10	$PPh_3Au(MeCN)SbF_6$	8	72	--
11	$^tBuXPhosAu(MeCN)SbF_6$	4	trace	35
12	$DavePhosAu(MeCN)SbF_6$	24	34	13
13	$BretterPhosAu(MeCN)SbF_6$	24	24	12
14	$XPhosAu(MeCN)SbF_6$	48	19	8
15	$SPhosAu(MeCN)SbF_6$	9	52	trace
16	$^tBuDavePhosAu(MeCN)SbF_6$	9	30	26
17	$IAdAu(PhCN)SbF_6$	22	61	--
18	$IPrAu(PhCN)SbF_6$	2.5	97	--
19	$IPrAuCl+AgBF_4$	22	47	--
20	IPrAuCl	50	NR	
21	$AgNTf_2$	21	complex	
22	$AgSbF_6$	60	complex	

[a]Conditions: ynamide **1a** (0.2 mmol, 1 equiv), cyclopropane **2a** (1 mmol, 5 equiv).
[b] Yield of the isolated product. [c] CH_3CN replaced CH_2Cl_2 as solvent.



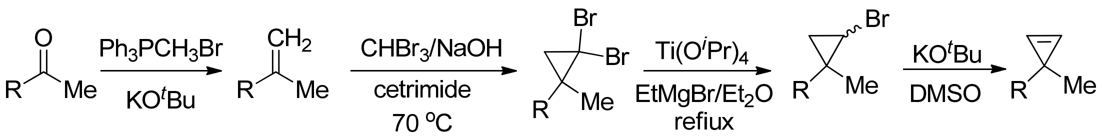


entry	2a (n equiv)	Au (x mol%)	T (°C)	solvent	time (h)	yield of 3a (%)[b]	recovered 1a (%)[b]
1	5	5	25	CH_2Cl_2	16	15	84
2	5	5	40	CH_2Cl_2	16	32	68
3	5	5	60	CH_2Cl_2	16	37	58
4	5	5	80	CH_2Cl_2	16	70	25
5	5	5	100	CH_2Cl_2	2.5	92 (97[c])	
6	2	5	100	CH_2Cl_2	1.5	74	20
7	3	5	100	CH_2Cl_2	2	90	
8	5	1	100	CH_2Cl_2	3	23	75
9	5	3	100	CH_2Cl_2	3	92	
10	5	5	100	DCE	1	95[c]	
11	5	5	25	DCE	22	26	78
12	5	5	40	DCE	5	33	64
13	5	5	60	DCE	5	64	26
14	5	5	80	DCE	1.5	92[c]	
15	5	3	100	DCE	1	90	
16	5	5	100	PhMe	27	63	25
17	5	5	100	$CHCl_3$	1	84	
18	5	5	100	trifluorotoluene	1.5	97	
19	5	5	100	CH_3NO_2	1	98	
20	5	5	100	MeCN	1	98(98[c])	
21	3	5	100	DCE	1.5	86	8
22	3	5	100	trifluorotoluene	3	80	11
23	3	5	100	CH_3NO_2	2	64	32
24	3	5	100	$CHCl_3$	2	87	10
25	3	5	100	MeCN	2	95	3
26	3	5	80	MeCN	5	95	5

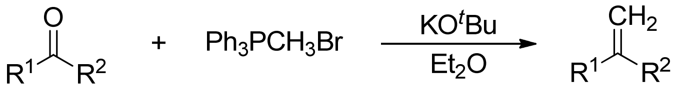
[a] Conditions: ynamide 1a (0.2 mmol, 1 equiv). [b] Yield determined by 1 H NMR of the crude product using PhCHO as the internal standard. [c] Yield of the isolated product.

General procedure: Ynamide **1a** (0.20 mmol, 1.0 equiv), catalyst (x mol%) and solvent (0.7 mL) were added to an oven-dried 10 mL pressure tube equipped with a stirrer bar under argon. Cyclopropene **2a** (n equiv) in 0.3 mL of solvent was added in dropwise and the resulting mixture stirred at indicated temperature. After completion of the reaction as indicated by TLC, removing the solvent under reduced pressure. The residual was purified by column chromatography (petroleum ether/ethyl acetate) on silica gel to give cyclopentadienes.

3. Procedures for the Preparation of Cyclopropenes

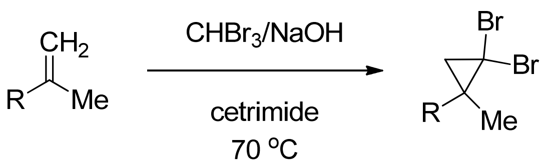


Preparations of 1,1-disubstituted alkenes



Under an atmosphere of argon, potassium *tert*-butoxide (36 mmol, 1.2 eq) was added to a stirred mixture of methyltriphenylphosphonium bromide (36 mmol, 1.2 eq, pre-dried in a vacuum oven for 5 hr) in anhydrous Et_2O. The resulting canary yellow mixture was allowed to stir for 1 h, after which a solution of the ketone (30 mmol, 1 eq) in anhydrous Et_2O was added dropwise. The reaction was monitored by TLC for complete consumption of the starting material. The crude mixture was then passed through a pad of celite and washed with Et_2O. All volatiles were removed under reduced pressure. The crude reaction mixture was then diluted with hexanes, and passed through a pad of silica gel by eluting with hexanes. The combined hexanes eluent was collected and concentrated under reduced pressure. The alkene product was isolated by flash column chromatography with hexanes as the eluent.

Preparation of 2,2-dibromocyclopropanes



According to a modified procedure of Rubin.[1] To a vigorously stirred mixture of α-methylstyrene (27.3 mL, 0.21 mol), bromoform (40.5 mL) and cetrimide (1 g), 50% aqueous solution of NaOH (45 mL) was added dropwise. A cooling bath was used occasionally to keep the temperature of the reaction mixture in the interval of 35-40

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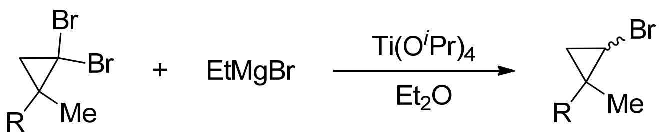
[1] Sherrill, W. M.; Kim, R.; Rubin, M. *Tetrahedron,* **2008**, *64*, 8610.

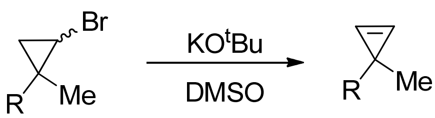
°C. The reaction mixture was vigorously stirred for 30 hrs, then water was added. The organic phase was separated and the aqueous phase was extracted with chloroform. Combined organic phases were washed (water, 2% HCl, brine), dried ($CaCl_2$), filtered, and concentrated under reduced pressure. Flash column chromatography of the resulting residue on silica gel (eluent – hexanes) gave the dibromocyclopropane products.

Synthesis of bromocyclopropanes



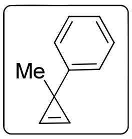
Bromocyclopropanes (0.1 mol) were prepared by partial reduction of the corresponding dibromocyclopropanes with EtMgBr (0.13 mol, 1.3 eq) in the presence of $Ti(O^iPr)_4$ (10 mmol, 0.1 eq) according to the reported protocol.[1] Ethylmagnesium bromide was added dropwise to a cooled (0 °C ice bath) stirring solution of the dibromocyclopropane and $Ti(O^iPr)_4$ in Et_2O under argon. The mixture turned dark orange instantly with generation of heat (fast addition of the Grignard reagent should be avoided to prevent evaporation of solvent). The reaction mixture was stirred at rt for 4 h, then quenched with 10% aq. HCl. The organic phase was separated and the aqueous layer was extracted twice with Et_2O. The combined ethereal layers were washed consecutively with sat. $NaHCO_3$ and brine, then dried with Na_2SO_4, filtered and concentrated under reduced pressure. The product was purified by flash column chromatography on silica gel (eluent – petroleum ether) to afford the bromocyclopropane as a mixture of diastereomers.

Synthesis of cyclopropenes



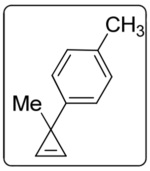
Cyclopropenes were prepared according to the literature protocol.[1] A solution of bromocyclopropane (76.3 mmol) in DMSO was added to a stirring solution of potassium *t*-butoxide (92 mmol, 1.2 eq) in DMSO. The mixture turned dark brown instantly and was stirred at rt overnight. It was then quenched with H_2O and extracted with ether. The ethereal layers were combined, washed with brine, dried with Na_2SO_4, filtered, and concentrated *in vacuo*. Flash column chromatography of the residue on silica gel (eluent – petroleum ether) afforded the cyclopropene products.

(1-methylcycloprop-2-en-1-yl)benzene 2a[1]



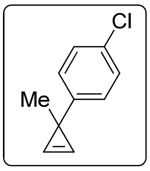
^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.28 (t, *J* = 7.6 Hz, 2H), 7.24 (s, 2H), 7.21 (d, *J* = 7.6 Hz, 2H), 7.14 (t, *J* = 7.2 Hz, 1H), 1.62 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.9, 127.8, 126.0, 125.0, 115.5, 25.4, 21.8.

1-methyl-4-(1-methylcycloprop-2-en-1-yl)benzene 2q[1]



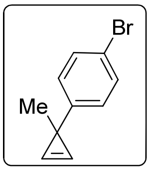
^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.23 (s, 2H), 7.09 (s, 4H), 2.30 (s, 3H), 1.60 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.9, 134.4, 128.5, 125.9, 115.7, 25.5, 21.5, 20.8.

1-chloro-4-(1-methylcycloprop-2-en-1-yl)benzene 2r[1]



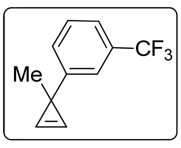
^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.23-7.21 (m, 4H), 7.10 (d, *J* = 8.8 Hz, 2H), 1.59 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.5, 130.7, 127.8, 127.4, 115.4, 25.3, 21.5.

1-bromo-4-(1-methylcycloprop-2-en-1-yl)benzene 2s[2]



^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.36 (d, *J* = 8.4 Hz, 2H), 7.21 (s, 2H), 7.05 (d, *J* = 8.4 Hz, 2H), 1.58 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.0, 130.7, 127.8, 118.8, 115.3, 25.2, 21.5.

1-(1-methylcycloprop-2-en-1-yl)-3-(trifluoromethyl)benzene 2t[3]

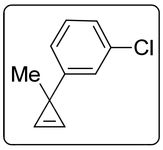


^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.43-7.37 (m, 4H), 7.25 (s, 2H), 1.63 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.0, 130.2 (q, $J_{C\text{-}F}$ =

[2] Phan, D. T.; Dong, V. M. *Tetrahedron* , **2013,** 69, 5726.
[3] Phan, D. H.; Kou, K. G.; Dong, V. M. *J. Am. Chem. Soc.*, **2010**, 132, 16354.

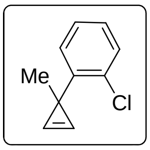
31.4 Hz), 129.4 (d, J_{C-F}= 1.2 Hz), 128.2, 124.5 (q, J_{C-F} = 270.4 Hz), 122.7 (q, J_{C-F} = 3.8 Hz), 121.7 (q, J_{C-F} = 3.8 Hz), 115.1, 25.1, 21.8; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.5.

1-chloro-3-(1-methylcycloprop-2-en-1-yl)benzene 2u[4]



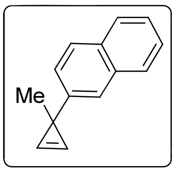
^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.20 (s, 2H), 7.17 (d, *J* = 7.6 Hz, 2H), 7.11-7.09 (m, 1H), 7.08-7.06 (m,1H), 1.59 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.3, 133.9, 129.0, 126.3, 125.0, 124.2, 115.1, 25.1, 21.6.

1-chloro-2-(1-methylcycloprop-2-en-1-yl)benzene 2v[1]



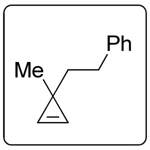
^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.61 (s, 2H), 7.26 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.21 (dd, *J* = 7.6, 2.0 Hz, 1H), 7.13 (td, *J* = 7.2, 1.2 Hz, 1H), 7.05 (td, *J* = 7.6, 1.6 Hz, 1H), 1.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.6, 133.6, 129.6, 129.3, 127.2, 127.1, 120.6, 27.3, 23.7.

2-(1-methylcycloprop-2-en-1-yl)naphthalene 2w[3]



^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.78 (d, *J* = 8.0 Hz, 2H), 7.74(d, *J* = 8.4 Hz, 1H), 7.68 (s, 1H), 7.45-7.37 (m, 2H), 7.33-7.29 (m, 3H), 1.73 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.3, 133.3, 131.4, 127.5, 127.4, 127.2, 125.8, 124.9, 124.7, 124.5, 115.7, 25.6, 22.1.

(2-(1-methylcycloprop-2-en-1-yl)ethyl)benzene 2x[5]



^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.30 (*J* =0.4 Hz, 2H), 7.26 -7.22 (m, 2H), 7.15-7.12 (m, 3H), 2.45-2.41 (m, 2H), 1.81-1.77 (m, 2H), 1.18 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.0, 128.4, 128.1, 125.4, 121.8, 41.9, 33.5, 27.1, 20.0.

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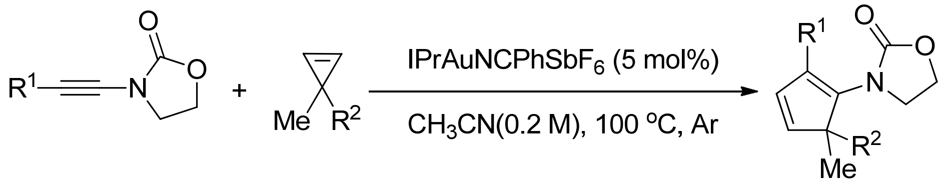
[4] Li, Z.; Peng, G.; Zhao, J.; Zhang, Q. *Org. Lett.* **2016**, *18*, 4840.

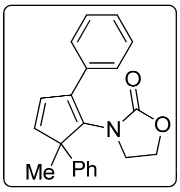
[5] Young, P. C.; Hadfield, M. S.; Arrowsmith, L.; Macleod, K. M.; Mudd, R. J.; Jordan-Hore, J. A.; Lee, A.-L. *Org. Lett.*, **2012**, 14, 898.

4. Procedure and Spectral Data of Products



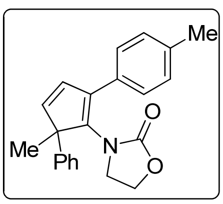
General procedure: Ynamide **1** (0.20 mmol, 1.0 eq), $IPrAuNCPhSbF_6$ (5 mol%) and CH_3CN (0.7 mL) were added to an oven-dried 10 mL pressure tube equipped with a stirrer bar under argon. The cyclopropene **2** (1 mmol, 5 eq) in 0.3 mL of CH_3CN was added in dropwise and the resulting mixture stirred at 100 °C. After completion of the reaction as indicated by TLC, removing the solvent under reduced pressure, the residual was purified by column chromatography (petroleum ether /ethyl acetate) on silica gel to give cyclopentadiene **3**.

3-(5-methyl-2,5-diphenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3a



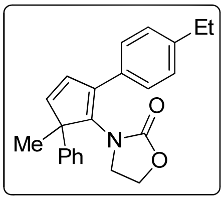
Compound **3a** was obtained as a pale yellow solid in 98% (62 mg) isolated yield, R_f = 0.34 (petroleum ether : ethyl acetate = 5 : 1); mp = 154-157 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.48-7.46 (m, 2H), 7.40-7.36 (m, 2H), 7.32-7.26 (m, 5H), 7.24-7.20 (m, 1H), 6.67 (d, *J* = 5.6 Hz, 1H), 6.52 (d, *J* = 5.6 Hz, 1H), 4.13-4.01 (m, 2H), 3.15-3.08 (m, 1H), 2.75-2.69 (m, 1H), 1.76 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 146.0, 143.5, 139.0, 137.6, 134.0, 130.3, 128.64, 128.60, 127.9, 127.05, 126.98, 125.8, 62.4, 60.6, 46.0, 18.3; IR (KBr) 1755, 1492, 1407, 1215, 1115, 748, 701 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{21}H_{20}NO_2$, 318.1494; found 318.1488.

3-(5-methyl-5-phenyl-2-(p-tolyl)cyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3b



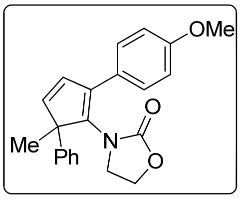
Compound **3b** was obtained as a white solid in 97% (64 mg) isolated yield, R_f = 0.33 (petroleum ether : ethyl acetate = 5 : 1); mp = 42-45 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.36 (d, *J* = 8.0 Hz, 2H), 7.32-7.22 (m, 5H), 7.19 (d, *J* = 8.0 Hz, 2H), 6.66 (d, *J* = 5.6 Hz, 1H), 6.51 (d, *J* = 5.6 Hz, 1H), 4.15-4.02 (m, 2H), 3.17-3.10 (m, 1H), 2.73-2.67 (m, 1H), 2.35 (s, 3H), 1.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.4, 145.9, 142.9, 139.2, 137.8, 137.6, 131.1, 130.4, 129.4, 128.6, 127.0, 125.8, 62.4, 60.6, 46.0, 21.2, 18.4; IR (KBr) 1757, 1407, 1214, 1117, 1037, 823, 763, 703 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{22}H_{22}NO_2$, 332.1651; found 332.1644.

3-(2-(4-ethylphenyl)-5-methyl-5-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3c



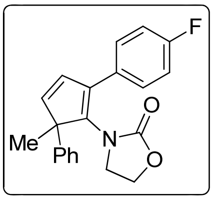
Compound **3c** was obtained as a white solid in 99% (68.5 mg) isolated yield, R_f = 0.39 (petroleum ether : ethyl acetate = 5 : 1); mp = 79-80 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.39 (d, *J* = 8.0 Hz, 2H), 7.31-7.25 (m, 4H), 7.22 (d, *J* = 8.0 Hz, 3H), 6.67 (d, *J* = 5.6 Hz, 1H), 6.50 (d, *J* = 5.6 Hz, 1H), 4.15-4.01 (m, 2H), 3.17-3.11 (m, 1H), 2.73-2.62 (m, 3H), 1.75 (s, 3H), 1.24 (t, *J* = 7.6 Hz, 3H) ; ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.4, 145.9, 144.1, 142.9, 139.2, 137.5, 131.3, 130.4, 128.6, 128.2, 127.0, 126.9, 125.8, 62.4, 60.6, 46.0, 28.5, 18.4, 15.3; IR (KBr) 2968, 1762, 1407, 1214, 1109, 1037, 838, 765, 703 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{23}H_{24}NO_2$, 346.1807; found 346.1801.

3-(2-(4-methoxyphenyl)-5-methyl-5-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3d



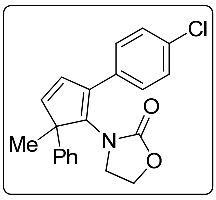
Compound **3d** was obtained as a pale yellow solid in 99% (69 mg) isolated yield, R_f= 0.19 (petroleum ether : ethyl acetate = 5 : 1); mp = 117-119 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.41 (d, *J* = 8.8 Hz, 2H), 7.31-7.20 (m, 5H), 6.92 (d, *J* = 8.8 Hz, 2H), 6.66 (d, *J* = 5.6 Hz, 1H), 6.50 (d, *J* = 5.6 Hz, 1H), 4.15-4.02 (m, 2H), 3.81 (s, 3H), 3.14 (dd, *J* = 9.2, 16.4 Hz, 1H), 2.69 (dd, *J* = 9.2, 15.6 Hz, 1H), 1.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.2, 156.4, 145.9, 142.1, 139.3, 137.1, 130.3, 128.6, 128.4, 126.9, 126.4, 125.8, 114.1, 62.4, 60.5, 55.1, 45.9, 18.4; IR (KBr) 2836, 1755, 1607, 1512, 1407, 1118, 1029, 836, 765, 703 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{22}H_{22}NO_3$, 348.1600; found 348.1593.

3-(2-(4-fluorophenyl)-5-methyl-5-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3e



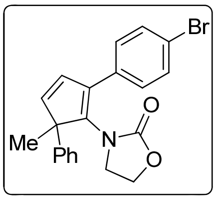
Compound **3e** was obtained as a white solid in 95% (63.7 mg) isolated yield, R_f = 0.29 (petroleum ether : ethyl acetate = 5 : 1); mp = 141-142 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.45 (dd, *J* = 5.6, 8.8 Hz, 2H), 7.30-7.22 (m, 5H), 7.07 (t, *J* = 8.8 Hz, 2H), 6.63 (d, *J* = 6.0 Hz, 1H), 6.52 (d, *J* = 6.0 Hz, 1H), 4.16-4.05 (m, 2H), 3.14-3.08 (m, 1H), 2.80-2.74 (m, 1H), 1.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.2 (d, $J_{C\text{-}F}$ = 246.4 Hz), 156.2, 146.2, 143.3, 138.9, 136.7, 130.19 (d, $J_{C\text{-}F}$ = 3.4 Hz), 130.1, 128.88 (d, $J_{C\text{-}F}$ = 8.0 Hz), 128.7, 127.1, 125.8, 115.7 (d, $J_{C\text{-}F}$ = 21.3 Hz), 62.4, 60.5, 46.0, 18.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ -113.1; IR (KBr) 1756, 1602, 1510, 1407, 1115, 841, 765, 703, 526 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{21}H_{19}FNO_2$, 336.1400; found 336.1393.

3-(2-(4-chlorophenyl)-5-methyl-5-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3f



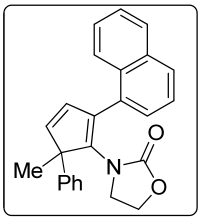
Compound **3f** was obtained as a pale yellow solid in 99% (69.6 mg) isolated yield, R_f = 0.36 (petroleum ether : ethyl acetate = 5 : 1); mp = 119-121ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.40 (d, *J* = 8.4 Hz, 2H), 7.34 (d, *J* = 8.4 Hz, 2H), 7.29-7.22 (m, 5H), 6.62 (d, *J* = 5.6 Hz, 1H), 6.51 (d, *J* = 5.6 Hz, 1H), 4.16-4.04 (m, 2H), 3.14-3.08 (m 1H), 2.82-2.76 (m, 1H), 1.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.1, 146.3, 143.9, 138.8, 136.6, 133.7, 132.6, 129.9, 128.9, 128.7, 128.5, 127.1, 125.8, 62.4, 60.6, 46.0, 18.3; IR (KBr) 1756, 1492, 1406, 1212, 1118, 834, 764, 702 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{21}H_{19}ClNO_2$, 352.1104; found 352.1098.

3-(2-(4-bromophenyl)-5-methyl-5-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3g



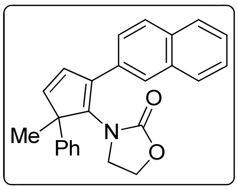
Compound **3g** was obtained as a pale yellow solid in 93% (73.6 mg) isolated yield, R_f = 0.35 (petroleum ether : ethyl acetate = 5 : 1); mp = 97-99ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.50 (d, *J* = 8.4 Hz, 2H), 7.33 (d, *J* = 8.4 Hz, 2H), 7.29-7.22 (m, 5H), 6.62 (d, *J* = 5.6 Hz, 1H), 6.52 (d, *J* = 5.6 Hz, 1H), 4.16-4.05 (m, 2H), 3.11 (dd, *J* = 8.8, 16.4 Hz, 1H), 2.82-2.76 (m, 1H), 1.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.1, 146.3, 143.9, 138.7, 136.5, 133.0, 131.8, 129.8, 128.7, 127.1, 125.7, 121.9, 62.4, 60.6, 46.0, 18.2; IR (KBr) 1754, 1488, 1406, 1213, 1117, 830, 761, 702 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{21}H_{19}BrNO_2$, 396.0599; found 396.0589.

3-(5-methyl-2-(naphthalen-1-yl)-5-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3h



Compound **3h** was obtained as a white solid in 93% (68 mg) isolated yield, R_f = 0.31 (petroleum ether : ethyl acetate = 5 : 1); mp = 69-71ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.96 (d, *J* = 7.6 Hz, 1H), 7.88-7.86 (m, 1H), 7.82 (d, *J* = 8.4 Hz, 1H), 7.54-7.43 (m, 6H), 7.34 (t, *J* = 7.2 Hz, 2H), 7.25 (t, *J* = 7.2 Hz, 1H), 6.62 (d, *J* = 5.6 Hz, 1H), 6.58 (d, *J* = 5.6 Hz, 1H), 3.89-3.74 (m, 2H), 2.88-2.68 (m, 2H), 1.88 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.4, 145.5, 139.3, 133.7, 132.2, 130.9, 128.7, 128.6, 128.4, 127.0, 126.2, 125.9, 125.6, 125.2, 62.3, 60.5, 46.5, 18.9; IR (KBr) 1756, 1412, 1215, 1106, 979, 805, 780, 703 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{25}H_{22}NO_2$, 368.1651; found 368.1644.

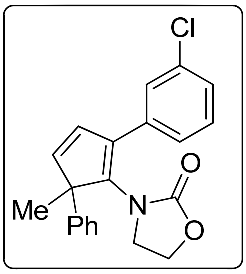
3-(5-methyl-2-(naphthalen-2-yl)-5-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3i



Compound **3i** was obtained as a pale yellow solid in 95% (70 mg) isolated yield, R_f = 0.29 (petroleum ether : ethyl acetate = 5 : 1); mp = 58-60ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.94 (s, 1H), 7.85-7.80 (m, 3H), 7.57 (dd, *J* = 1.6, 8.4 Hz, 1H), 7.48-7.44 (m, 2H), 7.35-7.21 (m, 5H), 6.78 (d, *J* = 6.0 Hz, 1H), 6.56 (d, *J* = 6.0 Hz, 1H), 4.12-4.00 (m, 2H), 3.16-3.09 (m, 1H), 2.75-2.69 (m, 1H), 1.80 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.4, 146.1, 143.9, 139.1, 137.7, 133.3, 132.8, 131.5, 130.4, 128.7, 128.4, 128.1, 127.6, 127.0, 126.4, 126.3, 126.2, 125.9, 124.8, 62.5, 60.8, 46.1, 18.5; IR (KBr) 1757, 1596, 1407, 1214, 1109, 1037, 861, 763, 705, 477 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for

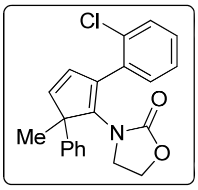
$C_{25}H_{22}NO_2$, 368.1651; found 368.1645.

3-(2-(3-chlorophenyl)-5-methyl-5-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3j



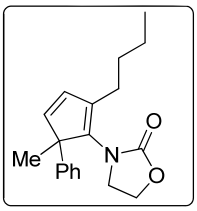
Compound **3j** was obtained as a white solid in 85% (59.7 mg) isolated yield, R_f = 0.30 (petroleum ether : ethyl acetate = 5 : 1); mp = 155-157ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.44 (s, 1H), 7.36-7.22 (m, 8H), 6.62 (d, *J* = 5.6 Hz, 1H), 6.52 (d, *J* = 5.6 Hz, 1H), 4.18-4.06 (m, 2H), 3.16-3.10 (m, 1H), 2.86-2.80 (m, 1H), 1.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.0, 146.3, 144.4, 138.6, 136.3, 136.0, 134.5, 130.0, 129.8, 128.8, 128.0, 127.2, 125.8, 125.3, 62.5, 60.6, 46.1, 18.2; IR (KBr) 1758, 1594, 1562, 1405, 1211, 1119, 1038, 761, 705 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{21}H_{19}ClNO_2$, 352.1104; found 352.1099.

3-(2-(2-chlorophenyl)-5-methyl-5-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3k



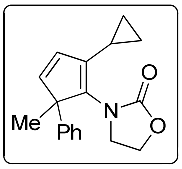
Compound **3k** was obtained as a white solid in 84% (59.2 mg) isolated yield, R_f = 0.27 (petroleum ether : ethyl acetate = 5 : 1); mp = 118-119ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.45-7.40 (m, 2H), 7.37 (d, *J* = 7.2 Hz, 2H), 7.32-7.21 (m, 5H), 6.49 (d, *J* = 5.6 Hz, 1H), 6.43 (d, *J* = 5.6 Hz, 1H), 4.04-4.00 (m, 2H), 3.11-3.04 (m, 1H), 2.96-2.90 (m, 1H), 1.76 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.7, 145.8, 144.9, 138.6, 135.2, 133.9, 132.2, 131.1, 130.5, 129.5, 129.0, 128.7, 127.0, 126.97, 125.8, 62.4, 59.7, 45.7, 18.1; IR (KBr) 1758, 1407, 1214, 1116, 752, 703 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{21}H_{19}ClNO_2$, 352.1104; found 352.1098.

3-(2-butyl-5-methyl-5-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3l



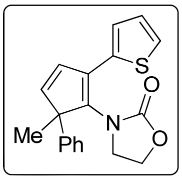
Compound **3l** was obtained as a white solid in 94% (55.7 mg) isolated yield, R_f = 0.41 (petroleum ether : ethyl acetate = 5 : 1); mp = 43-44ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.28-7.24 (m, 2H), 7.21-7.17 (m, 3H), 6.34-6.32 (m, 2H), 4.23-4.12 (m, 2H), 3.13-3.07 (m, 1H), 3.00-2.94 (m, 1H), 2.25 (t, *J* = 7.2 Hz, 2H), 1.60-1.49 (m, 5H), 1.43-1.32 (m, 2H), 0.94 (t, J =7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.2, 145.6, 142.9, 139.3, 139.1, 130.1, 128.5, 126.7, 125.6, 62.2, 58.5, 46.4, 30.0, 26.8, 22.6, 18.0, 13.9; IR (KBr) 1760, 1640, 1408, 1301, 1217, 1113, 757, 702 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{19}H_{24}NO_2$, 298.1807; found 298.1802.

3-(2-cyclopropyl-5-methyl-5-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3m



Compound **3m** was obtained as a white solid in 70% (39 mg) isolated yield, R_f = 0.24 (petroleum ether : ethyl acetate = 5 : 1); mp = 87-89ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.28-7.24 (m, 2H), 7.21-7.18 (m, 3H), 6.31 (d, J = 5.6 Hz, 1H), 6.96 (d, J = 5.6 Hz, 1H), 4.25-4.14 (m, 2H), 3.25-3.19 (m, 1H), 3.02-2.96 (m, 1H), 1.62-1.57 (m, 4H), 0.97-0.83 (m, 2H), 0.75-0.64 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 145.90, 142.5, 140.2, 139.4, 128.5, 126.7, 126.3, 125.7, 62.3, 58.9, 46.4, 18.1, 8.7, 6.1, 6.0; IR (KBr) 1758, 1412, 1215, 1112, 757, 703 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{18}H_{20}NO_2$, 282.1494; found 282.1487.

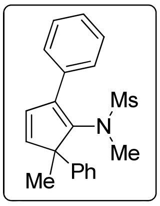
3-(5-methyl-5-phenyl-2-(thiophen-2-yl)cyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3n



Compound **3n** was obtained as a yellow solid in 48% (26.3 mg) isolated yield, R_f = 0.24 (petroleum ether : ethyl acetate = 5 : 1); ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.33 (d, J = 5.2 Hz, 1H), 7.28-7.21 (m, 6H), 7.07 (dd, J = 3.6, 4.8 Hz, 1H), 6.79 (d, J = 5.6 Hz, 1H), 6.53 (d, J = 5.6 Hz, 1H), 4.34 (dd, J = 8.8, 16.8 Hz, 1H), 4.24-4.18 (m, 1H), 3.35-3.29 (m, 1H), 2.80 (dd, J = 8.8, 16.8 Hz, 1H), 1.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.0, 146.3, 141.0, 138.9, 135.3, 132.0, 128.70, 128.67, 127.12, 126.99, 126.53, 126.45, 125.9, 62.8, 60.2, 45.3, 18.2; IR (KBr) 1756, 1404, 1213, 1112, 764, 702 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{19}H_{18}NO_2S$, 324.1058; found 324.1052.

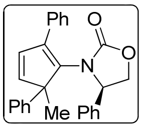
N-methyl-N-(5-methyl-2,5-diphenylcyclopenta-1,3-dien-1-yl)methanesulfonamide 3o

Compound **3o** was obtained as a oil in 56% (38 mg) isolated yield, R_f = 0.42 (petroleum ether : ethyl acetate = 5 : 1); ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.49 (d, J



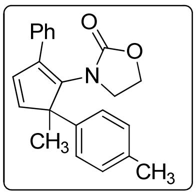
= 7.2 Hz, 2H), 7.41 (t, J = 7.2 Hz, 2H), 7.31-7.23 (m, 6H), 6.57 (d, J = 5.6 Hz, 1H), 6.47 (d, J = 5.6 Hz, 1H), 2.61 (s, 3H), 2.25 (s, 3H), 1.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.6, 146.8, 140.3, 138.8, 135.0, 130.6, 128.59, 128.56, 128.1, 127.9, 127.0, 126.3, 59.9, 39.4, 37.6, 18.3; IR (KBr) 1599, 1493, 1445, 1336, 1139, 1026, 963, 894, 854, 697, 572, 517 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{20}H_{22}NO_2S$, 340.1371; found 340.1365.

(4R)-3-(5-methyl-2,5-diphenylcyclopenta-1,3-dien-1-yl)-4-phenyloxazolidin-2-one 3p



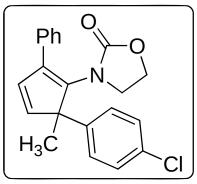
Compound **3p** was obtained as a pale yellow oil in 85% (100.5 mg) isolated yield, R_f = 0.34 (petroleum ether : ethyl acetate = 5 : 1); ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.41-7.40 (m, 4H), 7.16-7.11 (m, 7H), 6.96 (d, J = 8.0 Hz, 2H), 6.54 (d, J = 7.2 Hz, 2H), 6.42 (d, J = 5.6 Hz, 1H), 6.32 (d, J = 5.6 Hz, 1H), 4.81 (t, J = 8.0 Hz, 1H), 4.37 (t, J = 8.0 Hz, 1H), 3.95 (dd, J_1 = 8.4 Hz, J_2 = 8.0 Hz, 1H), 1.71 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.4, 146.3, 142.4, 138.5, 138.3, 136.8, 135.0, 130.0, 128.5, 128.42, 128.40, 128.1, 127.9, 127.8, 126.9, 126.7, 126.4, 70.2, 61.1, 61.0, 21.0; IR (KBr) 2961, 1741, 1394, 1251, 1037, 745, 700 cm^{-1}; HRMS-(DART) (m/z): $[M+Na]^+$ calcd for $C_{27}H_{23}NNaO_2$, 416.1626; found 416.1620.

3-(5-methyl-2-phenyl-5-(p-tolyl)cyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3q



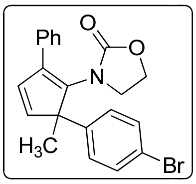
Compound **3q** was obtained as a pale yellow solid in 71% (47.2 mg) isolated yield, R_f = 0.34 (petroleum ether : ethyl acetate = 5 : 1); mp = 82-83 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.47-7.45 (m, 2H), 7.39-7.35 (m, 2H), 7.30-7.26 (m, 1H), 7.18 (d, J = 8.0 Hz, 2H), 7.08 (d, J = 8.0 Hz, 2H), 6.64 (d, J = 5.6 Hz, 1H), 6.48 (d, J = 5.6 Hz, 1H), 4.13-4.02 (m, 2H), 3.15-3.09 (m, 1H), 2.81-2.75 (m, 1H), 2.30 (s, 3H), 1.73 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 146.1, 143.4, 137.4, 136.5, 135.8, 134.0, 130.0, 129.3, 128.6, 127.8, 127.0, 125.6, 62.4, 60.2, 46.0, 20.9, 18.3; IR (KBr) 1758, 1511, 1407, 1212, 818, 746, 698, 522 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{22}H_{22}NO_2$, 332.1651; found 332.1645.

3-(5-(4-chlorophenyl)-5-methyl-2-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3r



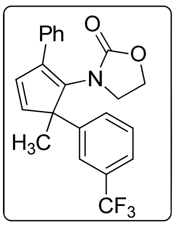
Compound **3r** was obtained as a pale yellow solid in 99% (71 mg) isolated yield, R_f = 0.32 (petroleum ether : ethyl acetate = 5 : 1); mp = 145-146 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.46 (d, *J* = 7.2 Hz, 2H), 7.40 (t, *J* = 7.6 Hz, 2H), 7.32 (t, *J* = 7.2 Hz, 1H), 7.27-7.22 (m, 4H), 6.68 (d, *J* = 5.6 Hz, 1H), 6.48 (d, *J* = 5.6 Hz, 1H), 4.18-4.07 (m, 2H), 3.20-3.14 (m, 1H), 2.84-2.78 (m, 1H), 1.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 145.7, 143.2, 137.9, 137.7, 133.8, 132.7, 130.6, 128.7, 128.1, 127.4, 127.1, 62.4, 60.1, 46.1, 18.4; IR (KBr) 1753, 1490, 1406, 1211, 1012, 827, 750, 697 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{21}H_{19}ClNO_2$, 352.1104; found 352.1099.

3-(5-(4-bromophenyl)-5-methyl-2-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3s



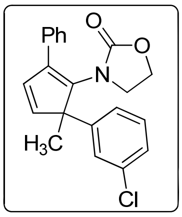
Compound **3s** was obtained as a pale yellow solid in 98% (77.8 mg) isolated yield, R_f = 0.30 (petroleum ether : ethyl acetate = 5 : 1); mp = 149-150 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.47-7.45 (m, 2H), 7.41-7.37 (m, 4H), 7.33-7.29 (m, 1H), 7.18 (d, *J* = 8.4 Hz, 2H), 6.67 (d, *J* = 5.6 Hz, 1H), 6.48 (d, *J* = 5.6 Hz, 1H), 4.18-4.07 (m, 2H), 3.21-3.14 (m, 1H), 2.85-2.79 (m, 1H), 1.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 145.6, 143.2, 138.3, 138.0, 133.8, 131.7, 130.7, 128.7, 128.1, 127.8, 127.1, 120.8, 62.4, 60.2, 46.1, 18.4; IR (KBr) 1763, 1487, 1407, 1117, 1009, 825, 749, 522 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{21}H_{19}BrNO_2$, 396.0599; found 396.0594.

3-(5-methyl-2-phenyl-5-(3-(trifluoromethyl)phenyl)cyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3t



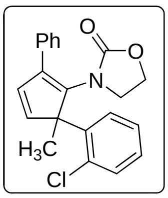
Compound **3t** was obtained as a white solid in 88% (68.1 mg) isolated yield, R_f = 0.33 (petroleum ether : ethyl acetate = 5 : 1); mp = 112-114 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.55 (s, 1H), 7.52-7.45 (m, 4H), 7.43-7.38 (m, 3H), 7.34-7.30 (m, 1H), 6.71 (d, *J* = 5.6 Hz, 1H), 6.52 (d, *J* = 5.6 Hz, 1H), 4.17-4.04 (m, 2H), 3.20-3.14 (m, 1H), 2.75-2.69 (m, 1H), 1.80 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 145.4, 143.1, 140.5, 138.4, 133.7, 131.0, 130.9 (q, $J_{C\text{-}F}$ = 31.8 Hz), 129.48 (d, $J_{C\text{-}F}$ = 1.0 Hz), 129.1, 128.8, 128.2, 127.1, 124.0 (q, $J_{C\text{-}F}$ = 270.9 Hz), 123.9 (q, $J_{C\text{-}F}$ = 3.8 Hz), 122.6 (q, $J_{C\text{-}F}$ = 3.8 Hz), 62.4, 60.4, 46.1, 18.4; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.5; IR (KBr) 1758, 1493, 1404, 1331, 1036, 979, 807, 747, 700 cm^{-1}; HRMS-(DART) (m/z): [M+H]$^+$ calcd for $C_{22}H_{19}F_3NO_2$, 386.1368; found 386.1362.

3-(5-(3-chlorophenyl)-5-methyl-2-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3u



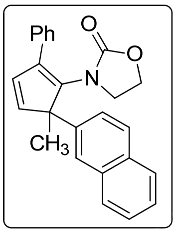
Compound **3u** was obtained as a yellow solid in 96% (67.8 mg) isolated yield, R_f = 0.29 (petroleum ether : ethyl acetate = 5 : 1); mp = 132-134 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.48-7.45 (m, 2H), 7.41-7.38 (m, 2H), 7.34-7.28 (m, 2H), 7.25-7.18 (m, 3H), 6.68 (d, J = 6.0 Hz, 1H), 6.48 (d, J = 6.0 Hz, 1H), 4.18-4.07 (m, 2H), 3.22-3.15 (m, 1H), 2.83-2.77 (m, 1H), 1.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 145.4, 143.0, 141.4, 138.1, 134.4, 133.7, 130.8, 129.9, 128.7, 128.2, 127.2, 127.1, 126.1, 124.1, 62.4, 60.3, 46.1, 18.3; IR (KBr) 1756, 1593, 1479, 1408, 1213, 1116, 1038, 754, 699 cm^{-1}; HRMS-(DART) (m/z): [M+H]$^+$ calcd for $C_{21}H_{19}ClNO_2$, 352.1104; found 352.1099.

3-(5-(2-chlorophenyl)-5-methyl-2-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3v



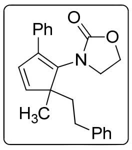
Compound **3v** was obtained as a white solid in 90% (63.1 mg) isolated yield, R_f = 0.22 (petroleum ether : ethyl acetate = 5 : 1); mp = 161-162 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.62 (dd, J = 1.2, 7.6 Hz, 1H), 7.47-7.45 (m, 2H), 7.41-7.37 (m, 1H), 7.33-7.19 (m, 4H), 6.69 (d, J = 5.6 Hz, 1H), 6.34 (d, J = 5.6 Hz, 1H), 4.20-4.13 (m, 1H), 4.09-4.03 (m, 1H), 3.45-3.39 (m, 1H), 3.08-3.01 (m, 1H), 1.81 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.8, 142.5, 140.0, 138.5, 137.3, 134.7, 134.1, 131.5, 131.0, 129.2, 128.6, 128.5, 127.7, 127.3, 127.0, 62.4, 60.1, 44.9, 22.7; IR (KBr) 1755, 1405, 1211, 1115, 1041, 748, 699 cm^{-1}; HRMS-(DART) (m/z): [M+H]$^+$ calcd for $C_{21}H_{19}ClNO_2$, 352.1104; found 352.1099.

3-(5-methyl-5-(naphthalen-2-yl)-2-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3w



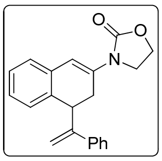
Compound **3w** was obtained as a pale yellow solid in 80% (59 mg) isolated yield, R_f = 0.29 (petroleum ether : ethyl acetate = 5 : 1); mp = 64-67 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.87 (s, 1H), 7.83 (d, *J* = 7.2 Hz, 1H), 7.78 (d, *J* = 7.6 Hz, 1H), 7.68 (d, *J* = 8.4 Hz, 1H), 7.52-7.45 (m, 4H), 7.43-7.39 (m, 2H), 7.32 (t, *J* = 7.2 Hz, 1H), 7.21 (dd, *J* = 1.6, 8.4 Hz, 1H), 6.74 (d, *J* = 5.6 Hz, 1H), 6.55 (d, *J* = 5.6 Hz, 1H), 4.09-3.94 (m, 2H), 3.13-3.07 (m, 1H), 2.79-2.73 (m, 1H), 1.88 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 146.1, 143.6, 138.3, 136.8, 134.1, 133.8, 132.5, 130.7, 128.8, 128.1, 128.0, 127.8, 127.4, 127.2, 126.2, 125.9, 124.6, 124.3, 62.4, 60.7, 46.0, 18.2; IR (KBr) 1759, 1407, 1210, 1113, 1038, 745, 698, 478 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{25}H_{22}NO_2$, 368.1652; found 368.1645.

3-(5-methyl-5-phenethyl-2-phenylcyclopenta-1,3-dien-1-yl)oxazolidin-2-one 3x



Compound **3x** was obtained as a colourless oil in 81% (55.7 mg) isolated yield, R_f = 0.38 (petroleum ether : ethyl acetate = 5 : 1); ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.45-7.43 (m, 2H), 7.41-7.37 (m, 2H), 7.32-7.28 (m, 1H), 7.23 (d, *J* = 7.2 Hz, 2H), 7.19-7.12 (m, 3H), 6.56 (d, *J* = 5.6 Hz, 1H), 6.34 (d, *J* = 5.6 Hz, 1H), 4.31-4.27 (m, 2H), 3.53 (t, *J* = 8.0 Hz, 2H), 2.72-2.64 (m, 1H), 2.56-2.48 (m, 1H), 2.08-1.94 (m, 2H), 1.34 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.9, 143.8, 142.7, 141.3, 138.7, 134.3, 130.0, 128.7, 128.4, 128.2, 127.9, 127.2, 125.6, 62.5, 58.3, 46.3, 38.4, 31.2, 21.1; IR (KBr) 1755, 1409, 1212, 1115, 1039, 753, 700 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{23}H_{24}NO_2$, 346.1807; found 346.1802.

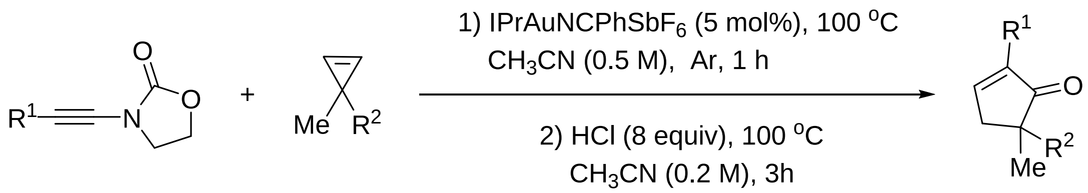
3-(4-(1-phenylvinyl)-3,4-dihydronaphthalen-2-yl)oxazolidin-2-one 4a



Compound **4a** was obtained as a colourless oil in 35% (22 mg) isolated yield, R_f = 0.48 (petroleum ether : ethyl acetate = 3 : 1); ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.52-7.50 (m, 1H), 7.40-7.32 (m, 4H), 7.28-7.23 (m, 4H), 6.98 (s, 1H), 5.62 (d, *J* = 3.2 Hz, 1H), 5.16 (d, *J* = 2.4 Hz, 1H), 4.51 (dd, *J* = 6.0, 8.8 Hz, 1H), 4.25-4.13 (m, 2H), 3.65-3.52 (m, 2H), 3.23-3.08 (m, 2H); ^{13}C NMR

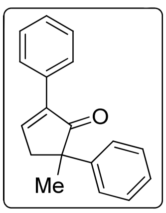
(100 MHz, $CDCl_3$) δ 157.1, 151.3, 144.3, 139.5, 136.2, 135.4, 129.1, 128.8, 128.44, 128.38, 127.4, 126.9, 125.5, 121.0, 104.0, 61.6, 47.5, 43.7, 35.0; IR (KBr) 2922, 1749, 1557, 1398, 1243, 1039, 753, 698 cm^{-1}; HRMS-(DART) (m/z): $[M+Na]^+$ calcd for $C_{21}H_{19}NNaO_2$, 340.1313; found 340.1309.

5. Representative synthetic application



Ynamide **1** (0.50 mmol, 1.0 eq), IPrAuNCPhSbF6 (5 mol%) and CH_3CN (1 mL) were added to an oven-dried 10 mL pressure tube equipped with a stirrer bar under argon, the cyclopropene **2** (1.5 mmol, 3 eq) was added in dropwise and the resulting mixture stirred at 100 °C. After completion of the reaction as indicated by TLC, 12 M HCl (340 μl, 8 equiv) was added, the reaction mixture was stirred at 100 °C for 3 h. Removing the solvent under reduced pressure, the residual was purified by column chromatography (petroleum ether/ethyl acetate 40:1) on silica gel to give cyclopent-2-enone **6**.

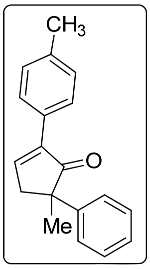
5-methyl-2,5-diphenylcyclopent-2-enone 6a[6]



Compound **6a** was obtained as a yellow solid in 80% (99.6 mg) isolated yield, R_f = 0.55 (petroleum ether : ethyl acetate =15 : 1); mp = 79-80 ºC; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.89 (t, *J* = 2.8 Hz, 1H), 7.77-7.75 (m, 2H), 7.41-7.28 (m, 7H), 7.23-7.19 (m, 1H), 3.14 (dd, *J* = 2.8, 19.6 Hz, 1H), 2.88 (dd, *J* = 2.8, 19.6 Hz, 1H), 1.61 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.2, 156.4, 143.7, 141.3, 131.7, 128.55, 128.47, 128.4, 127.1, 126.6, 125.9, 51.9, 45.2, 24.4.

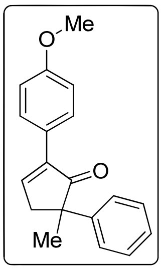
[6] P. Prempree, T. Siwapinyoyos, C. Thebtaranonth, Y. Thebtaranonth, *Tetrehedron Lett.* **1980**, *21*, 1169.

5-methyl-5-phenyl-2-(p-tolyl)cyclopent-2-enone 6b



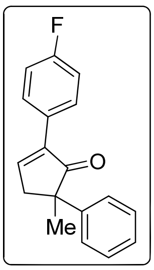
Compound **6b** was obtained as a pale yellow solid in 73% (95.4 mg) isolated yield, R_f = 0.58 (petroleum ether : ethyl acetate =15 : 1); mp = 104-105 ºC; ^1H NMR (400 MHz, $CDCl_3$, TMS) δ 7.85 (t, J = 2.8 Hz, 1H), 7.67(d, J = 8.4 Hz, 2H), 7.32-7.28 (m, 4H), 7.25-7.19 (m, 3H), 3.13 (dd, J = 2.8, 19.6 Hz, 1H), 2.87 (dd, J = 2.8, 19.6 Hz, 1H), 2.36 (s, 3H), 1.61 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.3, 155.5, 143.8, 141.2, 138.4, 129.1, 128.8, 128.5, 127.0, 126.5, 125.9, 51.9, 45.2, 24.4, 21.3; IR (KBr) 1698, 1303, 824, 748, 700 cm^{-1}; HRMS-(DART) (m/z): $[M+Na]^+$ calcd for $C_{19}H_{18}NaO$, 285.1255; found 285.1250.

2-(4-methoxyphenyl)-5-methyl-5-phenylcyclopent-2-enone 6c



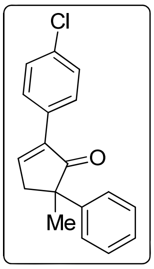
Compound **6c** was obtained as a white solid in 78% (108.4 mg) isolated yield, R_f = 0.32 (petroleum ether : ethyl acetate =15 : 1); mp = 98-99 ºC; ^1H NMR (400 MHz, $CDCl_3$, TMS) δ 7.78 (t, J = 2.8 Hz, 1H), 7.75-7.73 (m, 2H), 7.30-7.29 (m, 4H), 7.22-7.18 (m, 1H), 6.93-6.89 (m, 2H), 3.79 (s, 3H), 3.09 (dd, J = 2.8, 19.6 Hz, 1H), 2.83 (dd, J = 2.8, 19.6 Hz, 1H), 1.59 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.4, 159.8, 154.5, 143.8, 140.5, 128.5, 128.3, 126.5, 125.8, 124.3, 113.8, 55.2, 51.8, 45.1, 24.3; IR (KBr) 1699, 1510, 1260, 749, 698 cm^{-1}; HRMS-(DART) (m/z): $[M+H]^+$ calcd for $C_{19}H_{19}O_2$, 279.1385; found 279.1380.

2-(4-fluorophenyl)-5-methyl-5-phenylcyclopent-2-enone 6d



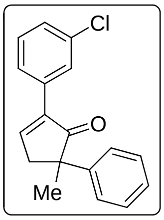
Compound **6d** was obtained as a yellow solid in 74% (94.5 mg) isolated yield, R_f = 0.51 (petroleum ether : ethyl acetate = 15 : 1); mp = 50-51 ºC; ^1H NMR (400 MHz, $CDCl_3$, TMS) δ 7.86 (t, J = 3.2 Hz, 1H), 7.79-7.75 (m, 2H), 7.34-7.30 (m, 4H), 7.25-7.20 (m, 1H), 7.11-7.06 (m, 2H), 3.15 (dd, J = 3.2, 20.0 Hz, 1H), 2.89 (dd, J = 3.2, 20.0 Hz, 1H), 1.62 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.2, 162.9 (d, J_{C-F} = 246.6 Hz), 156.0, 143.6, 140.3, 128.9 (d, J = 8.0 Hz), 128.6, 127.8 (d, J = 3.2 Hz), 126.7, 125.9, 115.4 (d, J_{C-F} = 21.3 Hz), 51.9, 45.2, 24.5; ^{19}F NMR (376 MHz, $CDCl_3$) δ -112.8; IR (KBr) 1704, 1508, 833, 699, 572 cm^{-1}; HRMS-(DART) (m/z): $[M+Na]^+$ calcd for $C_{18}H_{15}FNaO$, 289.1005; found 289.0999.

2-(4-chlorophenyl)-5-methyl-5-phenylcyclopent-2-enone 6e



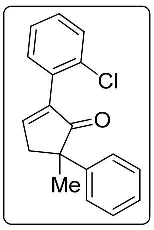
Compound **6e** was obtained as a yellow solid in 76% (106.3 mg) isolated yield, R_f = 0.51 (petroleum ether : ethyl acetate =15 : 1); mp = 78-79 ºC; ^1H NMR (400 MHz, $CDCl_3$, TMS) δ 7.90 (t, *J* = 3.2 Hz, 1H), 7.72 (d, *J* = 8.4 Hz, 2H), 7.37-7.31 (m, 6H), 7.25-7.20 (m, 1H), 3.15 (dd, *J* = 3.2, 20.0 Hz, 1H), 2.89 (dd, *J* = 3.2, 20.0 Hz, 1H), 1.61 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.0, 156.6, 143.5, 140.1, 134.4, 130.1, 128.65, 128.61, 128.4, 126.7, 125.9, 51.9, 45.2, 24.5; IR (KBr) 1703, 1492, 1092, 829, 699 cm^{-1}; HRMS-(DART) (m/z): $[M+Na]^+$ calcd for $C_{18}H_{15}ClNaO$, 305.0709; found 305.0704.

2-(3-chlorophenyl)-5-methyl-5-phenylcyclopent-2-enone 6f



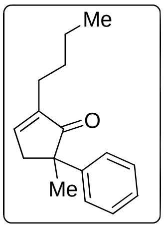
Compound **6f** was obtained as a yellow solid in 74% (104 mg) isolated yield, R_f = 0.45 (petroleum ether : ethyl acetate =15 : 1); mp = 71-72 ºC; ^1H NMR (400 MHz, $CDCl_3$, TMS) δ 7.86 (t, *J* = 2.8 Hz, 1H), 7.78 (s, 1H), 7.65-7.62 (m, 1H), 7.29-7.27 (m, 6H), 7.22-7.17 (m, 1H), 3.10 (dd, *J* = 2.8, 20.0 Hz, 1H), 2.84 (dd, *J* = 2.8, 20.0 Hz, 1H), 1.58 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 208.7, 157.5, 143.4, 139.8, 134.2, 133.3, 129.6, 128.5, 128.4, 127.0, 126.6, 125.8, 125.1, 51.8, 45.1, 24.3; IR (KBr) 1702, 1561, 734, 698 cm^{-1}; HRMS-(DART) (m/z): $[M+Na]^+$ calcd for $C_{18}H_{15}ClNaO$, 305.0709; found 305.0704.

2-(2-chlorophenyl)-5-methyl-5-phenylcyclopent-2-enone 6g



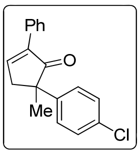
Compound **6g** was obtained as a yellow oil in 64% (90.2 mg) isolated yield, R_f = 0.43 (petroleum ether : ethyl acetate =15 : 1); ^1H NMR (400 MHz, $CDCl_3$, TMS) δ 7.87 (t, *J* = 2.8 Hz, 1H), 7.42-7.40 (m, 1H), 7.36-7.29 (m, 5H), 7.26-7.19 (m, 3H), 3.17 (dd, *J* = 2.8, 19.6 Hz, 1H), 2.93 (dd, *J* = 2.8, 19.6 Hz, 1H), 1.62 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 208.2, 160.4, 143.5, 140.9, 133.1, 131.0, 130.8, 129.7, 129.3, 128.5, 126.55, 126.48, 125.9, 50.9, 45.8, 24.4; IR (KBr) 1702, 1044, 752, 698 cm^{-1}; HRMS-(DART) (m/z): $[M+Na]^+$ calcd for $C_{18}H_{15}ClNaO$, 305.0709; found 305.0704.

2-butyl-5-methyl-5-phenylcyclopent-2-enone 6h



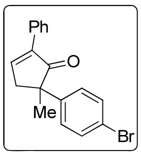
Compound **6h** was obtained as a yellow oil in 84% (95.5 mg) isolated yield, R_f = 0.66 (petroleum ether : ethyl acetate = 15 : 1); ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.34-7.32 (m, 1H), 7.31-7.24 (m, 4H), 7.21-7.17 (m, 1H), 3.01-2.94 (m, 1H), 2.76-2.69 (m, 1H), 2.26-2.22 (m, 2H), 1.55-1.47 (m, 5H), 1.40-1.31 (m, 2H), 0.92 (t, *J* =7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 211.4, 154.9, 144.5, 144.0, 128.4, 126.4, 125.8, 50.7, 45.7, 29.8, 24.8, 24.4, 22.4, 13.8; IR (KBr) 1705, 1496, 1445, 762, 699 cm^{-1}; HRMS-(DART) (m/z): $[M+Na]^+$ calcd for $C_{16}H_{20}NaO$, 251.1412; found 251.1406.

5-(4-chlorophenyl)-5-methyl-2-phenylcyclopent-2-enone 6i



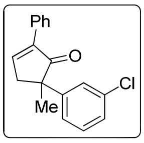
Compound **6i** was obtained as a pale yellow solid in 78% (110 mg) isolated yield, R_f = 0.43 (petroleum ether : ethyl acetate =15 : 1); mp = 83.5-84.5 ºC ; ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.85 (t, *J* = 2.8 Hz, 1H), 7.75-7.73 (m, 2H), 7.39-7.30 (m, 3H), 7.26-7.20 (m, 4H), 3.04 (dd, *J* = 2.8, 19.6 Hz, 1H), 2.83 (dd, *J* = 2.8, 19.6 Hz, 1H), 1.56 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 208.6, 156.3, 142.2, 141.0, 132.3, 131.4, 128.53, 128.51, 128.4, 127.4, 127.0, 51.4, 44.9, 24.5; IR (KBr) 1702, 1493, 1095, 823, 695 cm^{-1}; HRMS-(DART) (m/z): $[M+Na]^+$ calcd for $C_{18}H_{15}ClNaO$, 305.0709; found 305.0704.

5-(4-bromophenyl)-5-methyl-2-phenylcyclopent-2-enone 6j

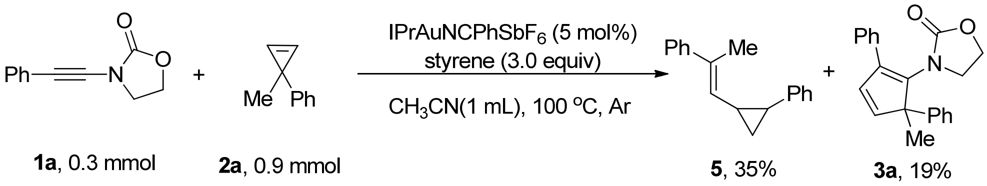


Compound **6j** was obtained as a yellow oil in 83% (135.1 mg) isolated yield, R_f = 0.38 (petroleum ether : ethyl acetate =15 : 1); ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.83 (t, *J* = 2.8 Hz, 1H), 7.75-7.73 (m, 2H), 7.41-7.29 (m, 5H), 7.18-7.15 (m, 2H), 3.02 (dd, *J* = 2.8, 20.0 Hz, 1H), 2.81 (dd, *J* = 2.8, 20.0 Hz, 1H), 1.54 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 208.5, 156.4, 142.7, 140.9, 131.44, 131.36, 128.5, 128.3, 127.7, 127.0, 120.4, 51.4, 44.8, 24.4; IR (KBr) 1700, 1490, 1008, 745, 694 cm^{-1}; HRMS-(DART) (m/z): $[M+Na]^+$ calcd for $C_{18}H_{15}BrNaO$, 349.0204; found 349.0198.

5-(3-chlorophenyl)-5-methyl-2-phenylcyclopent-2-enone 6k

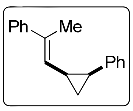


Compound **6k** was obtained as a yellow oil in 80% (112.8 mg) isolated yield, R_f = 0.45 (petroleum ether : ethyl acetate =15 : 1); ^{1}H NMR (400 MHz, $CDCl_3$, TMS) δ 7.85 (t, J = 2.8 Hz, 1H), 7.76-7.74 (m, 2H), 7.39-7.31 (m, 4H), 7.23-7.15 (m, 3H), 3.05 (dd, J = 2.8, 19.6 Hz, 1H), 2.83 (dd, J = 2.8, 19.6 Hz, 1H), 1.57 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 208.4, 156.4, 145.7, 141.1, 134.3, 131.4, 129.7, 128.5, 128.4, 127.0, 126.7, 126.3, 124.2, 51.6, 44.9, 24.4; IR (KBr) 1704, 1595, 750, 695 cm^{-1}; HRMS-(DART) (m/z): [M+Na]$^+$ calcd for $C_{18}H_{15}ClNaO$, 305.0709; found 305.0704.



Ynamide **1a** (0.30 mmol, 1.0 eq), IPrAuNCPhSbF6 (5 mol%) and CH_3CN (1.0 mL) were added to an oven-dried 10 mL pressure tube equipped with a stirrer bar under argon, the cyclopropene **2a** (0.9 mmol, 3.0 eq) and styrene (0.9 mmol, 3.0 equiv) was added dropwise and the resulting mixture stirred at 100 °C. After completion of the reaction as indicated by TLC, removing the solvent under reduced pressure, the residual was purified by column chromatography on silica gel.

((*E*)-1-((*1S, 2S*)-2-Phenylcyclopropyl)prop-1-en-2-yl)benzene 5[7]



Compound **5** was obtained as a colourless oil in 35% (79 mg) isolated yield, R_f = 0.5 (petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$, cis isomer): 7.28-7.10 (m, 10H), 5.10 (d, J = 9.2 Hz, 1H), 2.43 (dd, J = 8.4, 15.2 Hz, 1H), 2.13 (s, 3H), 2.10-2.02 (m, 1H), 1.41-1.35 (m, 1H), 1.06-1.02 (m, 1H); (trans isomer, only clearly assignable signals are listed): 5.32 (d, J = 9.2 Hz, 1H), 2.01-1.97 (m, 1H), 1.97-1.87 (m, 1H), 1.34-1.29 (m, 1H), 1.15-1.11 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$, cis isomer): 143.6, 138.9, 135.2, 129.0, 128.01, 127.96, 127.6, 126.3, 125.9, 125.3, 23.6, 18.9, 16.2, 13.0; (trans isomer, only clearly assignable signals are listed): 130.9,

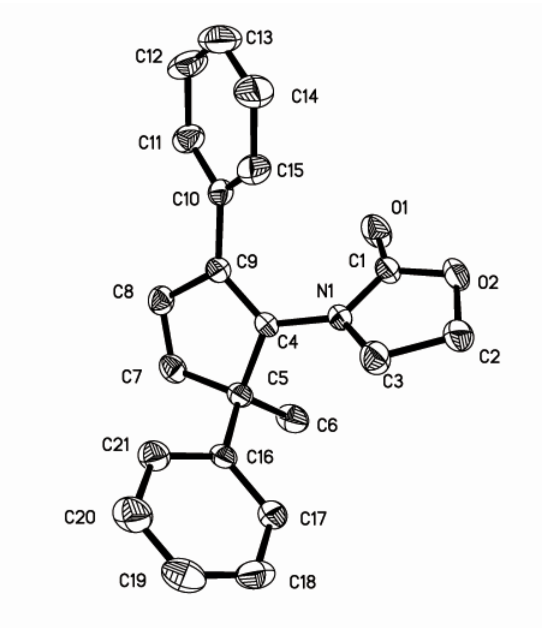
[7] González, M. J.; González, J.; López, L. A.; Vicente, R. *Angew. Chem. Int. Ed.* **2015**, *54*, 12139.

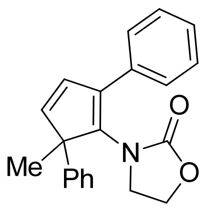
128.3, 128.2, 126.5, 125.7, 125.6, 25.6, 24.4, 17.6, 16.24.

6. X-ray crystal structures

General procedure for preparation of the crystal: The product (40 mg) was dissolved in ethyl acetate.The filtered through a pad of filter paper. The filtrate was then transferred into several test-tubes by different volumes. To these solution were added petroleum ether in dropwise. The samples prepared in this way were allowed to evaporate slowly at room temperature, which would eventually give colorless crystals on the surface of the tubes.

Colorless granular-shaped crystals **3a** was obtained from mixed solution (PE : EA =10:1).





X-ray structure of **3a**. Hydrogen atoms have been omitted for clarity. CCDC 1478721.

Bond precision:	C-C = 0.0026 A	Wavelength=0.71073	
Cell:	a=8.0521(16)	b=10.418(2)	c=10.027(2)
	alpha=90	beta=96.73(3)	gamma=90
Temperature:	293 K		
	Calculated	Reported	
Volume	835.3(3)	835.4(3)	
Space group	P 21	P2(1)	
Hall group	P 2yb		

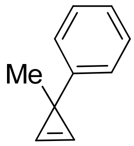
Moiety formula	C21 H19 N O2	
Sum formula	C21 H19 N O2	C21 H19 N O2
Mr	317.37	317.37
Dx,g cm-3	1.262	1.262
Z	2	2
Mu (mm-1)	0.081	0.081
F000	336.0	336.0
F000’	336.14	
h,k,lmax	10,13,13	10,13,13
Nref	3822[2017]	3594
Tmin,Tmax	0.990,0.992	
Tmin’	0.922	
Correction method=	Not given	

Data completeness= 1.78/0.94 Theta(max)= 27.480

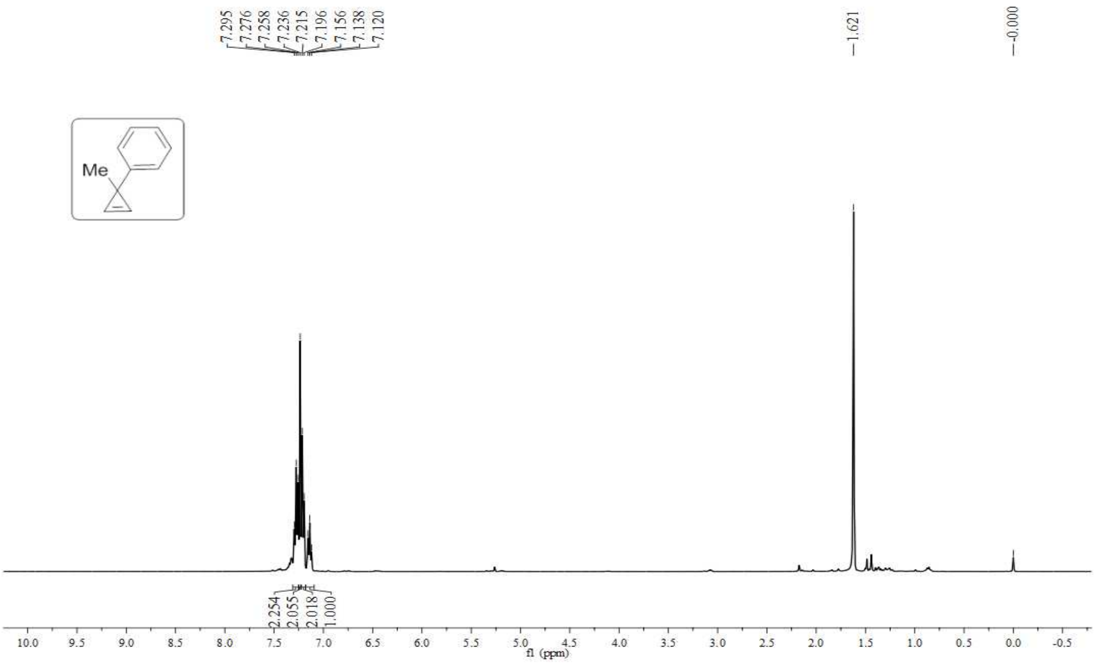
R(reflections)= 0.0396(2677) wR2(reflections)= 0.0844(3594)

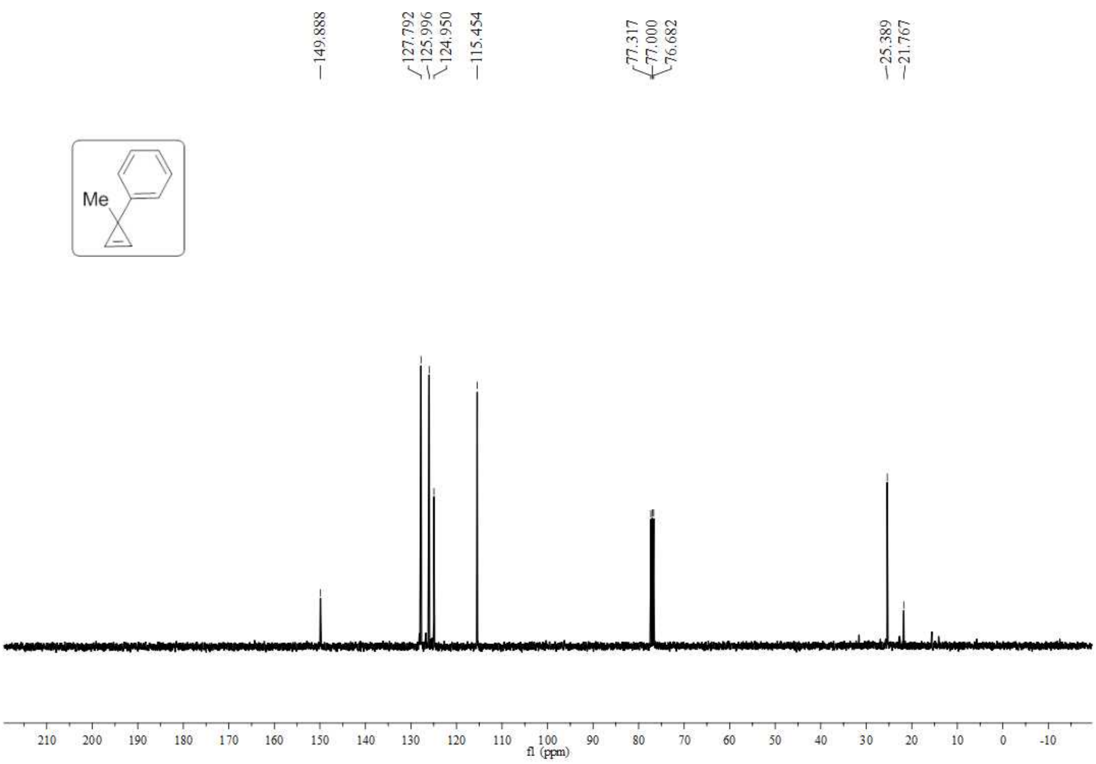
S = 0.992 Npar= 218

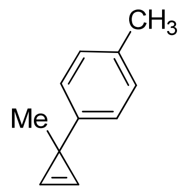
7. ^{1}H and ^{13}C NMR spectra of the substrates



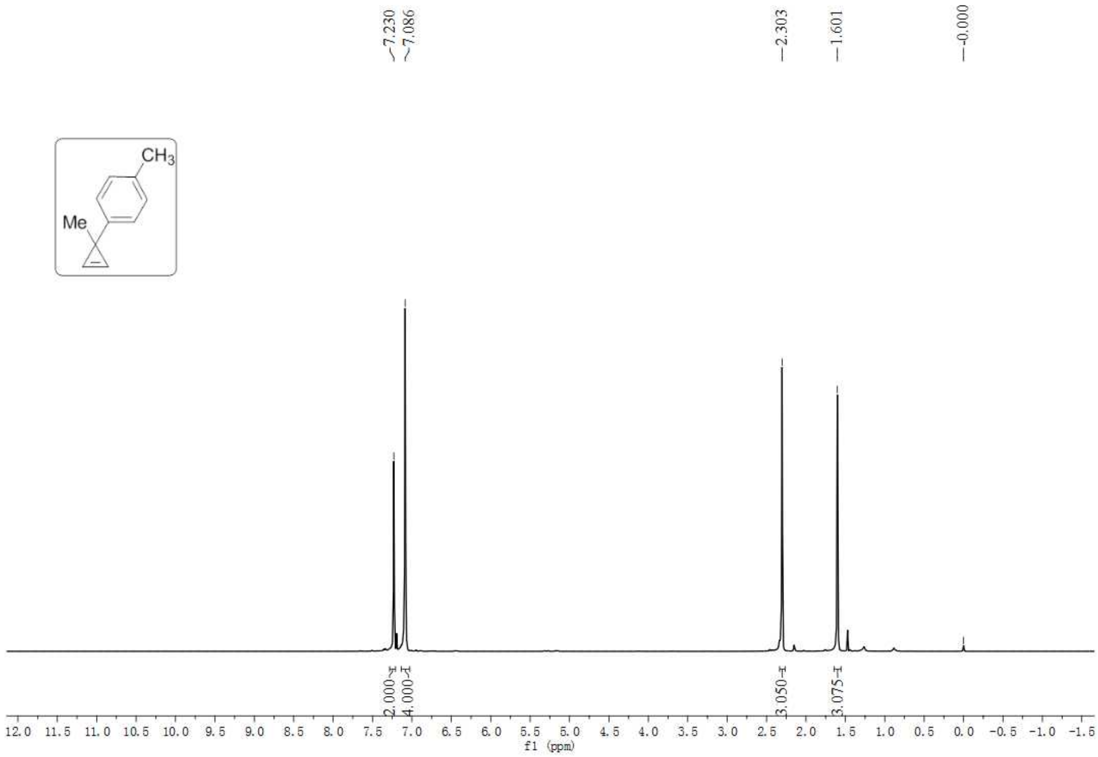
2a

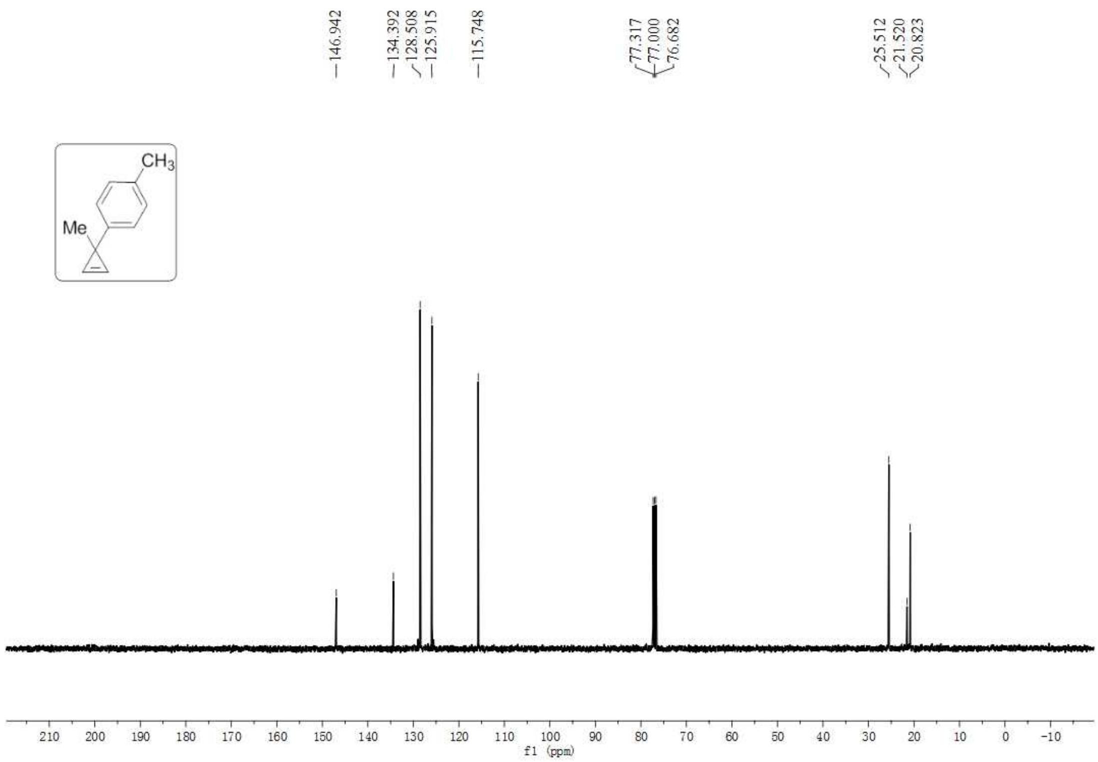


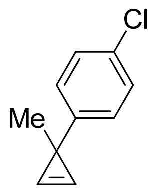




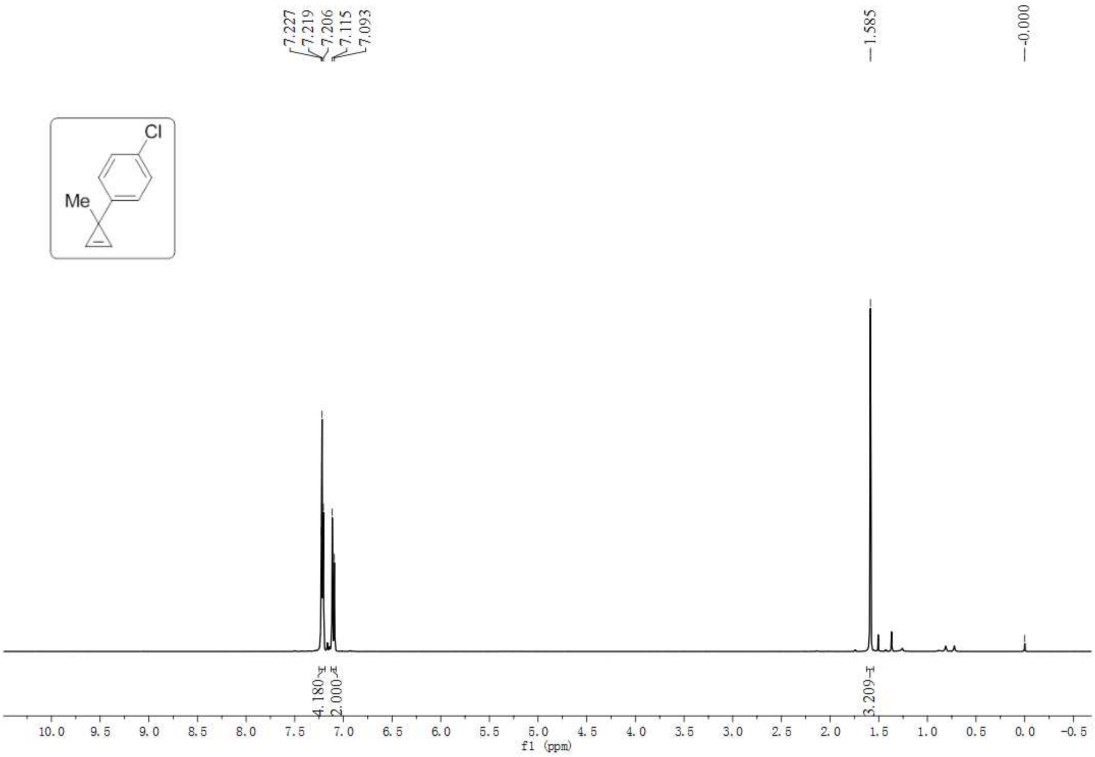
2q


7.230
7.086
2.303
1.601
0.000
Me
CH_3
2.000
4.000
3.050
3.075
12.0 11.5 11.0 10.5 10.0 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 -0.5 -1.0 -1.5
f1 (ppm)


146.942
134.392
128.508
125.915
115.748
77.317
77.000
76.682
25.512
21.520
20.823
Me
CH_3
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


Cl
Me

2r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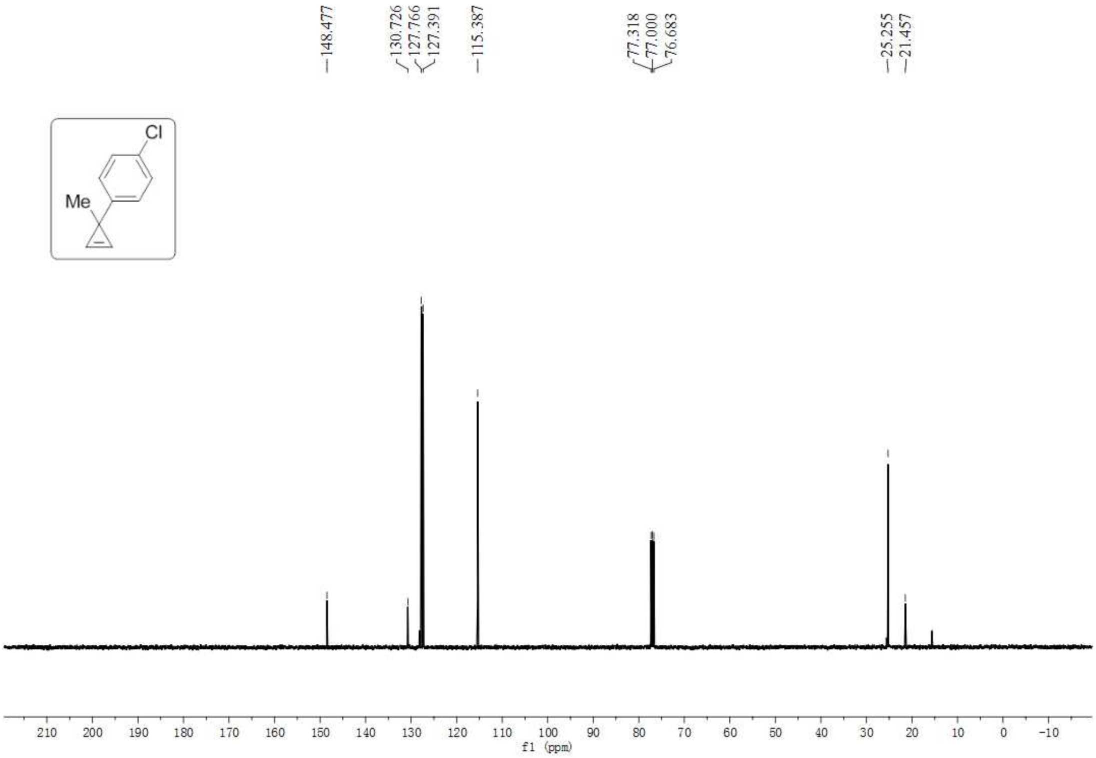
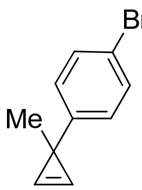
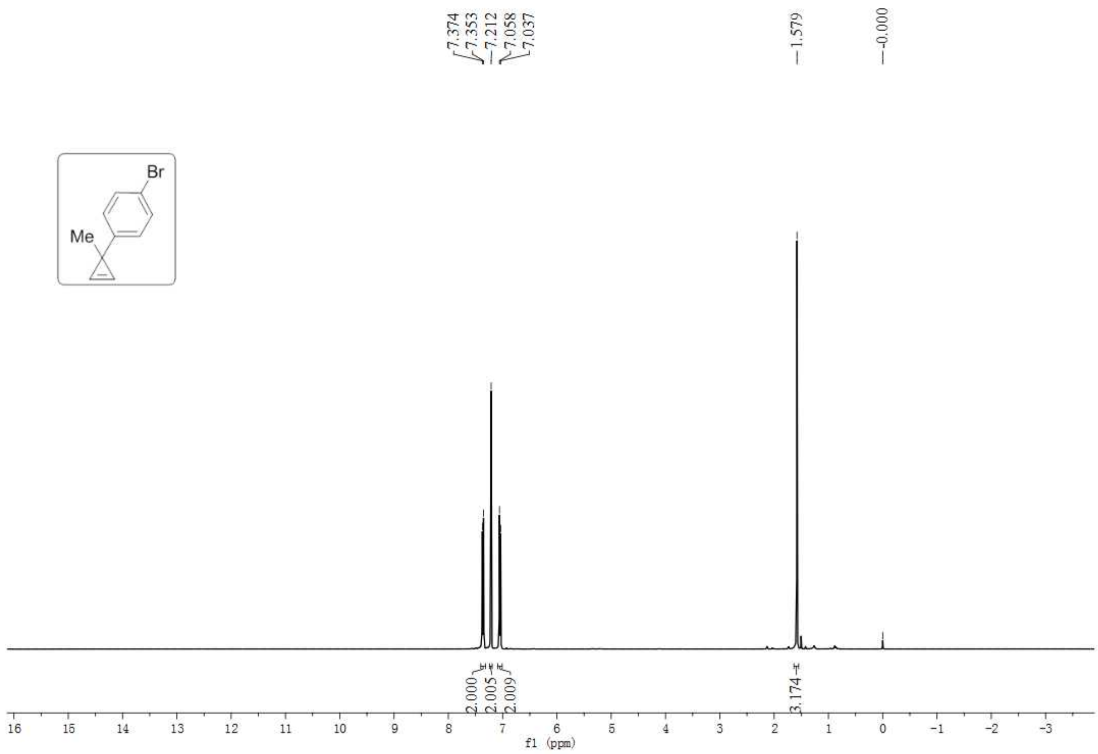
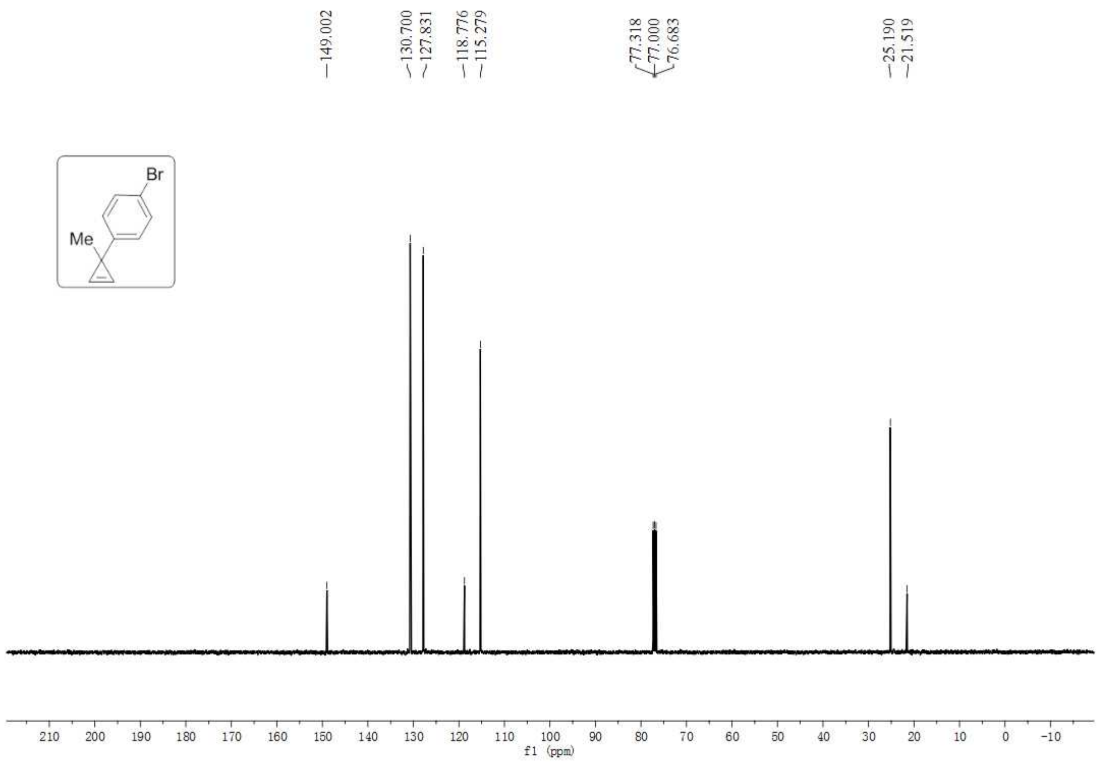
7.206
7.115
7.093
1.585
0.000
Cl
Me
4.180
2.000
3.209
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


148.477
130.726
127.766
127.391
115.387
77.318
77.000
76.683
25.255
21.457
Cl
Me
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



2s


7.374
7.353
7.212
7.058
7.037
1.579
0.000
Br
Me
2.000
2.005
2.009
3.174
f1 (ppm)


149.002
130.700
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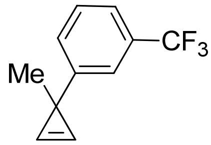
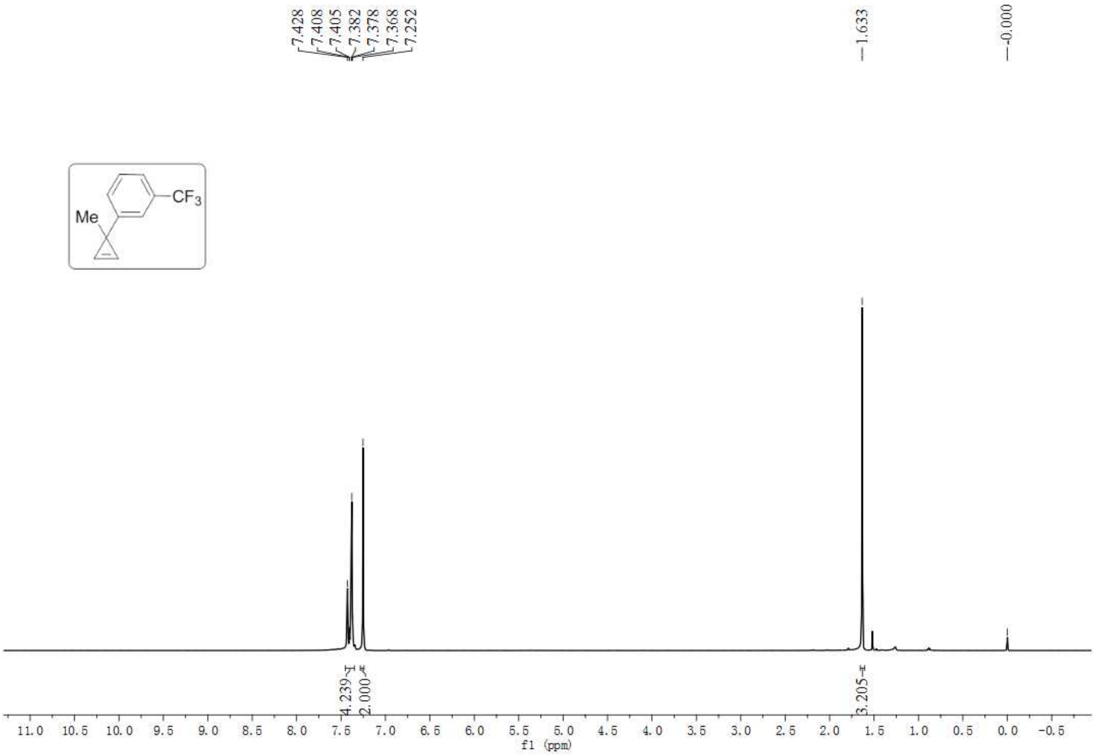
118.776
115.279
77.318
77.000
76.683
25.190
21.519
Br
Me
f1 (ppm)


Me
CF3

2t


7.428
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7.382
7.378
7.368
7.252
1.633
0.000
Me
CF3
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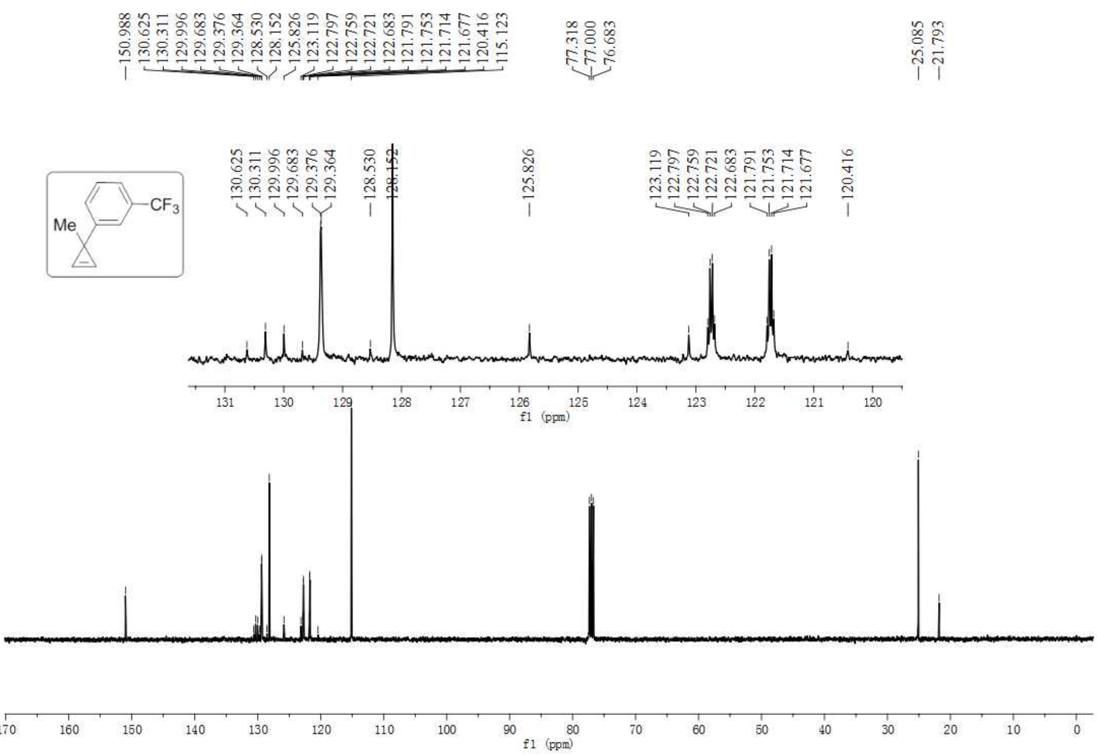
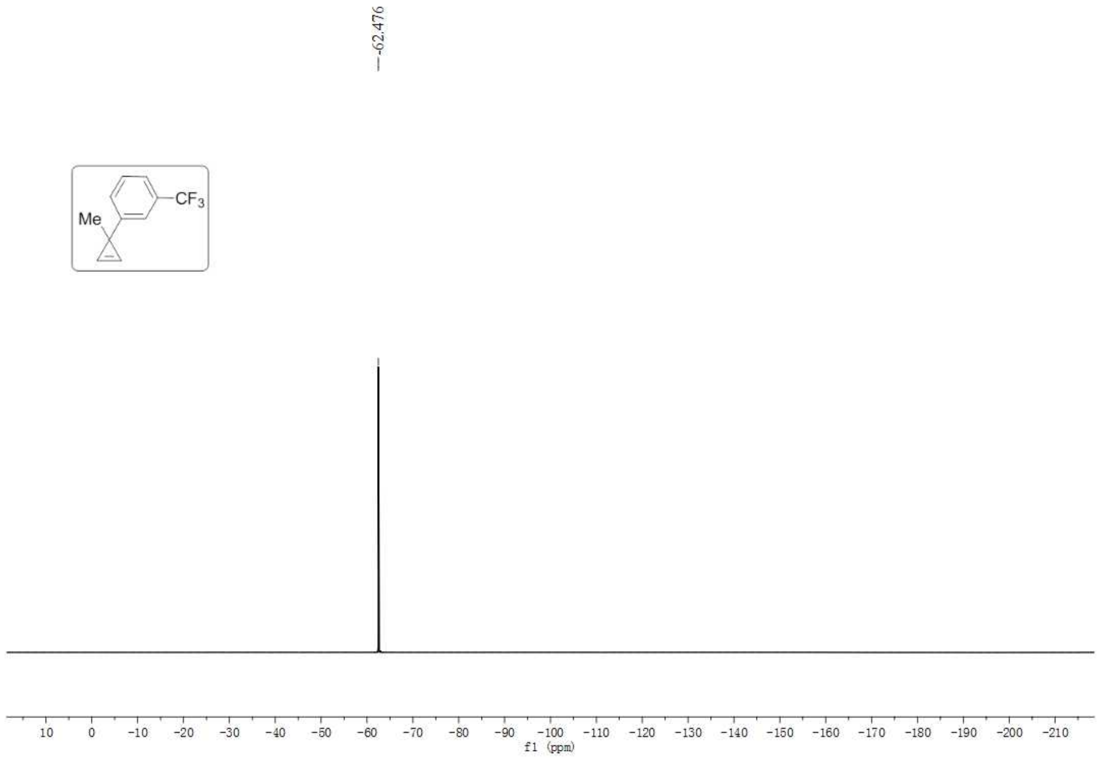
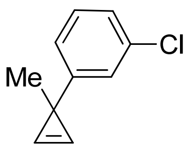
2.000
3.205
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

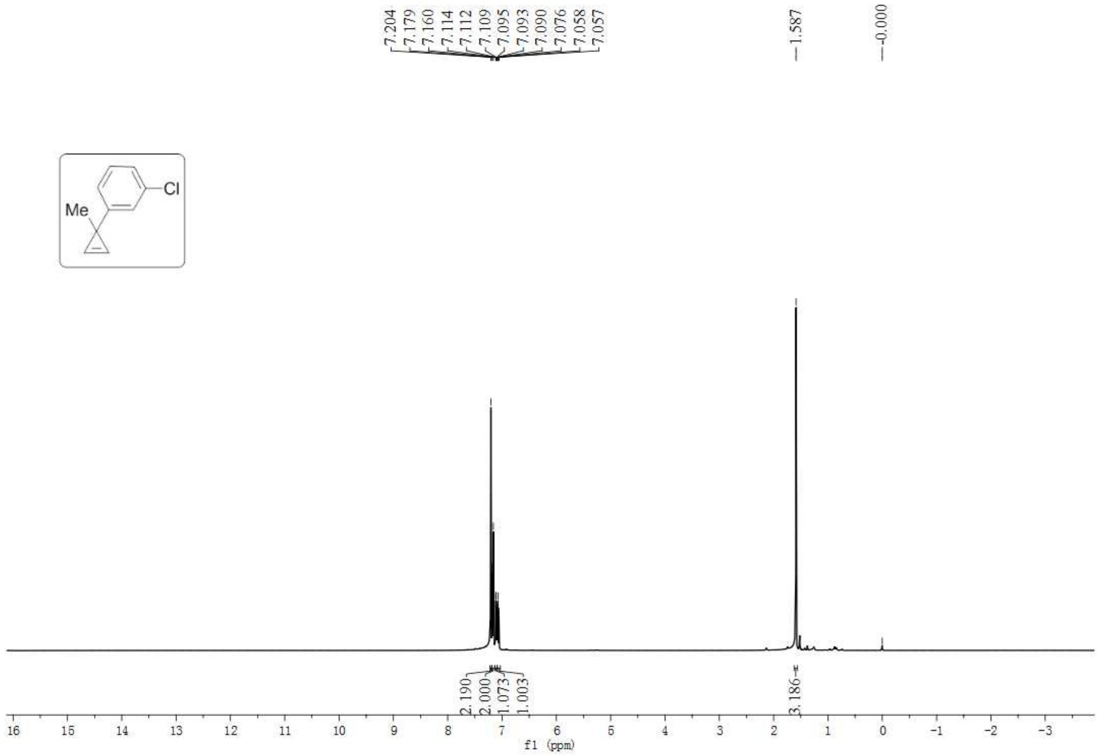

150.988
130.625
130.311
129.996
129.683
129.376
129.364
128.530
128.152
125.826
123.119
122.797
122.759
122.721
122.683
121.791
121.753
121.714
121.677
120.416
115.123
77.318
77.000
76.683
25.085
21.793
Me
CF3
131 130 129 128 127 126 125 124 123 122 121 120
f1 (ppm)
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



-62.476
Me
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)


Me
Cl

2u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7.179
7.160
7.114
7.112
7.109
7.095
7.093
7.090
7.076
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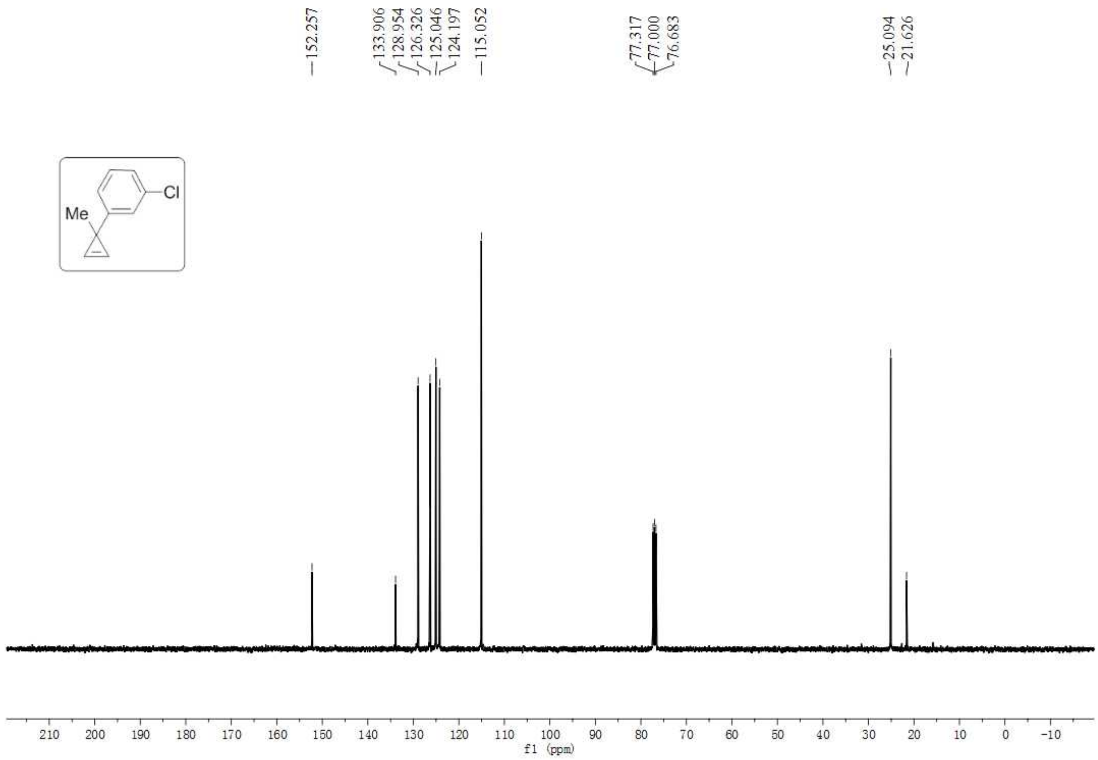
1.587
0.000
Me
Cl
2.190
2.000
1.073
1.003
3.186
f1 (ppm)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124.197
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77.000
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25.094
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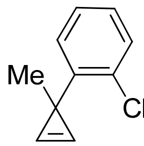
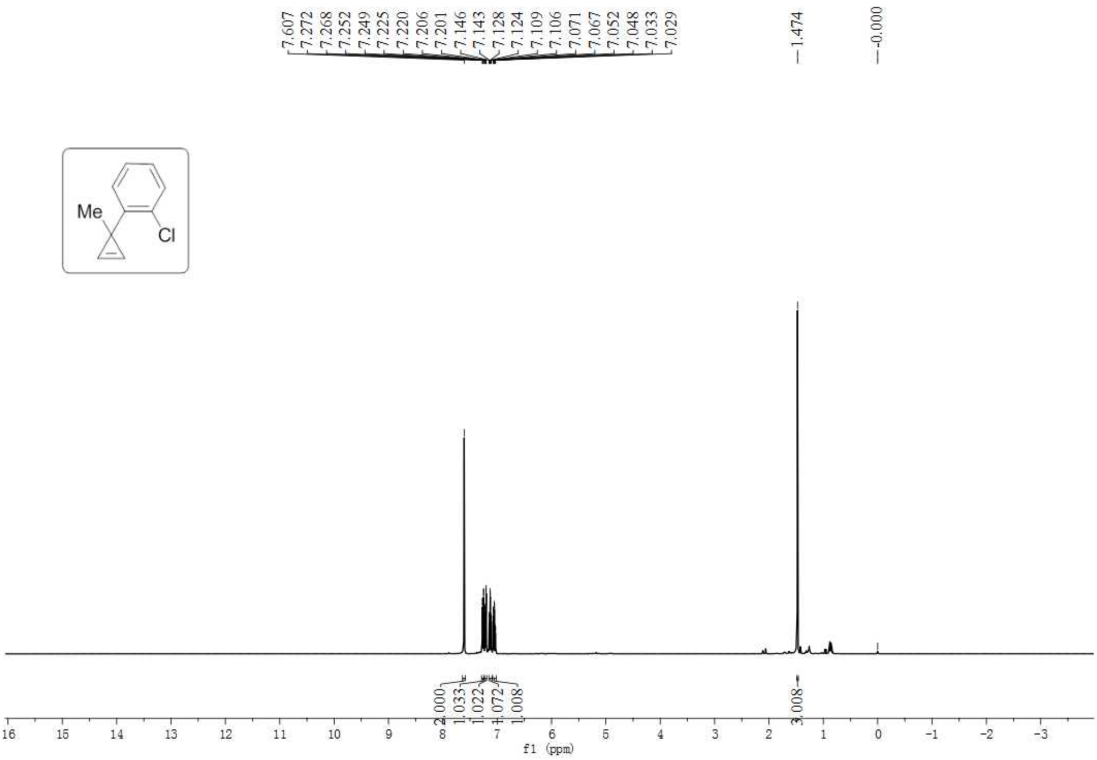
Me
Cl
f1 (ppm)


Me
Cl

2v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7.225
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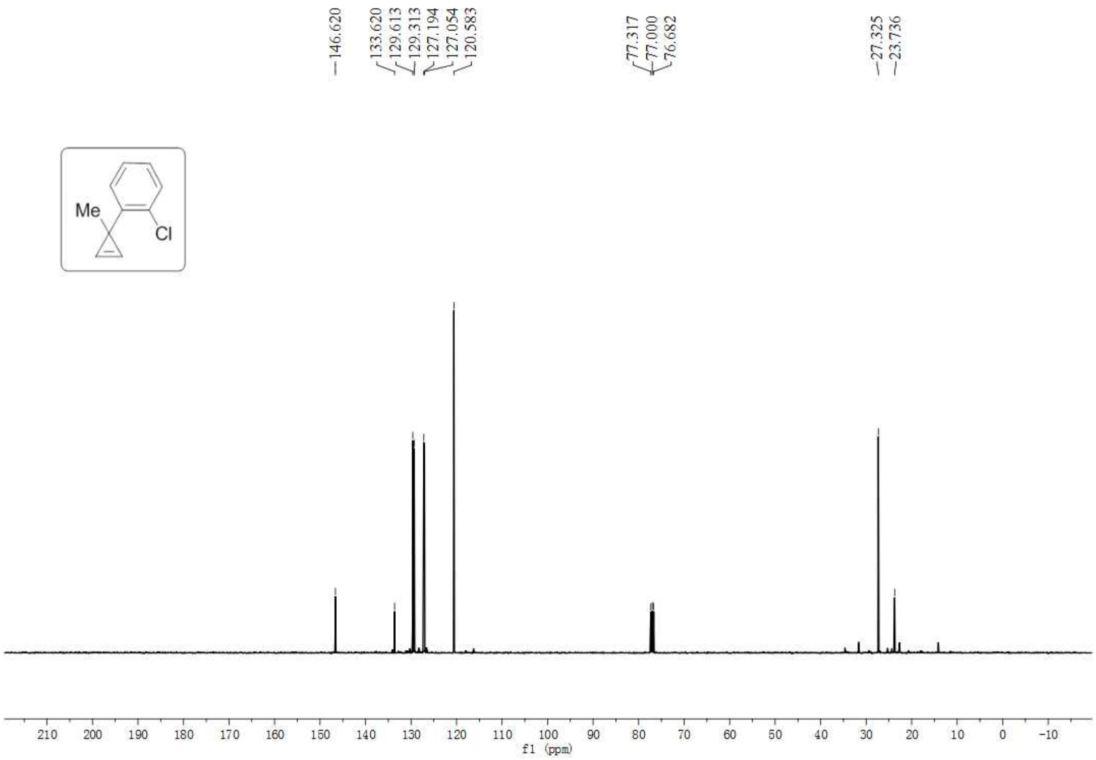
7.206
7.201
7.146
7.143
7.128
7.124
7.109
7.106
7.071
7.067
7.052
7.048
7.033
7.029
1.474
0.000
Me
Cl
2.000
1.033
1.022
1.072
1.008
3.008
f1 (ppm)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127.054
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77.000
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27.325
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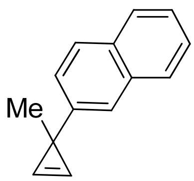
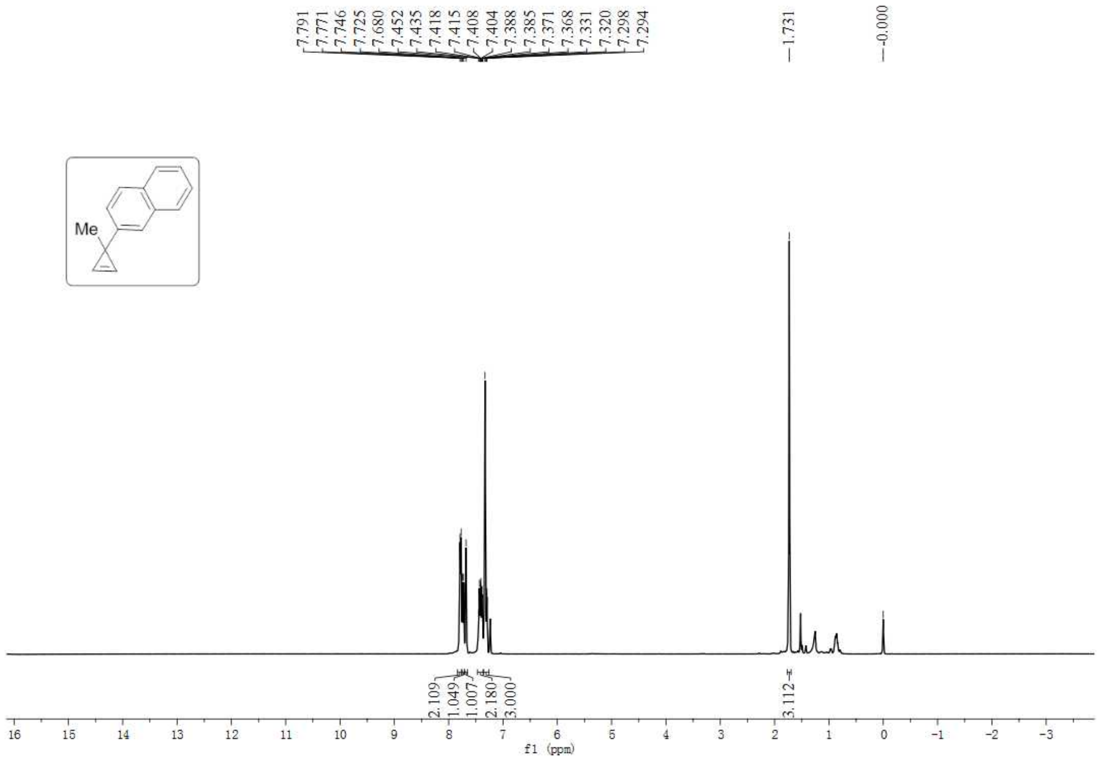
Me
Cl
f1 (ppm)


Me

2w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7.680
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7.435
7.418
7.415
7.408
7.404
7.388
7.385
7.371
7.368
7.331
7.320
7.298
7.294
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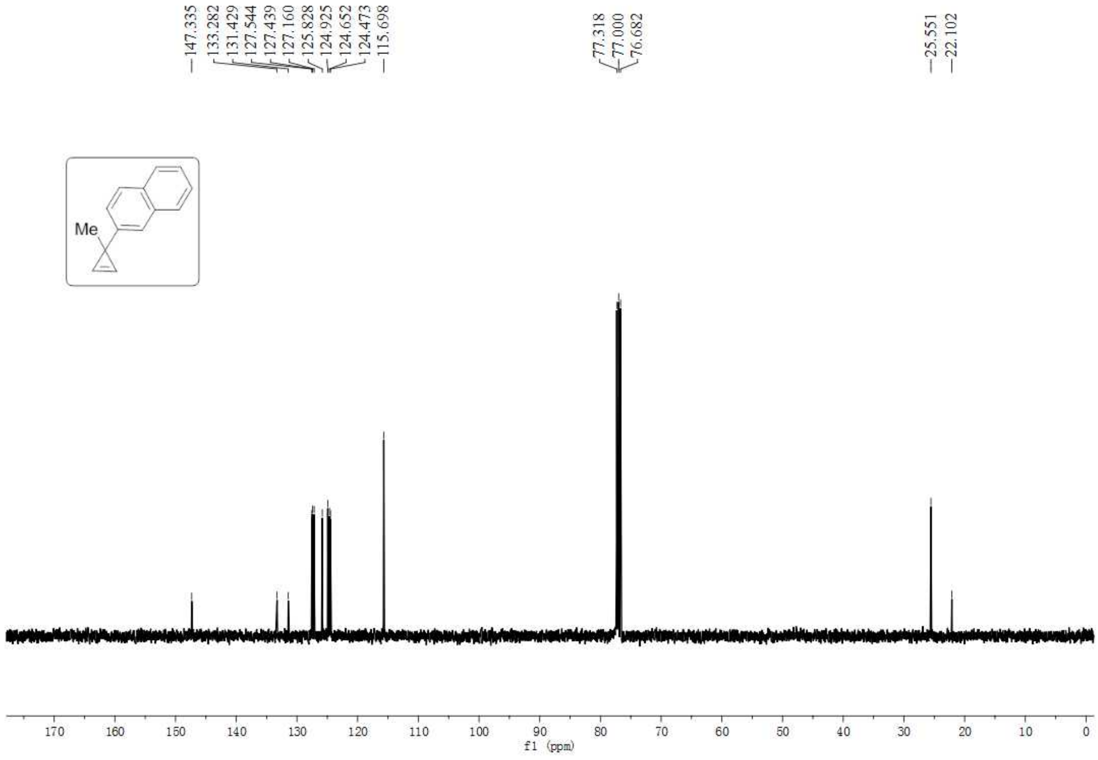
-0.000
Me
2.109
1.049
1.007
2.180
3.000
3.112
f1 (ppm)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127.439
127.160
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124.652
124.473
115.698
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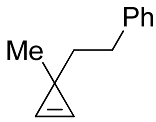
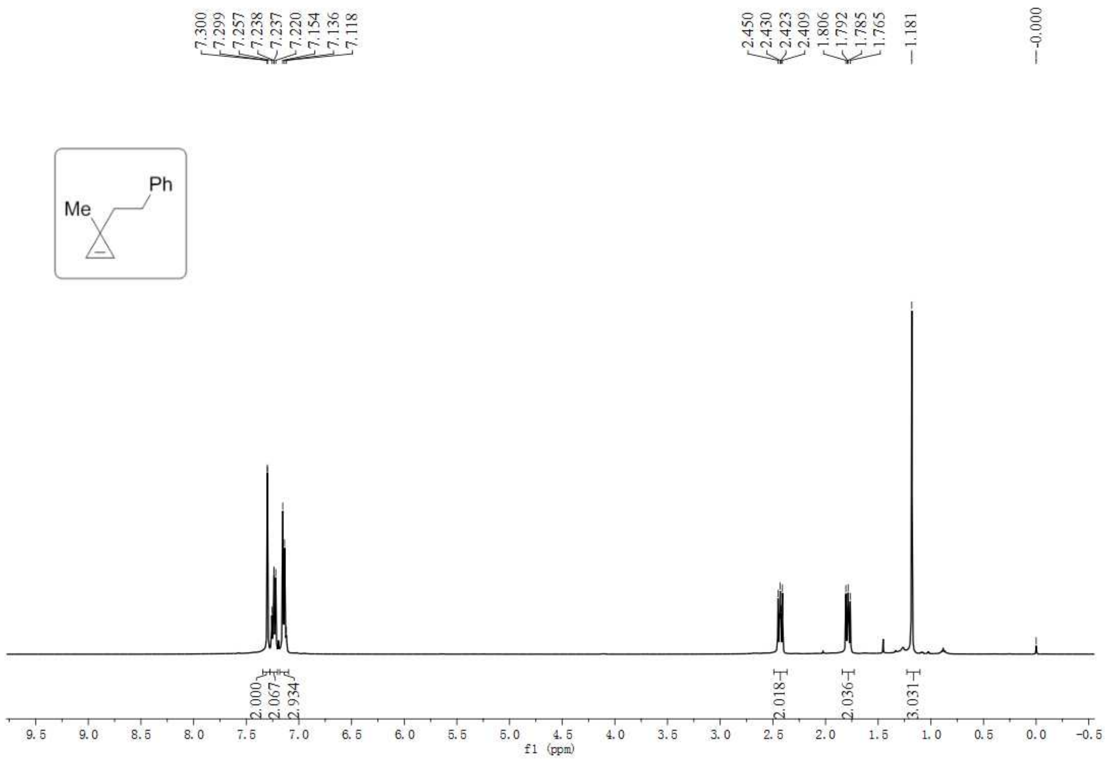
77.000
76.682
25.551
22.102
Me
f1 (ppm)


Ph
Me

2x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2.430
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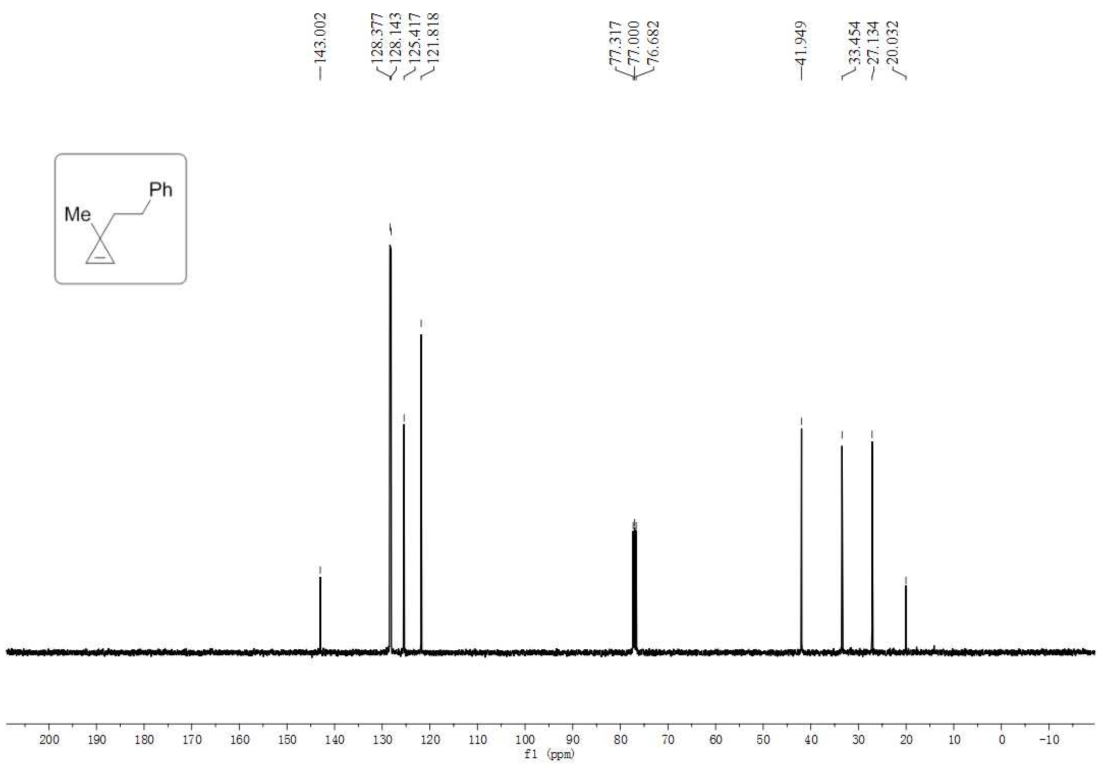
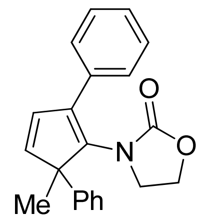
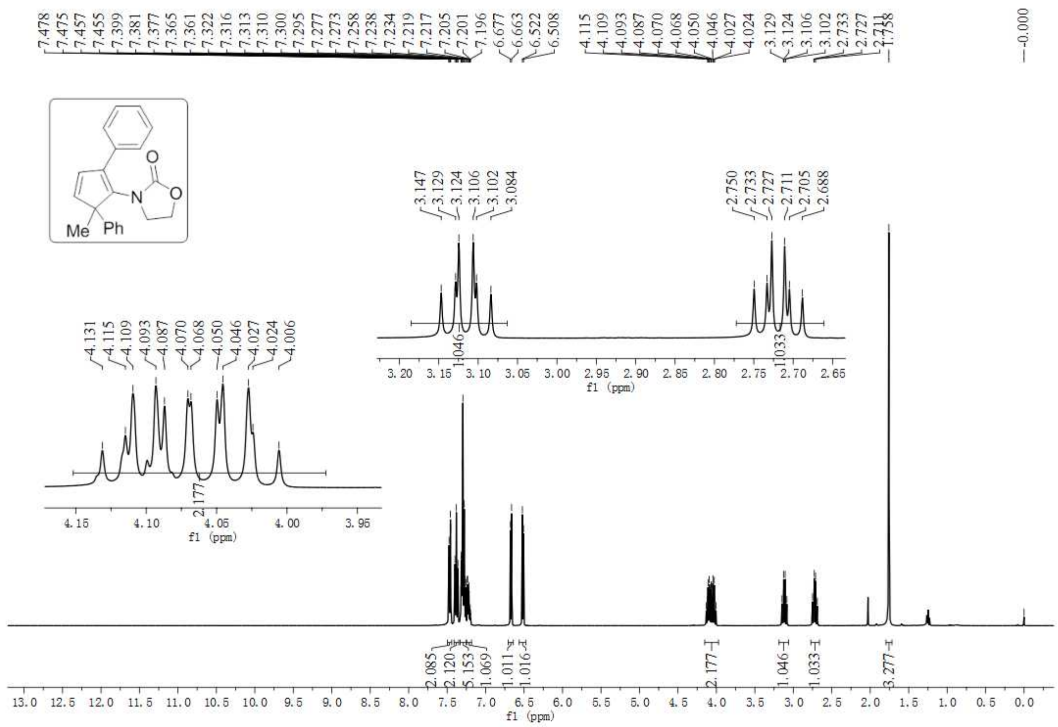
2.409
1.806
1.792
1.785
1.765
1.181
0.000
Ph
Me
2.000
2.067
2.934
2.018
2.036
3.031
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

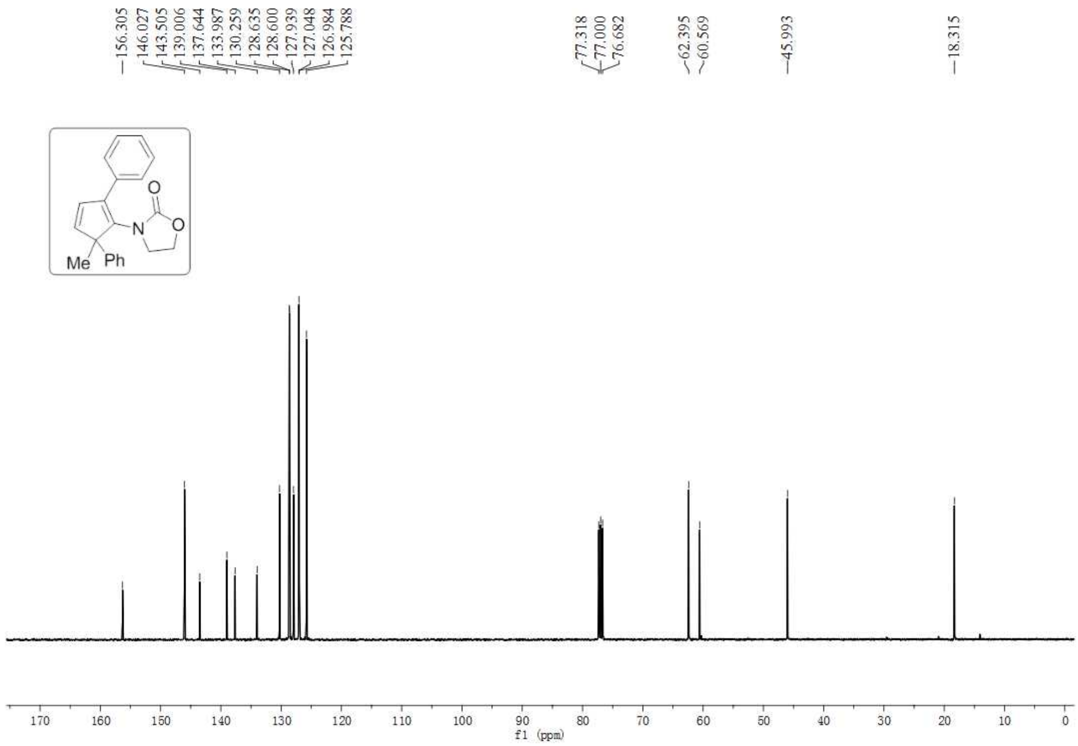

143.002
128.377
128.143
125.417
121.818
77.317
77.000
76.682
41.949
33.454
27.134
20.032
Ph
Me
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

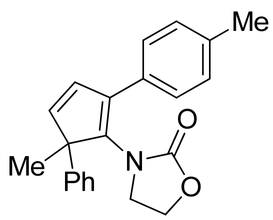
8. ^{1}H and ^{13}C NMR spectra for the products



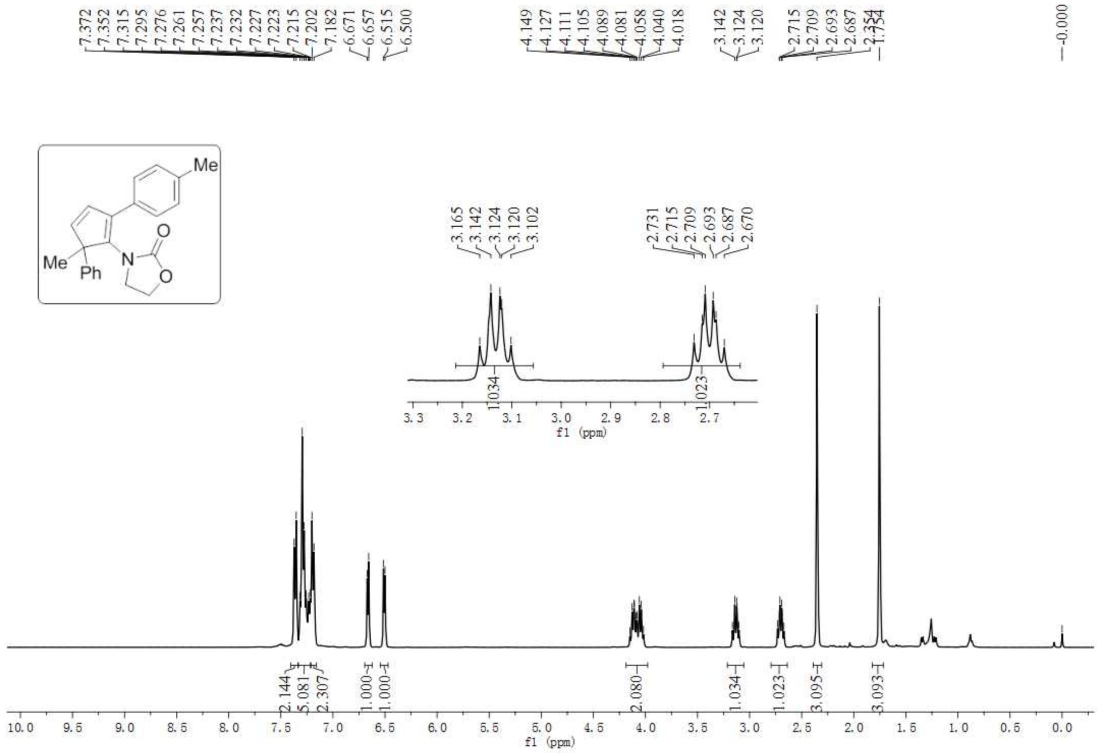
3a

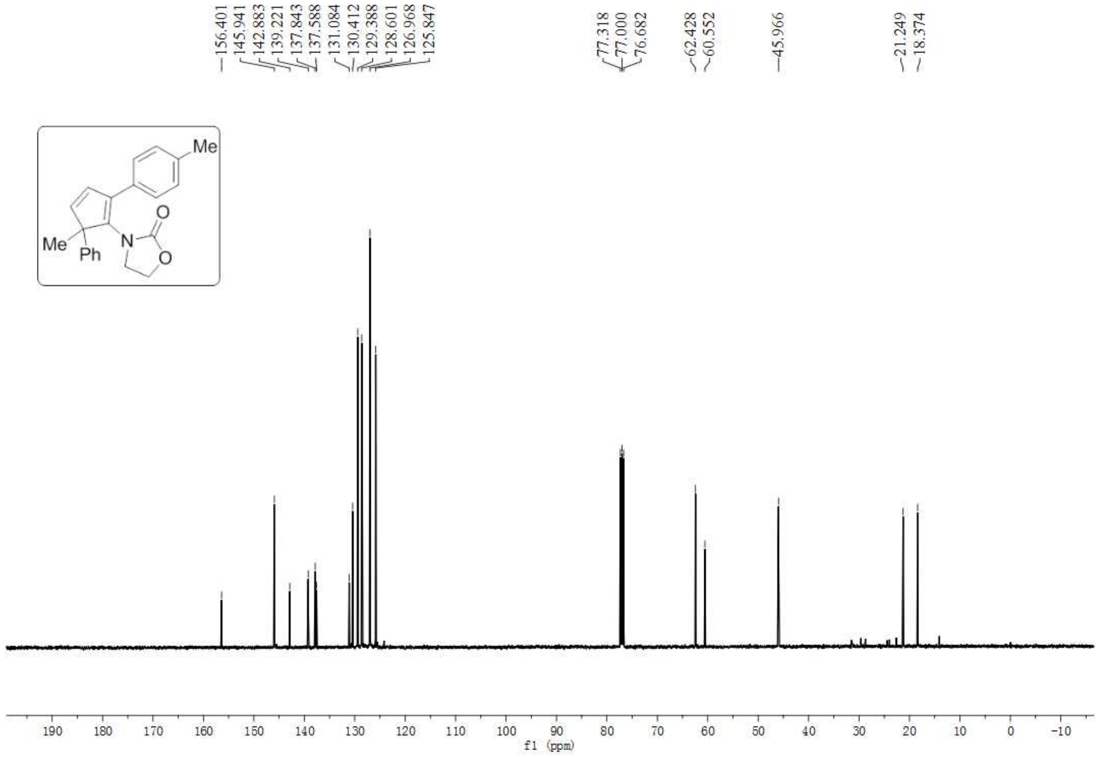


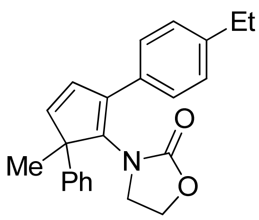




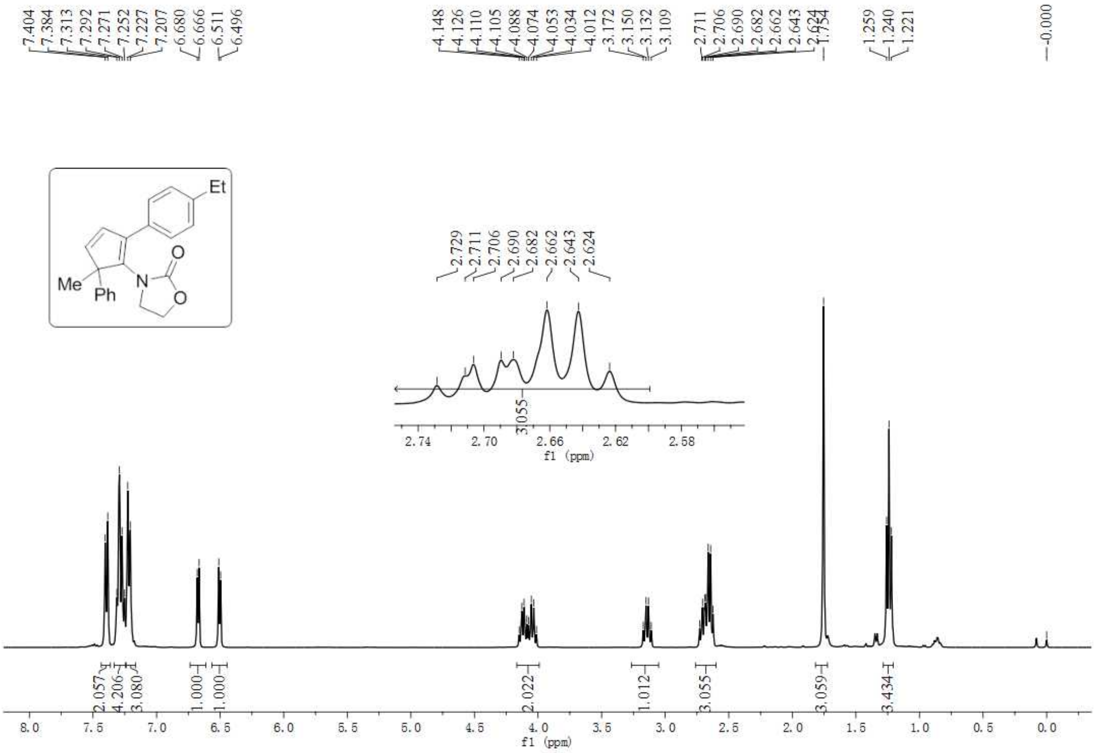
3b

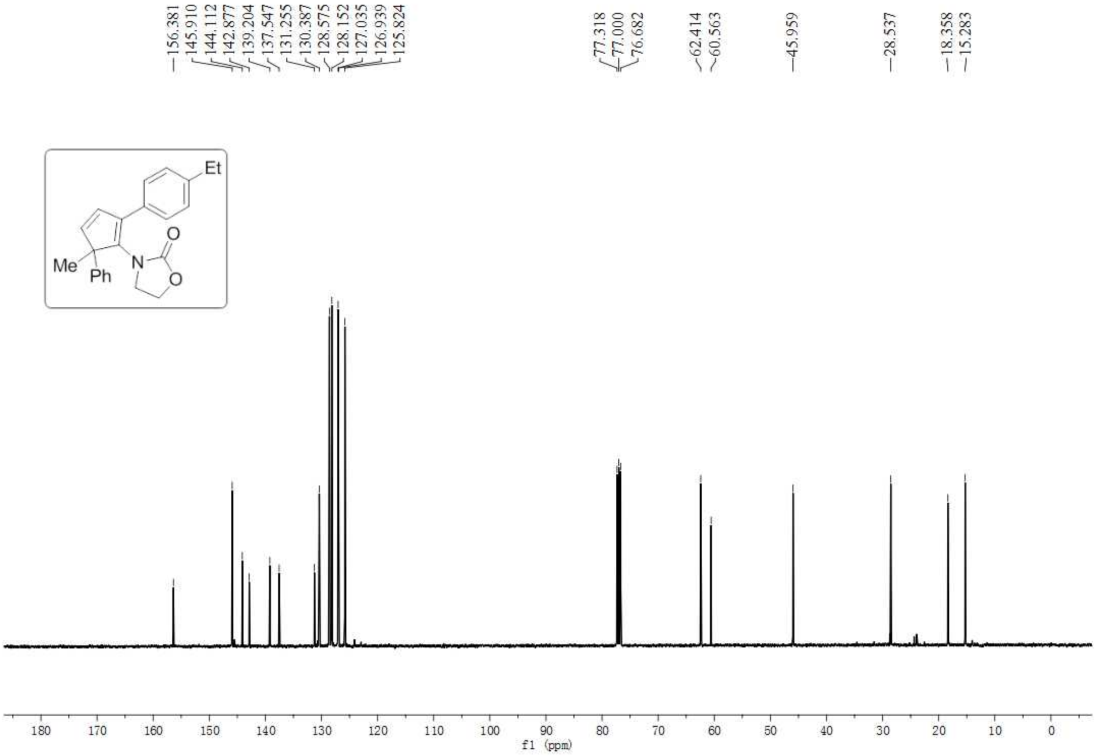


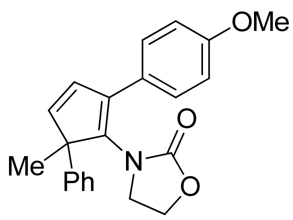



Et
O
Me
N
O
Ph

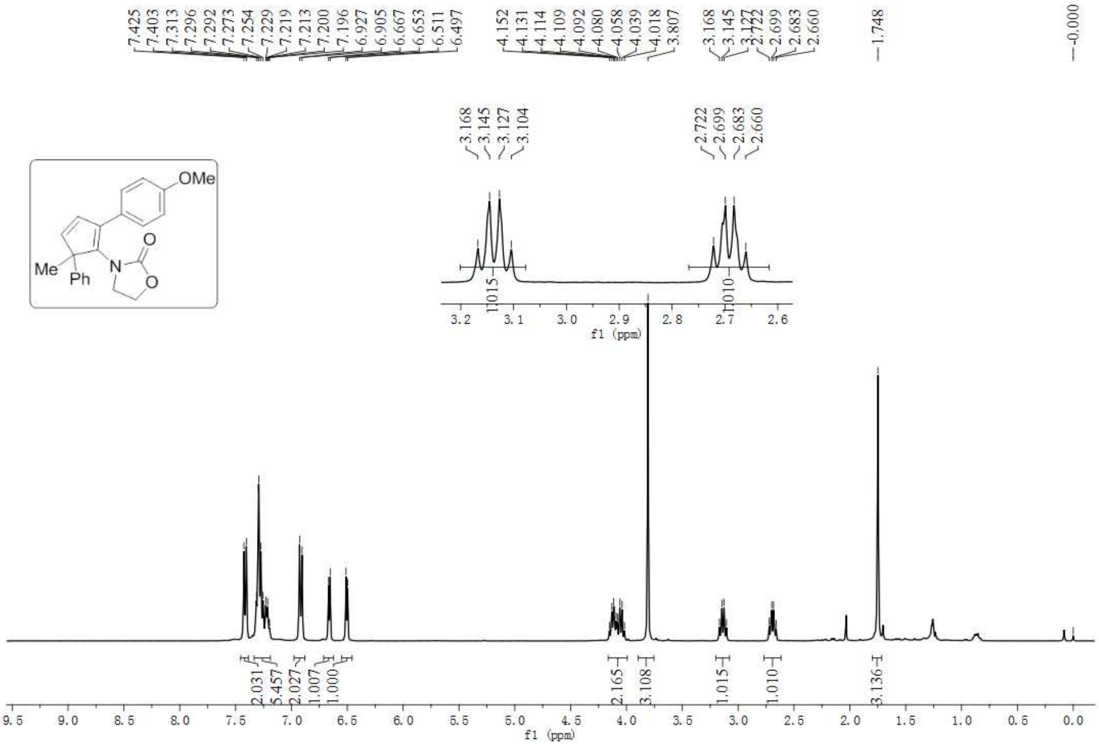
3c

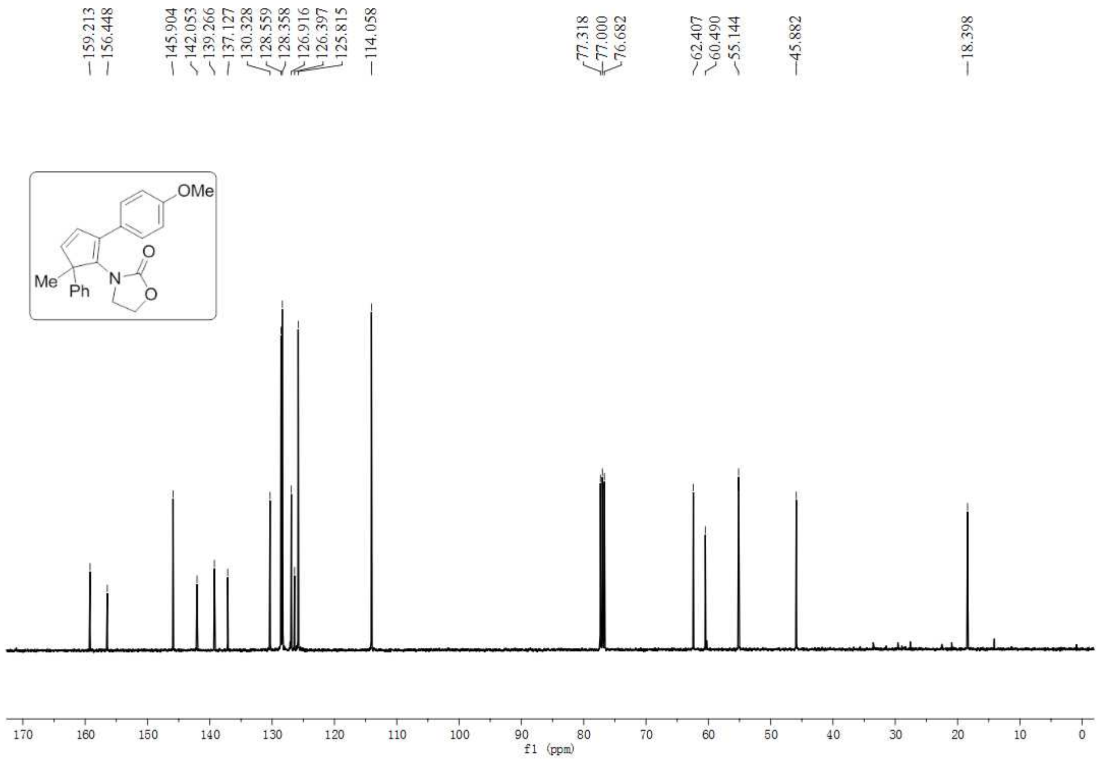

7.404
7.384
7.313
7.292
7.271
7.252
7.227
7.207
6.680
6.666
6.511
6.496
4.148
4.126
4.110
4.105
4.088
4.074
4.053
4.034
4.012
3.172
3.150
3.132
3.109
2.711
2.706
2.690
2.682
2.662
2.643
2.624
1.754
1.259
1.240
1.221
0.000
2.729
2.711
2.706
2.690
2.682
2.662
2.643
2.624
3.055
2.74
2.70
2.66
2.62
2.58
f1 (ppm)
2.057
4.206
3.080
1.000
1.000
2.022
1.012
3.055
3.059
3.434
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)

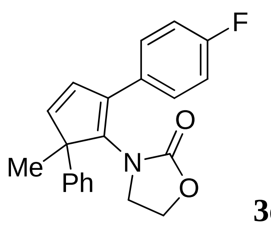

156.381
145.910
144.112
142.877
139.204
137.547
131.255
130.387
128.575
128.152
127.035
126.939
125.824
77.318
77.000
76.682
62.414
60.563
45.959
28.537
18.358
15.283
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



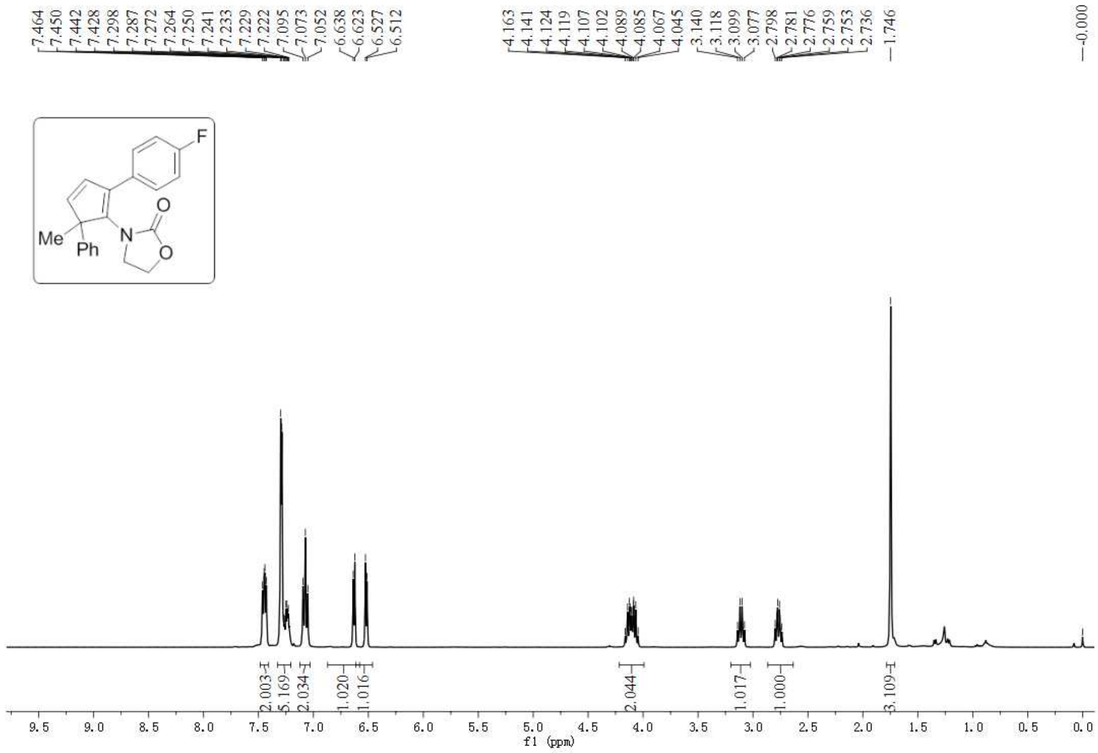
3d

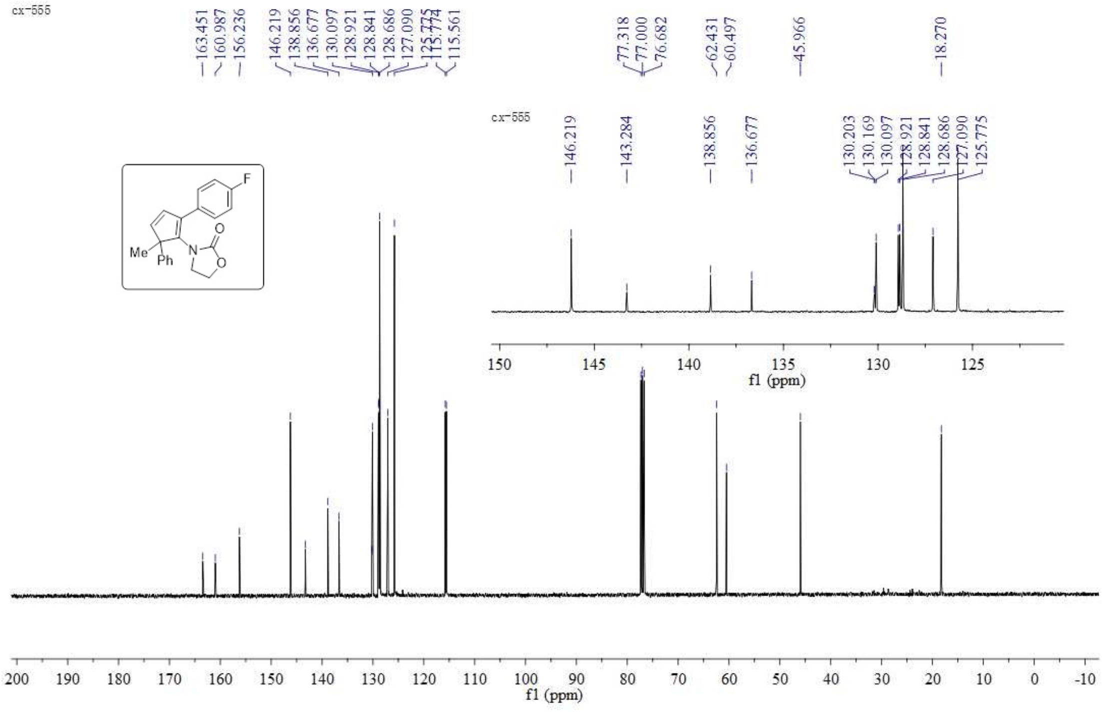

7.425
7.403
7.313
7.296
7.292
7.273
7.254
7.229
7.219
7.213
7.200
7.196
6.927
6.905
6.667
6.653
6.511
6.497
4.152
4.131
4.114
4.109
4.092
4.080
4.058
4.039
4.018
3.807
3.168
3.145
3.127
2.722
2.699
2.683
2.660
1.748
0.000
OMe
Me
Ph
N
O
3.168
3.145
3.127
3.104
2.722
2.699
2.683
2.660
1.015
1.010
f1 (ppm)
2.031
5.457
2.027
1.007
1.000
2.165
3.108
1.015
1.010
3.136
f1 (ppm)

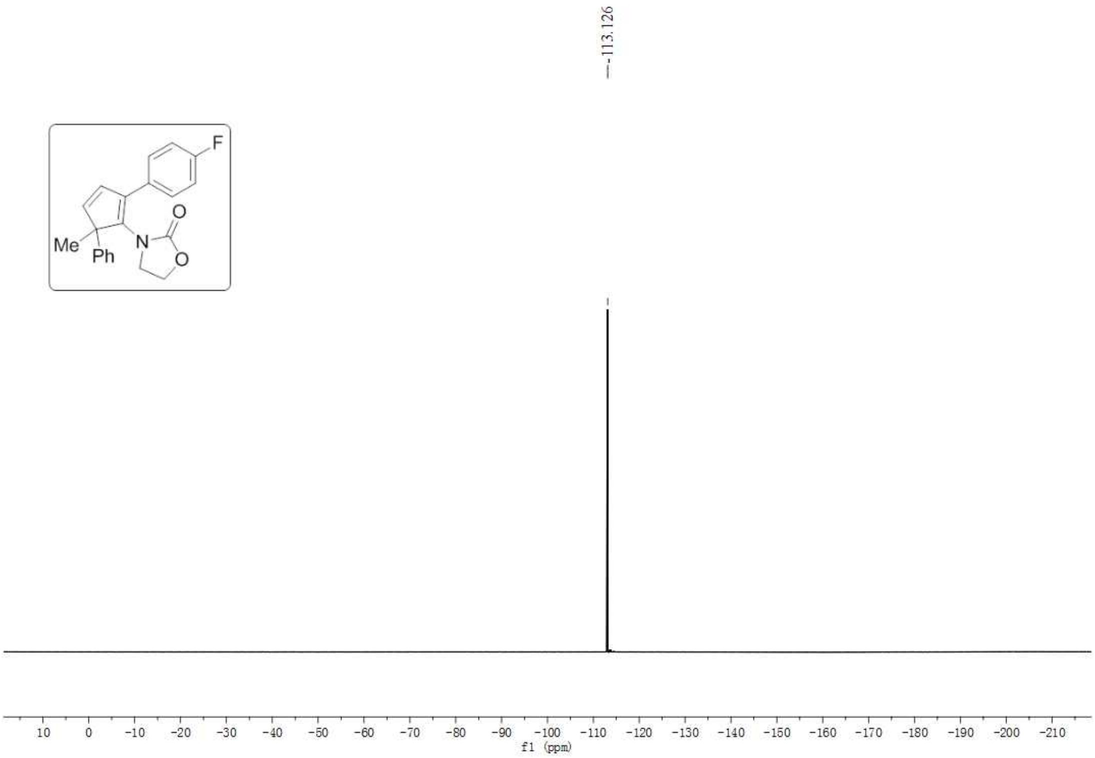

159.213
156.448
145.904
142.053
139.266
137.127
130.328
128.559
128.358
126.916
126.397
125.815
114.058
77.318
77.000
76.682
62.407
60.490
55.144
45.882
18.398
OMe
Me
Ph
N
O
f1 (ppm)

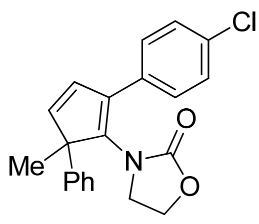


3e

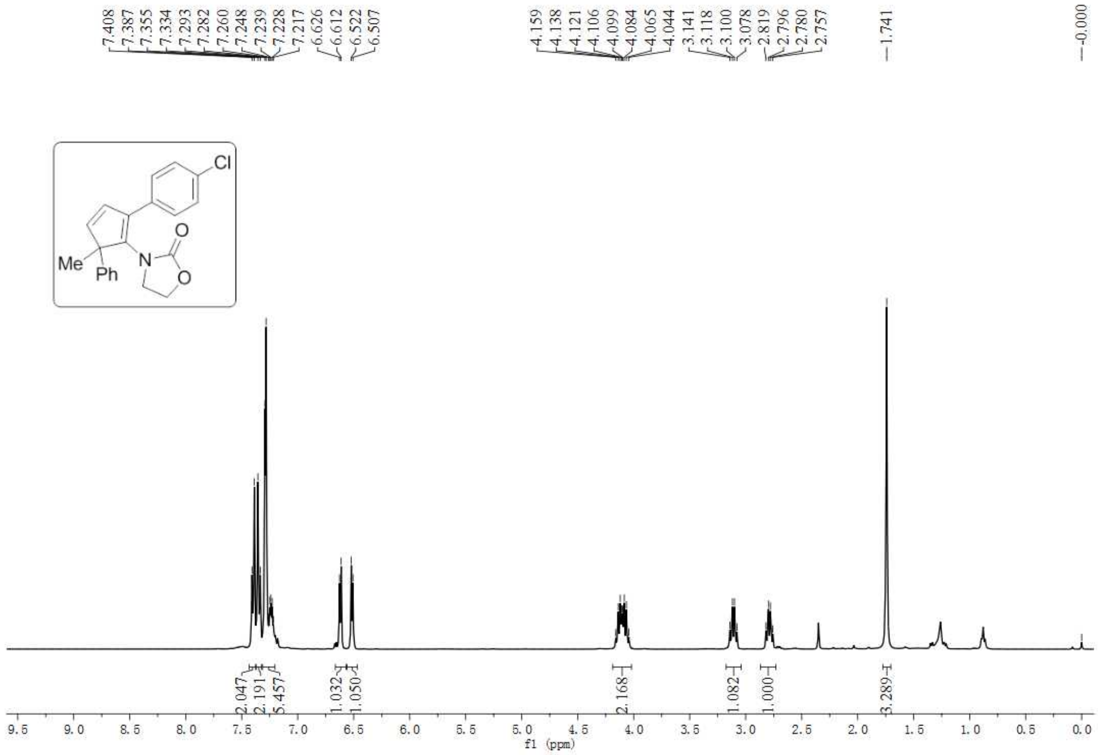


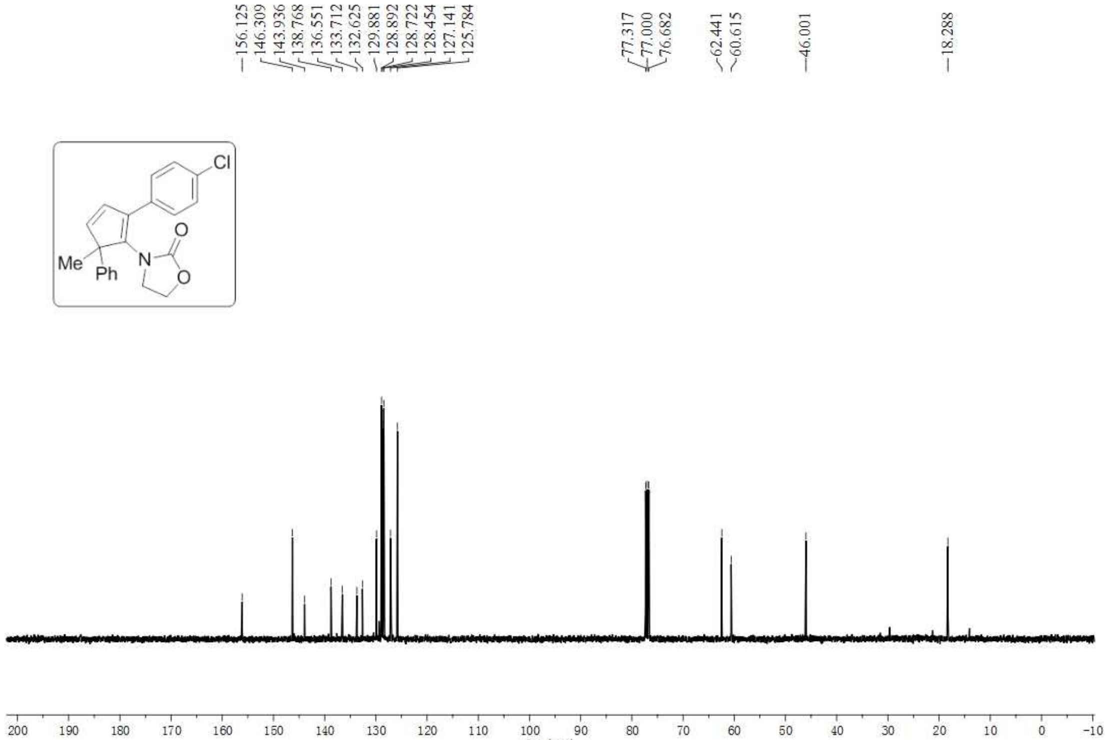



-113.126
F
O
Me
N
Ph
O
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)



3f


7.408
7.387
7.355
7.334
7.293
7.282
7.260
7.248
7.239
7.228
7.217
6.626
6.612
6.522
6.507
4.159
4.138
4.121
4.106
4.099
4.084
4.065
4.044
3.141
3.118
3.100
3.078
2.819
2.796
2.780
2.757
1.741
0.000
Cl
O
Me
N
Ph
O
2.047
2.191
5.457
1.032
1.050
2.168
1.082
1.000
3.289
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)


156.125
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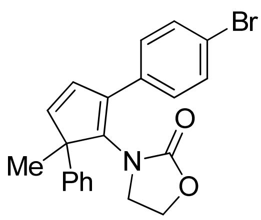
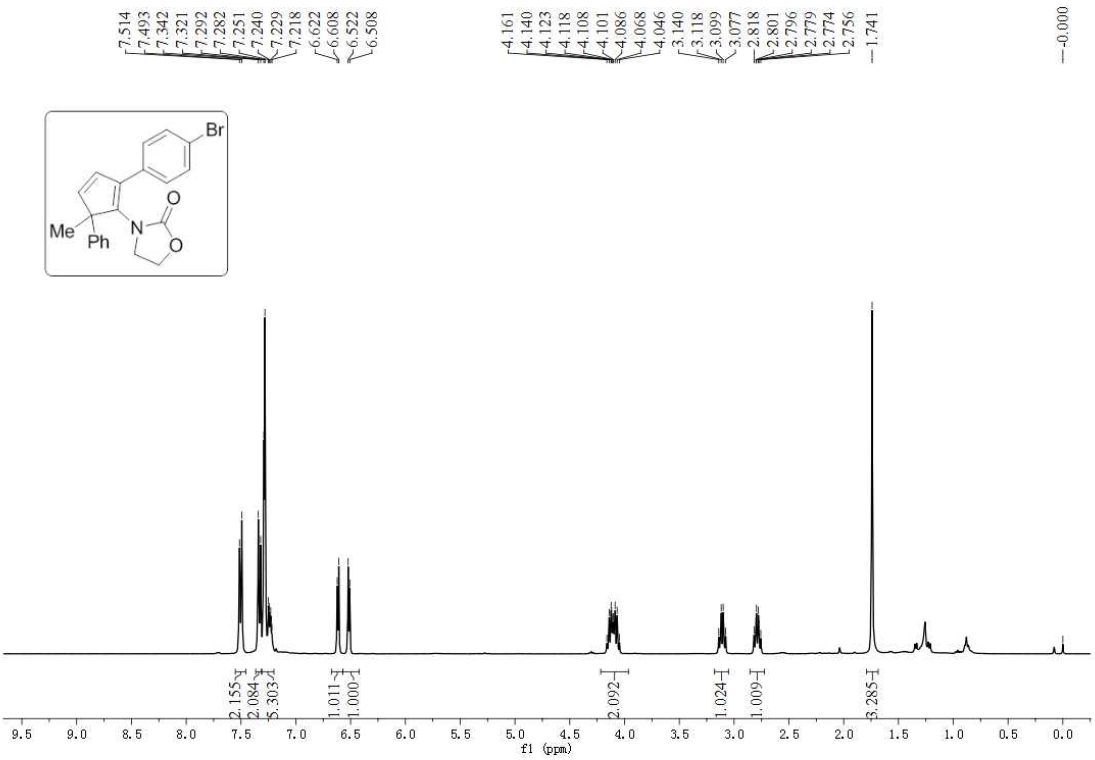
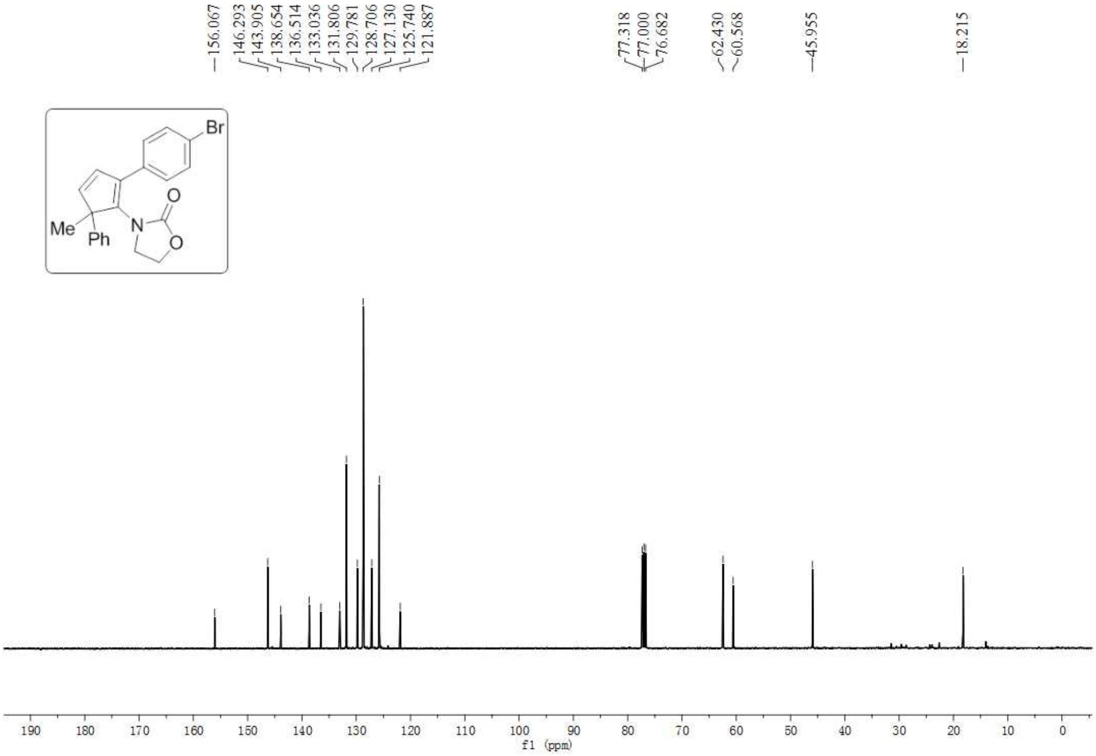
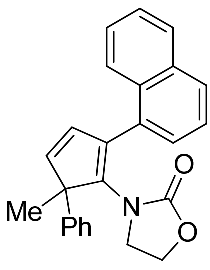
143.936
138.768
136.551
133.712
132.625
129.881
128.892
128.722
128.454
127.141
125.784
77.317
77.000
76.682
62.441
60.615
46.001
18.288
Cl
O
Me
N
Ph
O
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


Br
O
N
Me
Ph
O

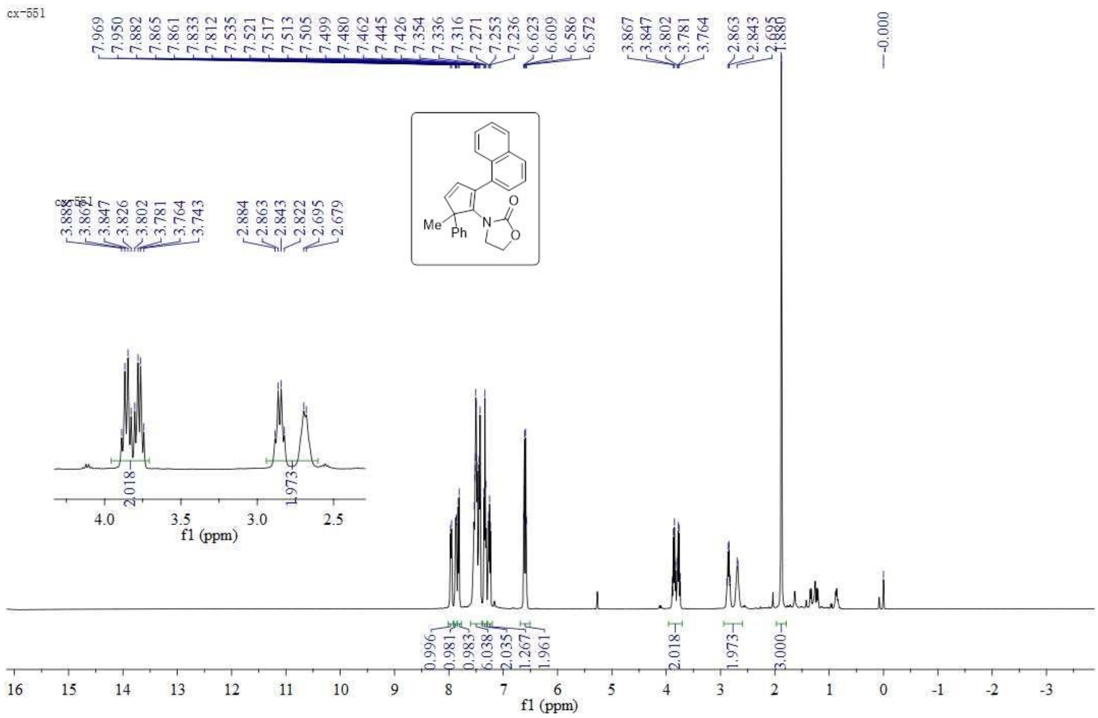
3g

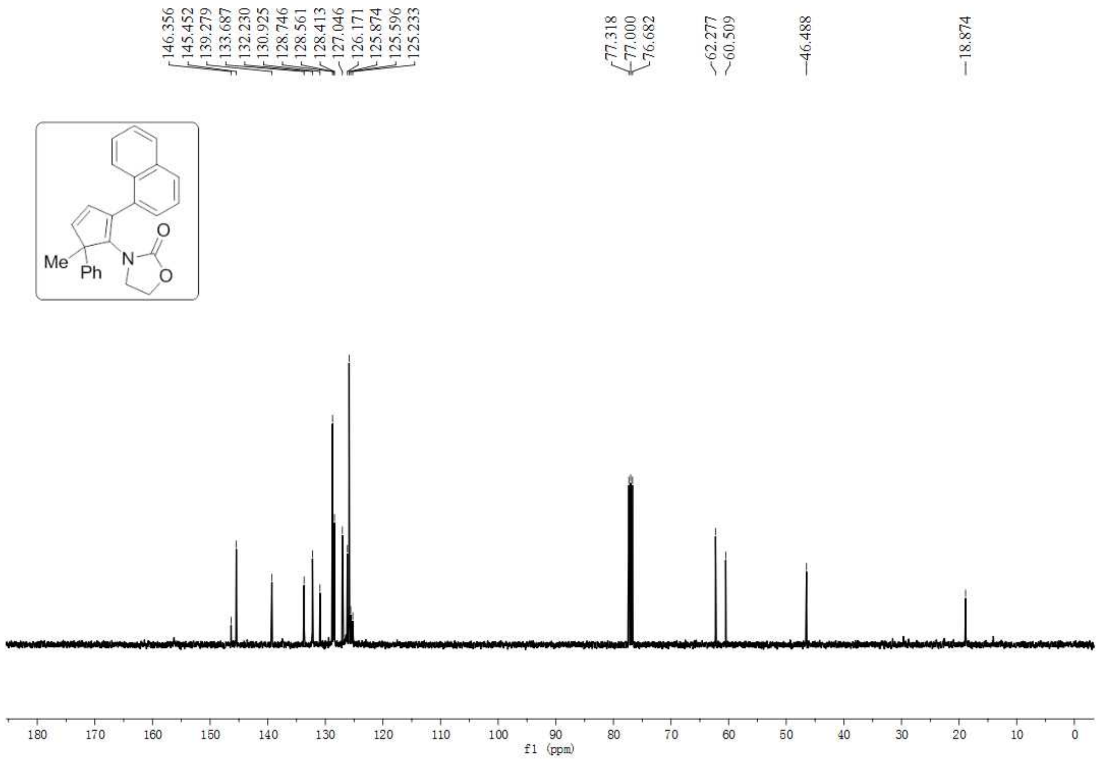

7.514
7.493
7.342
7.321
7.292
7.282
7.251
7.240
7.229
7.218
6.622
6.608
6.522
6.508
4.161
4.140
4.123
4.118
4.108
4.101
4.086
4.068
4.046
3.140
3.118
3.099
3.077
2.818
2.801
2.796
2.779
2.774
2.756
1.741
-0.000
2.155
2.084
5.303
1.011
1.000
2.092
1.024
1.009
3.285
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

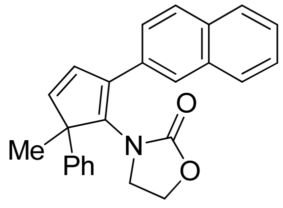

156.067
146.293
143.905
138.654
136.514
133.036
131.806
129.781
128.706
127.130
125.740
121.887
77.318
77.000
76.682
62.430
60.568
45.955
18.215
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



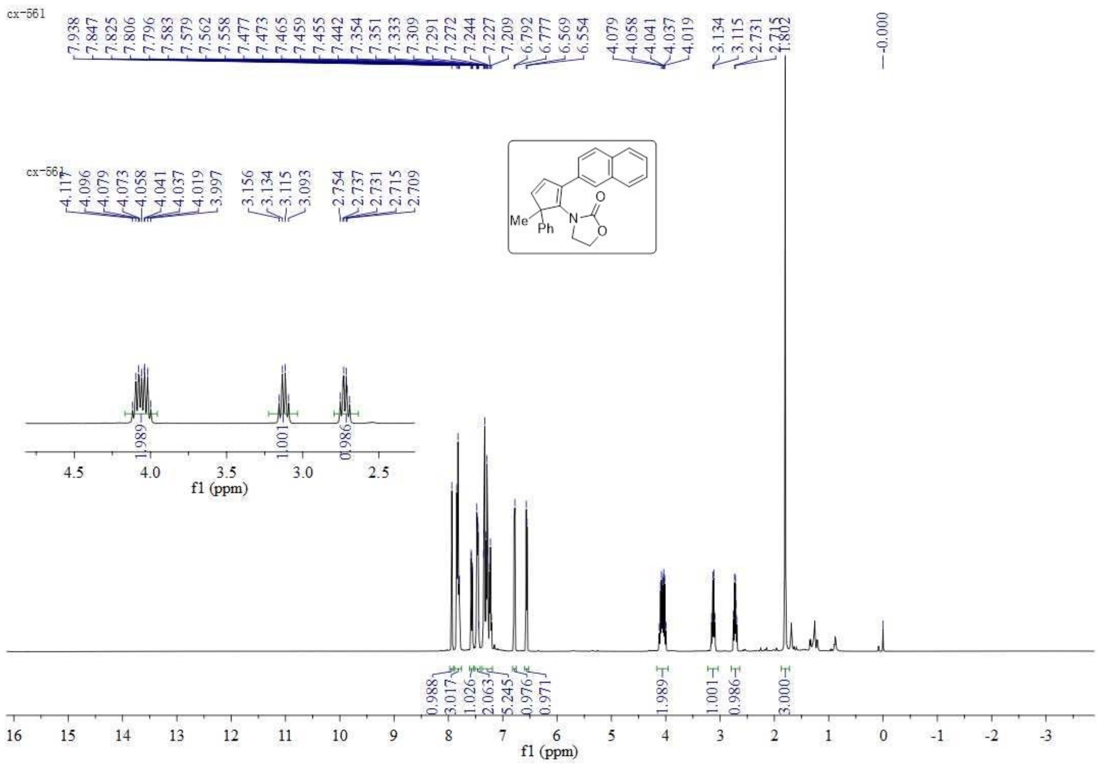
3h

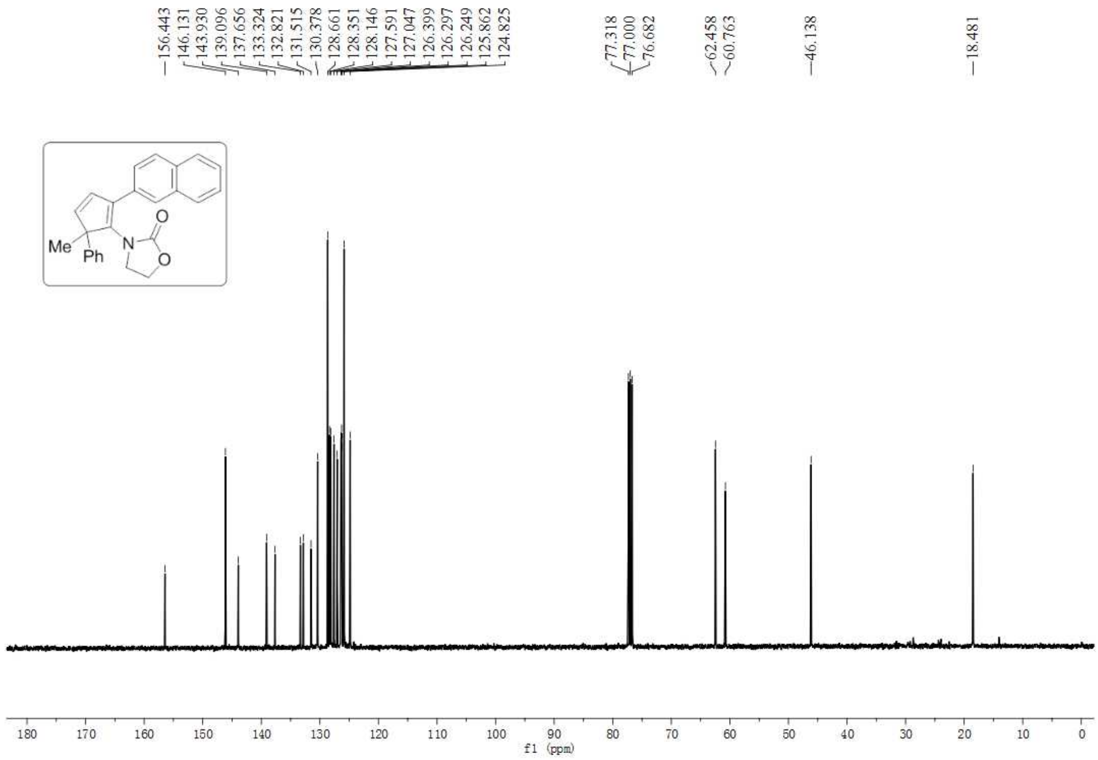

cx-551
7.969 7.950 7.882 7.865 7.861 7.833 7.812 7.535 7.521 7.517 7.513 7.505 7.499 7.480 7.462 7.445 7.426 7.354 7.336 7.316 7.271 7.253 7.236 6.623 6.609 6.586 6.572
3.867 3.847 3.802 3.781 3.764
2.863 2.843 2.695 1.880
-0.000
3.888 3.867 3.847 3.826 3.802 3.781 3.764 3.743
2.884 2.863 2.843 2.822 2.695 2.679
2.018
1.973
4.0 3.5 3.0 2.5
f1 (ppm)
Me
Ph
N
O
O
0.996 0.981 0.983 6.038 2.035 1.267 1.961
2.018
1.973
3.000
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)

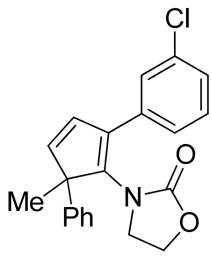

146.356 145.452 139.279 133.687 132.230 130.925 128.746 128.561 128.413 127.046 126.171 125.874 125.596 125.233
77.318 77.000 76.682
62.277 60.509
46.488
18.874
Me
Ph
N
O
O
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



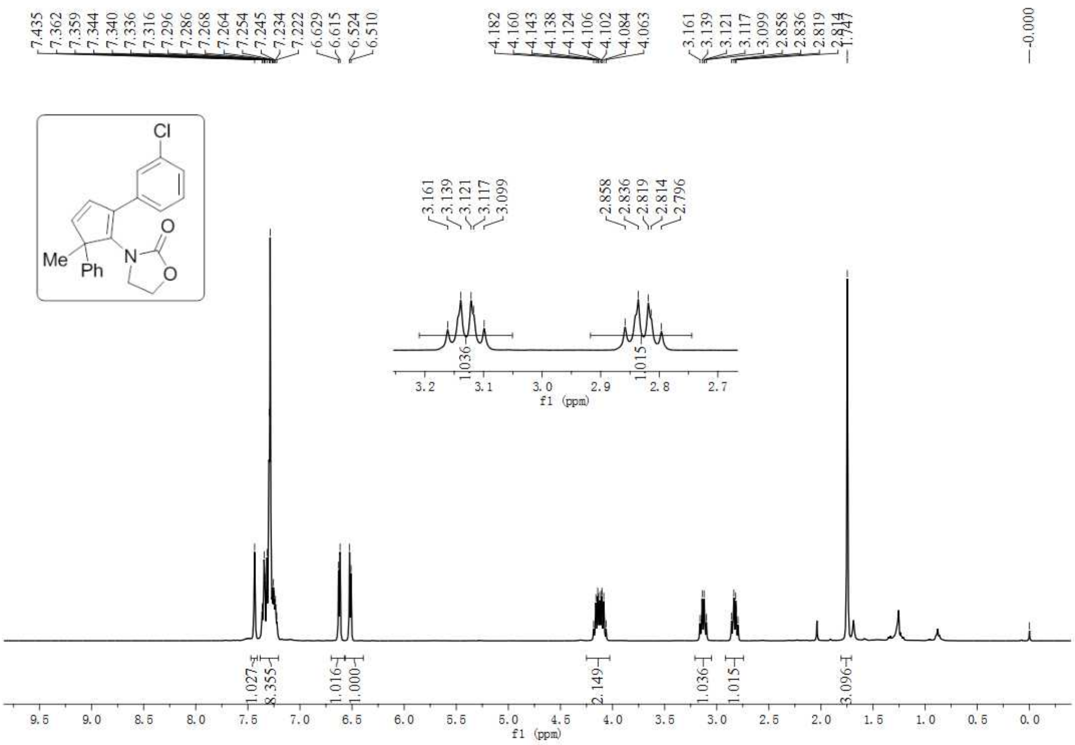
3i







3j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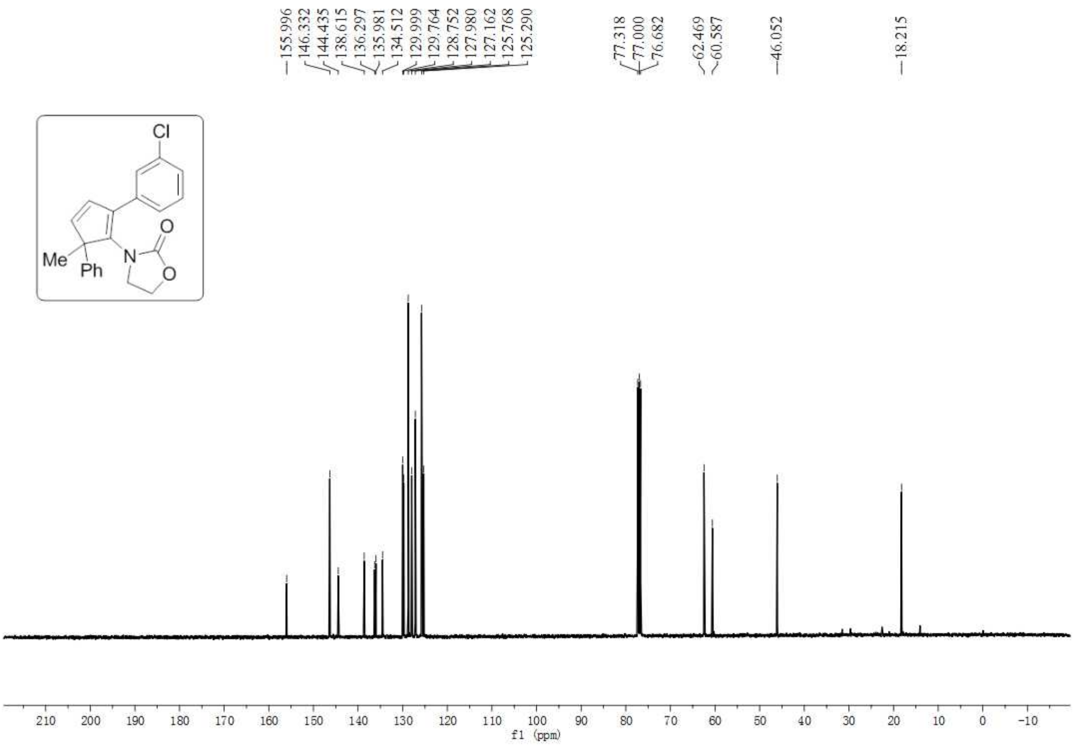
7.359
7.344
7.340
7.336
7.316
7.296
7.286
7.268
7.264
7.254
7.245
7.234
7.222
6.629
6.615
6.524
6.510
4.182
4.160
4.143
4.138
4.124
4.106
4.102
4.084
4.063
3.161
3.139
3.121
3.117
3.099
2.858
2.836
2.819
2.814
1.747
-0.000
1.036
1.015
3.2
3.1
3.0
2.9
2.8
2.7
f1 (ppm)
1.027
8.355
1.016
1.000
2.149
3.096
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)


155.996
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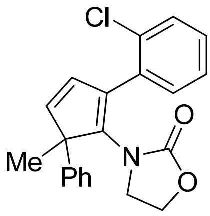
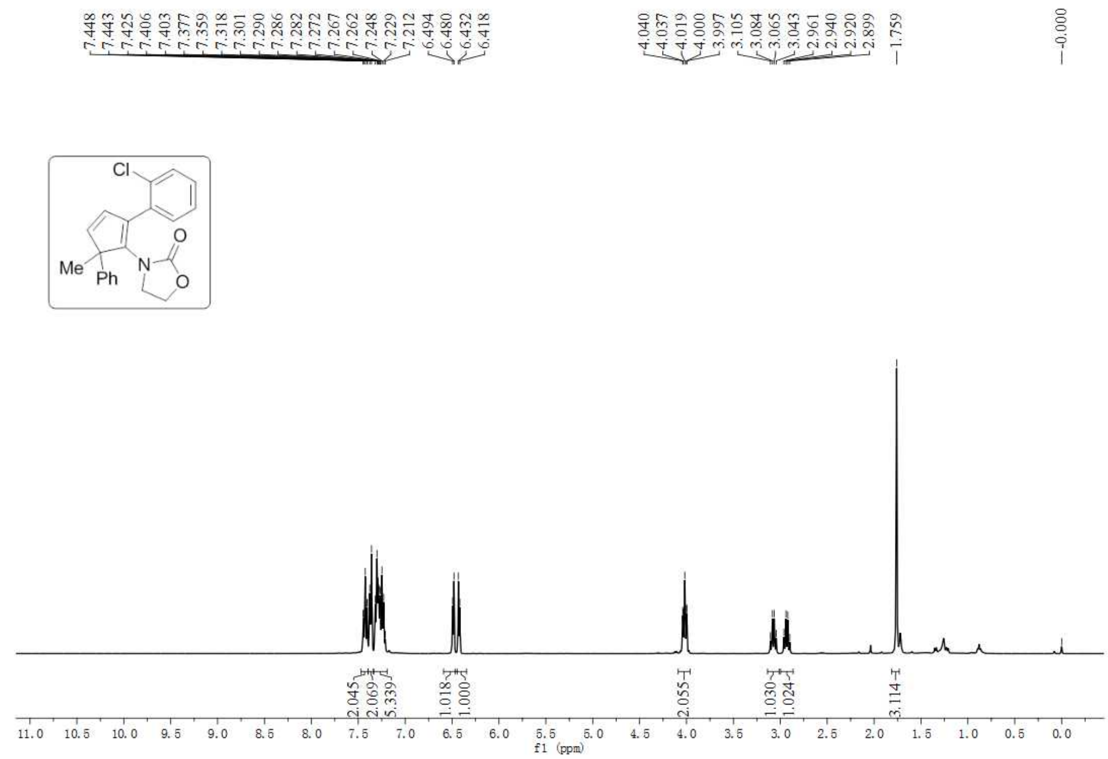
144.435
138.615
136.297
135.981
134.512
129.999
129.764
128.752
127.980
127.162
125.768
125.290
77.318
77.000
76.682
62.469
60.587
46.052
18.215
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)



3k



7.448
7.443
7.425
7.406
7.403
7.377
7.359
7.318
7.301
7.290
7.286
7.282
7.272
7.267
7.262
7.248
7.229
7.212
6.494
6.480
6.432
6.418
4.040
4.037
4.019
4.000
3.997
3.105
3.084
3.065
3.043
2.961
2.940
2.920
2.899
1.759
0.000
Cl
Me
Ph
N
O
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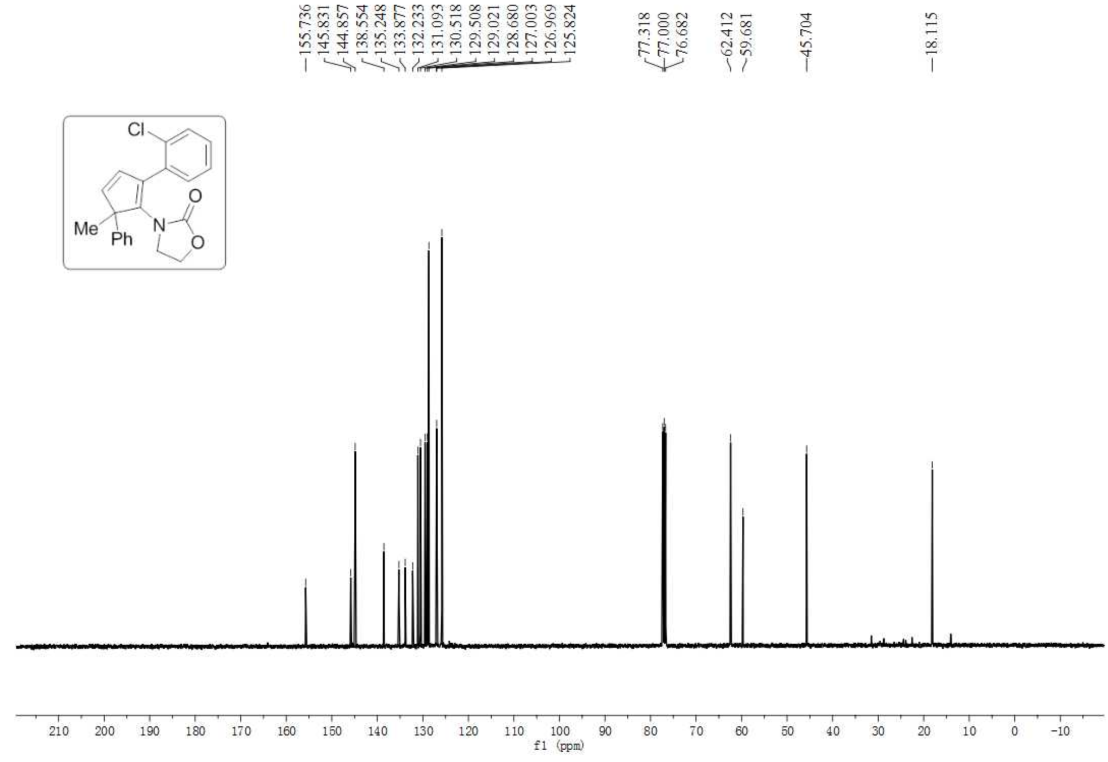
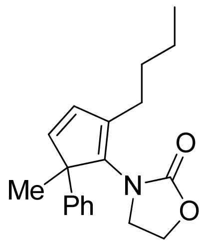
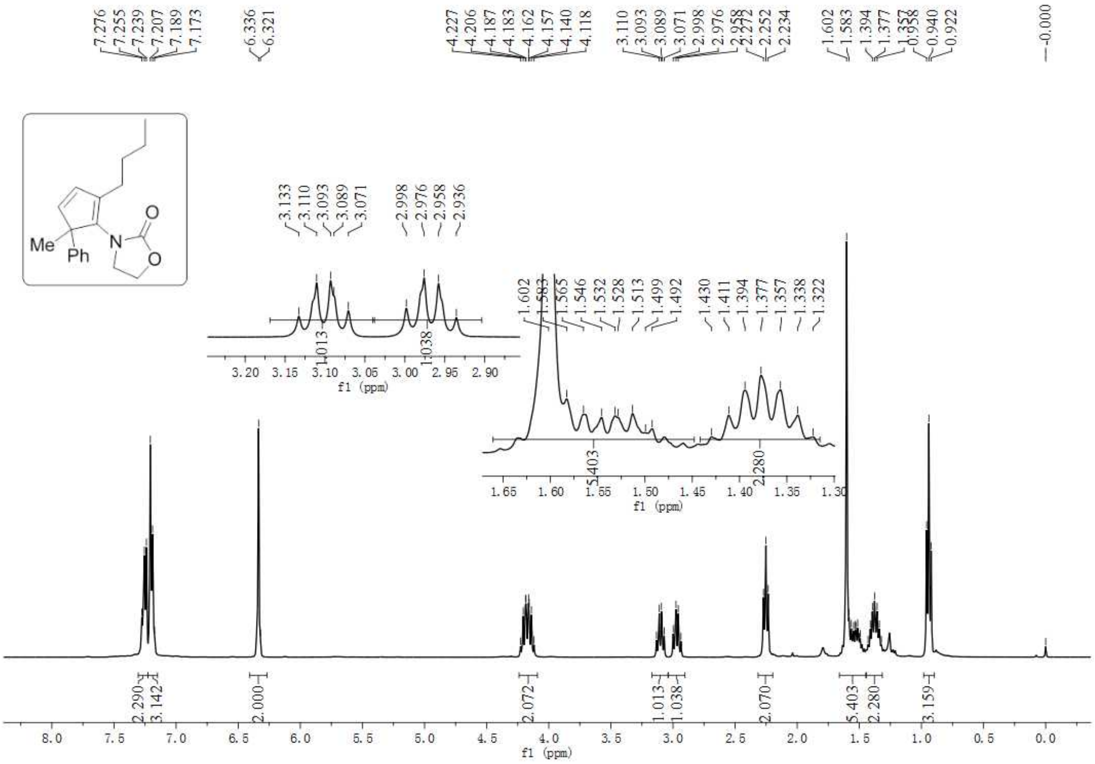
2.069
5.339
1.018
1.000
2.055
1.030
1.024
3.114
f1 (ppm)



155.736
145.831
144.857
138.554
135.248
133.877
132.233
131.093
130.518
129.508
129.021
128.680
127.003
126.969
125.824
77.318
77.000
76.682
62.412
59.681
45.704
18.115
Cl
Me
Ph
N
O
f1 (ppm)


Me
Ph
N
O
O

3l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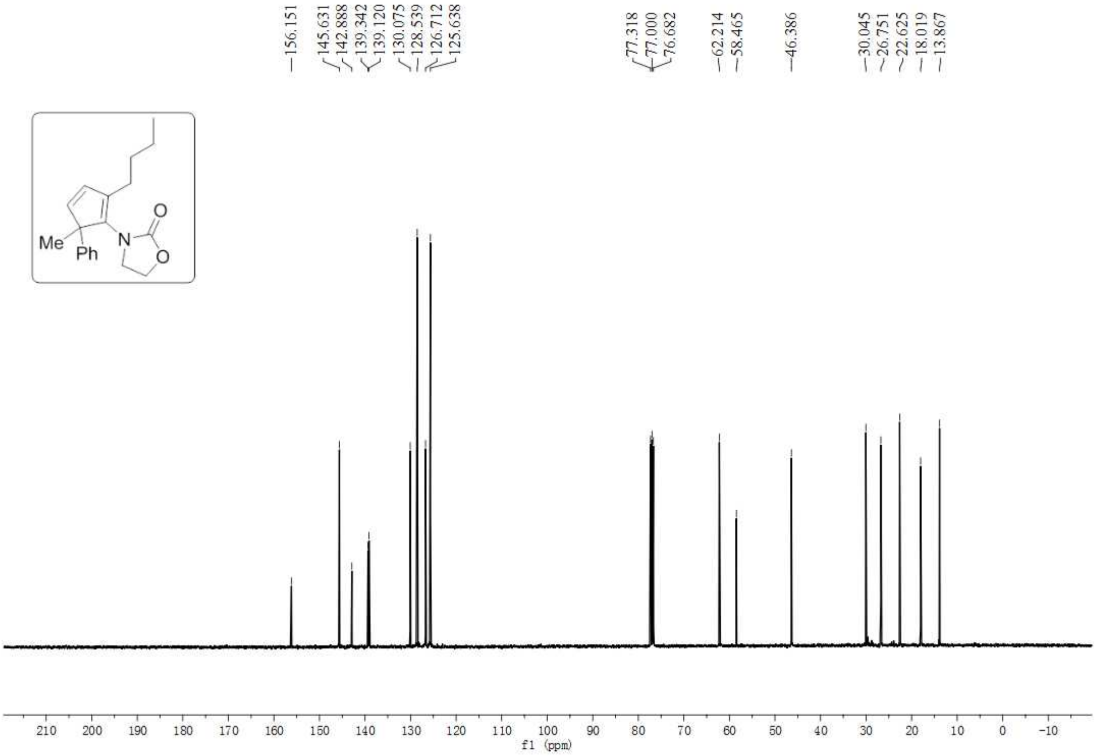
7.207
7.189
7.173
6.336
6.321
4.227
4.206
4.187
4.183
4.162
4.157
4.140
4.118
3.110
3.093
3.089
3.071
2.998
2.976
2.958
2.272
2.252
2.234
1.602
1.583
1.394
1.377
1.357
0.958
0.940
0.922
0.000
3.133
3.110
3.093
3.089
3.071
2.998
2.976
2.958
2.936
1.013
1.038
3.20 3.15 3.10 3.05 3.00 2.95 2.90
f1 (ppm)
1.602
1.583
1.565
1.546
1.532
1.528
1.513
1.499
1.492
1.430
1.411
1.394
1.377
1.357
1.338
1.322
5.403
2.280
1.65 1.60 1.55 1.50 1.45 1.40 1.35 1.30
f1 (ppm)
2.290
3.142
2.000
2.072
1.013
1.038
2.070
5.403
2.280
3.159
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)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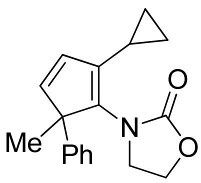
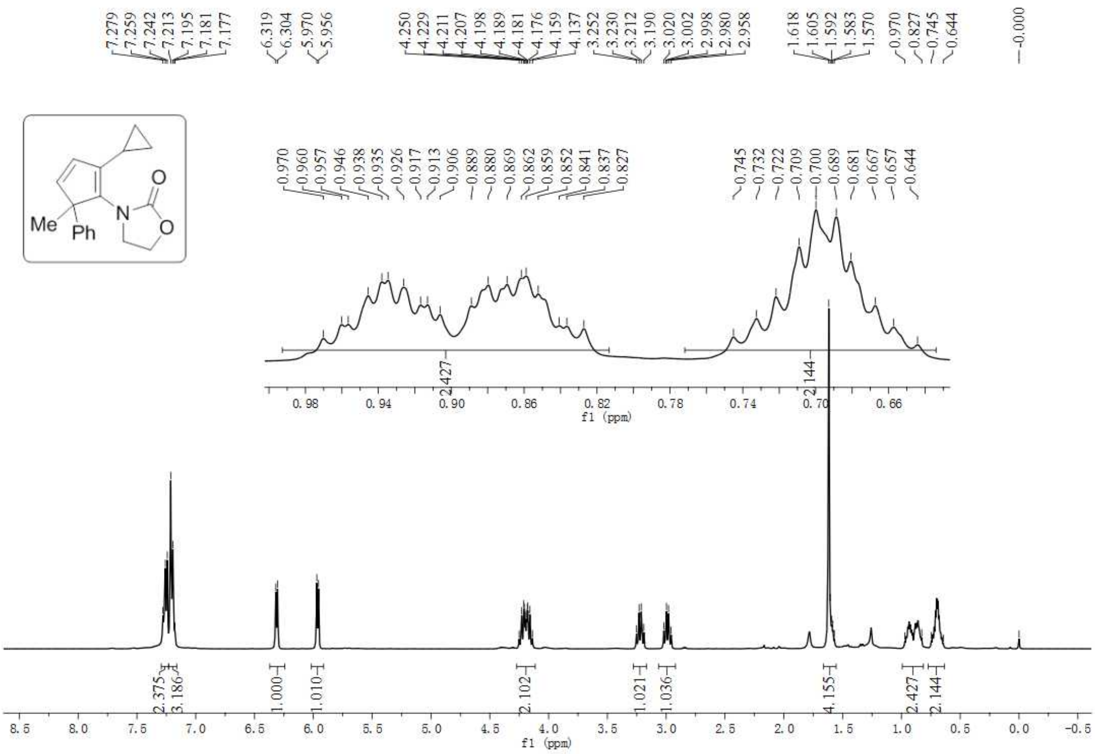
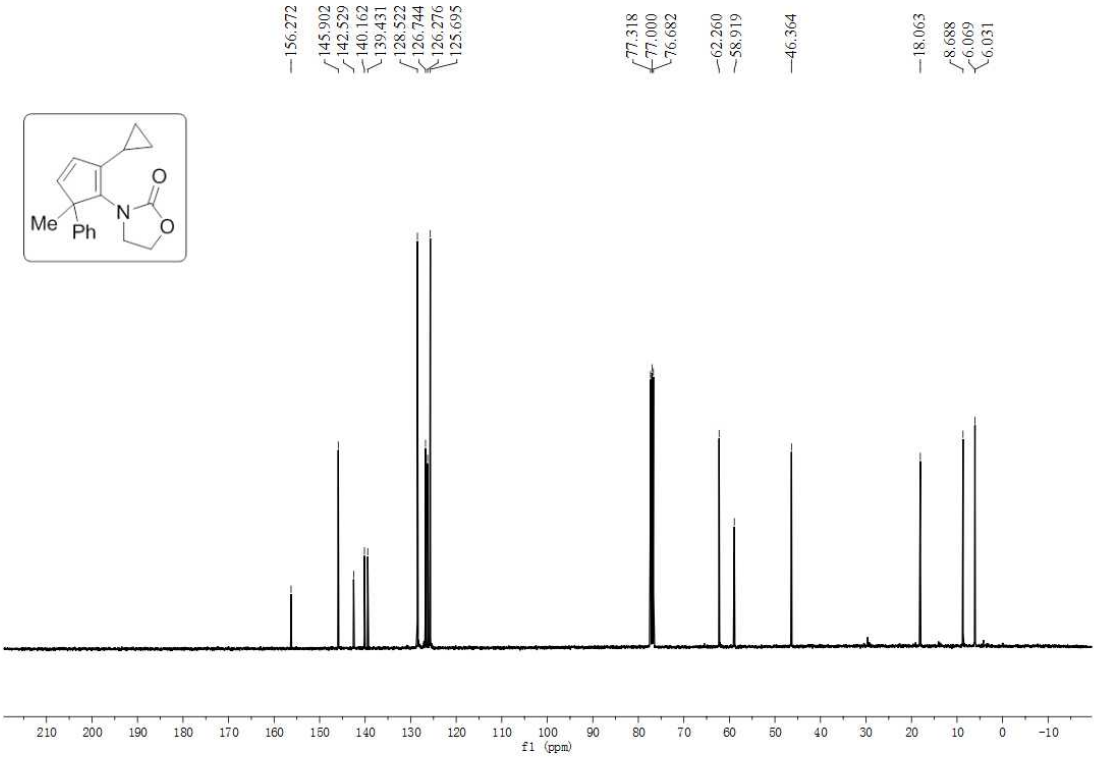
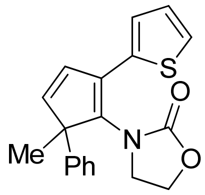
142.888
139.342
139.120
130.075
128.539
126.712
125.638
77.318
77.000
76.682
62.214
58.465
46.386
30.045
26.751
22.625
18.019
13.867
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



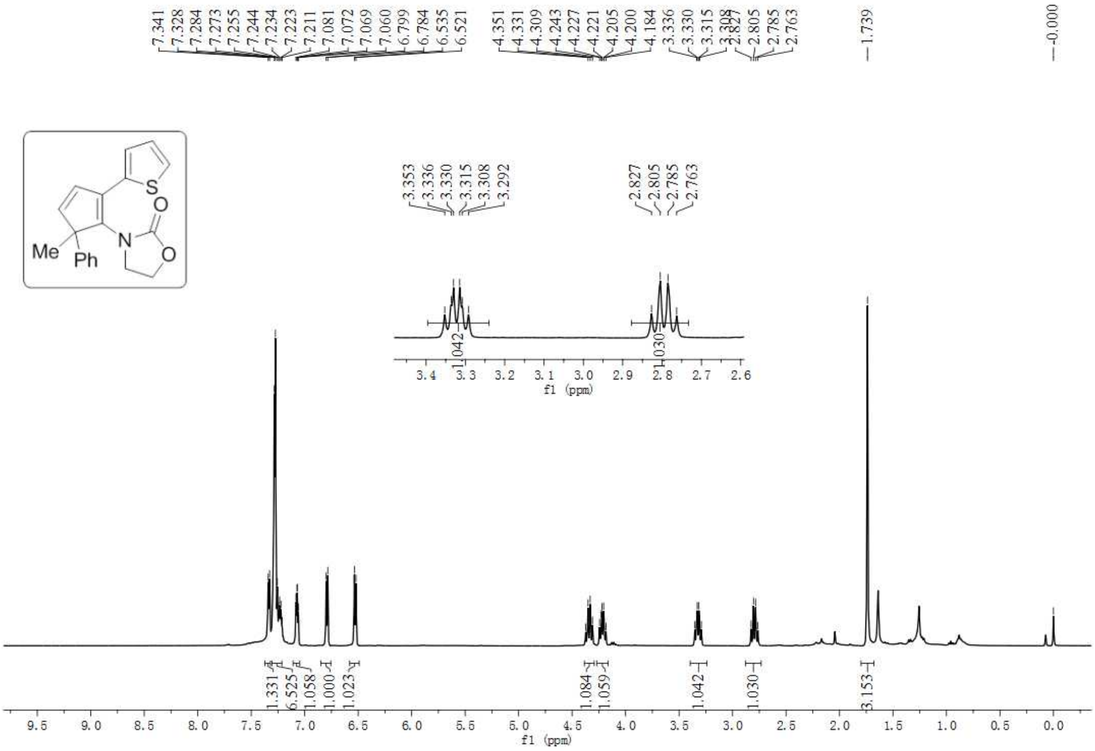
3m

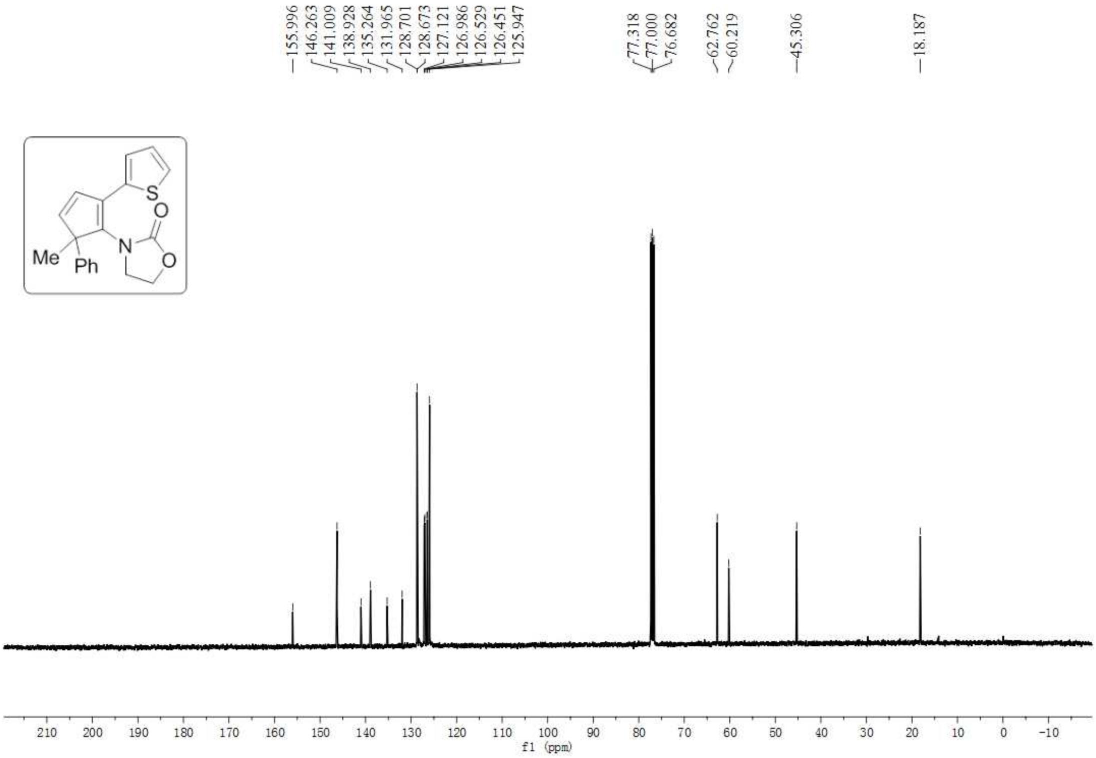

7.279
7.259
7.242
7.213
7.195
7.181
7.177
6.319
6.304
5.970
5.956
4.250
4.229
4.211
4.207
4.198
4.189
4.181
4.176
4.159
4.137
3.252
3.230
3.212
3.190
3.020
3.002
2.998
2.980
2.958
1.618
1.605
1.592
1.583
1.570
0.970
0.827
0.745
0.644
0.000
Me
Ph
N
O
O
0.970
0.960
0.957
0.946
0.938
0.935
0.926
0.917
0.913
0.906
0.889
0.880
0.869
0.862
0.859
0.852
0.841
0.837
0.827
0.745
0.732
0.722
0.709
0.700
0.689
0.681
0.667
0.657
0.644
2.427
2.144
f1 (ppm)
2.375
3.186
1.000
1.010
2.102
1.021
1.036
4.155
2.427
2.144
f1 (ppm)

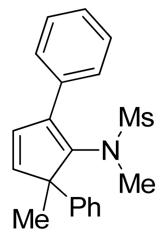

156.272
145.902
142.529
140.162
139.431
128.522
126.744
126.276
125.695
77.318
77.000
76.682
62.260
58.919
46.364
18.063
8.688
6.069
6.031
Me
Ph
N
O
O
f1 (ppm)



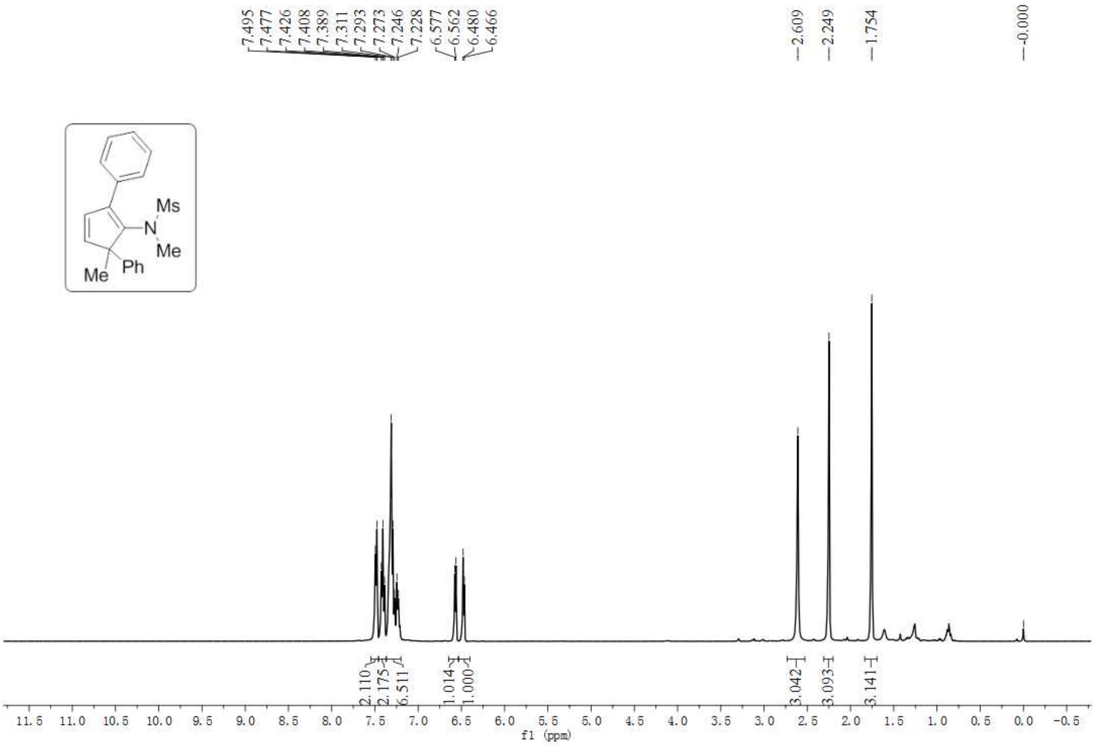
3n

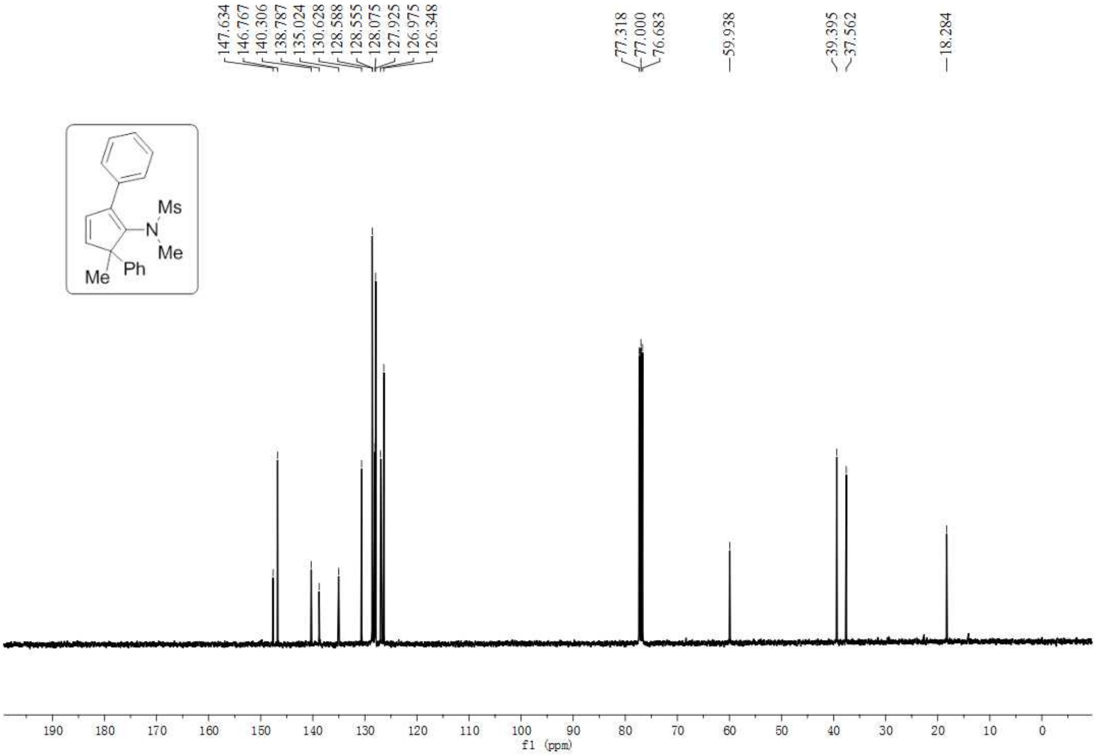

7.341
7.328
7.284
7.273
7.255
7.244
7.234
7.223
7.211
7.081
7.072
7.069
7.060
6.799
6.784
6.535
6.521
4.351
4.331
4.309
4.243
4.227
4.221
4.205
4.200
4.184
3.336
3.330
3.315
3.308
2.827
2.805
2.785
2.763
1.739
0.000
3.353
3.292
f1 (ppm)

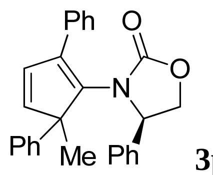

155.996
146.263
141.009
138.928
135.264
131.965
128.701
128.673
127.121
126.986
126.529
126.451
125.947
77.318
77.000
76.682
62.762
60.219
45.306
18.187
f1 (ppm)


Ms
N
Me
Me
Ph

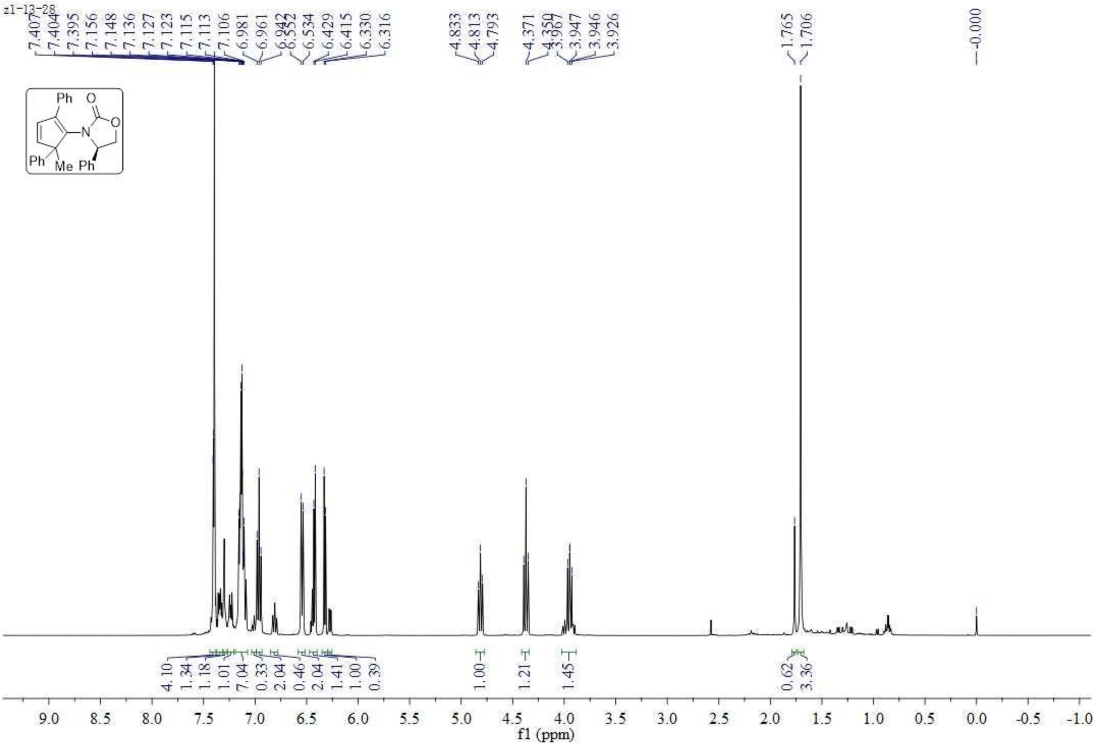
3o

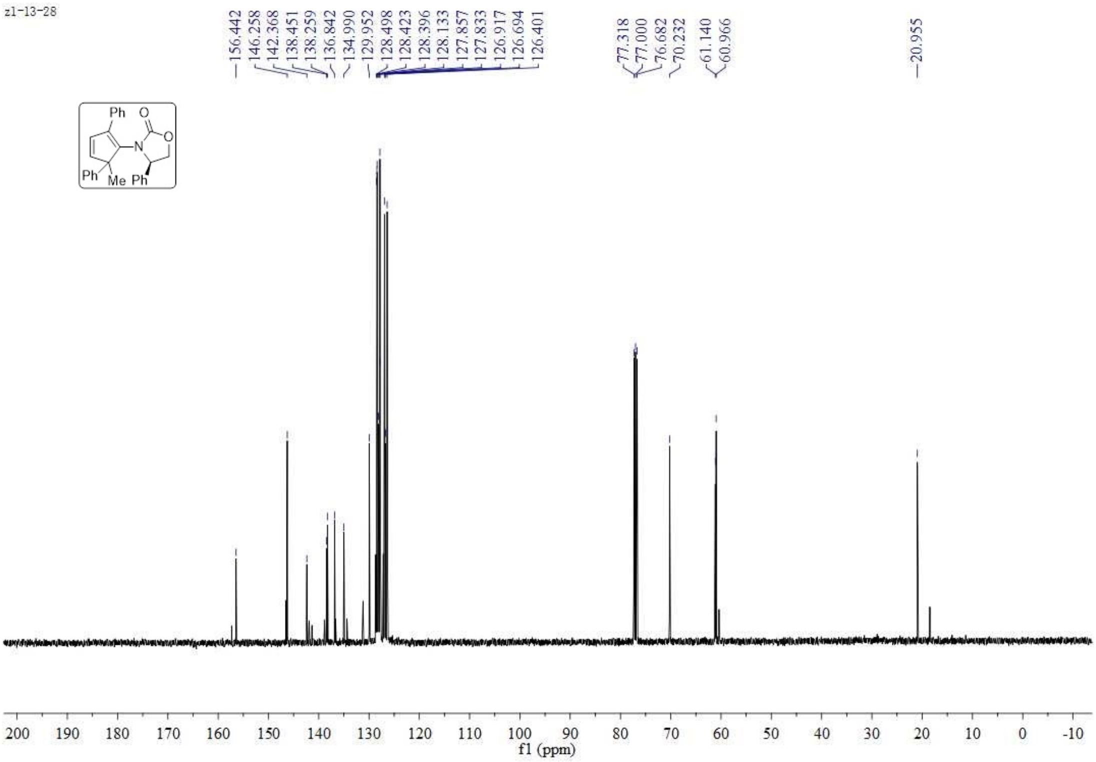

7.495
7.477
7.426
7.408
7.389
7.311
7.293
7.273
7.246
7.228
6.577
6.562
6.480
6.466
2.609
2.249
1.754
0.000
Ms
N
Me
Me
Ph
2.110
2.175
6.511
1.014
1.000
3.042
3.093
3.141
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

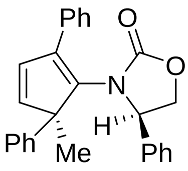

147.634
146.767
140.306
138.787
135.024
130.628
128.588
128.555
128.075
127.925
126.975
126.348
77.318
77.000
76.683
59.938
39.395
37.562
18.284
Ms
N
Me
Me
Ph
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Ph
O
N
O
Ph
Me
Ph

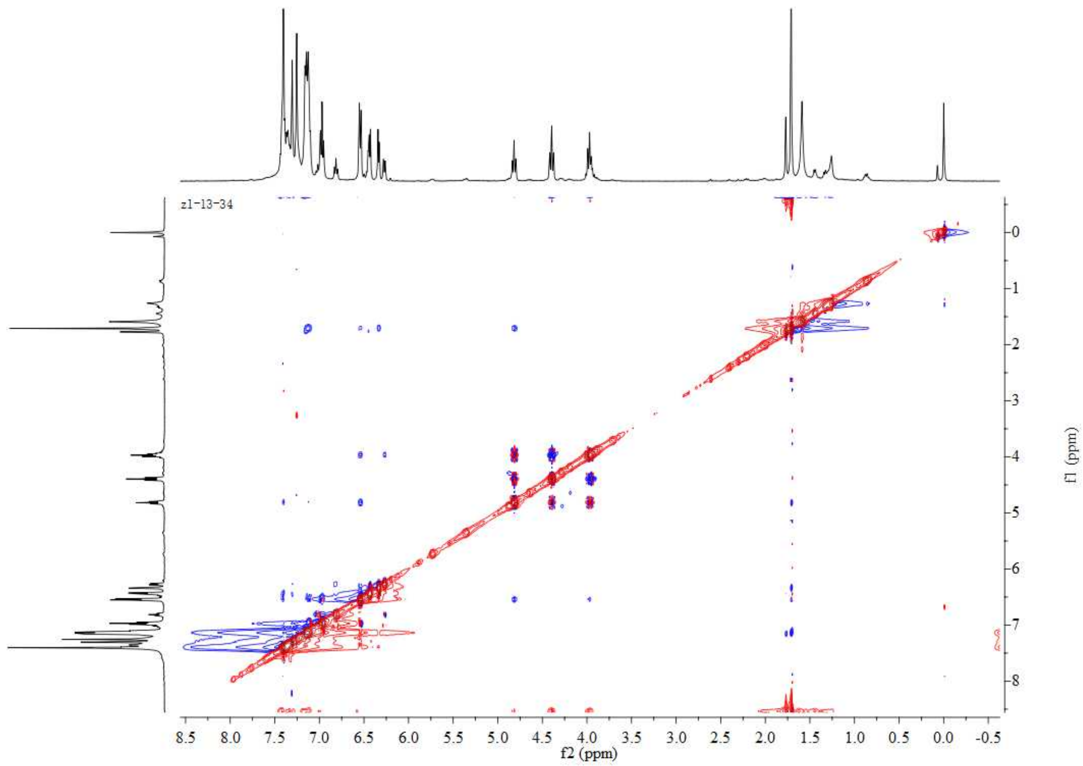
3p

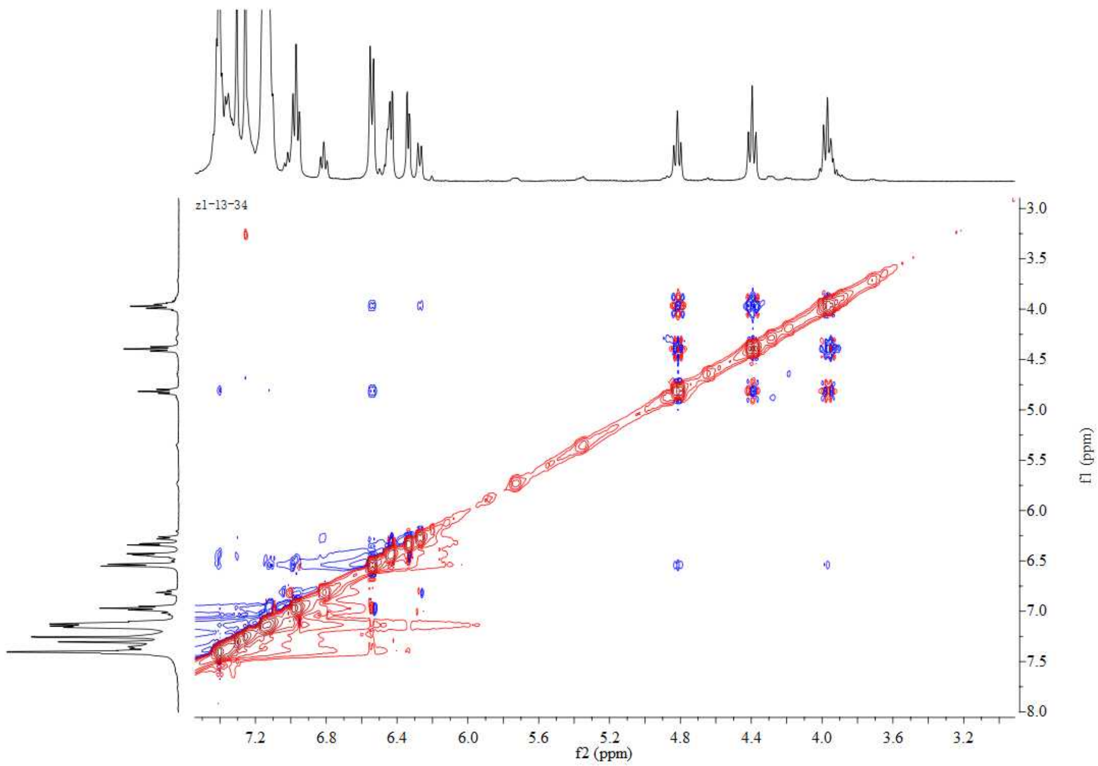

zl-13-28
7.407
7.404
7.395
7.156
7.148
7.136
7.127
7.123
7.115
7.113
7.106
6.981
6.961
6.942
6.552
6.534
6.429
6.415
6.330
6.316
4.833
4.813
4.793
4.371
4.350
3.967
3.947
3.946
3.926
1.765
1.706
0.000
4.10
1.34
1.18
1.01
7.04
0.33
2.04
0.46
2.04
1.41
1.00
0.39
1.00
1.21
1.45
0.62
3.36
f1 (ppm)

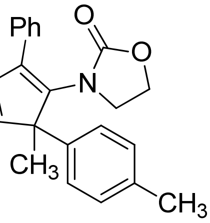

zl-13-28
156.442
146.258
142.368
138.451
138.259
136.842
134.990
129.952
128.498
128.423
128.396
128.133
127.857
127.833
126.917
126.694
126.401
77.318
77.000
76.682
70.232
61.140
60.966
20.955
f1 (ppm)



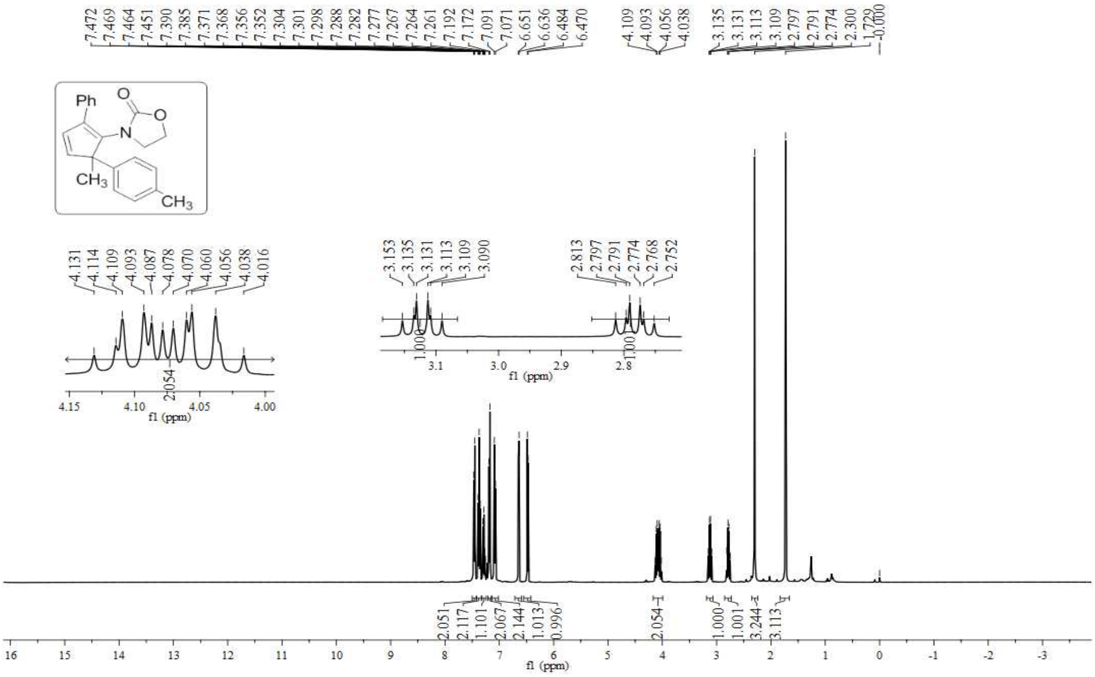
3p NOE

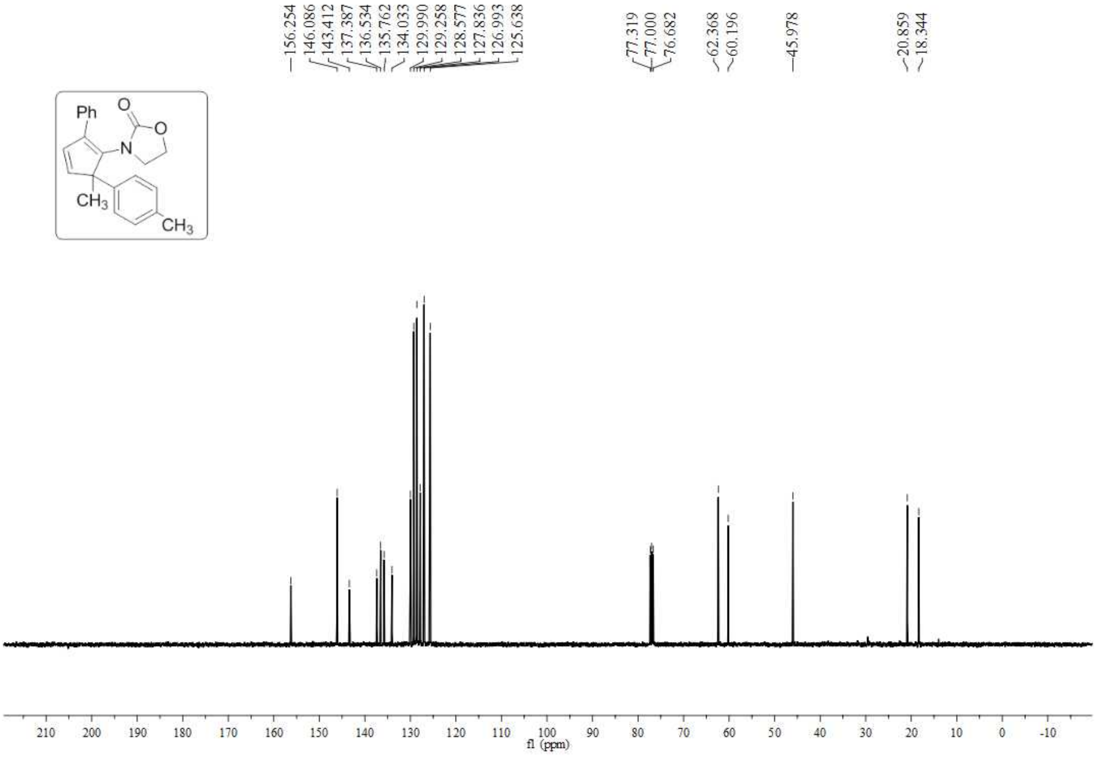


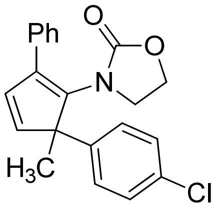


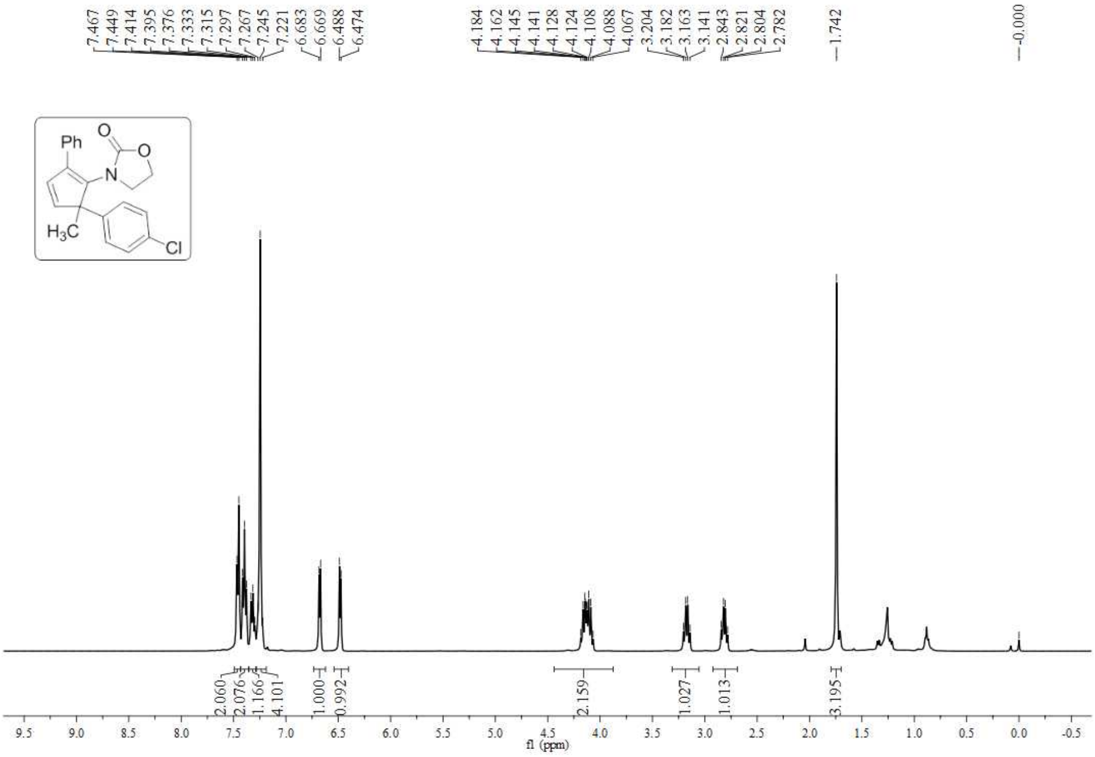


3q






Ph
O
O
N
H3C
Cl
3r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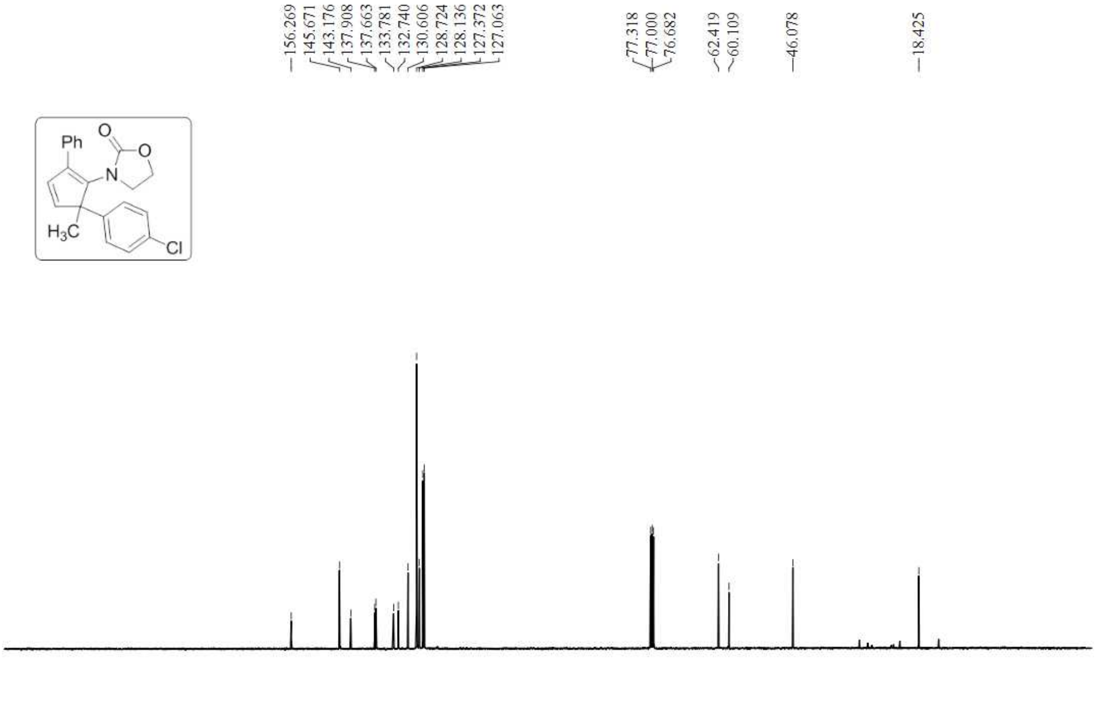
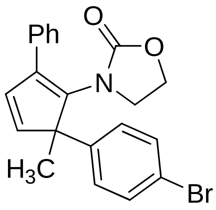
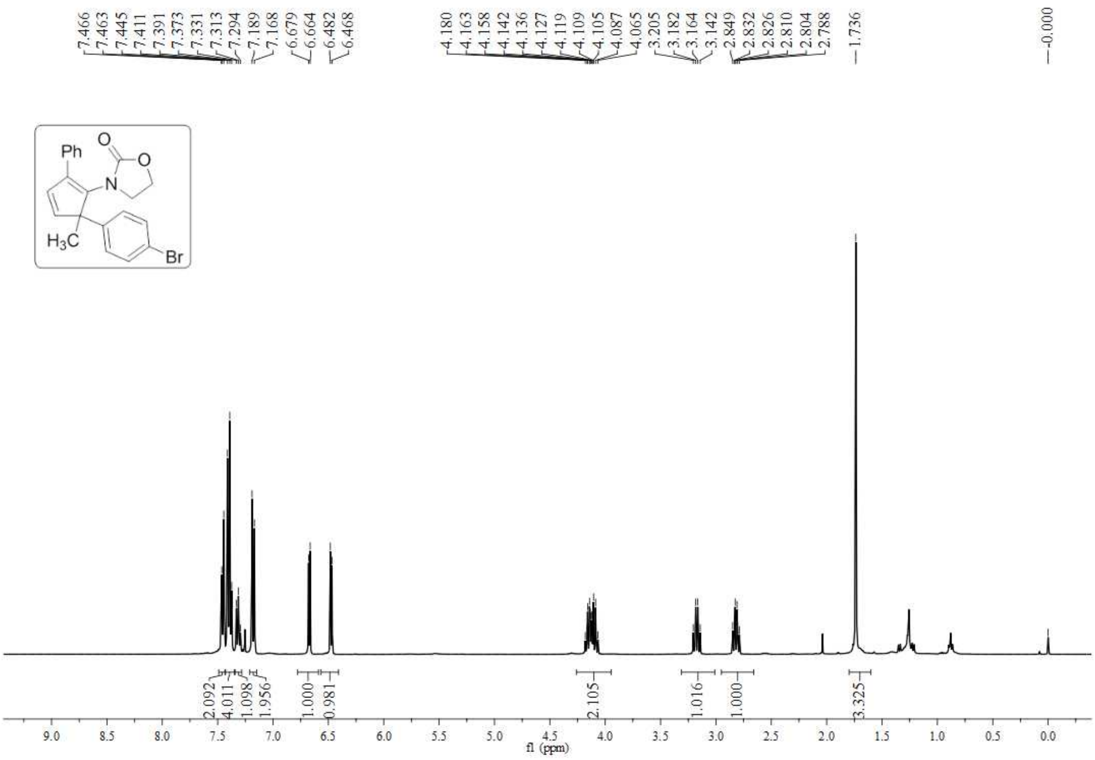
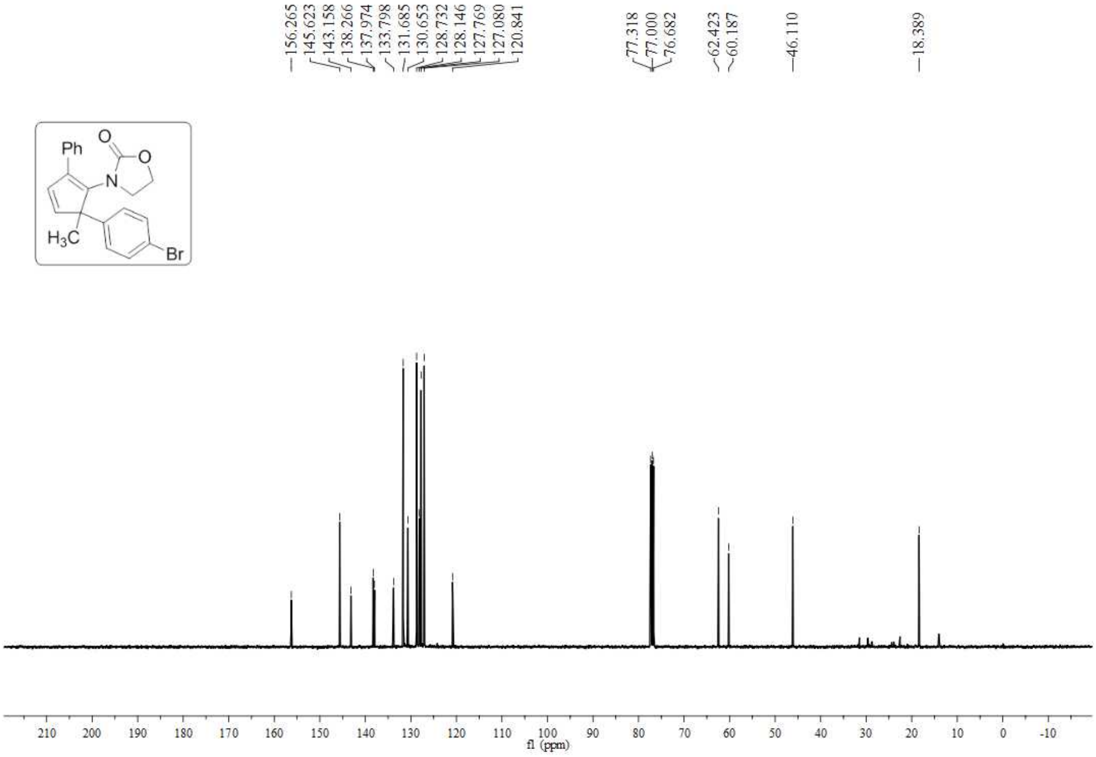
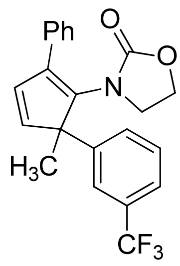
7.414
7.395
7.376
7.333
7.315
7.297
7.267
7.245
7.221
6.683
6.669
6.488
6.474
4.184
4.162
4.145
4.141
4.128
4.124
4.108
4.088
4.067
3.204
3.182
3.163
3.141
2.843
2.821
2.804
2.782
1.742
0.000
2.060
2.076
1.166
4.101
1.000
0.992
2.159
1.027
1.013
3.195
fl (ppm)


156.269
145.671
143.176
137.908
137.663
133.781
132.740
130.606
128.724
128.136
127.372
127.063
77.318
77.000
76.682
62.419
60.109
46.078
18.425
fl (ppm)

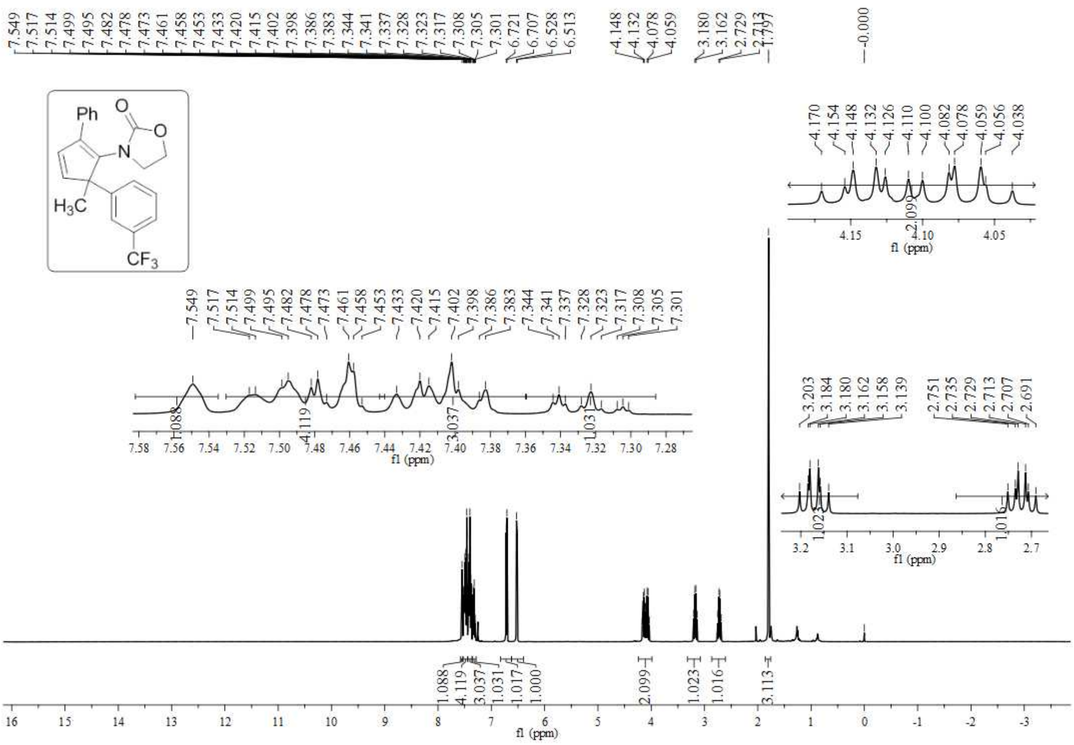

Ph
O
O
N
H3C
Br
3s


7.466
7.463
7.445
7.411
7.391
7.373
7.331
7.313
7.294
7.189
7.168
6.679
6.664
6.482
6.468
4.180
4.163
4.158
4.142
4.136
4.127
4.119
4.109
4.105
4.087
4.065
3.205
3.182
3.164
3.142
2.849
2.832
2.826
2.810
2.804
2.788
1.736
0.000
Ph
O
O
N
H3C
Br
2.092
4.011
1.098
1.956
1.000
0.981
2.105
1.016
1.000
3.325
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)


156.265
145.623
143.158
138.266
137.974
133.798
131.685
130.653
128.732
128.146
127.769
127.080
120.841
77.318
77.000
76.682
62.423
60.187
46.110
18.389
Ph
O
O
N
H3C
Br
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


Ph
O
O
N
H3C
CF3

3t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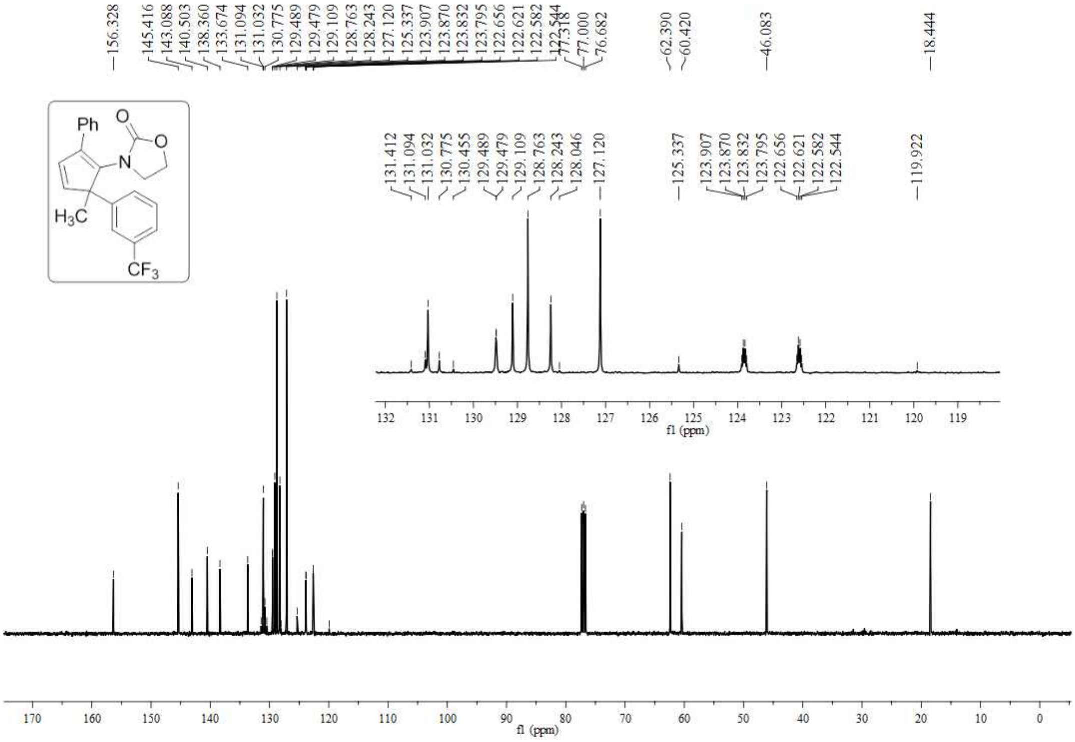
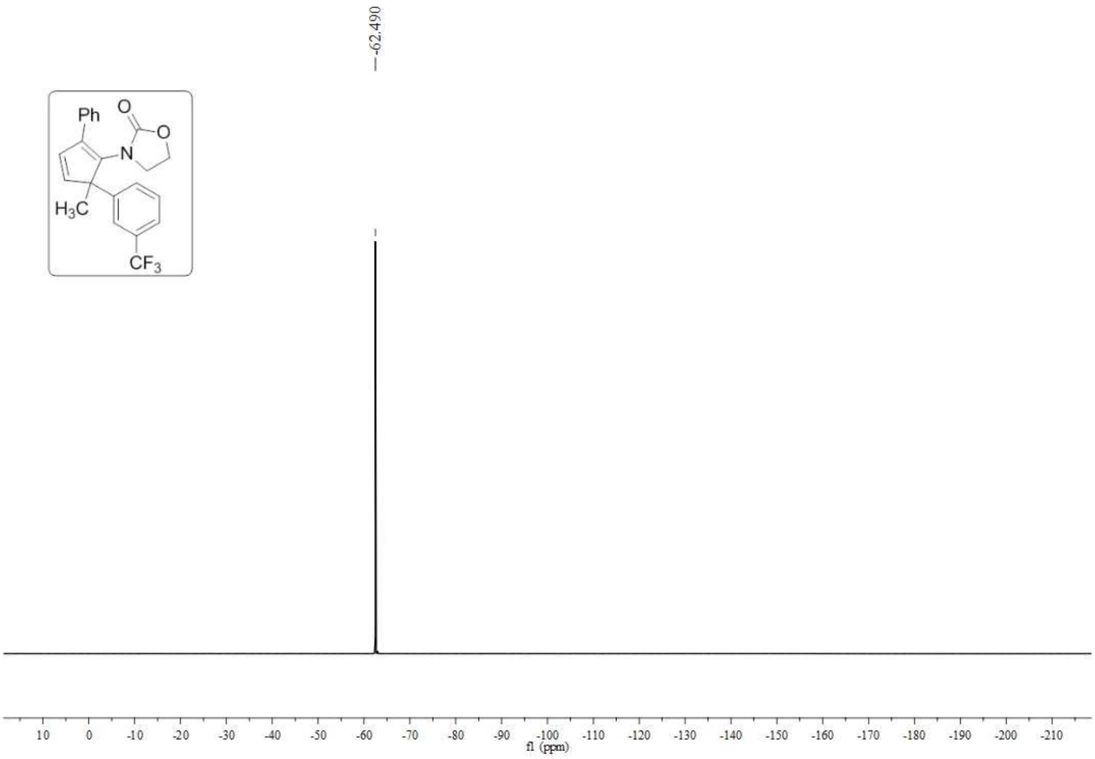
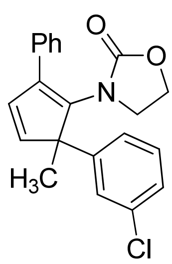
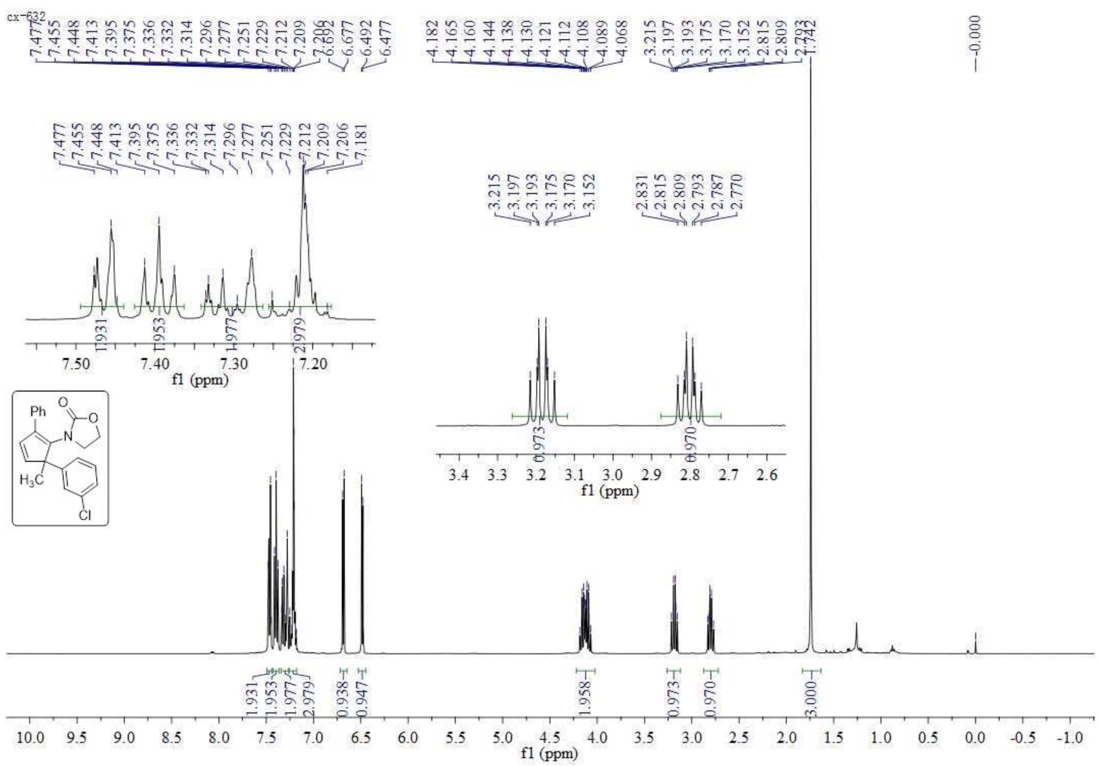
4.148 4.132 4.078 4.059
3.180 3.162 2.729 2.713 1.797
0.000
4.170 4.154 4.148 4.132 4.126 4.110 4.100 4.082 4.078 4.059 4.056 4.038
2.099
3.203 3.184 3.180 3.162 3.158 3.139
2.751 2.735 2.729 2.713 2.707 2.691
1.02
1.016
1.088
4.119
3.037
1.031
1.088 4.119 3.037 1.031 1.017 1.000
2.099 1.023 1.016 3.113
f1 (ppm)

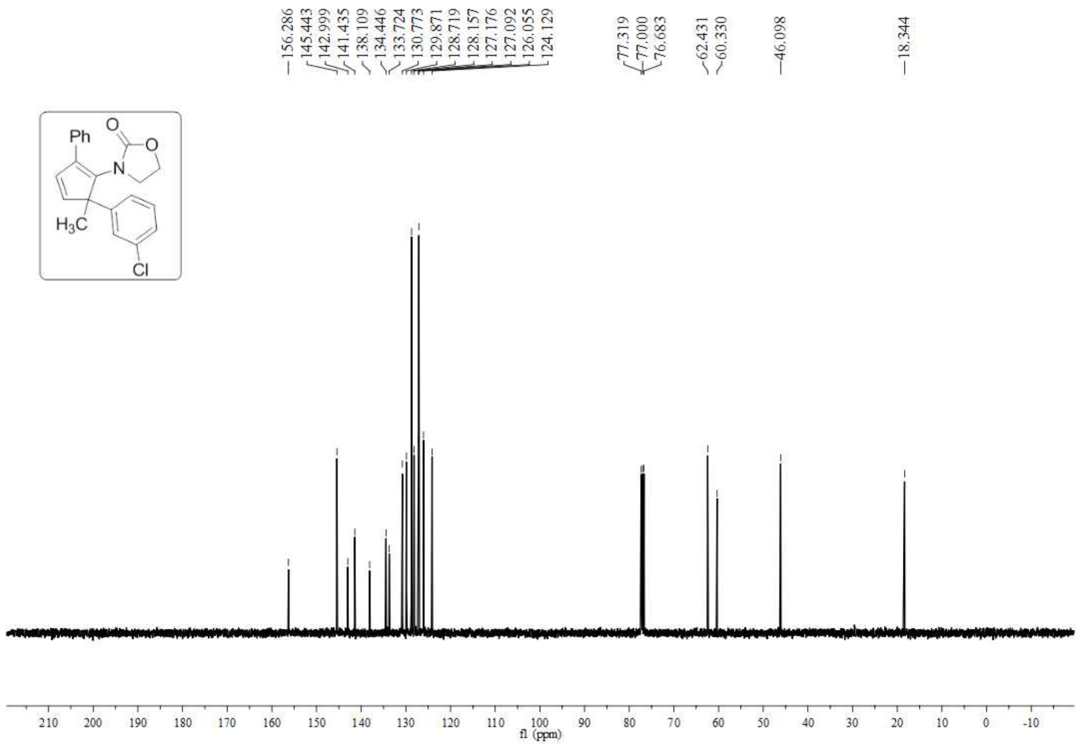

156.328
145.416 143.088 140.503 138.360 133.674 131.094 131.032 130.775 129.489 129.479 129.109 128.763 128.243 127.120 125.337 123.907 123.870 123.832 123.795 122.656 122.621 122.582 122.544 77.318 77.000 76.682
62.390 60.420
46.083
18.444
131.412 131.094 131.032 130.775 130.455 129.489 129.479 129.109 128.763 128.243 128.046 127.120
125.337 123.907 123.870 123.832 123.795 122.656 122.621 122.582 122.544
119.922
f1 (ppm)

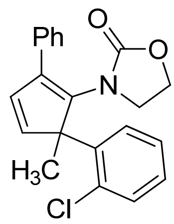

-62.490
Ph
O
O
N
H_3C
CF_3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


Ph
O
O
N
H3C
Cl

3u

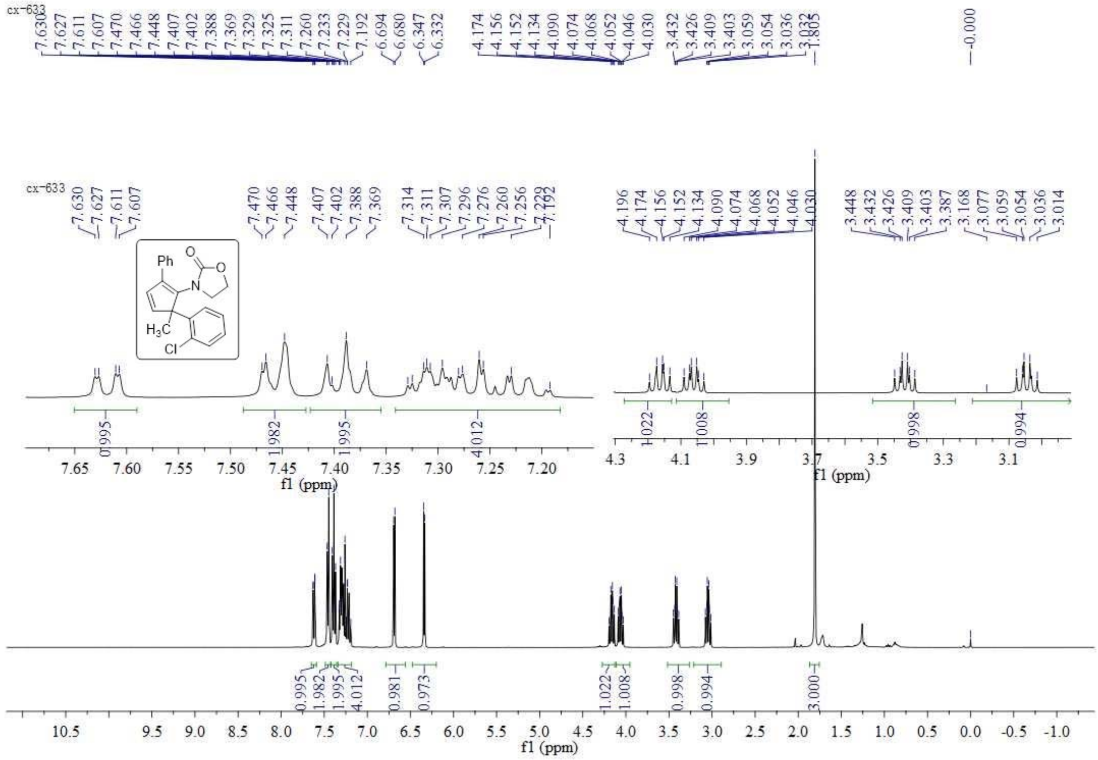

cx-632
7.477 7.455 7.448 7.413 7.395 7.375 7.336 7.332 7.314 7.296 7.277 7.251 7.229 7.212 7.209 7.206 6.692 6.677 6.492 6.477
4.182 4.165 4.160 4.144 4.138 4.130 4.121 4.112 4.108 4.089 4.068
3.215 3.197 3.193 3.175 3.170 3.152 2.815 2.809 2.793 1.742
-0.000
1.931 1.953 1.977 2.979 0.938 0.947 1.958 0.973 0.970 3.000
f1 (ppm)


156.286 145.443 142.999 141.435 138.109 134.446 133.724 130.773 129.871 128.719 128.157 127.176 127.092 126.055 124.129
77.319 77.000 76.683 62.431 60.330 46.098 18.344
f1 (ppm)

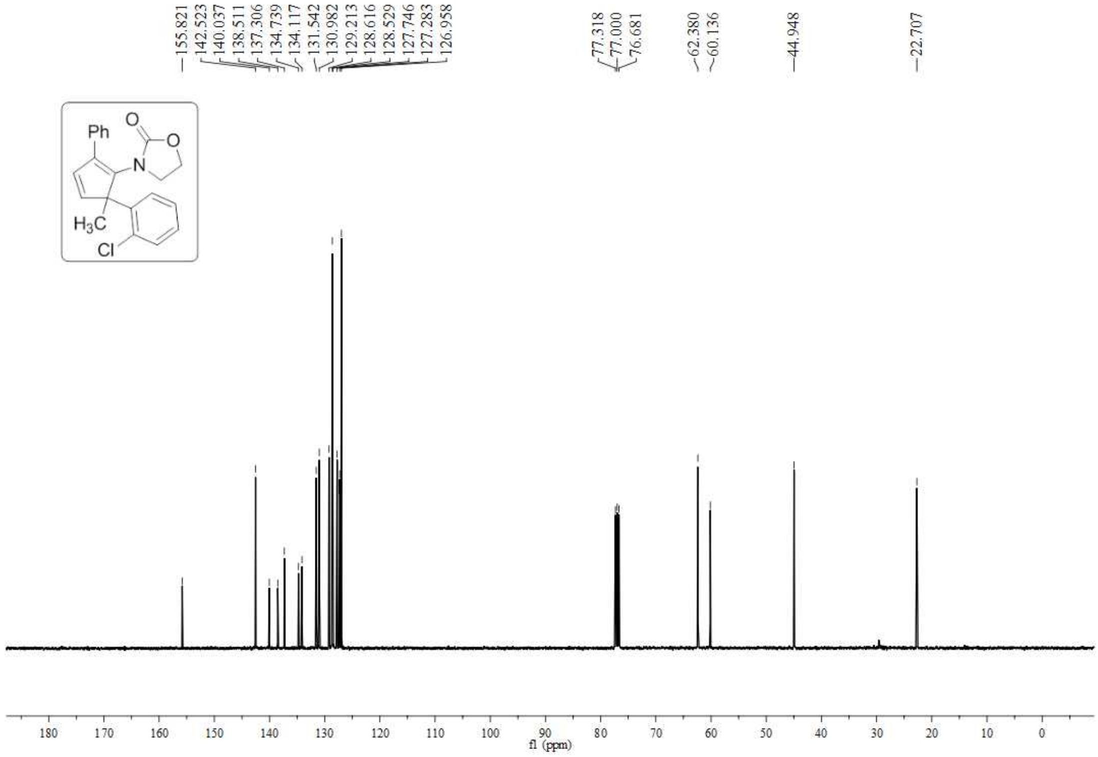


Ph
O
N
O
H3C
Cl

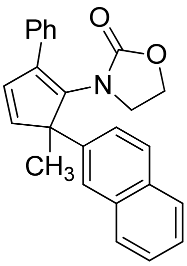
3v



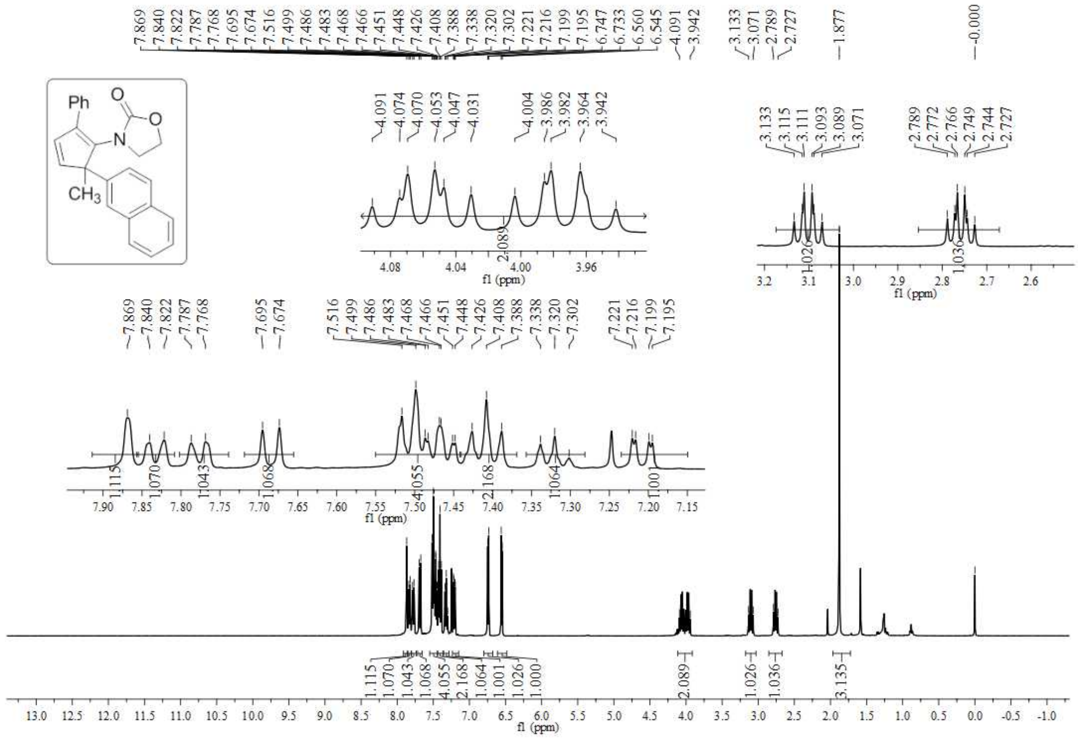
cx-633
7.630 7.627 7.611 7.607 7.470 7.466 7.448 7.407 7.402 7.388 7.369 7.329 7.325 7.311 7.260 7.233 7.229 7.192 6.694 6.680 6.347 6.332
4.174 4.156 4.152 4.134 4.090 4.074 4.068 4.052 4.046 4.030 3.432 3.426 3.409 3.403 3.059 3.054 3.036 3.032 1.805
0.000
cx-633
7.630 7.627 7.611 7.607 7.470 7.466 7.448 7.407 7.402 7.388 7.369 7.314 7.311 7.307 7.296 7.276 7.260 7.256 7.229 7.192
4.196 4.174 4.156 4.152 4.134 4.090 4.074 4.068 4.052 4.046 4.030
3.448 3.432 3.426 3.409 3.403 3.387 3.168 3.077 3.059 3.054 3.036 3.014
0.995 1.982 1.995 4.012
1.022 1.008 0.998 0.994
f1 (ppm)
0.995 1.982 1.995 4.012 0.981 0.973 1.022 1.008 0.998 0.994 3.000
f1 (ppm)

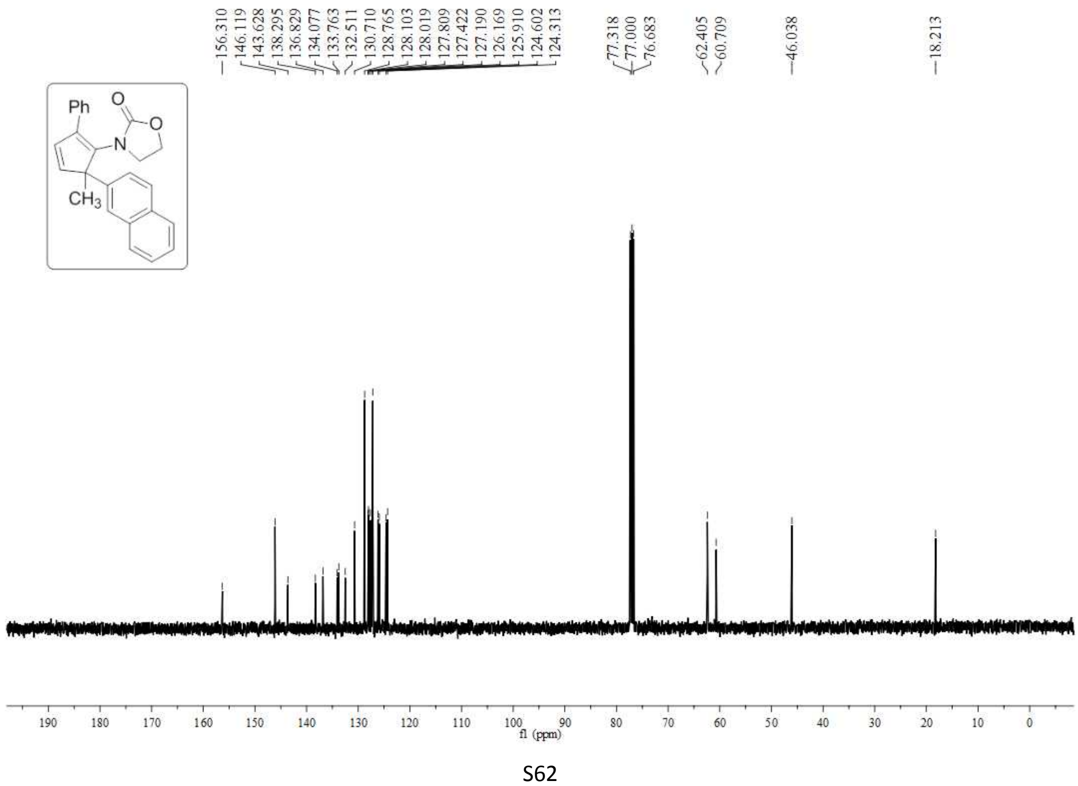


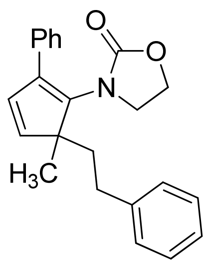
155.821 142.523 140.037 138.511 137.306 134.739 134.117 131.542 130.982 129.213 128.616 128.529 127.746 127.283 126.958
77.318 77.000 76.681 62.380 60.136 44.948 22.707
f1 (ppm)



3w

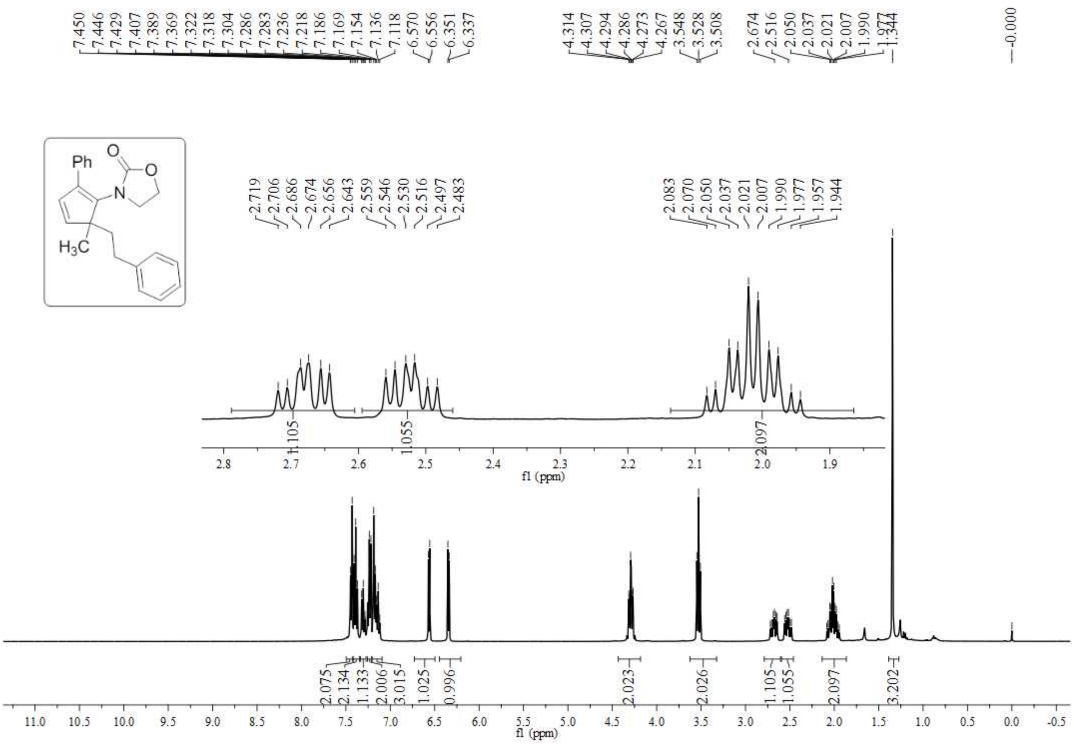




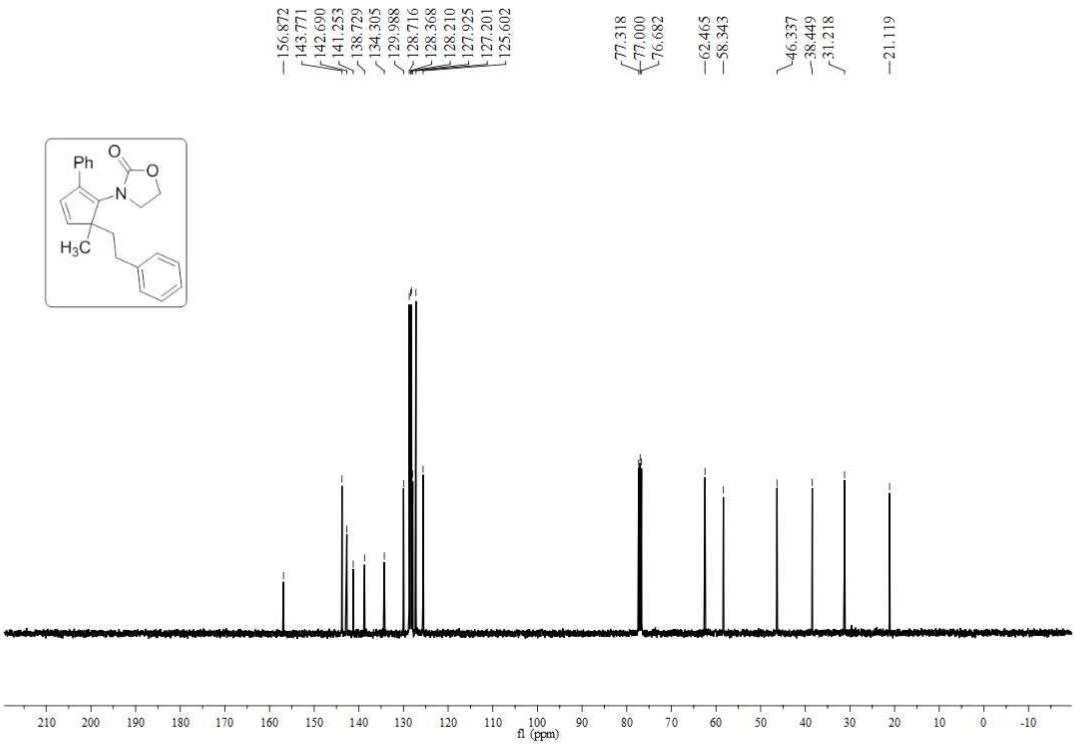


Ph
O
O
N
H_3C

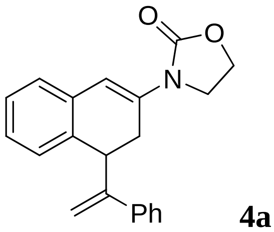
3x



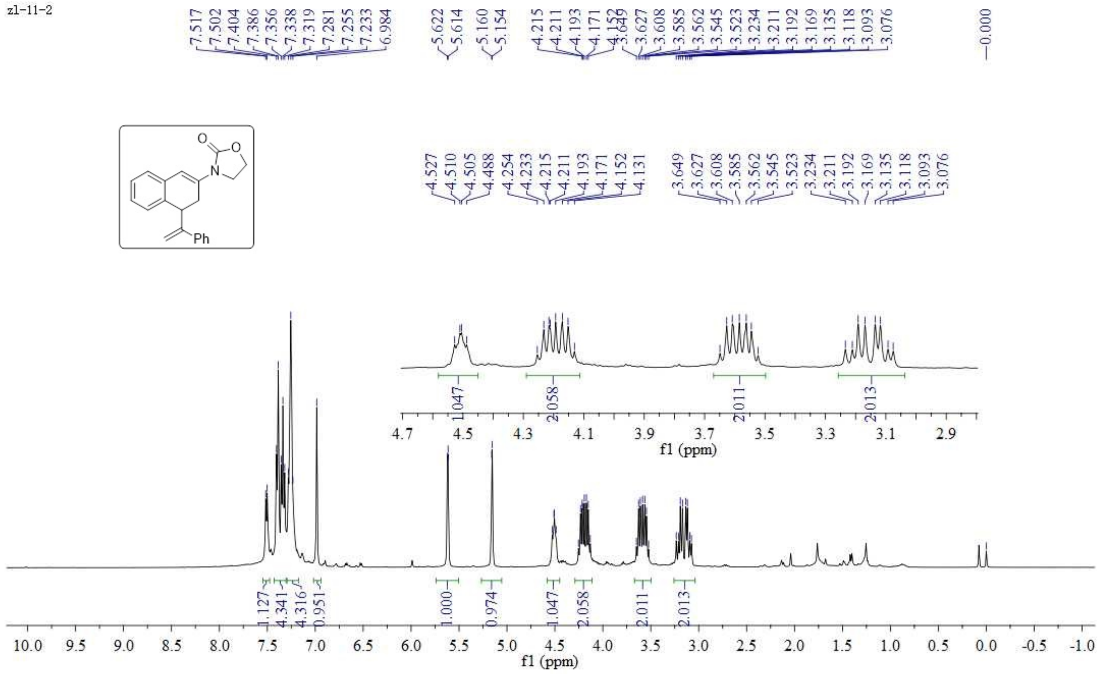
7.450 7.446 7.429 7.407 7.389 7.369 7.322 7.318 7.304 7.286 7.283 7.236 7.218 7.186 7.169 7.154 7.136 7.118 6.570 6.556 6.351 6.337
4.314 4.307 4.294 4.286 4.273 4.267 3.548 3.528 3.508
2.674 2.516 2.050 2.037 2.021 2.007 1.990 1.977 1.344
-0.000
2.719 2.706 2.686 2.674 2.656 2.643 2.559 2.546 2.530 2.516 2.497 2.483
2.083 2.070 2.050 2.037 2.021 2.007 1.990 1.977 1.957 1.944
1.105 1.055 2.097
2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9
f1 (ppm)
2.075 2.134 1.133 2.006 3.015 1.025 0.996 2.023 2.026 1.105 1.055 2.097 3.202
11.0 10.5 10.0 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 -0.5
f1 (ppm)

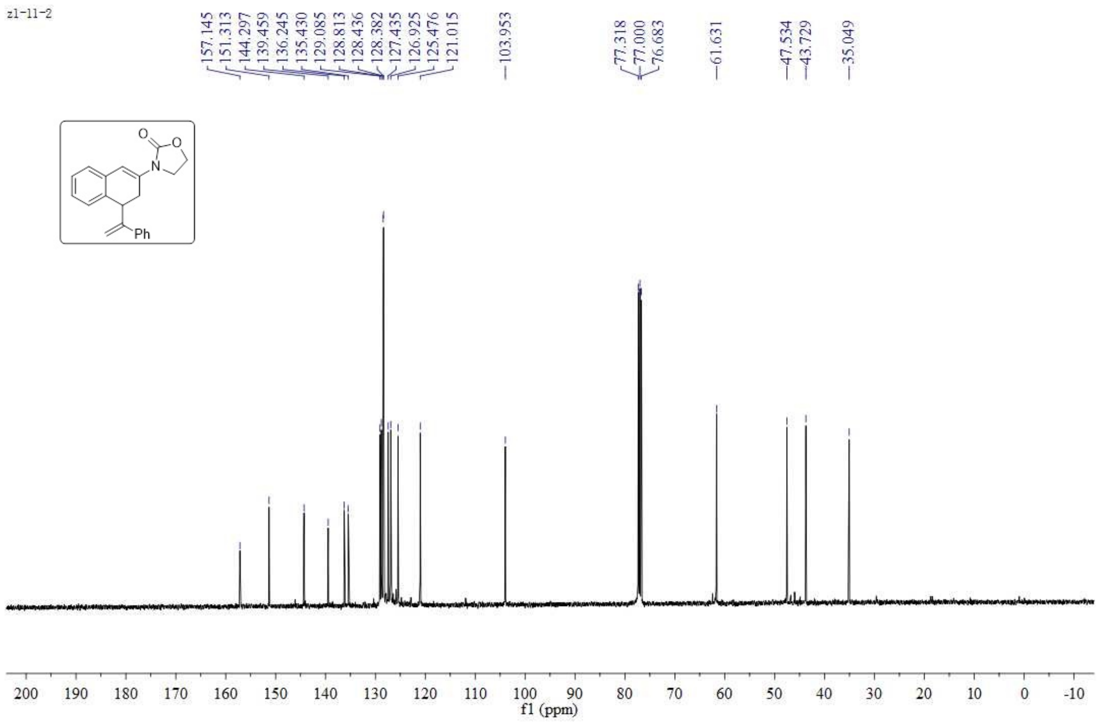


156.872 143.771 142.690 141.253 138.729 134.305 129.988 128.716 128.368 128.210 127.925 127.201 125.602
77.318 77.000 76.682
62.465 58.343
46.337 38.449 31.218
21.119
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



4a


z1-11-2
7.517
7.502
7.404
7.386
7.356
7.338
7.319
7.281
7.255
7.233
6.984
5.622
5.614
5.160
5.154
4.215
4.211
4.193
4.171
4.152
3.649
3.627
3.608
3.585
3.562
3.545
3.523
3.234
3.211
3.192
3.169
3.135
3.118
3.093
3.076
0.000
4.527
4.510
4.505
4.488
4.254
4.233
4.215
4.211
4.193
4.171
4.152
4.131
Ph
1.047
2.058
2.011
2.013
f1 (ppm)
1.127
4.341
4.316
0.951
1.000
0.974
f1 (ppm)


z1-11-2
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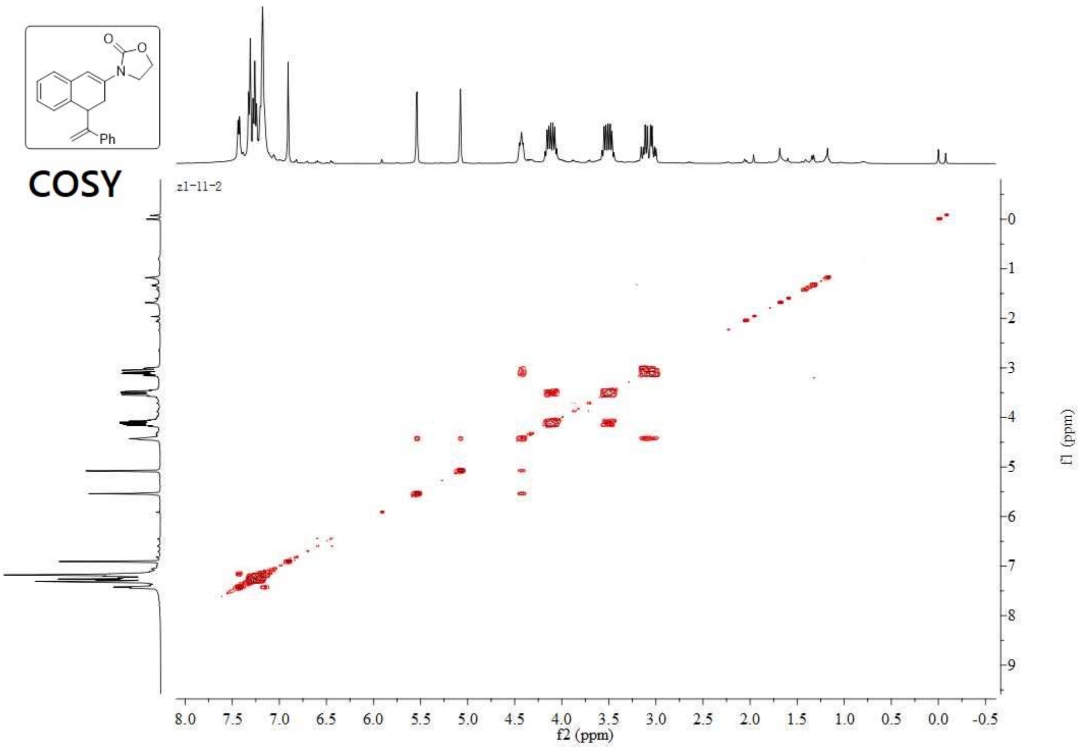
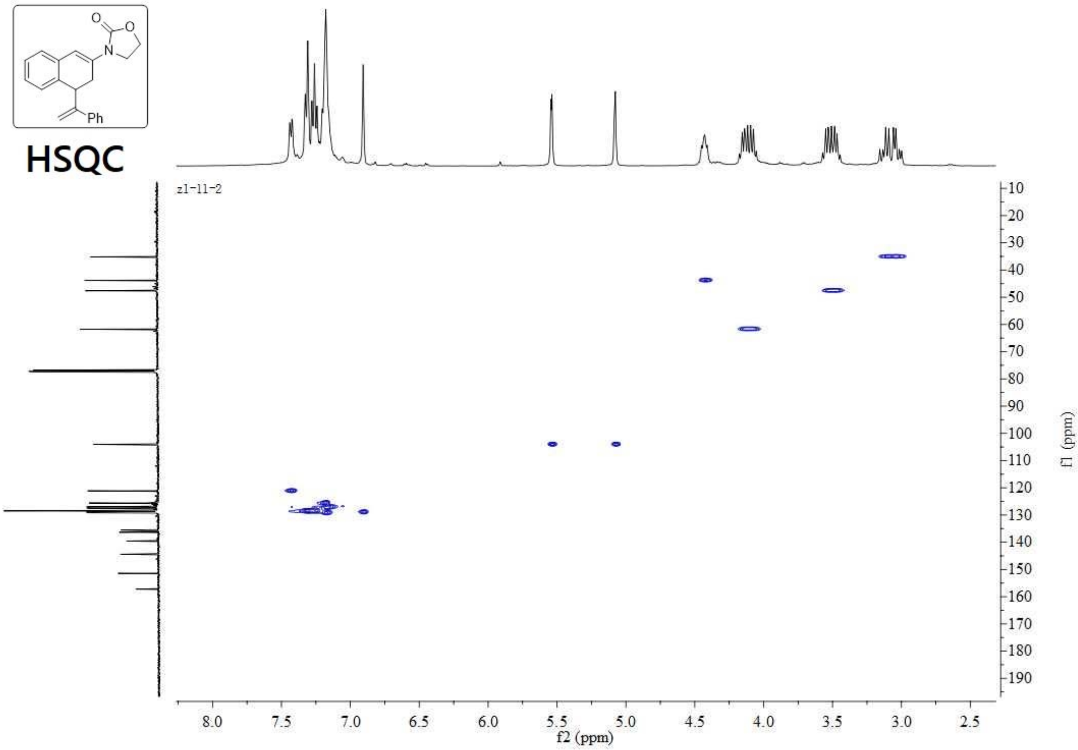
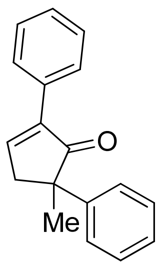
151.313
144.297
139.459
136.245
135.430
129.085
128.813
128.436
128.382
127.435
126.925
125.476
121.015
103.953
77.318
77.000
76.683
61.631
47.534
43.729
35.049
Ph
f1 (ppm)



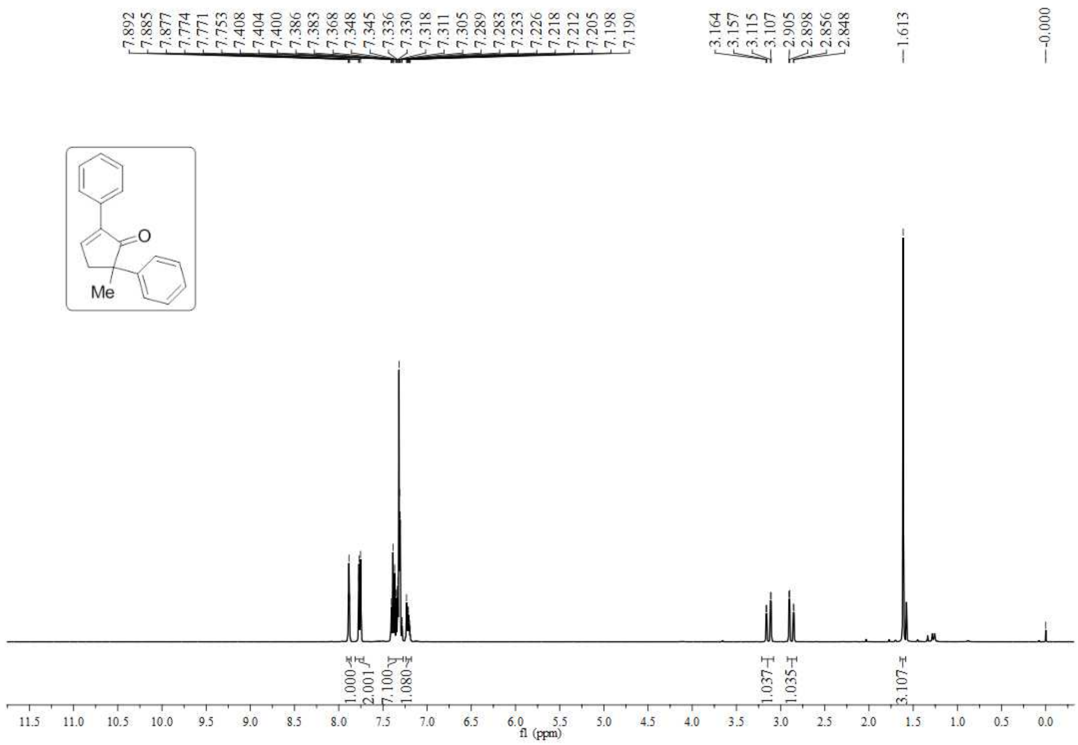
COSY



HSQC


O
Me

6a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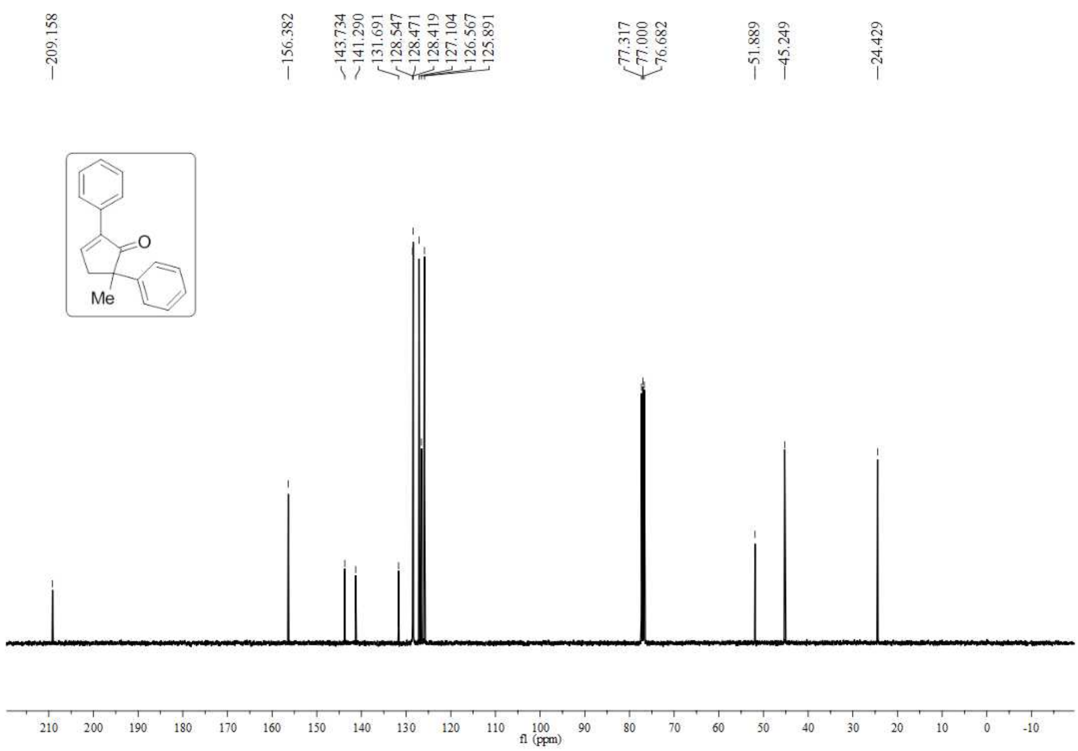
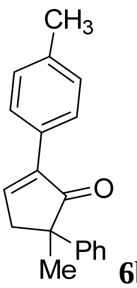
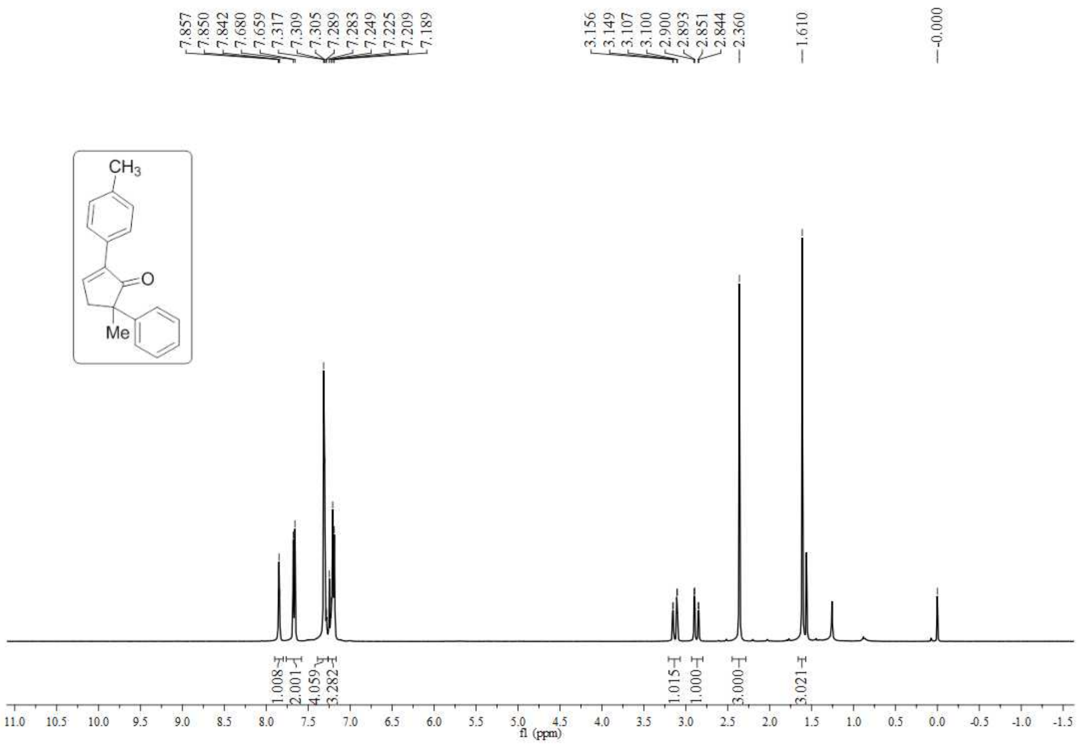
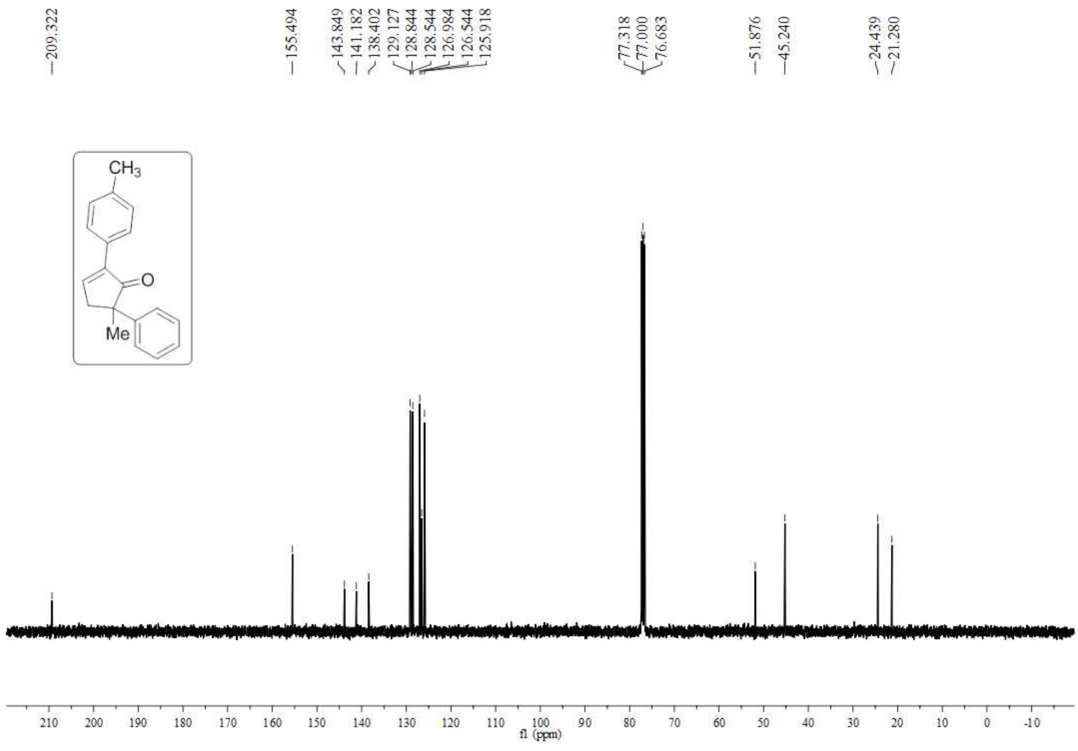
7.877
7.774
7.771
7.753
7.408
7.404
7.400
7.386
7.383
7.368
7.348
7.345
7.336
7.330
7.318
7.311
7.305
7.289
7.283
7.233
7.226
7.218
7.212
7.205
7.198
7.190
3.164
3.157
3.115
3.107
2.905
2.898
2.856
2.848
1.613
-0.000
1.000
2.001
7.100
1.080
1.037
1.035
3.107
fl (ppm)

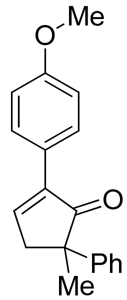

209.158
156.382
143.734
141.290
131.691
128.547
128.471
128.419
127.104
126.567
125.891
77.317
77.000
76.682
51.889
45.249
24.429
fl (ppm)


CH3
O
Ph
Me

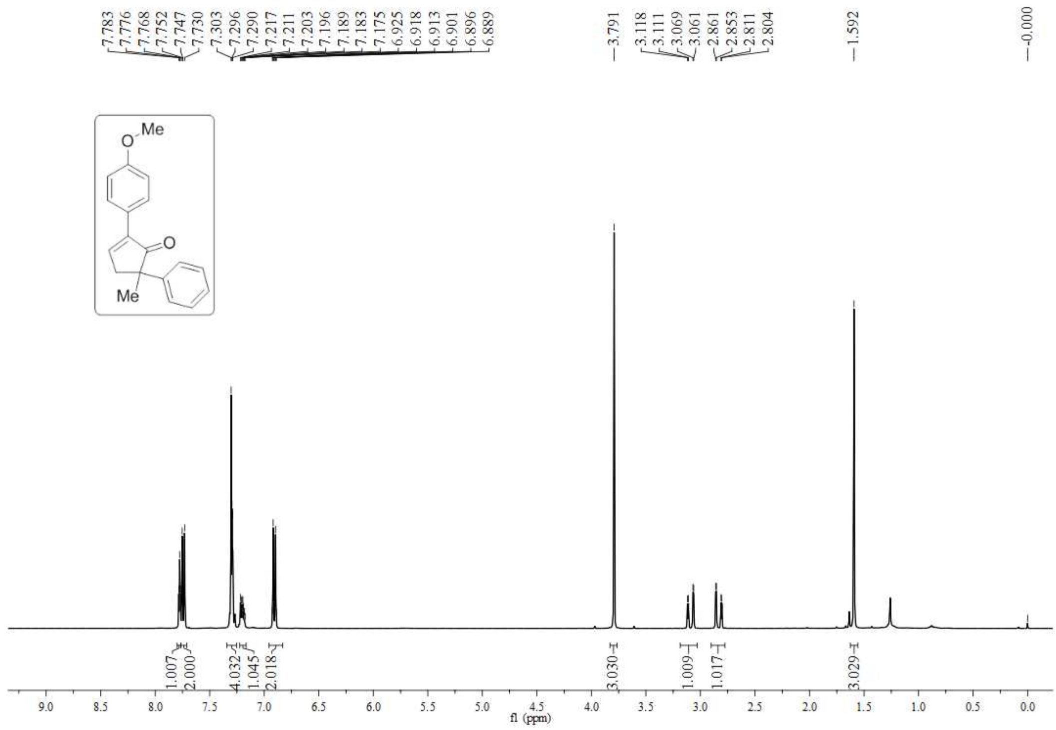
6b

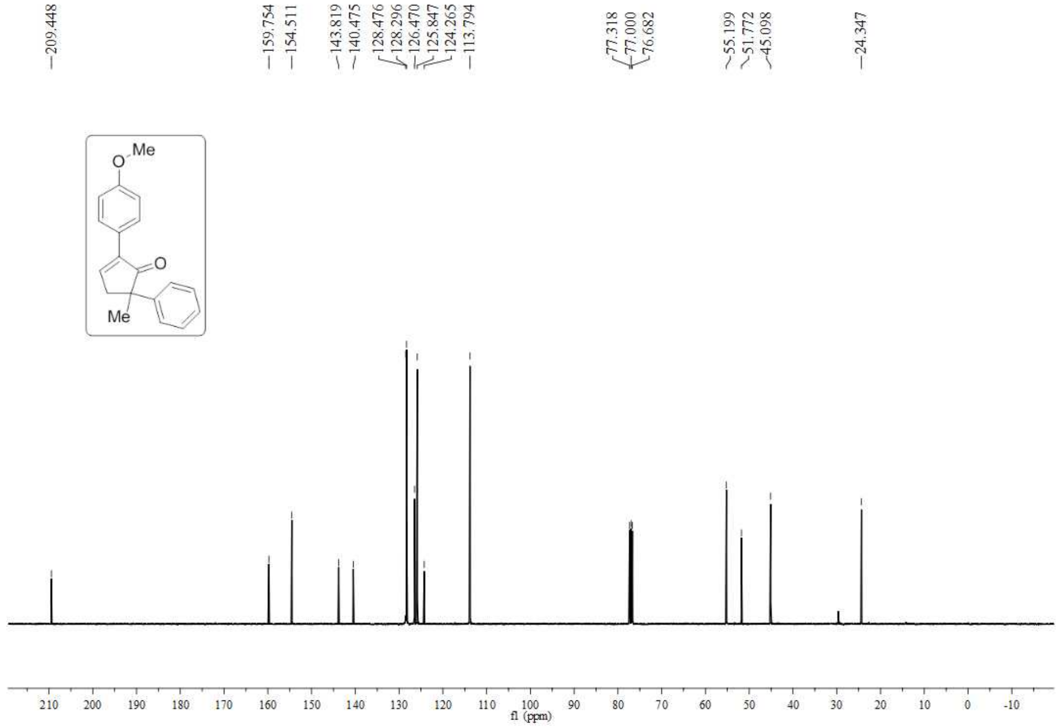

7.857
7.850
7.842
7.680
7.659
7.317
7.309
7.305
7.289
7.283
7.249
7.225
7.209
7.189
3.156
3.149
3.107
3.100
2.900
2.893
2.851
2.844
2.360
1.610
-0.000
1.008
2.001
4.059
3.282
1.015
1.000
3.000
3.021
f1 (ppm)

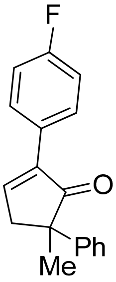

209.322
155.494
143.849
141.182
138.402
129.127
128.844
128.544
126.984
126.544
125.918
77.318
77.000
76.683
51.876
45.240
24.439
21.280
f1 (ppm)



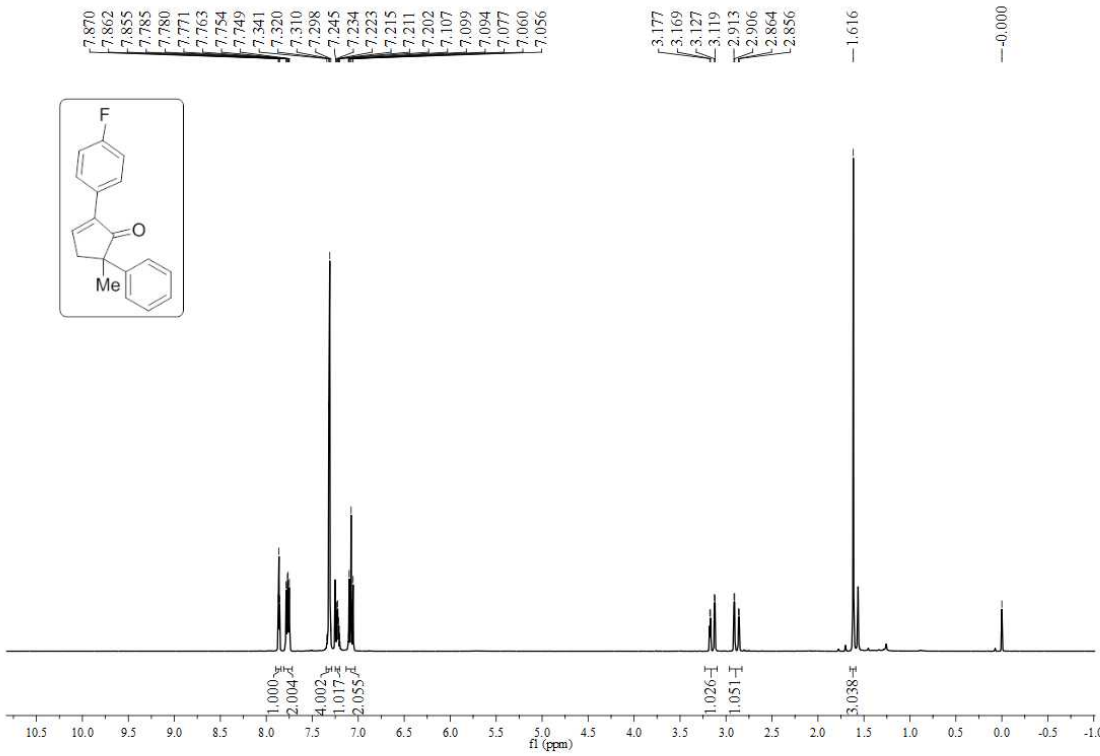
6c

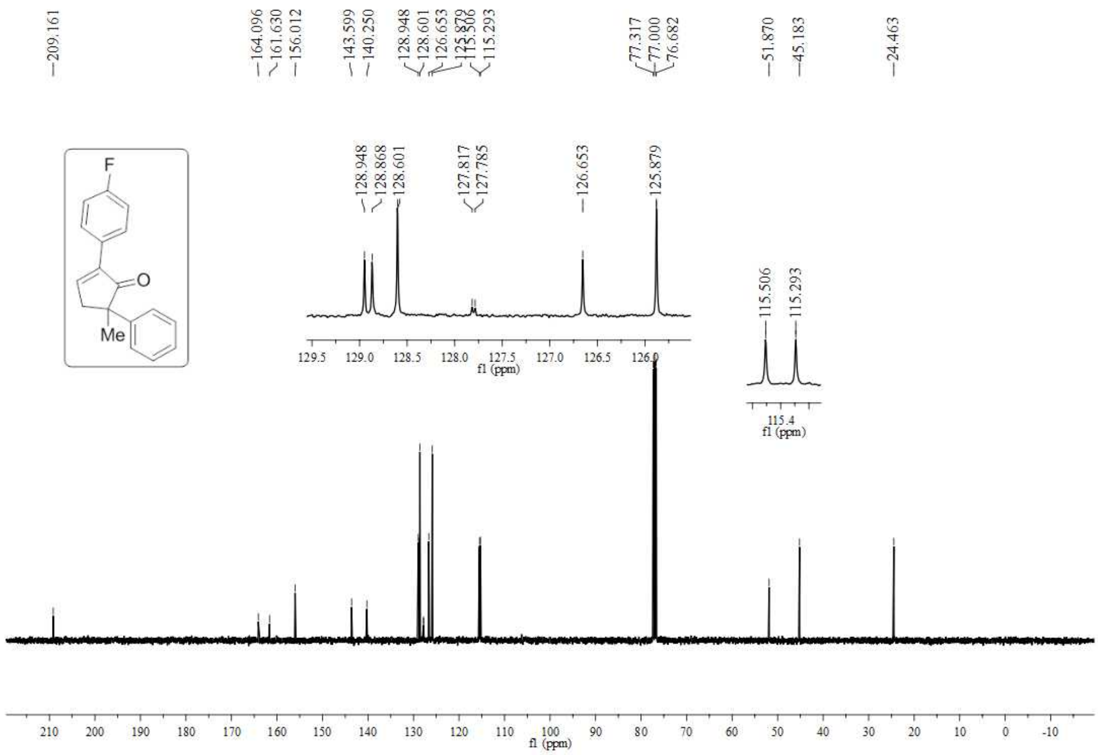


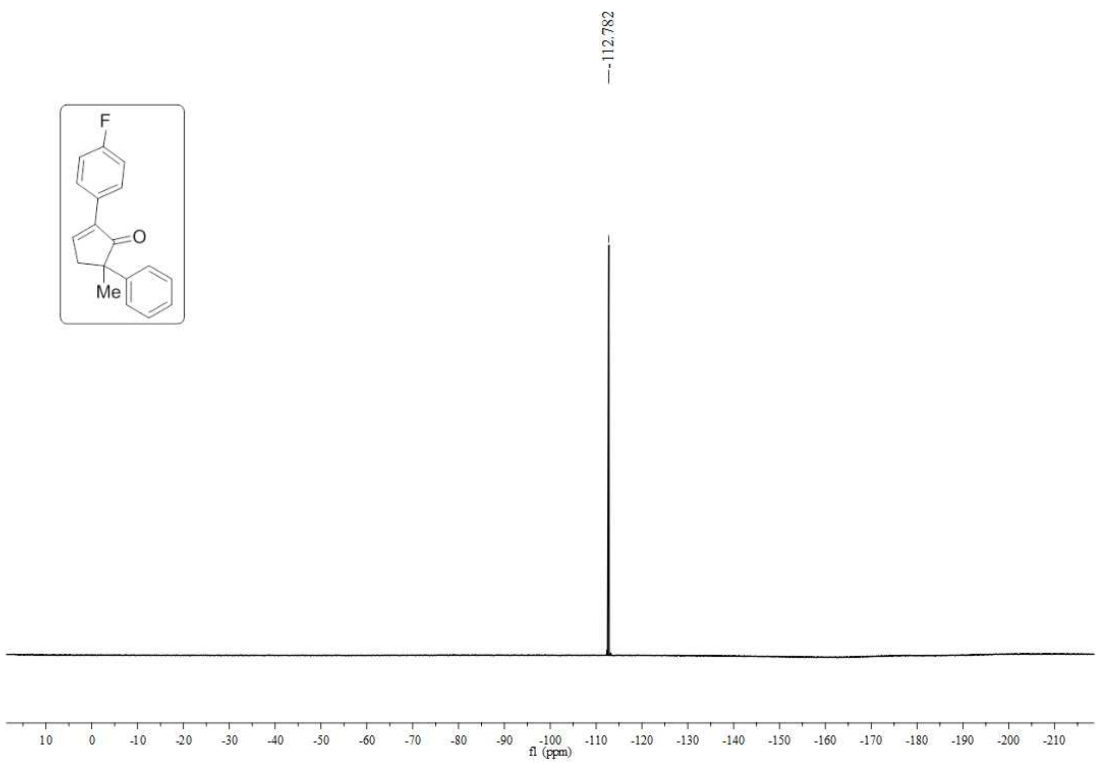


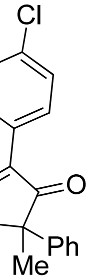

F
O
Ph
Me

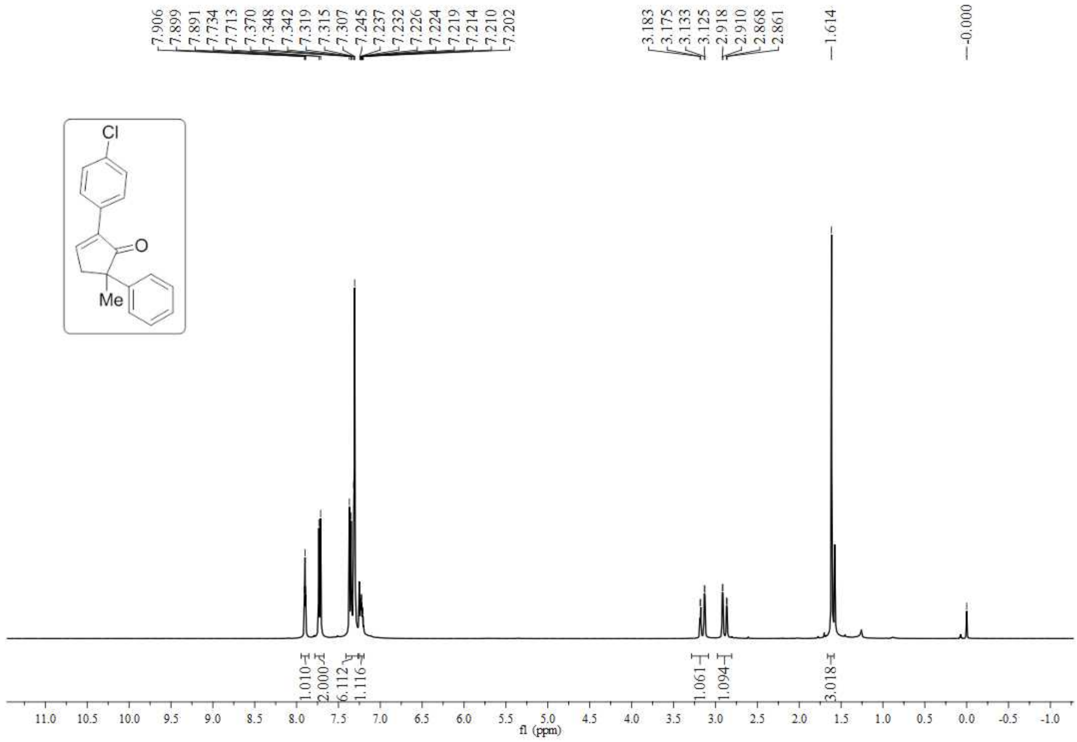
6d

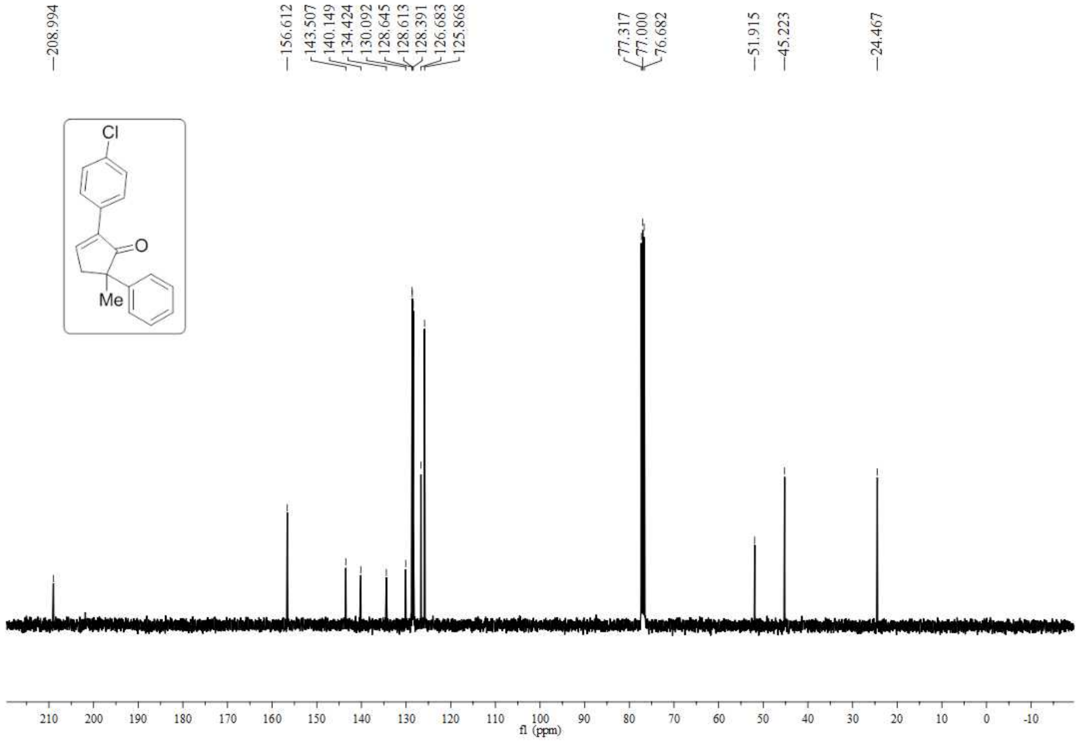

7.870
7.862
7.855
7.785
7.780
7.771
7.763
7.754
7.749
7.341
7.320
7.310
7.298
7.245
7.234
7.223
7.215
7.211
7.202
7.107
7.099
7.094
7.077
7.060
7.056
3.177
3.169
3.127
3.119
2.913
2.906
2.864
2.856
1.616
0.000
F
O
Me
1.000
2.004
4.002
1.017
2.055
1.026
1.051
3.038
f1 (ppm)


209.161
164.096
161.630
156.012
143.599
140.250
128.948
128.601
126.653
125.879
115.506
115.293
77.317
77.000
76.682
51.870
45.183
24.463
F
O
Me
128.948
128.868
128.601
127.817
127.785
126.653
125.879
f1 (ppm)
115.506
115.293
115.4
f1 (ppm)
f1 (ppm)


--112.782
F
O
Me
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


Cl
O
Ph
Me
6e


7.906
7.899
7.891
7.734
7.713
7.370
7.348
7.342
7.319
7.315
7.307
7.245
7.237
7.232
7.226
7.224
7.219
7.214
7.210
7.202
3.183
3.175
3.133
3.125
2.918
2.910
2.868
2.861
1.614
-0.000
1.010
2.000
6.112
1.116
1.061
1.094
3.018
fl (ppm)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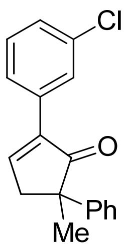
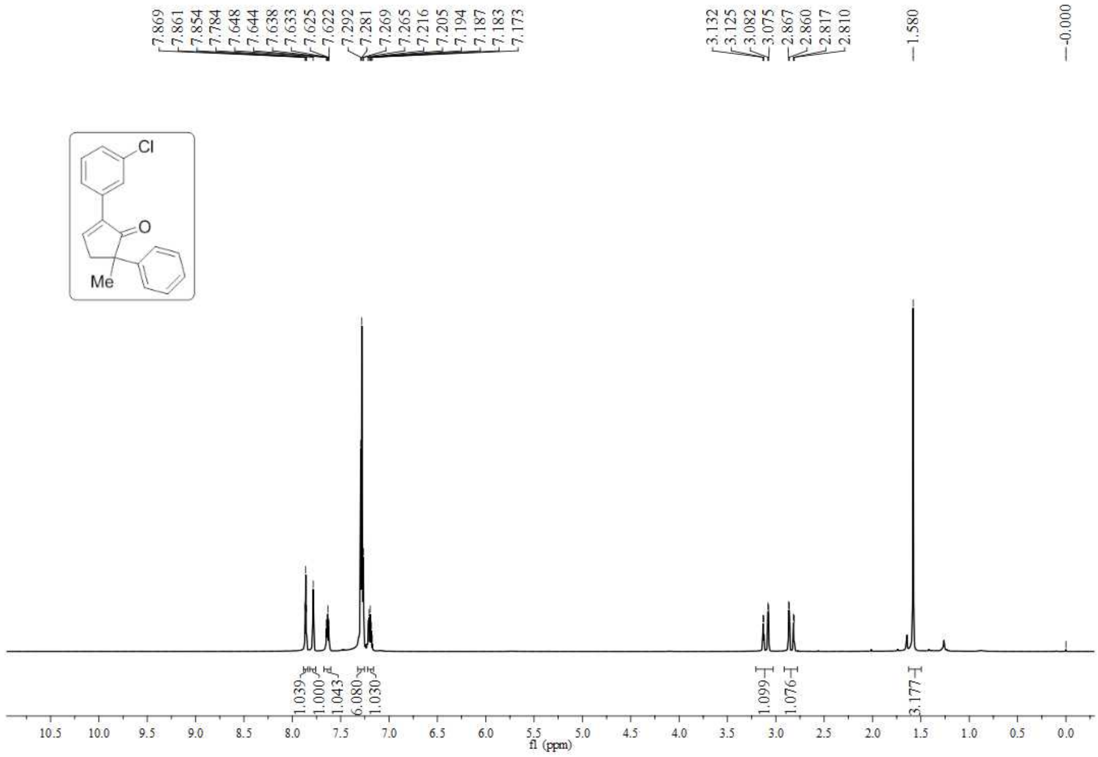
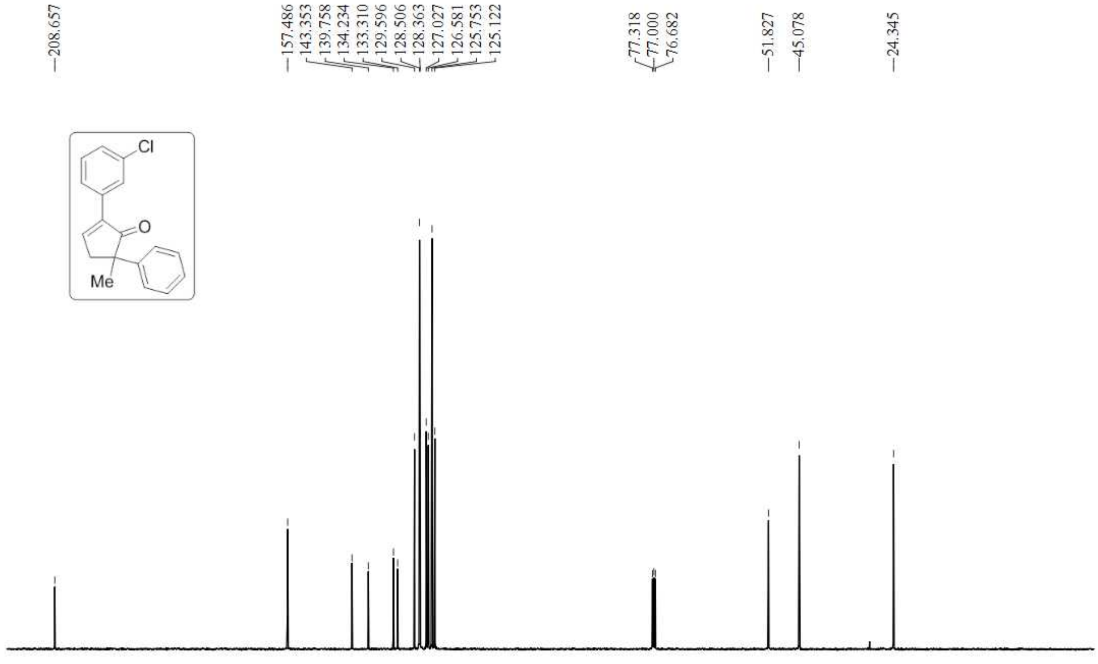
156.612
143.507
140.149
134.424
130.092
128.645
128.613
128.391
126.683
125.868
77.317
77.000
76.682
51.915
45.223
24.467
fl (ppm)



6f


7.869
7.861
7.854
7.784
7.648
7.644
7.638
7.633
7.625
7.622
7.292
7.281
7.269
7.265
7.216
7.205
7.194
7.187
7.183
7.173
3.132
3.125
3.082
3.075
2.867
2.860
2.817
2.810
1.580
0.000
Cl
O
Me
1.039
1.000
1.043
6.080
1.030
1.099
1.076
3.177
10.5
10.0
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)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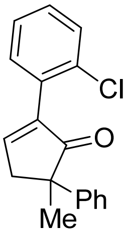
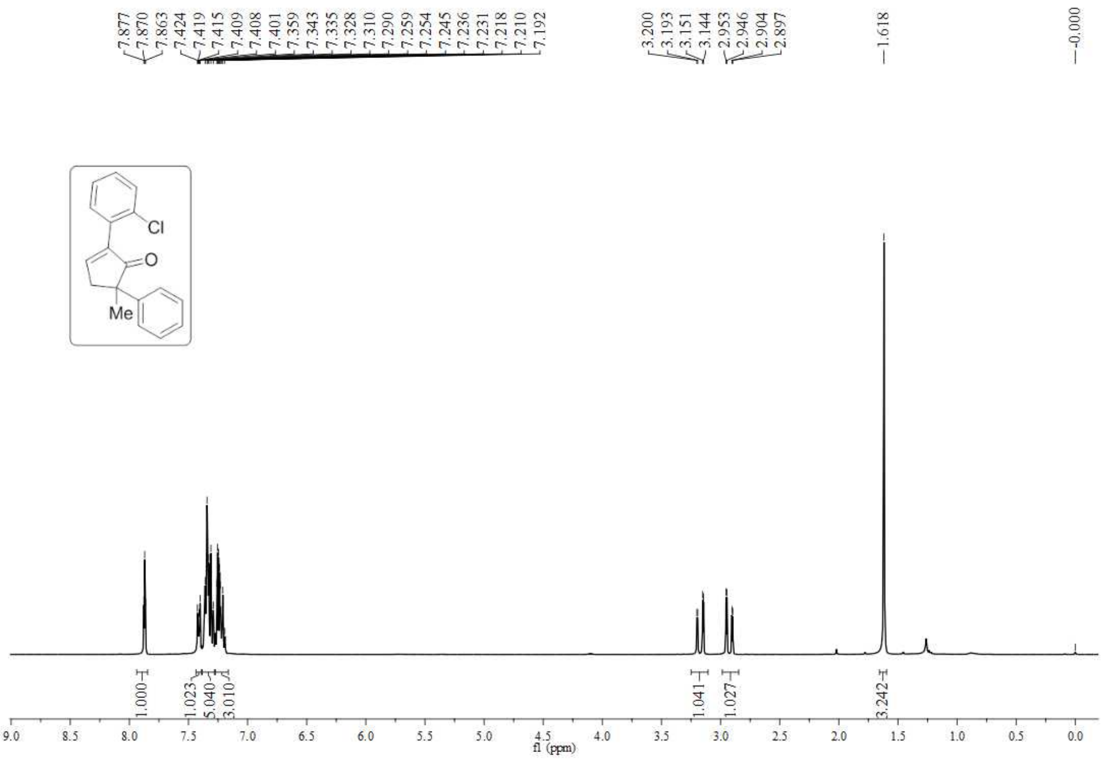
129.596
128.506
128.363
127.027
126.581
125.753
125.122
77.318
77.000
76.682
51.827
45.078
24.345
Cl
O
Me
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


Cl
O
Ph
Me

6g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7.870
7.863
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7.415
7.409
7.408
7.401
7.359
7.343
7.335
7.328
7.310
7.290
7.259
7.254
7.245
7.236
7.231
7.218
7.210
7.192
3.200
3.193
3.151
3.144
2.953
2.946
2.904
2.897
1.618
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Cl
O
Me
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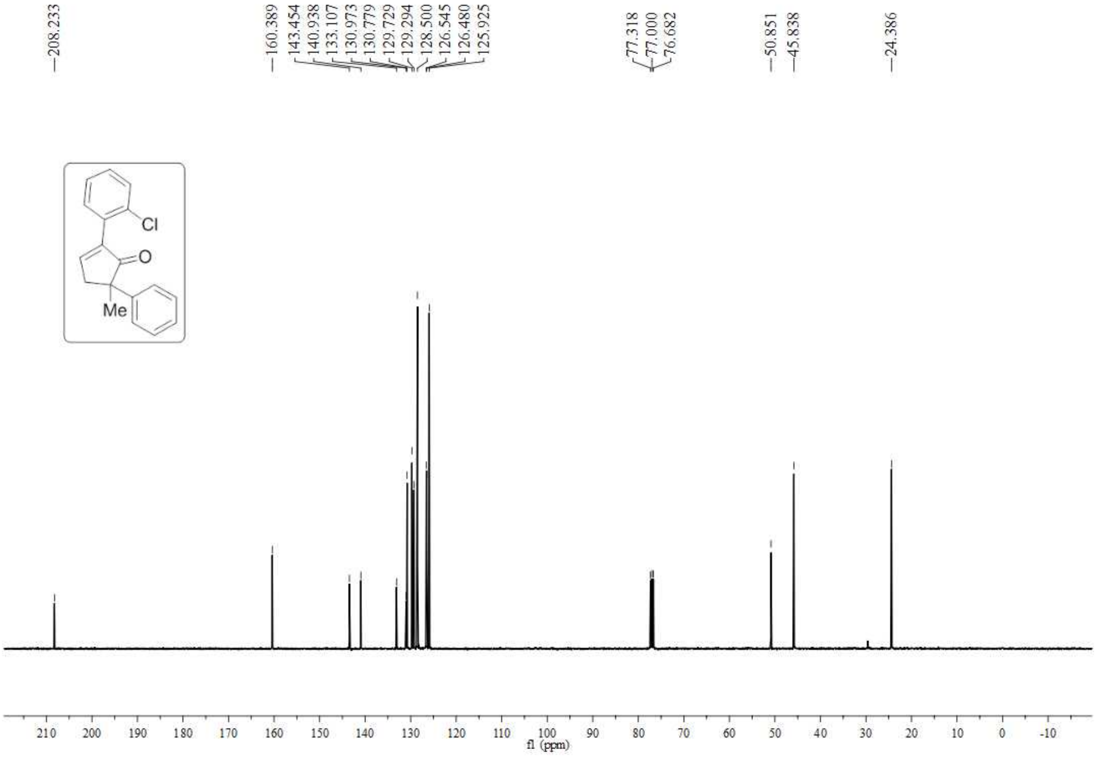
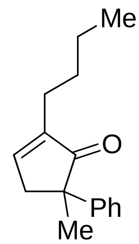
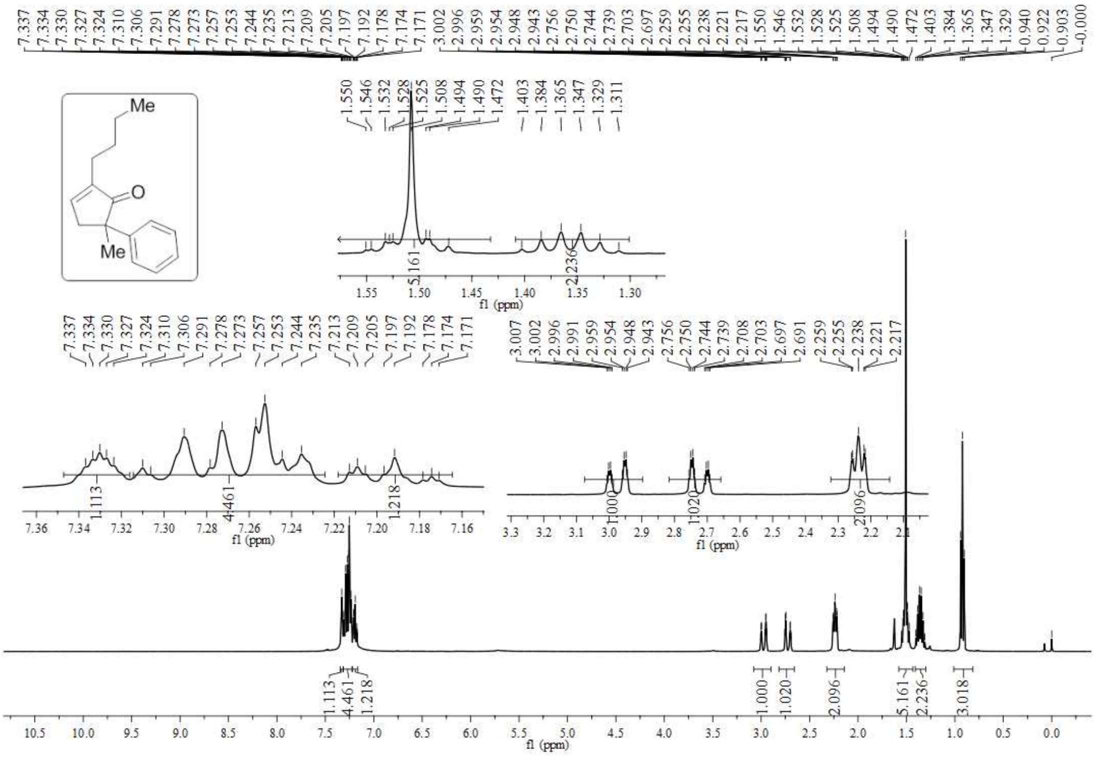
5.040
3.010
1.041
1.027
3.242
fl (ppm)


208.233
160.389
143.454
140.938
133.107
130.973
130.779
129.729
129.294
128.500
126.545
126.480
125.925
77.318
77.000
76.682
50.851
45.838
24.386
Cl
O
Me
fl (ppm)

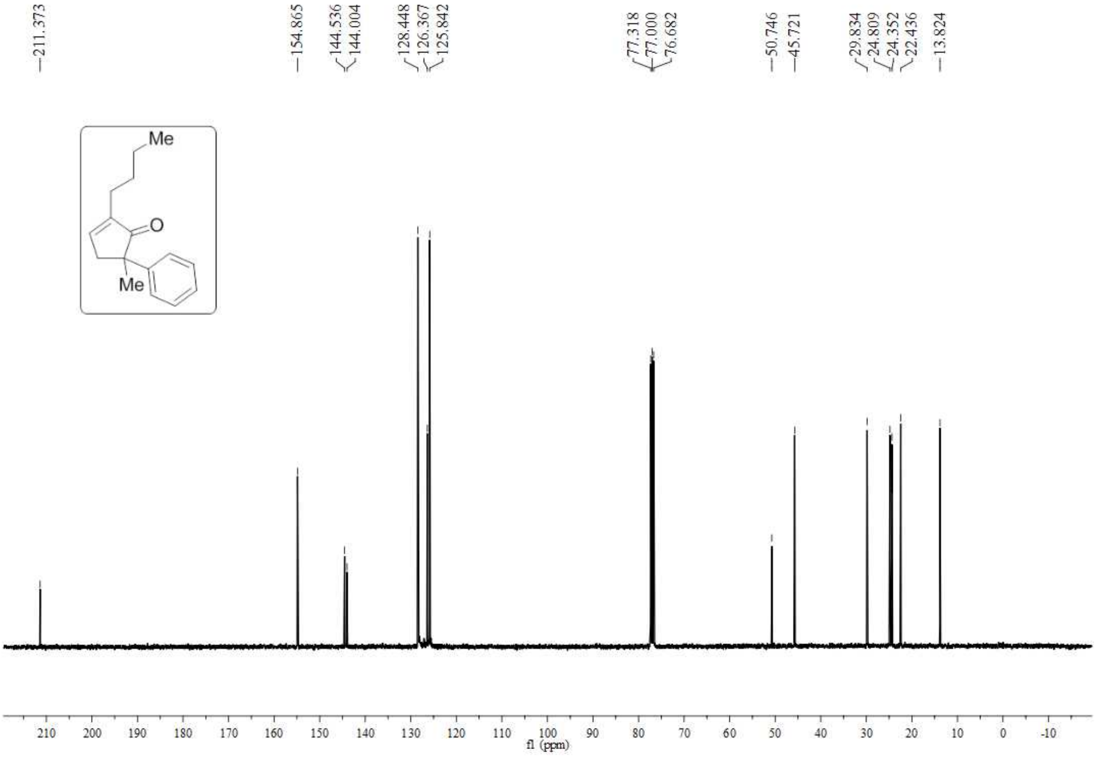


Me
O
Ph
Me

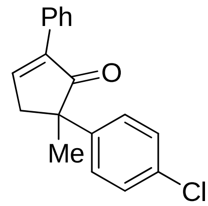
6h



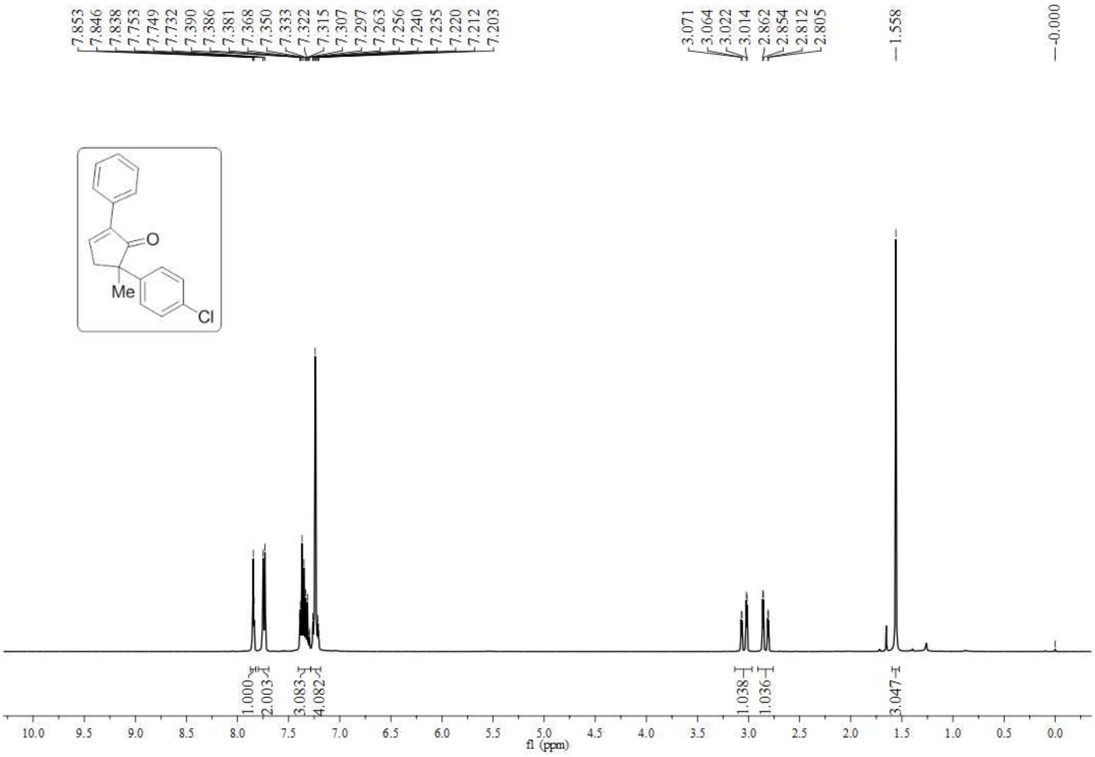
7.337 7.334 7.330 7.327 7.324 7.310 7.306 7.291 7.278 7.273 7.257 7.253 7.244 7.235 7.213 7.209 7.205 7.197 7.192 7.178 7.174 7.171 3.002 2.996 2.959 2.954 2.948 2.943 2.756 2.750 2.744 2.739 2.703 2.697 2.259 2.255 2.238 2.221 2.217 1.550 1.546 1.532 1.528 1.525 1.508 1.494 1.490 1.472 1.403 1.384 1.365 1.347 1.329 0.940 0.922 0.903 -0.000
Me
O
Me
1.550 1.546 1.532 1.528 1.525 1.508 1.494 1.490 1.472 1.403 1.384 1.365 1.347 1.329 1.311
5.161
2.236
f1 (ppm)
7.337 7.334 7.330 7.327 7.324 7.310 7.306 7.291 7.278 7.273 7.257 7.253 7.244 7.235 7.213 7.209 7.205 7.197 7.192 7.178 7.174 7.171
1.113
4.461
1.218
f1 (ppm)
3.007 3.002 2.996 2.991 2.959 2.954 2.948 2.943 2.756 2.750 2.744 2.739 2.708 2.703 2.697 2.691 2.259 2.255 2.238 2.221 2.217
1.000
1.020
2.096
f1 (ppm)
1.113 4.461 1.218 1.000 1.020 2.096 5.161 2.236 3.018
f1 (ppm)



211.373
154.865
144.536 144.004
128.448 126.367 125.842
77.318 77.000 76.682
50.746
45.721
29.834 24.809 24.352 22.436
13.824
Me
O
Me
f1 (ppm)


Ph
O
Me
Cl

6i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7.753
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7.732
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7.386
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7.368
7.350
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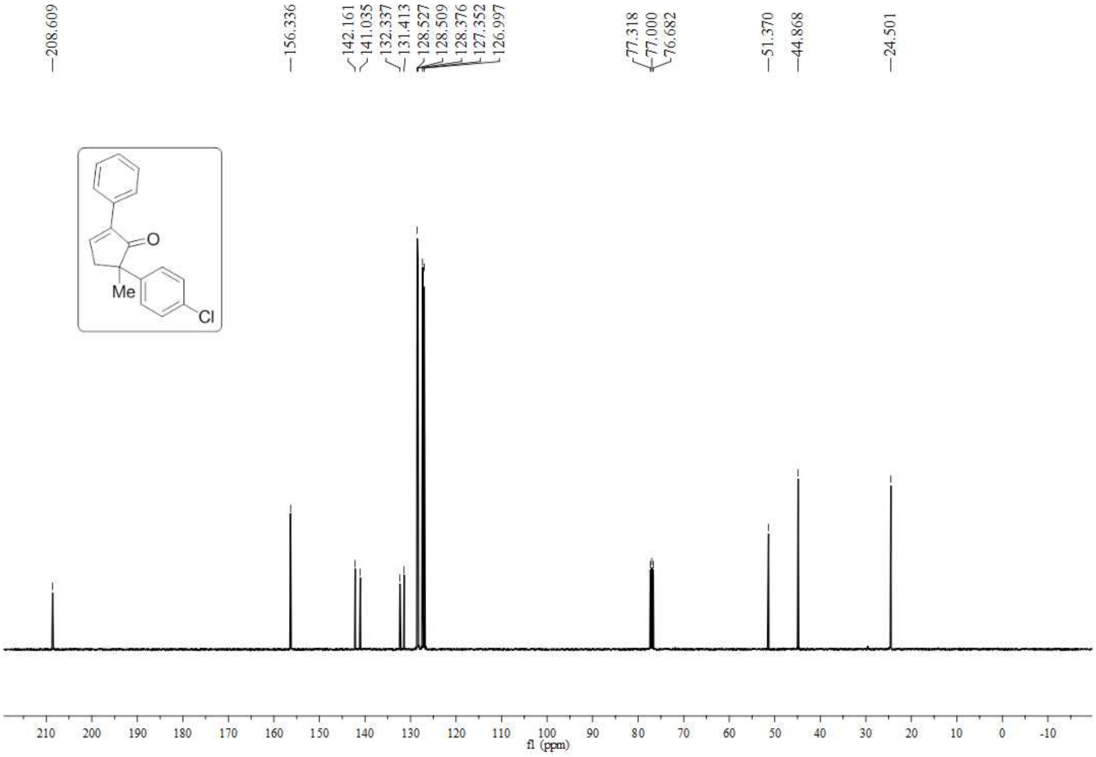
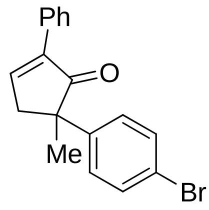
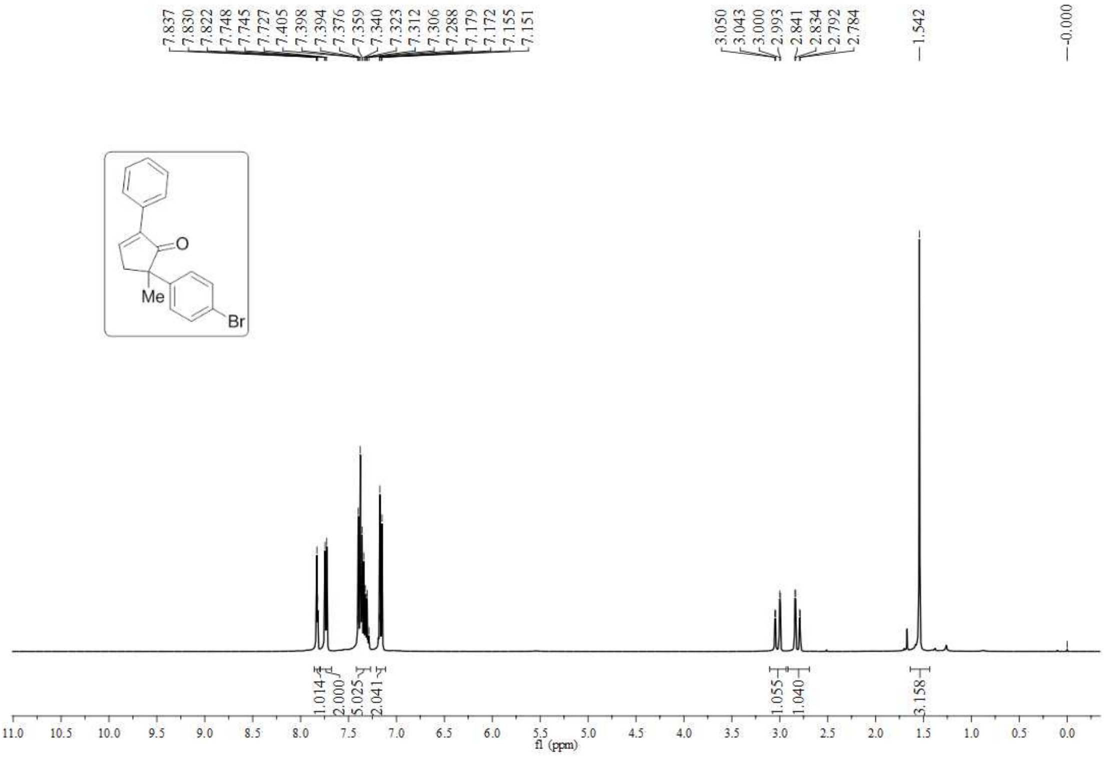
7.315
7.307
7.297
7.263
7.256
7.240
7.235
7.220
7.212
7.203
3.071
3.064
3.022
3.014
2.862
2.854
2.812
2.805
1.558
0.000
1.000
2.003
3.083
4.082
1.038
1.036
3.047
fl (ppm)


208.609
156.336
142.161
141.035
132.337
131.413
128.527
128.509
128.376
127.352
126.997
77.318
77.000
76.682
51.370
44.868
24.501
fl (ppm)


Ph
O
Me
Br

6j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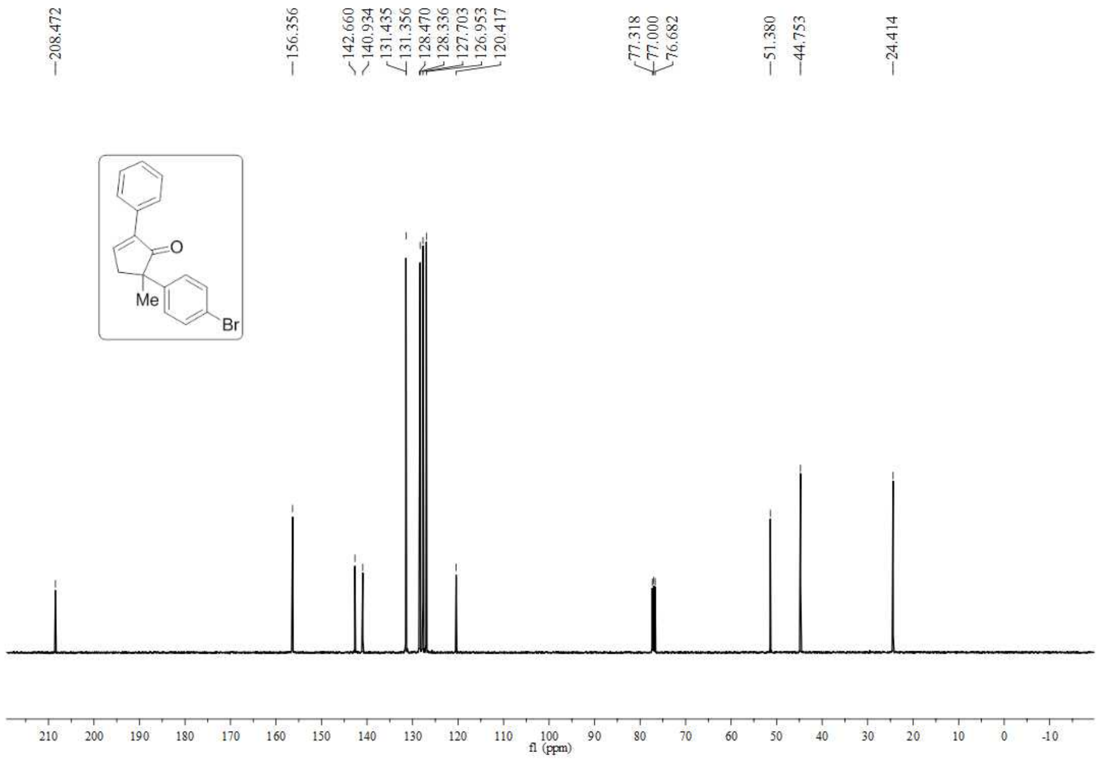
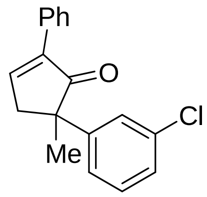
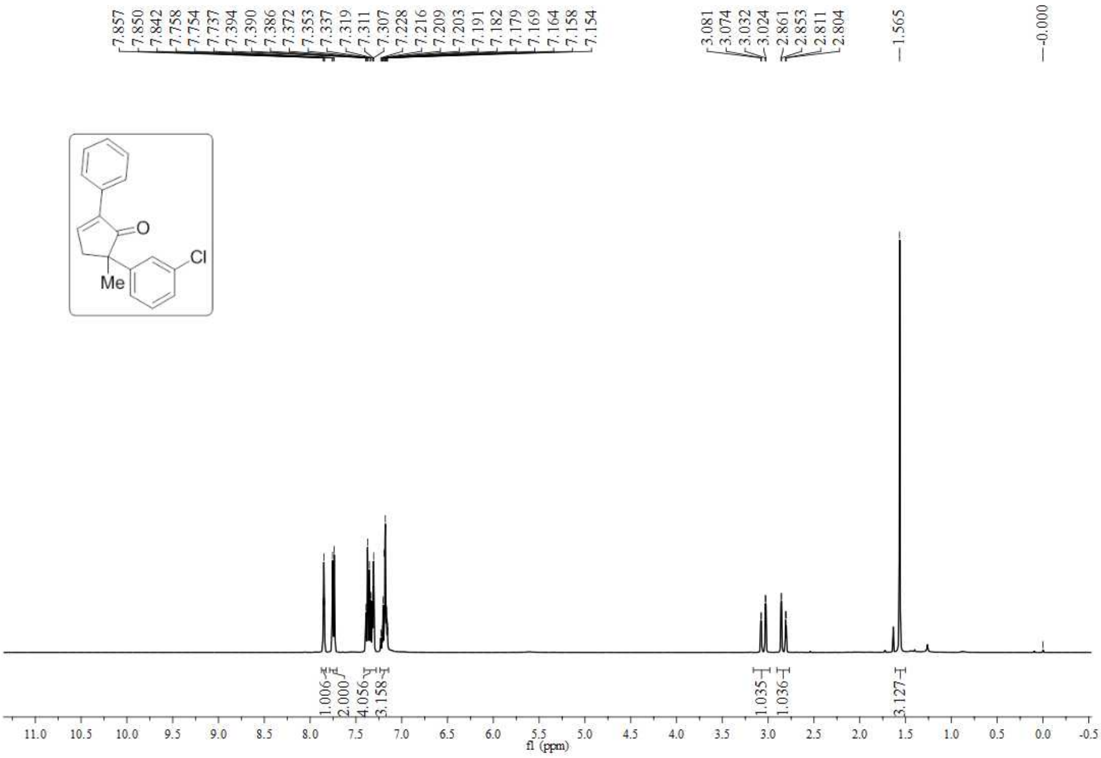
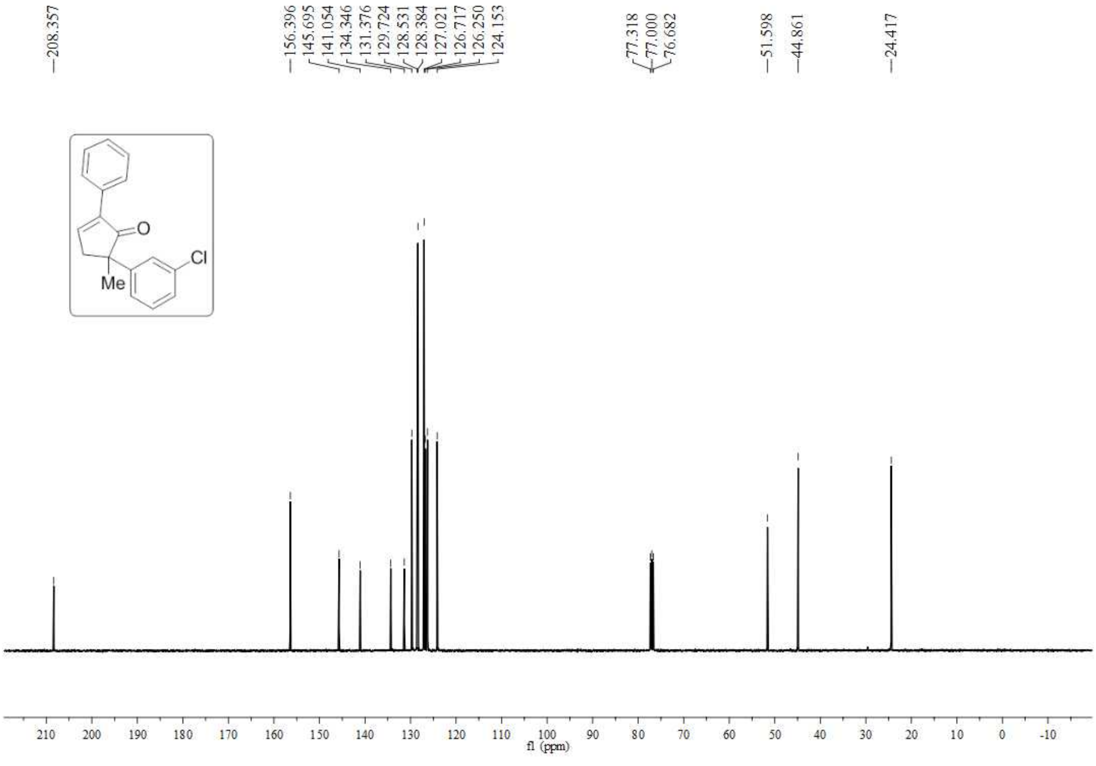
7.830
7.822
7.748
7.745
7.727
7.405
7.398
7.394
7.376
7.359
7.340
7.323
7.312
7.306
7.288
7.179
7.172
7.155
7.151
3.050
3.043
3.000
2.993
2.841
2.834
2.792
2.784
1.542
0.000
1.014
2.000
5.025
2.041
1.055
1.040
3.158
f1 (ppm)

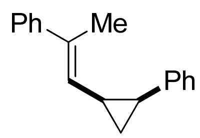

208.472
156.356
142.660
140.934
131.435
131.356
128.470
128.336
127.703
126.953
120.417
77.318
77.000
76.682
51.380
44.753
24.414
f1 (ppm)


Ph
O
Cl
Me

6k

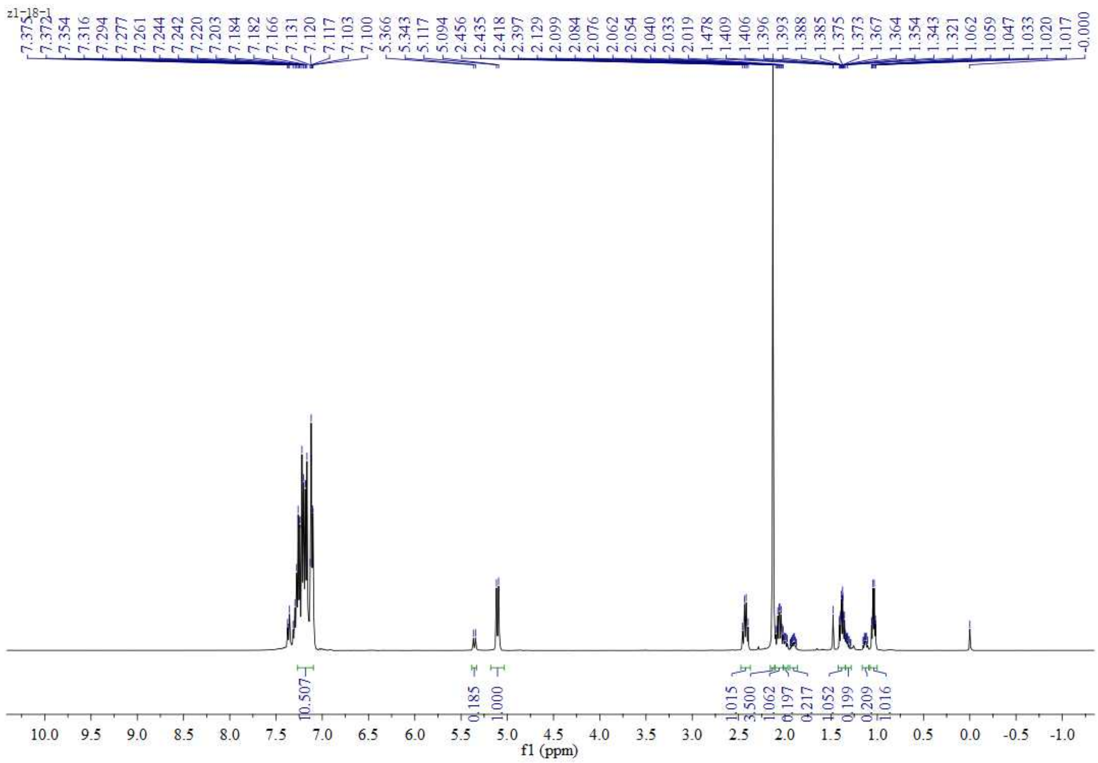

7.857
7.850
7.842
7.758
7.754
7.737
7.394
7.390
7.386
7.372
7.353
7.337
7.319
7.311
7.307
7.228
7.216
7.209
7.203
7.191
7.182
7.179
7.169
7.164
7.158
7.154
3.081
3.074
3.032
3.024
2.861
2.853
2.811
2.804
1.565
0.000
O
Cl
Me
1.006
2.000
4.056
3.158
1.035
1.036
3.127
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 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 -0.5
f1 (ppm)


208.357
156.396
145.695
141.054
134.346
131.376
129.724
128.531
128.384
127.021
126.717
126.250
124.153
77.318
77.000
76.682
51.598
44.861
24.417
O
Cl
Me
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

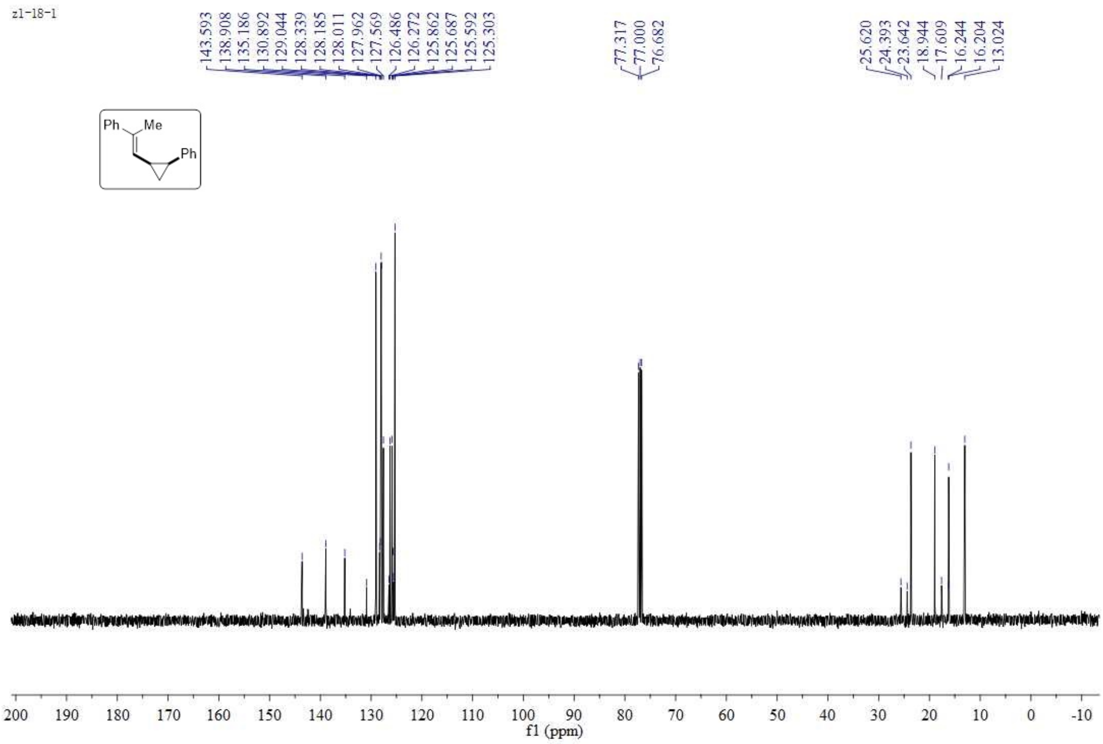


Ph
Me
Ph

5



z1-18-1
7.375 7.372 7.354 7.316 7.294 7.277 7.261 7.244 7.242 7.220 7.203 7.184 7.182 7.166 7.131 7.120 7.117 7.103 7.100 5.366 5.343 5.117 5.094 2.456 2.435 2.418 2.397 2.129 2.099 2.084 2.076 2.062 2.054 2.040 2.033 2.019 1.478 1.409 1.406 1.396 1.393 1.388 1.385 1.375 1.373 1.367 1.364 1.354 1.343 1.321 1.062 1.059 1.047 1.033 1.020 1.017 -0.000
10.507 0.185 1.000 1.015 3.500 1.062 0.197 0.217 1.052 0.199 0.209 1.016
10.0 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 -0.5 -1.0
f1 (ppm)



z1-18-1
143.593 138.908 135.186 130.892 129.044 128.339 128.185 128.011 127.962 127.569 126.486 126.272 125.862 125.687 125.592 125.303
77.317 77.000 76.682
25.620 24.393 23.642 18.944 17.609 16.244 16.204 13.024
Ph
Me
Ph
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)