# Electronic Supplementary Information

## Modular Construction of α-Furanyl Ketones *via* Semi-pinacol Rearrangement-Mediated Ring Expansion

Yang Chen,[a] Shifa Zhu*[,a,b]

[a]Key Laboratory of Functional Molecular Engineering of Guangdong Province, School of Chemistry and Chemical Engineering, South China University of Technology, Guangzhou, 510640, P. R. China;

[b]Guangdong Youmei Institute of Intelligent Biomanufacturing, Foshan 528225, PR China

*E-mail: zhusf@scut.edu.cn*

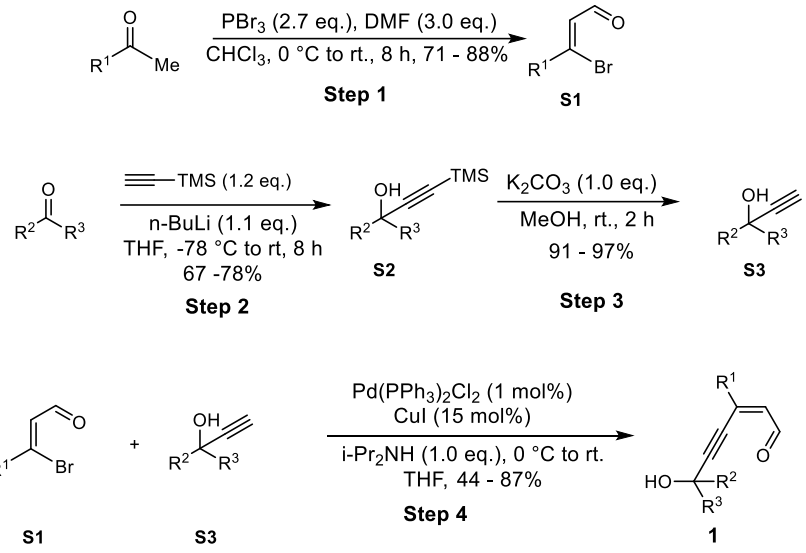
### Table of contents

# I. General information

All reactions were conducted under dry $N_2$ atmosphere in schlenk tube. Catalysts were commercial available. Commercially obtained reagents were used without purification. Reaction starting materials were prepared as depicted in the literature. $^1H$, $^{13}C$ NMR spectra were recorded on the Bruker AVANCE 400 (400 MHz for $^1H$; 101 MHz for $^{13}C$ C; 376 MHz for 19F) and Bruker AVANCE 500 (500 MHz for $^1H$; 126 MHz for $^{13}C$; 471 MHz for 19F), $^1H$ NMR and $^{13}C$ NMR chemical shifts were determined relative to internal standard TMS at $\delta$ 0.0. Chemical shifts ($\delta$) are reported in ppm, and coupling constants ($J$) are in Hertz (Hz). The following abbreviations were used to explain the multiplicities: s = singlet, d =doublet, t = triplet, q = quartet, m = multiplet, br = broad. Infrared (IR) spectra are recorded on a Nicolet 210 spectrophotometer and were recorded in potassium bromide (KBr) pellet. Mass spectra (MS) were obtained using ESI and DART mass spectrometer. Melting points were determined using a hot stage apparatus. All reagents were used as received from commercial sources, unless specified otherwise, or prepared as described in the literature.

# II. General Experimental Procedure

## 1. General procedure for preparation of enynals.[1]




**General procedure for preparation of bromo aldehyde (S1)**.

To a mixture of DMF (3.0 eq) and chloroform (0.5 M) was added $PBr_3$ (2.7 eq.) dropwise at 0 ℃, and the mixture was stirred for 60 min. before the addition of ketone (1.0 eq.). The resulting solution was stirred for 8 h at room temperature before it was poured into 300 ml water, neutralized with solid $NaHCO_3$, and extracted with dichloromethane. The extract was washed with a saturated NaCl solution, dried over anhydrous $MgSO_4$, and concentrated under reduced pressure. Purification of the crude product by flash column chromatography (silica gel, petroleum ether/ ethyl acetate = 20:1) gave **S1** with 71 - 88% yield.

**General procedure for preparation of propargylic alcohol (S2)**.

Trimethylsilylacetylene (1.2 eq.) was dissolved into THF (0.5 M), and the solution was cooled to -

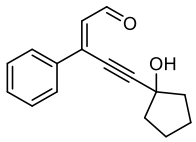
78 ℃. To this solution, n-Butyllithium (1.1 eq., 2.5M in hexane) was added. After being stirred for 20 minutes at -78 ℃, ketone (1.0 eq.) was added. The resulting mixture was allowed to warmed up to room temperature for 8 h, and then the reaction was quenched by saturated $NH_4Cl$ (aq.), and extracted three times with ether. The combined organic layer was dried over $MgSO_4$, and the solvent was removed under a reduced pressure. The residue was purified by collum chromatography (petroleum ether/ethyl acetate = 10:1) to afford the desired **S2** (67 - 78%) as an orange oil.

**General procedure for preparation of propargylic alcohol (S3).**

In a 25 mL one-neck round bottom flask equipped with magnetic stir bar was placed **S4** (1.0 eq.) and MeOH (1.0 M). To this stirring mixture was added $K_2CO_3$ (1.0 eq.) and the solution was stirred for 30 min, when TLC indicated the reaction was complete. Water (20 mL) was added and the solution was extracted (3 × 25 mL, $CH_2Cl_2$), dried ($MgSO_4$) and concentrated under vacuum. The crude product was purified by flash chromatography (petroleum ether/ethyl acetate = 5:1) to yield **S5** (91 - 97%) as an orange oil.

**General procedure for preparation of aryl-enynals (1)**.

The bromo aldehyde (1.2 eq.) and propargylic alcohol (1.0 eq.) were placed in a clean and anhydrous round-bottom flask equipped with a stir bar, then anhydrous THF and $^{i}Pr_2NH$ (1.0 eq.) were added under a nitrogen atmosphere, and the flask was cooled to 0 °C. Subsequently, CuI (15 mol%) and $Pd(PPh_3)_2Cl_2$ (1 mol%) were placed in the reaction flask; then after 20 min at 0 °C. Reaction progress was monitored by thin-layer chromatography (TLC) analysis. After complete consumption of the bromo aldehyde, the reaction was quenched with saturated $NH_4Cl$ and extracted with ethyl acetate (EtOAc). The combined organic layer was washed with brine, dried ($MgSO_4$), and concentrated. The crude material was typically purified by flash chromatography using a petroleum ether/ethyl acetate = 5:1 mixture as eluent to yield the enynals **1** (44 - 91%).



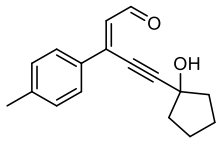

**(Z)-5-(1-hydroxycyclopentyl)-3-phenylpent-2-en-4-ynal (1a)**

Yield: 56%, yellow oil, $R_f$ = 0.34 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.22 (d, J = 8.0 Hz, 1H), 7.74 – 7.69 (m, 2H), 7.42 – 7.34 (m, 3H), 6.70 (d, J = 8.0 Hz, 1H), 3.59 (brs, 1H), 2.16 – 2.06 (m, 4H), 1.96 – 1.87 (m, 2H), 1.85 – 1.73 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.7, 193.7, 142.7, 135.4, 131.1, 130.8, 128.8, 127.2, 107.2, 77.8, 74.7, 42.4, 23.6.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{16}H_{17}O_2]^+$: 241.1223, Found. 241.1218.



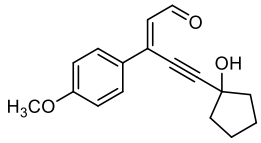

**(Z)-5-(1-hydroxycyclopentyl)-3-(p-tolyl)pent-2-en-4-ynal (1b)**

Yield: 55%, yellow oil, $R_f$ = 0.33 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.22 (d, *J* = 8.0 Hz, 1H), 7.64 (d, *J* = 7.9 Hz, 2H), 7.20 (d, *J* = 8.0 Hz, 2H), 6.70 (d, *J* = 8.1 Hz, 1H), 2.37 (s, 3H), 2.11 (t, *J* = 6.5 Hz, 4H), 1.97 – 1.88 (m, 2H), 1.85 – 1.75 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.7, 142.7, 141.8, 132.6, 130.0, 129.6, 127.2, 106.8, 77.9, 77.5, 42.4, 23.6, 21.4.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{17}H_{19}O_2]^+$: 255.1380, Found. 255.1382.



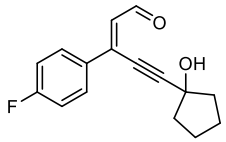

**(Z)-5-(1-hydroxycyclopentyl)-3-(4-methoxyphenyl)pent-2-en-4-ynal (1c)**

Yield: 67%, yellow oil, $R_f$ = 0.33 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.20 (d, *J* = 8.0 Hz, 1H), 7.75 – 7.70 (m, 2H), 6.97 – 6.89 (m, 2H), 6.67 (d, *J* = 8.0 Hz, 1H), 3.85 (s, 3H), 2.40 (brs, 1H), 2.14 – 2.08 (m, 4H), 1.97 – 1.88 (m, 2H), 1.88 – 1.77 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** $^{13}$C NMR (101 MHz, $CDCl_3$) δ 193.4, 162.2, 141.9, 129.1, 128.9, 127.8, 114.3, 106.1, 78.1, 74.9, 55.5, 42.5, 23.6, 23.5.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{17}H_{19}O_3]^+$: 271.1329, Found. 271.1331.




**(Z)-3-(4-fluorophenyl)-5-(1-hydroxycyclopentyl)pent-2-en-4-ynal (1d)**

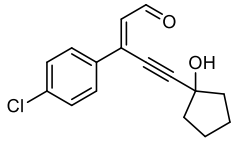
Yield: 68%, yellow oil, $R_f$ = 0.33 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** ) δ 10.21 (d, *J* = 7.8 Hz, 1H), 7.84 – 7.64 (m, 2H), 7.11 (t, *J* = 8.4 Hz, 2H), 6.67 (d, *J* = 7.9 Hz, 1H), 2.64 (brs, 1H), 2.11 (t, *J* = 6.4 Hz, 4H), 1.92 (qd, *J* = 10.5, 8.9, 5.2 Hz, 2H), 1.82 (qd, *J* = 8.4, 6.8, 3.8 Hz, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.2, 164.5 (d, *J* = 253.1 Hz), 141.2, 131.5 (d, *J* = 3.3 Hz), 130.7, 129.2 (d, *J* = 8.8 Hz), 116.0 (d, *J* = 22.0 Hz), 106.9, 77.8, 74.9, 42.5, 23.6.

**$^{19}$F NMR (376 MHz, $CDCl_3$)** δ -108.4.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{16}H_{16}FO_2]^+$: 259.1129, Found. 259.1125.



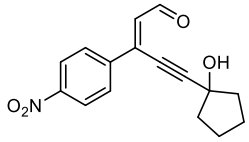

**(Z)-3-(4-chlorophenyl)-5-(1-hydroxycyclopentyl)pent-2-en-4-ynal (1e)**

Yield: 67%, yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.21 (d, *J* = 7.9 Hz, 1H), 7.70 – 7.64 (m, 2H), 7.46 – 7.33 (m, 2H), 6.69 (d, *J* = 7.9 Hz, 1H), 2.63 (brs, 1H), 2.17 – 2.06 (m, 4H), 1.99 – 1.87 (m, 2H), 1.87 – 1.77 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.2, 141.0, 137.3, 133.9, 131.1, 129.1, 128.4, 107.0, 77.6, 74.9, 42.5, 23.6.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{16}H_{16}ClO_2]^+$: 275.0833, Found. 275.0836.



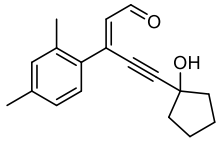

**(Z)-5-(1-hydroxycyclopentyl)-3-(4-nitrophenyl)pent-2-en-4-ynal (1f)**

Yield: 45%, yellow oil, $R_f$ = 0.31 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.26 (d, *J* = 7.7 Hz, 1H), 8.28 (d, *J* = 8.4 Hz, 2H), 7.91 (d, *J* = 8.1 Hz, 2H), 6.79 (d, *J* = 7.7 Hz, 1H), 2.40 (brs, 1H), 2.12 (t, *J* = 6.4 Hz, 4H), 2.00 – 1.89 (m, 2H), 1.89 – 1.72 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 192.9, 149.0, 141.5, 139.7, 133.2, 128.1, 124.0, 108.0, 77.1, 74.8, 42.5, 23.6.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C1_6H_{16}NO_4]^+$: 286.1074, Found. 286.1073.



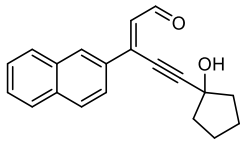

**(E)-3-(2,4-dimethylphenyl)-5-(1-hydroxycyclopentyl)pent-2-en-4-ynal (1g)**

Yield: 48%, yellow oil, $R_f$ = 0.37 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 9.42 (d, *J* = 8.2 Hz, 1H), 7.11 (d, *J* = 8.1 Hz, 2H), 7.05 (d, *J* = 7.8 Hz, 1H), 6.45 (d, *J* = 8.2 Hz, 1H), 2.37 (d, *J* = 2.9 Hz, 6H), 2.00 (t, *J* = 6.3 Hz, 4H), 1.93 – 1.83 (m, 2H), 1.80 – 1.71 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 192.5, 144.4, 139.4, 135.8, 135.2, 131.6, 131.4, 129.9, 126.5, 105.8, 82.7, 74.9, 42.3, 23.5, 21.2, 19.8.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{18}H_{21}O_2]^+$: 269.1536, Found. 269.1533.



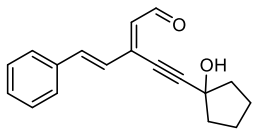

**(Z)-5-(1-hydroxycyclopentyl)-3-(naphthalen-2-yl)pent-2-en-4-ynal (1h)**

Yield: 56%, yellow oil, $R_f$ = 0.31 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.29 (d, *J* = 7.9 Hz, 1H), 8.28 (d, *J* = 1.9 Hz, 1H), 7.92 – 7.87 (m, 1H), 7.87 – 7.80 (m, 2H), 7.74 (dd, *J* = 8.7, 1.9 Hz, 1H), 7.59 – 7.49 (m, 2H), 6.86 (d, *J* = 7.9 Hz, 1H), 2.41 (brs, 1H), 2.24 – 2.08 (m, 4H), 2.03 – 1.89 (m, 2H), 1.88 – 1.78 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.4, 142.2, 134.5, 132.9, 132.7, 131.2, 129.1, 128.7, 128.4, 127.8, 127.7, 126.9, 123.2, 106.5, 78.1, 75.0, 42.6, 42.4, 23.6.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{20}H_{19}O_2]^+$: 291.1380, Found. 291.1381.



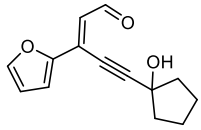

**(2Z,4E)-3-((1-hydroxycyclopentyl)ethynyl)-5-phenylpenta-2,4-dienal (1i)**

Yield: 78%, yellow oil, $R_f$ = 0.33 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.16 (d, *J* = 8.3 Hz, 1H), 7.52 – 7.46 (m, 2H), 7.43 (brs, 1H), 7.38 (d, *J* = 3.3 Hz, 1H), 7.37 – 7.32 (m, 2H), 6.84 (d, *J* = 15.6 Hz, 1H), 6.27 (d, *J* = 8.2 Hz, 1H), 2.20 – 2.03 (m, 4H), 1.99 – 1.87 (m, 2H), 1.85 – 1.76 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.3, 141.0, 139.8, 135.4, 133.4, 129.7, 128.9, 127.8, 127.2, 106.1, 75.7, 74.7, 42.5, 23.6.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{18}H_{19}O_2]^+$: 267.1380, Found. 267.1384.



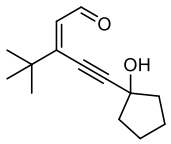
**(E)-3-(furan-2-yl)-5-(1-hydroxycyclopentyl)pent-2-en-4-ynal (1j)**

Yield: 56%, yellow oil, $R_f$ = 0.34 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.09 (d, *J* = 8.3 Hz, 1H), 7.51 (d, *J* = 1.7 Hz, 1H), 6.96 (d, *J* = 3.5 Hz, 1H), 6.65 (d, *J* = 8.3 Hz, 1H), 6.51 (dd, *J* = 3.5, 1.8 Hz, 1H), 3.27 (brs, 1H), 2.08 (td, *J* = 7.0, 6.2, 2.1 Hz, 4H), 1.97 – 1.87 (m, 2H), 1.85 – 1.74 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 192.8, 151.0, 145.9, 130.6, 126.6, 116.0, 112.9, 103.9, 75.5, 74.6, 42.4, 23.5.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{14}H_{15}O_3]^+$: 231.1016, Found. 231.1017.



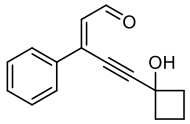
**(Z)-3-(tert-butyl)-5-(1-hydroxycyclopentyl)pent-2-en-4-ynal (1k)**

Yield: 67%, yellow oil, $R_f$ = 0.31 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.37 (d, *J* = 8.0 Hz, 1H), 8.32 (s, 1H), 8.02 (d, *J* = 7.9 Hz, 2H), 7.88 – 7.72 (m, 4H), 7.54 (m, 7H), 7.38 (d, *J* = 6.9 Hz, 3H), 6.95 (d, *J* = 7.9 Hz, 1H), 4.08 (brs, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 194.7, 156.8, 130.4, 106.7, 77.9, 74.6, 42.3, 37.6, 28.6, 23.4.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{14}H_{21}O_2]^+$: 221.1536, Found. 221.1539.



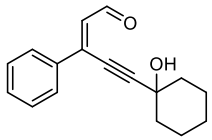
**(Z)-5-(1-hydroxycyclobutyl)-3-phenylpent-2-en-4-ynal (1l)**

Yield: 52%, yellow oil, $R_f$ = 0.33 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.34 – 10.18 (m, 1H), 7.86 – 7.65 (m, 2H), 7.50 – 7.35 (m, 3H), 6.84 – 6.49 (m, 1H), 3.96 (brs, 1H), 2.63 – 2.52 (m, 2H), 2.50 – 2.39 (m, 2H), 1.99 – 1.85 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.6, 142.7, 135.3, 131.2, 131.0, 128.9, 127.2, 106.6, 78.1, 68.1, 38.5, 13.2.

**HRMS (ESI)** ($[M+Na]^+$) Calcd. for $[C_{15}H_{14}NaO_2]^+$: 249.0886, Found. 249.0889.



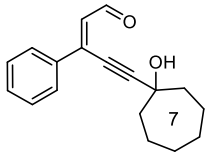
**(Z)-5-(1-hydroxycyclohexyl)-3-phenylpent-2-en-4-ynal (1m)**

Yield: 67%, yellow oil, $R_f$ = 0.33 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.28 (d, *J* = 8.0 Hz, 1H), 7.77 (d, *J* = 6.8 Hz, 2H), 7.50 – 7.39 (m, 3H), 6.76 (d, *J* = 8.0 Hz, 1H), 3.05 (brs, 1H), 2.14 – 1.99 (m, 2H), 1.87 – 1.70 (m, 4H), 1.67 – 1.50 (m, 3H), 1.45 – 1.21 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.3, 142.5, 135.5, 131.2, 131.2, 128.9, 127.2, 106.7, 78.9, 69.3, 39.7, 25.1, 23.3.

**HRMS (ESI)** ([M+Na]$^+$) Calcd. for $[C_{17}H_{18}NaO_2]^+$: 277.1199, Found. 277.1202.



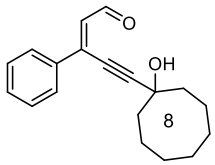

**(Z)-5-(1-hydroxycycloheptyl)-3-phenylpent-2-en-4-ynal (1n)**

Yield: 44%, yellow oil, $R_f$ = 0.31 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, CDCl$_3$)** δ 10.25 (d, *J* = 8.0 Hz, 1H), 7.75 (d, *J* = 7.3 Hz, 2H), 7.47 – 7.36 (m, 3H), 6.74 (d, *J* = 8.0 Hz, 1H), 3.34 (brs, 1H), 2.18 (dd, *J* = 14.2, 8.2 Hz, 2H), 2.01 (dd, *J* = 13.8, 9.2 Hz, 2H), 1.82 – 1.68 (m, 2H), 1.68 – 1.44 (m, 6H).

**$^{13}$C NMR (101 MHz, CDCl$_3$)** δ 193.5, 142.7, 135.5, 131.2, 131.1, 128.8, 127.2, 108.1, 78.0, 72.3, 42.8, 28.1, 22.2.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{18}H_{21}O_2]^+$: 269.1536, Found. 269.1539.



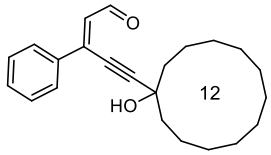

**(Z)-5-(1-hydroxycyclooctyl)-3-phenylpent-2-en-4-ynal (1o)**

Yield: 88%, yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, CDCl$_3$)** δ 10.22 (d, *J* = 8.0 Hz, 1H), 7.73 (d, *J* = 7.2 Hz, 2H), 7.47 – 7.30 (m, 3H), 6.71 (d, *J* = 8.0 Hz, 1H), 3.00 (brs, 1H), 2.08 (t, *J* = 9.0 Hz, 4H), 1.77 – 1.56 (m, 8H), 1.55 – 1.41 (m, 2H).

**$^{13}$C NMR (101 MHz, CDCl$_3$)** δ 193.5, 142.6, 135.5, 131.1, 131.1, 128.8, 127.2, 107.8, 77.9, 72.0, 37.9, 27.9, 24.4, 22.1.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{19}H_{23}O_2]^+$: 283.1693, Found. 283.1695.



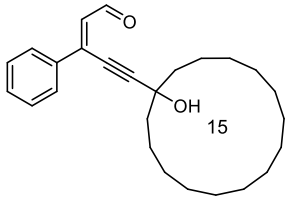

**(Z)-5-(1-hydroxycyclododecyl)-3-phenylpent-2-en-4-ynal (1p)**

Yield: 56%, yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, CDCl$_3$)** δ 10.26 (d, *J* = 7.9 Hz, 1H), 7.76 (d, *J* = 7.1 Hz, 2H), 7.51 – 7.36 (m, 3H), 6.75 (d, *J* = 7.9 Hz, 1H), 2.82 (s, 1H), 2.01 (td, *J* = 13.3, 4.4 Hz, 2H), 1.91 – 1.77 (m, 2H), 1.58 (d, *J* = 10.3 Hz, 2H), 1.51 – 1.25 (m, 16H).

**$^{13}$C NMR (101 MHz, CDCl$_3$)** δ 193.4, 142.5, 135.5, 131.1, 128.9, 127.2, 107.4, 78.2, 71.5, 35.7, 26.0, 25.9, 22.5, 22.2, 19.7.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{23}H_{31}O_2]^+$: 339.2319, Found. 339.2319.



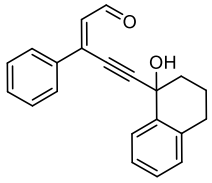

**(Z)-5-(1-hydroxycyclopentadecyl)-3-phenylpent-2-en-4-ynal (1q)**

Yield: 56%, yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.26 – 10.18 (m, 1H), 7.77 – 7.65 (m, 2H), 7.43 – 7.32 (m, 3H), 6.74 – 6.67 (m, 1H), 3.64 (brs, 1H), 1.95 – 1.78 (m, *J* = 6.1 Hz, 4H), 1.55 – 1.21 (m, 20H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.5, 142.6, 135.4, 131.1, 130.9, 128.8, 127.2, 107.8, 78.1, 77.6, 71.4, 39.3, 27.5, 26.9, 26.7, 26.7, 26.4, 22.2.

**HRMS (ESI)** ($[M+Na]^+$) Calcd. for $[C_{26}H_{36}NaO_2]^+$: 403.2608, Found. 403.2605.



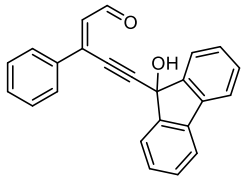

**(Z)-5-(1-hydroxy-1,2,3,4-tetrahydronaphthalen-1-yl)-3-phenylpent-2-en-4-ynal (1r)**

Yield: 59%, yellow oil, $R_f$ = 0.33 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.18 (d, *J* = 7.9 Hz, 1H), 7.77 (d, *J* = 6.9 Hz, 1H), 7.70 (d, *J* = 7.3 Hz, 2H), 7.47 – 7.32 (m, 3H), 7.27 – 7.19 (m, 2H), 7.10 (d, *J* = 6.8 Hz, 1H), 6.70 (d, *J* = 7.9 Hz, 1H), 3.29 (brs, 1H), 2.94 – 2.68 (m, 2H), 2.31 (t, *J* = 6.2 Hz, 2H), 2.14 – 2.00 (m, 1H), 2.00 – 1.86 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.4, 142.3, 138.3, 136.2, 135.4, 131.4, 131.2, 129.4, 128.9, 128.5, 127.8, 127.2, 126.8, 106.9, 79.1, 68.5, 38.8, 29.2, 19.3.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{21}H_{19}O_2]^+$: 303.1380, Found. 303.1383.



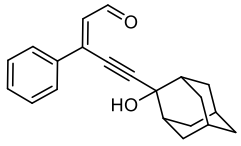

**(Z)-5-(9-hydroxy-9H-fluoren-9-yl)-3-phenylpent-2-en-4-ynal (1s)**

Yield: 50%, yellow oil, $R_f$ = 0.33 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 9.97 (d, *J* = 8.0 Hz, 1H), 7.69 (d, *J* = 7.3 Hz, 2H), 7.57 (d, *J* = 7.3 Hz, 2H), 7.51 (d, *J* = 7.3 Hz, 2H), 7.34 – 7.20 (m, 7H), 6.56 (d, *J* = 8.0 Hz, 1H), 4.35 (brs, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.6, 146.5, 142.2, 139.2, 135.1, 131.8, 131.3, 130.1, 128.9, 128.8, 127.3, 124.4, 120.5, 103.1, 77.3, 75.2.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{24}H_{17}O_2]^+$: 337.1223, Found. 337.1224.



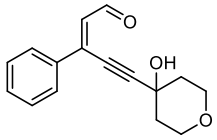

**(Z)-5-((1r,3r,5r,7r)-2-hydroxyadamantan-2-yl)-3-phenylpent-2-en-4-ynal (1t)**

Yield: 56%, yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 2:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.00 (d, *J* = 240.6, 8.1 Hz, 1H), 7.79 (dd, *J* = 7.8, 1.9 Hz, 2H), 7.53 – 7.40 (m, 3H), 6.77 (d, 1H), 2.27 (dd, *J* = 13.1, 3.1 Hz, 2H), 2.19 – 2.12 (m, 4H), 2.00 – 1.82 (m, 4H), 1.80 – 1.70 (m, 3H), 1.69 – 1.62 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.2, 142.4, 135.6, 131.3, 131.1, 128.9, 127.2, 107.4, 79.7, 73.4, 38.7, 37.4, 35.6, 31.5, 26.8, 26.7.

**HRMS (ESI)** ($[M+Na]^+$) Calcd. for $[C_{21}H_{22}NaO_2]^+$: 329.1512, Found. 329.1514.



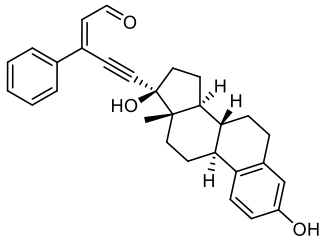
**(Z)-5-(4-hydroxytetrahydro-2H-pyran-4-yl)-3-phenylpent-2-en-4-ynal (1u)**

Yield: 58%, yellow oil, $R_f$ = 0.33 (petroleum ether/AcOEt = 5:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.26 (d, *J* = 7.9 Hz, 1H), 7.74 (dd, *J* = 7.8, 1.7 Hz, 2H), 7.51 – 7.38 (m, 3H), 6.77 (d, *J* = 7.9 Hz, 1H), 3.97 (dt, *J* = 11.8, 4.9 Hz, 2H), 3.71 (ddd, *J* = 11.7, 8.5, 3.0 Hz, 3H), 3.31 (s, 1H), 2.11 (dt, *J* = 13.3, 3.9 Hz, 2H), 1.97 (dd, *J* = 8.8, 4.0 Hz, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 192.9, 141.9, 135.3, 131.6, 131.3, 129.0, 127.1, 105.0, 79.3, 77.3, 66.3, 64.6, 39.6.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{16}H_{17}O_3]^+$: 257.1172, Found. 257.1178.



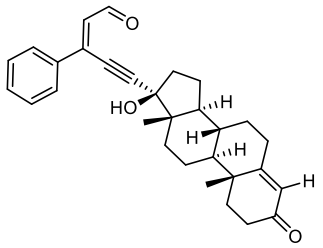
**(Z)-5-((8R,9S,13S,14S)-3,17-dihydroxy-13-methyl-7,8,9,11,12,13,14,15,16,17-decahydro-6H-cyclopenta[a]phenanthren-17-yl)-3-phenylpent-2-en-4-ynal (1v)**

Yield: 78%, yellow oil, $R_f$ = 0.33 (petroleum ether/AcOEt = 1:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δδ 10.31 (d, *J* = 8.0 Hz, 1H), 7.80 (d, *J* = 7.3 Hz, 2H), 7.45 (dq, *J* = 14.1, 7.0 Hz, 3H), 7.12 (d, *J* = 8.5 Hz, 1H), 7.02 (s, 1H), 6.81 (d, *J* = 8.0 Hz, 1H), 6.71 (d, *J* = 8.3 Hz, 1H), 6.64 (s, 1H), 3.78 (s, 1H), 2.81 (d, *J* = 6.4 Hz, 2H), 2.52 (td, *J* = 9.3, 4.7 Hz, 1H), 2.39 – 2.31 (m, 1H), 2.29 – 2.14 (m, 2H), 1.90 (dq, *J* = 13.0, 7.0, 5.7 Hz, 4H), 1.83 – 1.73 (m, 1H), 1.59 – 1.43 (m, 3H), 1.36 (ddt, *J* = 20.0, 13.3, 7.4 Hz, 1H), 1.00 (s, 3H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 194.0, 153.9, 143.3, 138.0, 135.5, 131.9, 131.4, 130.9, 129.0, 127.3, 126.5, 115.5, 113.0, 107.3, 81.1, 80.9, 77.4, 50.5, 48.2, 43.7, 39.5, 39.3, 33.4, 29.6, 27.4, 26.4, 25.9, 23.1, 13.1.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{29}H_{31}O_3]^+$: 427.2268, Found. 427.2272.

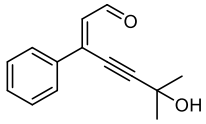


**(Z)-5-((8R,9S,10R,13S,14S,17R)-17-hydroxy-10,13-dimethyl-3-oxo-2,3,6,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-17-yl)-3-phenylpent-2-en-4-ynal (1w)**

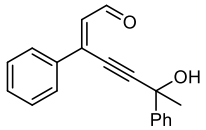
Yield: 62%, yellow oil, $R_f$ = 0.31 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.21 (d, *J* = 8.1 Hz, 1H), 7.71 (d, *J* = 7.4 Hz, 2H), 7.45 – 7.31 (m, 3H), 6.69 (d, *J* = 7.8 Hz, 1H), 5.70 (s, 1H), 4.12 (brs, 1H), 2.48 – 2.08 (m, 7H), 2.01 – 1.92 (m, 1H), 1.88 – 1.71 (m, 3H), 1.68 – 1.53 (m, 4H), 1.53 – 1.33 (m, 3H), 1.14 (s, 3H), 0.95 (s, 3H), 0.93 – 0.77 (m, 1H).

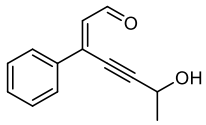
**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 199.8, 193.3, 171.5, 142.5, 135.5, 131.2, 131.0, 128.8, 127.2, 123.8, 107.1, 80.7, 80.2, 53.6, 50.8, 47.6, 39.2, 38.6, 36.2, 35.6, 33.8, 33.1, 32.7, 31.5, 23.3, 20.7, 17.4, 12.9.
**HRMS (ESI)** ([M+Na]$^+$) Calcd. for $[C_{30}H_{34}NaO_3]^+$: 465.2400, Found. 465.2402.



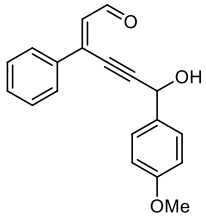

**(Z)-6-hydroxy-6-methyl-3-phenylhept-2-en-4-ynal (1x)**
Yield: 78%, yellow oil, $R_f$ = 0.37 (petroleum ether/AcOEt = 3:1).
**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.15 (d, *J* = 8.0 Hz, 1H), 7.64 (dd, *J* = 8.0, 1.7 Hz, 2H), 7.34 – 7.27 (m, 3H), 6.63 (d, *J* = 8.0 Hz, 1H), 4.40 (brs, 1H), 1.62 (s, 6H).
**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.8, 142.7, 135.2, 131.2, 130.8, 128.8, 127.2, 107.9, 76.6, 65.4, 31.1.
**HRMS (ESI)** ([M+Na]$^+$) Calcd. for $[C_{14}H_{14}NaO_2]^+$: 237.0886, Found. 237.0887.




**(Z)-6-hydroxy-3,6-diphenylhept-2-en-4-ynal (1y)**
Yield: 64%, yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 3:1).
**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.25 (d, *J* = 8.0 Hz, 1H), 7.77 (d, *J* = 7.3 Hz, 2H), 7.51 (d, *J* = 8.2 Hz, 2H), 7.48 – 7.40 (m, 3H), 6.95 (d, *J* = 8.2 Hz, 2H), 6.77 (d, *J* = 8.0 Hz, 1H), 5.74 (s, 1H), 3.94 – 3.46 (m, 4H), 3.37 (s, 1H).
**$^{13}$C NMR (101 MHz, $CDCl_3$)** ) δ 193.3, 160.0, 142.1, 135.2, 132.2, 131.7, 131.2, 128.9, 128.1, 127.2, 114.3, 102.5, 80.8, 77.3, 64.7, 55.4.
**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{19}H_{17}O_2]^+$: 277.1223, Found. 277.1224.




**(Z)-6-hydroxy-3-phenylhept-2-en-4-ynal (1z)**
Yield: 56%, yellow oil, $R_f$ = 0.37 (petroleum ether/AcOEt = 3:1).
**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.23 (d, *J* = 8.0 Hz, 1H), 7.74 (d, *J* = 8.1 Hz, 2H), 7.48 – 7.36 (m, 3H), 6.73 (d, *J* = 8.0 Hz, 1H), 4.86 (q, *J* = 6.7 Hz, 1H), 3.69 (brs, 1H), 1.61 (d, *J* = 6.7 Hz, 3H).
**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.7, 142.5, 135.2, 131.2, 131.2, 128.9, 127.2, 104.8, 78.5, 58.6, 24.0.
**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{13}H_{13}O_2]^+$: 201.0910, Found. 201.0910.



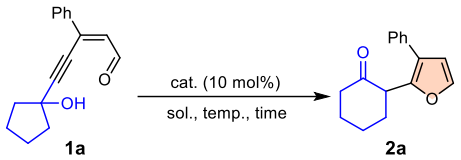

**(Z)-6-hydroxy-6-(4-methoxyphenyl)-3-phenylhex-2-en-4-ynal (1aa)**
Yield: 89%, yellow oil, $R_f$ = 0.37 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.25 (d, *J* = 8.0 Hz, 1H), 7.77 (d, *J* = 7.3 Hz, 2H), 7.51 (d, *J* = 8.2 Hz, 2H), 7.48 – 7.40 (m, 3H), 6.95 (d, *J* = 8.2 Hz, 2H), 6.77 (d, *J* = 8.0 Hz, 1H), 5.74 (s, 1H), 3.94 – 3.46 (m, 4H), 3.37 (s, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.3, 160.0, 142.1, 135.2, 132.2, 131.7, 131.2, 128.9, 128.1, 127.2, 114.3, 102.5, 80.8, 77.3, 64.7, 55.4.

**HRMS (ESI)** ([M+Na]$^+$) Calcd. for $[C_{19}H_{16}NaO_3]^+$: 315.0992, Found. 315.0995

## 2. Optimization of the reaction conditions for Synthesis of 2a[a]

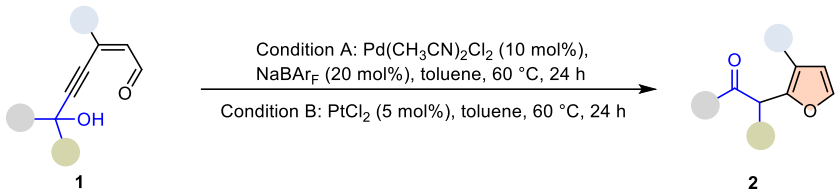



**1a** **2a**

| Entry | Cat. | T. | Sol. | Time/h | **2a** |
|---|---|---|---|---|---|
| 1 | $Pd(PhCN)_2Cl_2$ | rt | Toluene | 36 | trace |
| 2 | $Pd(CH_3CN)_2Cl_2$ | rt | Toluene | 36 | trace |
| 3 | $Pd(CH_3CN)_2Cl_2$ | 60 °C | Toluene | 36 | 50% |
| **4**[b] | **$Pd(CH_3CN)_2Cl_2$** | **60 °C** | **Toluene** | **6** | **79%** |
| **5**[c] | **$PtCl_2$** | **60 °C** | Toluene | **6** | **63%** |
| 6[b] | $Pd(CH_3CN)_2Cl_2$ | 80 °C | Toluene | 6 | 47% |
| 7[b] | $Pd(CH_3CN)_2Cl_2$ | 60 °C | THF | 24 | 40% |
| 8[b] | $Pd(CH_3CN)_2Cl_2$ | 60 °C | DCE | 24 | 16% |
| 9[d] | $Rh_2(OAc)_4$ | 60 °C | Toluene | 24 | 20% |

[a]Reaction conditions: **1a** (0.2 mmol), and 10 mol% cat. in solvent (2 mL) under $N_2$. The yield was determined by $^1$H NMR analysis using $CH_3NO_2$ as an internal standard; [b]$NaBAr_F$ (20 mol%) was used as additive. [c]$PtCl_2$ (5 mol%) was used. [d]$Rh_2(OAc)_4$ (2 mol%) was used.

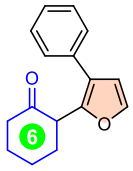
## 3. General procedure for the synthesis of 2a-2z.




**1** **2**

**Condition A**: under nitrogen atmosphere, to a solution of enynals **1** (0.2 mmol) in dry toluene (0.025 M), $Pd(CH_3CN)_2Cl_2$ (0.1 eq., 5.2 mg) and $NaBAr_F$ (0.2 eq., 35 mg) were added. The reaction mixture was then heated to a temperature of 60 °C and stirred for 24 hours. After the reaction was completed, the reaction mixture was filtered through short silica gel, and then the solvent was removed under reduced pressure. The bifuran product was purified by flash column chromatography (silica gel, petroleum ether/AcOEt = 10:1) to yield **2**.

**Condition B**: under nitrogen atmosphere, to a solution of enynals **1** (0.2 mmol) in dry toluene (0.025 M), $PtCl_2$ (0.05 eq., 2.7 mg) were added. The reaction mixture was then heated to a temperature of 60 °C and stirred for 24 hours. After the reaction was completed, the reaction mixture was filtered through short silica gel, and then the solvent was removed under reduced pressure. The bifuran product was purified by flash column chromatography (silica gel, petroleum ether/AcOEt = 10:1) to yield **2**.



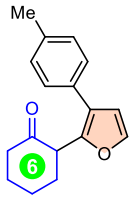
**2-(3-phenylfuran-2-yl)cyclohexan-1-one (2a)**

Condition A, Yield: 79% (38 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.38 – 7.34 (m, 2H), 7.34 – 7.28 (m, 3H), 7.26 – 7.20 (m, 1H), 6.44 (d, *J* = 1.9 Hz, 1H), 3.54 (t, *J* = 9.8 Hz, 1H), 2.42 – 2.20 (m, 4H), 2.19 – 2.08 (m, 1H), 1.91 – 1.73 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 216.6, 147.3, 141.4, 133.6, 128.7, 128.0, 127.1, 124.6, 111.6, 47.5, 38.2, 29.5, 21.1.

**HRMS (ESI)** ([M+Na]$^+$) Calcd. for $[C_{16}H_{16}NaO_2]^+$: 263.1043, Found. 263.1048.



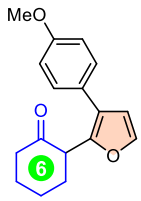
**2-(3-(p-tolyl)furan-2-yl)cyclohexan-1-one (2b)**

Condition A, Yield: 72% (36 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.45 (d, *J* = 1.7 Hz, 1H), 7.24 – 7.18 (m, 4H), 6.52 (d, *J* = 1.9 Hz, 1H), 3.85 (q, 1H), 2.63 (dt, *J* = 14.1, 4.5 Hz, 1H), 2.44 (dd, *J* = 12.9, 6.0 Hz, 1H), 2.40 (s, 3H), 2.29 – 2.18 (m, 2H), 2.16 – 2.00 (m, 2H), 1.96 – 1.81 (m, 1H), 1.80 – 1.69 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 208.8, 147.6, 141.4, 136.6, 130.9, 129.3, 128.0, 123.3, 111.7, 49.6, 42.0, 32.2, 27.2, 24.8, 21.1.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{17}H_{19}O_2]^+$: 255.1380, Found. 255.1383.



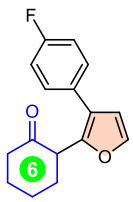
**2-(3-(4-methoxyphenyl)furan-2-yl)cyclohexan-1-one (2c)**

Condition A, Yield: 78% (42 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.43 (d, *J* = 1.9 Hz, 1H), 7.26 – 7.20 (m, 2H), 6.97 – 6.91 (m, 2H), 6.50 (d, *J* = 1.9 Hz, 1H), 3.85 (s, 3H), 2.62 (dt, 1H), 2.43 (td, *J* = 13.7, 13.0, 5.7 Hz, 1H), 2.27 – 2.17 (m, 2H), 2.15 – 2.00 (m, 2H), 1.95 – 1.81 (m, 1H), 1.80 – 1.68 (m, 1H), 1.68 – 1.57 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 208.9, 158.7, 147.4, 141.4, 129.2, 126.2, 123.0, 114.1, 111.7, 49.6, 41.9, 32.2, 27.2, 24.8.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{17}H_{19}O_3]^+$: 271.1329, Found. 271.1327.



**2-(3-(4-fluorophenyl)furan-2-yl)cyclohexan-1-one (2d)**

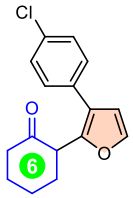
Condition A, Yield: 44% (23 mg), yellow oil, $R_f$ = 0.33 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.44 (d, *J* = 1.9 Hz, 1H), 7.31 – 7.24 (m, 2H), 7.13 – 7.04 (m, 2H), 6.49 (d, *J* = 1.9 Hz, 1H), 3.79 (dd, *J* = 10.9, 6.3 Hz, 1H), 2.63 (dtd, *J* = 14.2, 4.4, 1.5 Hz, 1H), 2.48 – 2.37 (m, 1H), 2.29 – 2.18 (m, 2H), 2.16 – 1.99 (m, 2H), 1.96 – 1.81 (m, 1H), 1.81 – 1.66 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 208.6, 162.0 (d, *J* = 245.9 Hz), 147.8, 141.5, 129.8 (d, *J* = 3.3 Hz), 129.7 (d, *J* = 8.0 Hz), 122.6, 115.5 (d, *J* = 21.5 Hz), 111.6, 77.4, 77.1, 76.7, 49.6, 41.9, 32.1, 27.1, 24.7.

**$^{19}$F NMR (376 MHz, $CDCl_3$)** δ -115.6.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{16}H_{16}FO_2]^+$: 259.1129, Found. 259.1127.



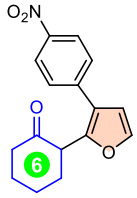

**2-(3-(4-chlorophenyl)furan-2-yl)cyclohexan-1-one (2e)**

Condition A, Yield: 56% (31 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.45 (d, *J* = 1.9 Hz, 1H), 7.40 – 7.34 (m, 2H), 7.26 – 7.20 (m, 2H), 6.50 (d, *J* = 1.9 Hz, 1H), 3.79 (dd, *J* = 10.9, 6.4 Hz, 1H), 2.63 (dtd, *J* = 14.3, 4.4, 1.4 Hz, 1H), 2.48 – 2.36 (m, 1H), 2.29 – 2.17 (m, 2H), 2.16 – 2.01 (m, 2H), 1.94 – 1.82 (m, 1H), 1.80 – 1.61 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 208.6, 148.0, 141.7, 132.8, 132.3, 129.3, 128.8, 122.5, 111.4, 49.6, 41.9, 32.1, 27.1, 24.7.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{16}H_{16}ClO_2]^+$: 275.0833, Found. 275.0829.



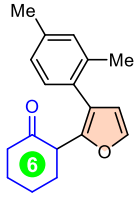

**2-(3-(4-nitrophenyl)furan-2-yl)cyclohexan-1-one (2f)**

Condition A, Yield: 37% (21 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 8.26 (d, *J* = 8.4 Hz, 2H), 7.50 (d, *J* = 1.9 Hz, 1H), 7.46 (d, *J* = 8.3 Hz, 2H), 6.58 (d, *J* = 1.9 Hz, 1H), 3.82 (q, *J* = 10.7, 6.6 Hz, 1H), 2.73 – 2.58 (m, 1H), 2.45 (td, *J* = 13.7, 13.1, 5.7 Hz, 1H), 2.26 (td, *J* = 10.3, 9.9, 3.6 Hz, 2H), 2.19 – 2.03 (m, 2H), 1.98 – 1.83 (m, 1H), 1.83 – 1.69 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 208.8, 147.6, 141.4, 136.6, 130.9, 129.3, 128.0, 123.3, 111.7, 49.6, 42.0, 32.2, 27.2, 24.8, 21.1.

**HRMS (ESI)** ([M+Na]$^+$) Calcd. for $[C_{16}H_{15}NNaO_4]^+$: 308.0893, Found. 308.0898.



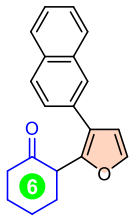

**2-(3-(2,4-dimethylphenyl)furan-2-yl)cyclohexan-1-one (2g)**

Condition A, Yield: 75% (38 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.45 (d, *J* = 1.9 Hz, 1H), 7.09 (s, 1H), 7.01 (s, 2H), 6.38 (d, *J* = 1.8 Hz, 1H), 3.56 (t, 1H), 2.55 (dtd, *J* = 14.0, 4.2, 1.4 Hz, 1H), 2.37 (s, 3H), 2.34 – 2.27 (m, 1H), 2.21 (s, 3H), 2.16 (td, *J* = 9.6, 8.8, 3.9 Hz, 2H), 2.10 – 2.02 (m, 1H), 2.02 – 1.93 (m, 1H), 1.89 – 1.76 (m, 1H), 1.74 – 1.63 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 208.6, 148.2, 141.0, 137.2, 137.0, 130.9, 130.2, 130.1, 126.4, 122.4, 112.7, 49.4, 42.0, 32.3, 27.2, 24.8, 21.1, 20.2.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{18}H_{21}O_2]^+$: 269.1536, Found. 269.1538.



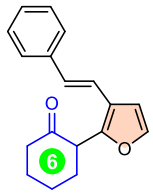
**2-(3-(naphthalen-2-yl)furan-2-yl)cyclohexan-1-one (2h)**

Condition A, Yield: 61% (35 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.90 – 7.83 (m, 3H), 7.75 (s, 1H), 7.51 (q, *J* = 4.1, 3.3 Hz, 3H), 7.45 (dd, *J* = 8.5, 1.7 Hz, 1H), 6.64 (d, *J* = 1.9 Hz, 1H), 3.93 (dd, *J* = 11.0, 6.3 Hz, 1H), 2.66 (dt, *J* = 14.2, 4.5 Hz, 1H), 2.44 (td, *J* = 13.6, 13.1, 5.8 Hz, 1H), 2.33 – 2.18 (m, 2H), 2.18 – 2.00 (m, 2H), 1.97 – 1.81 (m, 1H), 1.80 – 1.67 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 208.8, 148.2, 141.7, 133.5, 132.3, 131.3, 128.2, 127.9, 127.7, 126.6, 126.6, 126.3, 125.8, 123.5, 111.8, 49.8, 42.0, 32.2, 27.2, 24.8.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{20}H_{19}O_2]^+$: 291.1380, Found. 291.1385.



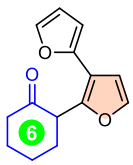
**(E)-2-(3-styrylfuran-2-yl)cyclohexan-1-one (2i)**

Condition A, Yield: 66% (35 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.50 – 7.45 (m, 2H), 7.40 (d, *J* = 2.0 Hz, 1H), 7.36 (t, *J* = 7.6 Hz, 2H), 7.29 – 7.22 (m, 1H), 6.89 – 6.75 (m, 2H), 6.67 (d, *J* = 2.0 Hz, 1H), 3.91 (t, *J* = 8.3 Hz, 1H), 2.69 – 2.58 (m, 1H), 2.53 – 2.42 (m, 1H), 2.31 – 2.21 (m, 2H), 2.18 – 2.03 (m, 2H), 1.97 – 1.76 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 207.9, 149.5, 142.1, 137.6, 128.6, 128.3, 127.3, 126.2, 120.8, 118.3, 108.0, 49.3, 41.8, 32.2, 27.3, 24.7.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{18}H_{19}O_2]^+$: 267.1380, Found. 267.1380.



**2-([2,3'-bifuran]-2'-yl)cyclohexan-1-one (2j)**

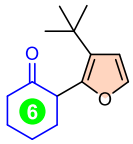
Condition B, Yield: 61% (28 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.39 (d, *J* = 2.1 Hz, 2H), 6.57 (d, *J* = 1.9 Hz, 1H), 6.42 (dd, *J* = 3.2, 1.8 Hz, 1H), 6.30 (d, *J* = 3.3 Hz, 1H), 4.21 (dd, *J* = 11.2, 6.3 Hz, 1H), 2.61 (dt, *J* = 14.5, 4.4 Hz, 1H), 2.49

(td, *J* = 13.5, 12.8, 5.8 Hz, 1H), 2.32 – 2.22 (m, 2H), 2.15 (dd, *J* = 11.7, 5.0 Hz, 1H), 2.06 (dd, *J* = 11.3, 5.0 Hz, 1H), 1.95 – 1.76 (m, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 207.9, 148.5, 147.9, 141.8, 141.2, 114.2, 111.1, 109.2, 105.7, 50.4, 42.0, 31.9, 27.3, 24.9.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{14}H_{15}O_3]^+$: 231.1016, Found. 231.1012.



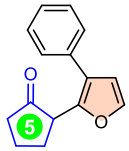
**2-(3-(tert-butyl)furan-2-yl)cyclohexan-1-one (2k)**

Condition A, Yield: 57% (25 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.40 (d, *J* = 1.3 Hz, 1H), 6.52 (t, *J* = 1.2 Hz, 1H), 3.79 – 3.65 (m, 1H), 1.99 – 1.77 (m, 4H), 1.77 – 1.62 (m, 4H), 1.38 (s, 3H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** ) δ 193.6, 147.8, 144.1, 142.9, 112.9, 47.8, 31.3, 29.4, 29.3, 26.2.

**HRMS (ESI)** ($[M+Na]^+$) Calcd. for $[C_{14}H_{20}NaO_2]^+$: 243.1356, Found. 243.1358.



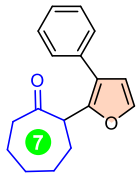
**2-(3-phenylfuran-2-yl)cyclopentan-1-one (2l)**

Condition A, Yield: 63% (28 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.38 – 7.34 (m, 2H), 7.34 – 7.28 (m, 3H), 7.26 – 7.20 (m, 1H), 6.44 (d, *J* = 1.9 Hz, 1H), 3.54 (t, *J* = 9.8 Hz, 1H), 2.42 – 2.20 (m, 4H), 2.19 – 2.08 (m, 1H), 1.91 – 1.73 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 216.6, 147.3, 141.4, 133.6, 128.7, 128.0, 127.1, 124.6, 111.6, 47.5, 38.2, 29.5, 21.1.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{15}H_{15}O_2]^+$: 227.1067, Found. 227.1068.



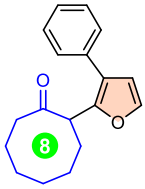
**2-(3-phenylfuran-2-yl)cycloheptan-1-one (2m)**

Condition B, Yield: 62% (31 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.49 (d, *J* = 6.9 Hz, 2H), 7.46 – 7.40 (m, 3H), 7.36 – 7.30 (m, 1H), 6.52 (d, *J* = 1.8 Hz, 1H), 3.97 (dd, *J* = 10.3, 4.8 Hz, 1H), 2.92 (td, *J* = 12.4, 3.0 Hz, 1H), 2.66 – 2.55 (m, 1H), 2.23 – 1.88 (m, 5H), 1.72 – 1.47 (m, 2H), 1.44 – 1.27 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 212.0, 149.0, 141.3, 133.5, 128.6, 128.2, 126.9, 122.7, 111.7, 51.4, 42.8, 30.4, 29.9, 28.1, 25.7.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{17}H_{19}O_2]^+$: 255.1380, Found. 255.1383.



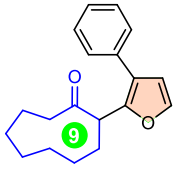
**2-(3-phenylfuran-2-yl)cyclooctan-1-one (2n)**

Condition B, Yield: 70% (37 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.39 (d, *J* = 7.5 Hz, 2H), 7.37 – 7.29 (m, 3H), 7.22 (t, *J* = 7.3 Hz, 1H), 6.41 (d, *J* = 1.8 Hz, 1H), 3.85 (dd, *J* = 11.8, 3.0 Hz, 1H), 2.86 (td, *J* = 12.2, 3.8 Hz, 1H), 2.48 (dtd, *J* = 15.3, 11.7, 3.7 Hz, 1H), 2.26 (ddd, *J* = 12.6, 6.3, 3.6 Hz, 1H), 1.94 – 1.79 (m, 2H), 1.78 – 1.71 (m, 1H), 1.70 – 1.61 (m, 2H), 1.59 – 1.51 (m, 1H), 1.49 – 1.35 (m, 2H), 1.31 – 1.15 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 214.5, 148.0, 141.6, 133.4, 128.6, 128.3, 127.0, 122.8, 111.8, 50.9, 39.8, 29.2, 28.1, 26.8, 26.3, 24.7.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{18}H_{21}O_2]^+$: 269.1536, Found. 269.1538.



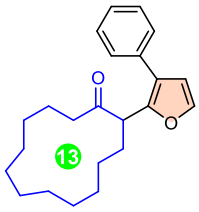
**2-(3-phenylfuran-2-yl)cyclononan-1-one (2o)**

Condition A, Yield: 53% (30 mg), yellow oil, $R_f$ = 0.31 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.64 (d, *J* = 7.4 Hz, 2H), 7.57 (s, 1H), 7.47 – 7.35 (m, 3H), 6.66 (s, 1H), 3.41 (td, *J* = 9.1, 4.1 Hz, 1H), 1.94 – 1.81 (m, 2H), 1.80 – 1.66 (m, 4H), 1.64 – 1.48 (m, 8H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 195.0, 146.4, 144.1, 133.7, 132.3, 129.3, 128.4, 128.1, 115.0, 46.0, 28.8, 26.5, 26.5, 25.6.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{19}H_{23}O_2]^+$: 283.1693, Found. 283.1691.



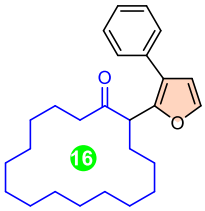
**2-(3-phenylfuran-2-yl)cyclotridecan-1-one (2p)**

Condition A, Yield: 58% (39 mg), yellow oil, $R_f$ = 0.31 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.37 (d, *J* = 5.4 Hz, 3H), 7.36 – 7.25 (m, 3H), 6.48 (s, 1H), 4.00 (d, *J* = 10.6 Hz, 1H), 2.44 (dd, *J* = 14.7, 10.2 Hz, 1H), 2.30 (tt, *J* = 20.0, 15.9, 6.0 Hz, 2H), 1.72 – 1.47 (m, 4H), 1.41 – 1.31 (m, 4H), 1.32 – 1.17 (m, 11H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 209.3, 147.8, 141.8, 133.4, 128.7, 128.1, 127.0, 123.1, 111.8, 50.8, 39.7, 29.7, 29.4, 26.7, 26.1, 25.9, 25.7, 25.7, 25.2, 24.8, 24.5, 23.0.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{23}H_{31}O_2]^+$: 339.2319, Found. 339.2316.



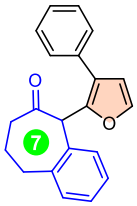

**2-(3-phenylfuran-2-yl)cyclohexadecan-1-one (2q)**

Condition B, Yield: 62% (47 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** ) δ 7.44 – 7.38 (m, 3H), 7.38 – 7.34 (m, 2H), 7.33 – 7.28 (m, 1H), 6.50 (d, *J* = 1.9 Hz, 1H), 3.96 (dd, *J* = 9.0, 5.8 Hz, 1H), 2.45 (ddd, *J* = 16.5, 7.6, 6.1 Hz, 1H), 2.37 – 2.16 (m, 2H), 1.76 (dq, *J* = 12.9, 6.6 Hz, 1H), 1.56 (ddt, *J* = 26.9, 13.6, 7.2 Hz, 2H), 1.28 (q, *J* = 7.5, 6.4 Hz, 22H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 208.9, 147.5, 141.7, 133.5, 128.7, 128.1, 127.0, 123.6, 111.8, 50.8, 39.8, 29.5, 27.6, 27.3, 27.1, 27.0, 26.5, 26.5, 26.5, 26.4, 26.4, 23.0.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{26}H_{37}O_2]^+$: 381.2788, Found. 381.2786.



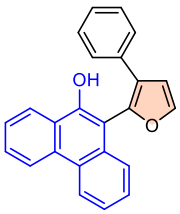

**5-(3-phenylfuran-2-yl)-5,7,8,9-tetrahydro-6H-benzo[7]annulen-6-one (2r)**

Condition B, Yield: 62% (37 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.71 (d, *J* = 7.2 Hz, 2H), 7.63 (s, 1H), 7.40 (q, *J* = 9.5, 8.4 Hz, 3H), 7.21 – 7.07 (m, 3H), 7.00 (d, *J* = 7.6 Hz, 1H), 6.75 (s, 1H), 4.83 (t, *J* = 6.5 Hz, 1H), 2.97 – 2.74 (m, 2H), 2.16 (q, *J* = 6.5, 6.0 Hz, 2H), 2.08 – 1.90 (m, 1H), 1.89 – 1.70 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 192.6, 146.6, 144.6, 138.1, 134.5, 134.4, 131.8, 129.5, 129.3, 128.5, 128.1, 126.5, 125.8, 115.2, 47.8, 29.3, 26.9, 20.5.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{21}H_{19}O_2]^+$: 303.1380, Found. 303.1377.



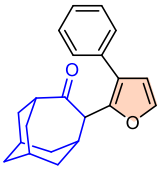

**10-(3-phenylfuran-2-yl)phenanthren-9-ol (2s)**

Condition B, Yield: 71% (48 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 8.67 (dd, *J* = 18.8, 8.4 Hz, 2H), 8.34 (d, *J* = 7.8 Hz, 1H), 7.78 – 7.68 (m, 2H), 7.62 (t, *J* = 7.6 Hz, 1H), 7.53 – 7.42 (m, 3H), 7.32 (dd, *J* = 6.5, 3.4 Hz, 2H), 7.14 (d, *J* = 5.3 Hz, 3H), 6.93 (d, *J* = 1.9 Hz, 1H), 5.91 (s, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** ) δ 149.2, 144.6, 142.7, 132.1, 132.1, 131.7, 128.9, 128.2, 127.5, 127.4, 126.7, 126.7, 125.2, 124.8, 124.5, 123.8, 122.7, 122.6, 111.3, 107.0.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{24}H_{17}O_2]^+$: 337.1223, Found. 337.1229.



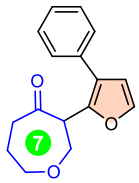
**5-(3-phenylfuran-2-yl)tricyclo[4.3.1.13,8]undecan-4-one (2t)**

Condition B (80 °C), Yield: 62% (38 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.62 (d, *J* = 6.9 Hz, 2H), 7.52 (d, *J* = 1.7 Hz, 1H), 7.47 – 7.36 (m, 3H), 6.62 (d, *J* = 1.7 Hz, 1H), 3.42 (s, 1H), 2.30 (q, *J* = 3.0 Hz, 2H), 2.17 (dd, *J* = 12.9, 3.0 Hz, 2H), 1.95 (p, *J* = 3.2 Hz, 1H), 1.91 – 1.80 (m, 5H), 1.76 (d, *J* = 13.4 Hz, 2H), 1.60 (d, *J* = 12.5 Hz, 2H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 193.7, 147.1, 143.5, 133.0, 132.5, 129.2, 128.3, 128.2, 114.8, 52.8, 38.9, 37.6, 33.0, 29.9, 28.0, 27.4.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{21}H_{23}O_2]^+$: 307.1693, Found. 307.1694.



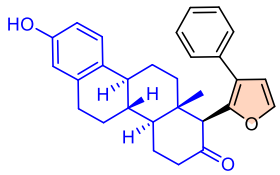
**3-(3-phenylfuran-2-yl)oxepan-4-one (2u)**

Condition B, Yield: 62% (32 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.37 – 7.29 (m, 5H), 7.24 (q, *J* = 4.5 Hz, 1H), 6.43 (d, *J* = 1.9 Hz, 1H), 4.06 (tt, *J* = 10.1, 3.4 Hz, 2H), 3.97 (ddd, *J* = 12.8, 5.5, 4.0 Hz, 1H), 3.62 (ddd, *J* = 12.6, 9.8, 2.6 Hz, 1H), 3.51 (ddd, *J* = 12.4, 9.9, 1.8 Hz, 1H), 3.02 (ddd, *J* = 14.2, 9.9, 3.9 Hz, 1H), 2.63 (ddd, *J* = 14.8, 5.5, 2.6 Hz, 1H), 2.34 (dtd, *J* = 15.5, 10.2, 2.5 Hz, 1H), 2.06 – 1.92 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 208.7, 148.0, 141.7, 133.4, 128.7, 128.2, 127.1, 123.2, 111.8, 71.2, 66.5, 50.2, 46.5, 31.4.

**HRMS (ESI)** ($[M+Na]^+$) Calcd. for $[C_{16}H_{16}NaO_3]^+$: 279.0992, Found. 279.0991.



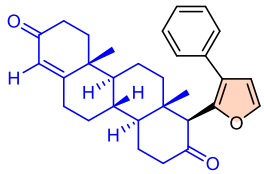
**(4aS,4bS,10bS,12aS)-8-hydroxy-12a-methyl-1-(3-phenylfuran-2-yl)-3,4,4a,4b,5,6,10b,11,12,12a-decahydrochrysen-2(1H)-one (2v)**

Condition B, Yield: 48% (41 mg), yellow oil, $R_f$ = 0.31 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.39 (d, *J* = 1.8 Hz, 1H), 7.29 (d, *J* = 7.4 Hz, 1H), 7.20 (d, *J* = 7.2 Hz, 1H), 7.14 (d, *J* = 6.5 Hz, 3H), 6.96 (d, *J* = 8.4 Hz, 1H), 6.49 (dd, *J* = 8.4, 2.7 Hz, 1H), 6.44 (d, *J* = 2.7 Hz, 1H), 6.39 (d, *J* = 1.8 Hz, 1H), 4.65 (s, 1H), 3.65 (s, 1H), 2.70 (dd, *J* = 8.4, 4.4 Hz, 2H), 2.52 – 2.45 (m, 1H), 2.31 (dd, *J* = 14.7, 12.0 Hz, 1H), 2.15 (td, *J* = 11.5, 7.7 Hz, 2H), 2.07 – 1.95 (m, 2H), 1.56 – 1.47 (m, 3H), 1.31 – 1.21 (m, 2H), 1.15 (s, 1H), 1.13 – 1.08 (m, 1H), 1.05 (s, 3H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 209.2, 153.6, 153.5, 146.0, 141.8, 138.0, 134.3, 132.3, 128.8, 128.7, 128.5, 126.9, 126.4, 126.2, 126.0, 124.9, 115.3, 115.0, 112.9, 111.5, 61.0, 49.9, 43.2, 42.9, 40.8, 39.5, 38.8, 29.8, 26.5, 26.1, 25.5, 15.7.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{29}H_{31}O_3]^+$: 427.2268, Found. 427.2272.



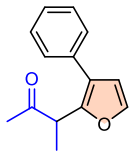
**(4aS,4bS,10aR,10bS,12aS)-10a,12a-dimethyl-1-(3-phenylfuran-2-yl)-1,3,4,4a,4b,5,6,9,10,10a,10b,11,12,12a-tetradecahydrochrysene-2,8-dione (2w)**

Condition B, Yield: 77% (68 mg), white solid, m.p. = 172 - 174 ℃, $R_f$ = 0.35 (petroleum ether/AcOEt = 3:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 10.21 (d, *J* = 8.1 Hz, 1H), 7.71 (d, *J* = 7.3 Hz, 2H), 7.45 – 7.32 (m, 3H), 6.69 (d, *J* = 7.8 Hz, 1H), 5.70 (s, 1H), 4.12 (s, 1H), 2.47 – 2.28 (m, 4H), 2.26 – 2.08 (m, 2H), 1.96 (dd, *J* = 17.5, 6.7 Hz, 1H), 1.79 (dd, *J* = 21.4, 8.6 Hz, 3H), 1.63 (td, *J* = 17.8, 15.6, 8.3 Hz, 4H), 1.54 – 1.33 (m, 3H), 1.14 (s, 3H), 1.02 – 0.83 (m, 5H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 199.8, 193.3, 171.5, 142.5, 135.5, 131.2, 131.0, 128.8, 127.2, 123.8, 107.1, 80.7, 80.2, 77.5, 53.6, 50.8, 47.6, 39.2, 38.6, 36.2, 35.6, 33.8, 33.1, 32.7, 31.5, 23.3, 20.7, 17.4, 12.9.

**HRMS (ESI)** ($[M+Na]^+$) Calcd. for $[C_{30}H_{34}NaO_3]^+$: 465.2400, Found. 465.2403.



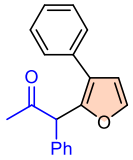
**3-(3-phenylfuran-2-yl)butan-2-one (2x)**

Condition B, Yield: 65% (28 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.48 – 7.38 (m, 5H), 7.37 – 7.31 (m, 1H), 6.57 (d, *J* = 1.9 Hz, 1H), 3.99 (q, *J* = 7.1 Hz, 1H), 2.04 (s, 3H), 1.50 (d, *J* = 7.1 Hz, 3H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 206.6, 141.8, 133.3, 128.8, 127.9, 127.1, 123.3, 111.9, 45.8, 27.9, 14.7.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{14}H_{15}O_2]^+$: 215.1067, Found. 215.1069.



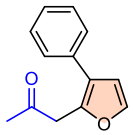
**1-phenyl-1-(3-phenylfuran-2-yl)propan-2-one (2y)**

Condition B, Yield: 63% (35 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (500 MHz, $CDCl_3$)** δ 7.49 (d, J = 1.9 Hz, 1H), 7.38 (dt, J = 13.8, 7.5 Hz, 4H), 7.31 (td, J = 7.3, 2.5 Hz, 6H), 6.57 (d, J = 1.8 Hz, 1H), 5.15 (s, 1H), 2.12 (s, 3H).

**$^{13}$C NMR (126 MHz, $CDCl_3$)** δ 204.0, 146.3, 142.3, 136.7, 133.2, 129.0, 128.8, 128.1, 127.5, 127.3, 124.6, 112.0, 57.6, 28.7.

**HRMS (ESI)** ($[M+H]^+$) Calcd. for $[C_{19}H_{17}O_2]^+$: 277.1223, Found. 277.1216.



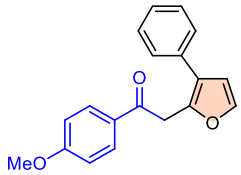
**1-(3-phenylfuran-2-yl)propan-2-one (2z)**

Condition B, Yield: 37% (15 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.47 – 7.40 (m, 3H), 7.39 – 7.31 (m, 3H), 6.60 (d, *J* = 1.9 Hz, 1H), 3.85 (s, 2H), 2.20 (s, 3H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 204.5, 144.1, 141.9, 133.2, 128.8, 127.7, 127.1, 124.1, 111.7, 77.3, 77.0, 76.7, 42.3, 29.4.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{13}H_{13}O_2]^+$: 201.0910, Found. 201.0916.




**1-(4-methoxyphenyl)-2-(3-phenylfuran-2-yl)ethan-1-one (2aa)**

Condition B, Yield: 69% (40 mg), yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

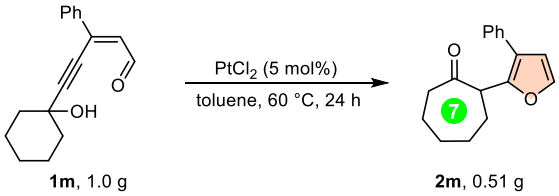
**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.38 – 7.34 (m, 2H), 7.34 – 7.28 (m, 3H), 7.26 – 7.20 (m, 1H), 6.44 (d, *J* = 1.9 Hz, 1H), 3.54 (t, *J* = 9.8 Hz, 1H), 2.42 – 2.20 (m, 4H), 2.19 – 2.08 (m, 1H), 1.91 – 1.73 (m, 1H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 216.6, 147.3, 141.4, 133.6, 128.7, 128.0, 127.1, 124.6, 111.6, 47.5, 38.2, 29.5, 21.1.

**HRMS (ESI)** ([M+Na]$^+$) Calcd. for $[C_{16}H_{16}NaO_2]^+$: 263.1043, Found. 263.1048.

## 4. Derivatization of product 2m

### 4.1 The gram-scale synthesis of product 2m

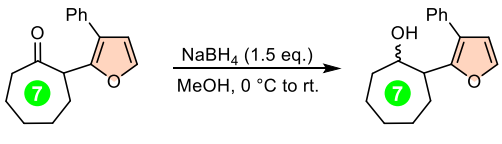



**1m**, 1.0 g **2m**, 0.51 g

**The general procedure for the gram-scale synthesis of product 2m:**

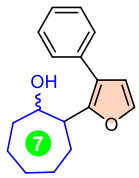
Under nitrogen atmosphere, to a solution of enynals **1m** (3.9 mmol, 1.0 g) in dry toluene (0.025 M), $PtCl_2$ (0.05 eq., 52 mg) were added. The reaction mixture was then heated to a temperature of 60 ºC and stirred for 24 hours. After the reaction was completed, the reaction mixture was filtered through short silica gel, and then the solvent was removed under reduced pressure. The bifuran product was purified by flash column chromatography (silica gel, petroleum ether/AcOEt = 10:1) to yield **2m**.

### 4.2 Derivatization of product 2m.




**2m** **3a**, 87%, dr = 2:1

To a solution of **2m** (50.8 mg, 0.2 mmol) in MeOH (2 mL), $NaBH_4$ (11.3 mg, 0.3 mmol) was added at 0 °C. The mixture was stirred at 0 °C to room temperature for 4 h. Then $H_2O$ (1 mL) was added. The organic layer was extracted with ethyl acetate and washed with brine, dried over $Na_2SO4$, filtered and then concentrated. The residue was purified by silica gel column chromatography (ethyl acetate/petroleum ether = 1/5, v/v) to afford the product.



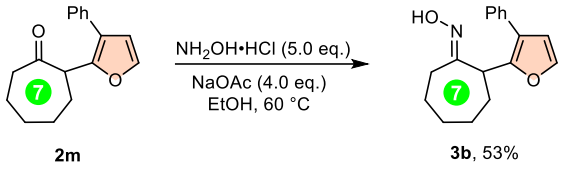
**2-(3-phenylfuran-2-yl)cycloheptan-1-ol (3a)**

Yield: 87%, dr = 2:1, yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 5:1).

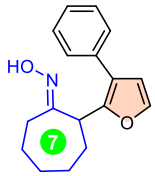
**$^1$H NMR (400 MHz, $CDCl_3$)** δ 7.49 (d, *J* = 7.2 Hz, 1H), 7.42 (ddt, *J* = 12.1, 8.6, 4.7 Hz, 5H), 7.33 (dq, *J* = 7.0, 3.0, 2.3 Hz, 1H), 6.53 (d, *J* = 1.9 Hz, 1H), 4.21 (dt, *J* = 6.4, 3.1 Hz, 1H), 3.28 (dt, *J* = 10.8, 3.0 Hz, 1H), 2.24 (dtd, *J* = 14.5, 10.7, 3.5 Hz, 1H), 2.12 – 1.94 (m, 1H), 1.91 – 1.45 (m, 7H).

**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 154.5, 153.5, 140.9, 134.0, 128.7, 128.6, 128.2, 128.1, 126.7, 120.7, 111.7, 111.6, 75.2, 73.3, 46.3, 42.4, 35.6, 35.1, 30.1, 28.1, 27.6, 27.0, 26.7, 26.3, 22.7, 22.3.

**HRMS (ESI)** ([M+H$^+$) Calcd. for $[C_{17}H_{21}O_2]^+$: 257.1536, Found. 257.1536.




To a solution of **2m** (50.8 mg, 0.2 mmol) in EtOH (2 mL), hydroxylamine hydrochloride (68.0 mg, 1.0 mmol) and sodium acetate (65.6 mg, 0.8 mmol) were added. The mixture was stirred at 60 ℃ for 8 h. Then $H_2O$ (1 mL) was added. The organic layer was extracted with ethyl acetate and washed with brine, dried over $Na_2SO4$, filtered and then concentrated. The residue was purified by silica gel column chromatography (ethyl acetate/petroleum ether = 1/20, v/v) to afford the product.



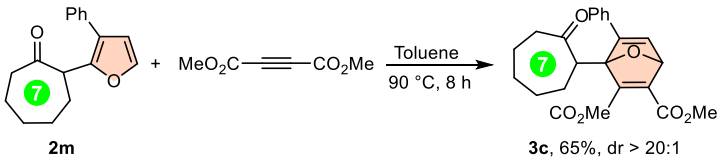
**(E)-2-(3-phenylfuran-2-yl)cycloheptan-1-one oxime (3b)**

Yield: 53%, yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 20:1).

**$^1$H NMR (400 MHz, $CDCl_3$)** δ 8.48 (s, 1H), 7.48 – 7.37 (m, 5H), 7.34 – 7.27 (m, 1H), 6.50 (d, *J* = 1.8 Hz, 1H), 4.00 (dd, *J* = 9.9, 6.1 Hz, 1H), 2.99 (ddd, *J* = 14.0, 6.7, 2.7 Hz, 1H), 2.47 (ddd, *J* = 14.3, 11.8, 2.7 Hz, 1H), 2.13 – 2.00 (m, 2H), 1.96 – 1.83 (m, 3H), 1.67 – 1.52 (m, 1H), 1.50 – 1.38 (m, 1H), 1.38 – 1.27 (m, 1H).

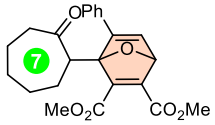
**$^{13}$C NMR (101 MHz, $CDCl_3$)** δ 163.4, 151.1, 141.0, 133.8, 128.6, 128.3, 126.7, 121.3, 111.6, 42.0, 31.7, 30.8, 27.0, 26.6, 25.6.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{17}H_{20}NO_2]^+$: 270.1489, Found. 270.1486.




To a 10-mL oven-dried round-bottom flask with a magnetic stirring bar, **2m** (50.8 mg, 0.2 mmol), dimethyl acetylenedicarboxylate (142.1 mg, 1.0 mmol, 5.0 equiv.), and toluene (2.0 mL) were added in sequence under $N_2$ atmosphere. Then the reaction mixture was stirred at 90 ℃ for 8 h. When the reaction

was completed (monitored by TLC), the crude reaction mixture was purified by flash column chromatography on silica gel (petroleum ether: EtOAc = 10:1) to give 51.5 mg of pure product **3c** as yellow oil, 65% yield.




**3c**

Yield: 65%, dr > 20:1, yellow oil, $R_f$ = 0.35 (petroleum ether/AcOEt = 10:1).

**$^1$H NMR (500 MHz, CDCl$_3$)** δ 7.38 (d, *J* = 7.1 Hz, 2H), 7.31 (t, *J* = 7.6 Hz, 2H), 7.23 (t, *J* = 7.5 Hz, 1H), 6.95 (d, *J* = 2.2 Hz, 1H), 5.73 (d, *J* = 2.2 Hz, 1H), 4.10 (dd, *J* = 10.2, 2.8 Hz, 1H), 3.91 (s, 3H), 3.80 (s, 3H), 2.23 – 2.15 (m, 1H), 2.00 – 1.83 (m, 5H), 1.79 – 1.70 (m, 1H), 1.67 – 1.55 (m, 2H), 1.55 – 1.41 (m, 1H).

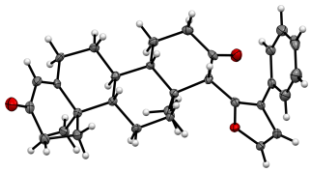
**$^{13}$C NMR (125 MHz, CDCl$_3$)** δ 210.1, 165.2, 163.1, 159.7, 154.4, 153.4, 136.7, 134.5, 128.5, 127.8, 126.0, 99.6, 83.4, 52.5, 52.3, 48.2, 43.5, 29.1, 28.7, 28.5, 23.8.

**HRMS (ESI)** ([M+H]$^+$) Calcd. for $[C_{23}H_{25}O_6]^+$: 397.1646, Found. 397.1641.

# III. General X-ray Procedures

Experimental Procedure Single crystals of **2w** was recrystallized by DCM/MeOH solvent system. A suitable crystal was selected and measured on a Agilent SuperNova, Dual, Cu at zero, AtlasS2 diffractometer. The crystal was kept at 100.0(2) K during data collection.

## 1. Crystallography information for 2w.



Ellipsoid drawing of the crystal structure of **2w**. The crystal of **2w** was obtained by slow evaporation of DCM/MeOH solution at rt.

**Table 1 Crystal data and structure refinement for 2w.**

| | |
|---|---|
| CCDC | 1989586 |
| Identification code | C36 |
| Empirical formula | $C_{30}H_{34}O_3$ |
| Formula weight | 442.57 |
| Temperature/K | 100.00(10) |
| Crystal system | monoclinic |
| Space group | $P2_1$ |
| a/Å | 7.2131(4) |
| b/Å | 14.0281(7) |
| c/Å | 11.7885(7) |
| α/° | 90 |

| | |
|---|---|
| β/° | 93.280(5) |
| γ/° | 90 |
| Volume/Å$^3$ | 1190.88(11) |
| Z | 2 |
| $\rho_{calc}$g/cm$^3$ | 1.234 |
| μ/mm$^{-1}$ | 0.078 |
| F(000) | 476.0 |
| Crystal size/mm$^3$ | 0.13 × 0.12 × 0.11 |
| Radiation | MoKα (λ = 0.71073) |
| 2Θ range for data collection/° | 4.518 to 50 |
| Index ranges | -8 ≤ h ≤ 8, -16 ≤ k ≤ 14, -13 ≤ l ≤ 13 |
| Reflections collected | 7053 |
| Independent reflections | 3627 [$R_{int}$ = 0.0541, $R_{sigma}$ = 0.0795] |
| Data/restraints/parameters | 3627/1/300 |
| Goodness-of-fit on F$^2$ | 1.004 |
| Final R indexes [I>=2σ (I)] | $R_1$ = 0.0447, $wR_2$ = 0.0901 |
| Final R indexes [all data] | $R_1$ = 0.0535, $wR_2$ = 0.0965 |
| Largest diff. peak/hole / e Å$^{-3}$ | 0.18/-0.22 |
| Flack parameter | 0.0(10) |

**Table 2 Fractional Atomic Coordinates (×10$^4$) and Equivalent Isotropic Displacement Parameters (Å$^2$×10$^3$) for 2w. $U_{eq}$ is defined as 1/3 of of the trace of the orthogonalised $U_{IJ}$ tensor.**

| Atom | *x* | *y* | *z* | U(eq) |
|---|---|---|---|---|
| O3 | 8785(3) | 6262.2(16) | 268(2) | 20.8(6) |
| O1 | 7519(4) | 928.9(19) | 7014(2) | 32.8(7) |
| O2 | 4482(4) | 6252.9(18) | -564(2) | 30.2(7) |
| C13 | 6739(5) | 4720(2) | 1482(3) | 15.5(8) |
| C18 | 6002(5) | 5754(2) | 1201(3) | 16.6(8) |
| C19 | 7428(5) | 6491(2) | 1013(3) | 17.5(8) |
| C17 | 4494(5) | 5710(2) | 246(3) | 18.7(8) |
| C12 | 8194(5) | 4784(2) | 2469(3) | 18.9(8) |
| C22 | 7759(5) | 7380(2) | 1439(3) | 16.8(8) |
| C20 | 9959(5) | 7023(2) | 250(3) | 20.9(9) |
| C14 | 5072(5) | 4126(2) | 1862(3) | 14.0(8) |
| C28 | 4710(5) | 7936(2) | 2127(3) | 21.0(9) |
| C9 | 5642(5) | 3139(2) | 2352(3) | 16.9(8) |
| C4 | 7827(5) | 2229(2) | 3813(3) | 17.3(8) |
| C23 | 6643(5) | 7932(2) | 2217(3) | 19.6(9) |
| C1 | 7638(5) | 1266(3) | 6064(3) | 22.7(9) |

| | | | | |
|---|---|---|---|---|
| C3 | 9242(5) | 2411(2) | 4814(3) | 21.9(9) |
| C11 | 8841(5) | 3811(2) | 2887(3) | 19.7(8) |
| C16 | 2964(5) | 5013(3) | 407(3) | 21.2(9) |
| C5 | 6110(5) | 1740(2) | 4222(3) | 17.7(8) |
| C15 | 3590(5) | 4040(3) | 889(3) | 19.4(8) |
| C6 | 6039(5) | 1360(2) | 5263(3) | 22.0(9) |
| C29 | 8707(5) | 1576(3) | 2934(3) | 23.1(9) |
| C7 | 4473(5) | 1684(2) | 3382(3) | 20.7(9) |
| C21 | 9412(5) | 7712(3) | 944(3) | 20.9(9) |
| C00Q | 7575(5) | 4278(2) | 435(3) | 20.8(9) |
| C8 | 3965(5) | 2644(2) | 2827(3) | 21.1(9) |
| C10 | 7211(5) | 3215(2) | 3282(3) | 16.9(8) |
| C27 | 3703(6) | 8487(3) | 2837(3) | 27.2(10) |
| C2 | 9475(5) | 1572(3) | 5636(3) | 22.3(9) |
| C26 | 4589(6) | 9051(3) | 3663(3) | 31.6(11) |
| C24 | 7511(6) | 8510(3) | 3055(4) | 27.7(10) |
| C25 | 6511(6) | 9056(3) | 3780(4) | 32.2(10) |

**Table 3 Anisotropic Displacement Parameters ($Å^2×10^3$) for 2w. The Anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U_{11}+2hka^*b^*U_{12}+\ldots]$.**

| Atom | $U_{11}$ | $U_{22}$ | $U_{33}$ | $U_{23}$ | $U_{13}$ | $U_{12}$ |
|---|---|---|---|---|---|---|
| O3 | 18.1(14) | 18.5(13) | 26.5(14) | 0.1(11) | 7.4(12) | 0.2(12) |
| O1 | 35.6(17) | 37.9(16) | 25.0(16) | 12.5(13) | 2.9(13) | 2.2(14) |
| O2 | 29.9(17) | 31.2(15) | 28.6(15) | 11.4(14) | -5.3(13) | -4.2(13) |
| C13 | 15(2) | 15.2(18) | 17(2) | -0.7(16) | 1.9(15) | 0.5(15) |
| C18 | 20(2) | 15.4(18) | 15.2(18) | 2.5(16) | 5.4(15) | -0.8(17) |
| C19 | 19(2) | 17.0(19) | 16.9(19) | 2.1(16) | 3.3(15) | 3.1(16) |
| C17 | 19(2) | 16.6(18) | 20(2) | -1.3(17) | 0.5(16) | 6.9(17) |
| C12 | 20(2) | 14.7(18) | 22(2) | 2.3(16) | 1.5(16) | -3.0(16) |
| C22 | 15(2) | 13.8(18) | 21(2) | 4.5(16) | 0.5(16) | 1.4(15) |
| C20 | 15(2) | 20.2(18) | 28(2) | 8.6(17) | 5.5(17) | 0.1(17) |
| C14 | 12.1(18) | 13.5(16) | 16.3(19) | -2.5(16) | -0.6(15) | -0.9(16) |
| C28 | 20(2) | 18.5(19) | 25(2) | 0.5(17) | -1.2(17) | 0.9(17) |
| C9 | 17(2) | 15.5(18) | 19(2) | -2.4(16) | 1.6(16) | -1.0(15) |
| C4 | 16(2) | 15.3(18) | 21(2) | 3.3(16) | 1.6(16) | -1.1(16) |
| C23 | 23(2) | 13.1(18) | 23(2) | 2.4(17) | 0.3(17) | 1.5(16) |
| C1 | 29(2) | 15.4(18) | 24(2) | 1.7(18) | 3.0(17) | 0.4(18) |
| C3 | 21(2) | 23(2) | 22(2) | 5.5(17) | 0.7(17) | 1.3(17) |

| | | | | | | |
|---|---|---|---|---|---|---|
| C11 | 15(2) | 20.2(19) | 23(2) | 2.8(17) | -3.4(16) | -2.9(16) |
| C16 | 18(2) | 25(2) | 21(2) | 0.6(17) | -2.3(16) | 0.9(17) |
| C5 | 17(2) | 9.6(17) | 27(2) | -1.3(16) | 2.6(16) | 0.7(15) |
| C15 | 17(2) | 20.6(19) | 20(2) | 1.8(18) | -1.4(15) | -2.8(17) |
| C6 | 19(2) | 17.9(18) | 30(2) | 2.5(18) | 7.2(17) | -2.2(17) |
| C29 | 19(2) | 23.1(19) | 27(2) | 5.2(18) | 3.9(17) | 3.5(17) |
| C7 | 16(2) | 17.7(18) | 29(2) | 5.8(17) | 0.5(16) | -6.1(16) |
| C21 | 18(2) | 17.3(19) | 27(2) | 6.0(18) | -1.7(16) | -1.5(17) |
| C00Q | 22(2) | 17.3(19) | 23(2) | -0.3(16) | 4.5(17) | -2.2(16) |
| C8 | 15(2) | 21.3(19) | 27(2) | 5.0(17) | -1.5(16) | -1.0(16) |
| C10 | 15(2) | 15.2(17) | 20(2) | 1.2(16) | 2.7(16) | -1.2(16) |
| C27 | 24(2) | 25(2) | 33(3) | 4.2(19) | 4.8(19) | 2.5(19) |
| C2 | 23(2) | 20.8(19) | 23(2) | 3.2(17) | -2.5(17) | 2.9(17) |
| C26 | 46(3) | 19(2) | 31(2) | 2(2) | 17(2) | 9(2) |
| C24 | 25(2) | 22(2) | 36(3) | -3.8(19) | 0.1(19) | -2.6(19) |
| C25 | 37(3) | 23(2) | 36(3) | -7(2) | 0(2) | -5(2) |

**Table 4 Bond Lengths for 2w.**

| Atom | Atom | Length/Å | Atom | Atom | Length/Å |
|---|---|---|---|---|---|
| O3 | C19 | 1.389(4) | C28 | C27 | 1.376(5) |
| O3 | C20 | 1.364(4) | C9 | C8 | 1.529(5) |
| O1 | C1 | 1.224(4) | C9 | C10 | 1.534(5) |
| O2 | C17 | 1.221(4) | C4 | C3 | 1.537(5) |
| C13 | C18 | 1.573(5) | C4 | C5 | 1.518(5) |
| C13 | C12 | 1.524(5) | C4 | C29 | 1.546(5) |
| C13 | C14 | 1.551(5) | C4 | C10 | 1.572(5) |
| C13 | C00Q | 1.535(4) | C23 | C24 | 1.398(5) |
| C18 | C19 | 1.483(5) | C1 | C6 | 1.454(5) |
| C18 | C17 | 1.522(5) | C1 | C2 | 1.507(5) |
| C19 | C22 | 1.361(5) | C3 | C2 | 1.526(5) |
| C17 | C16 | 1.495(5) | C11 | C10 | 1.536(4) |
| C12 | C11 | 1.516(5) | C16 | C15 | 1.536(5) |
| C22 | C23 | 1.475(5) | C5 | C6 | 1.342(5) |
| C22 | C21 | 1.435(5) | C5 | C7 | 1.499(5) |
| C20 | C21 | 1.340(5) | C7 | C8 | 1.532(5) |
| C14 | C9 | 1.547(5) | C27 | C26 | 1.383(6) |
| C14 | C15 | 1.527(5) | C26 | C25 | 1.386(6) |
| C28 | C23 | 1.392(5) | C24 | C25 | 1.380(5) |

**Table 5 Bond Angles for 2w.**

| Atom | Atom | Atom | Angle/° | Atom | Atom | Atom | Angle/° |
|---|---|---|---|---|---|---|---|
| C20 | O3 | C19 | 106.9(3) | C5 | C4 | C3 | 110.4(3) |
| C12 | C13 | C18 | 108.4(3) | C5 | C4 | C29 | 108.6(3) |
| C12 | C13 | C14 | 108.8(3) | C5 | C4 | C10 | 107.9(3) |
| C12 | C13 | C00Q | 110.6(3) | C29 | C4 | C10 | 111.8(3) |
| C14 | C13 | C18 | 107.4(3) | C28 | C23 | C22 | 122.3(3) |
| C00Q | C13 | C18 | 110.3(3) | C28 | C23 | C24 | 117.2(3) |
| C00Q | C13 | C14 | 111.2(3) | C24 | C23 | C22 | 120.4(3) |
| C19 | C18 | C13 | 116.4(3) | O1 | C1 | C6 | 122.3(3) |
| C19 | C18 | C17 | 113.0(3) | O1 | C1 | C2 | 121.7(4) |
| C17 | C18 | C13 | 109.7(3) | C6 | C1 | C2 | 115.9(3) |
| O3 | C19 | C18 | 116.9(3) | C2 | C3 | C4 | 113.8(3) |
| C22 | C19 | O3 | 109.3(3) | C12 | C11 | C10 | 111.2(3) |
| C22 | C19 | C18 | 133.8(3) | C17 | C16 | C15 | 115.1(3) |
| O2 | C17 | C18 | 121.7(3) | C6 | C5 | C4 | 123.0(4) |
| O2 | C17 | C16 | 122.4(4) | C6 | C5 | C7 | 120.9(3) |
| C16 | C17 | C18 | 115.8(3) | C7 | C5 | C4 | 116.1(3) |
| C11 | C12 | C13 | 112.4(3) | C14 | C15 | C16 | 112.7(3) |
| C19 | C22 | C23 | 128.4(3) | C5 | C6 | C1 | 124.0(3) |
| C19 | C22 | C21 | 106.3(3) | C5 | C7 | C8 | 113.3(3) |
| C21 | C22 | C23 | 125.3(3) | C20 | C21 | C22 | 107.1(3) |
| C21 | C20 | O3 | 110.5(3) | C7 | C8 | C9 | 112.4(3) |
| C9 | C14 | C13 | 113.3(3) | C9 | C10 | C4 | 113.8(3) |
| C15 | C14 | C13 | 110.3(3) | C9 | C10 | C11 | 111.5(3) |
| C15 | C14 | C9 | 111.7(3) | C11 | C10 | C4 | 113.3(3) |
| C27 | C28 | C23 | 121.1(4) | C28 | C27 | C26 | 120.7(4) |
| C8 | C9 | C14 | 110.2(3) | C1 | C2 | C3 | 111.4(3) |
| C8 | C9 | C10 | 109.7(3) | C27 | C26 | C25 | 119.5(4) |
| C10 | C9 | C14 | 112.0(3) | C25 | C24 | C23 | 122.0(4) |
| C3 | C4 | C29 | 109.5(3) | C24 | C25 | C26 | 119.4(4) |
| C3 | C4 | C10 | 108.6(3) | | | | |

**Table 6 Hydrogen Atom Coordinates (Å×10$^4$) and Isotropic Displacement Parameters (Å$^2$×10$^3$) for 2w.**

| Atom | *x* | *y* | *z* | U(eq) |
|---|---|---|---|---|
| H18 | 5377.22 | 5961.89 | 1874.71 | 20 |

| | | | | |
|---|---|---|---|---|
| H12A | 9254.17 | 5141.76 | 2229.22 | 23 |
| H12B | 7676.13 | 5128.53 | 3090.38 | 23 |
| H20 | 10994.77 | 7059.2 | -183.19 | 25 |
| H14 | 4516.55 | 4482.36 | 2471.52 | 17 |
| H28 | 4088.85 | 7560.12 | 1578.31 | 25 |
| H9 | 6081.64 | 2747.31 | 1733.31 | 20 |
| H3A | 10436.61 | 2555.94 | 4517.87 | 26 |
| H3B | 8851.16 | 2965.6 | 5230.24 | 26 |
| H11A | 9761.12 | 3887.19 | 3513.12 | 24 |
| H11B | 9421.41 | 3477.33 | 2279.85 | 24 |
| H16A | 2294.7 | 4911.13 | -319.86 | 25 |
| H16B | 2102.53 | 5292.71 | 914.97 | 25 |
| H15A | 2522.21 | 3706.82 | 1159.2 | 23 |
| H15B | 4078.39 | 3661.12 | 285.32 | 23 |
| H6 | 4896.18 | 1144.29 | 5486.5 | 26 |
| H29A | 9817.17 | 1868.58 | 2685.04 | 35 |
| H29B | 7842.29 | 1484.32 | 2293.46 | 35 |
| H29C | 9009.01 | 970.98 | 3276.3 | 35 |
| H7A | 3411.02 | 1446.68 | 3764.93 | 25 |
| H7B | 4743.98 | 1230.2 | 2793.15 | 25 |
| H21 | 9993.82 | 8296.31 | 1079.38 | 25 |
| H00A | 6829.07 | 4448.43 | -234.59 | 31 |
| H00B | 7603.07 | 3597.05 | 512.56 | 31 |
| H00C | 8815.55 | 4512.58 | 373.54 | 31 |
| H8A | 3437.11 | 3055.61 | 3385.66 | 25 |
| H8B | 3026.91 | 2542.17 | 2216.66 | 25 |
| H10 | 6695.9 | 3578.41 | 3900.55 | 20 |
| H27 | 2413.09 | 8479.51 | 2759.65 | 33 |
| H2A | 10031 | 1040.86 | 5253.29 | 27 |
| H2B | 10306.9 | 1753.91 | 6274.75 | 27 |
| H26 | 3899.56 | 9424.17 | 4136.81 | 38 |
| H24 | 8801.42 | 8527.52 | 3127.21 | 33 |
| H25 | 7122.38 | 9423.69 | 4340.81 | 39 |

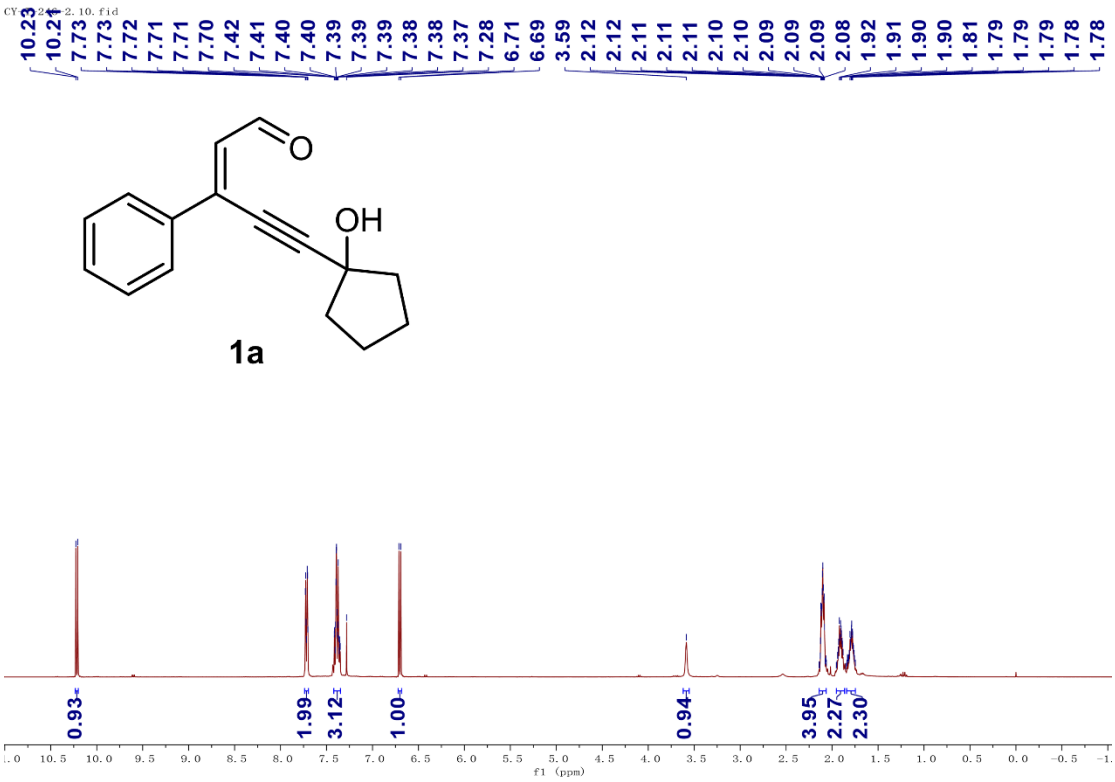
**Crystal structure determination of [2w]**

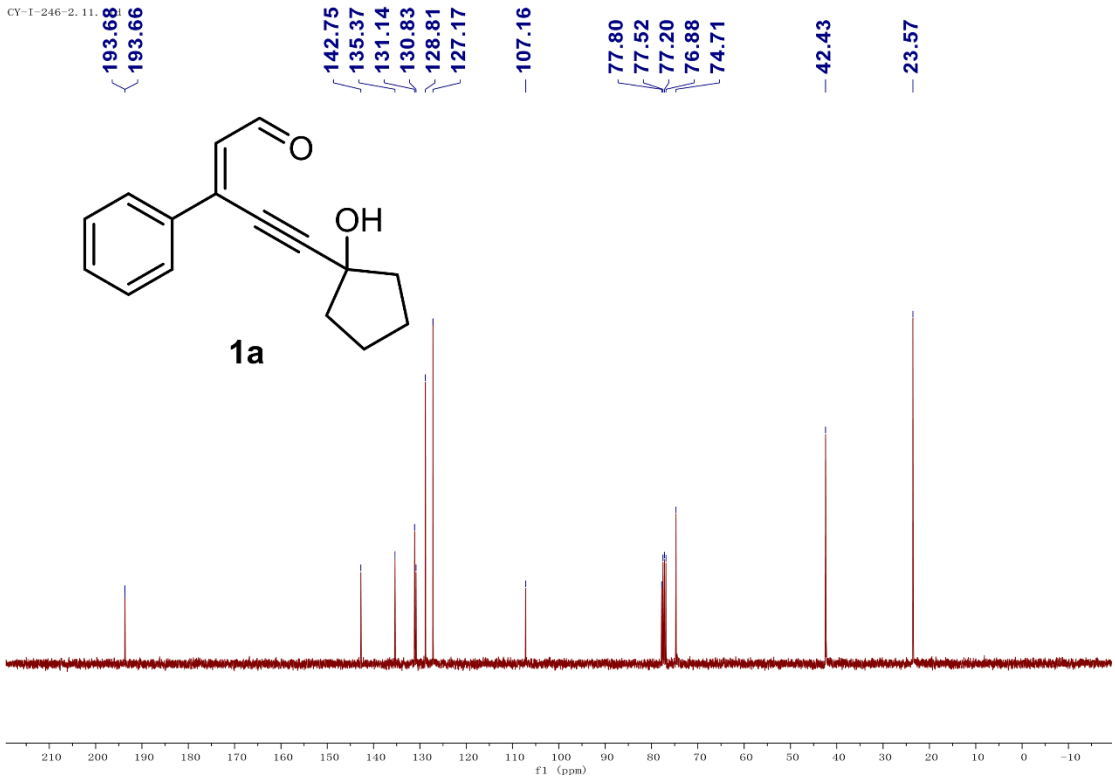
**Crystal Data** for $C_{30}H_{34}O_3$ ($M$ = 442.57 g/mol): monoclinic, space group $P2_1$ (no. 4), $a$ = 7.2131(4) Å, $b$ = 14.0281(7) Å, $c$ = 11.7885(7) Å, $\beta$ = 93.280(5), $V$ = 1190.88(11) Å$^3$, $Z$ = 2, $T$ = 100.00(10) K, μ(MoKα) = 0.078 mm$^{-1}$, *Dcalc* = 1.234 g/cm$^3$, 7053 reflections measured (4.518° ≤ 2Θ ≤ 50°), 3627 unique ($R_{int}$ = 0.0541, $R_{sigma}$ = 0.0795) which were used in all calculations. The final $R_1$ was 0.0447 (I > 2σ(I)) and $wR_2$ was 0.0965 (all data).

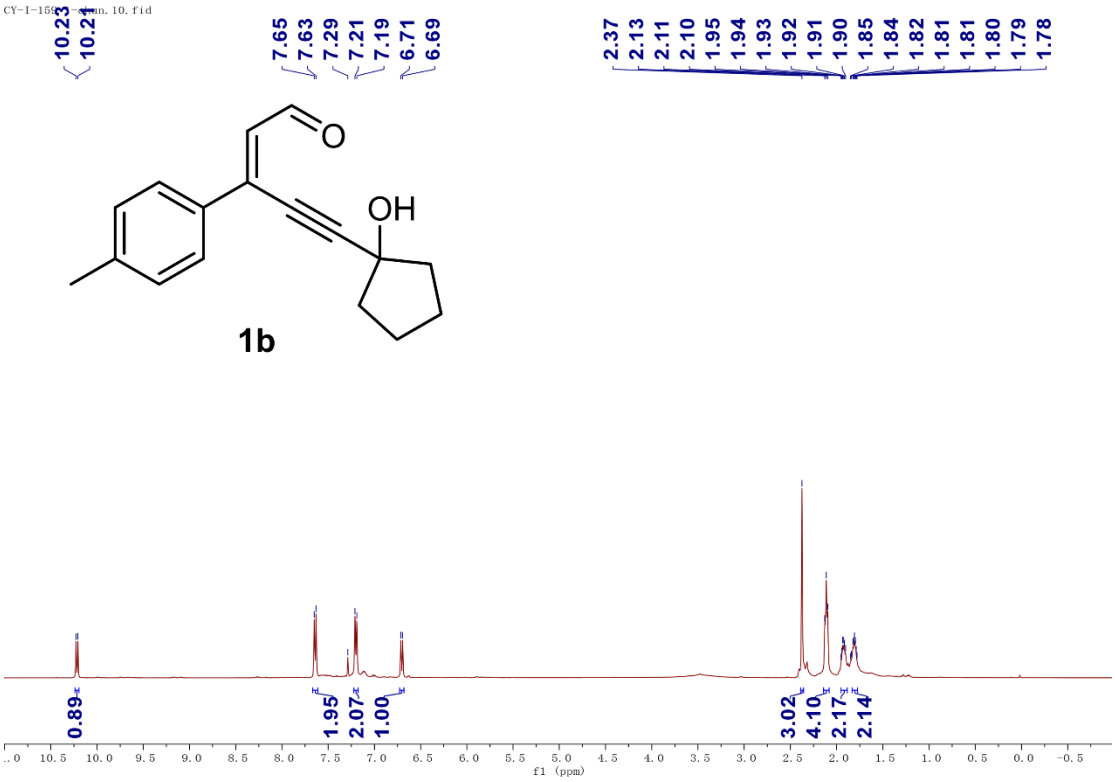
**References:**

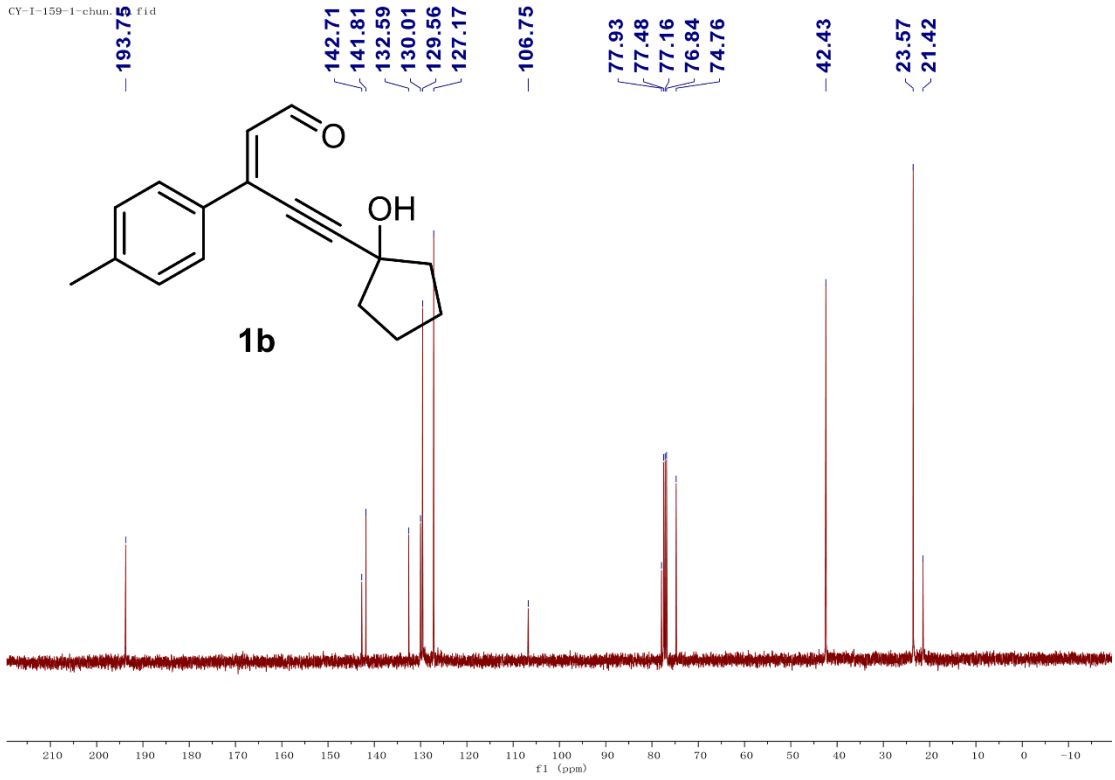
[1] (a) Tang, J. M.; Bhunia, S.; Abu Sohel, S. M.; Lin, M. Y.; Liao, H. Y.; Datta, S.; Das, A.; Liu, R. S. The skeletal rearrangement of gold- and platinum-catalyzed cycloisomerization of cis-4,6-dien-1-yn-3-ols: pinacol rearrangement and formation of bicyclo[4.1.0]heptenone and reorganized styrene derivatives. *J. Am. Chem. Soc.* **2007**, *129*, 15677-15683; (b) Le Fouler, V.; Chen, Y.; Gandon, V.; Bizet, V.; Salomé, C.; Fessard, T.; Liu, F.; Houk, K. N.; Blanchard, N. Activating Pyrimidines by Pre-distortion for the General Synthesis of 7-Aza-indazoles from 2-Hydrazonylpyrimidines via Intramolecular Diels–Alder Reactions. *J. Am. Chem. Soc.* **2019**, *141*, 15901-15909; (c) Hsu, Y. C.; Hsieh, S. A.; Li, P. H.; Liu, R. S. Gold-catalyzed N,O-functionalization of 1,4-diyn-3-ols with N-hydroxyanilines to form highly functionalized pyrrole derivatives. *Chem. Commun.* **2018**, *54*, 2114-2117; (d) Watson, I. D. G.; Ritter, S.; Toste, F. D. Asymmetric Synthesis of Medium-Sized Rings by Intramolecular Au(I)-Catalyzed Cyclopropanation. *J. Am. Chem. Soc.* **2009**, *131*, 2056-2057; (e) Tharra, P.; Baire, B. Mild Approach to 2-Acylfurans via Intercepted Meyer–Schuster Rearrangement of 6-Hydroxyhex-2-en-4-ynals. *J. Org. Chem.* **2015**, *80*, 8314-8328.

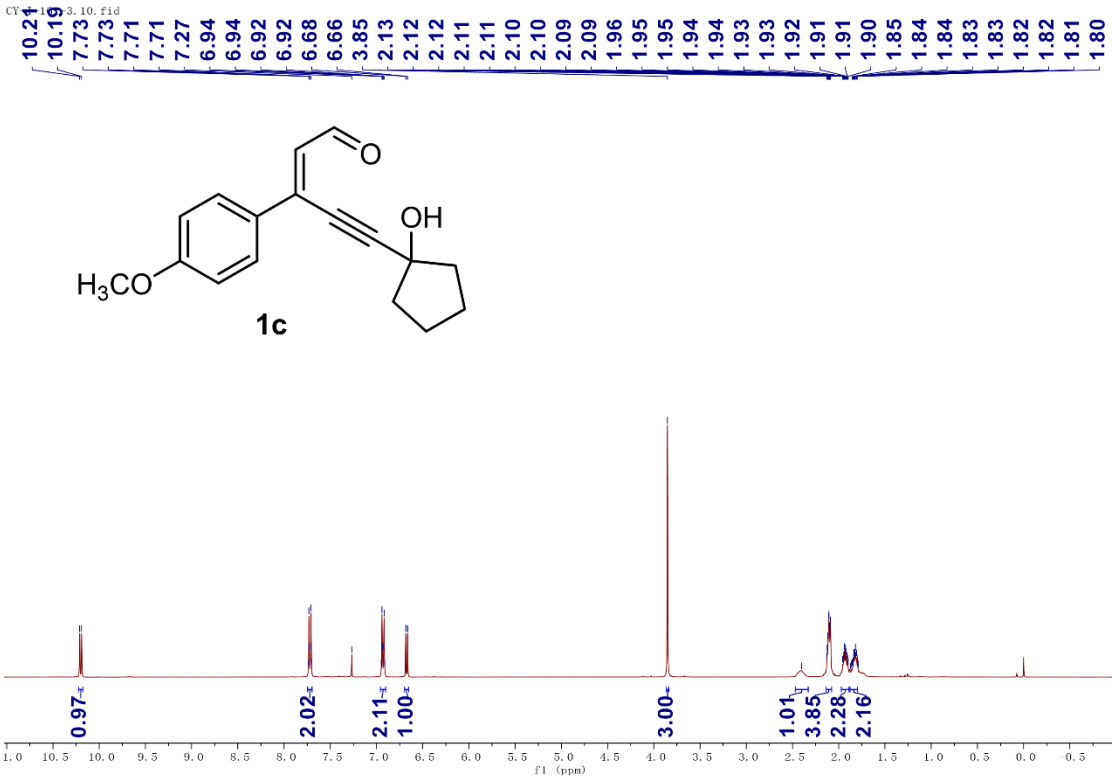
# IV. Copies of NMR spectra

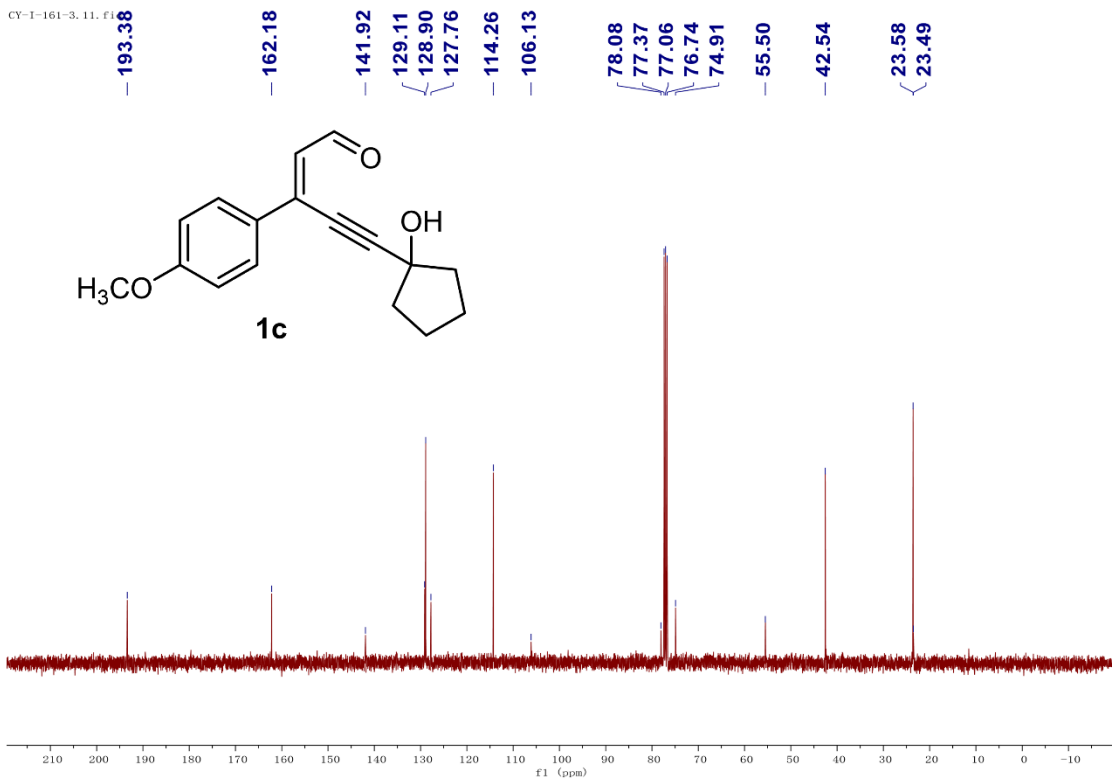


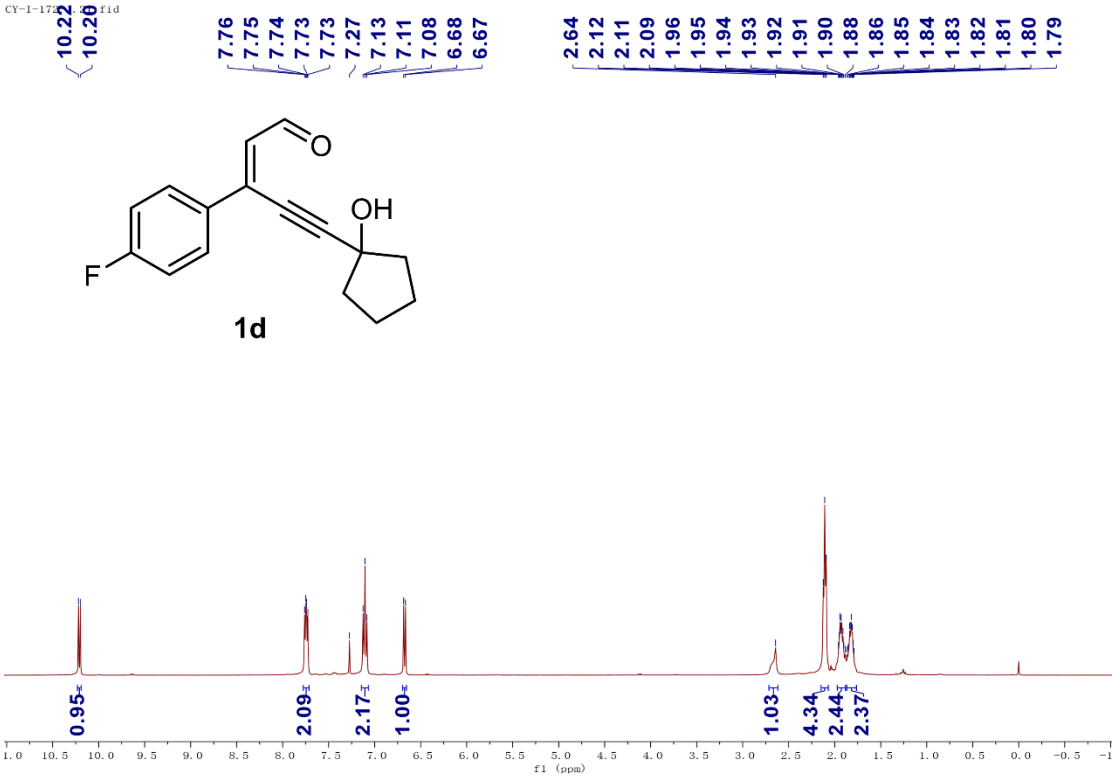



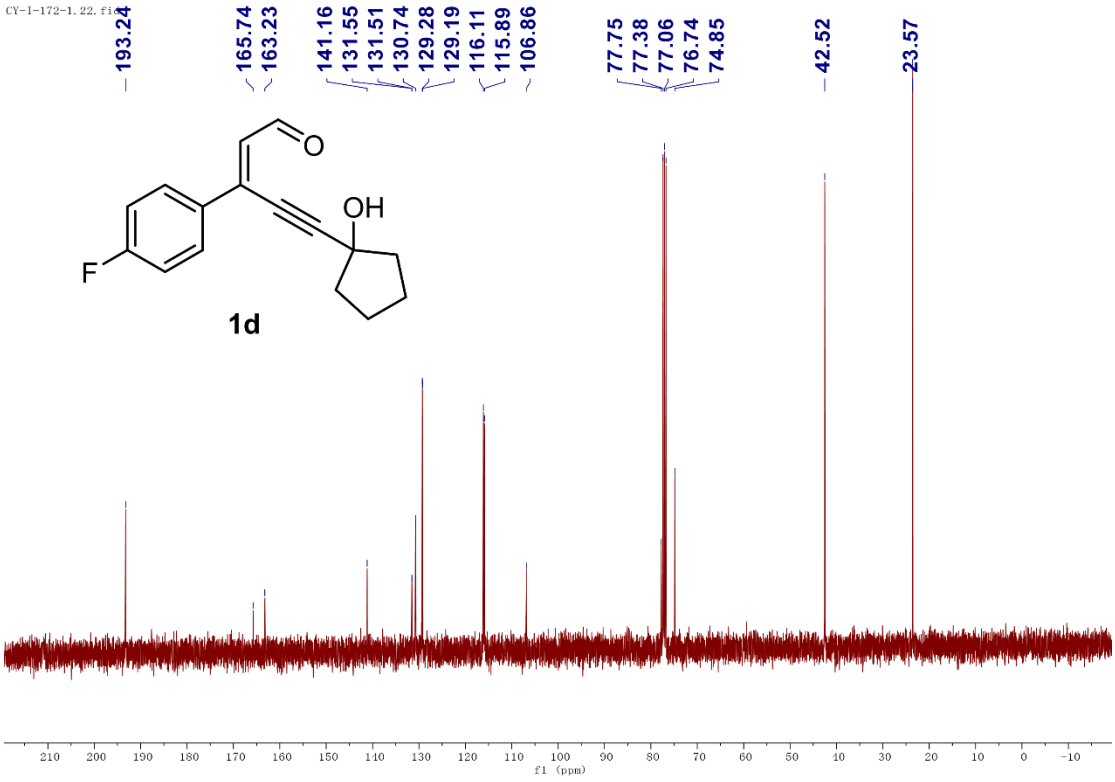

10.23
10.21
7.65
7.63
7.29
7.21
7.19
6.71
6.69
2.37
2.13
2.11
2.10
1.95
1.94
1.93
1.92
1.91
1.90
1.85
1.84
1.82
1.81
1.81
1.80
1.79
1.78
O
OH
1b
0.89
1.95
2.07
1.00
3.02
4.10
2.17
2.14
f1 (ppm)

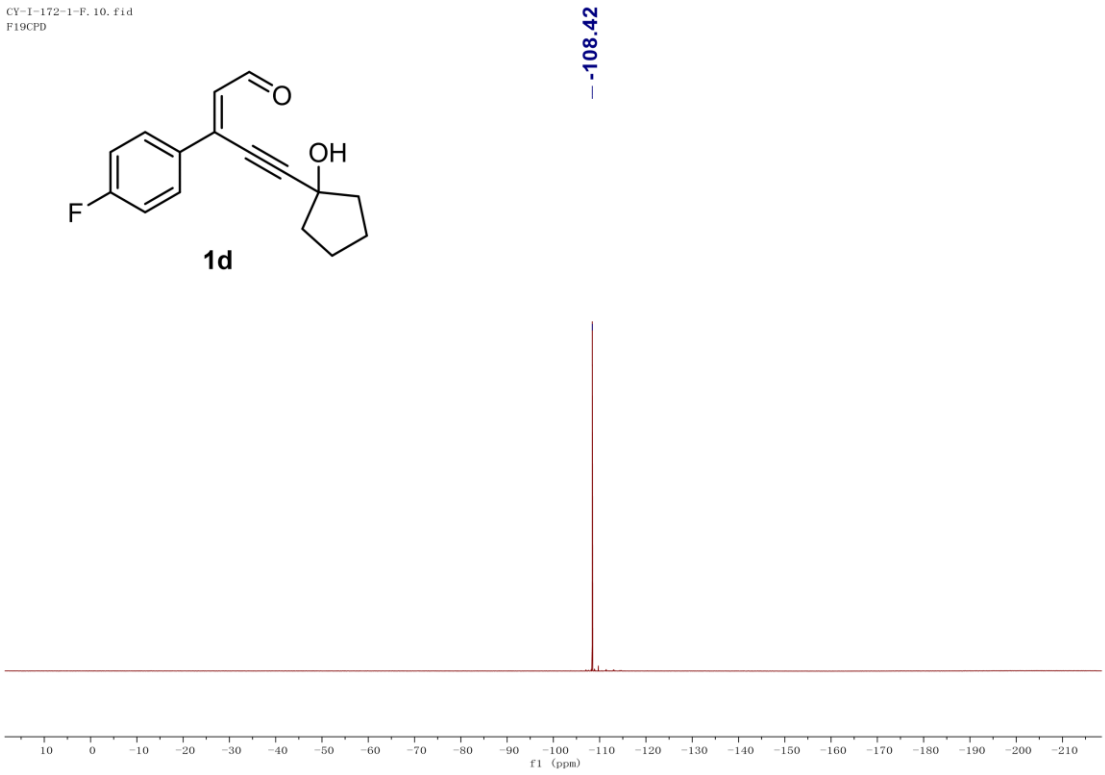

193.75
142.71
141.81
132.59
130.01
129.56
127.17
106.75
77.93
77.48
77.16
76.84
74.76
42.43
23.57
21.42
O
OH
1b
f1 (ppm)

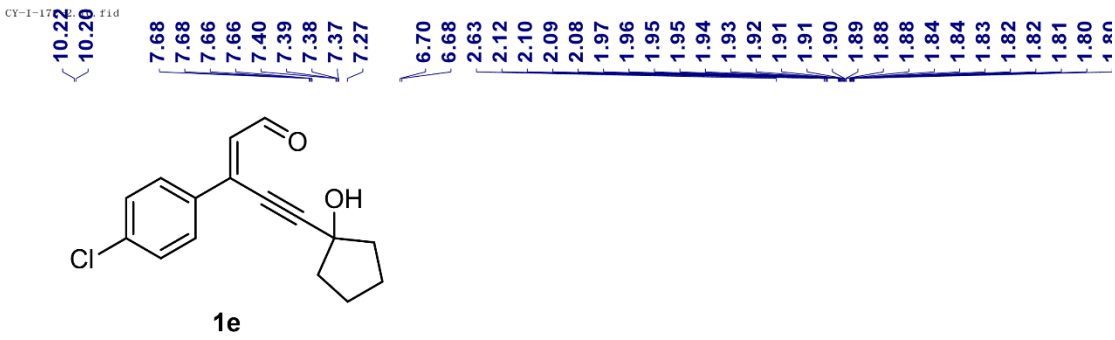

CY-I-161-3.10.fid
10.21
10.19
7.73
7.73
7.71
7.71
7.27
6.94
6.94
6.92
6.92
6.68
6.66
3.85
2.13
2.12
2.12
2.11
2.11
2.10
2.10
2.09
2.09
1.96
1.95
1.95
1.94
1.94
1.93
1.93
1.92
1.91
1.91
1.90
1.85
1.84
1.84
1.83
1.83
1.82
1.82
1.81
1.80
O
OH
H3CO
1c
0.97
2.02
2.11
1.00
3.00
1.01
3.85
2.28
2.16
f1 (ppm)


CY-I-161-3.11.fid
193.38
162.18
141.92
129.11
128.90
127.76
114.26
106.13
78.08
77.37
77.06
76.74
74.91
55.50
42.54
23.58
23.49
O
OH
H3CO
1c
f1 (ppm)

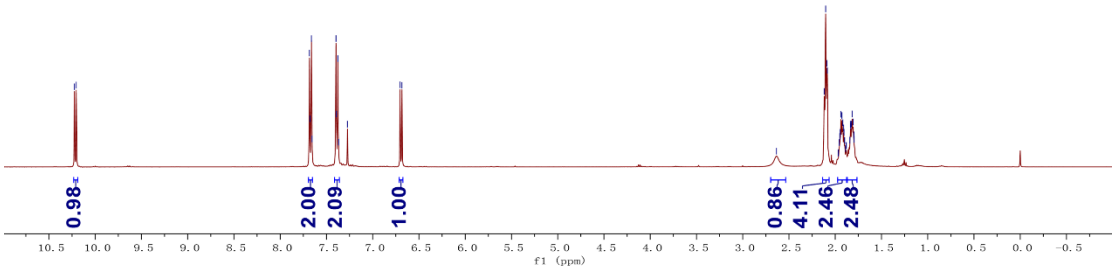

10.22
10.20
7.76
7.75
7.74
7.73
7.73
7.27
7.13
7.11
7.08
6.68
6.67
2.64
2.12
2.11
2.09
1.96
1.95
1.94
1.93
1.92
1.91
1.90
1.88
1.86
1.85
1.84
1.83
1.82
1.81
1.80
1.79
O
OH
F
1d
0.95
2.09
2.17
1.00
1.03
4.34
2.44
2.37
f1 (ppm)

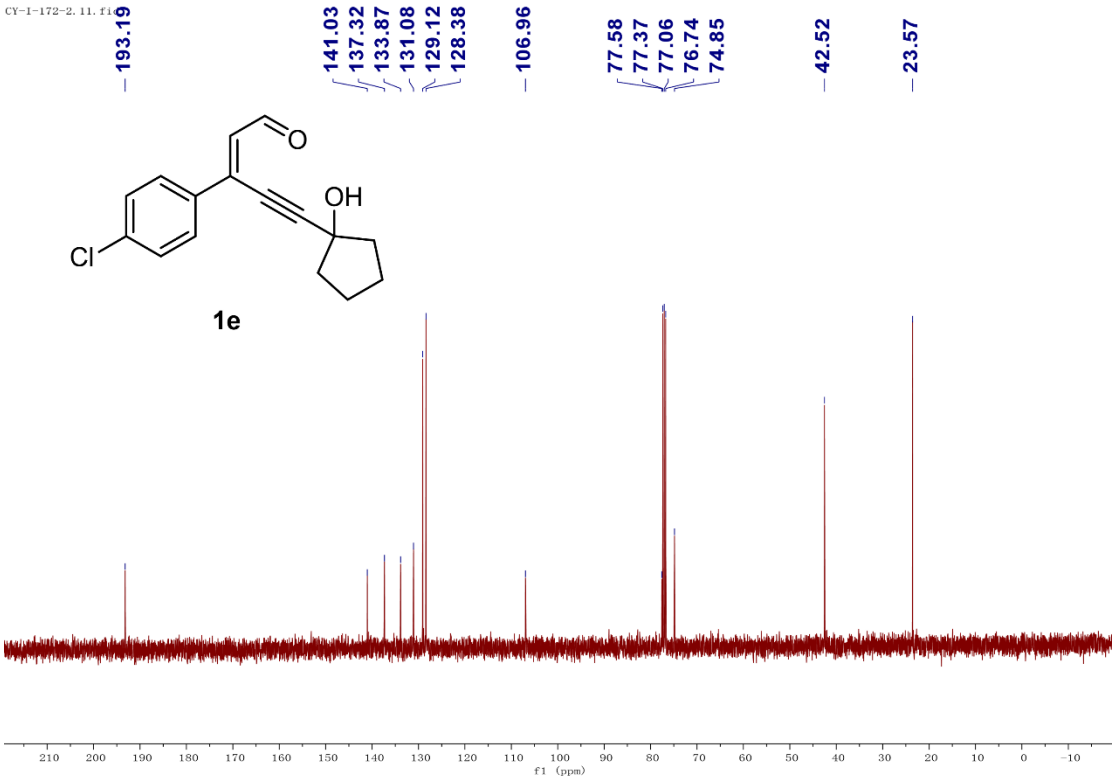

193.24
165.74
163.23
141.16
131.55
131.51
130.74
129.28
129.19
116.11
115.89
106.86
77.75
77.38
77.06
76.74
74.85
42.52
23.57
O
OH
F
1d
f1 (ppm)


CY-I-172-1-F.10.fid
F19CPD
-108.42
O
OH
F
1d
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)

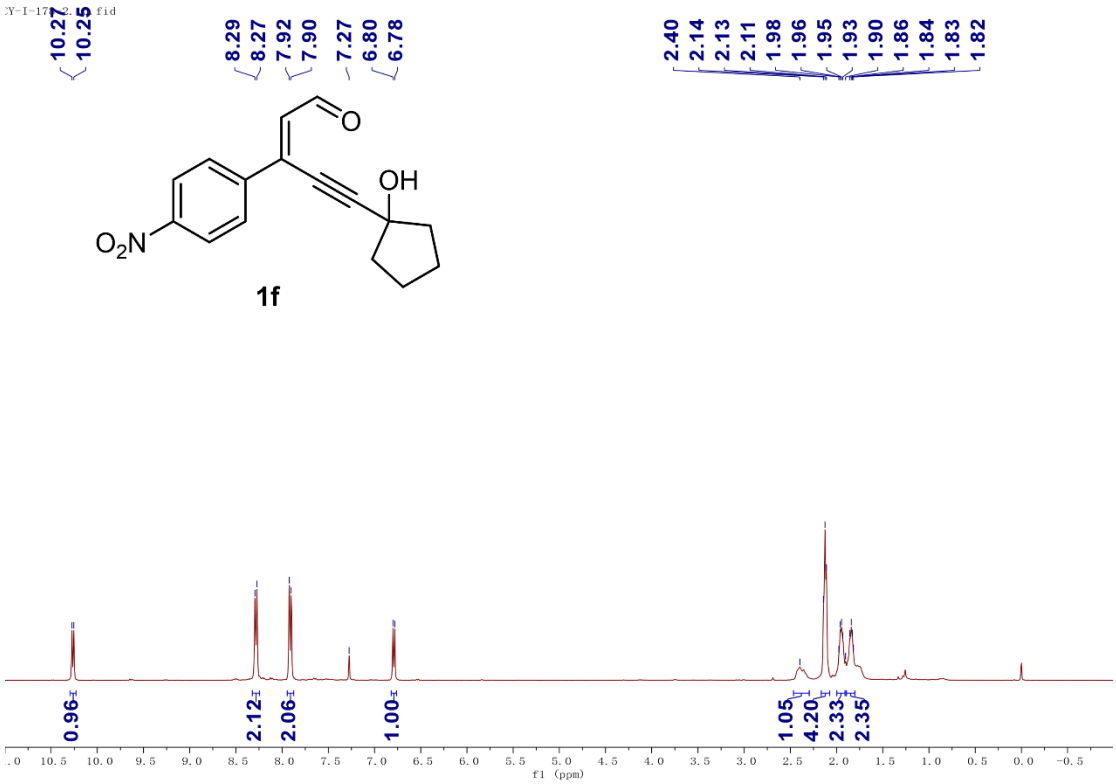

10.22
10.20
7.68
7.68
7.66
7.66
7.40
7.39
7.38
7.37
7.27
6.70
6.68
2.63
2.12
2.10
2.09
2.08
1.97
1.96
1.95
1.95
1.94
1.93
1.92
1.91
1.91
1.90
1.89
1.88
1.88
1.84
1.84
1.83
1.82
1.82
1.81
1.80
O
OH
Cl

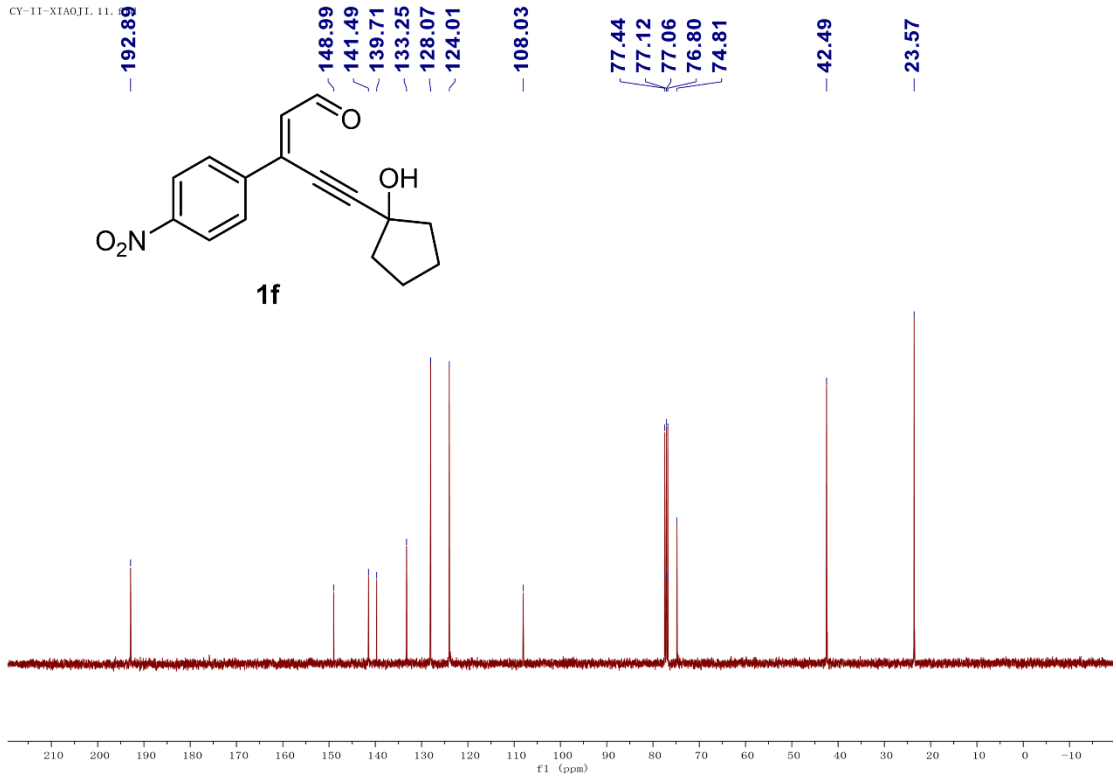
**1e**

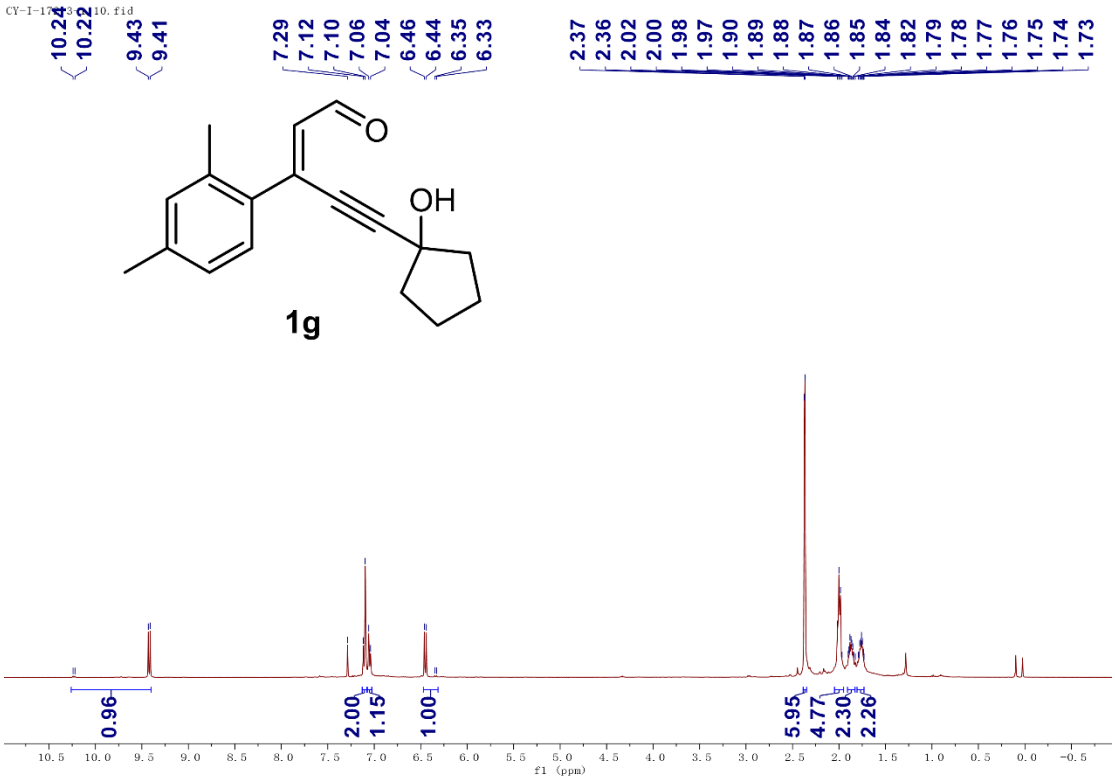

0.98
2.00
2.09
1.00
0.86
4.11
2.46
2.48
f1 (ppm)

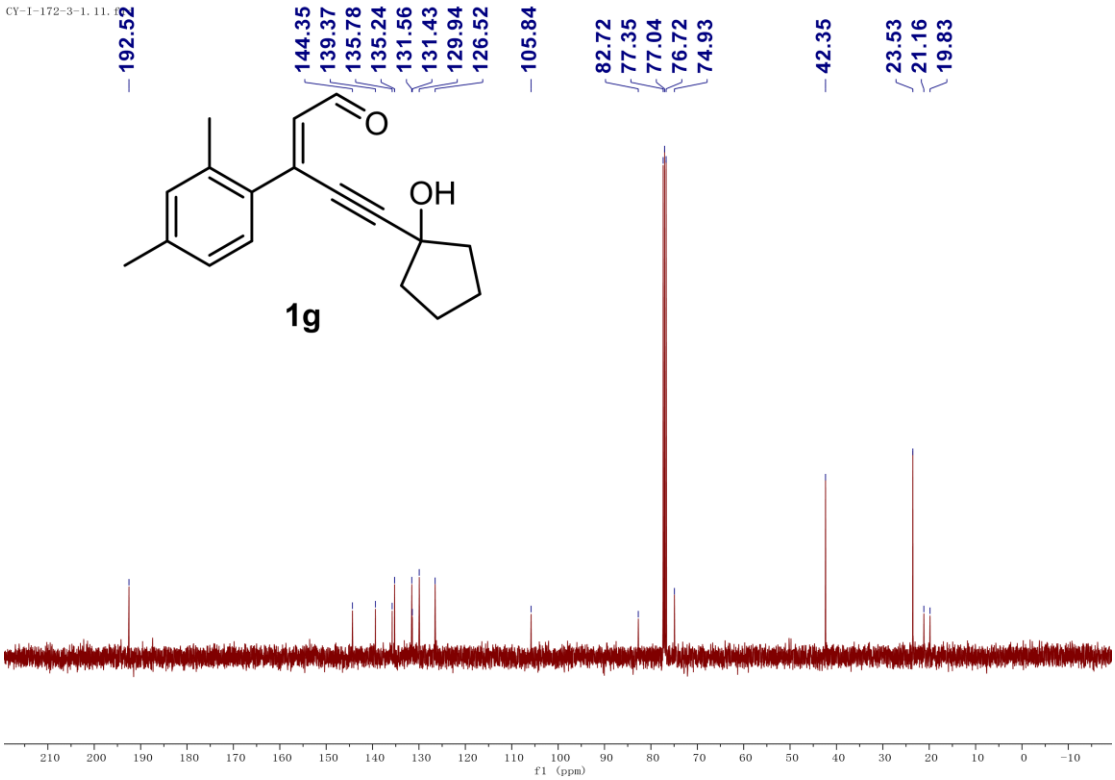

193.19
141.03
137.32
133.87
131.08
129.12
128.38
106.96
77.58
77.37
77.06
76.74
74.85
42.52
23.57
O
OH
Cl
f1 (ppm)

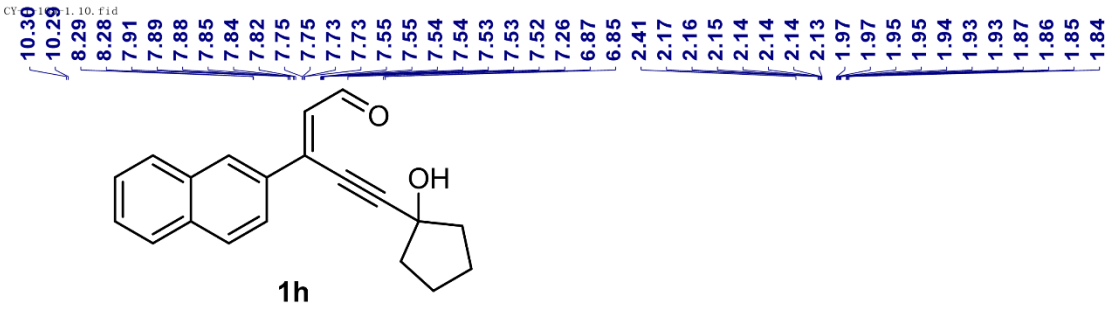
**1e**


10.27
10.25
8.29
8.27
7.92
7.90
7.27
6.80
6.78
2.40
2.14
2.13
2.11
1.98
1.96
1.95
1.93
1.90
1.86
1.84
1.83
1.82
O
OH
O2N
1f
0.96
2.12
2.06
1.00
1.05
4.20
2.33
2.35
f1 (ppm)

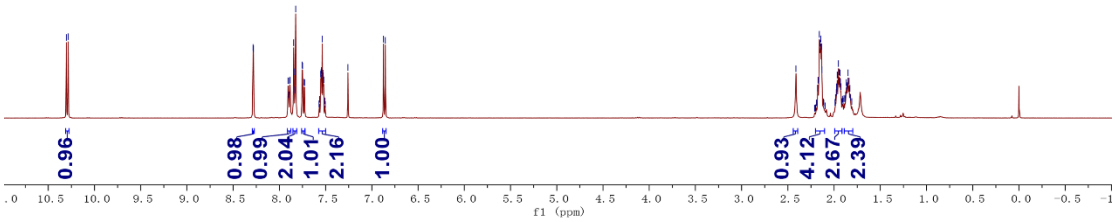

192.89
148.99
141.49
139.71
133.25
128.07
124.01
108.03
77.44
77.12
77.06
76.80
74.81
42.49
23.57
O
OH
O2N
1f
f1 (ppm)

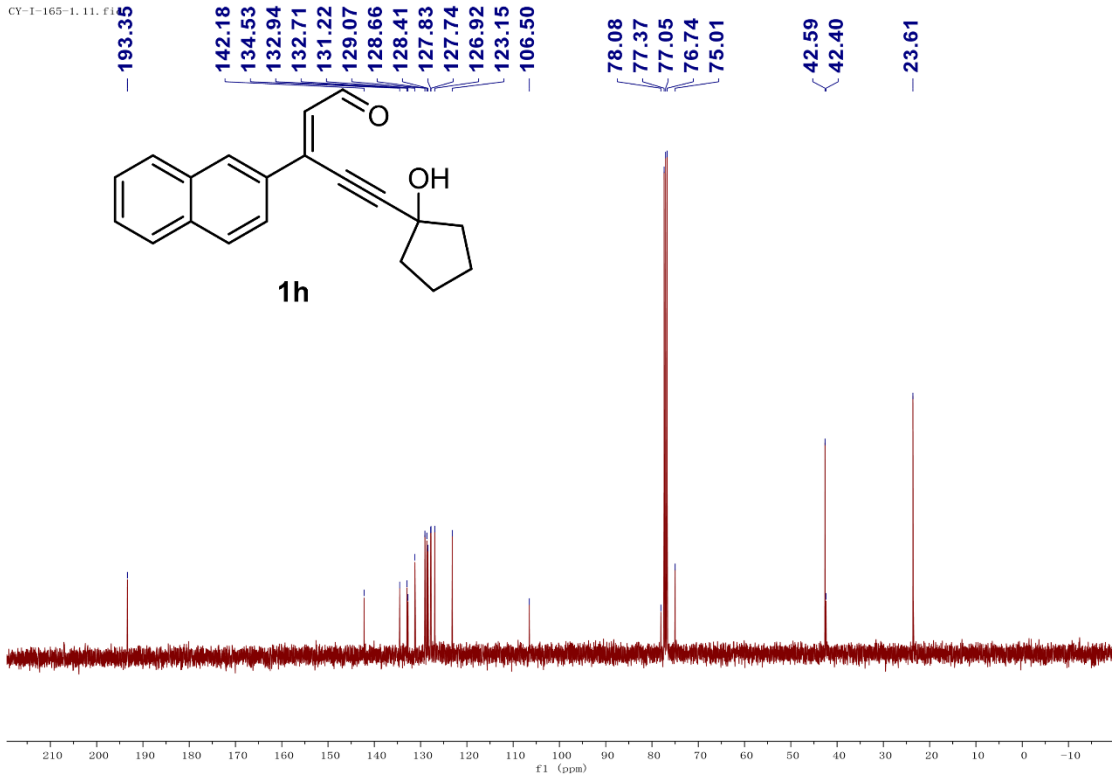

10.24
10.22
9.43
9.41
7.29
7.12
7.10
7.06
7.04
6.46
6.44
6.35
6.33
2.37
2.36
2.02
2.00
1.98
1.97
1.90
1.89
1.88
1.87
1.86
1.85
1.84
1.82
1.79
1.78
1.77
1.76
1.75
1.74
1.73
O
OH
1g
0.96
2.00
1.15
1.00
5.95
4.77
2.30
2.26
f1 (ppm)


192.52
144.35
139.37
135.78
135.24
131.56
131.43
129.94
126.52
105.84
82.72
77.35
77.04
76.72
74.93
42.35
23.53
21.16
19.83
O
OH
1g
f1 (ppm)

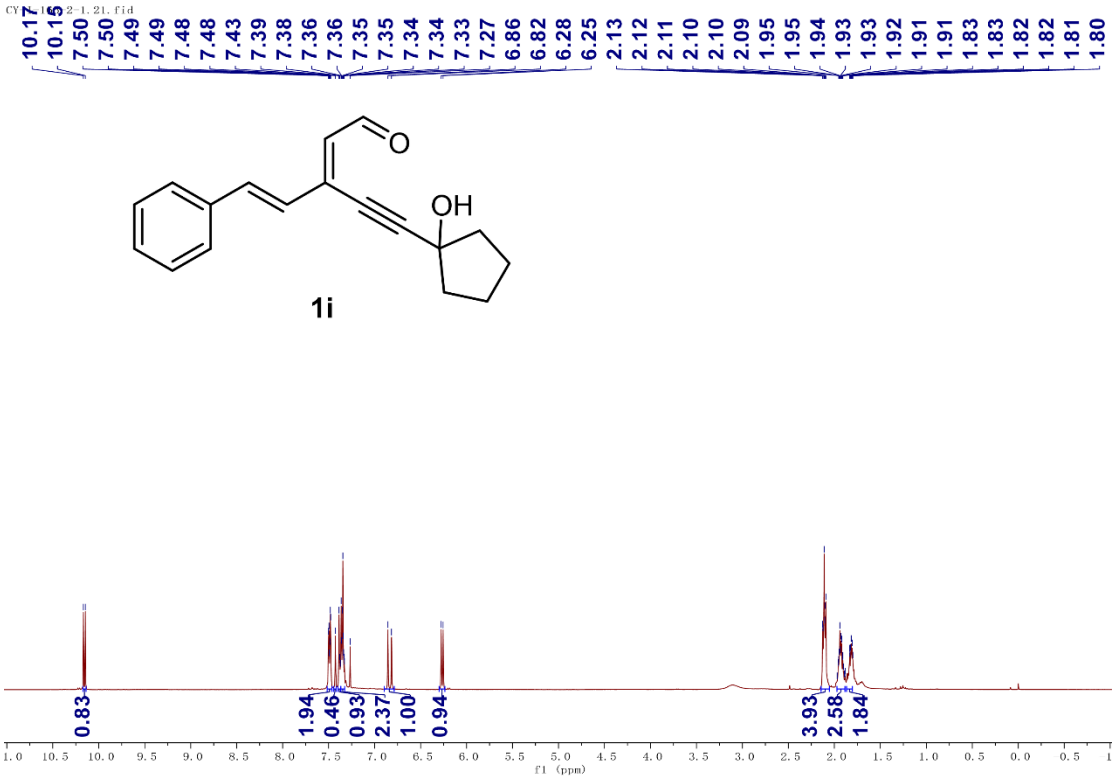

10.30
10.29
8.29
8.28
7.91
7.89
7.88
7.85
7.84
7.82
7.75
7.75
7.73
7.73
7.55
7.55
7.54
7.54
7.53
7.53
7.52
7.26
6.87
6.85
2.41
2.17
2.16
2.15
2.14
2.14
2.14
2.13
1.97
1.97
1.95
1.95
1.94
1.93
1.93
1.87
1.86
1.85
1.84
O
OH

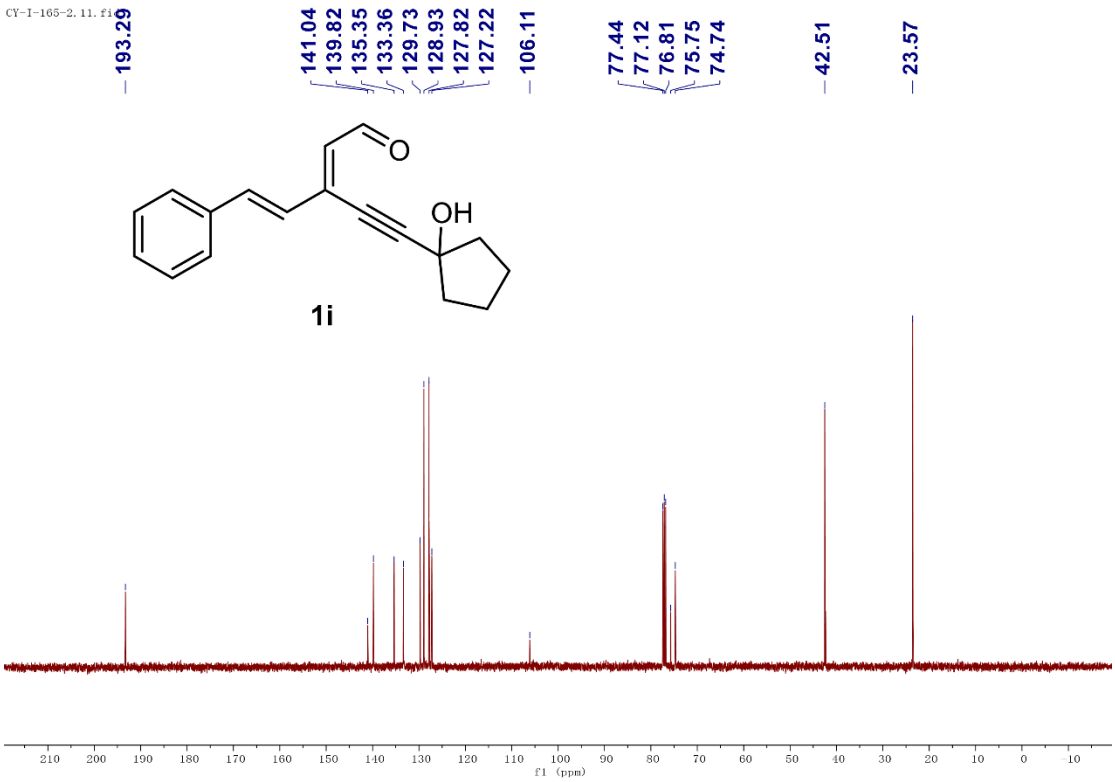
1h

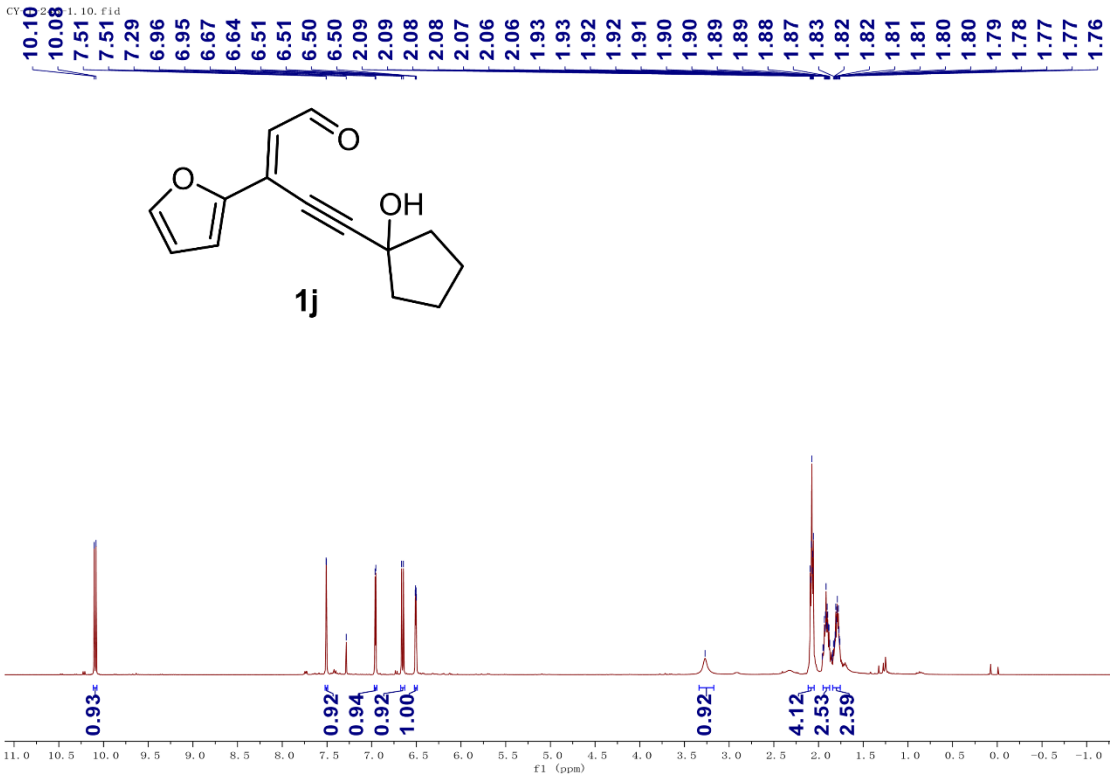

0.96
0.98
0.99
2.04
1.01
2.16
1.00
0.93
4.12
2.67
2.39
f1 (ppm)

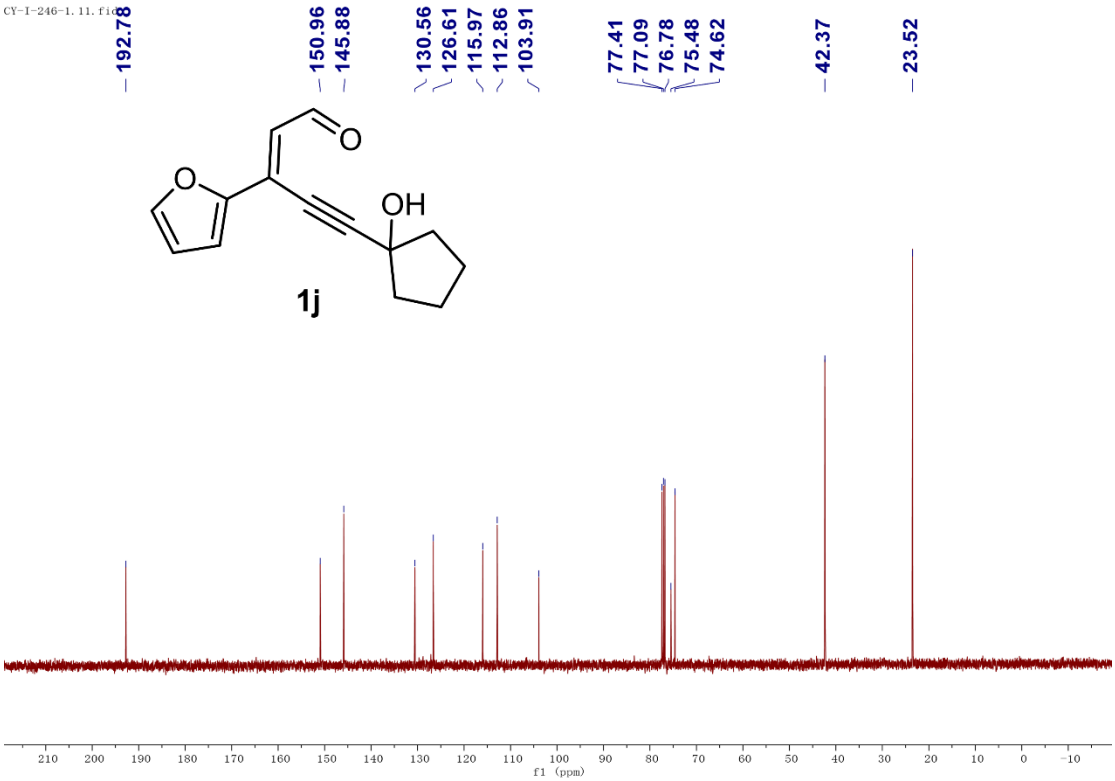

193.35
142.18
134.53
132.94
132.71
131.22
129.07
128.66
128.41
127.83
127.74
126.92
123.15
106.50
78.08
77.37
77.05
76.74
75.01
42.59
42.40
23.61
O
OH
f1 (ppm)

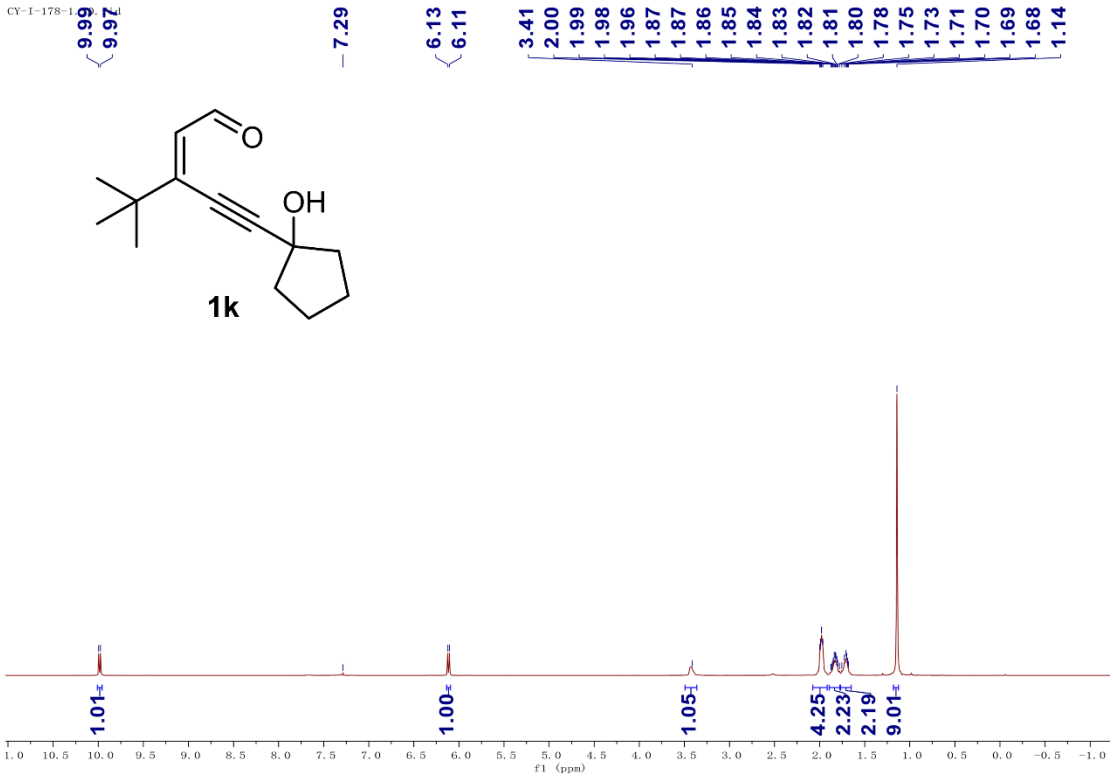
1h

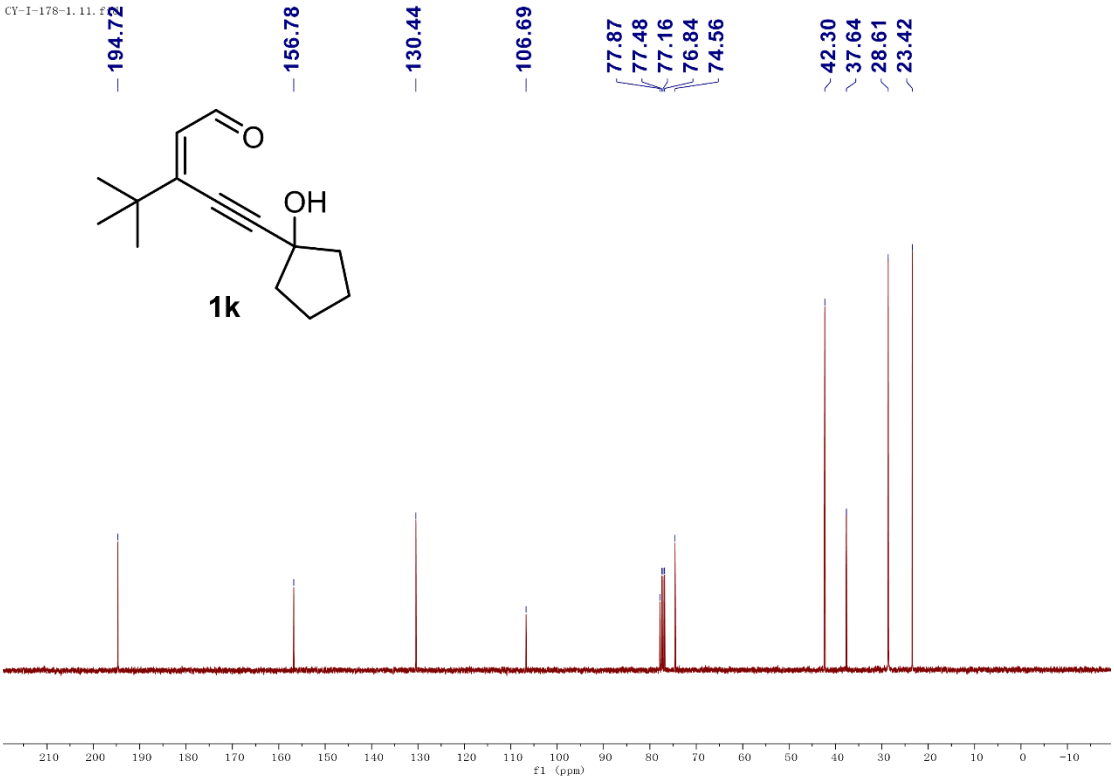

10.17
10.15
7.50
7.49
7.49
7.48
7.48
7.43
7.39
7.38
7.36
7.36
7.35
7.35
7.34
7.34
7.33
7.27
6.86
6.82
6.28
6.25
2.13
2.12
2.11
2.10
2.10
2.09
1.95
1.95
1.94
1.93
1.93
1.92
1.91
1.91
1.83
1.83
1.82
1.82
1.81
1.80
O
OH
1i
0.83
1.94
0.46
0.93
2.37
1.00
0.94
3.93
2.58
1.84
f1 (ppm)

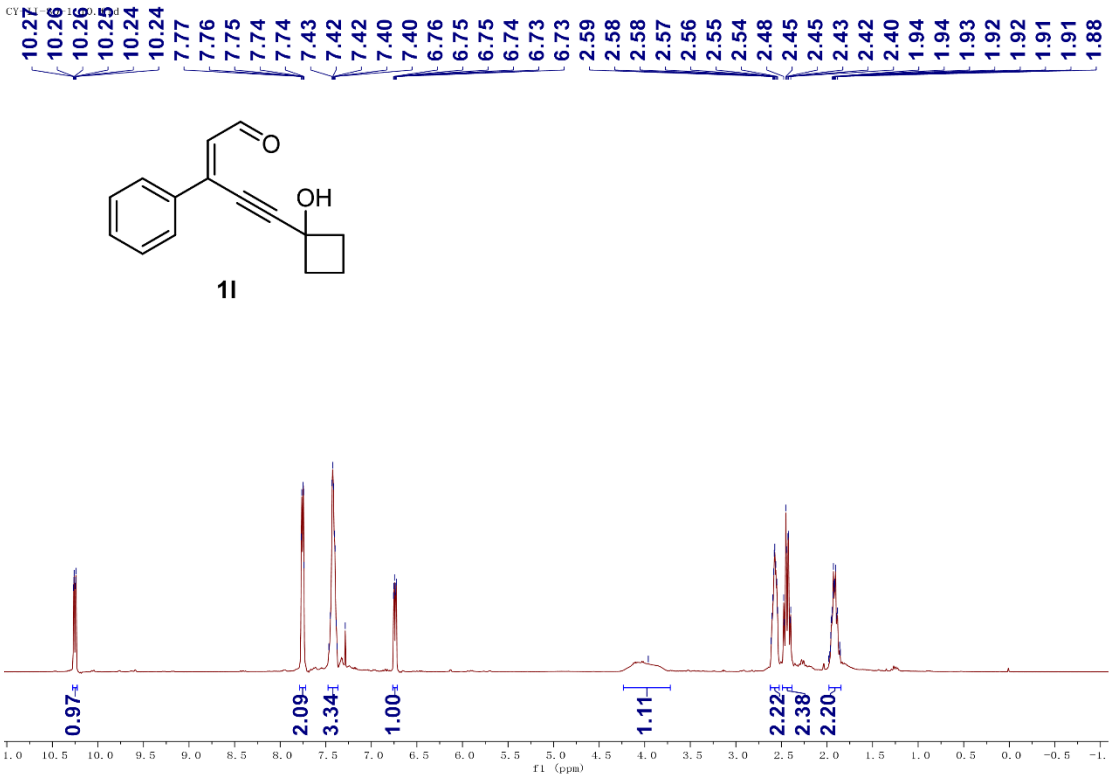

193.29
141.04
139.82
135.35
133.36
129.73
128.93
127.82
127.22
106.11
77.44
77.12
76.81
75.75
74.74
42.51
23.57
O
OH
1i
f1 (ppm)

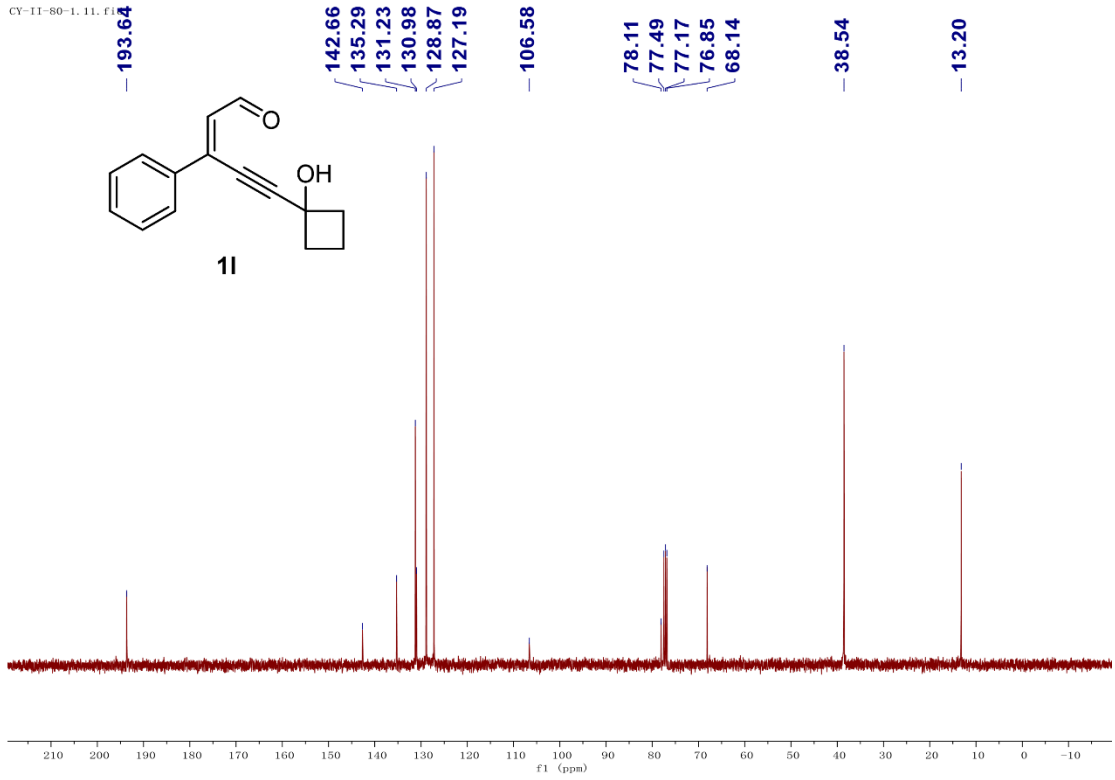

10.10
10.08
7.51
7.51
7.29
6.96
6.95
6.67
6.64
6.51
6.51
6.50
6.50
2.09
2.09
2.08
2.08
2.07
2.06
2.06
1.93
1.93
1.92
1.92
1.91
1.90
1.90
1.89
1.89
1.88
1.87
1.83
1.82
1.82
1.81
1.81
1.80
1.80
1.79
1.78
1.77
1.77
1.76
O
O
OH
1j
0.93
0.92
0.94
0.92
1.00
0.92
4.12
2.53
2.59
f1 (ppm)

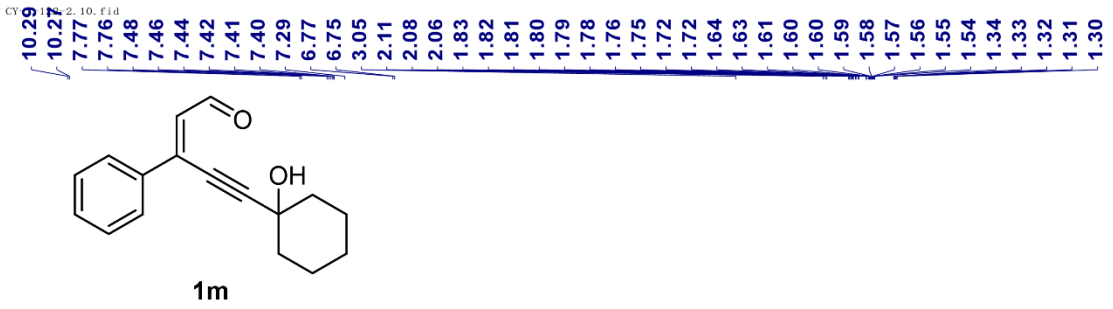

192.78
150.96
145.88
130.56
126.61
115.97
112.86
103.91
77.41
77.09
76.78
75.48
74.62
42.37
23.52
O
O
OH
1j
f1 (ppm)


9.99
9.97
7.29
6.13
6.11
3.41
2.00
1.99
1.98
1.96
1.87
1.87
1.86
1.85
1.84
1.83
1.82
1.81
1.80
1.78
1.75
1.73
1.71
1.70
1.69
1.68
1.14
O
OH
1k
1.01
1.00
1.05
4.25
2.23
2.19
9.01
f1 (ppm)

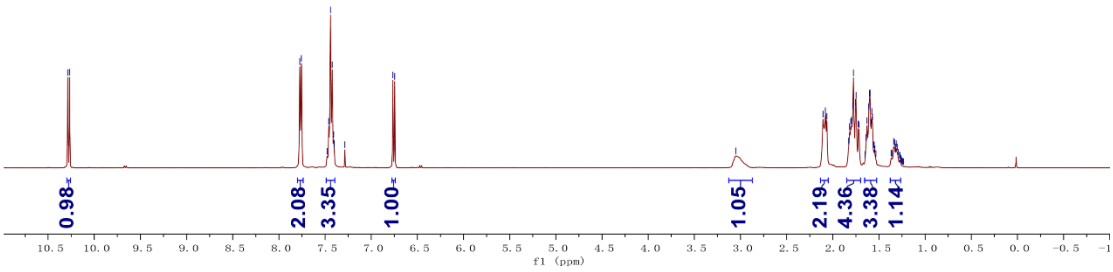

194.72
156.78
130.44
106.69
77.87
77.48
77.16
76.84
74.56
42.30
37.64
28.61
23.42
O
OH
1k
f1 (ppm)

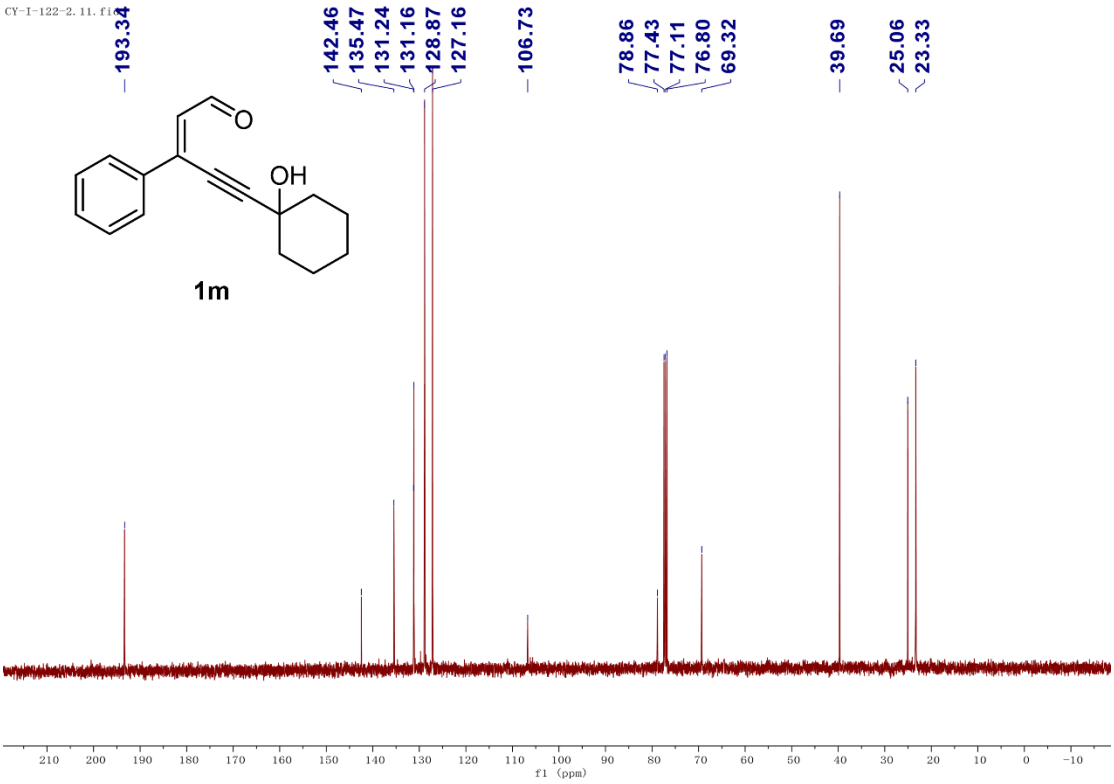

10.27 10.26 10.26 10.25 10.24 10.24 7.77 7.76 7.75 7.74 7.74 7.43 7.42 7.42 7.40 7.40 6.76 6.75 6.75 6.74 6.73 6.73 2.59 2.58 2.58 2.57 2.56 2.55 2.54 2.48 2.45 2.45 2.43 2.42 2.40 1.94 1.94 1.93 1.92 1.92 1.91 1.91 1.88
O
OH
1l
0.97 2.09 3.34 1.00 1.11 2.22 2.38 2.20
f1 (ppm)


193.64
142.66 135.29 131.23 130.98 128.87 127.19
106.58
78.11 77.49 77.17 76.85 68.14
38.54
13.20
O
OH
1l
f1 (ppm)

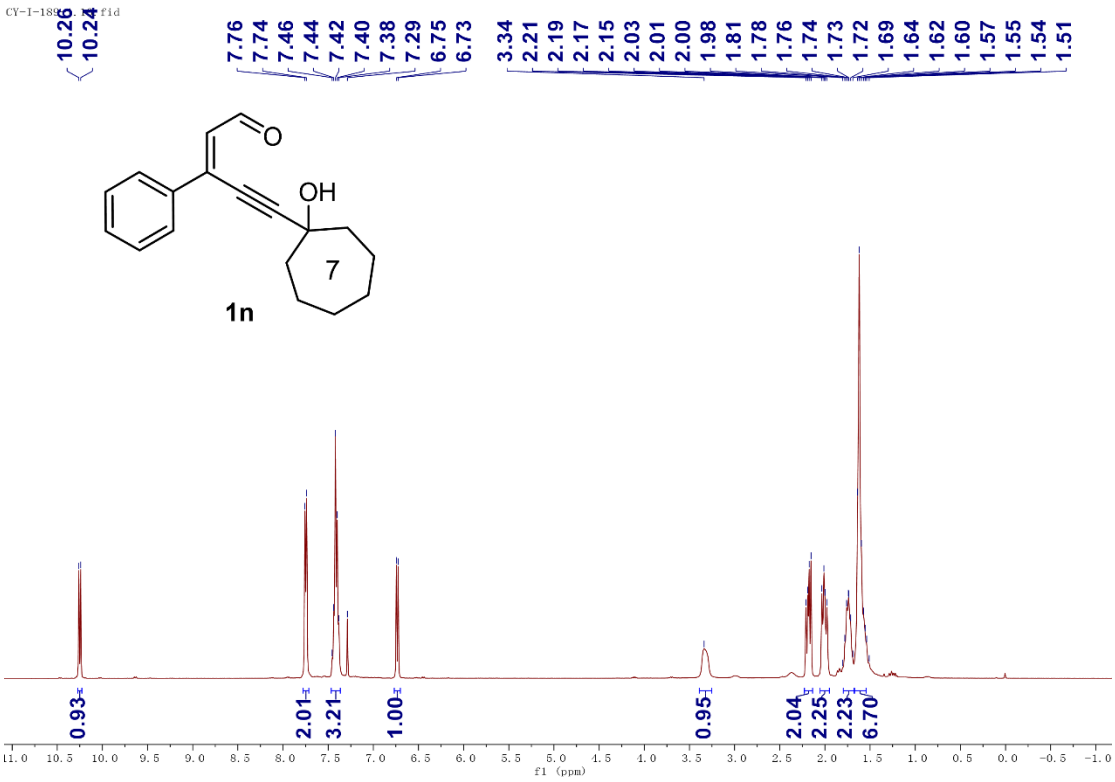

10.29
10.27
7.77
7.76
7.48
7.46
7.44
7.42
7.41
7.40
7.29
6.77
6.75
3.05
2.11
2.08
2.06
1.83
1.82
1.81
1.80
1.79
1.78
1.76
1.75
1.72
1.72
1.64
1.63
1.61
1.60
1.60
1.59
1.58
1.57
1.56
1.55
1.54
1.34
1.33
1.32
1.31
1.30
O
OH

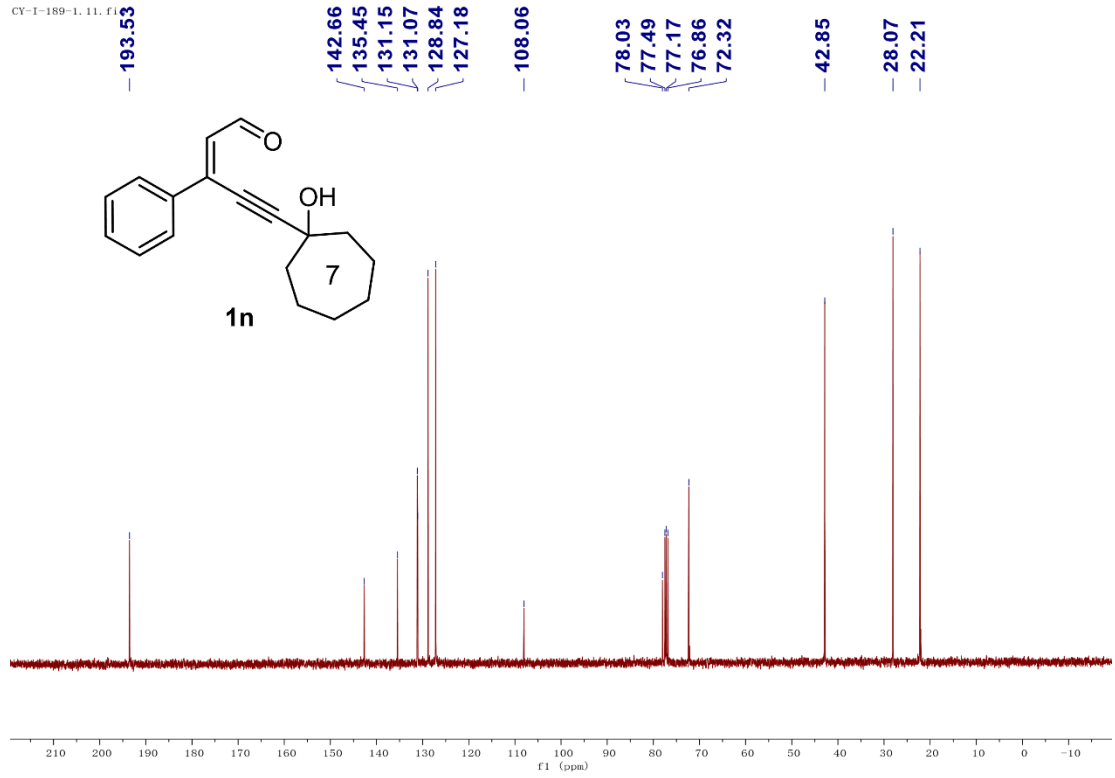
1m

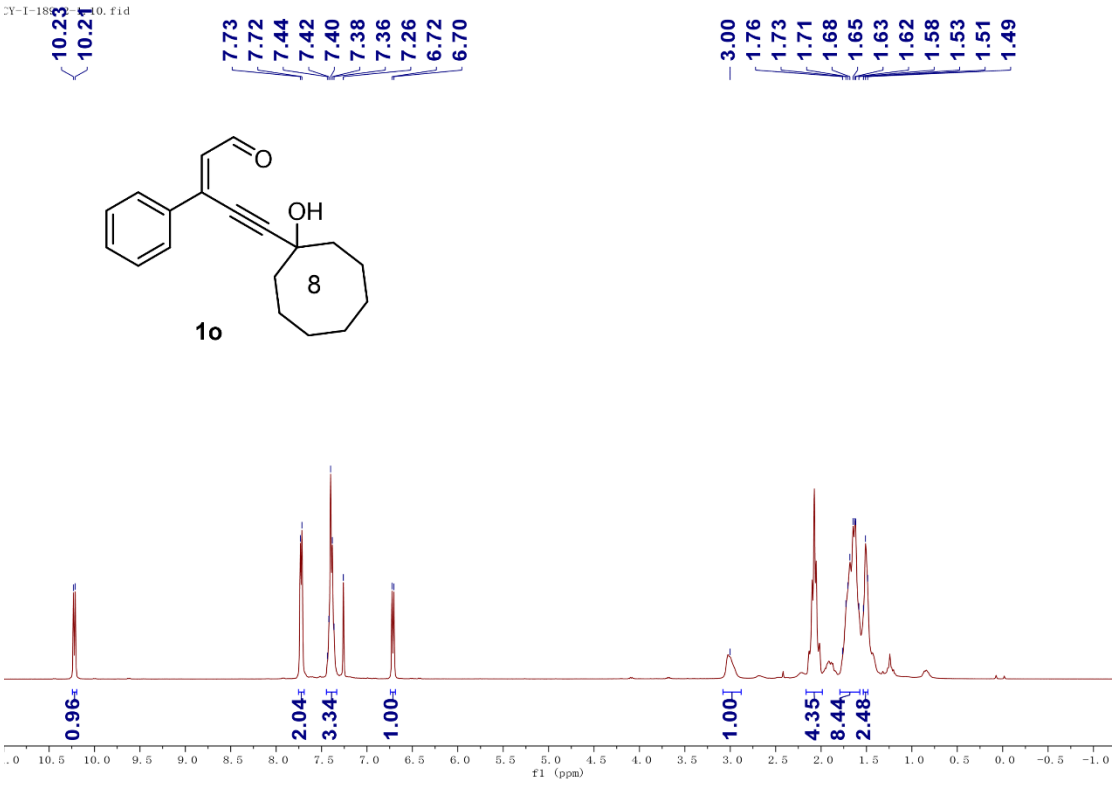

0.98
2.08
3.35
1.00
1.05
2.19
4.36
3.38
1.14
f1 (ppm)

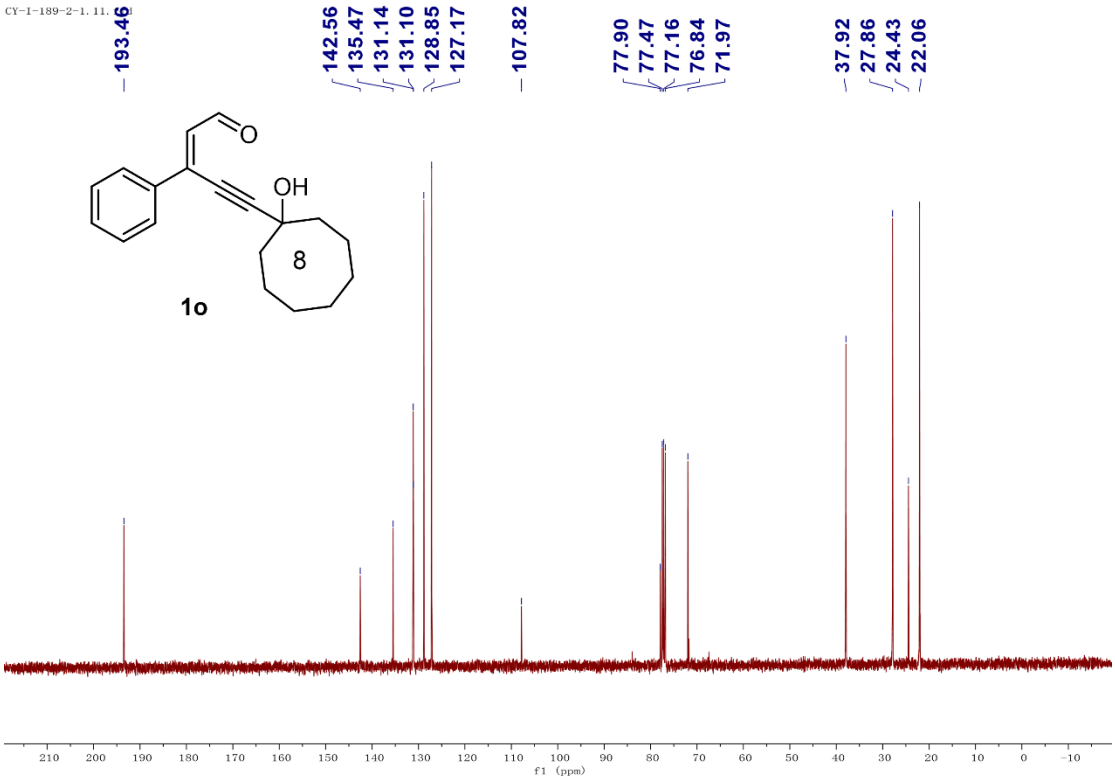

193.34
142.46
135.47
131.24
131.16
128.87
127.16
106.73
78.86
77.43
77.11
76.80
69.32
39.69
25.06
23.33
O
OH
f1 (ppm)

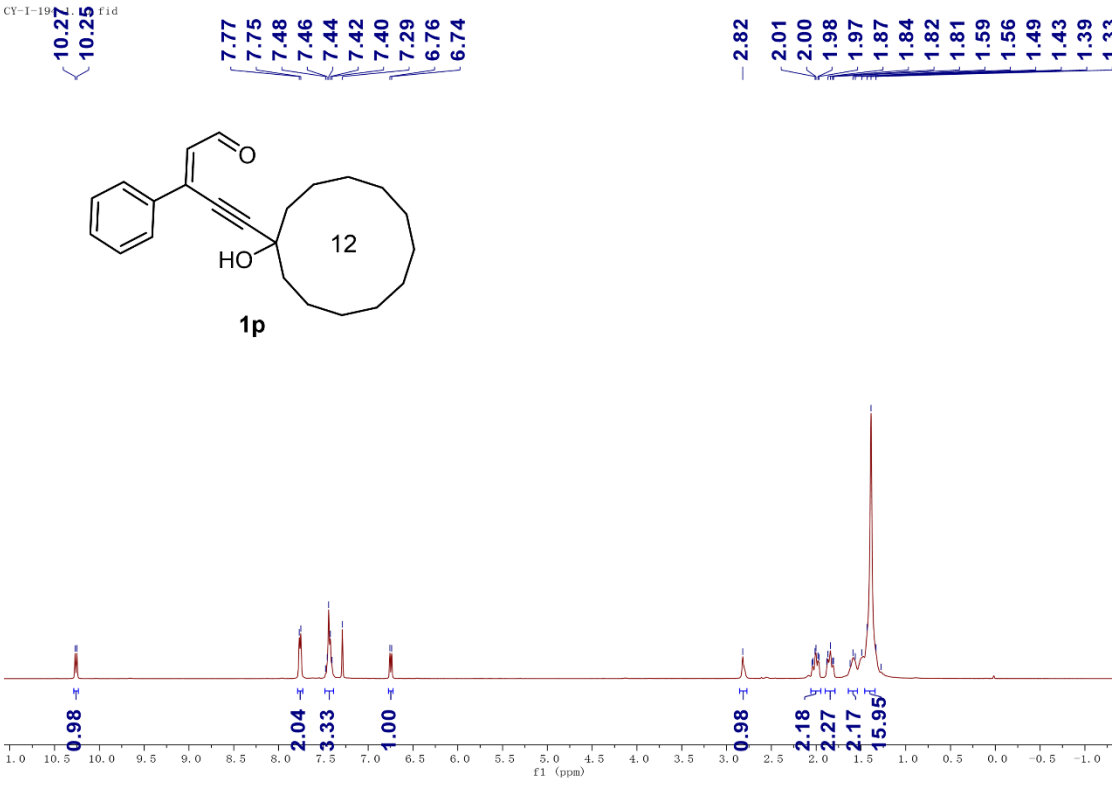
1m

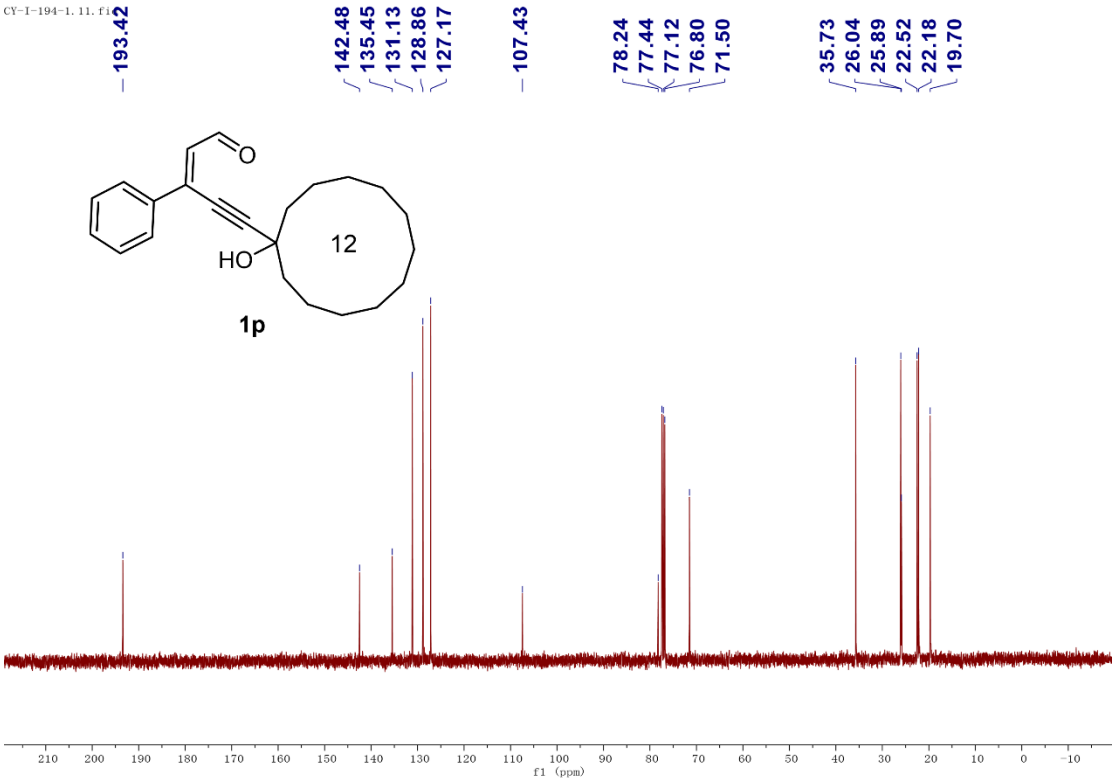

10.26
10.24
7.76
7.74
7.46
7.44
7.42
7.40
7.38
7.29
6.75
6.73
3.34
2.21
2.19
2.17
2.15
2.03
2.01
2.00
1.98
1.81
1.78
1.76
1.74
1.73
1.72
1.69
1.64
1.62
1.60
1.57
1.55
1.54
1.51
O
OH
7
1n
0.93
2.01
3.21
1.00
0.95
2.04
2.25
2.23
6.70
f1 (ppm)

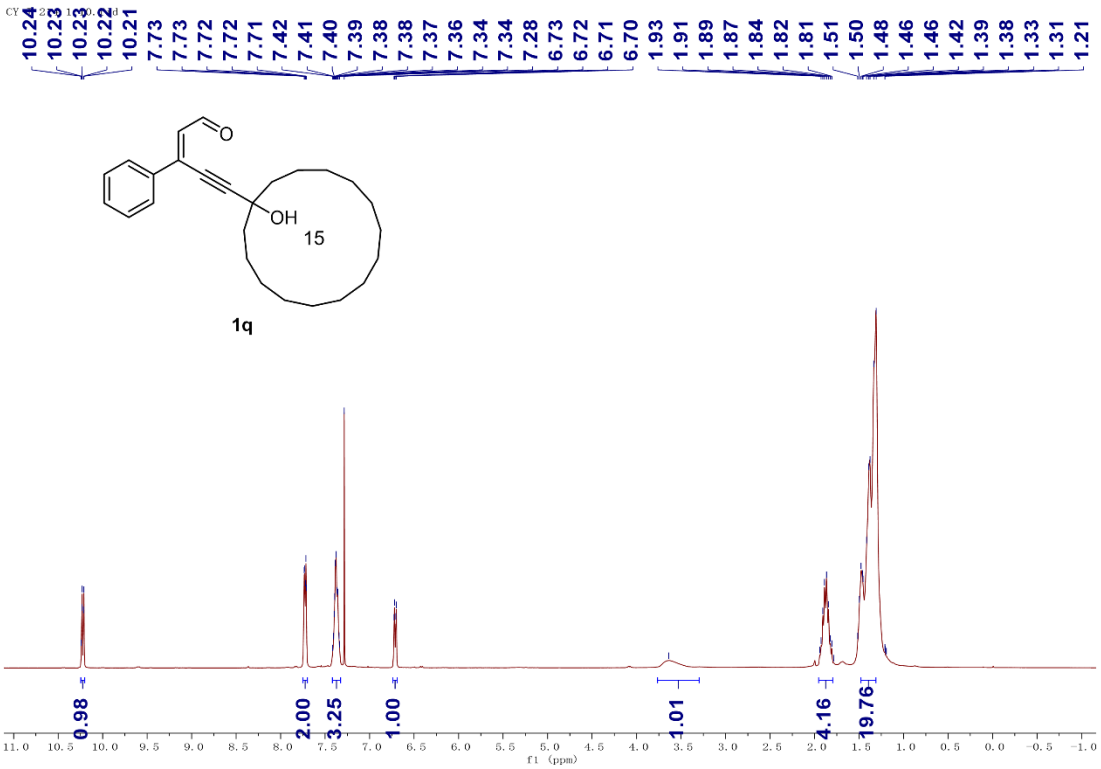

193.53
142.66
135.45
131.15
131.07
128.84
127.18
108.06
78.03
77.49
77.17
76.86
72.32
42.85
28.07
22.21
O
OH
7
1n
f1 (ppm)

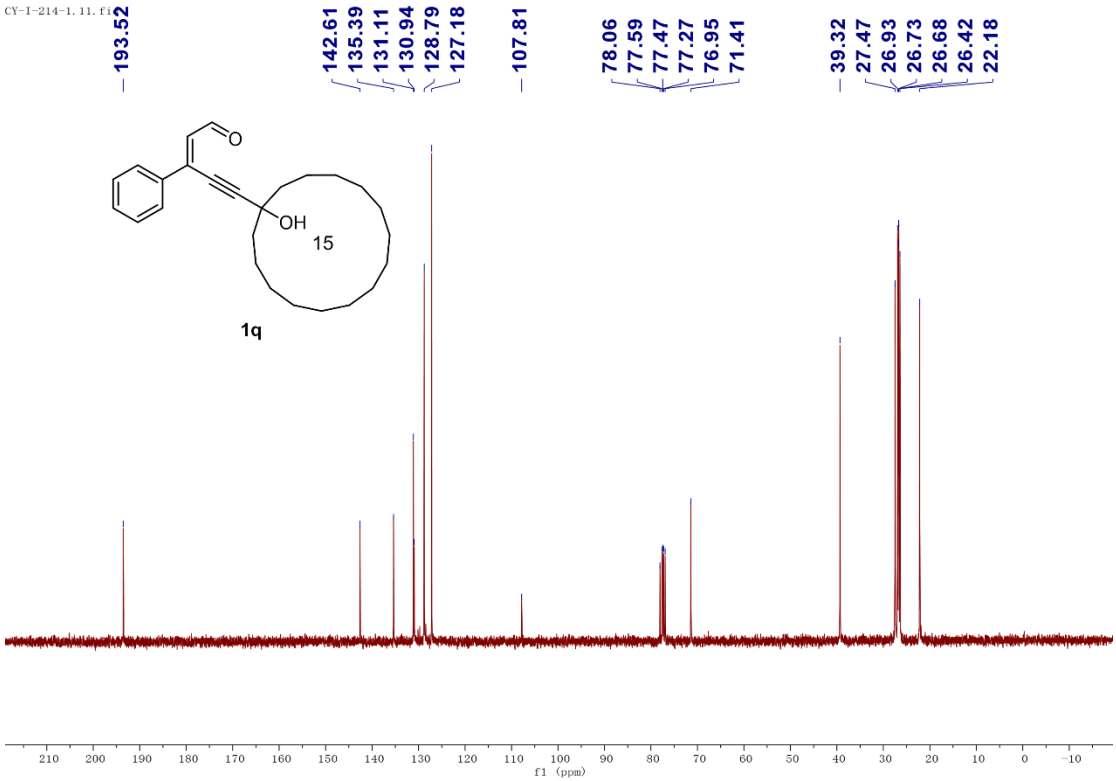

10.23
10.21
7.73
7.72
7.44
7.42
7.40
7.38
7.36
7.26
6.72
6.70
3.00
1.76
1.73
1.71
1.68
1.65
1.63
1.62
1.58
1.53
1.51
1.49
O
OH
8
1o
0.96
2.04
3.34
1.00
1.00
4.35
8.44
2.48
f1 (ppm)

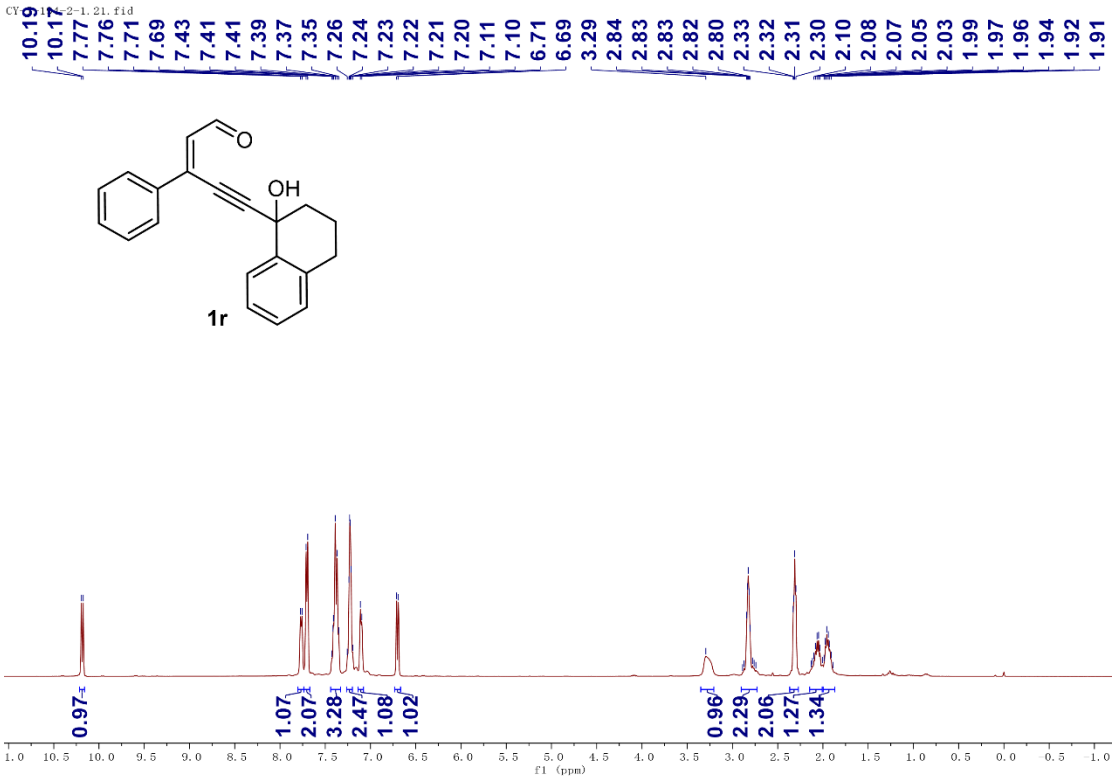

193.46
142.56
135.47
131.14
131.10
128.85
127.17
107.82
77.90
77.47
77.16
76.84
71.97
37.92
27.86
24.43
22.06
O
OH
8
1o
f1 (ppm)

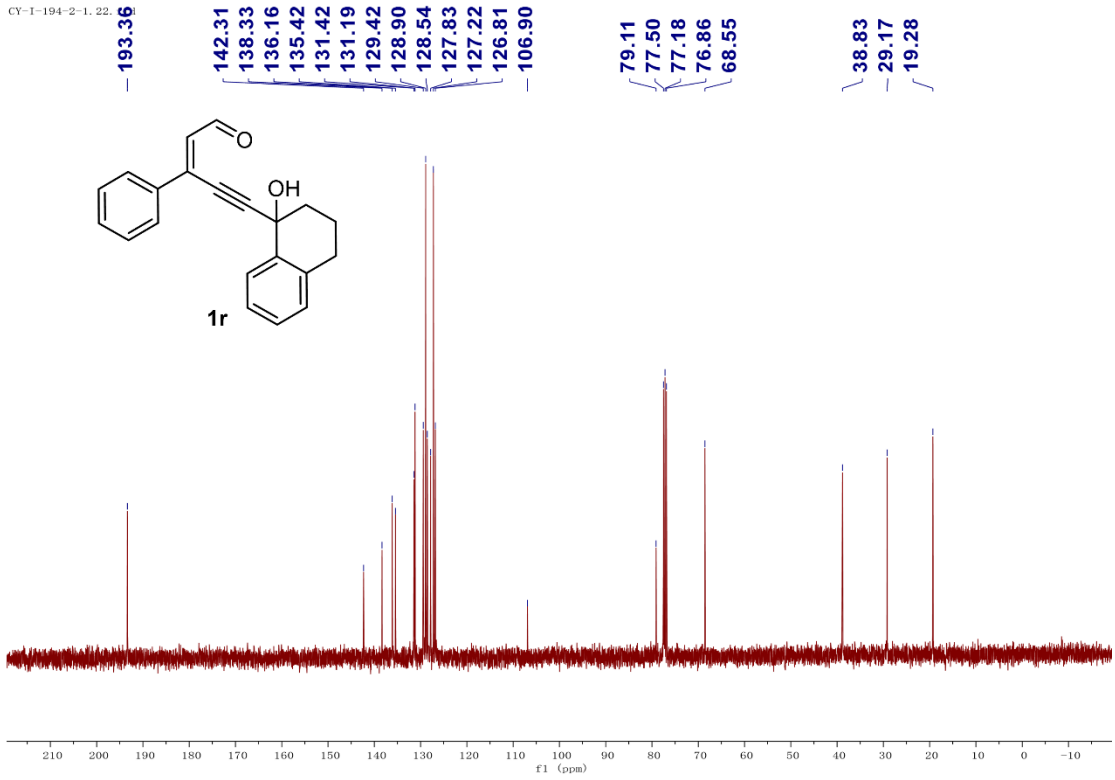

10.27
10.25
7.77
7.75
7.48
7.46
7.44
7.42
7.40
7.29
6.76
6.74
2.82
2.01
2.00
1.98
1.97
1.87
1.84
1.82
1.81
1.59
1.56
1.49
1.43
1.39
O
HO
12
1p
0.98
2.04
3.33
1.00
0.98
2.18
2.27
2.17
15.95
f1 (ppm)

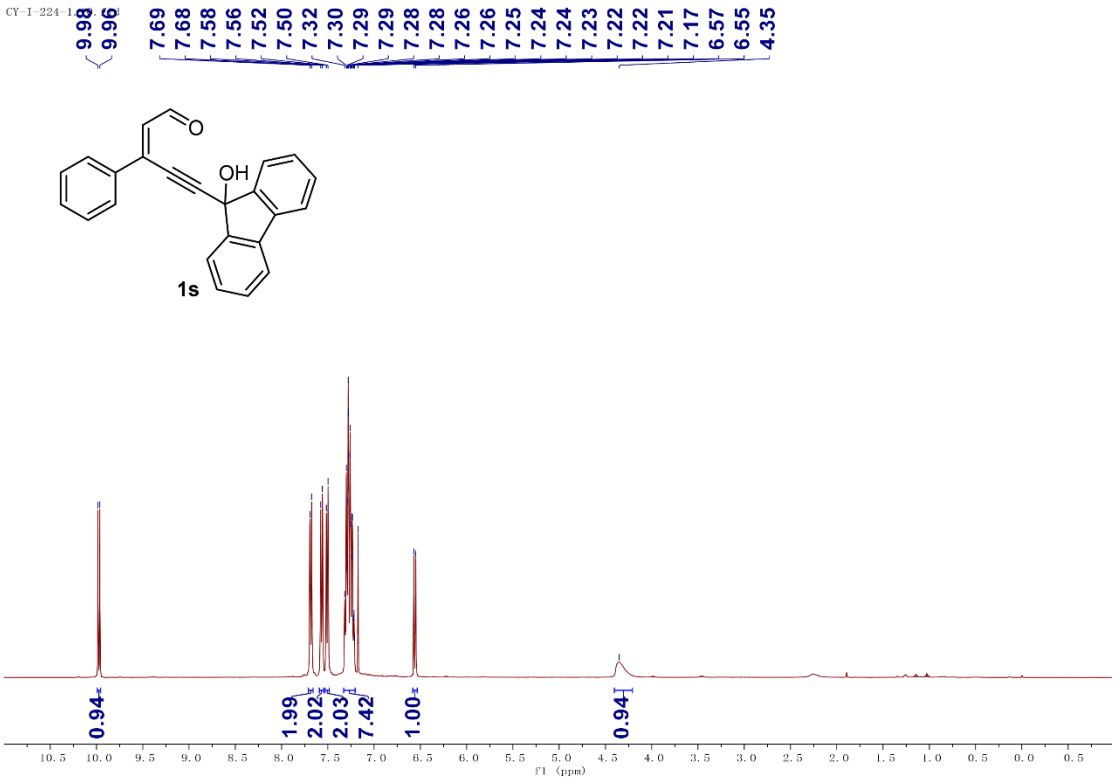

193.42
142.48
135.45
131.13
128.86
127.17
107.43
78.24
77.44
77.12
76.80
71.50
35.73
26.04
25.89
22.52
22.18
19.70
O
HO
12
1p
f1 (ppm)

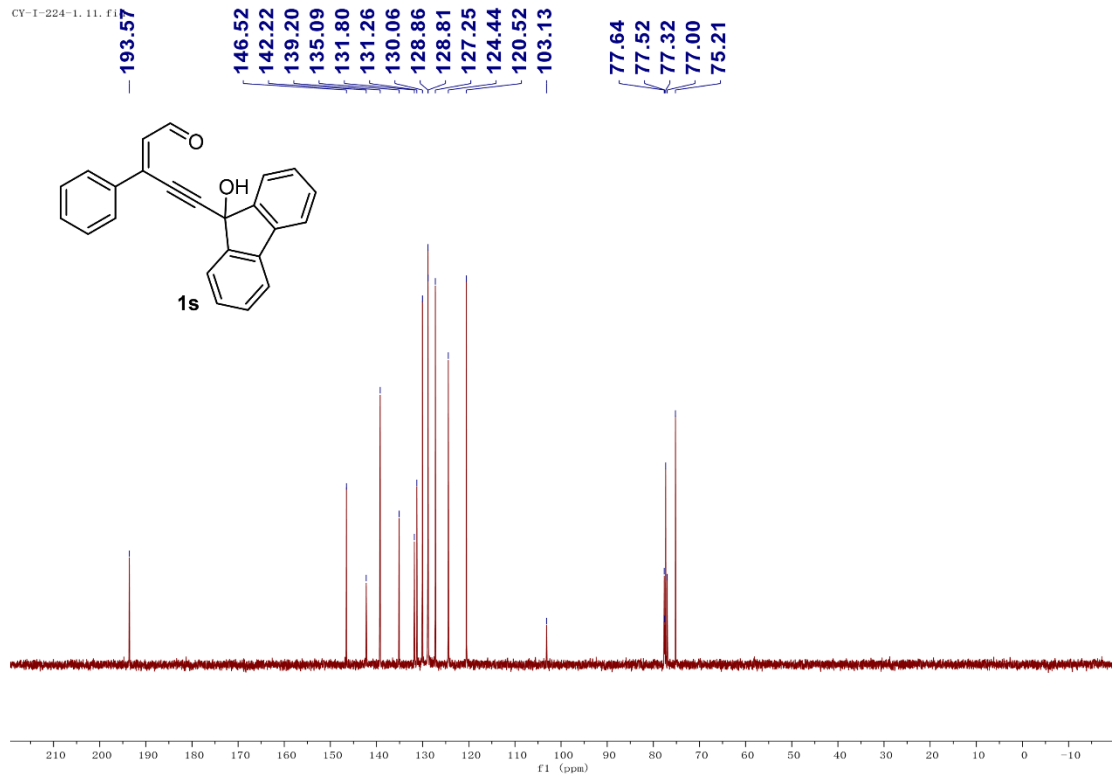

10.24
10.23
10.23
10.22
10.21
7.73
7.73
7.72
7.72
7.71
7.42
7.41
7.40
7.39
7.38
7.38
7.37
7.36
7.34
7.34
7.28
6.73
6.72
6.71
6.70
1.93
1.91
1.89
1.87
1.84
1.82
1.81
1.51
1.50
1.48
1.46
1.46
1.42
1.39
1.38
1.33
1.31
1.21
O
OH
15
1q
0.98
2.00
3.25
1.00
1.01
4.16
19.76
f1 (ppm)

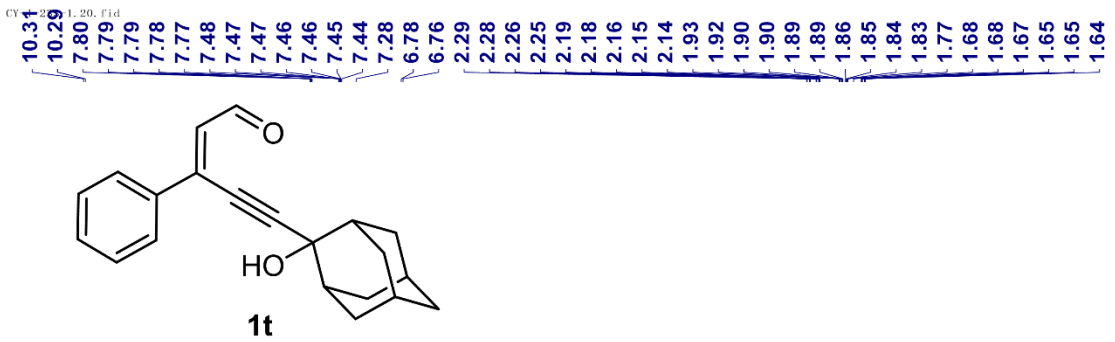

193.52
142.61
135.39
131.11
130.94
128.79
127.18
107.81
78.06
77.59
77.47
77.27
76.95
71.41
39.32
27.47
26.93
26.73
26.68
26.42
22.18
O
OH
15
1q
f1 (ppm)


10.19
10.17
7.77
7.76
7.71
7.69
7.43
7.41
7.41
7.39
7.37
7.35
7.26
7.24
7.23
7.22
7.21
7.20
7.11
7.10
6.71
6.69
3.29
2.84
2.83
2.83
2.82
2.80
2.33
2.32
2.31
2.30
2.10
2.08
2.07
2.05
2.03
1.99
1.97
1.96
1.94
1.92
1.91
O
OH
1r
0.97
1.07
2.07
3.28
2.47
1.08
1.02
0.96
2.29
2.06
1.27
1.34
f1 (ppm)

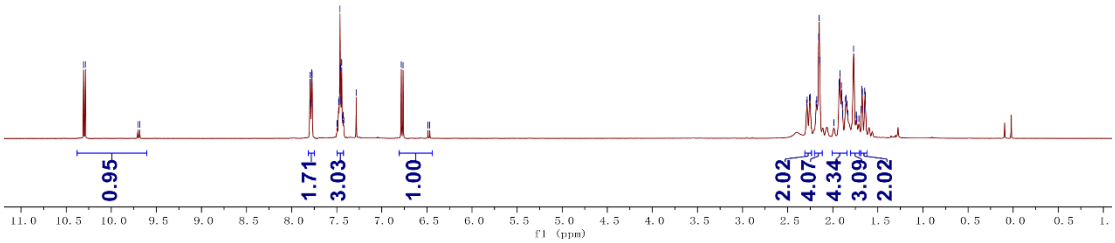

193.36
142.31
138.33
136.16
135.42
131.42
131.19
129.42
128.90
128.54
127.83
127.22
126.81
106.90
79.11
77.50
77.18
76.86
68.55
38.83
29.17
19.28
O
OH
1r
f1 (ppm)

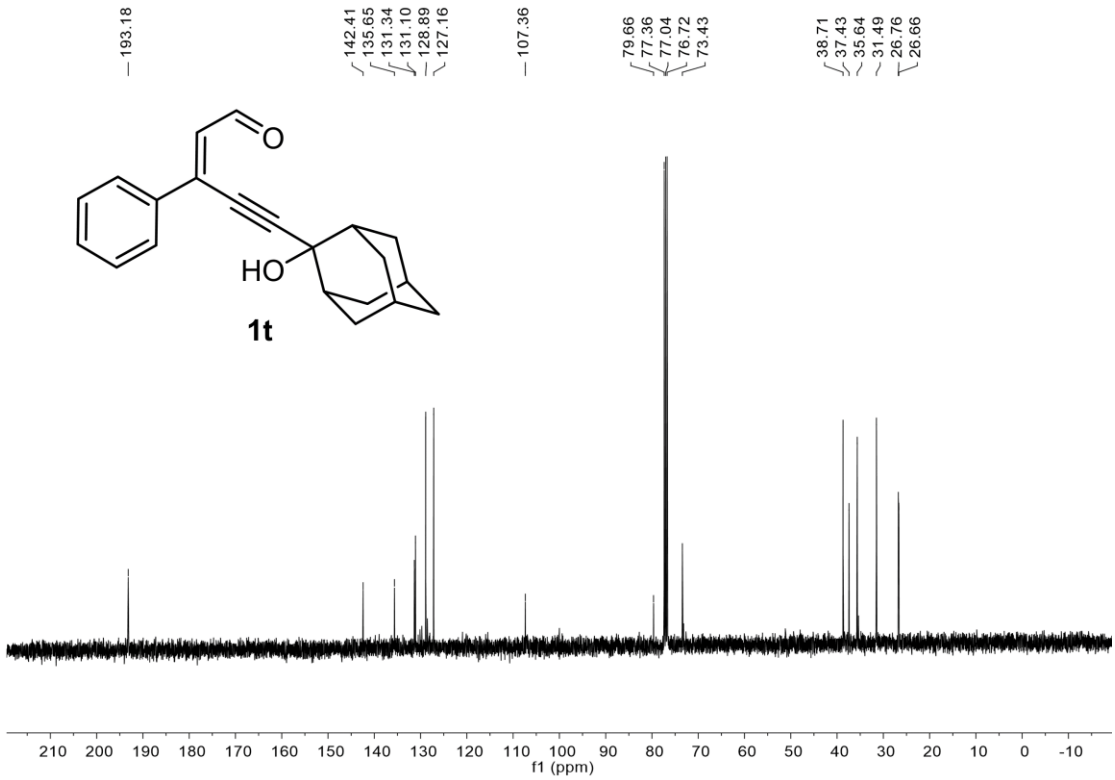

9.98
9.96
7.69
7.68
7.58
7.56
7.52
7.50
7.32
7.30
7.29
7.29
7.28
7.28
7.26
7.26
7.25
7.24
7.24
7.23
7.22
7.22
7.21
7.17
6.57
6.55
4.35
O
OH
1s
0.94
1.99
2.02
2.03
7.42
1.00
0.94
f1 (ppm)


193.57
146.52
142.22
139.20
135.09
131.80
131.26
130.06
128.86
128.81
127.25
124.44
120.52
103.13
77.64
77.52
77.32
77.00
75.21
O
OH
1s
f1 (ppm)

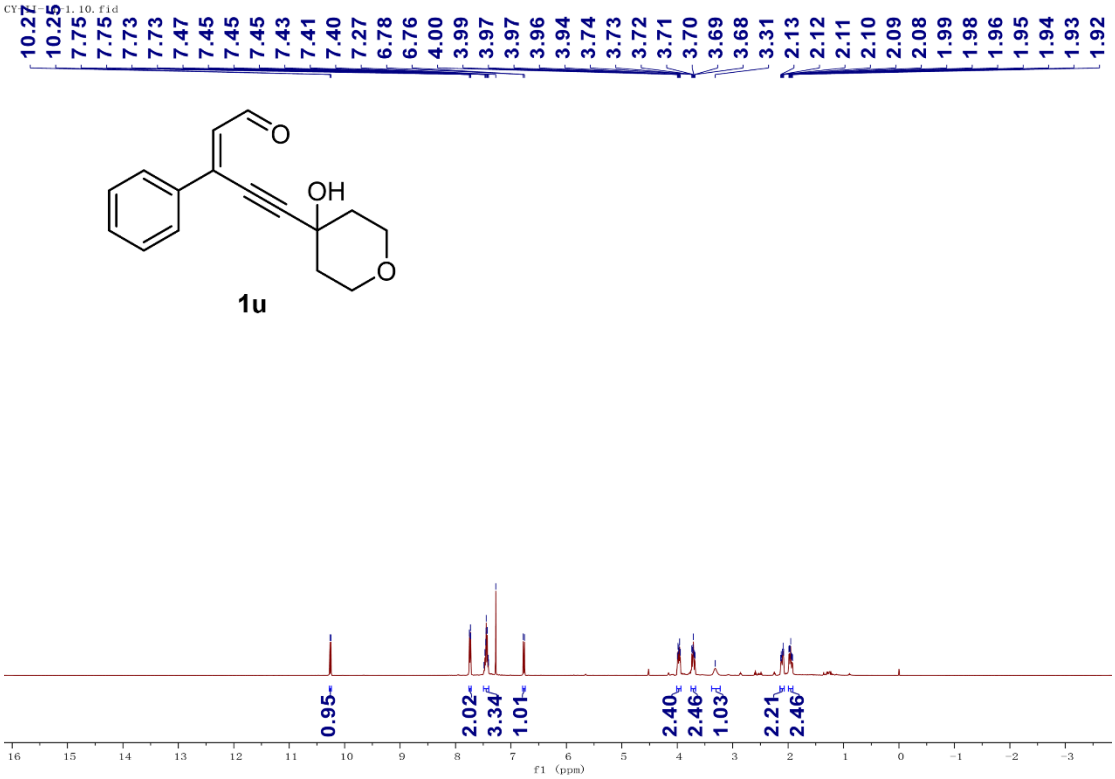

10.31
10.29
7.80
7.79
7.79
7.78
7.77
7.48
7.47
7.47
7.46
7.46
7.45
7.44
7.28
6.78
6.76
2.29
2.28
2.26
2.25
2.19
2.18
2.16
2.15
2.14
1.93
1.92
1.90
1.90
1.89
1.89
1.86
1.85
1.84
1.83
1.77
1.68
1.68
1.67
1.65
1.65
1.64
O
HO

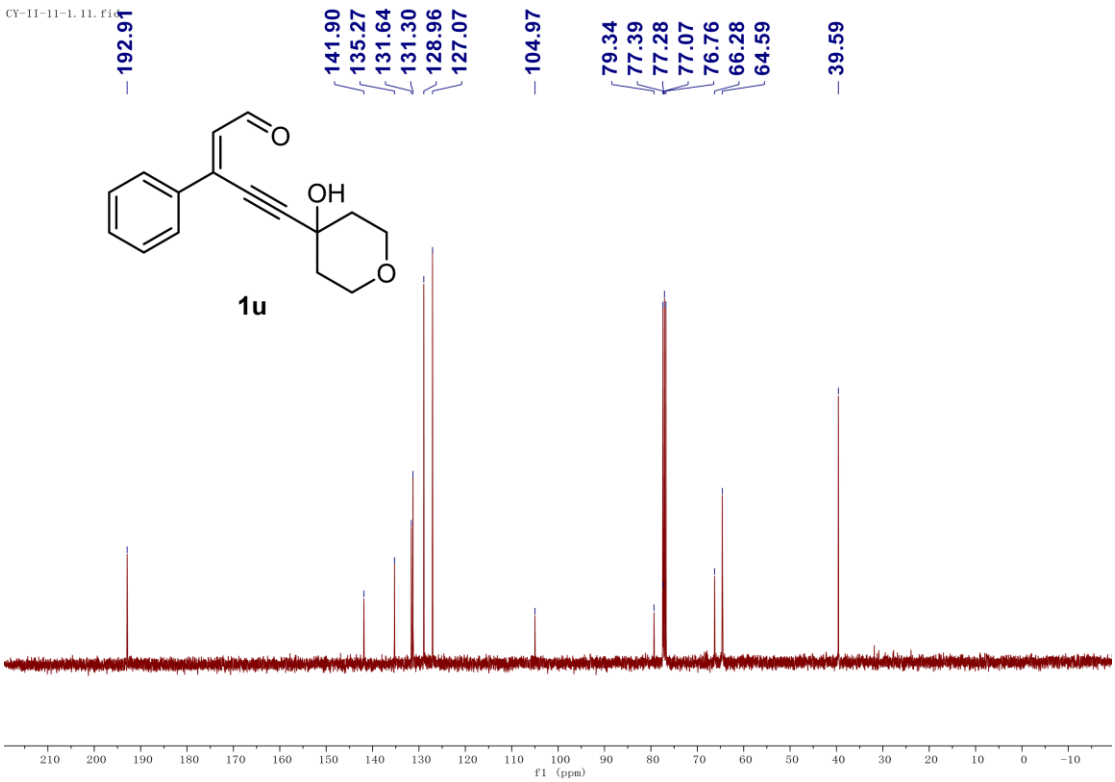
1t

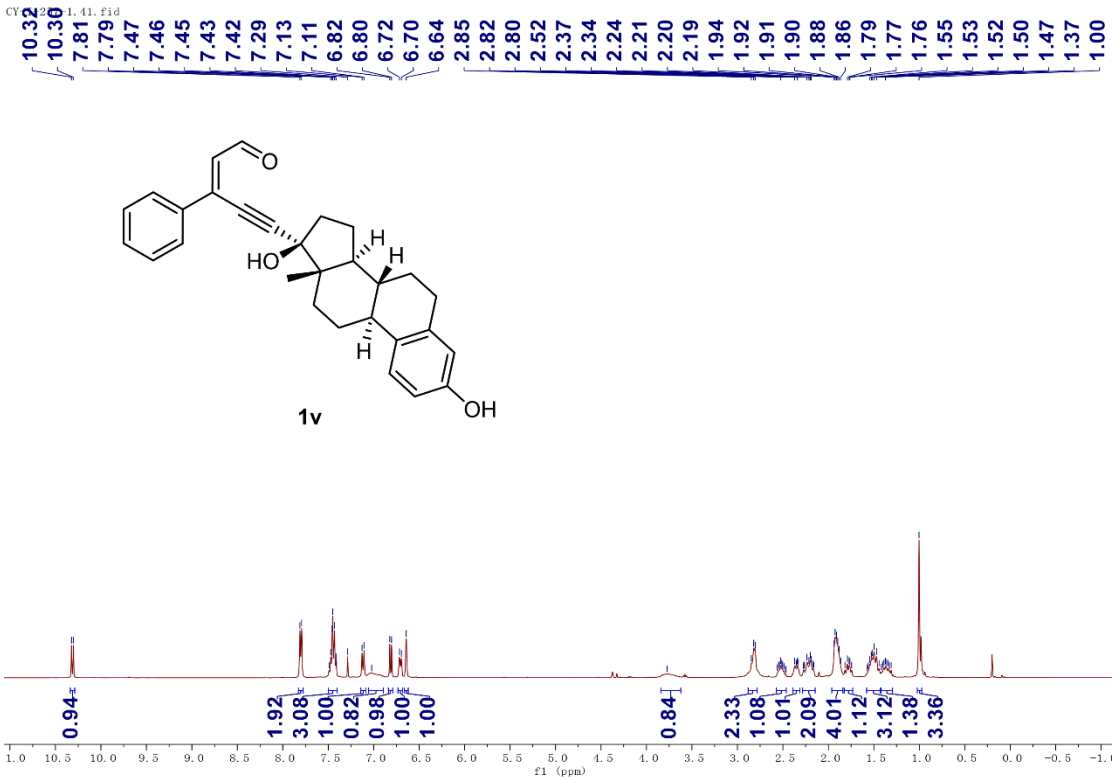

0.95
1.71
3.03
1.00
2.02
4.07
4.34
3.09
2.02
f1 (ppm)

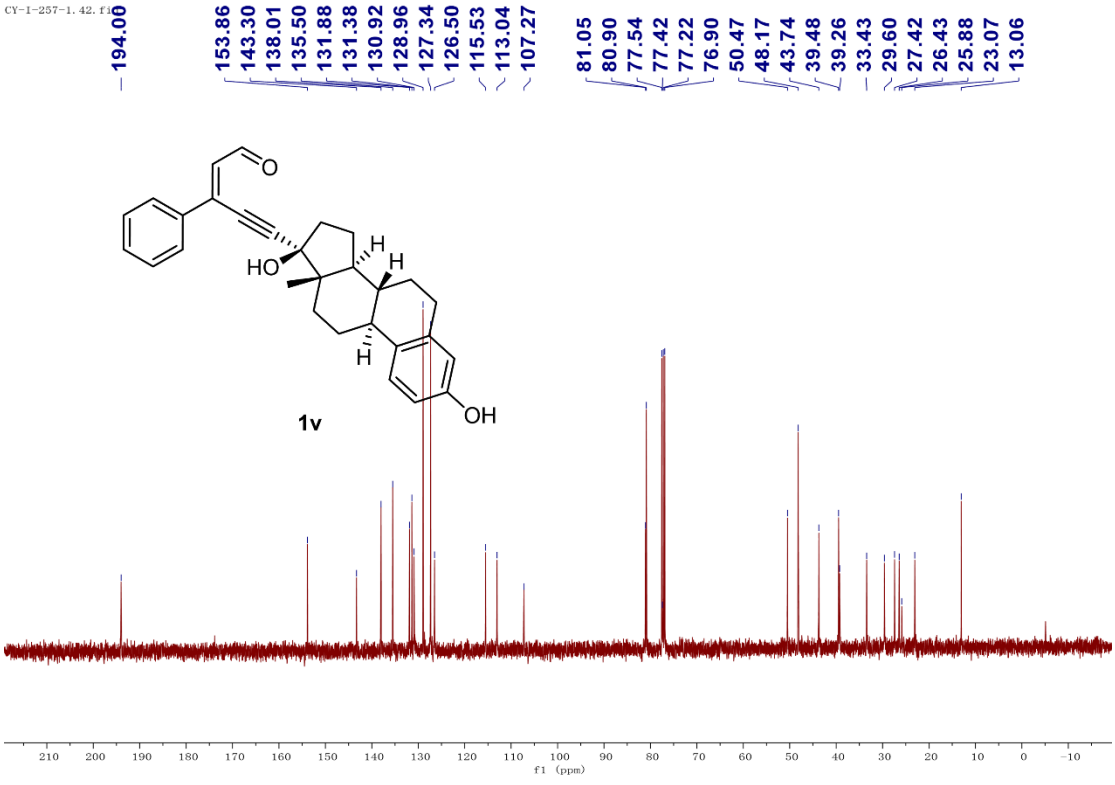

193.18
142.41
135.65
131.34
131.10
128.89
127.16
107.36
79.66
77.36
77.04
76.72
73.43
38.71
37.43
35.64
31.49
26.76
26.66
O
HO
f1 (ppm)

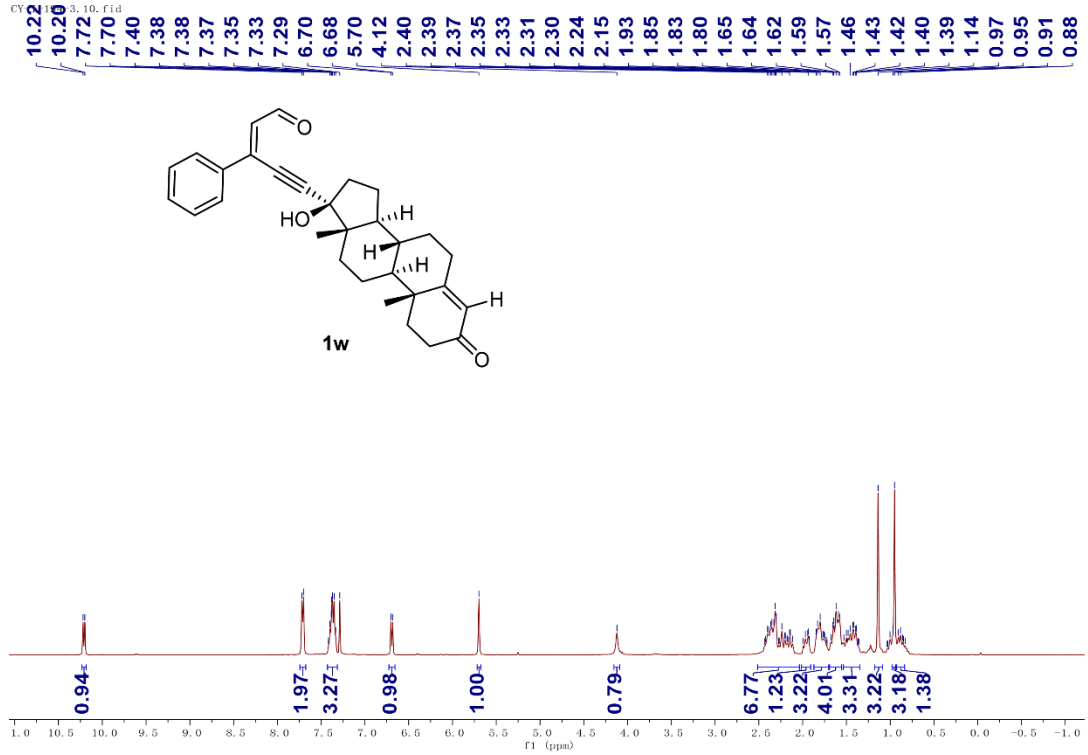
1t

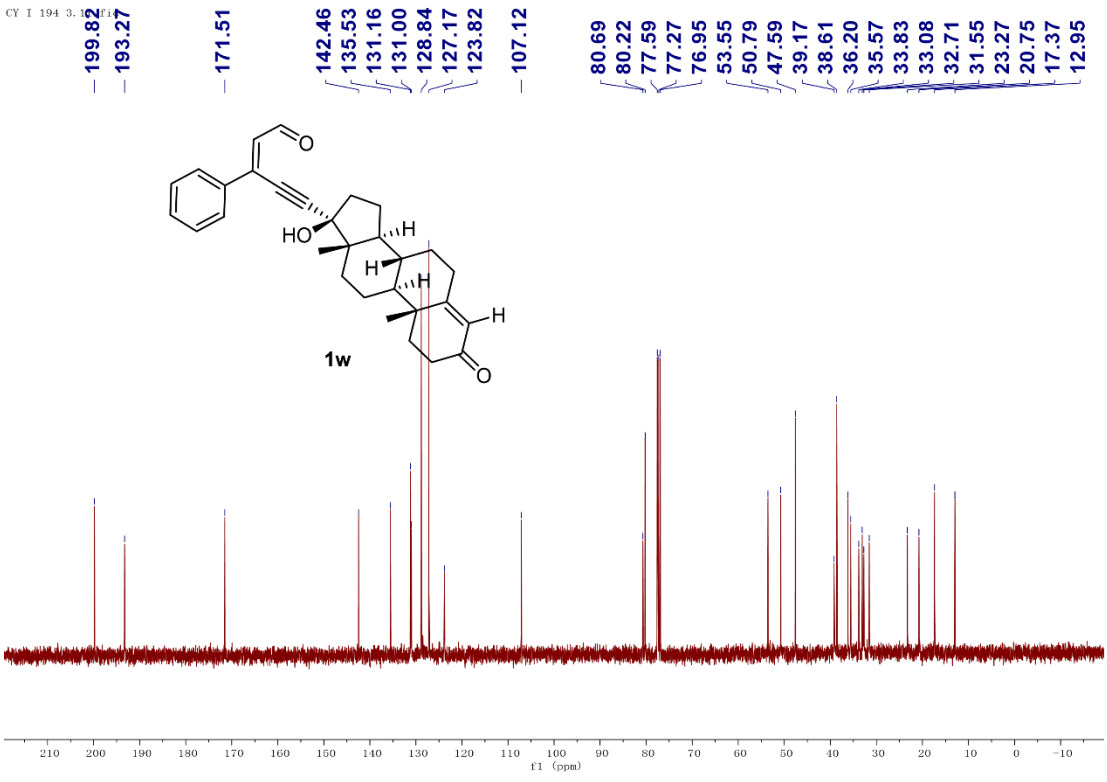

10.27
10.25
7.75
7.75
7.73
7.73
7.47
7.45
7.45
7.45
7.43
7.41
7.40
7.27
6.78
6.76
4.00
3.99
3.97
3.97
3.96
3.94
3.74
3.73
3.72
3.71
3.70
3.69
3.68
3.31
2.13
2.12
2.11
2.10
2.09
2.08
1.99
1.98
1.96
1.95
1.94
1.93
1.92
O
OH
O
1u
0.95
2.02
3.34
1.01
2.40
2.46
1.03
2.21
2.46
f1 (ppm)

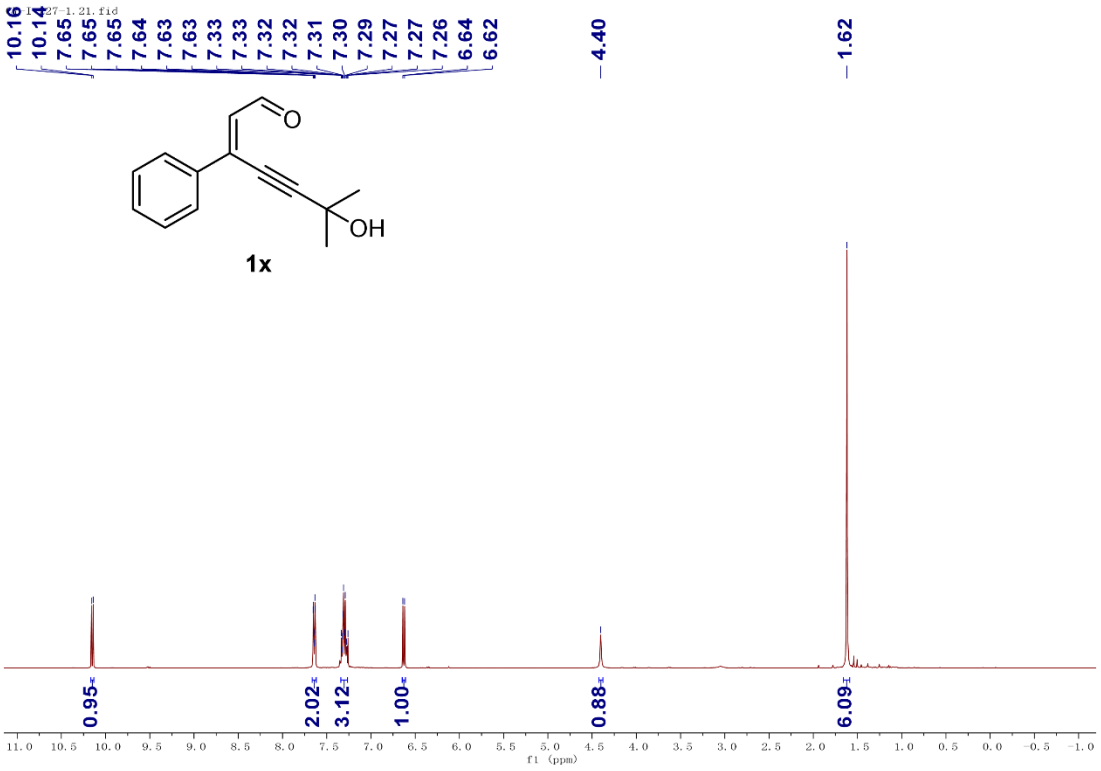

192.91
141.90
135.27
131.64
131.30
128.96
127.07
104.97
79.34
77.39
77.28
77.07
76.76
66.28
64.59
39.59
O
OH
O
1u
f1 (ppm)

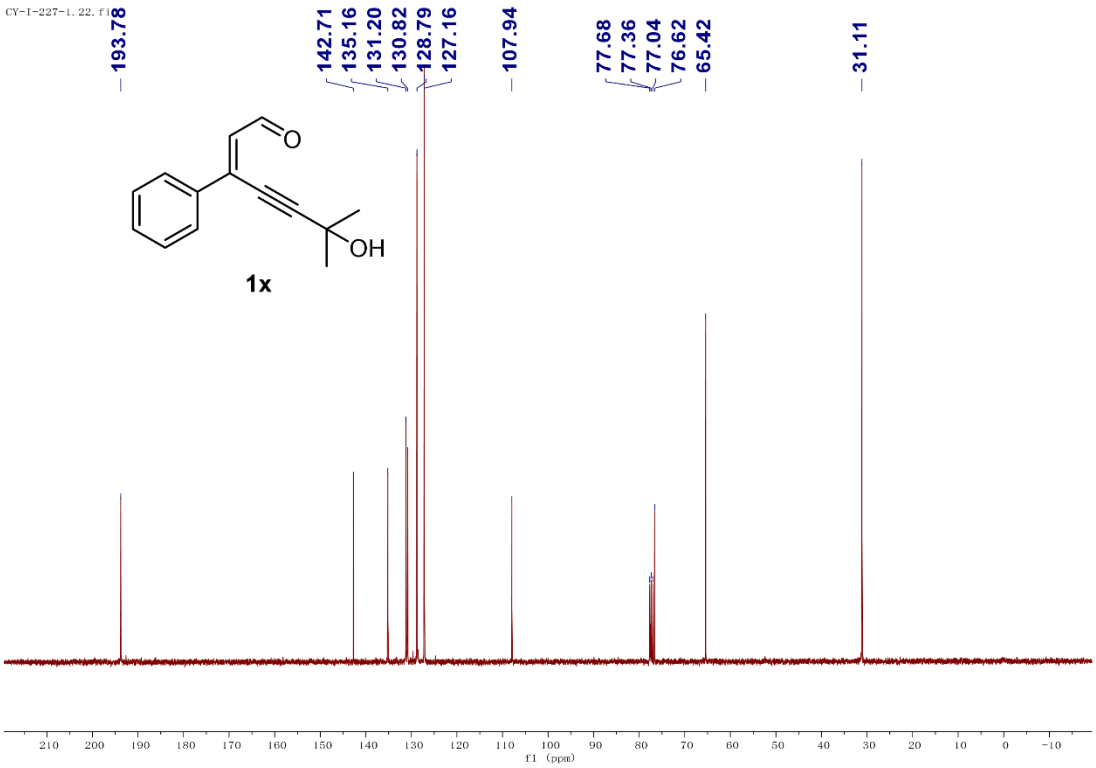

CY-1-257-1.41.fid
10.32
10.30
7.81
7.79
7.47
7.46
7.45
7.43
7.42
7.29
7.13
7.11
6.82
6.80
6.72
6.70
6.64
2.85
2.82
2.80
2.52
2.37
2.34
2.24
2.21
2.20
2.19
1.94
1.92
1.91
1.90
1.88
1.86
1.79
1.77
1.76
1.55
1.53
1.52
1.50
1.47
1.37
1.00
O
HO
H
H
H
OH
1v
0.94
1.92
3.08
1.00
0.82
0.98
1.00
1.00
0.84
2.33
1.08
1.01
2.09
4.01
1.12
3.12
1.38
3.36
f1 (ppm)

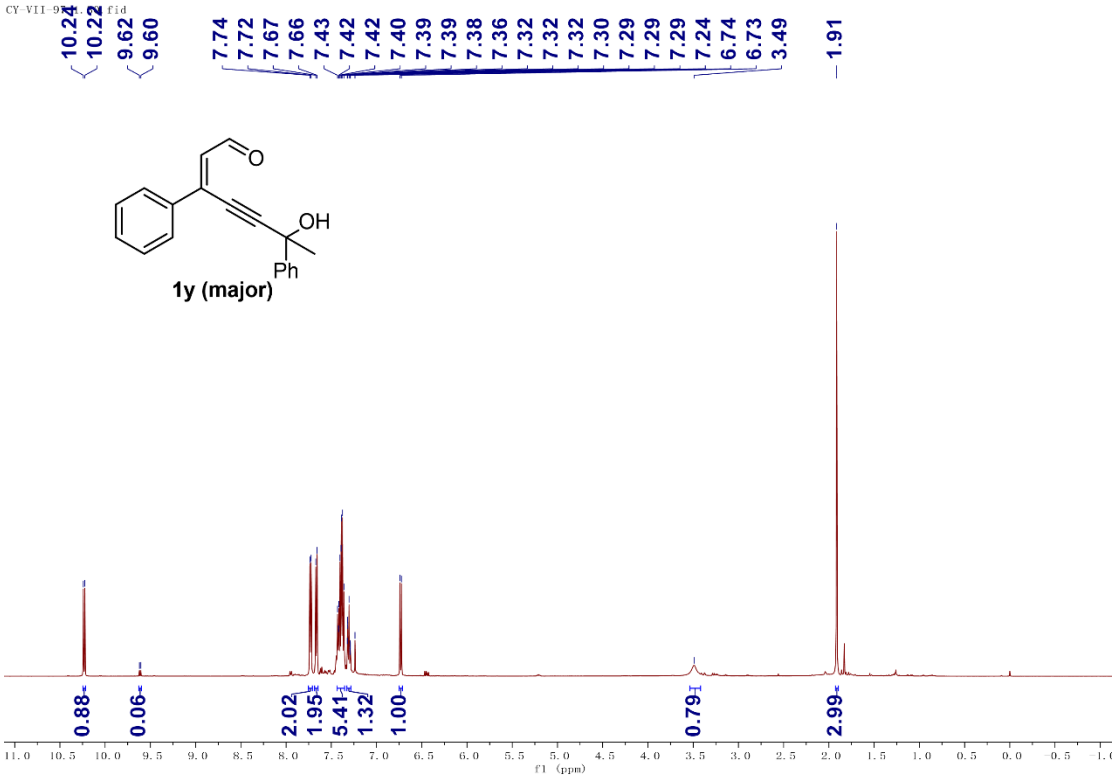

CY-1-257-1.42.fid
194.00
153.86
143.30
138.01
135.50
131.88
131.38
130.92
128.96
127.34
126.50
115.53
113.04
107.27
81.05
80.90
77.54
77.42
77.22
76.90
50.47
48.17
43.74
39.48
39.26
33.43
29.60
27.42
26.43
25.88
23.07
13.06
O
HO
H
H
H
OH
1v
f1 (ppm)

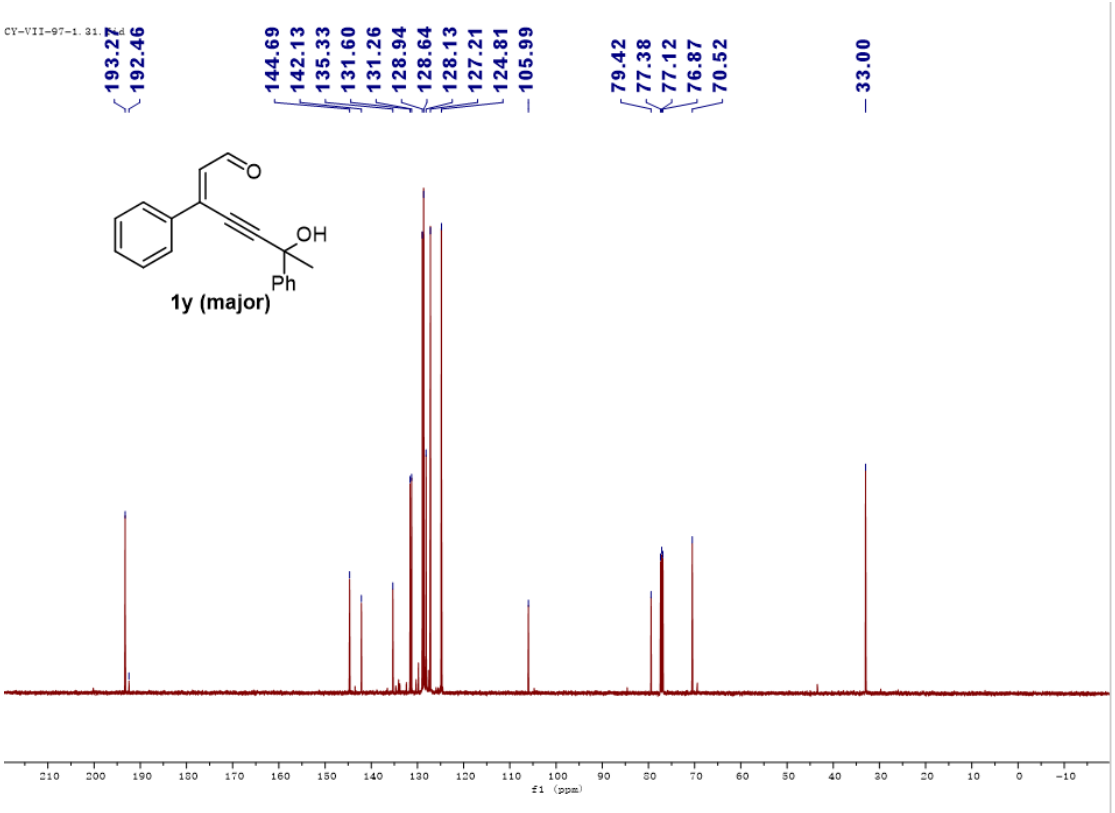

10.22
10.20
7.72
7.70
7.40
7.38
7.38
7.37
7.35
7.33
7.29
6.70
6.68
5.70
4.12
2.40
2.39
2.37
2.35
2.33
2.31
2.30
2.24
2.15
1.93
1.85
1.83
1.80
1.65
1.64
1.62
1.59
1.57
1.46
1.43
1.42
1.40
1.39
1.14
0.97
0.95
0.91
0.88
O
HO
H
H
H
H
O
1w
0.94
1.97
3.27
0.98
1.00
0.79
6.77
1.23
3.22
4.01
3.31
3.22
3.18
1.38
f1 (ppm)

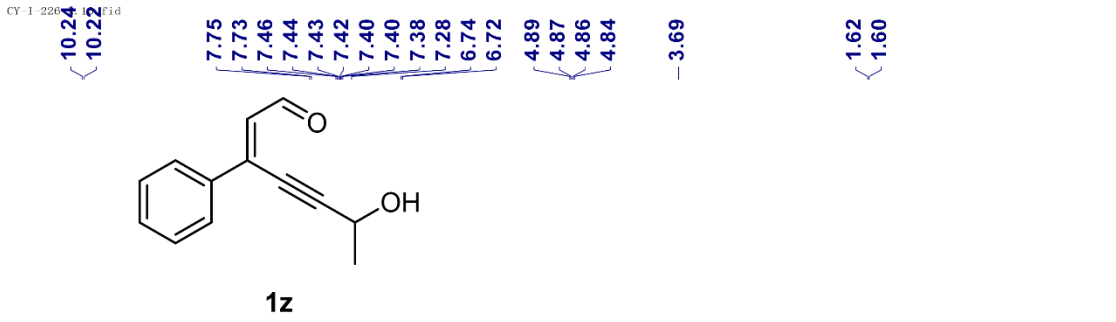

199.82
193.27
171.51
142.46
135.53
131.16
131.00
128.84
127.17
123.82
107.12
80.69
80.22
77.59
77.27
76.95
53.55
50.79
47.59
39.17
38.61
36.20
35.57
33.83
33.08
32.71
31.55
23.27
20.75
17.37
12.95
O
HO
H
H
H
H
O
1w
f1 (ppm)


10.16
10.14
7.65
7.65
7.65
7.64
7.63
7.63
7.33
7.33
7.32
7.32
7.31
7.30
7.29
7.27
7.27
7.26
6.64
6.62
4.40
1.62
O
OH
1x
0.95
2.02
3.12
1.00
0.88
6.09
f1 (ppm)

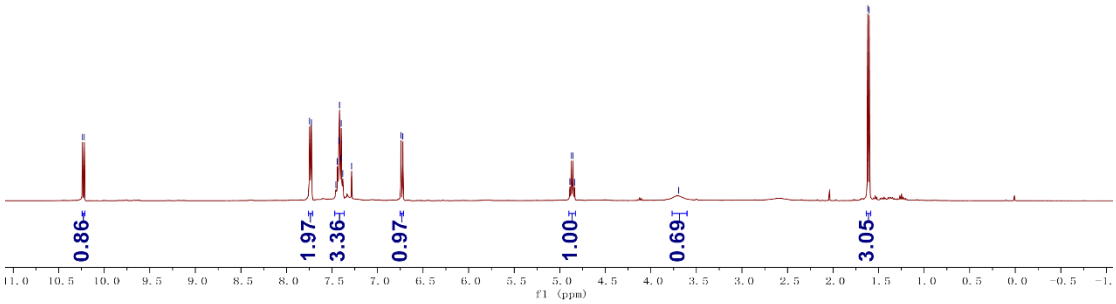

193.78
142.71
135.16
131.20
130.82
128.79
127.16
107.94
77.68
77.36
77.04
76.62
65.42
31.11
O
OH
1x
f1 (ppm)

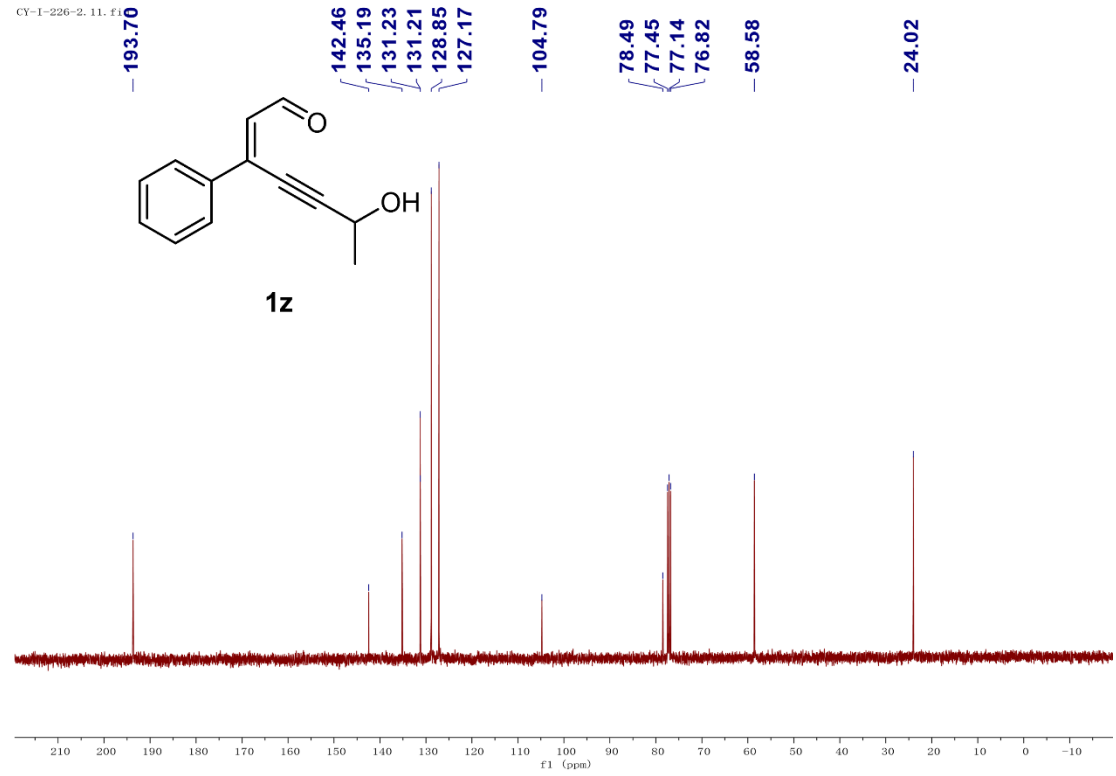

10.24
10.22
9.62
9.60
7.74
7.72
7.67
7.66
7.43
7.42
7.42
7.40
7.39
7.39
7.38
7.36
7.32
7.32
7.32
7.30
7.29
7.29
7.29
7.24
6.74
6.73
3.49
1.91
O
OH
Ph
1y (major)
0.88
0.06
2.02
1.95
5.41
1.32
1.00
0.79
2.99
f1 (ppm)


193.27
192.46
144.69
142.13
135.33
131.60
131.26
128.94
128.64
128.13
127.21
124.81
105.99
79.42
77.38
77.12
76.87
70.52
33.00
O
OH
Ph
1y (major)
f1 (ppm)

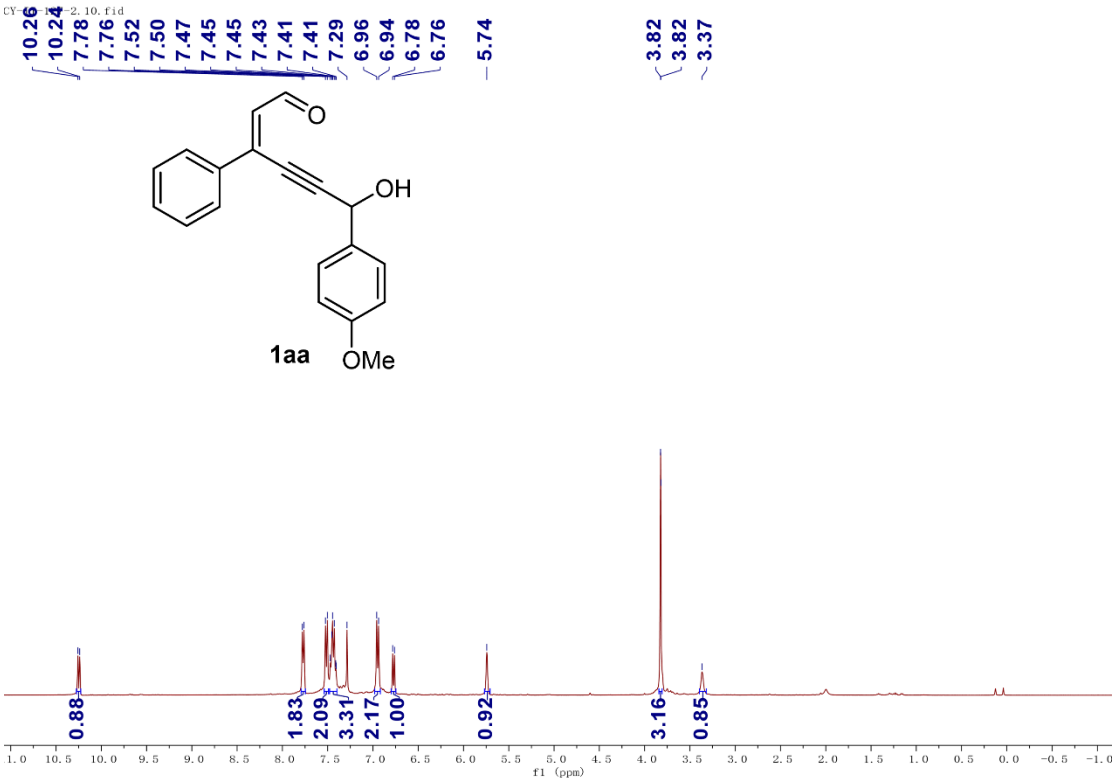

10.24
10.22
7.75
7.73
7.46
7.44
7.43
7.42
7.40
7.40
7.38
7.28
6.74
6.72
4.89
4.87
4.86
4.84
3.69
1.62
1.60
O
OH

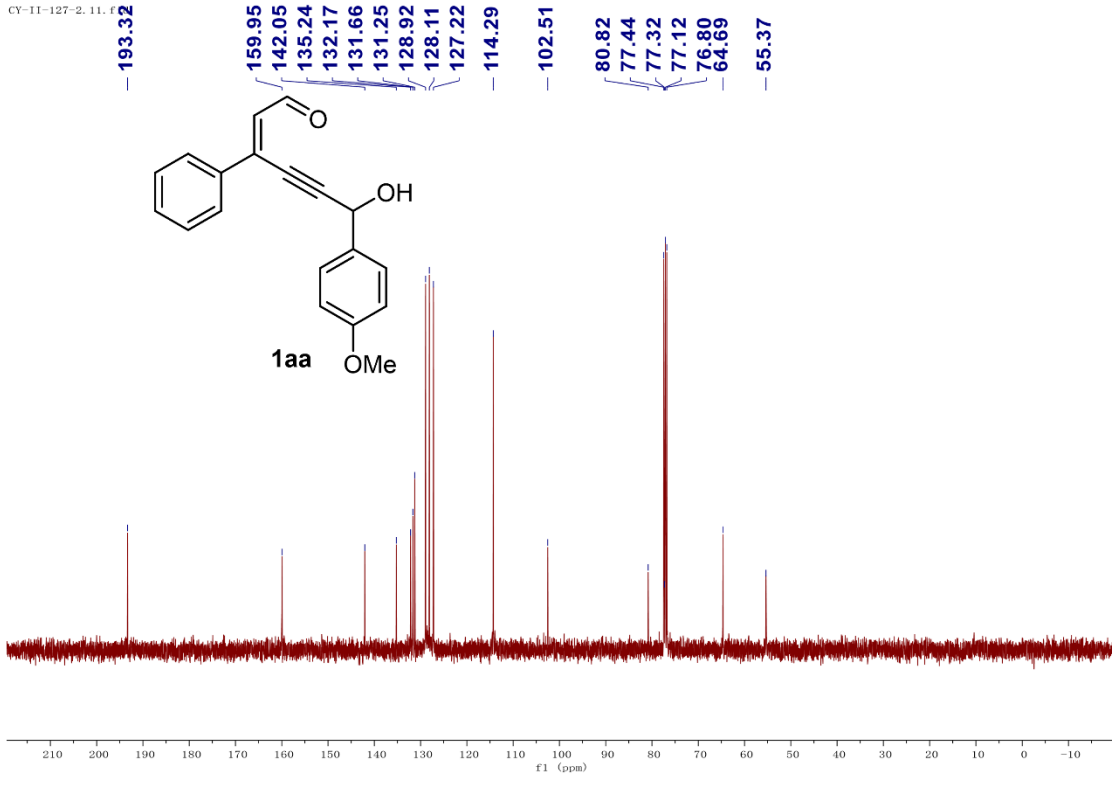
1z


0.86
1.97
3.36
0.97
1.00
0.69
3.05
f1 (ppm)

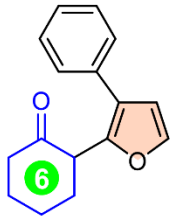

193.70
142.46
135.19
131.23
131.21
128.85
127.17
104.79
78.49
77.45
77.14
76.82
58.58
24.02
O
OH
f1 (ppm)

1z

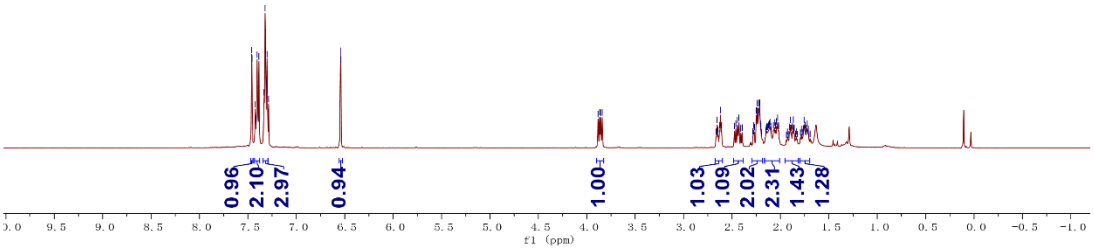

10.26
10.24
7.78
7.76
7.52
7.50
7.47
7.45
7.45
7.43
7.41
7.41
7.29
6.96
6.94
6.78
6.76
5.74
3.82
3.82
3.37
O
OH
1aa
OMe
0.88
1.83
2.09
3.31
2.17
1.00
0.92
3.16
0.85
f1 (ppm)

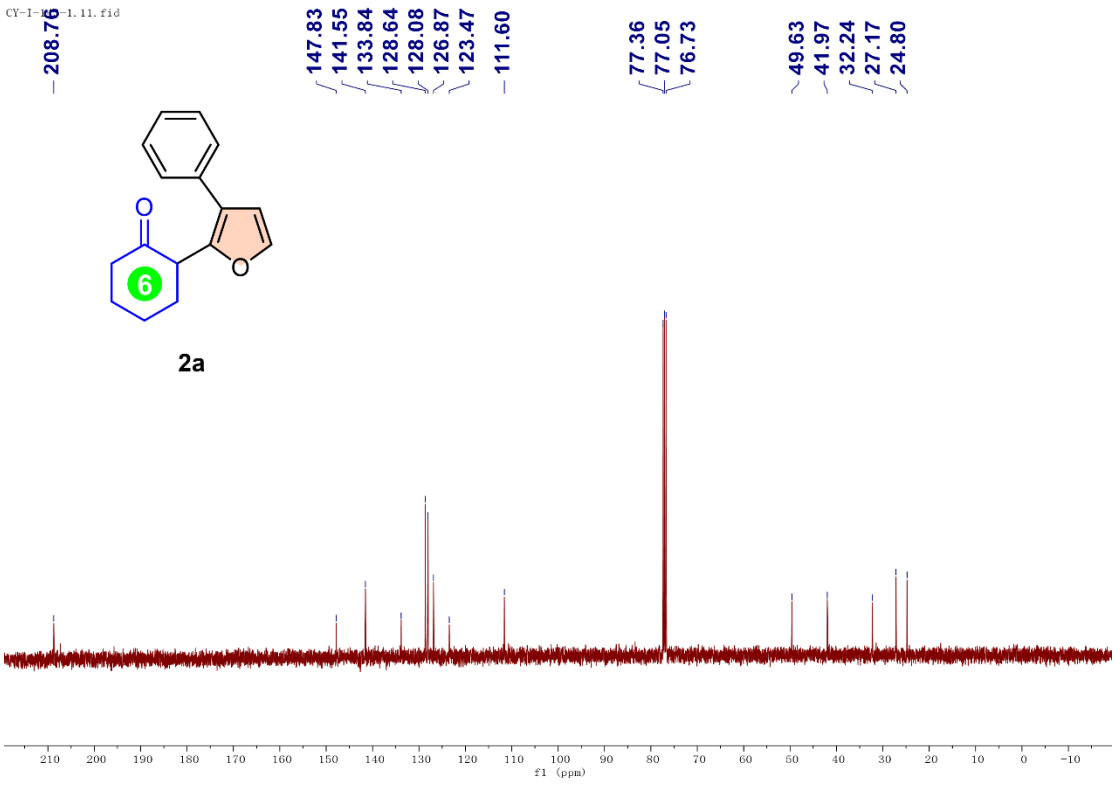

193.32
159.95
142.05
135.24
132.17
131.66
131.25
128.92
128.11
127.22
114.29
102.51
80.82
77.44
77.32
77.12
76.80
64.69
55.37
O
OH
1aa
OMe
f1 (ppm)


7.46
7.46
7.42
7.42
7.40
7.39
7.33
7.32
7.32
7.31
7.30
7.29
6.54
6.54
3.88
3.87
3.86
3.84
2.65
2.62
2.46
2.44
2.43
2.25
2.24
2.23
2.23
2.22
2.22
2.21
2.21
2.12
2.11
2.11
2.07
2.06
2.04
2.03
1.90
1.87
1.76
1.75
1.72


O
O
6

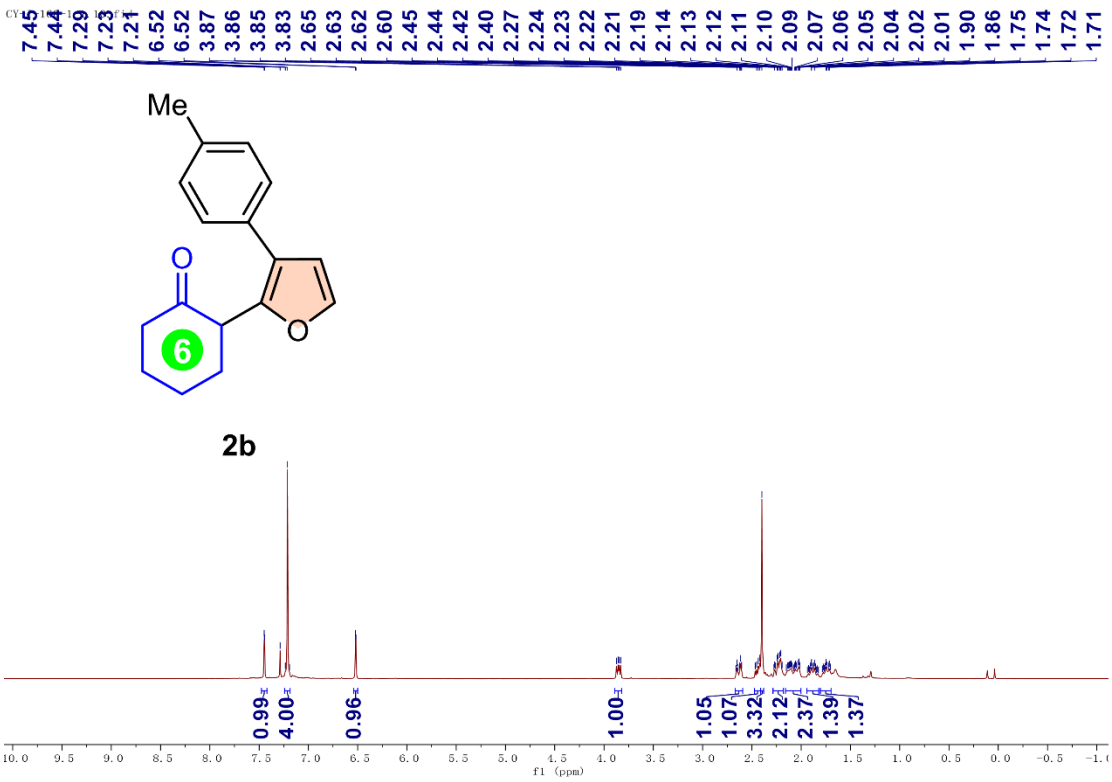
**2a**

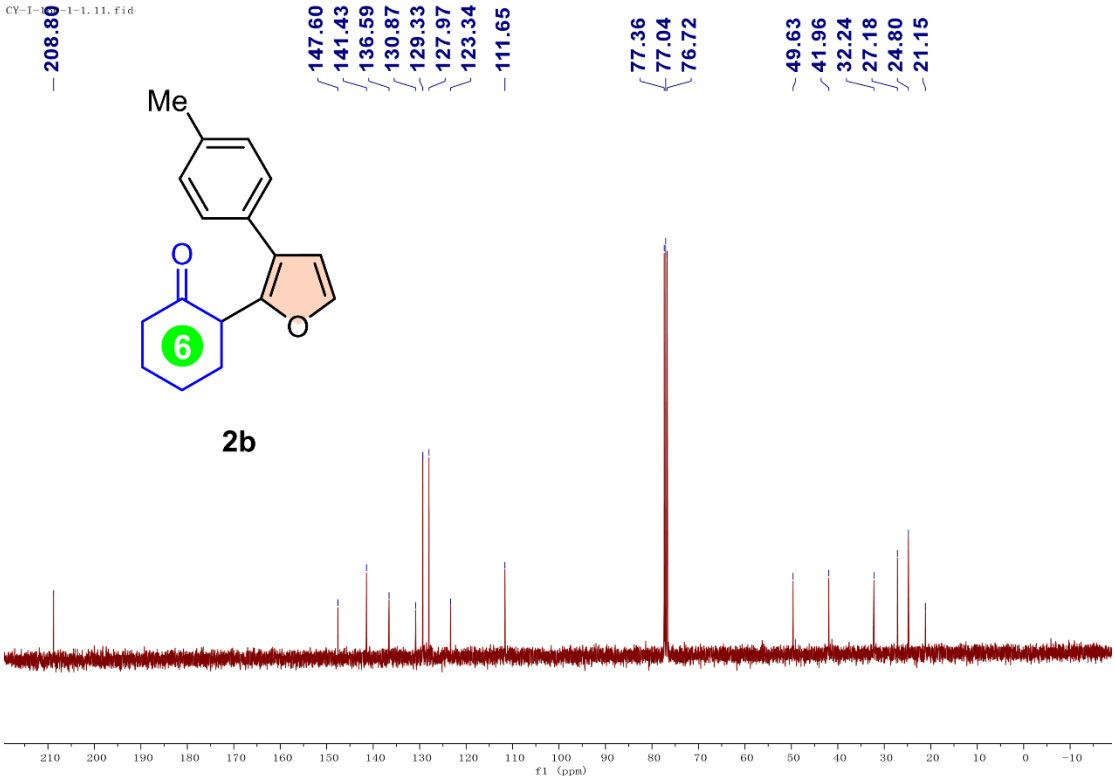

0.96
2.10
2.97
0.94
1.00
1.03
1.09
2.02
2.31
1.43
1.28
f1 (ppm)

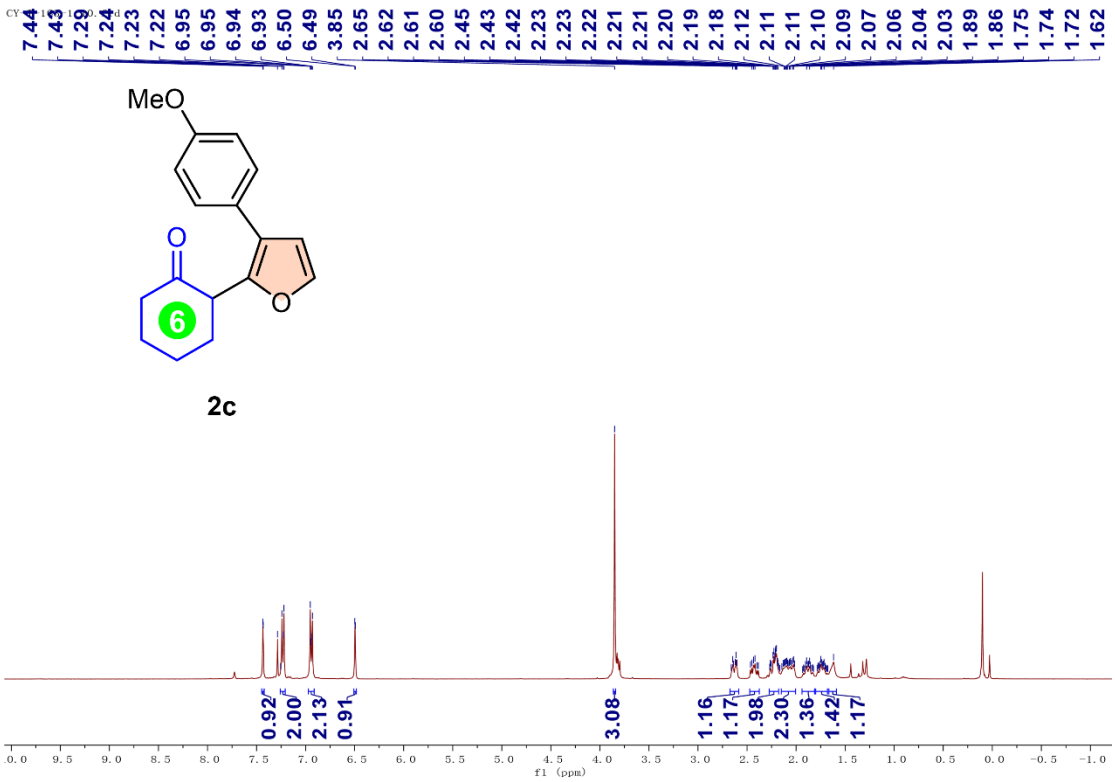

208.76
147.83
141.55
133.84
128.64
128.08
126.87
123.47
111.60
77.36
77.05
76.73
49.63
41.97
32.24
27.17
24.80
f1 (ppm)


O
O
6

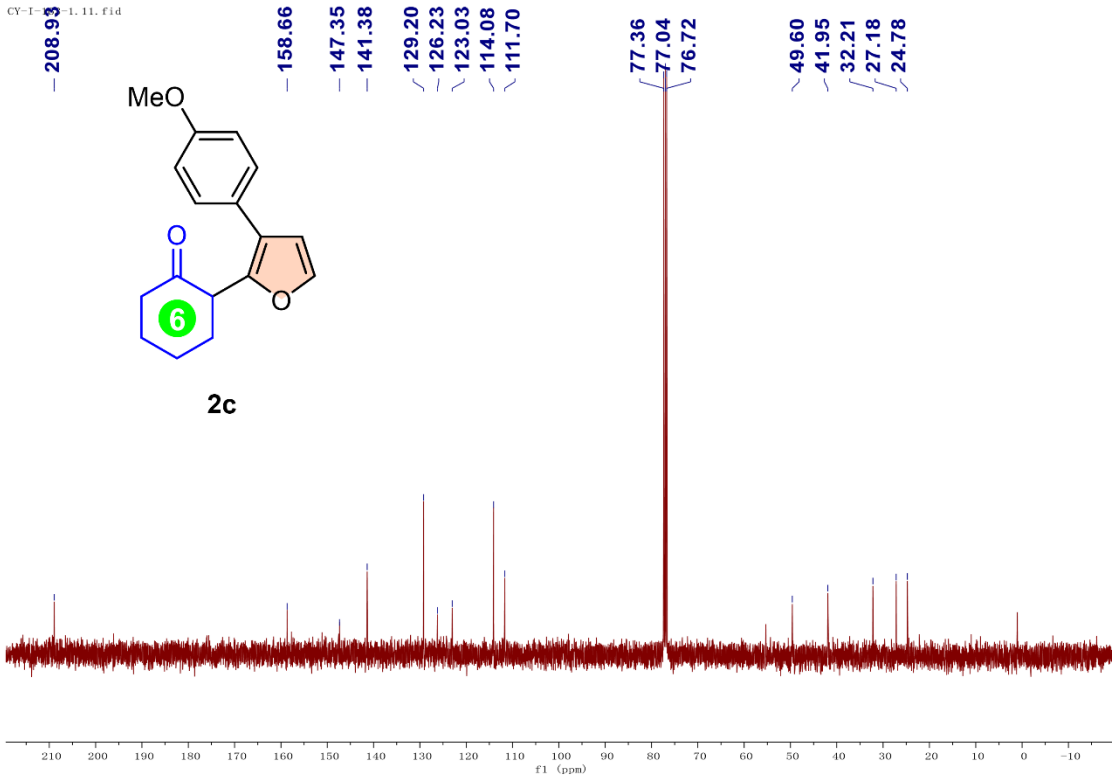
**2a**


7.45
7.44
7.29
7.23
7.21
6.52
6.52
3.87
3.86
3.85
3.83
2.65
2.63
2.62
2.60
2.45
2.44
2.42
2.40
2.27
2.24
2.23
2.22
2.21
2.19
2.14
2.13
2.12
2.11
2.10
2.09
2.07
2.06
2.05
2.04
2.02
2.01
1.90
1.86
1.75
1.74
1.72
1.71
Me
O
O
6
2b
0.99
4.00
0.96
1.00
1.05
1.07
3.32
2.12
2.37
1.39
1.37
f1 (ppm)

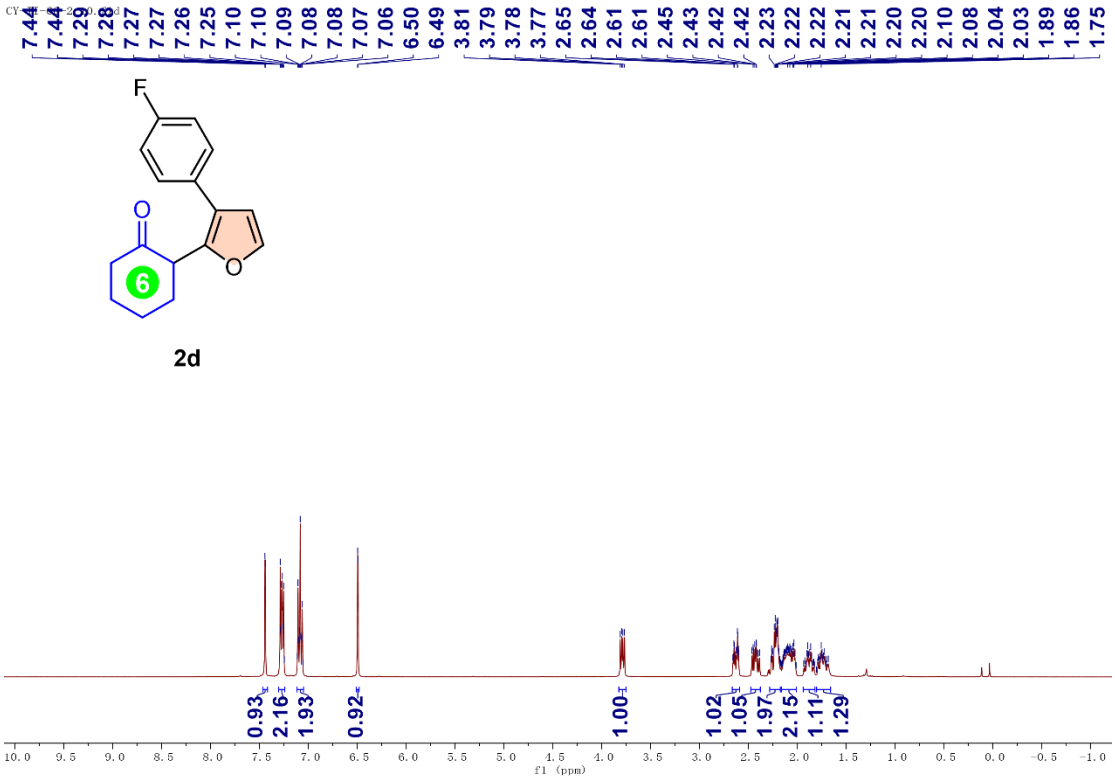

208.80
147.60
141.43
136.59
130.87
129.33
127.97
123.34
111.65
77.36
77.04
76.72
49.63
41.96
32.24
27.18
24.80
21.15
Me
O
O
6
2b
f1 (ppm)

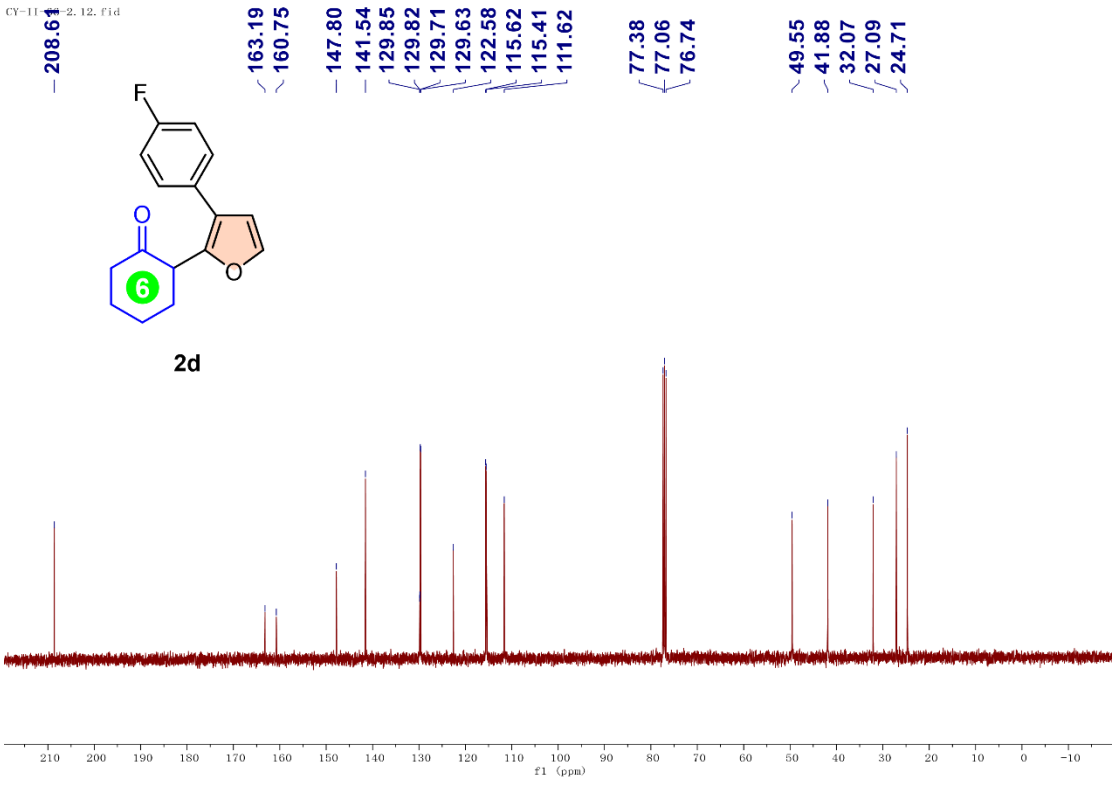

7.44
7.43
7.29
7.24
7.23
7.22
6.95
6.95
6.94
6.93
6.50
6.49
3.85
2.65
2.62
2.61
2.60
2.45
2.43
2.42
2.23
2.23
2.22
2.21
2.21
2.20
2.19
2.18
2.12
2.11
2.11
2.10
2.09
2.07
2.06
2.04
2.03
1.89
1.86
1.75
1.74
1.72
1.62
MeO
O
O
6
0.92
2.00
2.13
0.91
3.08
1.16
1.17
1.98
2.30
1.36
1.42
1.17
f1 (ppm)

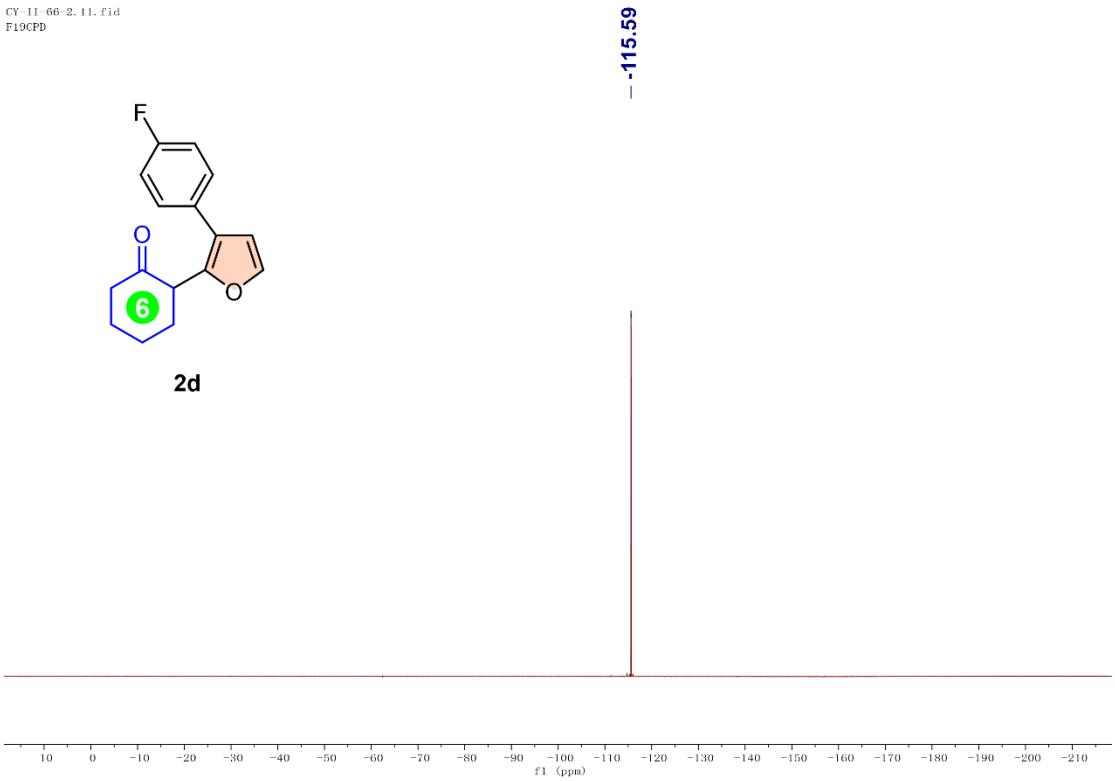
**2c**

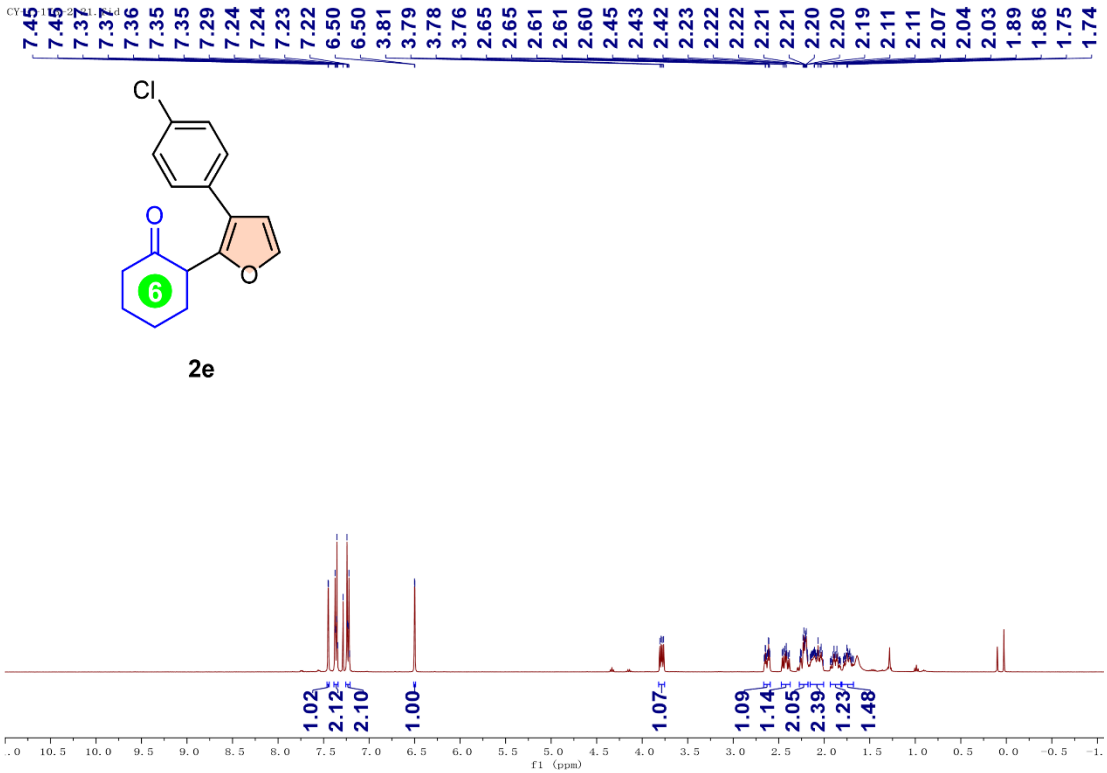

208.93
158.66
147.35
141.38
129.20
126.23
123.03
114.08
111.70
77.36
77.04
76.72
49.60
41.95
32.21
27.18
24.78
MeO
O
O
6
f1 (ppm)

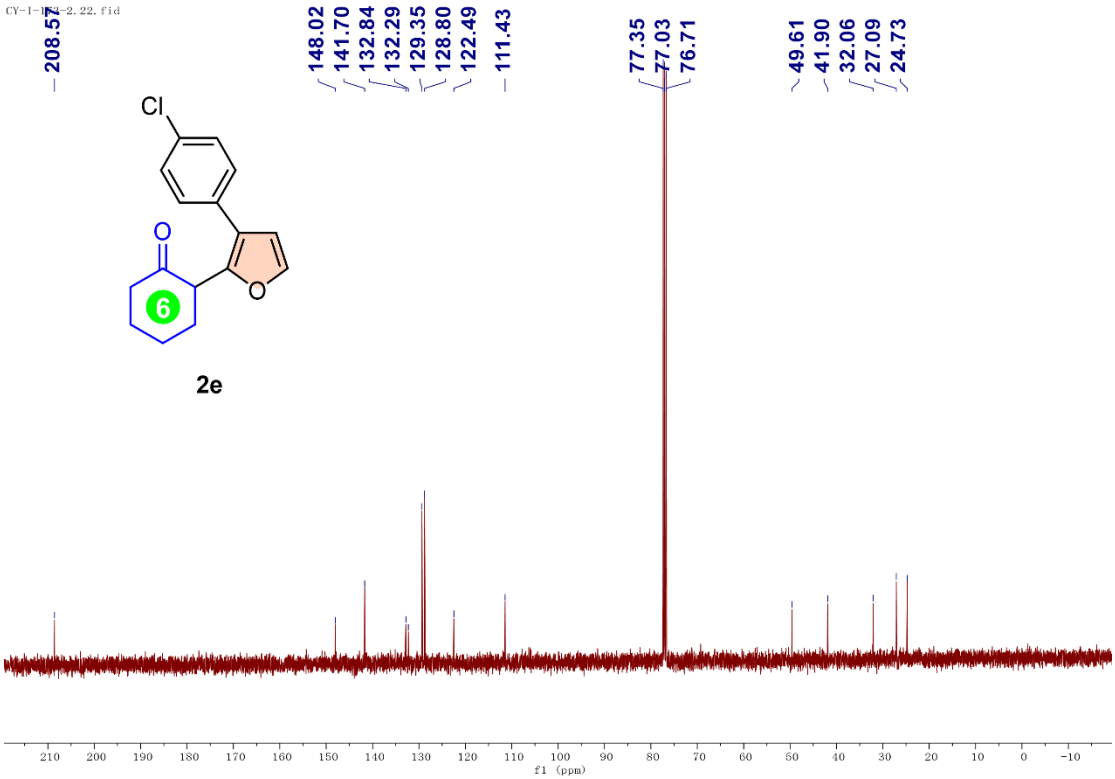
**2c**

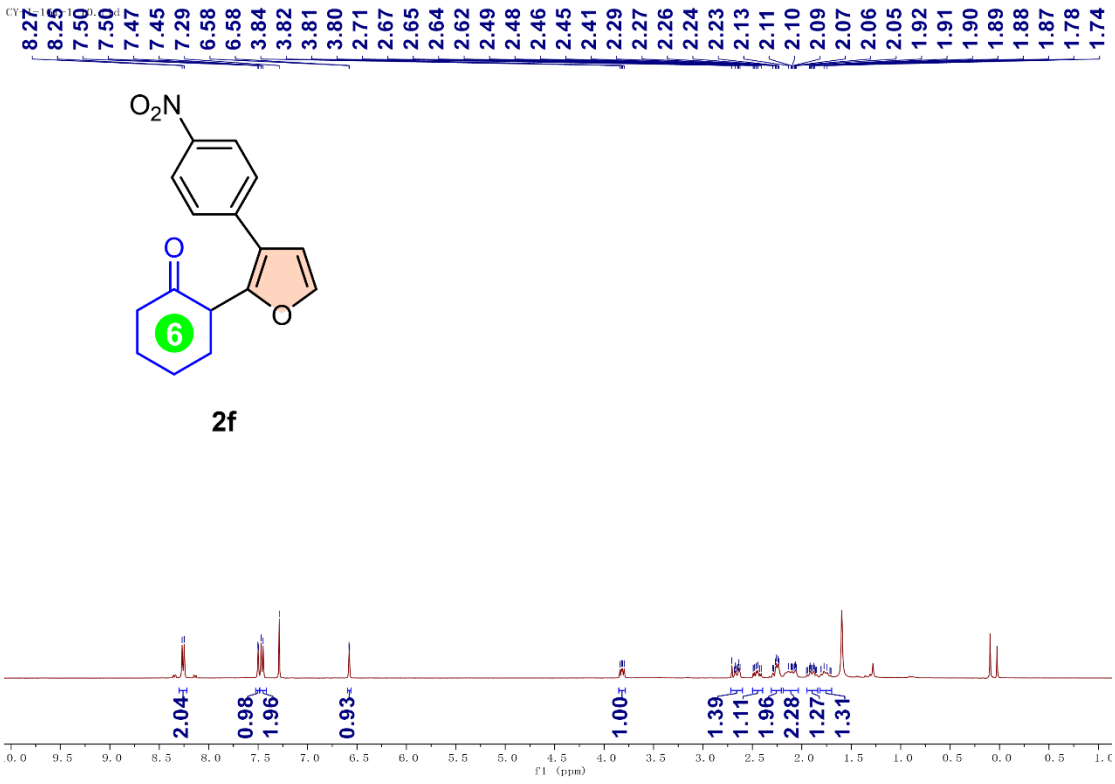

7.44
7.44
7.29
7.28
7.27
7.27
7.26
7.25
7.10
7.10
7.09
7.08
7.08
7.07
7.06
6.50
6.49
3.81
3.79
3.78
3.77
2.65
2.64
2.61
2.61
2.45
2.43
2.42
2.42
2.23
2.22
2.22
2.21
2.21
2.20
2.20
2.10
2.08
2.04
2.03
1.89
1.86
1.75
F
O
O
6
2d
0.93
2.16
1.93
0.92
1.00
1.02
1.05
1.97
2.15
1.11
1.29
f1 (ppm)

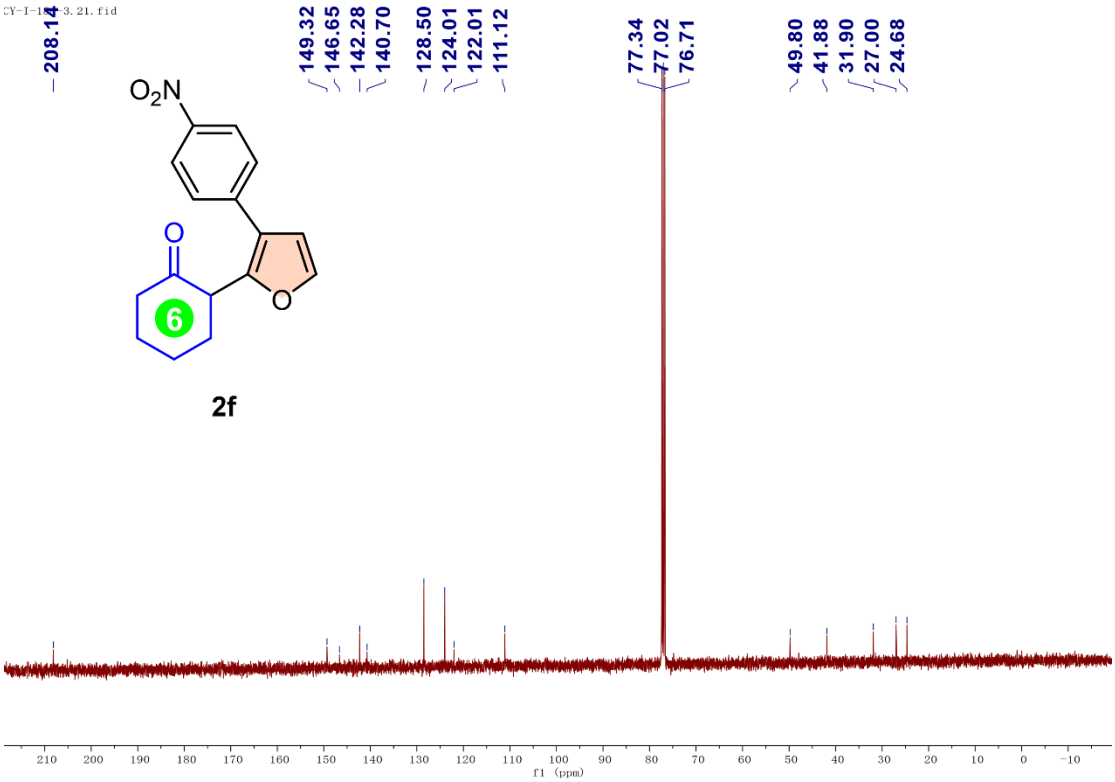

208.61
163.19
160.75
147.80
141.54
129.85
129.82
129.71
129.63
122.58
115.62
115.41
111.62
77.38
77.06
76.74
49.55
41.88
32.07
27.09
24.71
F
O
O
6
2d
f1 (ppm)

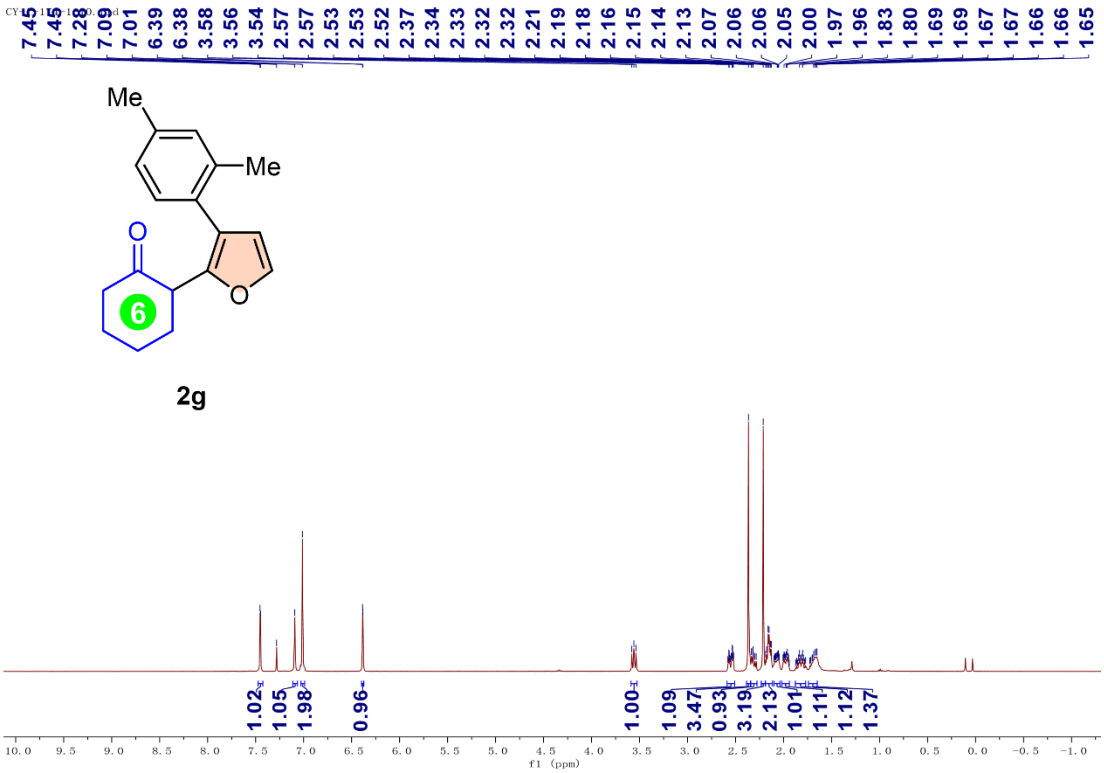

CY-II-66-2.11.fid
F19CPD
-115.59
F
O
O
6
2d
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


7.45 7.45 7.37 7.37 7.36 7.35 7.35 7.29 7.24 7.24 7.23 7.22 6.50 6.50 3.81 3.79 3.78 3.76 2.65 2.65 2.61 2.61 2.60 2.45 2.43 2.42 2.23 2.22 2.22 2.21 2.21 2.20 2.20 2.19 2.11 2.11 2.07 2.04 2.03 1.89 1.86 1.75 1.74
Cl
O
O
6
2e
1.02 2.12 2.10 1.00 1.07 1.09 1.14 2.05 2.39 1.23 1.48
f1 (ppm)

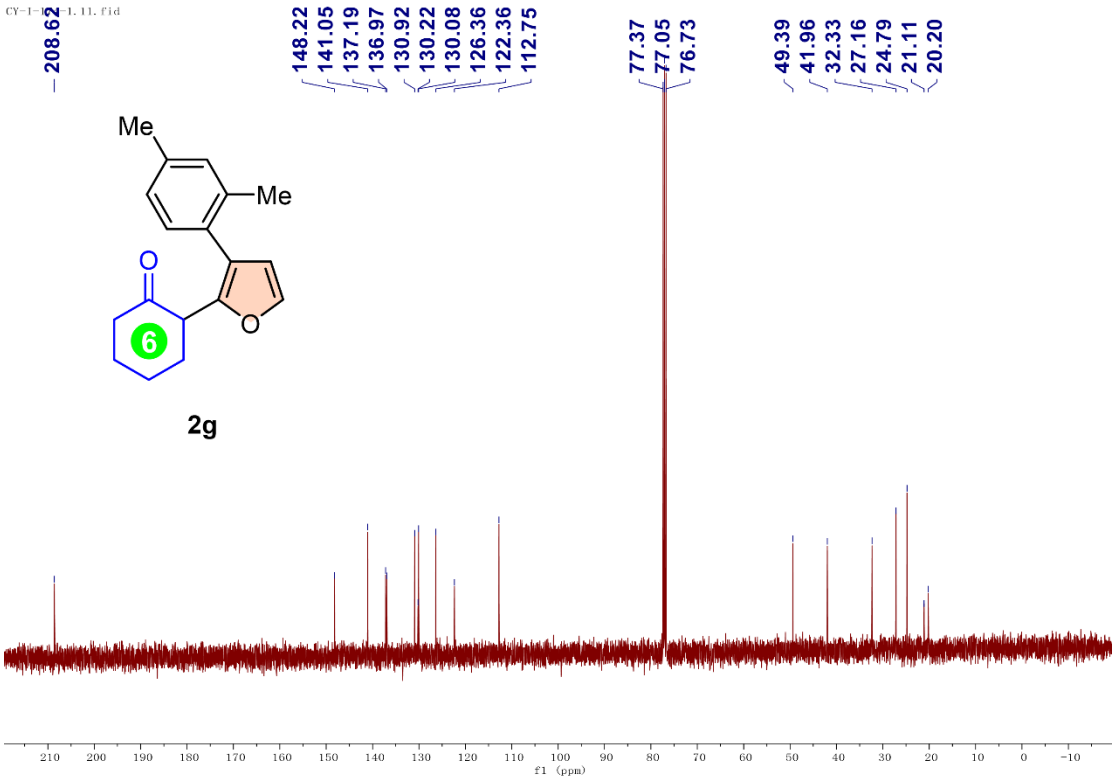

208.57
148.02 141.70 132.84 132.29 129.35 128.80 122.49 111.43
77.35 77.03 76.71
49.61 41.90 32.06 27.09 24.73
Cl
O
O
6
2e
f1 (ppm)


8.27
8.25
7.50
7.50
7.47
7.45
7.29
6.58
6.58
3.84
3.82
3.81
3.80
2.71
2.67
2.65
2.64
2.62
2.49
2.48
2.46
2.45
2.41
2.29
2.27
2.26
2.24
2.23
2.13
2.11
2.10
2.09
2.07
2.06
2.05
1.92
1.91
1.90
1.89
1.88
1.87
1.78
1.74
O2N
O
O
6
2f
2.04
0.98
1.96
0.93
1.00
1.39
1.11
1.96
2.28
1.27
1.31
f1 (ppm)


208.14
149.32
146.65
142.28
140.70
128.50
124.01
122.01
111.12
77.34
77.02
76.71
49.80
41.88
31.90
27.00
24.68
O2N
O
O
6
2f
f1 (ppm)

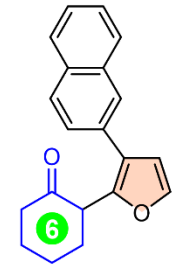

7.45
7.45
7.28
7.09
7.01
6.39
6.38
3.58
3.56
3.54
2.57
2.57
2.53
2.53
2.52
2.37
2.34
2.33
2.32
2.32
2.21
2.19
2.18
2.16
2.15
2.14
2.13
2.07
2.06
2.06
2.05
2.00
1.97
1.96
1.83
1.80
1.69
1.69
1.67
1.67
1.66
1.66
1.65
Me
Me
O
O
6
1.02
1.05
1.98
0.96
1.00
1.09
3.47
0.93
3.19
2.13
1.01
1.11
1.12
1.37
f1 (ppm)

**2g**

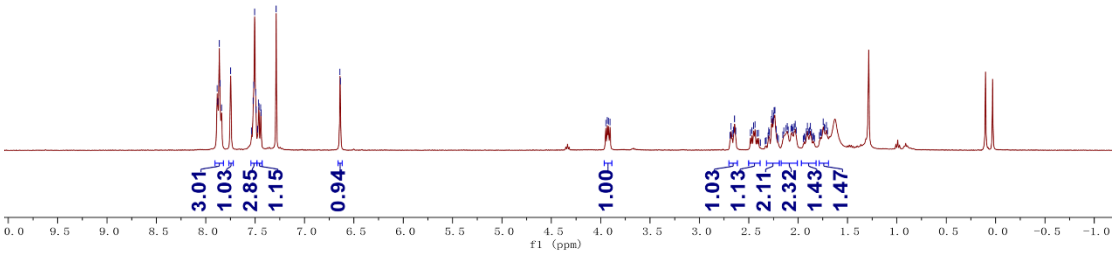

208.62
148.22
141.05
137.19
136.97
130.92
130.22
130.08
126.36
122.36
112.75
77.37
77.05
76.73
49.39
41.96
32.33
27.16
24.79
21.11
20.20
Me
Me
O
O
6
f1 (ppm)

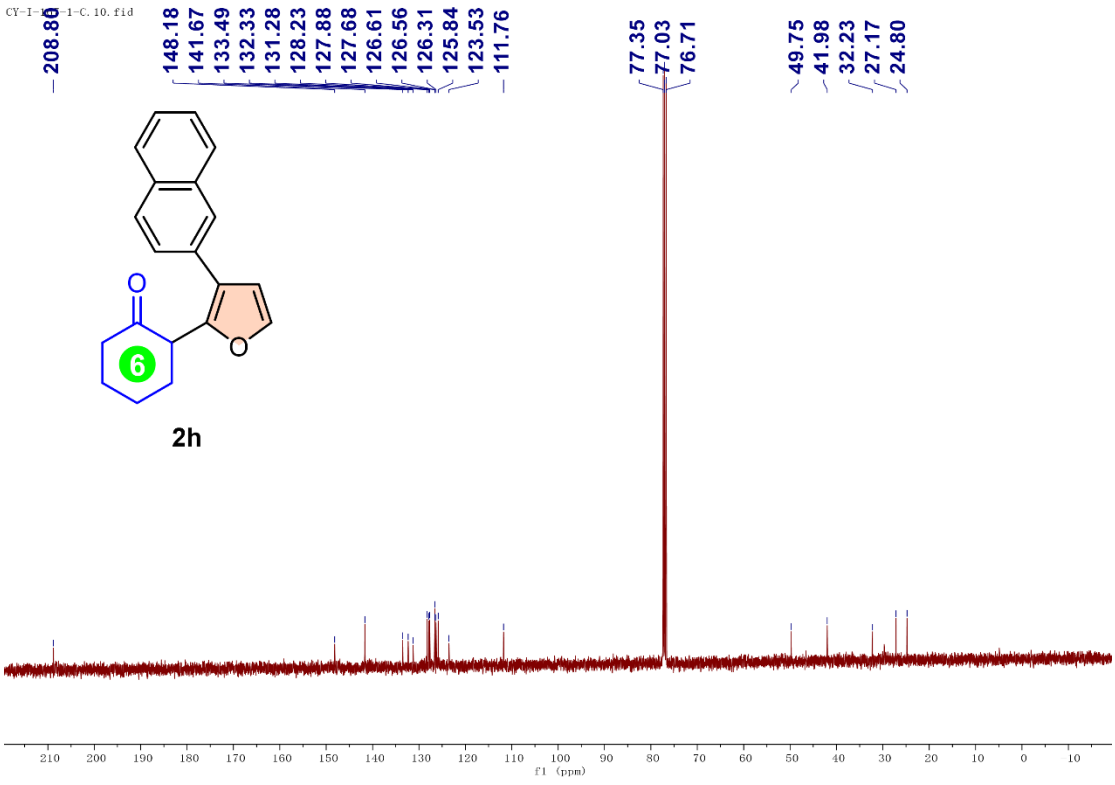
**2g**


7.89
7.88
7.86
7.86
7.84
7.75
7.52
7.51
7.51
7.49
7.49
7.46
7.44
7.44
7.29
6.64
6.64
3.95
3.93
3.92
3.91
2.68
2.64
2.45
2.44
2.27
2.26
2.25
2.25
2.24
2.23
2.12
2.11
2.06
2.04
2.03
1.91
1.88
1.75
1.74
1.73
1.71


O
O
6

**2h**

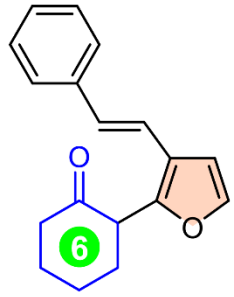

3.01
1.03
2.85
1.15
0.94
1.00
1.03
1.13
2.11
2.32
1.43
1.47
f1 (ppm)


208.80
148.18
141.67
133.49
132.33
131.28
128.23
127.88
127.68
126.61
126.56
126.31
125.84
123.53
111.76
77.35
77.03
76.71
49.75
41.98
32.23
27.17
24.80
f1 (ppm)

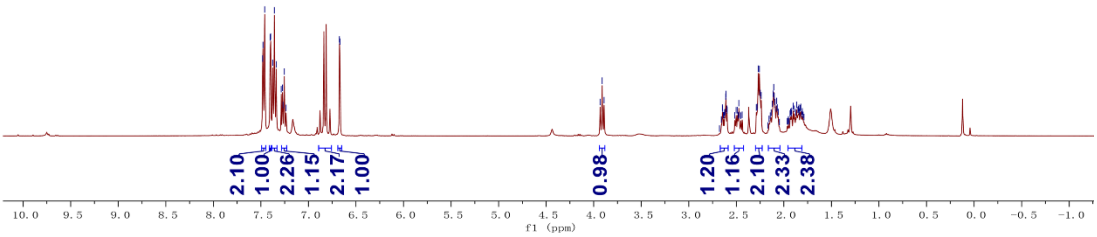

O
O
6

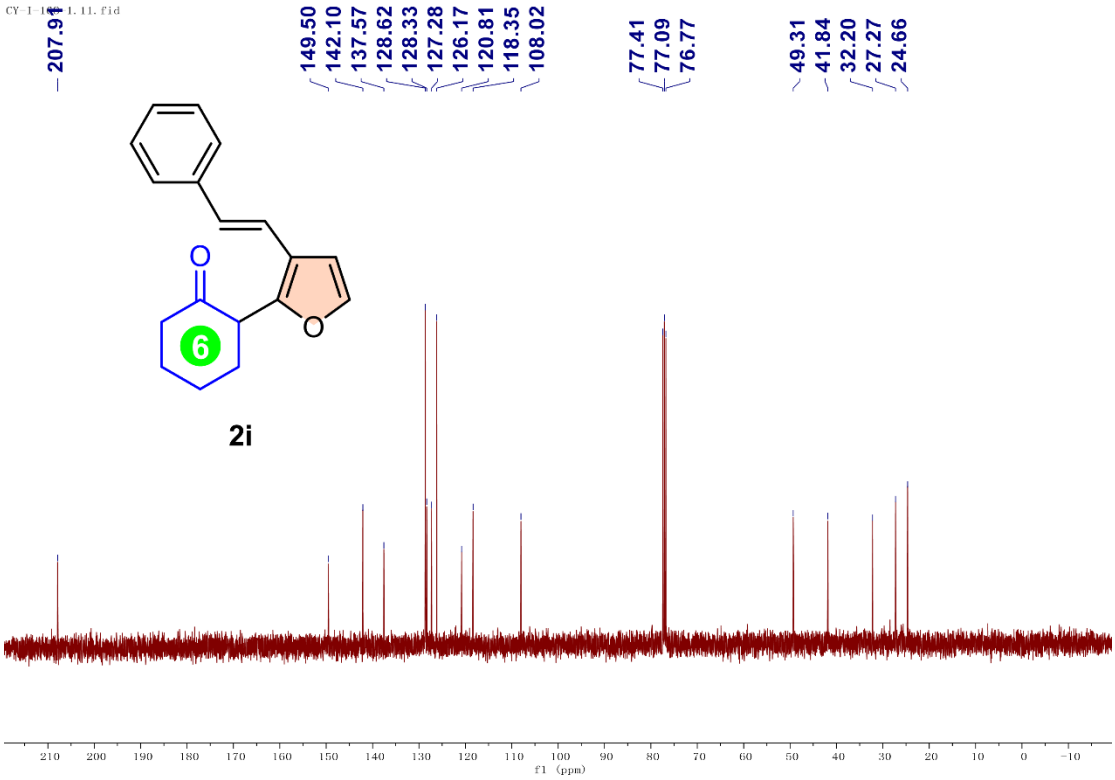
**2h**


7.48
7.48
7.46
7.40
7.40
7.38
7.36
7.34
7.29
7.27
7.27
7.25
7.24
6.67
6.67
3.93
3.91
3.89
2.65
2.61
2.61
2.60
2.47
2.29
2.28
2.27
2.26
2.25
2.24
2.12
2.11
2.11
2.10
2.09
2.08
2.08
2.07
1.90
1.89
1.87
1.84
1.83
1.82


O
6
O

**2i**

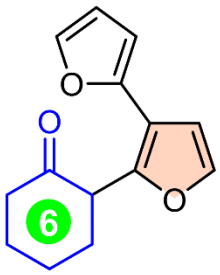

2.10
1.00
2.26
1.15
2.17
1.00
0.98
1.20
1.16
2.10
2.33
2.38
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


207.94
149.50
142.10
137.57
128.62
128.33
127.28
126.17
120.81
118.35
108.02
77.41
77.09
76.77
49.31
41.84
32.20
27.27
24.66
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)

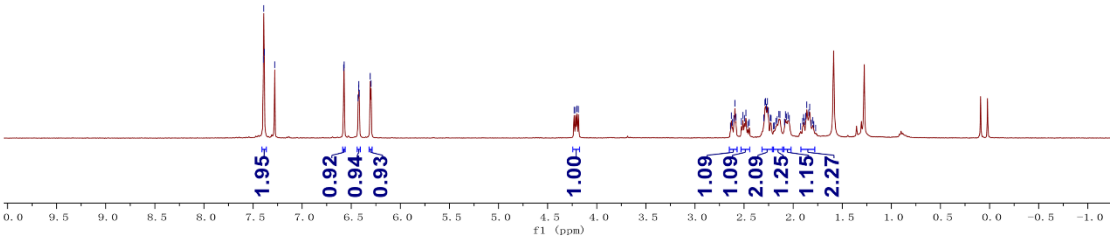

O
6
O

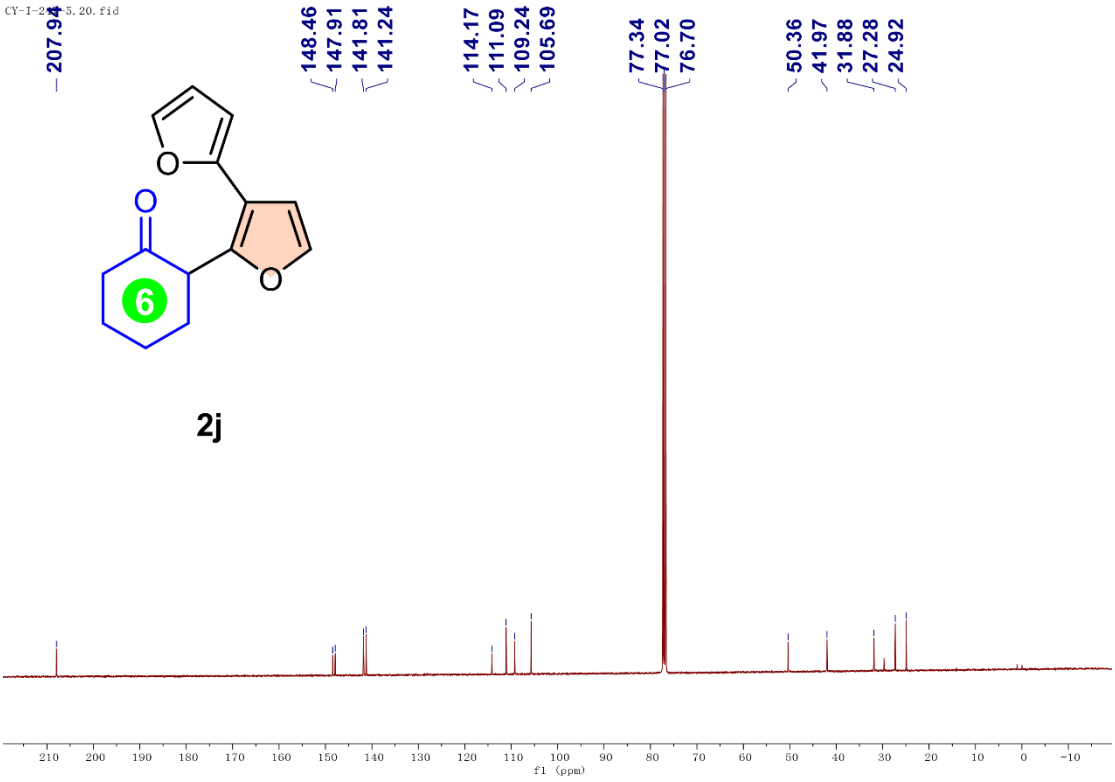
**2i**


7.40
7.39
7.39
7.28
6.58
6.57
6.43
6.43
6.42
6.42
6.31
6.30
4.23
4.22
4.20
4.19
2.63
2.60
2.59
2.58
2.51
2.50
2.48
2.30
2.29
2.28
2.27
2.26
2.25
2.23
2.22
2.16
2.15
2.13
2.08
2.07
2.05
2.04
1.89
1.87
1.86
1.84
1.83


O
O
O
6

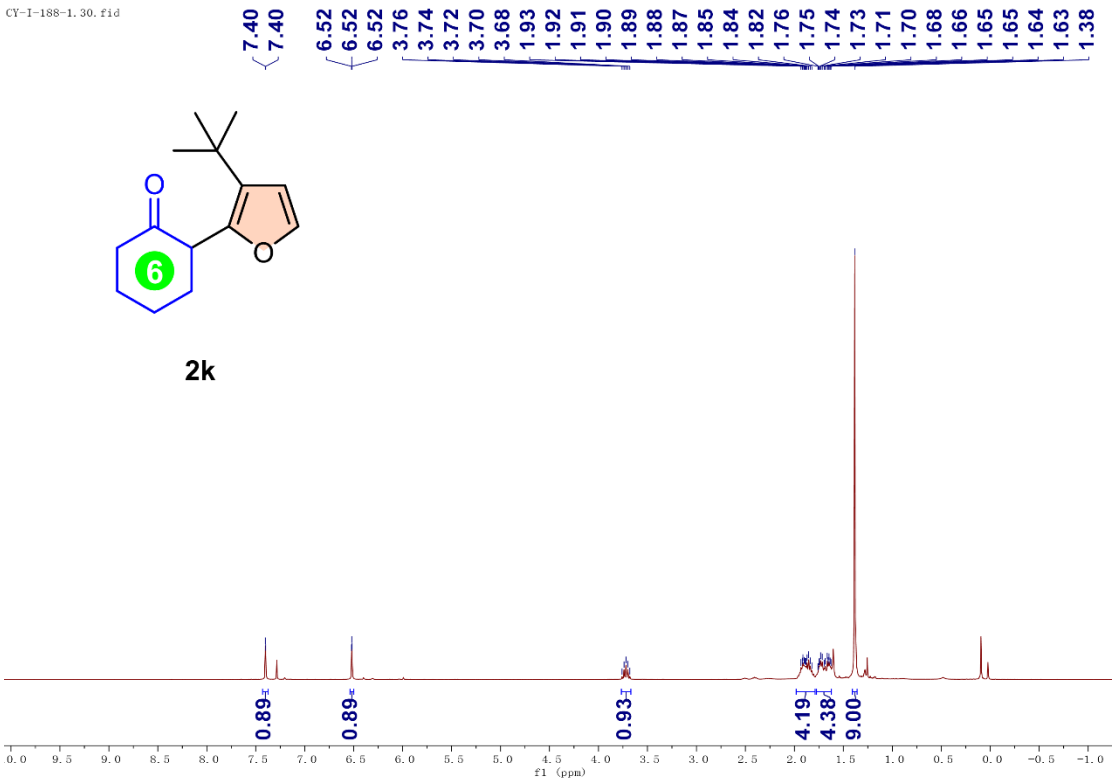
**2j**

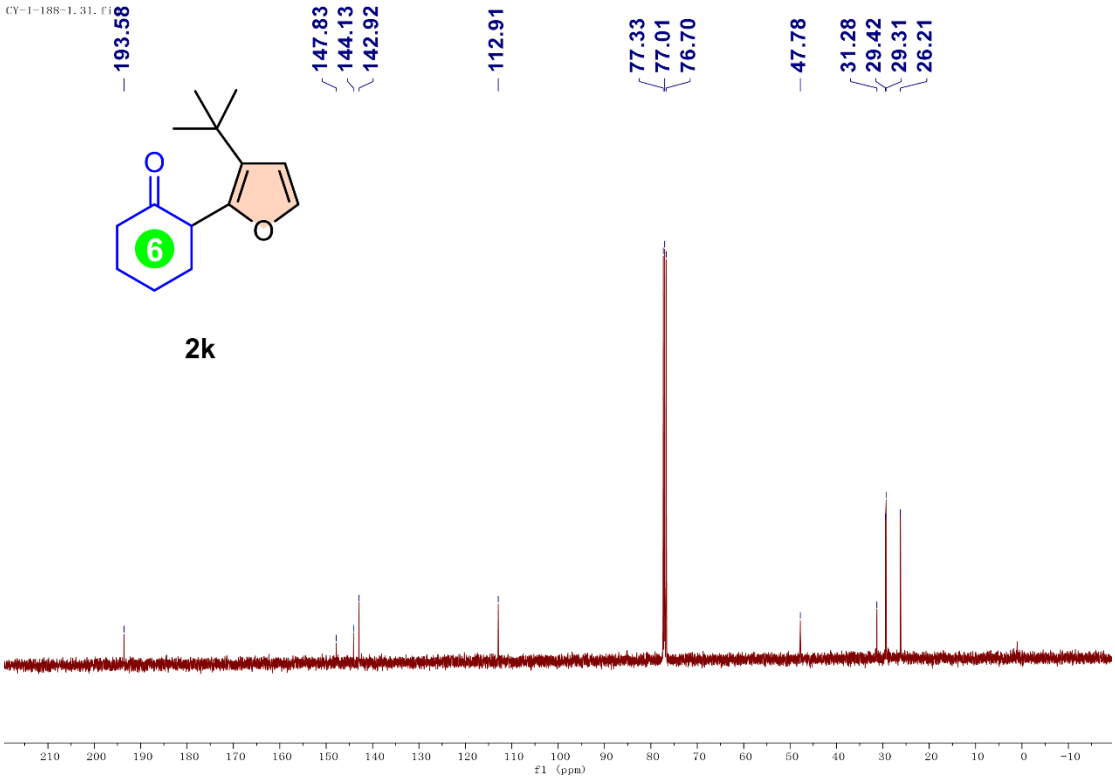

1.95
0.92
0.94
0.93
1.00
1.09
1.09
2.09
1.25
1.15
2.27
f1 (ppm)

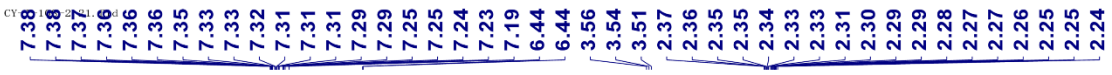

207.94
148.46
147.91
141.81
141.24
114.17
111.09
109.24
105.69
77.34
77.02
76.70
50.36
41.97
31.88
27.28
24.92
f1 (ppm)

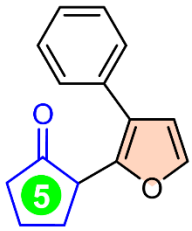

O
O
O
6

**2j**

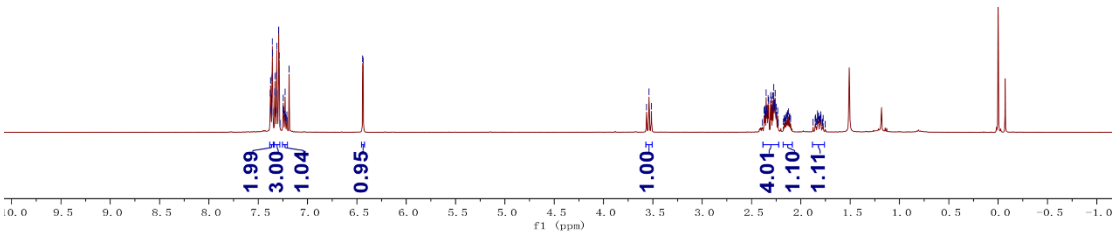

CY-I-188-1.30.fid
7.40
7.40
6.52
6.52
6.52
3.76
3.74
3.72
3.70
3.68
1.93
1.92
1.91
1.90
1.89
1.88
1.87
1.85
1.84
1.82
1.76
1.75
1.74
1.73
1.71
1.70
1.68
1.66
1.65
1.65
1.64
1.63
1.38
O
6
O
2k
0.89
0.89
0.93
4.19
4.38
9.00
f1 (ppm)

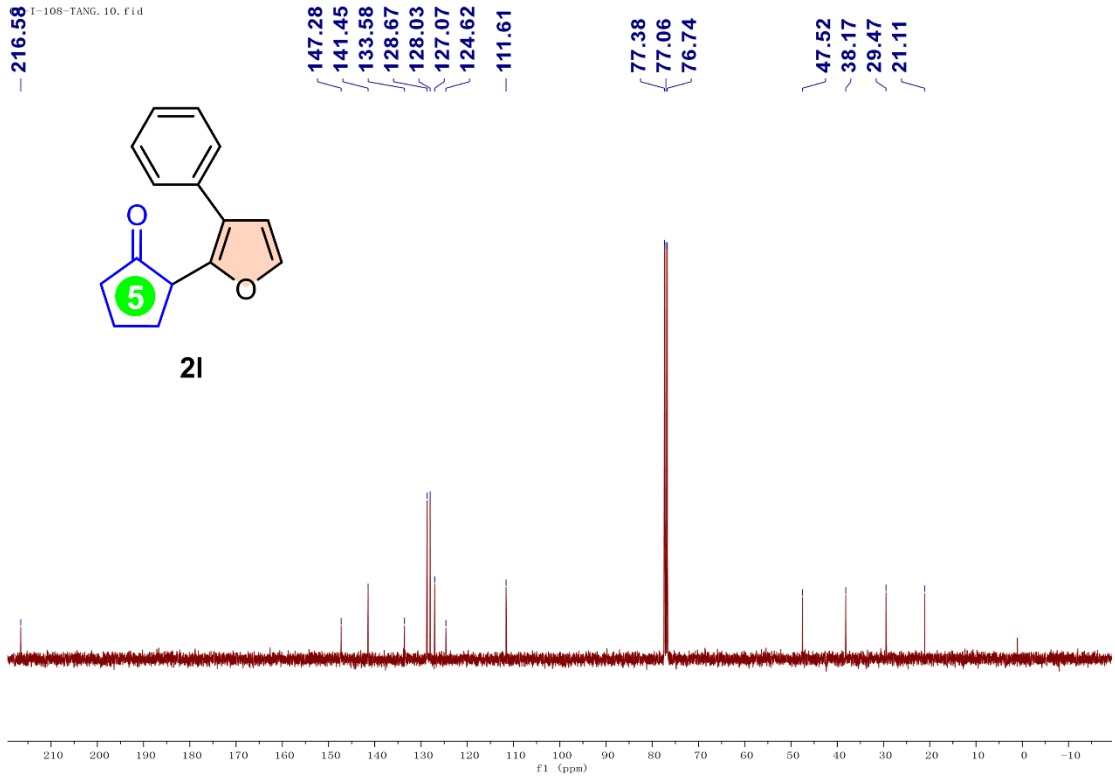

CY-I-188-1.31.fi
193.58
147.83
144.13
142.92
112.91
77.33
77.01
76.70
47.78
31.28
29.42
29.31
26.21
O
6
O
2k
f1 (ppm)


7.38
7.38
7.37
7.36
7.36
7.36
7.35
7.33
7.33
7.32
7.31
7.31
7.31
7.29
7.29
7.25
7.25
7.24
7.23
7.19
6.44
6.44
3.56
3.54
3.51
2.37
2.36
2.35
2.35
2.34
2.33
2.33
2.31
2.30
2.29
2.29
2.28
2.27
2.27
2.26
2.25
2.25
2.24


O
5
O

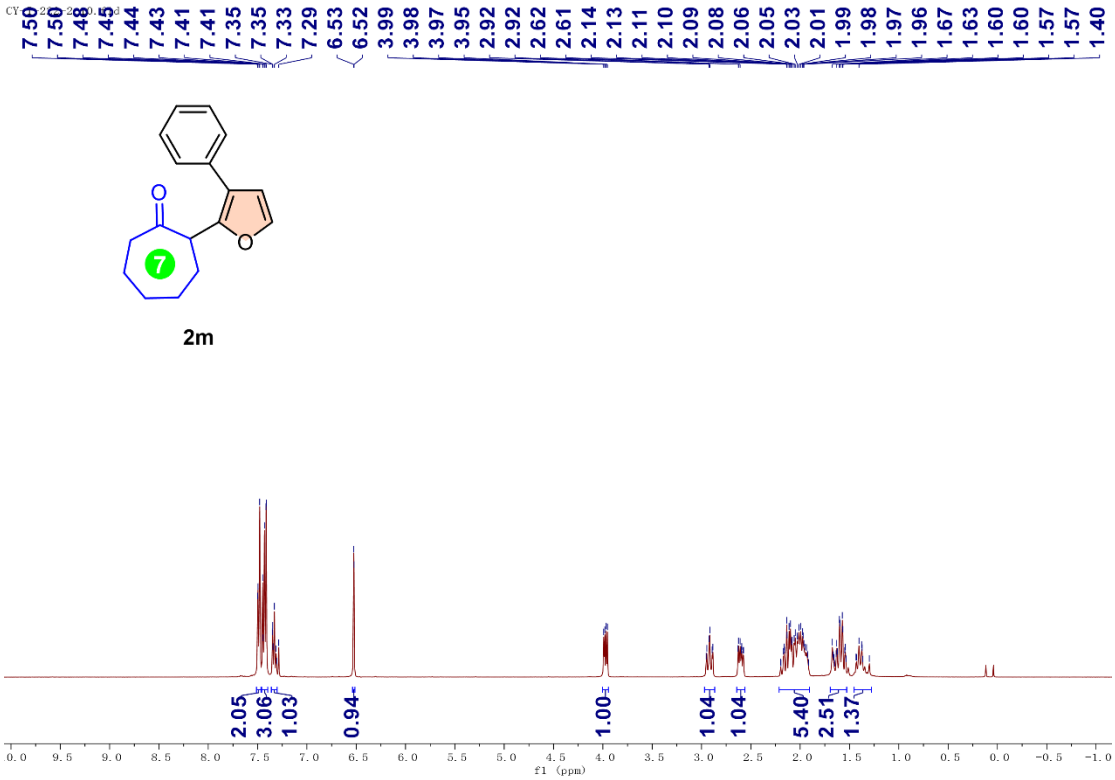
**2l**

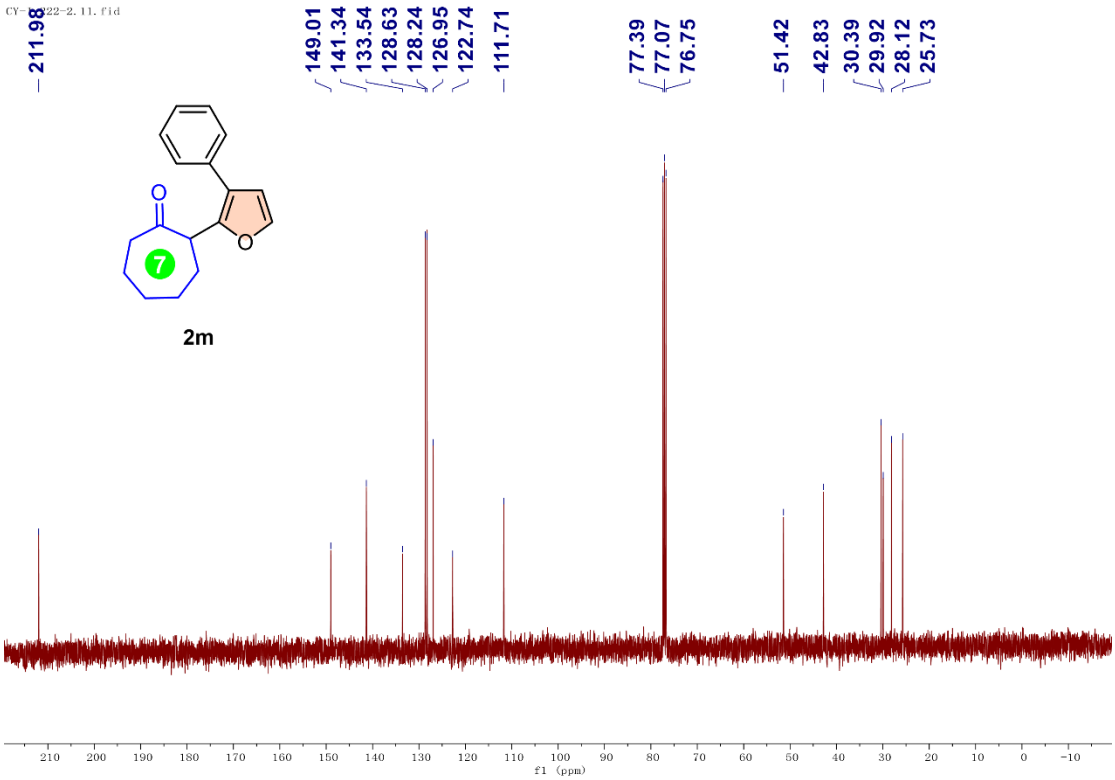

1.99
3.00
1.04
0.95
1.00
4.01
1.10
1.11
f1 (ppm)

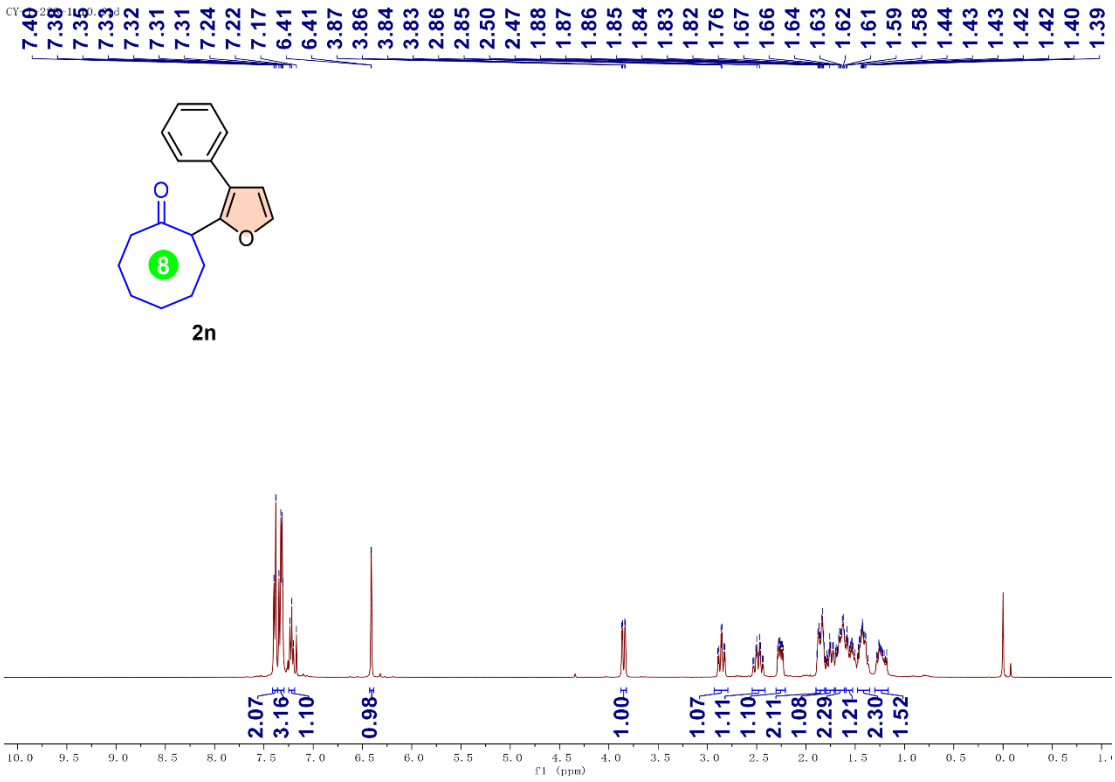

216.58
147.28
141.45
133.58
128.67
128.03
127.07
124.62
111.61
77.38
77.06
76.74
47.52
38.17
29.47
21.11
f1 (ppm)

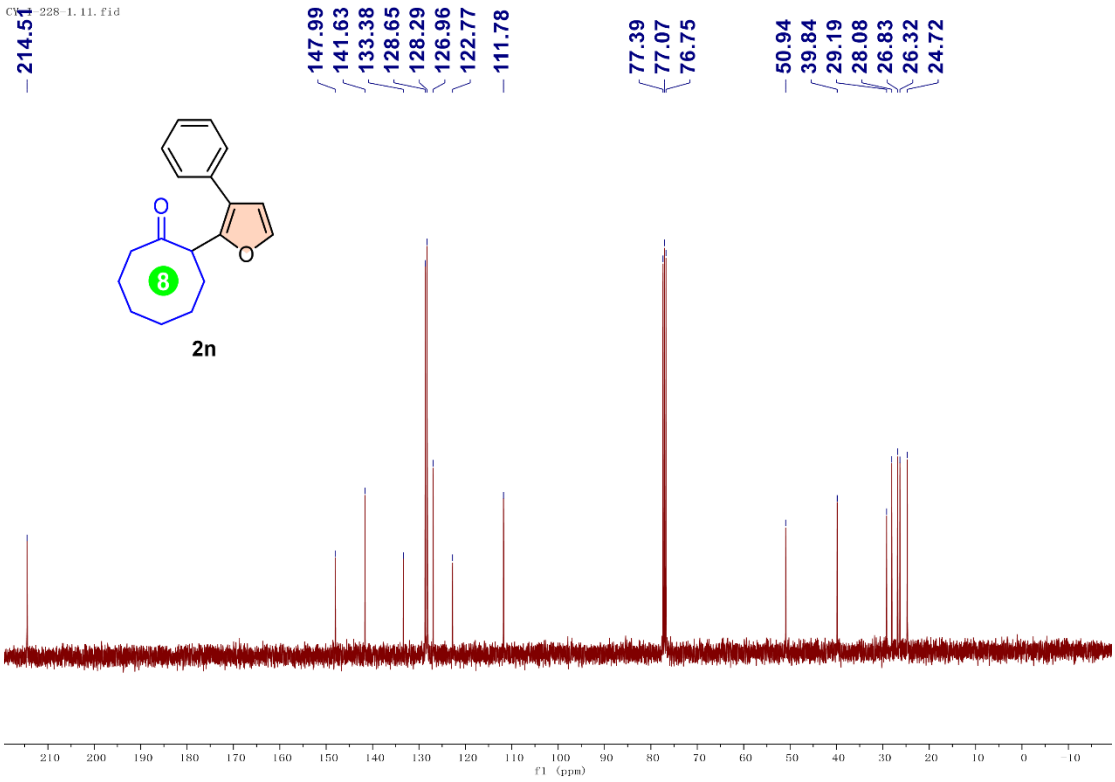

O
5
O

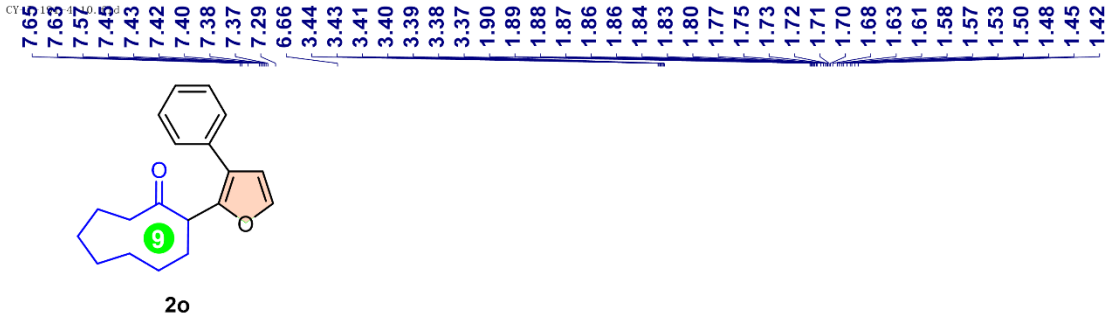
**2l**


7.50
7.50
7.48
7.45
7.44
7.43
7.41
7.41
7.35
7.35
7.33
7.29
6.53
6.52
3.99
3.98
3.97
3.95
2.92
2.92
2.62
2.61
2.14
2.13
2.11
2.10
2.09
2.08
2.06
2.05
2.03
2.01
1.99
1.98
1.97
1.96
1.67
1.63
1.60
1.60
1.57
1.57
1.40
O
O
7
2m
2.05
3.06
1.03
0.94
1.00
1.04
1.04
5.40
2.51
1.37
f1 (ppm)

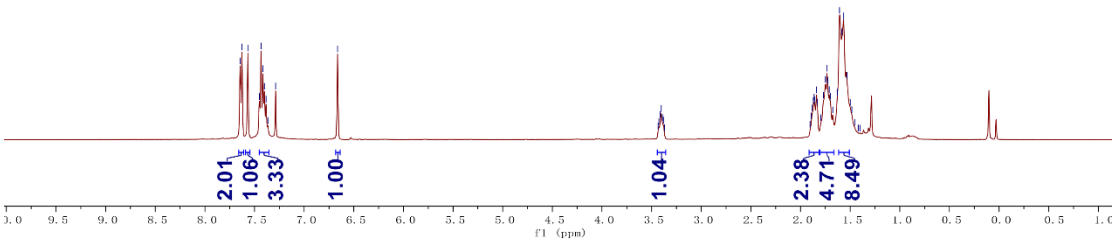

211.98
149.01
141.34
133.54
128.63
128.24
126.95
122.74
111.71
77.39
77.07
76.75
51.42
42.83
30.39
29.92
28.12
25.73
O
O
7
2m
f1 (ppm)

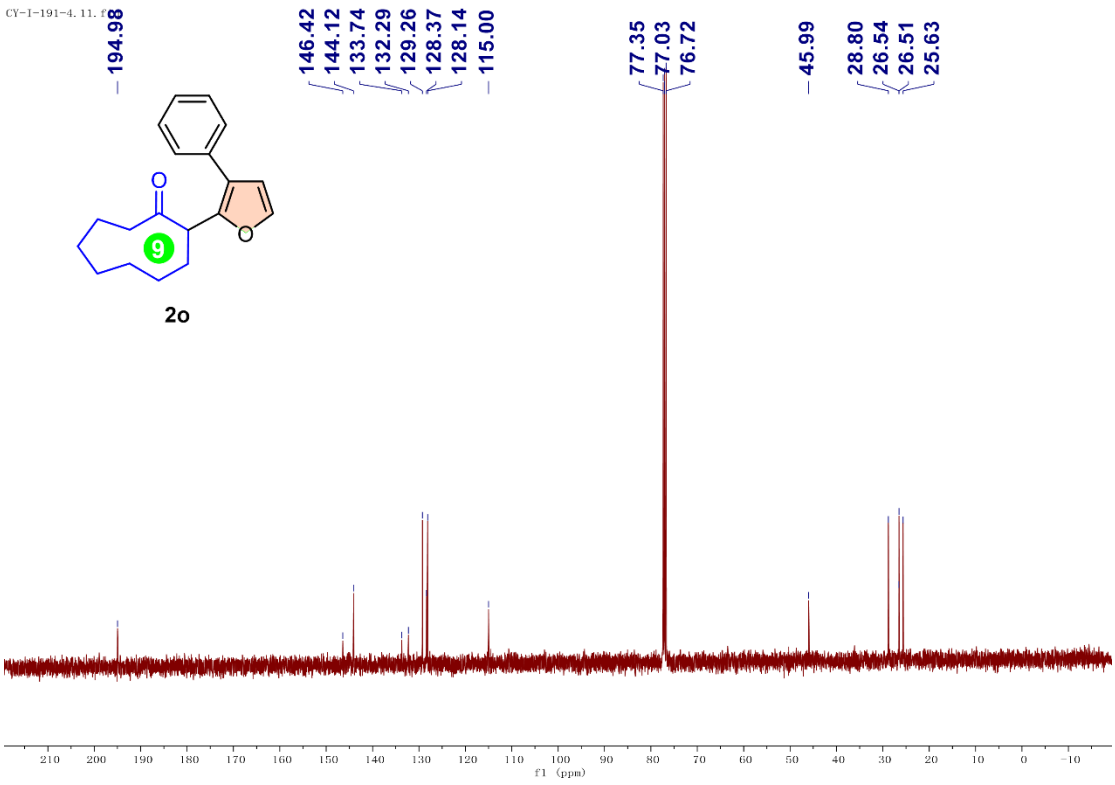

7.40
7.38
7.35
7.33
7.32
7.31
7.31
7.24
7.22
7.17
6.41
6.41
3.87
3.86
3.84
3.83
2.86
2.85
2.50
2.47
1.88
1.87
1.86
1.85
1.84
1.83
1.82
1.76
1.67
1.66
1.64
1.63
1.62
1.61
1.59
1.58
1.44
1.43
1.43
1.42
1.42
1.40
1.39
O
O
8
2n
2.07
3.16
1.10
0.98
1.00
1.07
1.11
1.10
2.11
1.08
2.29
1.21
2.30
1.52
f1 (ppm)


214.51
147.99
141.63
133.38
128.65
128.29
126.96
122.77
111.78
77.39
77.07
76.75
50.94
39.84
29.19
28.08
26.83
26.32
24.72
O
O
8
2n
f1 (ppm)

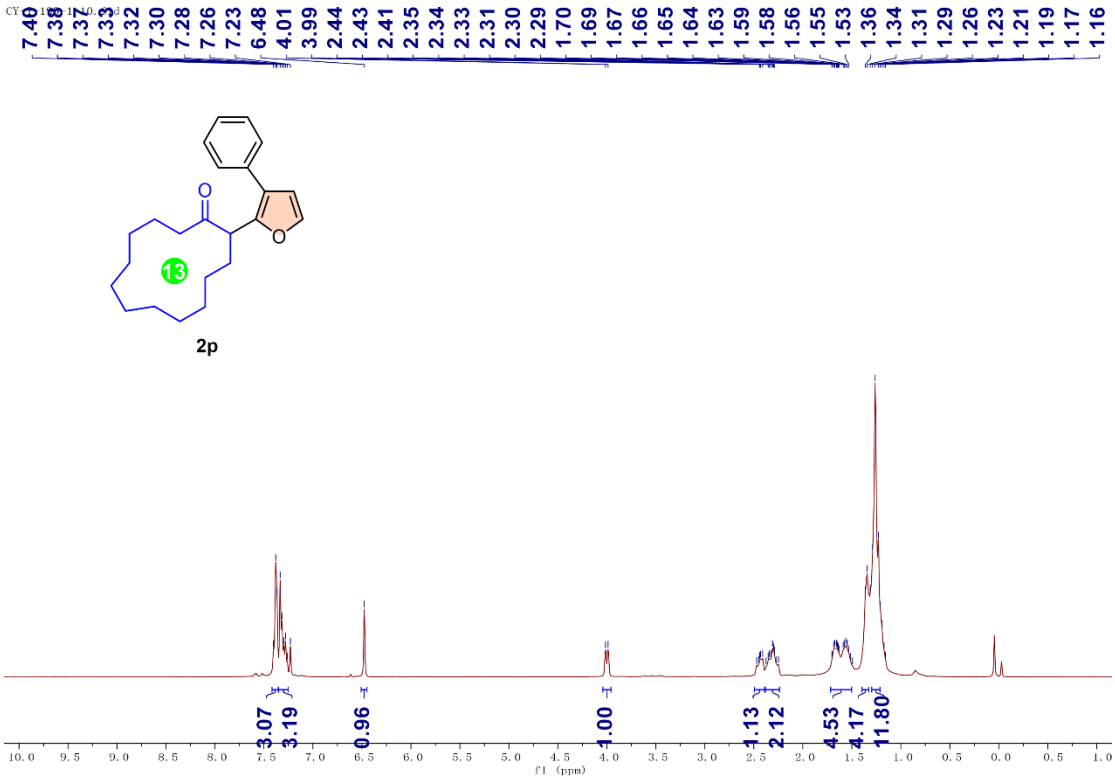

7.65
7.63
7.57
7.45
7.43
7.42
7.40
7.38
7.37
7.29
6.66
3.44
3.43
3.41
3.40
3.39
3.38
3.37
1.90
1.89
1.88
1.87
1.86
1.86
1.84
1.83
1.80
1.77
1.75
1.73
1.72
1.71
1.70
1.68
1.63
1.61
1.58
1.57
1.53
1.50
1.48
1.45
1.42
O
O
9

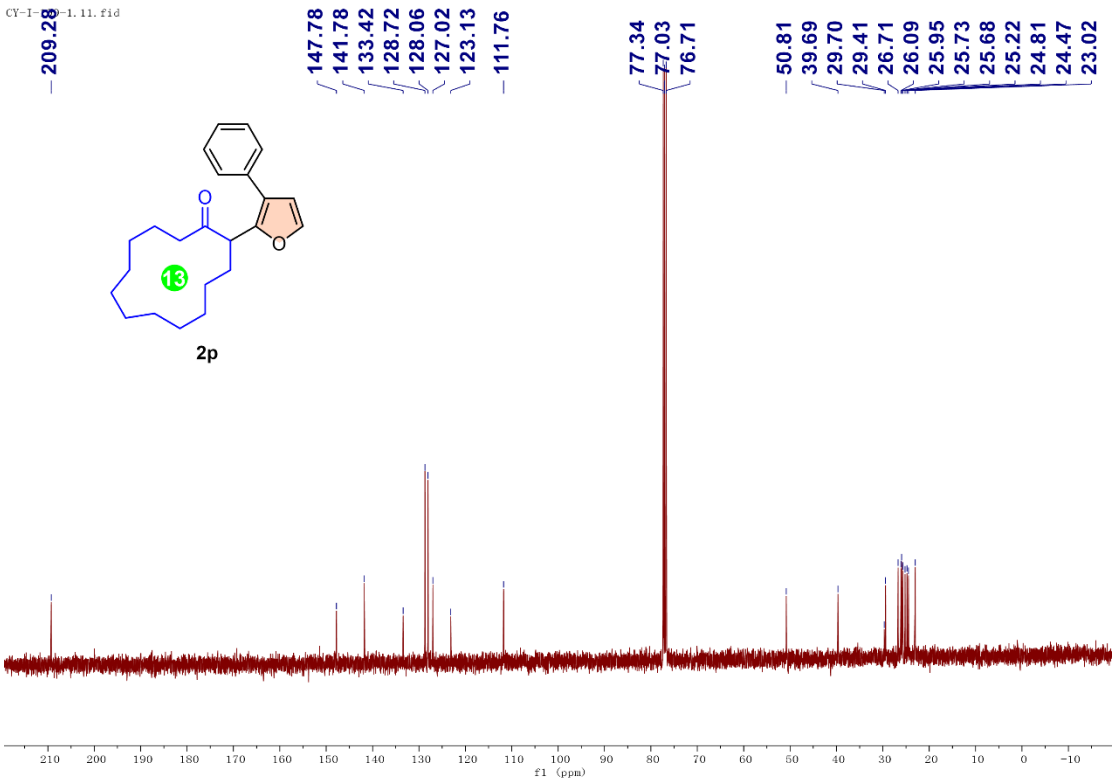
2o

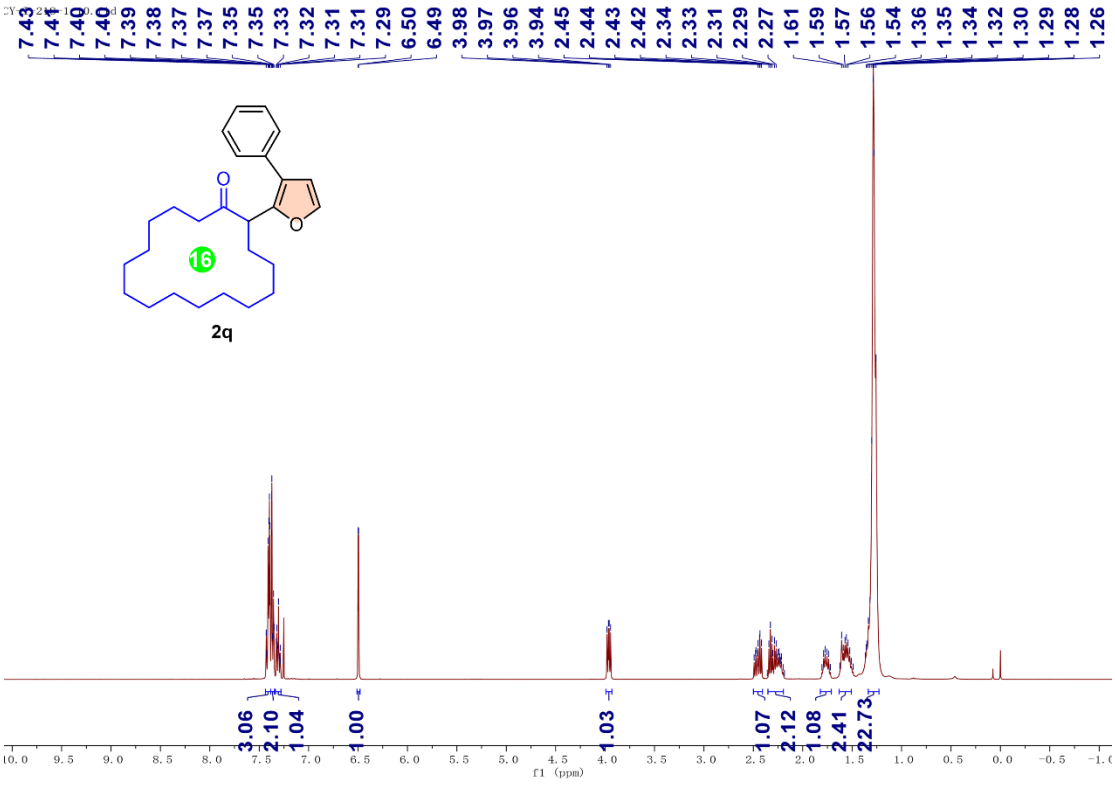

2.01
1.06
3.33
1.00
1.04
2.38
4.71
8.49
f1 (ppm)

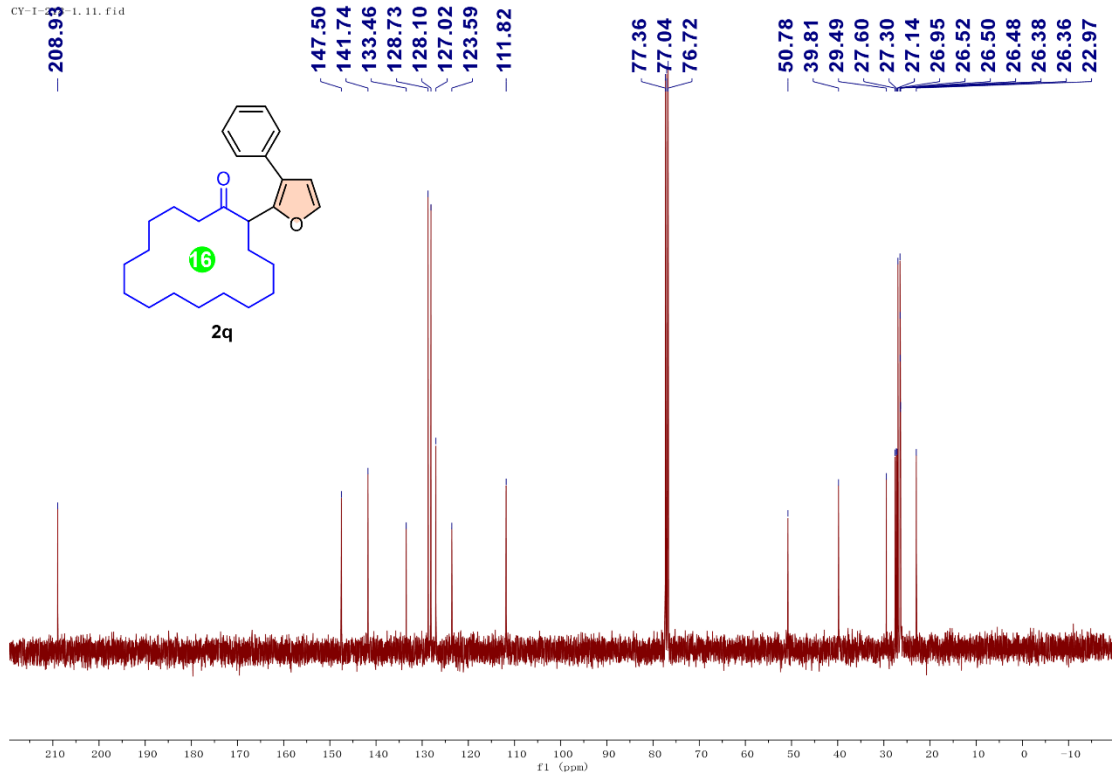

194.98
146.42
144.12
133.74
132.29
129.26
128.37
128.14
115.00
77.35
77.03
76.72
45.99
28.80
26.54
26.51
25.63
O
O
9
f1 (ppm)

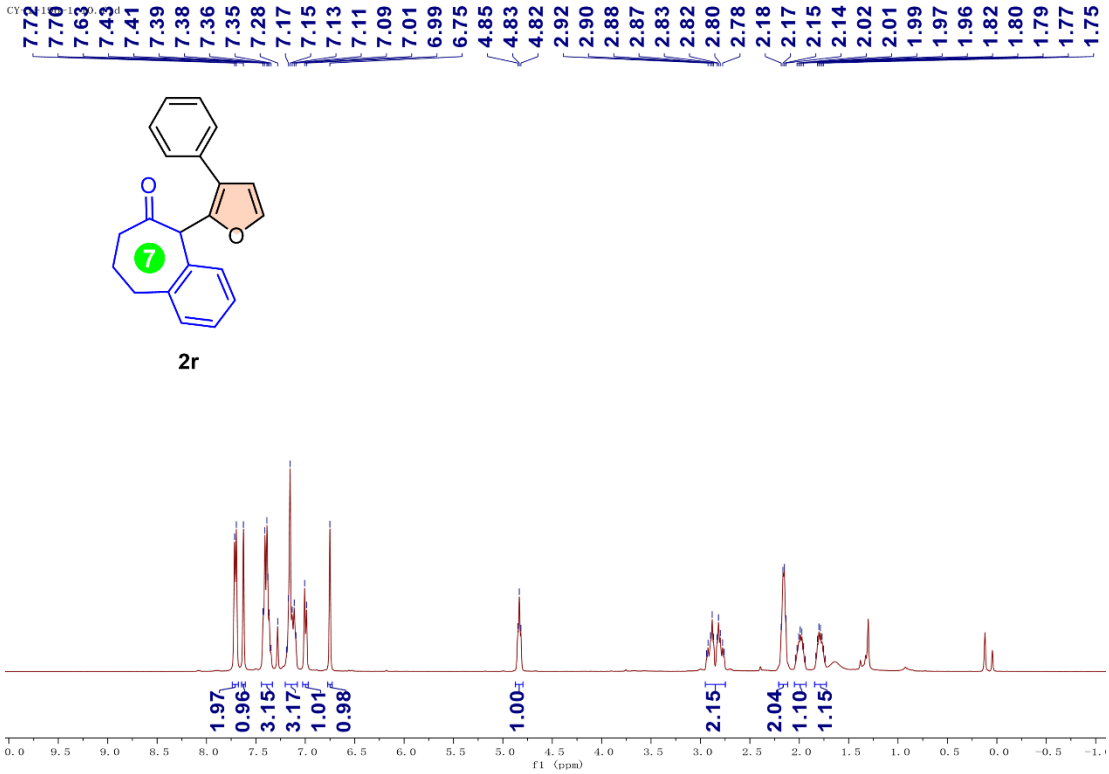
2o

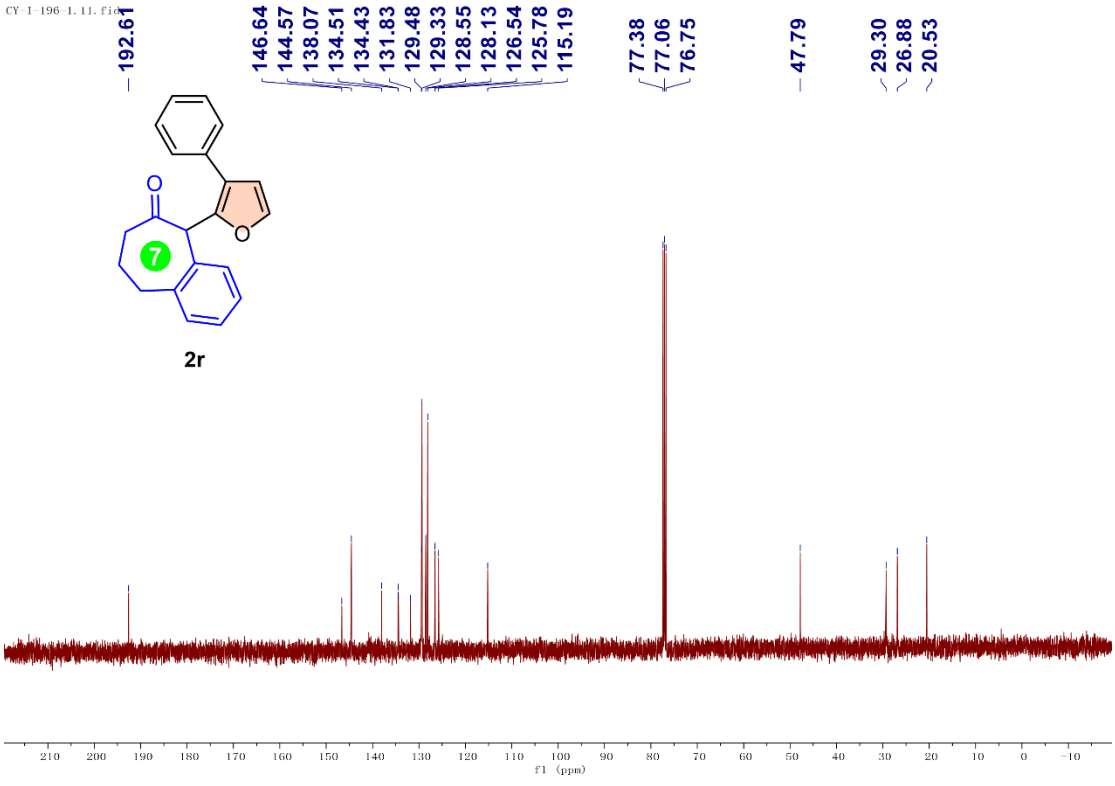

7.40
7.38
7.37
7.33
7.32
7.30
7.28
7.26
7.23
6.48
4.01
3.99
2.44
2.43
2.41
2.35
2.34
2.33
2.31
2.30
2.29
1.70
1.69
1.67
1.66
1.65
1.64
1.63
1.59
1.58
1.56
1.55
1.53
1.36
1.34
1.31
1.29
1.26
1.23
1.21
1.19
1.17
1.16
O
O
13
2p
3.07
3.19
0.96
1.00
1.13
2.12
4.53
4.17
11.80
f1 (ppm)

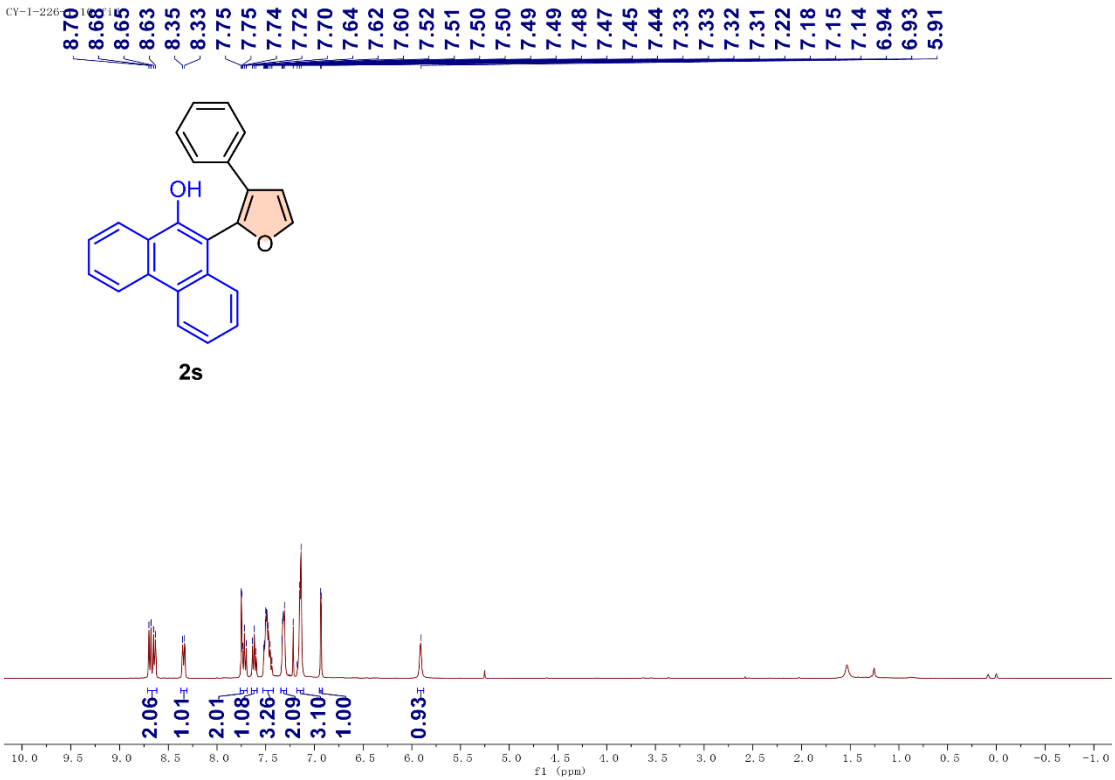

209.28
147.78
141.78
133.42
128.72
128.06
127.02
123.13
111.76
77.34
77.03
76.71
50.81
39.69
29.70
29.41
26.71
26.09
25.95
25.73
25.68
25.22
24.81
24.47
23.02
O
O
13
2p
f1 (ppm)

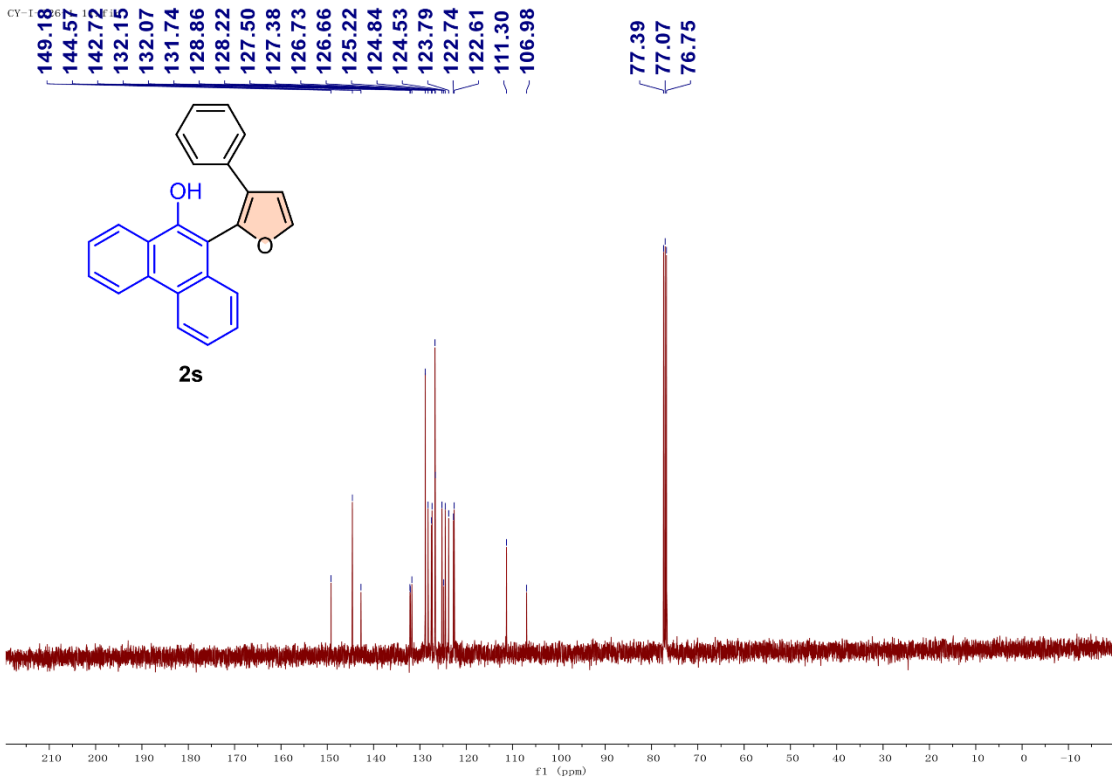

7.43 7.41 7.40 7.40 7.39 7.38 7.37 7.37 7.35 7.35 7.33 7.32 7.31 7.31 7.29 6.50 6.49 3.98 3.97 3.96 3.94 2.45 2.44 2.43 2.42 2.34 2.33 2.31 2.29 2.27 1.61 1.59 1.57 1.56 1.54 1.36 1.35 1.34 1.32 1.30 1.29 1.28 1.26
O
O
16
2q
3.06 2.10 1.04 1.00 1.03 1.07 2.12 1.08 2.41 22.73
f1 (ppm)

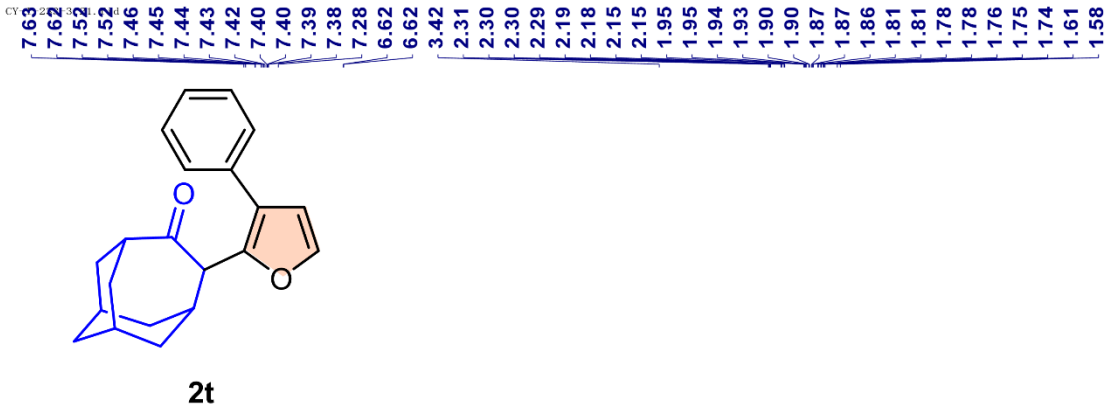

208.93
147.50 141.74 133.46 128.73 128.10 127.02 123.59 111.82
77.36 77.04 76.72
50.78 39.81 29.49 27.60 27.30 27.14 26.95 26.52 26.50 26.48 26.38 26.36 22.97
O
O
16
2q
f1 (ppm)


7.72
7.70
7.63
7.43
7.41
7.39
7.38
7.36
7.35
7.28
7.17
7.15
7.13
7.11
7.09
7.01
6.99
6.75
4.85
4.83
4.82
2.92
2.90
2.88
2.87
2.83
2.82
2.80
2.78
2.18
2.17
2.15
2.14
2.02
2.01
1.99
1.97
1.96
1.82
1.80
1.79
1.77
1.75
O
O
7
2r
1.97
0.96
3.15
3.17
1.01
0.98
1.00
2.15
2.04
1.10
1.15
f1 (ppm)

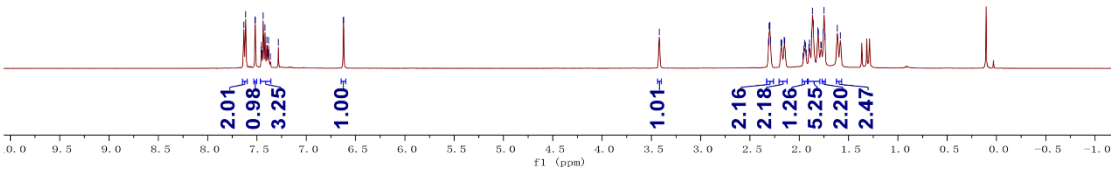

192.61
146.64
144.57
138.07
134.51
134.43
131.83
129.48
129.33
128.55
128.13
126.54
125.78
115.19
77.38
77.06
76.75
47.79
29.30
26.88
20.53
O
O
7
2r
f1 (ppm)

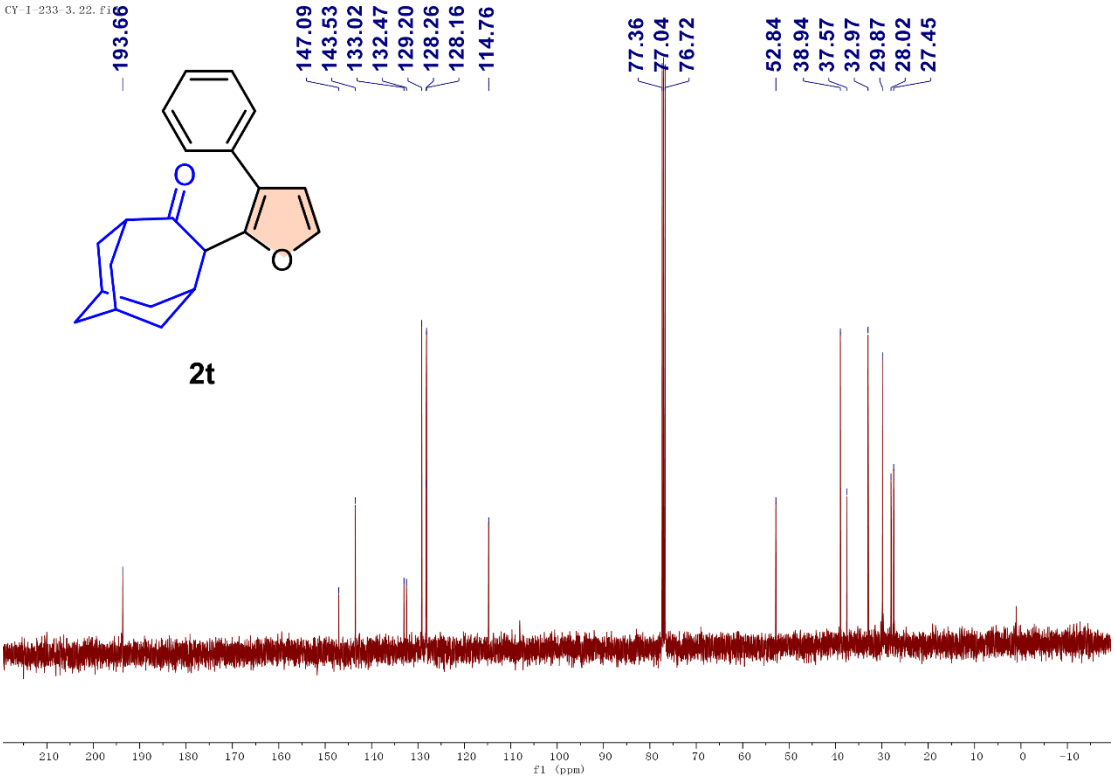

8.70
8.68
8.65
8.63
8.35
8.33
7.75
7.75
7.74
7.72
7.70
7.64
7.62
7.60
7.52
7.51
7.50
7.50
7.49
7.49
7.48
7.47
7.45
7.44
7.33
7.33
7.32
7.31
7.22
7.18
7.15
7.14
6.94
6.93
5.91
OH
O
2s
2.06
1.01
2.01
1.08
3.26
2.09
3.10
1.00
0.93
f1 (ppm)


149.18
144.57
142.72
132.15
132.07
131.74
128.86
128.22
127.50
127.38
126.73
126.66
125.22
124.84
124.53
123.79
122.74
122.61
111.30
106.98
77.39
77.07
76.75
OH
O
2s
f1 (ppm)

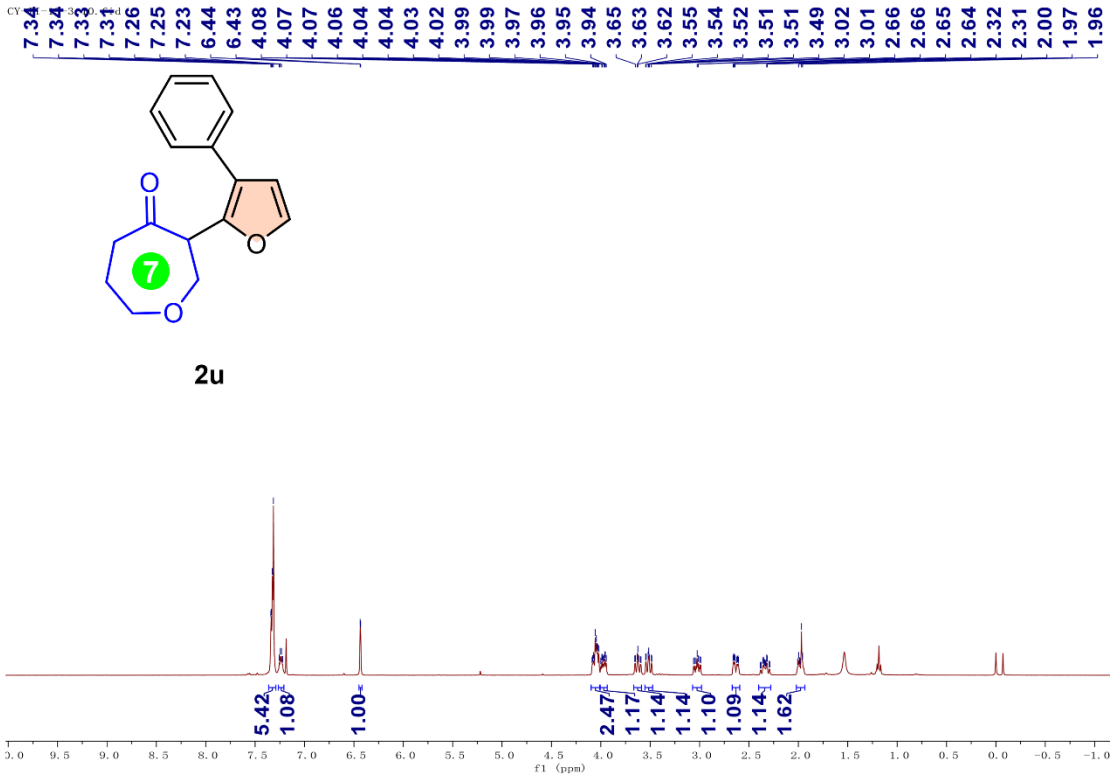

7.63
7.62
7.52
7.52
7.46
7.45
7.44
7.43
7.42
7.40
7.40
7.39
7.38
7.28
6.62
6.62
3.42
2.31
2.30
2.30
2.29
2.19
2.18
2.15
2.15
1.95
1.95
1.94
1.93
1.90
1.90
1.87
1.87
1.86
1.81
1.81
1.78
1.78
1.76
1.75
1.74
1.61
1.58
O
O

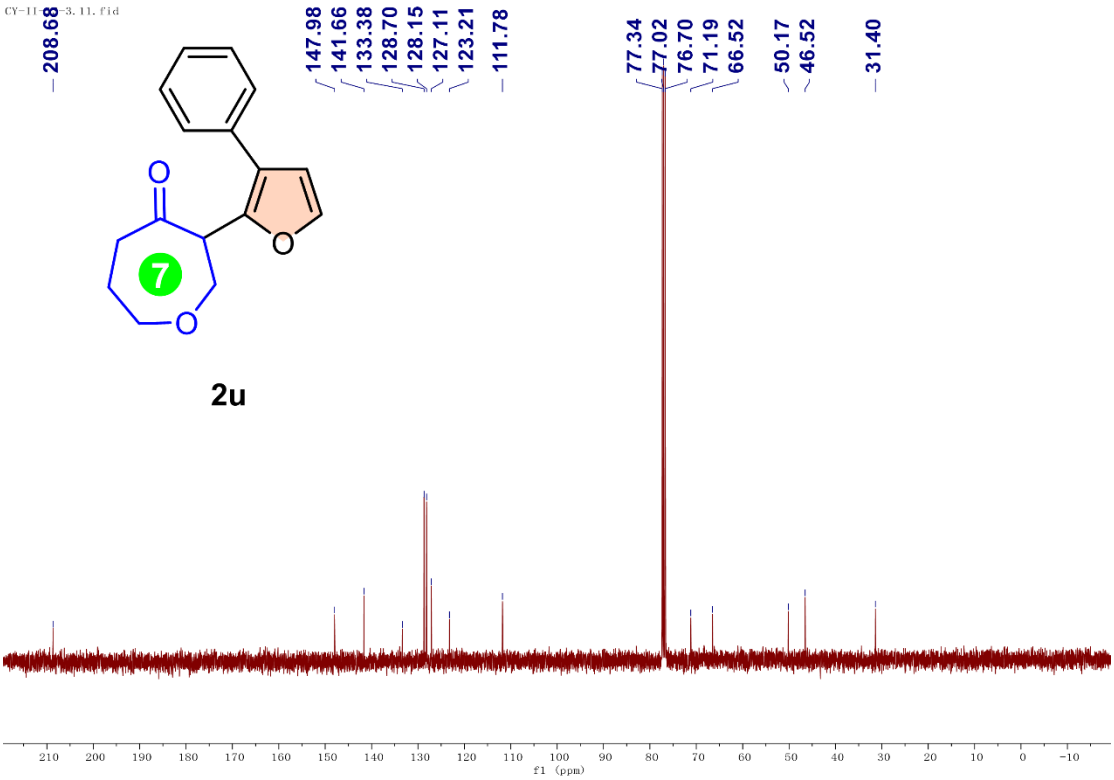
**2t**

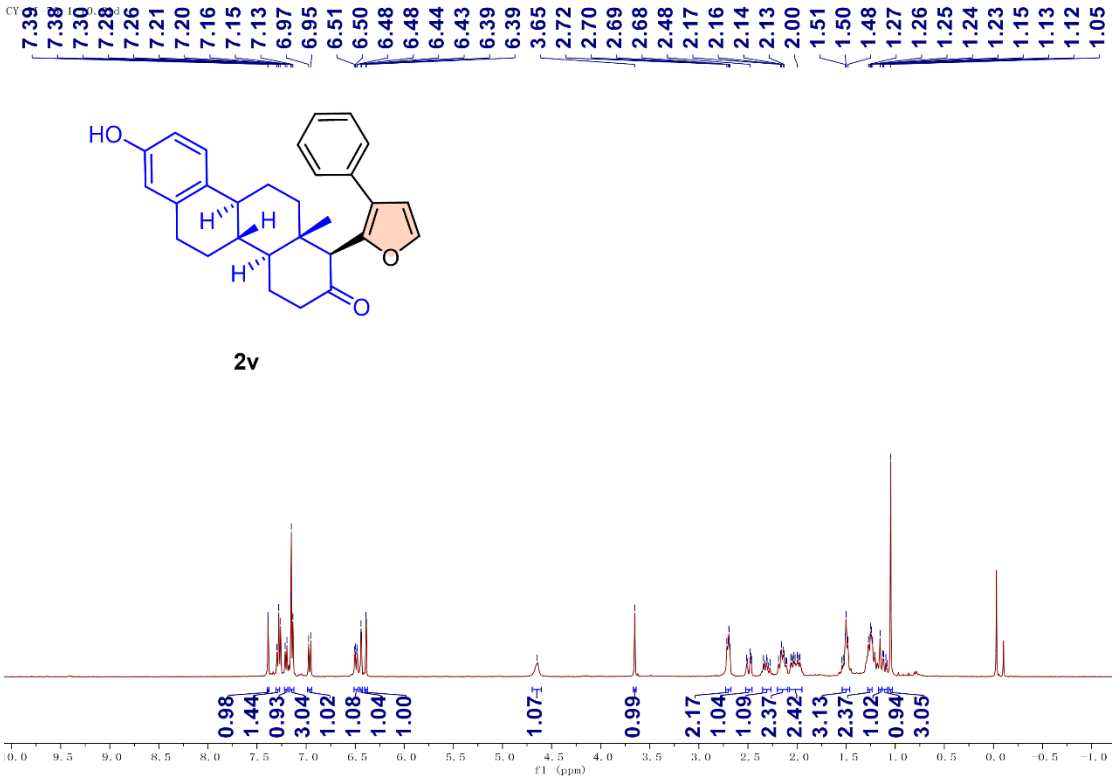

2.01
0.98
3.25
1.00
1.01
2.16
2.18
1.26
5.25
2.20
2.47
f1 (ppm)

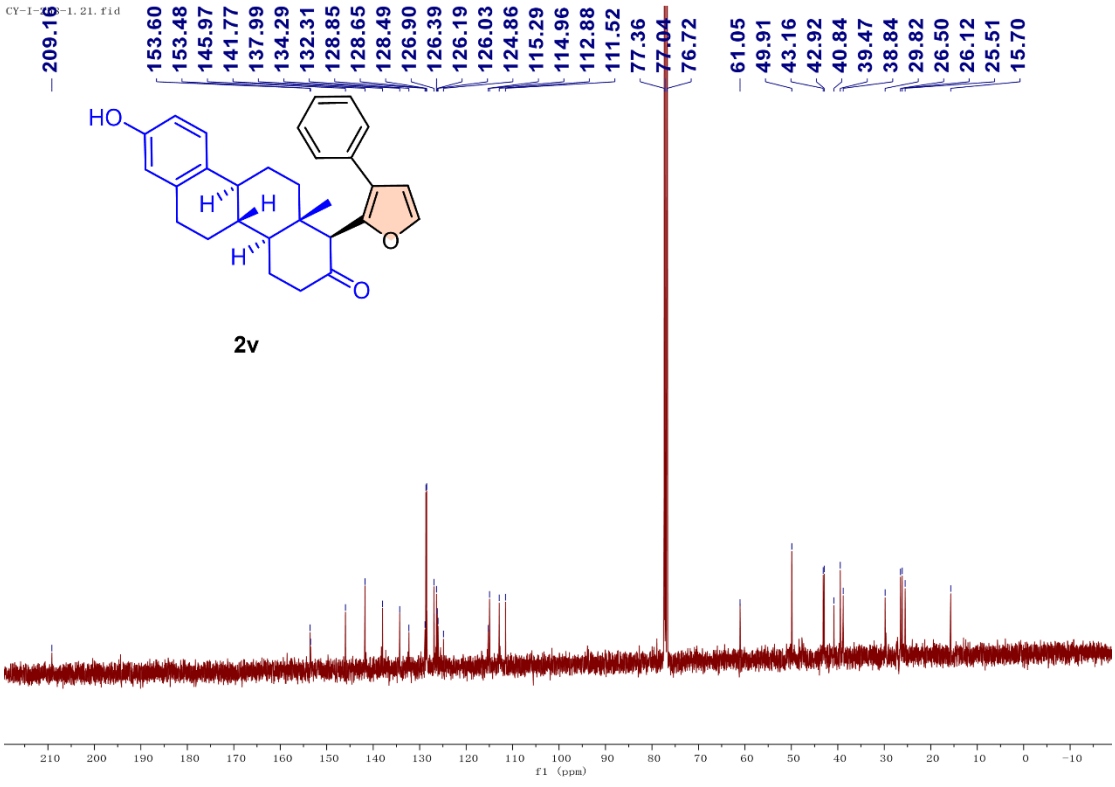

193.66
147.09
143.53
133.02
132.47
129.20
128.26
128.16
114.76
77.36
77.04
76.72
52.84
38.94
37.57
32.97
29.87
28.02
27.45
O
O
f1 (ppm)

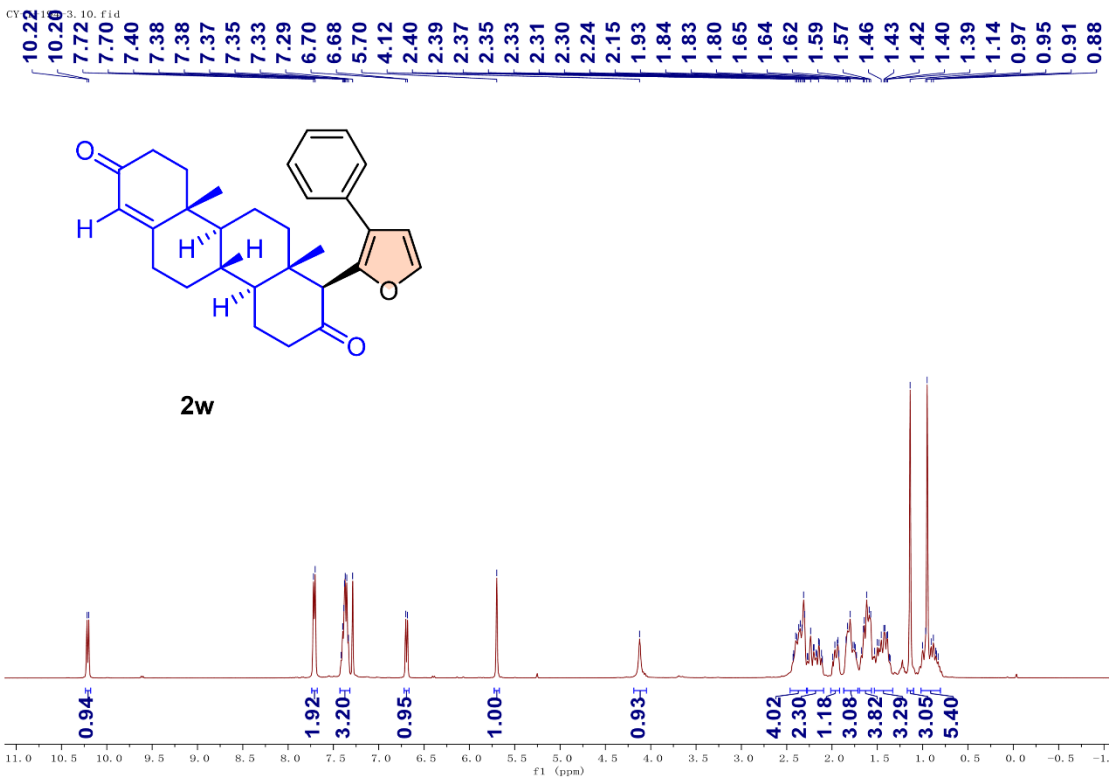
**2t**

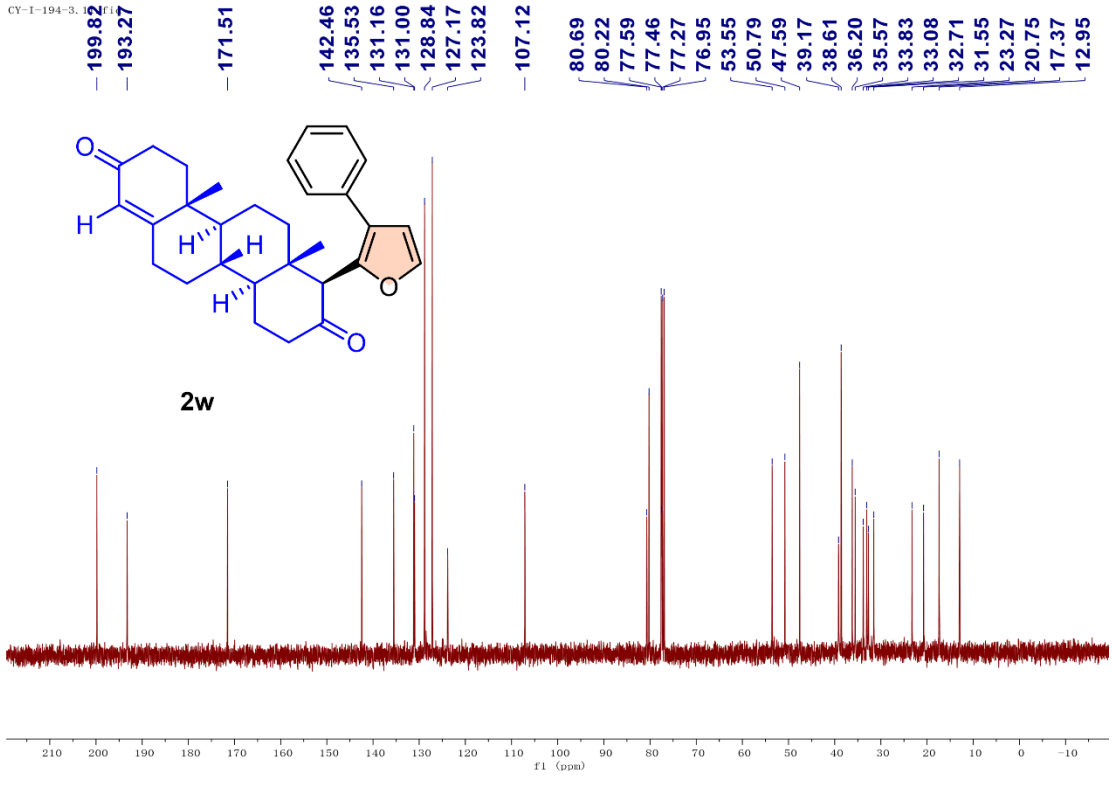

7.34
7.34
7.33
7.31
7.26
7.25
7.23
6.44
6.43
4.08
4.07
4.07
4.06
4.04
4.04
4.03
4.02
3.99
3.99
3.97
3.96
3.95
3.94
3.65
3.63
3.62
3.55
3.54
3.52
3.51
3.51
3.49
3.02
3.01
2.66
2.66
2.65
2.64
2.32
2.31
2.00
1.97
1.96
O
O
7
O
2u
5.42
1.08
1.00
2.47
1.17
1.14
1.14
1.10
1.09
1.14
1.62
f1 (ppm)

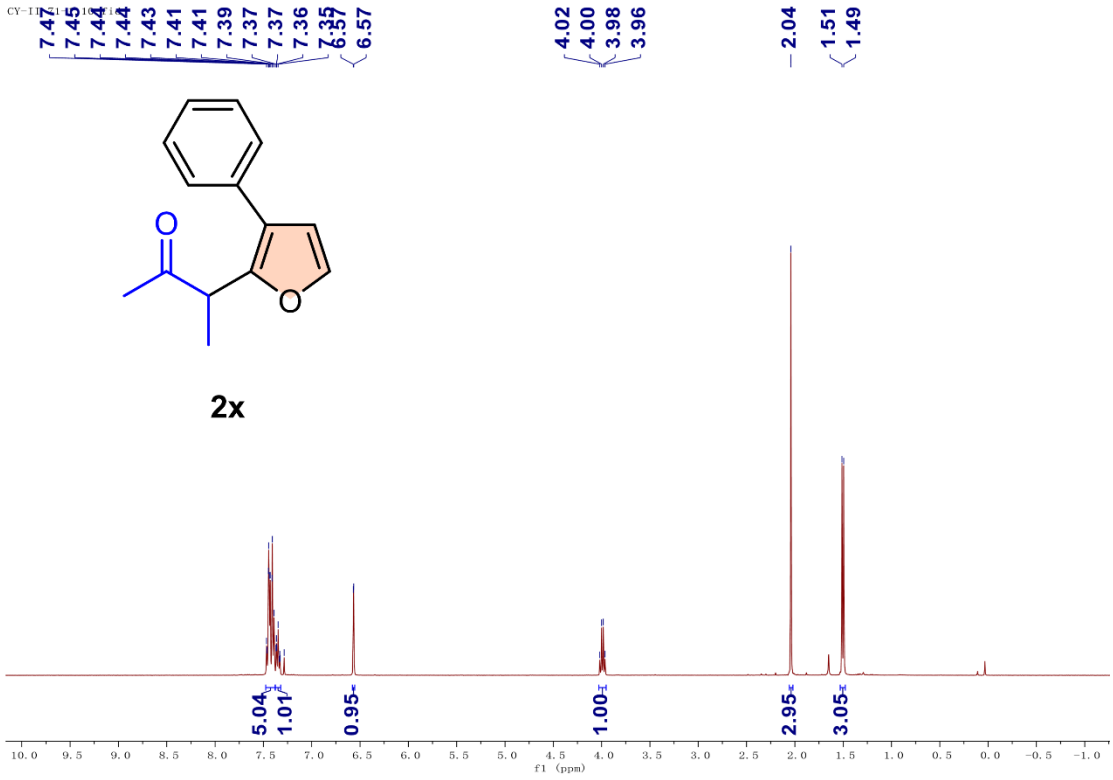

208.68
147.98
141.66
133.38
128.70
128.15
127.11
123.21
111.78
77.34
77.02
76.70
71.19
66.52
50.17
46.52
31.40
O
O
7
O
2u
f1 (ppm)

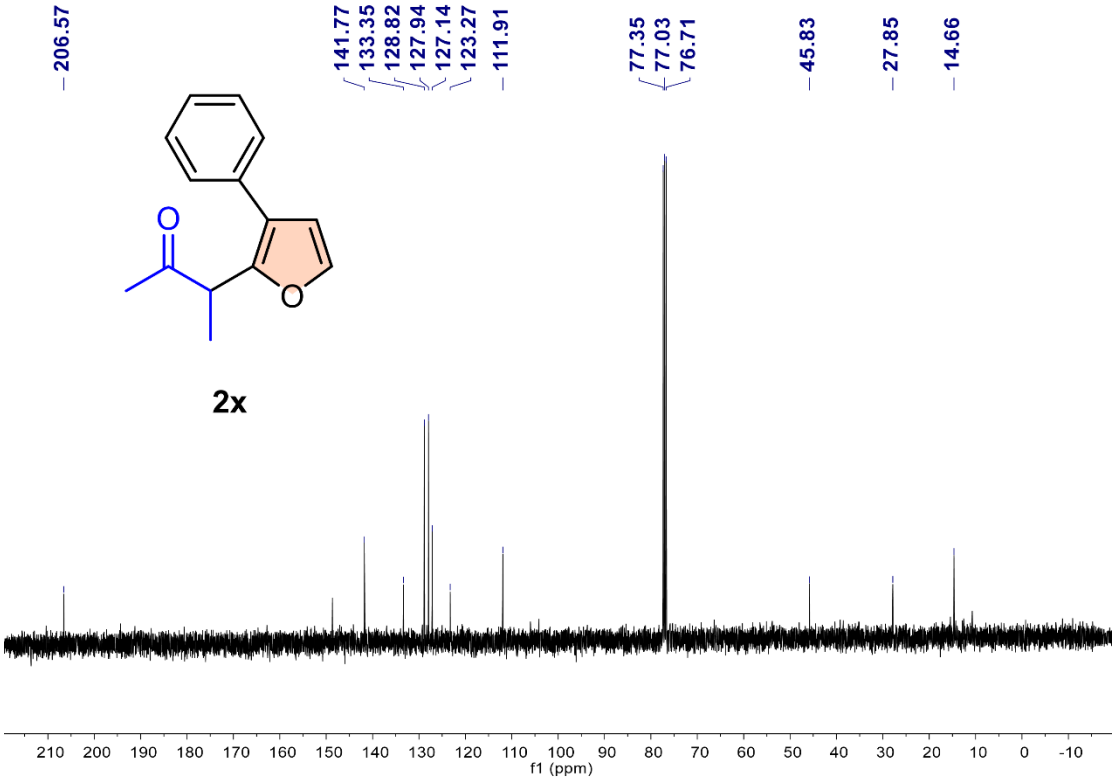

7.39
7.38
7.30
7.28
7.26
7.21
7.20
7.16
7.15
7.13
6.97
6.95
6.51
6.50
6.48
6.48
6.44
6.43
6.39
6.39
3.65
2.72
2.70
2.69
2.68
2.48
2.17
2.16
2.14
2.13
2.00
1.51
1.50
1.48
1.27
1.26
1.25
1.24
1.23
1.15
1.13
1.12
1.05
HO
H
H
H
O
O
2v
0.98
1.44
0.93
3.04
1.02
1.08
1.04
1.00
1.07
0.99
2.17
1.04
1.09
2.37
2.42
3.13
2.37
1.02
0.94
3.05
f1 (ppm)

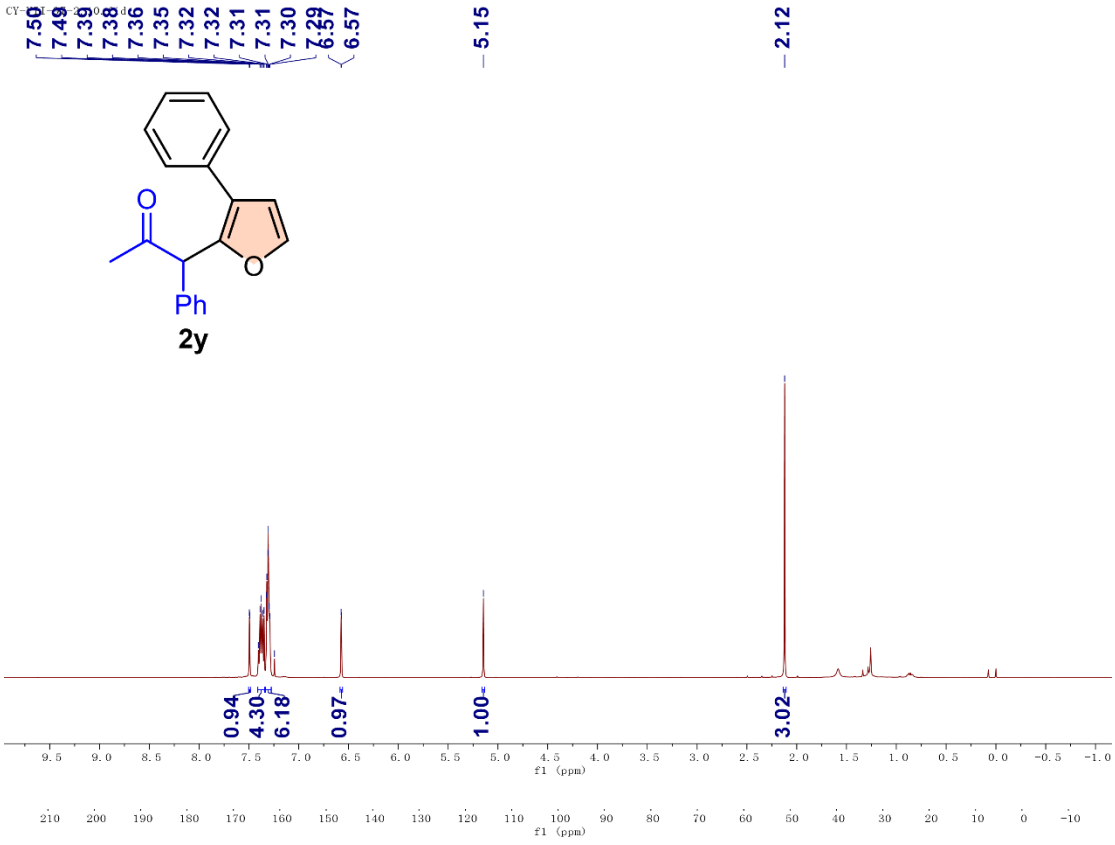

209.16
153.60
153.48
145.97
141.77
137.99
134.29
132.31
128.85
128.65
128.49
126.90
126.39
126.19
126.03
124.86
115.29
114.96
112.88
111.52
77.36
77.04
76.72
61.05
49.91
43.16
42.92
40.84
39.47
38.84
29.82
26.50
26.12
25.51
15.70
HO
H
H
H
O
O
2v
f1 (ppm)

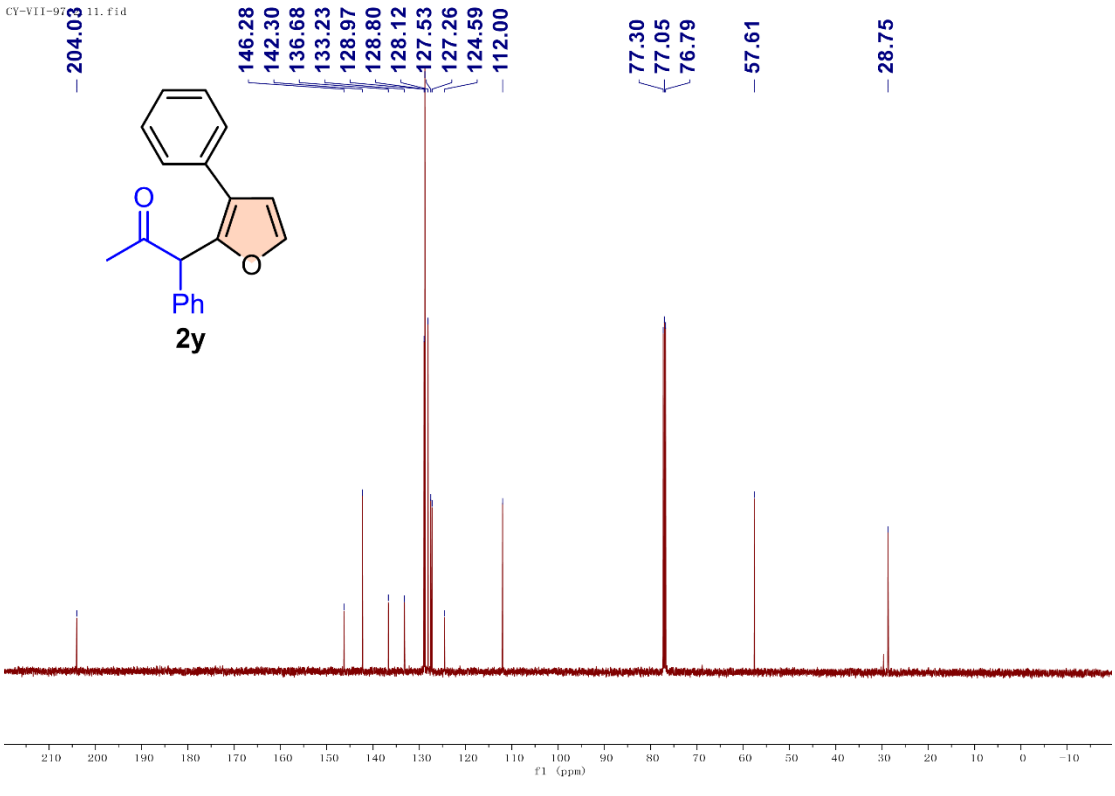

10.22
10.20
7.72
7.70
7.40
7.38
7.38
7.37
7.35
7.33
7.29
6.70
6.68
5.70
4.12
2.40
2.39
2.37
2.35
2.33
2.31
2.30
2.24
2.15
1.93
1.84
1.83
1.80
1.65
1.64
1.62
1.59
1.57
1.46
1.43
1.42
1.40
1.39
1.14
0.97
0.95
0.91
0.88
O
H
H
H
H
O
O
2w
0.94
1.92
3.20
0.95
1.00
0.93
4.02
2.30
1.18
3.08
3.82
3.29
3.05
5.40
f1 (ppm)

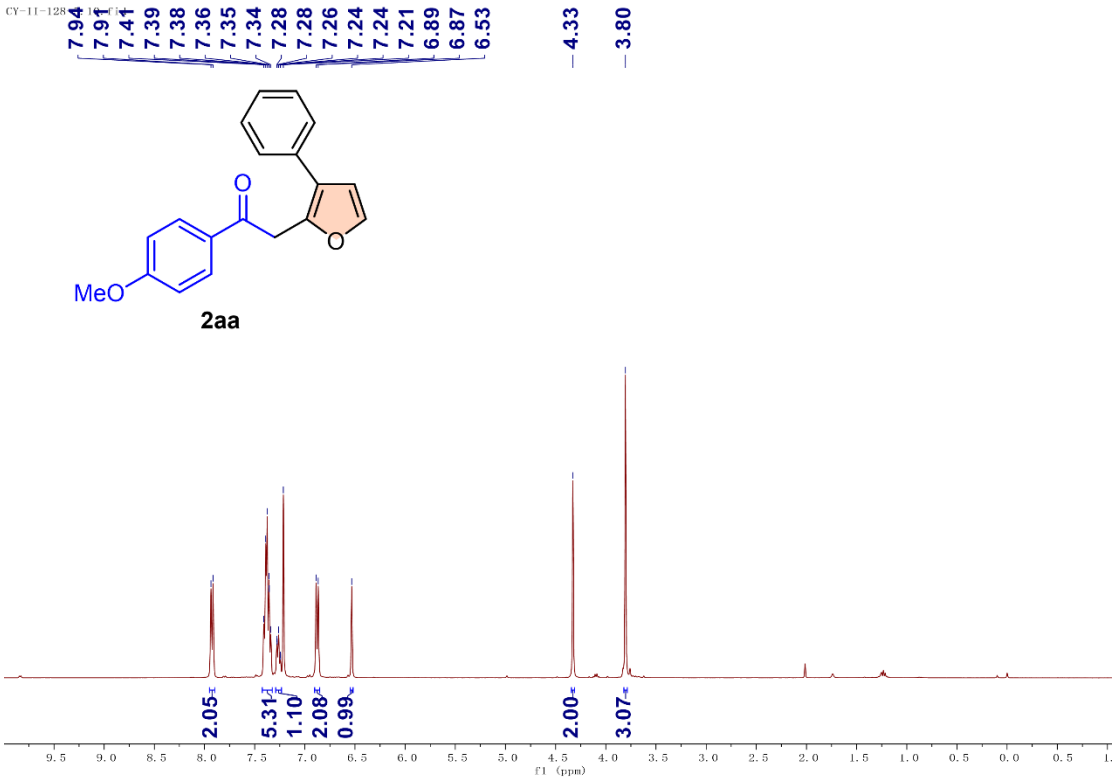

199.82
193.27
171.51
142.46
135.53
131.16
131.00
128.84
127.17
123.82
107.12
80.69
80.22
77.59
77.46
77.27
76.95
53.55
50.79
47.59
39.17
38.61
36.20
35.57
33.83
33.08
32.71
31.55
23.27
20.75
17.37
12.95
O
H
H
H
H
O
O
2w
f1 (ppm)

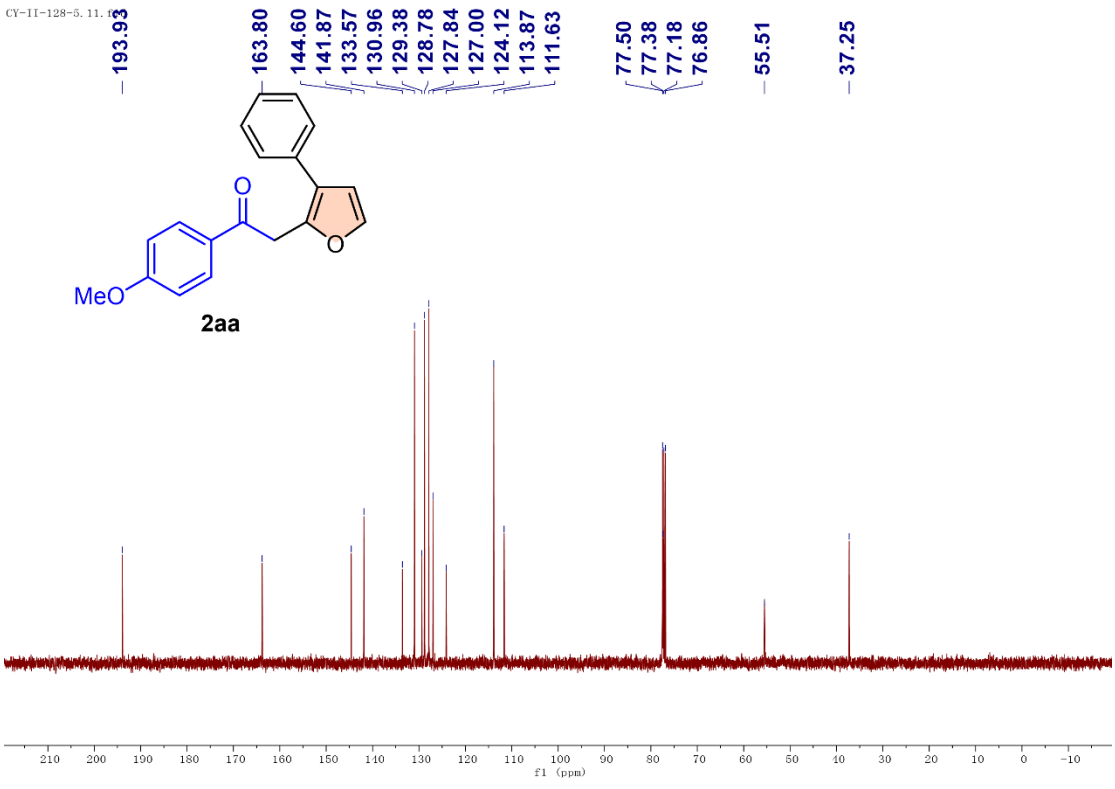

7.47
7.45
7.44
7.44
7.43
7.41
7.41
7.39
7.37
7.37
7.36
6.57
6.57
4.02
4.00
3.98
3.96
2.04
1.51
1.49
O
O
2x
5.04
1.01
0.95
1.00
2.95
3.05
f1 (ppm)


206.57
141.77
133.35
128.82
127.94
127.14
123.27
111.91
77.35
77.03
76.71
45.83
27.85
14.66
O
O
2x
f1 (ppm)

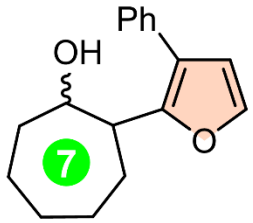

7.50
7.49
7.39
7.38
7.36
7.35
7.32
7.32
7.31
7.31
7.30
7.29
6.57
6.57
5.15
2.12
O
O
Ph
2y
0.94
4.30
6.18
0.97
1.00
3.02
f1 (ppm)
f1 (ppm)


204.03
146.28
142.30
136.68
133.23
128.97
128.80
128.12
127.53
127.26
124.59
112.00
77.30
77.05
76.79
57.61
28.75
O
O
Ph
2y
f1 (ppm)

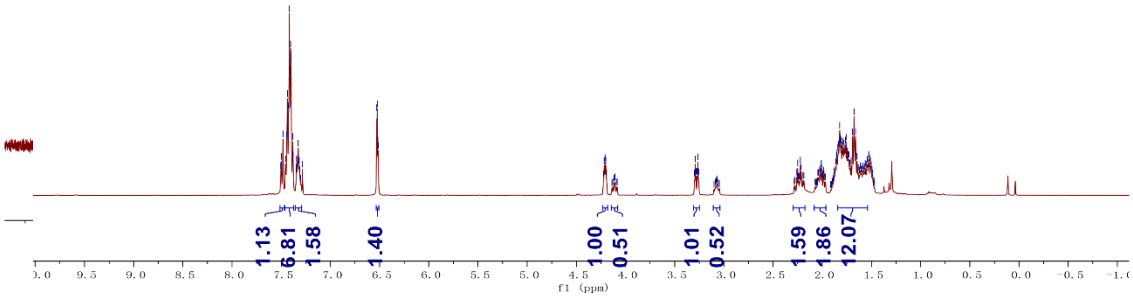

7.94
7.91
7.41
7.39
7.38
7.36
7.35
7.34
7.28
7.28
7.26
7.24
7.24
7.21
6.89
6.87
6.53
4.33
3.80
O
O
MeO
2aa
2.05
5.31
1.10
2.08
0.99
2.00
3.07
f1 (ppm)


193.93
163.80
144.60
141.87
133.57
130.96
129.38
128.78
127.84
127.00
124.12
113.87
111.63
77.50
77.38
77.18
76.86
55.51
37.25
O
O
MeO
2aa
f1 (ppm)

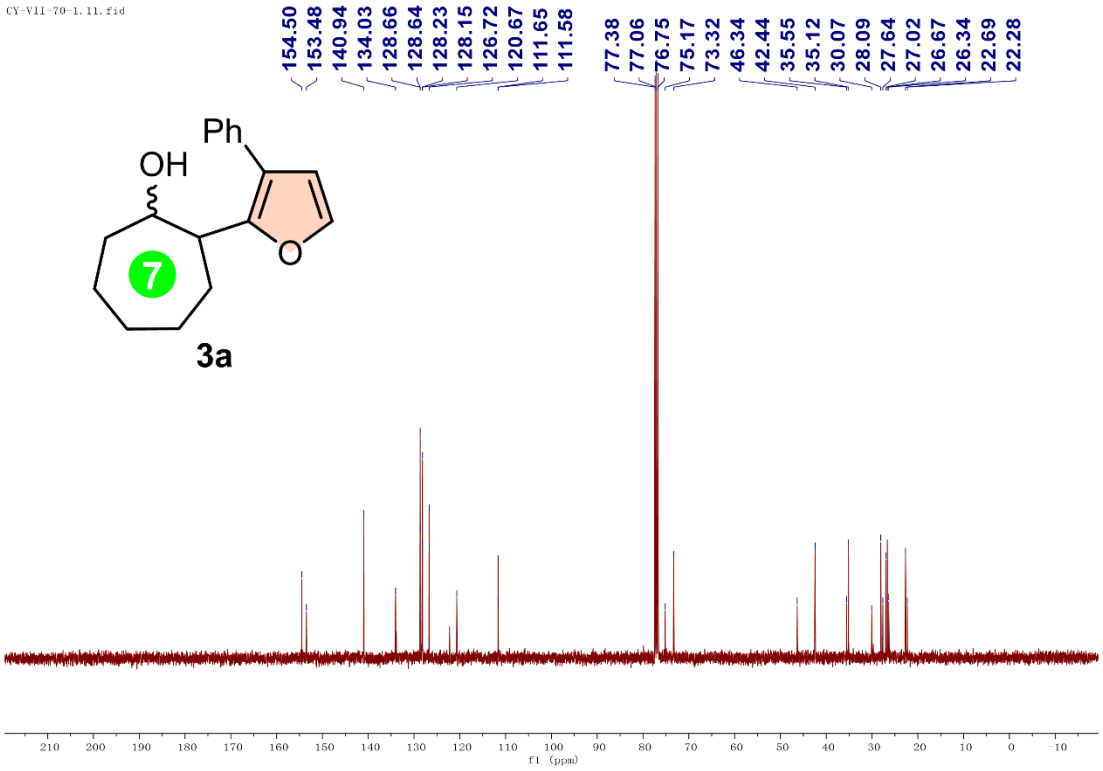
CY-V


**3a**




CY-VII-70-1.11.fid

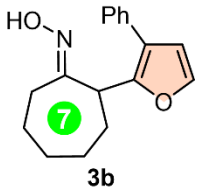




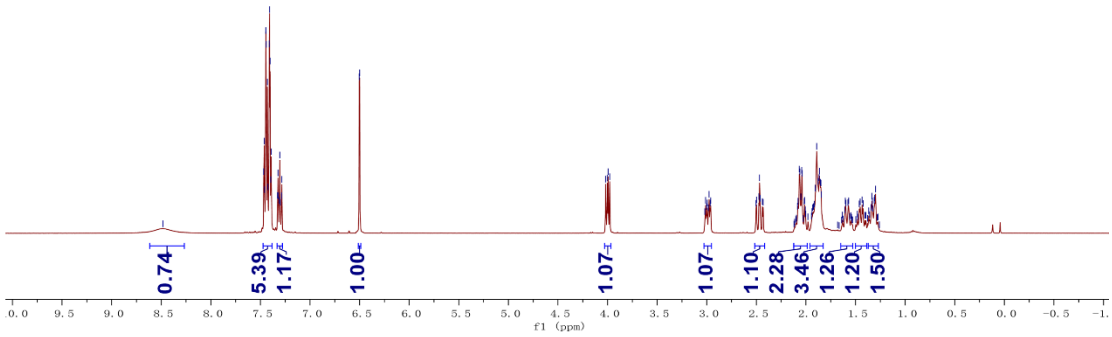


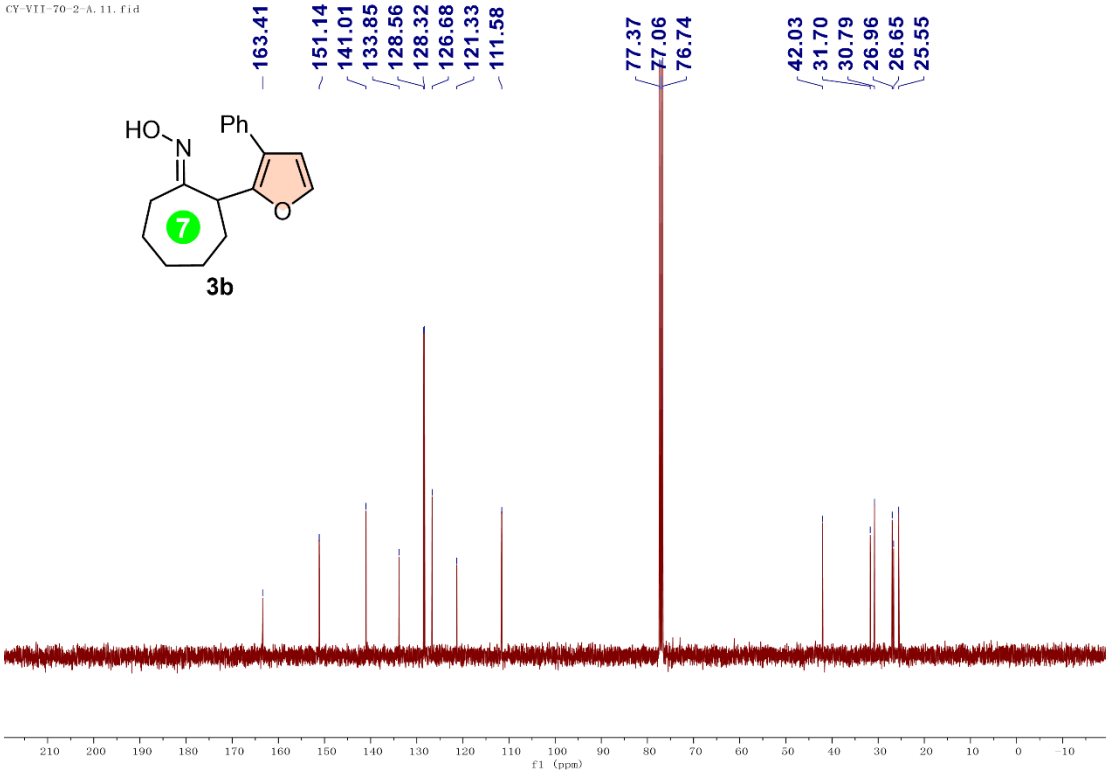
**3a**


7.47
7.46
7.46
7.45
7.44
7.43
7.42
7.41
7.41
7.40
7.40
7.39
7.33
7.32
7.32
7.30
7.29
7.28
6.50
6.50
4.02
4.00
3.99
3.98
2.98
2.47
2.47
2.07
2.06
2.05
2.04
2.04
1.91
1.89
1.89
1.88
1.87
1.86
1.85
1.85
1.84
1.34
1.30


HO
N
Ph
O
7

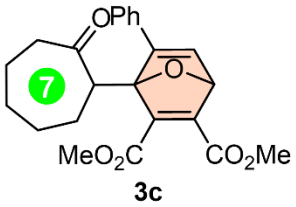
3b


0.74
5.39
1.17
1.00
1.07
1.07
1.10
2.28
3.46
1.26
1.20
1.50
f1 (ppm)

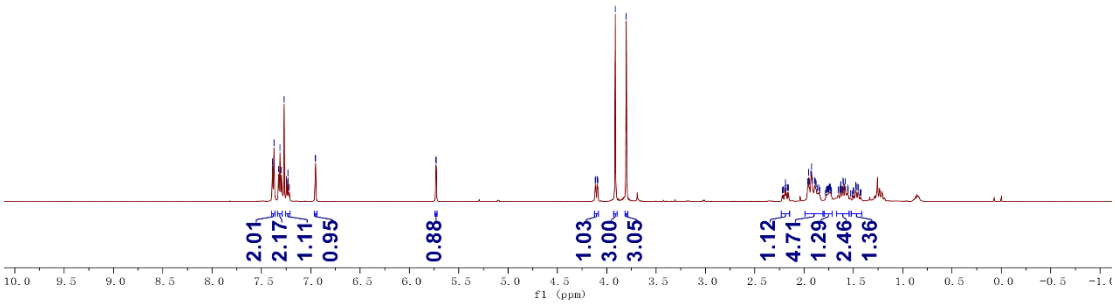

CY-VII-70-2-A.11.fid
163.41
151.14
141.01
133.85
128.56
128.32
126.68
121.33
111.58
77.37
77.06
76.74
42.03
31.70
30.79
26.96
26.65
25.55
HO
N
Ph
O
7
f1 (ppm)

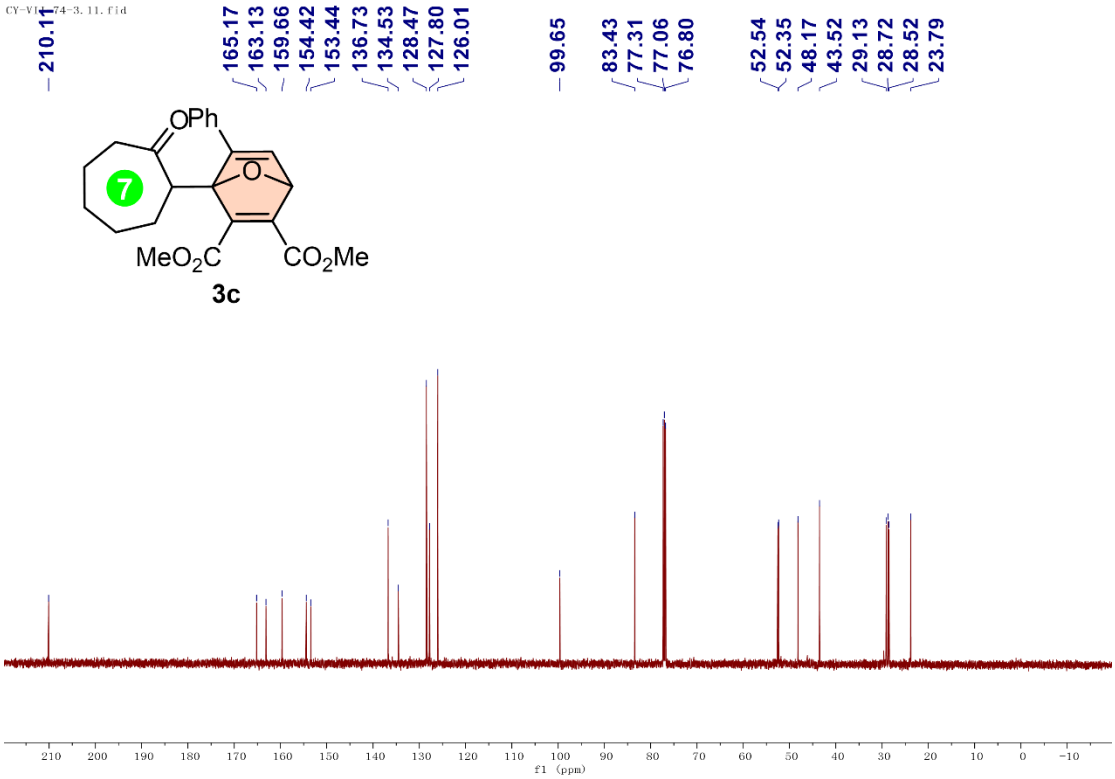
3b


7.39
7.39
7.37
7.33
7.31
7.30
7.27
7.25
7.24
7.23
7.22
6.96
6.95
5.73
5.73
4.12
4.11
4.10
4.09
3.91
3.80
2.19
1.96
1.95
1.95
1.93
1.92
1.91
1.89
1.89
1.88
1.75
1.74
1.73
1.63
1.63
1.61
1.60
1.59
1.58
1.48
1.47
1.45


OPh
O
7
MeO2C
CO2Me

3c


2.01
2.17
1.11
0.95
0.88
1.03
3.00
3.05
1.12
4.71
1.29
2.46
1.36
f1 (ppm)


210.11
165.17
163.13
159.66
154.42
153.44
136.73
134.53
128.47
127.80
126.01
99.65
83.43
77.31
77.06
76.80
52.54
52.35
48.17
43.52
29.13
28.72
28.52
23.79
f1 (ppm)


OPh
O
7
MeO2C
CO2Me

3c