

## Supplementary Material

# Continuous-Flow Photochemical Transformations of 1,4-Naphthoquinones and Phthalimides in a Concentrating Solar Trough Reactor

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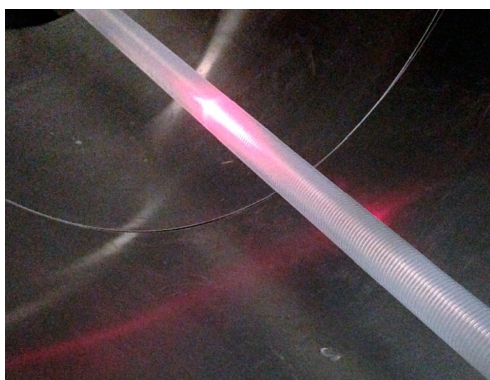
## Additional technical information on solar reactors

### *In-house solar parabolic trough continuous-flow capillary reactor*

<b>Length of glass tube</b>	1.2 m
<b>Outer diameter of glass tube</b>	3 cm
<b>Capillary tube material</b>	Fluorinated ethylene propylene (FEP), Bohlender GmbH
<b>External diameter</b>	3.2 mm
<b>Internal diameter</b>	1.6 mm
<b>Exposed length of tube</b>	27 m (plus additional ~70 cm on each end covered by black heat shrink tubing)
<b>Exposed volume of tube</b>	54 mL
<b>Pump</b>	Ismatec piston pump, model ISM321C
<b>Positioning to sun</b>	manually
<b>Concentrator material</b>	polished aluminum
<b>Concentration factor</b>	measured = 3 (theoretical = 13)

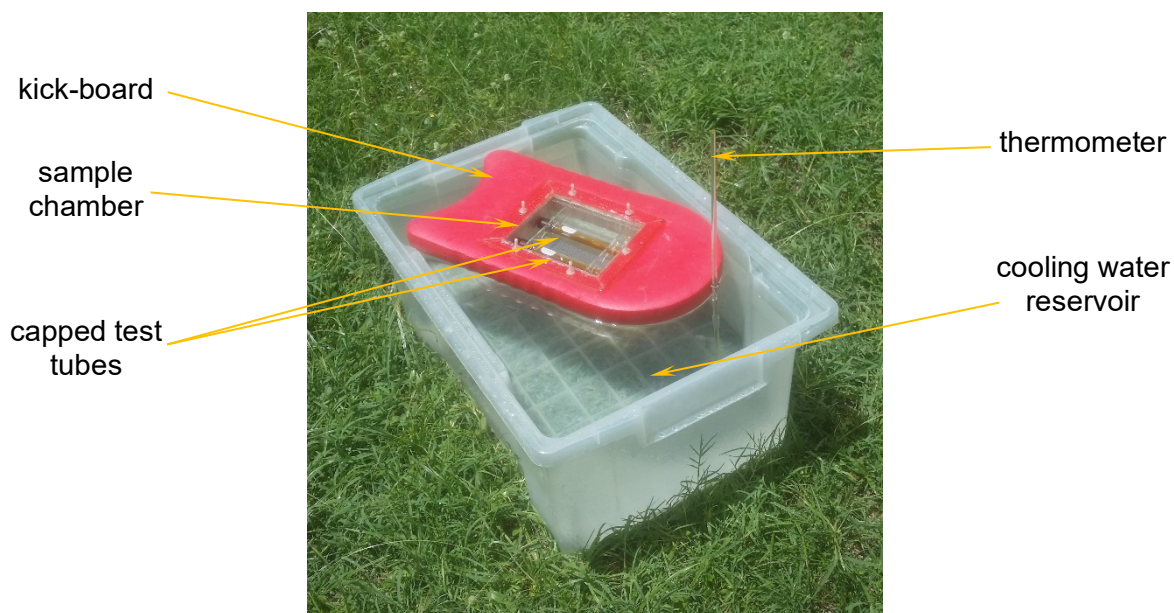


Illustration of light focusing by the trough using a red laser pointer. The capillary tube can be raised or lowered to achieve a broader or narrower focus line.

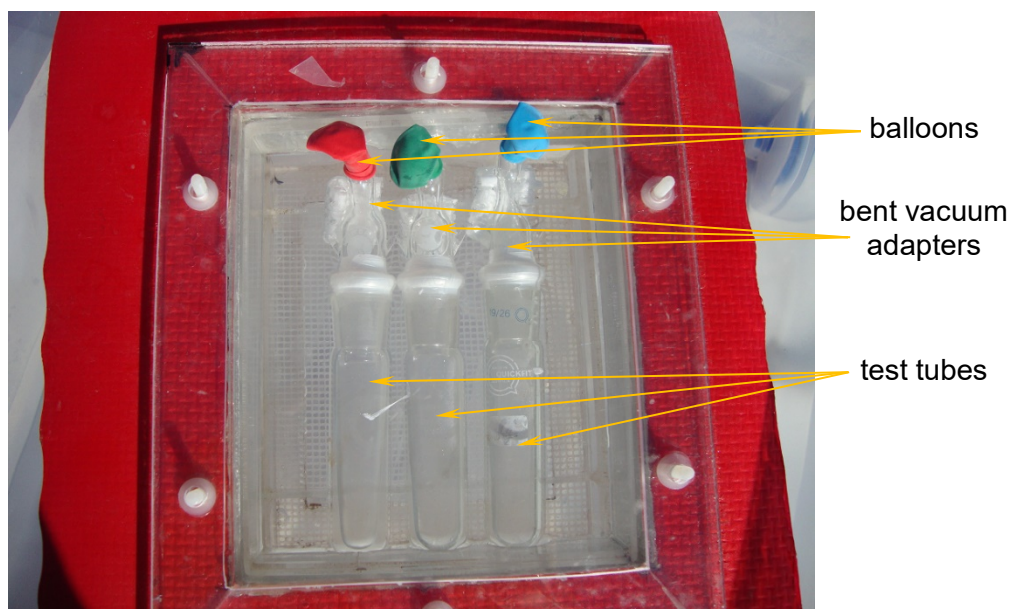


**Solar float (donated by Professor Emeritus Robert S. H. Liu from the University of Hawaii)**

View of solar float setup for naphthoquinone photoreactions.



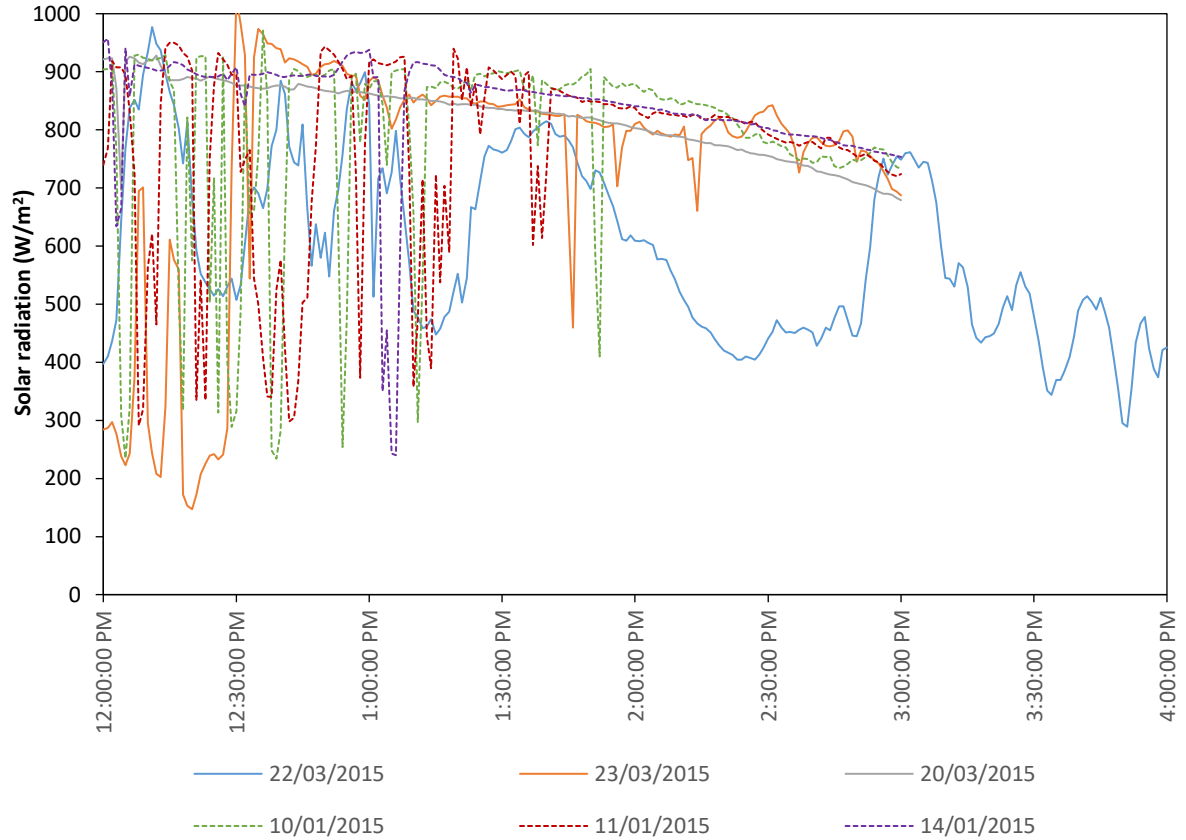
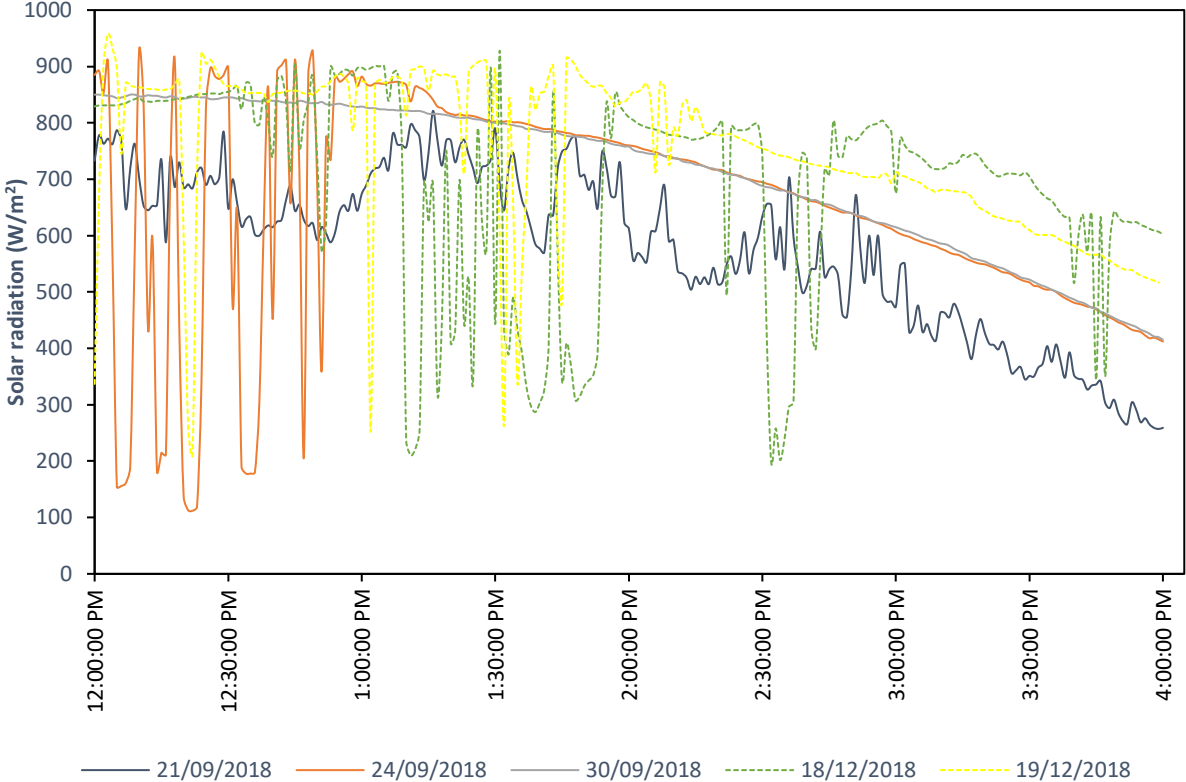
View of sample chamber for photodecarboxylations.



**Selected solar radiation data**

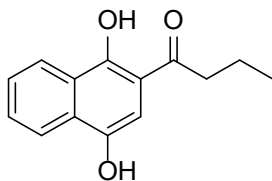
Photoacylations were conducted in February 2016 and April 2017. Photocycloadditions were conducted in September and December 2018. Photodecarboxylations were conducted in January and March 2015 and August 2009. All flow illuminations were launched at noon, when solar irradiation was most intense, and were typically run until 3-4 pm. All batch photoacylations and photocycloadditions were performed between

noon and 4 pm together with the corresponding flow experiments. Batch photodecarboxylations were conducted between 8 am and 5 pm instead.

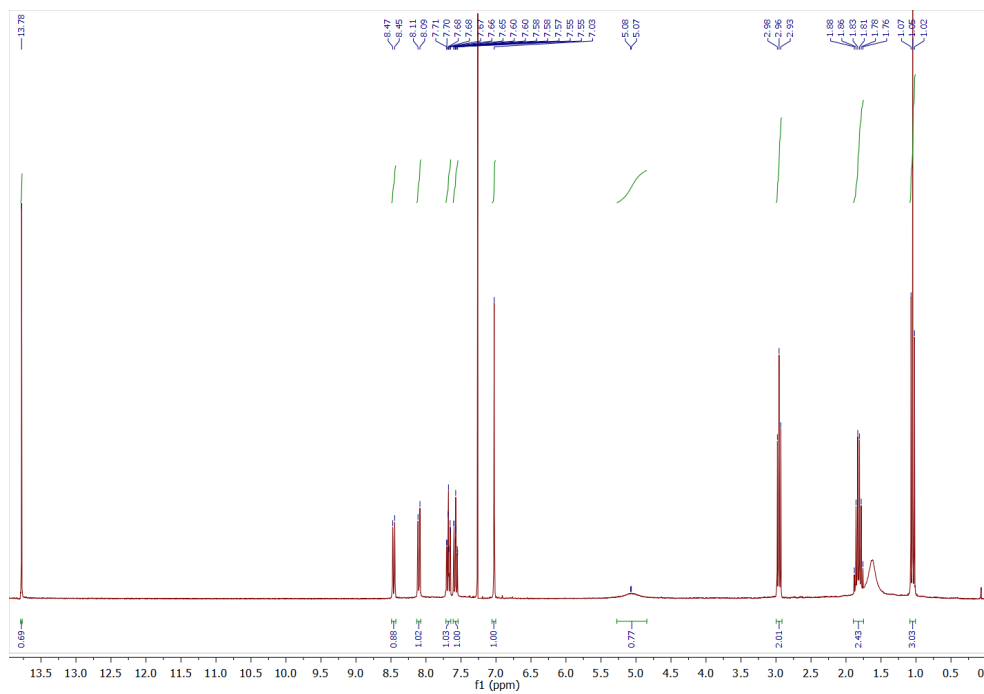


# $^1\text{H}$ - and $^{13}\text{C}$ -NMR spectra

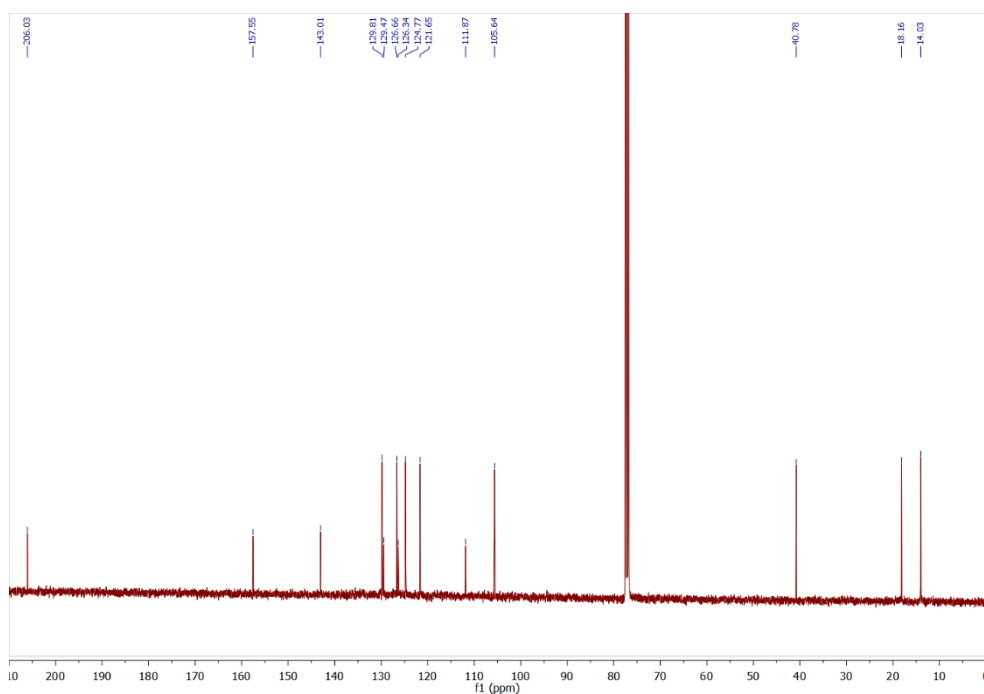
## 1-(1,4-Dihydroxynaphthalen-2-yl)butan-1-one (3a)



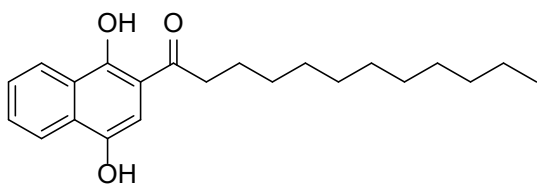
### $^1\text{H}$ -NMR (400 MHz, $\text{CDCl}_3$ ):



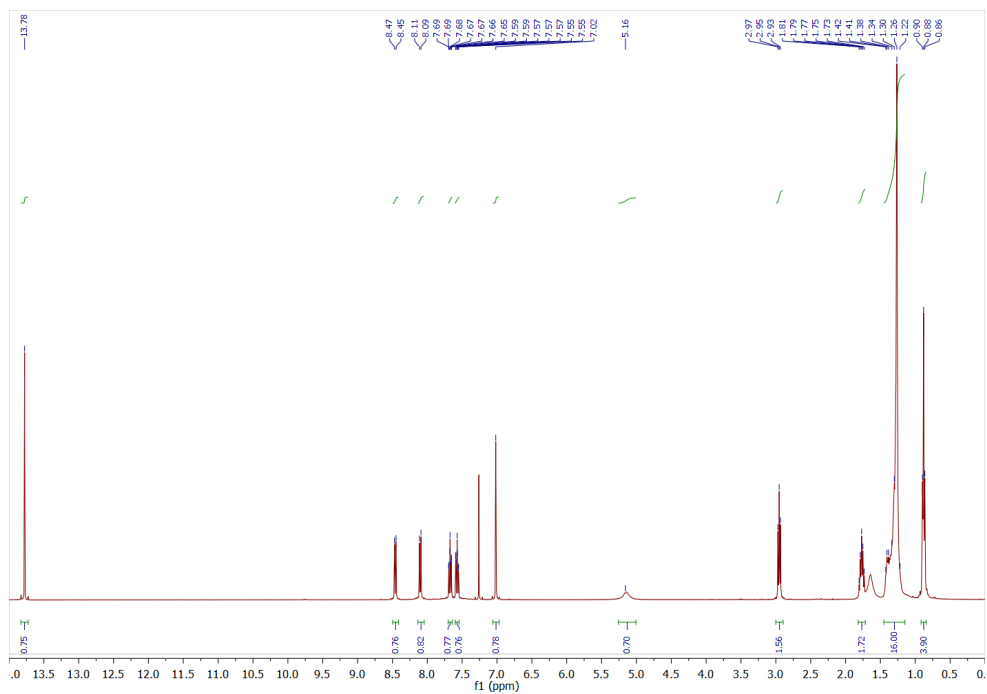
### $^{13}\text{C}$ -NMR (100 MHz, $\text{CDCl}_3$ ):



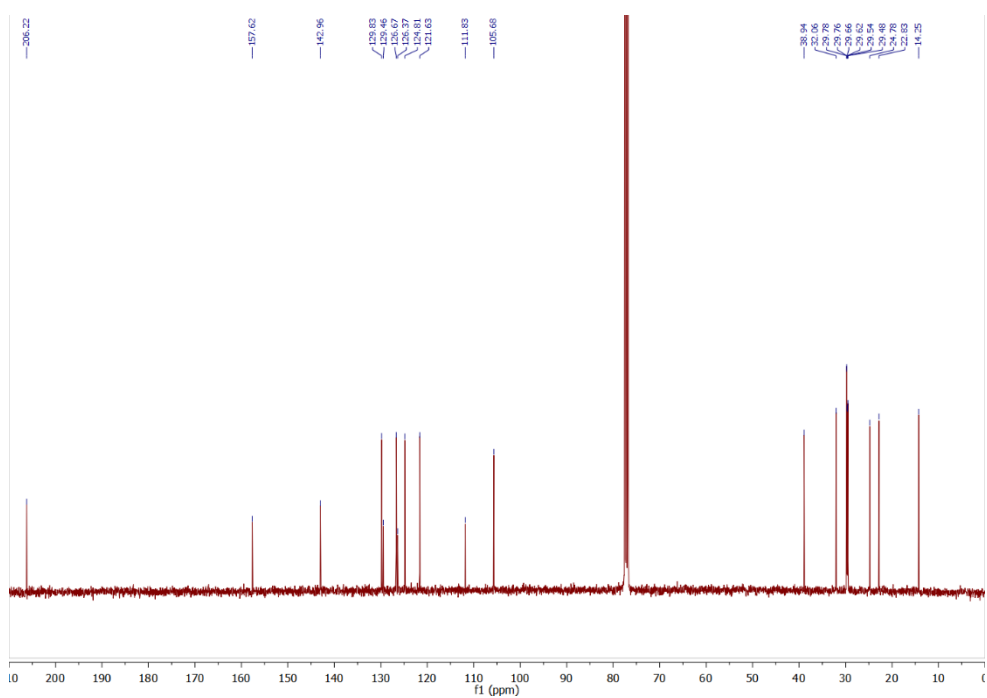
### 1-(1,4-Dihydroxynaphthalen-2-yl)dodecan-1-one (3b)



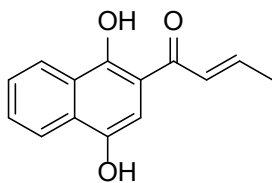
### <sup>1</sup>H-NMR (400 MHz, CDCl<sub>3</sub>):



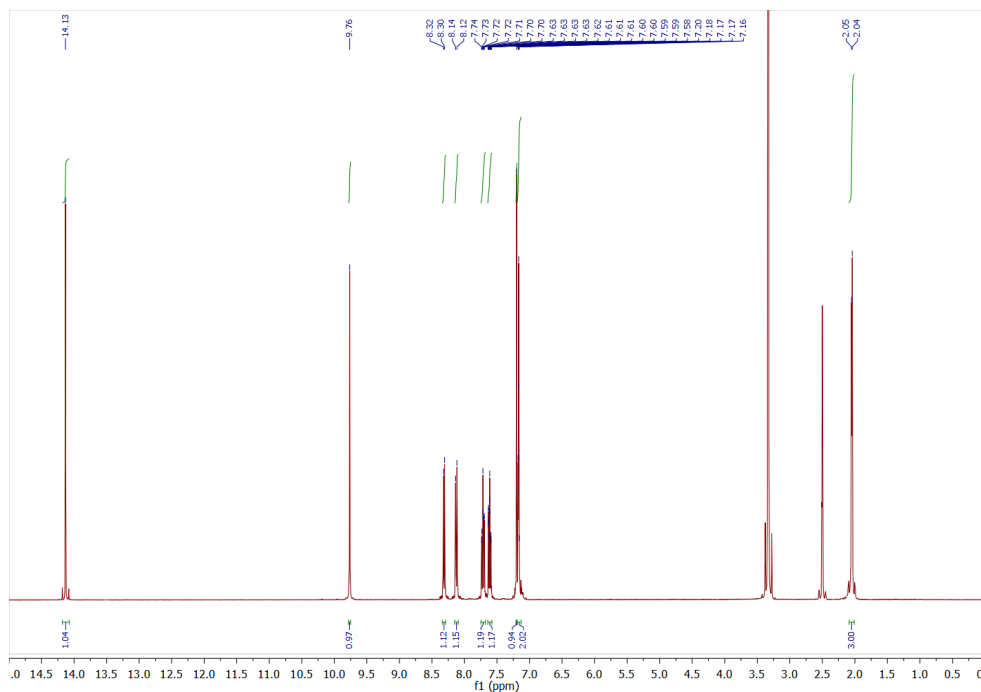
### <sup>13</sup>C-NMR (100 MHz, CDCl<sub>3</sub>):



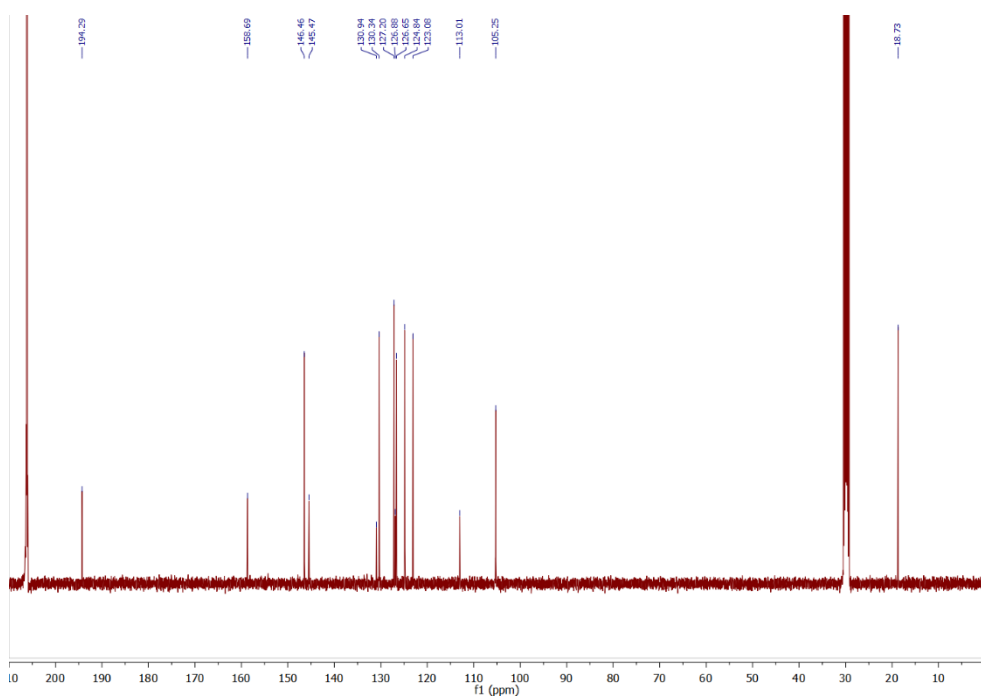
### 1-(1,4-Dihydroxynaphthalen-2-yl)buten-1-one (3c)



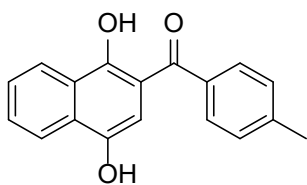
### <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>):



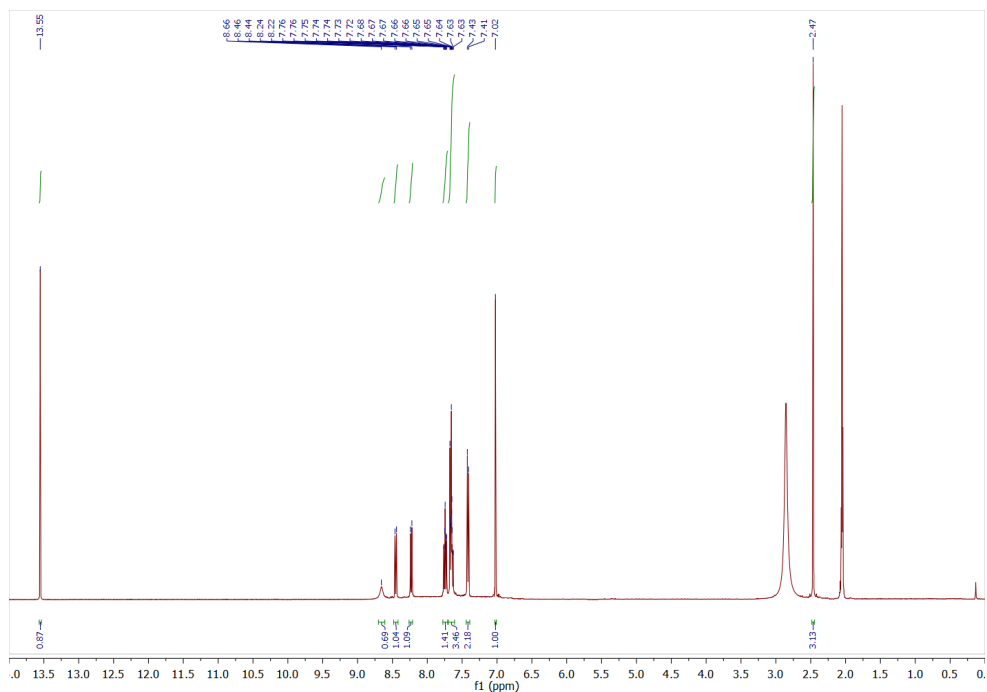
### <sup>13</sup>C-NMR (100 MHz, acetone-d<sub>6</sub>):



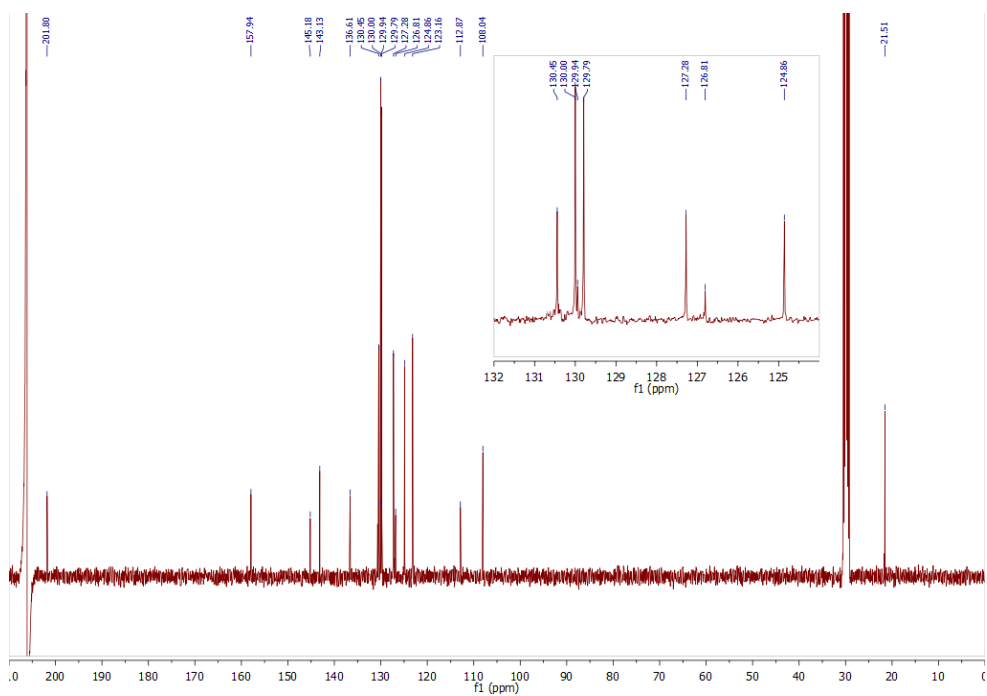
### (1,4-Dihydroxy-naphthalen-2-yl)-p-tolyl-methanone (3d)



### <sup>1</sup>H-NMR (400 MHz, acetone-d<sub>6</sub>):

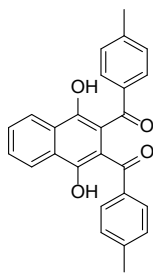


### <sup>13</sup>C-NMR (100 MHz, acetone-d<sub>6</sub>):

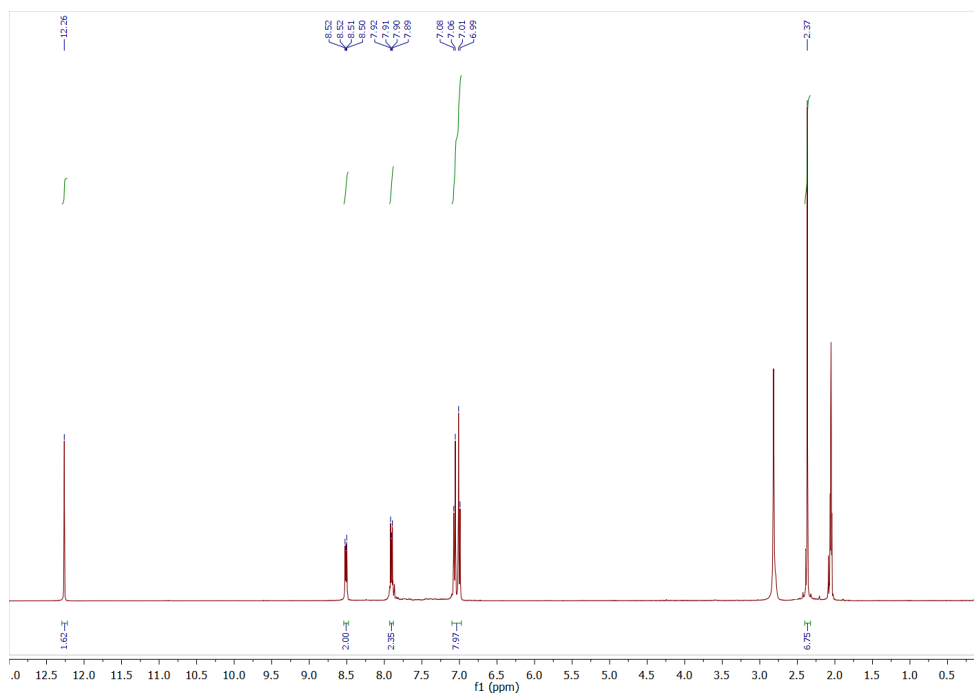




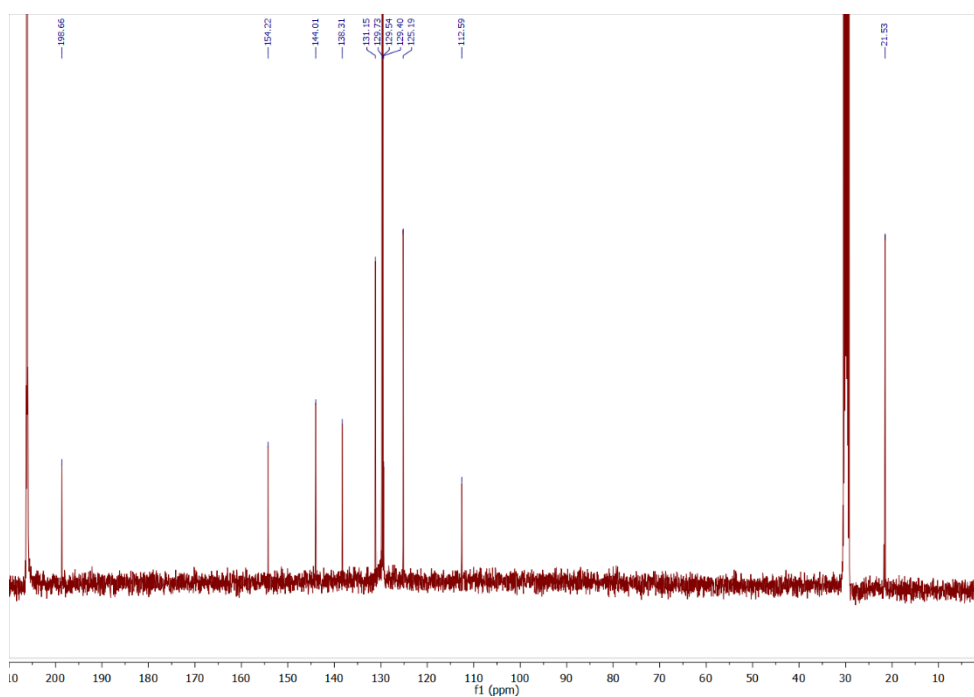
### (1,4-Dihydroxy-2-naphthalenyl)bis(*p*-tolylmethanone) (5)



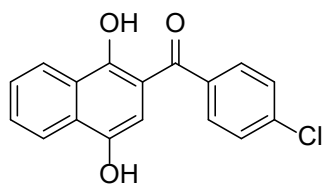
### <sup>1</sup>H-NMR (400 MHz, acetone-d<sub>6</sub>):



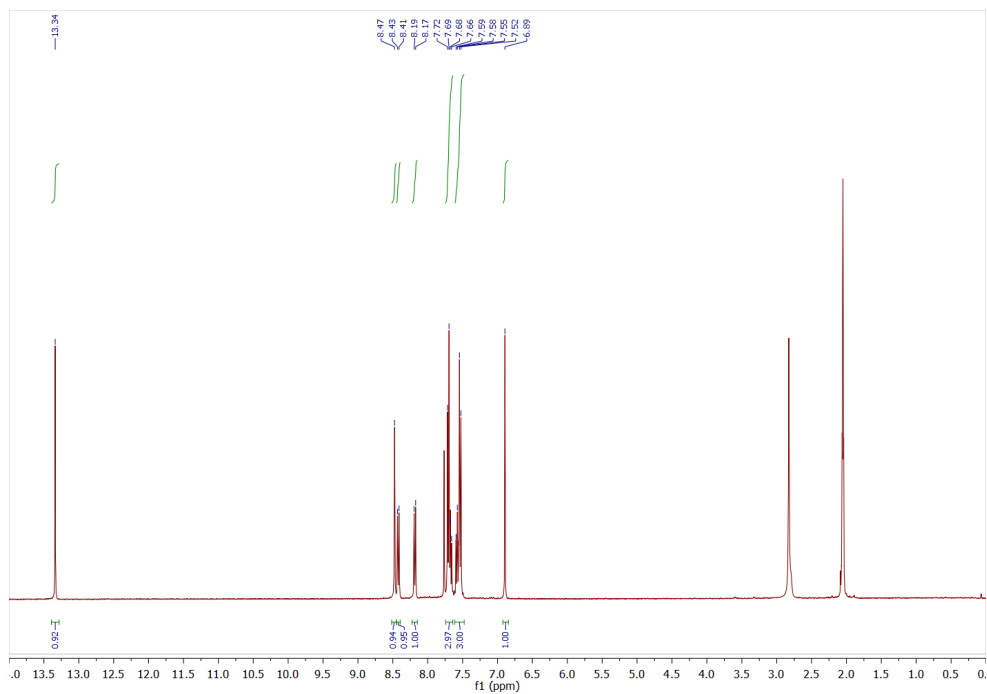
### <sup>13</sup>C-NMR (100 MHz, acetone-d<sub>6</sub>):



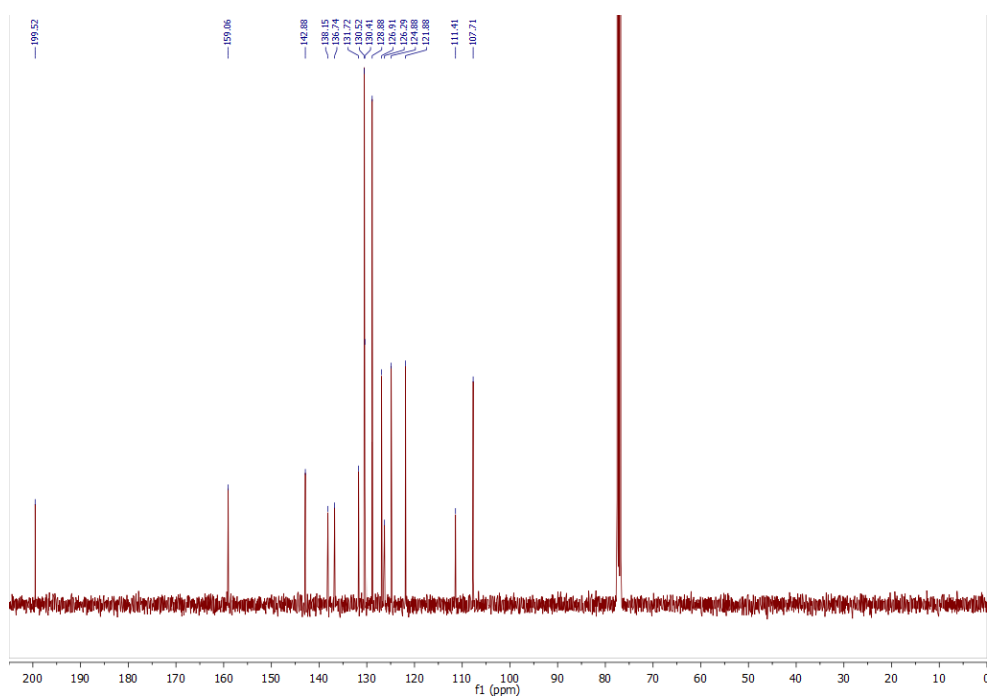
**(4-Chlorophenyl)-(1,4-dihydroxynaphthalen-2-yl)-methanone (3e)**



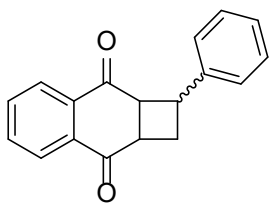
**<sup>1</sup>H-NMR (400 MHz, acetone-d<sub>6</sub>):**



**<sup>13</sup>C-NMR (100 MHz, CDCl<sub>3</sub>):**

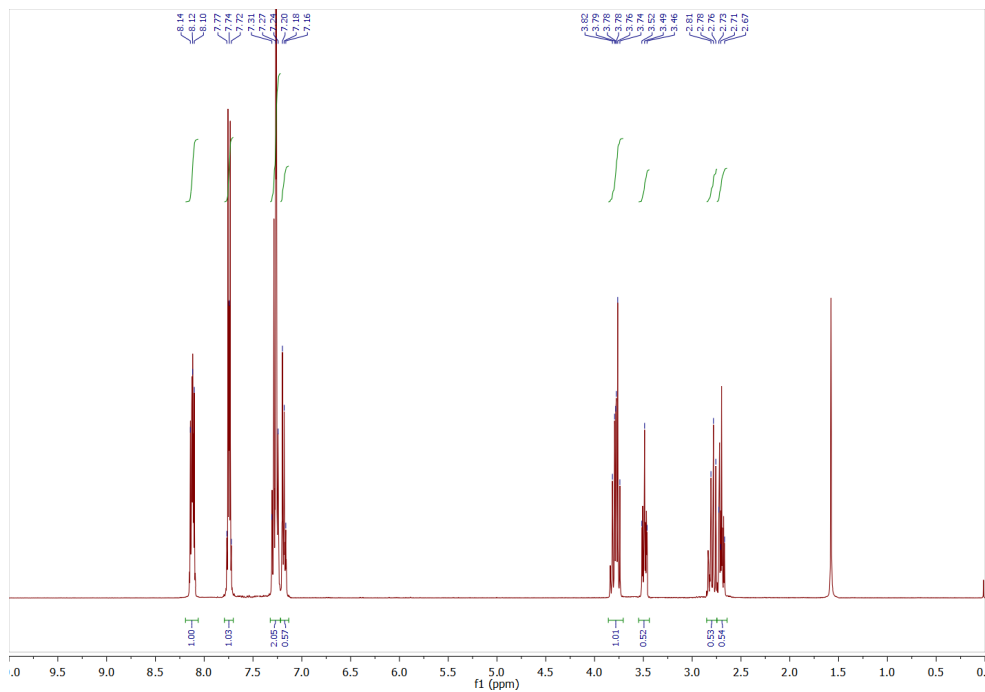


# 1-Phenyl-1,2,2a,8a-tetrahydrocyclobuta[b]naphthal-ene-3,8-dione (7a)

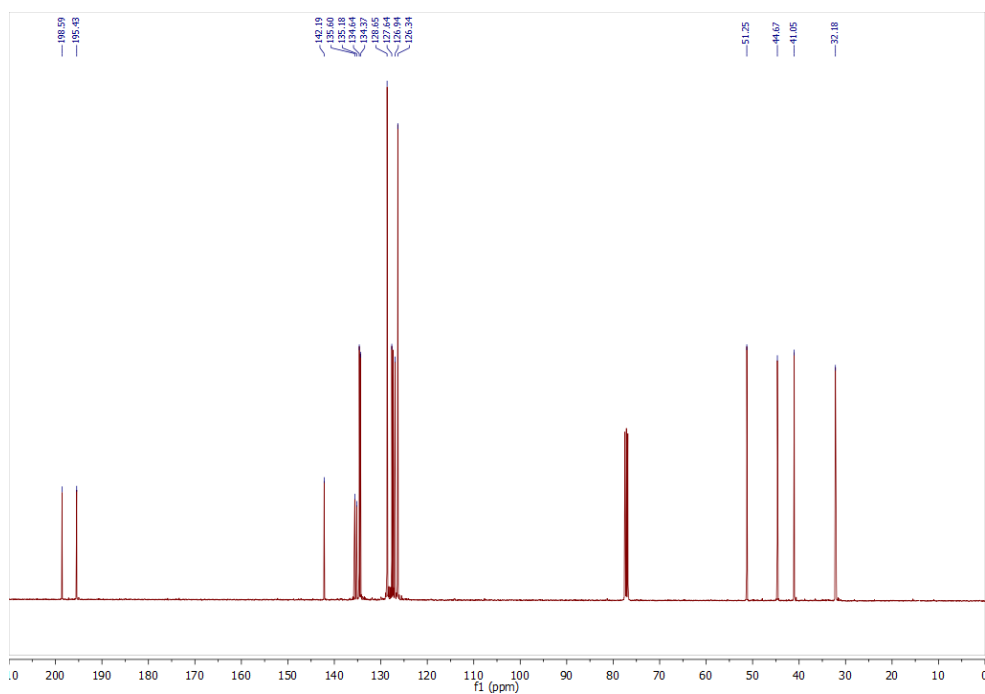


Main *anti*-isomer:

<sup>1</sup>H-NMR (400 MHz, CDCl<sub>3</sub>):

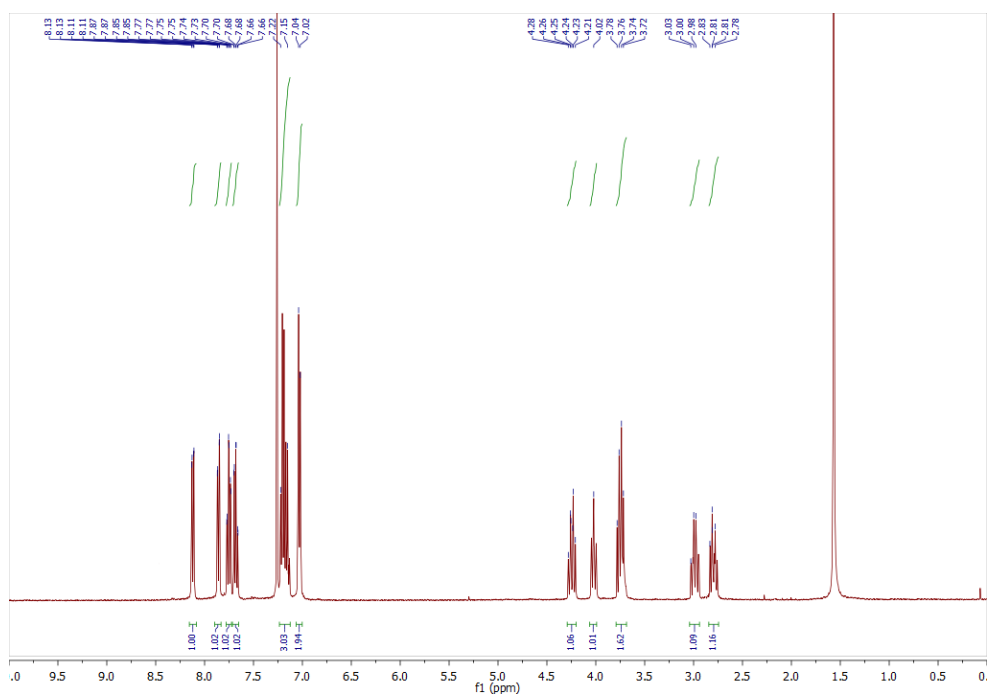


<sup>13</sup>C-NMR (100 MHz, CDCl<sub>3</sub>):

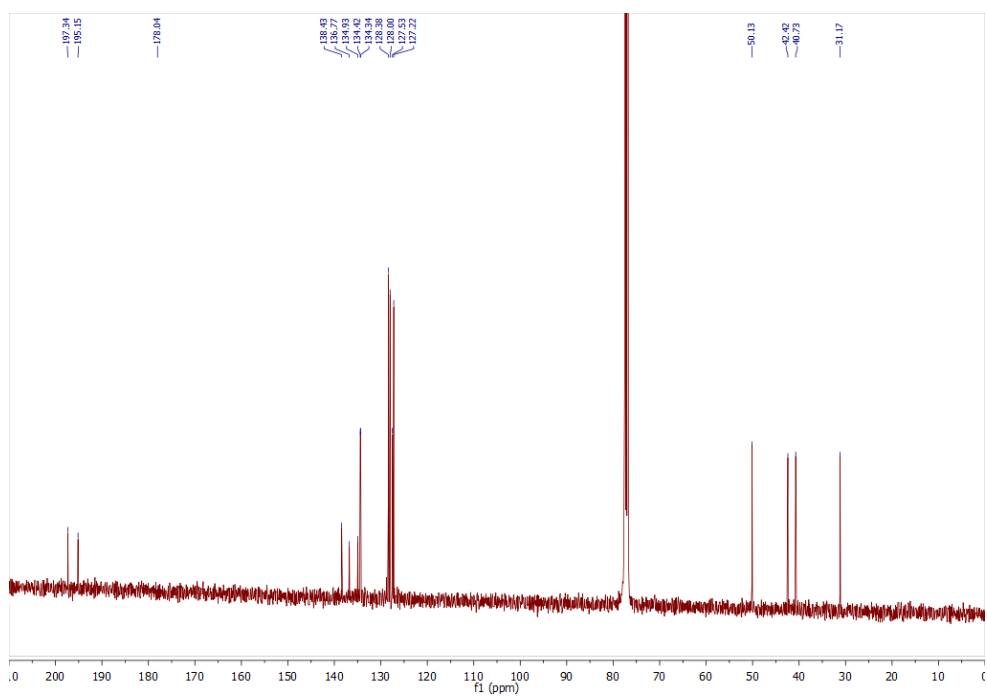


Minor *syn*-isomer:

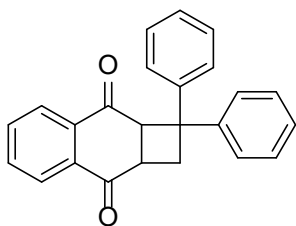
$^1\text{H-NMR}$  (400 MHz,  $\text{CDCl}_3$ ):



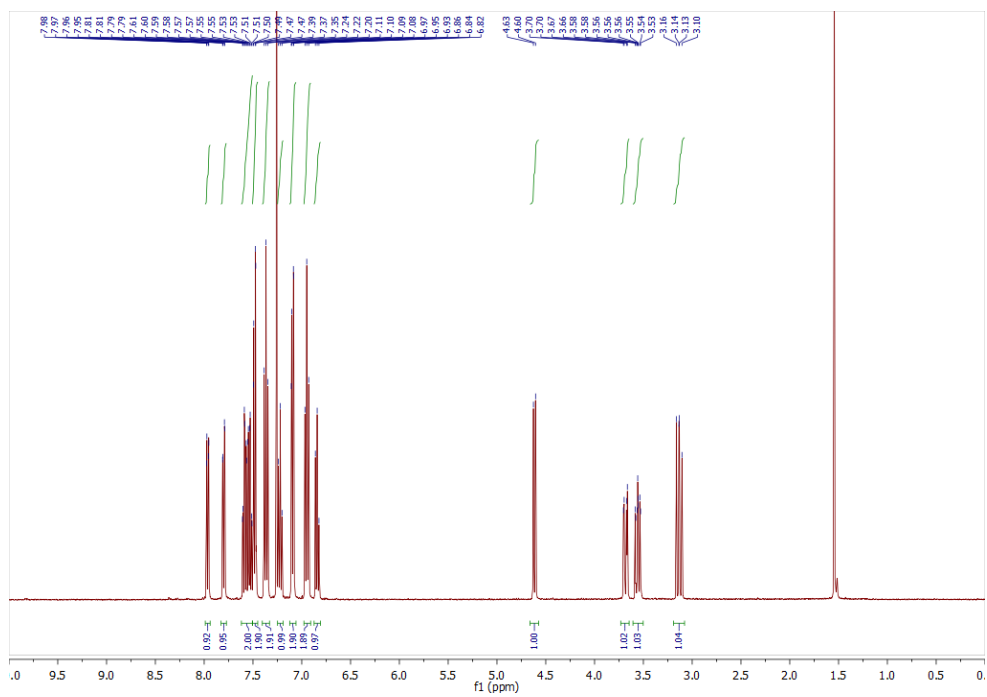
$^{13}\text{C-NMR}$  (100 MHz,  $\text{CDCl}_3$ ):



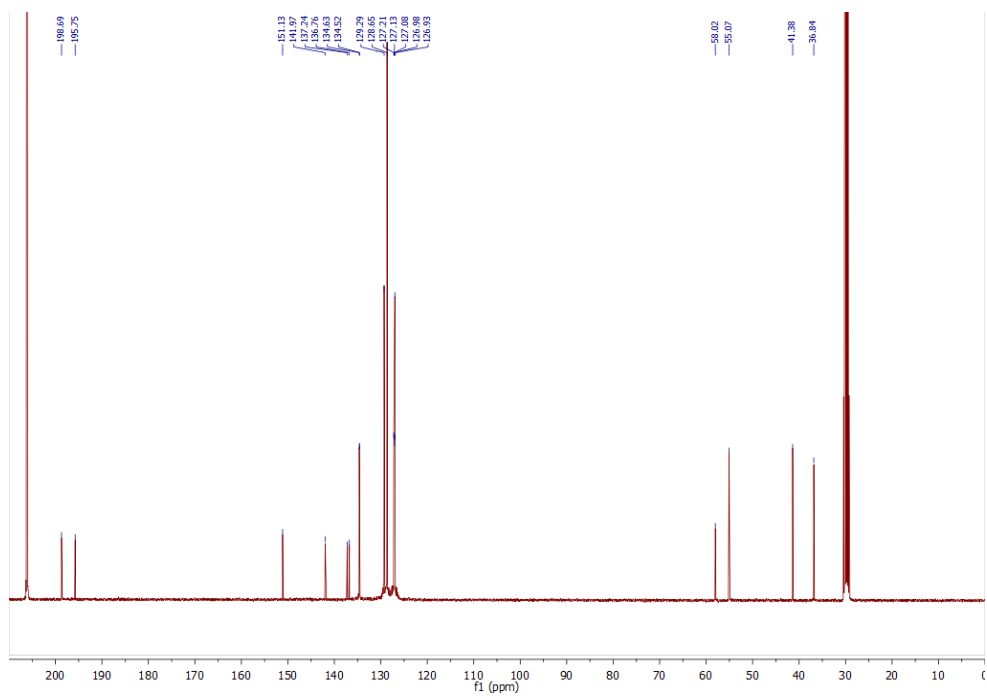
# 1,1-Diphenyl-1,2,2a,8a-tetrahydrocyclobuta[b]naphthalene-3,8-dione (7b)



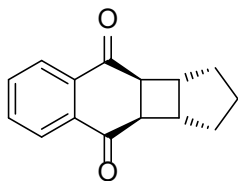
## <sup>1</sup>H-NMR (400 MHz, CDCl<sub>3</sub>):



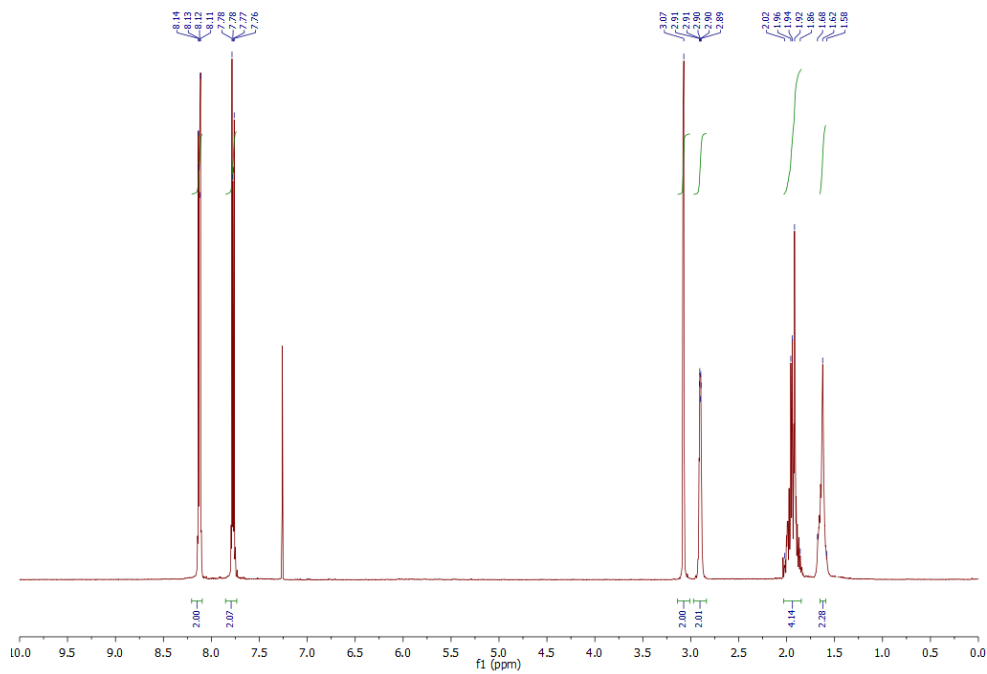
## <sup>13</sup>C-NMR (100 MHz, acetone-d<sub>6</sub>):



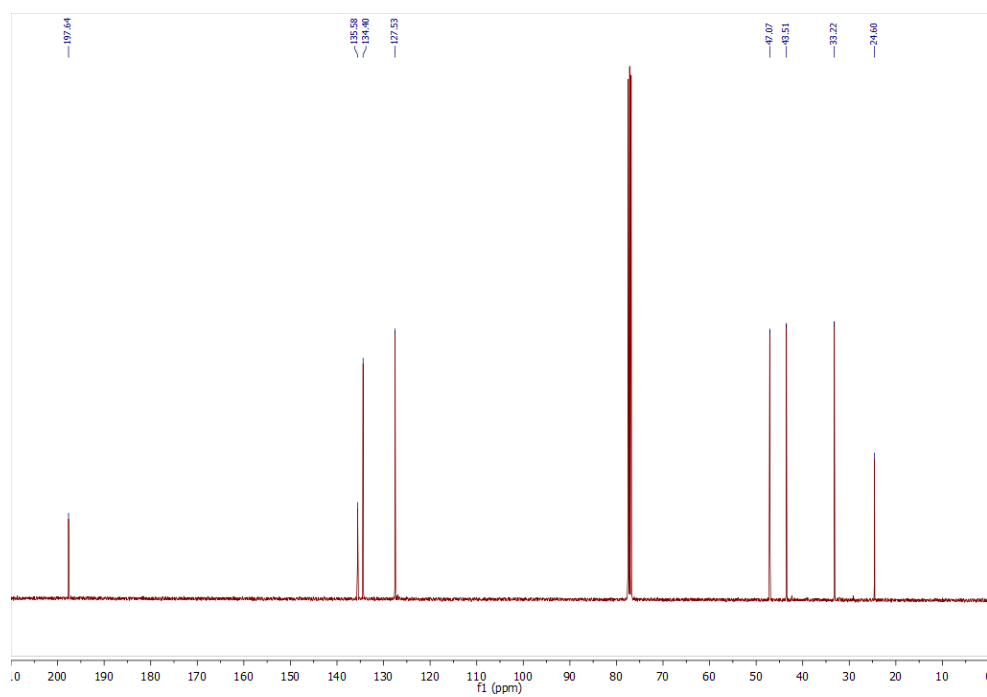
***anti*-2,3,3a,3b,9a,9b-Hexahydro-1H-cyclopenta[3,4]cyclobuta[1,2-b]naphthalene-4,9-dione (7c)**



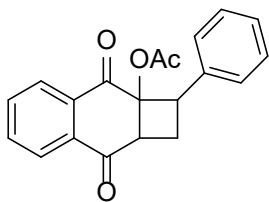
**$^1\text{H-NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**



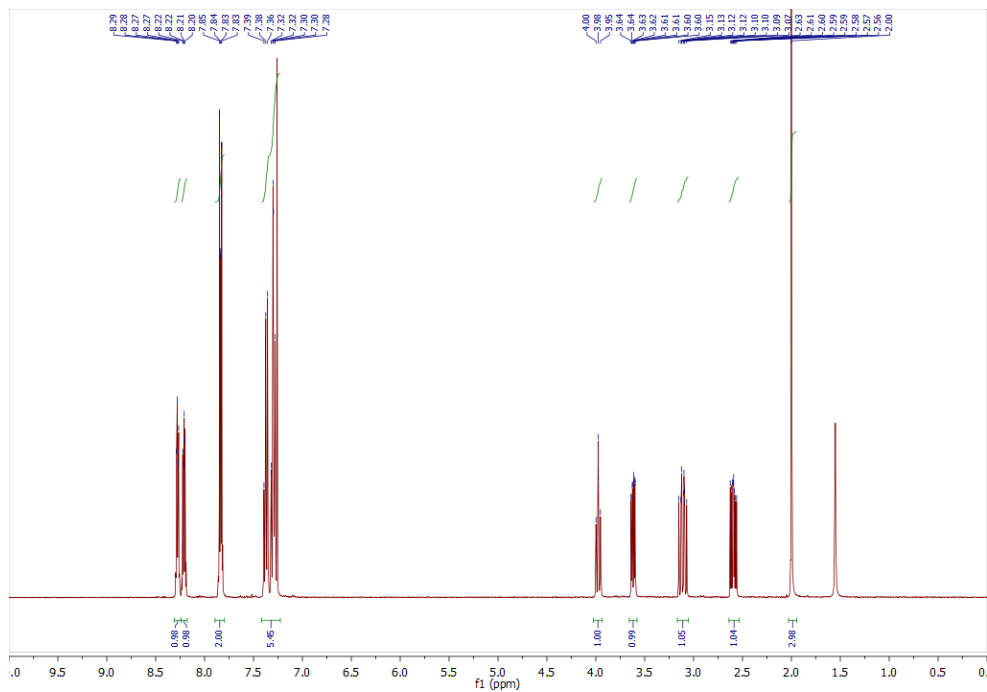
**$^{13}\text{C-NMR}$  (100 MHz,  $\text{CDCl}_3$ ):**



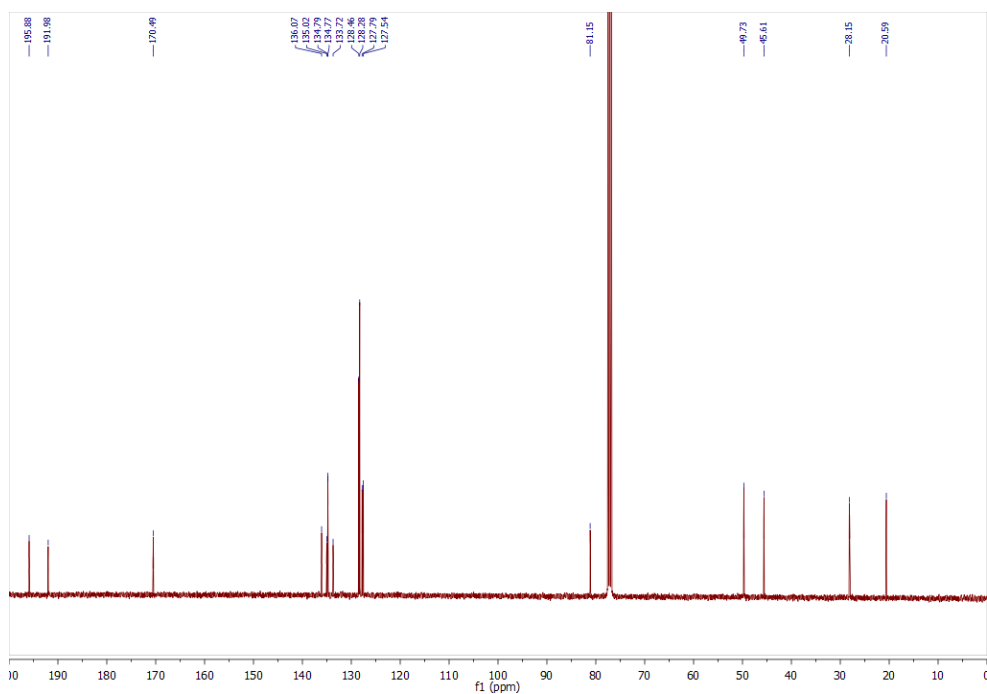
**3,8-Dioxo-2-phenyl-1,3,8,8a-tetrahydrocyclobuta[b]naphthalene-2a(2H)-yl acetate (7d)**



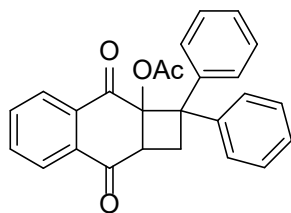
**<sup>1</sup>H-NMR (400 MHz, CDCl<sub>3</sub>):**



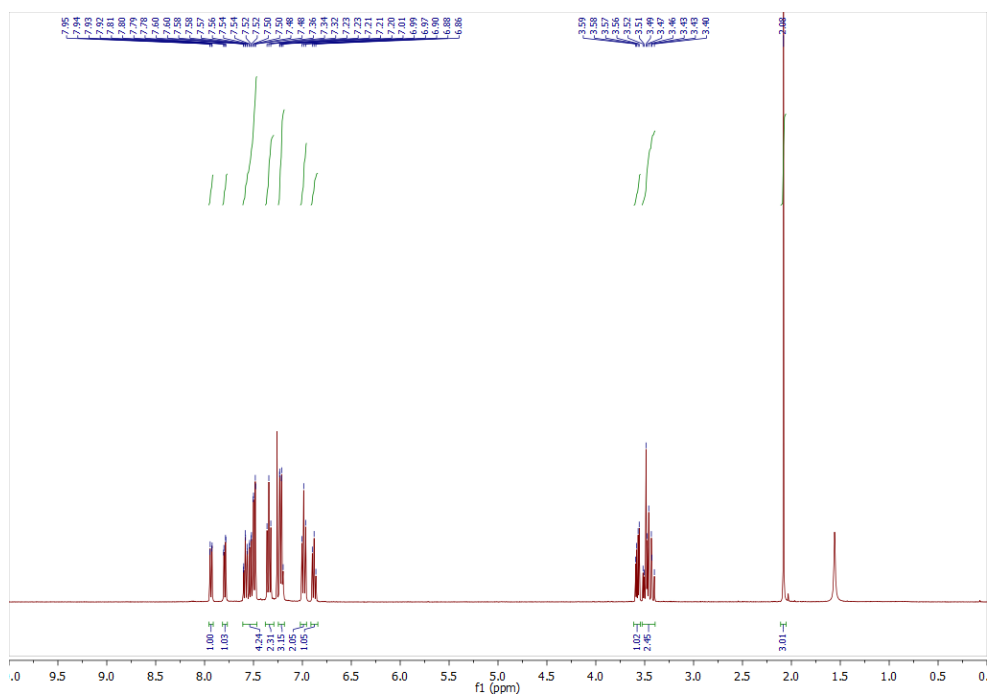
**<sup>13</sup>C-NMR (100 MHz, CDCl<sub>3</sub>):**



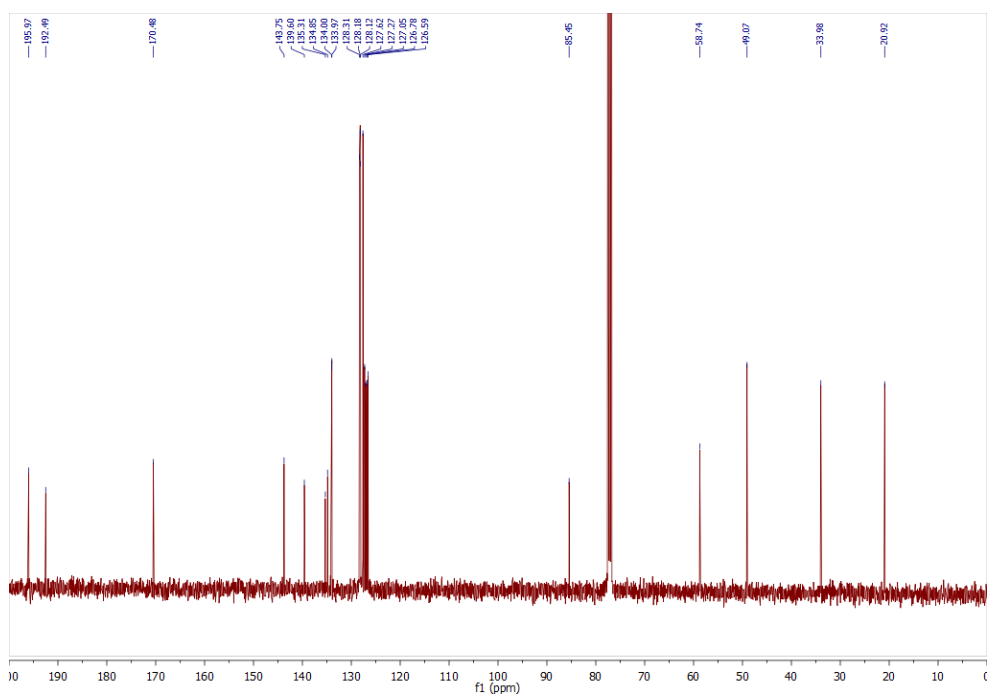
**3,8-Dioxo-2,2-diphenyl-1,3,8,8a-tetrahydrocyclobuta[b]-naphthalen-2a(2H)-yl acetate (7e)**



**<sup>1</sup>H-NMR (400 MHz, CDCl<sub>3</sub>):**

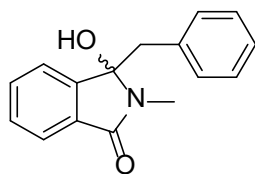


**<sup>13</sup>C-NMR (100 MHz, CDCl<sub>3</sub>):**

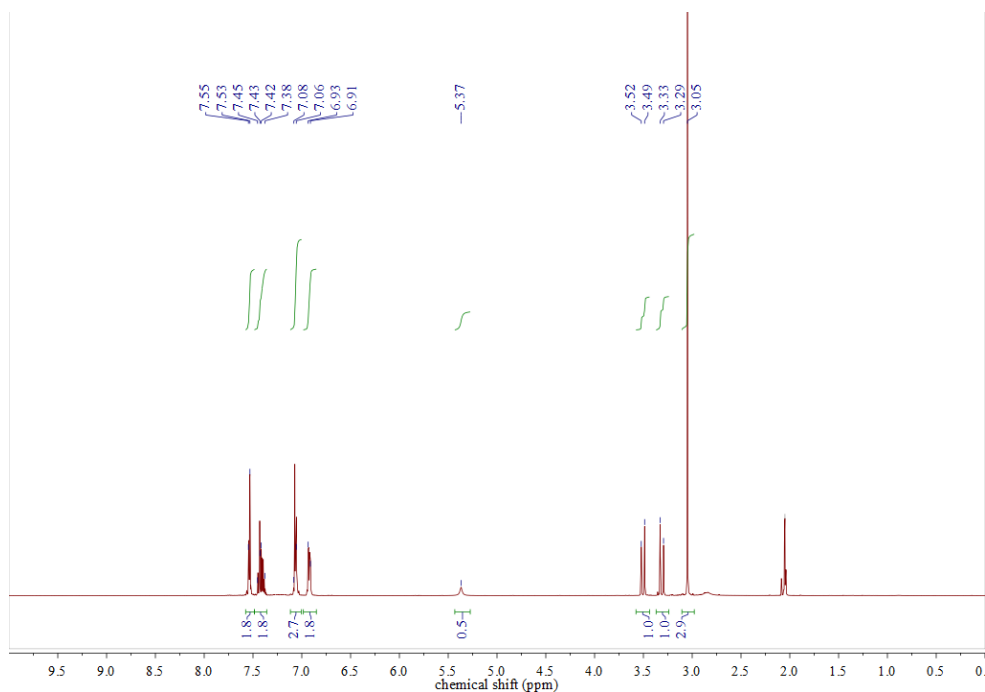




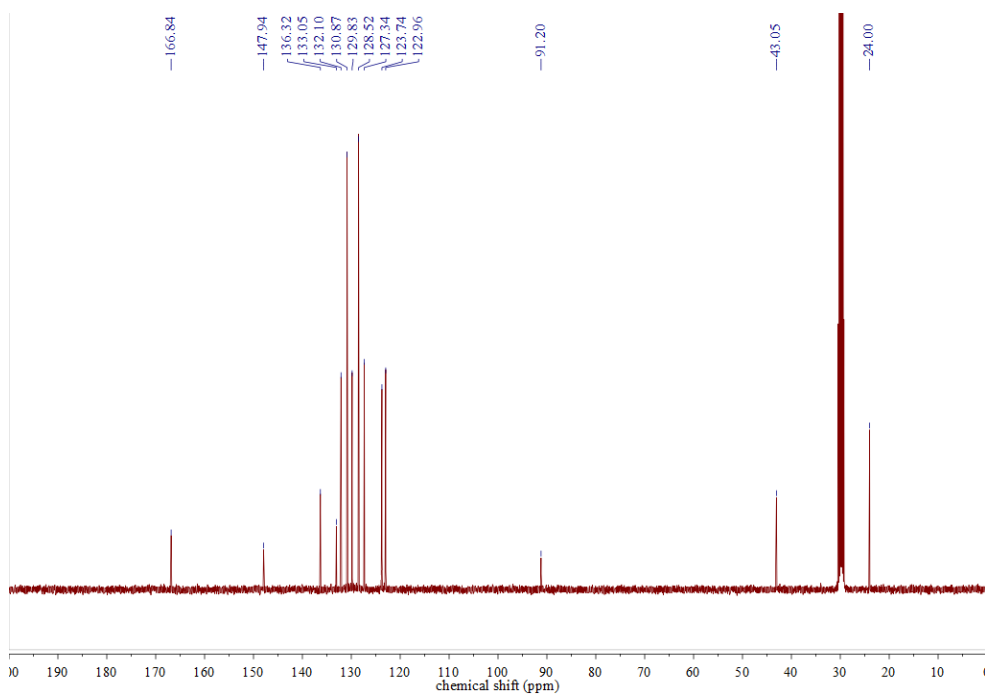
### 3-Benzyl-3-hydroxy-2-methylisoindolin-1-one (10a)



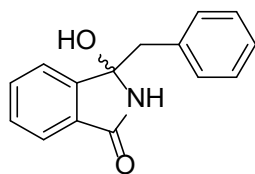
### <sup>1</sup>H-NMR (400 MHz, acetone-d<sub>6</sub>):



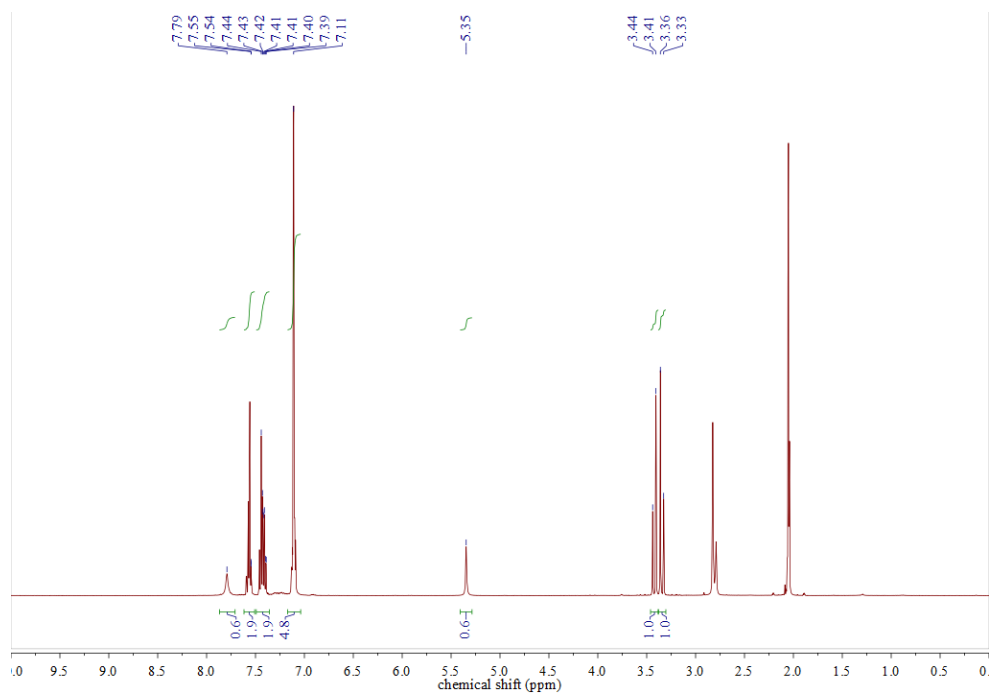
### <sup>13</sup>C-NMR (100 MHz, acetone-d<sub>6</sub>):



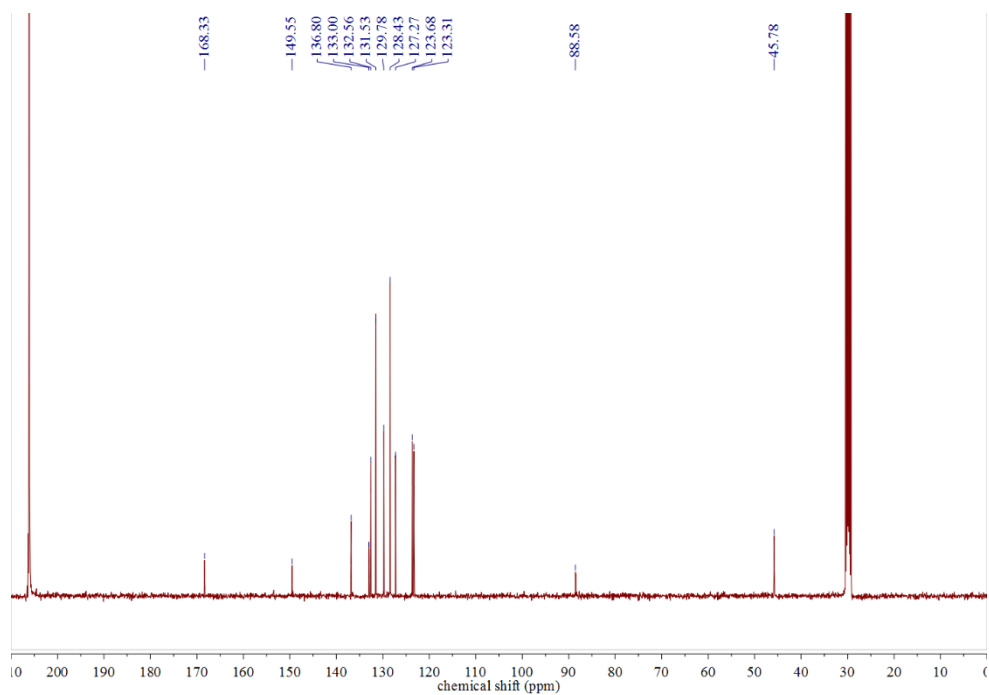
### 3-Benzyl-3-hydroxyisoindolin-1-one (10b)



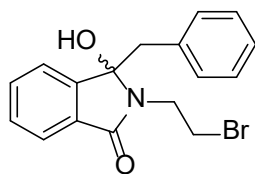
### <sup>1</sup>H-NMR (400 MHz, acetone-d<sub>6</sub>):



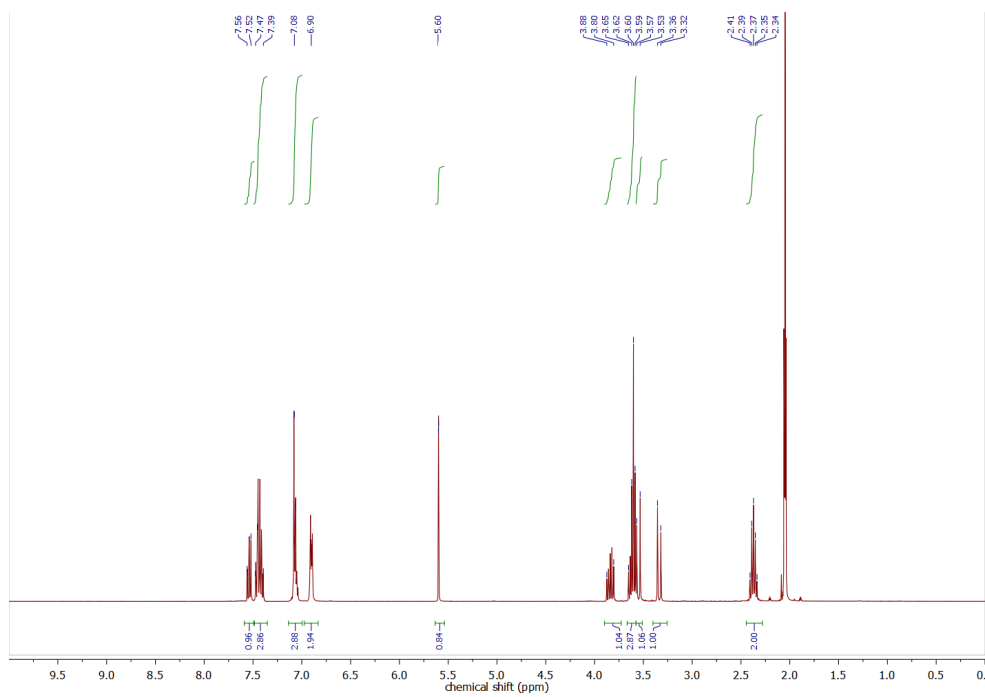
### <sup>13</sup>C-NMR (100 MHz, acetone-d<sub>6</sub>):



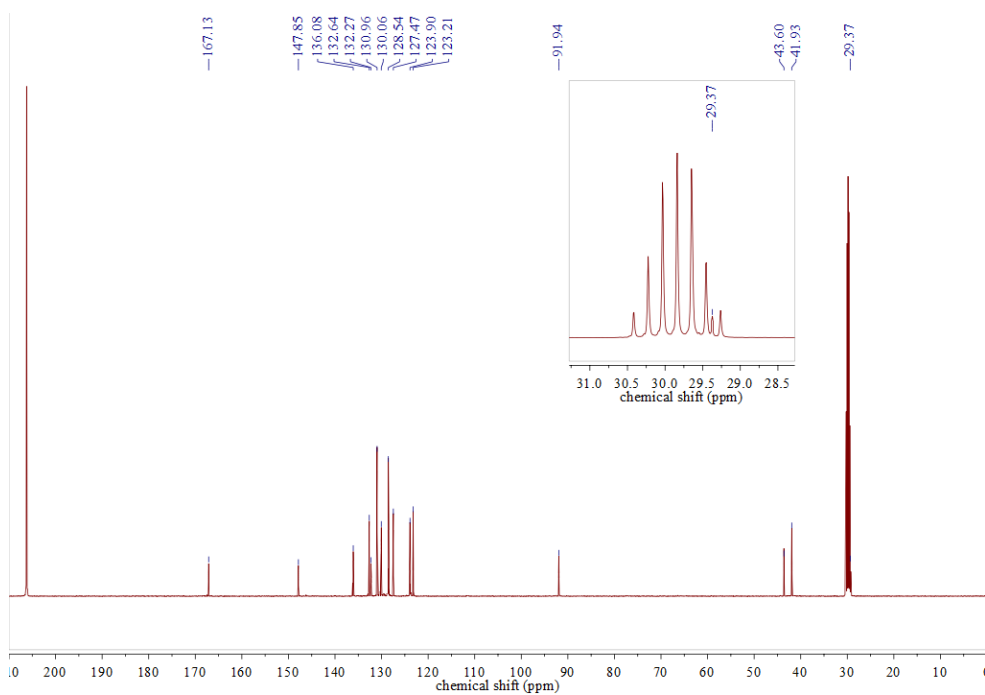
### 3-Benzyl-2-(2-bromoethyl)-3-hydroxyisoindolin-1-one (10c)



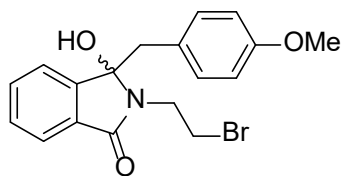
### $^1\text{H-NMR}$ (400 MHz, acetone- $d_6$ ):



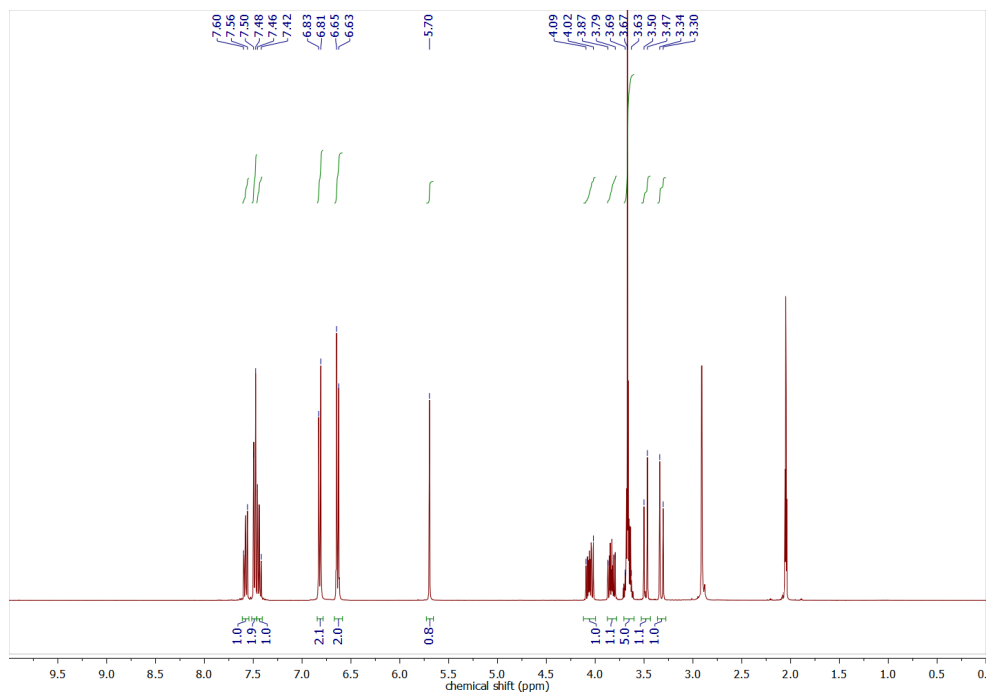
### $^{13}\text{C-NMR}$ (100 MHz, acetone- $d_6$ ):



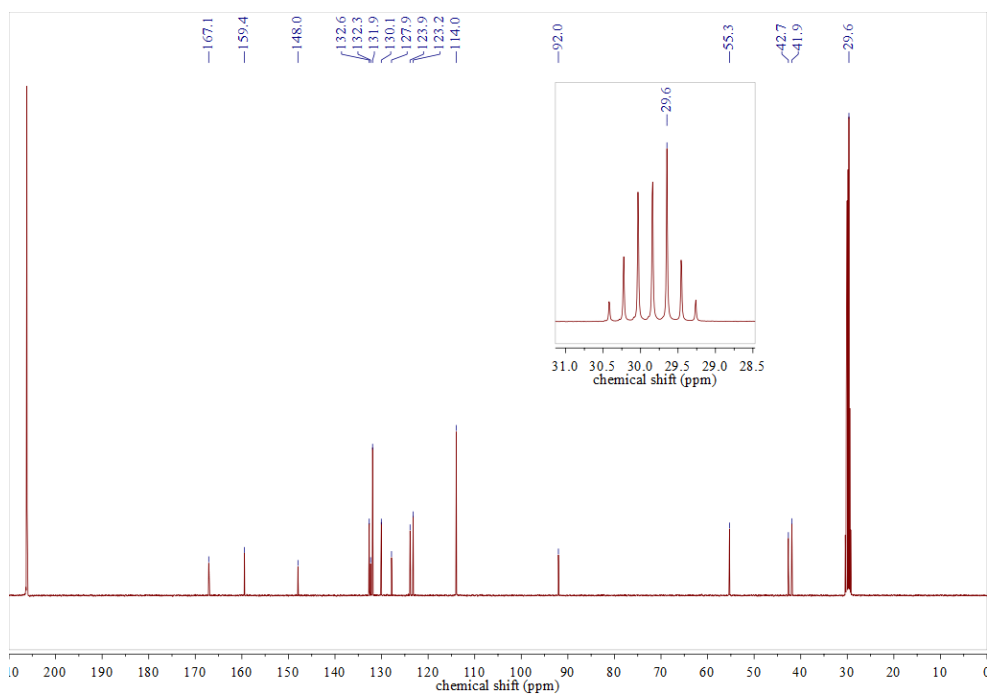
## 2-(2-Bromoethyl)-3-hydroxy-3-(4-methoxybenzyl)isoindolin-1-one (10d)



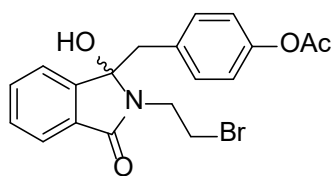
### $^1\text{H-NMR}$ (400 MHz, acetone- $d_6$ ):



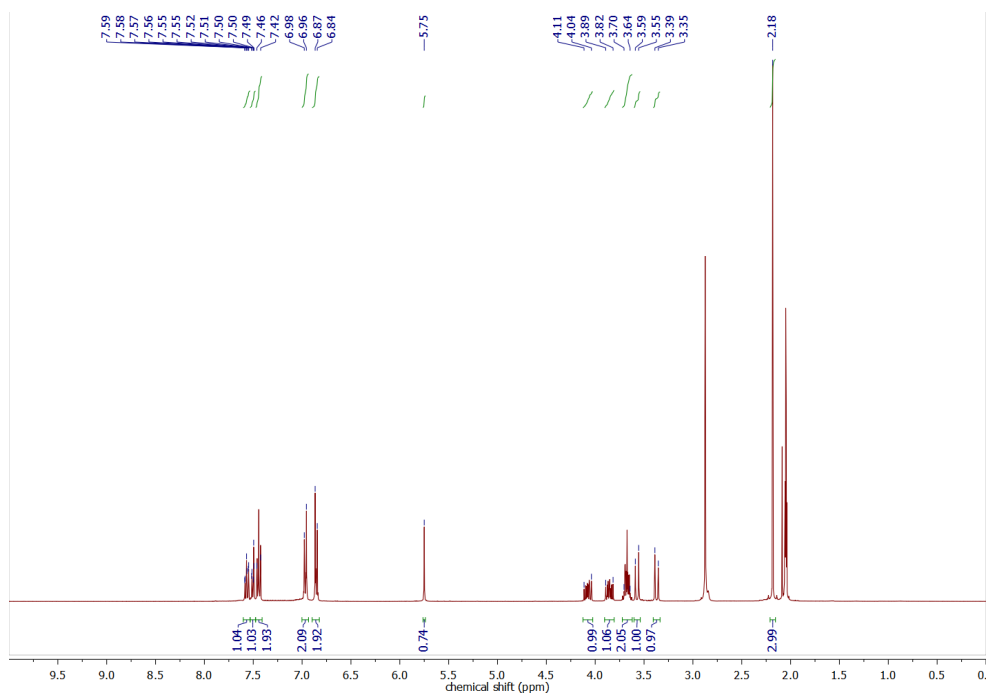
### $^{13}\text{C-NMR}$ (100 MHz, acetone- $d_6$ ):



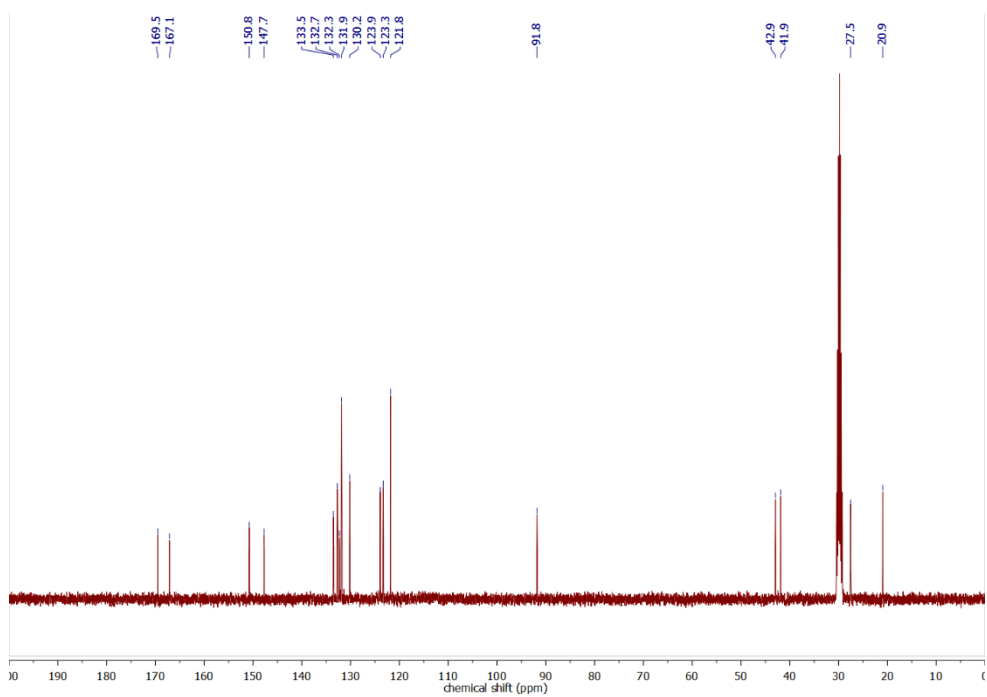
### 4-((2-(2-Bromoethyl)-1-hydroxy-3-oxoisoindolin-1-yl)methyl)phenyl acetate (10e)



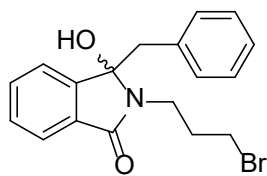
### <sup>1</sup>H-NMR (400 MHz, acetone-d<sub>6</sub>):



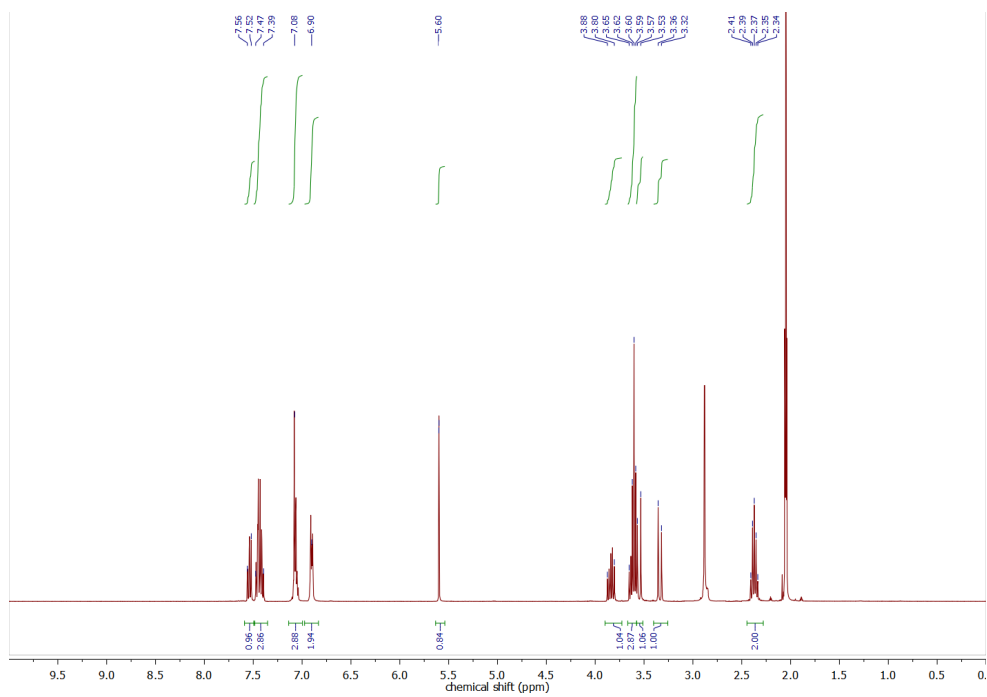
### <sup>13</sup>C-NMR (100 MHz, acetone-d<sub>6</sub>):



### 3-Benzyl-2-(3-bromopropyl)-3-hydroxyisoindolin-1-one (10f)



#### <sup>1</sup>H-NMR (400 MHz, acetone-d<sub>6</sub>):



#### <sup>13</sup>C-NMR (100 MHz, acetone-d<sub>6</sub>):

