Supporting Information

Iron/Photoredox Dual Catalysis for Acyl Nitrene-Based C-O Bond Formation towards Phthalides

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1.General information

Unless otherwise noted, all of the reagents were purchased from commercial suppliers and used without purification. All commercially available compounds were purchased from Energy Chemical, Bidepharm or Adamas. TLC was carried out on SiO_2 (silica gel 60 F254, Merck), and the spots were located with UV light (254 nm). Flash chromatography was carried out on SiO_2 (silica gel 60, 200-300 mesh). NMR spectra were measured on a Bruker magnetic resonance spectrometer (^1H at 400 MHz, ^{13}C at 100 MHz). Chemical shifts are reported in ppm using tetramethylsilane as internal standard (s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublets, m = multiplet). $CDCl_3$ and TMS were used as a solvent and an internal standard, respectively. MS data were obtained on an Agilent 5975C inert 350 EI mass spectrometer (GC-MS); IR spectra were recorded on a NEXUS FT-IR spectrometer. HRMS data were obtained on a VG ZAB-HS mass spectrometer, Brucker Apex IV FTMS spectrometer. Absorption spectra were obtained on a HITACHI U-2910 spectrometer. X-Ray single-crystal diffraction data were collected on an Agilent Technologies Gemini single-crystal diffractometer.

For light-promoted reactions, we use RLH-18 8-position Photo Reaction System, which manufactured by Beijing Rogertech Co. Ltd base in Beijing PRC. This Photo reactor we used have equipped 8 bule light 10W LED, other LEDs could be selected and replaced each positon. This blue light 10W LED's energy peak wavelength is 453.6 nm, peak width at half-height is 20.4 nm, Iirradiance@5W is 246 mW/cm^2. Irradiation vessel is general schlenk tube, LED irradiate through a high-reflection channel to the test tube, path length is 2 cm. no filter between LED and test tube. And the temperature of the heated reactor was set to indicate temperature.

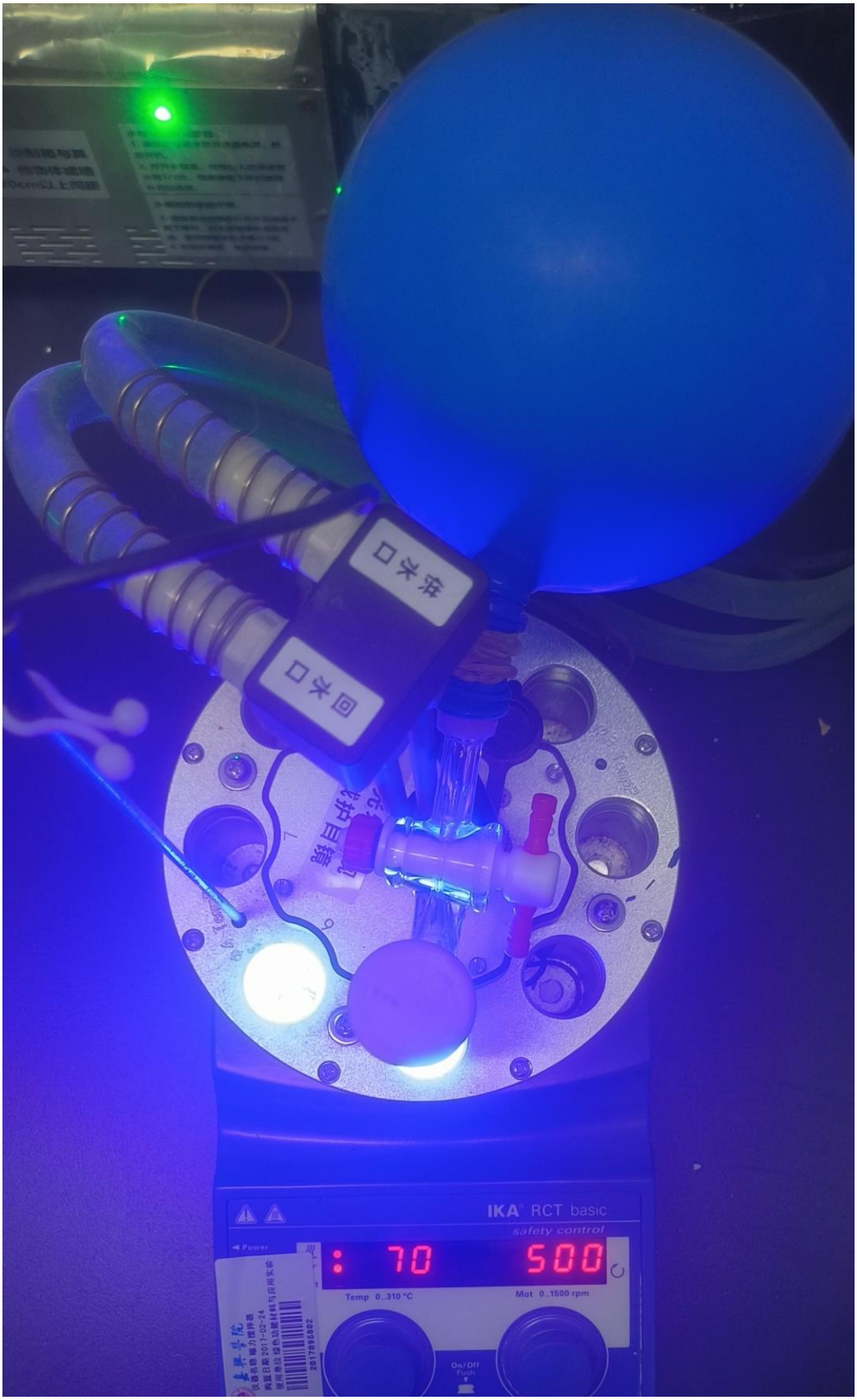


Figure S1. Setup for photocatalytic reactions

北京博测科技有限公司
http://www.rogertech.cn/
Tel: +86(010)59713125
Fax:

LED Test Report

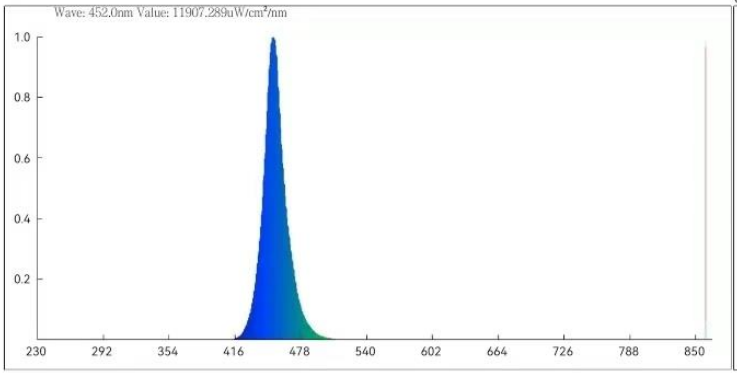
Product Mark

Model: 1-455 nm (452.6)@5W
Manufacture: Beijing Rogertech Co.ltd
Temperaturc: 23°C
Humidity: 20%
Tester: WU
Test Date: 2021-04-12,14:54:09

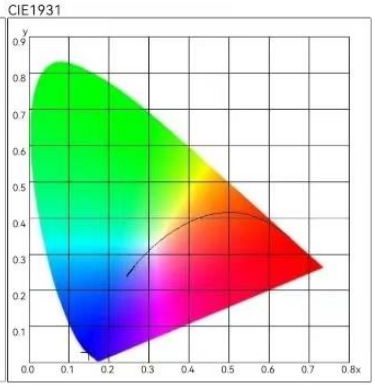
Parameter

Name	value	Name	Value	Name	Value	Name	Value
URH mW/cm²	0.0000	CIE u,v	0.1965,0.0556	CIE1931 Y	159560.406		
UVC mW/cm²	0.0000	CIE u',v'	0.1965,0.0833	CIE1931 Z	4664709.500		
UVB mW/cm²	0.0000	SDCM	100.00	TLCI-2012	0		
UVA mW/cm²	0.0000	Ra	-70.1	Integral (ms)	0.1		
Euv mW/cm²	0.00	Ee(mW/cm²)	289.80399	Peak Signal	63321		
Eb mW/cm²	289.13	S/P	22.956	Dark Signal	3504		
Eg mW/cm²	0.79	Dominant (nm)	457.40	Compensate level	2892		
Er mW/cm²	0.00	Purity (%)	99.2				
Eir mW/cm²	0.00	HalfWidth(nm)	19.8				
E(lx)	108979.77	Peak (nm)	452.6				
Candle E(fc)	10124.47	Center (nm)	453.3				
CCT (K)	100000	Centroid (nm)	455.0				
Duv	-0.06750	Color Ration (RGB)	0.0,5.5,94.5				
CIE x,y	0.1493,0.0281	CIE1931 X	846566.125				

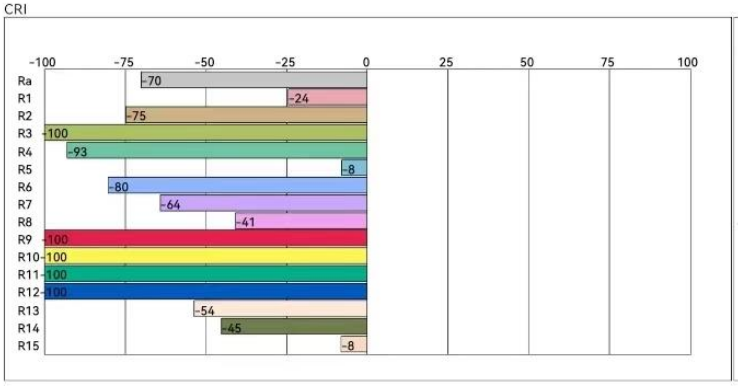
Spectrogram

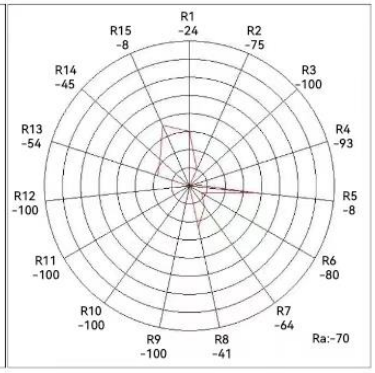


CIE1931



CRI





Instrument Status

Type: OHSP-350UV
SN: 0
Scan Range: 230-850nm
Integral Time: 0.050ms
Peak Signal: 63321
VDark: 3504

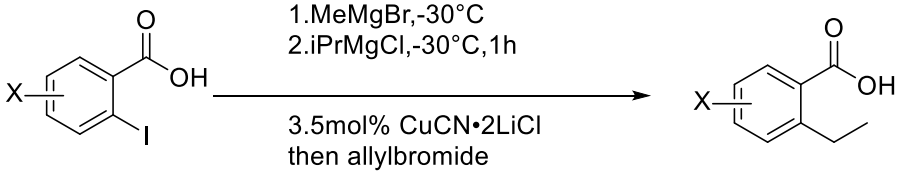
Remark: Test in 5W

- 1 -

Figure 2. Spectrophotocolormeter analysis report

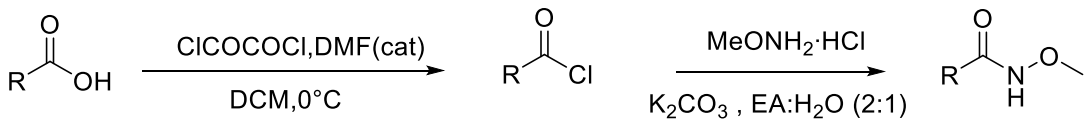
2.Procedure for the preparation of starting materials

(a) General procedure for the synthesis of Various types of benzoic acid



2-Ethylbenzoic acid was prepared by a slightly modified procedure from known literature [1]. To a stirred solution of 2-iodobenzoic acid in THF (0.33M) at -30 ºC was slowly added MeMgBr (1.0 equiv.), then iPrMgCl (1.2 equiv.) The reaction was stirred at -30 ºC for 1 h or until by GC/MS (aliquots were quenched with water prior to analysis) then the reaction was cooled to -40 ºC and CuCN·2LiCl in THF (5 mol%, 0.34M,) was added slowly and stirred for about 10 minutes while warming to -30 ºC. Iodoethane (3 equiv) was added Once and allow the reaction to warm to ambient temperature overnight. The reaction was diluted with EtOAc, quenched with NH_4Cl, and extracted with EtOAc (3 x 20 ml). The combined organic layers were washed with brine and dried over Na_2SO_4. This concentrated the organic layer and dissolved it in the corresponding alcohol (MeOH or ethanol, 0.25M). To the stirred solution was added NaOH (10 equiv, 2.5 M) and the reaction was stirred for 6 hours. The alcohol was distilled off and the crude mixture was washed with Et_2O. The aqueous layer was acidified with 1M HCl to pH =3 and extract with CH_2Cl_2. Wash the combined CH_2Cl_2 layers Dry with brine and Na_2SO_4. The crude mixture was concentrated and purified by the following methods Silica gel column chromatography gave 2-Ethylbenzoic acid. The residue was purified by column chromatography on silica gel (PE/EA = 5:1) to give the desired products.

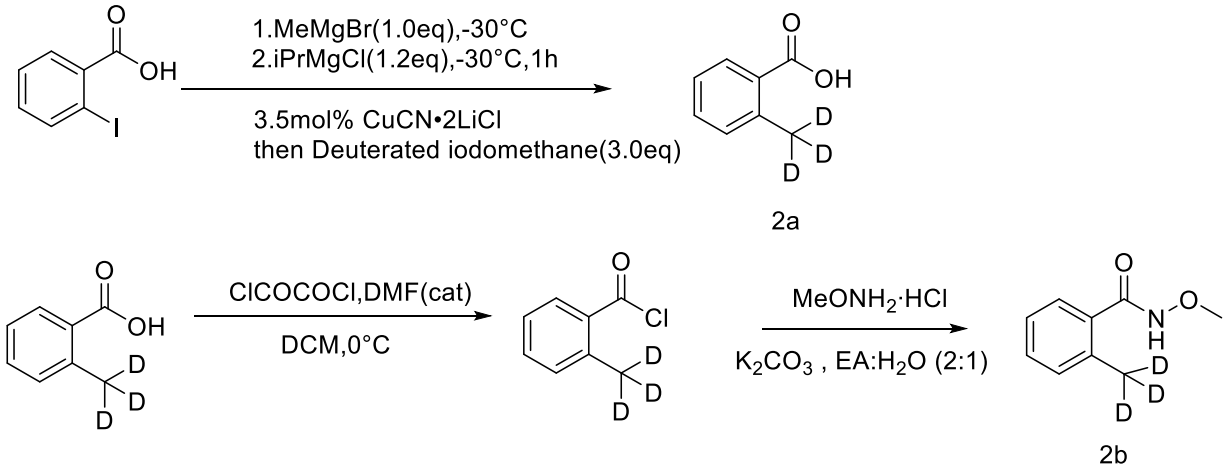
(b) General procedure for the synthesis of *N*-methoxybenzamide



A dried round-bottom flask was charged with acid (4.5 mmol), DCM (15 mL),

and 2 drops of DMF. Then, oxalyl chloride (0.60 mL, 0.876 g, 6.9 mmol) was added dropwise within 5 min at 0 ℃. The resulting mixture was stirred at room temperature for 3.5 h and concentrated under reduced pressure. The residues was dissolved in EtOAc (40 mL) and K_2CO_3 (1.24 g, 9.0 mmol), $MeONH_2$ ·HCl (458 mg, 5.4 mmol), water (20 mL) were added sequentially. The resulting mixture was stirred for 20 h at room temperature and extracted with EtOAc (50 mL). The organic layer was washed with saturated aqueous $NaHCO_3$ (15 mL × 2), brine (15 mL × 2), and dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. The crude product was recrystallized (EtOAc) to afford the product. In the case of an oil, The residue was purified by column chromatography on silica gel (PE/EA = 5:1 - 1:1) [2].

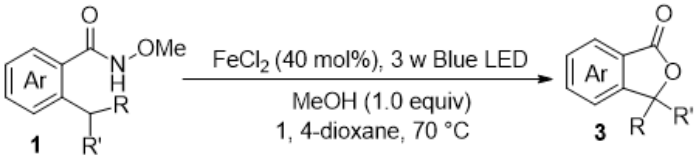
(c) General procedure for the synthesis of N-methoxy-2-(methyl-d3) benzamide



2a was prepared by a slightly modified procedure from known literature [1].2a is the product that has been reported[5]

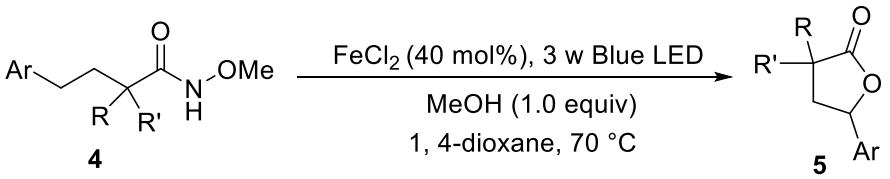
3.Experimental procedures

Procedure A:



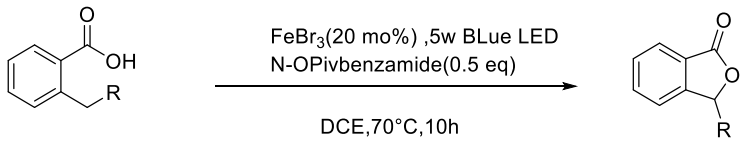
To a test tube was added *N*-methoxyamide 1 (0.3 mmol, 1.0 equiv.), $FeCl_2$ (0.12 mmol, 0.4 equiv.) followed by 1,4-dioxane (2 mL) in the mixture. Additional MeOH (1 eq) was added and the mixture was stirred for 3 w at 70℃ under blue light until the substrate was completely consumed and the resulting mixture was cooled to room temperature. Extract the mixture with EA (2 mL x 3). The combined organic layers were dried over anhydrous Na_2SO_4. The solvent was removed in vacuo and the residue was purified by silica gel chromatography using a mixture of petroleum ether/ethyl acetate on silica gel (PE/EA = 5:1-3:1) to give the desired product **3**.

Procedure B:



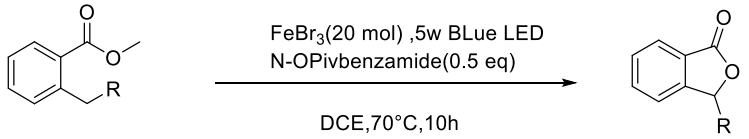
To a test tube was added *N*-methoxyamide **4** (0.3 mmol, 1.0 equiv.), $FeCl_2$ (0.12 mmol, 0.4 equiv.) followed by 1,4-dioxane (2 mL) in the mixture. Additional MeOH (1 eq) was added and the mixture was stirred for 3 w at 70℃ under blue light until the substrate was completely consumed and the resulting mixture was cooled to room temperature. Extract the mixture with EA (2 mL x 3). The combined organic layer was dried with anhydrous Na_2SO_4. The solvent was removed under vacuum and the residue was purified by silica gel chromatography, using a mixture of petroleum ether /ethyl acetate to give the desired product **5**[4].

Procedure C:



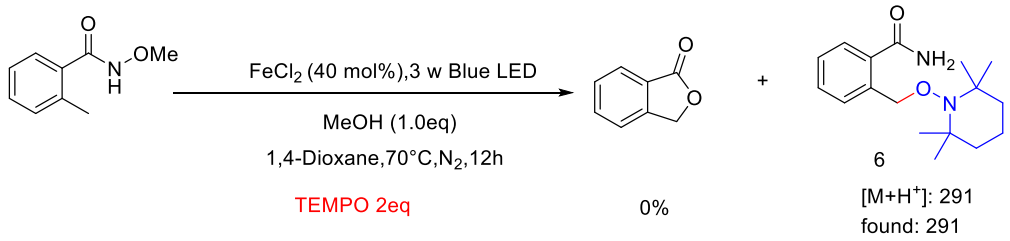
To the test tube was added 2-ethylbenzoic acid (0.4 mmol, 1.0 equiv.), $FeBr_3$ (0.08 mmol, 0.2 equiv.), N-(pivaloyloxy benzamide (0.2 mmol, 0.5 equiv), and then 1,2-Dichloroethane (3 mL) was added to the mixture. The mixture was then stirred under blue light at 70℃ for 5w until the substrate was completely consumed, and the resulting mixture was cooled to room temperature. Extract the mixture with EA (2 mL x 3). The combined organic layers were dried over anhydrous Na_2SO_4. The solvent was removed in vacuo and the residue was purified by silica gel chromatography using a petroleum ether/ethyl acetate mixture to give the desired product.

Procedure D:

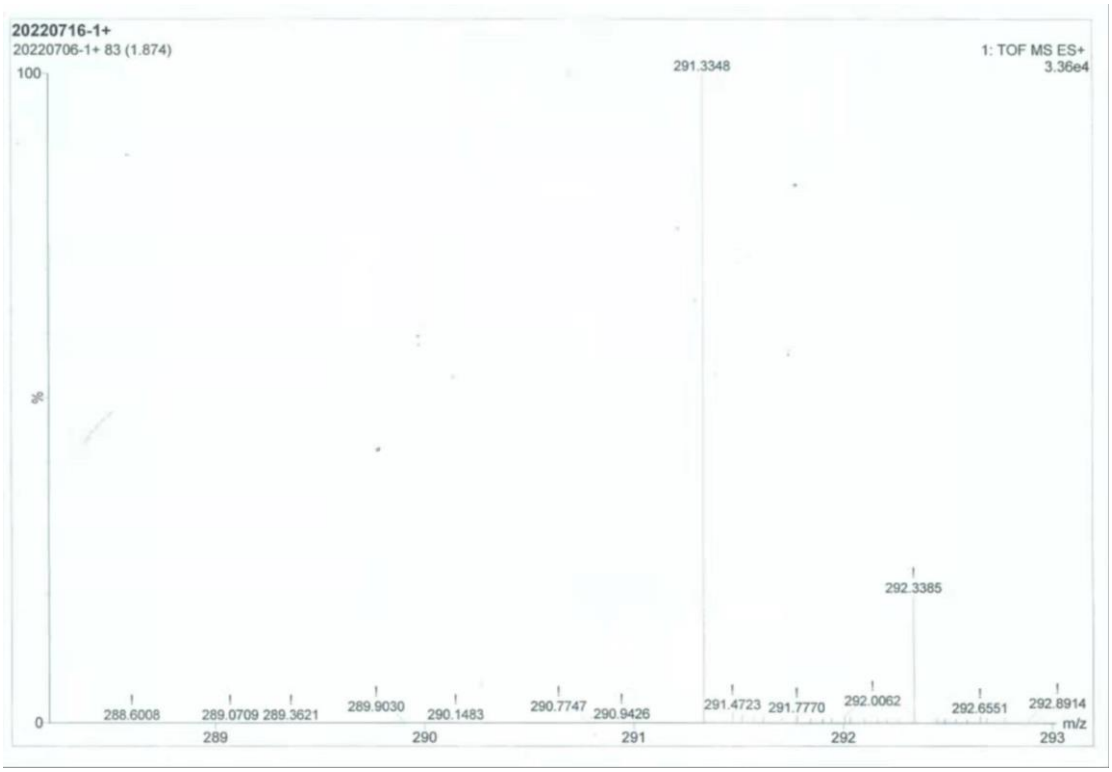


To the test tube was added 2-ethylbenzoic ester (0.4 mmol, 1.0 equiv.), $FeBr_3$ (0.08 mmol, 0.2 equiv.), N-(pivaloyloxy benzamide (0.2 mmol, 0.5 equiv), and then 1, 2-Dichloroethane (3 mL) was added to the mixture. The mixture was then stirred under blue light at 70℃ for 5w until the substrate was completely consumed, and the resulting mixture was cooled to room temperature. Extract the mixture with EA (2 mL x 3). The combined organic layers were dried over anhydrous Na_2SO_4. The solvent was removed in vacuo and the residue was purified by silica gel chromatography using a petroleum ether/ethyl acetate mixture to give the desired product.

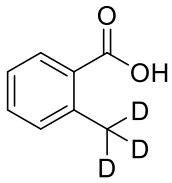
4.Mechanistic Studies



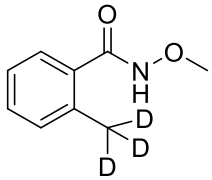
Under N_2 atmosphere, to a test tube were added N-Methoxyamide1 (0.3 mmol, 1.0 equiv.), $FeCl_2$ (0.12 mmol, 0.4 equiv.), TEMPO (93.8 mg, 0.6 mmol, 2.0 equiv.) and then 1,4-Dioxane (3 mL) was added to the mixture. The mixture was then stirred at 70 ℃ blue light for 3 w, The reaction mixture was irradiated under nitrogen atmosphere for 12 hours, and the resulting mixture was cooled to room temperature. The reaction was completely suppressed. The radical trapping product **6** could be observed by HR-MS (positive mode ESI).



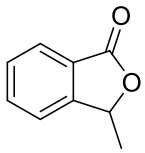
5.Characterization for all compounds



(methyl-d3)benzoic acid (2a): The title compound was prepared according to General procedure for the synthesis of Various types of benzoic acid[5]. White solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 – 8.05 (m, 1H), 7.49 – 7.42 (m, 1H), 7.32 – 7.25 (m, 2H). ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 173.4, 141.3, 133.0, 131.9, 131.6, 128.3, 125.9. IR (cm^{-1}): 2648, 1678 1384, 1287, 725.

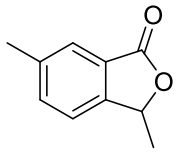


N-methoxy-2-(methyl-d3)benzamide (2b): The title compound was prepared according to the synthesis of N-methoxy-2-(methyl-d3) benzamide, White solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.45 (s, 1H), 7.28 – 7.18 (m, 2H), 7.15 – 7.04 (m, 2H), 3.72 (s, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 167.9, 136.6, 132.6, 130.9, 130.4, 127.2, 125.5, 64.2. IR (cm^{-1}): 3135, 2937, 1636, 1534, 1438, 1314, 1160, 1052.

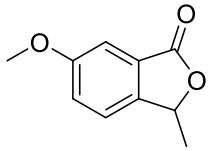


3-methylisobenzofuran-1(3H)-one (3a)[2]**:** The title compound was prepared according to the general procedure A, Colorless oil (35.5 mg, 80% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 – 7.75 (m, 1H), 7.62 – 7.58 (m, 1H), 7.45 – 7.38 (m, 2H), 5.49 (q, *J* = 6.3 Hz, 1H), 1.54 (d, *J* = 6.7 Hz, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 170.5, 151.2, 134.1, 129.0, 125.5, 125.4, 121.7, 77.8, 20.3; IR (cm^{-1}): 3063, 2982

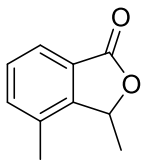
1760, 1467, 1347, 1287, 1045, 763; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{10}H_{11}O_2^+$: 149.0603, found: 149.0609



3, 6-dimethylisobenzofuran-1(3H)-one (3b)[2]**:** The title compound was prepared according to the general procedure A. Colorless oil (34.2 mg, 70% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (s, 1H), 7.45 – 7.43 (m, 1H), 7.30 – 7.28 (m, 1H), 5.48 (q, *J* = 6.6 Hz, 1H), 2.41 (s, 3H), 1.56 (d, *J* = 6.7 Hz, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 170.6, 148.6, 139.2, 135.2, 125.9, 125.5, 121.3, 77.7, 21.2, 20.5; IR (cm^{-1}): 2987, 2939, 1764, 1440, 1330, 1297, 1030, 943, 772; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{10}H_{11}O_2^+$:163.0759, found: 163.0756

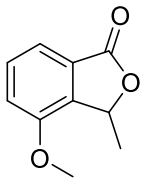


6-methoxy-3-methylisobenzofuran-1(3H)-one (3c): The title compound was prepared according to the general procedure A. White solid (32.5mg, 61% yield); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.25 (m, 2H), 7.21 – 7.19 (m, 1H), 5.49 (q, *J*= 6.6 Hz, 1H), 3.83 (s, 3H), 1.57 (d, *J* = 6.6 Hz, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 170.7, 170.5, 160.6, 143.7, 123.0, 122.4, 107.4, 77.7, 55.8, 20.5; IR (cm^{-1}): 2985, 2918, 2839 1760, 1609, 1498, 1397, 1280, 1090, 1045; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{10}H_{11}O_3^+$:179.0708; found: 179.0713

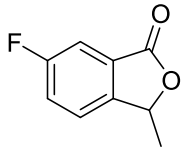


3,4-dimethylisobenzofuran-1(3H)-one (3d): The title compound was prepared according to the general procedure A. Colorless oil (30.1 mg, 62% yield). ^{1}H NMR

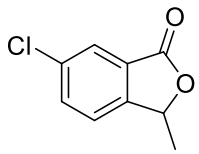
(400 MHz, $CDCl_3$) δ 7.70 – 7.69 (m, 1H), 7.41 – 7.39 (m, 2H), 5.54 (q, *J* = 6.3, Hz, 1H), 2.38 (s, 3H), 1.62 (d, *J* = 6.3 Hz, 3H); $^{13}C\{1H\}$NMR (100 MHz, $CDCl_3$) δ 170.7, 149.4, 135.4, 132.2, 129.3, 125.7, 123.2, 77.6, 19.3, 18.0; IR (cm^{-1}): 2986, 2933, 2868, 1770, 1623, 1492, 1387, 1310, 1269, 1061, 1050; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{10}H_{11}O_2^+$:163.0759; found: 163.0756



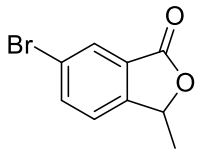
4-methoxy-3-methylisobenzofuran-1(3H)-one (3e): The title compound was prepared according to the general procedure A. White solid (37.4 mg, 70% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.40 (m, 2H), 7.08 – 7.06 (m, 2H), 5.51 (q, *J* = 6.4, 5.6 Hz, 1H), 3.88 (s, 3H), 1.61 (d, *J* = 6.5 Hz, 3H); $^{13}C\{1H\}$NMR (100 MHz, $CDCl_3$) δ 170.5, 154.3, 139.0, 130.9, 127.5, 117.0, 115.0, 77.0, 55.6, 19.0; IR (cm^{-1}): 2980, 2939, 2841, 1758, 1604, 1481, 1440, 1374, 1304, 1280, 1183, 1121, 1050; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{10}H_{11}O_3^+$:178.0708; found: 178.0715.



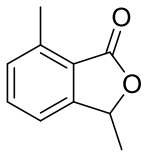
6-fluoro-3-methylisobenzofuran-1(3H)-one (3f): The title compound was prepared according to the general procedure A. White solid (30.8 mg, 62% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.58 – 7.49 (m, 1H), 7.45 – 7.34 (m, 2H), 5.55 (q, *J* = 6.6 Hz, 1H), 1.63 (d, *J* = 6.7 Hz, 3H); $^{13}C\{1H\}$NMR (100 MHz, $CDCl_3$) δ 169.2, 163.1 (d, J_{C-F} = 248.0 Hz), 146.7, 127.8, 123.3 (d, J_{C-F} = 9.0 Hz), 122.0 (d, J_{C-F} = 24.0 Hz), 112.0 (d, J_{C-F} = 24.0 Hz), 77.7, 20.4; ^{19}F NMR (376 MHz, $CDCl_3$) δ -111.8; IR (cm^{-1}): 3087, 2986, 1764, 1492, 1340, 1274, 1068, 1047, 731; HRMS (ESI-TOF): ($[M+Na]^+$) calcd for $C_9H_8FNaO_2^+$: 189.0328; found: 189.0329.



6-chloro-3-methylisobenzofuran-1(3H)-one (3g): The title compound was prepared according to the general procedure A. White solid (36.0 mg, 66% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (s, 1H), 7.62 – 7.60 (m, 1H), 7.37 – 7.35 (m, 1H), 5.53 (q, *J* = 6.6 Hz, 6.1 Hz, 1H), 1.60 (d, *J* = 5.8 Hz, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 168.9, 149.3, 135.4, 134.3, 127.6, 125.6, 122.9, 77.6, 20.3. IR (cm^{-1}): 3050, 2980, 2935, 1764, 1469, 1368, 1345, 1050, 932; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_9H_8ClO_2^+$: 183.0213; found: 183.0218.

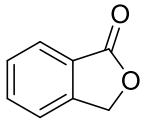


6-bromo-3-methylisobenzofuran-1(3H)-one: (3h)[3]**:** The title compound was prepared according to the general procedure A. Colorless oil (43.3 mg, 64% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (s, 1H), 7.79 – 7.77 (m, 1H), 7.33 – 7.31 (m, 1H), 5.52 (q, *J* = 6.6 Hz, 1H), 1.62 (d, *J* = 6.7 Hz, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 168.8, 149.8, 137.1, 128.6, 127.9, 123.2, 123.0, 77.7, 20.2; IR (cm^{-1}): 3045, 2991, 2933, 1758, 1475, 1392., 1304, 1045, 920; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_9H_8BrO_2^+$: 226.9708; found: 226.9704.

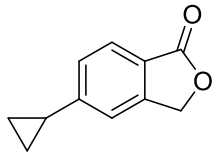


3,7-dimethylisobenzofuran-1(3H)-one (3i)[3]**:** The title compound was prepared according to the general procedure A. Colorless oil (33.9 mg, 70% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 – 7.50 (m, 1H), 7.23 – 7.21 (m, 1H), 5.48 (q, *J* = 6.4 Hz, 1H), 2.68 (s, 3H), 1.60 (d, *J* = 6.6 Hz, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 170.7, 151.7, 139.7, 133.7, 130.6, 123.2, 118.8, 77.2, 20.5, 17.4. IR (cm^{-1}): 3035, 2980, 2928, 1755, 1604, 1483, 1343, 1204, 1061 and 1035; HRMS (ESI-TOF): ($[M+H]^+$) calcd

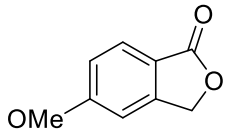
for $C_{10}H_{11}O_2^+$: 163.0759; found: 163.0756.



isobenzofuran-1(3H)-one (3J) [3]**:** The title compound was prepared according to the general procedure A. White solid (30.1 mg, 75% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.89 (m, 1H), 7.69 – 7.65 (m, 1H), 7.54 – 7.48 (m, 2H), 5.31 (s, 2H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 170.7, 146.5, 134.0, 125.7, 125.7, 122.0, 69.7; IR (cm^{-1}):1758, 1623, 1599, 1469, 1439, 1357, 1310, 1280, 1227, 1050, 1033, 997, 737; HRMS (ESI-TOF): ([M+H]$^+$) calcd for $C_8H_7O_2^+$: 135.0446; found: 135.0445.

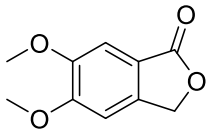


5-cyclopropylisobenzofuran-1(3H)-one (3k): The title compound was prepared according to the general procedure A. White solid (33.9 mg, 65% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 – 7.74 (m, 1H), 7.18 – 7.16 (m, 1H), 7.11 (s, 1H), 5.23 (s, 2H), 2.03 – 1.96 (m, 1H), 1.11 – 1.08 (m, 2H), 0.80 – 0.78 (m, 2H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ171.1, 151.9, 147.1, 126.7, 125.5, 122.9, 118.6, 69.4, 16.1,10.8. IR (cm^{-1}): 2984, 2915, 1747, 1610, 1451, 1392, 1368, 1050, 987, 814, 772; HRMS (ESI-TOF): ([M+H]$^+$) calcd for $C_{11}H_{11}O_2^+$: 175.0759; found: 175.0755.

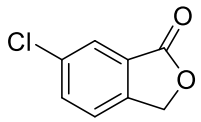


5-methoxyisobenzofuran-1(3H)-one (3l): The title compound was prepared according to the general procedure A. White solid (35.9 mg, 73% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 – 7.80 (m, 1H), 7.04 (d, *J*= 8.2 Hz, 1H), 6.91 (s, 1H), 5.24 (s, 2H), 3.89 (s, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 170.8, 164.6, 149.3, 127.2,

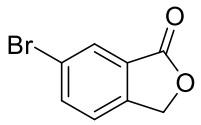
118.0, 116.5, 105.9, 69.1, 55.8. IR (cm^{-1}): 2986, 1752, 1612, 1491, 1277, 1109, 1055, 988, 854, 774; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_9H_9O_3^+$: 165.0552; found: 165.0546.



5,6-dimethoxyisobenzofuran-1(3H)-one (3m): The title compound was prepared according to the general procedure A. White solid (42.4 mg, 73% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (s, 1H), 6.89 (s, 1H), 5.20 (s, 2H), 3.96 (s, 3H), 3.92 (s, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 171.5, 154.9, 150.4, 141.0, 117.6, 106.1, 103.4, 69.1, 56.4, 56.3; IR (cm^{-1}): 2920, 1747, 1610, 1498, 1451, 1392, 1297, 1126, 1044, 997, 866, 772; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{10}H_{11}O_4^+$: 195.0657; found: 195.0665.

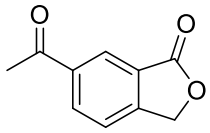


6-chloroisobenzofuran-1(3H)-one (3n): The title compound was prepared according to the general procedure A. White solid (33.8 mg, 67% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (s, 1H), 7.72 – 7.53 (m, 1H), 7.52 – 7.35 (m, 1H), 5.29 (s, 2H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 169.6, 144.6, 135.3, 134.3, 127.5, 125.6, 123.4, 69.5; IR (KBr): 3079, 1762, 1458, 1213, 1191, 1045, 996, 872, 824, 767 cm^{-1}; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_8H_6ClO_2^+$: 169.0056; found: 169.0060.

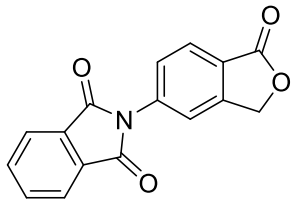


6-bromoisobenzofuran-1(3H)-one (3o): The title compound was prepared according to the general procedure A. White solid (38.0 mg, 60% yield). ^{1}H NMR (400 MHz,

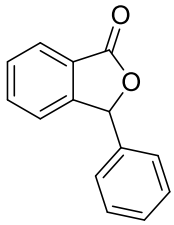
$CDCl_3$) δ 8.03 (s, 1H), 7.79 (d, *J* = 8.0 Hz, 1H), 7.38 (d, *J* = 8.0 Hz, 1H), 5.27 (s, 2H); $^{13}C\{1H\}$NMR (100 MHz, $CDCl_3$) δ 169.5, 145.1, 137.1, 128.8, 127.8, 123.7, 123.0, 69.5. IR (KBr): 3077, 1765, 1456, 1360, 1294, 1207, 1190, 1040, 993, 823, 767 cm^{-1}; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_8H_6BrO_2^+$: 212.9551; found: 212.9557.



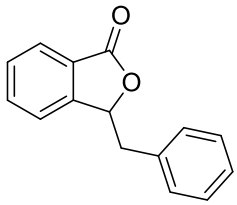
6-acetylisobenzofuran-1(3H)-one (3p): The title compound was prepared according to the general procedure A. White solid (32.2 mg, 61% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 8.43 (s, 1H), 8.31 – 8.29 (m, 1H), 7.61 – 7.59 (m, 1H), 5.38 (s, 2H), 2.66 (s, 3H); $^{13}C\{1H\}$NMR (100 MHz, $CDCl_3$) δ 196.4, 170.1, 150.7, 138.2, 133.6, 126.4, 126.0, 122.7, 69.7, 26.8. IR (cm^{-1}): 3085, 1768, 1677, 1445, 1251, 1194, 1060, 988, 860, 772; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{10}H_9O_3^+$: 177.0552; found: 175.0544.



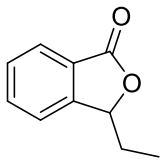
2-(1-oxo-1,3-dihydroisobenzofuran-5-yl)isoindoline-1,3-dione (3q): The title compound was prepared according to the general procedure A. White solid (54.9 mg, 59% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 8.07 – 7.94 (m, 3H), 7.84 (s, 2H), 7.73 – 7.64 (m, 2H), 5.38 (s, 2H); $^{13}C\{1H\}$NMR (100 MHz, $CDCl_3$) δ 170.1, 166.6, 147.3, 137.0, 134.9, 131.3, 127.0, 126.5, 124.7, 124.13 119.8, 69.4; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{14}H_{11}NO_4^+$: 280.0610; found: 280.0619.



3-phenylisobenzofuran-1(3H)-one (3r): The title compound was prepared according to the general procedure. Yellow solid (42.8 mg, 68% yield), ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 – 7.94 (m, 1H), 7.66 – 7.62 (m, 1H), 7.58 – 7.53 (m, 1H), 7.42 – 7.23 (m, 7H), 6.40 (s, 1H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 170.6, 149.7, 136.4, 134.3, 129.4, 129.3, 129.0, 127.0, 125.7, 125.56, 122.9, 82.7; IR (cm^{-1}): 2963, 1734, 1640, 1599, 1457, 1292, 1068, 967, 725; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{14}H_{11}O_2^+$: 211.0759; found: 211.0756.

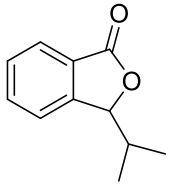


3-benzylisobenzofuran-1(3H)-one (3s): The title compound was prepared according to the general procedure A. White solid (50.4 mg, 75% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 – 7.82 (m, 1H), 7.63 – 7.57 (m, 1H), 7.50 – 7.46 (m, 1H), 7.30 – 7.16 (m, 6H), 5.68 (t, *J* = 6.3 Hz, 1H), 3.27 (dd, *J* = 14.1, 6.6 Hz, 1H), 3.15 (dd, *J* = 14.1, 6.1 Hz, 1H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 170.3, 149.1, 135.0, 133.7, 129.7, 129.2, 128.5, 127.1, 126.2, 125.7, 122.3, 81.2, 40.8; IR (cm^{-1}): 3027, 2920, 1758, 1463, 1286, 1203, 1074, 991, 748, 701, 548; HRMS (ESI-TOF): ($[M+Na]^+$) calcd for $C_{10}H_{10}NaO_2^+$: 247.0735; found: 247.0740.

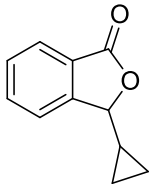


3-ethylisobenzofuran-1(3H)-one (3t): The title compound was prepared according to

the general procedure A. Colorless oil (36.9 mg, 76% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 – 7.0 (m , 1H), 7.62 – 7.59 (m, 1H), 7.49 – 7.43 (m, 1H), 7.41 – 7.38 (m, 1H), 5.39 (d, *J* = 4.1 Hz, 1H), 2.15 – 1.99 (m, 1H), 1.83 – 1.68 (m, 1H), 0.99 (t, *J* = 6.8 Hz, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 170.7, 149.7, 134.0, 129.0, 126.2, 125.5, 121.8, 82.3, 27.6, 8; IR (cm^{-1}): 3049, 2972, 2935, 2880, 1753, 1615, 1598, 1465, 1284; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{10}H_{12}O_2^+$: 163.0759; found: 163.0755.

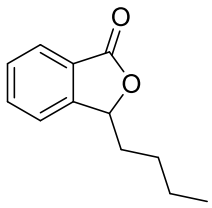


3-isopropylisobenzofuran-1(3H)-one (3u): The title compound was prepared according to the general procedure A. Colorless oil (36.4 mg, 69% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 – 7.87(m, 1H), 7.67 – 7.63 (m, 1H), 7.52 – 7.48 (m, 1H), 7.44 – 7.42 (m, 1H), 5.35 (d, *J* = 3.0 Hz, 1H), 2.31 – 2.22 (m, 1H), 1.11 (d, *J* = 6.9 Hz, 3H), 0.78 (d, *J* = 6.9 Hz, 3H); ^{13}C{1H}NMR (101 MHz, $CDCl_3$) δ 170.8, 148.8, 133.8, 129.0, 126.7, 125.6, 122.1, 85.6, 32.3, 18.7, 15.6. IR (cm^{-1}): 3054, 2968, 2933, 2898, 1745, 1710, 1612, 1596, 1465, 1284, 1064; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{11}H_{12}O_2^+$: 177.0916; found: 177.0924.

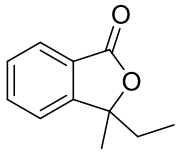


3-cyclopropylisobenzofuran-1(3H)-one (3v): The title compound was prepared according to the general procedure. White solid (34.1 mg, 65% yield). ^{1}H NMR (400 MHz, CDCl3) δ δ 7.86 (d, *J* = 7.6 Hz, 1H), 7.68 – 7.61 (m, 1H), 7.56 – 7.47 (m, 2H), 4.83 (d, *J* = 8.4 Hz, 1H), 1.06 (ddd, *J* = 12.9, 8.3, 4.8 Hz, 1H), 0.76 – 0.65 (m, 2H), 0.61 (dd, *J* = 8.2, 6.1 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.4, 149.6, 148.4,

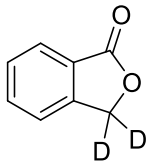
134.0, 129.2, 126.1, 125.5, 122.2, 85.2, 14.5, 2.8, 1.9; IR (cm^{-1}): 3063, 2997, 1764, 1457, 1333, 1280, 1079, 1020, 967, 755; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{11}H_{11}O_2^+$ 175.0759, found 175.0757.



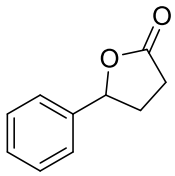
3-butylisobenzofuran-1(3H)-one (3w): The title compound was prepared according to the general procedure A. Colorless oil (31.9 mg, 56% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 – 7.83 (m, 1H), 7.70 – 7.62 (m, 1H), 7.54 – 7.47 (m, 1H), 7.45 – 7.40 (m, 1H), 5.46 (dd, *J* = 7.0, 3.5 Hz, 1H), 2.06 – 1.99 (m, 1H), 1.79 – 1.70 (m, 1H), 1.48 – 132 (m, 4H), 0.89 (t, *J* = 6.1 Hz, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 170.7, 150.1, 133.9, 129.0, 126.1, 125.6, 121.7, 81.4, 34.4, 26.9, 22.4, 13.9; IR (cm^{-1}): 2959, 2935, 2873, 1765, 1467, 1286, 1064, 763, 744, 696; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{10}H_{11}O_2^+$: 191.1072; found: 191.1066.



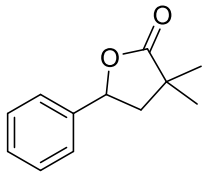
3-ethyl-3-methylisobenzofuran-1(3H)-one (3x): The title compound was prepared according to the general procedure A. Colorless oil (37.5 mg, 71% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 – 7.84 (m, 1H), 7.65 – 7.63 (m, 1H), 7.51 – 7.47 (m, 1H), 7.36 – 7.34 (m, 1H), 2.06 (dq, *J* = 14.7, 7.4 Hz, 1H), 1.90 (dq, *J* = 14.7, 7.4 Hz, 1H), 1.63 (s, 3H), 0.74 (t, *J* = 7.4 Hz, 3H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 170.1, 153.6, 134.0, 128.9, 126.2, 125.7, 120.9, 88.0, 32.8, 25.7, 7.8; IR (cm^{-1}): 2974, 1749, 1614, 1465, 1345, 1286, 1129, 1060, 920, 761, 695; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{11}H_{11}O_2^+$: 177.0916; found: 199.0736.



isobenzofuran-1(3H)-one-3,3-d$_2$ (3y): The title compound was prepared according to the general procedure A. White solid (26 mg, 64% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90-7.88 (m, 1H), 7.68-7.65 (m, 1H), 7.53-7.47 (m, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.1, 146.4, 134.0, 129.0, 125.7, 122.1. IR (cm^{-1}): 1755, 1621, 1595, 1464, 1384, 1263, 1193, 1126, 1018, 1007, 948, 722.

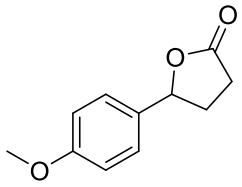


5-phenyldihydrofuran-2(3H)-one (5a)[4]**:** The title compound was prepared according to the general procedure A. Colorless oil (37.9 mg, 78% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.30 (m, 5H), 5.49 (t, *J* = 6.8 Hz, 1H), 2.68 – 2.61 (m, 3H), 2.21 – 2.13 (m, 1H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 176.9, 139.3, 128.7, 128.4, 125.2, 81.2, 30.9, 28.9. IR (cm^{-1}): 2961, 1774, 1216, 1175, 1141, 1024, 940, 759, 700; HRMS (ESI-TOF): ([M+H]$^+$) calcd for $C_{10}H_{11}O_2^+$: 163.0759; found: 163.0765.

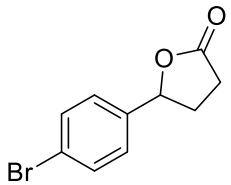


3,3-dimethyl-5-phenyldihydrofuran-2(3H)-one (5b)[4]**:** The title compound was prepared according to the general procedure A. Colorless oil (39.3 mg, 69% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.26 (m, 5H), 5.42 (d, *J* = 6.5 Hz, 1H), 2.51 – 2.43 (m, 1H), 2.05 (t, *J* = 11.3 Hz, 1H), 1.35 (s, 3H), 1.29 (s, 3H); ^{13}C{1H}NMR (101 MHz, $CDCl_3$) δ 181.7, 139.5, 128.7, 128.3, 125.3, 77.6, 46.0, 40.8, 24.9, 24.2; HRMS

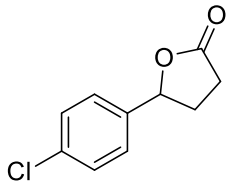
(ESI-TOF): ([M+H]$^+$) calcd for $C_{10}H_{11}O_2^+$: 191.1072; found: 191.1077.



5-(4-methoxyphenyl)dihydrofuran-2(3H)-one (5c)[4]: The title compound was prepared according to the general procedure A. Yellow solid (35.1 mg, 61% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 – 7.24 (m, 2H), 6.92 – 6.90 (m, 2H), 5.47 – 5.45 (m, 1H), 3.81 (s, 3H), 2.66 – 2.59 (m, 3H), 2.21 – 2.16 (m, 1H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 176.9, 159.7, 131.1, 126.9, 114.1, 81.3, 55.3, 30.9, 29.2; IR (cm^{-1}): 3527, 2940, 2360, 1775, 1514, 1249, 1027, 834; HRMS (ESI-TOF): ([M+H]$^+$) calcd for $C_{10}H_{11}O_2^+$: 191.1072; found: 191.1077.

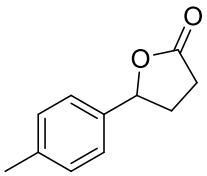


5-(4-bromophenyl)dihydrofuran-2(3H)-one (5d)[4]: The title compound was prepared according to the general procedure A. White solid (43.2 mg, 60% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.47 (m, 2H), 7.19 – 7.17 (m, 2H), 5.42 – 5.40 (m, 1H), 2.62 – 2.59 (m, 3H), 2.14 – 2.08 (m, 1H); ^{13}C{1H}NMR ($CDCl_3$, 100 MHz) δ 176.6, 138.4, 131.9, 127.0, 122.3, 80.5, 30.9, 28.9; IR (cm^{-1}): 3532, 2927, 1782, 1489, 1174, 1018, 810; HRMS (ESI-TOF): ([M+H]$^+$) calcd for $C_{10}H_{10}BrO_2^+$: 240.9864; found: 240.9869.

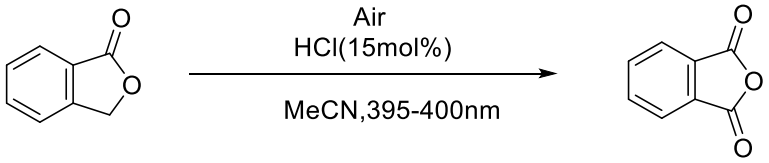


5-(4-chlorophenyl)dihydrofuran-2(3H)-one (5e)[4]: The title compound was

prepared according to the general procedure A. Red thick oil (38.2 mg, 65% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 – 7.33 (m, 2H), 7.26 – 7.24 (m, 2H), 5.46 – 5.45 (m, 1H), 2.70 – 2.64 (m, 3H), 2.16 – 2.10 (m, 1H); ^{13}C{1H}NMR ($CDCl_3$, 100 MHz) δ 176.5, 137.9, 134.3, 129.0, 126.7, 80.4, 30.9, 28.9; IR (cm^{-1}): 3533, 2932, 2361, 1781, 1492, 1175, 1021, 812; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{10}H_1ClO_2^+$: 197.0369; found: 197.0374.

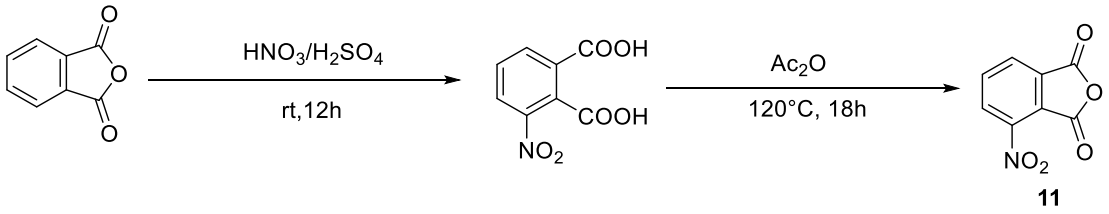


5-(p-tolyl)dihydrofuran-2(3H)-one (5f)[4]**:** The title compound was prepared according to the general procedure A. White solid (35.9 mg, 68% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 – 7.17 (m, 4H), 5.46 – 5.45 (m, 1H), 2.62 – 2.56(m, 3H), 2.34 (s, 3H), 2.24 – 2.09 (m, 1H); ^{13}C{1H}NMR (100 MHz, $CDCl_3$) δ 177.1, 138.3, 136.3, 129.4, 125.4, 81.4, 30.9, 29.1, 21.1; IR (cm^{-1}): 3505, 2928, 1770, 1455, 1180, 940; HRMS (ESI-TOF): ($[M+H]^+$) calcd for $C_{11}H_{13}O_2^+$: 177.0916; found: 177.0921.



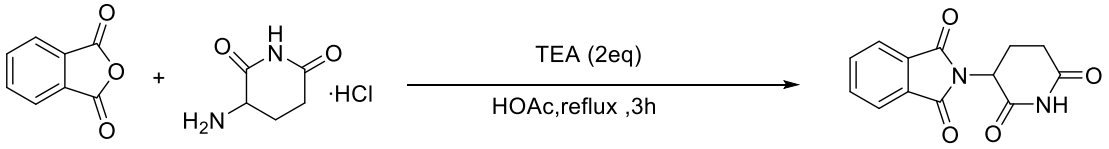
isobenzofuran-1,3-dione (10): Phthalide (40.2 mg, 0.3 mmol, 1.0 equiv.), HCl (4 μL, 0.045 mmol, 12.27 mol/L, 38% in water) and MeCN (3.0 ml) was added to an oven-dried quartz tube equipped with magnetic stirring bar. The vessel placed 2 cm away from one purple 20 W LED (395-400 nm). The reaction mixture was irradiated with for 8 h under air atmosphere. After irradiation, the reaction mixture was transferred to a 25 mL round-bottom flask and the solvent was concentrated in vacuo. The pure product was obtained by flash column chromatography on silica gel (97% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 – 7.99 (m, 2H), 7.96 – 7.90 (m, 2H);

$^{13}C\{1H\}NMR$ (100 MHz, $CDCl_3$) δ 162.8, 136.1, 131.2, 125.7; IR (cm^{-1}): 3092, 1851,1762, 1698, 1470, 1360, 1258, 1170, 905, 712



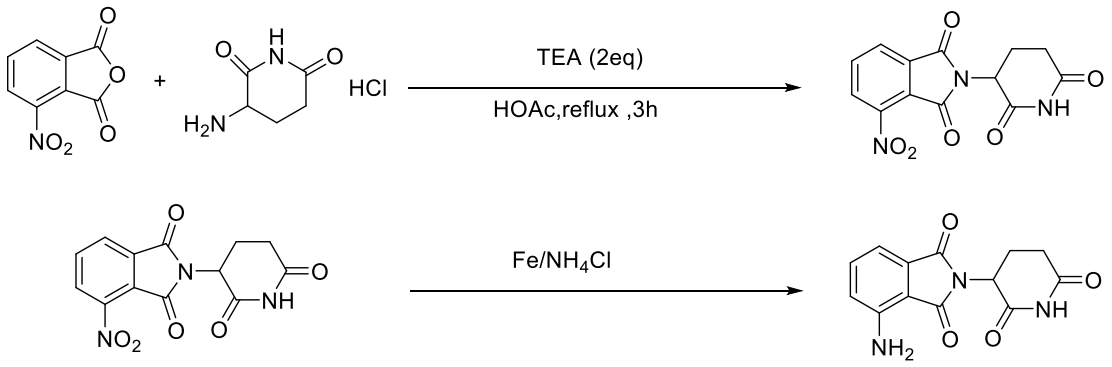
11

4-nitroisobenzofuran-1, 3-dione (11): To a stirred solution of nitric acid and sulfuric acid (0.086mL: 0.220 mL) at 0 ℃ was added phthalic anhydride (0.104 g, 0.70 mmol) in small portions. The reaction mixture was stirred at room temperature for 12h and t hen cooled to 0 ℃. This was followed by the addition of crushed ice. The solid which precipitated out was filtered to afford the compound as a white solid (0.133 g; 90% yi eld). A stirred solution of 3-nitrophthalic acid (0.133 g, 0.63 mmol) in acetic anhydri de (1.75 mL) was heated at 120 ℃ for 18h. The reaction mixture was cooled and conc entrated under reduced pressure. The crude solid obtained was washed with hexane an d triturated with 20% diethyl ether in hexane to afford as an off-white solid (0.112 g; 94% yield).Then the combined yield is 85%. White solid; mp 165−168℃; ^1H NMR (400 MHz, CD_3OD) δ 8.38 – 8.27 (m, 2H), 7.79 – 7.75 (m, 1H); $^{13}C\{1H\}NMR$ (100 MHz, CD_3OD) δ 166.5, 165.1,146.4, 135.5, 130.8, 130.4, 130.4, 127.8.



2-(2,6-dioxopiperidin-3-yl)isoindoline-1,3-dione(Thalidomide): To a stirred solution of 0.149 g (0.91 mmol) of 3-amino-piperidine-2, 6-dione hydrochloride in 5 ml of acetic acid was added 0.135 g (0.91 mmol) of phthalic anhydride and 0.203 g (2 mmol) of triethyl amine. Reaction mixture was heated to reflux and further stirred at reflux for 3 hours. The progress and completion of reaction was monitored by HPLC

till 3-amino-piperidine-2, 6-dione hydrochloride absent. Reaction mass was cooled to 25-30 ℃ and further stirred for 1 hour at 25-30 ℃. Solid was filtered and washed the wet cake with 7.5 mL of water. Wet compound was slurred in 5 mL of water and suspension mass was further stirred for 1 h. Solid was filtered and washed the wet cake with 7.5 mL of water. Dried under vacuum at 55-60 ℃ under vacuum to give 0.205 g thalidomide (87%, yield). mp 269-271℃; ^{1}H NMR (400 MHz, DMSO) δ 11.11 (s, 1H), 7.94 – 7.84 (m, 4H), 5.16 (dd, *J* = 6.8, 5.0 Hz, 1H), 2.95 – 2.80 (m, 1H), 2.62 – 2.47 (m, 2H), 2.11 – 2.00 (m, 1H); ^{13}C{1H}NMR (100 MHz, DMSO) δ 173.2, 170.3, 167.6, 135.3, 131.7, 123.9, 49.4, 31.4, 22.4; HRMS (ESI-TOF): ($[M+Na]^{+}$) calcd for $C_{13}H_{10}N_2NaO_4^{+}$: 281.0538; found: 281.0544.



4-amino-2-(2,6-dioxopiperidin-3-yl)isoindoline-1,3-dione (Pomalyst):

To 4-nitroisobenzofuran-1,3-dione (0.112 g, 0.58 mmol) in AcOH (5 mL) was added and 3-aminopiperidine-2,6-dione salt at room temperature acid salt (0.095 g, 0.58 mmol) and KOAc (0.114 g, 1.16 mmol) and stirred at 90 ℃ for 16 h under nitrogen atmosphere. After completion of the reaction (monitored by TLC), the acetic acid was removed under reduced pressure, and the residue was washed with methanol to give compound (0.153 g, 87%, yield), which was used in the next step without further purification.

Ammonium chloride (0.55 g, 1.02 mmol) was slowly added to the well-stirred water (0.5 mL) and 2.5mL solution of ethanol, then iron powder (0.112g, 2 mmol) was slowly added, and the stirring was continued to be heated to 90 ℃, 3-nitro-N-

(2,6-dioxo-3-piperidyl)-phthalimide 0.153g (0.51 mmol) was added to the system within 30min, refluxed and stirred for 1h, concentrated, and then Extracted with methanol solution (5 mL), centrifuged, poured out the methanol solution containing the compound, concentrated and crystallized again to obtain the final compound Pomalyst (0.132 g, 95% yield), yellow solid. mp 252°C; ^{1}H NMR (400 MHz, DMSO) δ 11.07 (s, 1H), 7.56 – 7.36 (m, 1H), 7.12 – 6.91 (m, 2H), 6.50 (s, 2H), 5.03 (dd, J = 13.6, 5.2 Hz, 1H), 2.94 – 2.79 (m, 1H), 2.62 – 2.49 (m, 2H), 2.10 – 1.89 (m, 1H); ^{13}C{1H}NMR (100 MHz, DMSO) δ 173.3, 170.6, 169.0, 167.8, 147.2, 135.9, 132.4, 122.2, 111.4, 109.0, 48.9, 31.4, 22.6; HRMS (ESI-TOF): ($[M+Na]^{+}$) calcd for $C_{13}H_{11}N_3NaO_4^{+}$: 296.0647; found: 296.0653.

6.References

1. Kopp, F.; Wunderlich, S.; Knochel, P, *Chem. Commun. (Cambridge, U. K.)* **2007**, 0, 2075.

2. Joe W. Wrigglesworth, Brian Cox, Guy C. Lloyd-Jones, and Kevin I. Booker-Milburn, *Organic Letters* **2011** 13 (19), 5326-5329.

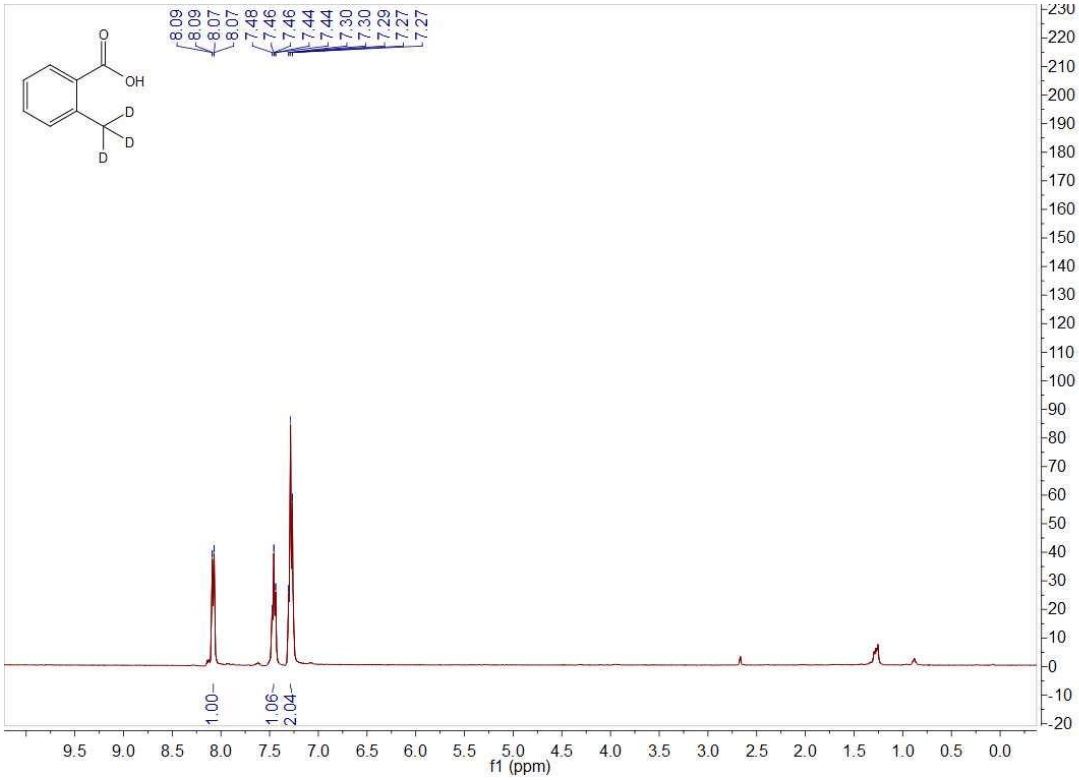
3. Juan Mangas-Sánchez, Eduardo Busto, Vicente Gotor-Fernández, and Vicente Gotor, *Organic Letters* **2012** 14 (6), 1444-1447.

4. Chenxiao Qi, Shengwen Yang, Vincent Gandon, and David Lebœuf, *Organic Letters* **2019** 21 (18), 7405-7409.

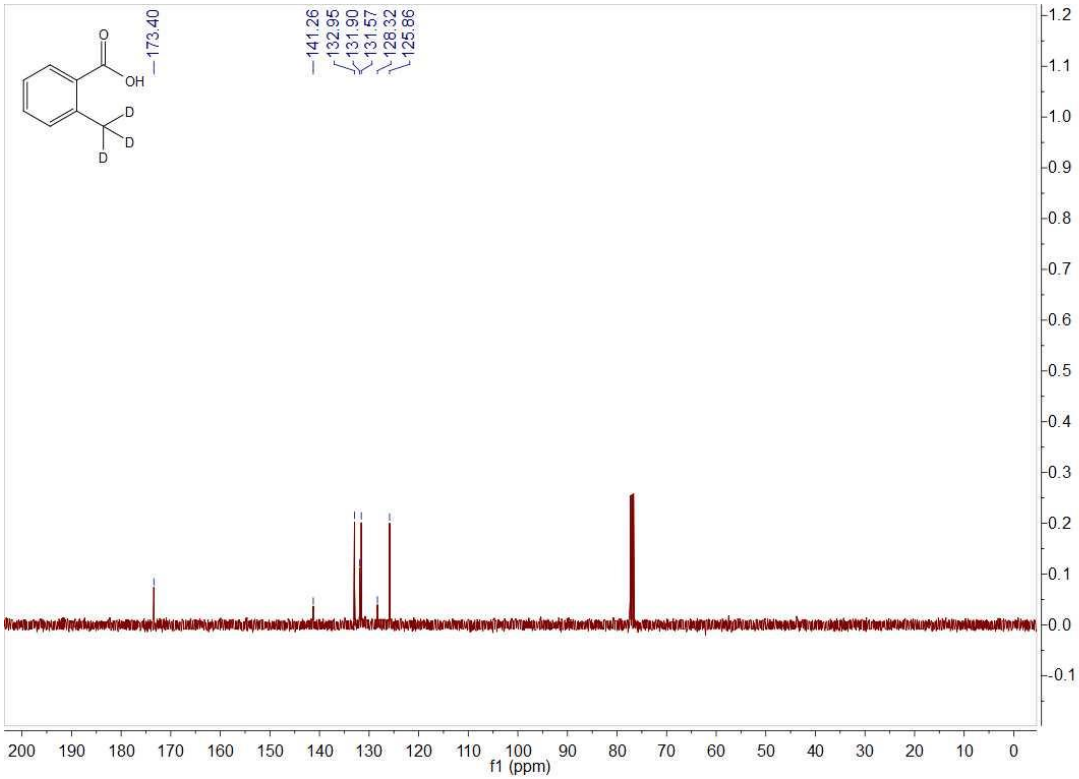
5. Le Thi Ngoc Chuc, Thi Anh Hong Nguyen and Duen-Ren Hou, *Org. Biomol. Chem., 2020,**18**, 2758-2768*

7.Copies of ^{1}H and ^{13}C NMR spectra of products

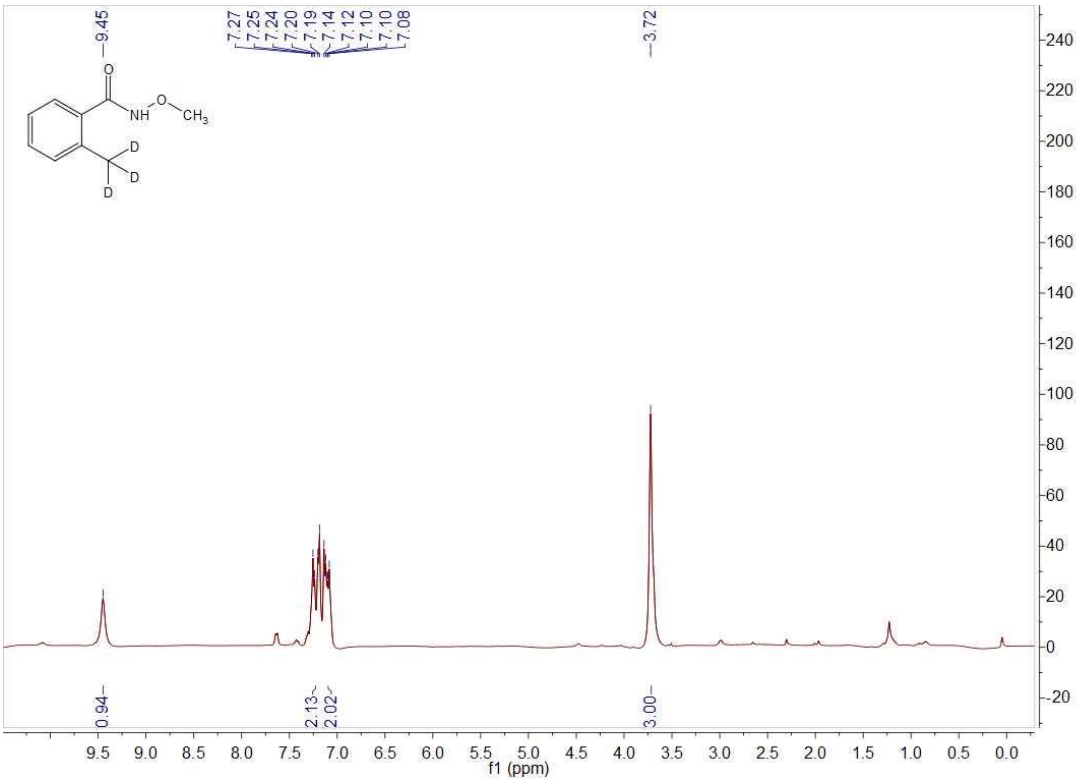
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **2a**



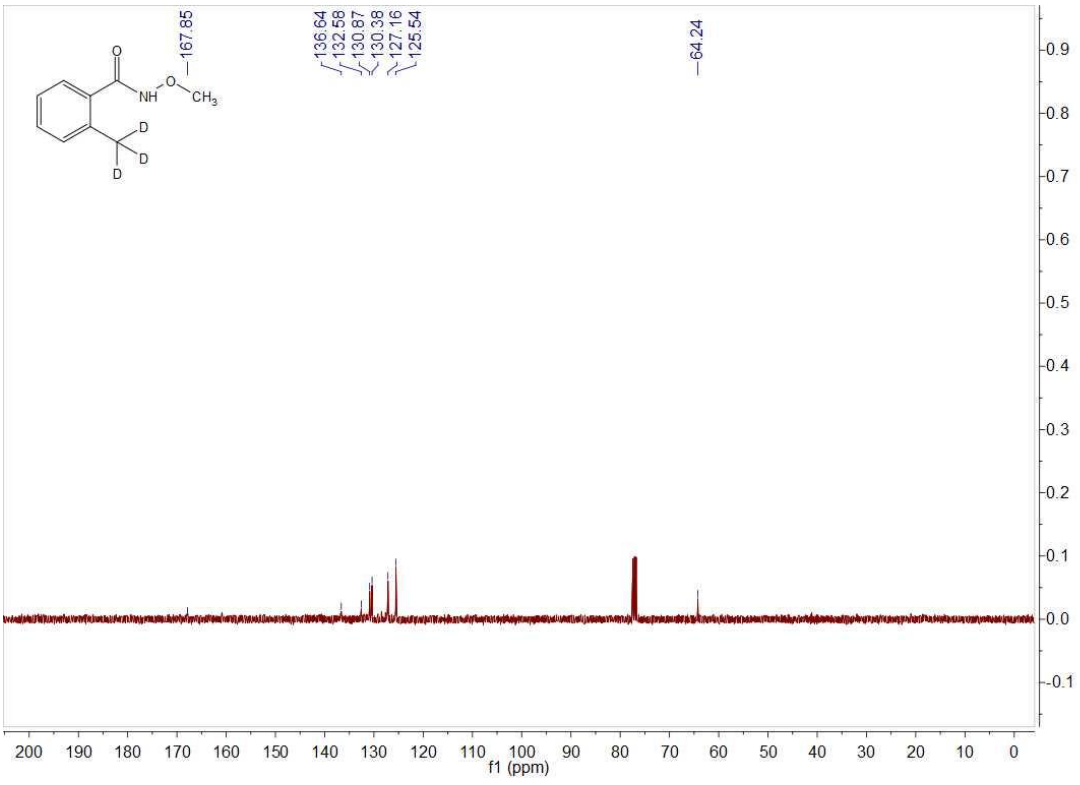
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **2a**



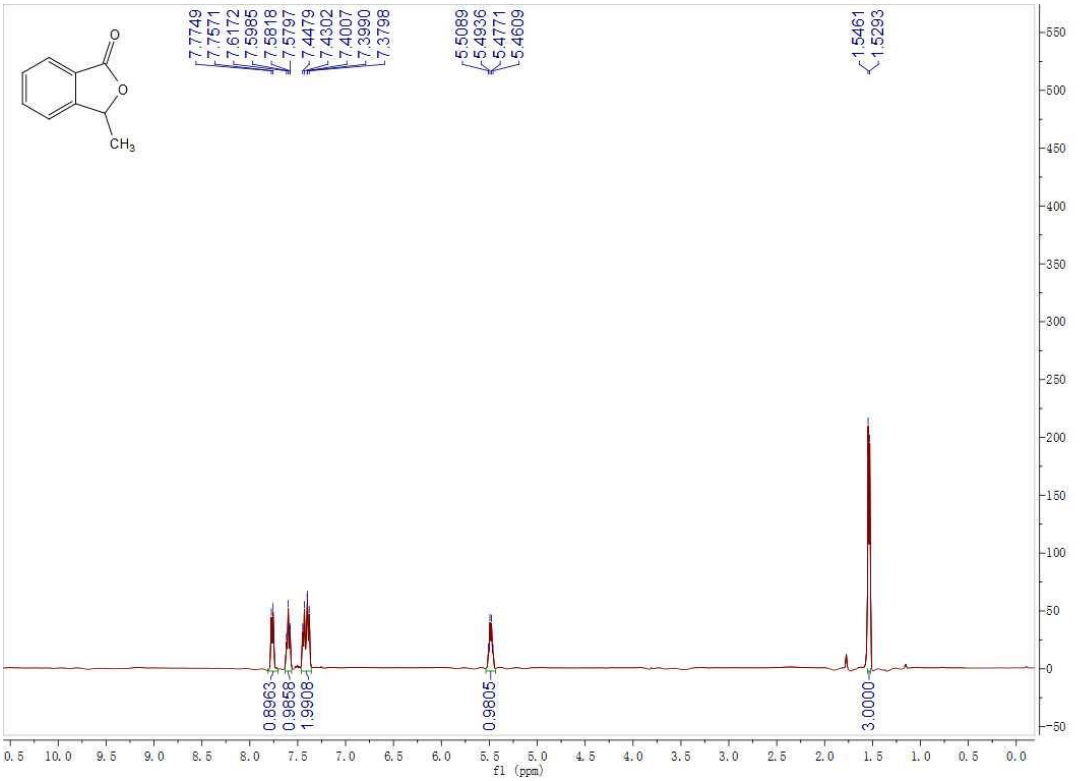
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **2b**



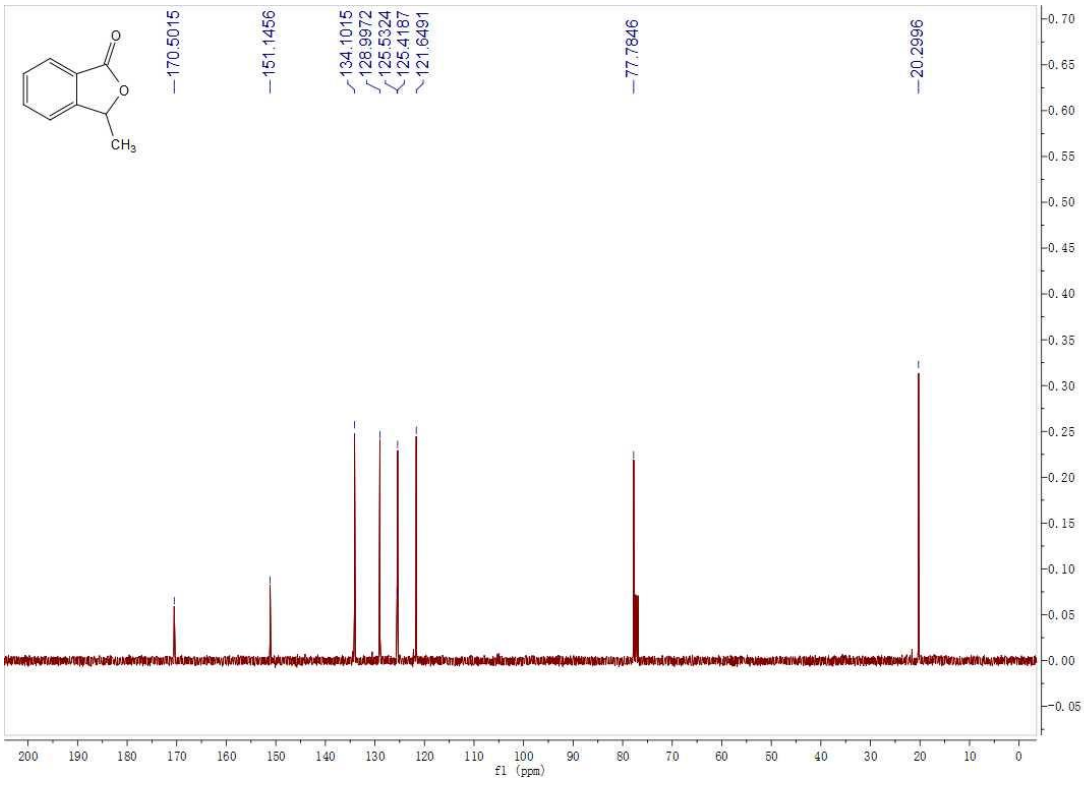
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **2b**



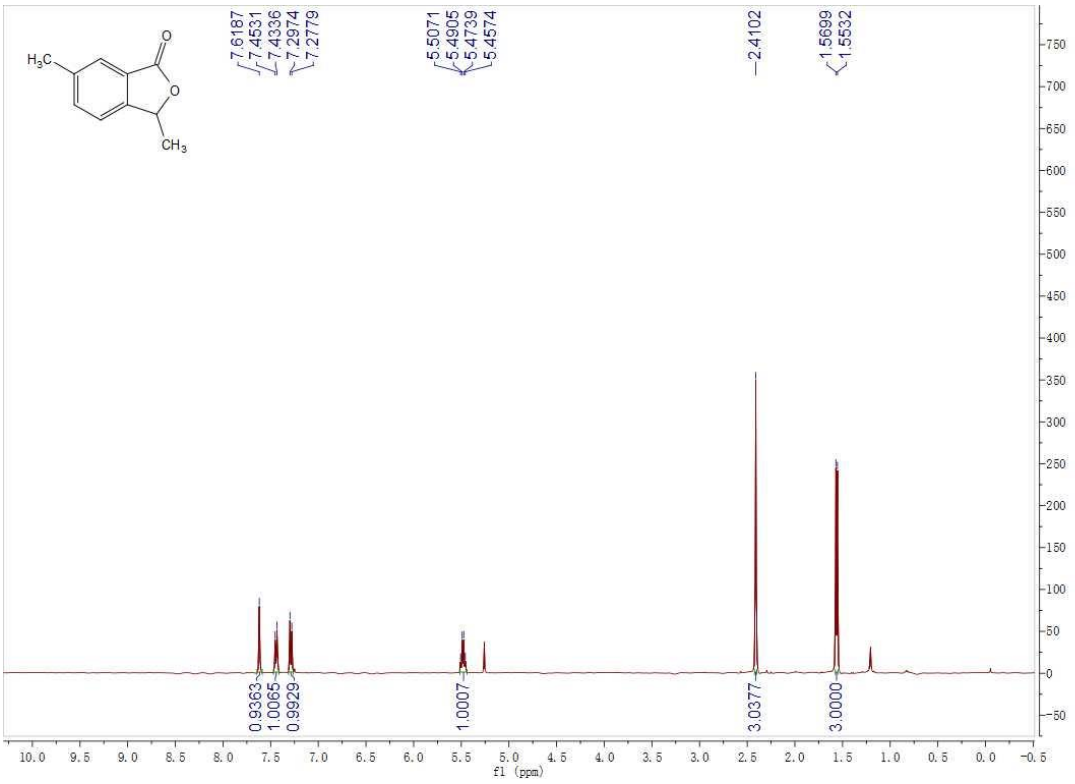
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3a**



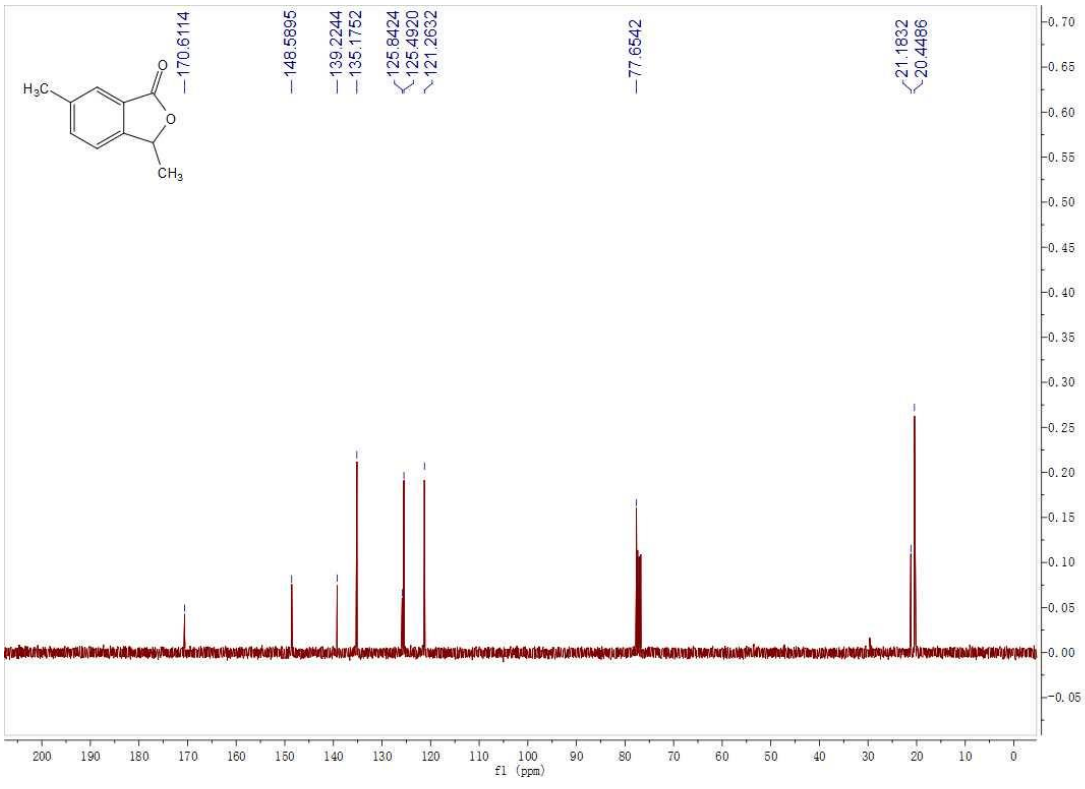
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3a**



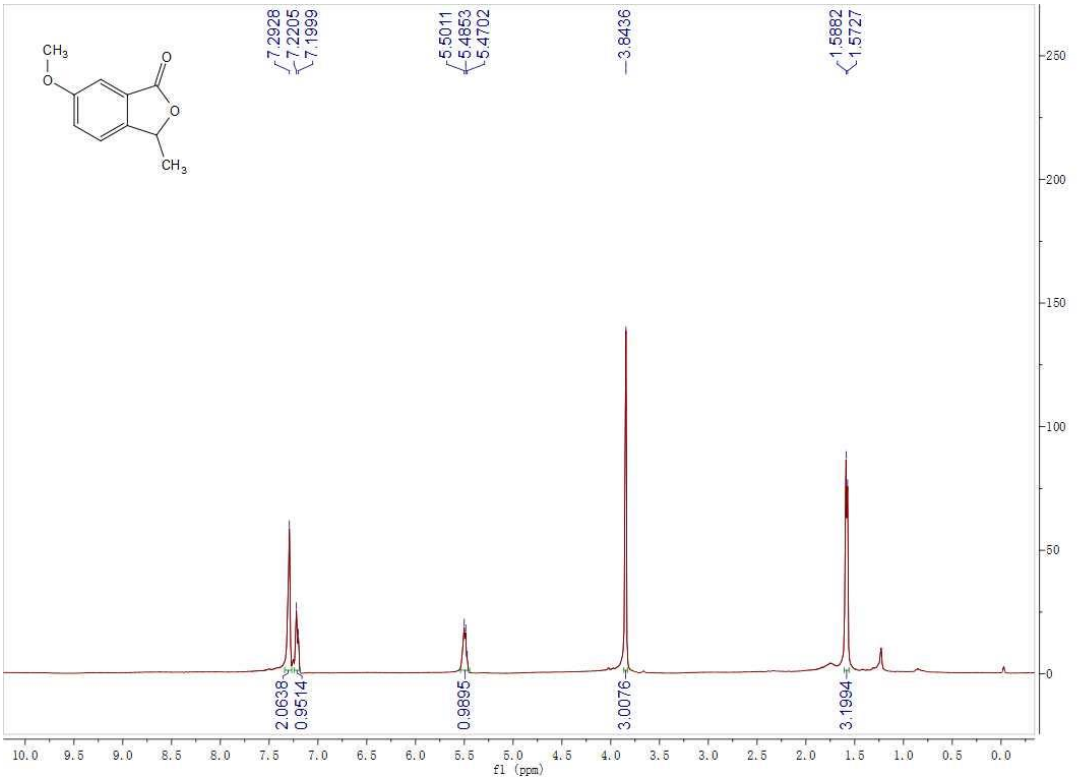
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3b**



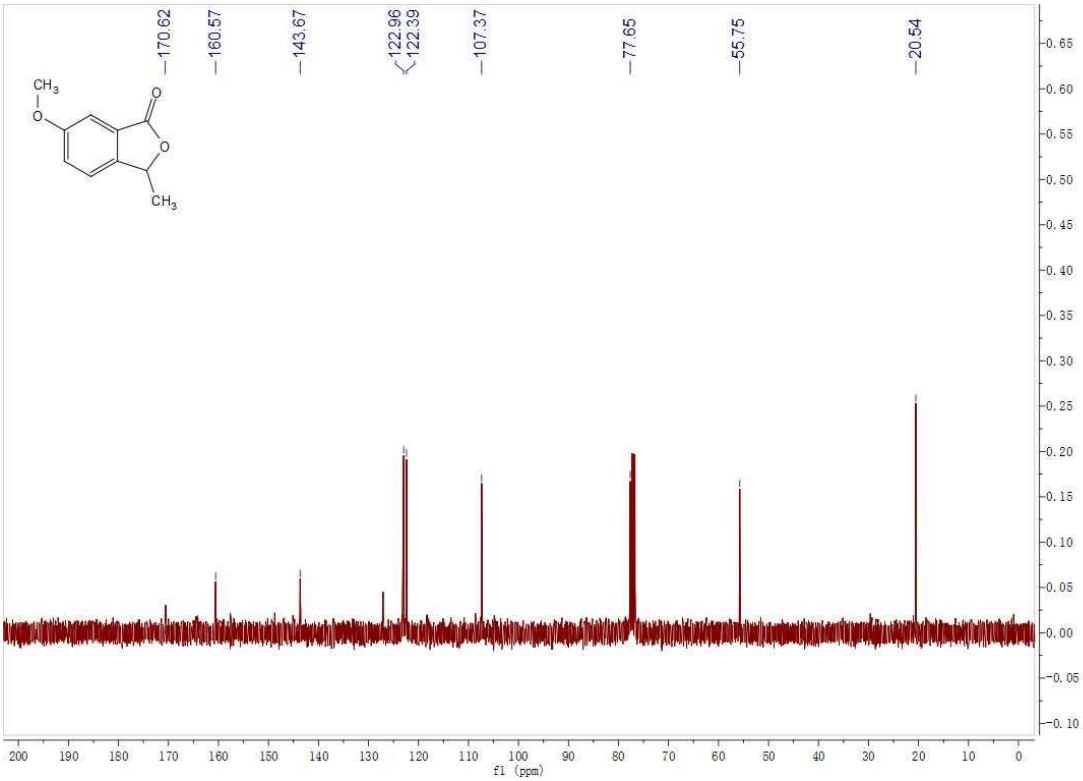
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3b**



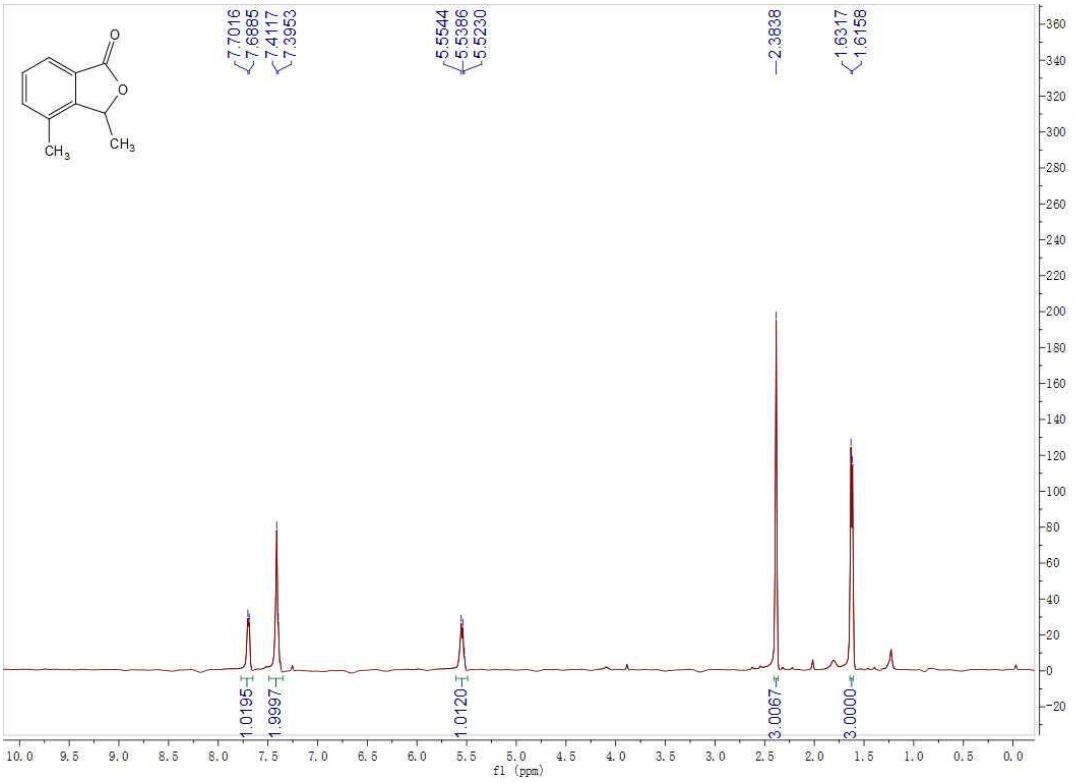
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3c**



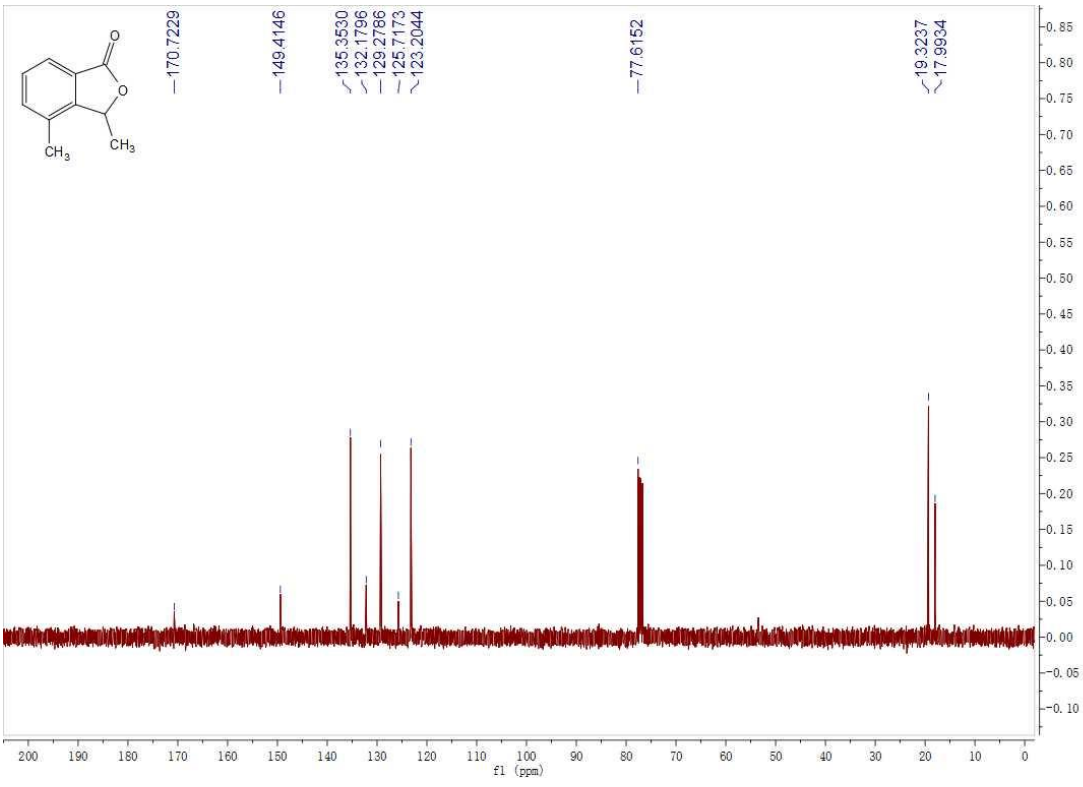
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3c**



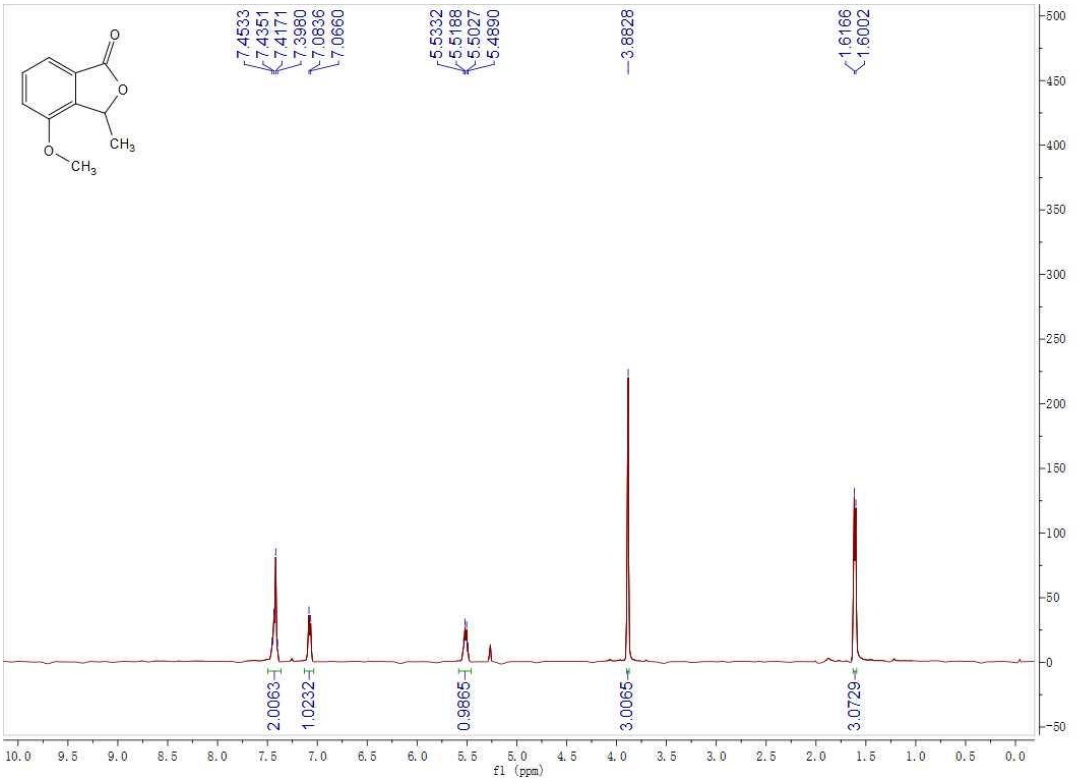
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3d**



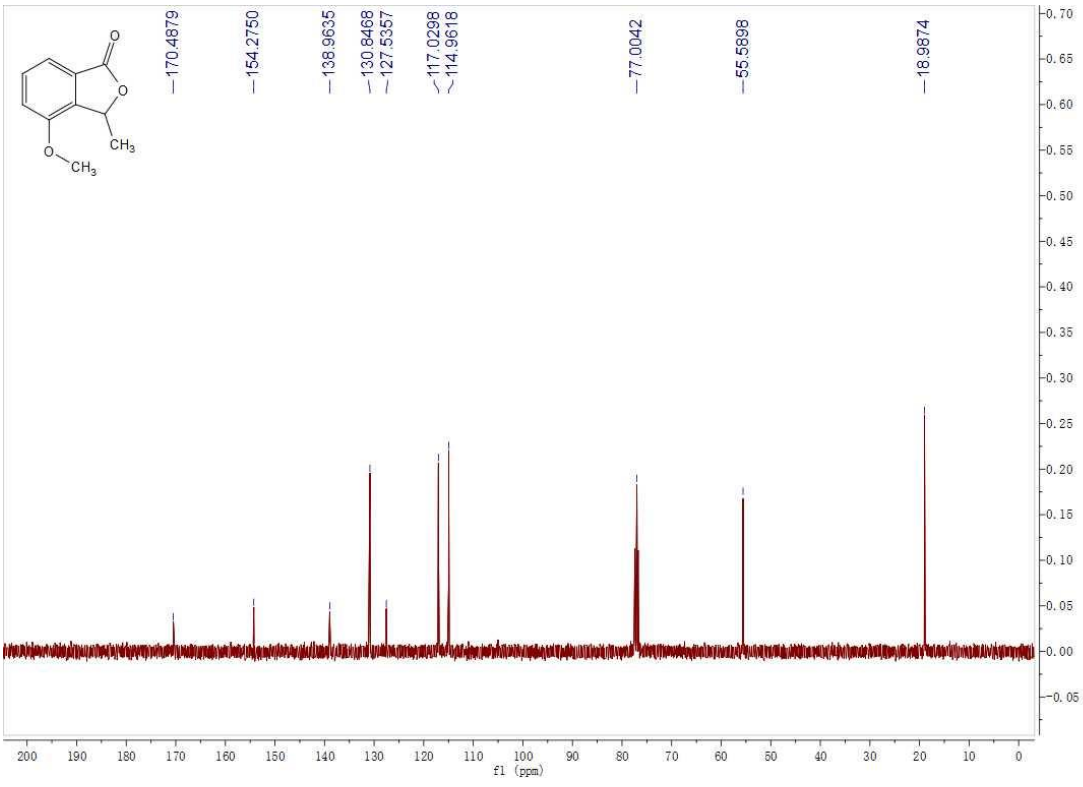
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3d**



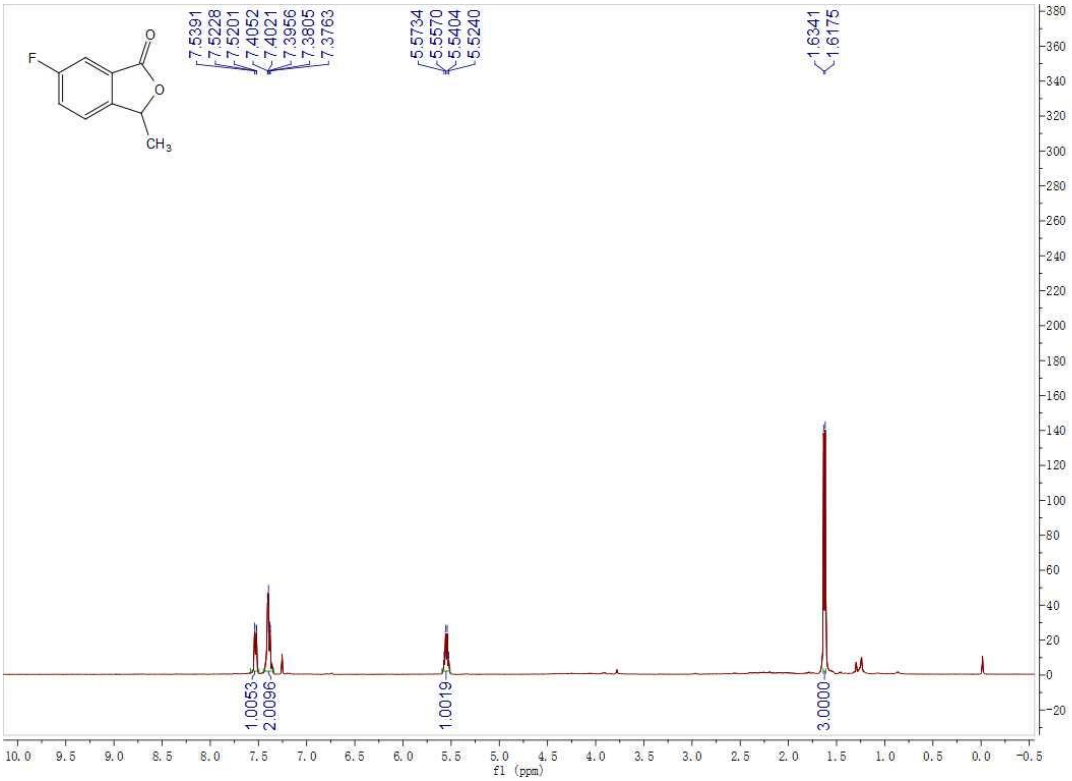
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3e**



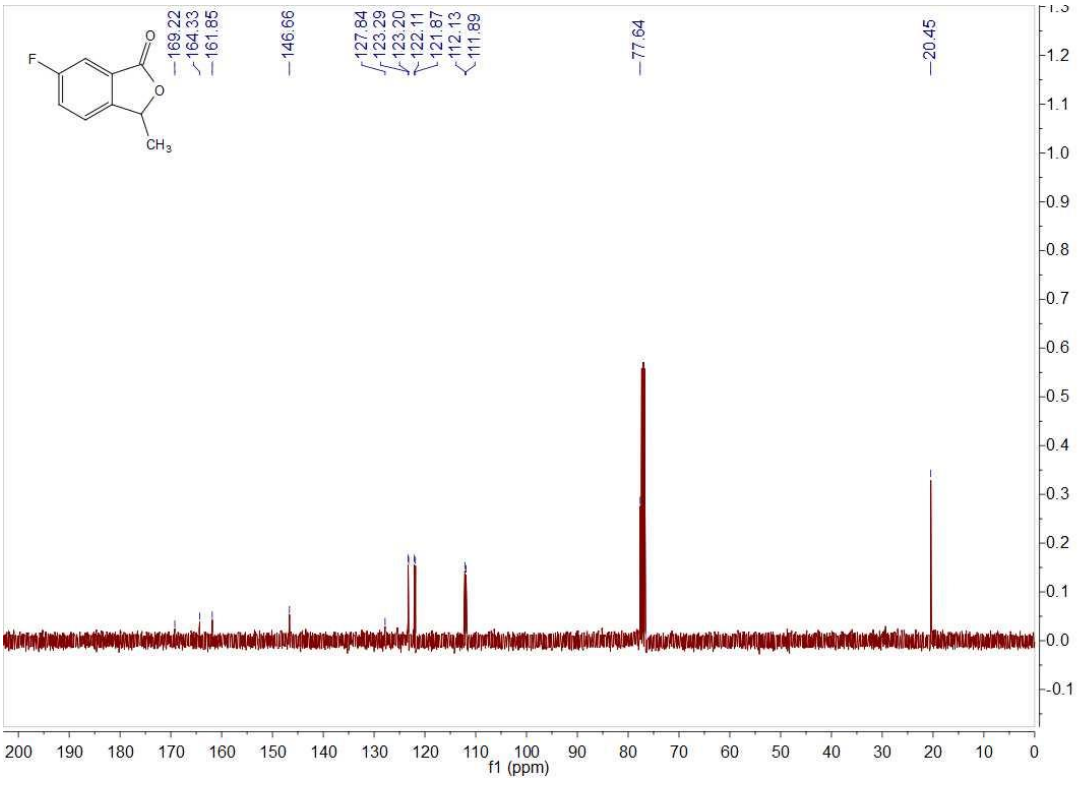
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3e**



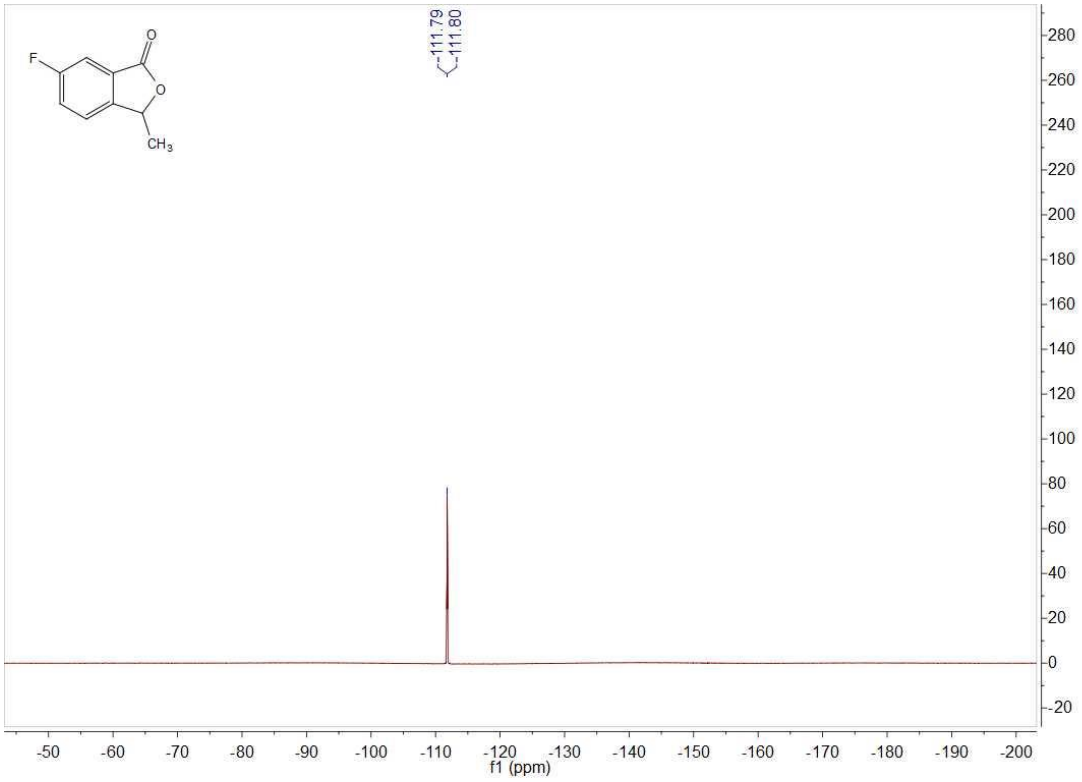
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3f**



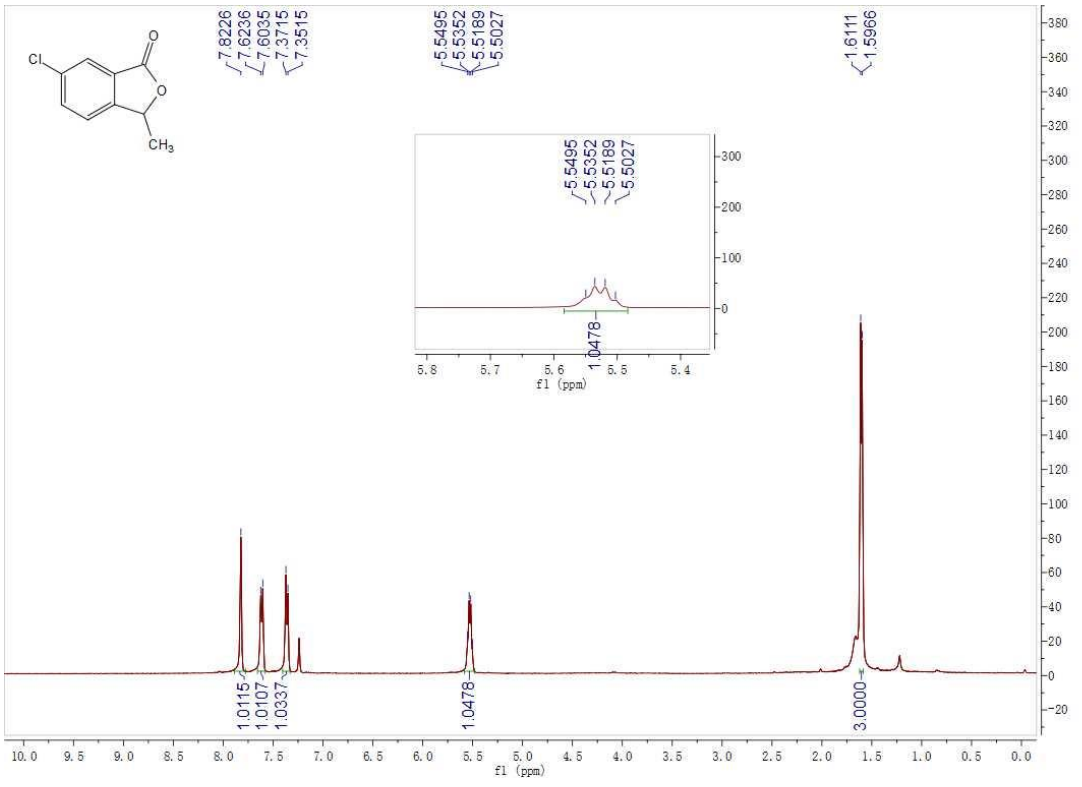
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3f**



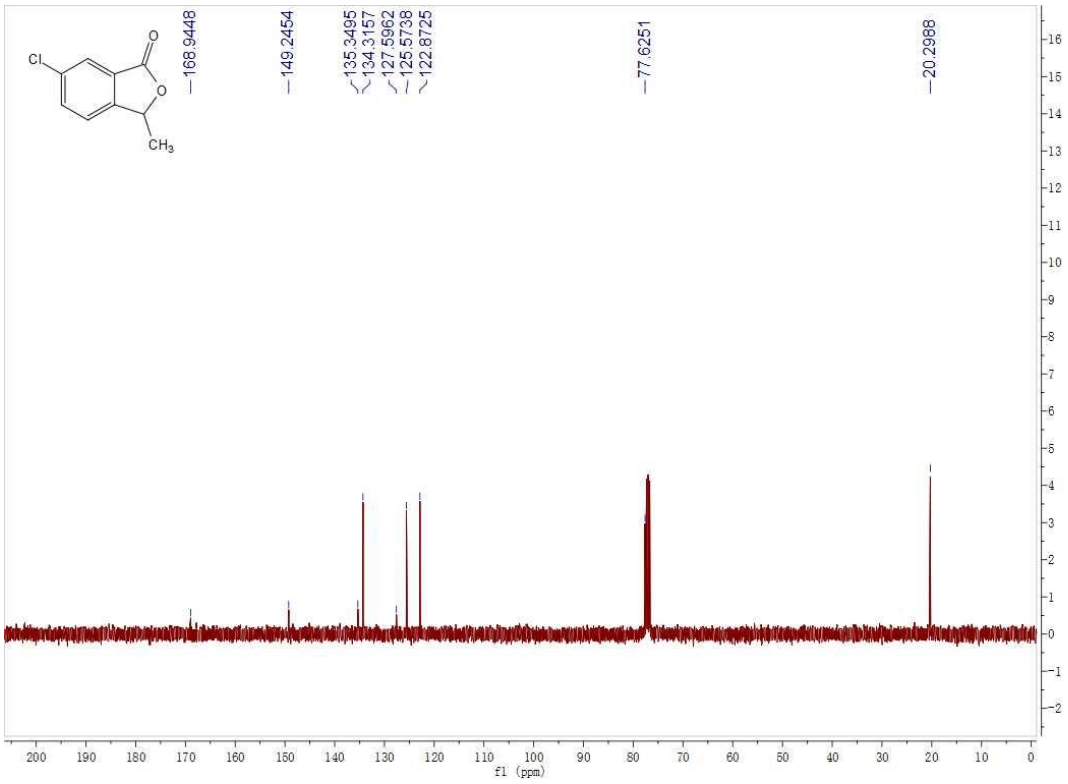
^{19}F NMR spectrum (376 MHz, $CDCl_3$) of compound **3f**



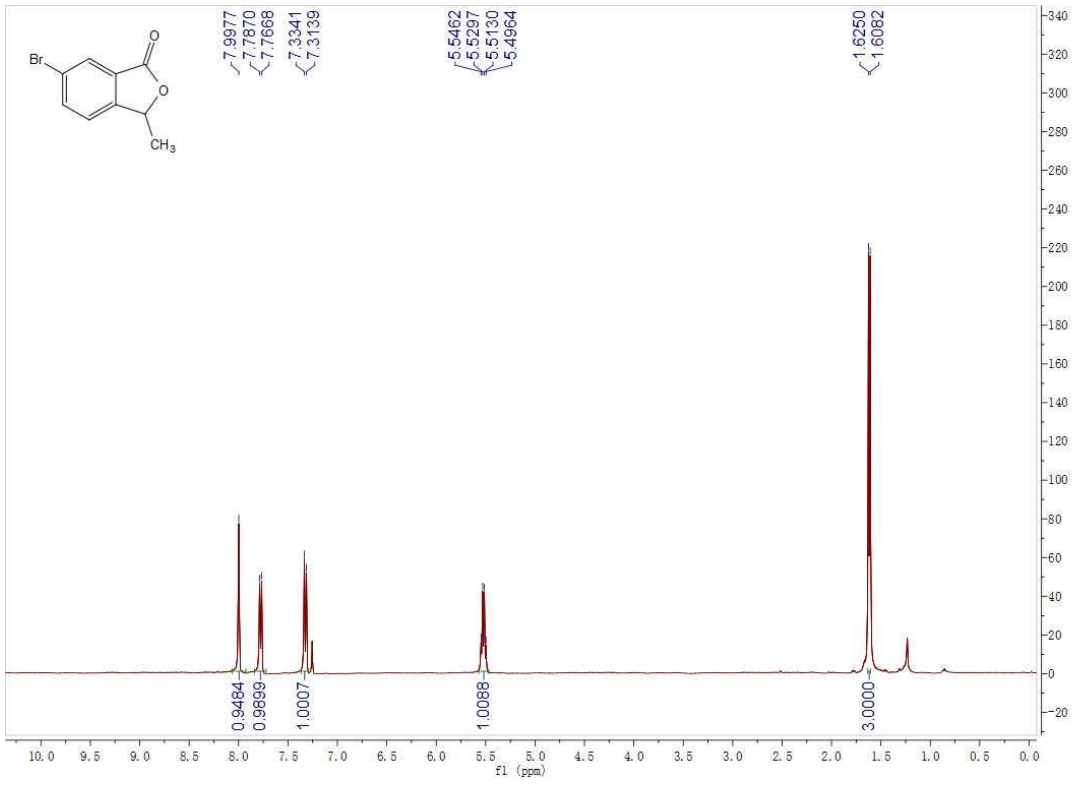
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3g**



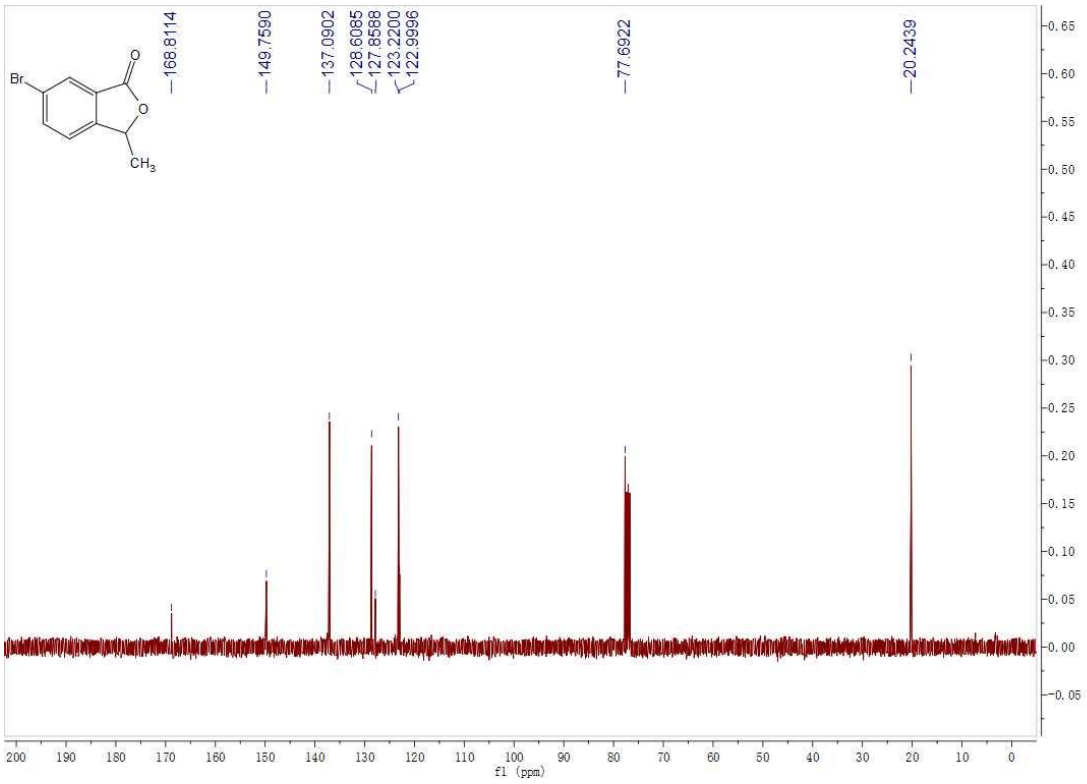
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3g**



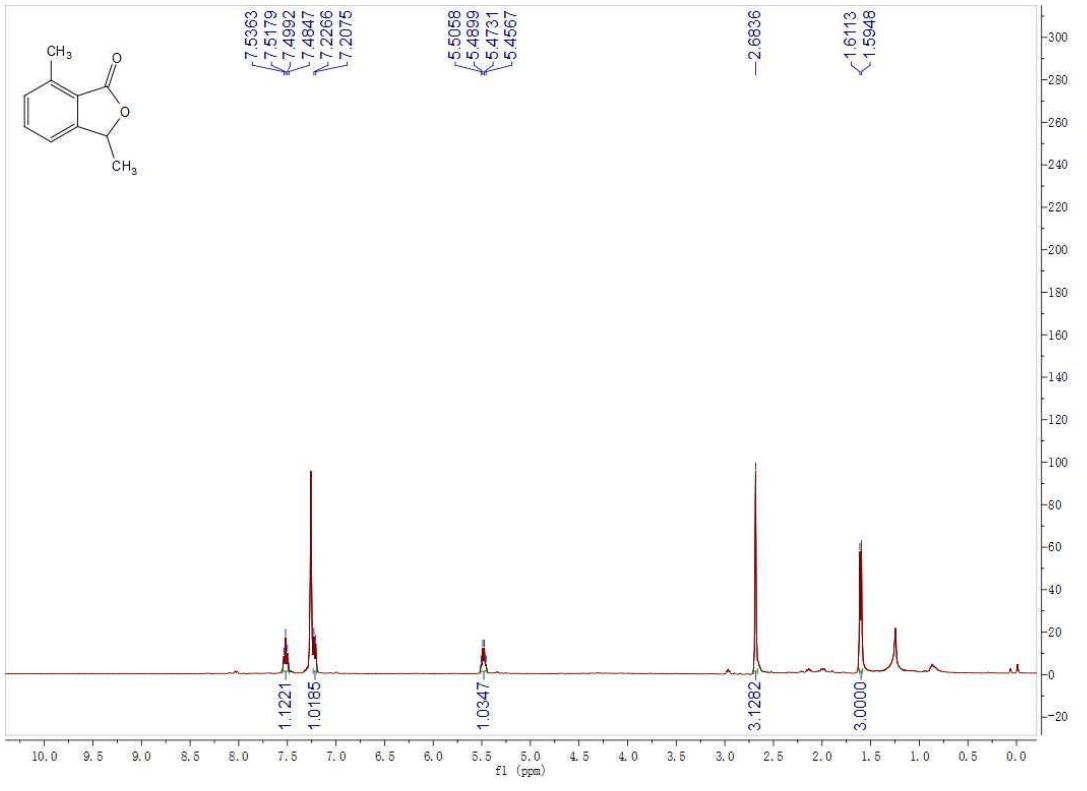
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3h**



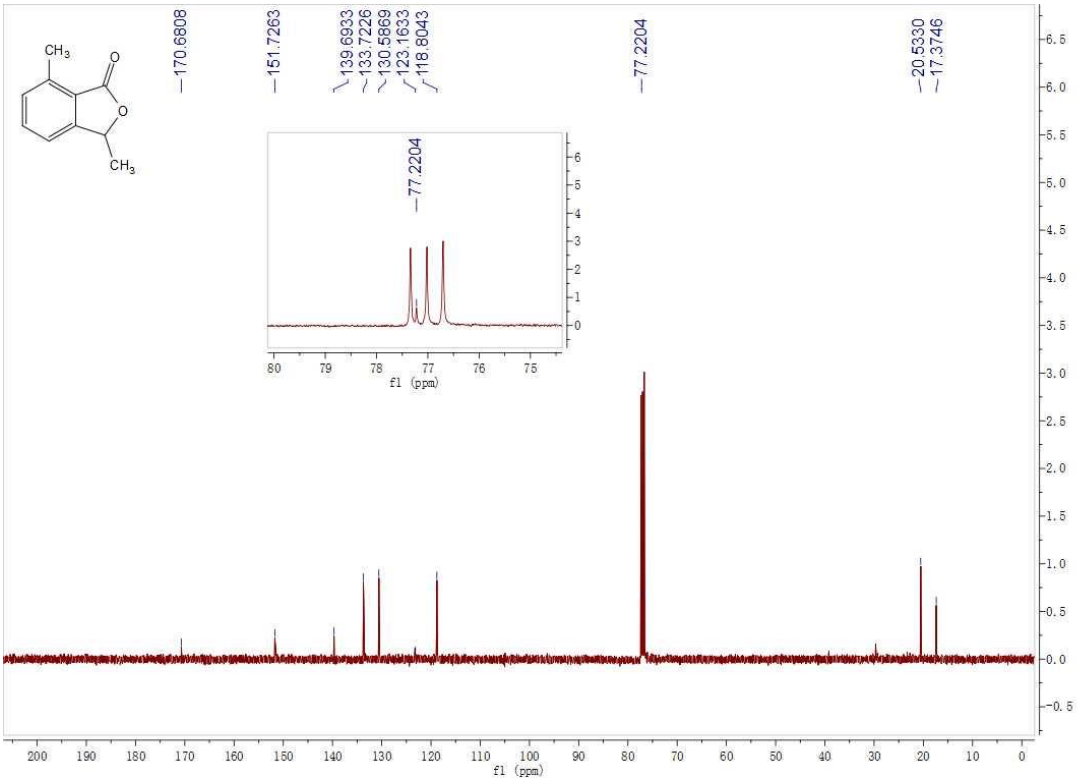
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3h**



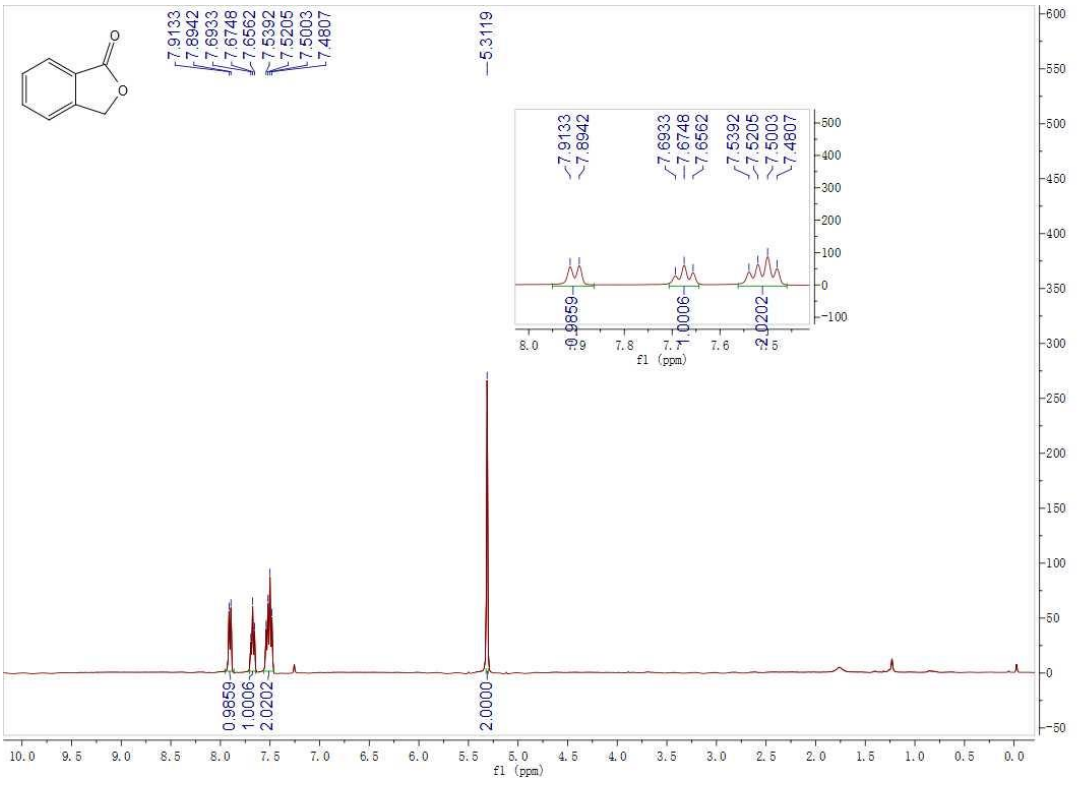
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3i**



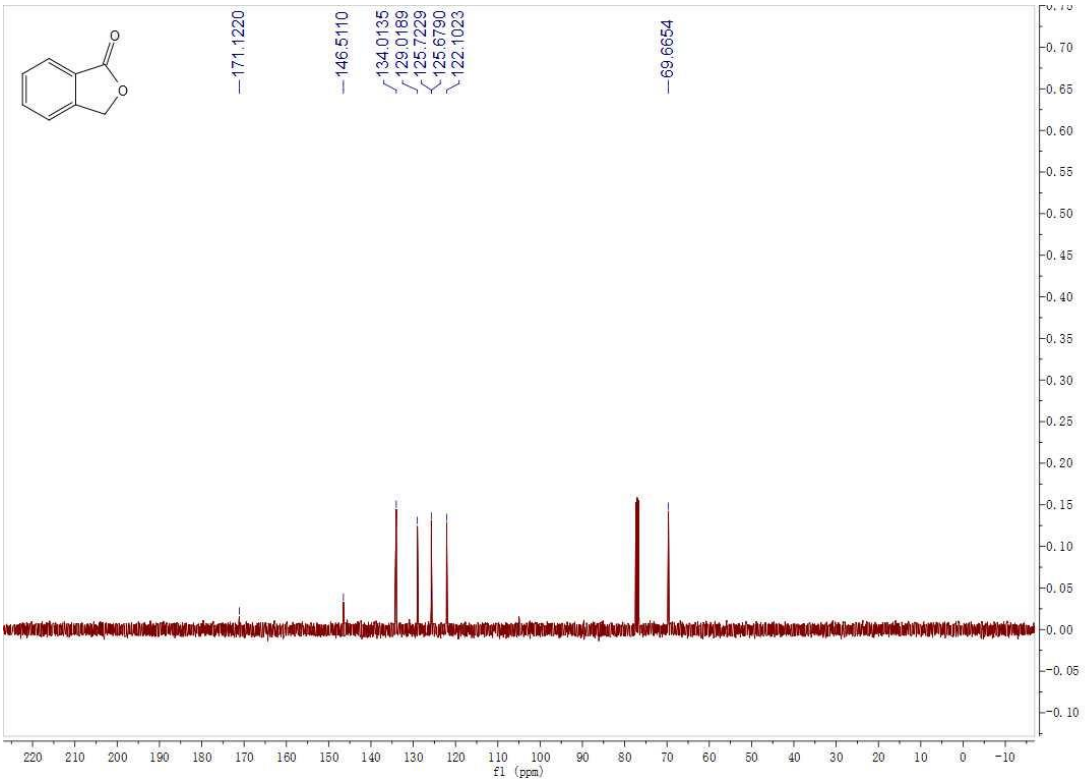
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3i**



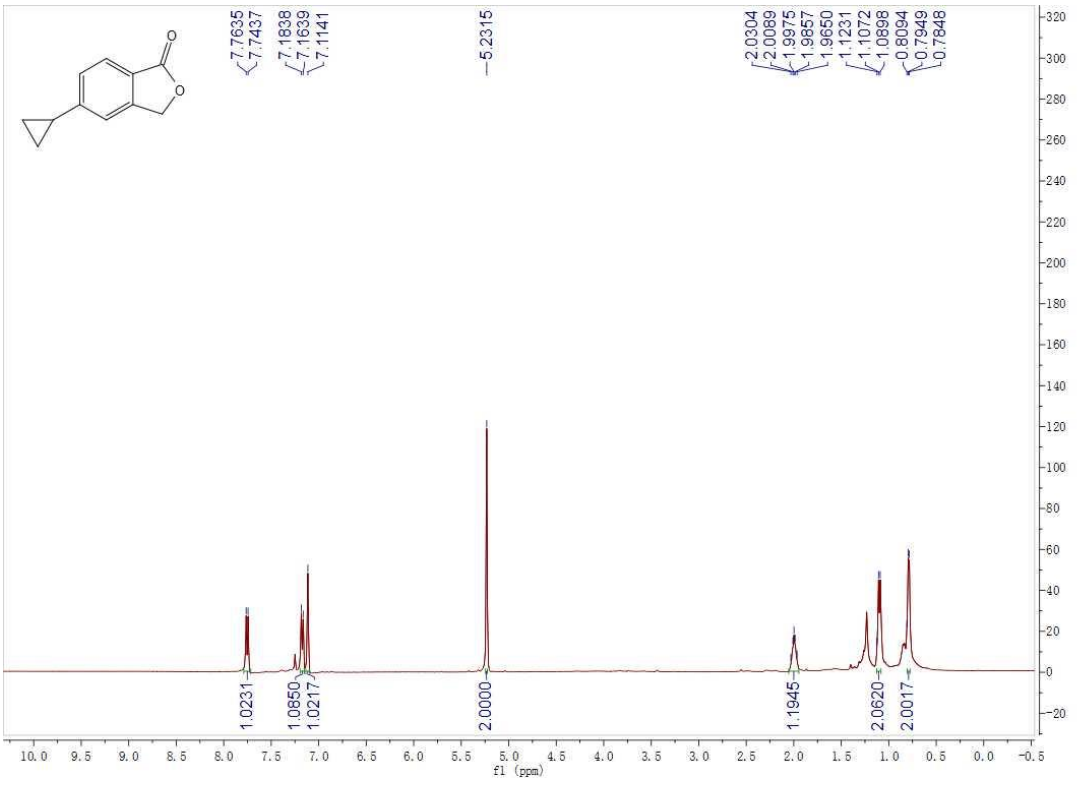
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3J**



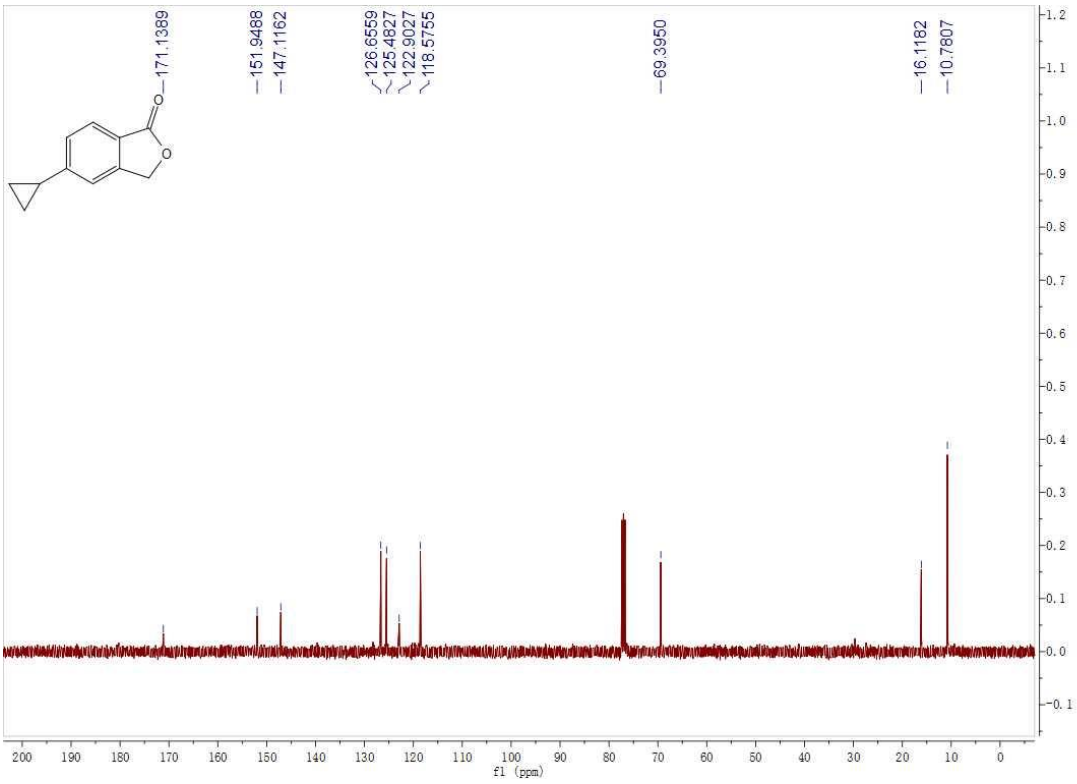
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3J**



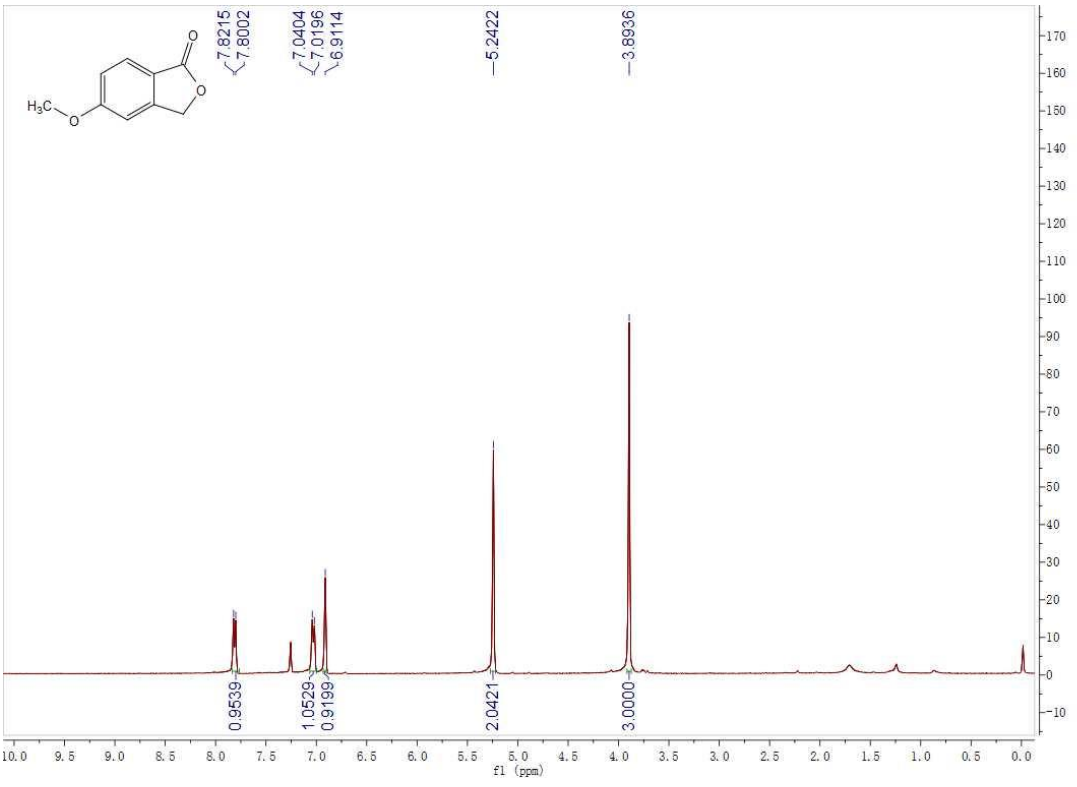
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3k**



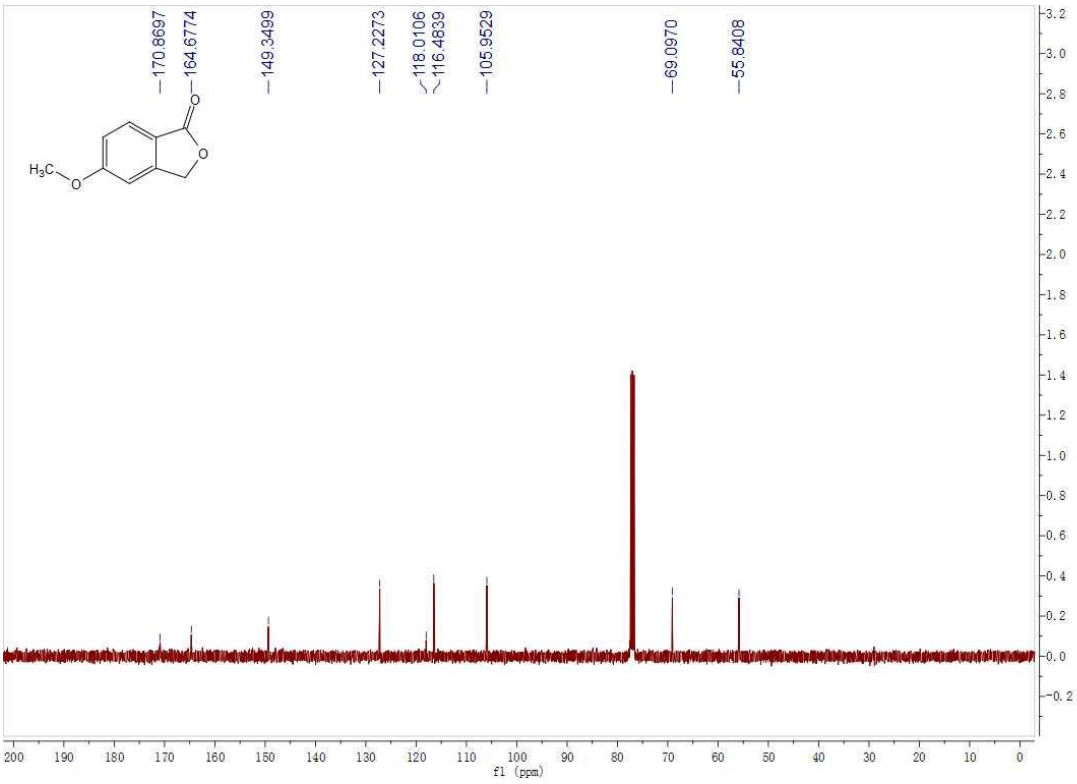
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3k**



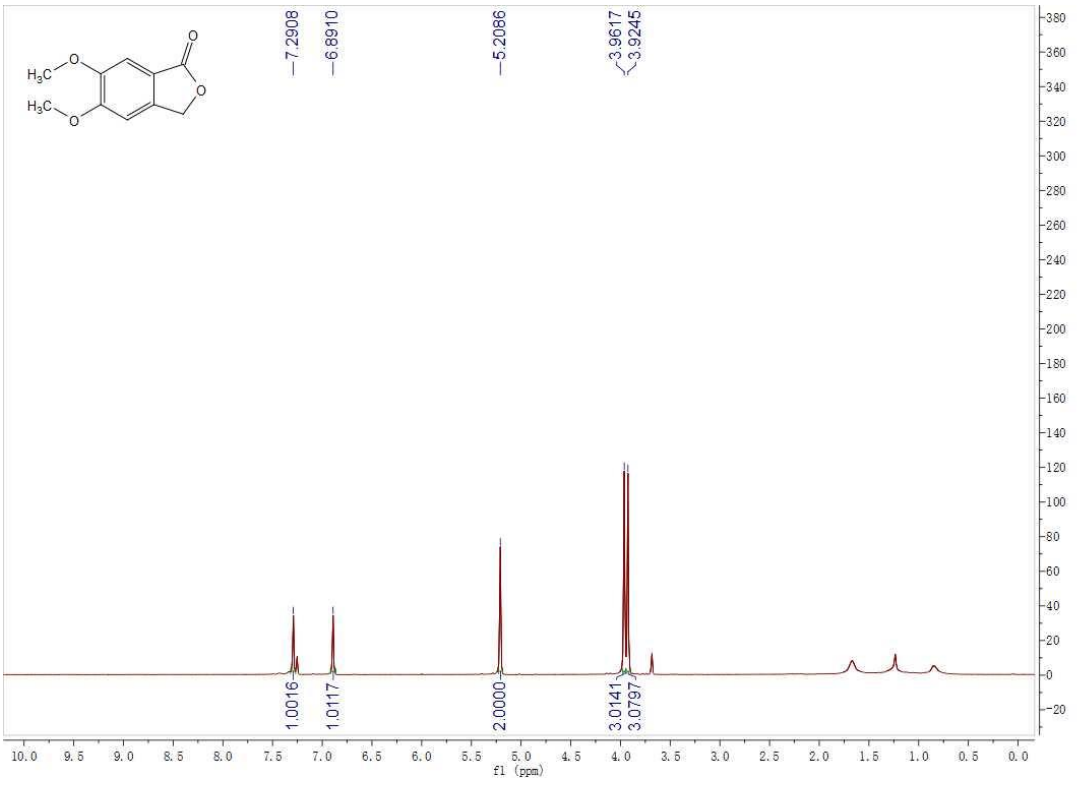
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3l**



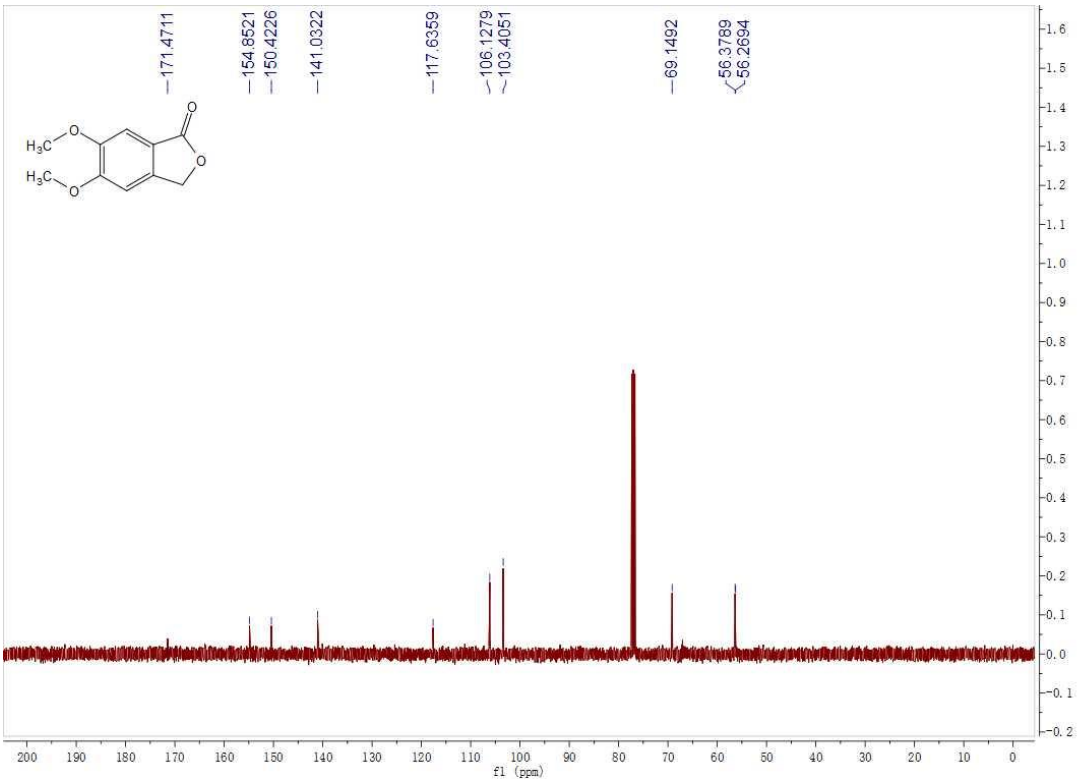
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3l**



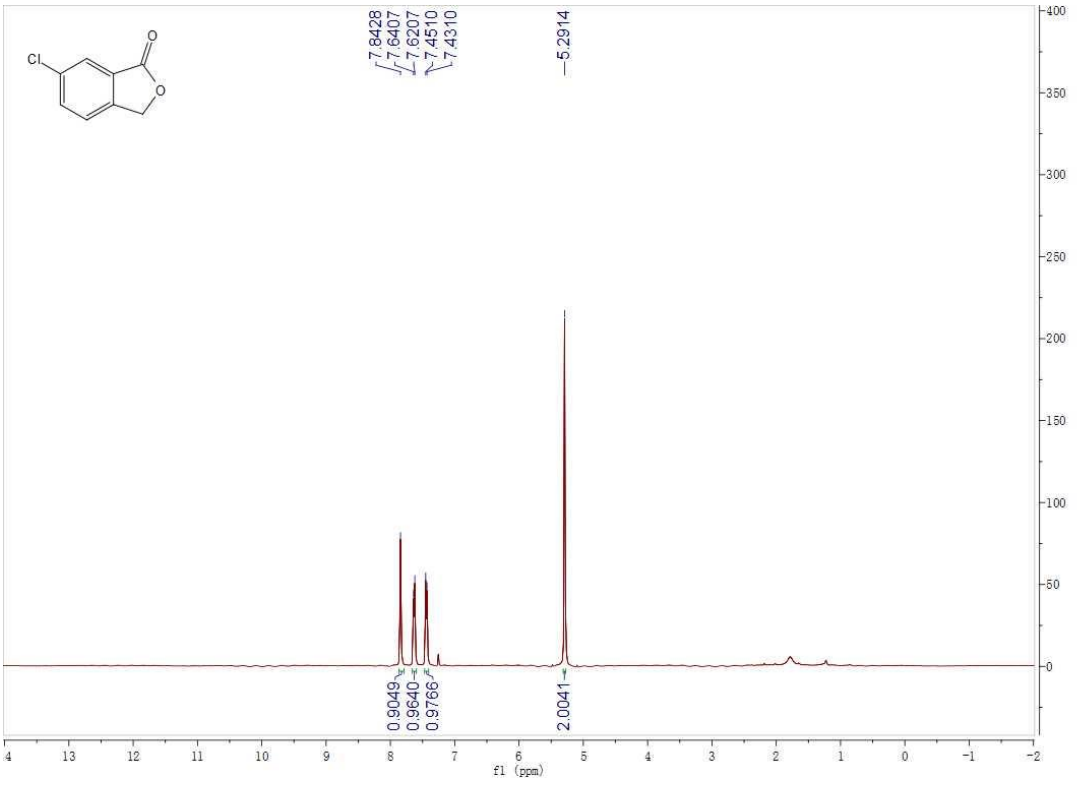
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3m**



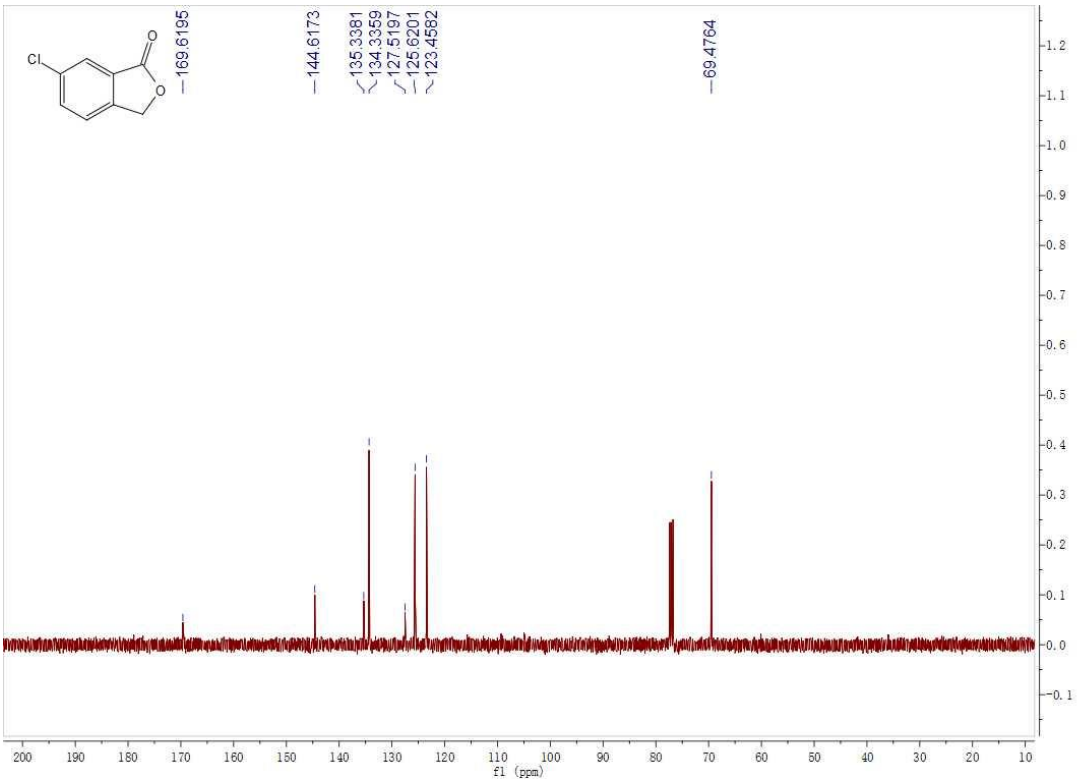
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3m**



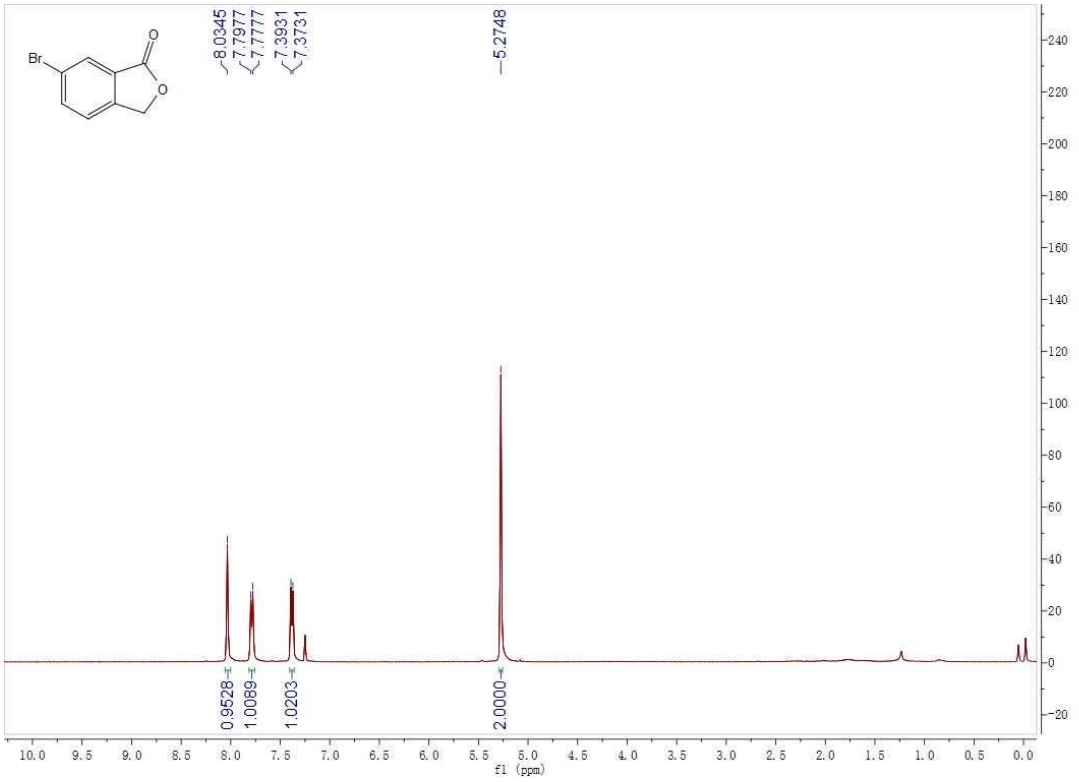
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3n**



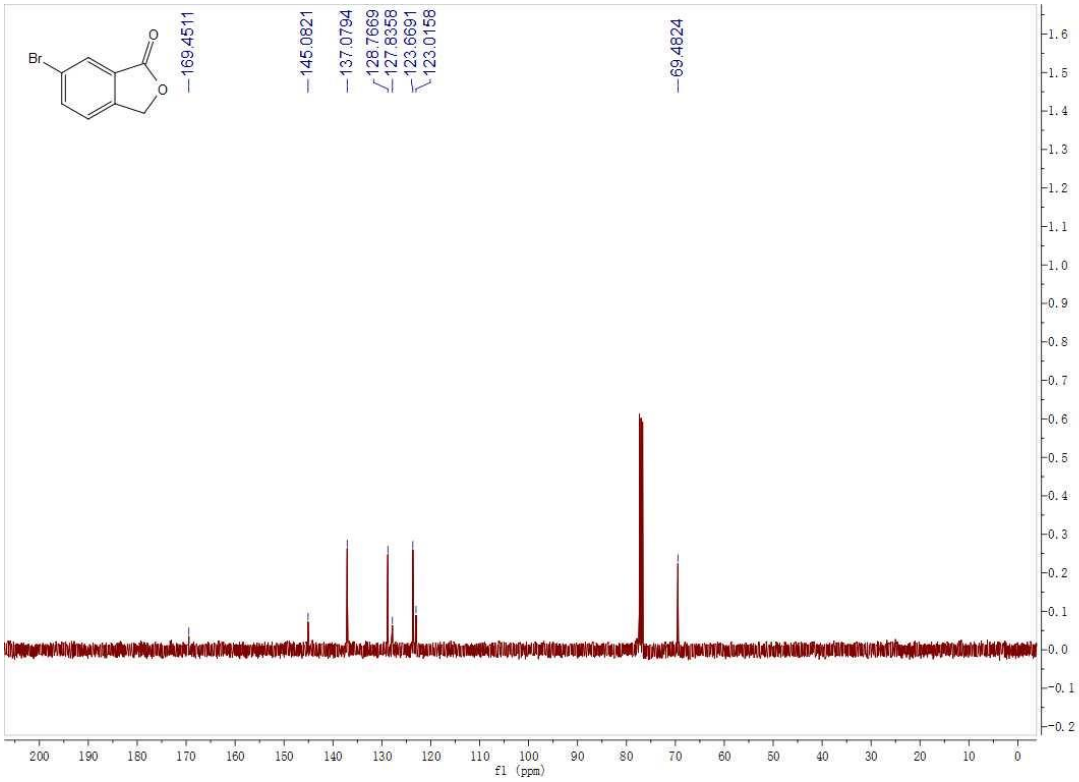
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3n**



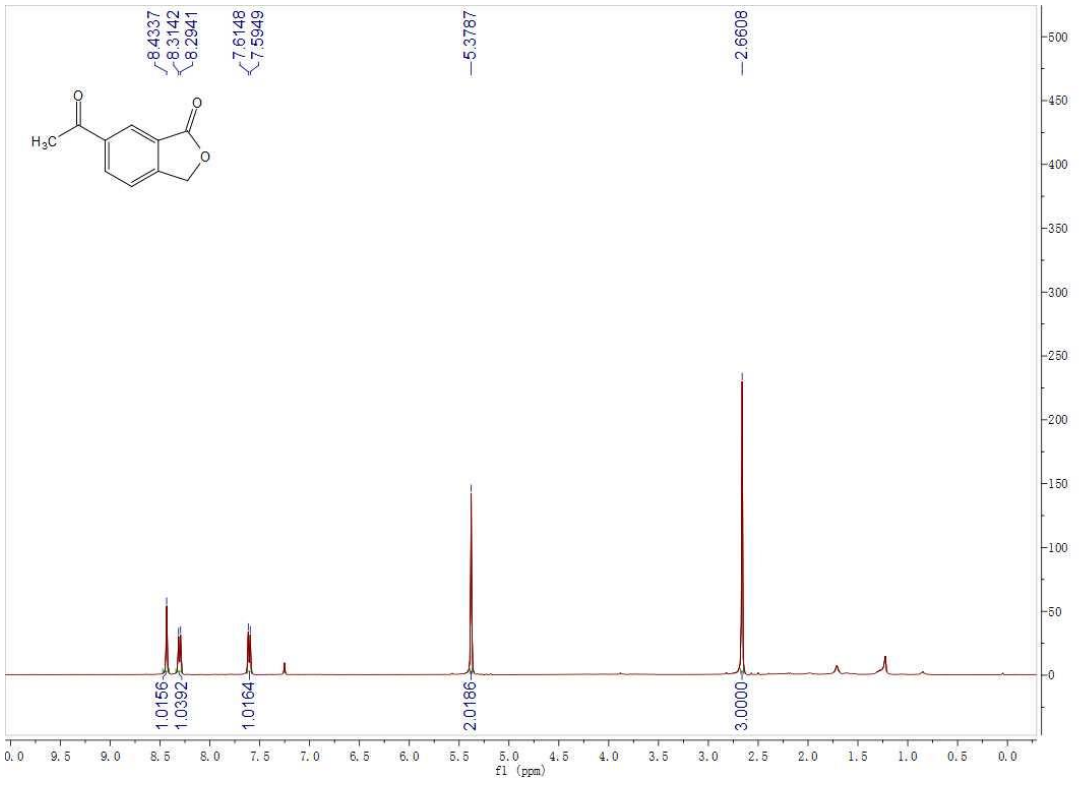
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3o**



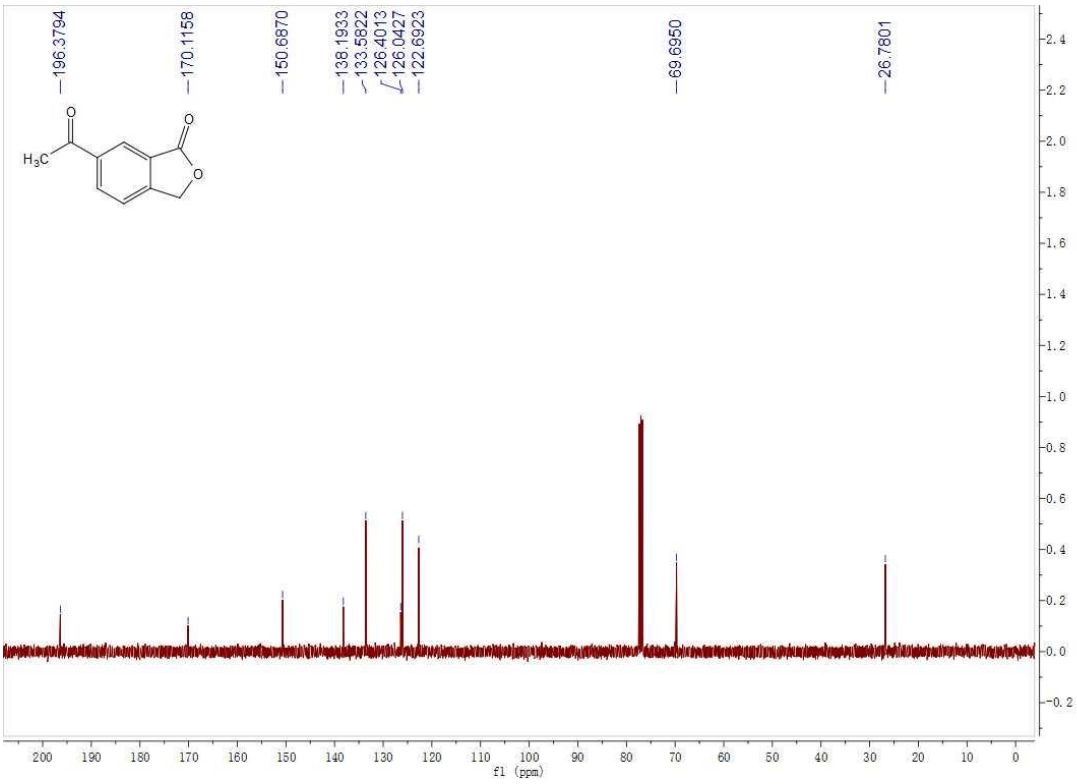
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3o**



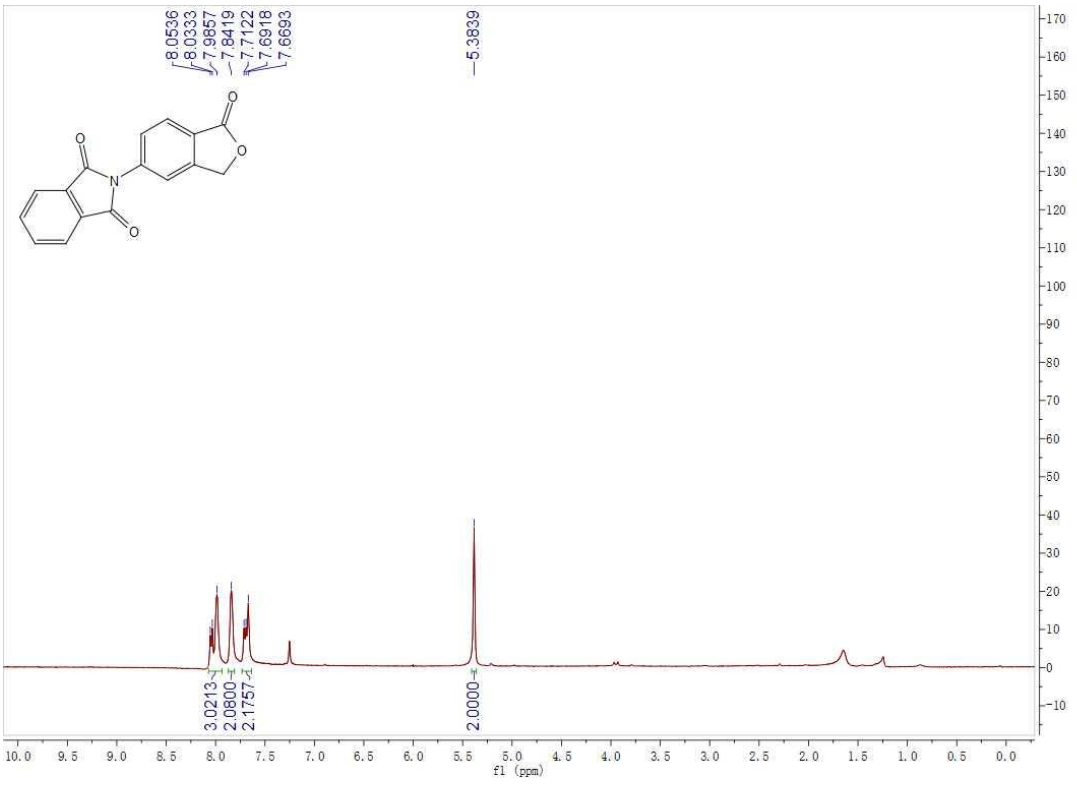
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3p**



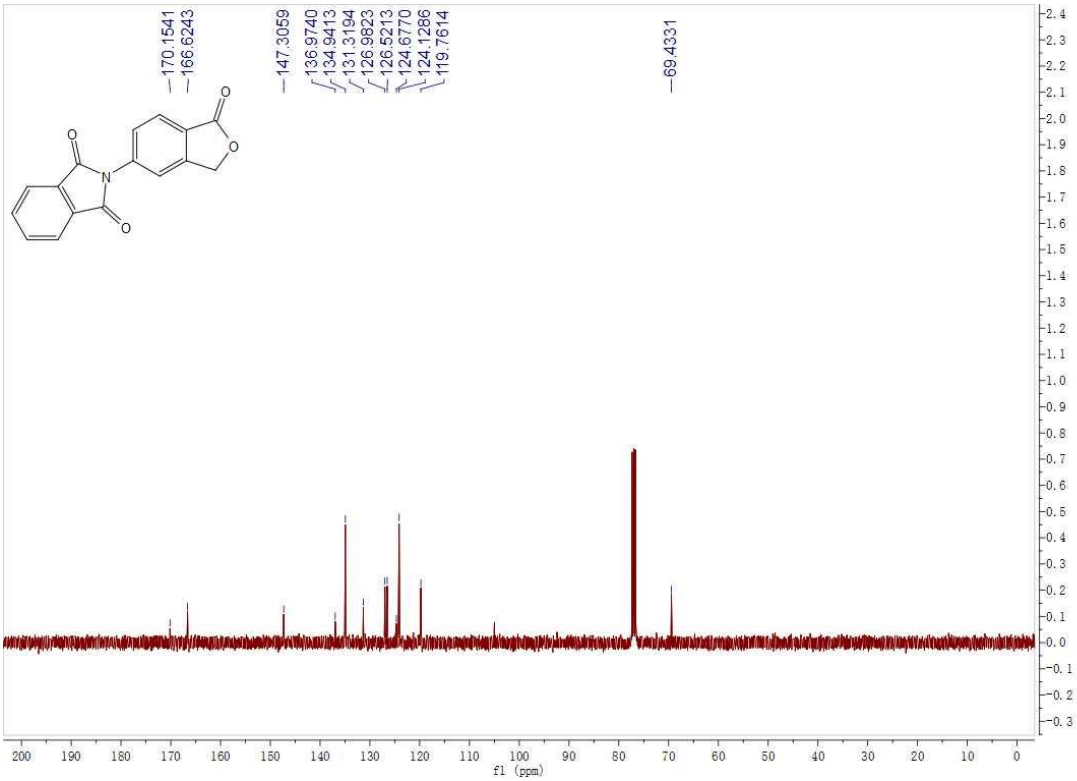
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3p**



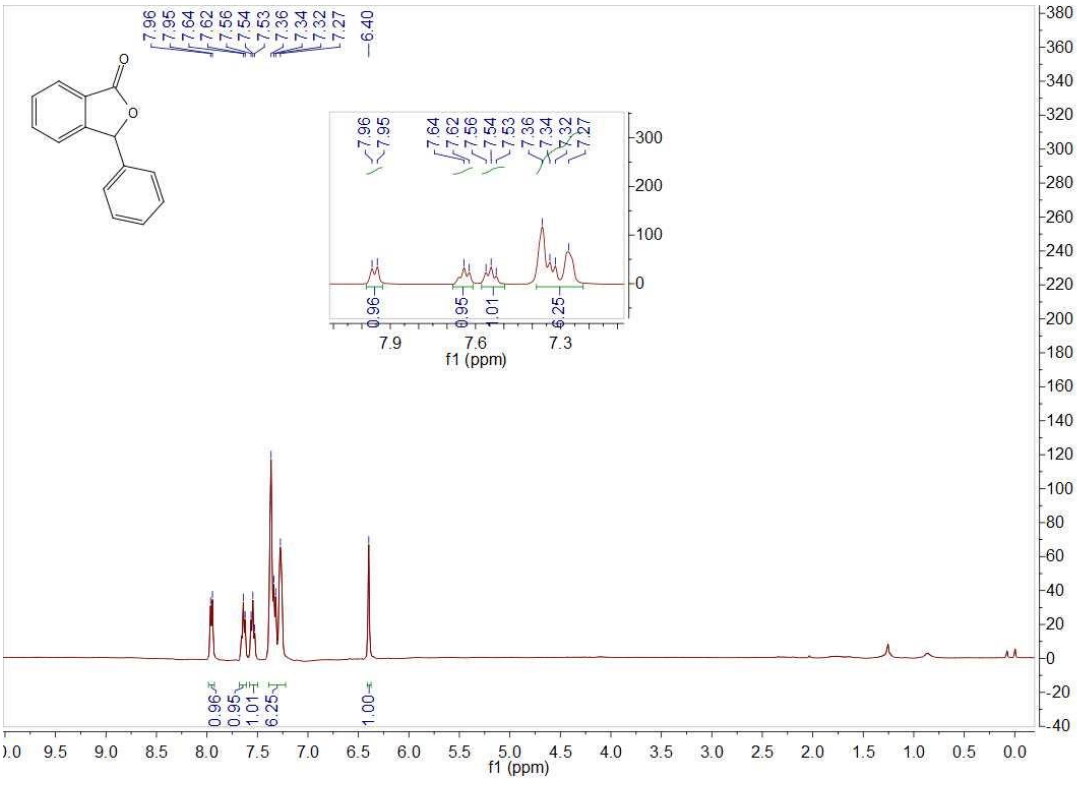
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3q**



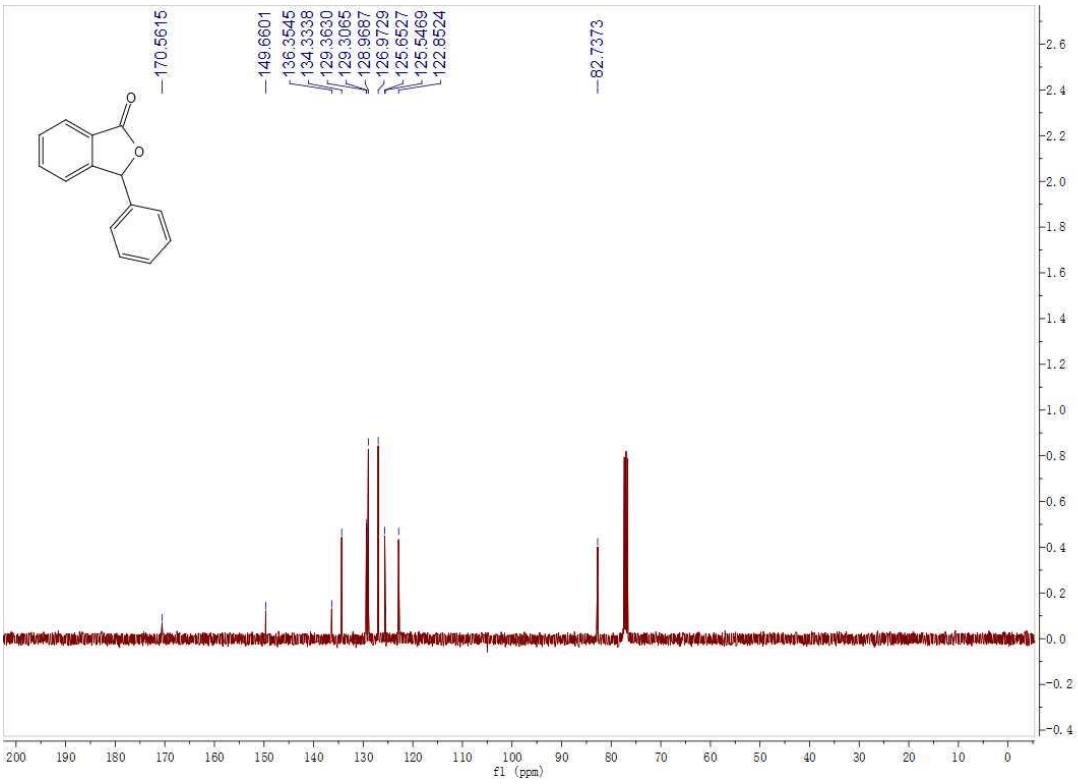
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3q**



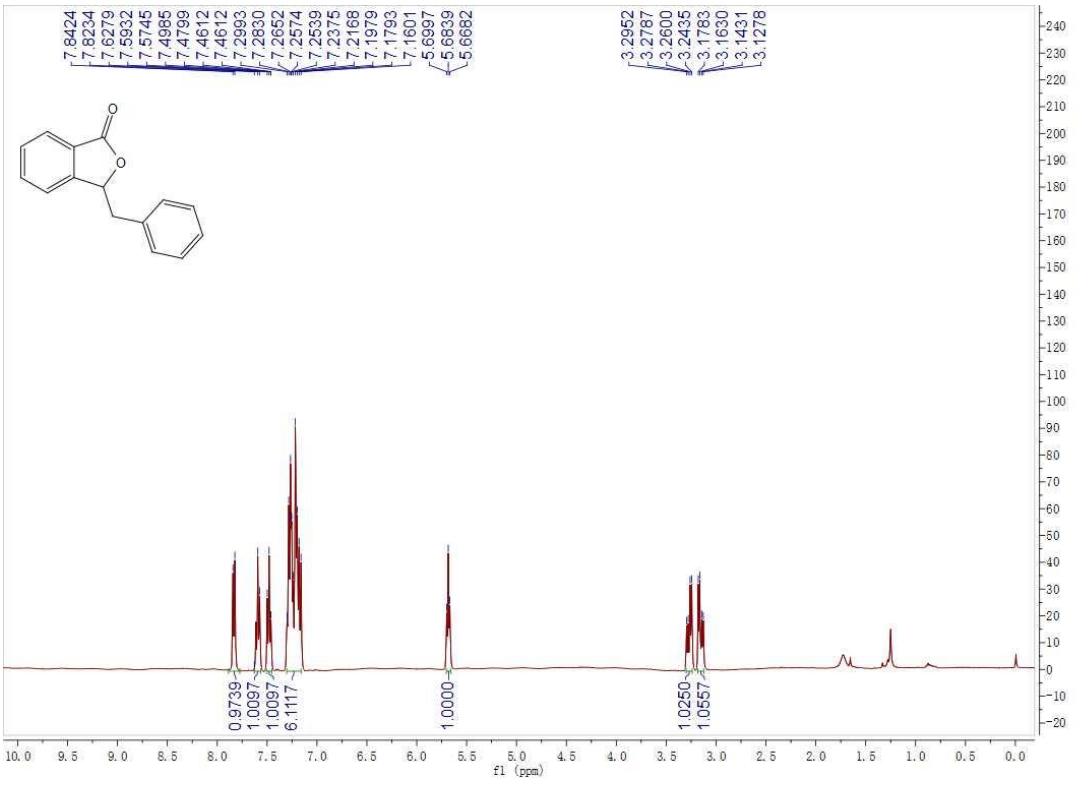
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3r**



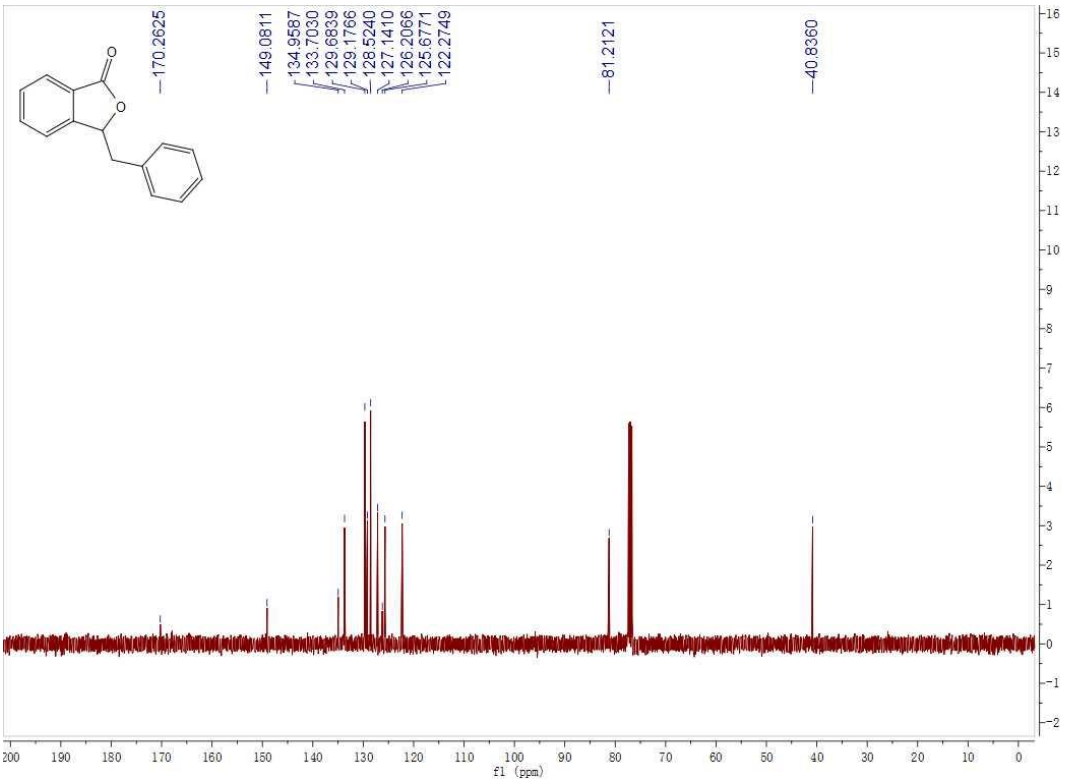
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3r**



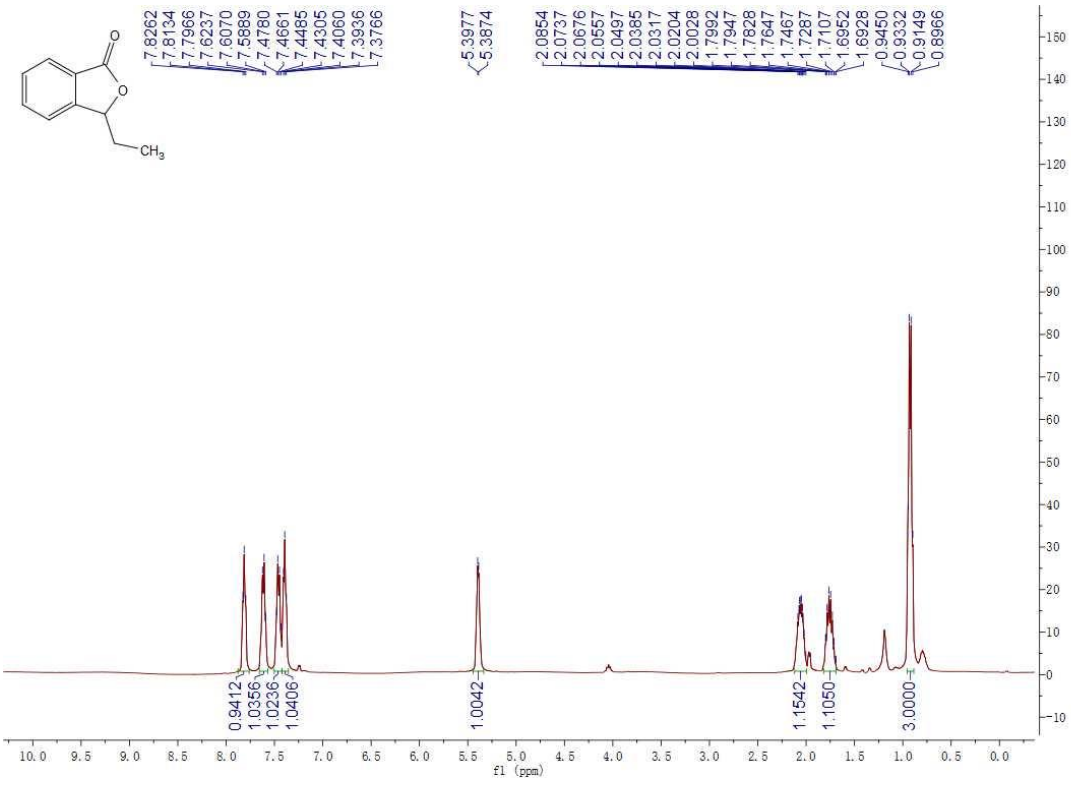
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3s**



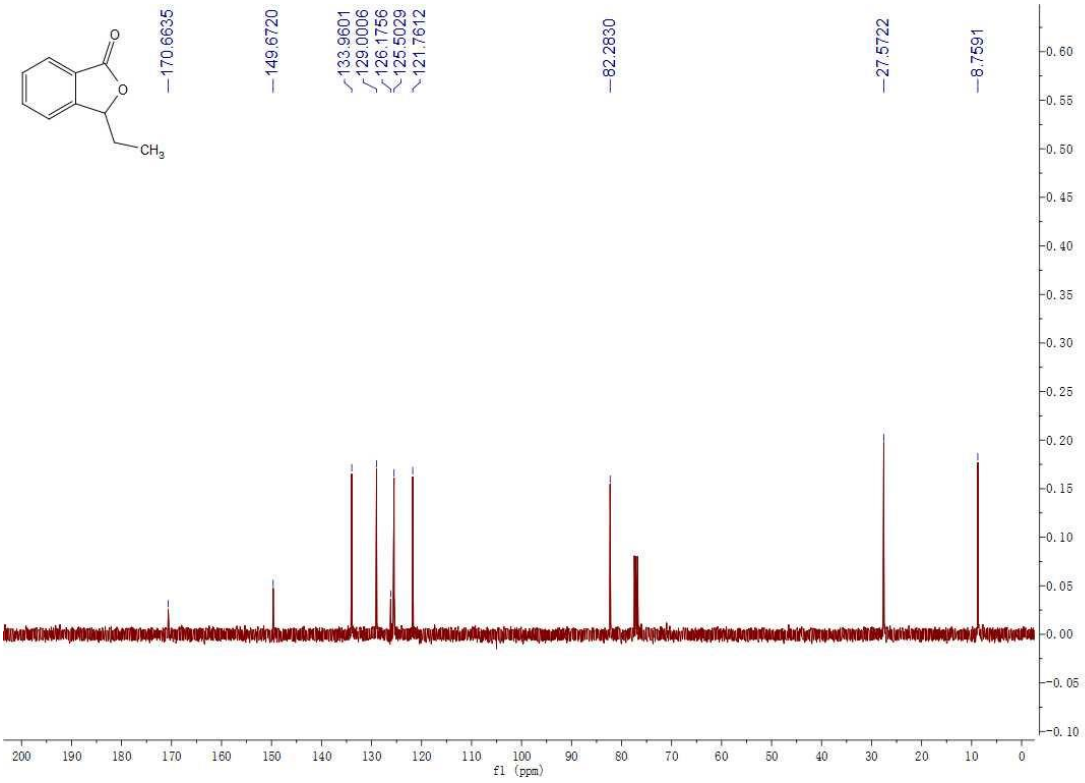
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3s**



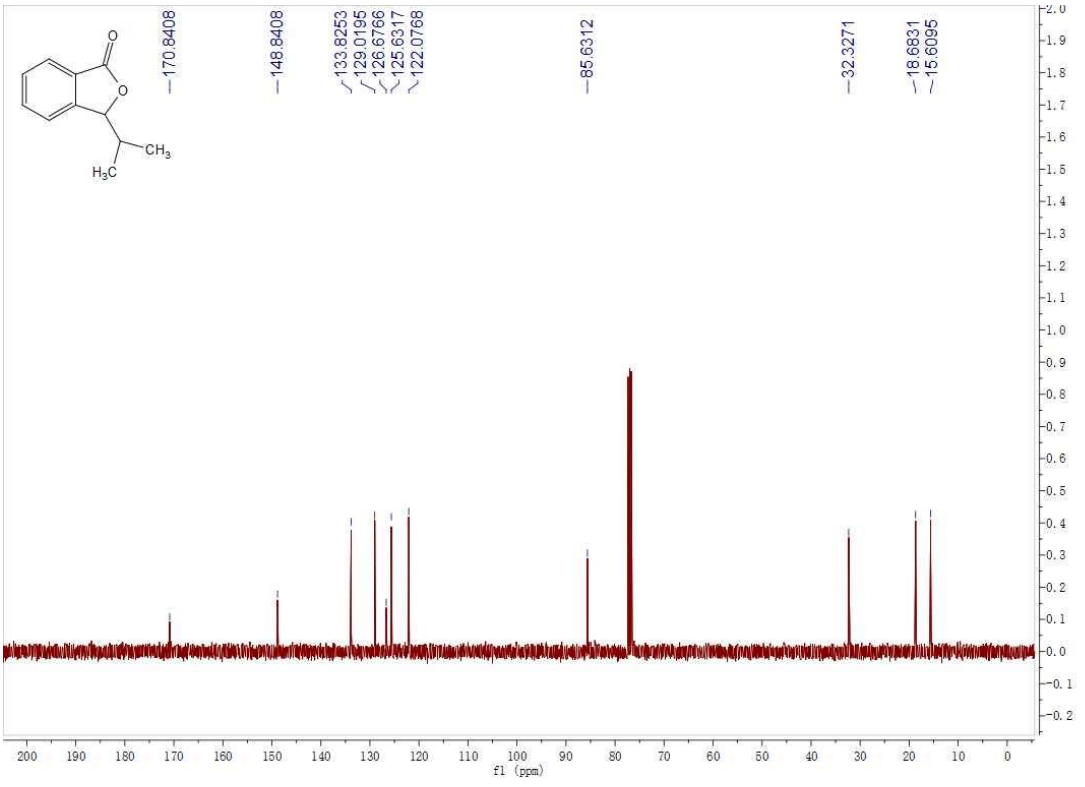
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3t**



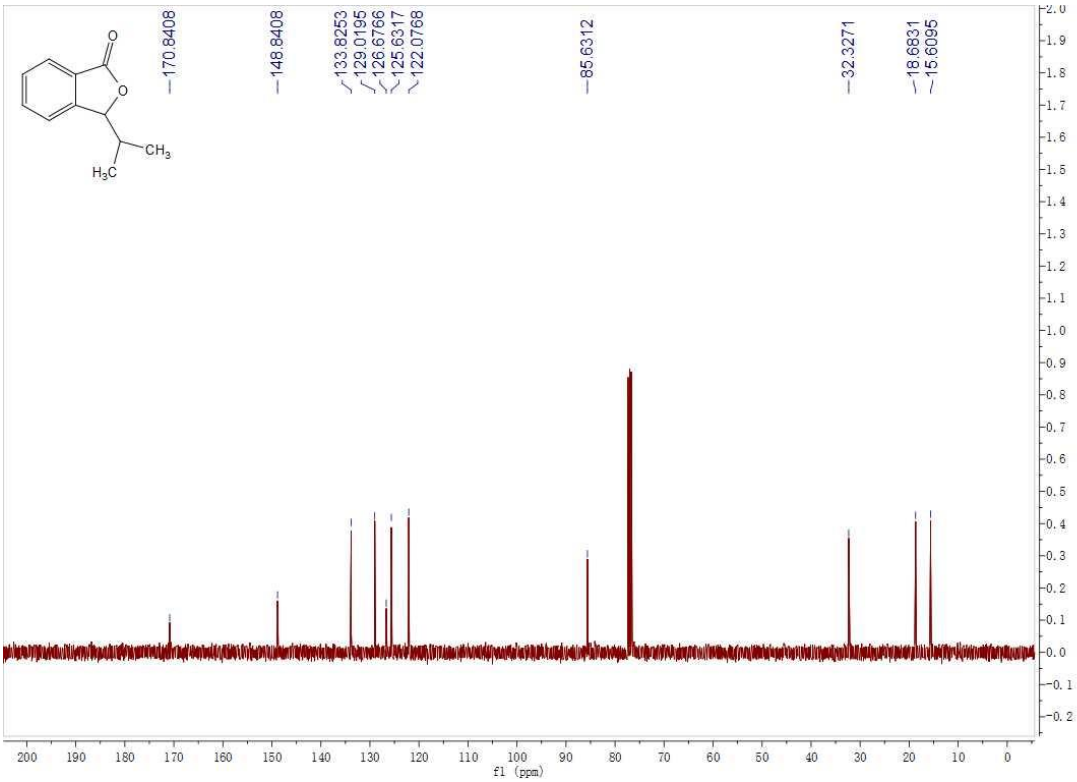
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3t**



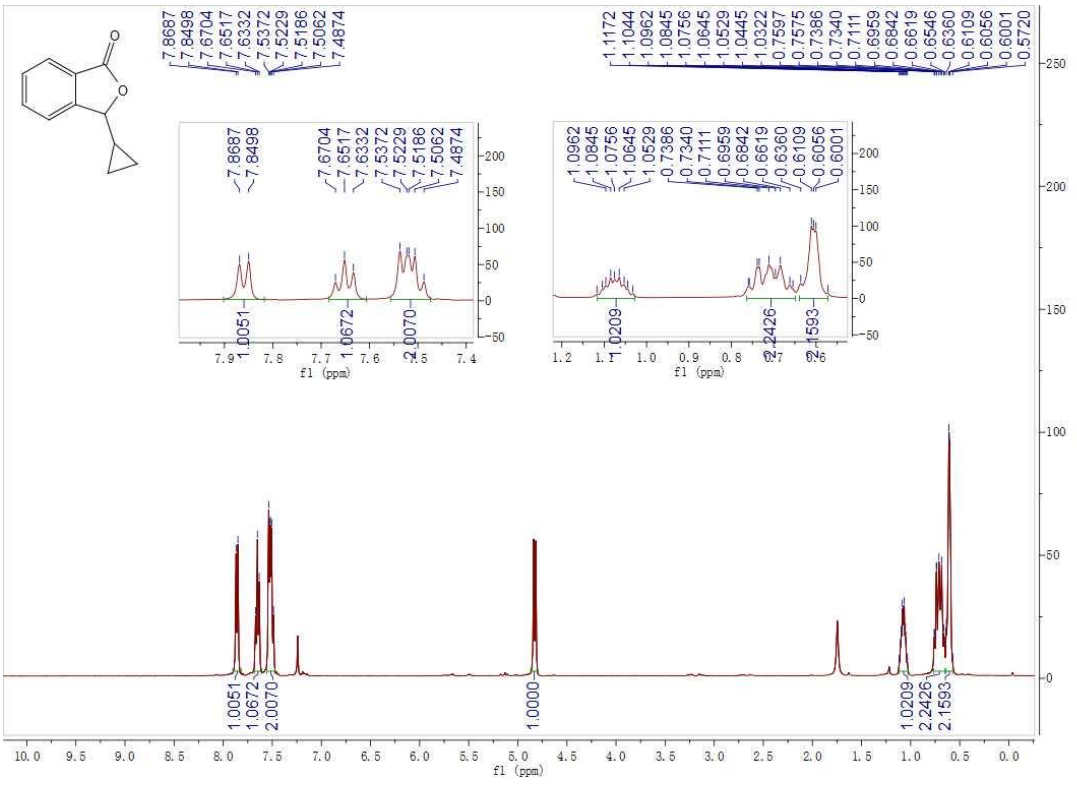
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3u**



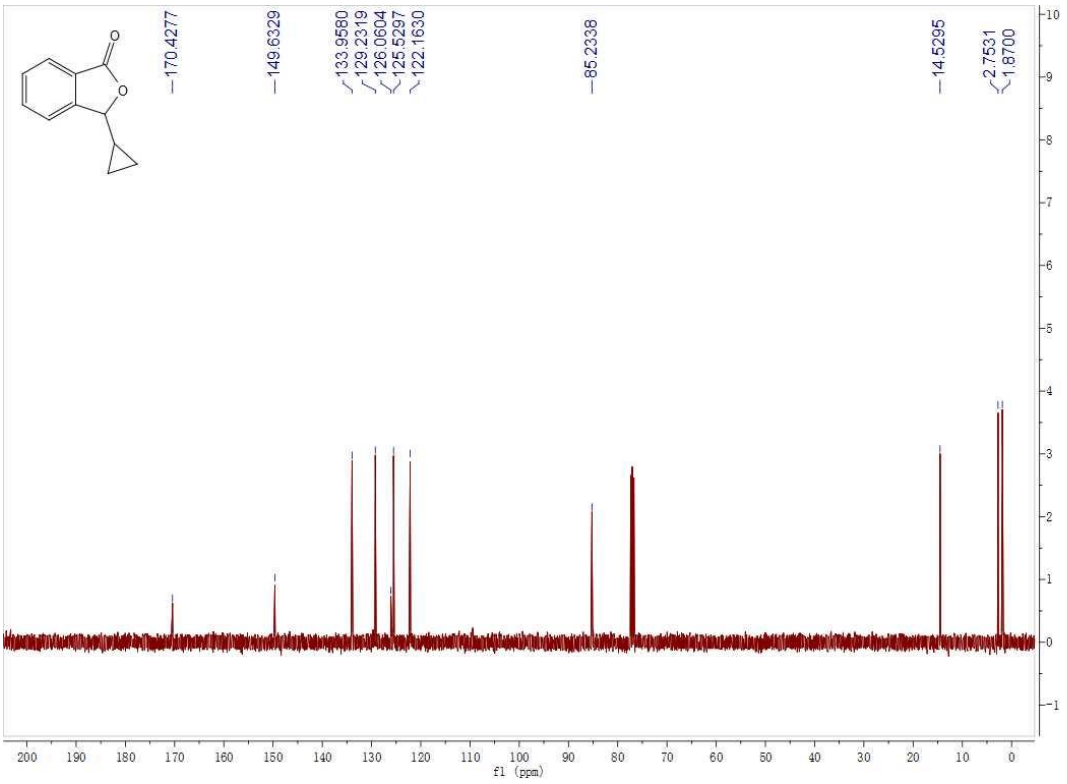
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3u**



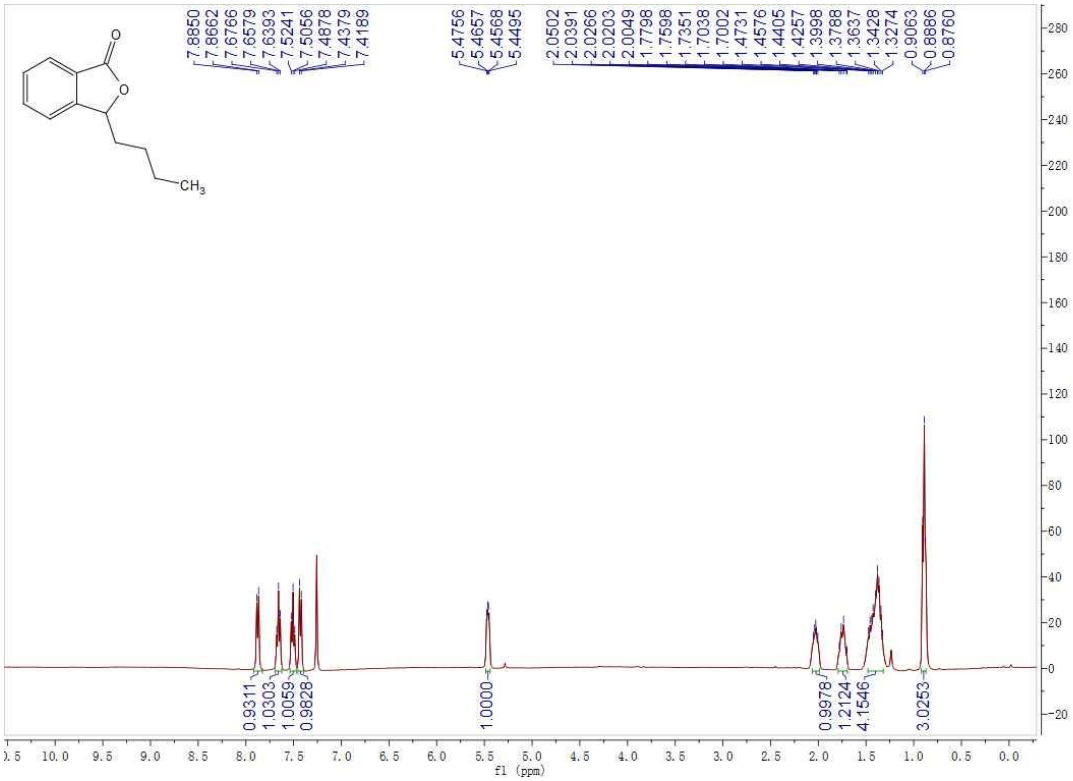
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3v**



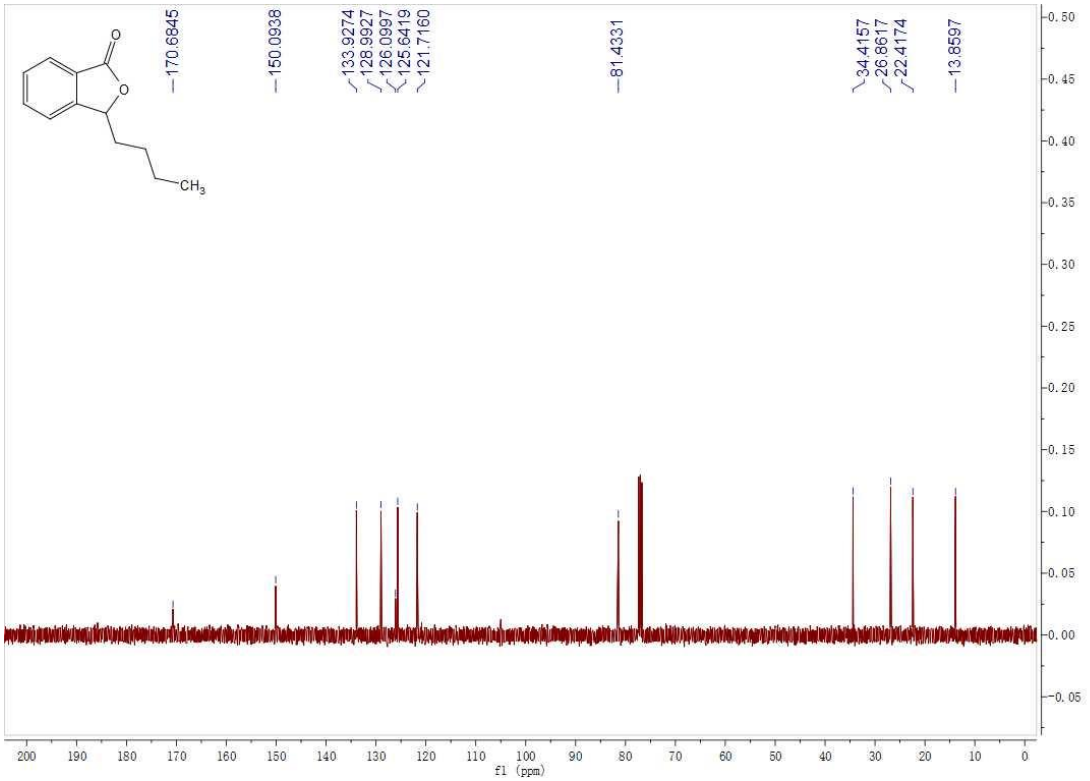
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3v**



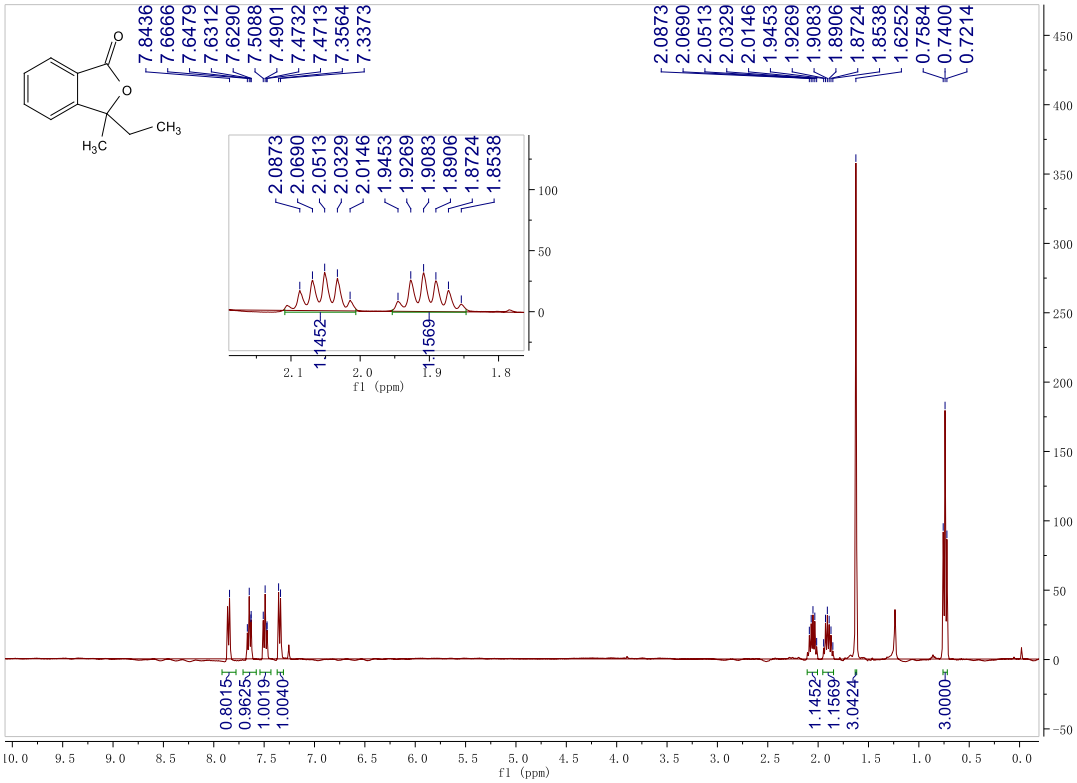
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3w**



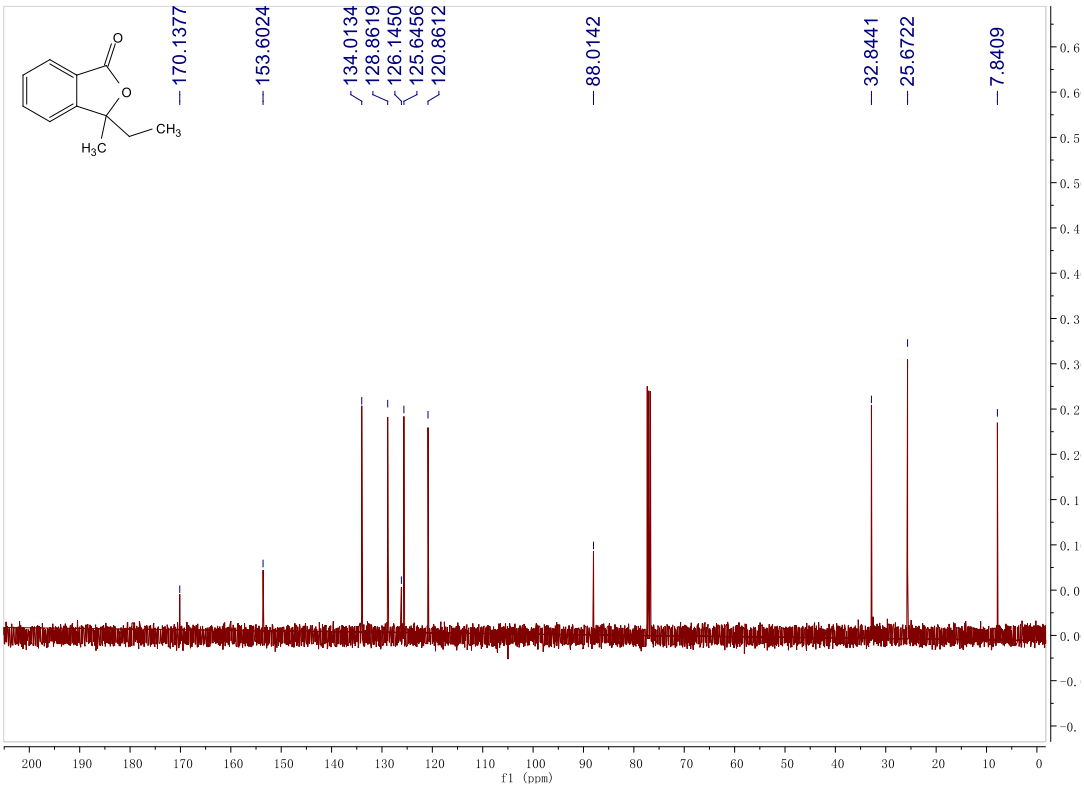
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3w**



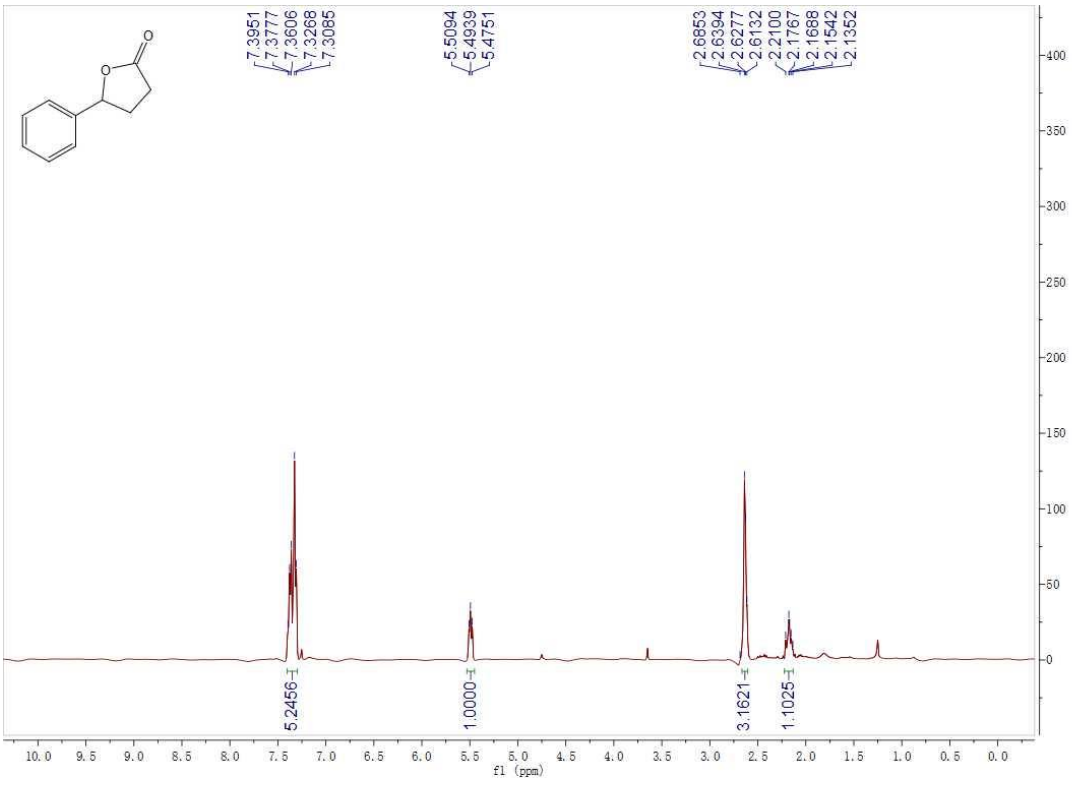
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **3x**



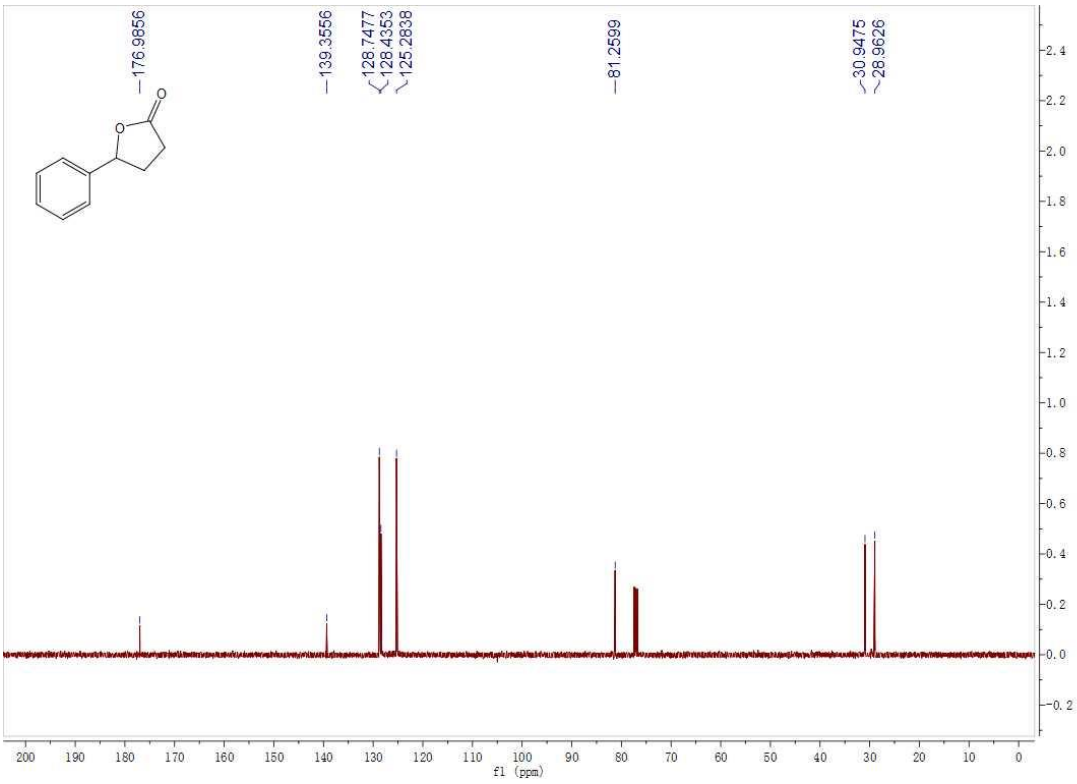
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **3x**



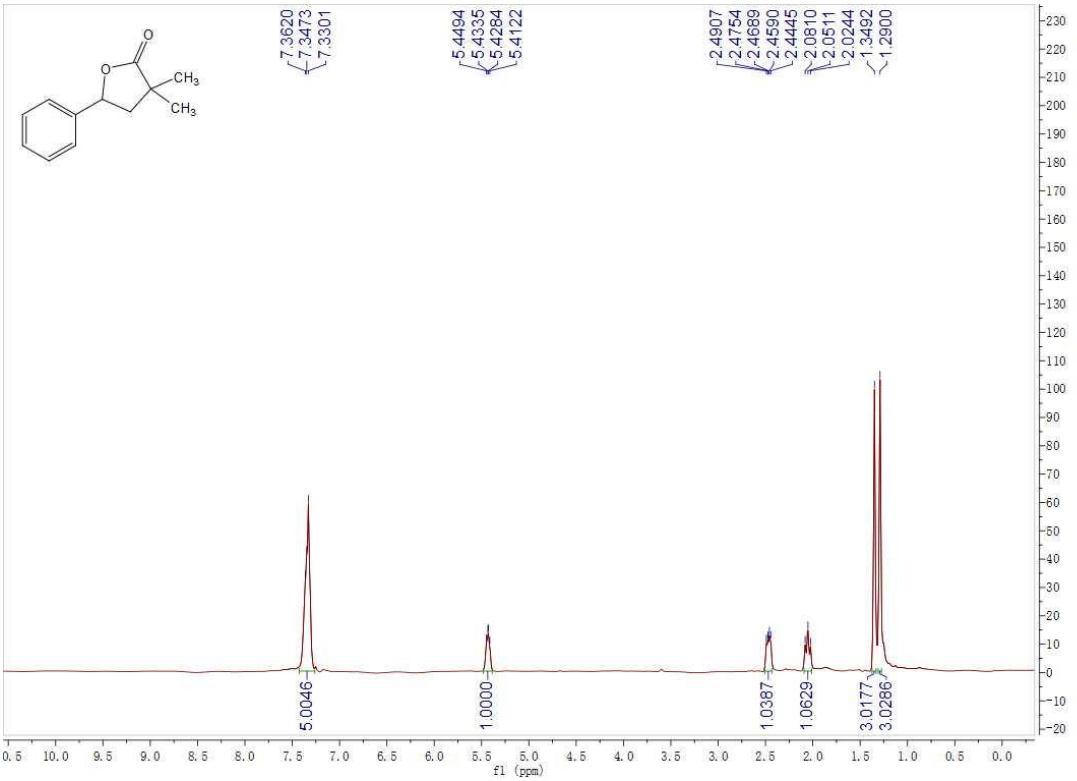
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **5a**



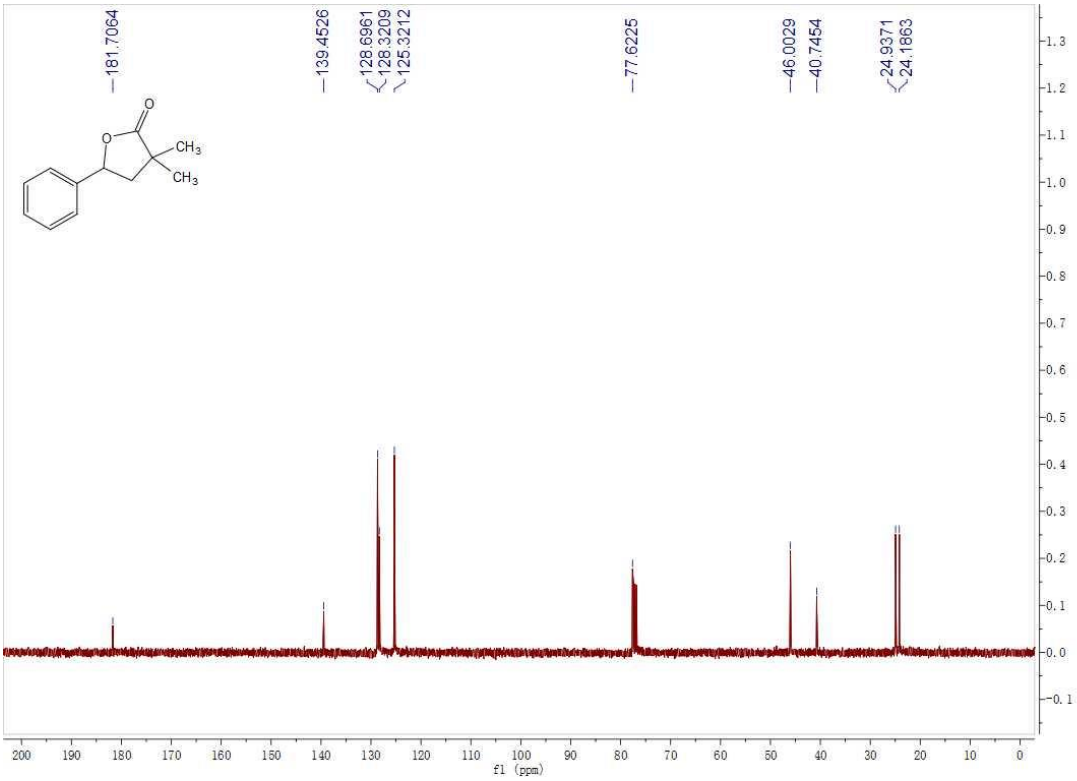
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **5a**



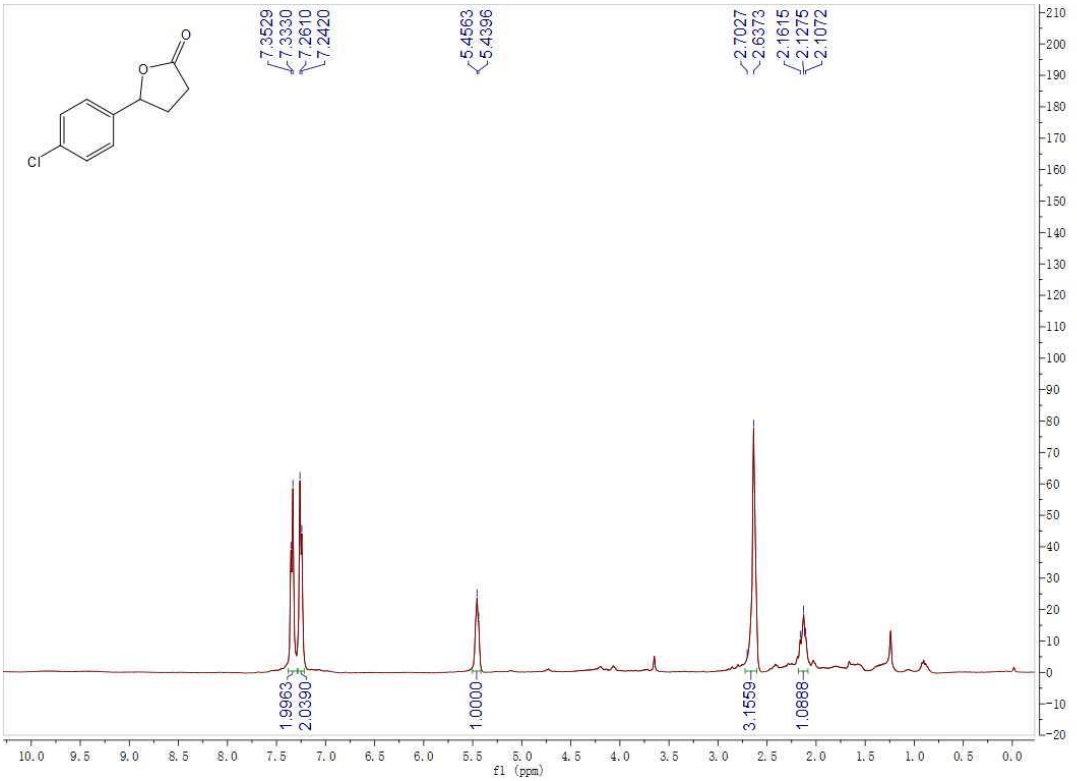
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **5b**



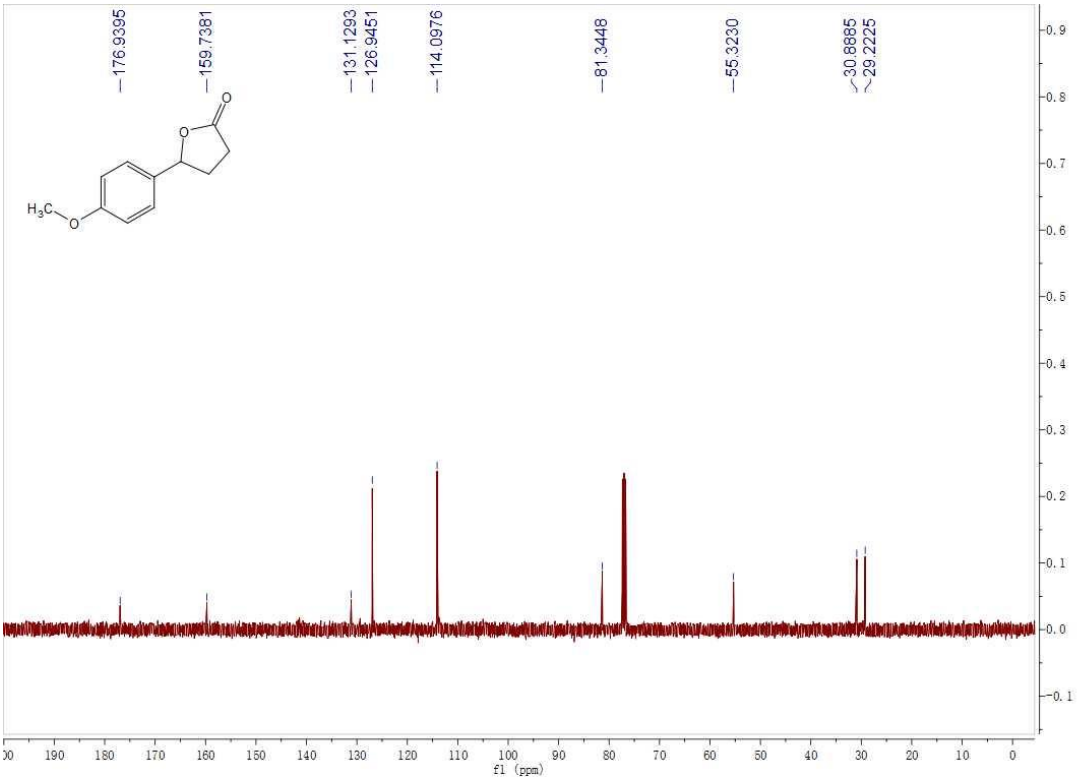
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **5b**



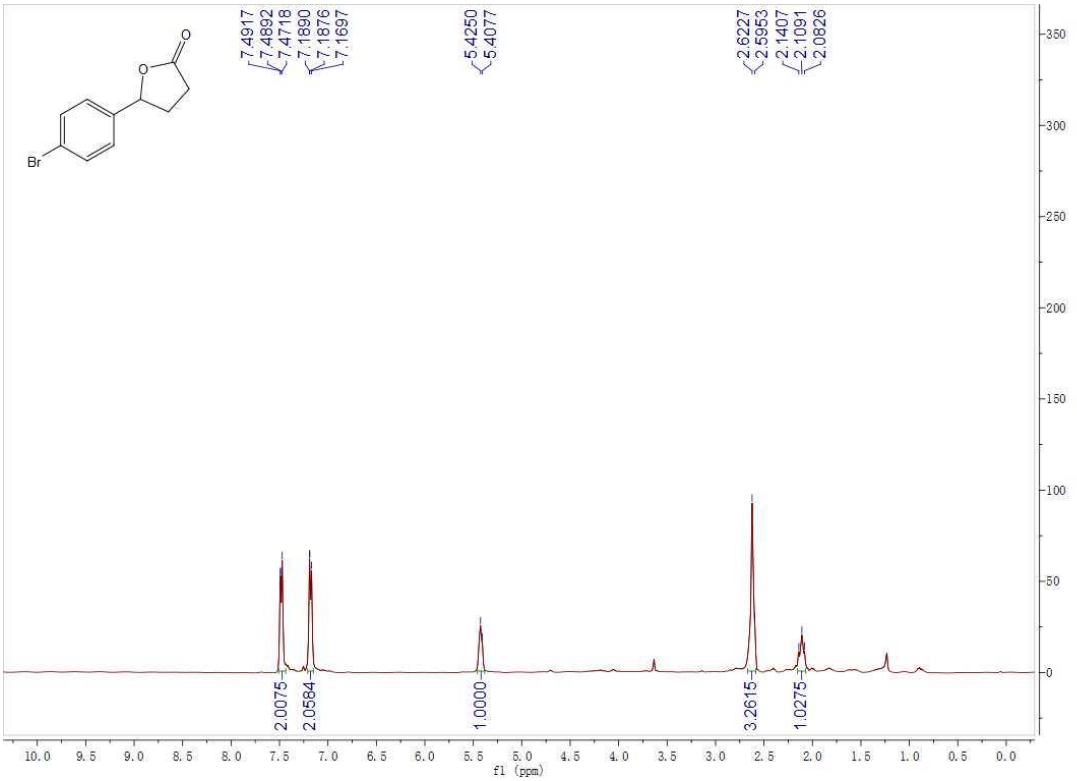
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **5c**



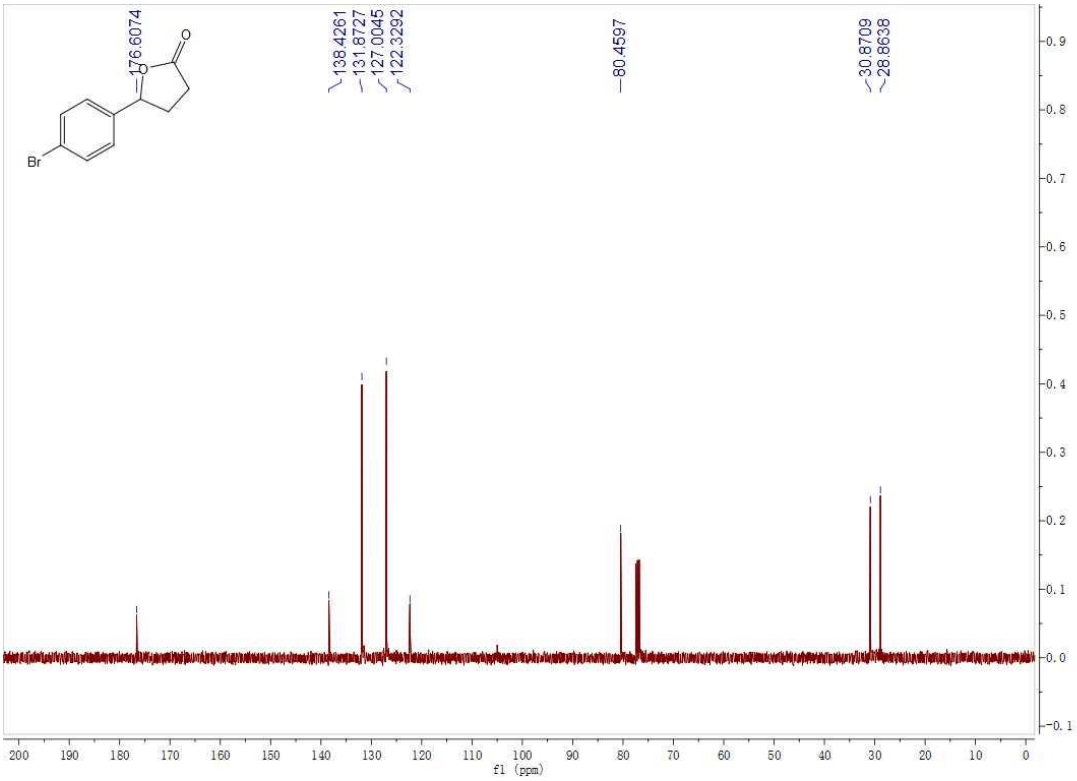
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **5c**



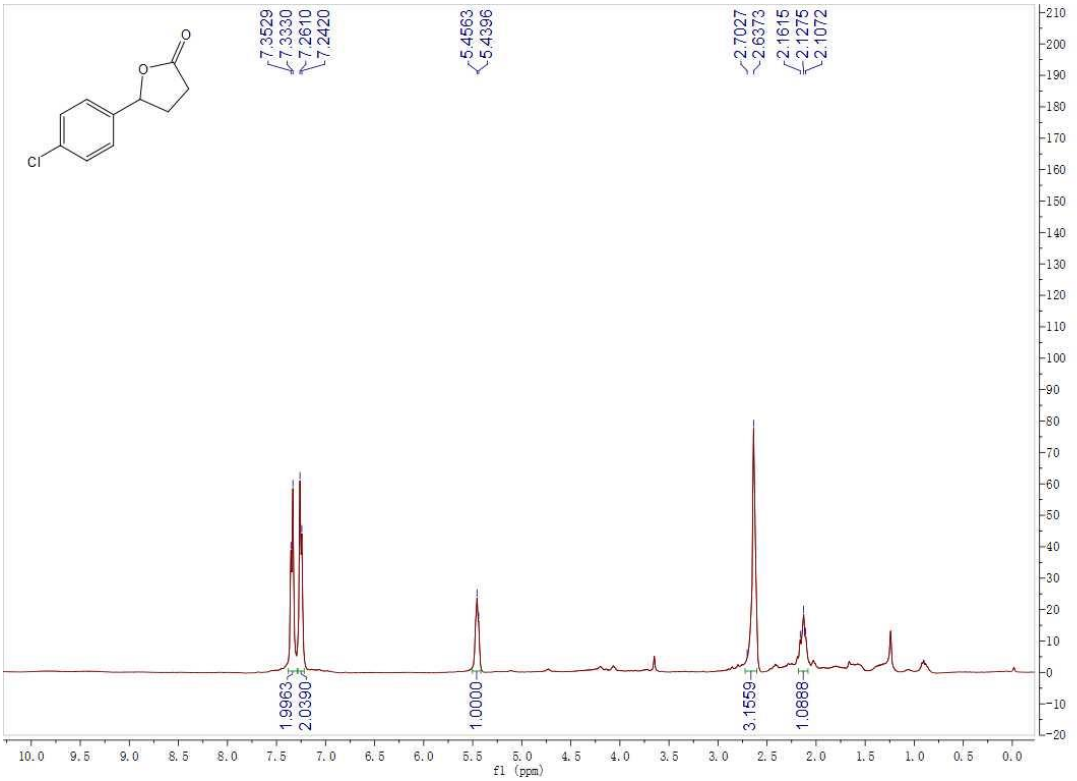
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **5d**



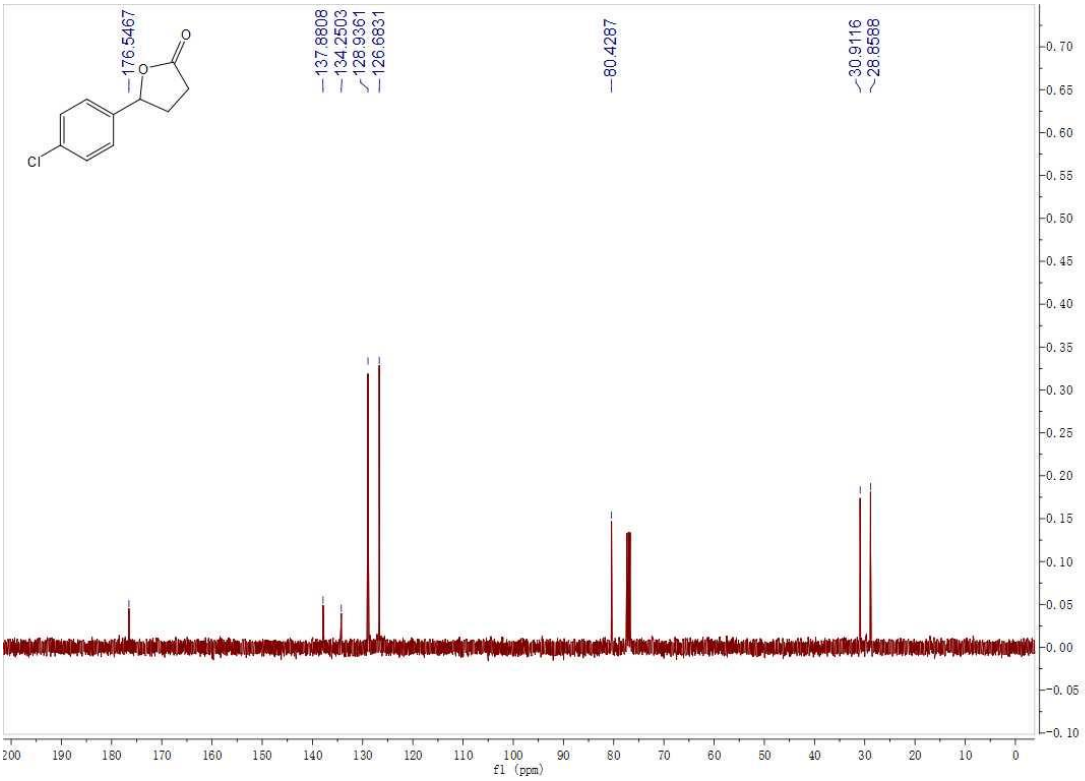
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **5d**



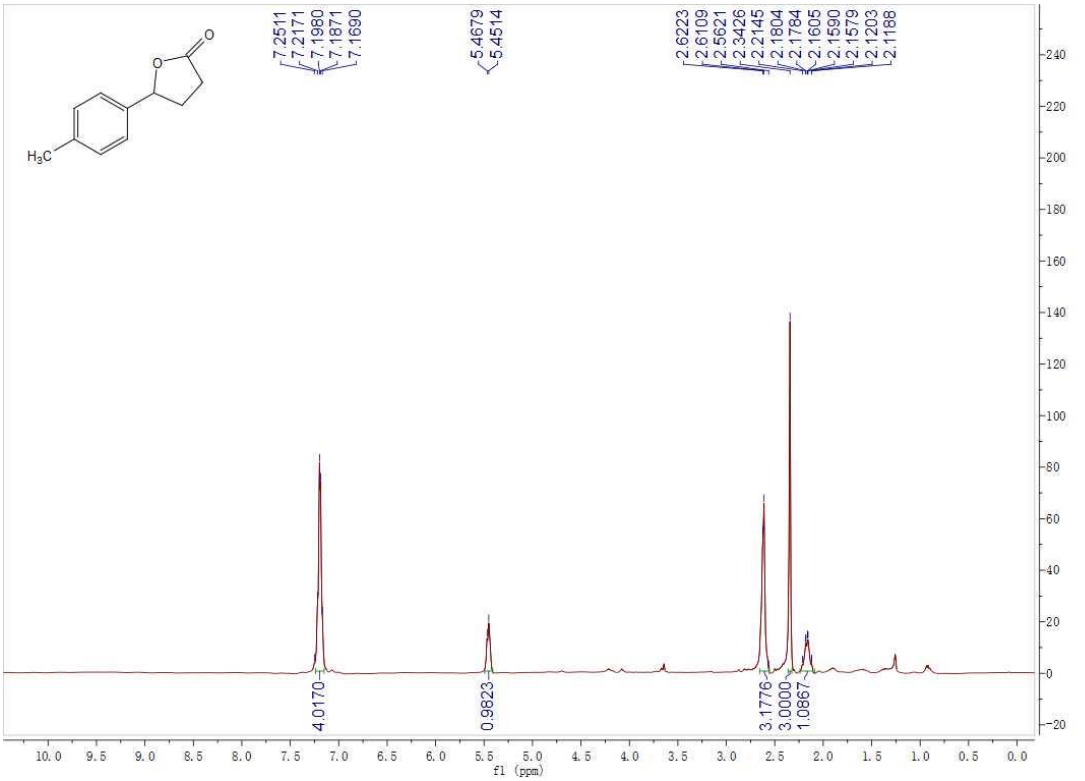
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **5e**



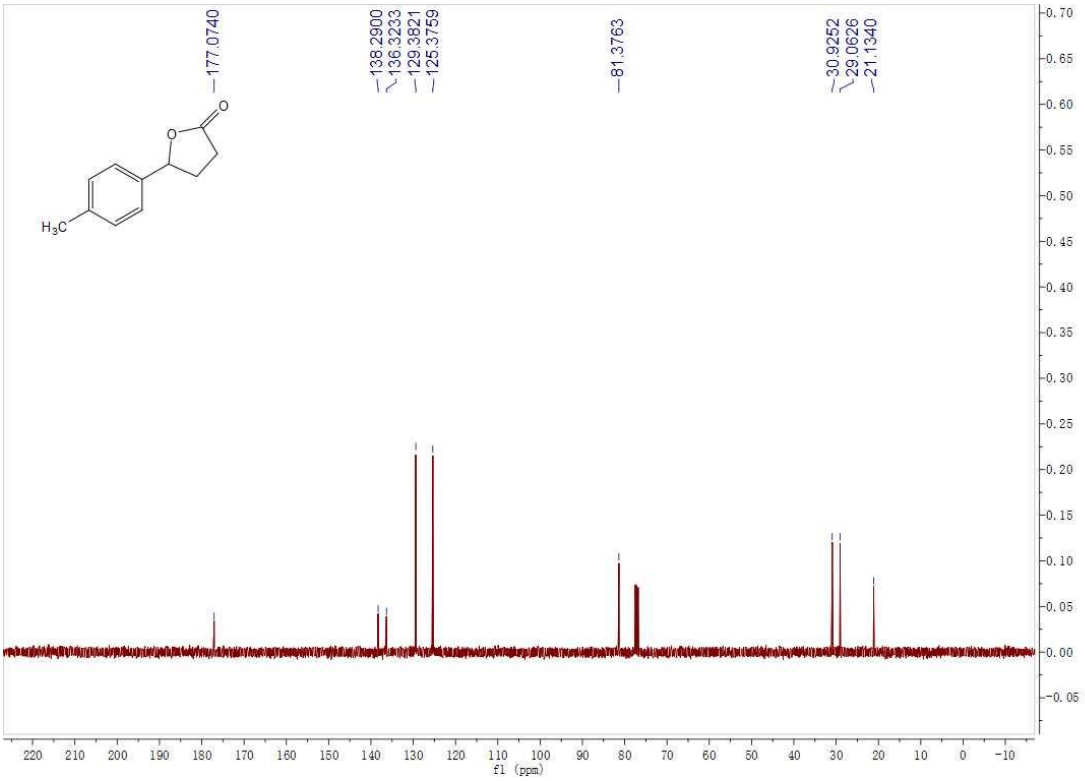
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **5e**



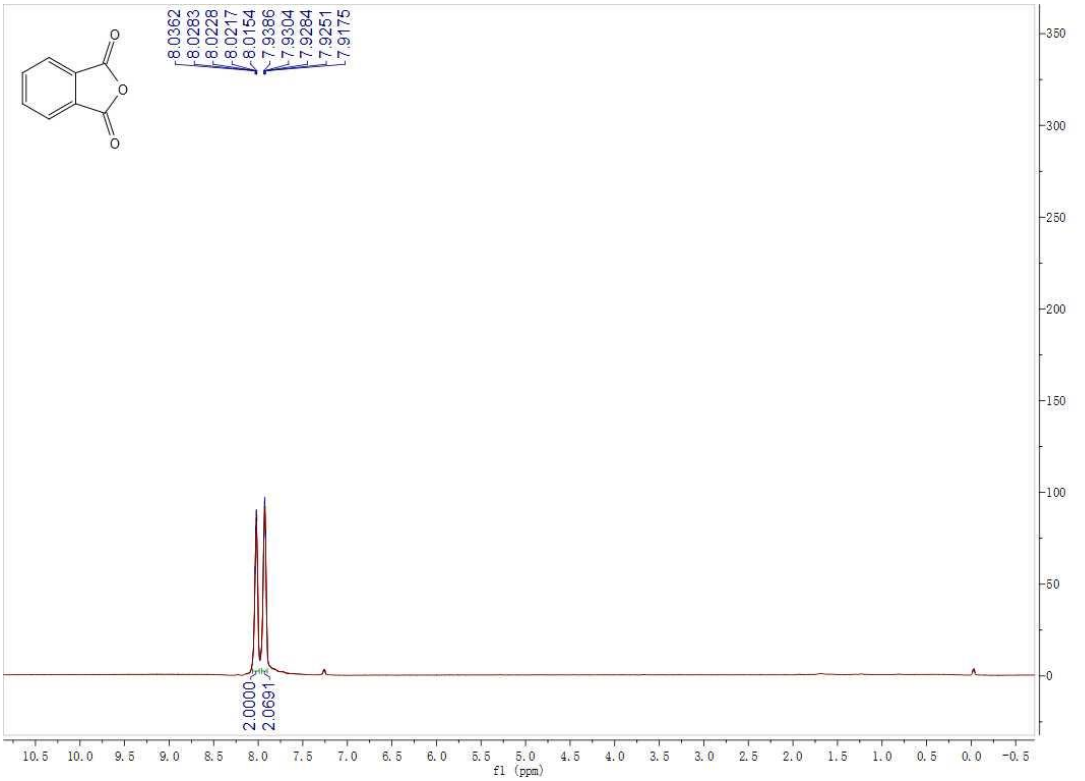
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **5f**



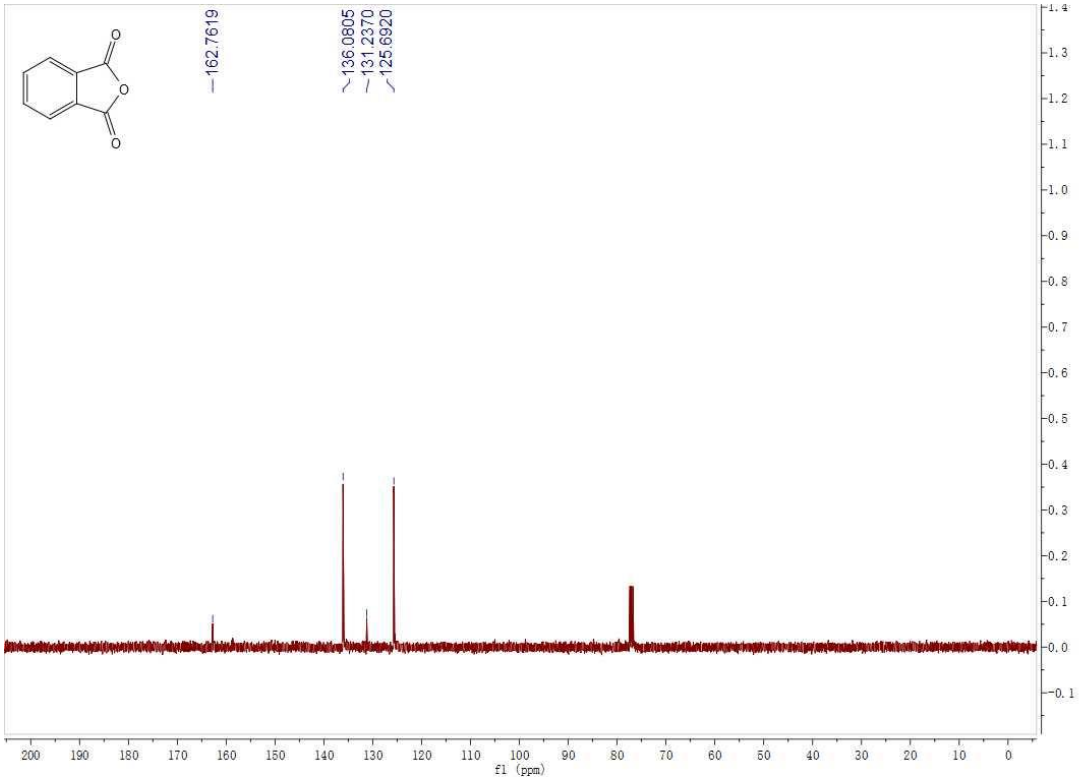
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **5f**



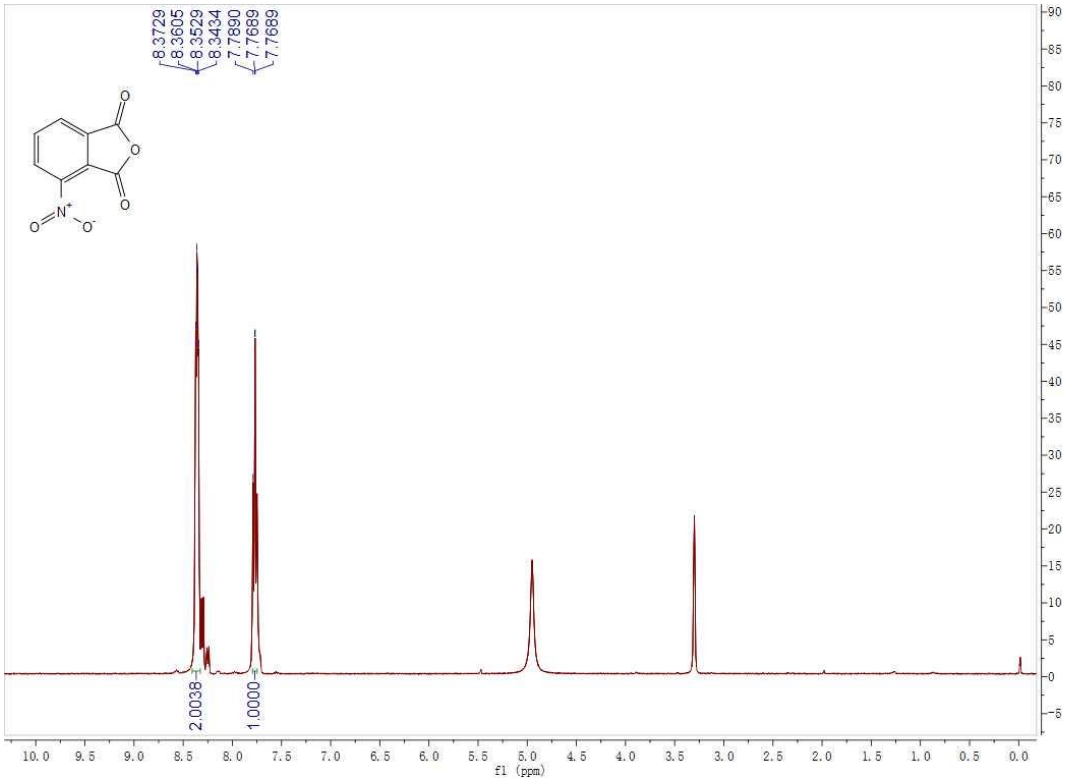
^{1}H NMR spectrum (400 MHz, $CDCl_3$) of compound **10**



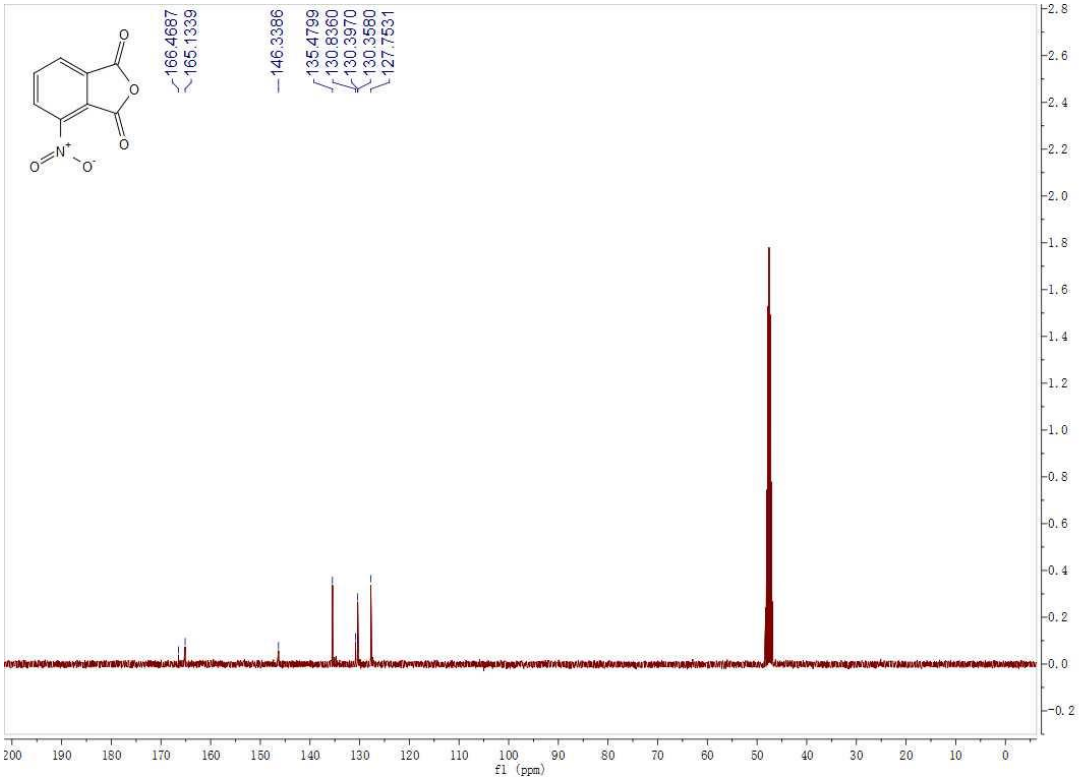
^{13}C NMR spectrum (100 MHz, $CDCl_3$) of compound **10**



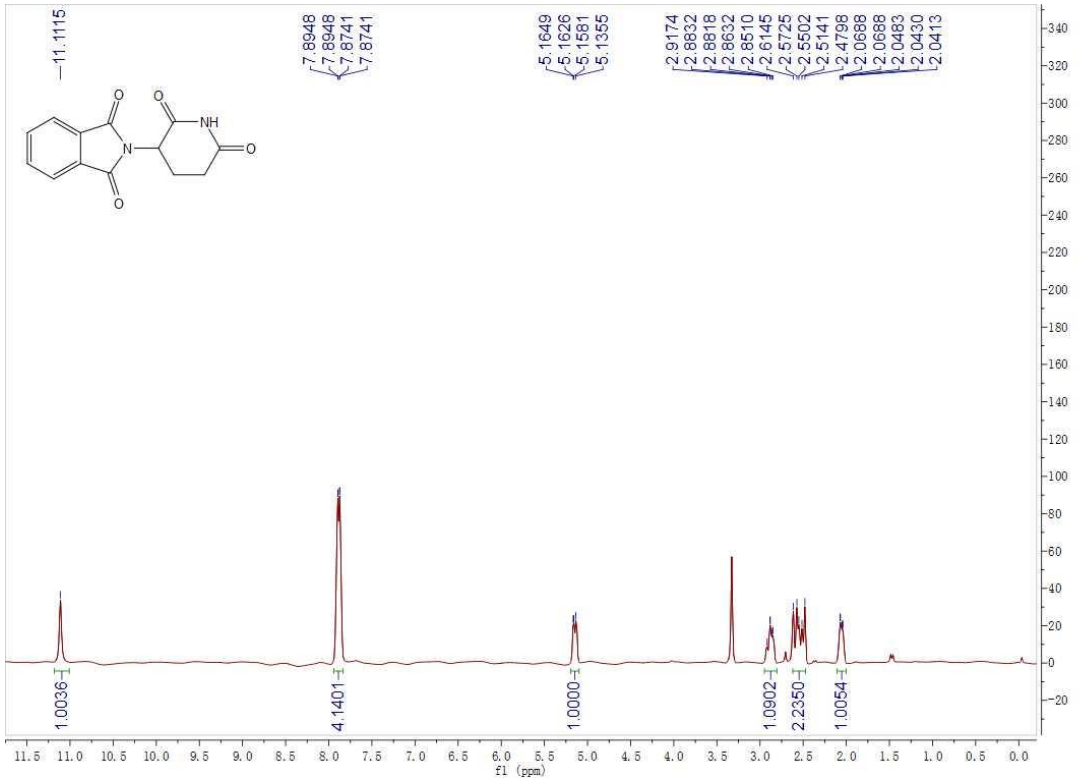
^{1}H NMR spectrum (400 MHz, CD_3OD) of compound **11**



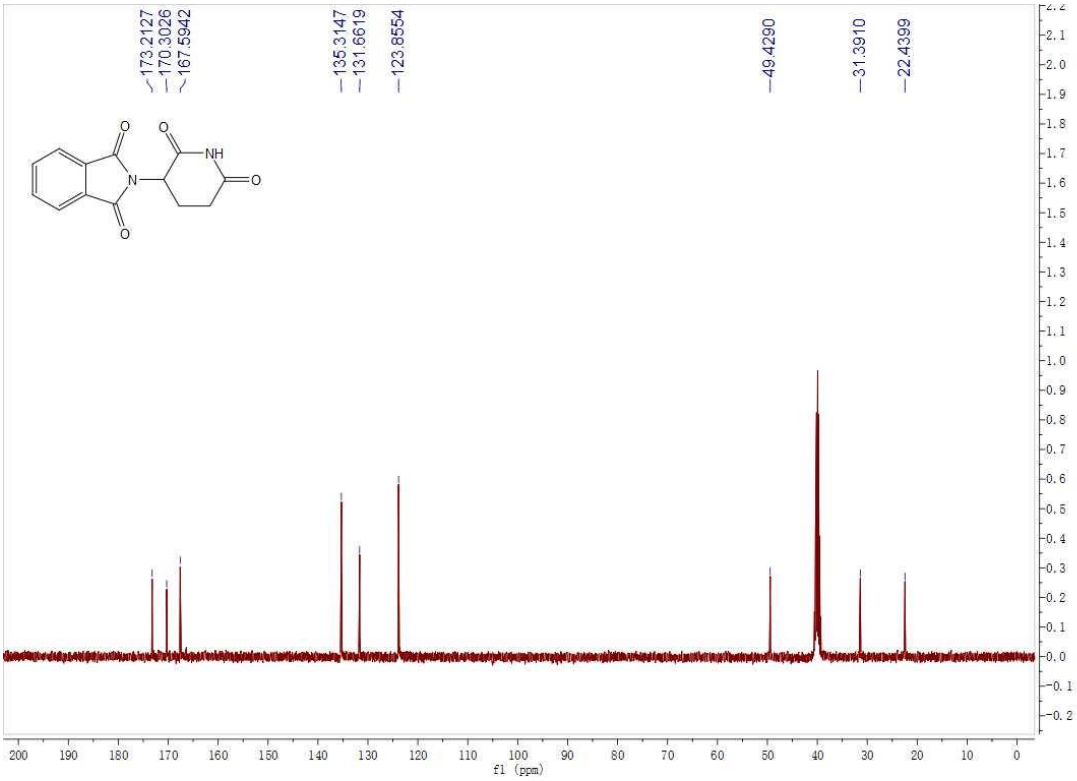
^{13}C NMR spectrum (100 MHz, CD_3OD) of compound **11**



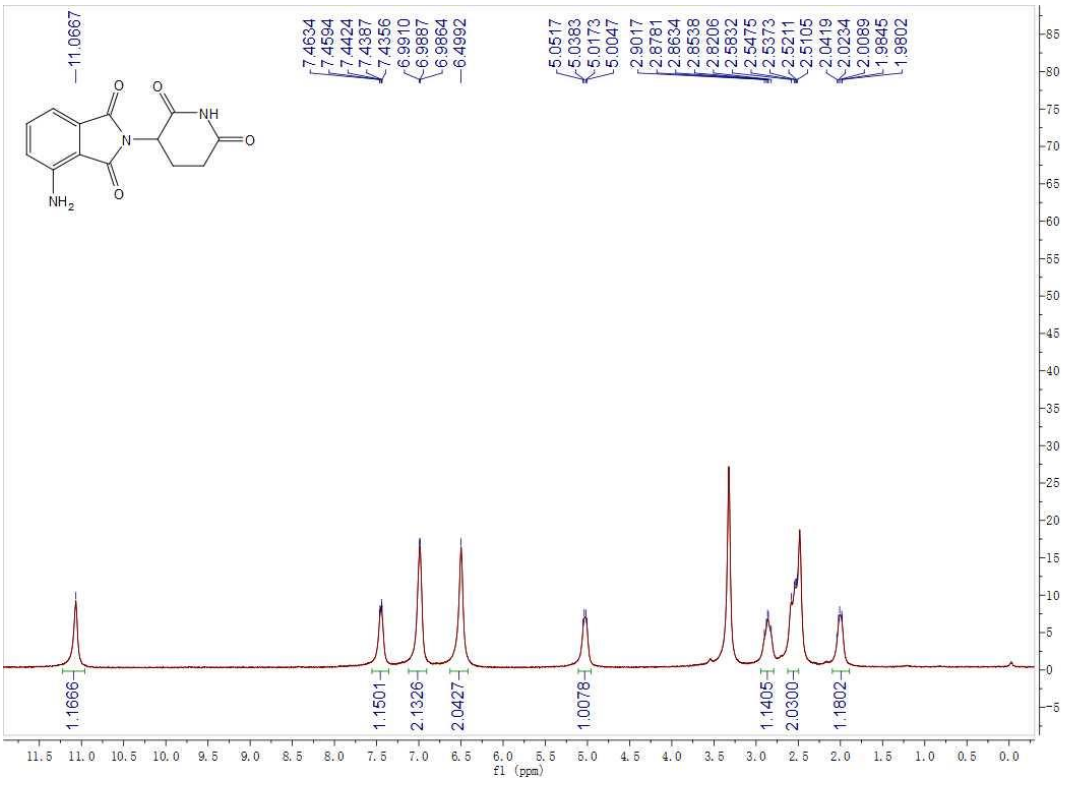
^{1}H NMR spectrum (400 MHz, DMSO) of compound **Thalidomide**



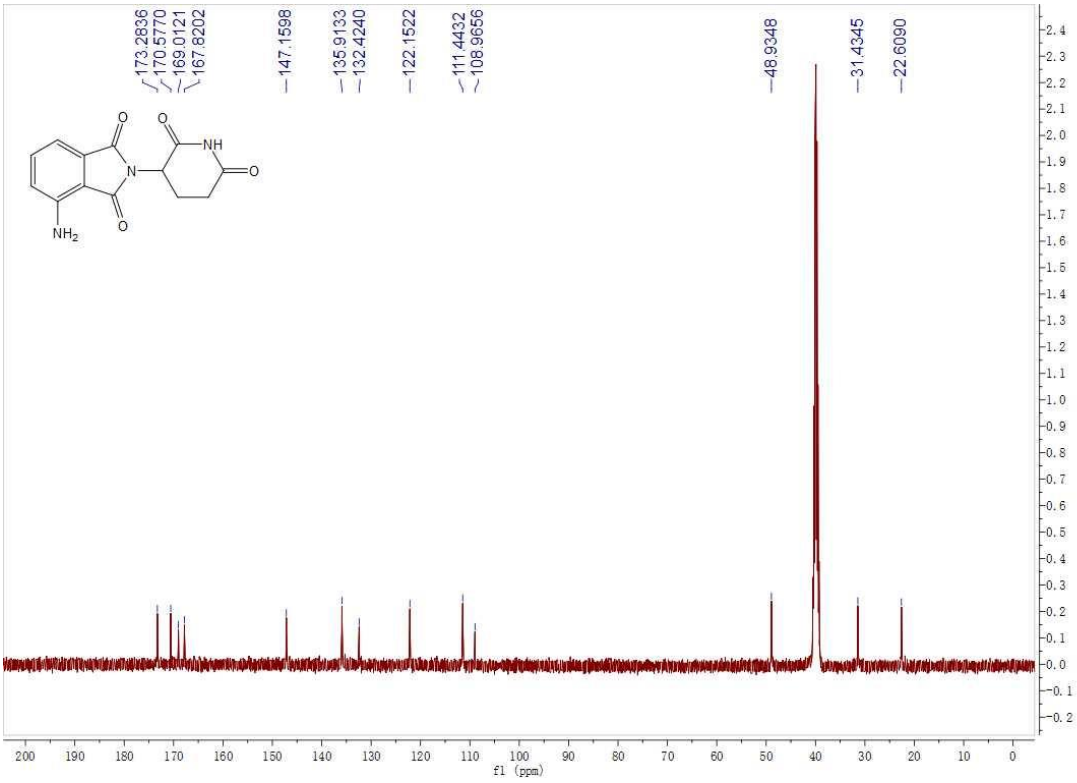
^{13}C NMR spectrum (100 MHz, DMSO) of compound **Thalidomide**



^{1}H NMR spectrum (400 MHz, DMSO) of compound **Pomalyst**



^{13}C NMR spectrum (100 MHz, DMSO) of compound **Pomalyst**



8.X-ray crystal structures for Product 3v

The crystal of **3v** was obtained by crystallization from a solution in DCM and Hexane after purification by column chromatography, the ellipsoid contour 50% probability.

checkCIF/PLATON report

You have not supplied any structure factors. As a result the full set of tests cannot be run.

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No syntax errors found. CIF dictionary Interpreting this report

Datablock: aa

```
Bond precision:   C-C = 0.0026 A          Wavelength=0.71073

Cell:             a=9.6676(10)     b=7.8965(8)        c=12.2576(10)
                  alpha=90         beta=95.669(8)     gamma=90
Temperature:      293 K

                 Calculated                Reported
Volume           931.17(16)                931.17(15)
Space group      P 21/c                    P2(1)/c
Hall group       -P 2ybc                   ?
Moiety formula   C11 H10 O2                ?
Sum formula      C11 H10 O2                C11 H10 O2
Mr               174.19                    174.19
Dx,g cm-3        1.242                     1.243
Z                4                         4
Mu (mm-1)        0.085                     0.085
F000             368.0                     368.0
F000'            368.19
h,k,lmax         12,9,15                   12,9,15
Nref             1933                      1929
Tmin,Tmax        0.968,0.981               0.842,1.000
Tmin'            0.966

Correction method= # Reported T Limits: Tmin=0.842 Tmax=1.000
AbsCorr = MULTI-SCAN

Data completeness= 0.998           Theta(max)= 26.500

R(reflections)= 0.0494( 1208)                wR2(reflections)=
                                             0.1208( 1929)
S = 1.057                Npar= 118
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Datablock aa - ellipsoid plot