

Palladium-Catalyzed Dearomatizing 2,5-Alkoxyarylation of Furan Rings: Diastereospecific Access to Spirooxindoles

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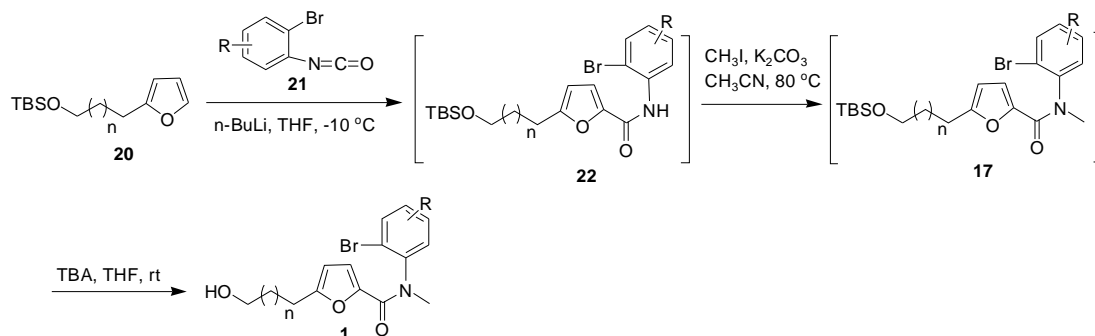
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General Experimental Details

IR spectra were recorded with FT-IR as a thin film or using KBr pellets and are expressed in cm^{-1} . ^1H (400 MHz) and ^{13}C (100 MHz) NMR spectra were recorded using CDCl_3 as a solvent. Chemical shifts are reported in ppm downfield to tetramethylsilane. Coupling constants are reported and expressed in Hz; splitting patterns are designated as s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), dd (double doublet), dt (double triplet), dq (double quartet). Infrared (IR) spectra were obtained on a Bruker Vector 22 spectrometer. Mass spectra were obtained from high resolution ESI mass spectrometer. All reactions were carried out using freshly distilled and dry solvents. Column chromatography was performed over silica gel (100-200 Mesh) using petroleum ether and ethyl acetate as the eluent.

General procedure for the preparation of **1**

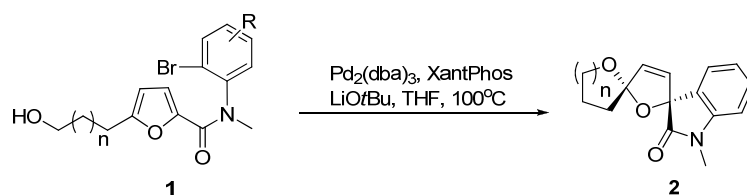


To a solution of **20** (3 mmol) in anhydrous THF (5 mL), at -10 °C under nitrogen atmosphere, was added a solution of *n*-BuLi (2.1 mL, 1.6 M in hexane, 3.3 mmol). The solution was stirred for 1 h at the same temperature and then a solution of **21** (3.3 mmol) in anhydrous THF (2 mL) was added dropwise. The reaction mixture was stirred for additional 30 mins, then was quenched with saturated aq. NH₄Cl (4 mL). The organic solvent was evaporated under reduced pressure and the aqueous layer was extracted with ethyl acetate (3 × 5 mL). The combined organic layers were washed with saturated brine, dried over sodium sulfate, concentrated under reduced pressure to provide the crude product which was submitted to the next step without further purification.

The mixture of above-made crude product **22**, CH₃I (10 mmol), K₂CO₃ (9 mmol) and CH₃CN (5 mL) was stirred at 80 °C under nitrogen atmosphere for about 8 h. The reaction mixture was filtered and the filtrate was concentrated to give the residue **17** which was submitted to the next step without further purification.

To the solution of the above-made residue in THF (5 ml) was added TBAF (3.6 mL, 1 M in THF). The reaction was stirred at room temperature about 30 mins. H₂O (5 mL) was added to the reaction mixture and THF was removed under reduced pressure. The resulting mixture was extracted with AcOEt (3 × 5 mL). The combined organic extracts were washed with brine, dried over Na₂SO₄, filtered and concentrated. The residue was purified by flash chromatography on a silica gel (using petroleum ether/ethyl acetate = 1:1 as the eluent) to give product **1**.

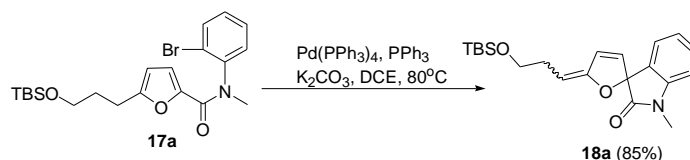
General procedure for the preparation of **2**



To a stirred solution of **1** (0.3 mmol) in THF (3 mL) were added LiOtBu (48 mg, 0.6 mmol), $\text{Pd}_2(\text{dba})_3$ (14 mg, 0.015 mmol, 5 mol%), and XantPhos (17.3 mg 0.03 mmol, 10 mol %) subsequently in a Schlenk flask under nitrogen atmosphere. The reaction mixture was heated at 100°C until the disappearance of the starting material according to the TLC. H_2O (5 mL) was added to the reaction mixture. The resulting mixture was extracted with AcOEt (3×5 mL). The combined organic extracts were washed with brine, dried over Na_2SO_4 , filtered and concentrated. The residue was purified by flash chromatography on a silica gel (using petroleum ether/ethyl acetate = 3:1 as the eluent) to give product **2**.

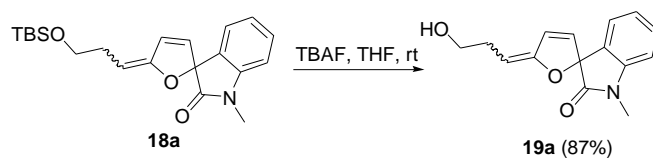
Details of Control Experiments

Preparation of **18a**



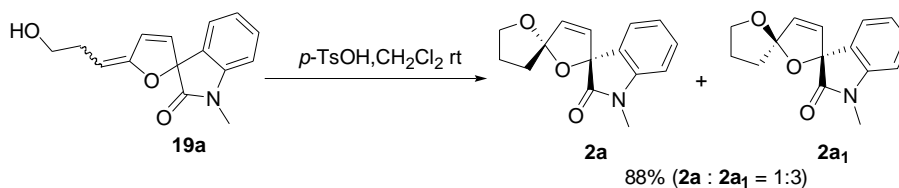
To a stirred solution of **17a** (0.3 mmol) in DCE (3 mL) were added K_2CO_3 (83 mg, 0.6 mmol), $\text{Pd}(\text{PPh}_3)_4$ (17 mg, 0.015 mmol, 5 mol %), and PPh_3 (8 mg, 0.03 mmol, 10 mol %) subsequently in a Schlenk flask under nitrogen atmosphere. The reaction was heated at 80°C until the disappearance of the starting material according to the TLC. H_2O (5 mL) was added to the reaction and the resulting mixture was extracted with AcOEt (3×5 mL). The combined organic extracts were washed with brine, dried over Na_2SO_4 , filtered and concentrated. The residue was purified by flash chromatography on a silica gel (using petroleum ether/ethyl acetate = 15:1 as the eluent) to give product **18a** (94 mg, 85%).

Preparation of 19a



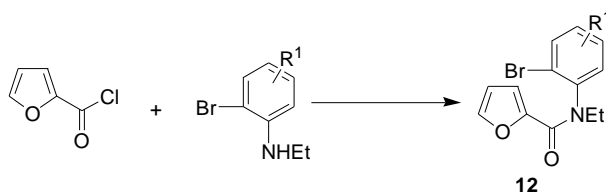
To a solution of **18a** (0.25 mmol) in THF (3 mL) were added TBAF (0.3 ml, 1 M in THF). The reaction mixture was stirred at room temperature until the disappearance of the starting material according to the TLC. H₂O (5 mL) was added to the reaction mixture. The resulting mixture was extracted with AcOEt (3× 5 mL). The combined organic extracts were washed with brine, dried over Na₂SO₄, filtered and concentrated. The residue was purified by flash chromatography on a silica gel (using petroleum ether/ethyl acetate = 1:1 as the eluent) to give product **19a** (55 mg, 87%).

Transformation of 19a into 2a



To a solution of **19a** (0.2 mmol) in CH₂Cl₂ (3 mL) were added *p*-TsOH (68 mg, 0.4 mmol). The reaction mixture was stirred at room temperature about 30 mins until the disappearance of the starting material according to the TLC. H₂O (5 mL) was added to the reaction and the resulting mixture was extracted with CH₂Cl₂ (3×3 mL). The combined organic extracts were washed with brine, dried over Na₂SO₄, filtered and concentrated. The residue was purified by flash chromatography on a silica gel (using petroleum ether/ethyl acetate = 3:1 as the eluent) to give product **2** (44 mg, 88%, **2a**:**2a₁** = 1:3).

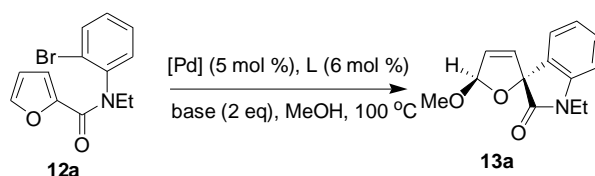
Typical procedure for the preparation of 12



To the mixture of aniline (6 mmol) in dry CH₂Cl₂ (20 mL) was added furan-2-carbonyl chloride

(1.16 g, 9 mmol) dropwise at 0 °C. After addition, the mixture was warmed to room temperature and stirred until aniline was disappear according to the TLC. H₂O (30 mL) was added to the reaction mixture, and the organic phase was separated. The aqueous phase was extracted with CH₂Cl₂ (3 x 10 mL), and the combined organic phase was washed with brine and dried over anhydrous Na₂SO₄. The filtrate was concentrated, and the residue was purified by flash chromatography on a silica gel (using petroleum ether : ethyl acetate = 14 : 1 as the eluent) to give product **12**.

Reaction conditions optimization for **13a**^a

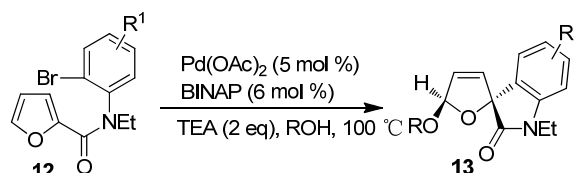


Entry	Pd	L	Base	Yield(%) b
1 ^a	Pd(OAc) ₂	BINAP	Et ₃ N	85
2	Pd(PPh ₃) ₄	BINAP	Et ₃ N	70
3	Pd ₂ (dba) ₃	BINAP	Et ₃ N	49
4	Pd(PPh ₃) ₂ Cl ₂	BINAP	Et ₃ N	82
5	Pd(MeCN) ₂ Cl ₂	BINAP	Et ₃ N	80
6	Pd(OAc) ₂	BINAP	K ₂ CO ₃	ND
7	Pd(OAc) ₂	BINAP	Cs ₂ CO ₃	ND
8	Pd(OAc) ₂	BINAP	DBU	38
9	Pd(OAc) ₂	BINAP	N,N-Dicyclohexymethylamine	61
10	Pd(OAc) ₂	BINAP	TMEDA	68
11	Pd(OAc) ₂	PPh ₃	Et ₃ N	54
12	Pd(OAc) ₂	PCy ₃	Et ₃ N	ND
13	Pd(OAc) ₂	dppf	Et ₃ N	73
14	Pd(OAc) ₂	Xanphos.	Et ₃ N	65
15	Pd(OAc) ₂	Davepos.	Et ₃ N	60
16 ^c	Pd(OAc) ₂	BINAP	Et ₃ N	32
17 ^d	Pd(OAc) ₂	BINAP	Et ₃ N	35
18 ^e	Pd(OAc) ₂	BINAP	Et ₃ N	38
19 ^f	Pd(OAc) ₂	BINAP	Et ₃ N	41
20 ^g	Pd(OAc) ₂	BINAP	Et ₃ N	47

^a Reaction conditions: unless otherwise noted, [Pd] (5 mol %), L (10 mol %), base (200 mol %), and **12a** (0.3 mmol) in MeOH (3 mL) at 100 °C under N₂ atmosphere for 18 h. BINAP = (±)-2,2'-bis(diphenylphosphino)-1,1'-binaphthalene; dppf = 1,1'-bis(diphenylphosphino)ferrocene; Xanphos =

4,5-bis-diphenylphosphanyl-9,9-dimethyl-9H-xanthene; Davepos = 2-dicyclohexylphosphino-2'-(N,N-dimethylamino)biphenyl. ^b The yield was determined by ¹HNMR methods using dibromomethane as an internal standard. ND = not detected. ^c Pd(OAc)₂ (5 mol %), BINAP (6 mol %), CH₃OH (200 mol %) in THF (3 mL). ^d Pd(OAc)₂ (5 mol %), BINAP (6 mol %), Et₃N (200 mol %), CH₃OH (200 mol %) in MeCN (3 mL). ^e The solvent v₁ (MeCN) : v₂ (CH₃OH) = 2 : 1. ^f The solvent v₁ (MeCN) : v₂ (CH₃OH) = 1 : 1. ^g The solvent v₁ (MeCN) : v₂ (CH₃OH) = 1 : 2.

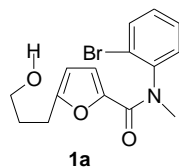
General procedure for the preparation of 13



To a dried Schlenk tube were added Pd(OAc)₂ (4 mg, 0.015 mmol) and BINAP (13 mg 0.018 mmol) under N₂, ROH (3.0 mL) was then introduced via syringe. The resulting mixture was stirred at room temperature for 1 h, after which **12** (0.3 mmol) and Et₃N (0.6 mmol) were added and the tube was sealed using Teflon cap. The mixture was stirred at 100 °C for 18 h. The solvent was then removed under vacuum and the residue was purified by chromatography on silica gel, eluting with ethyl/petroleum ether 1:14 (v/v) to afford the products.

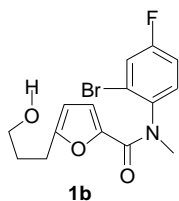
Characterization of 1

N-(2-bromophenyl)-5-(3-hydroxypropyl)-*N*-methylfuran-2-carboxamide (**1a**)



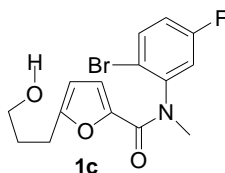
Colorless oil, (638 mg, 63% over 3 steps), IR (KBr) 3655, 3321, 3096, 2979, 1695, 1470, 1237, 1061, 973, 746 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) δ 7.67 (d, *J* = 7.9 Hz, 1H), 7.37 (t, *J* = 7.5 Hz, 1H), 7.30 – 7.24 (m, 2H), 6.01 (s, 1H), 5.88 (s, 1H), 3.52 (t, *J* = 5.8 Hz, 2H), 3.33 (s, 3H), 2.55 (t, *J* = 6.7 Hz, 2H), 2.46 (s, 1H), 1.73 – 1.61 (m, 2H); ¹³C NMR (100 MHz, CDCl₃) δ 159.2, 158.5, 145.5, 143.2, 133.7, 130.1, 129.6, 128.7, 123.4, 117.5, 107.2, 61.3, 37.1, 30.3, 24.2; HRMS (ESI) *m/z* calcd for C₁₅H₁₆BrNO₃ [M + H]⁺: 338.0386; Found: 338.0386.

N-(2-bromo-4-fluorophenyl)-5-(3-hydroxypropyl)-*N*-methylfuran-2-carboxamide (**1b**)



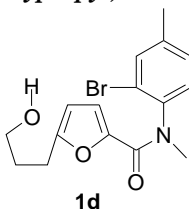
Yellow oil, (534 mg, 50% over 3 steps), IR (KBr) 3696, 3042, 2947, 1765, 1668, 1590, 1199, 967, 857, 700 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.43 – 7.41 (m, 1H), 7.28 (t, $J = 7.1$ Hz, 1H), 7.11 – 7.08 (m, 1H), 6.15 (s, 1H), 5.92 (s, 1H), 3.55 (t, $J = 6.1$ Hz, 2H), 3.32 (s, 3H), 2.57 (t, $J = 7.0$ Hz, 2H), 2.15 (s, 1H), 1.77 – 1.64 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 161.4, 159.2, 158.6, 145.5, 139.6, 130.9, 124.1, 120.8, 117.8, 115.7, 107.3, 61.4, 37.1, 30.3, 24.3; HRMS (ESI) m/z calcd for $\text{C}_{15}\text{H}_{15}\text{BrFNO}_3$: $[\text{M} + \text{H}]^+$: 356.0292; Found: 356.0295.

***N*-(2-bromo-5-fluorophenyl)-5-(3-hydroxypropyl)-*N*-methylfuran-2-carboxamide (1c)**



Colorless oil, (596 mg, 56% over 3 steps), IR (KBr) 3655, 3434, 2946, 1738, 1586, 1357, 1184, 861, 812, 746 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.66 – 7.62 (m, 1H), 7.08 – 7.01 (m, 2H), 6.35 (s, 1H), 5.97 (s, 1H), 3.57 (t, $J = 6.2$ Hz, 2H), 3.36 (s, 3H), 2.58 (t, $J = 7.2$ Hz, 2H), 1.74 – 1.67 (m, 2H), 1.63 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 163.3, 160.8, 159.0, 158.8, 145.3, 144.3, 134.3, 118.1, 117.3, 117.0, 107.4, 61.2, 36.9, 30.3, 24.3; HRMS (ESI) m/z calcd for $\text{C}_{15}\text{H}_{15}\text{BrFNO}_3$: $[\text{M} + \text{Na}]^+$: 378.0112; Found: 378.0115.

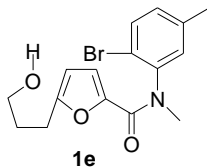
***N*-(2-bromo-4-methylphenyl)-5-(3-hydroxypropyl)-*N*-methylfuran-2-carboxamide (1d)**



Colorless oil, (548 mg, 49% over 3 steps), IR (KBr) 3321, 3042, 2946, 1636, 1429, 1266, 971, 744 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.49 (s, 1H), 7.17 (s, 2H), 5.90 (d, $J = 5.3$ Hz, 1H), 5.88 (d, $J = 5.3$ Hz, 1H), 3.55 (t, $J = 5.7$ Hz, 2H), 3.31 (s, 3H), 2.60 (t, $J = 7.1$ Hz, 2H), 2.39 (s, 3H), 2.20 (s, 1H), 1.77 – 1.66 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.4, 158.4, 145.5, 140.4, 140.2, 134.0,

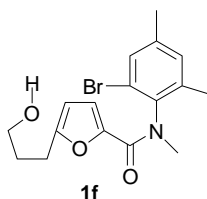
129.5, 129.4, 123.0, 117.3, 107.2, 61.4, 37.0, 30.4, 24.2, 20.8; HRMS (ESI) m/z calcd for $C_{16}H_{18}BrNO_3$: $[M + H]^+$: 374.0362; Found: 374.0366.

***N*-(2-bromo-5-methylphenyl)-5-(3-hydroxypropyl)-*N*-methylfuran-2-carboxamide (1e)**



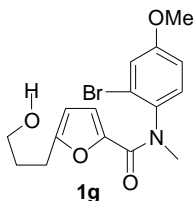
Colorless oil, (600 mg, 57% over 3 steps), IR (KBr) 3301, 2946, 1677, 1589, 1471, 1071, 958, 860, 763, 699 cm^{-1} ; 1H NMR (400 MHz, $CDCl_3$) δ 7.53 (d, $J = 8.1$ Hz, 1H), 7.12 (s, 1H), 7.08 (d, $J = 8.1$ Hz, 1H), 5.98 (s, 1H), 5.89 (s, 1H), 3.55 (t, $J = 6.1$ Hz, 2H), 3.33 (s, 3H), 2.59 (t, $J = 7.2$ Hz, 2H), 2.33 (s, 3H), 1.76 – 1.66 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.2, 158.4, 145.6, 142.7, 139.1, 133.2, 130.5, 130.4, 119.9, 117.4, 107.2, 61.4, 37.1, 30.4, 24.2, 20.7; HRMS (ESI) m/z calcd for $C_{16}H_{18}BrNO_3$: $[M + H]^+$: 352.0543; Found: 352.0549.

***N*-(2-bromo-4,6-dimethylphenyl)-5-(3-hydroxypropyl)-*N*-methylfuran-2-carboxamide (1f)**



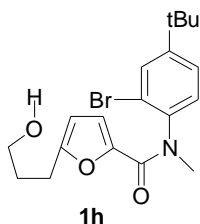
Yellow oil, (490 mg, 45% over 3 steps), IR (KBr) 3636, 3067, 2944, 1729, 1666, 1588, 1470, 1264, 963, 853, 746 cm^{-1} ; 1H NMR (400 MHz, $CDCl_3$) δ 7.33 (s, 1H), 7.05 (s, 1H), 5.87 (s, 1H), 5.83 (s, 1H), 3.56 (t, $J = 5.7$ Hz, 2H), 3.26 (s, 3H), 2.62 (t, $J = 7.4$ Hz, 2H), 2.34 (s, 3H), 2.31 (s, 1H), 2.19 (s, 3H), 1.76 – 1.71 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.3, 158.5, 145.5, 139.9, 138.8, 138.1, 131.6, 131.0, 123.8, 116.6, 107.3, 61.4, 35.4, 30.4, 24.3, 20.8, 18.3; HRMS (ESI) m/z calcd for $C_{17}H_{20}BrNO_3$: $[M + Na]^+$: 388.0519; Found: 388.0514.

***N*-(2-bromo-4-methoxyphenyl)-5-(3-hydroxypropyl)-*N*-methylfuran-2-carboxamide (1g)**



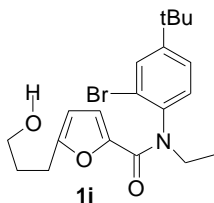
Colorless solid, (695 mg, 63% over 3 steps), m.p. = 103.2-104.8 °C, IR (KBr) 3635, 2920, 1734, 1641, 1595, 1426, 970, 866, 721 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.21 (d, J = 6.9 Hz, 2H), 6.91 (d, J = 8.5 Hz, 1H), 5.94 (s, 1H), 5.90 (s, 1H), 3.86 (s, 3H), 3.57 (t, J = 5.9 Hz, 2H), 3.32 (s, 3H), 2.62 (t, J = 7.1 Hz, 2H), 1.91 (s, 1H), 1.80 – 1.66 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.7, 159.5, 158.3, 145.6, 135.9, 130.3, 124.0, 118.5, 117.3, 114.4, 107.2, 61.6, 55.8, 37.1, 30.4, 24.3; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{18}\text{BrNO}_4$: $[\text{M} + \text{H}]^+$ 368.0492; Found: 368.0492.

***N*-(2-bromo-4-(*tert*-butyl)phenyl)-5-(3-hydroxypropyl)-*N*-methylfuran-2-carboxamide (1h)**



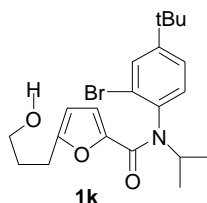
Colorless oil, (613 mg, 52% over 3 steps), IR (KBr) 3636, 3301, 2952, 2846, 1726, 1568, 1428, 956, 839, 750, 694 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.38 (d, J = 8.2 Hz, 1H), 7.21 (d, J = 8.2 Hz, 1H), 6.06 (s, 1H), 5.90 (s, 1H), 3.55 (t, J = 6.0 Hz, 2H), 3.33 (s, 3H), 2.57 (t, J = 6.7 Hz, 2H), 2.03 (s, 1H), 1.76 – 1.62 (m, 2H), 1.35 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.3, 158.2, 153.4, 145.7, 140.3, 130.5, 129.3, 125.7, 123.1, 117.4, 107.3, 61.4, 37.0, 34.8, 31.2, 30.3, 24.3; HRMS (ESI) m/z calcd for $\text{C}_{19}\text{H}_{24}\text{BrNO}_3$: $[\text{M} + \text{H}]^+$: 394.1012; Found: 394.1012.

***N*-(2-bromo-4-(*tert*-butyl)phenyl)-*N*-ethyl-5-(3-hydroxypropyl)furan-2-carboxamide (1i)**



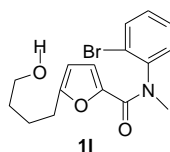
Colorless oil, (647 mg, 53% over 3 steps), IR (KBr) 3636, 3354, 2923, 1732, 1632, 1524, 1466, 968, 858, 828, 743, 697 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.34 (d, J = 8.2 Hz, 1H), 7.16 (d, J = 8.2 Hz, 1H), 5.98 (s, 1H), 5.88 (s, 1H), 4.25 – 4.15 (m, 1H), 3.55 (t, J = 5.9 Hz, 2H), 3.52 – 3.41 (m, 1H), 2.55 (t, J = 6.5 Hz, 2H), 2.00 (s, 1H), 1.74 – 1.63 (m, 2H), 1.35 (s, 9H), 1.22 (t, J = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 158.8, 158.1, 153.3, 145.9, 138.6, 130.6, 130.4, 125.3, 123.7, 117.2, 107.2, 61.5, 44.4, 34.8, 31.2, 30.4, 24.3, 12.7; HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{26}\text{BrNO}_3$: $[\text{M} + \text{H}]^+$: 408.1169; Found: 408.1169.

***N*-(2-bromo-4-(*tert*-butyl)phenyl)-5-(3-hydroxypropyl)-*N*-isopropylfuran-2-carboxamide (1k)**



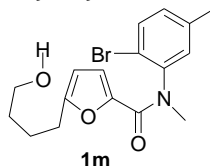
Colorless oil, (631 mg, 50% over 3 steps), IR (KBr) 3635, 3067, 2947, 1720, 1583, 1490, 1261, 971, 751, 696 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.64 (s, 1H), 7.39 (d, $J = 8.3$ Hz, 1H), 7.22 (d, $J = 8.3$ Hz, 1H), 5.87 (s, 2H), 4.92 – 4.85 (m, 1H), 3.56 (t, $J = 6.2$ Hz, 2H), 2.56 (t, $J = 7.3$ Hz, 2H), 2.10 (s, 1H), 1.72 – 1.66 (m, 2H), 1.36 (s, 12H), 1.13 (d, $J = 6.9$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 158.9, 158.0, 153.5, 146.4, 136.5, 130.9, 130.6, 125.8, 125.1, 116.9, 107.2, 61.4, 49.6, 34.8, 31.2, 30.4, 24.3, 21.9; HRMS (ESI) m/z calcd for $\text{C}_{21}\text{H}_{28}\text{BrNO}_3$: $[\text{M} + \text{H}]^+$: 422.1325; Found: 422.1323.

***N*-(2-bromophenyl)-5-(4-hydroxybutyl)-*N*-methylfuran-2-carboxamide (1l)**



Colorless oil, (473 mg, 45% over 3 steps), IR (KBr) 3635, 3043, 2946, 1741, 1677, 1584, 1479, 1185, 972, 857, 764, 692 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.68 (d, $J = 7.9$ Hz, 1H), 7.37 (t, $J = 7.5$ Hz, 1H), 7.30 – 7.23 (m, 2H), 6.07 (s, 1H), 5.87 (s, 1H), 3.60 (t, $J = 5.3$ Hz, 2H), 3.35 (s, 3H), 2.47 (t, $J = 7.0$ Hz, 2H), 1.81 (s, 1H), 1.55 – 1.45 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.2, 158.7, 145.5, 143.2, 133.6, 130.0, 129.5, 128.7, 123.5, 117.5, 107.1, 62.2, 37.0, 31.9, 27.6, 23.6; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{18}\text{BrNO}_3$ $[\text{M} + \text{H}]^+$: 352.0543; Found: 352.0540.

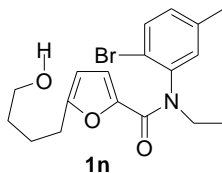
***N*-(2-bromo-5-methylphenyl)-5-(4-hydroxybutyl)-*N*-methylfuran-2-carboxamide (1m)**



Colorless oil, (536 mg, 49% over 3 steps), IR (KBr) 3636, 3056, 2921, 1736, 1631, 1591, 1426, 1359, 939, 807, 741, 704 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.52 (d, $J = 8.1$ Hz, 1H), 7.11 (s, 1H), 7.07 (d, $J = 8.1$ Hz, 1H), 5.98 (s, 1H), 5.87 (s, 1H), 3.60 (t, $J = 6.1$ Hz, 2H), 3.31 (s, 3H), 2.49

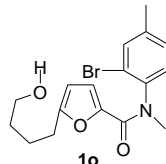
(t, $J = 7.0$ Hz, 2H), 2.32 (s, 3H), 1.55 – 1.45 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.2, 158.8, 145.4, 142.7, 139.1, 133.2, 130.5, 130.4, 119.8, 117.4, 107.1, 62.1, 37.1, 31.9, 27.6, 23.7, 20.7; HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{20}\text{BrNO}_3$: $[\text{M} + \text{H}]^+$ 366.0699; Found: 366.0700.

***N*-(2-bromo-5-methylphenyl)-*N*-ethyl-5-(4-hydroxybutyl)furan-2-carboxamide (1n)**



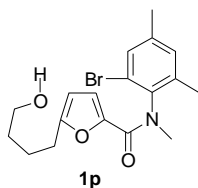
Yellow oil, (591 mg, 52% over 3 steps), IR (KBr) 3635, 3044, 2946, 1742, 1586, 1475, 1192, 968, 857, 697 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.53 (d, $J = 8.6$ Hz, 1H), 7.08 (d, $J = 5.9$ Hz, 2H), 5.92 (s, 1H), 5.85 (s, 1H), 4.20 – 4.10 (m, 1H), 3.60 (t, $J = 6.1$ Hz, 2H), 3.54 – 3.45 (m, 1H), 2.50 (s, 1H), 2.49 (t, $J = 7.0$ Hz, 2H), 2.33 (s, 3H), 1.59 – 1.45 (m, 4H), 1.22 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 158.8, 158.6, 145.6, 141.1, 138.6, 133.2, 131.5, 130.3, 120.6, 117.2, 107.1, 62.1, 44.5, 31.9, 27.7, 23.7, 20.7, 12.6; HRMS (ESI) m/z calcd for $\text{C}_{18}\text{H}_{22}\text{BrNO}_3$: $[\text{M} + \text{H}]^+$: 380.0856; Found: 380.0856.

***N*-(2-bromo-4-methylphenyl)-5-(4-hydroxybutyl)-*N*-methylfuran-2-carboxamide (1o)**



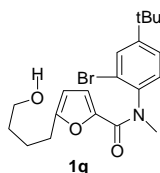
Colorless oil, (525 mg, 48% over 3 steps), IR (KBr) 3635, 3317, 3044, 2933, 1736, 1594, 1494, 1120, 950, 868, 797, 746 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.49 (s, 1H), 7.16 (s, 2H), 5.92 (s, 1H), 5.86 (s, 1H), 3.59 (t, $J = 5.7$ Hz, 2H), 3.31 (s, 3H), 2.50 (t, $J = 6.4$ Hz, 2H), 2.39 (s, 3H), 2.25 (s, 1H), 1.58 – 1.45 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.4, 158.7, 145.4, 140.4, 140.1, 134.0, 129.5, 129.4, 123.0, 117.3, 107.0, 62.1, 37.0, 31.9, 27.6, 23.7, 20.8; HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{20}\text{BrNO}_3$ $[\text{M} + \text{Na}]^+$: 388.0519; Found: 388.0516.

***N*-(2-bromo-4,6-dimethylphenyl)-5-(4-hydroxybutyl)-*N*-methylfuran-2-carboxamide (1p)**



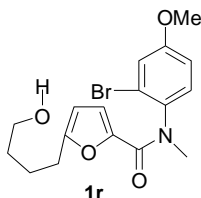
Colorless oil, (602 mg, 53% over 3 steps), IR (KBr) 3596, 3041, 2945, 1635, 1428, 1264, 930, 744, 701 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.32 (s, 1H), 7.04 (s, 1H), 5.85 (d, $J = 2.7$ Hz, 1H), 5.83 (d, $J = 2.7$ Hz, 1H), 3.61 (t, $J = 6.1$ Hz, 2H), 3.25 (s, 3H), 2.53 (t, $J = 6.6$ Hz, 2H), 2.34 (s, 3H), 2.19 (s, 3H), 1.60 – 1.45 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.3, 158.8, 145.4, 139.8, 138.8, 138.1, 131.6, 131.0, 123.8, 116.6, 107.1, 62.2, 35.3, 31.9, 27.7, 23.6, 20.8, 18.3; HRMS (ESI) m/z calcd for $\text{C}_{18}\text{H}_{22}\text{BrNO}_3$ $[\text{M} + \text{H}]^+$: 380.0856; Found: 380.0855.

***N*-(2-bromo-4-(tert-butyl)phenyl)-5-(4-hydroxybutyl)-*N*-methylfuran-2-carboxamide (1q)**



Colorless solid, (683 mg, 56% over 3 steps), m.p. = 77.8 – 78.4°C, IR (KBr) 3635, 3043, 2947, 1724, 1582, 1491, 1193, 968, 853, 750, 694 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.37 (d, $J = 8.2$ Hz, 1H), 7.21 (d, $J = 8.2$ Hz, 1H), 6.02 (s, 1H), 5.87 (s, 1H), 3.61 (t, $J = 5.7$ Hz, 2H), 3.33 (s, 3H), 2.47 (t, $J = 6.4$ Hz, 2H), 1.82 (s, 1H), 1.58 – 1.45 (m, 4H), 1.35 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.2, 158.6, 153.4, 145.6, 140.3, 130.5, 129.3, 125.7, 123.0, 117.4, 107.1, 62.2, 37.0, 34.8, 31.9, 31.2, 27.6, 23.6; HRMS (ESI) m/z calcd for $\text{C}_{20}\text{H}_{26}\text{BrNO}_3$ $[\text{M} + \text{H}]^+$: 408.1169; Found: 408.1169.

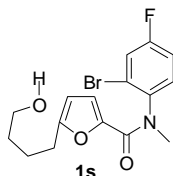
***N*-(2-bromo-4-methoxyphenyl)-5-(4-hydroxybutyl)-*N*-methylfuran-2-carboxamide (1r)**



Colorless solid, (720 mg, 63% over 3 steps), m.p. = 91.5 – 92.8°C, IR (KBr) 3065, 2946, 1736, 1588, 1438, 1144, 949, 862, 749 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.23 – 7.07 (m, 2H), 6.93 – 6.83 (m, 1H), 5.91 (s, 1H), 5.86 (s, 1H), 3.84 (s, 3H), 3.59 (t, $J = 5.7$ Hz, 2H), 3.29 (s, 3H), 2.52 (t,

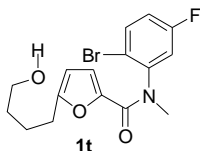
$J = 5.7$ Hz, 2H), 1.59 – 1.48 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.6, 159.5, 158.7, 145.4, 135.8, 130.3, 123.9, 118.5, 117.3, 114.4, 107.0, 62.1, 55.8, 37.1, 31.9, 27.7, 23.7; HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{20}\text{BrNO}_4$ $[\text{M} + \text{H}]^+$: 382.0648; Found: 382.0648.

***N*-(2-bromo-4-fluorophenyl)-5-(4-hydroxybutyl)-*N*-methylfuran-2-carboxamide (1s)**



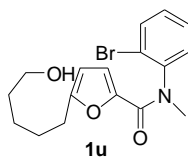
Yellow oil, (610 mg, 55% over 3 steps), IR (KBr) 3634, 3041, 2946, 1735, 1668, 1591, 1489, 1241 971, 855, 742, 703 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.46 – 7.37 (m, 1H), 7.37 – 7.24 (m, 1H), 7.16 – 7.05 (m, 1H), 6.19 (s, 1H), 5.91 (s, 1H), 3.59 (t, $J = 6.1$ Hz, 2H), 3.31 (s, 3H), 2.54 (s, 1H), 2.48 (t, $J = 7.0$ Hz, 2H), 1.59 – 1.41 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3) δ 161.5, 159.2, 158.9, 145.4, 139.5, 130.9, 124.1, 120.7, 117.8, 115.7, 107.1, 62.1, 37.1, 31.8, 27.6, 23.7; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{17}\text{BrFNO}_3$ $[\text{M} + \text{H}]^+$: 370.0449; Found: 370.0449.

***N*-(2-bromo-5-fluorophenyl)-5-(4-hydroxybutyl)-*N*-methylfuran-2-carboxamide (1t)**



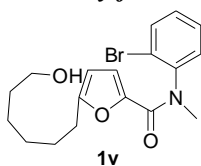
Colorless oil, (444 mg, 40% over 3 steps), IR (KBr) 3435, 3066, 2921, 1775, 1650, 1584, 1471, 1193, 967, 859, 746 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.65 – 7.61 (m, 1H), 7.14 – 6.97 (m, 2H), 6.33 (s, 1H), 5.92 (s, 1H), 3.62 (t, $J = 6.5$ Hz, 2H), 3.34 (s, 3H), 2.48 (t, $J = 7.0$ Hz, 2H), 1.94 (s, 1H), 1.55 – 1.45 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3) δ 163.3, 160.8, 158.9, 145.4, 134.3, 118.0, 117.5, 117.3, 116.9, 116.7, 107.2, 62.2, 36.9, 31.9, 27.7, 23.7; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{17}\text{BrFNO}_3$: $[\text{M} + \text{H}]^+$: 370.0449; Found: 370.0447.

***N*-(2-bromophenyl)-5-(5-hydroxypentyl)-*N*-methylfuran-2-carboxamide (1u)**



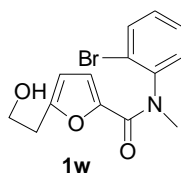
Yellow oil, (438 mg, 40% over 3 steps), IR (KBr) 3643, 3065, 2934, 1733, 1650, 1472, 1183, 917, 812, 746 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.65 (d, $J = 7.1$ Hz, 1H), 7.35 (t, $J = 7.1$ Hz, 1H), 7.28 – 7.22 (m, 2H), 6.06 (s, 1H), 5.83 (s, 1H), 3.59 (t, $J = 6.5$ Hz, 2H), 3.32 (s, 3H), 2.48 (t, $J = 7.0$ Hz, 2H), 2.28 (s, 1H), 1.52– 1.49 (m, 2H), 1.47– 1.41 (m, 2H), 1.27– 1.25 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.2, 158.9, 145.4, 143.1, 133.6, 130.0, 129.5, 128.7, 123.4, 117.5, 106.9, 62.4, 37.0, 32.2, 27.8, 27.1, 25.1; HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{20}\text{BrNO}_3$ $[\text{M} + \text{H}]^+$: 366.0699; Found: 366.0698.

***N*-(2-bromophenyl)-5-(6-hydroxyhexyl)-*N*-methylfuran-2-carboxamide (1v)**



Yellow oil, (530 mg, 46% over 3 steps), IR (KBr) 3615, 3206, 2945, 1660, 1584, 1473, 1187, 945, 747 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.67 (d, $J = 7.9$ Hz, 1H), 7.36 (t, $J = 7.5$ Hz, 1H), 7.23 – 7.29 (m, 2H), 6.08 (s, 1H), 5.84 (s, 1H), 3.62 (t, $J = 6.4$ Hz, 2H), 3.34 (s, 3H), 2.48 (t, $J = 7.0$ Hz, 2H), 1.69 (s, 1H), 1.55 – 1.49 (m, 2H), 1.46 – 1.37 (m, 2H), 1.36 – 1.25 (m, 2H), 1.25 – 1.22 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.2, 159.1, 145.5, 143.2, 133.6, 130.1, 129.5, 128.6, 123.5, 117.5, 106.8, 62.7, 37.0, 32.5, 28.6, 27.8, 27.3, 25.3; HRMS (ESI) m/z calcd for $\text{C}_{18}\text{H}_{22}\text{BrNO}_3$ $[\text{M} + \text{Na}]^+$: 402.0675; Found: 402.0671.

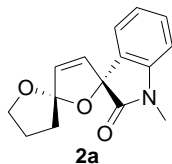
***N*-(2-bromophenyl)-5-(2-hydroxyethyl)-*N*-methylfuran-2-carboxamide (1w)**



Colorless oil, (406 mg, 42% over 3 steps), IR (KBr) 3606, 3051, 2948, 1733, 1588, 1431, 1265, 945, 743 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.67 (d, $J = 7.9$ Hz, 1H), 7.37 (t, $J = 7.5$ Hz, 1H), 7.27 (dd, $J = 13.5, 6.9$ Hz, 2H), 6.00 (s, 1H), 5.96 (s, 1H), 3.67 (t, $J = 5.6$ Hz, 2H), 3.33 (s, 3H), 2.72 (t, $J = 5.6$ Hz, 2H), 2.60 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.2, 156.0, 145.8, 143.0, 133.7, 130.0, 129.7, 128.7, 123.4, 117.5, 108.4, 60.0, 37.0, 31.6; HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{14}\text{BrNO}_3$ $[\text{M} + \text{Na}]^+$: 346.0049; Found: 346.0043.

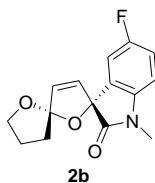
Characterization of 2

1'-methyl-spiro[2,3']oxindole-spiro[2,2']tetrahydrofuran-2,5-dihydrofuran (2a)



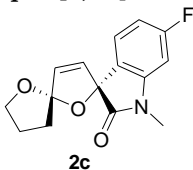
Yellow oil, (63 mg, 82%), IR (KBr) 2944, 2847, 1730, 1609, 1490, 1348, 1001, 864, 751, 692 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.34 (t, $J = 7.6$ Hz, 1H), 7.13 – 7.06 (m, 2H), 6.83 (d, $J = 7.8$ Hz, 1H), 6.15 (d, $J = 5.6$ Hz, 1H), 5.87 (d, $J = 5.6$ Hz, 1H), 4.28 – 4.16 (m, 1H), 4.05 – 3.89 (m, 1H), 3.20 (s, 3H), 2.31 – 2.23 (m, 2H), 2.23 – 2.12 (m, 1H), 2.06 – 1.99 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 173.7, 144.0, 132.0, 130.7, 130.2, 127.7, 124.2, 122.9, 120.6, 108.4, 89.0, 69.0, 37.7, 26.5, 24.7; HRMS (ESI) m/z calcd for $\text{C}_{15}\text{H}_{15}\text{NO}_3$ $[\text{M} + \text{Na}]^+$: 280.0944; Found: 280.0951.

1'-methyl-spiro[2,3']5'-fluoro-oxindole-spiro[2,2']tetrahydrofuran-2,5-dihydrofuran (2b)



Yellow oil, (76 mg, 85%), IR (KBr) 2925, 2849, 1730, 1494, 1110, 980, 804, 747, 699 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.11 (d, $J = 7.4$ Hz, 1H), 7.03 (t, $J = 8.8$ Hz, 1H), 6.79 – 3.71 (m, 1H), 6.15 (d, $J = 5.7$ Hz, 1H), 5.84 (d, $J = 5.7$ Hz, 1H), 4.24 – 4.10 (m, 1H), 3.98 – 3.92 (m, 1H), 3.20 (s, 3H), 2.47 (q, $J = 11.4$ Hz, 1H), 2.29 – 2.15 (m, 2H), 2.05 (t, $J = 11.3$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.3, 159.7, 139.2, 132.3, 130.2, 129.5, 121.0, 116.4, 113.5, 108.8, 89.0, 69.0, 37.0, 26.6, 24.7; HRMS (ESI) m/z calcd for $\text{C}_{15}\text{H}_{14}\text{FNO}_3$ $[\text{M} + \text{Na}]^+$: 298.0850; Found: 298.0858.

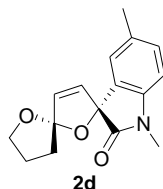
1'-methyl-spiro[2,3']6'-fluoro-oxindole-spiro[2,2']tetrahydrofuran-2,5-dihydrofuran (2c)



Yellow solid, (68 mg, 83%), m.p. = 124.8-125.5 $^{\circ}\text{C}$, IR (KBr) 2947, 2823, 1735, 1581, 1264, 1186, 965, 748 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.14 – 7.00 (m, 1H), 6.74 (t, $J = 8.8$ Hz, 1H), 6.57 (d, $J = 8.2$ Hz, 1H), 6.16 (d, $J = 5.7$ Hz, 1H), 5.84 (d, $J = 5.7$ Hz, 1H), 4.23 – 4.18 (m, 1H), 3.98 (q,

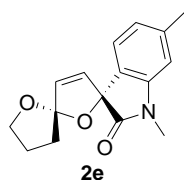
$J = 7.4$ Hz, 1H), 3.19 (s, 3H), 2.33 – 2.12 (m, 3H), 2.09 – 1.98 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.0, 164.3, 145.7, 132.4, 130.4, 125.6, 123.0, 120.5, 109.4, 97.4, 88.4, 69.0, 37.7, 26.6, 24.7; HRMS (ESI) m/z calcd for $\text{C}_{15}\text{H}_{14}\text{FNO}_3$ $[\text{M} + \text{Na}]^+$: 298.0850; Found: 298.0856.

1'-methyl-spiro[2,3']5'-methyl-oxindole-spiro[2,2']tetrahydrofuran-2,5-dihydrofuran (2d)



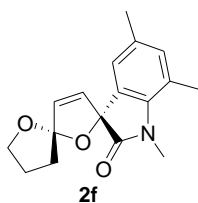
Yellow oil, (61 mg, 75%), IR (KBr) 2948, 2824, 1725, 1583, 1491, 1262, 947, 749 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.11 (d, $J = 7.9$ Hz, 1H), 6.91 (s, 1H), 6.70 (d, $J = 7.9$ Hz, 1H), 6.12 (d, $J = 5.7$ Hz, 1H), 5.84 (d, $J = 5.7$ Hz, 1H), 4.22 – 4.17 (m, 1H), 3.96 (q, $J = 7.5$ Hz, 1H), 3.16 (s, 3H), 2.31 (s, 3H), 2.26 (t, $J = 6.9$ Hz, 2H), 2.18 – 2.14 (m, 1H), 2.07 – 1.96 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 173.7, 141.6, 132.5, 131.9, 130.9, 130.4, 127.6, 125.0, 120.5, 108.2, 89.2, 69.0, 37.7, 26.5, 24.7, 20.9; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{17}\text{NO}_3$ $[\text{M} + \text{Na}]^+$: 294.1101; Found: 294.1105.

1'-methyl-spiro[2,3']6'-methyl-oxindole-spiro[2,2']tetrahydrofuran-2,5-dihydrofuran (2e)



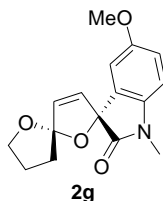
Yellow oil, (65 mg, 80%), IR (KBr) 2946, 2845, 1728, 1582, 1466, 1262, 948, 835, 751, 699 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.00 (d, $J = 7.5$ Hz, 1H), 6.88 (d, $J = 7.5$ Hz, 1H), 6.65 (s, 1H), 6.14 (d, $J = 5.6$ Hz, 1H), 5.85 (d, $J = 5.6$ Hz, 1H), 4.27 – 4.17 (m, 1H), 4.00 – 3.95 (m, 1H), 3.19 (s, 3H), 2.40 (s, 3H), 2.28 – 2.13 (m, 3H), 2.07 – 1.96 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.0, 144.1, 140.7, 131.9, 130.8, 124.7, 124.0, 123.4, 120.4, 109.3, 88.9, 68.9, 37.7, 26.4, 24.7, 21.9; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{17}\text{NO}_3$ $[\text{M} + \text{Na}]^+$: 294.1101; Found: 294.1105.

1'-methyl-spiro[2,3']5',7'-dimethyl-oxindole-spiro[2,2']tetrahydrofuran-2,5-dihydrofuran (2f)



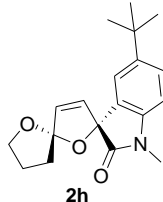
Yellow oil, (60 mg, 70%), IR (KBr) 2944, 2828, 1725, 1678, 1585, 1473, 1264, 1161, 990, 746 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 6.87 (s, 1H), 6.76 (s, 1H), 6.12 (d, $J = 5.6$ Hz, 1H), 5.84 (d, $J = 5.6$ Hz, 1H), 4.24 – 4.19 (m, 1H), 3.98 (q, $J = 7.5$ Hz, 1H), 3.46 (s, 3H), 2.52 (s, 3H), 2.28 (s, 3H), 2.27 – 2.16 (m, 3H), 2.05 – 1.99 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.4, 139.2, 134.3, 132.4, 131.7, 131.1, 128.3, 122.9, 120.4, 119.8, 88.7, 68.9, 37.7, 29.9, 24.7, 20.6, 18.7; HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{19}\text{NO}_3$ [$\text{M} + \text{Na}$] $^+$: 308.1257; Found: 308.1264.

1'-methyl-spiro[2,3']5'-methoxy-oxindole-spiro[2,2']tetrahydrofuran-2,5-dihydrofuran (2g)



Yellow oil, (63 mg, 75%), IR (KBr) 2947, 2823, 1726, 1582, 1492, 1265, 1188, 924, 856, 743 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 6.85 – 6.82 (m, 1H), 6.78 – 6.65 (m, 2H), 6.13 (d, $J = 5.6$ Hz, 1H), 5.85 (d, $J = 5.6$ Hz, 1H), 4.28 – 4.16 (m, 1H), 3.96 (q, $J = 7.4$ Hz, 1H), 3.78 (s, 3H), 3.16 (s, 3H), 2.29 – 2.12 (m, 3H), 2.06 – 1.98 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 173.4, 156.3, 137.4, 132.0, 130.7, 129.0, 120.6, 114.3, 111.7, 108.8, 89.3, 69.0, 55.8, 37.7, 26.6, 24.7; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{17}\text{NO}_4$ [$\text{M} + \text{Na}$] $^+$: 310.1050; Found: 310.1057.

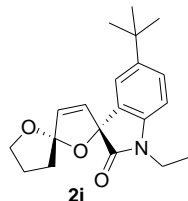
1'-methyl-spiro[2,3']5'-(tert-butyl)-oxindole-spiro[2,2']tetrahydrofuran-2,5-dihydrofuran (2h)



Yellow oil, (68 mg, 72%), IR (KBr) 2951, 2823, 1730, 1581, 1494, 1264, 1190, 947, 747 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.34 (d, $J = 7.4$ Hz, 1H), 7.11 (s, 1H), 6.74 (d, $J = 8.2$ Hz, 1H), 6.14 (d, $J = 5.7$ Hz, 1H), 5.86 (d, $J = 5.7$ Hz, 1H), 4.23 – 4.18 (m, 1H), 3.97 (q, $J = 7.5$ Hz, 1H), 3.17 (s, 3H), 2.29 – 2.16 (m, 3H), 2.08 – 1.97 (m, 1H), 1.30 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3) δ 173.8,

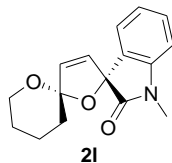
146.2, 141.6, 132.0, 130.9, 127.3, 126.9, 121.2, 120.5, 107.9, 89.3, 68.9, 37.8, 34.5, 31.5, 26.5, 24.7; HRMS (ESI) m/z calcd for $C_{19}H_{23}NO_3$ $[M + Na]^+$: 336.1570; Found: 336.1577.

1'-ethyl-spiro[2,3']5'-(tert-butyl)-oxindole-spiro[2,2']tetrahydrofuran-2,5-dihydrofuran (2i)



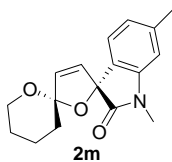
Yellow oil, (64 mg, 65%), IR (KBr) 2960, 1730, 1620, 1599, 1469, 1210, 976, 878, 832, 744 cm^{-1} ; 1H NMR (400 MHz, $CDCl_3$) δ 7.33 (d, $J = 7.5$ Hz, 1H), 7.11 (s, 1H), 6.76 (d, $J = 8.2$ Hz, 1H), 6.13 (d, $J = 5.7$ Hz, 1H), 5.86 (d, $J = 5.7$ Hz, 1H), 4.24 – 4.19 (m, 1H), 3.97 (q, $J = 7.4$ Hz, 1H), 3.81 – 3.62 (m, 2H), 2.34 – 2.12 (m, 3H), 2.04 – 2.01 (m, 1H), 1.30 (s, 9H), 1.26 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 145.9, 140.7, 131.8, 131.0, 127.5, 126.9, 121.4, 120.5, 108.1, 89.4, 69.0, 37.8, 35.0, 34.5, 31.5, 24.8, 12.6; HRMS (ESI) m/z calcd for $C_{20}H_{25}NO_3$ $[M + Na]^+$: 350.1727; Found: 350.1735.

1'-methyl-spiro[2,3']oxindole-spiro[2,2']tetrahydro-2H-pyran-2,5-dihydrofuran (2l)



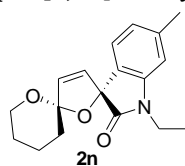
Yellow oil, (59 mg, 73%), IR (KBr) 2943, 2848, 1731, 1609, 1492, 1368, 1265, 1001, 976, 943, 866, 749 cm^{-1} ; 1H NMR (400 MHz, $CDCl_3$) δ 7.33 (t, $J = 7.6$ Hz, 1H), 7.14 – 7.02 (m, 2H), 6.82 (d, $J = 7.8$ Hz, 1H), 6.15 (d, $J = 5.7$ Hz, 1H), 5.81 (d, $J = 5.7$ Hz, 1H), 4.04 (t, $J = 11.8$ Hz, 1H), 3.91 – 3.82 (m, 1H), 2.10 – 1.96 (m, 1H), 1.91 (d, $J = 12.4$ Hz, 2H), 1.80 – 1.60 (m, 2H), 1.53 (d, $J = 13.4$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.8, 143.9, 134.4, 130.2, 130.1, 127.9, 124.4, 122.9, 112.1, 108.4, 89.9, 63.0, 35.3, 26.5, 24.7, 19.3; HRMS (ESI) m/z calcd for $C_{16}H_{17}NO_3$ $[M + Na]^+$: 294.1101; Found: 294.1108.

1'-methyl-spiro[2,3']6'-methyl-oxindole-spiro[2,2']tetrahydro-2H-pyran-2,5-dihydrofuran (2m)



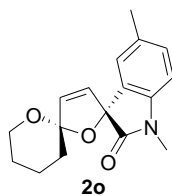
Yellow oil, (57 mg, 69%), IR (KBr) 2943, 2849, 1733, 1619, 1465, 1370, 1213, 1003, 978, 944, 807, 702 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 6.91 (d, $J = 7.5$ Hz, 1H), 6.78 (d, $J = 7.5$ Hz, 1H), 6.57 (s, 1H), 6.06 (d, $J = 5.7$ Hz, 1H), 5.71 (d, $J = 5.7$ Hz, 1H), 4.02 – 3.92 (m, 1H), 3.79 (t, $J = 9.7$ Hz, 1H), 3.10 (s, 3H), 2.31 (s, 3H), 1.96 – 1.92 (m, 1H), 1.89 – 1.77 (m, 2H), 1.69 – 1.55 (m, 2H), 1.45 (d, $J = 13.1$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.1, 144.0, 140.7, 134.2, 130.4, 125.0, 124.1, 123.4, 111.9, 109.3, 89.8, 63.0, 35.3, 26.4, 24.7, 21.9, 19.3; HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{19}\text{NO}_3$ $[\text{M} + \text{Na}]^+$: 308.1257; Found: 308.1263.

1'-ethyl-spiro[2,3']6'-methyl-oxindole-spiro[2,2'']tetrahydro-2H-pyran-2,5-dihydrofuran (2n)



Colorless oil, (60 mg, 67%), IR (KBr) 2925, 2850, 1730, 1464, 1212, 1101, 947, 801, 748, 699 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 6.91 (d, $J = 7.5$ Hz, 1H), 6.77 (d, $J = 7.5$ Hz, 1H), 6.59 (s, 1H), 6.06 (d, $J = 5.7$ Hz, 1H), 5.71 (d, $J = 5.7$ Hz, 1H), 3.97 (t, $J = 11.2$ Hz, 1H), 3.79 (t, $J = 7.5$ Hz, 1H), 3.68 – 3.61 (m, 2H), 2.31 (s, 3H), 1.93 – 1.89 (m, 1H), 1.83 (d, $J = 12.6$ Hz, 2H), 1.67 (d, $J = 5.1$ Hz, 2H), 1.51 – 1.39 (m, 1H), 1.20 (t, $J = 7.3$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 173.7, 143.1, 140.6, 134.0, 130.5, 125.2, 124.3, 123.1, 112.0, 109.4, 89.9, 63.0, 35.3, 34.9, 24.7, 21.9, 19.4, 12.6; HRMS (ESI) m/z calcd for $\text{C}_{18}\text{H}_{21}\text{NO}_3$ $[\text{M} + \text{Na}]^+$: 322.1414; Found: 322.1416.

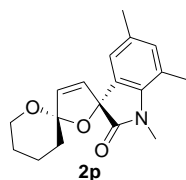
1'-methyl-spiro[2,3']5'-methyl-oxindole-spiro[2,2'']tetrahydro-2H-pyran-2,5-dihydrofuran (2o)



Colorless oil, (59 mg, 72%), IR (KBr) 2950, 2823, 1735, 1582, 1264, 939, 855, 747 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.12 (d, $J = 7.8$ Hz, 1H), 6.90 (s, 1H), 6.70 (d, $J = 7.8$ Hz, 1H), 6.14 (d, $J = 5.7$ Hz, 1H), 5.80 (d, $J = 5.7$ Hz, 1H), 4.04 (t, $J = 11.7$ Hz, 1H), 3.87 (d, $J = 10.5$ Hz, 1H), 3.18 (s, 3H), 2.32 (s, 3H), 2.06 – 1.95 (m, 3H), 1.79 – 1.61 (m, 2H), 1.54 (d, $J = 13.2$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 173.8, 141.5, 134.2, 132.5, 130.4, 130.4, 127.9, 125.1, 112.1, 108.1,

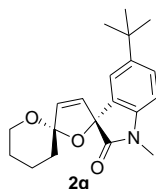
90.0, 63.0, 35.3, 26.5, 24.7, 21.0, 19.4; HRMS (ESI) m/z calcd for $C_{17}H_{19}NO_3$ $[M + Na]^+$: 308.1257; Found: 308.1264.

1'-methyl-spiro[2,3']5',7'-dimethyl-oxindole-spiro[2,2']tetrahydro-2H-pyran-2,5-dihydrofuran (2p)



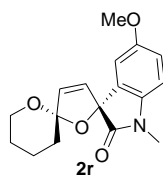
Colorless oil, (58 mg, 65%), IR (KBr) 2946, 2823, 1728, 1583, 1481, 1264, 944, 747 cm^{-1} ; 1H NMR (400 MHz, $CDCl_3$) δ 6.88 (s, 1H), 6.75 (s, 1H), 6.15 (d, $J = 5.7$ Hz, 1H), 5.80 (d, $J = 5.7$ Hz, 1H), 4.06 (t, $J = 11.7$ Hz, 1H), 3.89 (d, $J = 10.5$ Hz, 1H), 3.47 (s, 3H), 2.53 (s, 3H), 2.28 (s, 3H), 2.12 – 1.87 (m, 3H), 1.82 – 1.71 (m, 2H), 1.56 (d, $J = 13.3$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.5, 139.0, 134.3, 134.0, 132.4, 130.7, 128.6, 123.0, 119.8, 112.0, 89.6, 63.0, 35.3, 29.9, 24.7, 20.6, 19.4, 18.7; HRMS (ESI) m/z calcd for $C_{18}H_{21}NO_3$ $[M + Na]^+$: 322.1414; Found: 322.1416.

1'-methyl-spiro[2,3']5'-(tert-butyl)-oxindole-spiro[2,2']tetrahydro-2H-pyran-2,5-dihydrofuran (2q)



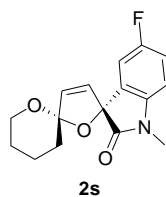
Yellow oil, (68 mg, 70%), IR (KBr) 2949, 2824, 1734, 1583, 1491, 1266, 942, 744 cm^{-1} ; 1H NMR (400 MHz, $CDCl_3$) δ 7.41 (s, 1H), 7.36 (d, $J = 8.1$ Hz, 1H), 6.77 (d, $J = 8.1$ Hz, 1H), 6.15 (d, $J = 5.7$ Hz, 1H), 5.85 (d, $J = 5.7$ Hz, 1H), 3.99 (t, $J = 11.5$ Hz, 1H), 3.85 (d, $J = 8.9$ Hz, 1H), 3.21 (s, 3H), 2.21 (d, $J = 9.8$ Hz, 1H), 1.96 (t, $J = 9.5$ Hz, 2H), 1.78 – 1.69 (m, 2H), 1.56 (d, $J = 12.6$ Hz, 1H), 1.32 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.8, 146.7, 141.0, 134.1, 130.6, 127.8, 126.5, 122.8, 112.1, 107.7, 90.3, 62.9, 34.6, 34.2, 31.4, 26.5, 24.8, 19.3; HRMS (ESI) m/z calcd for $C_{20}H_{25}NO_3$ $[M + Na]^+$: 350.1727; Found: 350.1730.

1'-methyl-spiro[2,3']5'-methoxy-oxindole-spiro[2,2']tetrahydro-2H-pyran-2,5-dihydrofuran (2r)



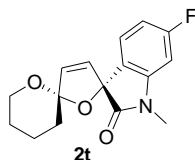
Yellow oil, (64 mg, 72%), IR (KBr) 2924, 2849, 1728, 1589, 1496, 1353, 1269, 1116, 1027, 980, 795, 747 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 6.97 (d, $J = 1.8$ Hz, 1H), 6.92 – 6.79 (m, 1H), 6.75 (d, $J = 8.4$ Hz, 1H), 6.14 (d, $J = 5.7$ Hz, 1H), 5.82 (d, $J = 5.7$ Hz, 1H), 3.99 (t, $J = 11.7$ Hz, 1H), 3.85 (s, 1H), 3.80 (s, 3H), 3.20 (s, 3H), 2.21 (d, $J = 9.1$ Hz, 1H), 1.96 (d, $J = 9.0$ Hz, 2H), 1.79 – 1.76 (m, 1H), 1.69 (d, $J = 14.1$ Hz, 1H), 1.56 (d, $J = 13.4$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.4, 156.6, 136.8, 134.2, 130.4, 129.3, 114.9, 112.3, 112.2, 108.7, 90.3, 63.1, 55.9, 34.3, 26.5, 24.8, 19.3; HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{19}\text{NO}_4$ $[\text{M} + \text{Na}]^+$: 324.1206; Found: 324.1212.

1'-methyl-spiro[2,3']5'-fluoro-oxindole-spiro[2,2']tetrahydro-2H-pyran-2,5-dihydrofuran (2s)



Yellow oil, (70 mg, 80%), m.p. = 127.9 – 128.5 $^\circ\text{C}$, IR (KBr) 2945, 2846, 1733, 1493, 1266, 1190, 1002, 980, 802, 700 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.00 (d, $J = 7.4$ Hz, 1H), 6.95 (t, $J = 8.8$ Hz, 1H), 6.72 – 6.61 (m, 1H), 6.06 (d, $J = 5.7$ Hz, 1H), 5.71 (d, $J = 5.7$ Hz, 1H), 3.87 (t, $J = 11.0$ Hz, 1H), 3.75 (d, $J = 7.8$ Hz, 1H), 3.12 (s, 3H), 2.09 (d, $J = 8.1$ Hz, 1H), 1.85 (p, $J = 13.1$ Hz, 2H), 1.68 (d, $J = 11.0$ Hz, 1H), 1.61 (t, $J = 7.1$ Hz, 1H), 1.47 (t, $J = 12.8$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.4, 159.7, 139.2, 134.6, 129.9, 116.3, 113.5, 112.5, 108.9, 108.8, 89.9, 63.1, 34.2, 26.6, 24.7, 19.3; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{16}\text{FNO}_3$ $[\text{M} + \text{Na}]^+$: 312.1006; Found: 312.1014.

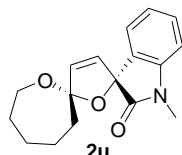
1'-methyl-spiro[2,3']6'-fluoro-oxindole-spiro[2,2']tetrahydro-2H-pyran-2,5-dihydrofuran (2t)



Yellow oil, (67 mg, 78%), IR (KBr) 2947, 2823, 1736, 1581, 1265, 932, 839, 746 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.29 – 7.27 (m, 1H), 6.87 – 6.65 (m, 1H), 6.63 – 6.50 (m, 1H), 6.14 (d, $J = 5.7$ Hz, 1H), 5.79 (d, $J = 5.7$ Hz, 1H), 3.95 (t, $J = 10.7$ Hz, 1H), 3.83 – 3.80 (m, 1H), 3.21 (s, 3H),

2.16 (t, $J = 10.4$ Hz, 1H), 1.93 (q, $J = 13.1$ Hz, 2H), 1.77 (d, $J = 11.5$ Hz, 1H), 1.69 – 1.64 (m, 1H), 1.56 (d, $J = 12.8$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.9, 164.3, 145.1, 134.5, 130.0, 126.8, 123.5, 112.3, 109.3, 97.2, 89.4, 63.1, 34.3, 26.6, 24.8, 19.3; HRMS (ESI) m/z calcd for $\text{C}_{16}\text{H}_{16}\text{FNO}_3$ [$\text{M} + \text{Na}$] $^+$: 312.1006; Found: 312.1011.

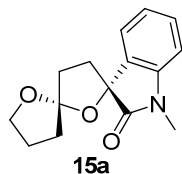
1'-methyl-spiro[2,3']oxindole-spiro[2,2']oxepane-2,5-dihydrofuran (2u)



Yellow oil, (41 mg, 50%), IR (KBr) 2941, 2848, 1729, 1580, 1468, 1349, 1268, 1153, 955, 864, 747 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.31 (t, $J = 8.7$ Hz, 2H), 7.13 – 7.01 (m, 1H), 6.80 (d, $J = 7.7$ Hz, 1H), 6.27 (d, $J = 5.7$ Hz, 1H), 5.74 (d, $J = 5.7$ Hz, 1H), 4.00 – 3.86 (m, 1H), 3.78 (d, $J = 12.7$ Hz, 1H), 3.19 (s, 3H), 2.42-2.31 (m, 2H), 1.88 (d, $J = 12.3$ Hz, 1H), 1.78 (d, $J = 7.2$ Hz, 1H), 1.70 (d, $J = 20.1$ Hz, 2H), 1.61 – 1.36 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3) δ 174.7, 143.4, 133.8, 130.0, 128.9, 128.2, 125.6, 123.2, 117.3, 108.2, 89.2, 64.1, 38.2, 30.9, 29.6, 26.4, 23.2; HRMS (ESI) m/z calcd for $\text{C}_{17}\text{H}_{19}\text{NO}_3$ [$\text{M} + \text{Na}$] $^+$: 308.1257; Found: 308.1259.

Characterization of 15a

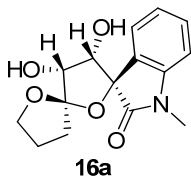
1'-methyl-spiro[2,3']oxindole-spiro[2,2']tetrahydrofuran-tetrahydrofuran (15a)



Yellow oil, (44 mg, 85%), IR (KBr) 2947, 2822, 1731, 1581, 1266, 936, 855, 746 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.46 (d, $J = 7.3$ Hz, 1H), 7.27 (d, $J = 6.7$ Hz, 1H), 7.08 (t, $J = 7.5$ Hz, 1H), 6.76 (d, $J = 7.7$ Hz, 1H), 4.03 – 3.92 (m, 2H), 3.15 (s, 3H), 2.66 – 2.58 (m, 1H), 2.48 – 2.41 (m, 1H), 2.32 (dt, $J = 19.9, 10.0$ Hz, 2H), 2.23 (dd, $J = 11.9, 7.1$ Hz, 1H), 2.15 – 2.01 (m, 2H), 1.95 (dd, $J = 20.7, 14.5$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 177.2, 143.5, 131.1, 129.4, 124.6, 123.3, 117.1, 108.0, 83.1, 67.2, 35.7, 35.3, 34.3, 26.0, 24.2; HRMS (ESI) m/z calcd for $\text{C}_{15}\text{H}_{17}\text{NO}_3$ [$\text{M} + \text{Na}$] $^+$: 282.1101; Found: 282.1105.

Characterization of 16a

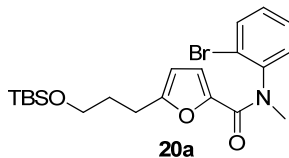
1'-methyl-spiro[2,3']oxindole-spiro[2,2']tetrahydrofuran-tetrahydrofuran-3,4-diol (16a)



white solid, (45 mg, 78%), m.p. = 168.1 – 169.7 °C, IR (KBr) 2947, 2846, 1713, 1610, 1469, 1352, 1185, 1013, 967, 693 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) δ 7.61 (d, *J* = 7.3 Hz, 1H), 7.29 (t, *J* = 7.8 Hz, 1H), 7.05 (t, *J* = 7.5 Hz, 1H), 6.76 (d, *J* = 7.7 Hz, 1H), 4.63 (d, *J* = 4.8 Hz, 1H), 4.42 (s, 1H), 4.16 – 3.99 (m, 1H), 3.95 – 3.73 (m, 2H), 3.22 (t, *J* = 17.7 Hz, 1H), 3.10 (s, 3H), 2.35 – 2.29 (m, 1H), 2.18 – 2.07 (m, 1H), 2.06 – 1.96 (m, 1H), 1.90 (s, 1H); ¹³C NMR (100 MHz, CDCl₃) δ 176.8, 144.2, 130.0, 127.3, 126.0, 122.9, 116.7, 108.2, 85.3, 75.9, 75.8, 68.5, 32.5, 26.4, 23.6; HRMS (ESI) *m/z* calcd for C₁₅H₁₇NO₅ [M + Na]⁺: 314.0999; Found: 314.1003.

Characterization of 20a

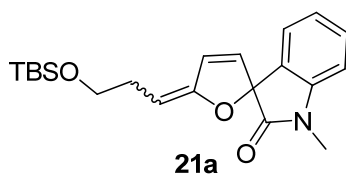
N-(2-bromophenyl)-5-(3-((tert-butyldimethylsilyl)oxy)propyl)-N-methylfuran-2-carboxamid (20a)



Yellow oil, (903 mg, 68%), IR (KBr) 2923, 2849, 1734, 1582, 1475, 1264, 1155, 969, 747 cm⁻¹; ¹H NMR (400 MHz, CDCl₃) δ 7.65 (d, *J* = 7.9 Hz, 1H), 7.34 (t, *J* = 7.5 Hz, 1H), 7.29 – 7.16 (m, 2H), 6.08 (s, 1H), 5.85 (s, 1H), 3.48 (t, *J* = 5.7 Hz, 2H), 3.33 (s, 3H), 2.50 (t, *J* = 6.9 Hz, 2H), 1.66 – 1.53 (m, 2H), 0.86 (s, 9H), 0.00 (s, 6H); ¹³C NMR (100 MHz, CDCl₃) δ 159.2, 158.6, 145.6, 143.3, 133.6, 130.0, 129.4, 128.6, 123.5, 117.4, 107.0, 61.8, 37.0, 30.2, 25.9, 24.4, 18.2, -5.3; HRMS (ESI) *m/z* calcd for C₂₁H₃₀BrNO₃Si [M + Na]⁺: 474.1071; Found: 474.1058.

Characterization of 21a

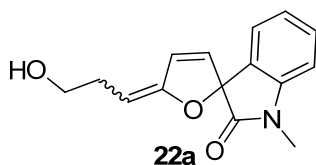
5-(3-((tert-butyldimethylsilyl)oxy)propylidene)-1'-methyl-5H-spiro[furan-2,3'-indolin]-2'-one (21a)



Yellow oil, (94 mg, 85%), IR (KBr) 2948, 2823, 1728, 1578, 1266, 945, 747 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.38 (t, $J = 7.7$ Hz, 1H), 7.21 (d, $J = 7.2$ Hz, 1H), 7.09 (t, $J = 7.4$ Hz, 1H), 6.87 (d, $J = 7.7$ Hz, 1H), 6.50 (d, $J = 5.6$ Hz, 1H), 5.91 (d, $J = 5.6$ Hz, 1H), 4.65 (t, $J = 7.4$ Hz, 1H), 3.67 (t, $J = 5.7$ Hz, 2H), 3.23 (s, 3H), 2.48 – 2.35 (m, 2H), 0.90 (s, 9H), 0.06 (s, 6H); ^{13}C NMR (100 MHz, CDCl_3) δ 173.1, 158.8, 143.6, 130.6, 129.9, 129.0, 126.8, 125.0, 123.2, 108.5, 96.7, 90.9, 62.8, 29.2, 26.5, 25.9, 18.3, -5.2; HRMS (ESI) m/z calcd for $\text{C}_{21}\text{H}_{29}\text{NO}_3\text{Si}$ [$\text{M} + \text{Na}$] $^+$: 394.1809; Found: 394.1810.

Characterization of 22a

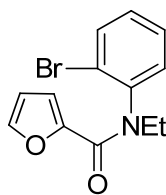
5-(3-hydroxypropylidene)-1'-methyl-5H-spiro[furan-2,3'-indolin]-2'-one (22a)



Yellow oil, (55 mg, 87%), IR (KBr) 2948, 2825, 1726, 1580, 1471, 1348, 1265, 944, 857, 750 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.36 (t, $J = 7.7$ Hz, 1H), 7.20 (d, $J = 7.2$ Hz, 1H), 7.08 (t, $J = 7.5$ Hz, 1H), 6.86 (d, $J = 7.8$ Hz, 1H), 6.50 (d, $J = 5.7$ Hz, 1H), 5.92 (d, $J = 5.7$ Hz, 1H), 4.64 (t, $J = 7.6$ Hz, 1H), 3.67 (t, $J = 5.7$ Hz, 2H), 3.21 (s, 3H), 2.49 – 2.37 (m, 2H), 1.89 (s, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 173.0, 159.8, 143.6, 130.8, 130.4, 128.9, 126.5, 125.0, 123.4, 108.7, 96.1, 91.0, 62.4, 29.1, 26.6; HRMS (ESI) m/z calcd for $\text{C}_{15}\text{H}_{15}\text{NO}_3$ [$\text{M} + \text{Na}$] $^+$: 280.0944; Found: 280.0945.

Characterization of 12

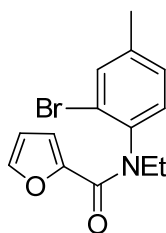
Furan-2-carboxylic acid (2-bromo-phenyl)-ethyl-amide (12a)



12a

White solid (747mg, 85%), m.p. = 70.3–72.8 °C, IR (KBr) 2986, 2833, 1730, 1620, 1453, 1260, 1020, 758 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.60 (d, $J = 7.9$ Hz, 1H), 7.33–7.28 (m, 1H), 7.19 (t, $J = 7.7$ Hz, 3H), 6.12 (br, 1H), 5.78 (br, 1H), 4.17 - 4.08 (m, 1H), 3.46–3.41 (m, 1H), 1.14 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 158.7, 147.2, 144.4, 141.1, 133.8, 131.1, 129.7, 128.4, 124.1, 115.7, 111.0, 44.4, 12.5; HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{12}\text{BrNO}_2$ $[\text{M}+\text{Na}]^+$: 315.99585, Found: 315.99585.

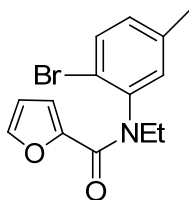
Furan-2-carboxylic acid (2-bromo-4-methyl-phenyl)-ethyl-amide(12b)



12b

White solid (810 mg, 88%), m.p. = 106.2–108.8 °C, IR (KBr) 2976, 1735, 1640, 1458, 1250, 880 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.51 (s, 1H), 7.33 (s, 1H), 7.18–7.12 (m, 2H), 6.20 (br, 1H), 5.81 (br, 1H), 4.25–4.18 (m, 1H), 3.55–3.47 (m, 1H), 2.40 (s, 3H), 1.21 (t, $J = 7.0$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 158.8, 147.1, 144.3, 140.2, 138.4, 134.2, 130.7, 129.2, 123.7, 115.6, 111.00, 44.4, 20.8, 12.6; HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{14}\text{BrNO}_2$ $[\text{M}+\text{Na}]^+$: 330.01151, Found: 330.01151.

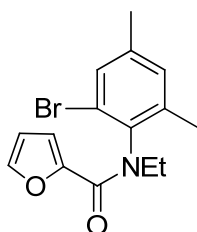
Furan-2-carboxylic acid (2-bromo-5-methyl-phenyl)-ethyl-amide (12c)



12c

White solid (801 mg, 87%), m.p. = 106.7–108.5 °C, IR (KBr) 2945, 1745, 1650, 1240, 1040, 885 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.54 (d, J = 8.5 Hz, 1H), 7.32 (s, 1H), 7.08 (s, 2H), 6.20 (br, 1H), 5.81 (br, 1H), 4.21–4.12 (m, 1H), 3.57–3.52 (m, 6.8 Hz, 1H), 2.34 (s, 3H), 1.23 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 158.7, 147.2, 144.3, 140.8, 138.8, 133.4, 131.6, 130.6, 120.6, 115.6, 111.0, 44.5, 20.8, 12.6; HRMS (ESI) m/z calcd for $\text{C}_{14}\text{H}_{14}\text{BrNO}_2$ $[\text{M}+\text{Na}]^+$: 330.01166, Found: 330.01169.

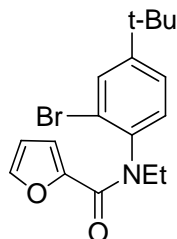
Furan-2-carboxylic acid (2-bromo-4,6-dimethyl-phenyl)-ethyl-amide (12d)



12d

White solid (869 mg, 90%), m.p. = 108.7–109.8 °C, IR (KBr) 2978, 1764, 1620, 1458, 1265, 1002. 865 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.35 (s, 2H), 7.05 (s, 1H), 6.37–6.09 (m, 1H), 5.72 (d, J = 3.1 Hz, 1H), 3.90–3.95 (m, 1H), 3.74–3.79 (m, 1H), 2.35 (s, 3H), 2.20 (s, 3H), 1.24 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 159.1, 147.3, 144.4, 139.9, 138.8, 137.4, 131.9, 131.2, 124.6, 114.8, 111.1, 44.6, 20.8, 18.8, 12.7; HRMS (ESI) m/z calcd for $\text{C}_{15}\text{H}_{16}\text{BrNO}_2$ $[\text{M}+\text{Na}]^+$: 344.02728, Found: 344.02728.

Furan-2-carboxylic acid (2-bromo-4-tert-butyl-phenyl)-ethyl-amide (12e)

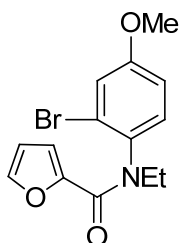


12e

White solid (932 mg, 89%), m.p. = 106.1–108.3 °C, IR (KBr) 2965, 1729, 1646, 1475, 1121, 1019, 931, 830 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.67 (d, J = 2.1 Hz, 1H), 7.37 (dd, J = 8.2, 2.2 Hz, 1H), 7.32 (s, 1H), 7.17 (d, J = 8.2 Hz, 1H), 6.20 (br, 1H), 5.75 (br, 1H), 4.19–4.24 (m, 1H), 3.47–3.52 (m, 1H), 1.35 (s, 9H), 1.23 (t, J = 7.2 Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 158.8,

153.7, 147.3, 144.3, 138.4, 130.8, 130.5, 125.5, 123.7, 115.4, 111.0, 44.1, 34.8, 31.2, 12.7; HRMS (ESI) m/z calcd for $C_{17}H_{20}BrNO_2 [M+Na]^+$: 372.05856, Found: 372.05856.

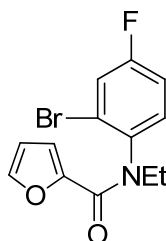
Furan-2-carboxylic acid (2-bromo-4-methoxy-phenyl)-ethyl-amide (12f)



12f

White solid (853 mg, 88%), m.p. = 105.2–107.8 °C, IR (KBr) 2995, 1733, 1623, 1480, 1268, 1023, 872 cm^{-1} ; 1H NMR (400 MHz, $CDCl_3$) δ 7.35 (s, 1H), 7.23 (s, 1H), 7.17 (d, J = 8.6 Hz, 1H), 6.91 (d, J = 8.5 Hz, 1H), 6.23 (br, 1H), 5.82 (br, 1H), 4.19–4.24 (m, 1H), 3.86 (s, 3H), 3.45–3.50 (m, 1H), 1.23 (t, J = 7.0 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.8, 159.0, 147.3, 144.4, 133.8, 131.5, 124.6, 118.8, 115.5, 114.1, 111.0, 55.8, 44.4, 12.6; HRMS m/z (ESI) calcd for $C_{14}H_{14}BrNO_3 [M+Na]^+$: 346.00625, Found: 346.00625.

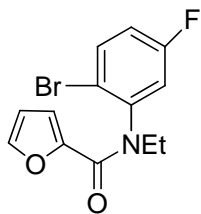
Furan-2-carboxylic acid (2-bromo-4-fluoro-phenyl)-ethyl-amide (12g)



12g

White solid (774 mg, 83%), m.p. = 126.2–127.5 °C, IR (KBr) 2942, 1721, 1610, 1435, 1253, 1045, 875 cm^{-1} ; 1H NMR (400 MHz, $CDCl_3$) δ 7.43 (d, J = 7.3 Hz, 1H), 7.29 (s, 1H), 7.27–7.23 (m, 1H), 7.10 (t, J = 8.1 Hz, 1H), 6.25 (br, 1H), 6.08 (br, 1H), 4.24–4.16 (m, 1H), 3.52–3.57 (m, 1H), 1.22 (t, J = 7.1 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.6, 158.8, 147.3, 144.5, 137.6, 132.0, 124.7, 121.0, 116.0, 115.5, 111.1, 44.5, 12.6; HRMS (ESI) m/z calcd for $C_{13}H_{11}BrFNO_2 [M+Na]^+$: 333.98642, Found: 333.98654.

Furan-2-carboxylic acid (2-bromo-5-fluoro-phenyl)-ethyl-amide (12h)

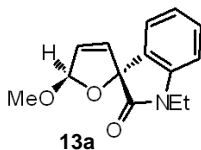


12h

White solid (784 mg, 84%), m.p. = 125.9–127.8 °C, IR (KBr) 2972, 1746, 1650, 1433, 1273, 885 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.65–7.61 (m, 1H), 7.29 (s, 1H), 7.03 (dd, $J = 5.6, 3.2$ Hz, 2H), 6.27 (br, 1H), 6.20 (br, 1H), 4.21–4.12 (m, 1H), 3.60–3.55 (m, 1H), 1.25 (d, $J = 7.1$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 161.9, 158.5, 147.2, 144.6, 142.6, 134.5, 118.5, 118.3, 117.1, 116.5, 111.2, 44.6, 12.7; HRMS (ESI) m/z calcd for $\text{C}_{13}\text{H}_{11}\text{BrFNO}_2$ $[\text{M}+\text{Na}]^+$: 333.68957, Found: 333.68957.

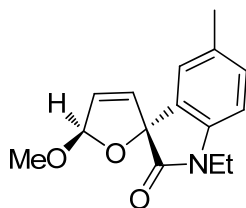
Characterization of 13

1'-Ethyl-5-methoxy-5H-spiro[furan-2,3'-indolin]-2'-one (13a)



Yellow oil, (53 mg, 72%), IR (KBr) 2986, 2928, 1724, 1608, 1463, 1201, 943, 857, 757 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.32 (t, $J = 7.6$ Hz, 1H), 7.12 (d, $J = 7.2$ Hz, 1H), 7.04 (t, $J = 7.4$ Hz, 1H), 6.85 (d, $J = 7.8$ Hz, 1H), 6.20 (s, 2H), 5.95 (d, $J = 5.4$ Hz, 1H), 3.78–3.72 (m, 2H), 3.55 (s, 3H), 1.28 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.2, 143.0, 132.5, 130.3, 129.9, 127.7, 124.5, 122.9, 110.5, 108.7, 89.6, 54.1, 35.0, 12.5; HRMS m/z (ESI) calculated for $\text{C}_{14}\text{H}_{15}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 268.09558; Found: 268.09558.

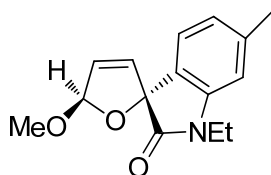
1'-Ethyl-5-methoxy-5'-methyl-5H-spiro[furan-2,3'-indolin]-2'-one (13b)



13b

Yellow oil, (54 mg, 70%), IR (KBr) 3087, 2977, 1726, 1615, 1494, 1372, 1210, 948, 875, 747 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.11 (d, $J = 7.9$ Hz, 1H), 6.95 (s, 1H), 6.74 (d, $J = 7.9$ Hz, 1H), 6.19 (d, $J = 7.1$ Hz, 2H), 5.94 (d, $J = 5.7$ Hz, 1H), 3.75-3.70 (m, 2H), 3.55 (s, 3H), 2.30 (s, 3H), 1.27 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.1, 140.5, 132.7, 132.5, 130.5, 129.7, 127.6, 125.2, 110.5, 108.4, 89.7, 54.1, 35.0, 20.9, 12.5; HRMS m/z (ESI) calculated for $\text{C}_{15}\text{H}_{17}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 282.11124; Found: 282.11124.

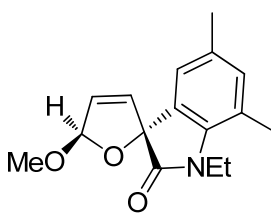
1'-Ethyl-5-methoxy-6'-methyl-5H-spiro[furan-2,3'-indolin]-2'-one (13c)



13c

Yellow oil, (47 mg, 60%), IR (KBr) 2977, 1727, 1619, 1455, 1203, 947, 816, 748 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.00 (d, $J = 7.4$ Hz, 1H), 6.85 (d, $J = 7.5$ Hz, 1H), 6.67 (s, 1H), 6.18 (s, 2H), 5.93 (d, $J = 5.8$ Hz, 1H), 3.76-3.70 (m, 2H), 3.54 (s, 3H), 2.38 (s, 3H), 1.28 (t, $J = 7.1$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.5, 143.1, 140.7, 132.7, 129.7, 124.7, 124.2, 123.3, 110.4, 109.5, 89.5, 54.1, 34.9, 21.9, 12.6; HRMS m/z (ESI) calculated for $\text{C}_{15}\text{H}_{17}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 282.11108; Found: 282.11115.

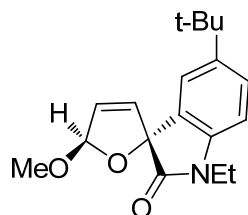
1'-Ethyl-5,5'-dimethoxy-5H-spiro[furan-2,3'-indolin]-2'-one (13d)



13d

Yellow oil, (41 mg, 50%), IR (KBr) 2985, 2925, 1722, 1645, 1473, 1342, 1266, 1224, 949, 862 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 6.87 (s, 1H), 6.77 (s, 1H), 6.25 – 6.08 (m, 2H), 5.91 (d, $J = 5.5$ Hz, 1H), 3.98-3.92 (m, 2H), 3.55 (s, 3H), 2.47 (s, 3H), 2.25 (s, 3H), 1.28 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 174.2, 138.3, 134.5, 133.0, 132.4, 129.4, 128.5, 123.0, 119.4, 110.4, 89.3, 54.0, 36.8, 20.5, 18.6, 14.6; HRMS m/z (ESI) Calculated for $\text{C}_{16}\text{H}_{19}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 296.12686; Found: 296.12692.

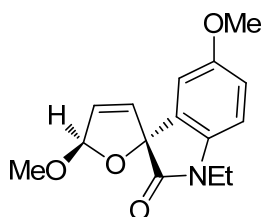
5'-(Tert-butyl)-1'-ethyl-5-methoxy-5H-spiro[furan-2,3'-indolin]-2'-one (13e)



13e

Yellow oil, (58 mg, 64%), IR (KBr) 2962, 2915, 1728, 1619, 1494, 1372, 1206, 948, 876, 744 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.35-7.33 (m, 1H), 7.14 (d, $J = 1.9$ Hz, 1H), 6.78 (d, $J = 8.2$ Hz, 1H), 6.21 (d, $J = 5.6$ Hz, 2H), 5.96 (d, $J = 5.4$ Hz, 1H), 3.75-3.72 (m, 2H), 3.56 (s, 3H), 1.29 (d, $J = 8.2$ Hz, 12H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.3, 146.2, 140.6, 132.8, 129.8, 127.2, 127.0, 121.5, 110.5, 108.2, 89.9, 54.3, 35.0, 34.5, 31.5, 12.6; HRMS m/z (ESI) calculated for $\text{C}_{18}\text{H}_{23}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 324.15839; Found: 324.15839.

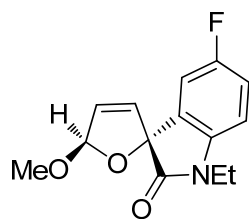
1'-Ethyl-5-methoxy-5',7'-dimethyl-5H-spiro[furan-2,3'-indolin]-2'-one and (13f)



13f

Yellow oil, (52 mg, 63%), IR (KBr) 2936, 2836, 1723, 1603, 1492, 1344, 1279, 1103, 1031, 946, 862, 703, 627 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 6.86-6.83 (m, 1H), 6.76 (d, $J = 8.5$ Hz, 1H), 6.73 (d, $J = 2.5$ Hz, 1H), 6.20-6.19 (m, 2H), 5.96-5.94 (m, 1H), 3.77 (s, 3H), 3.77-3.71 (m, 2H), 3.55 (s, 3H), 1.27 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 172.9, 156.3, 136.2, 132.6, 129.8, 128.9, 115.0, 111.4, 110.6, 109.2, 89.9, 55.9, 54.2, 35.1, 12.5; HRMS m/z (ESI) calculated for $\text{C}_{15}\text{H}_{17}\text{NO}_4$ $[\text{M}+\text{Na}]^+$: 298.10620; Found: 298.10617.

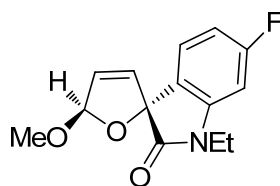
1'-Ethyl-5'-fluoro-5-methoxy-5H-spiro[furan-2,3'-indolin]-2'-one (13g)



13g

Yellow oil, (52 mg, 66%), IR (KBr) 3086, 2936, 1728, 1615, 1489, 1343, 1266, 1102, 1024, 946, 878, 734 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.02 (t, $J = 8.8$ Hz, 1H), 6.87 (d, $J = 7.4$ Hz, 1H), 6.80-6.77 (m, 1H), 6.26-6.17 (m, 2H), 5.94 (d, $J = 5.8$ Hz, 1H), 3.73-3.75 (m, 2H), 3.55 (s, 3H), 1.28 (t, $J = 6.8$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.0, 159.3, 138.8, 132.1, 130.27, 129.38, 116.5, 112.6, 110.66, 109.3, 89.5, 54.2, 35.2, 12.4; HRMS m/z (ESI) calculated for $\text{C}_{14}\text{H}_{14}\text{FNO}_3$ $[\text{M}+\text{Na}]^+$: 286.08615; Found: 286.08606.

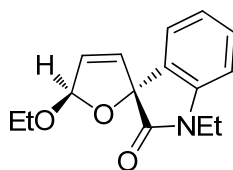
1'-Ethyl-6'-fluoro-5-methoxy-5H-spiro[furan-2,3'-indolin]-2'-one (13h)



13h

Yellow oil, (57 mg, 72%), IR (KBr) 2980, 2937, 1733, 1614, 1499, 1545, 1374, 1200, 953, 830, 742 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.13 – 7.03 (m, 1H), 6.72 (t, $J = 8.8$ Hz, 1H), 6.59 (d, $J = 8.9$ Hz, 1H), 6.21 (d, $J = 5.8$ Hz, 1H), 6.17 (s, 1H), 5.92 (d, $J = 5.8$ Hz, 1H), 3.71-3.75 (m, 2H), 3.54 (s, 3H), 1.28 (t, $J = 7.2$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.5, 163.13, 144.64, 132.23, 130.15, 125.9, 122.97, 110.50, 108.9, 97.6, 89.1, 54.3, 35.3, 12.5; HRMS m/z (ESI) calculated for $\text{C}_{14}\text{H}_{14}\text{FNO}_3$ $[\text{M}+\text{Na}]^+$: 286.08618; Found: 286.08615.

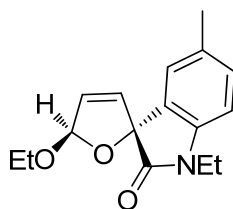
5-Ethoxy-1'-ethyl-5H-spiro[furan-2,3'-indolin]-2'-one (13i)



13i

Yellow oil, (54 mg, 69%), IR (KBr) 2977, 2932, 1728, 1611, 1463, 1359, 1290, 940, 859, 753 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.31 (t, $J = 7.3$ Hz, 1H), 7.12 (d, $J = 7.1$ Hz, 1H), 7.04 (t, $J = 7.3$ Hz, 1H), 6.84 (d, $J = 7.7$ Hz, 1H), 6.26 (s, 1H), 6.21 (d, $J = 5.6$ Hz, 1H), 5.93 (d, $J = 5.6$ Hz, 1H), 3.88-3.83 (dd, $J = 13.4, 6.7$ Hz, 2H), 3.75 (q, $J = 7.1$ Hz, 2H), 1.28 (t, $J = 7.0$ Hz, 6H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.2, 143.0, 132.2, 130.2, 130.2, 127.8, 124.5, 122.8, 109.6, 108.6, 89.6, 62.6, 35.0, 15.4, 12.6; HRMS m/z (ESI) calculated for $\text{C}_{15}\text{H}_{17}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 282.11115, Found: 282.11121.

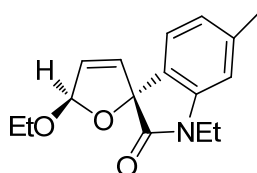
5-Ethoxy-1'-ethyl-5'-methyl-5H-spiro[furan-2,3'-indolin]-2'-one (13j)



13j

Yellow oil, (44 mg 54%), IR (KBr) 2978, 2930, 1728, 1633, 1493, 1372, 1251, 1105, 943, 812, 738 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.11 (d, $J = 7.9$ Hz, 1H), 6.94 (s, 1H), 6.73 (d, $J = 7.9$ Hz, 1H), 6.26 (s, 1H), 6.19 (d, $J = 5.8$ Hz, 1H), 5.92 (d, $J = 5.8$ Hz, 1H), 3.86-3.83 (m, 2H), 3.76-3.70 (m, 2H), 2.30 (s, 3H), 1.29-1.25 (m, 6H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.2, 140.5, 132.4, 130.4, 130.0, 128.3, 127.7, 125.2, 109.6, 108.4, 89.7, 62.5, 35.0, 20.9, 15.4, 12.6; HRMS m/z (ESI) calculated for $\text{C}_{16}\text{H}_{19}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 296.12701; Found: 296.12695.

5-Ethoxy-1'-ethyl-6'-methyl-5H-spiro[furan-2,3'-indolin]-2'-one (13k)

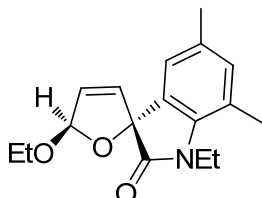


13k

Yellow oil, (46 mg, 56%), IR (KBr) 2977, 2930, 1728, 1619, 1452, 1212, 1024, 944, 833, 752 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.00 (d, $J = 7.5$ Hz, 1H), 6.84 (d, $J = 7.5$ Hz, 1H), 6.66 (s, 1H), 6.24 (s, 1H), 6.18 (d, $J = 5.8$ Hz, 1H), 5.91 (d, $J = 5.8$ Hz, 1H), 3.85-3.83 (m, 2H), 3.73 (q, J

= 7.1 Hz, 2H), 2.38 (s, 3H), 1.27 (t, $J = 7.1$ Hz, 6H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.5, 143.1, 140.6, 132.4, 130.0, 124.8, 124.2, 123.3, 109.5, 109.5, 89.5, 62.5, 34.9, 22.0, 15.4, 12.6; HRMS m/z (ESI) calculated for $\text{C}_{16}\text{H}_{19}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 296.12689; Found: 296.12704.

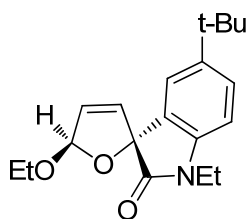
5-Ethoxy-1'-ethyl-5',7'-dimethyl-5H-spiro[furan-2,3'-indolin]-2'-one (13l)



13l

Yellow oil, (35 mg, 40%), IR (KBr) 2979, 2933, 1730, 1619, 1488, 1266, 1020, 942, 879, 758 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 6.86 (s, 1H), 6.77 (s, 1H), 6.25 (s, 1H), 6.17 (d, $J = 6.0$ Hz, 1H), 5.89 (d, $J = 5.8$ Hz, 1H), 3.97-3.90 (m, 2H), 3.88 – 3.68 (m, 2H), 2.47 (s, 3H), 2.25 (s, 3H), 1.27 (t, $J = 7.0$ Hz, 6H); ^{13}C NMR (101 MHz, CDCl_3) δ 174.3, 138.3, 134.5, 132.7, 132.4, 129.7, 128.6, 123.0, 119.4, 109.6, 89.3, 62.5, 36.8, 20.5, 18.6, 15.4, 14.6; HRMS m/z (ESI) calculated for $\text{C}_{17}\text{H}_{21}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 310.10264; Found: 310.10274.

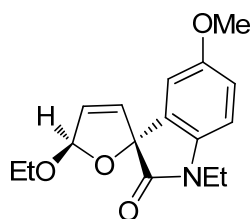
5'-(Tert-butyl)-5-ethoxy-1'-ethyl-5H-spiro[furan-2,3'-indolin]-2'-one (13m)



13m

Yellow oil, (54 mg, 57%), IR (KBr) 2977, 2934, 1724, 1639, 1494, 1275, 1209, 1030, 942, 878, 742 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.33 (d, $J = 8.2$ Hz, 1H), 7.13 (s, 1H), 6.78 (d, $J = 8.2$ Hz, 1H), 6.28 (s, 1H), 6.21 (d, $J = 5.8$ Hz, 1H), 5.94 (d, $J = 5.8$ Hz, 1H), 3.87-3.83 (m, 2H), 3.73 (q, $J = 7.1$ Hz, 2H), 1.28 (d, $J = 10.4$ Hz, 15H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.3, 146.2, 140.6, 132.5, 130.1, 127.3, 126.9, 121.5, 109.6, 108.1, 89.9, 62.7, 35.0, 34.5, 31.5, 15.4, 12.6; HRMS m/z (ESI) calculated for $\text{C}_{19}\text{H}_{25}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 338.17411; Found: 338.17440.

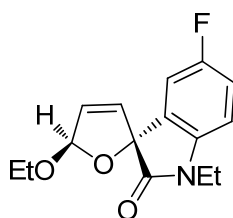
5-Ethoxy-1'-ethyl-5'-methoxy-5H-spiro[furan-2,3'-indolin]-2'-one (13n)



13n

Yellow oil, (49 mg, 56%), IR (KBr) 2975, 2928, 1723, 1649, 1540, 1472, 1266, 1017, 946, 863, 740 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 6.88-6.85 (m, 1H), 6.80 – 6.66 (m, 3H), 6.28 (s, 1H), 6.22 (t, $J = 4.6$ Hz, 1H), 5.95 (d, $J = 5.8$ Hz, 1H), 3.89-3.86 (m, 2H), 3.79 (s, 3H), 3.78-3.71 (m, 2H), 1.32-1.27 (m, 6H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.0, 156.3, 136.3, 132.3, 130.1, 129.0, 115.0, 111.4, 109.7, 109.1, 89.9, 62.5, 55.9, 35.1, 15.4, 12.6; HRMS m/z (ESI) calculated for $\text{C}_{16}\text{H}_{19}\text{NO}_4$ $[\text{M}+\text{Na}]^+$: 312.12216; Found: 312.12238.

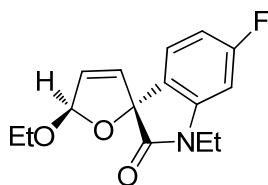
5-Ethoxy-1'-ethyl-5'-fluoro-5H-spiro[furan-2,3'-indolin]-2'-one (13o)



13o

Yellow oil, (60 mg, 72%), IR (KBr) 2979, 2936, 1734, 1614, 1498, 1375, 1202, 949, 831, 741 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.06-7.00 (m, 1H), 6.90-6.88 (m, 1H), 6.80-6.78 (m, 1H), 6.27 (s, 1H), 6.25 (d, $J = 5.9$ Hz, 1H), 5.95-5.93 (m, 1H), 3.87-3.83 (m, 2H), 3.77-3.74 (m, 2H), 1.31-1.27 (m, 6H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.5, 165.4, 144.7, 131.92, 130.45, 125.8, 123.1, 109.3, 108.8, 97.4, 89.04, 62.72, 35.21, 15.37, 12.46; HRMS m/z (ESI) calculated for $\text{C}_{15}\text{H}_{16}\text{FNO}_3$ $[\text{M}+\text{Na}]^+$: 300.10196; Found: 300.10202.

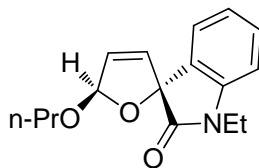
5-Ethoxy-1'-ethyl-5'-fluoro-5H-spiro[furan-2,3'-indolin]-2'-one (13p)



13p

Yellow oil, (62 mg, 74%), IR (KBr) 3086, 2979, 2936, 1734, 1614, 1498, 1375, 1202, 949, 831, 741 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.01 (t, $J = 8.8$ Hz, 1H), 6.87 (d, $J = 7.3$ Hz, 1H), 6.78-6.75 (m, 1H), 6.26 – 6.22 (m, 2H), 5.92 (d, $J = 5.8$ Hz, 1H), 3.85-3.83 (m, 2H), 3.74 (q, $J = 7.2$ Hz, 2H), 1.27 (t, $J = 6.9$ Hz, 6H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.0, 159.3, 138.8, 131.8, 130.6, 129.4, 116.4, 112.5, 109.8, 109.2, 89.5, 62.7, 35.1, 15.4, 12.5; HRMS m/z (ESI) calculated for $\text{C}_{15}\text{H}_{16}\text{FNO}_3$ $[\text{M}+\text{Na}]^+$: 300.10205; Found: 300.10196.

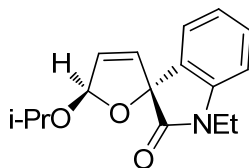
1'-Ethyl-5-propoxy-5H-spiro[furan-2,3'-indolin]-2'-one (13q)



13q

Yellow oil, (37 mg, 45%), IR (KBr) 3082, 2976, 2884, 1727, 1613, 1466, 1356, 1279, 1146, 940, 850, 745 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.31 (t, $J = 7.6$ Hz, 1H), 7.12 (d, $J = 7.3$ Hz, 1H), 7.04 (t, $J = 7.4$ Hz, 1H), 6.84 (d, $J = 7.8$ Hz, 1H), 6.25 (s, 1H), 6.21 (d, $J = 5.8$ Hz, 1H), 5.93 (d, $J = 5.8$ Hz, 1H), 3.77-3.72 (m, 4H), 1.72-1.63 (m, 2H), 1.28 (t, $J = 7.2$ Hz, 3H), 0.96 (t, $J = 7.4$ Hz, 3H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.2, 143.0, 132.2, 130.2, 130.2, 127.8, 124.5, 122.8, 109.9, 108.6, 89.6, 68.9, 35.0, 23.1, 12.6, 10.6; HRMS m/z (ESI) Calculated for $\text{C}_{16}\text{H}_{19}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 296.12714; Found: 296.12708.

1'-Ethyl-5-isopropoxy-5H-spiro[furan-2,3'-indolin]-2'-one (13r)



13r

Yellow oil, (39 mg, 47%), IR (KBr) 2972, 2921, 1730, 1649, 1525, 1486, 1364, 1209, 1107, 1022, 938, 850, 749 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.31 (d, $J = 7.4$ Hz, 1H), 7.12 (d, $J = 7.2$ Hz, 1H), 7.03 (t, $J = 7.5$ Hz, 1H), 6.83 (d, $J = 7.7$ Hz, 1H), 6.29 (s, 1H), 6.18 (d, $J = 5.8$ Hz, 1H), 5.91 (d, $J = 5.7$ Hz, 1H), 4.21-4.15 (m, 1H), 3.77-3.73 (m, 2H), 1.28 (s, 3H), 1.26-1.20 (m, 6H); ^{13}C NMR (101 MHz, CDCl_3) δ 173.2, 143.1, 131.9, 130.5, 130.2, 127.8, 124.4, 122.7, 108.5, 108.5, 89.6, 69.9, 35.0, 23.7, 22.5, 12.6; HRMS m/z (ESI) calculated for $\text{C}_{16}\text{H}_{19}\text{NO}_3$ $[\text{M}+\text{Na}]^+$: 296.12686; Found: 296.12686.

X-Ray crystal structure of **2r** (CCDC 1476097):

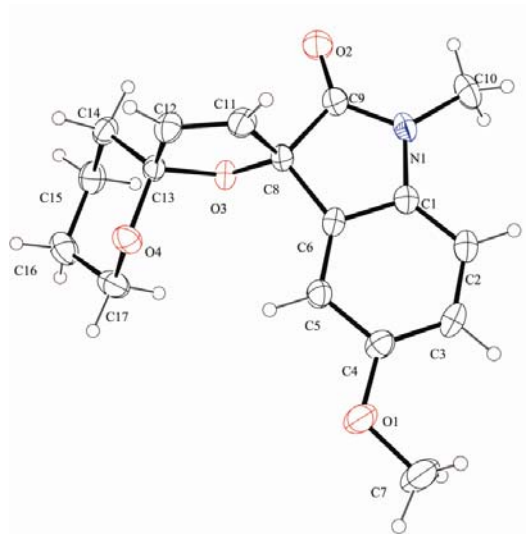


Table S1. Crystal data and structure refinement for sad1.

Identification code	sad1
Empirical formula	C ₁₇ H ₁₉ NO ₄
Formula weight	301.33
Temperature	571(2) K
Wavelength	0.71073 Å
Crystal system, space group	Monoclinic, P2(1)/n
Unit cell dimensions	a = 14.349(3) Å alpha = 90 deg. b = 7.2477(14) Å beta = 105.12(3) deg. c = 14.692(3) Å gamma = 90 deg.
Volume	1475.1(5) Å ³
Z, Calculated density	4, 1.357 Mg/m ³
Absorption coefficient	0.097 mm ⁻¹
F(000)	640
Crystal size	0.26 x 0.20 x 0.18 mm
Theta range for data collection	3.16 to 27.47 deg.
Limiting indices	-18<=h<=18, -9<=k<=9, -19<=l<=19
Reflections collected / unique	13577 / 3358 [R(int) = 0.1194]
Completeness to theta = 27.47	99.4 %
Max. and min. transmission	0.9828 and 0.9753
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	3358 / 0 / 199
Goodness-of-fit on F ²	0.845
Final R indices [I>2sigma(I)]	R ₁ = 0.0476, wR ₂ = 0.0894
R indices (all data)	R ₁ = 0.1560, wR ₂ = 0.1202
Largest diff. peak and hole	0.203 and -0.237 e.Å ⁻³

X-Ray crystal structure of **13h** (CCDC 1476096):

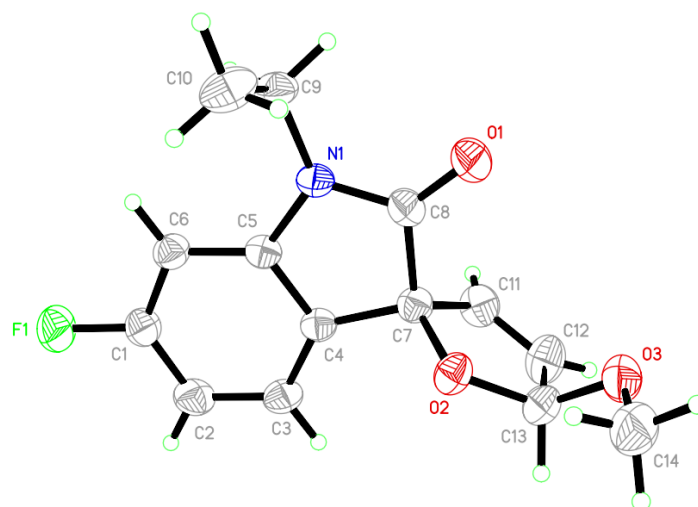
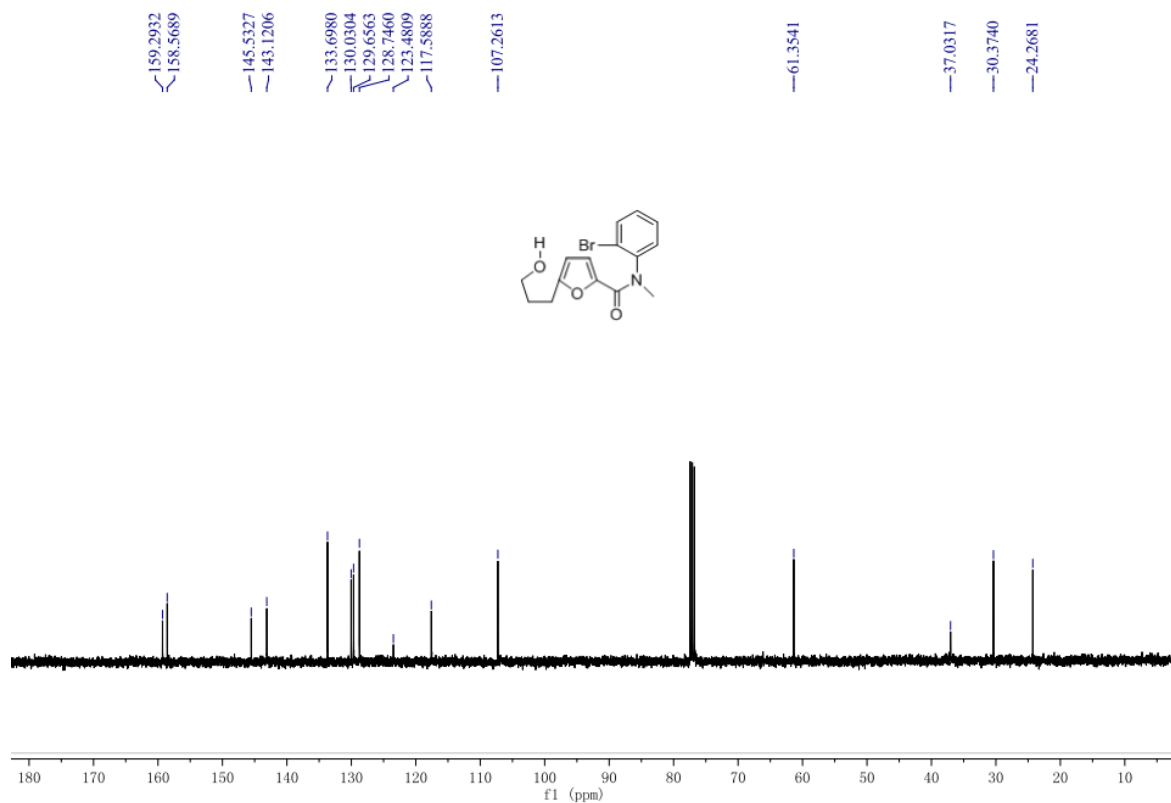
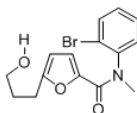
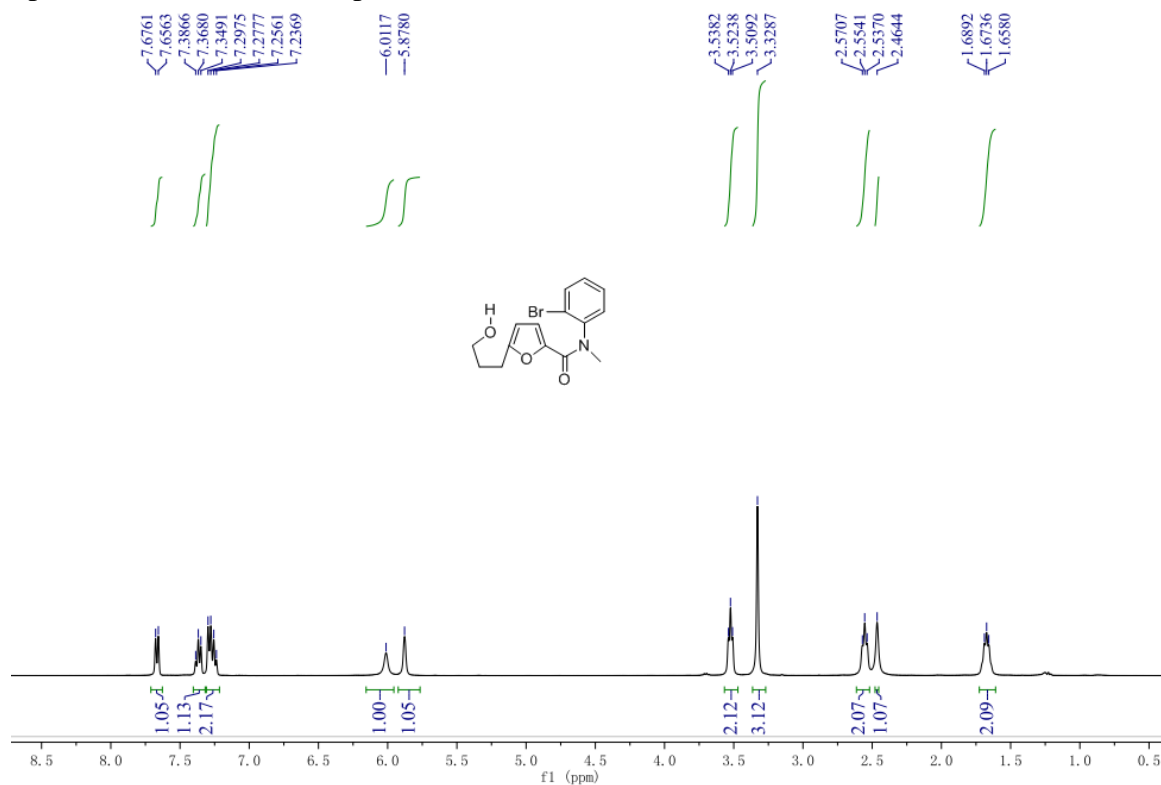
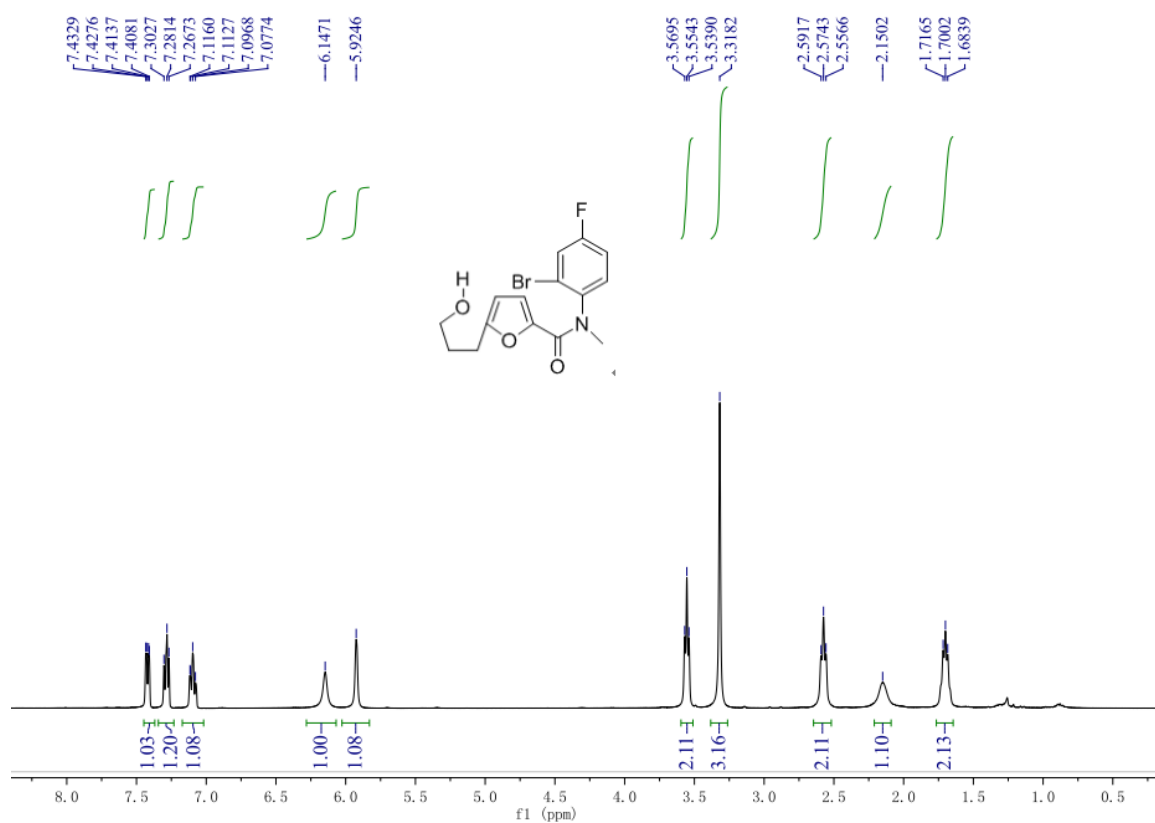


Table S2. Crystal data and structure refinement for sad.

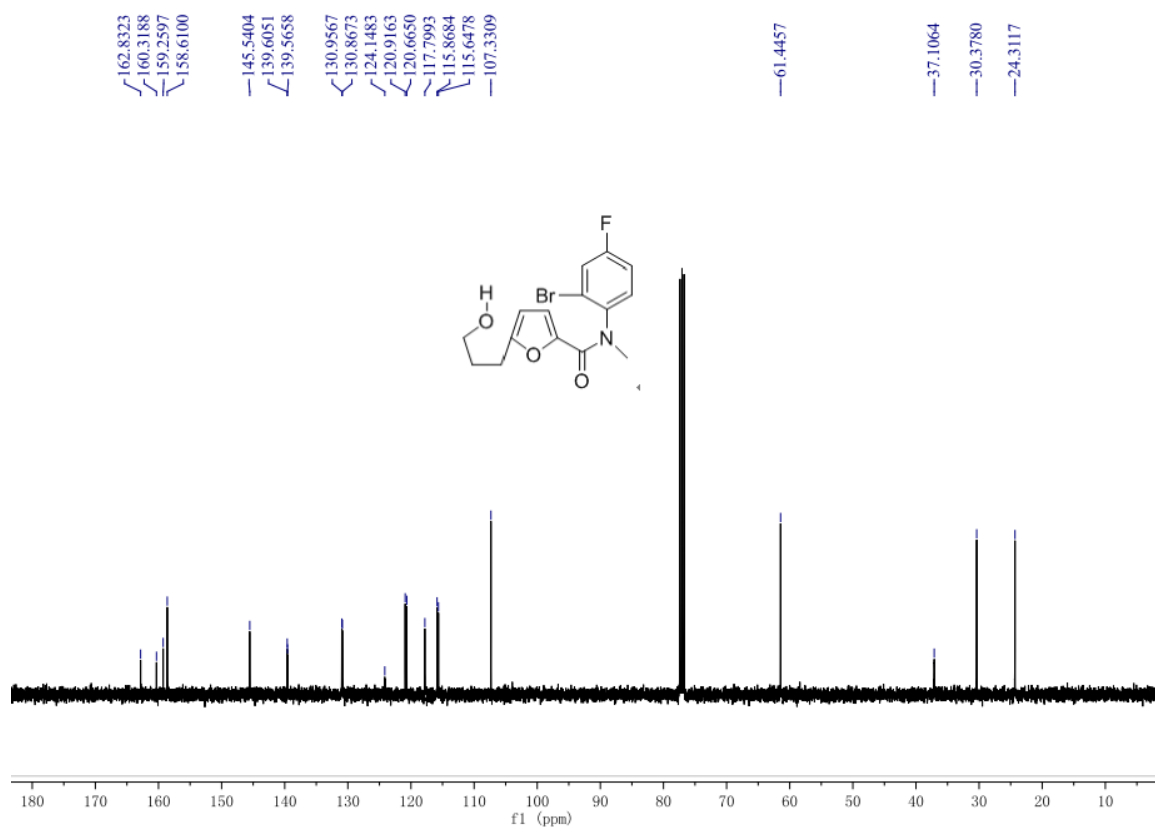
Identification code	sad
Empirical formula	C ₁₄ H ₁₄ FNO ₃
Formula weight	263.26
Temperature	293(2) K
Wavelength	0.71073 Å
Crystal system, space group	Orthorhombic, P2(1)2(1)2(1)
Unit cell dimensions	a = 8.2754(17) Å alpha = 90 deg. b = 12.082(2) Å beta = 90 deg. c = 13.332(3) Å gamma = 90 deg.
Volume	1333.0(5) Å ³
Z, Calculated density	4, 1.312 Mg/m ³
Absorption coefficient	0.102 mm ⁻¹
F(000)	552
Crystal size	0.25 x 0.20 x 0.20 mm
Theta range for data collection	3.06 to 27.45 deg.
Limiting indices	-10$\leq h \leq 10$, -15$\leq k \leq 15$, -15$\leq l \leq 17$
Reflections collected / unique	12993 / 3044 [R(int) = 0.0433]
Completeness to theta = 27.45	99.5 %
Max. and min. transmission	0.9800 and 0.9751
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	3044 / 0 / 173
Goodness-of-fit on F ²	1.008
Final R indices [I > 2sigma(I)]	R ₁ = 0.0330, wR ₂ = 0.0777
R indices (all data)	R ₁ = 0.0513, wR ₂ = 0.0902
Absolute structure parameter	-0.1(9)
Extinction coefficient	0.0069(19)
Largest diff. peak and hole	0.139 and -0.120 e.Å ⁻³

Spectra of all the new compounds

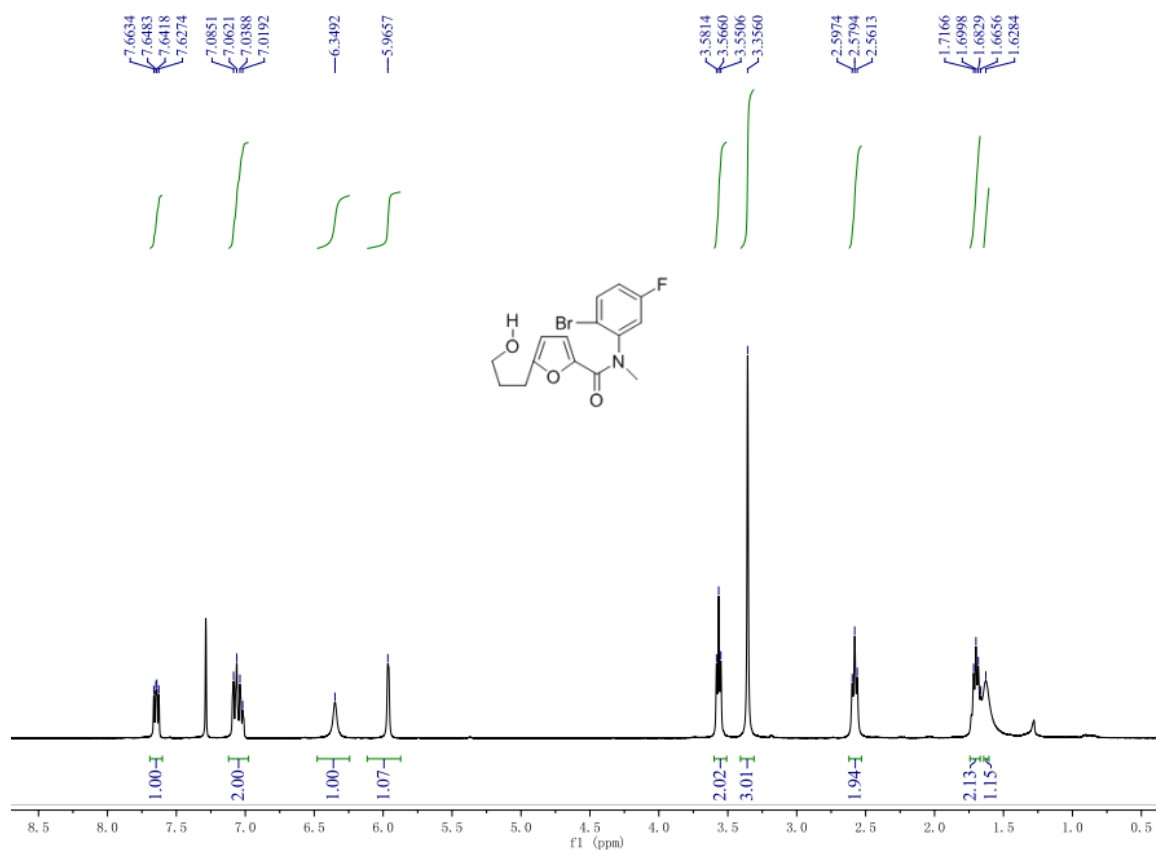




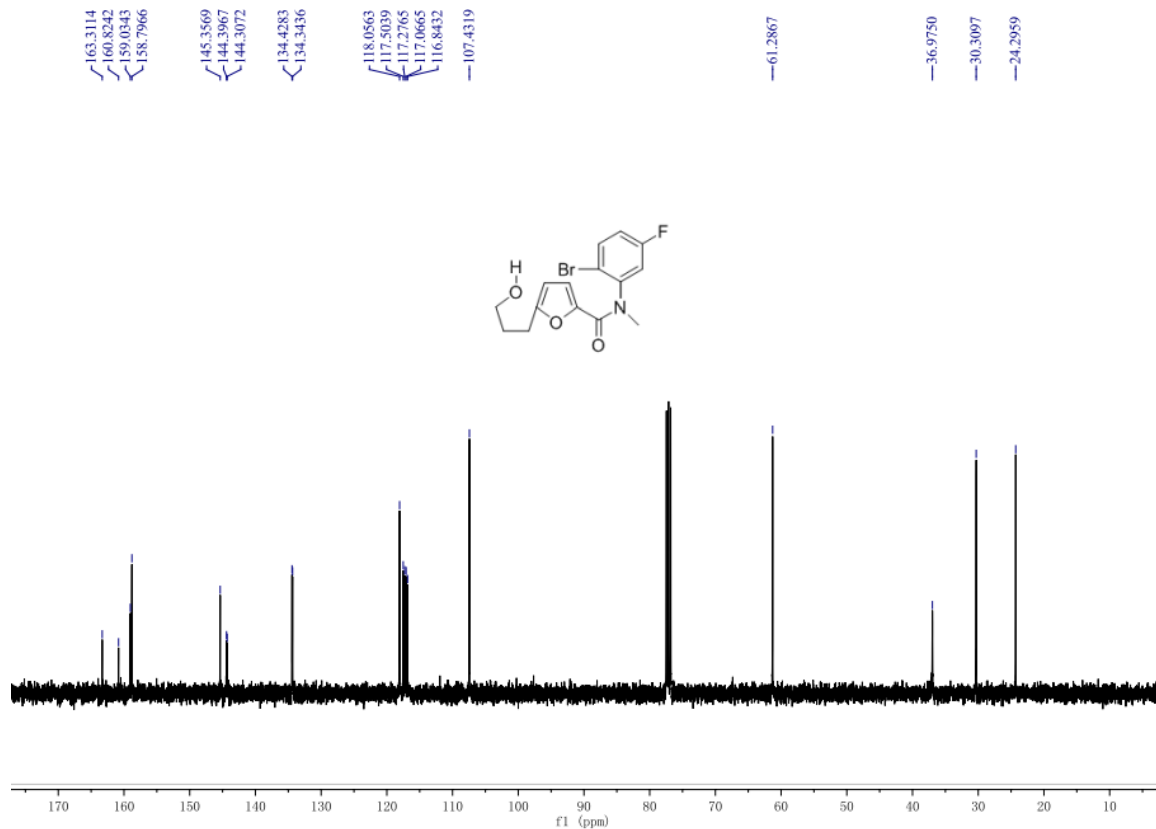
¹H NMR spectrum of **1b**



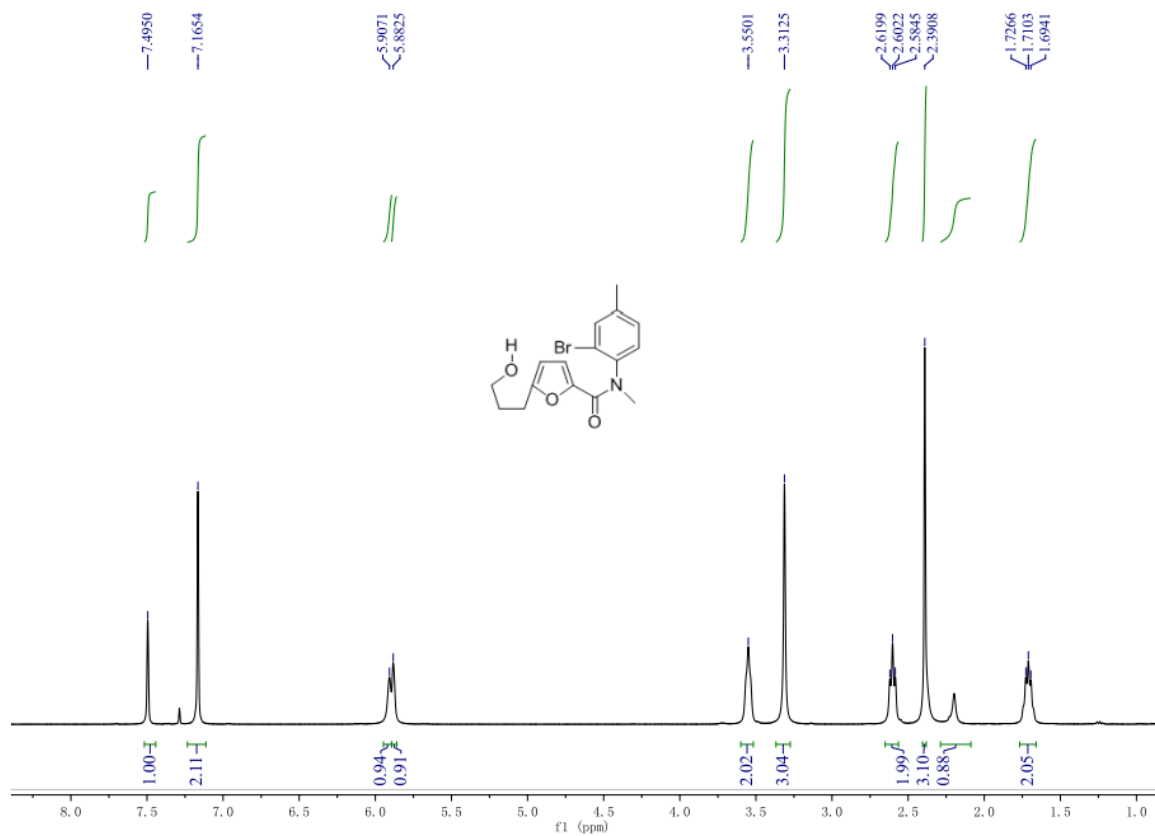
^{13}C NMR spectrum of **1b**



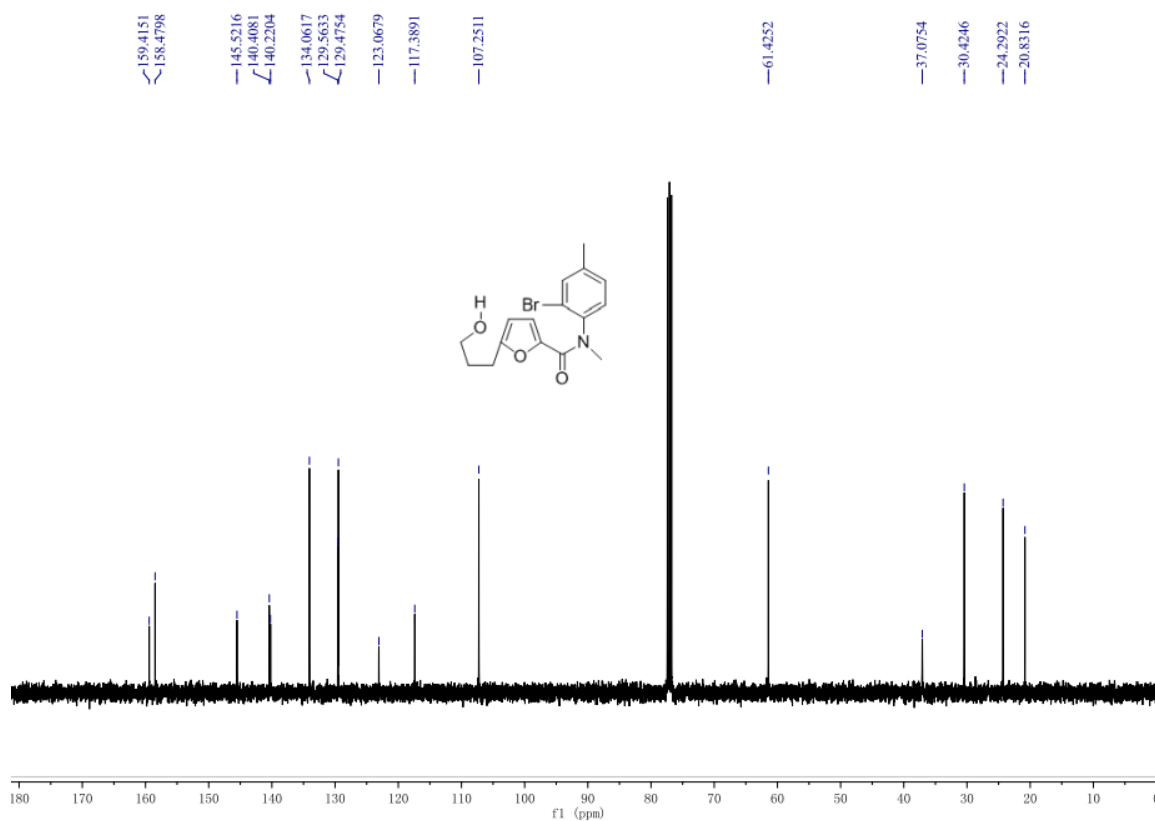
^1H NMR spectrum of **1c**



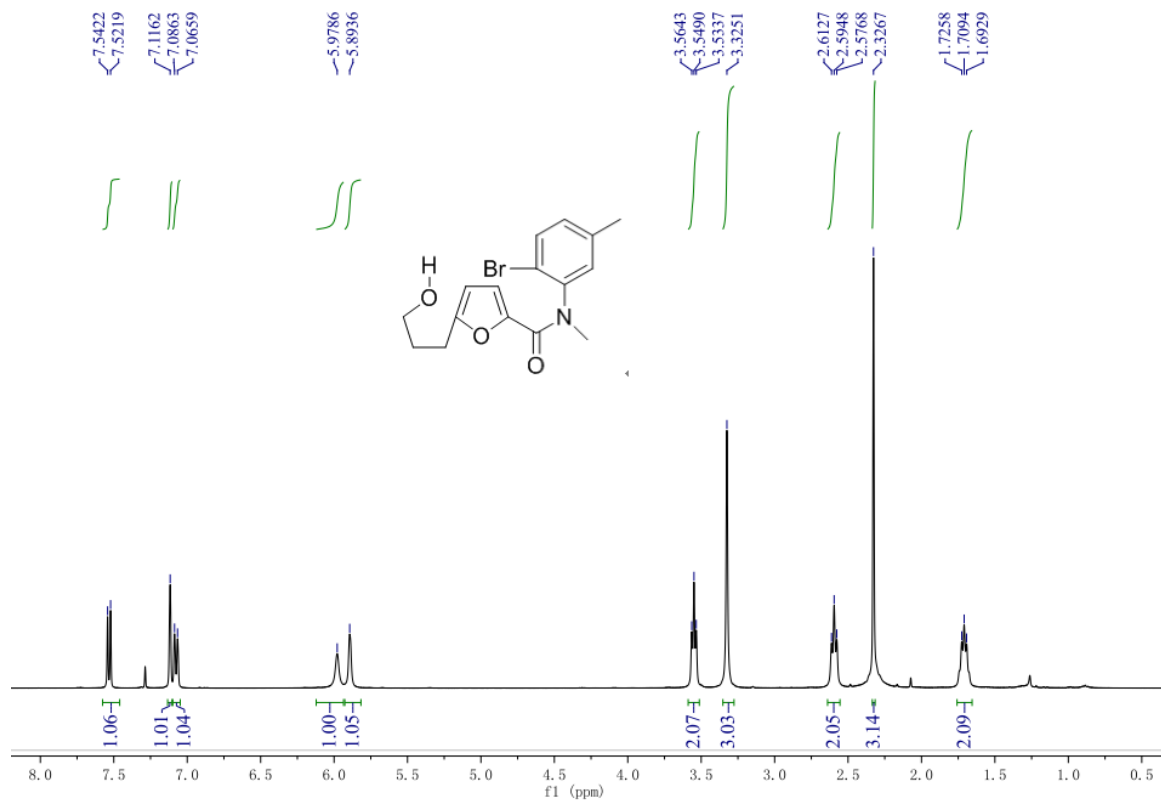
^{13}C NMR spectrum of **1c**



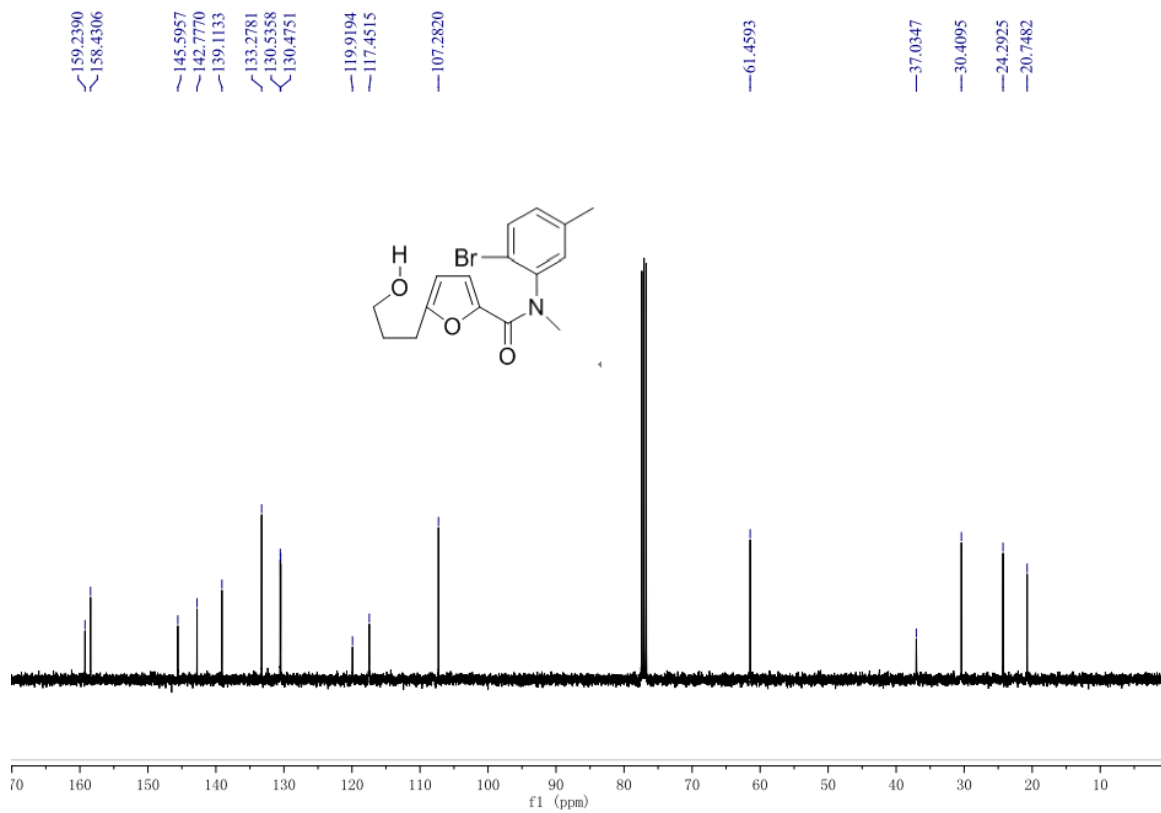
¹H NMR spectrum of **1d**



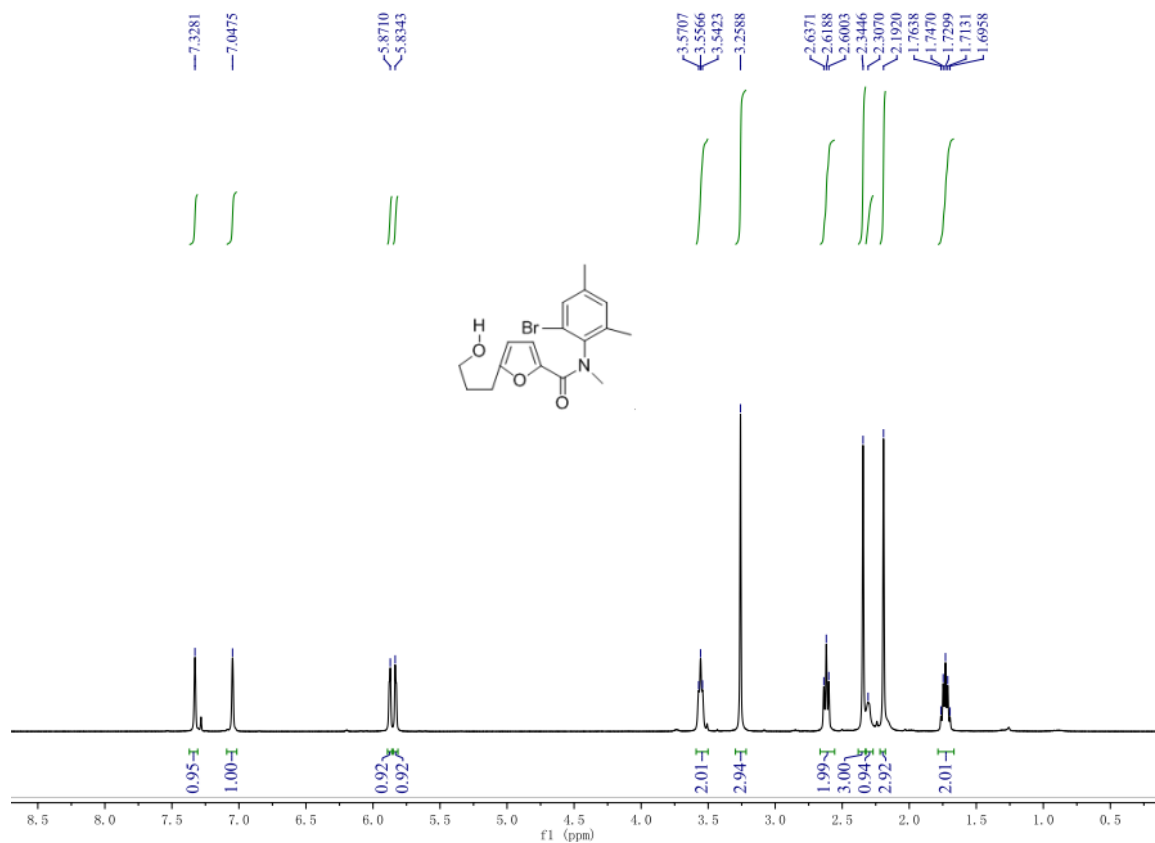
¹³C NMR spectrum of **1d**



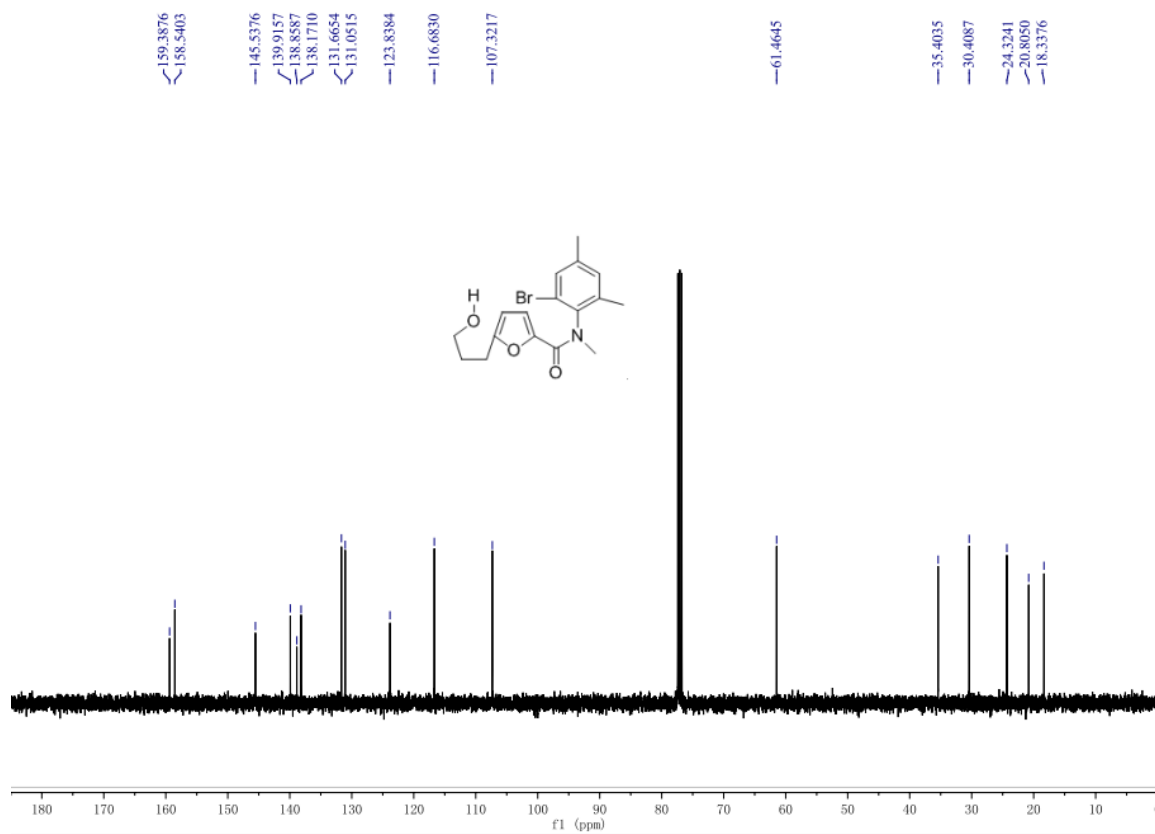
¹H NMR spectrum of **1e**



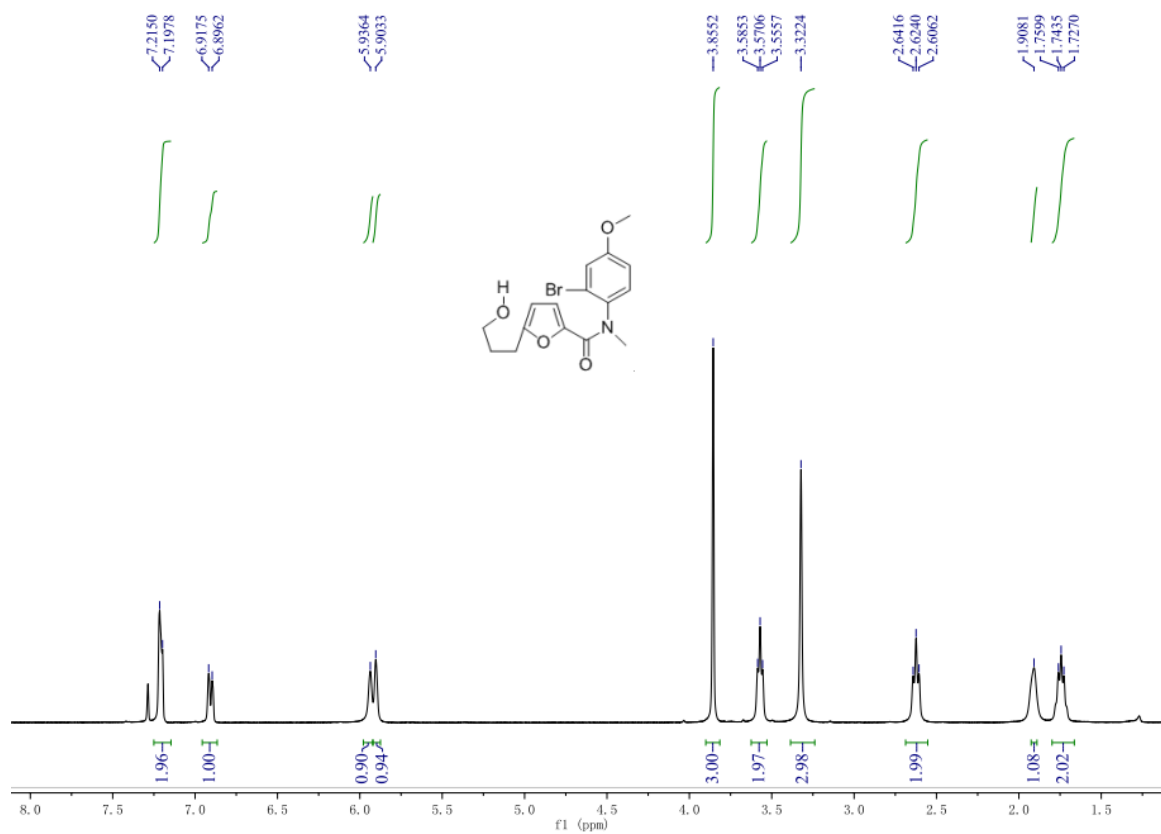
¹³C NMR spectrum of **1e**



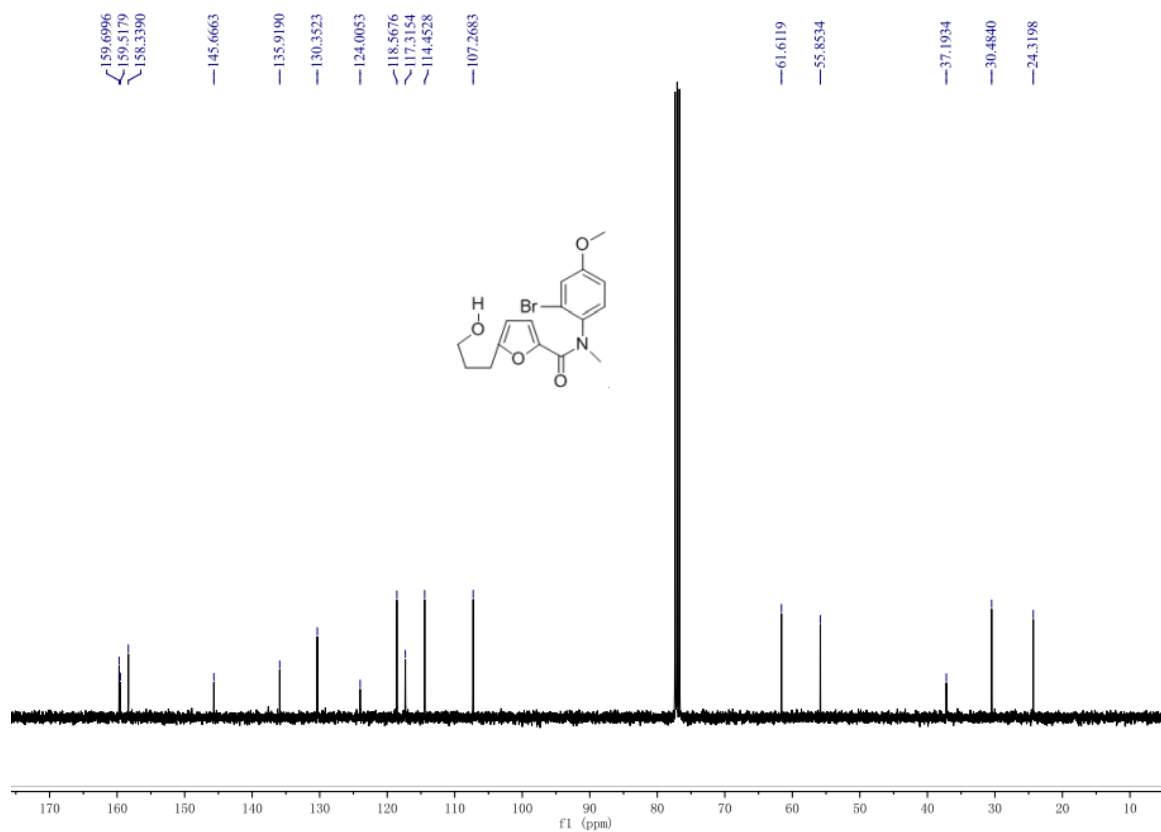
¹H NMR spectrum of **1f**



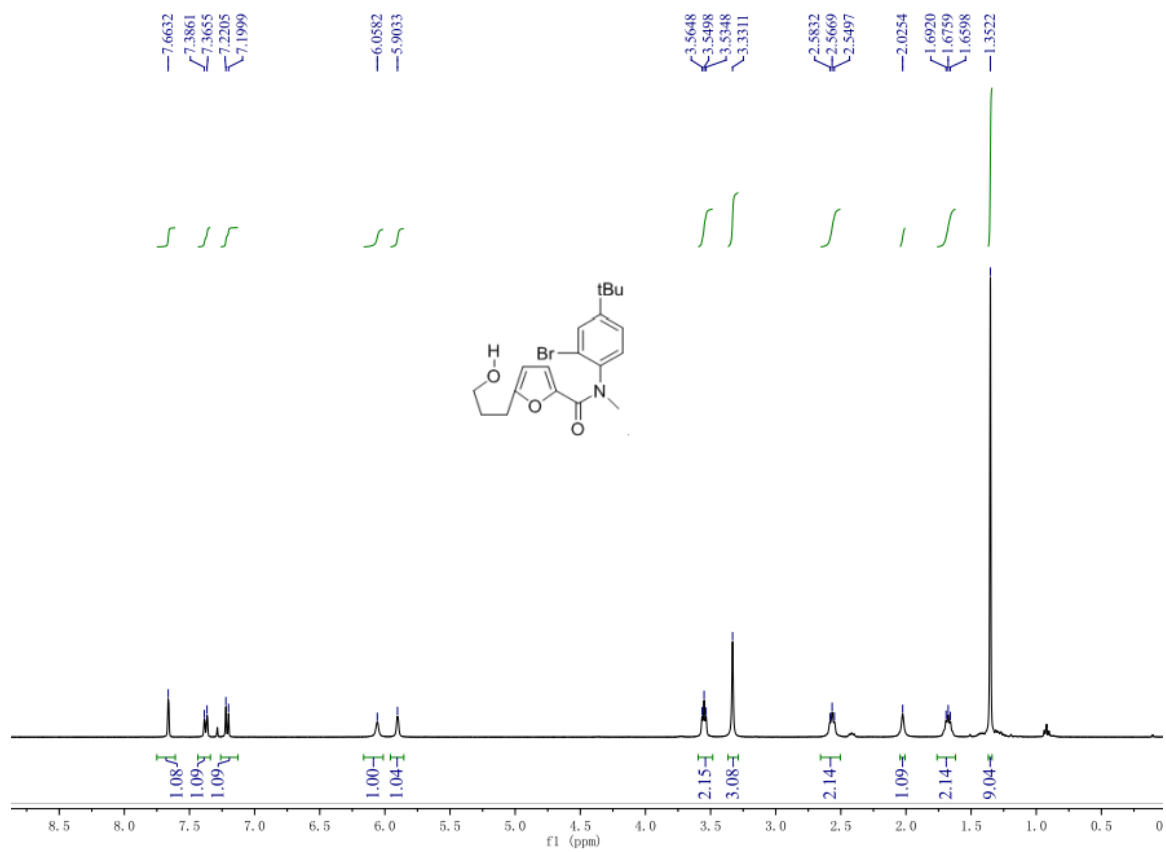
¹³C NMR spectrum of **1f**



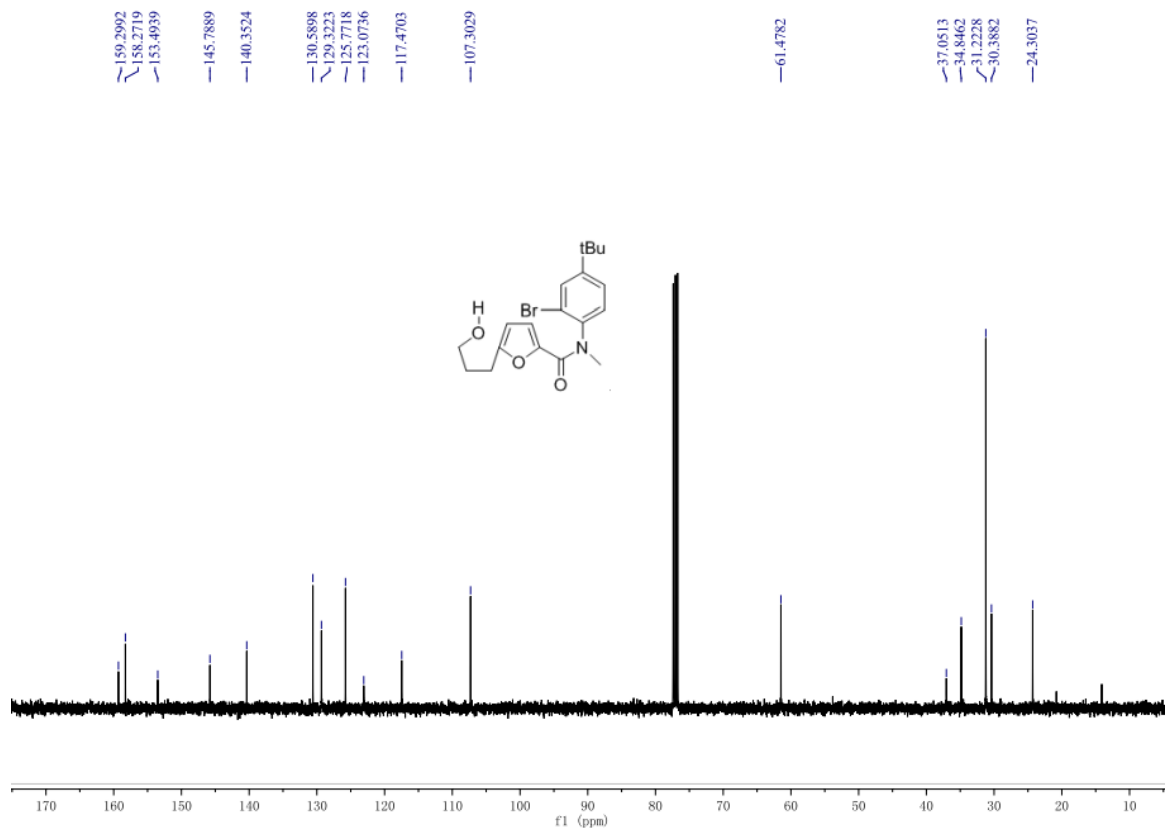
¹H NMR spectrum of **1g**



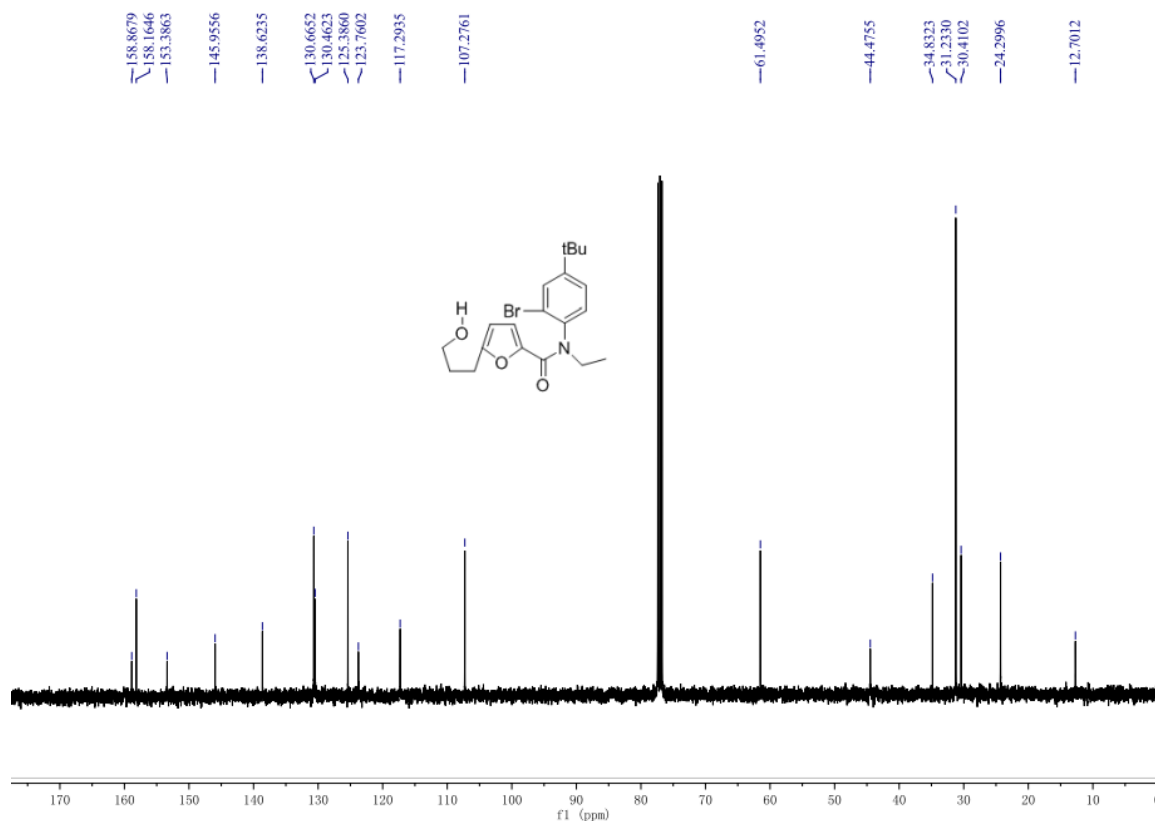
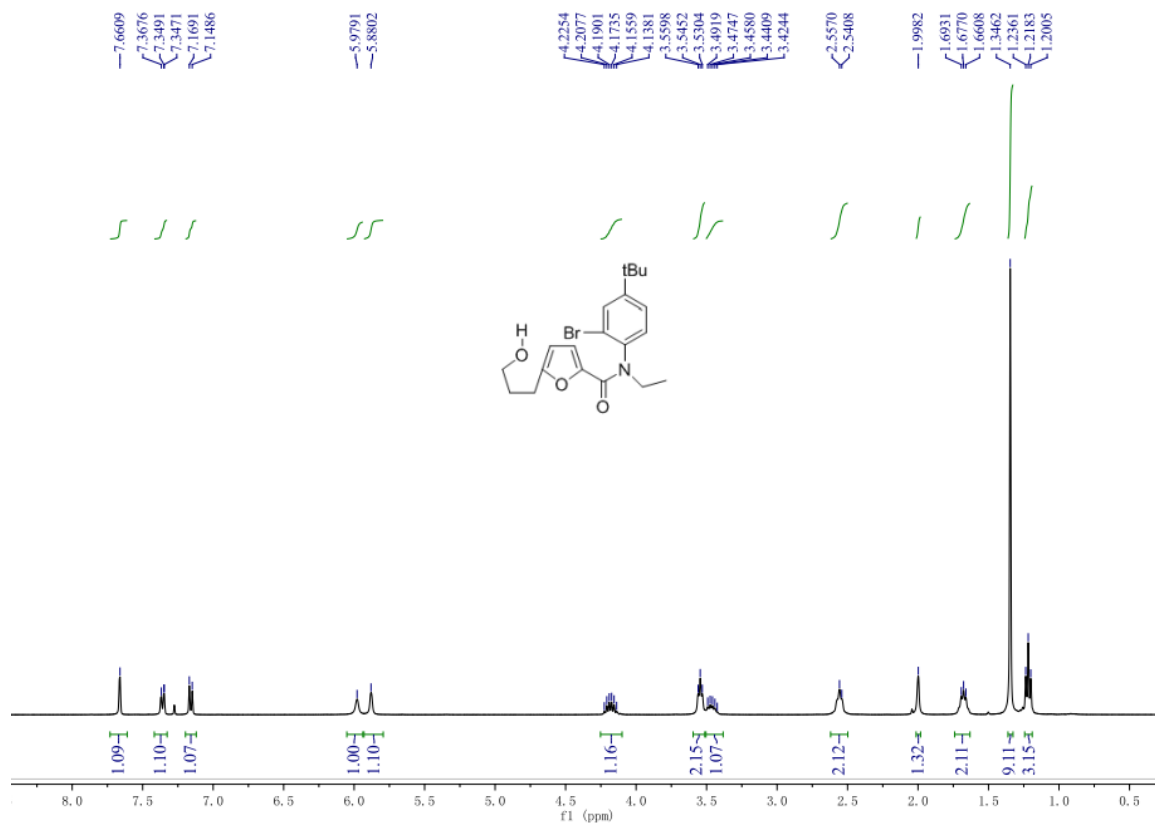
¹³C NMR spectrum of **1g**

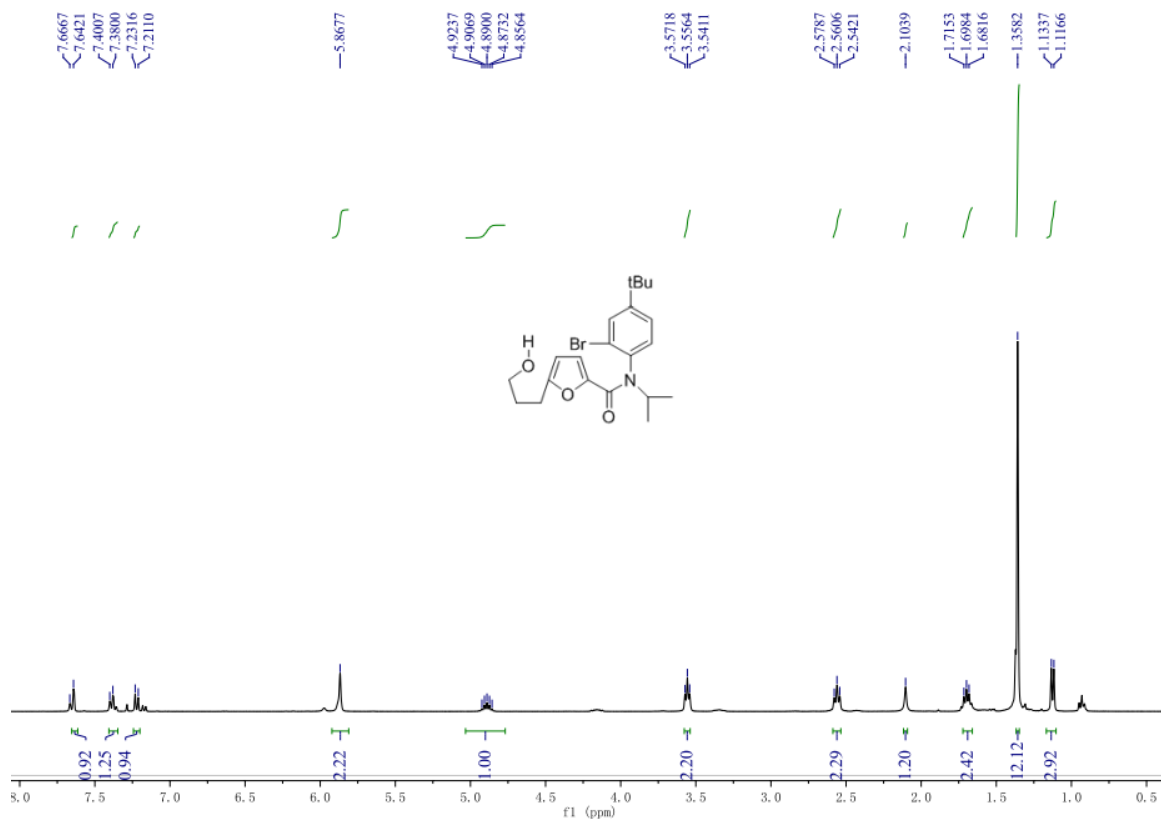


^1H NMR spectrum of **1h**

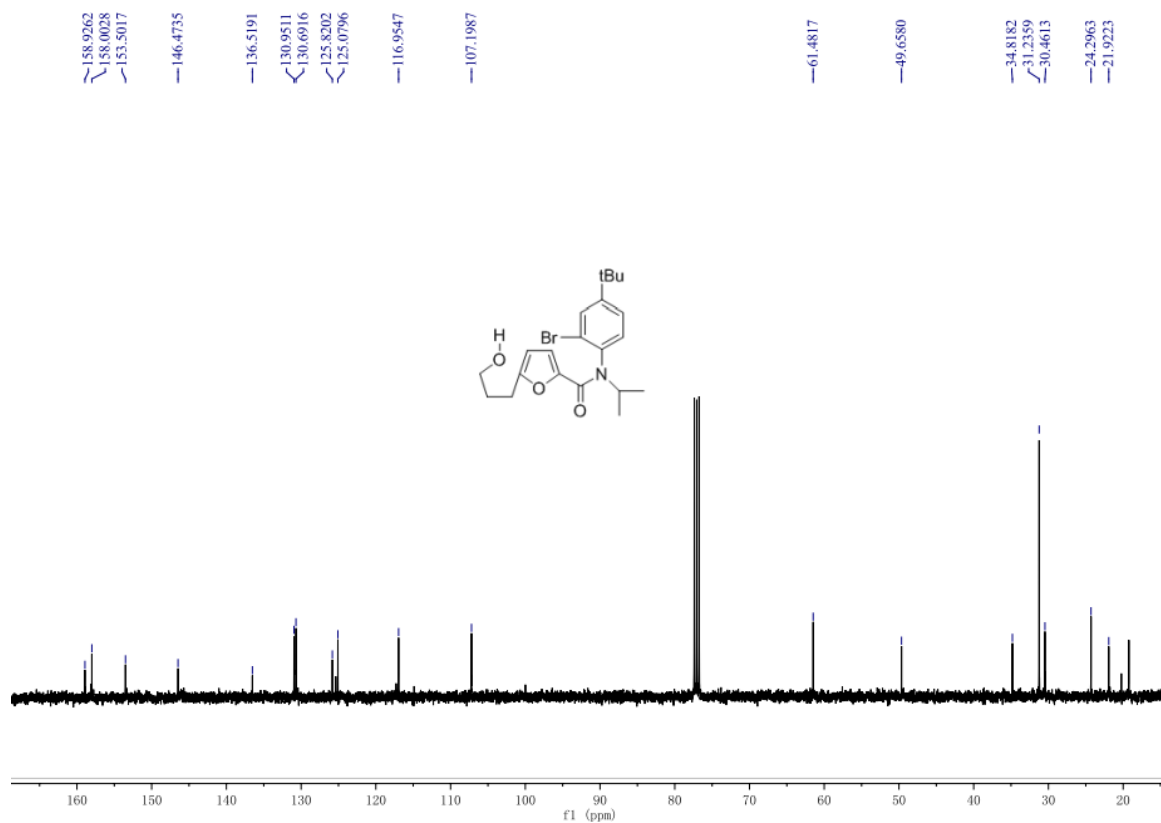


^{13}C NMR spectrum of **1h**

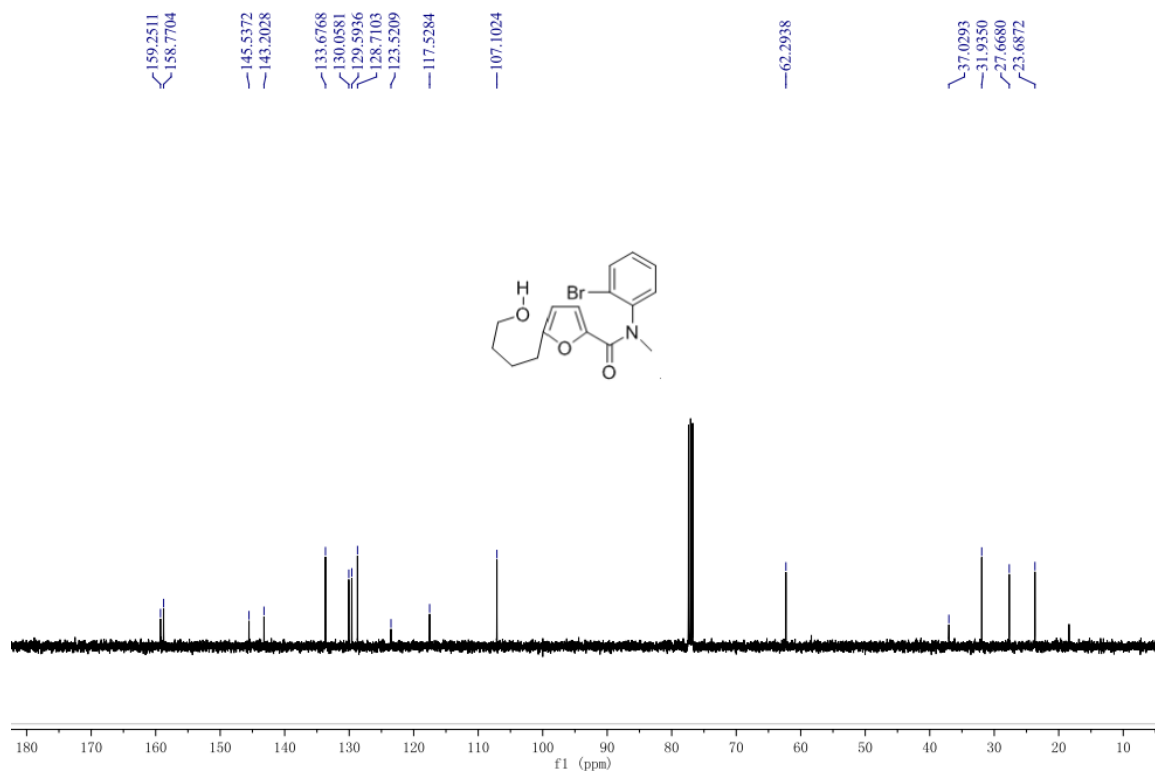
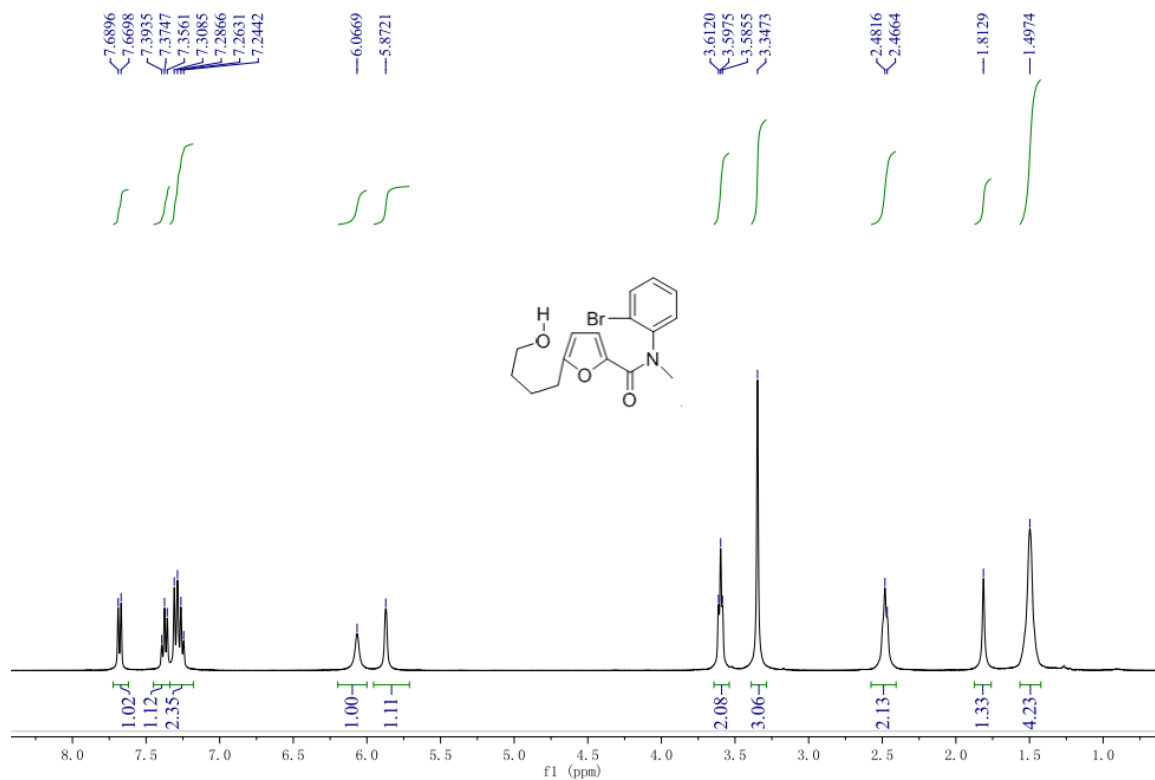


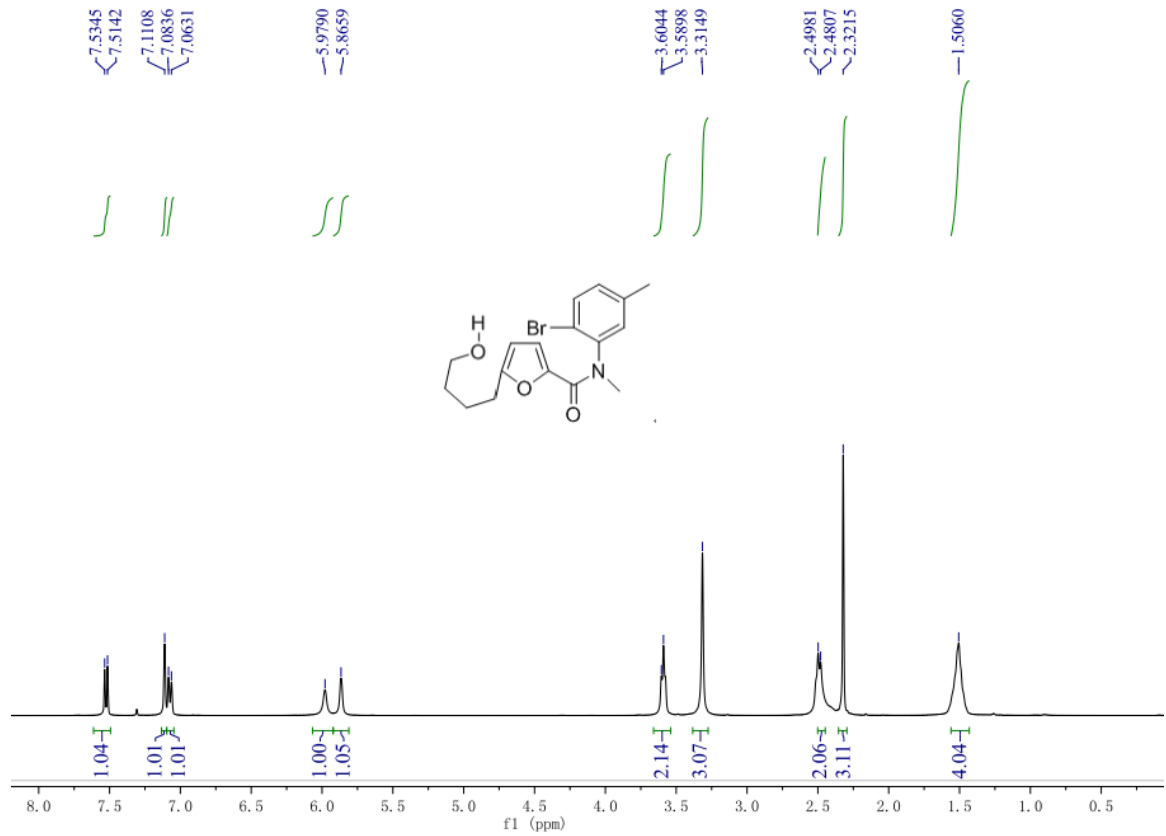


¹H NMR spectrum of **1k**

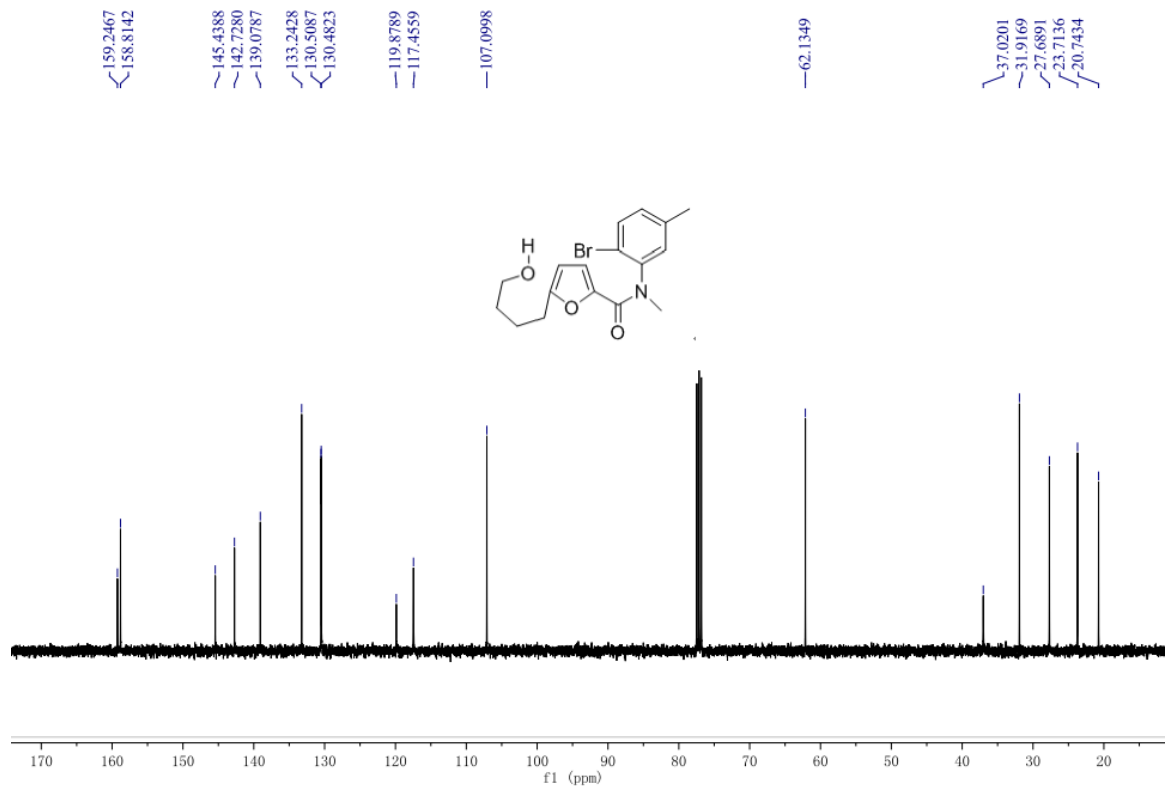


¹³C NMR spectrum of **1k**

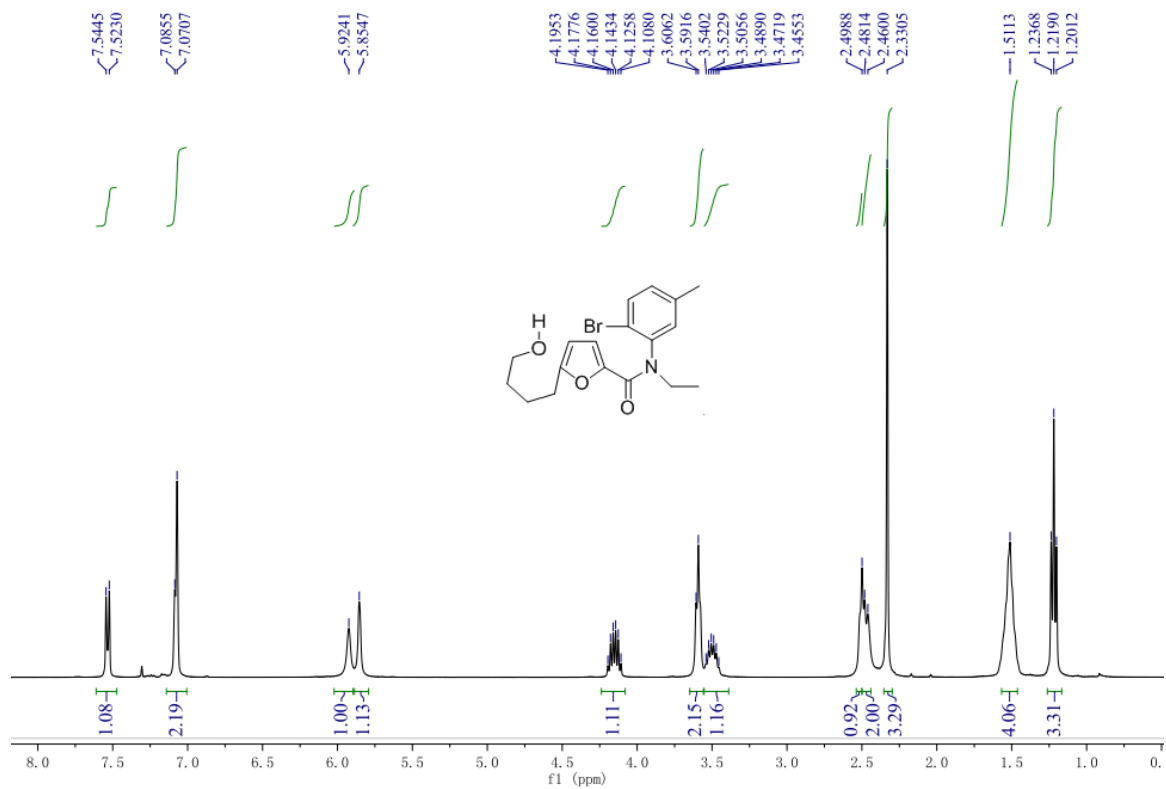




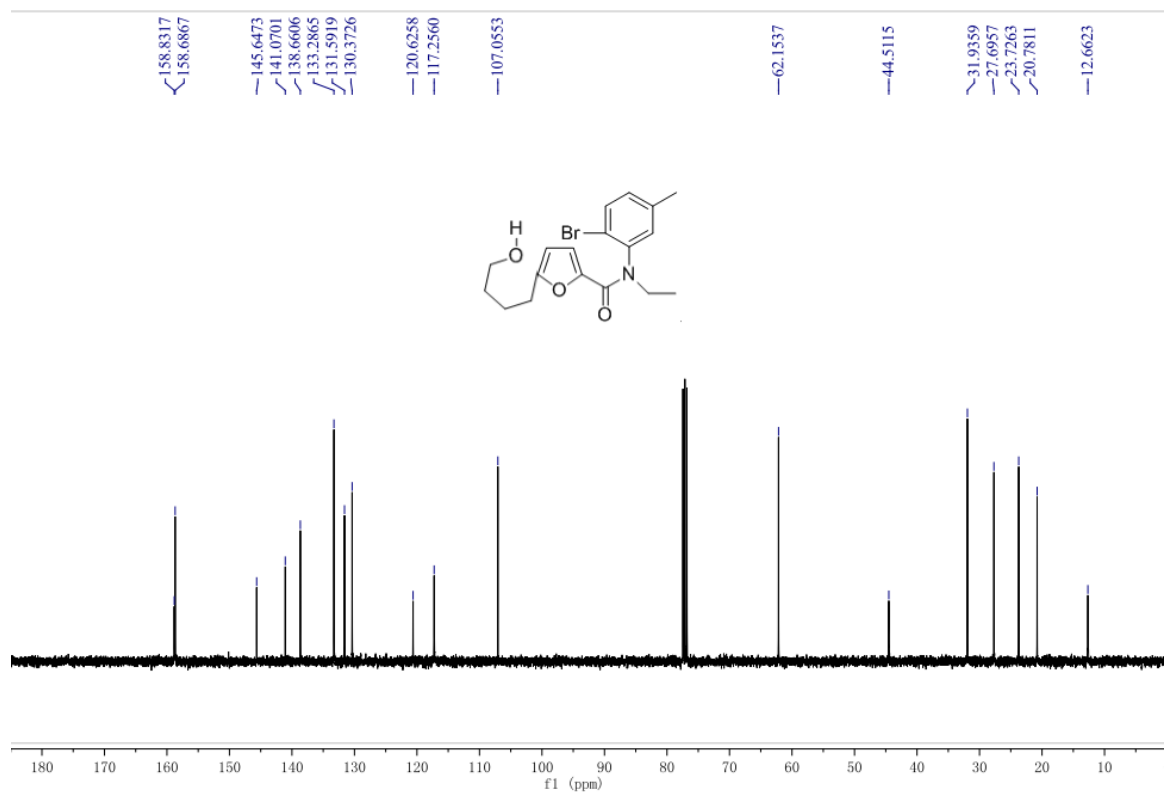
¹H NMR spectrum of **1m**



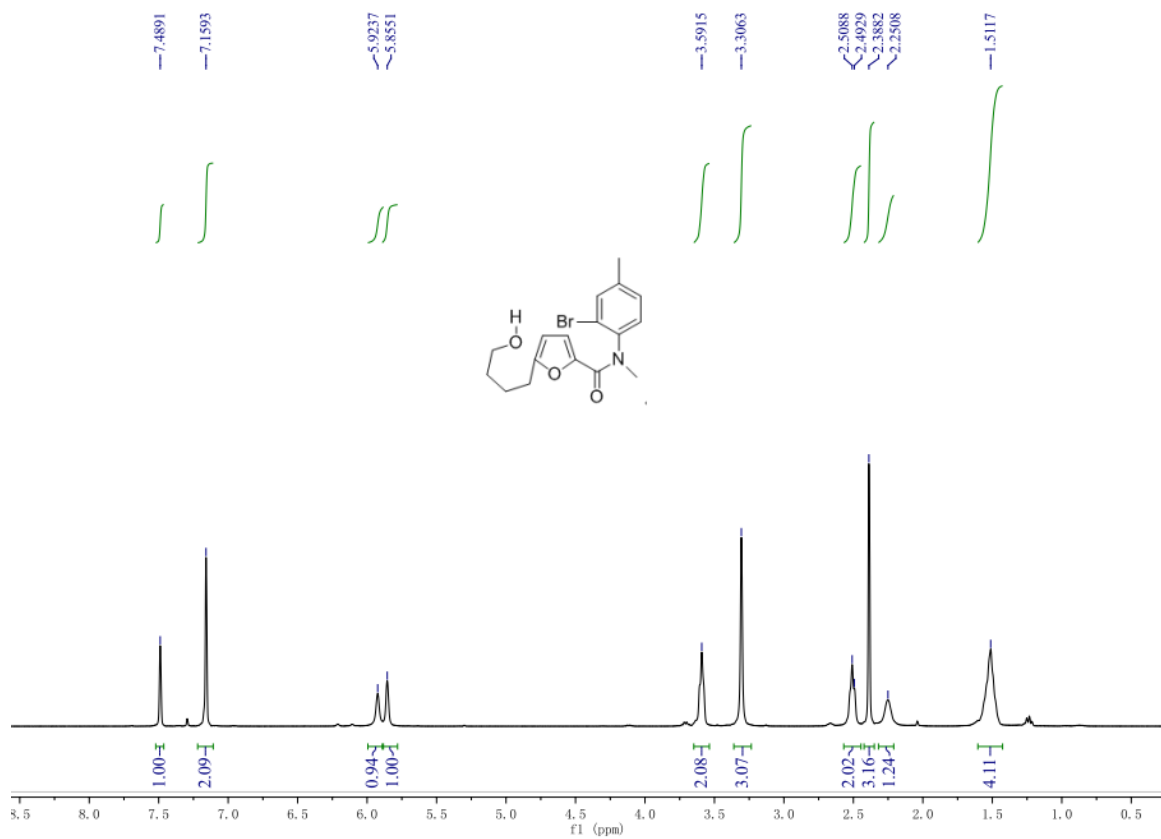
¹³C NMR spectrum of **1m**



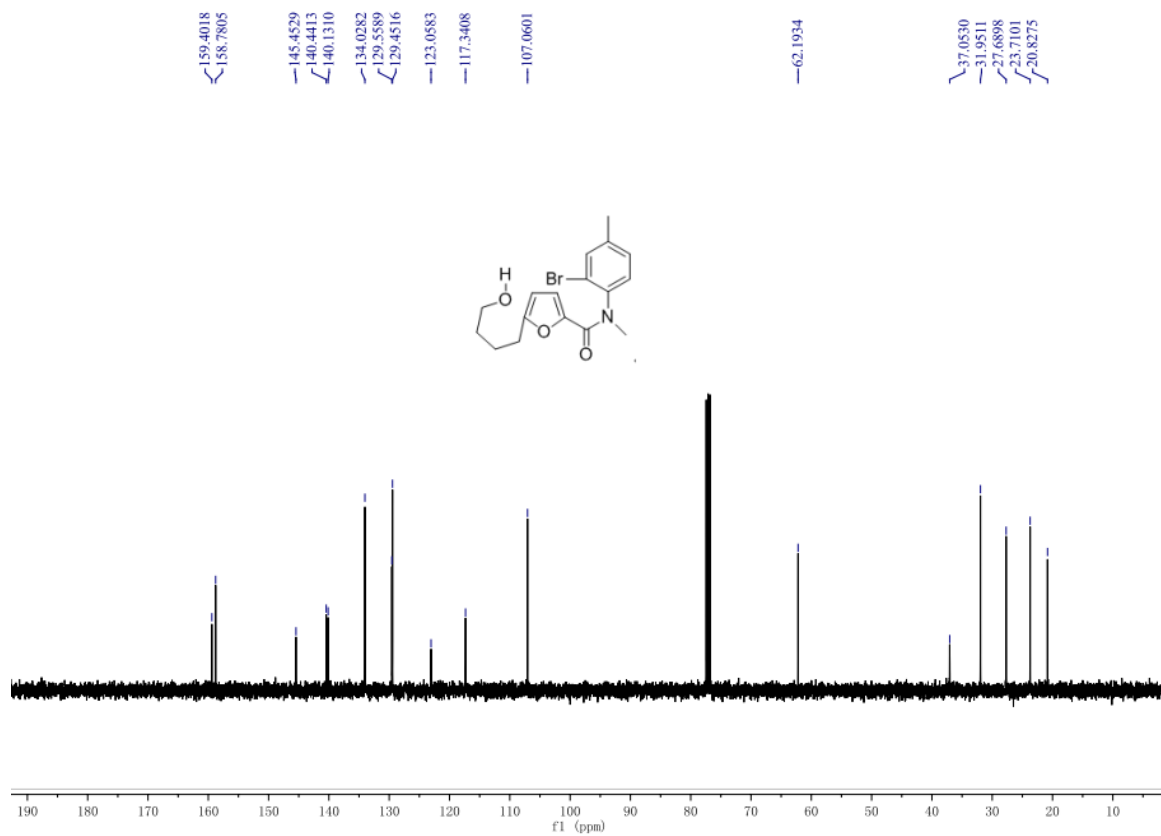
¹H NMR spectrum of **1n**



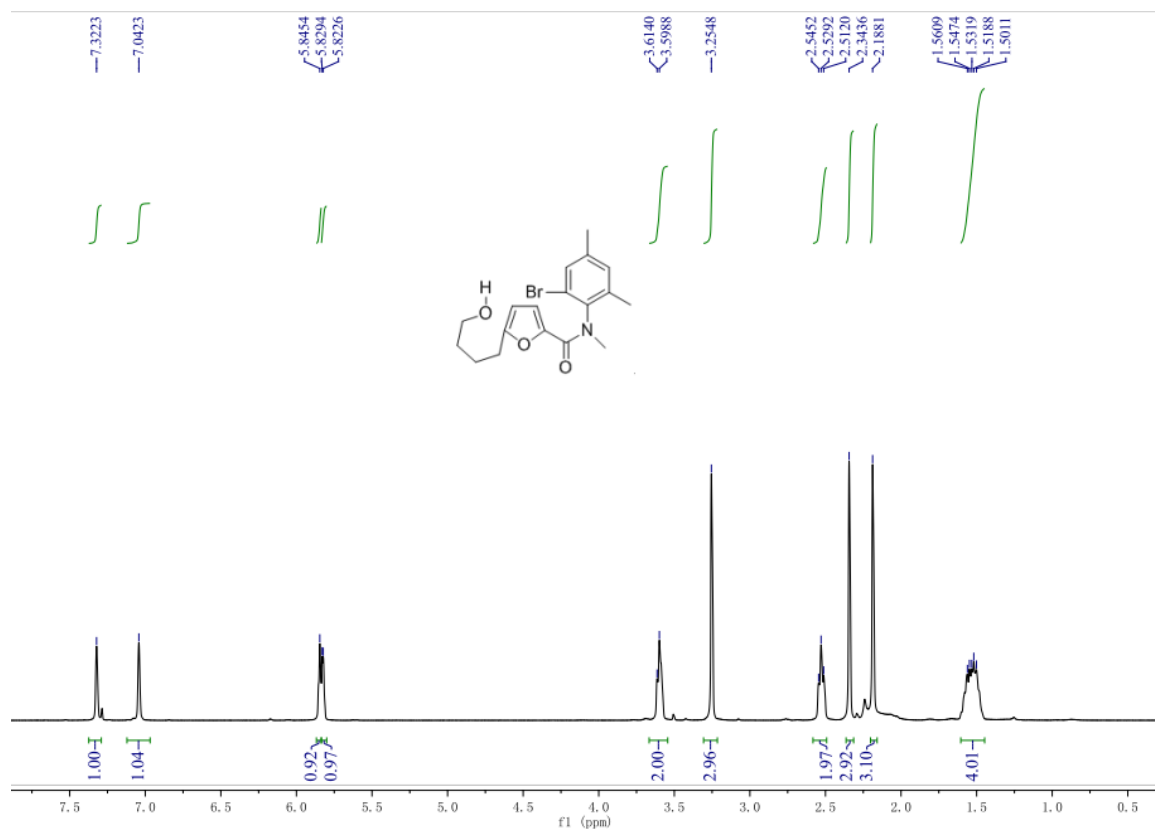
¹³C NMR spectrum of **1n**



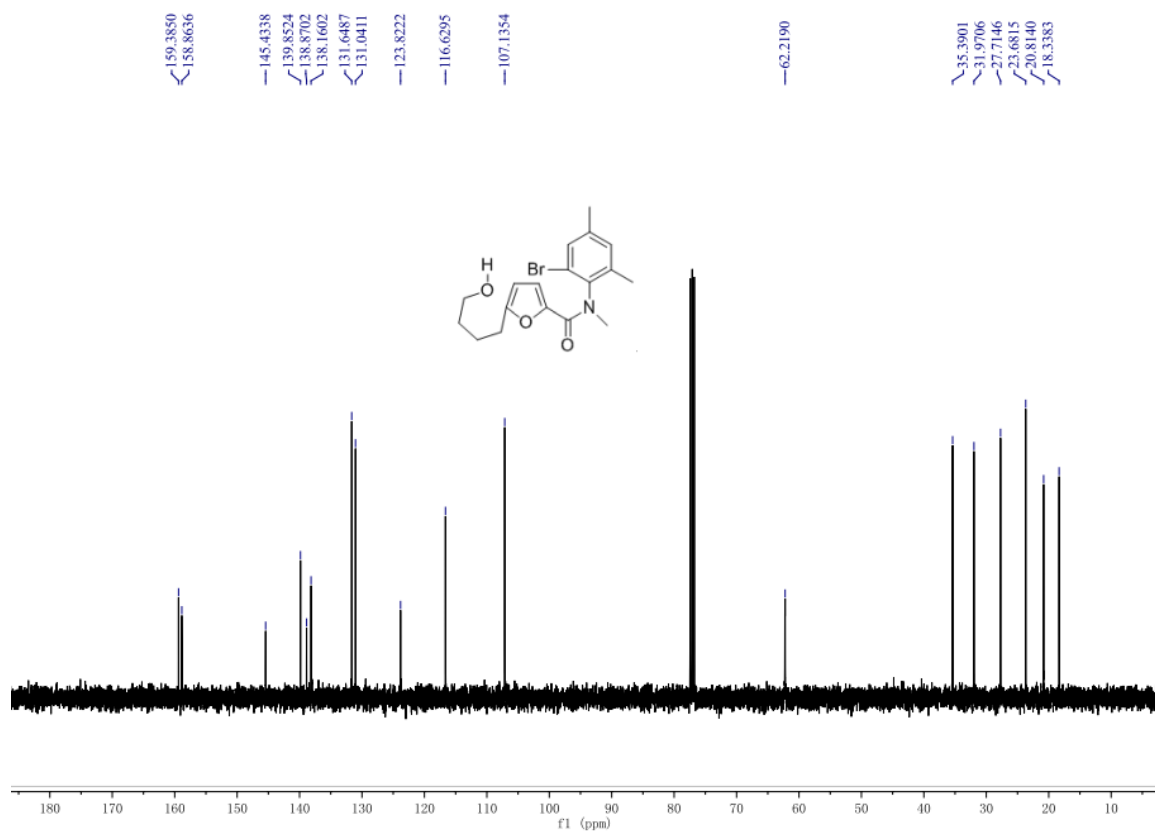
¹H NMR spectrum of **10**



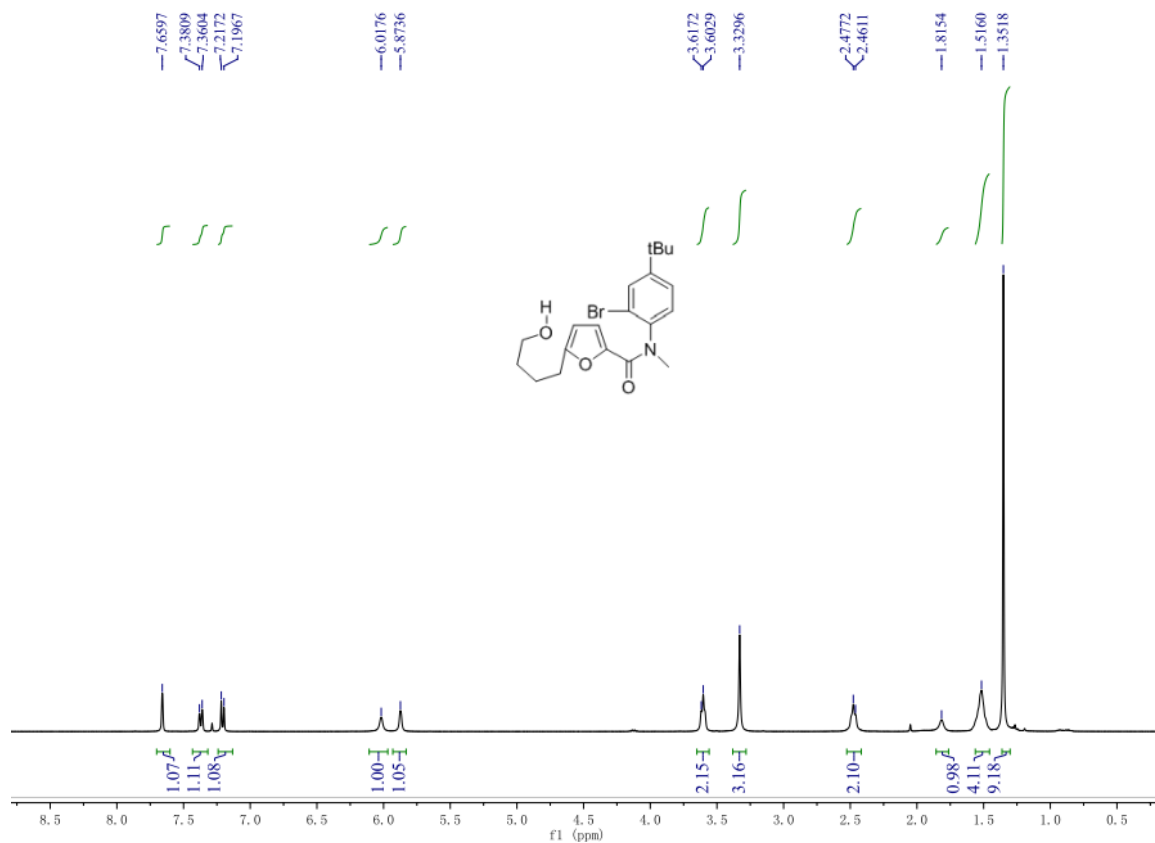
¹³C NMR spectrum of **10**



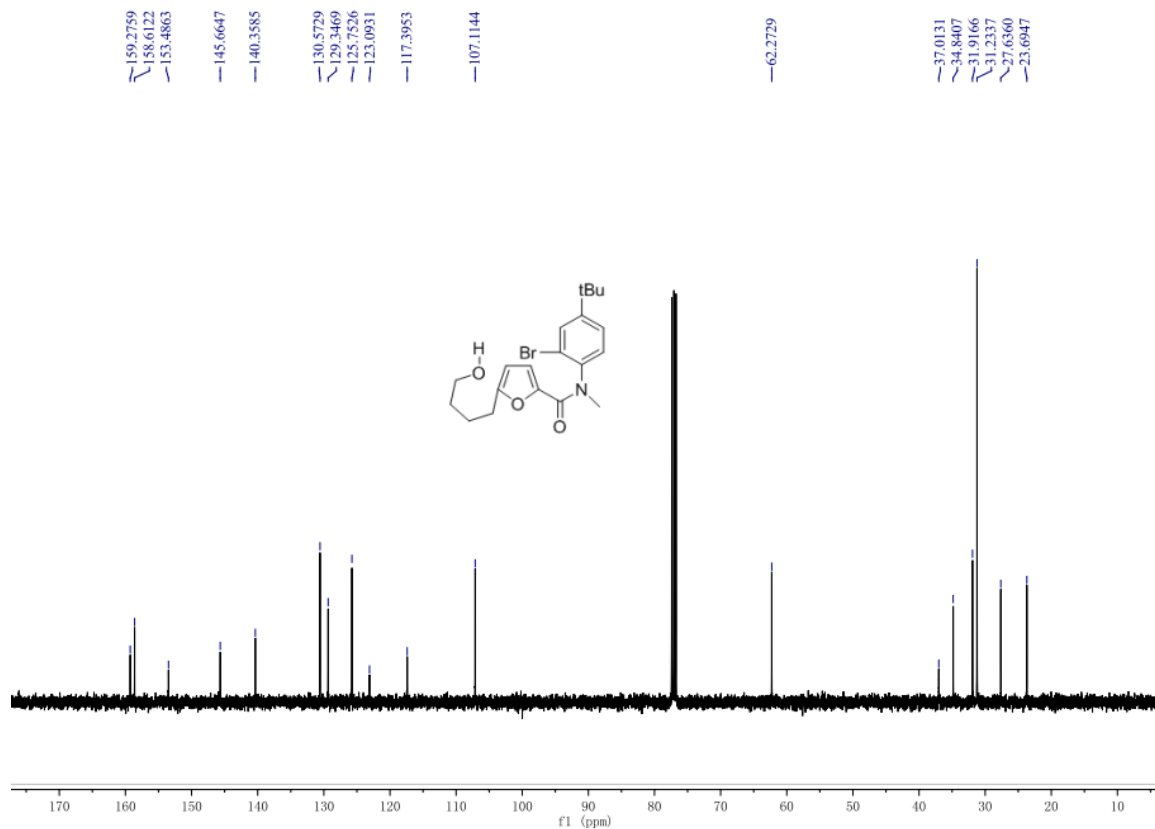
^1H NMR spectrum of **1p**



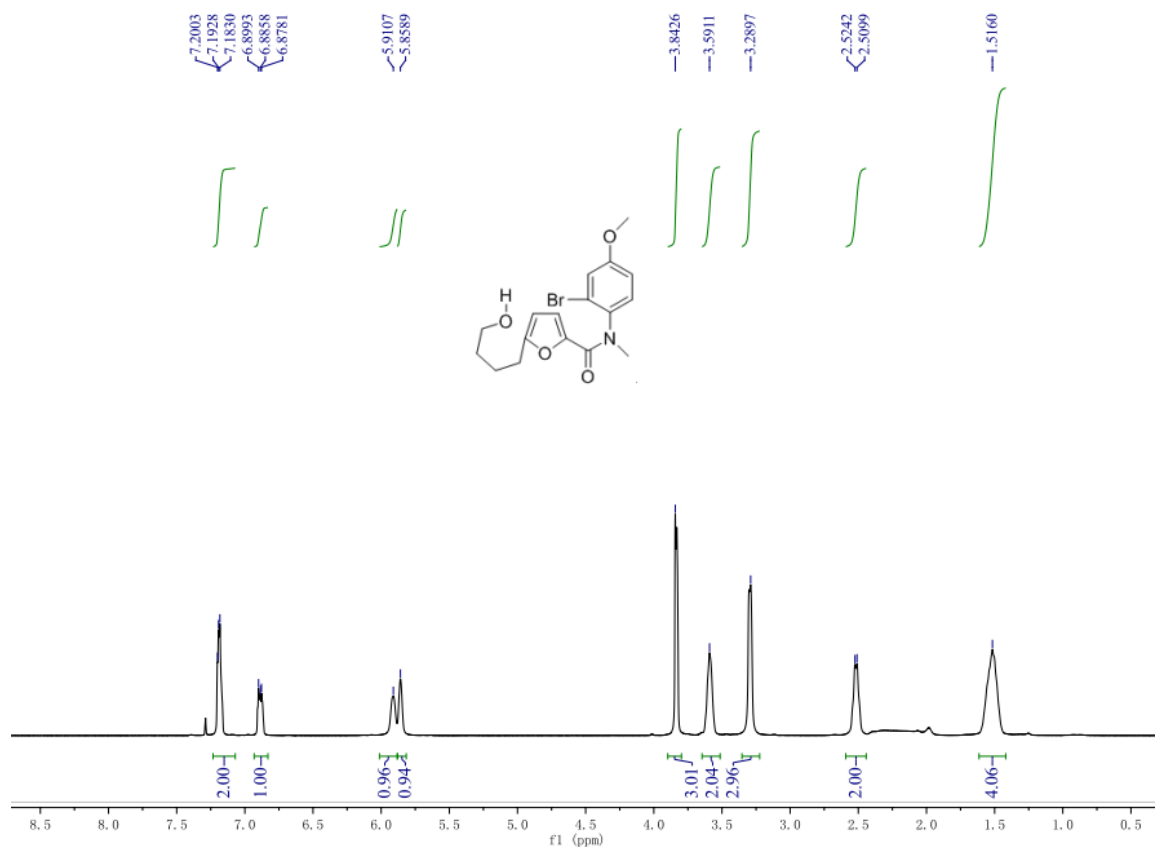
^{13}C NMR spectrum of **1p**



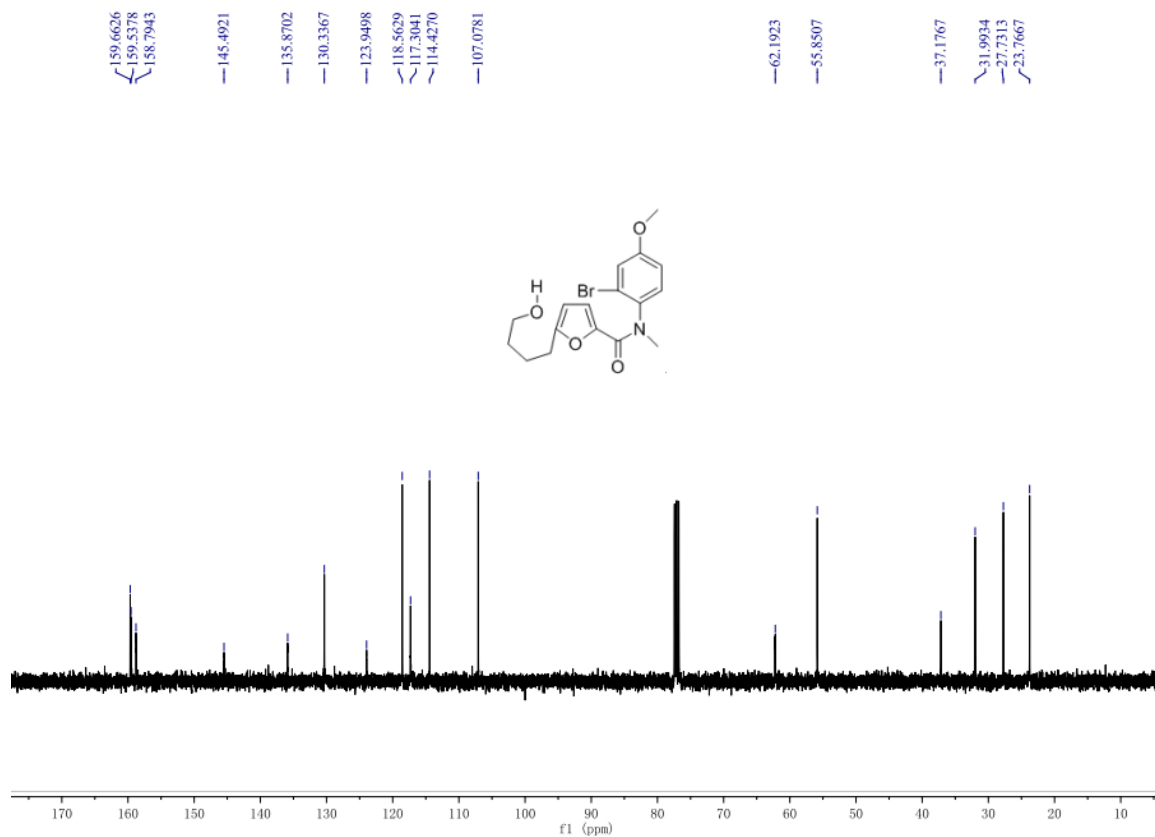
^1H NMR spectrum of **1q**



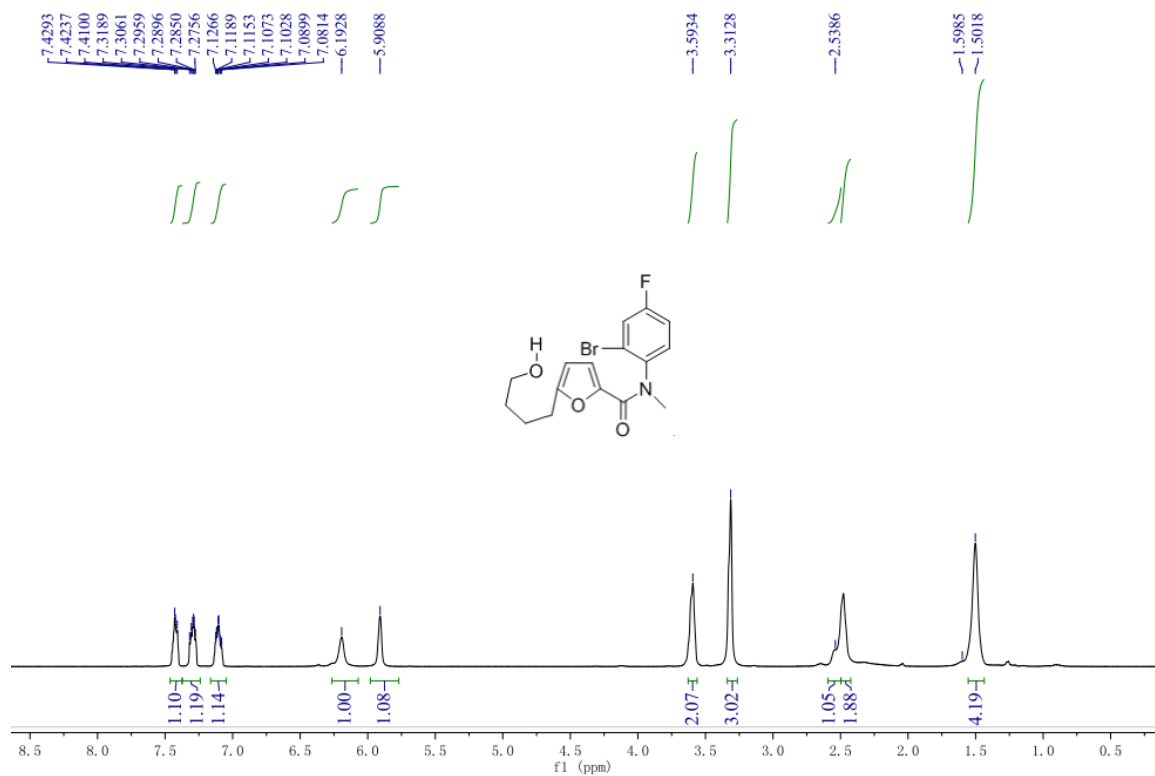
^{13}C NMR spectrum of **1q**



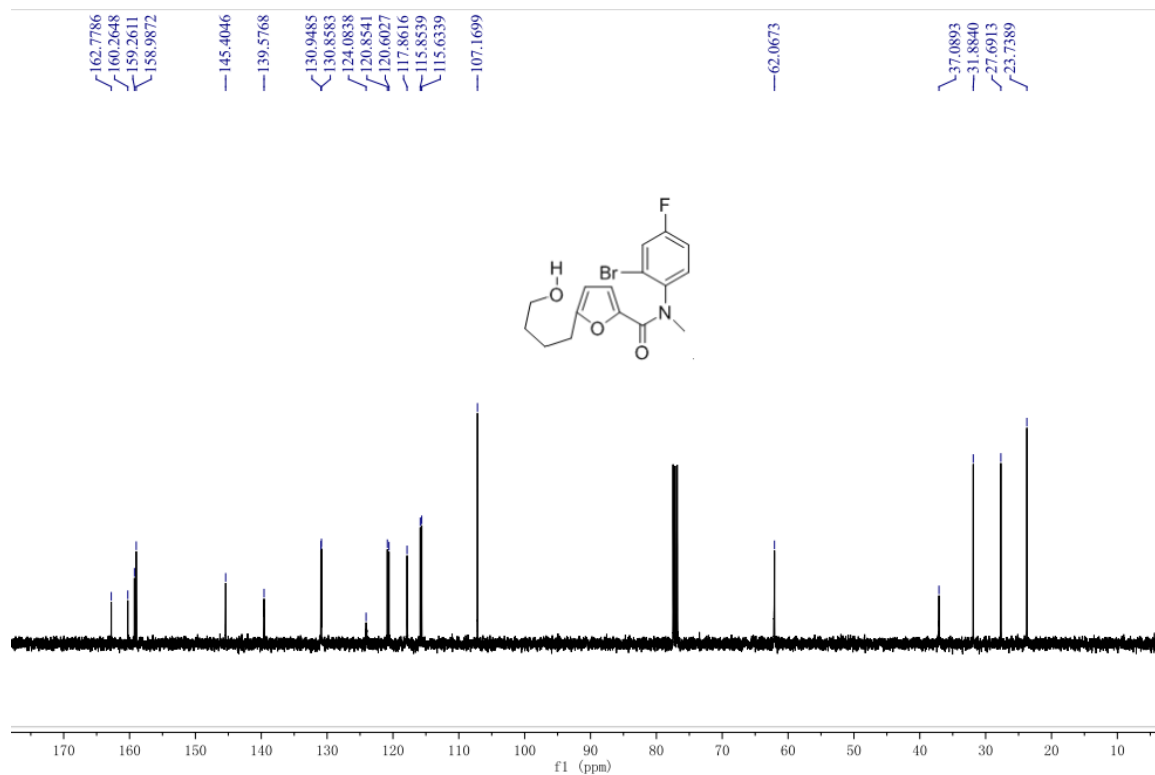
¹H NMR spectrum of **1r**



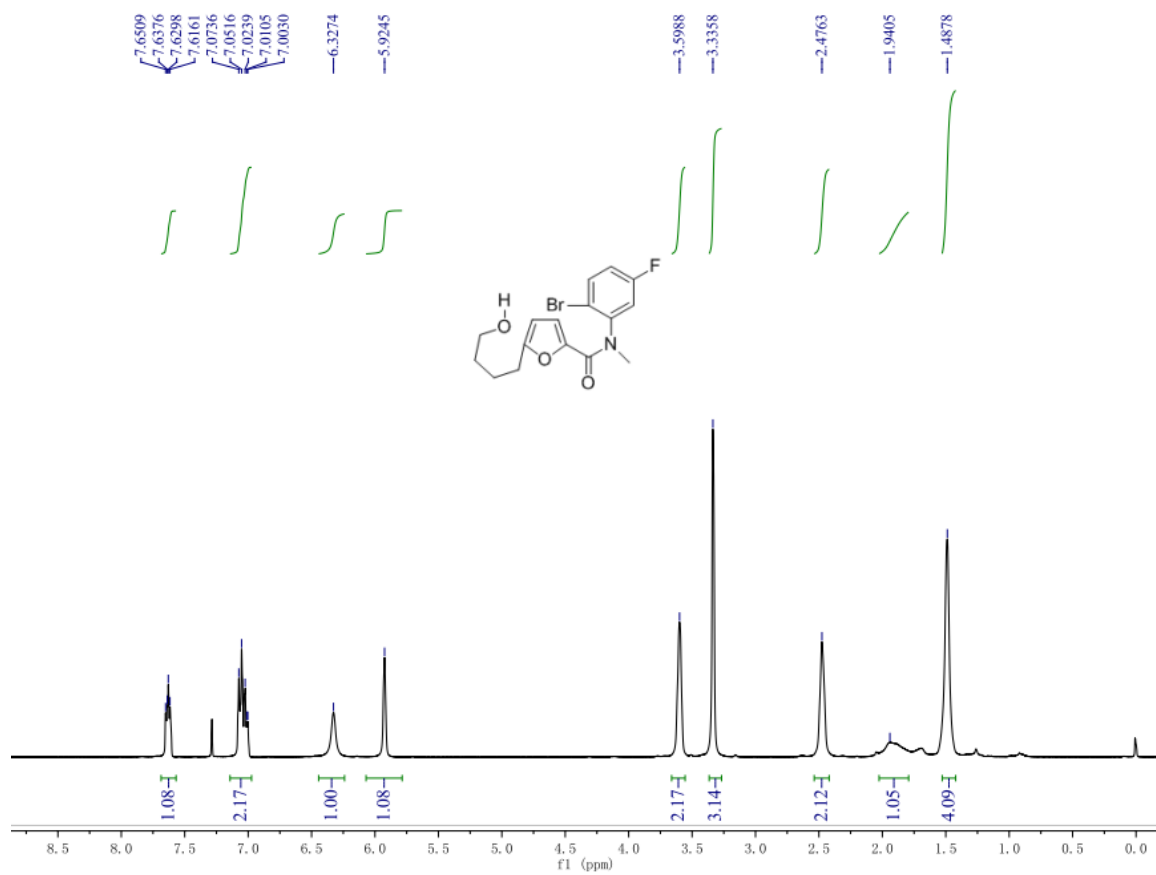
¹³C NMR spectrum of **1r**



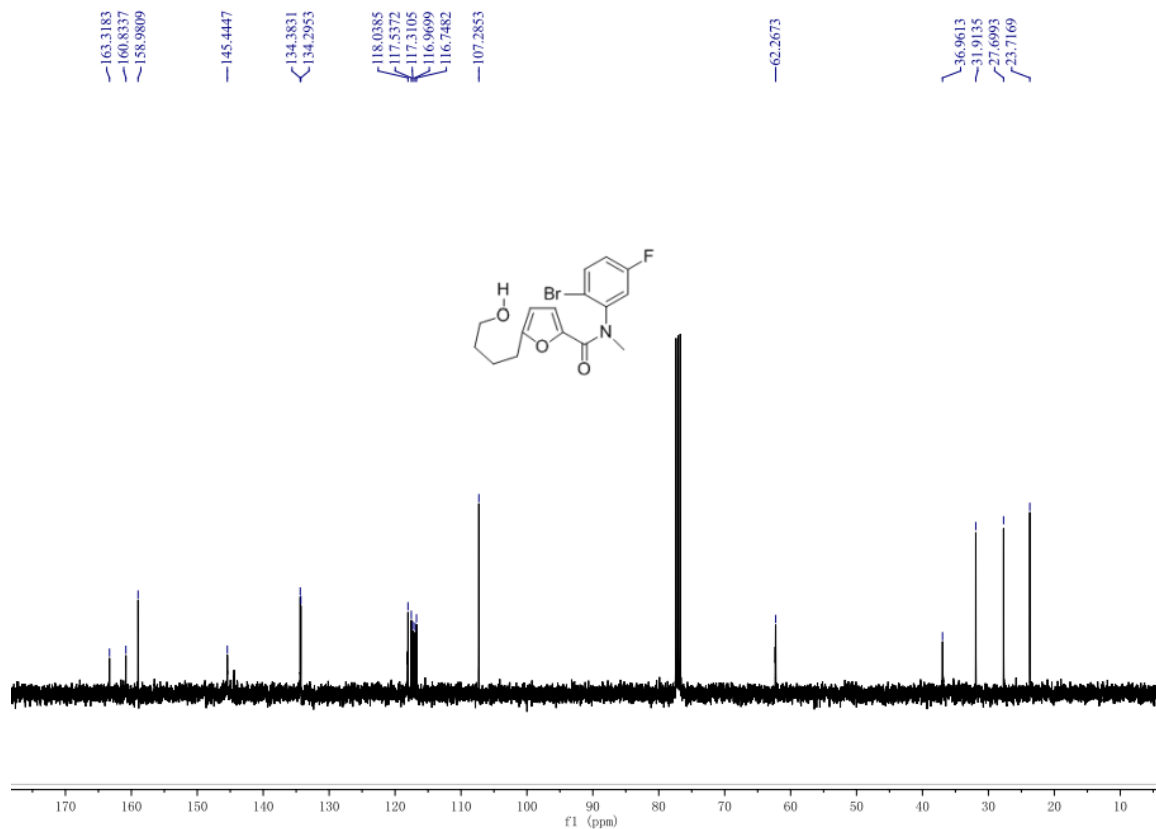
¹H NMR spectrum of **1s**



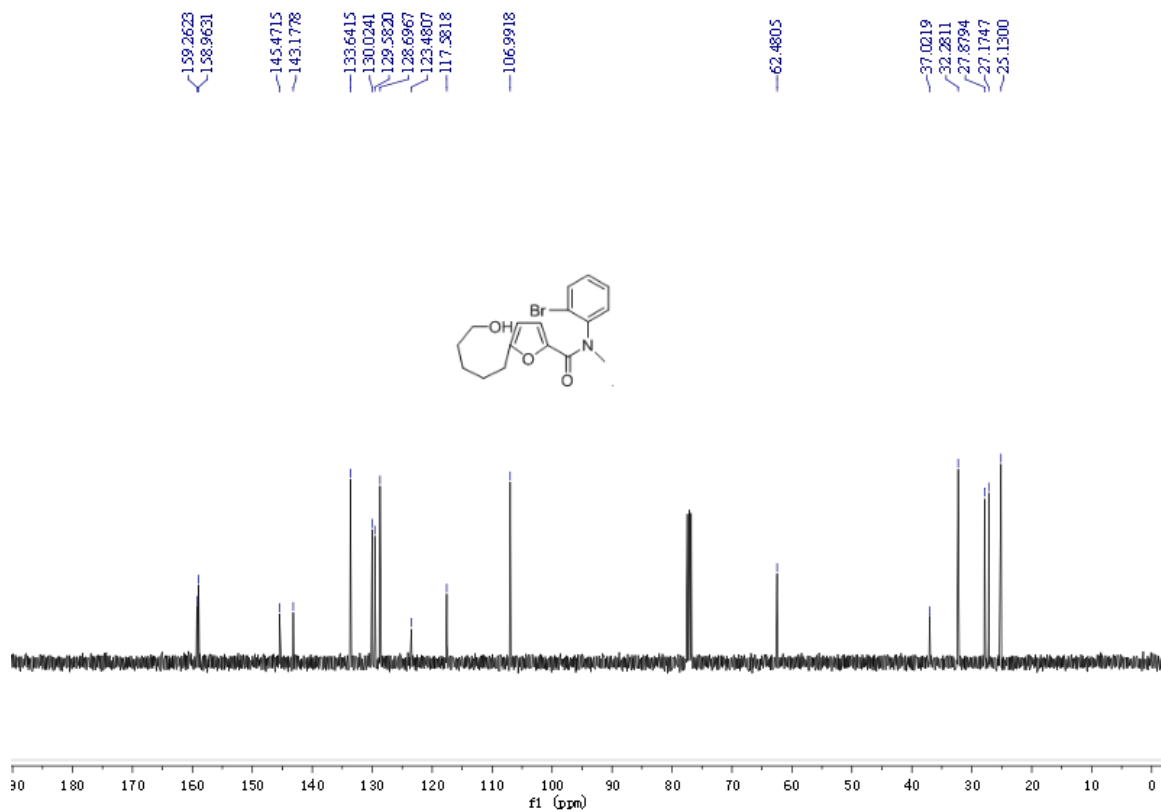
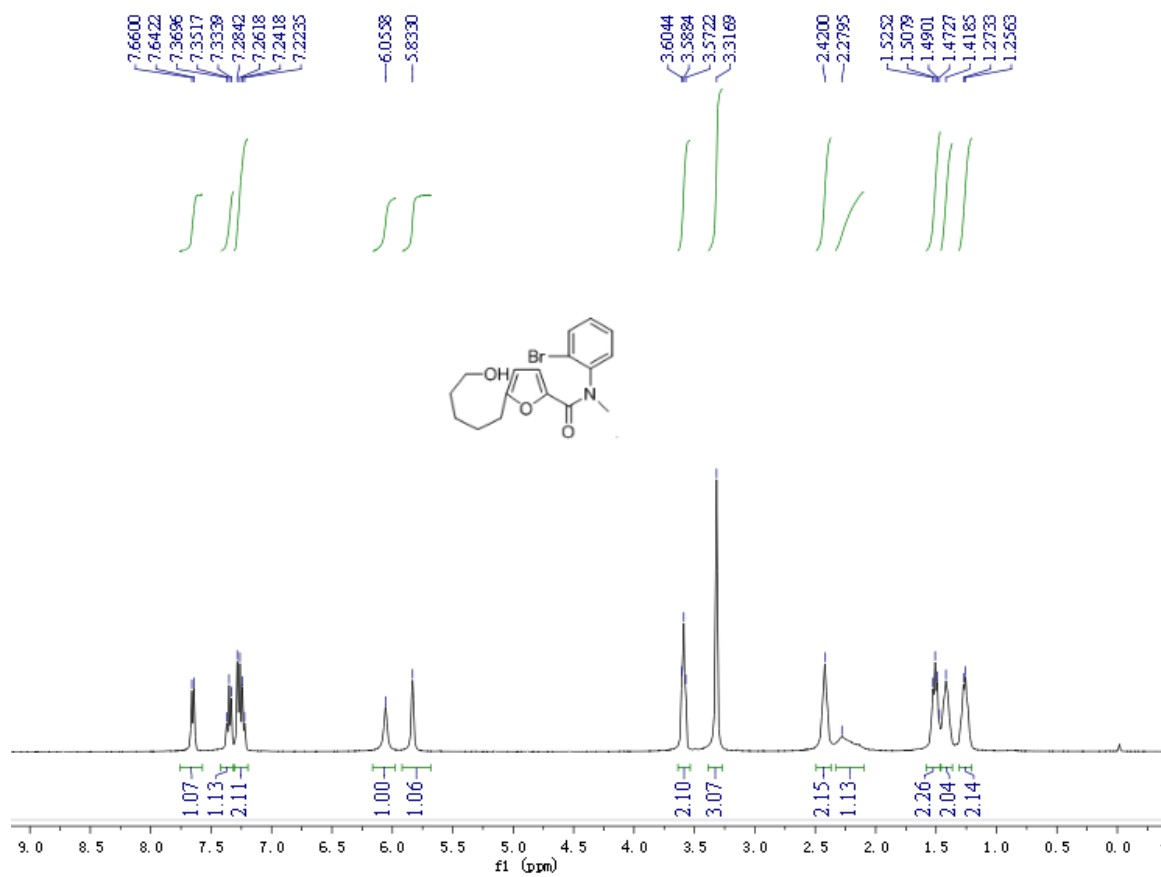
¹³C NMR spectrum of **1s**

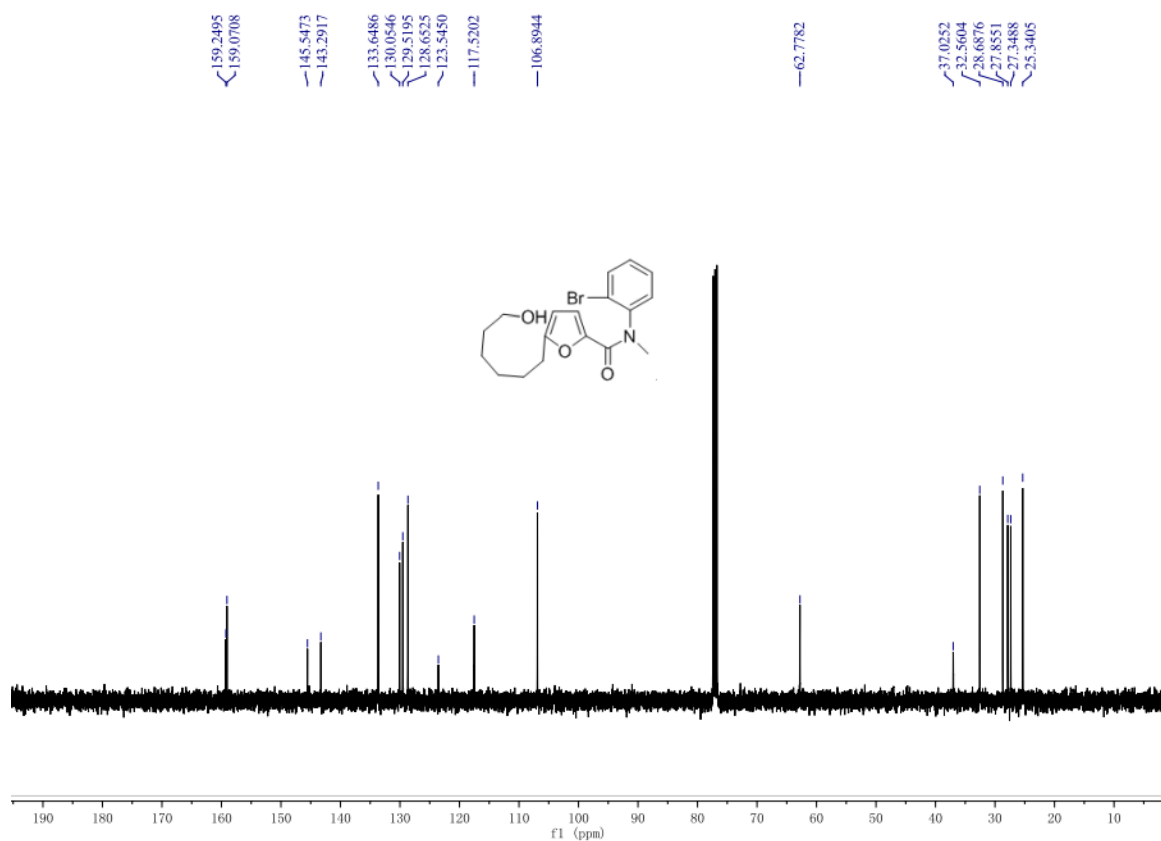
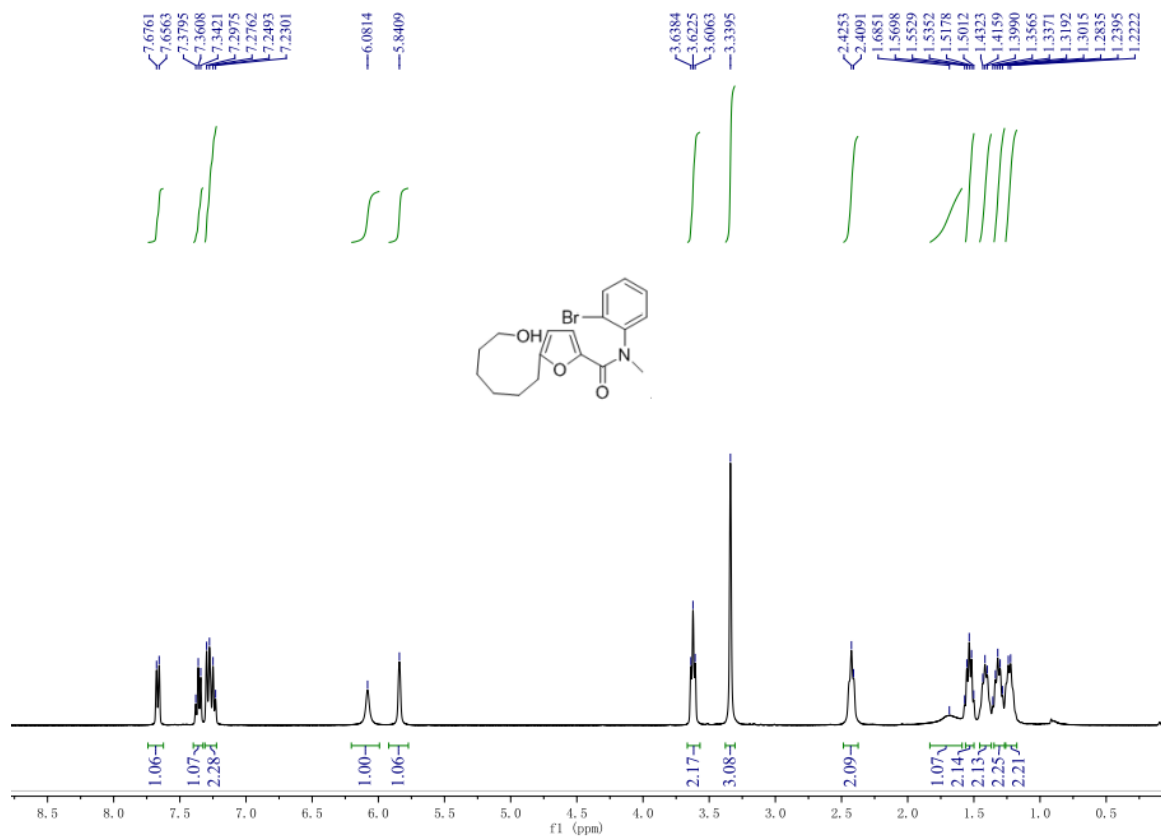


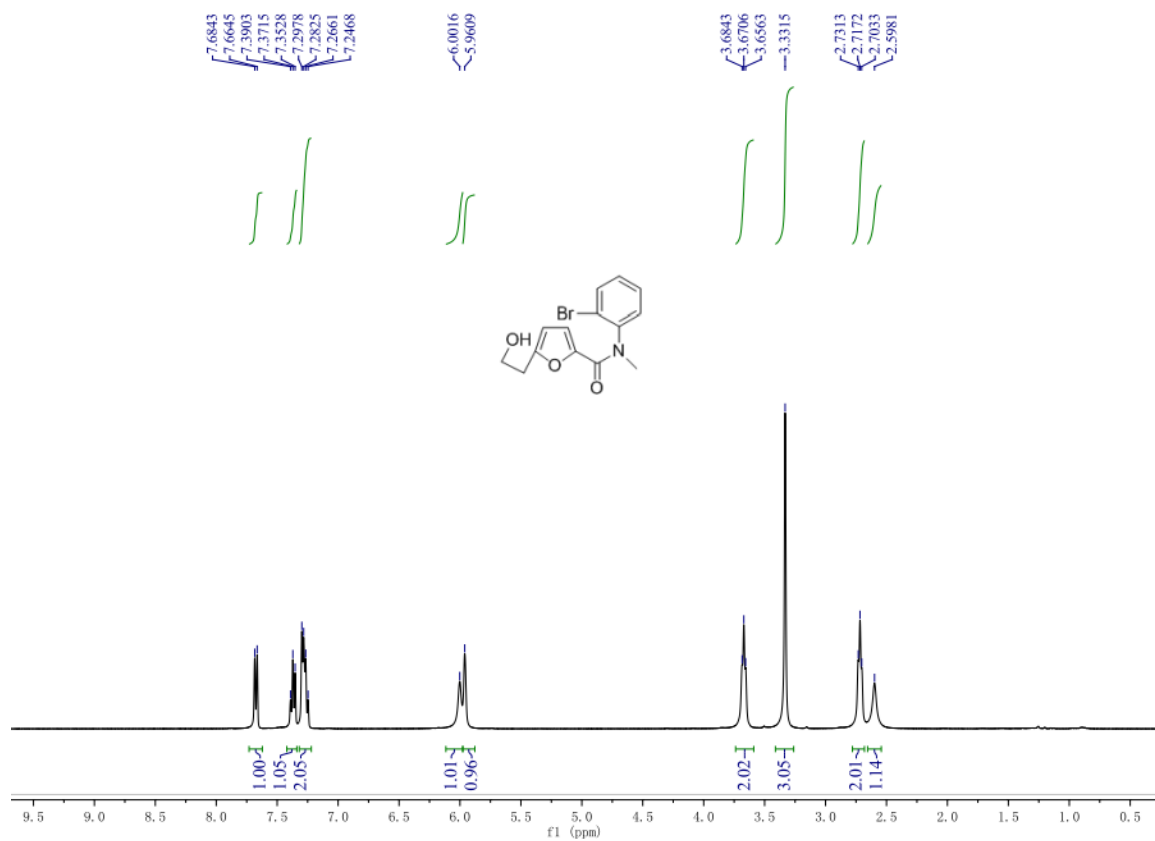
¹H NMR spectrum of **1t**



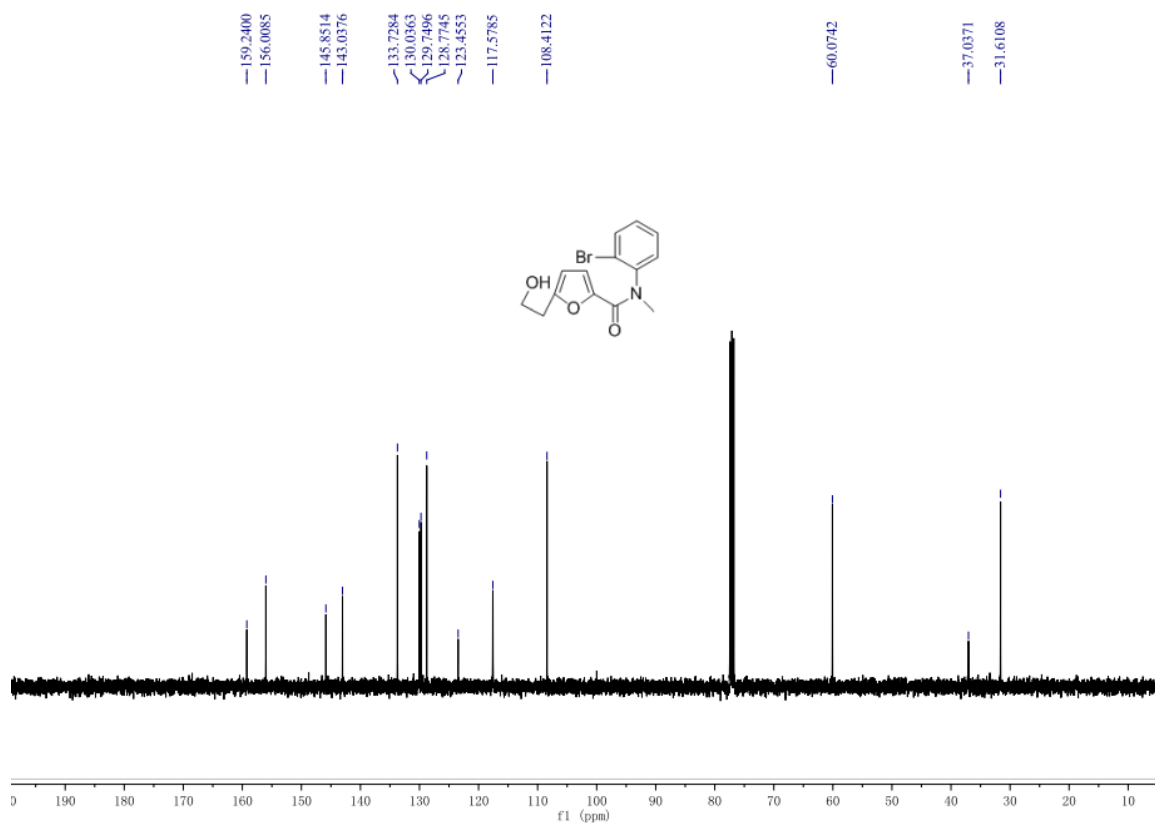
¹³C NMR spectrum of **1t**



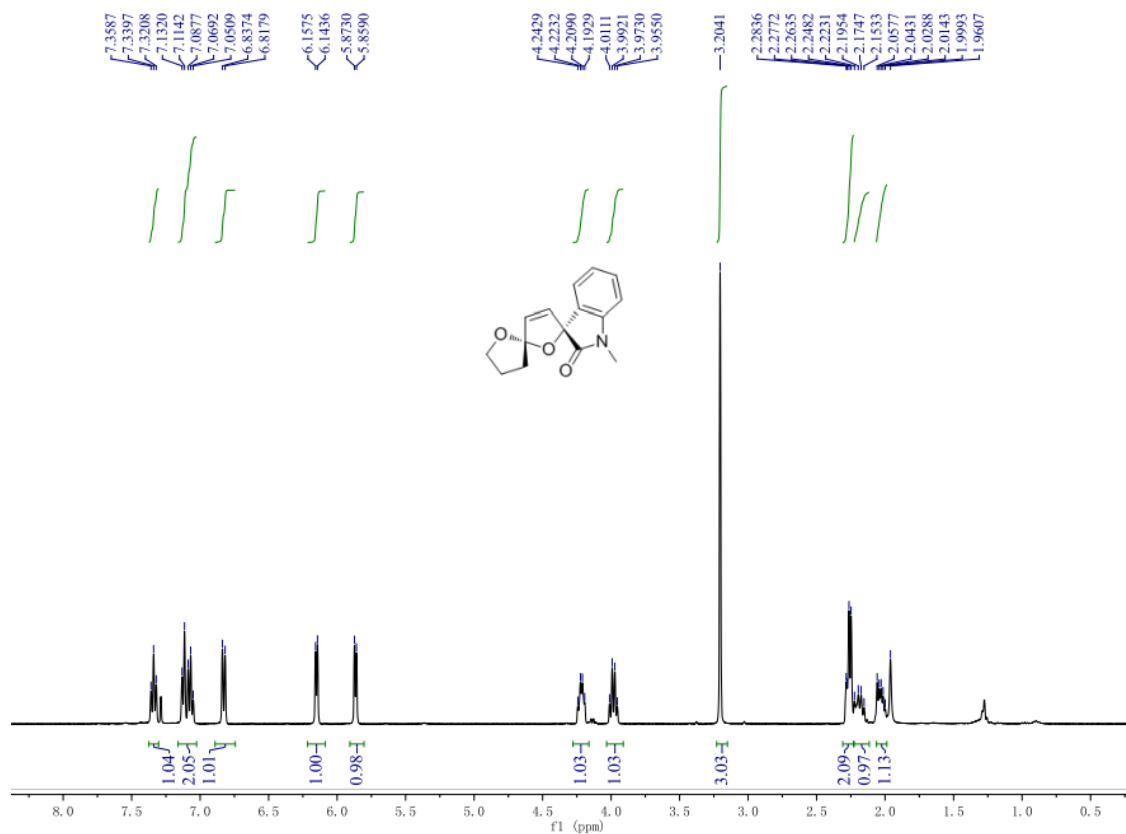




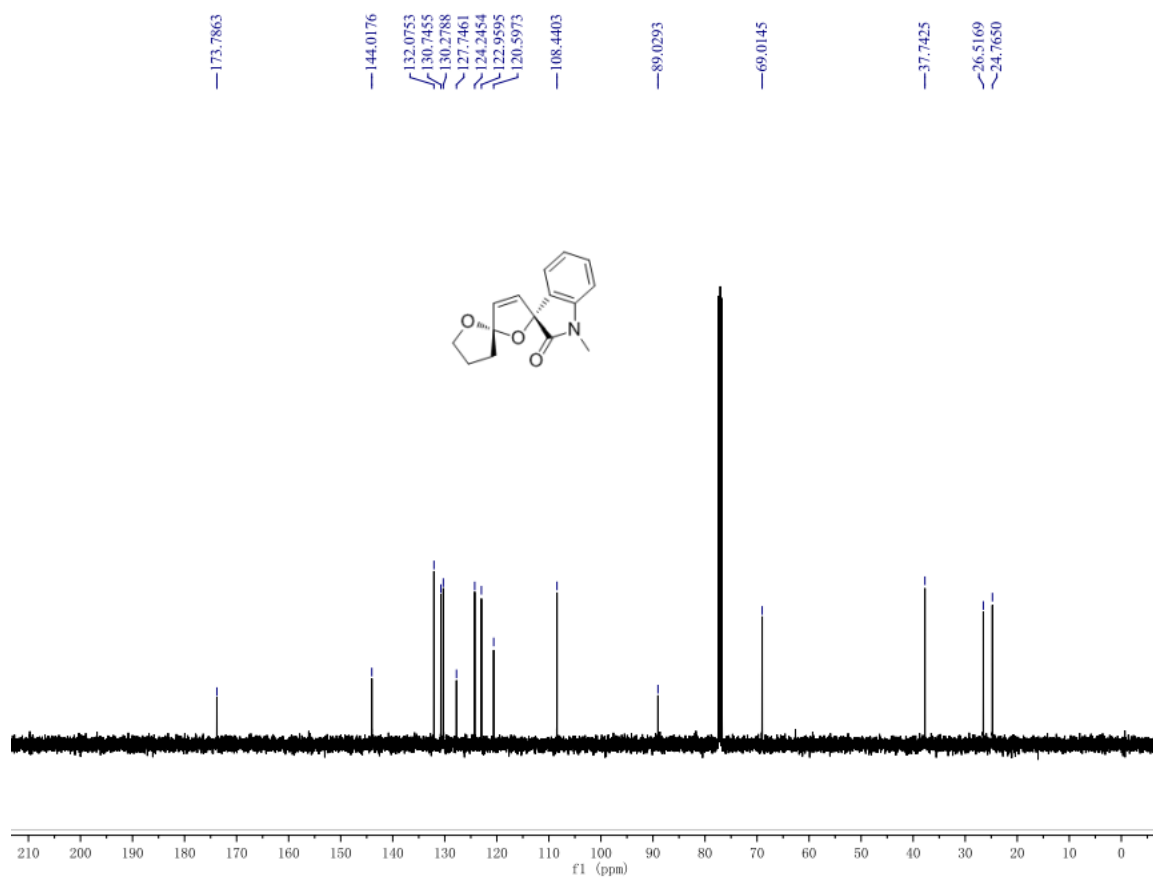
¹H NMR spectrum of **1w**



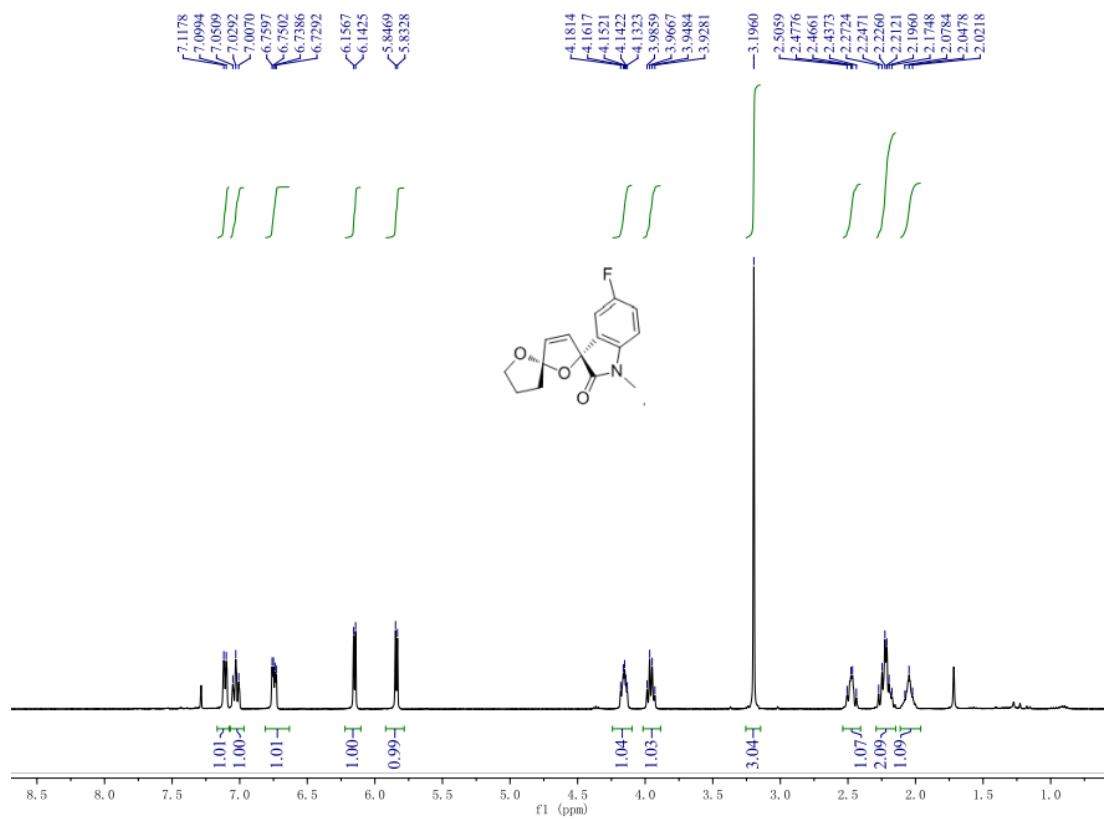
¹³C NMR spectrum of **1w**



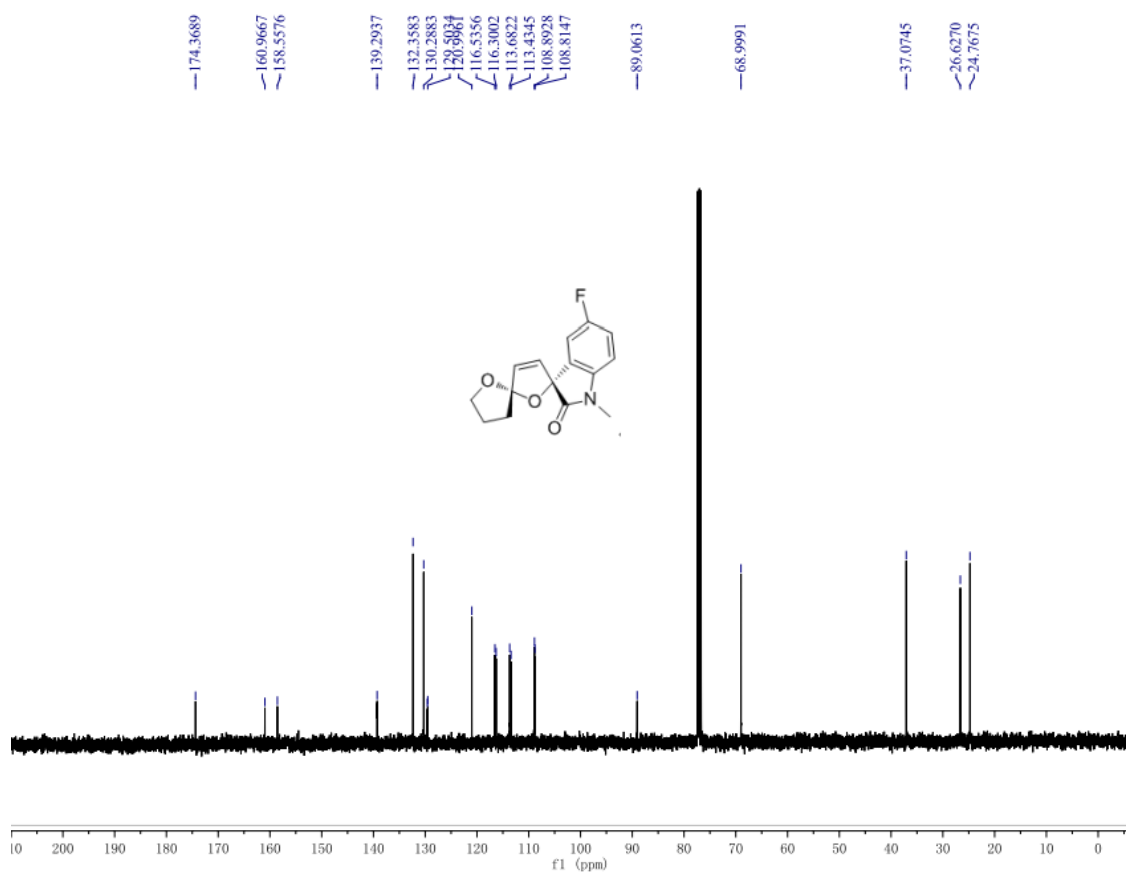
¹H NMR spectrum of **2a**



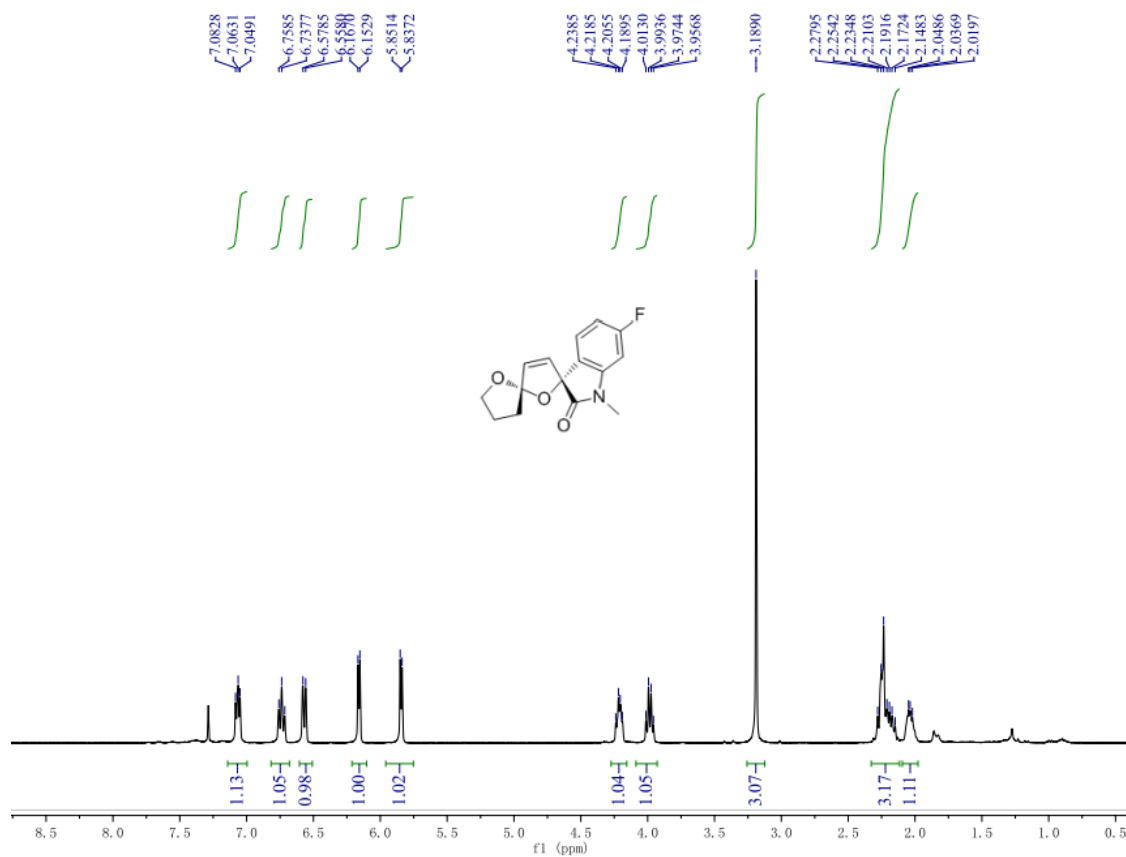
¹³C NMR spectrum of **2a**



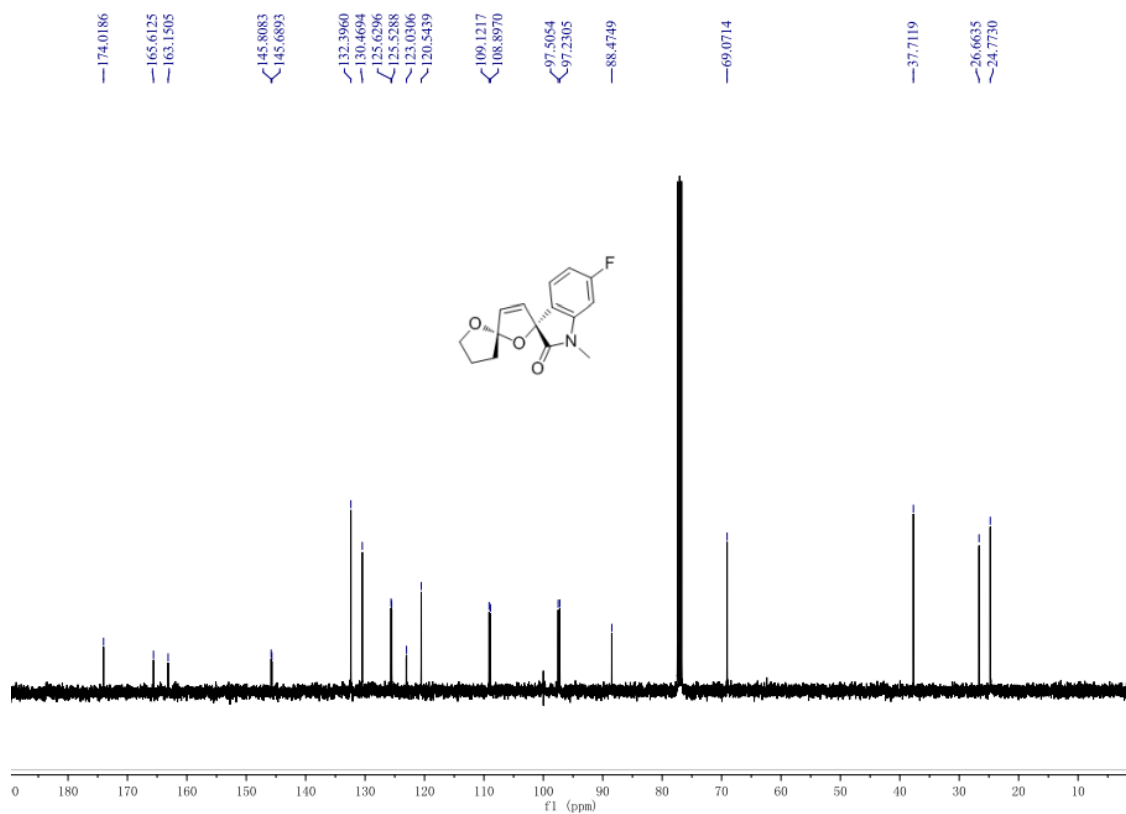
¹H NMR spectrum of **2b**



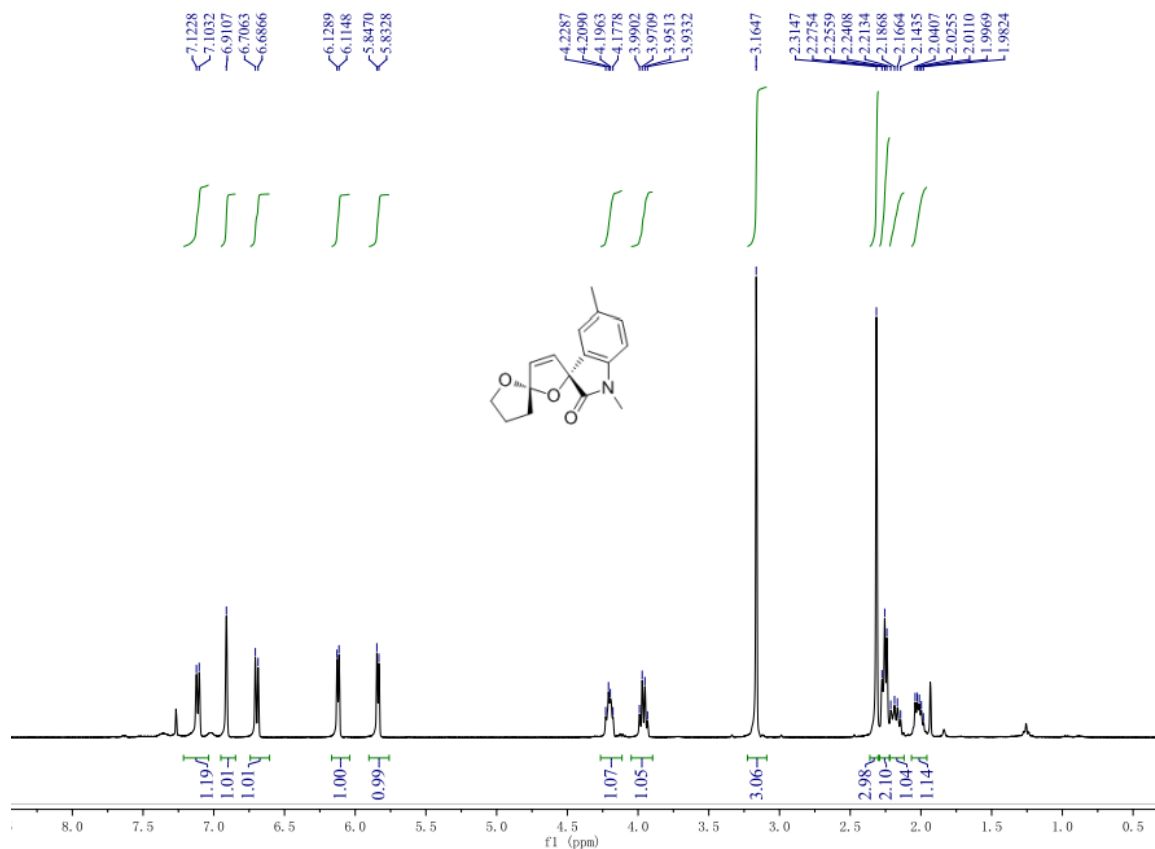
¹³C NMR spectrum of **2b**



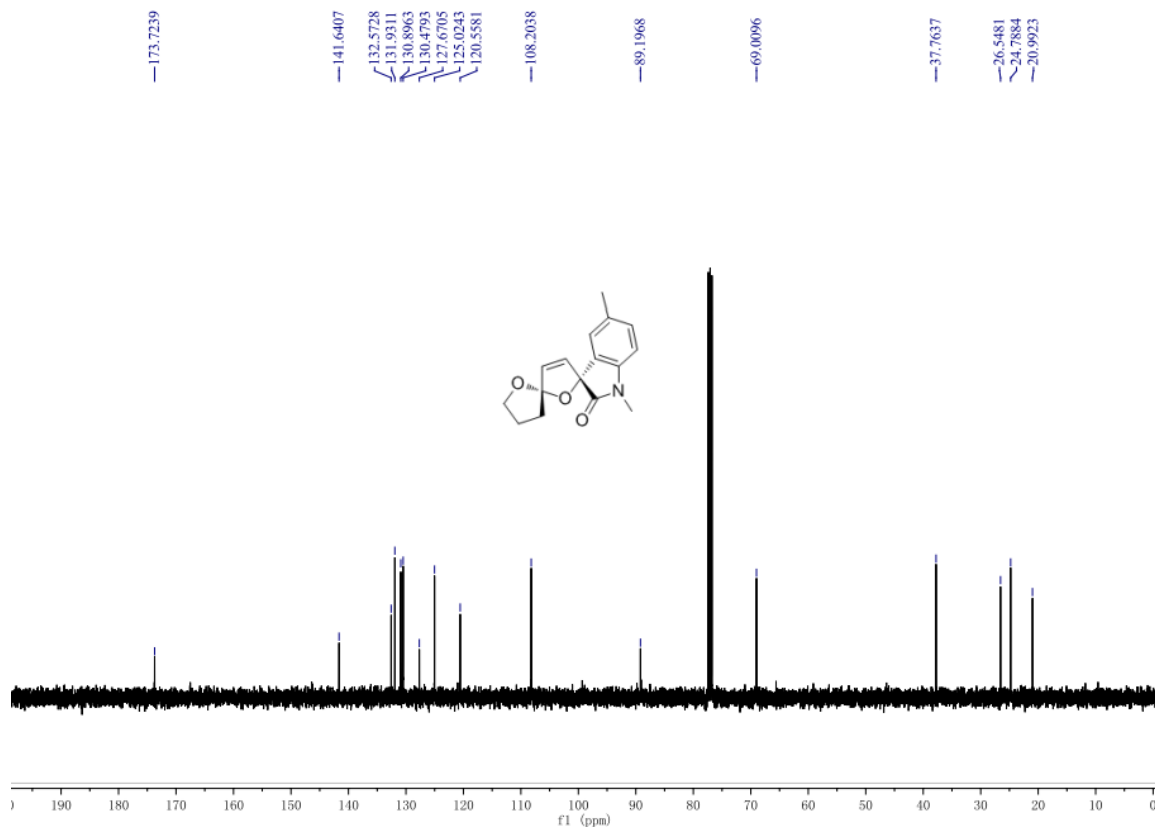
¹H NMR spectrum of 2c



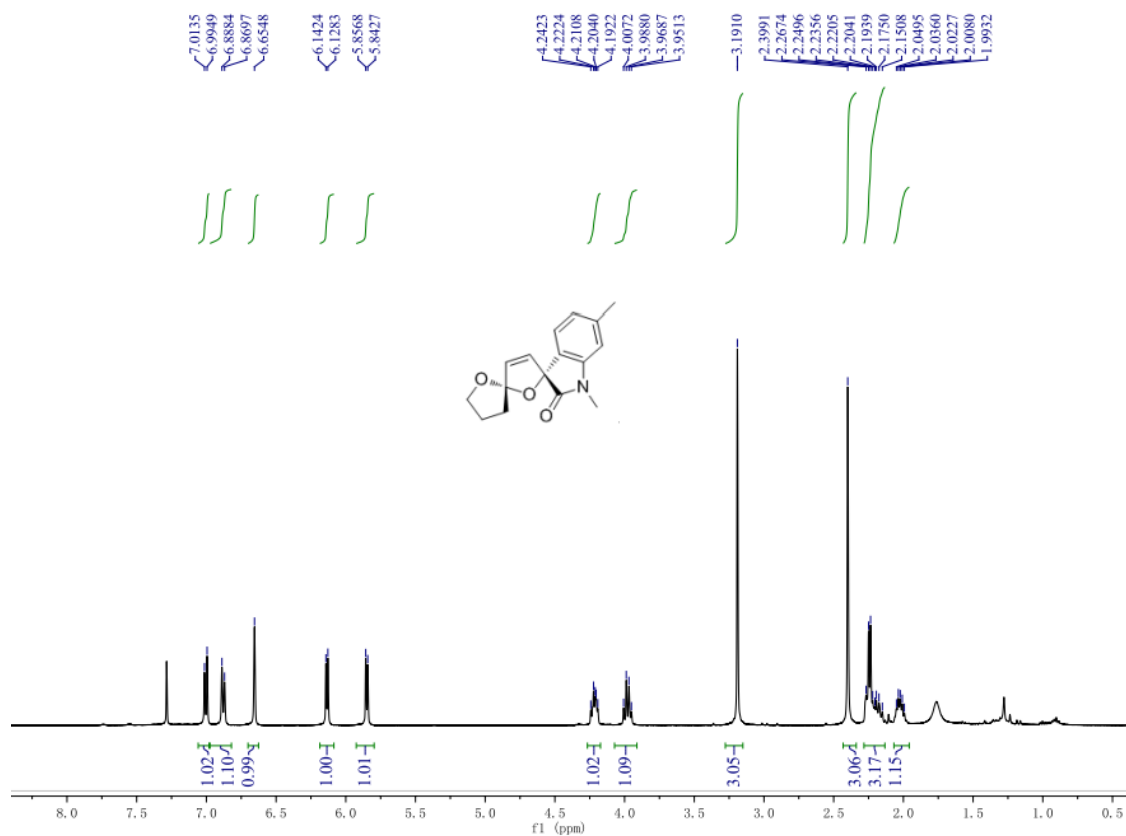
¹³C NMR spectrum of 2c



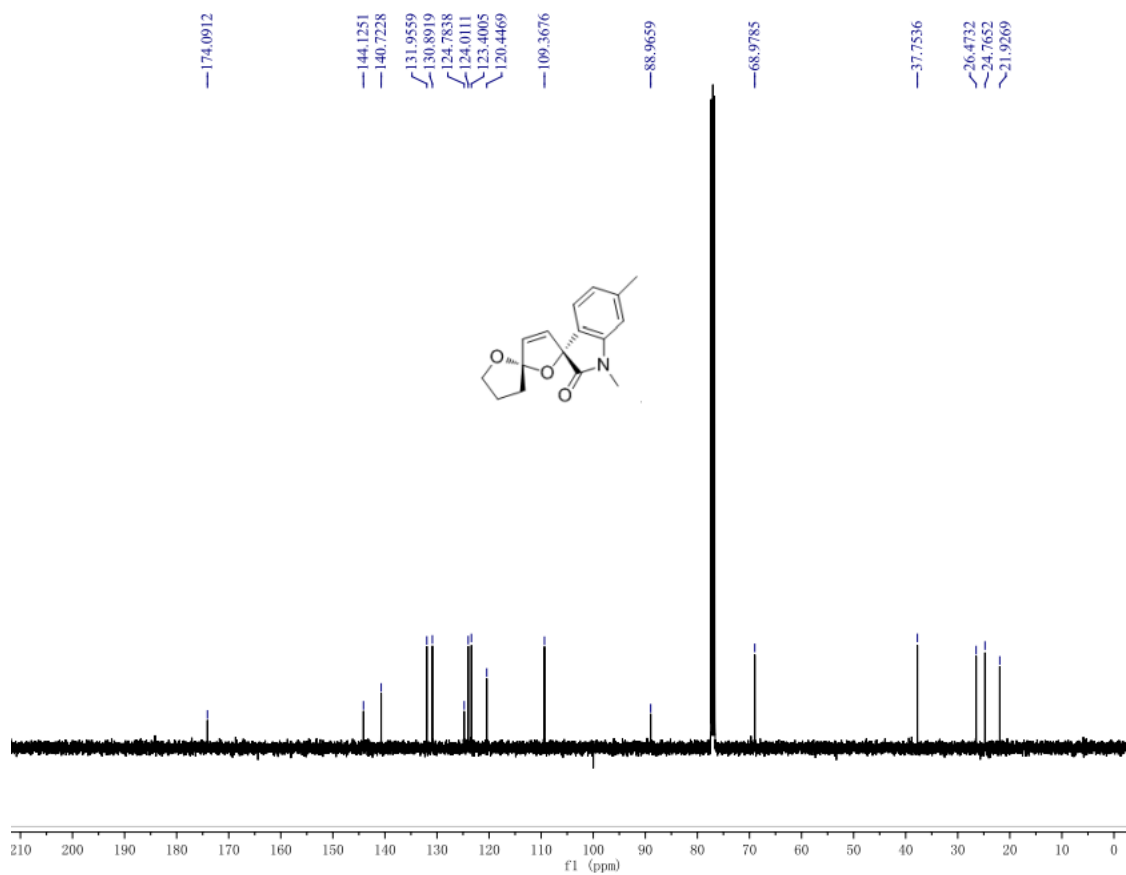
^1H NMR spectrum of **2d**



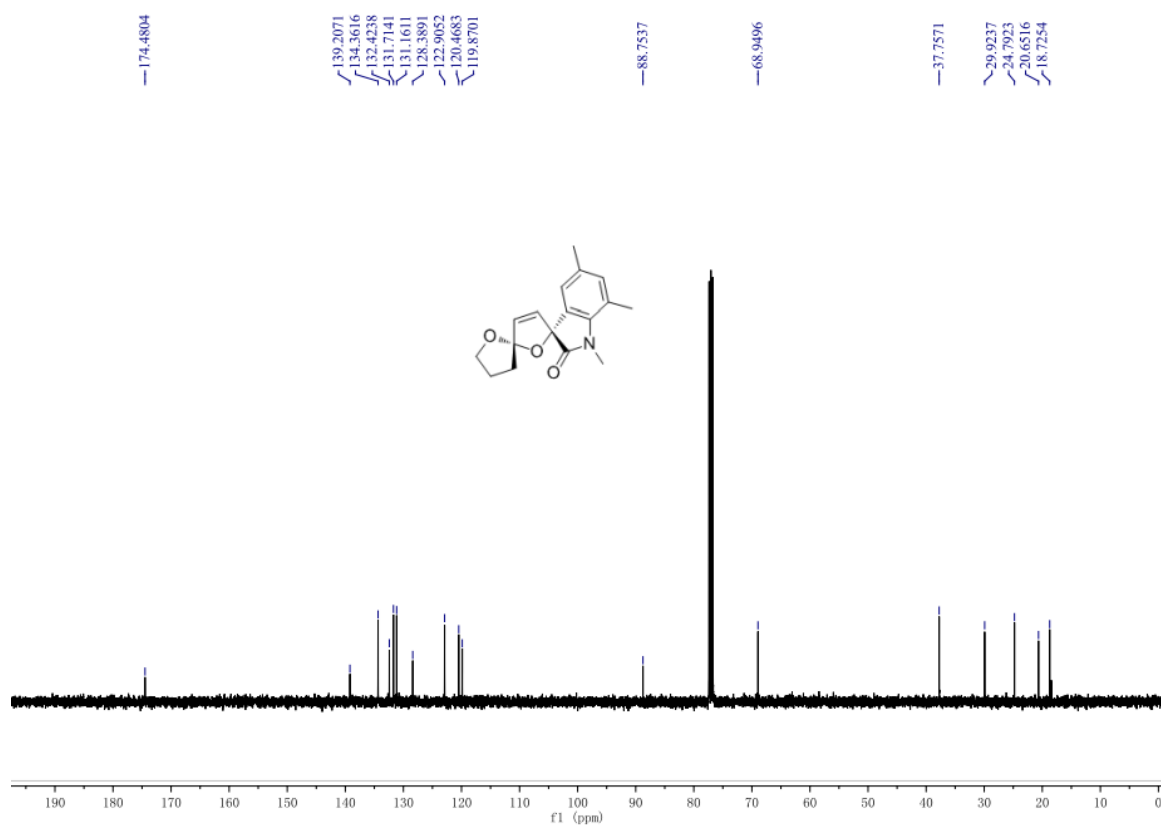
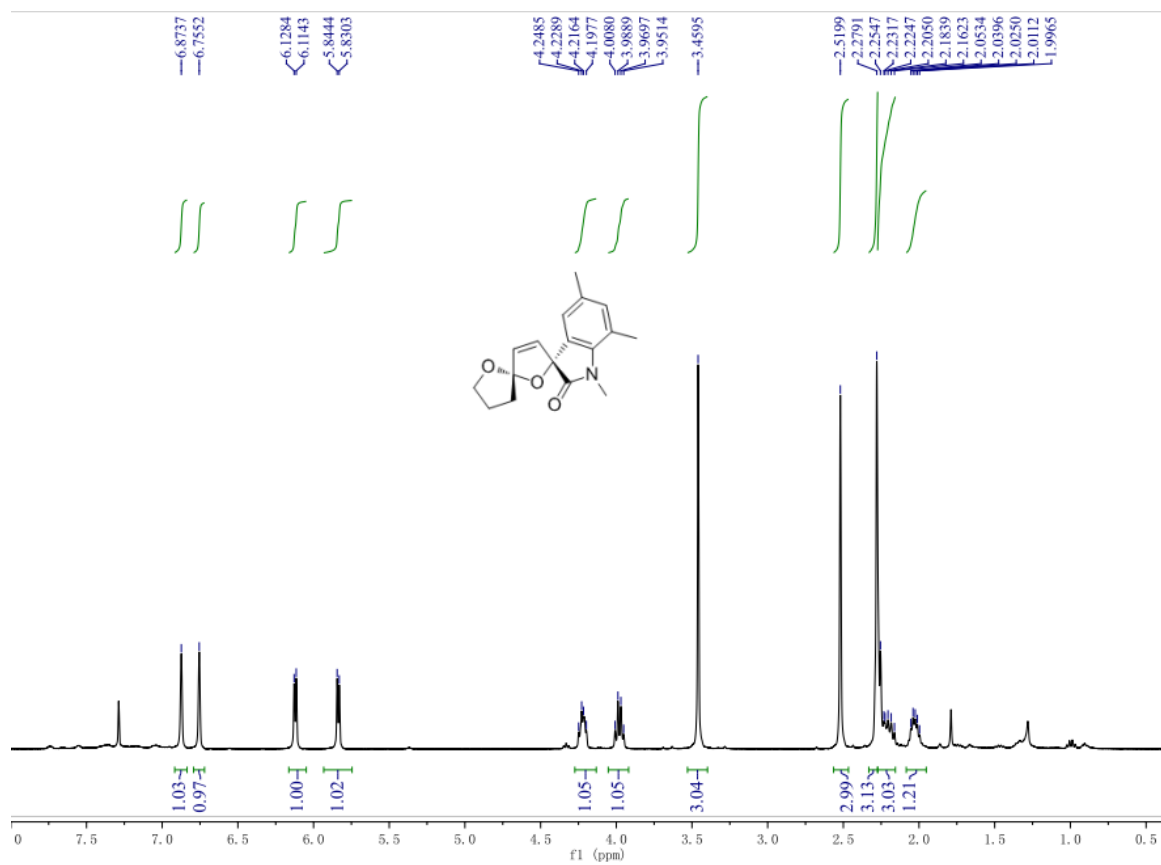
^{13}C NMR spectrum of **2d**

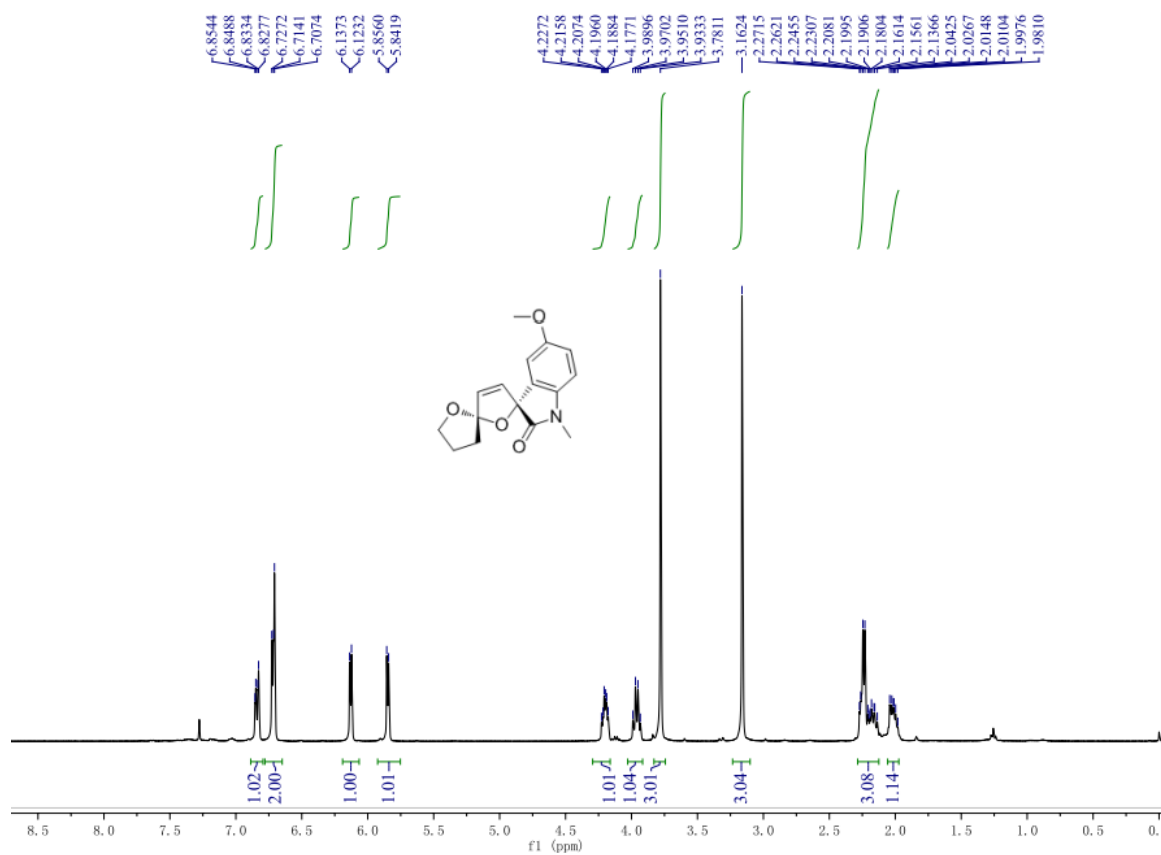


¹H NMR spectrum of **2e**

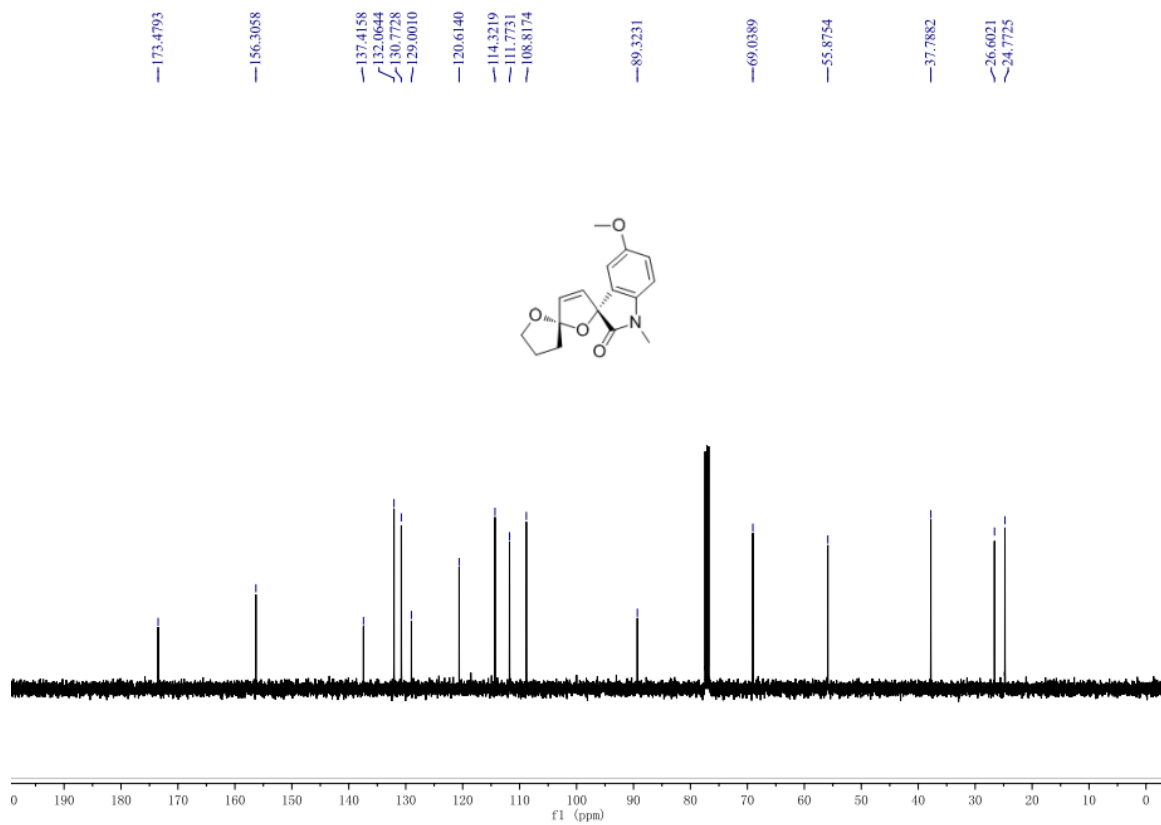


¹³C NMR spectrum of **2e**

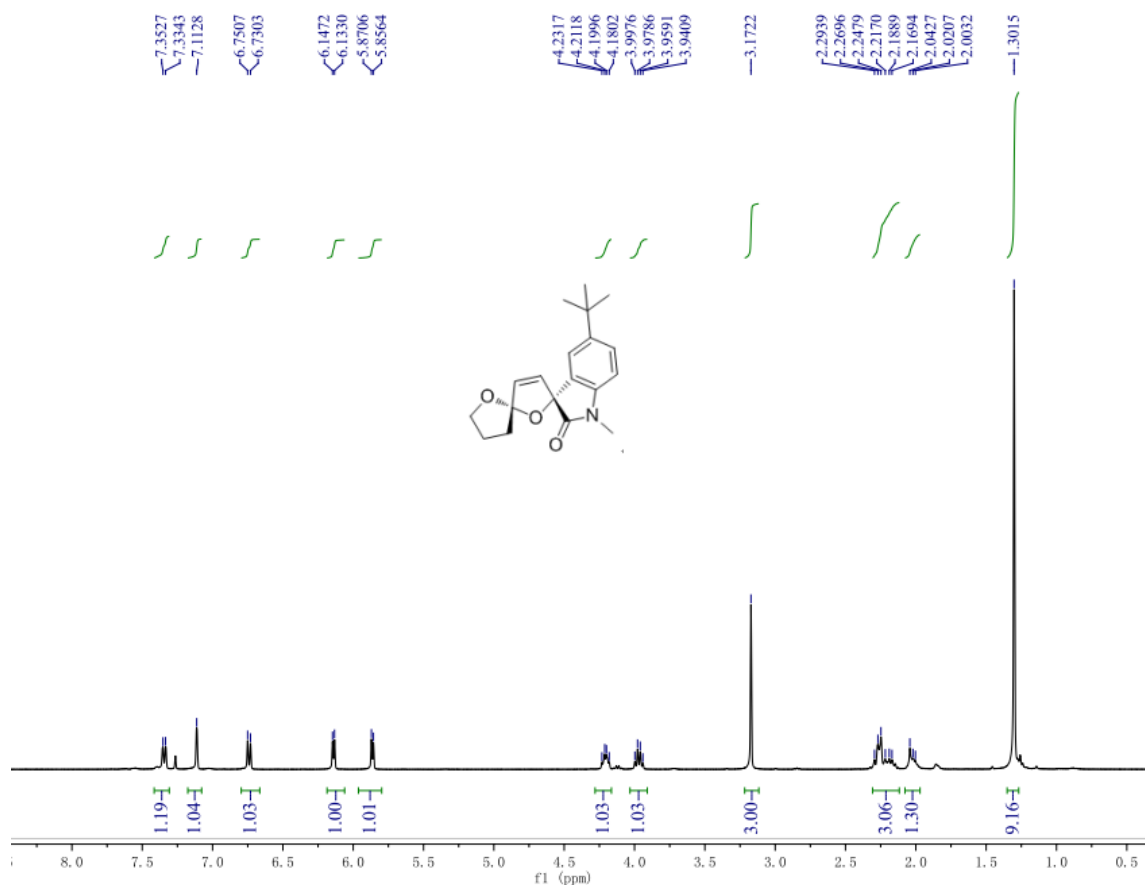




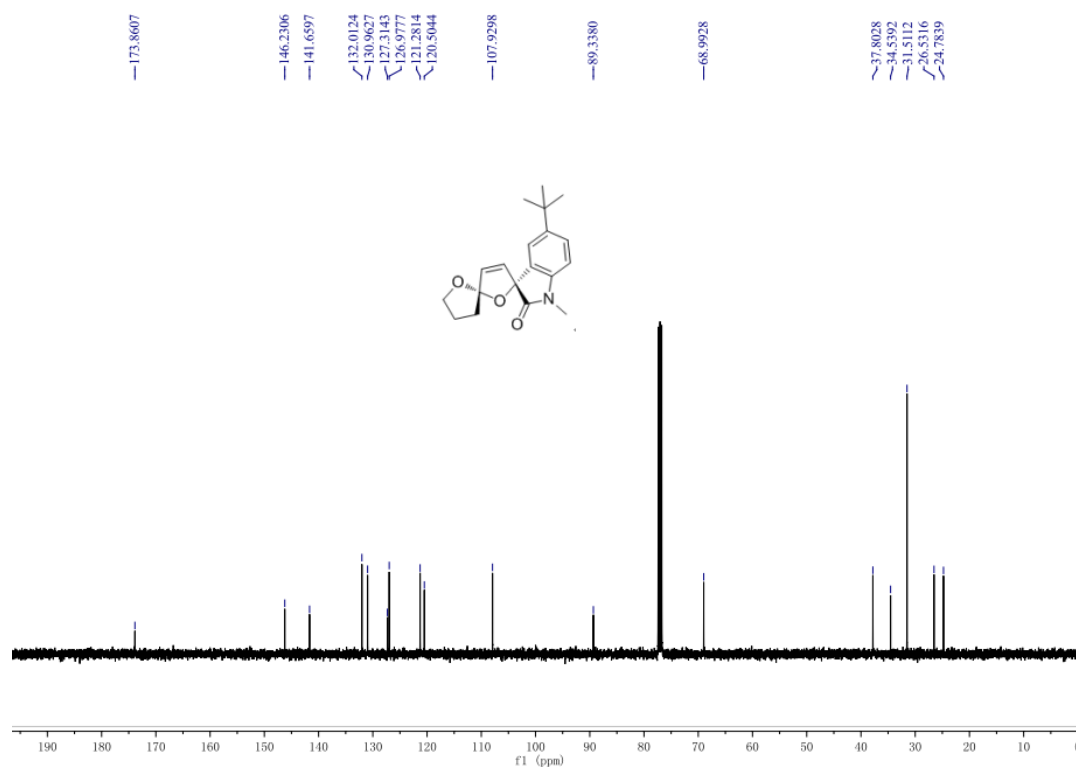
¹H NMR spectrum of 2g



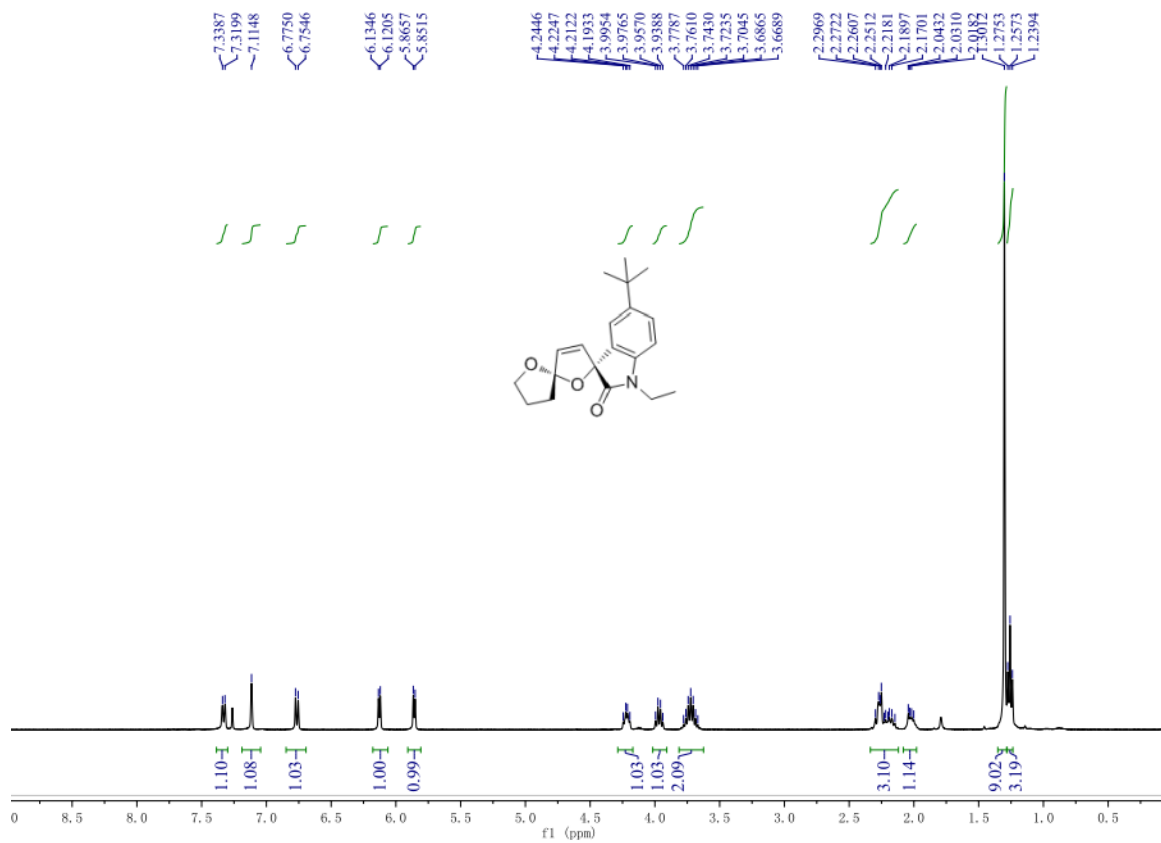
¹³C NMR spectrum of 2g



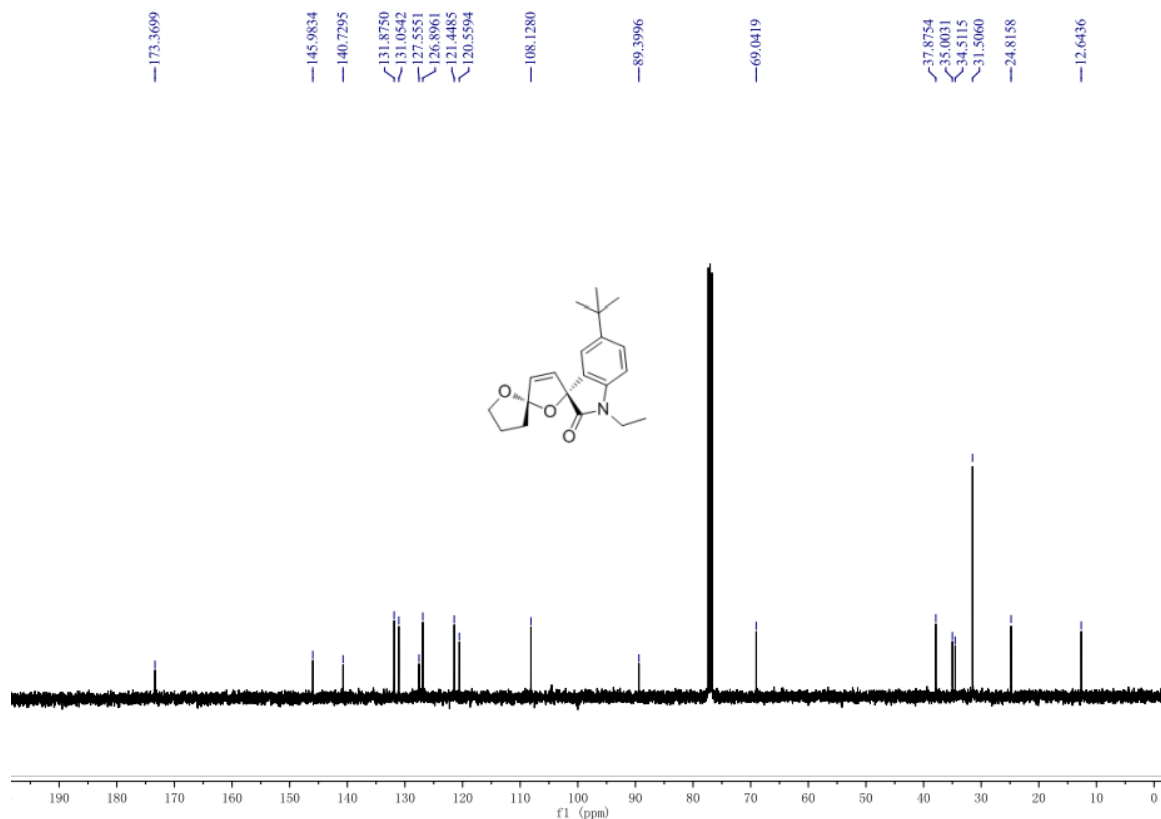
¹H NMR spectrum of 2h



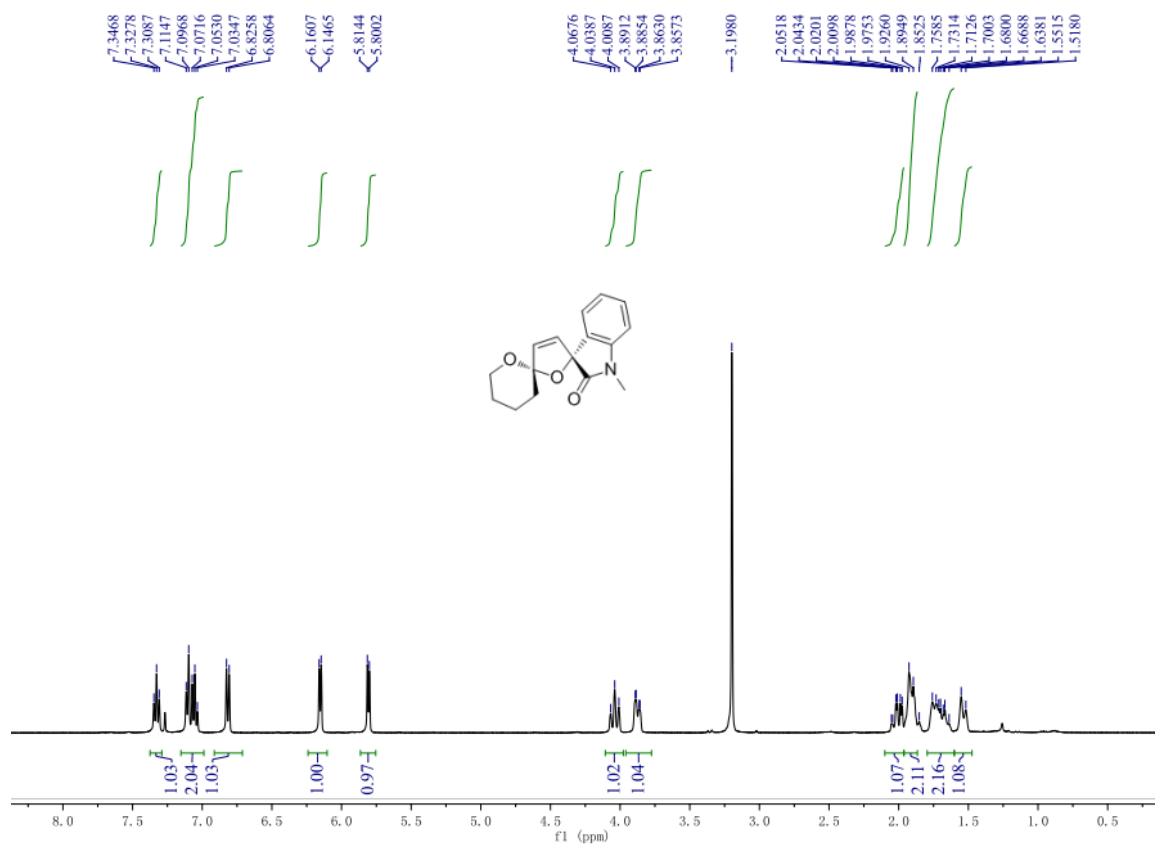
¹³C NMR spectrum of 2h



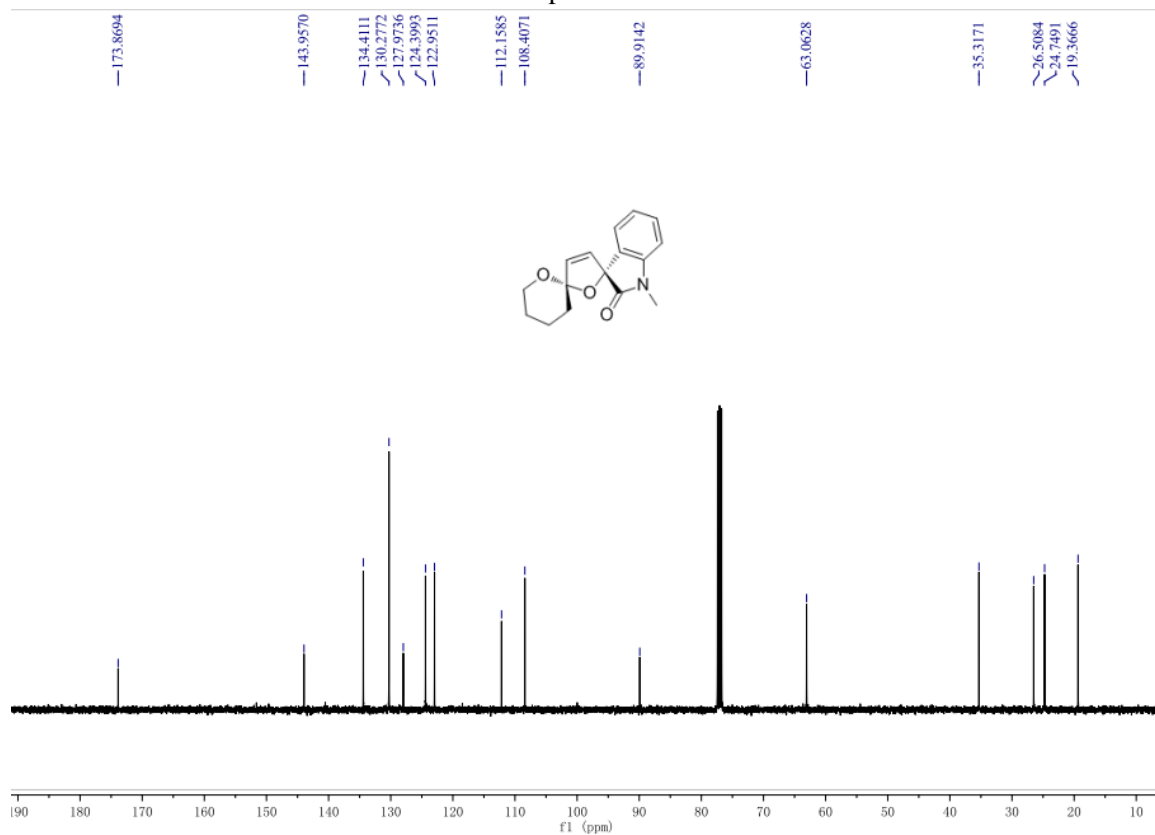
¹H NMR spectrum of **2i**



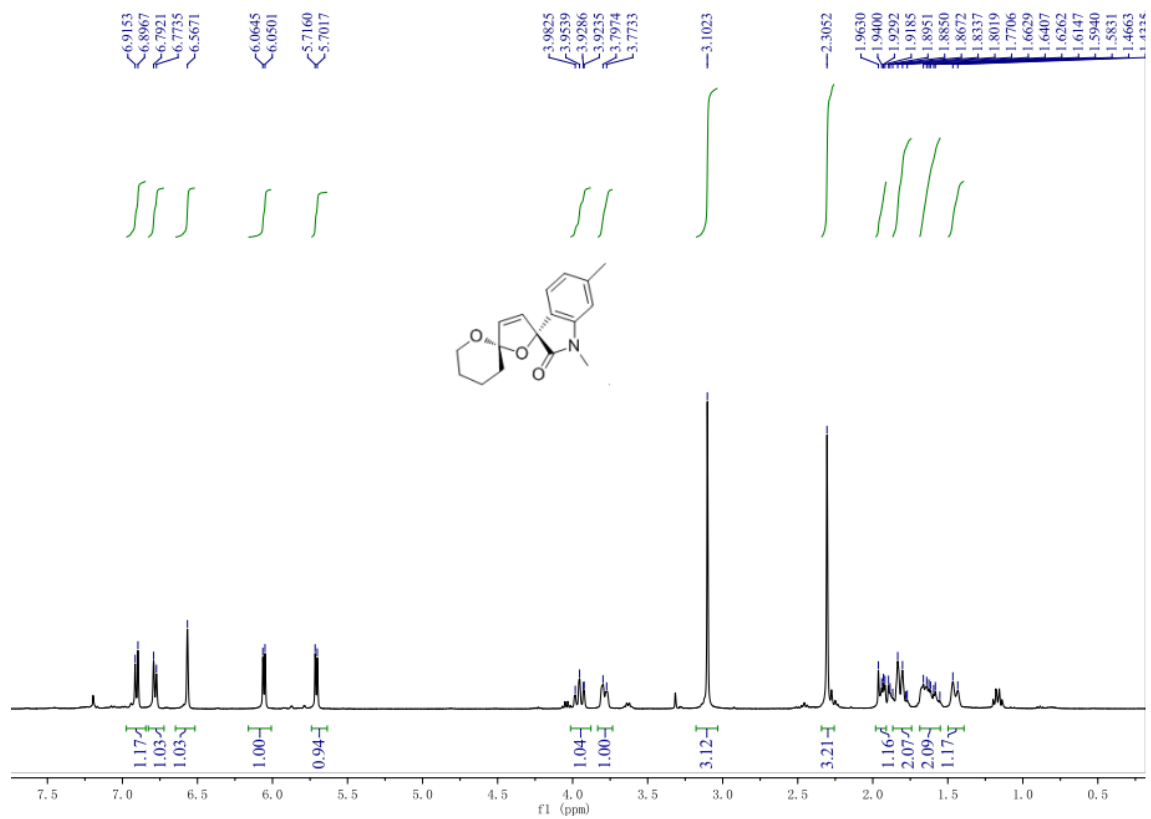
¹³C NMR spectrum of **2i**



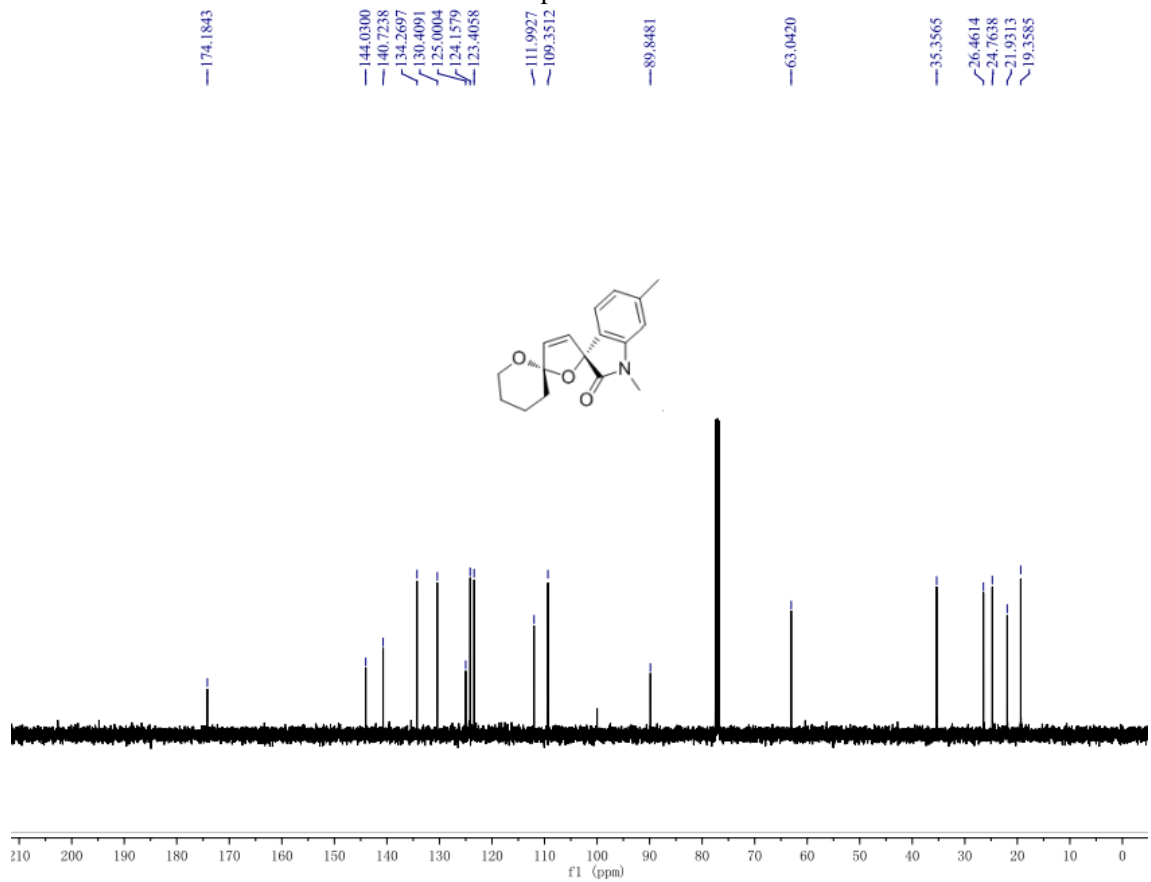
¹H NMR spectrum of **2l**



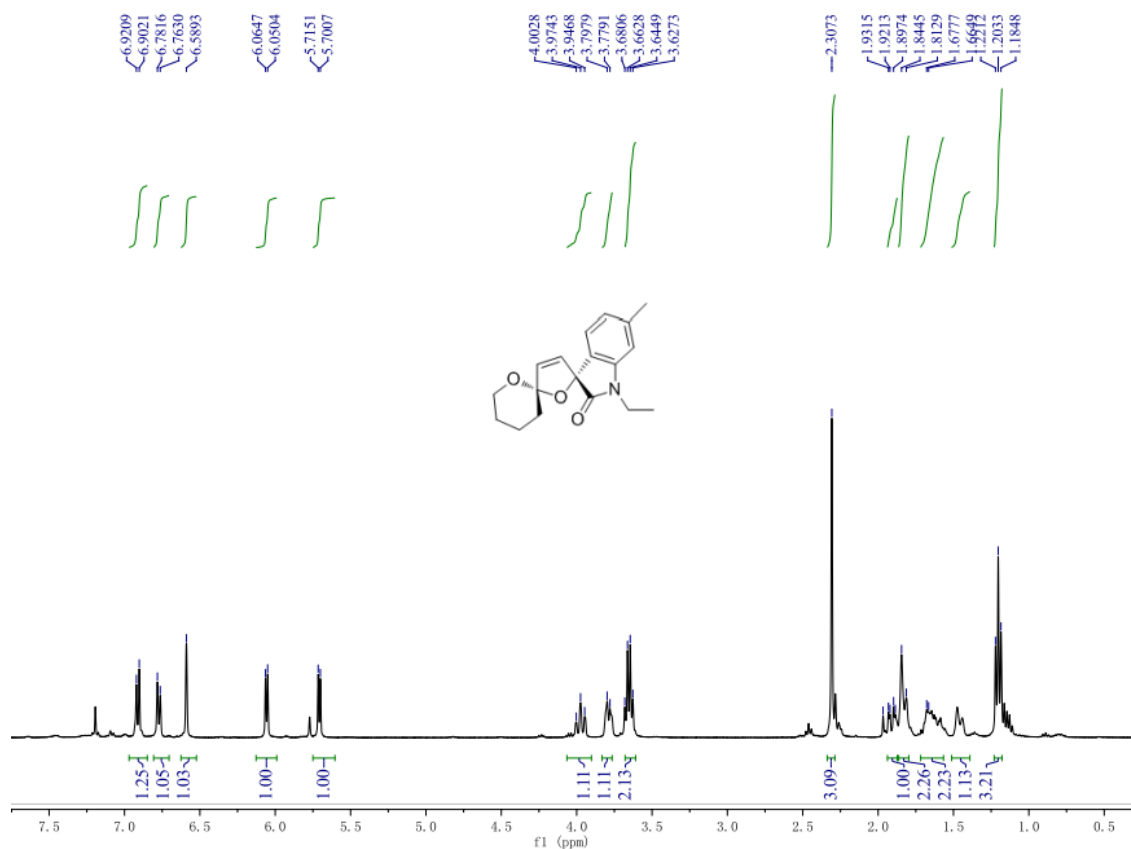
¹³C NMR spectrum of **2l**



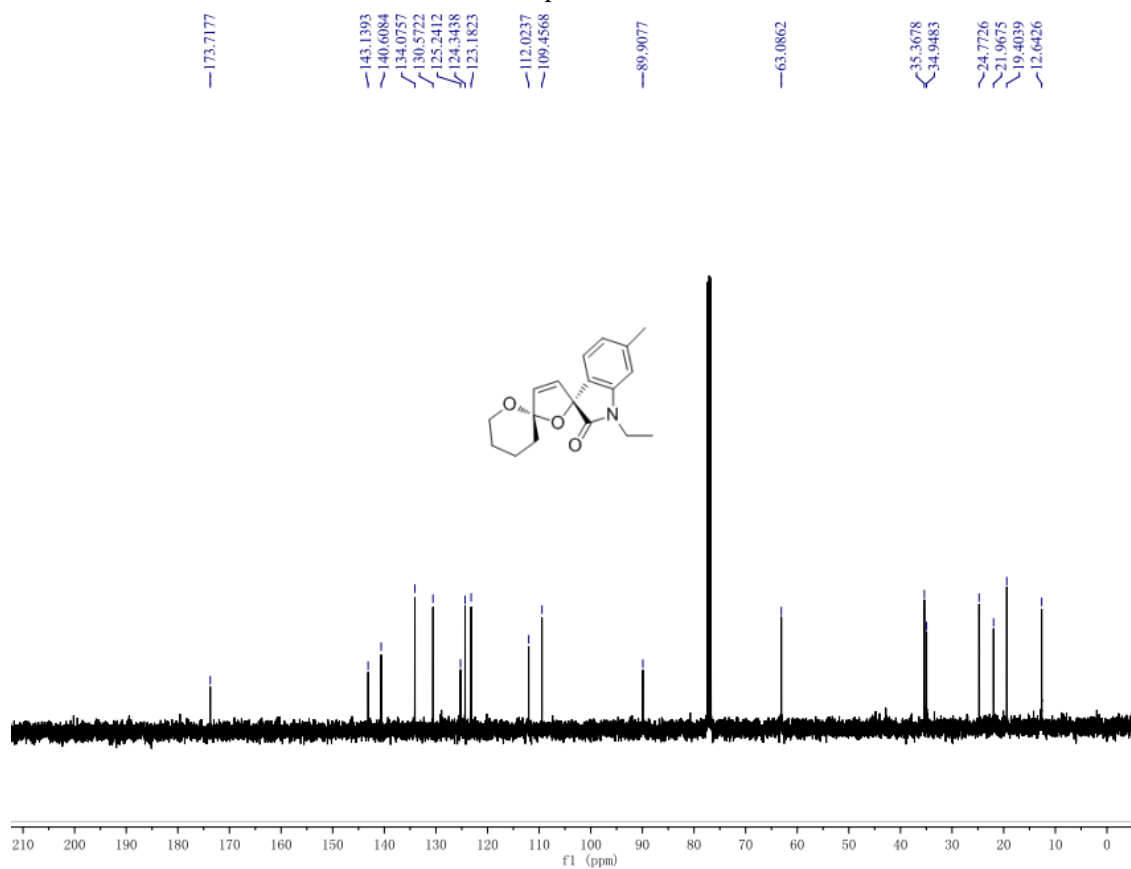
¹H NMR spectrum of 2m



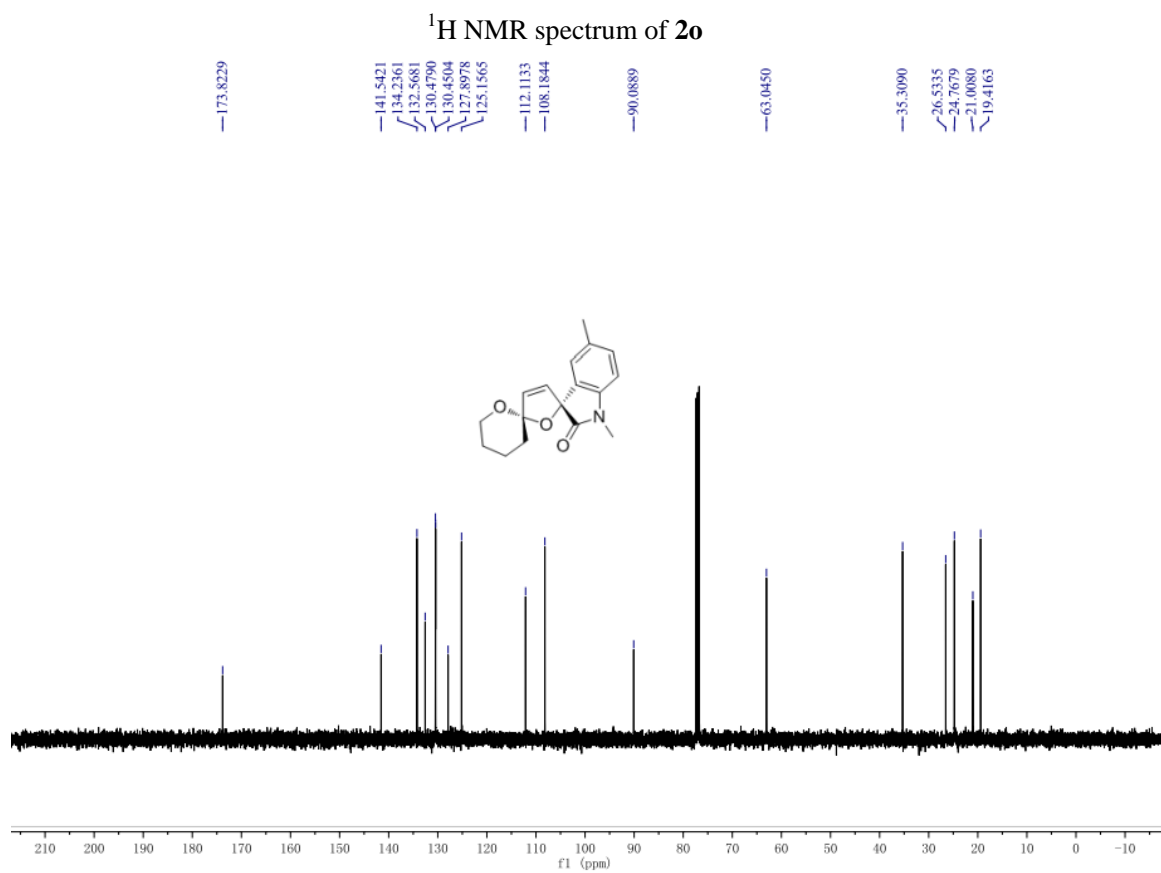
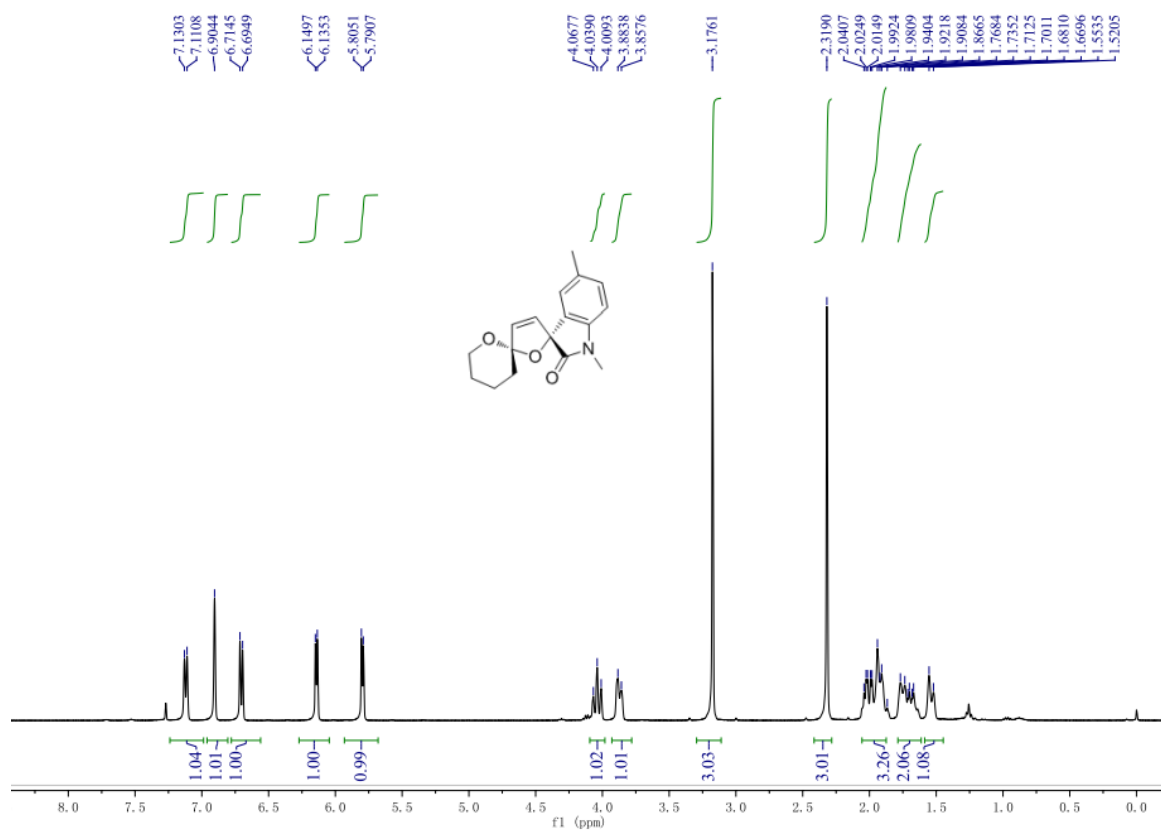
¹³C NMR spectrum of 2m

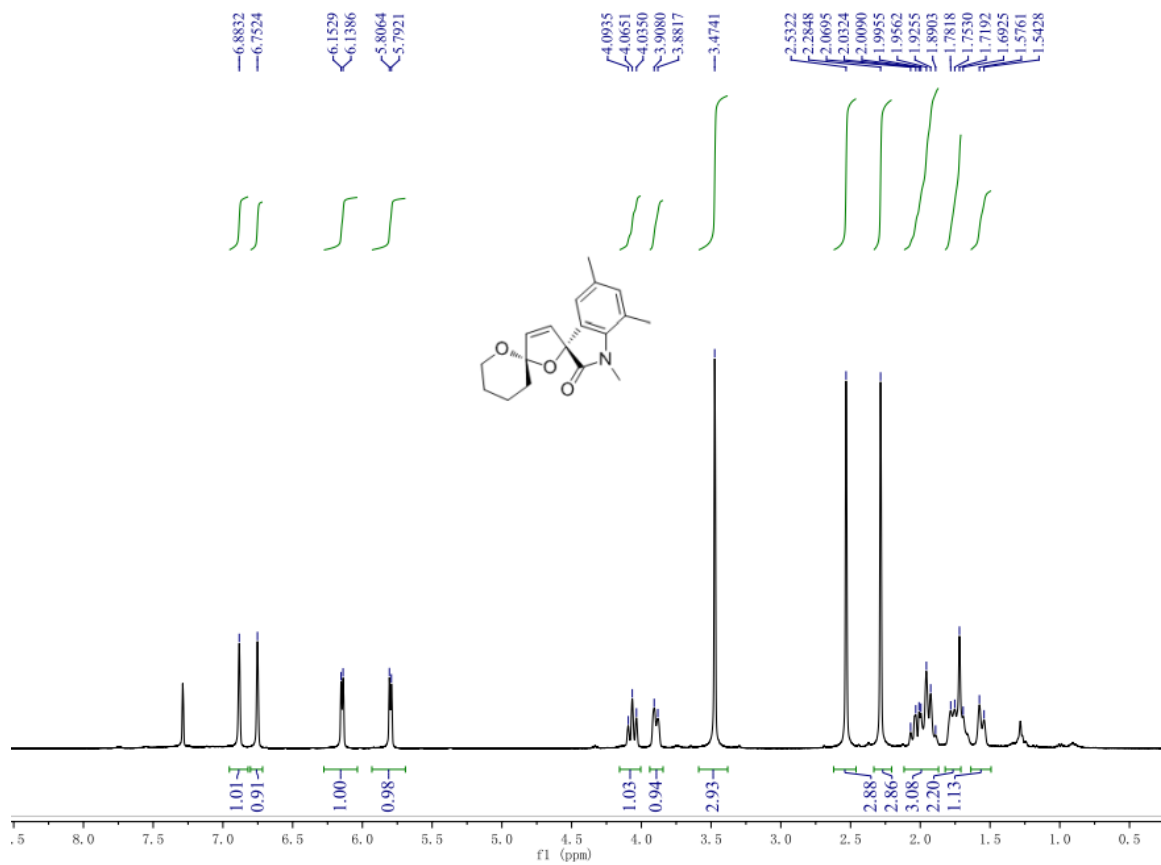


¹H NMR spectrum of **2n**

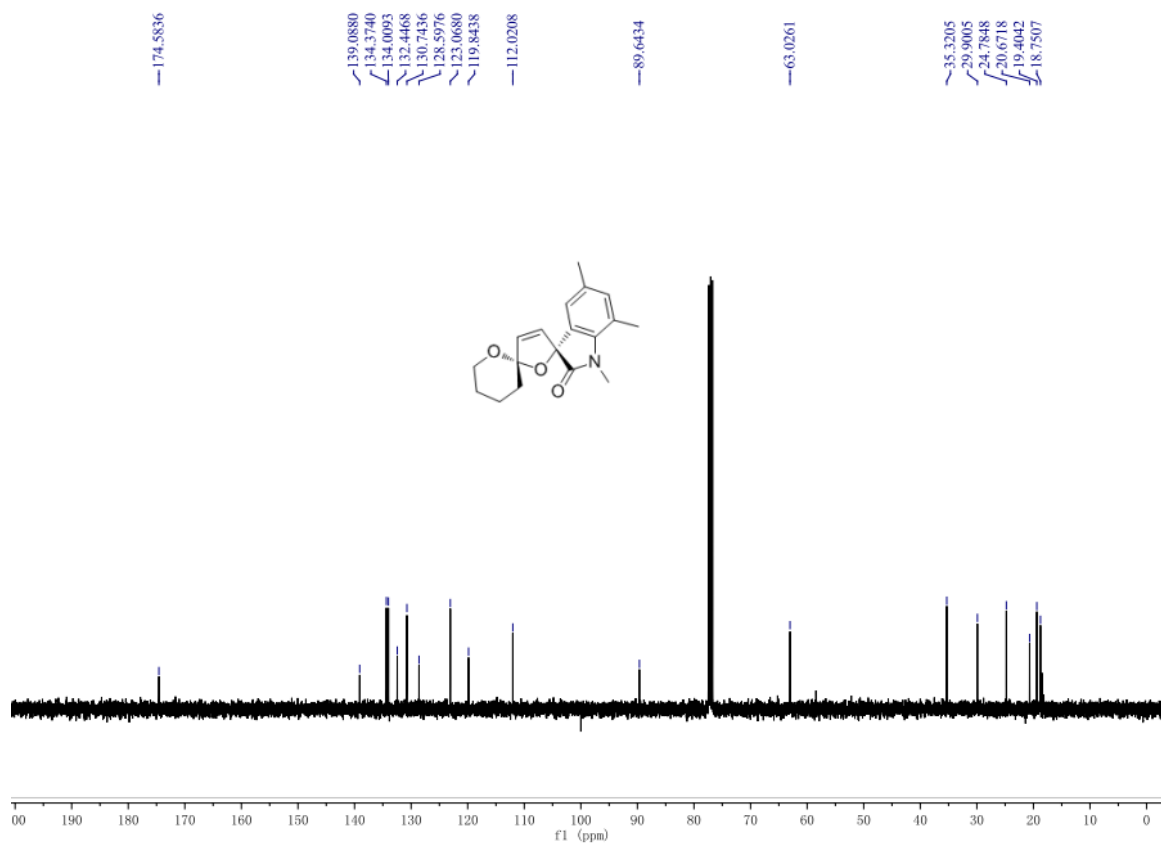


¹³C NMR spectrum of **2n**

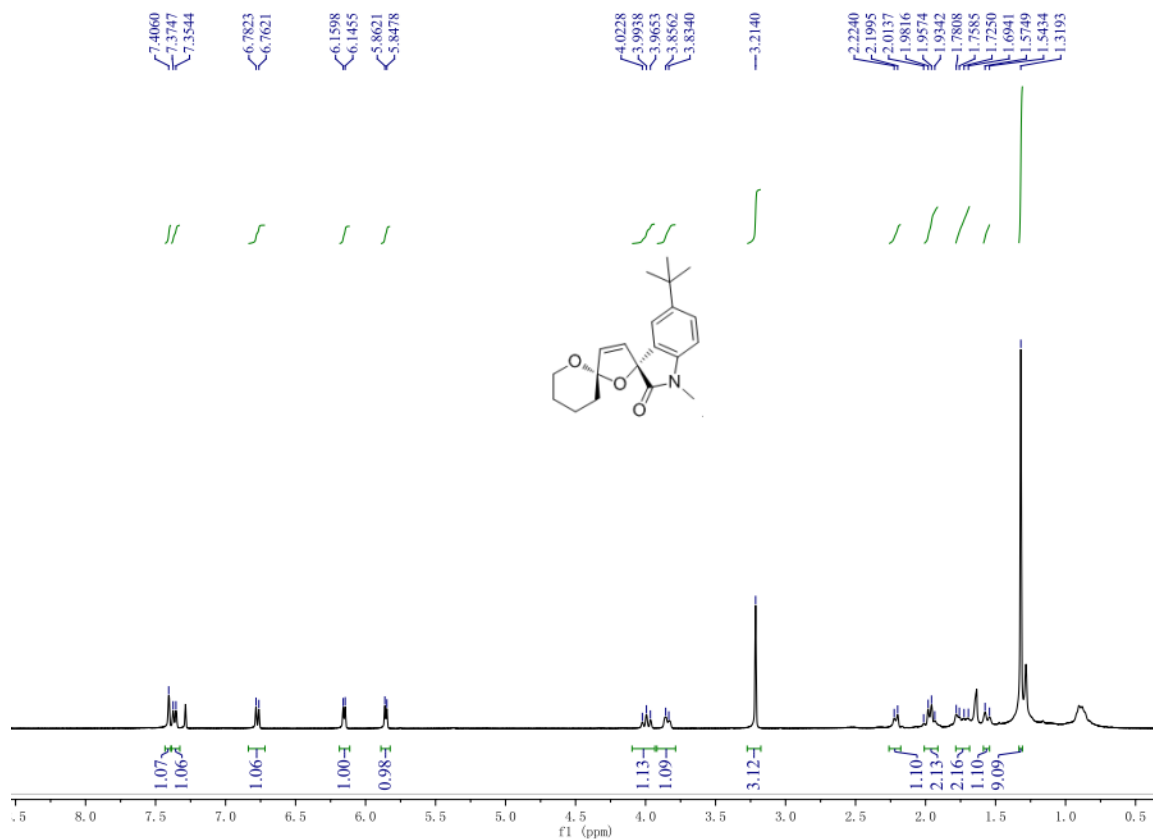




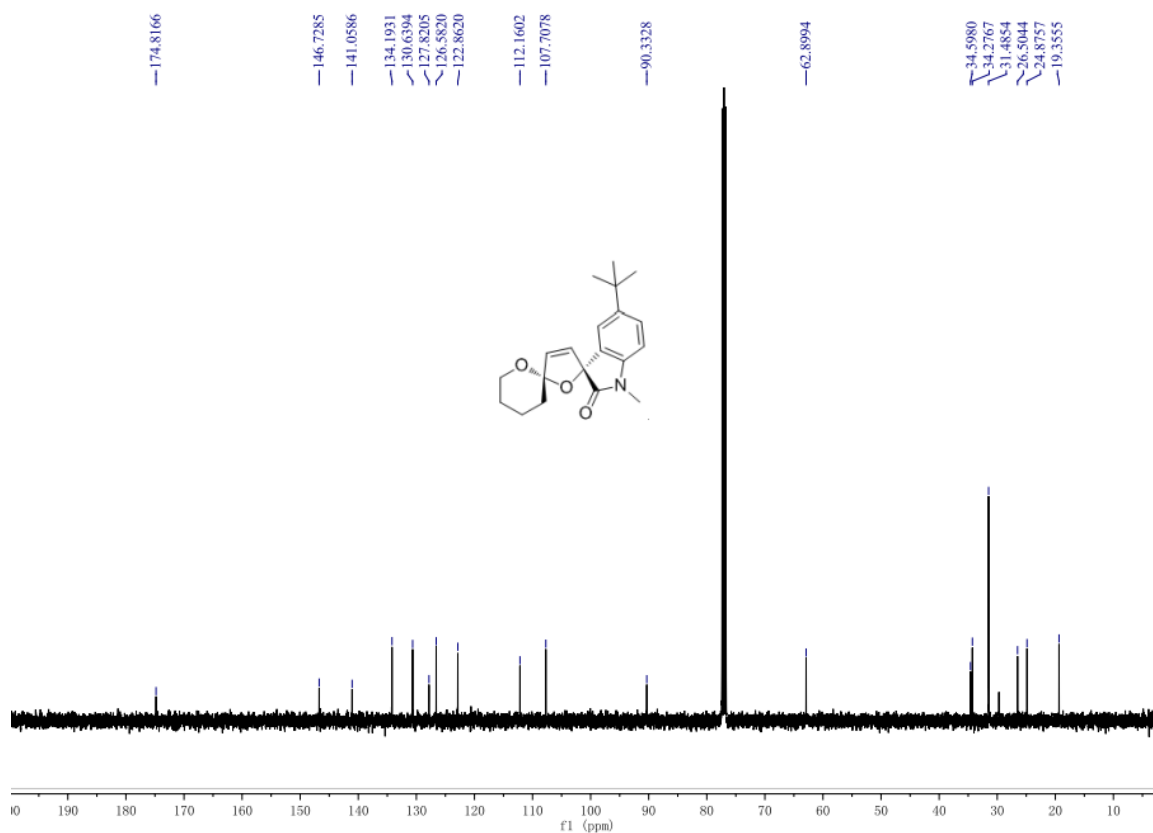
¹H NMR spectrum of 2p



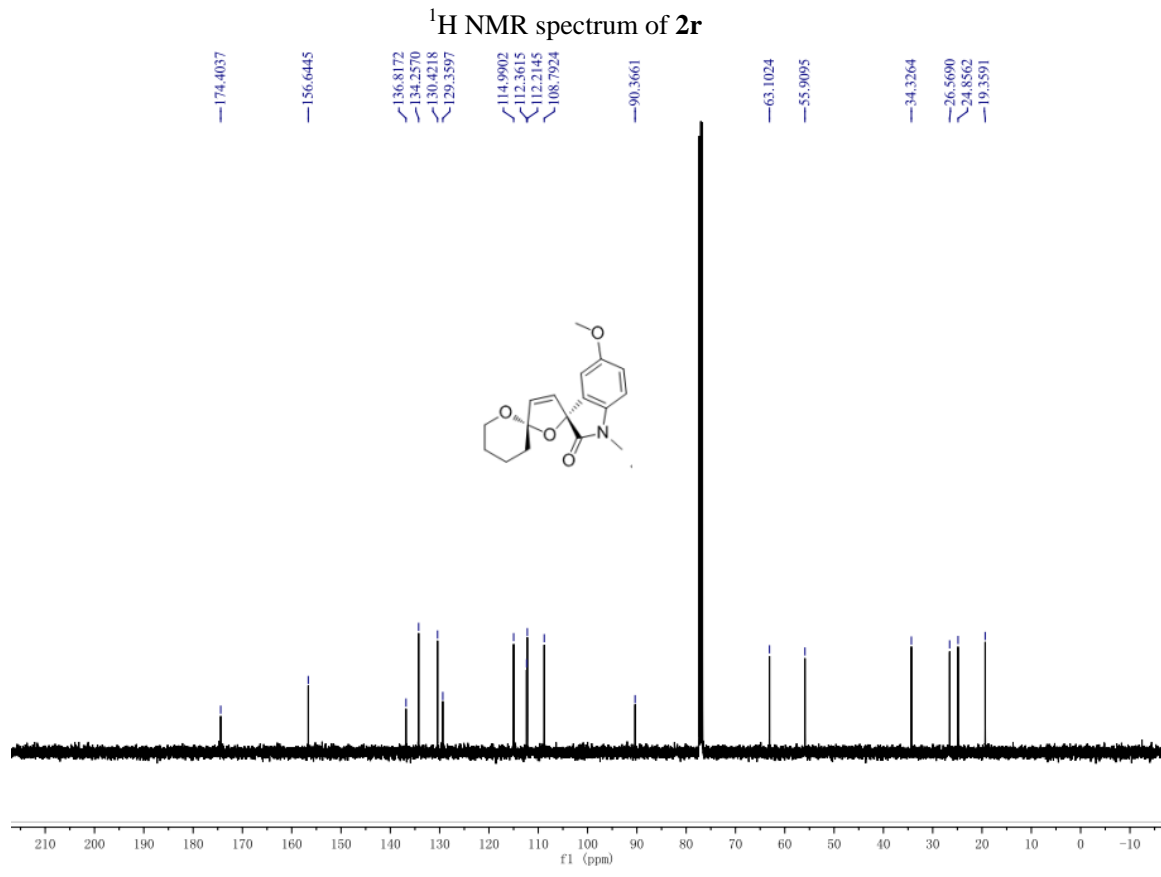
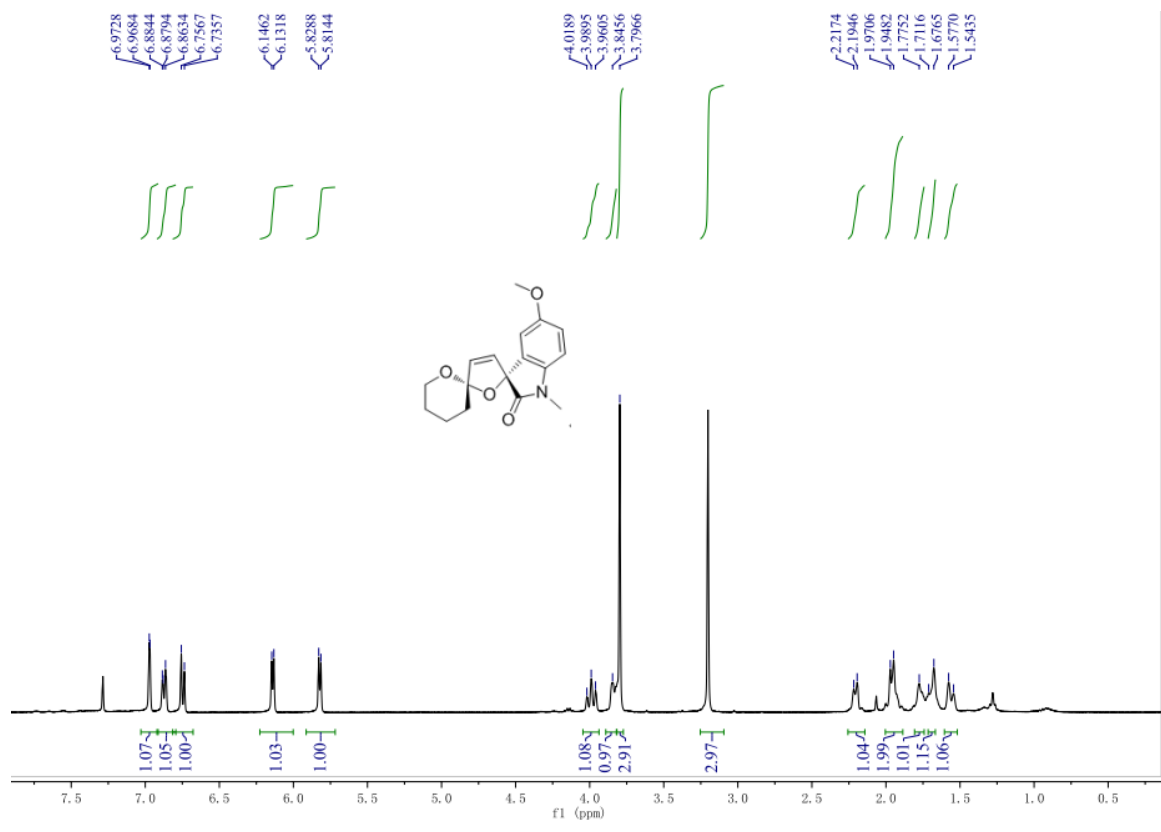
¹³C NMR spectrum of 2p

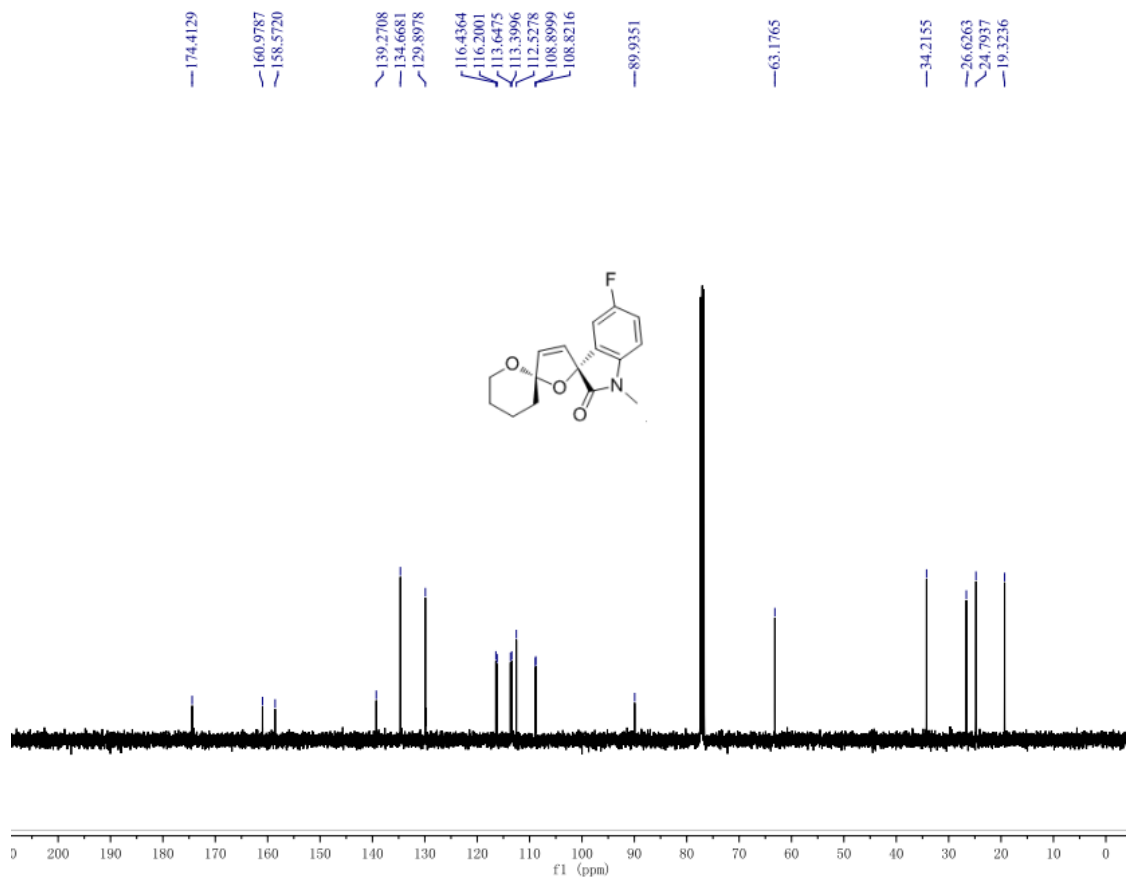


¹H NMR spectrum of 2q

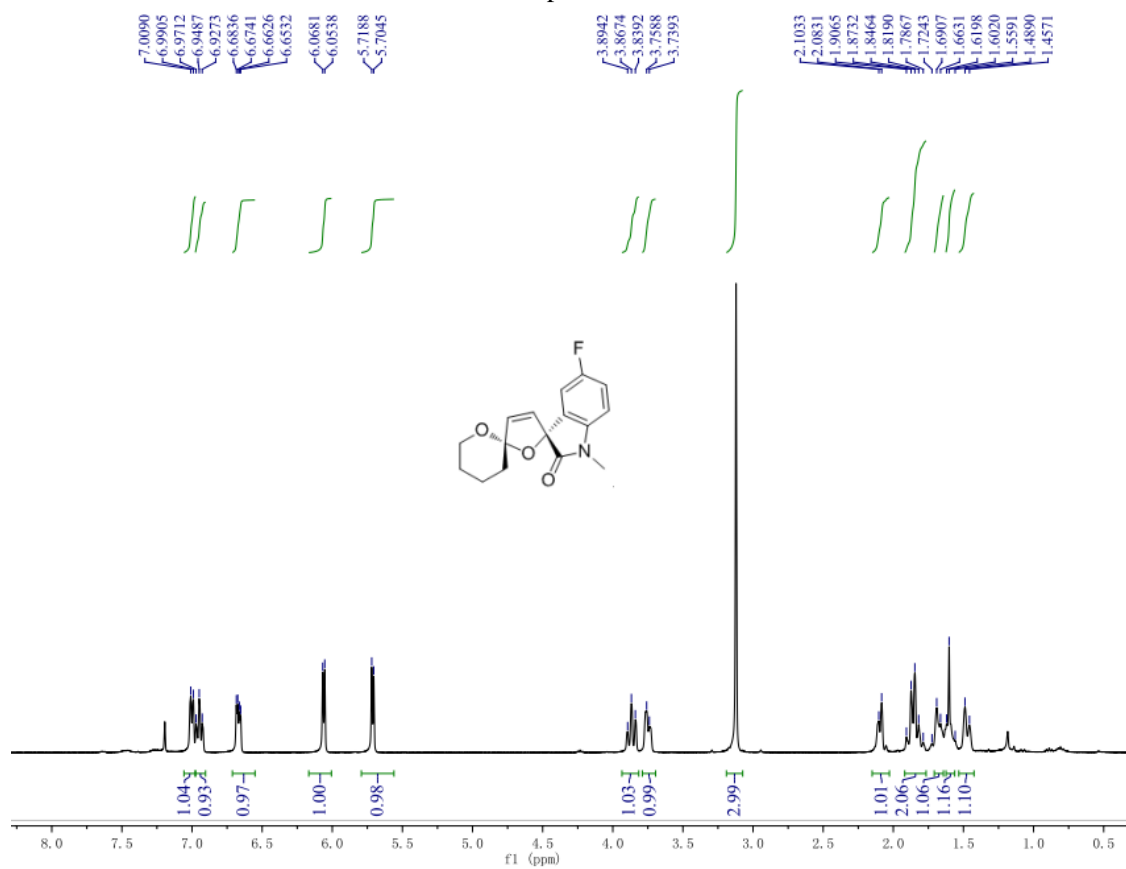


¹³C NMR spectrum of 2q

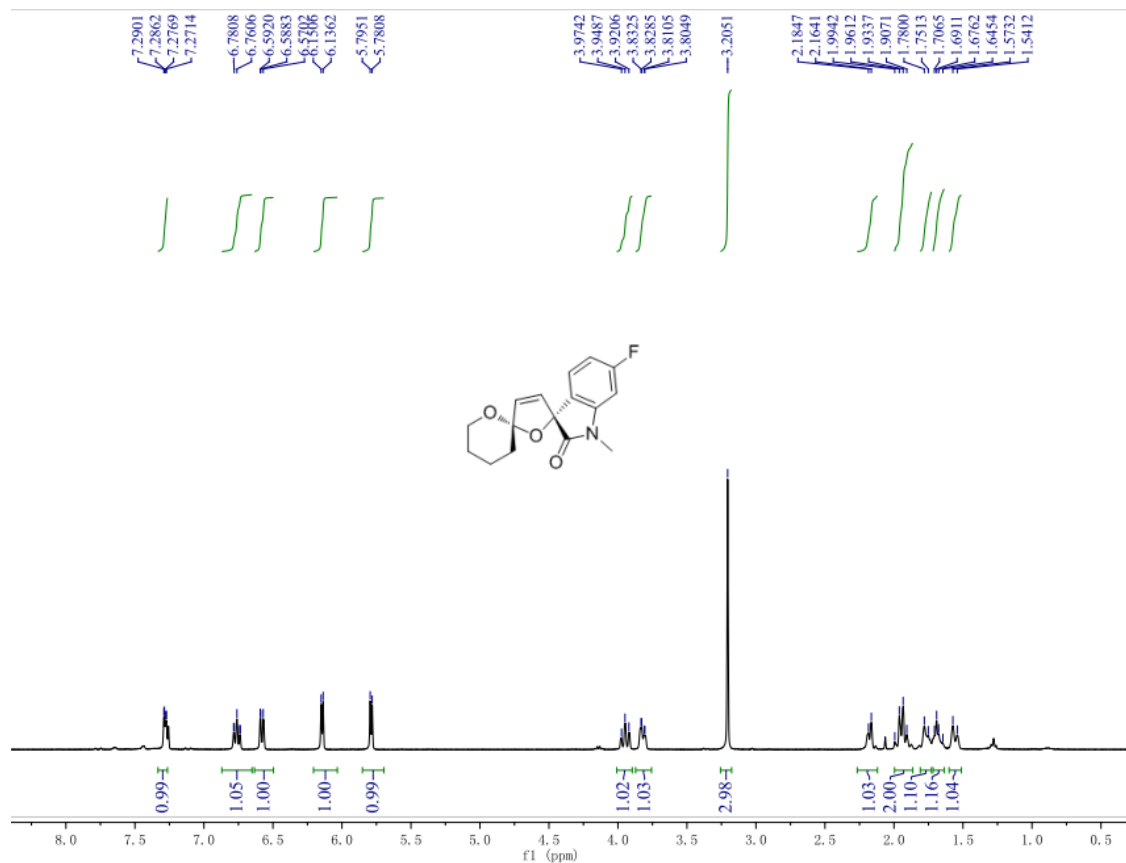




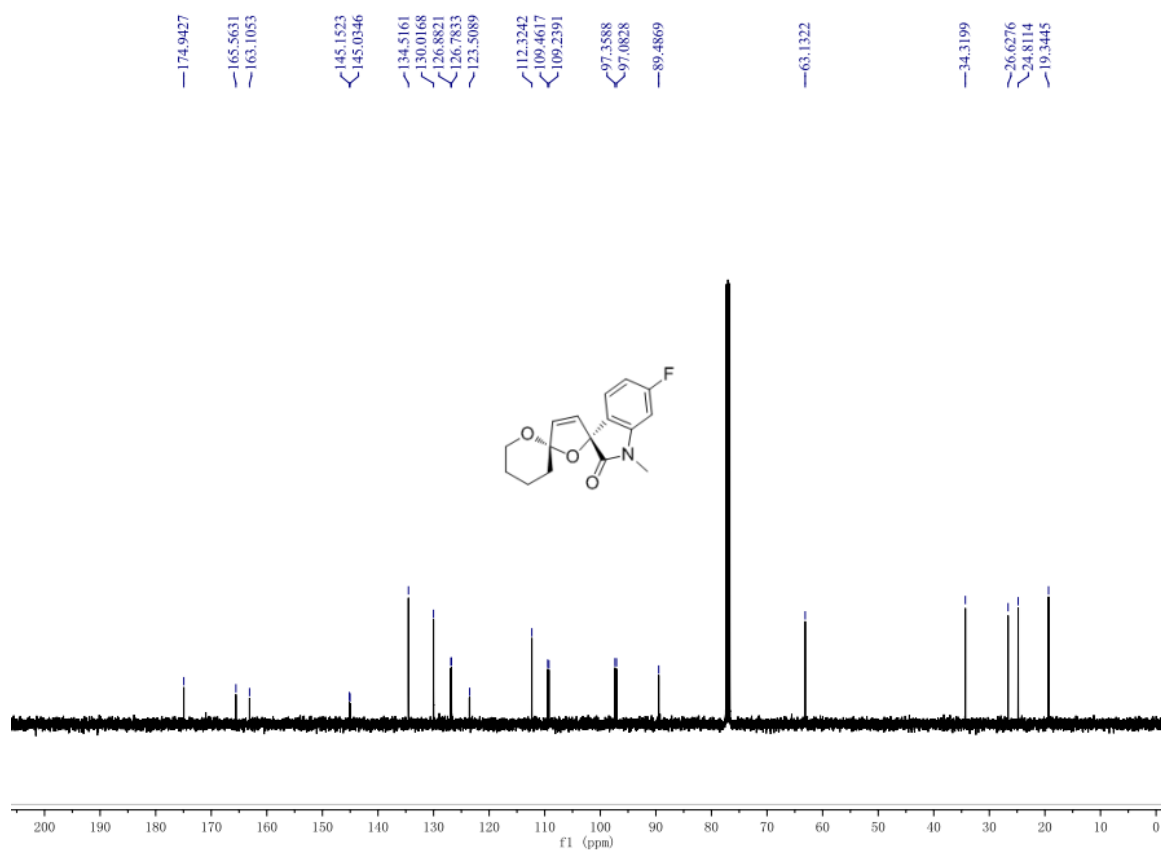
¹H NMR spectrum of 2s



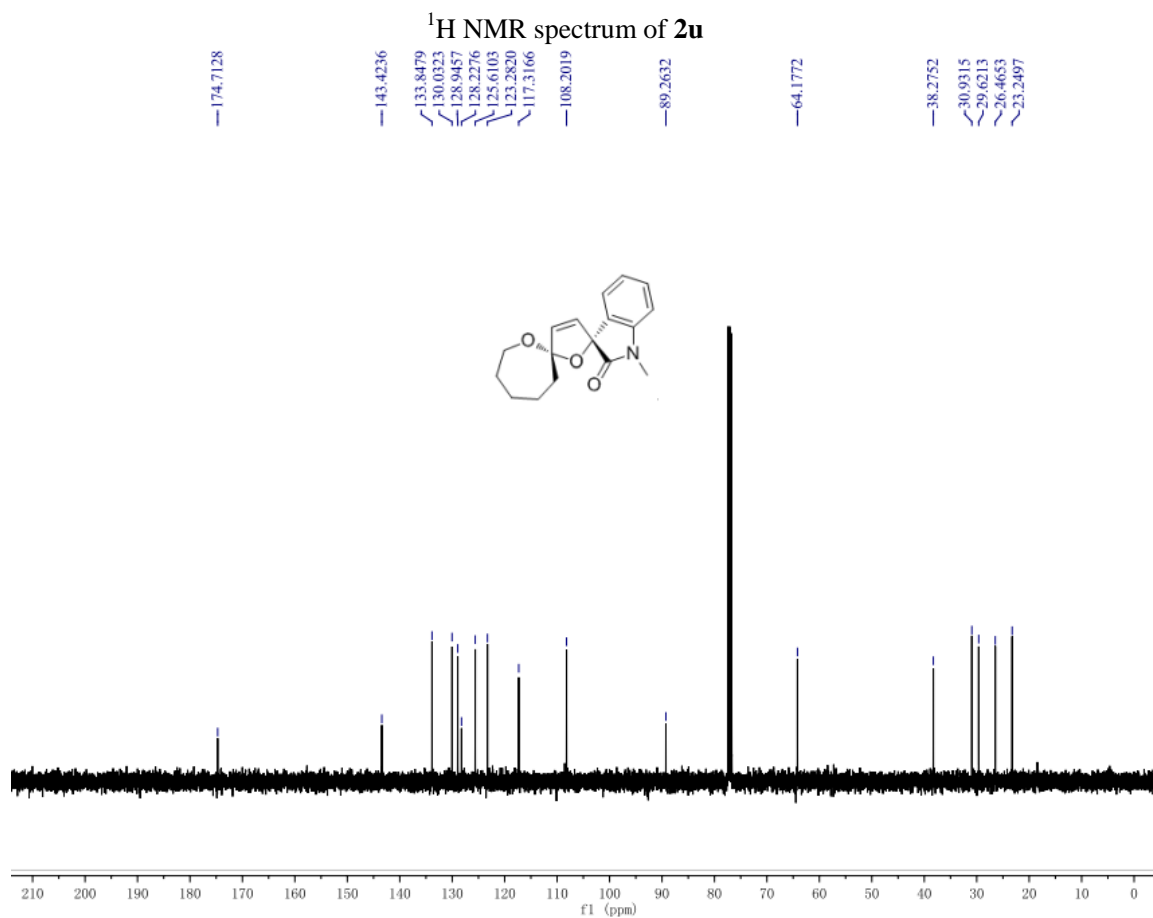
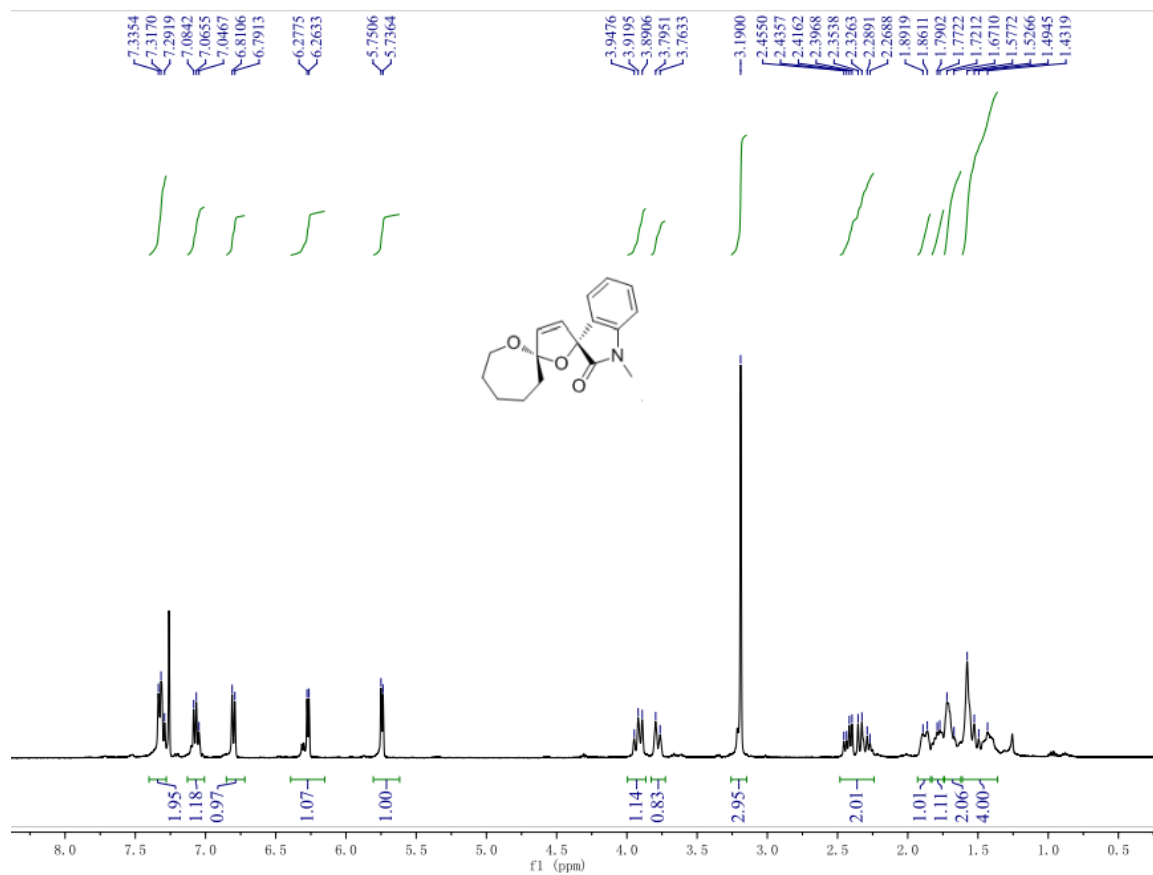
¹³C NMR spectrum of 2s

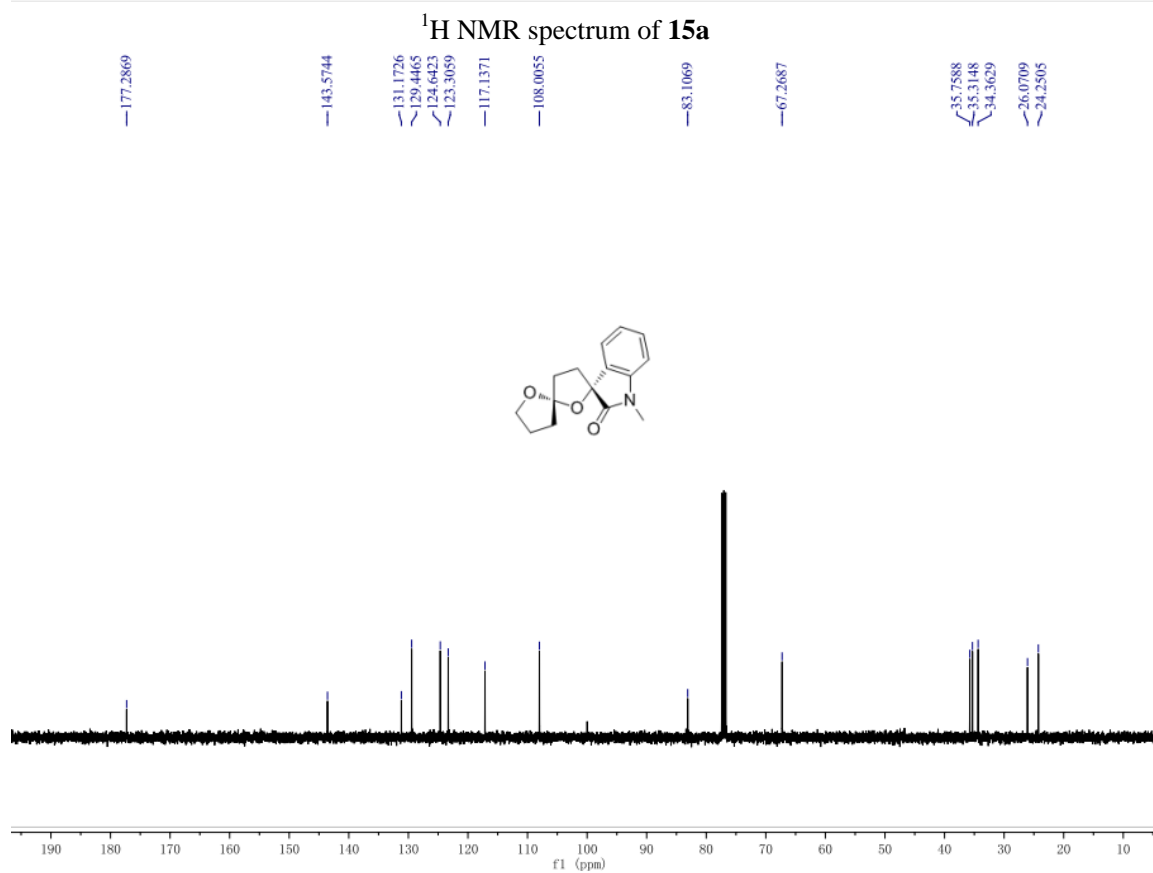
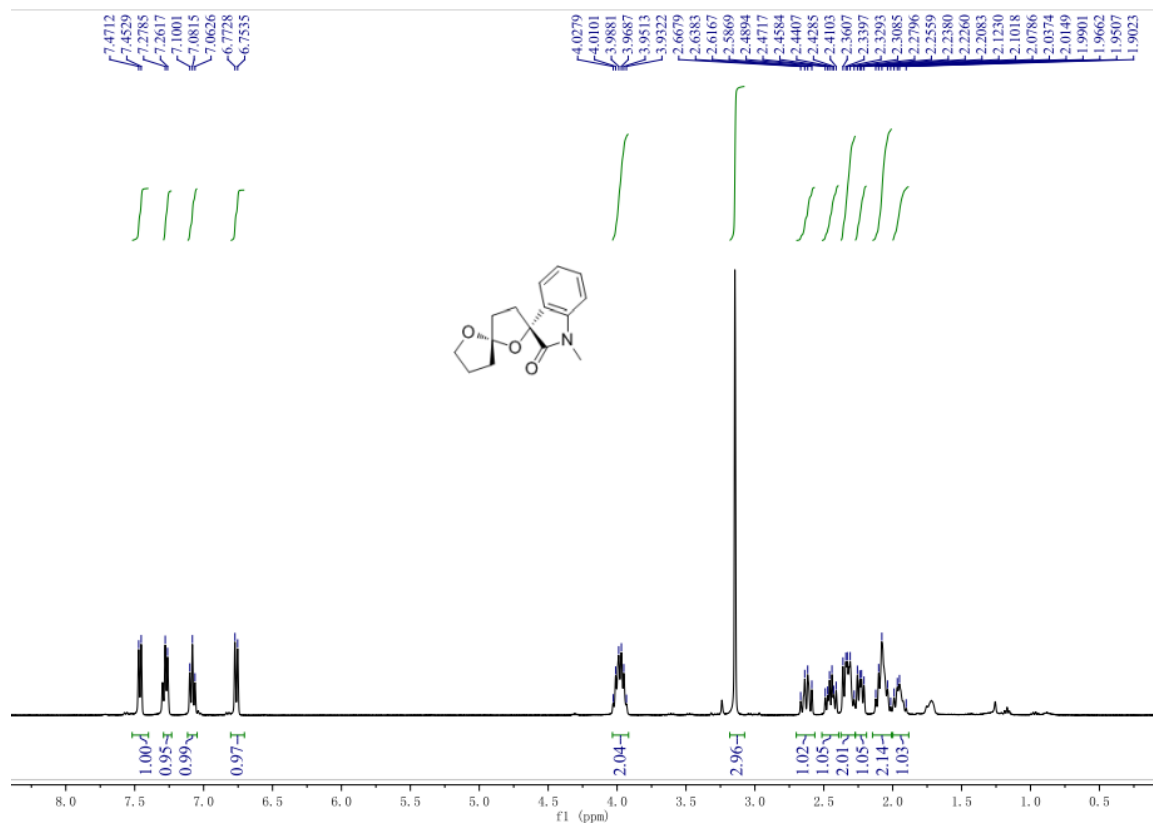


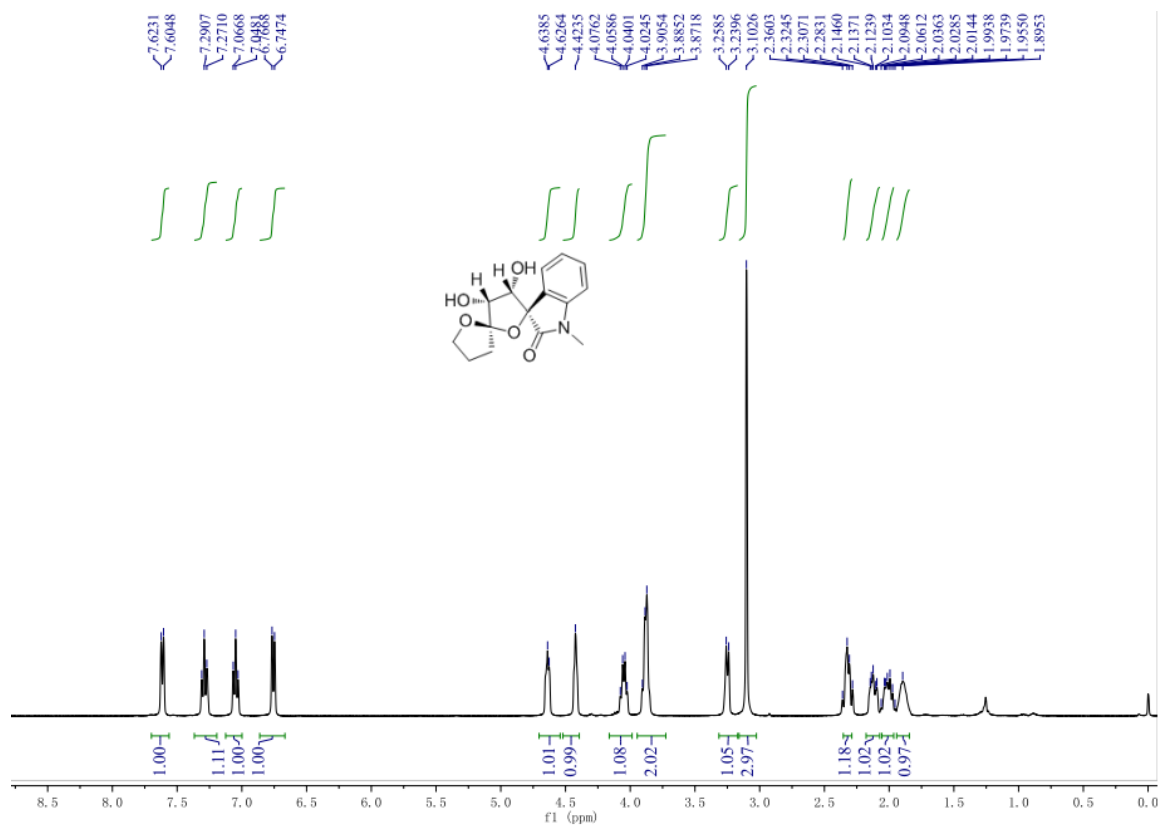
¹H NMR spectrum of 2t



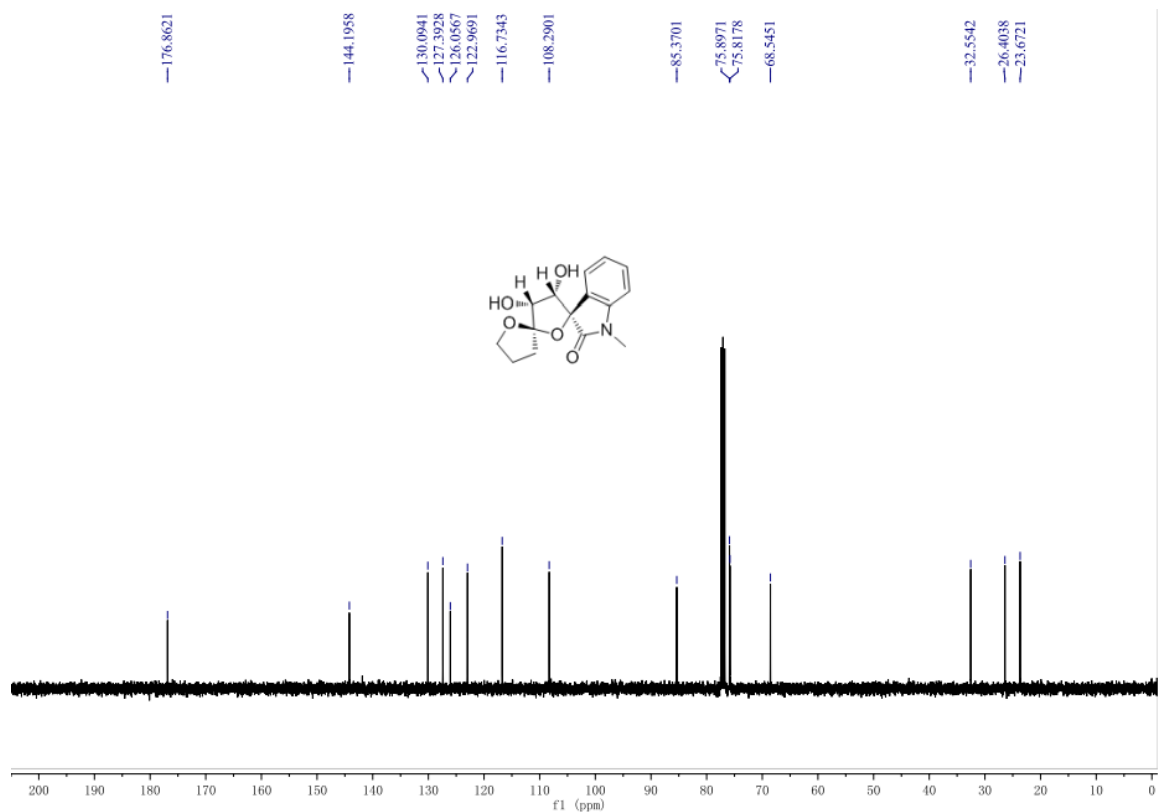
¹³C NMR spectrum of 2t



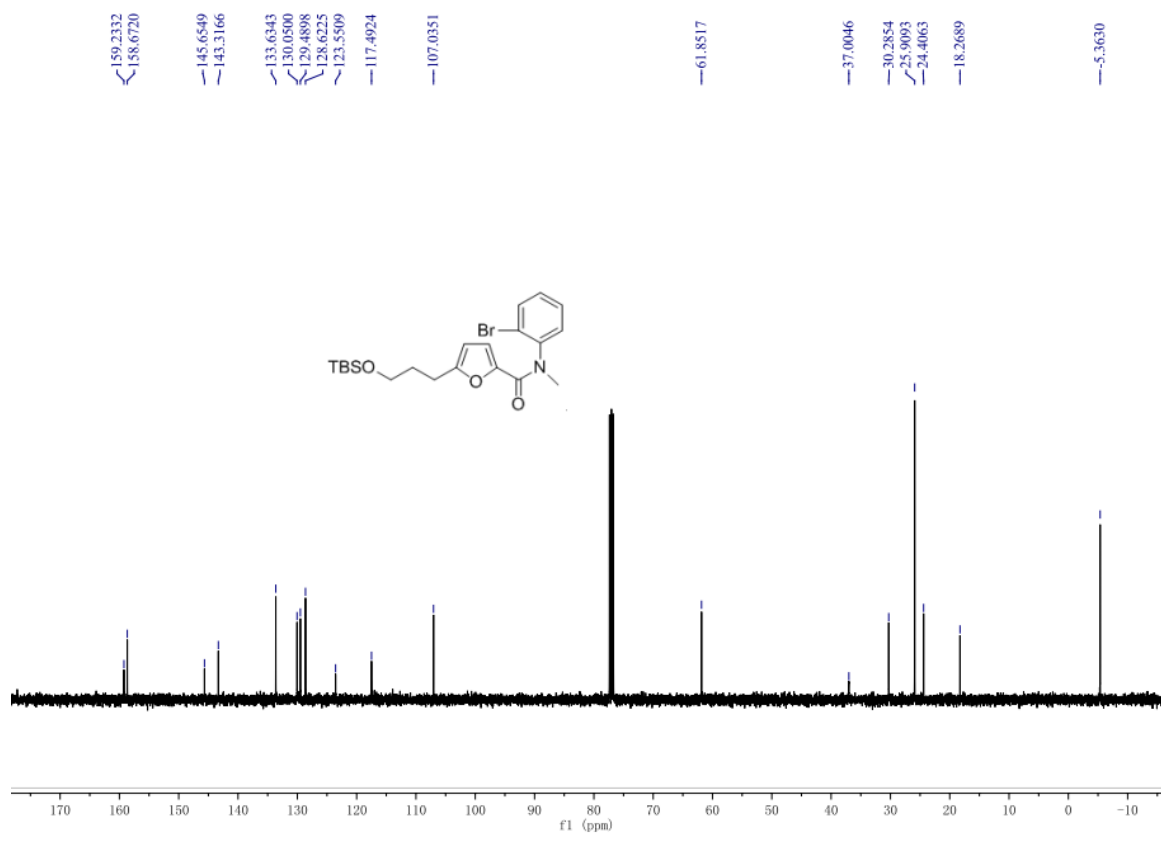
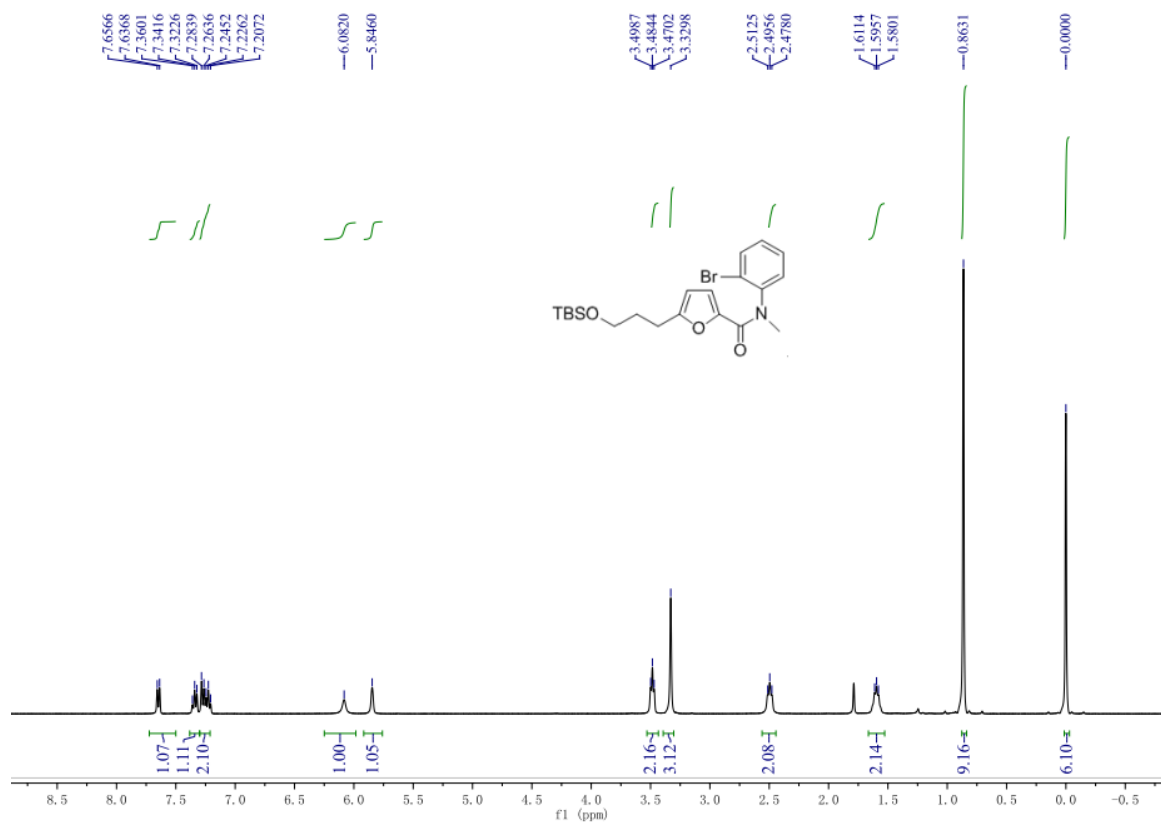


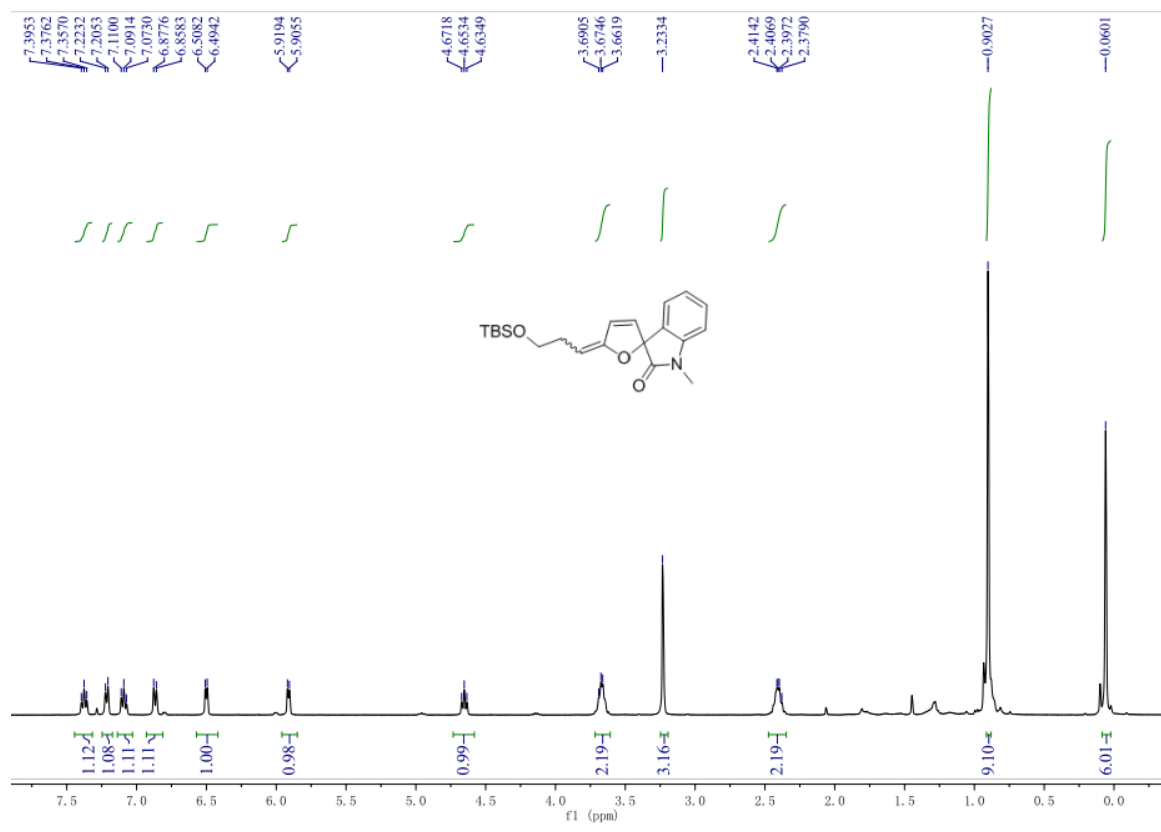


¹H NMR spectrum of 16a

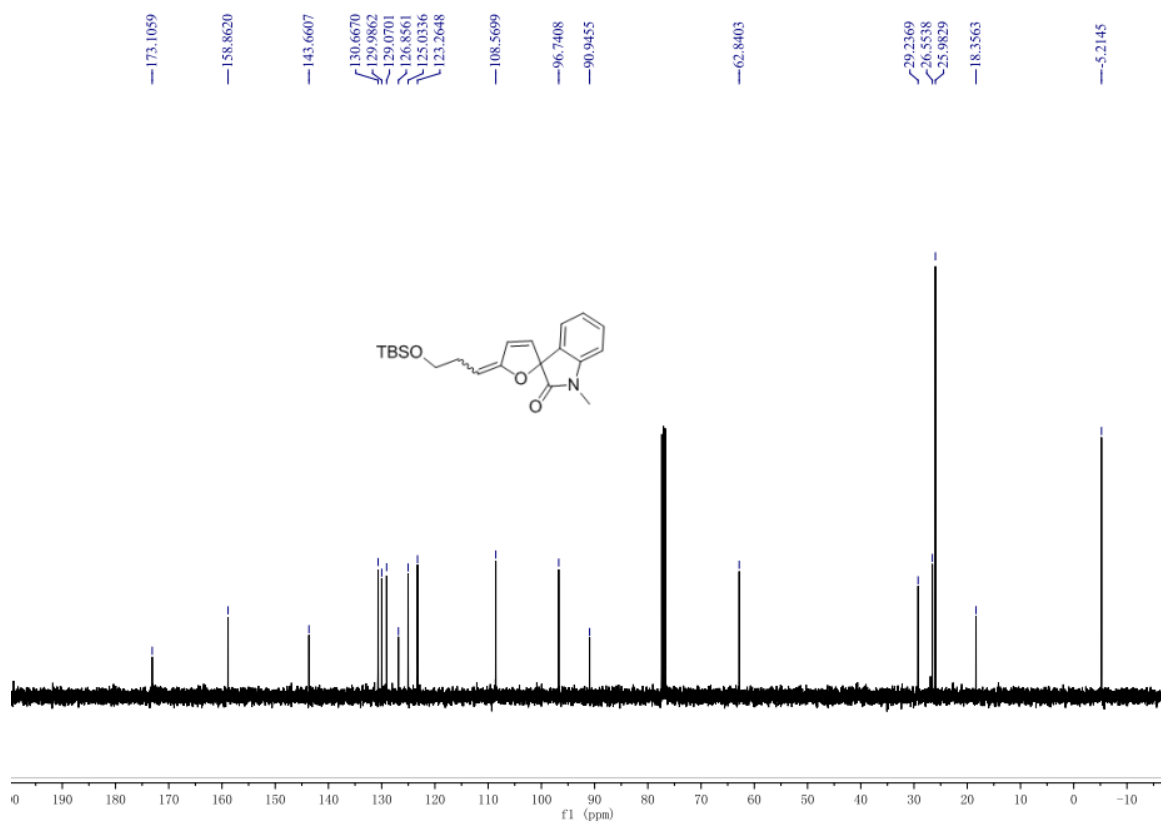


¹³C NMR spectrum of 16a

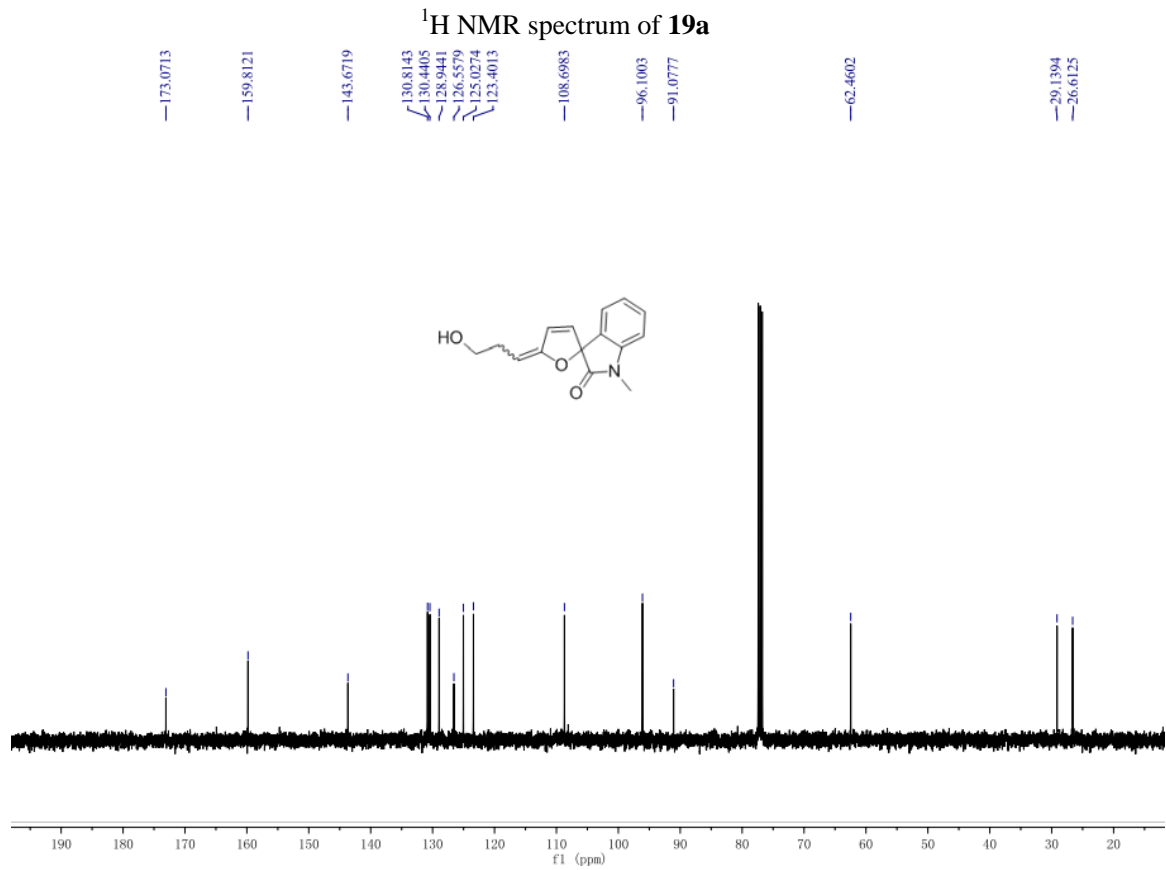
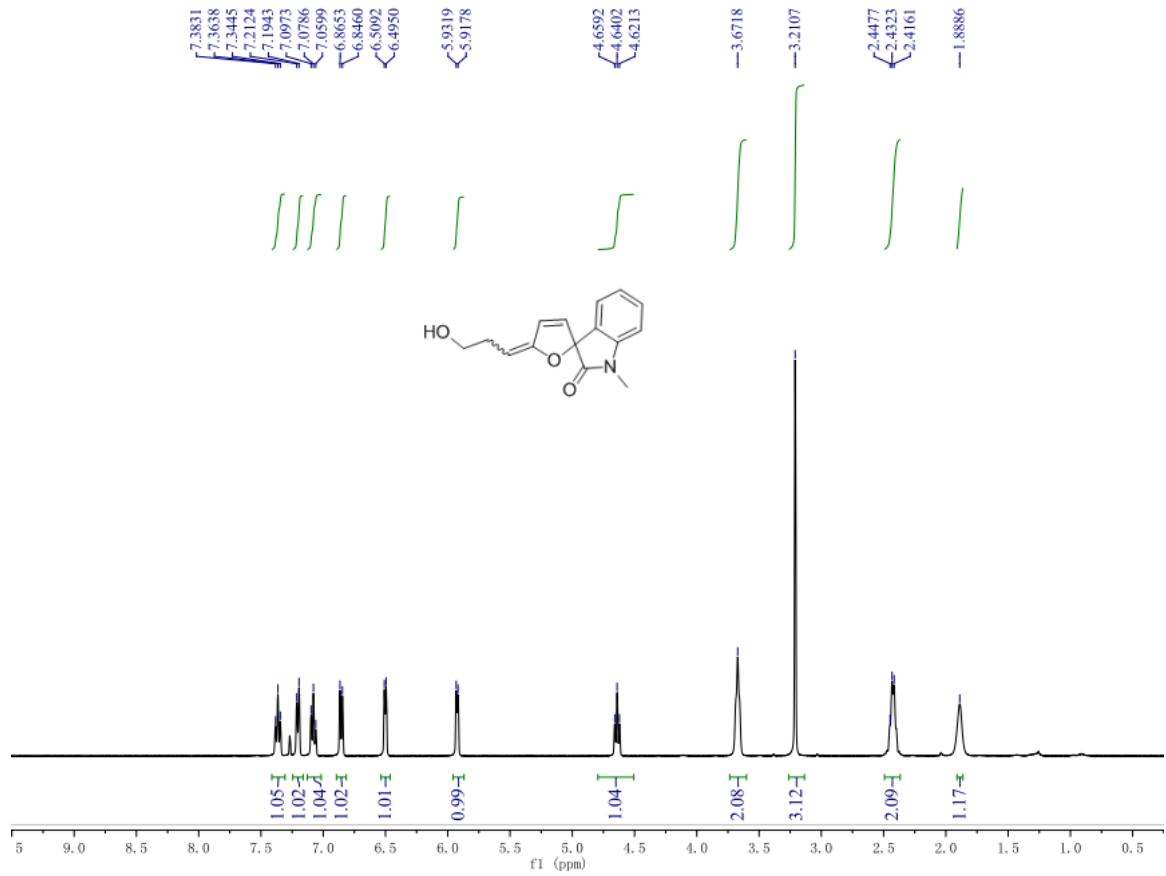


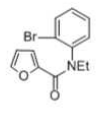
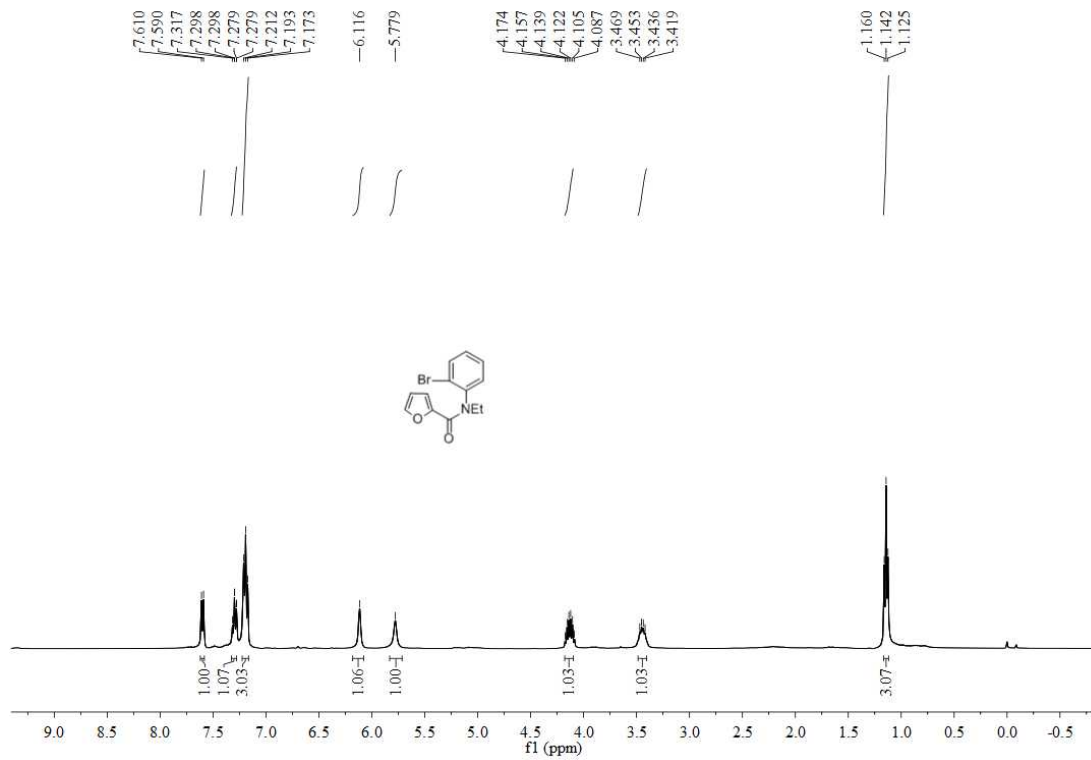


¹H NMR spectrum of 18a

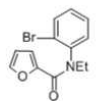
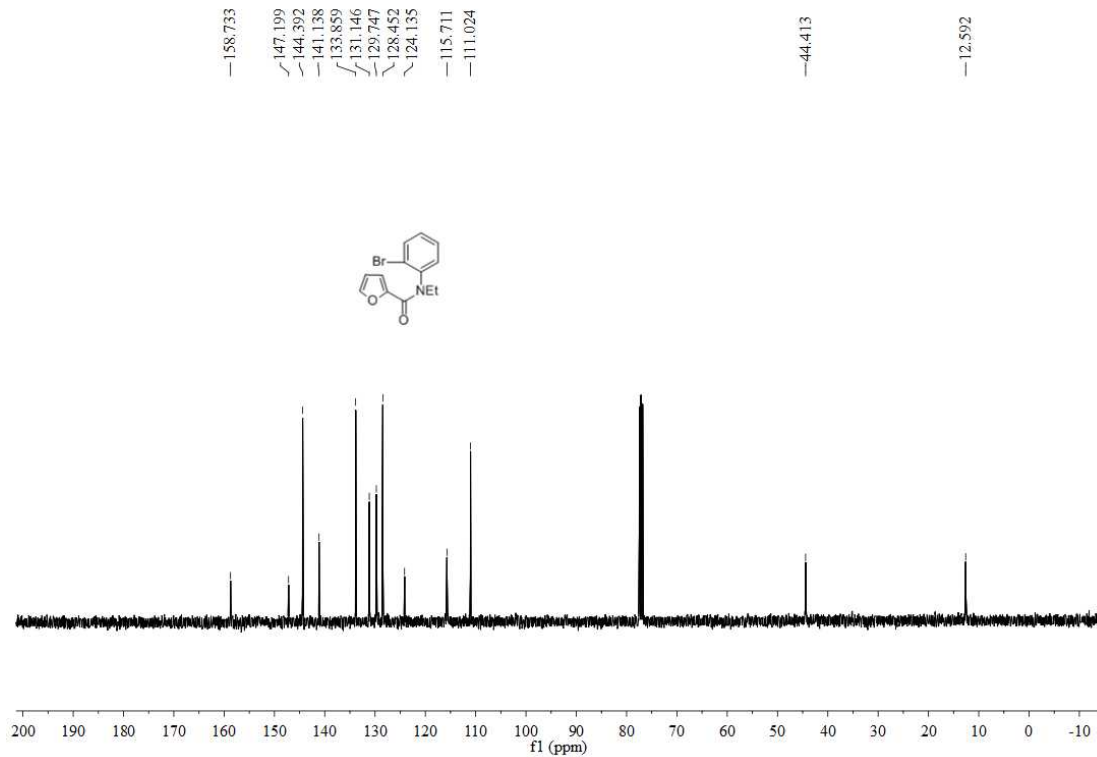


¹³C NMR spectrum of 18a

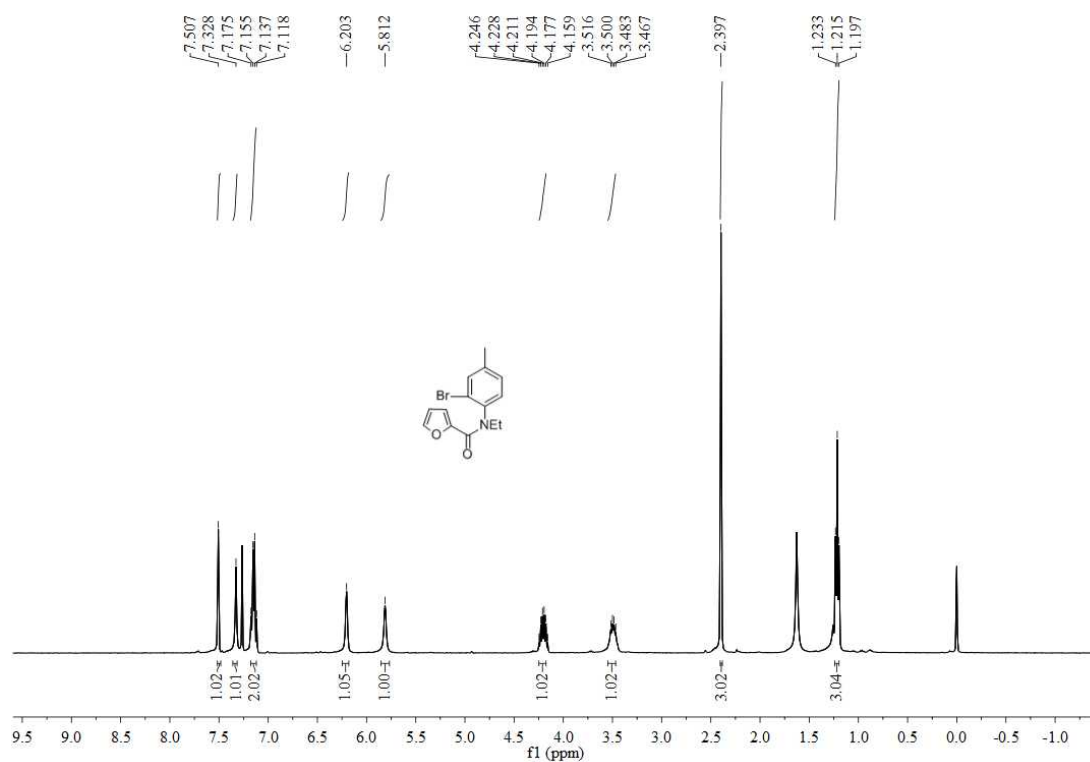




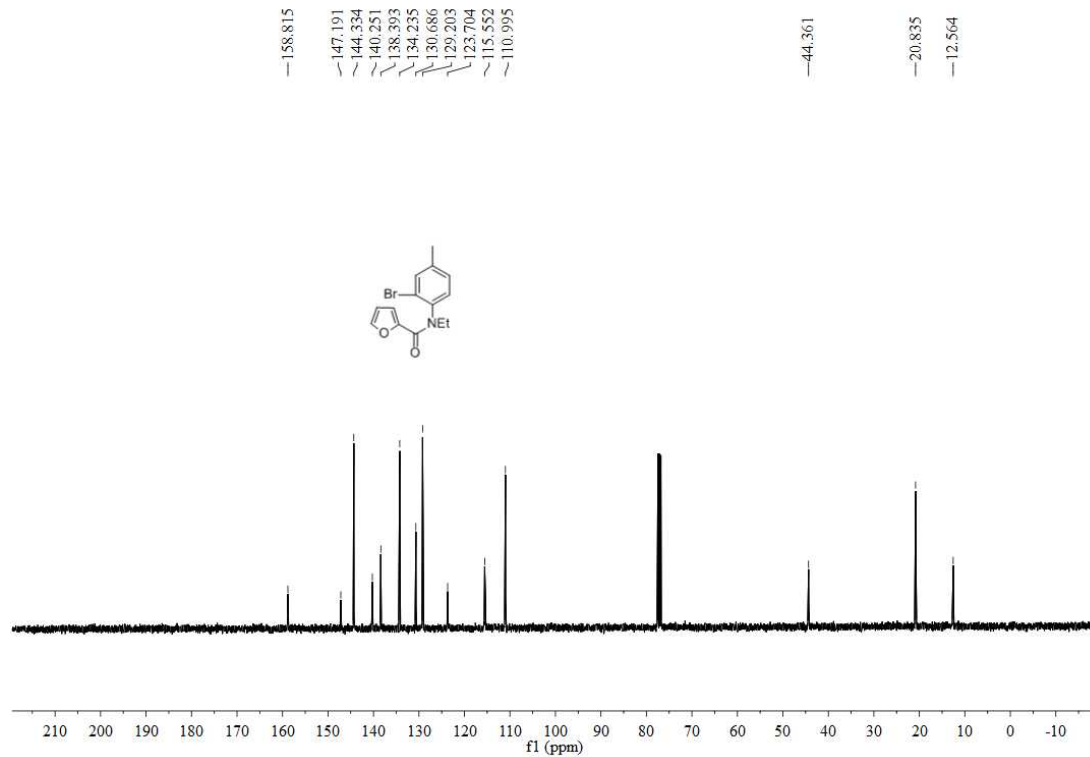
¹H NMR spectrum of **12a**



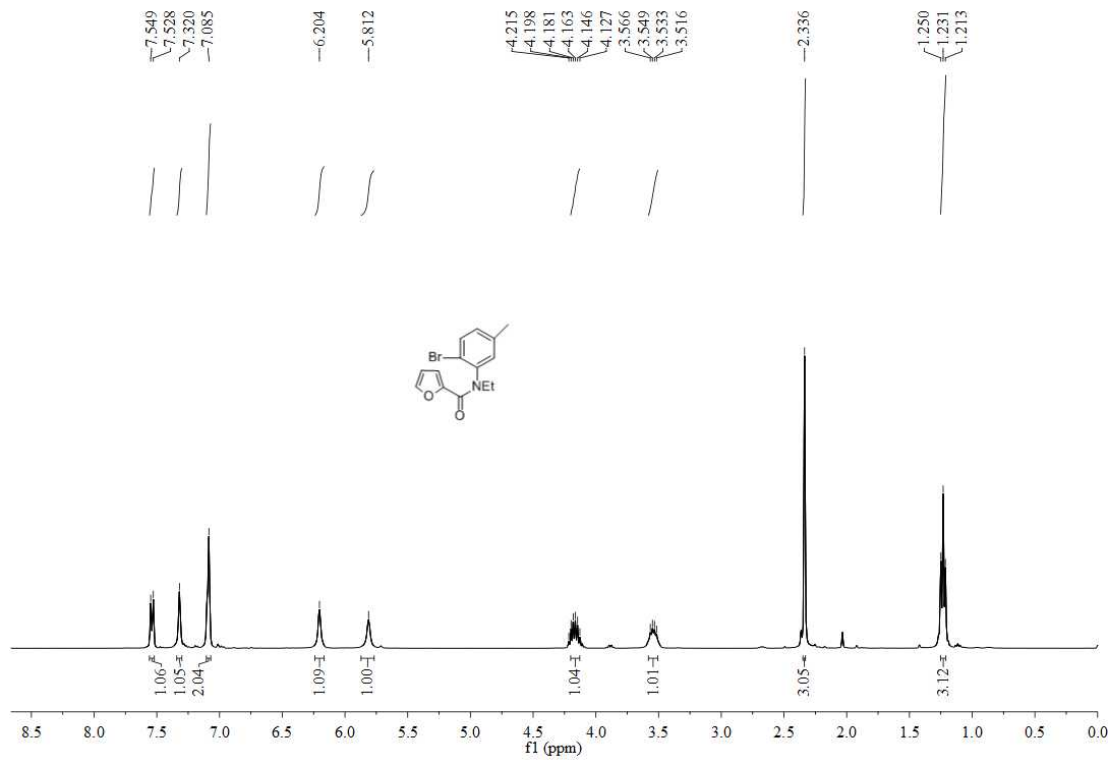
¹³C NMR spectrum of **12a**



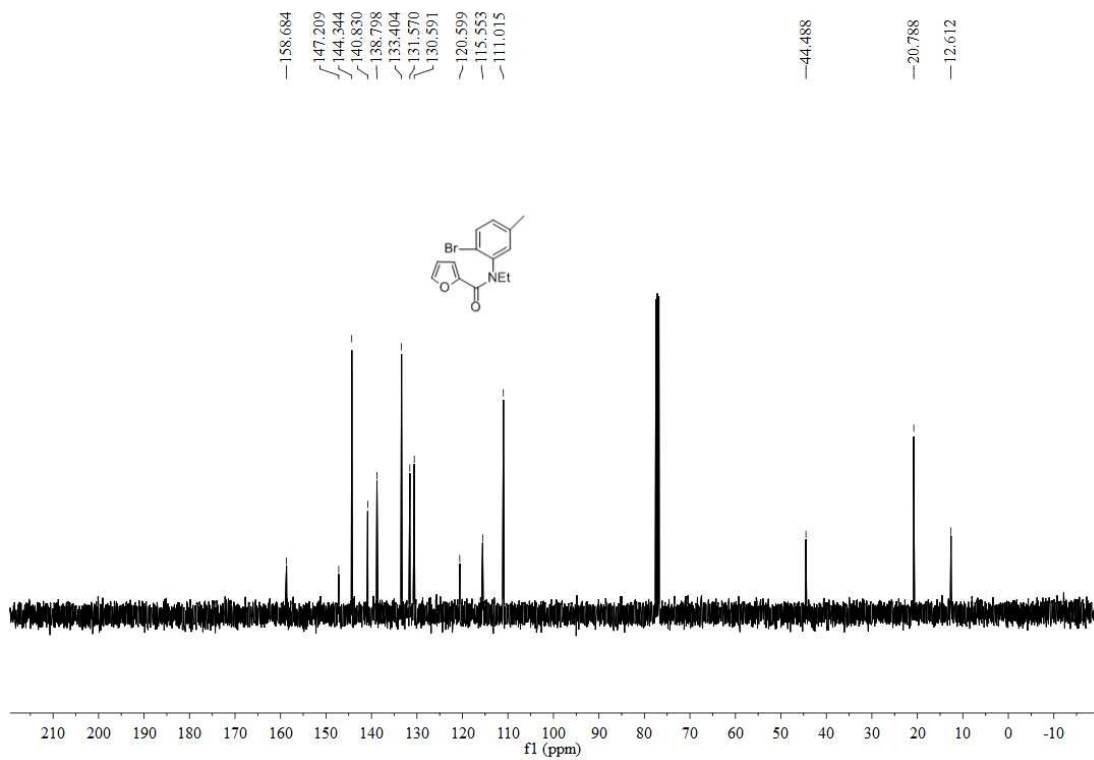
¹H NMR spectrum of **12b**



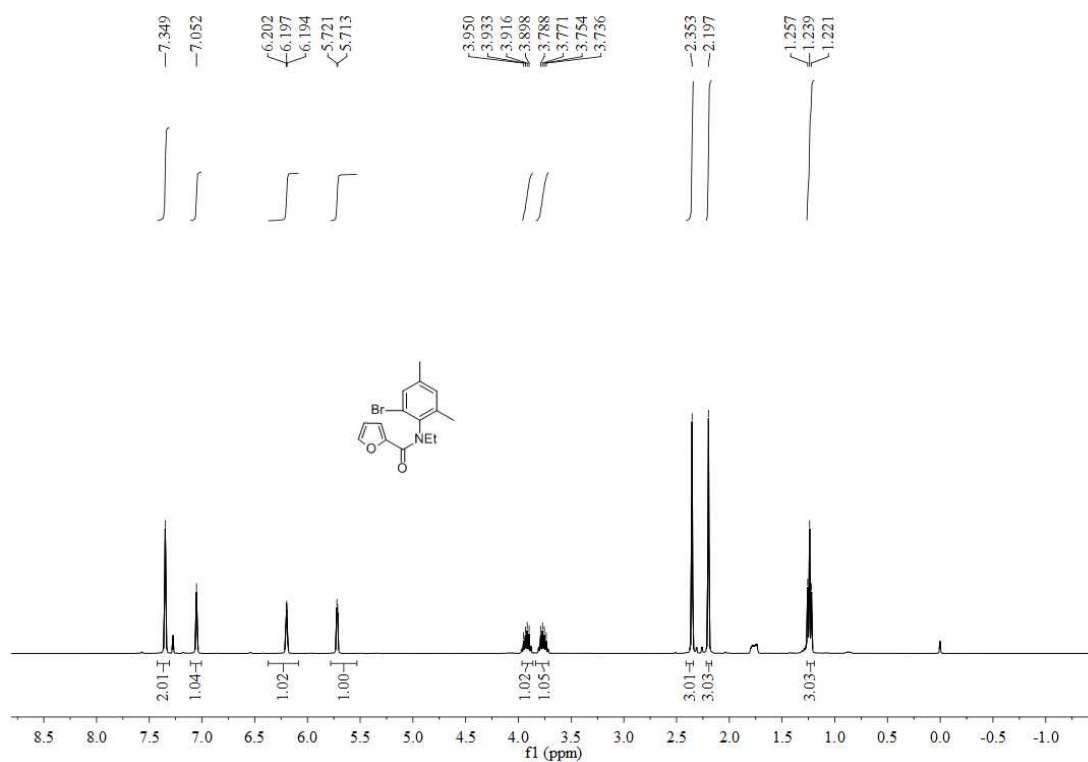
¹³C NMR spectrum of **12b**



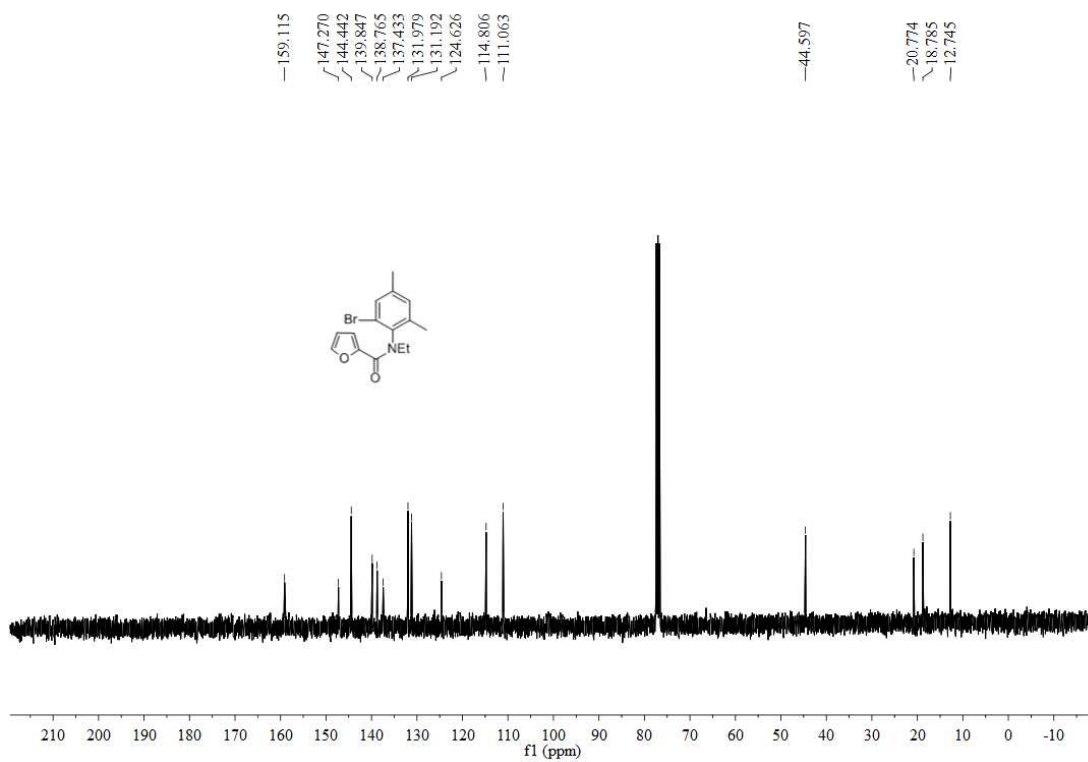
¹H NMR spectrum of 12c



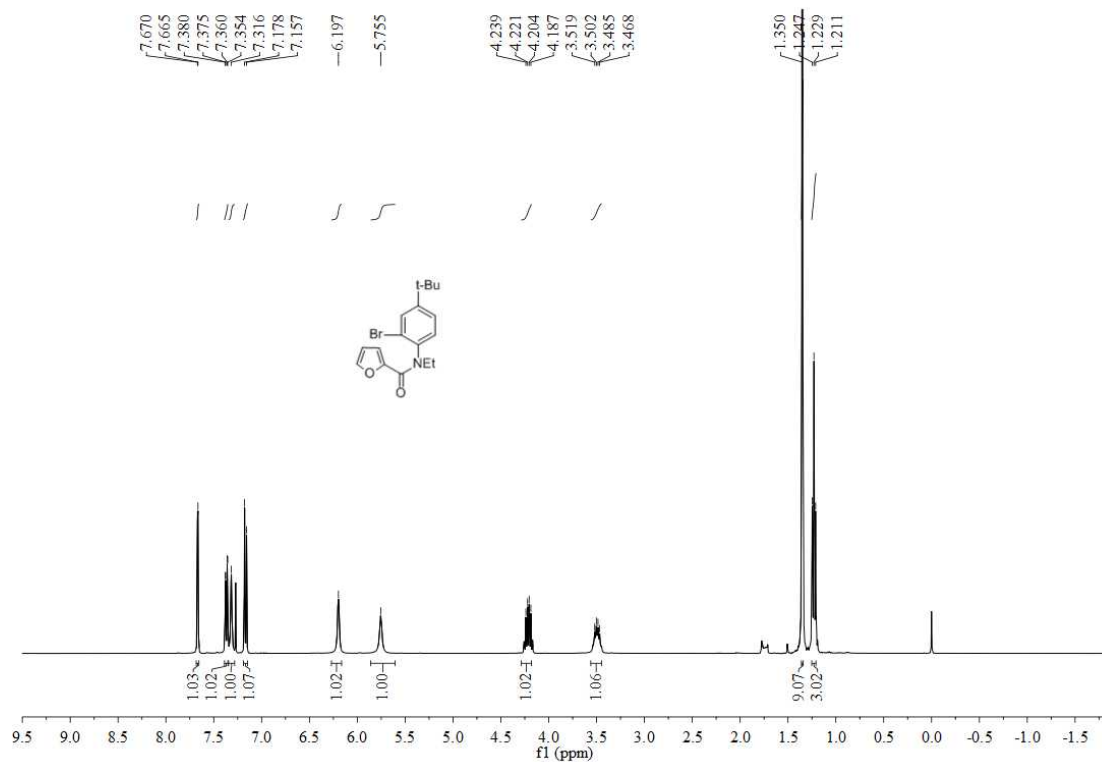
¹³C NMR spectrum of 12c



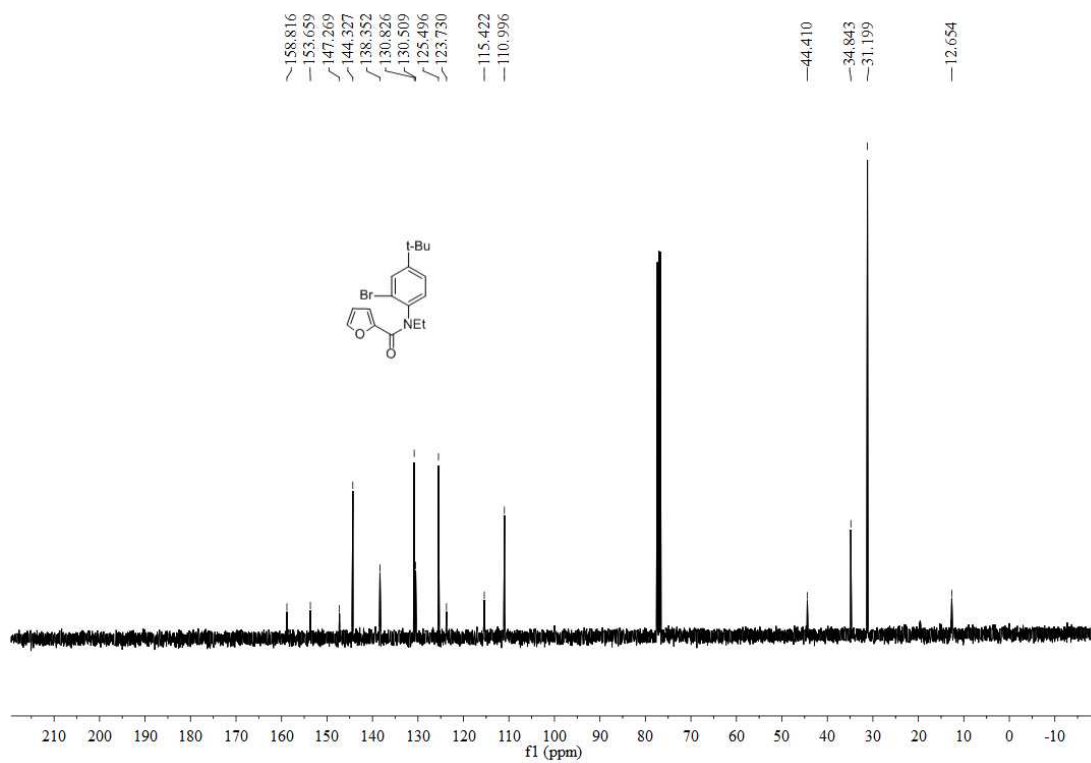
¹H NMR spectrum of 12d



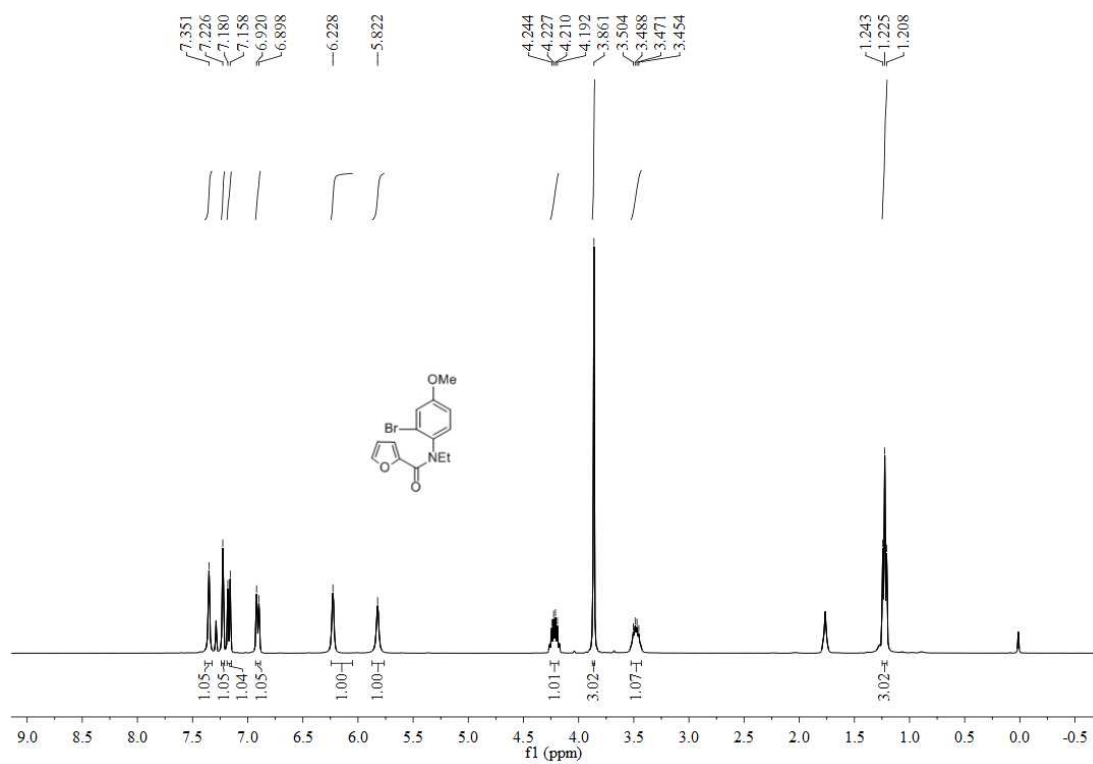
¹³C NMR spectrum of 12d



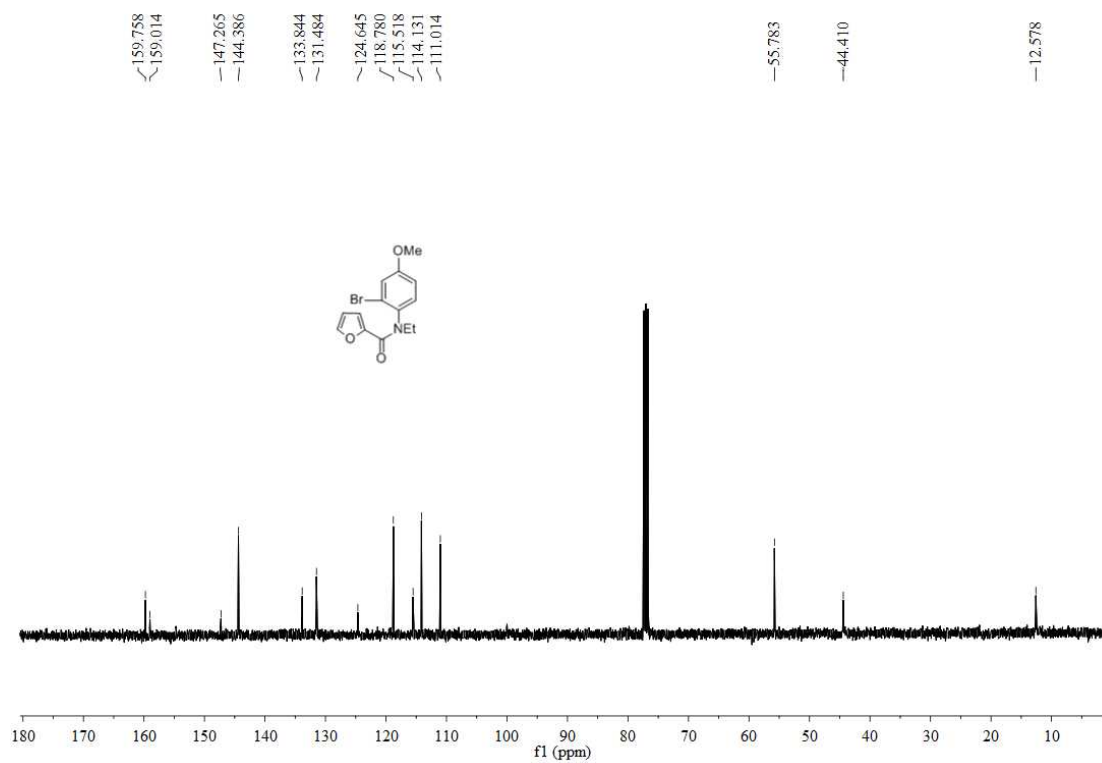
¹H NMR spectrum of 12e



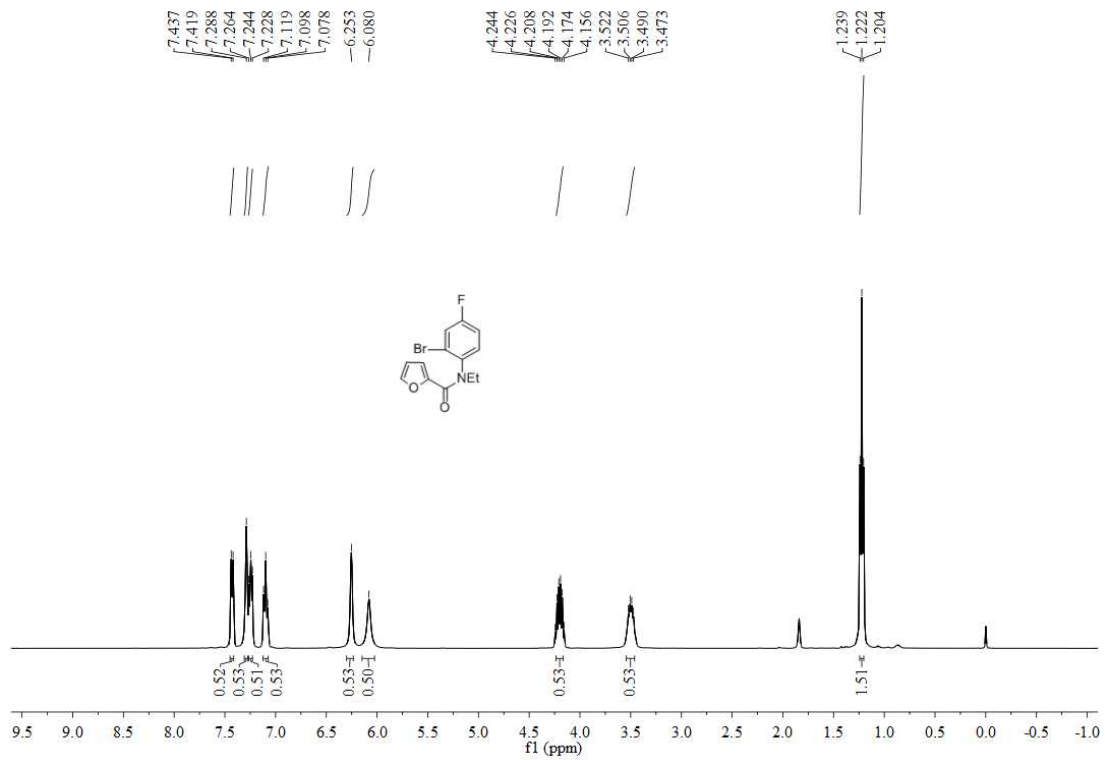
¹³C NMR spectrum of 12e



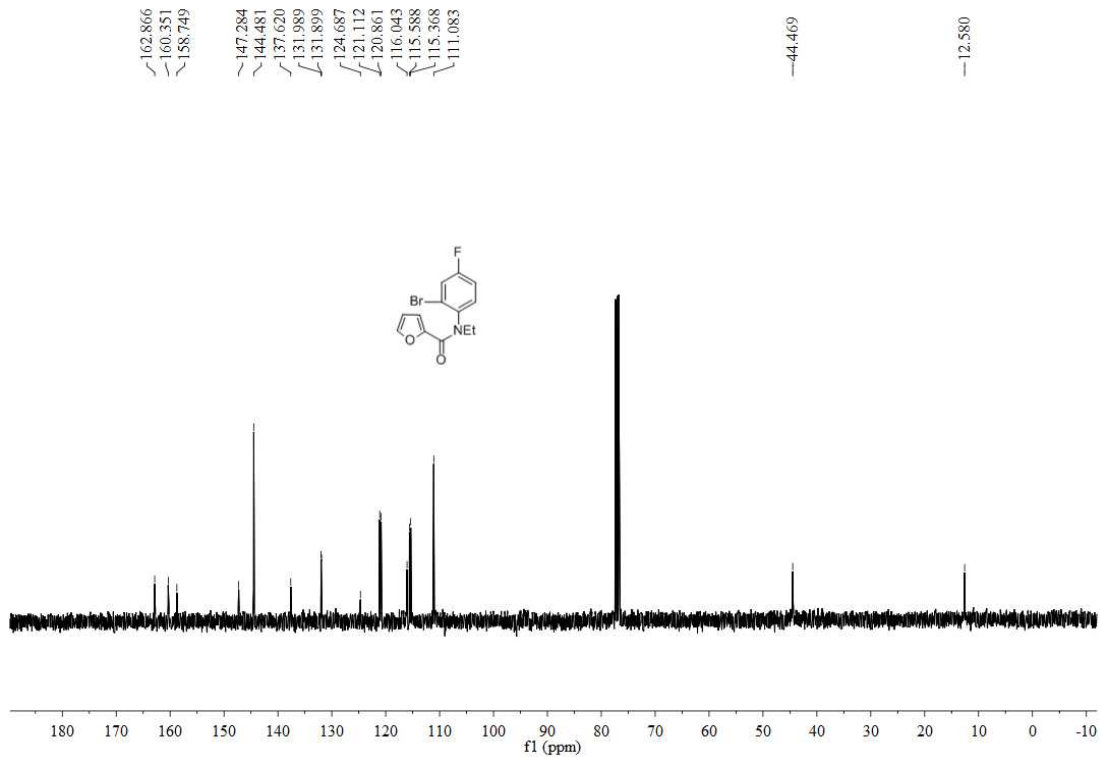
¹H NMR spectrum of 12f



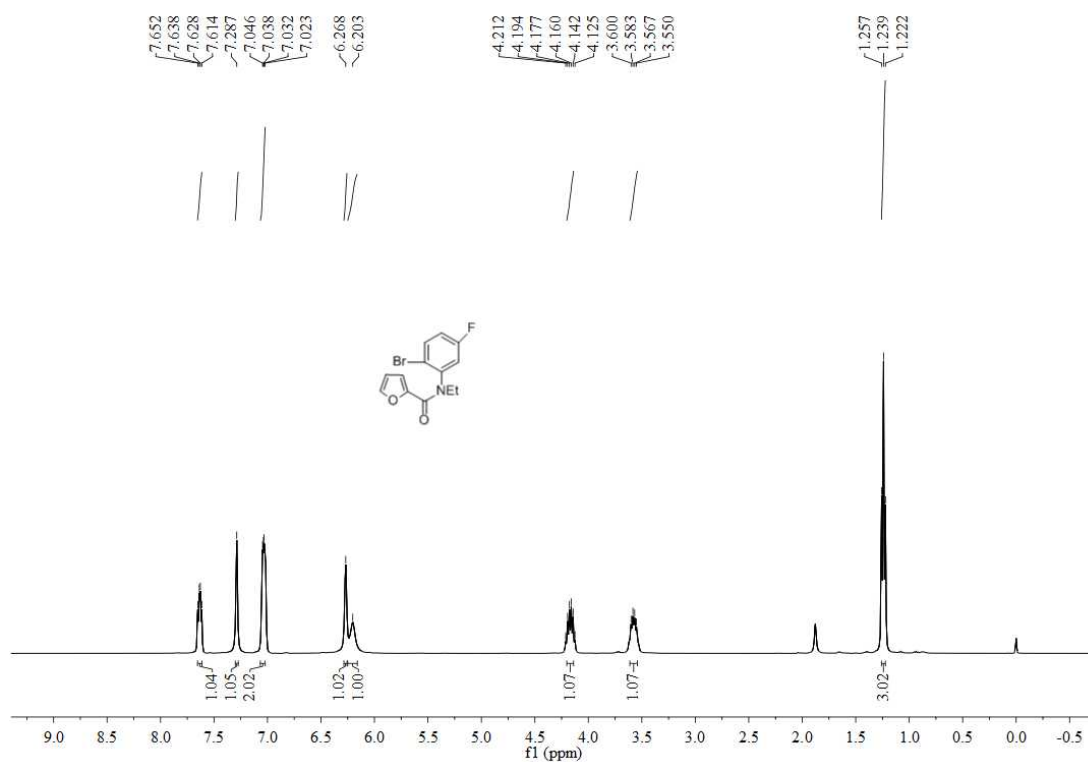
¹³C NMR spectrum of 12f



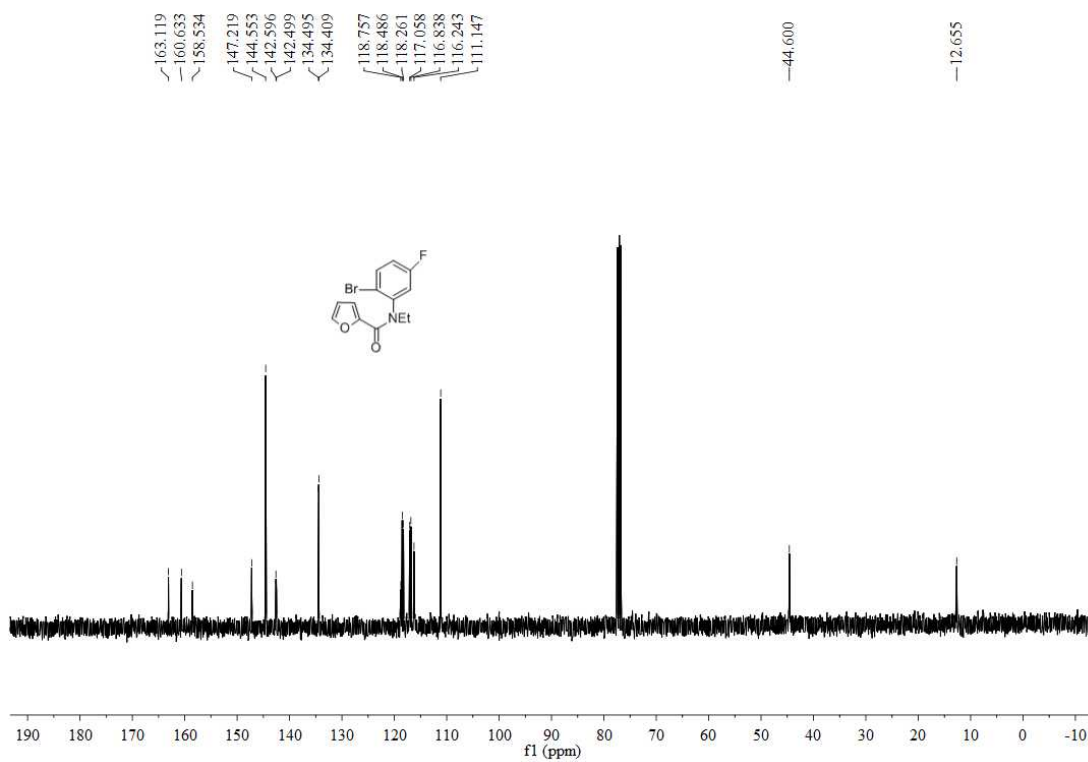
^1H NMR spectrum of **12g**



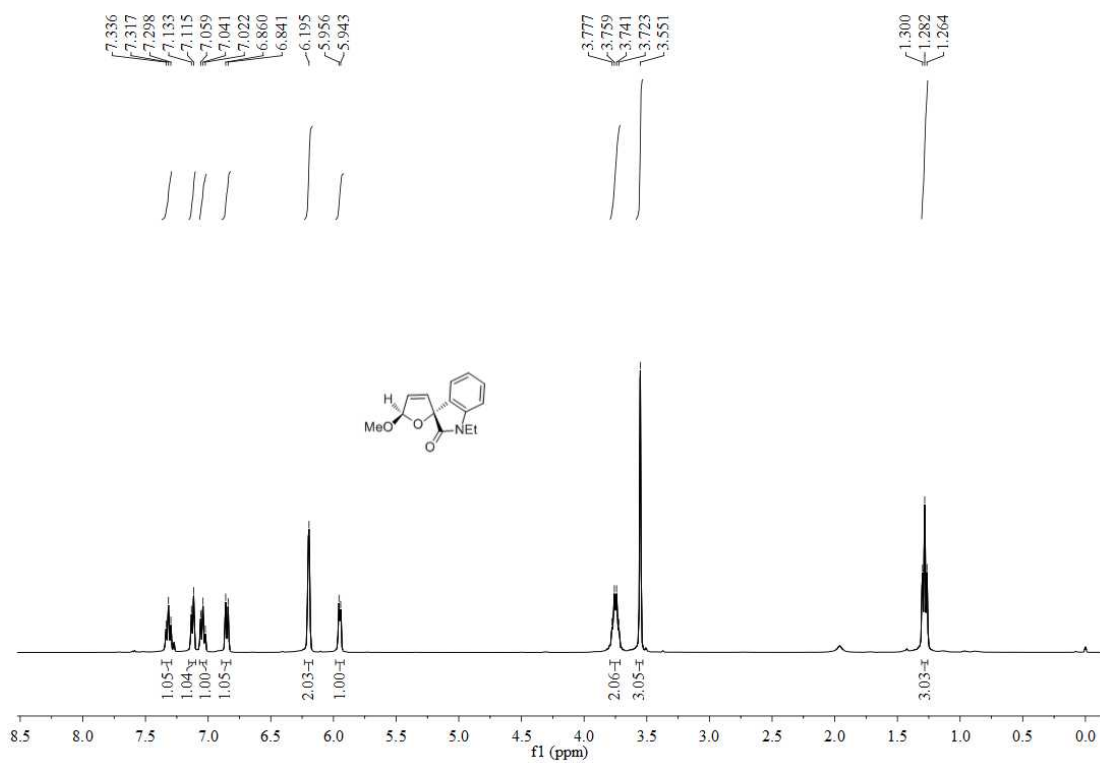
^{13}C NMR spectrum of **12g**



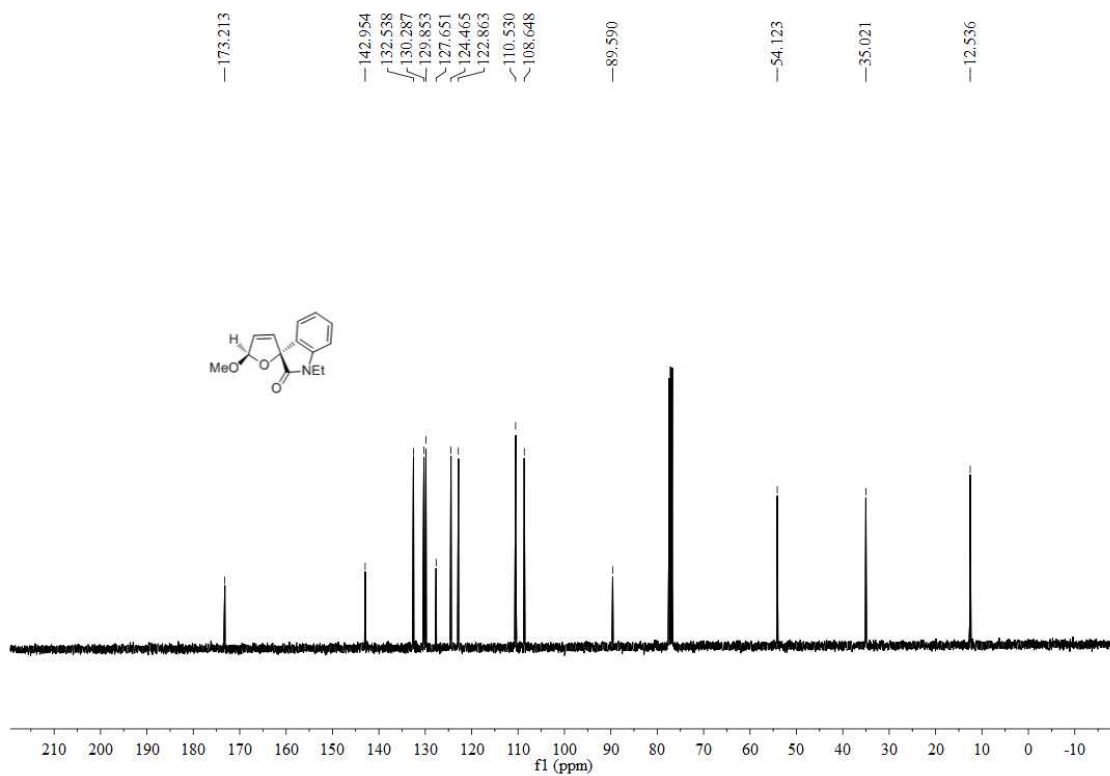
¹H NMR spectrum of 12h



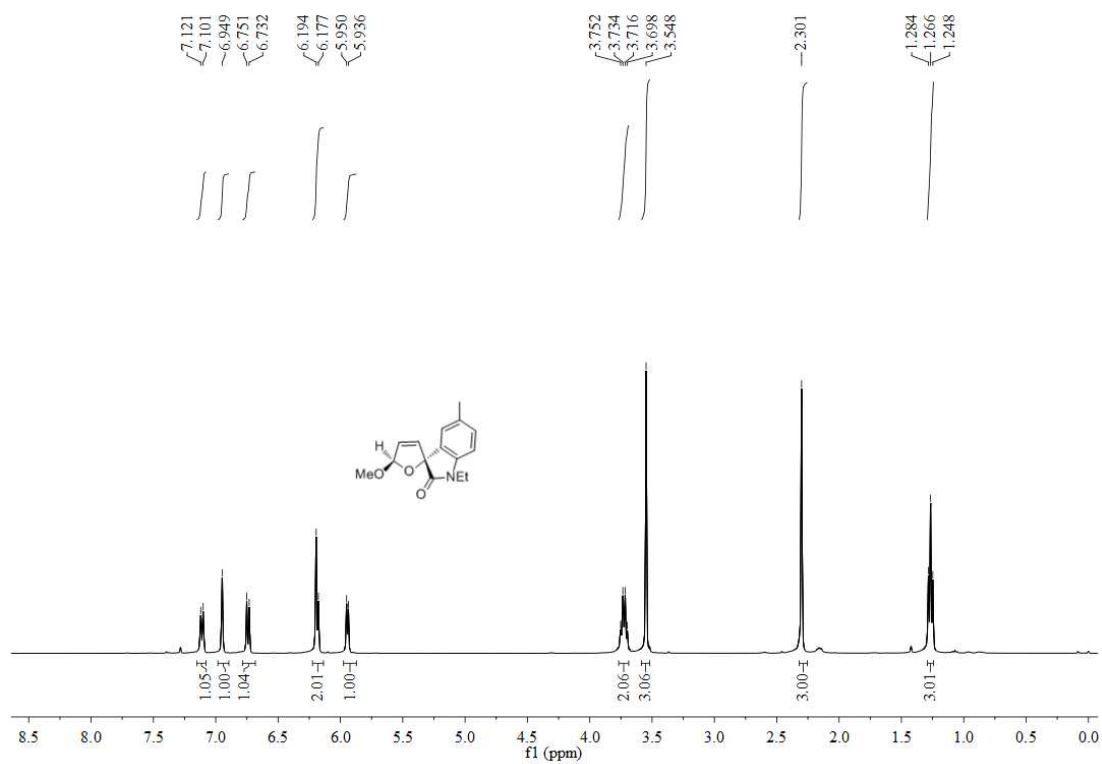
¹³C NMR spectrum of 12h



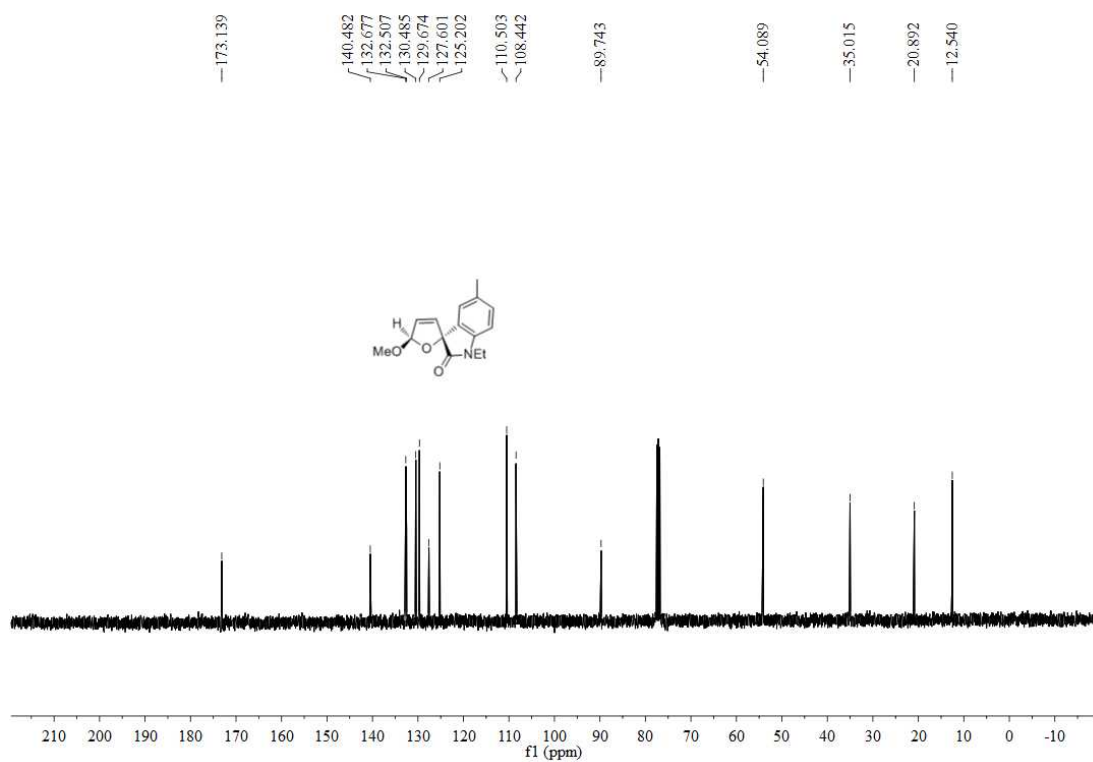
¹H NMR spectrum of 13a



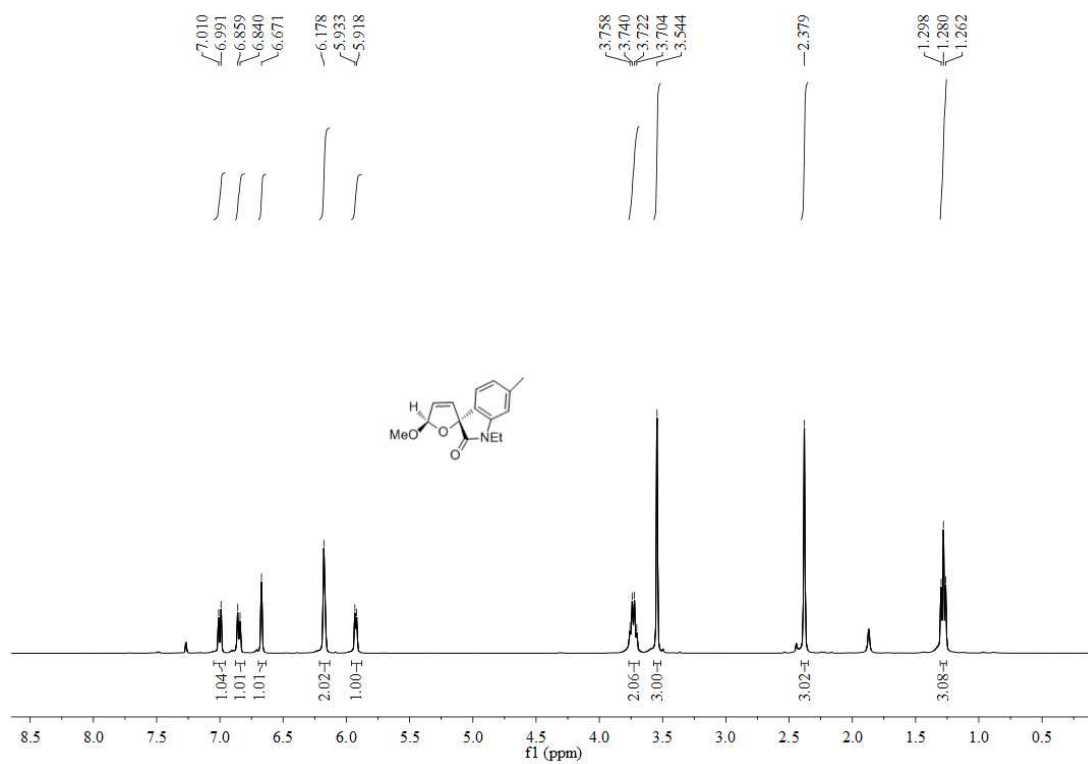
¹³C NMR spectrum of 13a



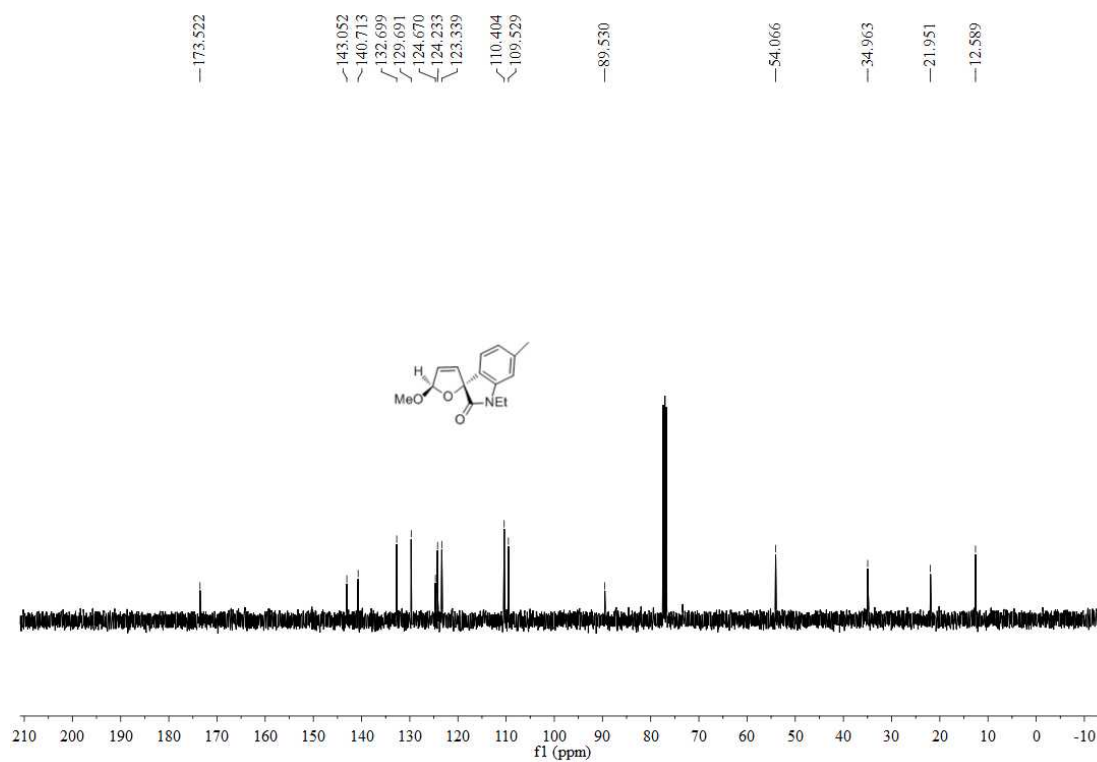
¹H NMR spectrum of **13b**



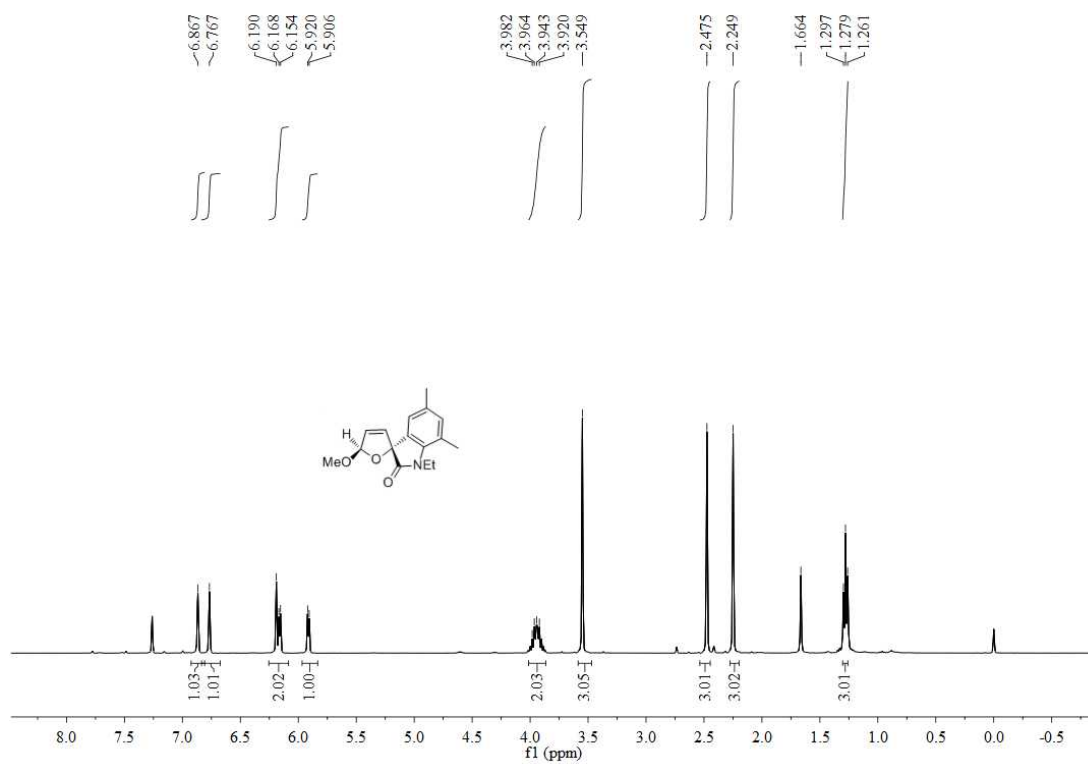
¹³C NMR spectrum of **13b**



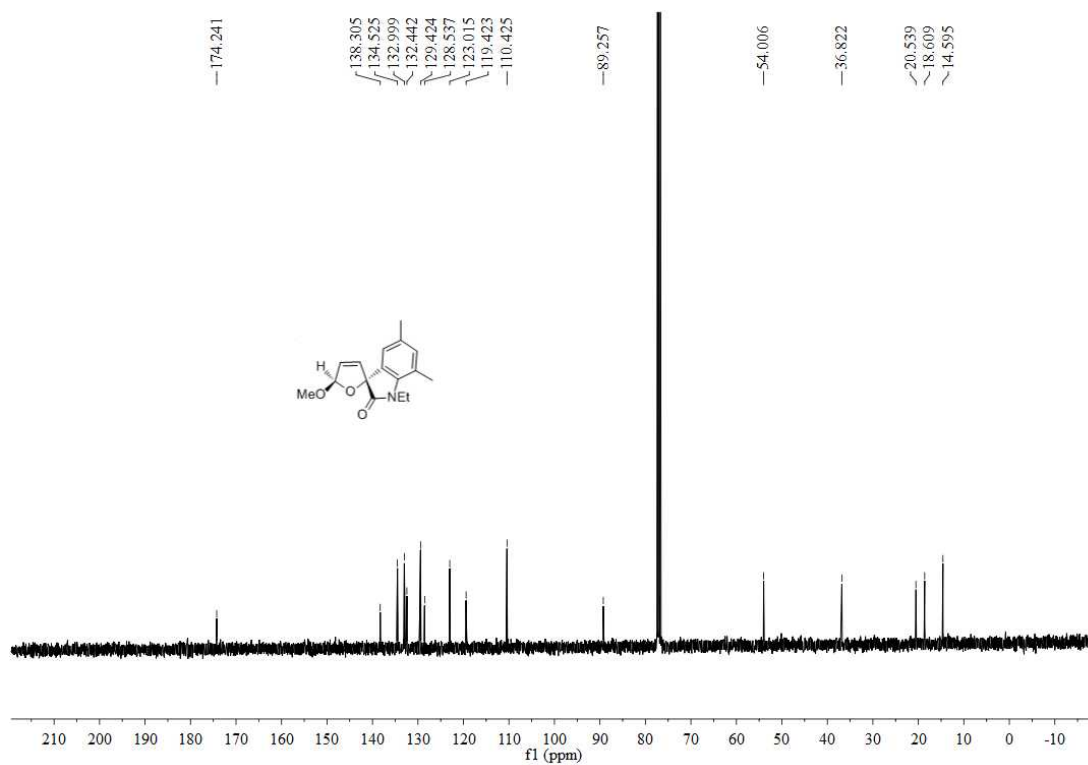
¹H NMR spectrum of 13c



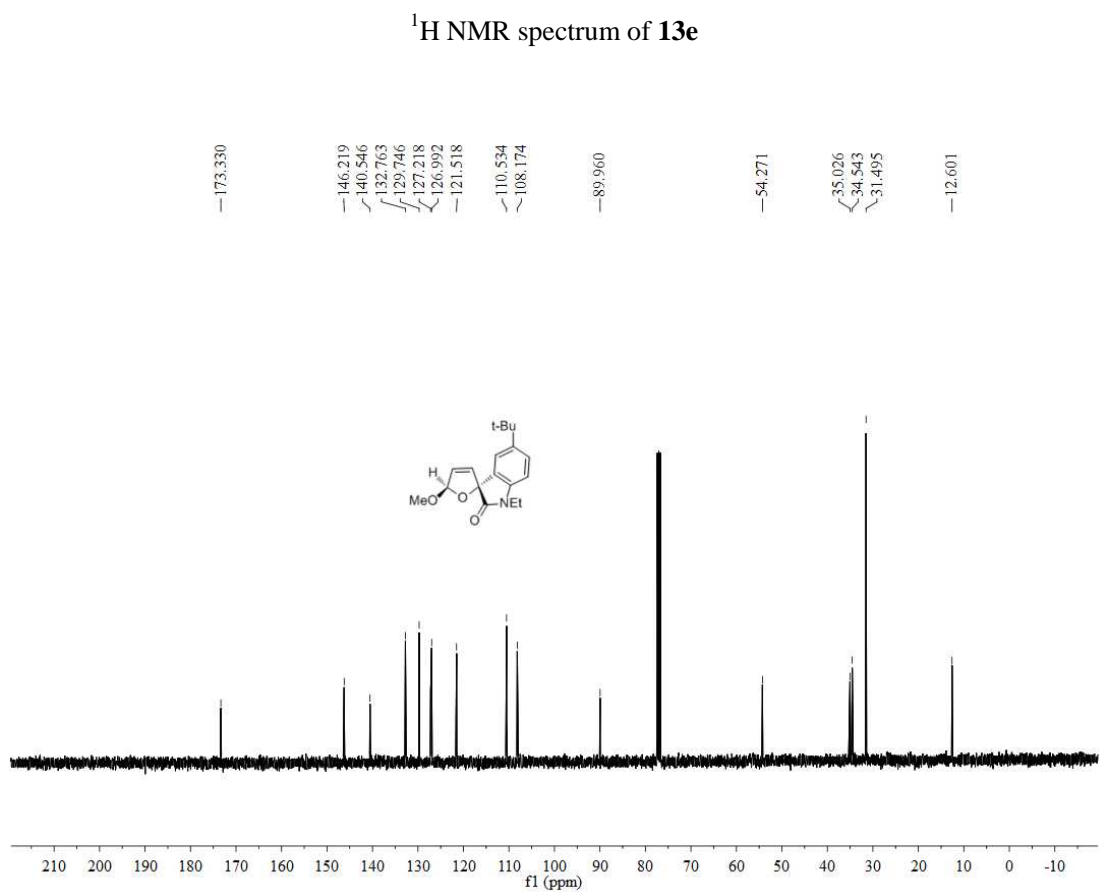
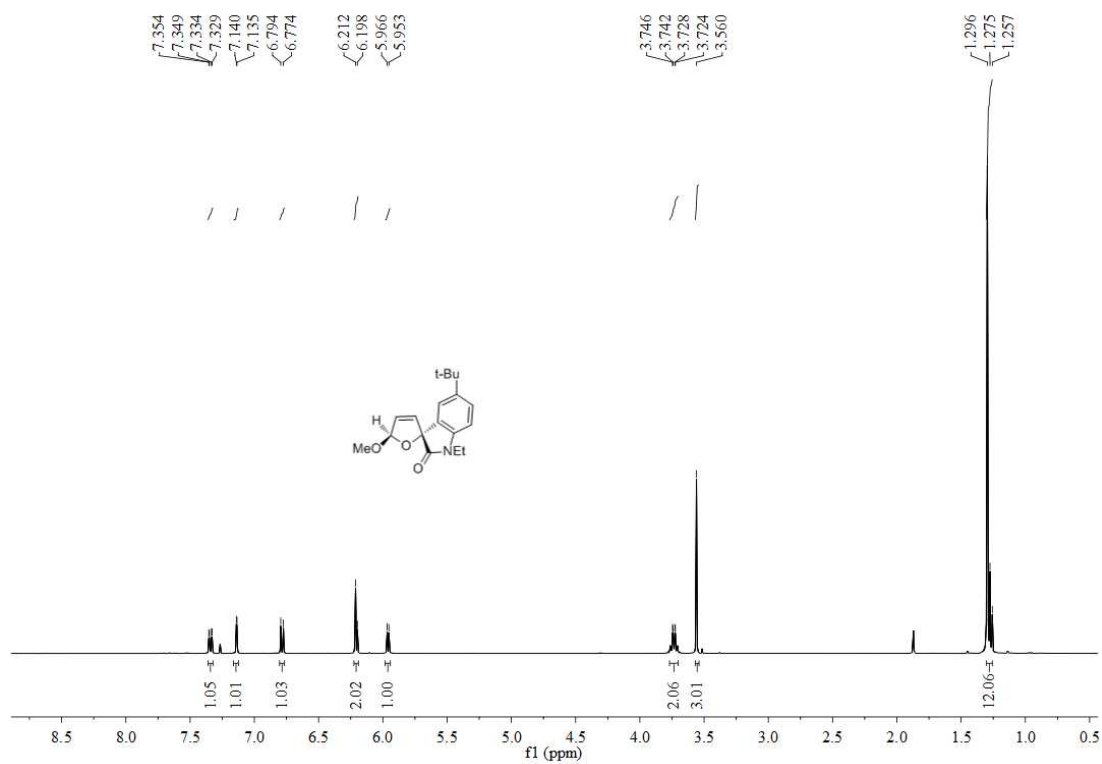
¹³C NMR spectrum of 13c

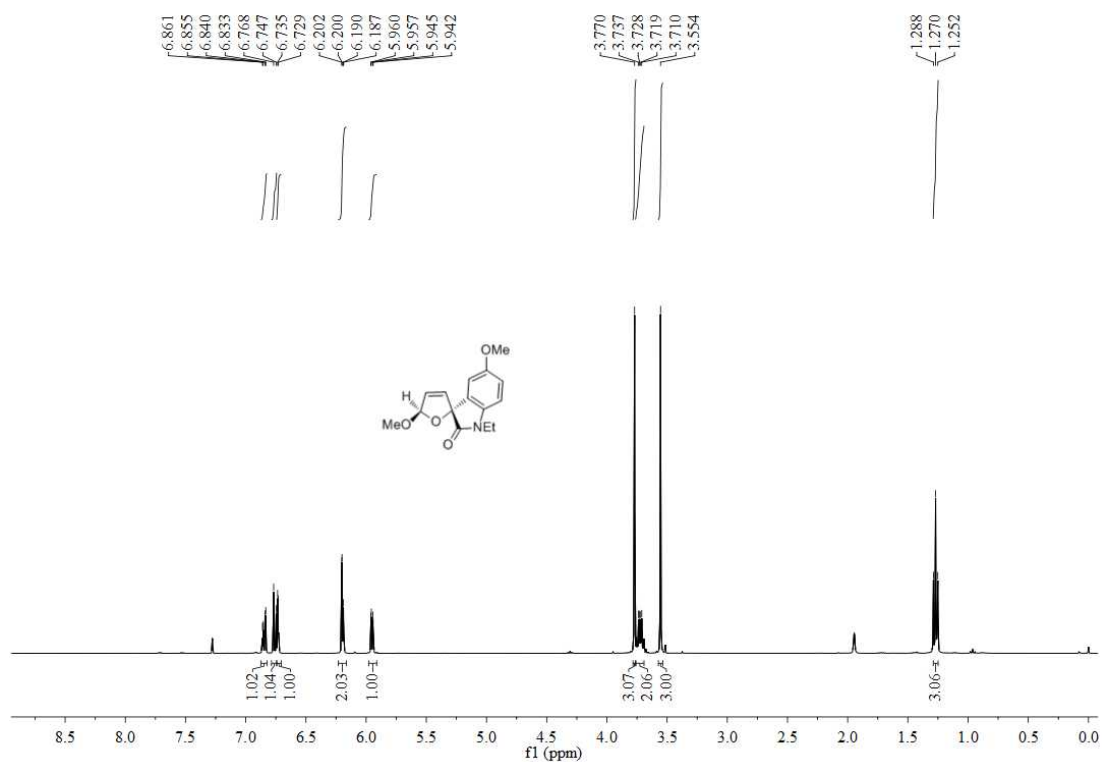


¹H NMR spectrum of 13d

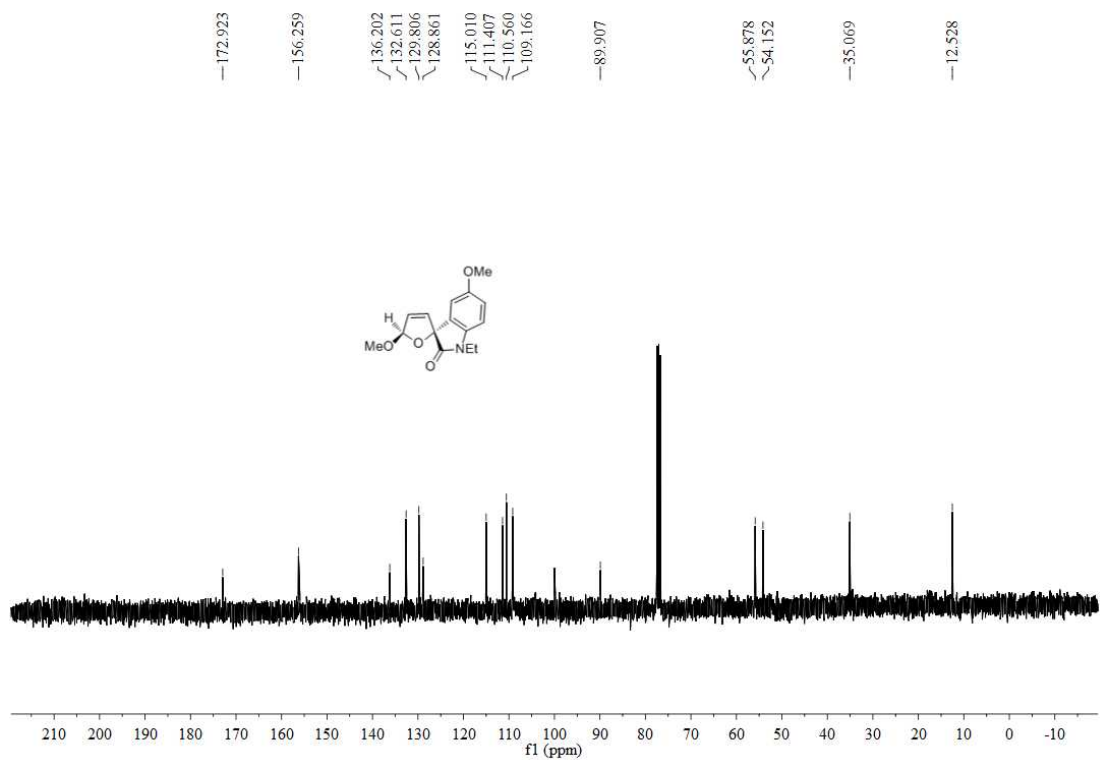


¹³C NMR spectrum of 13d

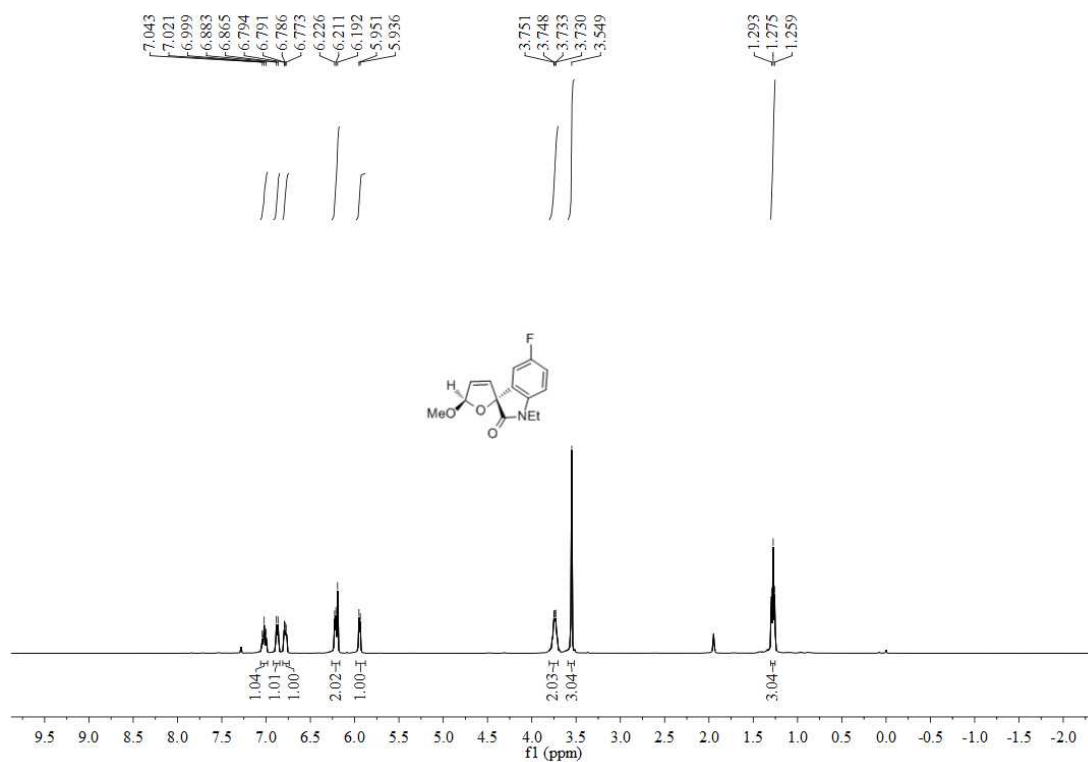




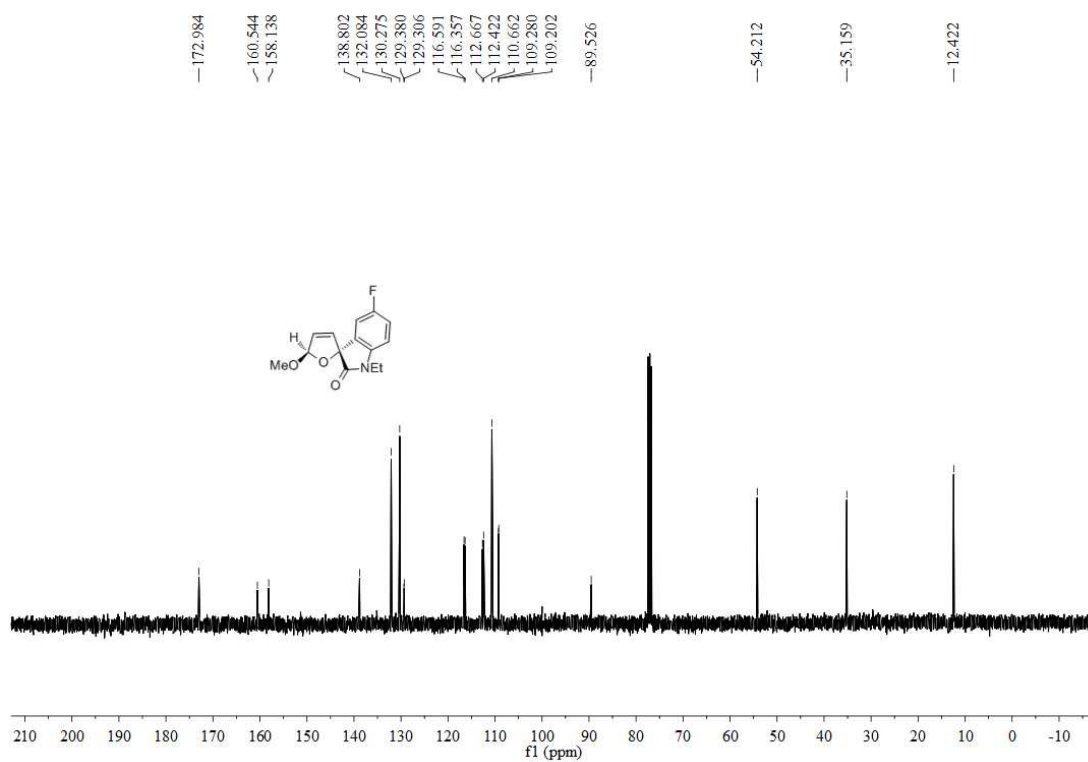
¹H NMR spectrum of **13f**



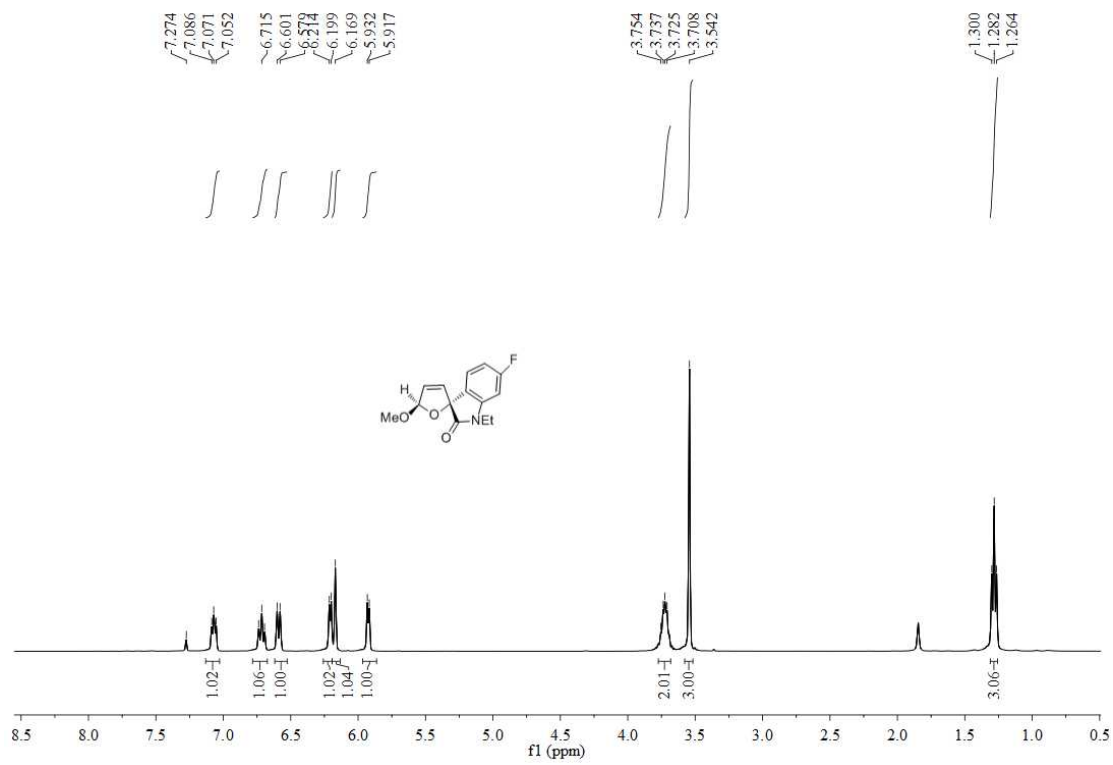
¹³C NMR spectrum of **13f**



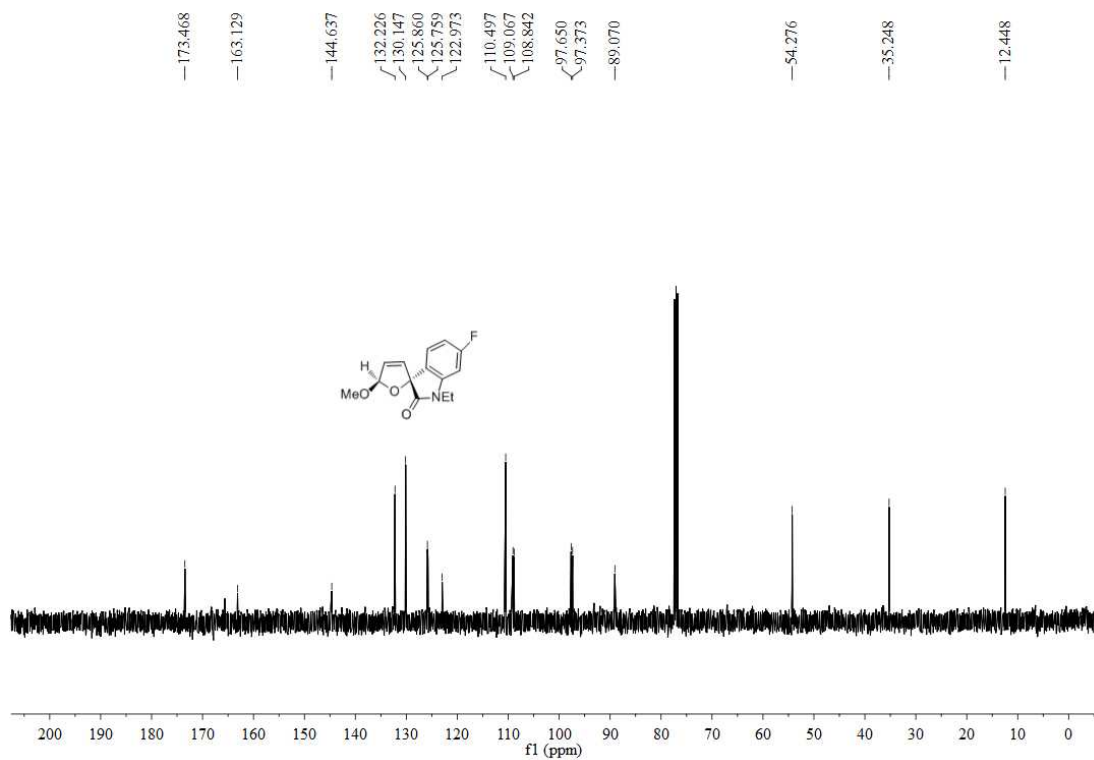
¹H NMR spectrum of **13g**



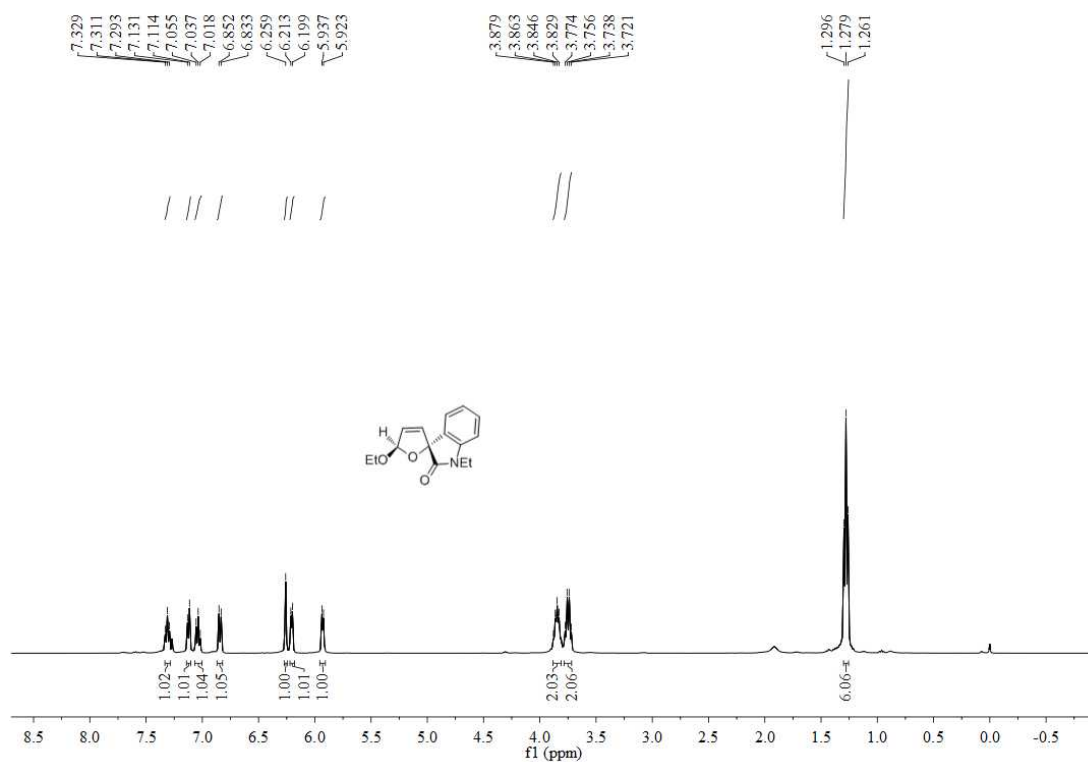
¹³C NMR spectrum of **13g**



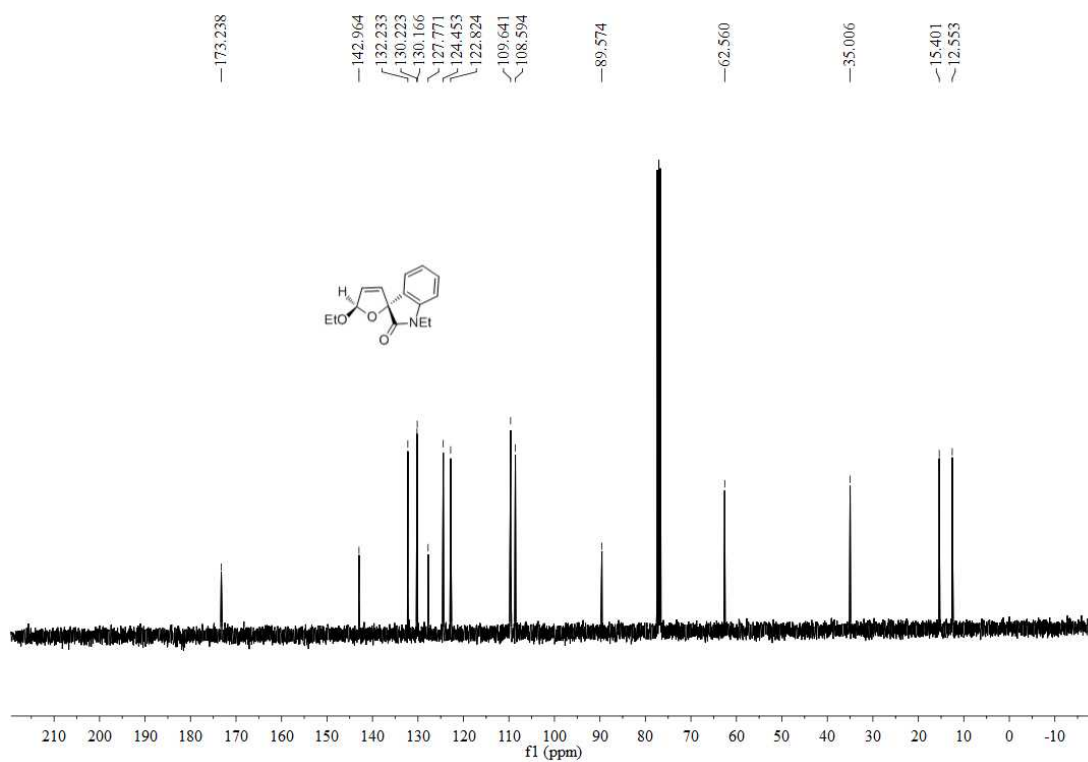
¹H NMR spectrum of 13h



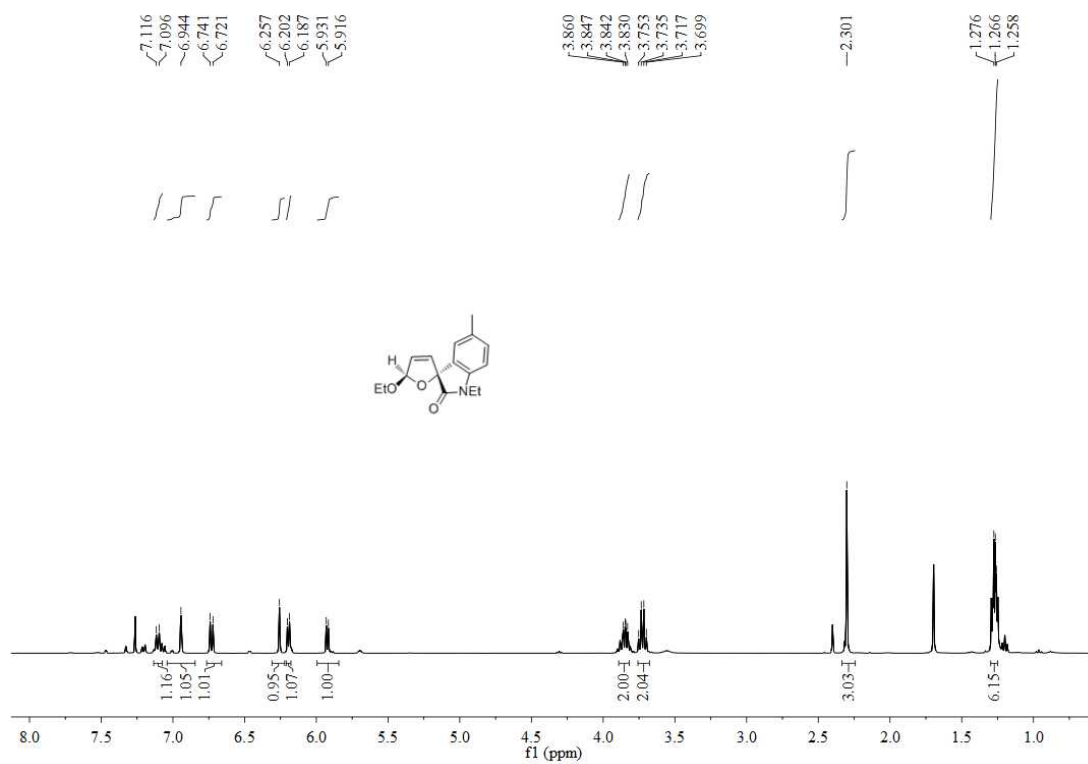
¹³C NMR spectrum of 13h



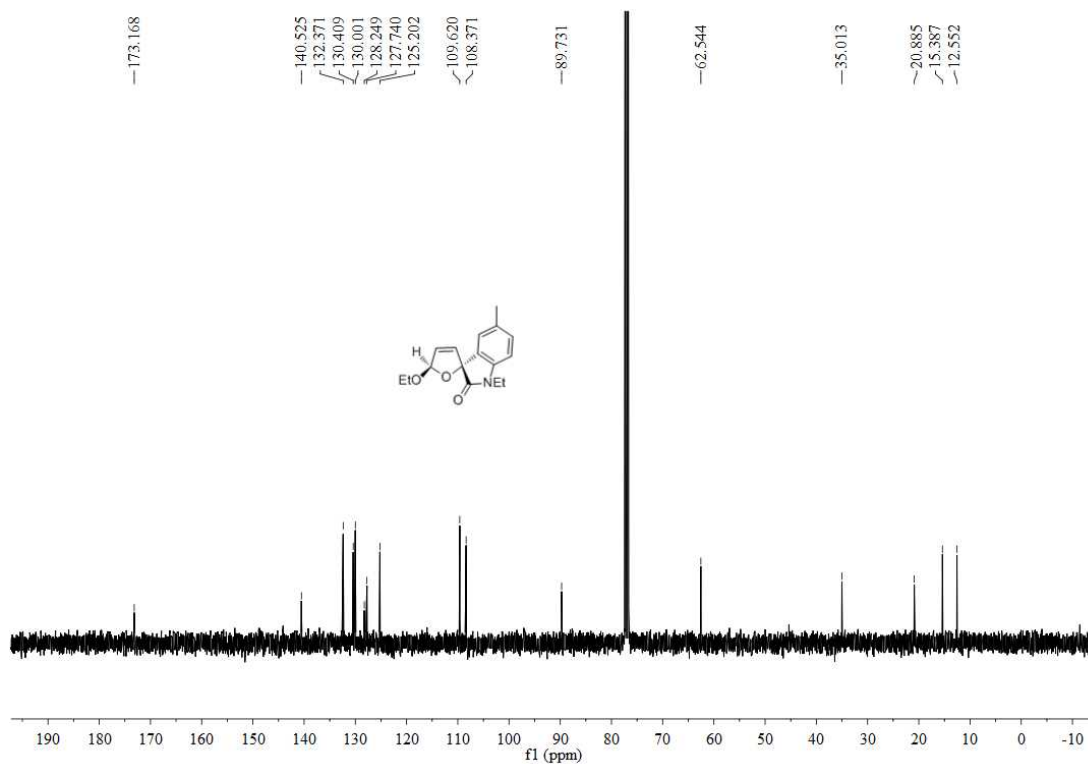
¹H NMR spectrum of **13i**



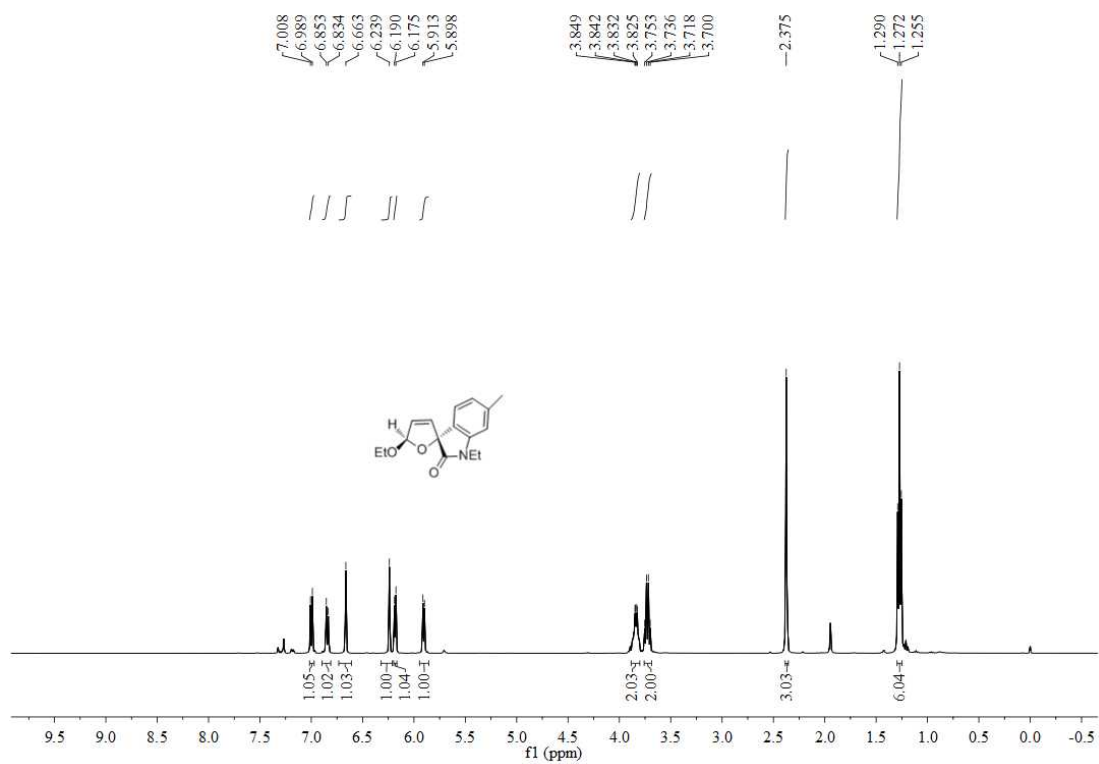
¹³C NMR spectrum of **13i**



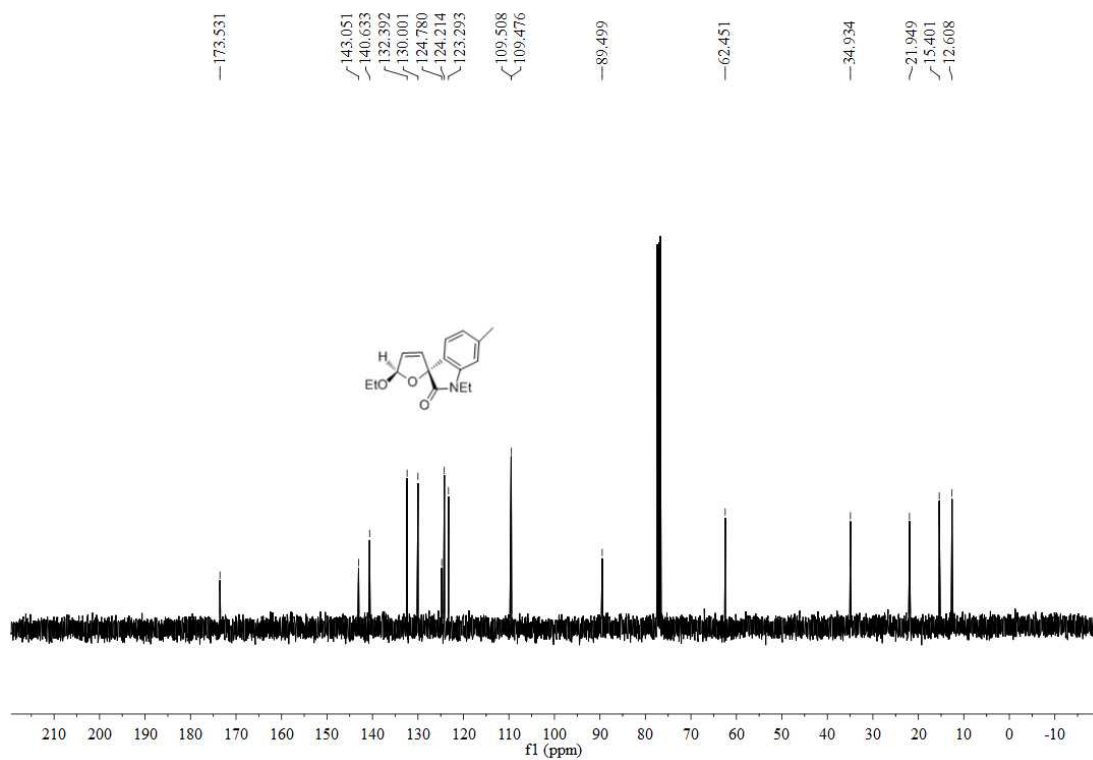
¹H NMR spectrum of 13j



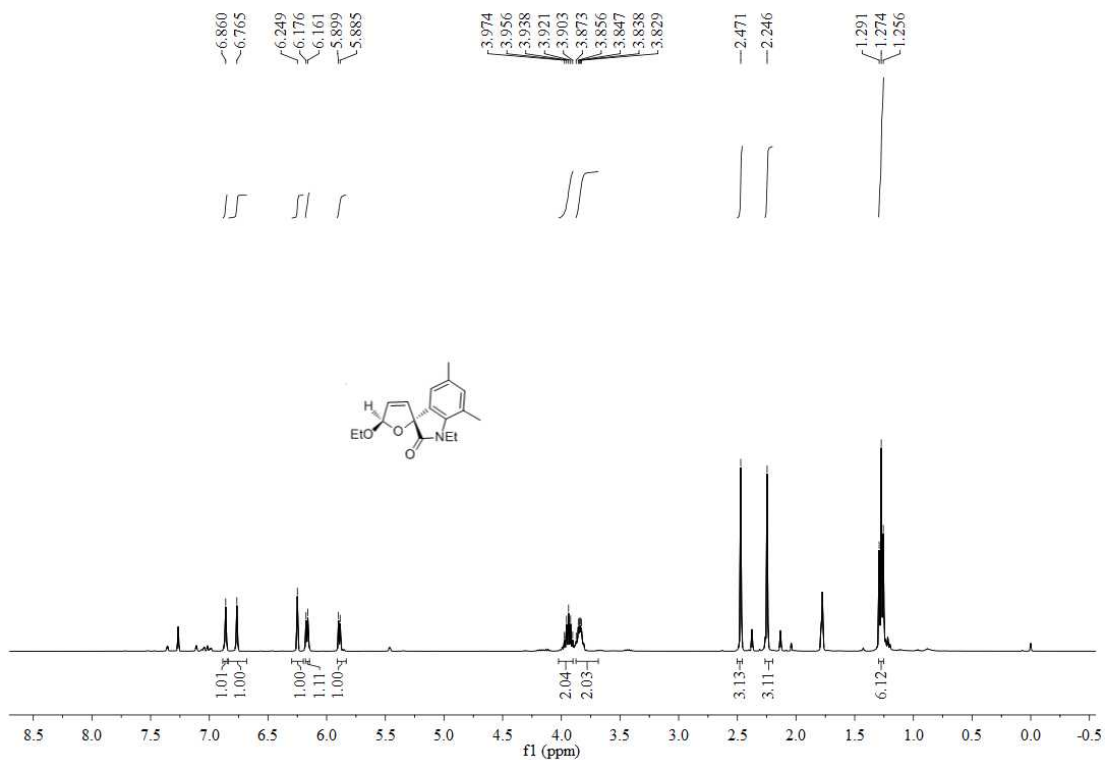
¹³C NMR spectrum of 13j



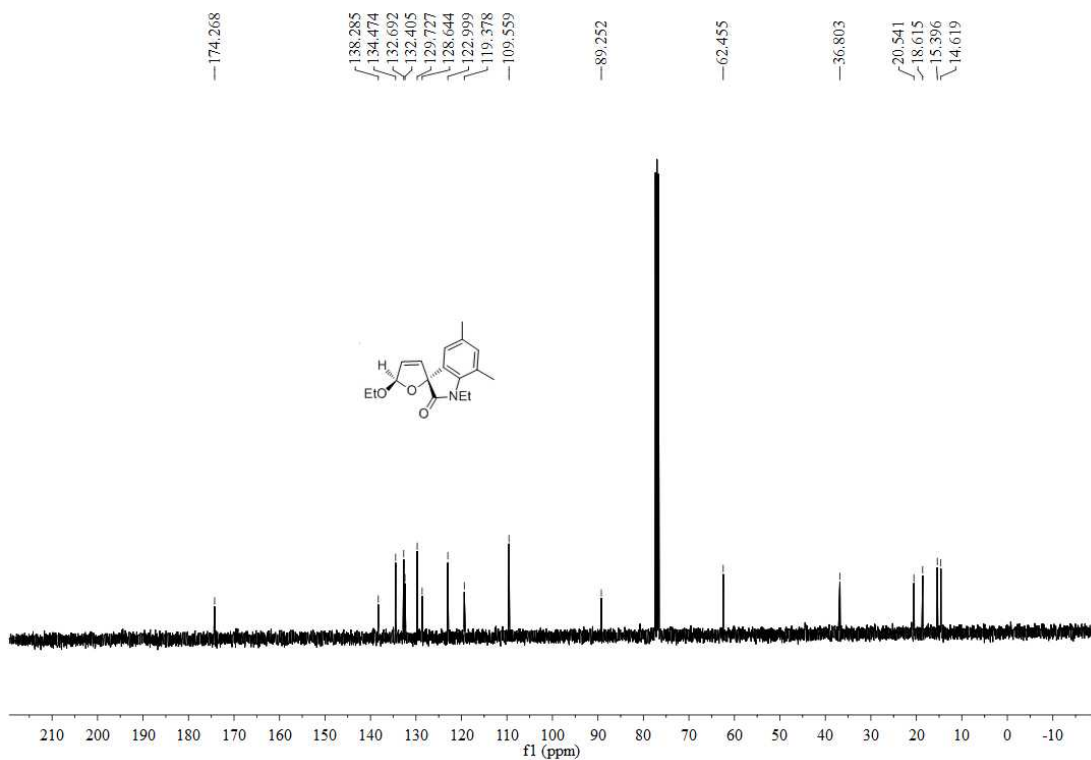
¹H NMR spectrum of **13k**



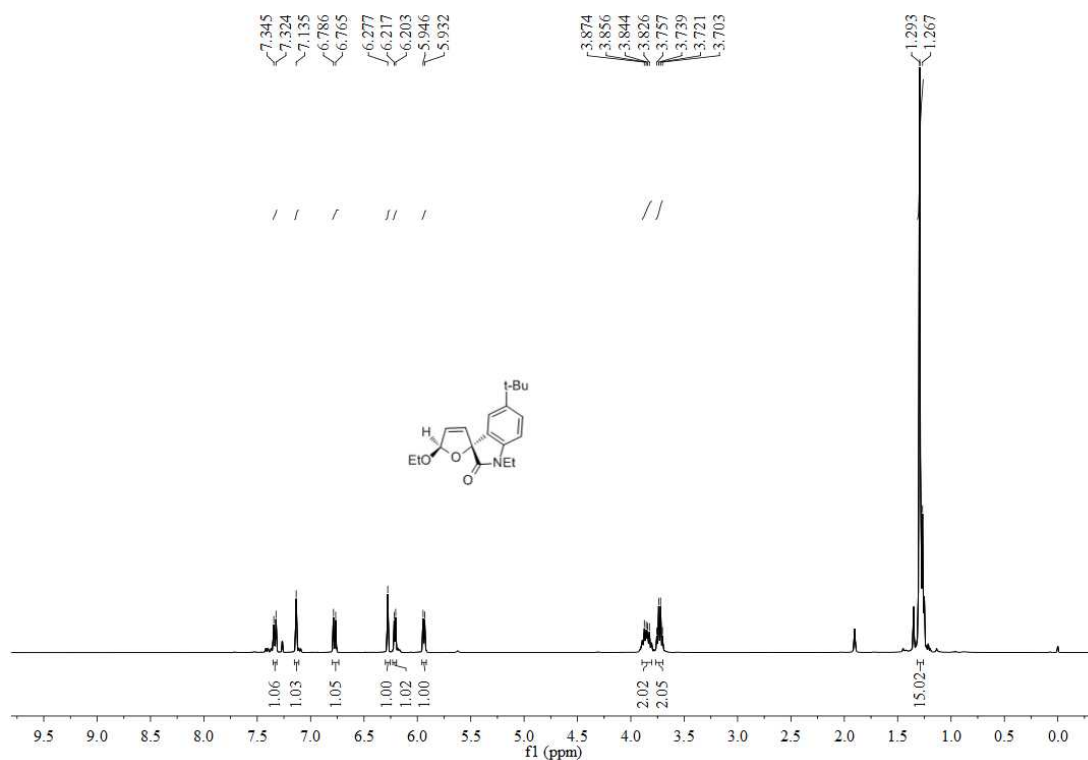
¹³C NMR spectrum of **13k**



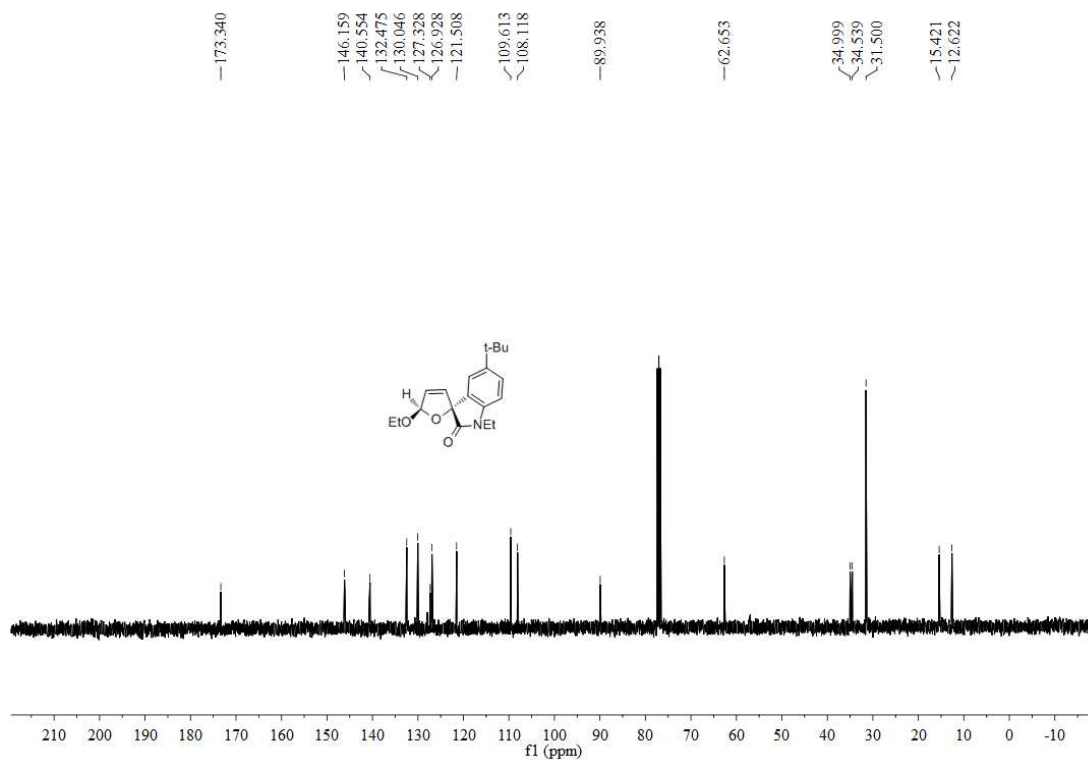
¹H NMR spectrum of **131**



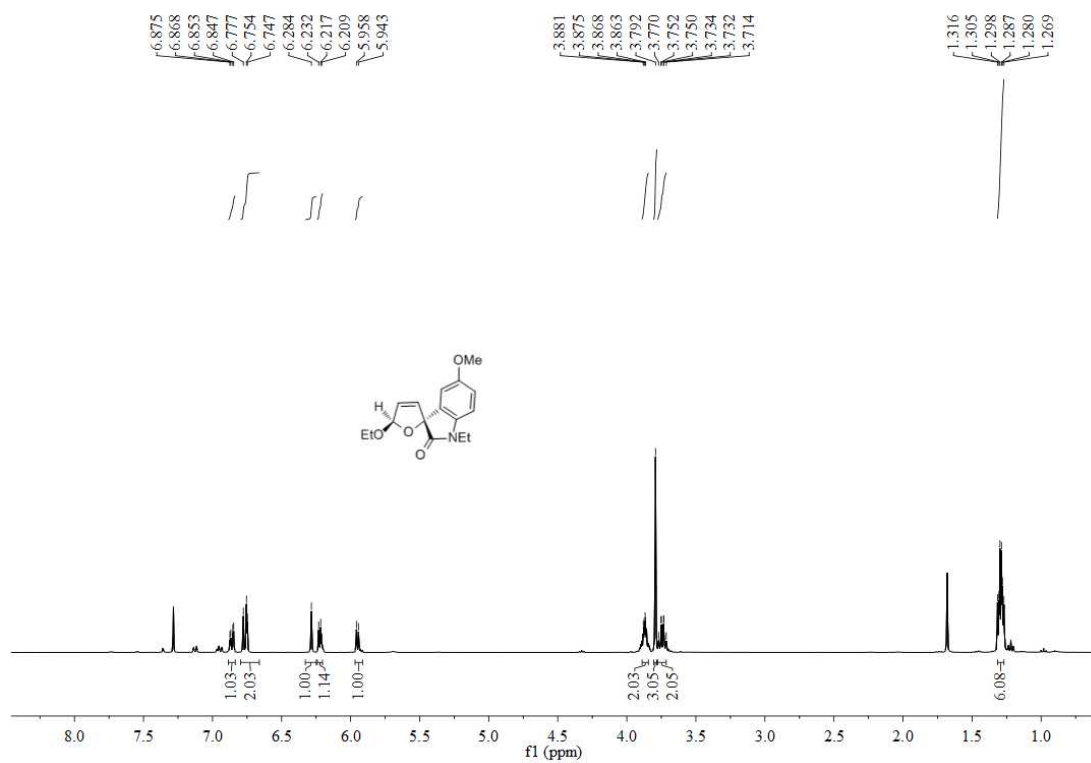
¹³C NMR spectrum of **131**



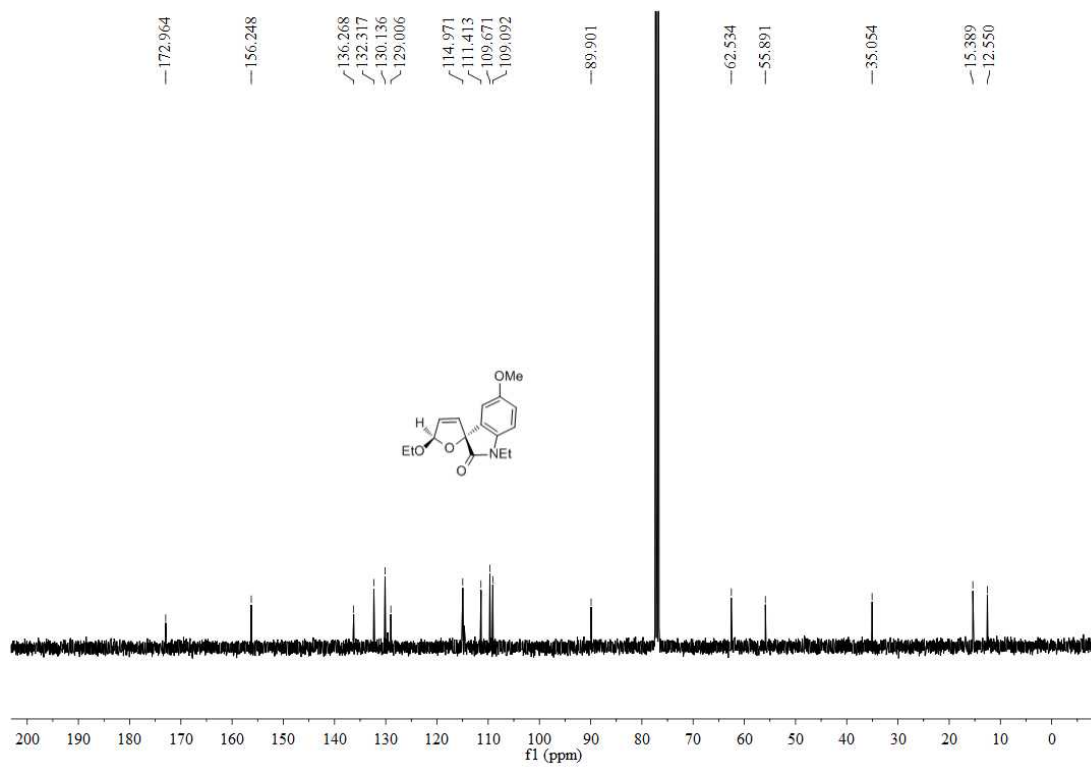
¹H NMR spectrum of **13m**



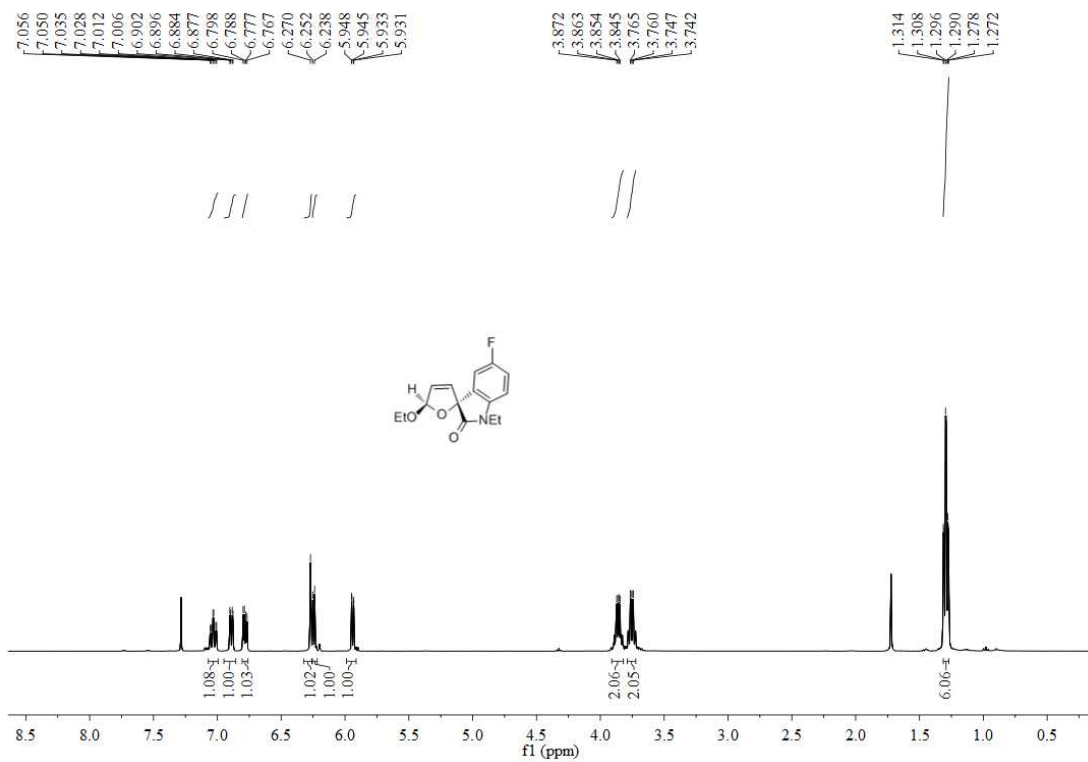
¹³C NMR spectrum of **13m**



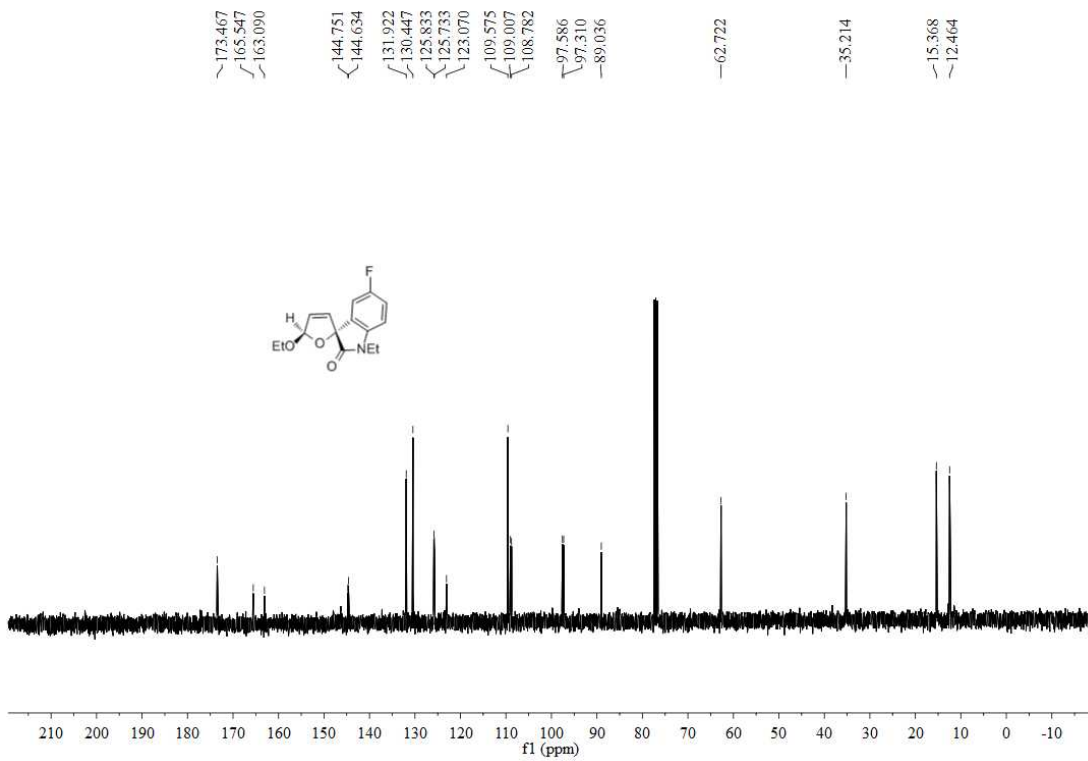
¹H NMR spectrum of 13n



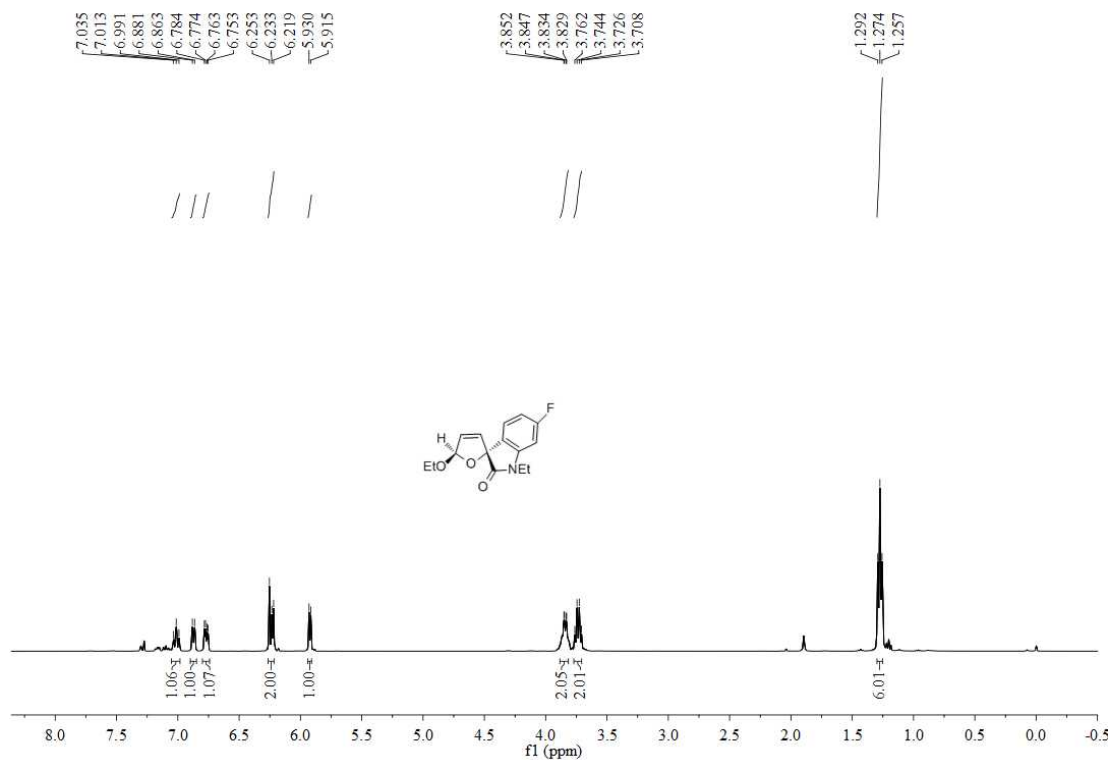
¹³C NMR spectrum of 13n



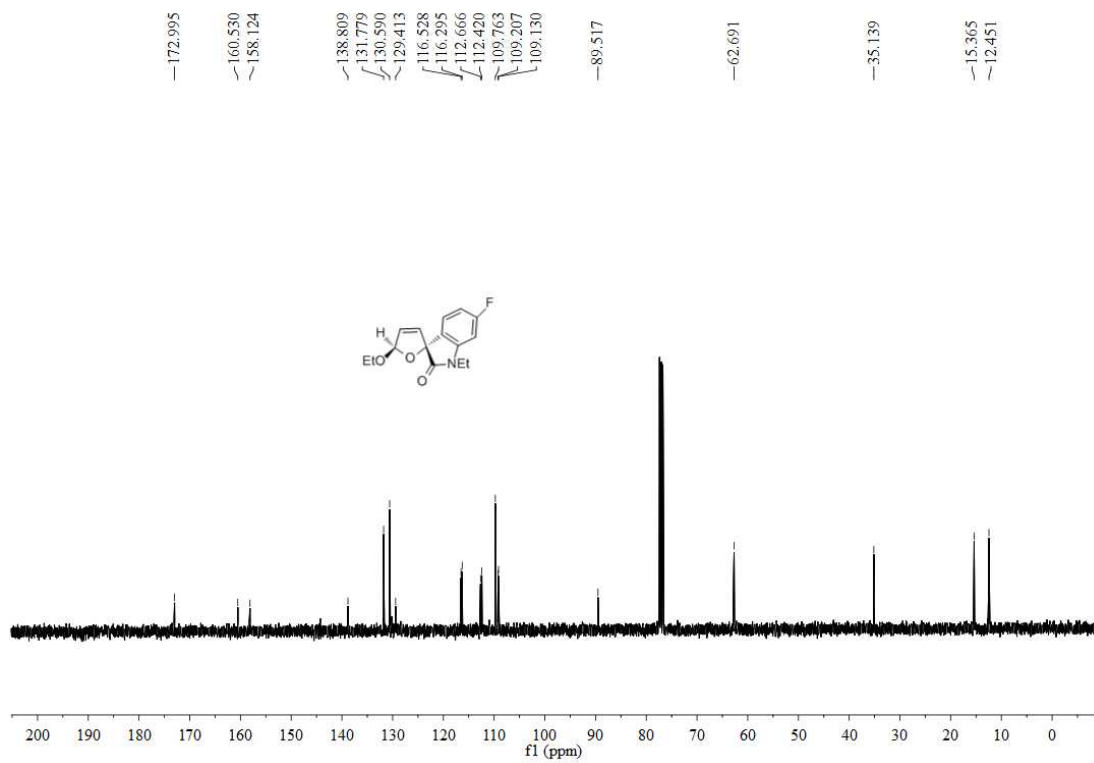
¹H NMR spectrum of **13o**



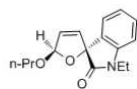
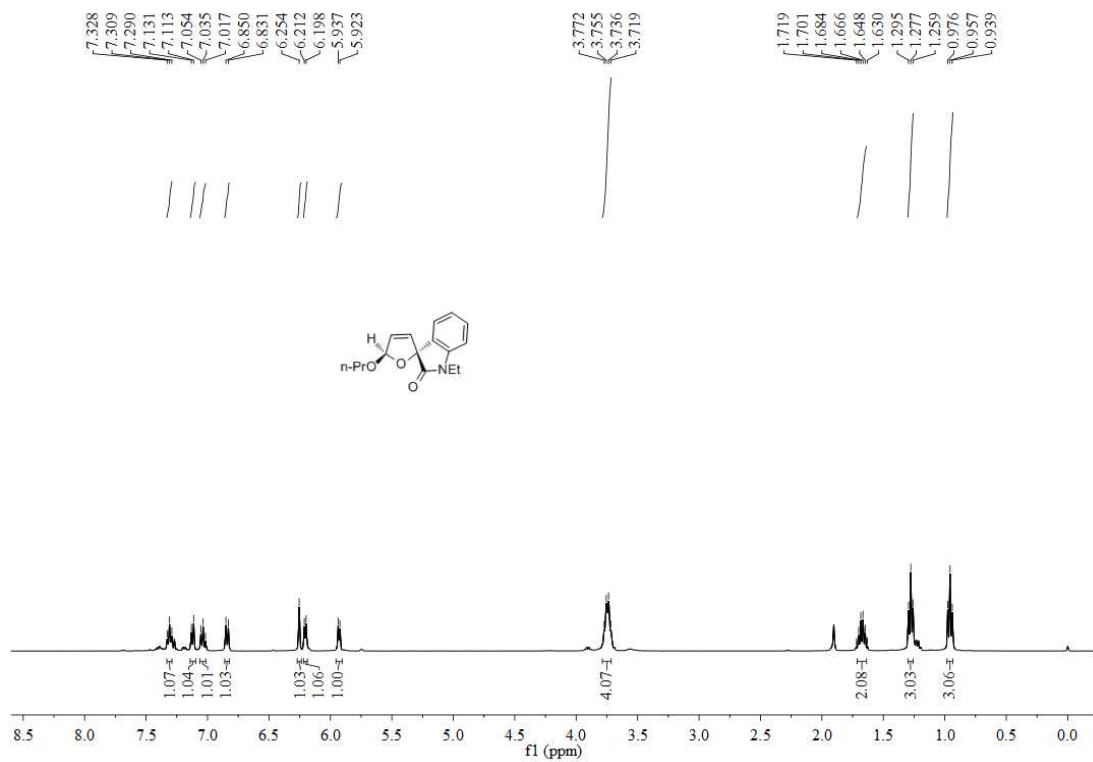
¹³C NMR spectrum of **13o**



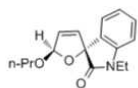
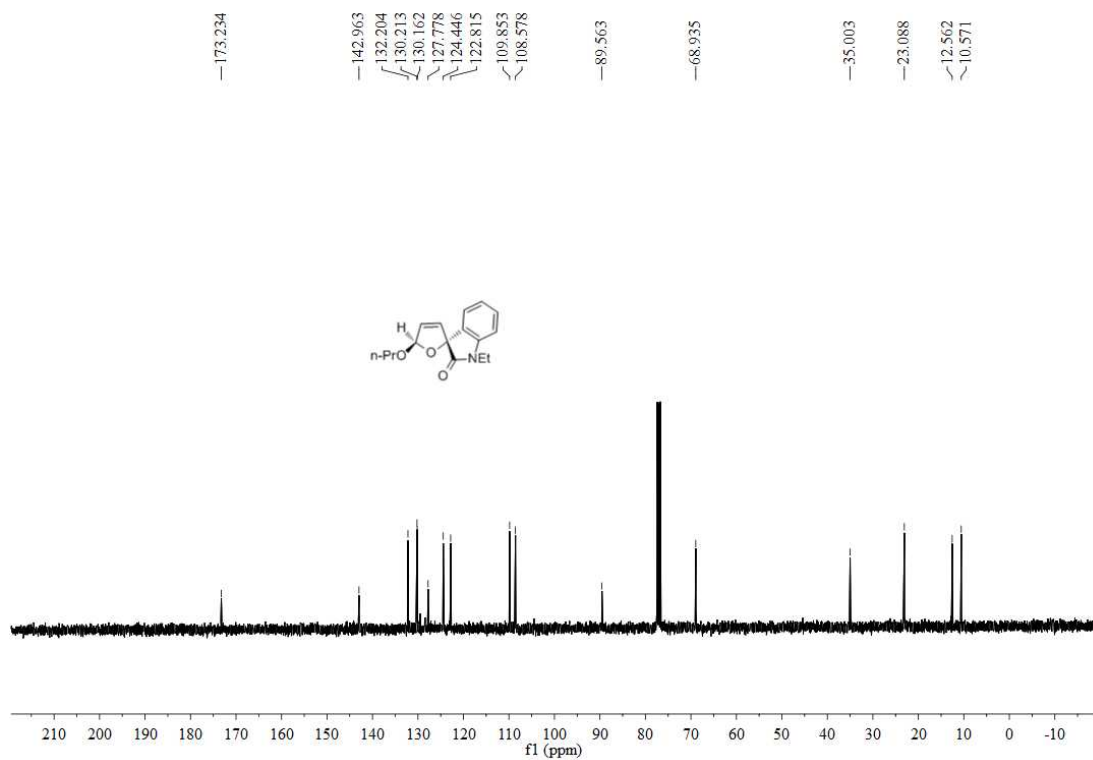
¹H NMR spectrum of 13p



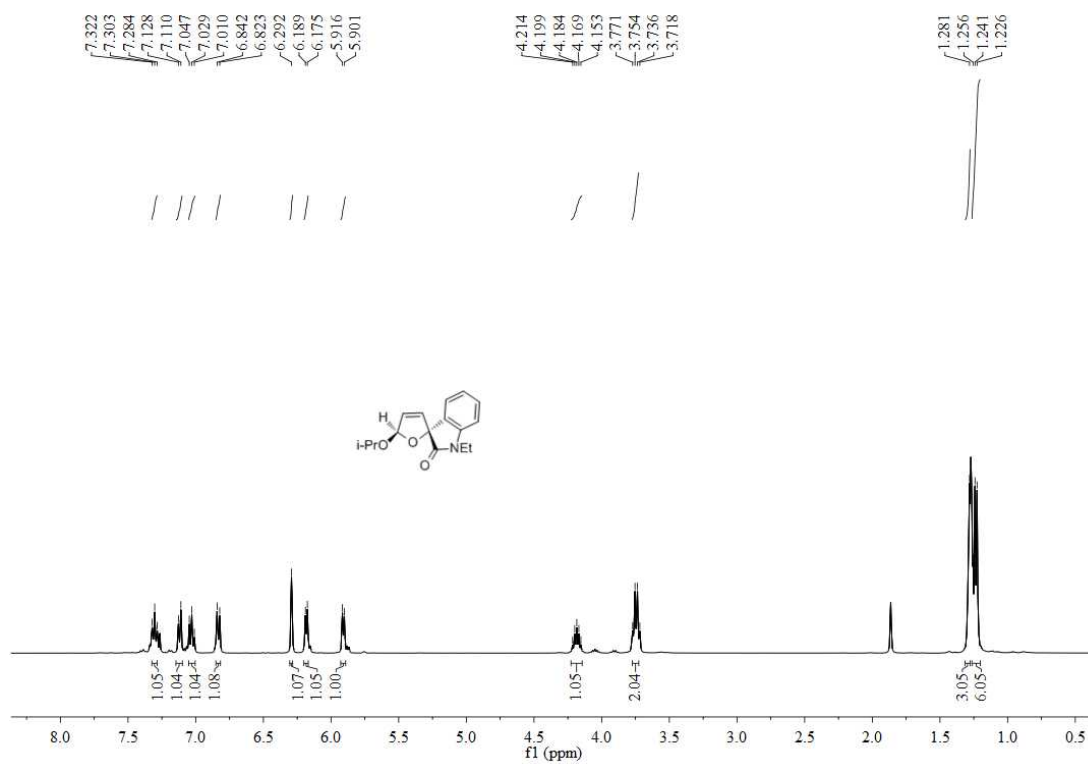
¹³C NMR spectrum of 13p



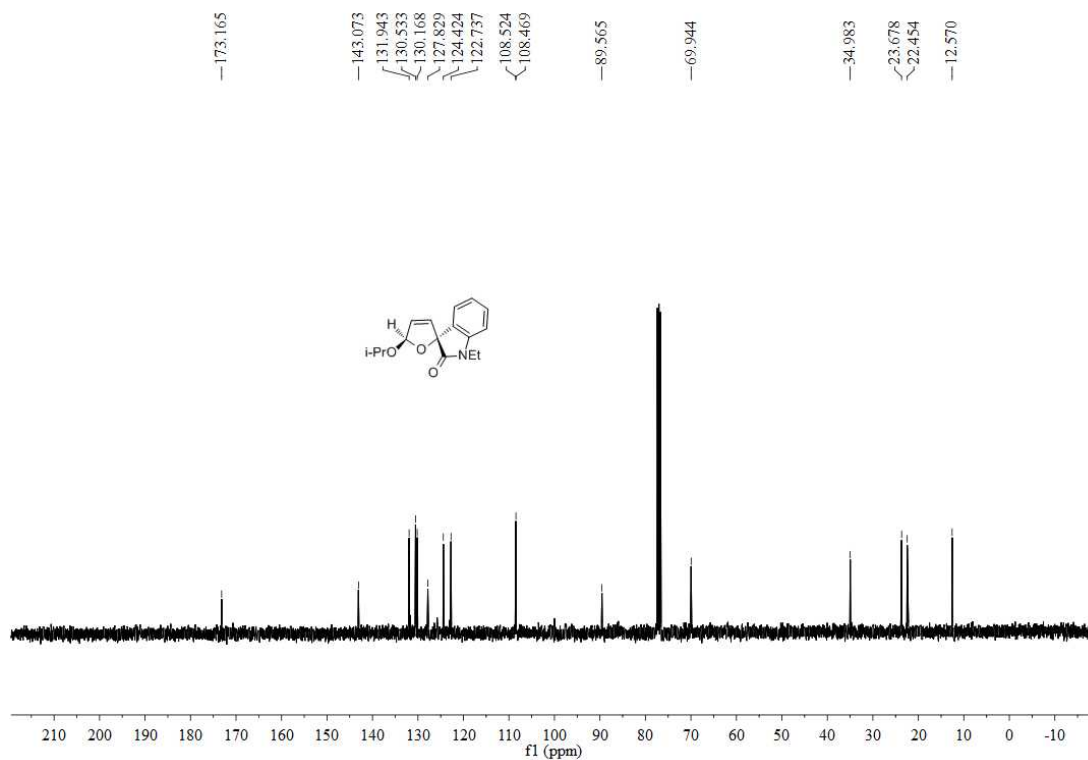
^1H NMR spectrum of **13q**



^{13}C NMR spectrum of **13q**



¹H NMR spectrum of **13r**



¹³C NMR spectrum of **13r**