

Supplementary information

Pyrrolyl radical-involved di-/tri-functionalization of alkenes by sulfonyl pyrroles via radical/radical cross-coupling

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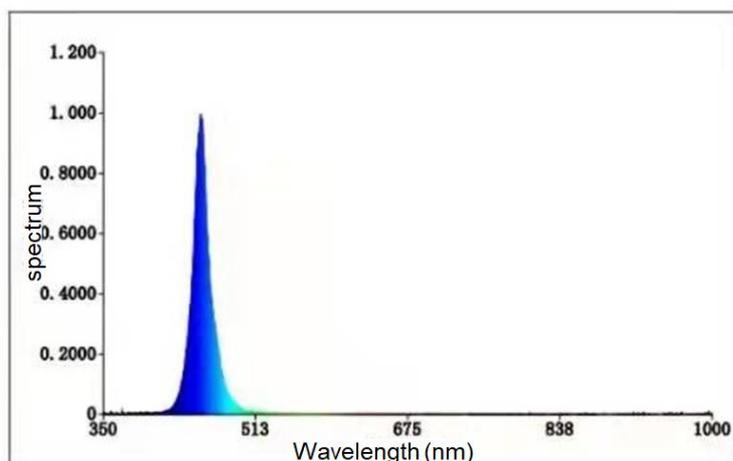
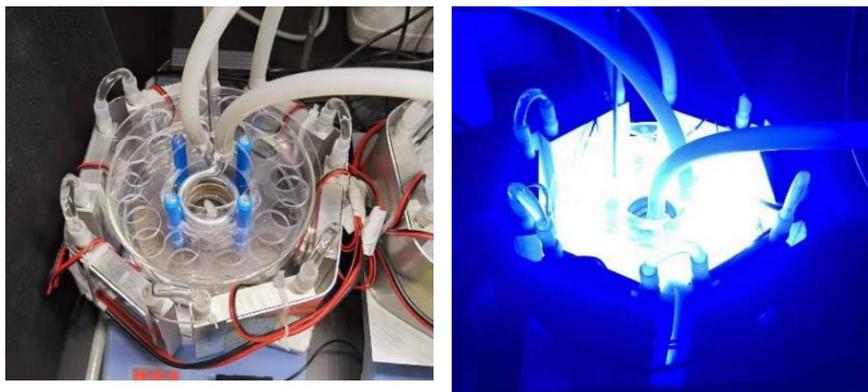
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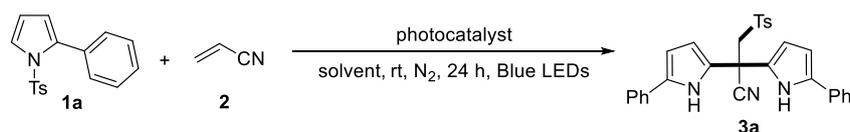
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1. General Experimental Information

All experiments were performed using standard Schlenk techniques under nitrogen atmosphere and carried out in anhydrous solvents. All anhydrous solvents and aryl sulfonyl chlorides were purchased from commercial sources (Adamas-Beta Co., Bidepharm Co. or Energy Chemical Co.) and used as received. Photocatalysts $[\text{Ir}[\text{dF}(\text{CF}_3)\text{ppy}]_2(\text{dtbbpy})]\text{PF}_6$, $[\text{Ir}[\text{dF}(\text{CF}_3)\text{ppy}]_2(\text{bpy})]\text{PF}_6$, $[\text{Ir}(\text{ppy})_2(\text{dtbbpy})]\text{PF}_6$, $[\text{Ir}(\text{ppy})_2(\text{bpy})]\text{PF}_6$, 4-CzIPN and 5CzBN were prepared according to the literature procedures^{1,2}. All products were identified using NMR analysis. ^1H NMR and ^{13}C NMR spectra were recorded in CDCl_3 or $\text{DMSO-}d_6$ on Bruker spectrometers at 400 or 500 MHz. All shifts are reported in parts per million (ppm) relative to residual CHCl_3 peak (7.26 and 77.16 ppm, ^1H NMR and ^{13}C NMR, respectively) and DMSO peak (2.50 and 39.52 ppm, ^1H NMR and ^{13}C NMR, respectively). Abbreviations are: s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet. High Resolution Mass Spectra were obtained on a Waters TripleTOF 6600 Quadrupole Time-of-Flight Mass Spectrometer (APCI or ESI). All flash chromatography was performed using silica gel, 300-400 mesh. TLC analysis was carried out on glassplates coated with silica gel 60 F254, 0.2 mm thickness. The plates were visualized using a 254 nm ultraviolet lamp or iodine cylinder. LED chips (30 W, 455 nm) were purchased from Xuzhou AIJIA Electronic Technology Co., and the parameter information was shown below. The reaction vessel placed 1 cm from the lamp and the experimental temperature was remained at 25 °C.



2. Optimization of the Reaction Conditions^a



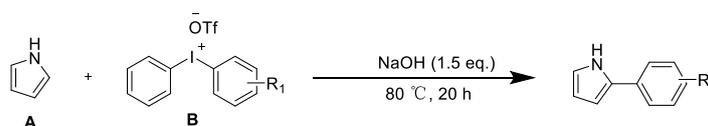
Entry	PC	Time	Solvent	Yield ^b
1	[Ir(ppy) ₂ (bpy)]PF ₆	24h	MeCN	22
2	[Ir(ditBubpy)PF ₆]	24h	MeCN	31
3	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	MeCN	36
4	4-CzIPN	24h	MeCN	trace
5	5CZBN	24h	MeCN	trace
6	[Ir(dF(CF ₃)ppy) ₂ (ditBubpy)]PF ₆	24h	MeCN	23
7	<i>fac</i> -[Ir(ppy) ₃]	24h	MeCN	17
8	-	24h	MeCN	trace
9	Thioxanthen	24h	MeCN	15 ^c
10	Mes-Acr-BF ₄	24h	MeCN	2 ^c
11	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	CH ₂ Cl ₂	nd
12	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	EtOAc	35
13	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	1,4-dioxane	26
14	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	MeOH	nd
15	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	THF	51
16	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	DMSO	21
17	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	DMF	41
18	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	DME	nd
19	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	^t BuOMe	58
20	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	2-Me-THF	39
21	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	di-n-butyl ether	trace
22	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	toluene	38
23	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	PhCl	42
24	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	PhCF ₃	24
25	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	^t BuOMe	39 ^c
26	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	^t BuOMe	47 ^d
27	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	^t BuOMe	53 ^e
28	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	^t BuOMe	53 ^f
29	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	^t BuOMe	36 ^g
30	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	12h	^t BuOMe	54
31	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	36h	^t BuOMe	57
32	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	^t BuOMe	61 ^h
33	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	^t BuOMe	74 ^{i,j}
34	[Ir(dFCF ₃ ppy) ₂ (dtbpy)]PF ₆	24h	^t BuOMe	nd ^k

^aReaction Conditions: **1a** (0.2 mmol, 2.0 equiv), **2** (0.1 mmol, 1.0 equiv), catalyst (3 mol%), solvent (1.0 mL), rt, 30 W blue LEDs, N₂. ^bHPLC yield with 4-Phenyl-1-butene as internal standard. ^c390nm. ^d425 nm. ^e^t-BuOMe (0.5 mL). ^f^t-BuOMe (1.5 mL). ^g^t-BuOMe (2.0 mL). ^h**1a** (0.3 mmol, 3.0 equiv). ⁱ**1a** (0.5 mmol, 5.0 equiv). ^jIsolated yield. ^kin dark.nd=not detected.

3. Experiment Procedures

General Procedure A: Preparation of 2-aryl pyrroles

Route 1:



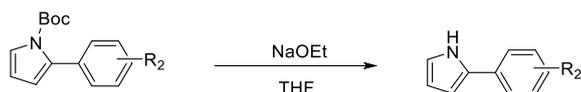
2-Aryl pyrroles were synthesized according to the literature procedures.³ Pyrrole **A** (50 mL), **B** (30 mmol, 1.0 equiv) and NaOH (45 mmol, 1.5 equiv) were added to a round-bottomed flask

under an atmosphere of N₂. The flask was placed in an oil bath and heated at 80 °C for 20 hours. Then the reaction mixture was cooled to room temperature and quenched with saturated solution of ammonium chloride, and extracted with ethyl acetate. The organic layers were washed with brine and dried over anhydrous Na₂SO₄, filtered and purified by flash chromatography on silica gel (petroleum/ethyl acetate/dichloromethane = 50/1/10).

Route 2:



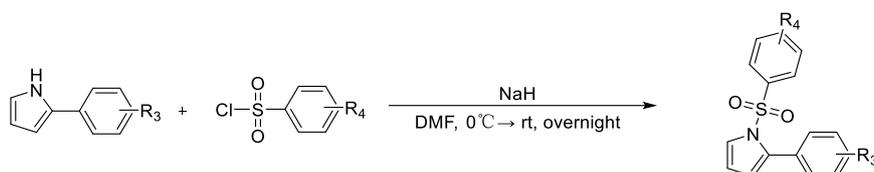
Iodobenzene (5 mmol, 1.0 equiv), (1-tertbutyloxycarbonylpyrrol-2-yl)boronic acid (5 mmol, 1.0 equiv), tetrakis(triphenylphosphine)palladium (5 %mol), potassium carbonate (12.5 mmol, 2.5equiv), DME (15 mL), and H₂O (2 mL) were added to a round-bottomed flask under an atmosphere of N₂. The mixture was heated at 80 °C for 8 hours. Then, the reaction mixture was cooled down to the room temperature. Water was added and the layers were separated. The water layer was extracted with dichloromethane, and then washing the combined organic with water. The organic layers were dried over anhydrous Na₂SO₄, filtered and purified by flash chromatography on silica gel (petroleum/ethyl acetate = 10/1).



To a round-bottomed flask under a nitrogen atmosphere, a solution of *N*-tert-butoxycarbonyl-2-arylpyrrole derivatives (5 mmol, 1.0 equiv), sodium ethoxide (7.5 mmol, 1.5 equiv) and THF (40 mL) were added. The reaction was allowed to continue at room temperature for 3 h and monitored by TLC. After the reaction was complete, saturated ammonium chloride solution was added to the reaction mixture and the resulting solution was extracted with ethyl acetate. The organic layer was washed with water and saturated brine, dried over anhydrous Na₂SO₄, filtered and purified by flash chromatography on silica gel (petroleum/ethyl acetate = 20/1).

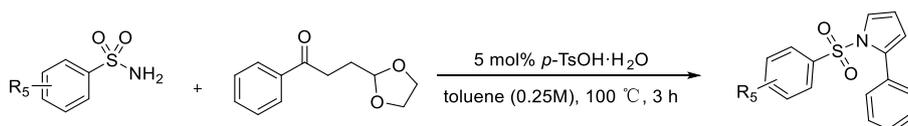
General Procedure B: Synthesis of 2-aryl-sulfonyl pyrroles

Route 1:



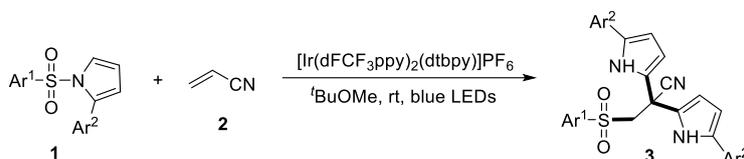
2-Aryl pyrroles (5 mmol, 1.0 equiv) dissolved in anhydrous DMF (10 mL) was added to a suspension of NaH (60% suspension in mineral oil, 6 mmol, 1.2 equiv) in anhydrous DMF (10 mL) and stirred at 0 °C for 30 min. Then, aryl sulfonyl chloride (5.5 mmol, 1.1 equiv) was added dropwise as a solution in anhydrous DMF (5 mL) at 0 °C. The resulting solution was allowed to warm to room temperature and stirred for overnight. Upon completion, the reaction mixture was diluted with water and extracted with ethyl acetate. The combined organic layer was washed with sat. aq. NaHCO₃, brine, and dried over anhydrous Na₂SO₄, filtered and purified by flash chromatography on silica gel (petroleum/ethyl acetate = 8/1 to 5/1).

Route 2:



Sulfonamide (3 mmol, 1.0 equiv), ketone (3.6 mmol, 1.2 equiv), *p*-TsOH · H₂O (0.15 mmol, 5 mol %), and toluene (12 mL) were added into a round-bottomed flask. Then, the mixture was stirred at 100 °C for 3 h. The reaction was quenched with sat. aq. NaHCO₃, and extracted with ethyl acetate. The combined organic layer was washed with brine, and dried over anhydrous Na₂SO₄, filtered and purified by flash chromatography on silica gel (petroleum/ethyl acetate = 8/1 to 5/1).

General Procedure C: Sulfonylation of acrylonitrile



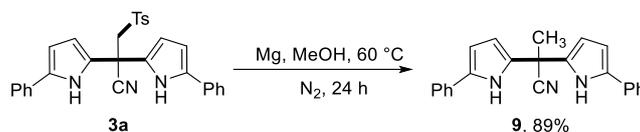
Sulfonyl pyrrole **1** (1.0 mmol, 5.0 equiv) and [Ir(dFCF₃ppy)₂(dtbbpy)]PF₆ (3 mol%, 6.7 mg) were added to a Schleck tube. The tube was sealed, evacuated and refilled with nitrogen for three times. Then, a solution of the acrylonitrile **2** (0.2 mmol, 1.0 equiv) in *t*BuOMe (2.0 mL) was added. The tube was irradiated by blue LEDs (30 W) at room temperature for 24 h. Upon completion, the reaction was purified by flash chromatography on silica gel (petroleum/ethyl acetate = 10/1 to 5/1).

General Procedure D: Sulfonylation of diarylethene

The sulfonyl pyrrole **1** (0.2 mmol, 1.0 equiv), [Ir(dFCF₃ppy)₂(dtbbpy)]PF₆ (3 %mol, 6.73 mg) were added to a Schleck tube. The tube was sealed, evacuated and refilled with nitrogen for three times. Then, a solution of diarylethene (0.4 mmol, 2.0 equiv) in MeCN (2.0 mL) were added by syringe. The tube was illuminated with blue LEDs (30 W) for 24 h. Upon completion, the reaction mixture was purified by flash chromatography on silica gel to provide the desired product **5**.

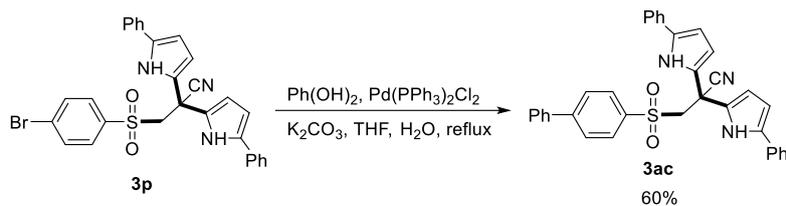
4. Derivation of the products

(1) Desulfonation of **3a**



The product **3a** (0.1 mmol, 1.0 equiv) and Mg (4 mmol, 40.0 equiv), were placed in a Schleck tube. The tube was sealed, evacuated and refilled with nitrogen for three times. Then, MeOH (1 mL) was added. The tube was placed in an oil bath and heated at 60 °C for 24 h. Then the reaction mixture was diluted with H₂O and extracted with DCM. The combined organic layers were washed with brine and dried over anhydrous Na₂SO₄, filtered and purified by flash chromatography on silica gel (petroleum/ethyl acetate = 5/1) to get **9** (pink solid, 29.9 mg, 89% yield).

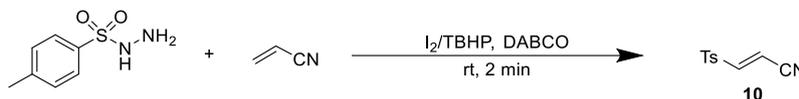
(2) Arylation of **3p**



The product **3p** (0.06 mmol, 1.0 equiv), K_2CO_3 (0.24 mmol, 4.0 equiv), $\text{Pd(PPh}_3)_2\text{Cl}_2$ (3 mol%, 1.3 mg), and phenyl boronic acid (0.09 mmol, 1.5 equiv) were added to a Schleck tube. The tube was sealed, evacuated and refilled with nitrogen for three times. Then, THF (2 mL) and H_2O (0.1 mL) were added. The reaction mixture was heated at 60 °C overnight. Upon completion, the reaction was quenched with sat. aq. NH_4Cl , and extracted with ethyl acetate. The combined organic layer was washed with brine, and dried over anhydrous Na_2SO_4 , filtered and purified by flash chromatography on silica gel (petroleum/ethyl acetate = 8/1 to 5/1) to get **3ac** (white solid, 19.2 mg, 60% yield).

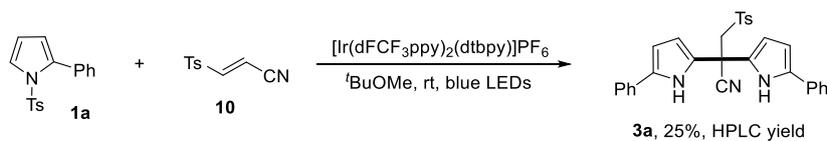
5. Control experiments

(1) Synthesis of alkene **10**



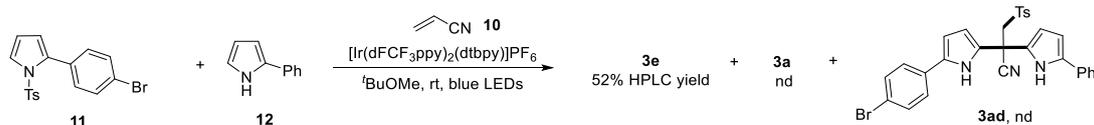
The alkene **10** was synthesized according to the literature procedures.⁴ 4-Methylbenzenesulfonylhydrazide (0.6 mmol, 1.2 equiv), TBHP (1.5 mmol, 3.0 equiv), I_2 (0.1 mmol, 20 mol%), and acrylonitrile (0.5 mmol, 1.0 equiv) were added to a Schleck tube. The tube was sealed and stirred for 1 min. Then DABCO (0.25 mmol, 50 mol%) was added. After stirring for 1 min, the reaction was quenched with sat. aq. $\text{Na}_2\text{S}_2\text{O}_3$, extracted with ethyl acetate and wash with water. Then the organic layer was dried over anhydrous Na_2SO_4 filtered and purified by flash chromatography on silica gel (petroleum/ethyl acetate = 10/1) to get **10** (brown solid, 72.5 mg, 70% yield).

(2) Synthesis of **3a** from 3-tosylacrylonitrile



The sulfonyl pyrrole **1a** (0.5 mmol, 5.0 equiv) and $[\text{Ir(dFCF}_3\text{ppy)}_2(\text{dtbbpy})]\text{PF}_6$ (3 mol%, 3.4 mg) were added to a Schleck tube. The tube was sealed, evacuated and refilled with nitrogen for three times. Then, the alkene **10** (0.1 mmol, 1.0 equiv) and $t\text{BuOMe}$ (2.0 mL) were added. The tube was irradiated by blue LEDs (30 W) for 24 h. The yield of **3a** was determined to be 25% by HPLC analysis.

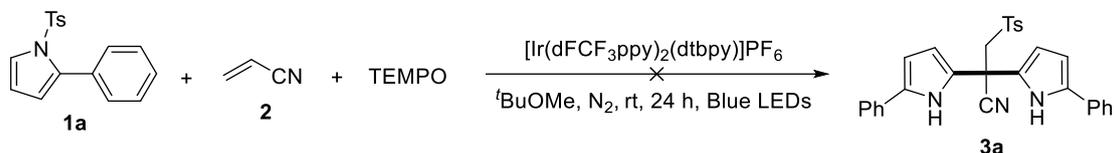
(3) 2-phenyl pyrrole added



The sulfonyl pyrrole **11** (0.3 mmol, 3.0 equiv), 2-phenyl pyrrole **12** (0.3 mmol, 3.0 equiv) and $[\text{Ir(dFCF}_3\text{ppy)}_2(\text{dtbbpy})]\text{PF}_6$ (3 mol%, 3.4 mg) were added to a Schleck tube. The tube was

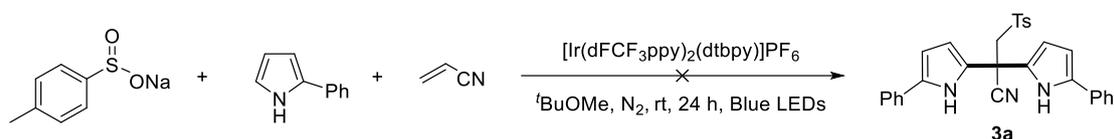
sealed, evacuated and refilled with nitrogen for three times. Then, the alkene **10** (0.1 mmol, 1.0 equiv) and ^tBuOMe (2.0 mL) were added. The tube was irradiated by blue LEDs (30 W) for 24 h. The yield of **3e** was determined to be 52% by HPLC analysis. The compounds of **3a** and **3ad** were not detected.

(4) Radical-trapping experiment with TEMPO



The sulfonyl pyrrole **1a** (0.5 mmol, 5.0 equiv), [Ir(dFCF₃ppy)₂(dtbbpy)]PF₆ (3 %mol, 3.36 mg), TEMPO (2,2,6,6-Tetramethylpiperidinoxy) (0.5 mmol, 5.0 equiv) were added to a Schleck tube. The tube was sealed, evacuated and refilled with nitrogen for three times. Then, the alkene **2** (0.1 mmol, 1.0 equiv) and ^tBuOMe (1.0 mL) were added. The tube was irradiated by blue LEDs (30 W) for 24 h. And the desired product was not detected.

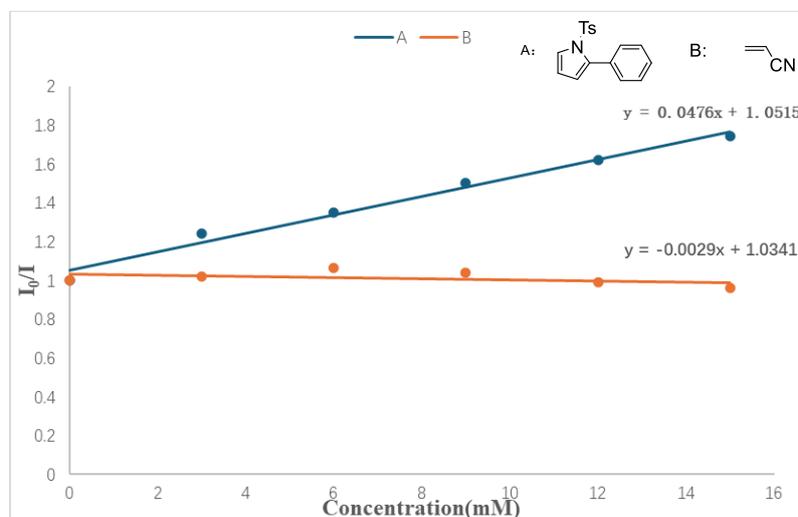
(5) Synthesis of **3a** from aryl sulfinate



The toluene sulfinate (0.5 mmol, 5.0 equiv), 2-phenyl pyrrole (0.5 mmol, 5.0 equiv), and [Ir(dFCF₃ppy)₂(dtbbpy)]PF₆ (3 %mol, 3.4 mg) were added to a Schleck tube. The tube was sealed, evacuated and refilled with nitrogen for three times. Then, acrylonitrile (0.1 mmol, 1.0 equiv) and ^tBuOMe (1.0 mL) were added to a Schleck tube. The tube was irradiated by blue LEDs (30 W) for 24 h. The desired product **3a** was not detected, suggesting that the reduction of sulfonyl pyrroles to sulfinate and pyrrole didn't exist in this reaction.

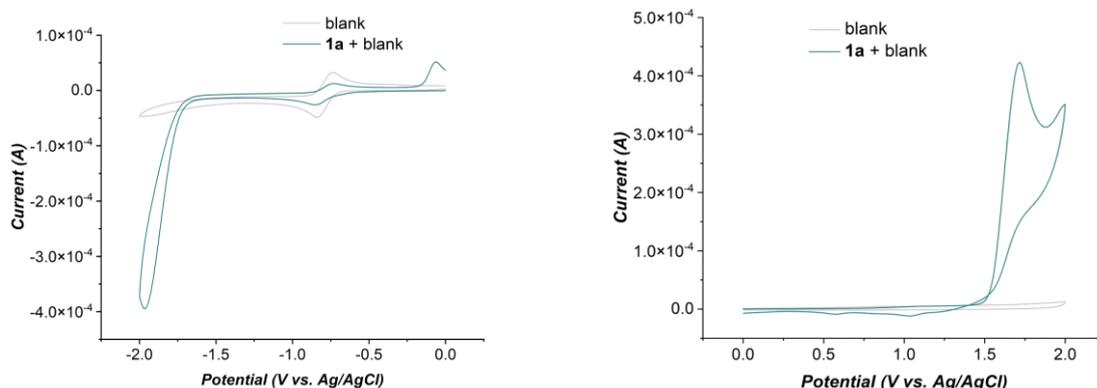
6. Stern-Volmer Quenching Experiments

Stern-Volmer experiments of [Ir(dFCF₃ppy)₂(dtbbpy)]PF₆ were carried out with different concentrations (0-15 mM) of 2-phenyl-*N*-tosyl-pyrrole **1a** and acrylonitrile **2** in ^tBuOMe. The solutions were irradiated at 380 nm and luminescence was measured over a range of 420-700 nm.



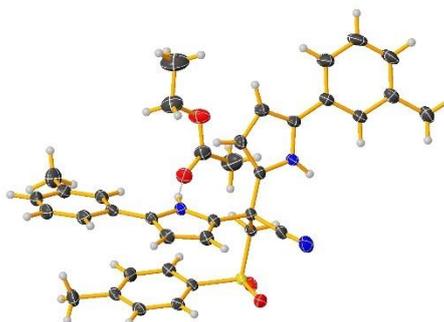
7. Cyclic Voltammetry Experiments

Cyclic voltammetry experiments were carried out by following conditions. Working electrode: glassy carbon, counter electrode: Pt, reference electrode: Ag/AgCl (3 M KCl). The solution of interest was sparged with nitrogen for 5 minutes before data collection. The analyte (0.01 M) and $n\text{Bu}_4\text{NPF}_6$ (0.1 M) were dissolved in MeCN. Scan rate: 100 mV/s.



8. The X-ray structure of $3\text{h}\cdot\text{EtOAc}$ (50% probability for thermal ellipsoids)

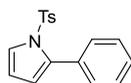
A colorless crystal of **3h** (CCDC 2403571) suitable for X-ray crystallography was obtained from a petroleum ether/ethyl acetate solution at room temperature under air.



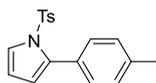
Empirical formula	$\text{C}_{36}\text{H}_{37}\text{N}_3\text{O}_4\text{S}$
Formula weight	607.74
Temperature/K	150.00(10)
Crystal system	monoclinic
Space group	$P2_1/n$
$a/\text{\AA}$	16.5967(3)
$b/\text{\AA}$	10.43665(15)
$c/\text{\AA}$	19.7266(3)
$\alpha/^\circ$	90
$\beta/^\circ$	109.1874(19)
$\gamma/^\circ$	90
Volume/ \AA^3	3227.11(10)
Z	4
$\rho_{\text{calc}}/\text{g/cm}^3$	1.251

μ/mm^{-1}	1.235
F(000)	1288.0
Crystal size/ mm^3	$0.068 \times 0.025 \times 0.022$
Radiation	$\text{CuK}\alpha$ ($\lambda = 1.54184$)
2Θ range for data collection/ $^\circ$	6.06 to 146.162
Index ranges	$-20 \leq h \leq 19, -12 \leq k \leq 12, -24 \leq l \leq 16$
Reflections collected	21994
Independent reflections	6345 [$R_{\text{int}} = 0.0510, R_{\text{sigma}} = 0.0385$]
Data/restraints/parameters	6345/0/402
Goodness-of-fit on F^2	1.028
Final R indexes [$I \geq 2\sigma(I)$]	$R_1 = 0.0466, wR_2 = 0.1236$
Final R indexes [all data]	$R_1 = 0.0519, wR_2 = 0.1307$
Largest diff. peak/hole / $e \text{ \AA}^{-3}$	0.34/-0.35

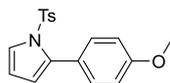
9. Characterization of sulfonyl pyrroles



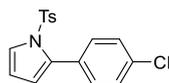
^1H NMR (500 MHz, CDCl_3) δ 7.45 – 7.42 (m, 1H), 7.37 – 7.33 (m, 1H), 7.32 – 7.27 (m, 2H), 7.21 – 7.24 (m, 4H), 7.09 (d, $J = 8.1$ Hz, 2H), 6.30 (t, $J = 3.4$ Hz, 1H), 6.15 (dd, $J = 3.3, 1.8$ Hz, 1H), 2.34 (s, 3H). **^{13}C NMR (126 MHz, CDCl_3)** δ 144.65, 136.04, 135.65, 131.47, 130.94, 129.37, 128.23, 127.36, 127.13, 124.10, 115.77, 112.03, 21.59. **HRMS** (APCI/[$\text{M}+\text{H}$] $^+$) calculated for $\text{C}_{17}\text{H}_{15}\text{NO}_2\text{S}$: 298.0896, found: 298.0909.



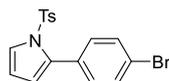
^1H NMR (400 MHz, CDCl_3) δ 7.41 – 7.40 (m, 1H), 7.25 (d, $J = 6.6$ Hz, 2H), 7.14 – 7.07 (m, 6H), 6.28 (t, $J = 3.3$ Hz, 1H), 6.12 (dd, $J = 3.3, 1.8$ Hz, 1H), 2.39 (s, 3H), 2.35 (s, 3H). **^{13}C NMR (101 MHz, CDCl_3)** δ 144.59, 138.12, 136.18, 135.75, 130.78, 129.36, 128.59, 128.09, 127.13, 123.93, 115.61, 112.12, 21.60, 21.37. **HRMS** (APCI/[$\text{M}+\text{H}$] $^+$) calculated for $\text{C}_{18}\text{H}_{17}\text{NO}_2\text{S}$: 312.1053, found: 312.1065.



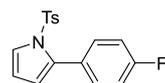
^1H NMR (500 MHz, CDCl_3) δ 7.41 – 7.40 (m, 1H), 7.23 (d, $J = 8.2$ Hz, 2H), 7.16 – 7.12 (m, 2H), 7.10 (d, $J = 8.1$ Hz, 2H), 6.85 – 6.80 (m, 2H), 6.28 (t, $J = 3.3$ Hz, 1H), 6.09 (dd, $J = 3.3, 1.8$ Hz, 1H), 3.84 (s, 3H), 2.35 (s, 3H). **^{13}C NMR (126 MHz, CDCl_3)** δ 159.70, 144.57, 135.81, 135.78, 132.24, 129.35, 127.14, 123.81, 123.72, 115.36, 112.80, 111.92, 55.29, 21.57. **HRMS** (APCI/[$\text{M}+\text{H}$] $^+$) calculated for $\text{C}_{18}\text{H}_{17}\text{NO}_3\text{S}$: 328.1002, found: 328.1009.



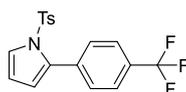
¹H NMR (500 MHz, CDCl₃) δ 7.44 – 7.43 (m, 1H), 7.30 – 7.27 (m, 2H), 7.25 (d, *J* = 8.4 Hz, 2H), 7.19 – 7.15 (m, 2H), 7.13 (d, *J* = 8.1 Hz, 2H), 6.30 (t, *J* = 3.4 Hz, 1H), 6.15 (dd, *J* = 3.3, 1.8 Hz, 1H), 2.36 (s, 3H). **¹³C NMR (101 MHz, CDCl₃)** δ 144.90, 135.54, 134.72, 134.39, 132.10, 129.94, 129.49, 127.63, 127.03, 124.51, 116.21, 112.23, 21.62. **HRMS (APCI/[M+H]⁺)** calculated for C₁₇H₁₄ClNO₂S: 332.0507, found: 332.0517.



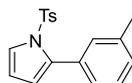
¹H NMR (400 MHz, CDCl₃) δ 7.46 – 7.41 (m, 3H), 7.25 (d, *J* = 8.1 Hz, 2H), 7.14 – 7.09 (m, 4H), 6.30 (t, *J* = 3.3 Hz, 1H), 6.15 (dd, *J* = 3.3, 1.7 Hz, 1H), 2.36 (s, 3H). **¹³C NMR (101 MHz, CDCl₃)** δ 144.91, 135.52, 134.74, 132.37, 130.59, 130.42, 129.50, 127.03, 124.56, 122.65, 116.23, 112.27, 21.62. **HRMS (APCI/[M+H]⁺)** calculated for C₁₇H₁₄BrNO₂S: 376.0001, found: 375.9991.



¹H NMR (400 MHz, CDCl₃) δ 7.44 – 7.43 (m, 1H), 7.22 (d, *J* = 2.0 Hz, 2H), 7.21 – 7.16 (m, 2H), 7.12 (d, *J* = 8.6 Hz, 2H), 7.02 – 6.95 (m, 2H), 6.30 (t, *J* = 3.3 Hz, 1H), 6.13 (dd, *J* = 3.3, 1.8 Hz, 1H), 2.36 (s, 3H). **¹³C NMR (101 MHz, CDCl₃)** δ 164.06, 161.60, 144.83, 135.62, 134.75, 132.74 (d, *J* = 8.3 Hz), 129.45, 127.45 (d, *J* = 3.3 Hz), 127.06, 124.13, 115.90, 114.49, 114.27, 111.97, 21.60. **¹⁹F NMR (376 MHz, CDCl₃)** δ -113.34. **HRMS (APCI/[M+H]⁺)** calculated for C₁₇H₁₄FNO₂S: 316.0802, found: 316.0816.

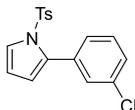


¹H NMR (500 MHz, CDCl₃) δ 7.56 (d, *J* = 8.4 Hz, 2H), 7.47 – 7.46 (m, 1H), 7.38 (d, *J* = 8.0 Hz, 2H), 7.24 (d, *J* = 8.4 Hz, 2H), 7.12 (d, *J* = 8.4 Hz, 2H), 6.33 (t, *J* = 3.4 Hz, 1H), 6.21 (dd, *J* = 3.4, 1.7 Hz, 1H), 2.36 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 145.02, 135.46, 135.15, 134.49, 130.99, 130.14 (q, *J* = 32.4 Hz), 129.52, 126.98, 125.05, 124.34 (q, *J* = 3.8 Hz), 123.06, 116.86, 112.41, 21.58. **¹⁹F NMR (471 MHz, CDCl₃)** δ -62.55. **HRMS (APCI/[M+H]⁺)** calculated for C₁₈H₁₄F₃NO₂S: 366.0770, found: 366.0779.

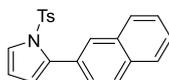


¹H NMR (500 MHz, CDCl₃) δ 7.43 – 7.42 (m, 1H), 7.23 (s, 2H), 7.18 (m, 2H), 7.10 (d, *J* = 8.1 Hz, 2H), 7.04 (d, *J* = 7.3 Hz, 1H), 6.95 (s, 1H), 6.29 (t, *J* = 3.3 Hz, 1H), 6.13 (dd, *J* = 3.3, 1.8 Hz, 1H), 2.35 (s, 3H), 2.30 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.59, 136.82, 136.10,

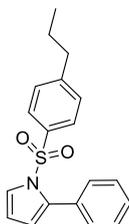
135.77, 131.65, 131.35, 129.31, 128.95, 128.05, 127.27, 127.24, 123.86, 115.48, 111.87, 21.58, 21.27. **HRMS** (APCI/[M+H]⁺) calculated for C₁₈H₁₇NO₂S: 312.1053, found: 312.1061.



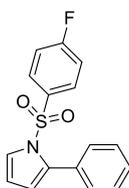
¹H NMR (500 MHz, CDCl₃) δ 7.45 – 7.44 (m, 1H), 7.34 – 7.31 (m, 1H), 7.26 (d, *J* = 3.2 Hz, 2H), 7.24 (d, *J* = 2.5 Hz, 1H), 7.20 – 7.19 (m, 1H), 7.14 (d, *J* = 8.1 Hz, 2H), 7.04 (t, *J* = 1.9 Hz, 1H), 6.31 (t, *J* = 3.3 Hz, 1H), 6.17 (dd, *J* = 3.3, 1.7 Hz, 1H), 2.37 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 147.40, 145.31, 138.08, 135.32, 133.86, 131.20, 129.67, 126.82, 126.12, 122.69, 117.97, 112.95, 21.62. **HRMS** (APCI/[M+H]⁺) calculated for C₁₇H₁₄ClNO₂S: 332.0507, found: 332.0510.



¹H NMR (500 MHz, CDCl₃) δ 7.89 (d, *J* = 8.2 Hz, 1H), 7.82 – 7.79 (m, 1H), 7.62 – 7.61 (m, 1H), 7.48 – 7.45 (m, 1H), 7.40 – 7.33 (m, 2H), 7.20 – 7.11 (m, 2H), 7.05 (d, *J* = 8.3 Hz, 2H), 6.82 (d, *J* = 8.0 Hz, 2H), 6.44 (t, *J* = 3.3 Hz, 1H), 6.29 (dd, *J* = 3.3, 1.8 Hz, 1H), 2.21 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.51, 135.10, 133.84, 132.97, 131.98, 130.60, 129.86, 129.25, 129.13, 128.66, 127.89, 127.76, 127.36, 125.87, 125.39, 124.48, 122.94, 116.56, 111.12, 21.43. **HRMS** (APCI/[M+H]⁺) calculated for C₂₁H₁₇NO₂S: 348.1053, found: 348.1066.

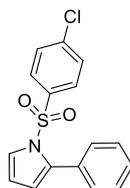


¹H NMR (500 MHz, CDCl₃) δ 7.45 – 7.44 (m, 1H), 7.35 – 7.30 (m, 1H), 7.28 – 7.18 (m, 6H), 7.06 (d, *J* = 8.1 Hz, 2H), 6.29 (t, *J* = 3.3 Hz, 1H), 6.14 (dd, *J* = 3.4, 1.8 Hz, 1H), 2.55 (t, *J* = 7.6 Hz, 2H), 1.61 – 1.54 (m, 2H), 0.87 (d, *J* = 7.3 Hz, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 149.27, 135.96, 135.86, 131.47, 130.98, 128.81, 128.21, 127.36, 127.16, 124.04, 115.63, 111.84, 37.82, 24.06, 13.60. **HRMS** (APCI/[M+H]⁺) calculated for C₁₉H₁₉NO₂S: 326.1209, found: 326.1212.

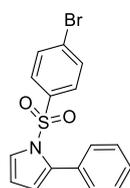


¹H NMR (500 MHz, CDCl₃) δ 7.44 – 7.43 (m, 1H), 7.39 – 7.27 (m, 5H), 7.23 – 7.18 (m, 2H), 6.96 (t, *J* = 8.6 Hz, 2H), 6.32 (t, *J* = 3.3 Hz, 1H), 6.17 (dd, *J* = 3.3, 1.8 Hz, 1H). **¹³C NMR (126 MHz, CDCl₃)** δ 166.55, 164.51, 136.04, 134.50 (d, *J* = 3.2 Hz), 131.22, 130.96, 130.03 (d, *J* = 9.7 Hz), 128.42, 127.48, 124.08, 116.08 (d, *J* = 22.9 Hz), 112.36. **¹⁹F NMR (471 MHz, CDCl₃)**

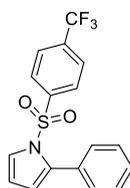
δ -103.00. **HRMS** (APCI/[M+H]⁺) calculated for C₁₆H₁₂FNO₂S: 302.0646, found: 302.0654.



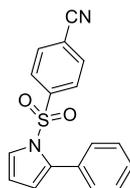
¹H NMR (500 MHz, CDCl₃) δ 7.43 – 7.42 (m, 1H), 7.39 – 7.34 (m, 1H), 7.33 – 7.30 (m, 2H), 7.27 (d, J = 9.0 Hz, 2H), 7.25 (s, 1H), 7.23 – 7.21 (m, 3H), 6.33 (t, J = 3.3 Hz, 1H), 6.18 (dd, J = 3.3, 1.8 Hz, 1H). **¹³C NMR (126 MHz, CDCl₃)** δ 140.28, 136.84, 136.07, 131.12, 130.94, 129.07, 128.54, 128.45, 127.49, 124.09, 116.12, 112.56. **HRMS** (APCI/[M+H]⁺) calculated for C₁₆H₁₂ClNO₂S: 318.0350, found: 318.0359.



¹H NMR (500 MHz, CDCl₃) δ 7.46 – 7.40 (m, 3H), 7.39 – 7.36 (m, 1H), 7.33 – 7.30 (m, 2H), 7.23 (d, J = 7.2 Hz, 2H), 7.17 (d, J = 8.6 Hz, 2H), 6.33 (t, J = 3.4 Hz, 1H), 6.18 (dd, J = 3.3, 1.8 Hz, 1H). **¹³C NMR (126 MHz, CDCl₃)** δ 137.38, 136.08, 132.06, 131.11, 130.93, 128.87, 128.57, 128.45, 127.49, 124.09, 116.14, 112.60. **HRMS** (APCI/[M+H]⁺) calculated for C₁₆H₁₂BrNO₂S: 361.9845, found: 361.9856.

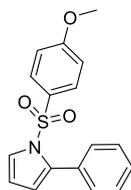


¹H NMR (500 MHz, CDCl₃) δ 7.56 – 7.55 (d, J = 8.2 Hz, 2H), 7.47 – 7.42 (m, 3H), 7.38 (t, J = 7.4 Hz, 1H), 7.31 (d, J = 15.2 Hz, 2H), 7.24 – 7.18 (m, 2H), 6.36 (t, J = 3.4 Hz, 1H), 6.19 (dd, J = 3.4, 1.7 Hz, 1H). **¹³C NMR (126 MHz, CDCl₃)** δ 141.80, 136.19, 135.16 (q, J = 33.2 Hz), 130.95, 130.93, 128.56, 127.66, 127.55, 125.89 (q, J = 3.8 Hz), 124.15, 121.87, 116.31, 112.88. **¹⁹F NMR (471 MHz, CDCl₃)** δ -63.33. **HRMS** (APCI/[M+H]⁺) calculated for C₁₇H₁₂F₃NO₂S: 352.0614, found: 352.0621.

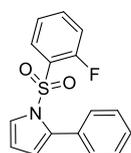


¹H NMR (500 MHz, CDCl₃) δ 7.61 – 7.56 (m, 2H), 7.45 – 7.43 (m, 1H), 7.42 – 7.39 (m, 2H), 7.39 – 7.35 (m, 1H), 7.34 – 7.29 (m, 2H), 7.21 – 7.19 (m, 2H), 6.37 (t, J = 3.3 Hz, 1H), 6.20 (dd, J = 3.3, 1.8 Hz, 1H). **¹³C NMR (126 MHz, CDCl₃)** δ 142.24, 136.21, 132.49, 130.90,

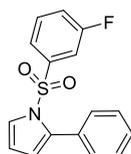
130.77, 128.69, 127.70, 127.63, 124.21, 117.29, 116.92, 116.51, 113.19. **HRMS** (APCI/[M+H]⁺) calculated for C₁₇H₁₂N₂O₂S: 309.0692, found: 309.0697.



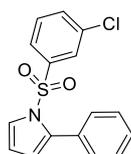
¹H NMR (500 MHz, CDCl₃) δ 7.43 – 7.42 (m, 1H), 7.35 – 7.33 (m, 1H), 7.31 – 7.28 (m, 2H), 7.27 – 7.22 (m, 4H), 6.74 (d, *J* = 8.6 Hz, 2H), 6.29 (t, *J* = 3.4 Hz, 1H), 6.15 (dd, *J* = 3.4, 1.8 Hz, 1H), 3.80 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 163.55, 135.88, 131.52, 130.96, 130.11, 129.42, 128.19, 127.35, 123.98, 115.62, 113.89, 111.80, 55.64. **HRMS** (APCI/[M+H]⁺) calculated for C₁₇H₁₅NO₃S: 314.0845, found: 314.0856.



¹H NMR (500 MHz, CDCl₃) δ 7.53 – 7.52 (m, 1H), 7.51 – 7.47 (m, 1H), 7.32 – 7.27 (m, 1H), 7.21 (t, *J* = 7.7 Hz, 2H), 7.17 – 7.15 (m, 1H), 7.11 (d, *J* = 7.4 Hz, 2H), 7.09 – 7.04 (m, 1H), 6.96 (t, *J* = 7.7 Hz, 1H), 6.32 (t, *J* = 3.4 Hz, 1H), 6.18 (dd, *J* = 3.3, 1.8 Hz, 1H). **¹³C NMR (126 MHz, CDCl₃)** δ 160.04, 157.98, 136.08 (d, *J* = 8.5 Hz), 135.11, 131.10, 130.93, 130.55, 128.25, 127.36, 124.28 (d, *J* = 2.0 Hz), 123.88 (d, *J* = 4.1 Hz), 116.98 (d, *J* = 20.6 Hz), 115.33, 111.00. **¹⁹F NMR (471 MHz, CDCl₃)** δ -108.71. **HRMS** (APCI/[M+H]⁺) calculated for C₁₆H₁₂FNO₂S: 302.0646, found: 302.0652.



¹H NMR (500 MHz, CDCl₃) δ 7.43 – 7.42 (m, 1H), 7.39 – 7.34 (m, 1H), 7.33 – 7.29 (m, 2H), 7.28 – 7.26 (m, 1H), 7.23 – 7.20 (m, 2H), 7.18 – 7.17 (m, 1H), 7.15 – 7.12 (m, 1H), 7.00 – 6.98 (m, 1H), 6.33 (t, *J* = 3.3 Hz, 1H), 6.18 (dd, *J* = 3.3, 1.8 Hz, 1H). **¹³C NMR (126 MHz, CDCl₃)** δ 162.86, 140.28 (d, *J* = 7.1 Hz), 136.16, 131.06, 130.95, 130.62 (d, *J* = 7.7 Hz), 128.52, 127.50, 124.12, 122.87 (d, *J* = 3.4 Hz), 120.89 (d, *J* = 21.2 Hz), 116.11, 114.55 (d, *J* = 25.0 Hz), 112.61. **¹⁹F NMR (471 MHz, CDCl₃)** δ -109.28. **HRMS** (APCI/[M+H]⁺) calculated for C₁₆H₁₂FNO₂S: 302.0646, found: 302.0656.

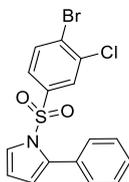


¹H NMR (500 MHz, CDCl₃) δ 7.44 – 7.40 (m, 2H), 7.39 – 7.34 (m, 1H), 7.33 – 7.28 (m, 2H), 7.25 – 7.18 (m, 5H), 6.32 (t, *J* = 3.4 Hz, 1H), 6.17 (dd, *J* = 3.3, 1.8 Hz, 1H). **¹³C NMR (126**

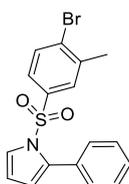
MHz, CDCl₃) δ 139.95, 136.11, 134.92, 133.76, 131.02, 130.11, 128.60, 127.54, 127.34, 125.15, 124.04, 116.12, 112.64. **HRMS** (APCI/[M+H]⁺) calculated for C₁₆H₁₂ClNO₂S: 318.0350, found: 318.0355.



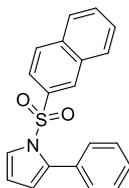
¹H NMR (500 MHz, CDCl₃) δ 7.63 – 7.56 (m, 1H), 7.42 – 7.39 (m, 1H), 7.37 – 7.36 (m, 2H), 7.35 – 7.26 (m, 3H), 7.23 – 7.19 (m, 2H), 7.17 (t, *J* = 7.9 Hz, 1H), 6.33 (t, *J* = 3.4 Hz, 1H), 6.18 (dd, *J* = 3.4, 1.8 Hz, 1H). **¹³C NMR (126 MHz, CDCl₃)** δ 139.97, 136.68, 136.06, 131.03, 130.97, 130.31, 130.19, 128.64, 127.56, 125.57, 124.00, 122.59, 116.11, 112.64. **HRMS** (APCI/[M+H]⁺) calculated for C₁₆H₁₂BrNO₂S: 361.9845, found: 361.9855.



¹H NMR (500 MHz, CDCl₃) δ 7.56 – 7.55 (d, *J* = 8.5 Hz, 1H), 7.42 – 7.40 (m, 1H), 7.39 (d, *J* = 1.4 Hz, 1H), 7.37 – 7.31 (m, 2H), 7.29 (d, *J* = 2.3 Hz, 1H), 7.25 – 7.22 (m, 2H), 7.08 – 7.06 (m, 1H), 6.35 (t, *J* = 3.3 Hz, 1H), 6.20 (dd, *J* = 3.3, 1.8 Hz, 1H). **¹³C NMR (126 MHz, CDCl₃)** δ 138.56, 136.08, 135.45, 134.16, 131.00, 130.85, 129.11, 128.90, 128.71, 127.57, 125.91, 123.98, 116.29, 112.89. **HRMS** (APCI/[M+H]⁺) calculated for C₁₆H₁₁BrClNO₂S: 395.9455, found: 395.9456.

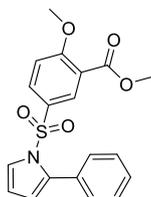


¹H NMR (500 MHz, CDCl₃) δ 7.45 (d, *J* = 8.4 Hz, 1H), 7.43 – 7.40 (m, 1H), 7.38 – 7.35 (m, 1H), 7.32 – 7.27 (m, 2H), 7.22 (d, *J* = 7.5 Hz, 2H), 7.08 (d, *J* = 2.5 Hz, 1H), 7.02 – 6.97 (m, 1H), 6.31 (t, *J* = 3.4 Hz, 1H), 6.16 (dd, *J* = 3.2, 1.6 Hz, 1H), 2.25 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 139.16, 137.28, 135.95, 132.87, 131.27, 131.25, 131.08, 129.15, 128.41, 127.42, 125.62, 123.96, 115.96, 112.33, 22.88. **HRMS** (APCI/[M+H]⁺) calculated for C₁₇H₁₄BrNO₂S: 376.0001, found: 376.0007.

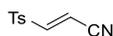


¹H NMR (500 MHz, CDCl₃) δ 7.83 (d, *J* = 8.2 Hz, 1H), 7.80 – 7.75 (m, 2H), 7.70 (d, *J* = 8.2

Hz, 1H), 7.63 (t, $J = 7.5$ Hz, 1H), 7.56 (t, $J = 7.4$ Hz, 1H), 7.53 – 7.52 (m, 1H), 7.39 – 7.37 (m, 1H), 7.36 – 7.33 (m, 1H), 7.24 (d, $J = 7.8$ Hz, 2H), 7.20 – 7.13 (m, 2H), 6.32 (t, $J = 3.3$ Hz, 1H), 6.13 (dd, $J = 3.3, 1.8$ Hz, 1H). $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 135.96, 135.21, 135.07, 131.60, 131.40, 131.08, 129.47, 129.35, 129.16, 128.35, 127.83, 127.56, 127.35, 124.07, 121.63, 115.74, 112.06. **HRMS** (APCI/[$\text{M}+\text{H}$] $^+$) calculated for $\text{C}_{20}\text{H}_{15}\text{NO}_2\text{S}$: 334.0896, found: 334.0902.

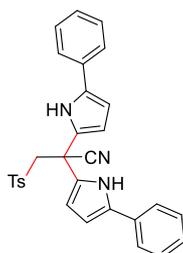


$^1\text{H NMR}$ (500 MHz, CDCl_3) δ 7.70 (d, $J = 2.5$ Hz, 1H), 7.43 – 7.41 (m, 1H), 7.36 – 7.33 (m, 1H), 7.32 – 7.29 (m, 2H), 7.25 – 7.23 (m, 2H), 6.84 (d, $J = 9.0$ Hz, 1H), 6.30 (t, $J = 3.4$ Hz, 1H), 6.16 (dd, $J = 3.3, 1.8$ Hz, 1H), 3.90 (s, 3H), 3.84 (s, 3H). $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 164.36, 162.73, 135.86, 132.51, 131.50, 131.31, 131.02, 129.71, 128.26, 127.44, 123.90, 120.24, 115.91, 112.20, 111.89, 56.51, 52.25. **HRMS** (APCI/[$\text{M}+\text{H}$] $^+$) calculated for $\text{C}_{19}\text{H}_{17}\text{NO}_5\text{S}$: 372.0900, found: 372.0926.

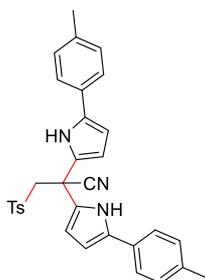


Following the literature procedures⁴, **10** was isolated as brown solid (72.5 mg, 70% yield). $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.70 (d, $J = 8.3$ Hz, 2H), 7.38 (d, $J = 8.1$ Hz, 2H), 7.21 (d, $J = 15.6$ Hz, 1H), 6.46 (d, $J = 15.4$ Hz, 1H), 2.47 (s, 3H). $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 148.3, 146.2, 133.8, 131.5, 128.1, 113.1, 110.1, 21.5. **HRMS** (ESI/[$\text{M}+\text{H}$] $^+$) calculated for $\text{C}_{10}\text{H}_{10}\text{NO}_2\text{S}$: 208.0427, found: 208.0418.

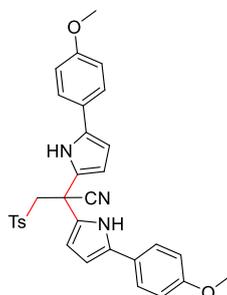
10. Characterization of products 3 and 9



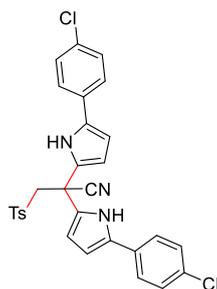
Following the General Procedure C, **3a** was isolated as white solid (72.7 mg, 74% yield). $^1\text{H NMR}$ (500 MHz, CDCl_3) δ 8.96 (s, 2H), 7.47 (d, $J = 8.0$ Hz, 2H), 7.29 – 7.27 (m, 4H), 7.24 – 7.20 (m, 4H), 7.11 (t, $J = 7.3$ Hz, 2H), 6.98 (d, $J = 8.2$ Hz, 2H), 6.26 (t, $J = 3.1$ Hz, 2H), 6.13 (t, $J = 3.2$ Hz, 2H), 4.29 (s, 2H), 2.01 (s, 3H). $^{13}\text{C NMR}$ (126 MHz, CDCl_3) δ 145.20, 135.57, 134.40, 131.69, 129.78, 128.85, 127.87, 126.80, 125.48, 124.05, 118.24, 110.71, 106.11, 63.20, 39.35, 21.31. **HRMS** (ESI/[$\text{M}+\text{H}$] $^+$) calculated for $\text{C}_{30}\text{H}_{25}\text{N}_3\text{O}_2\text{S}$: 492.1740, found: 492.1751.



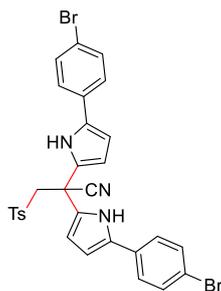
Following the **General Procedure C**, **3b** was isolated as light brown solid (83.0 mg, 80% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.89 (s, 2H), 7.55 (d, *J* = 8.0 Hz, 2H), 7.25 (d, *J* = 4.3 Hz, 4H), 7.12 – 7.10 (m, 4H), 7.07 (d, *J* = 8.0 Hz, 2H), 6.28 (t, *J* = 3.1 Hz, 2H), 6.18 (t, *J* = 3.2 Hz, 2H), 4.32 (s, 2H), 2.31 (s, 6H), 2.12 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 145.15, 136.65, 135.70, 134.48, 129.79, 129.53, 128.94, 127.87, 125.07, 124.02, 118.25, 110.52, 105.61, 63.41, 39.25, 21.37, 21.16. **HRMS (ESI/[M+H]⁺)** calculated for C₃₂H₂₉N₃O₂S: 520.2053, found: 520.2049.



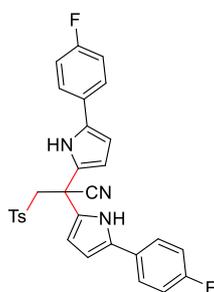
Following the **General Procedure C**, **3c** was isolated as white solid (39.7 mg, 36% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.83 (s, 2H), 7.56 (d, *J* = 8.2 Hz, 2H), 7.30 – 7.26 (m, 4H), 7.08 (d, *J* = 8.0 Hz, 2H), 6.86 – 6.82 (m, 4H), 6.21 (t, *J* = 3.1 Hz, 2H), 6.17 (t, *J* = 3.1 Hz, 2H), 4.32 (s, 2H), 3.78 (s, 6H), 2.14 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 158.67, 145.12, 135.73, 134.34, 129.77, 127.89, 125.46, 124.83, 124.71, 118.28, 114.30, 110.48, 105.06, 63.36, 55.35, 39.24, 21.42. **HRMS (ESI/[M+H]⁺)** calculated for C₃₂H₂₉N₃O₄S: 552.1952, found: 552.1949.



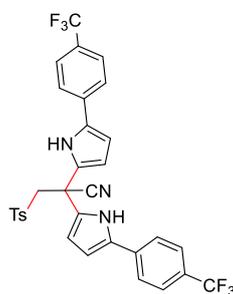
Following the **General Procedure C**, **3d** was isolated as light brown solid (82.7 mg, 74% yield). **¹H NMR (500 MHz, CDCl₃)** δ 9.11 (s, 2H), 7.55 (d, *J* = 7.8 Hz, 2H), 7.28 (d, *J* = 8.1 Hz, 4H), 7.23 (s, 4H), 7.08 (d, *J* = 7.9 Hz, 2H), 6.30 (t, *J* = 3.4 Hz, 2H), 6.17 (t, *J* = 3.4 Hz, 2H), 4.38 (s, 2H), 2.15 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 145.46, 135.42, 133.36, 132.46, 130.13, 129.86, 128.99, 127.86, 125.73, 125.24, 118.15, 110.86, 106.53, 63.14, 39.30, 21.41. **HRMS (ESI/[M+H]⁺)** calculated for C₃₀H₂₃Cl₂N₃O₂S: 560.0961, found: 560.0949.



Following the **General Procedure C**, **3e** was isolated as light brown solid (78.9 mg, 61% yield). **¹H NMR (500 MHz, CDCl₃)** δ 9.09 (s, 2H), 7.56 (d, *J* = 8.0 Hz, 2H), 7.39 (d, *J* = 8.1 Hz, 4H), 7.23 – 7.21 (m, 4H), 7.09 (d, *J* = 8.0 Hz, 2H), 6.31 (t, *J* = 1.4 Hz, 2H), 6.17 (t, *J* = 2.4 Hz, 2H), 4.38 (s, 2H), 2.16 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 145.49, 135.39, 133.36, 131.92, 130.55, 129.88, 127.86, 125.77, 125.53, 120.48, 118.13, 110.91, 106.59, 63.11, 39.31, 21.42. **HRMS (ESI/[M+H]⁺)** calculated for C₃₀H₂₃Br₂N₃O₂S: 647.9951, found: 647.9956.

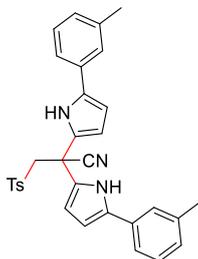


Following the **General Procedure C**, **3f** was isolated as white solid (63.2 mg, 60% yield). **¹H NMR (500 MHz, CDCl₃)** δ 9.01 (s, 2H), 7.53 (d, *J* = 7.9 Hz, 2H), 7.29 – 7.27 (m, 4H), 7.01 (d, *J* = 8.0 Hz, 2H), 6.95 – 6.92 (m, 4H), 6.21 (t, *J* = 3.1 Hz, 2H), 6.17 (t, *J* = 3.2 Hz, 2H), 4.47 (s, 2H), 2.06 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 162.73, 160.77, 145.26, 135.34, 133.66, 129.76, 128.04 (d, *J* = 3.1 Hz), 127.87, 125.76 (d, *J* = 7.9 Hz), 125.41, 118.37, 115.72 (d, *J* = 21.8 Hz), 110.80, 105.89, 62.86, 39.39, 21.30. **¹⁹F NMR (471 MHz, CDCl₃)** δ -115.22. **HRMS (ESI/[M+H]⁺)** calculated for C₃₀H₂₃F₂N₃O₂S: 528.1552, found: 528.1560.

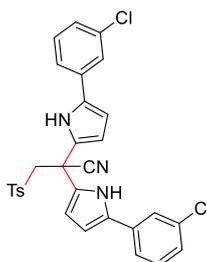


Following the **General Procedure C**, **3g** was isolated as white solid (52.7 mg, 42% yield). **¹H NMR (500 MHz, CDCl₃)** δ 9.27 (s, 2H), 7.59 (d, *J* = 8.0 Hz, 2H), 7.53 – 7.51 (m, 4H), 7.46 – 7.44 (m, 4H), 7.10 (d, *J* = 8.0 Hz, 2H), 6.42 (t, *J* = 3.1 Hz, 2H), 6.21 (t, *J* = 3.0 Hz, 2H), 4.45 (s, 2H), 2.13 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 145.69, 135.42, 134.78, 133.00, 129.94, 128.57 (q, *J* = 32.6 Hz), 127.88, 126.50, 125.85 (q, *J* = 4.0 Hz), 125.16, 123.94, 123.01, 118.03,

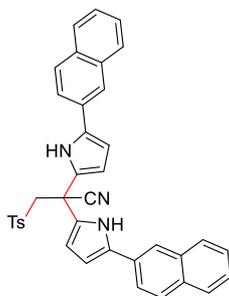
111.15, 107.73, 63.24, 39.34, 21.29. ^{19}F NMR (471 MHz, CDCl_3) δ -62.53. HRMS (ESI/[M+H] $^+$) calculated for $\text{C}_{32}\text{H}_{23}\text{F}_6\text{N}_3\text{O}_2\text{S}$: 628.1488, found: 628.1484.



Following the **General Procedure C**, **3h** was isolated as white solid (72.7 mg, 70% yield). ^1H NMR (500 MHz, CDCl_3) δ 8.91 (s, 2H), 7.57 (d, J = 8.0 Hz, 2H), 7.20 (s, 1H), 7.18 (s, 1H), 7.21 – 7.17 (m, 4H), 7.09 (d, J = 8.0 Hz, 2H), 7.01 (d, J = 7.2 Hz, 2H), 6.32 (t, J = 3.1 Hz, 2H), 6.19 (t, J = 3.1 Hz, 2H), 4.33 (s, 2H), 2.32 (s, 6H), 2.13 (s, 3H). ^{13}C NMR (126 MHz, CDCl_3) δ 145.22, 138.52, 135.69, 134.51, 131.62, 129.79, 128.77, 127.90, 127.68, 125.30, 124.75, 121.26, 118.22, 110.62, 106.06, 63.31, 39.28, 21.46, 21.35. HRMS (ESI/[M+H] $^+$) calculated for $\text{C}_{32}\text{H}_{29}\text{N}_3\text{O}_2\text{S}$: 520.2053, found: 520.2045.

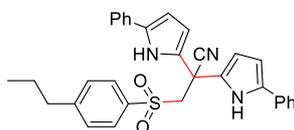


Following the **General Procedure C**, **3i** was isolated as little brown solid (79.4 mg, 71% yield). ^1H NMR (500 MHz, CDCl_3) δ 9.08 (s, 2H), 7.53 (d, J = 7.8 Hz, 2H), 7.25 (s, 1H), 7.21 – 7.18 (m, 3H), 7.15 (d, J = 7.7 Hz, 2H), 7.10 (d, J = 7.8 Hz, 2H), 6.99 (d, J = 7.9 Hz, 2H), 6.28 (t, J = 2.7 Hz, 2H), 6.20 (t, J = 2.5 Hz, 2H), 4.51 (s, 2H), 2.02 (s, 3H). ^{13}C NMR (126 MHz, CDCl_3) δ 145.34, 135.07, 134.69, 133.40, 133.12, 130.04, 129.72, 127.92, 126.55, 125.90, 124.06, 122.11, 118.25, 111.15, 106.92, 62.66, 39.48, 21.21. HRMS (ESI/[M+H] $^+$) calculated for $\text{C}_{30}\text{H}_{23}\text{Cl}_2\text{N}_3\text{O}_2\text{S}$: 560.0961, found: 560.0955.

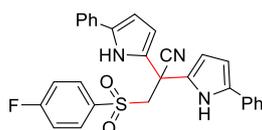


Following the **General Procedure C**, **3j** was isolated as white solid (59.1 mg, 50% yield). ^1H NMR (500 MHz, CDCl_3) δ 8.92 (s, 2H), 8.19 (d, J = 8.3 Hz, 2H), 7.83 (d, J = 7.9 Hz, 2H), 7.76 (d, J = 8.1 Hz, 2H), 7.60 (d, J = 8.0 Hz, 2H), 7.47 (d, J = 7.1 Hz, 1H), 7.45 – 7.40 (m, 5H),

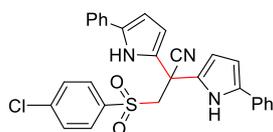
7.37 (d, $J = 7.0$ Hz, 2H), 7.16 (d, $J = 8.0$ Hz, 2H), 6.37 (t, $J = 3.1$ Hz, 2H), 6.34 (t, $J = 3.2$ Hz, 2H), 4.27 (s, 2H), 2.25 (s, 3H). ^{13}C NMR (126 MHz, CDCl_3) δ 145.26, 136.28, 133.98, 132.73, 131.10, 130.33, 128.50, 128.11, 128.09, 126.61, 126.37, 126.06, 125.51, 125.39, 125.36, 118.17, 109.99, 109.81, 63.21, 39.24, 21.57. HRMS (ESI/[M+H] $^+$) calculated for $\text{C}_{38}\text{H}_{29}\text{N}_3\text{O}_2\text{S}$: 592.2053, found: 592.2082.



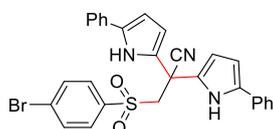
Following the **General Procedure C**, **3m** was isolated as white solid (80.0 mg, 77% yield). ^1H NMR (500 MHz, CDCl_3) δ 9.06 (s, 2H), 7.60 (d, $J = 8.1$ Hz, 2H), 7.38 – 7.37 (m, 4H), 7.31 – 7.28 (m, 4H), 7.19 (t, $J = 7.4$ Hz, 2H), 7.11 (d, $J = 8.1$ Hz, 2H), 6.33 (t, $J = 3.2$ Hz, 2H), 6.19 (t, $J = 3.2$ Hz, 2H), 4.34 (s, 2H), 2.39 (t, $J = 7.7$ Hz, 2H), 1.50 – 1.42 (m, 2H), 0.84 (t, $J = 7.3$ Hz, 3H). ^{13}C NMR (126 MHz, CDCl_3) δ 149.83, 135.97, 134.32, 131.73, 129.19, 128.87, 127.92, 126.84, 125.55, 124.07, 118.17, 110.60, 106.21, 63.42, 39.32, 37.67, 23.76, 13.65. HRMS (ESI/[M+H] $^+$) calculated for $\text{C}_{32}\text{H}_{29}\text{N}_3\text{O}_2\text{S}$: 520.2053, found: 520.2055.



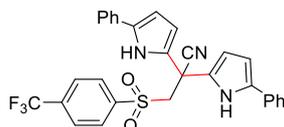
Following the **General Procedure C**, **3n** was isolated as white solid (60.4 mg, 61% yield). ^1H NMR (500 MHz, CDCl_3) δ 8.92 (s, 2H), 7.72 – 7.69 (m, 2H), 7.39 – 7.37 (m, 4H), 7.34 – 7.31 (m, 4H), 7.22 (t, $J = 7.3$ Hz, 2H), 6.99 (t, $J = 8.4$ Hz, 2H), 6.34 (t, $J = 3.2$ Hz, 2H), 6.18 (t, $J = 3.2$ Hz, 2H), 4.32 (s, 2H). ^{13}C NMR (126 MHz, CDCl_3) δ 166.93, 164.88, 134.44, 131.56, 130.91 (d, $J = 10.0$ Hz), 128.97, 127.08, 125.14, 124.12, 118.03, 116.55 (d, $J = 22.8$ Hz), 110.58, 106.39, 63.51, 39.19. ^{19}F NMR (471 MHz, CDCl_3) δ -102.30. HRMS (ESI/[M+H] $^+$) calculated for $\text{C}_{29}\text{H}_{22}\text{FN}_3\text{O}_2\text{S}$: 496.1490, found: 496.1500.



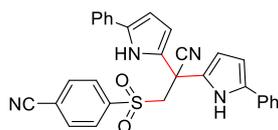
Following the **General Procedure C**, **3o** was isolated as white solid (74.6 mg, 73% yield). ^1H NMR (500 MHz, CDCl_3) δ 8.87 (s, 2H), 7.62 – 7.57 (m, 2H), 7.40 – 7.36 (m, 4H), 7.36 – 7.30 (m, 5H), 7.30 – 7.26 (m, 2H), 7.24 – 7.19 (m, 2H), 6.34 (t, $J = 3.2$ Hz, 2H), 6.19 (t, $J = 3.2$ Hz, 2H), 4.31 (s, 2H). ^{13}C NMR (126 MHz, CDCl_3) δ 140.91, 137.17, 134.46, 131.53, 129.47, 129.32, 128.98, 127.09, 125.09, 124.12, 117.98, 110.60, 106.41, 63.57, 39.19. HRMS (ESI/[M+H] $^+$) calculated for $\text{C}_{29}\text{H}_{22}\text{ClN}_3\text{O}_2\text{S}$: 512.1194, found: 512.1200.



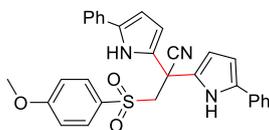
Following the **General Procedure C**, **3p** was isolated as light brown solid (77.7 mg, 70% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.92 (s, 2H), 7.48 (d, *J* = 8.3 Hz, 2H), 7.38 (s, 1H), 7.36 (d, *J* = 4.6 Hz, 2H), 7.34 (s, 3H), 7.32 – 7.29 (m, 4H), 7.20 (t, *J* = 7.3 Hz, 2H), 6.31 (t, *J* = 3.2 Hz, 2H), 6.18 (t, *J* = 3.2 Hz, 2H), 4.38 (s, 2H). **¹³C NMR (126 MHz, CDCl₃)** δ 137.45, 134.53, 132.39, 131.53, 129.49, 129.32, 128.96, 127.02, 125.06, 124.13, 118.10, 110.74, 106.31, 63.19, 39.26. **HRMS (ESI/[M+H]⁺)** calculated for C₂₉H₂₂BrN₃O₂S: 556.0689, found: 556.0686.



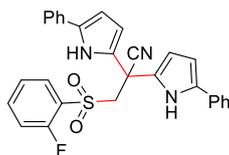
Following the **General Procedure C**, **3q** was isolated as brown solid (65.4 mg, 60% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.86 (s, 2H), 7.75 (d, *J* = 8.1 Hz, 2H), 7.51 (d, *J* = 8.1 Hz, 2H), 7.35 (d, *J* = 1.8 Hz, 1H), 7.32 – 7.31 (m, 4H), 7.30 – 7.29 (m, 3H), 7.20 (t, *J* = 7.2 Hz, 2H), 6.28 (t, *J* = 3.2 Hz, 2H), 6.17 (t, *J* = 3.2 Hz, 2H), 4.41 (s, 2H). **¹³C NMR (126 MHz, CDCl₃)** δ 141.96, 135.46, 134.51, 131.38, 128.96, 128.43, 127.14, 126.16 (d, *J* = 3.8 Hz), 124.84, 124.05, 117.98, 110.71, 106.41, 63.29, 39.19. **¹⁹F NMR (471 MHz, CDCl₃)** δ -63.47. **HRMS (ESI/[M+H]⁺)** calculated for C₃₀H₂₂F₃N₃O₂S: 546.1458, found: 546.1472.



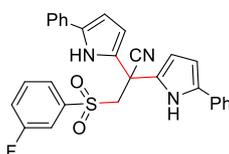
Following the **General Procedure C**, **3r** was isolated as yellow solid (34.1 mg, 34% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.67 (s, 2H), 7.66 (d, *J* = 8.1 Hz, 2H), 7.49 (d, *J* = 8.1 Hz, 2H), 7.36 (t, *J* = 6.6 Hz, 1H), 7.29 – 7.26 (m, 8H), 7.20 (d, *J* = 4.4 Hz, 1H), 7.18 (d, *J* = 4.2 Hz, 1H), 6.26 (t, *J* = 3.2 Hz, 2H), 6.12 (t, *J* = 3.2 Hz, 2H), 4.29 (s, 2H). **¹³C NMR (126 MHz, CDCl₃)** δ 134.56, 132.67, 131.23, 129.11, 128.40, 127.37, 124.72, 124.04, 117.78, 117.36, 116.71, 116.26, 110.64, 106.51, 63.60, 39.06. **HRMS (ESI/[M+H]⁺)** calculated for C₃₀H₂₂N₄O₂S: 503.1536, found: 503.1539.



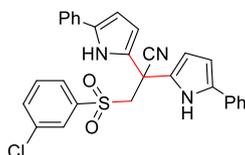
Following the **General Procedure C**, **3s** was isolated as yellow solid (31.4 mg, 31% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.90 (s, 2H), 7.69 – 7.63 (m, 2H), 7.43 – 7.39 (m, 4H), 7.36 (t, *J* = 7.7 Hz, 4H), 7.23 (d, *J* = 7.3 Hz, 2H), 6.85 – 6.82 (m, 2H), 6.40 (t, *J* = 3.2 Hz, 2H), 6.21 (t, *J* = 3.1 Hz, 2H), 4.22 (s, 2H), 3.68 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 164.05, 134.26, 131.65, 130.45, 130.21, 128.97, 127.02, 125.57, 124.05, 118.70, 114.48, 110.47, 106.39, 64.12, 55.56, 39.16. **HRMS (ESI/[M+H]⁺)** calculated for C₃₀H₂₅N₃O₃S: 508.1689, found: 508.1676.



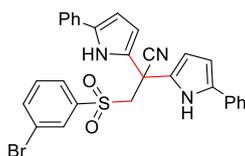
Following the **General Procedure C**, **3t** was isolated as white solid (70.3 mg, 71% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.83 (s, 2H), 7.61 – 7.58 (m, 1H), 7.38 – 7.34 (m, 5H), 7.34 – 7.29 (m, 4H), 7.22 – 7.18 (m, 2H), 7.02 – 6.92 (m, 2H), 6.24 (t, *J* = 3.1 Hz, 2H), 6.20 (t, *J* = 2.8 Hz, 2H), 4.48 (s, 2H). **¹³C NMR (126 MHz, CDCl₃)** δ 158.77 (d, *J* = 254.3 Hz), 136.21 (d, *J* = 8.6 Hz), 134.34, 131.55, 130.36, 128.93, 127.03, 126.28 (d, *J* = 14.2 Hz), 124.97, 124.57 (d, *J* = 3.4 Hz), 124.12, 117.89, 116.70 (d, *J* = 21.1 Hz), 110.51, 106.43, 62.60, 39.05. **¹⁹F NMR (471 MHz, CDCl₃)** δ -108.78. **HRMS (ESI/[M+H]⁺)** calculated for C₂₉H₂₂FN₃O₂S: 496.1490, found: 496.1502.



Following the **General Procedure C**, **3u** was isolated as white solid (72.3 mg, 73% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.87 (s, 2H), 7.51 – 7.49 (m, 1H), 7.40 – 7.35 (m, 5H), 7.35 – 7.29 (m, 5H), 7.24 – 7.20 (m, 2H), 7.10 – 7.05 (m, 1H), 6.35 (t, *J* = 3.2 Hz, 2H), 6.21 (t, *J* = 2.5 Hz, 2H), 4.33 (s, 2H). **¹³C NMR (126 MHz, CDCl₃)** δ 162.11 (d, *J* = 252.8 Hz), 140.63, 134.47, 131.53, 130.98 (d, *J* = 7.7 Hz), 128.93, 127.08, 125.05, 124.14, 123.64, 121.22 (d, *J* = 21.4 Hz), 117.98, 115.38 (d, *J* = 24.7 Hz), 110.63, 106.41, 63.55, 39.18. **¹⁹F NMR (471 MHz, CDCl₃)** δ -108.69. **HRMS (ESI/[M+H]⁺)** calculated for C₂₉H₂₂FN₃O₂S: 496.1490, found: 496.1502.

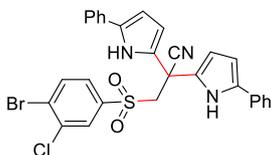


Following the **General Procedure C**, **3v** was isolated as white solid (93.0 mg, 91% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.88 (s, 2H), 7.60 (s, 1H), 7.55 (d, *J* = 7.8 Hz, 1H), 7.35 – 7.34 (m, 4H), 7.30 – 7.29 (m, 3H), 7.24 (d, *J* = 10.0 Hz, 2H), 7.21 – 7.18 (m, 3H), 6.34 (t, *J* = 3.1 Hz, 2H), 6.23 (t, *J* = 3.1 Hz, 2H), 4.40 (s, 2H). **¹³C NMR (126 MHz, CDCl₃)** δ 140.18, 135.32, 134.48, 133.95, 131.49, 130.29, 128.89, 128.03, 127.04, 125.89, 124.98, 124.11, 118.02, 110.72, 106.35, 63.35, 39.24. **HRMS (ESI/[M+H]⁺)** calculated for C₂₉H₂₂ClN₃O₂S: 512.1194, found: 512.1197.

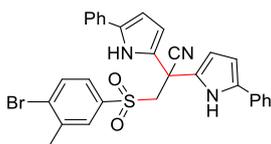


Following the **General Procedure C**, **3w** was isolated as light brown solid (79.9 mg, 72% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.87 (d, *J* = 2.8 Hz, 2H), 7.73 (d, *J* = 2.0 Hz, 1H), 7.58 (d, *J* = 7.1 Hz, 1H), 7.37 – 7.32 (m, 5H), 7.31 – 7.28 (m, 4H), 7.18 (t, *J* = 7.2 Hz, 2H), 7.08 (t,

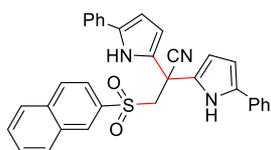
$J = 7.9$ Hz, 1H), 6.33 (t, $J = 3.1$ Hz, 2H), 6.23 (t, $J = 3.1$ Hz, 2H), 4.42 (s, 2H). ^{13}C NMR (126 MHz, CDCl_3) δ 140.10, 136.79, 134.53, 131.48, 130.79, 130.43, 128.86, 126.98, 126.34, 124.94, 124.13, 123.04, 118.12, 110.85, 106.31, 63.08, 39.31. HRMS (ESI/[M+H] $^+$) calculated for $\text{C}_{29}\text{H}_{22}\text{BrN}_3\text{O}_2\text{S}$: 556.0689, found: 556.0686.



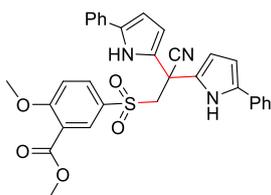
Following the **General Procedure C**, **3x** was isolated as light brown solid (87.2 mg, 74% yield). ^1H NMR (500 MHz, DMSO) δ 11.02 (s, 2H), 7.53 (d, $J = 8.5$ Hz, 1H), 7.42 (d, $J = 7.8$ Hz, 4H), 7.38 (d, $J = 2.2$ Hz, 1H), 7.33 (t, $J = 7.6$ Hz, 5H), 7.27 – 7.25 (m, 1H), 7.18 (t, $J = 7.4$ Hz, 2H), 6.37 (t, $J = 3.1$ Hz, 2H), 5.90 (t, $J = 3.2$ Hz, 2H), 5.00 (s, 2H). ^{13}C NMR (126 MHz, CDCl_3) δ 134.54, 134.43, 131.27, 129.51, 129.03, 127.23, 126.53, 124.72, 124.08, 117.80, 110.65, 106.50, 63.66, 39.11. HRMS (ESI/[M+H] $^+$) calculated for $\text{C}_{29}\text{H}_{21}\text{BrClN}_3\text{O}_2\text{S}$: 590.0299, found: 590.0299.



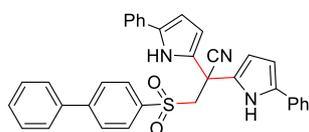
Following the **General Procedure C**, **3y** was isolated as yellow solid (100.2 mg, 88% yield). ^1H NMR (500 MHz, DMSO) δ 11.01 (d, $J = 3.1$ Hz, 2H), 7.46 – 7.41 (m, 5H), 7.36 (t, $J = 7.7$ Hz, 4H), 7.22 – 7.19 (m, 4H), 6.39 (t, $J = 3.1$ Hz, 2H), 5.90 (t, $J = 3.0$ Hz, 2H), 4.95 (s, 2H), 2.06 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 138.40, 137.72, 134.13, 132.76, 132.10, 130.78, 129.77, 129.11, 126.76, 126.66, 124.05, 119.46, 119.11, 110.72, 105.43, 79.38, 60.00, 22.63. HRMS (ESI/[M+H] $^+$) calculated for $\text{C}_{30}\text{H}_{24}\text{BrN}_3\text{O}_2\text{S}$: 570.0845, found: 570.0841.



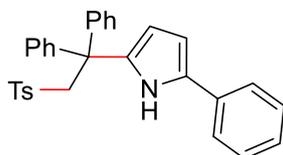
Following the **General Procedure C**, **3z** was isolated as yellow solid (65.4 mg, 62% yield). ^1H NMR (500 MHz, CDCl_3) δ 8.91 (s, 2H), 8.14 (d, $J = 1.9$ Hz, 1H), 7.72 (d, $J = 8.7$ Hz, 1H), 7.65 – 7.59 (m, 3H), 7.47 (t, $J = 7.6$ Hz, 2H), 7.40 (t, $J = 7.6$ Hz, 2H), 7.21 – 7.20 (m, 4H), 7.18 (s, 2H), 7.13 – 7.09 (m, 2H), 6.17 (t, $J = 3.2$ Hz, 2H), 6.11 (t, $J = 3.2$ Hz, 2H), 4.33 (s, 2H). ^{13}C NMR (126 MHz, CDCl_3) δ 135.41, 135.16, 134.22, 131.86, 131.50, 130.28, 129.58, 129.47, 129.40, 128.84, 127.78, 127.58, 126.87, 125.28, 123.98, 121.80, 118.16, 110.55, 106.33, 77.27, 77.01, 76.76, 63.55, 39.31. HRMS (ESI/[M+H] $^+$) calculated for $\text{C}_{33}\text{H}_{25}\text{N}_3\text{O}_2\text{S}$: 528.1740, found: 528.1748.



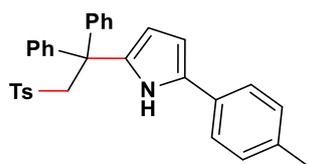
Following the **General Procedure C**, **3ab** was isolated as yellow solid (50.8 mg, 45% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.83 (s, 2H), 8.13 (d, *J* = 2.6 Hz, 1H), 7.72 – 7.67 (m, 1H), 7.40 – 7.32 (m, 8H), 7.25 – 7.21 (m, 2H), 6.79 (d, *J* = 8.9 Hz, 1H), 6.37 (t, *J* = 3.5 Hz, 2H), 6.22 (t, *J* = 3.4 Hz, 2H), 4.30 (s, 2H), 3.79 (s, 3H), 3.69 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 187.87, 162.92, 156.33, 134.29, 133.32, 131.89, 131.53, 128.96, 127.03, 125.25, 123.99, 122.04, 117.97, 112.21, 110.53, 106.44, 63.68, 56.30, 52.34, 39.27. **HRMS (ESI/[M+H]⁺)** calculated for C₃₂H₂₇N₃O₅S: 566.1744, found: 566.1751



Following the **General Procedure C**, **3ac** was isolated as white solid (49.8 mg, 45% yield). **¹H NMR (500 MHz, CDCl₃)** δ 9.00 (s, 2H), 7.74 (d, *J* = 8.2 Hz, 2H), 7.50 (d, *J* = 8.2 Hz, 2H), 7.39 – 7.35 (m, 7H), 7.31 – 7.27 (m, 5H), 7.26 (s, 1H), 7.17 (t, *J* = 7.4 Hz, 2H), 6.34 (t, *J* = 3.2 Hz, 2H), 6.22 (t, *J* = 3.2 Hz, 2H), 4.39 (s, 2H). **¹³C NMR (126 MHz, CDCl₃)** δ 146.95, 138.78, 137.20, 134.39, 131.64, 128.92, 128.90, 128.60, 128.40, 127.73, 127.30, 126.94, 125.40, 124.07, 118.14, 110.67, 106.32, 63.59, 39.31. **HRMS (ESI/[M+H]⁺)** calculated for C₃₅H₂₇N₃O₂S: 554.1897, found: 554.1896.

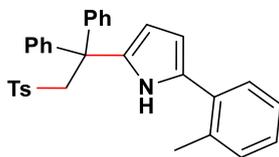


Following the **General Procedure D**, **5a** was isolated as white solid (40.6 mg, 85% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.15 (s, 1H), 7.61 (d, *J* = 7.7 Hz, 2H), 7.38 (q, *J* = 7.8 Hz, 4H), 7.22 – 7.17 (m, 3H), 7.17 – 7.11 (m, 6H), 6.94 (d, *J* = 7.8 Hz, 4H), 6.36 (t, *J* = 3.2 Hz, 1H), 5.16 (t, *J* = 3.1 Hz, 1H), 4.65 (s, 2H), 2.39 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.36, 144.17, 138.01, 135.66, 132.89, 132.64, 129.78, 128.93, 128.84, 127.80, 127.56, 127.14, 125.97, 123.57, 112.89, 104.71, 68.73, 52.42, 21.58. **HRMS (ESI/[M+H]⁺)** calculated for C₃₁H₂₇N₂O₂S: 478.1835, found: 478.1835.

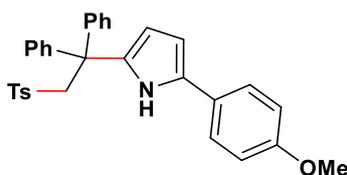


Following the **General Procedure D**, **5b** was isolated as white solid (39.3 mg, 80% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.09 (s, 1H), 7.51 (d, *J* = 7.8 Hz, 2H), 7.39 (d, *J* = 8.0 Hz, 2H),

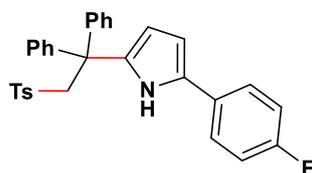
7.19 (d, $J = 7.5$ Hz, 4H), 7.16 – 7.12 (m, 6H), 6.94 (d, $J = 7.6$ Hz, 4H), 6.31 (t, $J = 3.1$ Hz, 1H), 5.14 (t, $J = 3.1$ Hz, 1H), 4.65 (s, 2H), 2.39 (s, 3H), 2.35 (s, 3H). ^{13}C NMR (126 MHz, CDCl_3) δ 144.34, 144.22, 138.02, 135.65, 135.25, 132.81, 130.16, 129.78, 129.59, 128.85, 127.78, 127.55, 127.11, 123.57, 112.73, 104.09, 68.73, 52.38, 21.59, 21.18. HRMS (ESI/[$\text{M}+\text{H}$] $^+$) calculated for : $\text{C}_{32}\text{H}_{29}\text{NO}_2\text{S}$: 492.1992, found: 492.2001.



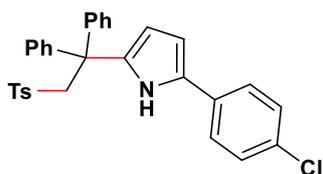
Following the **General Procedure D**, **5c** was isolated as white solid (32.9 mg, 67% yield). ^1H NMR (500 MHz, CDCl_3) δ 10.73 (s, 1H), 7.53 (d, $J = 7.7$ Hz, 1H), 7.37 (d, $J = 8.3$ Hz, 2H), 7.27 – 7.25 (m, 2H), 7.23 – 7.12 (m, 9H), 6.96 (d, $J = 7.7$ Hz, 4H), 6.19 (t, $J = 3.1$ Hz, 1H), 5.22 (t, $J = 3.1$ Hz, 1H), 4.66 (s, 2H), 2.56 (s, 3H), 2.40 (s, 3H). ^{13}C NMR (126 MHz, CDCl_3) δ 144.31, 138.12, 134.91, 134.68, 132.83, 132.24, 131.18, 129.73, 128.85, 127.80, 127.71, 127.53, 127.11, 126.45, 126.23, 112.10, 107.96, 68.55, 52.29, 21.70, 21.58. HRMS (ESI/[$\text{M}+\text{H}$] $^+$) calculated for : $\text{C}_{32}\text{H}_{29}\text{NO}_2\text{S}$: 492.1992, found: 492.1999.



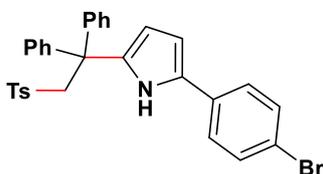
Following the **General Procedure D**, **5d** was isolated as white solid (35.1 mg, 69% yield). ^1H NMR (500 MHz, CDCl_3) δ 11.04 (s, 1H), 7.54 (d, $J = 8.7$ Hz, 2H), 7.39 (d, $J = 8.2$ Hz, 2H), 7.20 (t, $J = 7.2$ Hz, 2H), 7.14 (t, $J = 7.4$ Hz, 6H), 6.94 (d, $J = 6.2$ Hz, 6H), 6.24 (t, $J = 3.0$ Hz, 1H), 5.13 (t, $J = 3.0$ Hz, 1H), 4.65 (s, 2H), 3.83 (s, 3H), 2.40 (s, 3H). ^{13}C NMR (126 MHz, CDCl_3) δ 158.13, 144.25, 138.00, 134.97, 132.64, 129.79, 128.85, 127.78, 127.55, 127.11, 126.02, 124.92, 114.42, 112.69, 103.50, 68.75, 55.39, 52.37, 21.59. HRMS (ESI/[$\text{M}+\text{H}$] $^+$) calculated for : $\text{C}_{32}\text{H}_{29}\text{NO}_3\text{S}$: 508.1941, found: 508.1959.



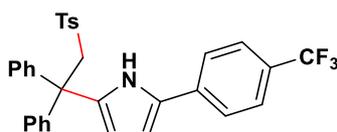
Following the **General Procedure D**, **5e** was isolated as white solid (36.6 mg, 74% yield). ^1H NMR (500 MHz, CDCl_3) δ 11.15 (s, 1H), 7.56 (dd, $J = 8.6, 5.3$ Hz, 2H), 7.39 (d, $J = 8.1$ Hz, 2H), 7.20 (t, $J = 7.2$ Hz, 2H), 7.14 (t, $J = 7.7$ Hz, 6H), 7.08 (t, $J = 8.7$ Hz, 2H), 6.93 (d, $J = 7.5$ Hz, 4H), 6.29 (t, $J = 3.1$ Hz, 1H), 5.14 (t, $J = 3.1$ Hz, 1H), 4.65 (s, 2H), 2.40 (s, 3H). ^{13}C NMR (126 MHz, CDCl_3) δ 161.41 (d, $J = 245.0$ Hz), 144.48, 144.14, 137.86, 135.69, 131.79, 129.84, 128.84, 127.85, 127.57, 127.21, 125.16 (d, $J = 7.8$ Hz), 115.86 (d, $J = 21.6$ Hz), 112.98, 104.56, 68.71, 52.40, 21.62. ^{19}F NMR (471 MHz, CDCl_3) δ -116.70. HRMS (ESI/[$\text{M}+\text{H}$] $^+$) calculated for : $\text{C}_{31}\text{H}_{26}\text{FNO}_2\text{S}$: 496.1741, found: 496.1759.



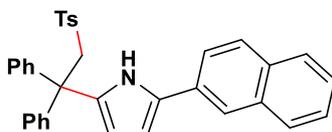
Following the **General Procedure D**, **5f** was isolated as white solid (35.3 mg, 69% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.21 (s, 1H), 7.53 (d, *J* = 8.3 Hz, 2H), 7.39 (d, *J* = 8.0 Hz, 2H), 7.34 (d, *J* = 8.6 Hz, 2H), 7.21 (t, *J* = 7.2 Hz, 2H), 7.15 (t, *J* = 7.7 Hz, 6H), 6.92 (d, *J* = 7.4 Hz, 4H), 6.34 (t, *J* = 3.1 Hz, 1H), 5.15 (t, *J* = 3.0 Hz, 1H), 4.65 (s, 2H), 2.40 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.46, 144.01, 137.80, 136.07, 131.50, 131.40, 129.81, 129.04, 128.78, 127.83, 127.54, 127.20, 124.73, 113.07, 105.13, 68.67, 52.39, 21.60. **HRMS (ESI/[M+H]⁺)** calculated for : C₃₁H₂₆ClNO₂S: 512.1446, found: 512.1441.



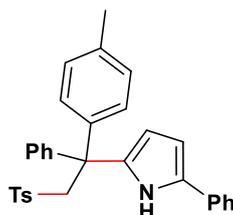
Following the **General Procedure D**, **5g** was isolated as white solid (34.4 mg, 62% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.22 (s, 1H), 7.48 (d, *J* = 3.2 Hz, 2H), 7.38 (d, *J* = 8.0 Hz, 2H), 7.23 – 7.06 (m, 10H), 6.92 (d, *J* = 7.8 Hz, 4H), 6.35 (t, *J* = 3.1 Hz, 1H), 5.15 (t, *J* = 3.1 Hz, 1H), 4.65 (s, 2H), 2.40 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.49, 144.01, 137.83, 136.18, 131.98, 131.85, 131.50, 129.83, 128.80, 127.85, 127.55, 127.23, 125.07, 119.39, 113.13, 105.25, 68.67, 52.41, 21.60. **HRMS (ESI/[M+H]⁺)** calculated for : C₃₁H₂₆BrNO₂S: 556.0940, found: 556.0936.



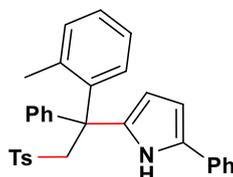
Following the **General Procedure D**, **5h** was isolated as white solid (33.2 mg, 61% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.39 (s, 1H), 7.68 (d, *J* = 8.1 Hz, 2H), 7.60 (d, *J* = 8.1 Hz, 2H), 7.38 (d, *J* = 7.9 Hz, 2H), 7.20 (t, *J* = 7.2 Hz, 2H), 7.17 – 7.11 (m, 6H), 6.92 (d, *J* = 7.7 Hz, 4H), 6.46 (t, *J* = 3.1 Hz, 1H), 5.19 (t, *J* = 3.1 Hz, 1H), 4.66 (s, 2H), 2.39 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.59, 143.93, 137.75, 137.07, 136.20, 131.11, 129.88, 128.80, 127.92, 127.47 (q, *J* = 33.5 Hz), 125.98 (q, *J* = 3.9 Hz), 123.40, 113.45, 106.55, 68.64, 52.46, 21.59. **¹⁹F NMR (471 MHz, CDCl₃)** δ -62.16. **HRMS (ESI/[M+H]⁺)** calculated for : C₃₂H₂₆F₃NO₂S: 546.1709, found: 546.1713.



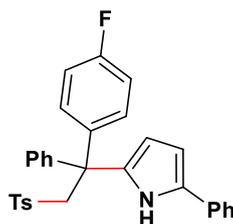
Following the **General Procedure D**, **5i** was isolated as white solid (33.7 mg, 64% yield). **¹H NMR (500 MHz, CDCl₃)** δ 10.73 (s, 1H), 8.57 – 8.43 (m, 1H), 7.92 – 7.85 (m, 1H), 7.79 (d, *J* = 8.1 Hz, 1H), 7.65 (d, *J* = 6.0 Hz, 1H), 7.56 – 7.48 (m, 3H), 7.39 (s, 2H), 7.23 – 7.12 (m, 8H), 7.02 (d, *J* = 6.9 Hz, 4H), 6.38 (t, *J* = 3.0 Hz, 1H), 5.37 (t, *J* = 3.1 Hz, 1H), 4.70 (s, 2H), 2.39 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.29, 138.20, 135.31, 134.18, 131.57, 131.24, 131.01, 129.74, 128.85, 128.45, 127.88, 127.54, 127.19, 127.16, 126.20, 125.95, 125.87, 125.70, 112.27, 108.83, 68.53, 52.40, 21.58. **HRMS (ESI/[M+H]⁺)** calculated for : C₃₅H₂₉NO₂S: 528.1992, found: 528.1994.



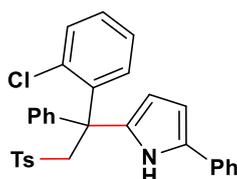
Following the **General Procedure D**, **5j** was isolated as white solid (36.4 mg, 74% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.17 (s, 1H), 7.61 (dd, *J* = 8.2, 1.4 Hz, 2H), 7.40 – 7.35 (m, 4H), 7.19 (t, *J* = 7.0 Hz, 2H), 7.16 – 7.12 (m, 4H), 6.98 – 6.90 (m, 4H), 6.80 (d, *J* = 8.3 Hz, 2H), 6.36 (t, *J* = 3.2 Hz, 1H), 5.16 (t, *J* = 3.2 Hz, 1H), 4.64 (dd, *J* = 15.1, 15.1 Hz, 2H), 2.40 (s, 3H), 2.29 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.43, 144.27, 141.04, 137.92, 136.80, 135.86, 132.90, 132.52, 129.68, 128.92, 128.77, 128.71, 128.41, 127.77, 127.55, 127.07, 125.93, 123.55, 112.77, 104.67, 68.84, 52.05, 21.61, 21.00. **HRMS (ESI/[M+H]⁺)** calculated for C₃₂H₂₉NO₂S: 492.1992, found: 492.2002.



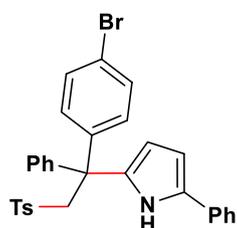
Following the **General Procedure D**, **5k** was isolated as white solid (33.9 mg, 69% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.18 (s, 1H), 7.62 (d, *J* = 7.2 Hz, 2H), 7.40 – 7.33 (m, 4H), 7.21 – 7.17 (m, 2H), 7.16 – 7.11 (m, 4H), 7.05 (t, *J* = 7.6 Hz, 1H), 6.99 (d, *J* = 7.3 Hz, 1H), 6.94 (d, *J* = 7.5 Hz, 2H), 6.76 – 6.68 (m, 2H), 6.36 (t, *J* = 3.1 Hz, 1H), 5.16 (t, *J* = 3.1 Hz, 1H), 4.67 (dd, *J* = 16.1, 14.3 Hz, 2H), 2.38 (s, 3H), 2.12 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.38, 144.29, 143.98, 137.94, 137.28, 135.78, 132.92, 132.58, 129.70, 129.53, 128.93, 128.82, 127.93, 127.77, 127.75, 127.56, 127.09, 126.15, 125.94, 123.58, 112.83, 104.68, 68.85, 52.26, 21.58, 21.49. **HRMS (ESI/[M+H]⁺)** calculated for C₃₂H₂₉NO₂S: 492.1992, found: 492.1997.



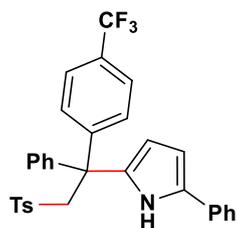
Following the **General Procedure D**, **5l** was isolated as white solid (33.5 mg, 67% yield). ¹H NMR (500 MHz, CDCl₃) δ 11.20 (s, 1H), 7.61 (d, *J* = 7.7 Hz, 2H), 7.43 – 7.36 (m, 4H), 7.21 (d, *J* = 7.3 Hz, 2H), 7.20 – 7.15 (m, 4H), 6.94 (d, *J* = 7.6 Hz, 2H), 6.91 – 6.85 (m, 2H), 6.79 (t, *J* = 8.5 Hz, 2H), 6.36 (t, *J* = 3.1 Hz, 1H), 5.14 (t, *J* = 3.0 Hz, 1H), 4.62 (dd, *J* = 15.3, 14.9 Hz, 2H), 2.40 (s, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 162.75, 160.79, 144.56 (d, *J* = 13.3 Hz), 139.43 (d, *J* = 3.2 Hz), 137.77, 135.49, 132.78 (d, *J* = 1.9 Hz), 130.68 (d, *J* = 8.1 Hz), 129.84, 128.97, 128.58, 127.95, 127.54, 127.31, 126.08, 123.57, 114.53 (d, *J* = 21.2 Hz), 112.91, 104.75, 68.74, 51.89, 21.60. ¹⁹F NMR (471 MHz, CDCl₃) δ -115.18. HRMS (ESI/[M+H]⁺) calculated for C₃₁H₂₆FNO₂S: 496.1741, found: 496.1744.



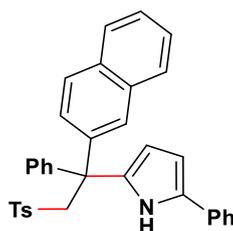
Following the **General Procedure D**, **5m** was isolated as white solid (28.6 mg, 56% yield). ¹H NMR (500 MHz, CDCl₃) δ 11.19 (s, 1H), 7.62 (d, *J* = 7.0 Hz, 2H), 7.39 (t, *J* = 7.7 Hz, 4H), 7.23 – 7.14 (m, 8H), 7.11 (t, *J* = 7.9 Hz, 1H), 6.97 – 6.91 (m, 2H), 6.85 (d, *J* = 6.7 Hz, 2H), 6.36 (t, *J* = 3.0 Hz, 1H), 5.15 (t, *J* = 3.0 Hz, 1H), 4.63 (dd, *J* = 15.2, 15.0 Hz, 2H), 2.40 (s, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 145.74, 144.79, 144.04, 134.88, 133.83, 132.92, 132.74, 129.90, 129.21, 129.07, 128.95, 128.57, 128.01, 127.48, 127.45, 127.41, 127.35, 126.10, 123.62, 113.06, 104.80, 68.45, 52.19, 21.62. HRMS (ESI/[M+H]⁺) calculated for C₃₁H₂₆ClNO₂S: 512.1446, found: 512.1457.



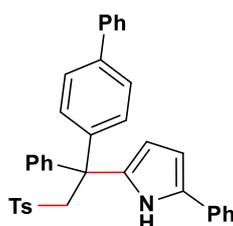
Following the **General Procedure D**, **5n** was isolated as white solid (38.3mg, 69% yield). ¹H NMR (500 MHz, CDCl₃) δ 11.21 (s, 1H), 7.61 (d, *J* = 7.7 Hz, 2H), 7.38 (dd, *J* = 13.5, 7.9 Hz, 4H), 7.23 – 7.12 (m, 8H), 6.95 (d, *J* = 7.2 Hz, 2H), 6.75 (d, *J* = 8.3 Hz, 2H), 6.36 (t, *J* = 3.1 Hz, 1H), 5.14 (t, *J* = 3.1 Hz, 1H), 4.63 (dd, *J* = 15.1, 15.0 Hz, 2H), 2.43 (s, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 144.68, 144.50, 142.45, 137.52, 134.99, 132.86, 132.74, 130.79, 130.69, 129.88, 128.98, 128.51, 128.01, 127.50, 127.38, 126.12, 123.59, 121.53, 113.03, 104.82, 68.59, 51.99, 21.65. HRMS (ESI/[M+H]⁺) calculated for C₃₁H₂₆BrNO₂S: 556.0940, found: 556.0938.



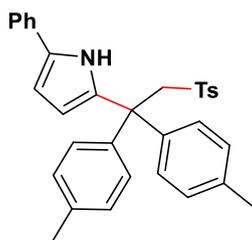
Following the **General Procedure D**, **5o** was isolated as white solid (26.7 mg, 49% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.23 (s, 1H), 7.62 (d, *J* = 7.8 Hz, 2H), 7.39 (t, *J* = 7.6 Hz, 2H), 7.35 (d, *J* = 8.0 Hz, 2H), 7.30 (d, *J* = 8.2 Hz, 2H), 7.24 – 7.18 (m, 4H), 7.13 (d, *J* = 8.0 Hz, 2H), 6.97 (dd, *J* = 29.1, 7.8 Hz, 4H), 6.37 (t, *J* = 3.1 Hz, 1H), 5.14 (t, *J* = 3.2 Hz, 1H), 4.68 (dd, *J* = 15.5, 15.3 Hz, 2H), 2.39 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 147.26, 144.76, 144.38, 137.40, 134.65, 133.02, 132.66, 129.92, 129.50, 128.99, 128.47, 128.09, 127.50, 127.45, 126.19, 124.52 (q, *J* = 3.3 Hz), 123.62, 113.17, 104.87, 68.38, 52.23, 21.51. **¹⁹F NMR (471 MHz, CDCl₃)** δ -62.57. **HRMS (ESI/[M+H]⁺)** calculated for C₃₂H₂₆F₃NO₂S: 546.1709, found: 546.1713.



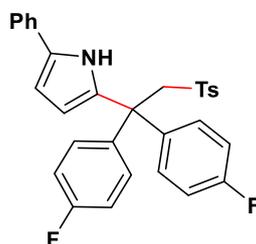
Following the **General Procedure D**, **5p** was isolated as white solid (31.6 mg, 60% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.30 (s, 1H), 7.73 (d, *J* = 8.0 Hz, 1H), 7.65 (d, *J* = 7.0 Hz, 2H), 7.58 (d, *J* = 8.0 Hz, 1H), 7.47 (t, *J* = 8.4 Hz, 2H), 7.43 (dd, *J* = 6.6, 1.5 Hz, 1H), 7.39 (t, *J* = 7.8 Hz, 3H), 7.27 (d, *J* = 8.1 Hz, 2H), 7.23 – 7.16 (m, 4H), 7.01 (d, *J* = 7.4 Hz, 2H), 6.98 – 6.91 (m, 3H), 6.39 (t, *J* = 3.1 Hz, 1H), 5.19 (t, *J* = 3.1 Hz, 1H), 4.76 (dd, *J* = 15.1, 14.1 Hz, 2H), 2.29 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.69, 144.32, 140.85, 137.52, 135.46, 132.91, 132.71, 132.62, 132.35, 129.59, 128.96, 128.73, 128.40, 127.92, 127.82, 127.47, 127.22, 127.13, 127.09, 126.32, 126.02, 126.00, 123.62, 113.02, 104.83, 68.77, 52.39, 21.51. **HRMS (ESI/[M+H]⁺)** calculated for C₃₅H₂₉NO₂S: 528.1992, found: 528.1985.



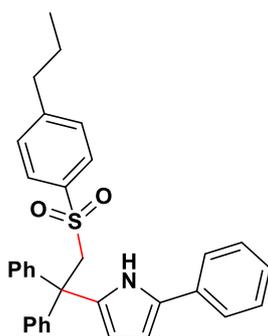
Following the **General Procedure D**, **5q** was isolated as white solid (45.9 mg, 83% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.24 (s, 1H), 7.63 (d, *J* = 7.7 Hz, 2H), 7.54 (d, *J* = 7.6 Hz, 2H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.40 – 7.30 (m, 7H), 7.24 – 7.16 (m, 4H), 7.10 (d, *J* = 7.9 Hz, 2H), 7.01 (d, *J* = 7.6 Hz, 2H), 6.96 (d, *J* = 8.1 Hz, 2H), 6.38 (t, *J* = 3.0 Hz, 1H), 5.21 (t, *J* = 3.1 Hz, 1H), 4.71 (dd, *J* = 15.3, 14.9 Hz, 2H), 2.33 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.47, 144.29, 142.81, 140.26, 139.75, 137.78, 135.55, 132.87, 132.68, 129.75, 129.35, 128.95, 128.81, 128.76, 127.88, 127.55, 127.47, 127.21, 126.90, 126.19, 126.00, 123.60, 112.92, 104.77, 68.85, 52.11, 21.54. **HRMS (ESI/[M+H]⁺)** calculated for C₃₇H₃₁NO₂S: 554.2148, found: 554.2145.



Following the **General Procedure D**, **5r** was isolated as white solid (32.3 mg, 64% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.15 (s, 1H), 7.63 – 7.55 (m, 2H), 7.40 – 7.34 (m, 4H), 7.19 (t, *J* = 7.4 Hz, 1H), 7.12 (d, *J* = 8.0 Hz, 2H), 6.92 (d, *J* = 7.9 Hz, 4H), 6.81 (d, *J* = 8.3 Hz, 4H), 6.35 (t, *J* = 3.1 Hz, 1H), 5.17 (t, *J* = 3.0 Hz, 1H), 4.62 (s, 2H), 2.40 (s, 3H), 2.29 (s, 6H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.18, 141.34, 137.90, 136.72, 136.06, 132.95, 132.42, 129.59, 128.92, 128.66, 128.40, 127.55, 125.89, 123.54, 112.68, 104.67, 68.97, 51.73, 21.62, 21.01. **HRMS (ESI/[M+H]⁺)** calculated for C₃₃H₃₁NO₂S: 506.2148, found: 506.2151.

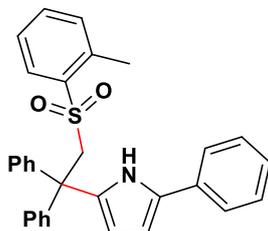


Following the **General Procedure D**, **5s** was isolated as white solid (29.2 mg, 57% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.13 (s, 1H), 7.53 (d, *J* = 8.1 Hz, 2H), 7.37 – 7.28 (m, 4H), 7.12 (d, *J* = 8.4 Hz, 3H), 6.84 – 6.72 (m, 8H), 6.28 (t, *J* = 3.0 Hz, 1H), 5.04 (t, *J* = 2.1 Hz, 1H), 4.51 (s, 2H), 2.34 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 162.80, 160.83, 144.83, 139.78 (d, *J* = 3.5 Hz), 137.61, 135.32, 132.95, 132.67, 130.44 (d, *J* = 8.2 Hz), 129.90, 129.00, 127.54, 126.19, 123.59, 114.70 (d, *J* = 21.3 Hz), 112.92, 104.78, 68.76, 51.43, 21.60. **¹⁹F NMR (471 MHz, CDCl₃)** δ -62.56. **HRMS (ESI/[M+H]⁺)** calculated for : C₃₁H₂₅F₂NO₂S: 514.1647, found: 514.1657.

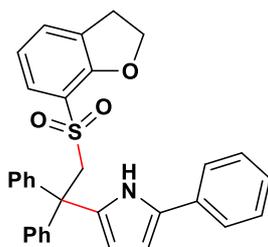


Following the **General Procedure D**, **5t** was isolated as white solid (30.8 mg, 61% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.15 (s, 1H), 7.61 (d, *J* = 7.2 Hz, 2H), 7.42 – 7.34 (m, 4H), 7.18 (t, *J* = 7.8 Hz, 3H), 7.13 (t, *J* = 7.3 Hz, 6H), 6.94 (d, *J* = 7.6 Hz, 4H), 6.36 (t, *J* = 3.1 Hz, 1H), 5.16 (t, *J* = 3.1 Hz, 1H), 4.66 (s, 2H), 2.61 (t, *J* = 7.6 Hz, 2H), 1.64 (h, *J* = 7.4 Hz, 2H), 0.95 (t, *J* = 7.3 Hz, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 148.98, 144.20, 138.21, 135.67, 132.94, 132.65, 129.22, 128.92, 128.86, 127.79, 127.55, 127.14, 125.96, 123.59, 112.89, 104.74, 68.76, 52.42,

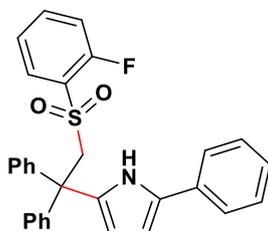
37.91, 24.25, 13.73. **HRMS** (ESI/[M+H]⁺) calculated for : C₃₃H₃₁NO₂S: 506.2148, found: 506.2153.



Following the **General Procedure D**, **5u** was isolated as white solid (40.1 mg, 84% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.16 (s, 1H), 7.61 (d, *J* = 7.2 Hz, 2H), 7.41 – 7.36 (m, 4H), 7.25 – 7.21 (m, 2H), 7.19 (t, *J* = 6.5 Hz, 3H), 7.14 (t, *J* = 7.6 Hz, 4H), 7.08 (t, *J* = 7.7 Hz, 1H), 6.94 (d, *J* = 7.2 Hz, 4H), 6.36 (t, *J* = 3.1 Hz, 1H), 5.14 (t, *J* = 3.1 Hz, 1H), 4.68 (s, 2H), 2.66 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.15, 138.97, 137.03, 135.49, 133.40, 132.88, 132.62, 132.44, 129.67, 128.90, 128.71, 127.79, 127.23, 126.80, 125.95, 123.55, 112.91, 104.68, 67.58, 52.46, 20.55. **HRMS** (ESI/[M+H]⁺) calculated for : C₃₁H₂₇NO₂S: 478.1835, found: 478.1844.

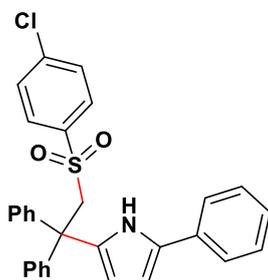


Following the **General Procedure D**, **5v** was isolated as white solid (36.9 mg, 73% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.23 (s, 1H), 7.64 – 7.59 (m, 2H), 7.40 – 7.32 (m, 3H), 7.19 (t, *J* = 7.0 Hz, 3H), 7.17 – 7.11 (m, 5H), 6.96 – 6.90 (m, 4H), 6.69 (d, *J* = 8.5 Hz, 1H), 6.36 (t, *J* = 3.1 Hz, 1H), 5.15 (t, *J* = 3.1 Hz, 1H), 4.66 (s, 2H), 4.63 (t, *J* = 8.8 Hz, 2H), 3.09 (t, *J* = 8.8 Hz, 2H). **¹³C NMR (126 MHz, CDCl₃)** δ 164.48, 144.32, 135.67, 132.91, 132.57, 132.27, 129.25, 128.92, 128.88, 128.29, 127.69, 126.98, 125.94, 125.03, 123.56, 112.89, 109.67, 104.71, 72.43, 69.08, 52.32, 28.85. **HRMS** (ESI/[M+H]⁺) calculated for : C₃₂H₂₇NO₃S: 506.1784, found: 506.1798.

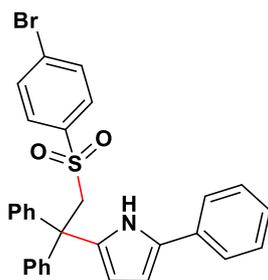


Following the **General Procedure D**, **5w** was isolated as white solid (37.1 mg, 77% yield). **¹H NMR (500 MHz, CDCl₃)** δ 10.89 (s, 1H), 7.58 (d, *J* = 6.8 Hz, 2H), 7.51 – 7.45 (m, 1H), 7.37 (t, *J* = 7.8 Hz, 2H), 7.21 – 7.16 (m, 2H), 7.14 – 7.12 (m, 2H), 7.12 – 7.08 (m, 5H), 7.01 – 6.97 (m, 5H), 6.33 (t, *J* = 3.1 Hz, 1H), 5.20 (t, *J* = 3.1 Hz, 1H), 4.86 (s, 2H). **¹³C NMR (126 MHz, CDCl₃)** δ 158.98 (d, *J* = 254.7 Hz), 143.97, 135.82 (d, *J* = 8.6 Hz), 135.35, 132.87, 132.67,

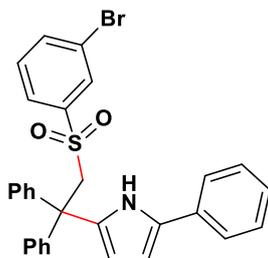
129.83, 128.95, 128.75 (d, $J = 1.5$ Hz), 127.79, 127.35, 126.05, 124.86 (d, $J = 3.5$ Hz), 123.62, 116.69 (d, $J = 21.0$ Hz), 112.92, 104.88, 68.20, 52.16. ^{19}F NMR (471 MHz, CDCl_3) δ -108.82. HRMS (ESI/[M+H] $^+$) calculated for : $\text{C}_{30}\text{H}_{24}\text{FNO}_2\text{S}$: 482.1585, found: 482.1598.



Following the **General Procedure D**, **5x** was isolated as white solid (47.3 mg, 95% yield). ^1H NMR (500 MHz, CDCl_3) δ 10.98 (s, 1H), 7.59 (d, $J = 7.2$ Hz, 2H), 7.41 – 7.35 (m, 4H), 7.29 (d, $J = 8.6$ Hz, 2H), 7.23 – 7.18 (m, 3H), 7.14 (t, $J = 7.6$ Hz, 5H), 6.93 (d, $J = 7.6$ Hz, 4H), 6.36 (t, $J = 3.1$ Hz, 1H), 5.18 (t, $J = 3.1$ Hz, 1H), 4.69 (s, 2H). ^{13}C NMR (126 MHz, CDCl_3) δ 144.01, 140.10, 139.10, 135.23, 132.79, 132.72, 129.41, 128.99, 128.96, 128.82, 127.89, 127.29, 126.08, 123.58, 113.02, 104.85, 68.92, 52.27. HRMS (ESI/[M+H] $^+$) calculated for : $\text{C}_{30}\text{H}_{24}\text{ClNO}_2\text{S}$: 498.1289, found: 498.1299.

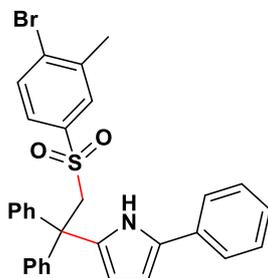


Following the **General Procedure D**, **5y** was isolated as white solid (38.4 mg, 71% yield). ^1H NMR (500 MHz, CDCl_3) δ 10.94 (s, 1H), 7.59 (d, $J = 7.0$ Hz, 2H), 7.46 (d, $J = 8.6$ Hz, 2H), 7.38 (t, $J = 7.8$ Hz, 2H), 7.30 (d, $J = 8.7$ Hz, 2H), 7.23 – 7.18 (m, 3H), 7.15 (t, $J = 7.6$ Hz, 4H), 6.94 (d, $J = 7.7$ Hz, 4H), 6.35 (t, $J = 3.1$ Hz, 1H), 5.19 (t, $J = 3.1$ Hz, 1H), 4.68 (s, 2H). ^{13}C NMR (126 MHz, CDCl_3) δ 144.00, 139.69, 135.18, 132.80, 132.72, 132.39, 129.04, 128.93, 128.80, 128.65, 127.88, 127.26, 126.06, 123.58, 113.02, 104.85, 68.94, 52.31. HRMS (ESI/[M+H] $^+$) calculated for : $\text{C}_{30}\text{H}_{24}\text{BrNO}_2\text{S}$: 542.0784, found: 542.0799.

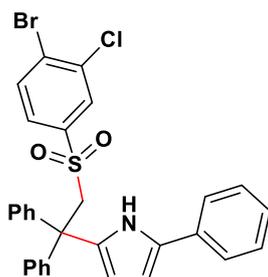


Following the **General Procedure D**, **5z** was isolated as white solid (47.6 mg, 88% yield). ^1H NMR (500 MHz, CDCl_3) δ 10.94 (s, 1H), 7.59 (d, $J = 7.4$ Hz, 3H), 7.45 (d, $J = 7.8$ Hz, 1H), 7.42 – 7.35 (m, 3H), 7.23 (d, $J = 3.4$ Hz, 1H), 7.21 – 7.19 (m, 3H), 7.13 (t, $J = 7.6$ Hz, 4H),

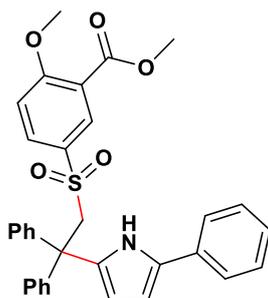
6.93 (d, $J = 7.8$ Hz, 4H), 6.36 (t, $J = 3.1$ Hz, 1H), 5.19 (t, $J = 3.1$ Hz, 1H), 4.71 (s, 2H). ^{13}C NMR (126 MHz, CDCl_3) δ 143.87, 142.29, 136.42, 135.17, 132.79, 132.77, 130.65, 130.56, 128.97, 128.82, 127.83, 127.49, 126.11, 125.95, 123.62, 123.21, 113.04, 104.91, 69.03, 52.19. HRMS (ESI/[M+H] $^+$) calculated for : $\text{C}_{30}\text{H}_{24}\text{BrNO}_2\text{S}$: 542.0784, found: 542.0792.



Following the **General Procedure D**, **5aa** was isolated as white solid (38.3 mg, 69% yield). ^1H NMR (500 MHz, CDCl_3) δ 10.99 (s, 1H), 7.59 (d, $J = 7.2$ Hz, 2H), 7.51 (d, $J = 8.3$ Hz, 1H), 7.38 (t, $J = 7.7$ Hz, 2H), 7.23 – 7.17 (m, 4H), 7.16 (d, $J = 2.4$ Hz, 1H), 7.13 (t, $J = 7.6$ Hz, 4H), 6.93 (d, $J = 7.4$ Hz, 4H), 6.35 (t, $J = 3.1$ Hz, 1H), 5.18 (t, $J = 3.1$ Hz, 1H), 4.69 (s, 2H), 2.30 (s, 3H). ^{13}C NMR (126 MHz, CDCl_3) δ 144.07, 139.56, 139.42, 135.25, 133.15, 132.82, 132.70, 131.17, 129.60, 128.93, 128.82, 127.76, 127.19, 126.04, 126.03, 123.58, 113.01, 104.83, 69.05, 52.27, 22.94. HRMS (ESI/[M+H] $^+$) calculated for : $\text{C}_{31}\text{H}_{26}\text{BrNO}_2\text{S}$: 556.0940, found: 556.0945.

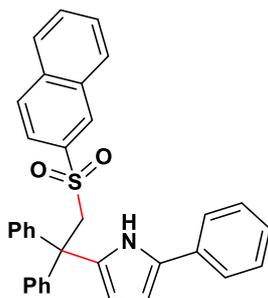


Following the **General Procedure D**, **5ab** was isolated as white solid (49.5 mg, 86% yield). ^1H NMR (500 MHz, CDCl_3) δ 10.80 (s, 1H), 7.61 – 7.55 (m, 3H), 7.38 (t, $J = 7.8$ Hz, 2H), 7.31 (s, 1H), 7.22 (t, $J = 8.0$ Hz, 4H), 7.14 (t, $J = 7.8$ Hz, 4H), 6.94 (d, $J = 7.3$ Hz, 4H), 6.35 (t, $J = 3.1$ Hz, 1H), 5.21 (t, $J = 3.1$ Hz, 1H), 4.71 (s, 2H). ^{13}C NMR (126 MHz, CDCl_3) δ 143.84, 140.83, 135.83, 134.88, 134.36, 132.80, 132.72, 129.44, 129.00, 128.94, 128.79, 127.84, 127.46, 126.29, 126.12, 123.60, 113.09, 104.95, 69.19, 52.17. HRMS (ESI/[M+H] $^+$) calculated for : $\text{C}_{30}\text{H}_{23}\text{BrClNO}_2\text{S}$: 576.0394, found: 576.0397.

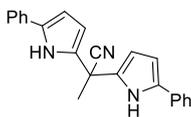


Following the **General Procedure D**, **5ac** was isolated as white solid (31.9 mg, 58% yield). ^1H

NMR (500 MHz, CDCl₃) δ 11.08 (s, 1H), 7.83 (d, $J = 2.6$ Hz, 1H), 7.61 (d, $J = 7.7$ Hz, 2H), 7.53 (dd, $J = 8.9, 2.6$ Hz, 1H), 7.38 (t, $J = 7.7$ Hz, 2H), 7.22 – 7.12 (m, 7H), 6.93 (d, $J = 7.1$ Hz, 4H), 6.86 (d, $J = 8.9$ Hz, 1H), 6.36 (t, $J = 3.1$ Hz, 1H), 5.17 (t, $J = 3.1$ Hz, 1H), 4.70 (s, 2H), 3.94 (s, 3H), 3.85 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 164.39, 162.71, 144.05, 135.37, 132.89, 132.83, 132.66, 132.03, 131.82, 128.94, 128.83, 127.82, 127.22, 126.03, 123.59, 120.60, 112.99, 112.31, 104.81, 68.93, 56.61, 52.28, 52.25. **HRMS (ESI/[M+H]⁺)** calculated for : C₃₃H₂₉NO₅S: 552.1839, found: 552.1849.



Following the **General Procedure D**, **5ad** was isolated as white solid (26.7 mg, 52% yield). **¹H NMR (500 MHz, CDCl₃)** δ 11.17 (s, 1H), 7.90 – 7.81 (m, 3H), 7.73 (d, $J = 8.2$ Hz, 1H), 7.67 – 7.54 (m, 5H), 7.40 (t, $J = 7.7$ Hz, 2H), 7.21 (t, $J = 7.4$ Hz, 1H), 7.09 – 7.00 (m, 6H), 6.93 (d, $J = 6.6$ Hz, 4H), 6.36 (t, $J = 3.1$ Hz, 1H), 5.17 (t, $J = 3.1$ Hz, 1H), 4.76 (s, 2H). **¹³C NMR (126 MHz, CDCl₃)** δ 144.01, 137.30, 135.55, 135.02, 132.90, 132.68, 132.04, 129.79, 129.67, 129.48, 129.31, 128.96, 128.80, 127.81, 127.72, 127.56, 127.25, 126.02, 123.62, 121.94, 112.93, 104.79, 68.53, 52.38. **HRMS (ESI/[M+H]⁺)** calculated for : C₃₄H₂₇NO₂S: 514.1835, found: 514.1841.



11 was isolated as pink solid (30.0 mg, 89% yield). **¹H NMR (500 MHz, CDCl₃)** δ 8.32 (s, 2H), 7.42 (d, $J = 7.7$ Hz, 4H), 7.34 (t, $J = 7.7$ Hz, 4H), 7.21 (t, $J = 7.4$ Hz, 2H), 6.47 (t, $J = 3.1$ Hz, 2H), 6.35 (t, $J = 3.1$ Hz, 2H), 2.12 (s, 3H). **¹³C NMR (126 MHz, CDCl₃)** δ 133.68, 131.93, 129.64, 128.94, 126.87, 124.06, 121.14, 108.63, 106.41, 36.88, 27.35. **HRMS (ESI/[M+H]⁺)** calculated for C₂₃H₁₉N₃: 338.1652, found: 338.1645.

11. DFT Calculation

All DFT calculations were performed using the Gaussian 16 C01 program⁵. The M06-2X⁶-D3(0)⁷/6-31G(d)⁸ method was employed for structure optimization and frequency analysis to obtain thermodynamic corrections. All transition state structures were verified by frequency analysis to ensure only one imaginary frequency, which were connected to the corresponding intermediates through Intrinsic Reaction Coordinate (IRC) calculations. Single-point energies were calculated using the M06-2X⁶-D3(0)⁷/def2-TZVP⁹/SMD(THF)¹⁰ method. CYLview programs were utilized for visualizing 3D structures.¹¹ The searching for minimal energy crossing points (MECP) was conducted using a modified version of Harvey's code¹² (sobMECP¹³) interfaced with Gaussian 16.

1a				O	1.144657	-0.355055	-2.244031
0 1				C	-4.734061	-0.651330	0.905637
C	1.761664	0.374433	0.884105	H	-5.424827	-1.273194	0.325895
C	2.438421	0.186918	2.060938	H	-4.807103	-0.966353	1.950325
C	2.944545	-1.146747	2.084851	H	-5.076192	0.383742	0.833259
C	2.554966	-1.756745	0.928917				
N	1.851155	-0.828333	0.173515	1a(Ti)			
H	2.578991	0.953612	2.810568	0 3			
H	3.542776	-1.598884	2.862631	C	-1.007946	-0.265908	-1.061987
H	2.708015	-2.752200	0.543404	C	-0.245556	0.175743	-2.249858
C	1.027864	1.566121	0.418918	C	0.459587	-0.889836	-2.702122
C	0.024428	2.099888	1.235726	C	0.237167	-1.989697	-1.810786
C	1.317565	2.188642	-0.801075	N	-0.556046	-1.579656	-0.716787
C	-0.694469	3.220334	0.831917	H	-0.309951	1.154537	-2.702349
H	-0.204276	1.607585	2.176520	H	1.074198	-0.935958	-3.591118
C	0.591277	3.304017	-1.206404	H	0.608719	-3.001634	-1.850768
H	2.100092	1.784658	-1.433361	C	-2.137340	0.346699	-0.482120
C	-0.418633	3.819121	-0.395134	C	-2.481870	1.681952	-0.833978
H	-1.476703	3.618852	1.470760	C	-2.972483	-0.335581	0.445799
H	0.819486	3.775505	-2.157174	C	-3.591496	2.294217	-0.282892
H	-0.983440	4.689107	-0.716067	H	-1.858322	2.229579	-1.533086
S	0.911734	-1.302437	-1.174420	C	-4.082135	0.290095	0.978646
C	-0.747207	-1.107739	-0.588037	H	-2.722196	-1.351729	0.724479
C	-1.469666	0.027580	-0.936641	C	-4.401220	1.606773	0.626244
C	-1.281674	-2.096827	0.235255	H	-3.833476	3.315644	-0.560122
C	-2.760952	0.170631	-0.439029	H	-4.711202	-0.249117	1.679835
H	-1.021907	0.785513	-1.572486	H	-5.271302	2.091776	1.056463
C	-2.571254	-1.932911	0.719516	S	0.339803	-1.713577	0.835232
H	-0.693796	-2.976177	0.479764	C	1.518294	-0.401118	0.745482
C	-3.326662	-0.800314	0.389631	C	1.119538	0.884436	1.108892
H	-3.333777	1.057235	-0.695736	C	2.756283	-0.642314	0.153896
H	-3.003696	-2.694499	1.362640	C	1.993261	1.941438	0.883118
O	1.204545	-2.713396	-1.335892	H	0.148350	1.040268	1.569005

C	3.615705	0.428842	-0.056604
H	3.034231	-1.655754	-0.117795
C	3.247061	1.730190	0.300674
H	1.699305	2.948606	1.166105
H	4.589613	0.255160	-0.506351
O	1.027615	-2.992037	0.742993
O	-0.614079	-1.422345	1.890659
C	4.198266	2.879663	0.091071
H	4.849052	3.005560	0.963450
H	4.840247	2.710378	-0.777353
H	3.659231	3.819002	-0.056661

TS1a_B

0 3			
C	0.983305	-0.344952	1.096799
C	0.215985	0.052874	2.294565
C	-0.486948	-1.030775	2.704304
C	-0.245484	-2.096772	1.774094
N	0.554743	-1.648171	0.708552
H	0.272054	1.016626	2.779402
H	-1.109938	-1.112349	3.584777
H	-0.620334	-3.108428	1.771338
C	2.085484	0.318444	0.513460
C	2.396485	1.652699	0.893775
C	2.919235	-0.314479	-0.447874
C	3.475907	2.312610	0.337053
H	1.770855	2.163065	1.618763
C	3.998604	0.358284	-0.987625
H	2.692552	-1.330107	-0.748257
C	4.285802	1.673603	-0.606499
H	3.693402	3.333288	0.636329
H	4.627796	-0.143220	-1.716107
H	5.131845	2.195742	-1.041260
S	-0.361128	-1.734556	-0.879242
C	-1.485193	-0.378061	-0.778742
C	-1.029179	0.895197	-1.117633
C	-2.730416	-0.573699	-0.183525
C	-1.852527	1.986622	-0.866481
H	-0.053401	1.015860	-1.578873
C	-3.538583	0.531024	0.051512
H	-3.052290	-1.578350	0.071811
C	-3.111777	1.821532	-0.281650
H	-1.513241	2.984642	-1.130402

H	-4.517515	0.393464	0.502977
O	-1.097157	-2.988114	-0.794733
O	0.607475	-1.476921	-1.931930
C	-4.008907	3.007876	-0.041335
H	-4.696684	3.148421	-0.882537
H	-4.614060	2.871580	0.858949
H	-3.429492	3.927965	0.069202

A

0 3			
C	-0.550789	-1.810649	0.348479
C	-1.240655	-1.606133	1.610658
C	-2.542276	-1.924570	1.372905
C	-2.595630	-2.307045	-0.032555
N	-1.419729	-2.223573	-0.628161
H	-0.800795	-1.270832	2.539709
H	-3.376677	-1.892320	2.059869
H	-3.479475	-2.618266	-0.579153
C	0.856902	-1.646024	0.071722
C	1.765283	-1.282760	1.081516
C	1.336360	-1.851271	-1.236934
C	3.114142	-1.130442	0.791196
H	1.409837	-1.121496	2.094414
C	2.682799	-1.689163	-1.521893
H	0.623764	-2.134519	-2.004278
C	3.576008	-1.328166	-0.510002
H	3.808846	-0.853829	1.578631
H	3.044300	-1.848462	-2.533024
H	4.632111	-1.209493	-0.733976
S	-2.475327	0.986358	-0.458159
C	-0.768388	1.443761	-0.175586
C	0.122723	1.381620	-1.240564
C	-0.357208	1.753586	1.116423
C	1.462536	1.662008	-1.000080
H	-0.233359	1.117669	-2.231285
C	0.985947	2.039212	1.330752
H	-1.083437	1.781444	1.922276
C	1.910476	1.995117	0.281551
H	2.176253	1.607974	-1.817706
H	1.326419	2.295310	2.330749
O	-3.264676	1.517317	0.668577
O	-2.793086	1.323865	-1.857497
C	3.363943	2.305799	0.522897
H	4.004827	1.693304	-0.117686

H	3.578356	3.357629	0.303406	C	-0.752795	1.465237	0.472026
H	3.641414	2.120430	1.564179	C	-0.137285	1.477646	1.819274
				C	1.138548	1.851030	1.653162
MECP				C	1.334125	2.067795	0.186753
0 1				N	0.070494	1.826711	-0.457771
C	-0.36495311	-1.72206829	0.32827397	H	-0.624733	1.214158	2.748601
C	-1.05104365	-1.56279702	1.59522456	H	1.921291	1.949890	2.393618
C	-2.37538108	-1.65613036	1.31483064	H	1.771221	3.033173	-0.095097
C	-2.45297612	-1.87311198	-0.12000760	C	-2.130897	1.040429	0.166273
N	-1.25810651	-1.91462211	-0.68535232	C	-3.044491	0.752379	1.183060
H	-0.58984655	-1.39774106	2.55598750	C	-2.525282	0.903997	-1.170640
H	-3.21215729	-1.58537203	1.99243917	C	-4.334738	0.334090	0.870740
H	-3.35684012	-2.02033992	-0.69768969	H	-2.755482	0.858431	2.224042
C	1.05320962	-1.66269024	0.08852519	C	-3.811758	0.485108	-1.479866
C	1.95159780	-1.39582038	1.13434321	H	-1.805476	1.135708	-1.949122
C	1.55802260	-1.83606328	-1.21152262	C	-4.719496	0.198192	-0.459688
C	3.30882050	-1.29985933	0.88498110	H	-5.038509	0.115030	1.667435
H	1.58109688	-1.25719793	2.14166866	H	-4.110892	0.381608	-2.518209
C	2.91524201	-1.73891041	-1.45348274	H	-5.725460	-0.129404	-0.703273
H	0.86526708	-2.03952616	-2.01705406	S	2.561526	0.863584	-0.478706
C	3.79488538	-1.46699569	-0.40815866	C	1.733321	-0.693409	-0.270171
H	3.99191060	-1.09048321	1.69804477	C	0.796074	-1.089799	-1.222722
H	3.29508085	-1.87369097	-2.45830606	C	1.993447	-1.456331	0.860947
H	4.85775009	-1.38646991	-0.60089783	C	0.102714	-2.274405	-1.021450
S	-2.71441529	1.04922460	-0.36284630	H	0.620632	-0.467193	-2.094320
C	-0.99709594	1.42707122	-0.14585287	C	1.295001	-2.647429	1.038890
C	-0.14069178	1.33915751	-1.23499243	H	2.736569	-1.119932	1.577174
C	-0.53220640	1.71324988	1.13260502	C	0.341563	-3.066508	0.108904
C	1.20753376	1.58881356	-1.03823632	H	-0.639342	-2.592565	-1.748982
H	-0.52471146	1.08468025	-2.21400261	H	1.491162	-3.258759	1.915259
C	0.81982564	1.95215092	1.30626309	O	3.708407	0.914737	0.425881
H	-1.21946025	1.75646865	1.96710359	O	2.711831	1.132720	-1.901859
C	1.70594371	1.89515047	0.22846586	C	-0.417063	-4.353873	0.301199
H	1.88808436	1.53234361	-1.87935861	H	-1.494675	-4.190275	0.204704
H	1.19772799	2.18381025	2.29507795	H	-0.128717	-5.091075	-0.455435
O	-3.47966094	1.71326672	0.67827287	H	-0.223282	-4.787662	1.284966
O	-3.06956937	1.24020029	-1.75766506				
C	3.16562870	2.17280367	0.42713821	1a'			
H	3.77274957	1.60011161	-0.27384962	0 1			
H	3.37320534	3.23278895	0.25787640	C	2.122027	-0.432464	0.562129
H	3.47727288	1.93198864	1.44352391	C	1.674344	-1.026395	1.734642
				C	0.383755	-1.548490	1.495740
B				C	0.086561	-1.259911	0.182103
0 1				H	2.217731	-1.050221	2.668553

H	-0.261174	-2.071831	2.186748	C	1.103934	-1.202719	-0.000078
C	3.386950	0.242164	0.256735	C	2.525076	1.200204	0.000138
C	4.548923	-0.098764	0.958911	H	0.614802	2.173044	0.000203
C	3.458846	1.232741	-0.729860	C	2.489829	-1.217271	-0.000153
C	5.752004	0.539000	0.682614	H	0.526416	-2.120572	-0.000163
H	4.505536	-0.882998	1.708817	C	3.204945	-0.018224	-0.000011
C	4.666719	1.860505	-1.013444	H	3.080492	2.132678	0.000262
H	2.558915	1.534451	-1.259559	H	3.019859	-2.164510	-0.000319
C	5.816834	1.517671	-0.307259	H	4.290470	-0.032889	-0.000014
H	6.645508	0.262335	1.233506				
H	4.706515	2.627399	-1.780657	D			
H	6.758635	2.010292	-0.526717	0 2			
S	-1.340587	-1.560928	-0.785325	S	-2.152921	-0.002078	-0.240247
C	-2.499594	-0.291035	-0.325336	C	-0.365602	0.001636	-0.095281
C	-2.471295	0.931151	-0.988692	C	0.303301	1.218601	-0.073910
C	-3.401121	-0.538144	0.705254	C	0.309115	-1.215725	-0.076188
C	-3.363707	1.924438	-0.602854	C	1.693114	1.208176	-0.006280
H	-1.771216	1.086082	-1.803492	H	-0.256685	2.147790	-0.088180
C	-4.285217	0.467321	1.077053	C	1.695539	-1.200010	-0.008830
H	-3.412381	-1.509923	1.188686	H	-0.248502	-2.146266	-0.091809
C	-4.278890	1.708057	0.431717	C	2.405077	0.006880	0.024661
H	-3.354613	2.882726	-1.115060	H	2.233050	2.150231	0.026339
H	-4.996514	0.286862	1.878521	H	2.240543	-2.139844	0.021976
O	-1.909191	-2.837045	-0.371553	O	-2.630524	-1.292981	0.285785
O	-0.923705	-1.295312	-2.164570	O	-2.636051	1.288339	0.281601
C	-5.264522	2.778898	0.821455	C	3.910099	-0.003594	0.089412
H	-4.871240	3.776440	0.609734	H	4.312224	1.008703	0.170387
H	-6.199093	2.665057	0.261109	H	4.259885	-0.579467	0.951762
H	-5.509220	2.724037	1.885408	H	4.334956	-0.466553	-0.807121
N	1.129027	-0.566856	-0.366707				
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				2			
C				0 1			
0 2				C	0.000000	-0.784007	0.000000
C	-1.037066	0.017989	0.000014	H	-0.696845	-1.616193	0.000000
C	-1.928164	1.165585	-0.000261	C	1.319576	-0.970125	0.000000
C	-3.186245	0.650727	-0.000012	H	1.736937	-1.970806	0.000000
C	-3.010842	-0.796545	-0.000047	H	2.010576	-0.133957	0.000000
N	-1.742394	-1.156558	0.000318	C	-0.583549	0.529640	0.000000
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H	-4.128435	1.181698	0.000086				
H	-3.803866	-1.537060	0.000066	TS_{D,E}			
C	0.406329	0.020695	0.000011	0 2			
C	1.138338	1.222253	0.000098	S	-1.932733	0.691885	-0.013633

C -0.165711 0.818341 -0.056522
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 C 0.523346 0.933457 1.147344
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 H -0.082989 0.512884 -2.183199
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 H 4.536522 0.644577 -1.011906
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 C -2.106828 -1.640214 0.429690
 H -3.144641 -1.661845 0.110308
 H -1.921611 -1.455504 1.484834
 C 0.187847 -2.413368 0.105774
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TS-1

O 2
 C 2.381112 0.314019 -1.398319
 H 1.520204 0.387133 -2.053984
 C 2.892917 -0.912431 -1.030278
 H 2.619498 -1.778065 -1.623307
 H 3.851164 -0.952698 -0.520816
 C 2.863248 1.521788 -0.829862
 N 3.262039 2.507529 -0.362113
 C -0.087629 -0.556199 0.618659
 C 0.791925 0.165695 1.548759
 C 1.951970 -0.526541 1.574418
 C 1.779325 -1.616375 0.613184
 N 0.496266 -1.625479 0.112504
 H 0.556692 1.070888 2.091407
 H 2.855080 -0.300610 2.126080
 H 2.342479 -2.544897 0.631488
 C -1.453313 -0.178235 0.251749
 C -2.051298 0.979724 0.765305
 C -2.179754 -0.985257 -0.637198

C -3.346730 1.325059 0.397561
 H -1.502146 1.616509 1.451502
 C -3.472725 -0.638511 -1.000673
 H -1.705019 -1.880173 -1.025344
 C -4.060118 0.517804 -0.485071
 H -3.799558 2.225696 0.799807
 H -4.028201 -1.269306 -1.687686
 H -5.071906 0.787922 -0.771288

TS-2

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 H 1.928485 0.335190 1.286797
 C 2.762781 2.106772 0.426000
 H 1.877104 2.710426 0.573585
 H 3.646206 2.570744 0.005003
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 C 1.752714 -0.075838 -1.004680
 N 0.495075 0.510575 -0.902471
 H -0.023048 -2.620383 0.138915
 H 2.509996 -2.183873 -0.633715
 H 2.448035 0.308099 -1.743941
 C -1.712458 -0.162043 -0.134055
 C -2.537062 -1.152838 0.411026
 C -2.253530 1.103152 -0.403565
 C -3.874284 -0.885207 0.683992
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 C -4.402946 0.374135 0.413727
 H -4.503854 -1.661238 1.107769
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 H -5.447067 0.582363 0.625914

E

O 2
 C 0.793864 0.232992 0.248482
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 C 1.308976 -0.961965 0.742660
 C 2.910830 0.802338 -0.710364

H	1.155787	2.065250	-0.814819	S	-2.133914	1.454236	0.241349
C	2.641971	-1.266530	0.494637	C	-2.875541	-1.275594	0.787795
H	0.676463	-1.620467	1.330203	H	-3.062039	-1.900461	1.670407
C	3.456223	-0.395661	-0.237098	C	-1.597825	-1.602164	-1.473476
H	3.541173	1.493954	-1.262374	N	-0.543907	-2.035721	0.604033
H	3.062205	-2.190162	0.882810	C	-0.275024	-1.468065	-1.622528
O	-1.372257	-0.122267	1.702355	H	-2.380057	-1.460573	-2.208734
O	-1.093883	2.062313	0.422998	C	0.327853	-1.716878	-0.294039
C	4.891963	-0.749922	-0.523861	H	0.259416	-1.183504	-2.519558
H	5.507017	0.146442	-0.635500	C	1.762322	-1.572738	0.022440
H	5.316334	-1.361898	0.275996	C	2.171166	-1.529961	1.359507
H	4.968126	-1.322565	-1.454796	C	2.717476	-1.448875	-0.989758
C	-1.748137	-0.105135	-0.928203	C	3.511868	-1.356227	1.677443
H	-1.542973	-1.177556	-0.926041	H	1.417782	-1.628417	2.134582
H	-1.277206	0.372524	-1.794101	C	4.062624	-1.287321	-0.670972
C	-3.196526	0.202477	-0.842439	H	2.414680	-1.487767	-2.031816
H	-3.525905	1.233453	-0.892907	C	4.461155	-1.235019	0.662284
C	-4.141984	-0.800143	-0.615311	H	3.820813	-1.319527	2.717574
N	-4.925852	-1.648148	-0.450482	H	4.799459	-1.200918	-1.463777
S	-0.915956	0.616929	0.531974	H	5.510183	-1.104268	0.910726
F				C	-1.837252	-2.046745	-0.057820
0 1				H	-2.189254	-3.089699	-0.091778
C	-0.367047	1.562824	0.017660	Pyrrole			
C	0.137317	1.595654	-1.277004	0 1			
C	0.466387	1.721594	1.121301	C	-1.012206	0.090978	0.020545
C	1.504557	1.772167	-1.461278	C	-1.879922	1.118598	0.335901
H	-0.543261	1.479728	-2.114467	C	-3.203577	0.629189	0.190513
C	1.832019	1.881086	0.919219	C	-3.111808	-0.681886	-0.213427
H	0.054727	1.735823	2.127001	H	-1.584857	2.101985	0.674238
C	2.368475	1.915130	-0.371635	H	-4.119618	1.172680	0.370694
H	1.910443	1.799998	-2.469485	H	-3.875298	-1.408491	-0.446835
H	2.492995	1.987016	1.774951	C	0.451109	0.038145	0.012491
O	-2.547274	2.633438	0.997512	C	1.195037	1.203446	-0.214081
O	-2.732328	1.138346	-1.053872	C	1.139453	-1.161982	0.232465
C	3.842269	2.140239	-0.583622	C	2.583844	1.168979	-0.215611
H	4.057563	3.210708	-0.676036	H	0.670918	2.134553	-0.408310
H	4.424365	1.749007	0.254560	C	2.529753	-1.197718	0.215267
H	4.188619	1.649186	-1.496980	H	0.583789	-2.070110	0.452742
C	-2.413388	0.062190	1.375059	C	3.258626	-0.032534	-0.006639
H	-3.180874	0.455758	2.046884	H	3.143109	2.082474	-0.393601
H	-1.491446	-0.101332	1.938449	H	3.044888	-2.137424	0.390087
C	-4.156077	-1.189025	0.070099	H	4.343598	-0.059428	-0.015180
N	-5.168190	-1.188054	-0.486500	N	-1.784393	-1.000105	-0.300717

H	-1.417629	-1.866804	-0.663358	C	2.194827	-2.328414	0.432057
				H	3.012582	-3.013779	0.252685
TS-3				N	0.951809	-2.586010	-0.114288
0 2				H	0.774059	-3.231672	-0.868892
C	0.031903	1.694906	-0.072277				
C	-0.458409	1.842425	1.219268	TsH			
C	-0.824921	1.655524	-1.168539	0 1			
C	-1.832825	1.938676	1.410950	S	-2.153775	-0.037877	-0.401252
H	0.239260	1.873177	2.050428	C	-0.362306	-0.025014	-0.201771
C	-2.196486	1.731761	-0.958190	C	0.276930	1.185231	0.025215
H	-0.427109	1.565944	-2.176174	C	0.358826	-1.212906	-0.319431
C	-2.717543	1.879632	0.330701	C	1.664994	1.203099	0.148969
H	-2.227347	2.055477	2.417137	H	-0.317940	2.089510	0.112777
H	-2.874726	1.677223	-1.805414	C	1.740512	-1.177167	-0.196195
O	2.221435	2.677330	-1.181618	H	-0.160349	-2.152587	-0.488127
O	2.403252	1.403177	1.005274	C	2.412371	0.030211	0.037853
C	-4.203672	1.997364	0.544274	H	2.175324	2.144509	0.333827
H	-4.527063	3.039764	0.447751	H	2.312891	-2.097687	-0.279529
H	-4.753639	1.406204	-0.193264	O	-2.458482	-1.171686	0.766773
H	-4.488581	1.652883	1.542246	O	-2.591658	1.299058	0.062701
C	1.963030	0.057443	-1.296136	C	3.914399	0.048025	0.159148
H	2.065120	0.423989	-2.323866	H	4.281207	1.046706	0.407202
H	1.007704	-0.475195	-1.218163	H	4.253606	-0.642268	0.937853
C	4.269155	-0.457570	-0.264419	H	4.385619	-0.261564	-0.779426
N	5.252211	-0.239571	0.316448	H	-2.103204	-0.848429	1.616934
S	1.799581	1.583529	-0.310775				
C	3.085098	-0.874530	-0.929930	TSF_G			
H	3.288477	-1.593391	-1.723103	0 1			
C	1.964142	-1.568019	1.601811	C	2.772071	1.595049	-0.092752
C	0.598520	-1.289582	1.662424	C	2.355053	2.159886	1.105260
H	2.741490	-1.178205	2.242805	C	2.332913	2.092266	-1.318439
C	-0.028459	-1.917460	0.585628	C	1.446415	3.213325	1.072702
H	0.103327	-0.641037	2.370710	H	2.731818	1.759573	2.041022
C	-1.401602	-1.807143	0.112480	C	1.416149	3.134659	-1.332236
C	-1.718768	-1.956843	-1.246334	H	2.712126	1.680452	-2.249973
C	-2.434514	-1.509910	1.014338	C	0.949578	3.698505	-0.138847
C	-3.029025	-1.814727	-1.688967	H	1.106307	3.658294	2.004508
H	-0.929807	-2.153324	-1.968672	H	1.052778	3.519553	-2.281271
C	-3.741648	-1.371532	0.569047	O	5.122955	0.659010	-0.810512
H	-2.203016	-1.406923	2.070395	O	4.060984	-0.170658	1.352446
C	-4.046168	-1.520435	-0.784262	C	-0.103423	4.772722	-0.155702
H	-3.254495	-1.927941	-2.744928	H	-1.089082	4.330880	0.033806
H	-4.530724	-1.149548	1.281500	H	0.081164	5.521962	0.619063
H	-5.070247	-1.414523	-1.128702	H	-0.143987	5.278199	-1.123704

C	3.190444	-1.080443	-0.992214	H	-0.090880	-0.944948	-1.174070
H	4.050581	-1.600349	-1.424412				
H	2.617285	-0.629403	-1.806594	G			
C	3.078714	-2.891975	0.722265	0 1			
N	3.651623	-3.559990	1.469893	C	1.150979	1.557776	-0.251092
S	3.949483	0.259315	-0.040360	C	0.455653	2.291427	0.710650
C	2.310677	-2.070140	-0.224000	C	0.528824	1.083958	-1.397515
H	1.909084	-2.756769	-0.982090	C	-0.900562	2.520156	0.524701
C	1.090701	-0.977753	1.855830	H	0.979725	2.690814	1.575040
N	0.266876	-0.593472	-0.227524	C	-0.828347	1.341222	-1.573908
C	0.186589	0.043707	1.922459	H	1.099434	0.507867	-2.118838
H	1.705158	-1.376429	2.653505	C	-1.560959	2.047660	-0.618346
C	-0.326153	0.248802	0.601225	H	-1.459065	3.086732	1.265444
H	-0.087449	0.622173	2.793440	H	-1.331767	0.968586	-2.461905
C	-1.375348	1.175298	0.165008	O	3.403388	0.532129	-1.150994
C	-1.538626	1.475469	-1.193576	O	3.492111	2.348780	0.638757
C	-2.234607	1.751207	1.104960	C	-3.034907	2.297038	-0.789511
C	-2.553986	2.329853	-1.602366	H	-3.259503	3.366385	-0.721994
H	-0.866324	1.039436	-1.927453	H	-3.391135	1.929800	-1.754629
C	-3.254036	2.604542	0.692516	H	-3.603315	1.784039	-0.005733
H	-2.129568	1.502727	2.156910	C	2.816015	-0.047670	1.373599
C	-3.418178	2.890784	-0.660855	H	2.126531	0.343788	2.127926
H	-2.675804	2.555580	-2.656908	H	3.825388	-0.016648	1.794762
H	-3.925152	3.037426	1.427749	C	3.527047	-2.120232	0.203137
H	-4.214015	3.555425	-0.982794	N	4.376592	-2.664045	-0.358133
C	1.084076	-1.506998	0.507009	S	2.861793	1.176192	0.038768
H	0.372879	-2.508155	0.475188	C	1.137779	-1.649045	0.235134
C	-2.438306	-2.231352	-0.509432	C	0.859262	-2.328130	-0.927334
C	-2.606041	-2.341171	0.868083	N	-0.050806	-1.195131	0.752800
C	-3.247254	-1.378074	-1.254178	C	-0.541225	-2.254793	-1.133617
C	-3.580539	-1.573679	1.499562	H	1.590866	-2.834628	-1.541144
H	-1.965462	-3.016355	1.428209	C	-1.085839	-1.532374	-0.090564
C	-4.231350	-0.631193	-0.613655	H	-0.136807	-0.493345	1.475499
H	-3.086966	-1.283093	-2.325214	H	-1.096773	-2.714081	-1.938790
C	-4.409889	-0.716671	0.768930	C	-2.470988	-1.144552	0.179292
H	-3.705141	-1.644181	2.577972	C	-2.891010	-0.757803	1.458312
H	-4.856273	0.045691	-1.191046	C	-3.415640	-1.161133	-0.856409
O	-0.463421	-2.109687	-2.190019	C	-4.216047	-0.404886	1.695873
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C	-5.474977	0.092140	1.463720	C	-4.741677	-0.825026	-0.614593
H	-6.328806	-0.536511	1.738900	H	-3.098937	-1.434679	-1.858809
H	-5.090925	0.542402	2.385152	C	-5.149428	-0.442255	0.662587
H	-5.843656	0.895481	0.819939	H	-4.522327	-0.115113	2.696375
S	-1.175030	-3.208440	-1.373815	H	-5.458785	-0.851220	-1.429374

H	-6.184542	-0.175924	0.850356	H	-4.397022	-1.086620	-2.063231
C	2.442678	-1.484651	0.969465	H	-5.713028	0.415873	1.740226
H	2.386552	-2.046414	1.914001	H	-6.244191	-0.515762	-0.502108
TS_{G,H}				C	2.407826	0.100409	0.247113
O 2				H	2.681382	1.265990	-0.103027
C	0.999911	-2.881816	-0.445296	S	2.290984	3.625116	0.093521
C	-0.039613	-3.096224	-1.344192	C	0.604040	3.208918	-0.413996
C	0.804161	-2.948819	0.931953	C	0.359466	2.777607	-1.714982
C	-1.311318	-3.356977	-0.843361	C	-0.435492	3.433196	0.481318
H	0.161205	-3.079195	-2.411462	C	-0.957182	2.561868	-2.116832
C	-0.478719	-3.186037	1.410503	H	1.189481	2.611848	-2.396844
H	1.645159	-2.809908	1.605579	C	-1.743402	3.218961	0.059836
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H	-0.651988	-3.220742	2.482690	H	-1.162271	2.228600	-3.131554
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O	2.669147	-2.822624	-2.474558	O	2.281565	3.599753	1.573878
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C	2.581064	-0.609853	-1.089427	H	-3.530095	1.959801	-2.549179
H	1.810363	-0.311181	-1.806656	H			
H	3.553706	-0.357801	-1.524660	O 2			
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N	4.269035	-0.326487	2.029233	C	0.482094	-2.267234	-0.384251
S	2.599045	-2.429356	-1.069533	C	1.054641	-0.913769	1.553912
C	1.083993	0.119421	0.873250	C	-0.829730	-2.346930	0.071121
C	0.754284	0.248329	2.225650	H	0.799743	-2.761722	-1.298158
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C	-4.912530	0.151392	1.056600	C	2.705849	0.289565	-1.324738
H	-3.364900	0.744215	2.423399	H	1.979177	-0.001215	-2.090509
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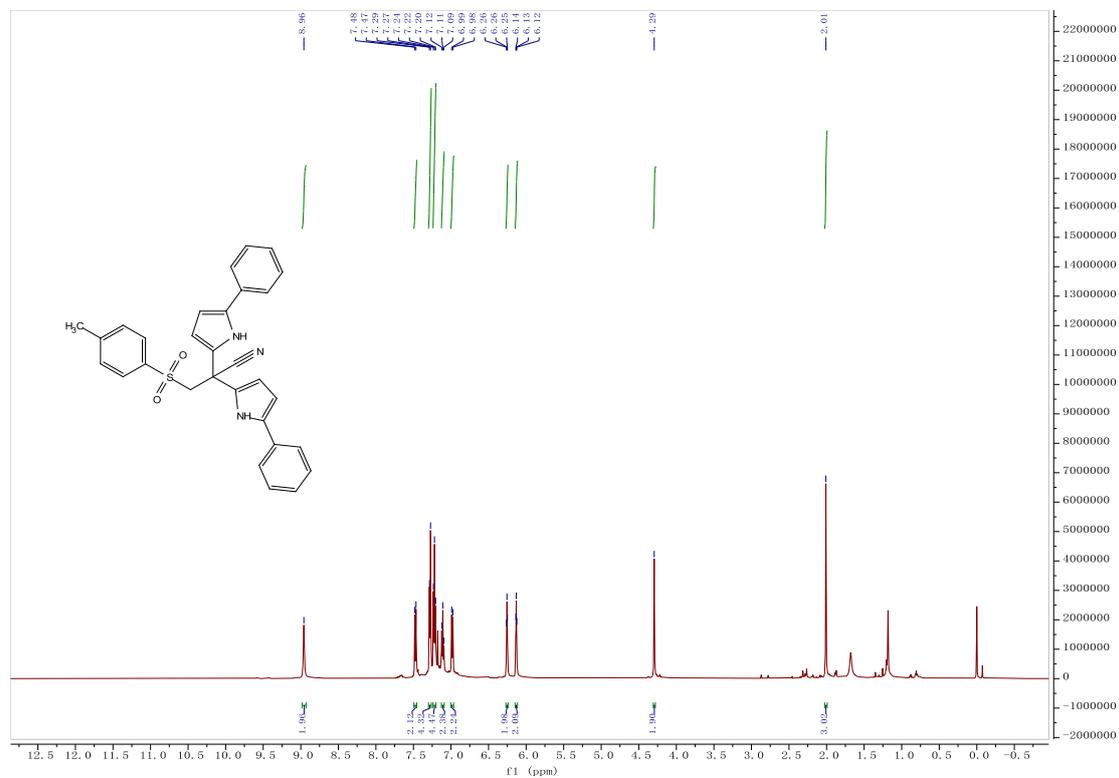
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C	-1.321064	1.552919	-0.188291	H	-0.835962	-1.565419	-3.274141
H	-0.087587	0.063508	-0.996356	C	-2.890543	-1.624186	-0.656047
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C	-4.953742	0.675550	0.166032	C	-6.354837	-0.382573	0.196549
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C	-5.120987	-0.260574	-0.853927	C	-6.403026	-0.652397	1.560833
H	-4.161853	-1.313045	-2.470471	H	-5.342621	-1.447565	3.259130
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C	2.267785	1.460836	-0.517221	C	0.227054	-0.511701	0.113244
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C	3.230464	0.755812	-0.125155	H	-0.160582	0.603525	-1.648429
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H	3.642770	-0.492716	3.520709	H	0.838517	2.685177	-2.164896
H	3.088185	2.717682	0.725607	C	-1.302025	5.270175	-0.244397
O	3.909181	-1.186060	-2.354738	H	-1.602455	3.714231	1.213272
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H	3.847182	-0.719487	-2.779544	C	2.059872	-3.482098	1.234618
H	4.254327	-1.052391	1.476775	C	1.262737	-4.314357	-1.295207
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O	2.745002	3.971655	-1.179356	C	2.440219	-4.731945	0.762234
C	4.658026	-2.433436	-0.844277	H	2.390416	-3.147422	2.213782
H	5.478806	-2.436946	-1.568412	C	2.046659	-5.153739	-0.507009
H	5.028499	-2.838272	0.100369	H	0.943127	-4.635033	-2.281921
H	3.880207	-3.110887	-1.214933	H	3.056437	-5.375525	1.382624
C	0.503954	2.756412	-0.716321	H	2.347895	-6.128088	-0.877910
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C	-0.771511	2.991974	1.383374				
N	-1.105014	3.700784	2.231945				
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C	-2.236567	2.098454	-1.649873				
N	-2.593107	0.810938	0.120192				
C	-3.483446	1.440486	-1.806051				
H	-1.782210	2.792311	-2.343138				
C	-3.684565	0.646545	-0.692862				
H	-2.473219	0.397286	1.036247				
H	-4.145213	1.503901	-2.658017				
C	-4.774892	-0.270489	-0.349686				
C	-4.546571	-1.399317	0.446829				
C	-6.069237	-0.030587	-0.825902				
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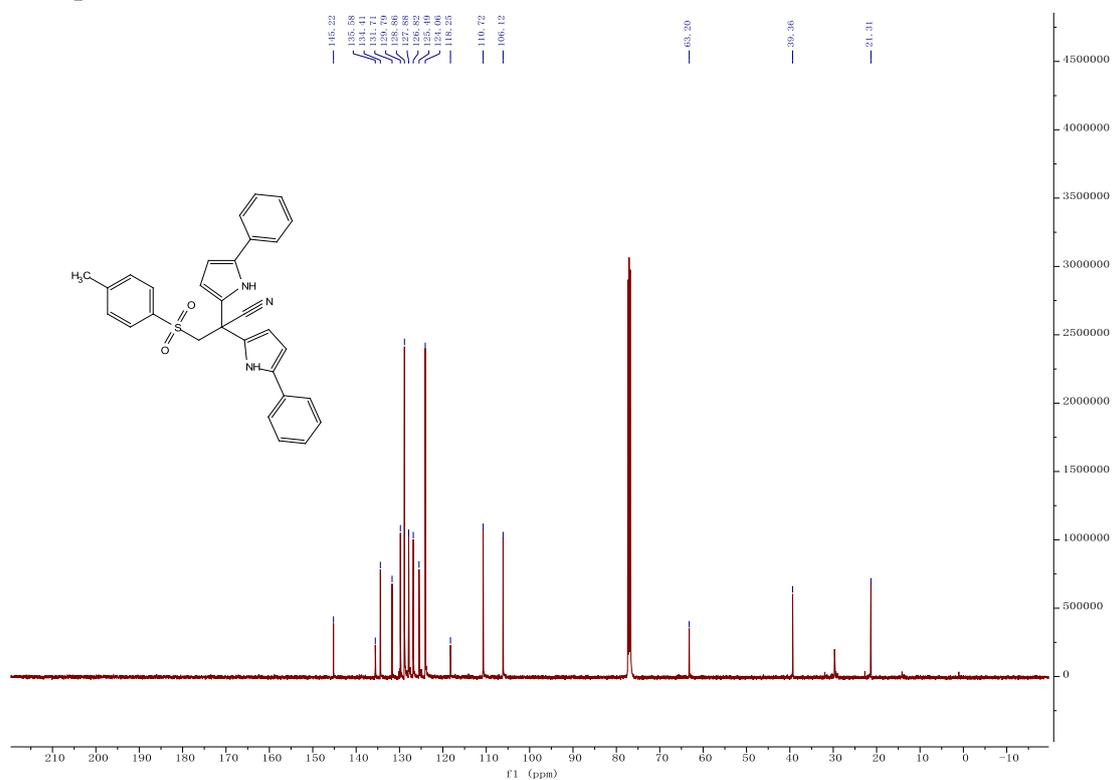
12. ¹H NMR and ¹³C NMR spectra

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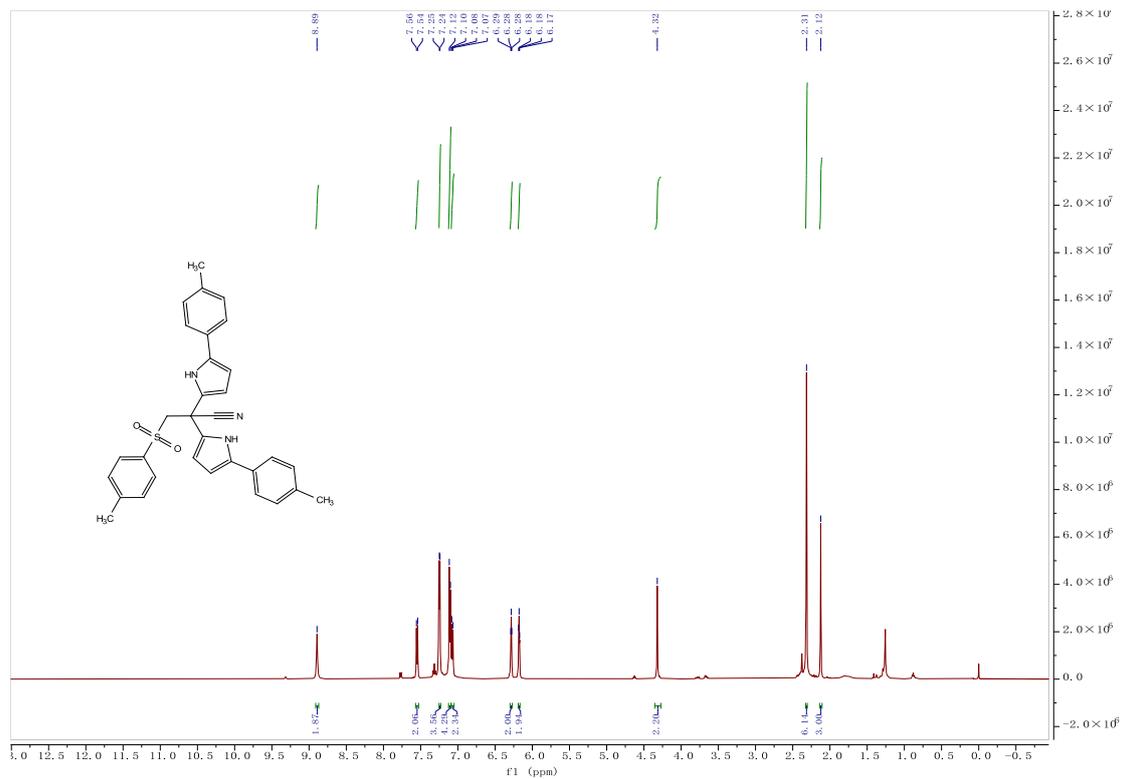
¹H Spectra



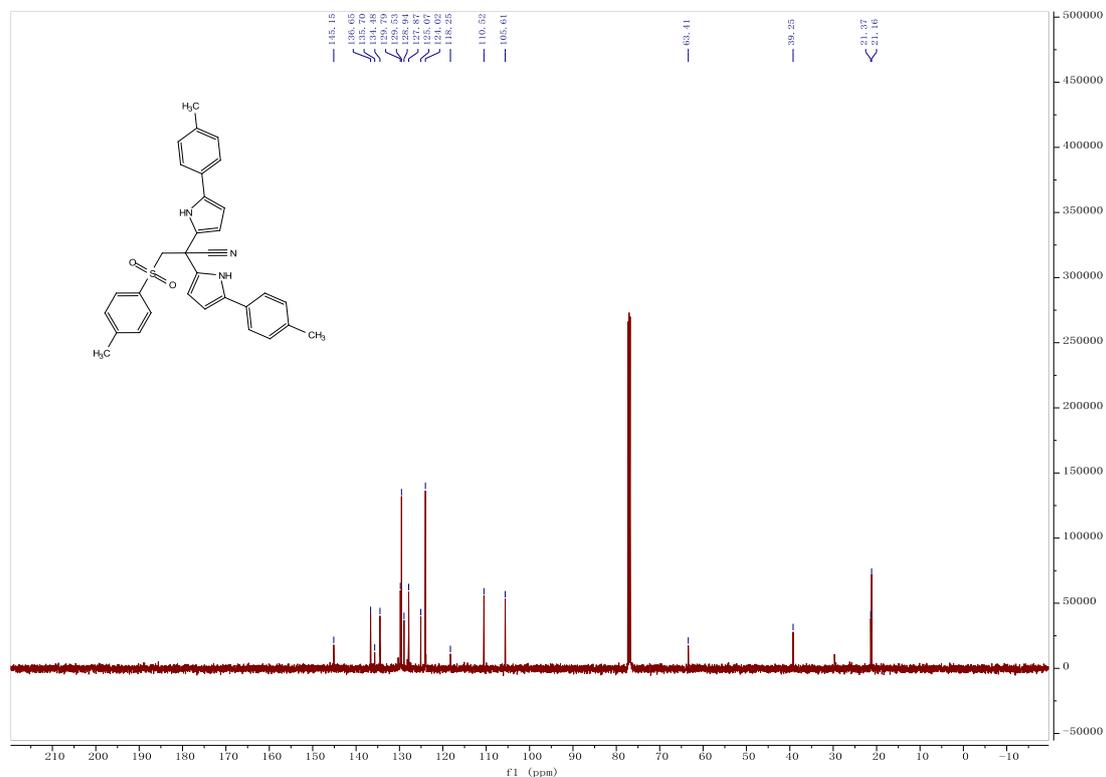
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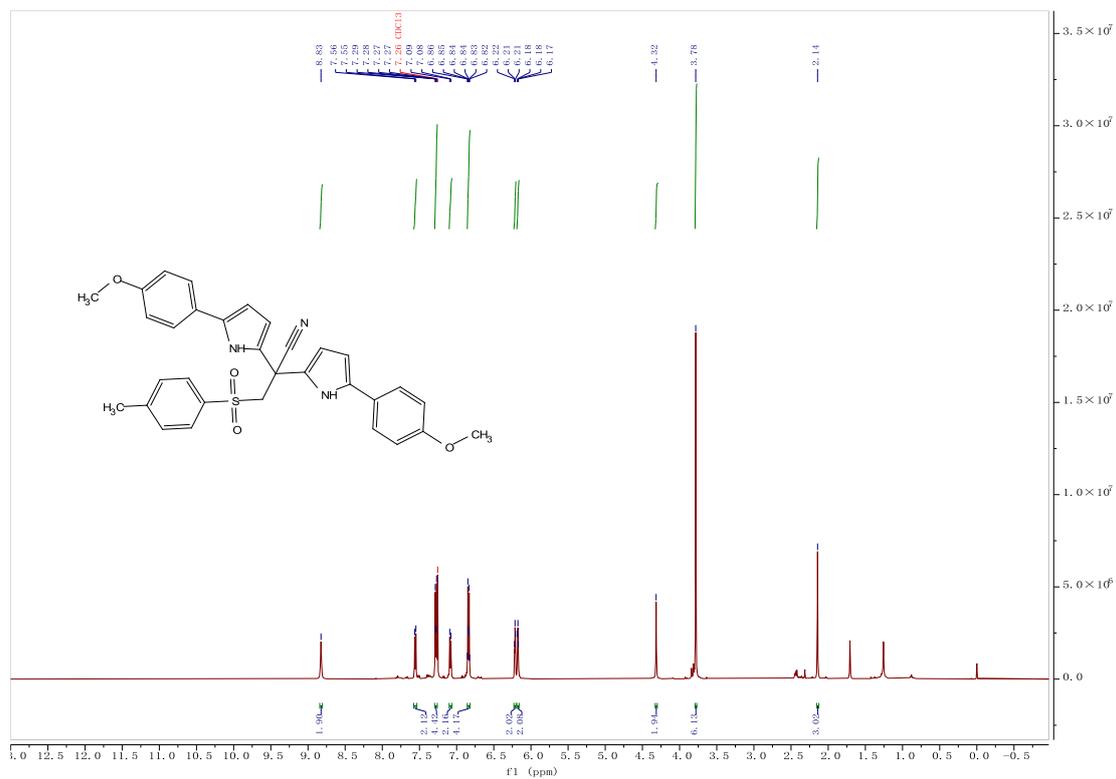
(3b)
¹H Spectra



¹³C Spectra

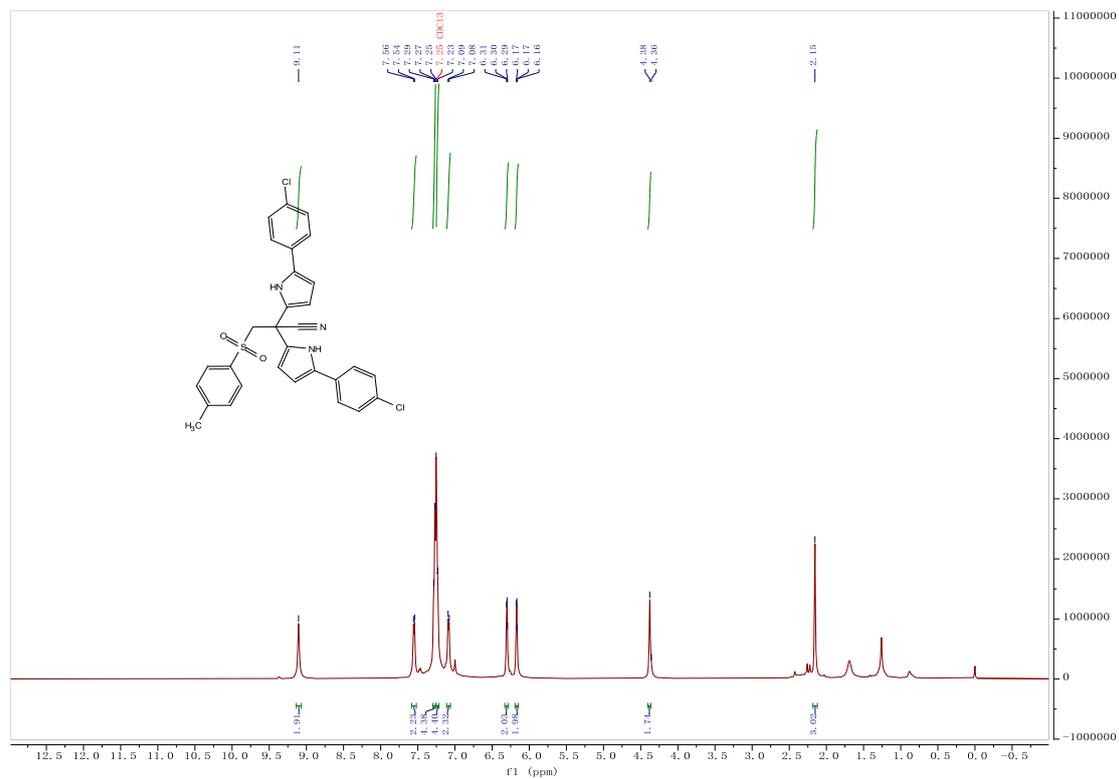


(3c)
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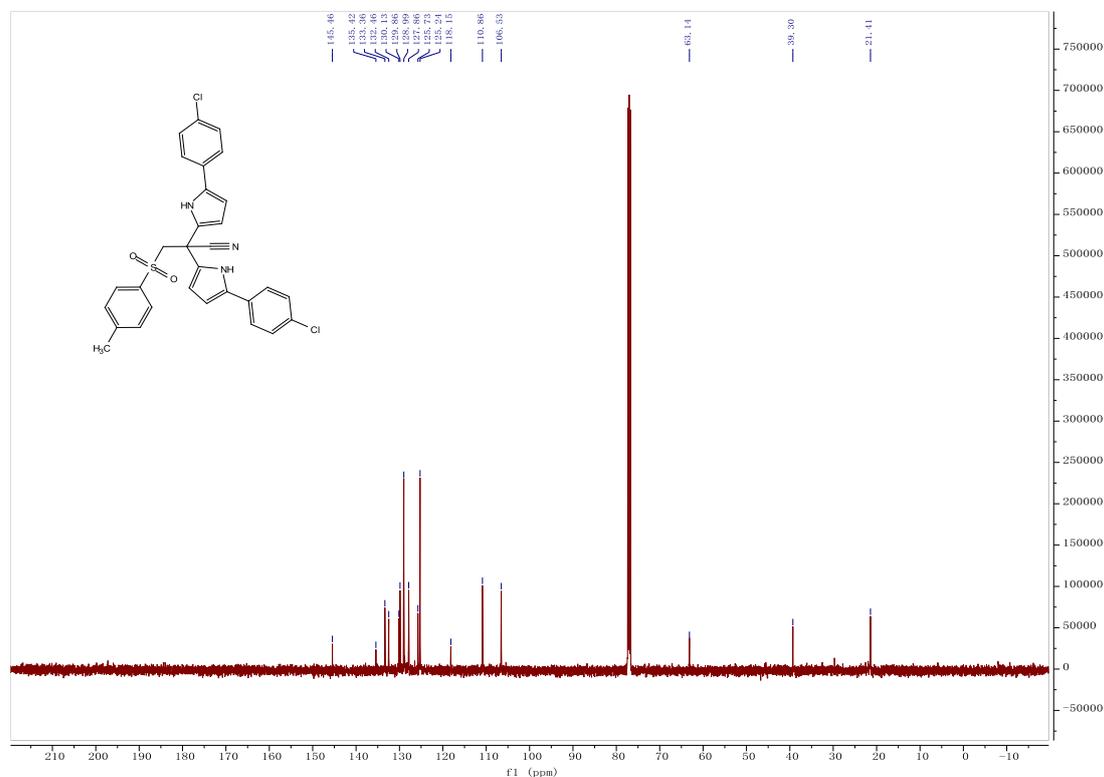


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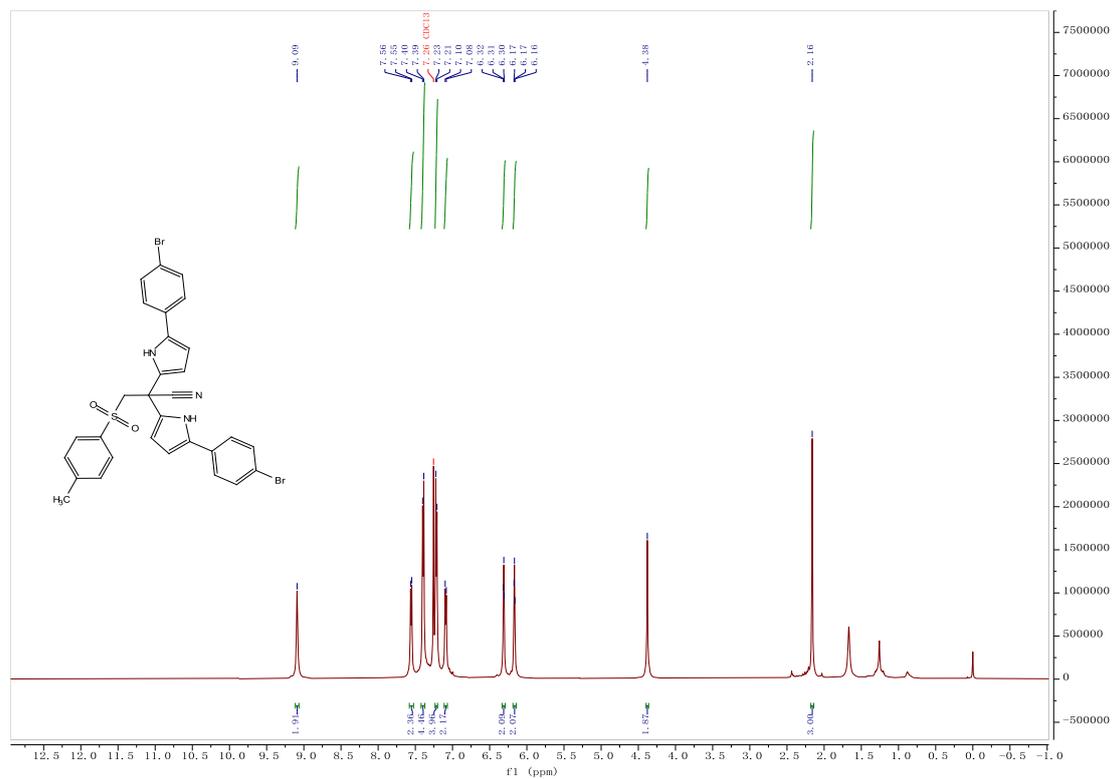
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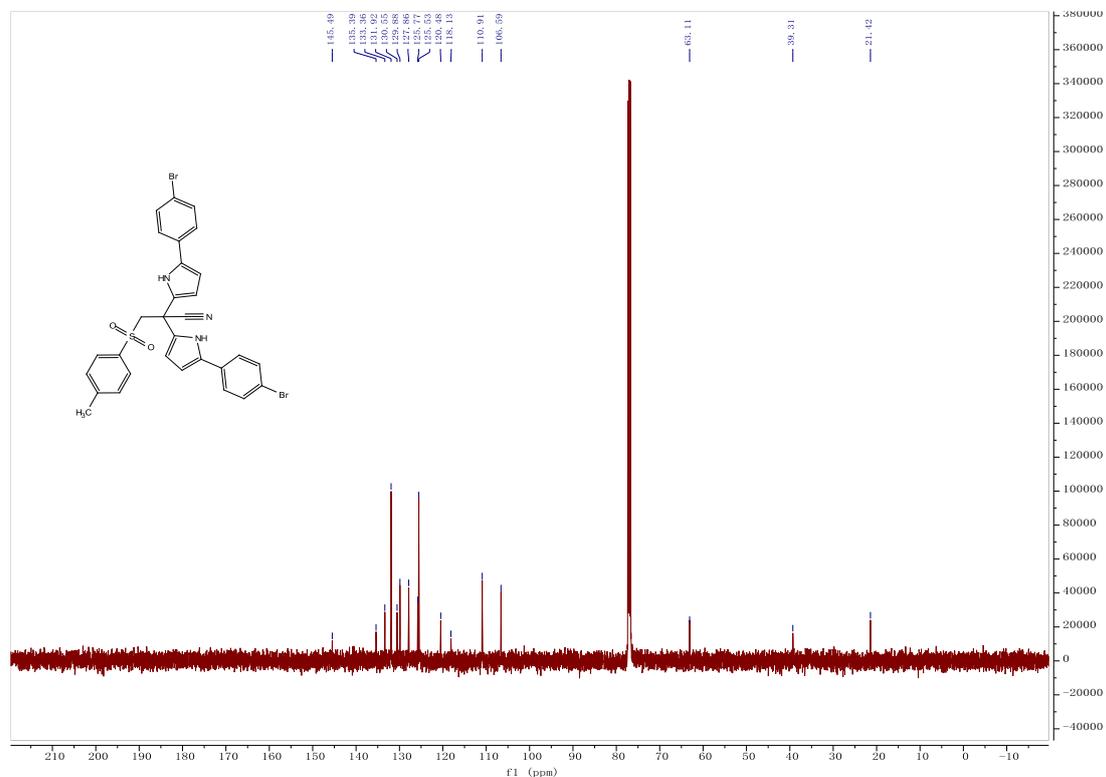
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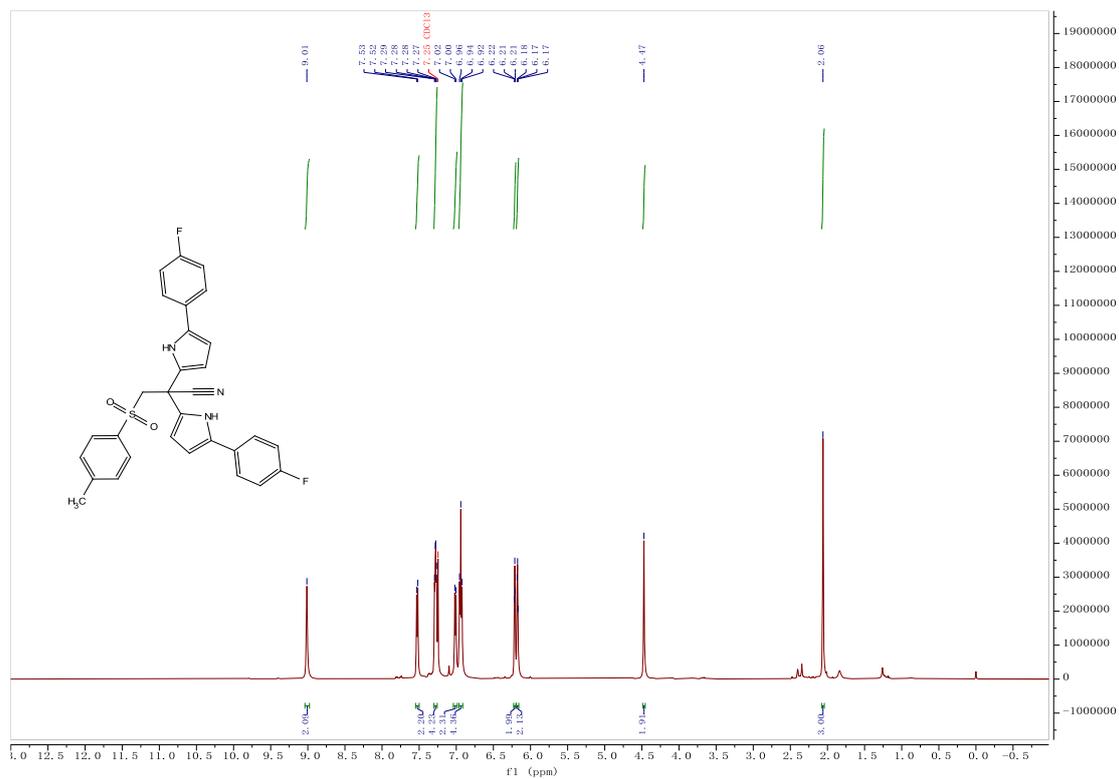
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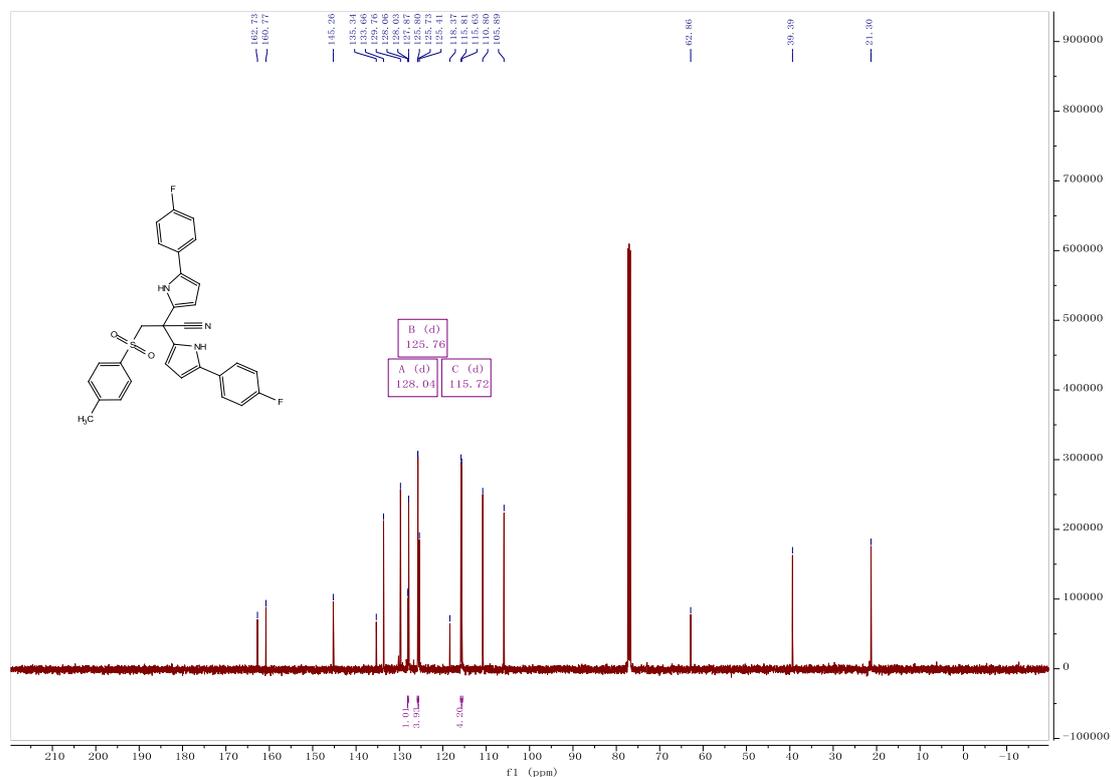
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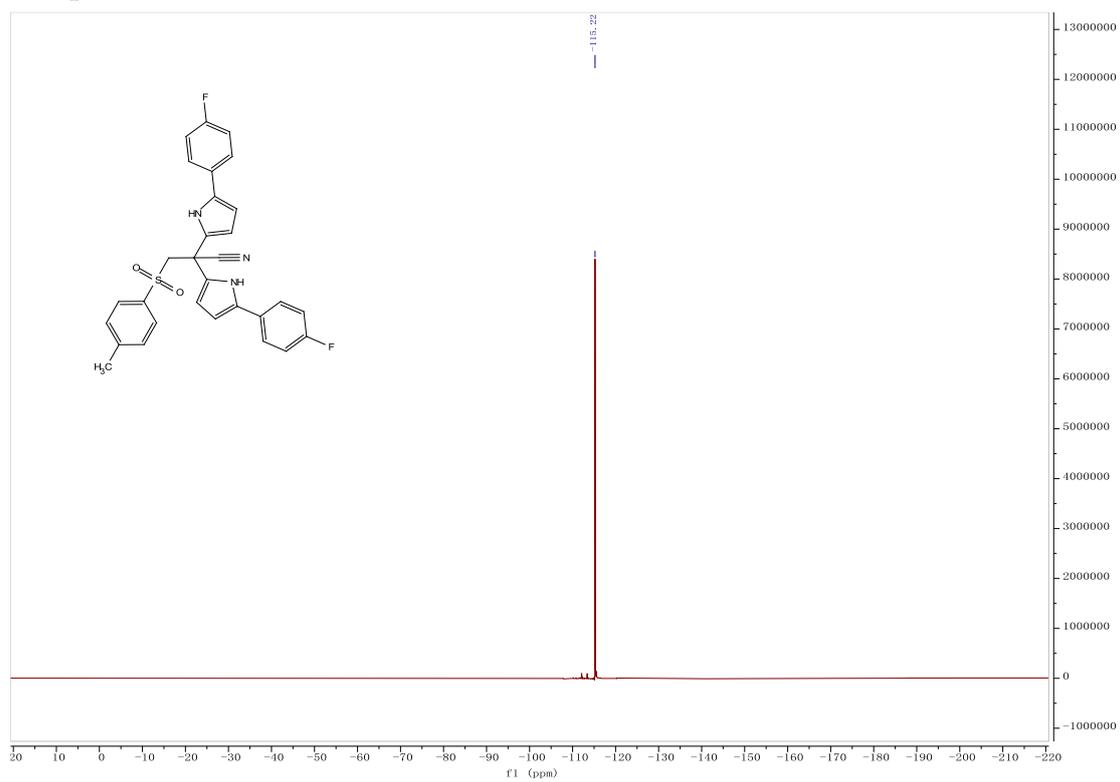
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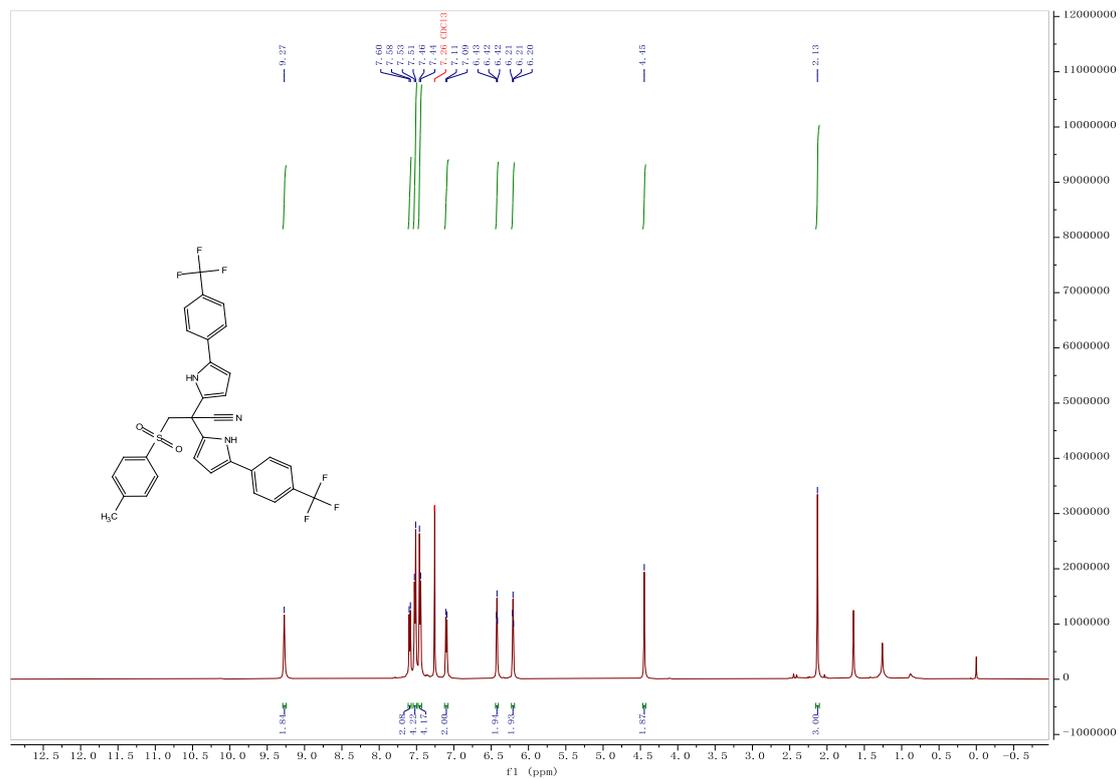
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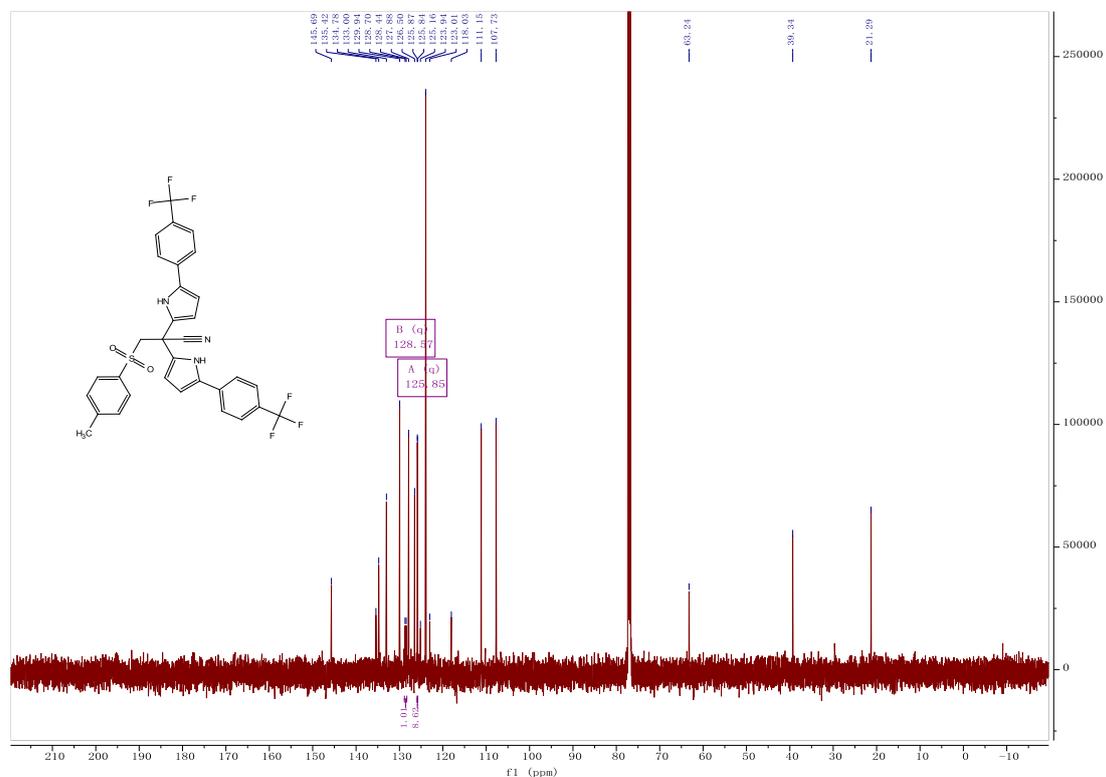
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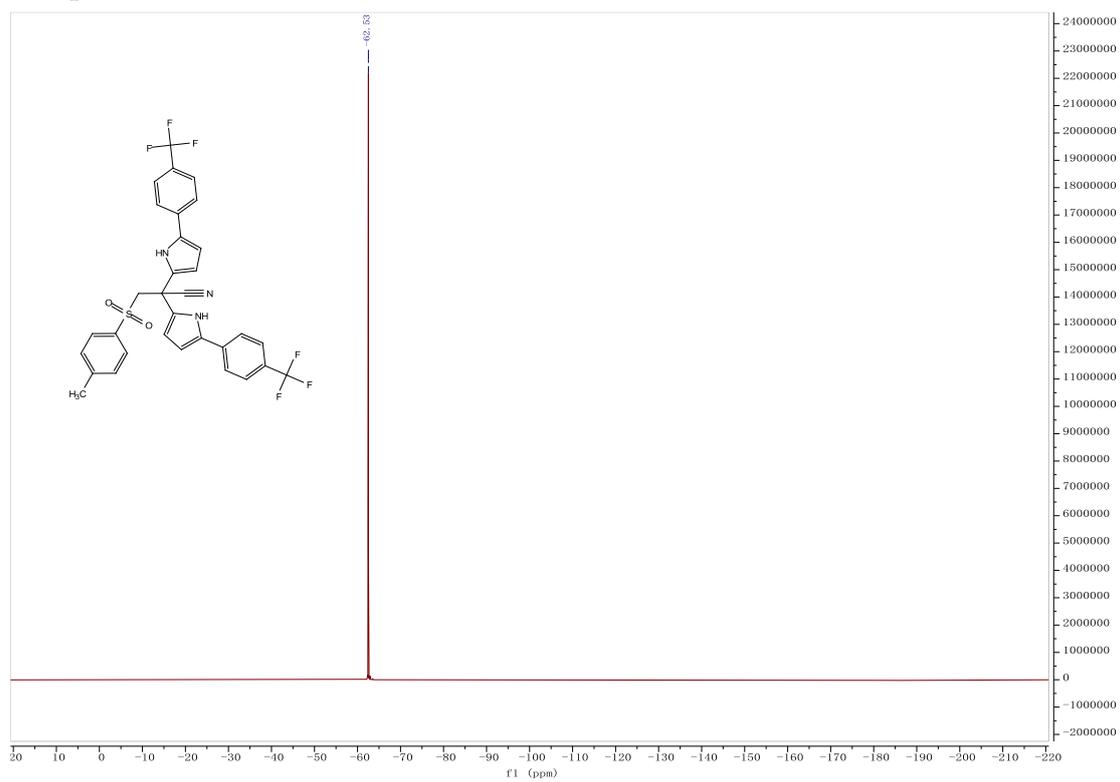
(3g)
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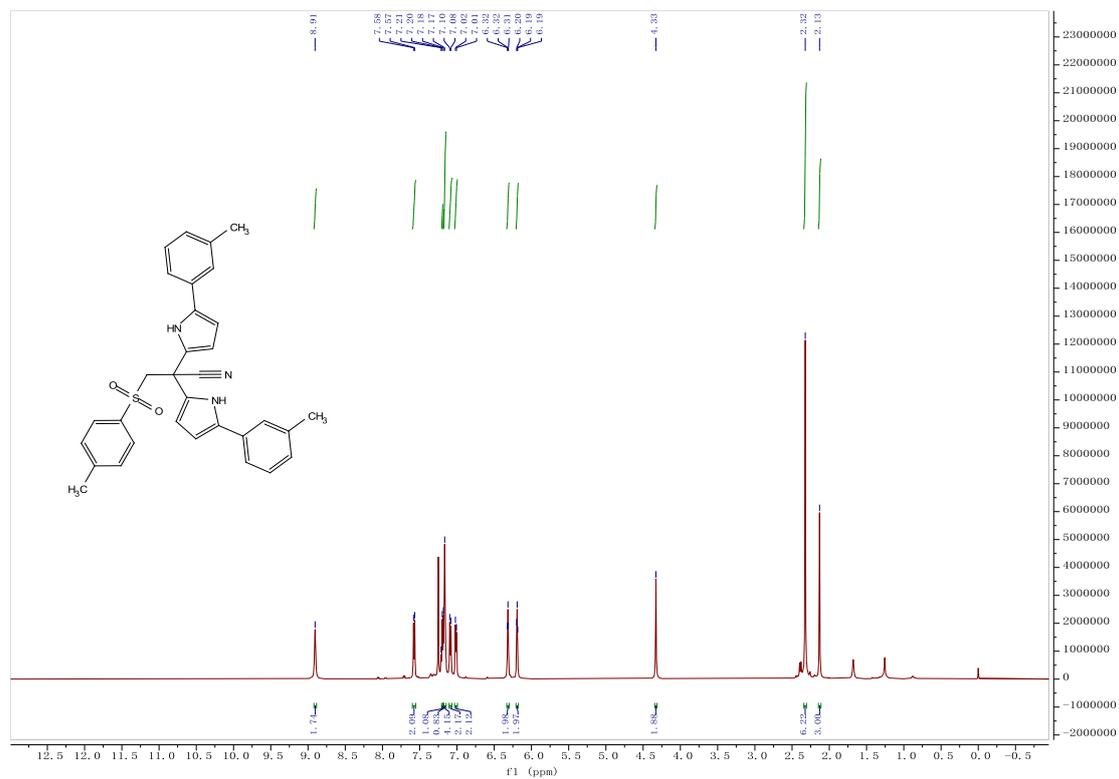
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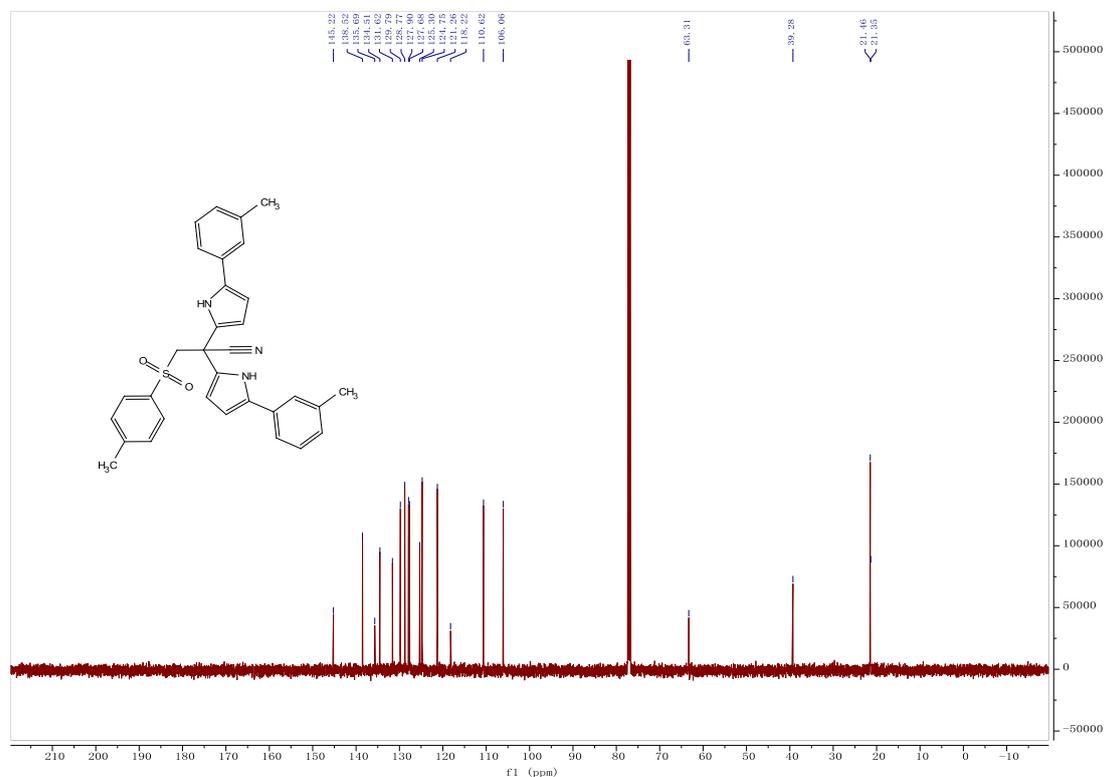
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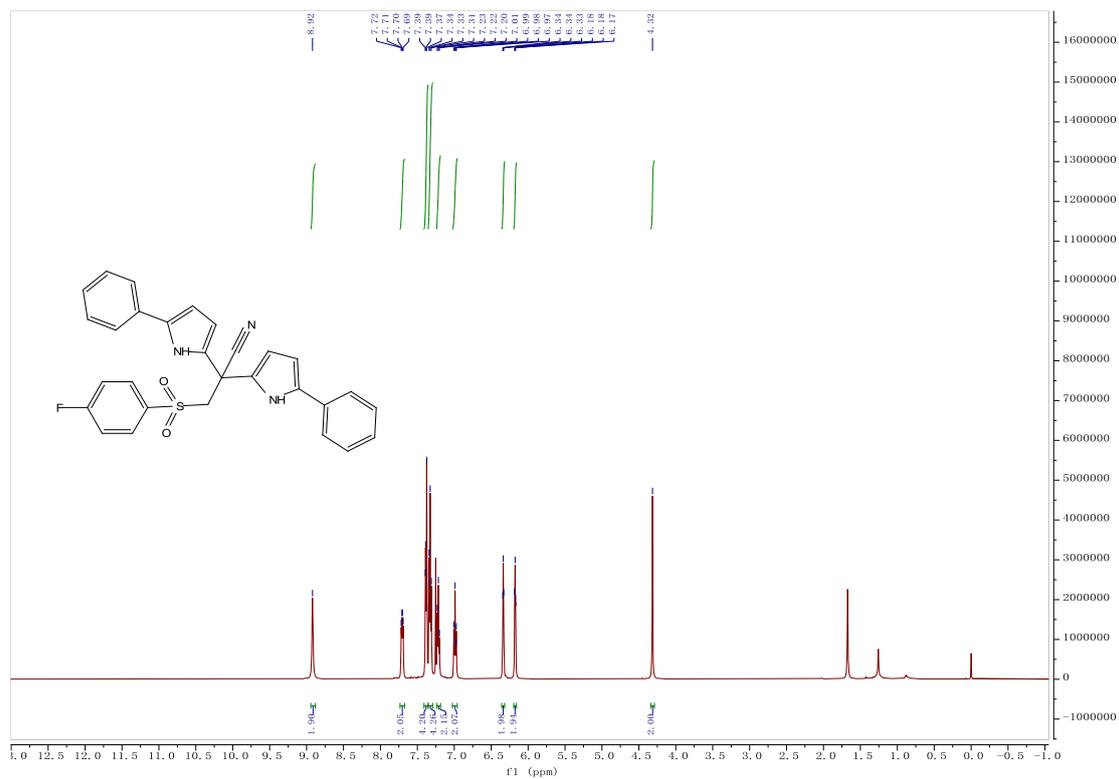
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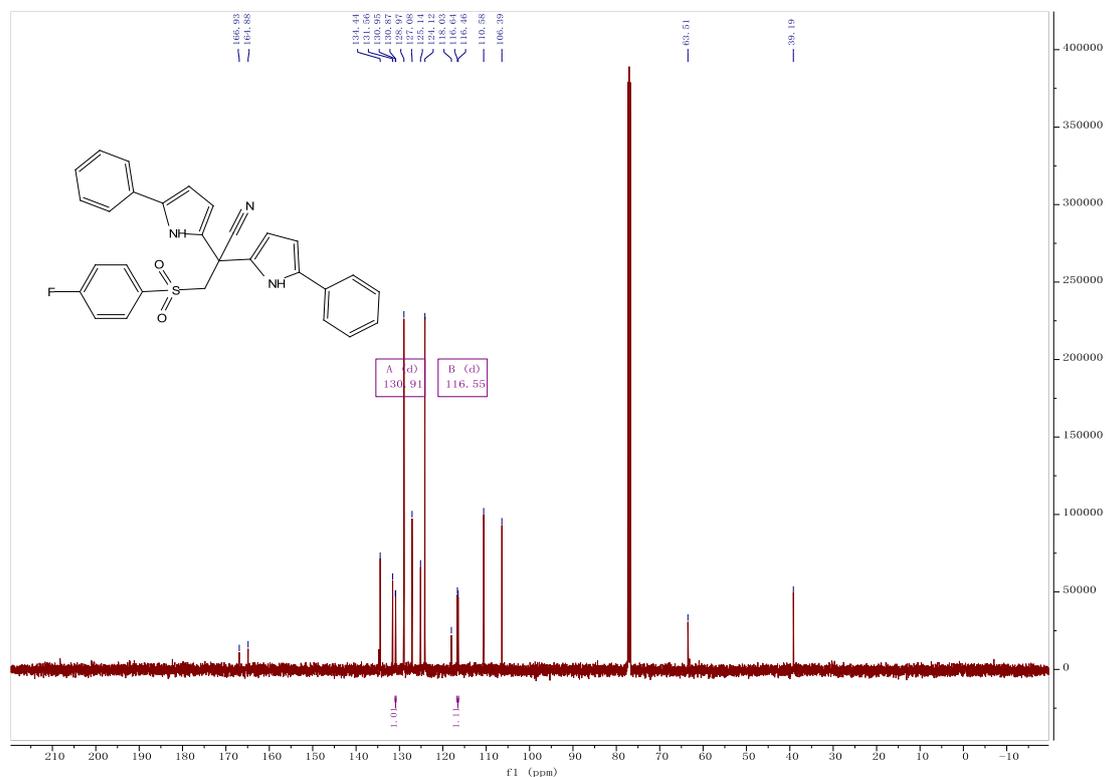
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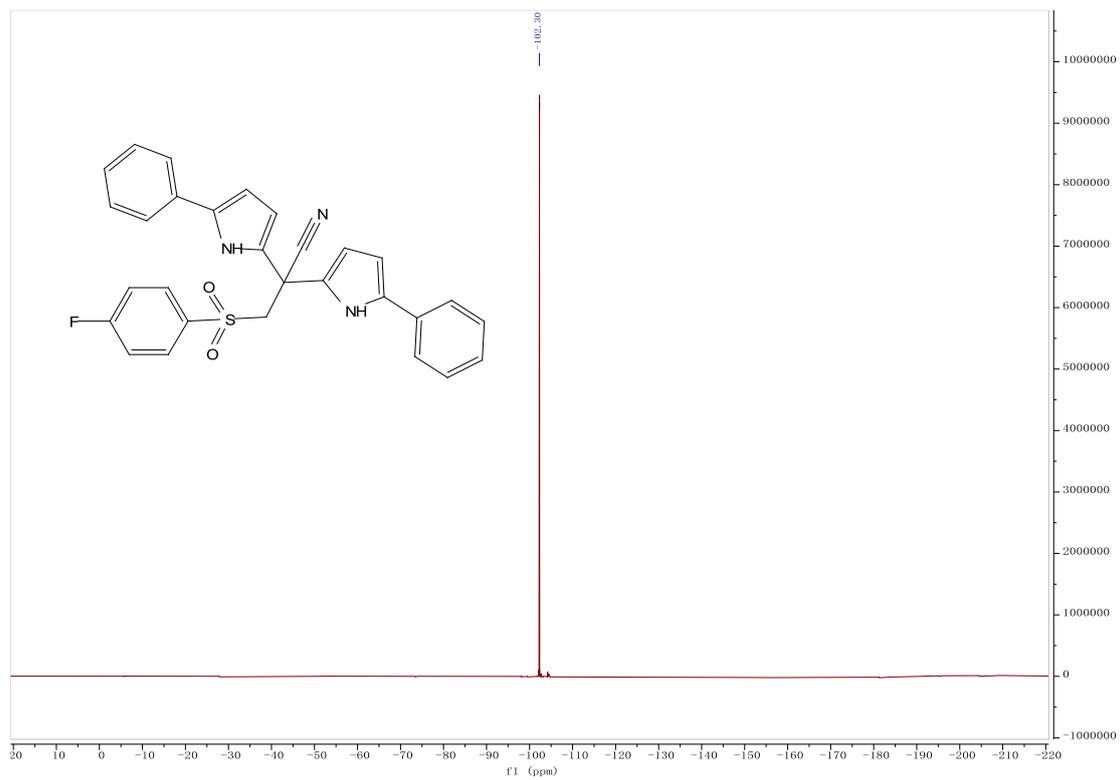
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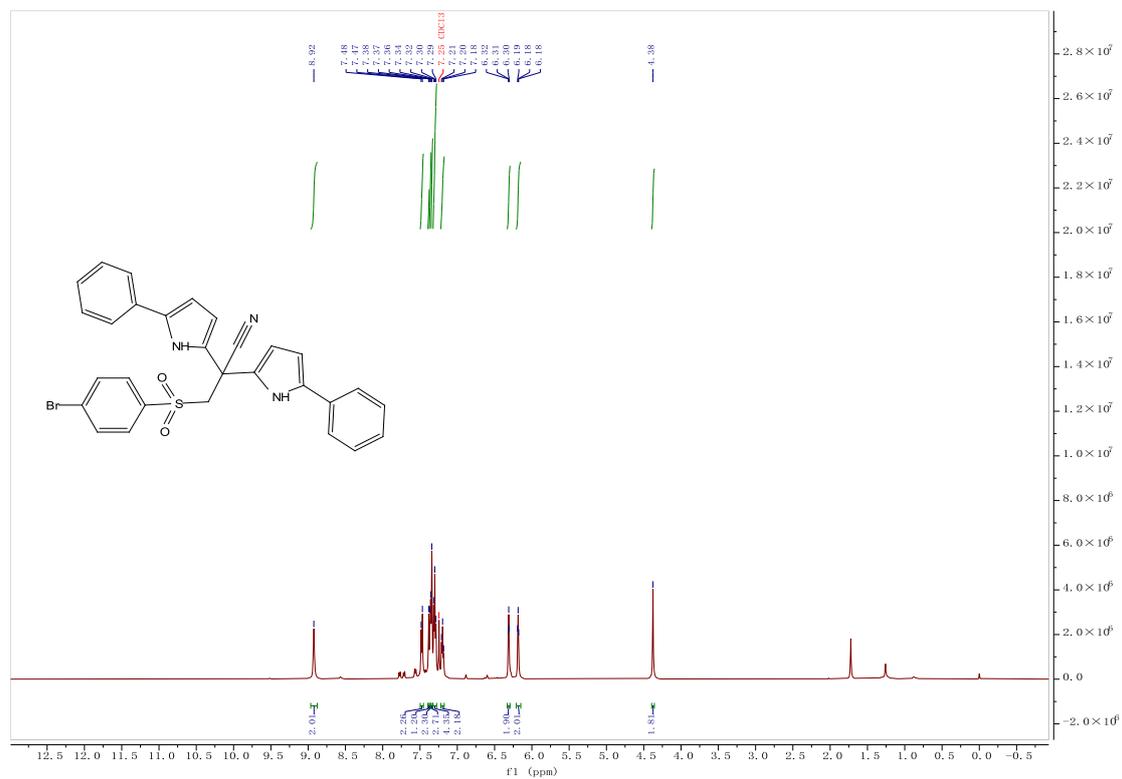
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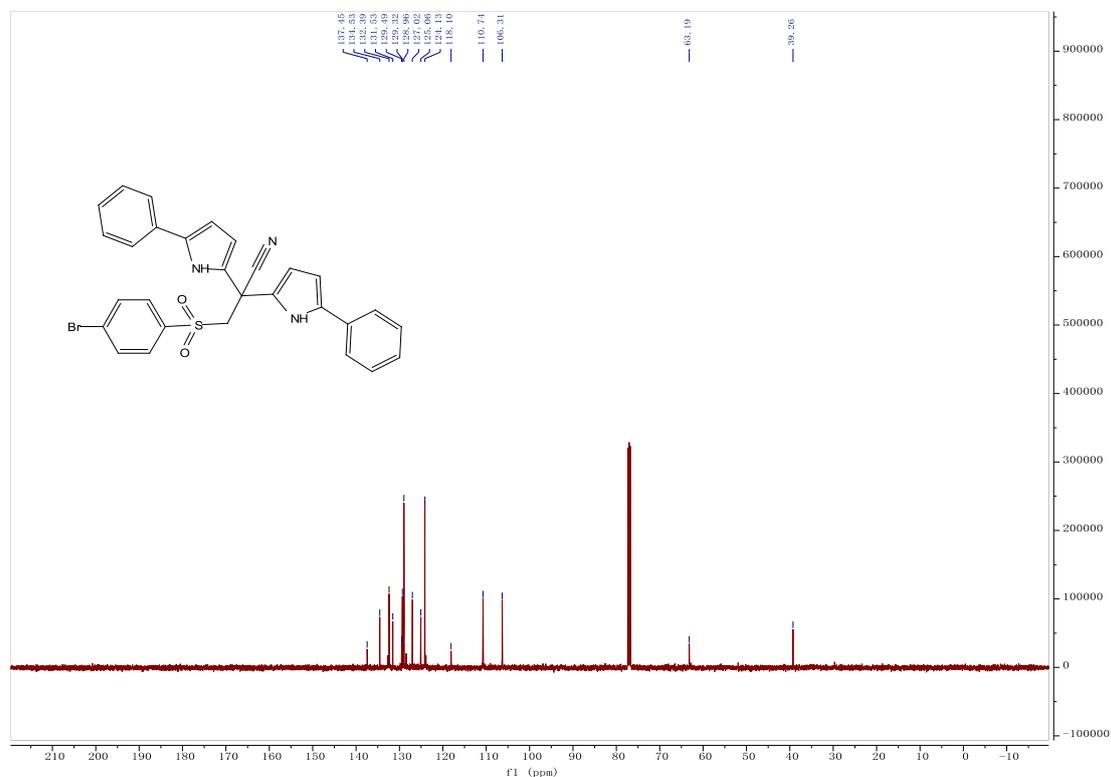
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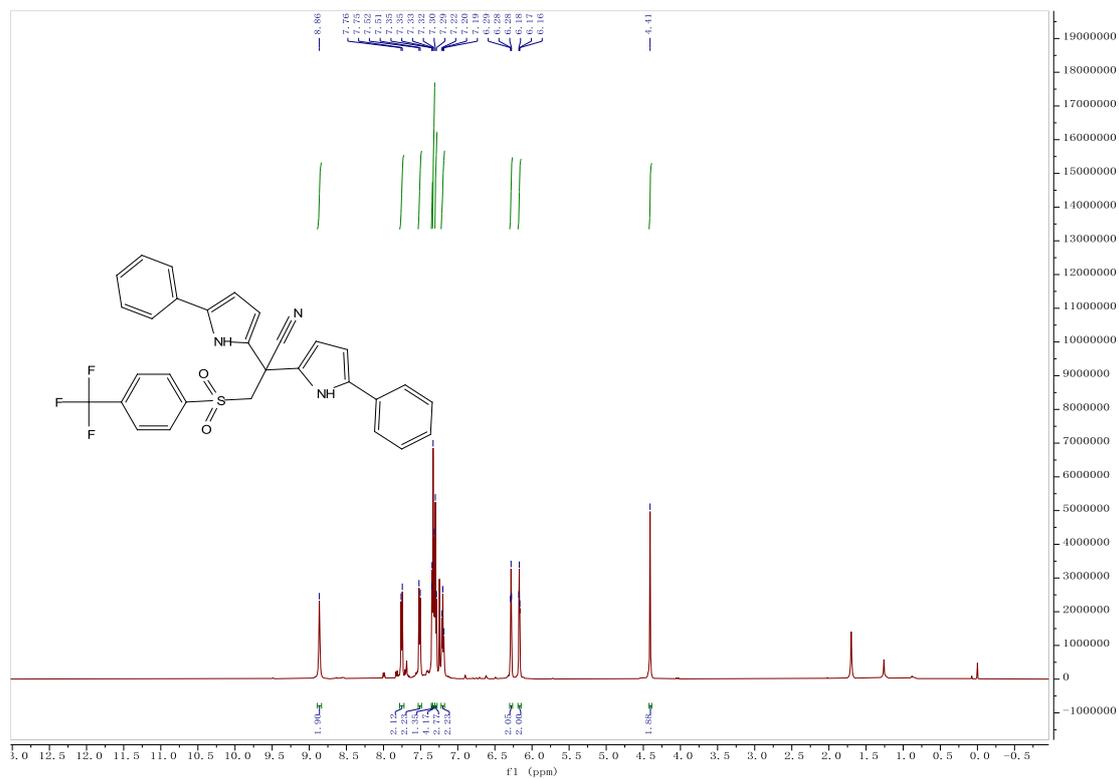
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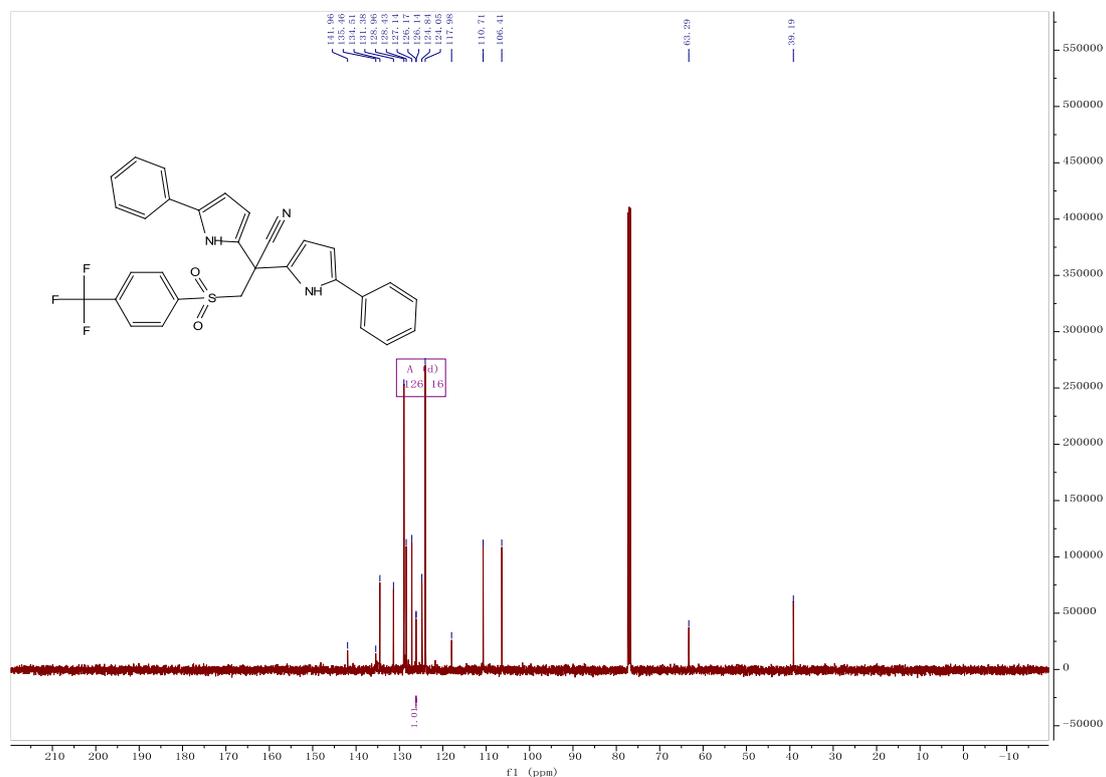
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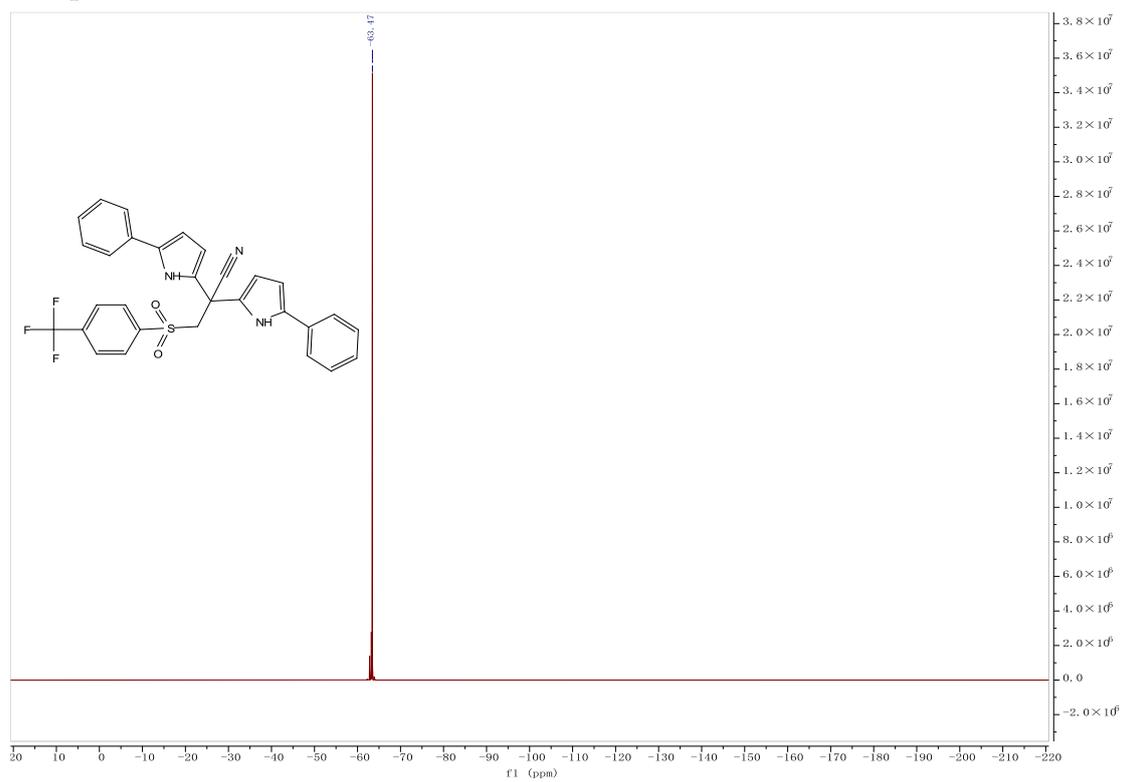
(3q)
¹H Spectra



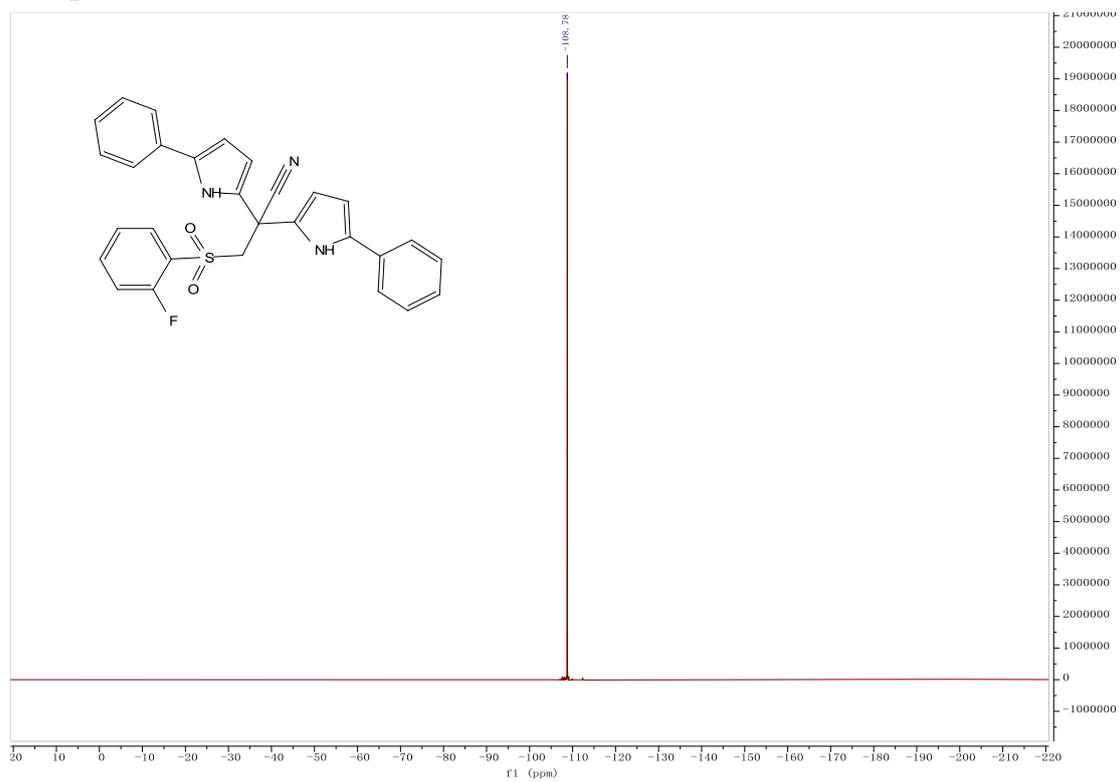
¹³C Spectra



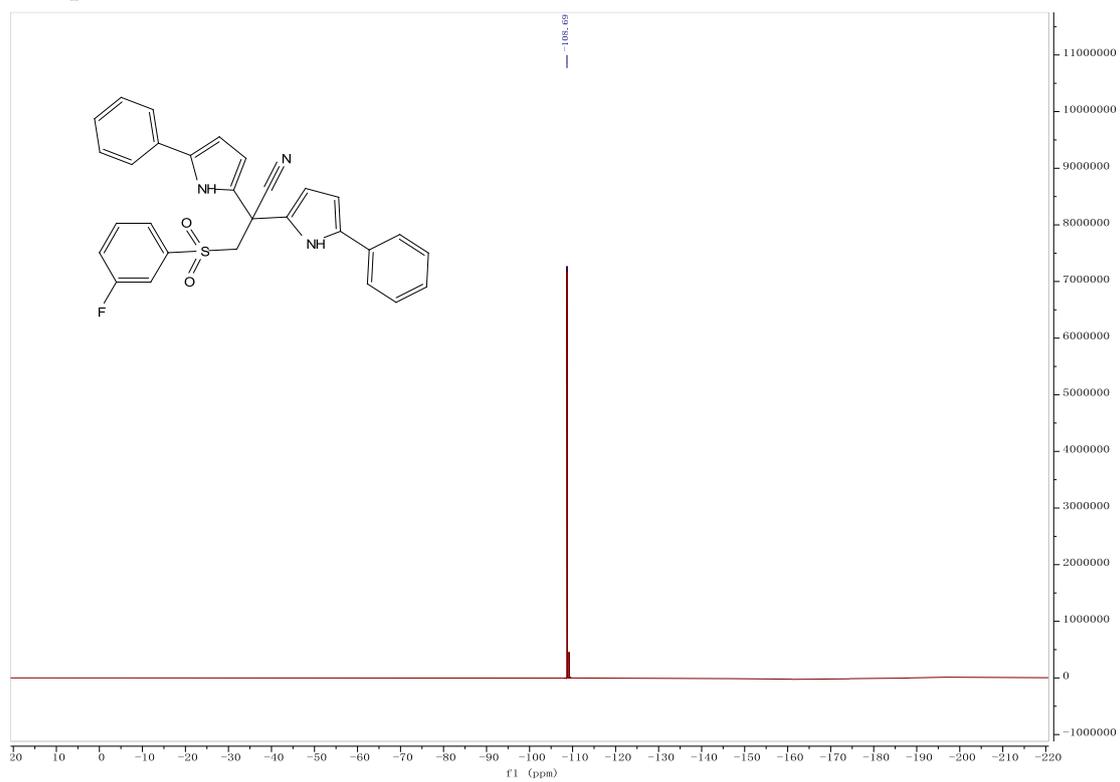
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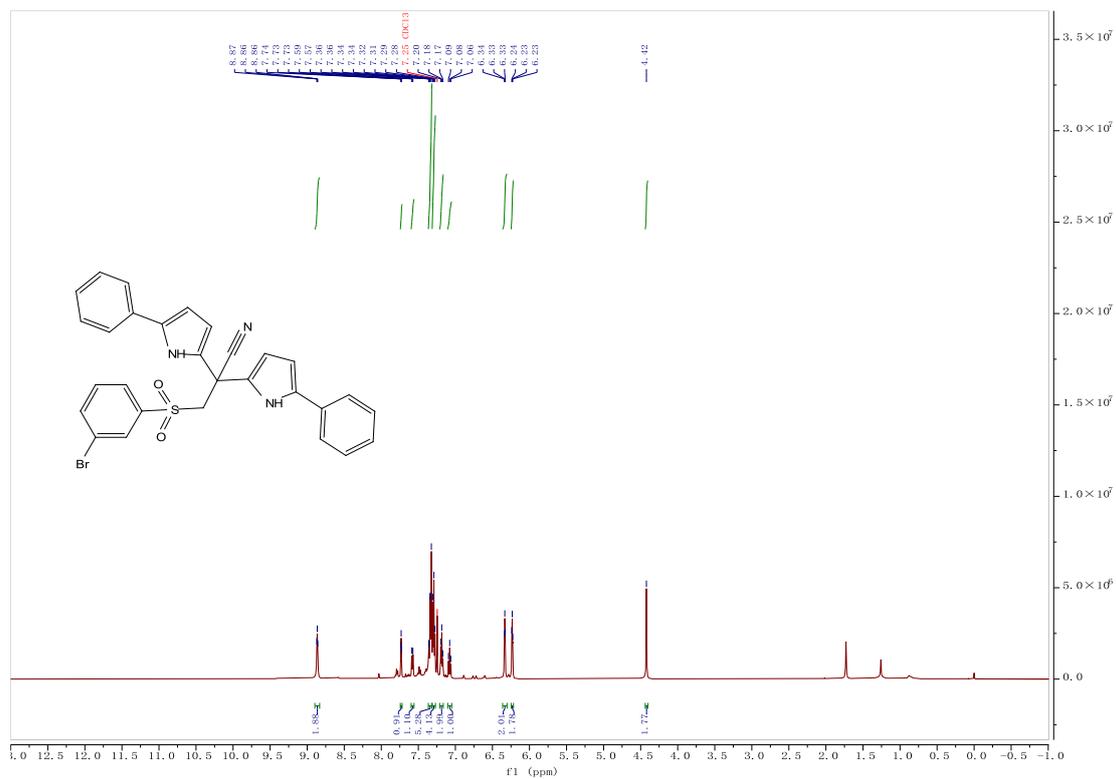
¹⁹F Spectra



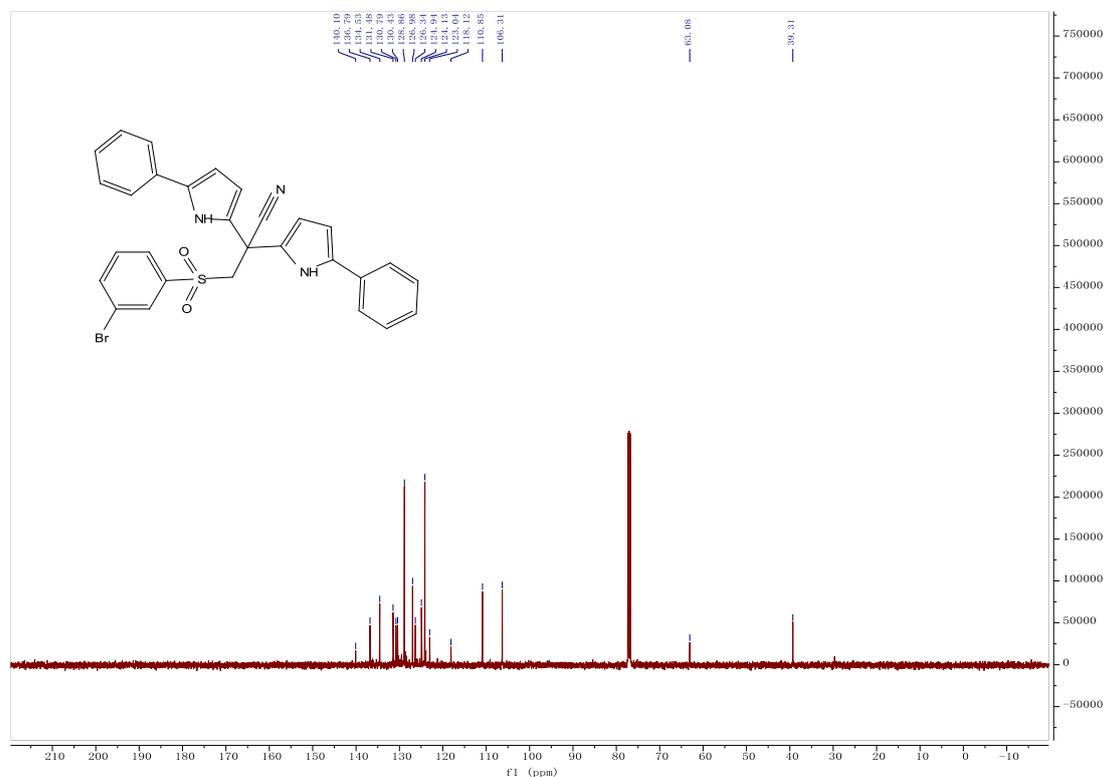
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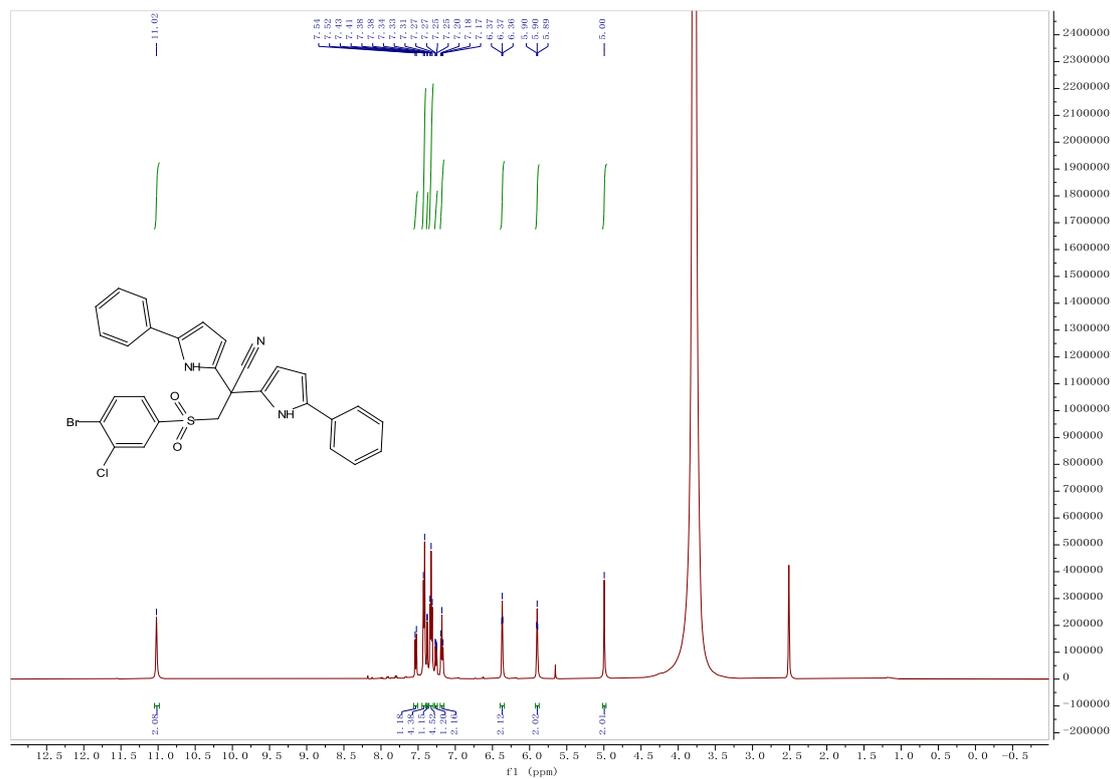
(3w)
¹H Spectra



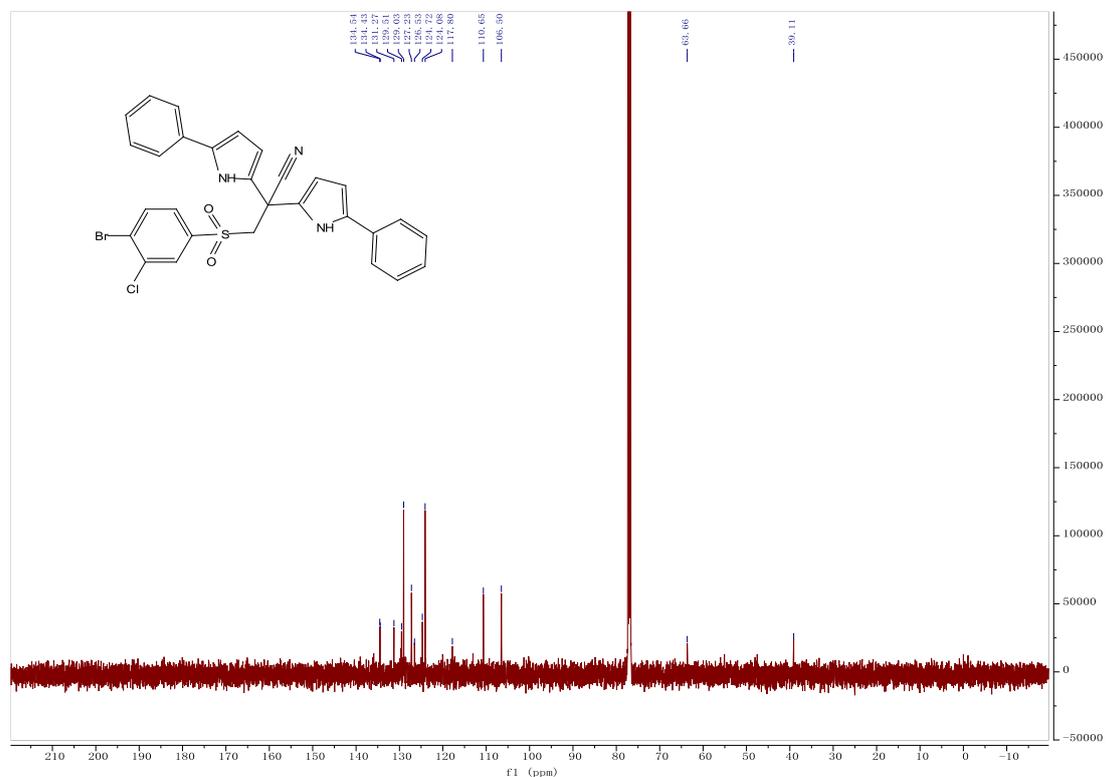
¹³C Spectra



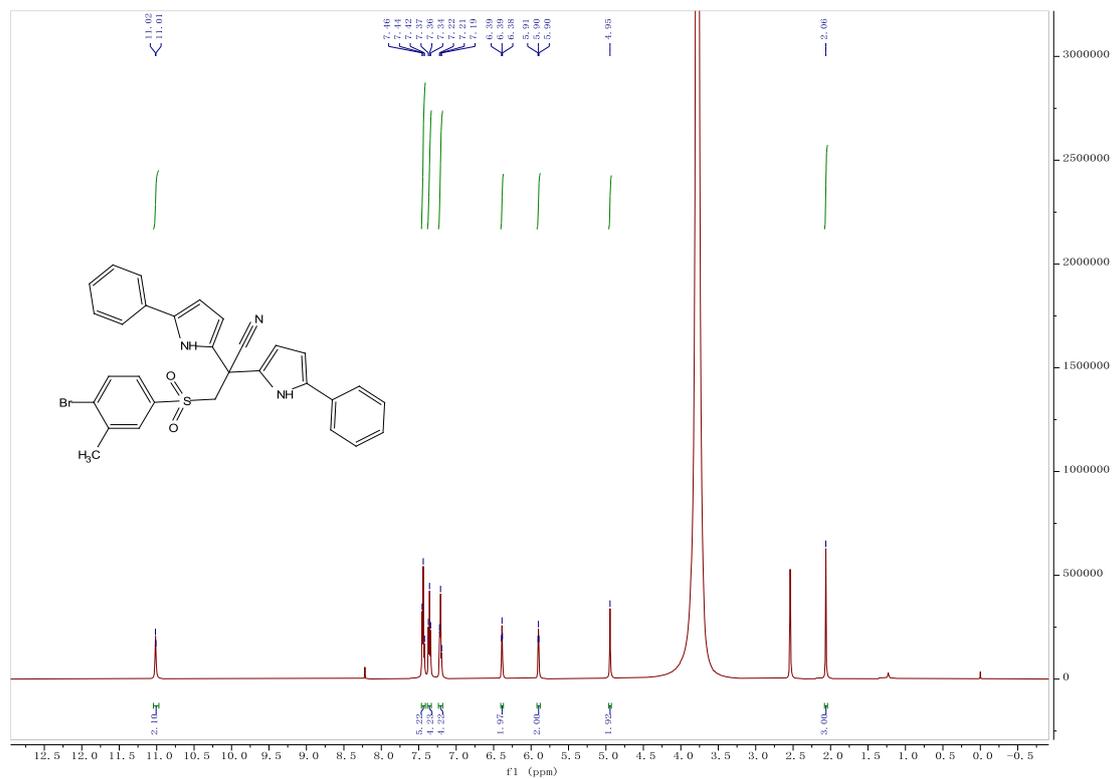
(3x)
¹H Spectra



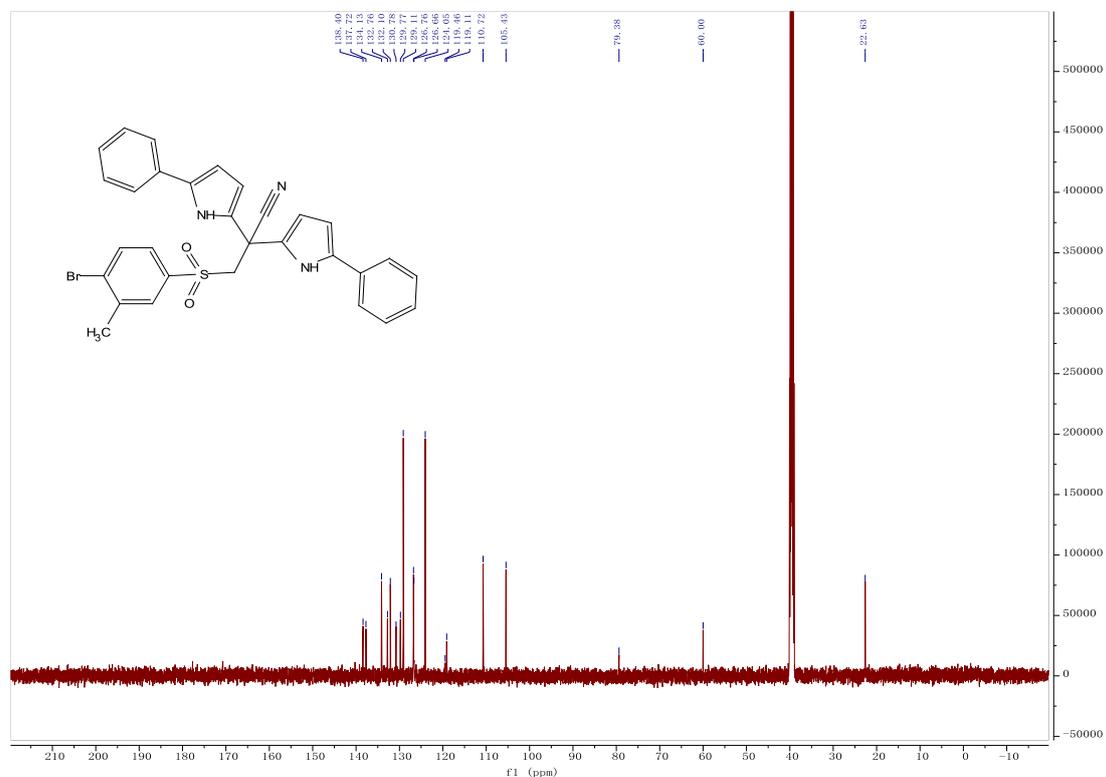
¹³C Spectra



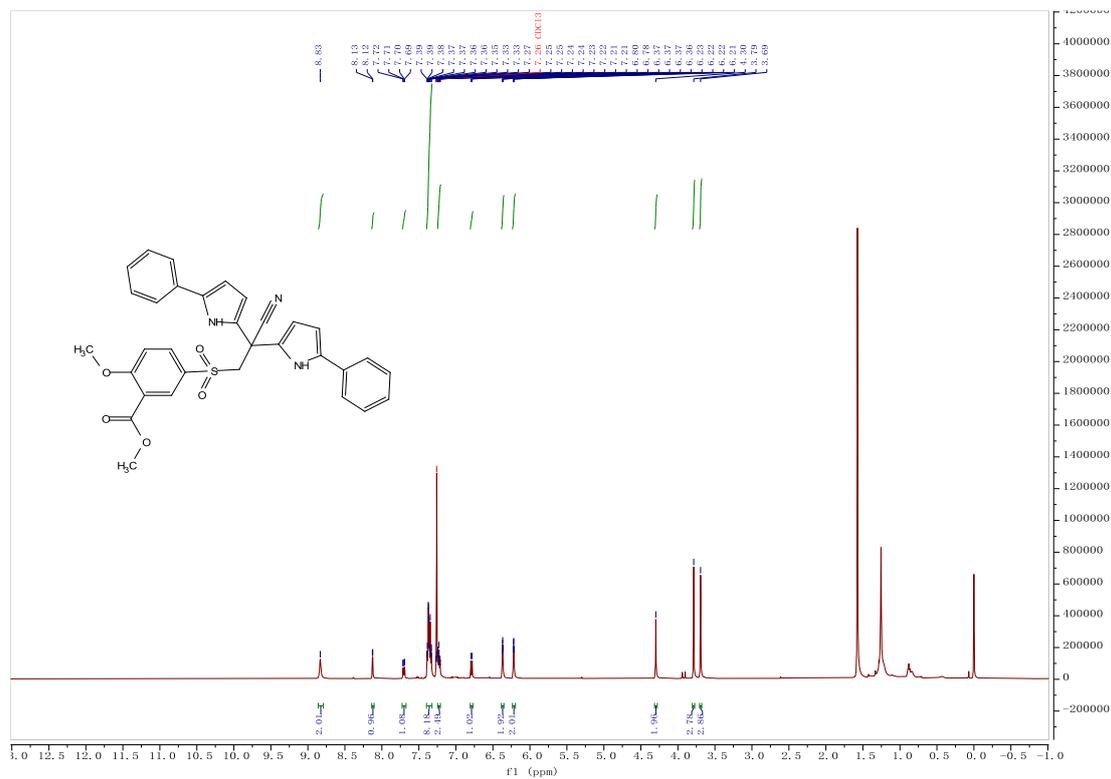
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¹H Spectra



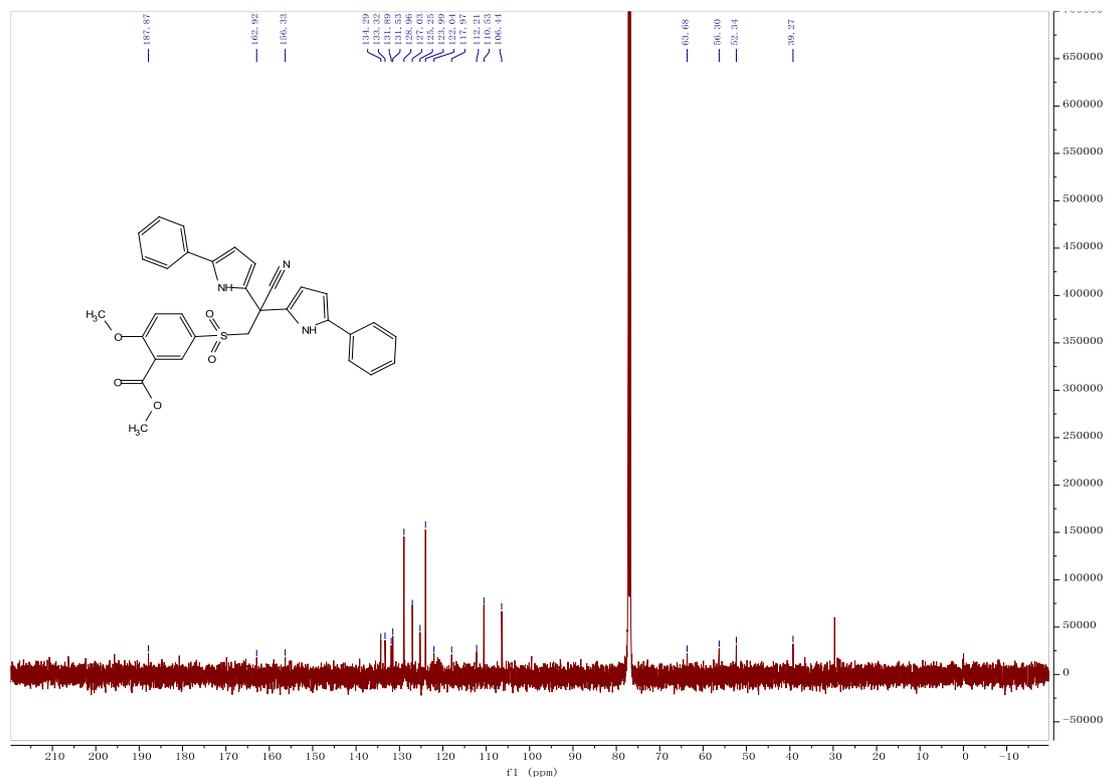
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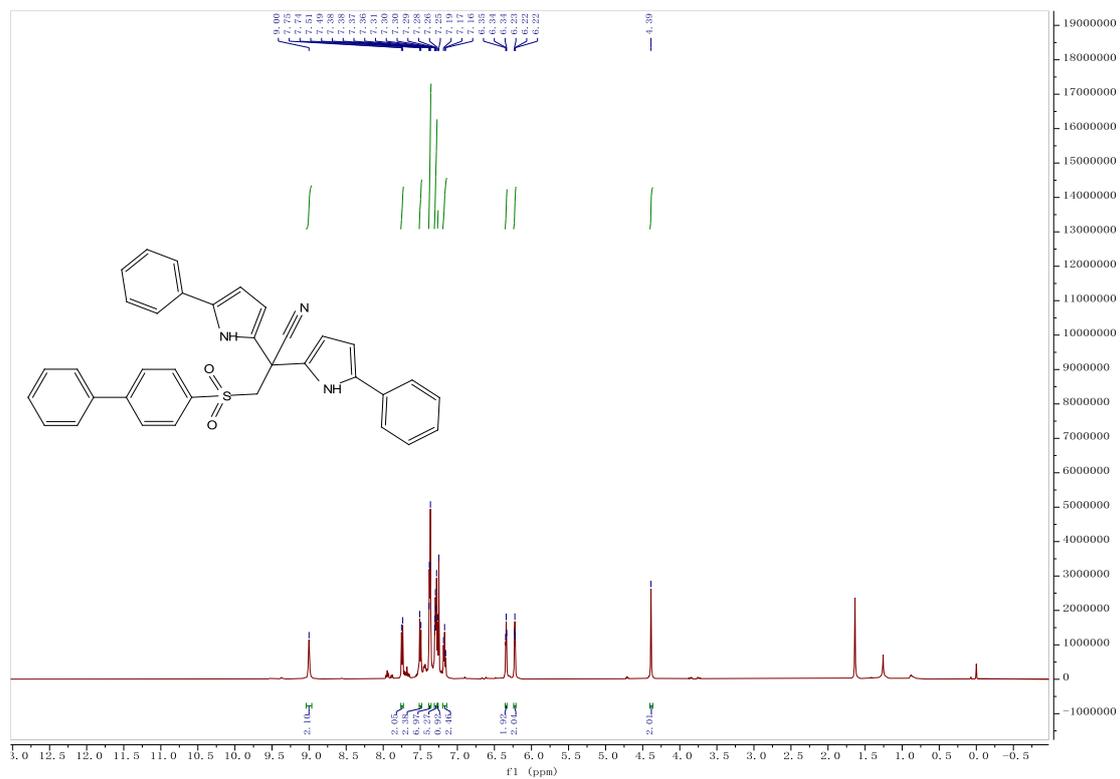
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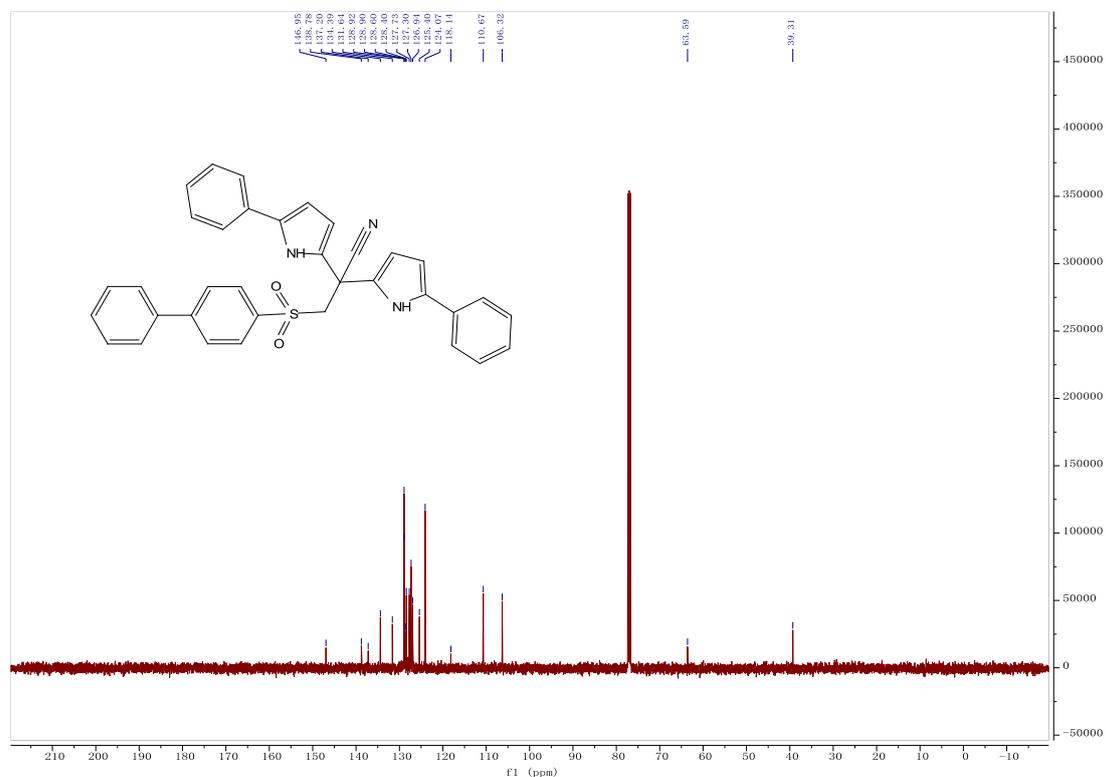
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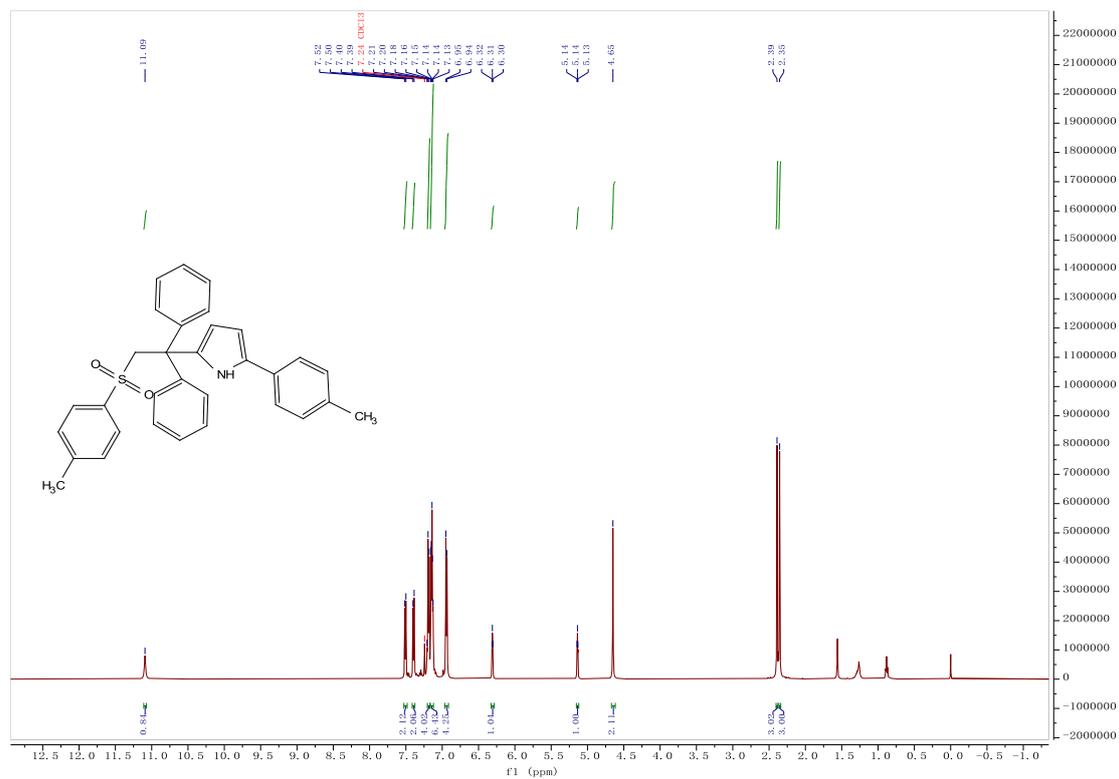
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¹H Spectra



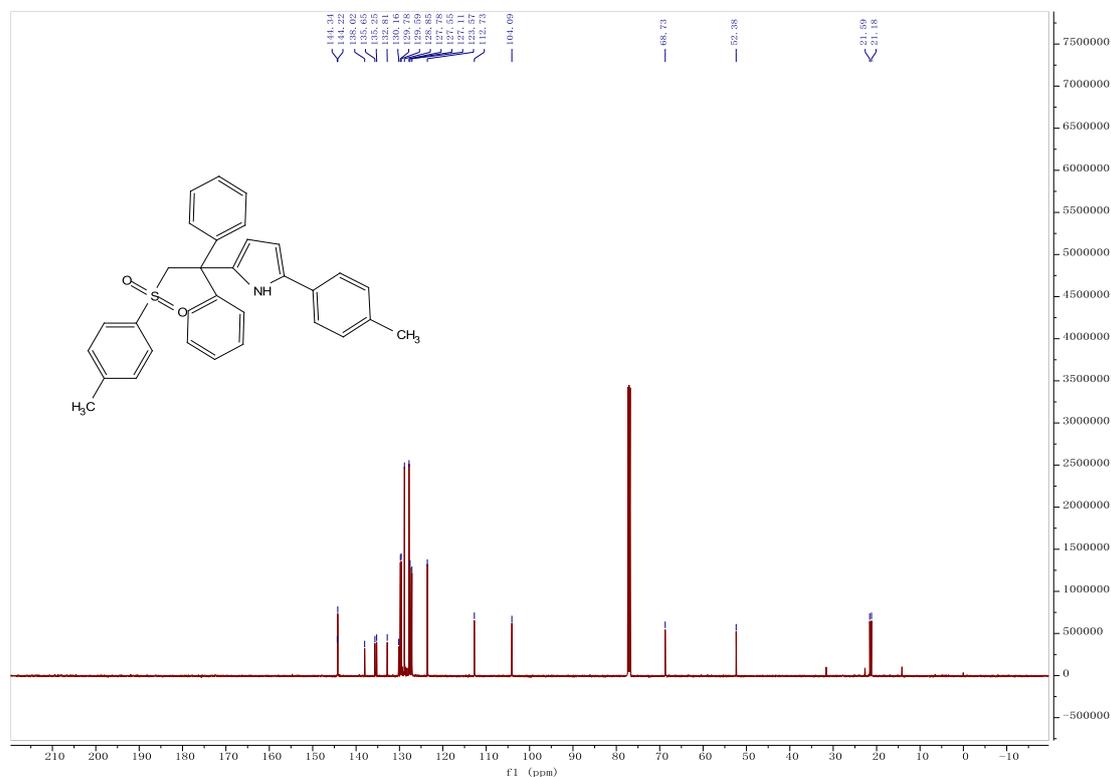
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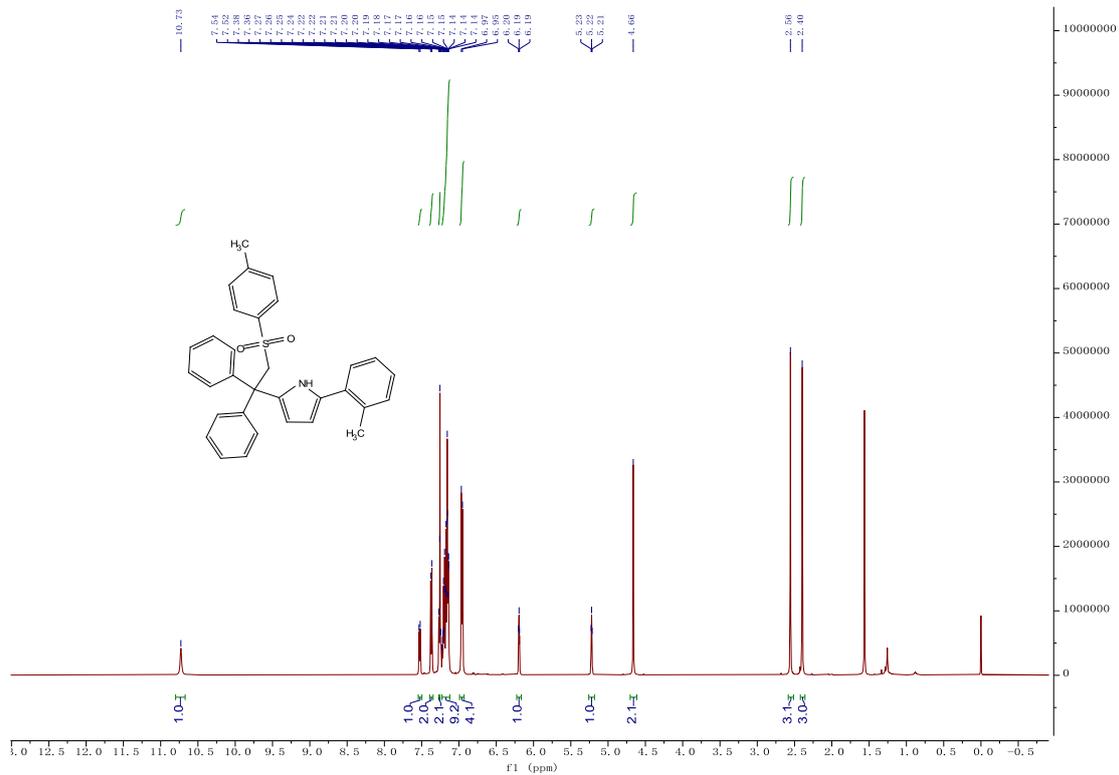
(5b)
¹H Spectra



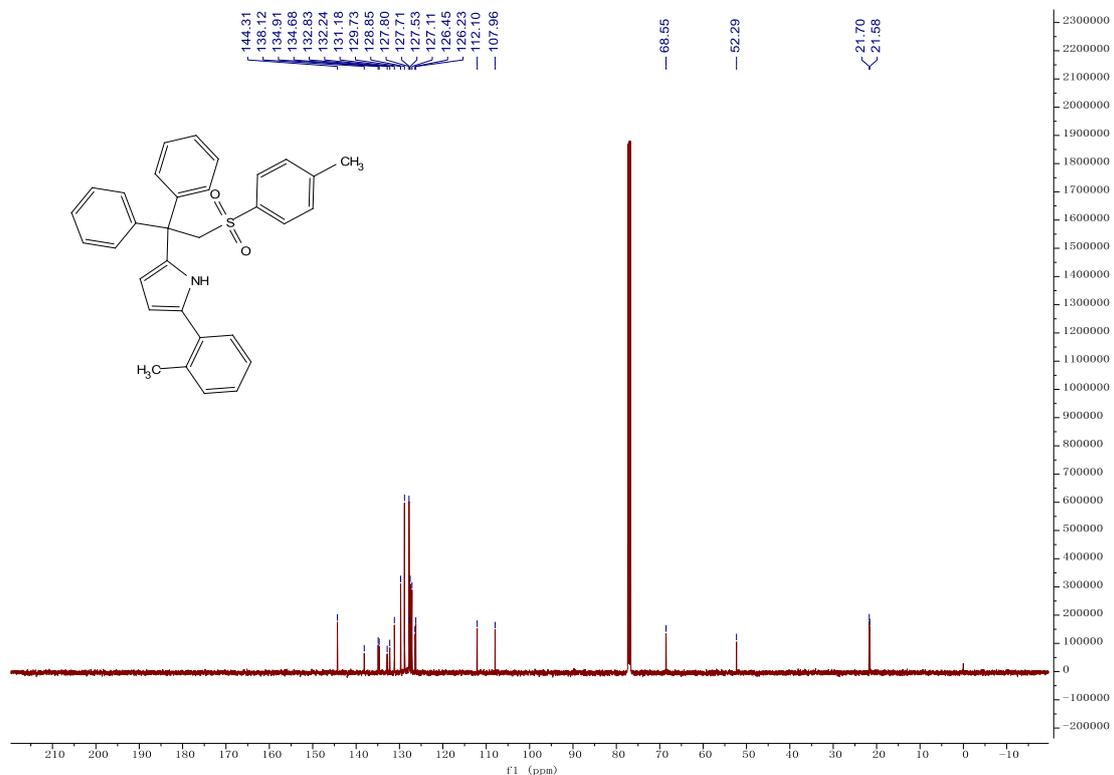
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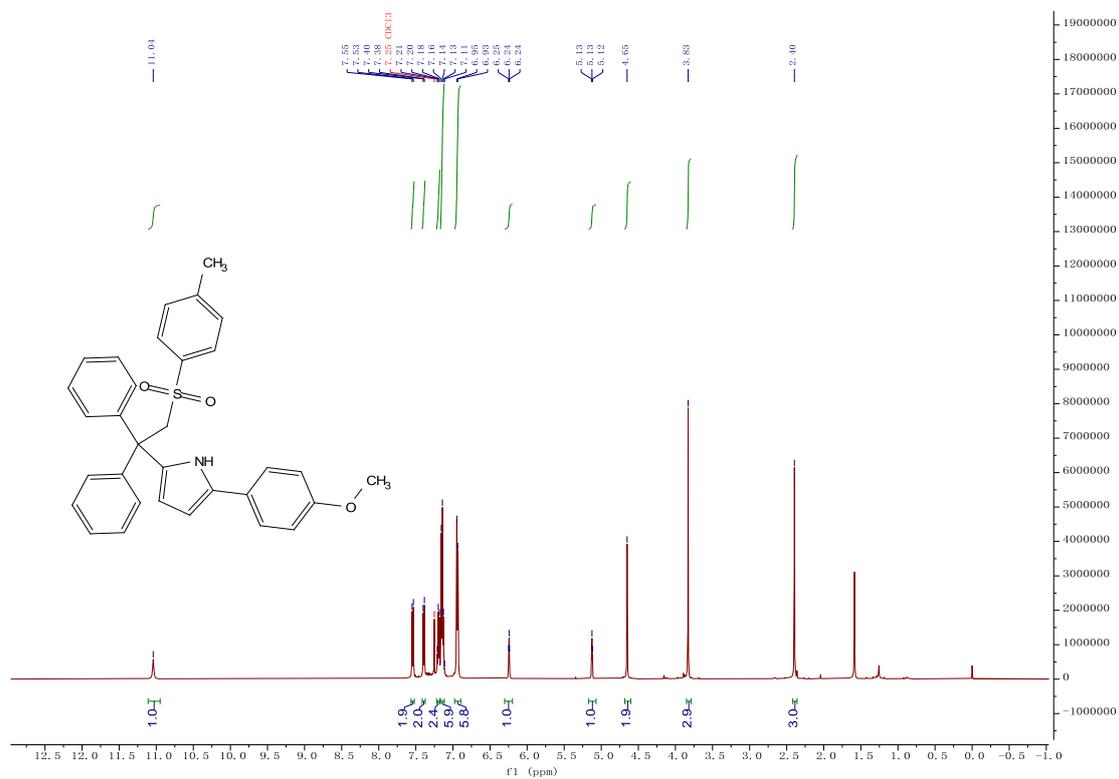
(5c)
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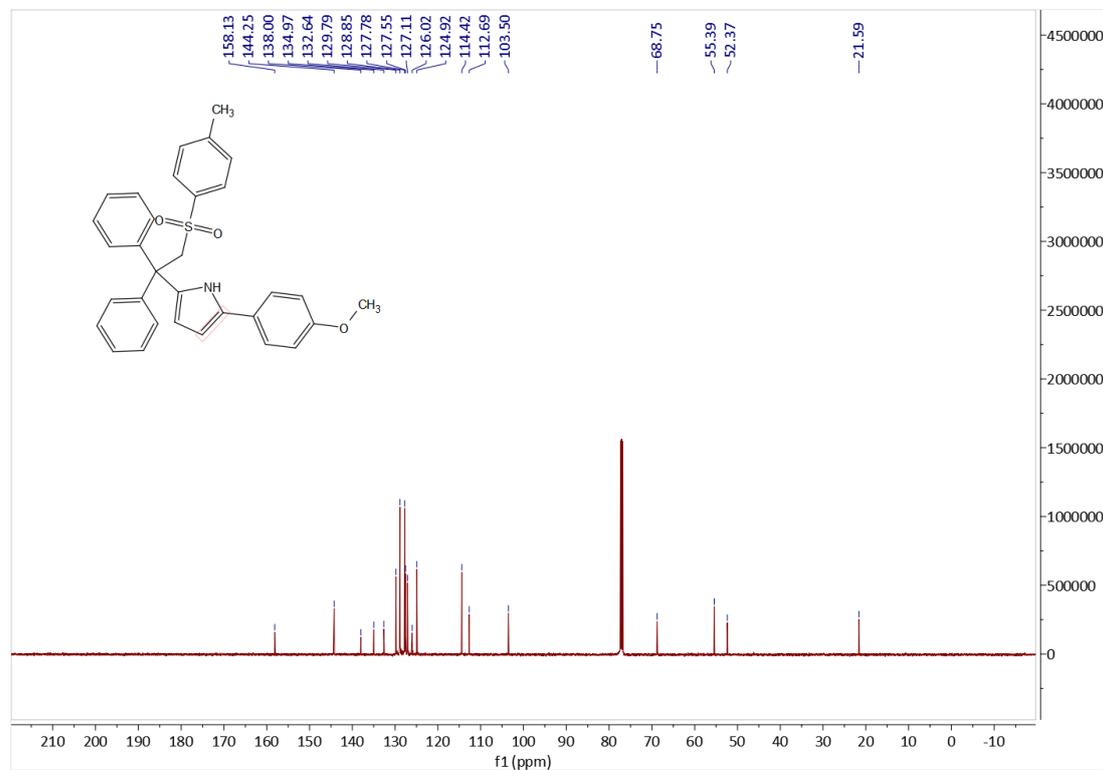
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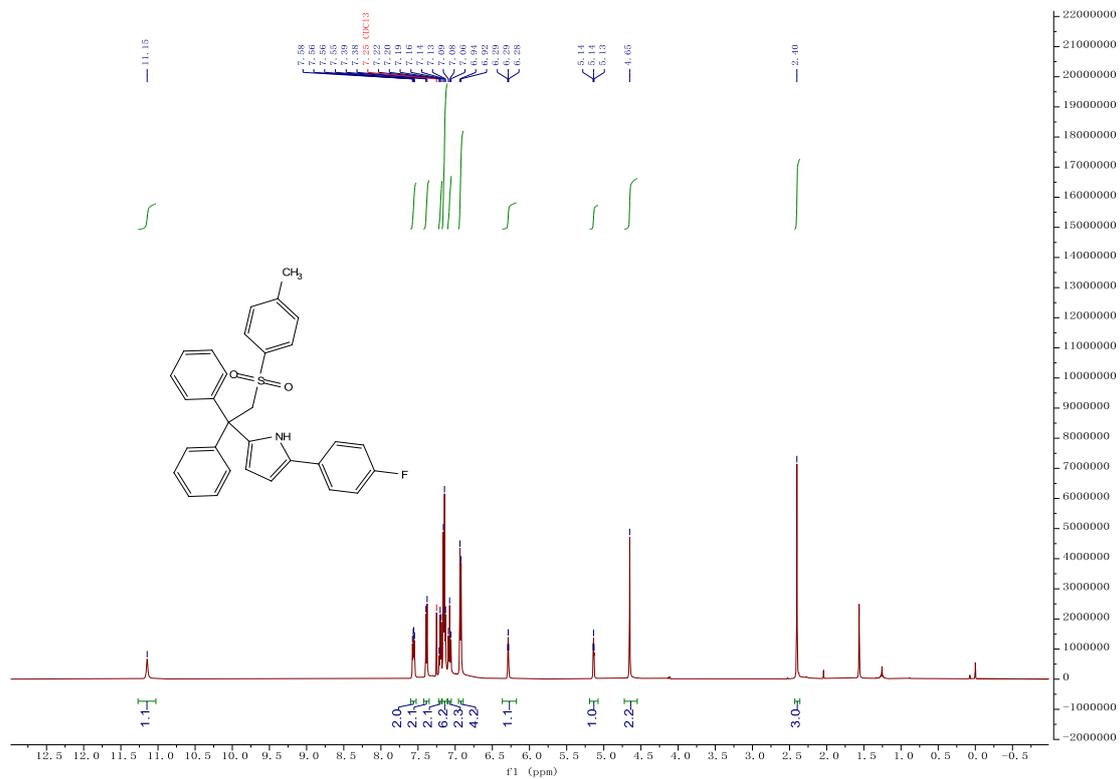
(5d)
¹H Spectra



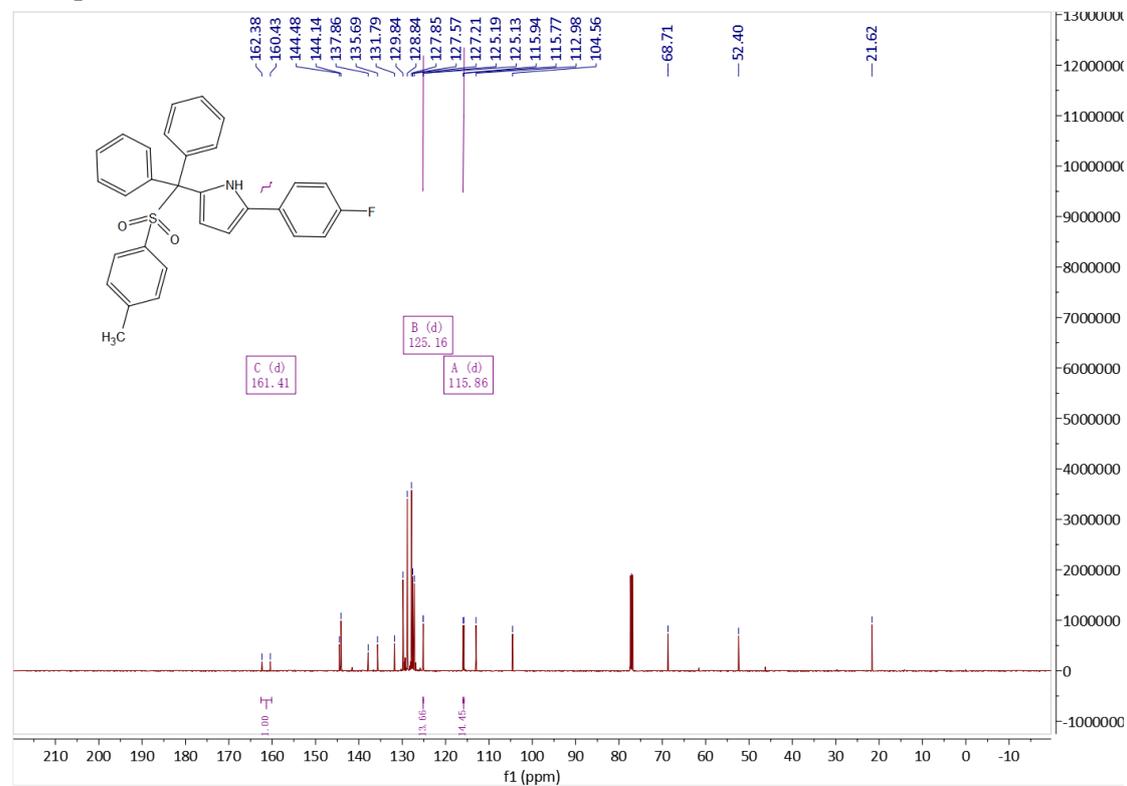
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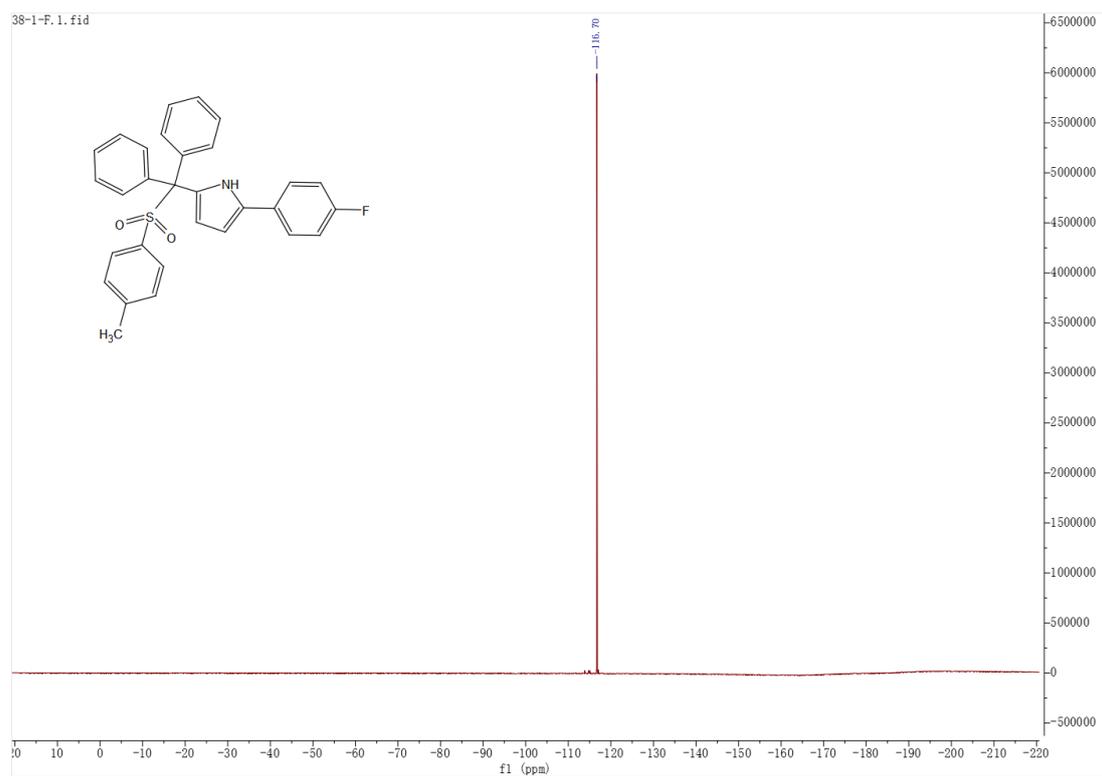
(5e)
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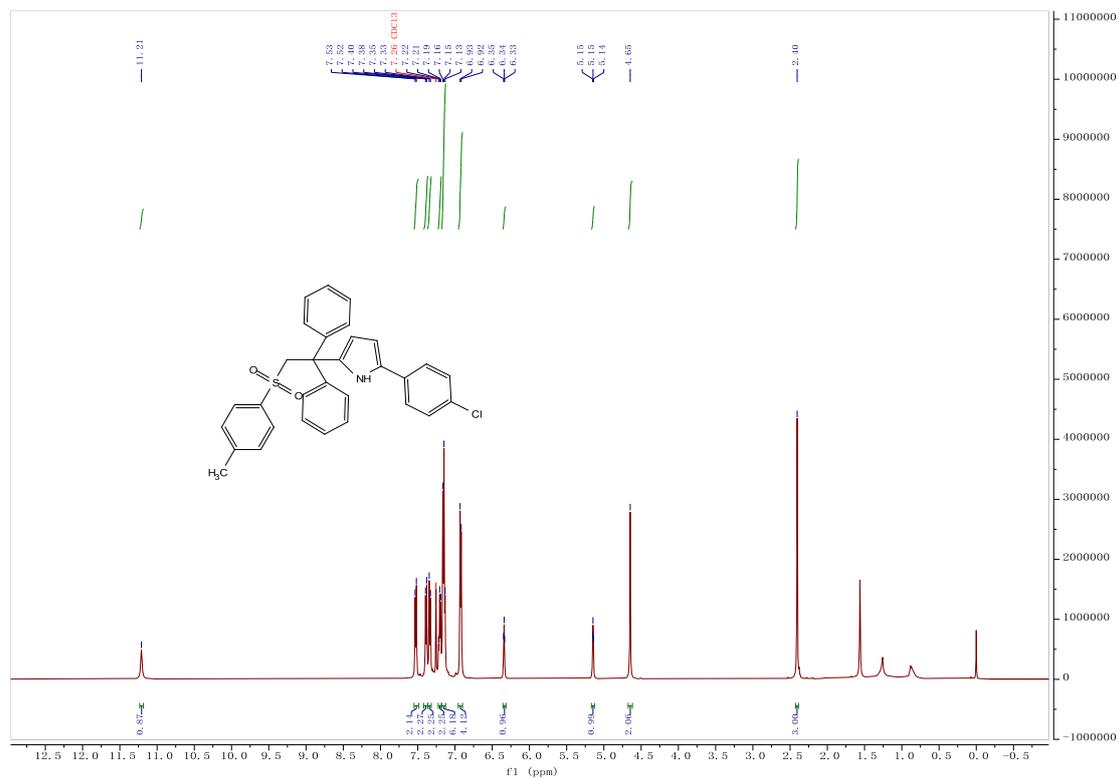
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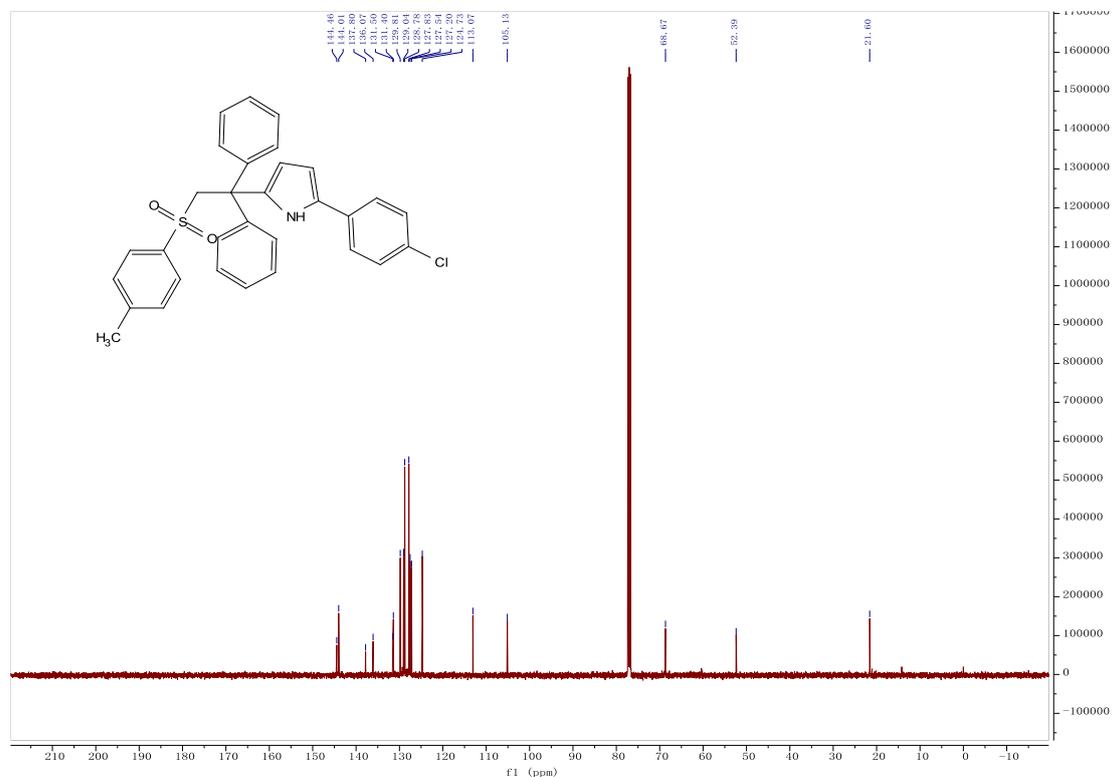
¹⁹F Spectra



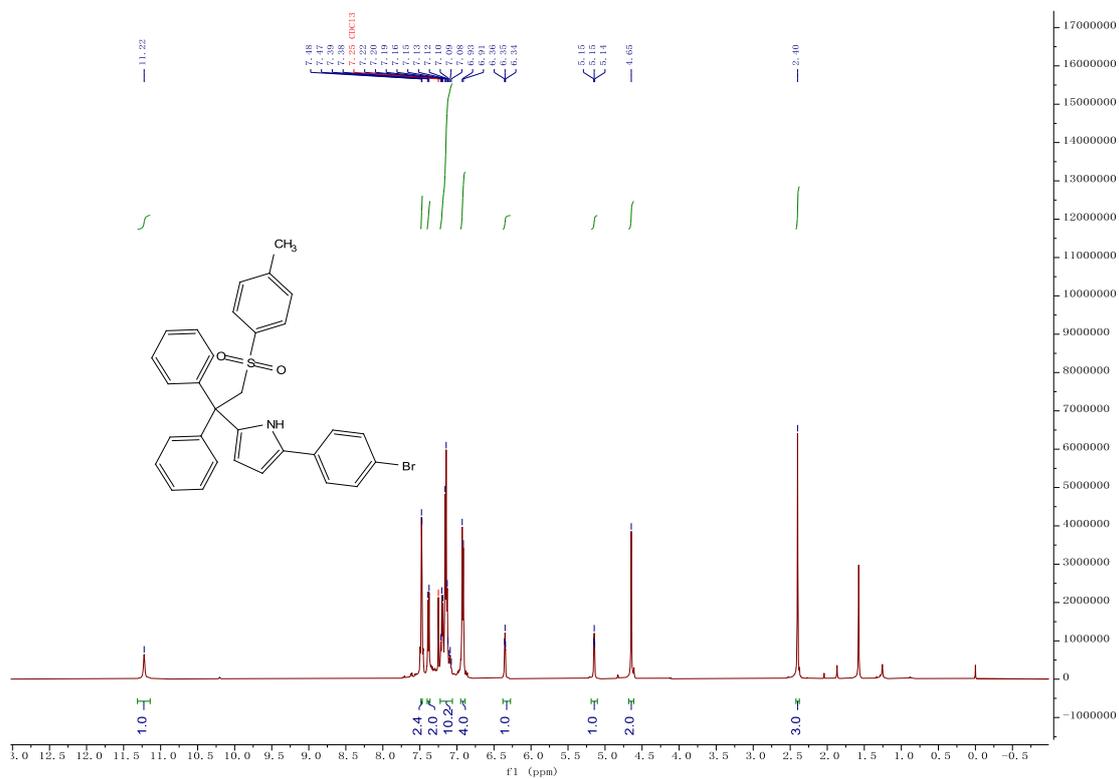
(5f)
¹H Spectra



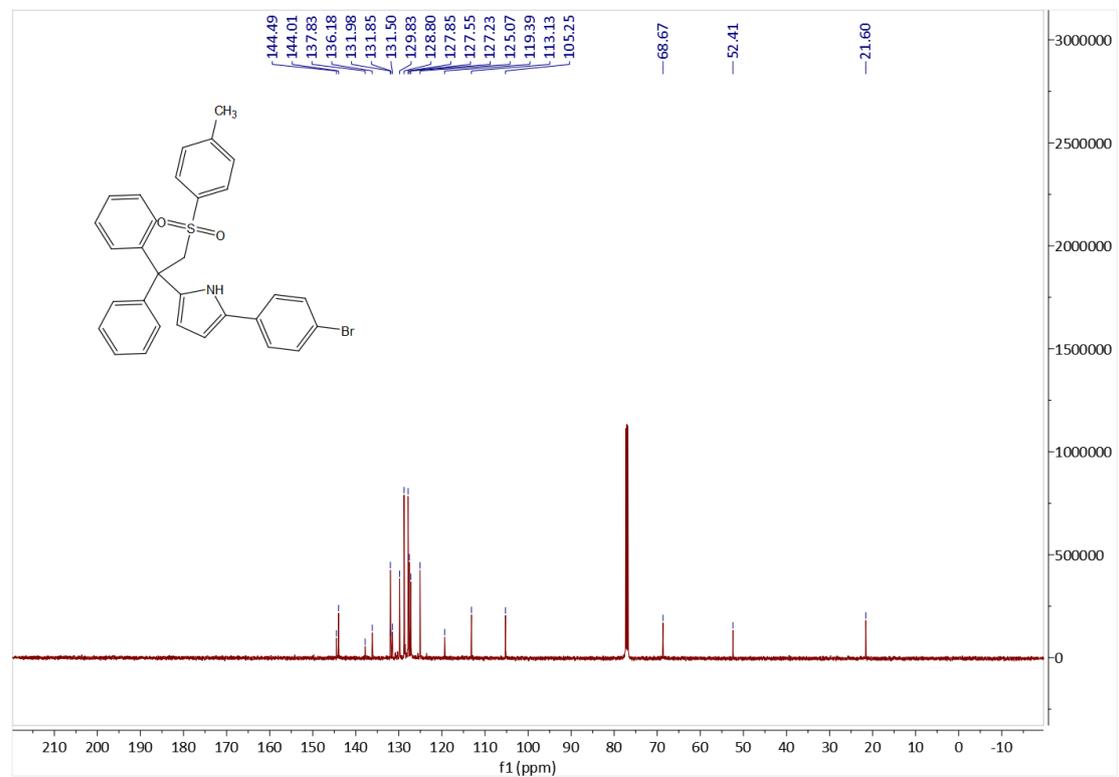
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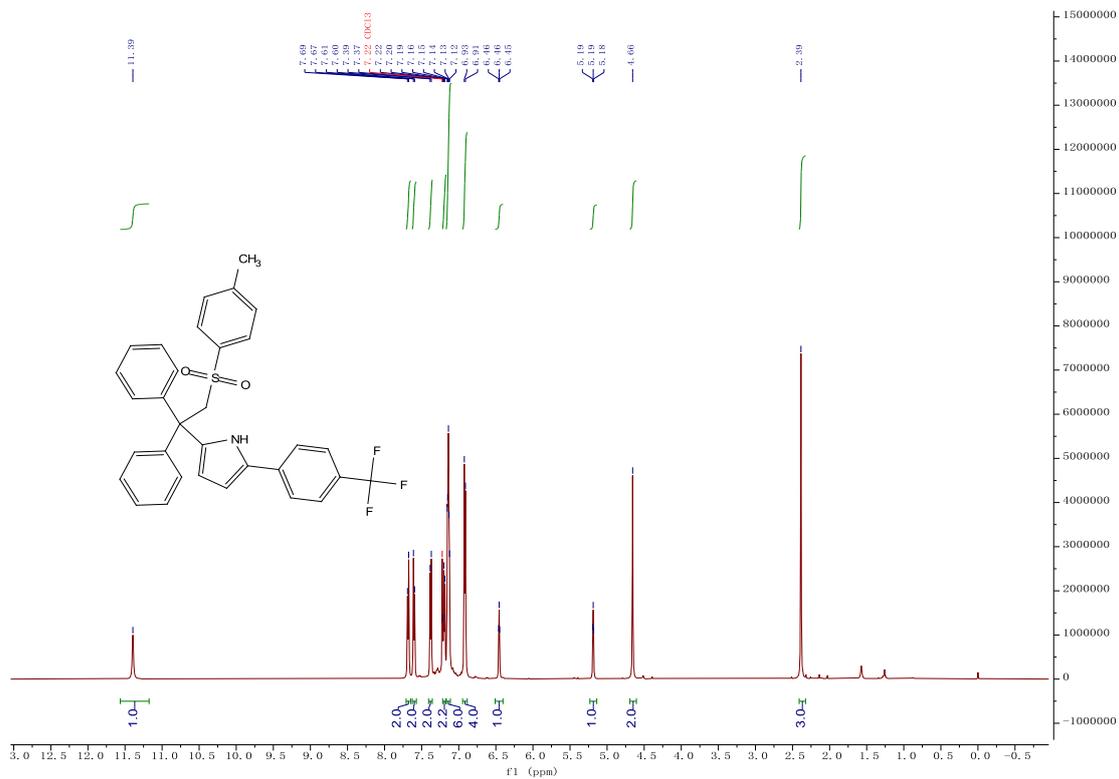
(5g)
¹H Spectra



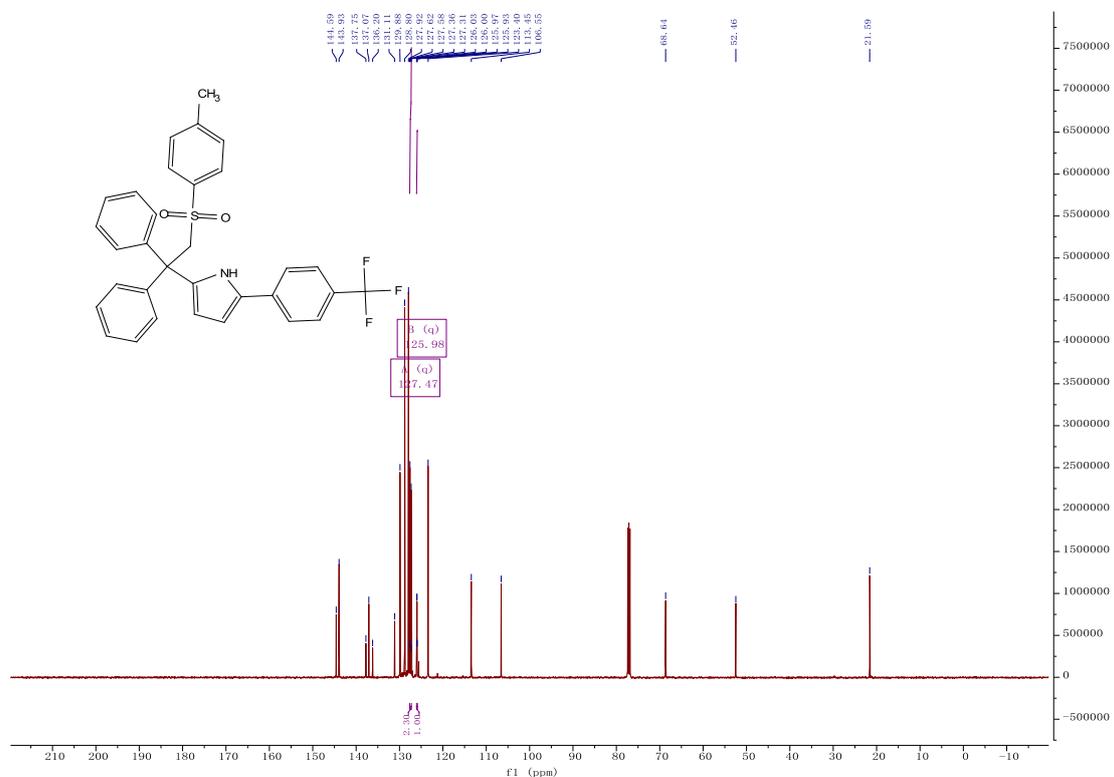
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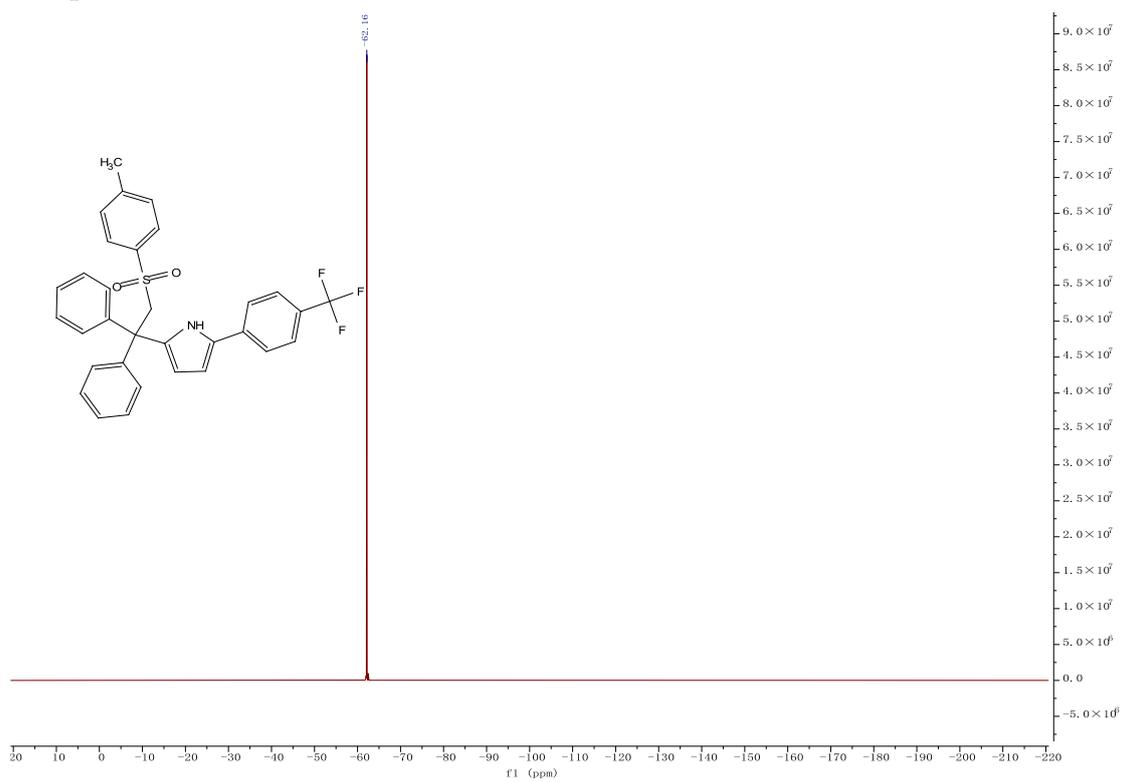
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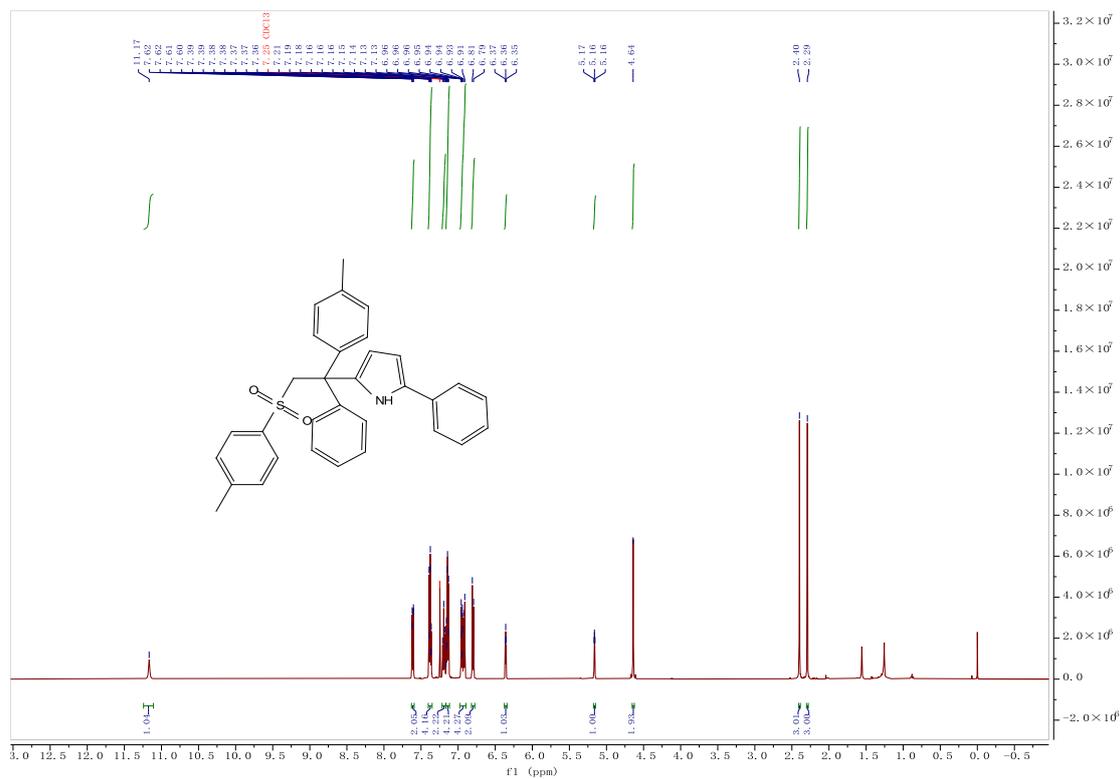
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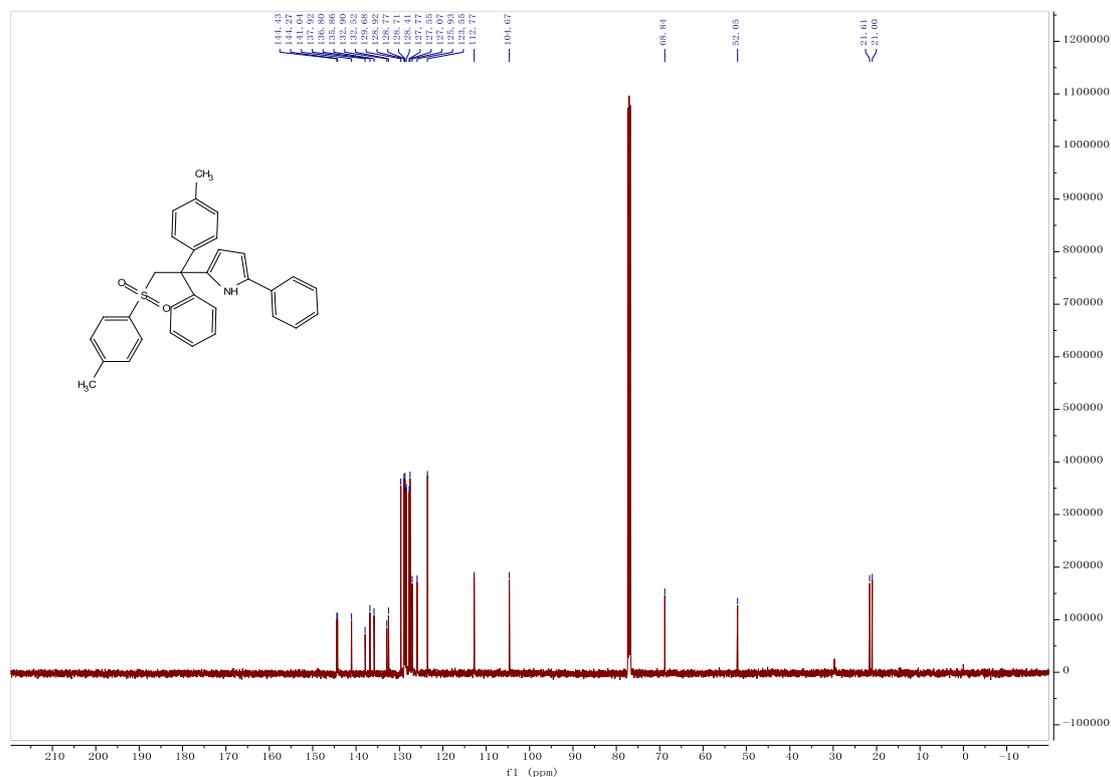
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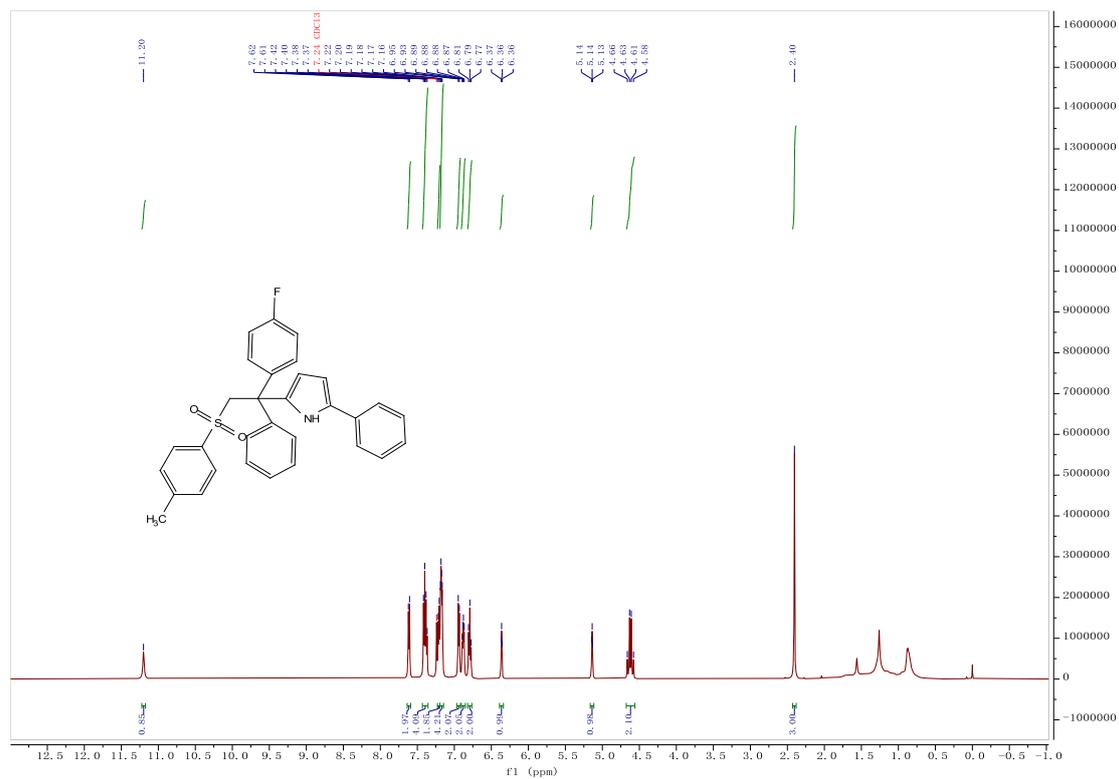
(5j)
¹H Spectra



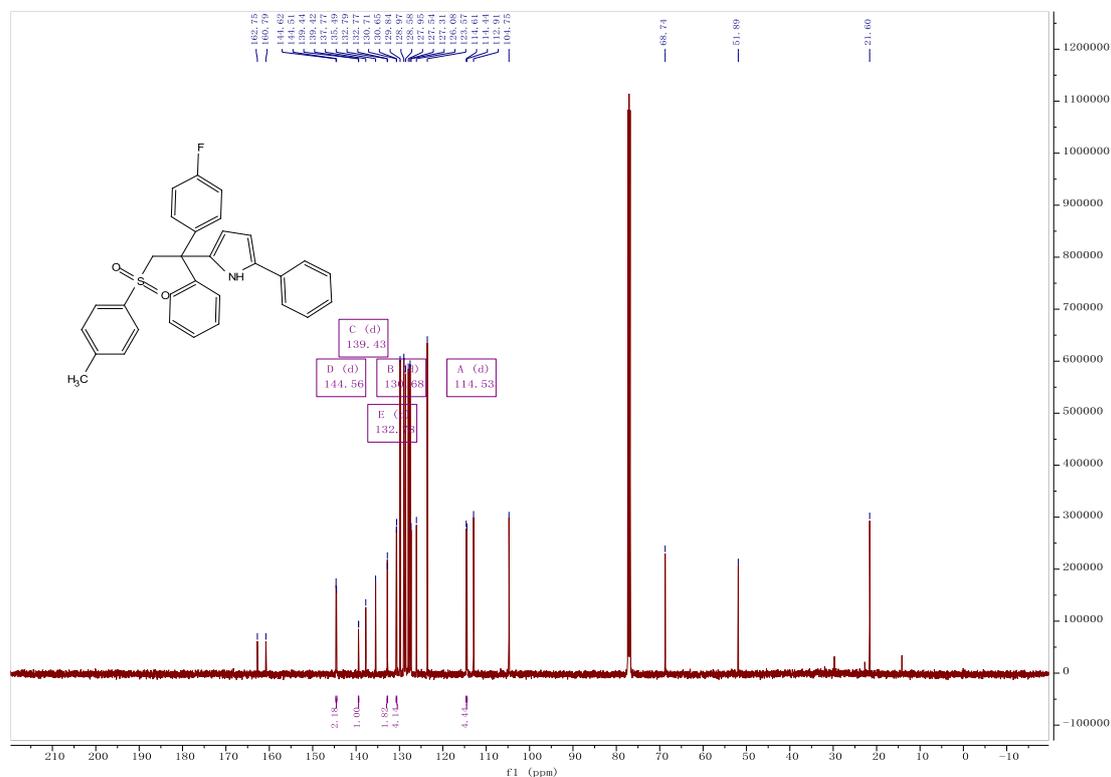
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(51)
¹H Spectra

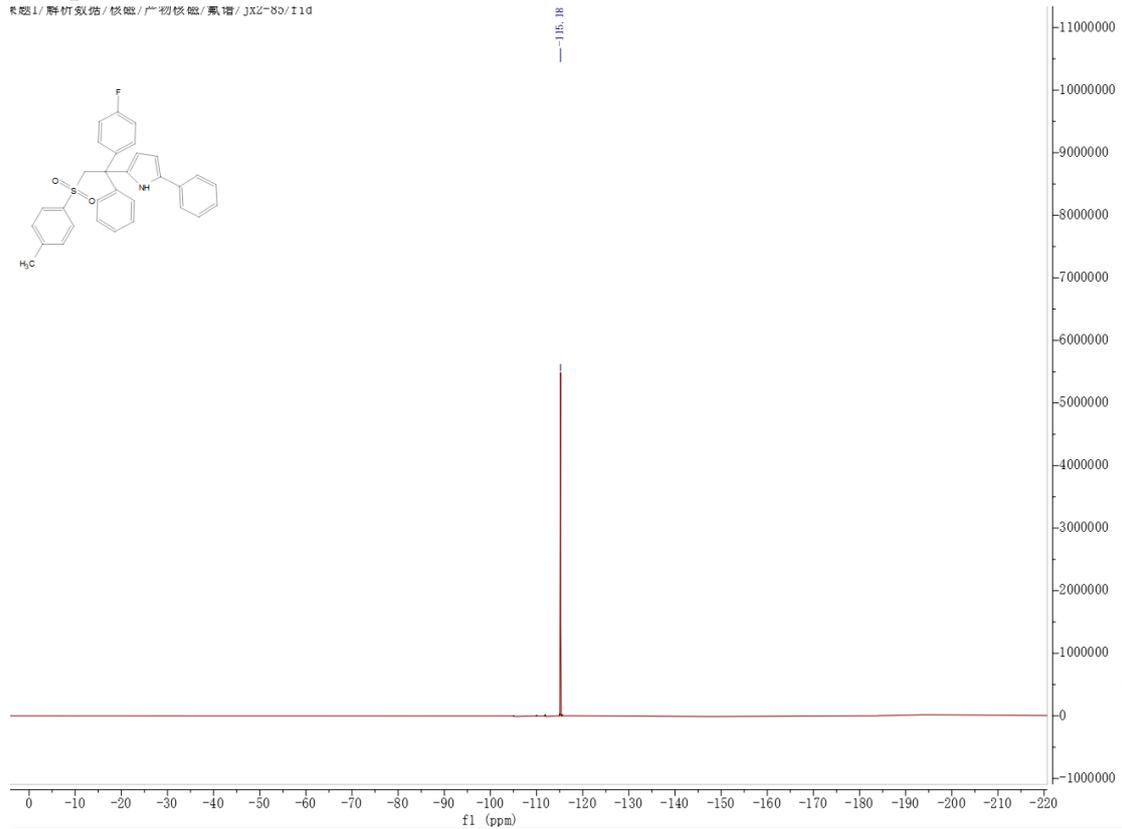


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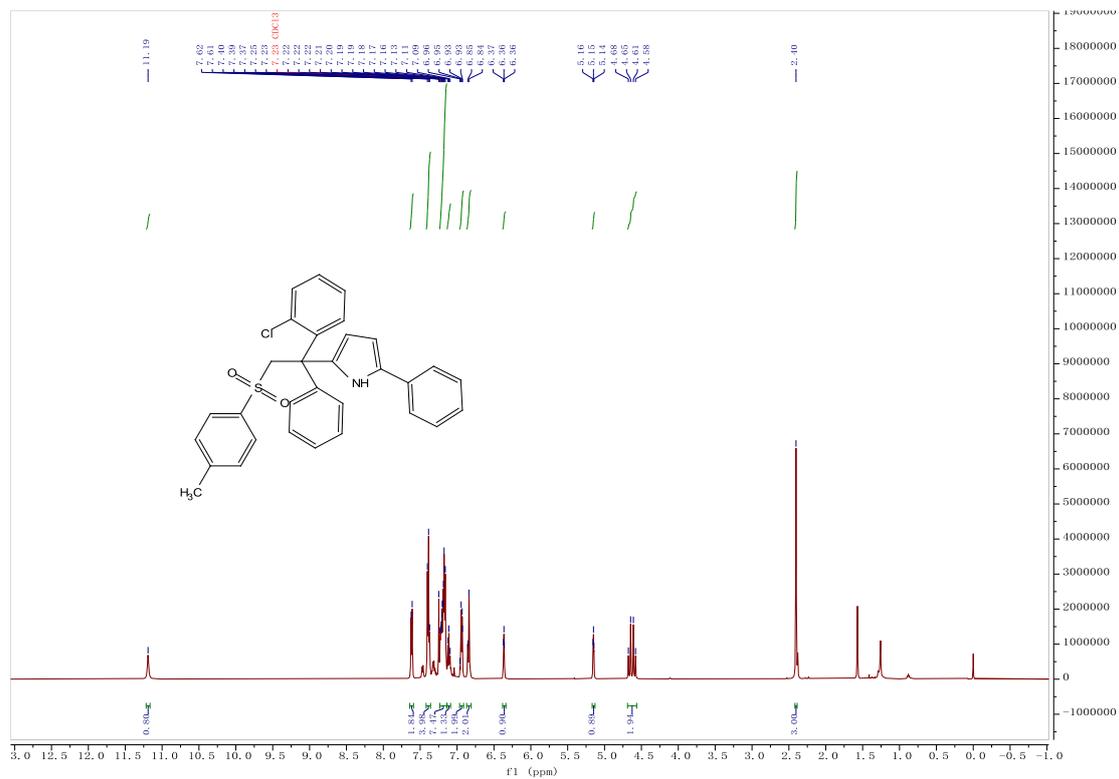


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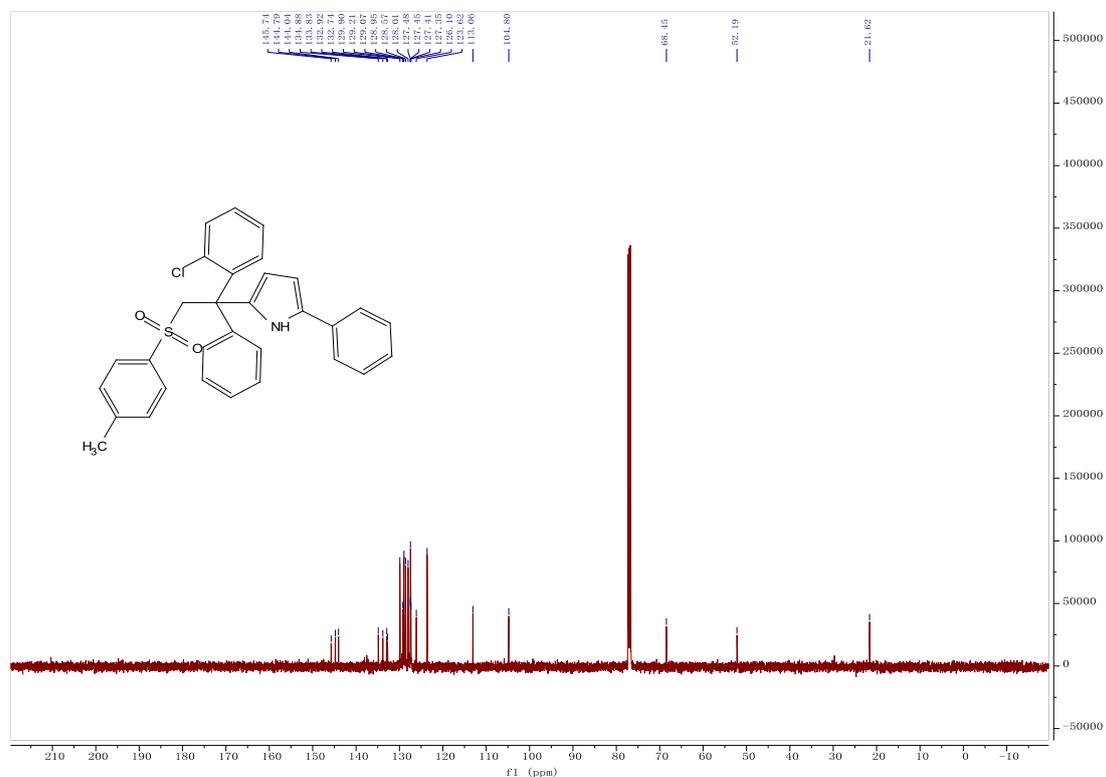
标题1/ 解机数据/ 核磁/ ¹⁹F核磁/ 氟谱/ JXZ-85/ 11d



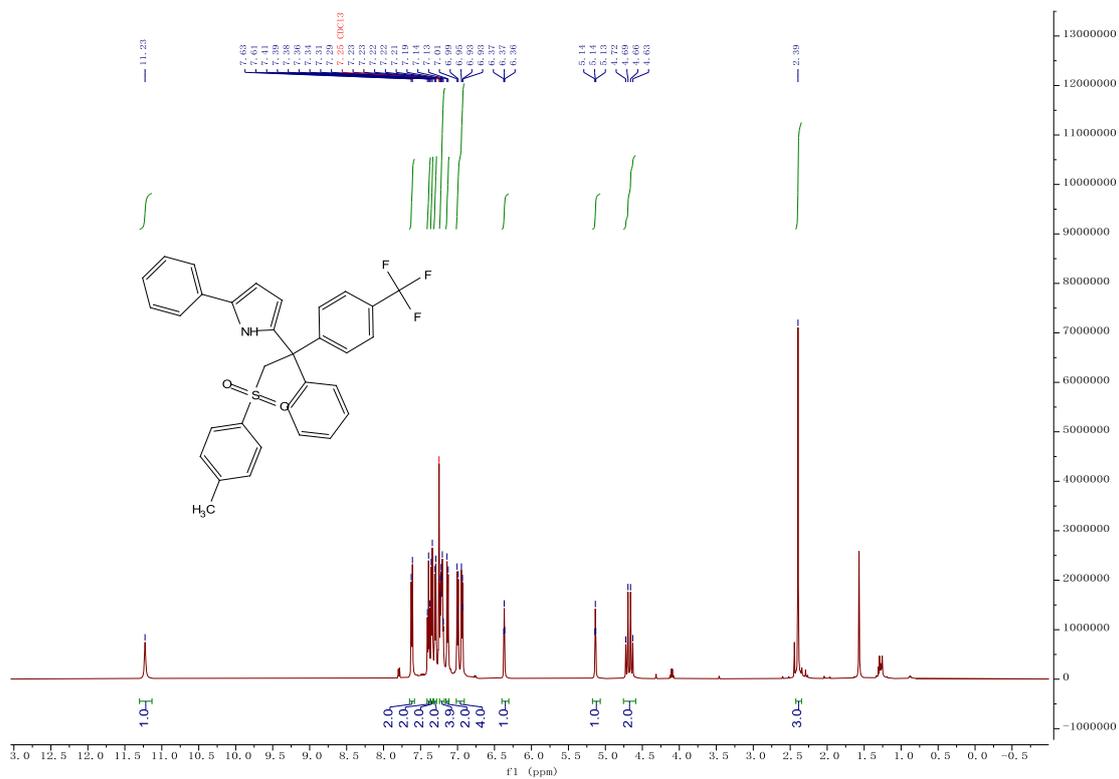
(5m)
¹H Spectra



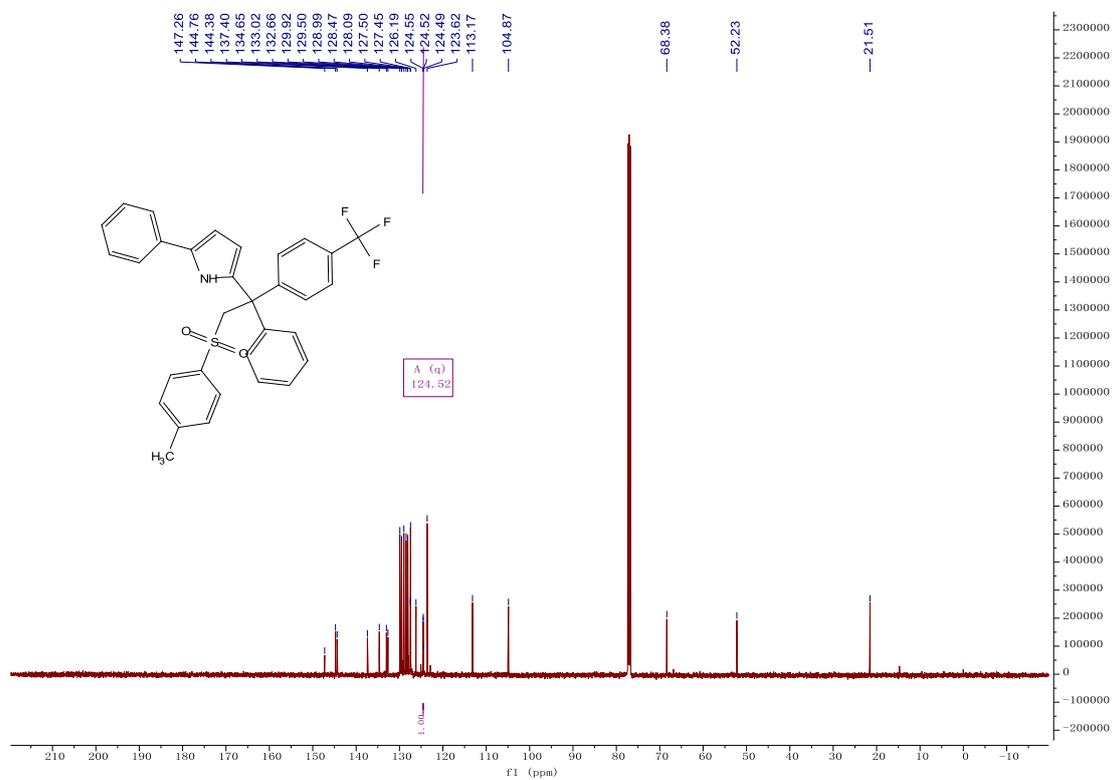
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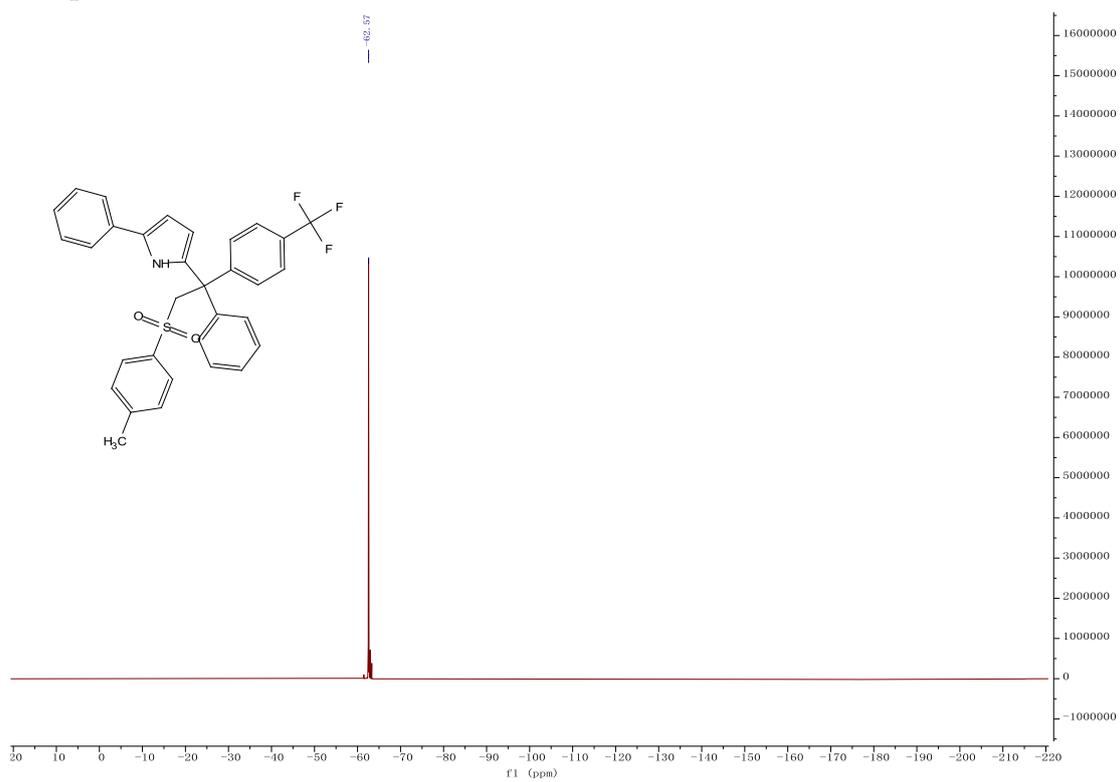
(5o)
¹H Spectra



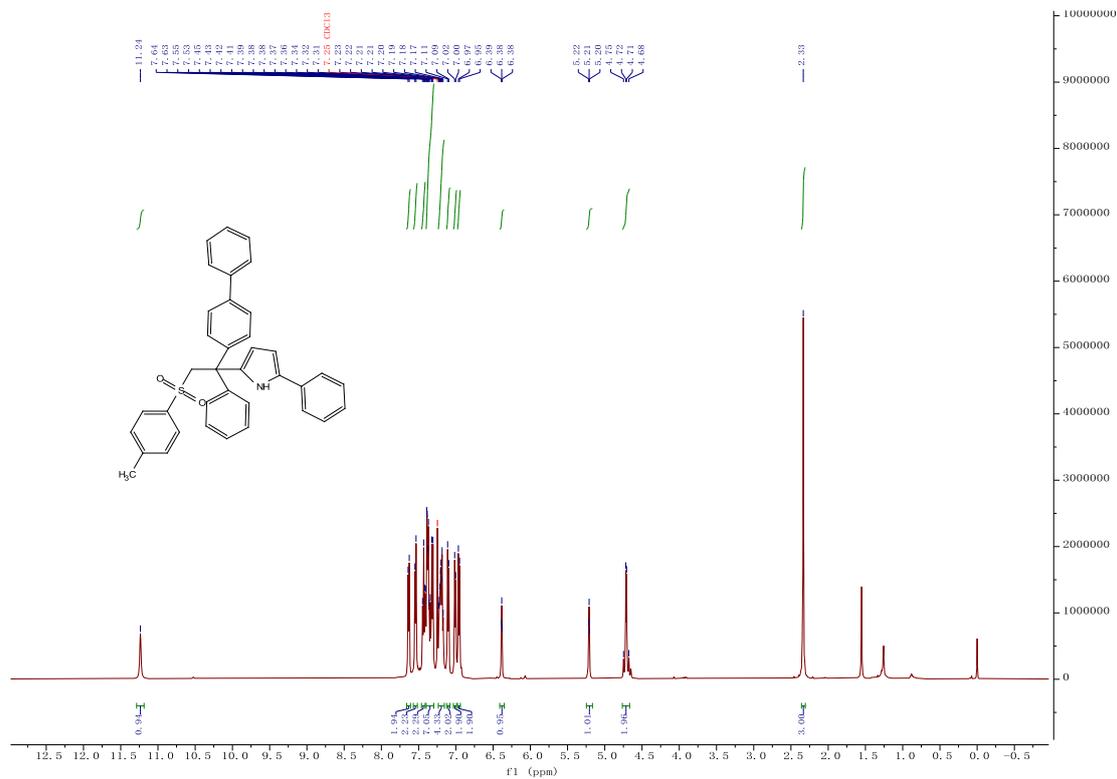
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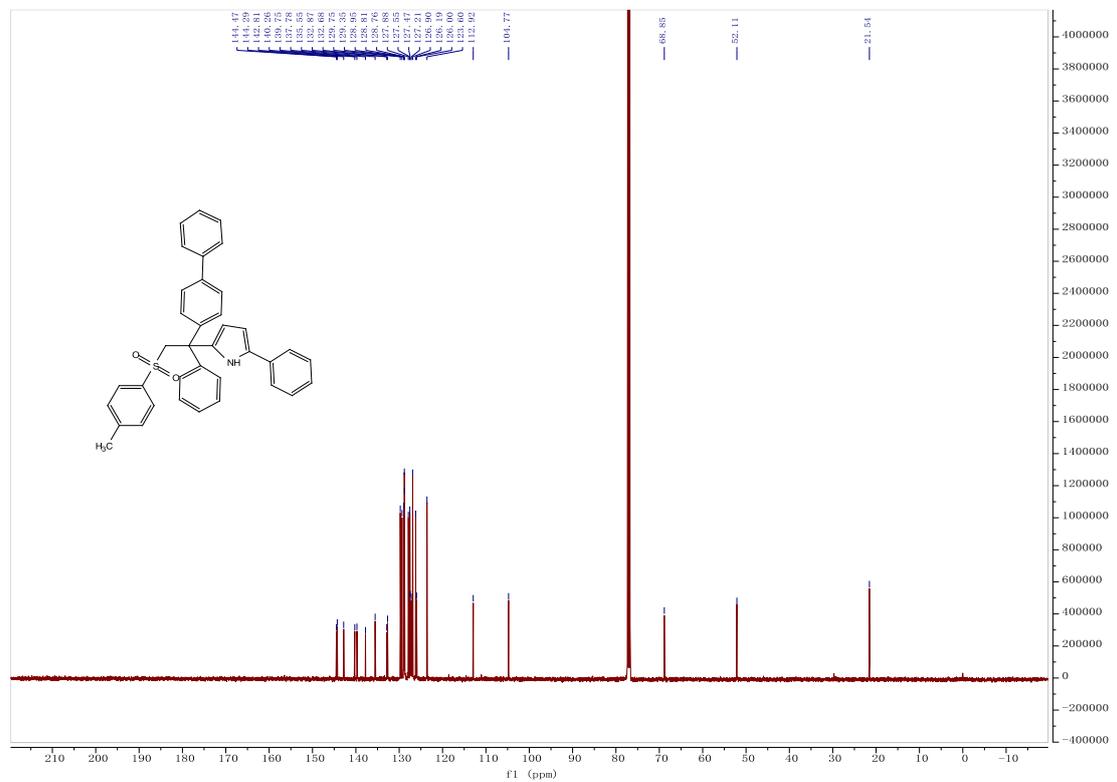
¹⁹F Spectra



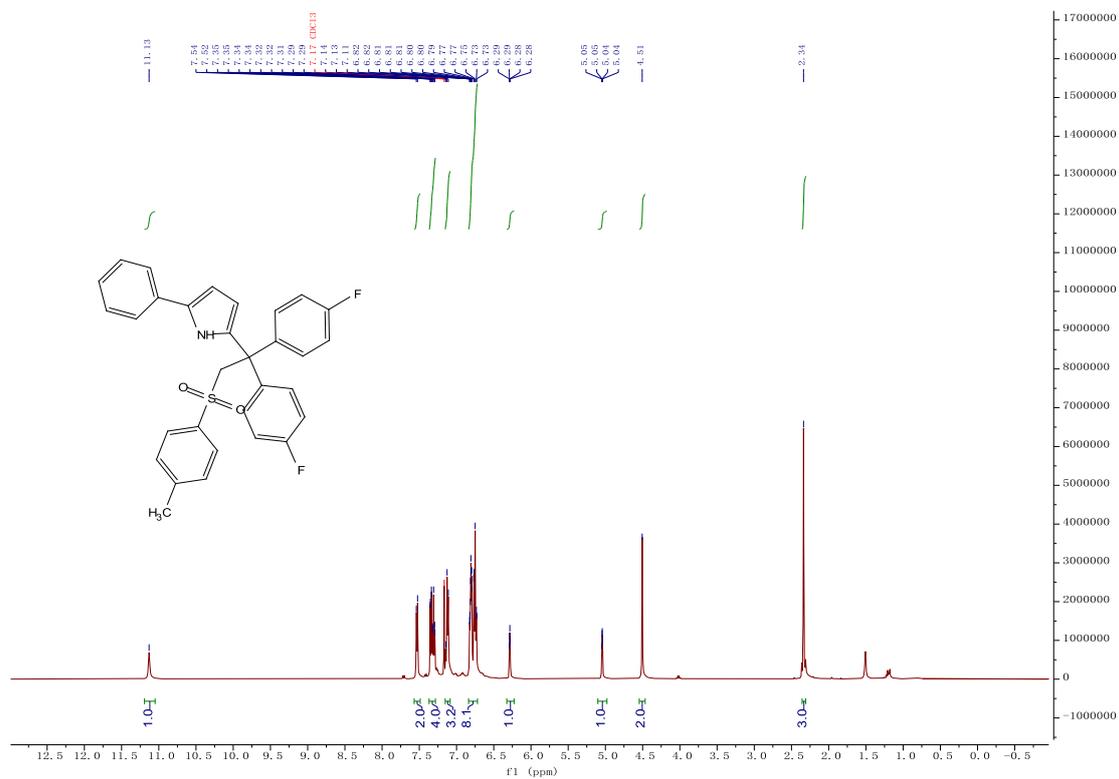
(5q)
¹H Spectra



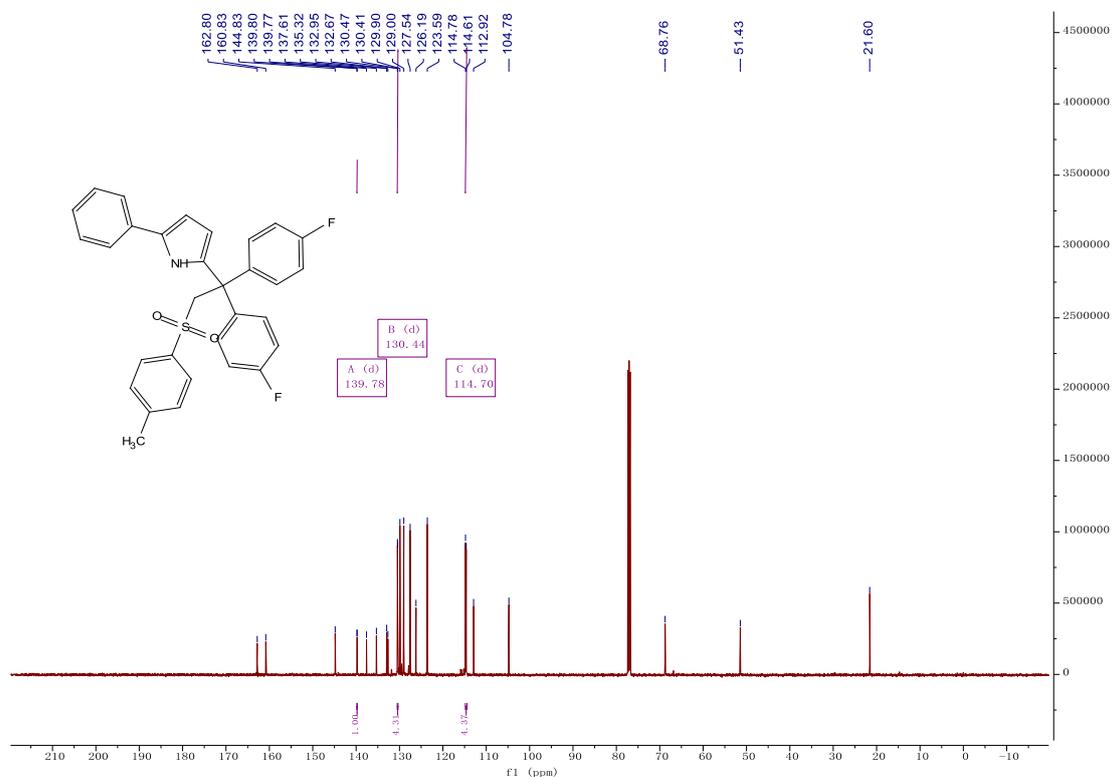
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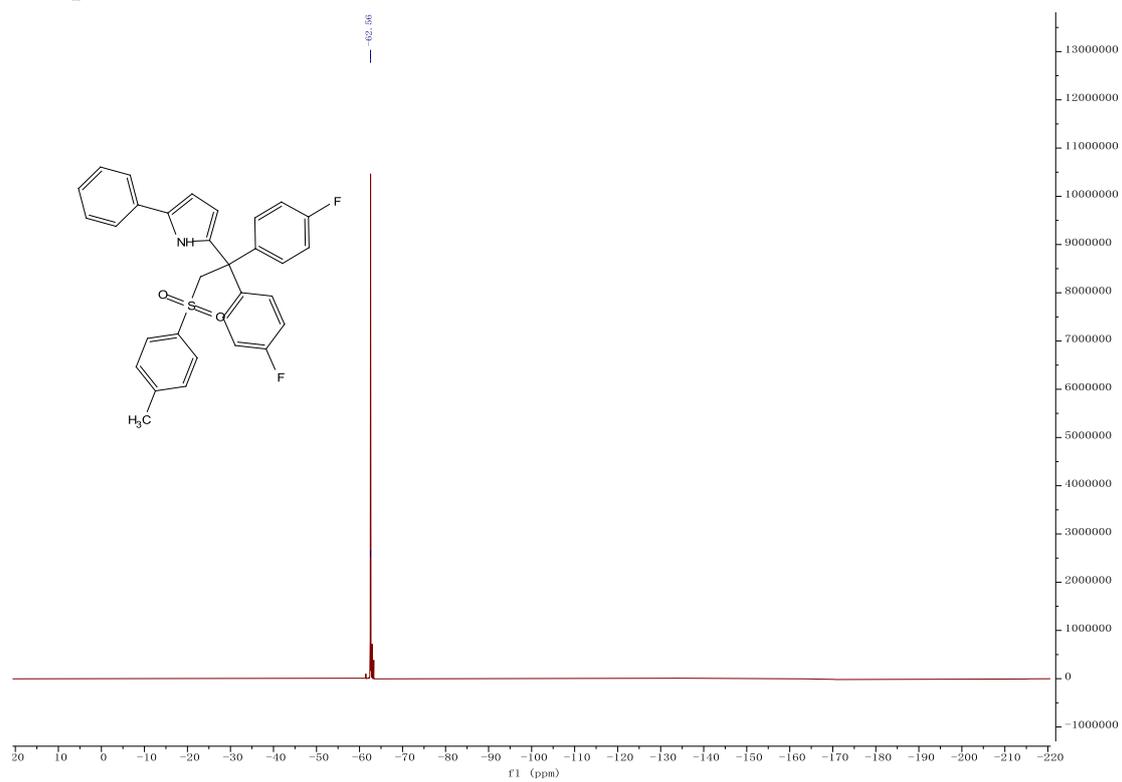
(5s)
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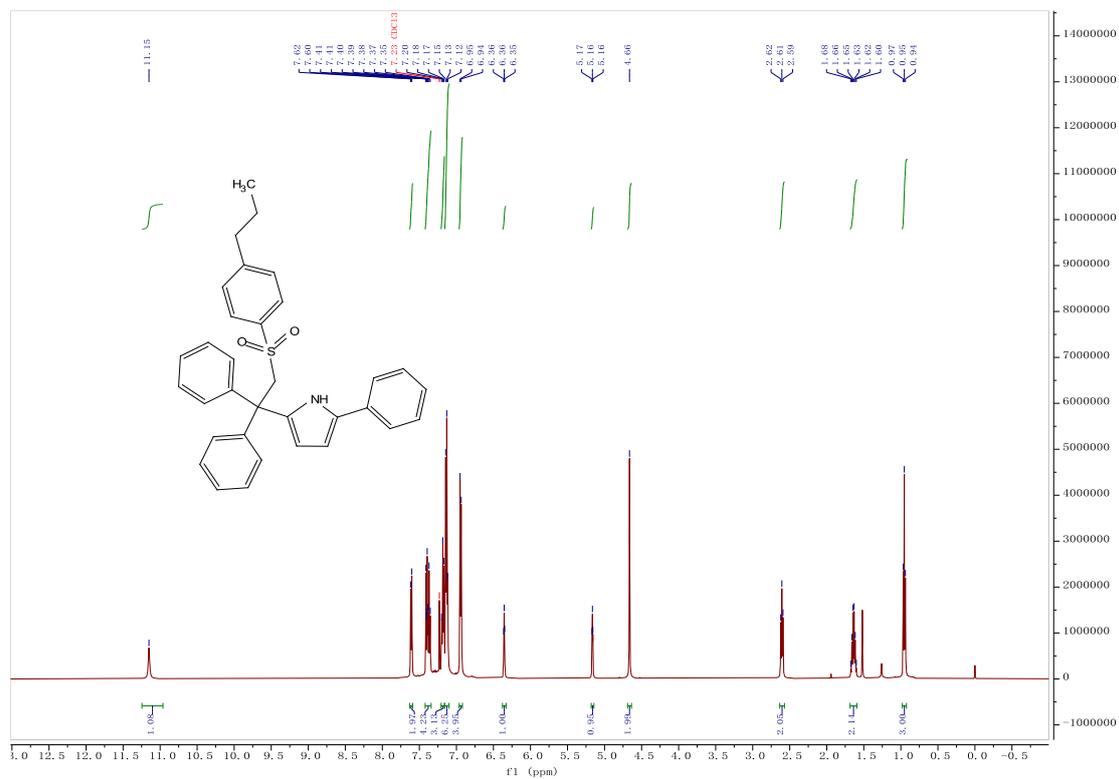
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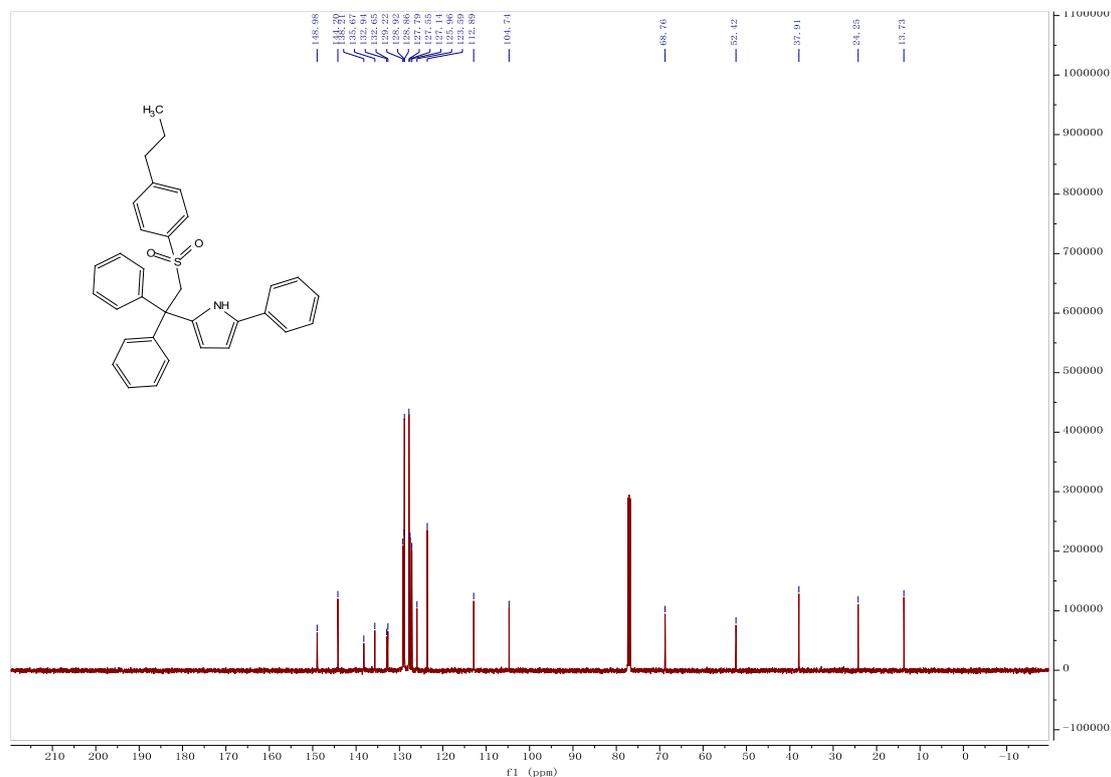
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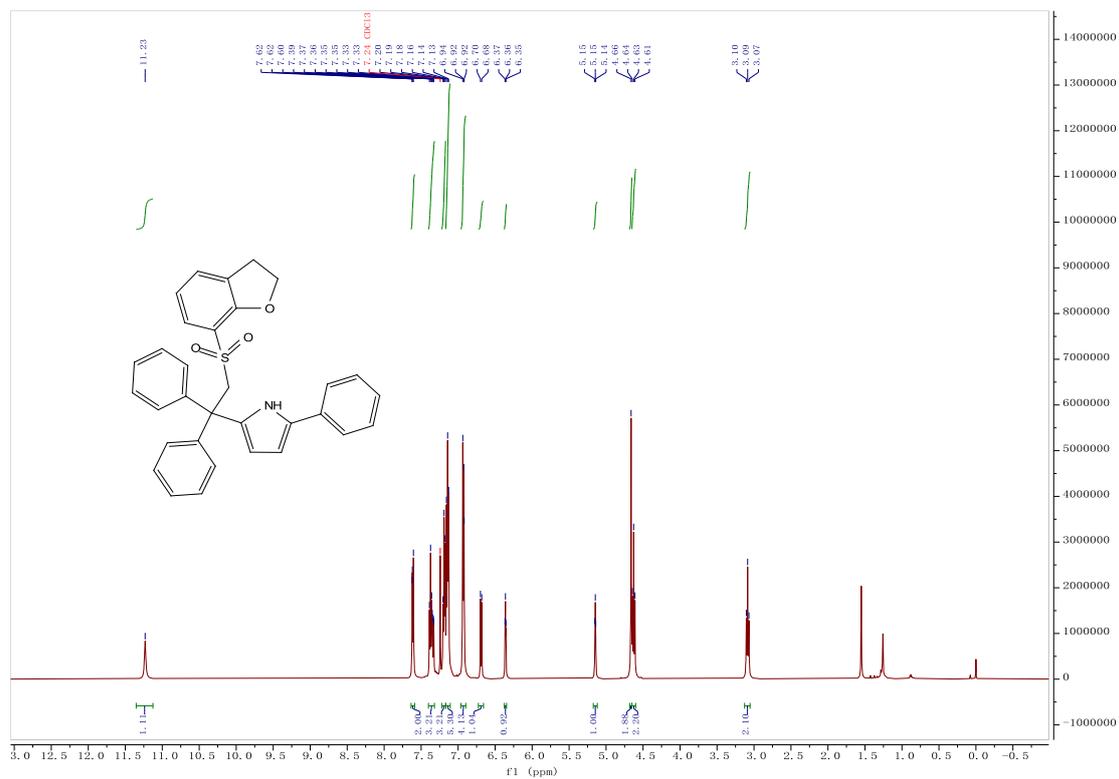
(5t)
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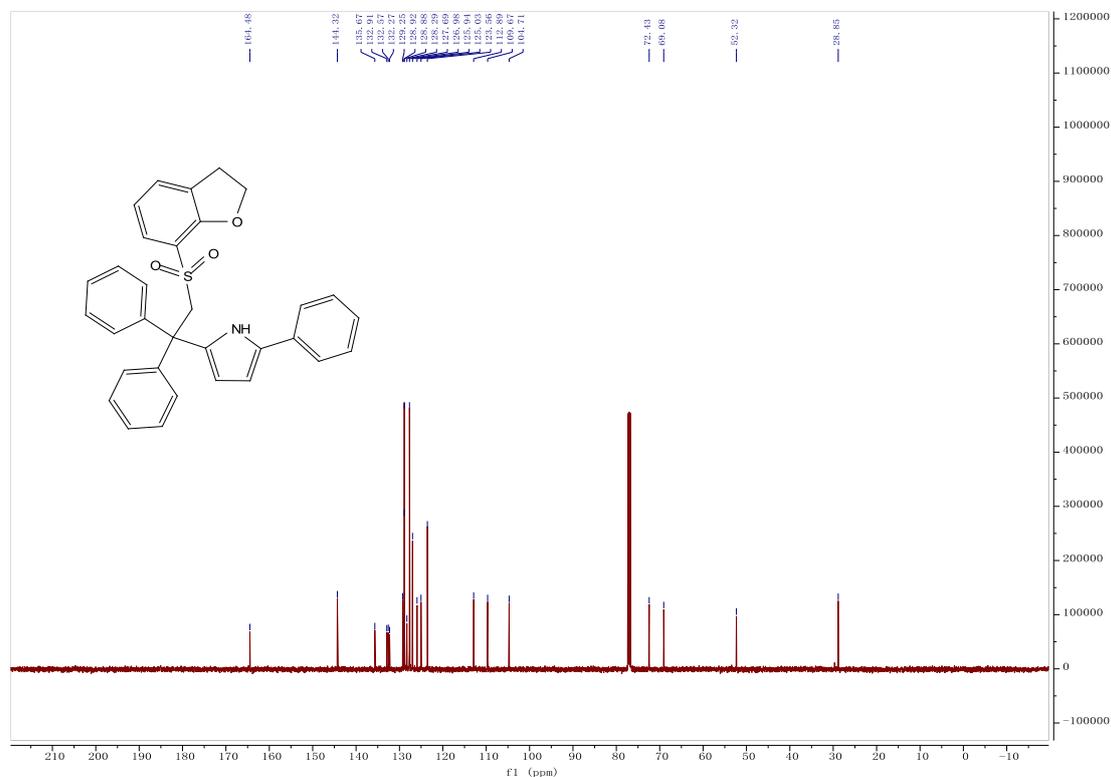
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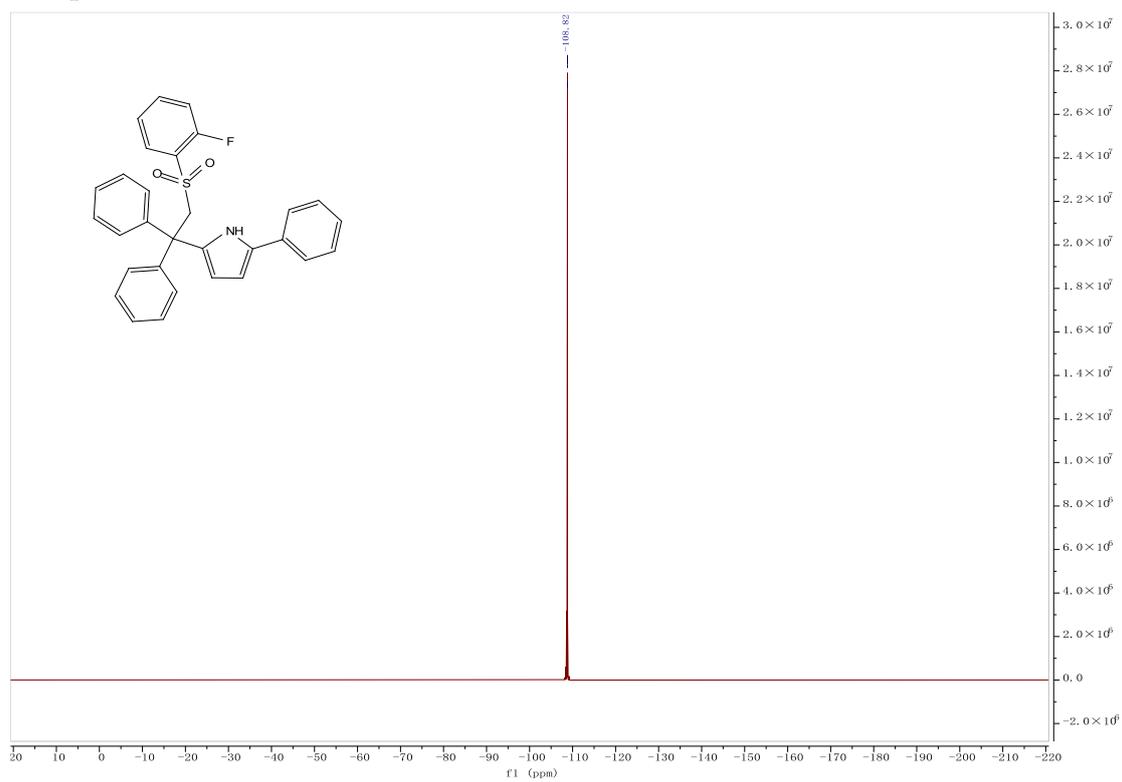
(5v)
¹H Spectra



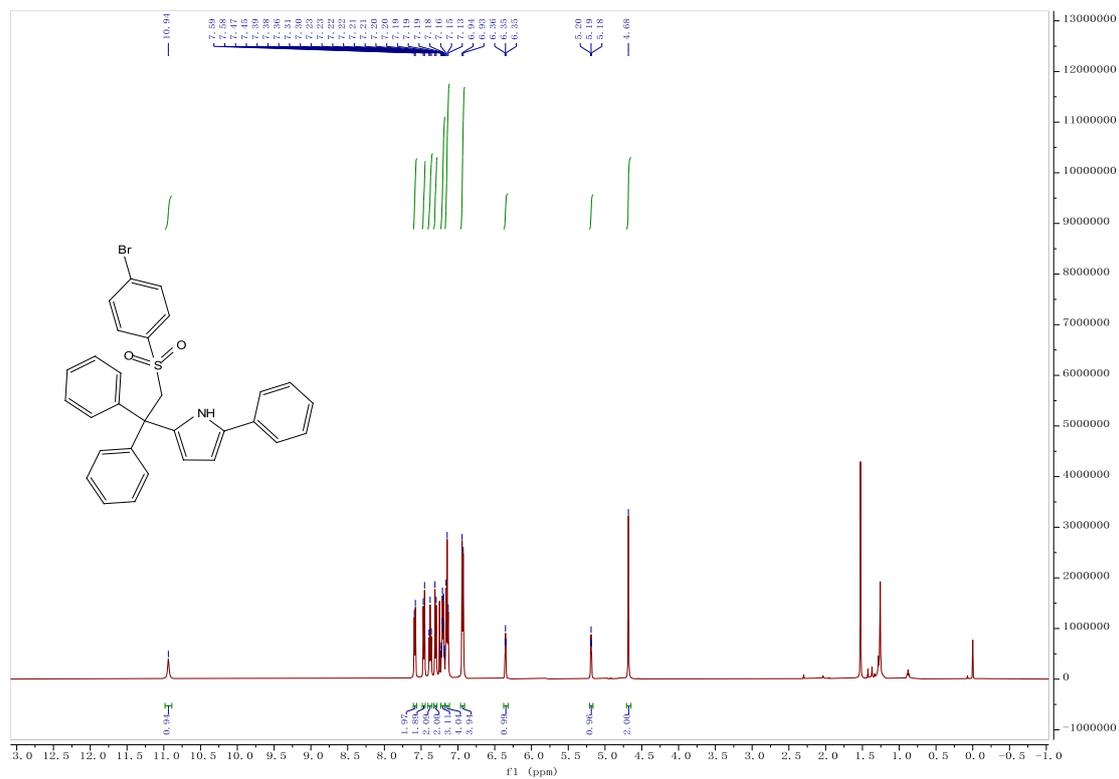
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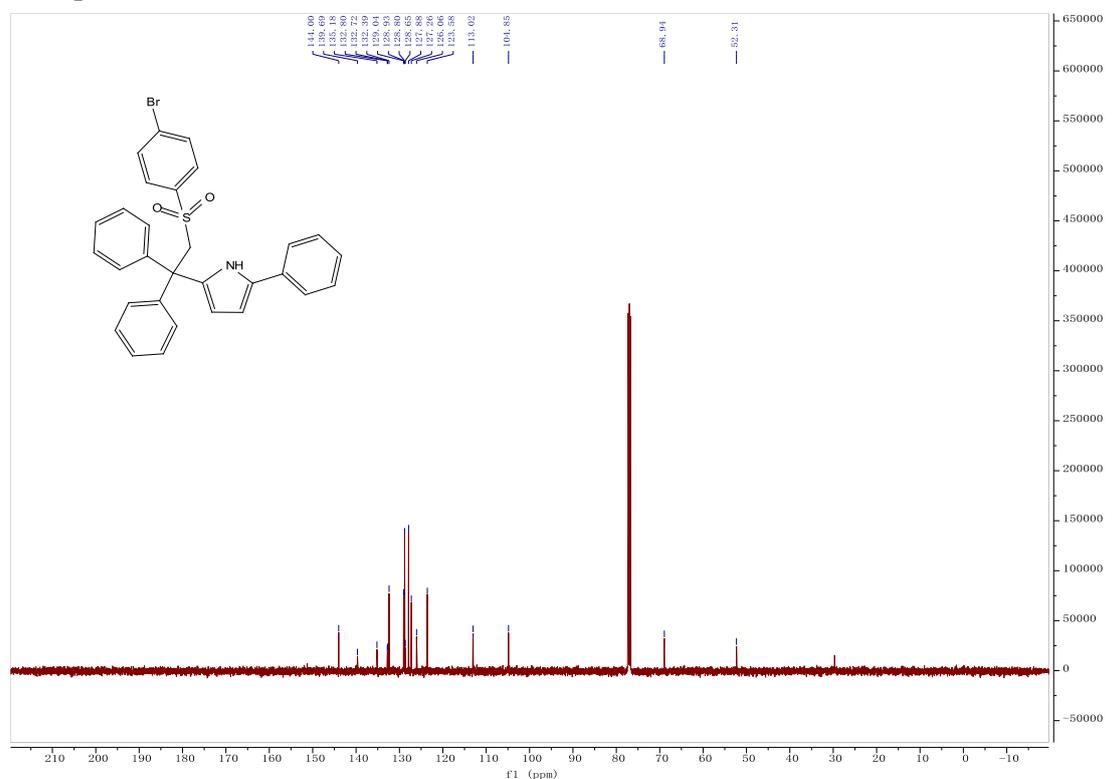
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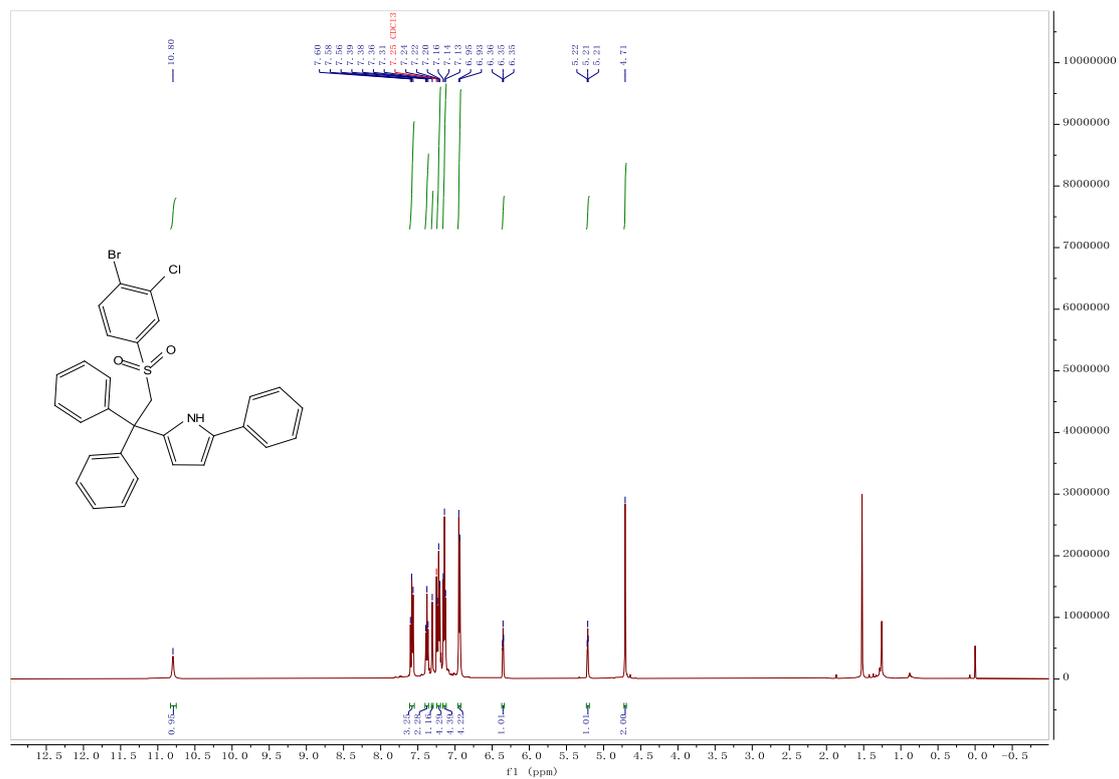
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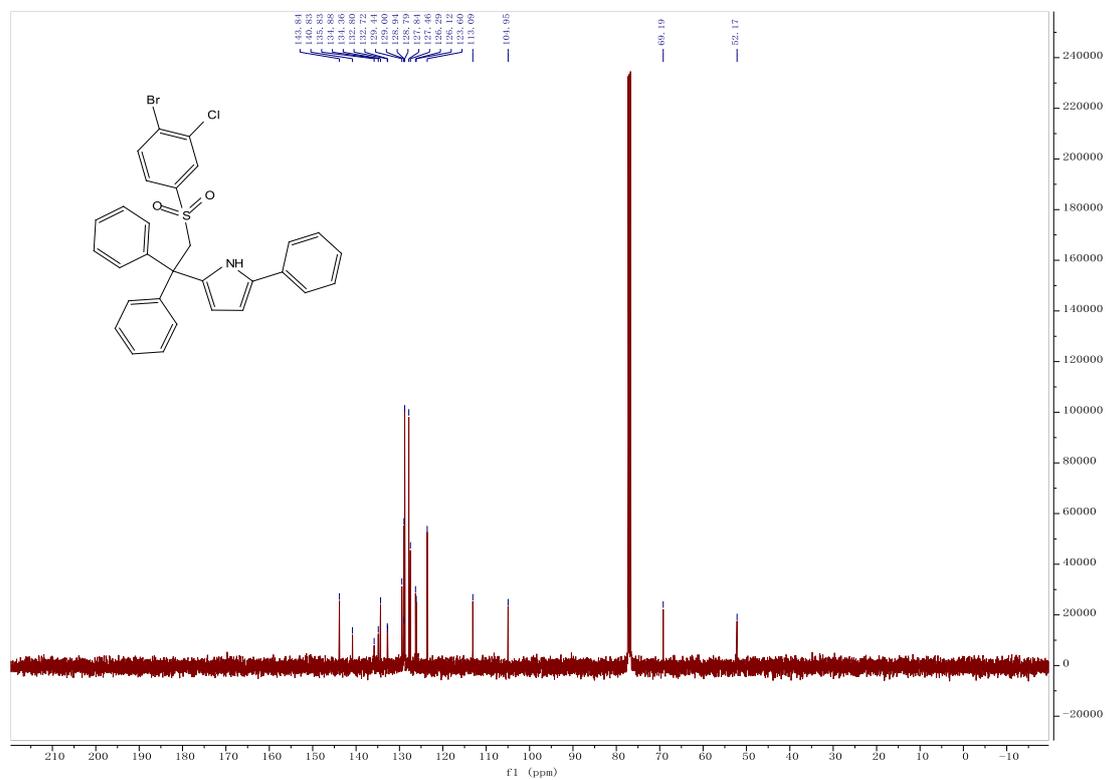
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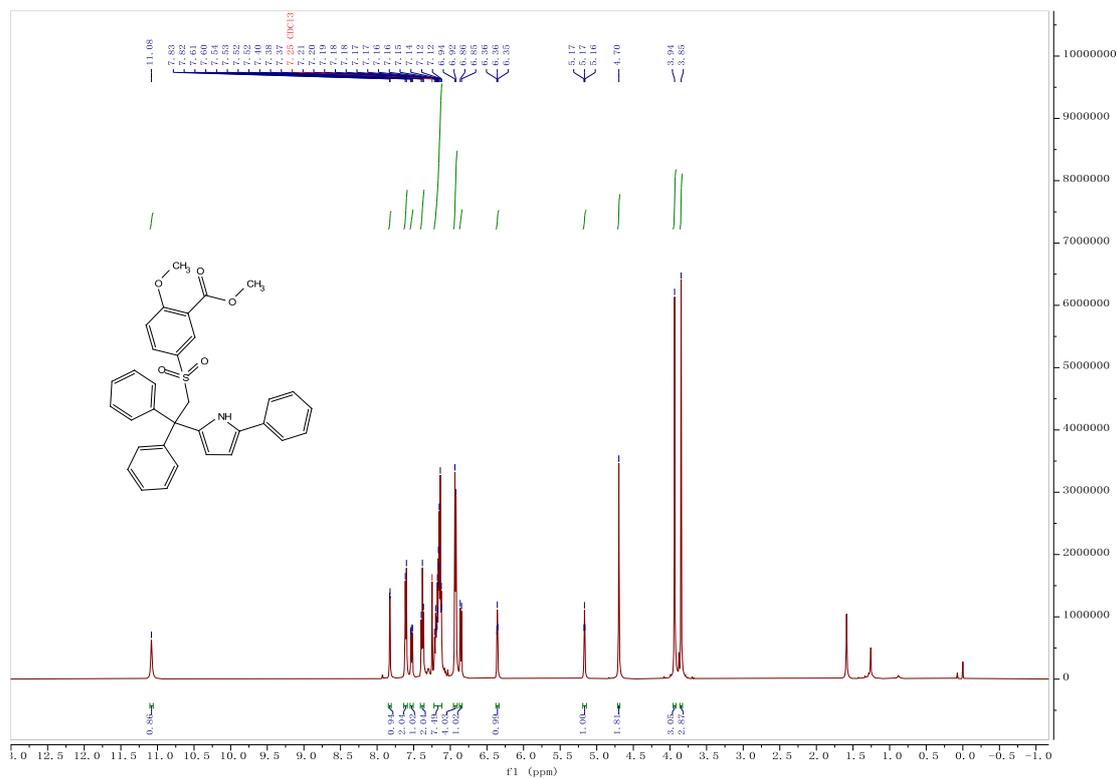
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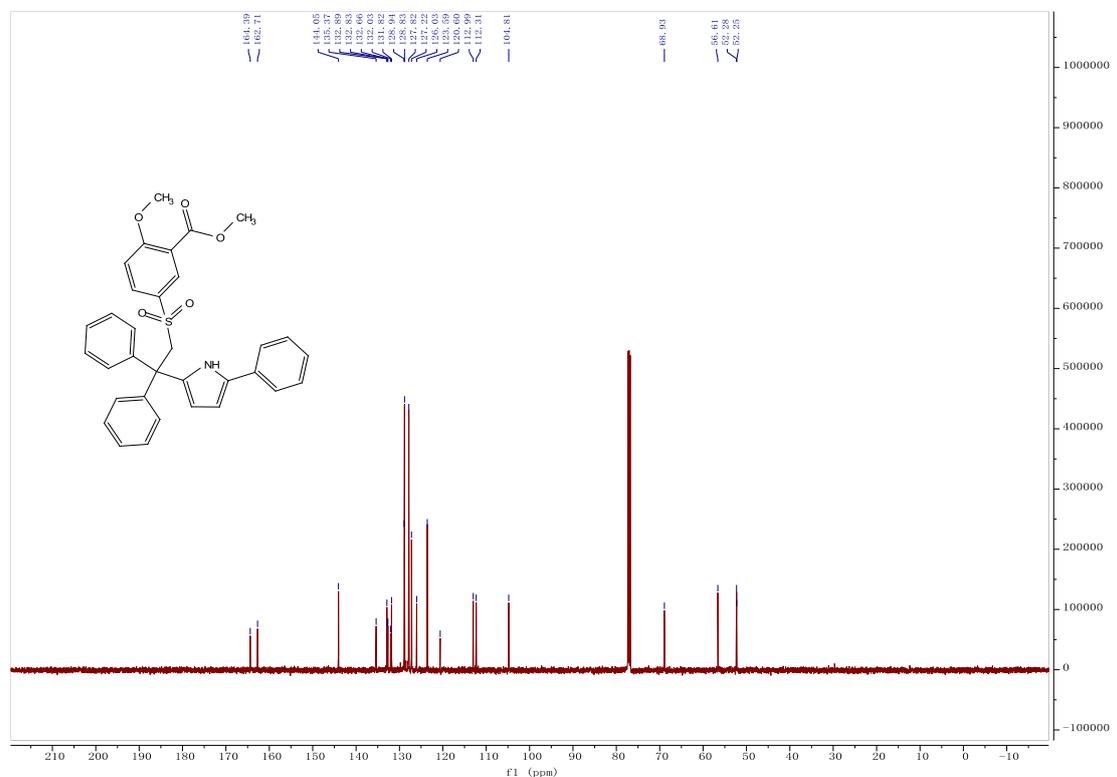
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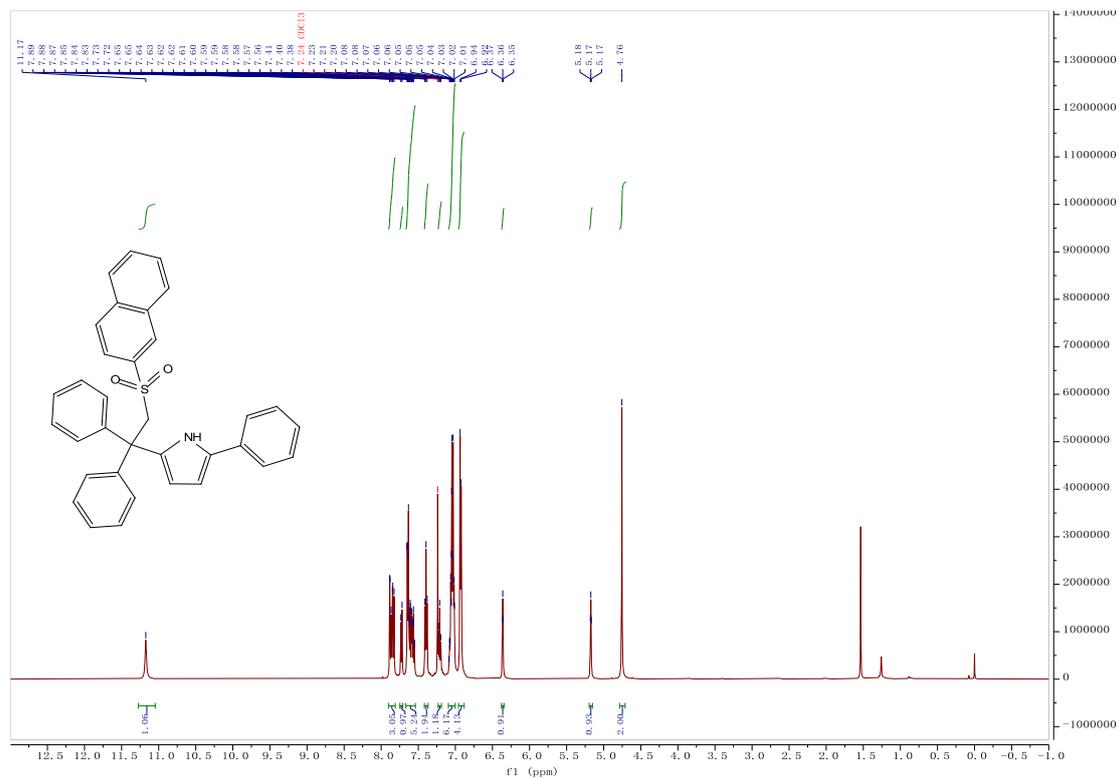
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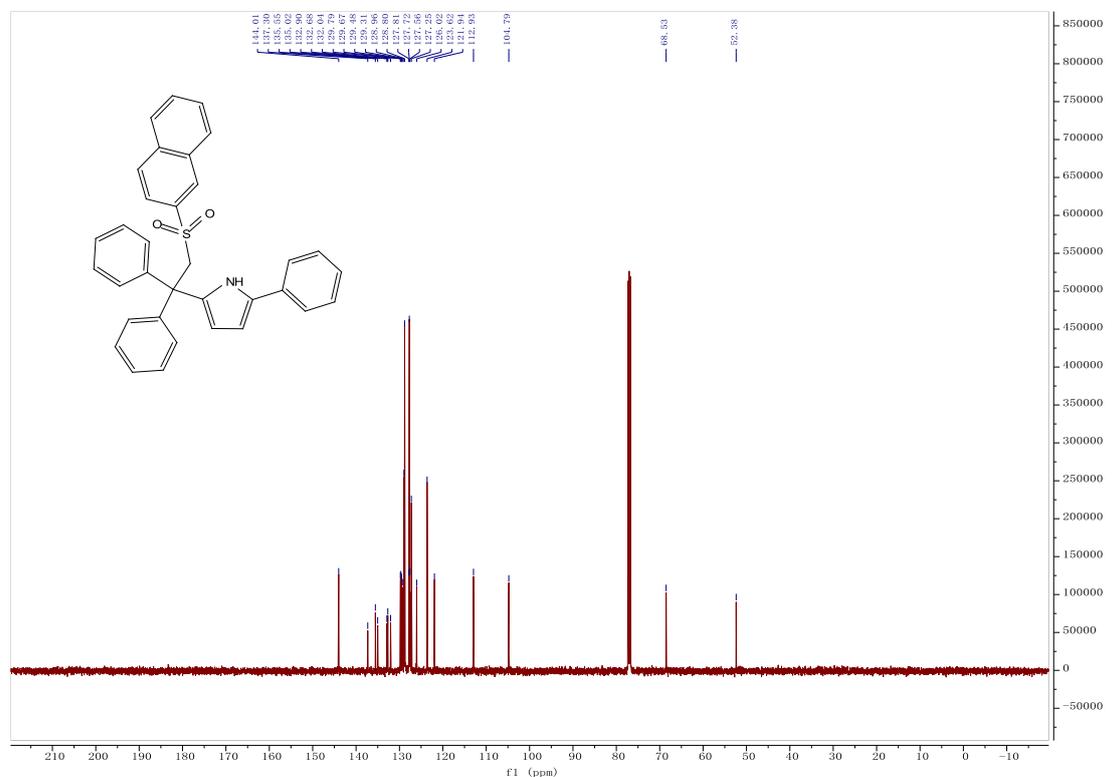
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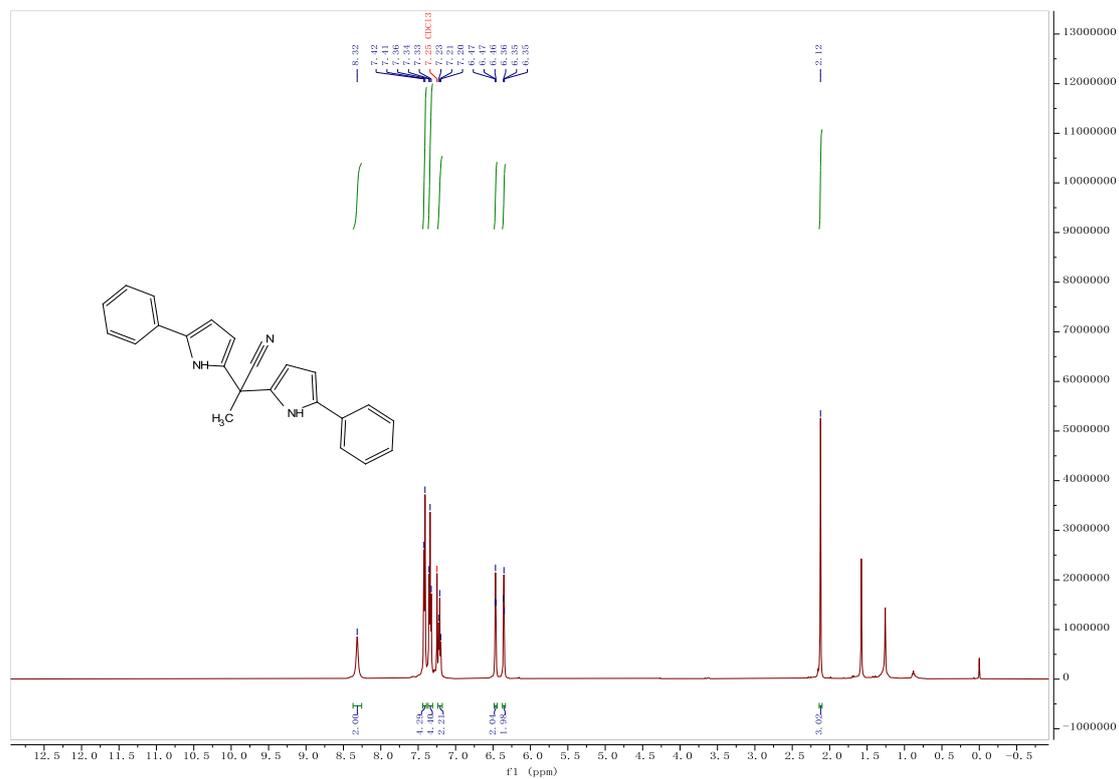
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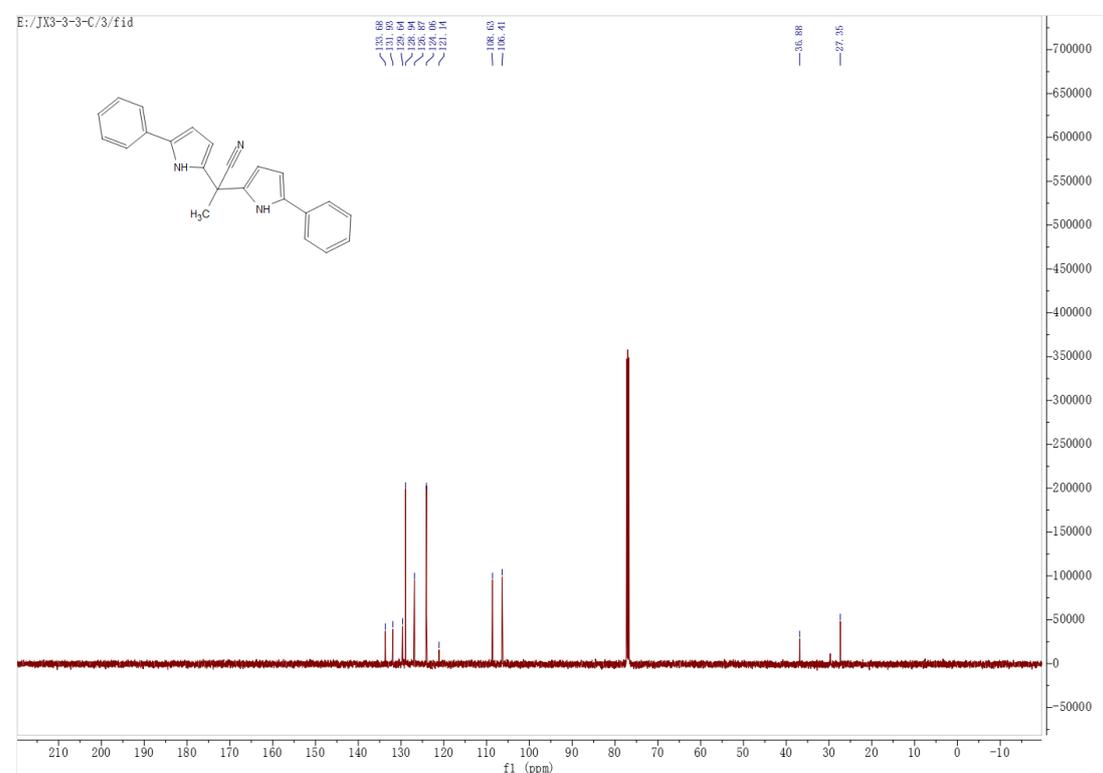
¹³C Spectra



(11) ¹H Spectra



¹³C Spectra



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