Supporting Information

Multi-Functionalization of β-Trifluoromethyl Enones Enabled 2,3-Dihydrofurans Synthesis

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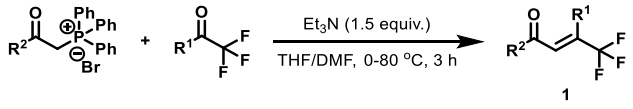
General information

Unless otherwise stated, all reagents were purchased from commercial suppliers and used without further purification. All reactions were carried out under air or N_2 atmosphere using undistilled solvent. Melting points were recorded on an electrothermal digital melting point apparatus. ^1H, ^{19}F, and ^{13}C NMR spectra were recorded in $CDCl_3$ on Bruker Avance or Joel 400 MHz spectrometers. NMR splitting patterns are designated as singlet (s), doublet (d), triplet (t), quartet (q), multiplet (m), broad (br), doublet of doublets (dd), *etc*. The chemical shifts (δ) are reported in ppm and coupling constants (*J*) in Hz. High resolution mass spectrometry (HRMS) data were obtained on a Waters LC-TOF mass spectrometer (Xevo G2-XS QTof) using electrospray ionization (ESI) in positive or negative mode. A suitable crystal was selected and recorded on a XtaLAB AFC12 (RINC): Kappa single diffractometer. Column chromatography was generally performed on silica gel (300-400 mesh) and reactions were monitored by thin layer chromatography (TLC) using UV light to visualize the course of the reactions.

General procedure for the synthesis of trifluoromethyl enones 1

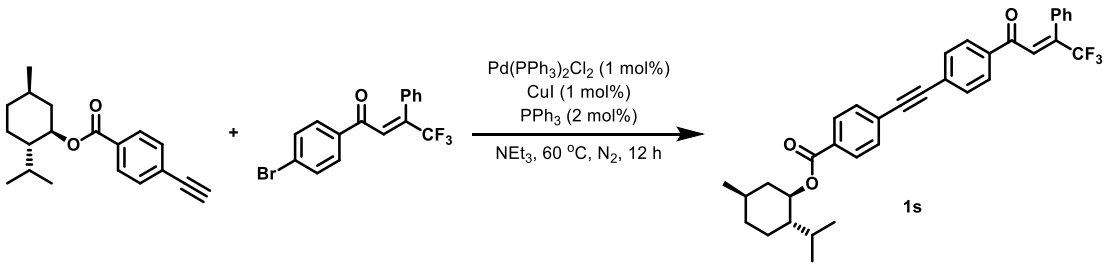
*The trifluoromethyl enones **1** utilized in the reaction are known compounds, which were synthesized by following previously reported methods.*[1-2]

a) General procedure A (GPA)



To a solution of triphenylphosphonium salt (7.5 mmol, 1.5 equiv.) and triethylamine (758.9 mg, 7.5 mmol, 1.5 equiv.) in THF (20 mL) was added a solution of a trifluoromethyl ketone (5.0 mmol, 1 equiv.) in DMF (1.6 mL) at 0 °C (ice bath) under air. The mixture was stirred for 15 min at this temperature. After warming to room temperature, the solution was heated at 80 °C (oil bath) for 3 h. The solution was quenched with saturated aqueous NH_4Cl solution (30 mL) and extracted with ethyl acetate (50 mL x 3). The organic extract was dried over $MgSO_4$ and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate: 100/1) to give the pure trifluoromethylated enones **1a-1r** and **1t-1x**.

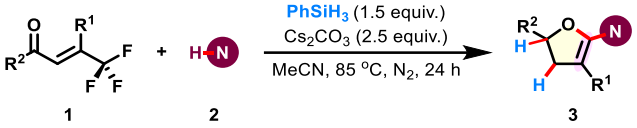
b) General procedure B (GPB)



A solution of (1*R*,2*S*,5*R*)-2-isopropyl-5-methylcyclohexyl 4-ethynylbenzoate (1.4 g, 5.0 mmol, 1 equiv.), (*E*)-1-(4-bromophenyl)-4,4,4-trifluoro-3-phenylbut-2-en-1-one (2.1 g, 6.0 mmol, 1.2 equiv.), bis(triphenylphosphine)palladium(II) chloride (35.0 mg, 0.05 mmol, 1.0 mol%), copper(I) iodide (9.5 mg, 0.05 mmol, 1.0 mol%), and triphenylphosphine (26.2 mg, 0.1 mmol, 2.0 mol%) in NEt_3 (10 mL) was stirred at 60 °C (oil bath) under N_2 for 12 h. The reaction was then quenched by

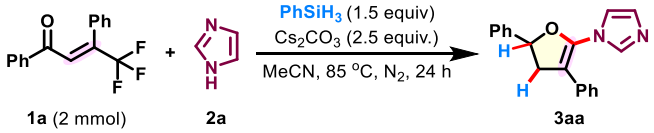
saturated NH_4Cl solution (10 mL) and extracted with EtOAc (20 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash silica gel column chromatography (300-400 mesh) using petroleum ether/ethyl acetate (100/1~50/1) as eluent to afford the pure product **1s** (1.8 g, 64% yield).

General procedure for the synthesis of 2,3-dihydrofurans 3



A solution of trifluoromethyl enone (0.3 mmol, 1 equiv.; **1**), N-nucleophile (0.45 mmol, 1.5 equiv.; **2**), phenylsilane (48.7 mg, 0.45 mmol, 1.5 equiv.), and Cs_2CO_3 (244.4 mg, 0.75 mmol, 2.5 equiv.) in MeCN (3.5 mL) was stirred at 85 °C (oil bath) under nitrogen atmosphere for 24 h. The reaction was then quenched by saturated NH_4Cl solution (10 mL) and extracted with EtOAc (10 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash silica gel column chromatography (300-400 mesh) using petroleum ether/ethyl acetate (10/1~4/1) as eluent to afford the pure product **3**.

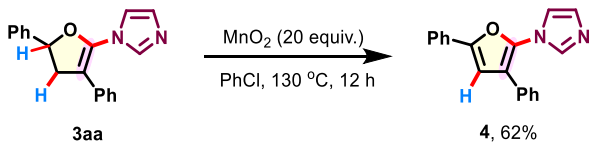
Scale-up synthesis of product 3aa



A solution of (*E*)-4,4,4-trifluoro-1,3-diphenylbut-2-en-1-one (552.5 mg, 2 mmol, 1 equiv.; **1a**), imidazole (204.3 mg, 3 mmol, 1.5 equiv.; **2a**), phenylsilane (324.6 mg, 3 mmol, 1.5 equiv.), and Cs_2CO_3 (1629.2 mg, 5 mmol, 2.5 equiv.) in MeCN (10 mL) was stirred at 85 °C (oil bath) under nitrogen atmosphere for 24 h. The reaction was then quenched by saturated NH_4Cl solution (20 mL) and extracted with EtOAc (20 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash silica gel column chromatography (300-400 mesh) using petroleum ether/ethyl acetate (10/1~4/1) as eluent to afford the pure product **3aa** (496.0 mg, 86% yield).

Further transformations of products 3aa and 3ab

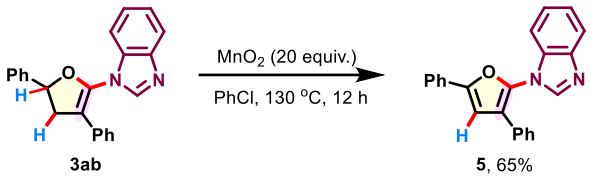
a) Oxidation of product 3aa



A solution of 1-(3,5-diphenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (86.5 mg, 0.3 mmol, 1 equiv.; **3aa**) and MnO_2 (521.6 mg, 6.0 mmol, 20 equiv.) in PhCl (3.5 mL) was stirred at 130 °C (oil bath) under air for 12 h. The reaction was then quenched by saturated NH_4Cl solution (10 mL) and

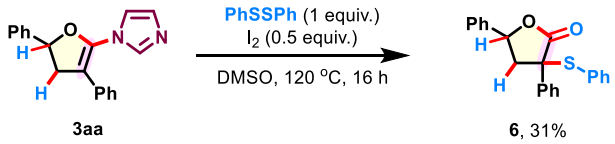
extracted with EtOAc (10 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash silica gel column chromatography (300-400 mesh) using petroleum ether/ethyl acetate (10/1~4/1) as eluent to afford the pure product **4** (53.3 mg, 62% yield).

b) Oxidation of product 3ab



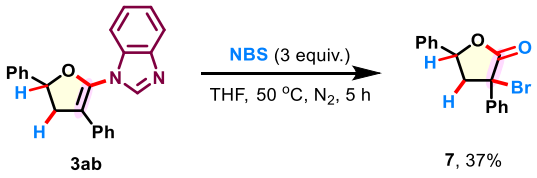
A solution of 1-(3,5-diphenyl-4,5-dihydrofuran-2-yl)-1*H*-benzo[*d*]imidazole (101.5 mg, 0.3 mmol, 1 equiv.; **3ab**) and MnO_2 (521.6 mg, 6.0 mmol, 20 equiv.) in PhCl (3.5 mL) was stirred at 130 °C (oil bath) under air for 12 h. The reaction was then quenched by saturated NH_4Cl solution (10 mL) and extracted with EtOAc (10 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash silica gel column chromatography (300-400 mesh) using petroleum ether/ethyl acetate (10/1~4/1) as eluent to afford the pure product **5** (65.6 mg, 65% yield).

c) The thioetherification of product 3aa



A solution of 1-(3,5-diphenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (86.5 mg, 0.3 mmol, 1 equiv.; **3aa**), diphenyl sulfide (65.5 mg, 0.3 mmol, 1 equiv.), and iodine (19.0 mg, 0.15 mmol, 0.5 equiv.) in DMSO (3.5 mL) was stirred at 120 °C (oil bath) under air for 16 h. The reaction was then quenched by saturated NH_4Cl solution (10 mL) and extracted with EtOAc (10 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash silica gel column chromatography (300-400 mesh) using petroleum ether/ethyl acetate (10/1~4/1) as eluent to afford the pure product **6** (32.2 mg, 31% yield).

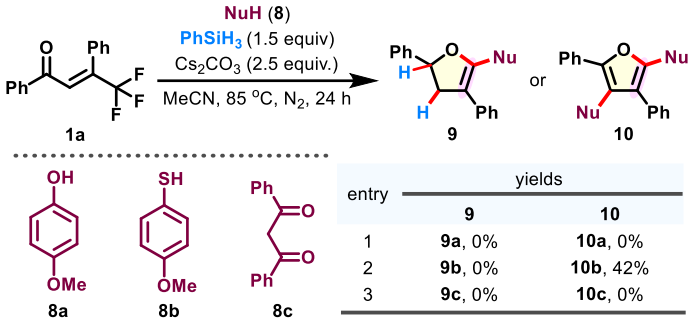
d) The bromination of product 3ab



A solution of 1-(3,5-diphenyl-4,5-dihydrofuran-2-yl)-1*H*-benzo[*d*]imidazole (101.5 mg, 0.3 mmol, 1 equiv.; **3ab**) and NBS (160.2 mg, 0.9 mmol, 3 equiv.) in THF (3.5 mL) was stirred at 50 °C (oil bath) under nitrogen atmosphere for 5 h. The reaction was then quenched by saturated NH_4Cl solution (10 mL) and extracted with EtOAc (10 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. The crude

product was purified by flash silica gel column chromatography (300-400 mesh) using petroleum ether/ethyl acetate (10/1~4/1) as eluent to afford the pure product **7** (35.2 mg, 37% yield).

General procedure for the reactions of trifluoromethyl enone 1a with O-/S-/C-nucleophiles 8

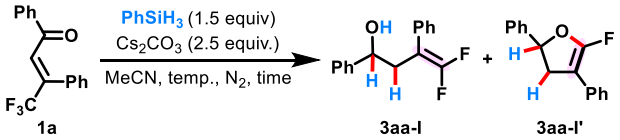


entry	yields	
	9	**10**
1	**9a**, 0%	**10a**, 0%
2	**9b**, 0%	**10b**, 42%
3	**9c**, 0%	**10c**, 0%

A solution of (*E*)-4,4,4-trifluoro-1,3-diphenylbut-2-en-1-one (82.9 mg, 0.3 mmol, 1 equiv.), O-/S-/C-nucleophile (0.45 mmol, 1.5 equiv.; **8**), phenylsilane (48.7 mg, 0.45 mmol, 1.5 equiv.), and Cs_2CO_3 (244.4 mg, 0.75 mmol, 2.5 equiv.) in MeCN (3.5 mL) was stirred at 85 °C (oil bath) under nitrogen atmosphere for 24 h. The reaction was then quenched by saturated NH_4Cl solution (10 mL) and extracted with EtOAc (10 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash silica gel column chromatography (300-400 mesh) using petroleum ether/ethyl acetate (50/1~20/1) as eluent to afford the pure product **10b** (62.6 mg, 42% yield).

Mechanistic studies

a) Hydrodefluorination of trifluoromethylated enone 1a

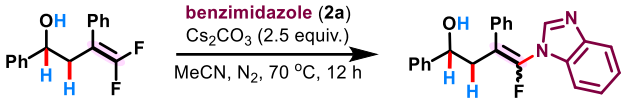


entry	temp. (°C)	time	NMR yield (%)		
			1a	**3aa-I**	**3aa-I'**
1	85	1 h	trace	36	<5
2	70	10 min	21	60	0

A solution of (*E*)-4,4,4-trifluoro-1,3-diphenylbut-2-en-1-one (82.9 mg, 0.3 mmol, 1 equiv.; **1a**), phenylsilane (48.7 mg, 0.45 mmol, 1.5 equiv.), and Cs_2CO_3 (244.4 mg, 0.75 mmol, 2.5 equiv.) in MeCN (3.5 mL) was stirred at 70 or 85 °C (oil bath) under nitrogen atmosphere for 10 min or 1 h. The reaction was then quenched by saturated NH_4Cl solution (10 mL) and extracted with EtOAc (10 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. ^1H NMR analysis of the obtained residue by using 4-fluoroanisole (0.1 mmol) as an internal standard indicated the formation of products **3aa-I** and **3aa-I'**, as well as the presence of residual **1a**.

This result suggested that OH-containing gem-difluoroalkene 3aa-I might be a reaction intermediate.

b) The intermediacy of *gem*-difluoroalkene 3aa-I

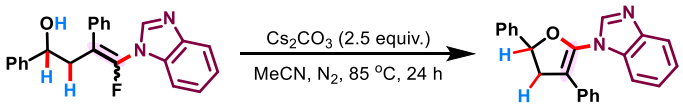


3aa-I **3aa-II**, 87% (*Z*/*E* = 1/11)

A solution of 4,4-difluoro-1,3-diphenylbut-3-en-1-ol (78.1 mg, 0.3 mmol, 1 equiv.; **3aa-I**), benzimidazole (53.2 mg, 0.45 mmol, 1.5 equiv.; **2a**), and Cs_2CO_3 (244.4 mg, 0.75 mmol, 2.5 equiv.) in MeCN (3.5 mL) was stirred at 70 °C (oil bath) under nitrogen atmosphere for 12 h. The reaction was then quenched by saturated NH_4Cl solution (10 mL) and extracted with EtOAc (10 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash silica gel column chromatography (300-400 mesh) using petroleum ether/ethyl acetate (4/1~2/1) as eluent to afford the pure product **3aa-II** (93.5 mg, 87% yield, *Z*/*E* = 1/11).

This result suggested that OH-containing gem-difluoroalkene 3aa-I might be a possible reaction intermediate.

c) The intermediacy of *α*-fluoroenamide 3aa-II

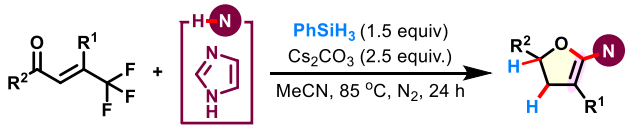


3aa-II **3ab**, 72%

A solution of 4-(1*H*-benzo[*d*]imidazol-1-yl)-4-fluoro-1,3-diphenylbut-3-en-1-ol (107.5 mg, 0.3 mmol, 1 equiv.; **3aa-II**) and Cs_2CO_3 (244.4 mg, 0.75 mmol, 2.5 equiv.) in MeCN (3.5 mL) was stirred at 85 °C (oil bath) under nitrogen atmosphere for 24 h. The reaction was then quenched by saturated NH_4Cl solution (10 mL) and extracted with EtOAc (10 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. The crude product was purified by flash silica gel column chromatography (300-400 mesh) using petroleum ether/ethyl acetate (10/1~4/1) as eluent to afford the pure product **3ab** (73.1 mg, 72% yield).

This result suggested that α-fluoroenamide 3aa-II might be a reaction intermediate.

d) The effect of R^1 substituent on the reactivity of trifluoromethylated enones



1 **2a**

3ua, R^1 = H, R^2 = Ph, 0%
3va, R^1 = Me, R^2 = Ph, trace
3wa, R^1 = Et, R^2 = 4-BrC_6H_4, trace
3xa, R^1 = CF_3, R^2 = Ph, trace

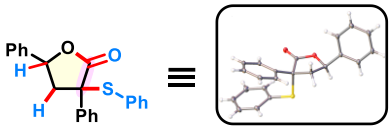
A solution of trifluoromethyl enone (0.3 mmol, 1 equiv.; **1**), imidazole (30.6 mg, 0.45 mmol, 1.5 equiv.; **2a**), phenylsilane (48.7 mg, 0.45 mmol, 1.5 equiv.), and Cs_2CO_3 (244.4 mg, 0.75 mmol, 2.5 equiv.) in MeCN (3.5 mL) was stirred at 85 °C (oil bath) under nitrogen atmosphere for 24 h. The reaction was then quenched by saturated NH_4Cl solution (10 mL) and extracted with EtOAc (10 mL x 3). The organic layer was washed with saturated brine twice, dried over $MgSO_4$, and concentrated under reduced pressure. The residue was directly analyzed by NMR analysis. No desired product

3ua was observed, and only trace amounts of the desired products **3va-xa** were formed. ***This result suggested that the presence of an aryl substituent significantly contributes to electron acceptance into the π-system and subsequent fluoride extrusion.***

The X-ray crystal structure of product 6

The single crystal was grown from the mixed solution of EtOAc/DCM by slowly evaporating the above solvents at room temperature.

3,5-Diphenyl-3-(phenylthio)dihydrofuran-2(3*H*)-one (**6**; displacement ellipsoids are drawn at the 50% probability levels):



6 ≡ CCDC 2335871

Table S1. Crystal data and structure refinement for product **6**.

Identification code	product **6**
Empirical formula	$C_{22}H_{18}O_2S$
Formula weight	346.42
Temperature/K	293.15
Crystal system	monoclinic
Space group	Pn
a/Å	11.5209(2)
b/Å	6.01778(11)
c/Å	12.8734(2)
α/°	90
β/°	98.9962(16)
γ/°	90
Volume/Å^3	881.53(3)
Z	2
ρ_{calc}g/cm^3	1.305
μ/mm^{-1}	1.717
F(000)	364.0
Crystal size/mm^3	0.14 × 0.13 × 0.12
Radiation	Cu Kα (λ = 1.54184)
2Θ range for data collection/°	15.574 to 152.288
Index ranges	$-14 \le h \le 14$, $-5 \le k \le 7$, $-16 \le l \le 16$
Reflections collected	5356
Independent reflections	2786 [R_{int} = 0.0171, R_{sigma} = 0.0156]
Data/restraints/parameters	2786/2/226
Goodness-of-fit on F^2	1.066

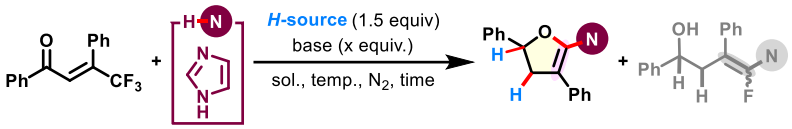
Final R indexes [I>=2σ (I)]	R_1 = 0.0331, wR_2 = 0.0910
Final R indexes [all data]	R_1 = 0.0332, wR_2 = 0.0912
Largest diff. peak/hole/e Å^{-3}	0.21/-0.26
Flack parameter	0.046(11)

Crystal structure determination of product 6.

Crystal Data for $C_{22}H_{18}O_2S$ (M =346.42 g/mol): monoclinic, space group Pn (no. 7), a = 11.5209(2) Å, b = 6.01778(11) Å, c = 12.8734(2) Å, β = 98.9962(16)°, V = 881.53(3) Å^3, Z = 2, T = 293.15 K, μ(Cu Kα) = 1.717 mm^{-1}, *Dcalc* = 1.305 g/cm^3, 5356 reflections measured (15.574° ≤ 2Θ ≤ 152.288°), 2786 unique (R_{int} = 0.0171, R_{sigma} = 0.0156) which were used in all calculations. The final R_1 was 0.0331 (I > 2σ(I)) and wR_2 was 0.0912 (all data).

Optimization of the reaction conditions

Table S2. Optimization of reaction conditions[a]

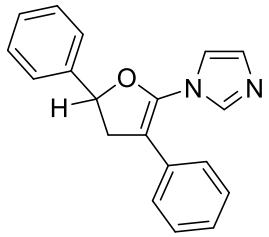


1a 2a 3aa 3aa'

Entry	*H*-source	Base (x equiv)	Temp. (°C)	Solvent	Time (h)	Yield (%)[b]	
						3aa	**3aa'** (*Z*/*E*)[c]
1	$PhSiH_3$	Cs_2CO_3 (2.5)	70	MeCN	12	12	55 (1/8)
2	$PhSiH_3$	Cs_2CO_3 (2.5)	70	MeCN	24	15	60 (1/11)
3	$PhSiH_3$	Cs_2CO_3 (2.5)	70	MeCN	2	4	83 (1/7)
4	$PhSiH_3$	Cs_2CO_3 (2.5)	70	MeCN	1	5	62 (1/11)
5	$PhSiH_3$	Cs_2CO_3 (2.5)	70/85	MeCN	2/24	61	21 (1/6)
6	**$PhSiH_3$**	**Cs_2CO_3 (2.5)**	**85**	**MeCN**	**24**	**83 (80)[d]**	**6 (1/5)**
7	$PhSiH_3$	Cs_2CO_3 (2.5)	85	DMF	24	53	trace
8	$PhSiH_3$	Cs_2CO_3 (2.5)	85	DMSO	24	52	trace
9	$PhSiH_3$	Cs_2CO_3 (2.5)	85	THF	24	22	41 (1/2)
10	$PhSiH_3$	Cs_2CO_3 (2.5)	100	Toluene	24	trace	41 (1/2)
11	$PhSiH_3$	CsF (2.5)	85	MeCN	24	78	8 (1/8)
12	$PhSiH_3$	K_2CO_3 (2.5)	85	MeCN	24	trace	38 (1/11)
13	$PhSiH_3$	LiOH (2.5)	85	MeCN	24	trace	22 (1/50)
14	$PhSiH_3$	DABCO (2.5)	85	MeCN	24	trace	trace
15	$PhSiH_3$	Cs_2CO_3 (3.5)	85	MeCN	24	58	trace
16	$PhSiH_3$	Cs_2CO_3 (1.5)	85	MeCN	24	51	33 (1/4)
17	$PhMe_2SiH$	Cs_2CO_3 (2.5)	85	MeCN	24	trace	trace
18	$NaBH_4$	Cs_2CO_3 (2.5)	85	MeCN	24	24	23 (1/3)
19	$LiAlH_4$	Cs_2CO_3 (2.5)	85	MeCN	24	trace	trace
20	$HP(O)Ph_2$	Cs_2CO_3 (2.5)	85	MeCN	24	trace	trace
21	Rongalite	Cs_2CO_3 (2.5)	85	MeCN	24	trace	trace
22	$PhSiH_3$	Cs_2CO_3 (2.5)	85	MeCN	36	35	30 (1/5)

[a] Reaction conditions: **1a** (0.3 mmol), **2a** (0.45 mmol), *H*-source (0.45 mmol), and base (0.45-1.05 mmol) in solvent (3.5 mL) at 70-100 °C under N_2 for 1-36 h. [b] Yields were determined by ^{19}F NMR analysis with 4-fluoroanisole (0.1 mmol) as an internal standard. [c] *Z*/*E* ratio was given in parentheses. [d] Isolated yield.

Characterization data for products



1-(3,5-Diphenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3aa):

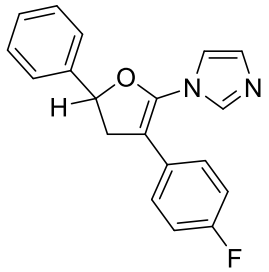
Yield = 80% (69.2 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.65 (s, 1H), 7.39 (dd, *J* = 8.2, 1.2 Hz, 2H), 7.37–7.32 (m, 2H), 7.31–7.27 (m, 1H), 7.22–7.16 (m, 2H), 7.13–7.08 (m, 1H), 7.05 (d, *J* = 6.1 Hz, 2H), 6.97–6.92 (m, 2H), 5.74–5.65 (m, 1H), 3.53 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.24 (dd, *J* = 14.6, 8.7 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 141.1, 140.6, 136.6, 132.4, 129.9, 128.9, 128.8, 128.5, 127.0, 126.4, 125.8, 118.1, 100.8, 80.7, 41.8 ppm.

HRMS (m/z): calcd for $C_{19}H_{17}N_2O$ $[M+H]^+$ 289.1335, found: 289.1331.



1-(3-(4-Fluorophenyl)-5-phenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3ba):

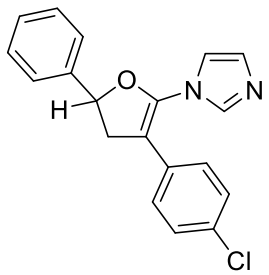
Yield = 81% (74.4 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.71 (s, 1H), 7.49–7.41 (m, 4H), 7.39–7.35 (m, 1H), 7.15–7.12 (m, 1H), 7.10–7.09 (m, 1H), 6.99–6.95 (m, 4H), 5.82–5.75 (m, 1H), 3.59 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.29 (dd, *J* = 14.6, 8.7 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 161.6 (d, *J* = 247.2 Hz), 141.0, 140.5, 136.5, 130.0, 129.0, 128.6, 128.0 (d, *J* = 7.9 Hz), 125.8, 118.0, 116.0, 115.7, 99.9, 80.7, 41.9 ppm.

HRMS (m/z): calcd for $C_{19}H_{16}FN_2O$ $[M+H]^+$ 307.1241, found: 307.1236.

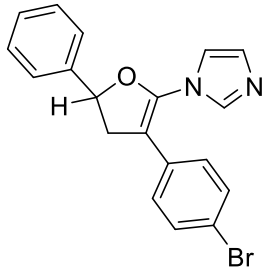


1-(3-(4-Chlorophenyl)-5-phenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3ca):

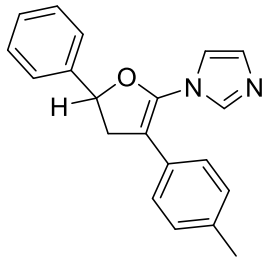
Yield = 90% (87.2 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

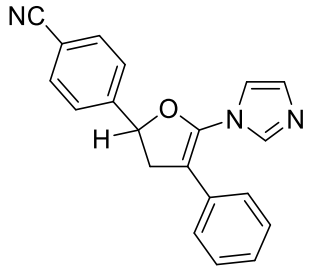
^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.71 (s, 1H), 7.49–7.41 (m, 4H), 7.40–7.35 (m, 1H), 7.25–7.21 (m, 2H), 7.14 (s, 1H), 7.09 (s, 1H), 6.97–6.91 (m, 2H), 5.83–5.75 (m, 1H), 3.58 (dd, *J* = 14.5, 10.2 Hz, 1H), 3.29 (dd, *J* = 14.5, 8.8 Hz, 1H) ppm.
^{13}C NMR (100 MHz, $CDCl_3$): δ = 141.0, 140.8, 136.5, 134.2, 132.5, 130.9, 130.1, 129.0, 128.6, 127.5, 125.8, 118.0, 99.9, 80.8, 41.6 ppm.
HRMS (m/z): calcd for $C_{19}H_{16}ClN_2O$ $[M+H]^+$ 323.0946, found: 323.0941.



1-(3-(4-Bromophenyl)-5-phenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3da):
Yield = 89% (98.1 mg). Yellow oil.
Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).
^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.71 (s, 1H), 7.50–7.42 (m, 4H), 7.40 (d, *J* = 8.9 Hz, 3H), 7.11 (d, *J* = 19.2 Hz, 2H), 6.87 (d, *J* = 8.5 Hz, 2H), 5.79 (t, *J* = 9.5 Hz, 1H), 3.57 (dd, *J* = 14.5, 10.2 Hz, 1H), 3.29 (dd, *J* = 14.5, 8.8 Hz, 1H) ppm.
^{13}C NMR (100 MHz, $CDCl_3$): δ = 141.1, 140.7, 136.4, 131.9, 131.4, 130.1, 129.0, 128.6, 127.8, 125.8, 120.5, 118.0, 99.9, 80.8, 41.5 ppm.
HRMS (m/z): calcd for $C_{19}H_{16}BrN_2O$ $[M+H]^+$ 367.0441, found: 367.0443.



1-(5-Phenyl-3-(*p*-tolyl)-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3ea):
Yield = 56% (50.8 mg). Yellow oil.
Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).
^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.72 (s, 1H), 7.49–7.41 (m, 4H), 7.39–7.35 (m, 1H), 7.14–7.07 (m, 4H), 6.92 (d, *J* = 8.1 Hz, 2H), 5.77 (t, *J* = 9.4 Hz, 1H), 3.59 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.30 (dd, *J* = 14.6, 8.7 Hz, 1H), 2.32 (s, 3H) ppm.
^{13}C NMR (100 MHz, $CDCl_3$): δ = 141.2, 140.0, 136.8, 136.6, 129.8, 129.5, 129.4, 128.9, 128.5, 126.3, 125.8, 118.1, 100.8, 80.6, 41.7, 21.2 ppm.
HRMS (m/z): calcd for $C_{20}H_{19}N_2O$ $[M+H]^+$ 303.1492, found: 303.1488.



4-(5-(1*H*-Imidazol-1-yl)-4-phenyl-2,3-dihydrofuran-2-yl)benzonitrile (3fa):

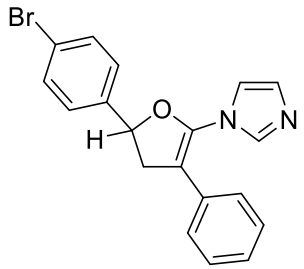
Yield = 91% (85.5 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.82–7.76 (m, 3H), 7.65 (d, *J* = 8.2 Hz, 2H), 7.38–7.32 (m, 2H), 7.31–7.27 (m, 1H), 7.24–7.18 (m, 2H), 7.12–7.07 (m, 2H), 5.95–5.88 (m, 1H), 3.76 (dd, *J* = 14.6, 10.4 Hz, 1H), 3.33 (dd, *J* = 14.6, 8.6 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 146.3, 140.3, 136.4, 132.8, 131.8, 130.0, 128.8, 127.3, 126.34, 126.27, 118.5, 118.0, 112.2, 100.7, 79.4, 41.8 ppm.

HRMS (m/z): calcd for $C_{20}H_{16}N_3O$ $[M+H]^+$ 314.1288, found: 314.1283.



1-(5-(4-Bromophenyl)-3-phenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3ga):

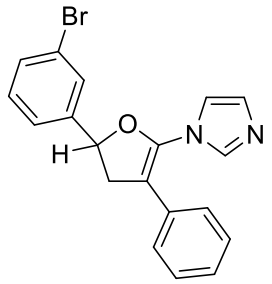
Yield = 88% (97.0 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.80 (s, 1H), 7.66–7.61 (m, 2H), 7.43 (d, *J* = 8.4 Hz, 2H), 7.35 (t, *J* = 7.4 Hz, 2H), 7.31–7.27 (m, 1H), 7.20 (d, *J* = 12.0 Hz, 2H), 7.12–7.08 (m, 2H), 5.82 (t, *J* = 9.4 Hz, 1H), 3.69 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.35 (dd, *J* = 14.6, 8.7 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 140.4, 140.1, 136.5, 132.1, 132.0, 129.9, 128.8, 127.5, 127.1, 126.3, 122.4, 118.0, 100.7, 80.0, 41.7 ppm.

HRMS (m/z): calcd for $C_{19}H_{16}BrN_2O$ $[M+H]^+$ 367.0441, found: 367.0439.

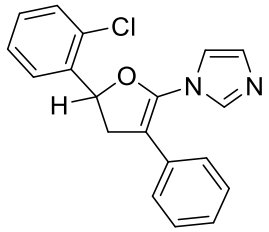


1-(5-(3-Bromophenyl)-3-phenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3ha):

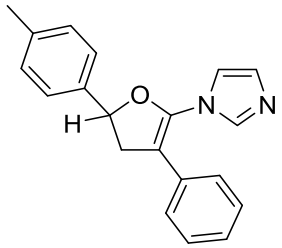
Yield = 83% (91.4 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

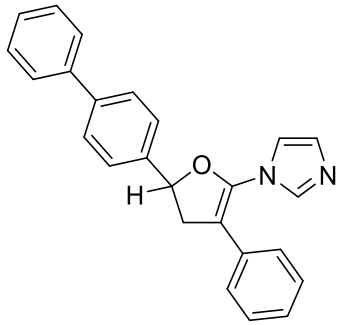
^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.74–7.71 (m, 1H), 7.61 (t, *J* = 1.7 Hz, 1H), 7.50–7.48 (m, 1H), 7.39 (d, *J* = 7.8 Hz, 1H), 7.28 (dd, *J* = 8.5, 1.4 Hz, 2H), 7.25 (d, *J* = 1.4 Hz, 1H), 7.22–7.18 (m, 1H), 7.15–7.13 (m, 1H), 7.11 (t, *J* = 1.3 Hz, 1H), 7.03–7.00 (m, 2H), 5.77–5.71 (m, 1H), 3.60 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.28 (dd, *J* = 14.6, 8.8 Hz, 1H) ppm.
^{13}C NMR (100 MHz, $CDCl_3$): δ = 143.3, 140.4, 136.6, 136.5, 132.1, 131.5, 130.6, 130.0, 128.9, 127.1, 126.4, 124.4, 123.0, 118.1, 100.8, 79.7, 41.8 ppm.
HRMS (m/z): calcd for $C_{19}H_{16}BrN_2O$ $[M+H]^+$ 367.0441, found: 367.0438.



1-(5-(2-Chlorophenyl)-3-phenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3ia):
Yield = 89% (86.2 mg). Yellow oil.
Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).
^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.75 (s, 1H), 7.61–7.57 (m, 1H), 7.42 (dd, *J* = 7.7, 1.4 Hz, 1H), 7.34 (dd, *J* = 7.4, 1.3 Hz, 1H), 7.32–7.26 (m, 2H), 7.25 (d, *J* = 1.4 Hz, 1H), 7.20–7.15 (m, 3H), 7.03–6.98 (m, 2H), 6.06 (dd, *J* = 10.3, 8.3 Hz, 1H), 3.80 (dd, *J* = 14.8, 10.4 Hz, 1H), 3.13 (dd, *J* = 14.8, 8.3 Hz, 1H) ppm.
^{13}C NMR (100 MHz, $CDCl_3$): δ = 140.3, 139.1, 136.5, 132.1, 131.3, 130.0, 129.9, 129.3, 128.8, 127.3, 127.1, 126.4, 126.2, 118.1, 100.9, 77.7, 41.1 ppm.
HRMS (m/z): calcd for $C_{19}H_{16}ClN_2O$ $[M+H]^+$ 323.0946, found: 323.0941.



1-(3-Phenyl-5-(*p*-tolyl)-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3ja):
Yield = 78% (70.8 mg). Yellow oil.
Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).
^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.72 (s, 1H), 7.38 (d, *J* = 8.1 Hz, 2H), 7.29–7.27 (m, 1H), 7.26–7.17 (m, 4H), 7.12 (d, *J* = 6.0 Hz, 2H), 7.05–7.01 (m, 2H), 5.75 (t, *J* = 9.5 Hz, 1H), 3.58 (dd, *J* = 14.6, 10.1 Hz, 1H), 3.32 (dd, *J* = 14.6, 8.8 Hz, 1H), 2.39 (s, 3H) ppm.
^{13}C NMR (100 MHz, $CDCl_3$): δ = 140.6, 138.4, 138.0, 136.6, 132.5, 129.8, 129.6, 128.8, 126.9, 126.3, 125.9, 118.1, 100.8, 80.8, 41.7, 21.3 ppm.
HRMS (m/z): calcd for $C_{20}H_{19}N_2O$ $[M+H]^+$ 303.1492, found: 303.1487.



1-(5-([1,1'-Biphenyl]-4-yl)-3-phenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3ka):

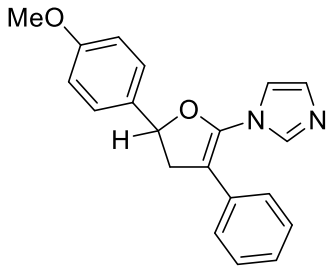
Yield = 94% (102.8 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.76 (s, 1H), 7.70–7.66 (m, 2H), 7.64–7.61 (m, 2H), 7.59–7.55 (m, 2H), 7.50–7.46 (m, 2H), 7.41–7.37 (m, 1H), 7.33–7.27 (m, 2H), 7.24–7.19 (m, 1H), 7.16–7.14 (m, 2H), 7.07–7.05 (m, 2H), 5.88–5.81 (m, 1H), 3.65 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.38 (dd, *J* = 14.6, 8.8 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 141.5, 140.6, 140.5, 140.0, 136.5, 132.4, 129.9, 128.9, 128.8, 127.7, 127.6, 127.2, 127.0, 126.34, 126.33, 118.1, 100.8, 80.5, 41.7 ppm.

HRMS (m/z): calcd for $C_{25}H_{21}N_2O$ $[M+H]^+$ 365.1648, found: 365.1643.



1-(5-(4-Methoxyphenyl)-3-phenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3la):

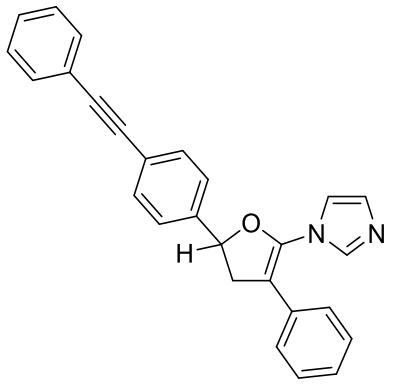
Yield = 58% (55.4 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.79 (s, 1H), 7.51 (d, *J* = 8.7 Hz, 2H), 7.36 (dd, *J* = 9.2, 5.7 Hz, 2H), 7.29 (d, *J* = 7.3 Hz, 1H), 7.19 (d, *J* = 6.3 Hz, 2H), 7.14–7.10 (m, 2H), 7.04 (d, *J* = 8.7 Hz, 2H), 5.82 (t, *J* = 9.5 Hz, 1H), 3.92 (s, 3H), 3.64 (dd, *J* = 14.6, 10.1 Hz, 1H), 3.42 (dd, *J* = 14.6, 8.9 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 159.9, 140.5, 136.6, 132.9, 132.5, 129.8, 128.8, 127.5, 126.9, 126.3, 118.1, 114.3, 100.8, 80.8, 55.5, 41.6 ppm.

HRMS (m/z): calcd for $C_{20}H_{19}N_2O_2$ $[M+H]^+$ 319.1441, found: 319.1443.



1-(3-Phenyl-5-(4-(phenylethynyl)phenyl)-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3ma):

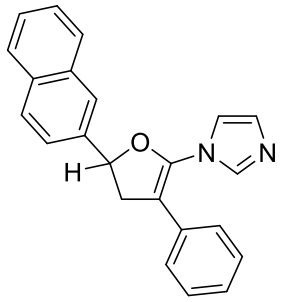
Yield = 87% (101.4 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.70 (s, 1H), 7.58–7.51 (m, 4H), 7.41 (d, *J* = 8.2 Hz, 2H), 7.32 (d, *J* = 2.0 Hz, 3H), 7.24 (dd, *J* = 7.2, 6.0 Hz, 2H), 7.19–7.14 (m, 1H), 7.12–7.08 (m, 2H), 7.02–6.98 (m, 2H), 5.75 (t, *J* = 9.5 Hz, 1H), 3.57 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.26 (dd, *J* = 14.6, 8.8 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 141.0, 140.5, 136.5, 132.2, 132.1, 131.7, 129.9, 128.8, 128.51, 128.47, 127.0, 126.3, 125.9, 123.5, 123.1, 118.1, 100.8, 90.1, 89.0, 80.3, 41.7 ppm.

HRMS (m/z): calcd for $C_{27}H_{21}N_2O$ $[M+H]^+$ 389.1648, found: 389.1651.



1-(5-(Naphthalen-2-yl)-3-phenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3na):

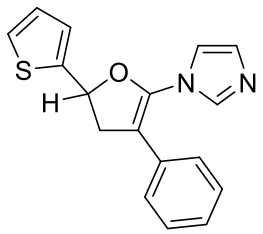
Yield = 82% (83.2 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.95–7.86 (m, 4H), 7.80 (s, 1H), 7.60 (dd, *J* = 8.5, 1.7 Hz, 1H), 7.56–7.50 (m, 2H), 7.30 (t, *J* = 7.5 Hz, 2H), 7.24–7.16 (m, 3H), 7.09–7.04 (m, 2H), 5.95 (t, *J* = 9.5 Hz, 1H), 3.66 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.42 (dd, *J* = 14.6, 8.9 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 140.6, 138.2, 136.6, 133.24, 133.15, 132.3, 129.9, 129.0, 128.8, 128.1, 127.8, 126.9, 126.6, 126.5, 126.3, 124.9, 123.4, 118.1, 100.8, 80.9, 41.7 ppm.

HRMS (m/z): calcd for $C_{23}H_{19}N_2O$ $[M+H]^+$ 339.1492, found: 339.1490.



1-(3-Phenyl-5-(thiophen-2-yl)-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3oa):

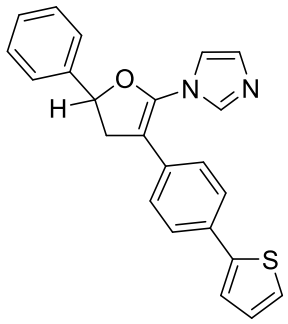
Yield = 84% (74.2 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.75 (s, 1H), 7.41 (dd, *J* = 5.1, 1.1 Hz, 1H), 7.37–7.32 (m, 2H), 7.30–7.27 (m, 1H), 7.24 (dd, *J* = 5.3, 2.3 Hz, 1H), 7.16 (d, *J* = 13.5 Hz, 2H), 7.12–7.08 (m, 3H), 6.04 (dd, *J* = 9.4, 8.0 Hz, 1H), 3.72 (dd, *J* = 14.7, 9.8 Hz, 1H), 3.47 (dd, *J* = 14.7, 7.7 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 143.6, 140.1, 136.5, 132.2, 129.9, 128.8, 127.02, 126.98, 126.3, 126.1, 125.8, 118.1, 101.0, 76.6, 41.8 ppm.

HRMS (m/z): calcd for $C_{17}H_{15}N_2OS$ $[M+H]^+$ 295.0900, found: 295.0905.



1-(5-Phenyl-3-(4-(thiophen-2-yl)phenyl)-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3pa):

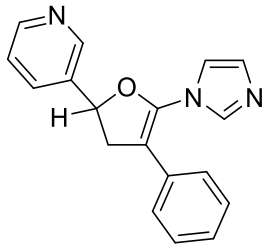
Yield = 84% (93.4 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.71 (s, 1H), 7.51–7.41 (m, 5H), 7.37 (dd, *J* = 8.1, 4.4 Hz, 4H), 7.11 (d, *J* = 16.6 Hz, 3H), 6.91–6.83 (m, 2H), 5.82–5.76 (m, 1H), 3.58 (dd, *J* = 14.5, 10.2 Hz, 1H), 3.30 (dd, *J* = 14.5, 8.8 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 141.1, 140.7, 136.5, 134.6, 134.4, 133.9, 133.7, 131.9, 131.4, 130.1, 129.0, 128.6, 127.8, 125.8, 120.6, 118.0, 99.9, 80.8, 41.5 ppm.

HRMS (m/z): calcd for $C_{23}H_{19}N_2OS$ $[M+H]^+$ 371.1213, found: 371.1210.

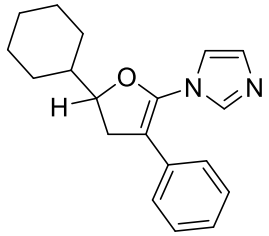


3-(5-(1*H*-Imidazol-1-yl)-4-phenyl-2,3-dihydrofuran-2-yl)pyridine (3qa):

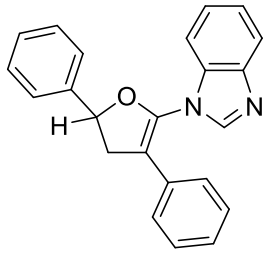
Yield = 61% (52.9 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

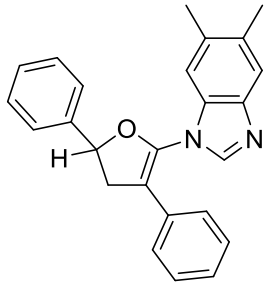
^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.79 (d, *J* = 1.7 Hz, 1H), 8.73–8.69 (m, 1H), 7.90 (d, *J* = 7.9 Hz, 1H), 7.80 (s, 1H), 7.44 (dd, *J* = 7.8, 4.8 Hz, 1H), 7.35 (t, *J* = 7.5 Hz, 2H), 7.29 (d, *J* = 7.3 Hz, 1H), 7.20 (d, *J* = 11.9 Hz, 2H), 7.10 (d, *J* = 7.3 Hz, 2H), 5.89 (t, *J* = 9.4 Hz, 1H), 3.74 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.38 (dd, *J* = 14.6, 8.6 Hz, 1H) ppm.
^{13}C NMR (100 MHz, $CDCl_3$): δ = 150.0, 147.7, 140.4, 139.6, 136.5, 133.4, 131.9, 130.0, 128.9, 127.2, 126.4, 123.8, 118.0, 100.7, 78.4, 41.6 ppm.
HRMS (m/z): calcd for $C_{18}H_{16}N_3O$ $[M+H]^+$ 290.1288, found: 290.1283.



1-(5-Cyclohexyl-3-phenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3ra):
Yield = 42% (37.1 mg). Yellow oil.
Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).
^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.75 (s, 1H), 7.38–7.34 (m, 2H), 7.30–7.27 (m, 1H), 7.21 (s, 1H), 7.15 (s, 1H), 7.10–7.07 (m, 2H), 4.66–4.59 (m, 1H), 3.30–3.10 (m, 2H), 2.09 (d, *J* = 12.7 Hz, 1H), 1.95–1.79 (m, 5H), 1.45–1.34 (m, 4H), 1.27–1.16 (m, 1H) ppm.
^{13}C NMR (100 MHz, $CDCl_3$): δ = 140.8, 136.5, 132.9, 129.7, 128.8, 126.6, 126.2, 118.1, 100.9, 84.1, 43.0, 36.7, 28.4, 28.1, 26.5, 25.9, 25.8 ppm.
HRMS (m/z): calcd for $C_{19}H_{23}N_2O$ $[M+H]^+$ 295.1805, found: 295.1804.



1-(3,5-Diphenyl-4,5-dihydrofuran-2-yl)-1*H*-benzo[*d*]imidazole (3ab):
Yield = 71% (72.1 mg). Yellow oil.
Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 2/1).
^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.06–8.05 (m, 1H), 7.88–7.86 (m, 1H), 7.57–7.52 (m, 2H), 7.48–7.43 (m, 2H), 7.41–7.38 (m, 1H), 7.37–7.32 (m, 2H), 7.30–7.27 (m, 1H), 7.22–7.14 (m, 3H), 6.99–6.93 (m, 2H), 5.92–5.84 (m, 1H), 3.77–3.70 (m, 1H), 3.48–3.42 (m, 1H) ppm.
^{13}C NMR (100 MHz, $CDCl_3$): δ = 143.5, 142.0, 141.1, 140.2, 132.32, 132.28, 132.2, 129.0, 128.8, 128.6, 126.9, 125.9, 124.3, 123.4, 120.6, 112.2, 103.5, 80.7, 41.2 ppm.
HRMS (m/z): calcd for $C_{23}H_{19}N_2O$ $[M+H]^+$ 339.1492, found: 339.1491.



1-(3,5-Diphenyl-4,5-dihydrofuran-2-yl)-5,6-dimethyl-1*H*-benzo[*d*]imidazole (3ac):

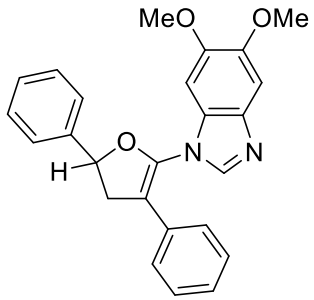
Yield = 68% (74.8 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.90 (s, 1H), 7.62 (s, 1H), 7.57–7.53 (m, 2H), 7.49–7.43 (m, 2H), 7.41–7.36 (m, 1H), 7.22–7.14 (m, 4H), 6.99–6.92 (m, 2H), 5.88 (t, *J* = 9.5 Hz, 1H), 3.72 (dd, *J* = 14.7, 10.2 Hz, 1H), 3.44 (dd, *J* = 14.7, 8.8 Hz, 1H), 2.38 (s, 3H), 2.31 (s, 3H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 142.0, 141.2, 140.5, 134.3, 133.5, 132.32, 132.30, 130.9, 128.9, 128.7, 128.5, 126.7, 125.92, 125.87, 120.5, 112.2, 103.4, 80.6, 41.1, 20.6, 20.4 ppm.

HRMS (m/z): calcd for $C_{25}H_{23}N_2O$ $[M+H]^+$ 367.1805, found: 367.1808.



1-(3,5-Diphenyl-4,5-dihydrofuran-2-yl)-5,6-dimethoxy-1*H*-benzo[*d*]imidazole (3ad):

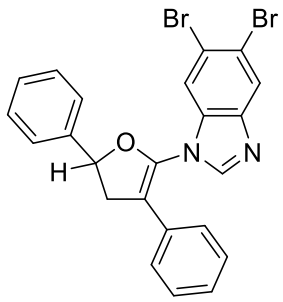
Yield = 59% (70.5 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.93 (s, 1H), 7.56–7.52 (m, 2H), 7.47–7.41 (m, 2H), 7.40–7.35 (m, 1H), 7.28 (s, 1H), 7.21–7.13 (m, 3H), 6.96–6.92 (m, 2H), 6.57 (s, 1H), 5.86 (dd, *J* = 10.1, 8.4 Hz, 1H), 3.91 (s, 3H), 3.75 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.61 (s, 3H), 3.44 (dd, *J* = 14.7, 8.3 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 147.8, 147.2, 141.1, 140.22, 140.18, 136.7, 132.4, 129.0, 128.7, 128.6, 126.8, 126.1, 125.9, 125.6, 102.3, 102.0, 94.9, 80.5, 56.3, 56.0, 41.0 ppm.

HRMS (m/z): calcd for $C_{25}H_{23}N_2O_3$ $[M+H]^+$ 399.1703, found: 399.1701.



5,6-Dibromo-1-(3,5-diphenyl-4,5-dihydrofuran-2-yl)-1*H*-benzo[*d*]imidazole (3ae):

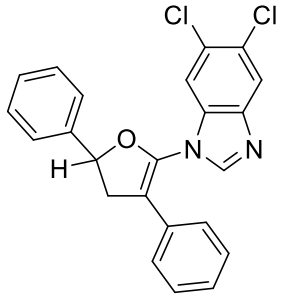
Yield = 56% (83.4 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.12 (d, *J* = 1.8 Hz, 1H), 7.99 (d, *J* = 1.1 Hz, 1H), 7.66–7.62 (m, 1H), 7.53 (d, *J* = 7.9 Hz, 2H), 7.47 (t, *J* = 7.4 Hz, 2H), 7.42 (d, *J* = 7.2 Hz, 1H), 7.25–7.19 (m, 3H), 6.93 (d, *J* = 7.5 Hz, 2H), 5.90 (t, *J* = 9.6 Hz, 1H), 3.70 (dd, *J* = 14.8, 10.2 Hz, 1H), 3.48 (dd, *J* = 14.8, 9.1 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 143.6, 140.6, 139.0, 134.1, 132.2, 131.6, 129.0, 128.9, 128.7, 127.8, 127.3, 125.9 (d, *J* = 3.0 Hz), 124.9, 119.8, 118.9, 116.8, 104.2, 81.1, 41.0 ppm.

HRMS (m/z): calcd for $C_{23}H_{17}Br_2N_2O$ $[M+H]^+$ 494.9702, found: 494.9701.



5,6-Dichloro-1-(3,5-diphenyl-4,5-dihydrofuran-2-yl)-1*H*-benzo[*d*]imidazole (3af):

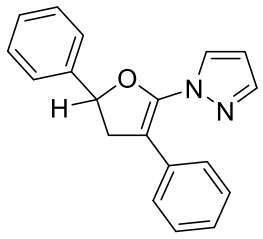
Yield = 40% (48.9 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.00 (s, 1H), 7.91 (s, 1H), 7.53–7.50 (m, 2H), 7.47–7.41 (m, 4H), 7.25–7.21 (m, 2H), 7.19 (dd, *J* = 3.4, 2.0 Hz, 1H), 6.91 (dd, *J* = 8.1, 1.3 Hz, 2H), 5.88 (t, *J* = 9.6 Hz, 1H), 3.69 (dd, *J* = 14.8, 10.2 Hz, 1H), 3.46 (dd, *J* = 14.8, 9.1 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 143.7, 142.7, 140.6, 139.1, 131.7, 131.4, 129.1, 129.0, 128.8, 128.5, 127.7, 127.3, 125.98, 125.96, 121.8, 113.7, 104.2, 81.1, 41.1 ppm.

HRMS (m/z): calcd for $C_{23}H_{17}Cl_2N_2O$ $[M+H]^+$ 407.0712, found: 407.0713.



1-(3,5-Diphenyl-4,5-dihydrofuran-2-yl)-1*H*-pyrazole (3ag):

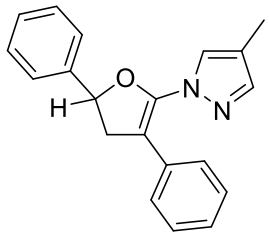
Yield = 51% (44.1 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.71 (d, *J* = 1.5 Hz, 1H), 7.56 (d, *J* = 2.5 Hz, 1H), 7.46 (d, *J* = 7.3 Hz, 2H), 7.35 (t, *J* = 7.4 Hz, 2H), 7.28 (dd, *J* = 5.9, 3.7 Hz, 1H), 7.17 (t, *J* = 7.4 Hz, 2H), 7.09 (dd, *J* = 8.3, 6.4 Hz, 1H), 6.91 (s, 2H), 6.35–6.33 (m, 1H), 5.79–5.72 (m, 1H), 3.57 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.28 (dd, *J* = 14.6, 8.8 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 143.2, 142.0, 141.3, 132.6, 130.8, 128.8, 128.4, 128.3, 126.6, 126.4, 125.9, 107.3, 102.1, 80.5, 41.6 ppm.

HRMS (m/z): calcd for $C_{19}H_{17}N_2O$ $[M+H]^+$ 289.1330, found: 289.1332.



1-(3,5-Diphenyl-4,5-dihydrofuran-2-yl)-4-methyl-1*H*-pyrazole (3ah):

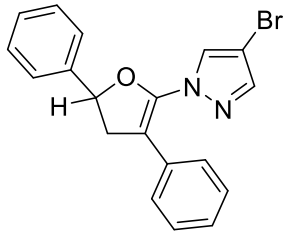
Yield = 55% (49.9 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.51 (s, 1H), 7.47–7.42 (m, 2H), 7.37–7.31 (m, 3H), 7.29–7.27 (m, 1H), 7.19–7.15 (m, 2H), 7.11–7.06 (m, 1H), 6.95 (dd, *J* = 8.3, 1.2 Hz, 2H), 5.75–5.68 (m, 1H), 3.55 (dd, *J* = 14.5, 10.2 Hz, 1H), 3.26 (dd, *J* = 14.5, 8.7 Hz, 1H), 2.04 (s, 3H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 143.3, 142.8, 141.4, 132.8, 128.84, 128.75, 128.3, 128.2, 126.39, 126.35, 125.9, 117.8, 101.2, 80.3, 41.6, 8.9 ppm.

HRMS (m/z): calcd for $C_{20}H_{19}N_2O$ $[M+H]^+$ 303.1492, found: 303.1489.



4-Bromo-1-(3,5-diphenyl-4,5-dihydrofuran-2-yl)-1*H*-pyrazole (3ai):

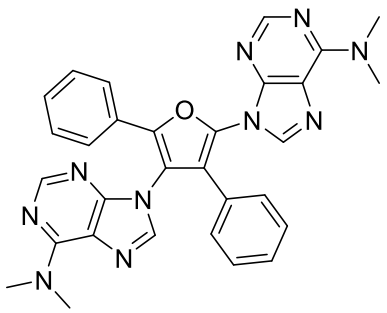
Yield = 48% (52.9 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.61 (dd, *J* = 12.2, 1.2 Hz, 2H), 7.45–7.40 (m, 2H), 7.34 (t, *J* = 6.6 Hz, 2H), 7.31–7.27 (m, 1H), 7.22–7.17 (m, 2H), 7.14–7.10 (m, 1H), 6.99–6.93 (m, 2H), 5.73 (t, *J* = 9.5 Hz, 1H), 3.56 (dd, *J* = 14.7, 10.2 Hz, 1H), 3.28 (dd, *J* = 14.7, 8.8 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 150.7, 142.5, 141.0, 132.1, 130.5, 128.9, 128.5, 128.4, 126.9, 126.5, 125.9, 102.5, 95.4, 80.7, 41.6 ppm.

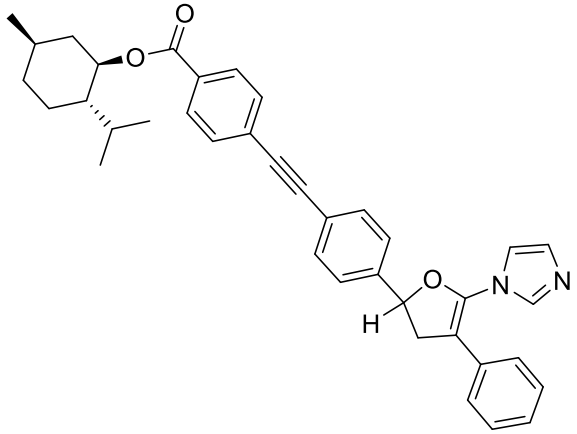
HRMS (m/z): calcd for $C_{19}H_{16}BrN_2O$ $[M+H]^+$ 367.0441, found: 367.0440.



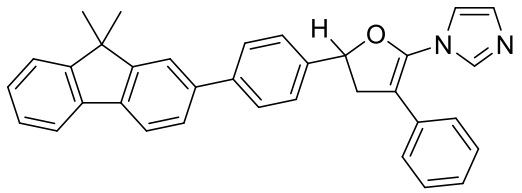
9,9'-(3,5-Diphenylfuran-2,4-diyl)bis(*N*,*N*-dimethyl-9*H*-purin-6-amine) (3aj):

Yield = 30% (48.8 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 1/1).
^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.45 (s, 1H), 8.40 (s, 1H), 7.74 (s, 1H), 7.66 (s, 1H), 7.23 (s, 5H), 7.16–7.10 (m, 1H), 7.07 (t, *J* = 7.5 Hz, 2H), 6.99 (d, *J* = 7.8 Hz, 2H), 3.51 (brs, 12H) ppm.
^{13}C NMR (100 MHz, $CDCl_3$): δ = 155.2, 155.1, 153.9, 153.7, 152.8, 152.0, 149.0, 138.5, 138.3, 134.9, 134.1, 129.4, 128.9, 128.6, 128.1, 127.4, 127.1, 125.3, 122.8, 119.8, 119.3, 115.5, 39.2–38.0 (m, 2C) ppm.
HRMS (m/z): calcd for $C_{30}H_{27}N_{10}O$ $[M+H]^+$ 543.2364, found: 543.2359.



(1*R*,2*S*,5*R*)-2-Isopropyl-5-methylcyclohexyl 4-((4-(5-(1*H*-imidazol-1-yl)-4-phenyl-2,3-dihydrofuran-2-yl)phenyl)ethynyl)benzoate (3sa):
Yield = 84% (143.8 mg). Yellow oil.
Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).
^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.96 (d, *J* = 8.3 Hz, 2H), 7.64 (d, *J* = 8.8 Hz, 1H), 7.52 (dd, *J* = 8.2, 3.7 Hz, 4H), 7.38 (d, *J* = 8.1 Hz, 2H), 7.18 (dd, *J* = 9.4, 5.3 Hz, 2H), 7.11 (t, *J* = 6.8 Hz, 1H), 7.07–7.03 (m, 2H), 6.97–6.92 (m, 2H), 5.71 (t, *J* = 9.5 Hz, 1H), 4.90–4.84 (m, 1H), 3.57–3.48 (m, 1H), 3.26–3.12 (m, 1H), 2.05 (d, *J* = 12.0 Hz, 1H), 1.92–1.85 (m, 1H), 1.65 (d, *J* = 11.7 Hz, 2H), 1.55–1.42 (m, 2H), 1.13–0.98 (m, 2H), 0.85 (d, *J* = 6.6 Hz, 7H), 0.72 (d, *J* = 6.9 Hz, 3H) ppm.
^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.6, 141.6, 140.5, 136.5, 132.3, 131.6, 130.4, 129.9, 129.6, 128.8, 127.6, 127.1, 126.3, 125.8, 122.9, 118.1, 100.8, 91.7, 89.4, 80.2, 75.2, 47.3, 41.8, 41.0, 34.3, 31.5, 26.6, 23.7, 22.1, 20.9, 16.6 ppm.
HRMS (m/z): calcd for $C_{38}H_{39}N_2O_3$ $[M+H]^+$ 571.2955, found: 571.2952.

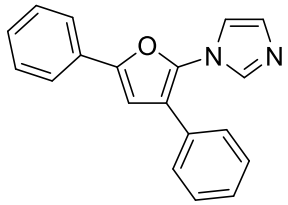


1-(5-(4-(9,9-Dimethyl-9*H*-fluoren-2-yl)phenyl)-3-phenyl-4,5-dihydrofuran-2-yl)-1*H*-imidazole (3ta):
Yield = 81% (116.8 mg). Yellow oil.
Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).
^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.84–7.79 (m, 2H), 7.79–7.73 (m, 3H), 7.70 (d, *J* = 1.3 Hz, 1H), 7.63–7.58 (m, 3H), 7.51–7.48 (m, 1H), 7.41–7.36 (m, 2H), 7.34–7.29 (m, 2H), 7.25–7.21 (m, 1H),

7.20–7.17 (m, 2H), 7.10–7.06 (m, 2H), 5.85 (t, *J* = 9.4 Hz, 1H), 3.66 (dd, *J* = 14.6, 10.2 Hz, 1H), 3.40 (dd, *J* = 14.6, 8.7 Hz, 1H), 1.58 (s, 6H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 154.4, 153.9, 141.9, 140.6, 139.8, 139.7, 138.81, 138.77, 136.6, 134.3, 134.2, 132.4, 129.9, 128.8, 127.7, 127.5, 127.1, 126.9, 126.34, 126.25, 122.7, 121.4, 120.4, 120.2, 118.1, 100.8, 80.5, 47.0, 41.7, 27.3 ppm.

HRMS (m/z): calcd for $C_{34}H_{29}N_2O$ $[M+H]^+$ 481.2274, found: 481.2273.



1-(3,5-Diphenylfuran-2-yl)-1*H*-imidazole (4):

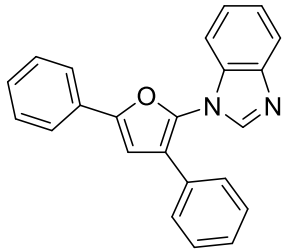
Yield = 62% (53.3 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.72 (s, 1H), 7.70 (t, *J* = 1.6 Hz, 1H), 7.69–7.68 (m, 1H), 7.43–7.40 (m, 2H), 7.35–7.28 (m, 4H), 7.21 (d, *J* = 1.7 Hz, 2H), 7.19 (t, *J* = 1.5 Hz, 1H), 7.17 (d, *J* = 1.3 Hz, 1H), 6.95 (s, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 151.0, 137.7, 137.5, 130.4, 130.2, 129.5, 129.1, 129.0, 128.4, 128.0, 127.0, 123.9, 119.8, 118.4, 106.6 ppm.

HRMS (m/z): calcd for $C_{19}H_{15}N_2O$ $[M+H]^+$ 287.1179, found: 287.1179.



1-(3,5-Diphenylfuran-2-yl)-1*H*-benzo[*d*]imidazole (5):

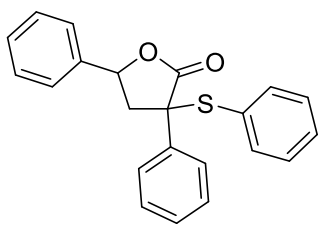
Yield = 65% (65.6 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 4/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.97 (s, 1H), 7.89 (d, *J* = 7.6 Hz, 1H), 7.72–7.68 (m, 2H), 7.40 (t, *J* = 7.7 Hz, 2H), 7.35–7.28 (m, 4H), 7.24–7.20 (m, 3H), 7.17–7.14 (m, 2H), 7.06 (s, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 151.9, 143.2, 142.8, 136.3, 133.9, 130.2, 129.5, 129.1, 129.0, 128.5, 128.0, 126.7, 124.5, 123.9, 123.5, 120.6, 120.4, 111.2, 106.3 ppm.

HRMS (m/z): calcd for $C_{23}H_{17}N_2O$ $[M+H]^+$ 337.1335, found: 337.1330.



3,5-Diphenyl-3-(phenylthio)dihydrofuran-2(3*H*)-one (6):

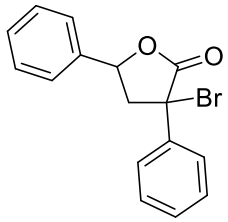
Yield = 31% (32.2 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 10/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.61–7.52 (m, 3H), 7.39–7.34 (m, 6H), 7.30–7.28 (m, 3H), 7.23 (dd, *J* = 7.2, 1.7 Hz, 3H), 5.73 (dd, *J* = 10.5, 5.6 Hz, 1H), 3.14 (dd, *J* = 13.8, 5.6 Hz, 1H), 2.77 (dd, *J* = 13.8, 10.5 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 172.8, 144.6, 138.3 (d, *J* = 6.4 Hz), 137.0, 130.2, 129.5, 128.9, 128.8, 128.3, 128.0, 127.6, 125.8, 122.1, 77.8, 57.3, 46.3 ppm.

HRMS (m/z): calcd for $C_{22}H_{19}O_2S$ $[M+H]^+$ 347.1100, found: 347.1102.



3-Bromo-3,5-diphenyldihydrofuran-2(3*H*)-one (7):

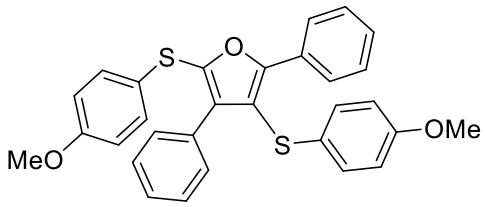
Yield = 37% (35.2 mg). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 10/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.86–7.83 (m, 2H), 7.45–7.37 (m, 8H), 5.80 (dd, *J* = 10.1, 4.7 Hz, 1H), 3.35 (dd, *J* = 14.5, 4.7 Hz, 1H), 2.80 (dd, *J* = 14.5, 10.1 Hz, 1H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 172.0, 137.3, 136.9, 129.5, 129.2, 129.1, 128.9, 127.8, 126.0, 78.9, 57.2, 49.0 ppm.

HRMS (m/z): calcd for $C_{16}H_{14}BrO_2$ $[M+H]^+$ 317.0172, found: 317.0176.



2,4-Bis((4-methoxyphenyl)thio)-3,5-diphenylfuran (10b):

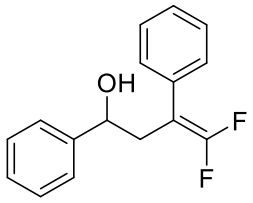
Yield = 42% (62.6 mg). Colorless oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 20/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.02 (d, *J* = 7.2 Hz, 2H), 7.30 (t, *J* = 7.4 Hz, 2H), 7.23 (d, *J* = 9.5 Hz, 6H), 7.17–7.14 (m, 2H), 6.87 (d, *J* = 8.8 Hz, 2H), 6.72 (d, *J* = 8.8 Hz, 2H), 6.59 (d, *J* = 8.8 Hz, 2H), 3.67 (s, 3H), 3.62 (s, 3H) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 159.3, 158.2, 141.8, 137.2, 131.5, 131.3, 130.2, 129.8, 129.2, 129.0, 128.6, 127.99-127.94 (3C), 127.5, 126.7, 125.8, 115.0, 114.8, 112.2, 55.5, 55.4 ppm.

HRMS (m/z): calcd for $C_{30}H_{25}O_3S_2$ $[M+H]^+$ 497.1240, found: 497.1242.



4,4-Difluoro-1,3-diphenylbut-3-en-1-ol (3aa-I):

Yield = 36% (28.1 mg). Colorless oil.

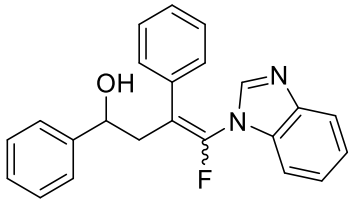
Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 100/1).

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.43–7.38 (m, 2H), 7.37–7.33 (m, 5H), 7.32–7.28 (m, 3H), 4.62 (dd, *J* = 8.1, 5.7 Hz, 1H), 2.99–2.88 (m, 1H), 2.81–2.75 (m, 1H), 2.13 (brs, 1H) ppm.

^{19}F NMR (376 MHz, $CDCl_3$): δ = -89.9 – -90.0 (m, 2F) ppm.

^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.5–149.5 (m, 1C), 143.6, 133.3, 128.7, 128.6, 128.5, 128.0, 127.6, 126.0, 89.6 (dd, *J* = 19.3, 16.9 Hz), 72.3 (t, *J* = 2.9 Hz), 37.7 ppm.

HRMS (m/z): calcd for $C_{16}H_{15}F_2O$ $[M+H]^+$ 261.1085, found: 261.1080.



4-(1*H*-Benzo[*d*]imidazol-1-yl)-4-fluoro-1,3-diphenylbut-3-en-1-ol (3aa-II):

Yield = 87% (93.5 mg, *Z*/*E*= 1/11). Yellow oil.

Purified by flash column chromatography through silica gel (petroleum ether/ethyl acetate, 2/1).

^{1}H NMR (400 MHz, $CDCl_3$) of *E*-isomer: δ = 7.60–7.56 (m, 1H), 7.34–7.31 (m, 5H), 7.29–7.27 (m, 1H), 7.25–7.21 (m, 2H), 7.11–7.07 (m, 4H), 6.90–6.87 (m, 2H), 4.66 (t, *J* = 7.1 Hz, 1H), 3.74 (brs, 1H), 3.25–3.10 (m, 2H) ppm.

^{19}F NMR (376 MHz, $CDCl_3$) of *E*-isomer: δ = -92.68 (s, 1F) ppm; ***Z*-isomer:** δ = -91.31 (s, 1F) ppm.

^{13}C NMR (100 MHz, $CDCl_3$) of *E*-isomer: δ = 144.0, 143.7, 142.3, 141.4, 134.6 (d, *J* = 3.8 Hz), 133.1 (d, *J* = 3.9 Hz), 128.8, 128.4, 128.1, 127.9, 127.74, 127.71, 126.3, 120.2, 115.7, 115.4, 111.0, 72.0 (d, *J* = 2.9 Hz), 39.6 ppm.

HRMS (m/z): calcd for $C_{23}H_{20}FN_2O$ $[M+H]^+$ 359.1554, found: 359.1553.

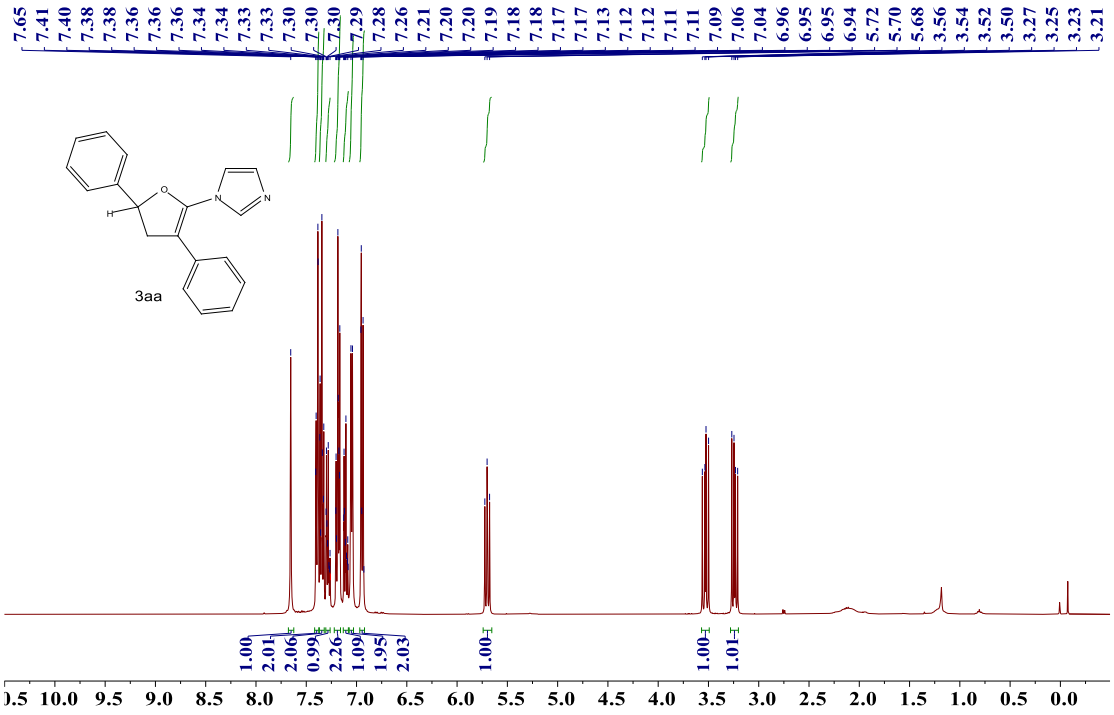
References

[1] Chu, X.-Q.; Sun, L.-W.; Chen, Y.-L.; Chen, J.-W.; Yu, Z.-L.; Ma, M.; Shen, Z.-L. $HP(O)Ph_2/H_2O$-Promoted Hydrodefluorination of Trifluoromethyl Alkenes, *Green Chem.* **2022**, *24*, 2777–2782.

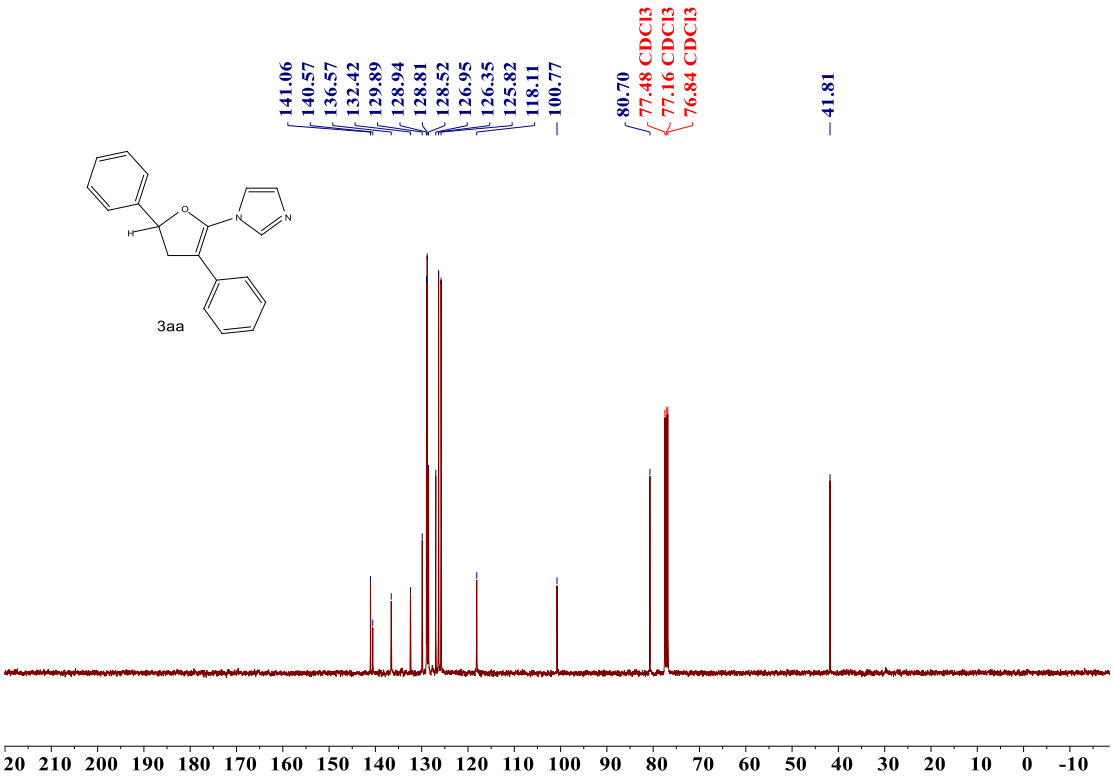
[2] Hu, Y.-F.; Feng, M.-H.; Zhang, P.-Y.; Xu, H.; Ma, M.; Shen, Z.-L.; Chu, X.-Q. Combining Hydrodefluorination and Defluorophosphorylation for Chemo- and Stereoselective Synthesis of *gem*-Fluorophosphine Alkenes, *Org. Lett.* **2023**, *25*, 6368–6373.

^{1}H, ^{19}F, and ^{13}C NMR spectra of products

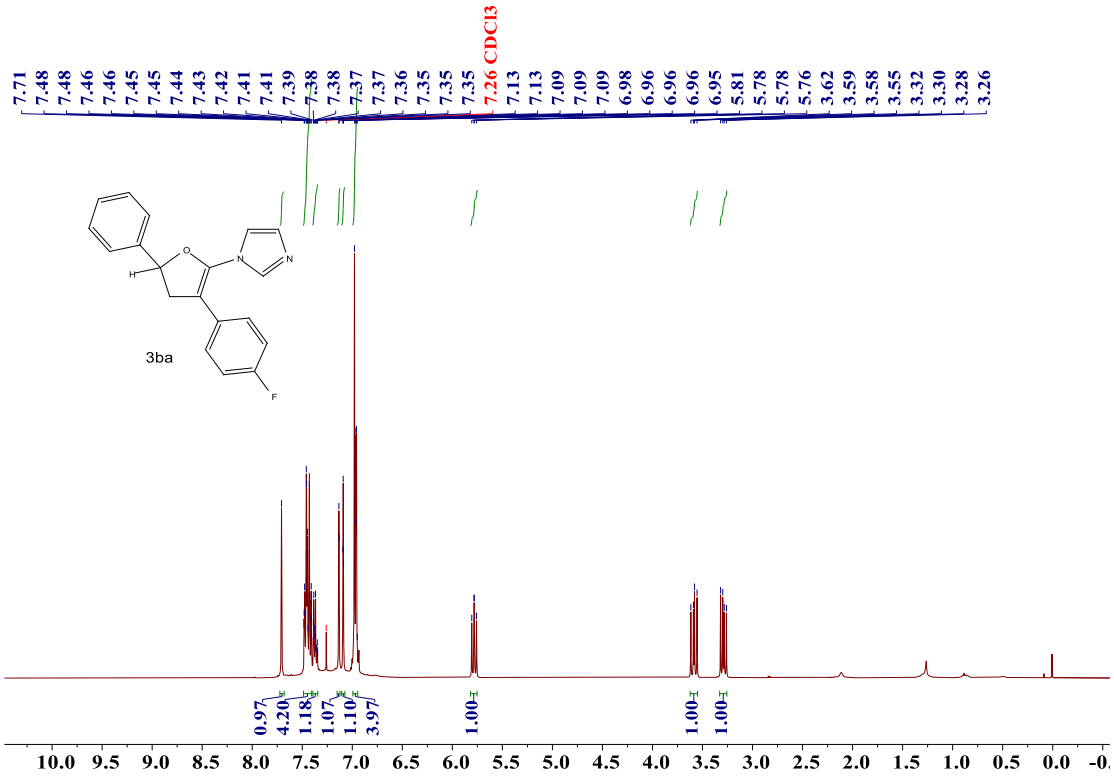
^{1}H NMR spectra of the product **3aa** (400 MHz, $CDCl_3$)



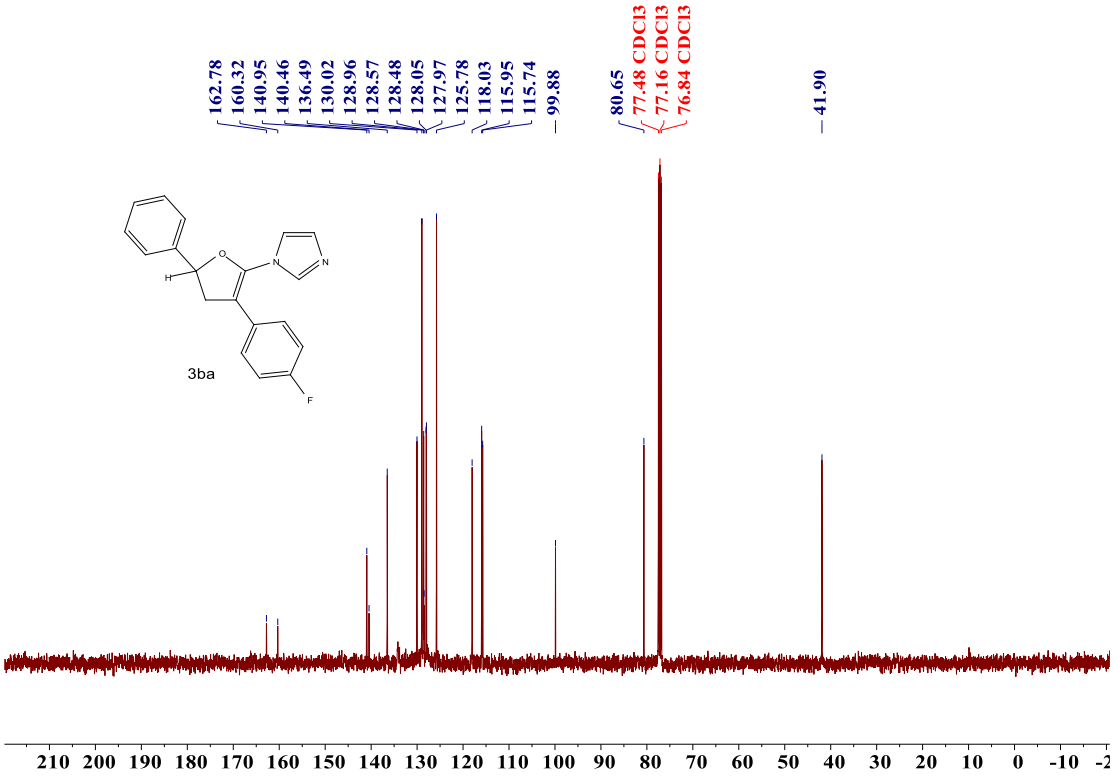
^{13}C NMR spectra of the product **3aa** (100 MHz, $CDCl_3$)



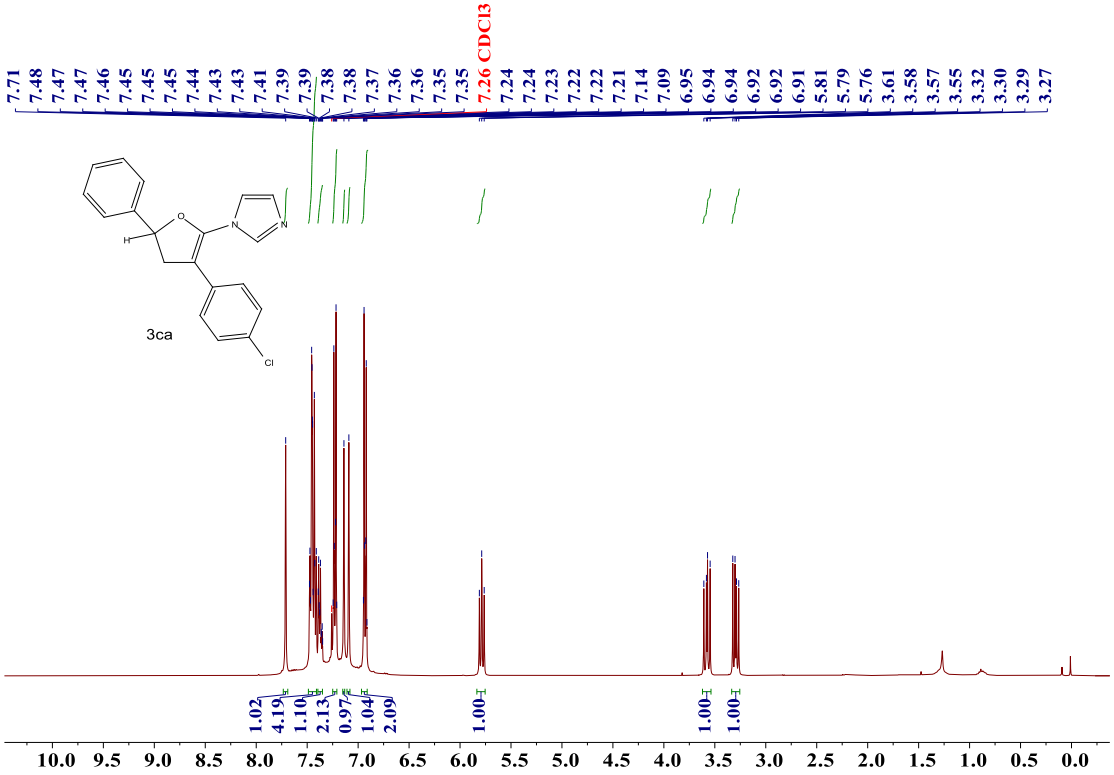
^{1}H NMR spectra of the product **3ba** (400 MHz, $CDCl_3$)



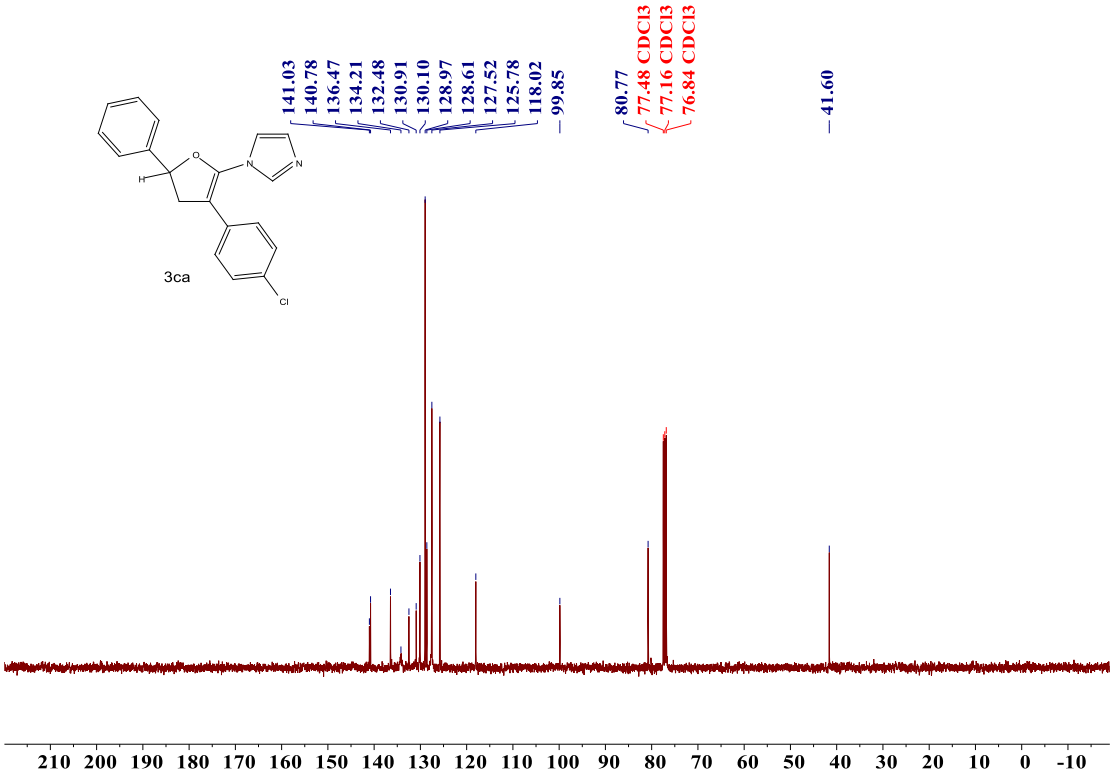
^{13}C NMR spectra of the product **3ba** (100 MHz, $CDCl_3$)



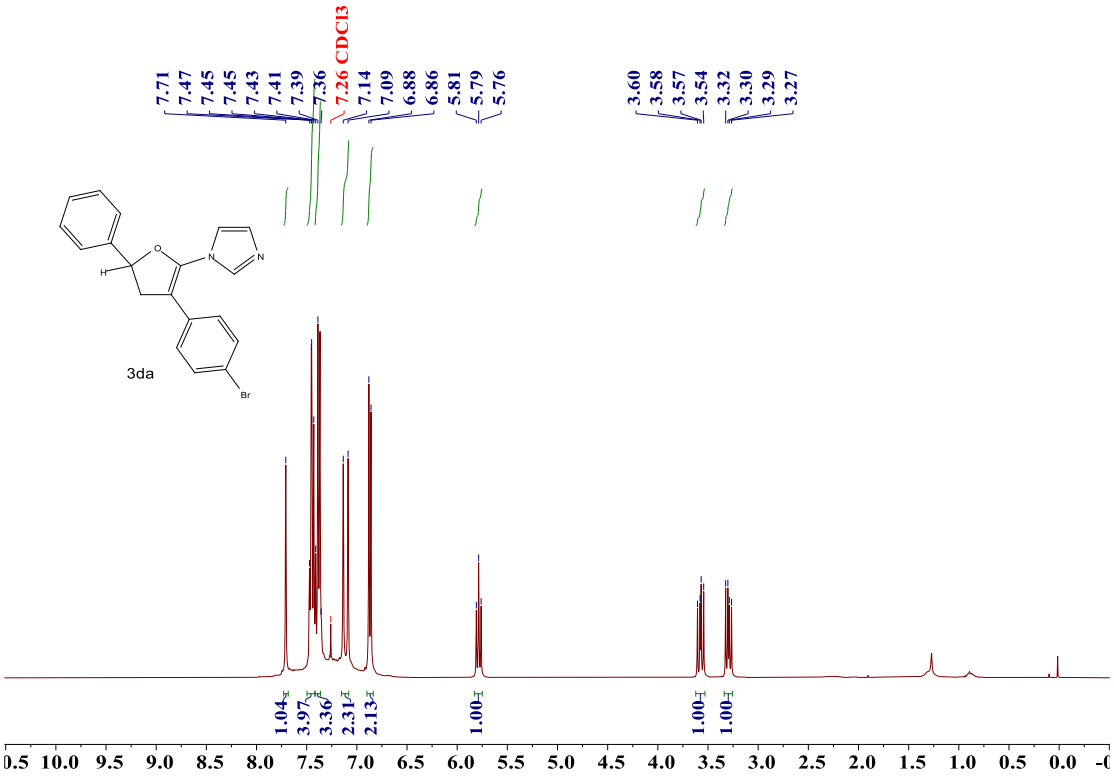
^{1}H NMR spectra of the product **3ca** (400 MHz, $CDCl_3$)



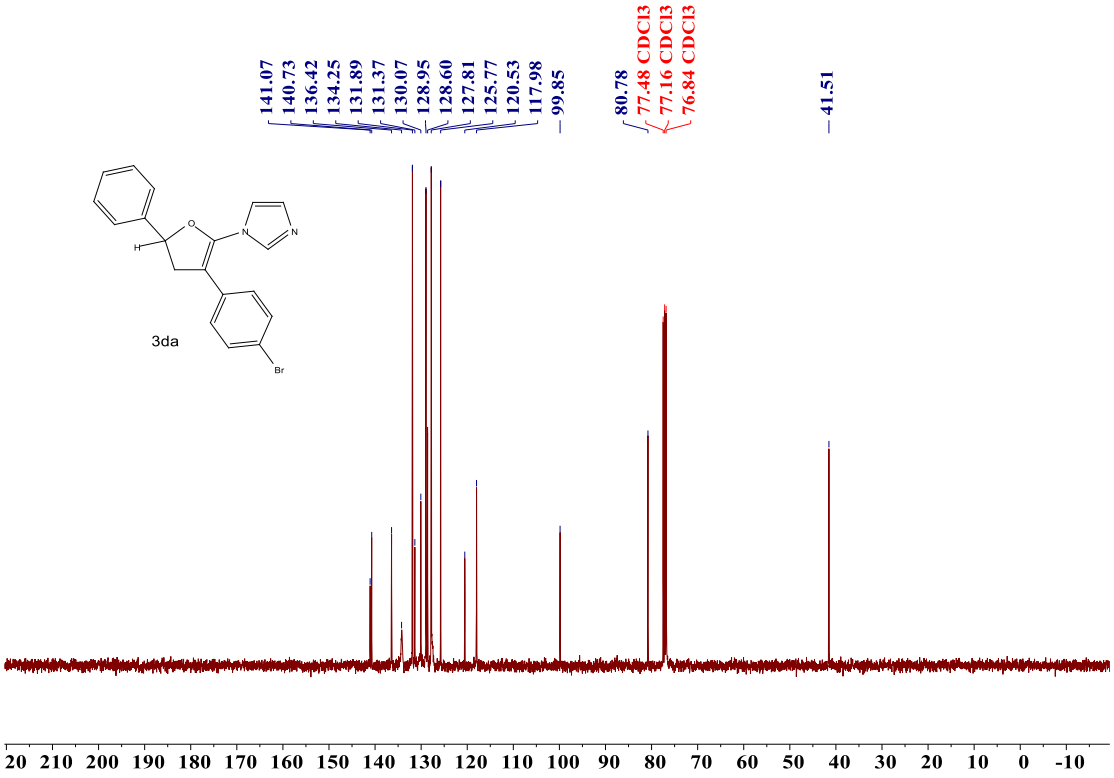
^{13}C NMR spectra of the product **3ca** (100 MHz, $CDCl_3$)



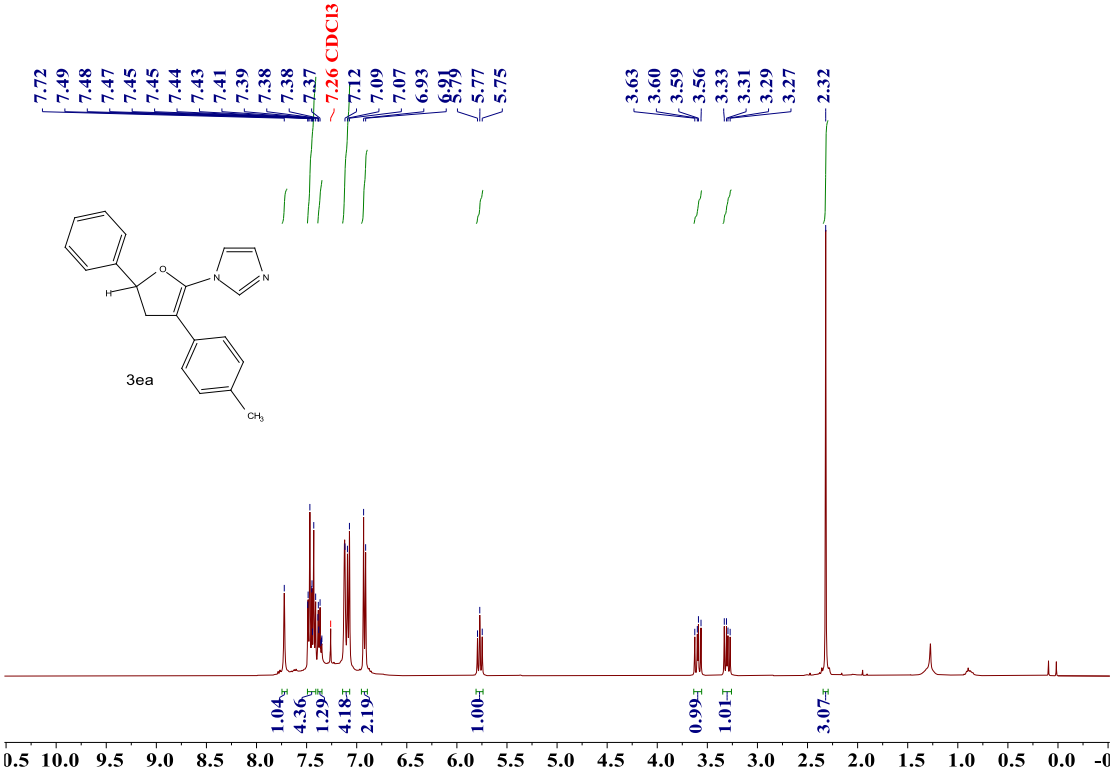
^{1}H NMR spectra of the product **3da** (400 MHz, $CDCl_3$)



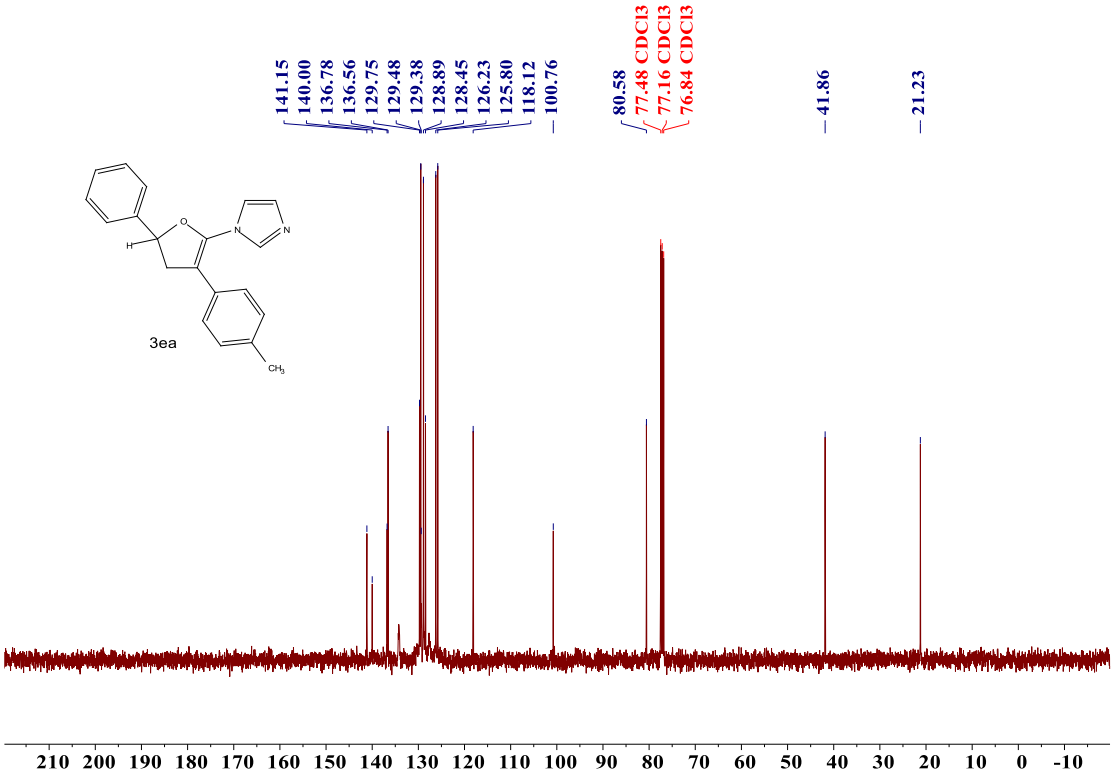
^{13}C NMR spectra of the product **3da** (100 MHz, $CDCl_3$)



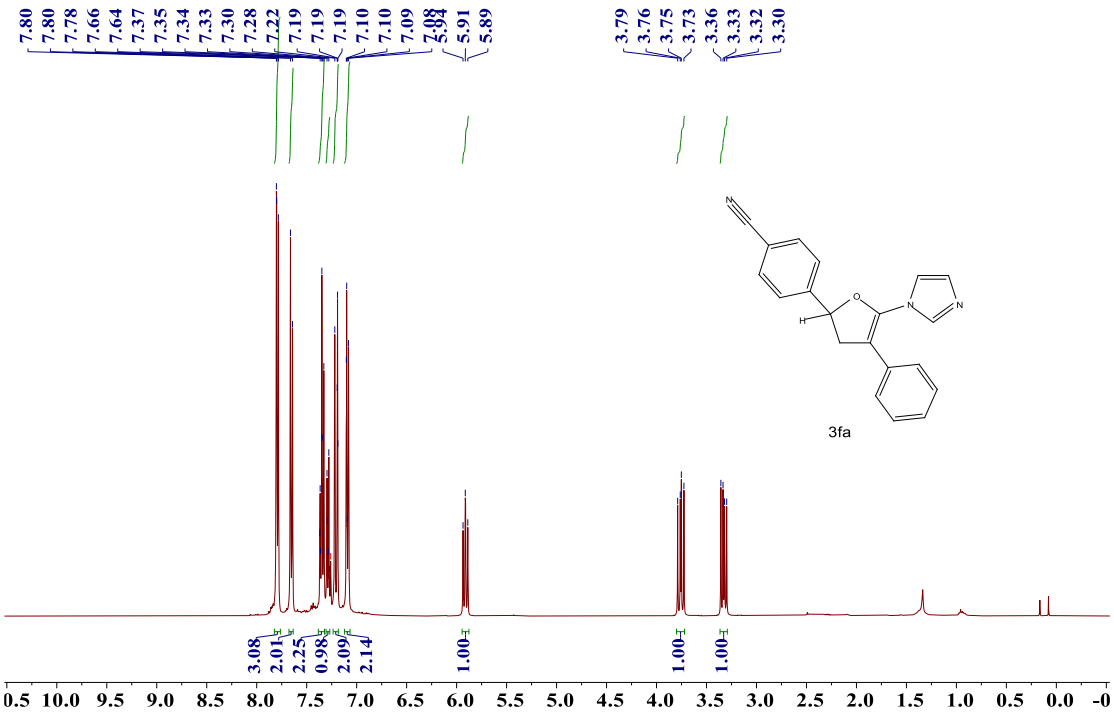
^{1}H NMR spectra of the product **3ea** (400 MHz, $CDCl_3$)



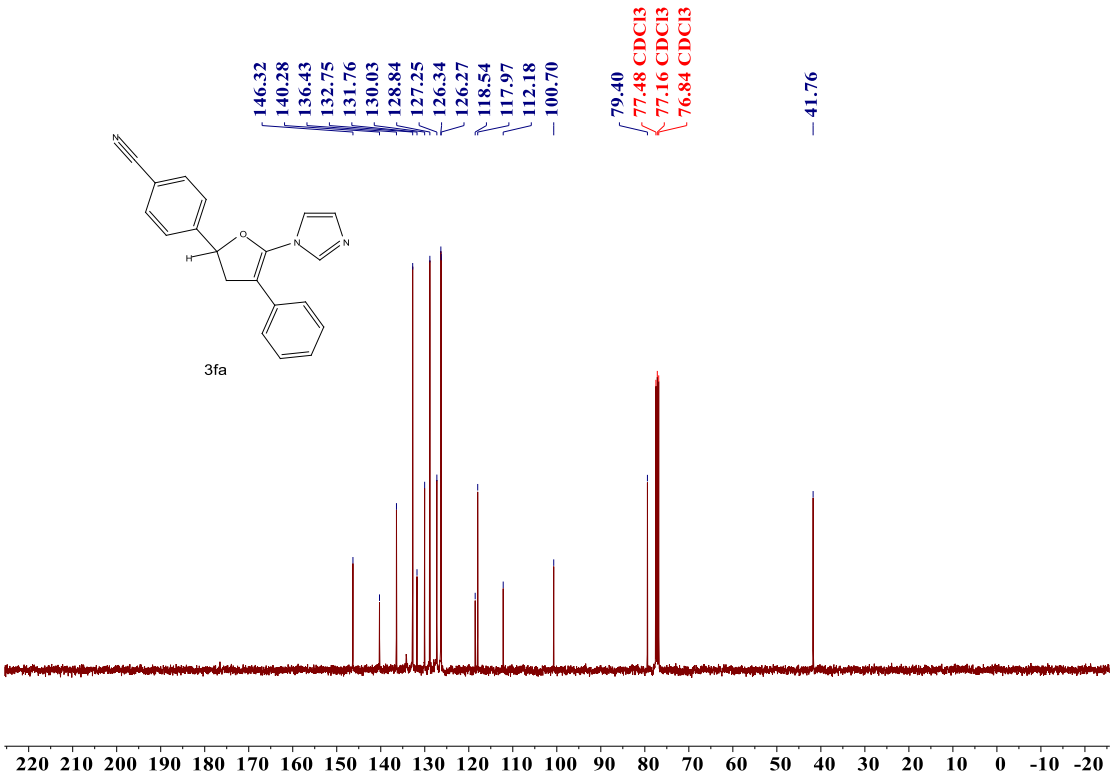
^{13}C NMR spectra of the product **3ea** (100 MHz, $CDCl_3$)



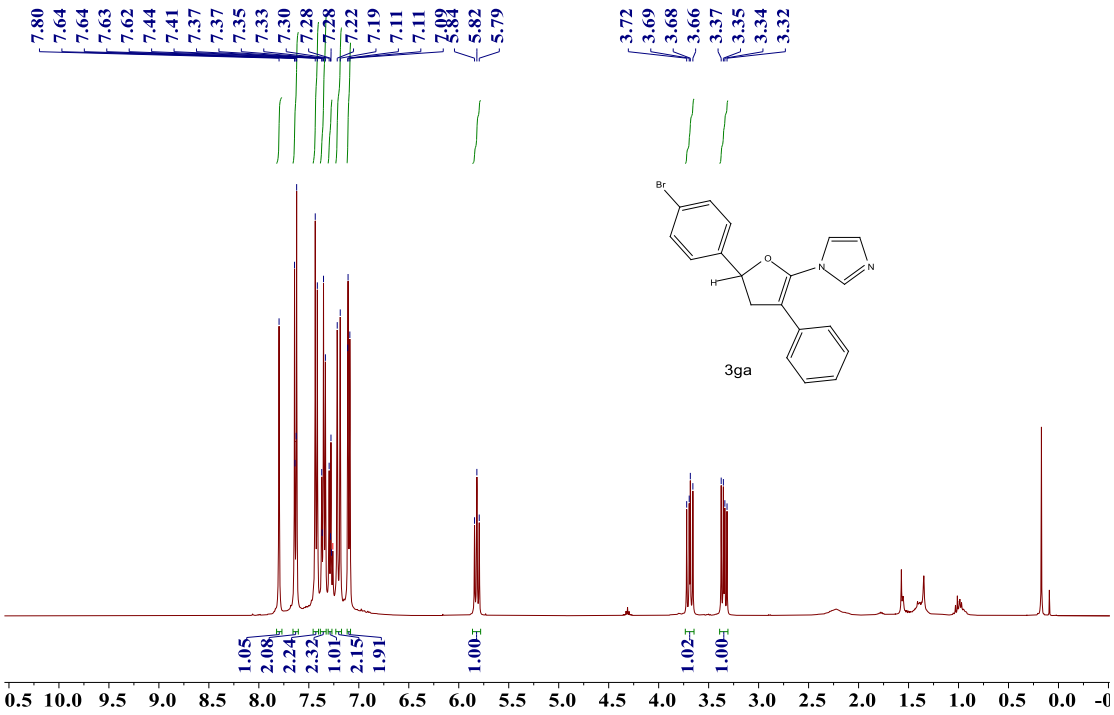
^{1}H NMR spectra of the product **3fa** (400 MHz, $CDCl_3$)



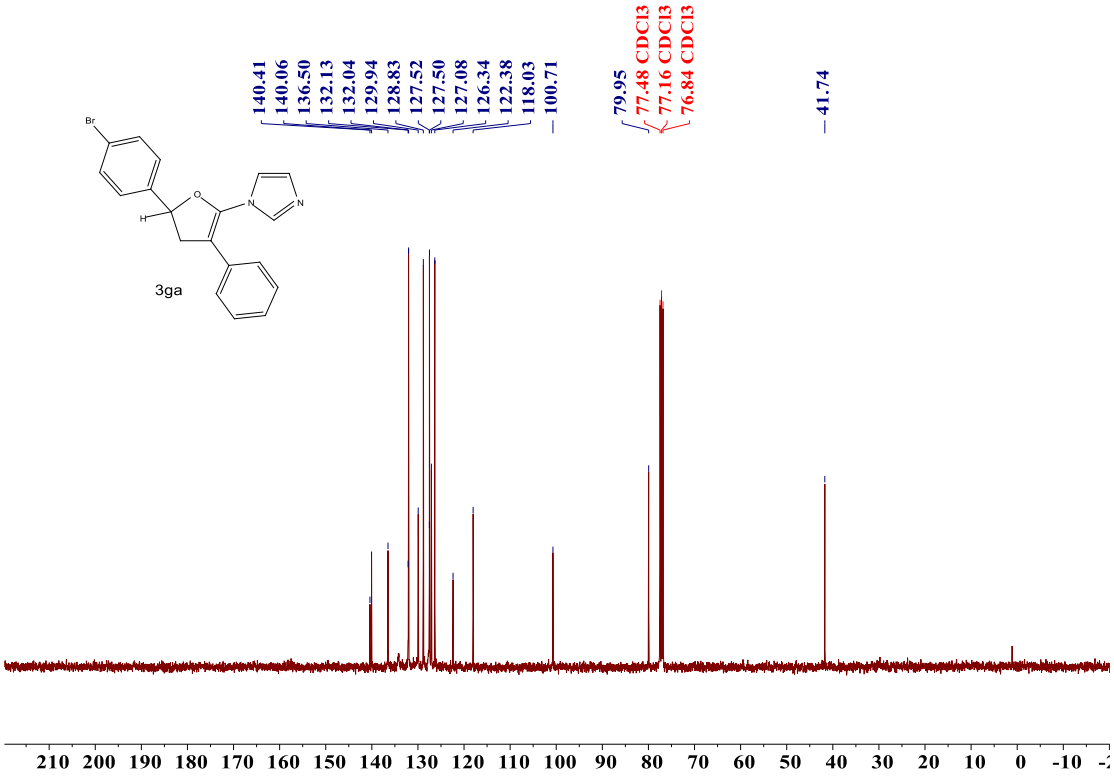
^{13}C NMR spectra of the product **3fa** (100 MHz, $CDCl_3$)



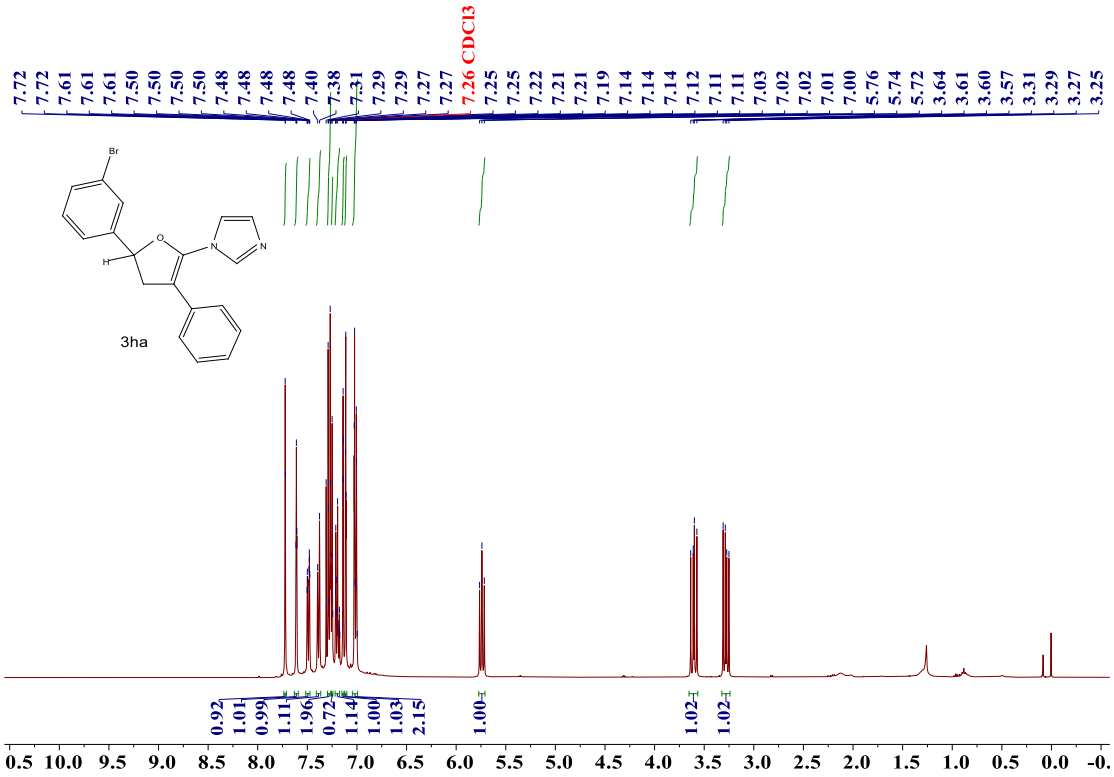
^{1}H NMR spectra of the product **3ga** (400 MHz, $CDCl_3$)



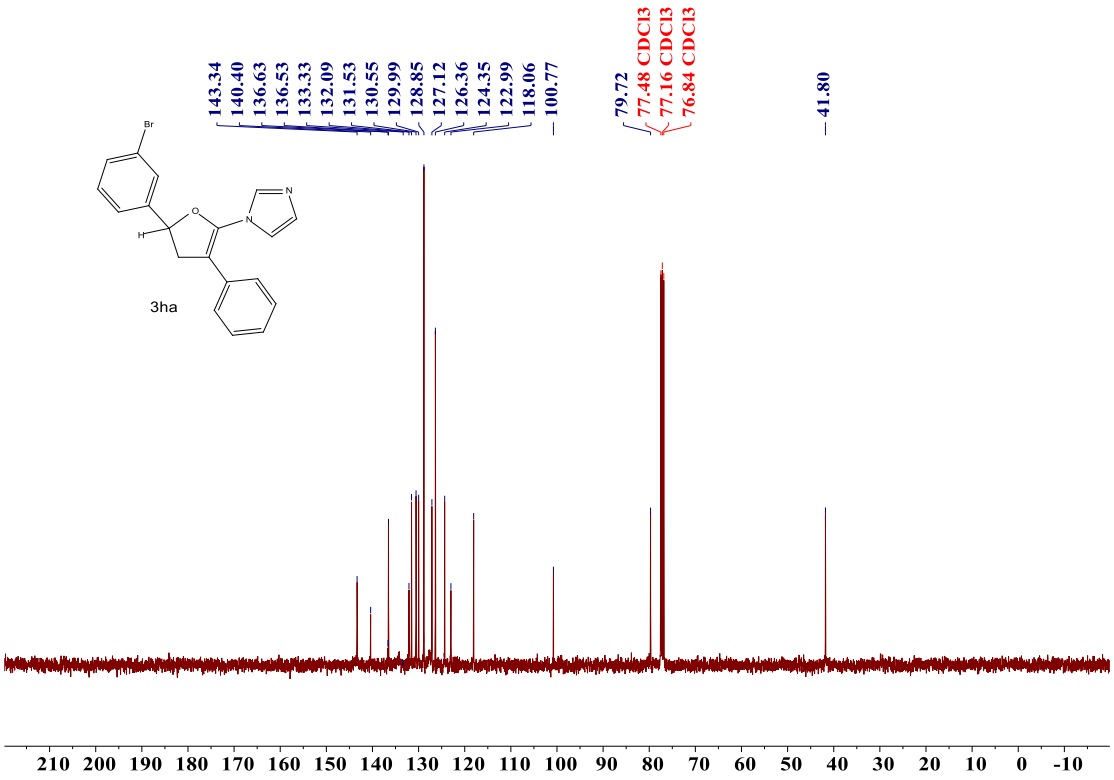
^{13}C NMR spectra of the product **3ga** (100 MHz, $CDCl_3$)



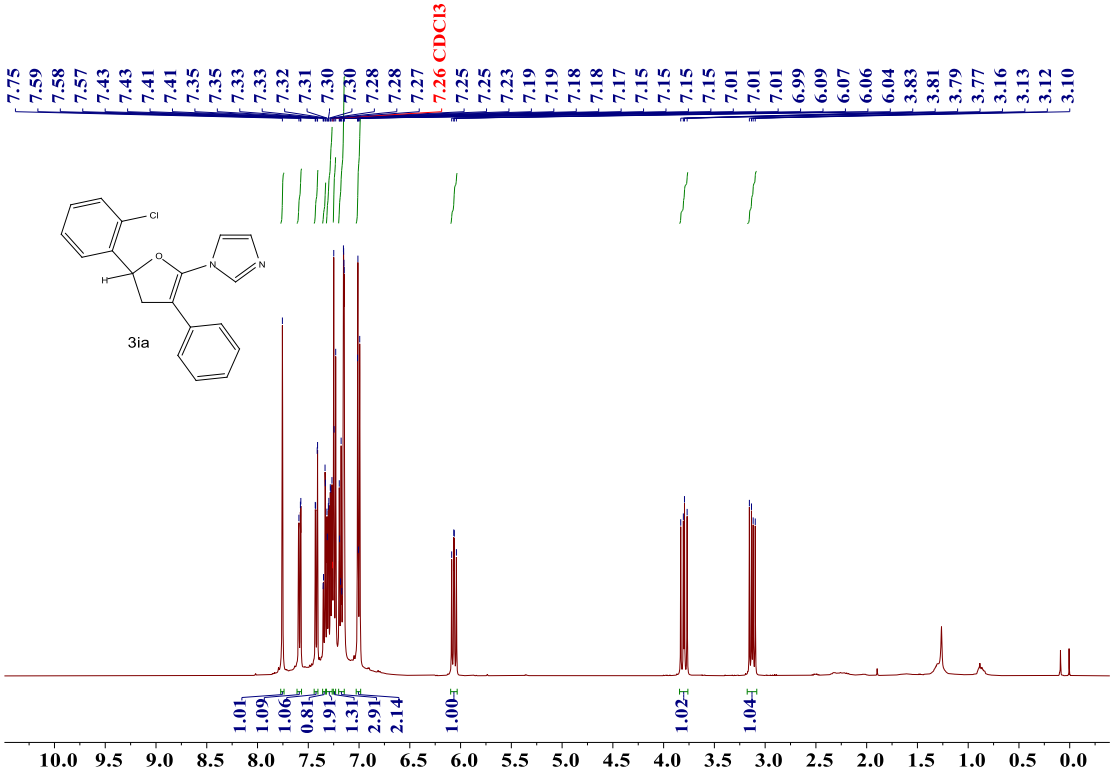
^{1}H NMR spectra of the product **3ha** (400 MHz, $CDCl_3$)



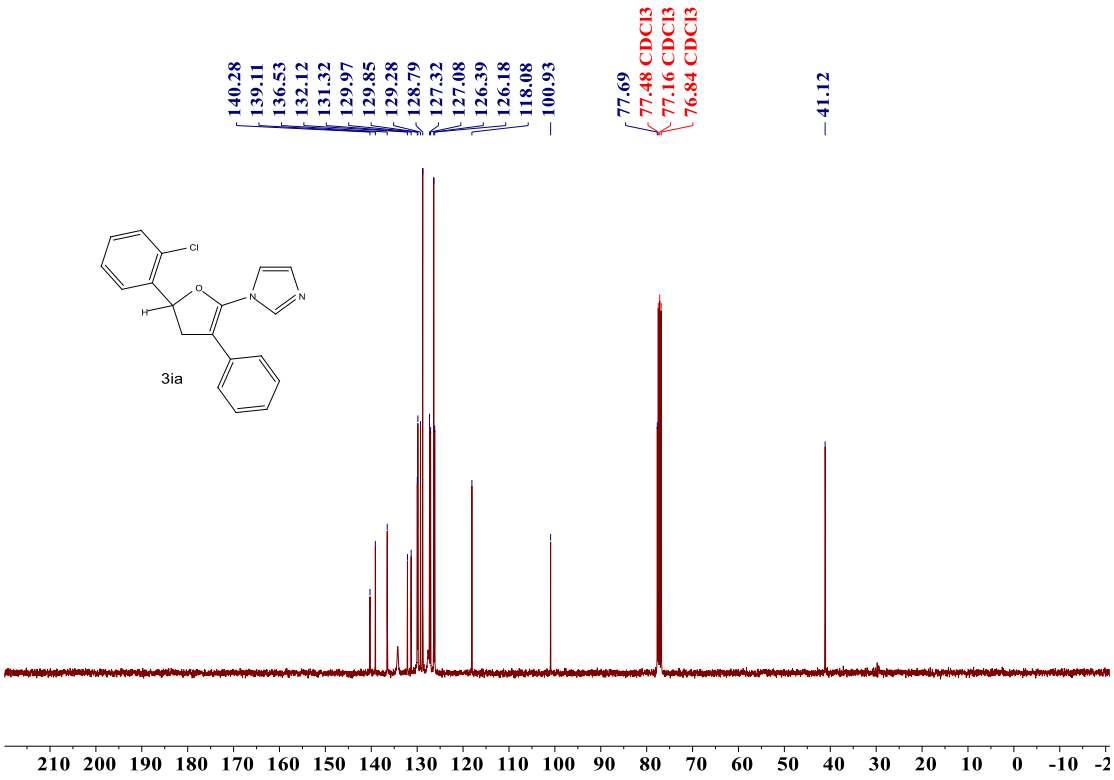
^{13}C NMR spectra of the product **3ha** (100 MHz, $CDCl_3$)



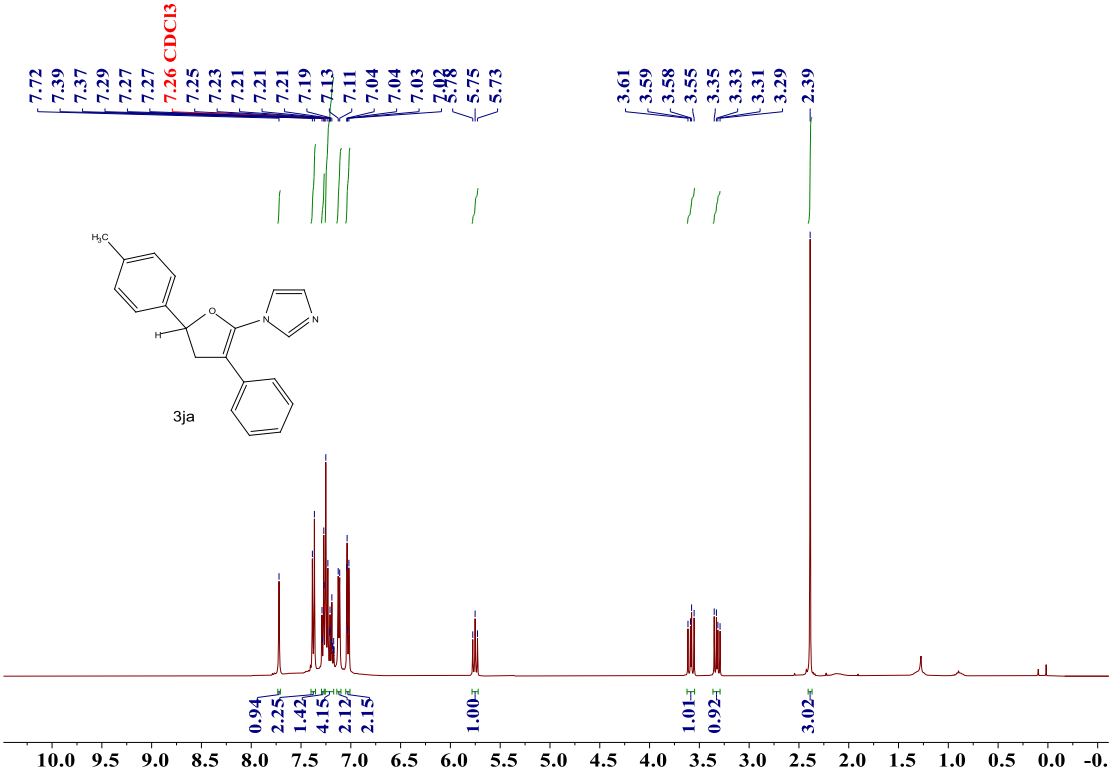
^{1}H NMR spectra of the product **3ia** (400 MHz, $CDCl_3$)



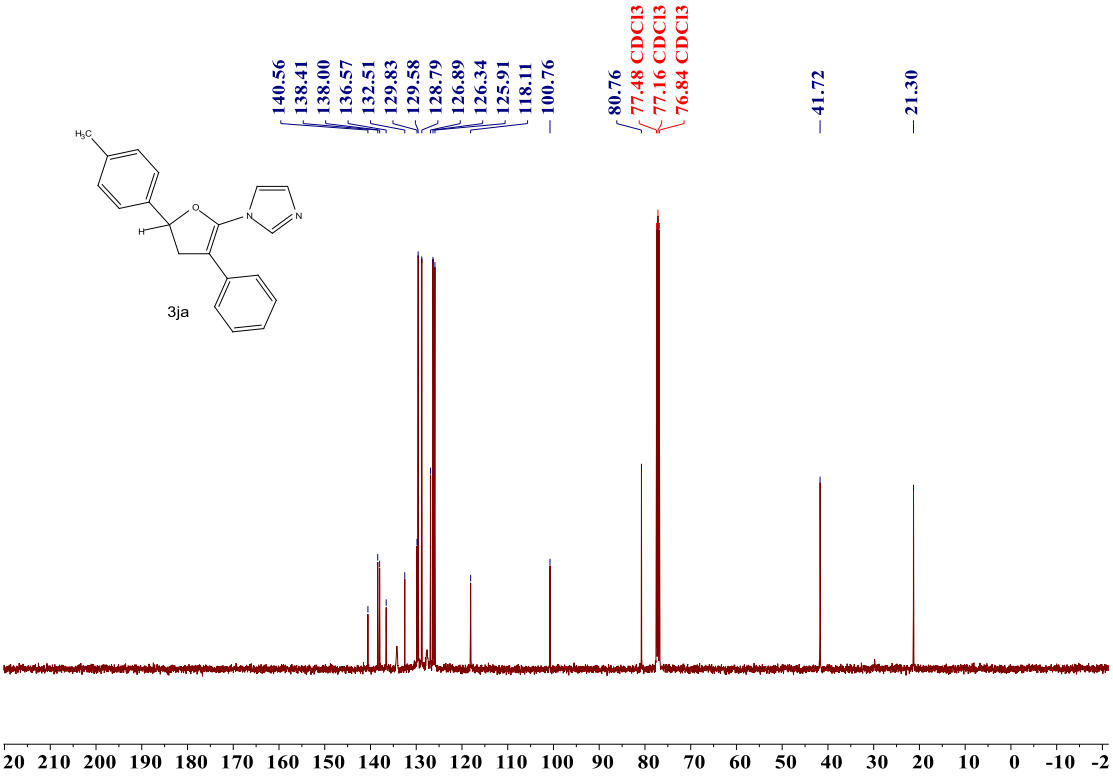
^{13}C NMR spectra of the product **3ia** (100 MHz, $CDCl_3$)



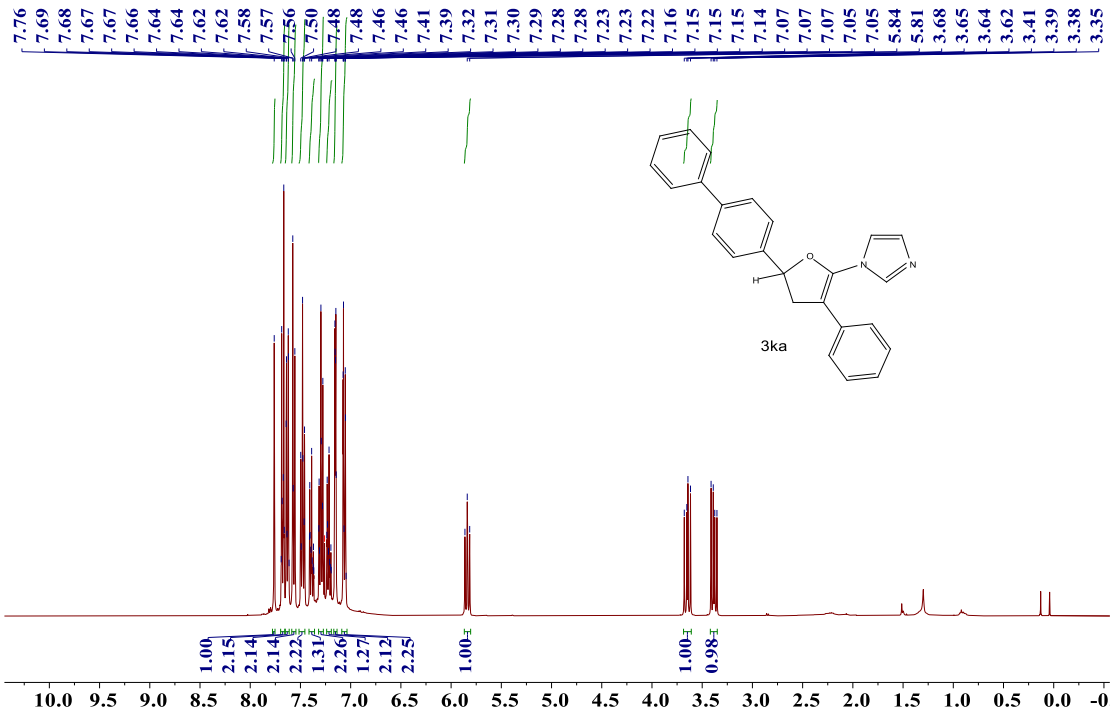
^{1}H NMR spectra of the product **3ja** (400 MHz, $CDCl_3$)



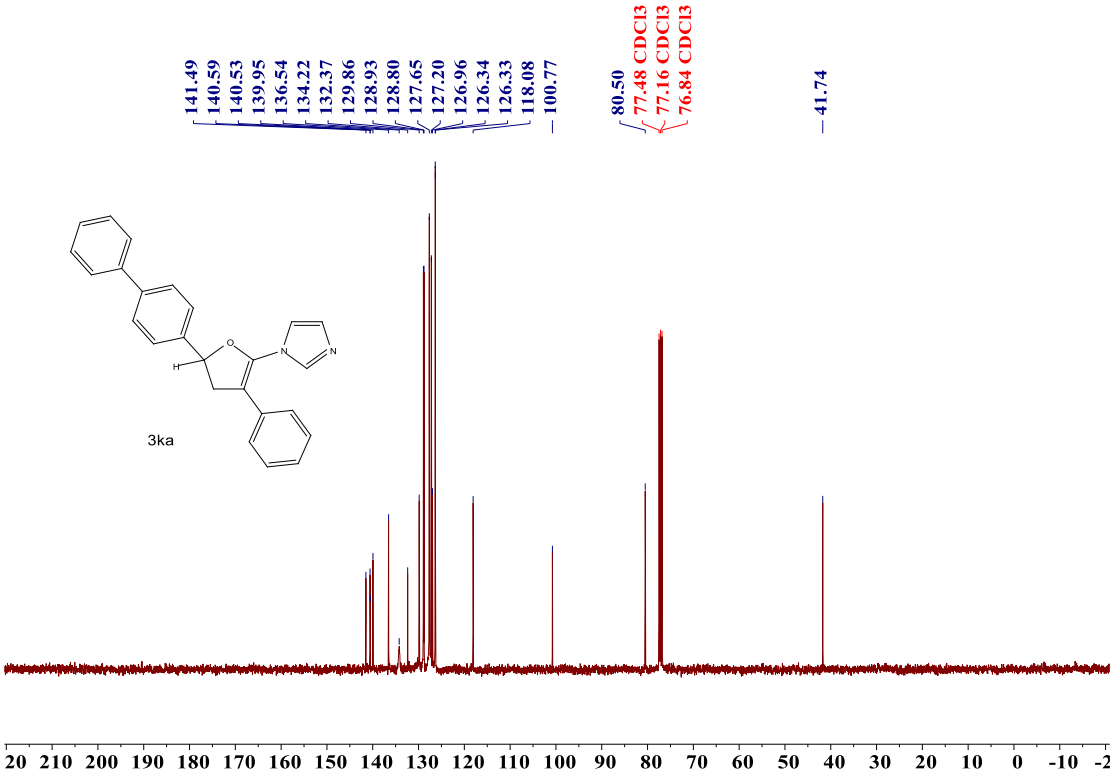
^{13}C NMR spectra of the product **3ja** (100 MHz, $CDCl_3$)



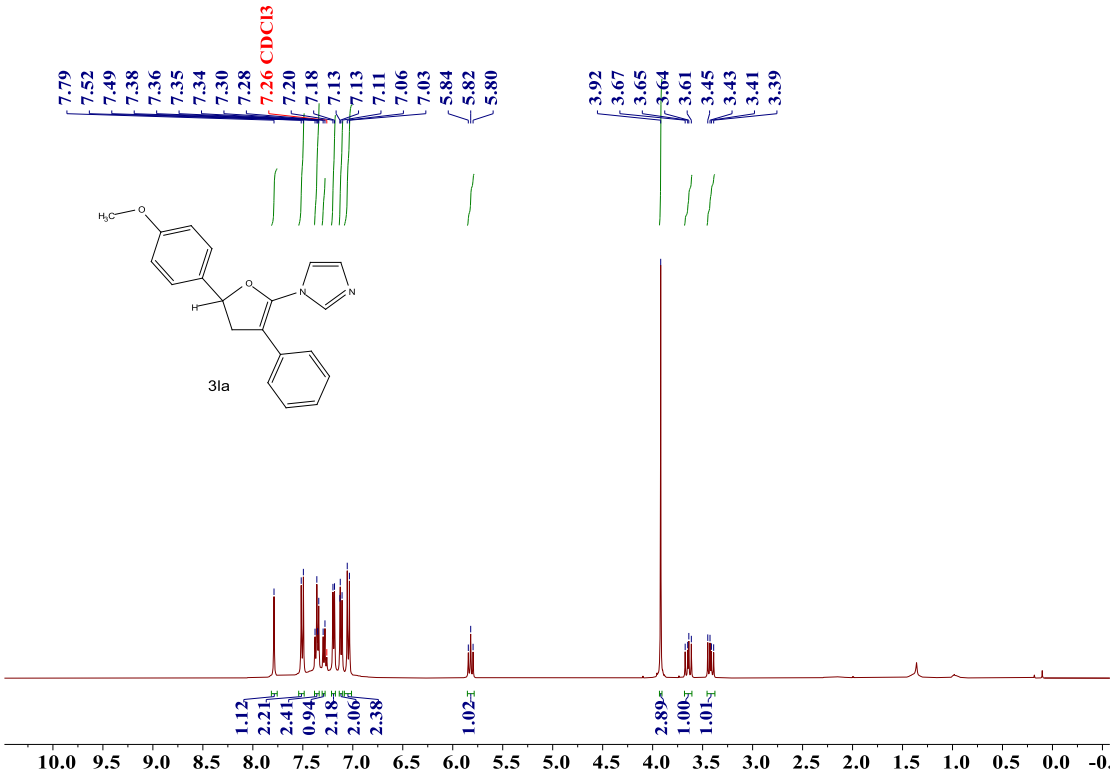
^{1}H NMR spectra of the product **3ka** (400 MHz, $CDCl_3$)



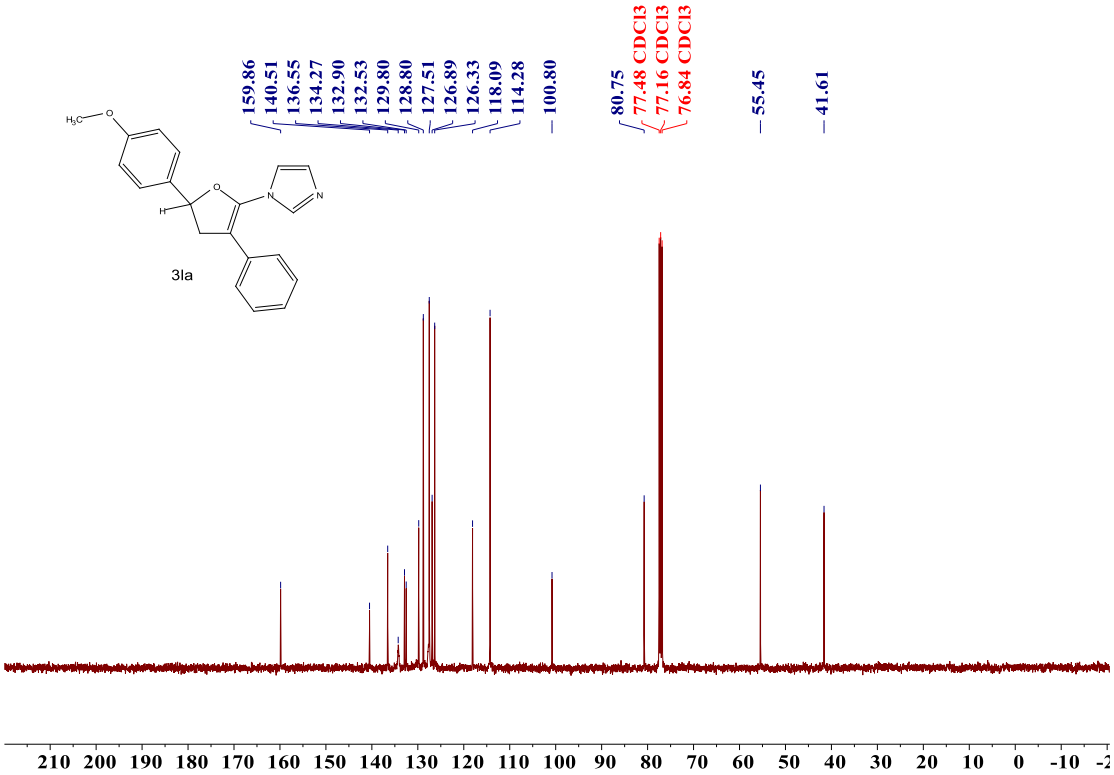
^{13}C NMR spectra of the product **3ka** (100 MHz, $CDCl_3$)



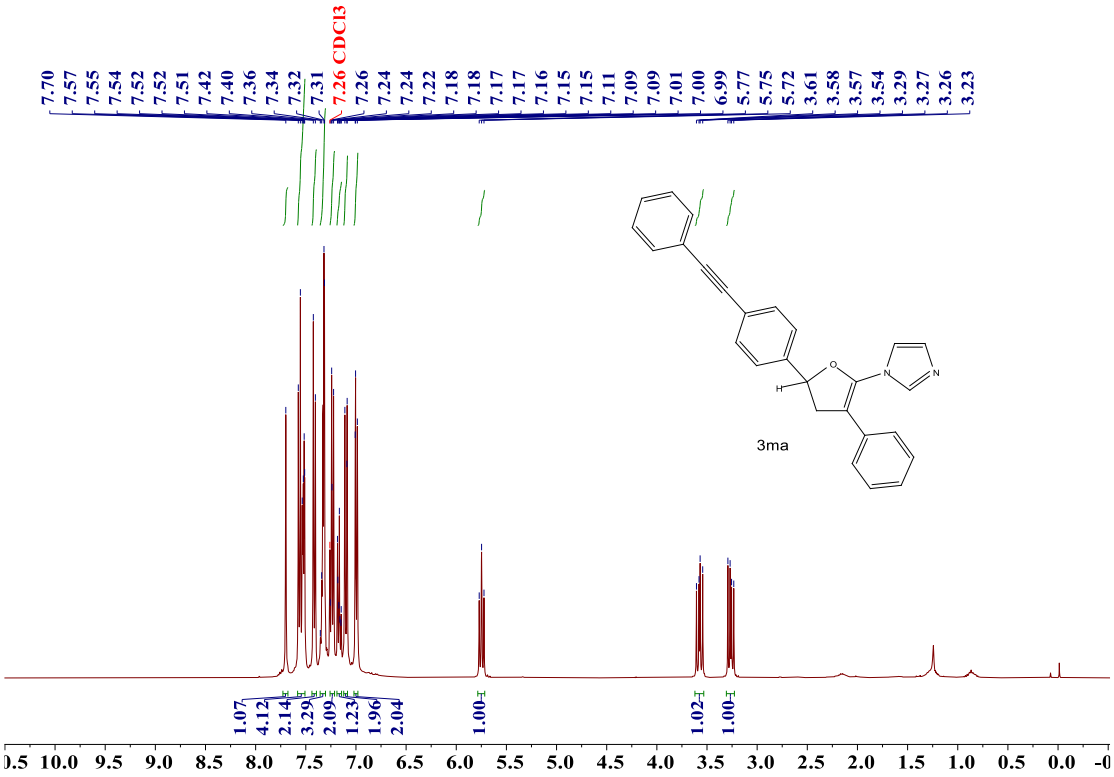
^{1}H NMR spectra of the product **3la** (400 MHz, $CDCl_3$)



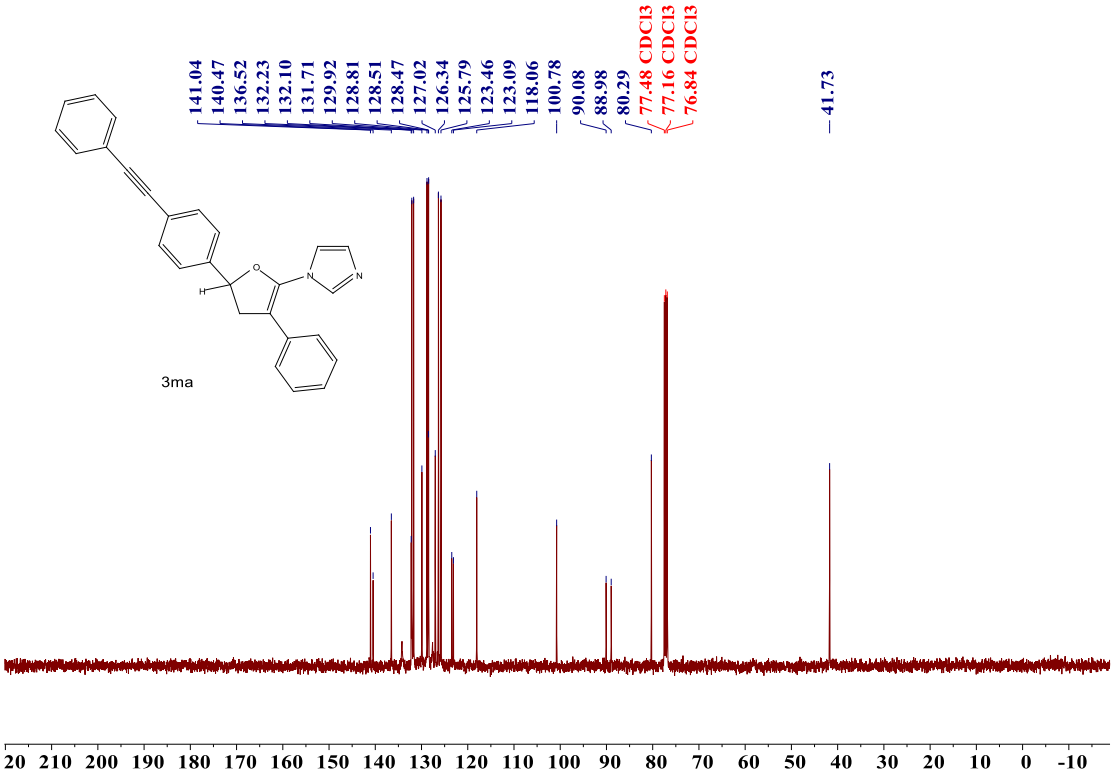
^{13}C NMR spectra of the product **3la** (100 MHz, $CDCl_3$)



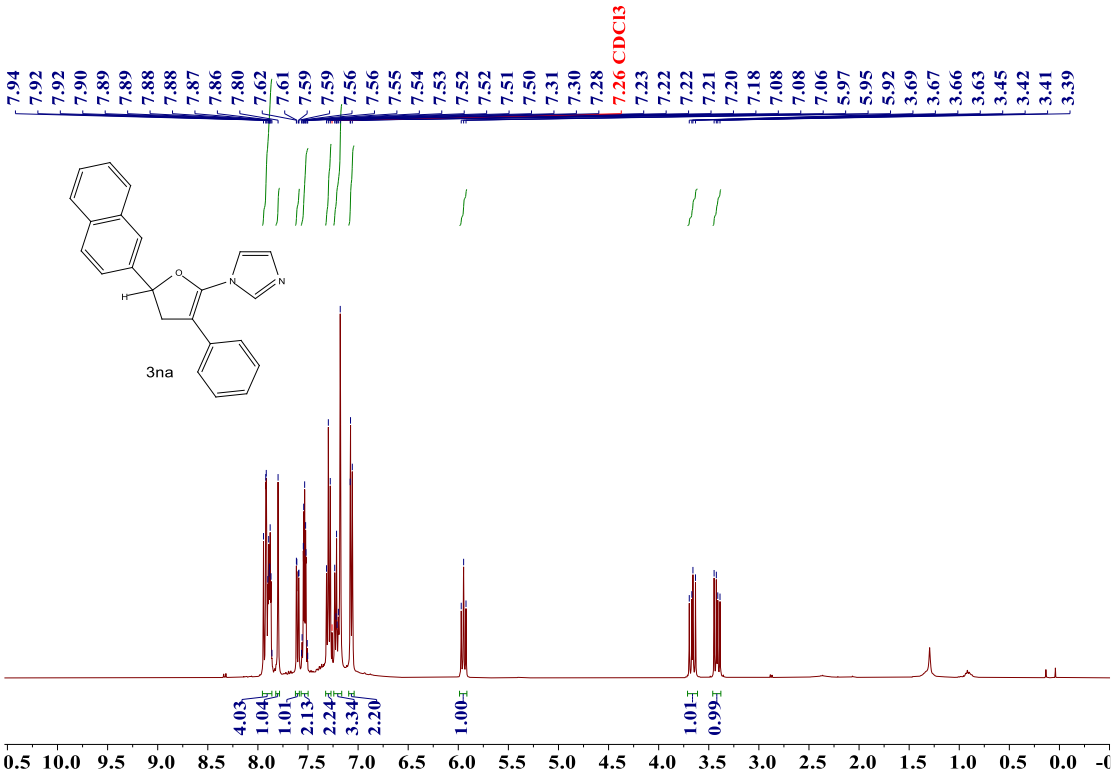
^{1}H NMR spectra of the product **3ma** (400 MHz, $CDCl_3$)



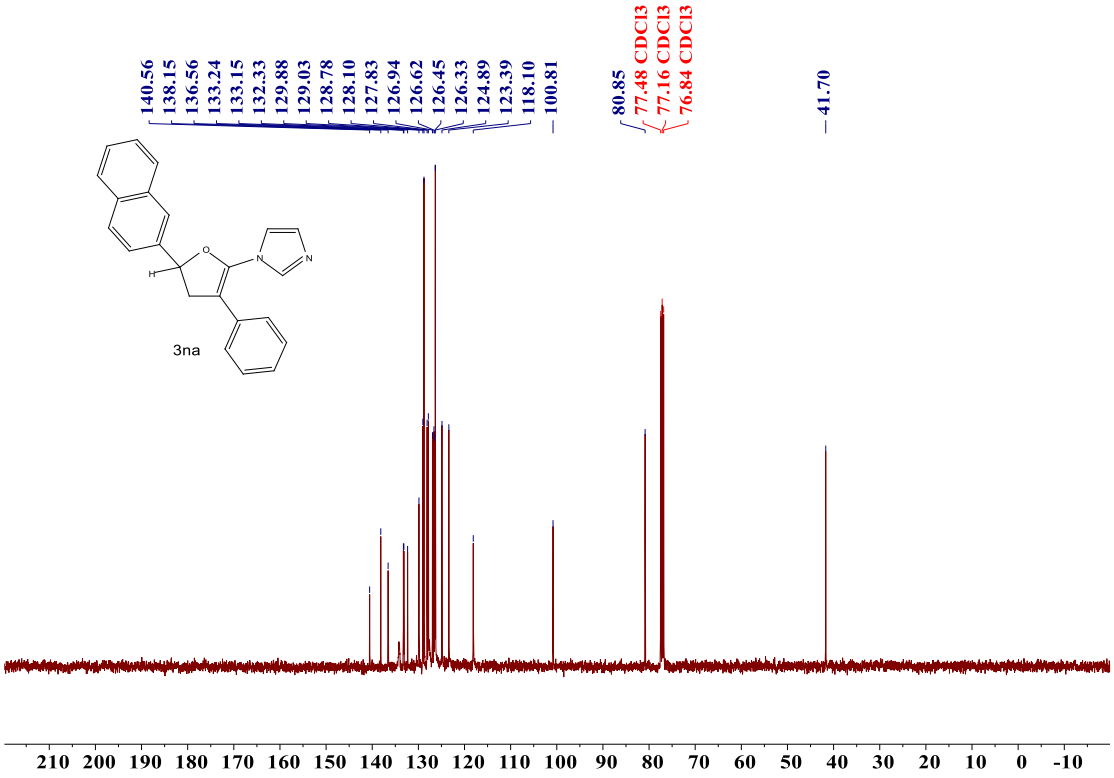
^{13}C NMR spectra of the product **3ma** (100 MHz, $CDCl_3$)



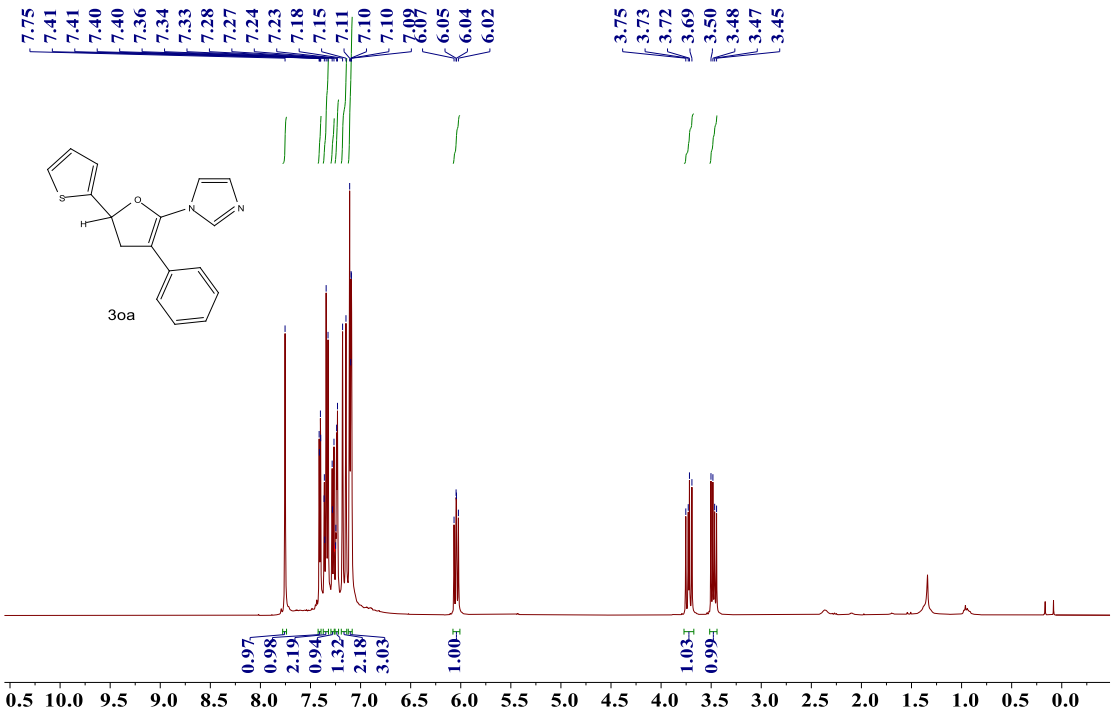
^{1}H NMR spectra of the product **3na** (400 MHz, $CDCl_3$)



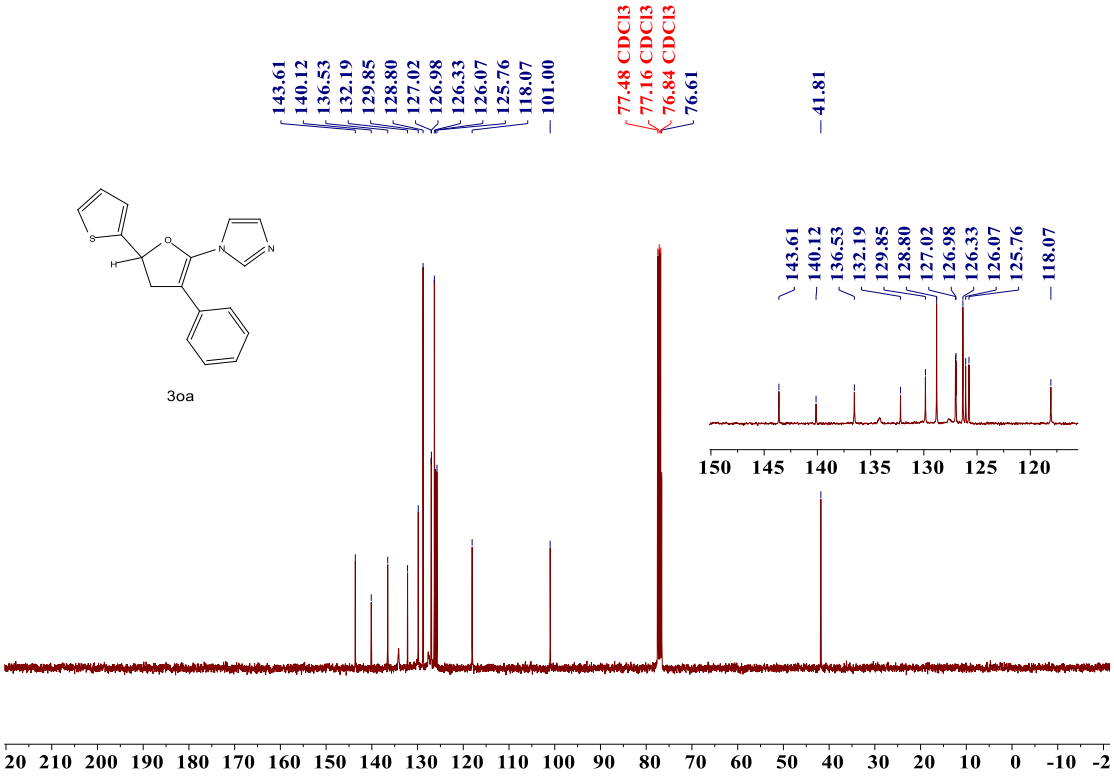
^{13}C NMR spectra of the product **3na** (100 MHz, $CDCl_3$)



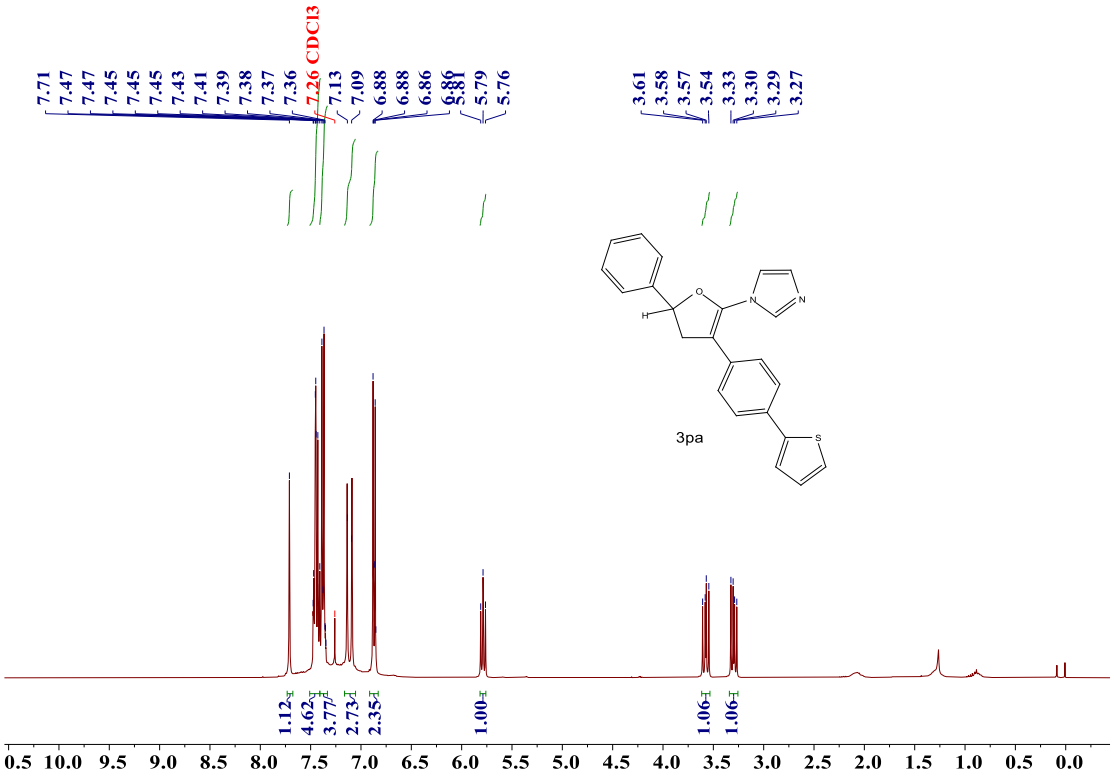
^{1}H NMR spectra of the product **3oa** (400 MHz, $CDCl_3$)



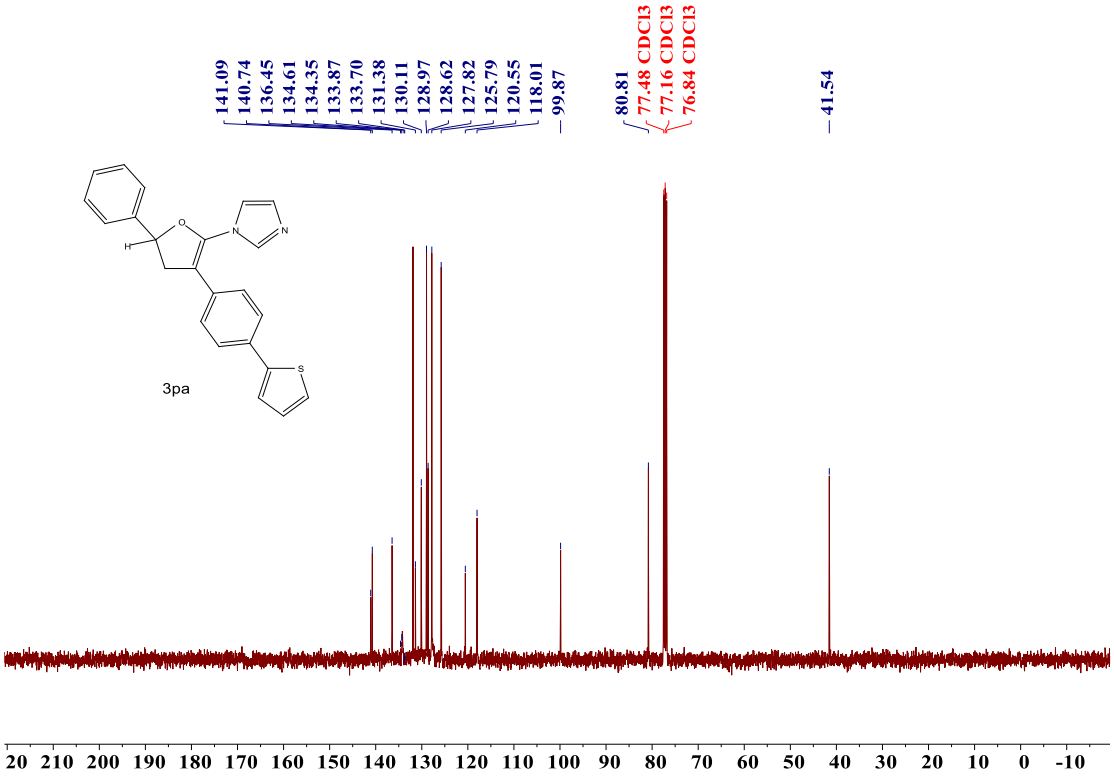
^{13}C NMR spectra of the product **3oa** (100 MHz, $CDCl_3$)



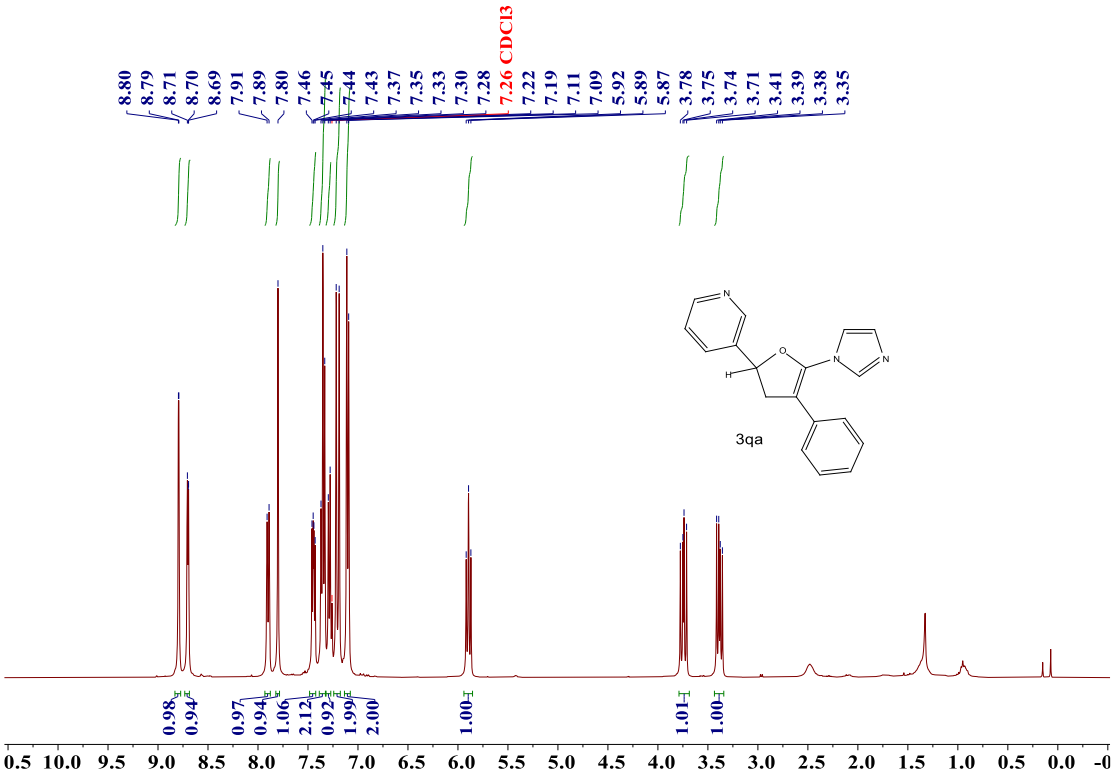
^{1}H NMR spectra of the product **3pa** (400 MHz, $CDCl_3$)



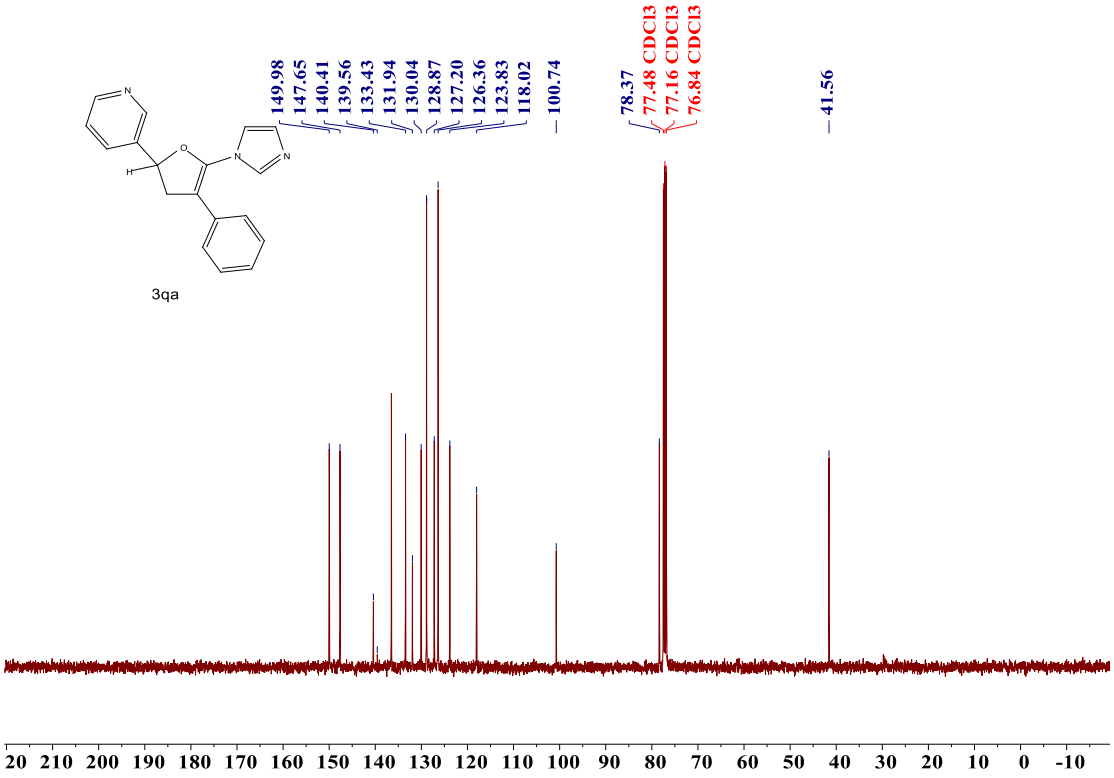
^{13}C NMR spectra of the product **3pa** (100 MHz, $CDCl_3$)



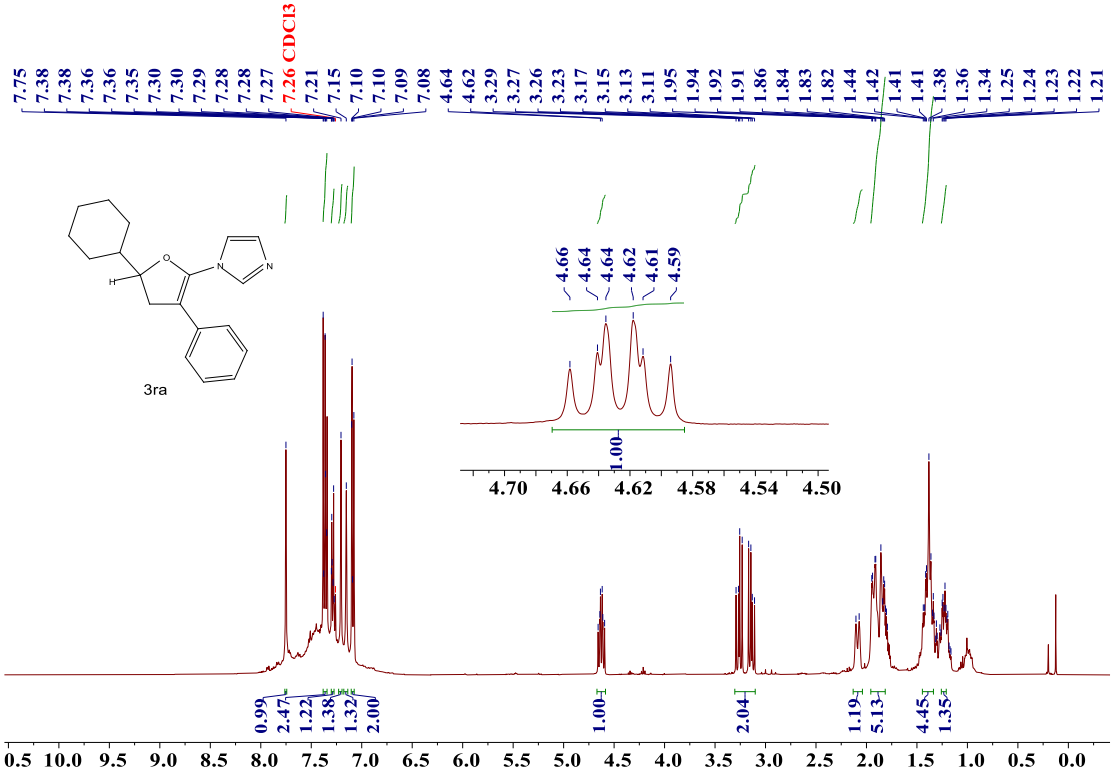
^{1}H NMR spectra of the product **3qa** (400 MHz, $CDCl_3$)



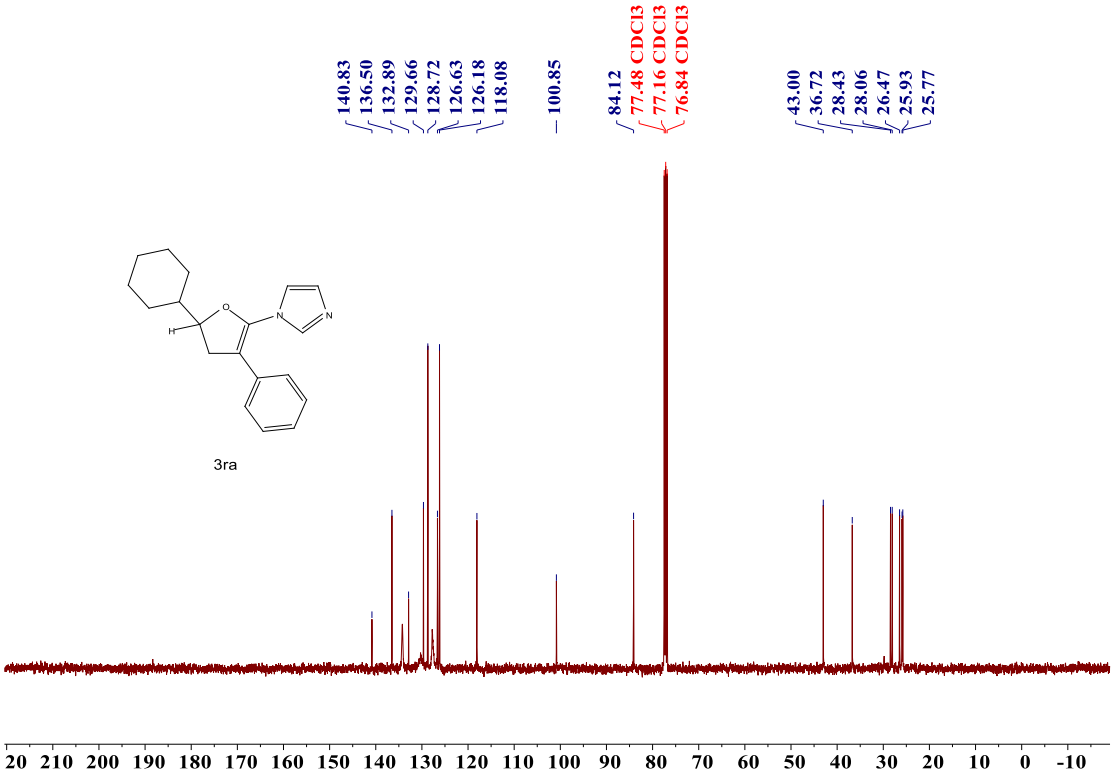
^{13}C NMR spectra of the product **3qa** (100 MHz, $CDCl_3$)



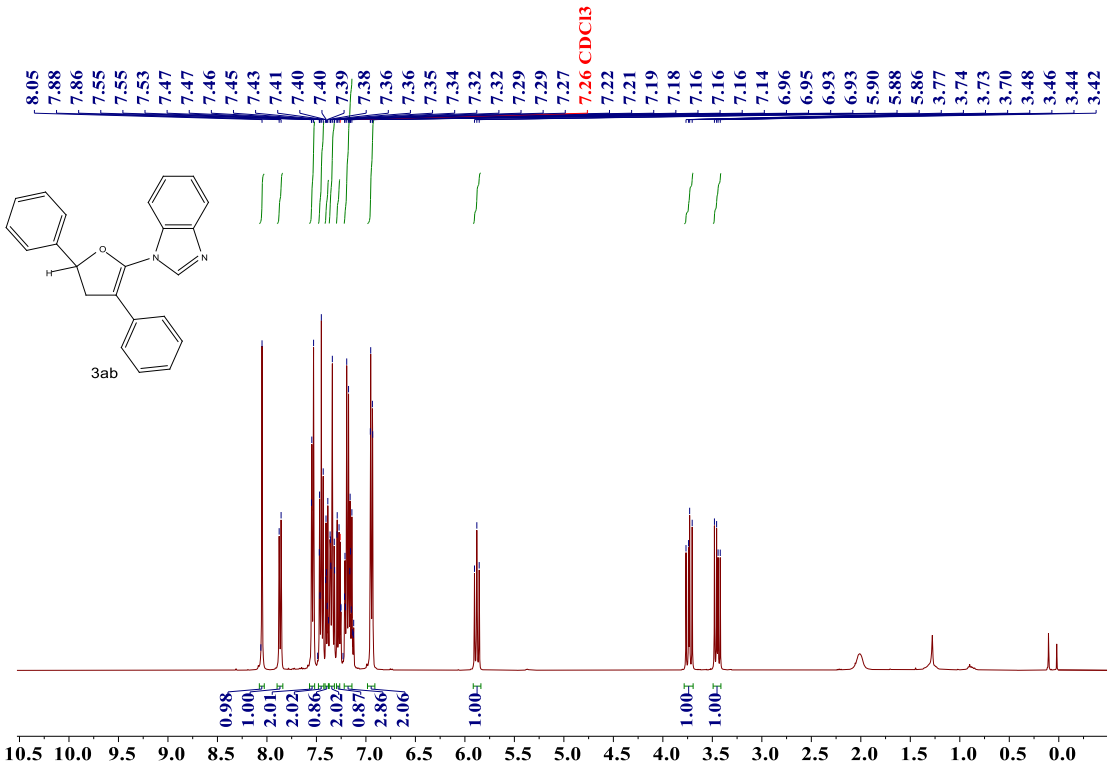
^{1}H NMR spectra of the product **3ra** (400 MHz, $CDCl_3$)



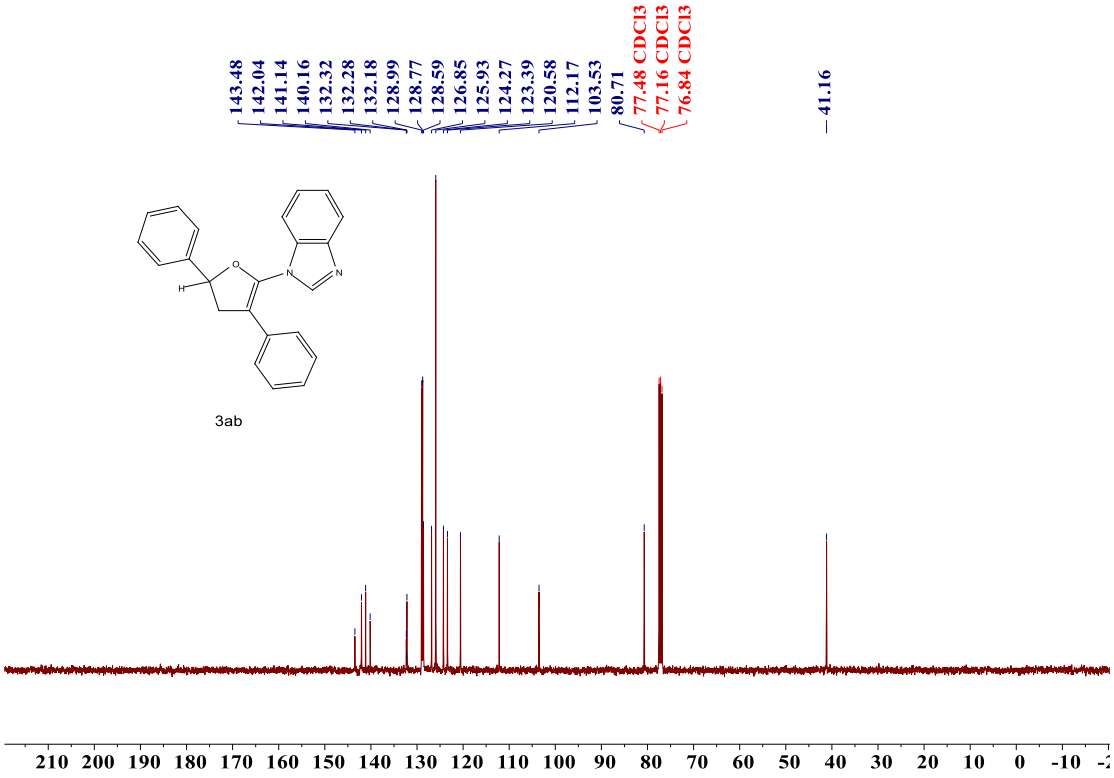
^{13}C NMR spectra of the product **3ra** (100 MHz, $CDCl_3$)



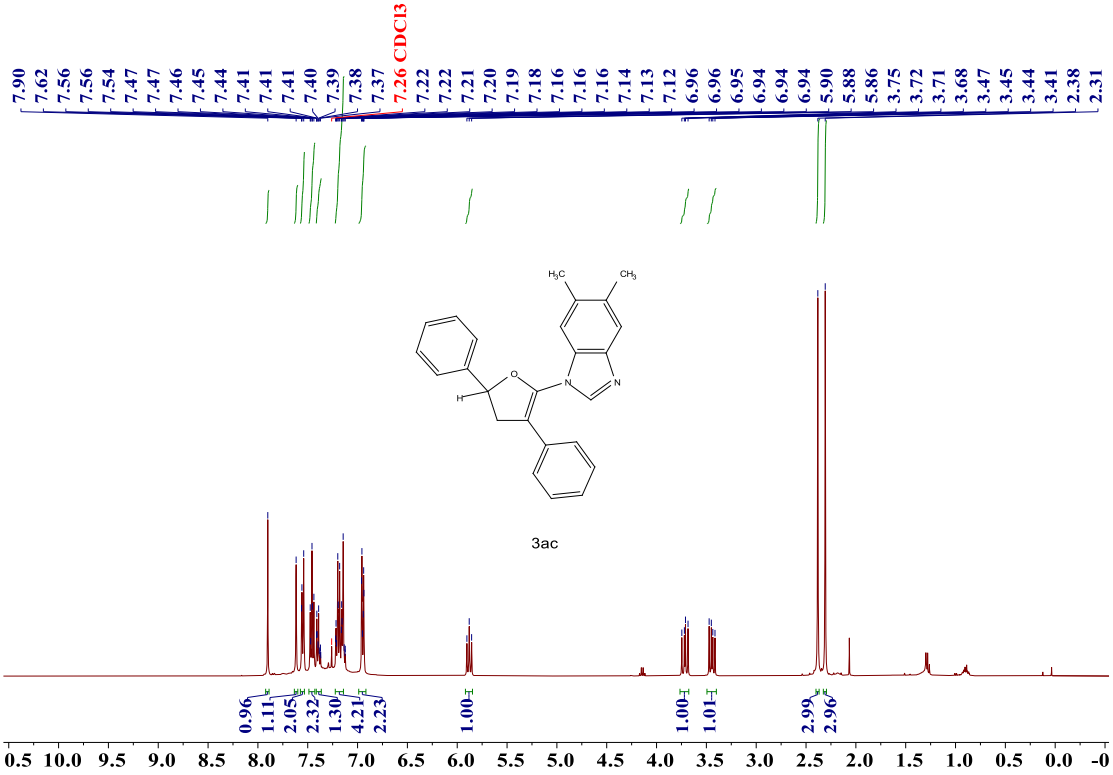
^{1}H NMR spectra of the product **3ab** (400 MHz, $CDCl_3$)



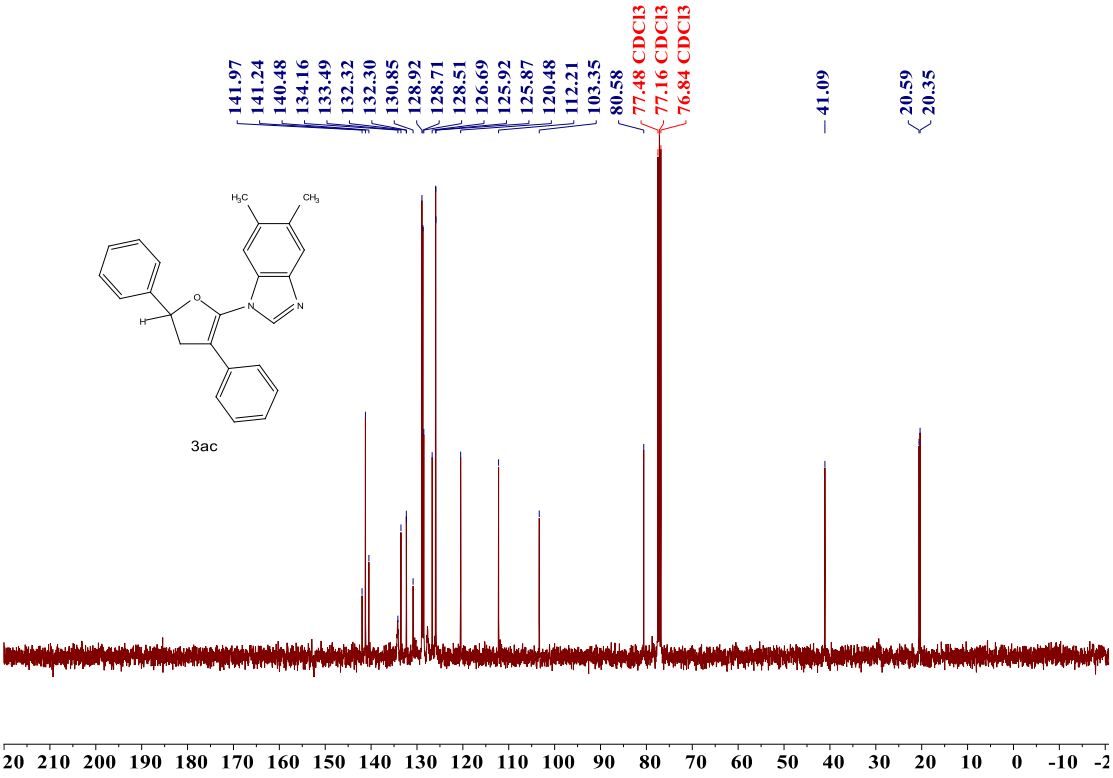
^{13}C NMR spectra of the product **3ab** (100 MHz, $CDCl_3$)



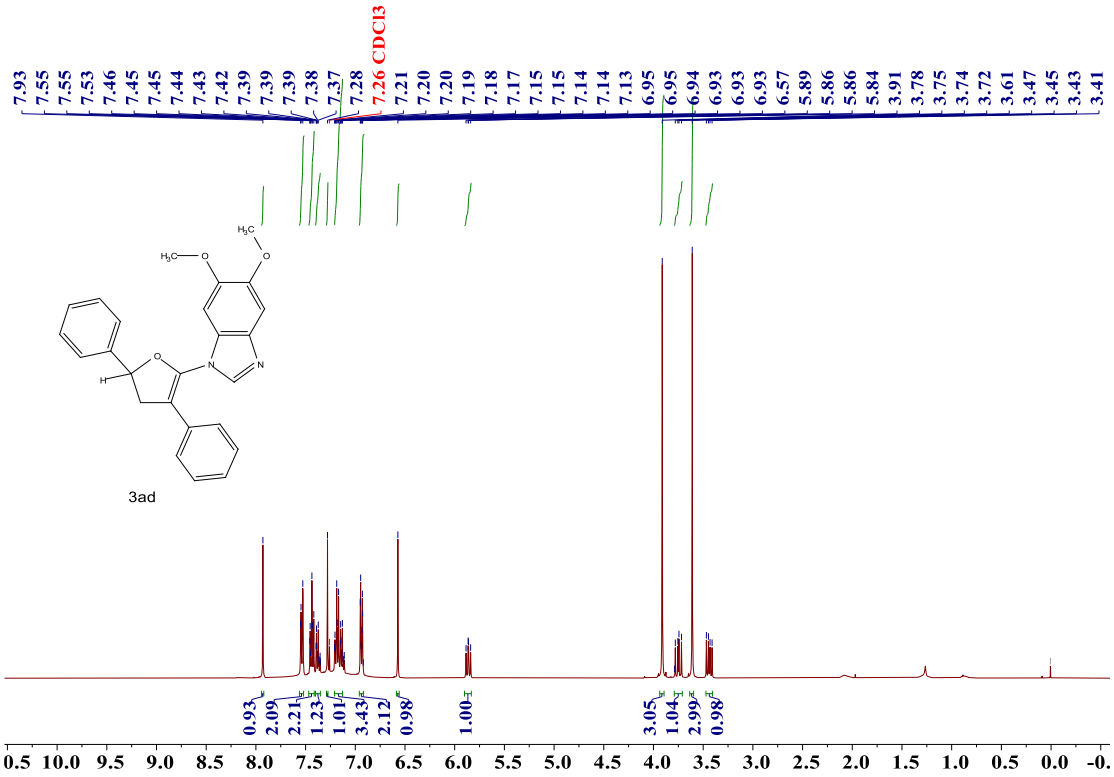
^{1}H NMR spectra of the product **3ac** (400 MHz, $CDCl_3$)



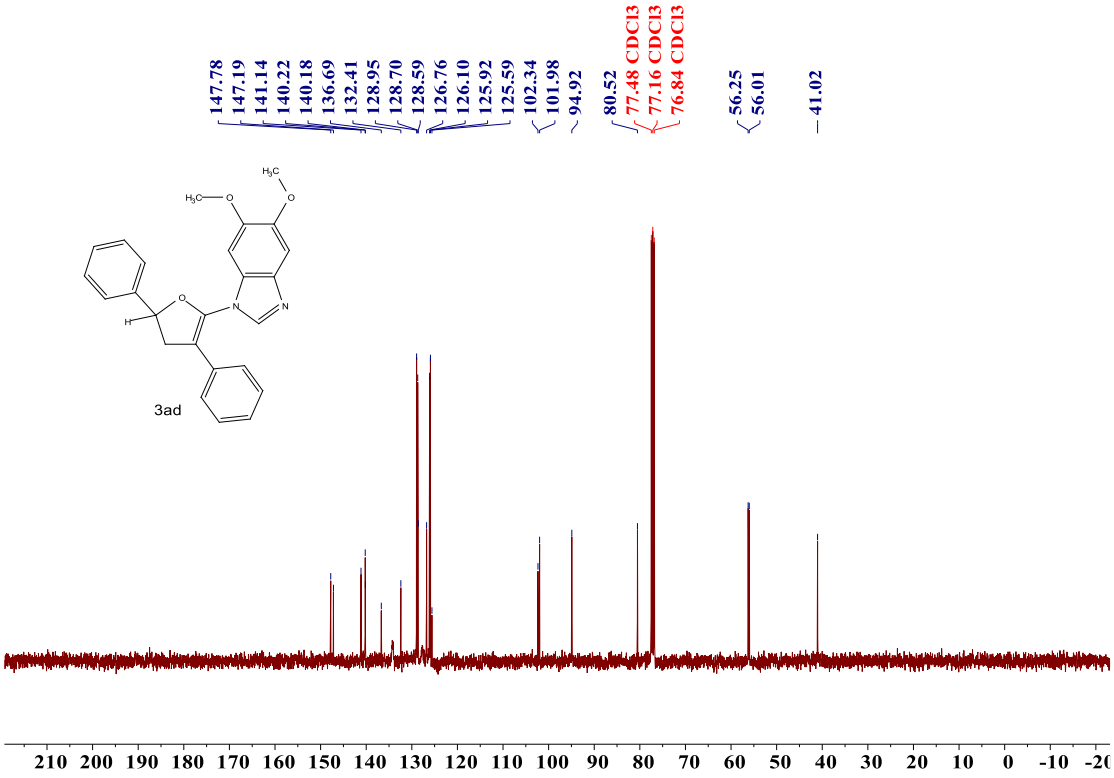
^{13}C NMR spectra of the product **3ac** (100 MHz, $CDCl_3$)



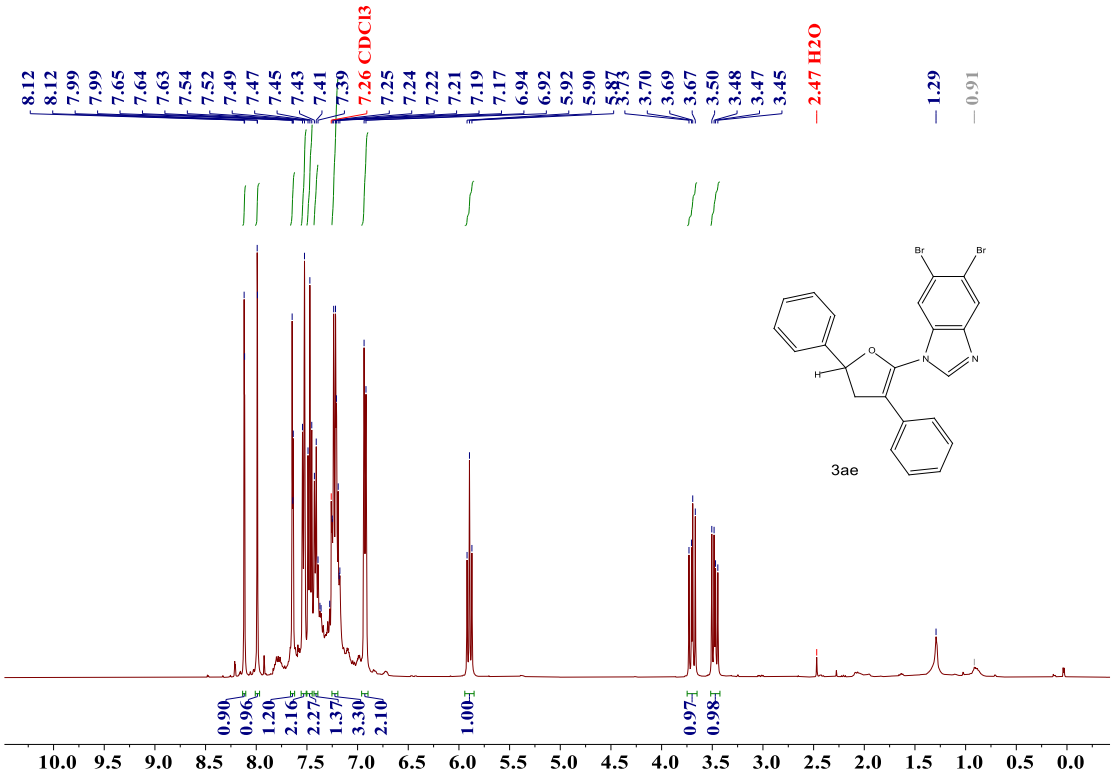
^{1}H NMR spectra of the product **3ad** (400 MHz, $CDCl_3$)



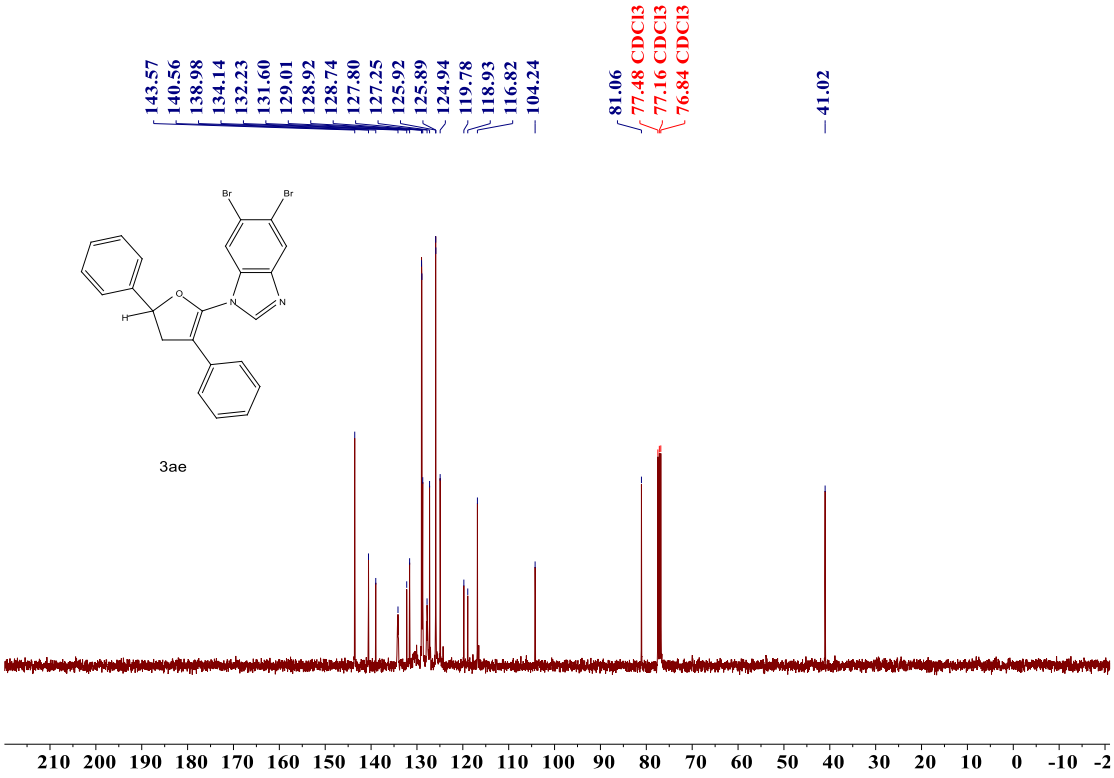
^{13}C NMR spectra of the product **3ad** (100 MHz, $CDCl_3$)



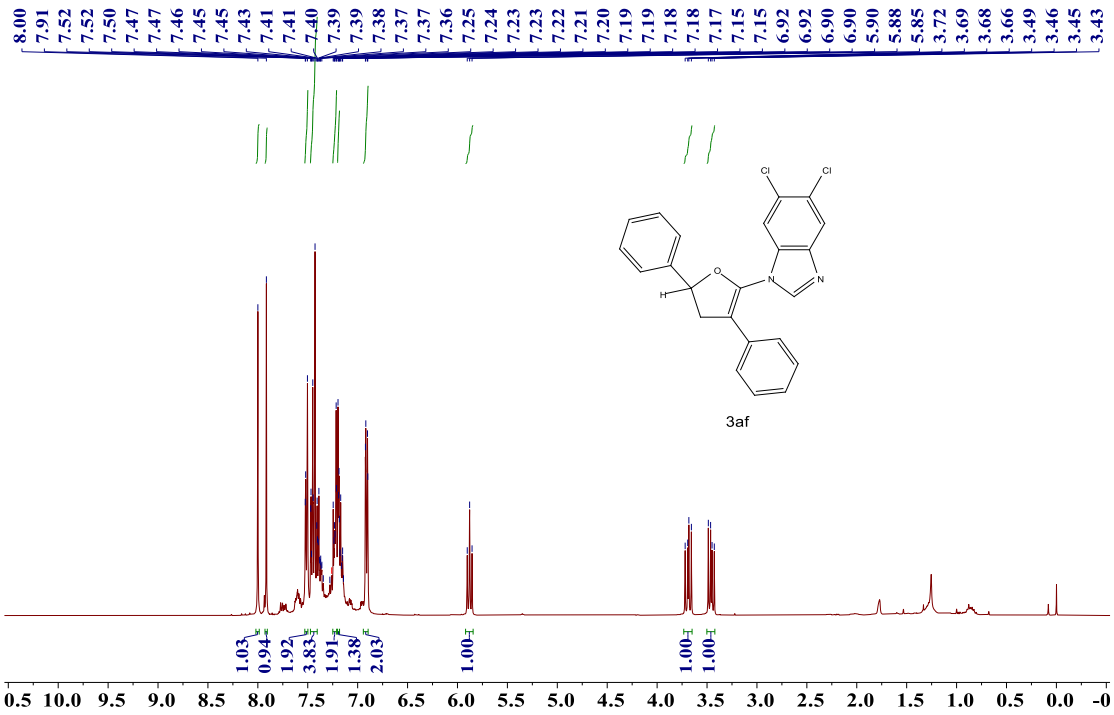
^{1}H NMR spectra of the product **3ae** (400 MHz, $CDCl_3$)



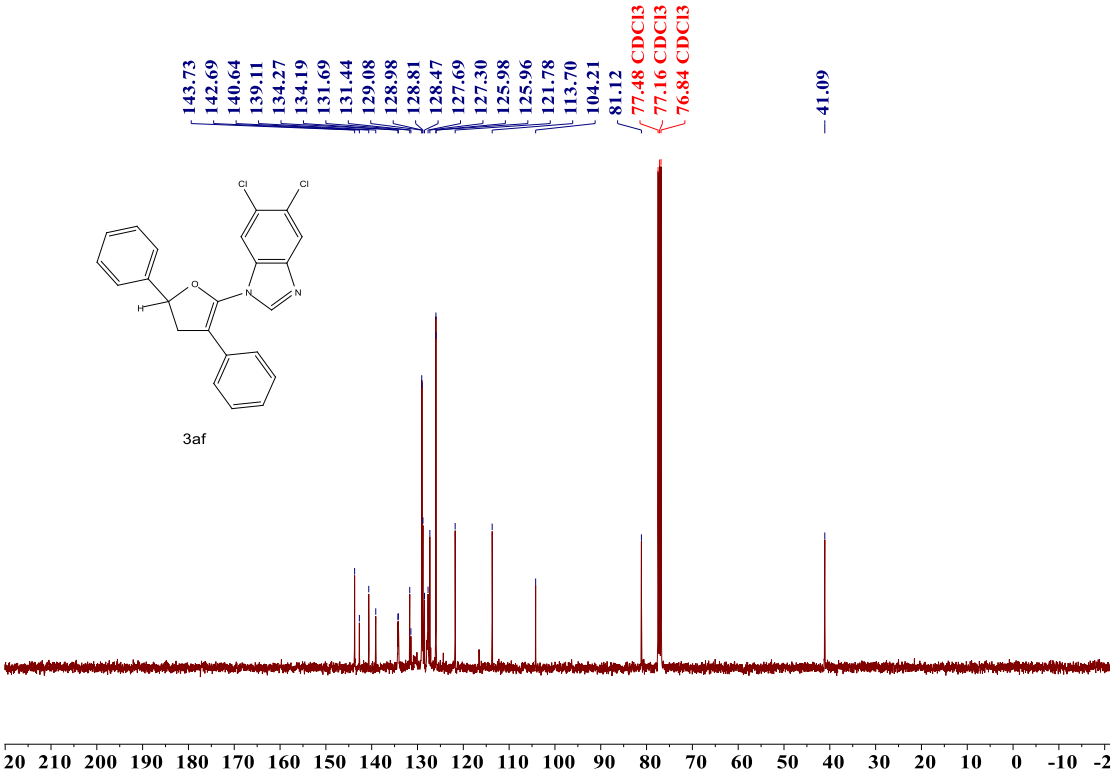
^{13}C NMR spectra of the product **3ae** (100 MHz, $CDCl_3$)



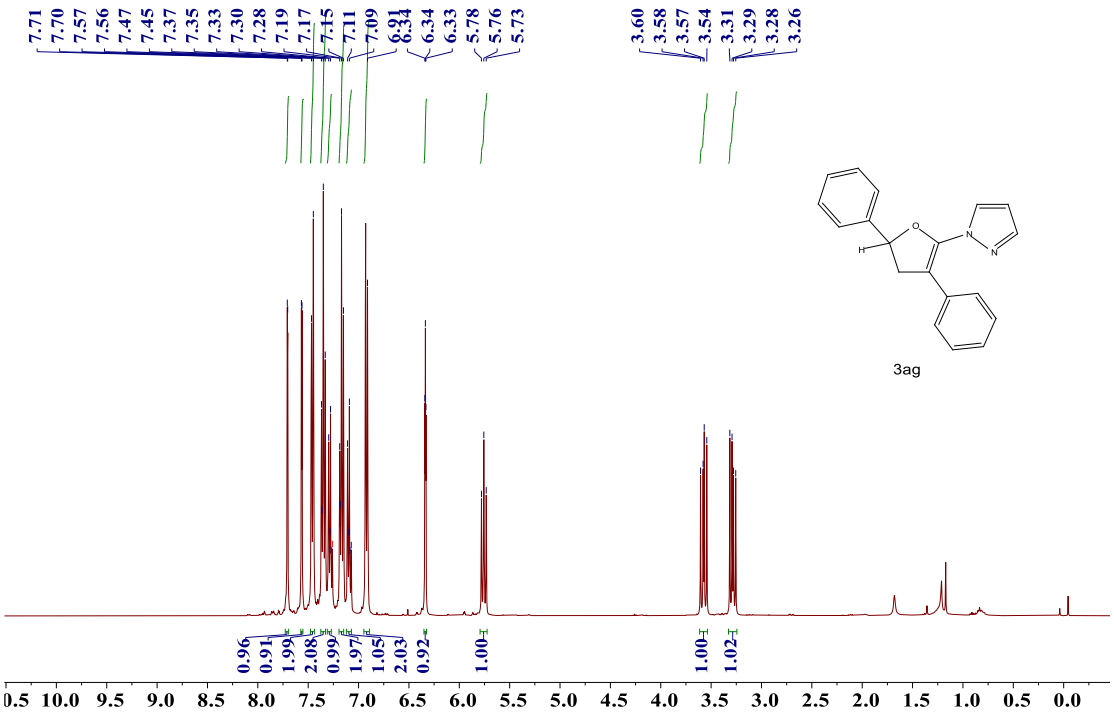
^{1}H NMR spectra of the product **3af** (400 MHz, $CDCl_3$)



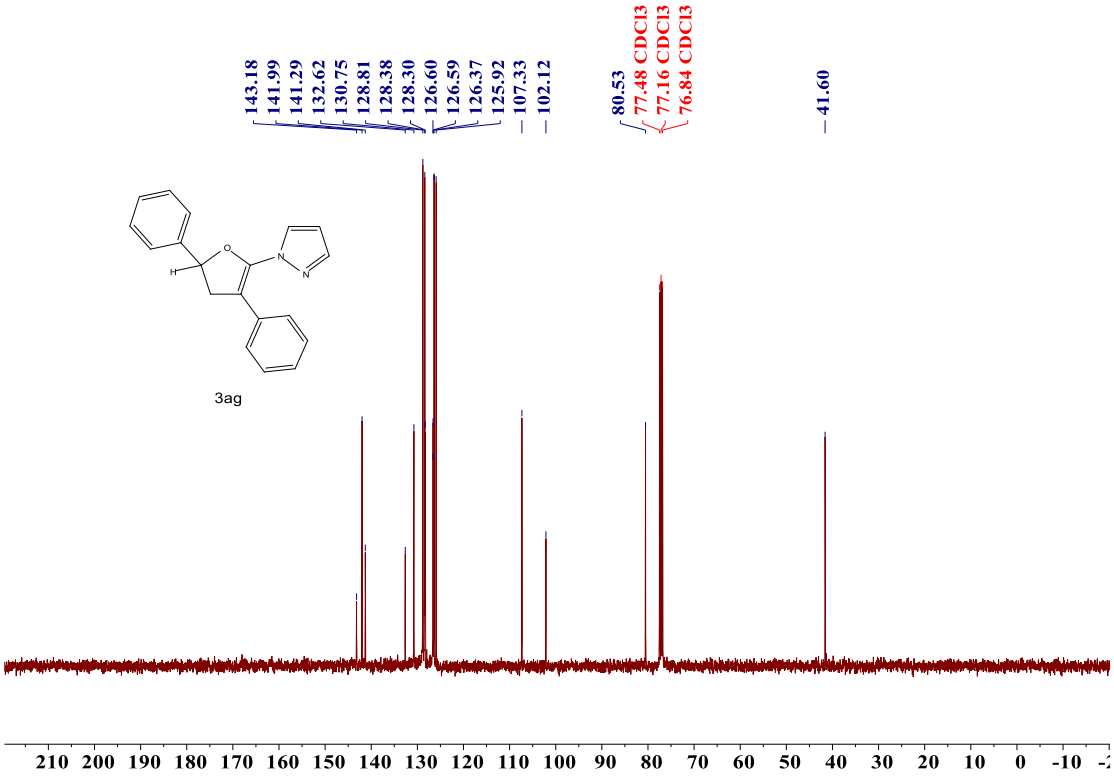
^{13}C NMR spectra of the product **3af** (100 MHz, $CDCl_3$)



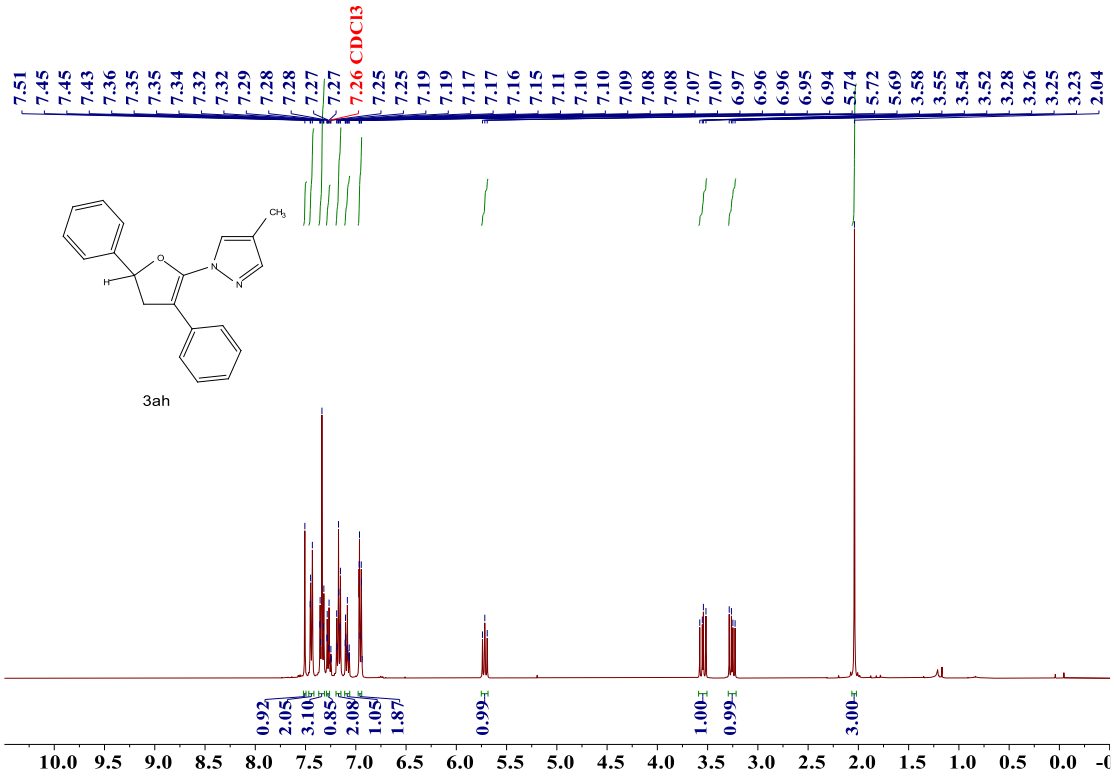
^{1}H NMR spectra of the product **3ag** (400 MHz, $CDCl_3$)



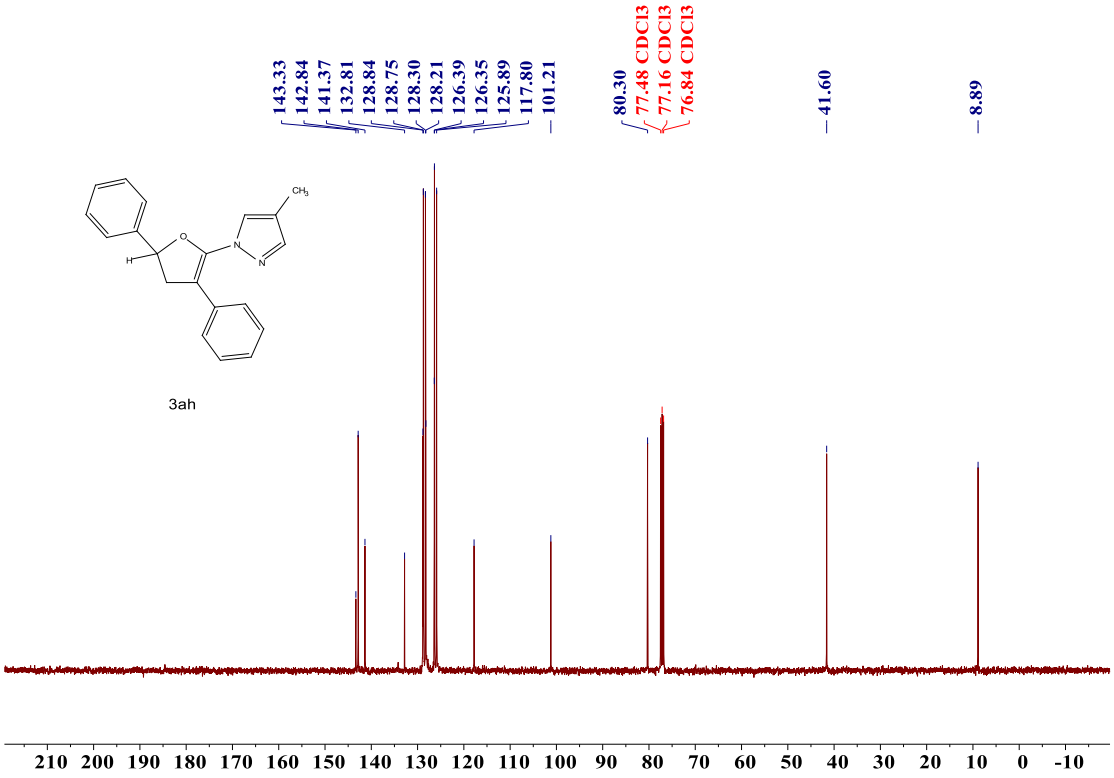
^{13}C NMR spectra of the product **3ag** (100 MHz, $CDCl_3$)



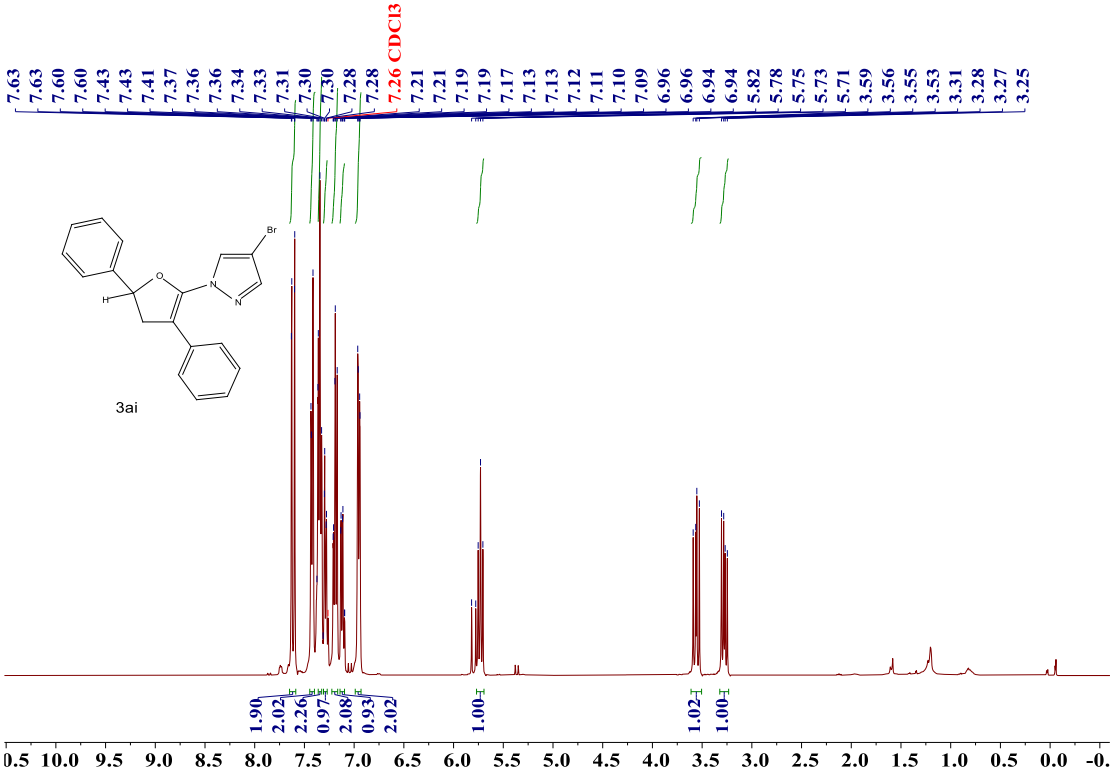
^{1}H NMR spectra of the product **3ah** (400 MHz, $CDCl_3$)



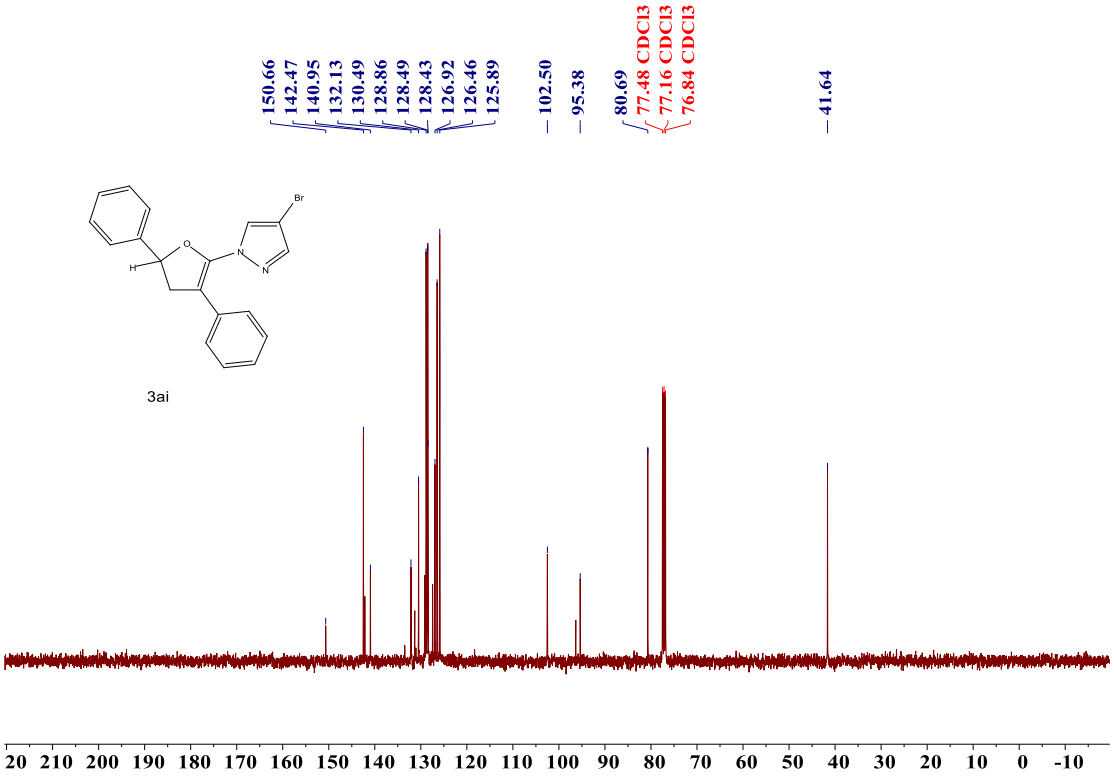
^{13}C NMR spectra of the product **3ah** (100 MHz, $CDCl_3$)



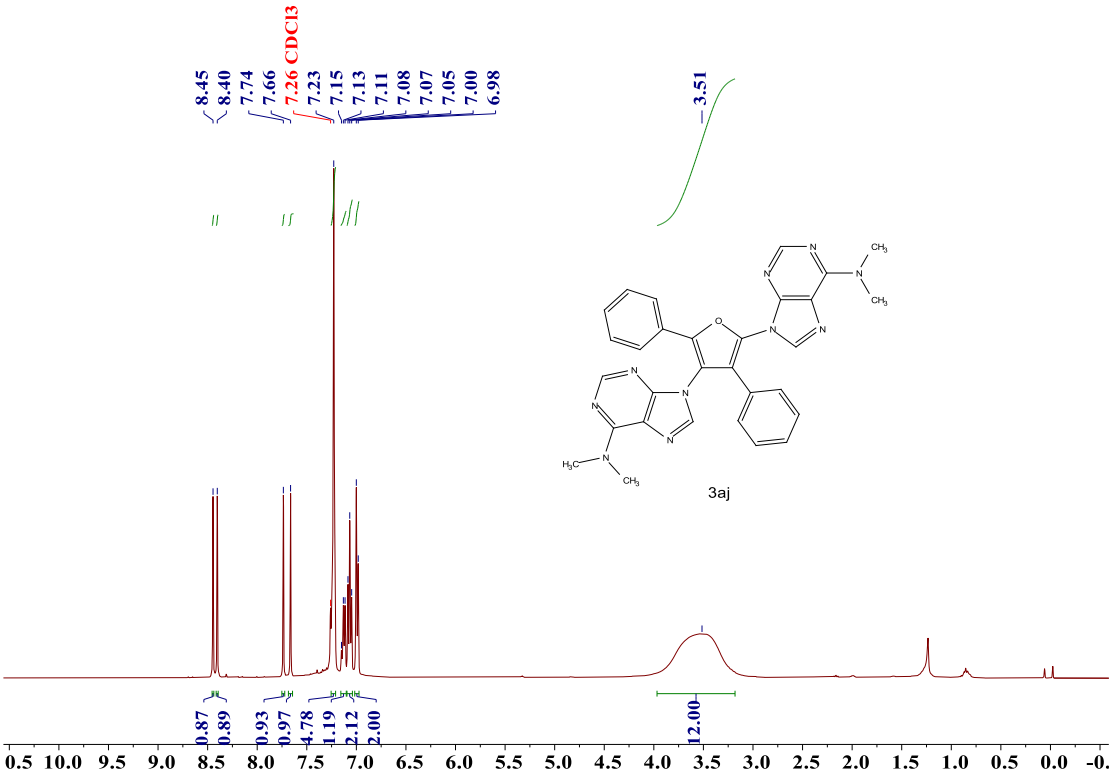
^{1}H NMR spectra of the product **3ai** (400 MHz, $CDCl_3$)



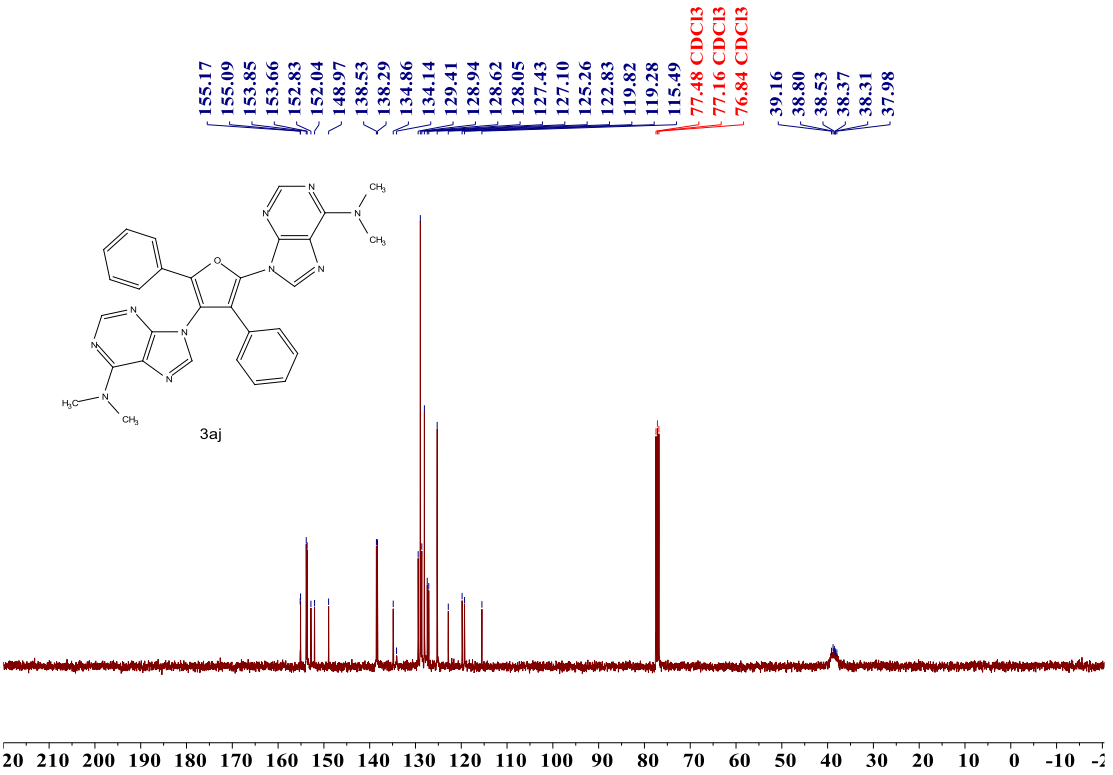
^{13}C NMR spectra of the product **3ai** (100 MHz, $CDCl_3$)



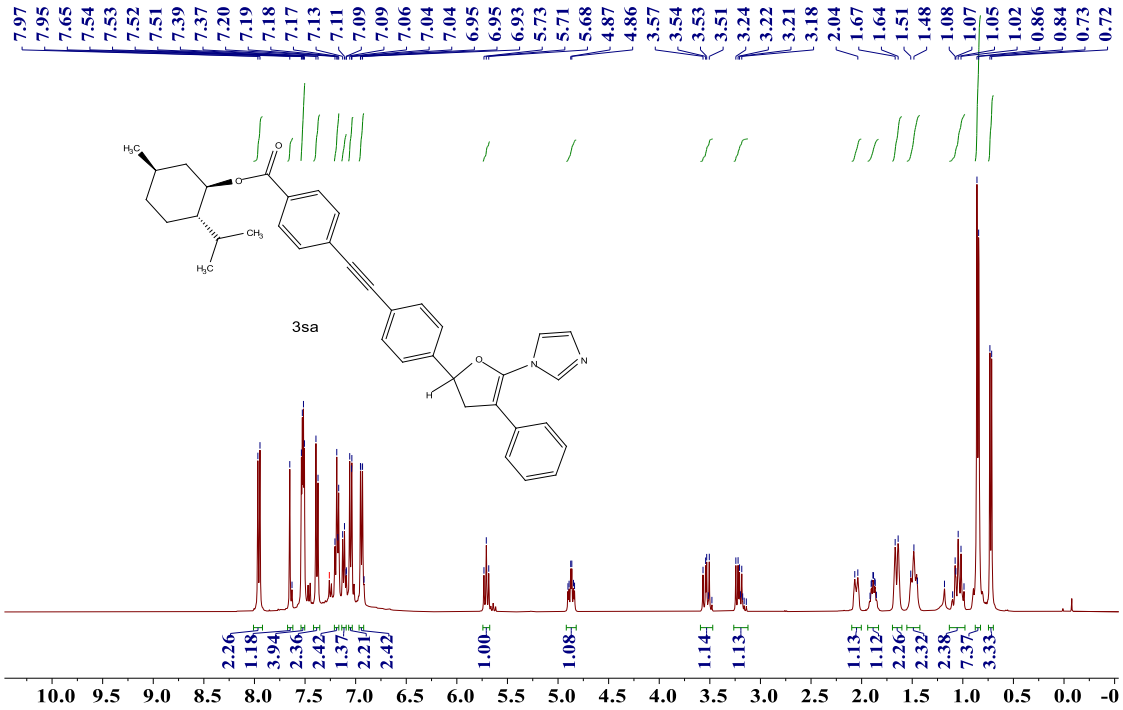
^{1}H NMR spectra of the product **3aj** (400 MHz, $CDCl_3$)



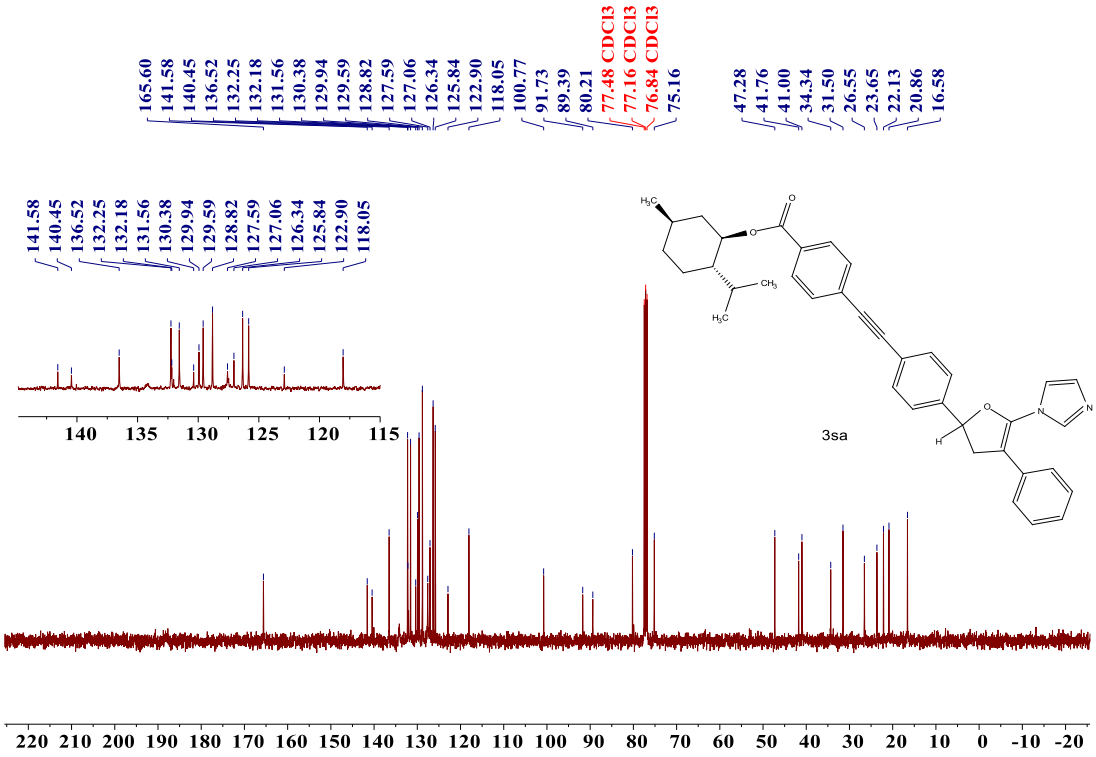
^{13}C NMR spectra of the product **3aj** (100 MHz, $CDCl_3$)



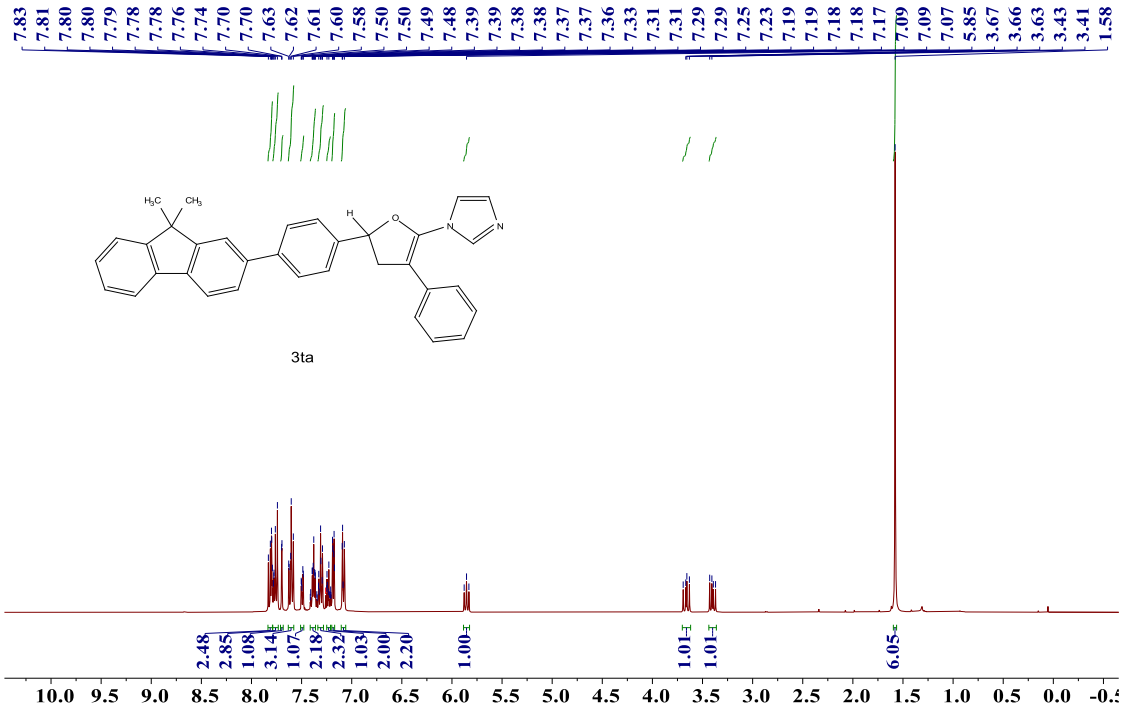
^{1}H NMR spectra of the product **3sa** (400 MHz, $CDCl_3$)



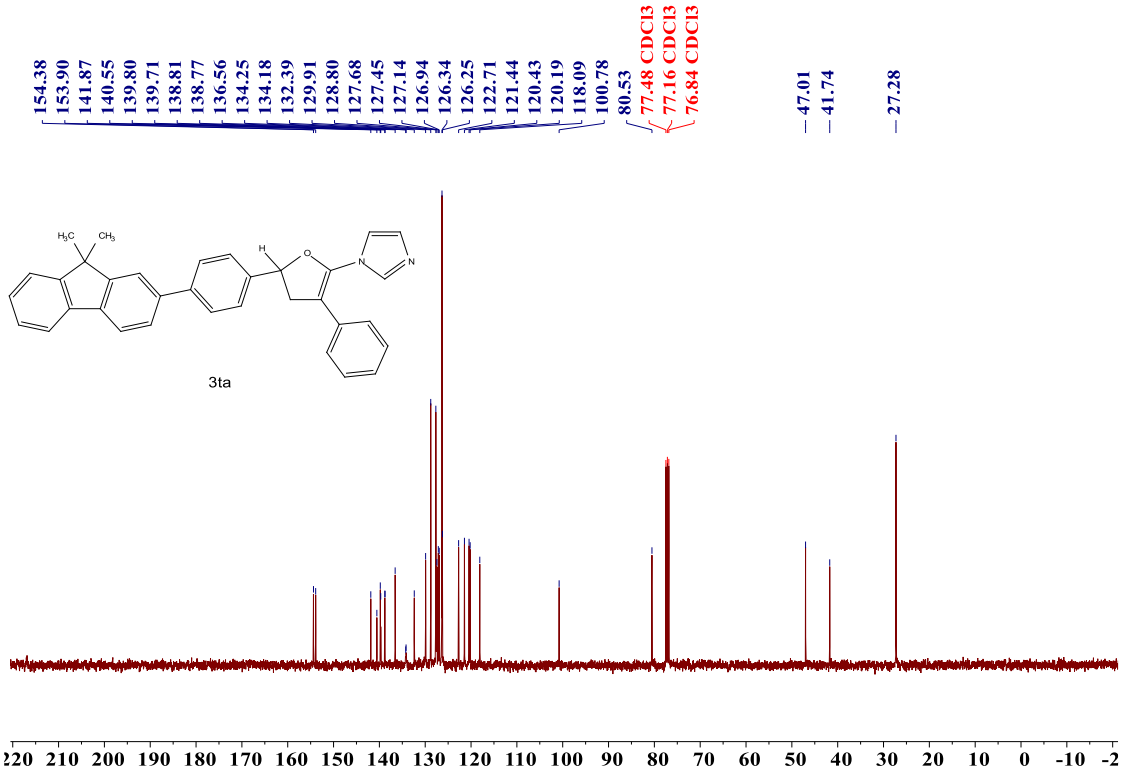
^{13}C NMR spectra of the product **3sa** (100 MHz, $CDCl_3$)



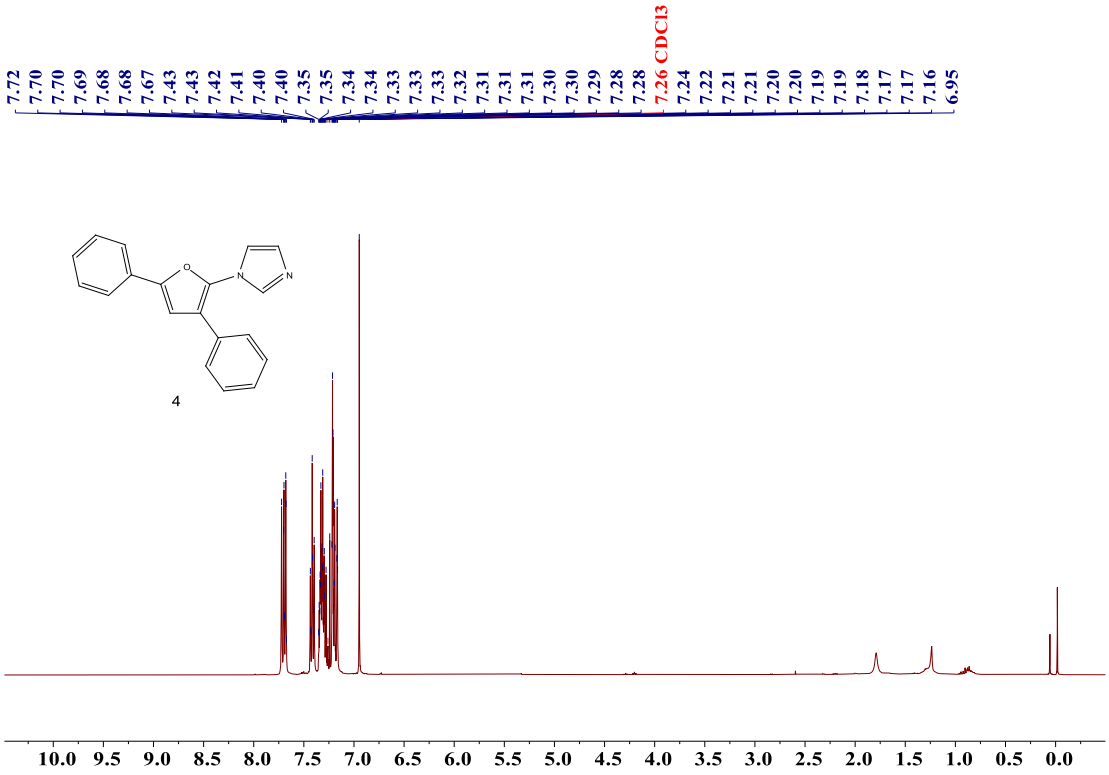
^{1}H NMR spectra of the product **3ta** (400 MHz, $CDCl_3$)



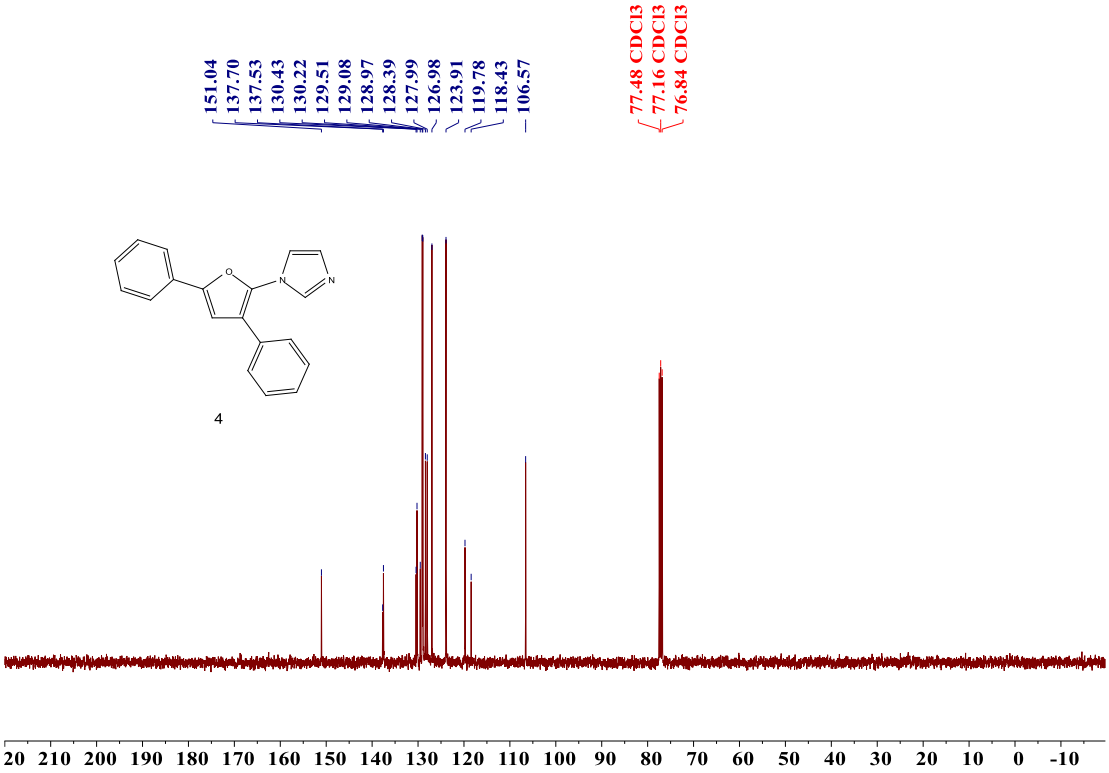
^{13}C NMR spectra of the product **3ta** (100 MHz, $CDCl_3$)



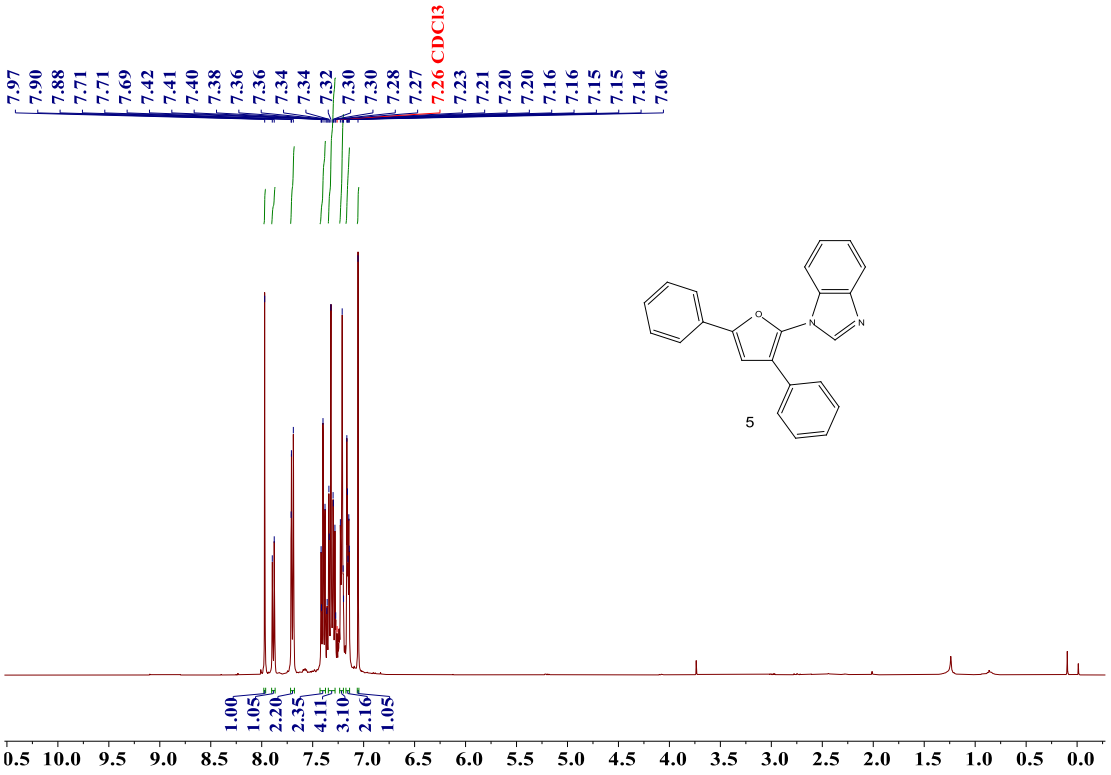
^{1}H NMR spectra of the product **4** (400 MHz, $CDCl_3$)



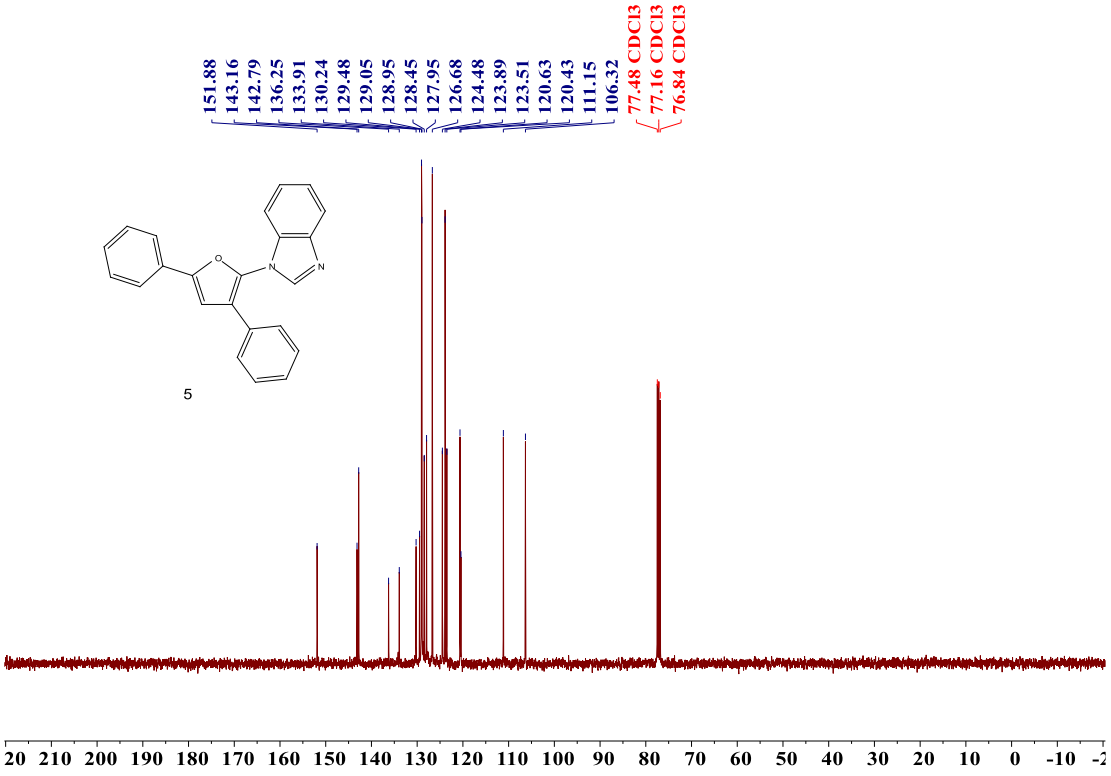
^{13}C NMR spectra of the product **4** (100 MHz, $CDCl_3$)



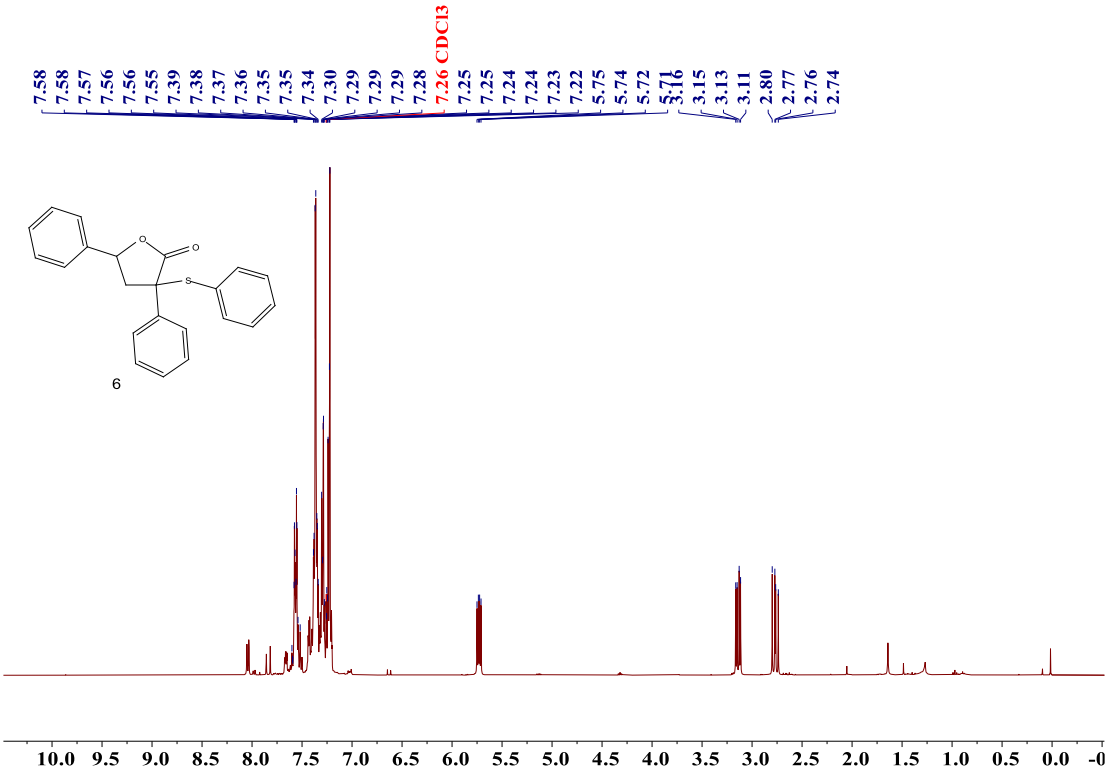
^{1}H NMR spectra of the product **5** (400 MHz, $CDCl_3$)



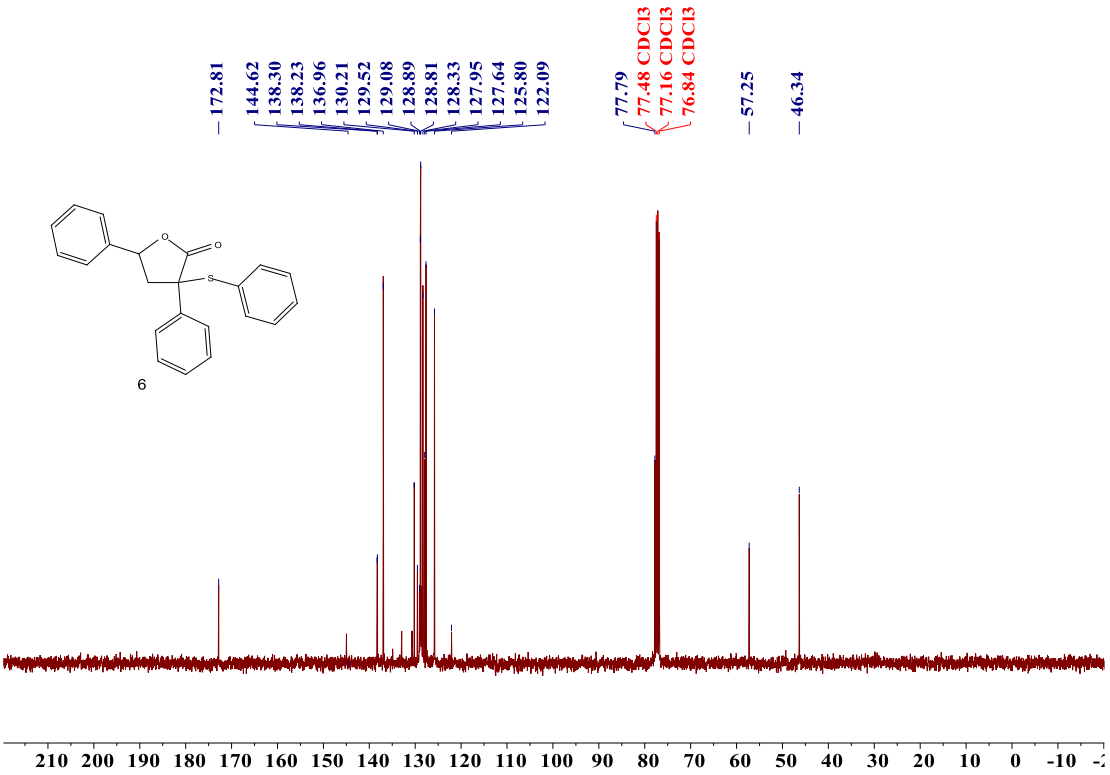
^{13}C NMR spectra of the product **5** (100 MHz, $CDCl_3$)



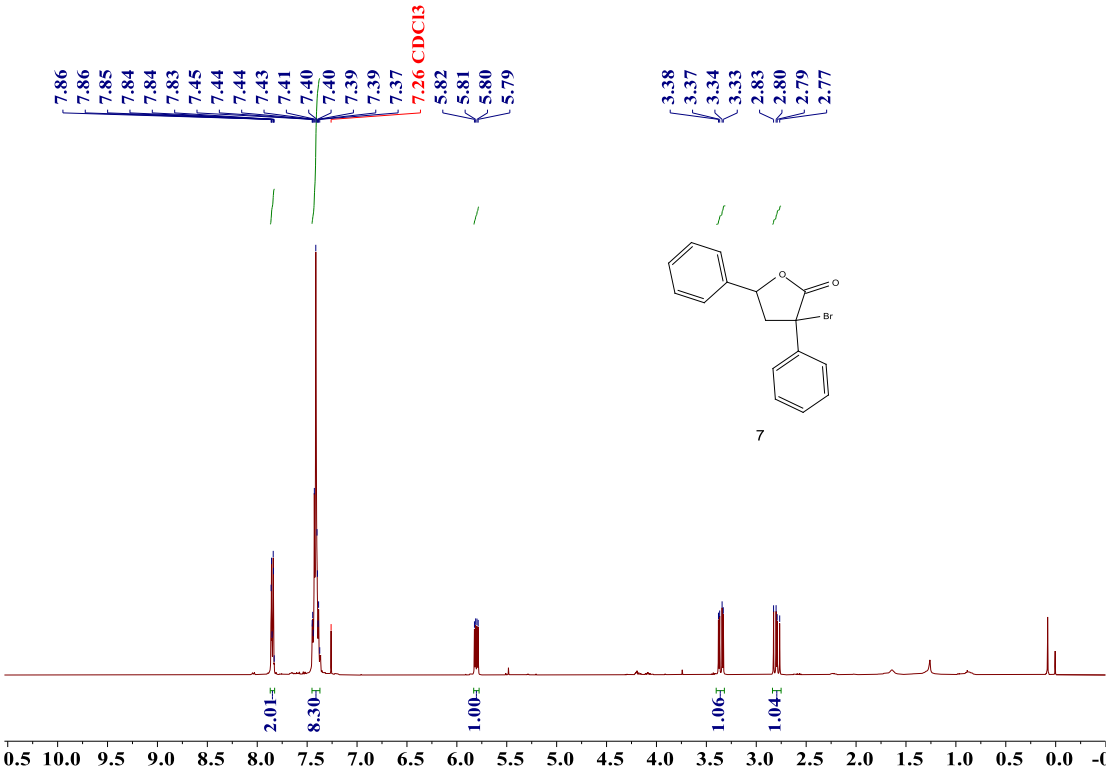
^{1}H NMR spectra of the product **6** (400 MHz, $CDCl_3$)



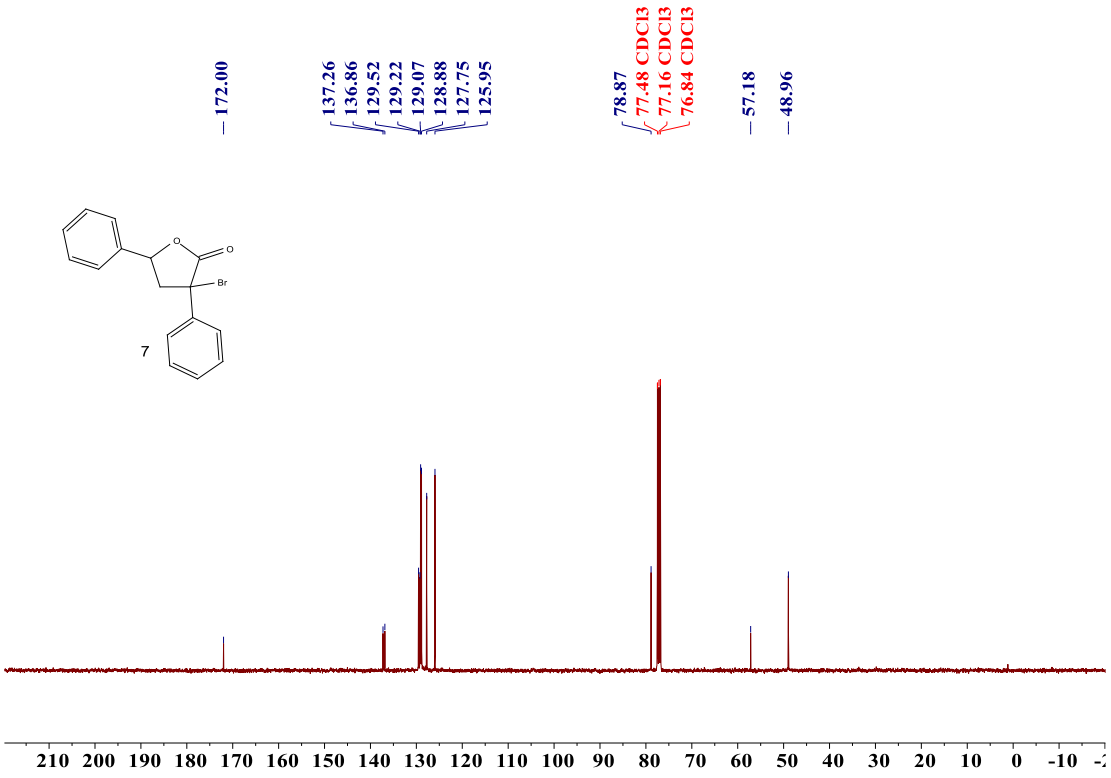
^{13}C NMR spectra of the product **6** (100 MHz, $CDCl_3$)



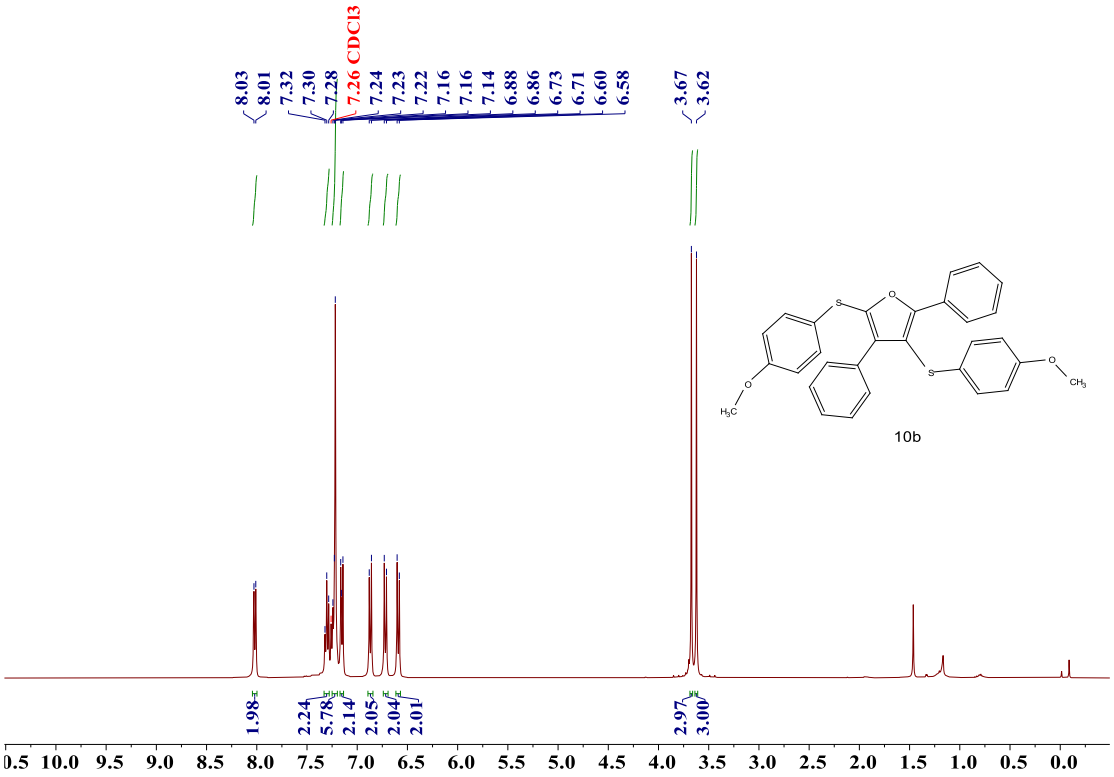
^{1}H NMR spectra of the product **7** (400 MHz, $CDCl_3$)



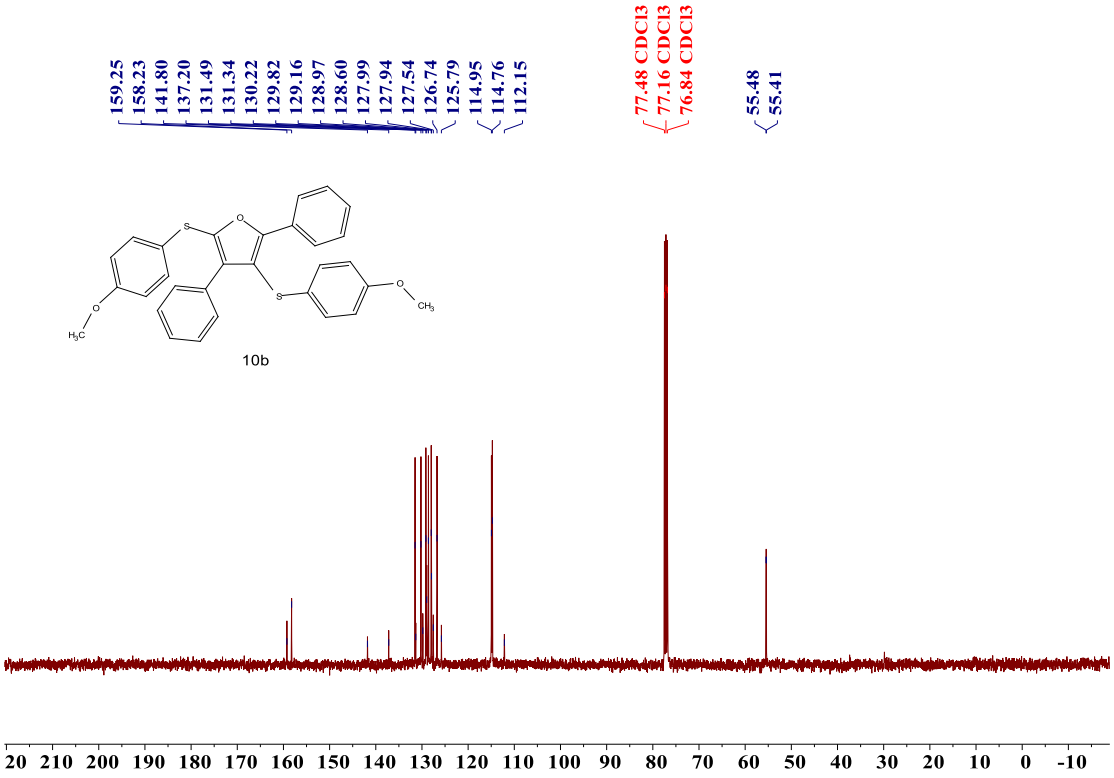
^{13}C NMR spectra of the product **7** (100 MHz, $CDCl_3$)



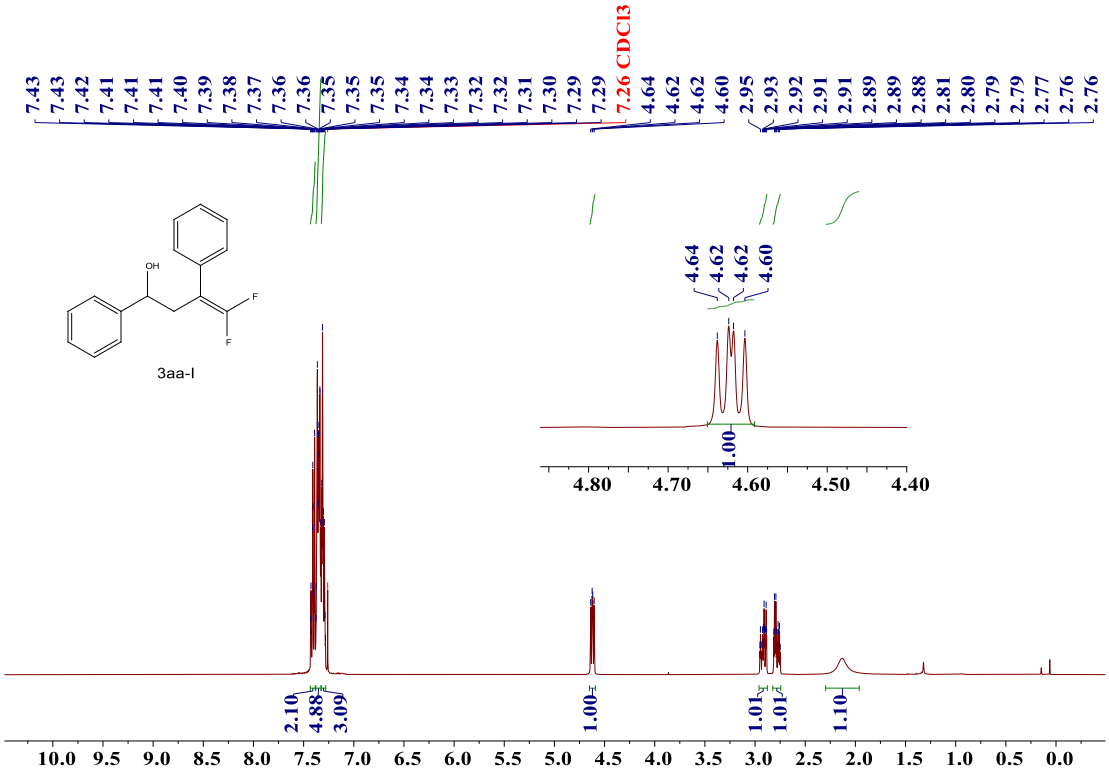
^{1}H NMR spectra of the product **10b** (400 MHz, $CDCl_3$)



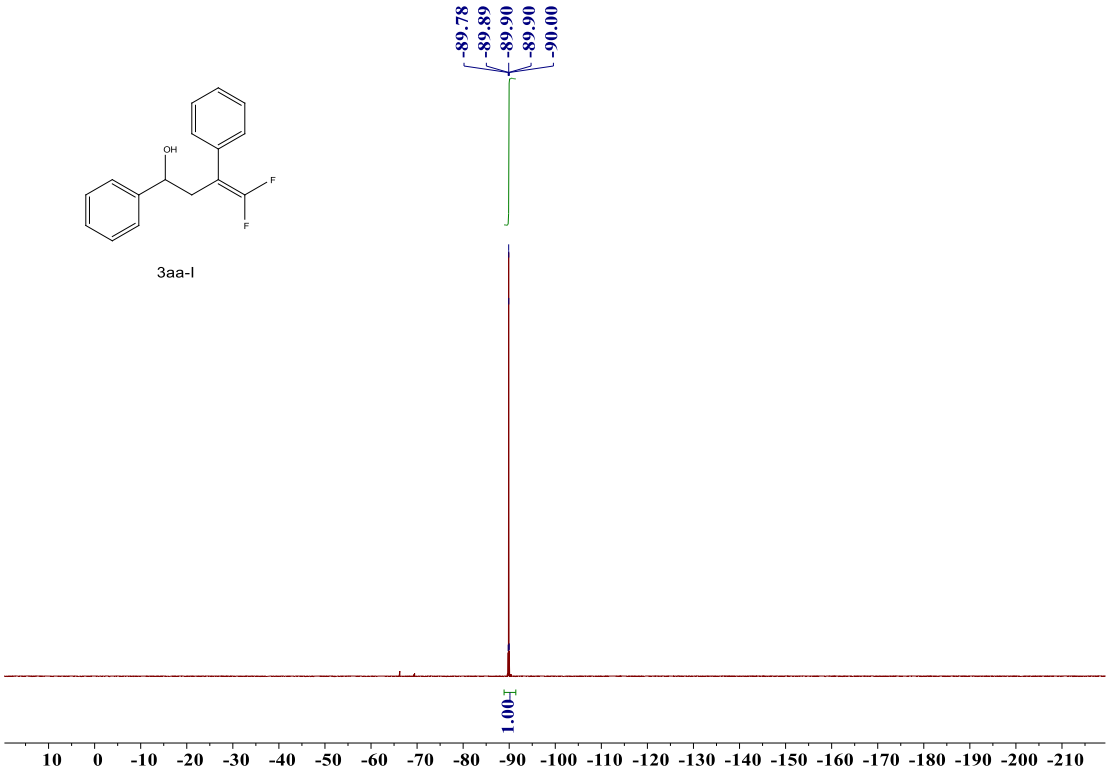
^{13}C NMR spectra of the product **10b** (100 MHz, $CDCl_3$)



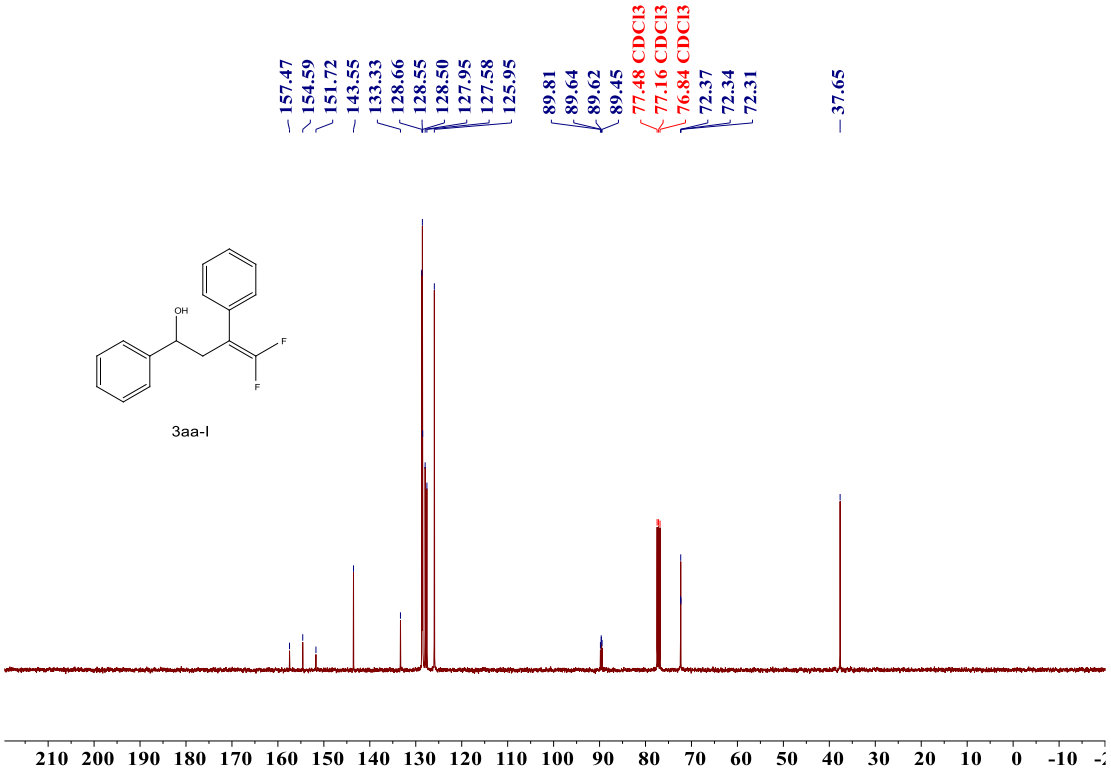
^{1}H NMR spectra of the product **3aa-I** (400 MHz, $CDCl_3$)



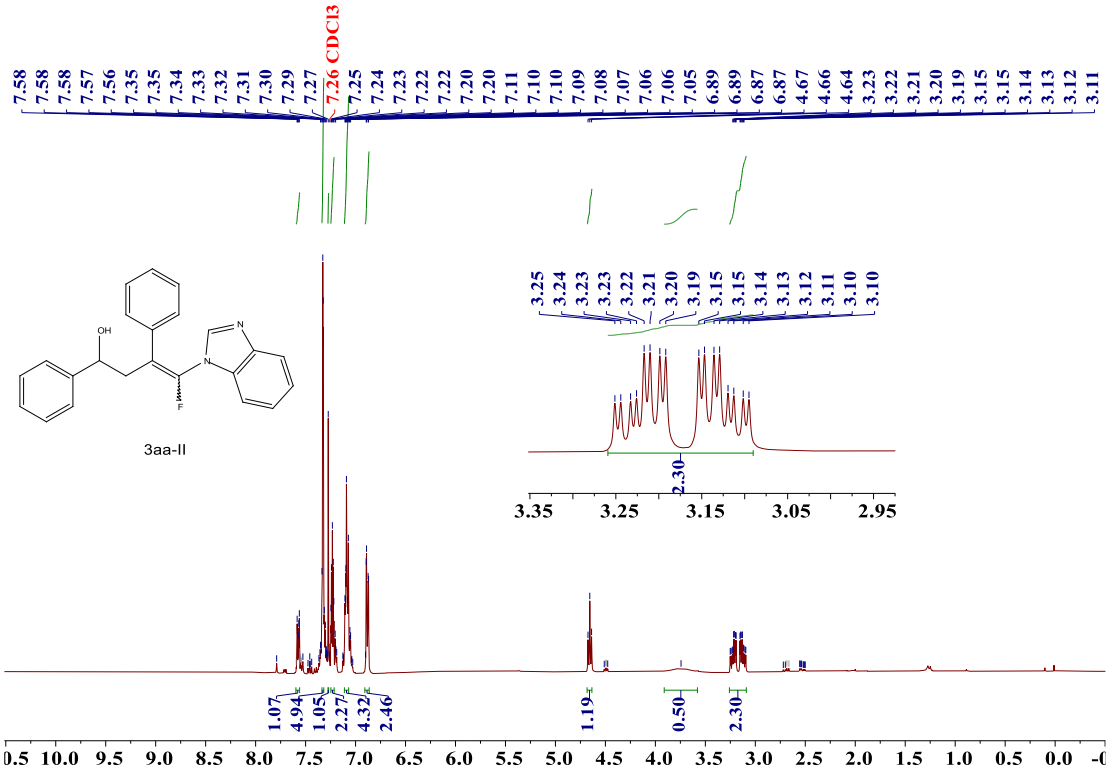
^{19}F NMR spectra of the product **3aa-I** (376 MHz, $CDCl_3$)



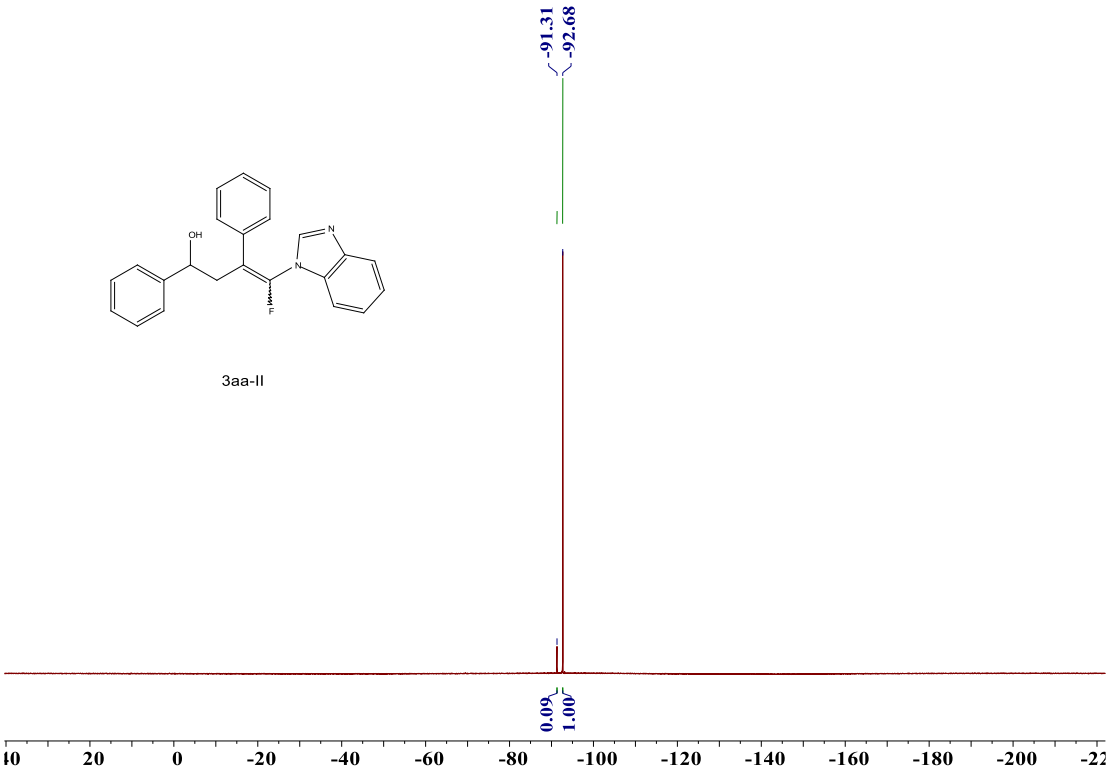
^{13}C NMR spectra of the product **3aa-I** (100 MHz, $CDCl_3$)



^{1}H NMR spectra of the product **3aa-II** (400 MHz, $CDCl_3$)



^{19}F NMR spectra of the product **3aa-II** (376 MHz, $CDCl_3$)



^{13}C NMR spectra of the product **3aa-II** (100 MHz, $CDCl_3$)