Supplementary Information

for

Transition-Metal-Free Synthesis of 4-Amino Isoquinolin-1(2*H*)-ones via Tandem Reaction of Arynes and Oxazoles

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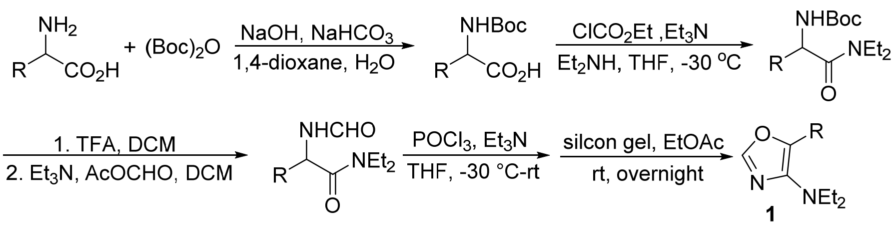
1 General information

Unless otherwise indicated, all reactions were conducted under nitrogen atmosphere in oven-dried glassware with magnetic stirring bar. All other chemicals were obtained from commercial supplies and used as received without any further purification. Column chromatograph was performed with silica gel (200~300 mesh) and analytical TLC on silica gel 60-F_{254}. ^{1}H, ^{13}C, ^{19}F NMR and NOE spectras were recorded on a Bruker AVANCE III spectrometer (400 MHz, 100 MHz and 376 MHz, respectively), Chemical shifts are reported parts per million (ppm) referenced to $CDCl_3$ (δ 7.26 ppm), tetramethylsilane (TMS, δ 0.00 ppm) for ^{1}H, ^{13}C and ^{19}F NMR. High-resolution mass spectra (HRMS) were obtained on a Q Exactive mass spectrometry and an LTQ Orbitrap XL mass spectrometry equipped with an APCI and ESI source from Thermo Scientific. X-Ray diffraction study for product **3ah** was carried out on Bruker D8 VENTURE photon II diffractometer with Iμs 3.0 microfocus X-ray source using APEX III program.

2 Experimental section

2.1 General procedure for synthesis of substrates 1a-1g, 1j-1q, 1s and 1u:



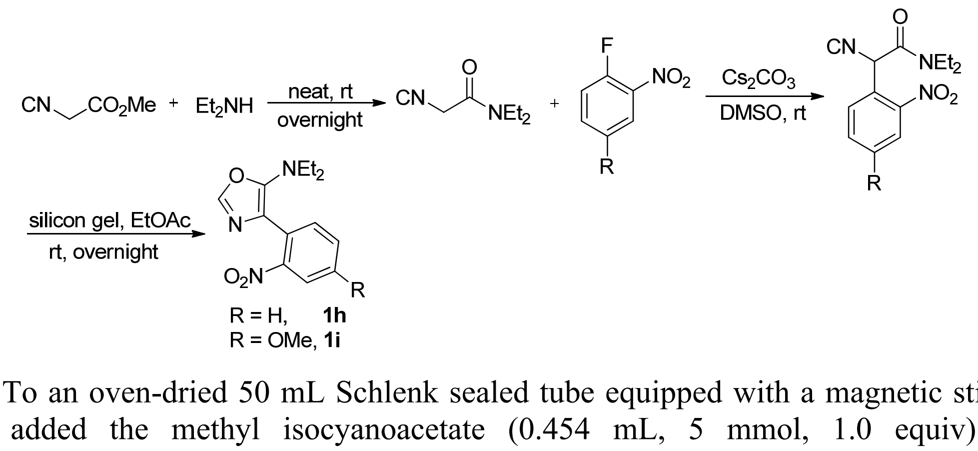
Substrates were prepared according to the known literature. [1, 2] To a 150 mL round-bottom flask was added amino acid (10 mmol), dioxane/H_2O (v/v=2:1, 30 mL), NaOH (0.4 g, 10 mmol) and then cooled in an ice-bath. Subsequently, $(Boc)_2O$ (3.27 g, 15 mmol) and $NaHCO_3$ (0.84 g, 10 mmol) were added to the reaction mixture which was reacted overnight at room temperature and monitored by TLC. After completion of the reaction, the solvent was evaporated to a half of the volume. The residue was diluted with EtOAc (40 mL), cooled in an ice-bath and acidified to pH=2-3 with 1.0 M HCl successively. The solution was layered, then the aqueous phase was extracted with EtOAc (2×20 mL). The combined organic phase was washed with H_2O and dried over anhydrous Na_2SO_4. The solution was concentrated under vacuum to give *N*-Boc-amino acid as colourless oil which was used for the next step without further purification.

To a solution of *N*-Boc-amino acid in anhydrous THF (30 mL) was added Et_3N (1.2 equiv) and cooled to -30 ℃, at this time, ethyl chloroformate (1.1 equiv) was added dropwise. After reacting for 30 min, Et_2NH (2.0 equiv) was added and the solution was stirred at this temperature for additional 15 min. Subsequently, the reaction mixture was warmed to room temperature naturally and continued to stir until the reaction was completed (detected by TLC, about 2 h). The reaction mixture was quenched with H_2O (30 mL) and extracted with ethyl acetate (2×20 mL). The combined organic phase was washed with 1.0 M HCl (20 mL), saturated $NaHCO_3$ (20 mL) and brine (20 mL) successively. The organic phase was then dried and concentrated under vacuum to afford corresponding amide which was used for the next step without further purification.

The obtained amide (1.0 equiv) was treated with trifluoroacetic acid (13 equiv) in DCM (1.0 M) at room temperature for 1 h. After removal of the solvent and excess trifluoroacetic acid, the residue was re-dissolved in DCM (20 mL) and washed with saturated $NaHCO_3$ (30 mL). The aqueous layer was extracted with DCM (2×30 mL), and the combined organic layer was washed with brine, dried over anhydrous Na_2SO_4 and concentrated under vacuum to get unprotected amide. This unprotected amide was dissolved in 20 mL of anhydrous DCM and cooled to 0 °C. To the solution was added acetic formic anhydride (3.0 equiv) and the reaction was stirred at this temperature for 15 min at 0 °C. Then, the reaction was warmed to room temperature and stirred for an additional 1 h until the complete consumption of starting material. The reaction was subsequently quenched with ice-water and extracted with DCM (3×10 mL). The combined organic phase was washed with cold water (2×20 mL), saturated $NaHCO_3$ (3×20 mL), and brine (20 mL). The organic phase was dried over anhydrous $NaSO_4$, then concentrated under vacuum to give the corresponding formamide in quantitative yield. The crude formamide was used in the next step without further purification.

To a solution of formamide in dry THF (30 mL) was added Et_3N (5.0 equiv), then cooled it to -30 ℃, at this time, $POCl_3$ (1.1 equiv) was added dropwise. The reaction mixture was reacted at this temperature for 2 h (monitored by TLC). Then, saturated aq. Na_2CO_3 (20 mL) was added and the reaction was warmed to room temperature. After separation of the reaction solution, the aqueous layer was extracted with ethyl acetate (2×20 mL), then the combined organic layer was washed with brine, dried and concentrated. The residue was dissolved in ethyl acetate (10 ml) and added silica gel for continued stirring overnight. Evaporation of the solvent under vacuum, followed by purification through flash chromatography on silica gel (200-300 mesh, PE/EA v/v=1:1), the desired 4, 5-disubstituted oxaole was obtained.

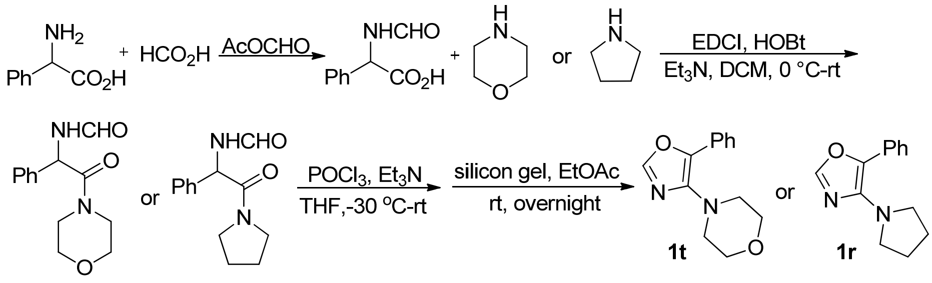
2.2 General procedure for synthesis of substrates 1h or 1i:[3, 4]



To an oven-dried 50 mL Schlenk sealed tube equipped with a magnetic stir bar was added the methyl isocyanoacetate (0.454 mL, 5 mmol, 1.0 equiv) and diethylamine (0.567 mL, 5.5 mmol, 1.1 equiv). Then, the reaction mixture was stirred at room temperature for overnight. The reaction mixture was further purified by silica gel flash chromatography (200-300 mesh, PE/EA v/v=2:1) to give the desired isocyanoacetamide.

To a solution of isocyanoacetamide (282 mg, 2 mmol, 1 equiv) in dry DMSO (10 mL) was added Cs_2CO_3 (978 mg, 3.0 mmol, 1.5 equiv). The mixture was stirred at room temperaturefor 10 min under an nitrogen atmosphere. Fluoroarene (2 mmol, 1 equiv) was added and stirring was continued at room temperature for 15 h. Then, the reaction was quenched with water and diluted with AcOEt (30 mL). After separation of the reaction mixture, the aqueous phase was extracted with AcOEt (3×30 mL). The combined organic layer was washed with brine, dried over anhydrous Na_2SO_4 and concentrated under vacuum. The residue was re-dissolved in AcOEt (10 mL) and added silica gel for continued stirring overnight. Evaporation of the solvent under vacuum, followed by purification through flash chromatography on silica gel (200-300 mesh, PE/EA v/v=3:1) to obtain pure oxazole compound **1h** or **1i**.

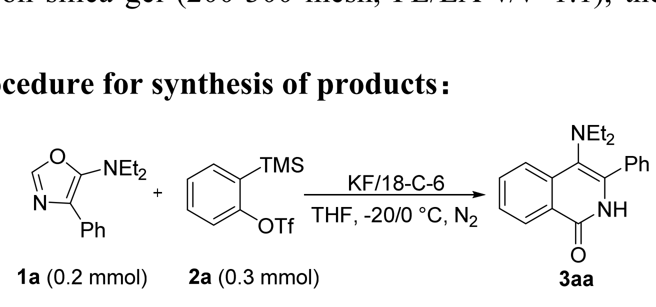
2.3 General procedure for synthesis of substrates 1r or 1t:[5, 6]



Acetic formic anhydride (3.0 equiv) was added dropwise to a solution of amino acid (1.0 equiv) in formic acid (20 mL) at 0 °C. After the addition was completed, the reaction mixture was stirred at room temperature for an additional 1 h. Ice-water (20 mL) was added and the mixture was concentrated under vacuum to give the white crystalline *N*-formyl amino acid. Subsequently, to a solution of *N*-formyl amino acid (1.0 equiv) and morpholine (1.2 equiv) in CH_2Cl_2 (50 mL) was added Et_3N (1.2 equiv), HOBt (1.2 equiv) and EDCl (1.2 equiv) successively, and then the reaction mixture was stirred for 24 h at room temperature. The reaction mixture was diluted with aqueous NH_4Cl solution (30 mL) and extracted with CH_2Cl_2 (2×30 mL). The organic phase was washed with brine and dried over anhydrous Na_2SO_4. Evaporation of solvent under vacuum to afford the crude product which was further purified by flash chromatography on silica gel (200-300 mesh, PE/EA v/v=1:1) to give the pure amide.

To a solution of formamide in dry THF (30 mL) was added Et_3N (5.0 equiv) and cooled to -30 °C, at this time, $POCl_3$ (1.1 equiv) was added dropwise. The reaction mixture was stirred at this temperature for 2 h (monitored by TLC). Then, saturated aq. Na_2CO_3 (20 mL) was added and the reaction was warmed to room temperature. The aqueous layer was extracted with ethyl acetate (2×20 mL) and the combined organic layer was washed with brine, dried and concentrated. The residue was dissolved in ethyl acetate (10 mL) and added silica gel for continued stirring overnight. Evaporation of the solvent under vacuum, followed by purification through flash chromatography on silica gel (200-300 mesh, PE/EA v/v=1:1), the desired **1r** or **1t** was obtained.

2. 4 General procedure for synthesis of products：



To an oven-dried 50 mL Schlenk sealed tube equipped with a magnetic stir bar was added KF (58.1 mg, 0.6 mmol, 3.0 equiv) and 18-Crown-6 (158.6 mg, 0.6 mmol, 3.0 equiv). Then the tube was evacuated under vacuum and charged with N_2 (1 atm, 3 times). The reaction mixture was dissolved in anhydrous THF (2.0 mL) under protection of N_2 atmosphere and subsequently cooled the reaction mixture to 0 or -20 °C with stirring. At this moment, aryne precursor **2** (0.3 mmol, 1.5 equiv) and oxazole **1** (0.2 mmol, 1.0 equiv) was successively added in the stirring solution under protection of N_2 atmosphere. The mixture was reacted at 0 or -20 °C until completion of the reaction which was detected by TLC. The reaction mixture was then diluted with 40 mL dichloromethane and washed with saturated K_2SO_4 aqueous solution (3×10 mL). The residue was successively dried with anhydrous Na_2SO_4, filtered and evaporated of solvent to give the crude product. The crude product was purified by column chromatography on silica gel (200-300 mesh, PE/EA v/v=5:1–2:1) to afford the corresponding isoquinolin-1(2*H*)-one.

2.5 Procedure for derivatization reaction:

2.5.1 Procedure for synthesis of 4-6:[7]

To an oven-dried 50 mL Schlenk sealed tube equipped with a magnetic stir bar was added **3aa** (58.4 mg, 0.2 mmol, 1.0 equiv). Then the tube was evacuated under vacuum and charged with N_2 (1 atm, 3 times). Cooled the reaction mixture to 0 °C, at this moment, DMF (2.0 mL) and NaH (16.0 mg, 0.4 mmol, 2.0 equiv) was added under N_2 atmosphere. After stirring for 30 min at 0 °C, the halide (0.4 mmol, 2.0 equiv) was added to the stirring solution, and then the reaction mixture was further reacted at room temperature. When complete consumption of **3aa** which was monitored by TLC, the reaction mixture was quenched with brine (10 mL) and extracted with ethyl acetate (2×20 mL). The combined organic phase was washed with brine (20 mL) and water, dried over anhydrous Na_2SO_4 and concentrated under vacuum to give the crude product. The crude product was purified by column chromatography on silica gel (200-300 mesh, PE/EA v/v=15:1) to afford the corresponding derivative product.

2.5.2 Procedure for synthesis of 7-9:[8]

To a 50 mL Schlenk sealed tube was added **3aa** (58.4 mg, 0.2 mmol, 1.0 equiv), bromide (0.3 mmol, 1.5 equiv), Cs_2CO_3 (97.7 mg, 0.3 mmol, 1.5 equiv) and DMF (1 mL). The reaction was heated to 50 °C in an oil bath for 3 h. Then, the reaction mixture was allowed to cool to ambient temperature, and diluted with EtOAc (20 mL). After the reaction mixture was washed with water (2 x 10 mL) and dried over anhydrous Na_2SO_4, evaporation of solvent giving the crude product which was further purified by flash column chromatography on silica gel (200-300 mesh, PE/EA=5:1) to give the desired *N*-substituted products.

2.5.3 Procedure for synthesis of 10 and 11[9, 10]:

To an oven-dried 50 mL Schlenk sealed tube equipped with a magnetic stir bar was added **3aa** (58.4 mg, 0.2 mmol, 1.0 equiv), anhydrous acetonitrile (2.0 mL), and $POCl_3$ (65μL, 0.7 mmol). The reaction mixture was reflux for 2 h, then cooled to 0 °C, diluted with dichloromethane (5 mL), and quenched with a dropwise addition of sat. aq. $NaHCO_3$ (5 mL). The biphasic mixture was stirred vigorously and allowed to warm to room temperature. After 1 h, the layers were separated and the aqueous fraction was extracted with DCM (2×10 mL). The combined organic layers were washed with sat. aq. $NaHCO_3$ (10 mL), brine (10 mL), dried over Na_2SO_4, and concentrated to yield crude product. The crude product was purified by column chromatography on silica gel (200-300 mesh, PE/EA v/v=15:1) to afford the pure product **10**.

To an oven-dried 50 mL Schlenk sealed tube equipped with a magnetic stir bar was added the **10** (62.1 mg, 0.2 mmol, 1 equiv). Then the tube was evacuated under vacuum and charged with N_2 (1 atm, 3 times). Then, Pd(dppf)Cl_2 (7.4 mg, 0.01 mmol, 5.0 mol%), TMEDA (0.051 mL, 0.34 mmol,1.7 equiv) and $NaBH_4$(12.9 mg, 0.34 mmol, 1.7 equiv) were introduced in sequence. The mixture was stirred at room temperature under N_2 atmosphere until the full consumption of **10**. The residue was quenched with brine and extracted with ethyl acetate. The organic phase was separated, then dried over Na_2SO_4. The solvent was evaporated to give the crude product which was purified by flash column chromatography on silica gel (200-300 mesh, PE/EA v/v=20:1) to afford the corresponding product in excellent yields.

2.5.4 Procedure for synthesis of 12-14:[11]

To a solution of **3aa** (87.6 mg, 0.3 mmol, 1.0 equiv) in anhydrous DCM (1 mL) was added pyridine (0.036 mL, 0.45 mmol, 1.5 equiv) and cooled to 0 ℃, then Tf_2O (0.056 mL, 0.33 mmol, 1.1 equiv) was added dropwise. After 30 min, the reaction mixture was warmed to room temperature and continued for stirring until the reaction was completed (detected by TLC). The reaction mixture was diluted with water (10 mL) and extracted with DCM (2×10 mL). The combined organic layer was dried over Na_2SO_4 and concentrated under vacuum to obtain crude product, which was further purified by silica gel flash chromatography on silica gel (200-300 mesh, PE/EA v/v=50:1) to give product **12**.

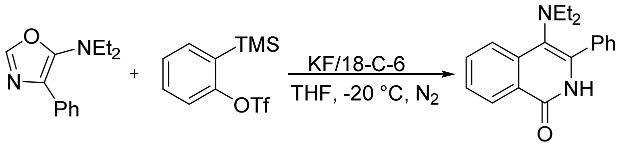
Under N_2 atmosphere, to a 25 mL Schlenk sealed tube was charged with **12** (84.9 mg, 0.2mmol, 1 equiv), $PhB(OH)_2$ (26.8 mg, 0.22 mmol, 1.1 equiv), $Pd(PPh_3)_4$ (9.2 mg, 4 mol%), Cs_2CO_3 (91.2 mg, 0.28 mmol, 1.4 equiv) and dry 1, 4-dioxane (2.0 mL). The mixture was reacted at 85 °C in oil bath overnight under nitrogen atmosphere. After completion of the reaction, the reaction mixture was cooled to room temperature. The reaction mixture was then diluted with water (10 mL) and extracted with DCM (2×10 mL), and the combined organic layers was dried over Na_2SO_4 and concentrated under vacuum to obtain crude product, which was further purified by silica gel flash chromatography on silica gel (200-300 mesh, PE/EA v/v=40:1) to give product **13**.

To a 25 mL Schlenk sealed tube was charged with **3fa** (74.5 mg, 0.2 mmol, 1 equiv), trimethylsilylacetylene (0.059 mL, 0.4 mmol, 2.0 equiv), $PdCl_2(PPh_3)_2$ (28.1 mg, 0.04 mmol, 20 mol %), CuI (7.6 mg, 0.04 mmol, 20 mol%), DIPEA (0.070 mL, 0.4 mmol, 2.0 equiv) and dry DMF (2 mL). The mixture was reacted at 80 °C in oil bath overnight under nitrogen atmosphere. After completion of the reaction, the reaction mixture was cooled to room temperature. The reaction mixture was dilution with water (10 mL) and extracted with DCM (2×10 mL). The organic layer was then dried and concentrated under vacuum to obtain crude product, which was further purified by silica gel flash chromatography on silica gel (PE/EA v/v=5:1) to give product **14**.

2.5.5 Procedure for one-pot synthesis of 4:

To an oven-dried 50 mL Schlenk sealed tube equipped with a magnetic stir bar was added KF (58.1 mg, 0.6 mmol, 3.0 equiv) and 18-Crown-6 (158.6 mg, 0.6 mmol, 3.0 equiv). Then the tube was evacuated under vacuum and charged with nitrogen (1 atm, 3 times). The reaction mixture was dissolved in anhydrous THF (2.0 mL) under protection of N_2 atmosphere and subsequently cooled the reaction mixture to -20 °C with stirring. At this moment, aryne precursor **2a** (89.4 mg, 0.3 mmol, 1.5 equiv) and oxazole **1a** (43.2 mg, 0.2 mmol, 1.0 equiv) was added in the stirring solution under protection of N_2 atmosphere. The mixture was reacted at -20 °C until completion of the reaction which was detected by TLC, then warming the reaction to 0 °C and NaH (16.0 mg, 0.4 mmol, 2.0 equiv) was added. After further stirring for 30 min, methyl iodide (25 μL, 0.4 mmol, 2.0 equiv) was added, and the solution was stirred at room temperature. When complete consumption of intermediate **3aa** which was monitored by TLC, the reaction mixture was quenched with brine (10 mL) and then extracted with EA (2×20 mL). The combined organic phase was washed with brine (20 mL) and H_2O (20 mL) respectively, then dried over anhydrous Na_2SO_4. After evaporation of solvent, the crude product was obtained which was subsequently purified by column chromatography on silica gel (200-300 mesh, PE/EA v/v=15:1) to afford the product **4** in 80% isolated yield.

2.5.6 Gram-scale preparation of 3aa:



1a (6 mmol) **2a** (9 mmol) **3aa,** 85%, 1.49 g

To an oven-dried 250 mL three-necked flask with a magnetic stir bar was added KF (1.046 g, 18 mmol, 3.0 equiv) and 18-Crown-6 (4.758 g, 18 mmol, 3.0 equiv). Then the tube was evacuated under vacuum and charged with N_2 (1 atm, 3 times). The reaction mixture was dissolved in anhydrous THF (60.0 mL) under protection of N_2 atmosphere and subsequently cooled the reaction mixture to -20 °C with stirring. At this moment, aryne precursor **2a** (2.682 g, 9.0 mmol, 1.5 equiv) and oxazole **1a** (1.296 g, 6.0 mmol, 1.0 equiv) was successively added to the stirring solution under protection of N_2 atmosphere. The mixture was reacted at -20 °C until completion of the reaction which was detected by TLC. The reaction mixture was then diluted with 100 mL dichloromethane and washed with saturated K_2SO_4 aqueous solution (3×40 mL). The residue was successively dried with anhydrous Na_2SO_4, filtered and evaporated of solvent to give the crude product. The crude product was purified by column chromatography on silica gel (200-300 mesh, PE/EA v/v=5:1−2:1) to afford the **3aa** in 1.49 g and 85% isolated yields.

2.6 Preparing single-crystal of 3ah and 3ai′ and relating crystal data:

Suitable single crystal for product **3ah** and **3ai′** were obtained by slow volatilization of the mixed solution (THF:*n*-hexane (v/v=1:3) as solvent) in a test tube for 5 days.

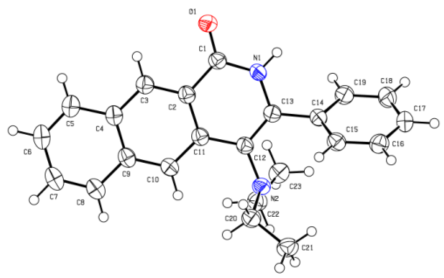


Figure S1 Crystal structure of **3ah** at 30% probability level.

Table S1 Crystal data and structure refinement for **3ah**.

Empirical formula	$C_{23}H_{22}N_2O$	
Formula weight	342.42	
Temperature	173.0 K	
Wavelength	1.54178 Å	
Crystal system	Triclinic	
Space group	P-1	
Unit cell dimensions	a = 9.8383(3) Å	α= 96.2480(10)°.
	b = 9.8397(3) Å	β= 115.9080(10)°.
	c = 10.3983(3) Å	γ = 94.5980(10)°.
Volume	890.84(5) $Å^3$	
Z	2	
Density (calculated)	1.277 Mg/m^3	
Absorption coefficient	0.613 mm^{-1}	
F(000)	364	
Crystal size	0.25 x 0.23 x 0.22 mm^3	
Theta range for data collection	4.790 to 77.508°.	
Index ranges	-12<=h<=12, -11<=k<=10, -13<=l<=13	
Reflections collected	13254	
Independent reflections	3684 [R(int) = 0.0517]	
Completeness to theta = 67.679°	99.1 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.7541 and 0.5836	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	3684/0 /237	
Goodness-of-fit on F^2	1.080	
Final R indices [I>2sigma(I)]	R_1 = 0.0540, wR_2 = 0.1547	
R indices (all data)	R_1 = 0.0642, wR_2 = 0.1663	
Extinction coefficient	n/a	
Largest diff. peak and hole	0.295 and -0.216 e.$Å^{-3}$	

The CCDC number of product 3ah is 2098712.

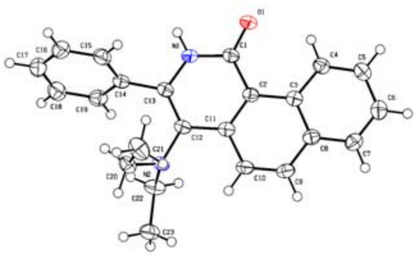


Figure S2 Crystal structure of **3ai′** at 30% probability level.

Table S2 Crystal data and structure refinement for **3ai′**.

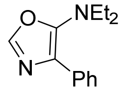
Empirical formula	$C_{23}H_{22}N_2O$

Formula weight	342.42	
Temperature	173.0 K	
Wavelength	0.71073 Å	
Crystal system	Triclinic	
Space group	P-1	
Unit cell dimensions	a = 9.4001(5) Å	α= 94.508(2)°.
	b = 9.5785(5) Å	β= 94.426(2)°.
	c = 10.6816(5) Å	γ = 110.611(2)°.
Volume	891.73(8) $Å^3$	
Z	2	
Density (calculated)	1.275 Mg/m^3	
Absorption coefficient	0.078 mm^{-1}	
F(000)	364	
Crystal size	0.19 x 0.17 x 0.16 mm^3	
Theta range for data collection	2.286 to 26.741°.	
Index ranges	-11<=h<=11, -12<=k<=12, -13<=l<=13	
Reflections collected	11292	
Independent reflections	3783 [R(int) = 0.0294]	
Completeness to theta = 25.242°	99.8 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.7454 and 0.6706	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	3783 / 0 / 237	
Goodness-of-fit on F2	1.032	
Final R indices [I>2sigma(I)]	R_1 = 0.0456, wR_2 = 0.1213	
R indices (all data)	R_1 = 0.0573, wR_2 = 0.1324	
Extinction coefficient	n/a	
Largest diff. peak and hole	0.275 and -0.189 e.$Å^{-3}$	

The CCDC number of product 3ai′ is 2132074.

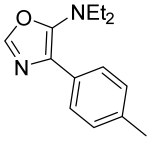
2.7 Characterization of substrates and products:

2.7.1 Characterization of substrates:



1a

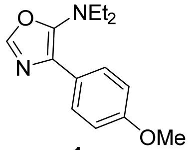
***N, N*-diethyl-4-phenyl-4, 5-dihydrooxazol-5-amine (1a):** ^1H NMR (400 MHz, $CDCl_3$) δ 8.09-8.01 (m, 2H), 7.70 (s, 1H), 7.43-7.33 (m, 2H), 7.28-7.22 (m, 1H), 3.10 (q, *J* = 7.2 Hz, 4H), 1.06 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.5, 146.8, 132.0, 128.3, 126.9, 126.5, 125.9, 47.4, 13.0.



1b

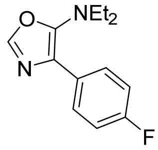
***N, N*-diethyl-4-(*p*-tolyl)-4, 5-dihydrooxazol-5-amine (1b):** ^1H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.4 Hz, 2H), 7.68 (s, 1H), 7.19 (d, *J* = 8.0 Hz, 2H), 3.07 (q, *J* =

7.2 Hz, 4H), 2.35 (s, 3H), 1.04 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.9, 146.8, 136.6, 129.1, 129.0, 126.8, 125.8, 47.5, 21.2, 13.0.



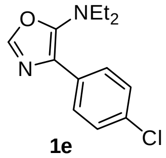
1c

***N, N*-diethyl-4-(4-methoxyphenyl)-4, 5-dihydrooxazol-5-amine (1c):** ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07-7.93 (m, 2H), 7.69 (s, 1H), 6.97-6.88 (m, 2H), 3.82 (s, 3H), 3.07 (q, *J* = 7.2 Hz, 4H), 1.04 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.7, 149.3, 146.9, 127.2, 126.9, 124.7, 113.7, 55.2, 47.6, 13.0.



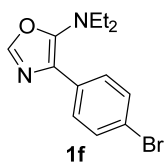
1d

***N, N*-diethyl-4-(4-fluorophenyl)-4, 5-dihydrooxazol-5-amin (1d)：** ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.08-8.01 (m, 2H), 7.70 (s, 1H), 7.11-7.02 (m, 2H), 3.07 (q, *J* = 7.2 Hz, 4H), 1.04 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.9 (d, *J* = 244.4 Hz), 150.1 (d, *J* = 1.8 Hz), 147.0, 128.1 (d, *J* = 3.2 Hz), 127.6 (d, *J* = 7.8 Hz), 126.2, 155.2 (d, *J* = 2.1 Hz), 47.6, 12.9.



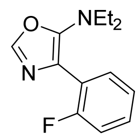
1e

4-(4-chlorophenyl)-*N, N*-diethyl-4, 5-dihydrooxazol-5-amine (1e): ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03-7.95 (m, 2H), 7.70 (s, 1H), 7.39-7.31 (m, 2H), 3.09 (q, *J* = 7.2 Hz, 4H), 1.04 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.6, 146.9, 132.6, 130.5, 128.5, 127.2, 125.8, 47.5, 13.0.



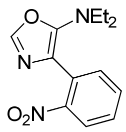
1f

4-(4-bromophenyl)-*N, N*-diethyl-4, 5-dihydrooxazol-5-amine (1f): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99-7.87 (m, 2H), 7.70 (s, 1H), 7.55-7.46 (m, 2H), 3.09 (q, *J* = 7.2 Hz, 4H), 1.04 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.6, 146.9, 131.4, 130.9, 127.5, 125.8, 120.8, 47.5, 12.9.



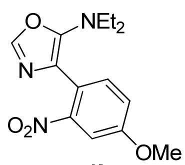
1g

***N, N*-diethyl-4-(2-fluorophenyl)-4, 5-dihydrooxazol-5-amine (1g):** ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65-7.58 (m, 2H), 7.30-7.23 (m, 1H), 7.19-7.13 (m, 1H), 7.13-7.05 (m, 1H), 3.09 (q, *J* = 7.2 Hz, 4H), 1.03 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.9 (d, *J* = 247.9 Hz), 152.1, 144.9, 130.7 (d, *J* = 3.3 Hz), 128.9 (d, *J* = 8.0 Hz), 123.8 (d, *J* = 3.6 Hz), 120.8 (d, *J* = 13.9 Hz), 116.8 (d, *J* = 1.5 Hz), 115.8 (d, *J* = 21.9 Hz), 45.8, 13.2. ^{19}F NMR (376 MHz, $CDCl_3$) δ -112.9.



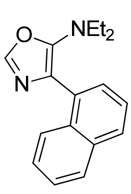
1h

***N, N*-diethyl-4-(2-nitrophenyl)oxazol-5-amine (1h):** ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (d, *J* = 8.0 Hz, 1H), 7.67 (d, *J* = 7.2 Hz, 1H), 7.61 (s, 1H), 7.56 (t, *J* = 7.6 Hz, 1H), 7.45-7.36 (m, 1H), 3.07 (q, *J* = 7.2 Hz, 4H), 1.04 (t, *J* = 7.2 Hz, 6H).



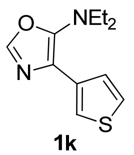
1i

***N, N*-diethyl-4-(4-methoxy-2-nitrophenyl)oxazol-5-amine (1i):** ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (s, 1H), 7.57 (d, *J* = 8.8 Hz, 1H), 7.33 (d, *J* = 2.8 Hz, 1H), 7.11 (dd, *J* = 8.8, 2.8 Hz, 1H), 3.88 (s, 3H), 3.03 (q, *J* = 7.2 Hz, 4H), 1.02 (t, *J* = 7.2 Hz, 6H).



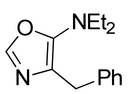
1j

***N, N*-diethyl-4-(naphthalen-1-yl)-4, 5-dihydrooxazol-5-amine (1j):** ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15-8.04 (m, 1H), 7.89-7.83 (m, 1H), 7.82 (d, *J* = 8.0 Hz, 1H), 7.70 (s, 1H), 7.56 (dd, *J* = 7.2, 1.6 Hz, 1H), 7.52-7.42 (m, 3H), 3.01 (q, *J* = 7.2 Hz, 4H), 0.97 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.2, 144.1, 133.8, 132.2, 130.2, 128.2, 128.1, 127.8, 126.2,125.9, 125.7, 125.1, 119.5, 45.7, 13.2.



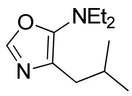
1k

***N*, *N*-diethyl-4-(thiophen-3-yl)-4, 5-dihydrooxazol-5-amine (1k):** ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (dd, *J* = 2.8, 1.2 Hz, 1H), 7.71-7.66 (m, 2H), 7.32 (dd, *J* = 5.2, 3.2 Hz, 1H), 3.08 (q, *J* = 7.2 Hz, 4H), 1.04 (t, *J* = 7.2 Hz, 6H).



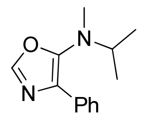
1l

4-benzyl-*N*, *N*-diethyl-4, 5-dihydrooxazol-5-amine (1l): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (s, 1H), 7.30-7.24 (m, 4H), 7.23-7.13 (m, 1H), 3.79 (s, 2H), 2.98 (q, *J* = 7.2 Hz, 4H), 0.99 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.6, 147.2, 139.5, 128.7, 128.3, 128.3, 126.1, 48.1, 31.6, 13.3.



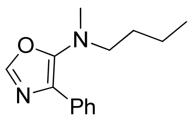
1m

***N*, *N*-diethyl-4-isobutyl-4, 5-dihydrooxazol-5-amine (1m):** ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (s, 1H), 2.96 (q, *J* = 7.2 Hz, 4H), 2.29 (d, *J* = 7.2 Hz, 2H), 2.11-1.99 (m, 1H), 0.99 (t, *J* = 7.2 Hz, 6H), 0.92 (d, *J* = 6.8 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.5, 146.9, 129.0, 48.1, 34.1, 27.6, 22.4, 13.1.



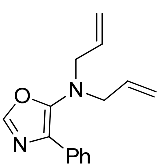
1n

***N*-isopropyl-*N*-methyl-4-phenyl-4, 5-dihydrooxazol-5-amine (1n):** ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06-7.93(m, 2H), 7.66 (s, 1H), 7.38 (t, *J* = 7.6 Hz, 2H), 7.27-7.20 (m, 1H), 3.40-3.26 (m, 1H), 2.74 (s, 3H), 1.13 (d, *J* = 6.4 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.7, 146.4, 132.1, 128.3, 126.9, 125.9, 124.9, 54.0, 35.6, 20.1.



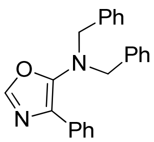
1o

***N*-butyl-*N*-methyl-4-phenyl-4, 5-dihydrooxazol-5-amine (1o) :** ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00-7.90 (m, 2H), 7.63 (s, 1H), 7.42-7.34 (m, 2H), 7.26-7.20 (m, 1H), 3.01 (t, *J* = 7.2 Hz, 2H), 2.77 (s, 3H), 1.53-1.41 (m, 2H), 1.34-1.20 (m, 2H), 0.85 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.2, 145.8, 132.0, 128.3, 126.8, 126.0, 123.3, 54.5, 40.4, 29.7, 20.2, 13.9.



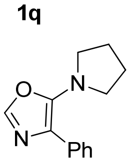
1p

***N*, *N*-diallyl-4-phenyl-4, 5-dihydrooxazol-5-amine (1p) :** ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03-7.94 (m, 2H), 7.65 (s, 1H), 7.39 (t, *J* = 8.0 Hz, 2H), 7.29-7.22 (m, 1H), 5.91-5.77 (m, 2H), 5.22-5.08 (m, 4H), 3.70-3.64 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.0, 146.4, 133.9, 131.8, 128.4, 127.0, 126.0, 125.1, 118.4, 55.2.



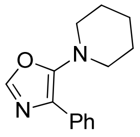
1q

***N*, *N*-dibenzyl-4-phenyl-4, 5-dihydrooxazol-5-amine (1q):** ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91-7.84 (m, 2H), 7.61 (s, 1H), 7.42-7.36 (m, 2H), 7.29-7.20 (m, 11H), 4.18 (s, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.0, 146.0, 136.9, 131.7, 128.8, 128.4, 128.3, 127.6, 127.0, 126.1, 124.5, 56.0.



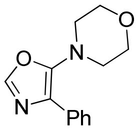
1r

4-phenyl-5-(pyrrolidin-1-yl)-4, 5-dihydrooxazole (1r): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75-7.62 (m, 2H), 7.52 (s, 1H), 7.42-7.31 (m, 2H), 7.24-7.14 (m, 1H), 3.30-3.20 (m, 4H), 1.98-1.87 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.7, 143.4, 132.7, 128.1, 126.6, 126.1, 118.3, 50.2, 25.4.



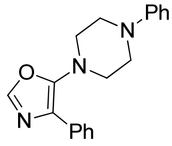
1s

4-phenyl-5-(piperidin-1-yl)-4, 5-dihydrooxazole (1s): ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02-7.88 (m, 2H), 7.62 (s, 1H), 7.43-7.35 (m, 2H), 7.27-7.20 (m, 1H), 3.05 (t, *J* = 5.2 Hz, 4H), 1.76-1.67 (m, 4H), 1.65-1.55 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.7, 145.5, 132.1, 128.4, 126.6, 125.7, 122.0, 51.3, 25.9, 23.9.



1t

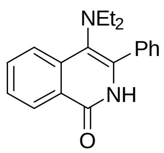
4-(4-phenyl-4, 5-dihydrooxazol-5-yl)morpholine (1t): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98-7.92 (m, 2H), 7.65 (s, 1H), 7.44-7.37 (m, 2H), 7.29-7.23 (m, 1H), 3.85 (t, J = 4.8 Hz, 4H), 3.11 (t, J = 4.8 Hz, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.2, 146.0, 131.6, 128.5, 127.1, 125.9, 123.3, 66.9, 50.3.



1u

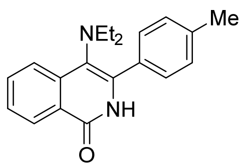
4-phenyl-5-(4-phenylpiperazin-1-yl)-4, 5-dihydrooxazole (1u): ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04-7.93 (m, 2H), 7.66 (s, 1H), 7.44-7.36 (m, 2H), 7.33-7.25 (m, 3H), 6.98 (d, J = 8.0 Hz, 2H), 6.95-6.86 (m, 1H), 3.38-3.32 (m, 4H), 3.32-3.25 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.4, 151.3, 146.0, 131.7, 129.2, 128.5, 127.0, 125.9, 123.1, 120.3, 116.6, 50.2, 49.6 .

2.7.2 Characterization of products:



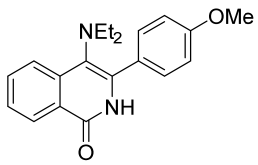
3aa

4-(diethylamino)-3-phenylisoquinolin-1(2*H*)-one (3aa): white solid (54.3 mg, 93% yield, TLC (PE/EA, 2:1): R_f = 0.23). mp 160-161 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.42 (dd, J = 8.0, 0.8 Hz, 1H), 8.29 (s, 1H), 8.00 (d, J = 8.0 Hz, 1H), 7.74-7.68 (m, 1H), 7.52-7.48 (m, 1H), 7.48-7.43 (m, 5H), 3.00-2.80 (m, 4H), 0.94 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.1, 140.5, 138.1, 135.3, 132.3, 129.1, 129.0, 128.3, 127.8, 126.4, 125.8, 125.0, 124.4, 48.4, 14.3. HRMS (ESI) m/z: $(M-H)^-$ calcd for $C_{19}H_{20}N_2O$ 291.1503; Found 291.1499. IR (KBr, thin film): 2970, 2844, 1657, 1607, 1545, 1490, 1459, 1376, 1245, 1117, 858, 781, 700, 577 cm^{-1}.



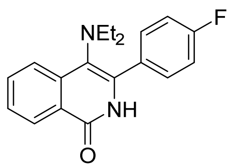
3ba

4-(diethylamino)-3-(p-tolyl)isoquinolin-1(2*H*)-one (3ba): white solid (51.0 mg, 84% yield, TLC (PE/EA, 5:1): R_f = 0.14). mp 164-165 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.41 (dd, J = 8.0, 1.2 Hz, 2H), 8.00 (d, J = 8.4 Hz, 1H), 7.74-7.66 (m, 1H), 7.53-7.45 (m, 1H), 7.35 (d, J = 8.0 Hz, 2H), 7.27 (s, 2H), 3.00-2.79 (m, 4H), 2.43 (s, 3H), 0.95 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.2, 140.6, 138.8, 138.2, 132.3, 132.2, 128.9, 127.7, 126.2, 125.7, 124.8, 124.3, 48.3, 21.4, 14.3. HRMS (ESI) m/z: $(M-H)^-$ calcd for $C_{20}H_{22}N_2O$ 305.1659; Found 305.1655. IR (KBr, thin film): 3154, 2970, 1642, 1508, 1470, 1348, 1218, 1113, 1025, 895, 785, 529 cm^{-1}.



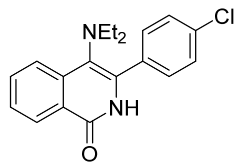
3ca

4-(diethylamino)-3-(4-methoxyphenyl)isoquinolin-1(2*H*)-one (3ca): white solid (56.4 mg, 88% yield, TLC (PE/EA, 3:1): R_f= 0.20). mp 159-160 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 (s, 1H), 8.40 (d, J = 7.6 Hz, 1H), 7.99 (d, J = 8.0 Hz, 1H), 7.74-7.66 (m, 1H), 7.52-7.45 (m, 1H), 7.44-7.37 (m, 2H), 7.02-6.96 (m, 2H), 3.88 (s, 3H), 3.00-2.82 (m, 4H), 0.95 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.2, 159.0, 139.6, 137.0 131.1, 129.4, 126.7 126.5, 125.1, 124.6, 123.8, 123.3, 112.6, 54.3, 47.3, 13.3. HRMS (ESI) m/z: $(M-H)^-$ calcd for $C_{20}H_{22}N_2O$ 321.1608; Found 321.1603. IR (KBr, thin film): 2970, 2850, 1641, 1512, 1465, 1346, 1247, 1176, 1035, 833, 777, 626 cm^{-1}.



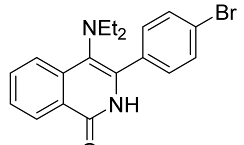
3da

4-(diethylamino)-3-(4-fluorophenyl)isoquinolin-1(2*H*)-one (3da): white solid (49.7 mg, 80% yield, TLC (PE/EA, 5:1): R_f= 0.16). mp 182-183 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.64 (s, 1H), 8.35 (d, J = 8.0 Hz, 1H), 7.95 (d, J = 8.0 Hz, 1H), 7.74-7.66 (m, 1H), 7.56-7.43 (m, 3H), 7.22-7.12 (m, 2H), 3.04-2.82 (m, 4H), 0.93 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.0 (d, J = 247.1 Hz), 162.6, 140.3, 132.2, 131.3 (d, J = 8.0 Hz), 131.1 (d, J = 3.4 Hz), 127.8, 126.4, 125.8, 125.2, 124.3, 115.1(d, J = 21.5 Hz), 48.4, 14.3. ^{19}F NMR (376 MHz, $CDCl_3$) δ -112.2. HRMS (ESI) m/z: $(M-H)^-$ calcd for $C_{19}H_{19}FN_2O$ 309.1409; Found 309.1403. IR (KBr, thin film): 2971, 1651, 1610, 1508, 1383, 1317, 1219, 1157, 841, 771, 628, 527 cm^{-1}.



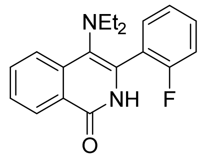
3ea

3-(4-chlorophenyl)-4-(diethylamino)isoquinolin-1(2*H*)-one (3ea): white solid (52.7 mg, 81% yield, TLC (PE/EA, 5:1): R_f = 0.15). mp 164-165 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.37 (s, 1H), 8.37 (dd, *J* = 8.0, 0.8 Hz, 1H), 7.94 (d, *J* = 8.0 Hz, 1H), 7.73-7.68 (m, 1H), 7.53-7.48 (m, 1H), 7.45 (s, 4H), 3.03-2.88 (m, 4H), 0.93 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.6, 140.1, 137.5, 134.8, 133.5, 132.3, 130.8, 128.3, 127.9, 126.5, 125.9, 125.2, 124.3, 48.4, 14.3. HRMS (ESI) m/z: $(M-H)^-$ calcd for $C_{19}H_{19}ClN_2O$ 325.1113; Found 325.1108. IR (KBr, thin film): 2967, 1643, 1604, 1549, 1489, 1469, 1346, 1093, 1016, 894, 777, 593 cm^{-1}.



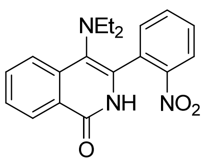
3fa

3-(4-bromophenyl)-4-(diethylamino)isoquinolin-1(2*H*)-one (3fa): white solid (57.5 mg, 78% yield, TLC (PE/EA, 5:1): R_f = 0.15). mp 175-176 ℃. 400 MHz, $CDCl_3$) δ 9.11 (s, 1H), 8.41-8.35 (m, 1H), 7.94 (d, *J* = 8.0 Hz, 1H), 7.74-7.67 (m, 1H), 7.64-7.58 (m, 2H), 7.54-7.48 (m, 1H), 7.42-7.34 (m, 2H), 3.04-2.86 (m, 4H), 0.93 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.6, 140.1, 137.5, 133.9, 132.3, 131.3, 131.1, 127.9, 126.5, 125.9, 125.2, 124.3, 123.1, 48.4, 14.3. HRMS (ESI) m/z: $(M-H)^-$ calcd for $C_{19}H_{19}BrN_2O$ 369.0608; Found 369.0600. IR (KBr, thin film): 3161, 1974, 1645, 1485, 1463, 1348, 1309, 1159, 1068, 864, 773, 586 cm^{-1}.



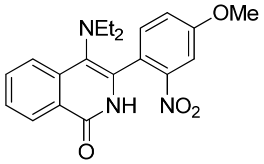
3ga

4-(diethylamino)-3-(2-fluorophenyl)isoquinolin-1(2*H*)-one (3ga): white solid (57.5 mg, 93% yield, TLC (PE/EA, 2:1): R_f = 0.25). mp 190-191 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.78 (s, 1H), 8.39 (dd, *J* = 8.0, 0.8 Hz, 1H), 7.99 (d, *J* = 8.4 Hz, 1H), 7.74-7.67 (m, 1H), 7.55-7.43 (m, 2H), 7.40 (td, *J* = 7.6, 2.0 Hz, 1H), 7.28-7.15 (m, 2H), 2.99-2.83 (m, 4H), 0.94 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.0, 160.1 (d, *J* = 247.0 Hz), 140.0, 132.7, 132.2, 131.8 (d, *J* = 2.7 Hz), 131.2 (d, *J* = 8.0 Hz), 127.9, 126.8, 126.7, 126.2, 124.5, 123.8 (d, *J* = 3.6 Hz), 122.9 (d, *J* = 15.4 Hz), 115.9 (d, *J* = 21.5 Hz), 48.3, 14.4. ^{19}F NMR (376 MHz, $CDCl_3$) δ -112.4. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{19}H_{20}FN_2O$ 311.1554; Found 311.1551. IR (KBr, thin film): 3307, 2949, 1945, 1654, 1450, 1345, 1320, 1221, 1108, 1070, 779, 587 cm^{-1}.



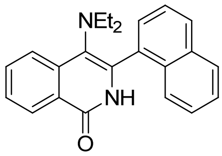
3ha

4-(diethylamino)-3-(2-nitrophenyl)isoquinolin-1(2*H*)-one (3ha): yellow solid (32.1 mg, 95% yield, TLC (PE/EA, 1:1): R_f = 0.11). mp 256-257 ℃. ^{1}H NMR (400 MHz, *d*$_6$-DMSO) δ 11.43 (s, 1H), 8.28 (t, *J* = 8.0 Hz, 2H), 7.91-7.82 (m, 2H), 7.76 (t, *J* = 7.6 Hz, 2H), 7.66 (d, *J* = 7.6 Hz, 1H), 7.54 (t, *J* = 7.6 Hz, 1H), 3.02-2.83 (m, 2H), 2.83-2.71 (m, 1H), 2.71-2.57 (m, 1H), 0.84 (t, *J* = 7.2 Hz, 3H), 0.70 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (100 MHz, *d*$_6$-DMSO) δ 161.4, 148.0, 139.5, 137.4, 134.3, 134.0, 132.7, 130.9, 130.4, 128.0, 126.9, 126.7, 125.0, 124.5, 124.2, 49.1, 48.0, 15.2, 15.1. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{19}H_{20}N_3O_3$ 338.1499; Found 338.1503. IR (KBr, thin film): 3438, 3158, 2977, 2923, 2855, 1647, 1605, 1525, 1468, 1352, 781, 703 cm^{-1}.



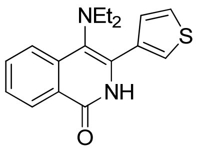
3ia

4-(diethylamino)-3-(4-methoxy-2-nitrophenyl)isoquinolin-1(2*H*)-one (3ia): yellow solid (86.1mg, 84% yield, TLC (PE/EA, 1:1): R_f = 0.12). mp 245-246 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.55 (s, 1H), 8.33 (d, *J* = 8.0 Hz, 1H), 7.90 (d, *J* = 8.0 Hz, 1H), 7.72 (d, *J* = 2.4 Hz, 1H), 7.68 (t, *J* = 7.6 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 1H), 7.41 (d, *J* = 8.8 Hz, 1H), 7.29-7.21 (m, 1H), 3.97 (s, 3H), 2.96-2.64 (m, 4H), 0.87 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.4, 160.4, 148.9, 139.8, 135.2, 133.9, 132.1, 127.9, 126.4, 126.1, 124.3, 122.1, 119.3, 109.6, 56.0, 48.4, 14.7. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{20}H_{22}N_3O_4$ 368.1605; Found 368.1609. IR (KBr, thin film): 3441, 3155, 2968, 2831, 1650, 1525, 1346, 1304, 1233, 1031, 778, 718 cm^{-1}.



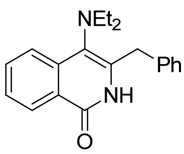
3ja

4-(diethylamino)-3-(naphthalen-1-yl)isoquinolin-1(2*H*)-one (3ja): white solid (57.9 mg, 85% yield, TLC (PE/EA, 2:1): R_f = 0.33). mp 196-197 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.43 (dd, *J* = 8.0, 0.8 Hz, 1H), 8.30 (s, 1H), 8.13 (d, *J* = 8.0 Hz, 1H), 8.01-7.87 (m, 2H), 7.79-7.67 (m, 2H), 7.60-7.48 (m, 4H), 7.48-7.42 (m, 1H), 3.07-2.86 (m, 2H), 2.62-2.38 (m, 2H), 1.05 (t, *J* = 7.2 Hz, 3H), 0.67 (t, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.6, 140.6, 136.2, 133.6, 132.4, 132.0, 131.7, 129.8, 128.5, 128.2, 127.7, 127.3, 126.8, 126.4, 125.9, 125.3, 124.8, 124.6, 49.6, 47.1, 14.8, 14.6. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{23}H_{23}N_2O$ 343.1805; Found 343.1800. IR (KBr, thin film): 2974, 1643, 1557, 1466, 1348, 1224, 1187, 1089, 1019, 916, 776, 575 cm^{-1}.



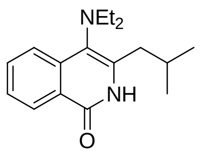
3ka

4-(diethylamino)-3-(thiophen-3-yl)isoquinolin-1(2*H*)-one (3ka): white solid (21.8 mg, 46% yield, TLC (PE/EA, 2:1): R_f = 0.32). mp 126-127 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.98 (s, 1H), 8.41 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.90 (d, *J* = 8.4 Hz, 1H), 7.72-7.64 (m, 2H), 7.52-7.46 (m, 1H), 7.46-7.39 (m, 2H), 3.17-2.95 (m, 4H), 0.97 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.3, 140.3, 135.0, 134.0, 132.2, 128.1, 127.9, 126.2, 125.6, 125.4, 125.3, 124.3, 124.2, 48.3, 14.1. HRMS (ESI) m/z: $(M+Na)^+$ calcd for $C_{17}H_{18}N_2OSNa$ 321.1032; Found 321.1032. IR (KBr, thin film): 3302, 2969, 2919, 1742, 1472, 1386, 1304, 1140, 1082, 1054, 717, 652, 549 cm^{-1}.



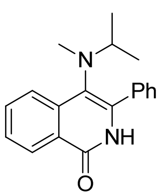
3la

3-benzyl-4-(diethylamino)isoquinolin-1(2*H*)-one (3la): white solid (27.0 mg, 46% yield, TLC (PE/EA, 2:1): R_f = 0.39). mp 114-115 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.30 (dd, *J* = 8.0, 1.2 Hz, 2H), 7.82 (d, *J* = 8.4 Hz, 1H), 7.69-7.63 (m, 1H), 7.47-7.41 (m, 1H), 7.36-7.29 (m, 2H), 7.29-7.26 (m, 1H), 7.23-7.18 (m, 2H), 4.19 (s, 2H), 3.25 (q, *J* = 7.2 Hz, 4H), 1.09 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.3, 139.2, 138.7, 137.0, 132.1, 129.1, 129.0, 128.2, 127.1, 126.0, 125.7, 124.6, 123.8, 49.2, 35.5, 15.2. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{20}H_{23}N_2O$ 307.1805; Found 307.1805. IR (KBr, thin film): 2970, 2925, 1651, 1553, 1467, 1344, 1238, 1135, 1028, 774, 713, 520 cm^{-1}.



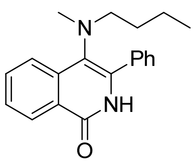
3ma

4-(diethylamino)-3-isobutylisoquinolin-1(2*H*)-one (3ma): white solid (30.1 mg, 56% yield, TLC (PE/EA, 2:1): R_f = 0.45). mp 91-92 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.40 (s, 1H), 8.40 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.81 (d, *J* = 8.0 Hz, 1H), 7.67-7.60 (m, 1H), 7.46-7.39 (m, 1H), 3.27-3.05 (m, 4H), 2.71 (d, *J* = 8.0 Hz, 2H), 2.26-2.21 (m,1H), 1.09-0.98 (m, 12H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.9, 140.5, 139.9, 131.9, 127.9, 125.5, 125.3, 125.0, 123.9, 49.0, 38.2, 29.7, 27.7, 22.5, 15.1. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{17}H_{25}N_2O$ 273.1961; Found 273.1962. IR (KBr, thin film): 3202, 2969, 2919, 1742, 1472, 1386, 1304, 1140, 1082, 1054, 717, 652, 549 cm^{-1}.



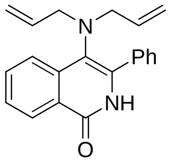
3na

4-(isopropyl(methyl)amino)-3-phenylisoquinolin-1(2*H*)-one (3na): white solid (56.9 mg, 92% yield, TLC (PE/EA, 3:1): R_f = 0.22). mp 142-143 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.55 (s, 1H), 8.42 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.86 (d, *J* = 8.0 Hz, 1H), 7.75-7.67 (m, 1H), 7.55-7.40 (m, 6H), 3.15-3.03 (m, 1H), 2.83 (s, 3H), 0.93-0.76 (m, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.2, 140.3, 138.7, 135.4, 132.3, 129.0, 128.8, 128.3, 128.0, 126.3, 126.2, 125.8, 124.3, 53.3, 40.5, 22.0, 21.6; HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{19}H_{21}N_2O$ 293.1648, found 293.1650; IR (KBr, thin film): 2972, 1651, 1607, 1469, 1377, 1272, 1195, 1078, 1029, 924, 771, 565 cm^{-1}.



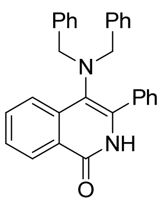
3oa

4-(butyl(methyl)amino)-3-phenylisoquinolin-1(2*H*)-one (3oa): white solid (58.4 mg, 95% yield, TLC (PE/EA, 3:1): R_f = 0.22). mp 152-153 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.55 (s, 1H), 8.41 (dd, *J* = 8.0, 0.8 Hz, 1H), 7.94 (d, *J* = 8.0 Hz, 1H), 7.78-7.68 (m, 1H), 7.58-7.38 (m, 6H), 2.78 (s, 3H), 2.64 (q, *J* = 7.6 Hz, 2H), 1.32-1.22 (m, 2H), 1.15-1.03 (m, 2H), 0.74 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.0, 139.2, 136.8, 135.3, 132.4, 129.0, 128.9, 128.5, 127.9, 127.2, 126.4, 125.9, 124.0, 55.8, 42.9, 30.9, 20.2, 13.9. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{20}H_{23}N_2O$ 307.1805; Found 307.1802. IR (KBr, thin film): 3163, 2948, 1641, 1467, 1348, 1272, 1186, 1033, 912, 786, 759, 568 cm^{-1}.



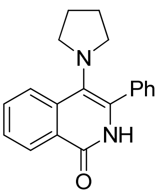
3pa

4-(diallylamino)-3-phenylisoquinolin-1(2*H*)-one (3pa): white solid (51.2 mg, 81% yield, TLC (PE/EA, 2:1): R_f = 0.37). mp 97-98 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.60 (s, 1H), 8.41 (dd, *J* = 8.0, 0.8 Hz, 1H), 7.99 (d, *J* = 8.0 Hz, 1H), 7.76-7.70 (m, 1H), 7.55-7.43 (m, 6H), 5.76-5.62 (m, 2H), 5.02-4.98 (m, 1H), 4.98-4.92 (m, 3H), 3.58-3.39 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.2, 140.7, 139.3, 137.2, 136.1, 133.4, 130.3, 130.1, 129.3, 128.9, 127.4, 126.7, 126.1, 124.9, 117.6, 58.1. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{21}H_{21}N_2O$ 317.1648; Found 317.1649. IR (KBr, thin film): 3007, 2845, 1645, 1466, 1412, 1341, 1208, 1171, 1025, 917, 775, 567 cm^{-1}.



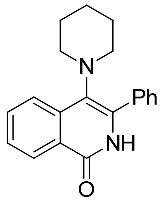
3qa

4-(dibenzylamino)-3-phenylisoquinolin-1(2*H*)-one (3qa): white solid (67.8 mg, 82% yield, TLC (PE/EA, 5:1): R_f = 0.12). mp 226-227 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.56 (s, 1H), 8.45 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.17 (d, *J* = 8.4 Hz, 1H), 7.83-7.75 (m, 1H), 7.58-7.51 (m, 1H), 7.48-7.37 (m, 1H), 7.36-7.28 (m, 2H), 7.26-7.15 (m, 6H), 7.10-6.96 (m, 4H), 6.95-6.84 (m, 2H), 4.1 (dd, J = 30.8, 14.0 Hz, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.7, 138.5, 138.5, 137.8, 135.0, 132.6, 129.2, 129.1, 128.8, 128.4, 128.3, 128.2, 127.1, 126.6, 125.9, 124.5, 124.2, 57.6; HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{29}H_{25}N_2O$ 417.1961; Found 417.1962. IR (KBr, thin film): 3030, 2843, 1656, 1608, 1494, 1447, 1349, 1264, 1192, 1081, 762, 698 cm^{-1}.



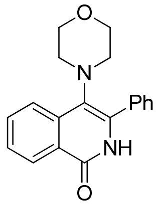
3ra

3-phenyl-4-(pyrrolidin-1-yl)isoquinolin-1(2*H*)-one (3ra): white solid (51.9 mg, 90% yield, TLC (PE/EA, 2:1): R_f = 0.31). mp 183-184 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.71 (s, 1H), 8.44 (d, *J* = 8.0 Hz, 1H), 7.77-7.67 (m, 2H), 7.54-7.42 (m, 6H), 3.07 (t, *J* = 6.4 Hz, 4H), 1.91-1.82 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.4, 138.6, 138.4, 134.8, 132.2, 128.8, 128.6, 128.3, 128.2, 126.2, 126.0, 123.3, 122.9, 51.5, 26.1. HRMS (ESI) m/z: $(M-H)^-$ calcd for $C_{19}H_{18}N_2O^-$ 289.1346; Found 289.1342. IR (KBr, thin film): 2963, 1648, 1611, 1471, 1348, 1265, 1148, 1032, 942, 781, 694, 558 cm^{-1}.



3sa

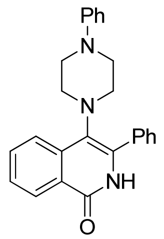
3-phenyl-4-(piperidin-1-yl)isoquinolin-1(2*H*)-one (3sa): white solid (55.9 mg, 92% yield, TLC (PE/EA, 2:1): R_f = 0.29). mp 251-252 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.32 (s, 1H), 8.35 (d, *J* = 8.0 Hz, 1H), 8.02 (d, *J* = 8.4 Hz, 1H), 7.77-7.68 (m, 1H), 7.64-7.35 (m, 6H), 3.13-2.87 (m, 2H), 2.58-2.34 (m, 2H), 1.74-1.56 (m, 3H), 1.54-1.36 (m, 2H), 1.30-1.13 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.9, 138.9, 135.4, 135.3, 132.4, 129.3, 129.1, 128.4, 128.1, 127.8, 126.5, 125.7, 123.7, 53.2, 27.0, 24.2; HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{20}H_{21}N_2O$ 305.1648; Found 305.1646. IR (KBr, thin film): 2937, 1654, 1553, 1469, 1346, 1270, 1211, 1118, 911, 777, 756, 599 cm^{-1}.



3ta

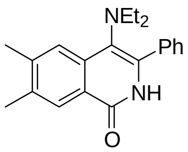
4-morpholino-3-phenylisoquinolin-1(2*H*)-one (3ta): white solid (57.0 mg, 90% yield, TLC (PE/EA, 1:1): R_f = 0.20). mp 248-249 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.43 (d, *J* = 7.6 Hz, 1H), 8.32 (s, 1H), 8.06 (dd, *J* = 8.4, 0.8 Hz, 1H), 7.76 (t, *J* =

7.6 Hz, 1H), 7.58-7.47 (m, 4H), 7.47-7.39 (m, 2H), 3.80-3.61 (m, 4H), 2.93 (d, *J* = 12.4 Hz, 2H), 2.77-2.65 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.3, 136.2, 134.8, 132.7, 129.5, 129.2, 128.7, 128.0, 126.8, 126.4, 123.3, 67.8, 52.1. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{19}H_{19}N_2O_2$ 307.1441; Found 307.1443. IR (KBr, thin film): 3440, 3154, 2950, 2851, 1647, 1557, 1449, 1269, 1200, 1105, 778, 564 cm^{-1}.



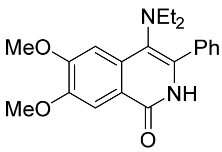
3ua

3-phenyl-4-(4-phenylpiperazin-1-yl)isoquinolin-1(2*H*)-one (3ua): white solid (17.8 mg, 20% yield, TLC (PE/EA, 1:1): R_f = 0.24). mp 245-246 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48-8.37 (m, 2H), 8.08 (d, *J* = 8.0 Hz, 1H), 7.78-7.70 (m, 1H), 7.57-7.43 (m, 6H), 7.29-7.21 (m, 2H), 6.94-6.83 (m, 3H), 3.29 (d, *J* = 11.2 Hz, 2H), 3.20-3.01 (m, 4H), 2.81 (t, *J* = 9.6 Hz, 2H). ^{13}C NMR (100 Hz, $CDCl_3$) δ 161.6, 151.6, 138.4, 135.7, 134.9, 132.8, 129.5, 129.1, 128.8, 128.0, 126.9, 126.6, 125.6, 125.7, 123.5, 120.0, 116.3, 51.9, 50.4. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{25}H_{24}N_3O$ 382.1914; Found 382.1913. IR (KBr, thin film): 3058, 2920, 1730, 1648, 1606, 1497, 1449, 1371, 124, 952, 757, 528 cm^{-1}.



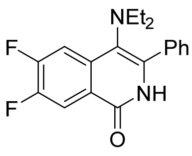
3ab

4-(diethylamino)-6, 7-dimethyl-3-phenylisoquinolin-1(2*H*)-one (3ab): white solid (52.7 mg, 83% yield, TLC (PE/EA, 2:1): R_f = 0.21). mp 244-245 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.72 (s, 1H), 8.14 (s, 1H), 7.73 (s, 1H), 7.47-7.42 (m, 5H), 3.01-2.80 (m, 4H), 2.44 (s, 3H), 2.41 (s, 3H), 0.93 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.9, 142.2, 138.5, 137.1, 135.9, 135.6, 129.0, 128.8, 128.3, 128.0, 124.8, 124.7, 123.9, 48.4, 20.8, 19.7, 14.3. HRMS (ESI) m/z: $(M-H)^-$ calcd for $C_{21}H_{24}N_2O^-$ 319.18159; Found 319.18094. IR (KBr, thin film): 2970, 2914, 2859, 1651, 1616, 1494, 1470, 1379, 1232, 1191, 1130, 1021, 773, 553 cm^{-1}.



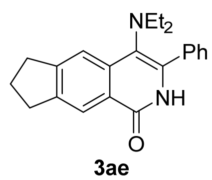
3ac

4-(diethylamino)-6, 7-dimethoxy-3-phenylisoquinolin-1(2*H*)-one (3ac): white solid (49.3 mg, 70% yield, TLC (PE/EA, 1:1): R_f = 0.25). mp 130-131 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.98 (s, 1H), 7.75 (s, 1H), 7.54-7.39 (m, 6H), 4.03 (d, *J* = 1.2 Hz, 6H), 2.99-2.72 (m, 4H), 0.97 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.9, 153.0, 148.5, 136.1, 135.8, 134.8, 128.7, 128.4, 127.8, 124.3, 118.9, 107.1, 104.5, 55.7, 55.0, 47.9, 14.1; HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{21}H_{25}N_2O_3$ 353.1860; Found 353.1859. IR (KBr, thin film): 2926, 2848, 1650, 1509, 1491, 1434, 1381, 1271, 1147, 1032, 878, 849, 765, 523 cm^{-1}.



3ad

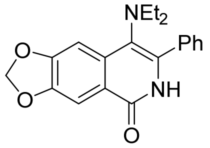
4-(diethylamino)-6, 7-difluoro-3-phenylisoquinolin-1(2*H*)-one (3ad): white solid (39.4 mg, 60% yield, TLC (PE/EA, 2:1): R_f = 0.40). mp 221-222 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.98 (s, 1H), 8.10 (dd, *J* = 10.4, 8.0 Hz, 1H), 7.82 (dd, *J* = 12.0, 7.6 Hz, 1H), 7.52-7.41 (m, 5H), 2.95-2. 64 (m, 4H), 0.95 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.5 (d, *J* = 53.5 Hz), 134.3, 132.1, 129.2, 128.7, 128.6, 128.3, 128.1, 126.2, 123.9, 115.3 (d, *J* = 20.4 Hz), 112.1 (d, *J* = 19.4 Hz), 48.0, 14.0. HRMS (ESI) m/z: $(M-H)^-$ calcd for $C_{19}H_{18}F_2N_2O$ 327.1314; Found 327.1309. IR (KBr, thin film): 2964, 2851, 1654, 1616, 1492, 1463, 1361, 1227, 1179, 883, 772, 542 cm^{-1}.



3ae

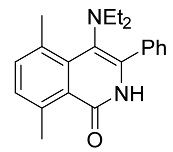
4-(diethylamino)-3-phenyl-2, 6, 7, 8-tetrahydro-1H-cyclopenta[g]isoquinoli n-1-one (3ae): white solid (49.8 mg, 76% yield, TLC (PE/EA, 2:1): R_f = 0.21). mp 228-229 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (s, 1H), 8.25 (s, 1H), 7.81 (s, 1H), 7.51-7.40 (m, 5H), 3.06 (q, *J* = 7.2 Hz, 4H), 3.01-2.83 (m, 4H), 2.21-2.11 (m, 2H), 0.93 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.1, 150.1, 143.7, 139.3, 136.9, 135.6, 129.1, 128.8, 128.3, 125.2, 124.5, 122.9, 119.5, 48.4, 33.4, 32.5, 25.7, 14.3. HRMS (ESI) m/z: $(M-H)^-$ calcd for

$C_{22}H_{24}N_2O$ 331.1816; Found 331.1810. IR (KBr, thin film): 2971, 2914, 2834, 1617, 1492, 1463, 1361, 1227, 1179, 883, 772, 542 cm^{-1}.



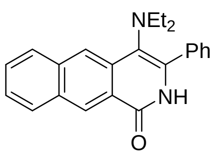
3af

8-(diethylamino)-7-phenyl-[1, 3]dioxolo[4, 5-g]isoquinolin-5(6*H*)-one (3af): white solid (51 mg, 76% yield, TLC (PE/EA, 2:1): R_f = 0.24). mp 265-266 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.84 (s, 1H), 7.71 (s, 1H), 7.51-7.38 (m, 6H), 6.09 (s, 2H), 2.95-2.69 (m, 4H), 0.93 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.3, 152.5, 147.7, 138.8, 137.1, 135.4, 129.3, 129.3, 128.2, 125.2, 121.4, 105.8, 103.1, 101.7, 48.3, 14.3. HRMS (ESI) m/z: (M-H)$^-$ calcd for $C_{20}H_{20}N_2O_3$ 335.1401; Found 335.1396. IR (KBr, thin film): 2970, 2835, 1641, 1463, 1379, 1257, 1120, 1029, 935, 877, 744, 507 cm^{-1}.



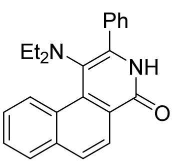
3ag

4-(diethylamino)-5, 8-dimethyl-3-phenylisoquinolin-1(2*H*)-one (3ag): white solid (41.01 mg, 64% yield, TLC (PE/EA, 5:1): R_f = 0.36). mp 159-160 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.68 (s, 1H), 7.47-7.38 (m, 5H), 7.25 (s, 1H), 7.03 (d, *J* = 7.6 Hz, 1H), 2.75-2.57 (m, 8H), 2.57-2.45 (m, 2H), 0.86 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.0, 142.8, 140.6, 140.1, 137.0, 136.8, 136.0, 133.2, 130.0, 129.4, 129.3, 128.7, 125.4, 123.3, 48.8, 24.4, 24.8, 24.7, 13.1; HRMS (ESI) m/z: (M+H)$^+$ calcd for $C_{21}H_{25}N_2O$ 321.1961; Found 321.1963. IR (KBr, thin film): 2969, 2927, 1695, 1573, 1493, 1442, 1375, 1287, 1187, 843, 783, 512 cm^{-1}.



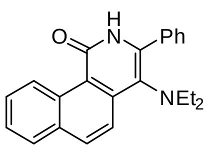
3ah

4-(diethylamino)-3-phenylbenzo[g]isoquinolin-1(2*H*)-one (3ah): white solid (57.53 mg, 84% yield, TLC (PE/EA, 5:1): R_f = 0.25). mp 252-253 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.04 (s, 1H), 8.45 (s, 1H), 8.13-8.04 (m, 2H), 8.00 (d, *J* = 8.4 Hz, 1H), 7.64-7.58 (m, 1H), 7.56-7.45 (m, 6H), 3.10-2.88 (m, 4H), 1.00 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.5, 136.4, 135.9, 135.6, 135.4, 131.5, 129.3, 129.2, 129.0, 128.9, 128.5, 128.3, 128.1, 126.0, 124.8, 124.3, 123.3, 48.4, 14.4. HRMS (ESI) m/z: (M-H)$^-$ calcd for $C_{23}H_{22}N_2O$ 341.1659; Found 341.1653. IR (KBr, thin film): 2968, 1655, 1624, 1486, 1446, 1361, 1200, 1123, 959, 892, 776, 537 cm^{-1}.



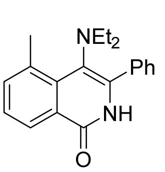
3ai

1-(diethylamino)-2-phenylbenzo[*f*]isoquinolin-4(3*H*)-one (3ai): fluorescent green solid (31.7 mg, 46% yield, TLC (PE/EA, 5:1): R_f = 0.11). mp 245-246 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 11.18 (s, 1H), 9.94 (d, *J* = 8.0 Hz, 1H), 8.17 (d, *J* = 9.2 Hz, 1H), 8.06 (d, *J* = 8.8 Hz, 1H), 7.90 (d, *J* = 7.2 Hz, 1H), 7.68-7.54 (m, 7H), 3.05-2.83 (m, 4H), 0.97 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.7, 143.7, 141.2, 135.6, 134.1, 132.8, 132.8, 130.0, 129.6, 129.0, 128.6, 128.5, 128.2, 126.9, 125.9, 123.1, 119.5, 49.4, 14.9. HRMS (ESI) m/z: (M+H)$^+$ calcd for $C_{23}H_{23}N_2O$ 343.1805; Found 343.1800. IR (KBr, thin film): 2968, 2926, 1633, 1548, 1446, 1246, 1191, 1097, 918, 833, 761, 510 cm^{-1}.



3ai'

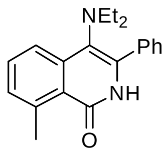
4-(diethylamino)-3-phenylbenzo[h]isoquinolin-1(2*H*)-one (3ai′): fluores cent green solid (13.5 mg, 20% yield, TLC (PE/EA, 5:1): R_f = 0.28). mp 222-223 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.07 (d, *J* = 8.8 Hz, 1H), 9.42 (s, 1H), 8.38 (d, *J* = 8.8 Hz, 1H), 7.91 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.85 (d, *J* = 8.8 Hz, 1H), 7.67-7.60 (m, 1H), 7.59-7.44 (m, 6H), 2.97-2.85 (m, 2H), 2.74-2.63 (m, 2H), 0.96 (t, *J* = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.6, 141.2, 138.7, 136.5, 135.5, 130.5, 129.3, 128.8, 128.8, 128.5, 128.4, 128.3, 127.9, 125.7, 124.8, 123.9, 123.7, 48.2, 12.8. HRMS (ESI) m/z: (M+H)$^+$ calcd for $C_{23}H_{23}N_2O$ 343.1805; Found 343.1802. IR (KBr, thin film): 2929, 1740, 1635, 1541, 1485, 1379, 1245, 1107, 917, 840, 762, 584 cm^{-1}.



3aj

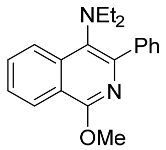
4-(diethylamino)-5-methyl-3-phenylisoquinolin-1(2*H*)-one (3aj): white solid (31.4 mg, 51% yield, TLC (PE/EA, 2:1): R_f = 0.68). mp 166-167 ℃. ^{1}H NMR (400

MHz, $CDCl_3$) δ 9.64 (s, 1H), 7.87 (d, J = 8.0 Hz, 1H), 7.55-7.41 (m, 6H), 7.20 (d, J = 7.2 Hz, 1H), 2.97-2.75 (m, 7H), 0.93 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.2, 142.2, 141.9, 138.1, 135.1, 131.3, 129.4, 129.0, 128.7, 128.1, 124.6, 123.9, 122.4, 48.2, 23.5, 14.2. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{20}H_{23}N_2O$ 307.1805; Found 307.1803. IR (KBr, thin film): 2973, 2847, 1642, 1564, 1465, 1379, 1257, 1120, 1029, 935, 877, 744, 507 cm^{-1}.

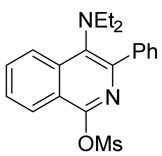

3aj'

4-(diethylamino)-8-methyl-3-phenylisoquinolin-1(2*H*)-one (3aj′): white solid (24.8 mg, 42% yield, TLC (PE/EA, 2:1): R_f = 0.49). mp 197-198 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.56-8.42 (m, 1H), 7.99 (d, J = 8.4 Hz, 1H), 7.70-7.63 (m, 1H), 7.53-7.42 (m, 4H), 7.33-7.27 (m, 2H), 3.21 (s, 3H), 2.85-2.66 (m, 4H), 0.89 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.3, 142.5, 139.2, 135.1, 131.7, 129.6, 128.6, 128.3, 128.0, 126.5, 126.3, 125.5, 124.1, 48.4, 33.8, 14.5. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{20}H_{23}N_2O$ 307.1805; Found 307.1804. IR (KBr, thin film): 2923, 2847, 1643, 1457, 1382, 1251, 1188, 1061, 905, 843, 775, 691, 514 cm^{-1}.

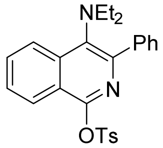
2.7.3 Characterization of derivatization products:


4

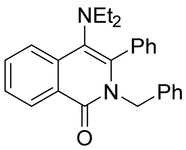
***N, N*-diethyl-1-methoxy-3-phenylisoquinolin-4-amine (4):** white solid (59.9 mg, 98% yield, TLC (PE/EA, 2:1): R_f = 0.31). mp 155-156 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (dd, J = 8.0, 1.2 Hz, 1H), 8.00 (d, J = 7.6 Hz, 1H), 7.70-7.63 (m, 1H), 7.52-7.45 (m, 4H), 7.32-7.27 (m, 2H), 3.21 (s, 3H), 2.83-2.66 (m, 4H), 0.89 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 Hz, $CDCl_3$) δ 162.3, 142.5, 139.2, 135.1, 131.7, 129.6, 128.6, 128.3, 128.0, 126.5, 126.3, 125.4, 124.1, 48.4, 33.8, 14.5. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{20}H_{23}N_2O$ 307.1805; Found 307.1801. IR (KBr, thin film): 3068, 2962, 2834, 1643, 1583, 1494, 1345, 1259, 1183, 783, 745, 519 cm^{-1}.


5

4-(diethylamino)-3-phenylisoquinolin-1-yl methanesulfonate (5): white solid (39.8 mg, 68% yield, TLC (PE/EA, 5:1): R_f = 0.56). mp 86-87 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25 (t, J = 8.0 Hz, 2H), 7.79-7.74 (m, 1H), 7.67-7.61 (m, 3H), 7.49-7.43 (m, 2H), 7.43-7.37 (m, 1H), 3.64 (s, 3H), 3.05 (q, J = 7.2 Hz, 4H), 1.01 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.3, 146.9, 140.8, 140.2, 138.9, 130.9, 129.3, 128.0, 127.8, 124.6, 124.2, 120.8, 48.0, 41.6, 14.3. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{20}H_{23}N_2O_3S$ 371.1424; Found 371.1424. IR (KBr, thin film): 3058, 3025, 2975, 2838, 1614, 1585, 1448, 1261, 1183, 892, 813, 573 cm^{-1}.

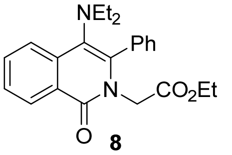

6

4-(diethylamino)-3-phenylisoquinolin-1-yl 4-methylbenzenesulfonate (6): white solid (58.0 mg, 65% yield, TLC (PE/EA, 5:1): R_f = 0.62). mp 89-90 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (d, J = 8.4 Hz, 1H), 8.20 (d, J = 8.0 Hz, 1H), 7.99 (d, J = 8.0 Hz, 2H), 7.73 (t, J = 7.6 Hz, 1H), 7.62 (t, J = 7.2 Hz, 1H), 7.48-7.34 (m, 5H), 7.24 (d, J = 8.0 Hz, 2H), 3.02 (q, J = 6.8 Hz, 4H), 2.42 (s, 3H), 0.97 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.0, 146.8, 144.8, 140.7, 139.8, 138.3, 134.7, 130.6, 129.4, 129.4, 129.3, 127.6, 127.6, 127.5, 124.5, 124.2, 120.6, 48.0, 21.7, 14.3. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{26}H_{27}N_2O_3S$ 447.1737; Found 447.1739. IR (KBr, thin film): 3065, 2968, 2858, 1590, 1450, 1374, 1340, 1192, 1048, 892, 774, 541 cm^{-1}.

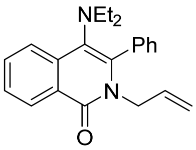

7

2-benzyl-4-(diethylamino)-3-phenylisoquinolin-1(2*H*)-one (7): colorless oily liquid (56.1 mg, 74% yield, TLC (PE/EA, 10:1): R_f = 0.33). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.54 (d, J = 8.0 Hz, 1H), 8.03 (d, J = 8.4 Hz, 1H), 7.69 (t, J = 7.2 Hz, 1H), 7.52 (t, J = 7.6 Hz, 1H), 7.36 (t, J = 7.6 Hz, 1H), 7.28 (t, J = 7.6 Hz, 2H), 7.20-7.09 (m, 3H), 7.04 (d, J = 7.2 Hz, 2H), 6.81(t, J = 3.2 Hz, 2H), 5.08 (s, 2H), 2.85-2.55 (m, 4H), 0.88 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.3, 142.4, 139.4, 137.9, 134.1, 132.0, 130.2, 128.6, 128.5, 128.2, 127.6, 126.8, 126.7, 125.7, 124.3, 48.6, 48.4, 14.5. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{26}H_{27}N_2O$ 383.2118;

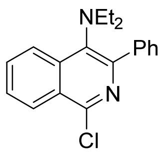
Found 383.2119. IR (KBr, thin film): 3422, 3065, 3026, 2967, 2923, 2837, 1654, 1579, 1341, 1077, 783, 702 cm^{-1}.


8

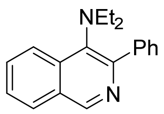
ethyl 2-(4-(diethylamino)-1-oxo-3-phenylisoquinolin-2(1H)-yl)acetate (8): colorless oily liquid (56.4 mg, 75% yield, TLC (PE/EA, 10:1): R_f = 0.35).^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 (d, J = 8.0 Hz, 1H), 8.15 (d, J = 8.4 Hz, 1H), 7.73-7.60 (m, 3H), 7.53 (t, J = 7.6 Hz, 1H), 7.45-7.30 (m, 3H), 5.04 (s, 2H), 4.22 (q, J = 7.2 Hz, 2H), 3.15-2.90 (m, 4H), 1.21 (t, J = 7.2 Hz, 3H), 0.96 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 155.1, 146.9, 141.1, 140.2, 133.8, 130.0, 129.4, 127.5, 127.2, 126.2, 124.4, 124.3, 119.3, 62.8, 60.8, 48.3, 14.4, 14.1. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{23}H_{27}N_2O_3$ 379.2016; Found 379.2022. IR (KBr, thin film): 3057, 2971, 2926, 2840, 1763, 1620, 1578, 1340, 1212, 1162, 1096, 766 cm^{-1}.


9

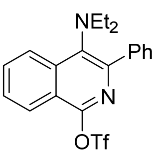
2-allyl-4-(diethylamino)-3-phenylisoquinolin-1(2H)-one (9): yellow solid (49.7 mg, 75% yield, TLC (PE/EA, 10:1): R_f = 0.23). mp 71-72 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (d, J = 8.0 Hz, 1H), 8.01 (d, J = 7.2 Hz, 1H), 7.68 (t, J = 7.2 Hz, 1H), 7.50 (t, J = 7.6 Hz, 1H), 7.47-7.37 (m, 3H), 7.35-7.27 (m, 2H), 5.83-5.70 (m, 1H), 5.05 (d, J = 10.4 Hz, 1H), 4.78 (d, J = 17.2 Hz, 1H), 4.37 (d, J = 4.8 Hz, 2H), 2.85-2.63 (m, 4H), 0.90 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.7, 142.3, 139.4, 134.3, 133.2, 131.9, 130.1, 128.7, 128.2, 127.7, 126.5, 126.5, 125.6, 124.2, 116.3, 77.4, 77.1, 76.78, 48.4, 47.8, 14.5; HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{22}H_{25}N_2O$ 333.1961; Found 333.1963. IR (KBr, thin film): 3069, 2965, 2926, 2837, 1650, 1608, 1581, 1548, 1426, 1334, 1209, 778 cm^{-1}.


10

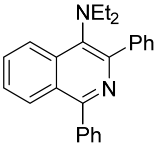
chloro-*N, N*-diethyl-3-phenylisoquinolin-4-amine (10): white solid (60.5 mg, 97% yield, TLC (PE/EA, 5:1): R_f = 0.78); mp 64-65 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (t, J = 8.4 Hz, 2H), 7.79-7.72 (m, 1H), 7.68-7.63(m, 1H), 7.60-7.55 (m, 2H), 7.47-7.41 (m, 2H), 7.41-7.35 (m, 1H), 2.99 (q, J = 7.2 Hz, 4H), 0.99 (t, J = 7.2 Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.9, 146.1, 140.3, 139.8, 139.0, 130.5, 129.3, 128.0, 127.8, 127.8, 126.9, 126.7, 125.0, 48.0, 14.3. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{19}H_{20}ClN_2$ 311.1310; Found 311.1313. IR (KBr, thin film): 2964, 2828, 1607, 1556, 1442, 1382, 1259, 1174, 1056, 856, 767, 606 cm^{-1}.


11

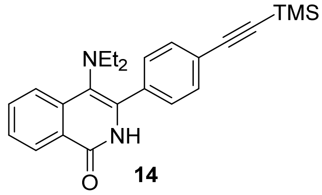
***N, N*-diethyl-3-phenylisoquinolin-4-amine (11):** yellow solid (50.7 mg, 92% yield, TLC (PE/EA, 20:1): R_f = 0.13). mp 91-92 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.11 (s, 1H), 8.27 (d, J = 8.4 Hz, 1H), 7.98 (d, J = 8.0 Hz, 1H), 7.70 (t, J = 7.2Hz, 1H), 7.62-7.53 (m, 3H), 7.45 (t, J = 7.2 Hz, 2H), 7.38 (t, J = 7.2 Hz, 1H), 3.02 (q, J = 7.2 Hz, 4H), 0.99 (t, J = 7.2 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.0, 148.4, 141.8, 139.0, 137.7, 129.8, 129.3, 129.1, 127.9, 127.7, 127.4, 126.7, 124.4, 48.0, 14.3. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{19}H_{21}N_2$ 277.1699; Found 277.1703. IR (KBr, thin film): 3420, 3051, 2965, 2834, 1623, 1554, 1498, 1349, 1239, 1188, 1069, 769 cm^{-1}.


12

4-(diethylamino)-3-phenylisoquinolin-1-yl trifluoromethanesulfonate (12): yellow solid (117.9 mg, 93% yield, TLC (PE/EA, 50:1): R_f = 0.56). mp 91-92 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.28 (d, J = 8.8 Hz, 1H), 8.11 (d, J = 8.4 Hz, 1H), 7.80 (t, J = 7.6 Hz, 1H), 7.72-7.63 (m, 3H), 7.49-7.36 (m, 3H), 3.09 (q, J = 7.2 Hz, 4H), 1.02 (t, J = 7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.1, 145.9, 140.2, 139.1, 138.2, 130.1, 128.3, 127.3, 127.0, 126.9, 124.0, 122.2, 119.0, 117.7(q, J = 319.0 Hz), 46.94, 13.22; HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{20}H_{20}F_3N_2O_3S$ 425.1141; Found 425.1144. IR (KBr, thin film): 2982, 2935, 2837, 1626, 1590, 1415, 1337, 1248, 1212, 1141, 1040, 888, 775 cm^{-1}.


13

***N, N*-diethyl-1, 3-diphenylisoquinolin-4-amine (13)**: yellow solid (38.74 mg, 55% yield, TLC (PE/EA, 40:1): R_f = 0.34). mp 98-99 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (d, J = 8.4 Hz, 1H), 8.09 (d, J = 8.8 Hz, 1H), 7.77-7.60 (m, 5H), 7.46 (dt, J = 24.4, 7.2 Hz, 6H), 7.35 (t, J = 7.2 Hz, 1H), 3.05 (q, J = 7.2 Hz, 4H), 1.04 (t, J = 7.2 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.4, 150.1, 141.9, 139.9, 138.4, 138.1, 130.2, 129.5, 129.3, 128.2, 127.8, 127.3, 127.0, 126.4, 124.7, 48.1, 14.5. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{25}H_{25}N_2$ 353.2012; Found 353.2015. IR (KBr, thin film): 3054, 3021, 2968, 2923, 2858, 1614, 1548, 1498, 1388, 1254, 1028, 778 cm^{-1}.



14

4-(diethylamino)-3-(4-((trimethylsilyl)ethynyl)phenyl)isoquinolin-1(2H)-one (14): yellow solid (46.32 mg, 60% yield, TLC (PE/EA, 2:1): R_f = 0.49). mp 254-255 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.50 (s, 1H), 8.36 (d, J = 8.0 Hz, 1H), 7.95 (s, 1H), 7.75-7.65 (m, 1H), 7.57 (d, J = 8.0 Hz, 2H), 7.53-7.40 (m, ,3H), 3.10-2.81 (m, 4H), 0.93 (t, J = 6.8 Hz, 6H), 0.29 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.2, 140.1, 137.6, 135.2, 132.4, 131.9, 129.1, 128.0, 126.7, 125.9, 125.2, 124.4, 123.8, 104.5, 95.9, 48.5, 14.3, 0.0. HRMS (ESI) m/z: $(M+H)^+$ calcd for $C_{24}H_{29}N_2OSi$ 389.2049; Found 389.2052. IR (KBr, thin film): 3679, 3164, 2971, 2923, 2852, 2149, 1647, 1605, 1445, 1251, 867, 840 cm^{-1}.

2.8 Reference

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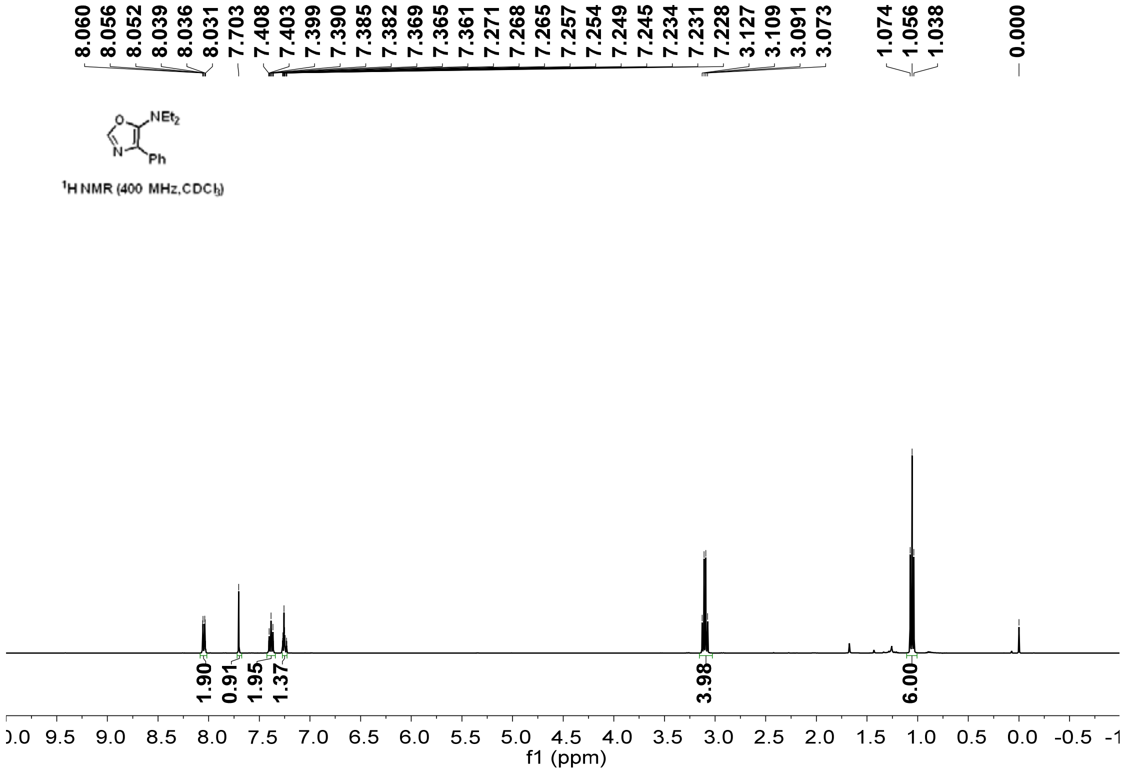
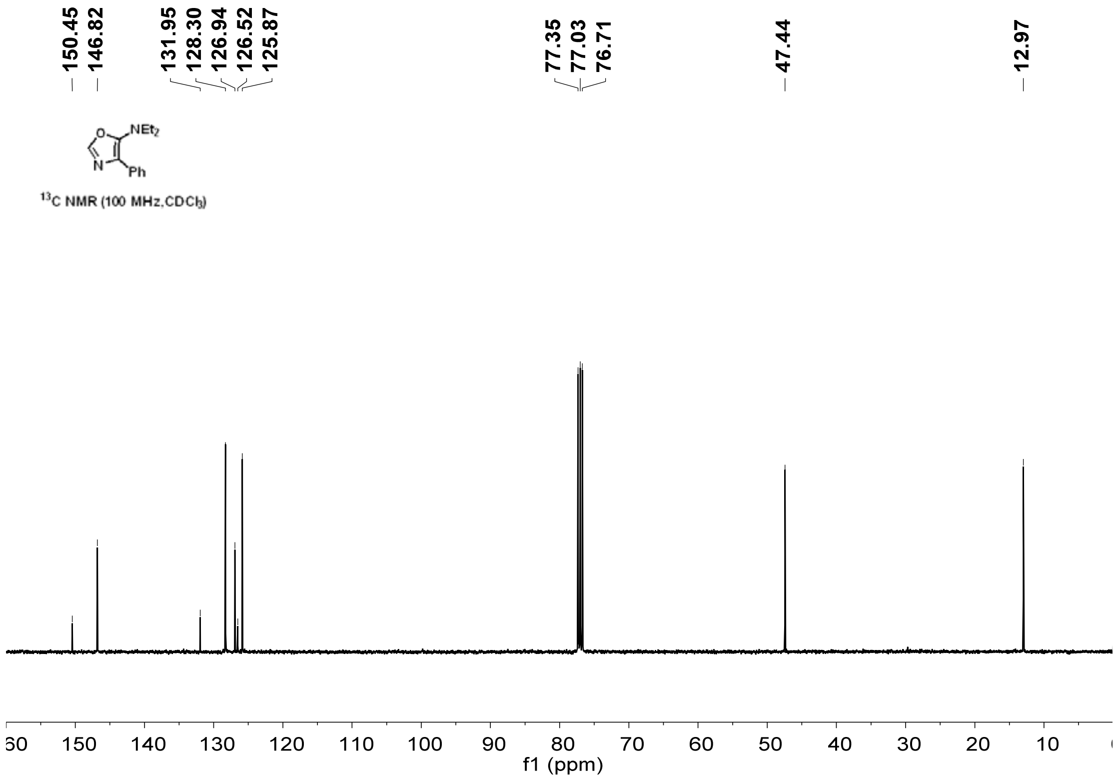
3 Copies of NMR spectra of substrates and products

3.1 Copies of NMR spectra of substrates:

1a





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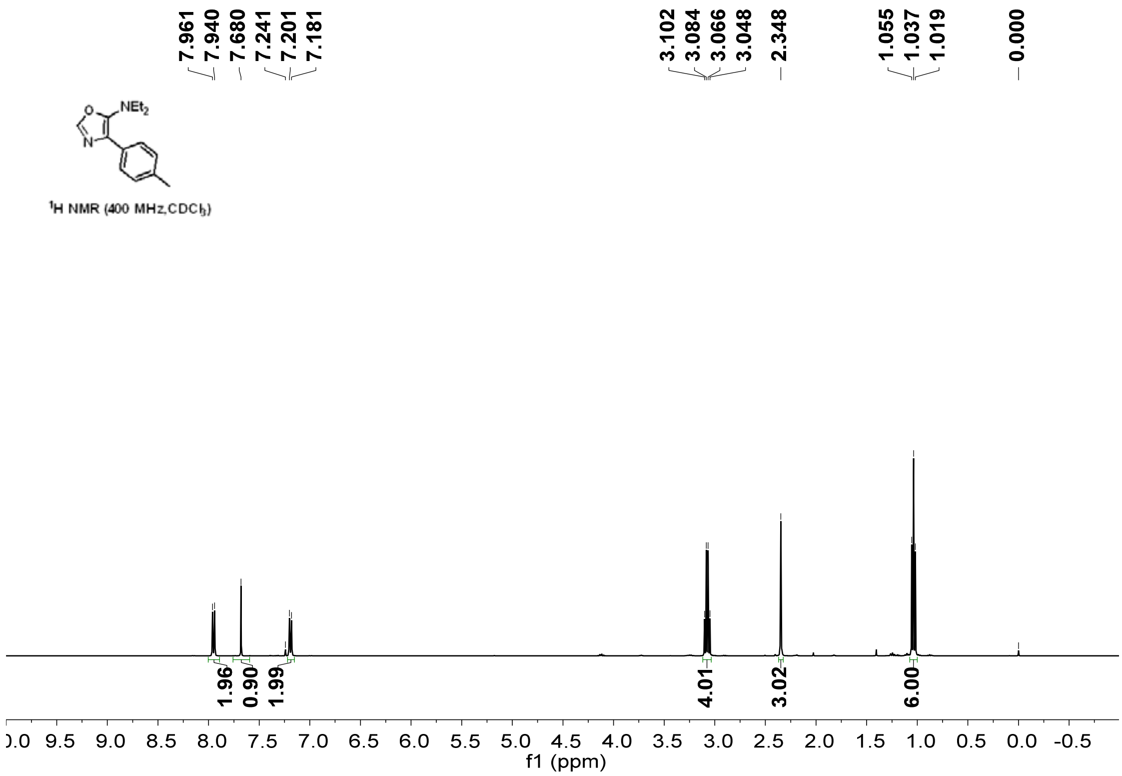
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7.241
7.201
7.181
3.102
3.084
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3.048
2.348
1.055
1.037
1.019
0.000
NEt2
O
N
1H NMR (400 MHz,CDCl3)
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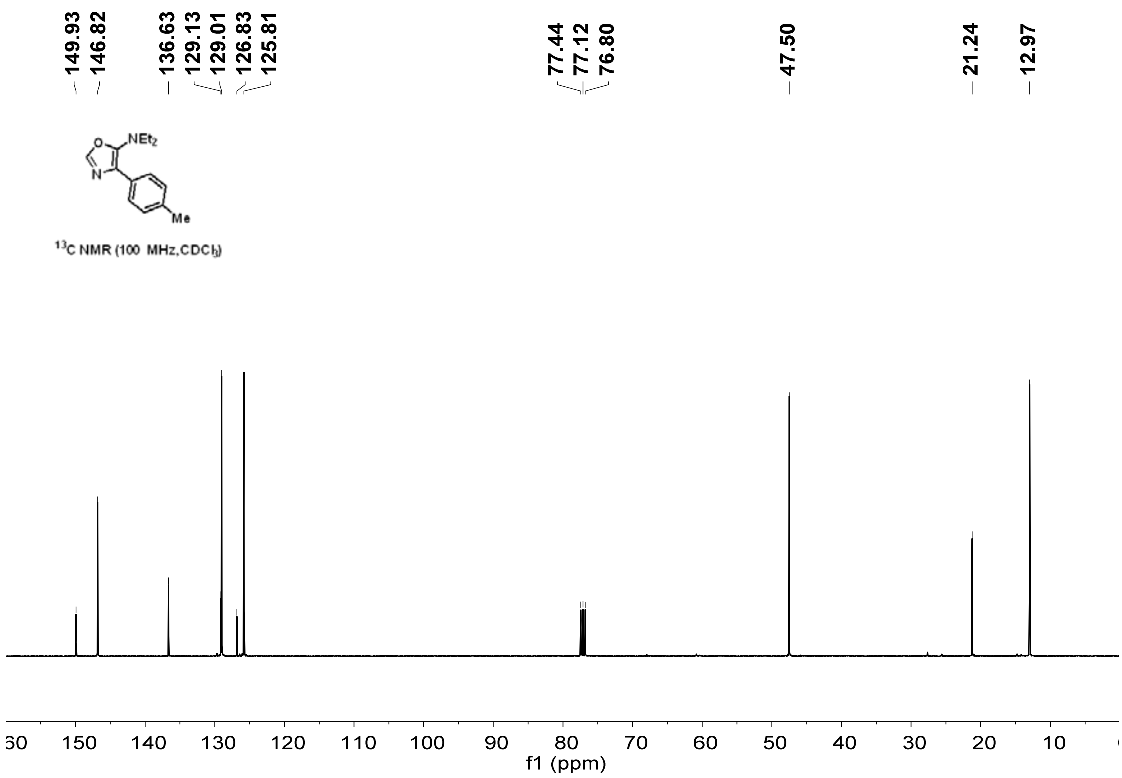
0.90
1.99
4.01
3.02
6.00
f1 (ppm)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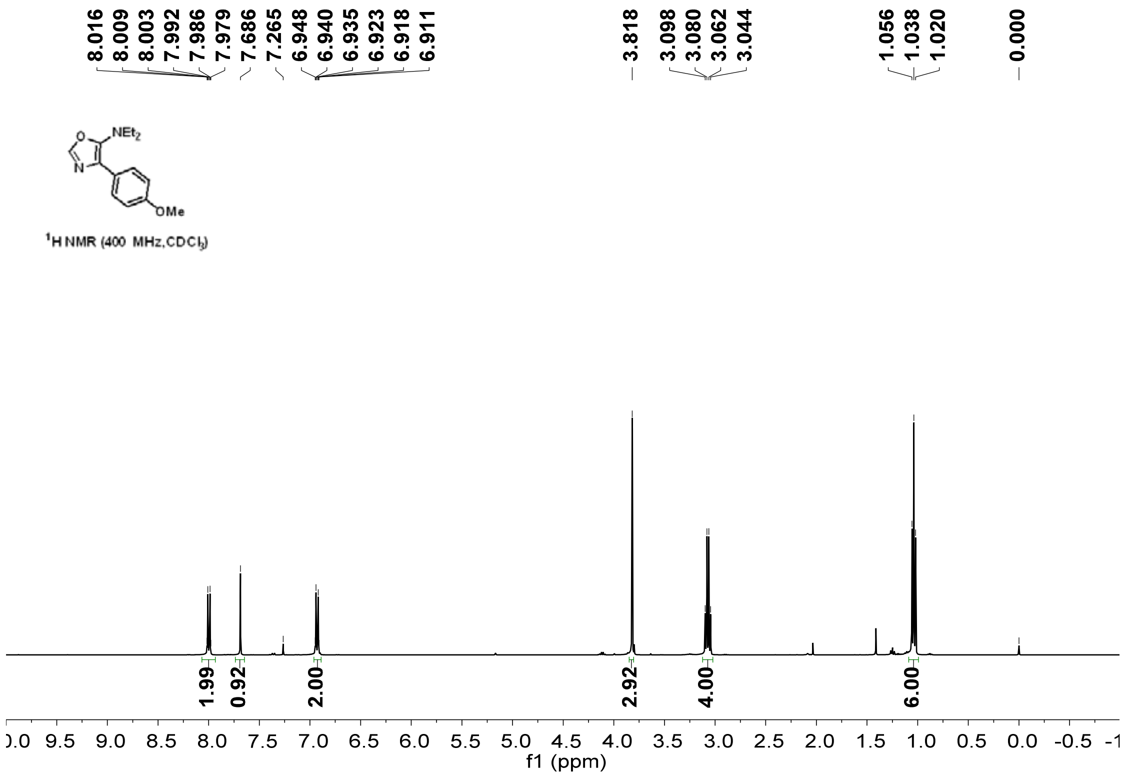
146.82
136.63
129.13
129.01
126.83
125.81
77.44
77.12
76.80
47.50
21.24
12.97
NEt2
O
N
Me
13C NMR (100 MHz,CDCl3)
f1 (ppm)

1c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8.003
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7.986
7.979
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7.265
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6.940
6.935
6.923
6.918
6.911
3.818
3.098
3.080
3.062
3.044
1.056
1.038
1.020
0.000
NEt2
O
N
OMe
1H NMR (400 MHz,CDCl3)
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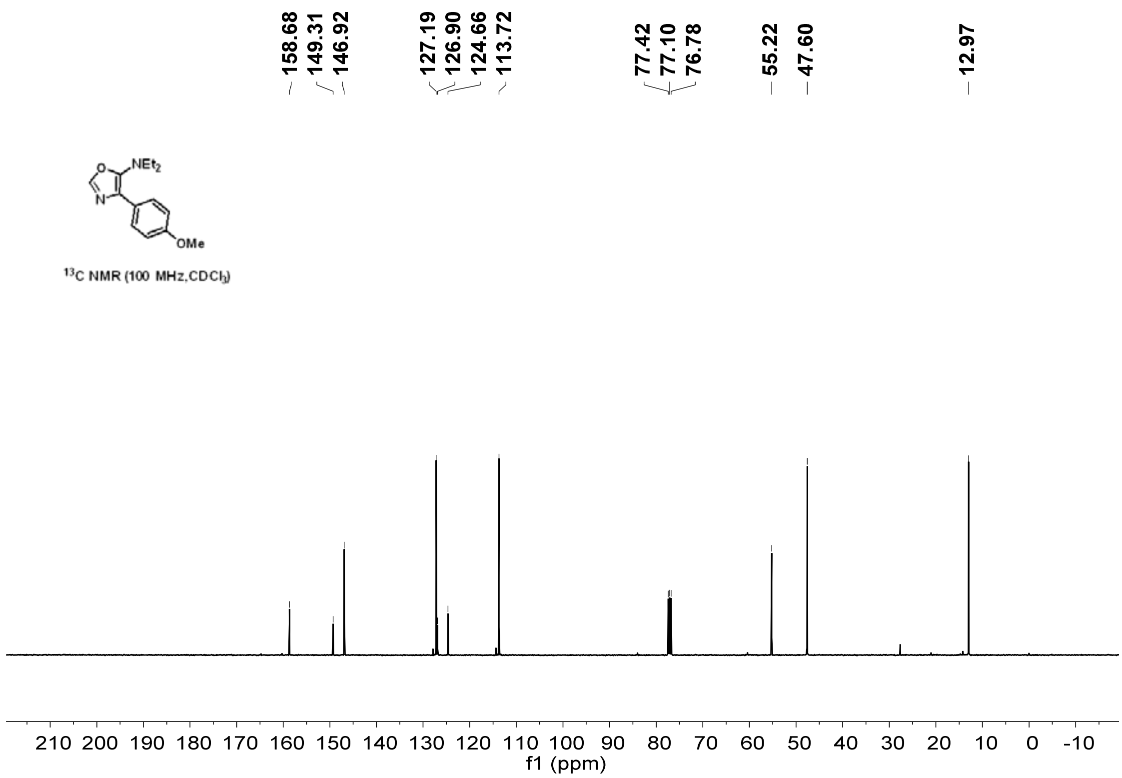
0.92
2.00
2.92
4.00
6.00
f1 (ppm)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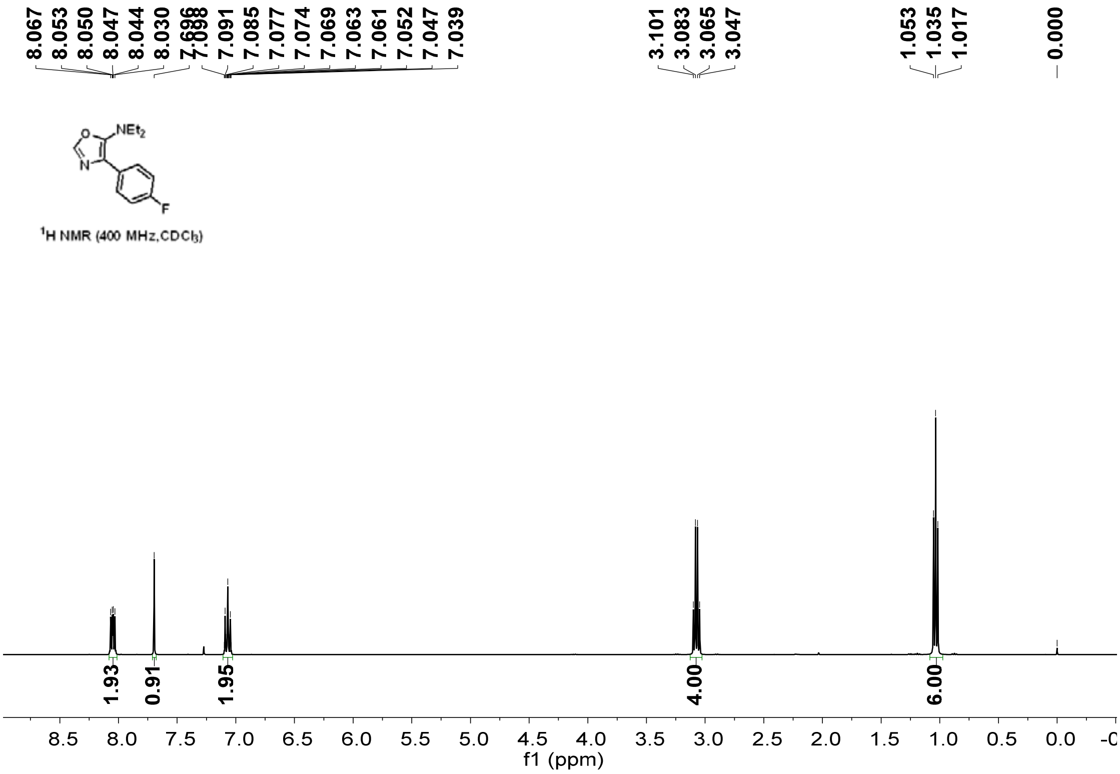
127.19
126.90
124.66
113.72
77.42
77.10
76.78
55.22
47.60
12.97
NEt2
O
N
OMe
13C NMR (100 MHz,CDCl3)
f1 (ppm)

1d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8.044
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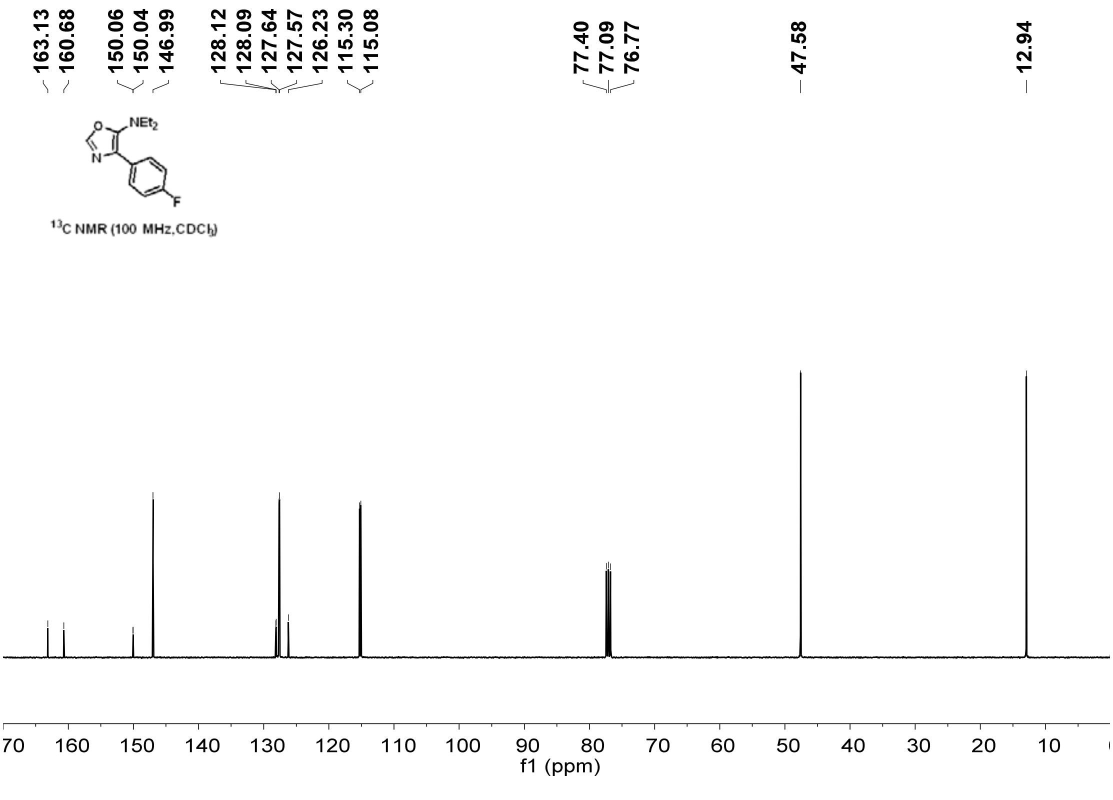
7.085
7.077
7.074
7.069
7.063
7.061
7.052
7.047
7.039
3.101
3.083
3.065
3.047
1.053
1.035
1.017
0.000
NEt2
O
N
F
1H NMR (400 MHz,CDCl3)
1.93
0.91
1.95
4.00
6.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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128.09
127.64
127.57
126.23
115.30
115.08
77.40
77.09
76.77
47.58
12.94
NEt2
O
N
F
13C NMR (100 MHz,CDCl3)
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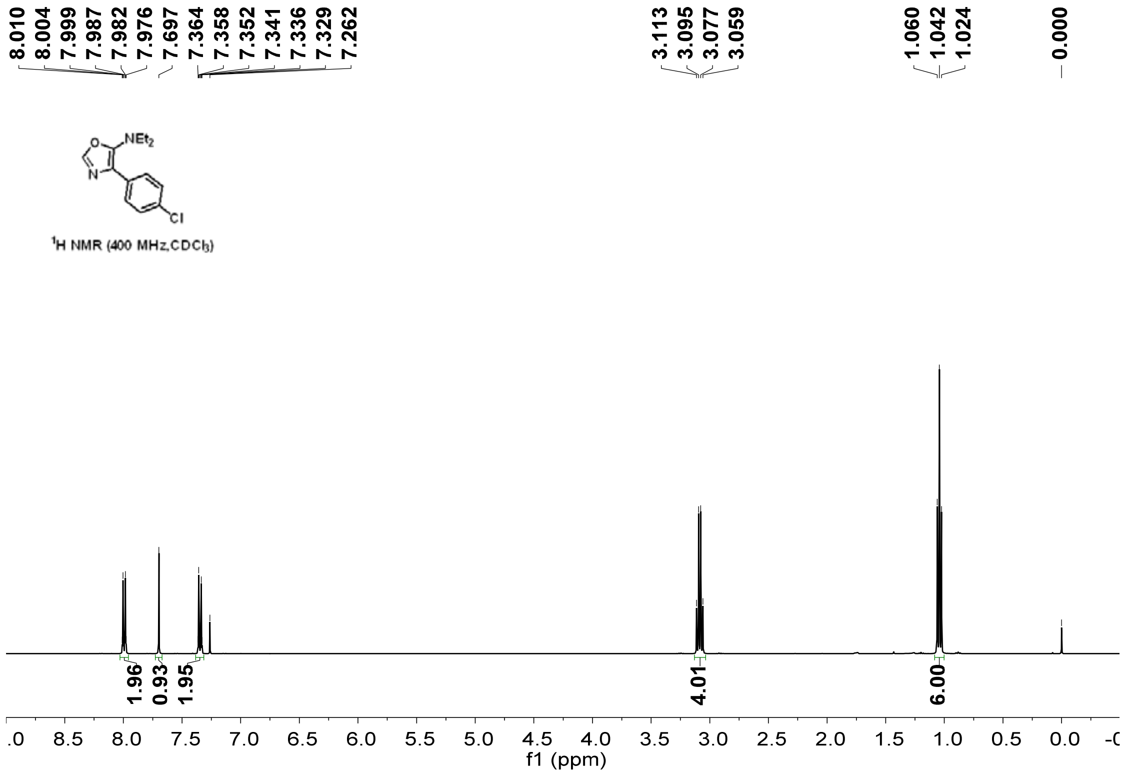
f1 (ppm)

1e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1.060 1.042 1.024
0.000
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O
N
Cl
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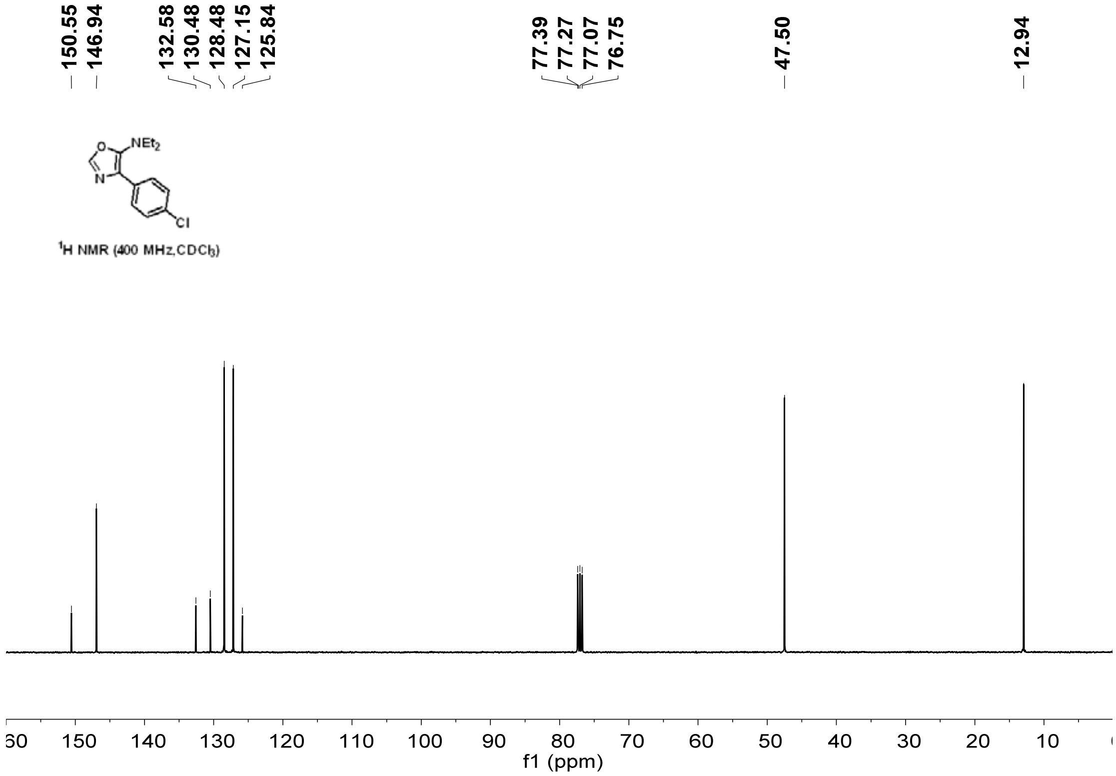
4.01
6.00
f1 (ppm)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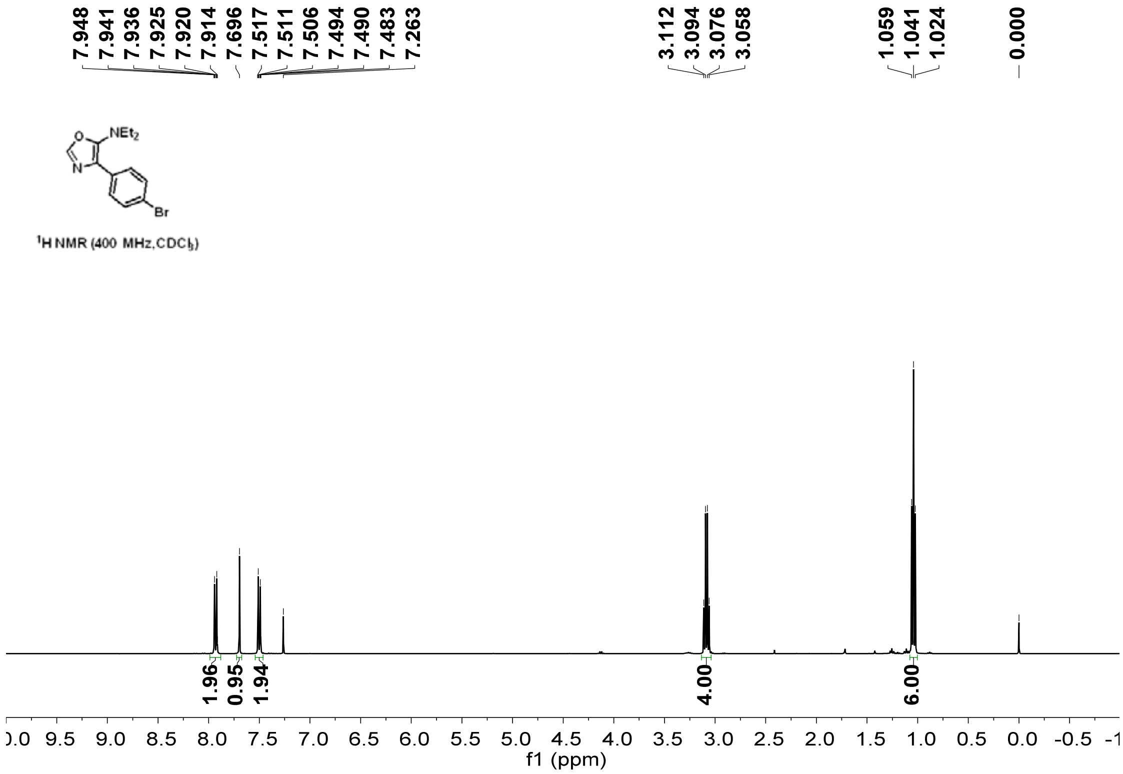
N
Cl
1H NMR (400 MHz,CDCl3)
f1 (ppm)

1f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7.511
7.506
7.494
7.490
7.483
7.263
3.112
3.094
3.076
3.058
1.059
1.041
1.024
0.000
NEt2
O
N
Br
1H NMR (400 MHz,CDCl3)
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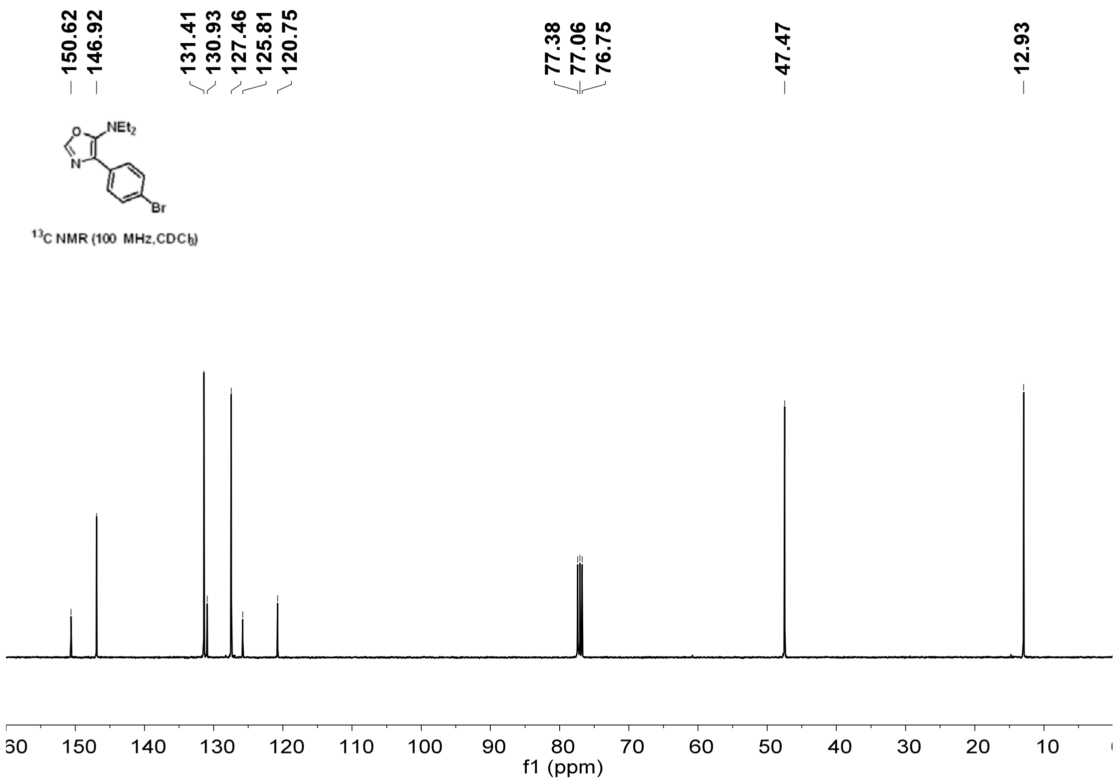
1.94
4.00
6.00
f1 (ppm)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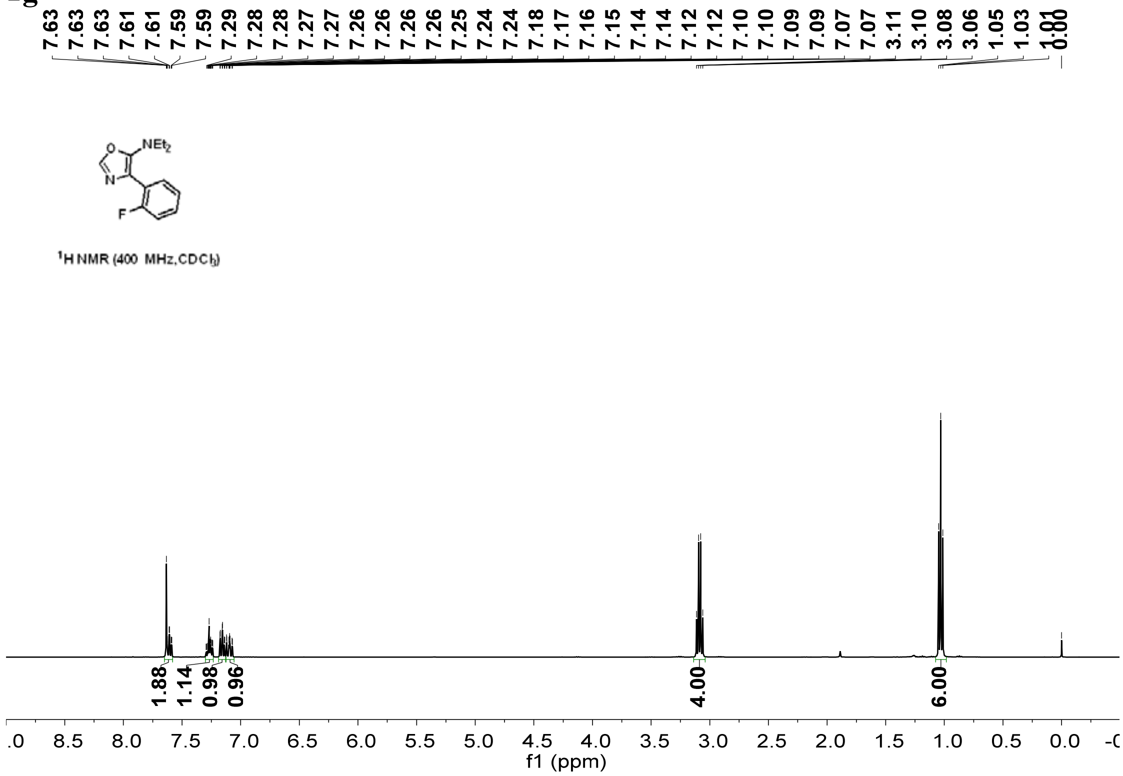
O
N
Br
13C NMR (100 MHz,CDCl3)
f1 (ppm)

1g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NEt2
O
N
F
1H NMR (400 MHz,CDCl3)
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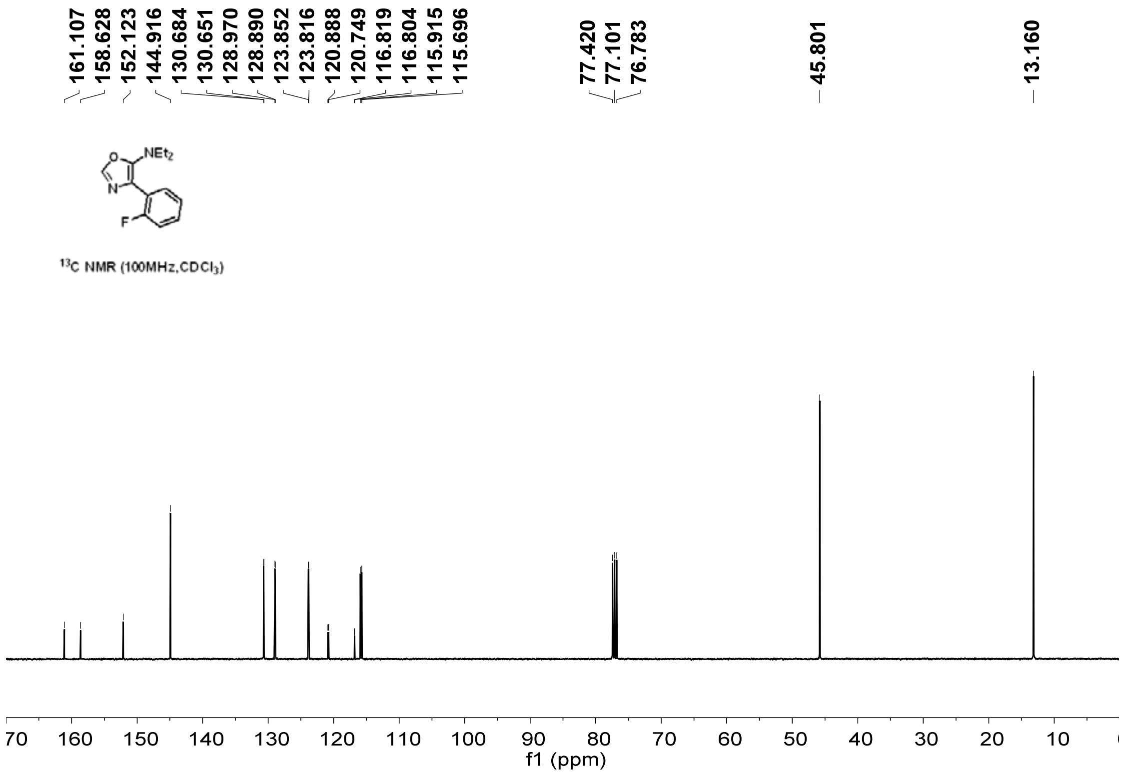
4.00
6.00
f1 (ppm)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45.801
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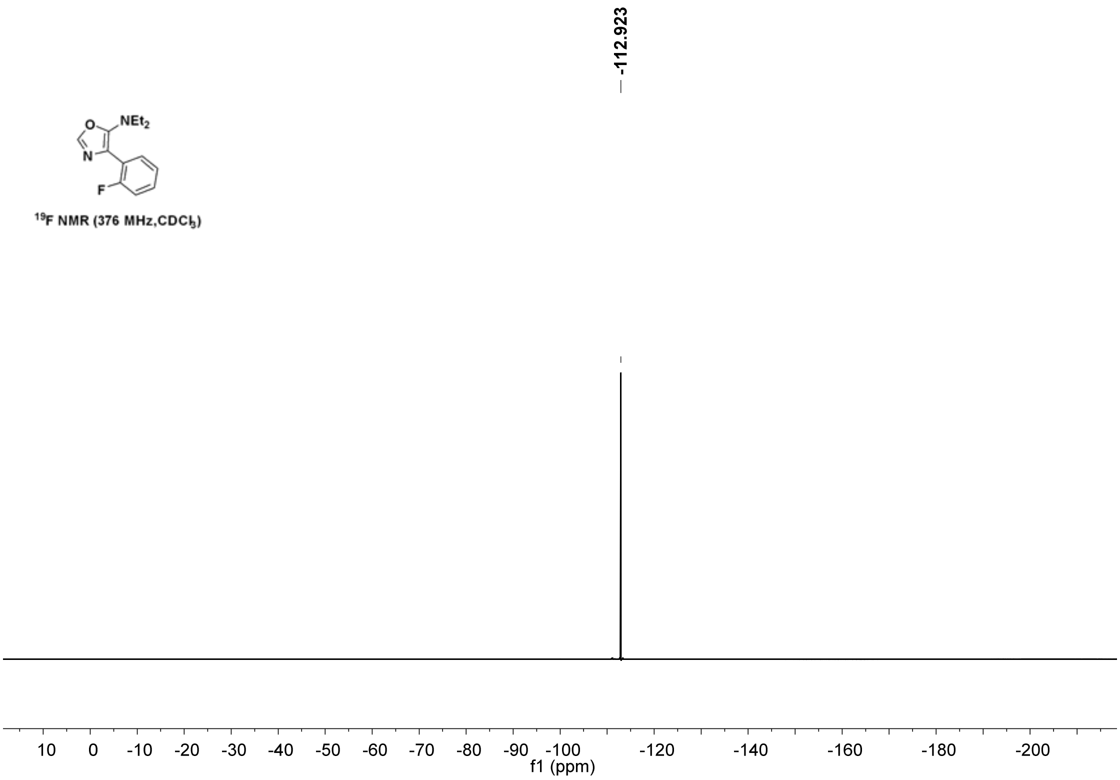
N
F
13C NMR (100MHz,CDCl3)
f1 (ppm)



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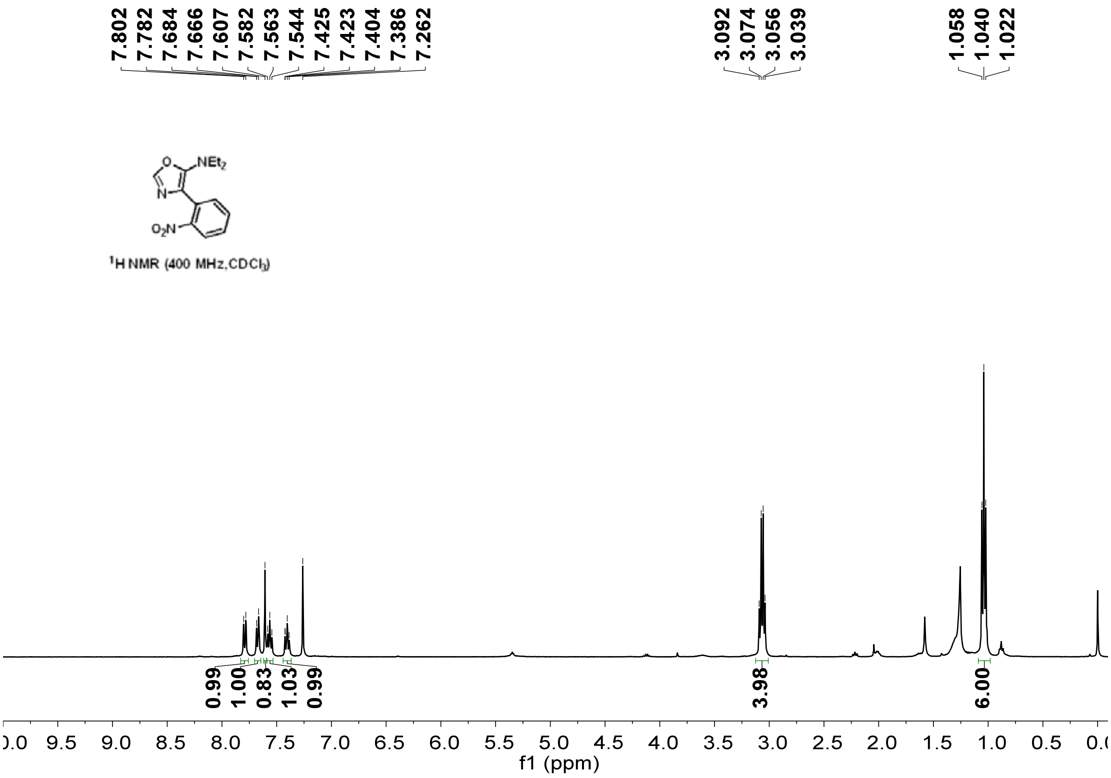
f1 (ppm)

1h



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3.074
3.056
3.039
1.058
1.040
1.022
NEt2
O
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O2N
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1.03
0.99
3.98
6.00
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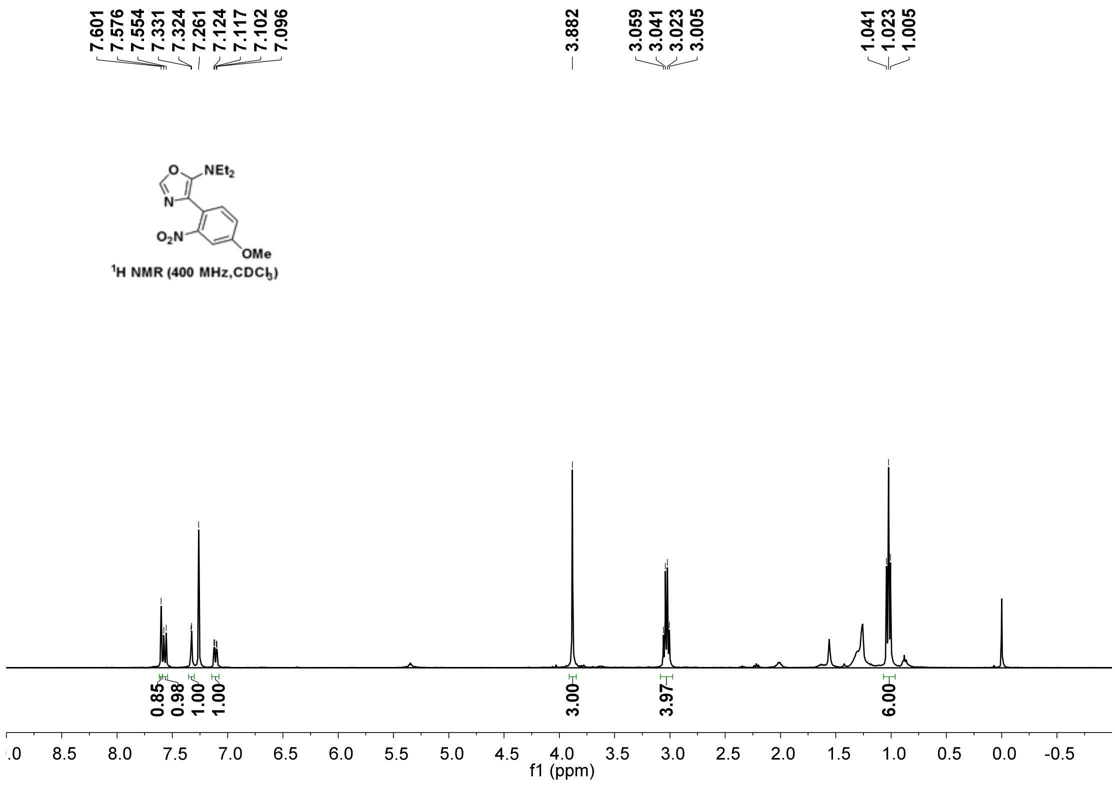
1i



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1.005
NEt2
O2N
OMe
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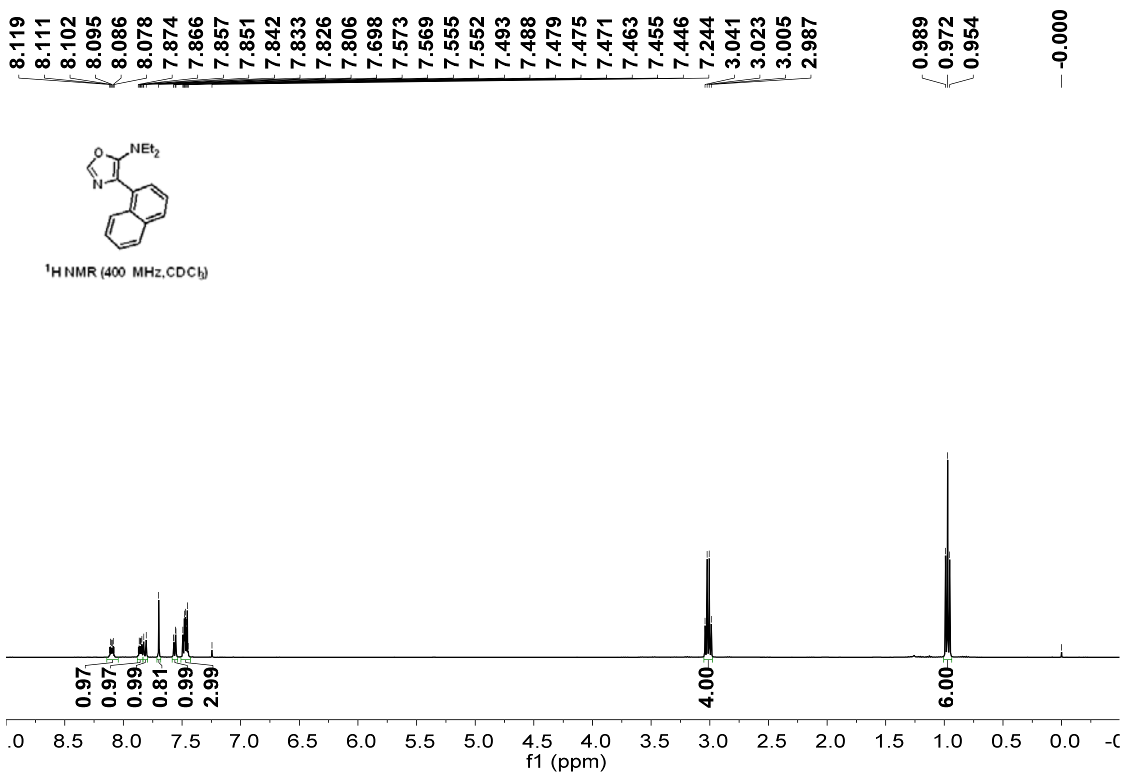
f1 (ppm)

1j



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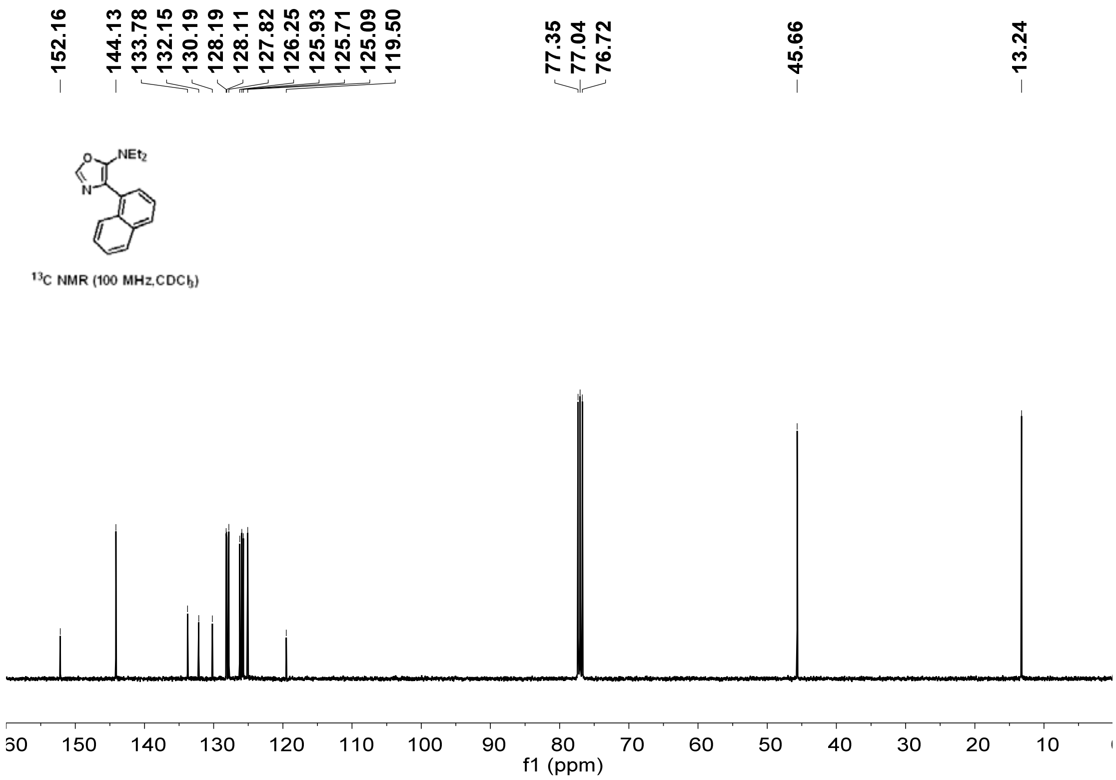
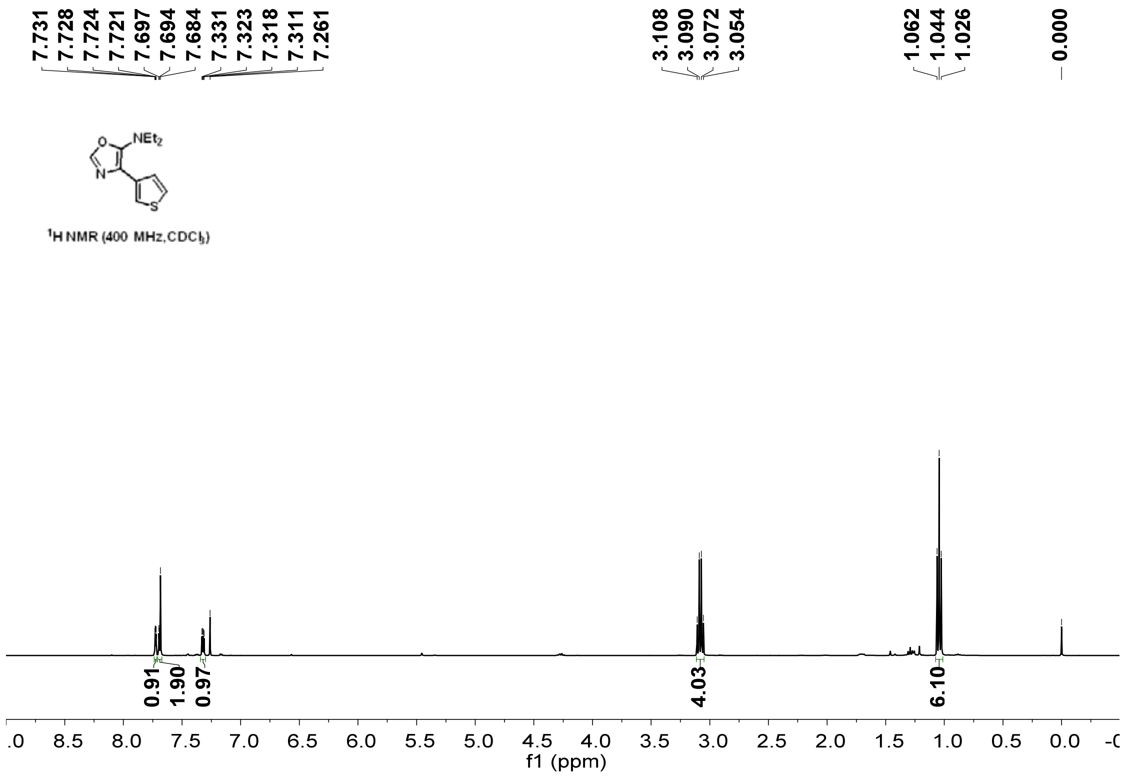
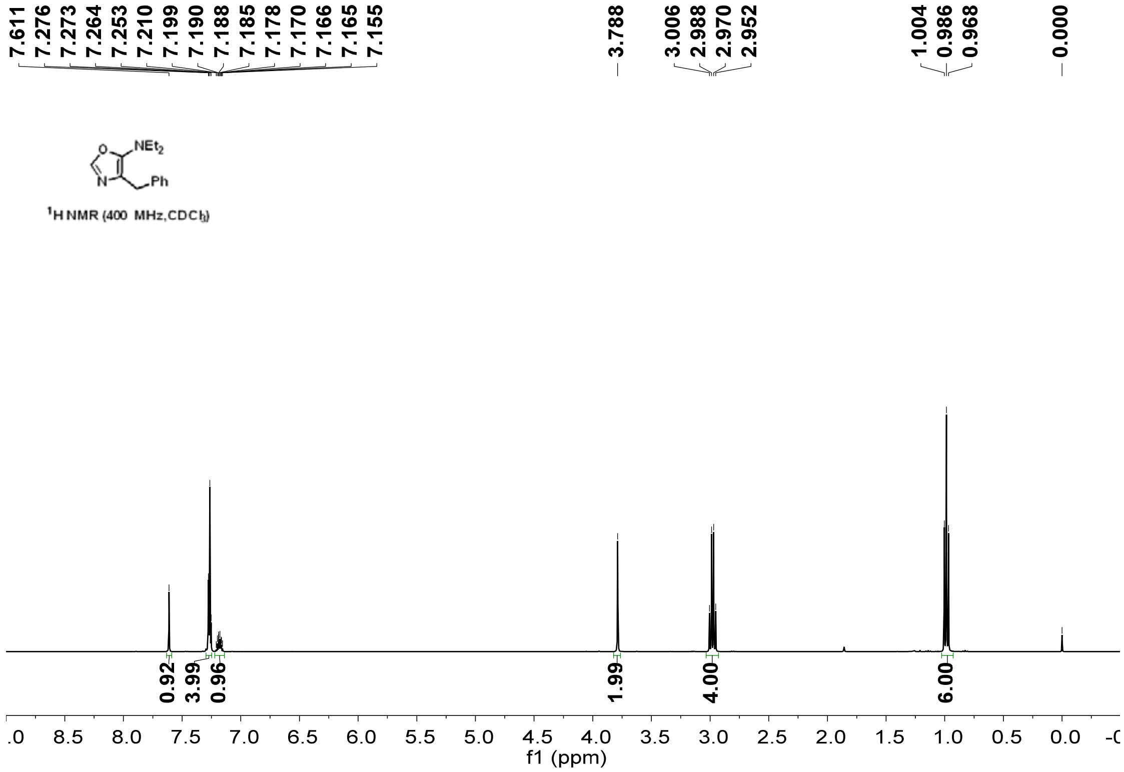
7.842
7.833
7.826
7.806
7.698
7.573
7.569
7.555
7.552
7.493
7.488
7.479
7.475
7.471
7.463
7.455
7.446
7.244
3.041
3.023
3.005
2.987
0.989
0.972
0.954
-0.000
NEt2
1H NMR (400 MHz,CDCl3)
0.97
0.97
0.99
0.81
0.99
2.99
4.00
6.00
f1 (ppm)

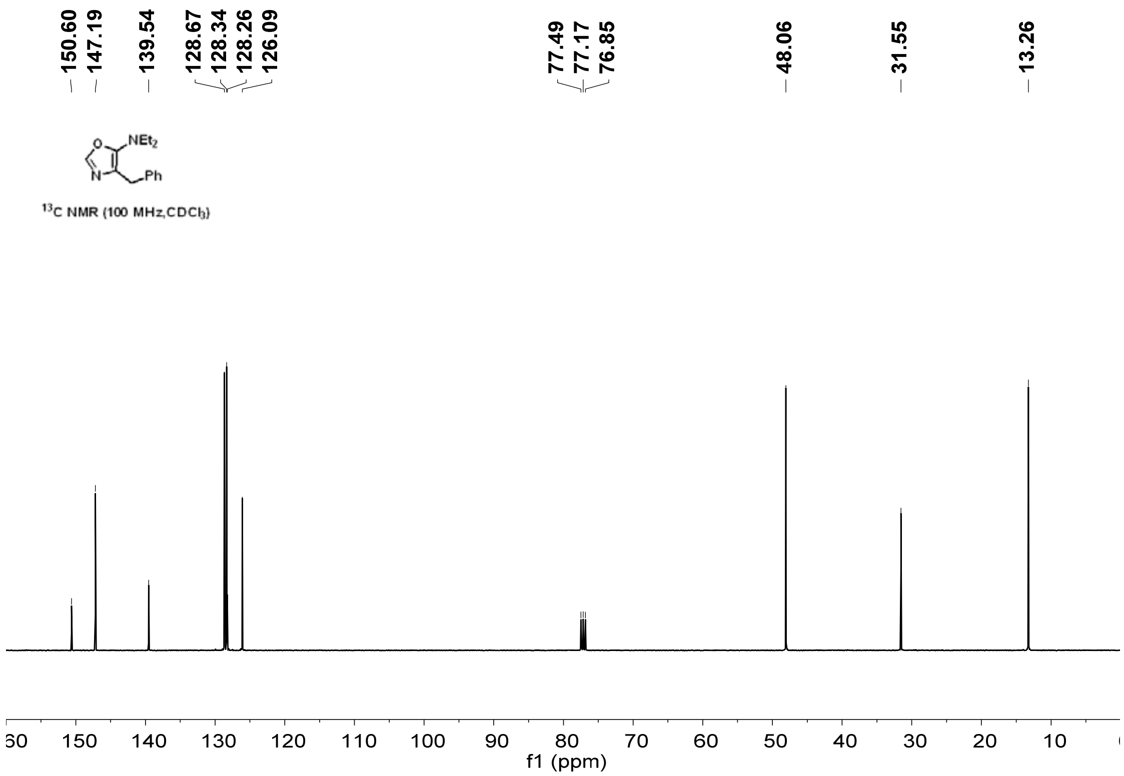

152.16
144.13
133.78
132.15
130.19
128.19
128.11
127.82
126.25
125.93
125.71
125.09
119.50
77.35
77.04
76.72
45.66
13.24
NEt2
O
N
13C NMR (100 MHz,CDCl3)
60 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

1k

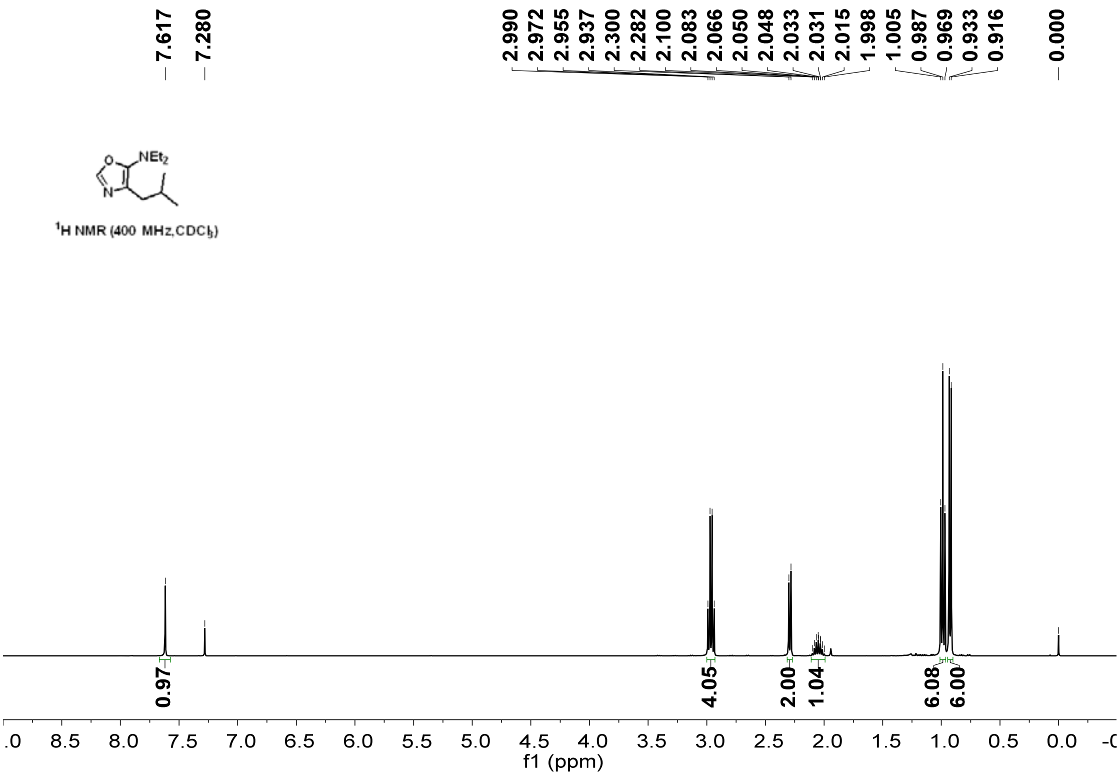

7.731
7.728
7.724
7.721
7.697
7.694
7.684
7.331
7.323
7.318
7.311
7.261
3.108
3.090
3.072
3.054
1.062
1.044
1.026
0.000
NEt2
O
N
S
1H NMR (400 MHz,CDCl3)
0.91
1.90
0.97
4.03
6.10
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

1l

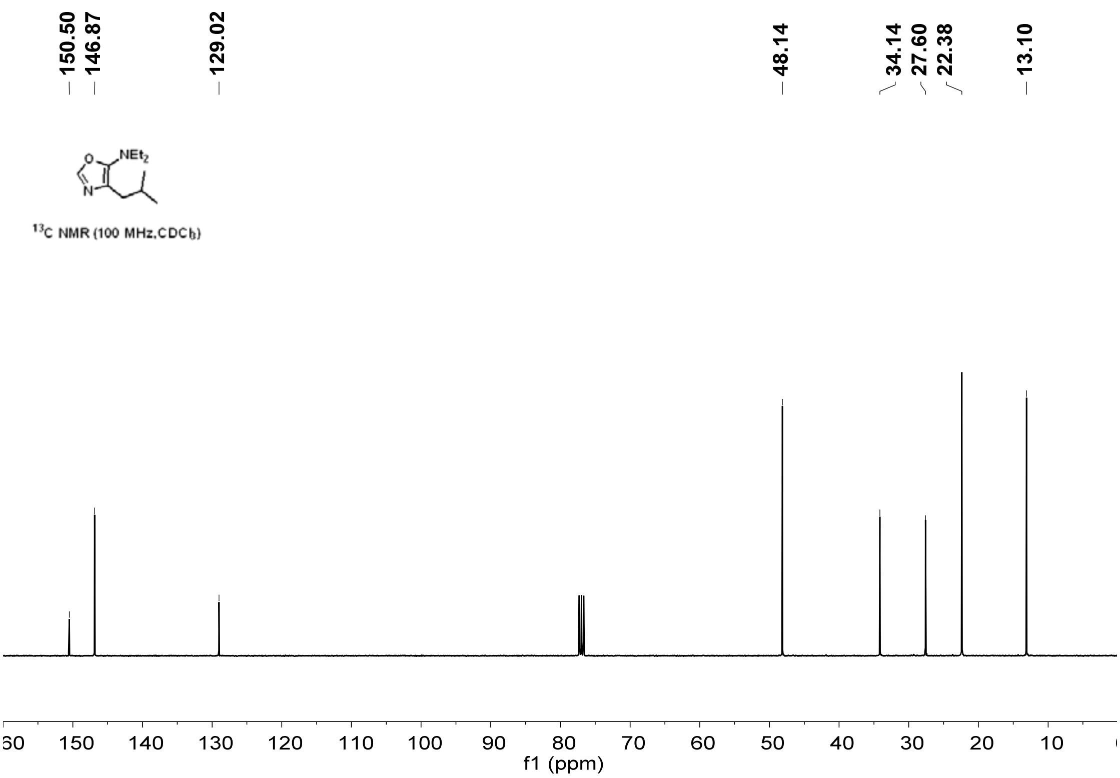

7.611
7.276
7.273
7.264
7.253
7.210
7.199
7.190
7.188
7.185
7.178
7.170
7.166
7.165
7.155
3.788
3.006
2.988
2.970
2.952
1.004
0.986
0.968
0.000
NEt2
Ph
O
N
1H NMR (400 MHz,CDCl3)
0.92
3.99
0.96
1.99
4.00
6.00
f1 (ppm)


150.60
147.19
139.54
128.67
128.34
128.26
126.09
77.49
77.17
76.85
48.06
31.55
13.26
NEt2
Ph
O
N
13C NMR (100 MHz,CDCl3)
f1 (ppm)

1m

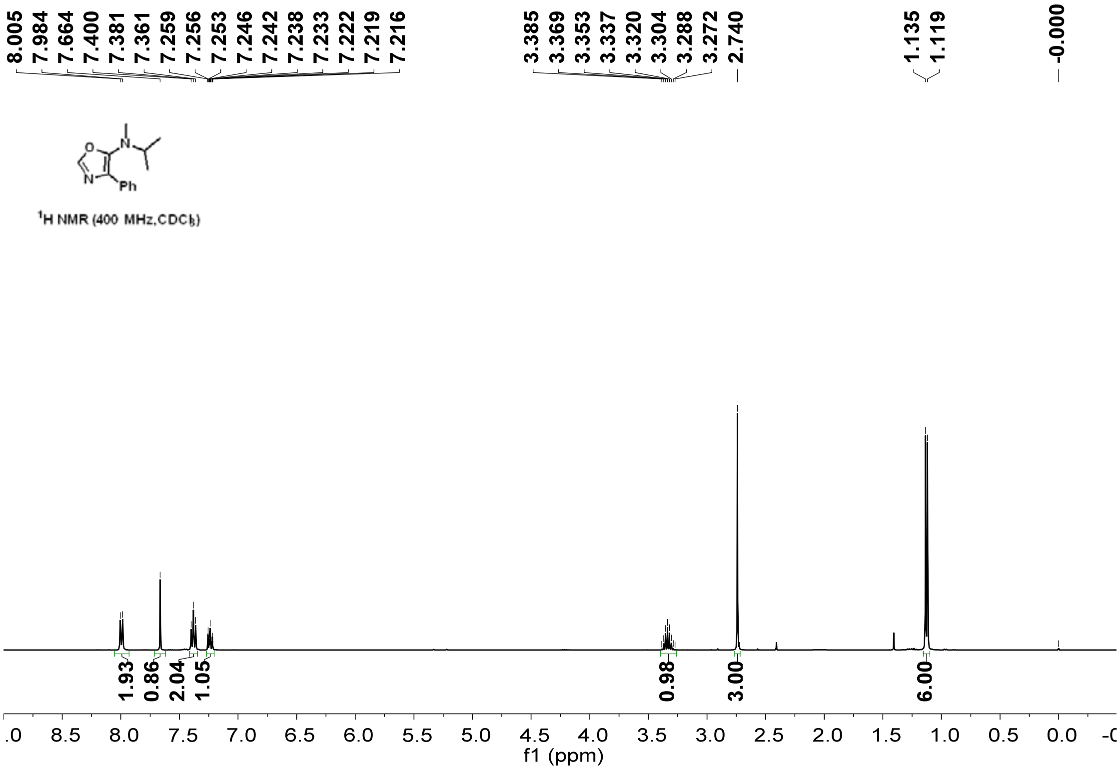


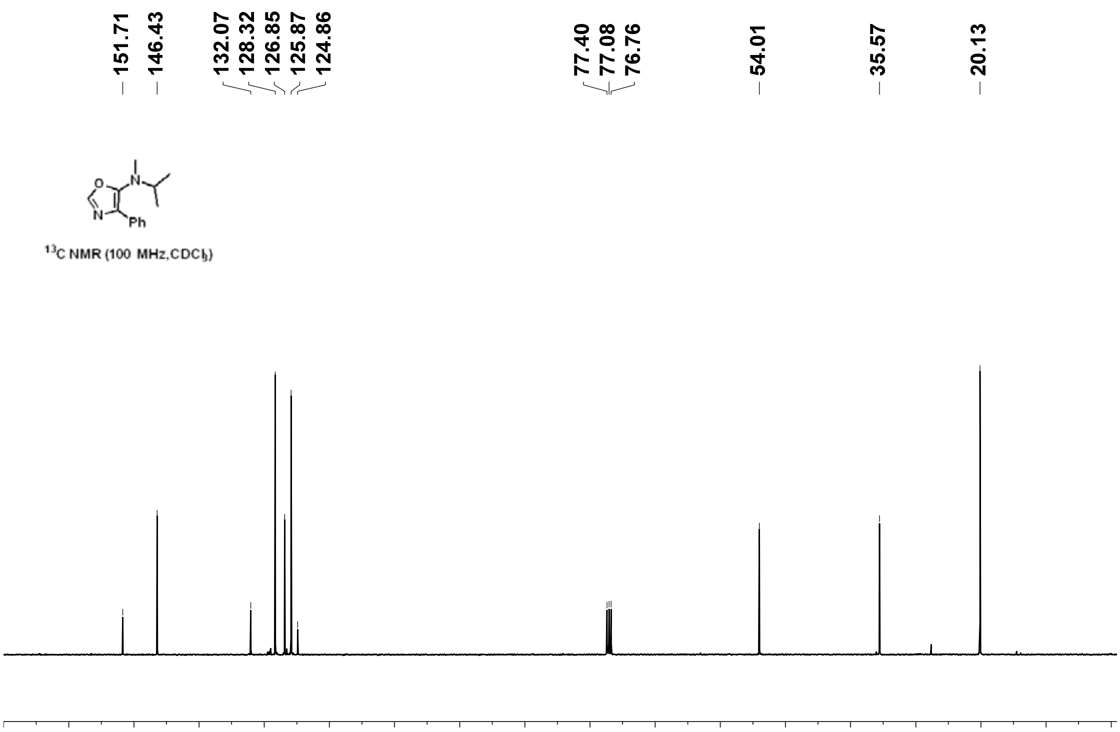
7.617
7.280
2.990
2.972
2.955
2.937
2.300
2.282
2.100
2.083
2.066
2.050
2.048
2.033
2.031
2.015
1.998
1.005
0.987
0.969
0.933
0.916
0.000
NEt2
O
N
1H NMR (400 MHz,CDCl3)
0.97
4.05
2.00
1.04
6.08
6.00
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)



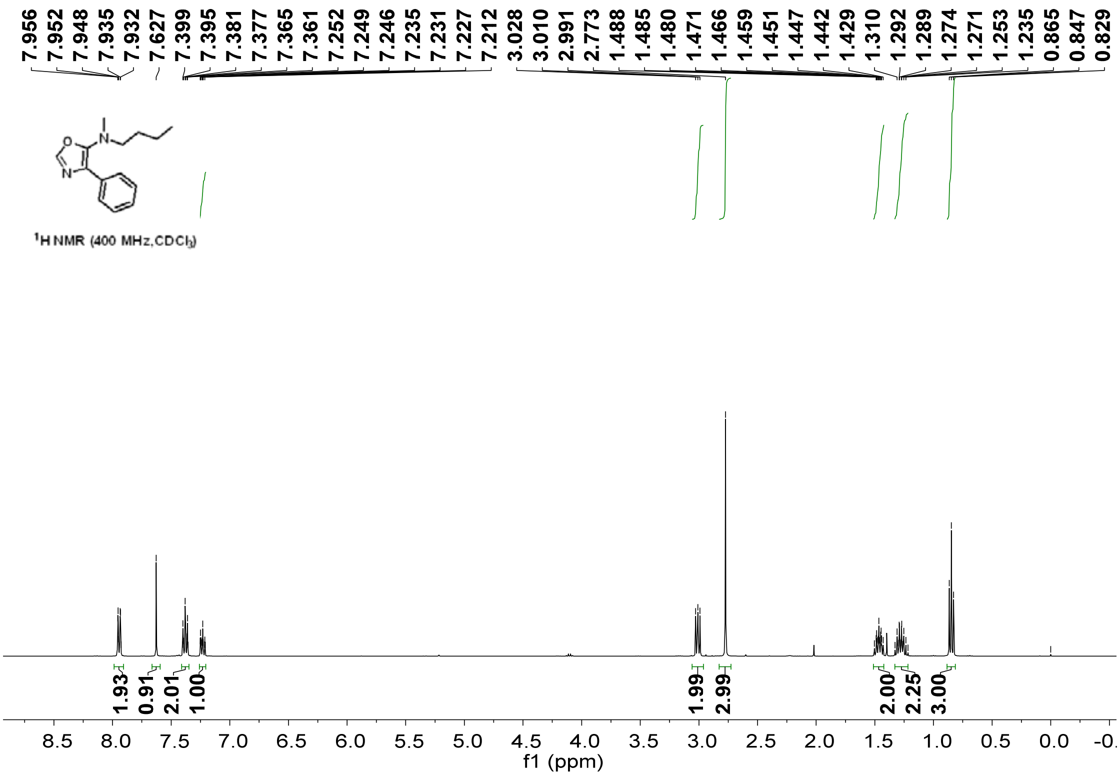
150.50
146.87
129.02
48.14
34.14
27.60
22.38
13.10
NEt2
O
N
13C NMR (100 MHz,CDCl3)
60 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

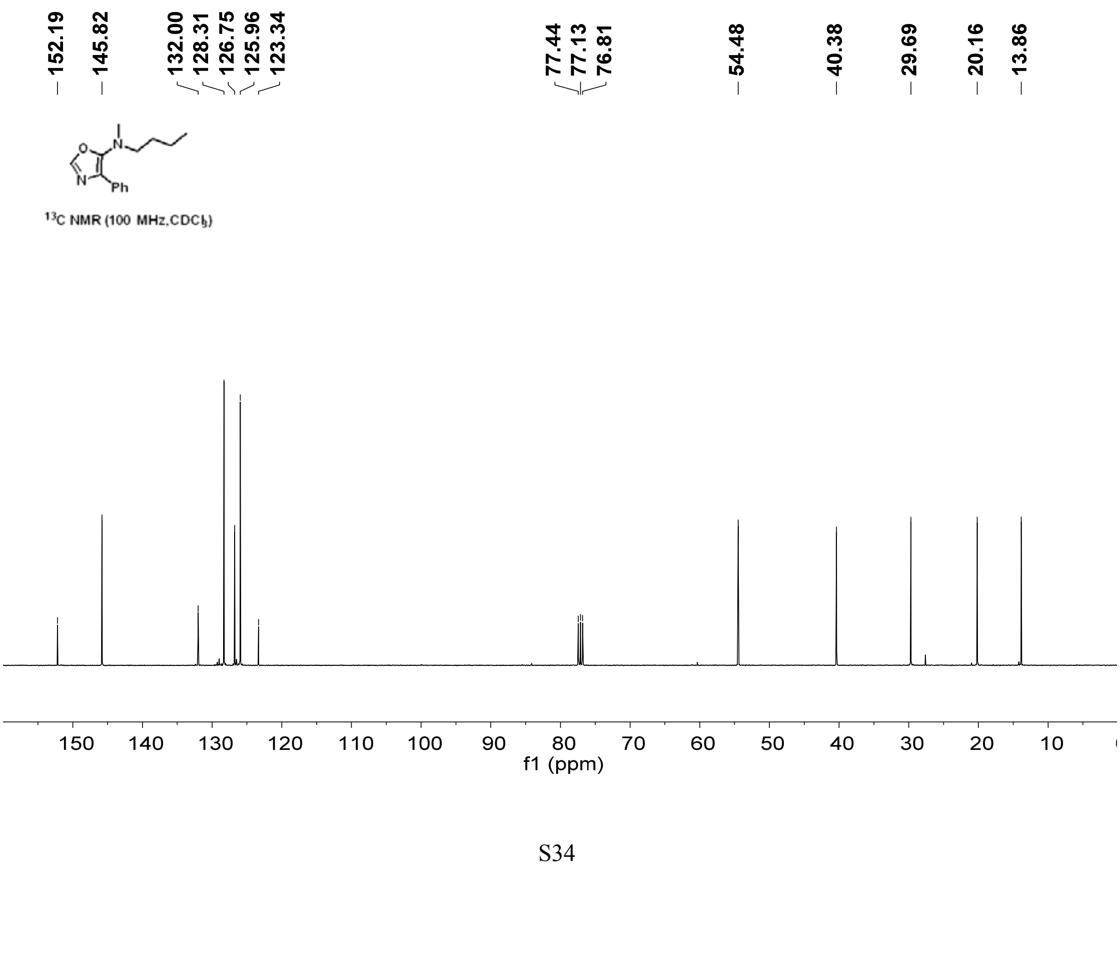
1n


8.005
7.984
7.664
7.400
7.381
7.361
7.259
7.256
7.253
7.246
7.242
7.238
7.233
7.222
7.219
7.216
3.385
3.369
3.353
3.337
3.320
3.304
3.288
3.272
2.740
1.135
1.119
-0.000
O
N
Ph
^{1}H NMR (400 MHz,CDCl$_3$)
1.93
0.86
2.04
1.05
0.98
3.00
6.00
f1 (ppm)

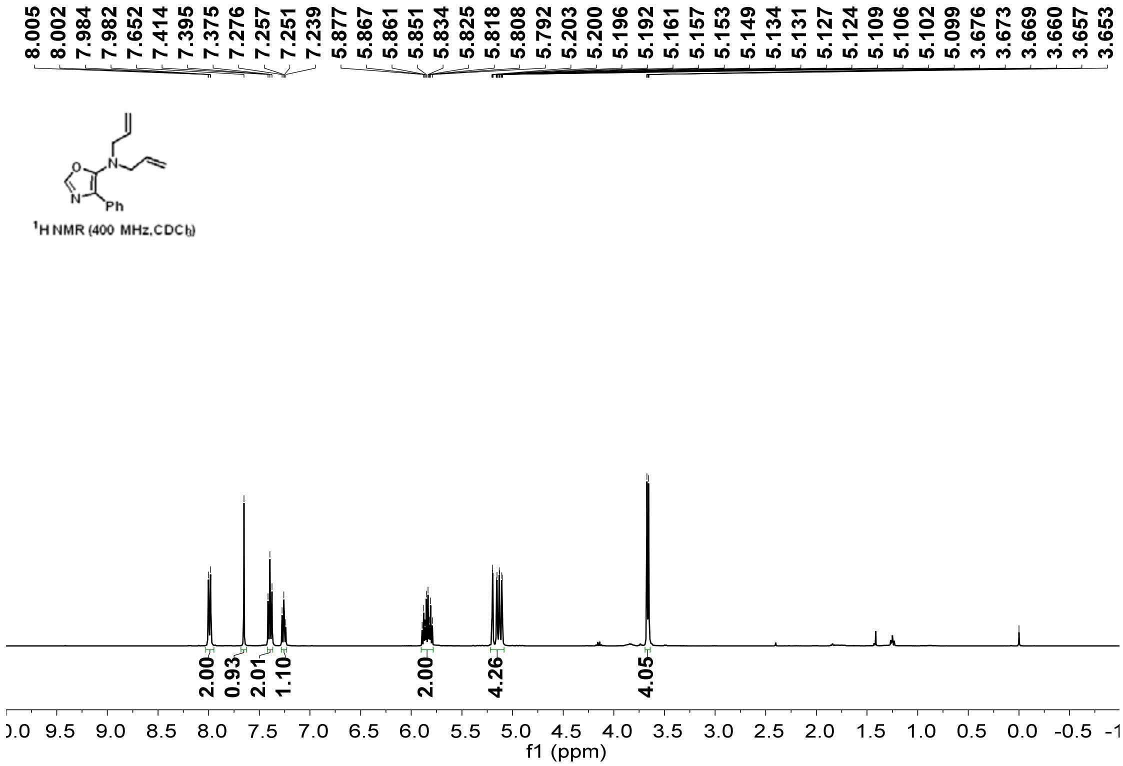

151.71
146.43
132.07
128.32
126.85
125.87
124.86
77.40
77.08
76.76
54.01
35.57
20.13
O
N
Ph
^{13}C NMR (100 MHz,CDCl$_3$)
f1 (ppm)

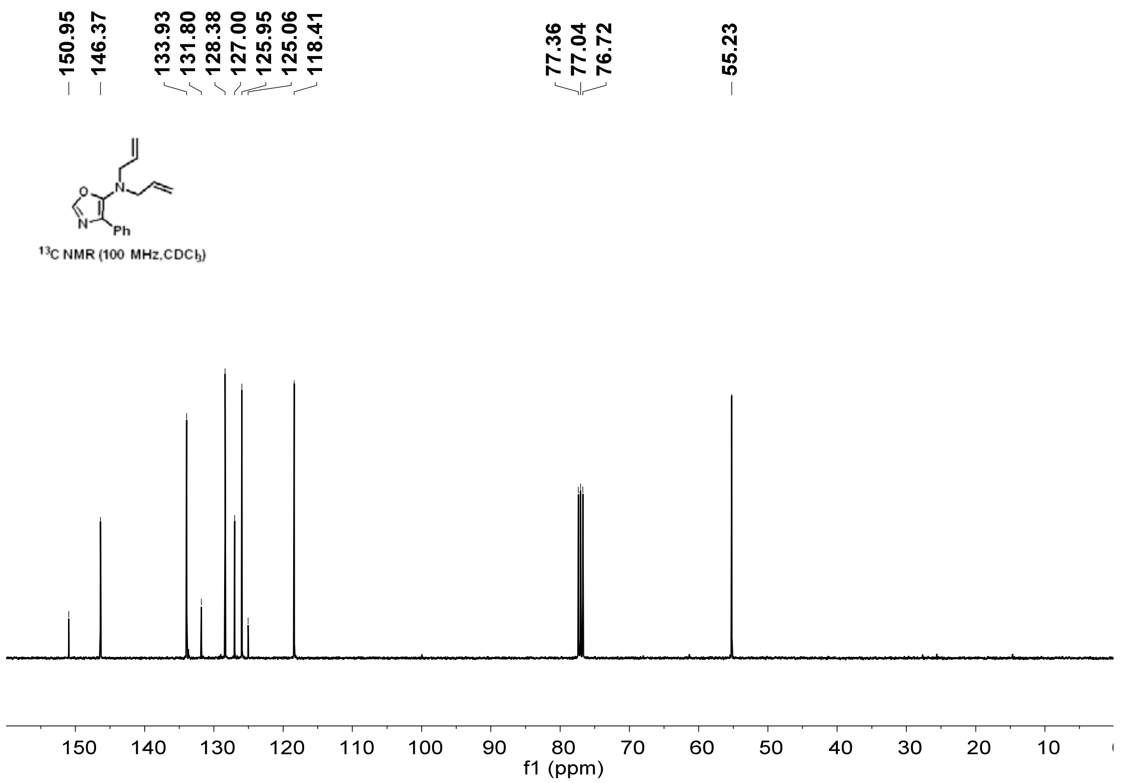
1o


7.956
7.952
7.948
7.935
7.932
7.627
7.399
7.395
7.381
7.377
7.365
7.361
7.252
7.249
7.246
7.235
7.231
7.227
7.212
3.028
3.010
2.991
2.773
1.488
1.485
1.480
1.471
1.466
1.459
1.451
1.447
1.442
1.429
1.310
1.292
1.289
1.274
1.271
1.253
1.235
0.865
0.847
0.829
^{1}H NMR (400 MHz,CDCl$_3$)
1.93
0.91
2.01
1.00
1.99
2.99
2.00
2.25
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

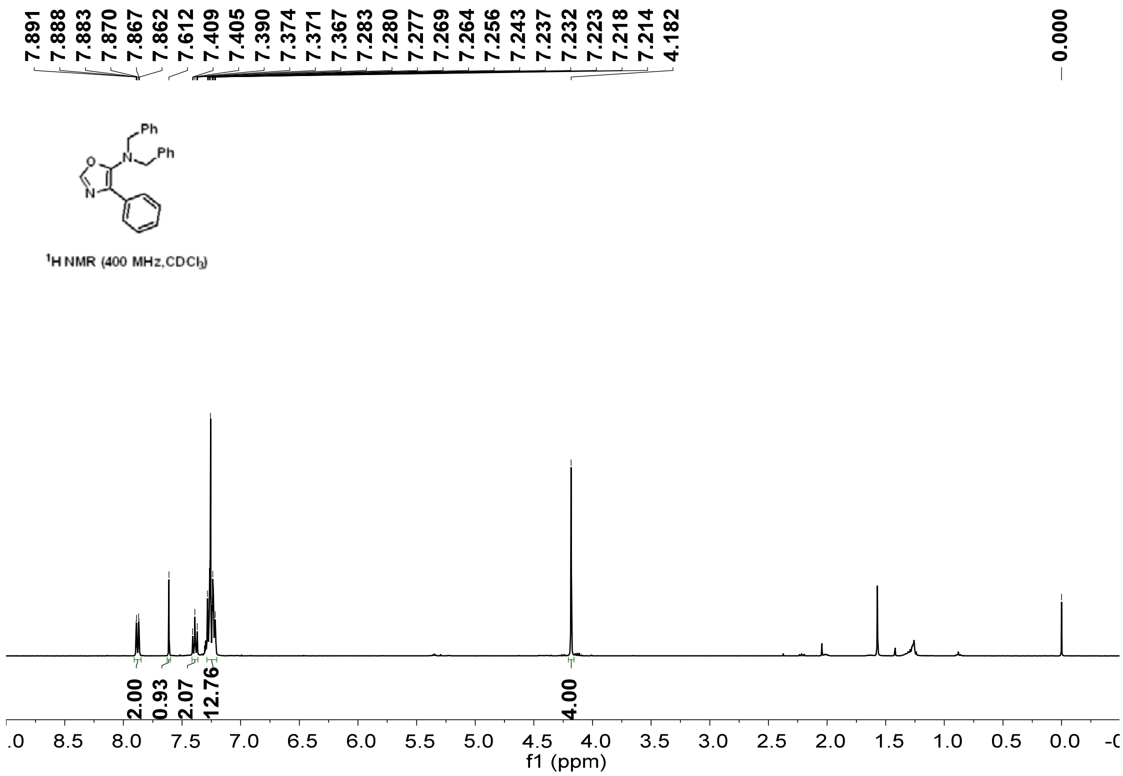

152.19
145.82
132.00
128.31
126.75
125.96
123.34
77.44
77.13
76.81
54.48
40.38
29.69
20.16
13.86
Ph
^{13}C NMR (100 MHz,CDCl$_3$)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

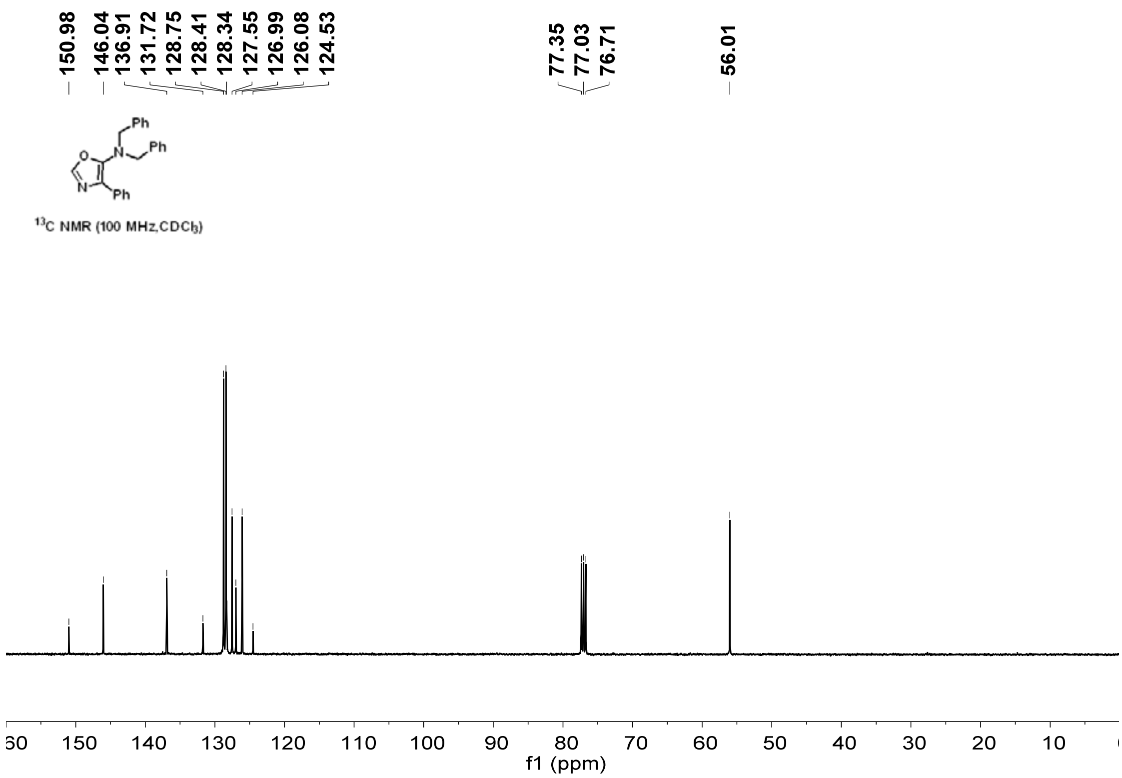
1p


8.005
8.002
7.984
7.982
7.652
7.414
7.395
7.375
7.276
7.257
7.251
7.239
5.877
5.867
5.861
5.851
5.834
5.825
5.818
5.808
5.792
5.203
5.200
5.196
5.192
5.161
5.157
5.153
5.149
5.134
5.131
5.127
5.124
5.109
5.106
5.102
5.099
3.676
3.673
3.669
3.660
3.657
3.653
O
N
N
Ph
1H NMR (400 MHz,CDCl3)
2.00
0.93
2.01
1.10
2.00
4.26
4.05
f1 (ppm)

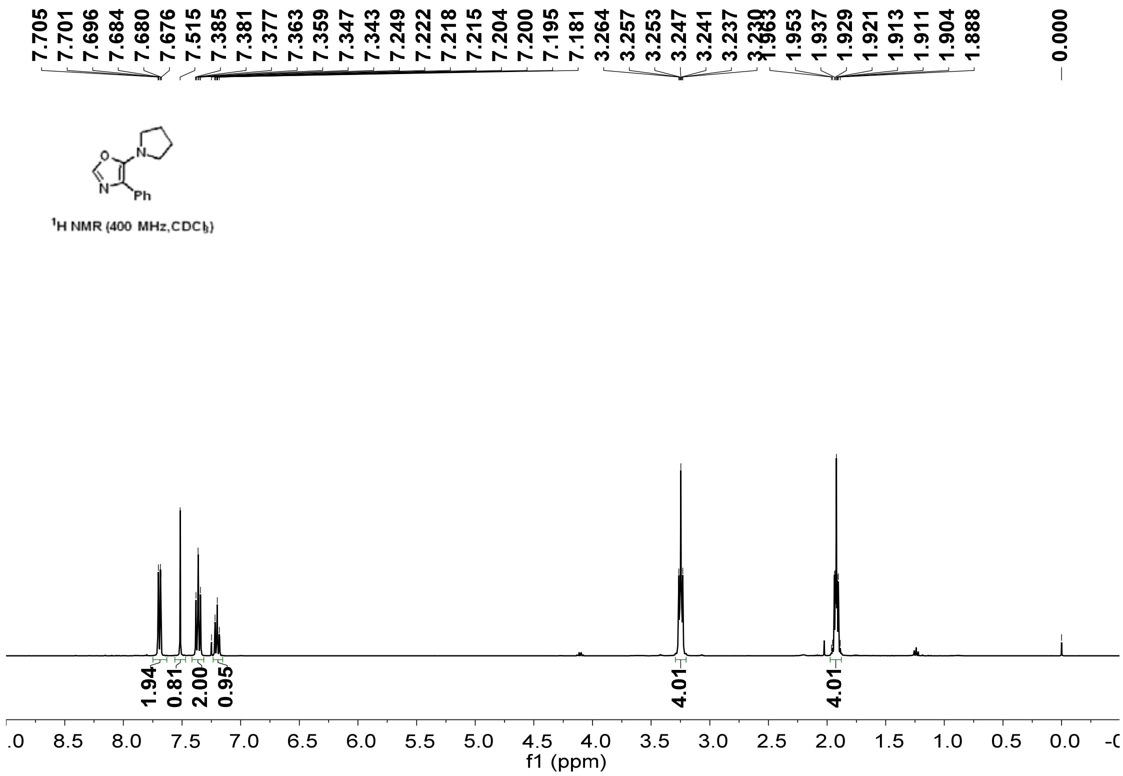

150.95
146.37
133.93
131.80
128.38
127.00
125.95
125.06
118.41
77.36
77.04
76.72
55.23
O
N
N
Ph
13C NMR (100 MHz,CDCl3)
f1 (ppm)

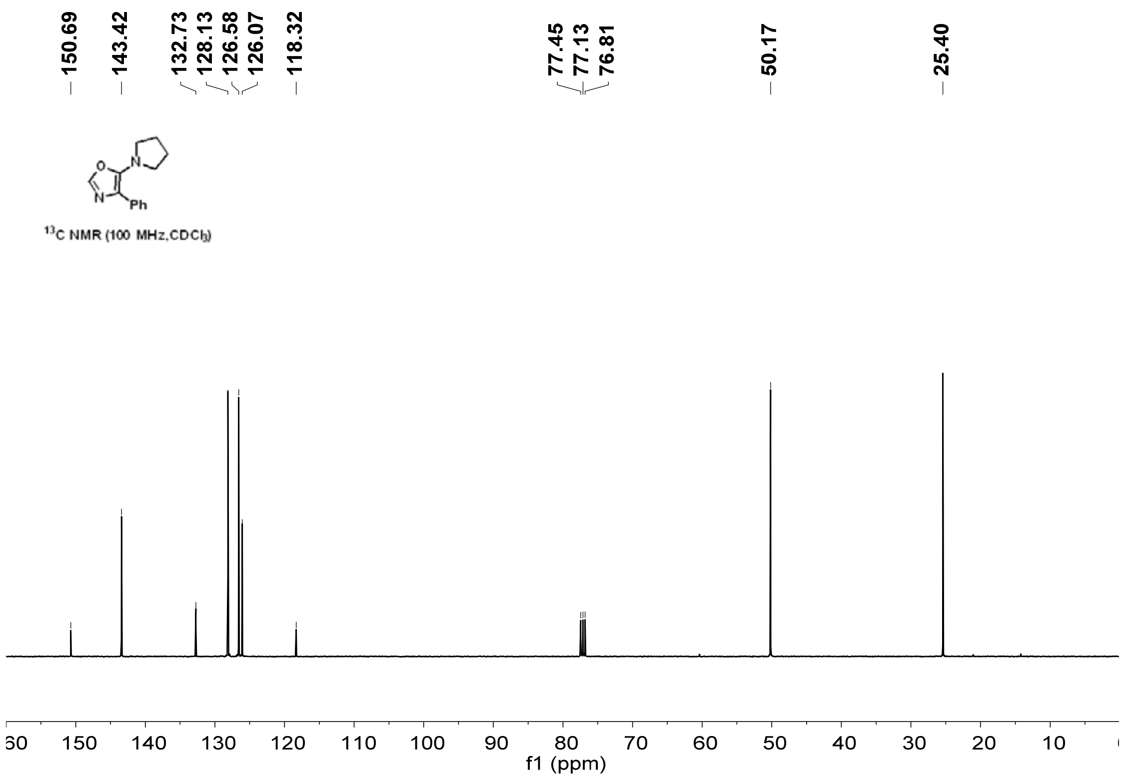
1q


7.891 7.888 7.883 7.870 7.867 7.862 7.612 7.409 7.405 7.390 7.374 7.371 7.367 7.283 7.280 7.277 7.269 7.264 7.256 7.243 7.237 7.232 7.223 7.218 7.214 4.182
0.000
Ph
N
Ph
O
N
^{1}H NMR (400 MHz,CDCl$_3$)
2.00
0.93
2.07
12.76
4.00
f1 (ppm)

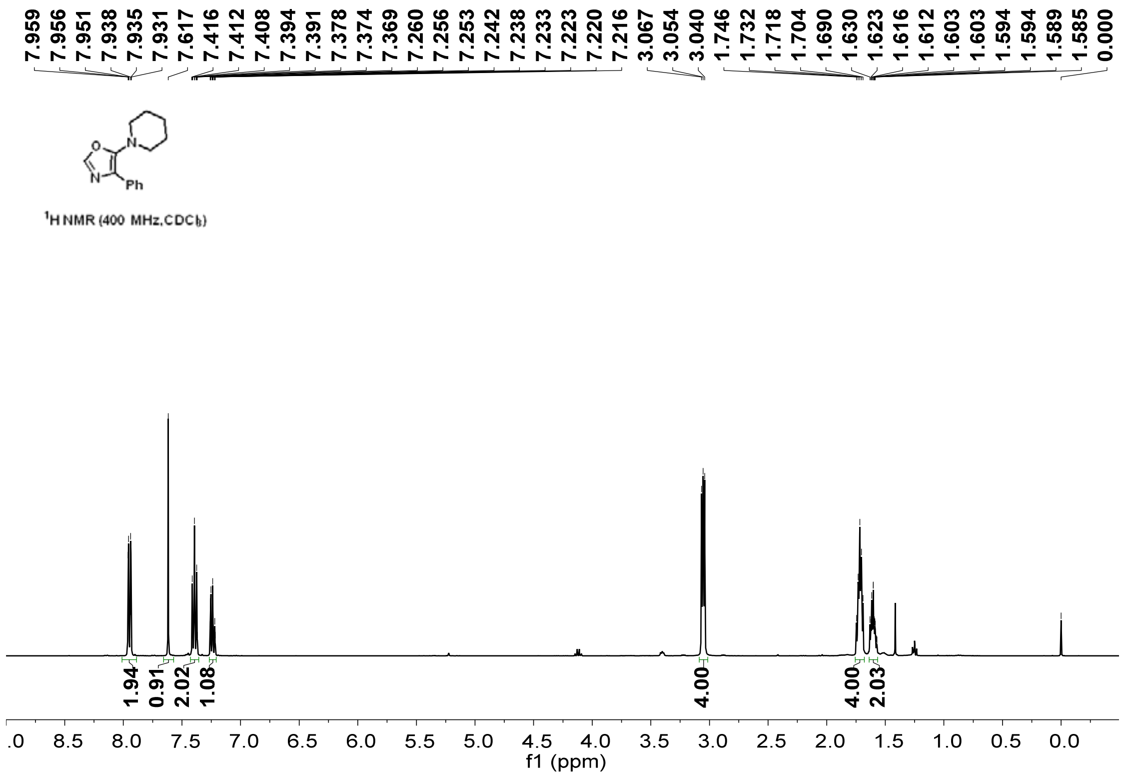

150.98
146.04 136.91 131.72 128.75 128.41 128.34 127.55 126.99 126.08 124.53
77.35 77.03 76.71
56.01
Ph
N
Ph
O
N
Ph
^{13}C NMR (100 MHz,CDCl$_3$)
f1 (ppm)

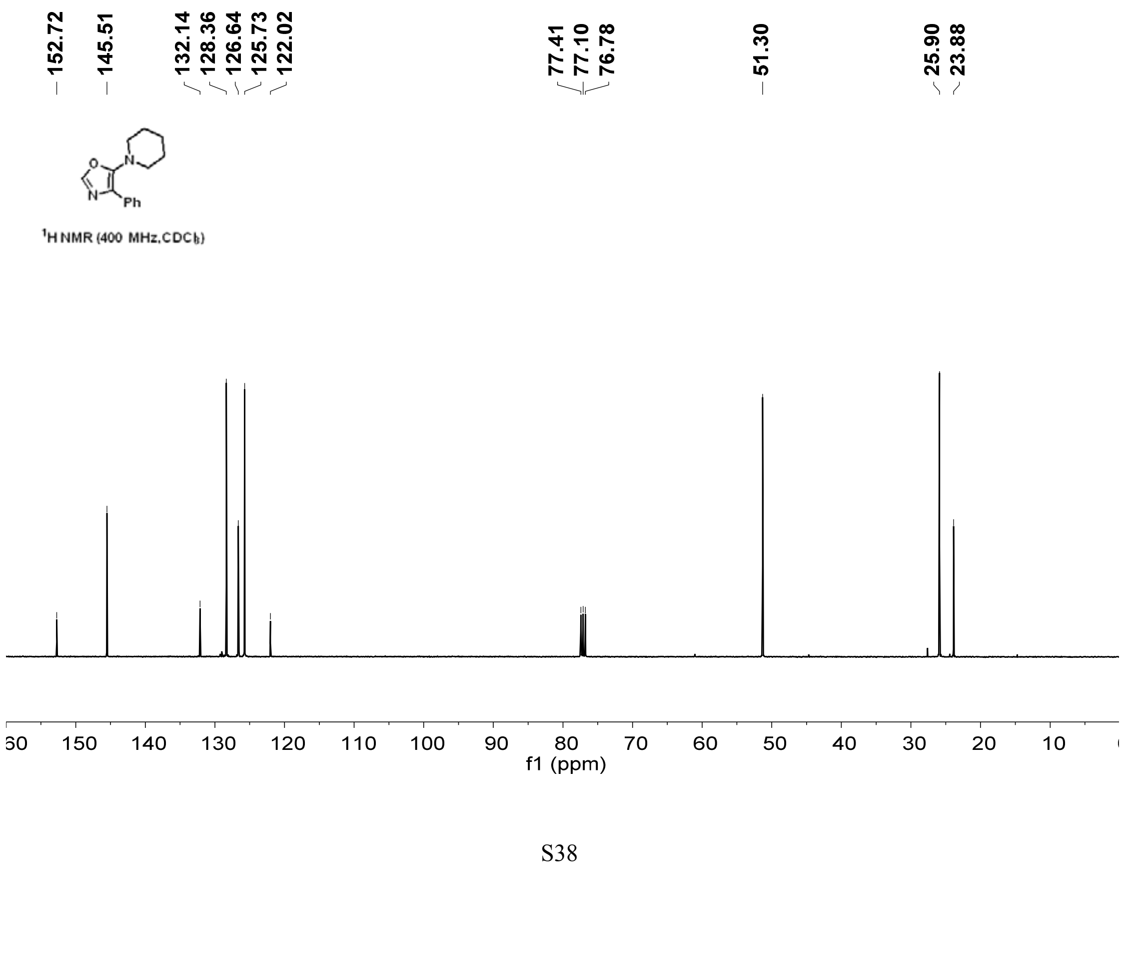
1r


7.705 7.701 7.696 7.684 7.680 7.676 7.515 7.385 7.381 7.377 7.363 7.359 7.347 7.343 7.249 7.222 7.218 7.215 7.204 7.200 7.195 7.181 3.264 3.257 3.253 3.247 3.241 3.237 1.953 1.937 1.929 1.921 1.913 1.911 1.904 1.888 0.000
O
N
N
Ph
1H NMR (400 MHz,CDCl3)
1.94 0.81 2.00 0.95
4.01
4.01
f1 (ppm)

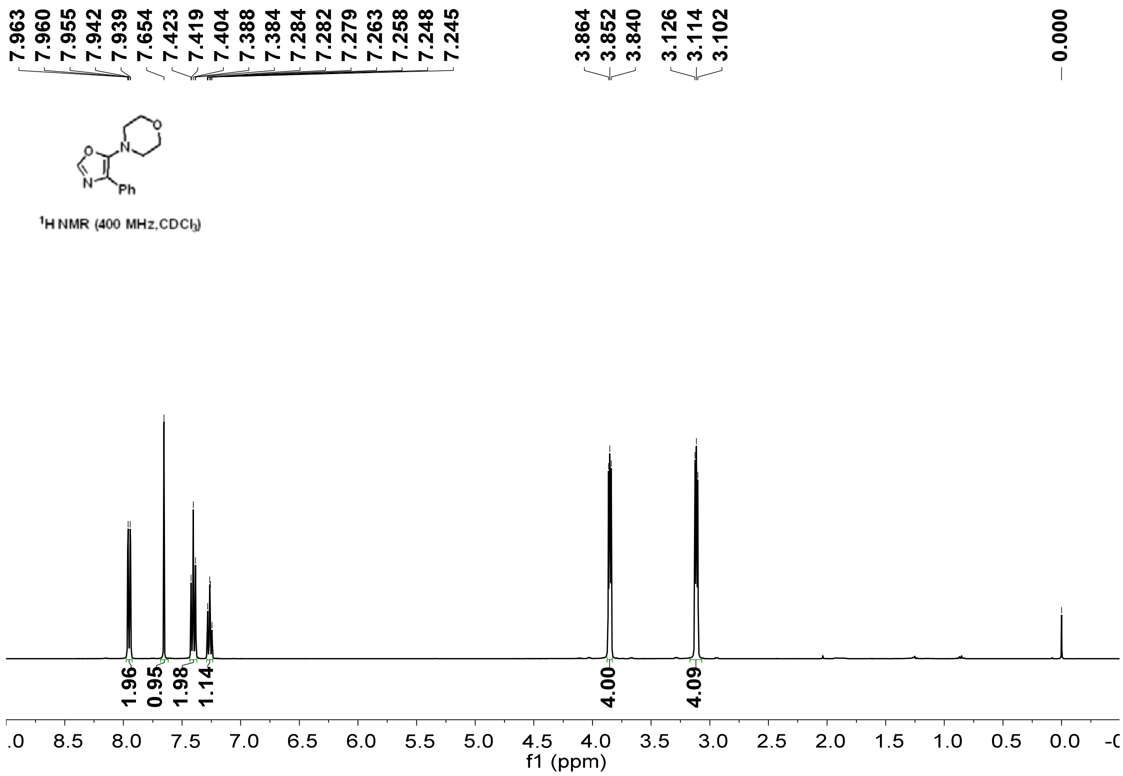

150.69 143.42 132.73 128.13 126.58 126.07 118.32 77.45 77.13 76.81 50.17 25.40
O
N
N
Ph
13C NMR (100 MHz,CDCl3)
f1 (ppm)

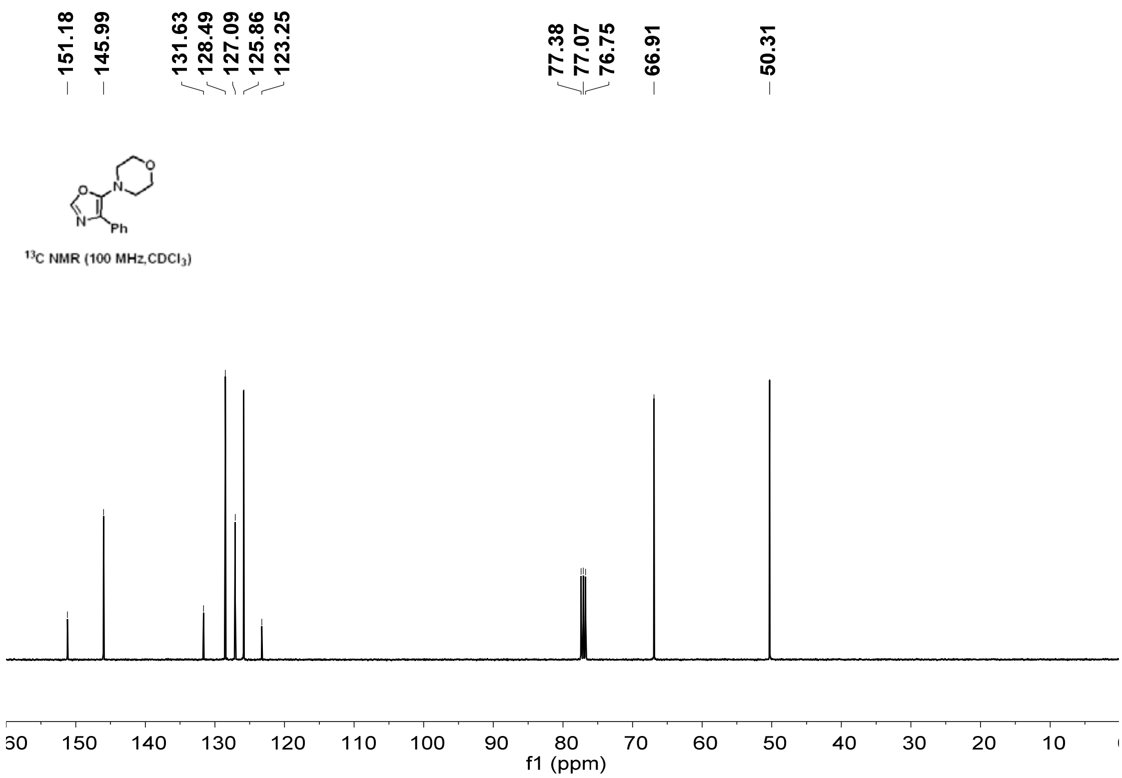
1s


7.959 7.956 7.951 7.938 7.935 7.931 7.617 7.416 7.412 7.408 7.394 7.391 7.378 7.374 7.369 7.260 7.256 7.253 7.242 7.238 7.233 7.223 7.220 7.216 3.067 3.054 3.040 1.746 1.732 1.718 1.704 1.690 1.630 1.623 1.616 1.612 1.603 1.603 1.594 1.594 1.589 1.585 0.000
Ph
O
N
^{1}H NMR (400 MHz,CDCl$_3$)
1.94 0.91 2.02 1.08
4.00
4.00 2.03
f1 (ppm)

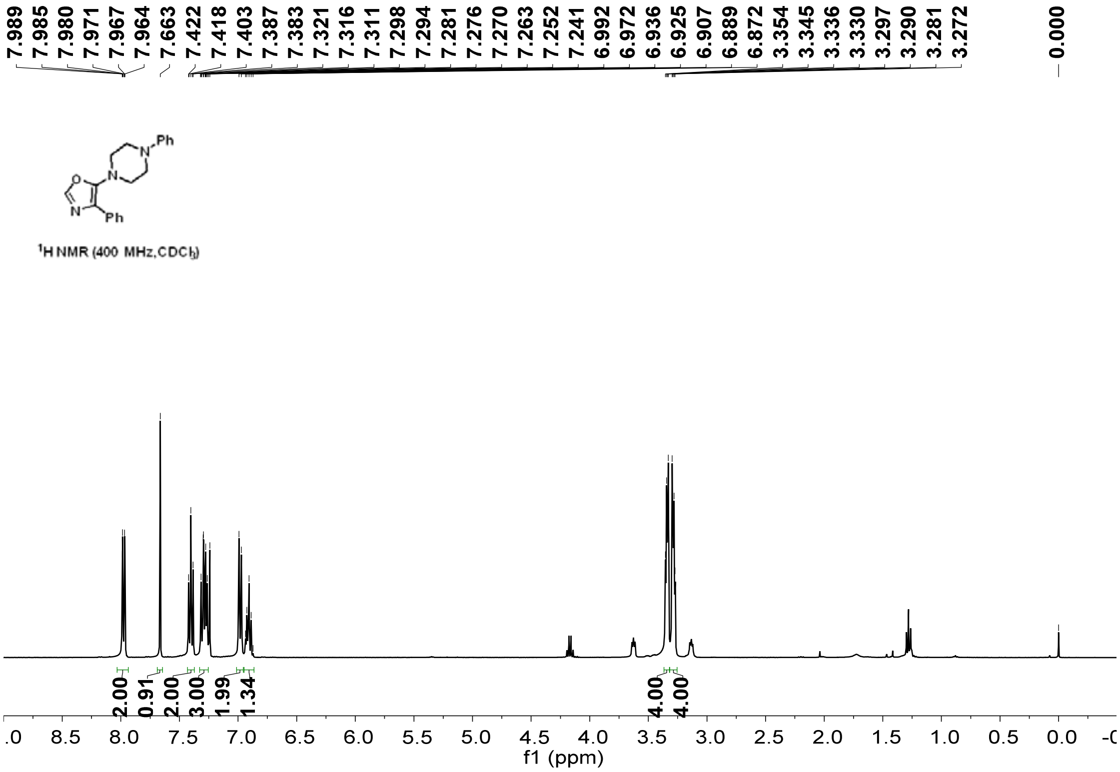

152.72 145.51 132.14 128.36 126.64 125.73 122.02 77.41 77.10 76.78 51.30 25.90 23.88
Ph
O
N
^{1}H NMR (400 MHz,CDCl$_3$)
f1 (ppm)

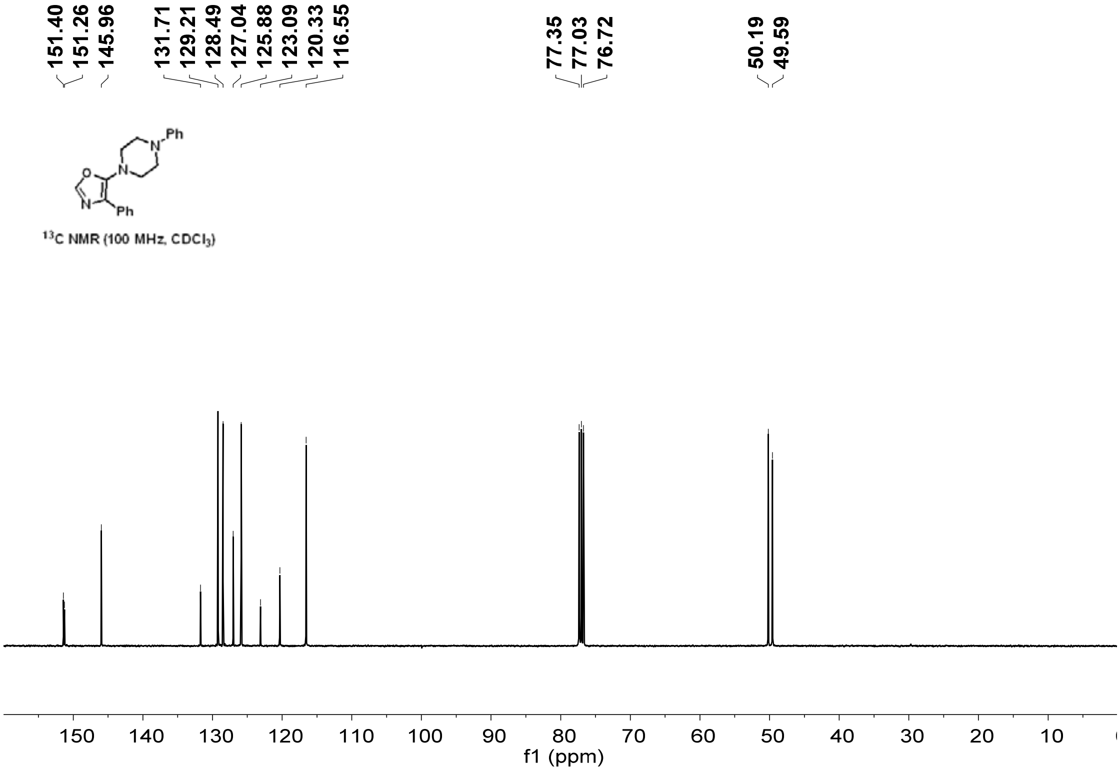
1t


7.963
7.960
7.955
7.942
7.939
7.654
7.423
7.419
7.404
7.388
7.384
7.284
7.282
7.279
7.263
7.258
7.248
7.245
3.864
3.852
3.840
3.126
3.114
3.102
0.000
O
N
N
Ph
¹H NMR (400 MHz,CDCl₃)
1.96
0.95
1.98
1.14
4.00
4.09
f1 (ppm)


151.18
145.99
131.63
128.49
127.09
125.86
123.25
77.38
77.07
76.75
66.91
50.31
O
N
N
Ph
¹³C NMR (100 MHz,CDCl₃)
f1 (ppm)

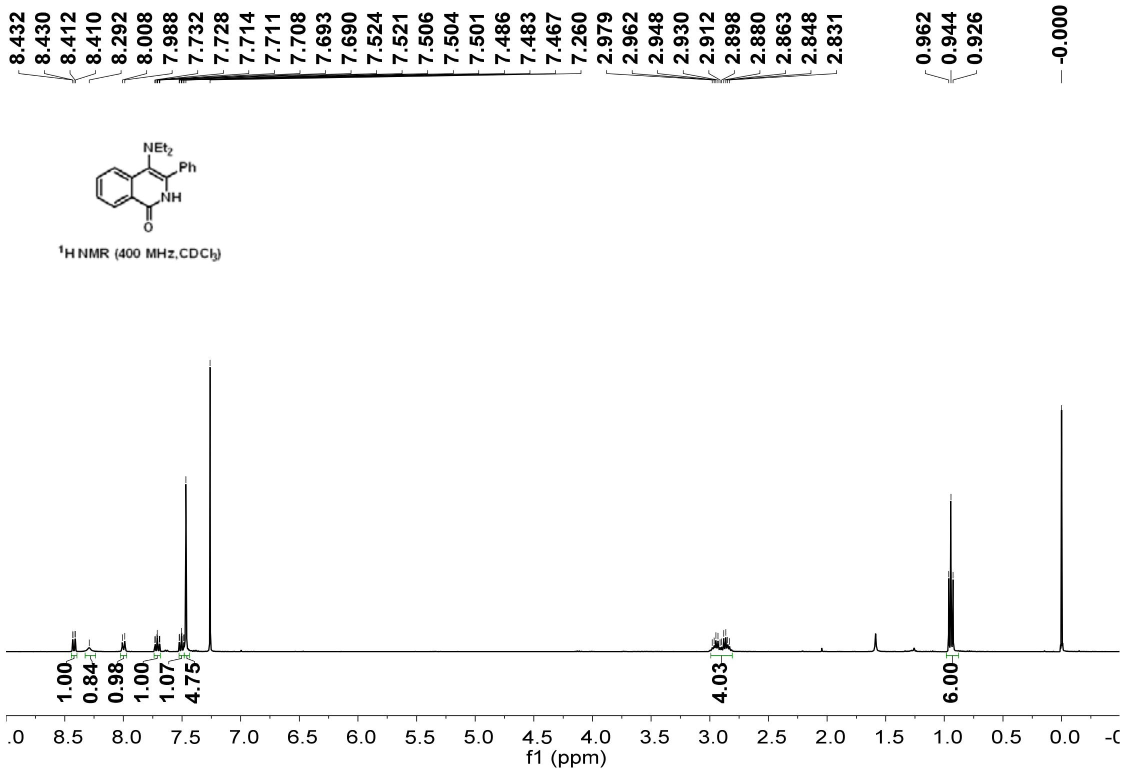
1u

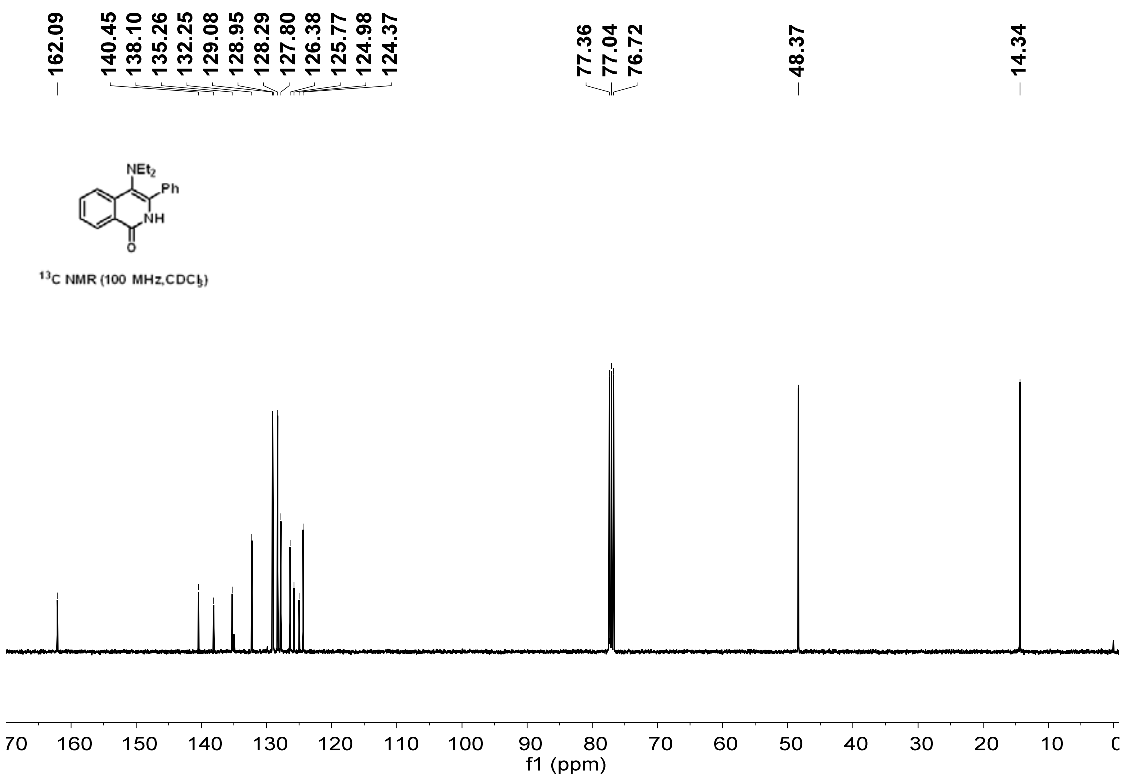

7.989
7.985
7.980
7.971
7.967
7.964
7.663
7.422
7.418
7.403
7.387
7.383
7.321
7.316
7.311
7.298
7.294
7.281
7.276
7.270
7.263
7.252
7.241
6.992
6.972
6.936
6.925
6.907
6.889
6.872
3.354
3.345
3.336
3.330
3.297
3.290
3.281
3.272
0.000
Ph
O
N
N
N
Ph
1H NMR (400 MHz, CDCl3)
2.00
0.91
2.00
3.00
1.99
1.34
4.00
4.00
f1 (ppm)


151.40
151.26
145.96
131.71
129.21
128.49
127.04
125.88
123.09
120.33
116.55
77.35
77.03
76.72
50.19
49.59
Ph
O
N
N
N
Ph
13C NMR (100 MHz, CDCl3)
f1 (ppm)

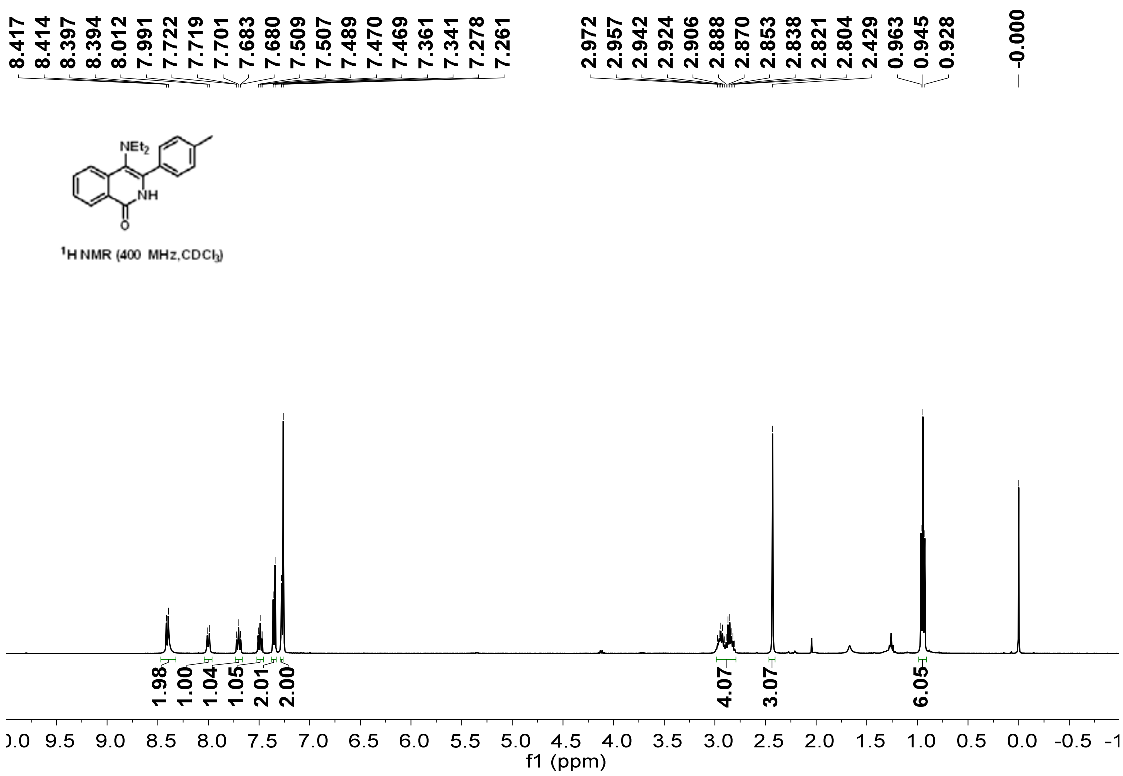
3.2 Copies of NMR spectra of products:

3aa

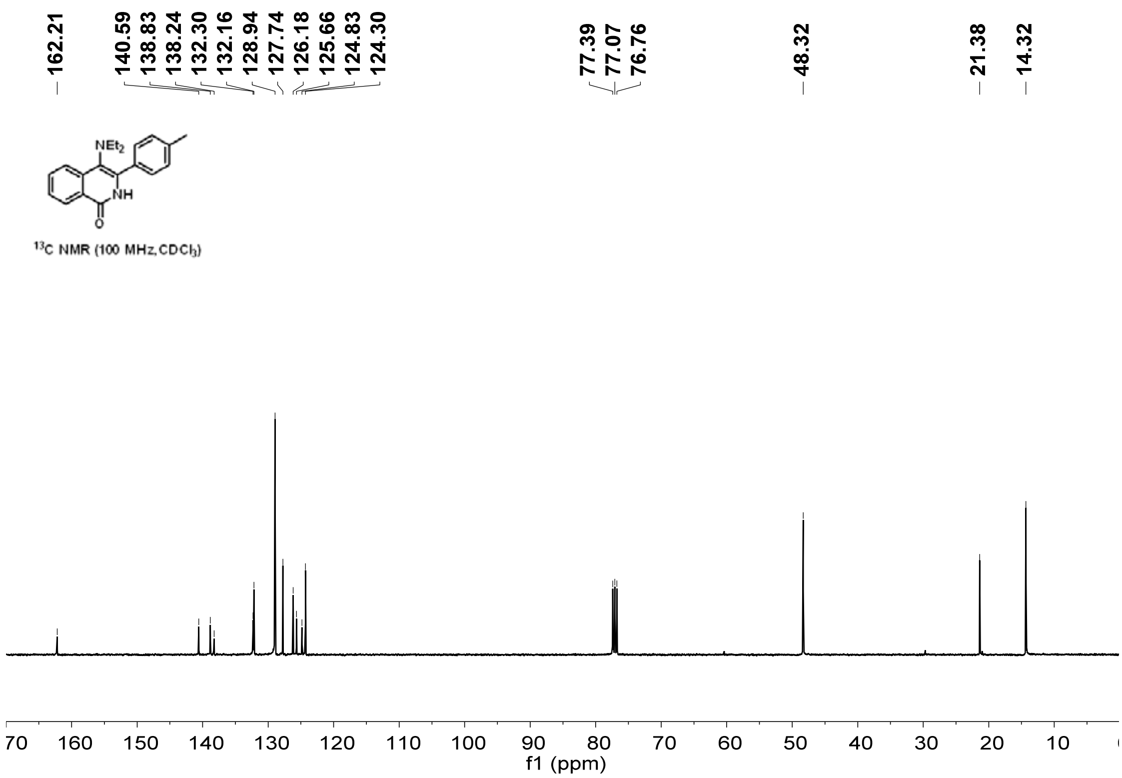




3ba

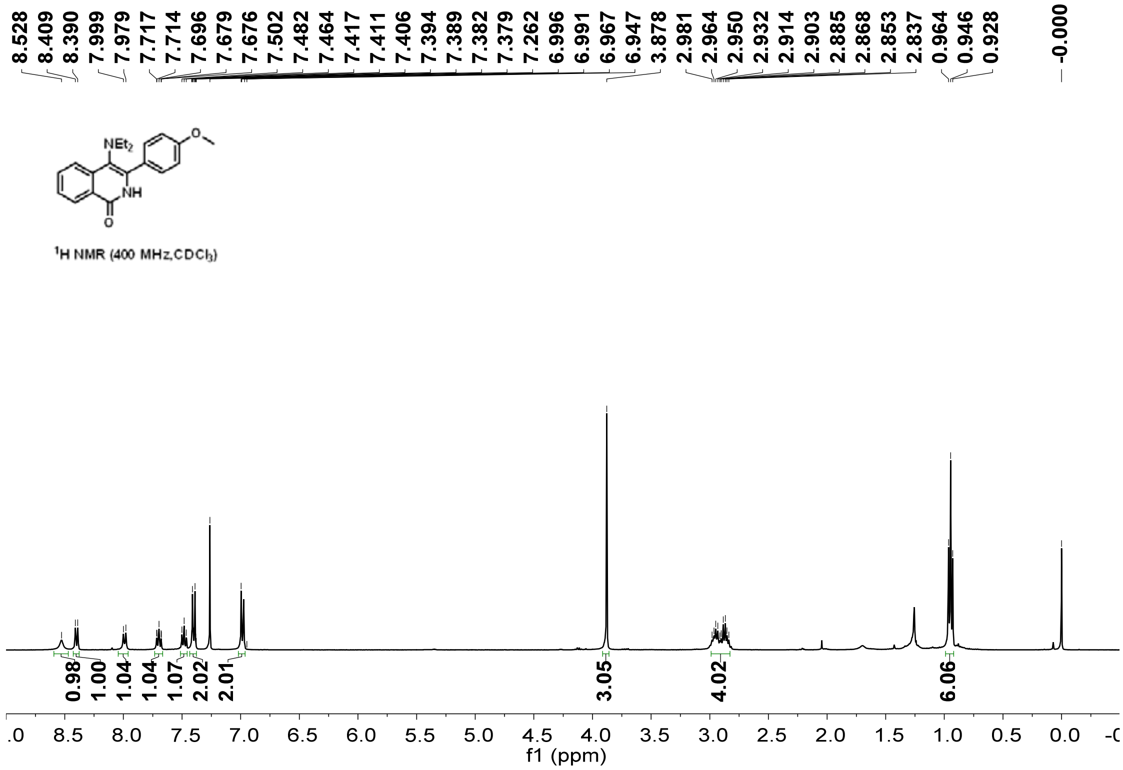


8.417
8.414
8.397
8.394
8.012
7.991
7.722
7.719
7.701
7.683
7.680
7.509
7.507
7.489
7.470
7.469
7.361
7.341
7.278
7.261
2.972
2.957
2.942
2.924
2.906
2.888
2.870
2.853
2.838
2.821
2.804
2.429
0.963
0.945
0.928
-0.000
NEt2
NH
O
1H NMR (400 MHz,CDCl3)
1.98
1.00
1.04
1.05
2.01
2.00
4.07
3.07
6.05
f1 (ppm)

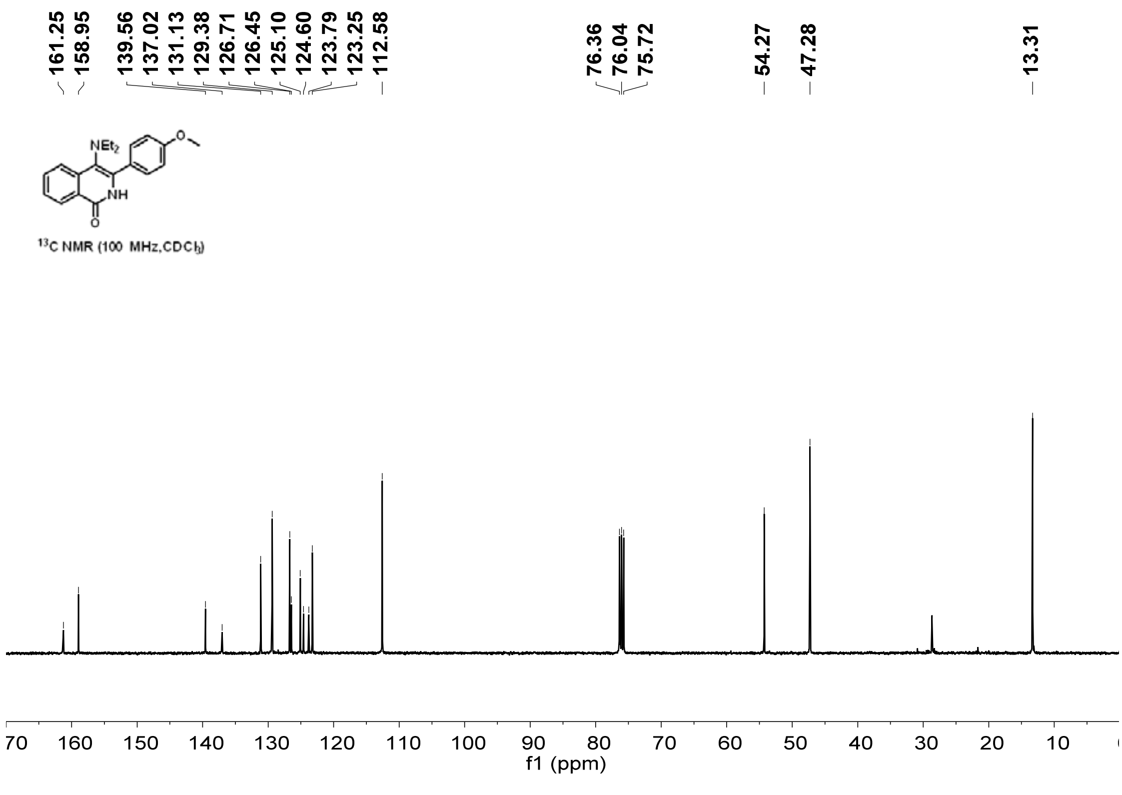


162.21
140.59
138.83
138.24
132.30
132.16
128.94
127.74
126.18
125.66
124.83
124.30
77.39
77.07
76.76
48.32
21.38
14.32
NEt2
NH
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

3ca

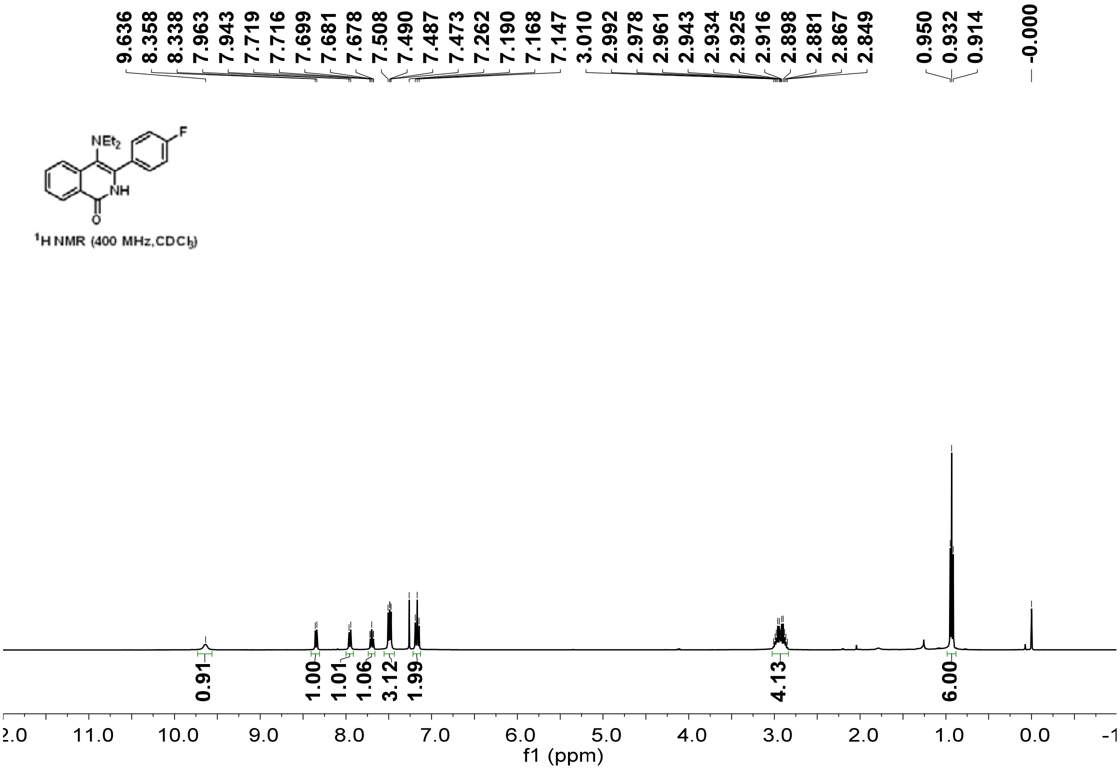


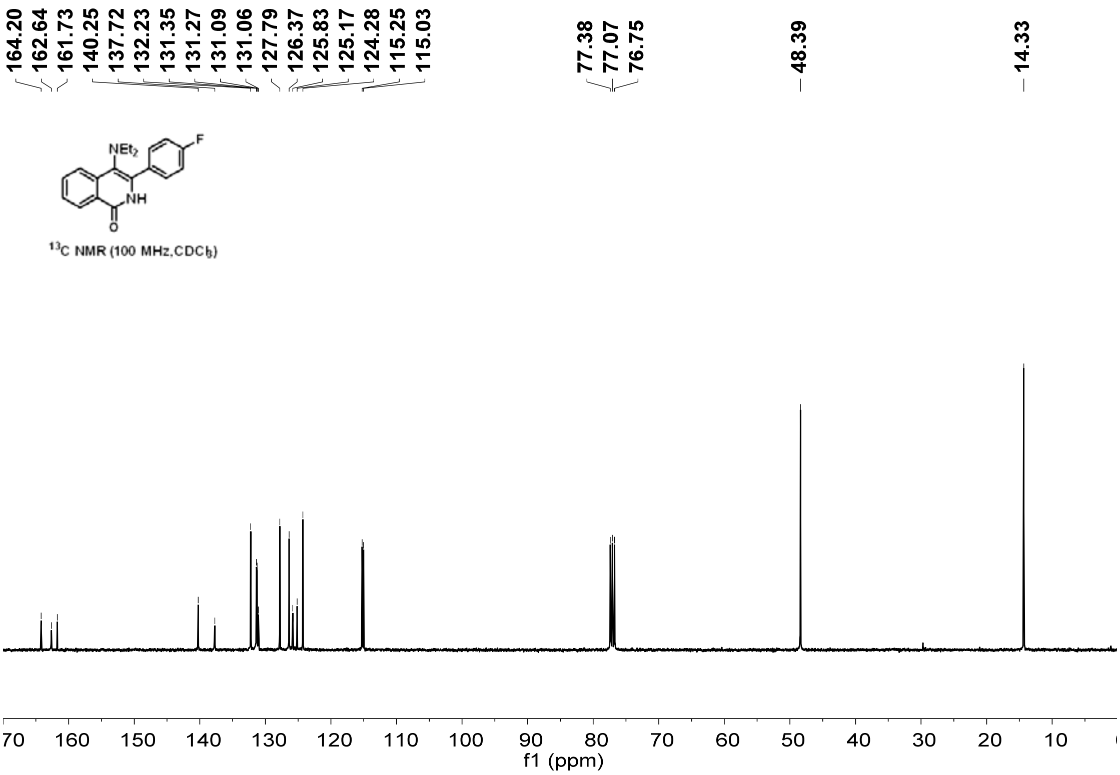
8.528 8.409 8.390 7.999 7.979 7.717 7.714 7.696 7.679 7.676 7.502 7.482 7.464 7.417 7.411 7.406 7.394 7.389 7.382 7.379 7.262 6.996 6.991 6.967 6.947 3.878 2.981 2.964 2.950 2.932 2.914 2.903 2.885 2.868 2.853 2.837 0.964 0.946 0.928 -0.000
NEt2
NH
O
^{1}H NMR (400 MHz,CDCl$_3$)
0.98 1.00 1.04 1.04 1.07 2.02 2.01 3.05 4.02 6.06
f1 (ppm)

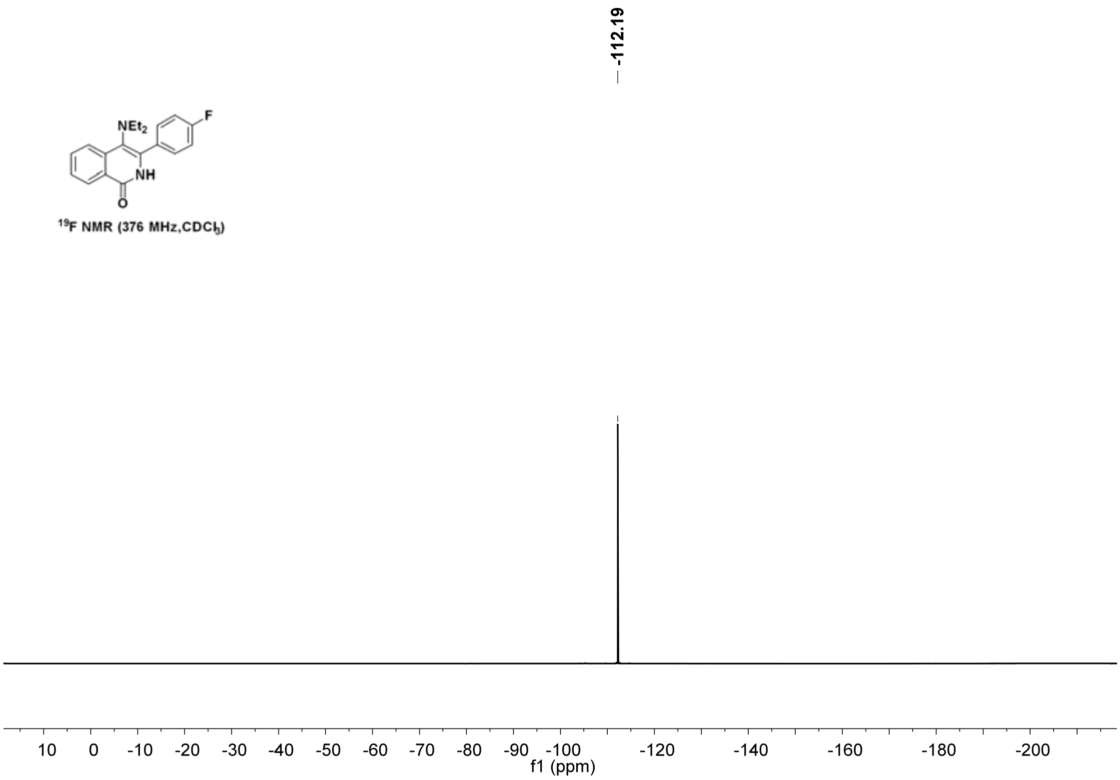


161.25 158.95 139.56 137.02 131.13 129.38 126.71 126.45 125.10 124.60 123.79 123.25 112.58 76.36 76.04 75.72 54.27 47.28 13.31
NEt2
NH
O
^{13}C NMR (100 MHz,CDCl$_3$)
f1 (ppm)

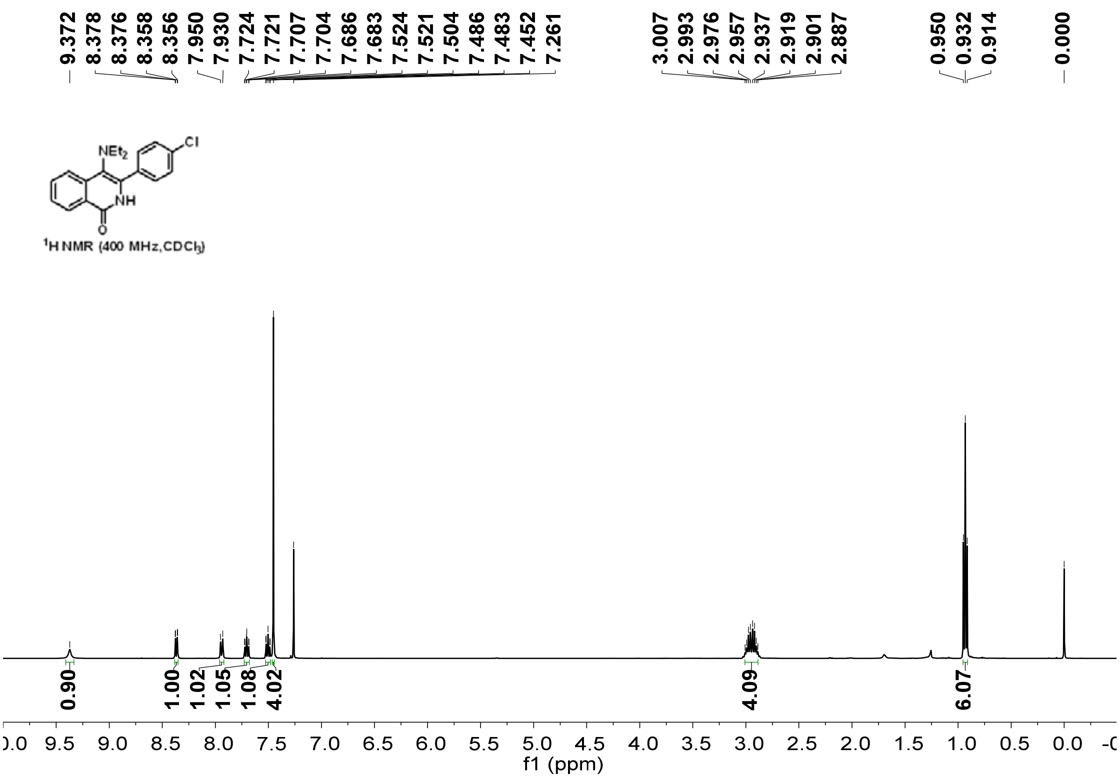
3da

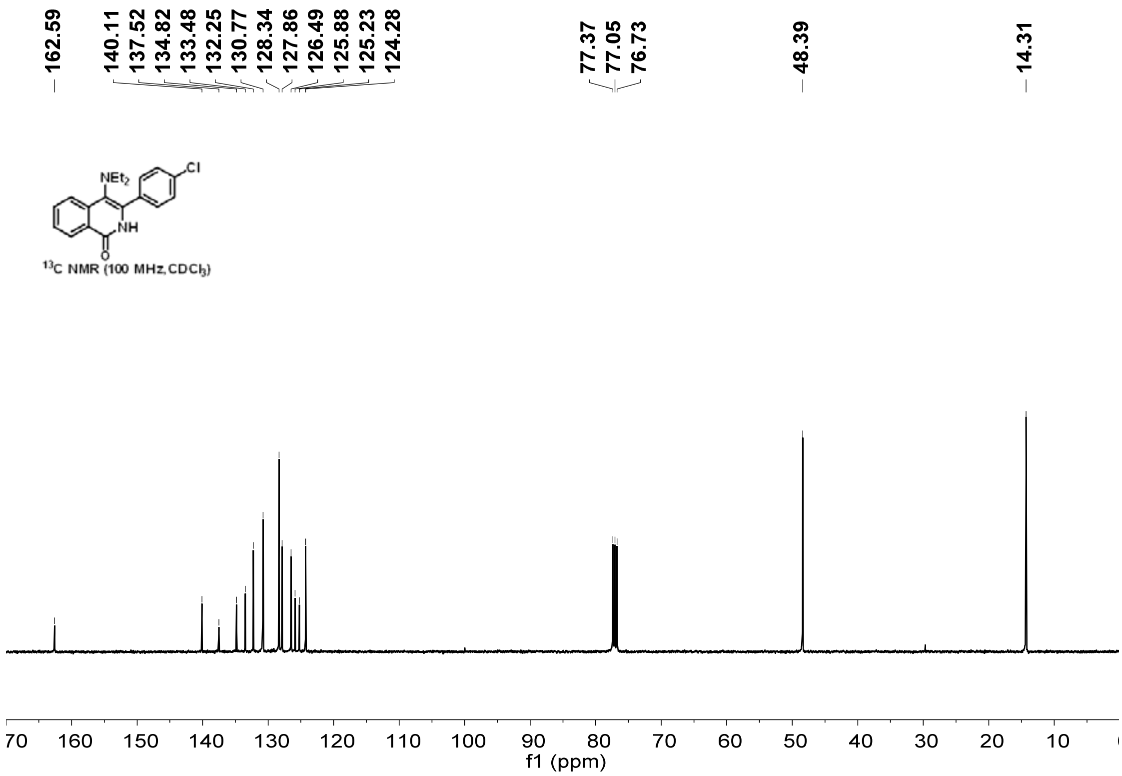

9.636
8.358
8.338
7.963
7.943
7.719
7.716
7.699
7.681
7.678
7.508
7.490
7.487
7.473
7.262
7.190
7.168
7.147
3.010
2.992
2.978
2.961
2.943
2.934
2.925
2.916
2.898
2.881
2.867
2.849
0.950
0.932
0.914
-0.000
NEt2
F
NH
O
1H NMR (400 MHz,CDCl3)
0.91
1.00
1.01
1.06
3.12
1.99
4.13
6.00
f1 (ppm)


164.20
162.64
161.73
140.25
137.72
132.23
131.35
131.27
131.09
131.06
127.79
126.37
125.83
125.17
124.28
115.25
115.03
77.38
77.07
76.75
48.39
14.33
NEt2
F
NH
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

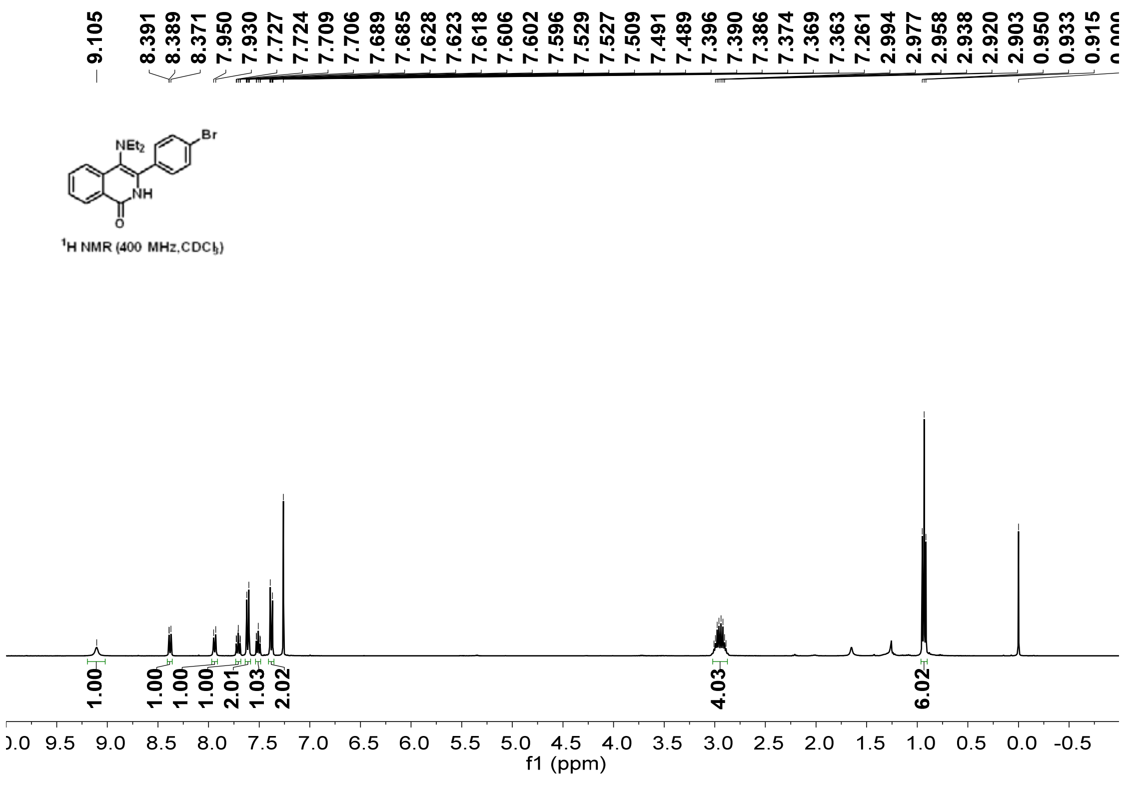

-112.19
NEt2
F
NH
O
19F NMR (376 MHz,CDCl3)
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180 -200
f1 (ppm)

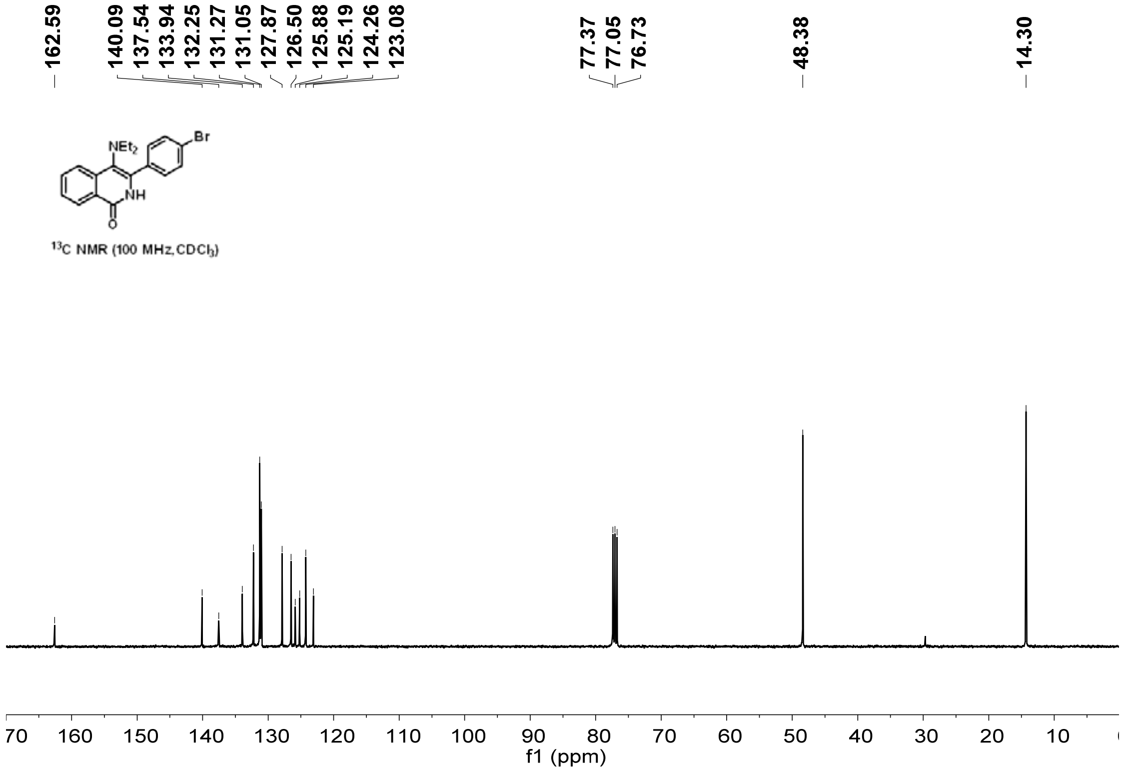
3ea


9.372
8.378 8.376 8.358 8.356 7.950 7.930 7.724 7.721 7.707 7.704 7.686 7.683 7.524 7.521 7.504 7.486 7.483 7.452 7.261
3.007 2.993 2.976 2.957 2.937 2.919 2.901 2.887
0.950 0.932 0.914
0.000
NEt2
Cl
NH
O
1H NMR (400 MHz,CDCl3)
0.90 1.00 1.02 1.05 1.08 4.02 4.09 6.07
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

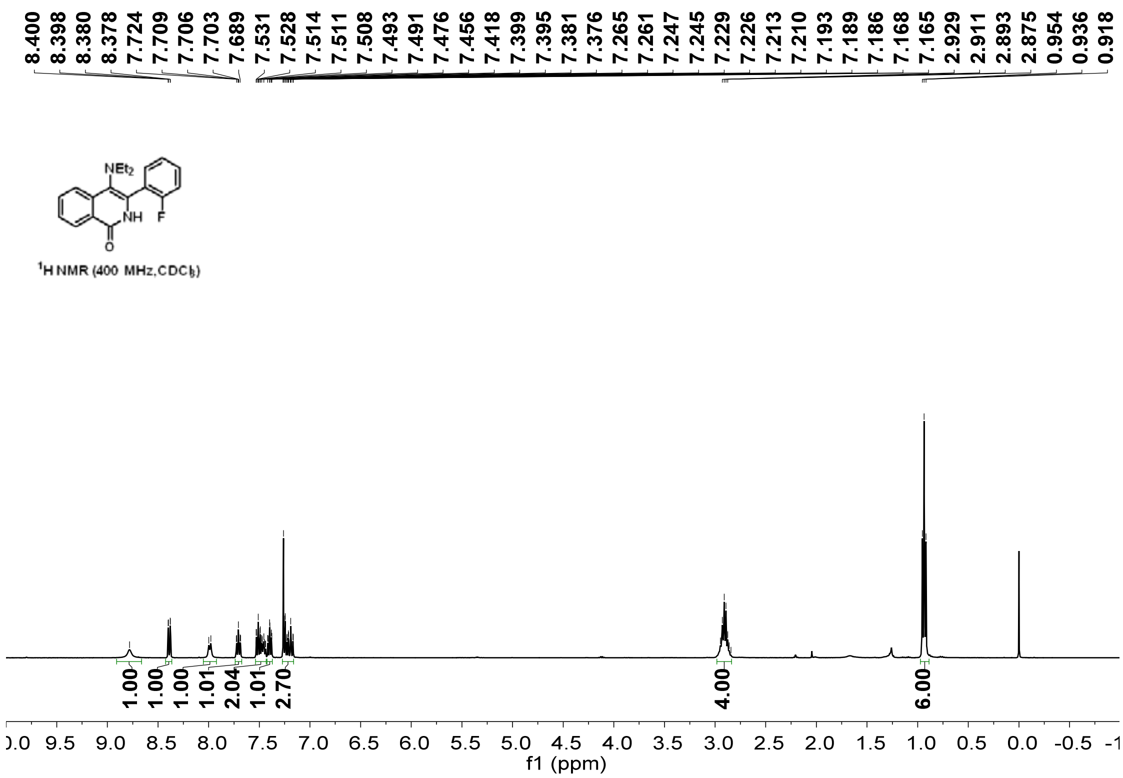

NEt2
Cl
NH
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

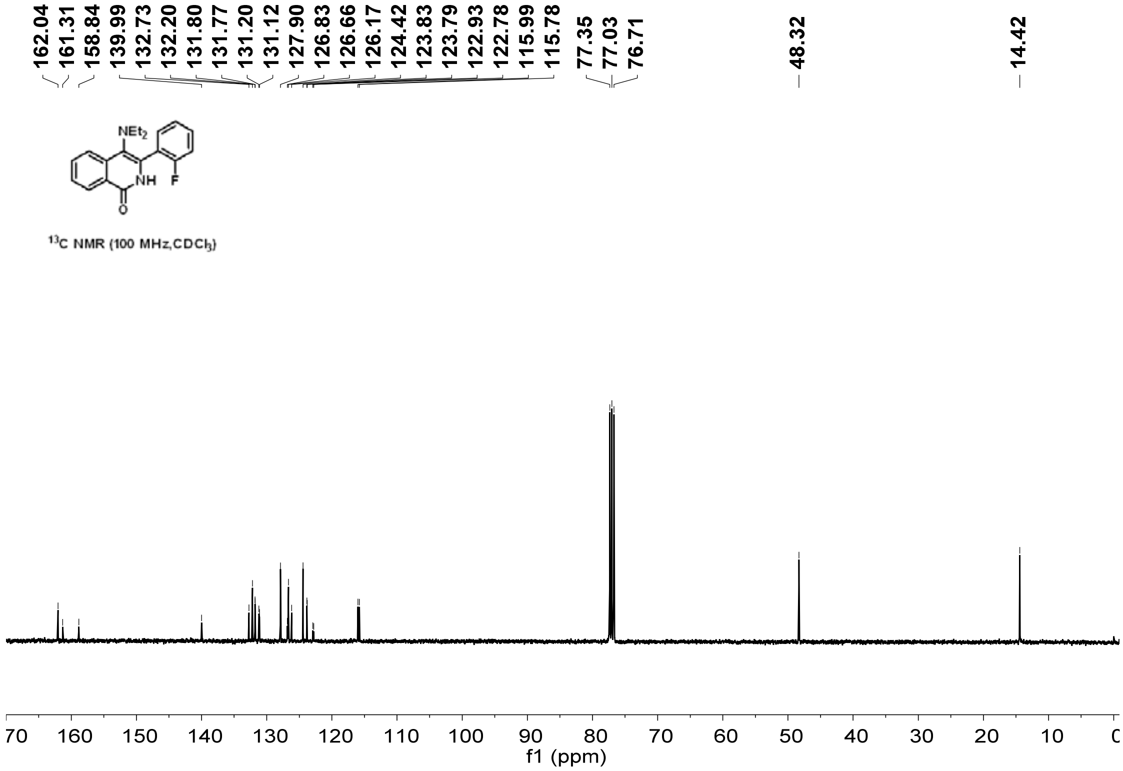
3fa


NEt2
Br
NH
O
1H NMR (400 MHz,CDCl3)
f1 (ppm)

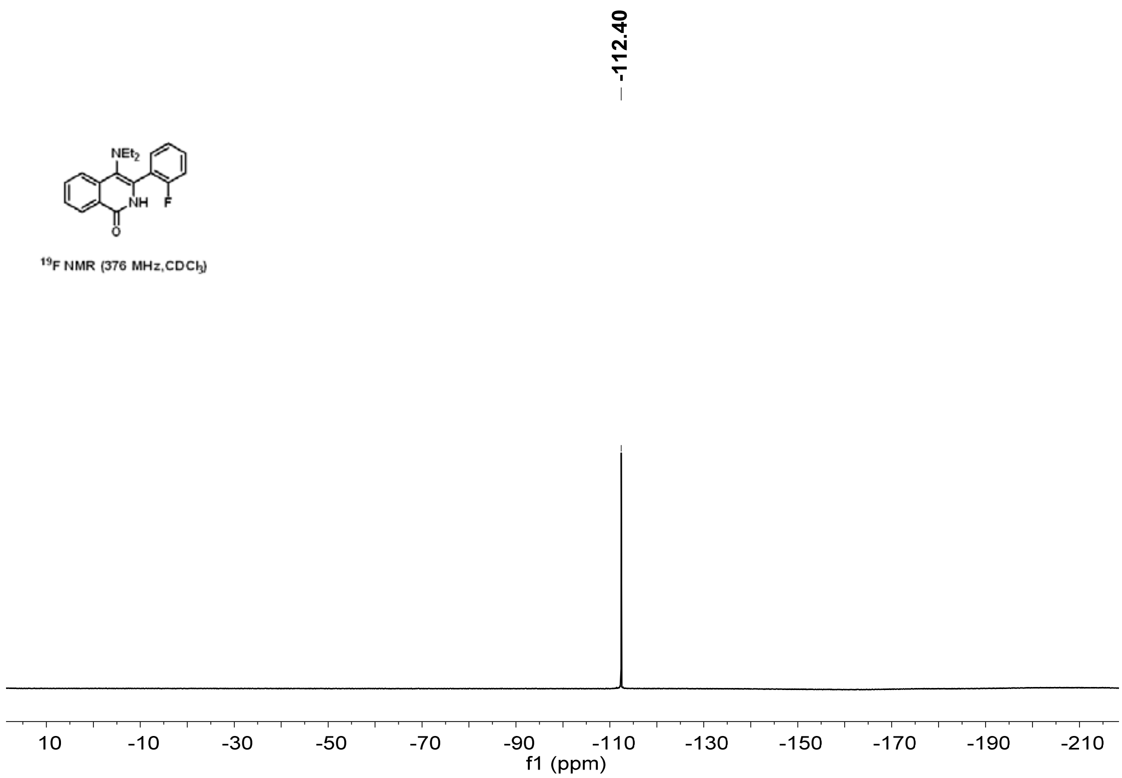

162.59
140.09
137.54
133.94
132.25
131.27
131.05
127.87
126.50
125.88
125.19
124.26
123.08
77.37
77.05
76.73
48.38
14.30
NEt₂
Br
NH
O
¹³C NMR (100 MHz, CDCl₃)
f1 (ppm)

3ga


8.400
8.398
8.380
8.378
7.724
7.709
7.706
7.703
7.689
7.531
7.528
7.514
7.511
7.508
7.493
7.491
7.476
7.456
7.418
7.399
7.395
7.381
7.376
7.265
7.261
7.247
7.245
7.229
7.226
7.213
7.210
7.193
7.189
7.186
7.168
7.165
2.929
2.911
2.893
2.875
0.954
0.936
0.918
NEt₂
F
NH
O
¹H NMR (400 MHz, CDCl₃)
1.00
1.00
1.00
1.01
2.04
1.01
2.70
4.00
6.00
f1 (ppm)

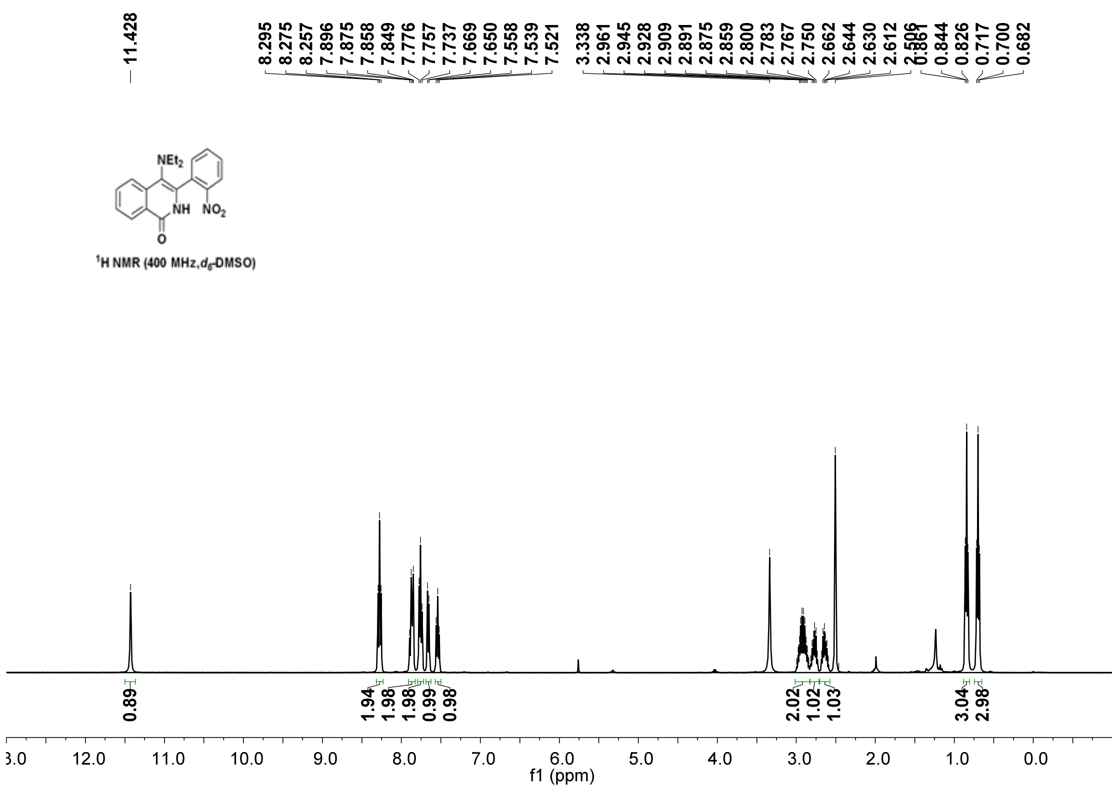


162.04
161.31
158.84
139.99
132.73
132.20
131.80
131.77
131.20
131.12
127.90
126.83
126.66
126.17
124.42
123.83
123.79
122.93
122.78
115.99
115.78
77.35
77.03
76.71
48.32
14.42
NEt2
NH
F
O
13C NMR (100 MHz,CDCl3)
70 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

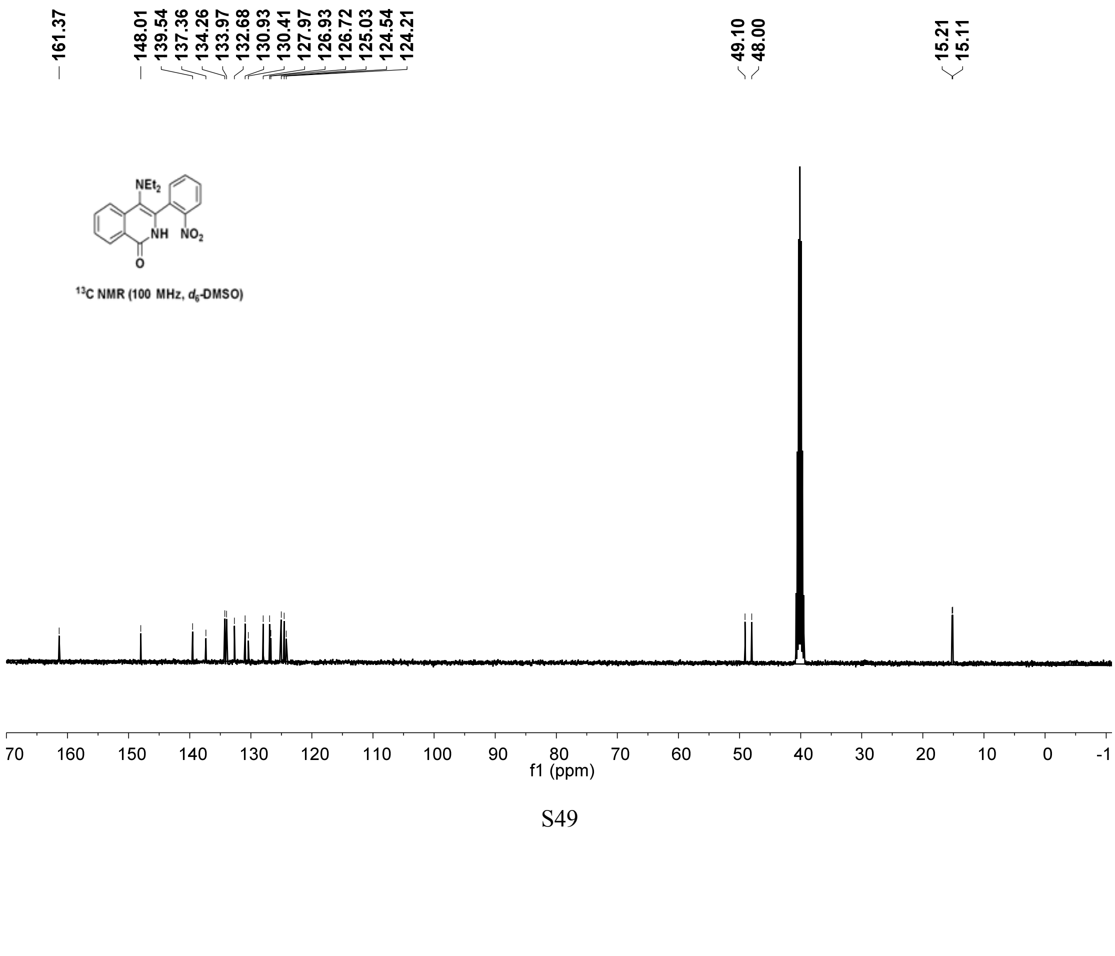


-112.40
NEt2
NH
F
O
19F NMR (376 MHz,CDCl3)
10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210
f1 (ppm)

3ha

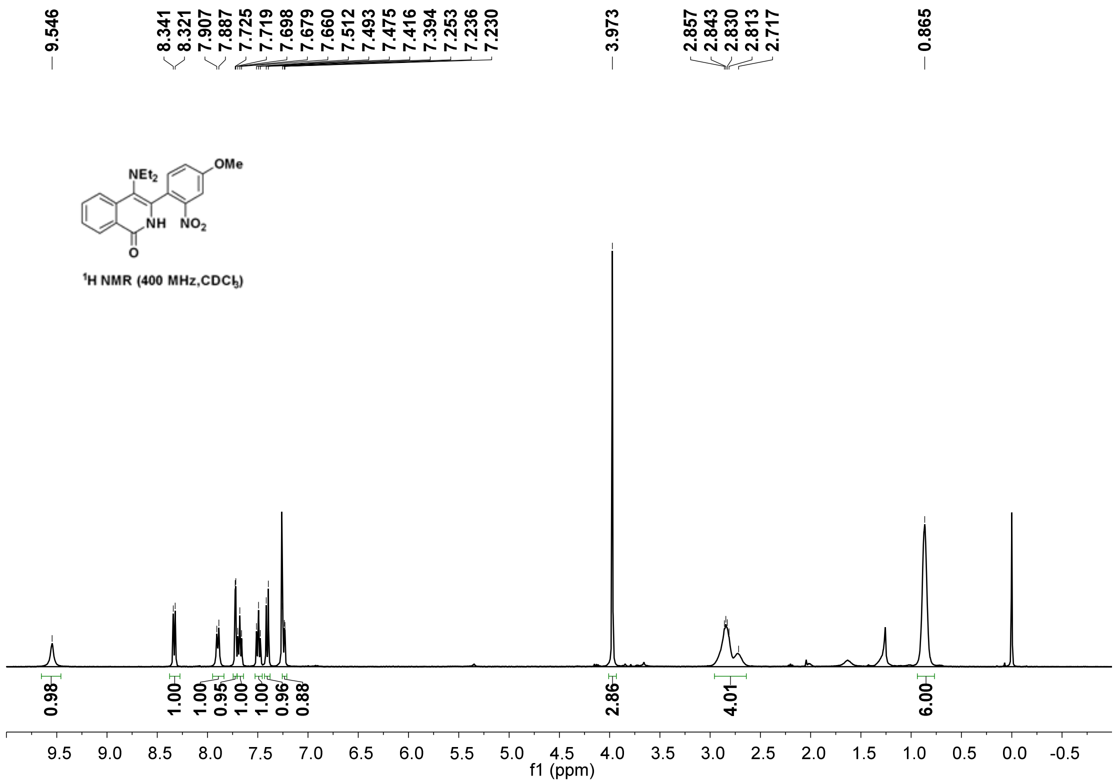


11.428
8.295
8.275
8.257
7.896
7.875
7.858
7.849
7.776
7.757
7.737
7.669
7.650
7.558
7.539
7.521
3.338
2.961
2.945
2.928
2.909
2.891
2.875
2.859
2.800
2.783
2.767
2.750
2.662
2.644
2.630
2.612
0.844
0.826
0.717
0.700
0.682
NEt2
NH
NO2
O
1H NMR (400 MHz, d6-DMSO)
0.89
1.94
1.98
1.98
0.99
0.98
2.02
1.02
1.03
3.04
2.98
f1 (ppm)

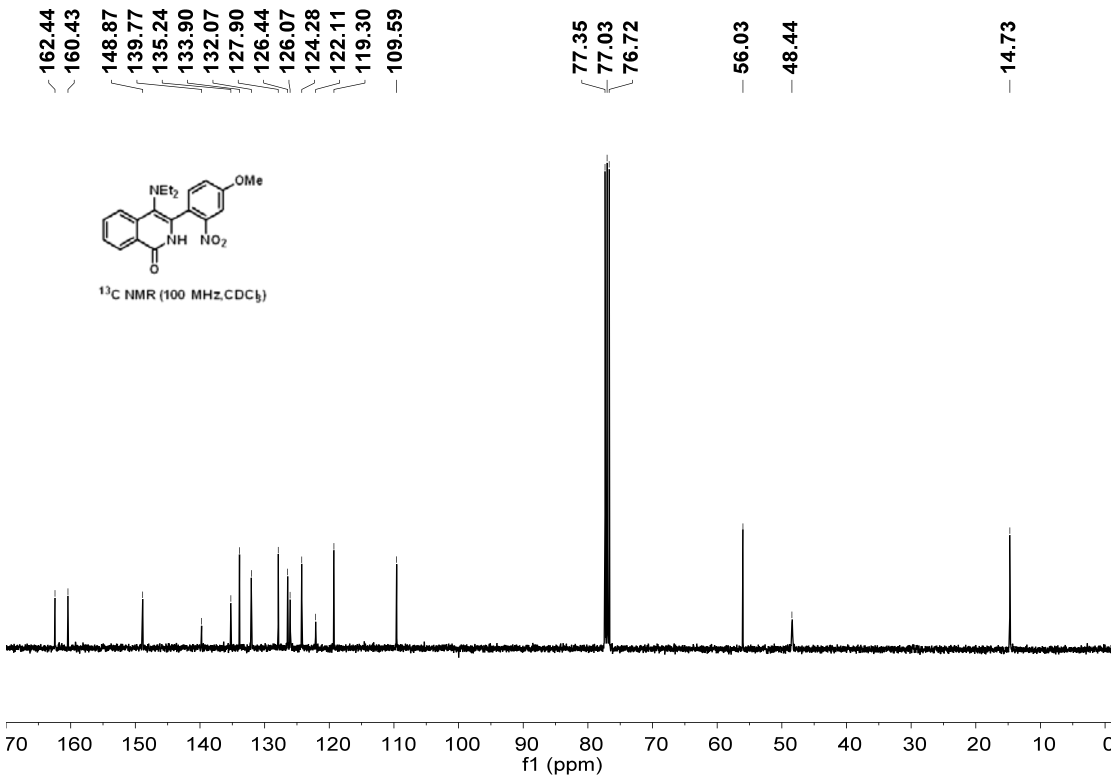


161.37
148.01
139.54
137.36
134.26
133.97
132.68
130.93
130.41
127.97
126.93
126.72
125.03
124.54
124.21
49.10
48.00
15.21
15.11
NEt2
NH
NO2
O
13C NMR (100 MHz, d6-DMSO)
f1 (ppm)

3ia

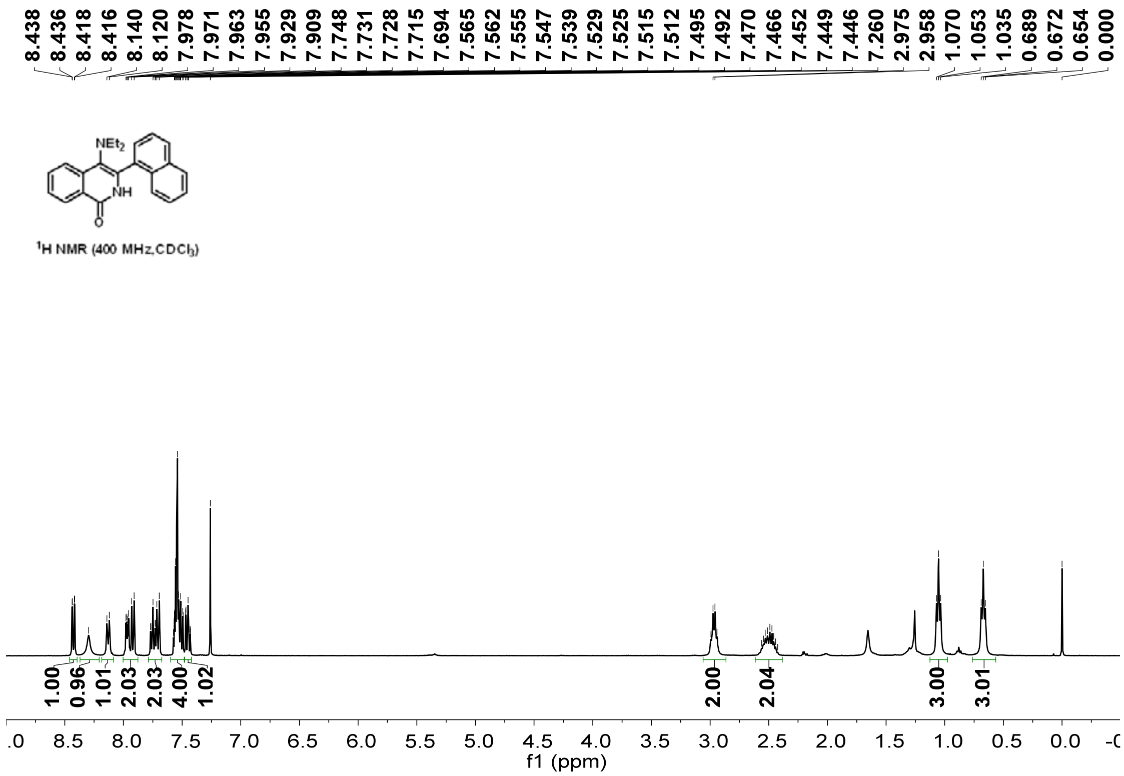


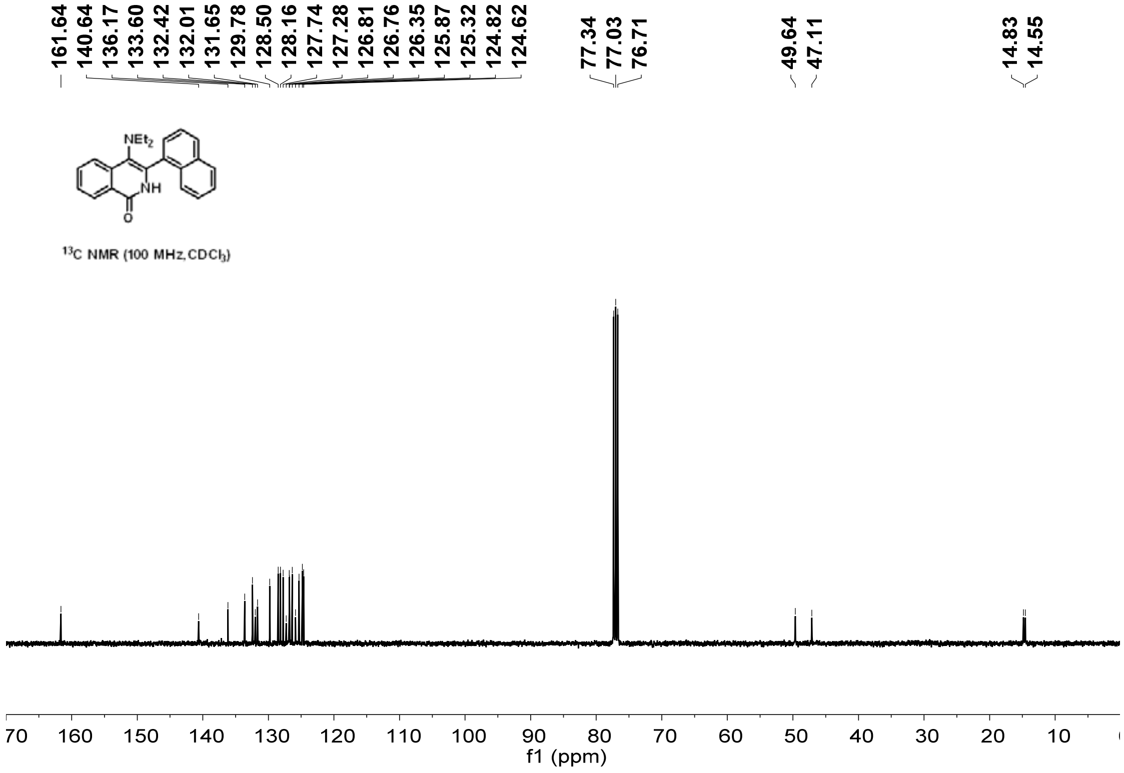
9.546
8.341
8.321
7.907
7.887
7.725
7.719
7.698
7.679
7.660
7.512
7.493
7.475
7.416
7.394
7.253
7.236
7.230
3.973
2.857
2.843
2.830
2.813
2.717
0.865
NEt2
OMe
NH
NO2
O
1H NMR (400 MHz,CDCl3)
0.98
1.00
1.00
0.95
1.00
1.00
0.96
0.88
2.86
4.01
6.00
f1 (ppm)



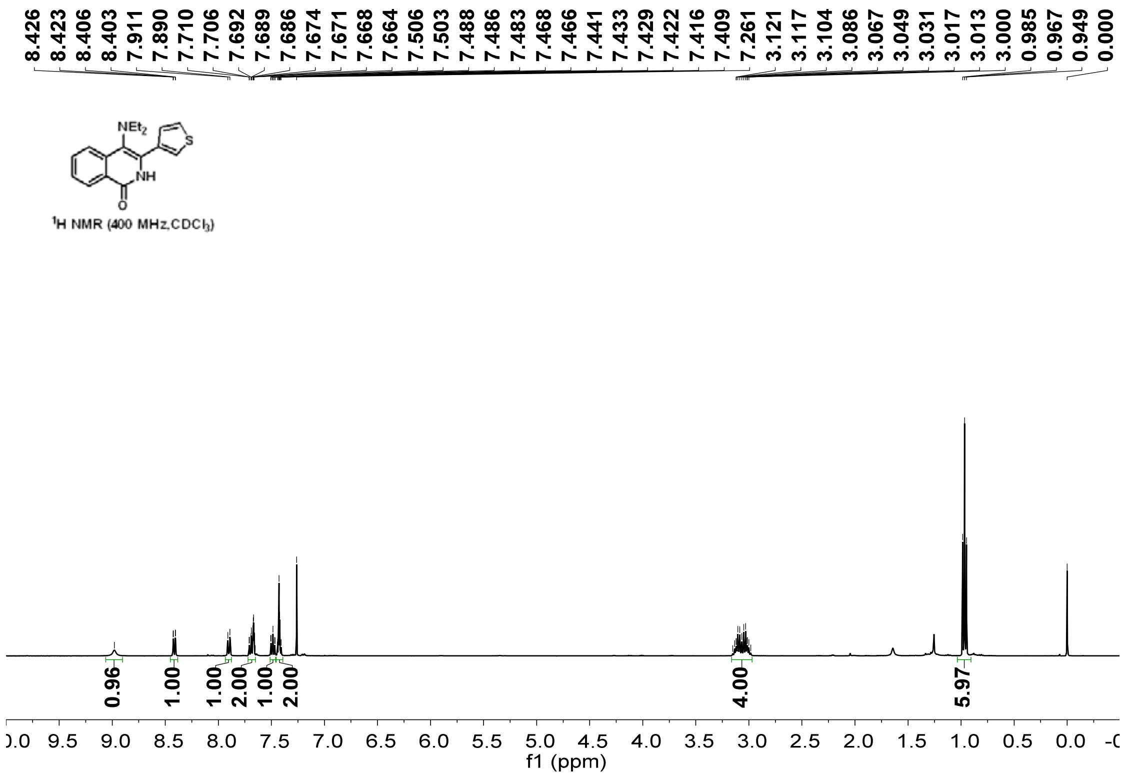
162.44
160.43
148.87
139.77
135.24
133.90
132.07
127.90
126.44
126.07
124.28
122.11
119.30
109.59
77.35
77.03
76.72
56.03
48.44
14.73
NEt2
OMe
NH
NO2
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

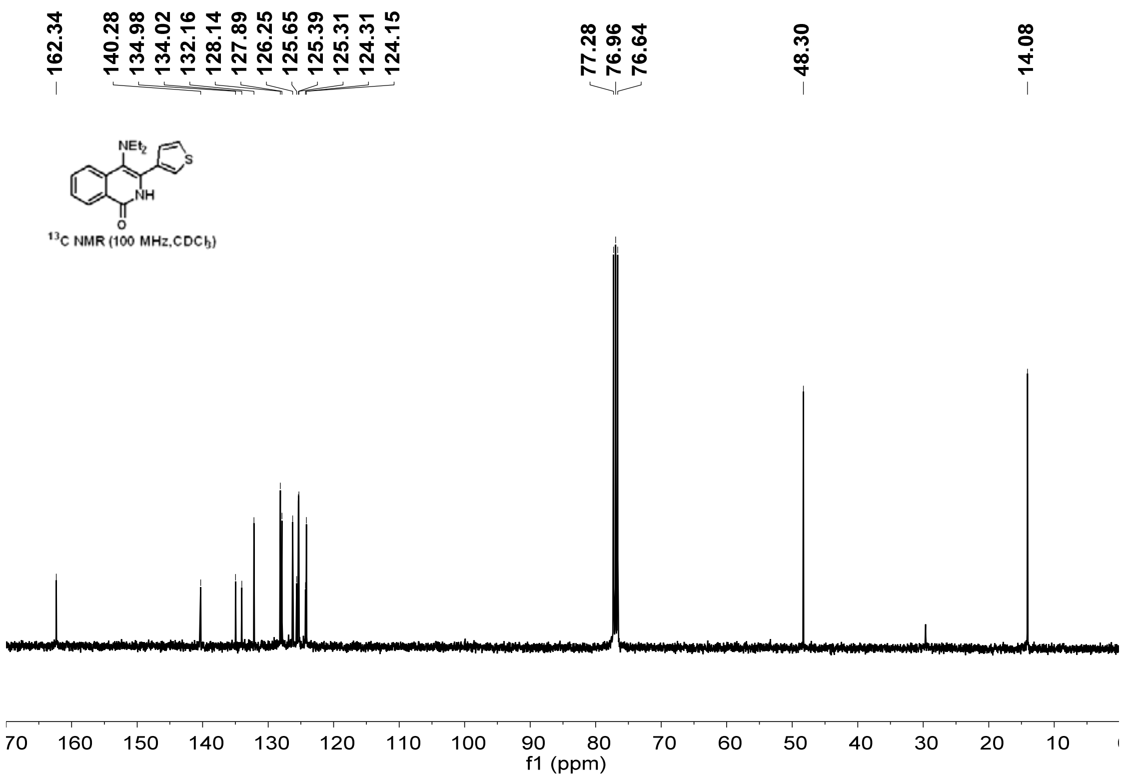
3ja


8.438 8.436 8.418 8.416 8.140 8.120 7.978 7.971 7.963 7.955 7.929 7.909 7.748 7.731 7.728 7.715 7.694 7.565 7.562 7.555 7.547 7.539 7.529 7.525 7.515 7.512 7.495 7.492 7.470 7.466 7.452 7.449 7.446 7.260 2.975 2.958 1.070 1.053 1.035 0.689 0.672 0.654 0.000
NEt2
NH
O
1H NMR (400 MHz,CDCl3)
1.00 0.96 1.01 2.03 2.03 4.00 1.02 2.00 2.04 3.00 3.01
f1 (ppm)

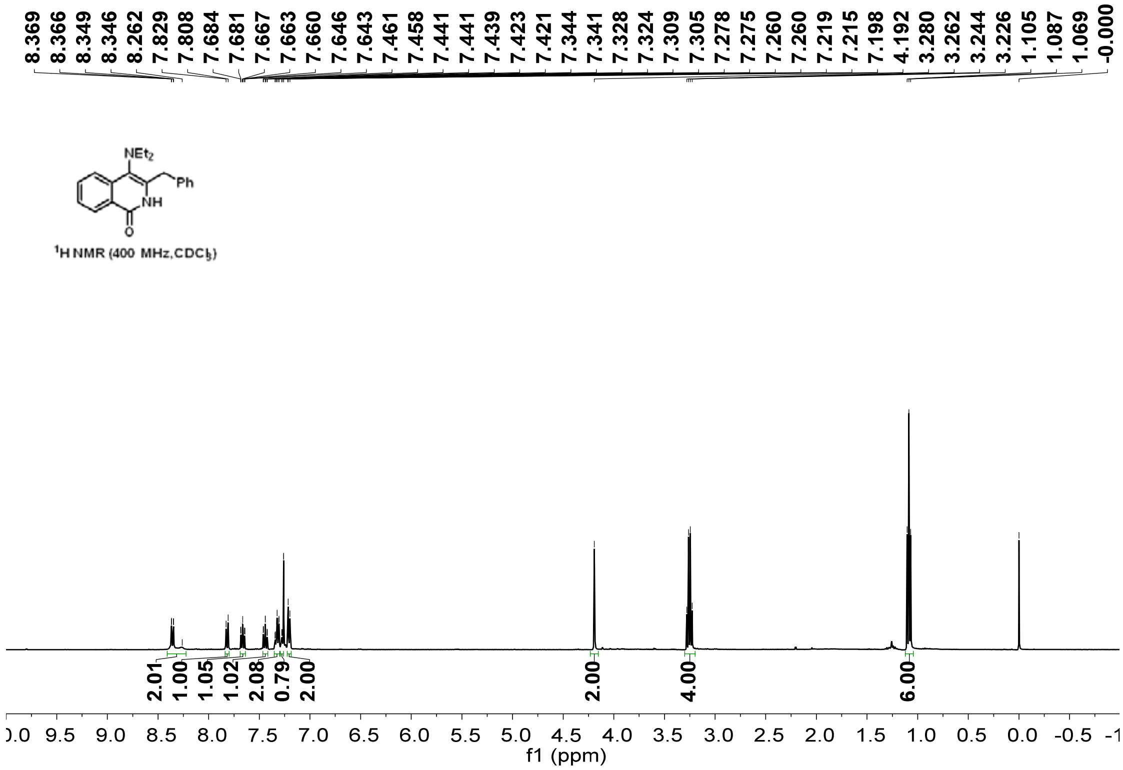

161.64 140.64 136.17 133.60 132.42 132.01 131.65 129.78 128.50 128.16 127.74 127.28 126.81 126.76 126.35 125.87 125.32 124.82 124.62 77.34 77.03 76.71 49.64 47.11 14.83 14.55
NEt2
NH
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

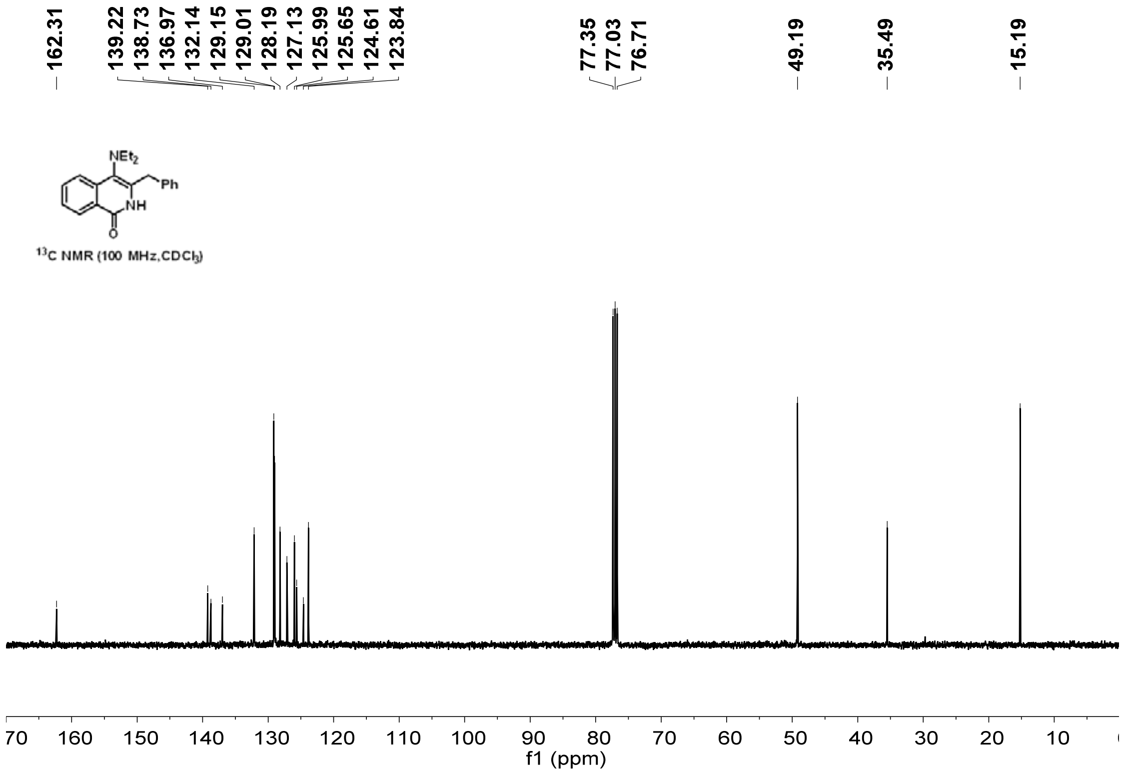
3ka



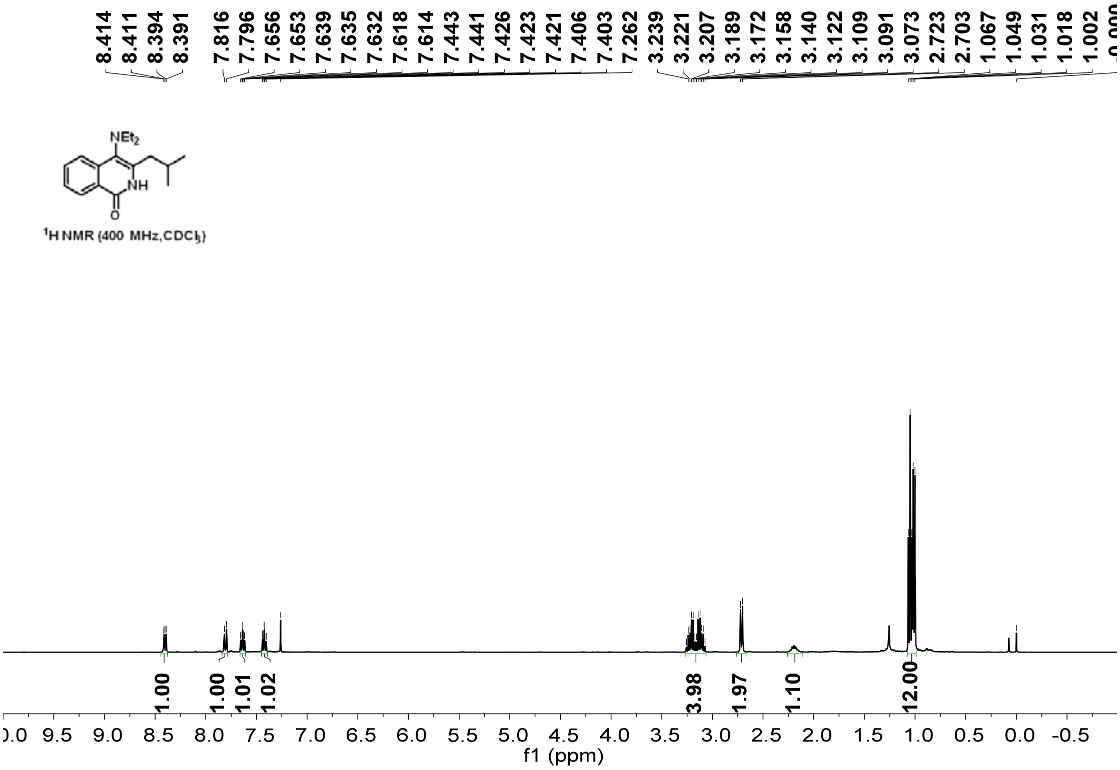


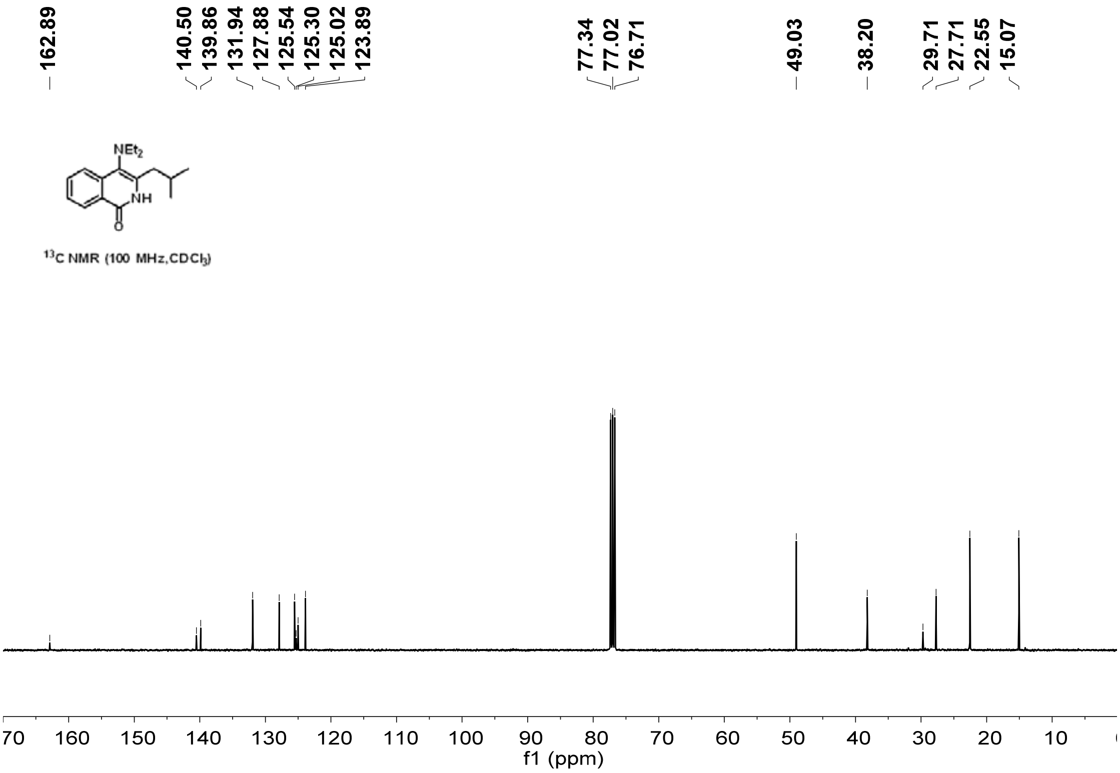
3la


8.369 8.366 8.349 8.346 8.262 7.829 7.808 7.684 7.681 7.667 7.663 7.660 7.646 7.643 7.461 7.458 7.441 7.441 7.439 7.423 7.421 7.344 7.341 7.328 7.324 7.309 7.305 7.278 7.275 7.260 7.260 7.219 7.215 7.198 4.192 3.280 3.262 3.244 3.226 1.105 1.087 1.069 -0.000
^{1}H NMR (400 MHz, CDCl$_3$)
2.01 1.00 1.05 1.02 2.08 0.79 2.00 2.00 4.00 6.00
f1 (ppm)

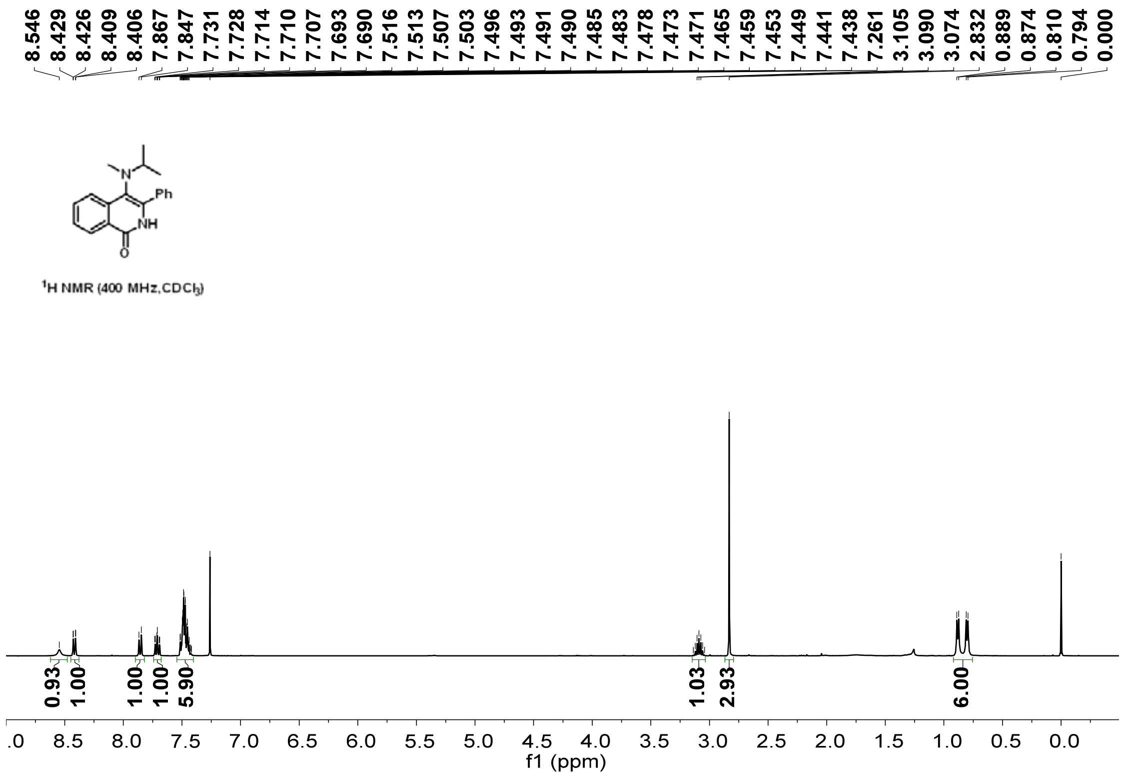

162.31 139.22 138.73 136.97 132.14 129.15 129.01 128.19 127.13 125.99 125.65 124.61 123.84 77.35 77.03 76.71 49.19 35.49 15.19
^{13}C NMR (100 MHz, CDCl$_3$)
f1 (ppm)

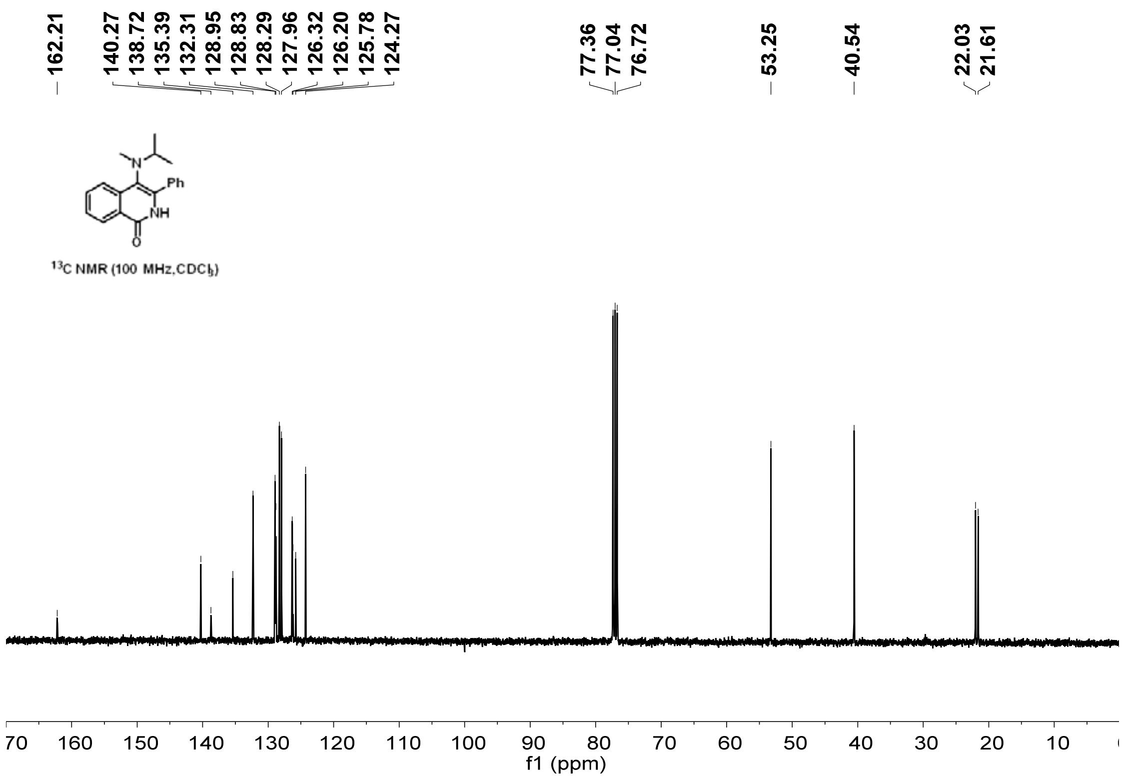
3ma


8.414
8.411
8.394
8.391
7.816
7.796
7.656
7.653
7.639
7.635
7.632
7.618
7.614
7.443
7.441
7.426
7.423
7.421
7.406
7.403
7.262
3.239
3.221
3.207
3.189
3.172
3.158
3.140
3.122
3.109
3.091
3.073
2.723
2.703
1.067
1.049
1.031
1.018
1.002
NEt2
NH
O
^{1}H NMR (400 MHz, CDCl3)
1.00
1.00
1.01
1.02
3.98
1.97
1.10
12.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

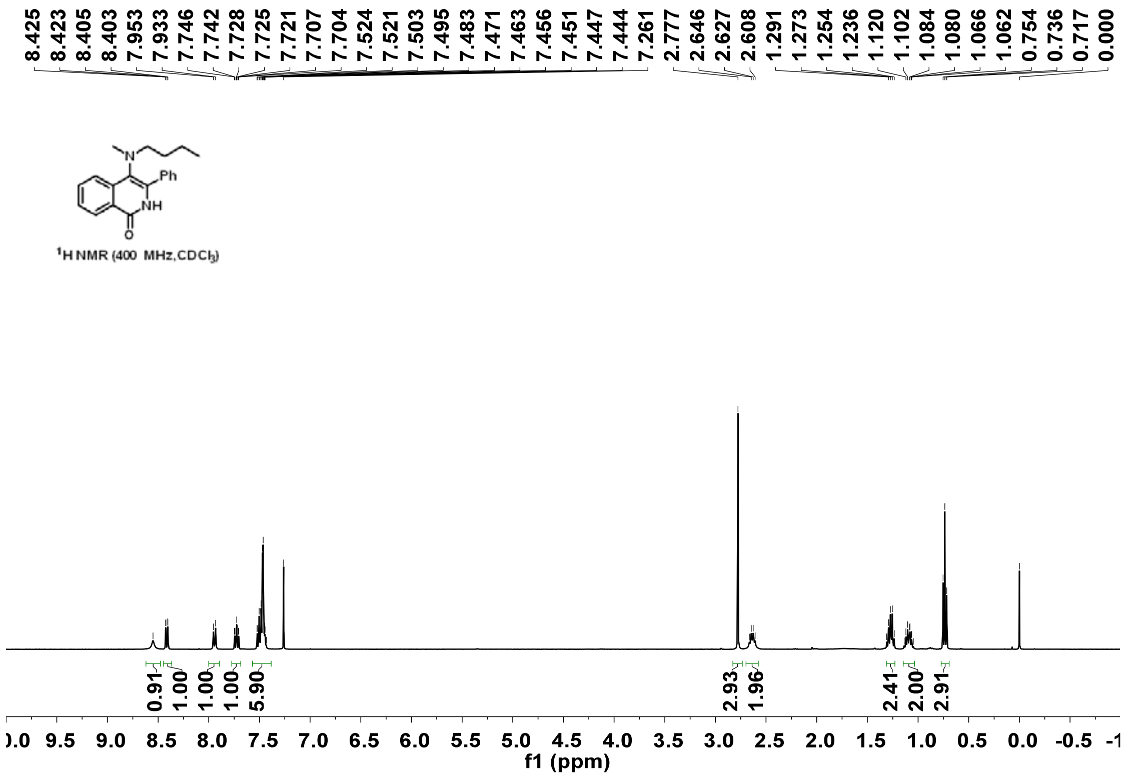

162.89
140.50
139.86
131.94
127.88
125.54
125.30
125.02
123.89
77.34
77.02
76.71
49.03
38.20
29.71
27.71
22.55
15.07
NEt2
NH
O
^{13}C NMR (100 MHz, CDCl3)
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

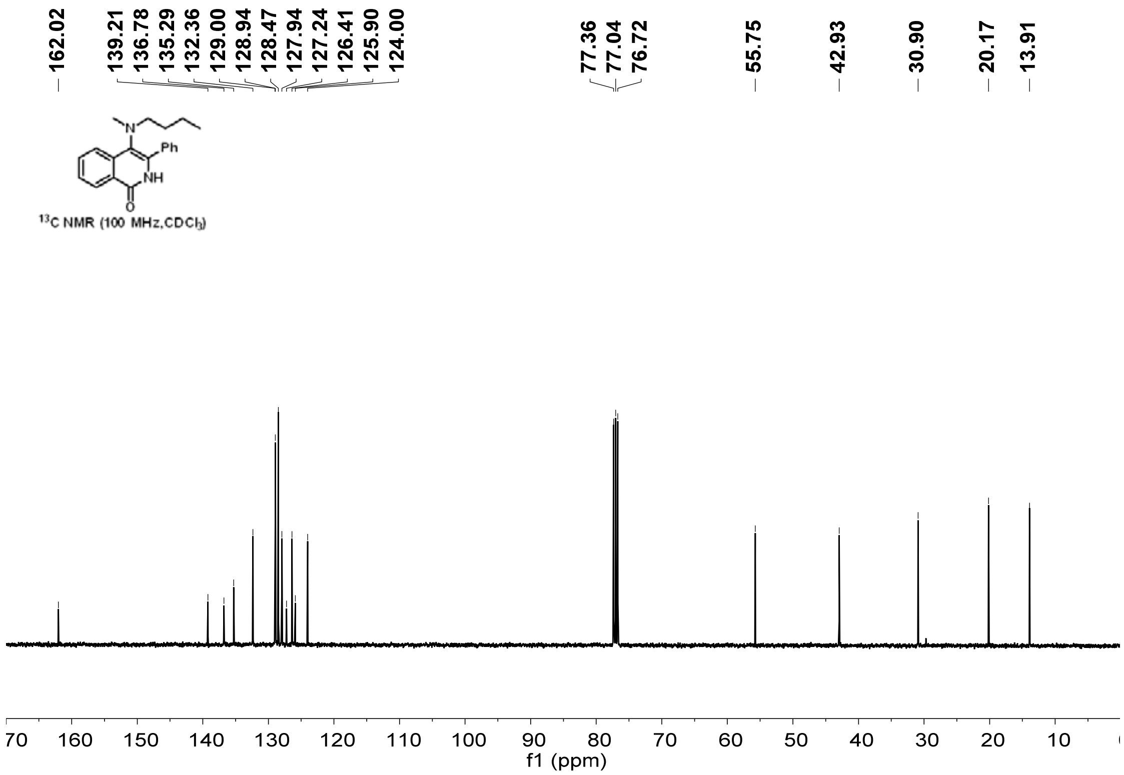
3na



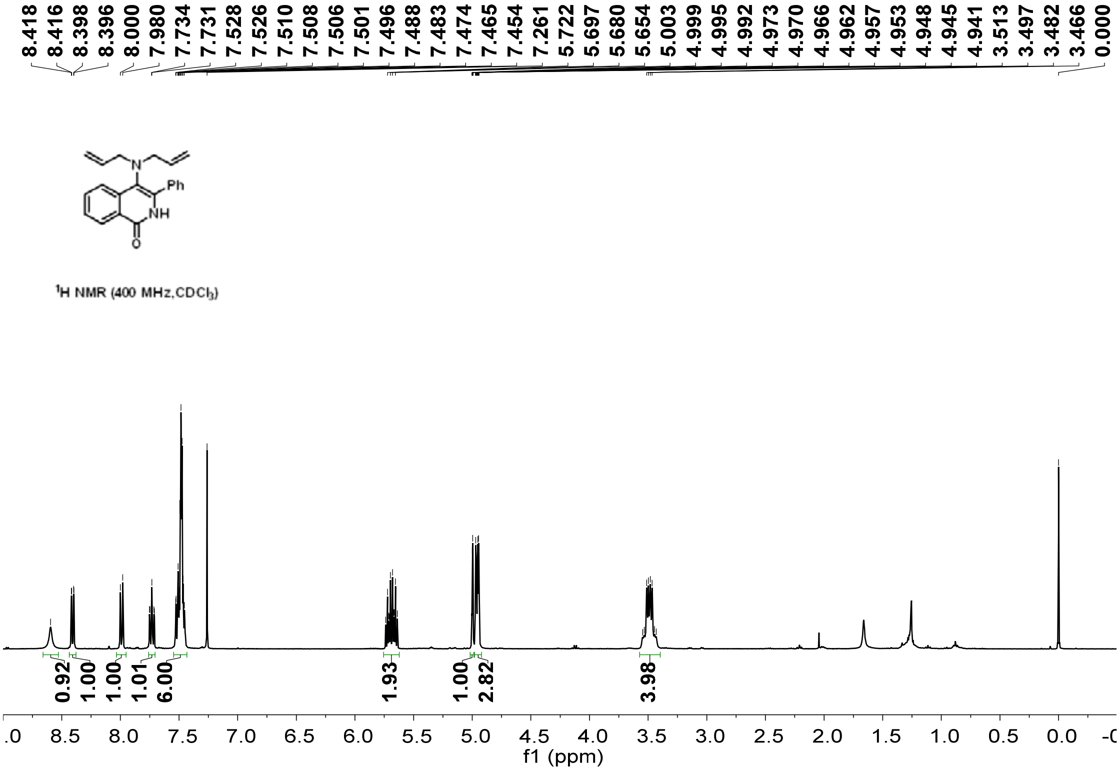


3oa

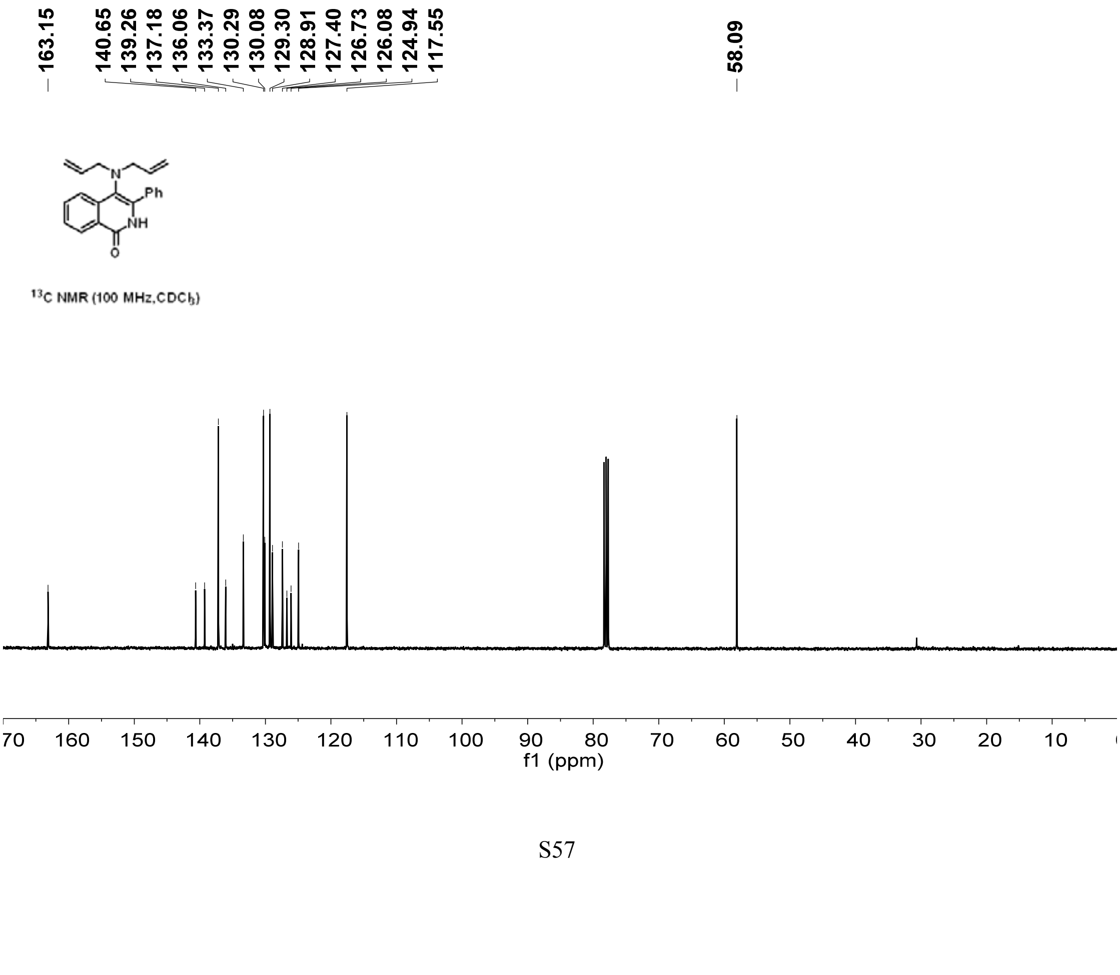

8.425 8.423 8.405 8.403 7.953 7.933 7.746 7.742 7.728 7.725 7.721 7.707 7.704 7.524 7.521 7.503 7.495 7.483 7.471 7.463 7.456 7.451 7.447 7.444 7.261 2.777 2.646 2.627 2.608 1.291 1.273 1.254 1.236 1.120 1.102 1.084 1.080 1.066 1.062 0.754 0.736 0.717 0.000
Ph
NH
O
^{1}H NMR (400 MHz,CDCl$_3$)
0.91 1.00 1.00 1.00 5.90 2.93 1.96 2.41 2.00 2.91
f1 (ppm)


162.02 139.21 136.78 135.29 132.36 129.00 128.94 128.47 127.94 127.24 126.41 125.90 124.00 77.36 77.04 76.72 55.75 42.93 30.90 20.17 13.91
Ph
NH
O
^{13}C NMR (100 MHz,CDCl$_3$)
f1 (ppm)

3pa

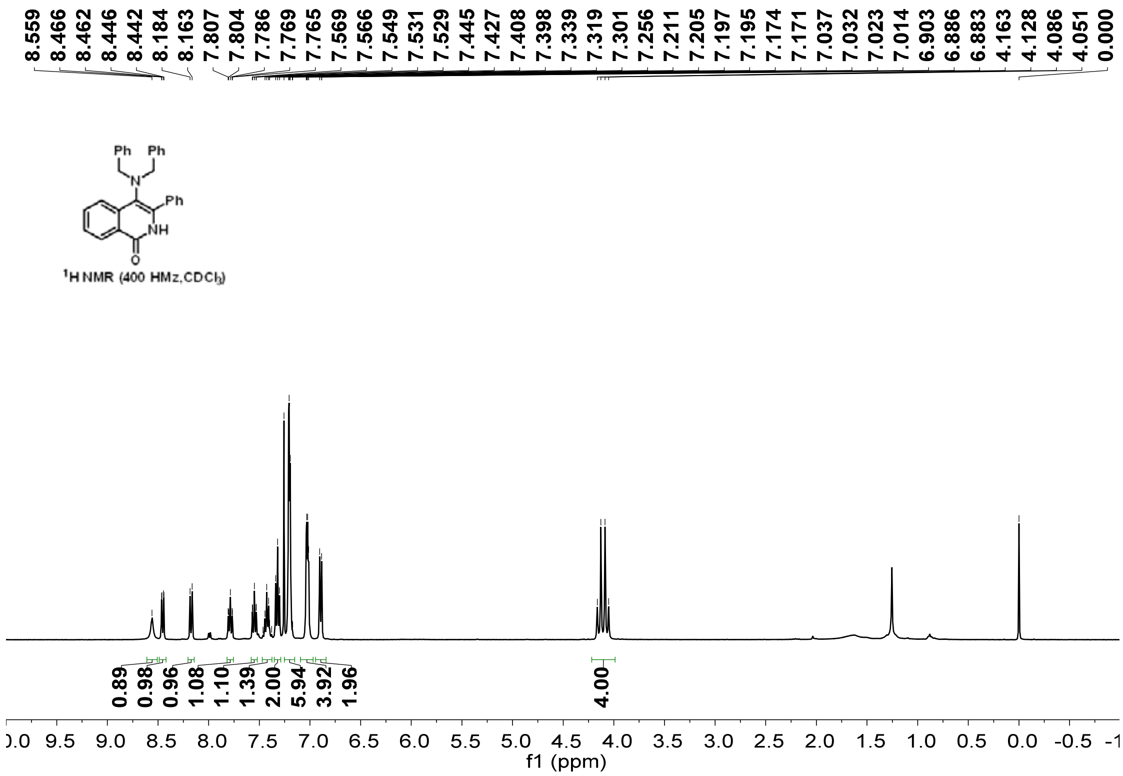


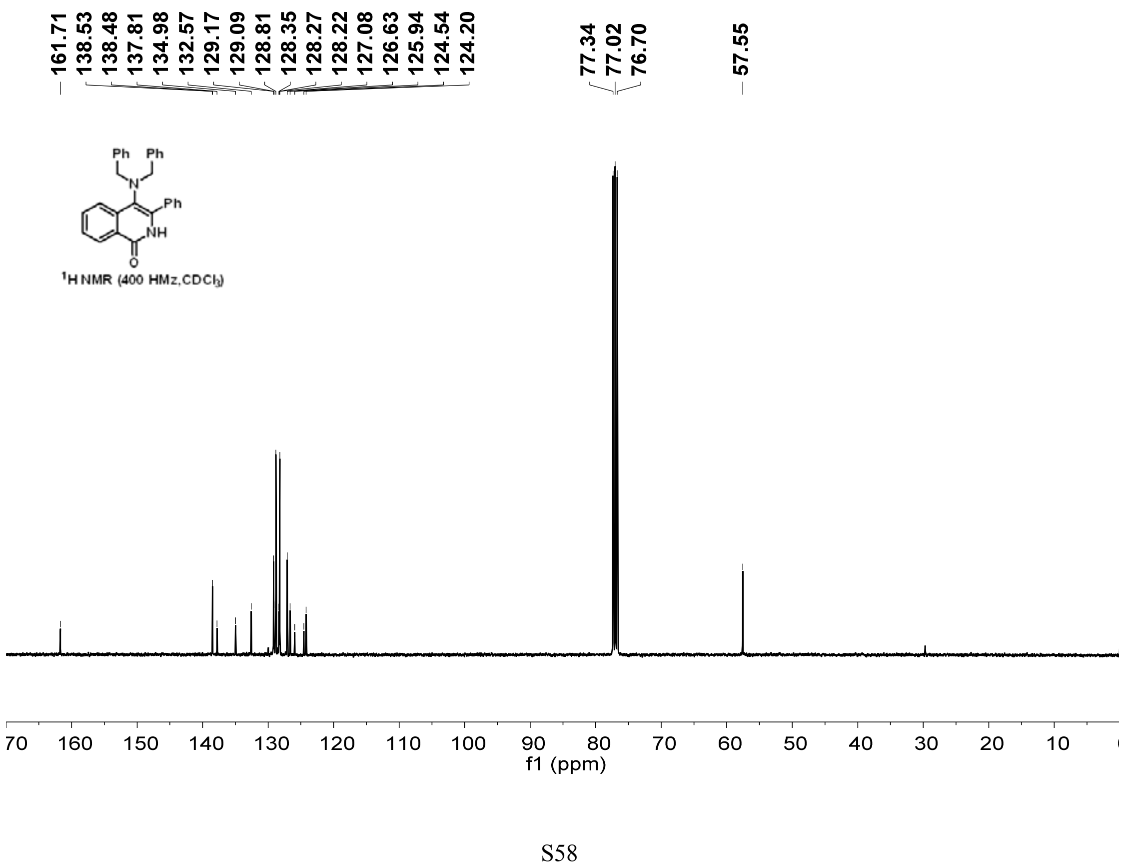
8.418
8.416
8.398
8.396
8.000
7.980
7.734
7.731
7.528
7.526
7.510
7.508
7.506
7.501
7.496
7.488
7.483
7.474
7.465
7.454
7.261
5.722
5.697
5.680
5.654
5.003
4.999
4.995
4.992
4.973
4.970
4.966
4.962
4.957
4.953
4.948
4.945
4.941
3.513
3.497
3.482
3.466
0.000
Ph
NH
O
N
^{1}H NMR (400 MHz,CDCl$_3$)
0.92
1.00
1.00
1.01
6.00
1.93
1.00
2.82
3.98
f1 (ppm)



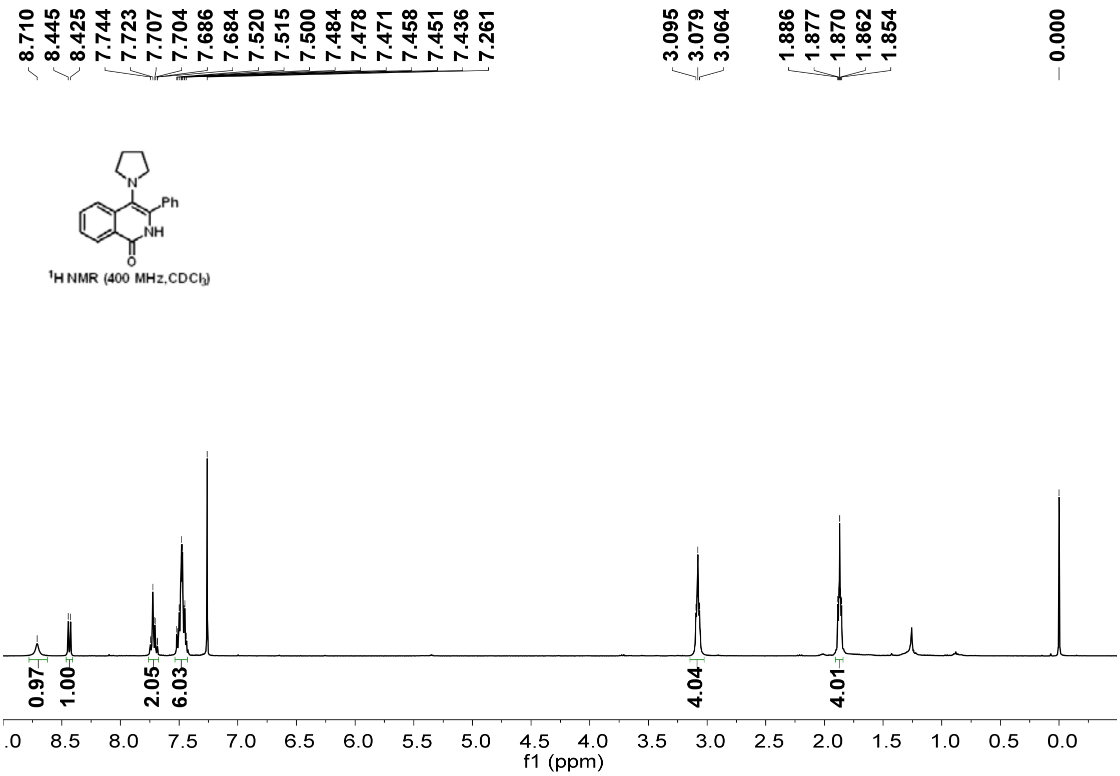
163.15
140.65
139.26
137.18
136.06
133.37
130.29
130.08
129.30
128.91
127.40
126.73
126.08
124.94
117.55
58.09
Ph
NH
O
N
^{13}C NMR (100 MHz,CDCl$_3$)
f1 (ppm)

3qa

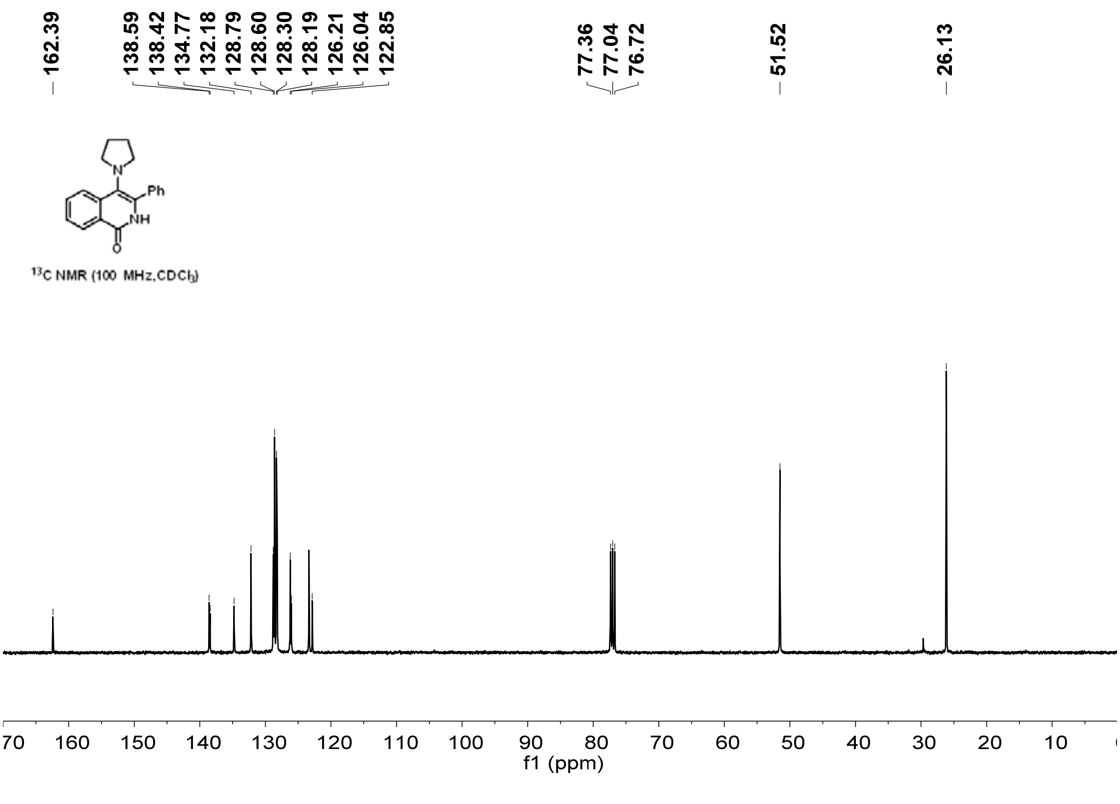

8.559 8.466 8.462 8.446 8.442 8.184 8.163 7.807 7.804 7.786 7.769 7.765 7.566 7.549 7.531 7.529 7.445 7.427 7.408 7.398 7.339 7.319 7.301 7.256 7.211 7.205 7.197 7.195 7.174 7.171 7.037 7.032 7.023 7.014 6.903 6.886 6.883 4.163 4.128 4.086 4.051 0.000
Ph
Ph
N
Ph
NH
O
^{1}H NMR (400 HMz,CDCl$_3$)
0.89 0.98 0.96 1.08 1.10 1.39 2.00 5.94 3.92 1.96
4.00
f1 (ppm)


161.71 138.53 138.48 137.81 134.98 132.57 129.17 129.09 128.81 128.35 128.27 128.22 127.08 126.63 125.94 124.54 124.20
77.34 77.02 76.70
57.55
Ph
Ph
N
Ph
NH
O
^{1}H NMR (400 HMz,CDCl$_3$)
f1 (ppm)

3ra

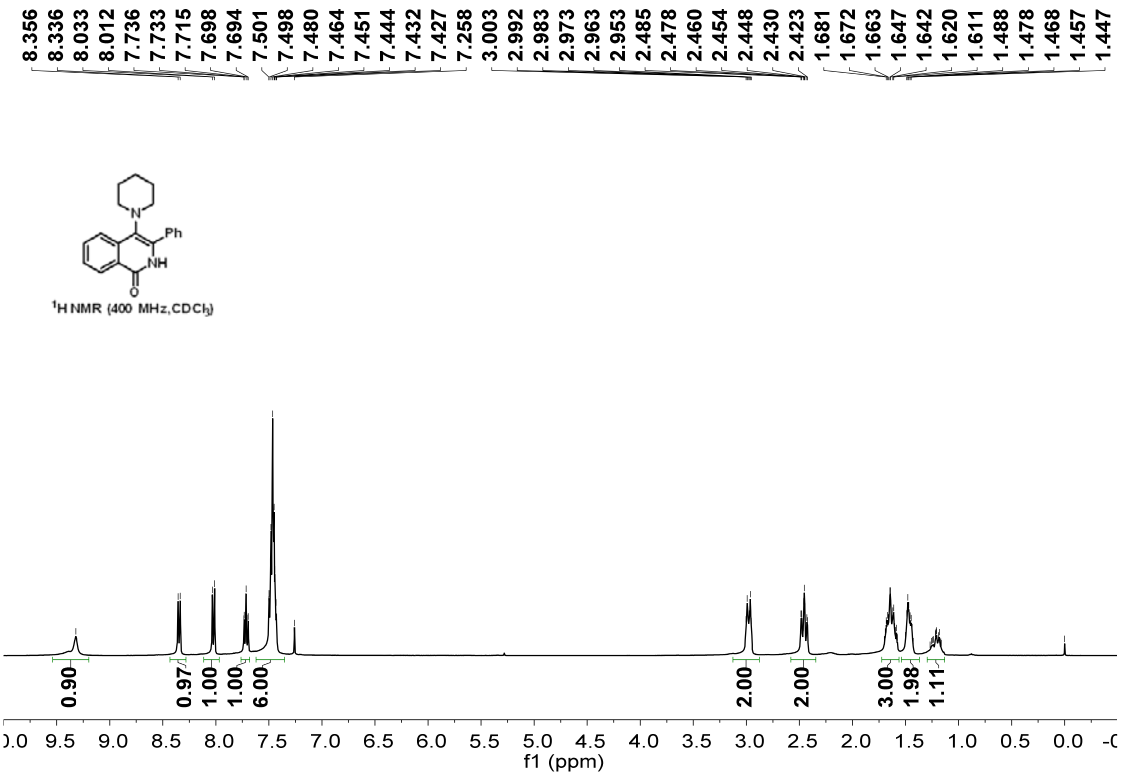


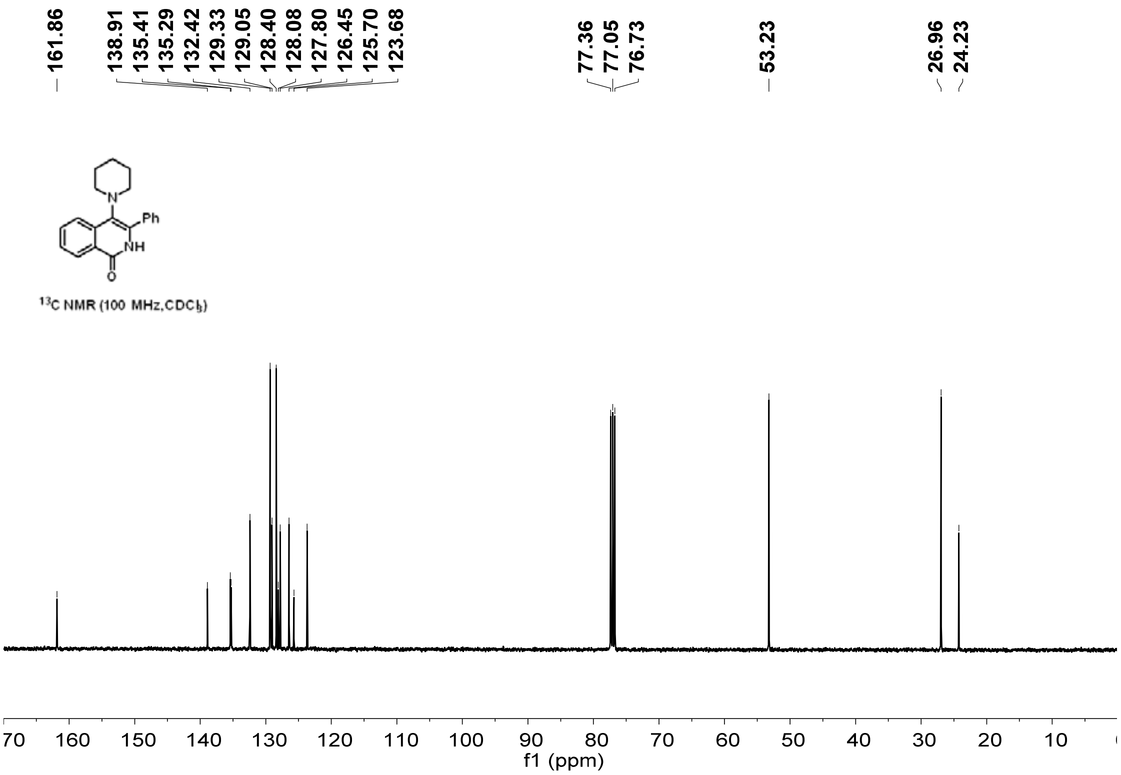
8.710
8.445
8.425
7.744
7.723
7.707
7.704
7.686
7.684
7.520
7.515
7.500
7.484
7.478
7.471
7.458
7.451
7.436
7.261
3.095
3.079
3.064
1.886
1.877
1.870
1.862
1.854
0.000
Ph
NH
O
N
^{1}H NMR (400 MHz,CDCl$_3$)
0.97
1.00
2.05
6.03
4.04
4.01
f1 (ppm)



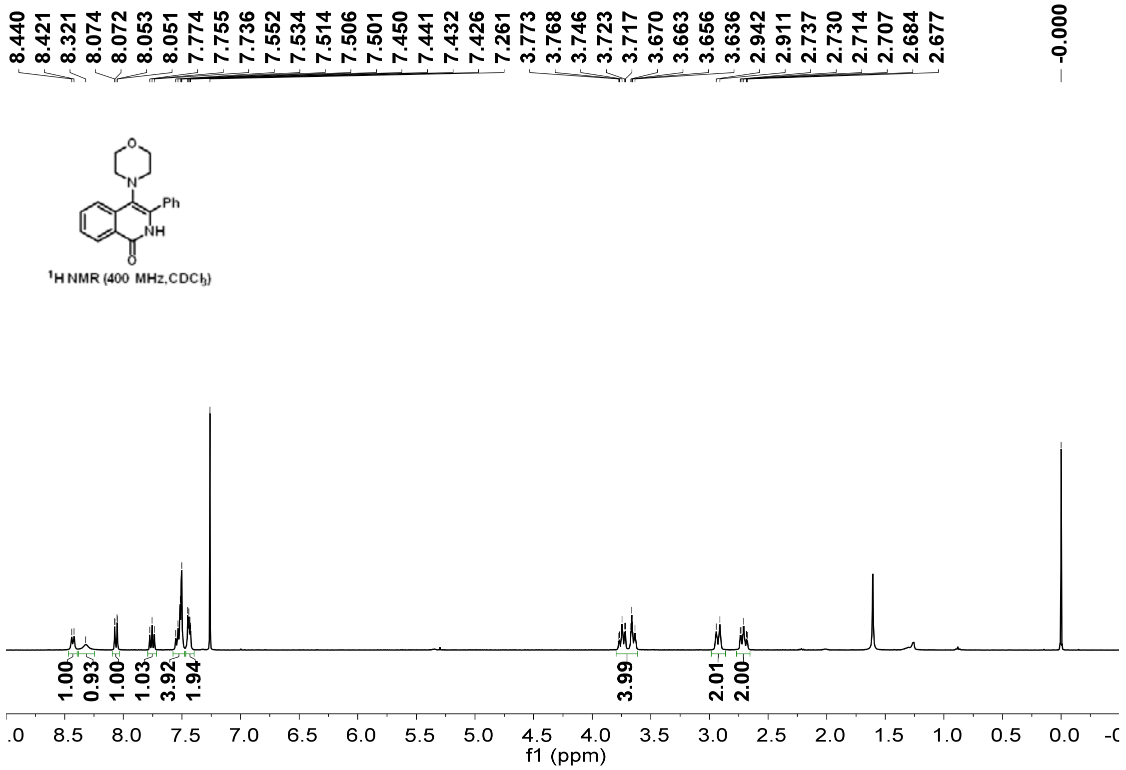
162.39
138.59
138.42
134.77
132.18
128.79
128.60
128.30
128.19
126.21
126.04
122.85
77.36
77.04
76.72
51.52
26.13
Ph
NH
O
N
^{13}C NMR (100 MHz,CDCl$_3$)
f1 (ppm)

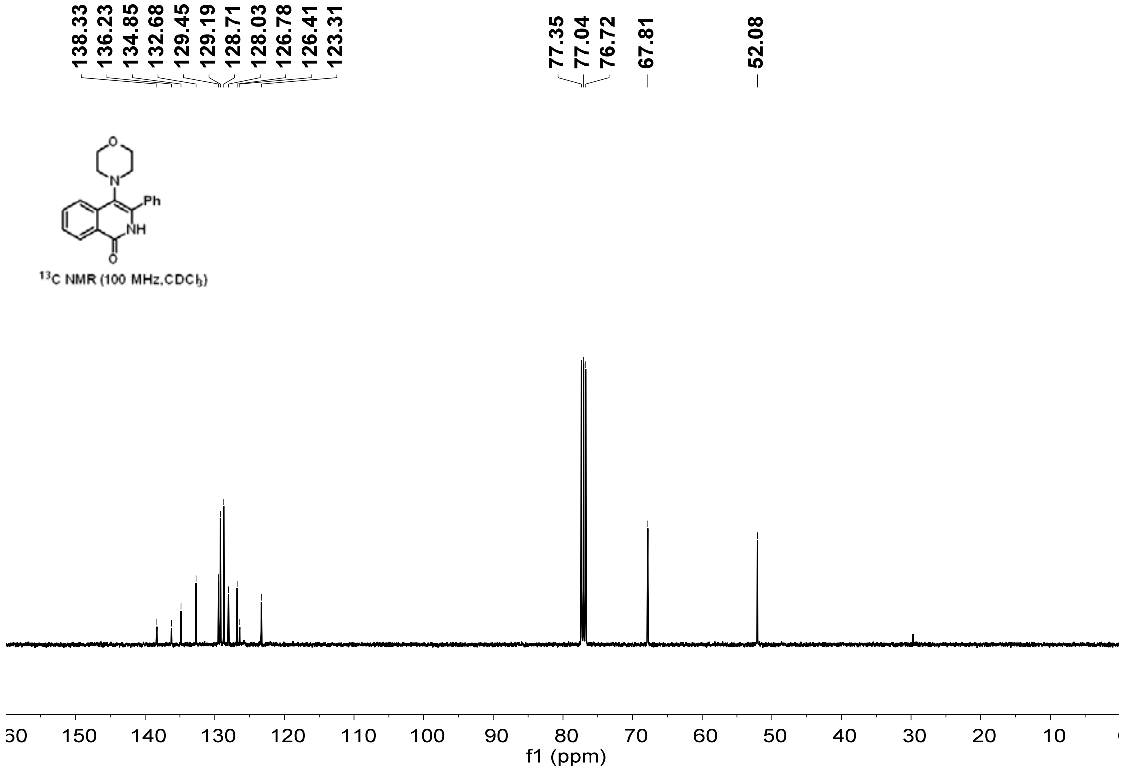
3sa


8.356
8.336
8.033
8.012
7.736
7.733
7.715
7.698
7.694
7.501
7.498
7.480
7.464
7.451
7.444
7.432
7.427
7.258
3.003
2.992
2.983
2.973
2.963
2.953
2.485
2.478
2.460
2.454
2.448
2.430
2.423
1.681
1.672
1.663
1.647
1.642
1.620
1.611
1.488
1.478
1.468
1.457
1.447
N
Ph
NH
O
1H NMR (400 MHz,CDCl3)
0.90
0.97
1.00
1.00
6.00
2.00
2.00
3.00
1.98
1.11
f1 (ppm)

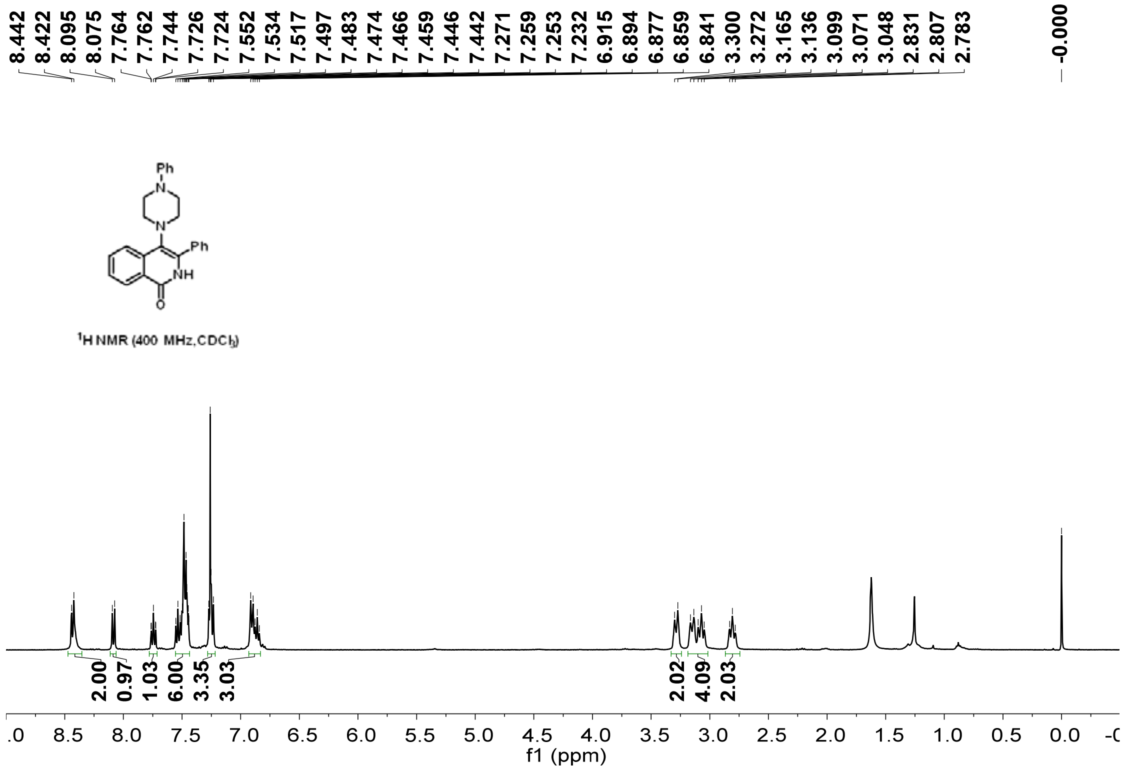

161.86
138.91
135.41
135.29
132.42
129.33
129.05
128.40
128.08
127.80
126.45
125.70
123.68
77.36
77.05
76.73
53.23
26.96
24.23
N
Ph
NH
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

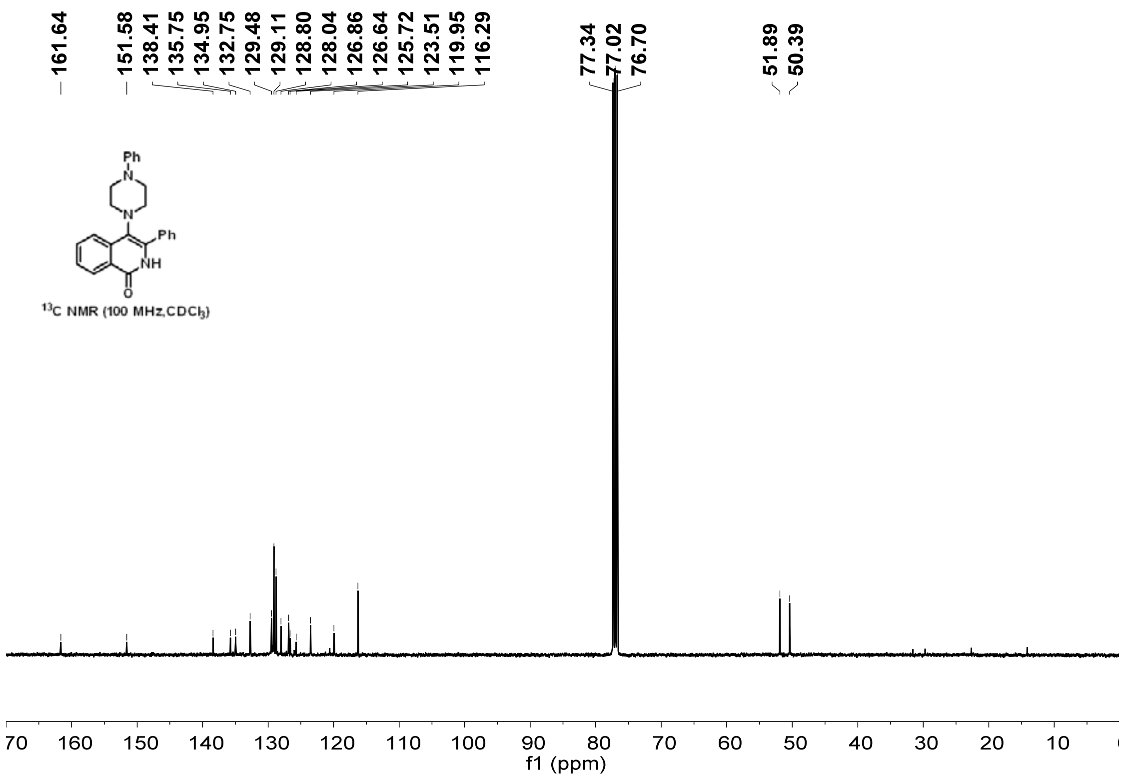
3ta


8.440
8.421
8.321
8.074
8.072
8.053
8.051
7.774
7.755
7.736
7.552
7.534
7.514
7.506
7.501
7.450
7.441
7.432
7.426
7.261
3.773
3.768
3.746
3.723
3.717
3.670
3.663
3.656
3.636
2.942
2.911
2.737
2.730
2.714
2.707
2.684
2.677
-0.000
O
N
Ph
NH
O
¹H NMR (400 MHz,CDCl₃)
1.00
0.93
1.00
1.03
3.92
1.94
3.99
2.01
2.00
f1 (ppm)

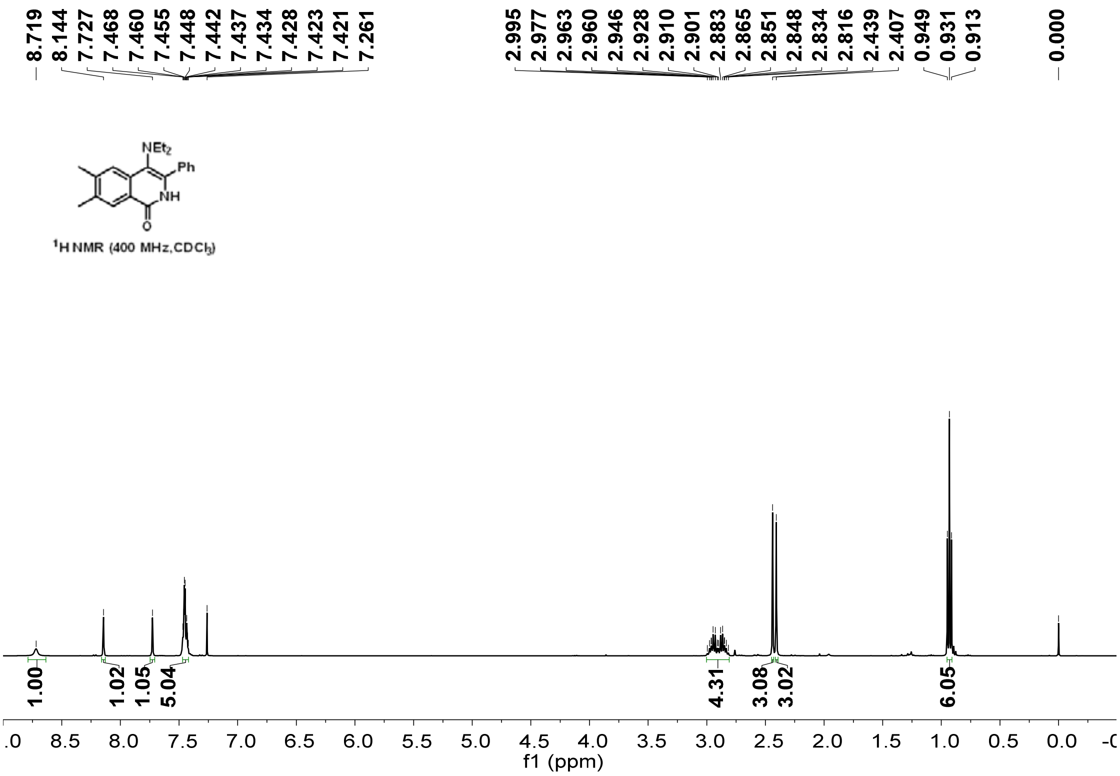

138.33
136.23
134.85
132.68
129.45
129.19
128.71
128.03
126.78
126.41
123.31
77.35
77.04
76.72
67.81
52.08
O
N
Ph
NH
O
¹³C NMR (100 MHz,CDCl₃)
f1 (ppm)

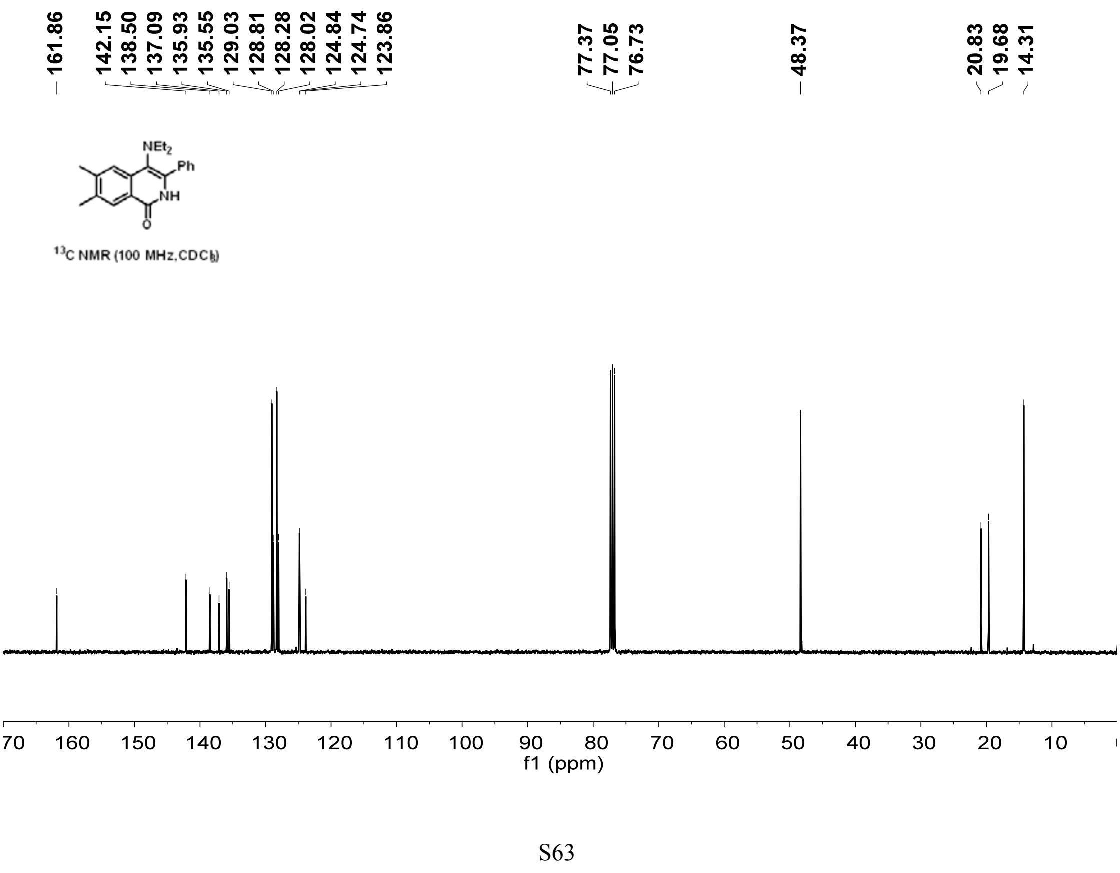
3ua


8.442
8.422
8.095
8.075
7.764
7.762
7.744
7.726
7.724
7.552
7.534
7.517
7.497
7.483
7.474
7.466
7.459
7.446
7.442
7.271
7.259
7.253
7.232
6.915
6.894
6.877
6.859
6.841
3.300
3.272
3.165
3.136
3.099
3.071
3.048
2.831
2.807
2.783
-0.000
Ph
N
N
Ph
NH
O
1H NMR (400 MHz,CDCl3)
2.00
0.97
1.03
6.00
3.35
3.03
2.02
4.09
2.03
f1 (ppm)

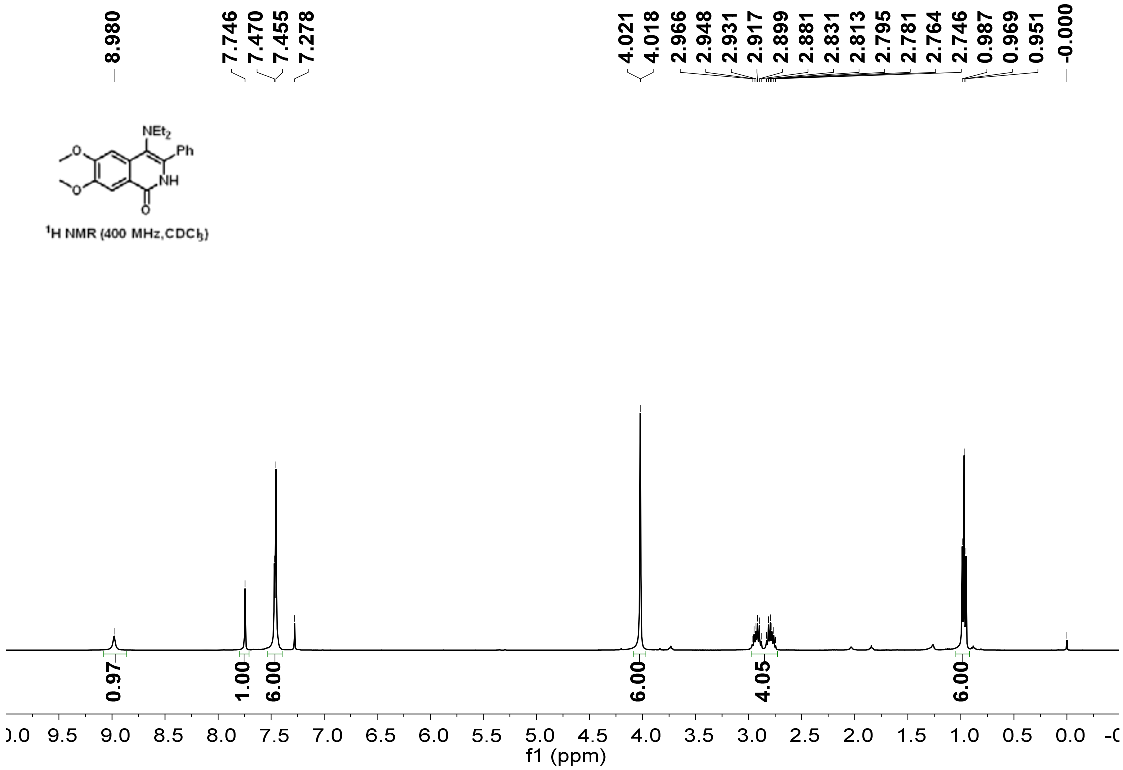

161.64
151.58
138.41
135.75
134.95
132.75
129.48
129.11
128.80
128.04
126.86
126.64
125.72
123.51
119.95
116.29
77.34
77.02
76.70
51.89
50.39
Ph
N
N
Ph
NH
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

3ab

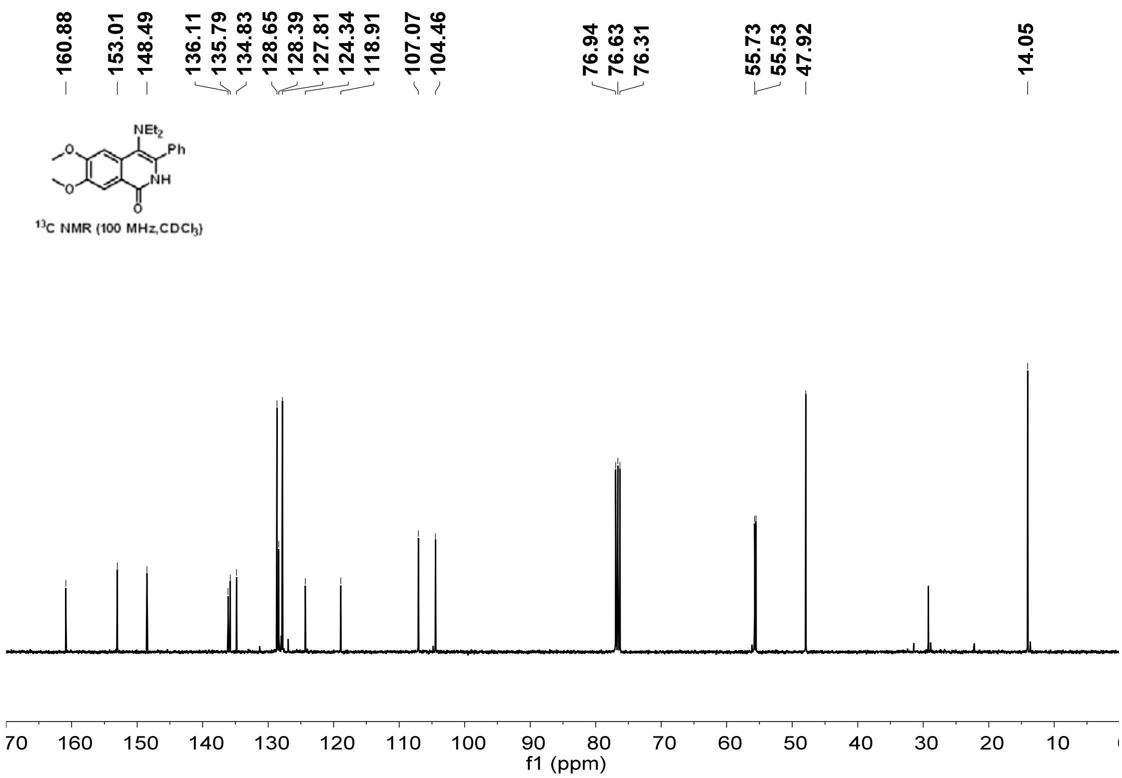

8.719
8.144
7.727
7.468
7.460
7.455
7.448
7.442
7.437
7.434
7.428
7.423
7.421
7.261
2.995
2.977
2.963
2.960
2.946
2.928
2.910
2.901
2.883
2.865
2.851
2.848
2.834
2.816
2.439
2.407
0.949
0.931
0.913
0.000
NEt2
Ph
NH
O
1H NMR (400 MHz,CDCl3)
1.00
1.02
1.05
5.04
4.31
3.08
3.02
6.05
f1 (ppm)


161.86
142.15
138.50
137.09
135.93
135.55
129.03
128.81
128.28
128.02
124.84
124.74
123.86
77.37
77.05
76.73
48.37
20.83
19.68
14.31
NEt2
Ph
NH
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

3ac

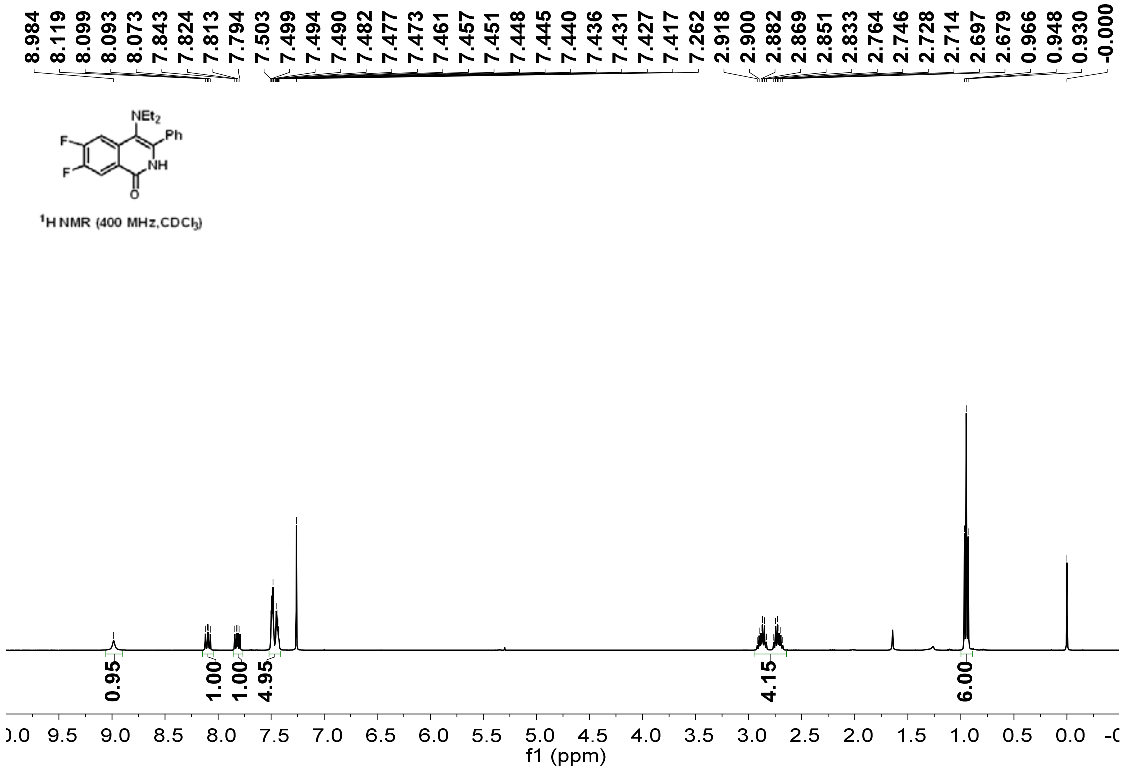


8.980
7.746
7.470
7.455
7.278
4.021
4.018
2.966
2.948
2.931
2.917
2.899
2.881
2.831
2.813
2.795
2.781
2.764
2.746
0.987
0.969
0.951
-0.000
NEt2
Ph
NH
O
1H NMR (400 MHz,CDCl3)
0.97
1.00
6.00
6.00
4.05
6.00
f1 (ppm)

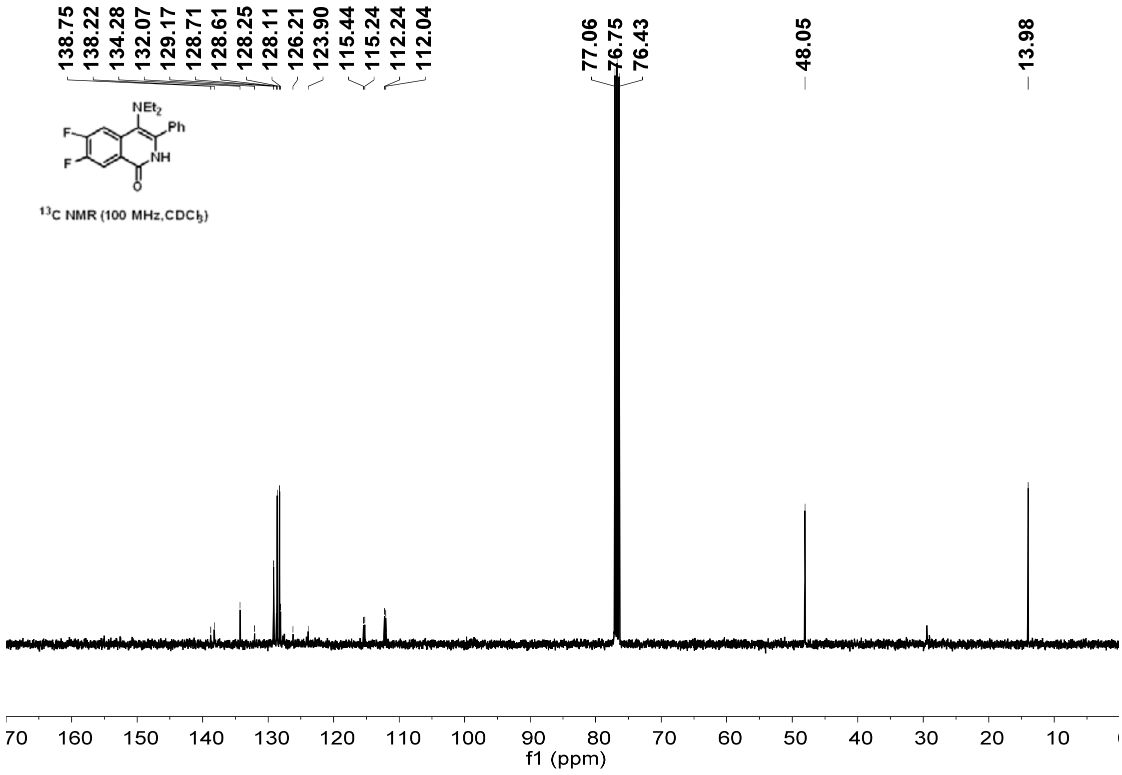


160.88
153.01
148.49
136.11
135.79
134.83
128.65
128.39
127.81
124.34
118.91
107.07
104.46
76.94
76.63
76.31
55.73
55.53
47.92
14.05
NEt2
Ph
NH
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

3ad

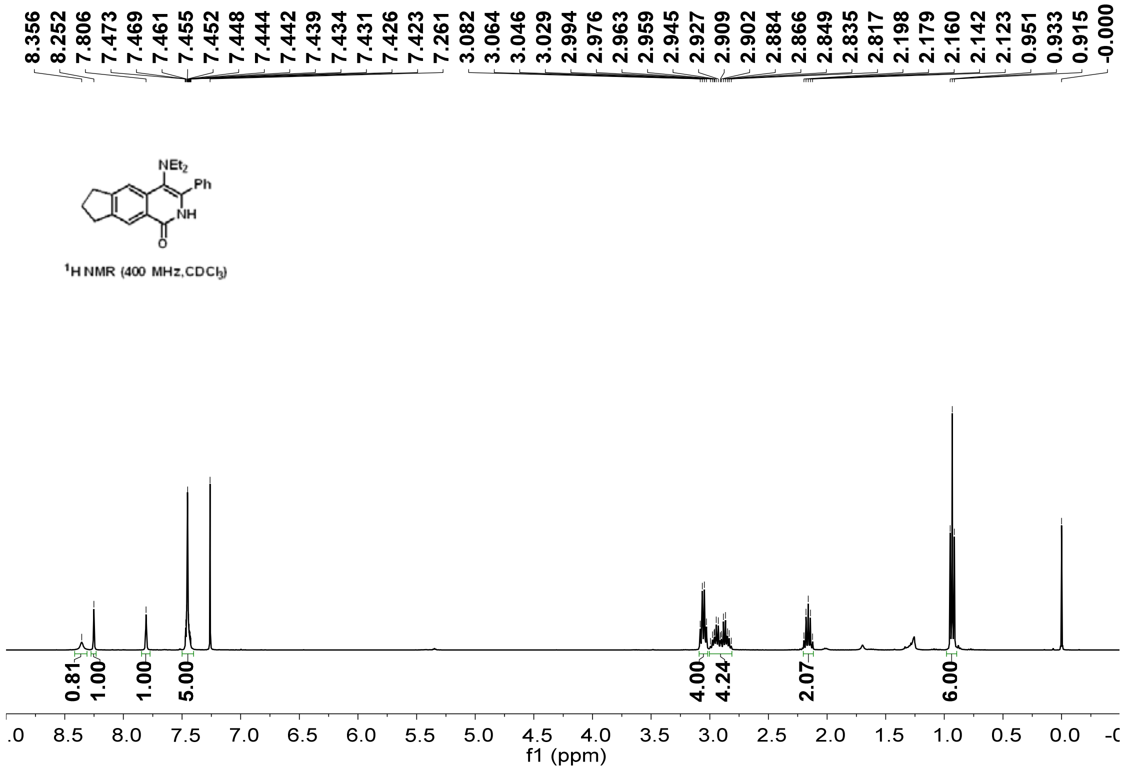


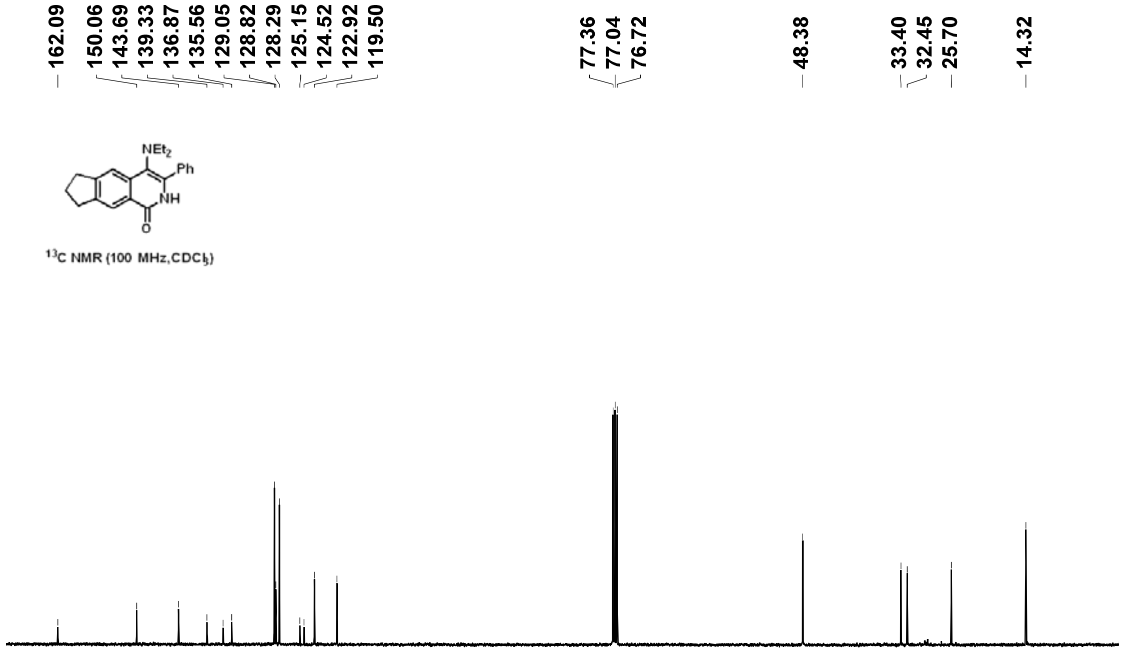
8.984
8.119
8.099
8.093
8.073
7.843
7.824
7.813
7.794
7.503
7.499
7.494
7.490
7.482
7.477
7.473
7.461
7.457
7.451
7.448
7.445
7.440
7.436
7.431
7.427
7.417
7.262
2.918
2.900
2.882
2.869
2.851
2.833
2.764
2.746
2.728
2.714
2.697
2.679
0.966
0.948
0.930
-0.000
NEt2
Ph
F
F
NH
O
1H NMR (400 MHz,CDCl3)
0.95
1.00
1.00
4.95
4.15
6.00
f1 (ppm)



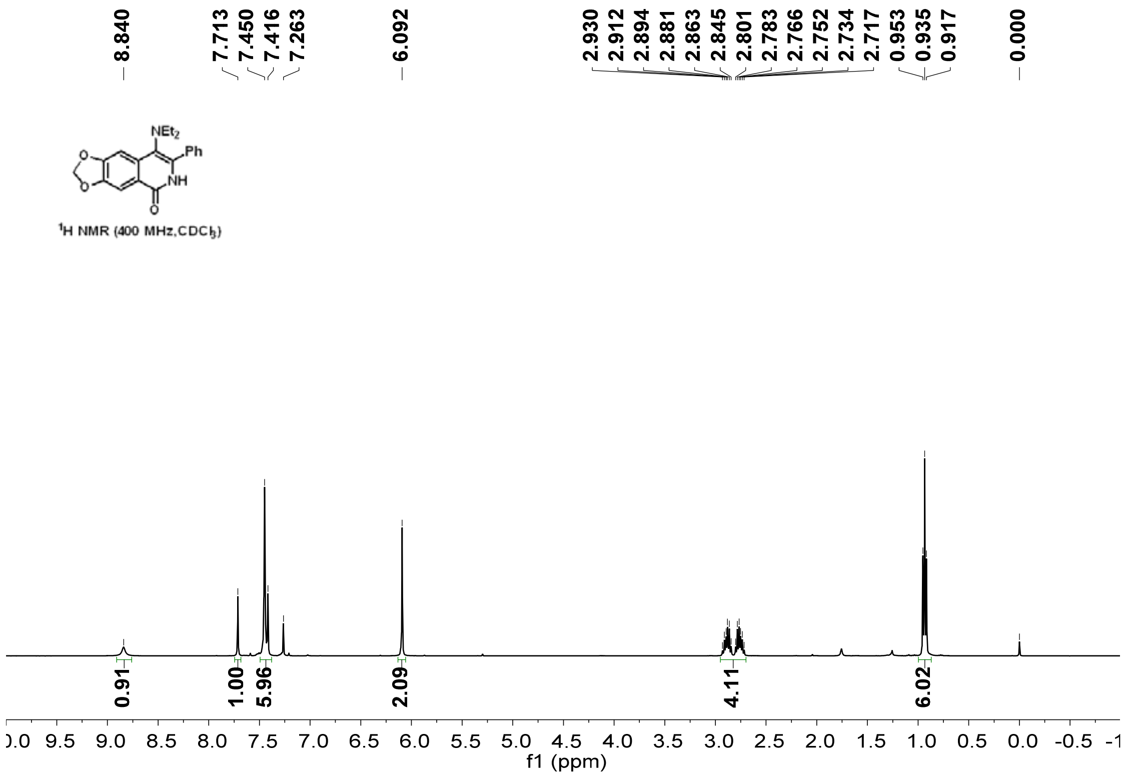
138.75
138.22
134.28
132.07
129.17
128.71
128.61
128.25
128.11
126.21
123.90
115.44
115.24
112.24
112.04
77.06
76.75
76.43
48.05
13.98
NEt2
Ph
F
F
NH
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

3ae

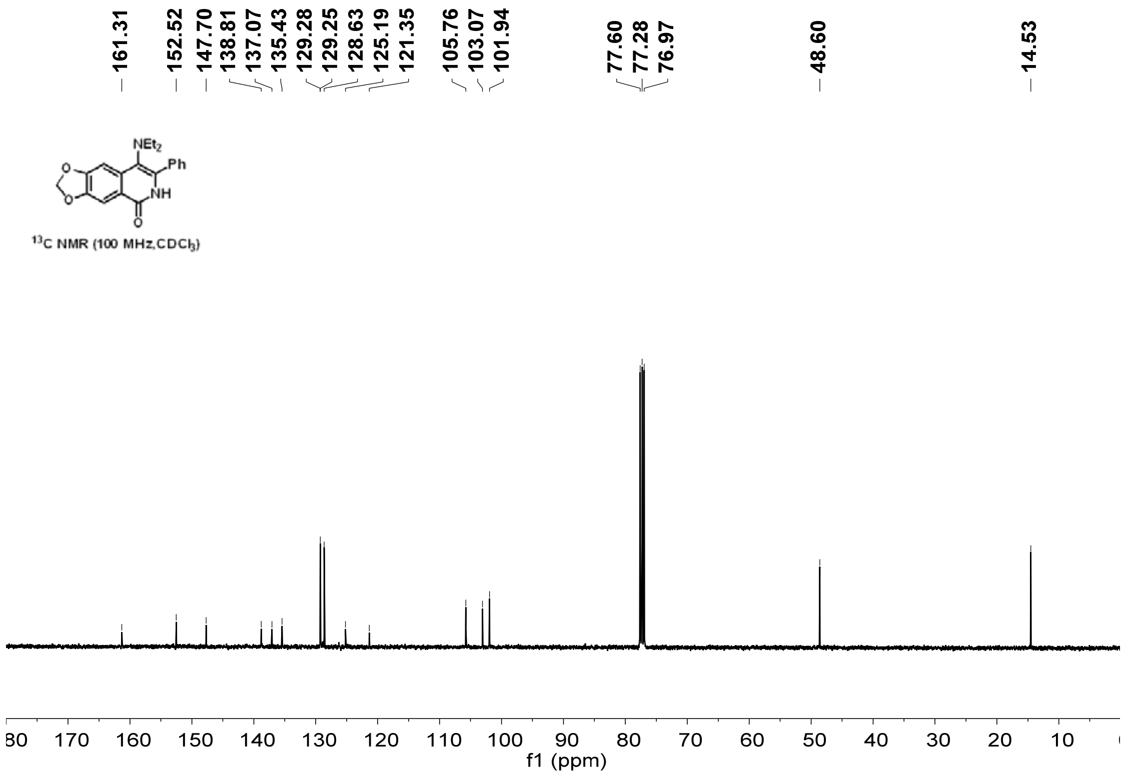

8.356
8.252
7.806
7.473
7.469
7.461
7.455
7.452
7.448
7.444
7.442
7.439
7.434
7.431
7.426
7.423
7.261
3.082
3.064
3.046
3.029
2.994
2.976
2.963
2.959
2.945
2.927
2.909
2.902
2.884
2.866
2.849
2.835
2.817
2.198
2.179
2.160
2.142
2.123
0.951
0.933
0.915
-0.000
NEt2
Ph
NH
O
1H NMR (400 MHz,CDCl3)
0.81
1.00
1.00
5.00
4.00
4.24
2.07
6.00
f1 (ppm)


162.09
150.06
143.69
139.33
136.87
135.56
129.05
128.82
128.29
125.15
124.52
122.92
119.50
77.36
77.04
76.72
48.38
33.40
32.45
25.70
14.32
NEt2
Ph
NH
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

3af

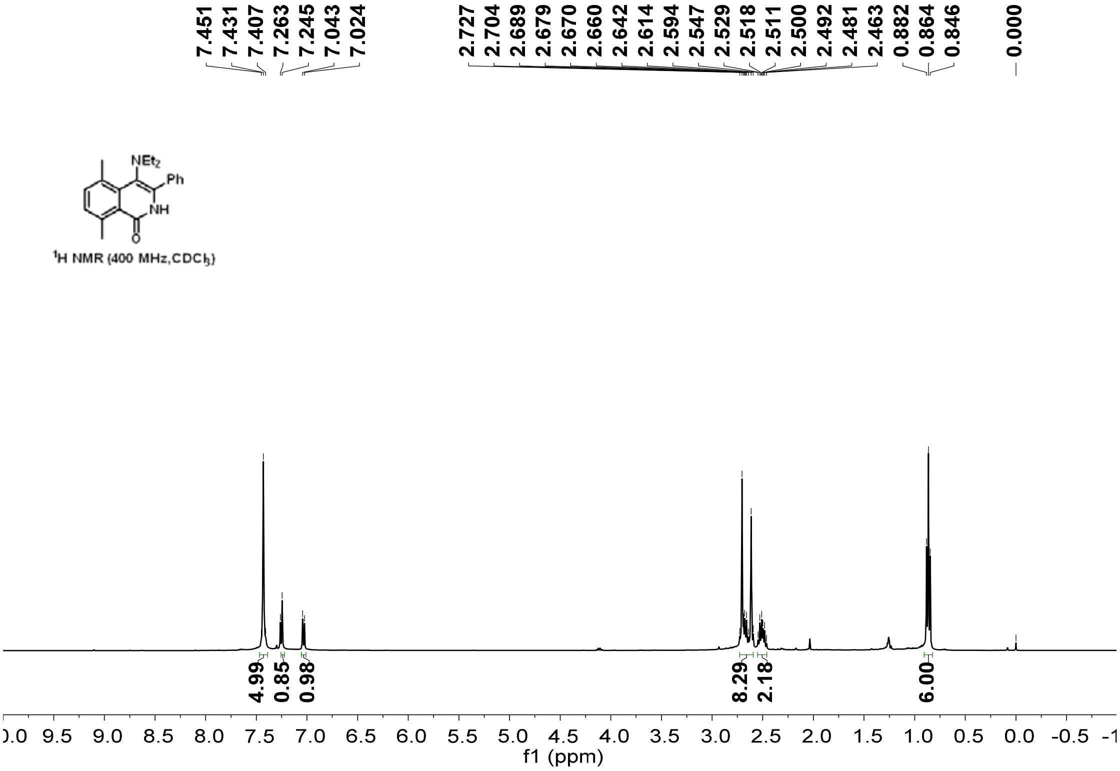


NEt2
Ph
NH
O
^{1}H NMR (400 MHz,CDCl$_3$)
8.840
7.713
7.450
7.416
7.263
6.092
2.930
2.912
2.894
2.881
2.863
2.845
2.801
2.783
2.766
2.752
2.734
2.717
0.953
0.935
0.917
0.000
0.91
1.00
5.96
2.09
4.11
6.02
f1 (ppm)

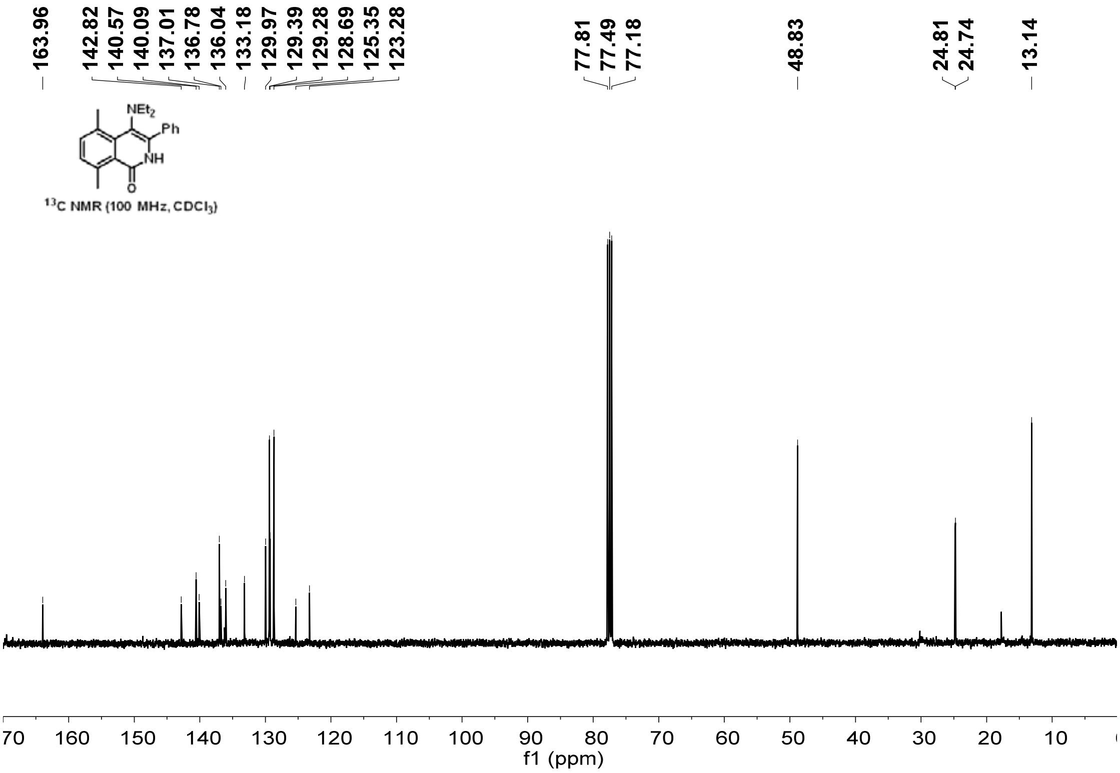


NEt2
Ph
NH
O
^{13}C NMR (100 MHz,CDCl$_3$)
161.31
152.52
147.70
138.81
137.07
135.43
129.28
129.25
128.63
125.19
121.35
105.76
103.07
101.94
77.60
77.28
76.97
48.60
14.53
f1 (ppm)

3ag

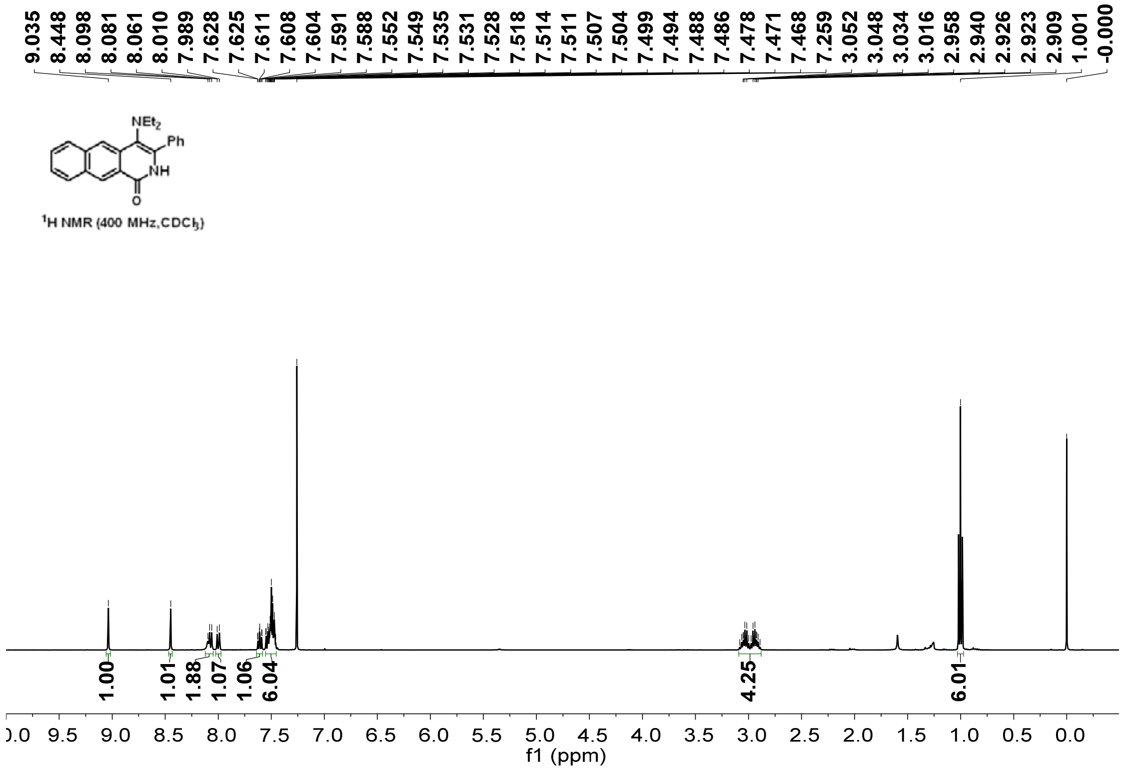


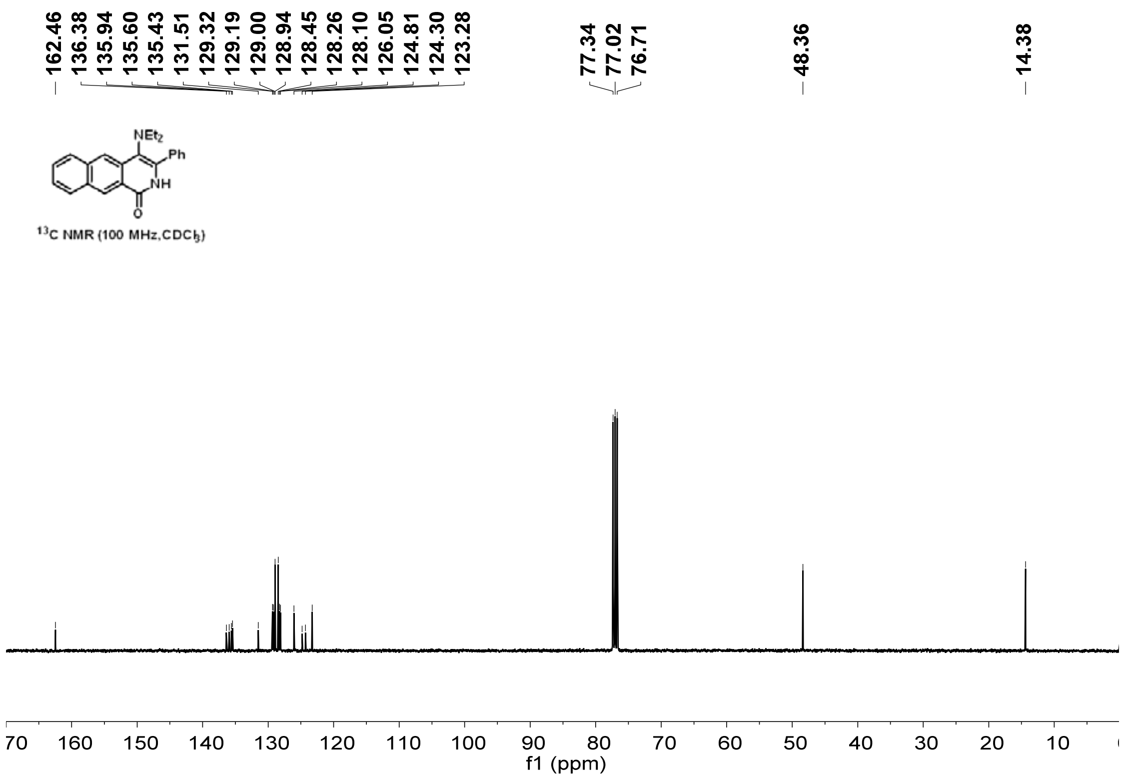
7.451
7.431
7.407
7.263
7.245
7.043
7.024
2.727
2.704
2.689
2.679
2.670
2.660
2.642
2.614
2.594
2.547
2.529
2.518
2.511
2.500
2.492
2.481
2.463
0.882
0.864
0.846
0.000
NEt2
Ph
NH
O
¹H NMR (400 MHz, CDCl3)
4.99
0.85
0.98
8.29
2.18
6.00
f1 (ppm)



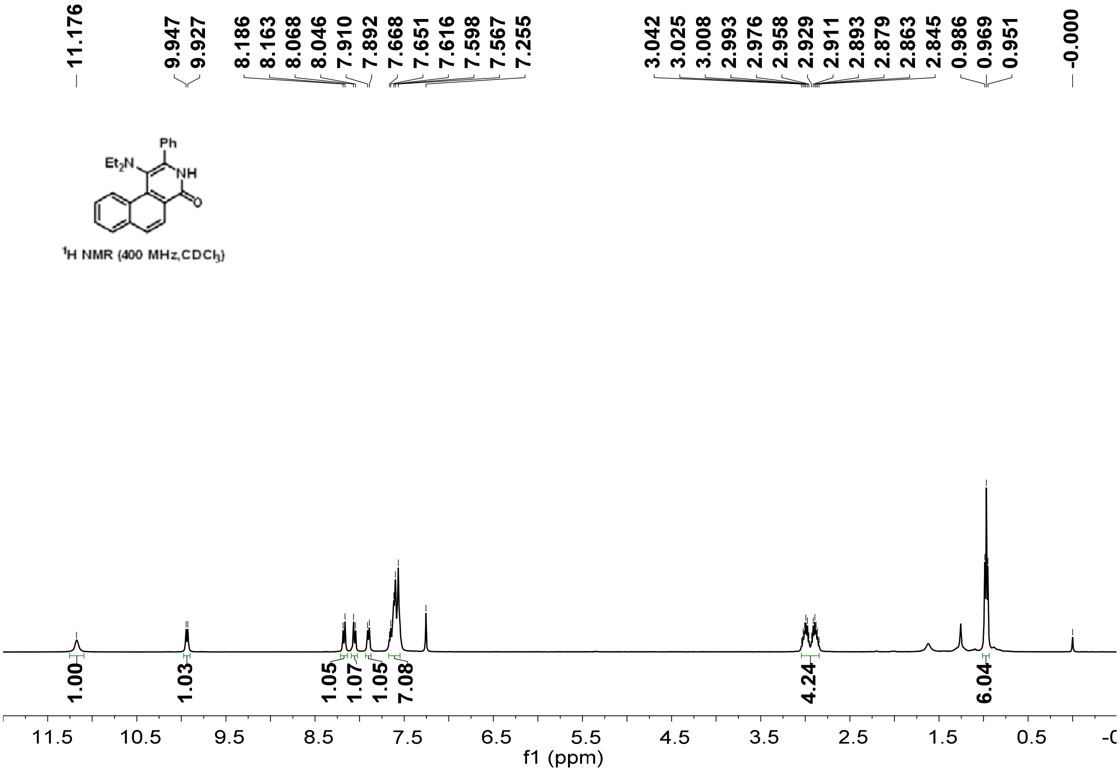
163.96
142.82
140.57
140.09
137.01
136.78
136.04
133.18
129.97
129.39
129.28
128.69
125.35
123.28
77.81
77.49
77.18
48.83
24.81
24.74
13.14
NEt2
Ph
NH
O
¹³C NMR (100 MHz, CDCl3)
f1 (ppm)

3ah

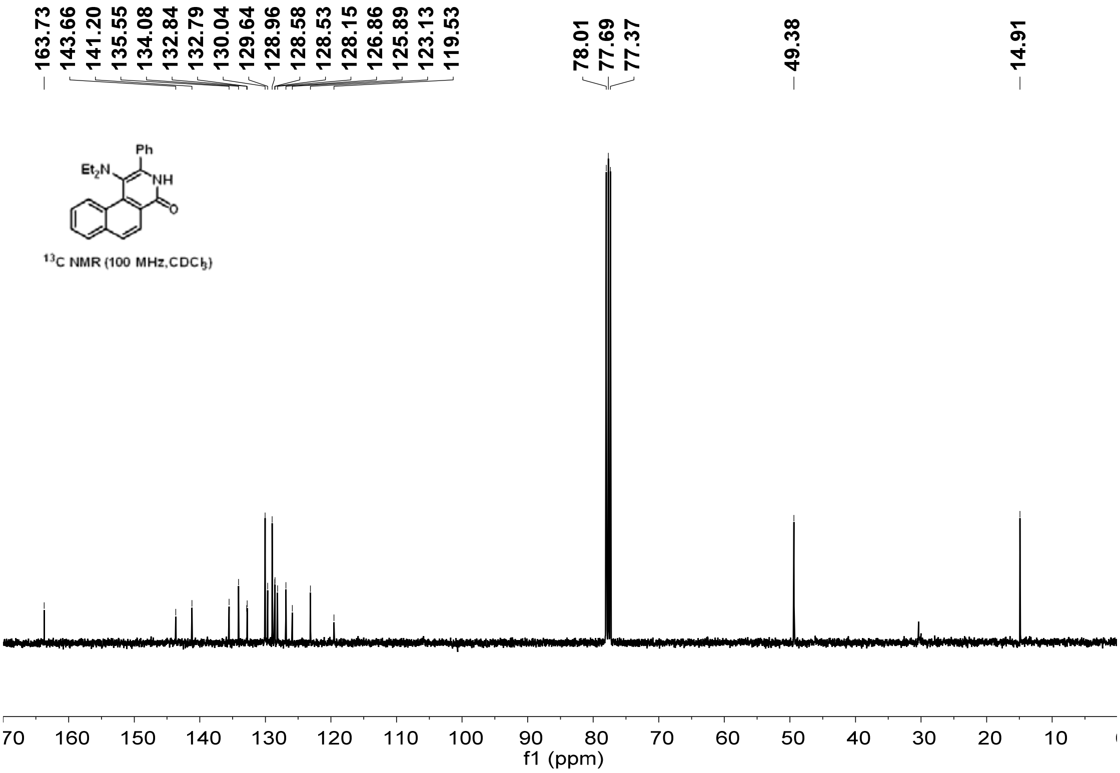




3ai

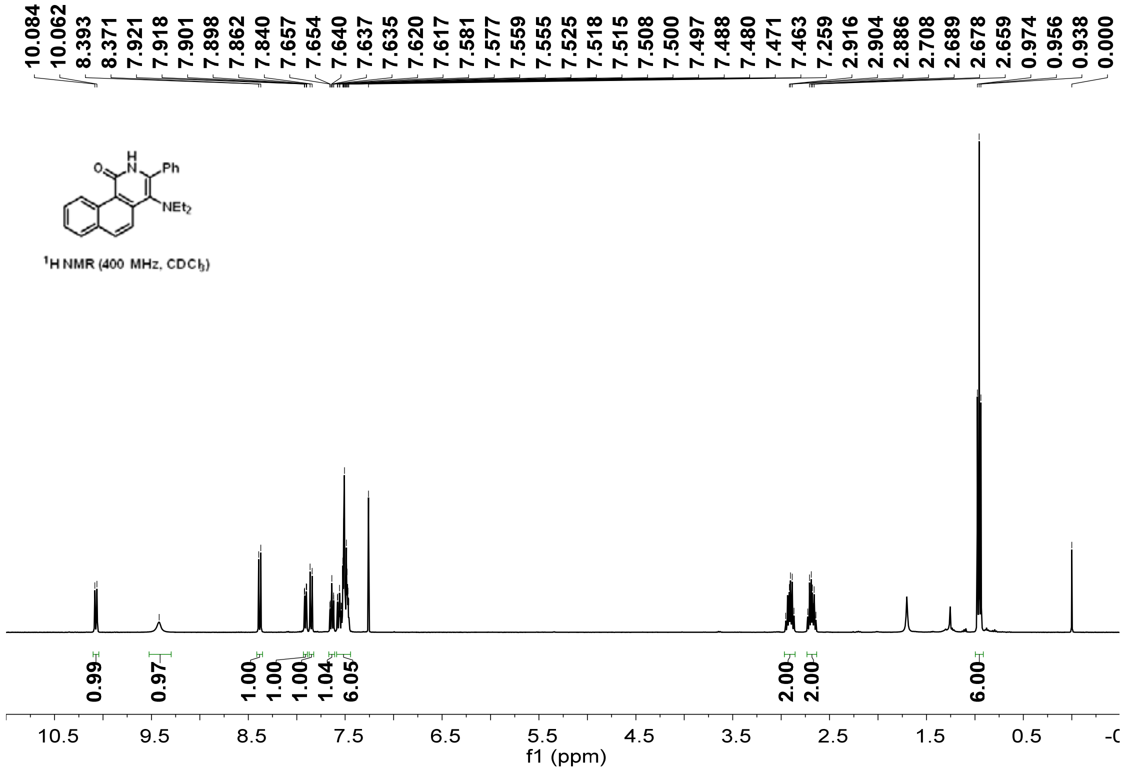


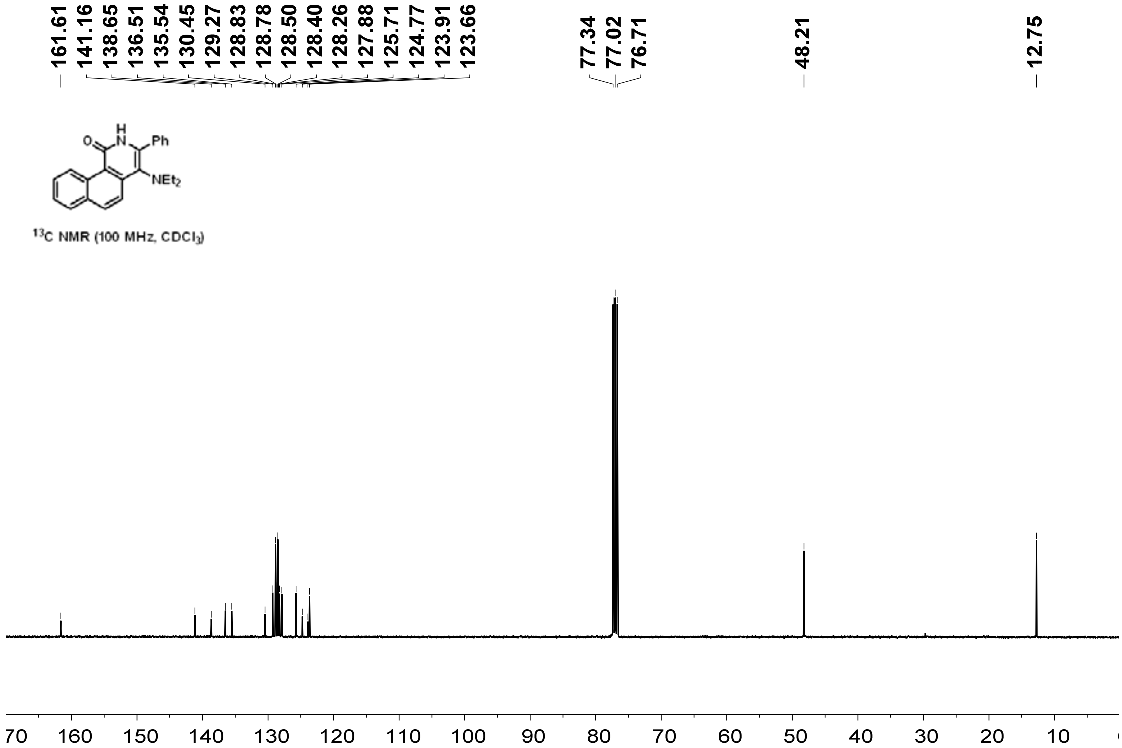
11.176
9.947
9.927
8.186
8.163
8.068
8.046
7.910
7.892
7.668
7.651
7.616
7.598
7.567
7.255
3.042
3.025
3.008
2.993
2.976
2.958
2.929
2.911
2.893
2.879
2.863
2.845
0.986
0.969
0.951
-0.000
Ph
Et_2N
NH
O
^1H NMR (400 MHz,$CDCl_3$)
1.00
1.03
1.05
1.07
1.05
7.08
4.24
6.04
f1 (ppm)



163.73
143.66
141.20
135.55
134.08
132.84
132.79
130.04
129.64
128.96
128.58
128.53
128.15
126.86
125.89
123.13
119.53
78.01
77.69
77.37
49.38
14.91
Ph
Et_2N
NH
O
^{13}C NMR (100 MHz,$CDCl_3$)
f1 (ppm)

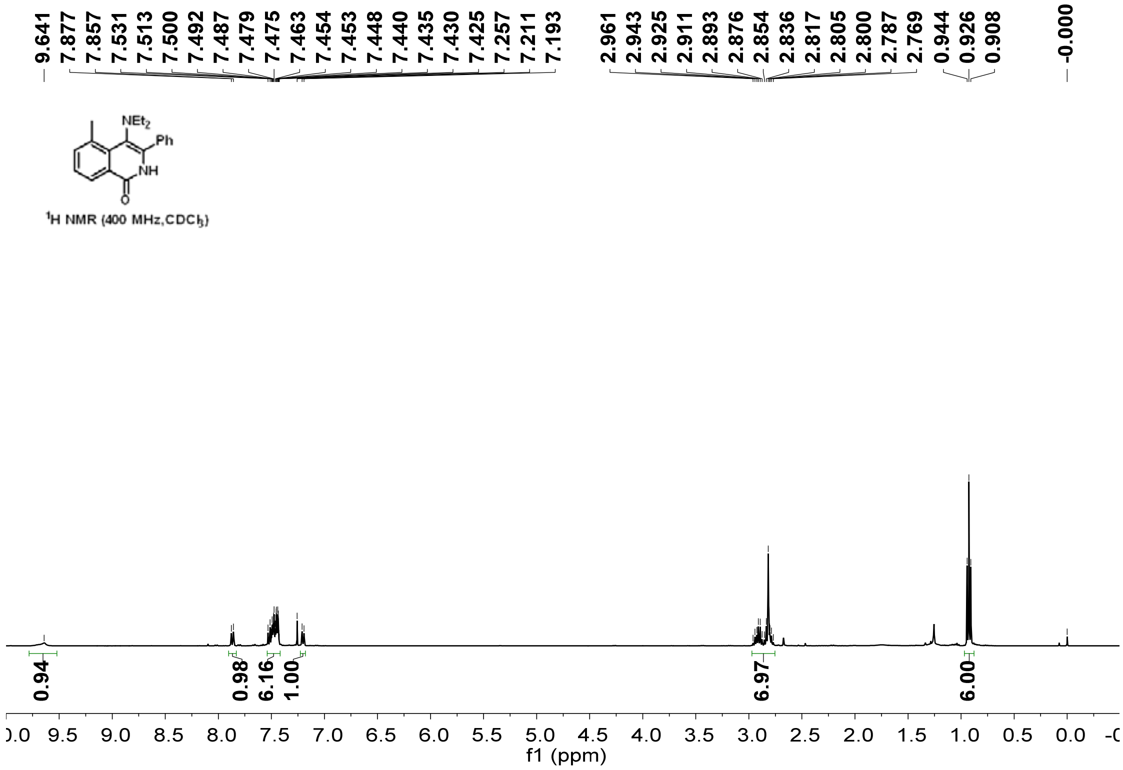
3ai′

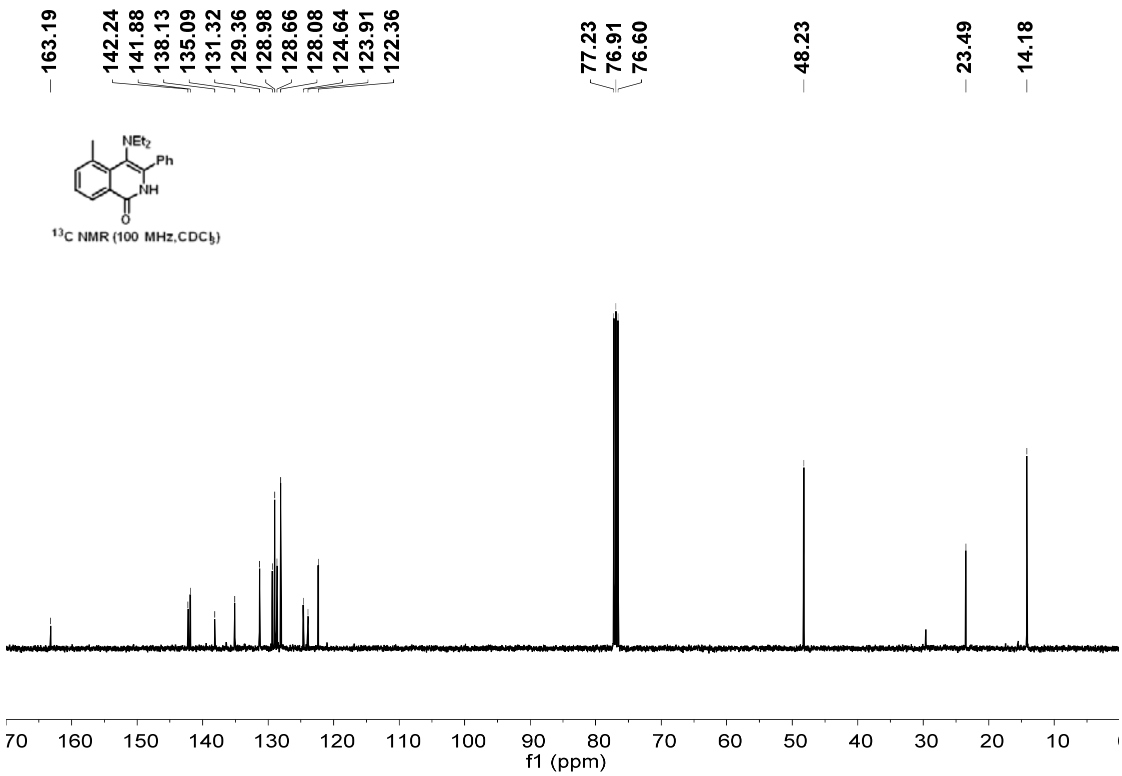


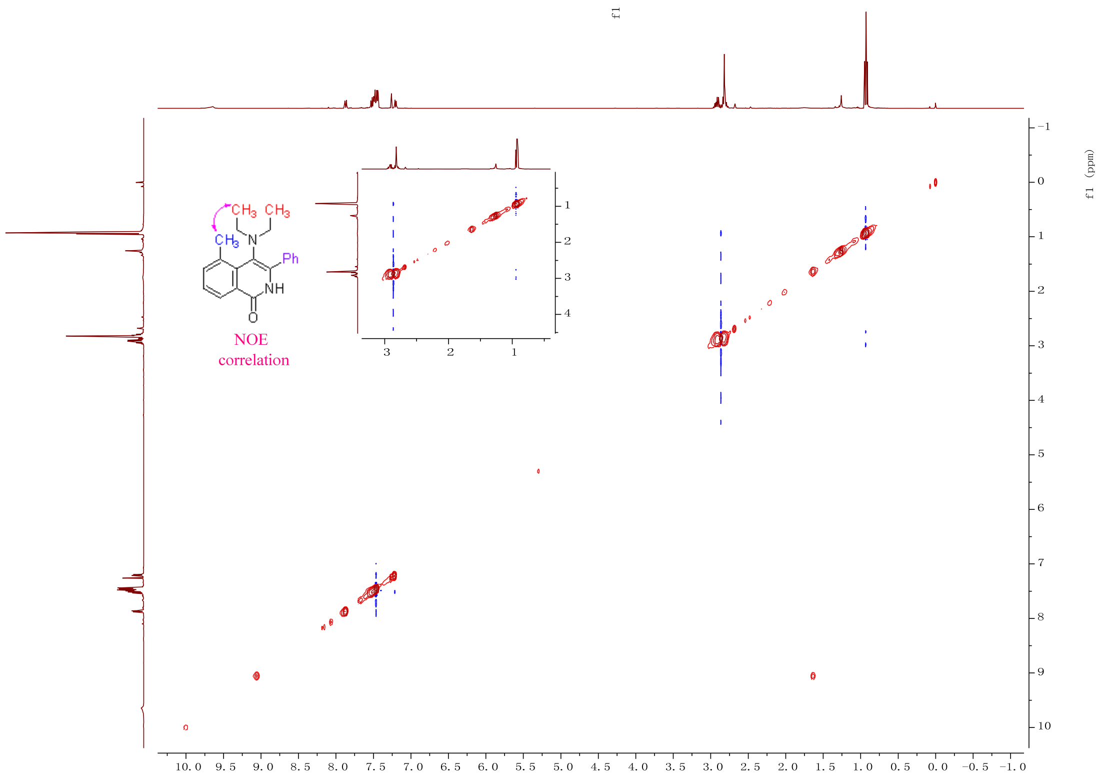


3aj

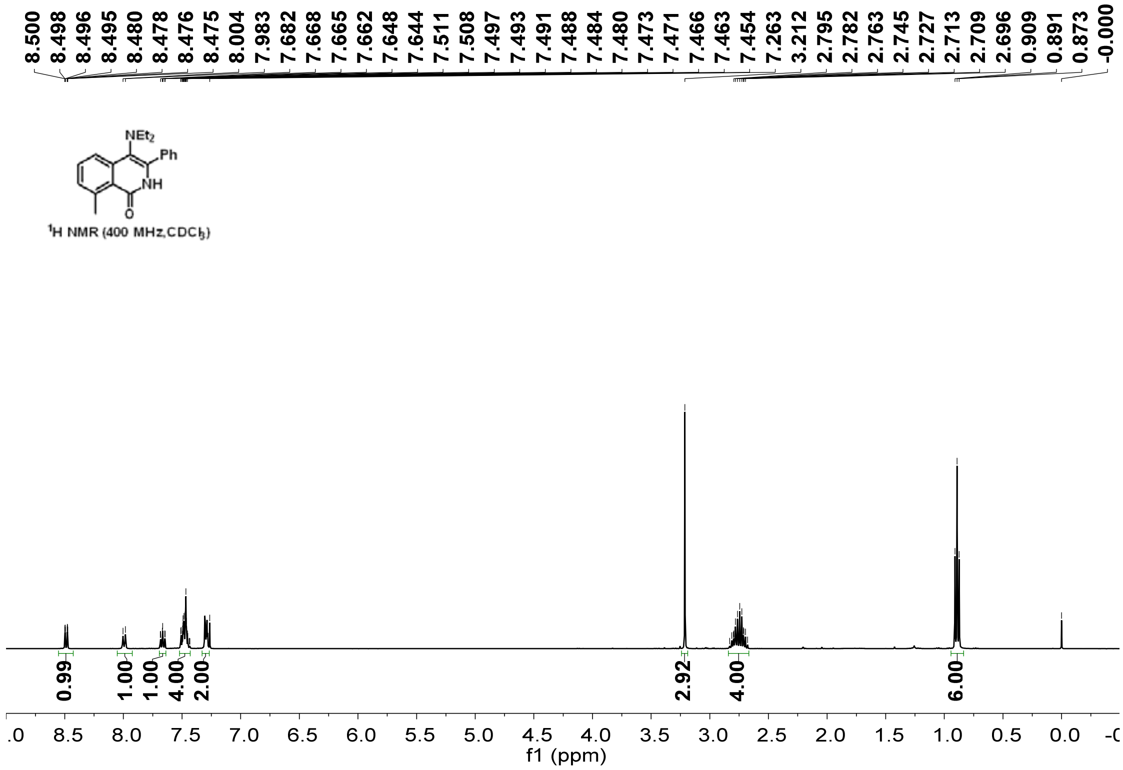
The regioselectivity was determined by NOE experiment. For **3aj**, NOE correlation was observed between methyl-H in the 5th position and methyl-H of diethylin.



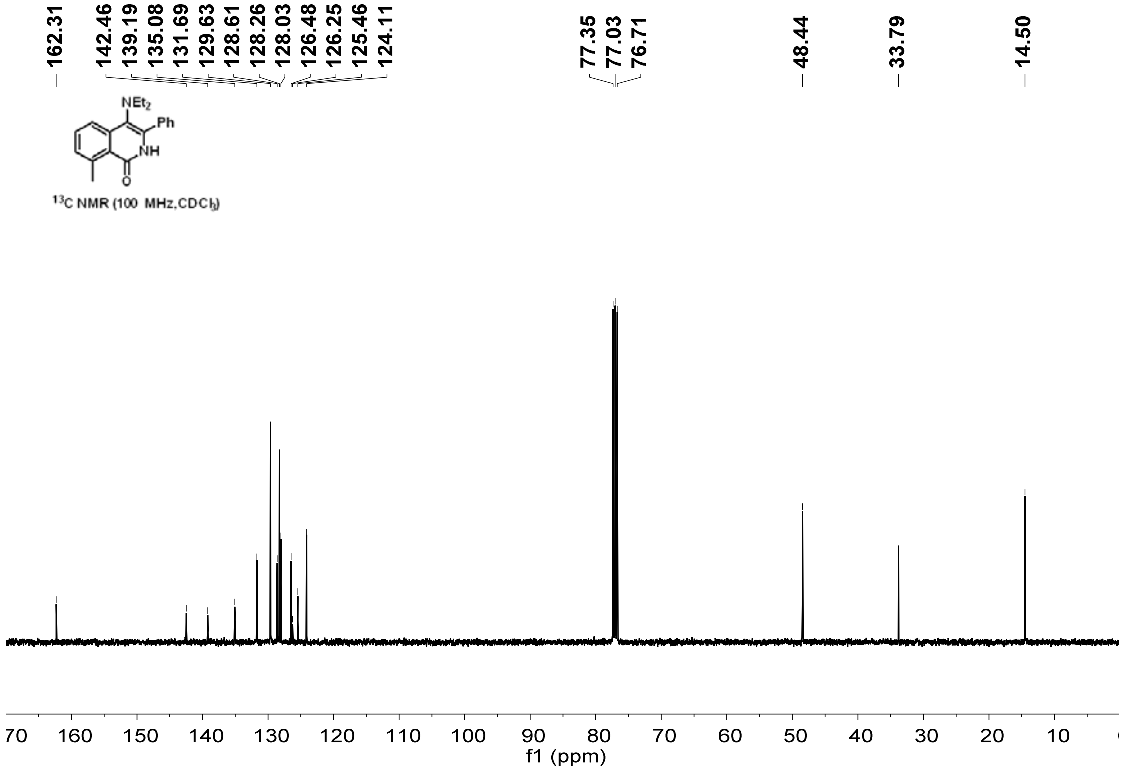



CH3
CH3
CH3
N
Ph
NH
O
NOE
correlation
f1 (ppm)
f1

3aj′



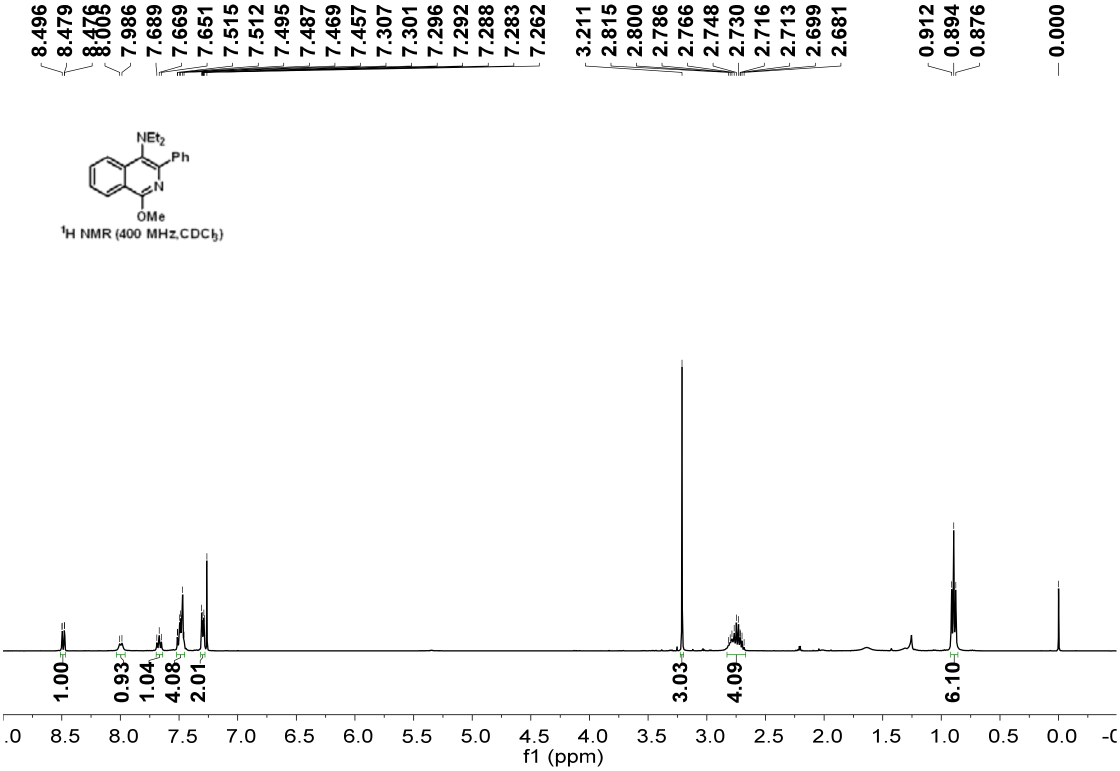
8.500 8.498 8.496 8.495 8.480 8.478 8.476 8.475 8.004 7.983 7.682 7.668 7.665 7.662 7.648 7.644 7.511 7.508 7.497 7.493 7.491 7.488 7.484 7.480 7.473 7.471 7.466 7.463 7.454 7.263 3.212 2.795 2.782 2.763 2.745 2.727 2.713 2.709 2.696 0.909 0.891 0.873 -0.000
NEt2
Ph
NH
O
1H NMR (400 MHz,CDCl3)
0.99 1.00 1.00 4.00 2.00 2.92 4.00 6.00
f1 (ppm)

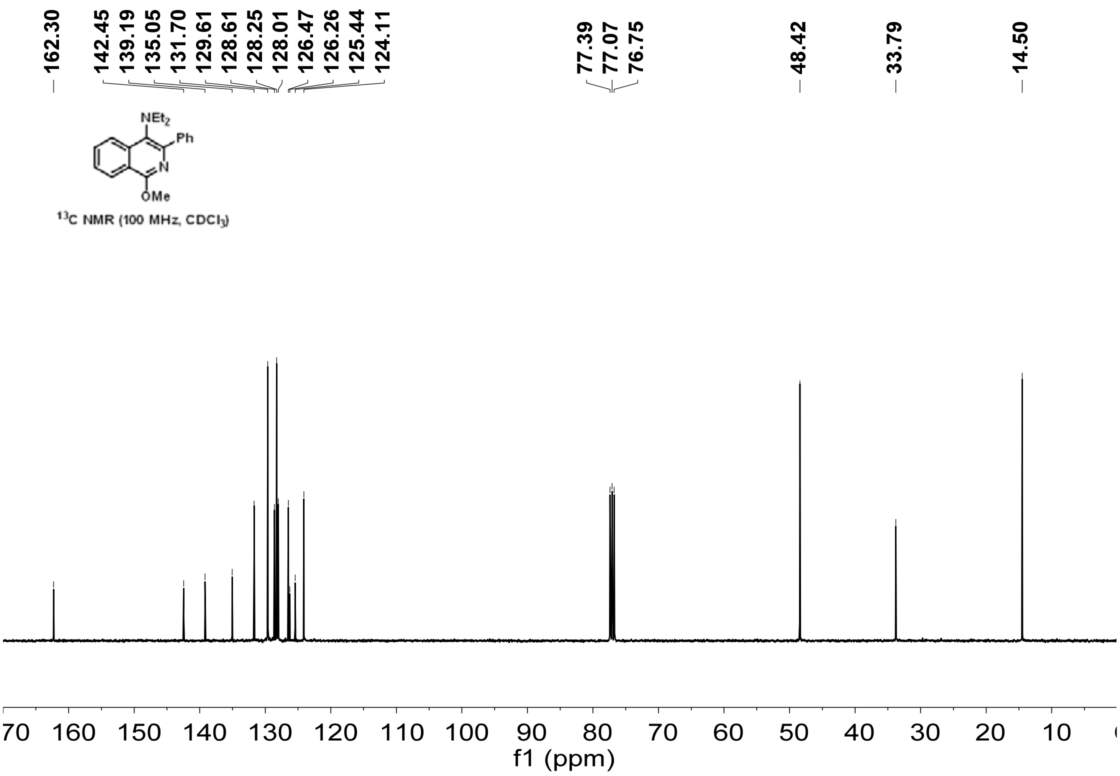


162.31 142.46 139.19 135.08 131.69 129.63 128.61 128.26 128.03 126.48 126.25 125.46 124.11 77.35 77.03 76.71 48.44 33.79 14.50
NEt2
Ph
NH
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

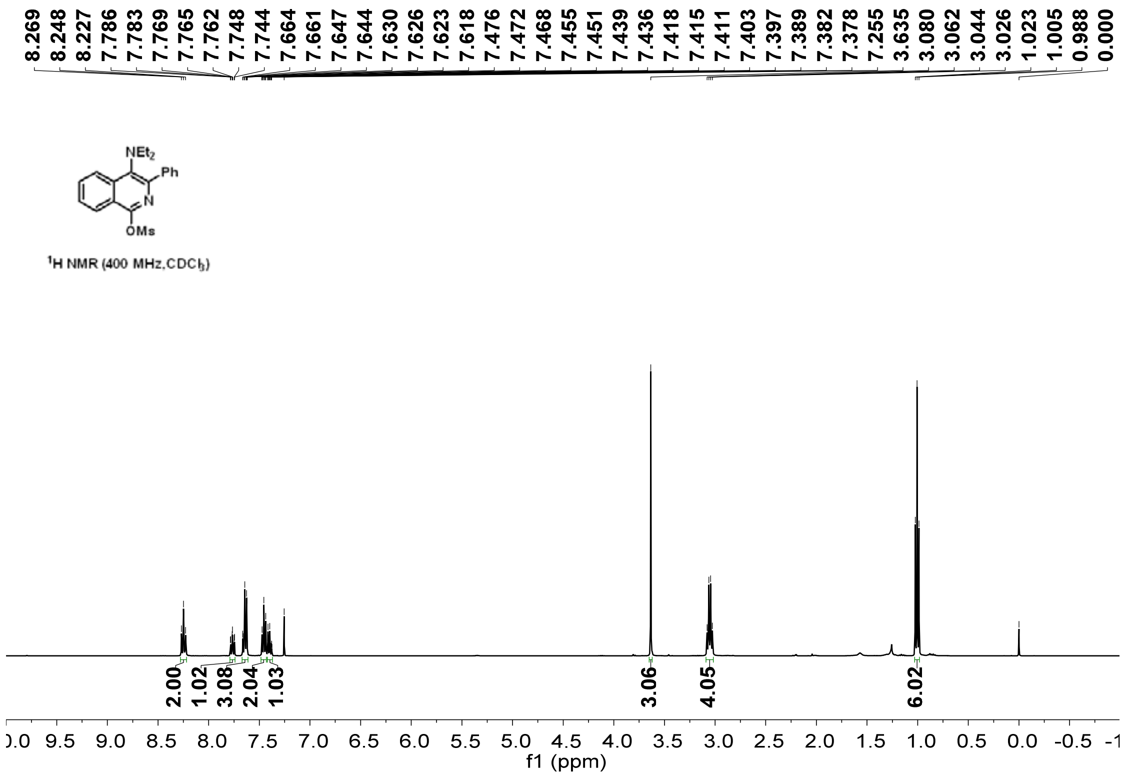
3.3 Copies of NMR spectra of derivatization products:

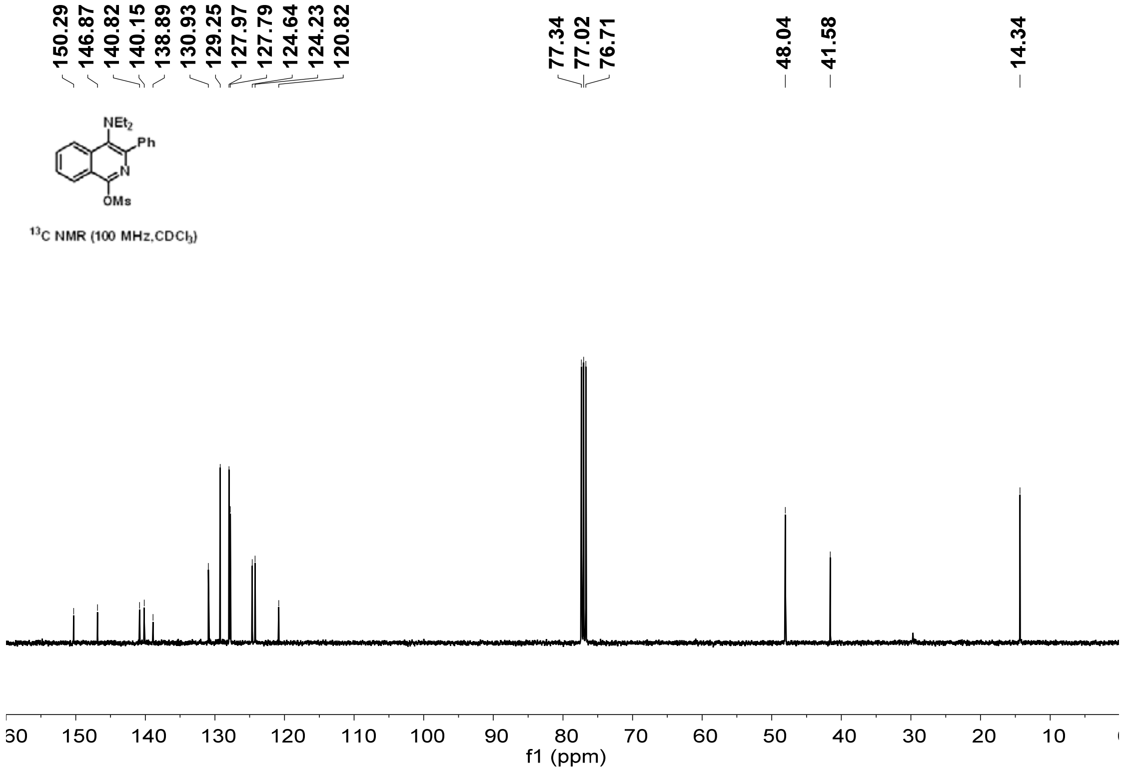
4



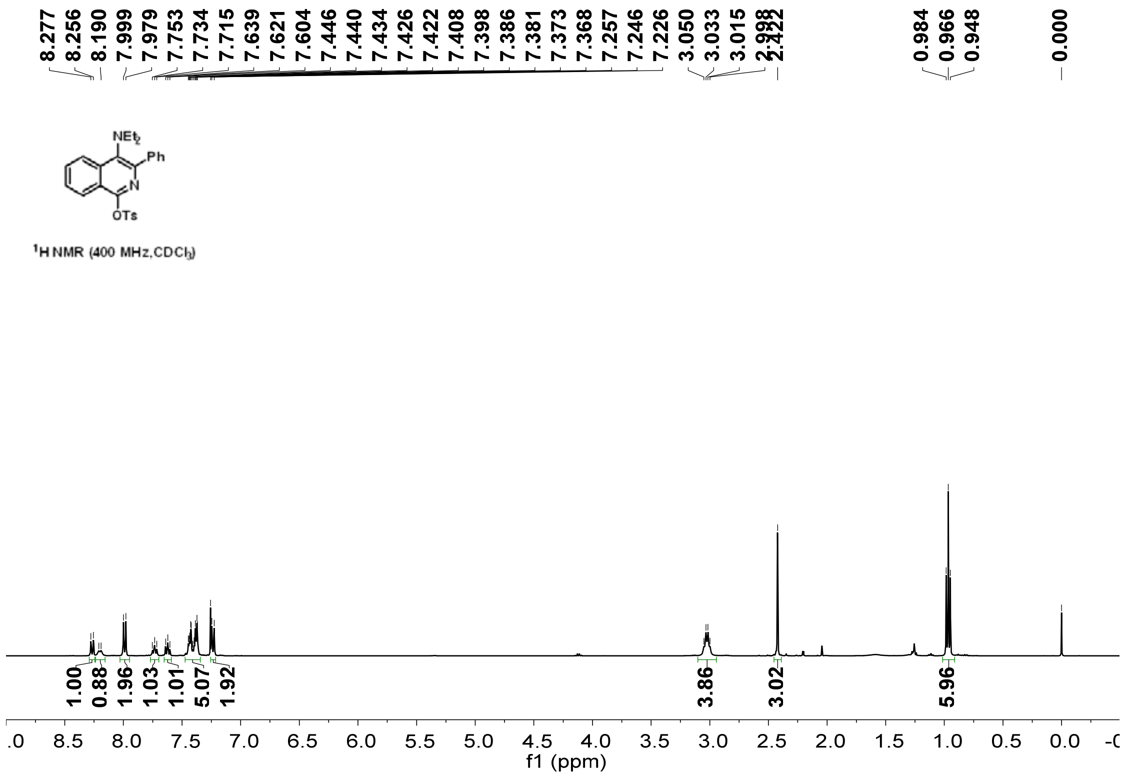


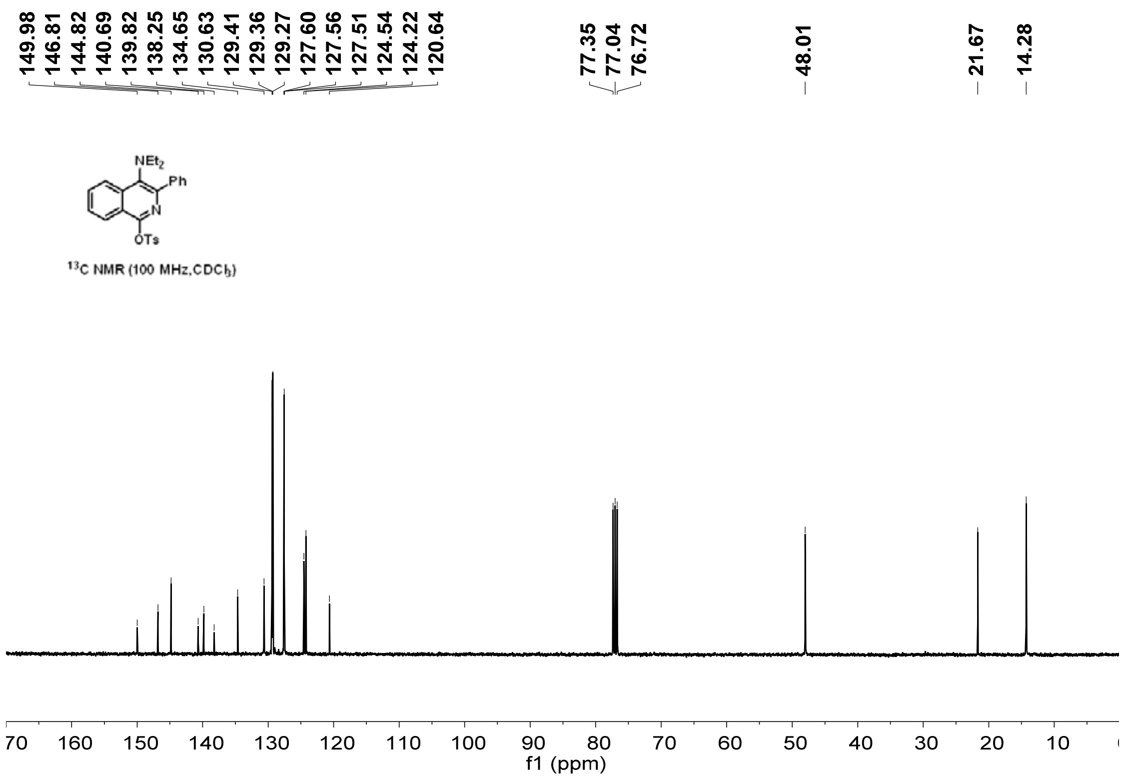
5


8.269
8.248
8.227
7.786
7.783
7.769
7.765
7.762
7.748
7.744
7.664
7.661
7.647
7.644
7.630
7.626
7.623
7.618
7.476
7.472
7.468
7.455
7.451
7.439
7.436
7.418
7.415
7.411
7.403
7.397
7.389
7.382
7.378
7.255
3.635
3.080
3.062
3.044
3.026
1.023
1.005
0.988
0.000
NEt2
Ph
N
OMs
1H NMR (400 MHz,CDCl3)
2.00
1.02
3.08
2.04
1.03
3.06
4.05
6.02
f1 (ppm)

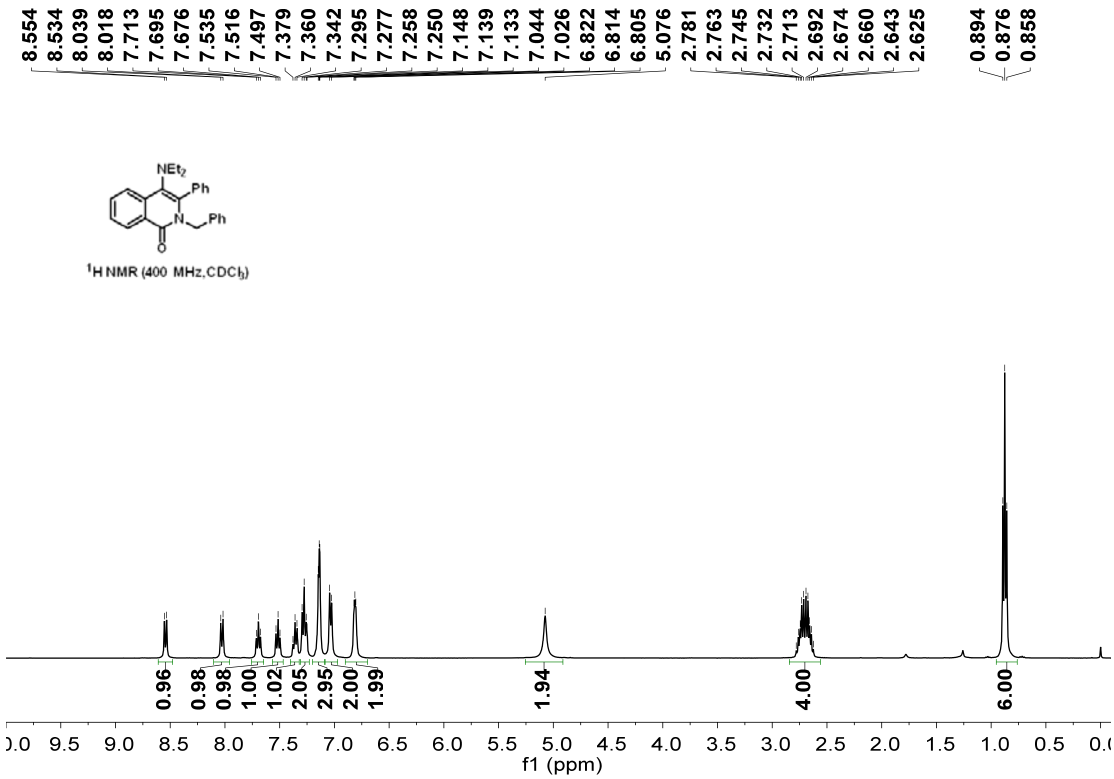

150.29
146.87
140.82
140.15
138.89
130.93
129.25
127.97
127.79
124.64
124.23
120.82
77.34
77.02
76.71
48.04
41.58
14.34
NEt2
Ph
N
OMs
13C NMR (100 MHz,CDCl3)
f1 (ppm)

6

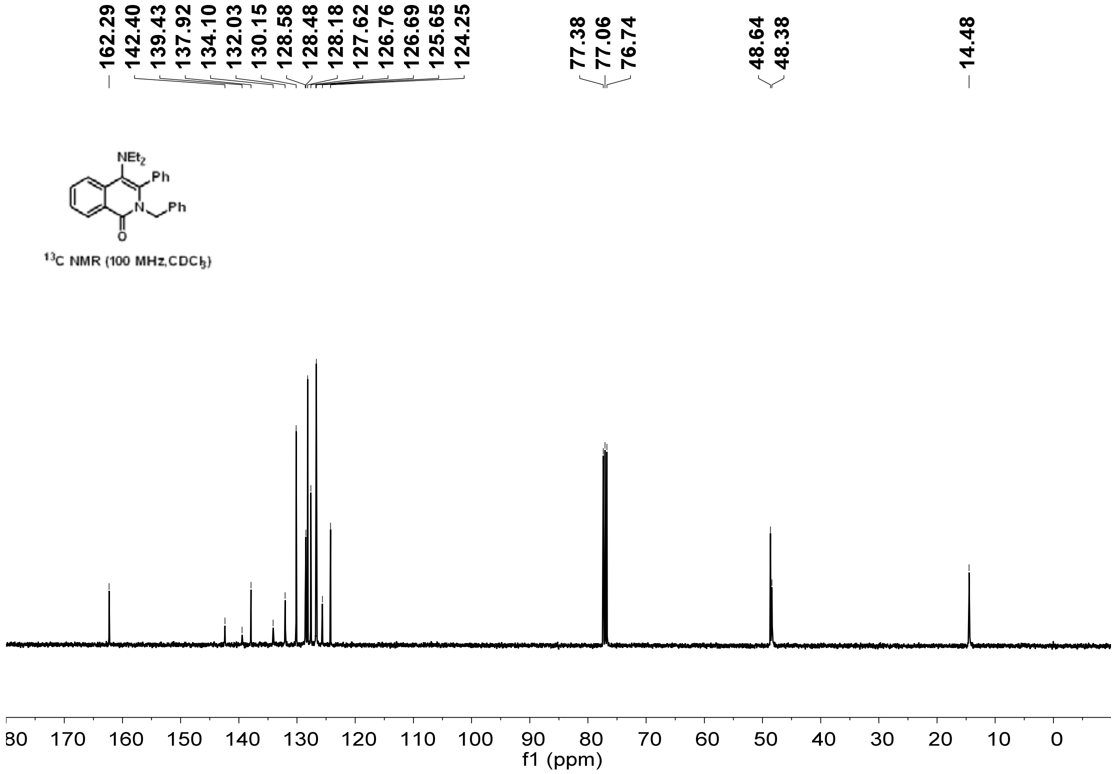

8.277
8.256
8.190
7.999
7.979
7.753
7.734
7.715
7.639
7.621
7.604
7.446
7.440
7.434
7.426
7.422
7.408
7.398
7.386
7.381
7.373
7.368
7.257
7.246
7.226
3.050
3.033
3.015
2.998
2.422
0.984
0.966
0.948
0.000
NEt2
Ph
N
OTs
1H NMR (400 MHz,CDCl3)
1.00
0.88
1.96
1.03
1.01
5.07
1.92
3.86
3.02
5.96
f1 (ppm)


149.98
146.81
144.82
140.69
139.82
138.25
134.65
130.63
129.41
129.36
129.27
127.60
127.56
127.51
124.54
124.22
120.64
77.35
77.04
76.72
48.01
21.67
14.28
NEt2
Ph
N
OTs
13C NMR (100 MHz,CDCl3)
f1 (ppm)

7

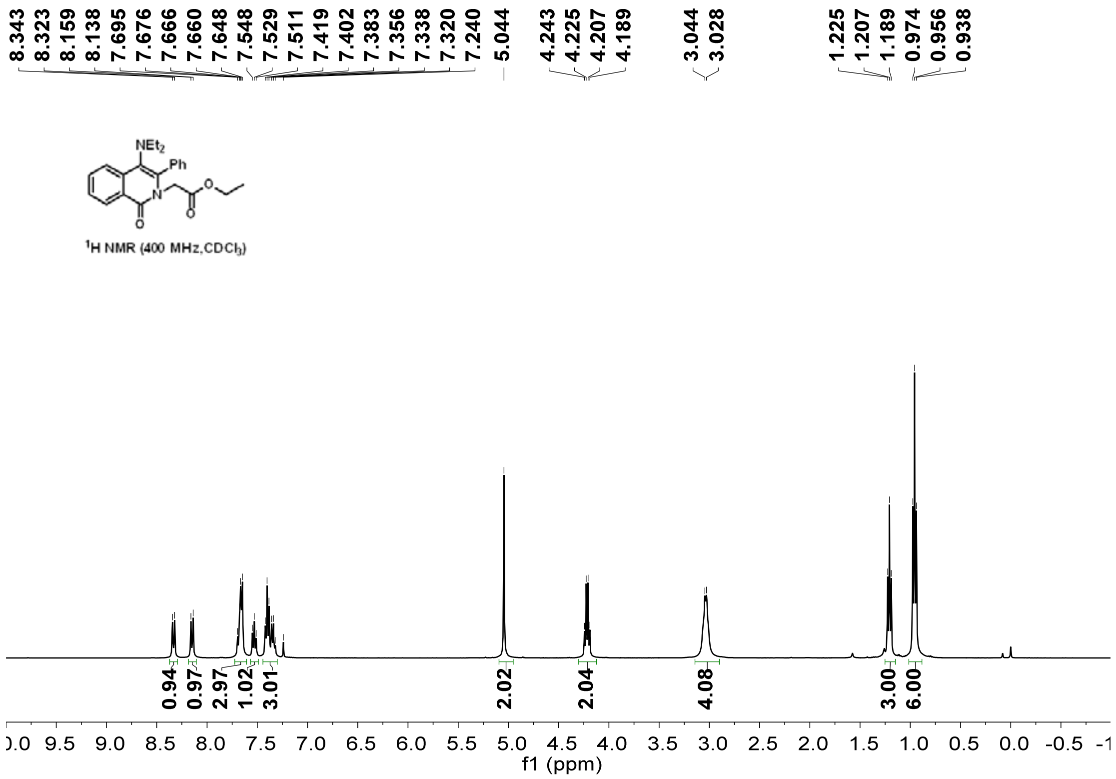


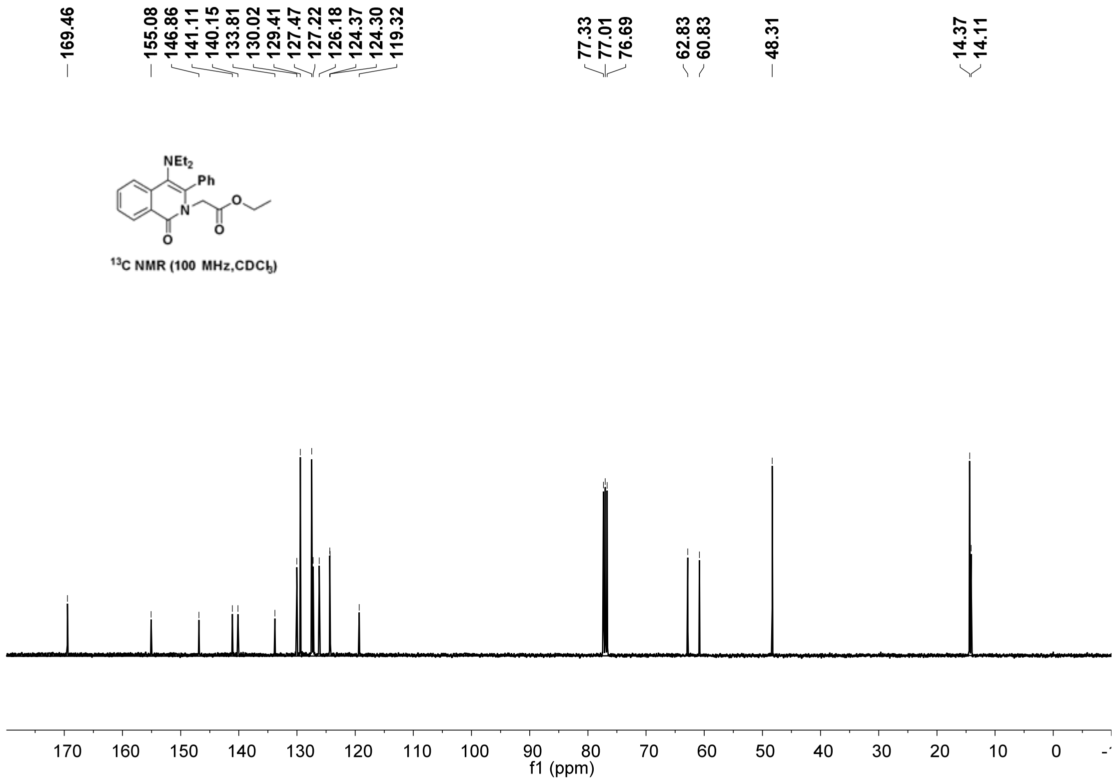
8.554
8.534
8.039
8.018
7.713
7.695
7.676
7.535
7.516
7.497
7.379
7.360
7.342
7.295
7.277
7.258
7.250
7.148
7.139
7.133
7.044
7.026
6.822
6.814
6.805
5.076
2.781
2.763
2.745
2.732
2.713
2.692
2.674
2.660
2.643
2.625
0.894
0.876
0.858
NEt2
Ph
N
Ph
O
1H NMR (400 MHz,CDCl3)
0.96
0.98
0.98
1.00
1.02
2.05
2.95
2.00
1.99
1.94
4.00
6.00
f1 (ppm)



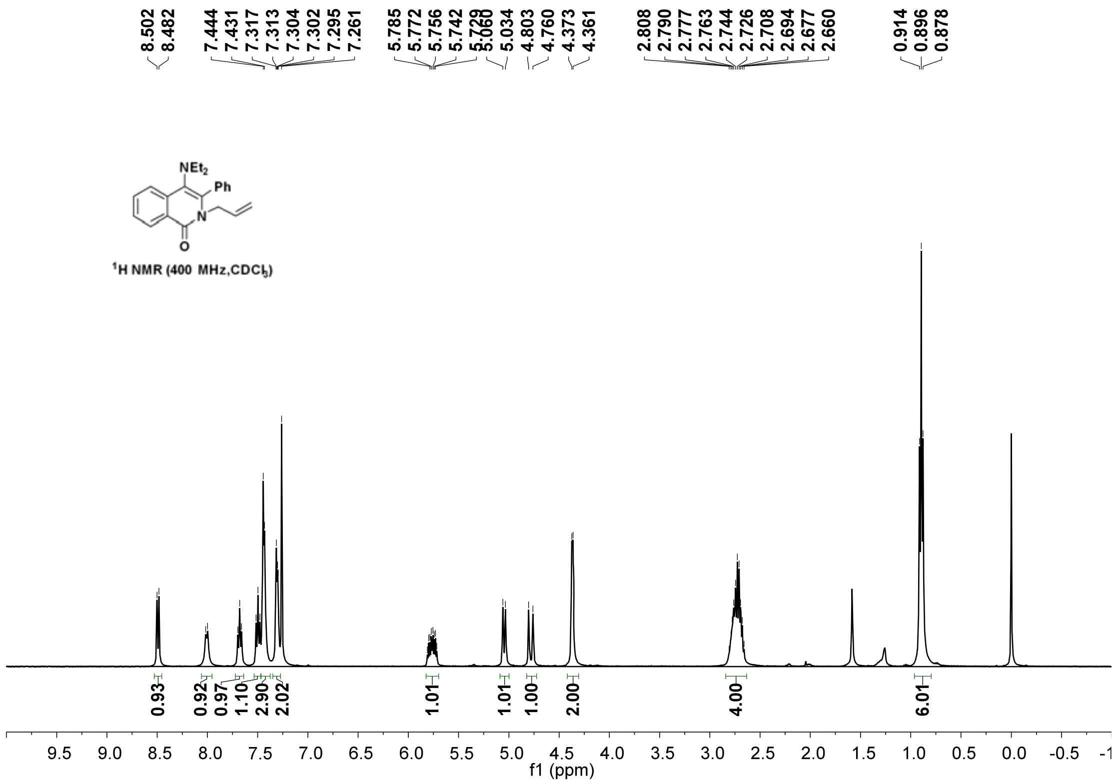
162.29
142.40
139.43
137.92
134.10
132.03
130.15
128.58
128.48
128.18
127.62
126.76
126.69
125.65
124.25
77.38
77.06
76.74
48.64
48.38
14.48
NEt2
Ph
N
Ph
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

8

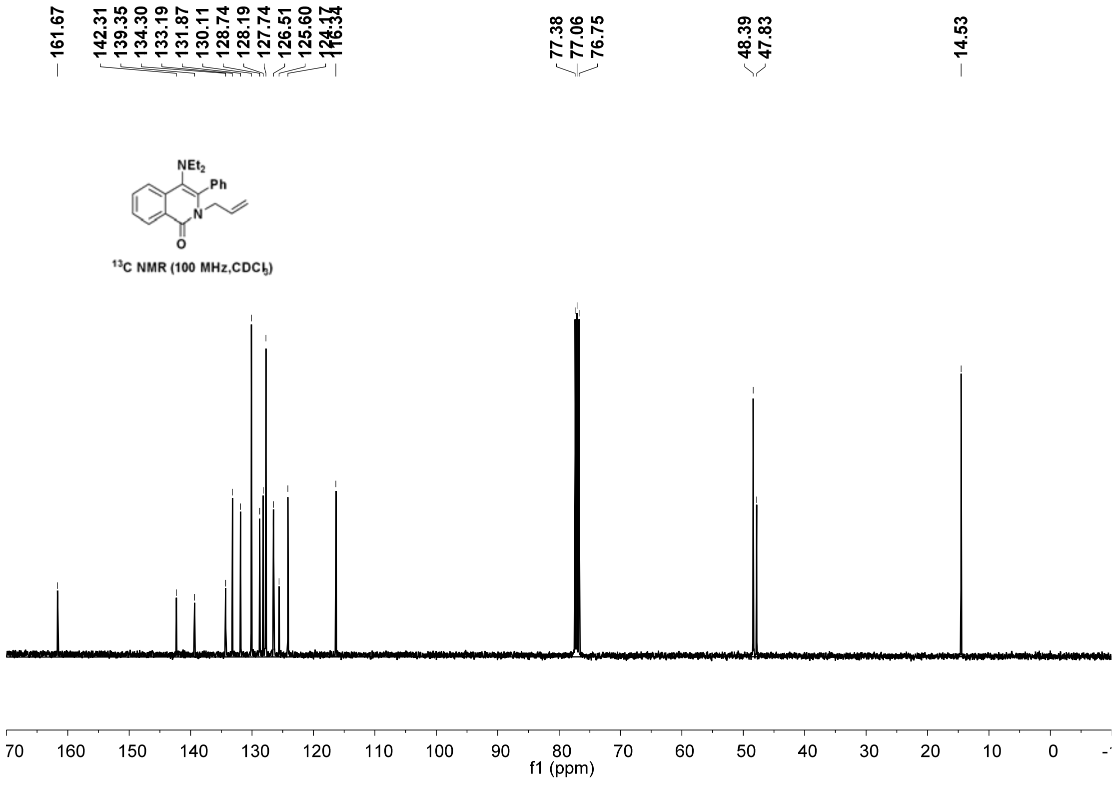

8.343 8.323 8.159 8.138 7.695 7.676 7.666 7.660 7.648 7.548 7.529 7.511 7.419 7.402 7.383 7.356 7.338 7.320 7.240
5.044
4.243 4.225 4.207 4.189
3.044 3.028
1.225 1.207 1.189 0.974 0.956 0.938
NEt2
Ph
N
O
1H NMR (400 MHz,CDCl3)
0.94 0.97 2.97 1.02 3.01
2.02
2.04
4.08
3.00 6.00
f1 (ppm)


169.46
155.08 146.86 141.11 140.15 133.81 130.02 129.41 127.47 127.22 126.18 124.37 124.30 119.32
77.33 77.01 76.69
62.83 60.83
48.31
14.37 14.11
NEt2
Ph
N
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

9

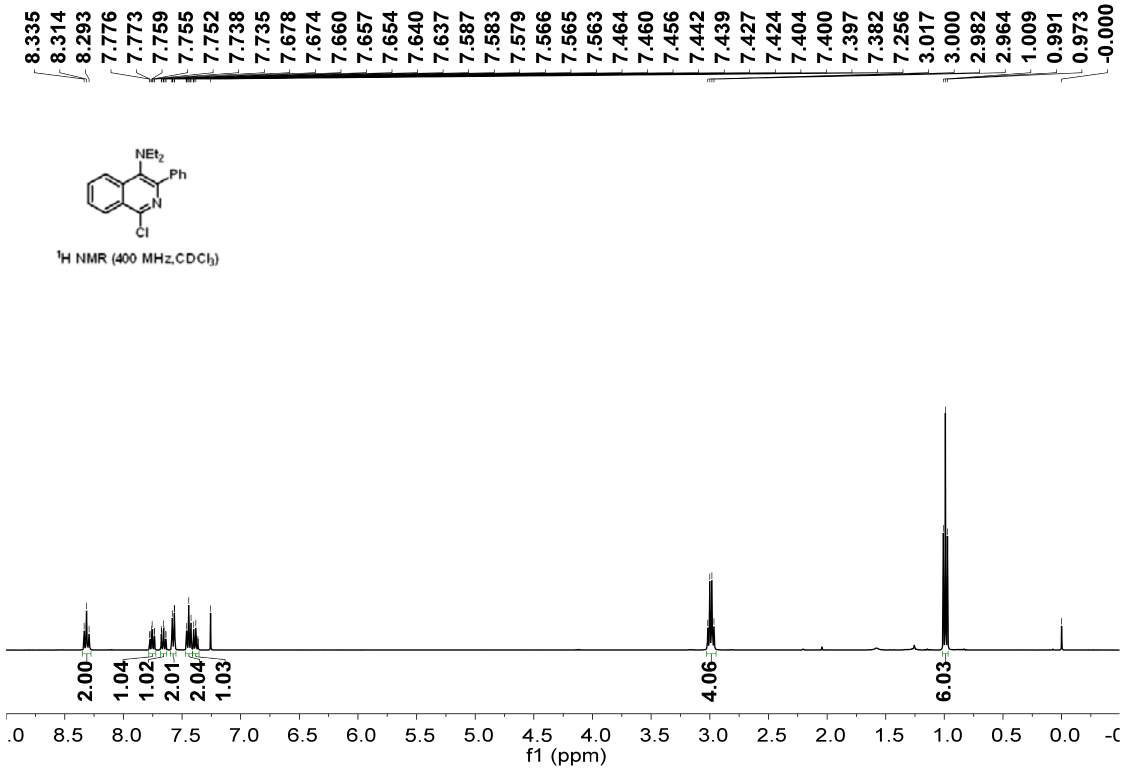


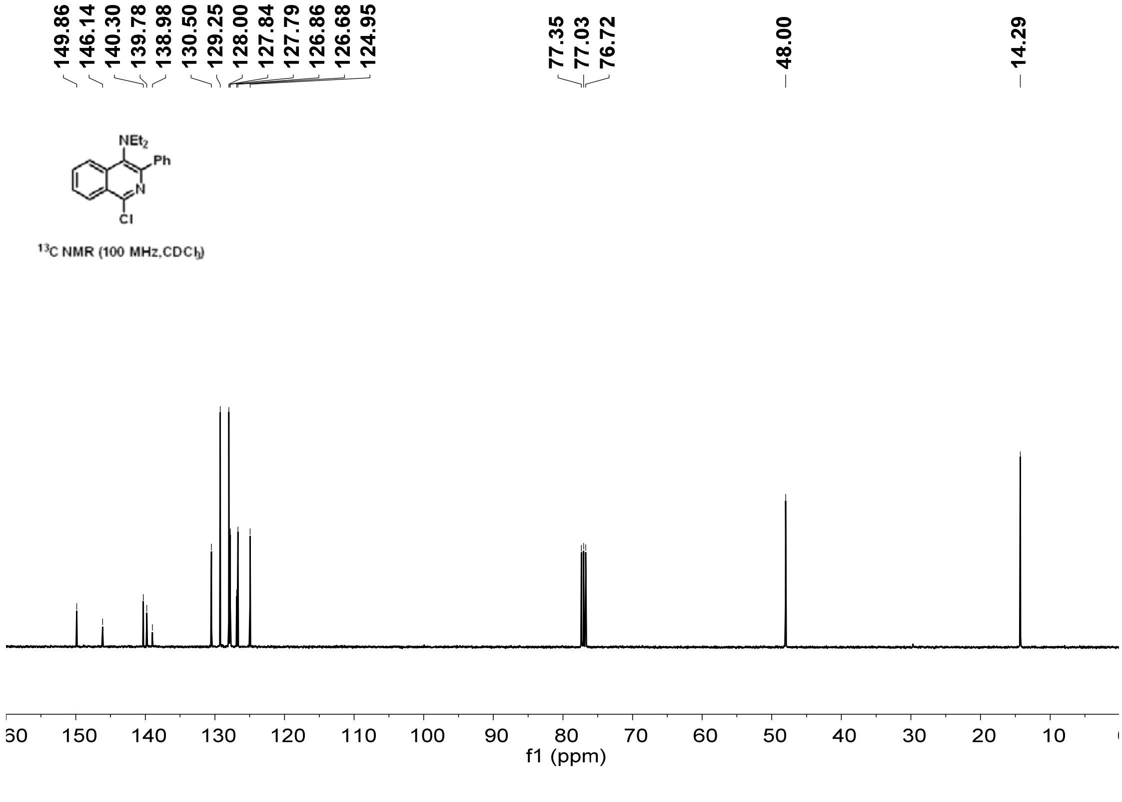
NEt2
Ph
N
O
1H NMR (400 MHz,CDCl3)
8.502
8.482
7.444
7.431
7.317
7.313
7.304
7.302
7.295
7.261
5.785
5.772
5.756
5.742
5.729
5.060
5.034
4.803
4.760
4.373
4.361
2.808
2.790
2.777
2.763
2.744
2.726
2.708
2.694
2.677
2.660
0.914
0.896
0.878
0.93
0.92
0.97
1.10
2.90
2.02
1.01
1.01
1.00
2.00
4.00
6.01
f1 (ppm)



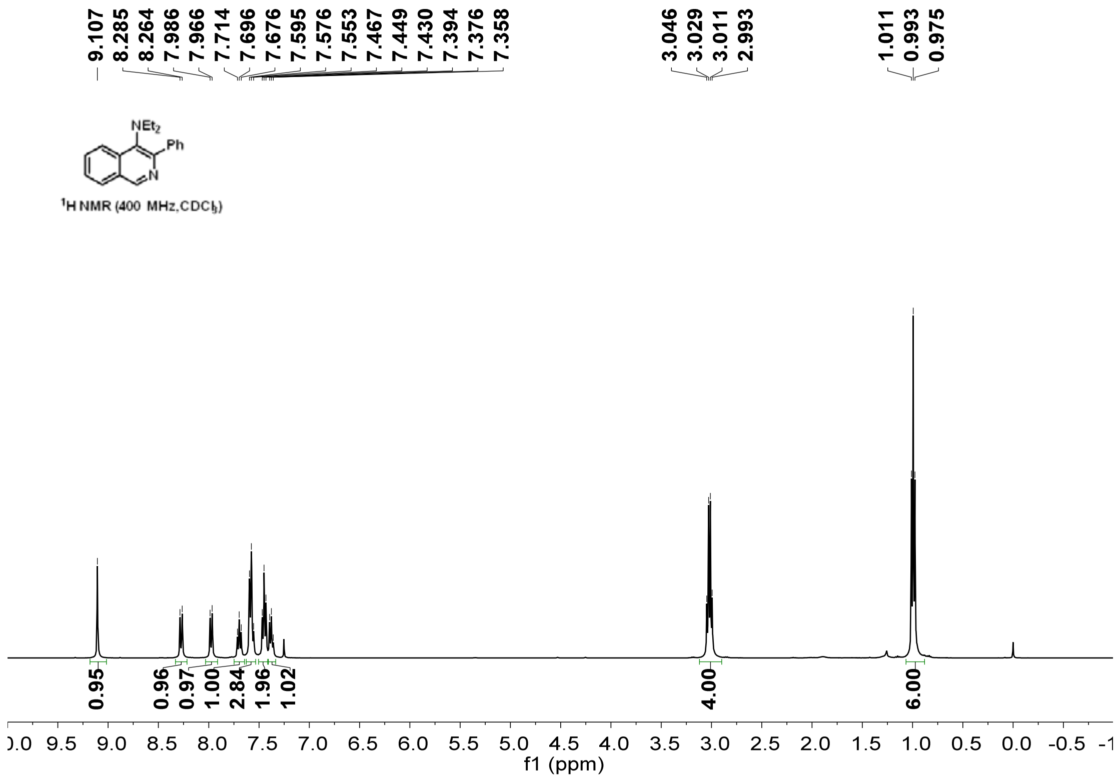
161.67
142.31
139.35
134.30
133.19
131.87
130.11
128.74
128.19
127.74
126.51
125.60
124.17
116.34
77.38
77.06
76.75
48.39
47.83
14.53
NEt2
Ph
N
O
13C NMR (100 MHz,CDCl3)
f1 (ppm)

10

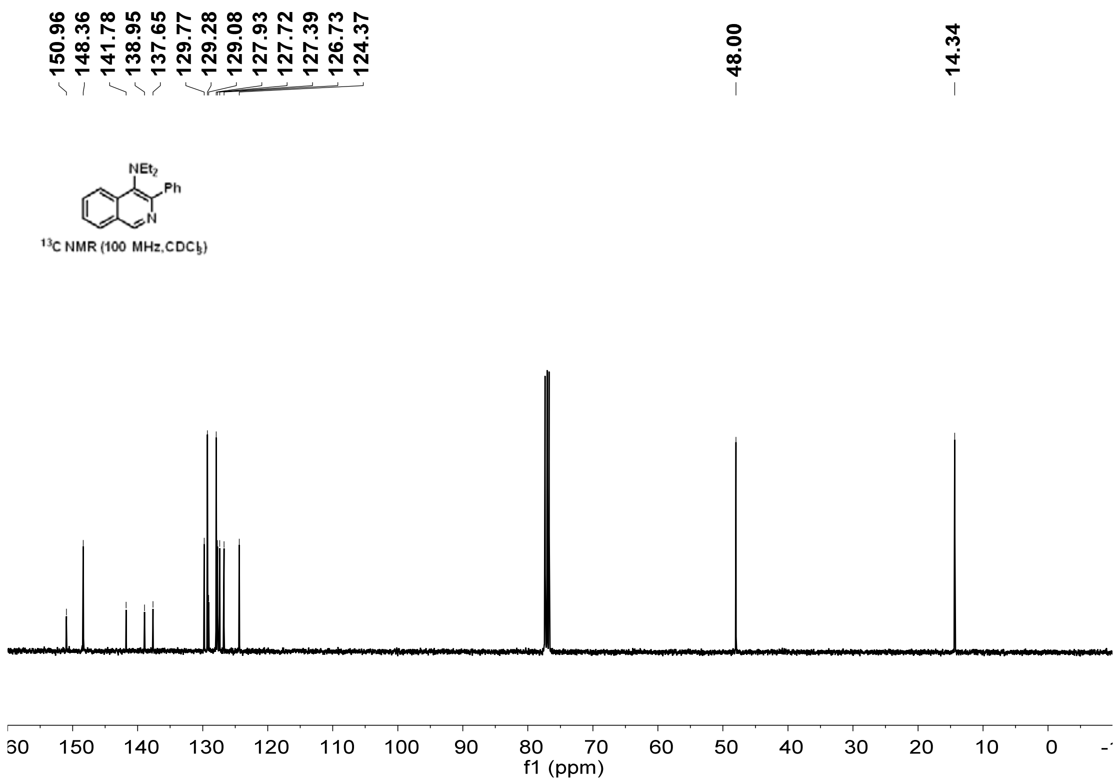

8.335
8.314
8.293
7.776
7.773
7.759
7.755
7.752
7.738
7.735
7.678
7.674
7.660
7.657
7.654
7.640
7.637
7.587
7.583
7.579
7.566
7.565
7.563
7.464
7.460
7.456
7.442
7.439
7.427
7.424
7.404
7.400
7.397
7.382
7.256
3.017
3.000
2.982
2.964
1.009
0.991
0.973
-0.000
NEt2
Ph
N
Cl
1H NMR (400 MHz,CDCl3)
2.00
1.04
1.02
2.01
2.04
1.03
4.06
6.03
f1 (ppm)


149.86
146.14
140.30
139.78
138.98
130.50
129.25
128.00
127.84
127.79
126.86
126.68
124.95
77.35
77.03
76.72
48.00
14.29
NEt2
Ph
N
Cl
13C NMR (100 MHz,CDCl3)
f1 (ppm)

11

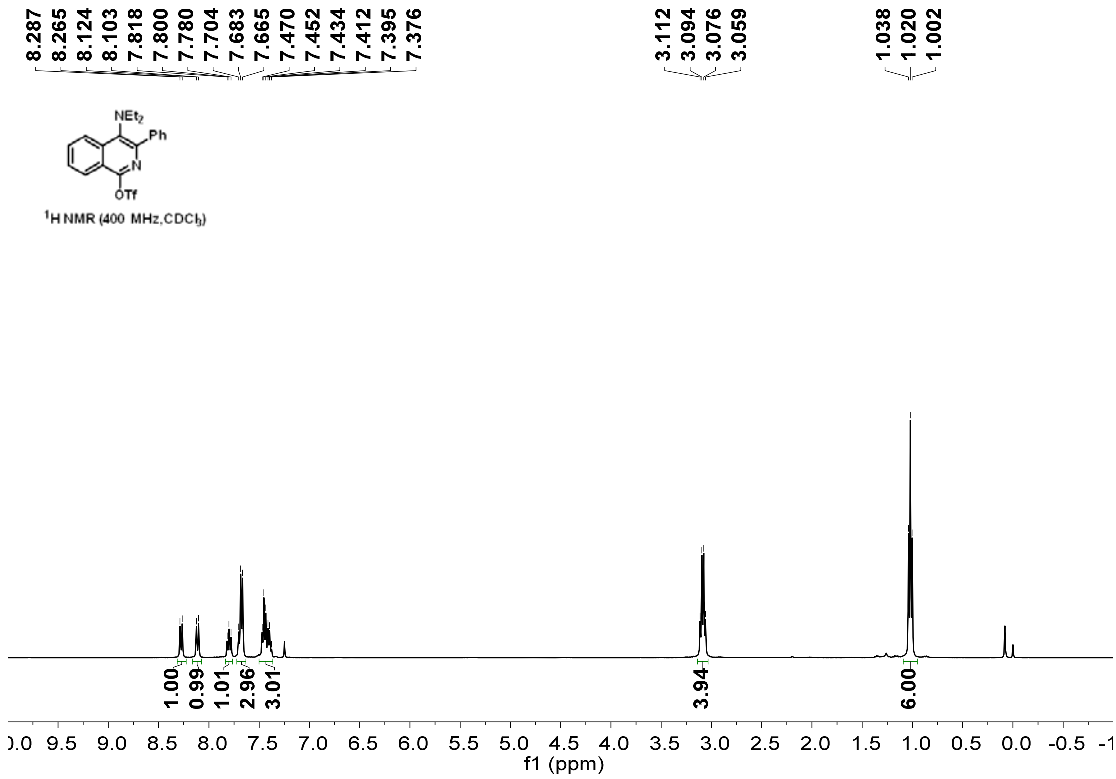


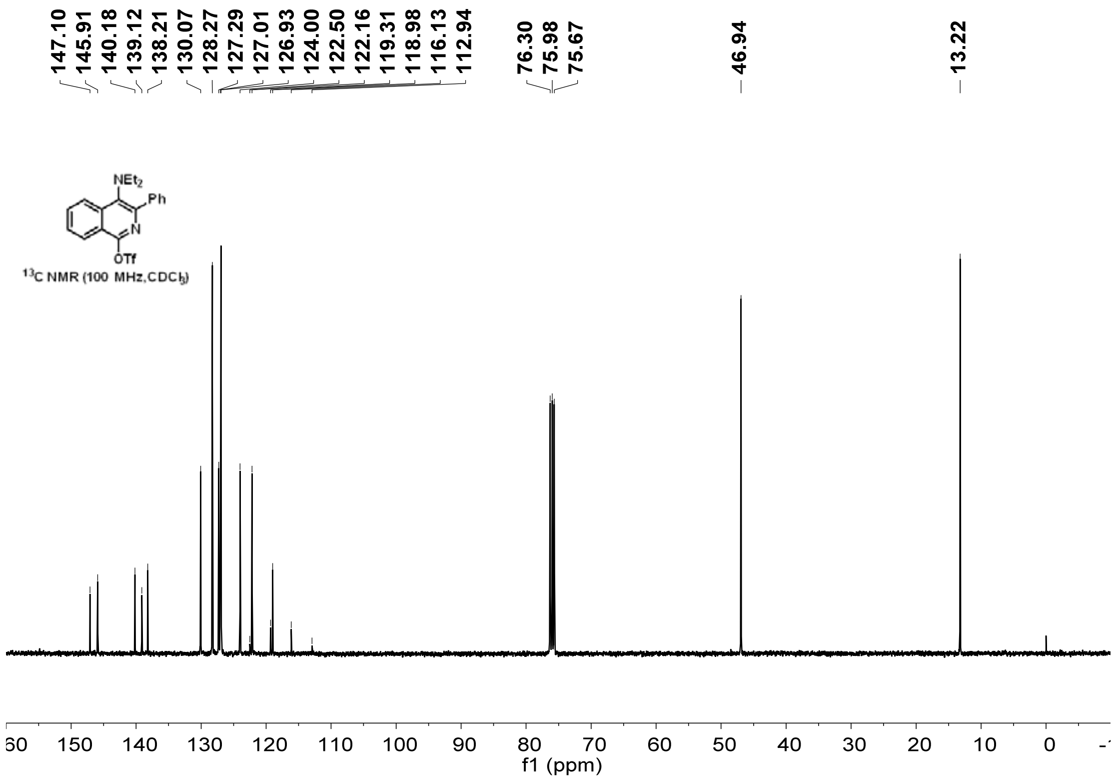
9.107 8.285 8.264 7.986 7.966 7.714 7.696 7.676 7.595 7.576 7.553 7.467 7.449 7.430 7.394 7.376 7.358
3.046 3.029 3.011 2.993
1.011 0.993 0.975
NEt2
Ph
N
1H NMR (400 MHz,CDCl3)
0.95 0.96 0.97 1.00 2.84 1.96 1.02
4.00
6.00
f1 (ppm)



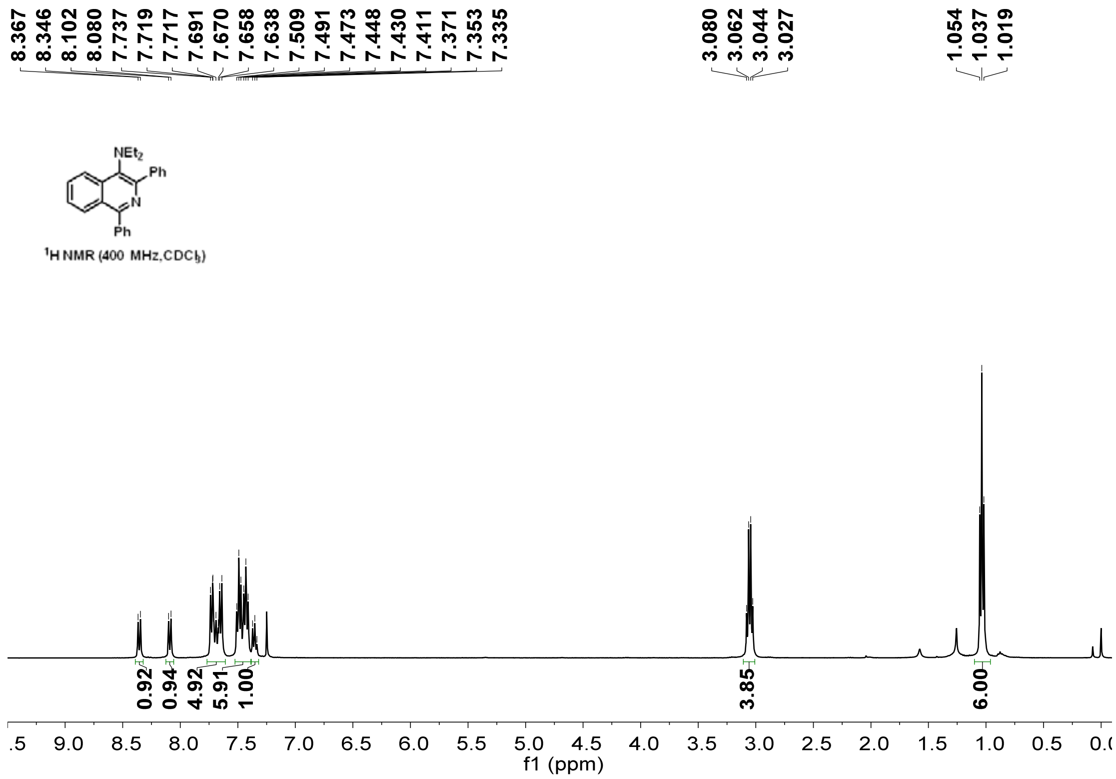
150.96 148.36 141.78 138.95 137.65 129.77 129.28 129.08 127.93 127.72 127.39 126.73 124.37
48.00
14.34
NEt2
Ph
N
13C NMR (100 MHz,CDCl3)
f1 (ppm)

12

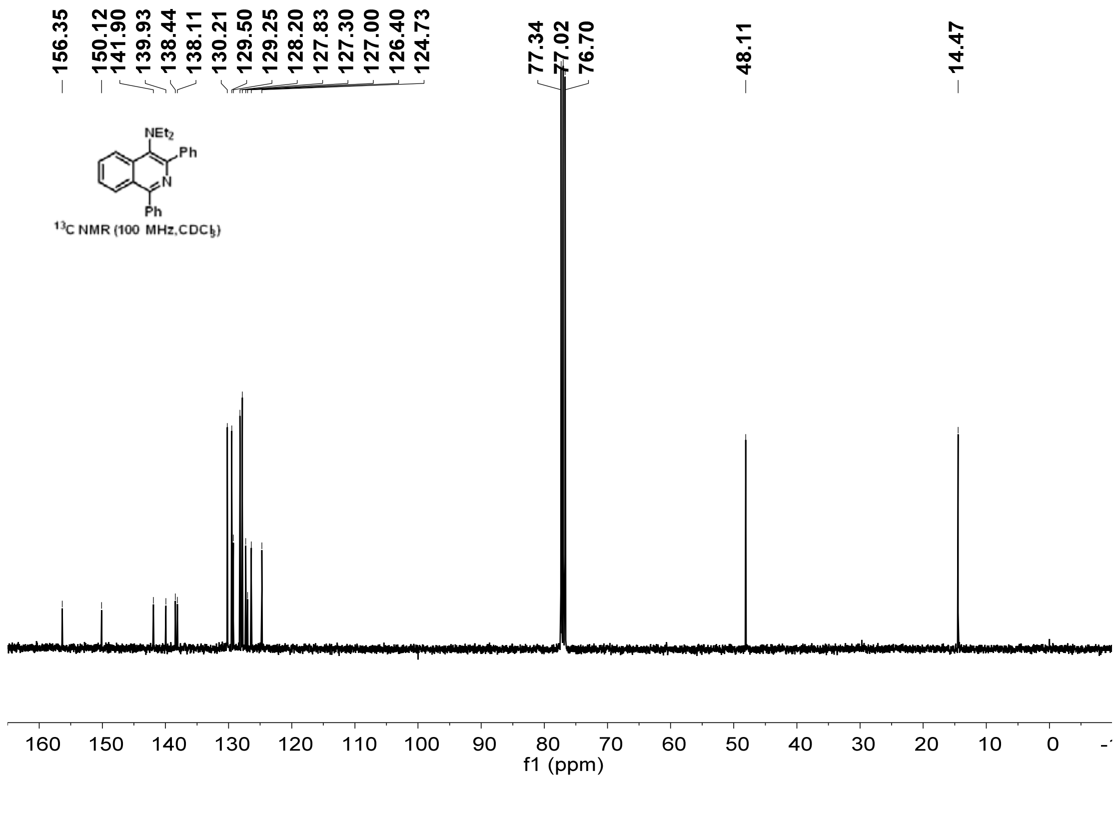

8.287
8.265
8.124
8.103
7.818
7.800
7.780
7.704
7.683
7.665
7.470
7.452
7.434
7.412
7.395
7.376
3.112
3.094
3.076
3.059
1.038
1.020
1.002
NEt2
Ph
N
OTf
1H NMR (400 MHz,CDCl3)
1.00
0.99
1.01
2.96
3.01
3.94
6.00
f1 (ppm)


147.10
145.91
140.18
139.12
138.21
130.07
128.27
127.29
127.01
126.93
124.00
122.50
122.16
119.31
118.98
116.13
112.94
76.30
75.98
75.67
46.94
13.22
NEt2
Ph
N
OTf
13C NMR (100 MHz,CDCl3)
f1 (ppm)

13

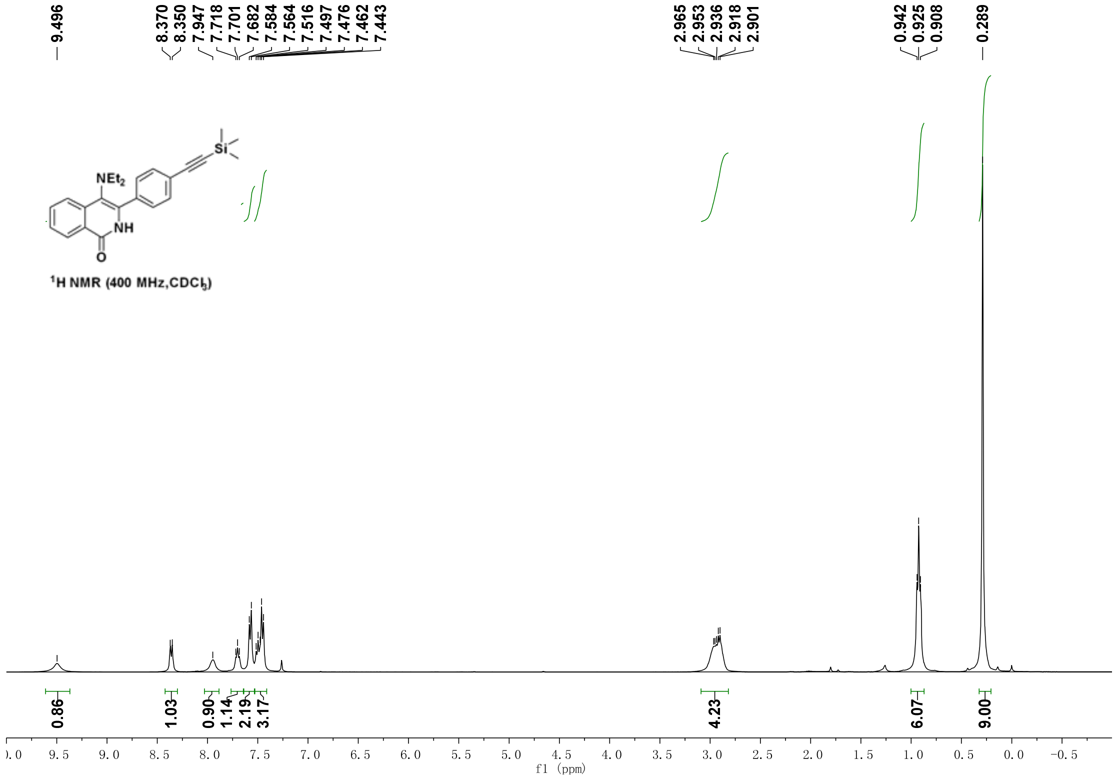


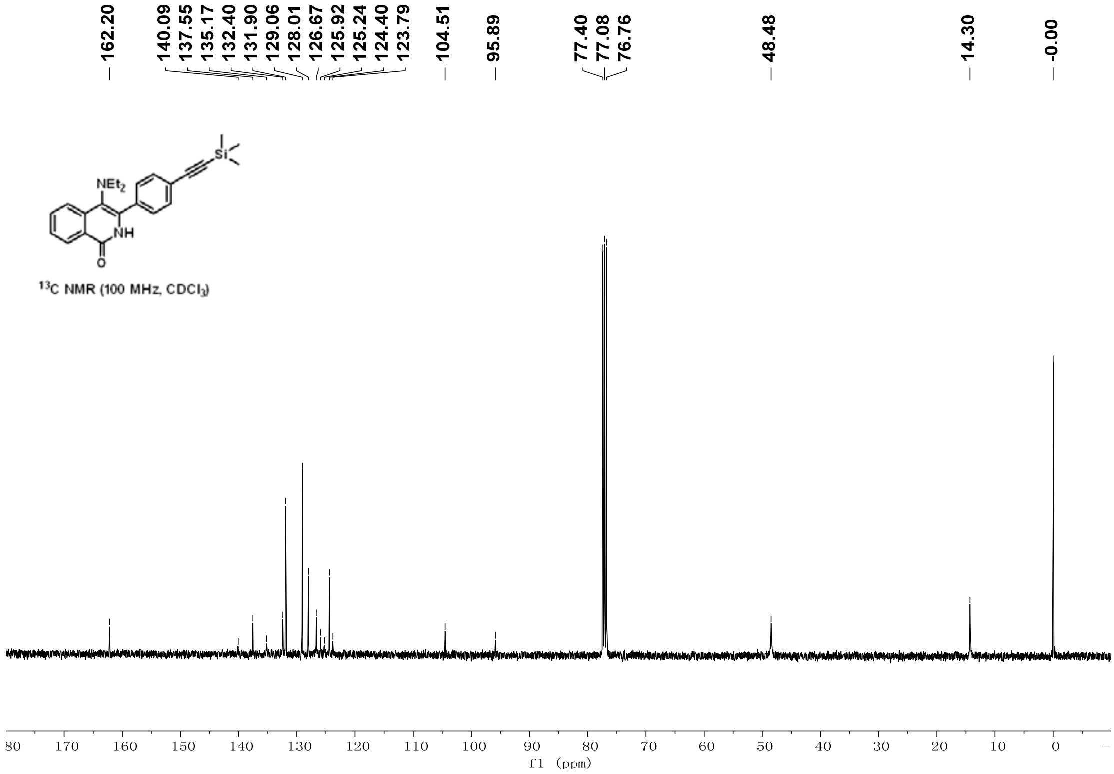
8.367
8.346
8.102
8.080
7.737
7.719
7.717
7.691
7.670
7.658
7.638
7.509
7.491
7.473
7.448
7.430
7.411
7.371
7.353
7.335
3.080
3.062
3.044
3.027
1.054
1.037
1.019
NEt2
Ph
N
Ph
1H NMR (400 MHz,CDCl3)
0.92
0.94
4.92
5.91
1.00
3.85
6.00
f1 (ppm)



156.35
150.12
141.90
139.93
138.44
138.11
130.21
129.50
129.25
128.20
127.83
127.30
127.00
126.40
124.73
77.34
77.02
76.70
48.11
14.47
NEt2
Ph
N
Ph
13C NMR (100 MHz,CDCl3)
f1 (ppm)

14


9.496
8.370
8.350
7.947
7.718
7.701
7.682
7.584
7.564
7.516
7.497
7.476
7.462
7.443
2.965
2.953
2.936
2.918
2.901
0.942
0.925
0.908
0.289
NEt2
Si
NH
O
1H NMR (400 MHz,CDCl3)
0.86
1.03
0.90
1.14
2.19
3.17
4.23
6.07
9.00
f1 (ppm)


162.20
140.09
137.55
135.17
132.40
131.90
129.06
128.01
126.67
125.92
125.24
124.40
123.79
104.51
95.89
77.40
77.08
76.76
48.48
14.30
-0.00
NEt2
Si
NH
O
13C NMR (100 MHz, CDCl3)
f1 (ppm)