Supporting Information

Co(III)-catalyzed *Z*-selective oxidative C–H/C–H cross-coupling of alkenes with triisopropylsilylacetylene

Tingxing Zhao, Dekun Qin, Weiguo Han, Shiping Yang, Boya Feng, Ge Gao and Jingsong You**

Key Laboratory of Green Chemistry and Technology of Ministry of Education, College of Chemistry, Sichuan University, 29 Wangjiang Road, Chengdu 610064, China

E-mails: *gg2b@scu.edu.cn; jsyou@scu.edu.cn*

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I. General remarks

Unless otherwise noted, all reagents were obtained from commercial suppliers and used without further purification. Substituted acrylamides **1**, **5** were prepared according to the reported literatures.[1] THF, DCE, DMF, 1,4-dioxane and toluene were dried using solvent purification system, while other solvents were dried according to known methods and distilled prior to use.[2]

NMR spectra were obtained on an Agilent 400-MR DD2 spectrometer. The ^{1}H NMR (400 MHz) chemical shifts were measured relative to $CDCl_3$ as the internal reference ($CDCl_3$: δ = 7.26 ppm). The ^{13}C NMR (100 MHz) chemical shifts were given using $CDCl_3$ as the internal standard ($CDCl_3$: δ = 77.16 ppm). High resolution mass spectra (HR-MS) were obtained with a Shimadzu LCMS-IT-TOF (ESI). X-Ray single-crystal diffraction data were collected on an Oxford Xcalibur E single crystal diffractometer.

II. General procedure for the synthesis of acrylamides

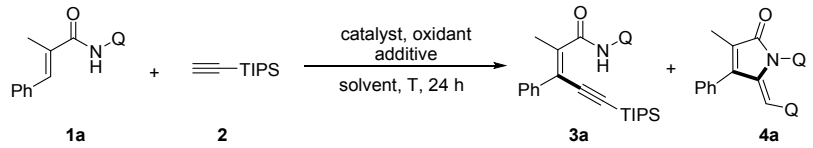
The synthesis of **1a** is representative: An oven-dried 100 mL round-bottom flask was charged with (*E*)-2-methyl-3-phenylacrylic acid (810.0 mg, 5 mmol) and DCM (20 mL) under N_2 atmosphere, the mixture was cooled to 0 °C, and then oxalyl chloride (0.6 mL, 7mmol) was added dropwise, then DMF (2 drops) was added. The mixture was stirred at room temperature for 3 h and then the solvent was evaporated to obtain the crude acid chloride, then without further purification the crude acid chloride dissolved in DCM (10 mL), then added dropwise to a solution of 8-aminoquinoline (748.8 mg, 5.2 mmol) and Et_3N (2 mL, 15 mmol) in DCM (20 mL) at 0 °C under N_2 atmosphere. The resulting mixture was stirred at room temperature overnight. Then water was added, and extracted with DCM three times, then dried over Na_2SO_4. After removal of the solvent under reduced pressure, the residue was purified by column

chromatography on silica gel (petroleum ether/ DCM = 3/1, v/v) to give the desired product as a white solid (1051.6 mg, 73% yield).

III. Optimization of the reaction conditions

An oven-dried Schlenk tube equipped with a magnetic stir bar was charged with (*E*)-2-methyl-3-phenyl-*N*-(quinolin-8-yl)acrylamide **1a** (28.8 mg, 0.1 mmol, 1.0 equiv), catalyst, oxidant, additive. The Schlenk tube was evacuated and filled with a nitrogen gas three times, then ethynyltriisopropylsilane **2**, solvent (1.0 mL) were added under a nitrogen atmosphere. The reaction mixture was stirred at room temperature for 2 min, and then heated at the indicated temperature for 24 hours. The reaction mixture was cooled to ambient temperature, diluted with 5 mL of DCM, filtered through a celite pad, and washed with 20 mL of DCM. The combined filtrate was concentrated, and the resulting residue was purified by column chromatography on silica gel using petroleum ether/THF (v/v = 20/1) as eluent to provide the desired product **3a**.

Table S1. Optimization of the reaction conditions.[a,b]



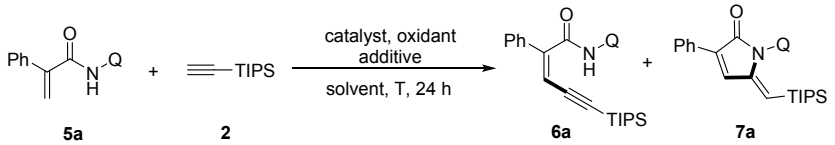
Entry	Catalyst	Oxidant	Additive	Solvent	Yield of **3a**	Yield of **4a**
1	$Fe(OAc)_2$	Ag_2CO_3	KOAc	THF	n.d	n.d
2	$Co(OAc)_2$	Ag_2CO_3	KOAc	THF	7%	n.d
3	$Ni(OAc)_2$	Ag_2CO_3	KOAc	THF	trace	n.d
4	$Cu(OAc)_2$	Ag_2CO_3	KOAc	THF	9%	n.d
5	$Co(acac)_2$	Ag_2CO_3	KOAc	THF	35%	5%
6	$Co(acac)_3$	Ag_2CO_3	KOAc	THF	39%	n.d
7	$CoBr_2$	Ag_2CO_3	KOAc	THF	17%	trace
8	$CoCl_2$	Ag_2CO_3	KOAc	THF	trace	n.d
9	$Co_2(CO)_8$	Ag_2CO_3	KOAc	THF	trace	n.d
10	Co_2O_3	Ag_2CO_3	KOAc	THF	n.d	n.d
11	$Co(acac)_3$	Ag_2CO_3	KOAc	DCE	27%	9%
12	$Co(acac)_3$	Ag_2CO_3	KOAc	DMF	n.d	n.d
13	$Co(acac)_3$	Ag_2CO_3	KOAc	toluene	23%	n.d

14	$Co(acac)_3$	Ag_2CO_3	KOAc	dioxane	9%	n.d
15	$Co(acac)_3$	Ag_2CO_3	KOAc	NMP	n.d	n.d
16	$Co(acac)_3$	Ag_2CO_3	KOAc	DMSO	n.d	n.d
17	$Co(acac)_3$	Ag_2CO_3	KOAc	*t*-BuOH	n.d	n.d
18	$Co(acac)_3$	Ag_2CO_3	HOAc	THF	trace	n.d
19	$Co(acac)_3$	Ag_2CO_3	$Zn(OAc)_2$	THF	29%	n.d
20	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_3$	THF	56%	n.d
21	**$Co(acac)_3$**	**Ag_2CO_3**	**$Mn(OAc)_2$**	**THF**	**73%**	**n.d**
22	$Co(acac)_3$	Ag_2CO_3	$MnCl_2$	THF	trace	n.d
23	$Co(acac)_3$	Ag_2CO_3	$MnSO_4$	THF	43%	n.d
24	$Co(acac)_3$	Ag_2CO_3	--	THF	27%	n.d
25	--	Ag_2CO_3	$Mn(OAc)_2$	THF	n.d	n.d
26	$Co(acac)_3$	--	$Mn(OAc)_2$	THF	n.d	n.d
27[b]	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_2$	THF	54%	n.d
28[c]	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_2$	THF	67%	n.d
29[d]	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_2$	THF	61%	n.d
30	$Co(acac)_3$	Ag_2O	$Mn(OAc)_2$	THF	29%	n.d
31	$Co(acac)_3$	Ag_2SO_4	$Mn(OAc)_2$	THF	trace	n.d
32	$Co(acac)_3$	AgOAc	$Mn(OAc)_2$	THF	trace	n.d
33	$Co(acac)_3$	AgOPiv	$Mn(OAc)_2$	THF	24%	n.d
34	$Co(acac)_3$	AgF	$Mn(OAc)_2$	THF	n.d	n.d
35	$Co(acac)_3$	$AgBF_4$	$Mn(OAc)_2$	THF	n.d	n.d
36	$Co(acac)_3$	$AgNO_3$	$Mn(OAc)_2$	THF	n.d	n.d
37[e]	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_2$	THF	59%	n.d
38[f]	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_2$	THF	45%	n.d
39[g]	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_2$	THF	46%	n.d
40[h]	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_2$	THF	39%	n.d
41[i]	$Co(acac)_3$	Ag_2CO_3/O_2	$Mn(OAc)_2$	THF	38%	n.d
42	$Co(acac)_3$	BQ	$Mn(OAc)_2$	THF	n.d	n.d
43	$Co(acac)_3$	DDQ	$Mn(OAc)_2$	THF	n.d	n.d
44	$Co(acac)_3$	$PhI(OAc)_2$	$Mn(OAc)_2$	THF	n.d	n.d
45	$Co(acac)_3$	DTBP	$Mn(OAc)_2$	THF	n.d	n.d
46	$Co(acac)_3$	TBHP	$Mn(OAc)_2$	THF	n.d	n.d
47	$Co(acac)_3$	$K_2S_2O_8$	$Mn(OAc)_2$	THF	n.d	n.d
48	$Co(acac)_3$	$Mn(OAc)_3 \cdot 2H_2O$	$Mn(OAc)_2$	THF	n.d	n.d
49	$Co(acac)_3$	$NaClO_3$	$Mn(OAc)_2$	THF	n.d	n.d
50	$Co(acac)_3$	oxone	$Mn(OAc)_2$	THF	n.d	n.d
51	$Co(acac)_3$	$Cu(OAc)_2$	$Mn(OAc)_2$	THF	11%	n.d
52	$Co(acac)_3$	CuOAc	$Mn(OAc)_2$	THF	n.d	n.d
53	$Co(acac)_3$	CuBr	$Mn(OAc)_2$	THF	n.d	n.d
54	$Co(acac)_3$	CuCl	$Mn(OAc)_2$	THF	n.d	n.d
55	$Co(acac)_3$	CuI	$Mn(OAc)_2$	THF	n.d	n.d
56	$Co(acac)_3$	Cu_2O	$Mn(OAc)_2$	THF	n.d	n.d
57	$Co(acac)_3$	O_2	$Mn(OAc)_2$	THF	n.d	n.d
58	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_2$	toluene	51%	n.d
59	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_2$	DME	n.d	n.d
60	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_2$	$(n\text{-}Bu)_2O$	46%	n.d
61	$Co(acac)_3$	Ag_2CO_3	$Mn(OAc)_2$	dioxane	64%	n.d
62	$Co(OAc)_2$	Ag_2CO_3	$Mn(OAc)_2$	THF	28%	n.d
63	$Ni(OAc)_2$	Ag_2CO_3	$Mn(OAc)_2$	THF	17%	n.d

64	$Cu(OAc)_2$	Ag_2CO_3	$Mn(OAc)_2$	THF	20%	n.d
65	$Fe(OAc)_2$	Ag_2CO_3	$Mn(OAc)_2$	THF	n.d	n.d

[a]Reaction conditions: catalyst (0.01 mmol, 10 mol %), oxidant (0.2 mmol, 2.0 equiv), **1a** (28.8 mg, 0.1 mmol, 1.0 equiv), **2** (35 μL, 0.15 mmol, 1.5 equiv), additive (0.1 mmol, 1.0 equiv), and solvent (1 mL) at 120 °C for 24 h under N_2 atmosphere. [b]100 °C. [c]140 °C. [d]**2** (0.12 mmol, 1.2 equiv). [e]Ag_2CO_3 (1.5 equiv). [f]Ag_2CO_3 (1.0 equiv). [g]Ag_2CO_3 (1.5 equiv), 130 °C. [h]Ag_2CO_3 (1.5 equiv), 140 °C. [i]Ag_2CO_3 (1.0 equiv), O_2. n.d = not detected.

Table S2. Optimization of the reaction conditions for terminal acrylamides.[a,b]



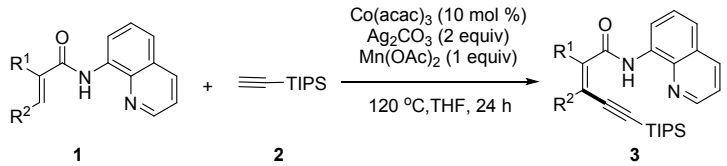
5a **2** **6a** **7a**

Entry	$Co(acac)_3$	Additive	T (°C)	Yield of **6a**	Yield of **7a**	**5a**
1	10%	--	120 °C	20%	13%	0%
2	10%	KOAc (1 equiv)	120 °C	16%	24%	0%
3	10%	PivOH (1 equiv)	120 °C	25%	<10%	0%
4	10%	--	80 °C	20%	20%	55%
5	20%	--	80 °C	30%	37%	30%
6	30%	--	80 °C	40%	46%	0%
7	30%	PivOH (1 equiv)	80 °C	56%	32%	0%
8	**30%**	**PivOH (2 equiv)**	**80 °C**	**70%**	**27%**	**0%**
9	30%	PivOH (3 equiv)	80 °C	68%	24%	0%

[a]Reaction conditions: $Co(acac)_3$, Ag_2CO_3 (0.2 mmol, 2.0 equiv), $Mn(OAc)_2$ (0.1 mmol, 1.0 equiv), terminal acrylamides **5a** (0.1 mmol, 1.0 equiv), **2** (35 μL, 0.15 mmol, 1.5 equiv), and THF (1 mL) for 24 h under a N_2 atmosphere. [b]Isolated yield.

IV. General procedure for the cross-coupling of acrylamides with triisopropylsilylacetylene

Internal acrylamides:

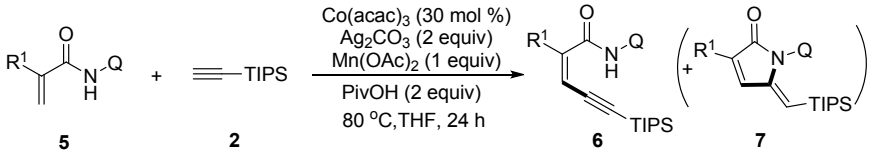


1 **2** **3**

An oven-dried Schlenk tube equipped with a magnetic stir bar was charged with $Co(acac)_3$ (3.6 mg, 0.01 mmol, 10 mol %), Ag_2CO_3 (55.2 mg, 0.2 mmol, 2.0 equiv), $Mn(OAc)_2$ (17.3 mg, 0.1 mmol, 1.0 equiv), internal acrylamides **1** (0.1 mmol, 1.0 equiv).

The Schlenk tube was evacuated and filled with a nitrogen gas three times. Then, ethynyltriisopropylsilane **2** (35 µL, 0.15 mmol, 1.5 equiv), and THF (1 mL) were added under a nitrogen atmosphere. The reaction mixture was stirred at room temperature for 2 min, and then heated at 120 °C for 24 hours. Then the reaction mixture was cooled to ambient temperature, diluted with 5 mL of DCM, filtered through a celite pad, and washed with 20 mL of DCM. The combined filtrate was concentrated, and the resulting residue was purified by column chromatography on silica gel to provide the desired product.

Terminal acrylamides:



5 **2** **6** **7**

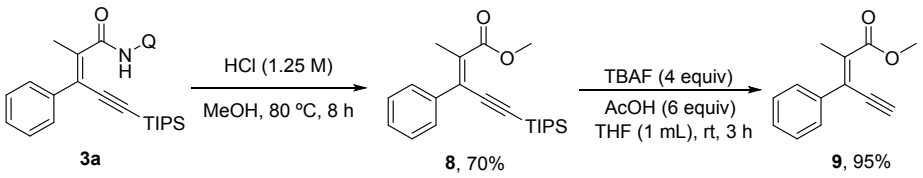
An oven-dried Schlenk tube equipped with a magnetic stir bar was charged with $Co(acac)_3$ (10.8 mg, 0.03 mmol, 30 mol %), Ag_2CO_3 (55.2 mg, 0.2 mmol, 2.0 equiv), $Mn(OAc)_2$ (17.3 mg, 0.1 mmol, 1.0 equiv), PivOH (20.4 mg, 0.2 mmol, 2.0 equiv) terminal acrylamides **5** (0.1 mmol, 1.0 equiv). The Schlenk tube was evacuated and filled with a nitrogen gas three times. Then, ethynyltriisopropylsilane **2** (35 µL, 0.15 mmol, 1.5 equiv), and THF (1 mL) were added under a nitrogen atmosphere. The reaction mixture was stirred at room temperature for 2 min, and then heated at 80 °C for 24 hours. Then the reaction mixture was cooled to ambient temperature, diluted with 5 mL of DCM, filtered through a celite pad, and washed with 20 mL of DCM. The combined filtrate was concentrated, and the resulting residue was purified by column chromatography on silica gel to provide the desired product **6** and **7**.

V. Procedure for the recycle of silver carbonate[3]

After a standard reaction (0.1 mmol scale), the reaction mixture was cooled down to ambient temperature and diluted with 5 mL of DCM. A combination of 11 reaction mixtures was filtered through a celite pad. The residue was washed with DCM (50 mL) and H_2O (50 mL), and then dissolved in 30 mL of HNO_3 (20%, v/v in distilled water). After being stirred for 12 h, the mixture was filtered and the water phase was evaporated under vacuum to give a black solid. The solid was washed with ethanol and a small amount of acetone to remove the manganese salt. The crude $AgNO_3$ was redissolved in distilled water, and an 10% aqueous solution of Na_2CO_3 was added. The mixture was stirred for 2 hours to let Ag_2CO_3 precipitate out. After filtration, the solid was washed with distilled water (3 × 10 mL) to afford Ag_2CO_3 as a light brown solid (539.9 mg, 89% yield).

The cross-coupling reaction of **1a** with **2** under the optimal conditions by using the regenerated Ag_2CO_3 gave the desired enyne **3a** in 61% yield.

VI. Removal of the directing and protecting groups[4]



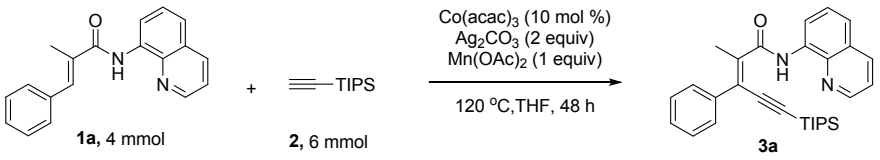
3a **8**, 70% **9**, 95%

An oven-dried Schlenk tube with a magnetic stir bar was charged with **3a** (93.7 mg, 0.2 mmol) and 1.25 M HCl in MeOH (3 mL) were added, and then heated at 80 °C for 8 h. After being cooled to room temperature, Et_3N (1 mL) was added, then concentrated, and the resulting residue was purified via column chromatography on silica gel (petroleum ether/THF = 50/1, v/v) to provide the desired product **8** (49.9 mg,

70%).

Under a N_2 atmosphere, **8** (35.6 mg, 0.1 mmol, 1 equiv) dissolved in THF (1 mL) was added to a dry Schlenk tube, TBAF (52.3 mg, 0.2 mmol, 4 equiv) and acetic acid (18.0 mg, 0.3 mmol, 6 equiv) were added successively. The reaction mixture was stirred at room temperature for 3 h (checked by TLC). Then quenched with saturated $NaHCO_3$, extracted with DCM, the organic layer was removed by rotary evaporation, and the resulting residue was purified via column chromatography on silica gel (petroleum ether/THF = 50/1, v/v) to provide the desired product **9** (19.0 mg, 95%).

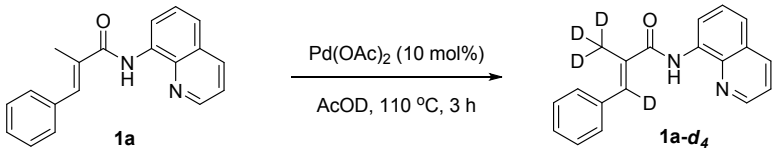
VII. Synthesis of 3a on a 4 mmol scale



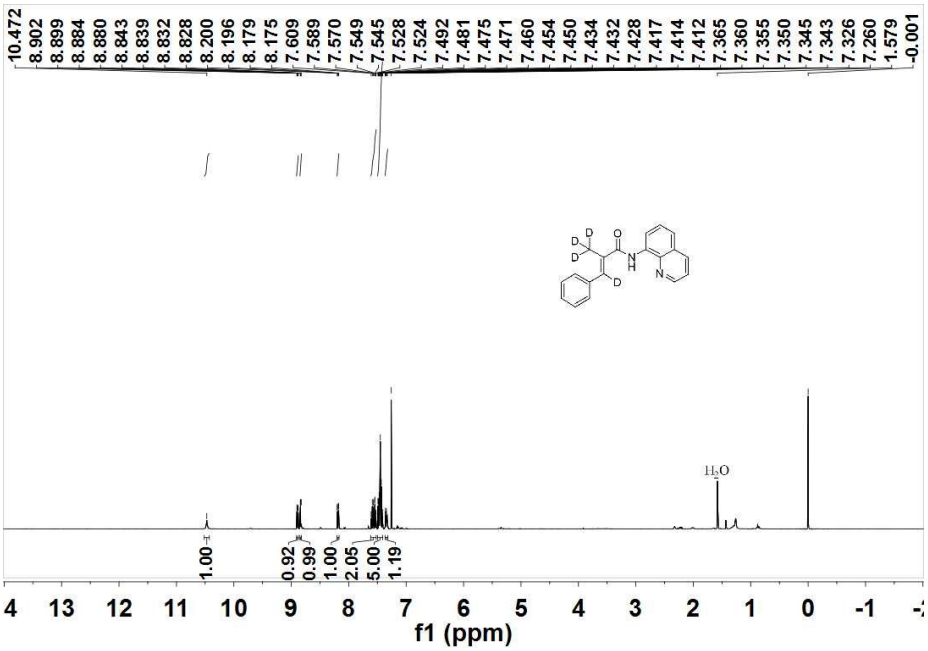
A 100 mL oven-dried Schlenk tube equipped with a magnetic stir bar was charged with $Co(acac)_3$ (142.5 mg, 0.4 mmol, 10 mol %), Ag_2CO_3 (2206.0 mg, 8 mmol, 2.0 equiv), $Mn(OAc)_2$ (692.4 mg, 4 mmol, 1.0 equiv), acrylamides **1a** (1152.5 mg, 4 mmol, 1.0 equiv). The Schlenk tube was evacuated and filled with a nitrogen gas three times. Then, ethynyltriisopropylsilane **2** (1094.3 mg, 6 mmol, 1.5 equiv), and THF (5 mL) were added under a nitrogen atmosphere. The reaction mixture was stirred at room temperature for 2 min, and then heated at 120 °C for 48 hours. Then the reaction mixture was cooled to ambient temperature, diluted with 50 mL of DCM, filtered through a celite pad, and washed with 100 mL of DCM. The combined filtrate was concentrated, and the resulting residue was purified via column chromatography on silica gel (petroleum ether/THF = 20/1, v/v) providing the corresponding product **3a** (1273.6 mg, 68% yield).

VIII. Mechanistic study

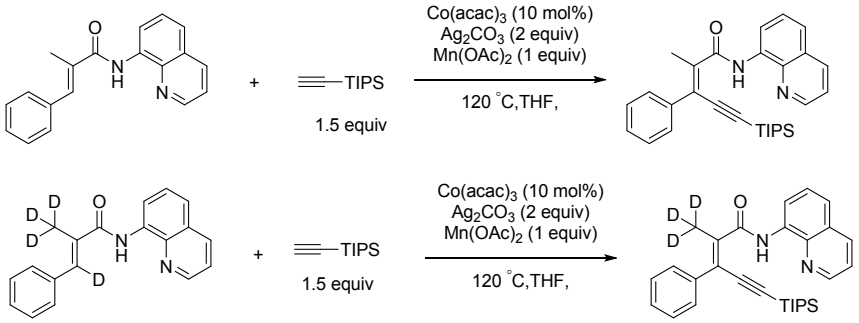
(i). Preparation of deuterated substrates[1]



An oven-dried Schlenk tube with a magnetic stir bar was charged with (*E*)-2-methyl-3-phenyl-*N*-(quinolin-8-yl)acrylamide **1a** (288.1 mg, 1 mmol), $Pd(OAc)_2$ (22.4 mg, 0.1 mmol). The Schlenk tube was evacuated and filled with a nitrogen gas three times. Then, AcOD (1 mL) were added under a nitrogen atmosphere and the reaction mixture was allowed to stir at 110 °C for 3 h. After the mixture was cooled to room temperature, the solvent was removed by rotary evaporation. The residue was purified by flash column chromatography on silica gel (petroleum ether/THF = 20/1, v/v). This sequence was repeated one more time to give the deuterium labeled product **1a**-d_4 as a white solid (201.6 mg, 69%).



(ii). Kinetic Isotope Studies(parallel experiments)[1b,4,5]



KIE = K_H/K_D = 1.63

An oven-dried Schlenk tube with a magnetic stir bar was charged with $Co(acac)_3$ (3.6 mg, 0.01 mmol, 10 mol %), Ag_2CO_3 (55.2 mg, 0.2 mmol, 2.0 equiv), $Mn(OAc)_2$ (17.3 mg, 0.1 mmol, 1.0 equiv), **1a** or **1a**-d_4 (0.1 mmol, 1.0 equiv). The Schlenk tube was evacuated and filled with a nitrogen gas three times. Then, ethynyltriisopropylsilane **2** (35 µL, 0.15 mmol, 1.5 equiv) and THF (1 mL) were added under a nitrogen atmosphere. The reaction mixture was stirred at room temperature for 2 min, and then heated at 120 °C for 0.5 h, 1 h, 1.5 h, 2 h. After the mixture was cooled to room temperature, the solvent was removed by rotary evaporation. The crude residue was subjected to the ^{1}H NMR analysis, using CH_2Br_2 (7 µL, 0.1 mmol) as internal standard.

A KIE value of 1.63 was obtained.

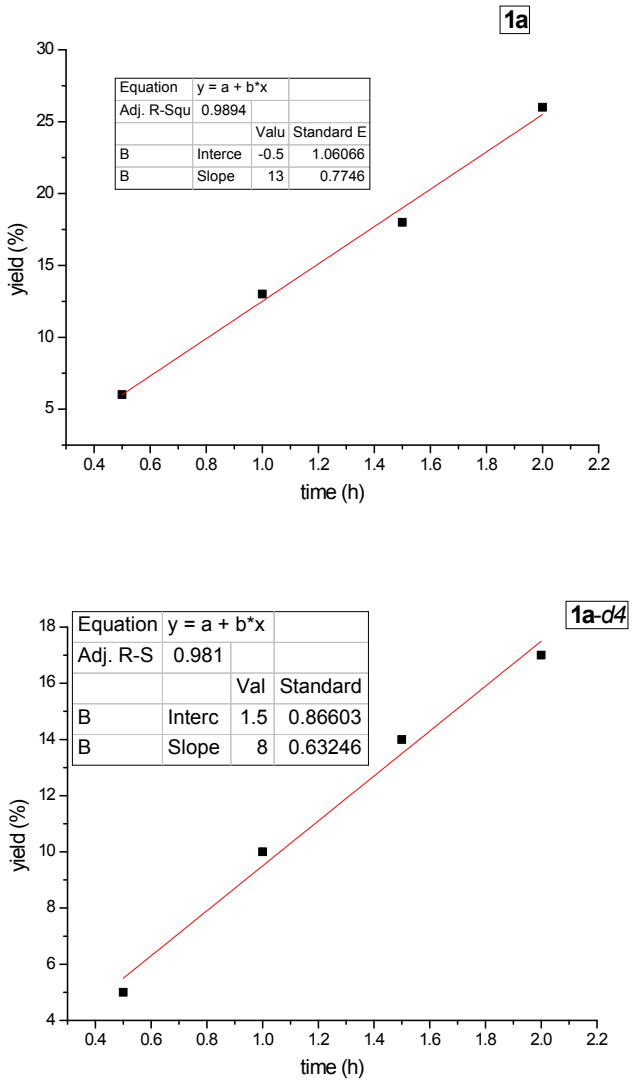
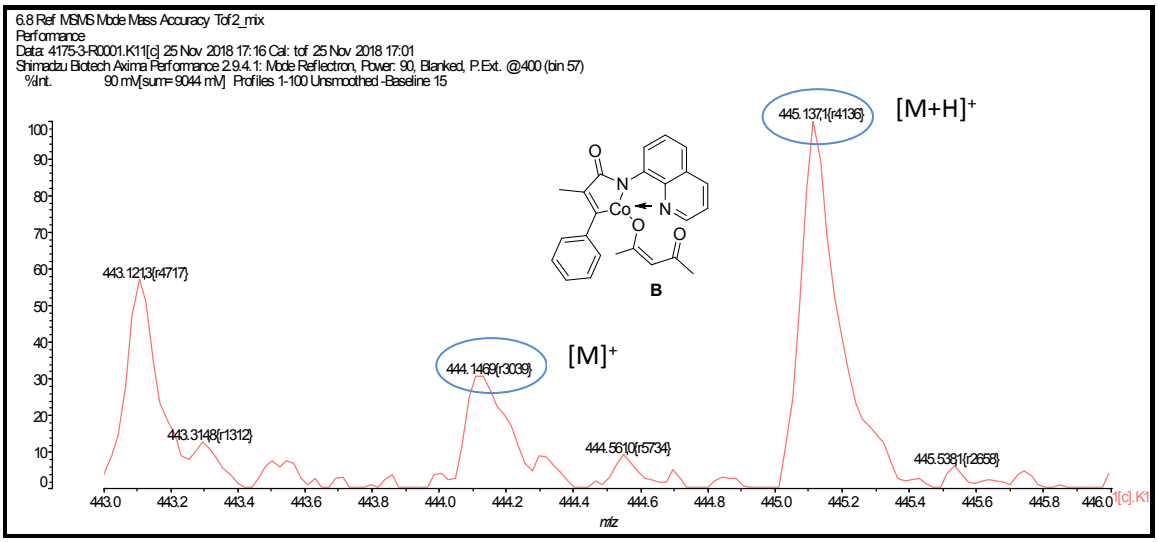
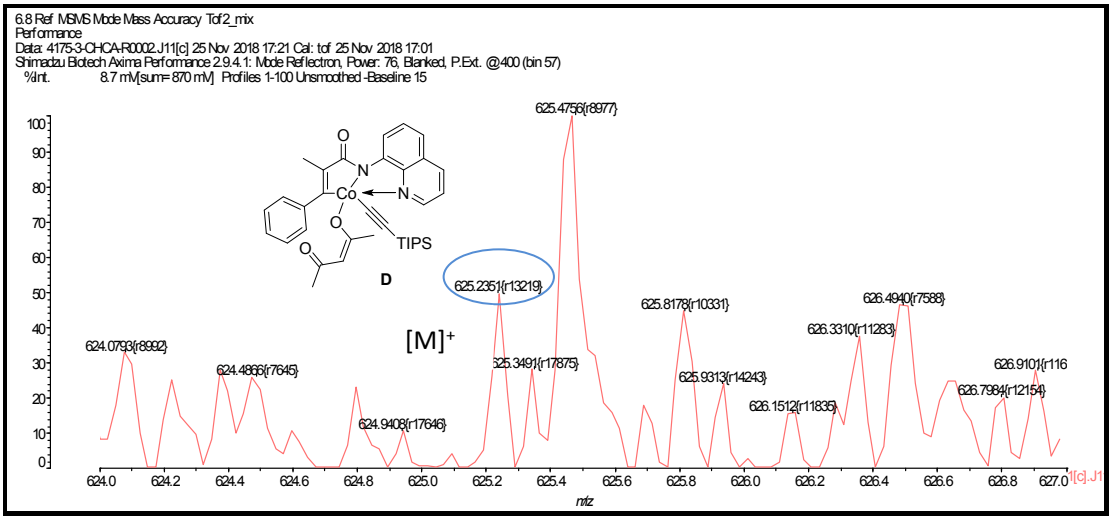


Figure S1 Kinetic experiments of **1a** and **1a**-d_4

(iii). MALDI-TOF-MS analysis



A MALDI-TOF analysis experiment was performed by the reaction **1a** with **2** under standard conditions for 3 h. A series of signals identified with acrylamide-Co intermediate **B**. MALDI-TOF-MS of **B** calcd for $C_{24}H_{21}CoN_2O_3$ $[M]^+$ 444.0884, found 444.1469, $C_{24}H_{22}CoN_2O_3$ $[M+H]^+$ 445.0962, found 445.1371.



MALDI-TOF-MS of **D** calcd for $C_{35}H_{42}CoN_2O_3Si$ $[M]^+$ 625.2297, found 625.2351.

(iv). Radical trapping experiments[4]

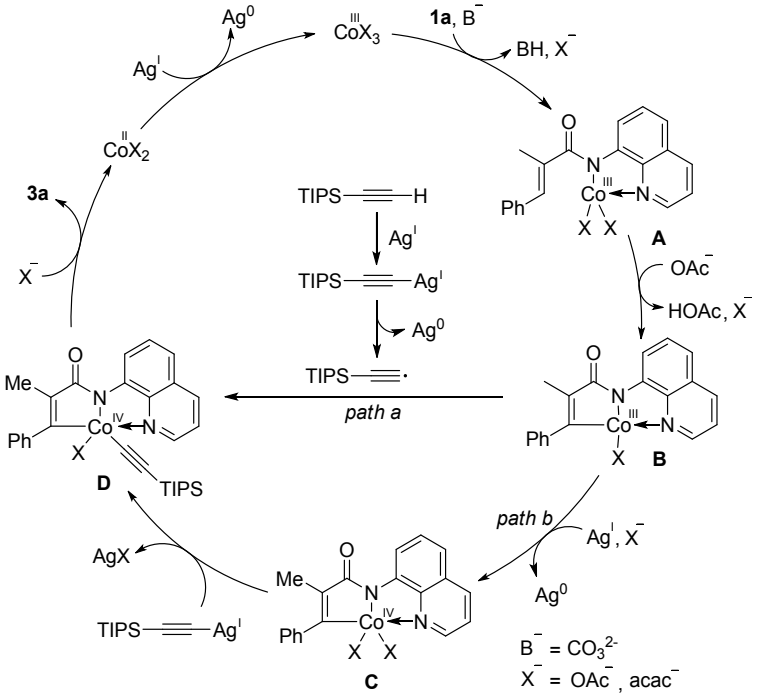
An oven-dried Schlenk tube with a magnetic stir bar was charged with $Co(acac)_3$ (3.6 mg, 0.01 mmol, 10 mol %), Ag_2CO_3 (55.2 mg, 0.2 mmol, 2.0 equiv), $Mn(OAc)_2$ (17.3 mg, 0.1 mmol, 1.0 equiv), and **1a** (28.8 mg, 0.1 mmol, 1.0 equiv), radical scavenger. The

Schlenk tube was evacuated and filled with a nitrogen gas three times. Then, ethynyltriisopropylsilane **2** (35 μL, 0.15 mmol, 1.5 equiv) and THF (1 mL) were added under a nitrogen atmosphere. The reaction mixture was stirred at room temperature for 2 min, and then heated at 120 °C for 24h. After being cooled to room temperature, the reaction mixture was filtered through a silica-gel pad and washed with 10-20 mL of DCM. The filtrate was concentrated and was purified via column chromatography on silica gel gave **3a.**

Table S3 Radical trapping experiments

entry	TEMPO	Yield
1	1 equiv	38%
2	2 equiv	20%
3	3 equiv	13%
4	6 equiv	15%

(v). Plausible mechanistic pathway

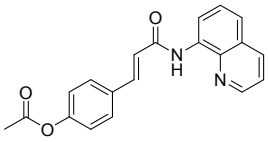


Scheme S1. Plausible Mechanism

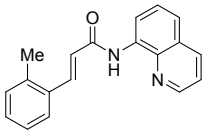
Based on the preliminary results and previous reports,[6] a plausible mechanism is

proposed. The deprotonation of **1a** allows coordination of **1a** to [Co^{III}] to form the intermediate **A**. The vinylic C−H bond activation occurs to give the intermediate **B** with the assistance of acetate. **B** can be directly oxidized by the in situ generated alkynyl radical to form a [Co^{IV}] intermediate **D** (path a), or be oxidized to a [Co^{IV}] species **C** by Ag_2CO_3, followed by a transmetalation process with alkynyl-Ag^{I} species to generate **D** (path b). Finally, reductive elimination of **D** gave the cross-coupled product **3a** and a [Co^{II}] species. Oxidation of [Co^{II}] by silver will regenerate [Co^{III}] for the next catalytic cycle.

IX. Experimental data for the described substances

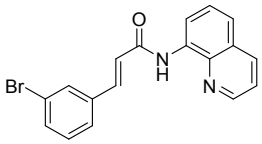


(*E*)-4-(3-oxo-3-(quinolin-8-ylamino)prop-1-en-1-yl)phenyl acetate (1d). A white solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.33 (s, 3H), 6.77 (d, *J* = 15.2 Hz, 1H), 7.14-7.16 (m, 2H), 7.48 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.53-7.55 (m, 1H), 7.57-7.61 (m, 1H), 7.62-7.65 (m, 2H), 7.81 (d, *J* = 15.6 Hz, 1H), 8.19 (dd, *J* = 8.4, 2.0 Hz, 1H), 8.84 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.91 (dd, *J* = 7.6, 1.6 Hz, 1H), 10.01 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 20.3, 117.0, 121.80, 121.84, 121.9, 122.2, 127.7, 128.1, 129.3, 132.7, 134.7, 136.6, 138.6, 141.2, 148.3, 151.9, 164.1, 169.4 ppm. HRMS (ESI^+): calcd for $C_{20}H_{16}N_2NaO_3$ $[M+Na]^+$ 355.1059, found 355.1058.

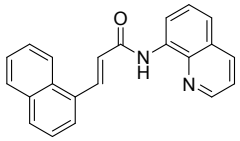


(*E*)-*N*-(quinolin-8-yl)-3-(o-tolyl)acrylamide (1e). A white solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.51 (s, 3H), 6.73 (d, *J* = 15.2 Hz, 1H), 7.23-7.24 (m, 2H), 7.27-7.29 (m, 1H),

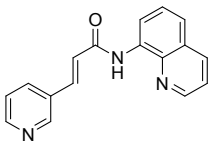
7.48 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.53-7.55 (m, 1H), 7.57-7.61 (m, 1H), 7.66-7.68 (m, 1H), 8.13 (d, *J* = 15.2 Hz, 1H), 8.19 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.84 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.93 (dd, *J* = 7.6, 1.6 Hz, 1H), 10.02 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 20.1, 116.9, 121.80, 121.82, 122.7, 126.40, 126.42, 127.7, 128.1, 129.8, 130.9, 133.9, 134.8, 136.6, 137.9, 138.6, 140.1, 148.3, 164.4 ppm. HRMS (ESI$^+$): calcd for $C_{19}H_{17}N_2O$ $[M+H]^+$ 289.1341, found 289.1344.



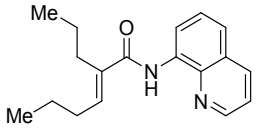
(*E*)-3-(3-bromophenyl)-*N*-(quinolin-8-yl)acrylamide (1j). A white solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 6.81 (d, *J* = 15.6 Hz, 1H), 7.29 (t, *J* = 7.8 Hz, 1H), 7.47-7.56 (m, 4H), 7.57-7.61 (m, 1H), 7.73-7.78 (m, 2H), 8.19 (dd, *J* = 8.4, 2.0 Hz, 1H), 8.84 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.90 (dd, *J* = 7.6, 1.6 Hz, 1H), 10.04 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 117.1, 121.9, 122.0, 123.1, 123,2, 127.1, 127.6, 128.1, 130.5, 130.6, 132.8, 134.6, 136.6, 137.1, 138.6, 140.6, 148.4, 163.7 ppm. HRMS (ESI$^+$): calcd for $C_{18}H_{14}{}^{79}BrN_2O$ $[M+H]^+$ 353.0290, found 353.0287; calcd for $C_{18}H_{14}{}^{81}BrN_2O$ $[M+H]^+$ 355.0269, found 355.0263.



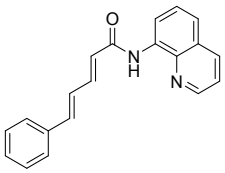
(*E*)-3-(naphthalen-1-yl)-*N*-(quinolin-8-yl)acrylamide (1l). A white solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 6.90 (d, *J* = 15.6 Hz, 1H), 7.49 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.53-7.57 (m, 3H), 7.58-7.63 (m, 2H), 7.86-7.92 (m, 3H), 8.20 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.31 (d, *J* = 8.4 Hz, 1H), 8.68 (d, *J* = 15.6 Hz, 1H), 8.85 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.97 (dd, *J* = 7.6, 1.6 Hz, 1H), 10.09 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 117.0, 121.85, 121.88, 123.8, 124.4, 125.0, 125.6, 126.4, 126.9, 127.7, 128.1, 128.8, 130.3, 131.7, 132.4, 133.8, 134.8, 136.6, 138.6, 139.5, 148.3, 164.2 ppm. HRMS (ESI$^+$): calcd for $C_{22}H_{17}N_2O$ $[M+H]^+$ 325.1341, found 325.1343.



(*E*)-3-(pyridin-3-yl)-*N*-(quinolin-8-yl)acrylamide (10). A white solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 6.88 (d, *J* = 15.6 Hz, 1H), 7.34 (dd, *J* = 7.6, 4.8 Hz, 1H), 7.48 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.53-7.60 (m, 2H), 7.80 (d, *J* = 15.6 Hz, 1H), 7.90 (dt, *J* = 8.0, 1.6 Hz, 1H), 8.18 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.60 (dd, *J* = 4.8, 1.6 Hz, 1H), 8.83-8.84 (m, 2H), 8.90 (dd, *J* = 7.2, 1.6 Hz, 1H), 10.05 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 117.1, 121.9, 122.1, 123.7, 123.8, 127.6, 128.1, 130.7, 134.46, 134.50, 136.6, 138.5, 138.6, 148.4, 149.7, 150.8, 163.4 ppm. HRMS (ESI$^+$): calcd for $C_{17}H_{14}N_3O$ $[M+H]^+$ 276.1137, found 276.1137.

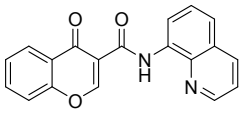


(*E*)-2-propyl-*N*-(quinolin-8-yl)hex-2-enamide (1r). A pale yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.98-1.03 (m, 6H), 1.50-1.63 (m, 4H), 2.25 (dd, *J* = 14.8, 7.2 Hz, 2H), 2.48-2.52 (m, 2H), 6.59 (t, *J* = 7.4 Hz, 1H), 7.45 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.48-7.50 (m, 1H), 7.53-7.57 (m, 1H), 8.16 (dd, *J* = 8.4, 2.0 Hz, 1H), 8.78-8.85 (m, 2H), 10.30 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 14.1, 14.3, 22.5, 22.6, 29.4, 30.7, 116.4, 121.3, 121.7, 127.6, 128.1, 135.0, 136.5, 137.1, 137.4, 138.9, 148.3, 167.9 ppm. HRMS (ESI$^+$): calcd for $C_{18}H_{23}N_2O$ $[M+H]^+$ 283.1810, found 283.18101.

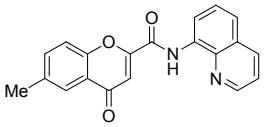


(2*E*, 4*E*)-5-phenyl-*N*-(quinolin-8-yl)penta-2,4-dienamide (1u). A pale yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 6.39 (d, *J* = 14.8 Hz, 1H), 6.93-7.02 (m, 2H), 7.29-7.33 (m, 1H), 7.36-7.39 (m, 2H), 7.46-7.49 (m, 2H), 7.51-7.53 (m, 2H), 7.55-7.63 (m, 2H), 8.18 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.83 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.90 (dd, *J* = 7.6, 1.6 Hz, 1H), 9.94 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 116.9, 121.7, 121.8, 125.0, 126.5, 127.2,

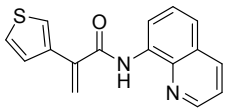
127.7, 128.1, 128.9, 129.0, 134.8, 136.4, 136.6, 138.6, 140.0, 142.2, 148.3, 164.5 ppm. HRMS (ESI$^+$): calcd for $C_{20}H_{17}N_2O$ $[M+H]^+$ 301.1341, found 301.1345.



4-oxo-*N*-(quinolin-8-yl)-4*H*-chromene-3-carboxamide (1v). A pale yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.34 (d, *J* = 4.4 Hz, 1H), 7.49-7.57 (m, 2H), 7.62-7.65 (m, 2H), 7.76-7.83 (m, 2H), 8.23-8.29 (m, 2H), 8.90-8.96 (m, 2H), 11.38 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 112.6, 117.7, 118.7, 122.2, 123.3, 124.5, 126.2, 127.5, 128.2, 133.29, 133.30, 134.8, 136.7, 138.9, 149.0, 155.2, 155.5, 157.2, 178.4 ppm. HRMS (ESI$^+$): calcd for $C_{19}H_{13}N_2O_3$ $[M+H]^+$ 317.0926, found 317.0927.

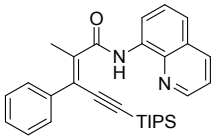


6-methyl-4-oxo-*N*-(quinolin-8-yl)-4*H*-chromene-2-carboxamide (1w). A pale yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 2.50 (s, 3H), 7.30 (s, 1H), 7.54 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.58-7.67 (m, 4H), 8.04 (s, 1H), 8.23 (dd, *J* = 8.0, 2.0 Hz, 1H), 8.90 (dd, *J* = 6.8, 2.4 Hz, 1H), 8.94 (dd, *J* = 4.4, 1.6 Hz, 1H), 11.34 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 21.2, 112.4, 117.7, 118.4, 122.2, 123.3, 124.2, 125.5, 127.5, 128.2, 133.3, 136.0, 136.3, 136.6, 138.9, 149.0, 153.7, 155.1, 157.3, 178.5 ppm. HRMS (ESI$^+$): calcd for $C_{20}H_{15}N_2O_3$ $[M+H]^+$ 331.1083, found 331.1080.

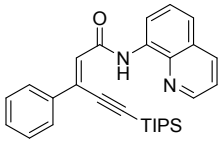


***N*-(quinolin-8-yl)-2-(thiophen-3-yl)acrylamide (5i).** A colorless liquid. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 5.88 (s, 1H), 6.19 (s, 1H), 7.33 (dd, *J* = 4.8, 1.2 Hz, 1H), 7.38-7.44 (m, 2H), 7.51-7.54 (m, 1H), 7.55-7.59 (m, 1H), 7.62 (dd, *J* = 3.2, 1.6 Hz, 1H), 8.14 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.72 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.89 (dd, *J* = 7.6, 1.6 Hz, 1H), 10.36 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 116.8, 120.3, 121.7, 122.0, 124.5, 126.2,

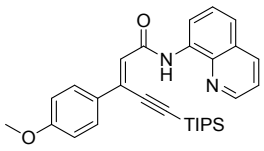
127.1, 127.5, 128.0, 134.6, 136.4, 137.2, 138.8, 140.6, 148.4, 165.9 ppm. HRMS (ESI^+): calcd for $C_{16}H_{13}N_2OS$ $[M+H]^+$ 281.0749, found 281.0745.



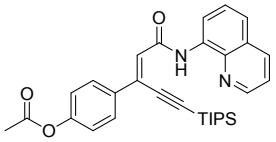
(*Z*)-2-methyl-3-phenyl-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (3a). A pale yellow solid (34.2 mg, 73% yield). ^1H NMR (400 MHz, $CDCl_3$): δ = 1.05 (m, 21H), 2.18 (s, 3H), 7.31-7.35 (m, 1H), 7.39-7.45 (m, 3H), 7.49-7.50 (m, 1H), 7.51-7.52 (m, 1H), 7.53-7.54 (m, 1H), 7.57 (d, *J* = 8.4 Hz, 1H), 8.16 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.81 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.91 (dd, *J* = 7.2, 1.6 Hz, 1H), 10.40 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.1, 18.0, 18.4, 98.2, 105.1, 117.2, 121.6, 121.9, 124.2, 127.5, 128.0, 128.1, 128.3, 129.2, 134.7, 136.4, 137.8, 138.9, 141.5, 148.3, 168.8 ppm. HRMS (ESI^+): calcd for $C_{30}H_{36}N_2NaOSi$ $[M+Na]^+$ 491.2495, found 491.2491.



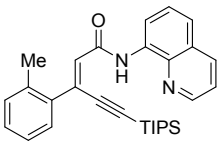
(*Z*)-3-phenyl-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (3b). A pale yellow liquid (31.8 mg, 70% yield). ^1H NMR (400 MHz, $CDCl_3$): δ = 0.90-0.94 (m, 21H), 6.84 (s, 1H), 7.40-7.47 (m, 4H), 7.52-7.60 (m, 2H), 7.79-7.81 (m, 2H), 8.17 (dd, *J* = 8.0, 2.0 Hz, 1H), 8.80 (dd, *J* = 4.4, 2.0 Hz, 1H), 8.85 (dd, *J* = 7.2, 1.2 Hz, 1H), 10.47 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.6, 102.4, 104.7, 117.6, 121.6, 122.0, 127.1, 127.5, 128.0, 128.7, 129.3, 129.6, 130.6, 134.6, 136.4, 137.2, 139.0, 148.4, 164.2 ppm. HRMS (ESI^+): calcd for $C_{29}H_{35}N_2OSi$ $[M+H]^+$ 455.2519, found 455.2523.



(*Z*)-3-(4-methoxyphenyl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (3c). A pale yellow solid (31.9 mg, 66% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.93-0.95 (m, 21H), 3.86 (s, 3H), 6.76 (s, 1H), 6.93-6.95 (m, 2H), 7.44 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.51-7.59 (m, 2H), 7.73-7.76 (m, 2H), 8.16 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.79 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.84 (dd, *J* = 7.6, 1.6 Hz, 1H), 10.44 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.6, 55.5, 102.6, 104.4, 114.0, 117.5, 121.6, 121.8, 127.3, 127.5, 128.0, 128.5, 129.6, 130.2, 134.7, 136.4, 139.0, 148.3, 160.8, 164.4 ppm. HRMS (ESI$^+$): calcd for $C_{30}H_{36}N_2O_2Si$ $[M+H]^+$ 485.2624, found 485.2626.

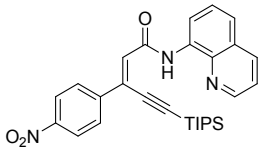


(*Z*)-4-(5-oxo-5-(quinolin-8-ylamino)-1-(triisopropylsilyl)pent-3-en-1-yn-3-yl)phenyl acetate (3d). A pale yellow liquid (28.2 mg, 55% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.93-0.95 (m, 21H), 2.33 (s, 3H), 6.81 (s, 1H), 7.15-7.17 (m, 2H), 7.45 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.52-7.57 (m, 2H), 7.80-7.782 (m, 2H), 8.16 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.79 (dd, *J* = 4.4, 2.0 Hz, 1H), 8.84 (dd, *J* = 7.2, 1.6 Hz, 1H), 10.44 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.6, 21.3, 102.2, 105.0, 117.6, 121.6, 121.8, 122.0, 127.5, 128.1, 128.3, 129.3, 129.7, 134.6, 134.8, 136.4, 139.0, 148.4, 151.7, 164.0, 169.4 ppm. HRMS (ESI$^+$): calcd for $C_{31}H_{37}N_2O_3Si$ $[M+H]^+$ 513.2573, found 513.2574.

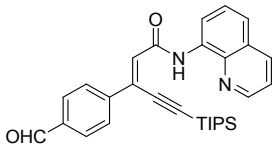


(*Z*)-*N*-(quinolin-8-yl)-3-(o-tolyl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (3e). A pale yellow liquid (23.9 mg, 51% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.88-0.91 (m, 21H), 2.54 (s, 3H), 6.42 (s, 1H), 7.21-7.24 (m, 2H), 7.36-7.38 (m, 1H), 7.45 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.52-7.60 (m, 2H), 8.17 (dd, *J* = 8.4, 2.0 Hz, 1H), 8.80 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.86 (dd, *J* = 7.2, 1.6 Hz,

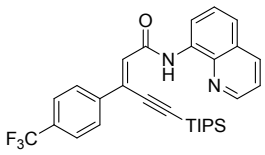
1H), 10.44 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.5, 20.4, 102.9, 105.5, 117.6, 121.6, 122.0, 126.1, 127.5, 128.1, 128.6, 128.9, 130.7, 132.1, 133.5, 134.6, 135.7, 136.4, 139.0, 148.4, 163.7 ppm. HRMS (ESI$^+$): calcd for $C_{30}H_{37}N_2OSi$ $[M+H]^+$ 469.2675, found 469.2676.



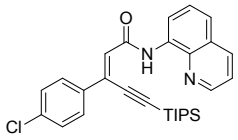
(*Z*)-3-(4-nitrophenyl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (3f). A yellow solid (25.9 mg, 52% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.92-0.96 (m, 21H), 6.93 (s, 1H), 7.47 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.55-7.59 (m, 2H), 7.93-7.95 (m, 2H), 8.19 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.27-8.30 (m, 2H), 8.80 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.85 (dd, *J* = 6.8, 2.4 Hz, 1H), 10.46 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.2, 18.6, 101.3, 106.3, 117.6, 121.8, 122.4, 124.0, 127.5, 128.0, 128.1, 128.6, 132.0, 134.3, 136.5, 138.9, 143.5, 148.3, 148.4, 163.2 ppm. HRMS (ESI$^+$): calcd for $C_{29}H_{33}N_3NaO_3Si$ $[M+Na]^+$ 522.2189, found 522.2190.



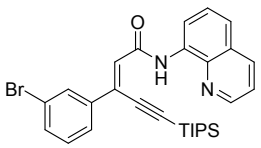
(*Z*)-3-(4-formylphenyl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (3g). A yellow liquid (20.2 mg, 42% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.83-0.97 (m, 21H), 6.92 (s, 1H), 7.46 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.56-7.61 (m, 2H), 7.68-7.73 (m, 1H), 7.95 (s, 3H), 8.18 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.80 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.86 (dd, *J* = 6.8, 2.0 Hz, 1H), 10.07 (s, 1H), 10.46 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.6, 101.7, 105.8, 117.6, 121.7, 122.2, 127.6, 127.8, 128.1, 129.5, 130.1, 131.4, 134.4, 136.5, 136.8, 138.9, 143.1, 148.4, 163.5, 191.8 ppm. HRMS (ESI$^+$): calcd for $C_{30}H_{35}N_2O_2Si$ $[M+H]^+$ 483.2468, found 483.2470.



(*Z*)-*N*-(quinolin-8-yl)-3-(4-(trifluoromethyl)phenyl)-5-(triisopropylsilyl)-pent-2-en-4-ynamide (3h). A yellow solid (38.1 mg, 73% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.92-0.95 (m, 21H), 6.88 (s, 1H), 7.46 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.56-7.60 (m, 2H), 7.69 (d, *J* = 8.4 Hz, 2H), 7.90 (d, *J* = 8.4 Hz, 2H), 8.18 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.80 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.86 (dd, *J* = 7.2, 2.0 Hz, 1H), 10.45 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.6, 101.8, 105.6, 117.6, 121.7, 122.2, 124.1 (q, $J_{C\text{-}F}$ = 271.0 Hz), 125.7 (q, $J_{C\text{-}F}$ = 3.0 Hz), 127.4, 127.5, 128.1, 129.3, 130.9, 131.3 (q, $J_{C\text{-}F}$ = 33.0 Hz), 134.4, 136.5, 138.9, 140.7 (q, $J_{C\text{-}F}$ = 2.0 Hz), 148.4, 163.6 ppm. HRMS (ESI$^+$): calcd for $C_{30}H_{34}F_3N_2OSi$ $[M+H]^+$ 523.2392, found 523.2398.

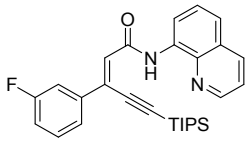


(*Z*)-3-(4-chlorophenyl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (3i). A yellow solid (27.3 mg, 56% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.92-0.94 (m, 21H), 6.80 (d, *J* = 4.0 Hz, 1H), 7.38-7.41 (m, 2H), 7.43-7.47 (m, 1H), 7.52-7.57 (m, 2H), 7.70-7.73 (m, 2H), 8.15-8.18 (m, 1H), 8.78-8.80 (m, 1H), 8.83-8.84 (m, 1H) 10.43 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.6, 102.1, 105.2, 117.6, 121.7, 122.1, 127.5, 128.1, 128.4, 128.9, 129.45, 129.52, 134.5, 135.6, 135.7, 136.4, 139.0, 148.4, 163.9 ppm. HRMS (ESI$^+$): calcd for $C_{29}H_{34}{}^{35}ClN_2OSi$ $[M+H]^+$ 489.2129, found 489.2130; calcd for $C_{29}H_{34}{}^{37}ClN_2OSi$ $[M+H]^+$ 491.2099, found 491.2094.



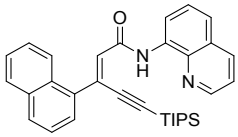
(*Z*)-3-(3-bromophenyl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide

(3j). A yellow solid (30.3 mg, 57% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.95-0.96 (m, 21H), 6.82 (s, 1H), 7.27-7.31 (m, 1H), 7.45 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.51-7.57 (m, 3H), 7.70 (dq, *J* = 7.6, 1.2 Hz, 1H), 7.98 (t, *J* = 1.8 Hz, 1H), 8.17 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.80 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.85 (dd, *J* = 7.2, 2.0 Hz, 1H), 10.44 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.6, 101.9, 105.6, 117.6, 121.7, 122.1, 122.9, 125.4, 127.5, 128.0, 129.3, 129.9, 130.2, 130.5, 132.4, 134.5, 136.4, 138.9, 139.2, 148.4, 163.7 ppm. HRMS (ESI$^+$): calcd for $C_{29}H_{34}{}^{79}BrN_2OSi$ $[M+H]^+$ 533.1624, found 533.1626; calcd for $C_{29}H_{34}{}^{81}BrN_2OSi$ $[M+H]^+$ 535.1603, found 535.1598.



(*Z*)-3-(3-fluorophenyl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide

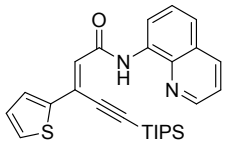
(3k). A yellow solid (33.0 mg, 70% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.94-0.95 (m, 21H), 7.10 (tdd, *J* = 8.3, 2.4, 0.8 Hz, 1H), 7.36-7.41 (m, 1H), 7.45 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.49-7.53 (m, 1H), 7.54-7.59 (m, 3H), 8.17 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.80 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.85 (dd, *J* = 7.2, 1.6 Hz, 1H), 10.45 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.5, 101.9, 105.2, 114.3 (d, $J_{C\text{-}F}$ = 24.0 Hz), 116.4 (d, $J_{C\text{-}F}$ = 21.0 Hz), 117.6, 121.7, 122.1, 122.6 (d, $J_{C\text{-}F}$ = 3.0 Hz), 127.5, 128.0, 129.4 (d, $J_{C\text{-}F}$ = 3.0 Hz), 130.0, 130.2 (d, $J_{C\text{-}F}$ = 8.0 Hz), 134.5, 136.4, 138.9, 139.4 (d, $J_{C\text{-}F}$ = 7.0 Hz), 148.4, 163.0 (d, $J_{C\text{-}F}$ = 245.0 Hz), 163.8 ppm. HRMS (ESI$^+$): calcd for $C_{29}H_{34}FN_2OSi$ $[M+H]^+$ 473.2424, found 473.2425.



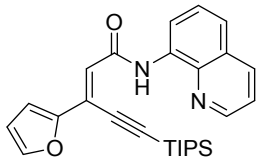
(*Z*)-3-(naphthalen-1-yl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide

(3l). A pale yellow liquid (20.2 mg, 40% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.84-0.92 (m, 21H), 6.66 (s, 2H), 7.44-762 (m, 7H), 7.87-7.90 (m, 2H), 8.18 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.45-8.48

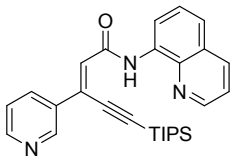
(m, 1H), 8.82 (dd, *J* = 4.4, 2.0 Hz, 1H), 8.91 (dd, *J* = 7.6, 1.6 Hz, 1H), 10.54 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.5, 103.8, 106.1, 117.6, 121.7, 122.0, 125.4, 126.0, 126.2, 126.37, 126.44, 127.6, 128.1, 128.4, 129.3, 130.6, 131.1, 133.8, 134.2, 134.6, 136.4, 137.3, 139.0, 148.4, 163.6 ppm. HRMS (ESI$^+$): calcd for $C_{33}H_{37}N_2OSi$ $[M+H]^+$ 505.2675, found 505.2681.



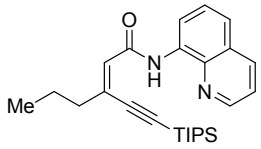
(*E*)-*N*-(quinolin-8-yl)-3-(thiophen-2-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (3m). A yellow solid (18.5 mg, 40% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.97-0.98 (m, 21H), 6.77 (s, 1H), 7.07 (dd, *J* = 5.2, 3.6 Hz, 1H), 7.37 (dd, *J* = 5.2, 1.2 Hz, 1H), 7.45 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.53-7.57 (m, 4H), 8.16 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.80 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.83 (dd, *J* = 7.6, 1.6 Hz, 1H), 10.37 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 10.3, 17.6, 100.4, 102.9, 109.2, 116.5, 120.6, 120.9, 123.7, 125.1, 126.5, 126.7, 126.9, 127.1, 133.7, 135.4, 138.0, 141.3, 147.3, 162.6 ppm. HRMS (ESI$^+$): calcd for $C_{27}H_{32}N_2NaOSSi$ $[M+Na]^+$ 483.1902, found 483.1905.



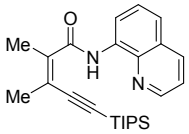
(*E*)-3-(furan-2-yl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (3n). A pale yellow liquid (20.0 mg, 45% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.00-1.01 (m, 21H), 6.50 (dd, *J* = 3.6, 1.6 Hz, 1H), 6.81-6.82 (m, 1H), 6.90 (s, 1H), 7.44 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.47 (m, 1H), 7.50-7.58 (m, 2H), 8.15 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.79 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.85 (dd, *J* = 7.2, 1.6 Hz, 1H), 10.31 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 10.3, 17.6, 99.2, 101.4, 111.4, 111.9, 116.4, 119.5, 120.6, 120.8, 123.5, 126.6, 127.0, 133.7, 135.4, 137.9, 143.1, 147.3, 151.0, 162.6 ppm. HRMS (ESI$^+$): calcd for $C_{27}H_{32}N_2NaO_2Si$ $[M+Na]^+$ 467.2131, found 467.2126.



(*Z*)-3-(pyridin-3-yl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (3o). A pale yellow liquid (27.3 mg, 6o% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.91-0.98 (m, 21H), 6.86 (s, 1H), 7.36 (ddd, *J* = 5.6, 4.8, 0.8 Hz, 1H), 7.46 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.54-7.60 (m, 2H), 8.05 (dq, *J* = 8.4, 2.0 Hz, 1H), 8.18 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.64 (dd, *J* = 4.8, 1.6 Hz, 1H), 8.80 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.85 (dd, *J* = 7.2, 2.0 Hz, 1H), 9.04 (dd, *J* = 2.4, 0.4 Hz, 1H), 10.45 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.6, 101.4, 105.9, 117.6, 121.7, 122.2, 123.5, 127.5, 127.8, 128.1, 130.5, 133.0, 134.2, 134.4, 136.5, 138.9, 148.4, 148.5, 150.4, 163.5 ppm. HRMS (ESI$^+$): calcd for $C_{28}H_{34}N_3OSi$ $[M+H]^+$ 456.2471, found 456.2475.

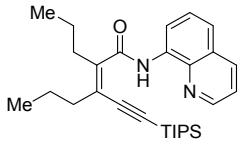


(*Z*)-*N*-(quinolin-8-yl)-3-((triisopropylsilyl)ethynyl)hex-2-enamide (3p). A pale yellow liquid (29.8 mg, 71% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.94-0.97 (m, 21H), 1.09 (t, *J* = 14.8 Hz, 3H), 2.25-2.32 (m, 2H), 3.44 (s, 2H), 6.30 (t, *J* = 15.2 Hz, 1H), 7.43 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.48-7.54 (m, 2H), 8.13 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.77 (d, *J* = 1.6 Hz, 1H), 8.78 (dd, *J* = 3.2, 2.0 Hz, 1H), 10.15 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 13.6, 18.7, 22.4, 41.2, 88.9, 108.3, 116.1, 116.6, 121.6, 121.7, 127.4, 128.0, 134.7, 136.2, 138.8, 144.8, 148.3, 168.3 ppm. HRMS (ESI$^+$): calcd for $C_{26}H_{37}N_2OSi$ $[M+H]^+$ 421.2675, found 421.2679.

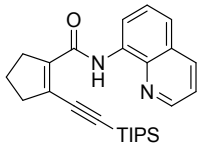


(*Z*)-2,3-dimethyl-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (3q). A yellow solid (30.0 mg, 74% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.65-0.74 (m, 21H), 2.03 (d, *J*

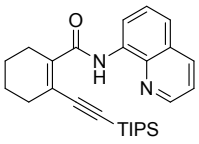
= 0.8 Hz, 3H), 2.07 (d, *J* = 0.8 Hz, 3H), 7.42 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.48-7.55 (m, 2H), 8.14 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.78 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.82 (dd, *J* = 7.2, 1.6 Hz, 1H), 10.26 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.1, 16.3, 18.4, 20.5, 41.2, 96.6, 106.2, 117.1, 119.4, 121.5, 121.7, 127.5, 128.0, 134.7, 136.3, 138.9, 140.0, 148.3, 168.7 ppm. HRMS (ESI$^+$): calcd for $C_{25}H_{34}N_2NaOSi$ $[M+Na]^+$ 429.2338, found 429.2335.



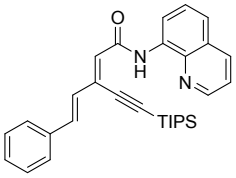
(*Z*)-2-propyl-*N*-(quinolin-8-yl)-3-((triisopropylsilyl)ethynyl)hex-2-ena-mide (3r). A pale yellow liquid (37.9 mg, 82% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.62-0.73 (m, 21H), 0.96-1.03 (m, 6H), 1.53-1.59 (m, 2H), 1.69-1.71 (m, 2H), 2.29-2.33 (m, 2H), 2.46-2.50 (m, 2H), 7.41 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.47-7.54 (m, 2H), 8.13 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.78 (dd, *J* = 4.4, 2.0 Hz, 1H), 8.86 (dd, *J* = 7.6, 2.0 Hz, 1H), 10.21 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 10.8, 11.1, 14.0, 14.3, 18.4, 21.7, 22.2, 32.2, 34.7, 96.8, 105.2, 116.8, 121.5, 121.6, 123.6, 127.5, 128.0, 134.9, 136.2, 138.9, 145.0, 148.3, 168.9 pm. HRMS (ESI$^+$): calcd for $C_{29}H_{43}N_2OSi$ $[M+H]^+$ 463.3145, found 463.3146.



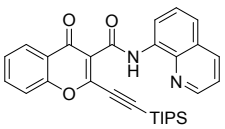
***N*-(quinolin-8-yl)-2-((triisopropylsilyl)ethynyl)cyclopent-1-enecarboxa-mide (3s).** A white solid (33.4 mg, 80% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.86-0.96 (m, 21H), 1.94-2.02 (m, 2H), 2.77 (tt, *J* = 7.8, 2.4 Hz, 2H), 2.90 (tt, *J* = 7.6, 2.8 Hz, 2H), 7.42 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.49-7.56 (m, 2H), 8.13 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.75 (dd, *J* = 7.2, 1.6 Hz, 1H), 8.78 (dd, *J* = 4.4, 1.6 Hz, 1H), 10.51 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.2, 18.5, 22.2, 34.2, 39.8, 101.8, 102.8, 117.8, 121.5, 121.9, 127.4, 127.8, 128.1, 134.6, 136.3, 139.3, 144.3, 148.4, 163.8 pm. HRMS (ESI$^+$): calcd for $C_{26}H_{35}N_2OSi$ $[M+H]^+$ 419.2519, found 419.2522.



***N*-(quinolin-8-yl)-2-((triisopropylsilyl)ethynyl)cyclohex-1-enecarbox-amide (3t).** A white solid (35.0 mg, 81% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.70-0.76 (m, 21H), 1.71-1.72 (m, 4H), 2.37 (d, *J* = 2.0 Hz, 2H), 2.37 (d, *J* = 2.4 Hz, 2H), 7.40-7.44 (m, 1H), 7.47-7.55 (m, 2H), 8.12-8.15 (m, 1H), 8.77-8.84 (m, 2H), 10.29 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.1, 18.4, 21.7, 22.0, 26.6, 31.4, 97.2, 105.4, 117.2, 121.5, 121.7, 121.8, 127.5, 128.0, 134.7, 136.3, 139.0, 141.5, 148.3, 168.1 pm. HRMS (ESI$^+$): calcd for $C_{27}H_{37}N_2OSi$ $[M+H]^+$ 433.2675, found 433.2680.

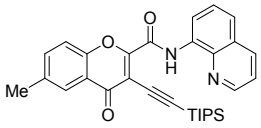


(2*Z*,4*E*)-5-phenyl-*N*-(quinolin-8-yl)-3-((triisopropylsilyl)ethynyl)penta-2,4-dienamide (3u). A yellow solid (22.6 mg, 47% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.99-1.00 (m, 21H), 6.45 (s, 1H), 6.88 (d, *J* = 15.2 Hz, 1H), 7.32-7.33 (m, 1H), 7.36-7.40 (m, 3H), 7.43-7.45 (m, 1H), 7.47-7.51 (m, 3H), 7.53-7.58 (m, 2H), 8.16 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.80 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.82 (dd, *J* = 7.2, 1.6 Hz, 1H), 10.41 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.7, 110.2, 117.6, 121.6, 121.9, 127.3, 127.5, 128.1, 128.2, 128.9, 129.0, 129.7, 131.0, 134.7, 136.3, 136.4, 137.1, 139.0, 148.3, 164.0 ppm. HRMS (ESI$^+$): calcd for $C_{31}H_{36}N_2NaOSi$ $[M+Na]^+$ 503.2495, found 503.2498.

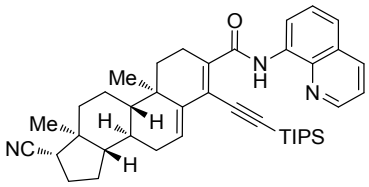


4-oxo-*N*-(quinolin-8-yl)-2-((triisopropylsilyl)ethynyl)-4*H*-chromene-3-carboxamide (3v). A yellow solid (23.3 mg, 47% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.01 (s, 21H), 7.45-

7.51 (m, 2H), 7.61-7.66 (m, 3H), 7.74-7.79 (m, 1H), 8.21 (dd, *J* = 8.4, 2.0 Hz, 1H), 8.27 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.85 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.89-8.93 (m, 1H), 11.06 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.6, 95.4, 106.4, 110.2, 117.8, 118.7, 122.0, 122.8, 123.1, 126.3, 126.3, 127.5, 128.1, 133.6, 134.8, 136.5, 138.9, 148.8, 154.9, 157.7, 158.3, 176.4 pm. HRMS (ESI$^+$): calcd for $C_{30}H_{33}N_2O_3Si$ $[M+H]^+$ 497.2260, found 497.2258.

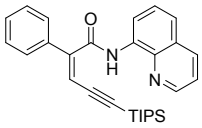


6-methyl-4-oxo-*N*-(quinolin-8-yl)-3-((triisopropylsilyl)ethynyl)-4*H*-chromene-2-carboxamide (3w). A pale yellow liquid (23.0 mg, 45% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.01 (s, 21H), 2.48 (s, 3H), 7.49 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.52-7.56 (m, 2H), 7.61 (s, 1H), 7.62 (s, 1H), 8.04 (s, 1H), 8.21 (dd, *J* = 8.0, 1.2 Hz, 1H), 8.85 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.89-8.93 (m, 1H), 11.04 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.6, 21.2, 95.6, 106.2, 117.8, 118.4, 122.0, 122.4, 123.1, 125.6, 127.5, 128.1, 133.6, 136.1, 136.4, 136.5, 138.9, 148.8, 153.2, 157.8, 158.1, 176.5 pm. HRMS (ESI$^+$): calcd for $C_{31}H_{35}N_2O_3Si$ $[M+H]^+$ 511.2417, found 511.2414.

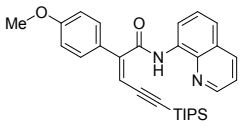


(8S,9S,10R,13S,14S,17S)-17-cyano-10,13-dimethyl-*N*-(quinolin-8-yl)-4-((triisopropylsilyl)ethynyl)-2,7,8,9,10,11,12,13,14,15,16,17-dodecahydro-1*H*-cyclopenta[*a*]phenanthrene-3-carboxamide (3x). A white solid (49.3 mg, 78% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.63-0.77 (m, 21H), 0.97 (s, 3H), 1.04-1.05 (m, 2H), 6.46-6.47 (m, 1H), 7.42 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.50-7.51 (m, 1H), 7.54 (d, *J* = 8.4 Hz, 1H), 8.14 (dd, *J* = 8.4, 2.0 Hz, 1H), 8.77 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.84 (dd, *J* = 7.2, 2.0 Hz, 1H), 10.28 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.2, 14.4, 18.4, 19.2, 20.9, 24.3, 24.7, 26.7, 30.4, 31.8, 32.3, 32.8, 35.0, 40.2, 44.4, 48.4, 54.8, 98.8, 102.1, 117.1, 120.8, 121.3, 121.5, 121.7, 125.6, 127.4, 127.8,

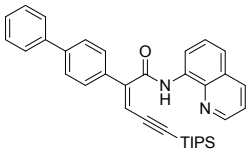
128.0, 134.7, 136.3, 138.9, 139.2, 148.3, 168.3 pm. HRMS (ESI$^+$): calcd for $C_{41}H_{54}N_3OSi$ $[M+H]^+$ 632.4036, found 632.4034.



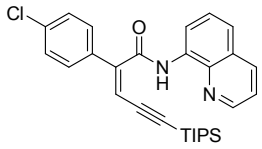
(*Z*)-2-phenyl-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (6a). A pale yellow liquid (32.3 mg, 70% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.76-0.78 (m, 21H), 6.34 (s, 1H), 7.34-7.39 (m, 3H), 7.44 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.53-7.60 (m, 4H), 8.16 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.76 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.96 (dd, *J* = 6.8, 2.0 Hz, 1H), 10.33 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 1.2, 18.4, 102.8, 109.4, 110.2, 117.1, 121.6, 122.1, 126.6, 127.5, 128.0, 128.9, 129.3, 134.7, 135.5, 136.3, 138,7, 148.4, 149.2, 166.2 ppm. HRMS (ESI$^+$): calcd for $C_{29}H_{35}N_2OSi$ $[M+H]^+$ 455.2519, found 455.2521.



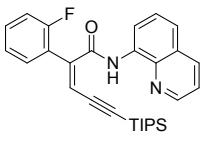
(*Z*)-2-(4-methoxyphenyl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (6b). A white solid (25.1 mg, 52% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.72-0.77 (m, 21H), 3.82 (s, 3H), 6.24 (s, 1H), 6.88-6.90 (m, 2H), 7.43 (dd, *J* = 8.4, 4.4 Hz, 1H) 7.51-7.59 (m, 4H), 8.16 (dd, *J* = 8.0, 1.6 Hz, 1H) 8.76 (dd, *J* = 4.4, 2.0 Hz, 1H) 8.95 (dd, *J* = 6.8, 2.0 Hz, 1H), 10.31 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.2, 18.4, 55.5, 99.9, 103.1, 107.2, 114.3, 117.1, 121.6, 122.0, 127.5, 127.98, 128.01, 134.7, 136.3, 138.7, 148.4, 148.8, 160.6, 166.8 ppm. HRMS (ESI$^+$): calcd for $C_{30}H_{36}N_2NaO_2Si$ $[M+Na]^+$ 507.2444, found 507.2445.



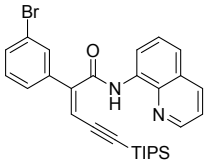
(*Z*)-2-([1,1'-biphenyl]-4-yl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (6c). A white solid (26.5 mg, 50% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.77-0.79 (m, 21H), 6.40 (s, 1H), 7.33-7.38 (m, 1H), 7.42-7.46 (m, 3H), 7.54-7.57 (m, 2H), 7.59-7.60 (m, 2H), 7.61-7.62 (m, 2H), 7.66-7.67 (m, 1H), 7.68-7.69 (m, 1H), 8.17 (dd, *J* = 8.4, 2.0 Hz, 1H), 8.77 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.98 (dd, *J* = 7.2, 2.0 Hz, 1H), 10.38 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.2, 18.4, 101.1, 102.9, 109.1, 117.1, 121.7, 122.1, 127.1, 127.2, 127.5, 127.6, 127.8, 128.0, 129.0, 134.4, 134.7, 136.3, 138.7, 140.4, 142.0, 148.4, 148.8, 166.2 ppm. HRMS (ESI$^+$): calcd for $C_{35}H_{39}N_2OSi$ $[M+H]^+$ 531.2832, found 531.2830.



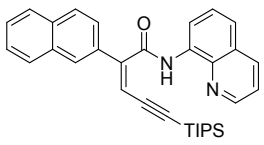
(*Z*)-2-(4-chlorophenyl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (6d). A white solid (30.7 mg, 63% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.75-0.77 (m, 21H), 6.33 (s, 1H), 7.32-7.36 (m, 2H), 7.44 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.51-7.52 (m, 1H), 7.53-7.54 (m, 1H), 7.56-7.60 (m, 2H), 8.17 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.77 (dd, *J* = 4.0, 2.0 Hz, 1H), 8.93 (dd, *J* = 6.4, 2.4 Hz, 1H), 10.35 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.1, 18.4, 101.8, 102.4, 110.1, 117.2, 121.7, 122.2, 127.5, 127.98, 127.99, 129.1, 134.1, 134.5, 135.2, 136.4, 138.7, 147.8, 148.4, 165.8 ppm. HRMS (ESI$^+$): calcd for $C_{29}H_{34}{}^{35}ClN_2OSi$ $[M+H]^+$ 489.2129, found 489.2130; calcd for $C_{29}H_{34}{}^{37}ClN_2OSi$ $[M+H]^+$ 491.2099, found 491.2091.



(*Z*)-2-(2-fluorophenyl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (6e). A colorless liquid (23.2 mg, 49% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.76-0.80 (m, 21H), 6.43 (s, 1H), 7.06-7.11 (m, 1H), 7.16 (td, *J* = 8.8, 1.2 Hz, 1H), 7.30-7.36 (m, 1H), 7.44 (dd, *J* = 8.4, 2.2 Hz, 1H), 7.49-7.53 (m, 1H), 7.54-7.58 (m, 2H), 8.16 (dd, *J* = 8.4, 2.0 Hz, 1H), 8.79 (dd, *J* = 2.2, 1.6 Hz, 1H), 8.90 (dd, *J* = 6.8, 2.4 Hz, 1H), 10.48 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.1, 18.4, 102.2, 102.5, 113.8 (d, $J_{C\text{-}F}$ = 6.0 Hz), 116.3 (d, $J_{C\text{-}F}$ = 22.0 Hz), 117.1, 121.6, 122.0, 124.5 (d, $J_{C\text{-}F}$ = 8.0 Hz), 124.6 (d, $J_{C\text{-}F}$ = 4.0 Hz), 127.5, 128.0, 130.3 (d, $J_{C\text{-}F}$ = 3.0 Hz), 130.8 (d, $J_{C\text{-}F}$ = 9.0 Hz), 134.6, 136.3, 138.8, 144.1, 148.4, 160.3 (d, $J_{C\text{-}F}$ = 250.0 Hz), 165.4 ppm. HRMS (ESI$^+$): calcd for $C_{29}H_{34}FN_2OSi$ $[M+H]^+$ 473.2424, found 473.2427.

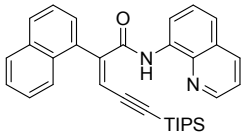


(*Z*)-2-(3-bromophenyl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (6f). A pale yellow liquid (27.1 mg, 51% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.75-0.77 (m, 21H), 6.34 (s, 1H), 7.23 (d, *J* = 8.0 Hz, 1H), 7.43-7.45 (m, 1H), 7.46-7.49 (m, 1H), 7.50-7.57 (m, 3H), 7.58-7.60 (m, 1H), 7.73-7.75 (m, 1H), 8.17 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.77 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.93 (dd, *J* = 6.4, 2.4 Hz, 1H), 10.36 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.1, 18.4, 102.24, 102.27, 111.0, 117.2, 121.7, 122.3, 123.0, 125.4, 127.5, 128.0, 129.6, 130.3, 132.1, 134.4, 136.4, 137.7, 138.7, 147.5, 148.4, 165.5 ppm. HRMS (ESI$^+$): calcd for $C_{29}H_{34}{}^{79}BrN_2OSi$ $[M+H]^+$ 533.1624, found 533.1627; calcd for $C_{29}H_{34}{}^{81}BrN_2OSi$ $[M+H]^+$ 535.1603, found 535.1598.

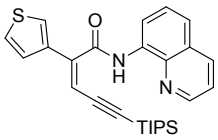


(*Z*)-2-(naphthalen-2-yl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide

(6g). A pale yellow liquid (36.3 mg, 72% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.77-0.79 (m, 21H), 6.49 (s, 1H), 7.42-7.48 (m, 3H), 7.55-7.62 (m, 2H), 7.69 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.80-7.85 (m, 3H), 8.05 (d, *J* = 1.6 Hz, 1H), 8.17 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.76 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.93 (dd, *J* = 7.6, 1.6 Hz, 1H), 10.40 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.2, 18.4, 101.3, 102.9, 109.6, 117.2, 121.7, 122.1, 123.5, 126.6, 126.7, 126.9, 127.5, 127.7, 128.0, 128.6, 128.8, 132.6, 133.4, 133.6, 134.7, 136.3, 138.7, 148.4, 149.1, 166.3 ppm. HRMS (ESI$^+$): calcd for $C_{33}H_{37}N_2OSi$ $[M+H]^+$ 505.2675, found 505.2681.

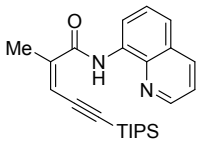


(*Z*)-2-(naphthalen-1-yl)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (6h). A pale yellow liquid (21.2 mg, 42% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.90-0.91 (m, 21H), 6.31 (s, 1H), 7.40-7.54 (m, 7H), 7.62-7.64 (m, 1H), 7.85-7.90 (m, 2H), 8.12-8.15 (m, 2H), 8.72 (dd, *J* = 4.4, 2.0 Hz, 1H), 8.85 (dd, *J* = 6.4, 2.8 Hz, 1H), 10.56 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.3, 18.5, 102.3, 102.4, 116.1, 117.1, 121.6, 122.0, 125.5, 126.2, 126.9, 127.5, 127.7, 128.0, 128.6, 129.5, 131.8, 133.9, 134.6, 135.4, 136.3, 138.9, 148.2, 148.4, 165.3 ppm. HRMS (ESI$^+$): calcd for $C_{33}H_{37}N_2OSi$ $[M+H]^+$ 505.2675, found 505.2673.

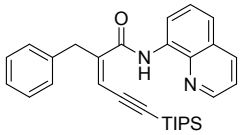


(*Z*)-*N*-(quinolin-8-yl)-2-(thiophen-3-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (6i). A pale yellow liquid (15.2 mg, 33% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.74-0.76 (m, 21H), 6.30 (s, 1H), 7.31-7.33 (m, 2H), 7.44 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.53-7.59 (m, 3H), 8.16 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.77 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.93 (dd, *J* = 7.2, 2.0 Hz, 1H), 10.32 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.0, 18.2, 101.1, 102.4, 108.1, 117.0, 121.5, 121.9, 124.3, 124.9, 126.4, 127.3, 127.8, 134.4, 136.2, 136.7, 138.6, 143.9, 148.2, 165.6 ppm. HRMS (ESI$^+$):

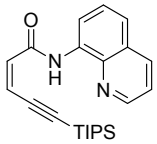
calcd for $C_{27}H_{33}N_2OSSi$ $[M+H]^+$ 461.2083, found 461.2081.



(*Z*)-2-methyl-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (6j). A white solid (18.0 mg, 46% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.75-0.78 (m, 21H), 2.15 (d, *J* = 1.6 Hz, 3H), 5.95 (q, *J* = 1.6 Hz, 1H), 7.43 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.50-7.57 (m, 2H), 8.15 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.78-8.81 (m, 2H), 10.41 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.1, 18.4, 20.5, 99.0, 102.2, 111.4, 117.4, 121.6, 122.0, 127.4, 128.0, 134.4, 136.3, 139.0, 145.8, 148.4, 166.6 ppm. HRMS (ESI$^+$): calcd for $C_{24}H_{33}N_2OSi$ $[M+H]^+$ 393.2362, found 393.2366.

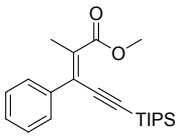


(*Z*)-2-benzyl-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (6k). A colorless liquid (21.5 mg, 46% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.68-0.77 (m, 21H), 3.84 (d, *J* = 1.6 Hz, 2H), 5.73 (t, *J* = 1.8 Hz, 1H), 7.21-7.25 (m, 1H), 7.28-7.34 (m, 4H), 7.42 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.50-7.56 (m, 2H), 8.14 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.76 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.81 (dd, *J* = 6.8, 2.0 Hz, 1H), 10.40 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.1, 18.4, 39.8, 100.4, 102.0, 112.0, 117.3, 121.6, 122.0, 126.9, 127.4, 128.0, 128.8, 129.6, 134.4, 136.3, 137.7, 139.0, 148.4, 149.5, 166.1 ppm. HRMS (ESI$^+$): calcd for $C_{30}H_{37}N_2OSi$ $[M+H]^+$ 469.2675, found 469.2676.

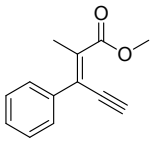


(*Z*)-*N*-(quinolin-8-yl)-5-(triisopropylsilyl)pent-2-en-4-ynamide (6l). A pale yellow liquid (17.8 mg, 47% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 0.91-0.93 (m, 21H), 6.17 (d, *J* = 12.0 Hz, 1H), 6.38 (d, *J* = 12.0 Hz, 1H), 7.44 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.51-7.57 (m, 2H), 8.15 (dd, *J* = 8.0,

1.6 Hz, 1H), 8.78-8.81 (m, 2H), 10.36 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.2, 18.5, 101.9, 104.1, 117.2, 117.6, 121.6, 122.1, 127.5, 128.0, 134.4, 135.0, 136.4, 139.0, 148.4, 163.5 ppm. HRMS (ESI$^+$): calcd for $C_{23}H_{31}N_2OSi$ $[M+H]^+$ 379.2206, found 379.2210.



(*Z*)-methyl 2-methyl-3-phenyl-5-(triisopropylsilyl)pent-2-en-4-ynoate (8). A colourless liquid (49.9 mg, 70%). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.04-1.11 (m, 21H), 1.98 (s, 3H), 3.83 (s, 3H), 7.28-7.41 (m, 5H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 11.4, 17.6, 18.8, 52.2, 99.4, 106.0, 128.1, 128.2, 128.4, 128.9, 135.5, 138.4, 169.5 ppm. HRMS (ESI$^+$): calcd for $C_{22}H_{33}O_2Si$ $[M+H]^+$ 357.2250, found 357.2251.



(*E*)-methyl 2-methyl-3-phenylpent-2-en-4-ynoate (9). A colourless liquid (19.0 mg, 95% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 1.97 (s, 3H), 3.45 (d, J = 4.0 Hz, 1H), 3.85 (s, 3H), 7.31-7.35 (m, 3H), 7.37-7.41 (m, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 17.3, 52.2, 83.2, 85.4, 128.4, 128.45, 128.51, 128.7, 136.7, 138.1, 168.7 ppm. HRMS (ESI$^+$): calcd for $C_{13}H_{12}NaO_2$ $[M+Na]^+$ 223.0735, found 223.0727.

X. Reference

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   (b) J.-L. Pan, C. Chen, Z.-G. Ma, J. Zhou, L.-R. Wang, S.-Y. Zhang, *Org. Lett.*, 2017, **19**, 5216.
2. D. D. Perrin, W. L. F. Armarego, In Purification of Laboratory Chemicals, 3rd ed.; *Pergamon Press: New York*, 1988.
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4. F.-X. Luo, Z.-C. Cao, H.-W. Zhao, D. Wang, Y.-F. Zhang, X. Xu, Z.-J. Shi, *Organometallics,* 2017, **36**, 18.
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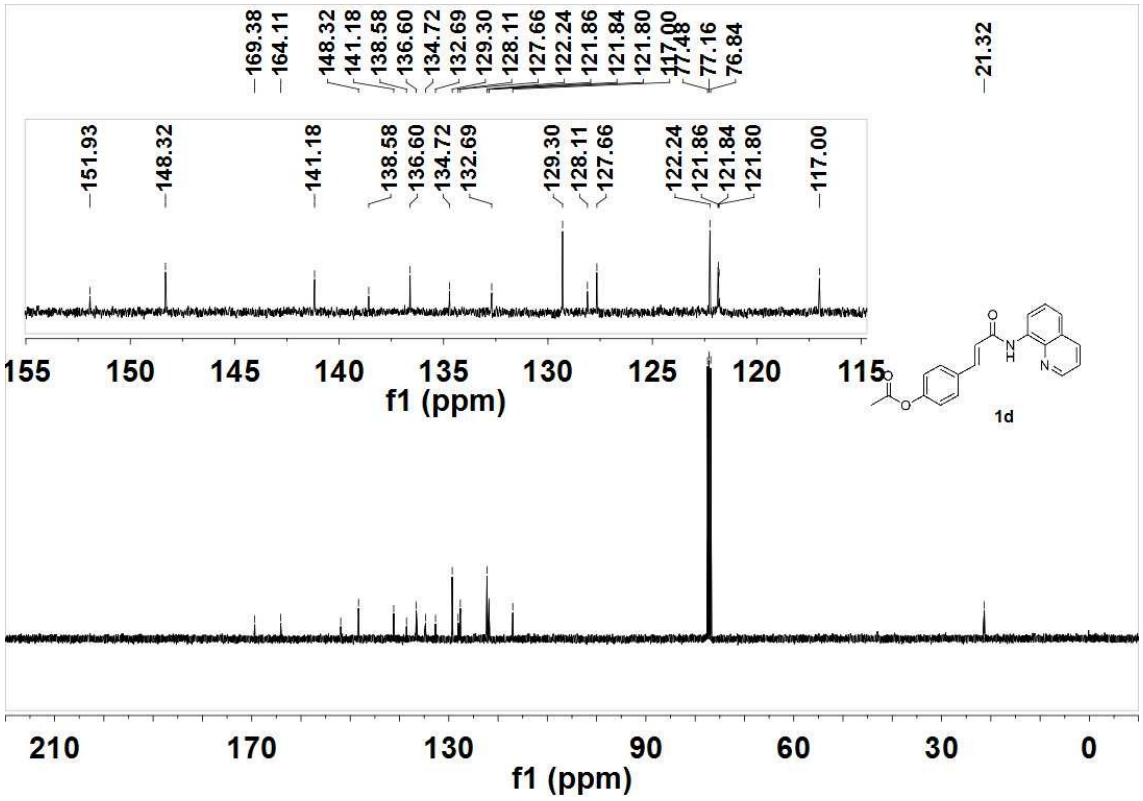
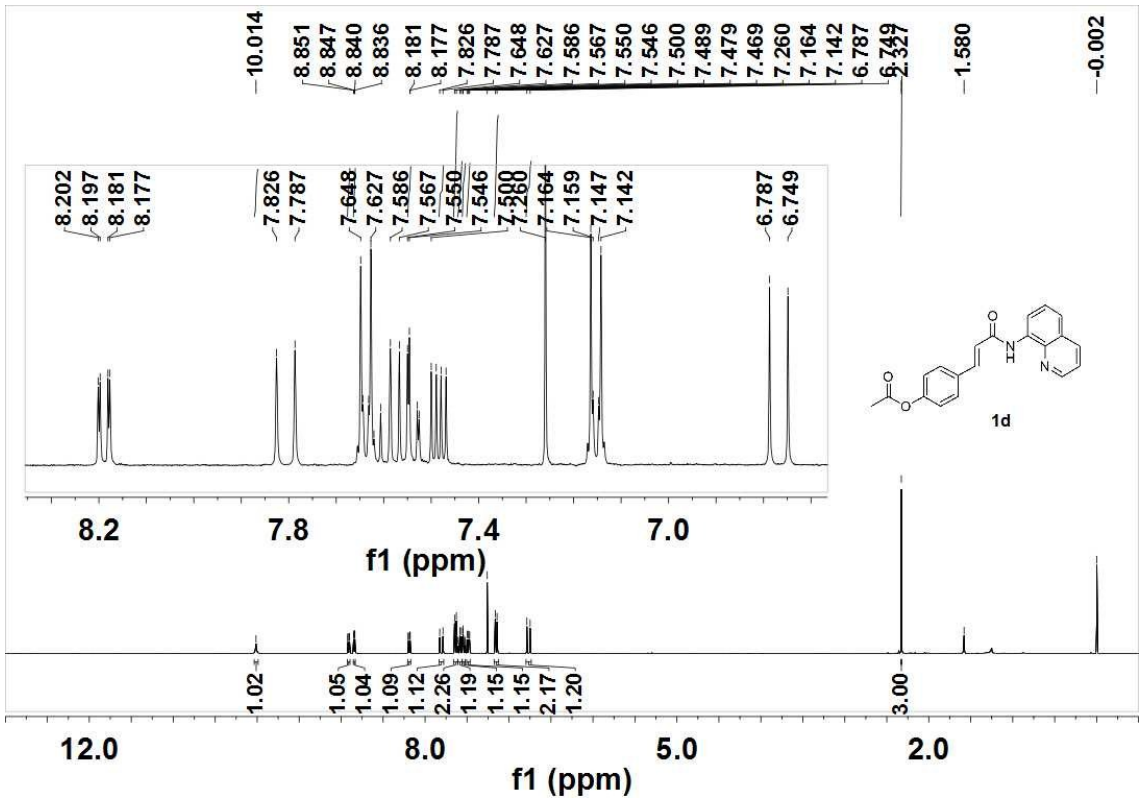
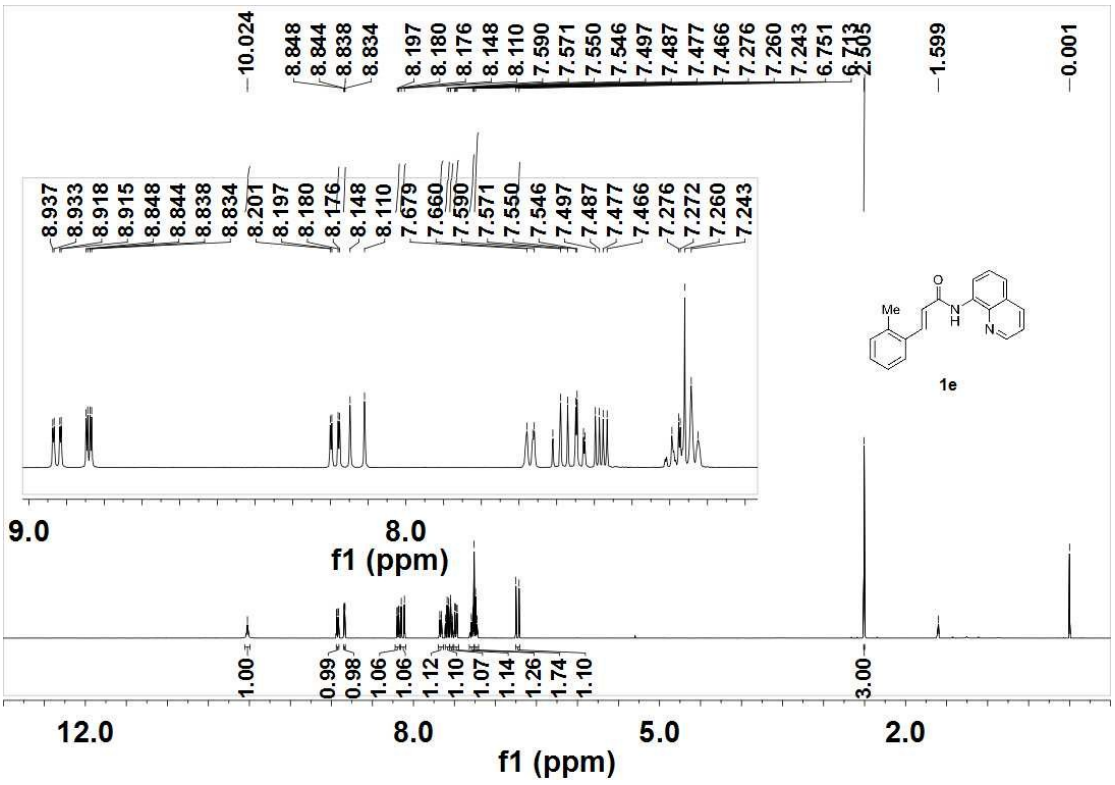
(b) Y. Wang, C. Du, Y. Wang, X. Guo, L. Fang, M.-P. Song, J.-L. Niu, D. Wei, *Adv. Synth. Catal.,* 2018, **360**, 2668.

XI. Copies of ^{1}H, ^{13}C NMR spectra



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7.546
7.497
7.487
7.477
7.466
7.276
7.260
7.243
6.751
6.713
2.505
1.599
0.001
8.937
8.933
8.918
8.915
8.848
8.844
8.838
8.834
8.201
8.197
8.180
8.176
8.148
8.110
7.679
7.660
7.590
7.571
7.550
7.546
7.497
7.487
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7.276
7.272
7.260
7.243
Me
O
N
H
N
1e
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8.0
f1 (ppm)
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0.99
0.98
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1.06
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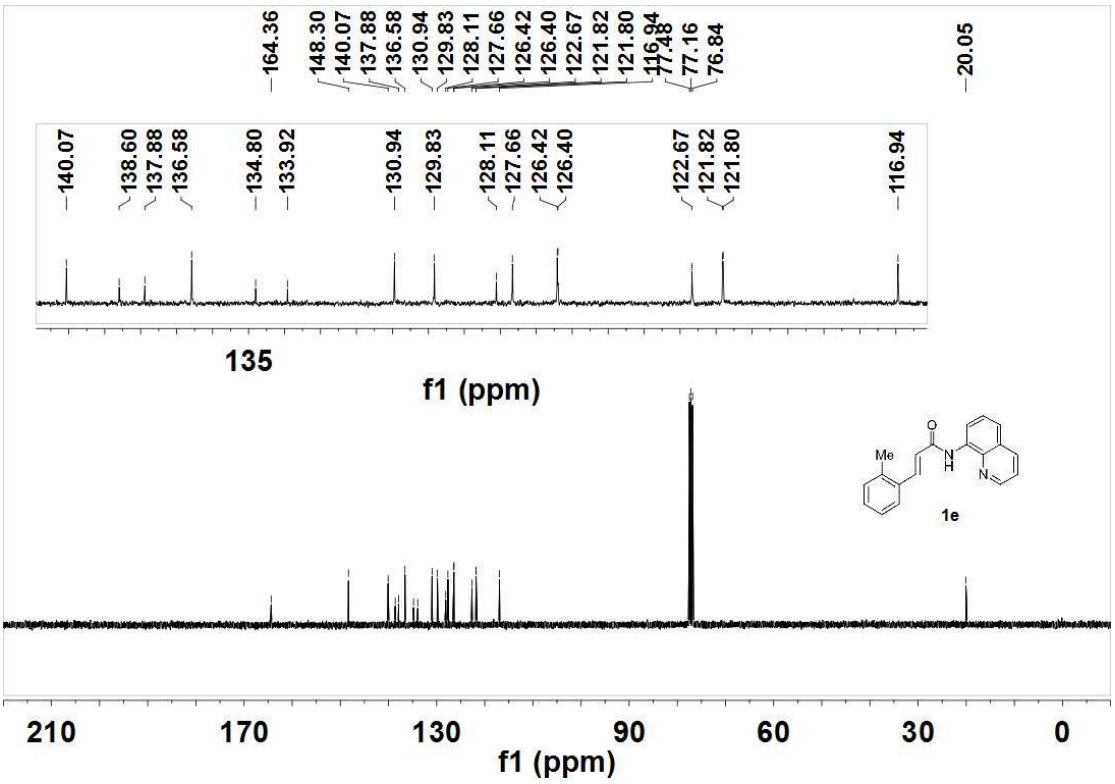
2.0
f1 (ppm)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126.40
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121.82
121.80
116.94
77.48
77.16
76.84
20.05
140.07
138.60
137.88
136.58
134.80
133.92
130.94
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128.11
127.66
126.42
126.40
122.67
121.82
121.80
116.94
135
f1 (ppm)
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O
N
H
N
1e
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170
130
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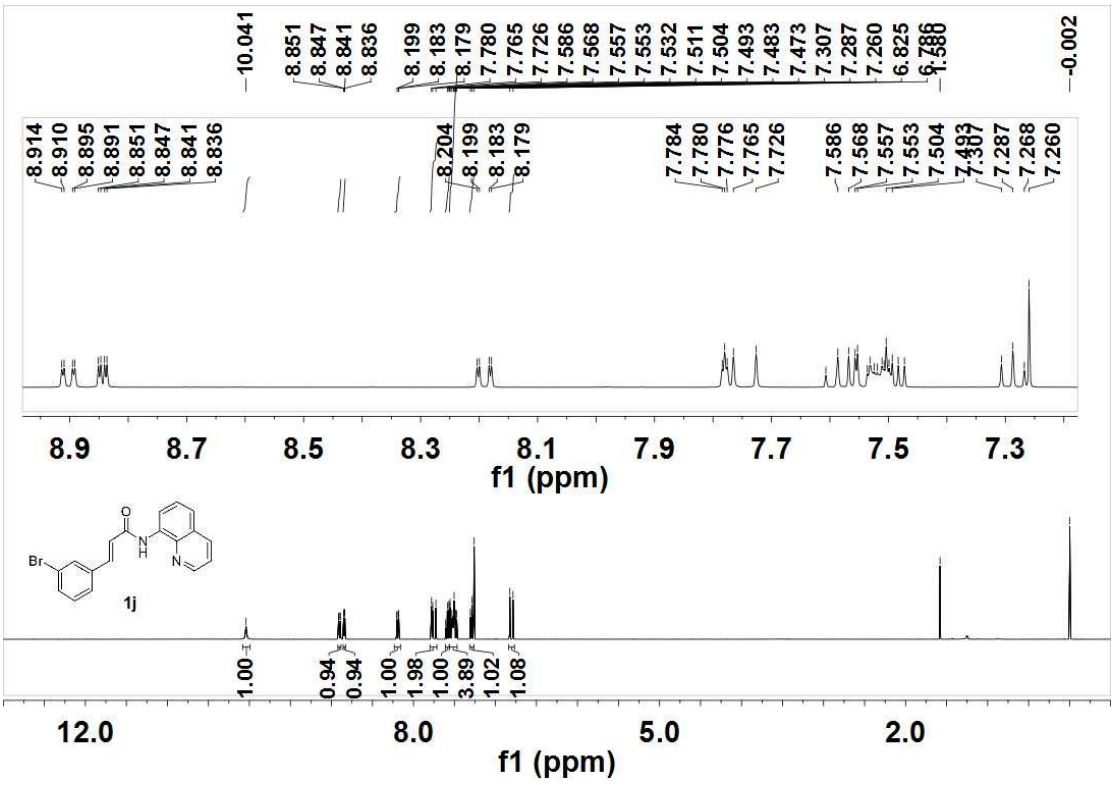
30
0
f1 (ppm)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7.568
7.557
7.553
7.532
7.511
7.504
7.493
7.483
7.473
7.307
7.287
7.260
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8.179
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7.780
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7.726
7.586
7.568
7.557
7.553
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7.493
7.307
7.287
7.268
7.260
8.9
8.7
8.5
8.3
8.1
7.9
7.7
7.5
7.3
f1 (ppm)
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O
N
H
N
1j
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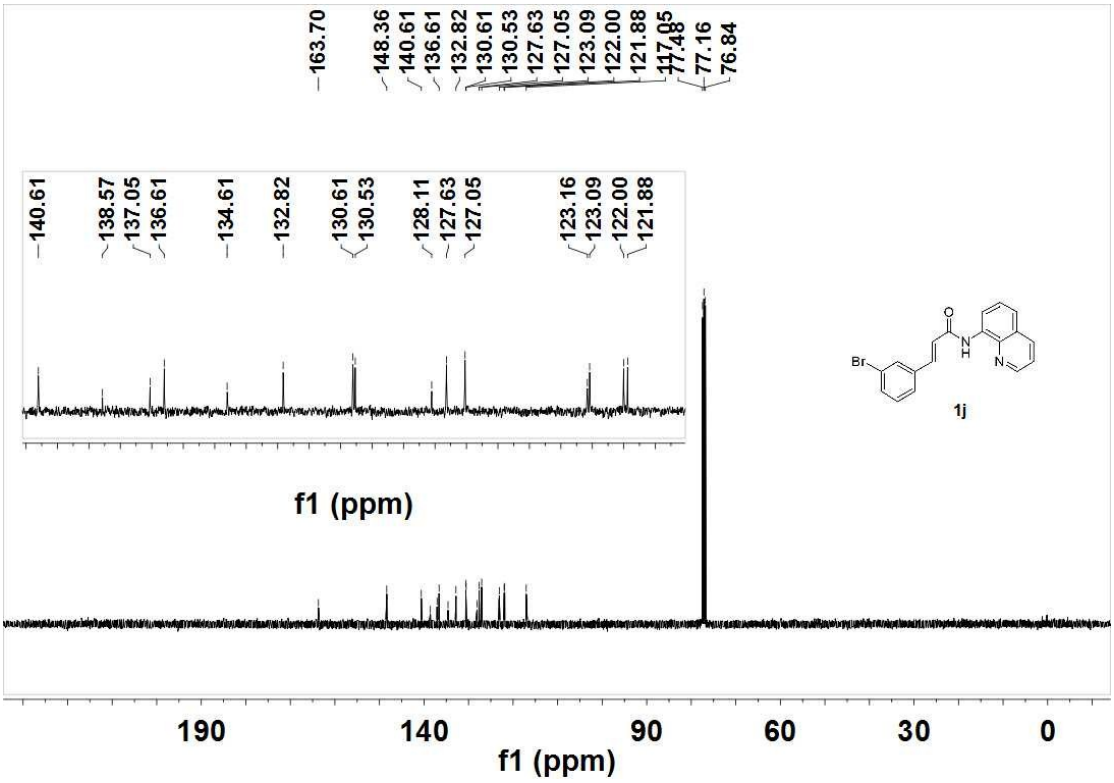
2.0
f1 (ppm)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77.48
77.16
76.84
140.61
138.57
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136.61
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128.11
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127.05
123.16
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f1 (ppm)
Br
O
N
H
N
1j
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140
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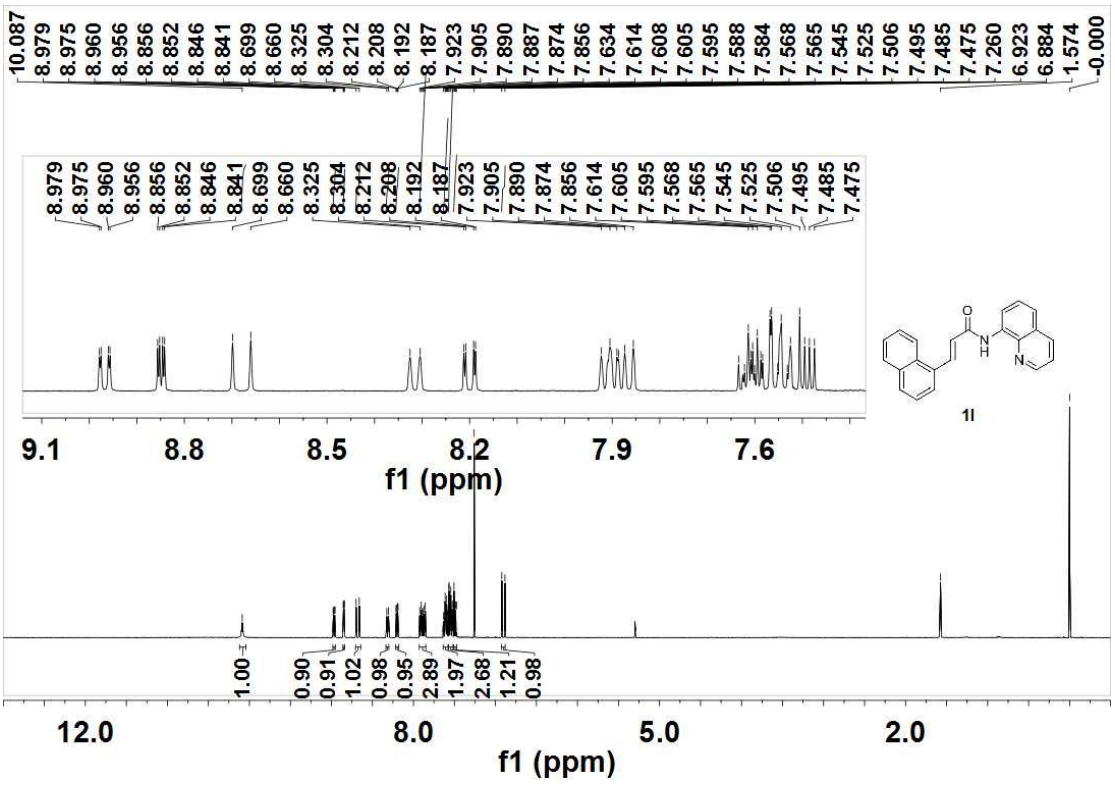
30
0
f1 (ppm)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8.208
8.192
8.187
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7.890
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7.634
7.614
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1.02
0.98
0.95
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f1 (ppm)
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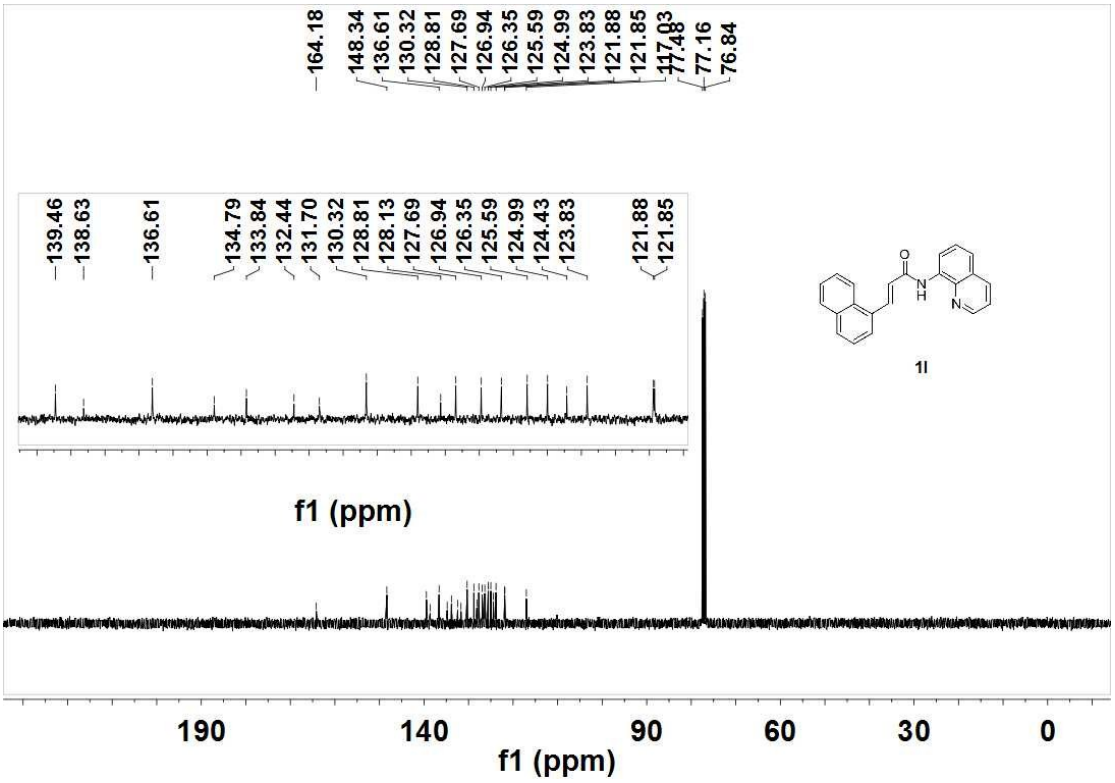
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132.44
131.70
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128.13
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121.88
121.85
f1 (ppm)
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140
90
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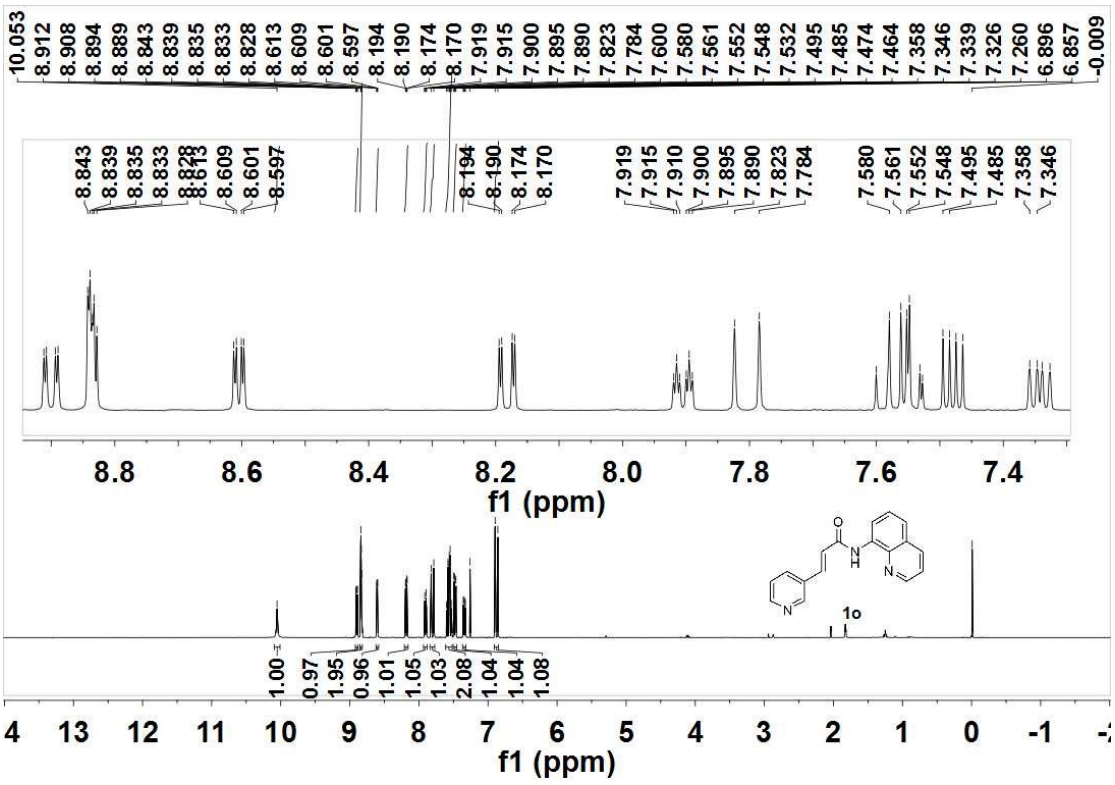
30
0
f1 (ppm)
1l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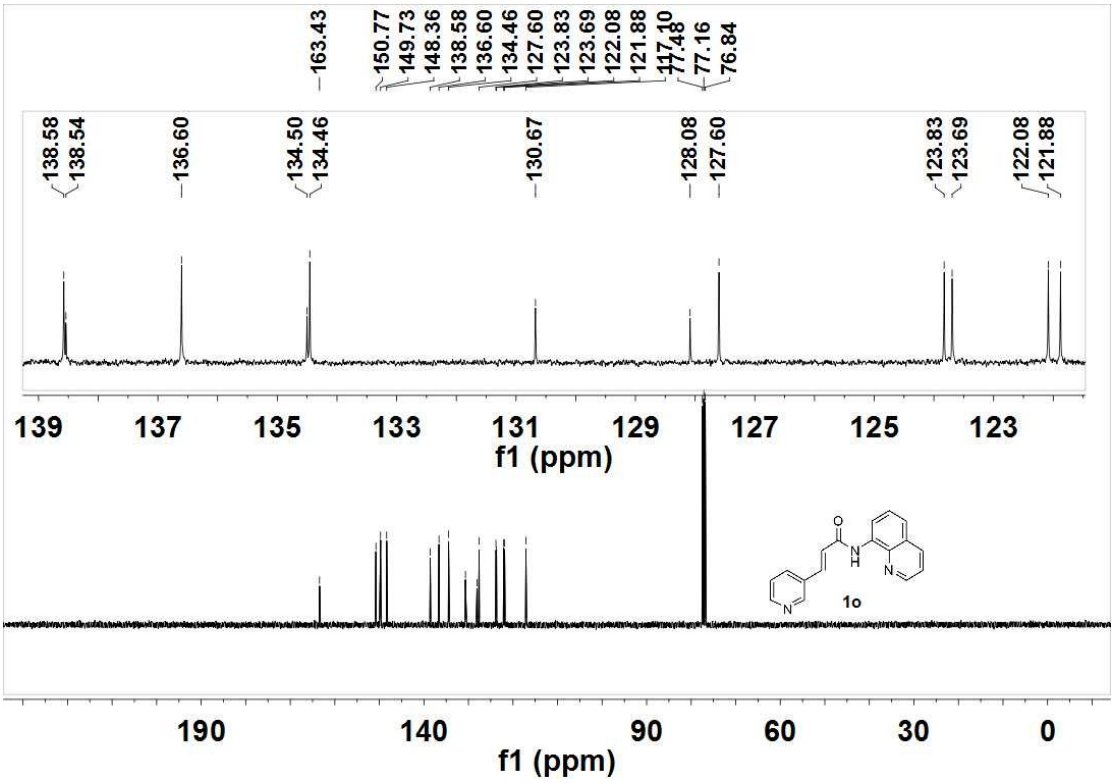
f1 (ppm)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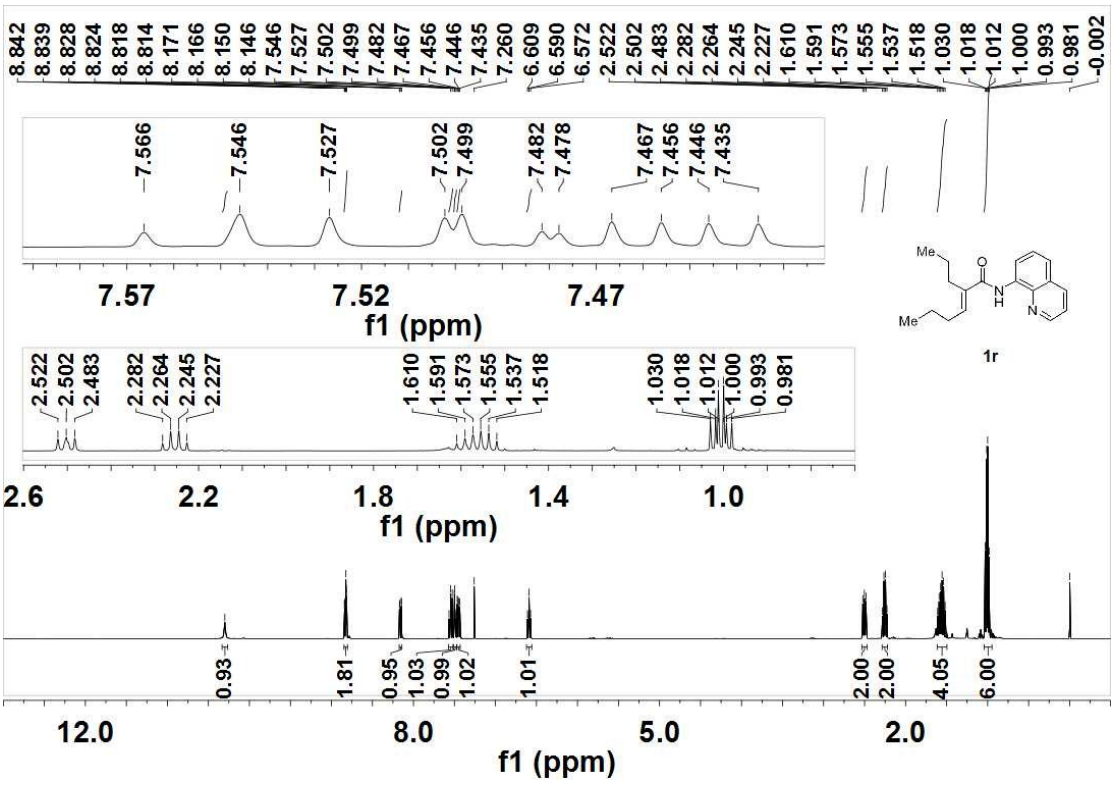
f1 (ppm)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7.57 7.52 7.47
f1 (ppm)
Me Me O N H N
1r
2.522 2.502 2.483 2.282 2.264 2.245 2.227 1.610 1.591 1.573 1.555 1.537 1.518 1.030 1.018 1.012 1.000 0.993 0.981
2.6 2.2 1.8 1.4 1.0
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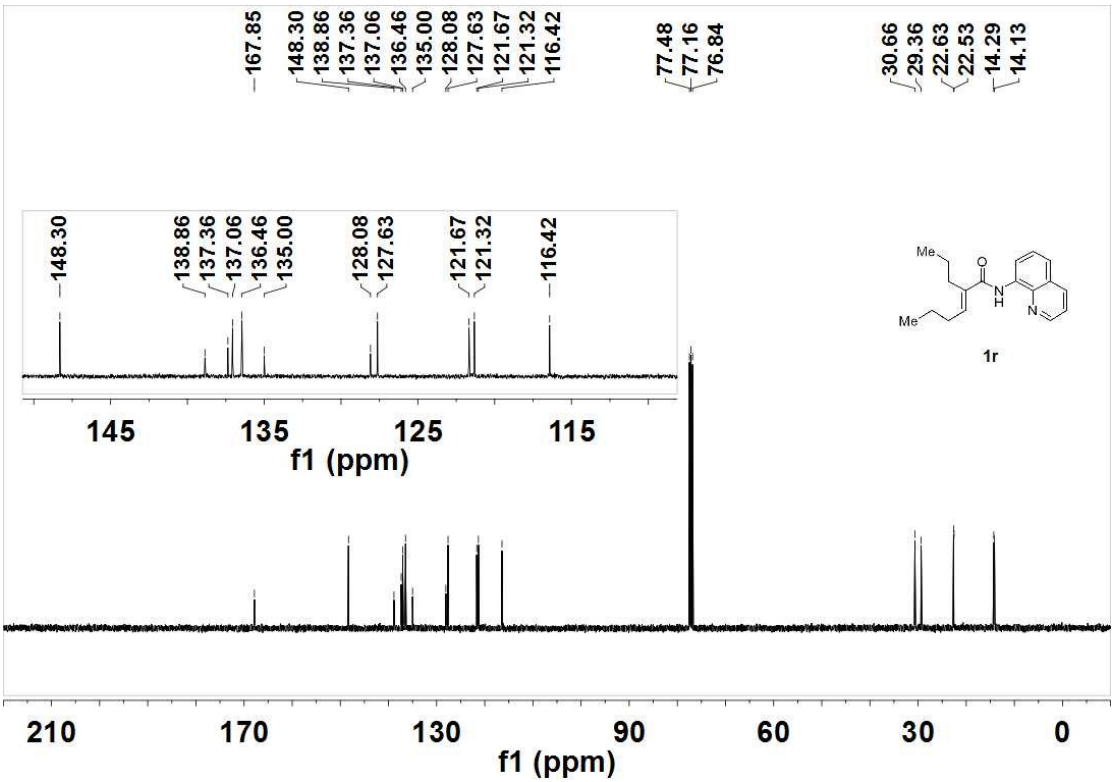
f1 (ppm)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Me Me O N H N
1r
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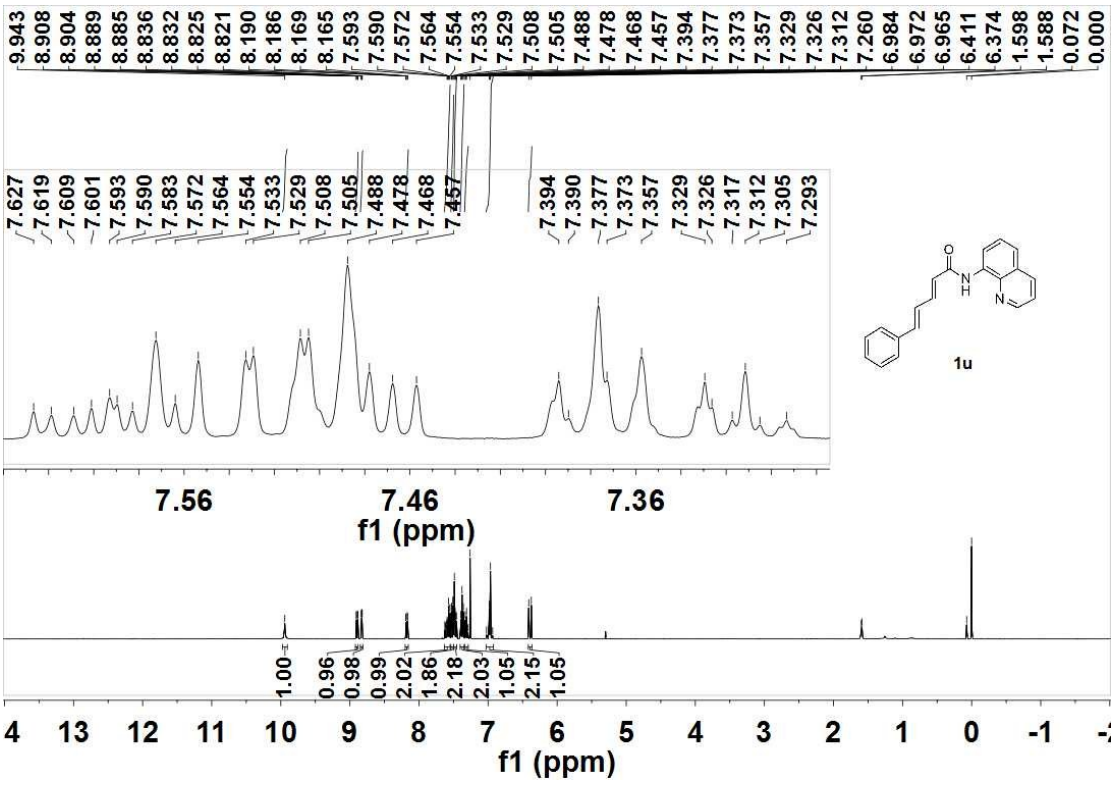
f1 (ppm)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0.99
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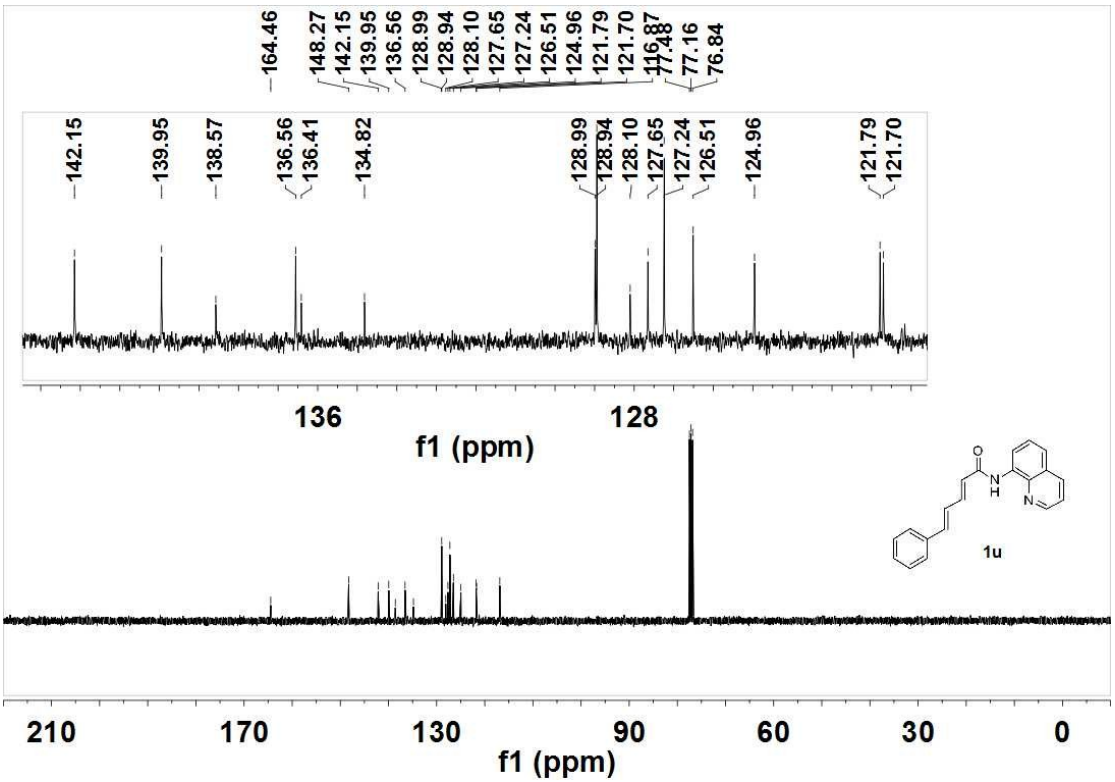
f1 (ppm)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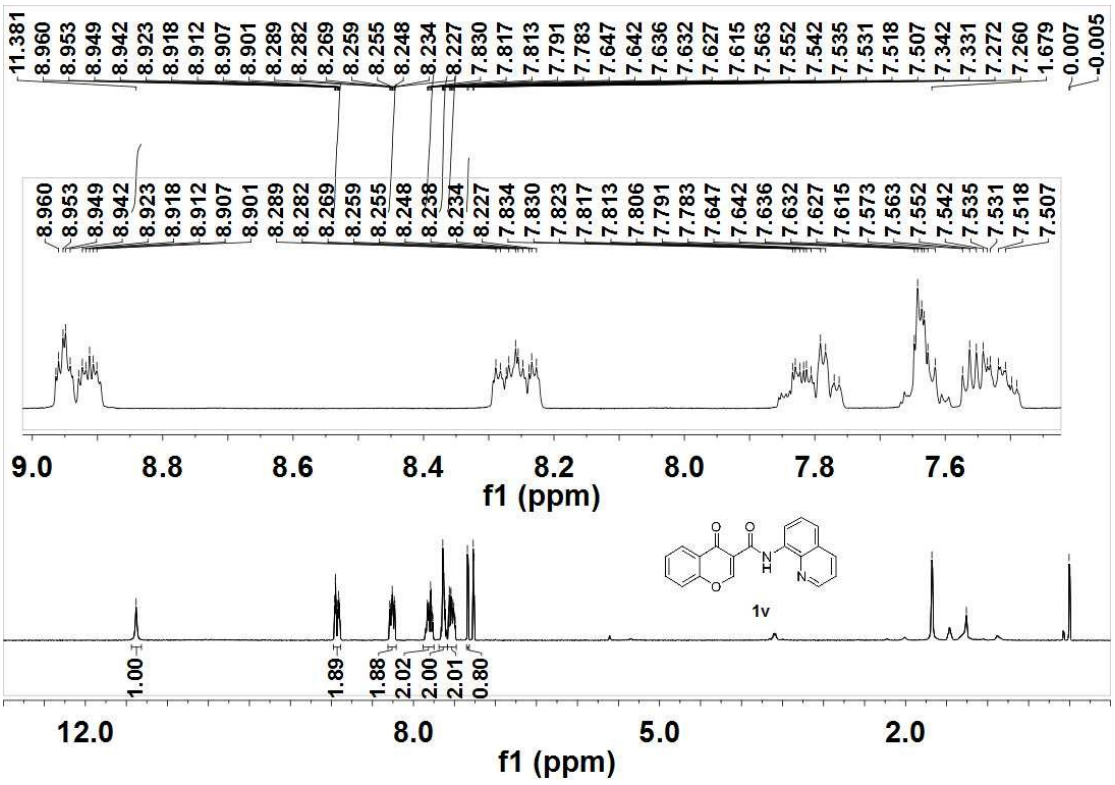
128.94
128.10
127.65
127.24
126.51
124.96
121.79
121.70
1u
136
128
f1 (ppm)
210 170 130 90 60 30 0
f1 (ppm)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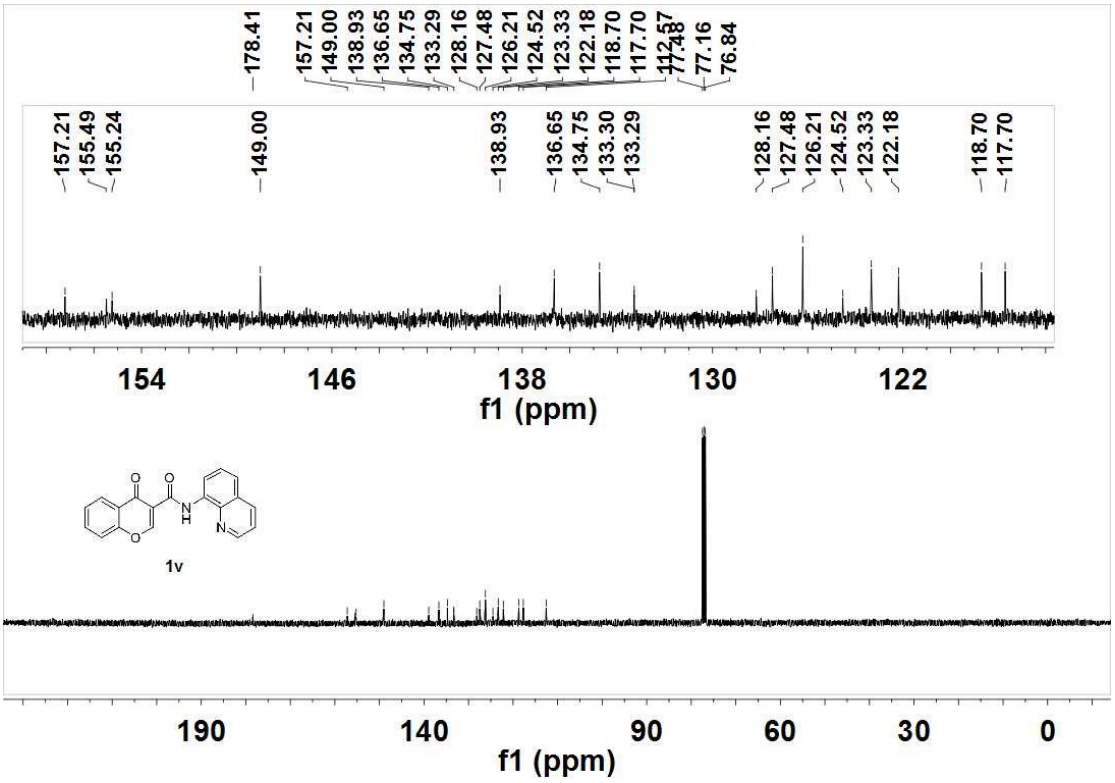
8.960
8.953
8.949
8.942
8.923
8.918
8.912
8.907
8.901
8.289
8.282
8.269
8.259
8.255
8.248
8.234
8.227
7.830
7.817
7.813
7.791
7.783
7.647
7.642
7.636
7.632
7.627
7.615
7.563
7.552
7.542
7.535
7.531
7.518
7.507
7.342
7.331
7.272
7.260
1.679
0.007
-0.005
8.960
8.953
8.949
8.942
8.923
8.918
8.912
8.907
8.901
8.289
8.282
8.269
8.259
8.255
8.248
8.238
8.234
8.227
7.834
7.830
7.823
7.817
7.813
7.806
7.791
7.783
7.647
7.642
7.636
7.632
7.627
7.615
7.573
7.563
7.552
7.542
7.535
7.531
7.518
7.507
9.0
8.8
8.6
8.4
8.2
8.0
7.8
7.6
f1 (ppm)
1v
1.00
1.89
1.88
2.02
2.00
2.01
0.80
12.0
8.0
5.0
2.0
f1 (ppm)


178.41
157.21
149.00
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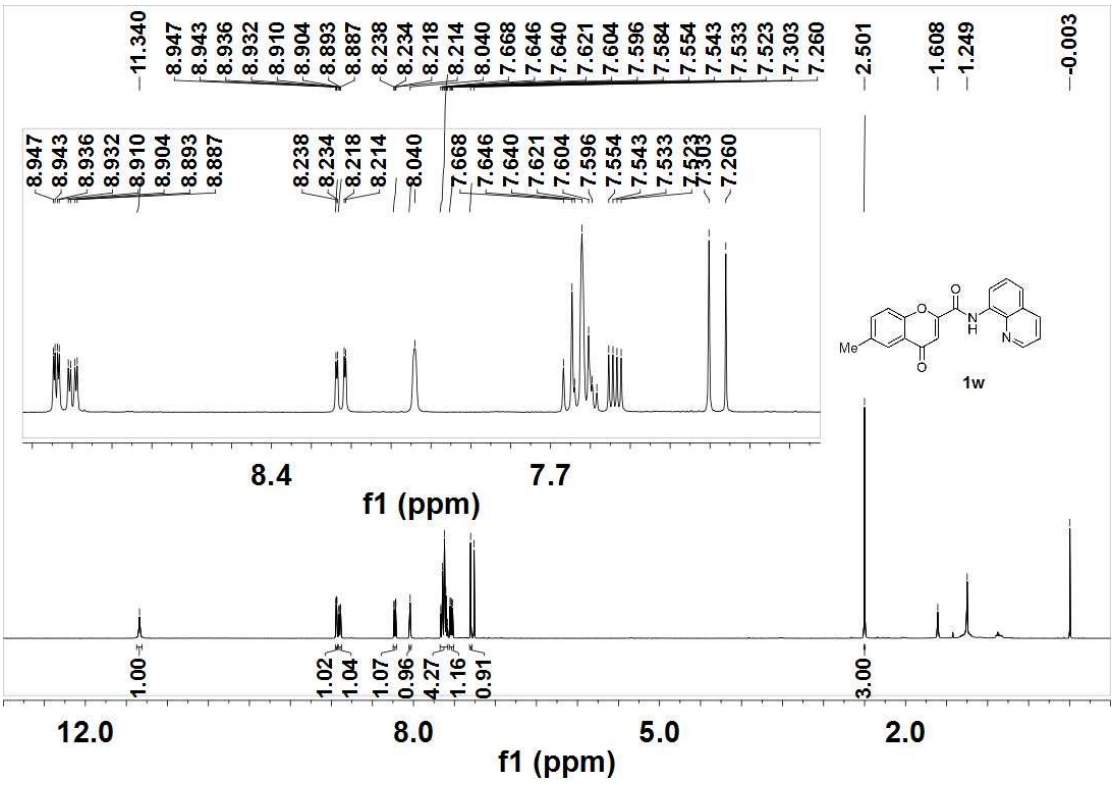
136.65
134.75
133.29
128.16
127.48
126.21
124.52
123.33
122.18
118.70
117.70
112.57
77.48
77.16
76.84
157.21
155.49
155.24
149.00
138.93
136.65
134.75
133.30
133.29
128.16
127.48
126.21
124.52
123.33
122.18
118.70
117.70
154
146
138
130
122
f1 (ppm)
1v
190
140
90
60
30
0
f1 (ppm)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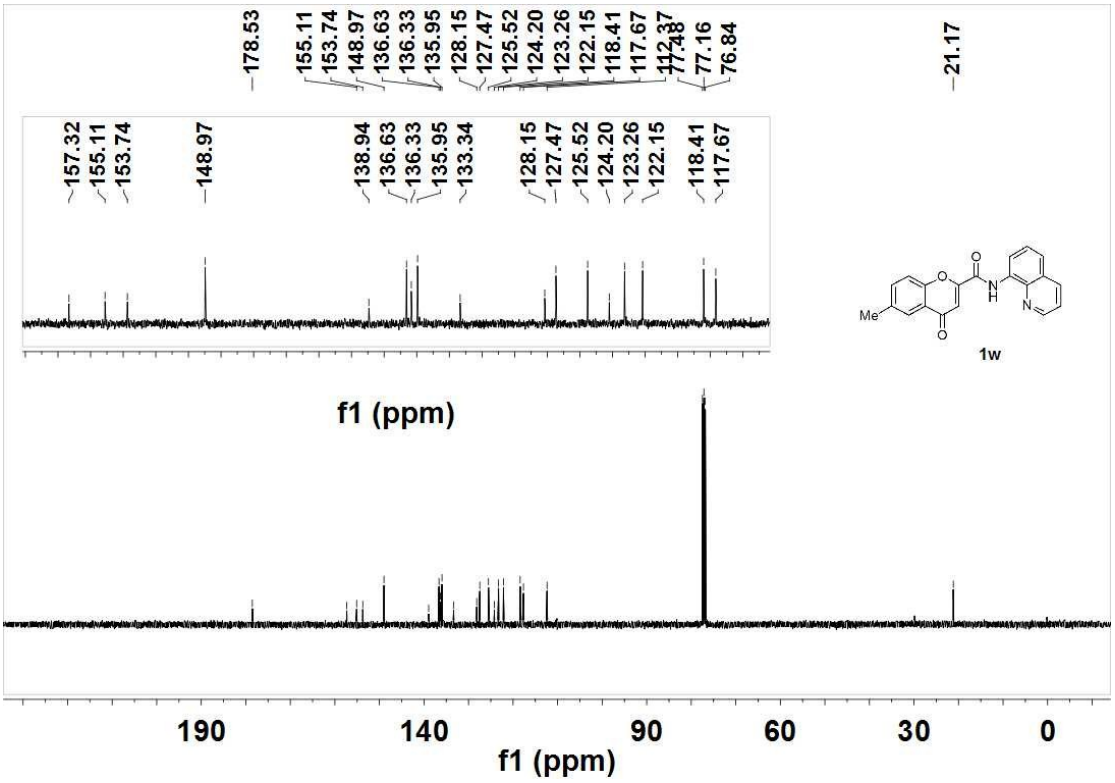
8.947
8.943
8.936
8.932
8.910
8.904
8.893
8.887
8.238
8.234
8.218
8.214
8.040
7.668
7.646
7.640
7.621
7.604
7.596
7.584
7.554
7.543
7.533
7.523
7.303
7.260
2.501
1.608
1.249
0.003
1.00
1.02
1.04
1.07
0.96
4.27
1.16
0.91
3.00
Me
1w
8.4
7.7
f1 (ppm)
12.0
8.0
5.0
2.0
f1 (ppm)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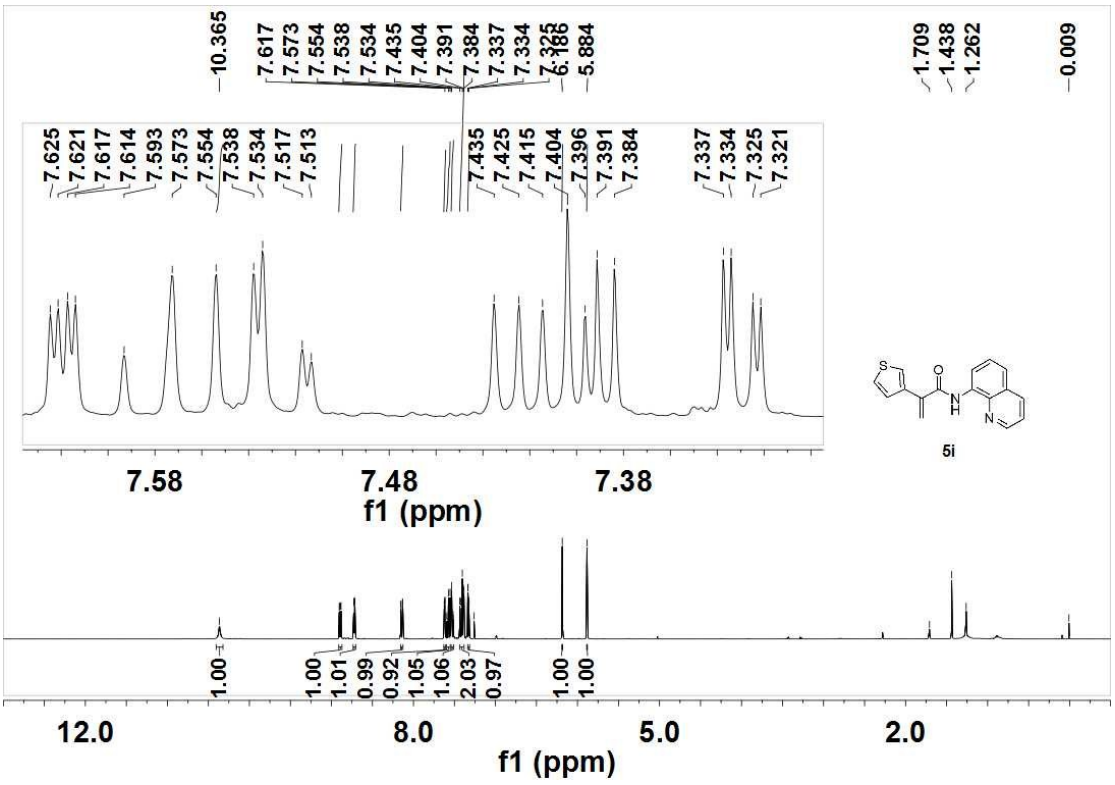
155.11
153.74
148.97
136.63
136.33
135.95
128.15
127.47
125.52
124.20
123.26
122.15
118.41
117.67
112.37
77.48
77.16
76.84
21.17
157.32
155.11
153.74
148.97
138.94
136.63
136.33
135.95
133.34
128.15
127.47
125.52
124.20
123.26
122.15
118.41
117.67
Me
1w
f1 (ppm)
190
140
90
60
30
0
f1 (ppm)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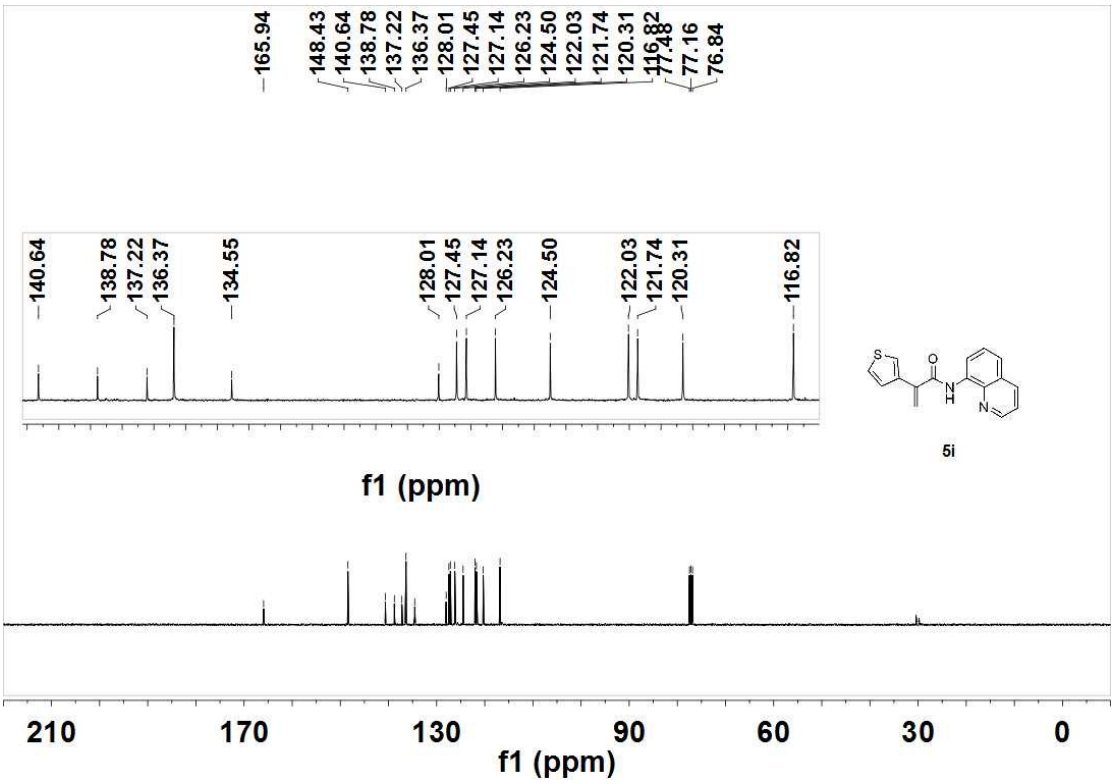
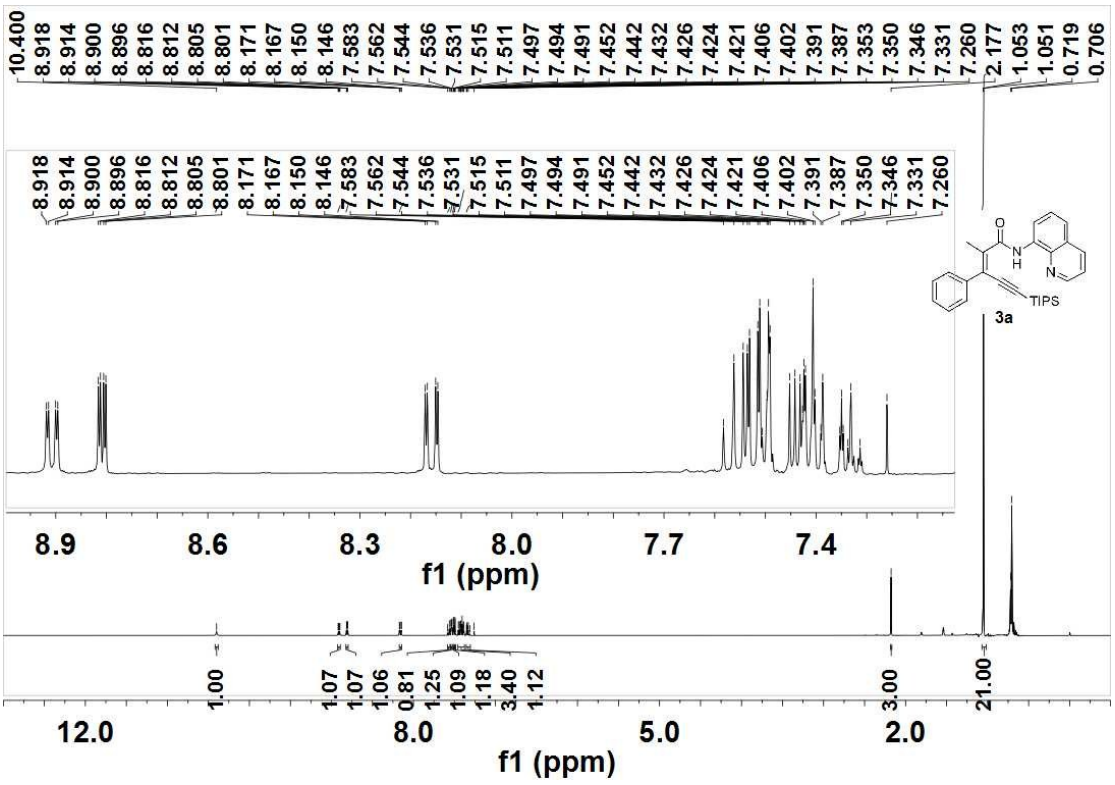
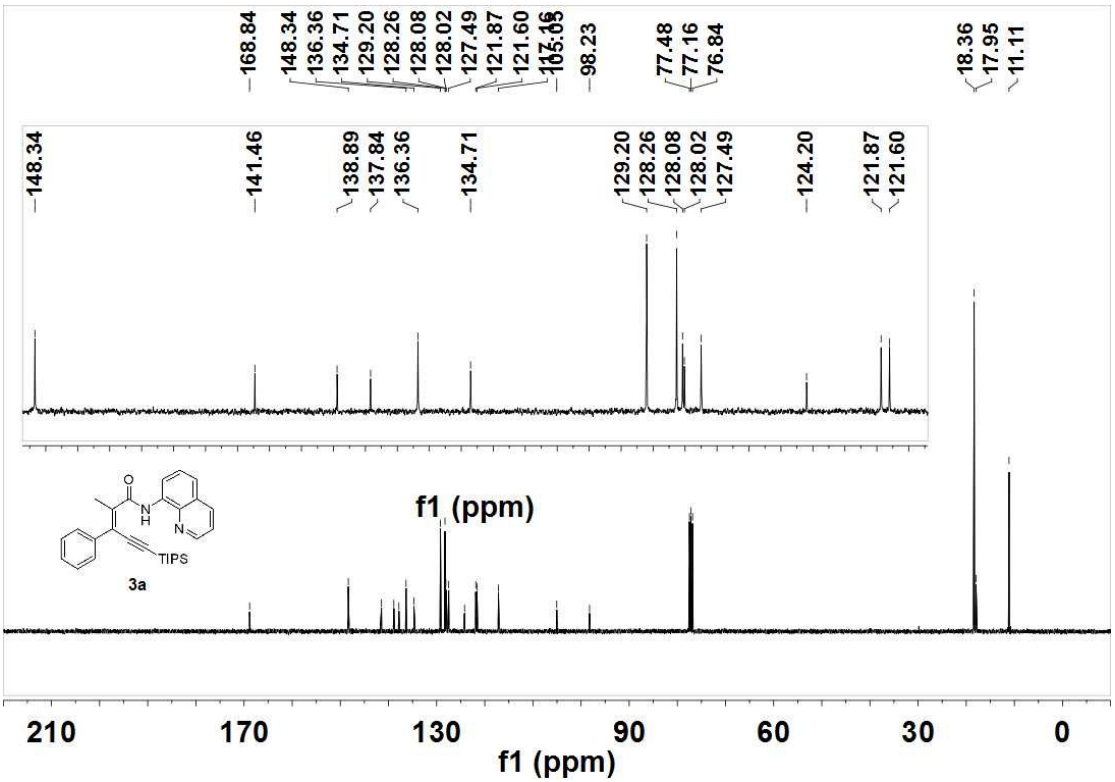
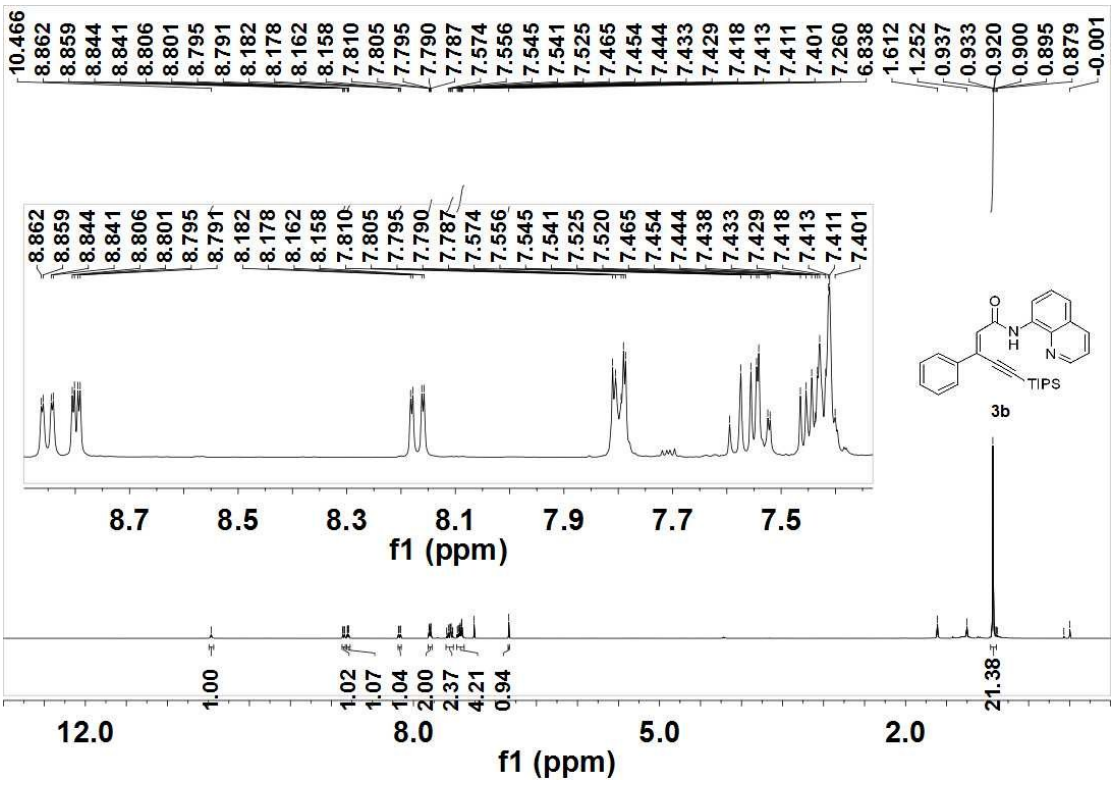
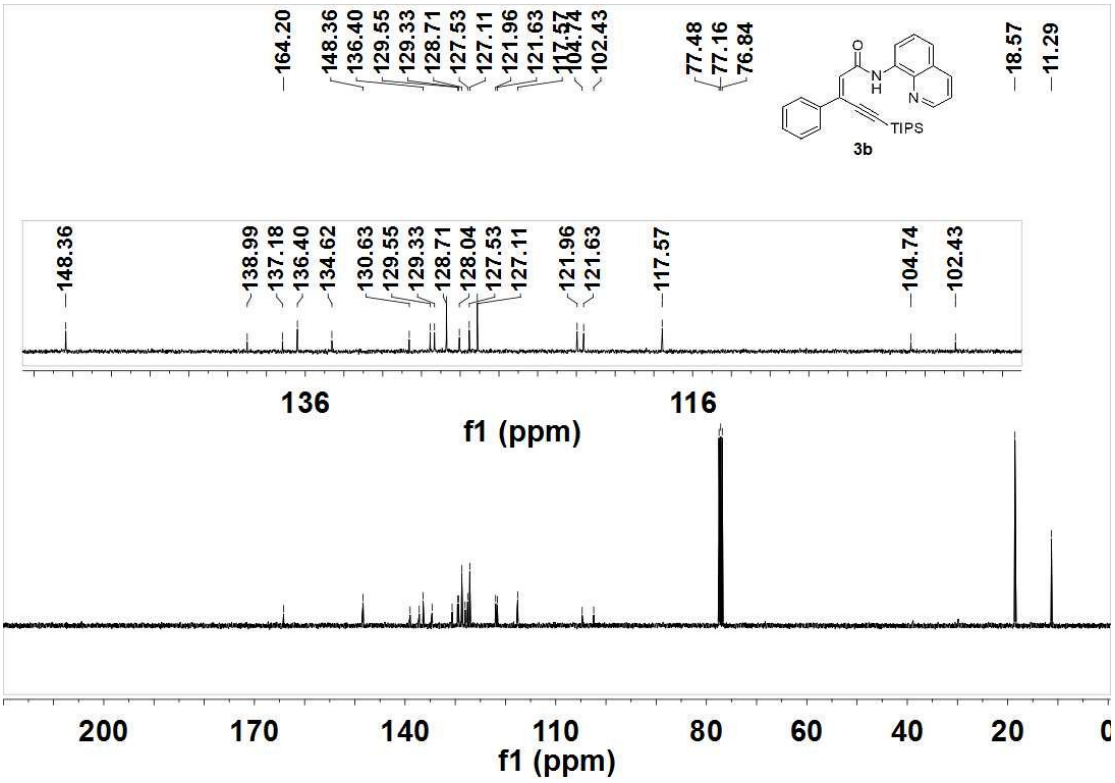
7.573
7.554
7.538
7.534
7.435
7.404
7.391
7.384
7.337
7.334
7.325
7.321
6.186
5.884
1.709
1.438
1.262
0.009
7.625
7.621
7.617
7.614
7.593
7.573
7.554
7.538
7.534
7.517
7.513
7.435
7.425
7.415
7.404
7.396
7.391
7.384
7.337
7.334
7.325
7.321
7.58
7.48
7.38
f1 (ppm)
5i
1.00
1.00
1.01
0.99
0.92
1.05
1.06
2.03
0.97
1.00
1.00
12.0
8.0
5.0
2.0
f1 (ppm)

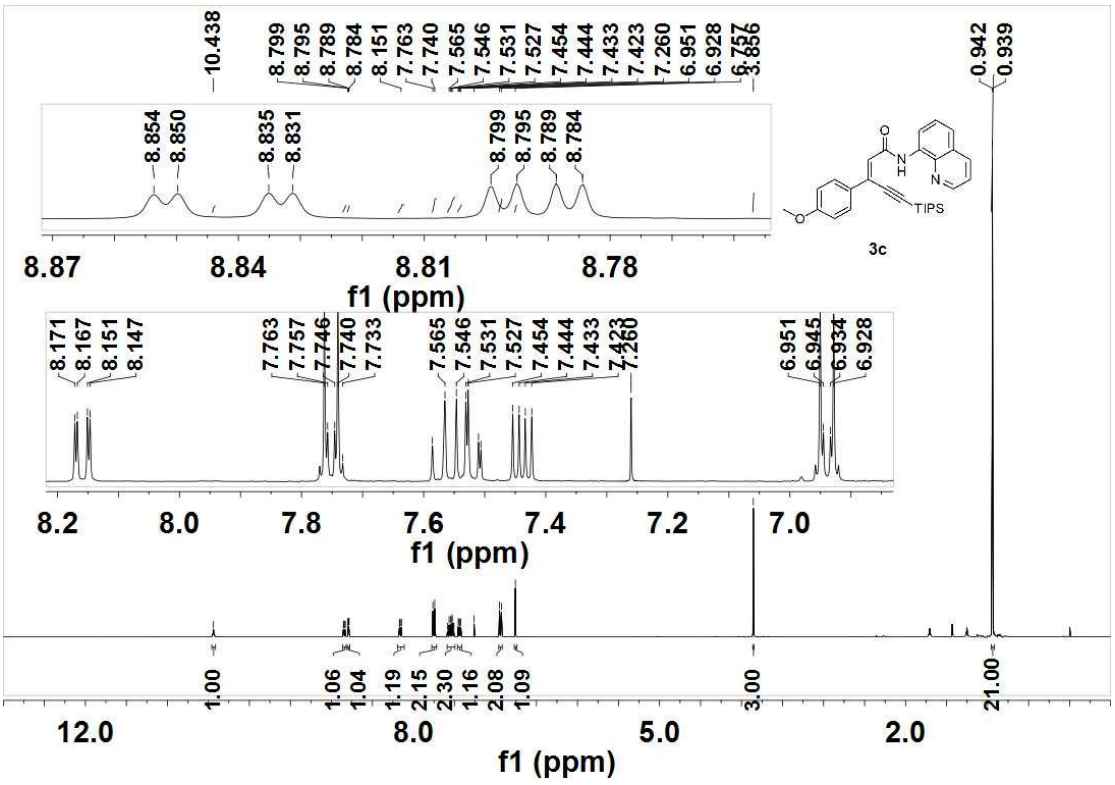

165.94
148.43
140.64
138.78
137.22
136.37
128.01
127.45
127.14
126.23
124.50
122.03
121.74
120.31
116.82
77.48
77.16
76.84
140.64
138.78
137.22
136.37
134.55
128.01
127.45
127.14
126.23
124.50
122.03
121.74
120.31
116.82
f1 (ppm)
5i
210
170
130
90
60
30
0
f1 (ppm)


10.400
8.918
8.914
8.900
8.896
8.816
8.812
8.805
8.801
8.171
8.167
8.150
8.146
7.583
7.562
7.544
7.536
7.531
7.515
7.511
7.497
7.494
7.491
7.452
7.442
7.432
7.426
7.424
7.421
7.406
7.402
7.391
7.387
7.353
7.350
7.346
7.331
7.260
2.177
1.053
1.051
0.719
0.706
TIPS
3a
8.9
8.6
8.3
8.0
7.7
7.4
f1 (ppm)
1.00
1.07
1.07
1.06
0.81
1.25
1.09
1.18
3.40
1.12
3.00
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


168.84
148.34
136.36
134.71
129.20
128.26
128.08
128.02
127.49
121.87
121.60
98.23
77.48
77.16
76.84
18.36
17.95
11.11
148.34
141.46
138.89
137.84
136.36
134.71
129.20
128.26
128.08
128.02
127.49
124.20
121.87
121.60
TIPS
3a
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)


10.466
8.862
8.859
8.844
8.841
8.806
8.801
8.795
8.791
8.182
8.178
8.162
8.158
7.810
7.805
7.795
7.790
7.787
7.574
7.556
7.545
7.541
7.525
7.465
7.454
7.444
7.433
7.429
7.418
7.413
7.411
7.401
7.260
6.838
1.612
1.252
0.937
0.933
0.920
0.900
0.895
0.879
-0.001
8.862
8.859
8.844
8.841
8.806
8.801
8.795
8.791
8.182
8.178
8.162
8.158
7.810
7.805
7.795
7.790
7.787
7.574
7.556
7.545
7.541
7.525
7.520
7.465
7.454
7.444
7.438
7.433
7.429
7.418
7.413
7.411
7.401
8.7
8.5
8.3
8.1
7.9
7.7
7.5
f1 (ppm)
O
N
H
N
TIPS
3b
1.00
1.02
1.07
1.04
2.00
2.37
4.21
0.94
21.38
12.0
8.0
5.0
2.0
f1 (ppm)


164.20
148.36
136.40
129.55
129.33
128.71
127.53
127.11
121.96
121.63
117.57
104.74
102.43
77.48
77.16
76.84
18.57
11.29
O
N
H
N
TIPS
3b
148.36
138.99
137.18
136.40
134.62
130.63
129.55
129.33
128.71
128.04
127.53
127.11
121.96
121.63
117.57
104.74
102.43
136
116
f1 (ppm)
200
170
140
110
80
60
40
20
0
f1 (ppm)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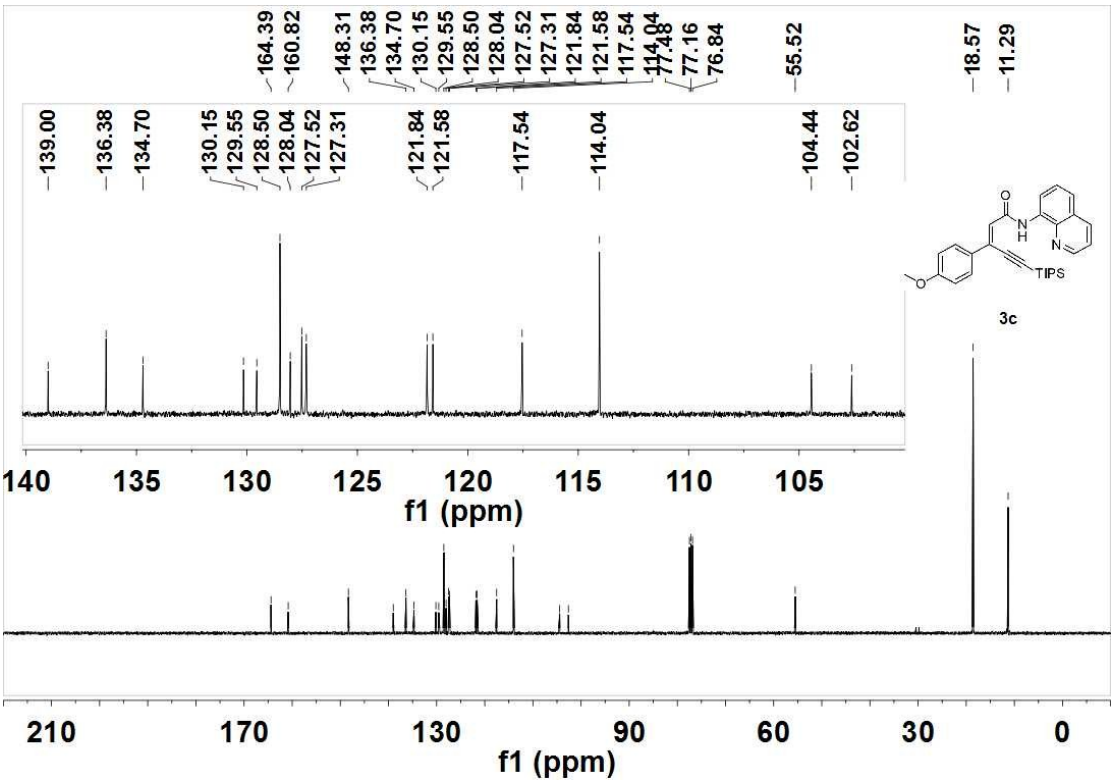
8.799
8.795
8.789
8.784
8.151
7.763
7.740
7.565
7.546
7.531
7.527
7.454
7.444
7.433
7.423
7.260
6.951
6.928
3.856
0.942
0.939
8.854
8.850
8.835
8.831
8.799
8.795
8.789
8.784
8.87
8.84
8.81
8.78
f1 (ppm)
8.171
8.167
8.151
8.147
7.763
7.757
7.746
7.740
7.733
7.565
7.546
7.531
7.527
7.454
7.444
7.433
7.423
7.260
6.951
6.945
6.934
6.928
8.2
8.0
7.8
7.6
7.4
7.2
7.0
f1 (ppm)
1.00
1.06
1.04
1.19
2.15
2.30
1.16
2.08
1.09
3.00
21.00
12.0
8.0
5.0
2.0
f1 (ppm)
TIPS
3c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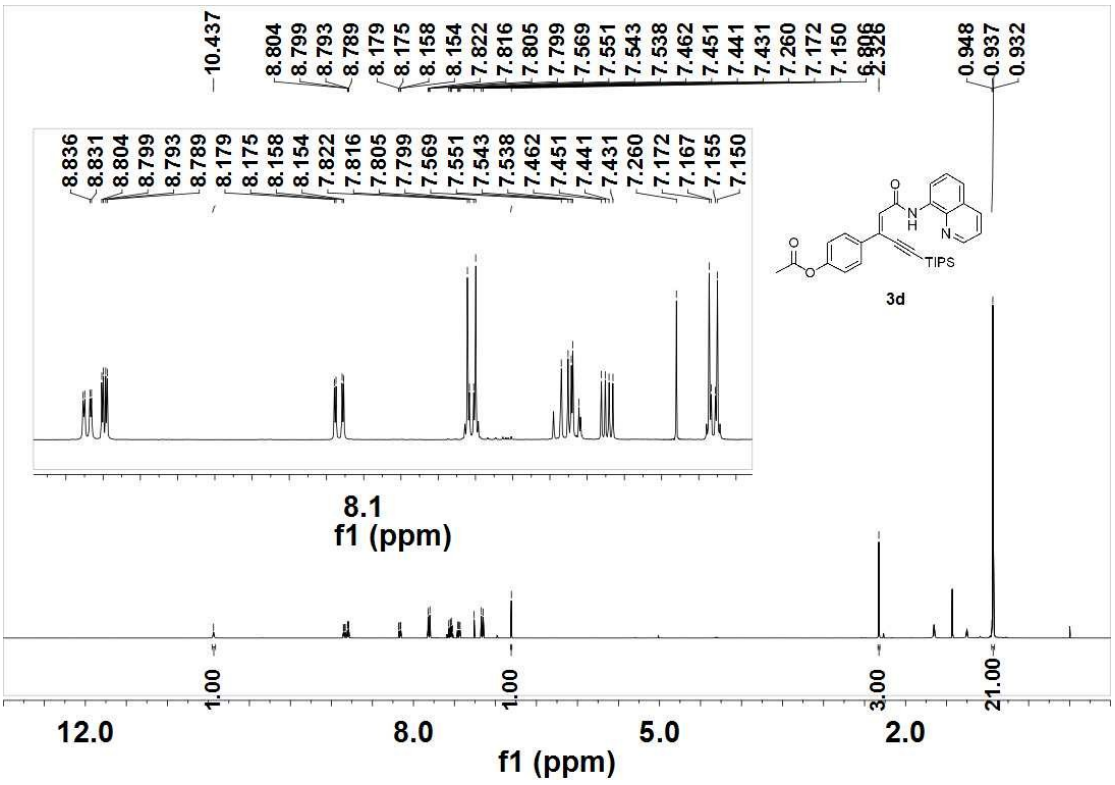
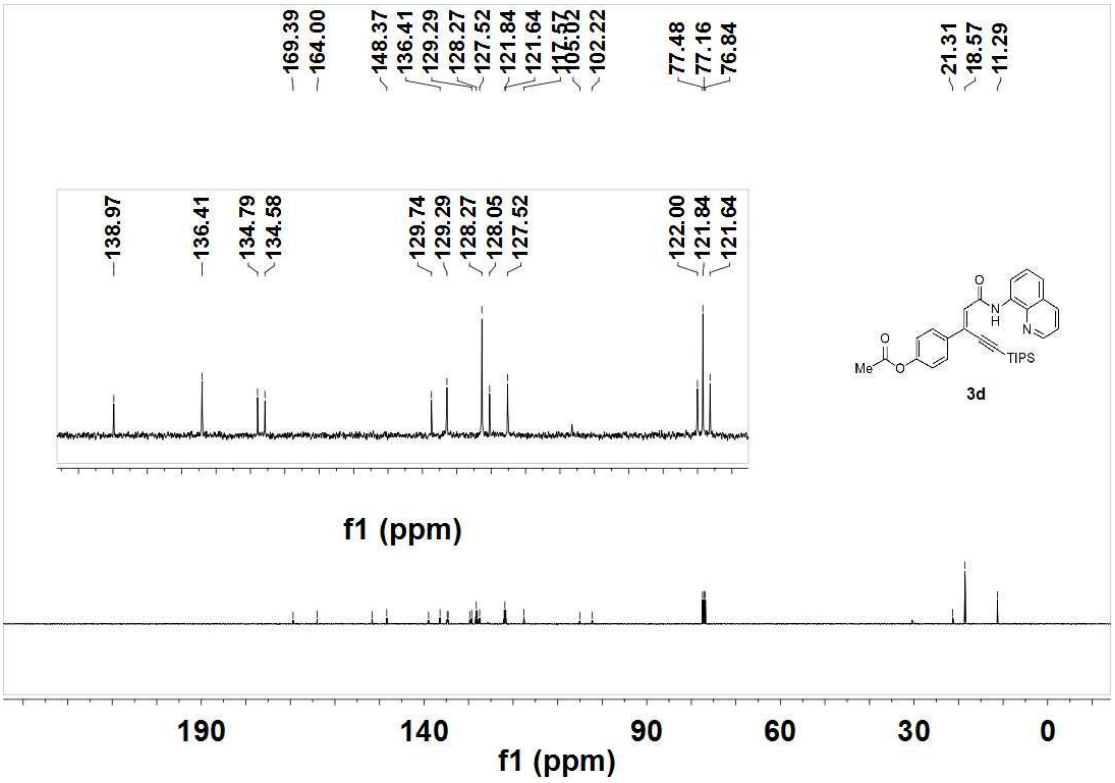
160.82
148.31
136.38
134.70
130.15
129.55
128.50
128.04
127.52
127.31
121.84
121.58
117.54
114.04
77.48
77.16
76.84
55.52
18.57
11.29
139.00
136.38
134.70
130.15
129.55
128.50
128.04
127.52
127.31
121.84
121.58
117.54
114.04
104.44
102.62
140
135
130
125
120
115
110
105
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)
TIPS
3c


10.437
8.804
8.799
8.793
8.789
8.179
8.175
8.158
8.154
7.822
7.816
7.805
7.799
7.569
7.551
7.543
7.538
7.462
7.451
7.441
7.431
7.260
7.172
7.150
2.326
0.948
0.937
0.932
8.836
8.831
8.804
8.799
8.793
8.789
8.179
8.175
8.158
8.154
7.822
7.816
7.805
7.799
7.569
7.551
7.543
7.538
7.462
7.451
7.441
7.431
7.260
7.172
7.167
7.155
7.150
3d
8.1
f1 (ppm)
1.00
1.00
3.00
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


169.39
164.00
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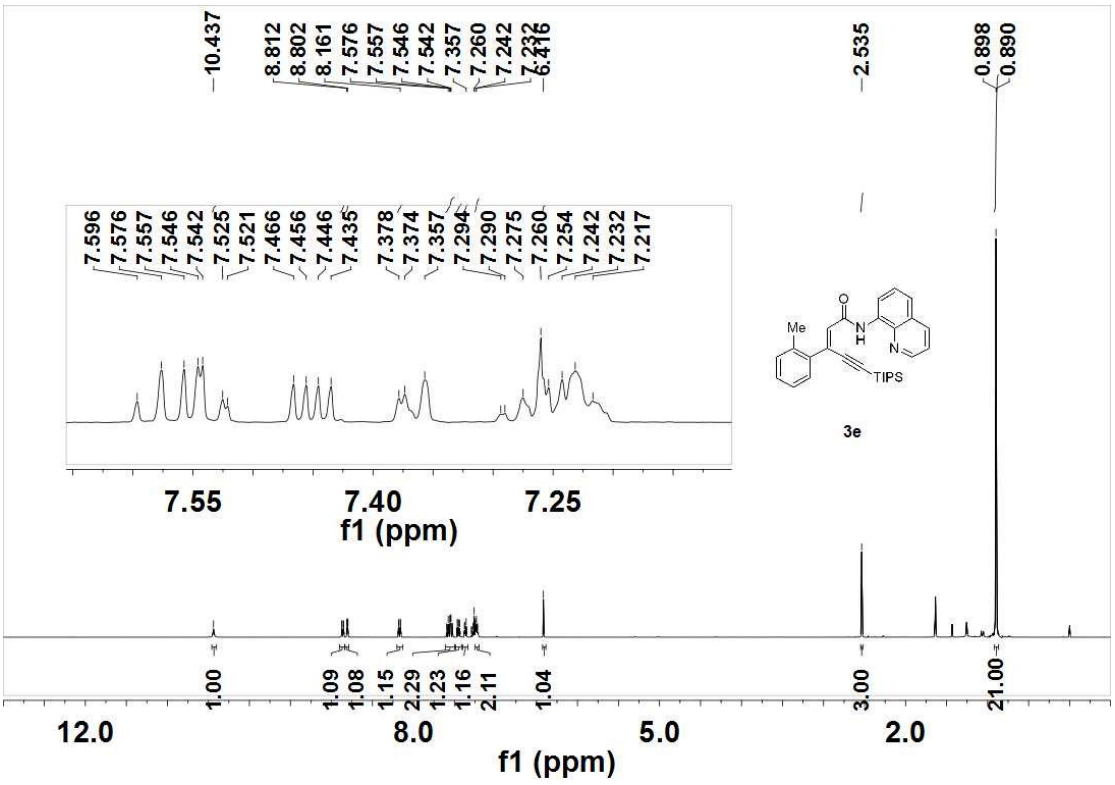
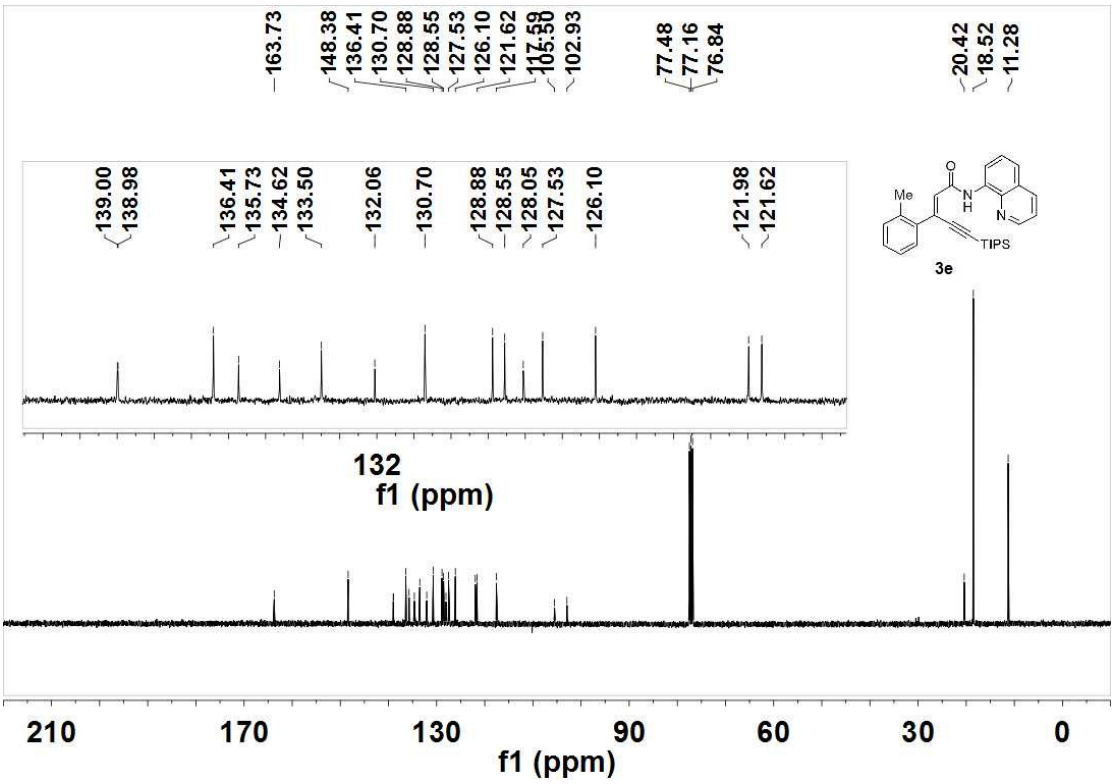
136.41
129.29
128.27
127.52
121.84
121.64
117.57
105.02
102.22
77.48
77.16
76.84
21.31
18.57
11.29
138.97
136.41
134.79
134.58
129.74
129.29
128.27
128.05
127.52
122.00
121.84
121.64
3d
f1 (ppm)
190
140
90
60
30
0
f1 (ppm)


10.437
8.812
8.802
8.161
7.576
7.557
7.546
7.542
7.357
7.260
7.242
2.535
0.898
0.890
7.596
7.576
7.557
7.546
7.542
7.525
7.521
7.466
7.456
7.446
7.435
7.378
7.374
7.357
7.294
7.290
7.275
7.260
7.254
7.242
7.232
7.217
Me
N
H
O
N
TIPS
3e
7.55
7.40
7.25
f1 (ppm)
1.00
1.09
1.08
1.15
2.29
1.23
1.16
2.11
1.04
3.00
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


163.73
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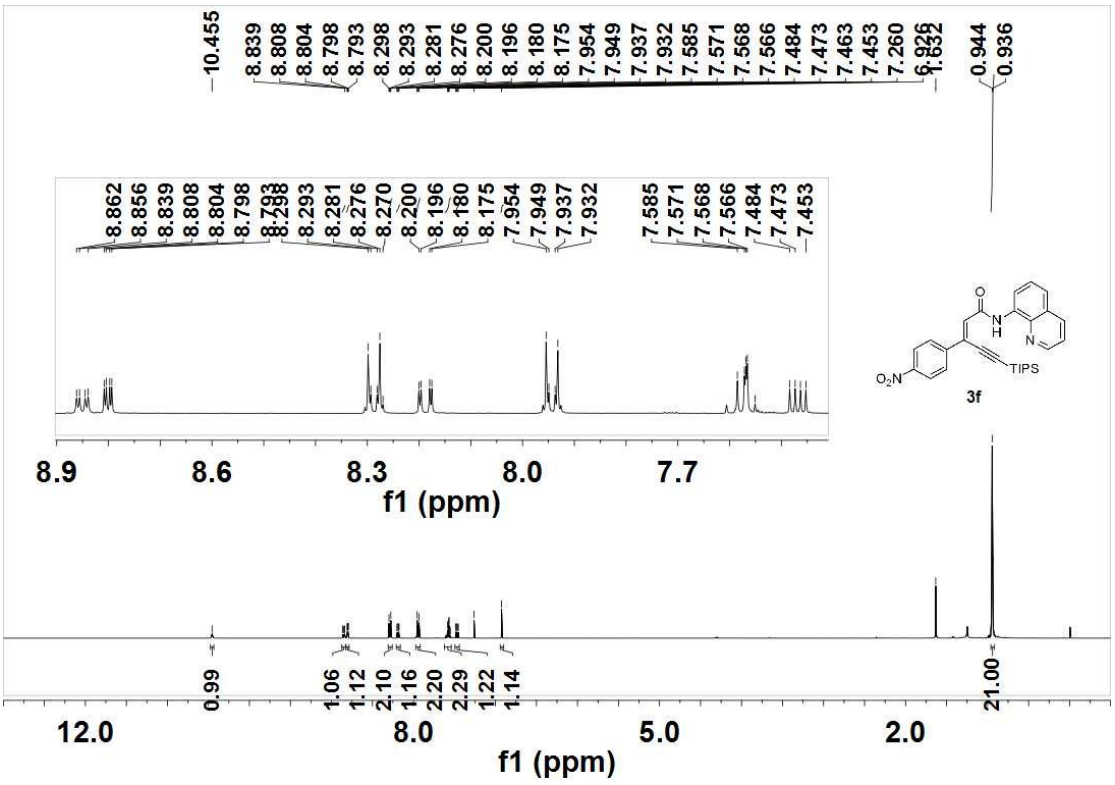
128.55
127.53
126.10
121.62
102.93
77.48
77.16
76.84
20.42
18.52
11.28
139.00
138.98
136.41
135.73
134.62
133.50
132.06
130.70
128.88
128.55
128.05
127.53
126.10
121.98
121.62
Me
N
H
O
N
TIPS
3e
132
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)


10.455
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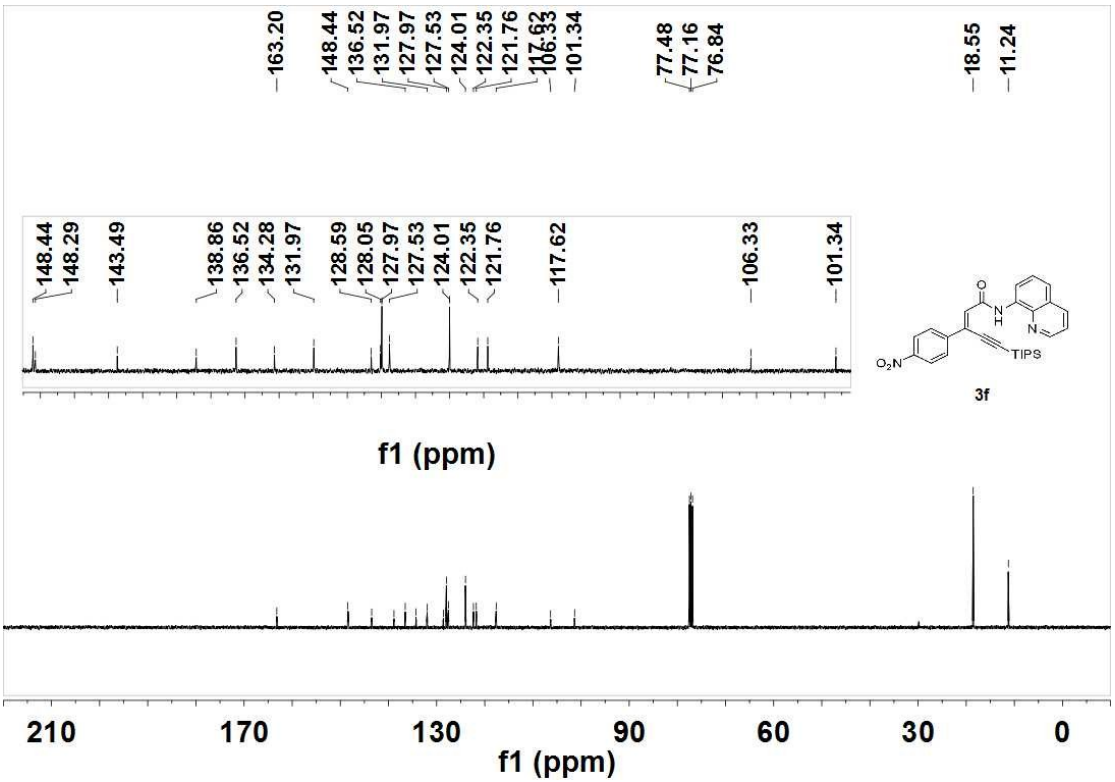
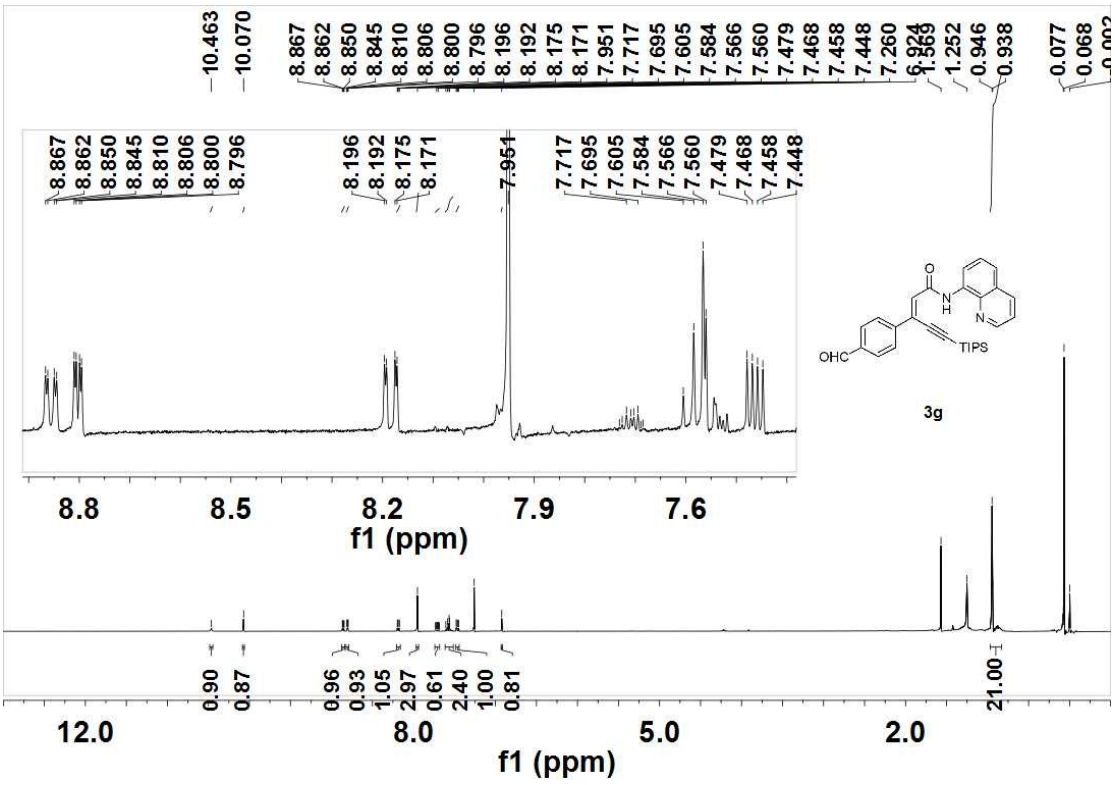
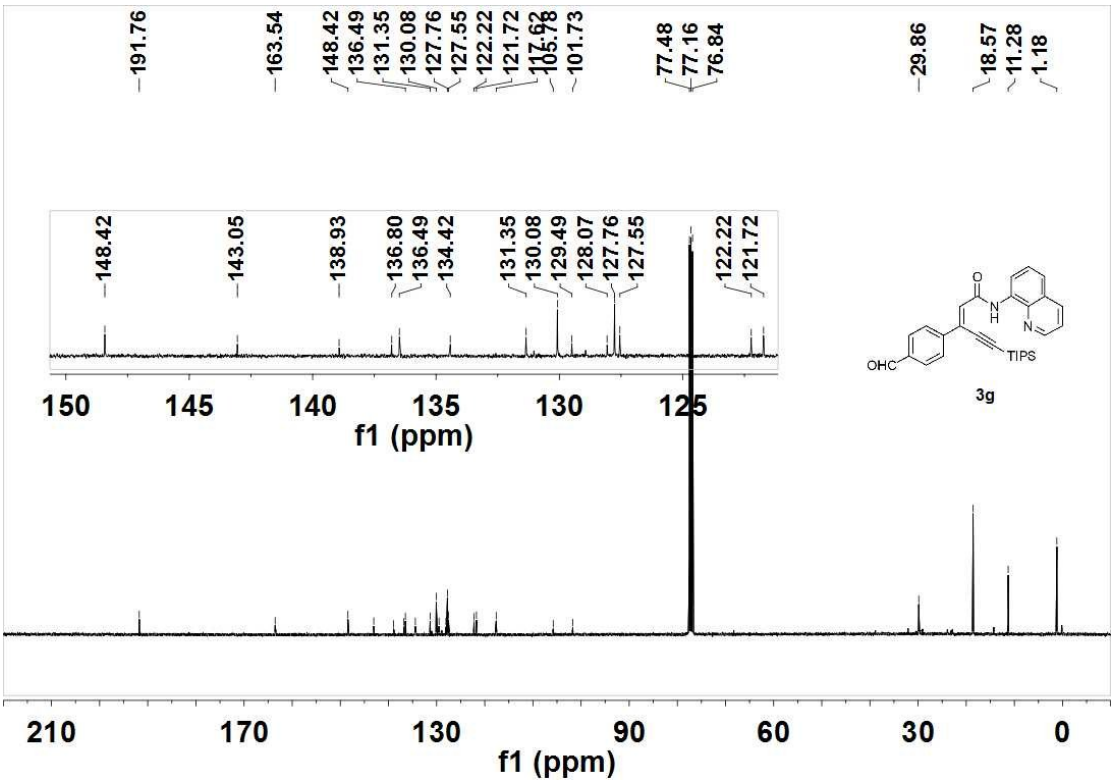
8.808
8.804
8.798
8.793
8.298
8.293
8.281
8.276
8.200
8.196
8.180
8.175
7.954
7.949
7.937
7.932
7.585
7.571
7.568
7.566
7.484
7.473
7.463
7.453
7.260
1.632
0.944
0.936
8.862
8.856
8.839
8.808
8.804
8.798
8.293
8.281
8.276
8.270
8.200
8.196
8.180
8.175
7.954
7.949
7.937
7.932
7.585
7.571
7.568
7.566
7.484
7.473
7.453
8.9
8.6
8.3
8.0
7.7
f1 (ppm)
3f
0.99
1.06
1.12
2.10
1.16
2.20
2.29
1.22
1.14
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


163.20
148.44
136.52
131.97
127.97
127.53
124.01
122.35
121.76
117.62
106.33
101.34
77.48
77.16
76.84
18.55
11.24
148.44
148.29
143.49
138.86
136.52
134.28
131.97
128.59
128.05
127.97
127.53
124.01
122.35
121.76
117.62
106.33
101.34
3f
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)


10.463
10.070
8.867
8.862
8.850
8.845
8.810
8.806
8.800
8.796
8.196
8.192
8.175
8.171
7.951
7.717
7.695
7.605
7.584
7.566
7.560
7.479
7.468
7.458
7.448
7.260
6.924
6.569
1.252
0.946
0.938
0.077
0.068
0.90
0.87
0.96
0.93
1.05
2.97
0.61
2.40
1.00
0.81
21.00
12.0
8.0
5.0
2.0
f1 (ppm)
8.8
8.5
8.2
7.9
7.6
f1 (ppm)
OHC
TIPS
3g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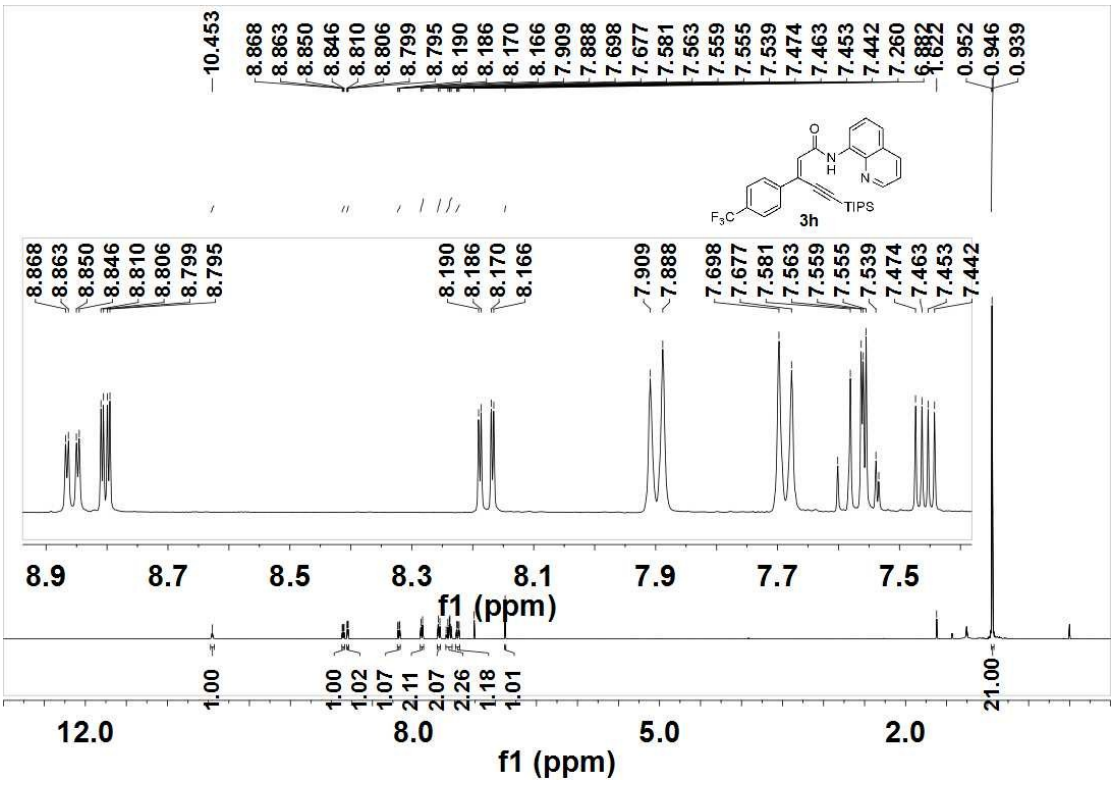
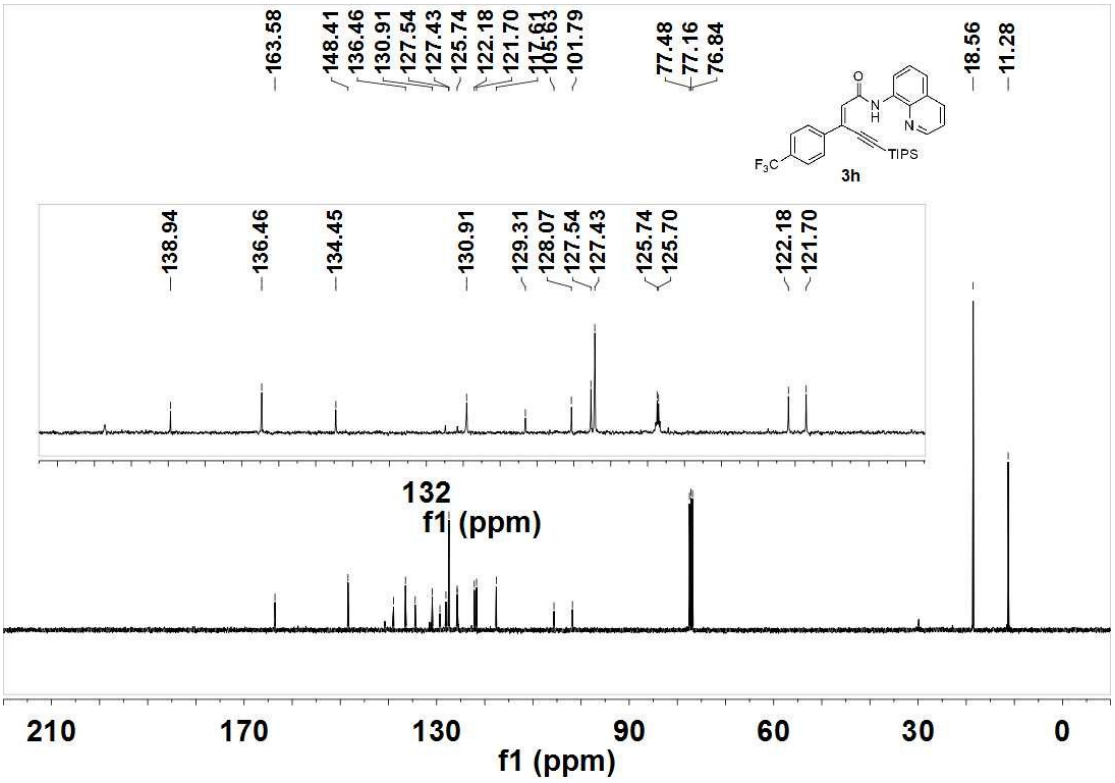
163.54
148.42
136.49
131.35
130.08
127.76
127.55
122.22
121.72
117.62
105.78
101.73
77.48
77.16
76.84
29.86
18.57
11.28
1.18
148.42
143.05
138.93
136.80
136.49
134.42
131.35
130.08
129.49
128.07
127.76
127.55
122.22
121.72
150
145
140
135
130
125
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)
OHC
TIPS
3g


10.453
8.868
8.863
8.850
8.846
8.810
8.806
8.799
8.795
8.190
8.186
8.170
8.166
7.909
7.888
7.698
7.677
7.581
7.563
7.559
7.555
7.539
7.474
7.463
7.453
7.442
7.260
6.882
6.822
0.952
0.946
0.939
3h
f1 (ppm)
1.00
1.00
1.02
1.07
2.11
2.07
2.26
1.18
1.01
21.00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148.41
136.46
130.91
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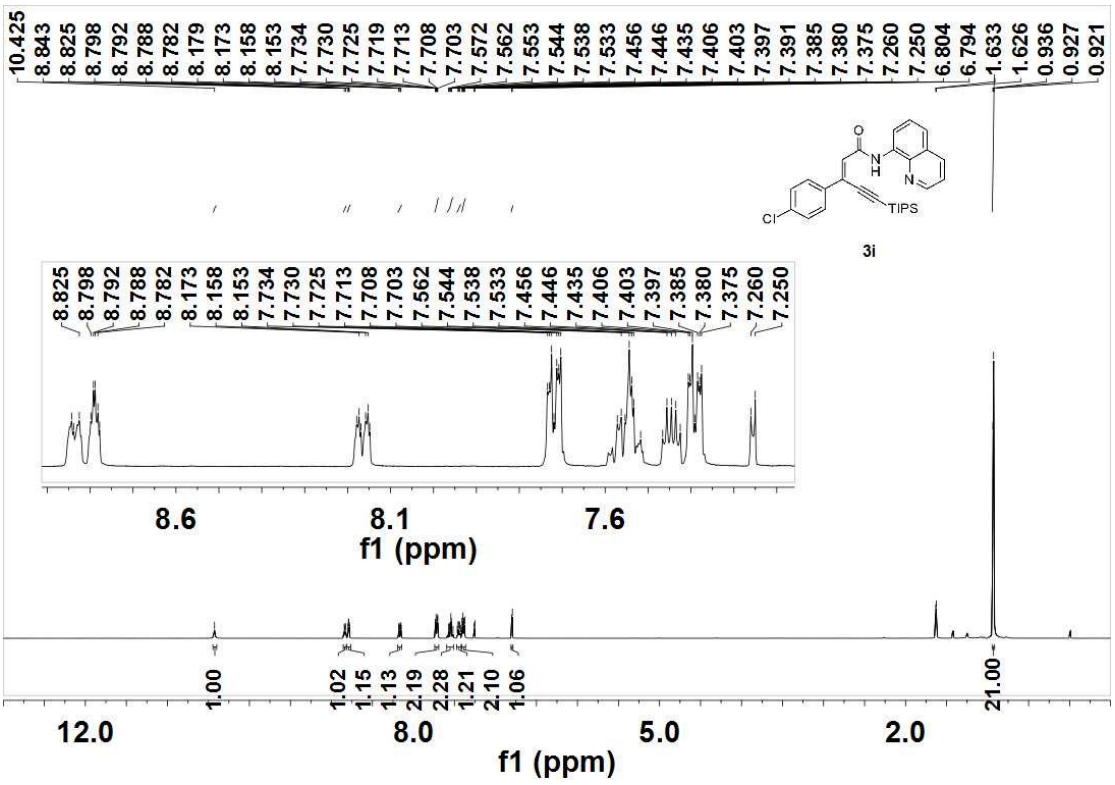
127.43
125.74
122.18
121.70
117.61
105.63
101.79
77.48
77.16
76.84
18.56
11.28
3h
138.94
136.46
134.45
130.91
129.31
128.07
127.54
127.43
125.74
125.70
122.18
121.70
f1 (ppm)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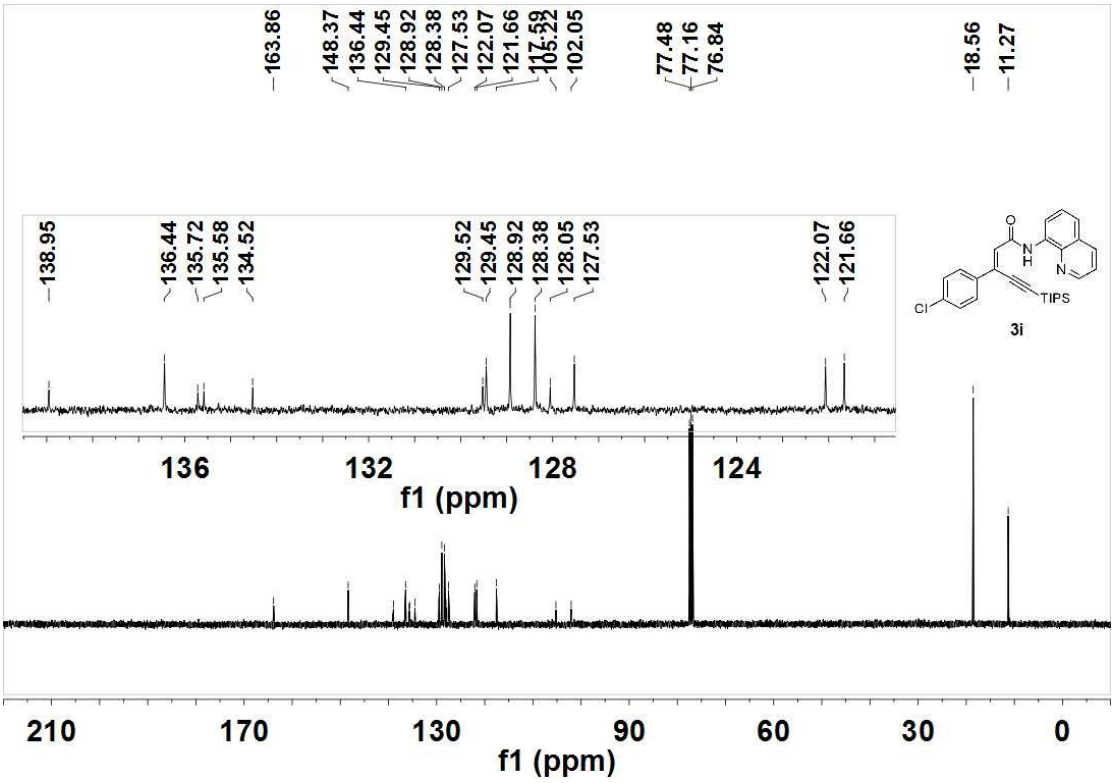
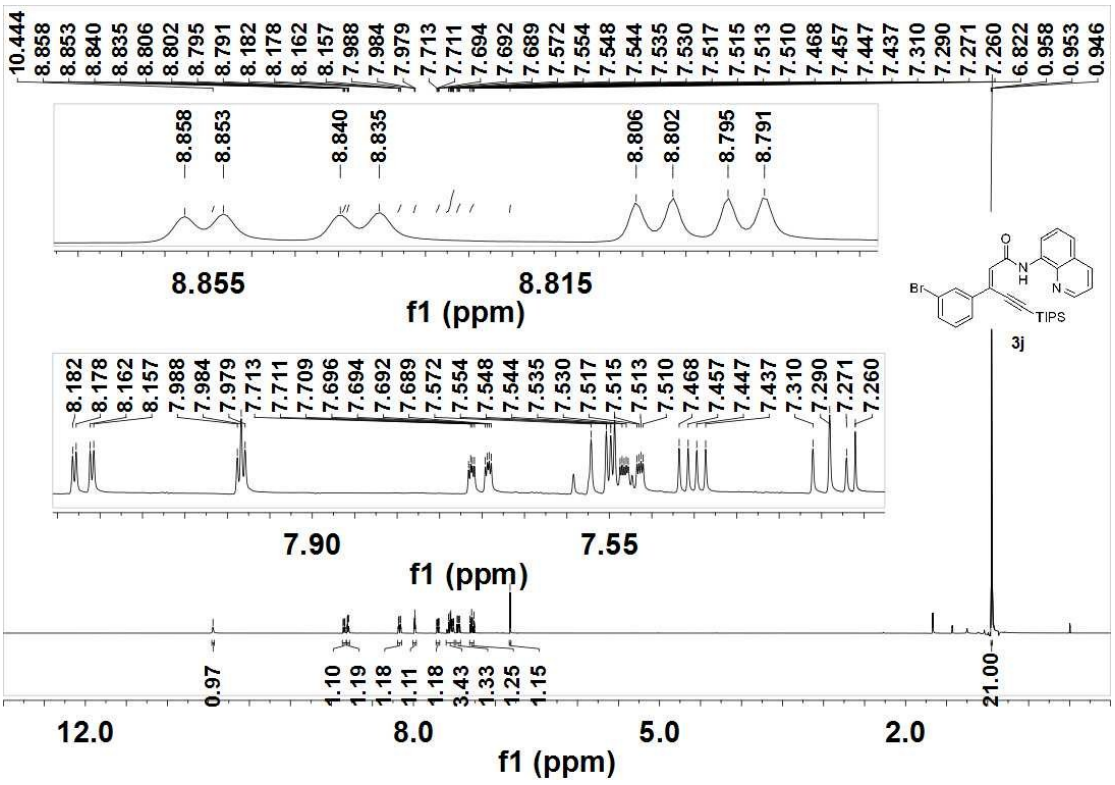
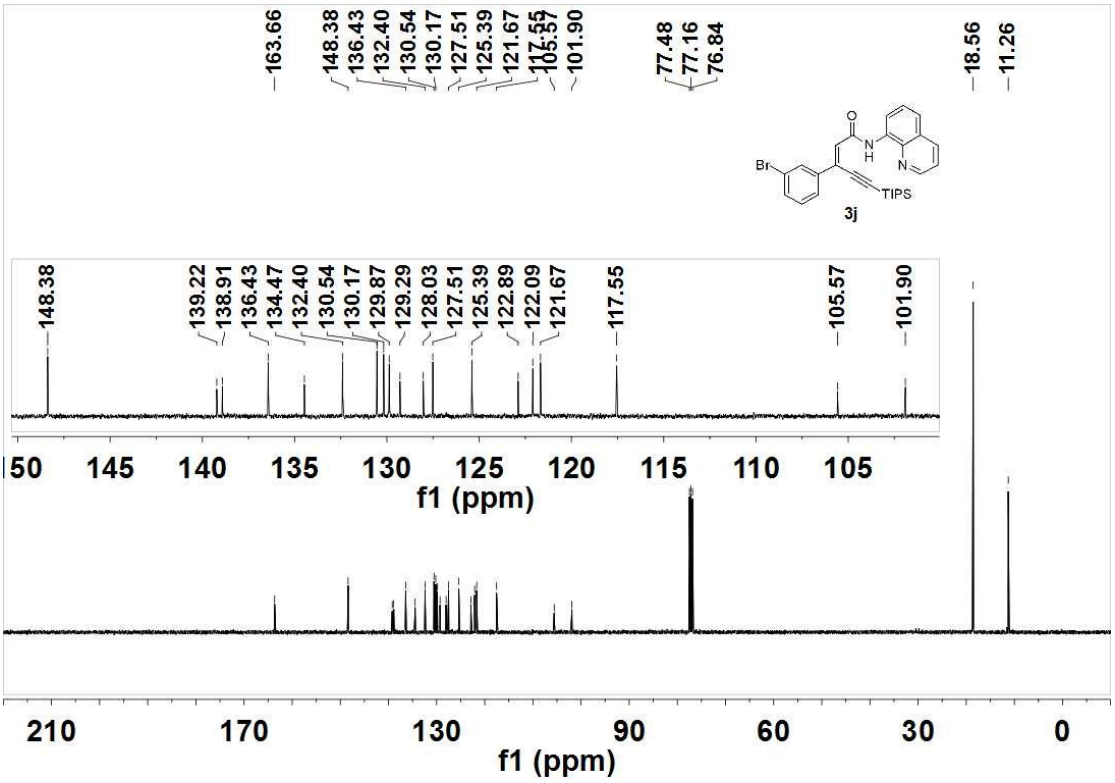
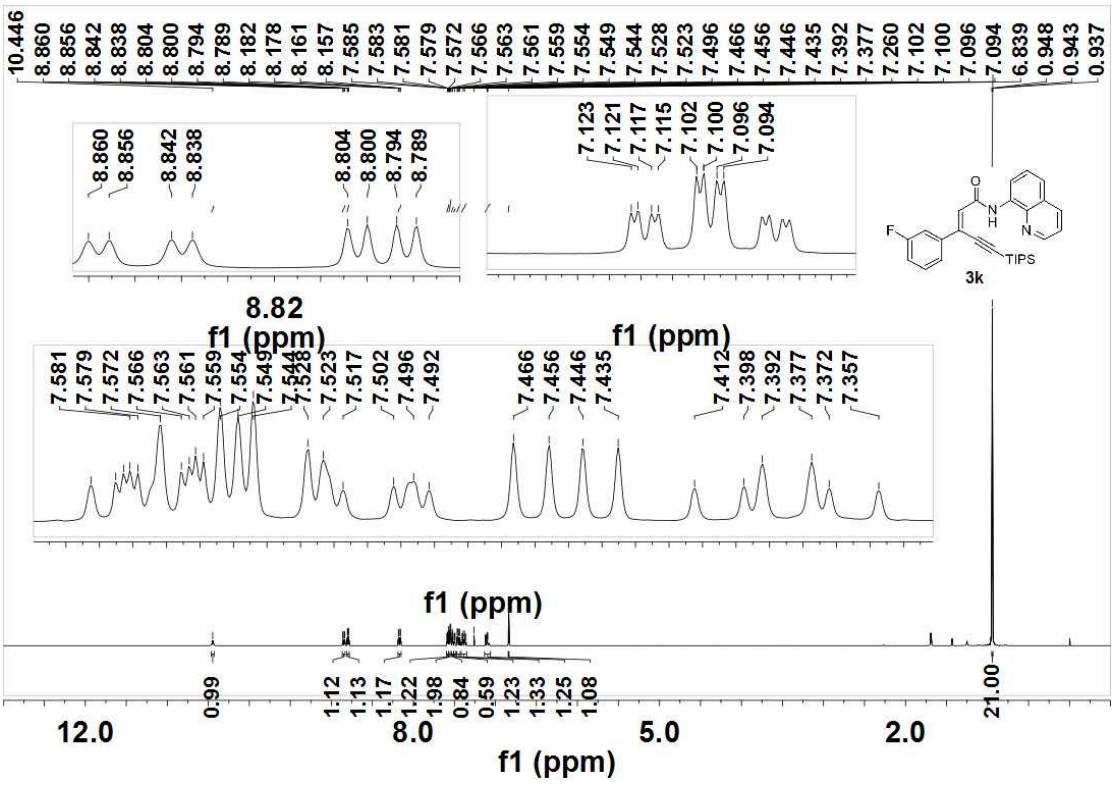
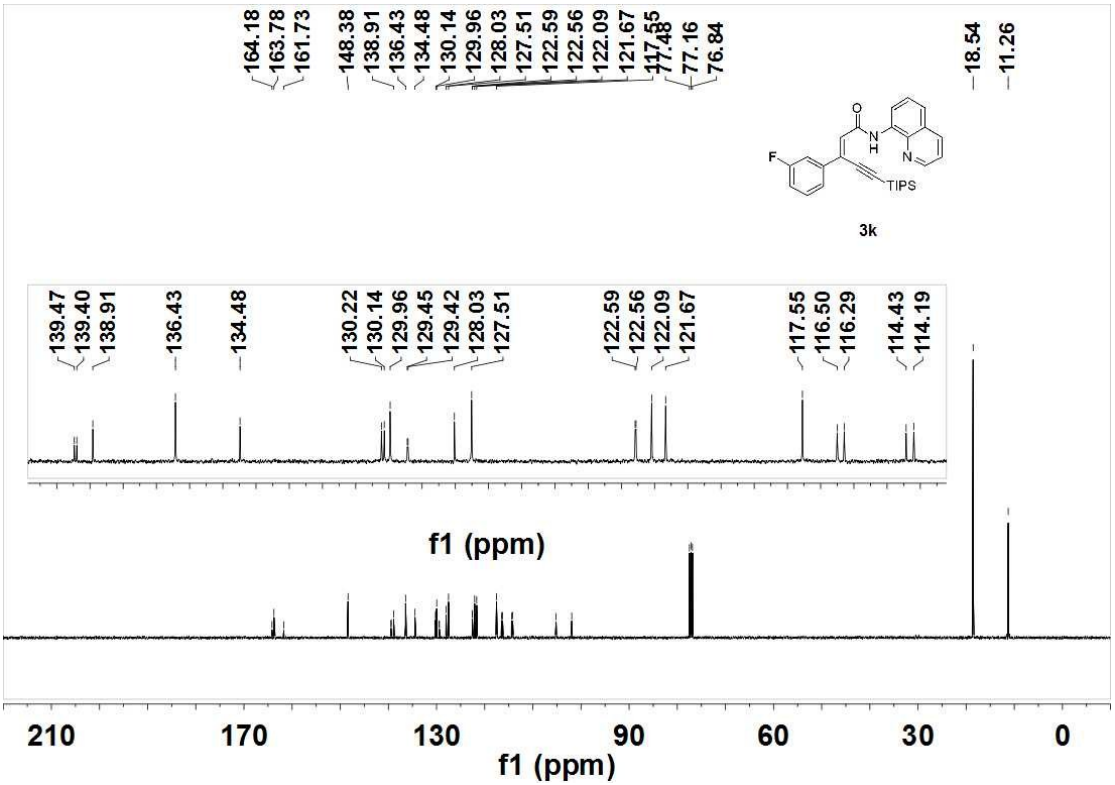
8.825
8.798
8.792
8.788
8.782
8.179
8.173
8.158
8.153
8.734
7.730
7.725
7.719
7.713
7.708
7.703
7.572
7.562
7.553
7.544
7.538
7.533
7.456
7.446
7.435
7.406
7.403
7.397
7.391
7.385
7.380
7.375
7.260
7.250
6.804
6.794
1.633
1.626
0.936
0.927
0.921
3i
8.6
8.1
7.6
f1 (ppm)
1.00
1.02
1.15
1.13
2.19
2.28
1.21
2.10
1.06
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


163.86
148.37
136.44
129.45
128.92
128.38
127.53
122.07
121.66
102.05
77.48
77.16
76.84
18.56
11.27
138.95
136.44
135.72
135.58
134.52
129.52
129.45
128.92
128.38
128.05
127.53
122.07
121.66
3i
136
132
128
124
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)


10.444
8.858
8.853
8.840
8.835
8.806
8.802
8.795
8.791
8.182
8.178
8.162
8.157
7.988
7.984
7.979
7.713
7.711
7.709
7.696
7.694
7.692
7.689
7.572
7.554
7.548
7.544
7.535
7.530
7.517
7.515
7.513
7.510
7.468
7.457
7.447
7.437
7.310
7.290
7.271
7.260
6.822
0.958
0.953
0.946
8.855
8.815
7.90
7.55
f1 (ppm)
Br
TIPS
3j
0.97
1.10
1.19
1.18
1.11
1.18
3.43
1.33
1.25
1.15
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


163.66
148.38
136.43
132.40
130.54
130.17
127.51
125.39
121.67
117.55
105.57
101.90
77.48
77.16
76.84
18.56
11.26
Br
TIPS
3j
148.38
139.22
138.91
136.43
134.47
132.40
130.54
130.17
129.87
129.29
128.03
127.51
125.39
122.89
122.09
121.67
117.55
105.57
101.90
150
145
140
135
130
125
120
115
110
105
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)


10.446
8.860
8.856
8.842
8.838
8.804
8.800
8.794
8.789
8.182
8.178
8.161
8.157
7.585
7.583
7.581
7.579
7.572
7.566
7.563
7.561
7.559
7.554
7.549
7.544
7.528
7.523
7.496
7.466
7.456
7.446
7.435
7.392
7.377
7.260
7.102
7.100
7.096
7.094
6.839
0.948
0.943
0.937
F
TIPS
3k
8.82
f1 (ppm)
f1 (ppm)
f1 (ppm)
0.99
1.12
1.13
1.17
1.22
1.98
0.84
0.59
1.23
1.33
1.25
1.08
21.00
12.0
8.0
5.0
2.0
f1 (ppm)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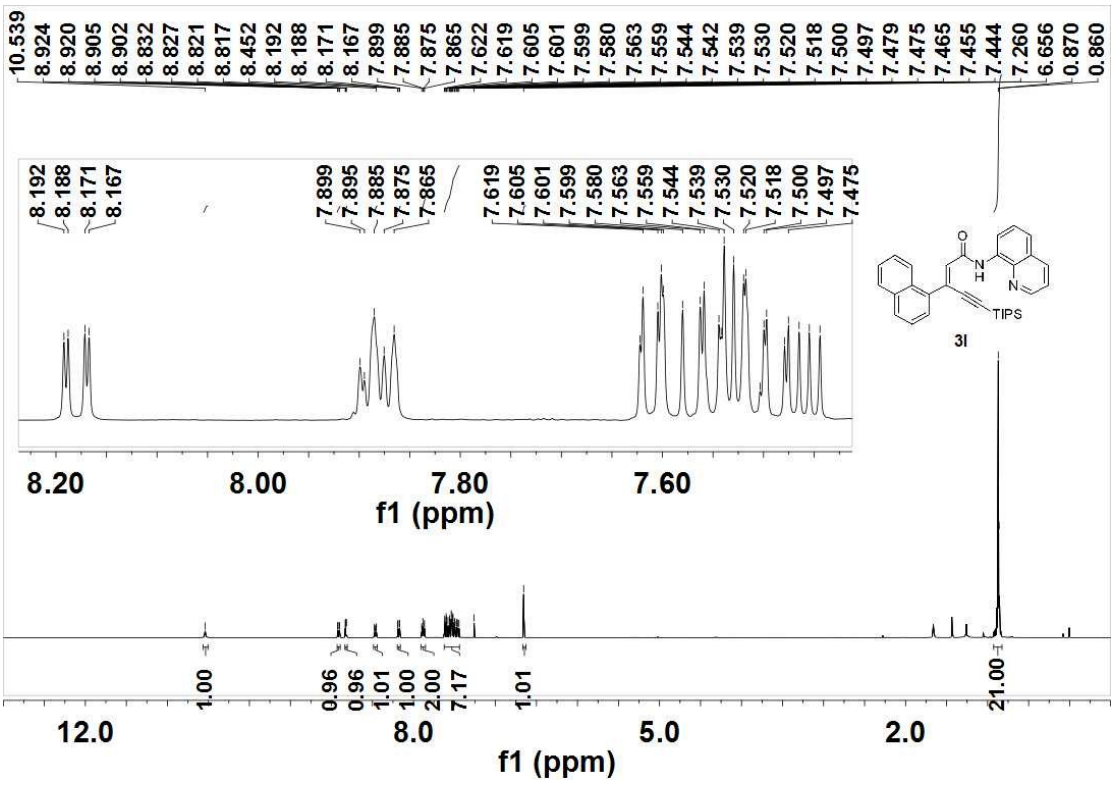
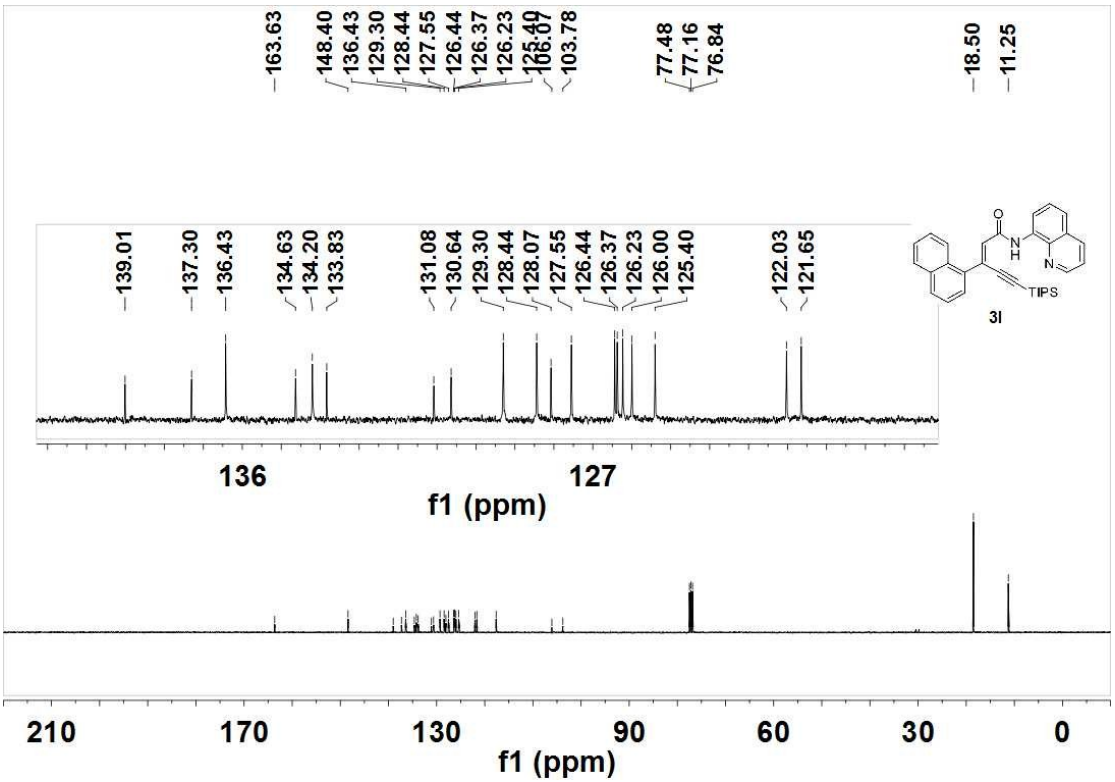
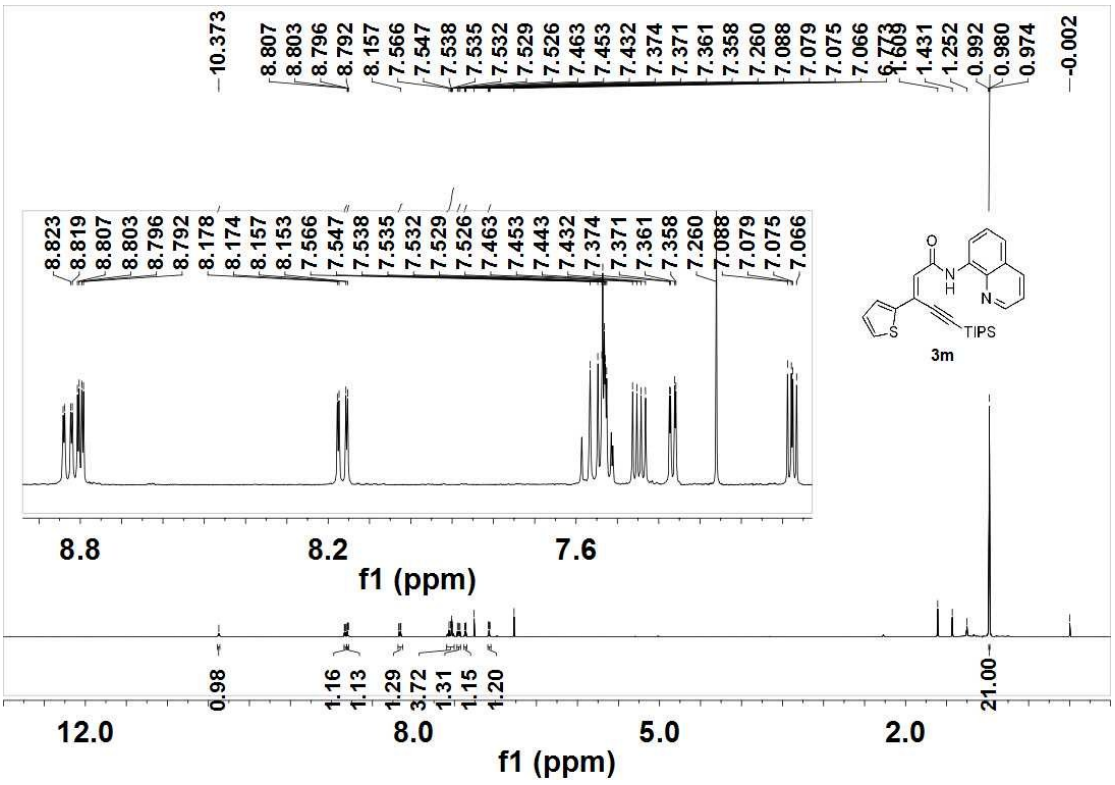
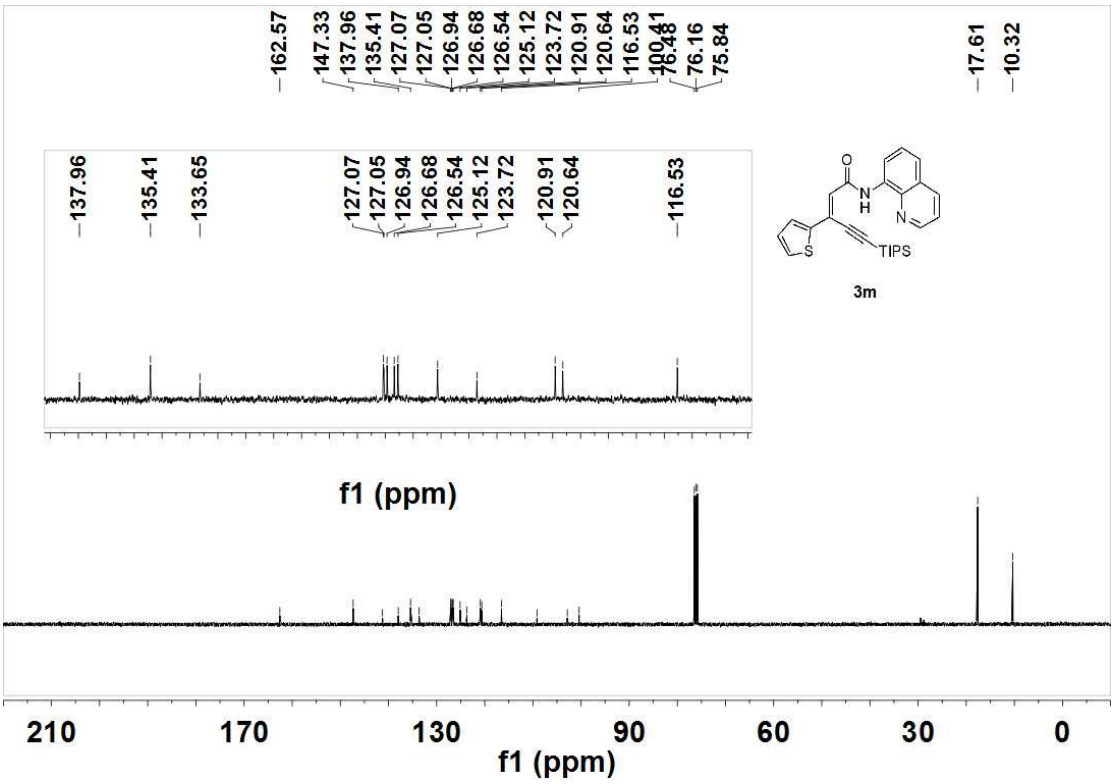
163.78
161.73
148.38
138.91
136.43
134.48
130.14
129.96
128.03
127.51
122.59
122.56
122.09
121.67
77.48
77.16
76.84
18.54
11.26
F
TIPS
3k
139.47
139.40
138.91
136.43
134.48
130.22
130.14
129.96
129.45
129.42
128.03
127.51
122.59
122.56
122.09
121.67
117.55
116.50
116.29
114.43
114.19
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)


10.539
8.924
8.920
8.905
8.902
8.832
8.827
8.821
8.817
8.452
8.192
8.188
8.171
8.167
7.899
7.885
7.875
7.865
7.622
7.619
7.605
7.601
7.599
7.580
7.563
7.559
7.544
7.542
7.539
7.530
7.520
7.518
7.500
7.497
7.479
7.475
7.465
7.455
7.444
7.260
6.656
0.870
0.860
8.20
8.00
7.80
7.60
f1 (ppm)
1.00
0.96
0.96
1.01
1.00
2.00
7.17
1.01
21.00
12.0
8.0
5.0
2.0
f1 (ppm)
TIPS
3l


163.63
148.40
136.43
129.30
128.44
127.55
126.44
126.37
126.23
103.78
77.48
77.16
76.84
18.50
11.25
139.01
137.30
136.43
134.63
134.20
133.83
131.08
130.64
129.30
128.44
128.07
127.55
126.44
126.37
126.23
126.00
125.40
122.03
121.65
136
127
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)
TIPS
3l


10.373
8.807
8.803
8.796
8.792
8.157
7.566
7.547
7.538
7.535
7.532
7.529
7.526
7.463
7.453
7.432
7.374
7.371
7.361
7.358
7.260
7.088
7.079
7.075
7.066
1.431
1.252
0.992
0.980
0.974
0.002
8.823
8.819
8.807
8.803
8.796
8.792
8.178
8.174
8.157
8.153
7.566
7.547
7.538
7.535
7.532
7.529
7.526
7.463
7.453
7.443
7.432
7.374
7.371
7.361
7.358
7.260
7.088
7.079
7.075
7.066
3m
8.8
8.2
7.6
f1 (ppm)
0.98
1.16
1.13
1.29
3.72
1.31
1.15
1.20
21.00
12.0
8.0
5.0
2.0
f1 (ppm)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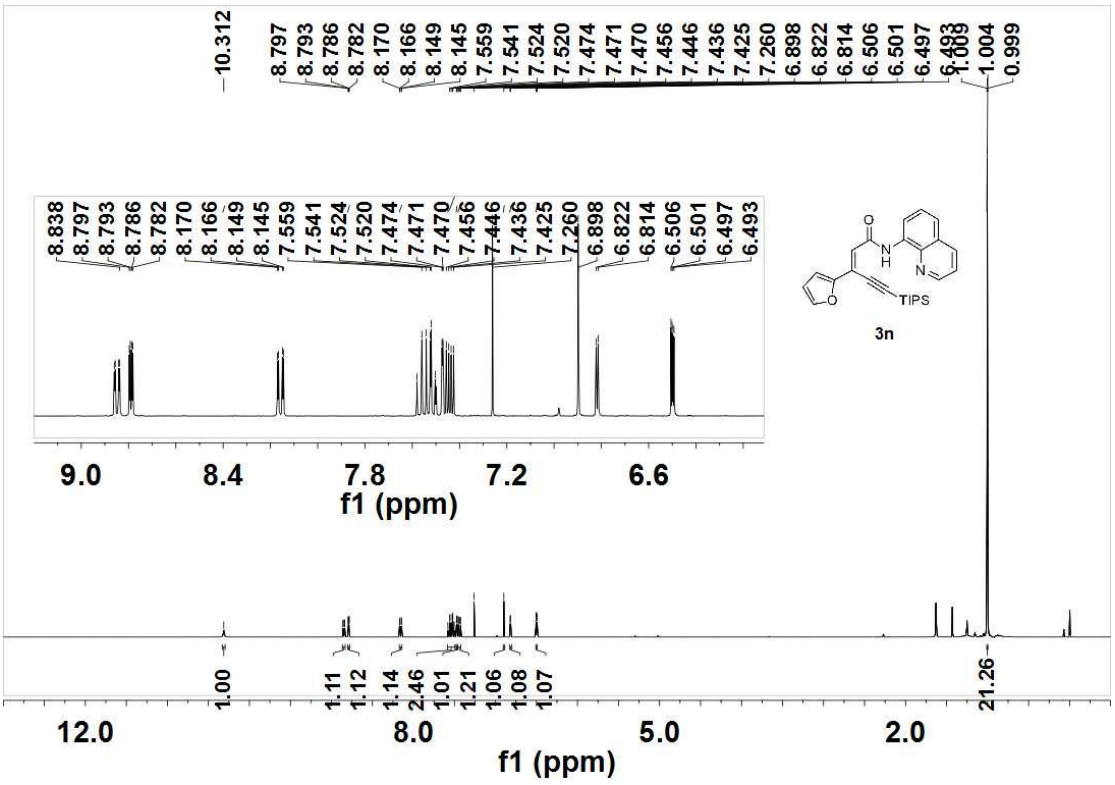
147.33
137.96
135.41
127.07
127.05
126.94
126.68
126.54
125.12
123.72
120.91
120.64
116.53
100.41
76.48
76.16
75.84
17.61
10.32
137.96
135.41
133.65
127.07
127.05
126.94
126.68
126.54
125.12
123.72
120.91
120.64
116.53
3m
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)


10.312
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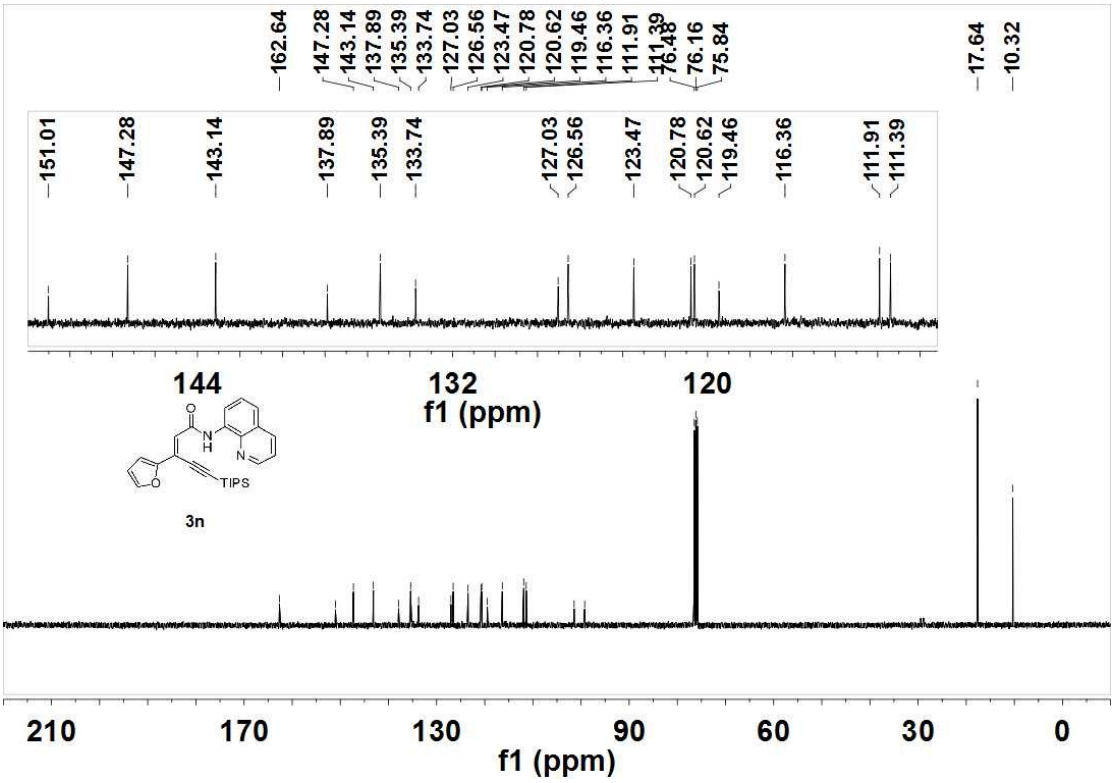
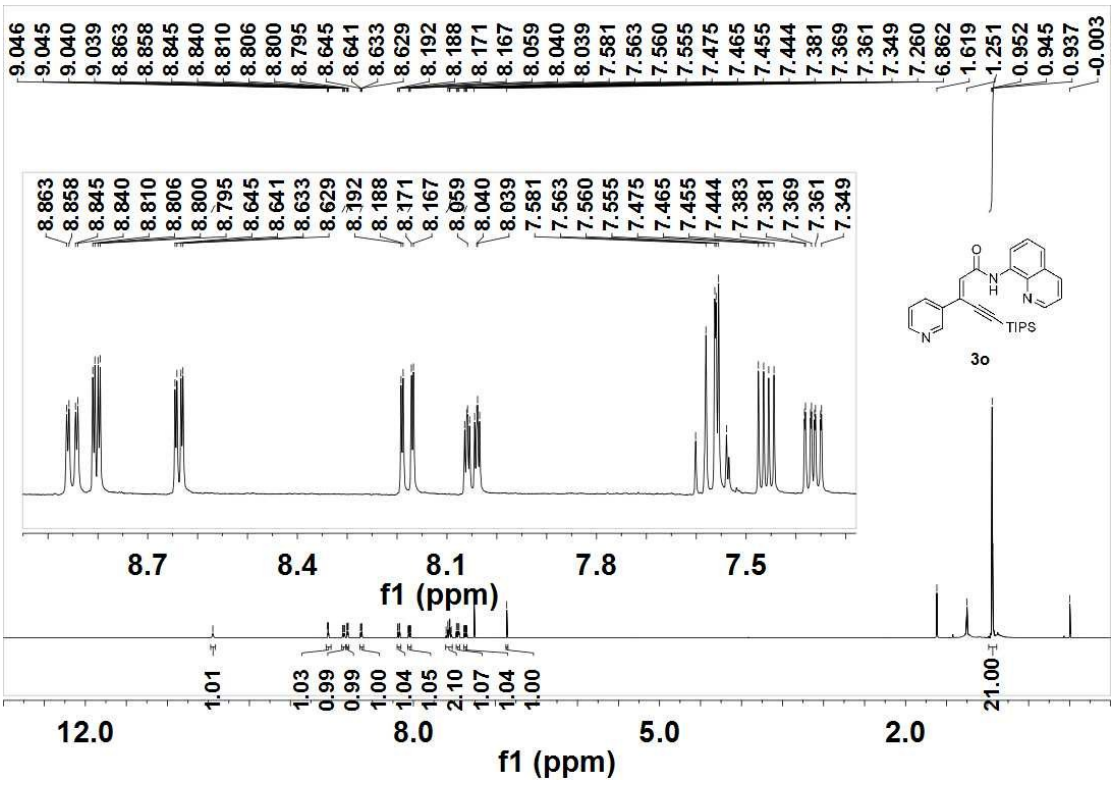
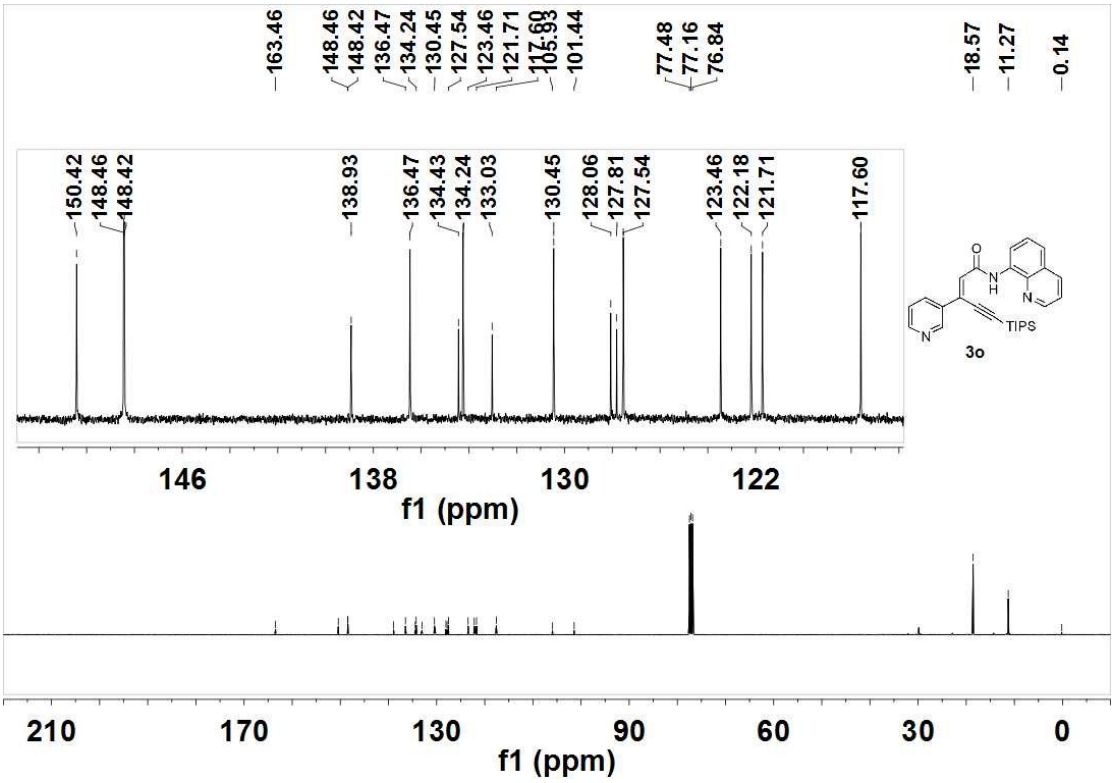
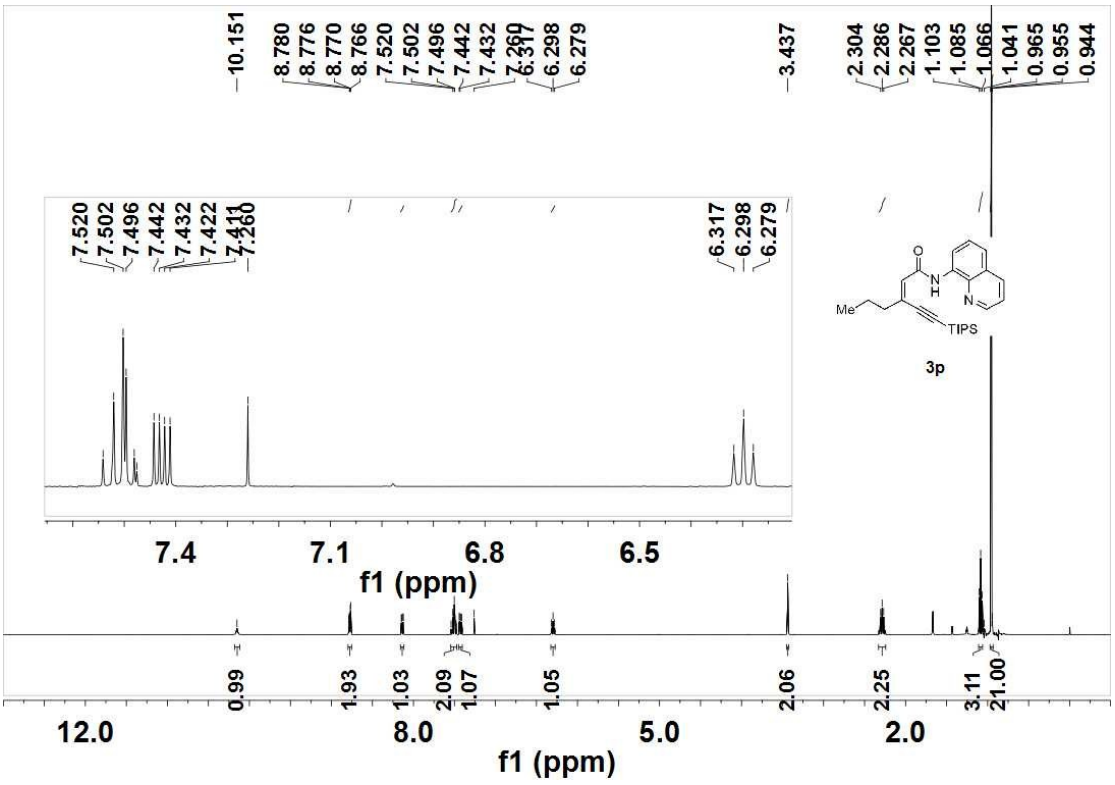
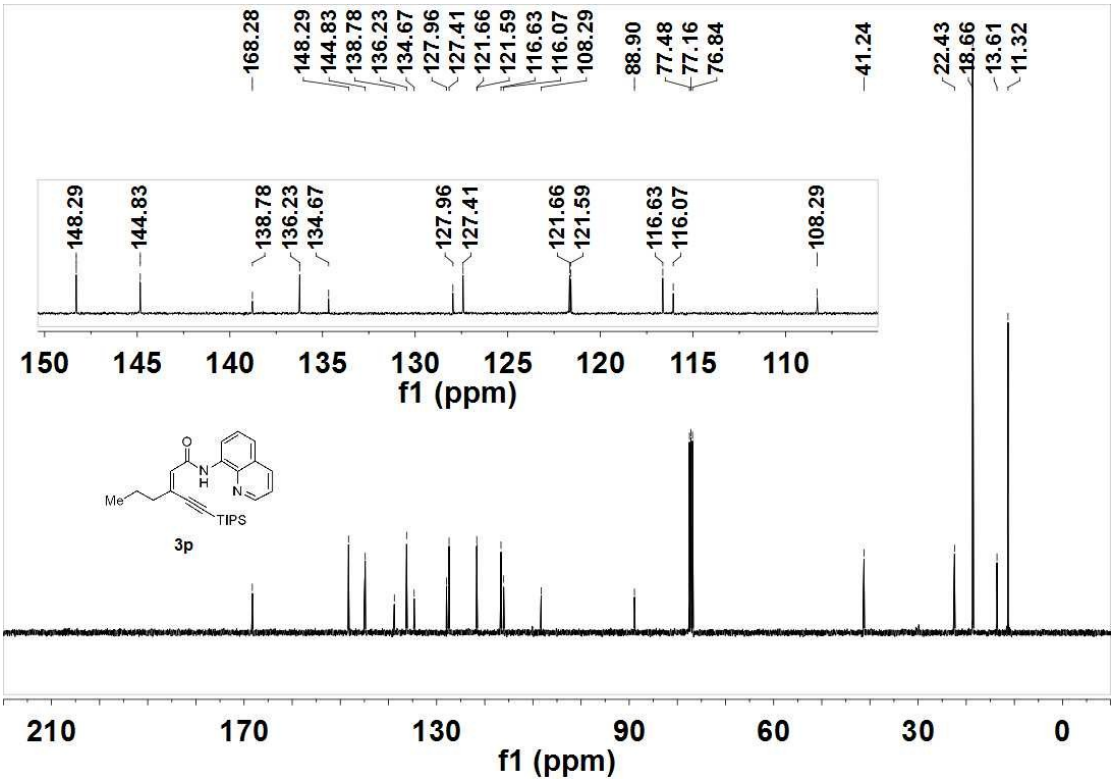
8.793
8.786
8.782
8.170
8.166
8.149
8.145
7.559
7.541
7.524
7.520
7.474
7.471
7.470
7.456
7.446
7.436
7.425
7.260
6.898
6.822
6.814
6.506
6.501
6.497
6.493
1.004
0.999
8.838
8.797
8.793
8.786
8.782
8.170
8.166
8.149
8.145
7.559
7.541
7.524
7.520
7.474
7.471
7.470
7.456
7.446
7.436
7.425
7.260
6.898
6.822
6.814
6.506
6.501
6.497
6.493
9.0
8.4
7.8
7.2
6.6
f1 (ppm)
O
N
H
N
O
TIPS
3n
1.00
1.11
1.12
1.14
2.46
1.01
1.21
1.06
1.08
1.07
21.26
12.0
8.0
5.0
2.0
f1 (ppm)

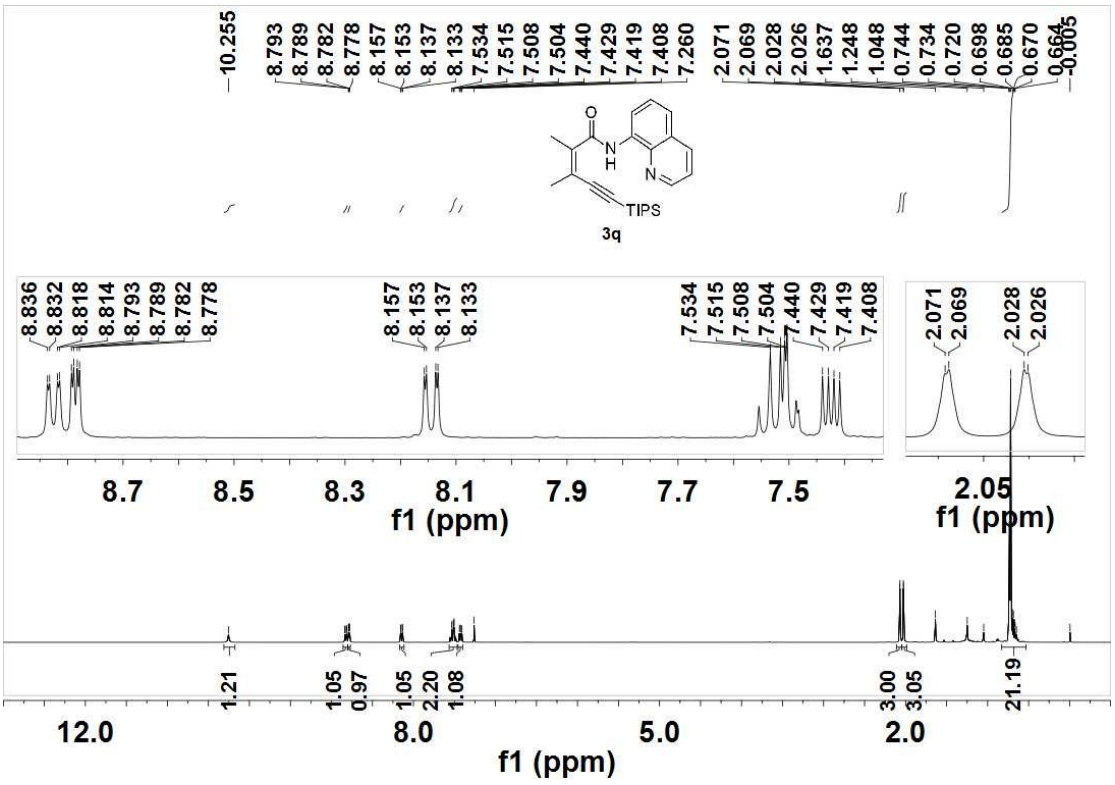

162.64
147.28
143.14
137.89
135.39
133.74
127.03
126.56
123.47
120.78
120.62
119.46
116.36
111.91
111.39
76.48
76.16
75.84
17.64
10.32
151.01
147.28
143.14
137.89
135.39
133.74
127.03
126.56
123.47
120.78
120.62
119.46
116.36
111.91
111.39
144
132
120
f1 (ppm)
O
N
H
N
O
TIPS
3n
210
170
130
90
60
30
0
f1 (ppm)

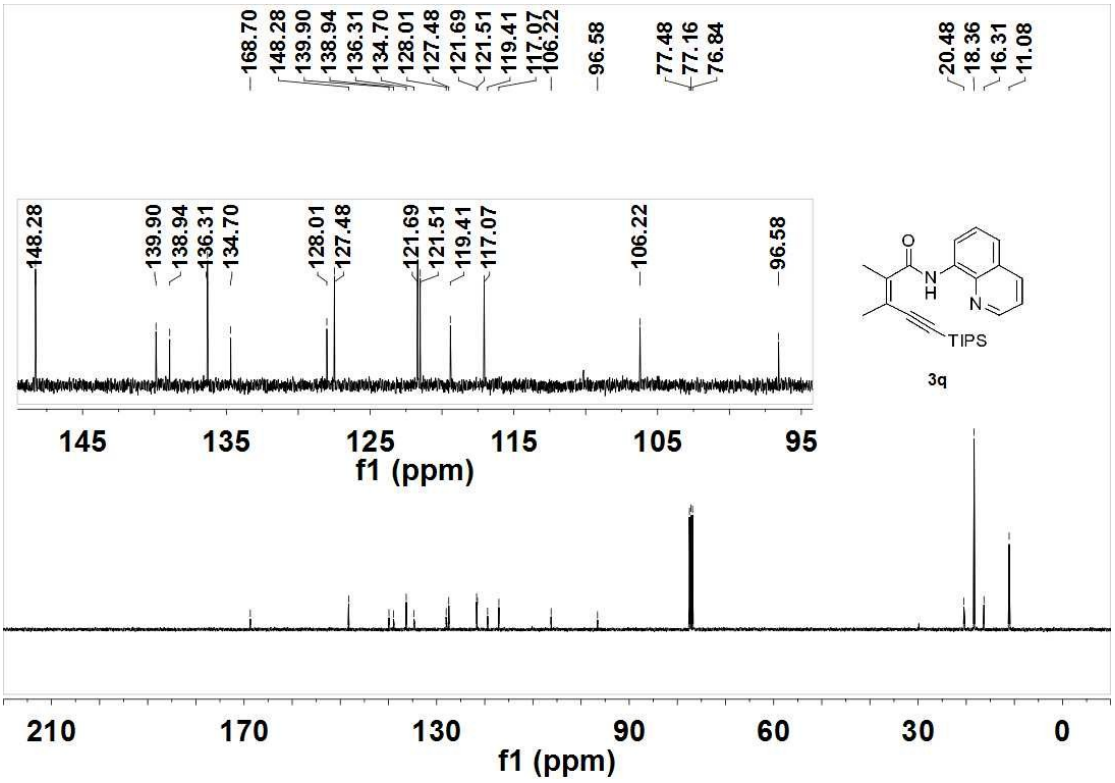

9.046
9.045
9.040
9.039
8.863
8.858
8.845
8.840
8.810
8.806
8.800
8.795
8.645
8.641
8.633
8.629
8.192
8.188
8.171
8.167
8.059
8.040
8.039
7.581
7.563
7.560
7.555
7.475
7.465
7.455
7.444
7.381
7.369
7.361
7.349
7.260
6.862
1.619
1.251
0.952
0.945
0.937
-0.003
TIPS
3o
8.7
8.4
8.1
7.8
7.5
f1 (ppm)
1.01
1.03
0.99
0.99
1.00
1.04
1.05
2.10
1.07
1.04
1.00
21.00
12.0
8.0
5.0
2.0
f1 (ppm)

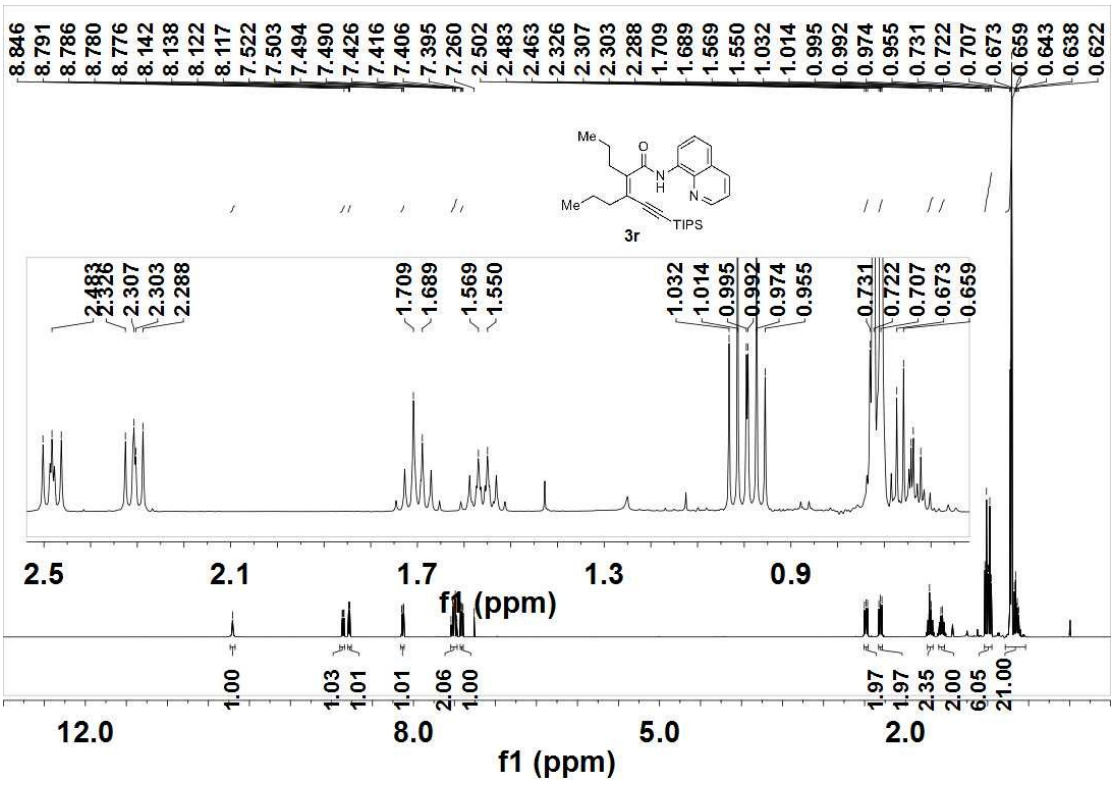

163.46
148.46
148.42
136.47
134.24
130.45
127.54
123.46
121.71
117.60
105.93
101.44
77.48
77.16
76.84
18.57
11.27
0.14
150.42
148.46
148.42
138.93
136.47
134.43
134.24
133.03
130.45
128.06
127.81
127.54
123.46
122.18
121.71
117.60
TIPS
3o
146
138
130
122
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)

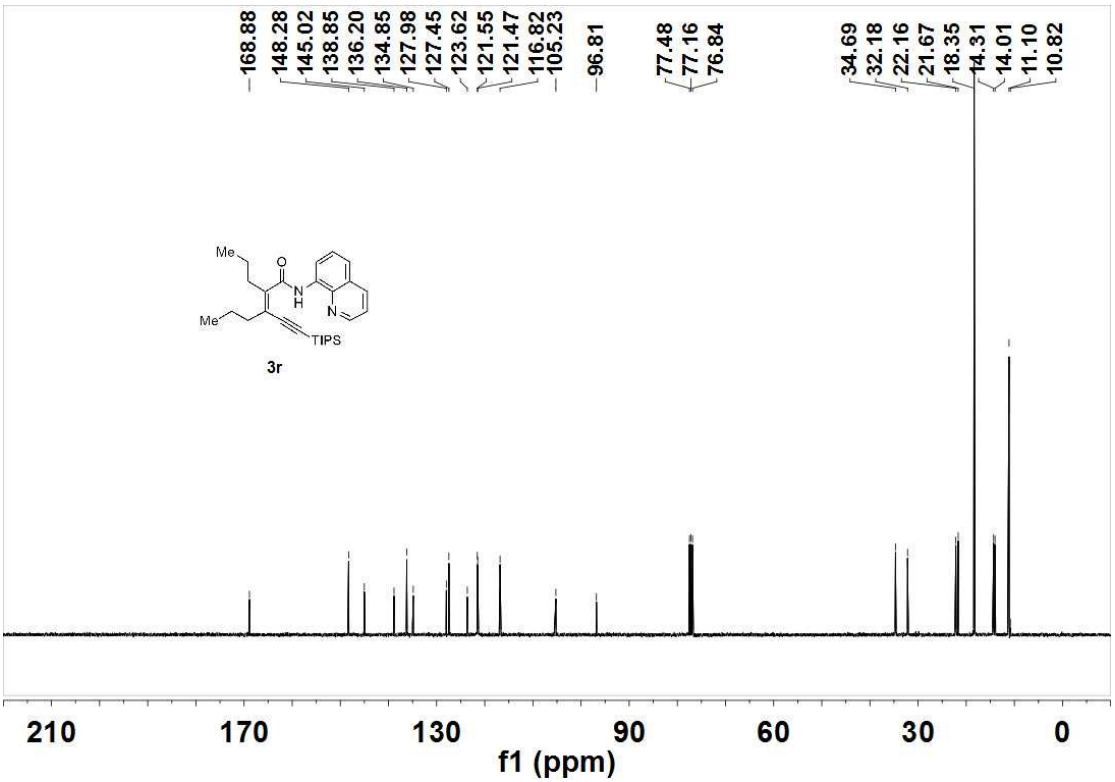

10.151
8.780
8.776
8.770
8.766
7.520
7.502
7.496
7.442
7.432
7.260
6.317
6.298
6.279
3.437
2.304
2.286
2.267
1.103
1.085
1.066
1.041
0.965
0.955
0.944
Me
TIPS
3p
f1 (ppm)
0.99
1.93
1.03
2.09
1.07
1.05
2.06
2.25
3.11
21.00

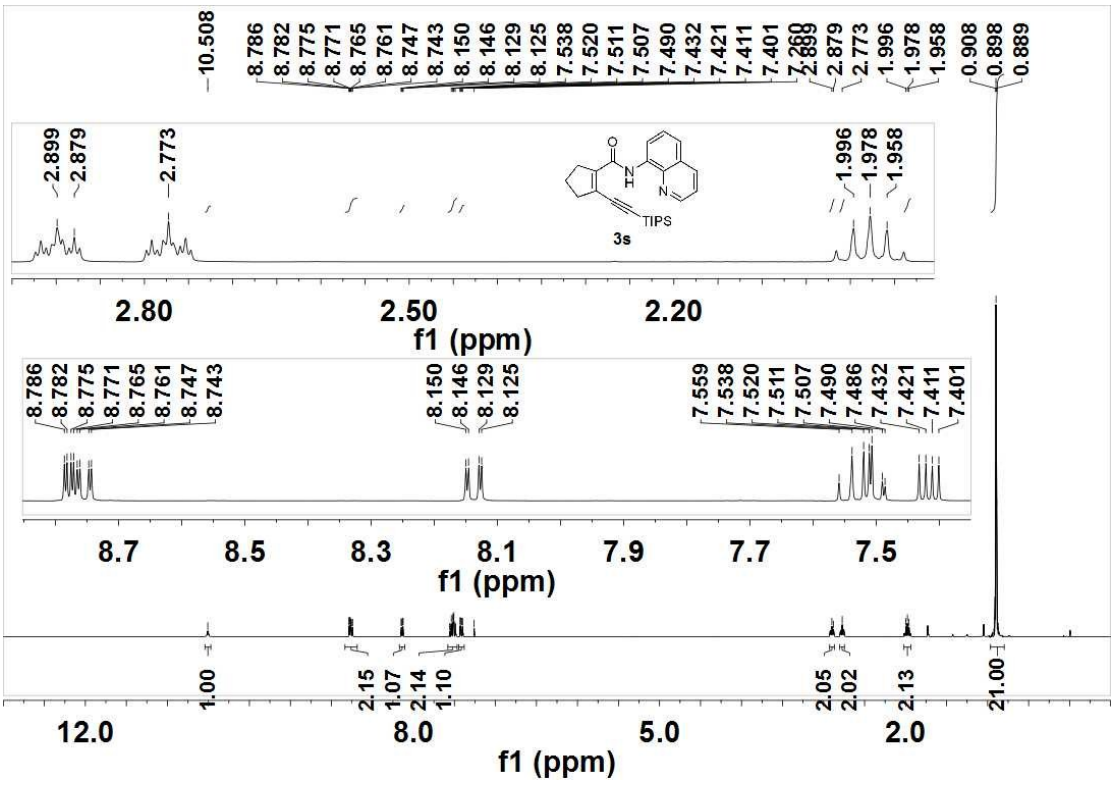

168.28
148.29
144.83
138.78
136.23
134.67
127.96
127.41
121.66
121.59
116.63
116.07
108.29
88.90
77.48
77.16
76.84
41.24
22.43
18.66
13.61
11.32
Me
TIPS
3p
f1 (ppm)

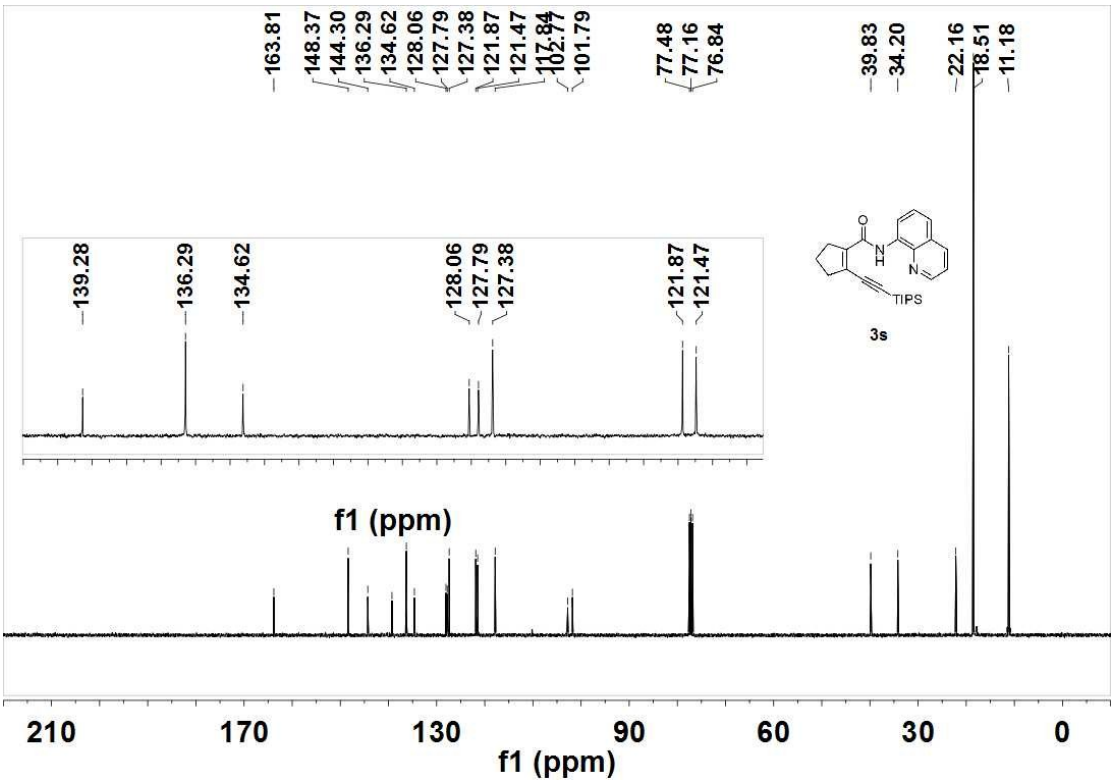

10.255
8.793
8.789
8.782
8.778
8.157
8.153
8.137
8.133
7.534
7.515
7.508
7.504
7.440
7.429
7.419
7.408
7.260
2.071
2.069
2.028
2.026
1.637
1.248
1.048
0.744
0.734
0.720
0.698
0.685
0.670
0.664
0.005
TIPS
3q
f1 (ppm)
1.21
1.05
0.97
1.05
2.20
1.08
3.00
3.05
21.19

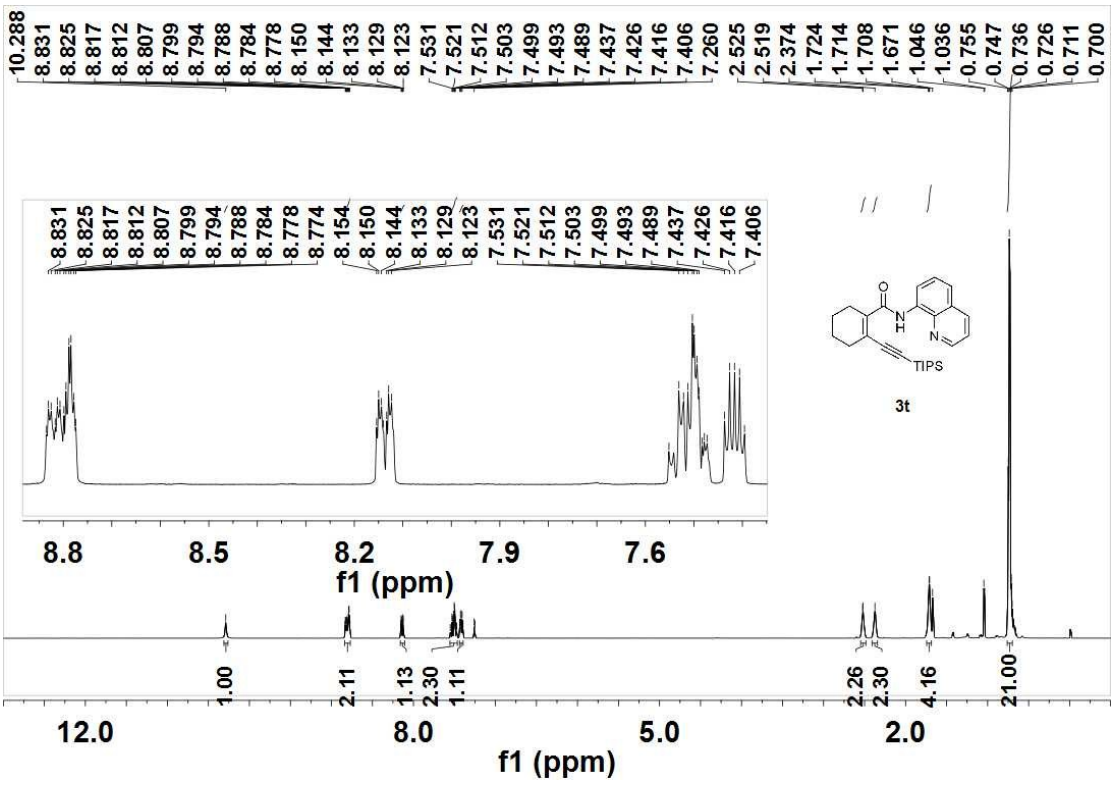

168.70
148.28
139.90
138.94
136.31
134.70
128.01
127.48
121.69
121.51
119.41
117.07
106.22
96.58
77.48
77.16
76.84
20.48
18.36
16.31
11.08
TIPS
3q
f1 (ppm)

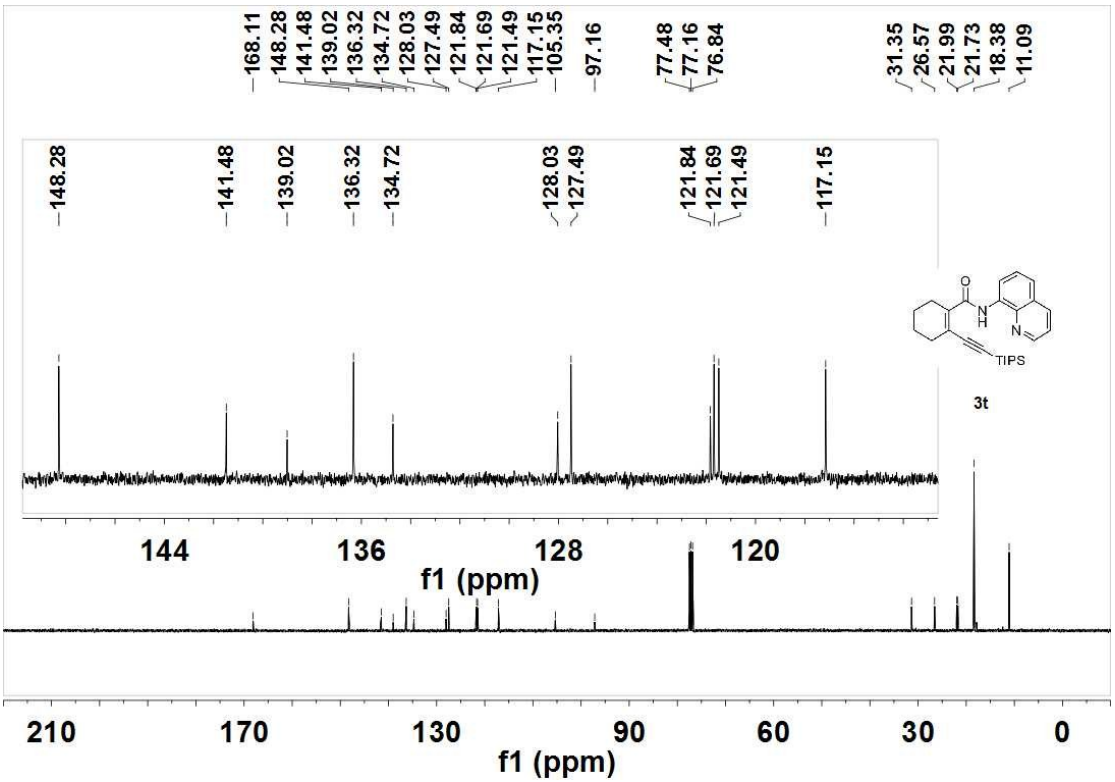

8.846
8.791
8.786
8.780
8.776
8.142
8.138
8.122
8.117
7.522
7.503
7.494
7.490
7.426
7.416
7.406
7.395
7.260
2.502
2.483
2.463
2.326
2.307
2.303
2.288
1.709
1.689
1.569
1.550
1.032
1.014
0.995
0.992
0.974
0.955
0.731
0.722
0.707
0.673
0.659
0.643
0.638
0.622
Me
O
N
H
N
Me
TIPS
3r
2.5
2.1
1.7
1.3
0.9
f1 (ppm)
1.00
1.03
1.01
1.01
2.06
1.00
1.97
1.97
2.35
2.00
6.05
21.00
12.0
8.0
5.0
2.0
f1 (ppm)

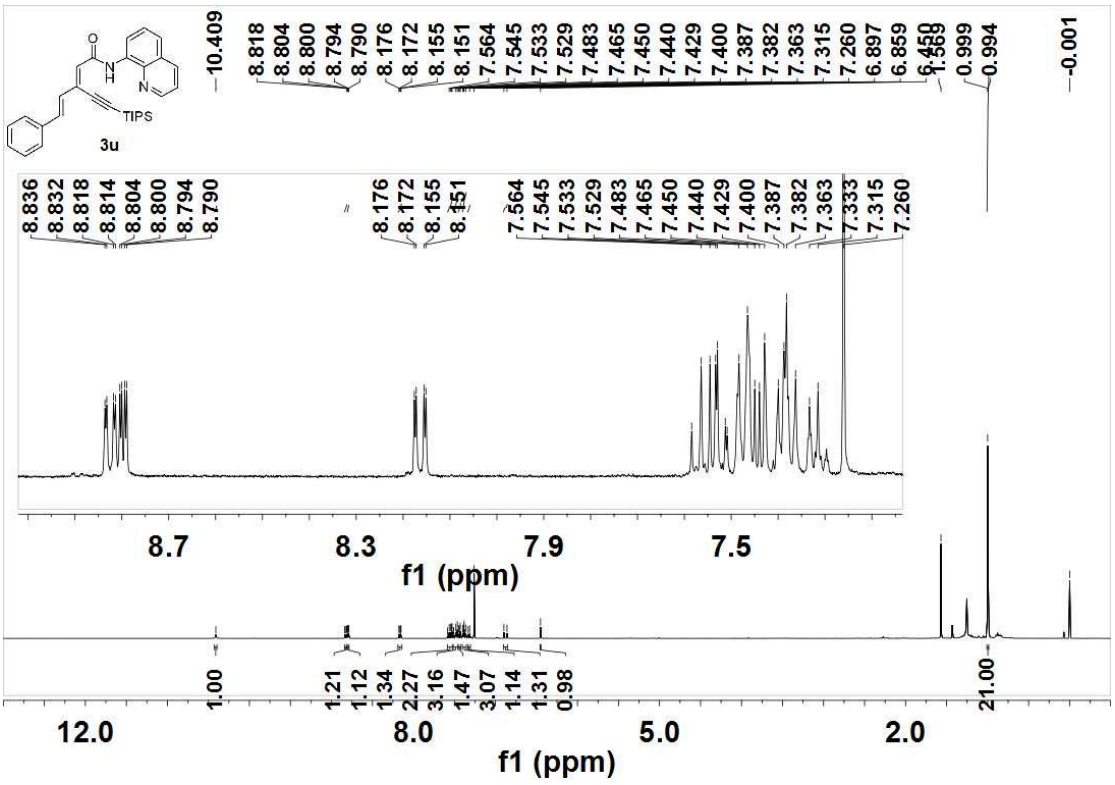

168.88
148.28
145.02
138.85
136.20
134.85
127.98
127.45
123.62
121.55
121.47
116.82
105.23
96.81
77.48
77.16
76.84
34.69
32.18
22.16
21.67
18.35
14.31
14.01
11.10
10.82
Me
O
N
H
N
Me
TIPS
3r
210
170
130
90
60
30
0
f1 (ppm)

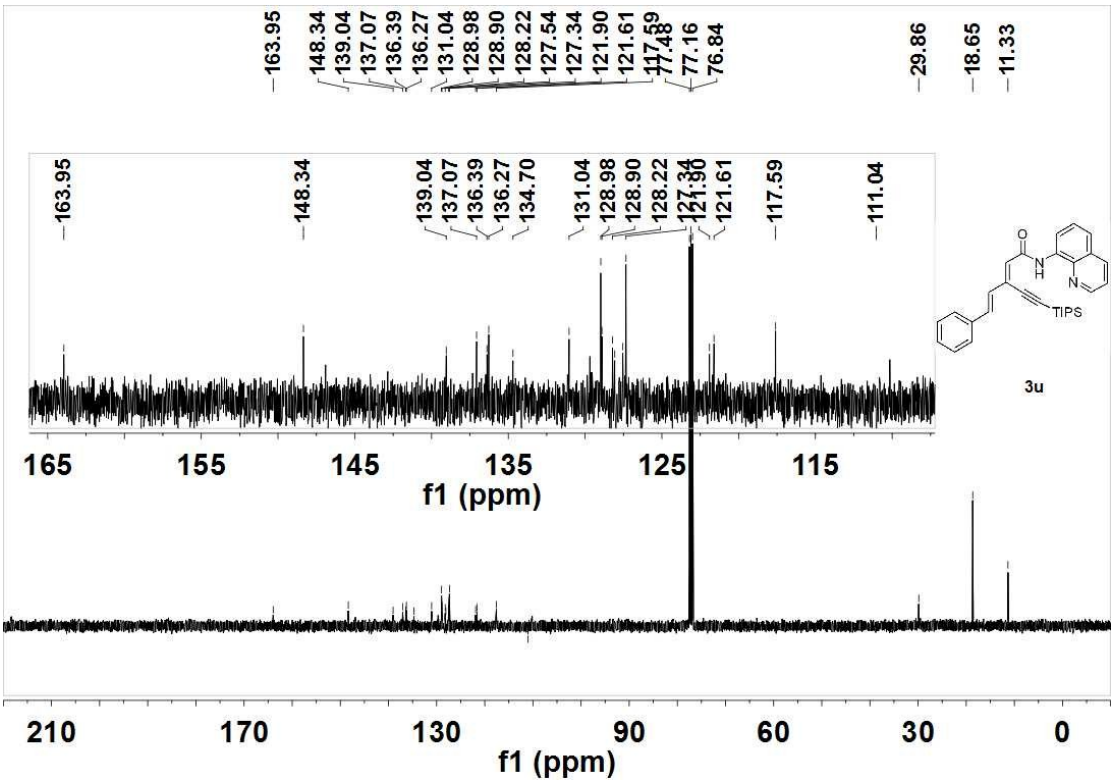

10.508
8.786
8.782
8.775
8.771
8.765
8.761
8.747
8.743
8.150
8.146
8.129
8.125
7.538
7.520
7.511
7.507
7.490
7.432
7.421
7.411
7.401
2.899
2.879
2.773
1.996
1.978
1.958
0.908
0.898
0.889
TIPS
3s
f1 (ppm)
1.00
2.15
1.07
2.14
1.10
2.05
2.02
2.13
21.00

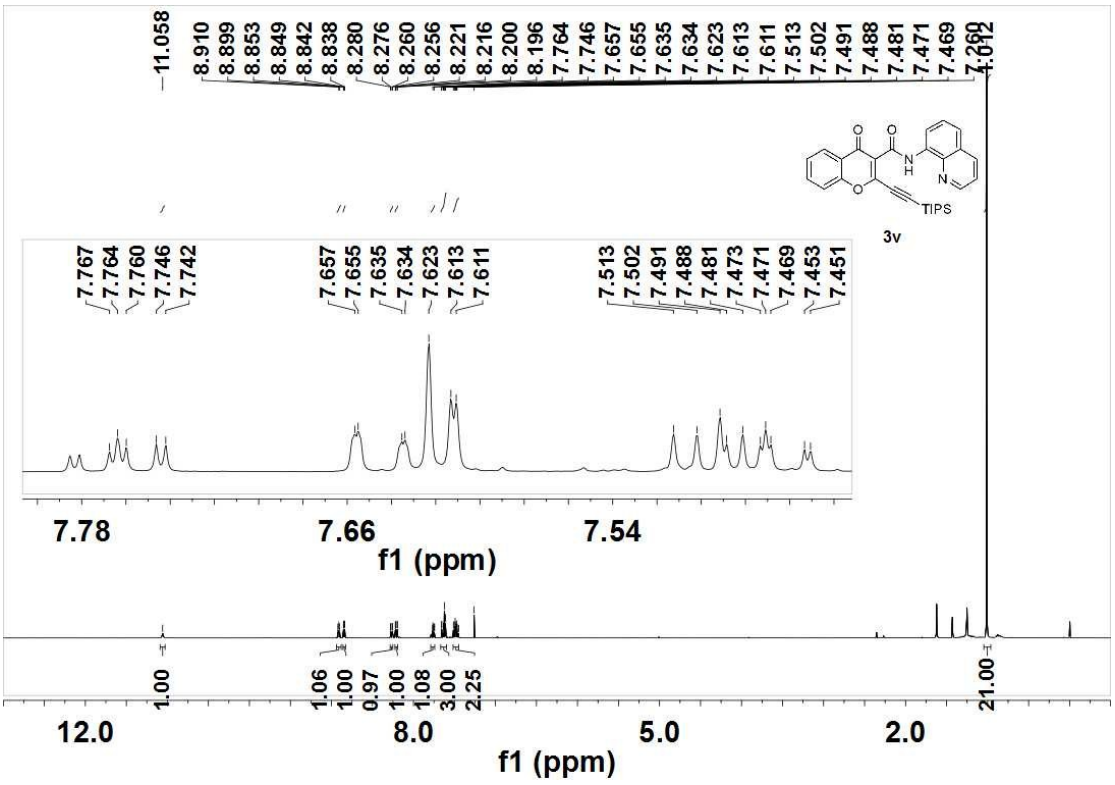

163.81
148.37
144.30
136.29
134.62
128.06
127.79
127.38
121.87
121.47
117.84
102.77
101.79
77.48
77.16
76.84
39.83
34.20
22.16
18.51
11.18
139.28
136.29
134.62
128.06
127.79
127.38
121.87
121.47
TIPS
3s
f1 (ppm)

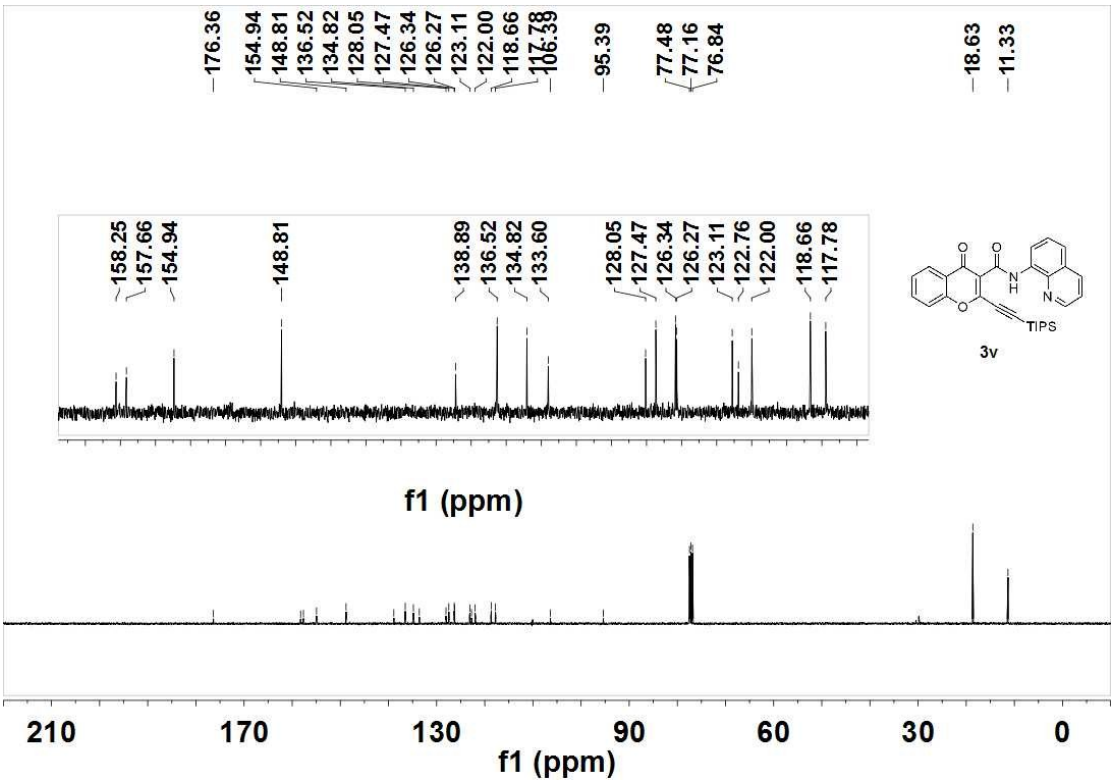

10.288
8.831
8.825
8.817
8.812
8.807
8.799
8.794
8.788
8.784
8.778
8.150
8.144
8.133
8.129
8.123
7.531
7.521
7.512
7.503
7.499
7.493
7.489
7.437
7.426
7.416
7.406
7.260
2.525
2.519
2.374
1.724
1.714
1.708
1.671
1.046
1.036
0.755
0.747
0.736
0.726
0.711
0.700
8.8
8.5
8.2
7.9
7.6
f1 (ppm)
1.00
2.11
1.13
2.30
1.11
2.26
2.30
4.16
21.00
12.0
8.0
5.0
2.0
f1 (ppm)
TIPS
3t

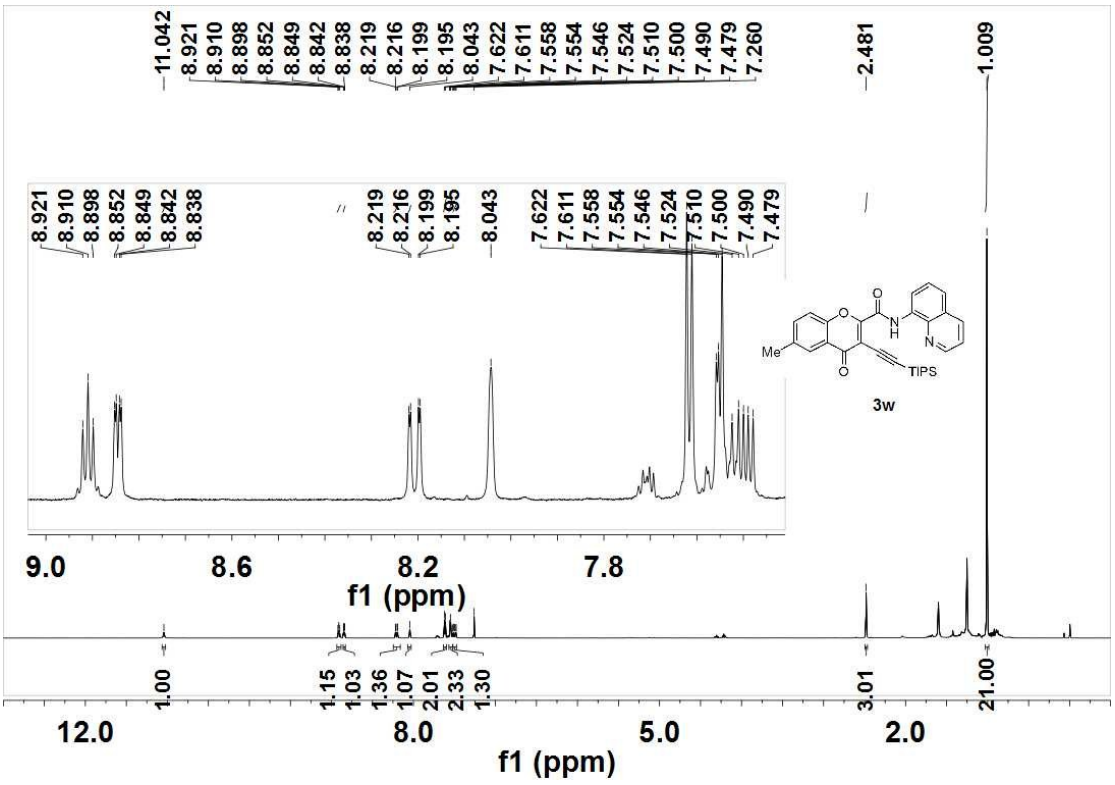

168.11
148.28
141.48
139.02
136.32
134.72
128.03
127.49
121.84
121.69
121.49
117.15
105.35
97.16
77.48
77.16
76.84
31.35
26.57
21.99
21.73
18.38
11.09
144
136
128
120
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)
TIPS
3t

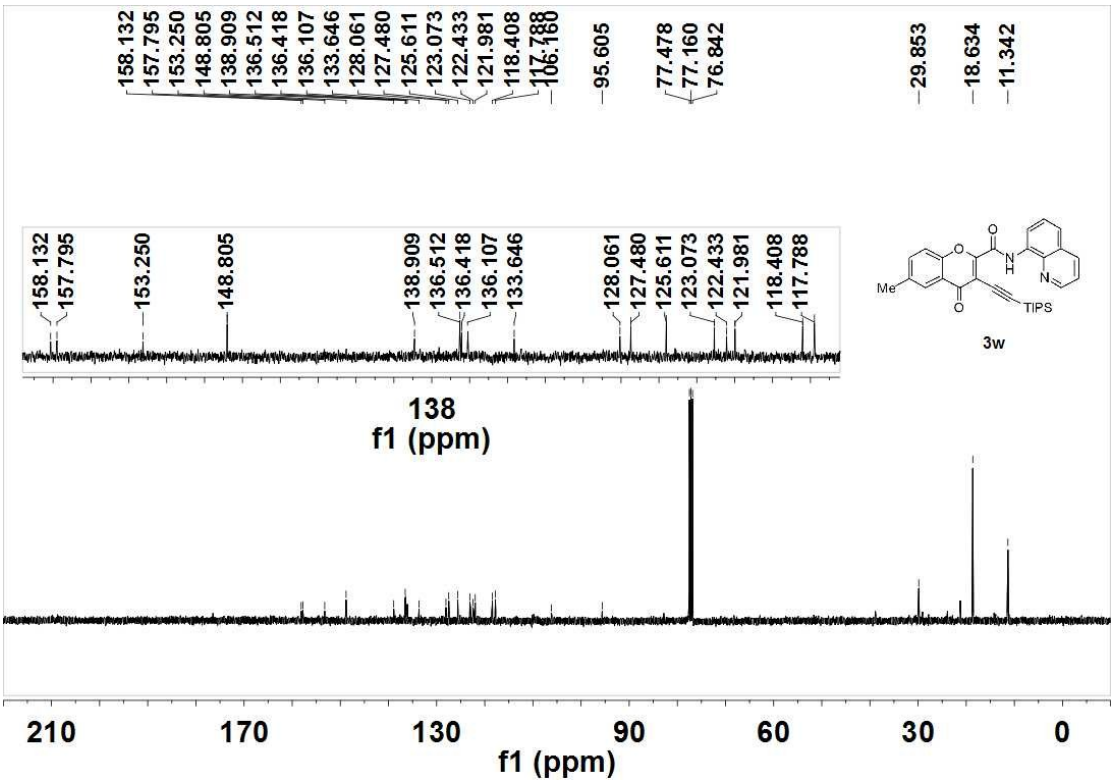

3u
TIPS
10.409
8.818
8.804
8.800
8.794
8.790
8.176
8.172
8.155
8.151
7.564
7.545
7.533
7.529
7.483
7.465
7.450
7.440
7.429
7.400
7.387
7.382
7.363
7.315
7.260
6.897
6.859
6.450
1.569
0.999
0.994
-0.001
8.836
8.832
8.818
8.814
8.804
8.800
8.794
8.790
8.176
8.172
8.155
8.151
7.564
7.545
7.533
7.529
7.483
7.465
7.450
7.440
7.429
7.400
7.387
7.382
7.363
7.333
7.315
7.260
8.7
8.3
7.9
7.5
f1 (ppm)
1.00
1.21
1.12
1.34
2.27
3.16
1.47
3.07
1.14
1.31
0.98
21.00
12.0
8.0
5.0
2.0
f1 (ppm)

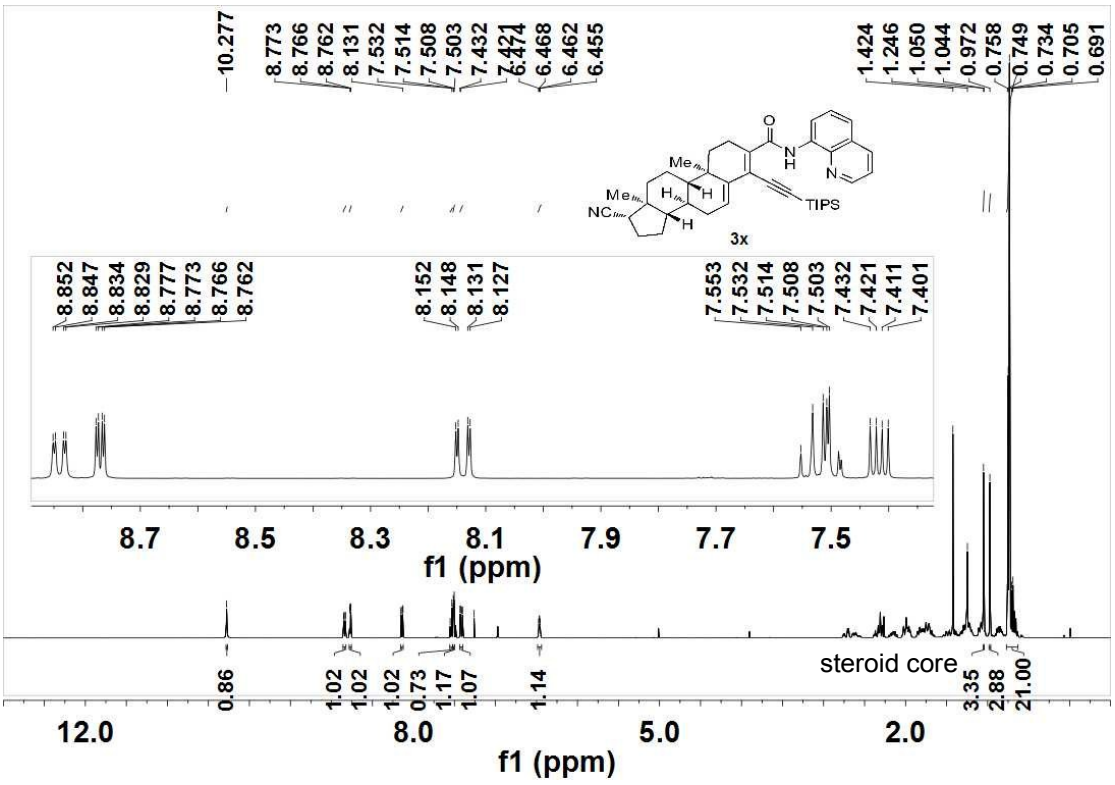

163.95
148.34
139.04
137.07
136.39
136.27
131.04
128.98
128.90
128.22
127.54
127.34
121.90
121.61
117.59
77.48
77.16
76.84
29.86
18.65
11.33
163.95
148.34
139.04
137.07
136.39
136.27
134.70
131.04
128.98
128.90
128.22
127.34
121.90
121.61
117.59
111.04
3u
TIPS
165
155
145
135
125
115
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)

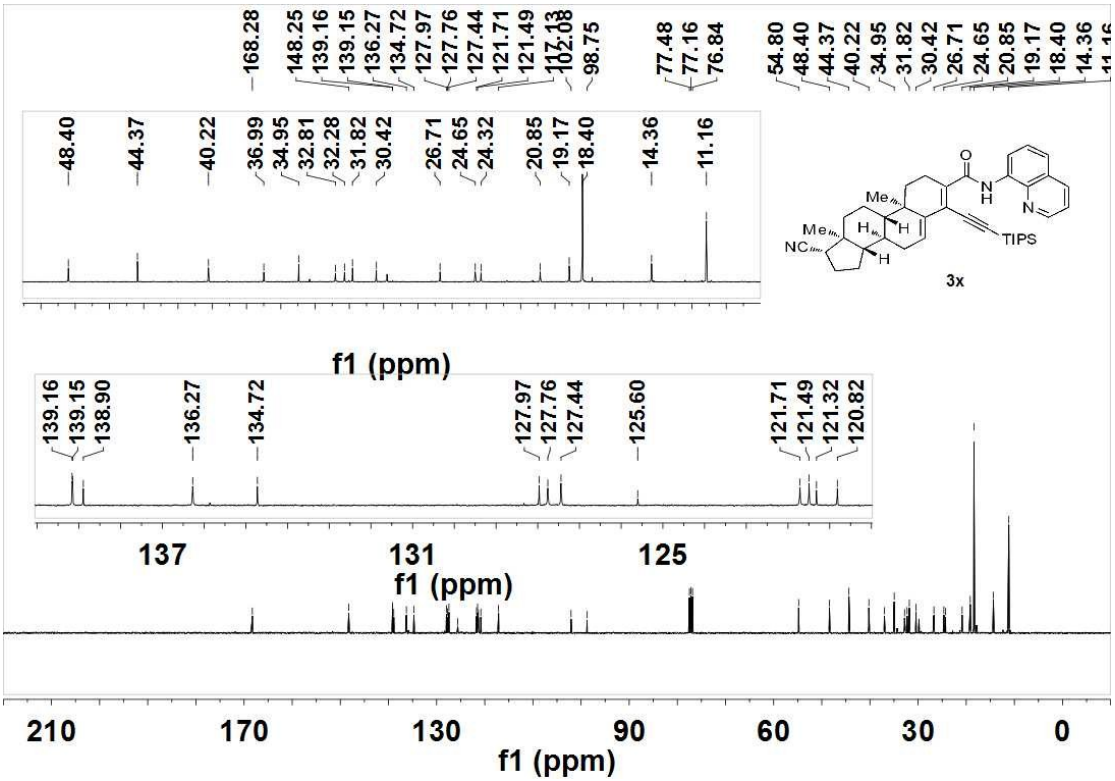

11.058
8.910
8.899
8.853
8.849
8.842
8.838
8.280
8.276
8.260
8.256
8.221
8.216
8.200
8.196
7.764
7.746
7.657
7.655
7.635
7.634
7.623
7.613
7.611
7.513
7.502
7.491
7.488
7.481
7.471
7.469
7.260
4.012
3v
7.767
7.764
7.760
7.746
7.742
7.657
7.655
7.635
7.634
7.623
7.613
7.611
7.513
7.502
7.491
7.488
7.481
7.473
7.471
7.469
7.453
7.451
7.78
7.66
7.54
f1 (ppm)
1.00
1.06
1.00
0.97
1.00
1.08
3.00
2.25
21.00
12.0
8.0
5.0
2.0
f1 (ppm)

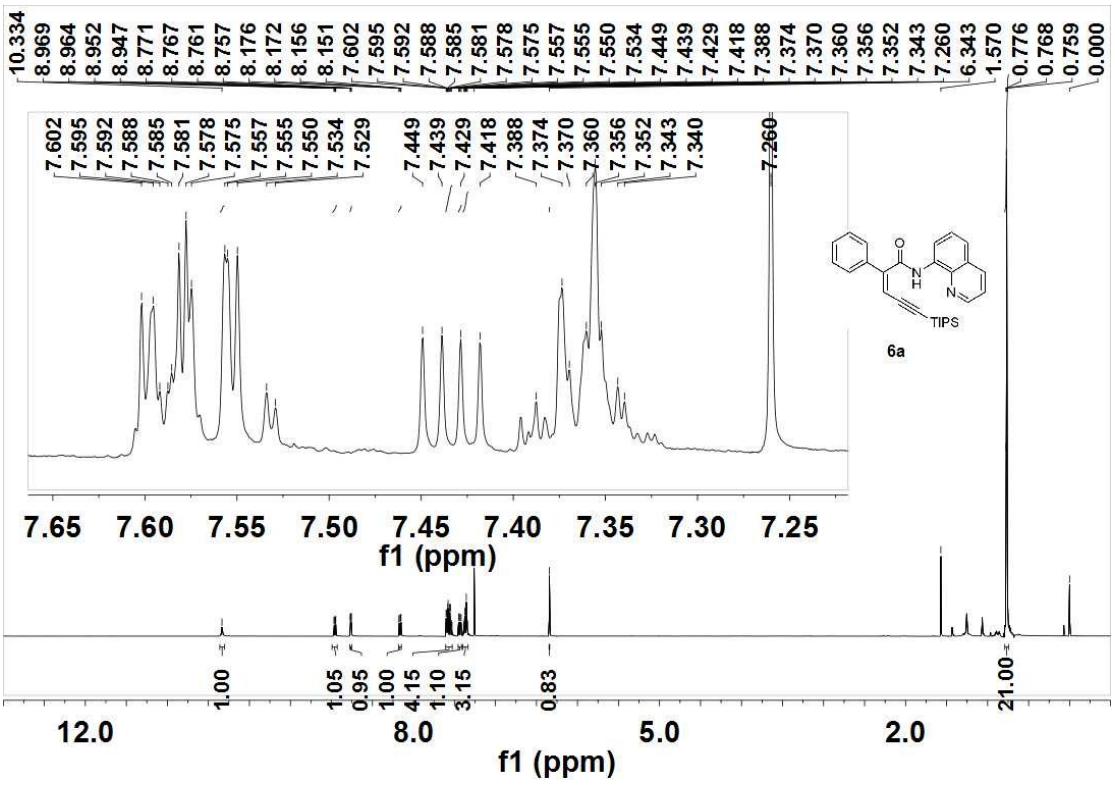

176.36
154.94
148.81
136.52
134.82
128.05
127.47
126.34
126.27
123.11
122.00
118.66
117.78
106.39
95.39
77.48
77.16
76.84
18.63
11.33
158.25
157.66
154.94
148.81
138.89
136.52
134.82
133.60
128.05
127.47
126.34
126.27
123.11
122.76
122.00
118.66
117.78
3v
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)

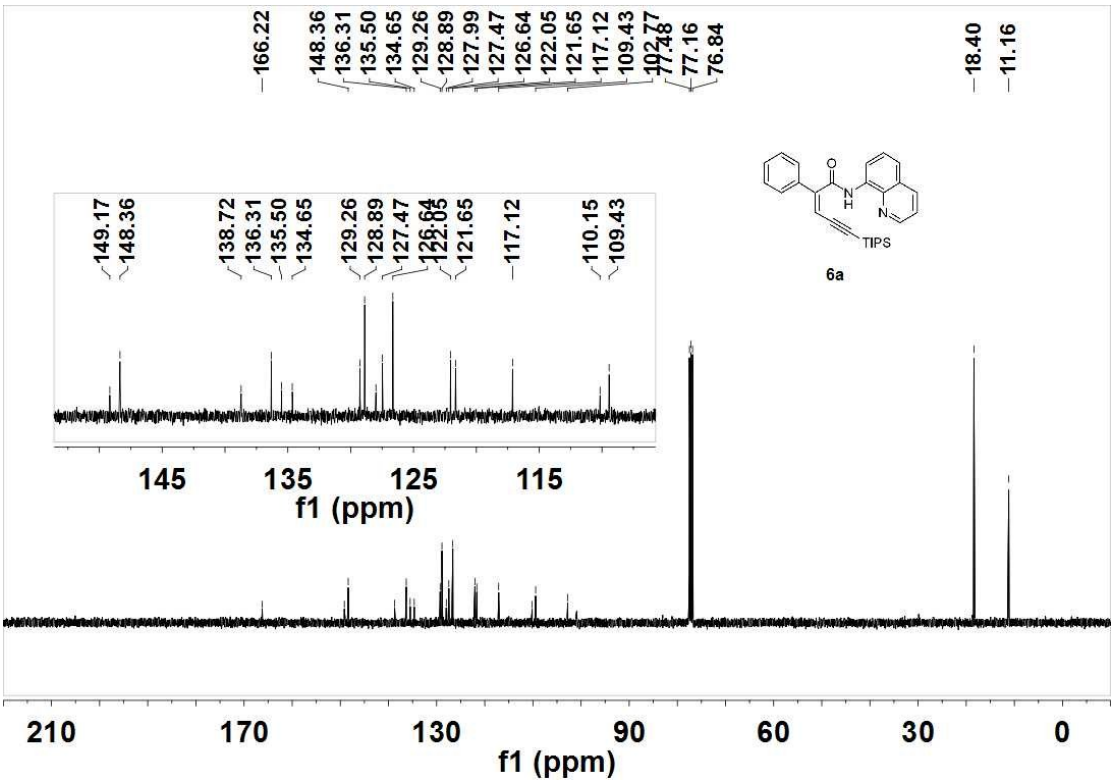

11.042
8.921
8.910
8.898
8.852
8.849
8.842
8.838
8.219
8.216
8.199
8.195
8.043
7.622
7.611
7.558
7.554
7.546
7.524
7.510
7.500
7.490
7.479
7.260
2.481
1.009
Me
TIPS
3w
9.0
8.6
8.2
7.8
f1 (ppm)
1.00
1.15
1.03
1.36
1.07
2.01
2.33
1.30
3.01
21.00
12.0
8.0
5.0
2.0
f1 (ppm)

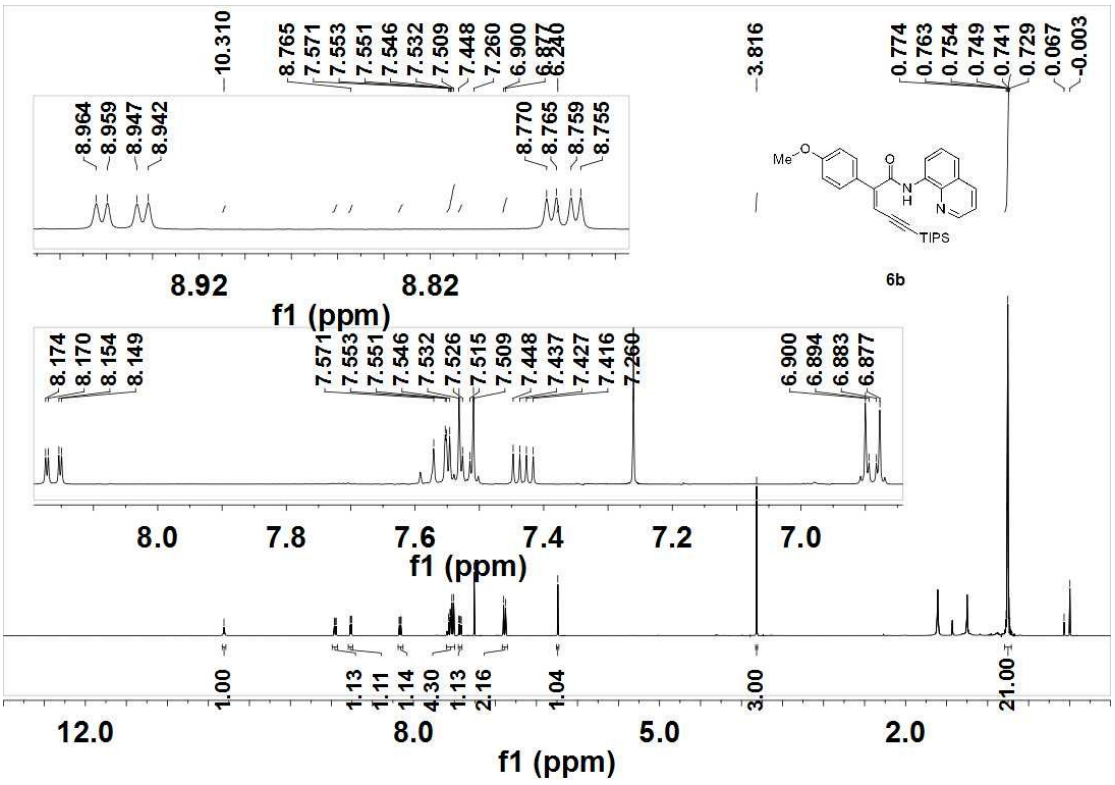

158.132
157.795
153.250
148.805
138.909
136.512
136.418
136.107
133.646
128.061
127.480
125.611
123.073
122.433
121.981
118.408
117.788
106.160
95.605
77.478
77.160
76.842
29.853
18.634
11.342
Me
TIPS
3w
138
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)

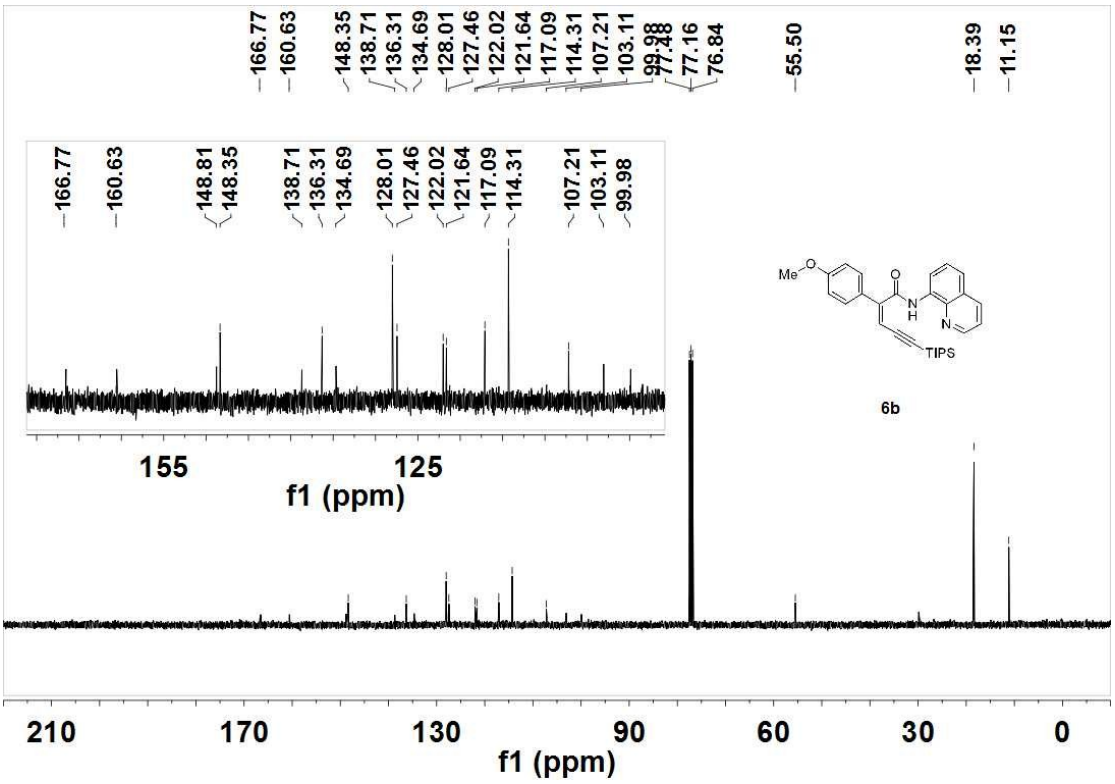

10.277
8.773
8.766
8.762
8.131
7.532
7.514
7.508
7.503
7.432
7.421
7.411
6.468
6.462
6.455
1.424
1.246
1.050
1.044
0.972
0.758
0.749
0.734
0.705
0.691
3x
8.852
8.847
8.834
8.829
8.777
8.773
8.766
8.762
8.152
8.148
8.131
8.127
7.553
7.532
7.514
7.508
7.503
7.432
7.421
7.411
7.401
8.7
8.5
8.3
8.1
7.9
7.7
7.5
f1 (ppm)
steroid core
0.86
1.02
1.02
1.02
0.73
1.17
1.07
1.14
3.35
2.88
21.00
12.0
8.0
5.0
2.0
f1 (ppm)

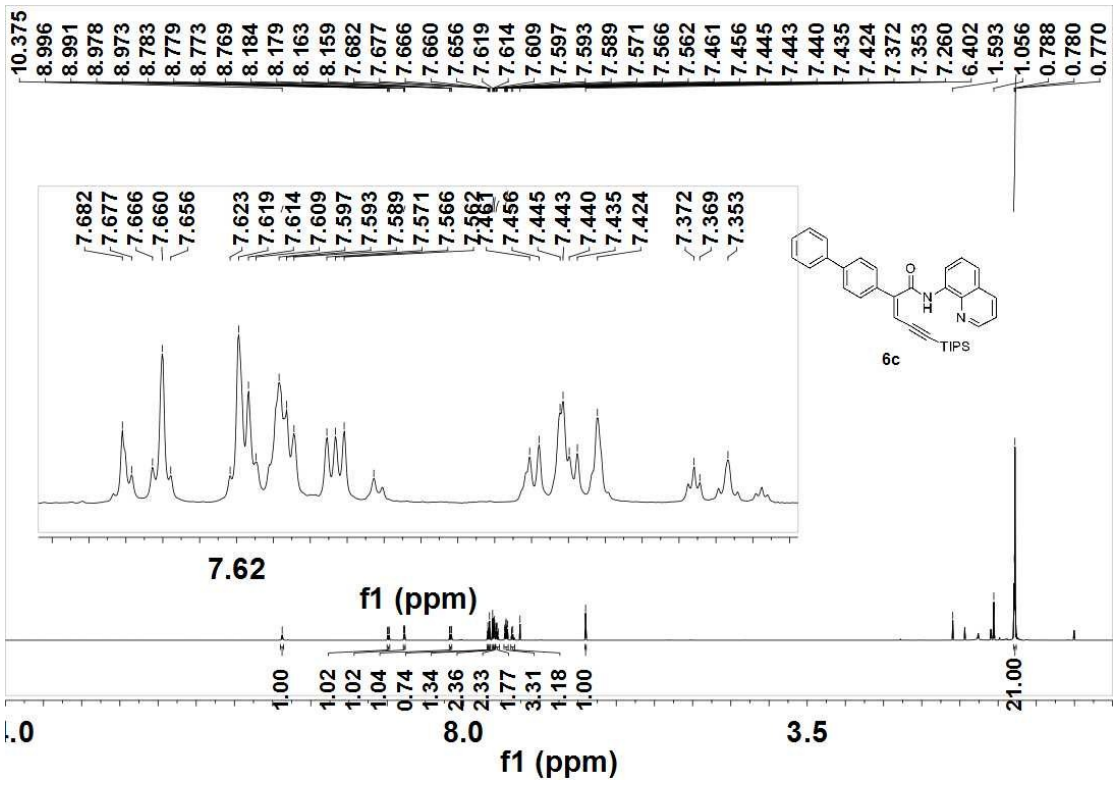

168.28
148.25
139.16
139.15
136.27
134.72
127.97
127.76
127.44
121.71
121.49
117.13
102.08
98.75
77.48
77.16
76.84
54.80
48.40
44.37
40.22
34.95
31.82
30.42
26.71
24.65
20.85
19.17
18.40
14.36
48.40
44.37
40.22
36.99
34.95
32.81
32.28
31.82
30.42
26.71
24.65
24.32
20.85
19.17
18.40
14.36
11.16
3x
f1 (ppm)
139.16
139.15
138.90
136.27
134.72
127.97
127.76
127.44
125.60
121.71
121.49
121.32
120.82
137
131
125
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)

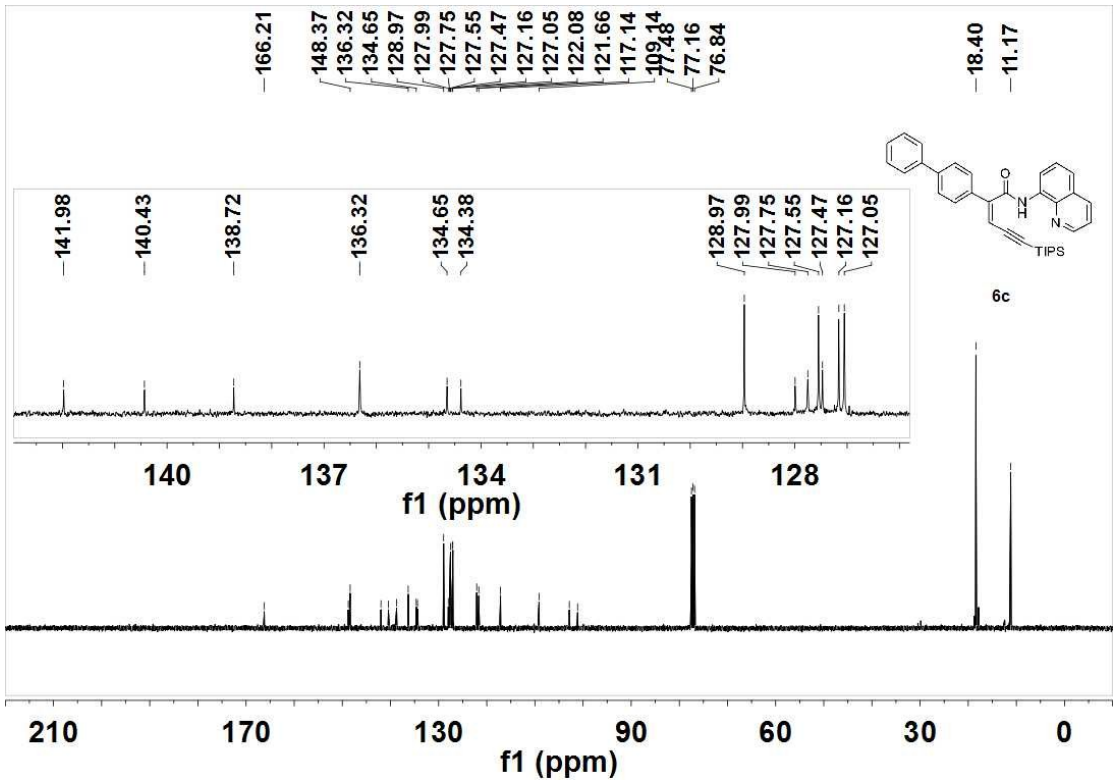

10.334 8.969 8.964 8.952 8.947 8.771 8.767 8.761 8.757 8.176 8.172 8.156 8.151 7.602 7.595 7.592 7.588 7.585 7.581 7.578 7.575 7.557 7.555 7.550 7.534 7.529 7.449 7.439 7.429 7.418 7.388 7.374 7.370 7.360 7.356 7.352 7.343 7.340 7.260 6.343 1.570 0.776 0.768 0.759 0.000
7.65 7.60 7.55 7.50 7.45 7.40 7.35 7.30 7.25
f1 (ppm)
1.00 1.05 0.95 1.00 4.15 1.10 3.15 0.83 21.00
12.0 8.0 5.0 2.0
f1 (ppm)
TIPS
6a

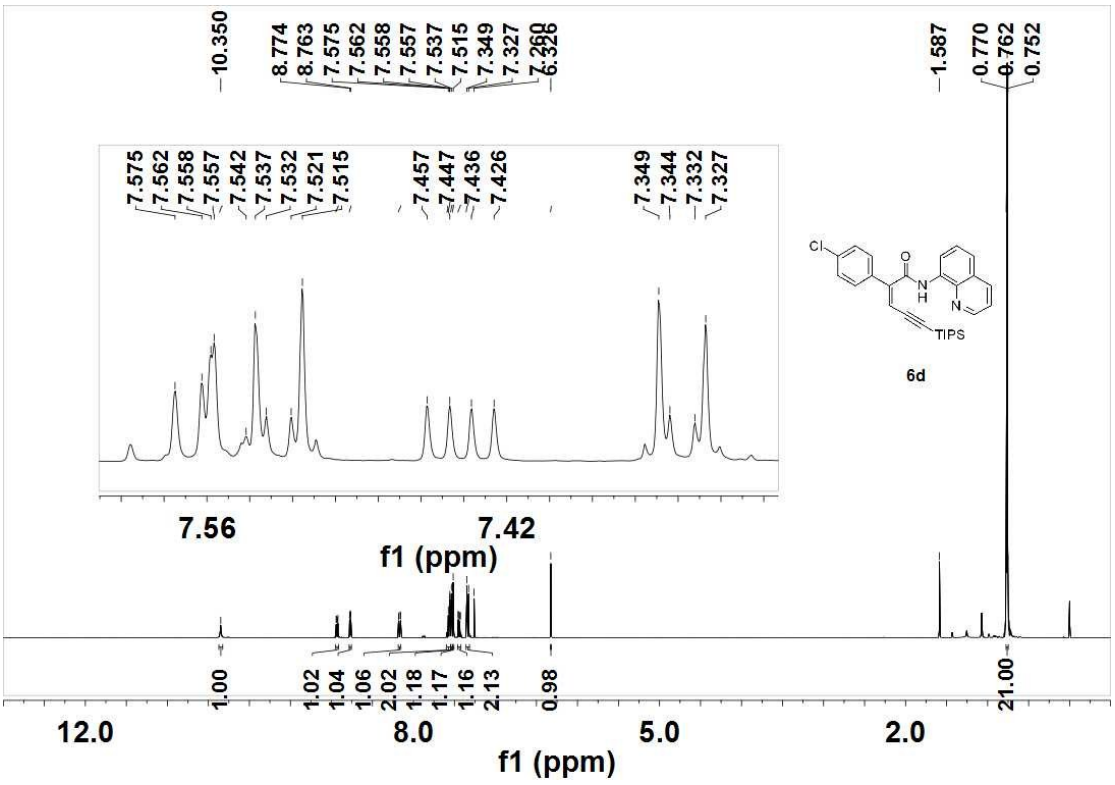

166.22 148.36 136.31 135.50 134.65 129.26 128.89 127.99 127.47 126.64 122.05 121.65 117.12 109.43 102.77 77.48 77.16 76.84 18.40 11.16
149.17 148.36 138.72 136.31 135.50 134.65 129.26 128.89 127.47 121.65 117.12 110.15 109.43
145 135 125 115
f1 (ppm)
210 170 130 90 60 30 0
f1 (ppm)
TIPS
6a


10.310
8.765
7.571
7.553
7.551
7.546
7.532
7.509
7.448
7.260
6.900
6.877
6.240
3.816
0.774
0.763
0.754
0.749
0.741
0.729
0.067
-0.003
8.964
8.959
8.947
8.942
8.770
8.765
8.759
8.755
8.92
8.82
f1 (ppm)
Me
O
N
H
N
TIPS
6b
8.174
8.170
8.154
8.149
7.571
7.553
7.551
7.546
7.532
7.526
7.515
7.509
7.448
7.437
7.427
7.416
7.260
6.900
6.894
6.883
6.877
8.0
7.8
7.6
7.4
7.2
7.0
f1 (ppm)
1.00
1.13
1.11
1.14
4.30
1.13
2.16
1.04
3.00
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


166.77
160.63
148.35
138.71
136.31
134.69
128.01
127.46
122.02
121.64
117.09
114.31
107.21
103.11
99.98
77.16
76.84
55.50
18.39
11.15
166.77
160.63
148.81
148.35
138.71
136.31
134.69
128.01
127.46
122.02
121.64
117.09
114.31
107.21
103.11
99.98
Me
O
N
H
N
TIPS
6b
155
125
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)


10.375
8.996
8.991
8.978
8.973
8.783
8.779
8.773
8.769
8.184
8.179
8.163
8.159
7.682
7.677
7.666
7.660
7.656
7.623
7.619
7.614
7.609
7.597
7.593
7.589
7.571
7.566
7.562
7.461
7.456
7.445
7.443
7.440
7.435
7.424
7.372
7.369
7.353
7.260
6.402
1.593
1.056
0.788
0.780
0.770
1.00
1.02
1.02
1.04
0.74
1.34
2.36
2.33
1.77
3.31
1.18
1.00
21.00
7.62
f1 (ppm)
8.0
3.5
f1 (ppm)
TIPS
6c


166.21
148.37
136.32
134.65
128.97
127.99
127.75
127.55
127.47
127.16
127.05
122.08
121.66
117.14
109.14
77.48
77.16
76.84
18.40
11.17
141.98
140.43
138.72
136.32
134.65
134.38
128.97
127.99
127.75
127.55
127.47
127.16
127.05
140
137
134
131
128
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)
TIPS
6c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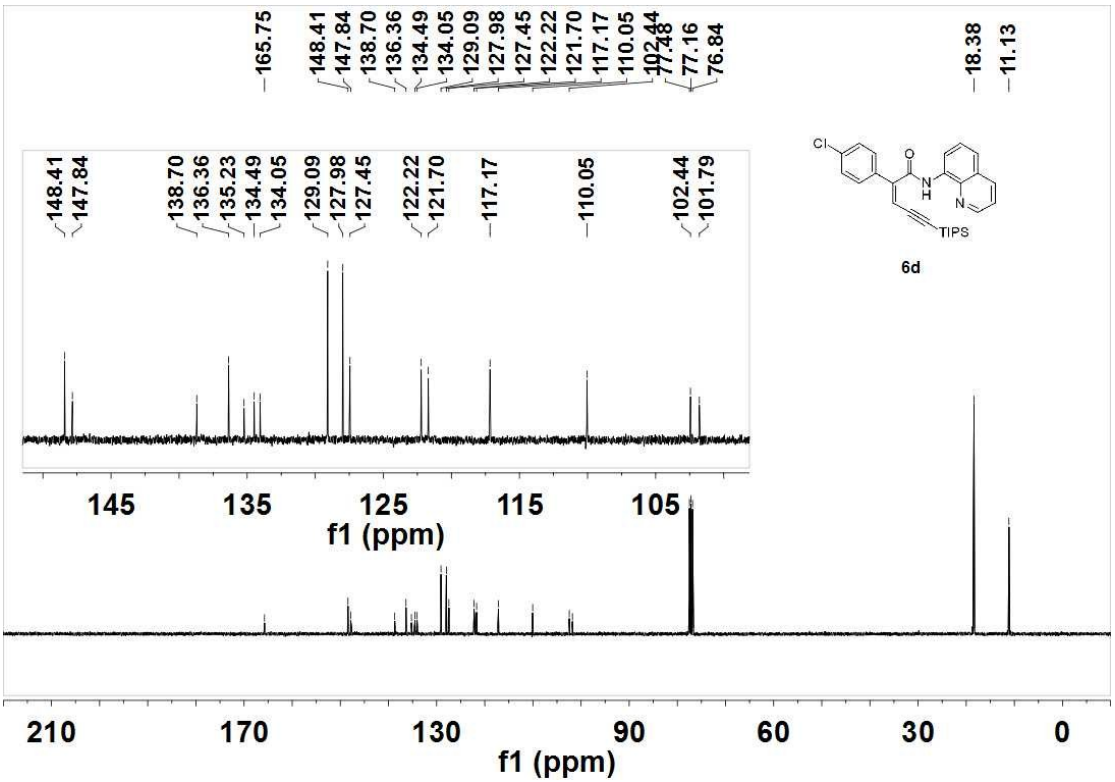
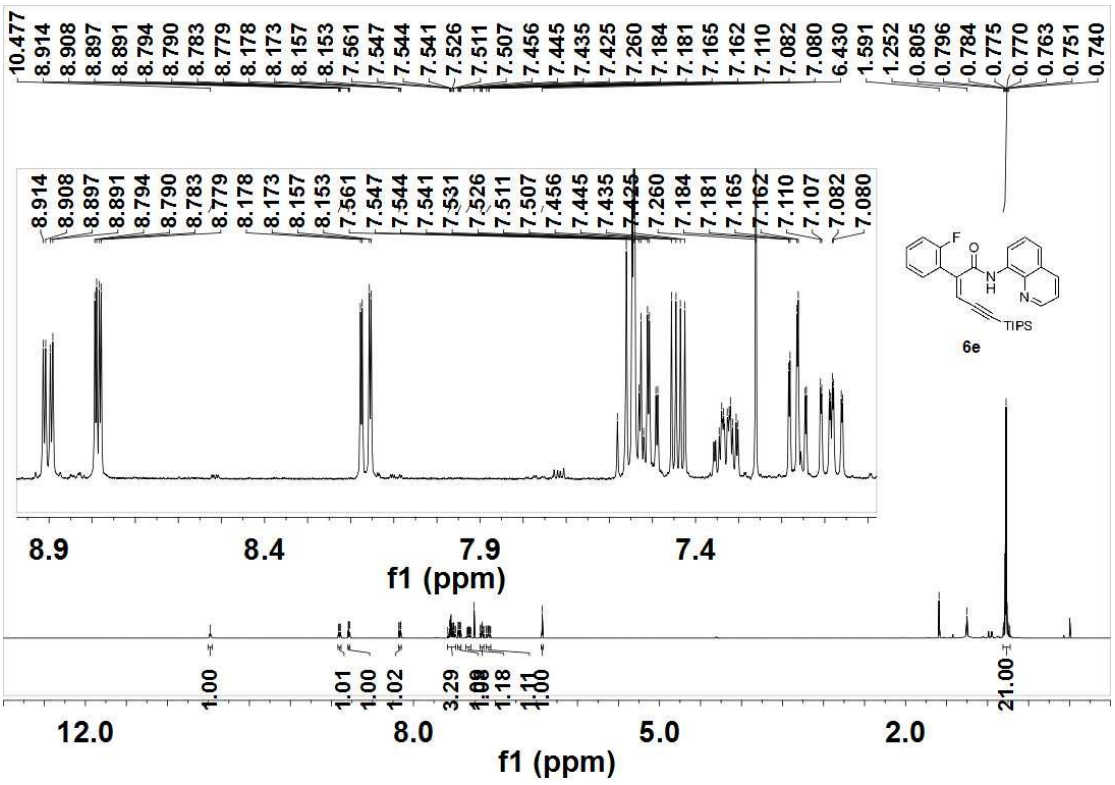
8.774
8.763
7.575
7.562
7.558
7.557
7.537
7.515
7.349
7.327
7.260
6.326
1.587
0.770
0.762
0.752
7.575
7.562
7.558
7.557
7.542
7.537
7.532
7.521
7.515
7.457
7.447
7.436
7.426
7.349
7.344
7.332
7.327
7.56
7.42
f1 (ppm)
Cl
O
N
H
N
TIPS
6d
1.00
1.02
1.04
1.06
2.02
1.18
1.17
1.16
2.13
0.98
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


165.75
148.41
147.84
138.70
136.36
134.49
134.05
129.09
127.98
127.45
122.22
121.70
117.17
110.05
102.44
77.48
77.16
76.84
18.38
11.13
148.41
147.84
138.70
136.36
135.23
134.49
134.05
129.09
127.98
127.45
122.22
121.70
117.17
110.05
102.44
101.79
145
135
125
115
105
f1 (ppm)
Cl
O
N
H
N
TIPS
6d
210
170
130
90
60
30
0
f1 (ppm)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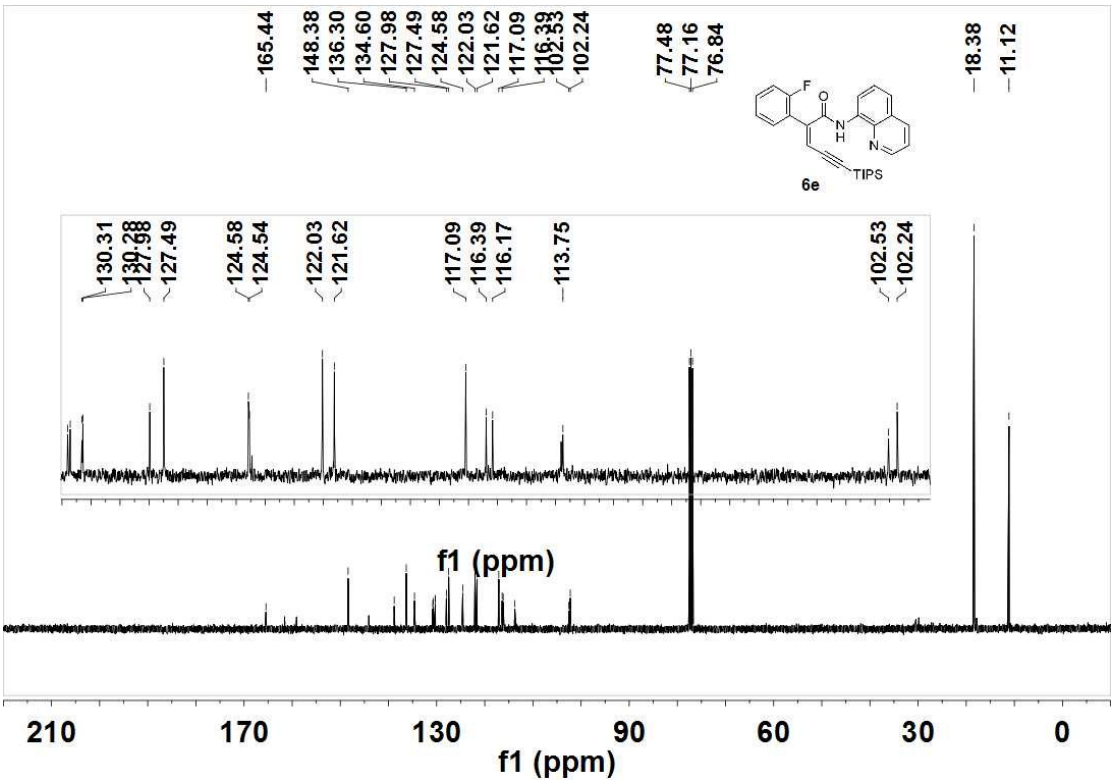
8.914
8.908
8.897
8.891
8.794
8.790
8.783
8.779
8.178
8.173
8.157
8.153
7.561
7.547
7.544
7.541
7.526
7.511
7.507
7.456
7.445
7.435
7.425
7.260
7.184
7.181
7.165
7.162
7.110
7.082
7.080
6.430
1.591
1.252
0.805
0.796
0.784
0.775
0.770
0.763
0.751
0.740
F
O
N
H
N
TIPS
6e
8.9
8.4
7.9
7.4
f1 (ppm)
1.00
1.01
1.00
1.02
3.29
1.18
1.11
1.00
21.00
12.0
8.0
5.0
2.0
f1 (ppm)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148.38
136.30
134.60
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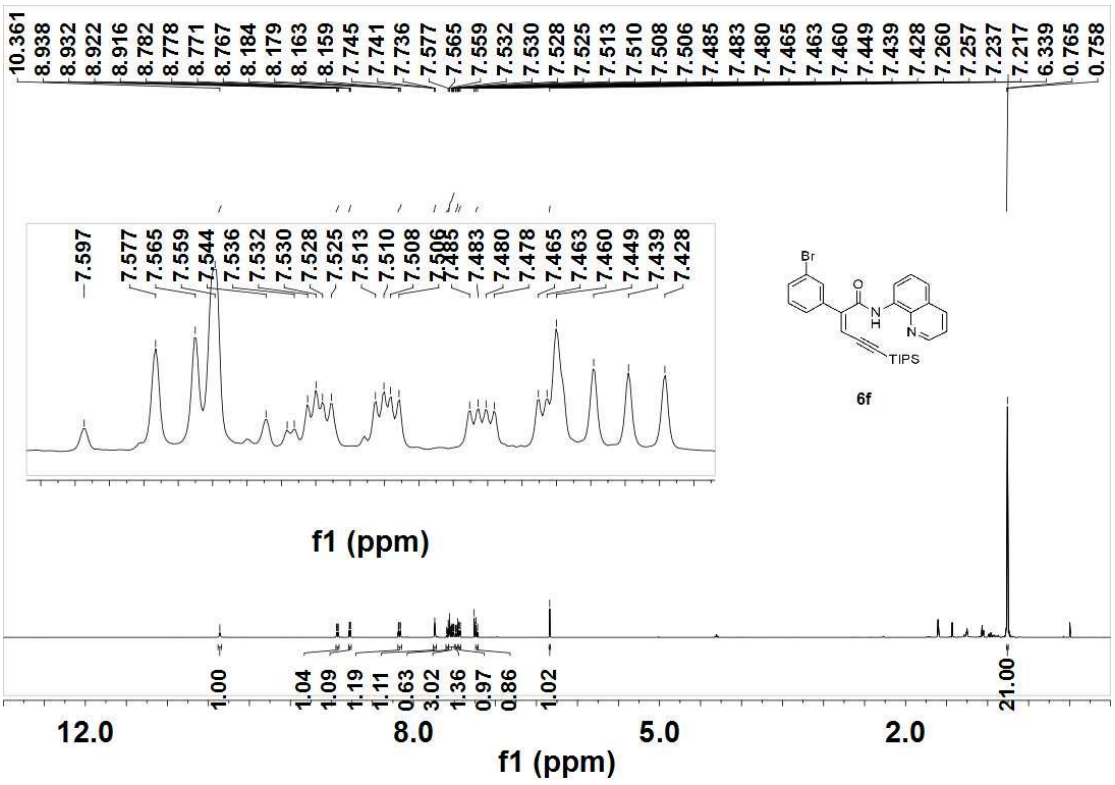
127.49
124.58
122.03
121.62
117.09
116.39
116.17
102.53
102.24
77.48
77.16
76.84
18.38
11.12
F
O
N
H
N
TIPS
6e
130.31
127.49
124.58
124.54
122.03
121.62
117.09
116.39
116.17
113.75
102.53
102.24
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)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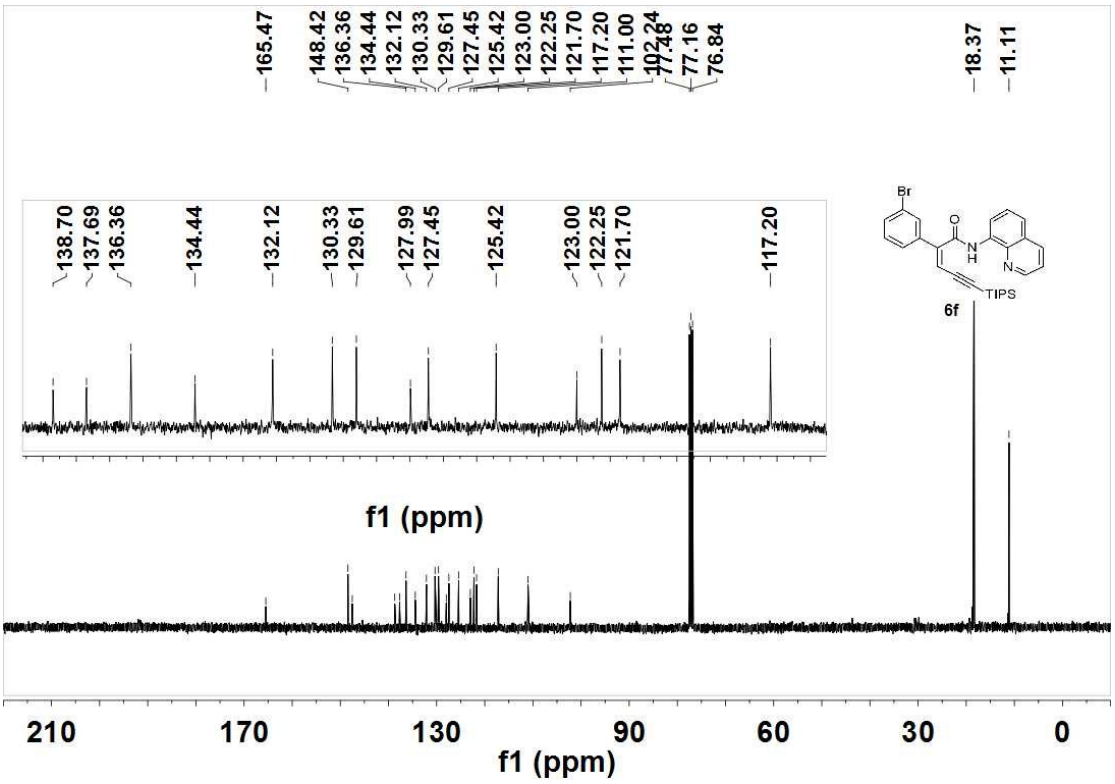
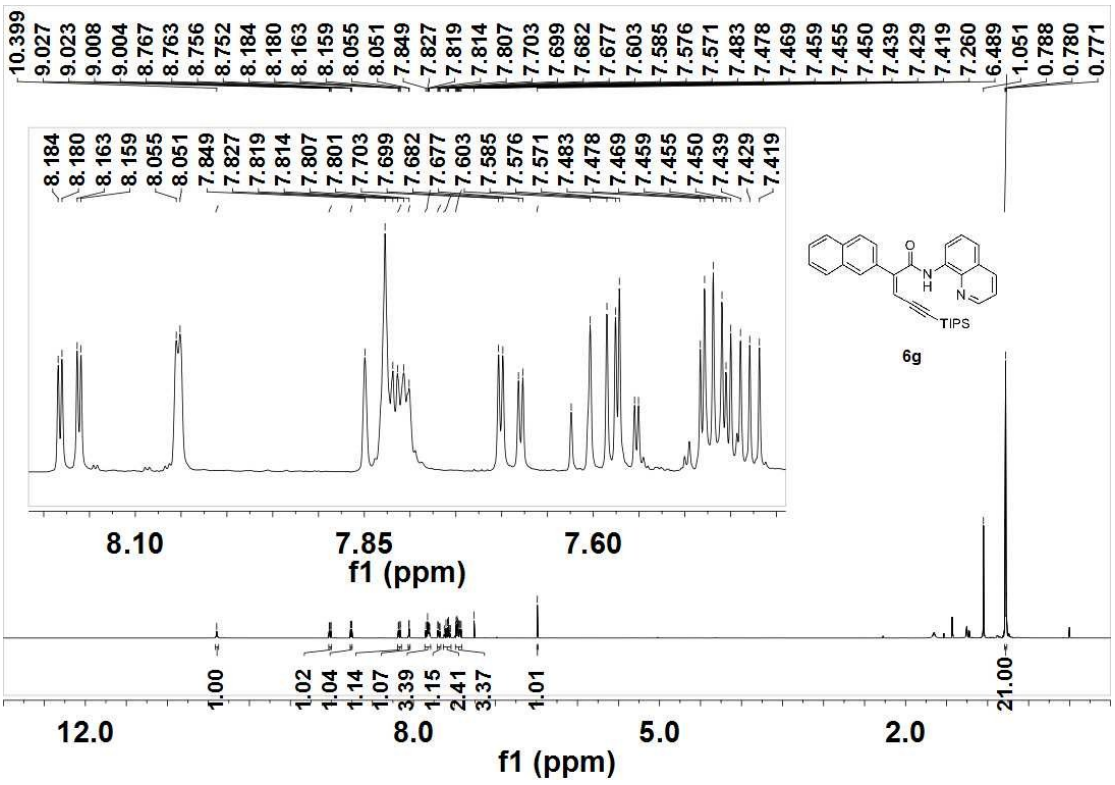
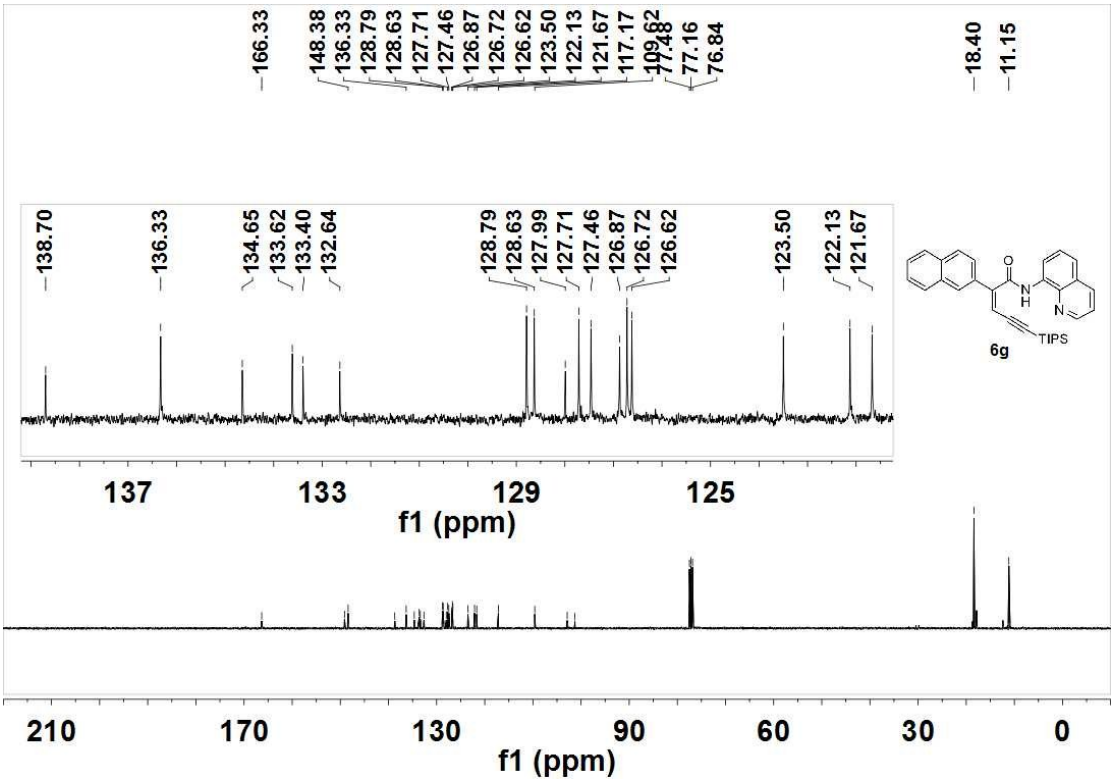
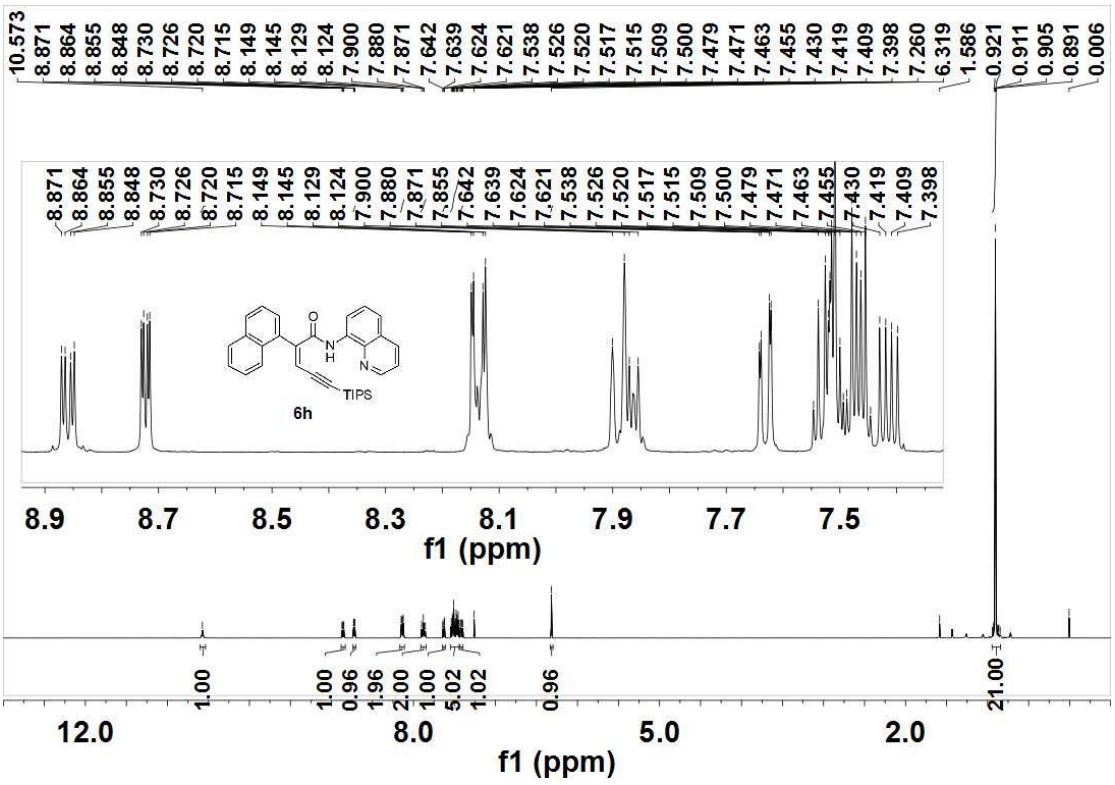
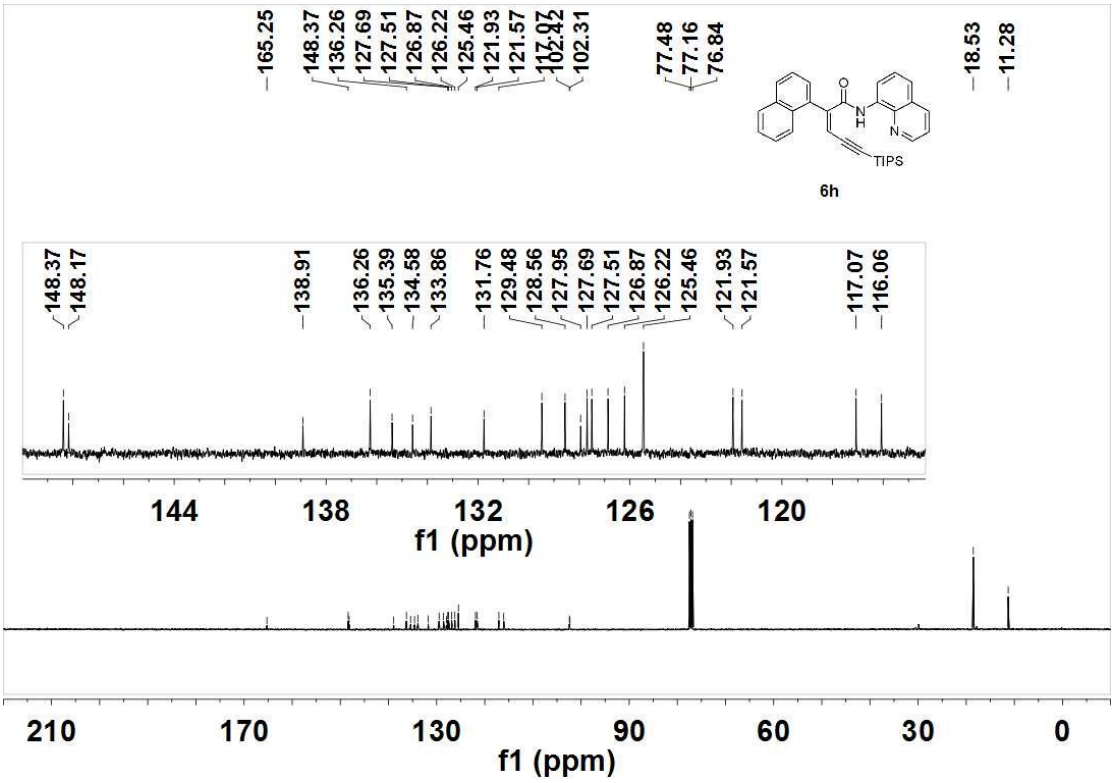
8.938
8.932
8.922
8.916
8.782
8.778
8.771
8.767
8.184
8.179
8.163
8.159
7.745
7.741
7.736
7.577
7.565
7.559
7.532
7.530
7.528
7.525
7.513
7.510
7.508
7.506
7.485
7.483
7.480
7.465
7.463
7.460
7.449
7.439
7.428
7.260
7.257
7.237
7.217
6.339
0.765
0.758
7.597
7.577
7.565
7.559
7.544
7.536
7.532
7.530
7.528
7.525
7.513
7.510
7.508
7.506
7.485
7.483
7.480
7.478
7.465
7.463
7.460
7.449
7.439
7.428
Br
O
N
H
N
TIPS
6f
f1 (ppm)
1.00
1.04
1.09
1.19
1.11
0.63
3.02
1.36
0.97
0.86
1.02
21.00
12.0
8.0
5.0
2.0
f1 (ppm)

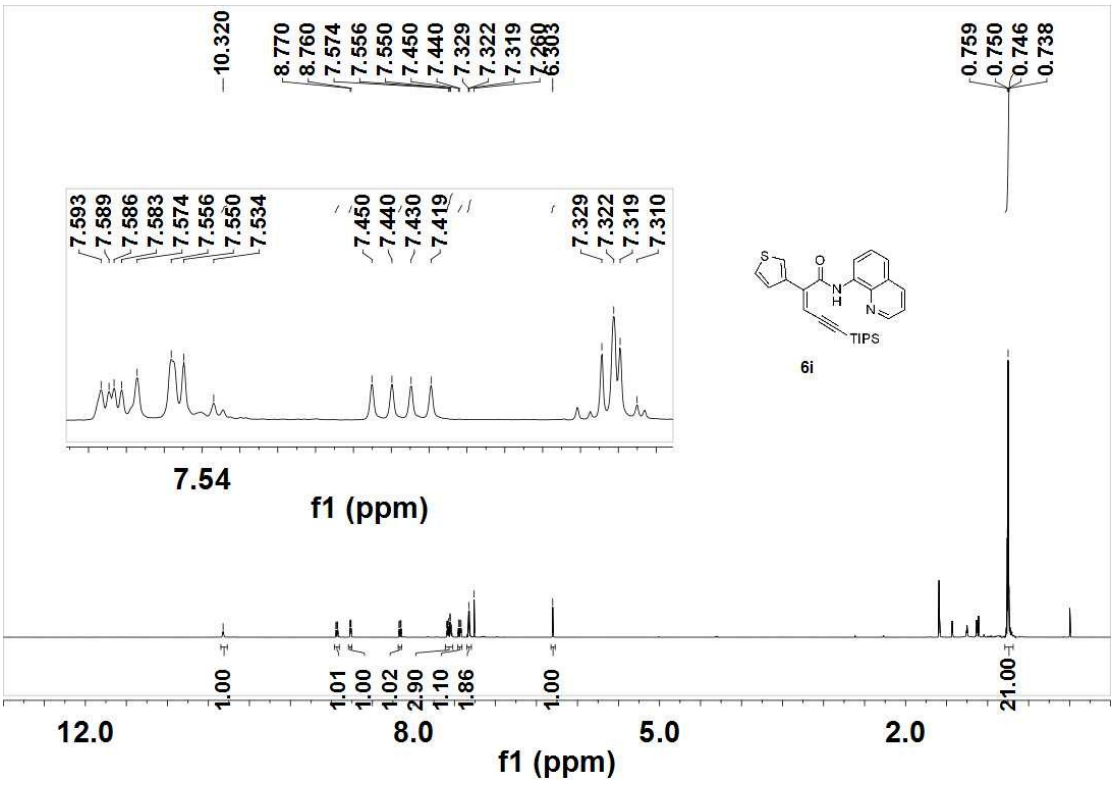

165.47
148.42
136.36
134.44
132.12
130.33
129.61
127.45
125.42
123.00
122.25
121.70
117.20
111.00
102.24
77.48
77.16
76.84
18.37
11.11
138.70
137.69
136.36
134.44
132.12
130.33
129.61
127.99
127.45
125.42
123.00
122.25
121.70
117.20
Br
O
N
H
N
TIPS
6f
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)

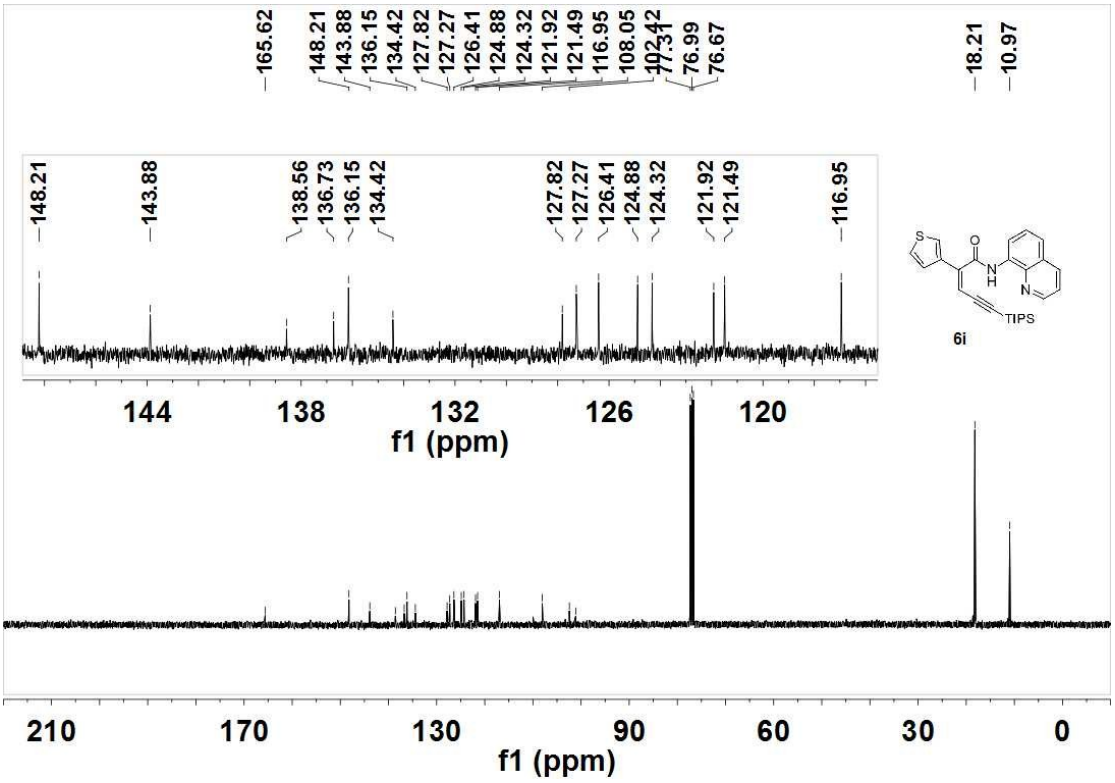

10.399
9.027
9.023
9.008
9.004
8.767
8.763
8.756
8.752
8.184
8.180
8.163
8.159
8.055
8.051
7.849
7.827
7.819
7.814
7.807
7.703
7.699
7.682
7.677
7.603
7.585
7.576
7.571
7.483
7.478
7.469
7.459
7.455
7.450
7.439
7.429
7.419
7.260
6.489
1.051
0.788
0.780
0.771
8.10
7.85
7.60
f1 (ppm)
6g
1.00
1.02
1.04
1.14
1.07
3.39
1.15
2.41
3.37
1.01
21.00
12.0
8.0
5.0
2.0
f1 (ppm)

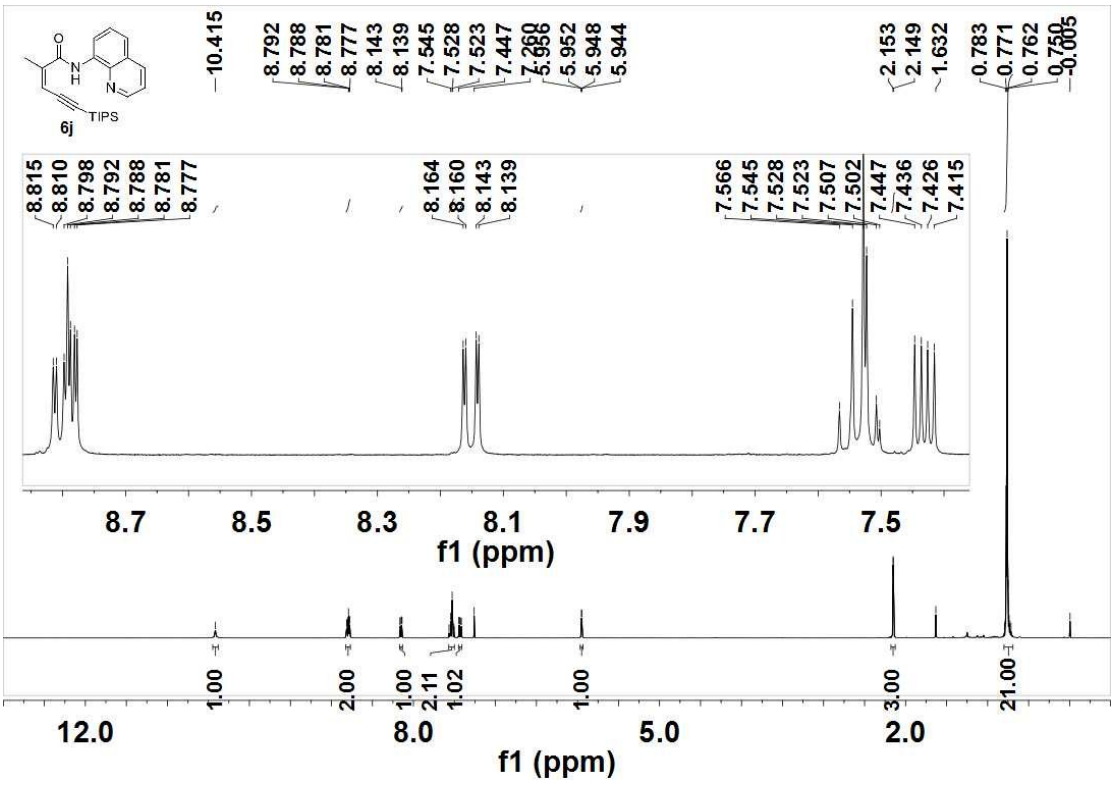

166.33
148.38
136.33
128.79
128.63
127.71
127.46
126.87
126.72
126.62
123.50
122.13
121.67
117.17
109.62
77.48
77.16
76.84
18.40
11.15
138.70
136.33
134.65
133.62
133.40
132.64
128.79
128.63
127.99
127.71
127.46
126.87
126.72
126.62
123.50
122.13
121.67
6g
137
133
129
125
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)

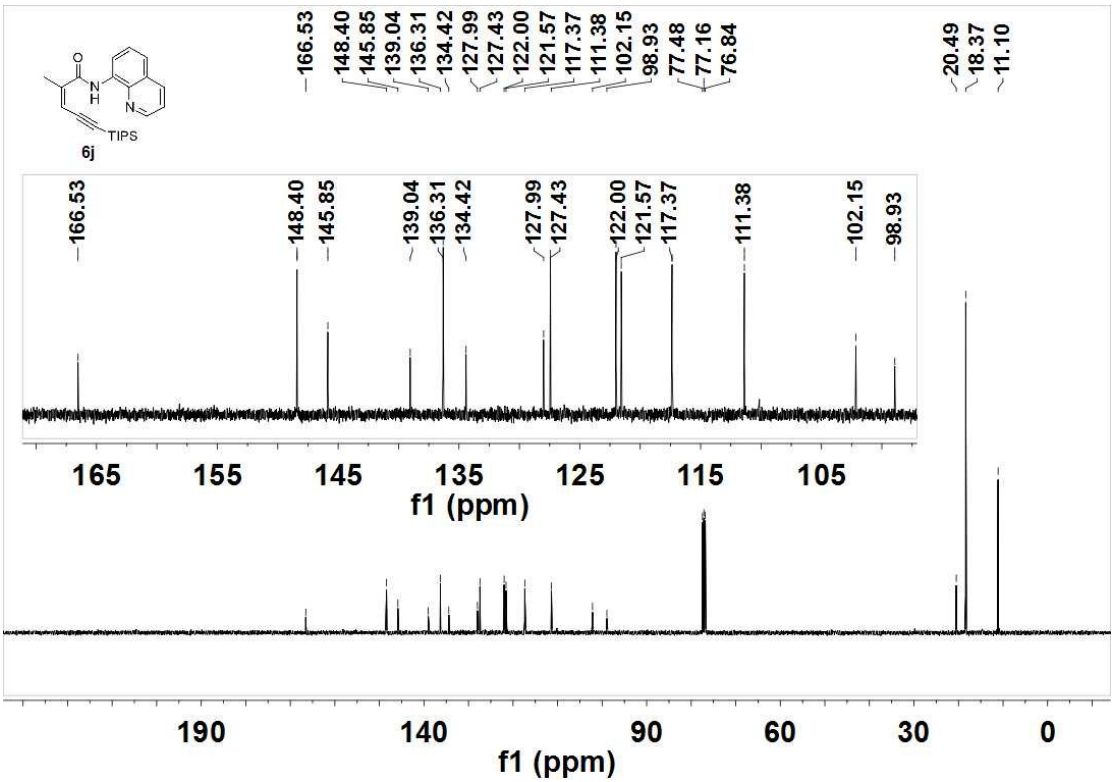

10.573
8.871
8.864
8.855
8.848
8.730
8.726
8.720
8.715
8.149
8.145
8.129
8.124
7.900
7.880
7.871
7.642
7.639
7.624
7.621
7.538
7.526
7.520
7.517
7.515
7.509
7.500
7.479
7.471
7.463
7.455
7.430
7.419
7.409
7.398
7.260
6.319
1.586
0.921
0.911
0.905
0.891
0.006
6h
TIPS
8.9
8.7
8.5
8.3
8.1
7.9
7.7
7.5
f1 (ppm)
1.00
1.00
0.96
1.96
2.00
1.00
5.02
1.02
0.96
21.00
12.0
8.0
5.0
2.0
f1 (ppm)

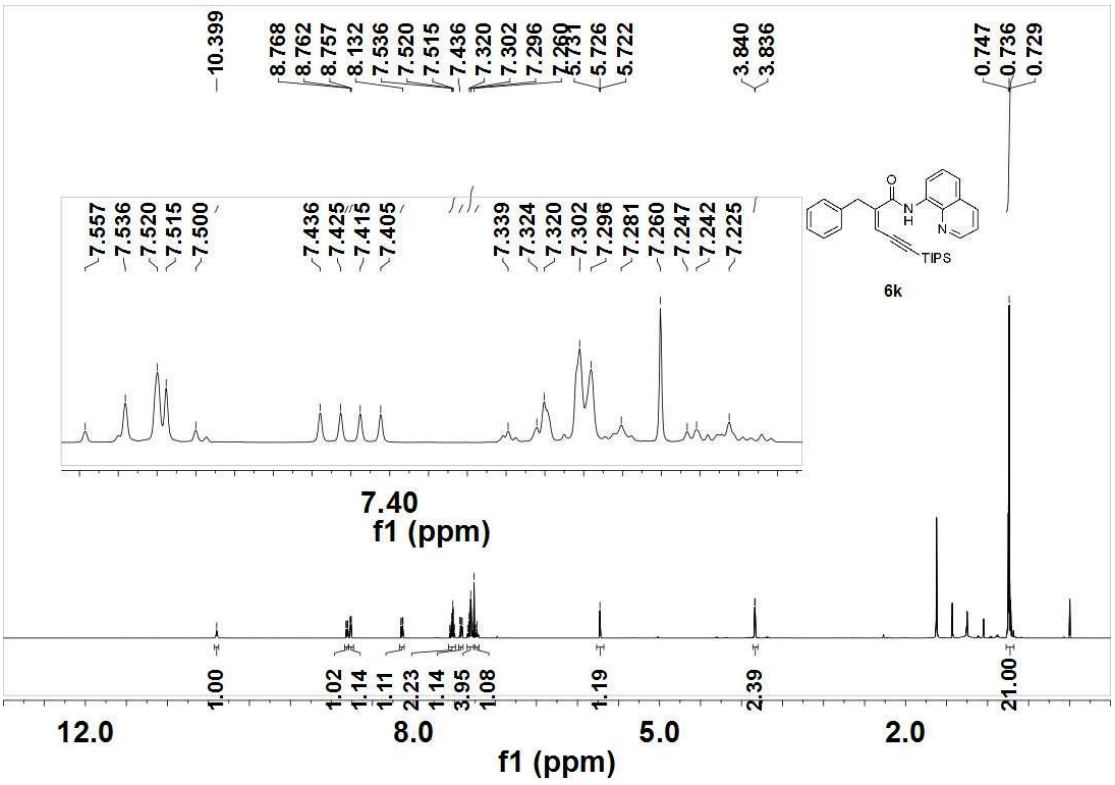

165.25
148.37
136.26
127.69
127.51
126.87
126.22
125.46
121.93
121.57
117.07
102.42
102.31
77.48
77.16
76.84
18.53
11.28
6h
TIPS
148.37
148.17
138.91
136.26
135.39
134.58
133.86
131.76
129.48
128.56
127.95
127.69
127.51
126.87
126.22
125.46
121.93
121.57
117.07
116.06
144
138
132
126
120
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)

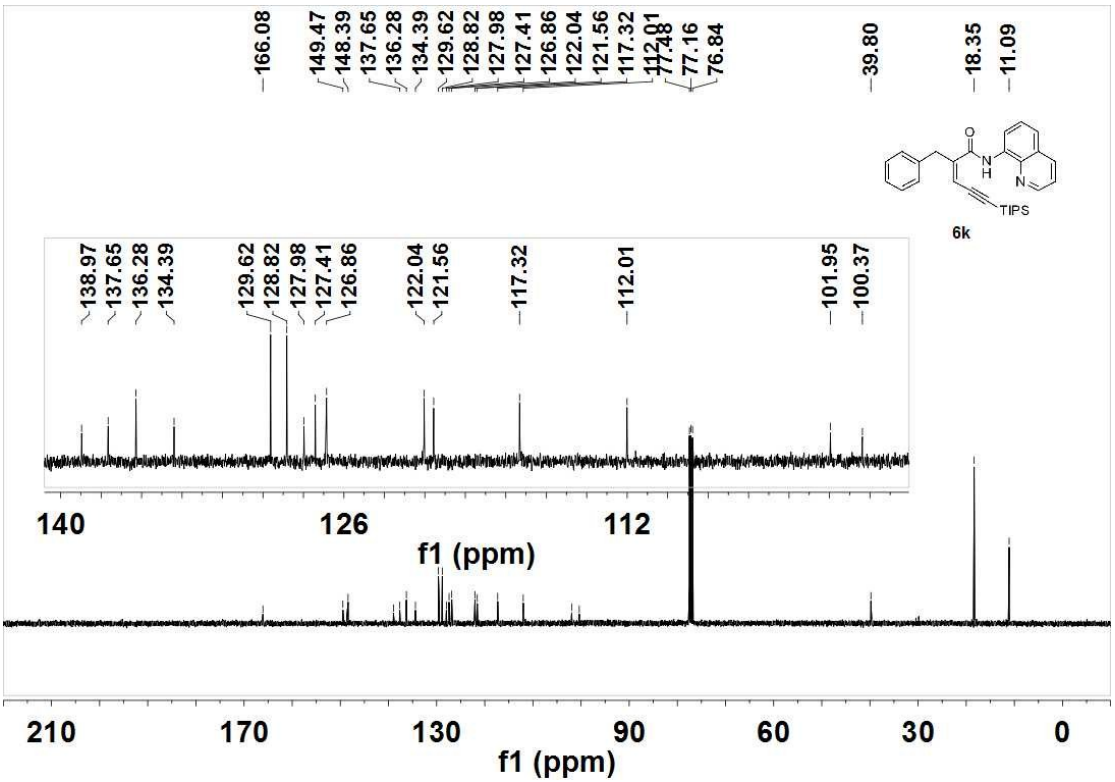

10.320
8.770
8.760
7.574
7.556
7.550
7.450
7.440
7.329
7.322
7.319
7.260
6.303
0.759
0.750
0.746
0.738
7.593
7.589
7.586
7.583
7.574
7.556
7.550
7.534
7.450
7.440
7.430
7.419
7.329
7.322
7.319
7.310
7.54
f1 (ppm)
6i
1.00
1.01
1.00
1.02
2.90
1.10
1.86
1.00
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


165.62
148.21
143.88
136.15
134.42
127.82
127.27
126.41
124.88
124.32
121.92
121.49
116.95
108.05
102.42
77.31
76.99
76.67
18.21
10.97
148.21
143.88
138.56
136.73
136.15
134.42
127.82
127.27
126.41
124.88
124.32
121.92
121.49
116.95
6i
144
138
132
126
120
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)


6j
TIPS
10.415
8.792
8.788
8.781
8.777
8.143
8.139
7.545
7.528
7.523
7.447
5.952
5.948
5.944
2.153
2.149
1.632
0.783
0.771
0.762
0.750
0.005
8.815
8.810
8.798
8.792
8.788
8.781
8.777
8.164
8.160
8.143
8.139
7.566
7.545
7.528
7.523
7.507
7.502
7.447
7.436
7.426
7.415
8.7
8.5
8.3
8.1
7.9
7.7
7.5
f1 (ppm)
1.00
2.00
1.00
2.11
1.02
1.00
3.00
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


6j
TIPS
166.53
148.40
145.85
139.04
136.31
134.42
127.99
127.43
122.00
121.57
117.37
111.38
102.15
98.93
77.48
77.16
76.84
20.49
18.37
11.10
165
155
145
135
125
115
105
f1 (ppm)
190
140
90
60
30
0
f1 (ppm)


10.399
8.768
8.762
8.757
8.132
7.536
7.520
7.515
7.436
7.320
7.302
7.296
5.726
5.722
3.840
3.836
0.747
0.736
0.729
7.557
7.536
7.520
7.515
7.500
7.436
7.425
7.415
7.405
7.339
7.324
7.320
7.302
7.296
7.281
7.260
7.247
7.242
7.225
TIPS
6k
7.40
f1 (ppm)
1.00
1.02
1.14
1.11
2.23
1.14
3.95
1.08
1.19
2.39
21.00
12.0
8.0
5.0
2.0
f1 (ppm)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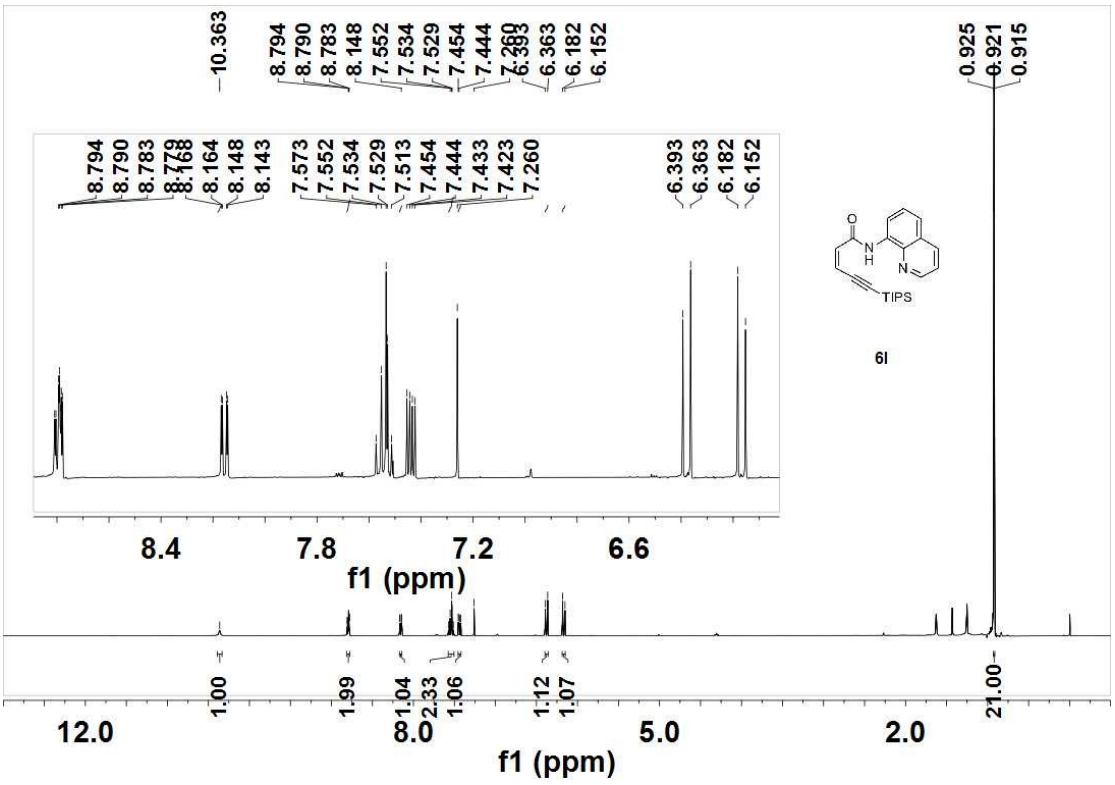
149.47
148.39
137.65
136.28
134.39
129.62
128.82
127.98
127.41
126.86
122.04
121.56
117.32
112.01
77.48
77.16
76.84
39.80
18.35
11.09
TIPS
6k
138.97
137.65
136.28
134.39
129.62
128.82
127.98
127.41
126.86
122.04
121.56
117.32
112.01
101.95
100.37
140
126
112
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)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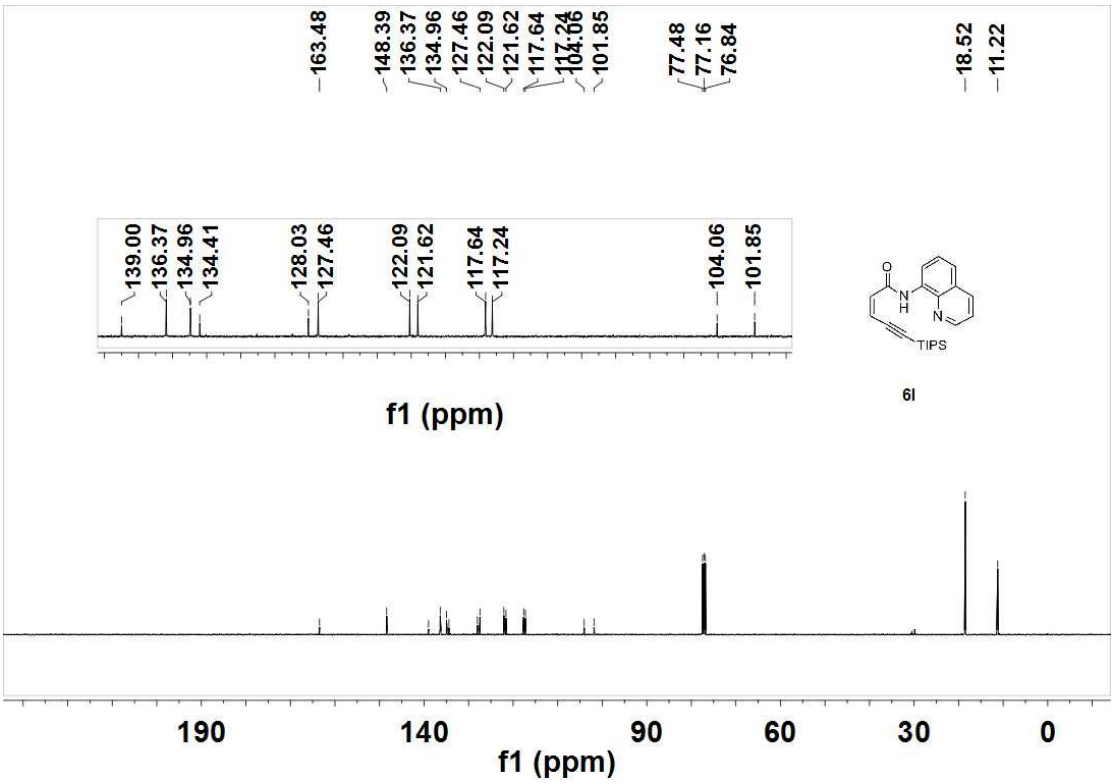
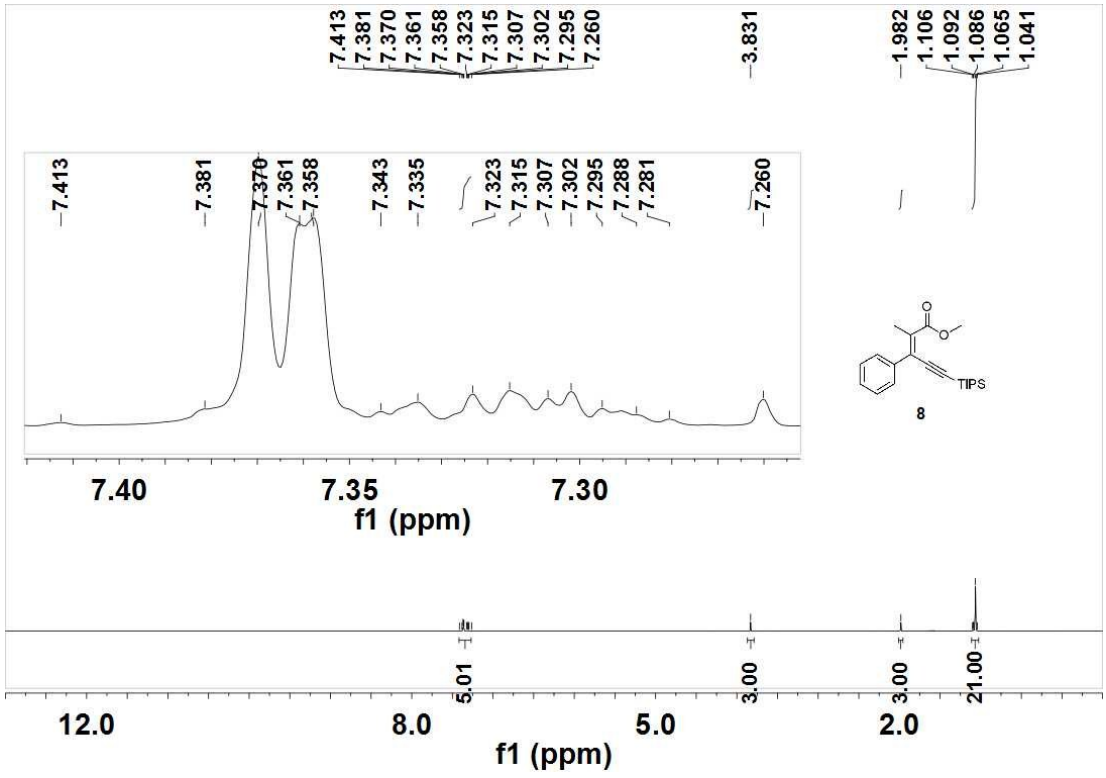
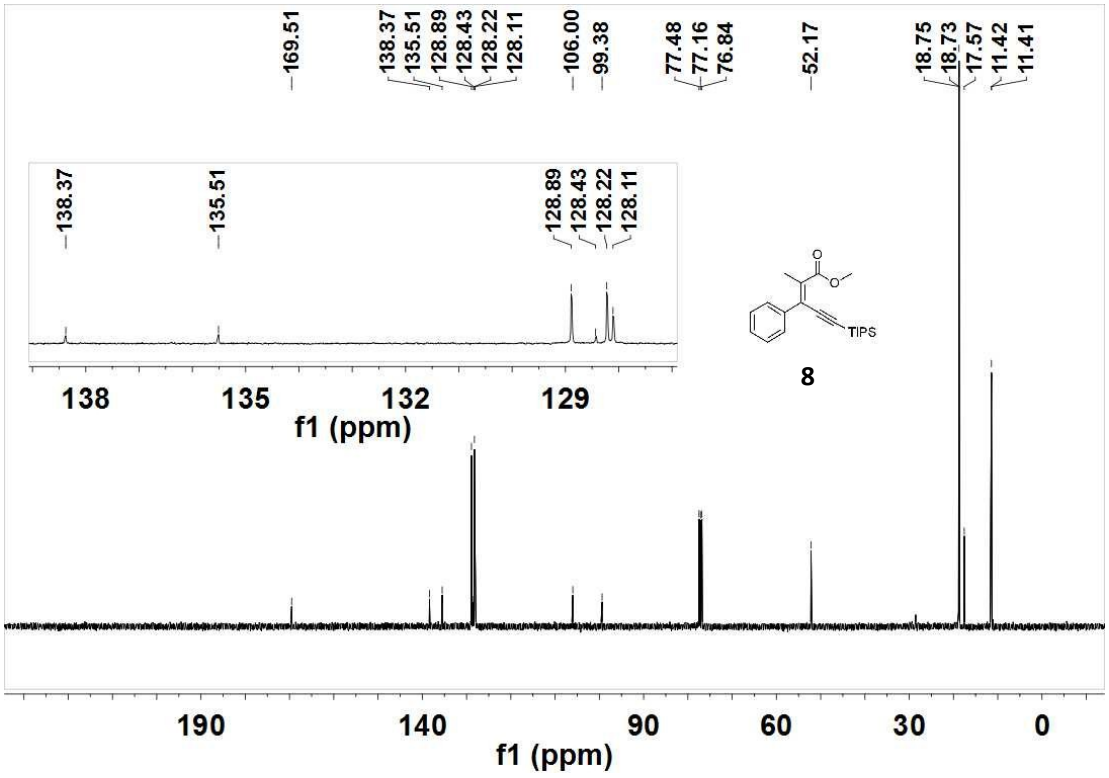
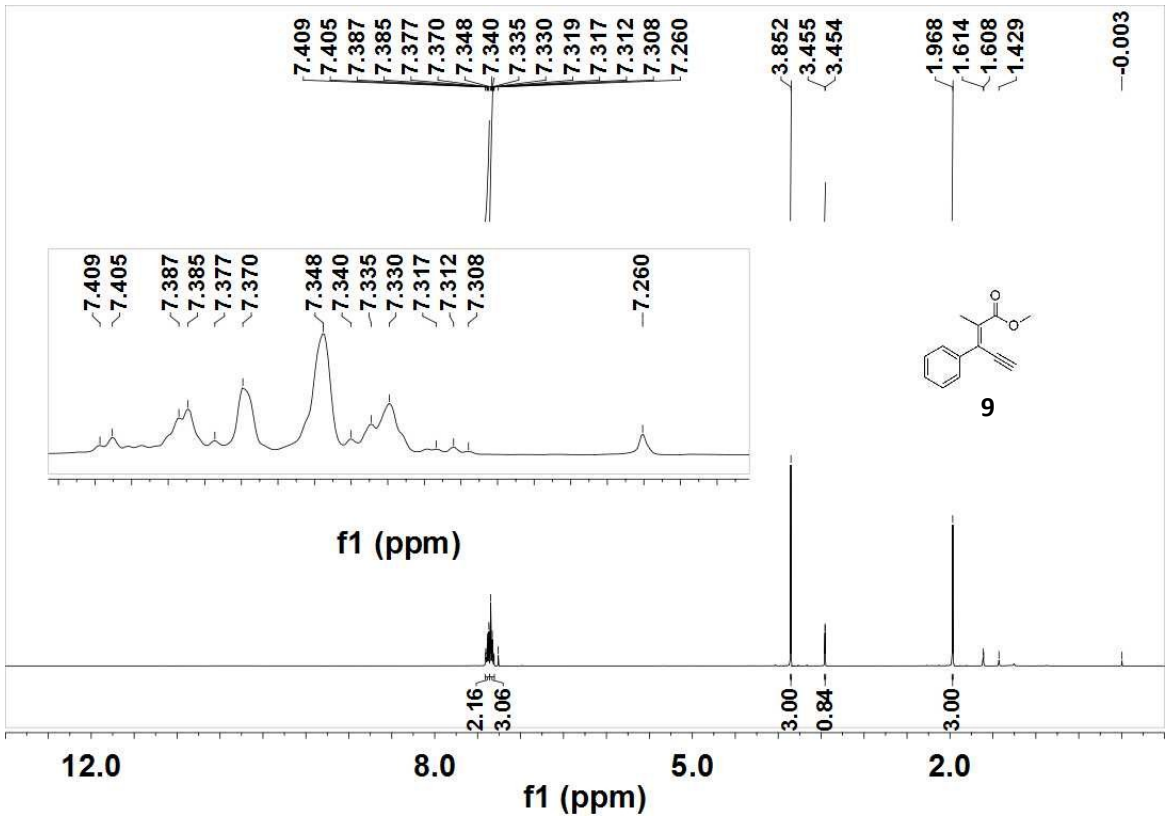
8.794
8.790
8.783
8.148
7.552
7.534
7.529
7.454
7.444
6.363
6.182
6.152
0.925
0.921
0.915
8.794
8.790
8.783
8.779
8.168
8.164
8.148
8.143
7.573
7.552
7.534
7.529
7.513
7.454
7.444
7.433
7.423
7.260
6.393
6.363
6.182
6.152
8.4
7.8
7.2
6.6
f1 (ppm)
6l
1.00
1.99
1.04
2.33
1.06
1.12
1.07
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


163.48
148.39
136.37
134.96
127.46
122.09
121.62
117.64
117.24
104.06
101.85
77.48
77.16
76.84
18.52
11.22
139.00
136.37
134.96
134.41
128.03
127.46
122.09
121.62
117.64
117.24
104.06
101.85
f1 (ppm)
6l
190
140
90
60
30
0
f1 (ppm)


7.413
7.381
7.370
7.361
7.358
7.323
7.315
7.307
7.302
7.295
7.260
3.831
1.982
1.106
1.092
1.086
1.065
1.041
7.40
7.35
7.30
f1 (ppm)
TIPS
8
5.01
3.00
3.00
21.00
12.0
8.0
5.0
2.0
f1 (ppm)


169.51
138.37
135.51
128.89
128.43
128.22
128.11
106.00
99.38
77.48
77.16
76.84
52.17
18.75
18.73
17.57
11.42
11.41
138
135
132
129
f1 (ppm)
TIPS
8
190
140
90
60
30
0
f1 (ppm)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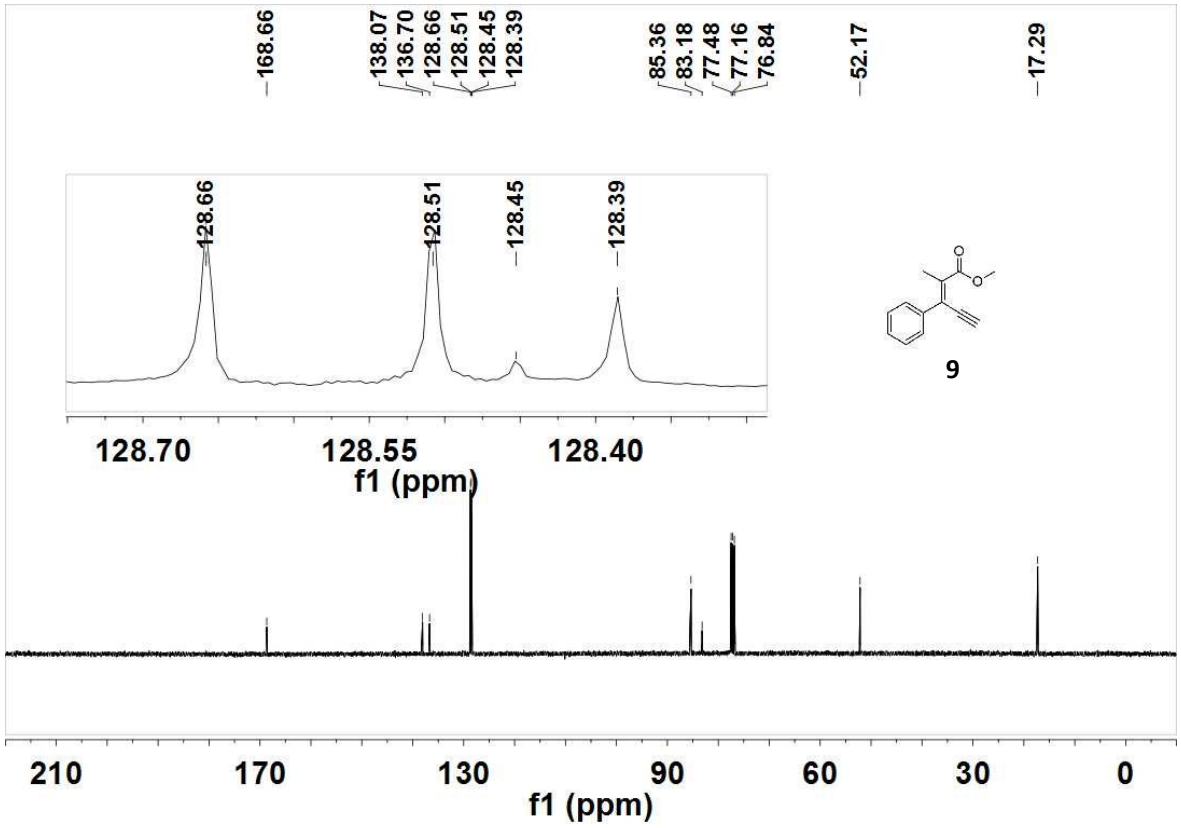
7.405
7.387
7.385
7.377
7.370
7.348
7.340
7.335
7.330
7.319
7.317
7.312
7.308
7.260
3.852
3.455
3.454
1.968
1.614
1.608
1.429
-0.003
9
f1 (ppm)
2.16
3.06
3.00
0.84
3.00
12.0
8.0
5.0
2.0
f1 (ppm)


168.66
138.07
136.70
128.66
128.51
128.45
128.39
85.36
83.18
77.48
77.16
76.84
52.17
17.29
9
128.70
128.55
128.40
f1 (ppm)
210
170
130
90
60
30
0
f1 (ppm)