Supplementary Information

Iodine Promoted Cascade Cycloisomerization of 1-En-6,11-diynes

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General Remarks

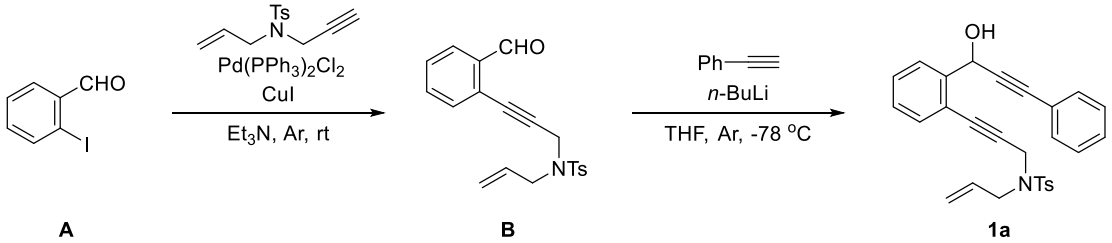
Column chromatography was carried out on silica gel (200-300 mesh). ^{1}H NMR spectra were recorded on 400 or 600 MHz in $CDCl_3$ and chemical shifts (ppm) were recorded with tetramethylsilane (TMS) as the internal reference standard. ^{13}C NMR spectra were recorded on 100 or 150 MHz in $CDCl_3$, ^{19}F NMR spectra were recorded on 376 MHz in $CDCl_3$. Multiplicities are given as: s (singlet), d (doublet), t (triplet), dd (doublet of doublets), dq (doublet of quartets), q (quartet) or m (multiplet). HR-MS was obtained using a Q-TOF or Q-Orbitrap instrument equipped with ESI source. The copies of ^{1}H NMR, ^{13}C NMR, and ^{19}F NMR spectra of all compounds are provided in the Supporting Information. Room temperature is 23–25 °C. THF was distilled immediately before use from Na/benzophenone. 3-Ethoxypropanenitrile was purchased from Shanghai Bide Pharmaceutical Technology Co., Ltd without further purification. Other commercially available reagents and solvents were used without further purification.

General Procedures

For the Preparation of Starting Materials

For the synthesis of **1a** (This procedure was also used for the synthesis of substrate **1b**−**1j**, **1m**−**1n**, **1p**−**1y**):

$Pd(PPh_3)_2Cl_2$ (71.9 mg, 0.1 mmol, 1 mol %) and CuI (38.1 mg, 0.2 mmol, 2 mol %) were sequentially added to a stirred solution of 2-iodobenzaldehyde **A** (2.32 g, 10 mmol) in triethylamine (40 mL) under argon at room temperature. The mixture was allowed to stir for 10 min. Then *N*-allyl-4-methyl-*N*-(prop-2-yn-1-yl)benzenesulfonamide (2.74 g, 11 mmol, 1.1 equiv) was added. The mixture was allowed to stir overnight. An aqueous saturated solution of NH_4Cl (40 mL) was poured into the resulting mixture, and the mixture was extracted with ethyl acetate (2 × 50 mL). The organic layers were combined to be washed with brine and dried over Na_2SO_4 for 20 min. Then the solution would be concentrated under reduced pressure. The obtained residue would be further purified by flash column chromatography (silica gel, petroleum ether/ethyl acetate, 5:1) to give *N*-allyl-*N*-(3-(2-formylphenyl)prop-2-yn-1-yl)-4-methylbenzenesulfonamide **B** (98%, 3.46 g, 9.8 mmol).



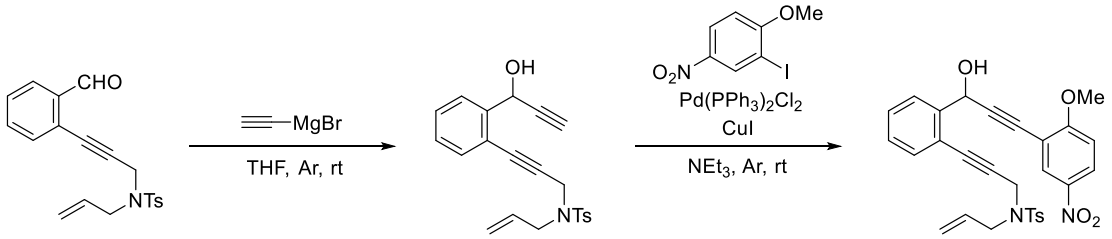
A **B** **1a**

n-BuLi (2.5 M, 2.9 mL, 1.4 equiv) was added dropwise via a syringe to a stirred solution of phenylacetylene (0.61 g, 6 mmol, 1.2 equiv) in dry THF (30 mL) under argon at −78 °C. The reaction mixture was allowed to stir for 10 min. Then, the solution of *N*-allyl-*N*-(3-(2-formylphenyl) prop-2-yn-1-yl)-4-methylbenzenesulfonamide **B** (1.77 g, 5 mmol) in THF was added at −78 °C. The reaction mixture was allowed to stir for 10 min at room temperature. After the completion of the reaction determined by TLC, the reaction mixture was quenched by an aqueous saturated solution of NH_4Cl (30 mL) and extracted with ethyl acetate (2 × 50 mL). The organic layers were combined to be washed with brine and dried over Na_2SO_4 for 20 min. Then the solution would be concentrated under reduced pressure. The obtained residue would be further purified by flash column chromatography (silica gel, petroleum ether/ethyl acetate, 3:1) to give *N*-allyl-*N*-(3-(2-(1-hydroxy-3-phenylprop-2-yn-1-yl)phenyl)prop-2-yn-1-yl)-4-methylbenzenesulfonamide **1a** (95%, 2.16 g, 4.75 mmol).

For the synthesis of **1o** (This procedure was also used for the synthesis of substrate **1k** and **1l**):

Ethynylmagnesium bromide (0.5 mol/L in THF, 24 mL, 1.2 equiv) was added dropwise into a stirred solution of *N*-allyl-*N*-(3-(2-formylphenyl) prop-2-yn-1-yl)-4-methylbenzenesulfonamide **B** (3.53 g, 10 mmol) in THF (35 mL) under argon. The mixture was allowed to stir for 4 h at

room temperature. After the completion of the reaction determined by TLC, the reaction mixture was quenched by addition of an aqueous saturated solution of NH_4Cl (35 mL) and extracted with ethyl acetate (2×50 mL). The combined organic layers were washed with brine, dried over Na_2SO_4, and concentrated under reduced pressure. The resulting material *N*-allyl-*N*-(3-(2-(1-hydroxyprop-2-yn-1-yl)phenyl)prop-2-yn-1-yl)-4-methylbenzenesulfonamide **C** (90%, 3.42 g, 9 mmol) was directly used for the next step without further purification.



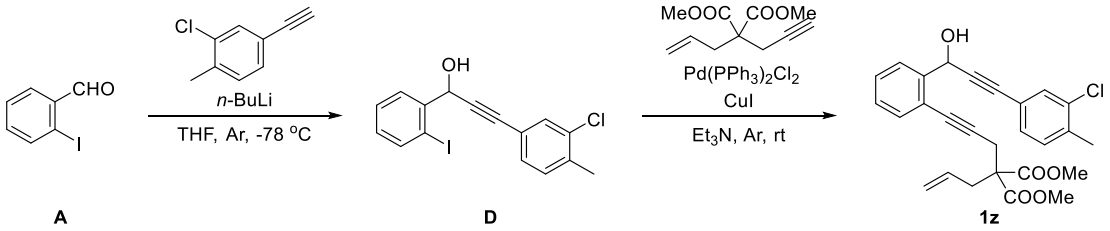
B **C** **1o**

$Pd(PPh_3)_2Cl_2$ (56.2 mg, 0.08 mmol, 1 mol %) and CuI (30.5 mg, 0.16 mmol, 2 mol %) were sequentially added to a stirred solution of 2-iodo-1-methoxy-4-nitrobenzene (2.68 g, 9.6 mmol, 1.2 equiv) in triethylamine (40 mL) under argon at room temperature. The mixture was allowed to stir for 10 min. Then *N*-allyl-*N*-(3-(2-(1-hydroxyprop-2-yn-1-yl)phenyl)prop-2-yn-1-yl)-4-methylbenzenesulfonamide **C** (3.04 g, 8 mmol) was added. The mixture was allowed to stir overnight. An aqueous saturated solution of NH_4Cl (40 mL) was poured into the resulting mixture, and the mixture was extracted with ethyl acetate (2 × 40 mL). The organic layers were combined to be washed with brine and dried over Na_2SO_4 for 20 min. Then the solution would be concentrated under

reduced pressure. The obtained residue would be further purified by flash column chromatography (silica gel, petroleum ether/ethyl acetate, 2:1) to give *N*-allyl-*N*-(3-(2-(1-hydroxy-3-(2-methoxy-5-nitrophenyl)prop-2-yn-1-yl)phenyl)prop-2-yn-1-yl)-4-methylbenzenesulfonamide **1o** (96%, 4.08 g, 7.7 mmol).

For the synthesis of **1z**:

Compound 3-(3-chloro-4-methylphenyl)-1-(2-iodophenyl)prop-2-yn-1-ol **D** (98%) was synthesized via a similar preparation procedure as substrate **1a**.

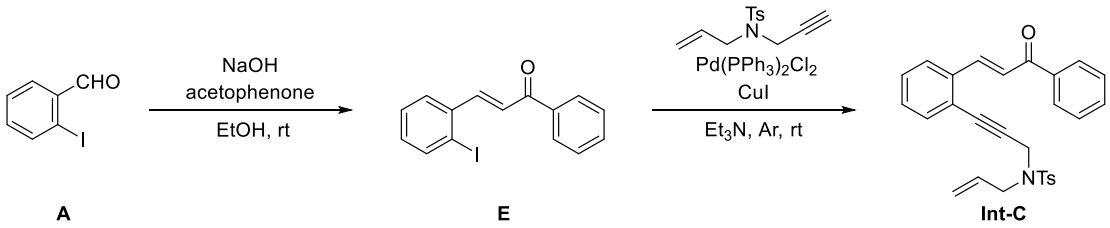


A **D** **1z**

Substrate dimethyl 2-allyl-2-(3-(2-(3-(3-chloro-4-methylphenyl)-1-hydroxyprop-2-yn-1-yl)phenyl)prop-2-yn-1-yl)malonate **1z** (86%) was synthesized via a similar preparation procedure as compound **B**.

For the Synthesis of Intermediate Int-C

Acetophenone (1.2 g, 10 equiv, 10 mmol) and NaOH (0.6 g, 1.5 equiv, 15 mmol) were sequentially added to a stirred solution of 2-iodobenzaldehyde **A** (2.32 g, 10 mmol) in EtOH (40 mL) at room temperature. The mixture was allowed to stir for 3 h. An aqueous saturated solution of NH_4Cl (40 mL) was poured into the resulting mixture, and the mixture was extracted with ethyl acetate (2 × 40 mL). The organic layers were combined to be washed with brine and dried over Na_2SO_4 for 20 min. Then the solution would be concentrated under reduced pressure. The obtained residue would be further purified by flash column chromatography (silica gel, petroleum ether/ethyl acetate, 20:1) to give 3-(2-iodophenyl)-1-phenylprop-2-en-1-one **E** (82%, 2.74 g, 8.2 mmol).

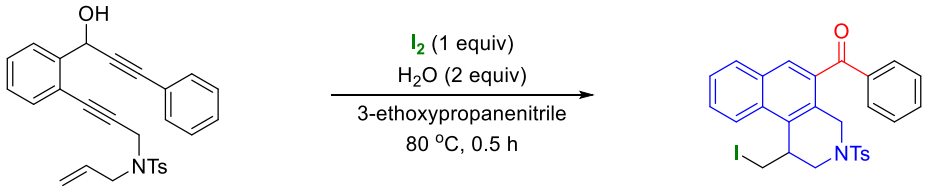


A **E** **Int-C**

Compound *N*-allyl-4-methyl-*N*-(3-(2-(3-oxo-3-phenylprop-1-en-1-yl) phenyl)prop-2- yn-1-yl)benzenesulfonamide **Int-C** (95%) was synthesized via a similar preparation procedure as substrate **1a**.

For the Synthesis of Products

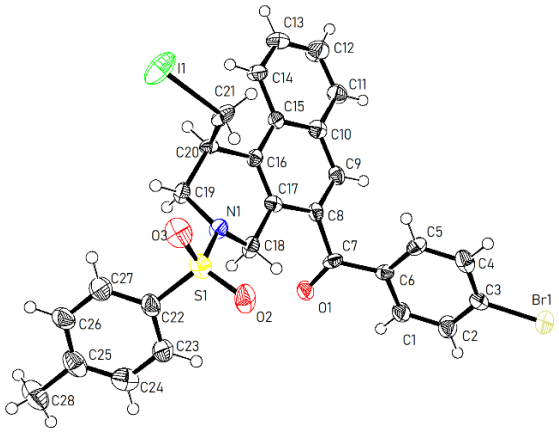
For the synthesis of **2a**:

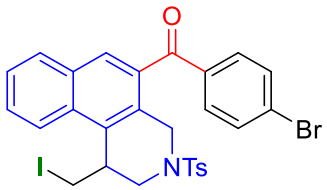


1a **2a**

Water (7.2 μL, 0.40 mmol, 2.0 equiv) and iodine (50.8 mg, 0.2 mmol, 1.0 equiv) were sequentially added to an oven-dried tube charged with of *N*-allyl-*N*-(3-(2-(1-hydroxy-3-phenylprop-2-yn-1-yl)phenyl)prop-2-yn-1-yl)-4-methylbenzenesulfonamide (**1a**; 91.0 mg, 0.2 mmol) in 3-ethoxypropanenitrile. The resulting mixture was allowed to stir at 80 °C for 0.5 h. And the reaction mixture was quenched with a saturated aqueous solution of $Na_2S_2O_3$ (3−5 mL) and then extracted with ethyl ether (2×15 mL), washed with saturated brine, dried over Na_2SO_4, and evaporated under reduced pressure. The residue was further purified by chromatography on silica gel (petroleum ether/ethyl acetate, 10:1) to afford the product (1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[*f*] isoquinolin-5-yl)(phenyl)methanone **2a** in 82% yield.

X-ray Single Crystal Diffraction Data





2j

The ellipsoid contour percent probability level is 50% in the caption of the thermal ellipsoid plot. CCDC 1913985

Bond precision:	C-C = 0.0085 A	Wavelength=0.71073	
Cell:	a=14.8474(5)	b=30.0430(15)	c=26.3798(6)
	alpha=90	beta=90	gamma=90
Temperature:	173 K		

	Calculated	Reported
Volume	11767.0(8)	11767.0(8)
Space group	P b c n	P b c n
Hall group	-P 2n 2ab	-P 2n 2ab
Moiety formula	C28 H23 Br I N O3 S [+ solvent]	C28 H23 Br I N O3 S
Sum formula	C28 H23 Br I N O3 S [+ solvent]	C28 H23 Br I N O3 S
Mr	660.33	660.34
Dx,g cm-3	1.491	1.491
Z	16	16
Mu (mm-1)	2.545	2.545
F000	5216.0	5216.0
F000’	5207.75	
h,k,lmax	18, 37, 32	18, 37, 32
Nref	11606	11570
Tmin,Tmax	0.565,0.683	0.703,1.000
Tmin’	0.551	

Correction method= # Reported T Limits: Tmin=0.703 Tmax=1.000
AbsCorr = MULTI-SCAN

Data completeness= 0.997	Theta(max)= 26.022
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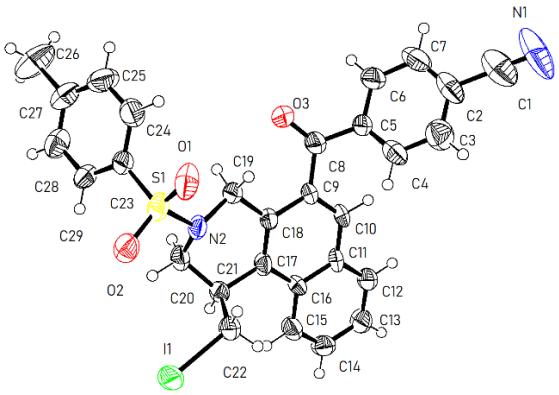
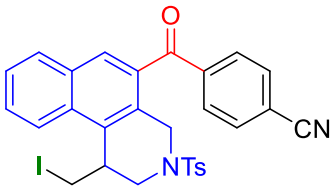
S = 0.978	Npar= 633





2l

The ellipsoid contour percent probability level is 50% in the caption of the thermal ellipsoid plot. CCDC 1935327

Bond precision:	C-C = 0.0146 A	Wavelength=0.71073	
Cell:	a=25.670(2)	b=10.5220(7)	c=9.8072(12)
	alpha=90	beta=90	gamma=90
Temperature:	293 K		

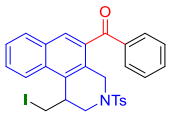
	Calculated	Reported
Volume	2648.9(4)	2648.9(4)
Space group	P n a 21	P n a 21
Hall group	P 2c -2n	P 2c -2n
Moiety formula	C29 H23 I N2 O3 S	C29 H23 I N2 O3 S
Sum formula	C29 H23 I N2 O3 S	C29 H23 I N2 O3 S
Mr	606.45	606.45
Dx,g cm-3	1.521	1.521
Z	4	4
Mu (mm-1)	1.321	1.321
F000	1216.0	1216.0
F000’	1215.04	
h,k,lmax	31, 12, 12	31, 12, 12
Nref	5206 [2763]	4113
Tmin,Tmax	0.788,0.853	0.483,1.000
Tmin’	0.788	

Correction method= # Reported T Limits: Tmin=0.483 Tmax=1.000
AbsCorr = MULTI-SCAN

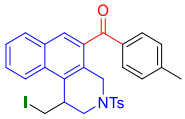
Data completeness= 1.49/0.79	Theta(max)= 26.020
R(reflections)= 0.0515(3092)	wR2(reflections)= 0.1061(4113)
S = 1.067	Npar= 326

Characterization Data

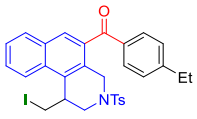
Characterization Data of 2a−2v



(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)(phenyl)methanone (2a): white solid; 95.4 mg; 82% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.92 (d, J = 8.4 Hz, 1H), 7.84−7.77 (m, 6H), 7.73−7.69 (m, 1H), 7.65 (t, J = 7.6 Hz, 1H), 7.57−7.48 (m, 3H), 7.37 (d, J = 8.0 Hz, 2H), 4.77 (d, J = 16.8 Hz, 1H), 4.44 (d, J = 12.0 Hz, 1H), 4.12 (d, J = 16.4 Hz, 1H), 3.84 (d, J = 10.8 Hz, 1H), 3.70 (t, J = 10.8 Hz, 1H), 3.53 (d, J = 10.0 Hz, 1H), 2.75 (d, J = 11.6 Hz, 1H), 2.43 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 196.8, 143.9, 137.4, 133.4, 132.4, 132.1, 131.9, 131.0, 131.0, 130.4, 129.9, 129.8, 129.3, 128.5, 128.2, 127.8, 126.7, 122.4, 47.5, 45.9, 40.1, 21.5, 7.7; HRMS (ESI/Q-TOF) m/z $[M+H]^+$ calcd for $C_{28}H_{25}INO_3S$ 582.0594, found 582.0593 (0.2 ppm).

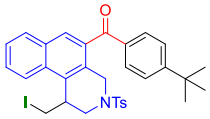


(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)(p-tolyl)methanone (2b): light yellow solid; 89.3 mg; 75% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.91 (d, J = 8.4 Hz, 1H), 7.81−7.68 (m, 7H), 7.54 (t, J = 7.6 Hz, 1H), 7.36 (d, J = 8.0 Hz, 2H), 7.30 (d, J = 8.0 Hz, 2H), 4.75 (d, J = 16.4 Hz, 1H), 4.43 (d, J = 12.0 Hz, 1H), 4.10 (d, J = 16.4 Hz, 1H), 3.83 (d, J = 11.2 Hz, 1H), 3.69 (t, J = 10.8 Hz, 1H), 3.53 (d, J = 10.4 Hz, 1H), 2.74 (d, J = 11.6 Hz, 1H), 2.46 (s, 3H), 2.43 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 196.5, 144.5, 143.8, 134.7, 133.8, 132.4, 132.0, 131.8, 131.0, 130.6, 130.5, 129.8, 129.8, 129.2, 129.1, 128.0, 127.8, 126.7, 122.4, 47.4, 45.9, 40.1, 21.7, 21.5, 7.8; HRMS (ESI/Q-TOF) m/z $[M+Na]^+$ calcd for $C_{29}H_{26}INNaO_3S$ 618.0570, found 618.0570 (0 ppm).

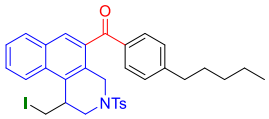


(4-ethylphenyl)(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)methanone (2c): yellow solid; 86.5 mg; 71% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.91 (d, J = 8.4 Hz, 1H), 7.81−7.76 (m, 6H), 7.70 (t, J = 7.6 Hz, 1H), 7.54 (t, J = 7.6 Hz, 1H), 7.37−7.31 (m, 4H), 4.75 (d, J = 16.4 Hz, 1H), 4.43 (d, J = 11.6 Hz, 1H), 4.10 (d, J = 16.4 Hz, 1H), 3.83 (d, J = 10.8 Hz, 1H), 3.69 (t, J = 10.8 Hz, 1H), 3.53 (d, J = 10.0 Hz, 1H), 2.79−2.73 (m, 3H), 2.43 (s, 3H), 1.30 (t, J = 7.6 Hz, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 196.5, 150.6,

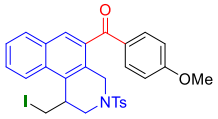
143.8, 134.9, 133.8, 132.4, 132.0, 131.8, 131.0, 130.6, 130.5, 129.8, 129.8, 129.1, 128.0, 127.8, 126.7, 122.4, 47.4, 45.9, 40.1, 29.0, 21.5, 15.2, 7.8; HRMS (ESI/Q-TOF) *m/z* $[M+H]^+$ calcd for $C_{30}H_{29}INO_3S$ 610.0907, found 610.0907 (0 ppm).



(4-(tert-butyl)phenyl)(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl) methanone (2d): light yellow solid; 98.2 mg; 77% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.93 (d, *J* = 8.4 Hz, 1H), 7.83−7.78 (m, 6H), 7.71 (t, *J* = 7.6 Hz, 1H), 7.54 (dd, *J* = 18.0 Hz 7.6 Hz, 3H), 7.37 (d, *J* = 8.0 Hz, 2H), 4.74 (d, *J* = 16.8 Hz, 1H), 4.43 (d, *J* = 12.0 Hz, 1H), 4.11 (d, *J* = 16.4 Hz, 1H), 3.84 (t, *J* = 10.8 Hz, 1H), 3.70 (t, *J* = 10.8 Hz, 1H), 3.54 (d, *J* = 10.0 Hz, 1H), 2.77 (d, *J* = 12.0 Hz, 1H), 2.43 (s, 3H), 1.38 (s, 9H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 196.5, 157.5, 143.9, 134.7, 133.9, 132.7, 132.1, 131.9, 131.1, 130.5, 130.5, 129.9, 129.8, 129.1, 128.2, 127.9, 126.7, 125.6, 122.5, 47.5, 45.9, 40.2, 35.2, 31.1, 21.5, 7.8; HRMS (ESI/Q-TOF) *m/z* $[M+Na]^+$ calcd for $C_{32}H_{32}INNaO_3S$ 660.1040, found 660.1041 (0.2 ppm).

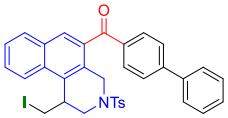


(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)(4-pentylphenyl)metha none (2e): light yellow solid; 75.6 mg; 58% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.92 (d, *J* = 8.4 Hz, 1H), 7.83−7.74 (m, 6H), 7.75−7.69 (m, 1H), 7.55 (t, *J* = 7.6 Hz, 1H), 7.37 (d, *J* = 7.6 Hz, 2H), 7.30 (d, *J* = 8.0 Hz, 2H), 4.74 (d, *J* = 16.4 Hz, 1H), 4.43 (d, *J* = 11.6 Hz, 1H), 4.11 (d, *J* = 16.4 Hz, 1H), 3.84 (d, *J* = 10.8 Hz, 1H), 3.70 (t, *J* = 10.8 Hz, 1H), 3.54 (d, *J* = 10.0 Hz, 1H), 2.77−2.67 (m, 3H), 2.43 (s, 3H), 1.68 (t, *J* = 6.8 Hz, 2H), 1.36 (d, *J* = 6.8 Hz, 4H), 0.93−0.90 (m, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 196.6, 149.6, 143.9, 134.9, 133.9, 132.5, 132.1, 131.9, 131.0, 130.7, 130.5, 129.9, 129.8, 129.1, 128.6, 128.2, 127.9, 126.7, 122.5, 47.5, 45.9, 40.2, 36.0, 31.4, 30.8, 22.5, 21.5, 14.0, 7.8; HRMS (ESI/Q-TOF) *m/z* $[M+H]^+$ calcd for $C_{33}H_{35}INO_3S$ 652.1377, found 652.1376 (0.2 ppm).

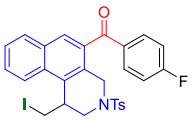


(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)(4-methoxyphenyl)met hanone (2f): light yellow solid; 75.8 mg; 62% yield; ^{1}H NMR (600 MHz, $CDCl_3$) δ ppm 7.92 (d, *J* = 8.4 Hz, 1H), 7.84−7.81 (m, 3H), 7.78−7.76 (m, 3H), 7.72−7.69 (m, 1H), 7.55 (t, *J* = 7.8 Hz, 1H), 7.36 (d, *J* = 7.8 Hz, 2H), 6.97 (d, *J* = 9.0 Hz, 2H), 4.70 (d, *J* = 16.2 Hz, 1H), 4.43

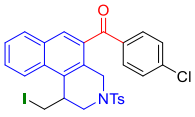
(d, *J* = 12.0 Hz, 1H), 4.08 (d, *J* = 16.2 Hz, 1H), 3.91 (s, 3H), 3.84−3.82 (m, 1H), 3.71−3.67 (m, 1H), 3.54 (d, *J* = 10.2 Hz, 1H), 2.76 (d, *J* = 11.4 Hz, 1H), 2.43 (s, 3H); $^{13}C\{^{1}H\}$ NMR (150 MHz, $CDCl_3$) δ ppm 195.4, 164.1, 143.9, 134.3, 132.8, 132.6, 132.0, 131.7, 131.2, 130.1, 129.9, 129.7, 129.6, 129.0, 128.0, 127.9, 126.7, 122.5, 113.9, 55.6, 47.4, 46.0, 40.2, 21.5, 7.7; HRMS (ESI/Q-TOF) *m*/*z* $[M+H]^+$ calcd for $C_{29}H_{27}INO_4S$ 612.0700, found 612.0700 (0 ppm).



[1,1'-biphenyl]-4-yl(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)methanone (2g): yellow solid; 93.4 mg; 71% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.92 (t, *J* = 8.4 Hz, 3H), 7.87−7.83 (m, 2H), 7.78 (d, *J* = 7.6 Hz, 2H), 7.72 (d, *J* = 8.0 Hz, 3H), 7.67 (d, *J* = 7.2 Hz, 2H), 7.56 (t, *J* = 7.6 Hz, 1H), 7.50 (t, *J* = 7.2 Hz, 2H), 7.44−7.40 (m, 1H), 7.35 (d, *J* = 7.6 Hz, 2H), 4.78 (d, *J* = 16.4 Hz, 1H), 4.44 (d, *J* = 12.0 Hz, 1H), 4.12 (d, *J* = 16.8 Hz, 1H), 3.85 (d, *J* = 10.8 Hz, 1H), 3.71 (t, *J* = 10.4 Hz, 1H), 3.54 (d, *J* = 10.0 Hz, 1H), 2.75 (d, *J* = 11.6 Hz, 1H), 2.41 (s, 3H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 196.4, 146.2, 143.9, 139.6, 136.1, 133.7, 132.5, 132.2, 131.9, 131.1, 131.0, 130.8, 130.5, 129.9, 129.3, 129.0, 128.4, 128.1, 127.8, 127.3, 127.2, 126.8, 122.5, 47.6, 45.9, 40.2, 21.5, 7.8; HRMS (ESI/Q-TOF) *m*/*z* $[M+H]^+$ calcd for $C_{34}H_{29}INO_3S$ 658.0907, found 658.0907 (0 ppm).

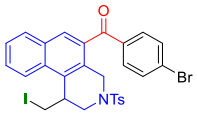


(4-fluorophenyl)(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)methanone (2h): yellow solid; 95.9 mg; 80% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.92 (d, *J* = 8.4 Hz, 1H), 7.89−7.59 (m, 2H), 7.80 (dd, *J* = 16.0 Hz 8.4 Hz, 4H), 7.73 (t, *J* = 8.0 Hz, 1H), 7.56 (t, *J* = 7.6 Hz, 1H), 7.37 (d, *J* = 8.0 Hz, 2H), 7.18 (t, *J* = 8.4 Hz, 2H), 4.73 (d, *J* = 16.8 Hz, 1H), 4.43 (d, *J* = 11.6 Hz, 1H), 4.09 (d, *J* = 16.4 Hz, 1H), 3.84 (d, *J* = 10.8 Hz, 1H), 3.69 (t, *J* = 10.8 Hz, 1H), 3.52 (d, *J* = 10.0 Hz, 1H), 2.75 (d, *J* = 11.6 Hz, 1H), 2.44 (s, 3H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 195.2, 166.0 (d, ^{1}J = 254 Hz, 1C), 144.0, 133.7 (d, ^{3}J = 3 Hz, 1C), 133.3, 133.1, 133.0, 132.4, 132.3, 132.0, 131.0, 130.7, 129.9, 129.4, 128.0, 127.8, 126.9, 122.5, 115.8 (d, ^{2}J = 22 Hz, 1C), 47.5, 45.9, 40.1, 21.5, 7.6; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm −104.27−−104.34 (m, 1F); HRMS (ESI/Q-TOF) *m*/*z* $[M+Na]^+$ calcd for $C_{28}H_{23}FINNaO_3S$ 622.0320, found 622.0320 (0 ppm).

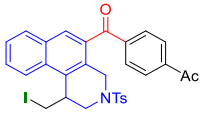


(4-chlorophenyl)(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)meth

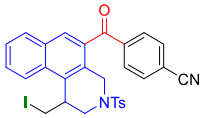
anone (2i): yellow solid; 97.3 mg; 79% yield; ^{1}H NMR (600 MHz, $CDCl_3$) δ ppm 7.93 (d, J = 8.4 Hz, 1H), 7.82 (d, J = 7.8 Hz, 1H), 7.79−7.77 (m, 5H), 7.73 (t, J = 7.8 Hz, 1H), 7.57 (t, J = 7.8 Hz, 1H), 7.48 (d, J = 8.4 Hz, 2H), 7.37 (d, J = 8.4 Hz, 2H), 4.74 (d, J = 16.8 Hz, 1H), 4.43 (d, J = 12.0 Hz, 1H), 4.09 (d, J = 16.8 Hz, 1H), 3.84 (d, J = 10.8 Hz, 1H), 3.70−3.67 (m, 1H), 3.52 (d, J = 10.2 Hz, 1H), 2.76 (d, J = 11.4 Hz, 1H), 2.44 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ ppm 195.6, 144.0, 140.0, 135.8, 133.2, 132.5, 132.4, 132.1, 131.7, 131.1, 131.0, 129.9, 129.9, 129.5, 128.9, 128.1, 127.9, 126.9, 122.5, 47.6, 45.9, 40.2, 21.5, 7.6; HRMS (ESI/Q-TOF) m/z [M+H]$^{+}$ calcd for $C_{28}H_{24}ClINO_3S$ 616.0205, found 616.0205 (0 ppm).



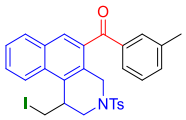
(4-bromophenyl)(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)meth anone (2j): yellow solid; 110.9 mg; 84% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.98 (s, 1H), 7.83−7.76 (m, 6H), 7.71 (s, 1H), 7.66 (t, J = 7.6 Hz, 1H), 7.53−7.49 (m, 2H), 7.37 (d, J = 8.0 Hz, 2H), 4.72 (d, J = 16.8 Hz, 1H), 4.42 (d, J = 12.0 Hz, 1H), 4.07 (d, J = 16.4 Hz, 1H), 3.79 (d, J = 10.8 Hz, 1H), 3.71−3.66 (m, 1H), 3.46 (d, J = 10.0 Hz, 1H), 2.76 (d, J = 12.0 Hz, 1H), 2.44 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 195.7, 144.0, 136.2, 133.0, 132.4, 132.4, 132.1, 131.9, 131.8, 131.1, 131.0, 129.9, 129.9, 129.5, 128.7, 128.1, 127.8, 126.9, 122.5, 47.6, 45.9, 40.1, 21.5, 7.6; HRMS (ESI/Q-TOF) m/z [M+Na]$^{+}$ calcd for $C_{28}H_{23}BrINNaO_3S$ 681.9519, found 681.9520 (0.1 ppm).



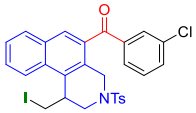
1-(4-(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinoline-5-carbonyl)phenyl)et han-1-one (2k): yellow solid; 77.3 mg; 62% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.06 (d, J = 8.0 Hz, 2H), 7.94−7.89 (m, 3H), 7.82−7.78 (m, 4H), 7.74 (t, J = 7.6 Hz, 1H), 7.56 (t, J = 7.6 Hz, 1H), 7.38 (d, J = 7.6 Hz, 2H), 4.82 (d, J = 16.4 Hz, 1H), 4.44 (d, J = 12.0 Hz, 1H), 4.14 (d, J = 16.8 Hz, 1H), 3.84 (d, J = 10.8 Hz, 1H), 3.69 (t, J = 10.8 Hz, 1H), 3.52 (d, J = 10.0 Hz, 1H), 2.76 (d, J = 12.0 Hz, 1H), 2.68 (s, 3H), 2.44 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 197.3, 196.1, 143.9, 141.0, 140.2, 132.7, 132.5, 132.5, 132.2, 131.8, 130.9, 130.4, 130.0, 129.9, 129.7, 128.3, 128.3, 127.8, 126.9, 122.5, 47.6, 45.8, 40.2, 26.9, 21.5, 7.6; HRMS (ESI/Q-Orbitrap) m/z [M+H]$^{+}$ calcd for $C_{30}H_{27}INO_4S$ 624.0700, found 624.0703 (0.5 ppm).



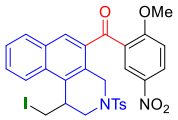
4-(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinoline-5-carbonyl)benzonitrile (2l): white solid; 66.7 mg; 55% yield; ^{1}H NMR (600 MHz, $CDCl_3$) δ ppm 7.95−7.92 (m, 3H), 7.83−7.79 (m, 6H), 7.76 (t, *J* = 7.8 Hz, 1H), 7.59 (t, *J* = 7.8 Hz, 1H), 7.39 (d, *J* = 8.4 Hz, 2H), 4.80 (d, *J* = 16.8 Hz, 1H), 4.44 (d, *J* = 12.0 Hz, 1H), 4.13 (d, *J* = 16.8 Hz, 1H), 3.85 (d, *J* = 10.8 Hz, 1H), 3.69 (t, *J* = 10.8 Hz, 1H), 3.51 (d, *J* = 10.2 Hz, 1H), 2.77 (d, *J* = 11.4 Hz, 1H), 2.45 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ ppm 195.2, 144.1, 141.1, 132.8, 132.6, 132.4, 132.3, 132.2, 132.0, 130.9, 130.6, 130.1, 130.0, 129.9, 128.4, 127.9, 127.1, 122.6, 117.8, 116.5, 47.7, 45.9, 40.3, 21.5, 7.4; HRMS (ESI/Q-Orbitrap) *m/z* [M+Na]$^{+}$ calcd for $C_{29}H_{23}IN_2NaO_3S$ 629.0366, found 629.0365 (0.2 ppm).



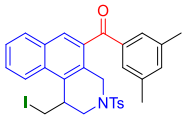
(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)(m-tolyl)methanone (2m): light yellow solid; 81.0 mg; 68% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.91 (d, *J* = 8.4 Hz, 1H), 7.80−7.76 (m, 4H), 7.69 (dd, *J* = 15.2 Hz 7.6 Hz, 2H), 7.59 (d, *J* = 7.6 Hz, 1H), 7.54 (t, *J* = 7.6 Hz, 1H), 7.45 (d, *J* = 7.6 Hz, 1H), 7.37 (t, *J* = 7.6 Hz, 3H), 4.77 (d, *J* = 8.4 Hz, 1H), 4.43 (d, *J* = 11.6 Hz, 1H), 4.11 (d, *J* = 16.8 Hz, 1H), 3.82 (d, *J* = 10.8 Hz, 1H), 3.69 (t, *J* = 10.8 Hz, 1H), 3.52 (d, *J* = 10.0 Hz, 1H), 2.74 (d, *J* = 12.0 Hz, 1H), 2.42 (s, 3H), 2.41 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 197.0, 143.8, 138.4, 137.4, 134.2, 133.6, 132.4, 132.0, 131.8, 130.9, 130.8, 130.6, 129.8, 129.8, 129.2, 128.3, 128.1, 127.7, 127.7, 126.7, 122.3, 47.5, 45.8, 40.0, 21.5, 21.2, 7.7; HRMS (ESI/Q-TOF) *m/z* [M+Na]$^{+}$ calcd for $C_{29}H_{26}INNaO_3S$ 618.0570, found 618.0570 (0 ppm).



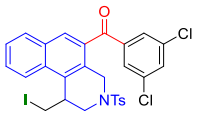
(3-chlorophenyl)(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)methanone (2n): light yellow solid; 91.2 mg; 74% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.93 (d, *J* = 8.4 Hz, 1H), 7.84−7.80 (m, 5H), 7.78−7.68 (m, 2H), 7.63−7.55 (m, 2H), 7.45 (t, *J* = 8.0 Hz, 1H), 7.38 (d, *J* = 8.0 Hz, 2H), 4.76 (d, *J* = 16.4 Hz, 1H), 4.44 (d, *J* = 10.4 Hz, 1H), 4.10 (d, *J* = 16.4 Hz, 1H), 3.84 (d, *J* = 10.8 Hz, 1H), 3.70 (t, *J* = 10.8 Hz, 1H), 3.53 (d, *J* = 10.4 Hz, 1H), 2.76 (d, *J* = 11.6 Hz, 1H), 2.44 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 195.4, 144.0, 139.1, 134.9, 133.3, 132.7, 132.4, 132.1, 131.3, 130.9, 130.1, 130.0, 129.9, 129.8, 129.6, 128.5, 128.2, 127.8, 126.9, 122.5, 47.5, 45.9, 40.2, 21.5, 7.6 (One of the peak of aryl group is overlapped in ^{13}C NMR spectrum); HRMS (ESI/Q-TOF) *m/z* [M+H]$^{+}$ calcd for $C_{28}H_{24}ClINO_3S$ 616.0205, found 616.0205 (0 ppm).



(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)(2-methoxy-5-nitrophenyl)methanone (2o): light yellow solid; 61.7 mg; 47% yield; ^{1}H NMR (600 MHz, $CDCl_3$) δ ppm 8.42 (dd, J = 9.6 Hz 3.0 Hz, 1H), 8.32 (d, J = 2.4 Hz, 1H), 7.92 (d, J = 8.4 Hz, 1H), 7.86−7.82 (m, 3H), 7.78−7.73 (m, 2H), 7.54 (t, J = 7.8 Hz, 1H), 7.40 (d, J = 8.4 Hz, 2H), 7.13 (d, J = 9.0 Hz, 1H), 5.07 (d, J = 17.4 Hz, 1H), 4.46 (d, J = 11.4 Hz, 1H), 4.22 (d, J = 16.8 Hz, 1H), 3.85−3.83 (m, 4H), 3.72 (t, J = 10.8 Hz, 1H), 3.53 (d, J = 10.2 Hz, 1H), 2.78 (d, J = 12.0 Hz, 1H), 2.45 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ ppm 194.6, 162.2, 143.9, 141.1, 133.5, 132.9, 132.7, 132.6, 132.4, 131.1, 130.3, 130.1, 129.9, 129.6, 128.8, 128.2, 127.8, 126.8, 125.8, 122.5, 111.7, 56.7, 48.1, 45.7, 40.2, 21.5, 7.7; HRMS (ESI/Q-Orbitrap) m/z $[M+H]^+$ calcd for $C_{29}H_{26}IN_2O_6S$ 657.0551, found 657.0551 (0 ppm).

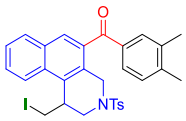


(3,5-dimethylphenyl)(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)methanone (2p): light yellow solid; 80.5 mg; 66% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.92 (d, J = 8.4 Hz, 1H), 7.82−7.77 (m, 4H), 7.70 (t, J = 7.6 Hz, 1H), 7.54 (t, J = 7.6 Hz, 1H), 7.42 (s, 2H), 7.36 (d, J = 7.6 Hz, 2H), 7.28 (s, 1H), 4.75 (d, J = 16.4 Hz, 1H), 4.44 (d, J = 12.0 Hz, 1H), 4.10 (d, J = 16.8 Hz, 1H), 3.83 (d, J = 11.2 Hz, 1H), 3.70 (t, J = 10.8 Hz, 1H), 3.53 (d, J = 10.0 Hz, 1H), 2.75 (d, J = 11.6 Hz, 1H), 2.42 (s, 3H), 2.36 (s, 6H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 197.2, 143.8, 138.2, 137.5, 135.2, 133.9, 132.4, 131.9, 131.8, 131.0, 130.6, 129.8, 129.8, 129.1, 128.1, 127.8, 127.6, 126.6, 122.4, 47.5, 45.9, 40.0, 21.5, 21.1, 7.7; HRMS (ESI/Q-TOF) m/z $[M+H]^+$ calcd for $C_{30}H_{29}INO_3S$ 610.0907, found 610.0906 (0.2 ppm).

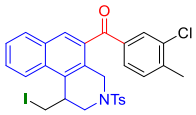


(3,5-dichlorophenyl)(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)methanone (2q): yellow solid; 97.6 mg; 75% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.93 (d, J = 8.4 Hz, 1H), 7.85 (d, J = 8.0 Hz, 1H), 7.81−7.74 (m, 4H), 7.67 (d, J = 0.8 Hz, 2H), 7.60−7.57 (m, 2H), 7.39 (d, J = 7.6 Hz, 2H), 4.76 (d, J = 16.4 Hz, 1H), 4.44 (d, J = 11.6 Hz, 1H), 4.09 (d, J = 16.8 Hz, 1H), 3.84 (d, J = 10.8 Hz, 1H), 3.69 (t, J = 10.8 Hz, 1H), 3.52 (d, J = 10.4 Hz, 1H), 2.75 (d, J = 11.6 Hz, 1H), 2.44 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 194.0, 144.0, 140.2, 135.5, 132.9, 132.7, 132.4, 132.3, 132.0, 131.6, 130.8, 130.1, 129.9,

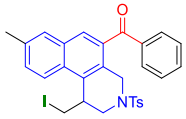
128.5, 128.2, 127.8, 127.0, 122.5, 47.5, 45.8, 40.1, 21.5, 7.5; HRMS (ESI/Q-TOF) *m/z* $[M+H]^+$ calcd for $C_{28}H_{23}Cl_2INO_3S$ 649.9815, found 649.9815 (0 ppm).



(3,4-dimethylphenyl)(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl) methanone (2r): yellow solid; 95.1 mg; 78% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.93 (d, *J* = 8.8 Hz, 1H), 7.82−7.77 (m, 4H), 7.73−7.68 (m, 1H), 7.64 (s, 1H), 7.57−7.52 (m, 2H), 7.36 (d, *J* = 8.0 Hz, 2H), 7.26−7.23 (m, 2H), 4.73 (d, *J* = 16.4 Hz, 1H), 4.44 (d, *J* = 11.6 Hz, 1H), 4.11 (d, *J* = 16.4 Hz, 1H), 3.84 (d, *J* = 10.8 Hz, 1H), 3.71 (t, *J* = 10.8 Hz, 1H), 3.54 (d, *J* = 10.0 Hz, 1H), 2.76 (d, *J* = 11.6 Hz, 1H), 2.43 (s, 3H), 2.37 (s, 3H), 2.32 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 196.9, 143.9, 143.4, 137.1, 135.2, 134.1, 132.5, 132.0, 131.8, 131.3, 131.1, 130.5, 129.9, 129.8, 129.8, 129.1, 128.4, 128.2, 127.9, 126.7, 122.5, 47.5, 46.0, 40.2, 21.5, 20.2, 19.8, 7.8; HRMS (ESI/Q-TOF) *m/z* $[M+Na]^+$ calcd for $C_{30}H_{28}INNaO_3S$ 632.0727, found 632.0727 (0 ppm).

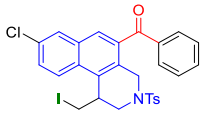


(3-chloro-4-methylphenyl)(1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)methanone (2s): yellow solid; 107.1 mg; 85% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.91 (d, *J* = 8.4 Hz, 1H), 7.82−7.77 (m, 5H), 7.73−7.69 (m, 1H), 7.61−7.53 (m, 2H), 7.38−7.34 (m, 3H), 7.56 (d, *J* = 16.4 Hz, 1H), 4.43 (d, *J* = 12.0 Hz, 1H), 4.09 (d, *J* = 16.4 Hz, 1H), 3.82 (d, *J* = 10.8 Hz, 1H), 3.68 (t, *J* = 10.8 Hz, 1H), 3.51 (d, *J* = 10.8 Hz, 1H), 2.74 (d, *J* = 12.0 Hz, 1H), 2.47 (s, 3H), 2.43 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 195.1, 143.9, 142.2, 136.6, 134.8, 132.9, 132.3, 132.2, 131.9, 130.9, 130.9, 130.9, 130.6, 129.9, 129.8, 129.3, 128.6, 128.0, 127.7, 126.8, 122.4, 47.4, 45.8, 40.0, 21.5, 20.4, 7.6; HRMS (ESI/Q-TOF) *m/z* $[M+Na]^+$ calcd for $C_{29}H_{25}ClINNaO_3S$ 652.0181, found 652.0181 (0 ppm).

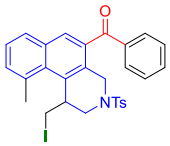


(1-(iodomethyl)-8-methyl-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)(phenyl)met hanone (2t): light yellow solid; 104.8 mg; 88% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.84−7.78 (m, 5H), 7.74 (s, 1H), 7.65 (t, *J* = 7.6 Hz, 1H), 7.58−7.48 (m, 4H), 7.37 (d, *J* = 8.0 Hz, 2H), 4.75 (d, *J* = 16.4 Hz, 1H), 4.42 (d, *J* = 12.0 Hz, 1H), 4.10 (d, *J* = 16.4 Hz, 1H), 3.81 (d, *J* = 10.8 Hz, 1H), 3.70 (t, *J* = 10.8 Hz, 1H), 3.52 (d, *J* = 9.6 Hz, 1H), 2.75 (d, *J* = 12.0 Hz, 1H), 2.51 (s, 3H), 2.43 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 197.0, 143.9, 137.6,

136.7, 133.5, 133.4, 132.5, 132.0, 131.5, 131.3, 130.6, 130.4, 130.2, 129.9, 128.9, 128.5, 127.9, 127.3, 122.3, 47.6, 45.9, 40.2, 21.5, 21.3, 7.9; HRMS (ESI/Q-TOF) *m*/*z* $[M+Na]^+$ calcd for $C_{29}H_{26}INNaO_3S$ 618.0570, found 618.0569 (0.2 ppm).

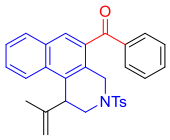


(8-chloro-1-(iodomethyl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)(phenyl)methanone (2u): deep yellow solid; 76.4 mg; 62% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.86−7.81 (m, 3H), 7.76 (d, *J* = 8.0 Hz, 3H), 7.70−7.60 (m, 3H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.36 (d, *J* = 8.0 Hz, 2H), 4.73 (d, *J* = 16.4 Hz, 1H), 4.42 (d, *J* = 12.0 Hz, 1H), 4.07 (d, *J* = 12.4 Hz, 1H), 3.78 (d, *J* = 10.8 Hz, 1H), 3.68 (t, *J* = 10.8 Hz, 1H), 3.45 (d, *J* = 9.6 Hz, 1H), 2.75 (d, *J* = 11.6 Hz, 1H), 2.43 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 196.4, 143.9, 137.0, 134.7, 133.7, 132.6, 132.4, 132.3, 131.8, 130.3, 130.1, 129.8, 129.8, 129.5, 128.6, 128.4, 128.3, 127.7, 124.2, 47.4, 45.7, 40.1, 21.5, 7.3; HRMS (ESI/Q-TOF) *m*/*z* $[M+Na]^+$ calcd for $C_{28}H_{23}ClINNaO_3S$ 638.0024, found 638.0023 (0.2 ppm).



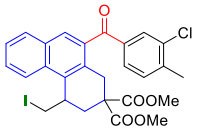
(1-(iodomethyl)-10-methyl-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)(phenyl)methanone (2v): light yellow solid; 91.7 mg; 77% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.80 (dd, *J* = 16.8 Hz 8.0 Hz, 5H), 7.73 (s, 1H), 7.64 (t, *J* = 7.6 Hz, 1H), 7.56−7.47 (m, 4H), 7.36 (d, *J* = 8.0 Hz, 2H), 4.76 (d, *J* = 16.4 Hz, 1H), 4.42 (d, *J* = 11.6 Hz, 1H), 4.09 (d, *J* = 16.8 Hz, 1H), 3.79 (d, *J* = 11.6 Hz, 1H), 3.69 (t, *J* = 10.4 Hz, 1H), 3.51 (d, *J* = 10.0 Hz, 1H), 2.73 (d, *J* = 11.6 Hz, 1H), 2.49 (s, 3H), 2.42 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 196.9, 143.8, 137.5, 136.6, 133.4, 133.3, 132.4, 131.9, 131.4, 131.2, 130.6, 130.3, 130.1, 129.8, 128.8, 128.4, 127.8, 127.2, 122.2, 47.5, 45.8, 40.1, 21.5, 21.3, 7.88; HRMS (ESI/Q-TOF) *m*/*z* $[M+Na]^+$ calcd for $C_{29}H_{26}INNaO_3S$ 618.0570, found 618.0571 (0.2 ppm).

Characterization Data of 2y and 2z



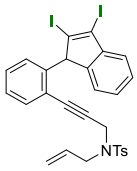
phenyl(1-(prop-1-en-2-yl)-3-tosyl-1,2,3,4-tetrahydrobenzo[f]isoquinolin-5-yl)methanone (2y): yellow solid; 67.4 mg; 70% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.89−7.83 (m, 3H), 7.79−7.71 (m, 4H), 7.64 (t, *J* = 7.6 Hz, 1H), 7.59−7.55 (m, 1H), 7.51−7.46 (m, 3H), 7.32

(d, *J* = 8.0 Hz, 2H), 5.01 (m, 1H), 4.78 (d, *J* = 16.4 Hz, 1H), 4.48 (s, 1H), 4.23 (d, *J* = 16.4 Hz, 1H), 4.10−4.04 (m, 2H), 2.93 (dd, *J* = 11.6 Hz 3.6 Hz, 1H), 2.41 (s, 3H), 1.96 (s, 3H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 197.2, 145.1, 143.5, 137.7, 133.5, 133.3, 133.1, 132.9, 132.4, 130.8, 130.5, 130.4, 129.7, 129.3, 128.6, 128.5, 128.3, 127.7, 126.4, 123.9, 115.9, 47.1, 47.0, 43.6, 21.8, 21.5; HRMS (ESI/Q-TOF) *m*/*z* $[M+H]^+$ calcd for $C_{30}H_{28}NO_3S$ 482.1784, found 482.1784 (0 ppm).

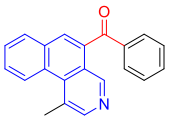


dimethyl 10-(3-chloro-4-methylbenzoyl)-4-(iodomethyl)-3,4-dihydrophenanthrene-2, 2(1H)-dicarboxylate (2z): yellow solid; 89.8 mg; 76% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.92 (d, *J* = 8.8 Hz, 1H), 7.83 (d, *J* = 7.6 Hz, 2H), 7.71 (s, 1H), 7.68−7.63 (m, 2H), 7.53 (t, *J* = 7.6 Hz, 1H), 7.35 (d, *J* = 7.6 Hz, 1H), 4.15 (d, *J* = 7.2 Hz, 1H), 3.74 (s, 3H), 3.65 (d, *J* = 12.0 Hz, 1H), 3.46 (s, 3H), 3.34 (s, 2H), 3.29 (t, *J* = 10.0 Hz, 1H), 3.07−3.02 (m, 1H), 2.46 (s, 3H), 2.36−2.27 (m, 1H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 196.2, 171.8, 170.6, 142.3, 136.9, 136.7, 134.8, 133.9, 131.7, 131.5, 131.1, 130.8, 130.3, 129.7, 128.5, 128.3, 128.2, 126.3, 122.8, 54.1, 52.9, 52.6, 35.7, 35.2, 33.8, 20.5, 14.8; HRMS (ESI/Q-TOF) *m*/*z* $[M+H]^+$ calcd for $C_{27}H_{25}ClIO_5$ 591.0430, found 591.0430 (0 ppm).

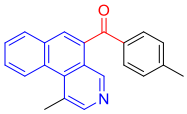
Characterization Data of 3a, 4a−4c, 4i, 4j and Int-C



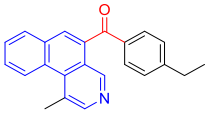
N-allyl-N-(3-(2-(2,3-diiodo-1H-inden-1-yl)phenyl)prop-2-yn-1-yl)-4-methylbenzenesulfo namide (3a): yellow solid; 88.4 mg; 64% yield; ^{1}H NMR (600 MHz, $CDCl_3$) δ ppm 7.76 (d, *J* = 8.4 Hz, 2H), 7.34−7.30 (m, 2H), 7.22−7.21 (m, 1H), 7.18−7.15 (m, 3H), 7.13−7.09 (m, 2H), 7.01 (d, *J* = 7.2 Hz, 1H), 6.44 (d, *J* = 7.8 Hz, 1H), 5.82−5.76 (m, 1H), 5.30−5.21 (m, 2H), 4.93 (s, 1H), 4.43 (d, *J* = 5.4 Hz, 2H), 3.97−3.94 (m, 2H), 2.23 (m, 3H); $^{13}C\{^{1}H\}$ NMR (150 MHz, $CDCl_3$) δ ppm 147.2, 145.0, 143.5, 139.7, 136.2, 132.7, 132.1, 129.5, 129.3, 127.8, 127.6, 127.2, 126.7, 126.6, 123.3, 123.1, 122.9, 119.9, 116.4, 110.1, 87.1, 84.0, 62.2, 49.3, 36.8, 21.5; HRMS (ESI/Q-Orbitrap) *m*/*z* $[M+H]^+$ calcd for $C_{28}H_{24}I_2NO_2S$ 691.9612, found 691.9607 (0.7 ppm).



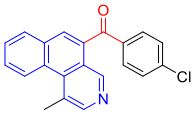
(1-methylbenzo[f]isoquinolin-5-yl)(phenyl)methanone (4a): white solid; 95% yield; ^{1}H NMR (600 MHz, $CDCl_3$) δ ppm 9.25 (s, 1H), 8.95 (d, J = 8.4 Hz, 1H), 8.62 (s, 1H), 7.94−7.91 (m, 3H), 7.88 (s, 1H), 7.79−7.72 (m, 2H), 7.46 (t, J = 7.8 Hz, 2H), 3.10 (s, 3H); ^{13}C{^{1}H} NMR (150 MHz, $CDCl_3$) δ ppm 196.9, 148.9, 148.4, 137.7, 134.9, 134.7, 133.7, 132.7, 130.7, 130.3, 130.2, 129.9, 128.7, 128.6, 128.3, 128.0, 127.9, 125.3, 23.8; HRMS (ESI/Q-Orbitrap) m/z $[M+H]^+$ calcd for $C_{21}H_{16}NO$ 298.1226, found 298.1226 (0 ppm).



(1-methylbenzo[f]isoquinolin-5-yl)(p-tolyl)methanone (4b): yellow solid; 88% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.24 (s, 1H), 8.93 (d, J = 8.0 Hz, 1H), 8.60 (s, 1H), 7.92−7.69 (m, 6H), 7.25 (d, J = 7.6 Hz, 2H), 3.08 (s, 3H), 2.41 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 196.5, 148.7, 148.3, 144.7, 135.1, 134.6, 132.6, 130.5, 130.4, 129.8, 129.8, 129.3, 128.6, 128.3, 127.8, 127.8, 125.2, 23.8, 21.6; HRMS (ESI/Q-Orbitrap) m/z $[M+H]^+$ calcd for $C_{22}H_{18}NO$ 312.1383, found 312.1381 (0.6 ppm).

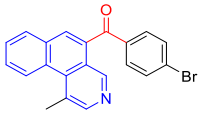


(4-ethylphenyl)(1-methylbenzo[f]isoquinolin-5-yl)methanone (4c): yellow solid; 90% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.25 (s, 1H), 8.89 (d, J = 8.4 Hz, 1H), 8.58 (s, 1H), 7.90−7.82 (m, 4H), 7.74−7.66 (m, 2H), 7.26 (d, J = 8.0 Hz, 2H), 3.05 (s, 3H), 2.69 (q, J = 7.6 Hz, 2H), 1.24 (t, J = 7.6 Hz, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 196.4, 150.7, 148.7, 148.3, 135.2, 135.0, 134.5, 132.6, 130.4, 129.8, 129.7, 128.5, 128.2, 128.0, 127.8, 127.7, 125.2, 28.8, 23.7, 15.0; HRMS (ESI/Q-Orbitrap) m/z $[M+H]^+$ calcd for $C_{23}H_{20}NO$ 326.1539, found 326.1538 (0.3 ppm).

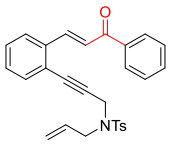


(4-chlorophenyl)(1-methylbenzo[f]isoquinolin-5-yl)methanone (4i): yellow solid; 99% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.22 (s, 1H), 8.95 (d, J = 8.0 Hz, 1H), 8.62 (s, 1H), 7.94 (dd, J = 7.6 Hz 1.6 Hz, 1H), 7.86 (t, J = 8.0 Hz, 3H), 7.81−7.73 (m, 2H), 7.44 (dd, J = 6.8 Hz 2.0 Hz, 2H), 3.10 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 195.6, 149.0, 148.2, 140.2, 136.0, 134.7, 134.3, 132.5, 131.6, 130.8, 130.4, 130.0, 129.0, 128.7, 128.4, 128.2, 127.9, 125.0, 23.8; HRMS (ESI/Q-Orbitrap) m/z $[M+H]^+$ calcd for $C_{21}H_{15}ClNO$

332.0837, found 332.0836 (0.3 ppm).

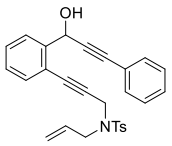


(4-bromophenyl)(1-methylbenzo[f]isoquinolin-5-yl)methanone (4j): yellow solid; 97% yield; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.22 (s, 1H), 8.93 (d, J = 8.0 Hz, 1H), 8.61 (s, 1H), 7.93 (d, J = 7.6 Hz, 1H), 7.86 (s, 1H), 7.80−7.71 (m, 4H), 7.60−7.58 (m, 2H), 3.09 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 195.7, 149.0, 148.2, 136.4, 134.7, 134.2, 132.5, 131.9, 131.6, 130.7, 130.4, 129.9, 129.0, 128.7, 128.4, 128.2, 127.8, 125.0, 23.8; HRMS (ESI/Q-Orbitrap) m/z [M+H]$^{+}$ calcd for $C_{21}H_{15}BrNO$ 376.0332, found 376.0329 (0.8 ppm).



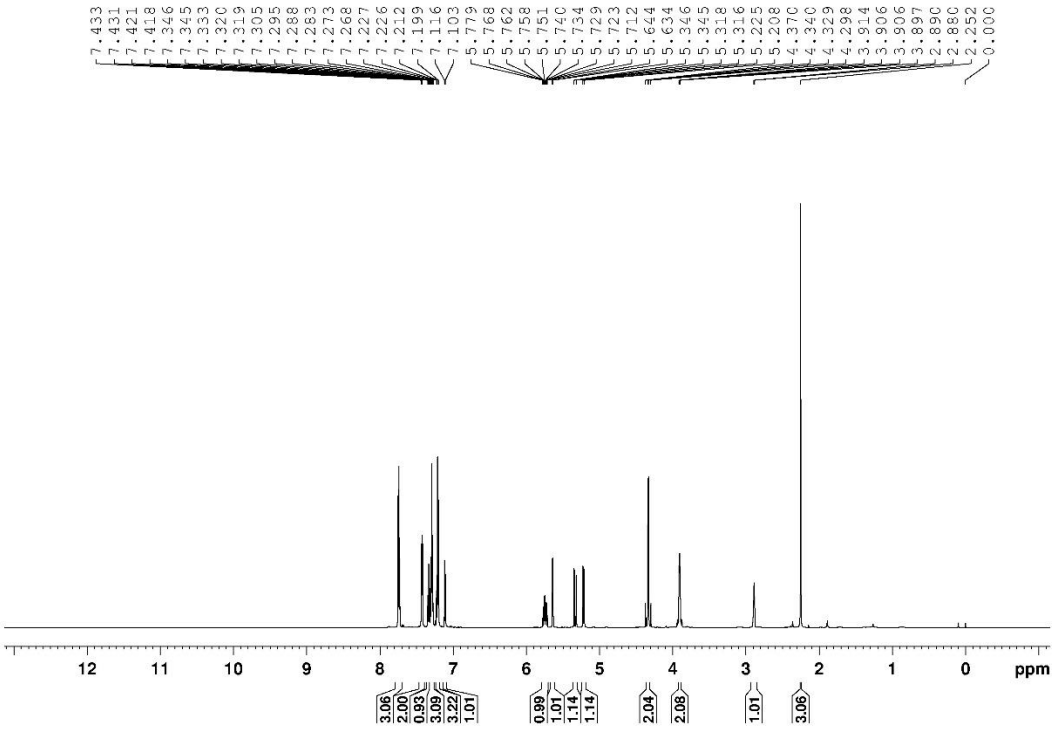
N-allyl-4-methyl-N-(3-(2-(3-oxo-3-phenylprop-1-en-1-yl)phenyl)prop-2-yn-1-yl)benzenesulfonamide (Int-C): light yellow solid; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.02−8.00 (m, 2H), 7.88 (d, J = 15.6 Hz, 1H), 7.74−7.71 (m, 3H), 7.62−7.58 (m, 1H), 7.53−7.47 (m, 3H), 7.36−7.27 (m, 2H), 7.11 (d, J = 8.0 Hz, 3H), 5.85−5.75 (m, 1H), 5.38 (d, J = 16.8 Hz, 1H), 5.29−5.26 (m, 1H), 4.36 (s, 2H), 3.92 (d, J = 6.4 Hz, 2H), 2.18 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ ppm 190.1, 143.4, 141.9, 137.9, 135.9, 135.5, 132.9, 132.9, 131.8, 129.6, 129.4, 128.6, 128.6, 128.4, 127.6, 125.7, 123.5, 123.4, 120.2, 88.0, 83.2, 49.4, 36.7, 21.2; HRMS (ESI/Q-Orbitrap) m/z [M+H]$^{+}$ calcd for $C_{28}H_{26}NO_3S$ 456.1628, found 456.1628 (0 ppm).

^{1}H NMR, ^{13}C NMR, and ^{19}F NMR Spectra

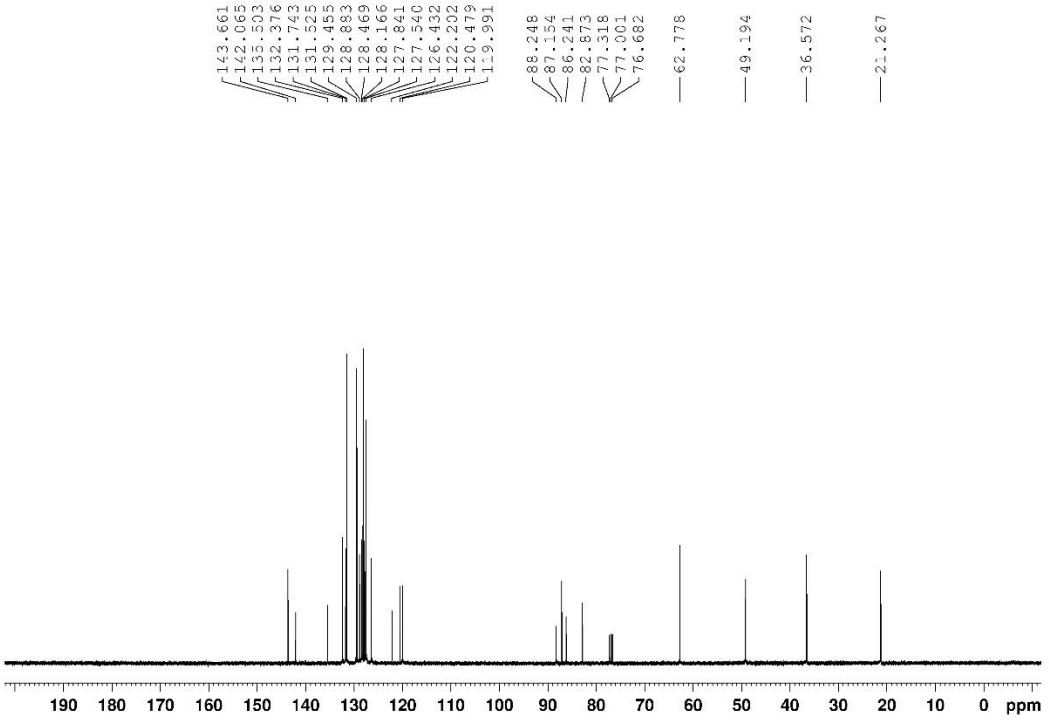


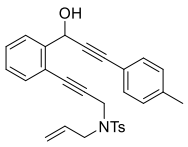
1a

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



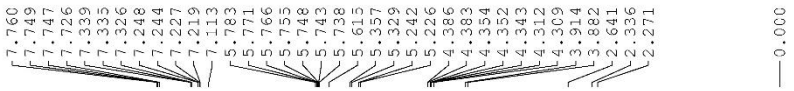
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

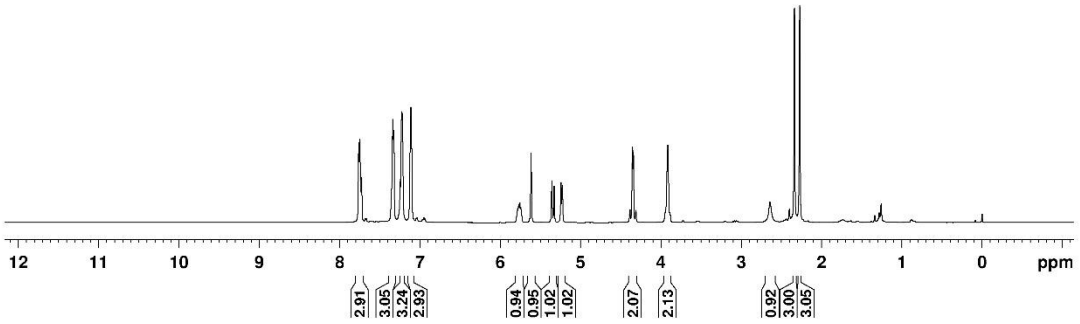




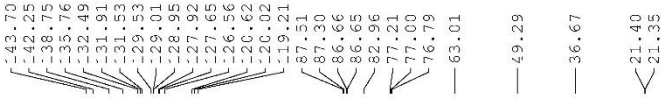
1b

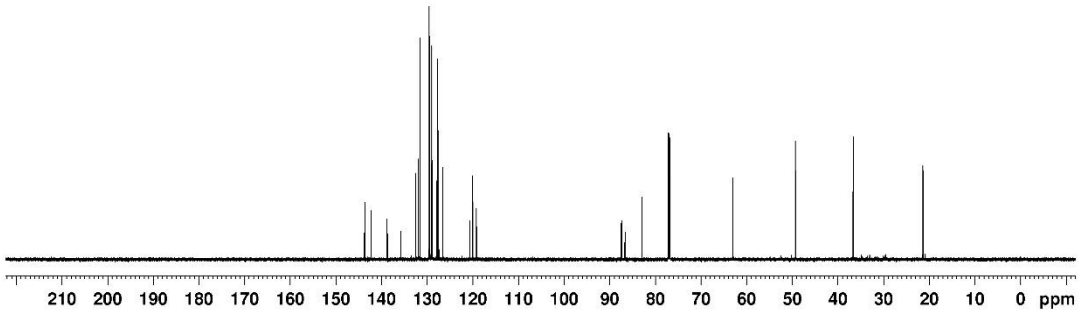
^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.

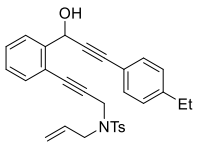




^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.

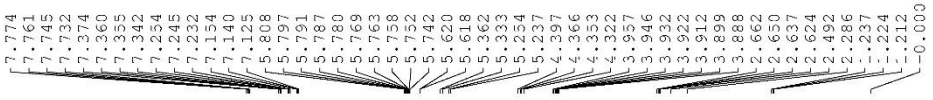


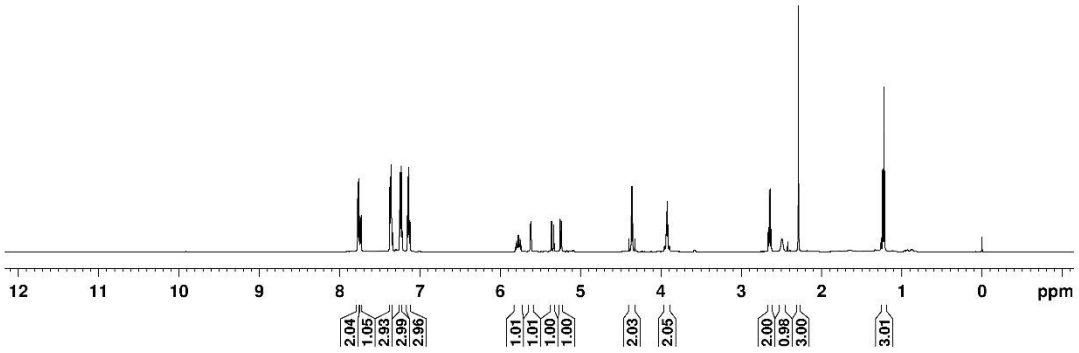




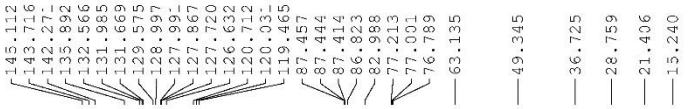
1c

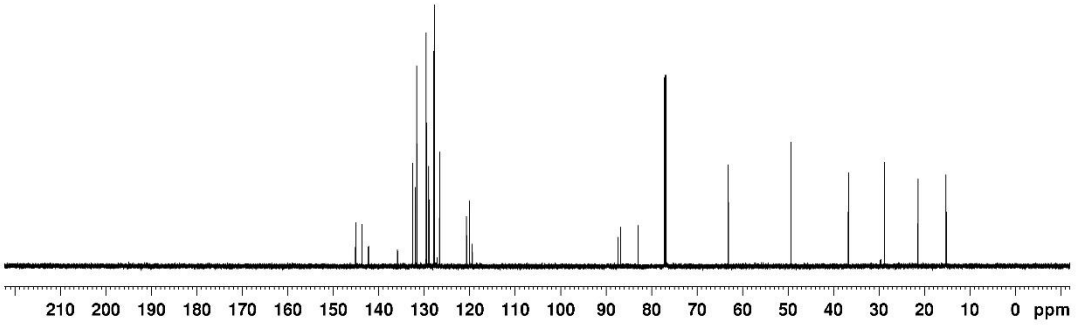
^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.

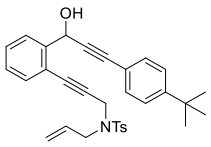




^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.

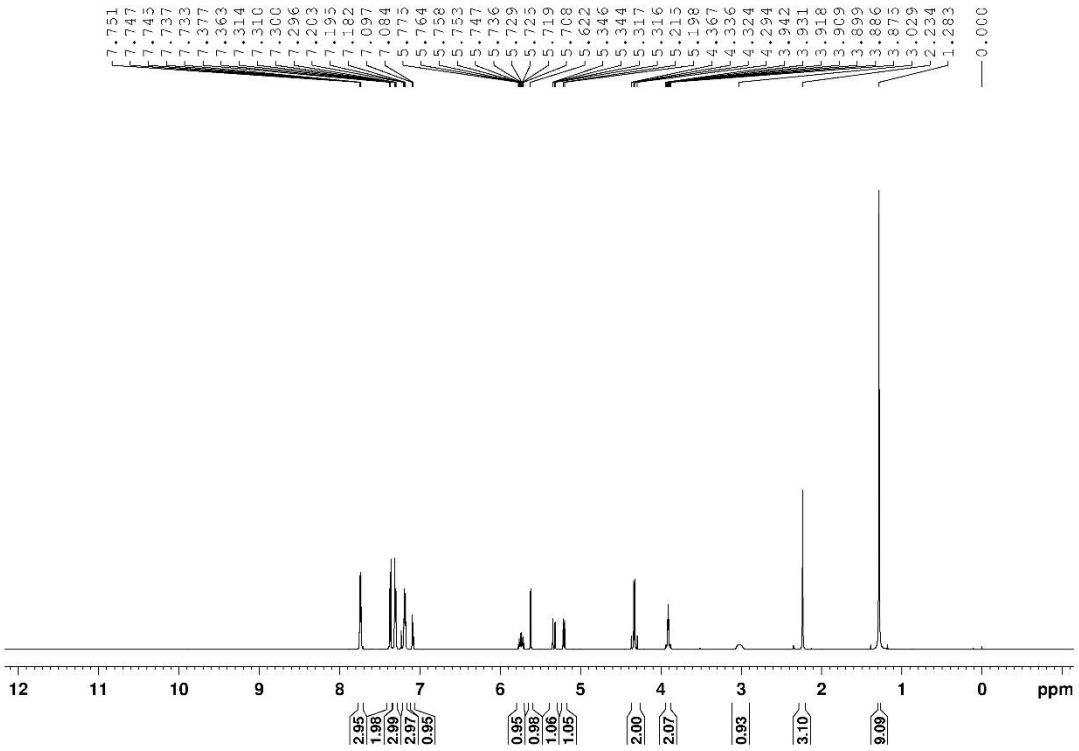




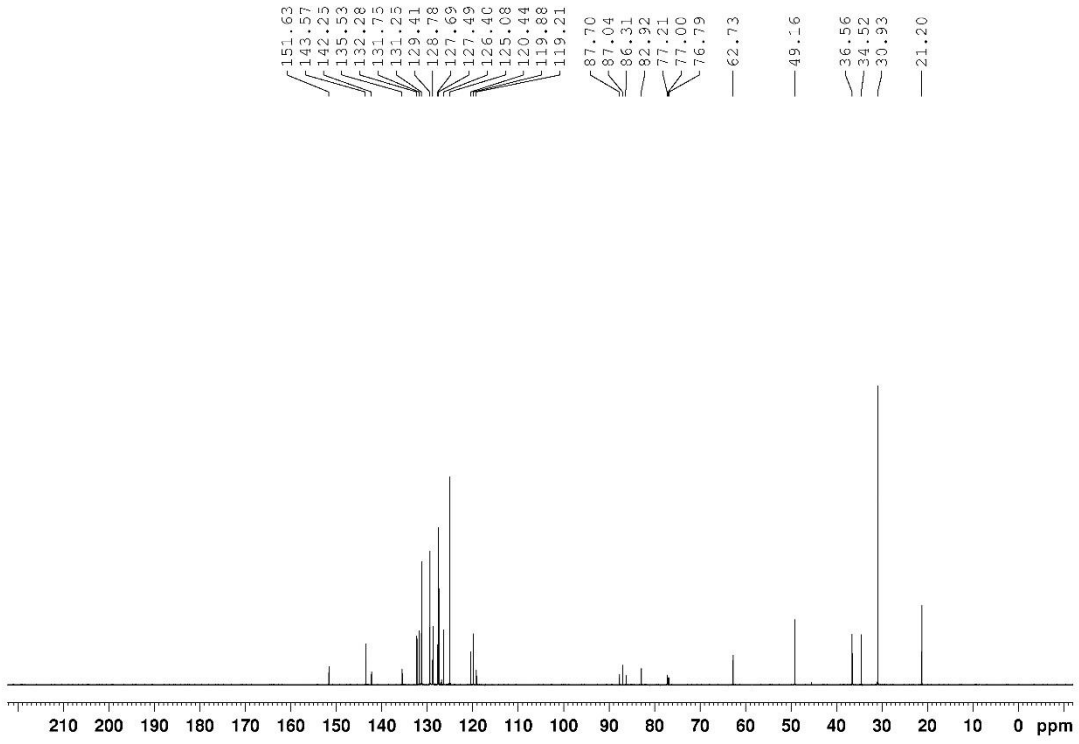


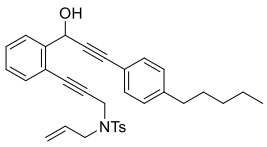
1d

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



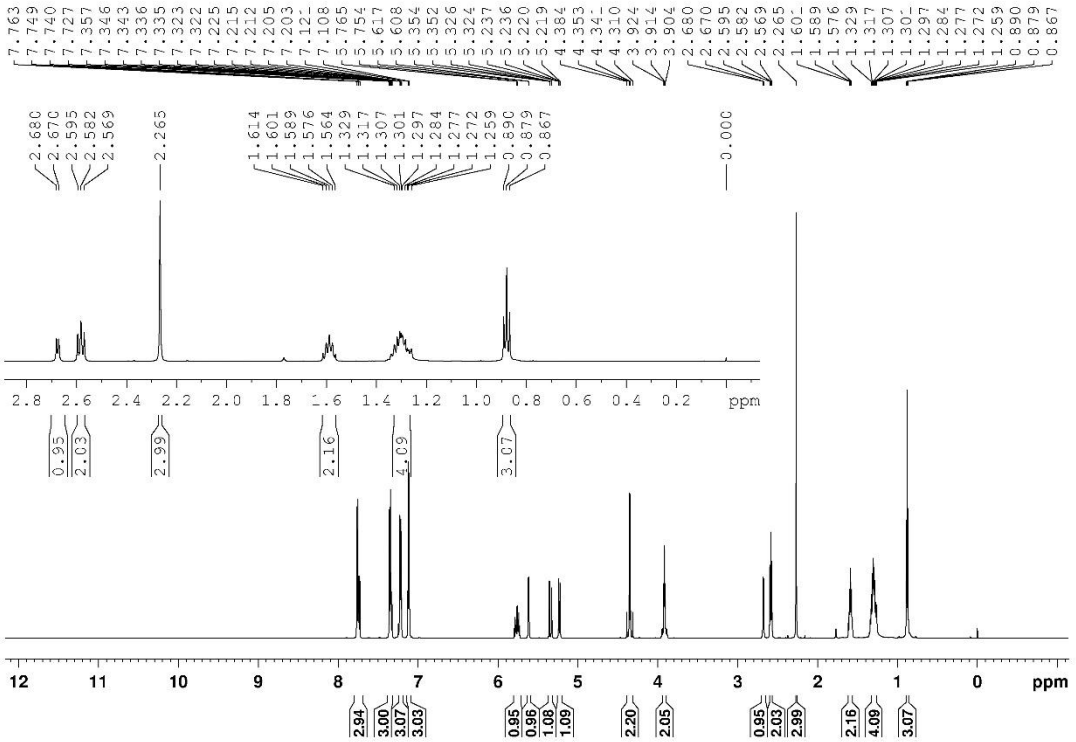
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.



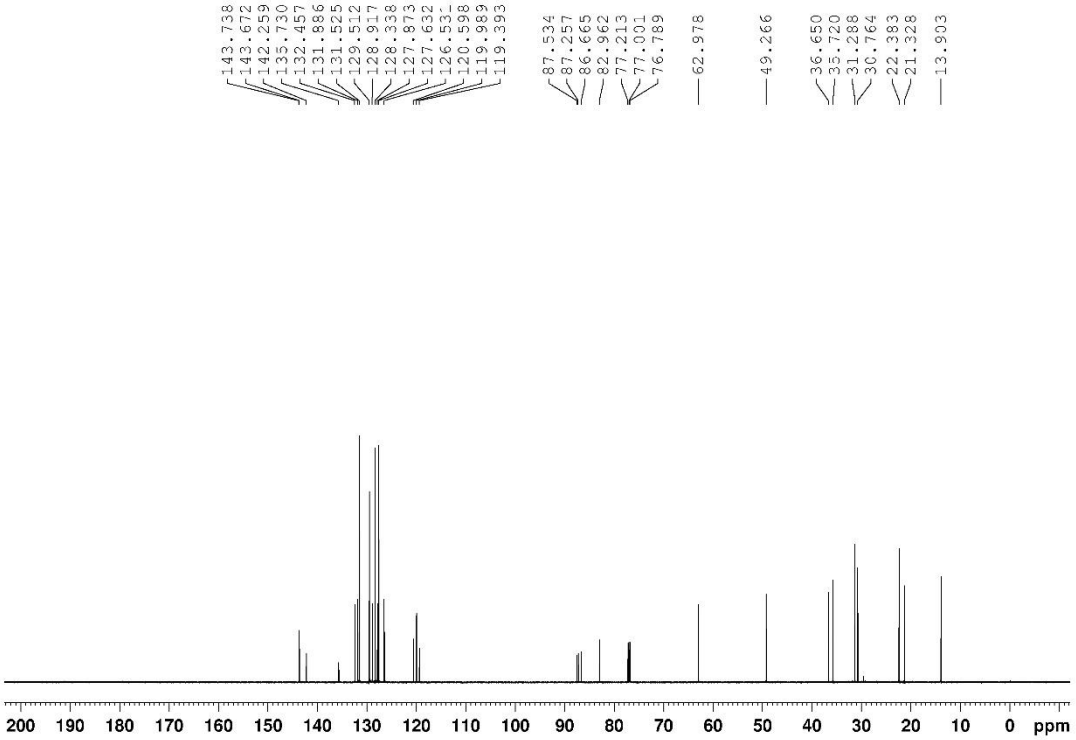


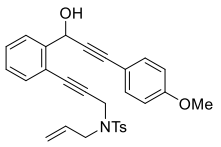
1e

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



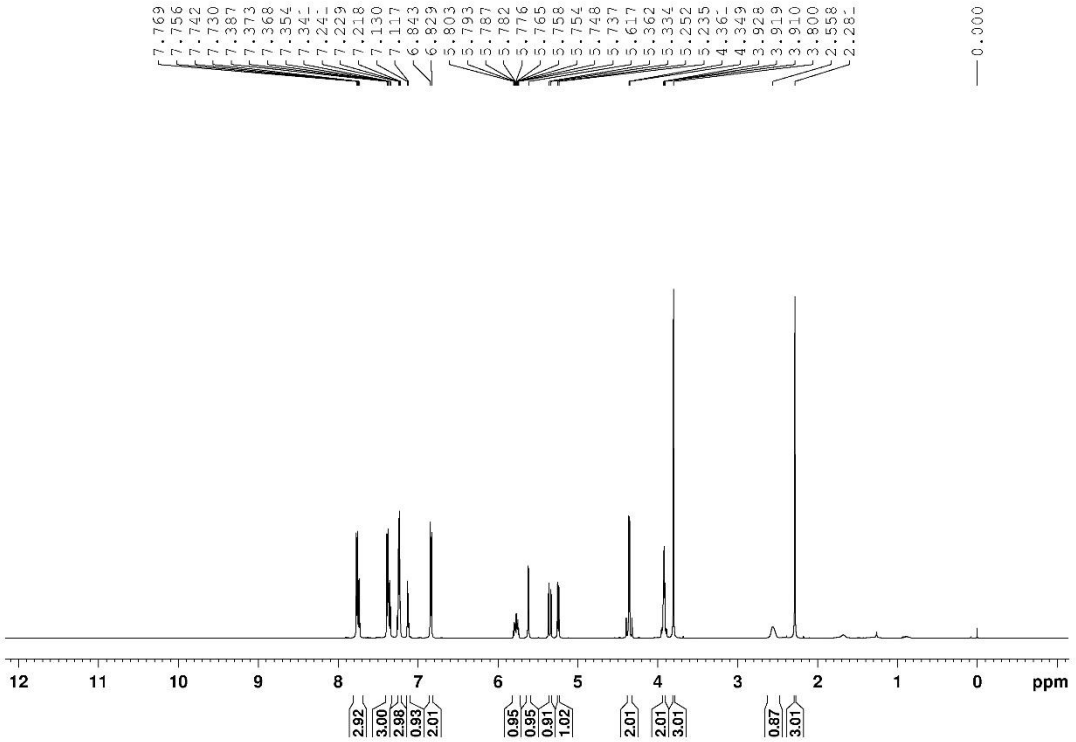
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.



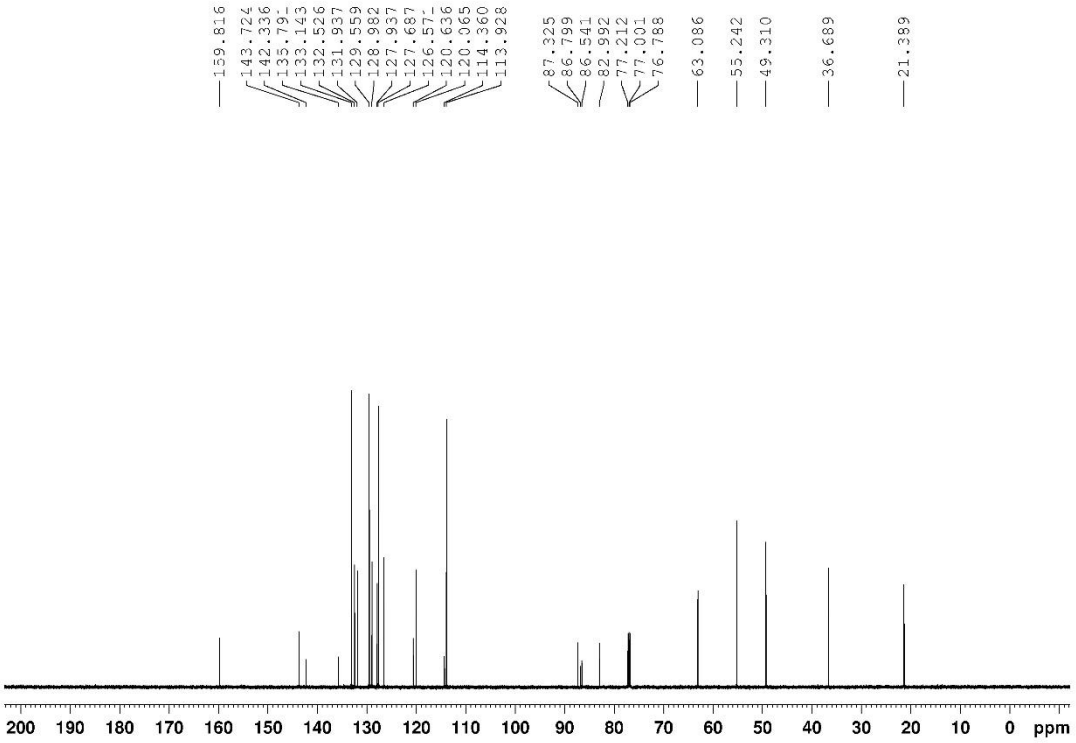


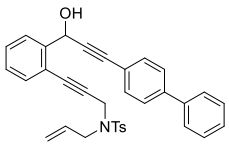
1f

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



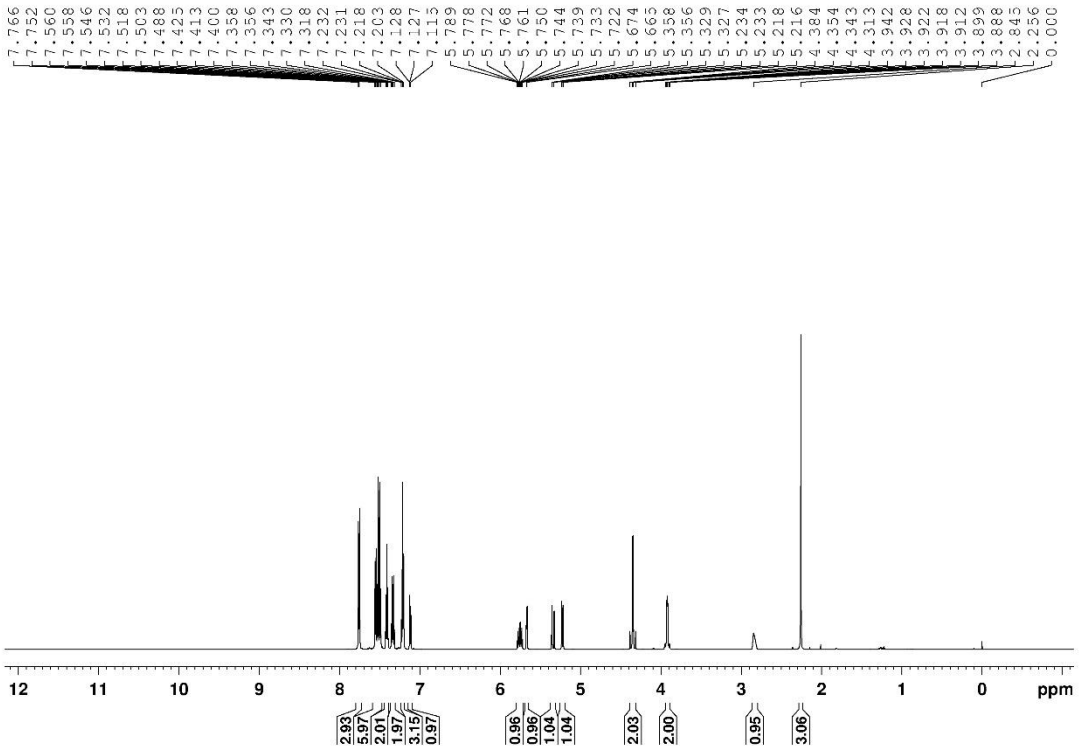
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.



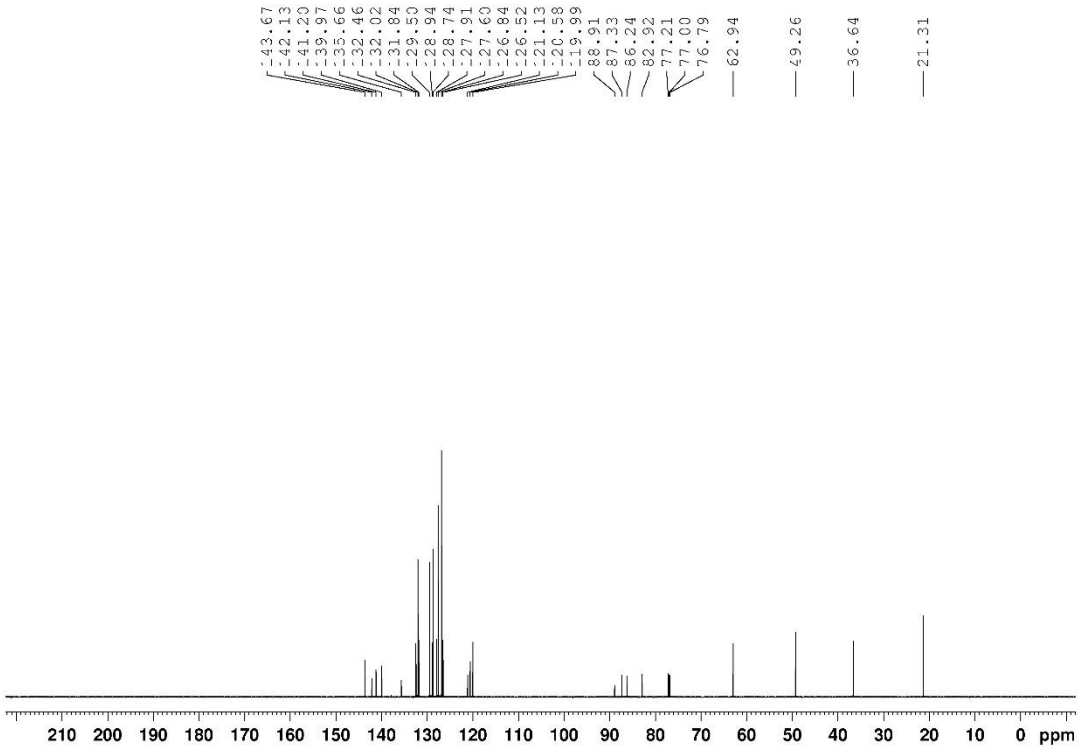


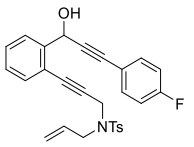
1g

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



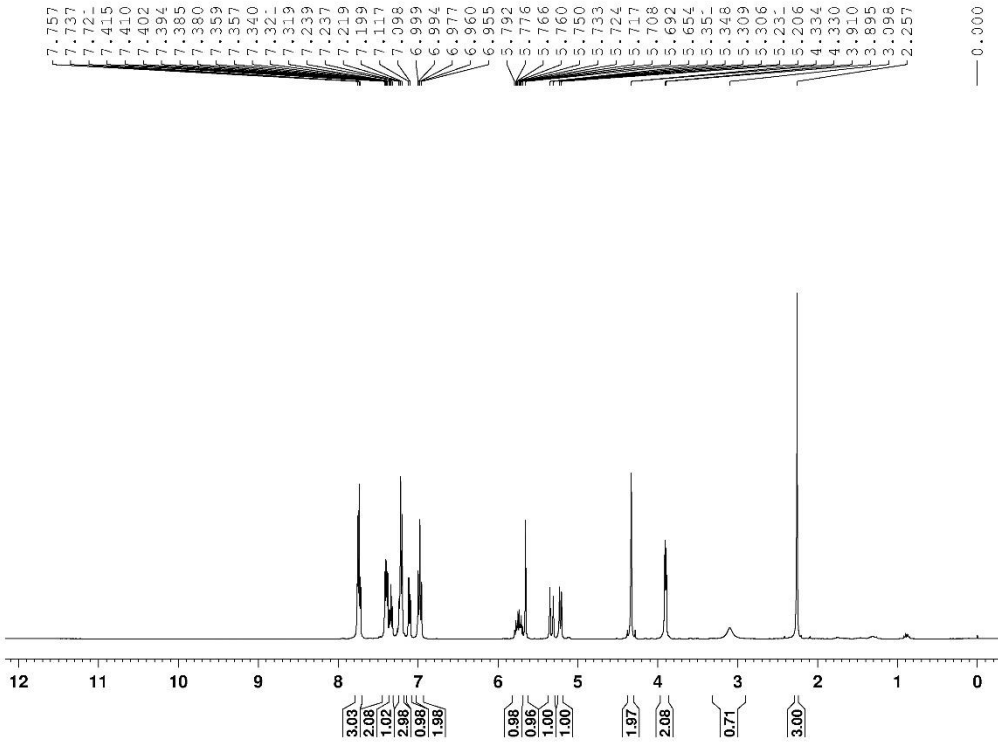
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.



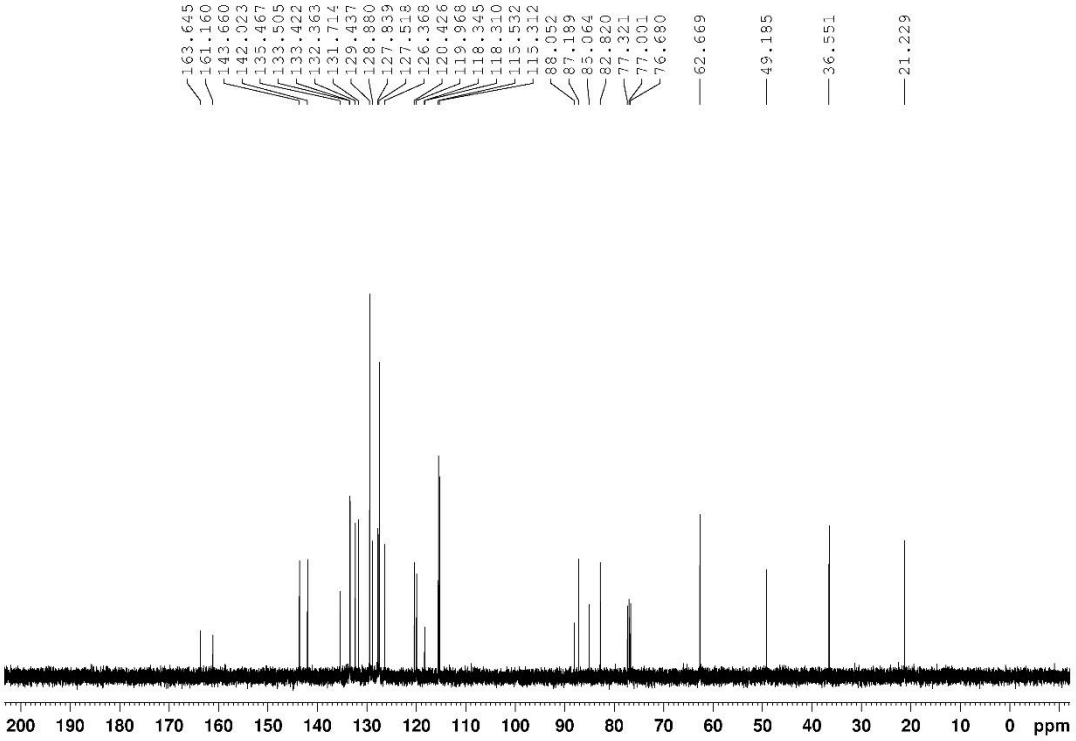


1h

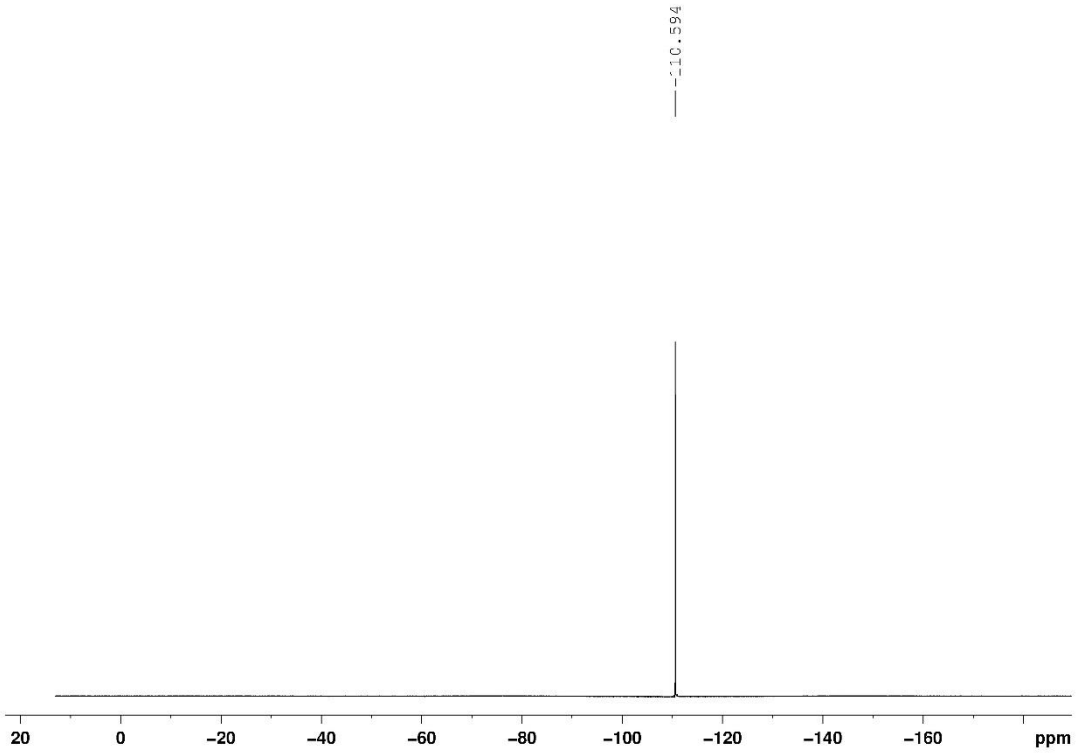
^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.

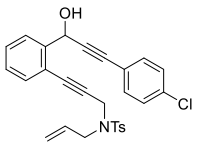


^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



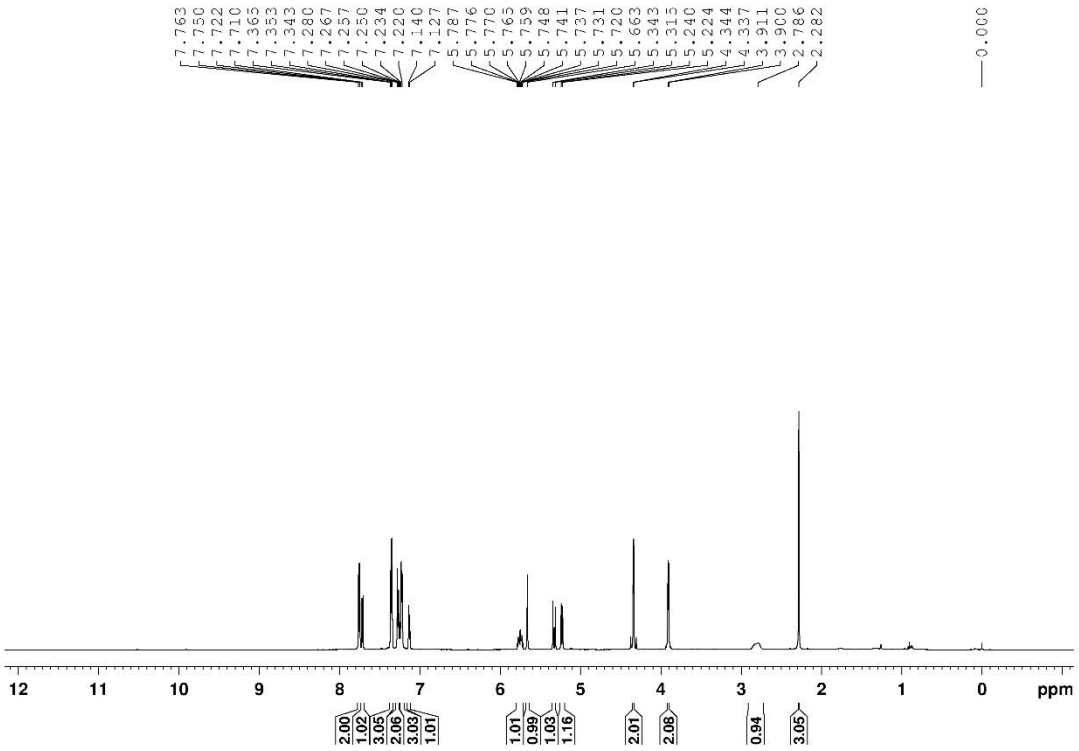
^{19}F NMR spectrum was recorded on 376 MHz in $CDCl_3$.



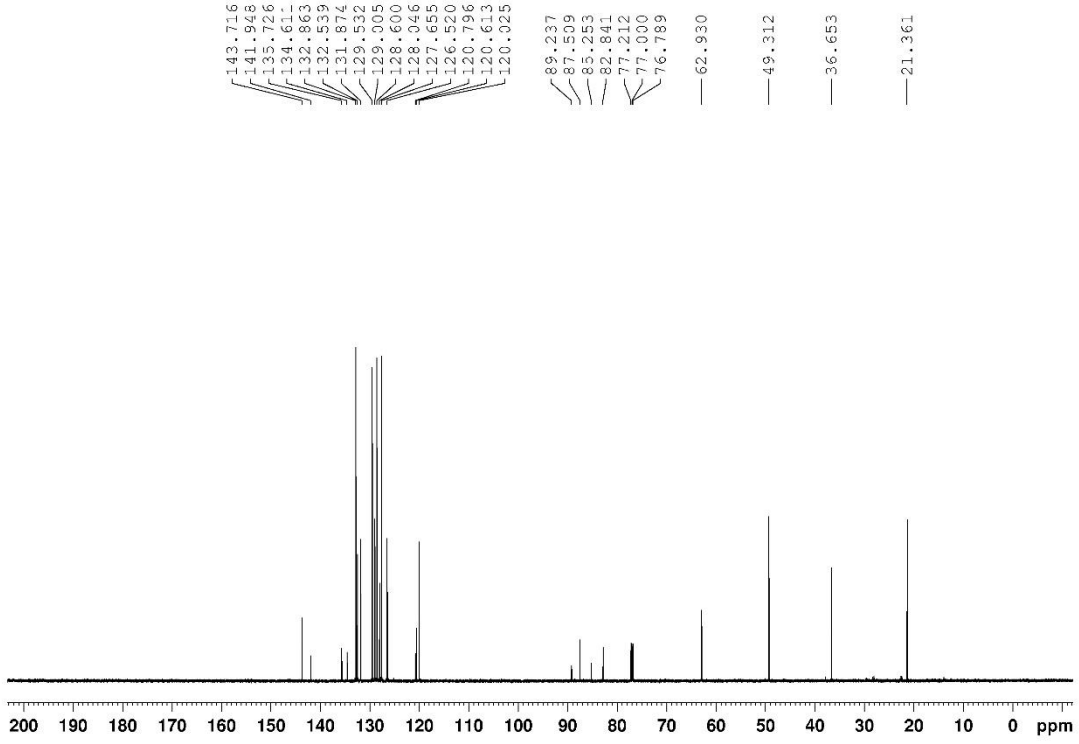


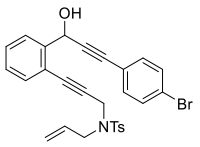
1i

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



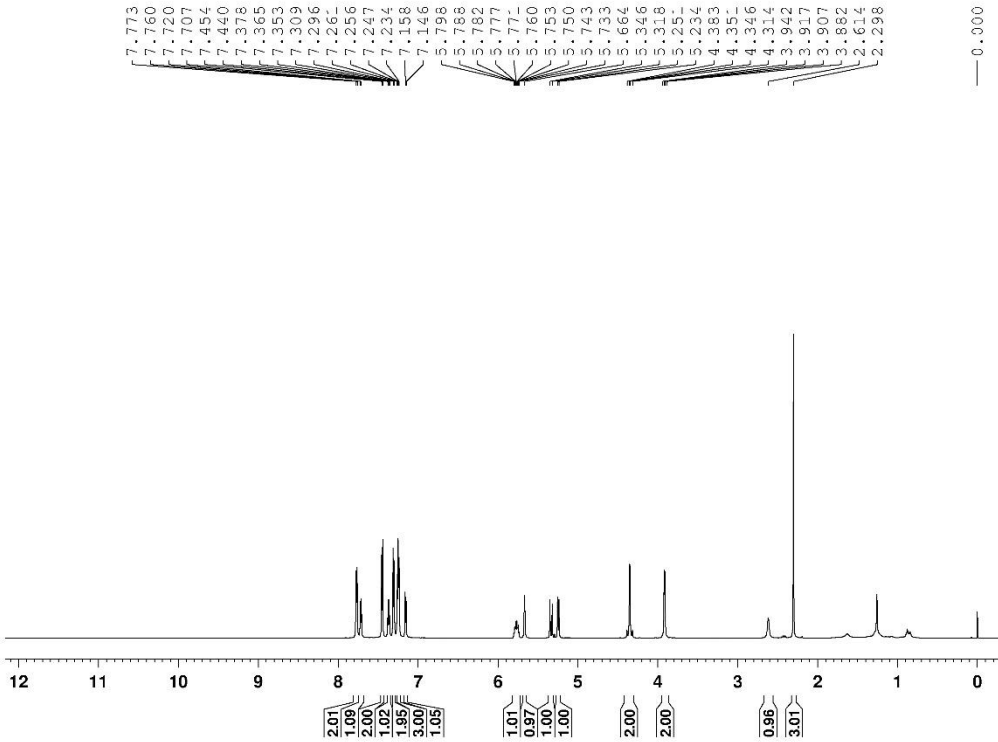
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.



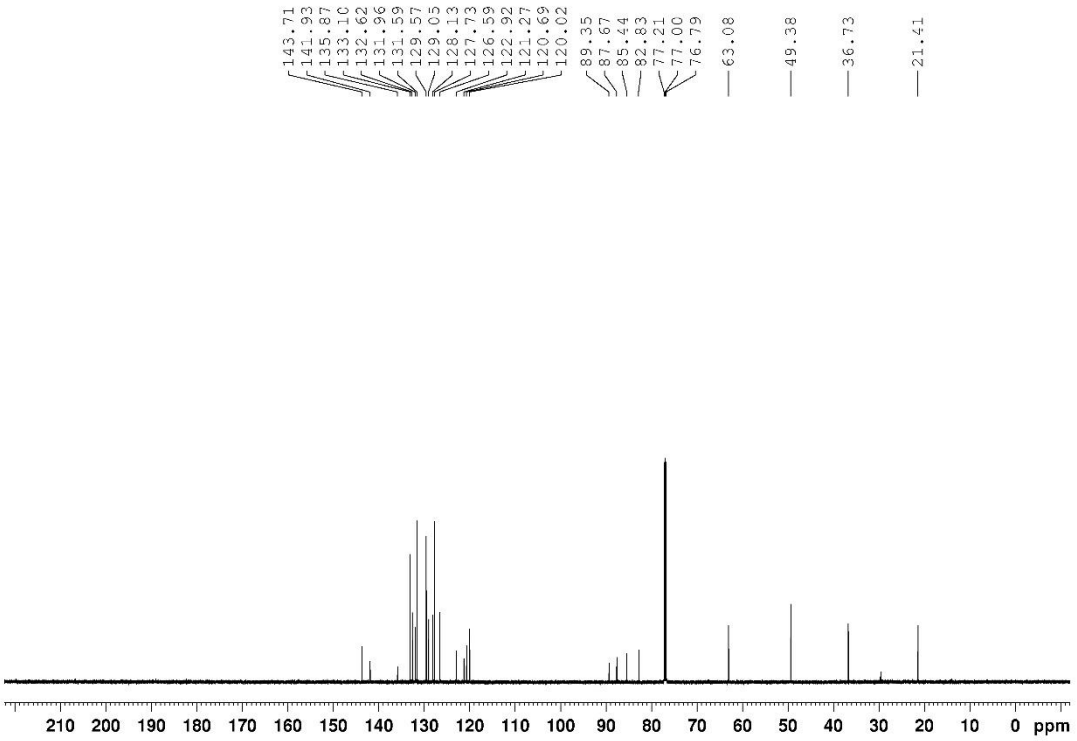


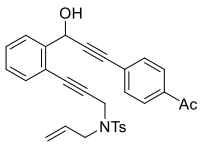
1j

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



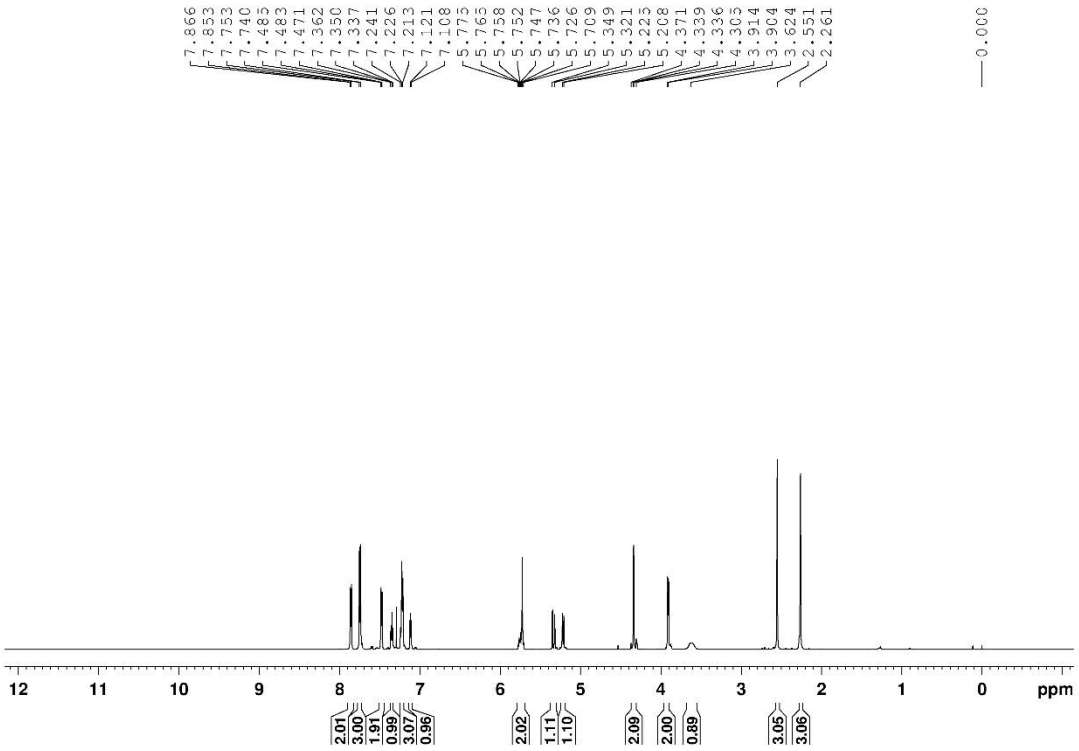
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.



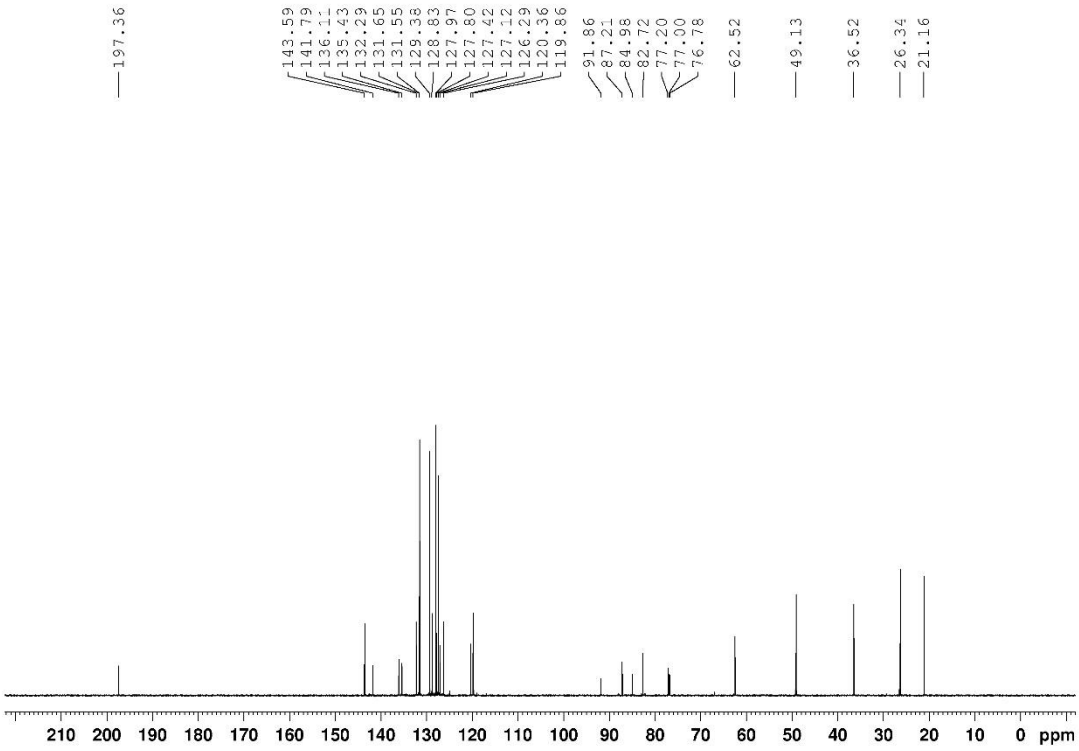


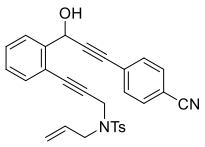
1k

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



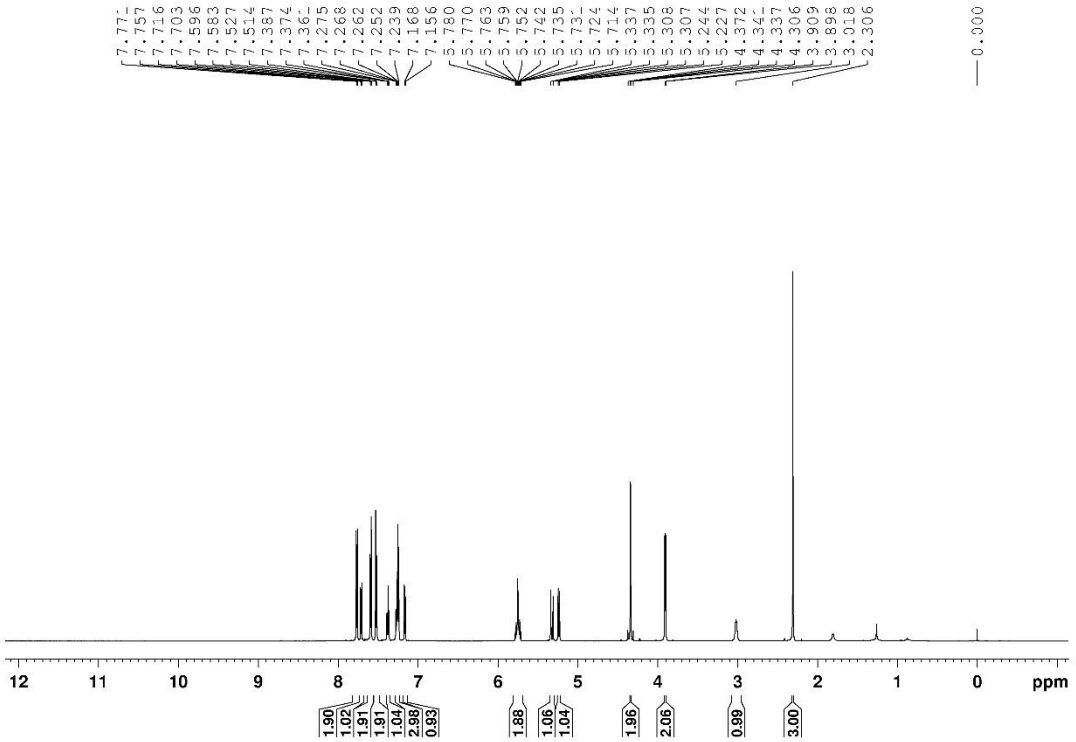
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.



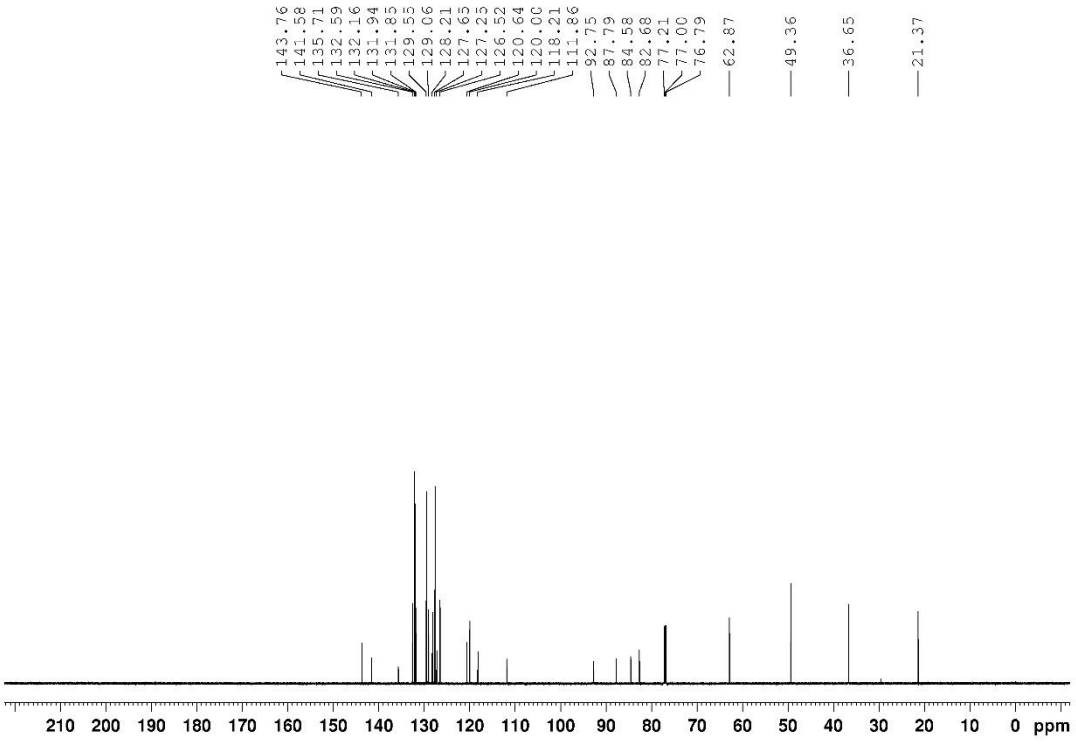


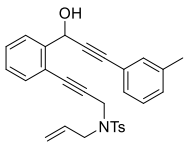
1l

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



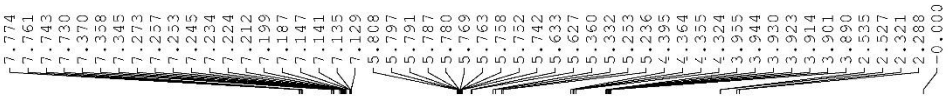
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.

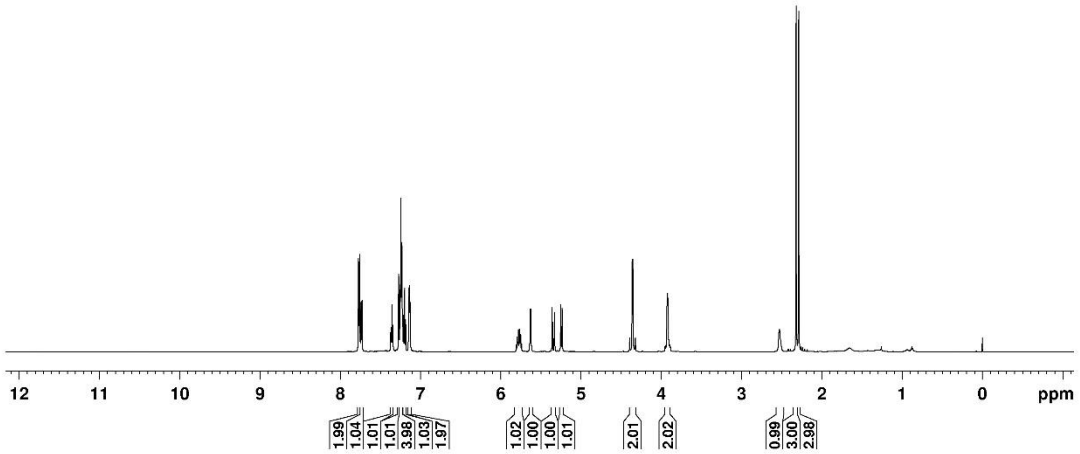




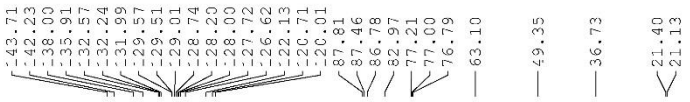
1m

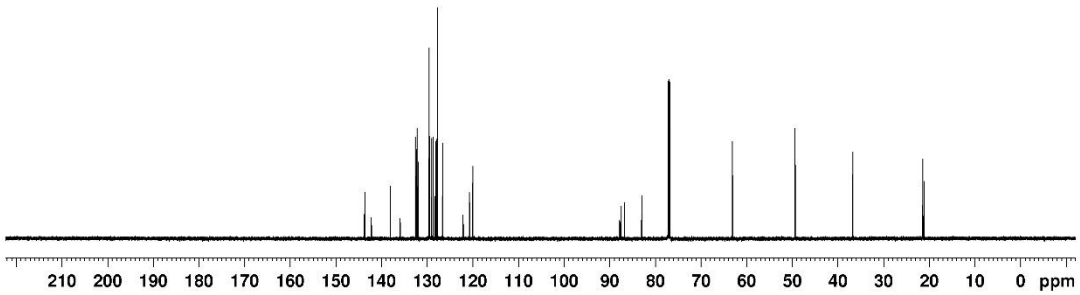
^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.

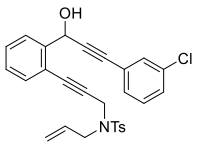




^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.

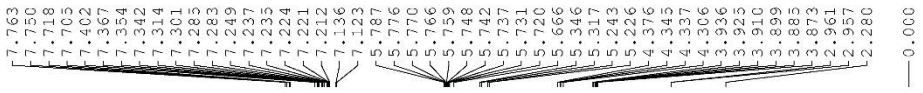


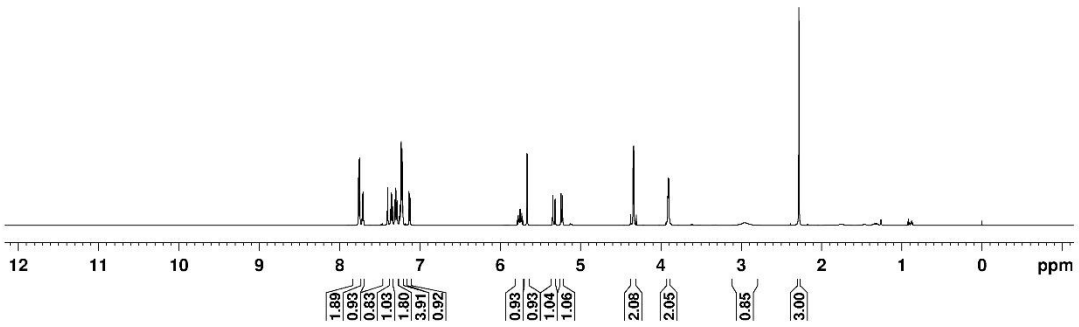




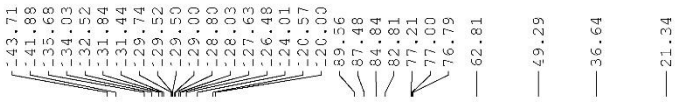
1n

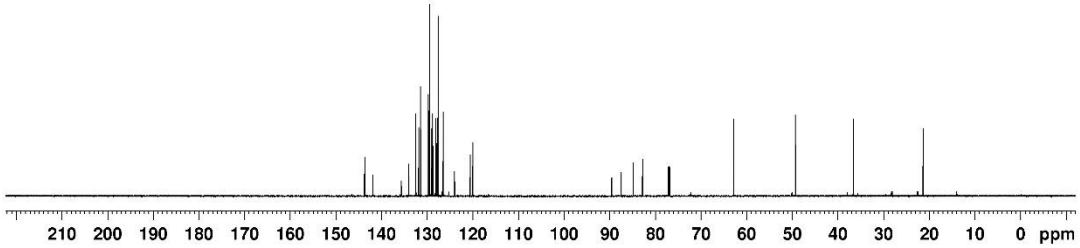
^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.

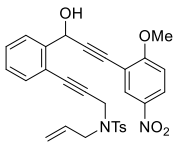




^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.

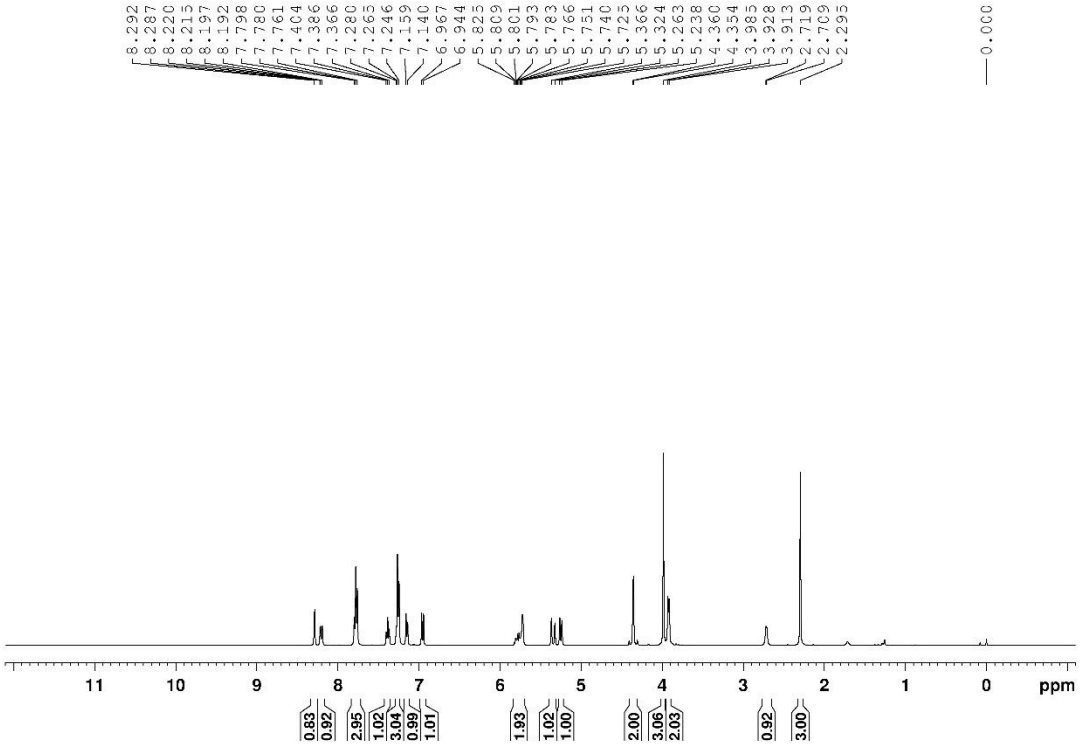




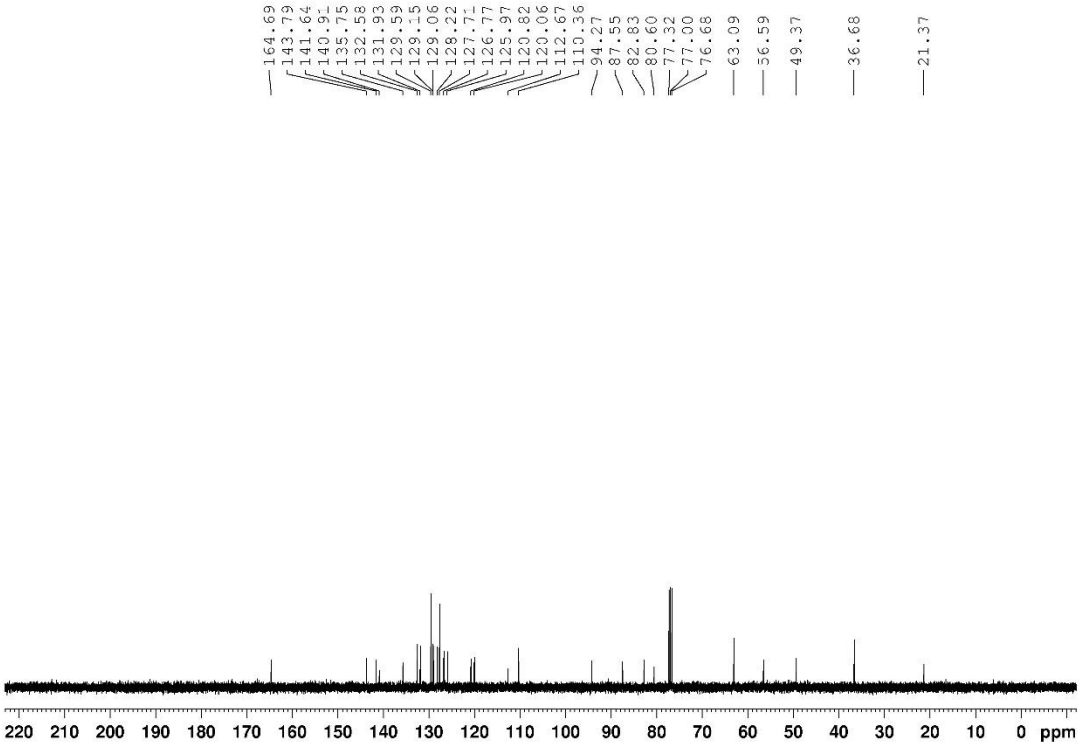


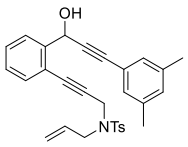
1o

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



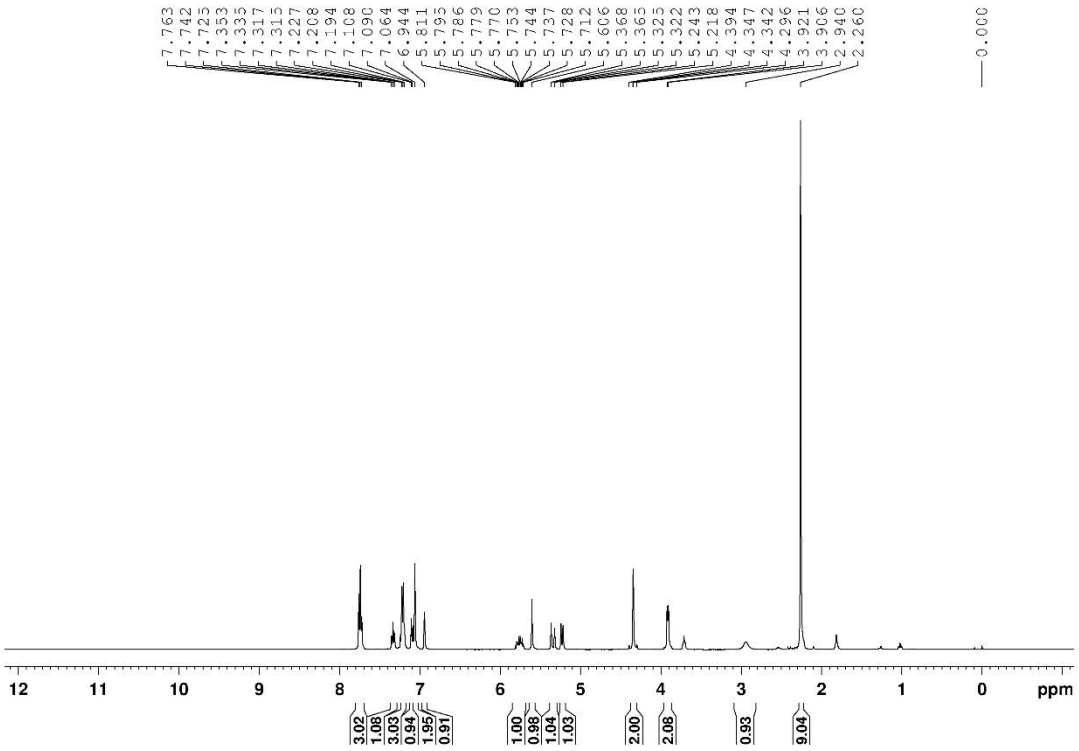
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



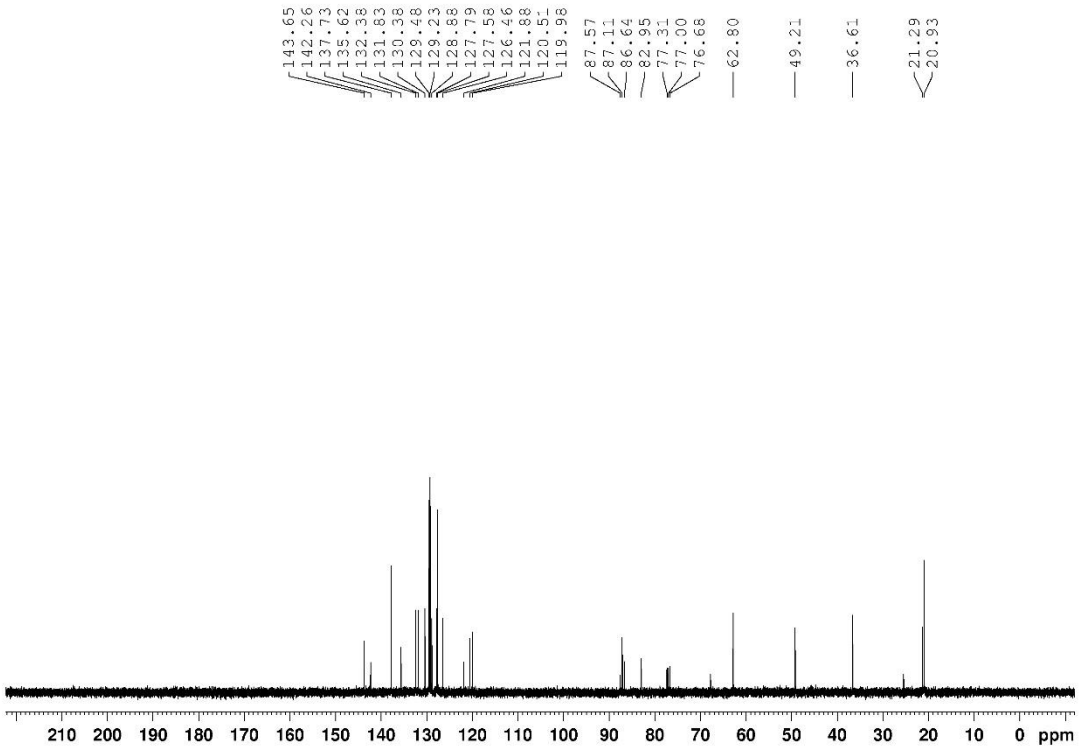


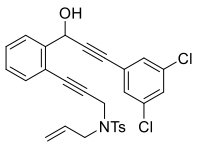
1p

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



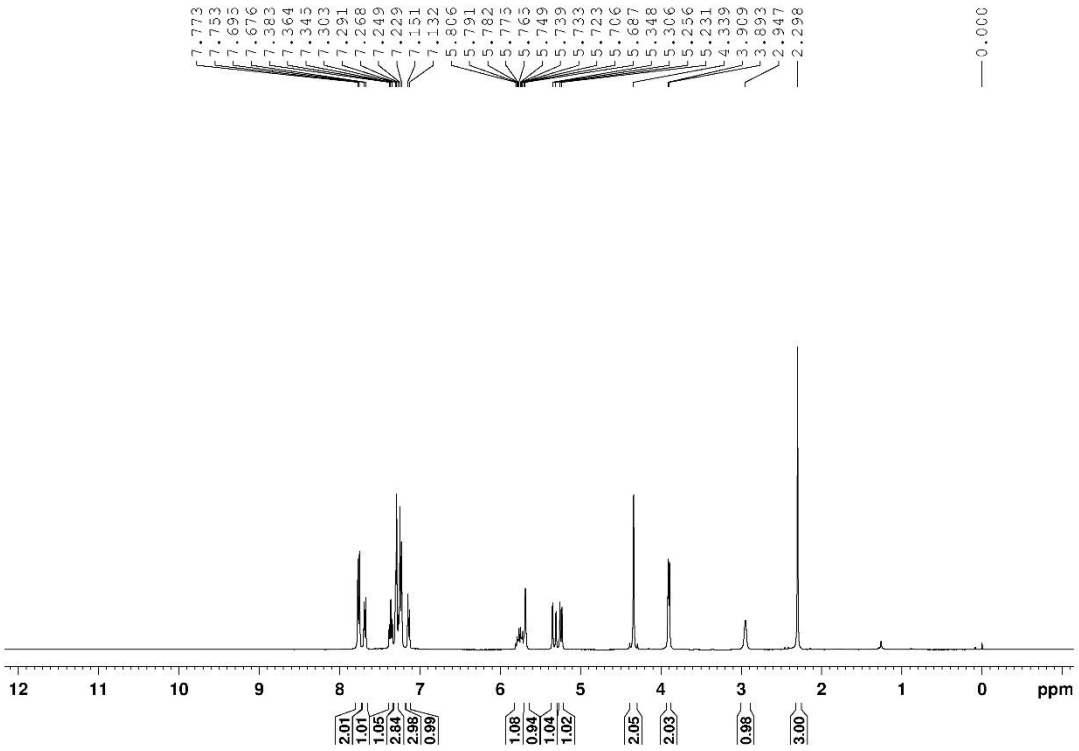
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



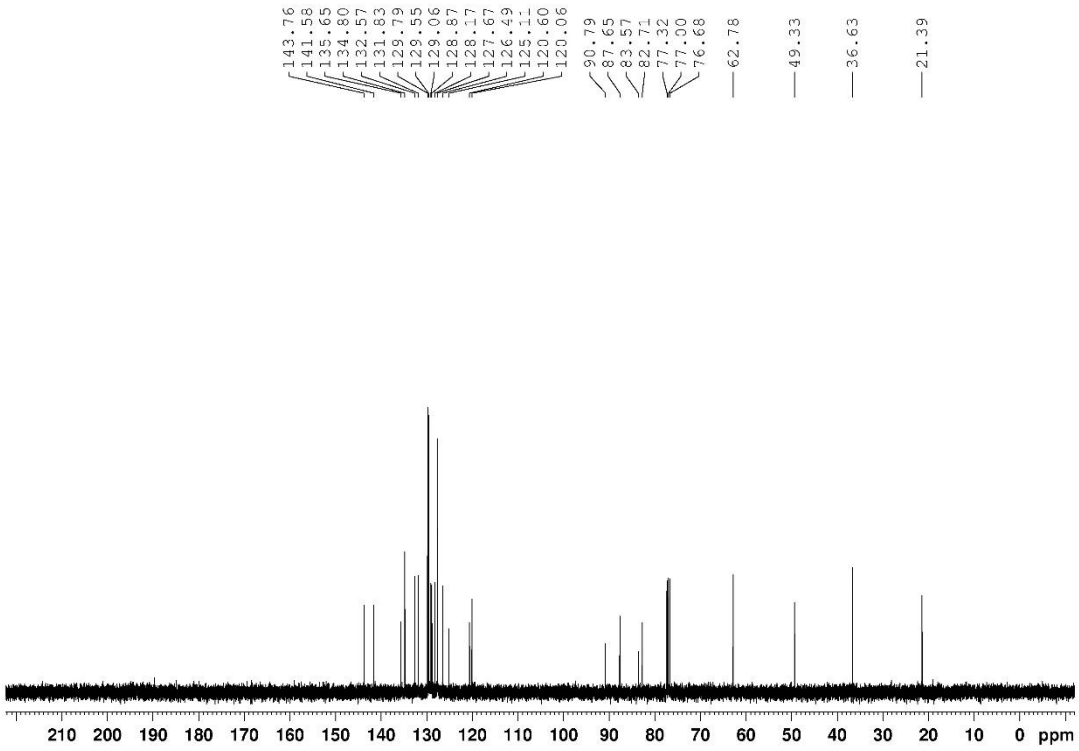


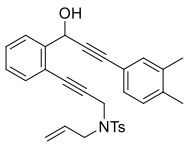
1q

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



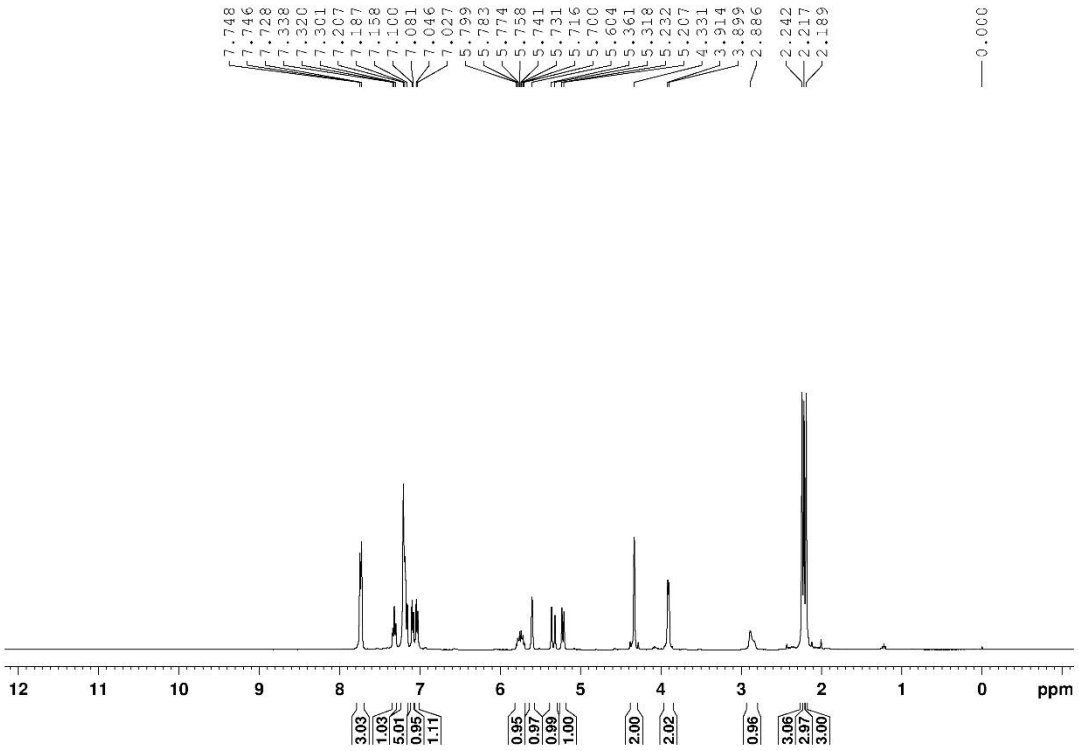
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



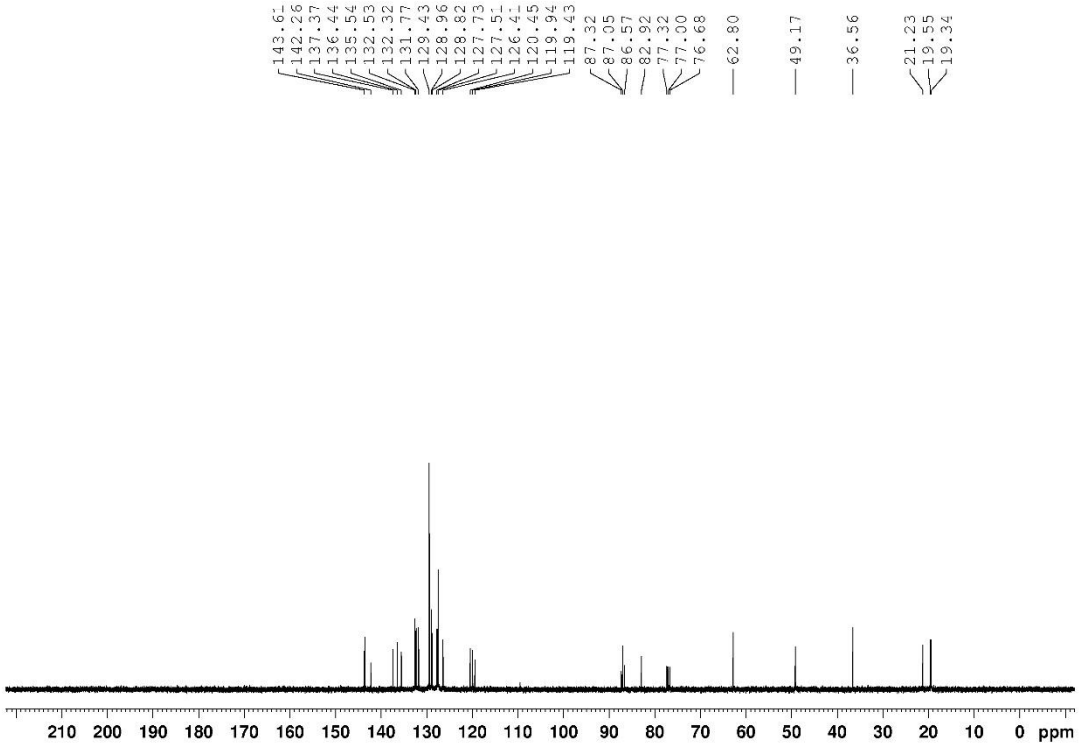


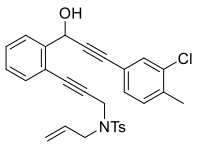
1r

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



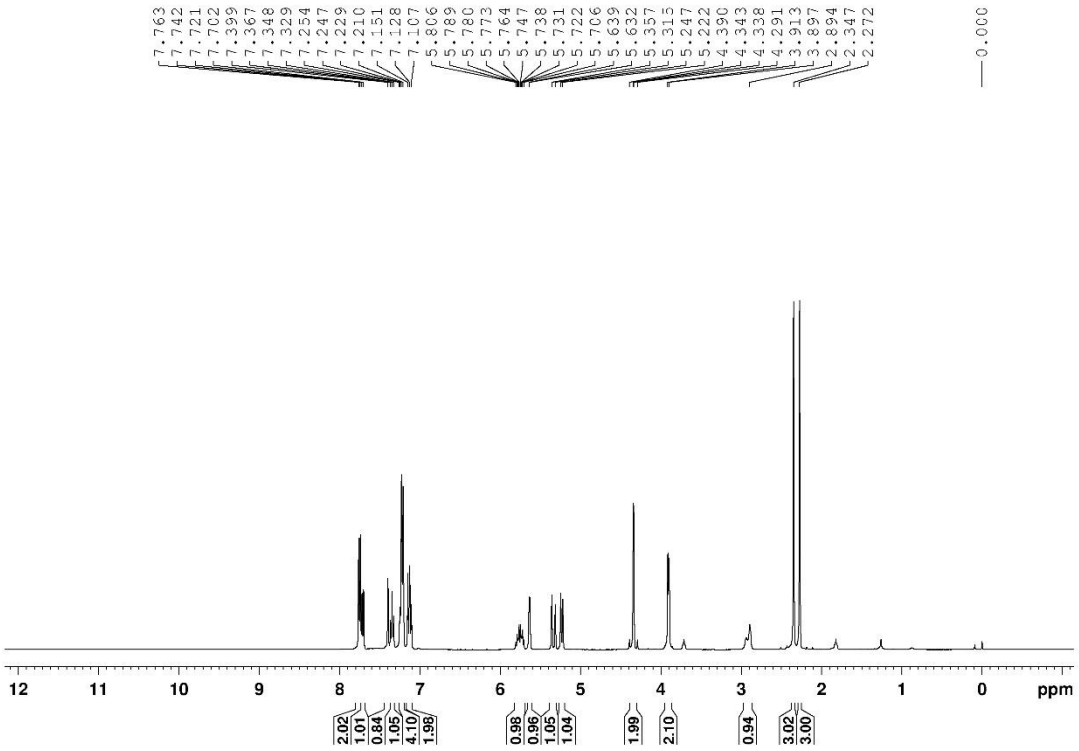
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



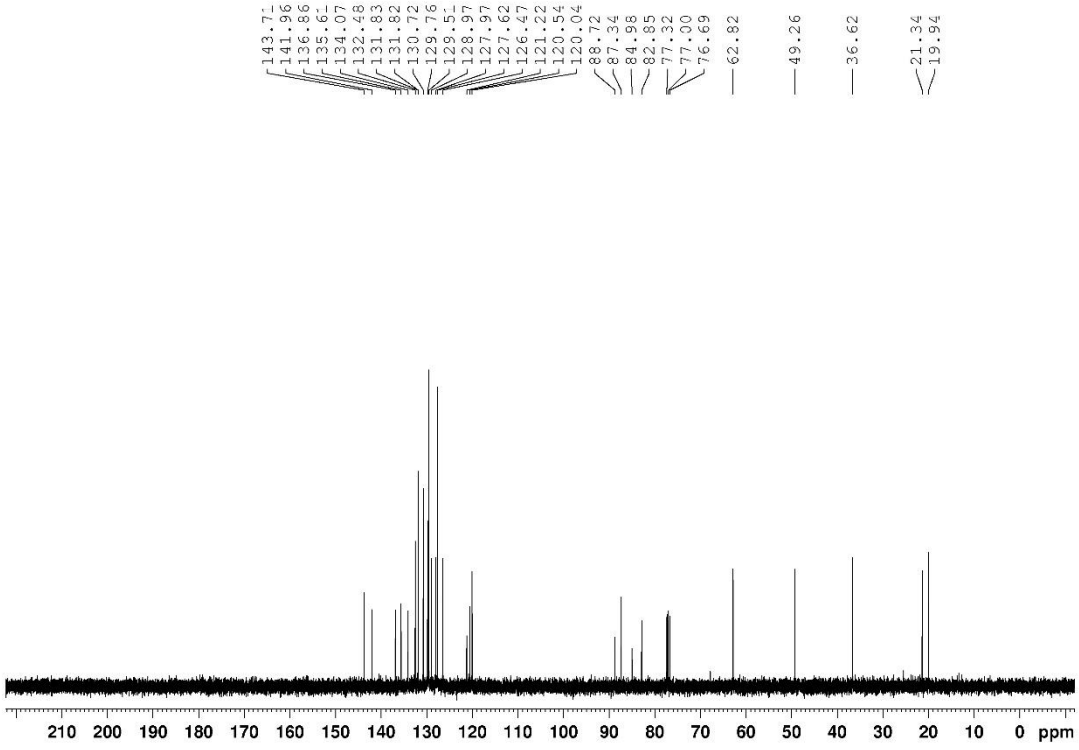


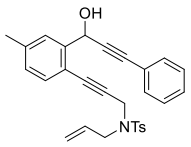
1s

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



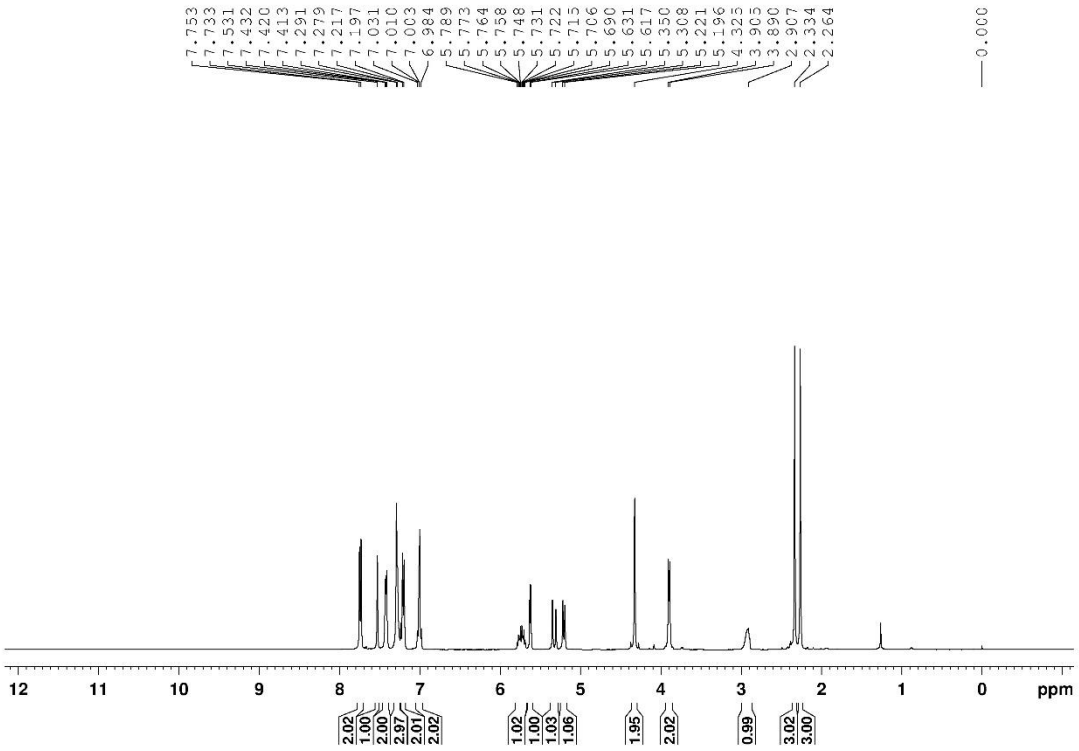
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



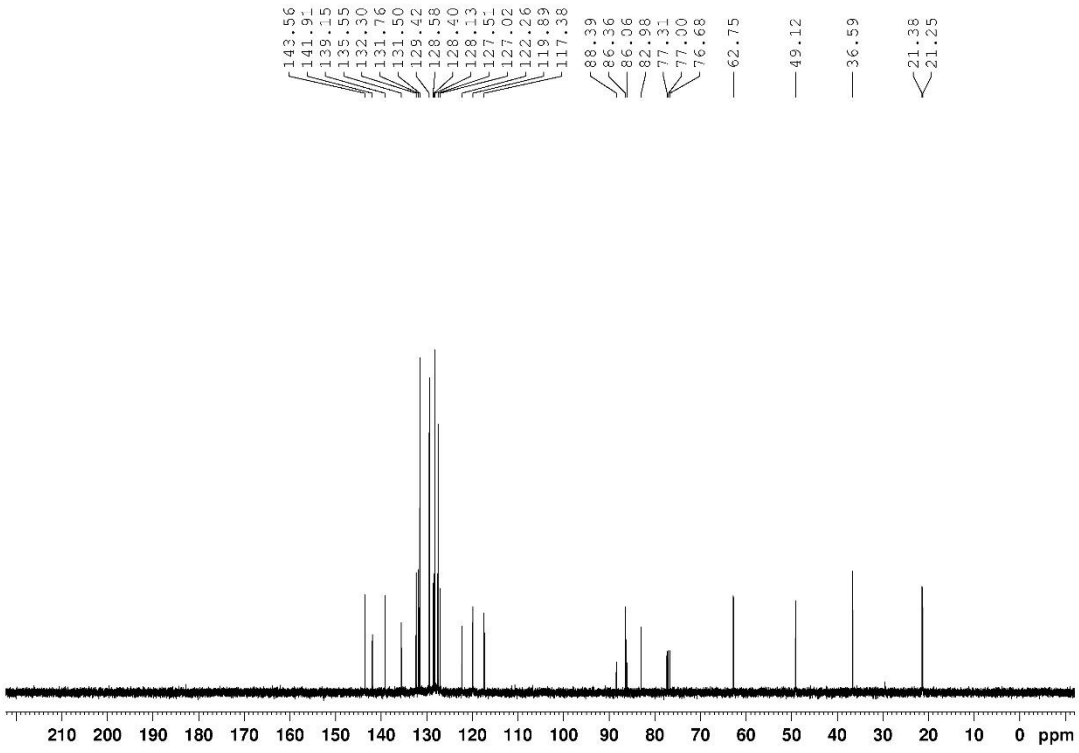


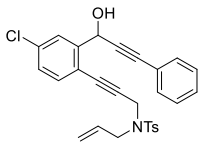
1t

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



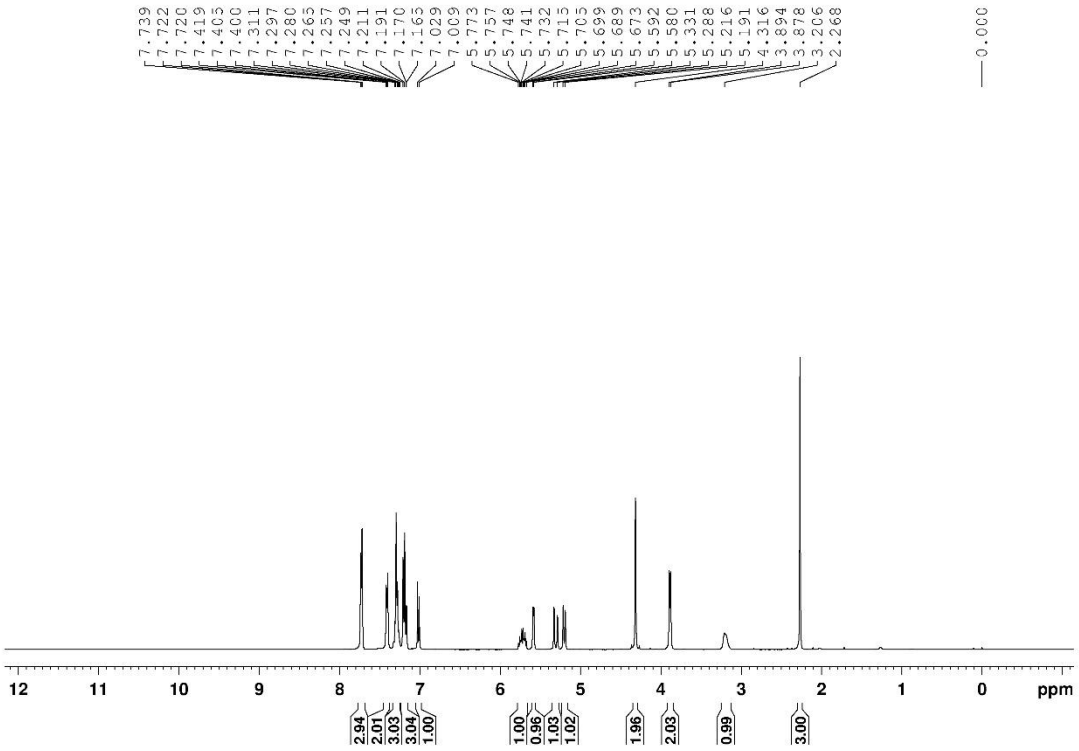
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



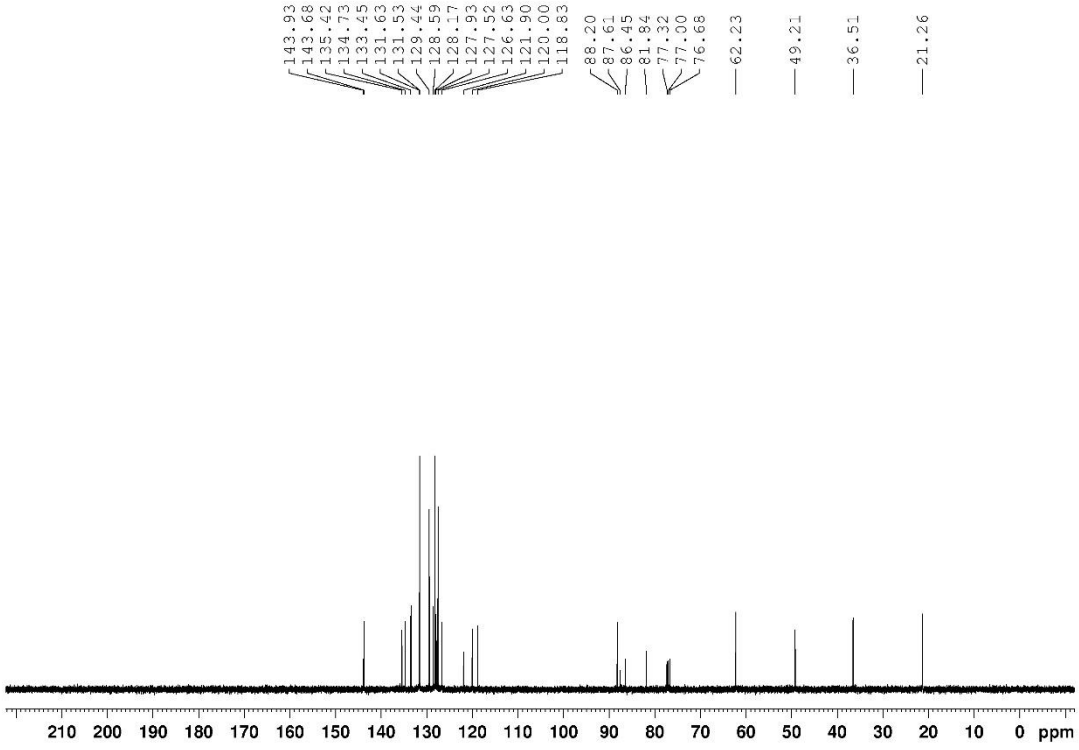


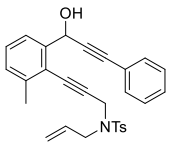
1u

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



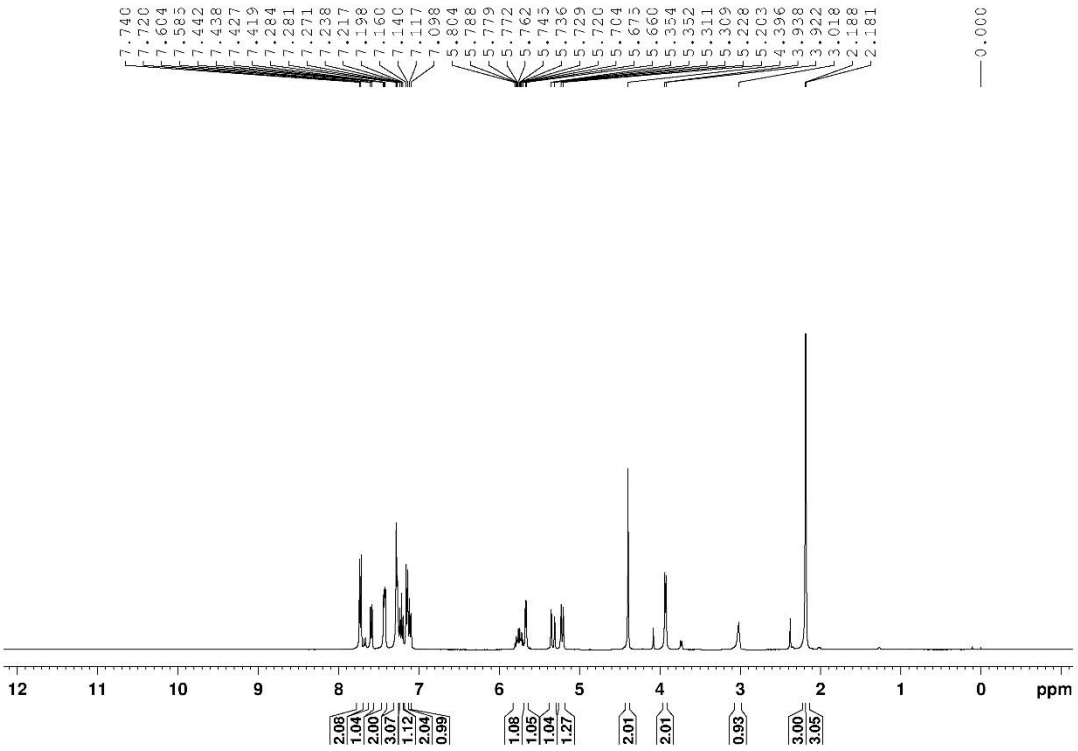
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



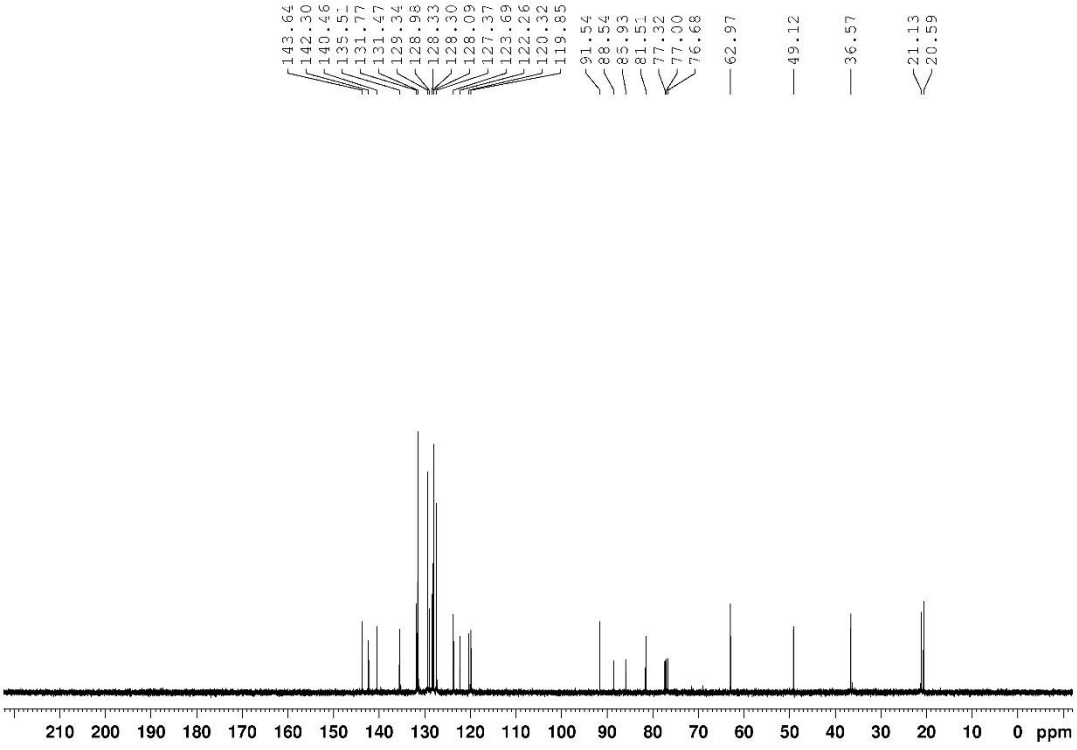


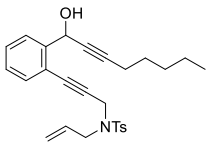
1v

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



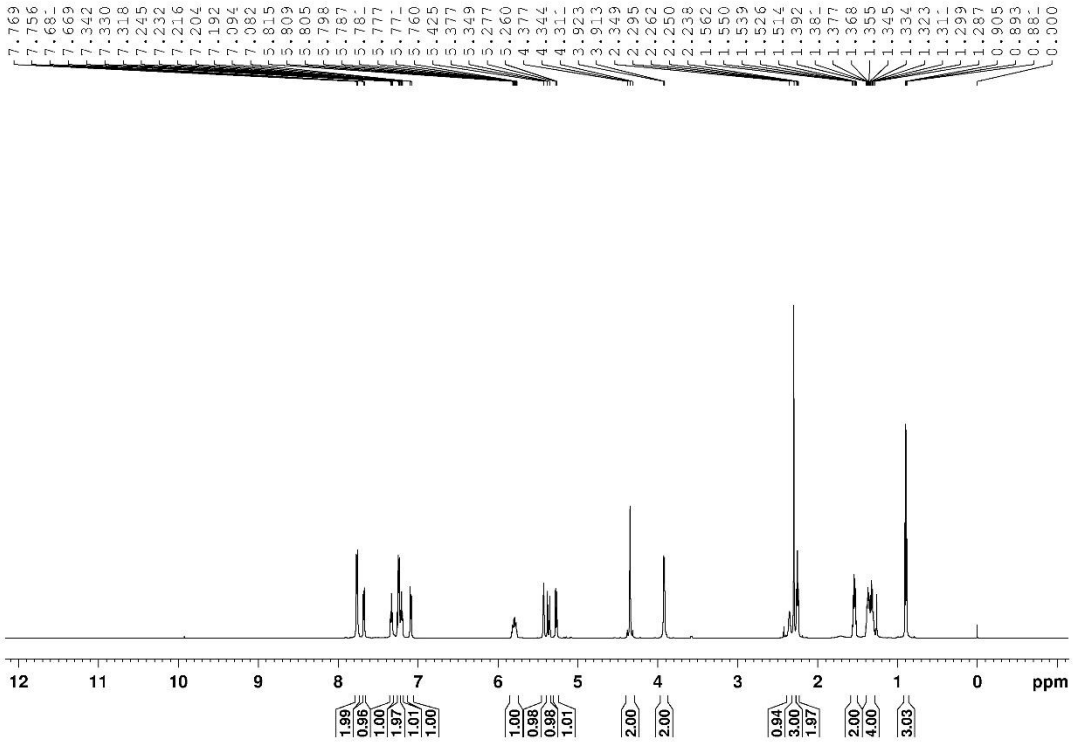
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



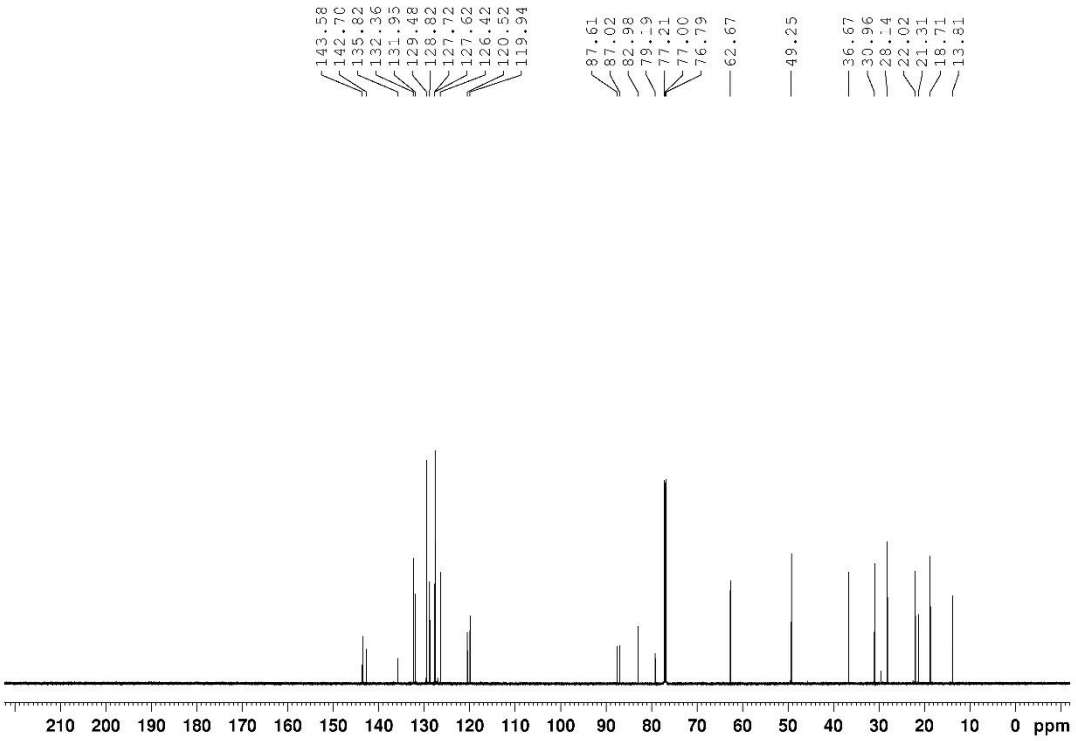


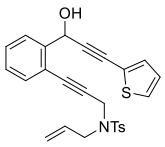
1w

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



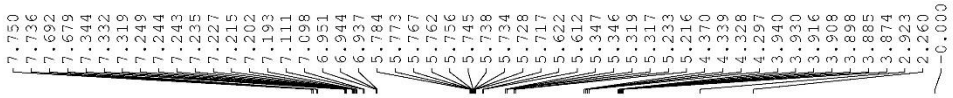
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.

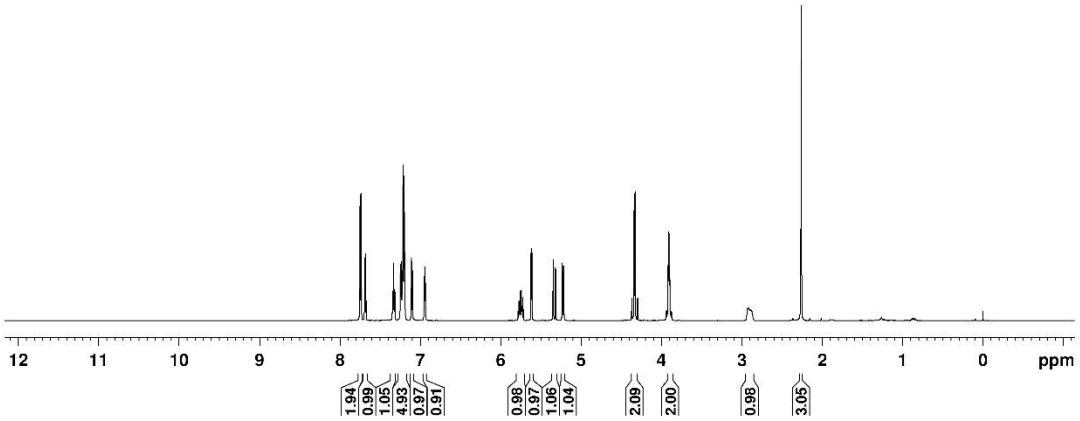




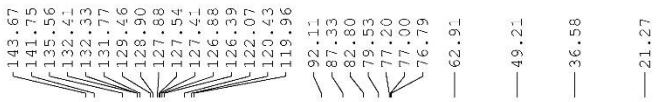
1x

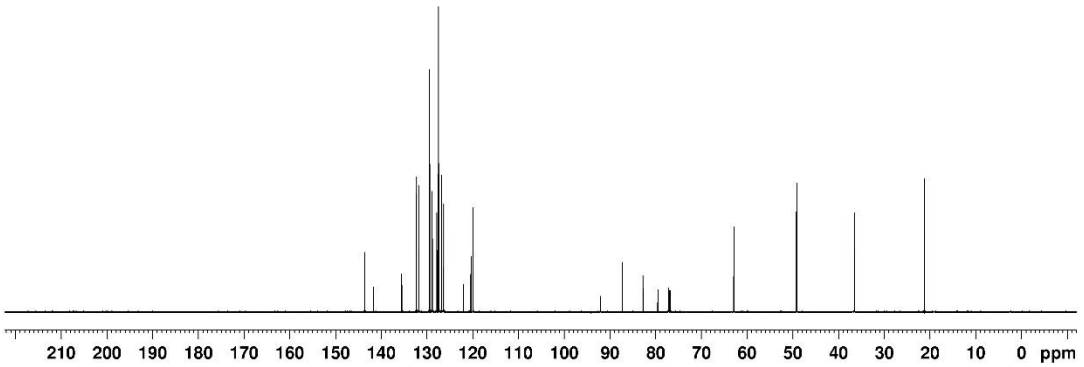
^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.

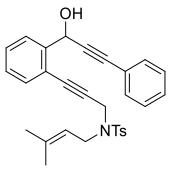




^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.

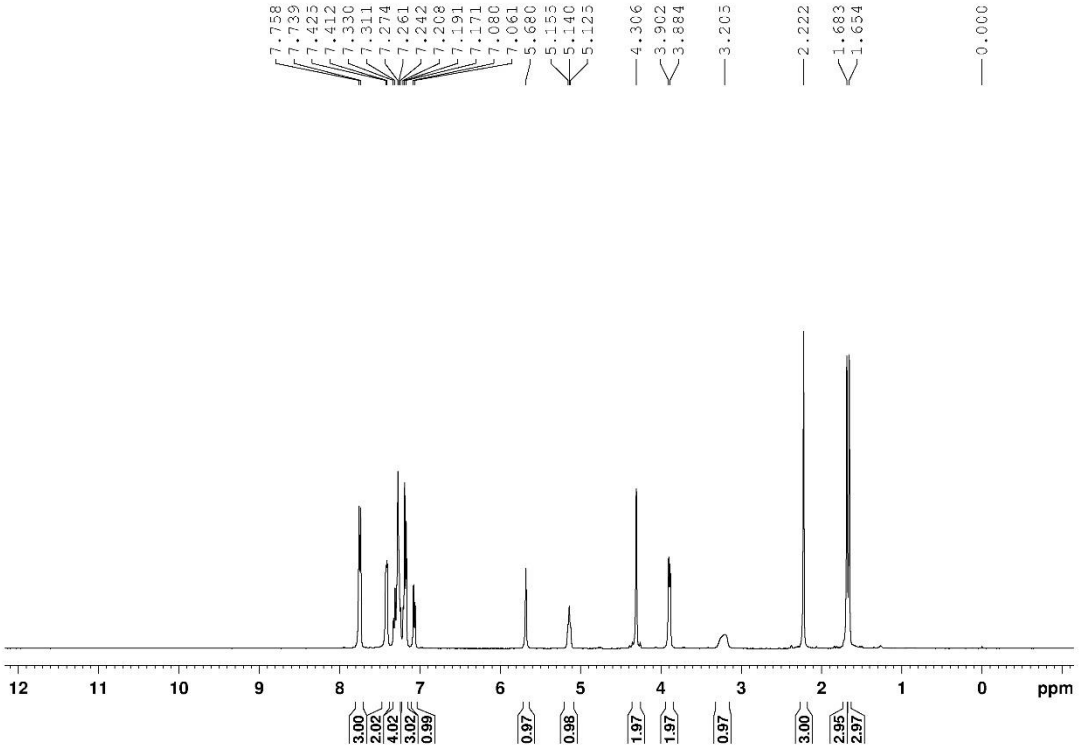




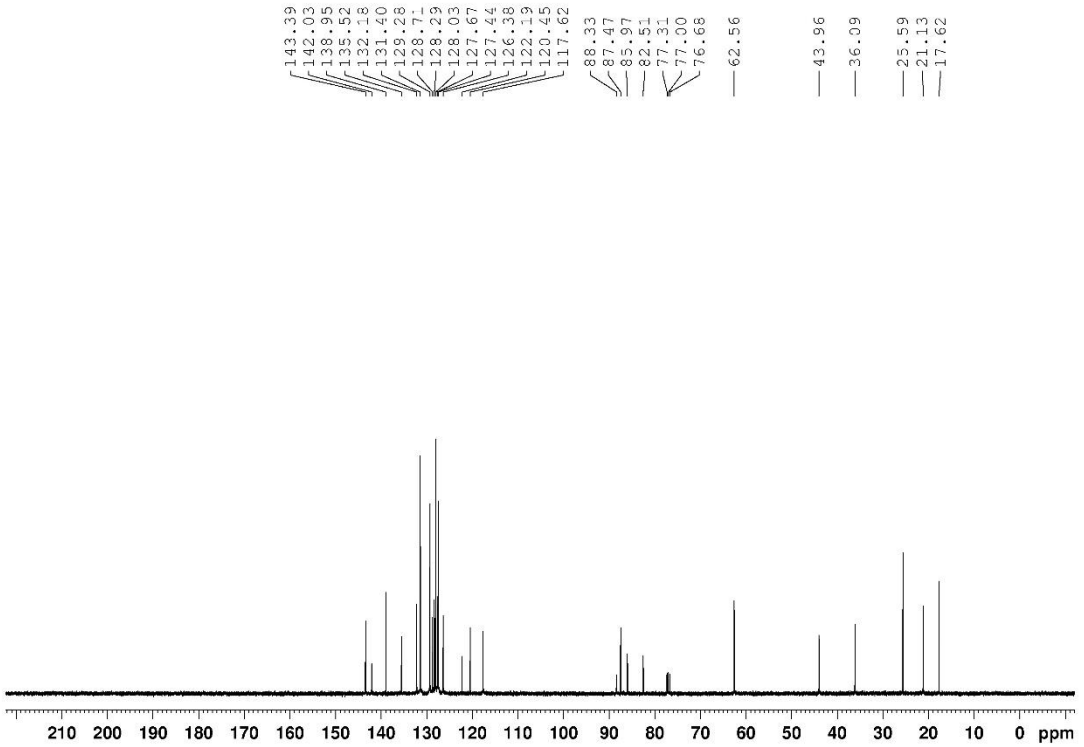


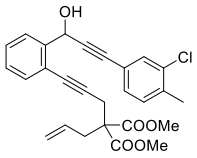
1y

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



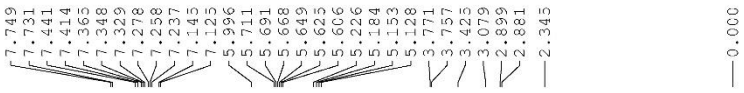
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

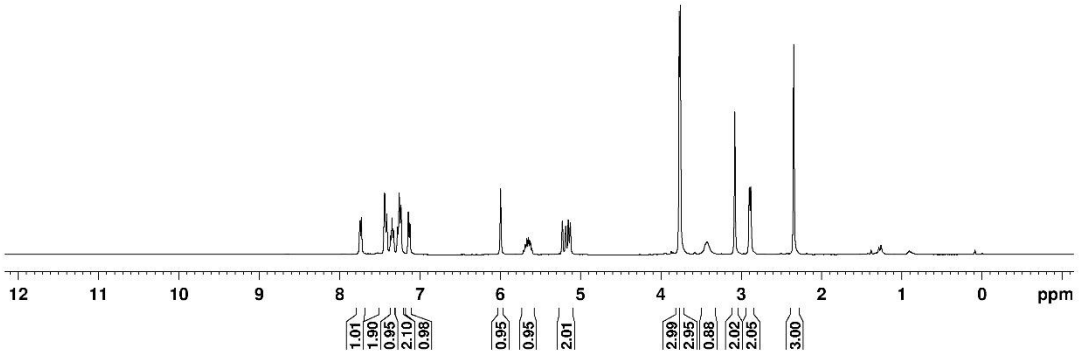




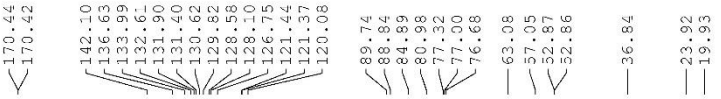
1z

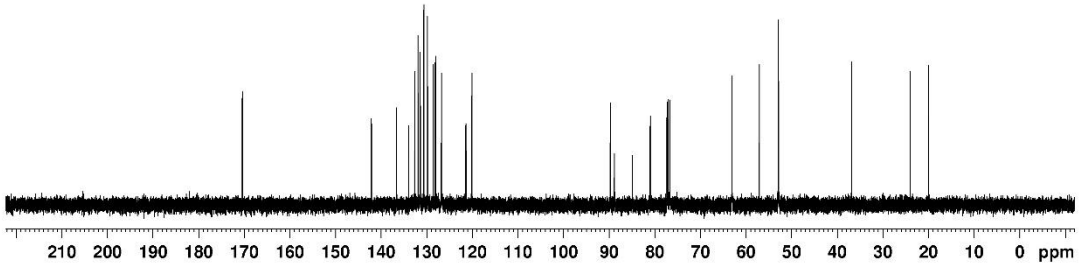
^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.

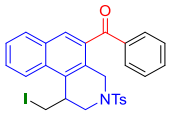




^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

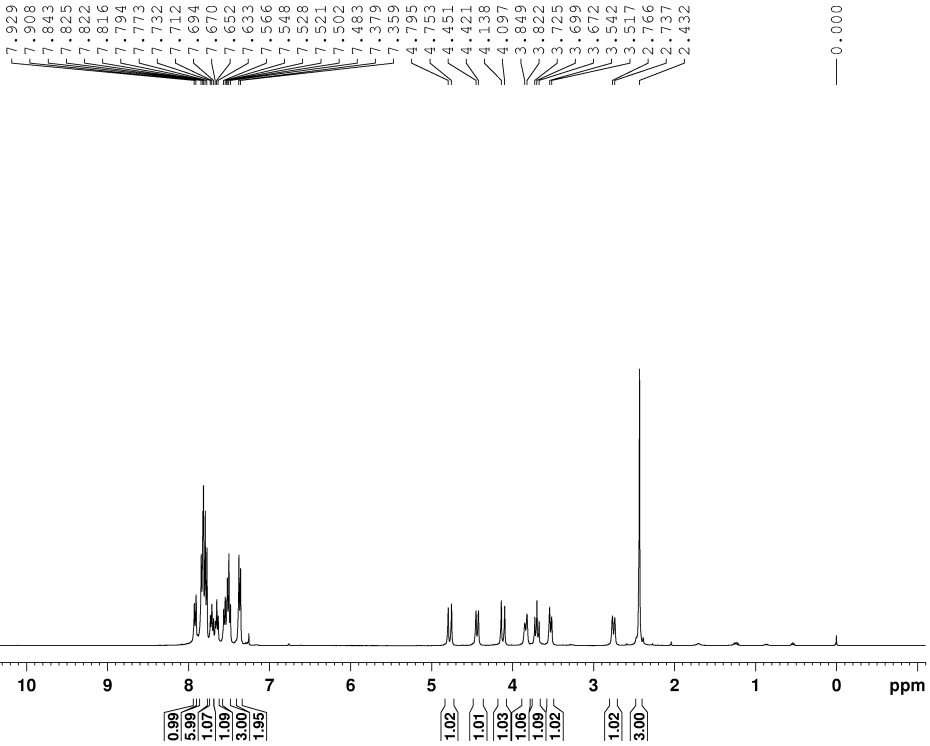




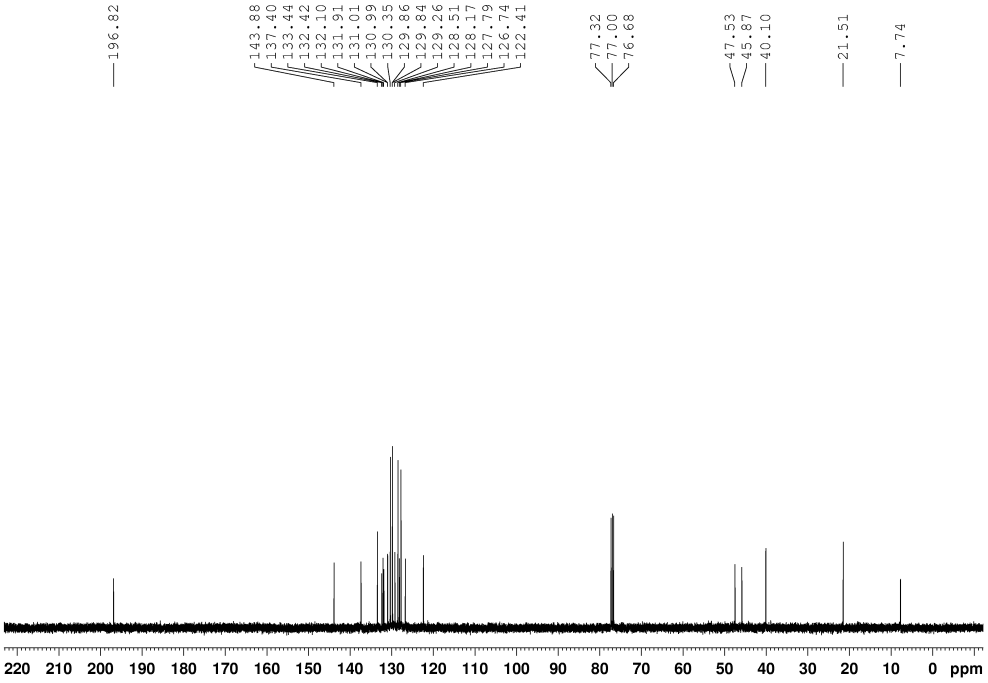


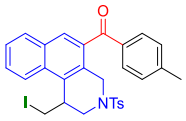
2a

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



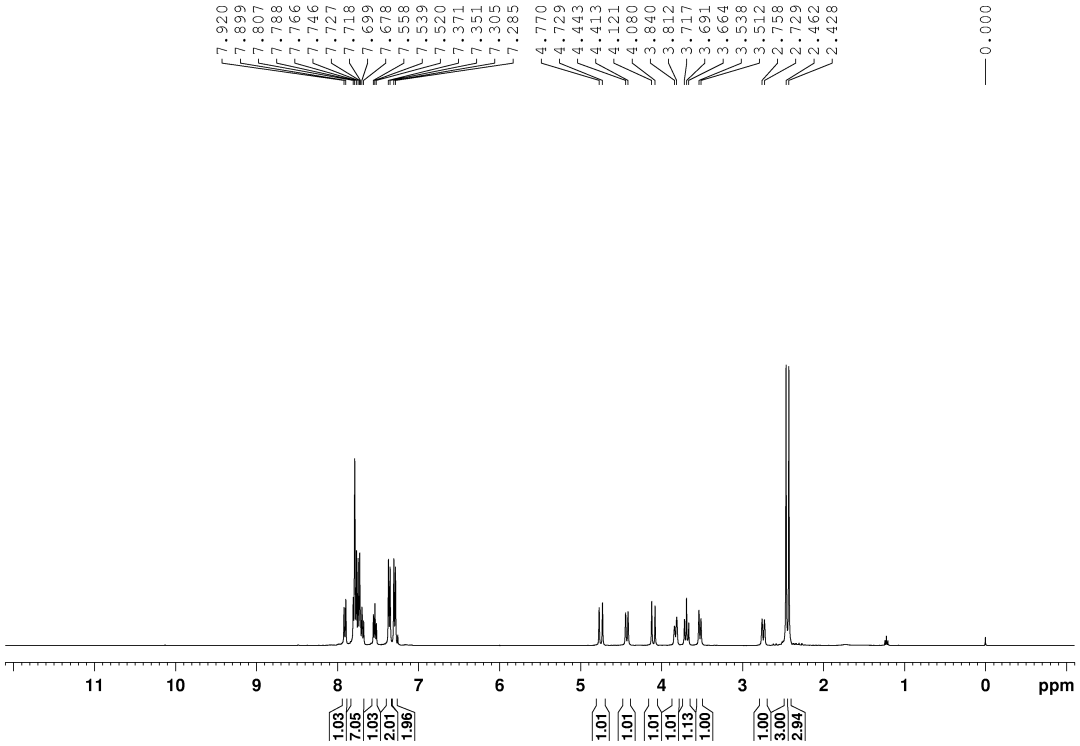
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



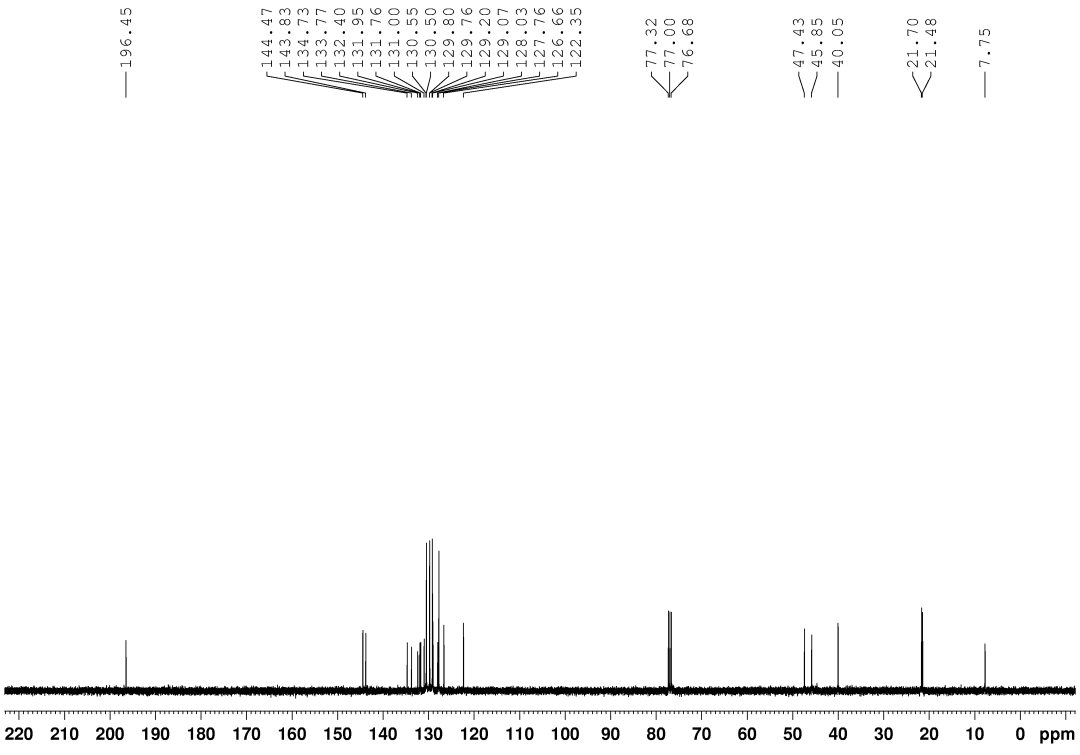


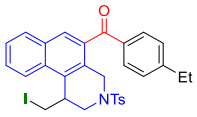
2b

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



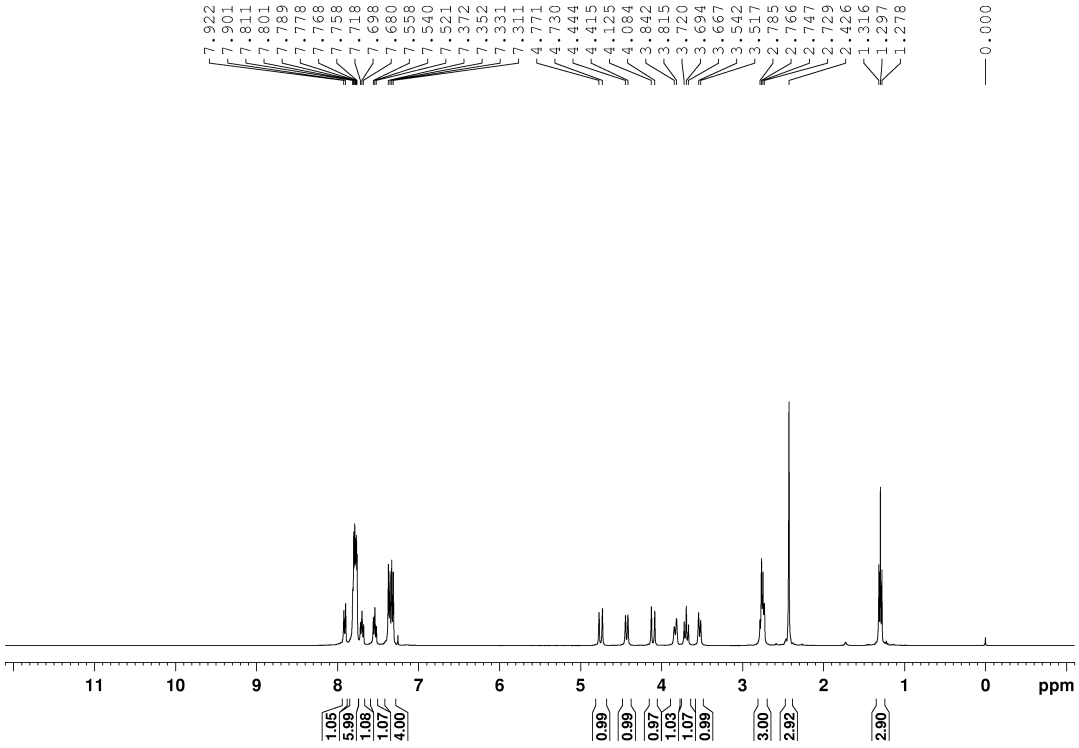
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



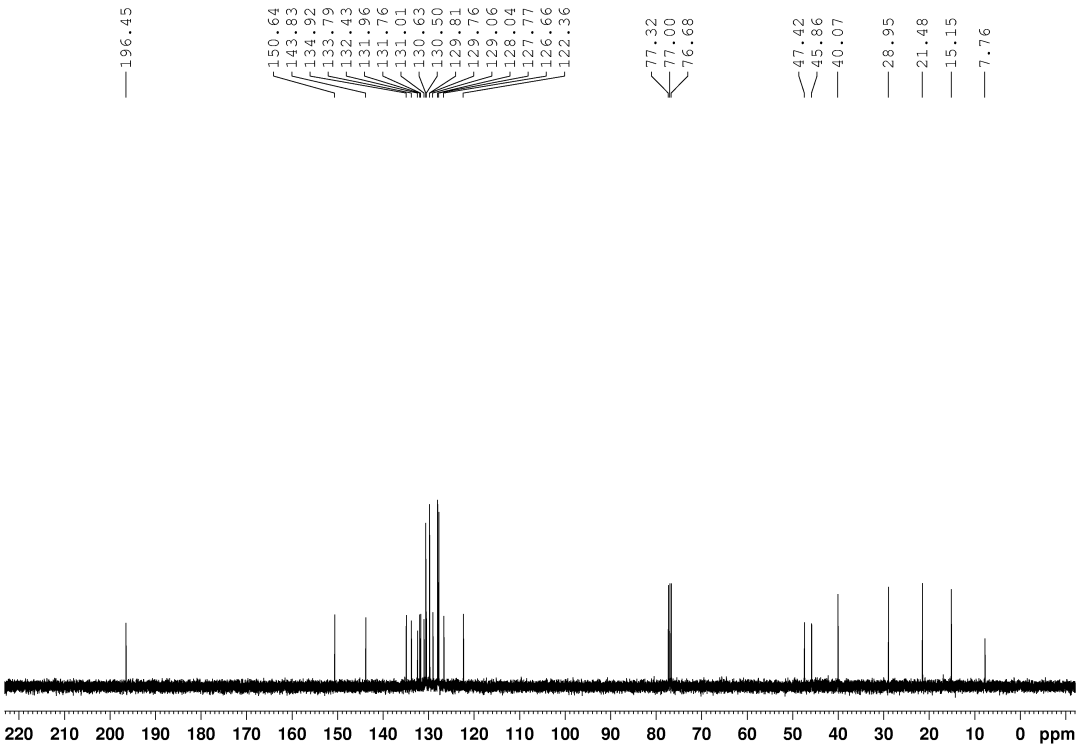


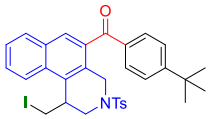
2c

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



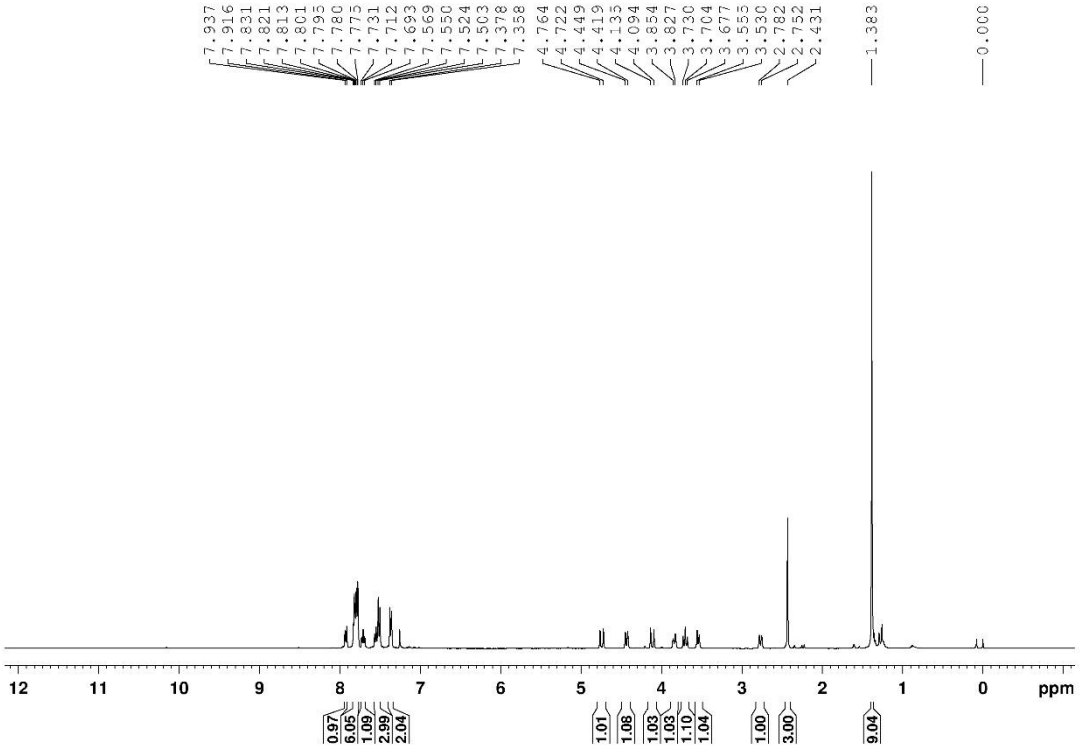
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



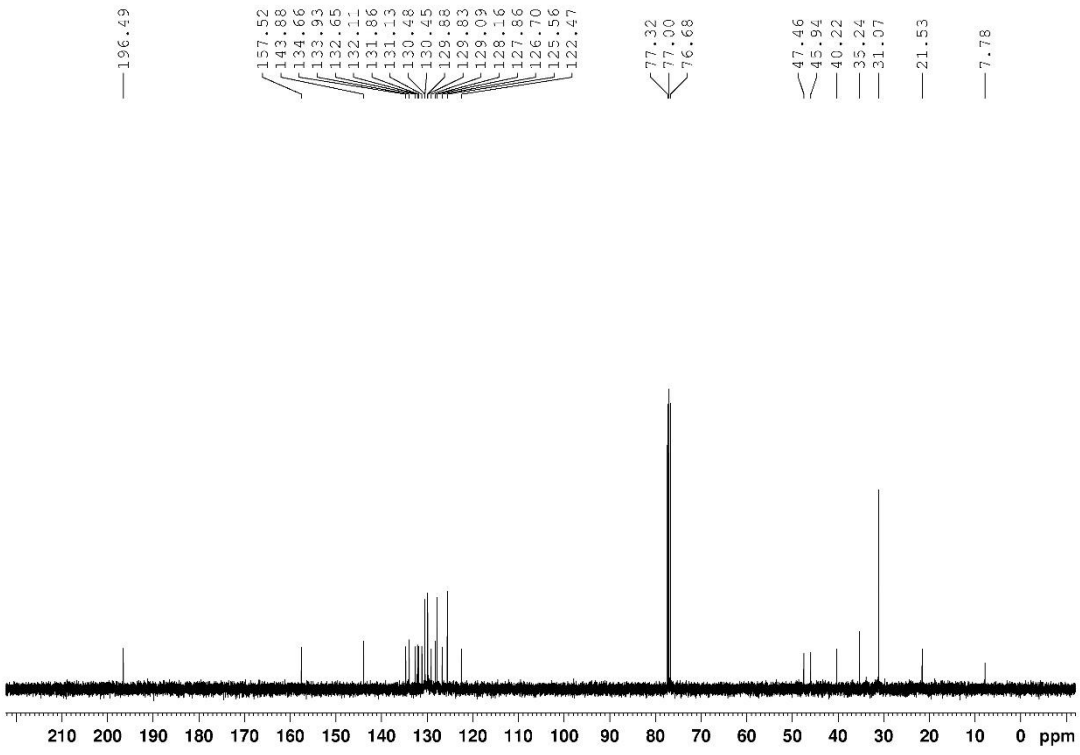


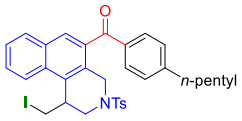
2d

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



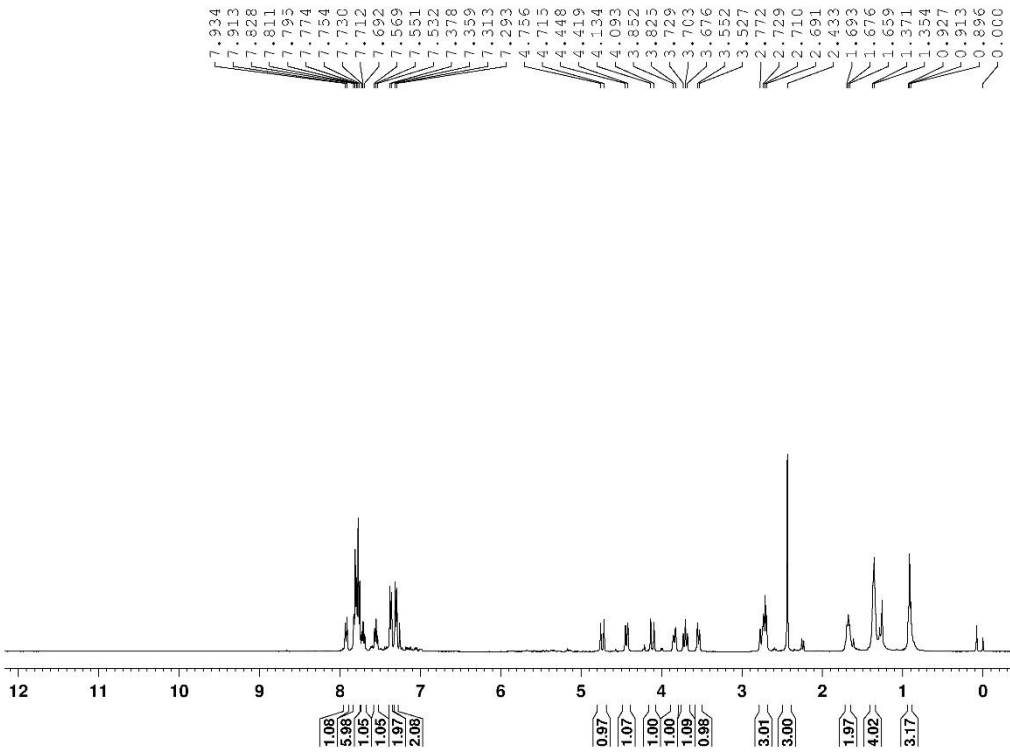
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



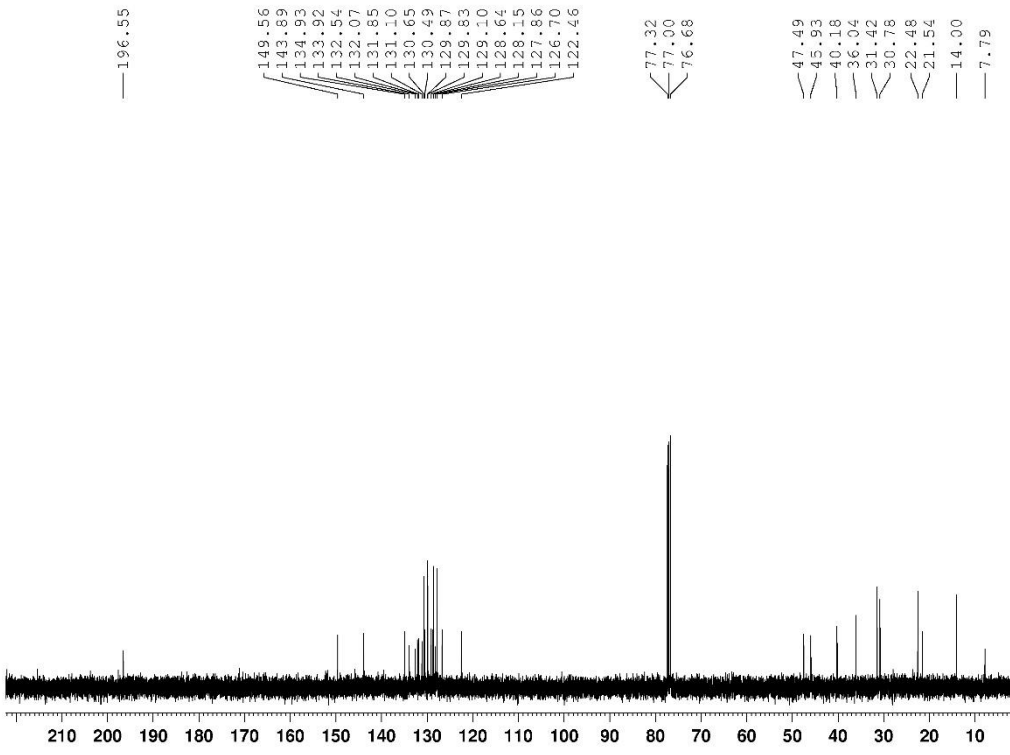


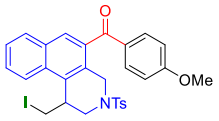
2e

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



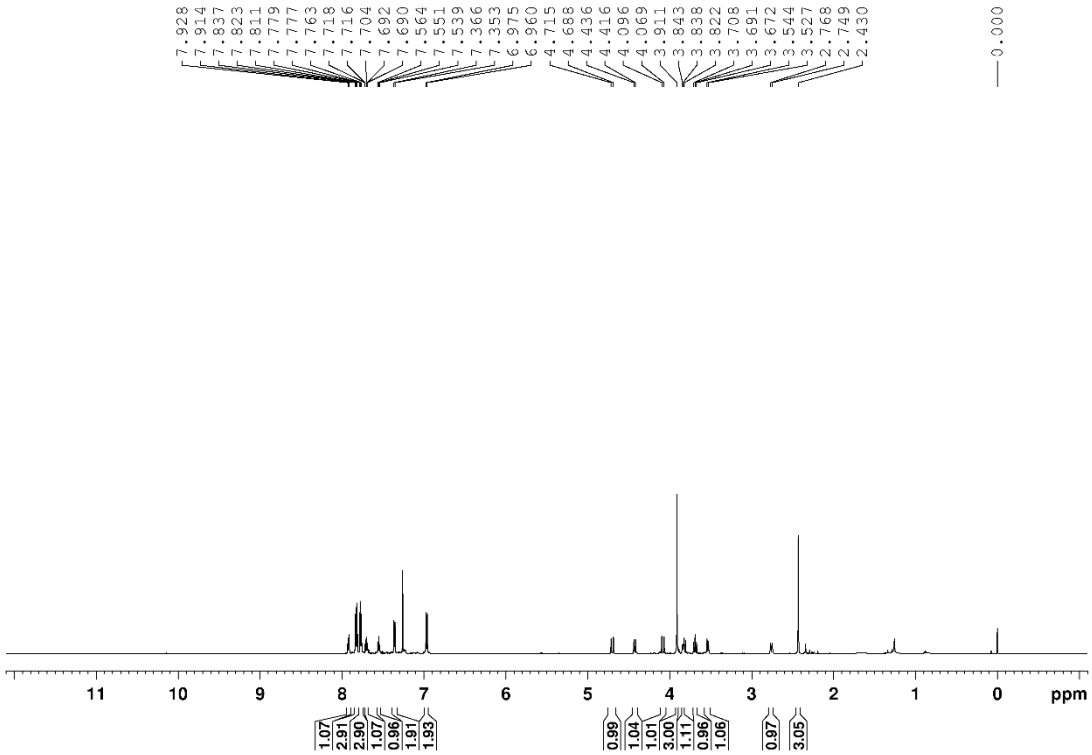
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



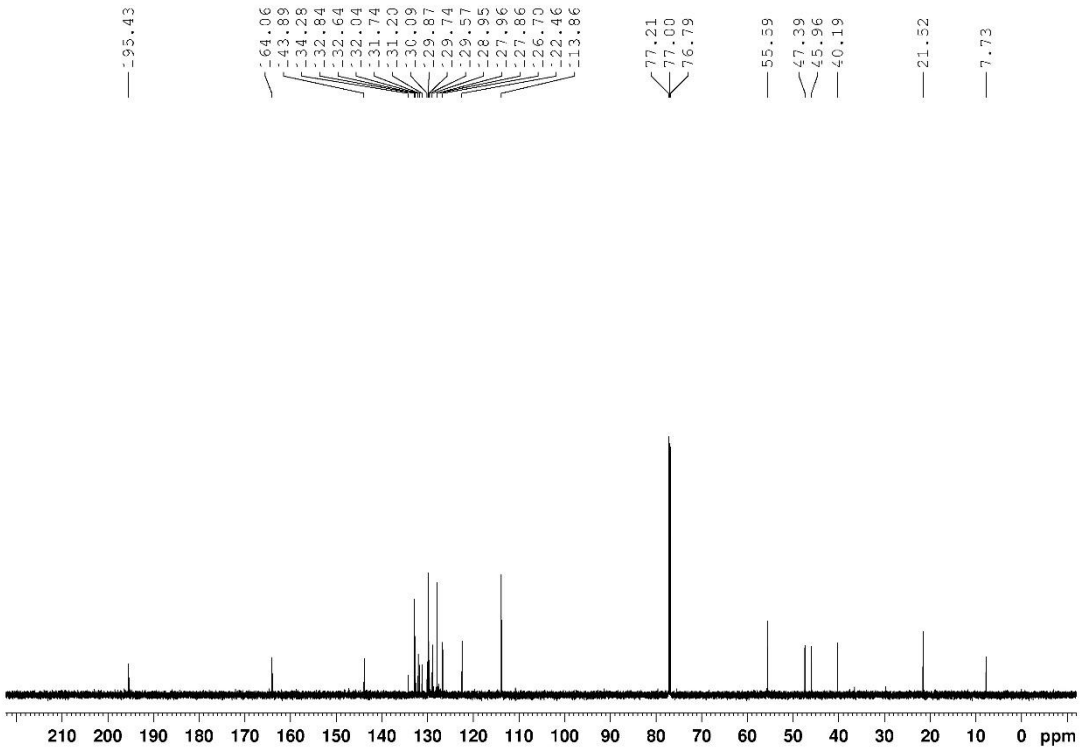


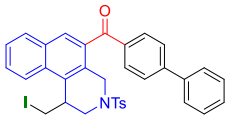
2f

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



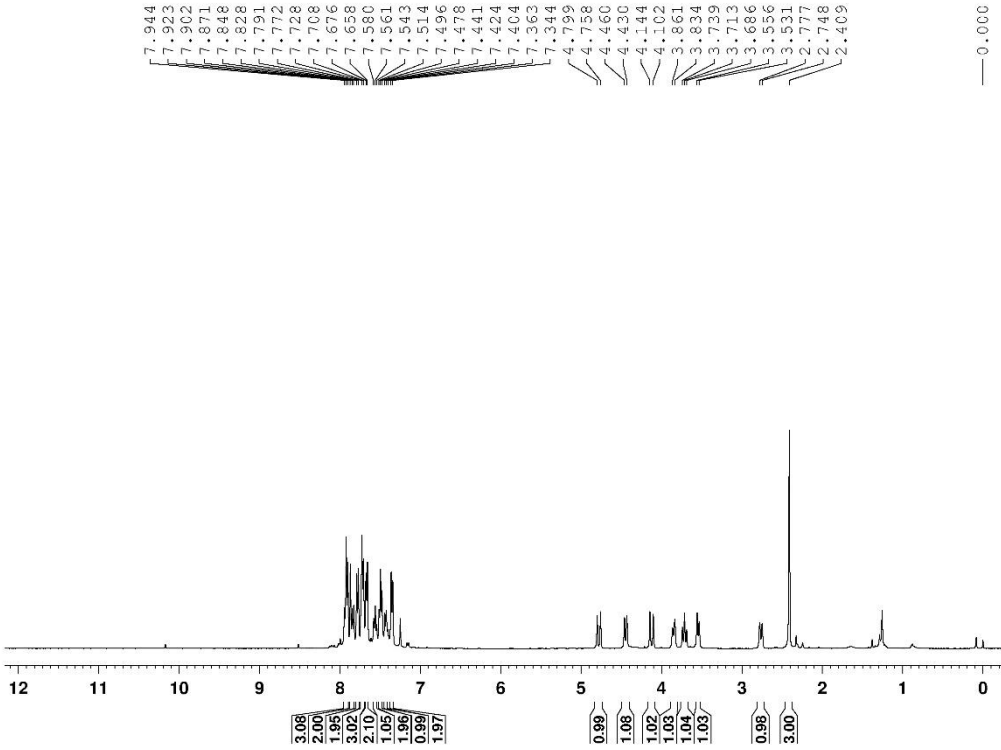
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.



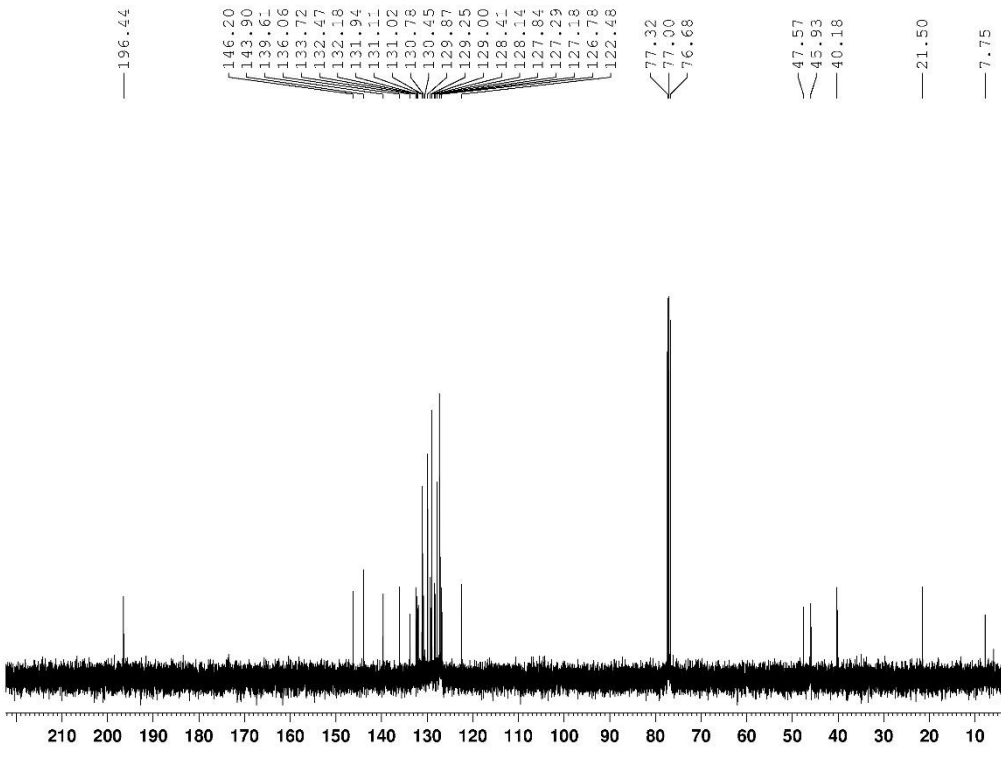


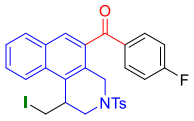
2g

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



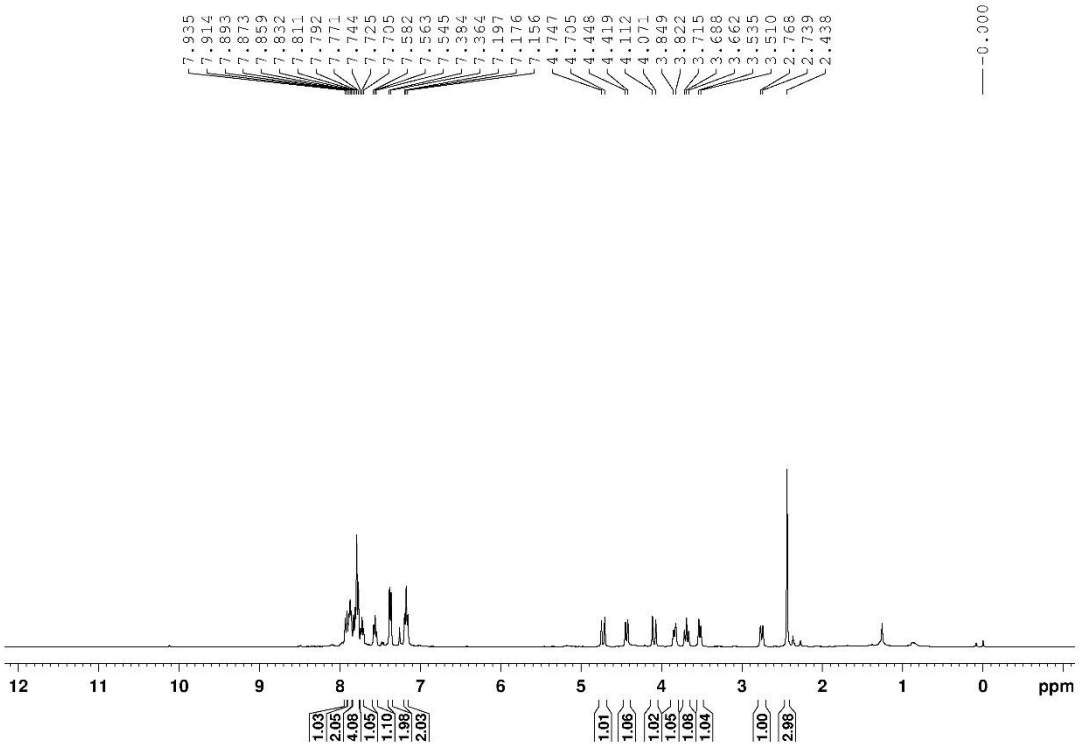
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



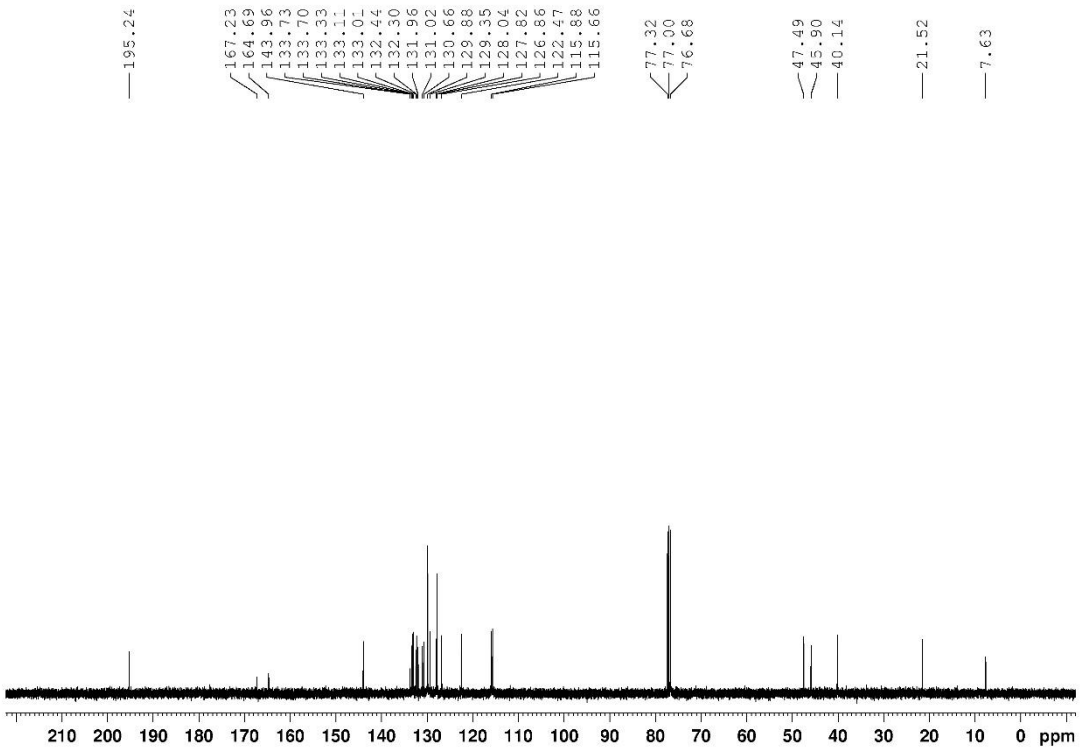


2h

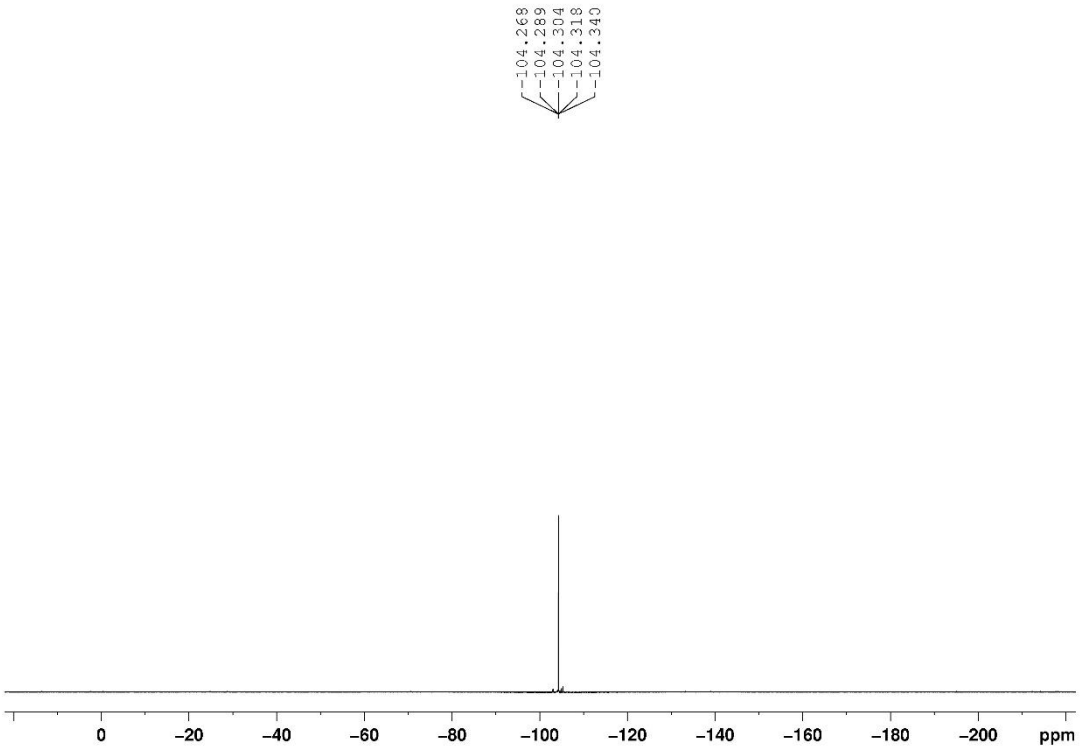
^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.

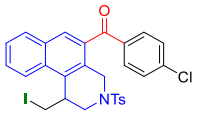


^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



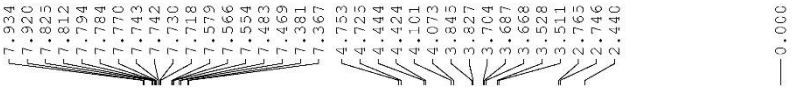
^{19}F NMR spectrum was recorded on 376 MHz in $CDCl_3$.

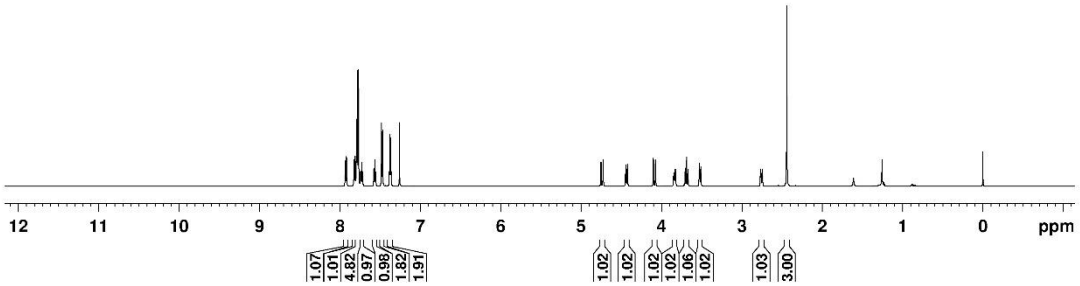

-104.268
-104.289
-104.304
-104.318
-104.340
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm



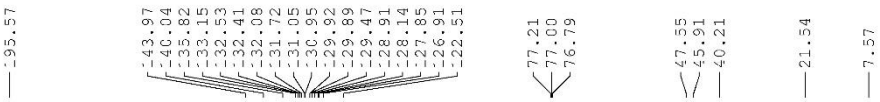
2i

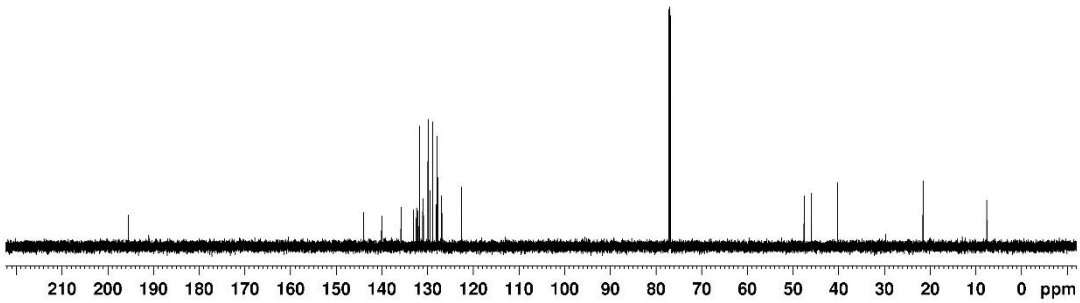
^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.

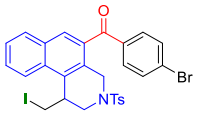




^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.

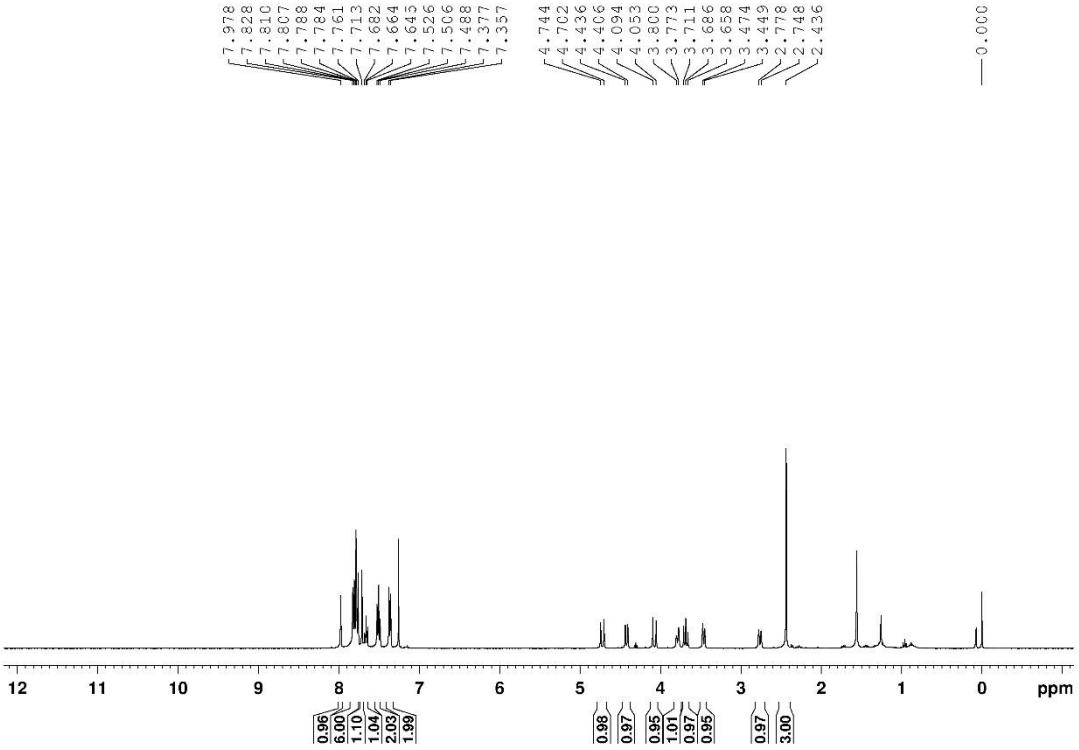




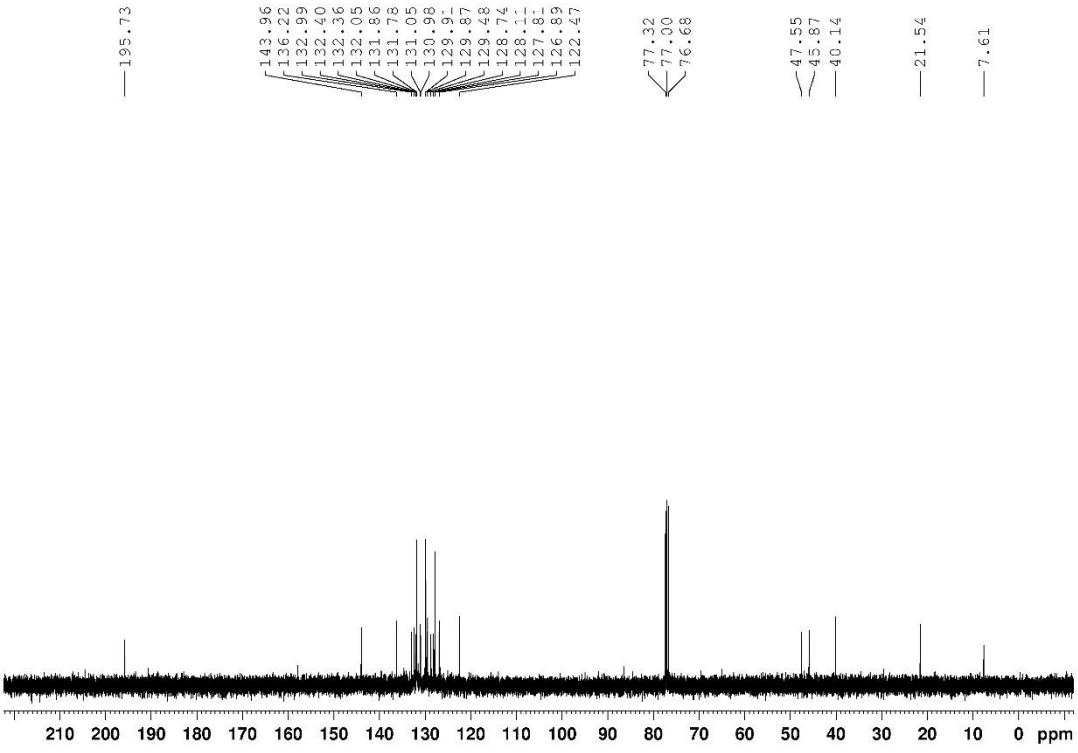


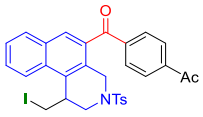
2j

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



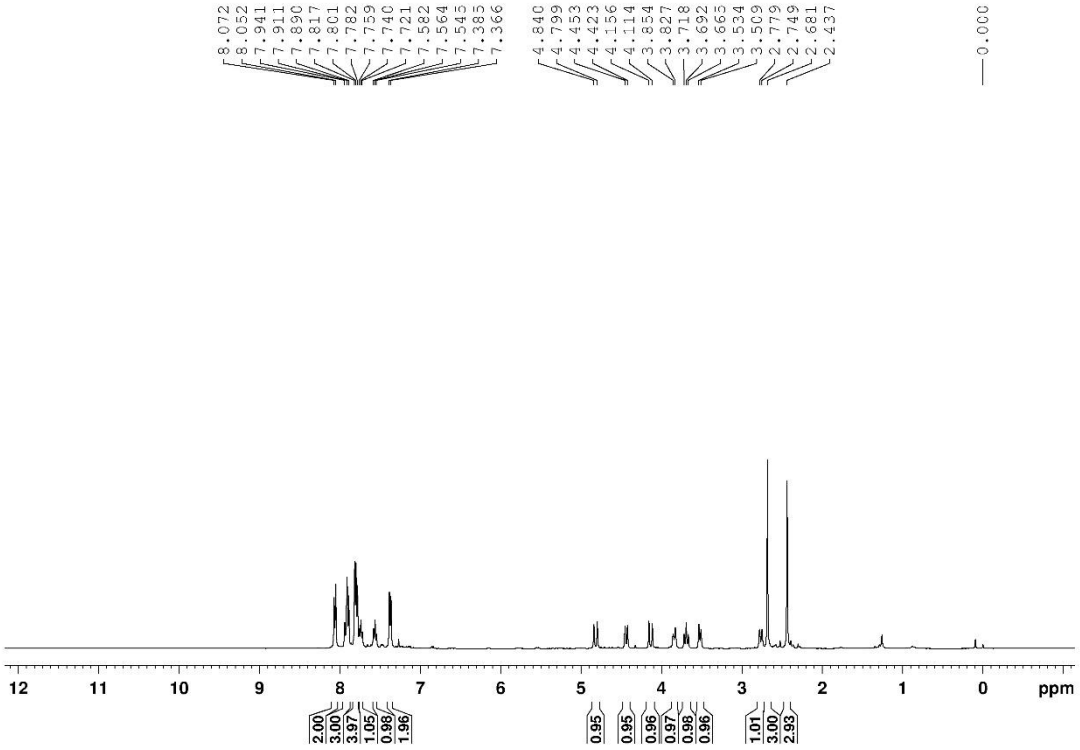
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



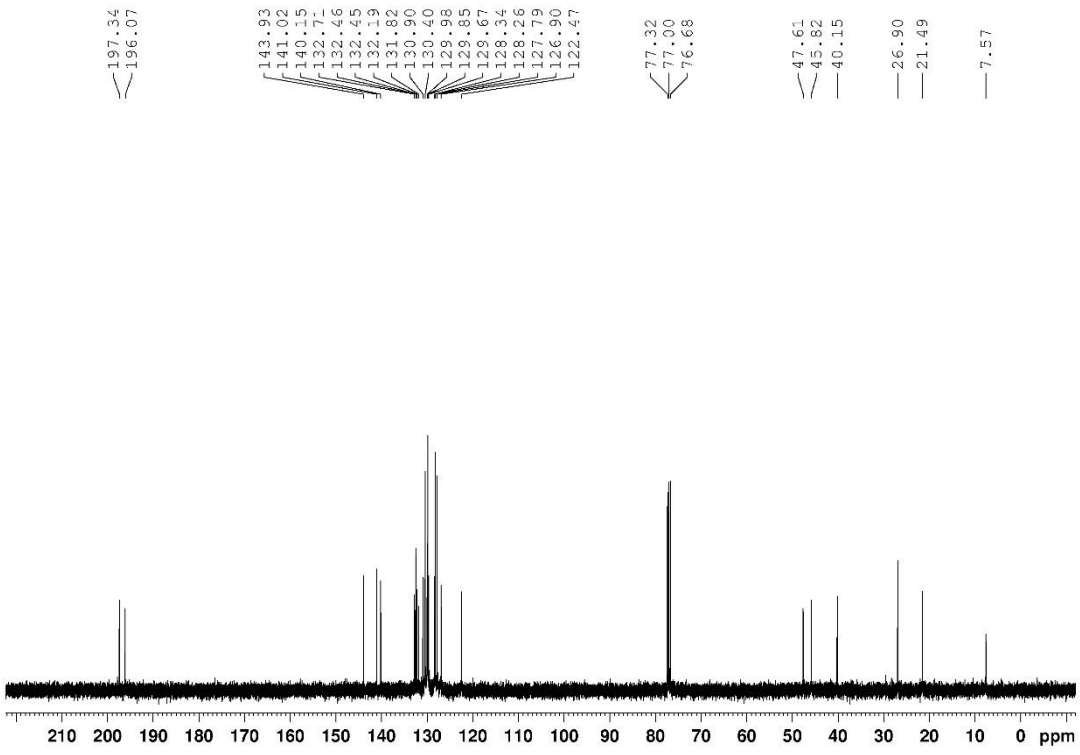


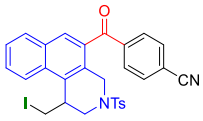
2k

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



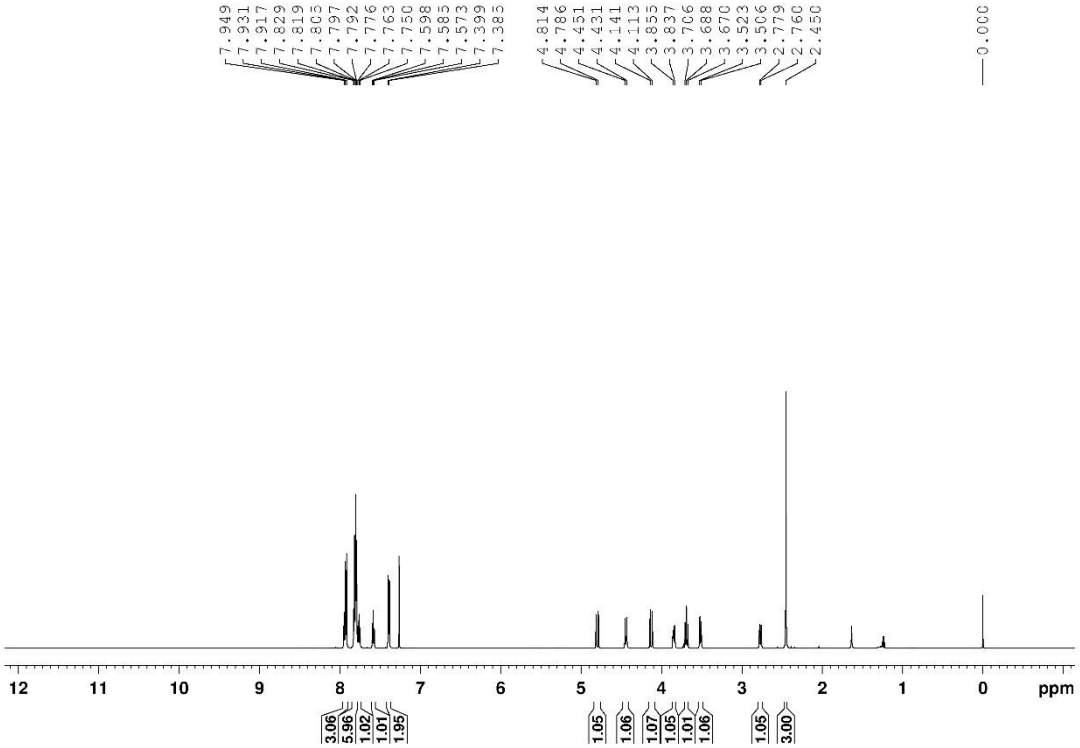
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



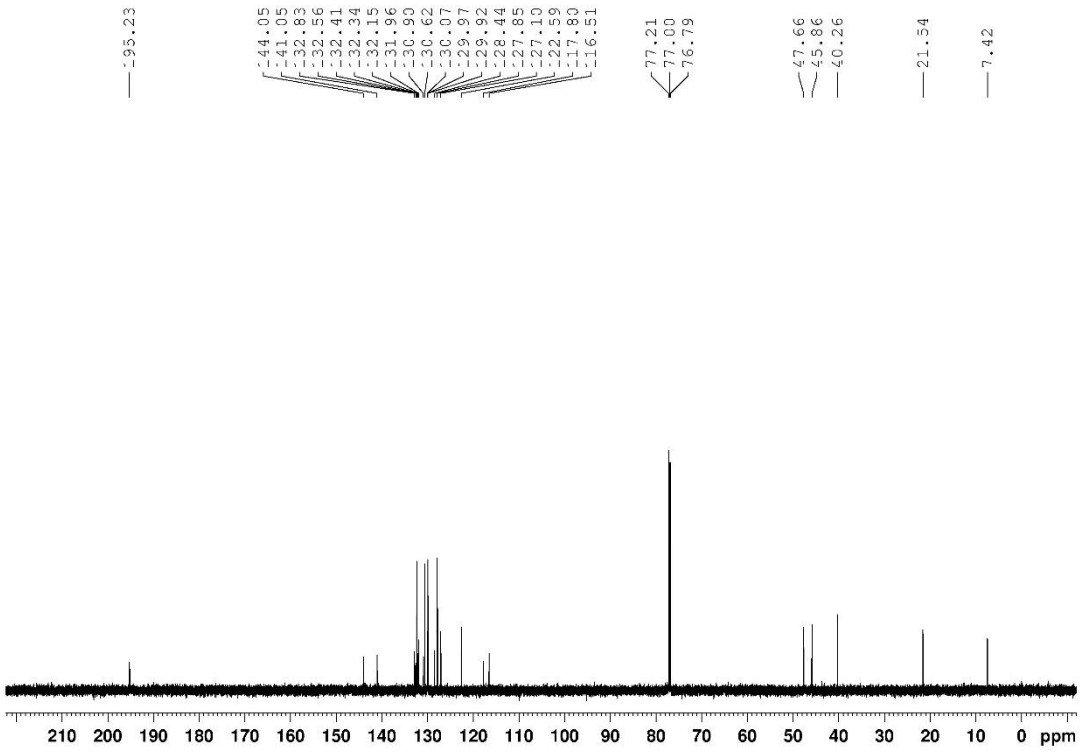


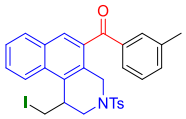
2l

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



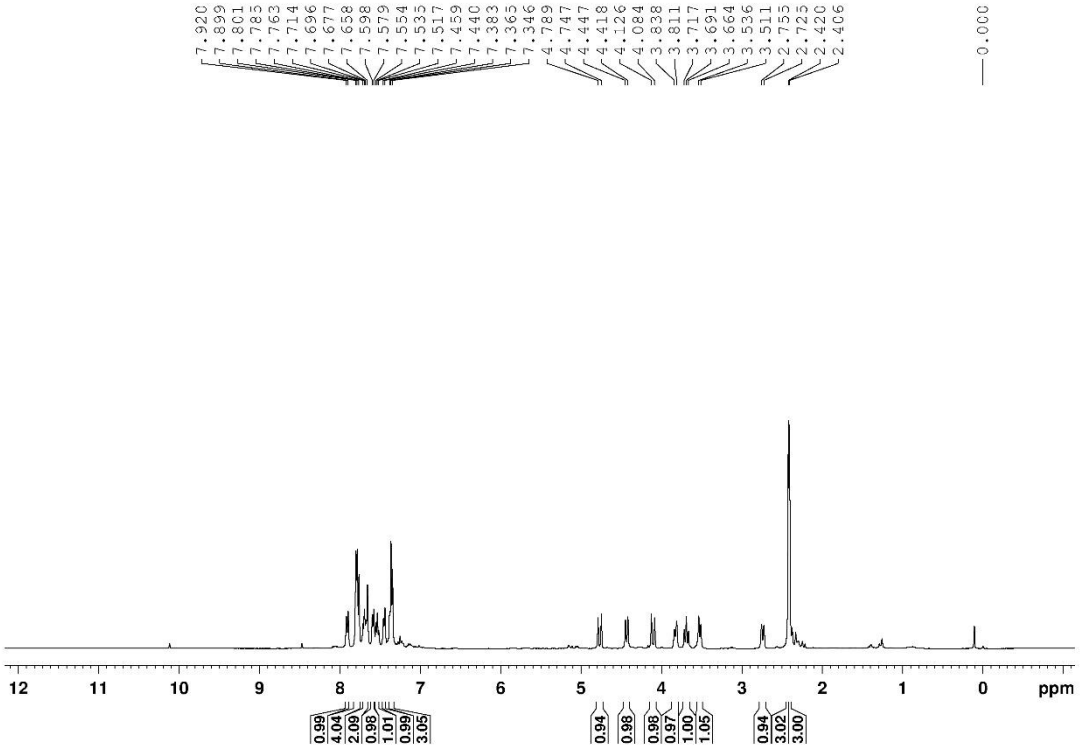
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.



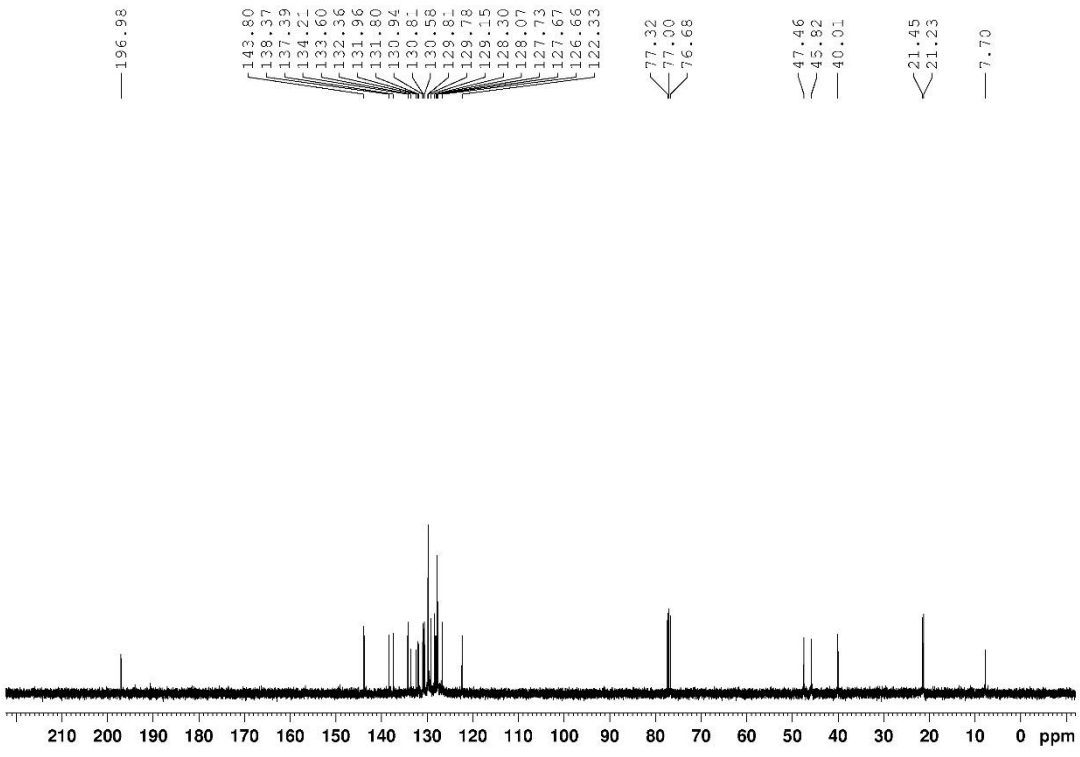


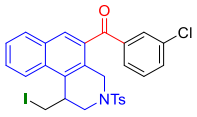
2m

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



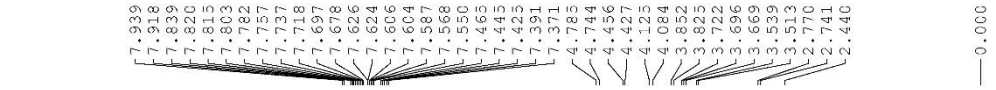
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

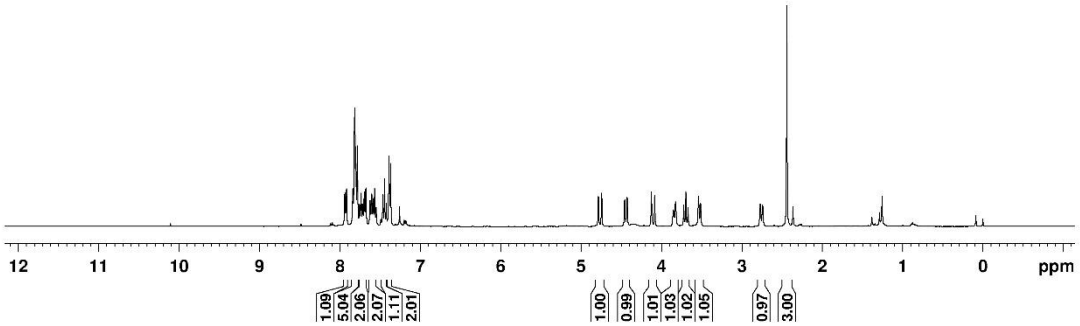




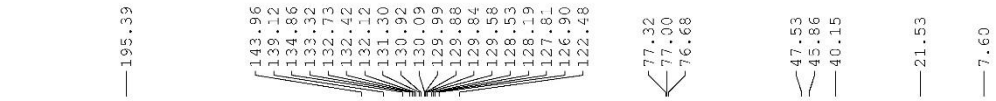
2n

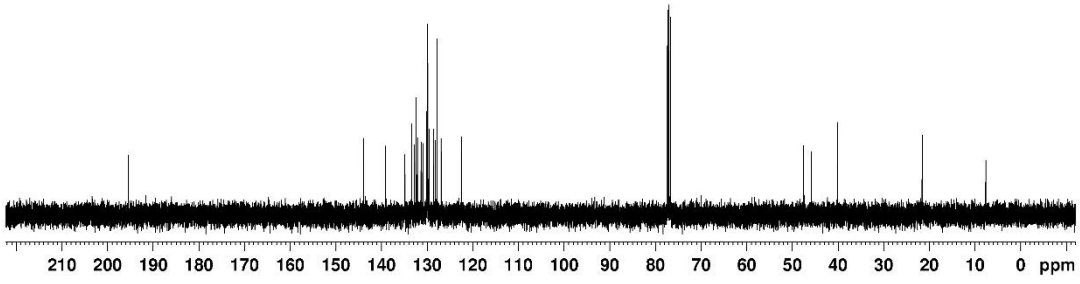
^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.

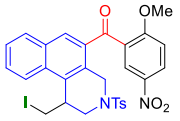




^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

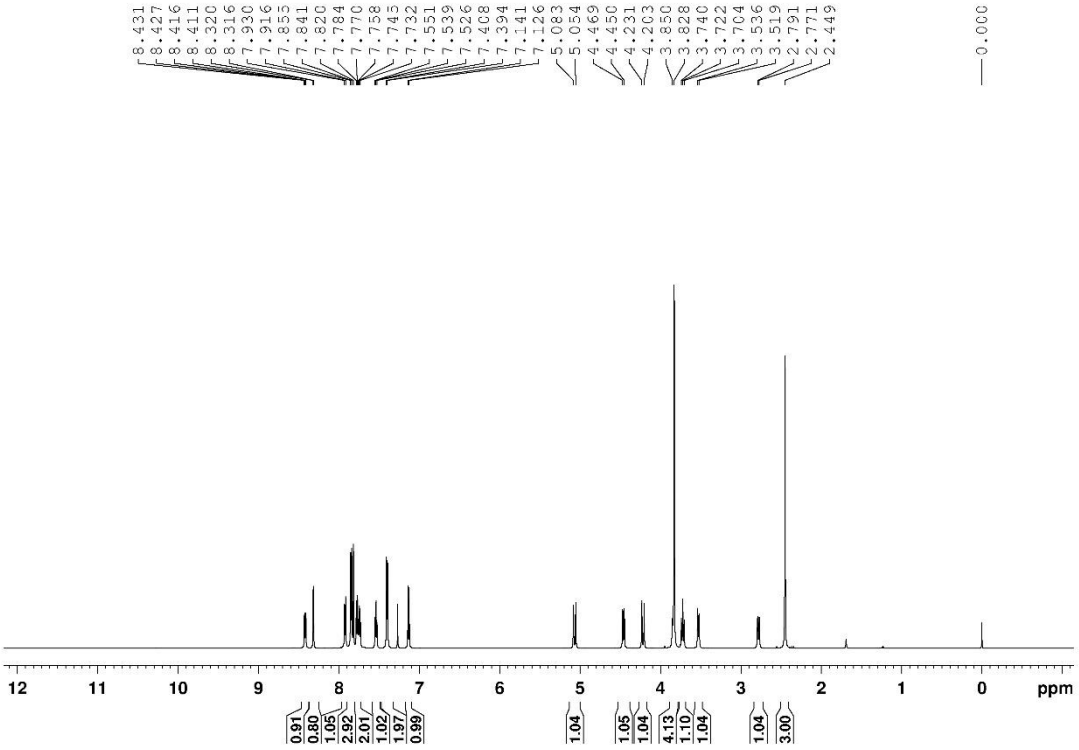




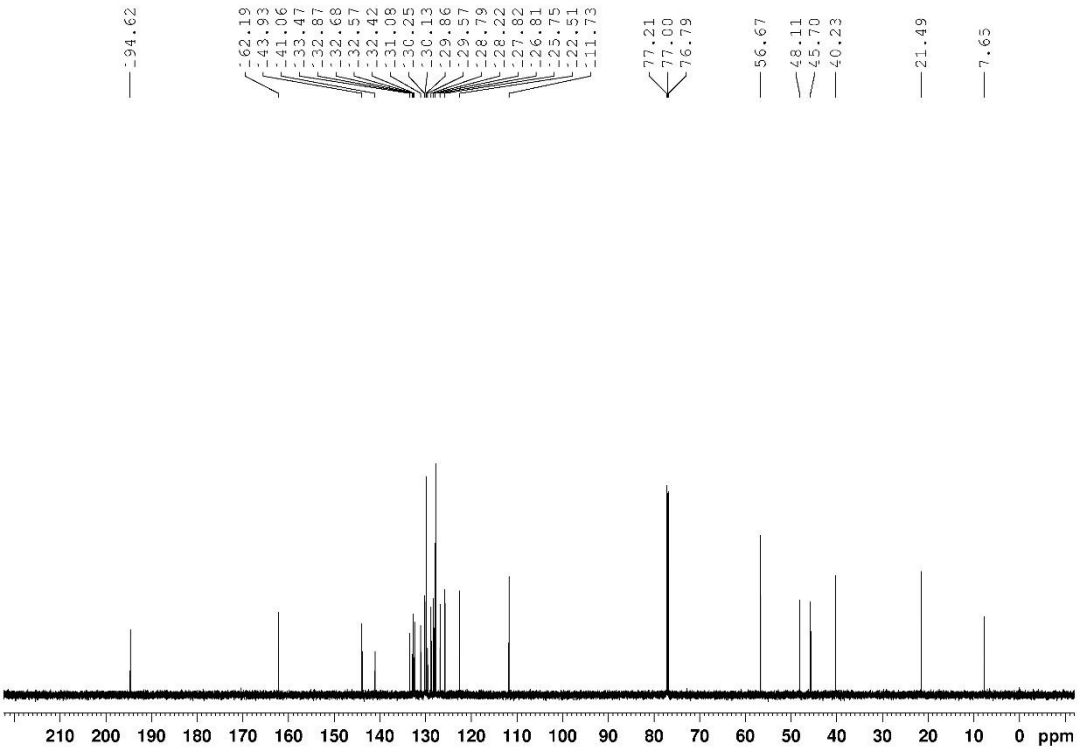


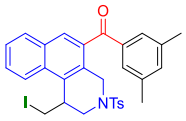
2o

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



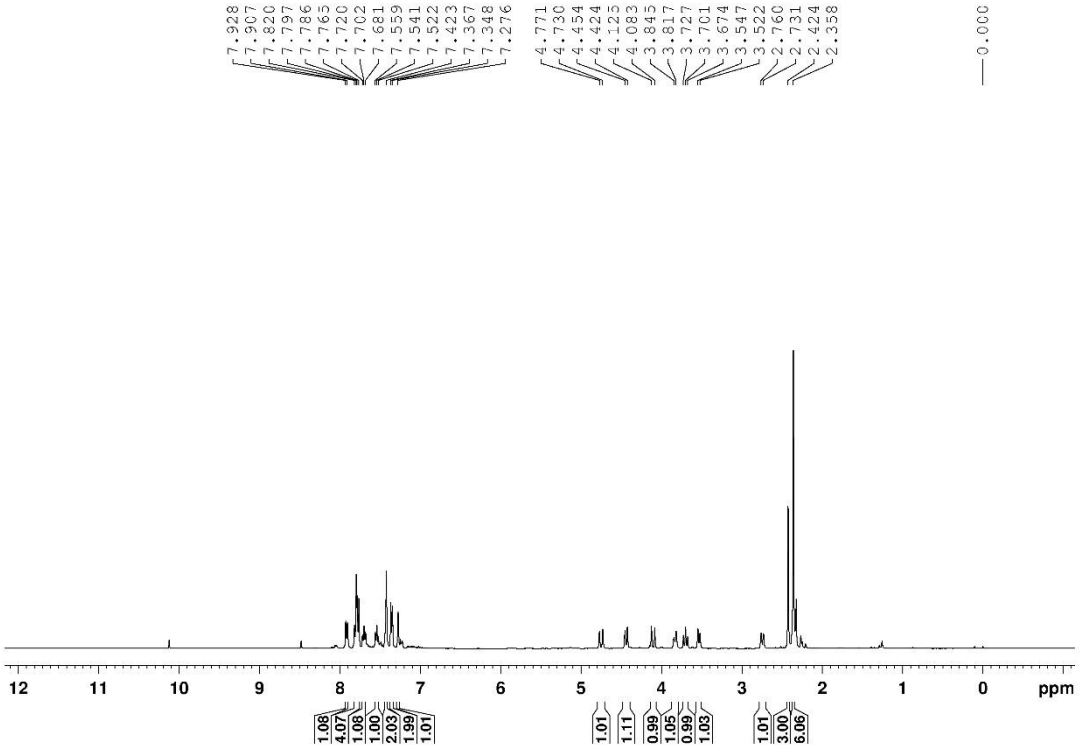
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.



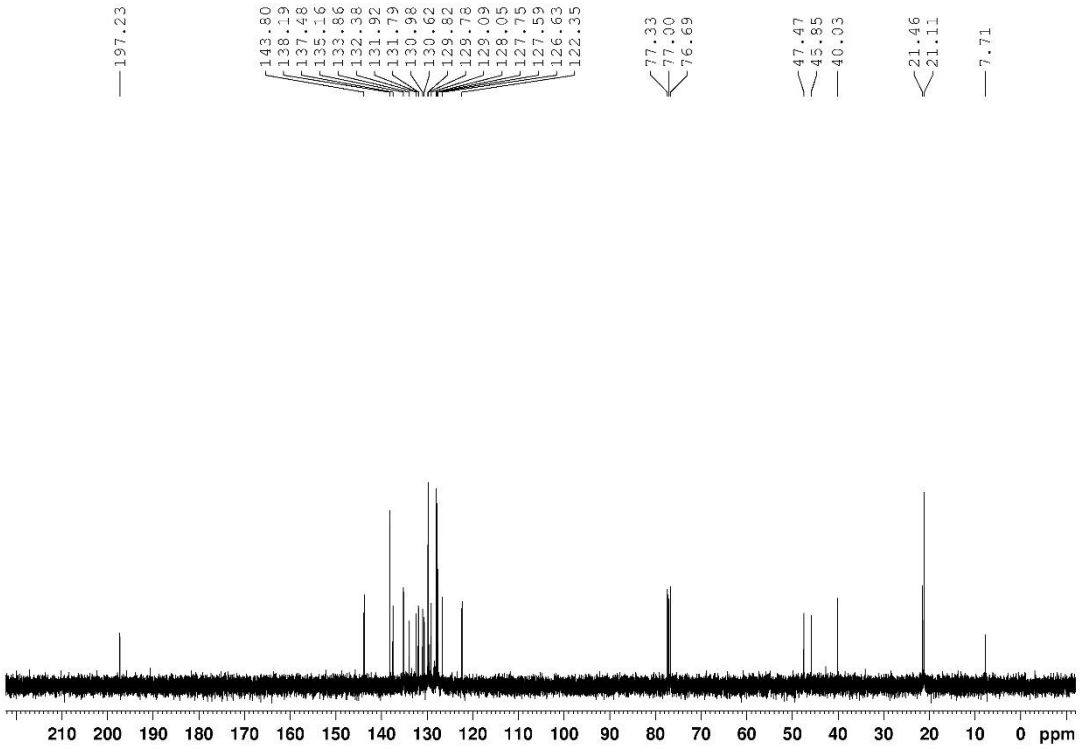


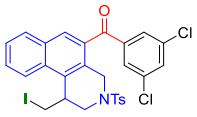
2p

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



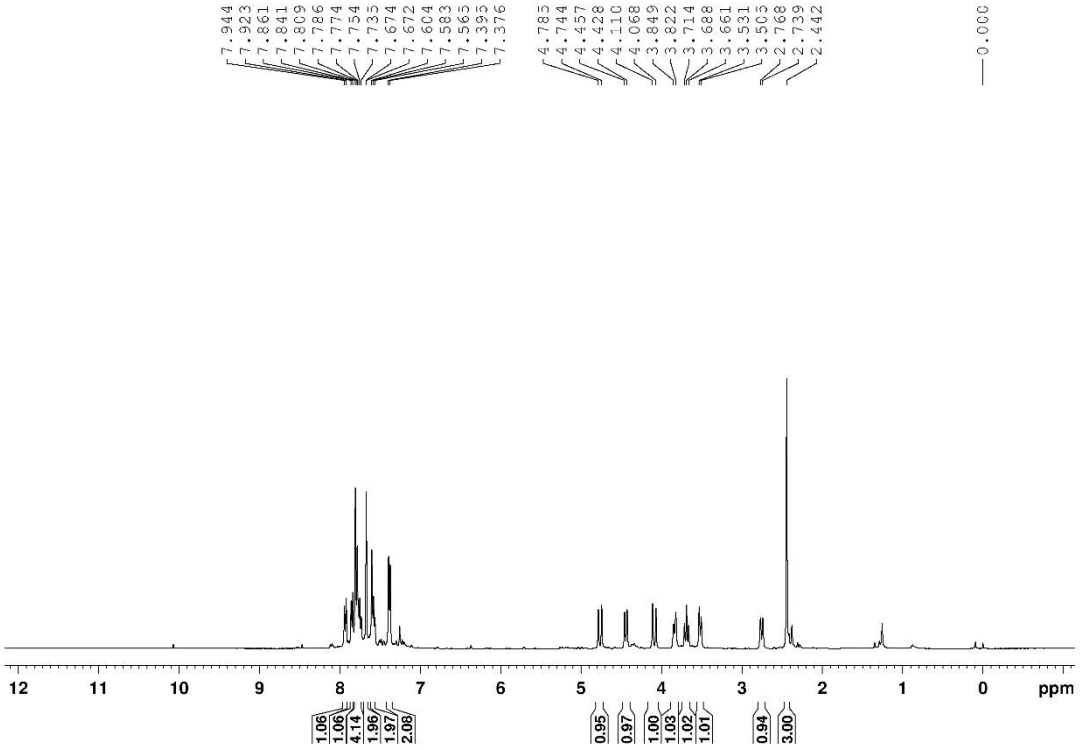
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



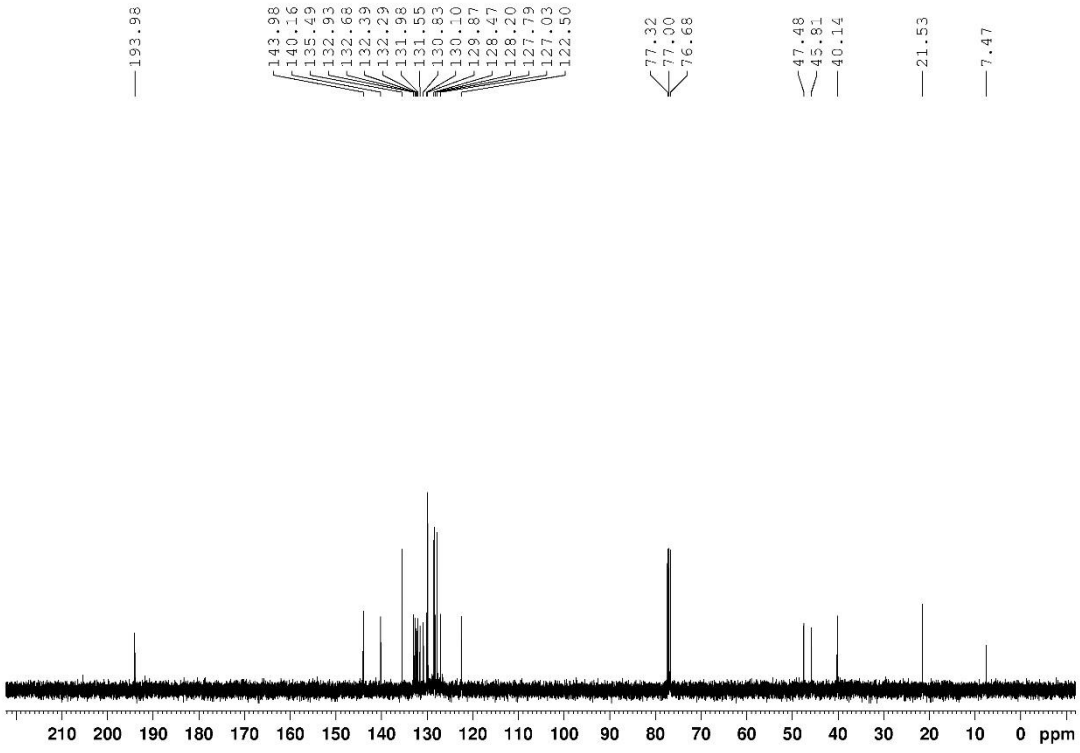


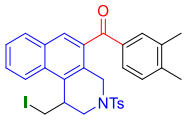
2q

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



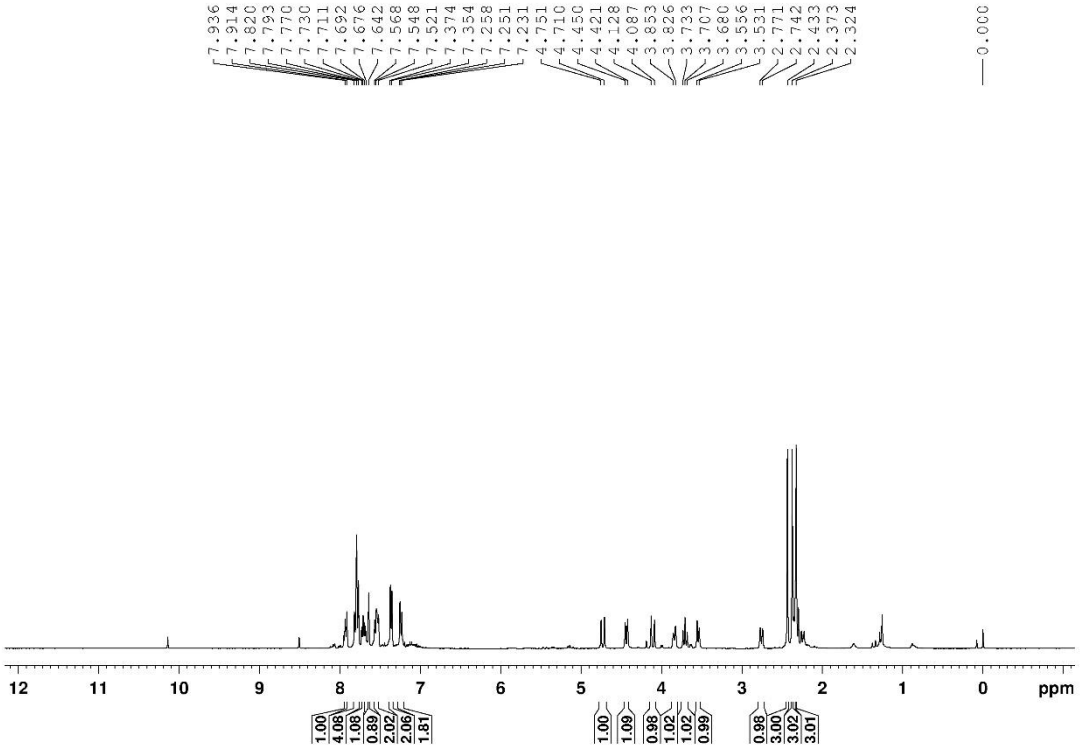
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



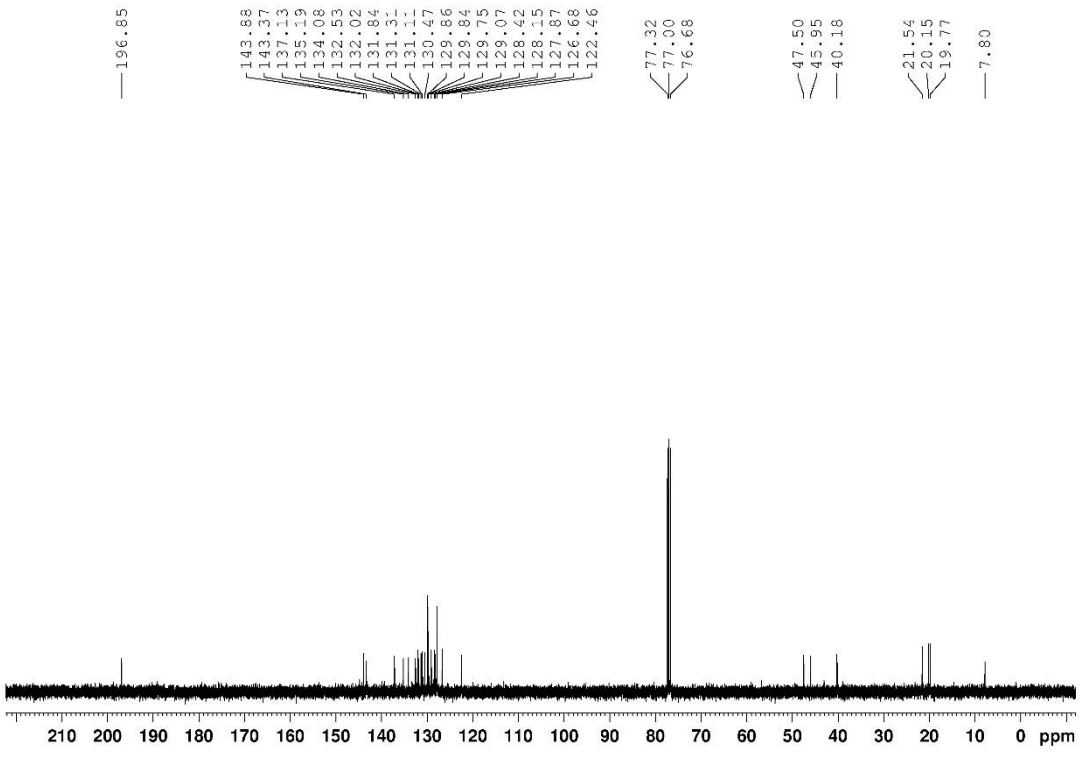


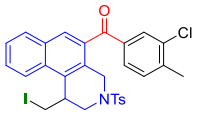
2r

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



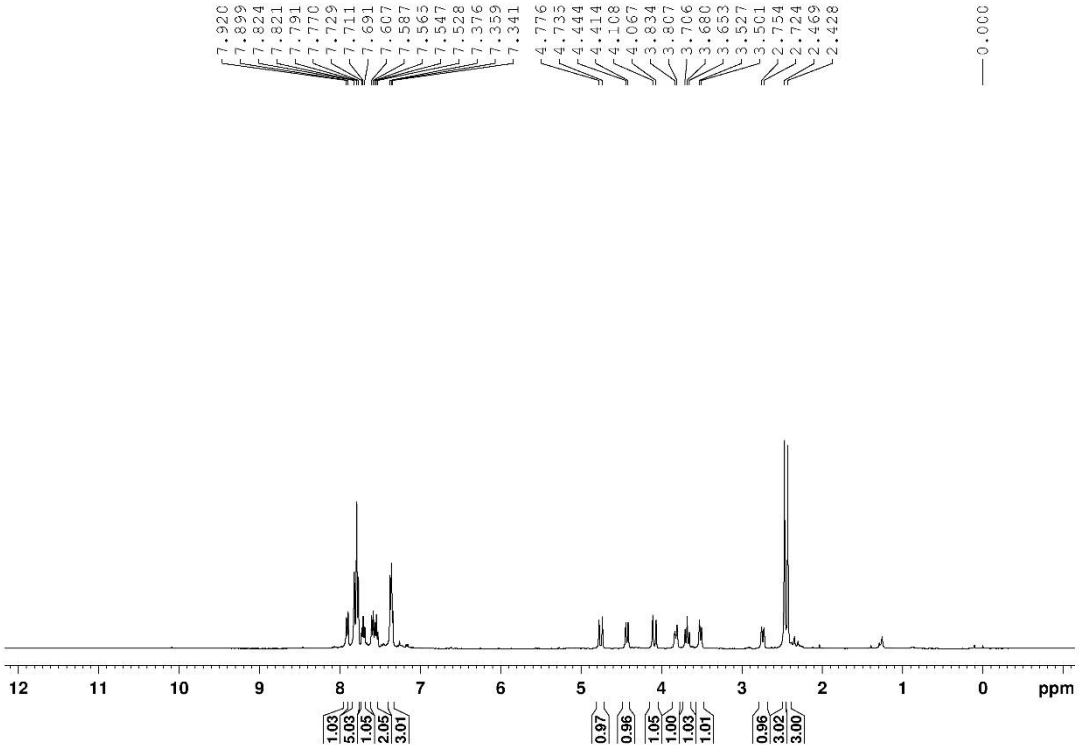
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



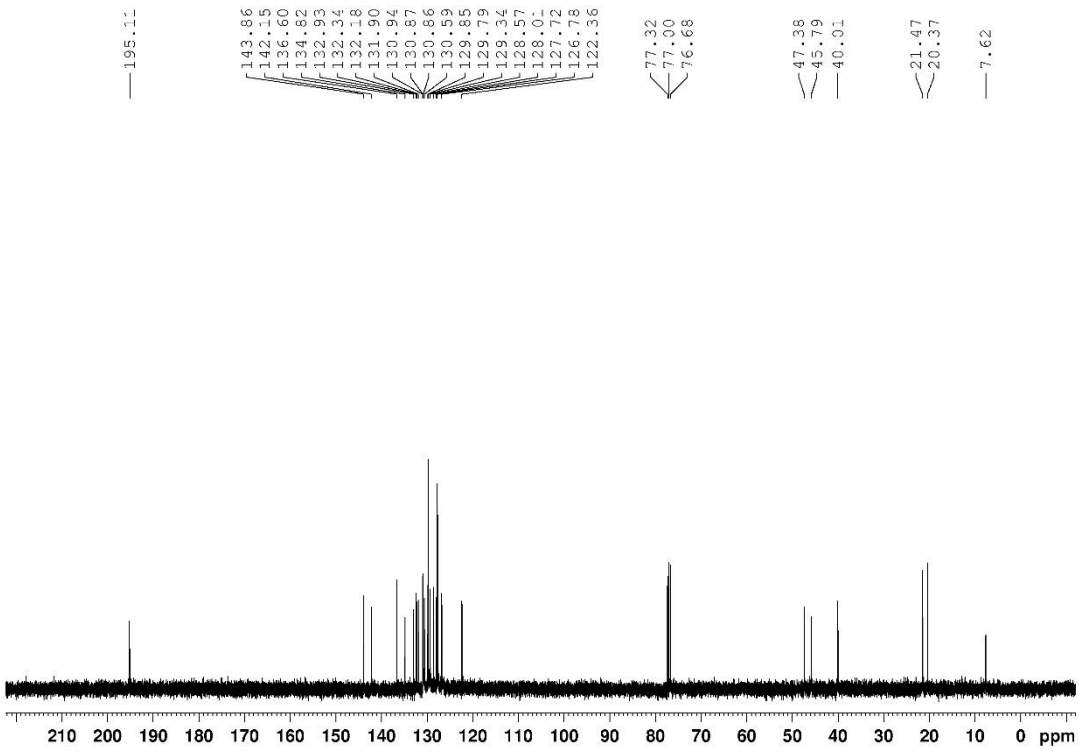


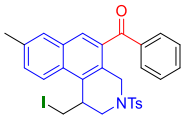
2s

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



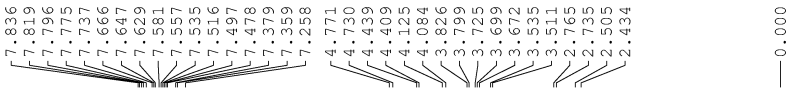
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

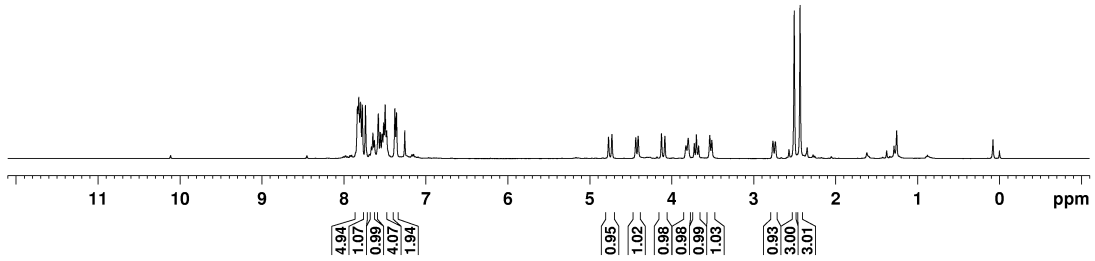




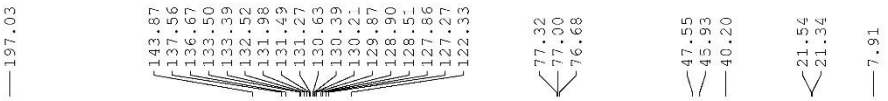
2t

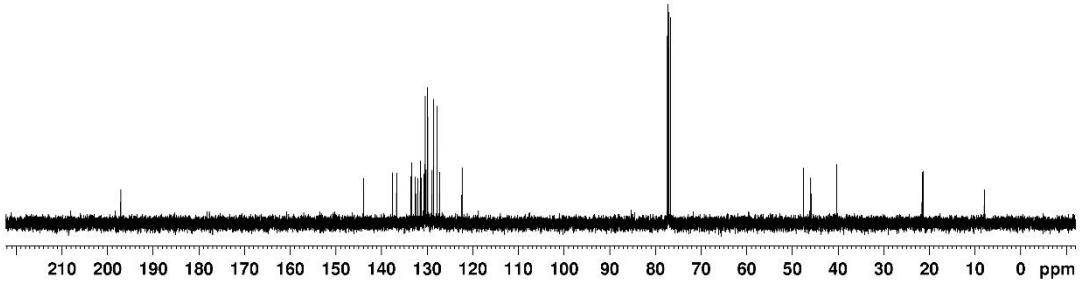
^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.

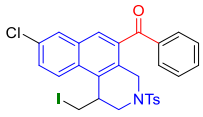




^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

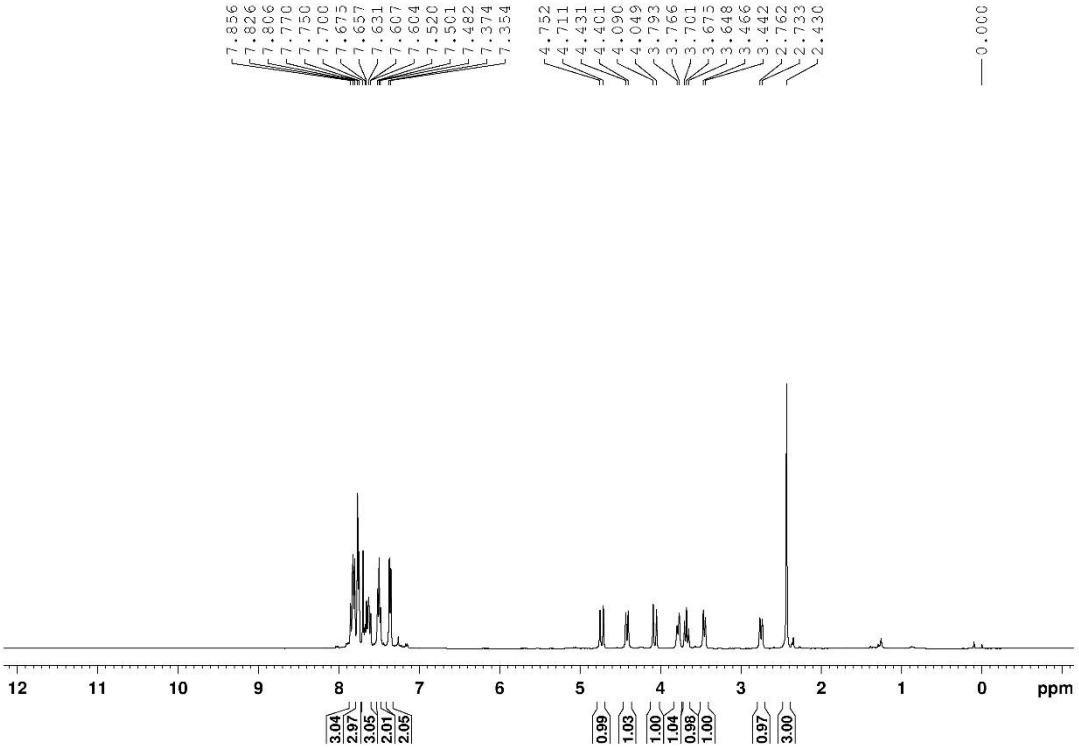




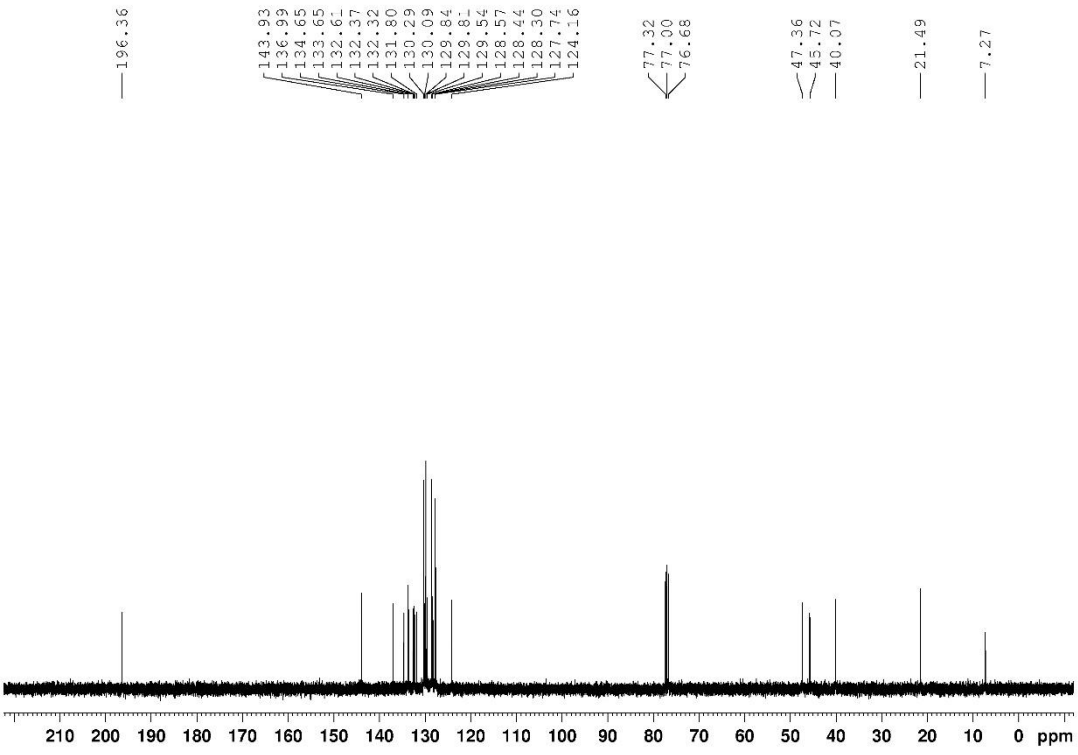


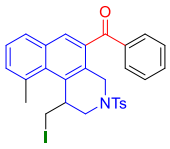
2u

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



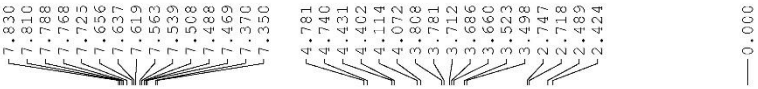
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

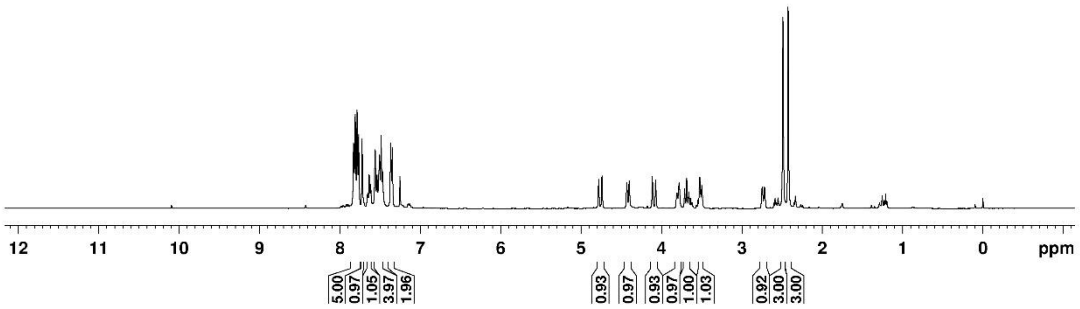




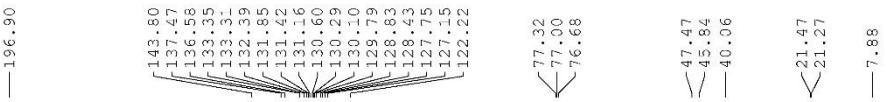
2v

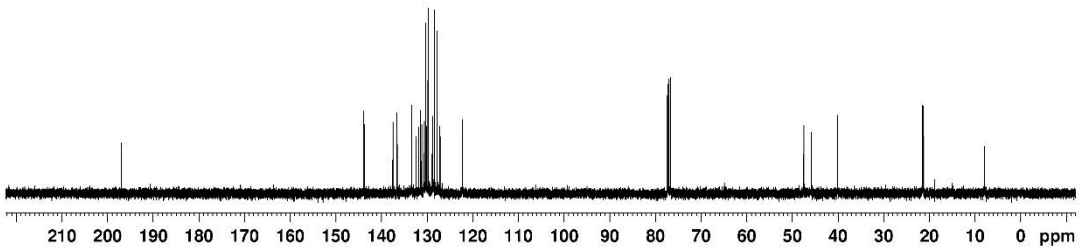
^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.

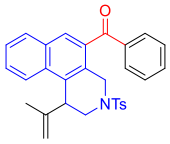




^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

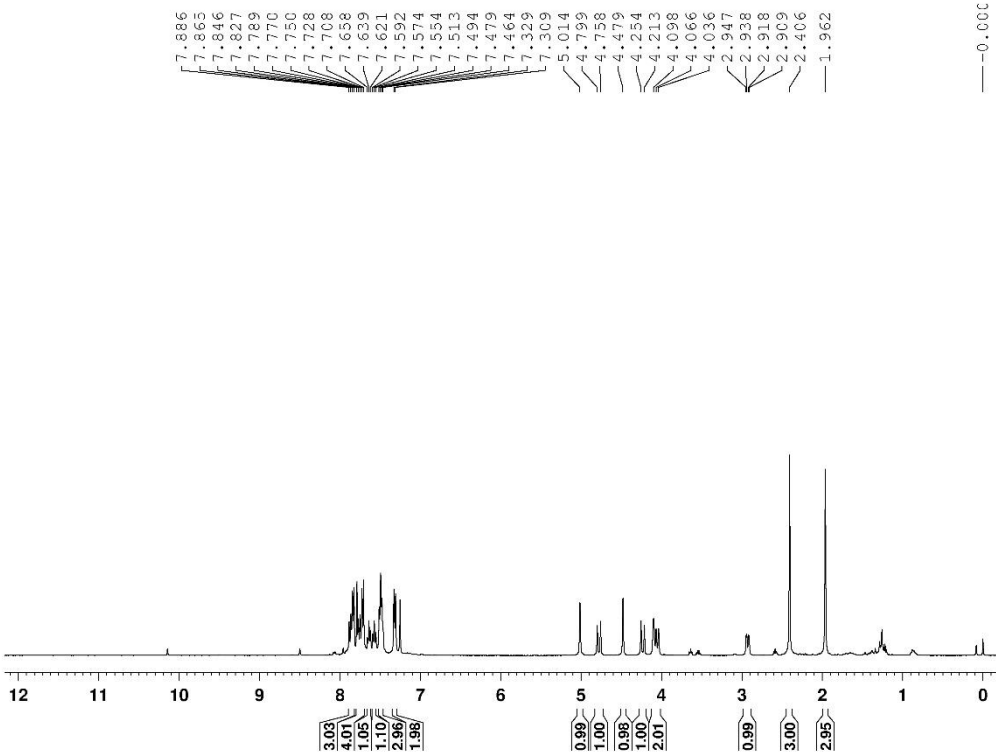




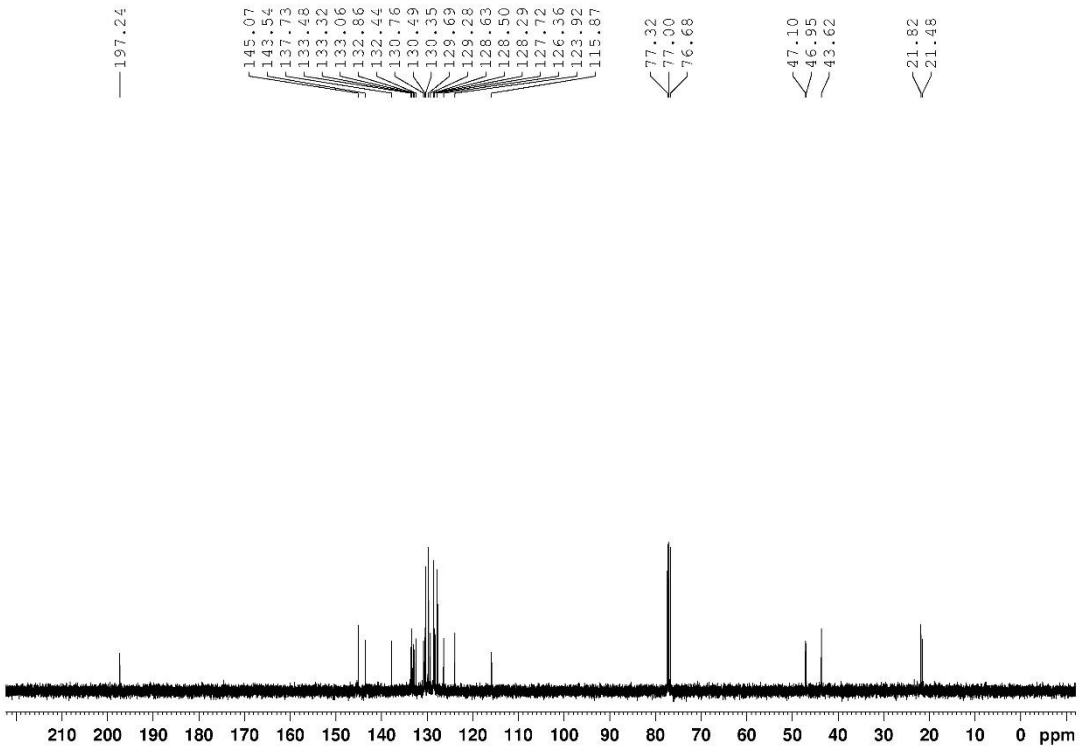


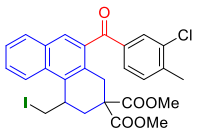
2y

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



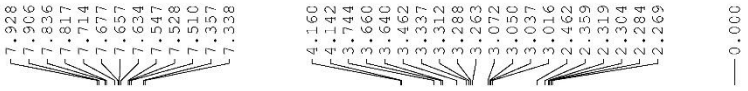
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

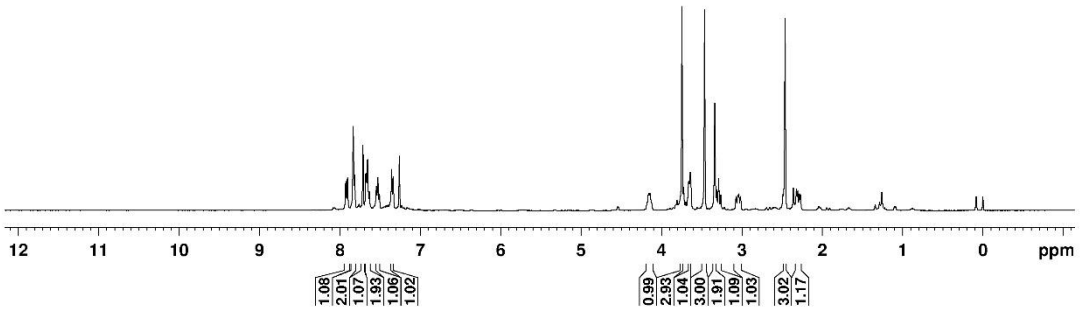




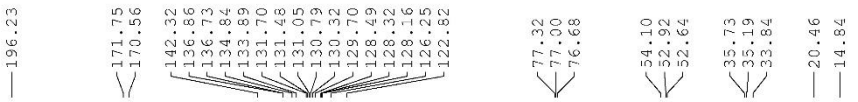
2z

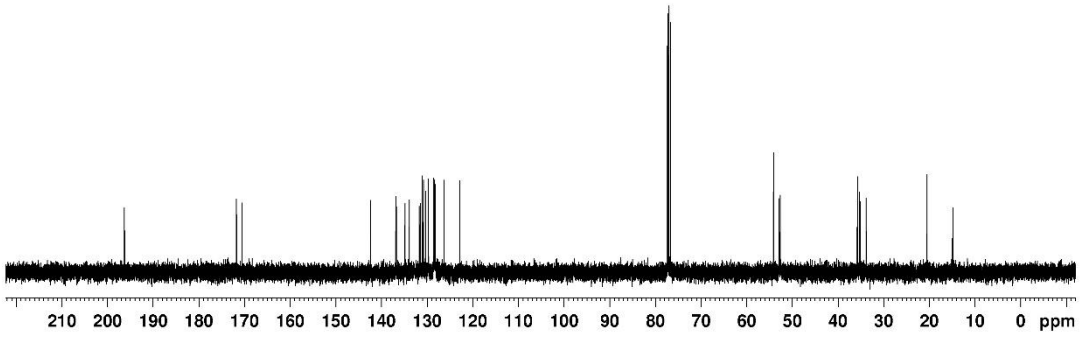
^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.

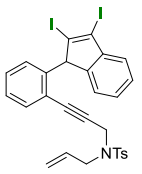




^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

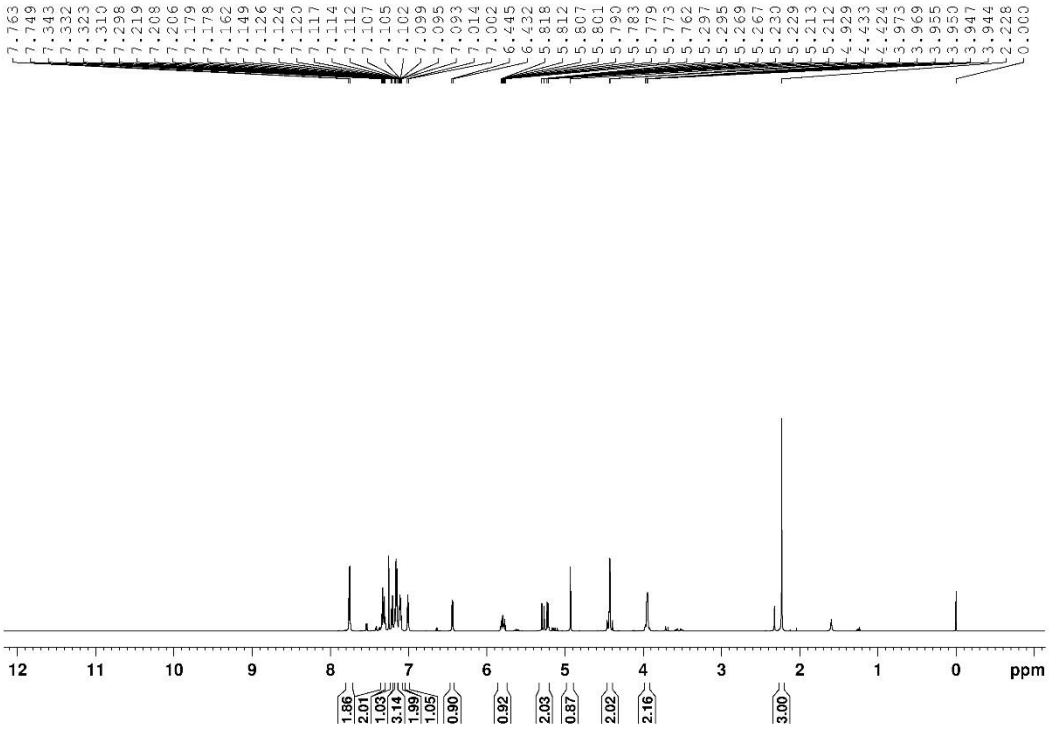




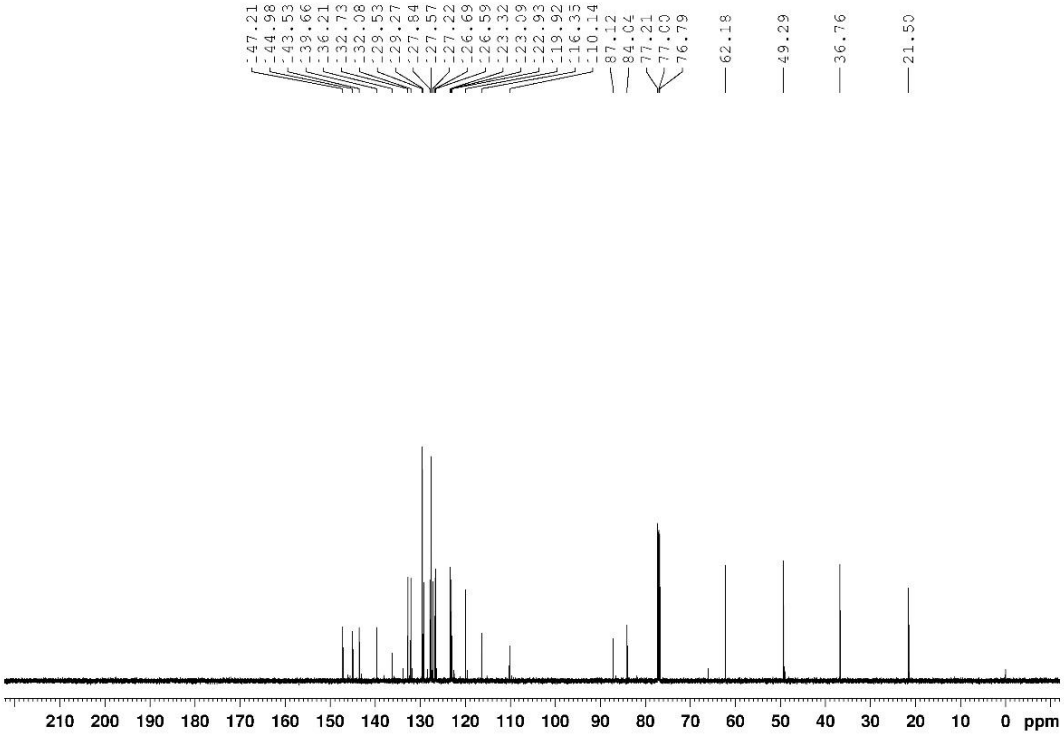


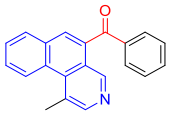
3a

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$. (This by-product could not be isolated from a complex thoroughly)



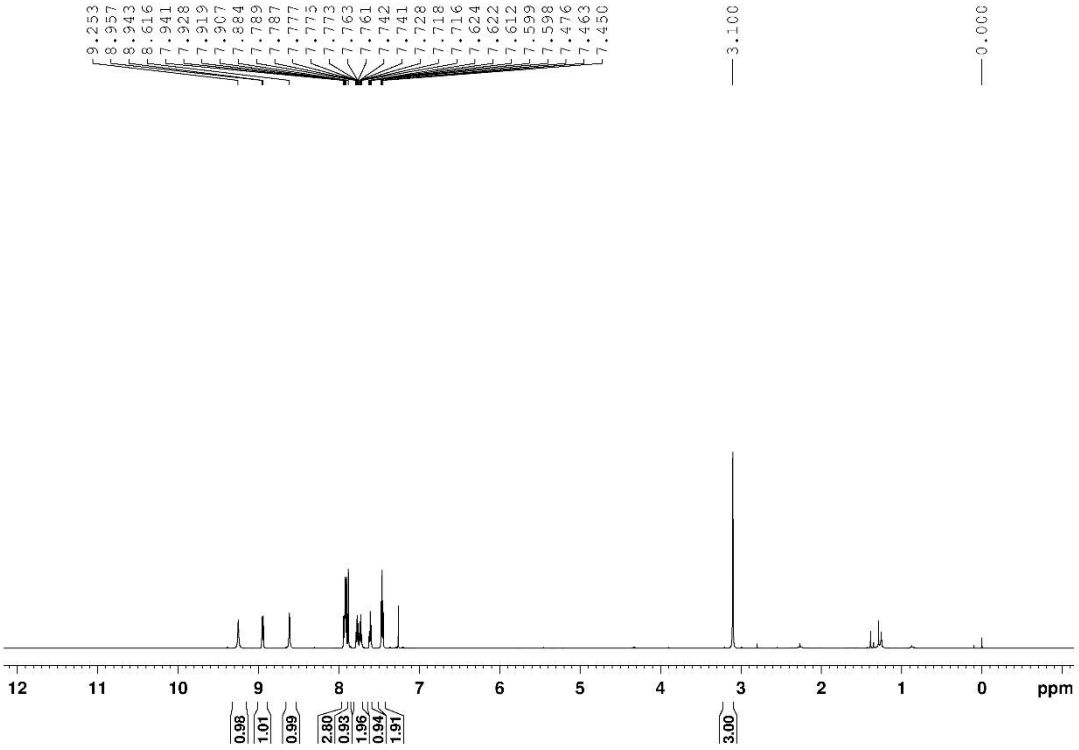
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$. (This by-product could not be isolated from a complex thoroughly)



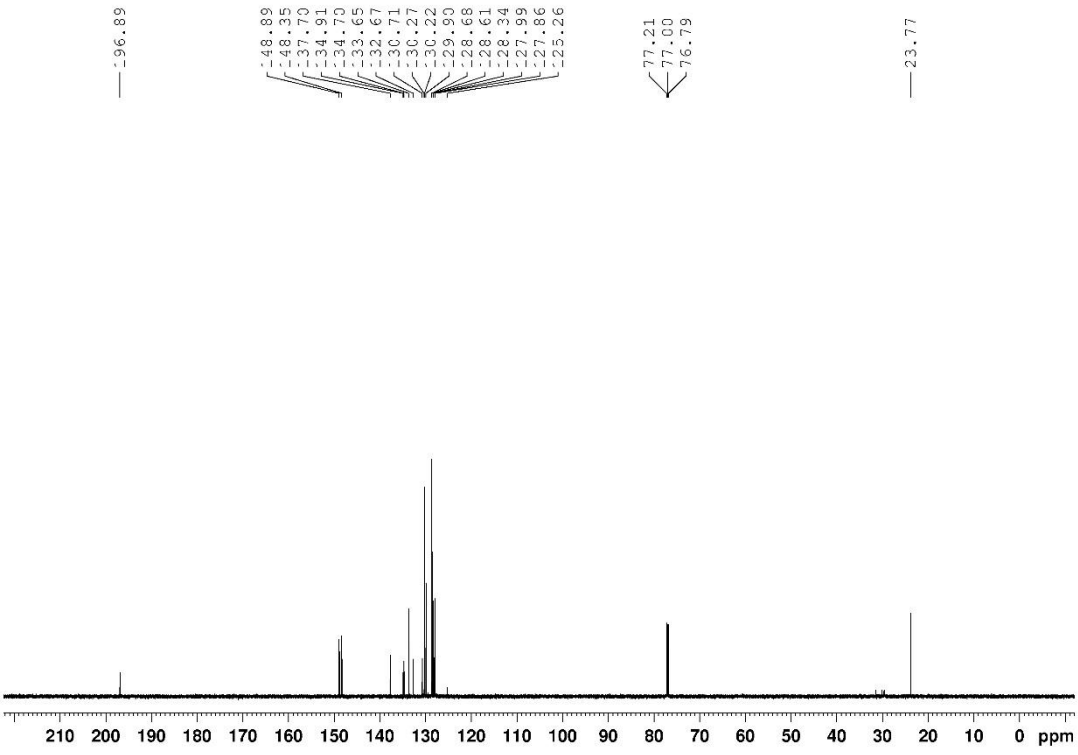


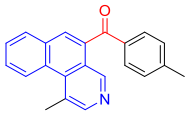
4a

^{1}H NMR spectrum was recorded on 600 MHz in $CDCl_3$.



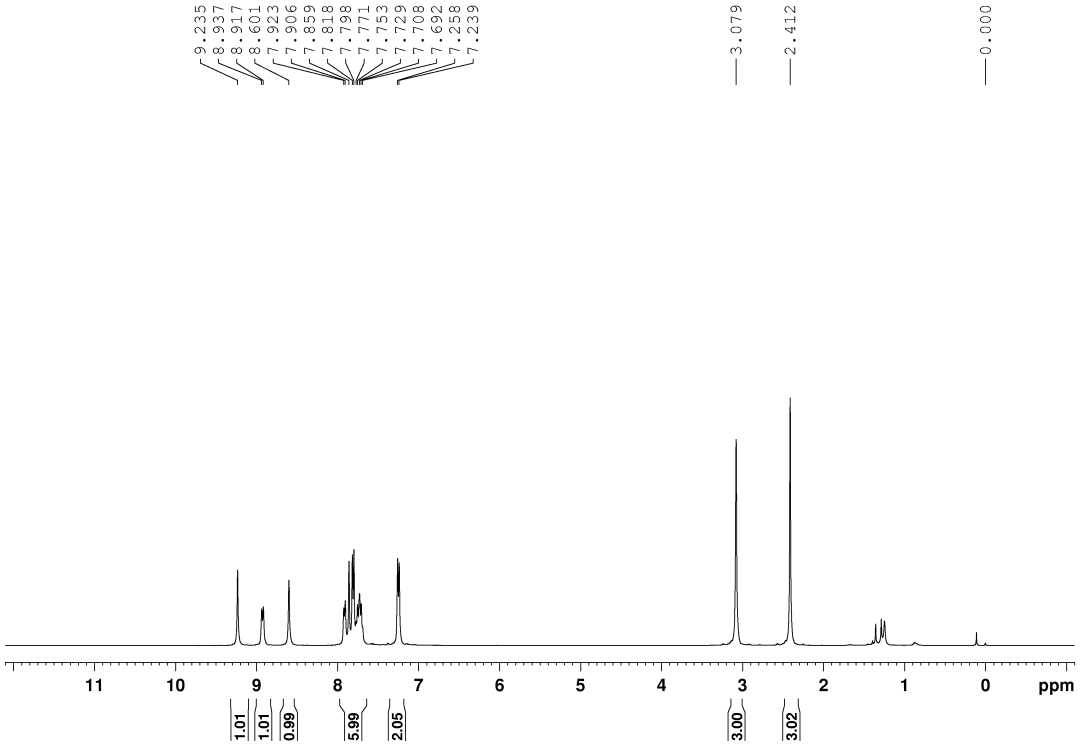
^{13}C{H} NMR spectrum was recorded on 150 MHz in $CDCl_3$.



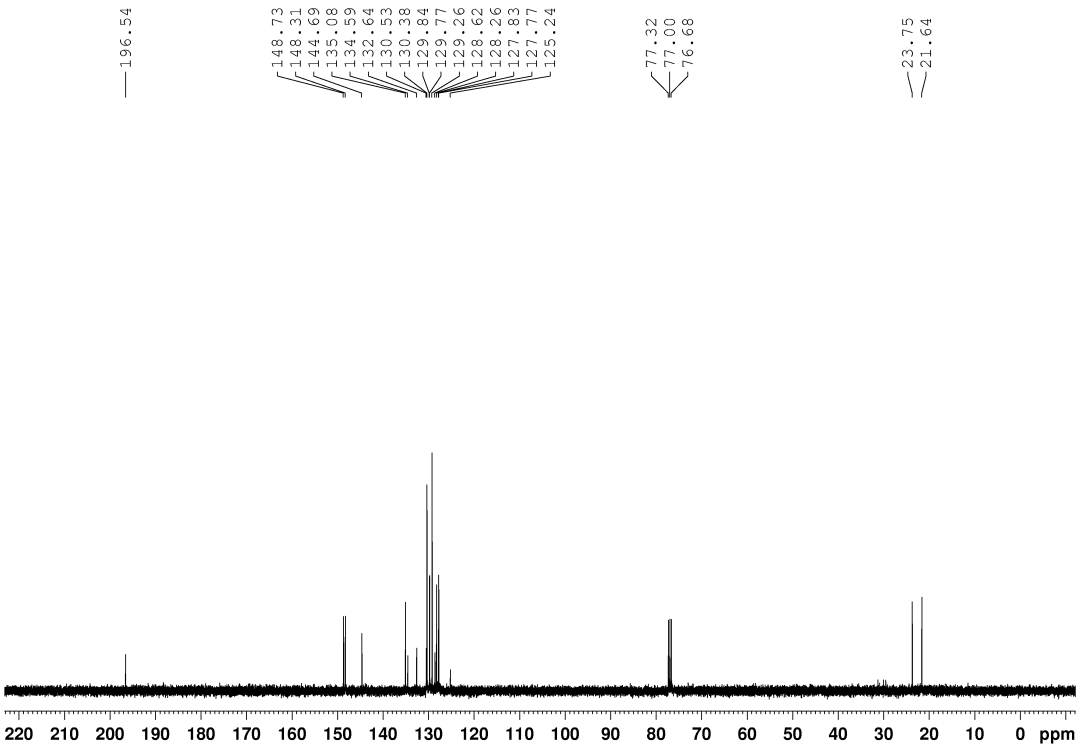


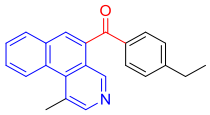
4b

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



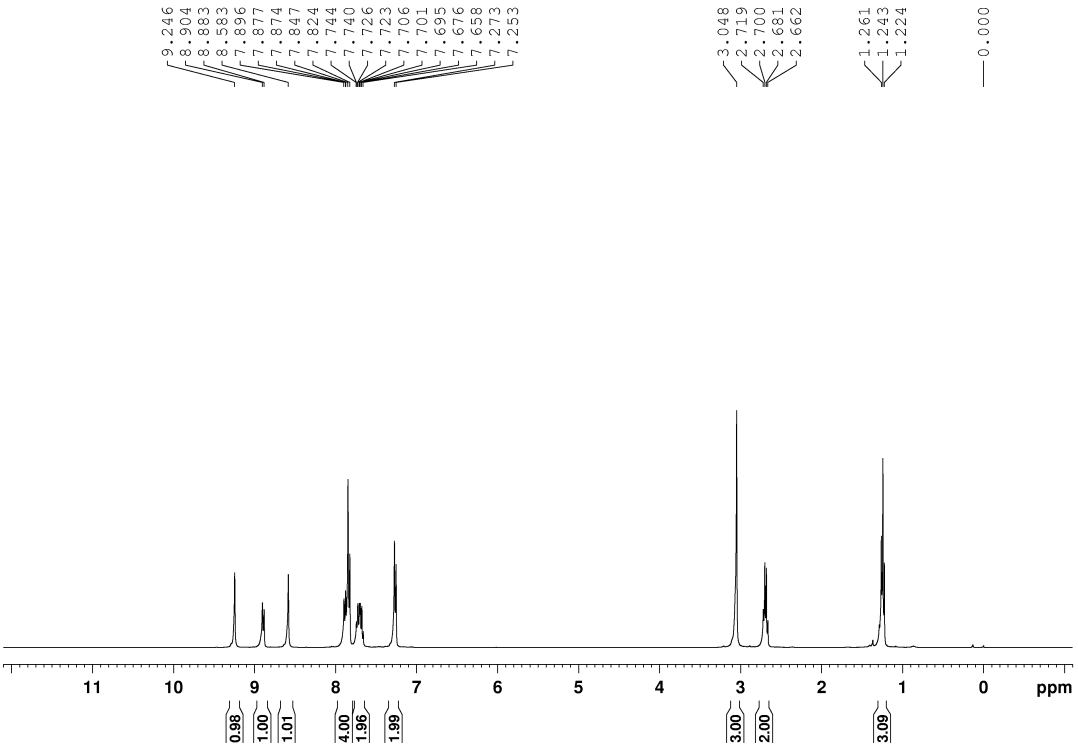
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



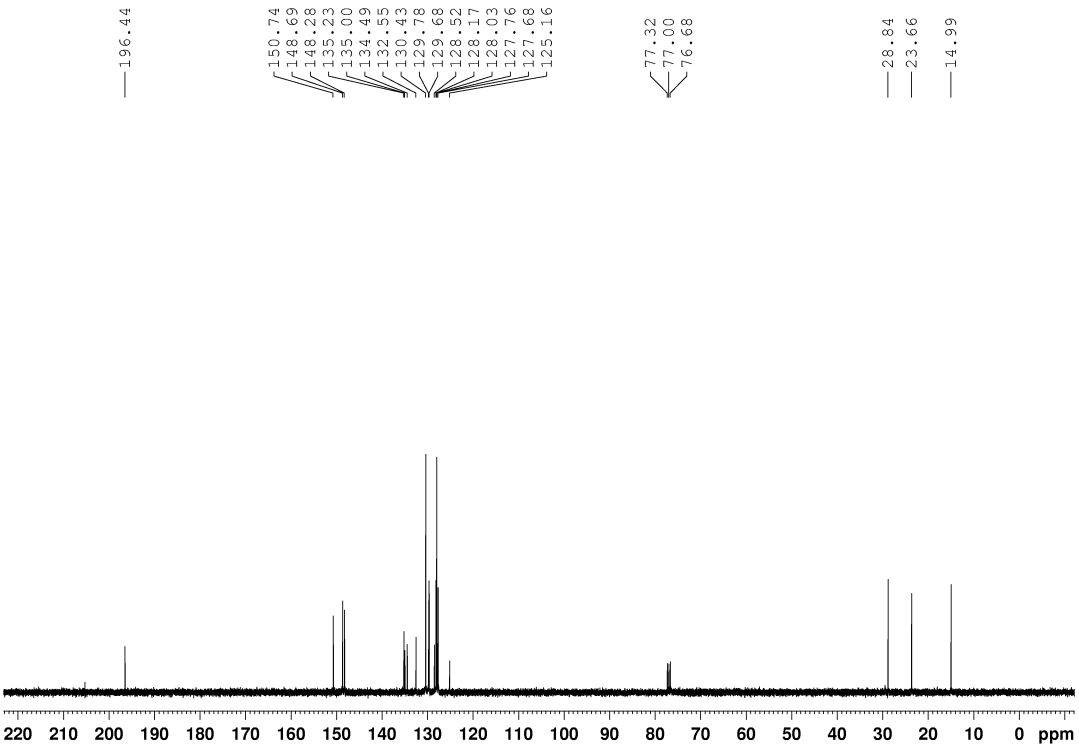


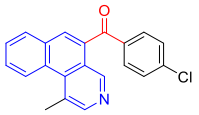
4c

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



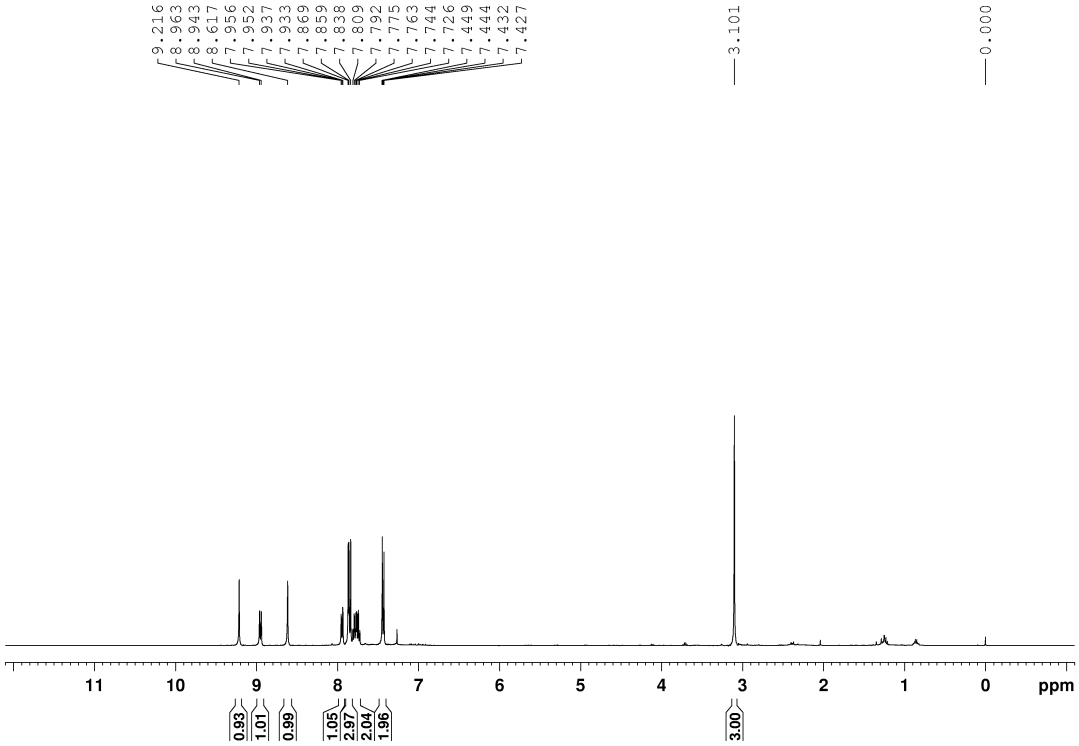
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



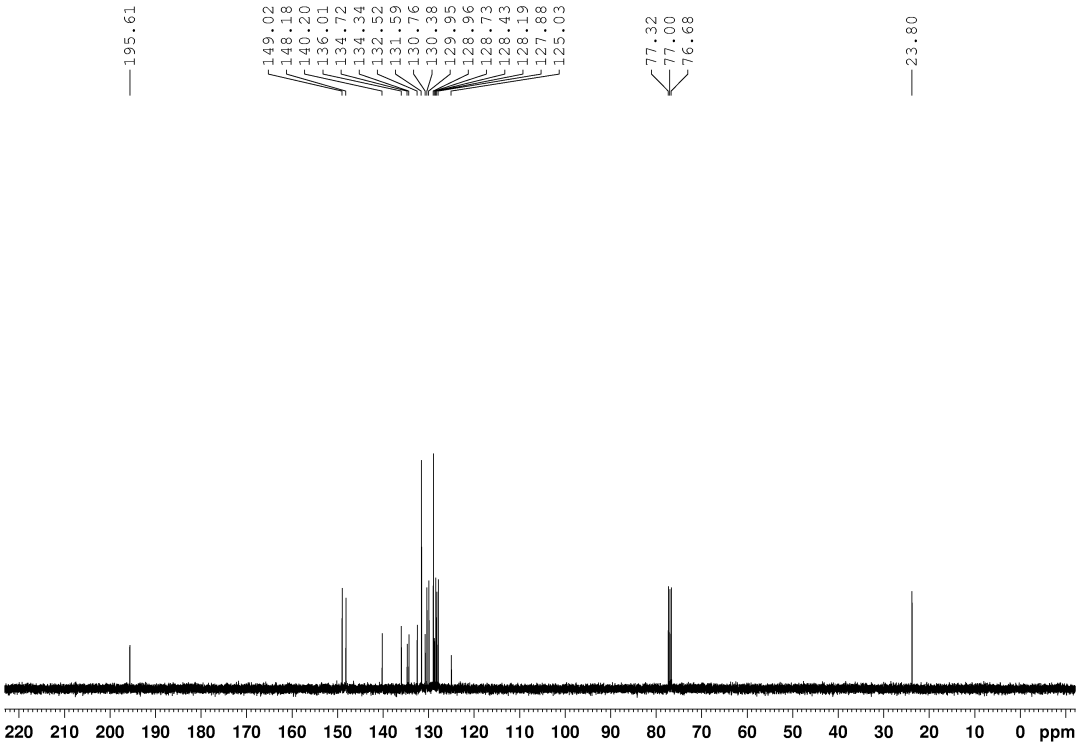


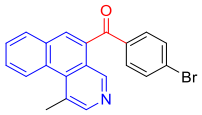
4i

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



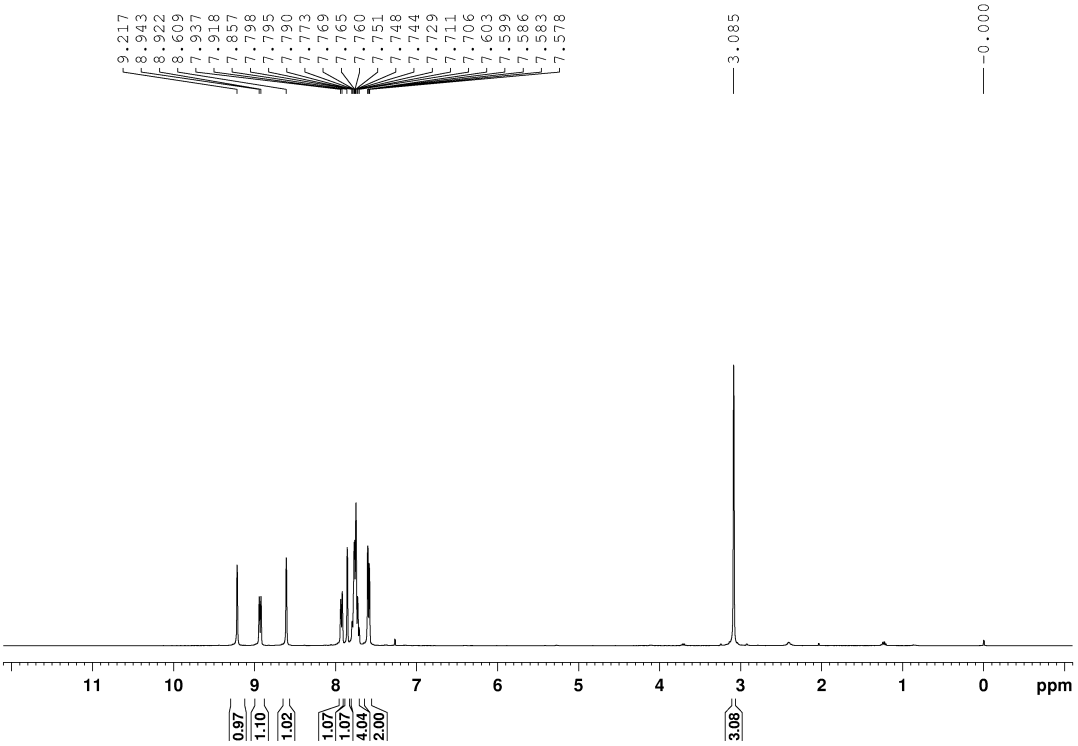
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.



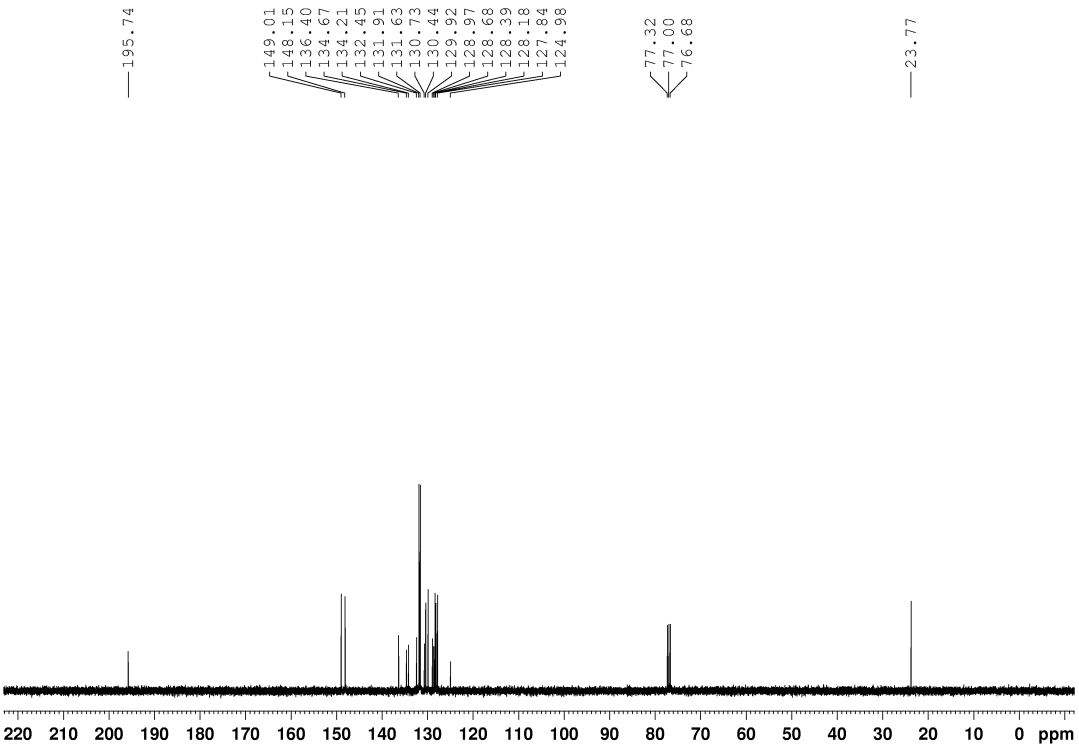


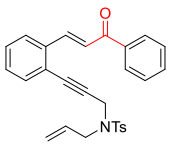
4j

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.



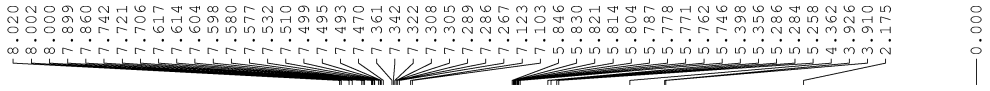
^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.

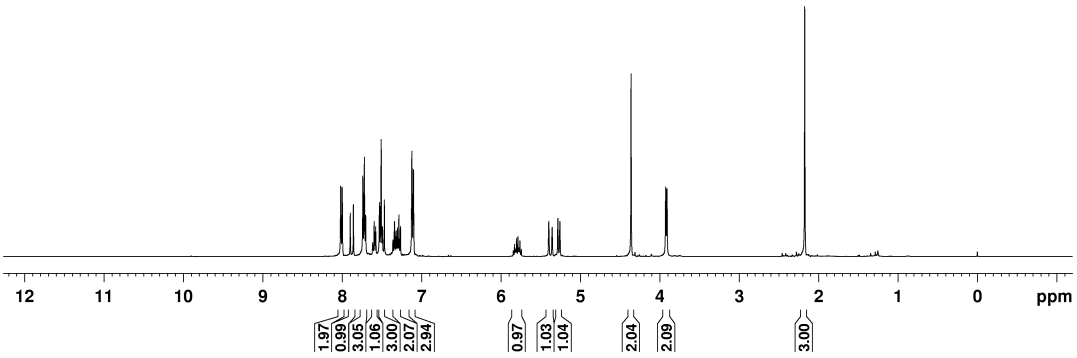




Int-C

^{1}H NMR spectrum was recorded on 400 MHz in $CDCl_3$.





^{13}C{H} NMR spectrum was recorded on 100 MHz in $CDCl_3$.