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Supporting information

Rhodium-Catalysed Regioselective [4+2]-type Annulation of 1-H-Indazoles with Propargyl Alcohols: A direct entry to 6-alkenylindazolo[3,2-a]isoquinolines

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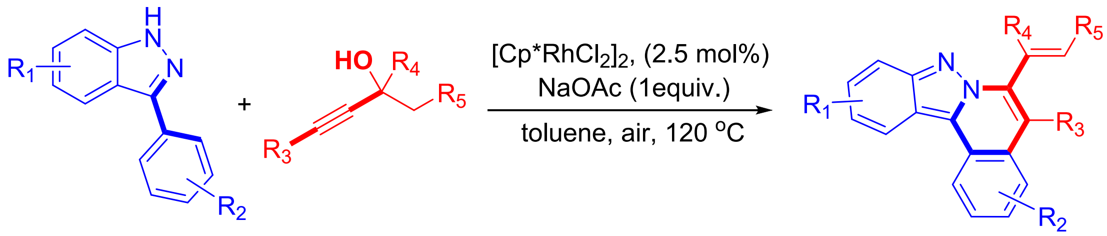
1. General Information

Unless otherwise stated, all commercial materials and solvents were used directly without further purification. NMR spectra were measured on a 400 MHz Bruker spectrometer (^{1}H 400MHz, ^{13}C 100MHz, ^{19}F NMR 376 MHz) using $CDCl_3$ (spectra were referenced to the solvent peaks ^{1}H: residual $CDCl_3$ = 7.26 ppm, ^{13}C: $CDCl_3$ = 77.00 ppm) as the solvent. High-resolution mass spectra (HRMS) were measured on ESI-TOF. Melting points were measured on a microscopic apparatus and were uncorrected. Column chromatography was performed on silica gel (70-230 mesh ASTM) using the reported eluents. Thin-layer chromatography (TLC) was carried out on 4×5 cm plates with a layer thickness of 0.2 mm (silica gel 60 F254). Starting materials 1*H*-indazoles **1**[1] and propargyl alcohols **2**[2] were prepared according to the reported procedures.

2. General catalytic procedure

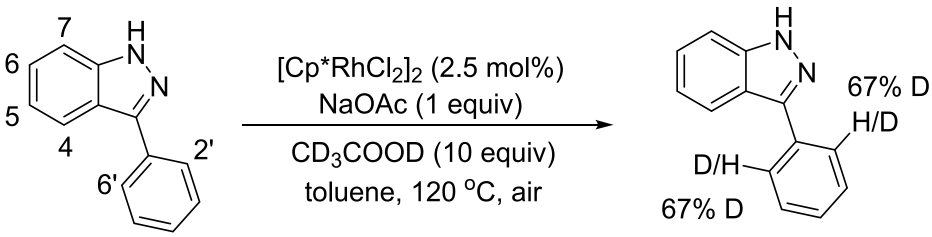


1 **2** **3**

A reaction tube (25 mL) equipped with a magnetic stirrer bar was charged with 3-aryl-1*H*-indazoles **1** (0.1 mmol), propargyl alcohols **2** (0.1 mmol), $[Cp^*RhCl_2]_2$ (0.0025 mmol, 2.5 mmol%), NaOAc (0.1 mmol, 1 eq.) and toluene (1.5 mL). The reaction mixture was sealed and stirred at 120 °C (metal module heating) for 12 h under air. After cooled to room temperature, the solvent was removed under reduced pressure, purification was performed by flash column chromatography on silica gel with petroleum ether/ethyl acetate (gradient mixture ratio from 80:1 to 60:1) as eluent to give the corresponding compounds **3**.

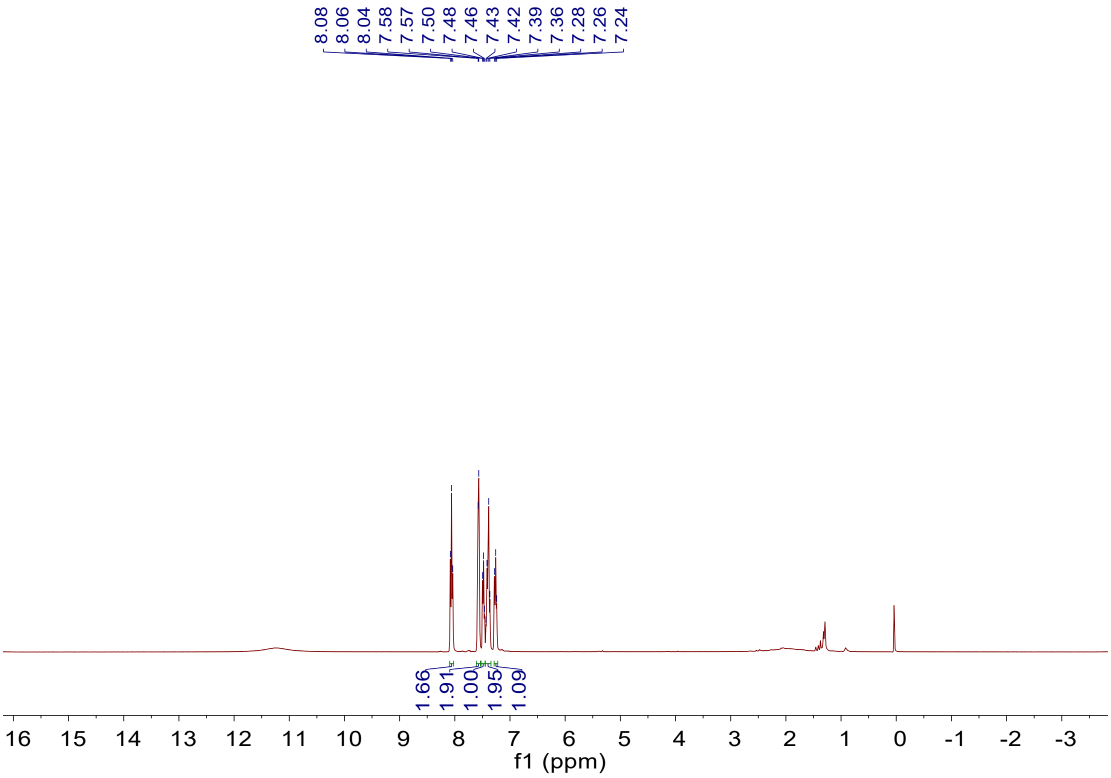
3. Mechanism Exploration

(1) H/D exchange experiment



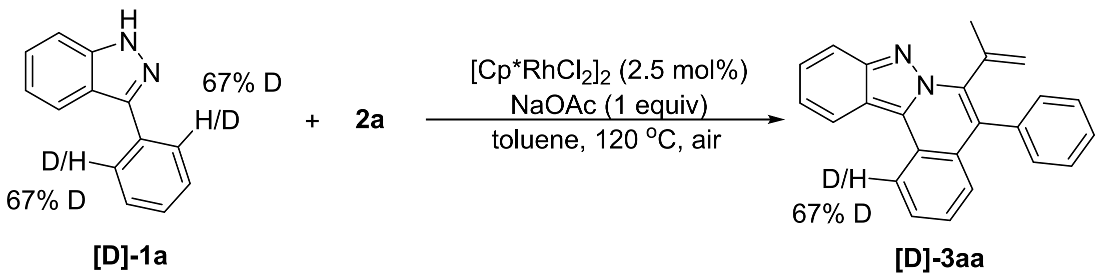
1a **[D]-1a**

To a tube equipped with magnetic stir bar, 3-phenyl-1*H*-indazole **1a** (38.4 mg, 0.2 mmol), [Cp*RhCl$_2$]$_2$ (3.1 mg, 0.005 mmol), NaOAc (16.4 mg, 0.2 mmol), CD_3COOD (10 equiv) were added in toluene (2.0 mL). The mixture was sealed and stirred at 120 °C in a heating mantle for 12 h. After the mixture was cooled to room temperature, the solvent was removed under reduced pressure, purification was performed by flash column chromatography on silica gel to give the corresponding product **[D]-1a**. The deuterium incorporation was calculated based on ^{1}H NMR spectrum of **[D]-1a**.



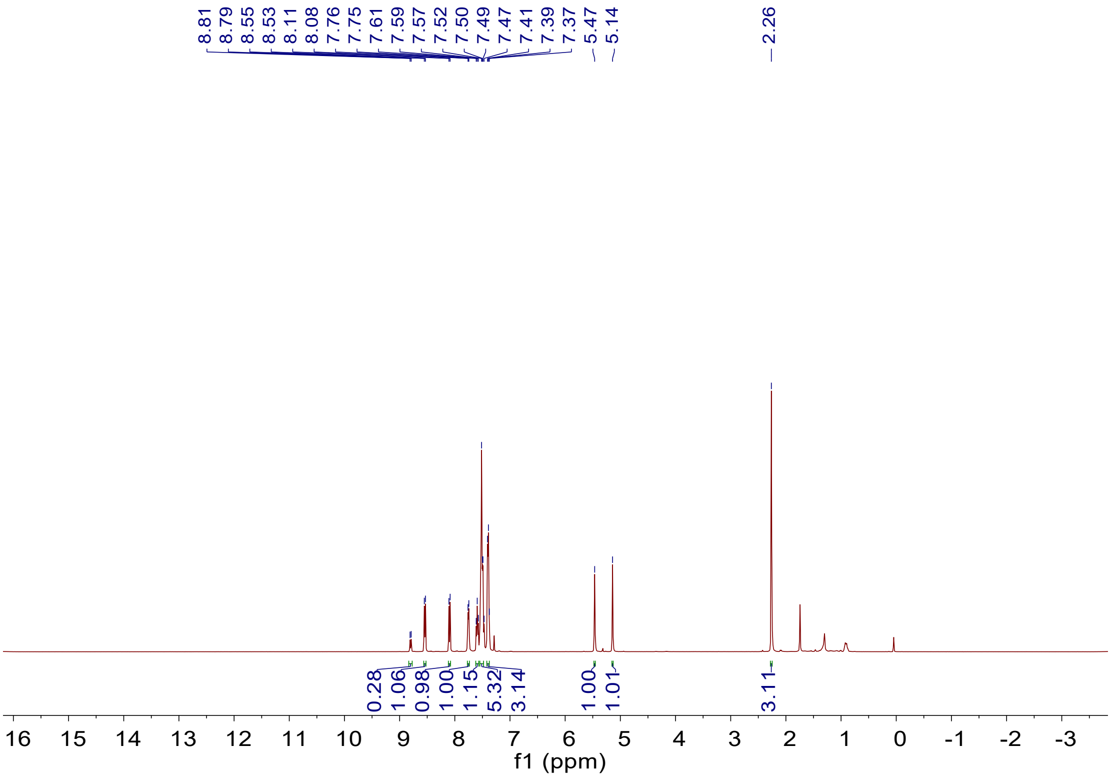
To a tube equipped with magnetic stir bar, 3-phenyl-1*H*-indazole **1a** (38.4 mg, 0.2 mmol), [Cp*RhCl$_2$]$_2$ (3.1 mg, 0.005 mmol), CD_3COOD (10 equiv) were added in toluene (2.0 mL). The mixture was sealed and stirred at 120 °C in a heating mantle for 12 h. After the mixture was cooled to room temperature, the solvent was removed under reduced pressure, purification was performed by flash column chromatography on silica gel to give the corresponding product **[D]-1a**. No deuteration of **1a** was observed in the absence of NaOAc.

Kinetic Isotope Effect (KIE) Study[3]

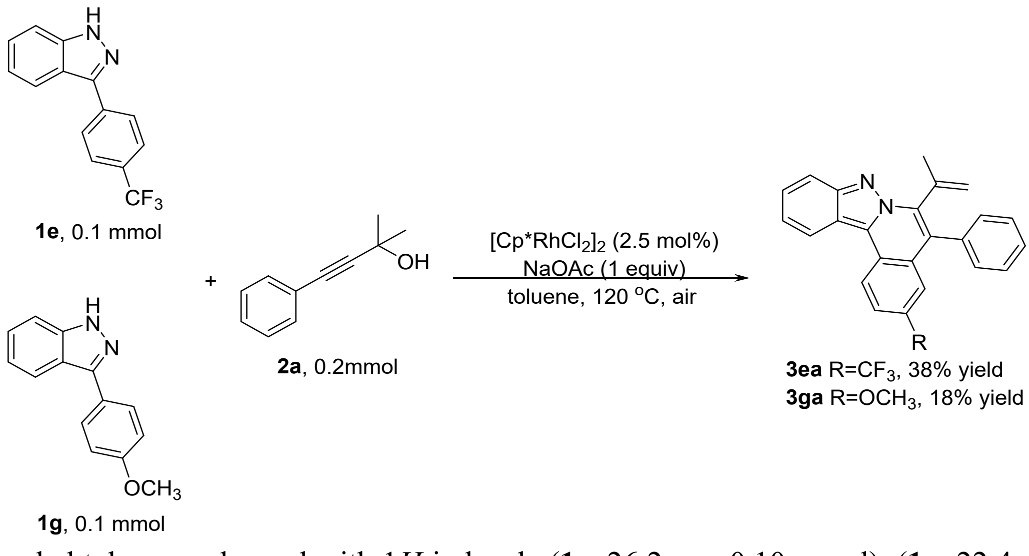


A reaction tube (25 mL) equipped with a magnetic stirrer bar was charged with **[D]-1a**

(0.2 mmol), propargyl alcohol **2a** (0.2 mmol), $[Cp^*RhCl_2]_2$ (0.005 mmol, 2.5 mmol%), NaOAc (0.2 mmol, 1 eq.) and toluene (2 mL). The reaction mixture was sealed and stirred at 120 °C (metal module heating) for 12 h under air. When the reaction was completed, the solvent was removed under reduced pressure and residue was purified by flash column chromatography on silica gel with petroleum ether/ethyl acetate (gradient mixture ratio from 60:1 to 30:1) as eluent to afford the product **[D]-3aa**. The KIE value was determined to be k_H/k_D = 80%/77% = 1.03.



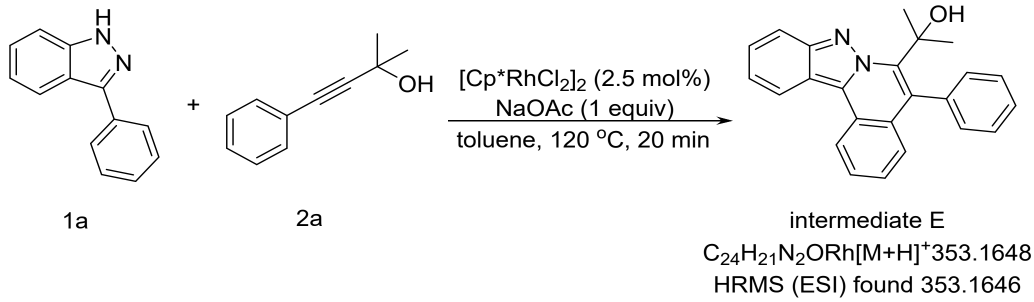
(2) Competitive Reaction



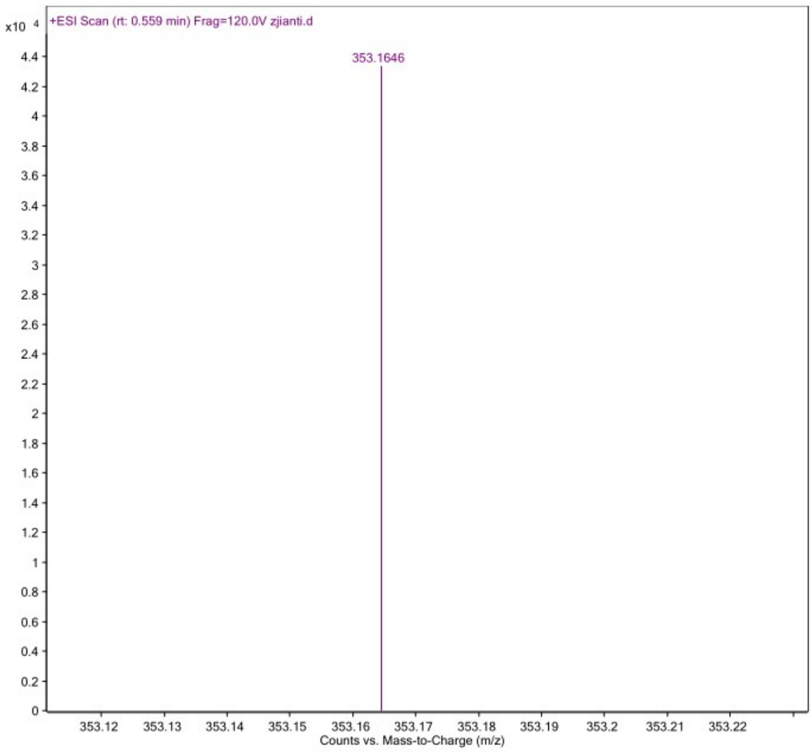
A sealed tube was charged with 1*H*-indazole (**1e**, 26.2 mg, 0.10 mmol), (**1g**, 22.4 mg, 0.10 mmol) $[Cp^*RhCl_2]_2$ (0.005 mmol, 3.1 mg, 2.5 mmol %), NaOAc (0.2 mmol, 16.4

mg), propargyl alcohol **2a** (32.0 mg, 0.20 mmol) and toluene (2.0 mL). The reaction mixture was sealed and stirred at 120 °C (metal module heating) for 12 h under air atmosphere. After cooling to room temperature, the solvent was removed under reduced pressure. The resulted mixture was purified by silica gel with petroleum ether/ethyl acetate (gradient mixture ratio from 60:1 to 30:1) as eluent to give **3ea** (30.3 mg, 38% yield) and **3ga** (13.3 mg, 18% yield).

(3) Reaction of the Intermediate



To a tube equipped with magnetic stir bar, **1a** (38.4 mg, 0.2 mmol), **2a** (32.0 mg, 0.20 mmol), [Cp*RhCl$_2$]$_2$ (3.1 mg, 0.005 mmol) and NaOAc (0.2 mmol, 1 eq.) were added in toluene (2.0 mL). The mixture was sealed and stirred at 120 °C in a heating mantle for 20 min. Then, the reaction was cooled to room temperature. The reaction mixture was detected by HRMS-ESI.



4. X-ray Crystallographic data of 3aa and 4aa

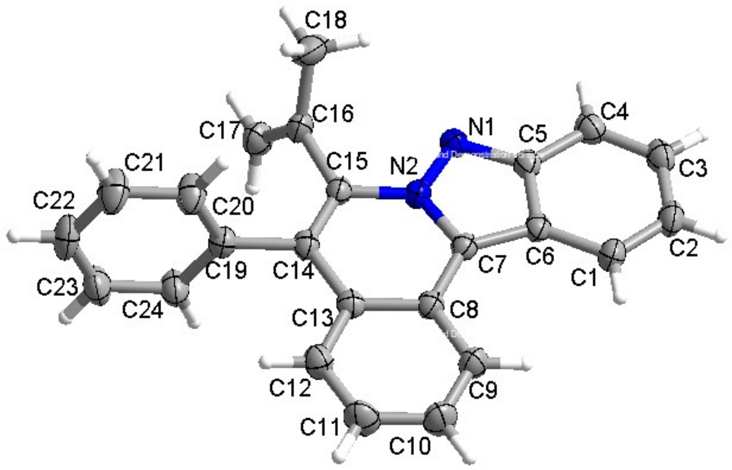


Figure S1. X-ray molecular structure of 3aa with the probability at 50% level.

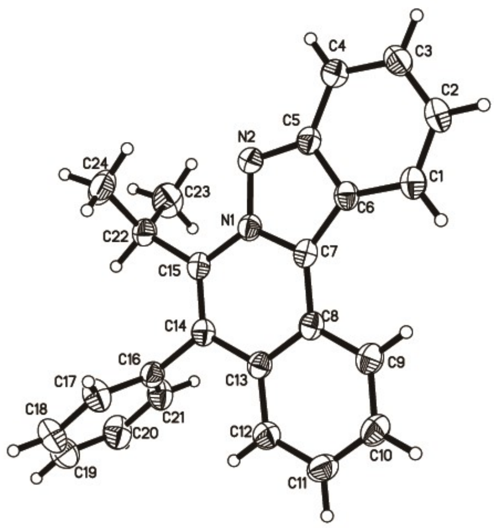


Figure S2. X-ray molecular structure of 4aa with the probability at 50% level.

The single crystal of compound **3aa**, **4aa** was prepared by the slow evaporation from the solution of DCM and pentane with the compounds (**3aa**, **4aa**) at room temperature. The structures of **3aa**, **4aa** were determined by the X-ray diffraction. Further information can be found in the CIF file. These crystals were deposited in the Cambridge Crystallographic Data Centre and assigned as CCDC **2163815**, **2163816**. ORTEP view of complex Ellipsoids are represented at the 50% probability level.

Table S1 Crystal data and structure refinement for 3aa.

Identification code	CCDC 2163815
Empirical formula	$C_{24}H_{18}N_2$
Formula weight	334.40
Temperature/K	293(2)
Crystal system	triclinic
Space group	P-1
a/Å	9.2335(11)
b/Å	10.0272(9)
c/Å	10.7951(9)
α/°	88.861(7)
β/°	77.287(9)
γ/°	65.410(10)
Volume/Å^3	883.65(17)
Z	2
ρ_{calc}g/cm^3	1.257
μ/mm^{-1}	0.569
F(000)	352.0
Crystal size/mm^3	0.19 × 0.13 × 0.11
Radiation	CuKα (λ = 1.54184)
2Θ range for data collection/°	8.424 to 134.142
Index ranges	$-11 \leq h \leq 10$, $-10 \leq k \leq 11$, $-12 \leq l \leq 12$
Reflections collected	6224
Independent reflections	3147 [R_{int} = 0.0282, R_{sigma} = 0.0420]
Data/restraints/parameters	3147/0/237
Goodness-of-fit on F^2	1.045
Final R indexes [I>=2σ (I)]	R_1 = 0.0495, wR_2 = 0.1289
Final R indexes [all data]	R_1 = 0.0694, wR_2 = 0.1483
Largest diff. peak/hole / e Å^{-3}	0.17/-0.17

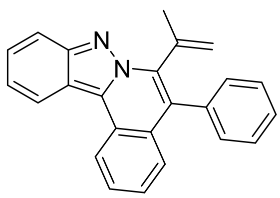
Table S2 Crystal data and structure refinement for 4aa.

Identification code	CCDC 2163816
Empirical formula	$C_{24}H_{20}N_2$
Formula weight	336.42
Temperature/K	293(2)
Crystal system	orthorhombic
Space group	Pbca
a/Å	20.5537(10)
b/Å	8.6676(3)
c/Å	20.5338(8)
α/°	90

β/°	90
γ/°	90
Volume/Å^3	3658.1(3)
Z	8
ρ_{calc}g/cm^3	1.222
μ/mm^{-1}	0.550
F(000)	1424.0
Crystal size/mm^3	0.18 × 0.13 × 0.1
Radiation	CuKα (λ = 1.54184)
2Θ range for data collection/°	8.604 to 134.154
Index ranges	-24 ≤ h ≤ 24, -6 ≤ k ≤ 10, -24 ≤ l ≤ 18
Reflections collected	9387
Independent reflections	3273 [R_{int} = 0.0300, R_{sigma} = 0.0304]
Data/restraints/parameters	3273/0/238
Goodness-of-fit on F^2	1.035
Final R indexes [I>=2σ (I)]	R_1 = 0.0417, wR_2 = 0.1089
Final R indexes [all data]	R_1 = 0.0575, wR_2 = 0.1216
Largest diff. peak/hole / e Å^{-3}	0.17/-0.12

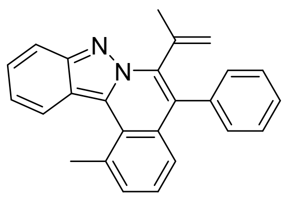
5. Characterization of products

5-Phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3aa)



Yellow solid. 26.7 mg, Yield: 80%, mp 202-203 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60
^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.78 (d, J = 8.1 Hz, 1H), 8.52 (d, J = 8.4 Hz, 1H), 8.06 (d, J = 8.7 Hz, 1H), 7.73 (t, J = 7.4 Hz, 1H), 7.56 (t, J = 7.7 Hz, 1H), 7.47 (q, J = 9.3, 8.1 Hz, 5H), 7.36 (t, J = 5.9 Hz, 3H), 5.43 (s, 1H), 5.11 (s, 1H), 2.23 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.2, 138.1, 138.1, 136.6, 130.7, 130.3, 129.4, 128.2, 127.9, 127.7, 127.3, 127.1, 126.9, 126.5, 125.4, 122.7, 121.5, 121.4, 121.2, 117.7, 116.6, 22.4. HRMS (ESI) m/z calcd for $C_{24}H_{19}N_2$ [M+H]$^+$ 335.1543, found 335.1541.

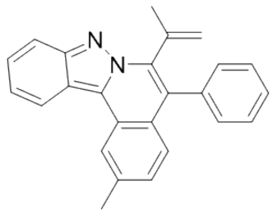
1-Methyl-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ba)



Yellow solid. 9.7 mg, Yield: 28%, mp 190-191 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.43 (d, J = 8.8 Hz, 1H), 8.06 (d, J = 8.6 Hz, 1H), 7.60 – 7.47 (m, 5H), 7.42 (t, J = 7.7 Hz, 1H), 7.38 – 7.33 (m, 2H), 7.31 – 7.27 (m, 2H), 5.42 (s, 1H), 5.09 (s, 1H), 3.19 (s, 3H), 2.23 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.3, 138.4, 137.5, 137.1, 133.1, 131.2, 131.1, 130.7, 128.2, 127.6, 126.7, 126.6, 125.2, 124.9, 123.8, 121.2, 120.3, 117.8, 117.4, 24.8, 22.4. HRMS (ESI) m/z calcd for $C_{25}H_{21}N_2$ $[M+H]^+$ 349.1699, found 349.1699

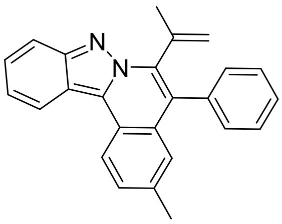
4-Methyl-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ca)



Yellow solid. 21.9 mg, Yield: 63%, mp 202-203 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.62 – 8.51 (m, 2H), 8.09 (d, *J* = 8.4 Hz, 1H), 7.59 (t, *J* = 7.2 Hz, 1H), 7.55 – 7.46 (m, 3H), 7.46 – 7.30 (m, 5H), 5.45 (s, 1H), 5.13 (s, 1H), 2.67 (s, 3H), 2.26 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.1, 138.2, 138.1, 137.2, 136.8, 130.7, 130.1, 128.7, 128.2, 127.7, 127.3, 127.2, 127.0, 126.4, 125.5, 122.4, 121.5, 121.3, 121.2, 117.6, 116.5, 22.4, 22.0. HRMS (ESI) *m/z* calcd for $C_{25}H_{21}N_2$ $[M+H]^+$ 349.1699, found 349.1702

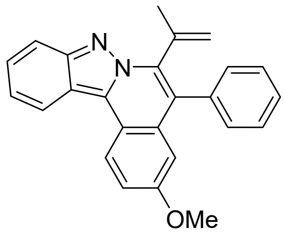
3-Methyl-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3da)



Yellow solid. 14.2 mg, Yield: 41%, mp 213-214 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.66 (d, *J* = 8.2 Hz, 1H), 8.49 (d, *J* = 8.3 Hz, 1H), 8.05 (d, *J* = 8.5 Hz, 1H), 7.59 – 7.44 (m, 5H), 7.40 – 7.30 (m, 3H), 7.22 (s, 1H), 5.43 (s, 1H), 5.10 (s, 1H), 2.43 (s, 3H), 2.23 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.2, 138.3, 138.1, 137.1, 136.8, 130.7, 130.4, 129.6, 128.2, 127.7, 127.1, 126.8, 126.2, 123.2, 122.6, 121.5, 121.2, 121.0, 117.5, 116.3, 22.4, 21.9. HRMS (ESI) *m/z* calcd for $C_{25}H_{21}N_2$ $[M+H]^+$ 349.1699, found 349.1702

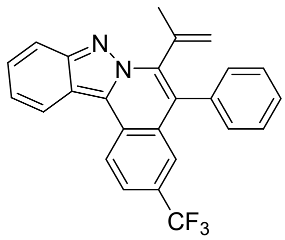
3-Methoxy-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ea)



Yellow solid. 17.8 mg, Yield: 49%, mp 219-220 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.70 (d, *J* = 8.9 Hz, 1H), 8.46 (d, *J* = 8.5 Hz, 1H), 8.01 (d, *J* = 8.7 Hz, 1H), 7.57 – 7.43 (m, 4H), 7.39 – 7.28 (m, 4H), 6.82 (d, *J* = 2.6 Hz, 1H), 5.42 (s, 1H), 5.09 (s, 1H), 3.74 (s, 3H), 2.22 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 158.4, 149.3, 138.4, 138.2, 136.7, 131.3, 130.6, 130.6, 128.3, 127.8, 127.2, 125.9, 124.3, 121.4, 121.2, 120.8, 119.8, 117.6, 117.4, 115.8, 108.7, 55.3, 22.4. HRMS (ESI) *m/z* calcd for $C_{25}H_{21}N_2O$ $[M+H]^+$ 365.1648, found 365.1650

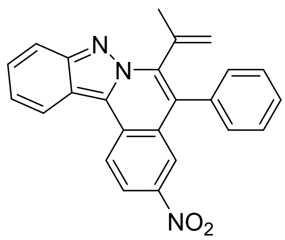
5-Phenyl-6-(prop-1-en-2-yl)-3-(trifluoromethyl)indazolo[3,2-a]isoquinoline (3fa)



Yellow solid. 28.5 mg, Yield: 71%, mp 213-214 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.84 (d, *J* = 8.2 Hz, 1H), 8.48 (d, *J* = 7.8 Hz, 1H), 8.09 (d, *J* = 8.7 Hz, 1H), 7.92 (d, *J* = 8.5 Hz, 1H), 7.73 (s, 1H), 7.58 (t, *J* = 8.3 Hz, 1H), 7.56 – 7.50 (m, 3H), 7.44 – 7.34 (m, 3H), 5.46 (s, 1H), 5.12 (s, 1H), 2.24 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.2, 139.4, 137.8, 135.6, 130.6, 129.5, 129.0, 128.5, 128.5 (q, *J* = 32.7 Hz), 128.3, 127.5, 127.2, 126.4, 125.4, 124.4 (q, *J* = 4.3 Hz), 124.0 (q, *J* = 272.2 Hz), 124.0 (q, *J* = 3.2 Hz), 123.3, 122.4, 121.9, 120.8, 118.0, 116.9, 22.2. **^{19}F NMR** (376 MHz, $CDCl_3$, ppm) δ -62.14. HRMS (ESI) *m/z* calcd for $C_{25}H_{18}F_3N_2$ $[M+H]^+$ 403.1417, found 403.1418

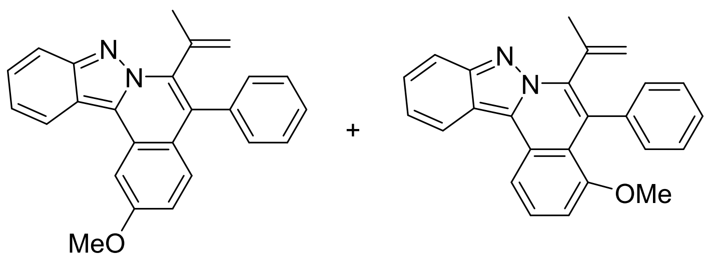
3-Nitro-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ga)



Yellow solid. 30.7 mg, Yield: 81%, mp 252-253 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.84 (d, J = 9.0 Hz, 1H), 8.54 – 8.47 (m, 2H), 8.34 (d, J = 2.3 Hz, 1H), 8.11 (d, J = 8.7 Hz, 1H), 7.66 – 7.59 (m, 1H), 7.57 – 7.51 (m, 3H), 7.46 (t, J = 7.5 Hz, 1H), 7.40 – 7.33 (m, 2H), 5.46 (s, 1H), 5.12 (s, 1H), 2.23 (s, 3H). **^{13}C NMR** (400 MHz, $CDCl_3$, ppm) δ 149.3, 145.6, 140.1, 137.5, 135.1, 130.6, 129.2, 129.2, 128.8, 128.7, 128.6, 127.8, 126.6, 123.5, 123.2, 123.1, 122.1, 122.1, 120.7, 118.4, 117.4, 22.2. HRMS (ESI) m/z calcd for $C_{24}H_{18}N_3O_2$ [M+H]$^+$ 380.1394, found 380.1392

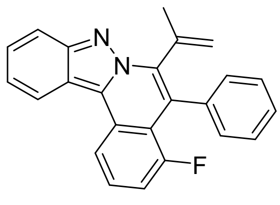
2-Methoxy-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ha) / 4-Methoxy-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ha')



Yellow solid., 28.4 mg, Yield: 78% **(3ha**:**3ha'**=1:0.82**)**, column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.54 – 8.46 (m, 1H), 8.46 – 8.41 (m, 0.57H), 8.14 (d, *J* = 2.5 Hz, 0.45H), 8.11 – 8.06 (m, 1H), 7.69 (t, *J* = 8.1 Hz, 0.56H), 7.62 – 7.56 (m, 1H), 7.54 – 7.46 (m, 1.51H), 7.42 – 7.34 (m, 4H), 7.30 (s, 1H), 7.13 (dd, *J* = 9.1, 2.6 Hz, 047H), 6.94 (d, *J* = 7.5 Hz, 0.55H), 5.45 (s, 1H), 5.12 (s, 0.45H), 5.08 (s, 0.54H), 4.08 (s, 1.34H), 3.41 (s, 1.66H), 2.25 (s, 1.34H), 2.14 (s, 1.65H). **^{13}C NMR** (400 MHz, $CDCl_3$, ppm) δ 159.3, 157.2, 149.3, 149.1, 140.7, 138.2, 138.1, 138.1, 136.8, 136.0, 130.7, 130.0, 129.8, 129.0, 128.9, 128.2, 127.7, 127.1, 127.1, 127.0, 126.7, 126.6, 126.4, 126.2, 124.7, 123.8, 121.5, 121.5, 121.3, 121.3, 121.2, 120.9, 119.4, 117.6, 117.6, 116.7, 116.6, 116.6, 115.6, 109.1, 104.0, 55.8, 55.6, 22.4. HRMS (ESI) *m/z* calcd for $C_{25}H_{21}N_2O$ [M+H]$^+$ 365.1648, found 365.1651

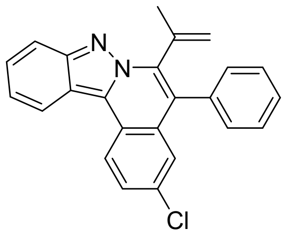
4-Fluoro-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ia)



Yellow solid. 30.2 mg, Yield: 86%, mp 182-183 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.58 (d, *J* = 8.2 Hz, 1H), 8.47 (d, *J* = 8.5 Hz, 1H), 8.07 (d, *J* = 8.7 Hz, 1H), 7.68 (td, *J* = 8.0, 4.9 Hz, 1H), 7.60 – 7.55 (m, 1H), 7.45 – 7.32 (m, 6H), 7.15 (dd, *J* = 12.4, 7.9 Hz, 1H), 5.44 (s, 1H), 5.07 (s, 1H), 2.15 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 159.3 (d, *J* = 256.4 Hz), 149.3, 139.3, 138.5, 138.5, 137.5, 129.5 (d, *J* = 2.8 Hz), 128.9 (d, *J* = 9.3 Hz), 127.4 (d, *J* = 21.15 Hz), 127.4, 127.2 (d, *J* = 3.3 Hz), 122.5 (d, *J* = 2.4 Hz), 122.0, 121.8, 121.0, 118.9 (d, *J* = 4.5 Hz), 118.1 (d, *J* = 9.1 Hz), 117.9, 116.6, 113.7 (d, *J* = 22.8 Hz), 22.4. **^{19}F NMR** (376 MHz, $CDCl_3$, ppm) δ -105.46. HRMS (ESI) *m/z* calcd for $C_{24}H_{17}FN_2Na$ [M+Na]$^+$ 375.1268, found 375.1264

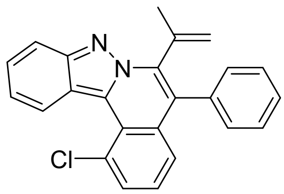
3-Chloro-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ja)



Yellow solid. 22.1 mg, Yield: 60%, mp 219-220 ℃. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.70 (d, J = 8.7 Hz, 1H), 8.46 (d, J = 8.5 Hz, 1H), 8.08 (d, J = 8.7 Hz, 1H), 7.69 (dd, J = 8.7, 2.1 Hz, 1H), 7.61 – 7.56 (m, 1H), 7.56 – 7.50 (m, 3H), 7.43 (d, J = 2.1 Hz, 1H), 7.42 – 7.34 (m, 3H), 5.46 (s, 1H), 5.12 (s, 1H), 2.24 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.2, 139.1, 137.9, 135.9, 132.9, 130.7, 130.6, 129.8, 128.5, 128.4, 128.1, 127.4, 126.5, 125.6, 124.1, 123.6, 121.8, 120.9, 117.8, 116.4, 22.3. HRMS (ESI) *m/z* calcd for $C_{24}H_{18}ClN_2$ $[M+H]^+$ 369.1153, found 369.1154

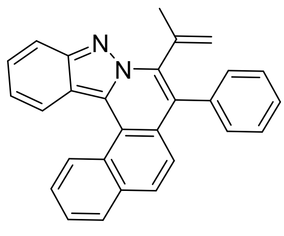
1-Chloro-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ka)



Yellow solid. 20.2 mg, Yield: 55%, mp 182-183 ℃. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.91 (d, J = 8.7 Hz, 1H), 8.07 (d, J = 8.6 Hz, 1H), 7.76 (d, J = 6.8 Hz, 1H), 7.61 – 7.47 (m, 4H), 7.45 – 7.25 (m, 5H), 5.44 (s, 1H), 5.10 (s, 1H), 2.23 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.5, 138.7, 138.1, 136.4, 132.4, 130.7, 130.0, 129.4, 128.6, 128.4, 127.9, 127.0, 126.9, 126.0, 125.9, 125.9, 124.1, 121.4, 120.5, 117.6, 117.4, 22.3. HRMS (ESI) *m/z* calcd for $C_{24}H_{18}ClN_2$ $[M+H]^+$ 369.1153, found 369.1153

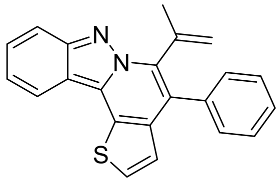
7-Phenyl-8-(prop-1-en-2-yl)benzo[h]indazolo[3,2-a]isoquinoline (3la)



Yellow solid. 16.5 mg, Yield: 43%, mp 219-220 ℃. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 9.33 (d, J = 8.2 Hz, 1H), 8.68 (d, J = 8.6 Hz, 1H), 8.12 (d, J = 8.7 Hz, 1H), 8.02 (d, J = 7.5 Hz, 1H), 7.85 – 7.71 (m, 3H), 7.61 (t, 1H), 7.57 – 7.49 (m, 3H), 7.45 – 7.37 (m, 3H), 7.31 – 7.25 (m, 1H), 5.49 (s, 1H), 5.16 (s, 1H), 2.29 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.7, 138.5, 138.3, 136.7, 132.7, 131.4, 130.8, 128.4, 128.3, 128.2, 127.8, 127.7, 127.5, 127.5, 127.1, 126.7, 125.9, 124.2, 122.8, 122.6, 121.4, 119.6, 117.6, 117.2, 22.2. HRMS (ESI) *m/z* calcd for $C_{28}H_{21}N_2$ $[M+H]^+$ 385.1699, found 385.1698

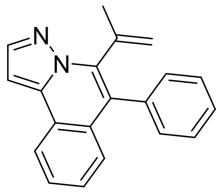
4-Phenyl-5-(prop-1-en-2-yl)thieno[2',3':3,4]pyrido[1,2-b]indazole (3ma)



Yellow solid. 26.8 mg, Yield: 79%, mp 202-203 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.21 (d, *J* = 8.2 Hz, 1H), 8.00 (d, *J* = 8.7 Hz, 1H), 7.61 – 7.52 (m, 2H), 7.51 – 7.38 (m, 5H), 7.32 (t, *J* = 7.3 Hz, 1H), 7.10 (d, *J* = 5.0 Hz, 1H), 5.47 (s, 1H), 5.11 (s, 1H), 2.29 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.4, 137.7, 137.3, 136.6, 135.5, 130.0, 129.8, 128.3, 127.9, 127.8, 127.6, 126.2, 124.6, 124.3, 121.9, 120.4, 120.4, 116.6, 114.6, 22.2. HRMS (ESI) *m/z* calcd for $C_{22}H_{17}N_2S$ $[M+H]^+$ 341,1107, found 341,1109

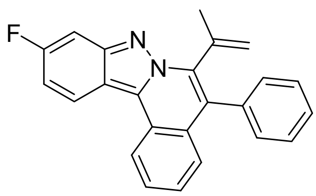
6-Phenyl-5-(prop-1-en-2-yl)pyrazolo[5,1-a]isoquinoline (3na)



Yellow solid. 11.1 mg, Yield: 39%, mp 194-195 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.19 (d, *J* = 7.8 Hz, 1H), 8.06 (s, 1H), 7.56 (t, *J* = 6.9 Hz, 1H), 7.53 – 7.40 (m, 4H), 7.38 – 7.29 (m, 3H), 7.11 (s, 1H), 5.36 (s, 1H), 5.07 (s, 1H), 2.15 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 141.0, 138.2, 137.9, 137.9, 136.6, 130.9, 130.1, 128.2, 127.7, 127.5, 127.1, 126.8, 123.7, 123.5, 122.2, 121.1, 97.4, 22.5. HRMS (ESI) *m/z* calcd for $C_{20}H_{17}N_2$ $[M+H]^+$ 285.1386, found 285.1385

10-Fluoro-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3oa)

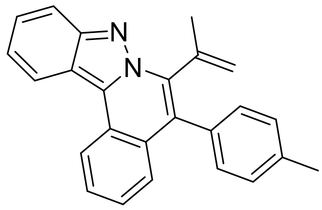


Yellow solid. 25.7 mg, Yield: 73%, mp 189-190 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.69 (d, *J* = 8.2 Hz, 1H), 8.45 (dd, *J* = 9.1, 5.2 Hz, 1H), 7.72 (t, *J* = 7.5 Hz, 1H), 7.61 (dd, *J* = 10.2, 2.2 Hz, 1H), 7.49 (td, *J* = 7.9, 3.7 Hz, 5H), 7.35 (dd, *J* = 7.1, 2.0 Hz, 2H), 7.12 (td, *J* = 9.1, 2.2 Hz, 1H), 5.43 (s, 1H), 5.10 (s, 1H), 2.21 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 162.3 (d, *J* = 244.6 Hz), 149.5 (d, *J* = 13.3 Hz), 138.0, 136.4, 130.7, 129.7, 128.3, 128.0, 127.8, 127.4 (d, *J* = 3.8 Hz), 126.4, 124.8, 122.8 (d, *J* = 10.9 Hz), 122.6, 121.6, 113.7, 112.3 (d, *J* = 27.7 Hz), 101.0

(d, J = 23.7 Hz), 22.4. **^{19}F NMR** (376 MHz, $CDCl_3$, ppm) δ -112.46. HRMS (ESI) *m/z* calcd for $C_{24}H_{17}FN_2Na$ $[M+Na]^+$ 375.1268, found 375.1269

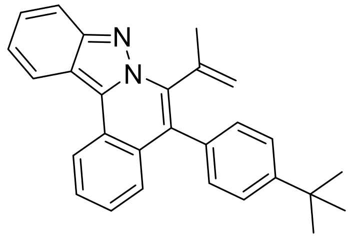
6-(Prop-1-en-2-yl)-5-(p-tolyl)indazolo[3,2-a]isoquinoline (3ab)



Yellow solid. 26.4 mg, Yield: 76%, mp 210-211 ℃. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.78 (d, J = 8.1 Hz, 1H), 8.54 (d, J = 8.5 Hz, 1H), 8.10 (d, J = 8.7 Hz, 1H), 7.77 – 7.69 (m, 1H), 7.59 (t, 1H), 7.54 – 7.49 (m, 2H), 7.38 (t, 1H), 7.35 – 7.25 (m, 4H), 5.49 (s, 1H), 5.15 (s, 1H), 2.51 (s, 3H), 2.27 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.1, 138.2, 138.1, 137.4, 133.6, 130.6, 130.3, 129.6, 129.0, 127.8, 127.3, 127.1, 126.9, 126.5, 125.4, 122.7, 121.4, 121.3, 121.2, 117.6, 116.6, 22.4, 21.4. HRMS (ESI) *m/z* calcd for $C_{25}H_{21}N_2$ $[M+H]^+$ 349.1699, found 349.1701

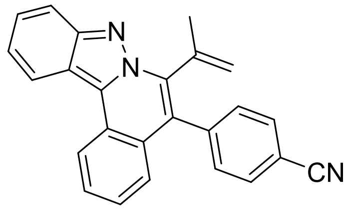
5-(4-(Tert-butyl)phenyl)-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ac)



Yellow solid. 26.9 mg, Yield: 69%, mp 233-234 ℃. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.77 (d, J = 7.6 Hz, 1H), 8.52 (d, J = 8.0 Hz, 1H), 8.10 (d, J = 8.1 Hz, 1H), 7.75 – 7.67 (m, 1H), 7.61 – 7.54 (m, 1H), 7.50 (s, 4H), 7.41 – 7.33 (m, 1H), 7.30 (d, J = 7.4 Hz, 2H), 5.47 (s, 1H), 5.14 (s, 1H), 2.26 (s, 3H), 1.46 (s, 9H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 150.6, 149.1, 138.1, 133.4, 130.3, 130.2, 129.7, 127.8, 127.4, 127.1, 126.9, 126.6, 125.3, 125.1, 122.6, 121.5, 121.3, 121.2, 117.6, 116.6, 34.7, 31.5, 22.4. HRMS (ESI) *m/z* calcd for $C_{28}H_{27}N_2$ $[M+H]^+$ 391.2169, found 391.2168

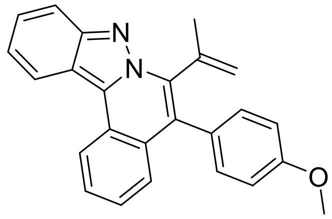
4-(6-(Prop-1-en-2-yl)indazolo[3,2-a]isoquinolin-5-yl)benzonitrile (3ad)



Yellow solid. 26.9 mg, Yield: 75%, mp 250-251 ℃. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.78 (d, J = 7.7 Hz, 1H), 8.50 (d, J = 8.3 Hz, 1H), 8.04 (d, J = 8.7 Hz, 1H), 7.84 – 7.72 (m, 3H), 7.60 – 7.46 (m, 4H), 7.37 (t, J = 7.5 Hz, 1H), 7.31 (d, J = 8.2 Hz, 1H), 5.43 (s, 1H), 5.06 (s, 1H), 2.22 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.3, 141.9, 138.2, 137.8, 132.1, 131.6, 130.4, 128.4, 128.3, 127.5, 127.3, 126.6, 125.4, 124.5, 122.9, 122.2, 121.8, 121.2, 118.7, 117.7, 116.5, 112.0, 22.3. HRMS (ESI) *m/z* calcd for $C_{25}H_{18}N_3$ $[M+H]^+$ 360.1495, found 360.1493

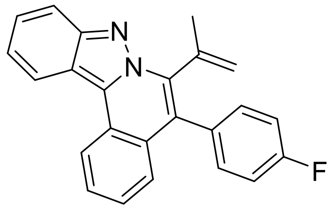
5-(4-Methoxyphenyl)-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ae)



Yellow solid. 29.8 mg, Yield: 82%, mp 241-242 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.78 (d, J = 8.1 Hz, 1H), 8.53 (d, J = 8.5 Hz, 1H), 8.09 (d, J = 8.7 Hz, 1H), 7.77 – 7.70 (m, 1H), 7.58 (t, J = 7.7 Hz, 1H), 7.55 – 7.48 (m, 2H), 7.38 (t, J = 7.5 Hz, 1H), 7.29 (d, J = 7.7 Hz, 2H), 7.05 (d, J = 7.9 Hz, 2H), 5.49 (s, 1H), 5.14 (s, 1H), 3.93 (s, 3H), 2.24 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 159.1, 149.1, 138.3, 138.3, 131.8, 130.2, 129.8, 128.7, 127.9, 127.3, 127.1, 126.9, 126.2, 125.3, 122.7, 121.4, 121.3, 121.2, 117.6, 116.6, 113.7, 55.3, 22.4. HRMS (ESI) *m/z* calcd for $C_{25}H_{21}N_2O$ $[M+H]^+$ 365.1648, found 365.1649

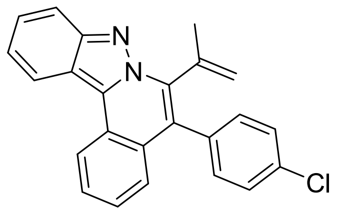
5-(4-Fluorophenyl)-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3af)



Yellow solid. 27.4 mg, Yield: 78%, mp 237-238 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.76 (d, J = 8.1 Hz, 1H), 8.50 (d, J = 8.4 Hz, 1H), 8.06 (d, J = 8.6 Hz, 1H), 7.73 (t, J = 7.4 Hz, 1H), 7.56 (t, J = 7.6 Hz, 1H), 7.50 (t, J = 7.6 Hz, 1H), 7.46 – 7.40 (m, 1H), 7.39 – 7.29 (m, 3H), 7.24 – 7.16 (m, 2H), 5.46 (s, 1H), 5.10 (s, 1H), 2.22 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 162.4 (d, J = 247.1 Hz), 149.2, 138.4, 138.1, 132.5 (d, J = 3.6 Hz), 132.3, 130.3, 129.3, 128.0, 127.2, 127.0 (d, J = 1.5 Hz), 125.4, 122.8, 121.7, 121.5, 121.2, 117.7, 116.5, 115.4 (d, J = 21.4 Hz), 22.4. **^{19}F NMR** (376 MHz, $CDCl_3$, ppm) δ -114.10. HRMS (ESI) *m/z* calcd for $C_{24}H_{18}FN_2$ $[M+H]^+$ 353.1449, found 353.1451

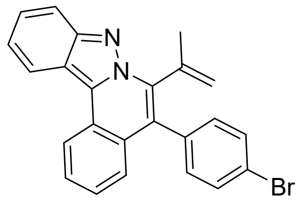
5-(4-Chlorophenyl)-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ag)



Yellow solid. 28.7 mg, Yield: 78%, mp 241-242 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.75 (d, *J* = 8.2 Hz, 1H), 8.49 (d, *J* = 8.5 Hz, 1H), 8.06 (d, *J* = 8.7, 2.5 Hz, 1H), 7.72 (t, *J* = 7.7 Hz, 1H), 7.56 (t, *J* = 8.0 Hz, 1H), 7.48 (t, *J* = 8.0 Hz, 3H), 7.41 (d, *J* = 8.5 Hz, 1H), 7.35 (t, *J* = 7.8 Hz, 1H), 7.29 (d, *J* = 8.0 Hz, 2H), 5.46 (s, 1H), 5.10 (s, 1H), 2.22 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.2, 138.2, 138.0, 135.1, 133.9, 130.3, 129.1, 128.6, 128.1, 127.3, 127.1, 127.0, 125.4, 125.2, 122.8, 121.8, 121.5, 121.2, 117.7, 116.5, 22.4. HRMS (ESI) *m/z* calcd for $C_{24}H_{18}ClN_2$ $[M+H]^+$ 369.1153, found 369.1151

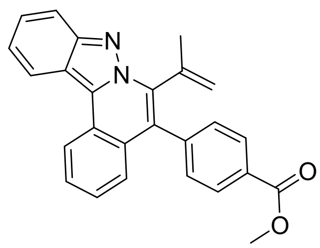
5-(4-Bromophenyl)-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ah)



Yellow solid. 30.0 mg, Yield: 73%, mp 253-254 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.77 (d, *J* = 7.9 Hz, 1H), 8.51 (d, *J* = 8.2 Hz, 1H), 8.08 (d, *J* = 8.4 Hz, 1H), 7.74 (t, *J* = 6.7 Hz, 1H), 7.65 (d, *J* = 7.3 Hz, 2H), 7.58 (t, *J* = 7.0 Hz, 1H), 7.52 (t, *J* = 7.0 Hz, 1H), 7.44 (d, 1H), 7.38 (t, *J* = 7.0 Hz, 1H), 7.26 (d, *J* = 7.2 Hz, 2H), 5.48 (s, 1H), 5.12 (s, 1H), 2.24 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.2, 138.2, 137.9, 135.6, 132.4, 131.5, 130.3, 129.0, 128.1, 127.3, 127.1, 127.0, 125.4, 125.2, 122.8, 122.1, 121.9, 121.5, 121.2, 117.7, 116.5, 22.4. HRMS (ESI) *m/z* calcd for $C_{24}H_{18}BrN_2$ $[M+H]^+$ 413.0648, found 413.0649

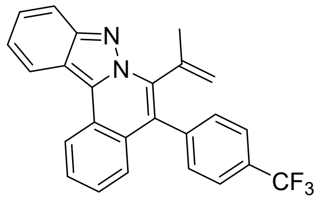
Methyl 4-(6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinolin-5-yl)benzoate (3ai)



Yellow solid. 28.4 mg, Yield: 70%, mp 244-245 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.78 (d, *J* = 7.4 Hz, 1H), 8.51 (d, *J* = 7.9 Hz, 1H), 8.20 (d, *J* = 7.7 Hz, 2H), 8.07 (d, *J* = 8.6 Hz, 1H), 7.79 – 7.71 (m, 1H), 7.58 (t, 1H), 7.54 – 7.43 (m, 3H), 7.42 – 7.34 (m, 2H), 5.43 (s, 1H), 5.10 (s, 1H), 4.01 (s, 3H), 2.24 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 166.9, 149.2, 141.7, 138.0, 137.9, 130.9, 130.4, 129.7, 129.5, 128.8, 128.1, 127.3, 127.1, 126.9, 125.4, 125.4, 122.8, 122.0, 121.6, 121.2, 117.7, 116.5, 52.3, 22.3. HRMS (ESI) *m/z* calcd for $C_{26}H_{21}N_2O_2$ $[M+H]^+$ 393.1598, found 393.1597

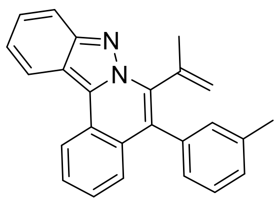
6-(Prop-1-en-2-yl)-5-(4-(trifluoromethyl)phenyl)indazolo[3,2-a]isoquinoline (3aj)



Yellow solid. 29.3 mg, Yield: 73%, mp 244-245 ℃. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.78 (d, *J* = 8.0 Hz, 1H), 8.51 (d, *J* = 8.5 Hz, 1H), 8.06 (d, *J* = 8.7 Hz, 1H), 7.80 – 7.72 (m, *J* = 6.9 Hz, 3H), 7.57 (t, *J* = 7.7 Hz, 1H), 7.54 – 7.45 (m, *J* = 7.6 Hz, 3H), 7.40 – 7.33 (m, *J* = 8.6 Hz, 2H), 5.44 (s, 1H), 5.09 (s, 1H), 2.23 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.3, 140.6, 138.3, 137.8, 131.2, 130.4, 130.1 (q, *J* = 31.9 Hz), 128.8, 128.2, 127.4, 127.2, 126.8, 125.4, 125.3 (q, *J* = 3.7 Hz), 125.0, 124.2 (q, *J* = 272.52 Hz), 122.8, 122.1, 121.6, 121.2, 117.7, 116.5, 22.3. **^{19}F NMR** (376 MHz, $CDCl_3$, ppm) δ -62.39 (s). HRMS (ESI) *m/z* calcd for $C_{25}H_{18}F_3N_2$ $[M+H]^+$ 403.1417, found 403.1419.

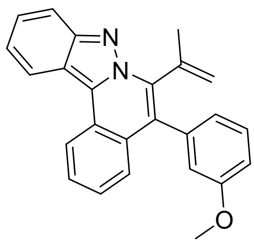
4-Methyl-5-phenyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ak)



Yellow solid. 26.1 mg, Yield: 75%, mp 171-172 ℃. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.79 (d, *J* = 8.1 Hz, 1H), 8.54 (d, *J* = 8.4 Hz, 1H), 8.10 (d, *J* = 8.6 Hz, 1H), 7.74 (t, 1H), 7.59 (t, *J* = 7.5 Hz, 1H), 7.56 – 7.48 (m, 2H), 7.46 – 7.36 (m, 2H), 7.35 – 7.29 (m, 1H), 7.24 – 7.16 (m, 2H), 5.48 (s, 1H), 5.16 (s, 1H), 2.48 (s, 3H), 2.28 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.1, 138.2, 138.0, 137.8, 136.5, 131.4, 130.3, 129.5, 128.5, 128.1, 127.9, 127.4, 127.1, 126.9, 126.6, 125.3, 122.7, 121.5, 121.4, 121.2, 117.6, 116.6, 22.4, 21.6. HRMS (ESI) *m/z* calcd for $C_{25}H_{21}N_2$ $[M+H]^+$ 349.1699, found 349.1700

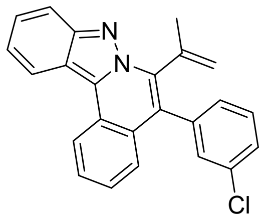
5-(3-Methoxyphenyl)-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3al)



Yellow solid. 29.4 mg, Yield: 81%, mp 185-186 ℃. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.76 (d, *J* = 8.0 Hz, 1H), 8.51 (d, *J* = 8.4 Hz, 1H), 8.07 (d, *J* = 8.6 Hz, 1H), 7.76 – 7.67 (m, 1H), 7.56 (t, *J* = 7.6 Hz, 1H), 7.53 – 7.46 (m, 2H), 7.45 – 7.32 (m, 2H), 7.05 – 6.91 (m, 3H), 5.47 (s, 1H), 5.15 (s, 1H), 3.86 (s, 3H), 2.27 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 159.4, 149.2, 138.1, 138.0, 137.9, 130.3, 129.3, 129.3, 127.9, 127.3, 127.2, 127.0, 126.3, 125.3, 123.3, 122.7, 121.5, 121.4, 121.2, 117.6, 116.5, 113.1, 55.3, 22.4. HRMS (ESI) *m/z* calcd for $C_{25}H_{21}N_2O$ $[M+H]^+$ 365.1648, found 365.1649

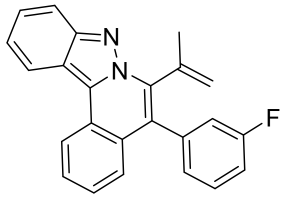
5-(3-Chlorophenyl)-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3am)



Yellow solid. 28.2 mg, Yield: 81%, mp 159-160 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.75 (d, *J* = 8.0 Hz, 1H), 8.49 (d, *J* = 8.4 Hz, 1H), 8.06 (d, *J* = 8.7 Hz, 1H), 7.72 (t, *J* = 7.4 Hz, 1H), 7.56 (t, *J* = 7.6 Hz, 1H), 7.53 – 7.32 (m, 6H), 7.28 – 7.22 (m, 1H), 5.47 (s, 1H), 5.12 (s, 1H), 2.24 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.2, 138.5, 138.3, 137.9, 134.2, 130.7, 130.4, 129.6, 129.0, 128.9, 128.1, 128.1, 127.3, 127.1, 127.0, 125.3, 125.0, 122.8, 121.9, 121.6, 121.2, 117.7, 116.5, 22.4. HRMS (ESI) *m/z* calcd for $C_{24}H_{18}ClN_2$ $[M+H]^+$ 369.1153, found 369.1152

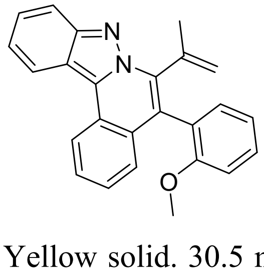
5-(3-Fluorophenyl)-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3an)



Yellow solid. 24.6 mg, Yield: 70%, mp 162-163 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.77 (d, *J* = 8.1 Hz, 1H), 8.51 (d, *J* = 8.4 Hz, 1H), 8.06 (d, *J* = 8.7 Hz, 1H), 7.74 (t, *J* = 7.5 Hz, 1H), 7.57 (t, *J* = 7.6 Hz, 1H), 7.47 (dt, *J* = 20.9, 7.4 Hz, 3H), 7.37 (t, *J* = 7.4 Hz, 1H), 7.22 – 7.13 (m, 2H), 7.10 (d, *J* = 9.3 Hz, 1H), 5.46 (s, 1H), 5.12 (s, 1H), 2.24 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 162.6 (d, *J* = 247.1 Hz), 149.2, 138.8 (d, *J* = 8.0 Hz), 138.2, 137.9, 130.4, 129.8 (d, *J* = 8.4 Hz), 129.0, 128.1, 127.2 (d, *J* = 20.3 Hz), 127.0, 126.6, 125.4, 125.1 (d, *J* = 1.9 Hz), 122.8, 121.8, 121.5, 121.2, 118.0, 117.7, 116.5, 114.9 (d, *J* = 20.9 Hz), 22.3. **^{19}F NMR** (376 MHz, $CDCl_3$, ppm) δ -112.98. HRMS (ESI) *m/z* calcd for $C_{24}H_{18}FN_2$ $[M+H]^+$ 353.1449, found 353.1448

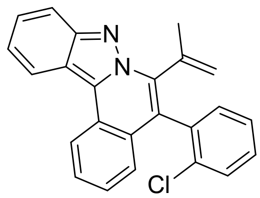
5-(2-Methoxyphenyl)-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ao)



Yellow solid. 30.5 mg, Yield: 84%, mp 159-160 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.80 (d, *J* = 8.1 Hz, 1H), 8.55 (d, *J* = 8.4 Hz, 1H), 8.11 (d, *J* = 8.6 Hz, 1H), 7.74 (t, *J* = 7.5 Hz, 1H), 7.59 (t, *J* = 7.6 Hz, 1H), 7.51 (t, *J* = 7.6 Hz, 2H), 7.45 – 7.34 (m, 2H), 7.27 (d, *J* = 7.4 Hz, 1H), 7.13 (t, *J* = 7.3 Hz, 1H), 7.07 (d, *J* = 8.3 Hz, 1H), 5.40 (s, 1H), 5.23 (s, 1H), 3.73 (s, 3H), 2.29 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 157.8, 149.1, 138.6, 138.3, 132.0, 130.5, 129.7, 129.4, 127.8, 127.1, 127.0, 126.9, 125.5, 125.4, 123.3, 122.7, 121.2, 120.5, 119.9, 117.6, 116.6, 110.7, 55.3, 21.8. HRMS (ESI) *m/z* calcd for $C_{25}H_{21}N_2O$ $[M+H]^+$ 365.1648, found 365.1647

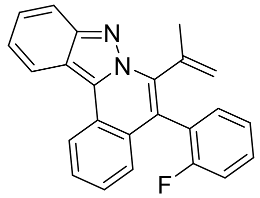
5-(2-Chlorophenyl)-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ap)



Yellow solid. 30.1 mg, Yield: 82%, mp 196-197 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.79 (d, *J* = 8.2 Hz, 1H), 8.52 (d, *J* = 8.5 Hz, 1H), 8.07 (d, *J* = 8.7 Hz, 1H), 7.74 (t, *J* = 7.6 Hz, 1H), 7.60 – 7.54 (m, 2H), 7.51 (t, *J* = 7.7 Hz, 1H), 7.48 – 7.33 (m, 4H), 7.30 (d, *J* = 8.2 Hz, 1H), 5.39 (s, 1H), 5.30 (s, 1H), 2.28 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.3, 138.4, 138.2, 135.7, 135.2, 132.3, 130.6, 129.7, 129.6, 128.4, 128.1, 127.3, 127.2, 126.8, 126.5, 125.3, 123.9, 122.9, 121.5, 121.2, 120.3, 117.7, 116.6, 21.9. HRMS (ESI) *m/z* calcd for $C_{24}H_{18}ClN_2$ $[M+H]^+$ 369.1153, found 369.1152

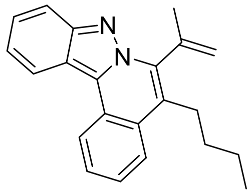
5-(2-Fluorophenyl)-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3aq)



Yellow solid. 28.5 mg, Yield: 81%, mp 209-210 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.79 (d, *J* = 8.1 Hz, 1H), 8.53 (d, *J* = 8.4 Hz, 1H), 8.10 (d, *J* = 8.7 Hz, 1H), 7.75 (t, *J* = 7.5 Hz, 1H), 7.59 (t, *J* = 7.6 Hz, 1H), 7.56 – 7.47 (m, 2H), 7.34 (dtd, *J* = 32.3, 17.0, 16.1, 8.5 Hz, 5H), 5.45 (s, 1H), 5.25 (s, 1H), 2.31 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 160.7 (d, *J* = 245.9 Hz), 149.2, 139.0, 138.3, 132.7, 130.6, 130.3 (d, *J* = 8.0 Hz), 128.9, 128.1, 127.3 (d, *J* = 11.1 Hz), 126.5, 125.4, 124.3, 124.1 (d, *J* = 4.0 Hz), 122.8, 121.5, 121.2, 120.7, 120.2, 117.7, 116.6, 115.8 (d, *J* = 21.9 Hz), 21.8. **^{19}F NMR** (376 MHz, $CDCl_3$, ppm) δ -112.52. HRMS (ESI) *m/z* calcd for $C_{24}H_{18}FN_2$ $[M+H]^+$ 353.1449, found 353.1448

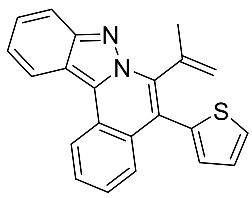
5-Butyl-6-(prop-1-en-2-yl)indazolo[3,2-a]isoquinoline (3ar)



Yellow solid. 20.4 mg, Yield: 65%, mp 189-190 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.73 (d, *J* = 8.0 Hz, 1H), 8.45 (d, *J* = 8.4 Hz, 1H), 8.04 (d, *J* = 8.4 Hz, 2H), 7.72 (t, *J* = 7.5 Hz, 1H), 7.64 (t, *J* = 7.6 Hz, 1H), 7.53 (t, *J* = 7.6 Hz, 1H), 7.32 (t, *J* = 7.5 Hz, 1H), 5.76 (s, 1H), 5.37 (s, 1H), 3.26 – 3.15 (m, 1H), 3.09 – 2.94 (m, 1H), 2.36 (s, 3H), 1.85 – 1.50 (m, 4H), 1.04 (t, *J* = 7.2 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 148.9, 139.0, 137.5, 129.7, 128.3, 127.6, 127.0, 126.8, 125.8, 124.9, 123.9, 123.3, 121.1, 121.1, 119.6, 117.5, 116.5, 33.7, 28.8, 23.4, 22.2, 14.0. HRMS (ESI) *m/z* calcd for $C_{22}H_{23}N_2$ $[M+H]^+$ 315.1856, found 315.1855

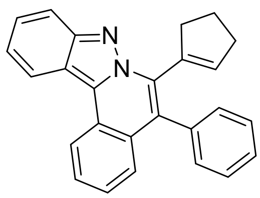
6-(Prop-1-en-2-yl)-5-(thiophen-2-yl)indazolo[3,2-a]isoquinoline (3as)



Yellow solid. 27.5 mg, Yield: 81%, mp 168-169 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.78 (d, *J* = 8.1 Hz, 1H), 8.52 (d, *J* = 8.5 Hz, 1H), 8.08 (d, *J* = 8.7 Hz, 1H), 7.75 (t, *J* = 7.5 Hz, 1H), 7.62 – 7.48 (m, 4H), 7.38 (t, *J* = 7.5 Hz, 1H), 7.32 (s, 1H), 7.16 (d, *J* = 4.7 Hz, 1H), 5.50 (s, 1H), 5.16 (s, 1H), 2.26 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.2, 138.6, 138.2, 136.0, 130.3, 130.3, 129.5, 128.0, 127.2, 127.0, 127.0, 125.3, 125.3, 125.1, 122.7, 121.5, 121.4, 121.2, 121.0, 117.7, 116.5, 22.3. HRMS (ESI) *m/z* calcd for $C_{22}H_{17}N_2S$ $[M+H]^+$ 341.1107, found 341.1107

6-(Cyclopent-1-en-1-yl)-5-phenylindazolo[3,2-a]isoquinoline (3at)



Yellow solid. 30.6 mg, Yield: 85%, mp 174-175 °C. column chromatography eluent, EtOAc/PE = 1:80 → 1:60

^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 8.76 (d, *J* = 8.1 Hz, 1H), 8.51 (d, *J* = 8.4 Hz, 1H), 8.03 (d, *J* = 8.6 Hz, 1H), 7.71 (t, *J* = 7.3 Hz, 1H), 7.59 – 7.42 (m, 6H), 7.39 – 7.32 (m, 3H), 5.73 (s, 1H), 2.95 – 2.77 (m, 2H), 2.44 – 2.30 (m, 2H), 2.02 (p, *J* = 7.3 Hz, 2H). **^{13}C NMR** (100 MHz, $CDCl_3$, ppm) δ 149.1, 137.1, 136.6, 136.2, 134.9, 130.7, 130.3, 129.2, 128.1, 127.8, 127.6, 127.5, 127.2, 127.0, 126.8, 125.4, 122.7, 121.3, 121.2, 117.7, 116.5, 35.6, 33.2, 23.6. HRMS (ESI) *m/z* calcd for $C_{26}H_{21}N_2$ $[M+H]^+$ 361.1699, found 369.1700

6. References

(1) Li, P.; Zhao, J.; Wu, C.; Larock, R. C.; Shi, F. Synthesis of 3-Substituted Indazoles from Arynes and N-Tosylhydrazones. *Org. Lett.* **2011**, *13*, 3340−3343.

(2) (a) Panyam, P. K. R.; Gandhi, T. Palladium(II)/N-Heterocyclic Carbene-Catalyzed Regioselective Heteroannulation of Tertiary Propargyl Alcohols and o-Haloanilines to form 2-Alkenylindoles. *Adv. Synth. Catal*. **2017**, *359*, 1144-1151.

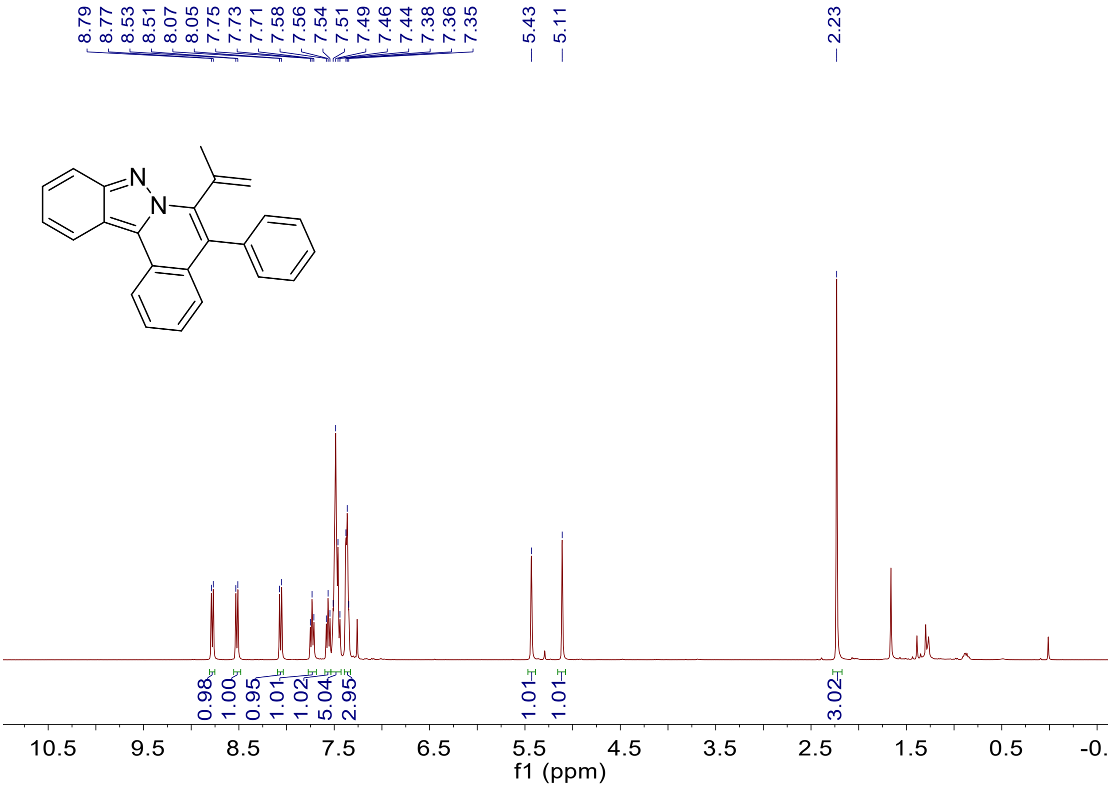
(b) Hashmi, A. S. K.; Wang, T.; Shi, S.; Rudolph, M. Regioselectivity Switch: Gold(I)-Catalyzed Oxidative Rearrangement of Propargyl Alcohols to 1,3-Diketones. *J. Org. Chem*. **2012**, *77*, 7761−7767.

(3) Song, Z.; Yang, Z.; Wang, P.; Shi, Z.; Li, T.; Cui, X. Ruthenium(II)-Catalyzed Regioselective [3 + 2] Spiroannulation of 2H-Imidazoles with 2-Alkynoates. *Org. Lett*. **2020**, *22*, 6272−6276

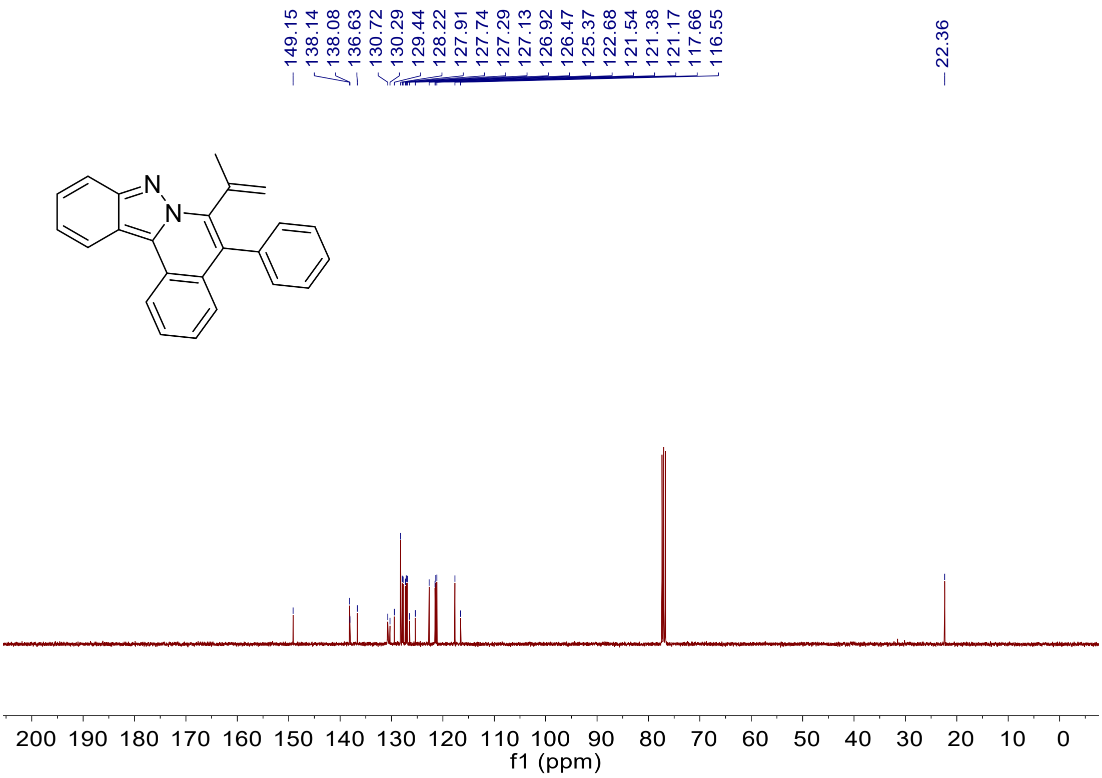
(4) Huang, L.; Yao, Z.; Huang, G.; Ao, Y.; Zhu, B.; Li, S.; Cui, X. One-Pot Synthesis of Fused Indolin-3-Ones via a [3+ 3] Cycloaddition Reaction. *Adv. Synth. Catal*. **2021**, *359*, 5092−5098.

7. Copies of NMR Spectra.

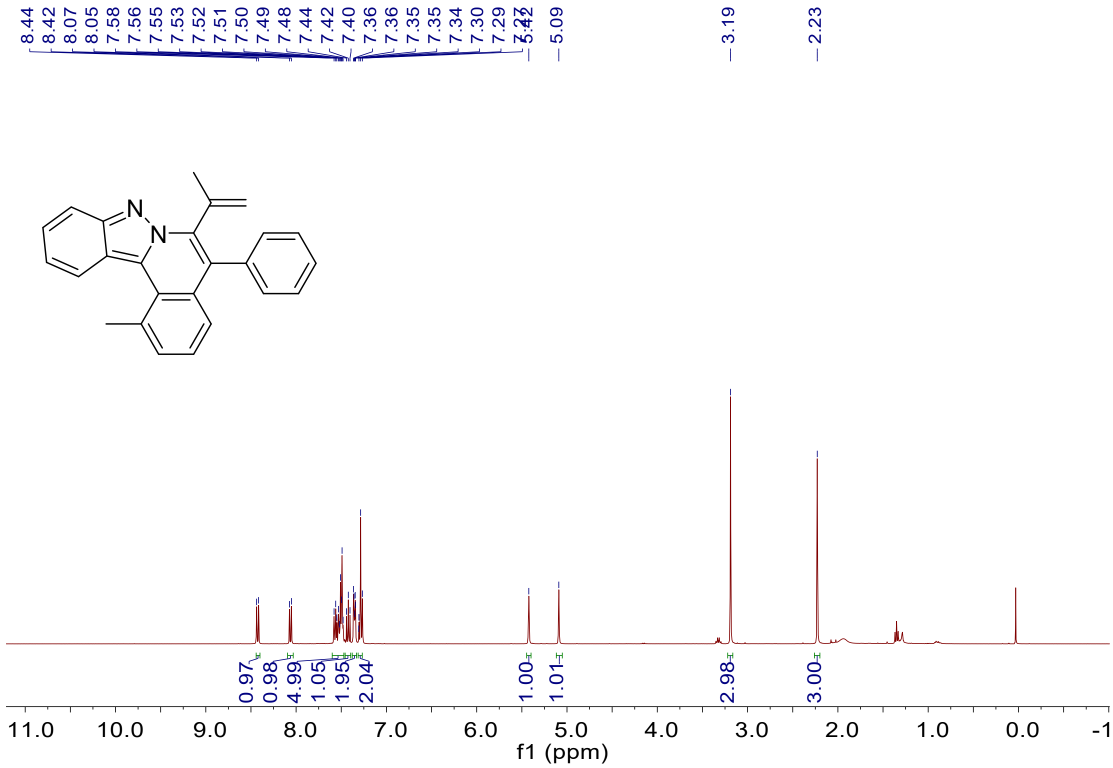
^{1}H NMR ($CDCl_3$) spectrum of **3aa**



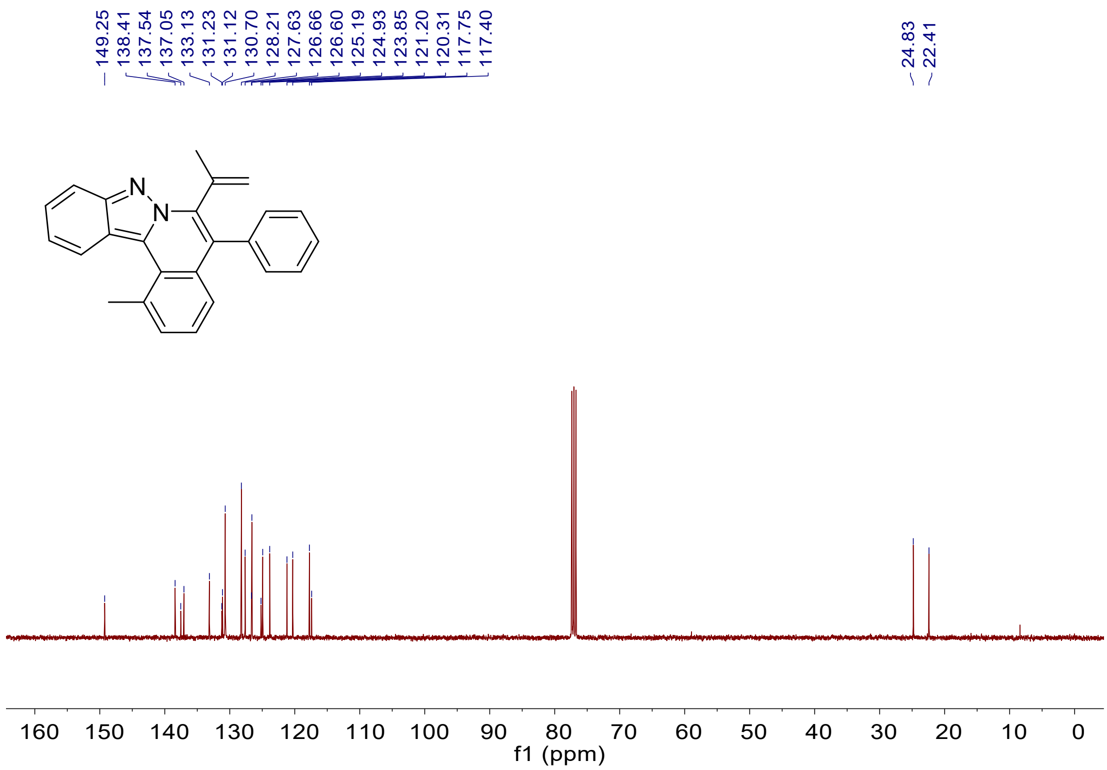
^{13}C NMR ($CDCl_3$) spectrum of **3aa**



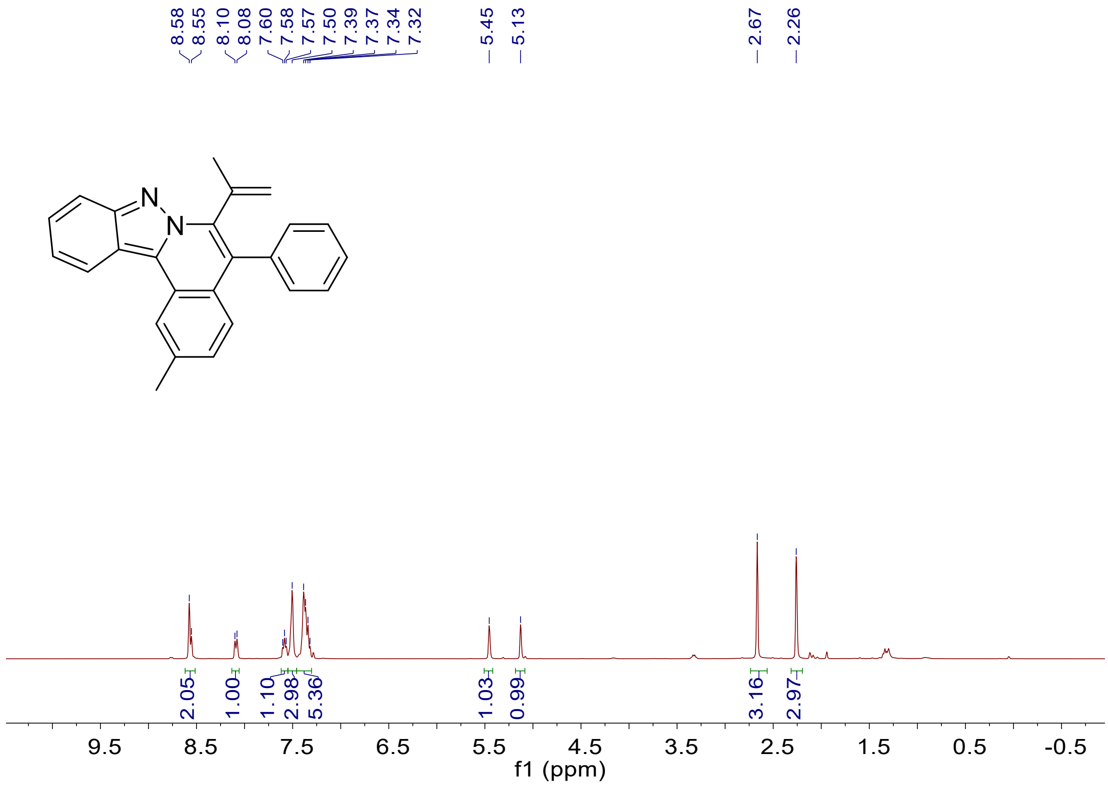
^{1}H NMR ($CDCl_3$) spectrum of **3ba**



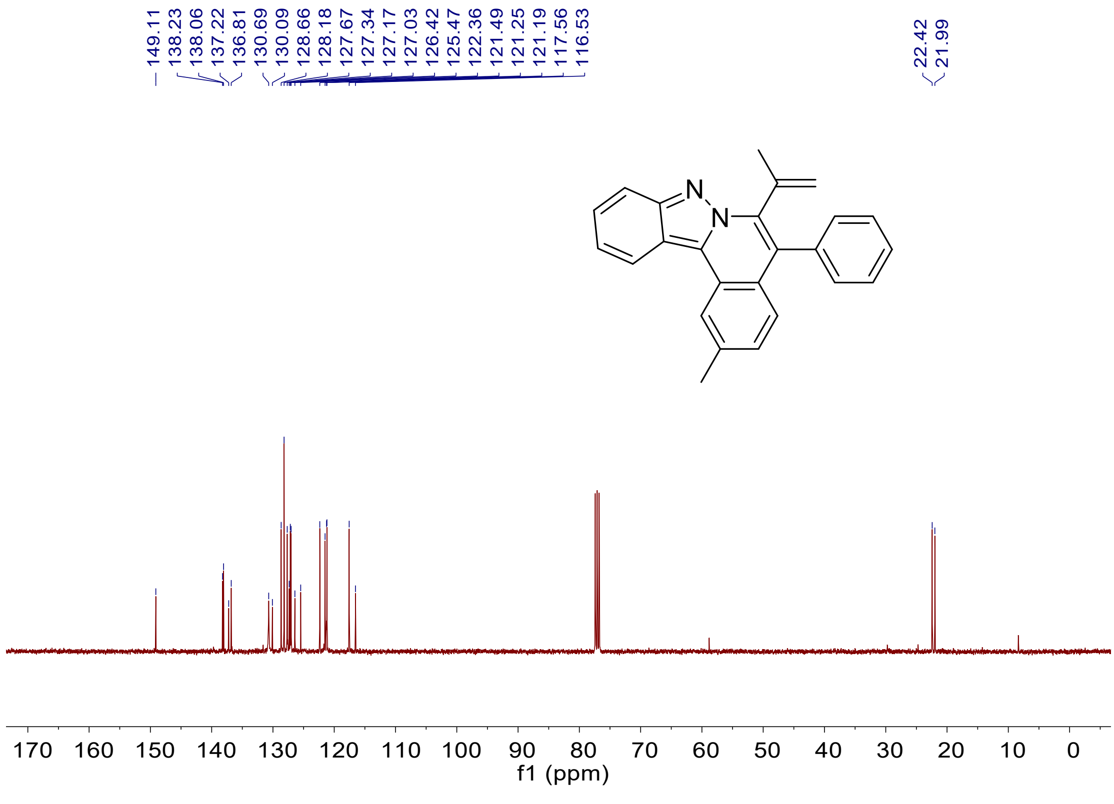
^{13}C NMR ($CDCl_3$) spectrum of **3ba**



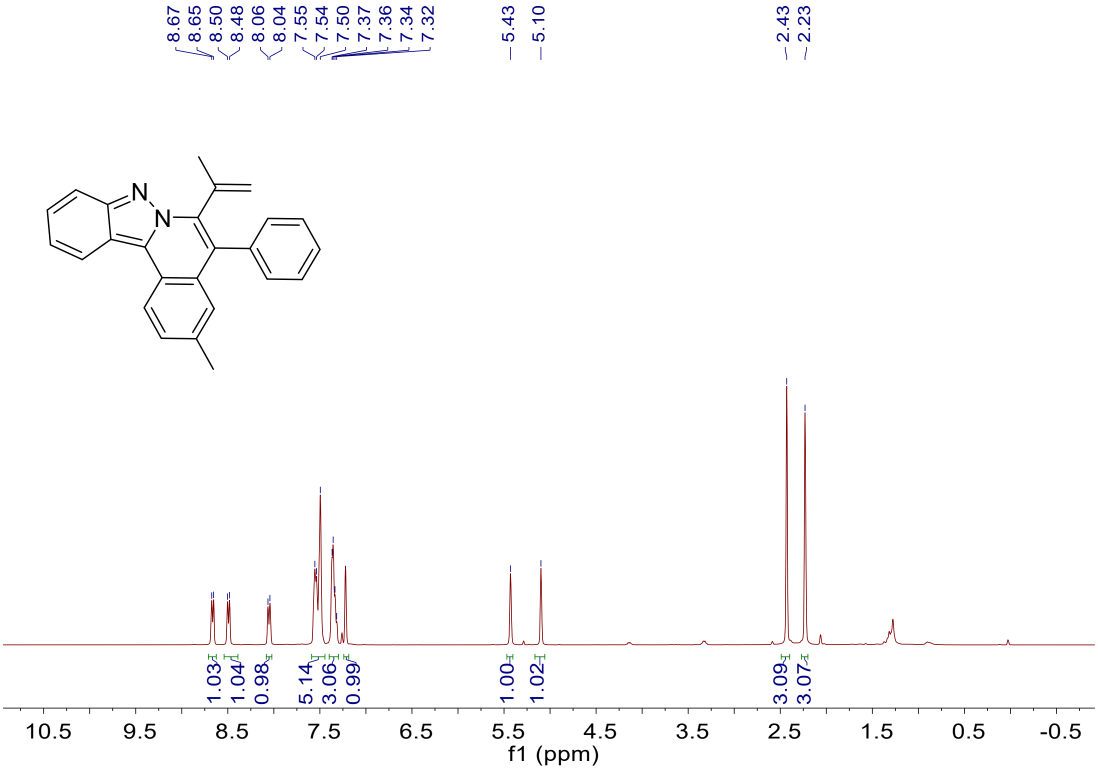
^{1}H NMR ($CDCl_3$) spectrum of **3ca**



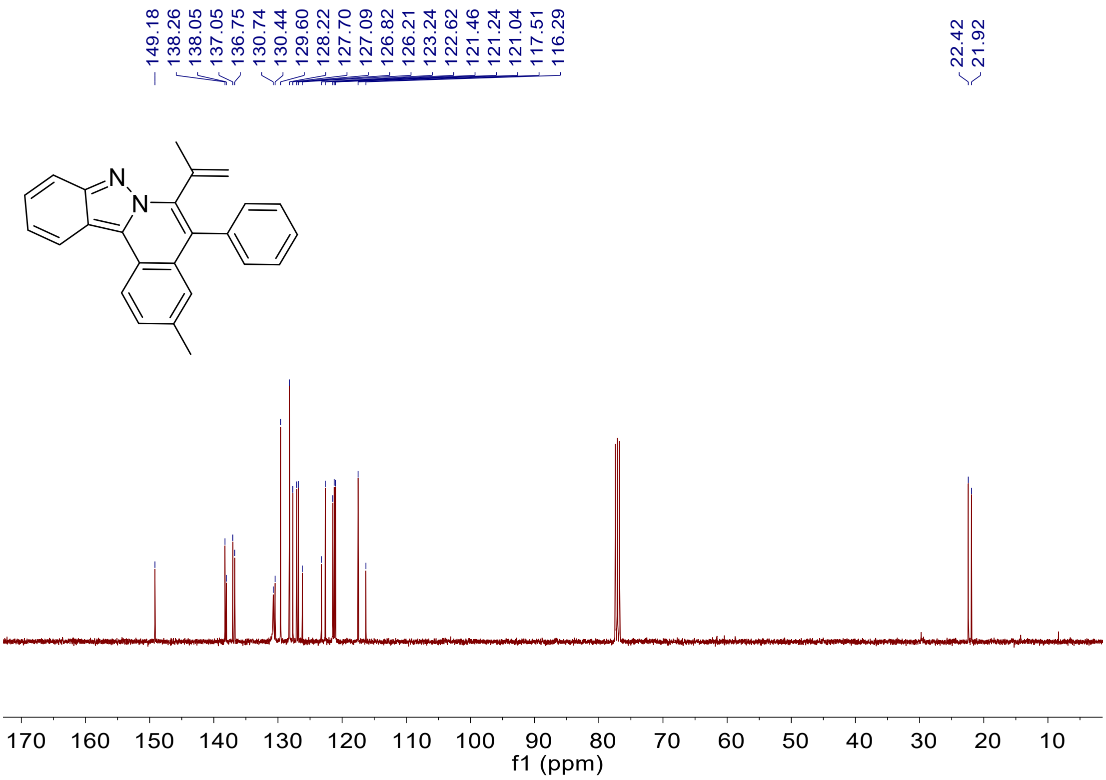
^{13}C NMR ($CDCl_3$) spectrum of **3ca**



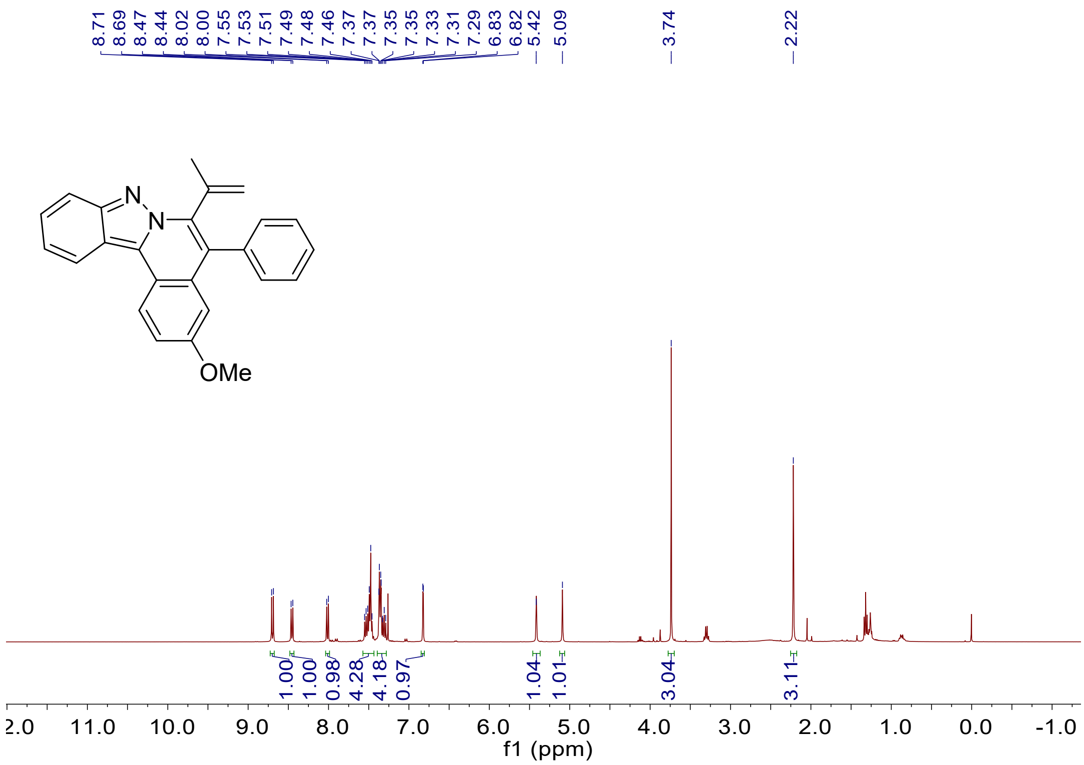
[1]H NMR ($CDCl_3$) spectrum of **3da**



[13]C NMR ($CDCl_3$) spectrum of **3da**



^{1}H NMR ($CDCl_3$) spectrum of **3ea**



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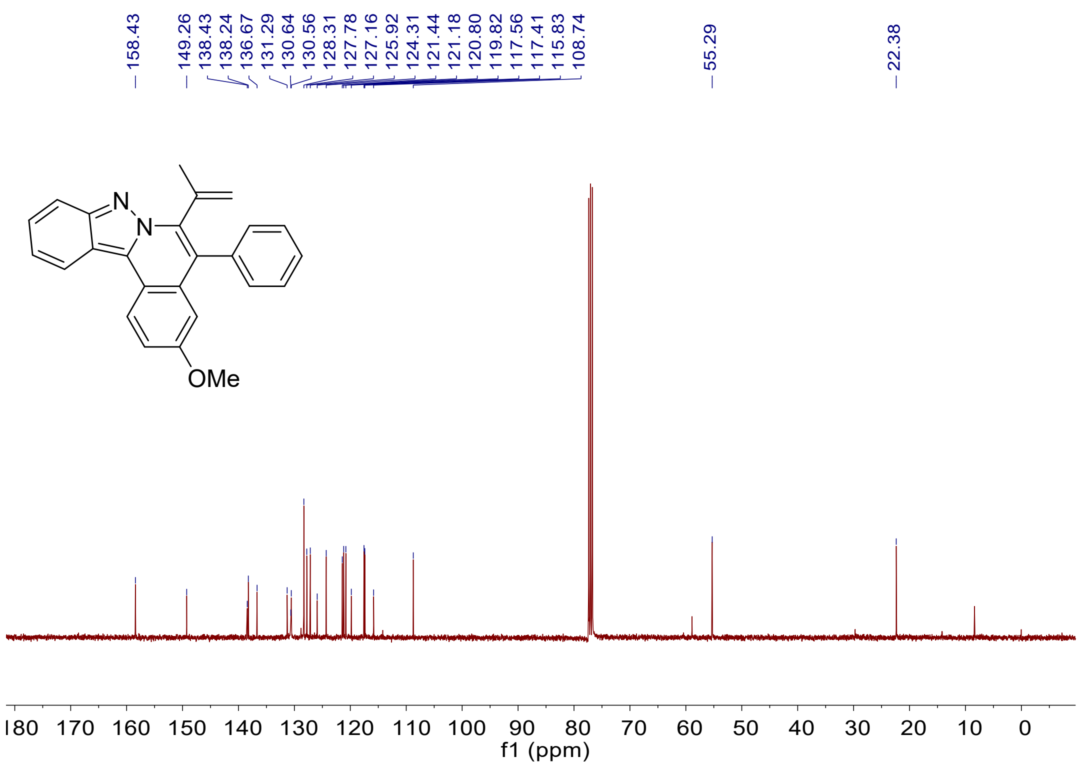
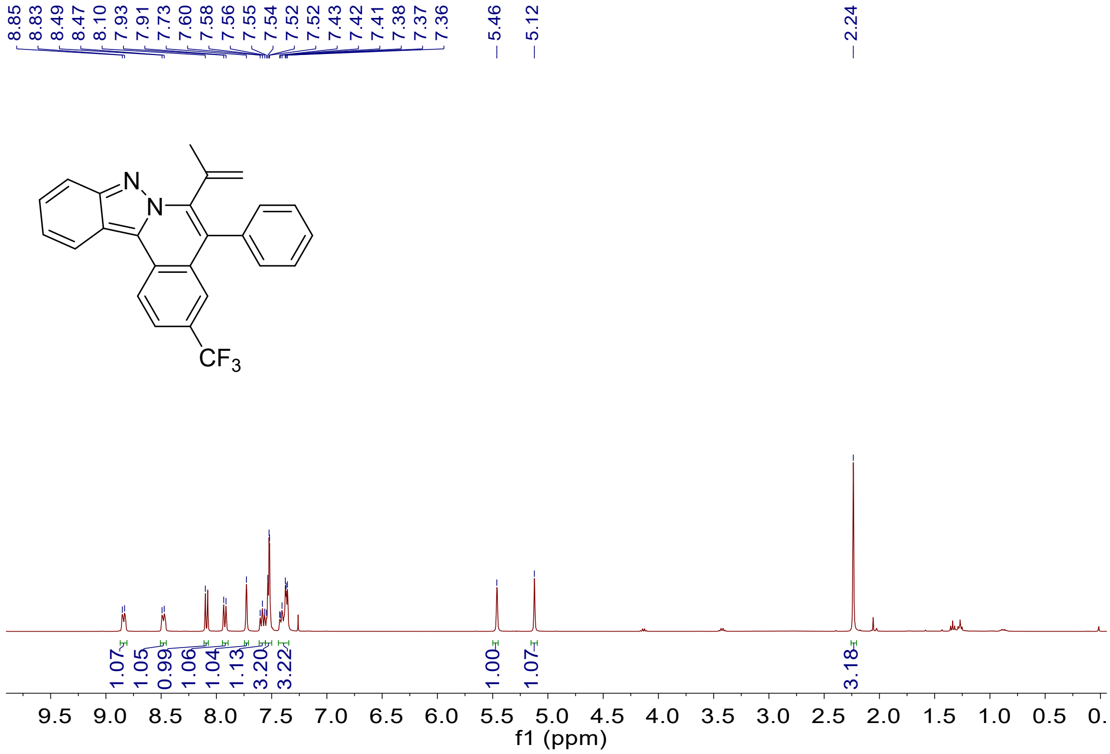
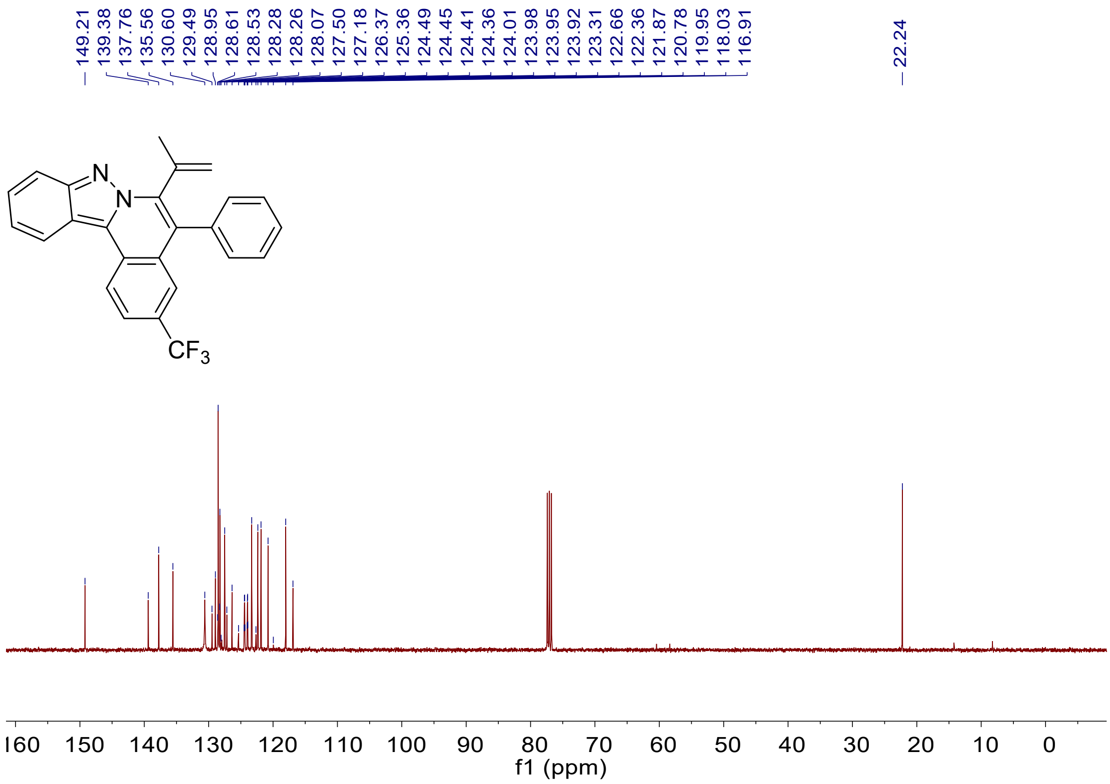


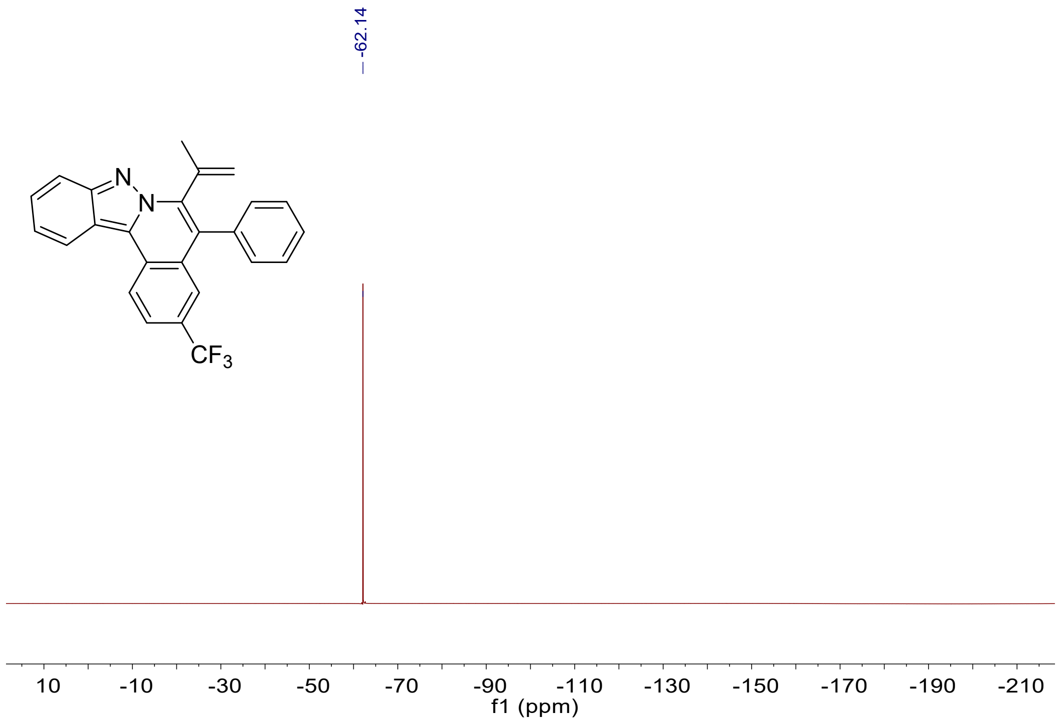
^{1}H NMR ($CDCl_3$) spectrum of **3fa**



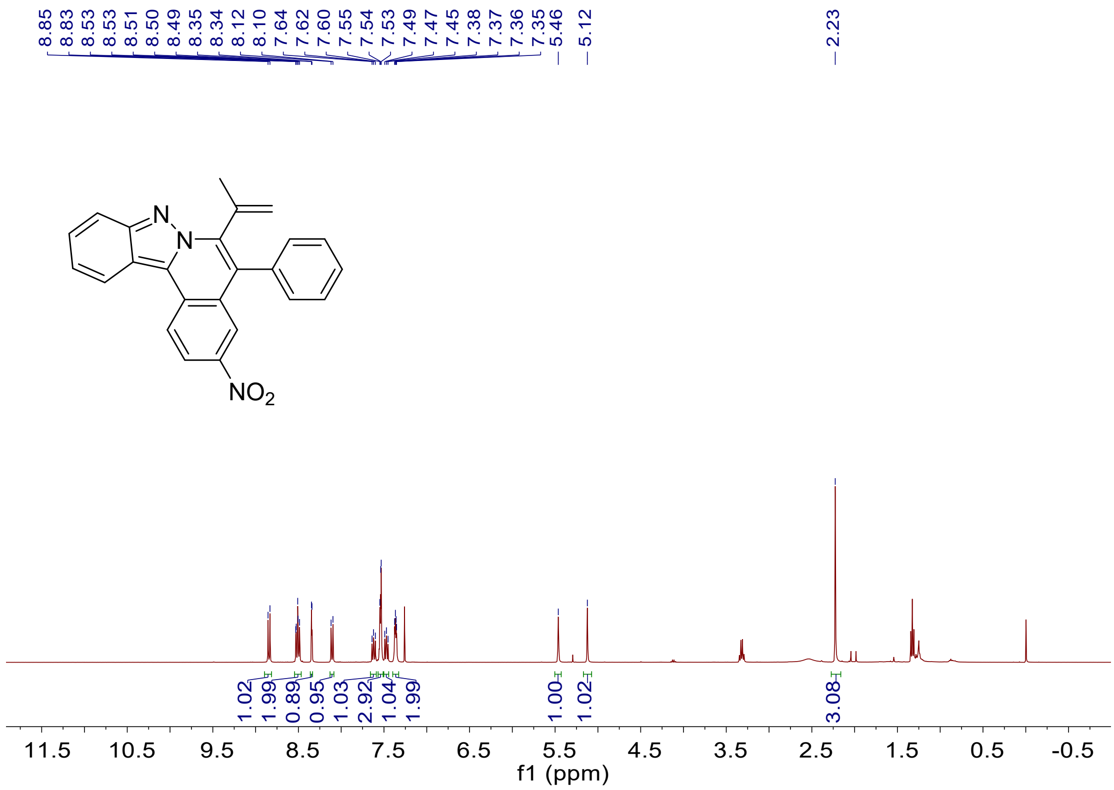
^{13}C NMR ($CDCl_3$) spectrum of **3fa**



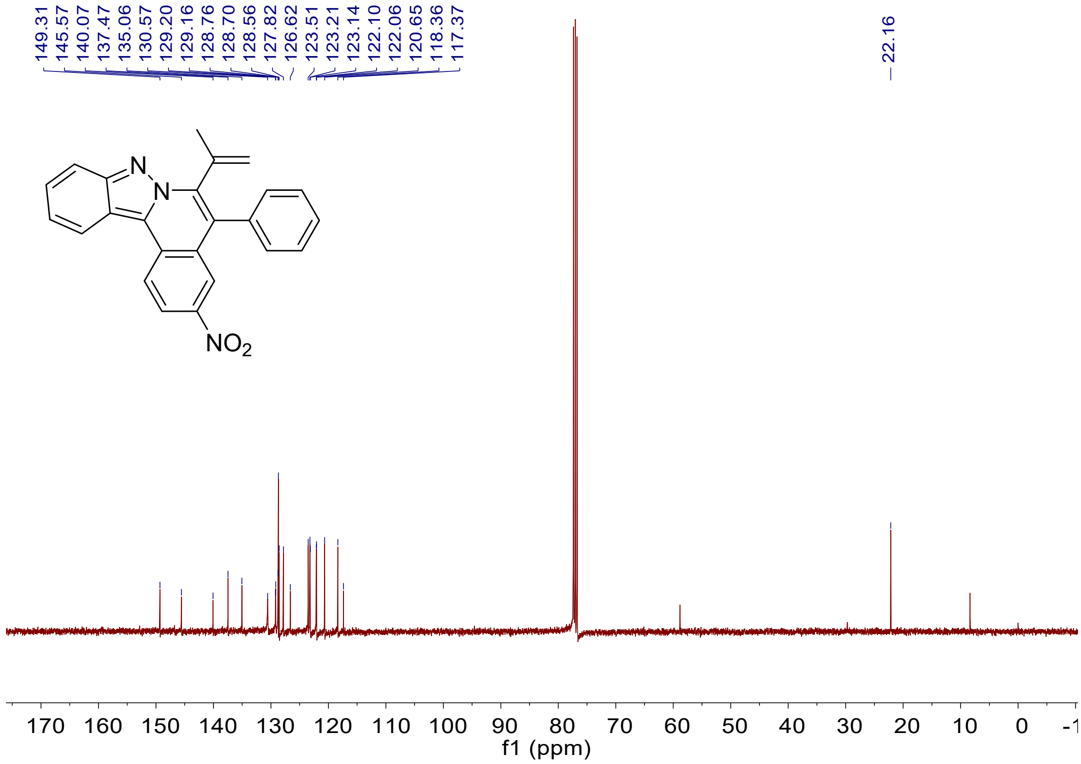
^{19}F NMR ($CDCl_3$) spectrum of **3fa**



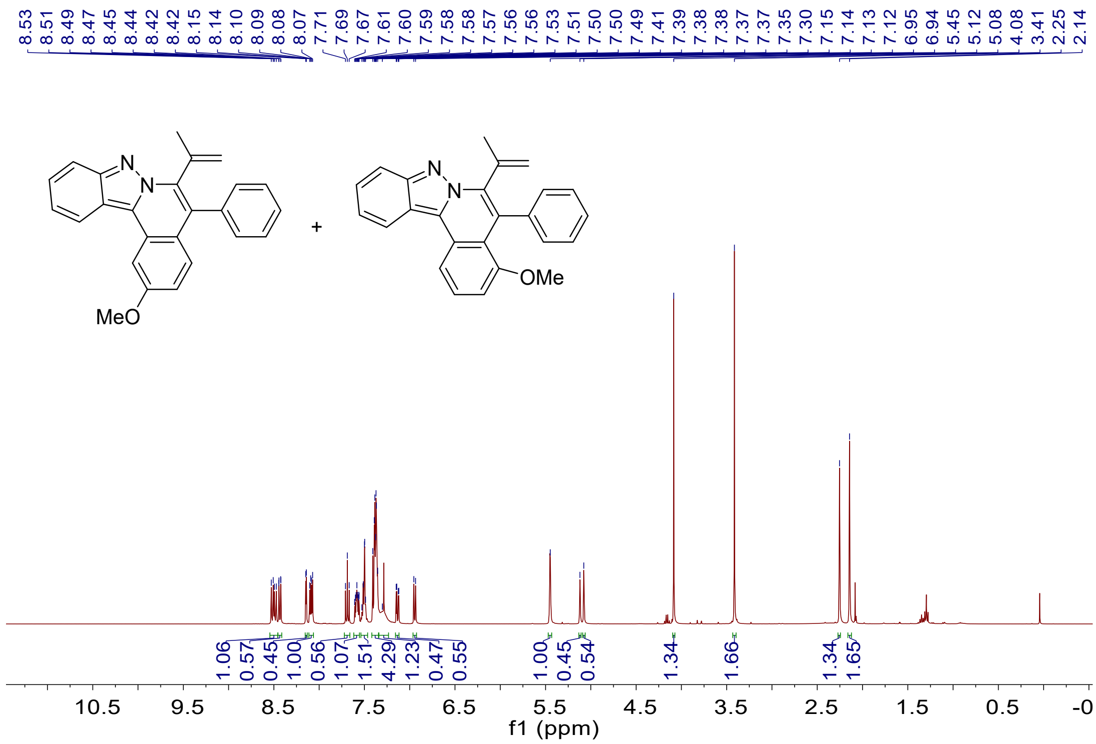
^{1}H NMR ($CDCl_3$) spectrum of **3ga**



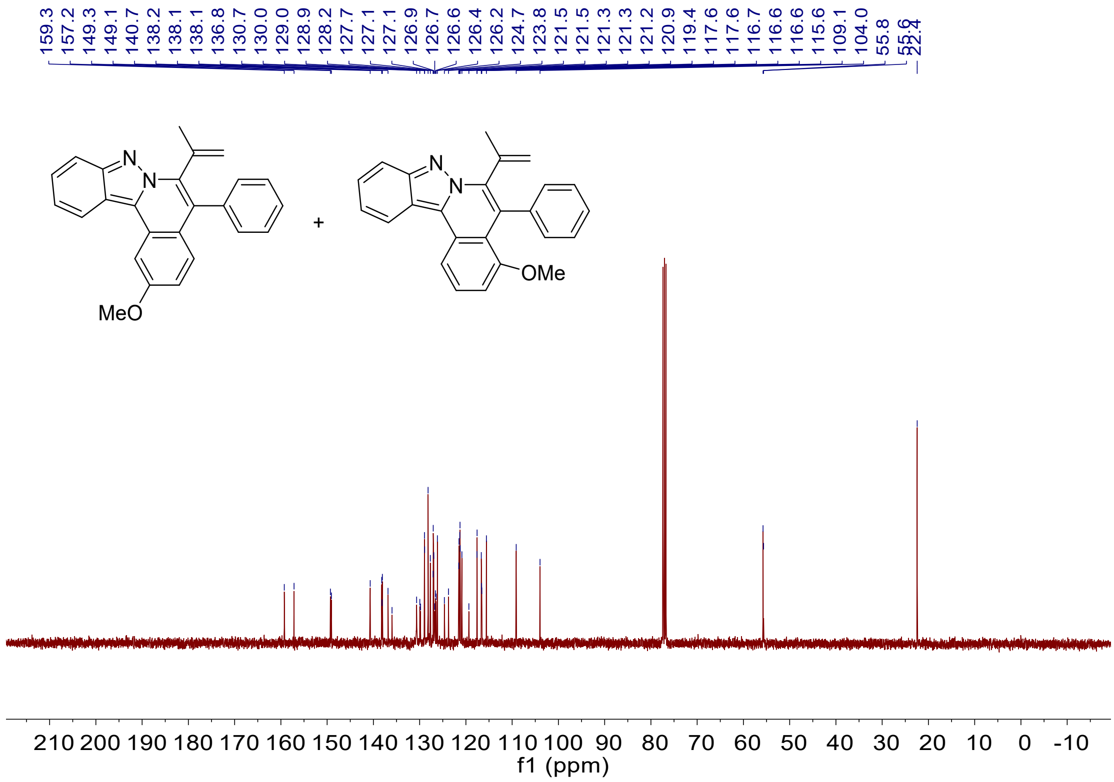
^{13}C NMR ($CDCl_3$) spectrum of **3ga**



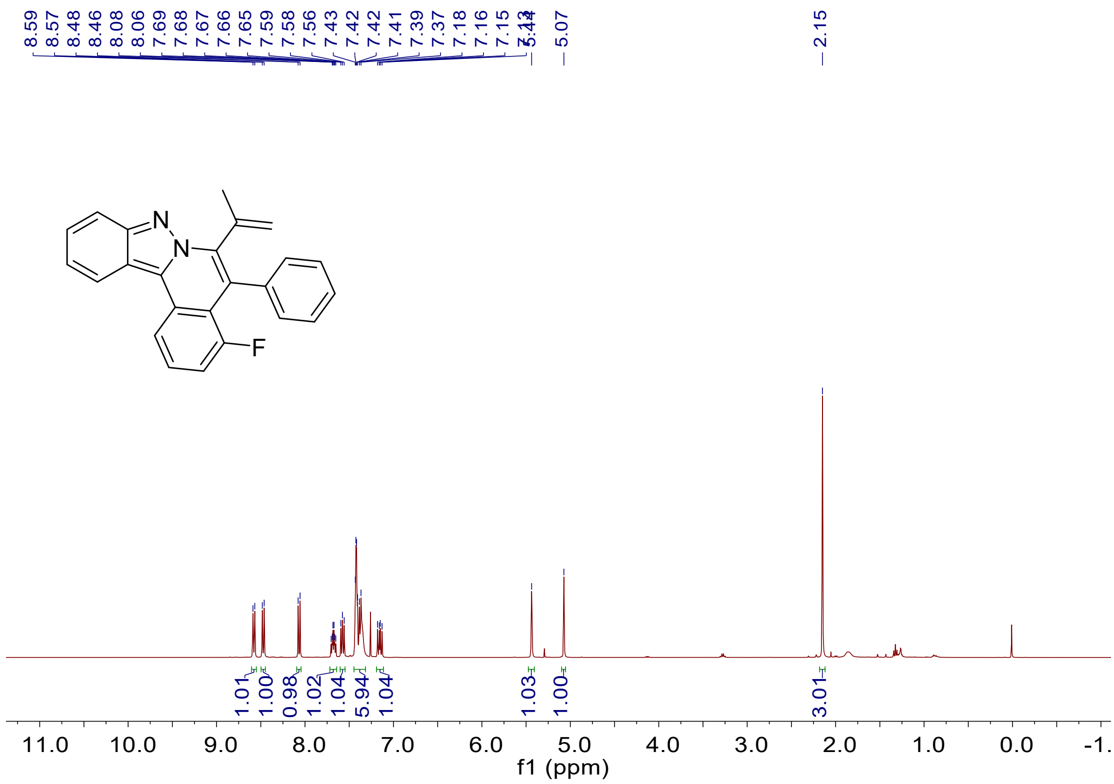
^1H NMR ($CDCl_3$) spectrum of **3ha/3ha'**



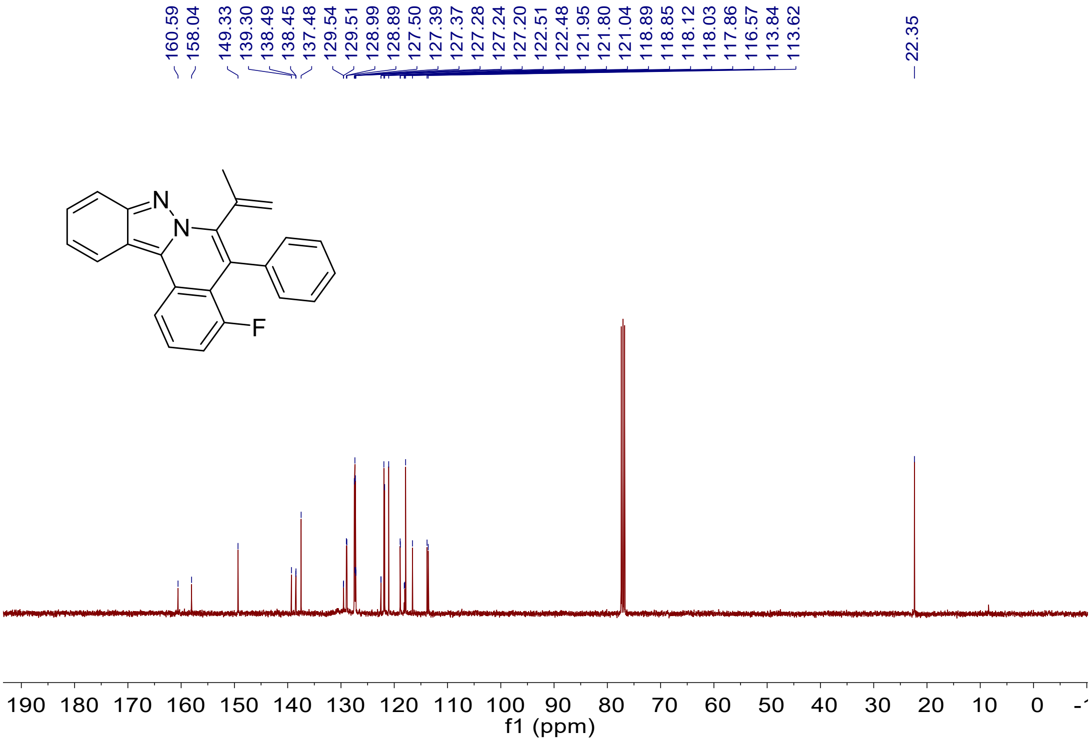
^{13}C NMR ($CDCl_3$) spectrum of **3ha/3ha'**



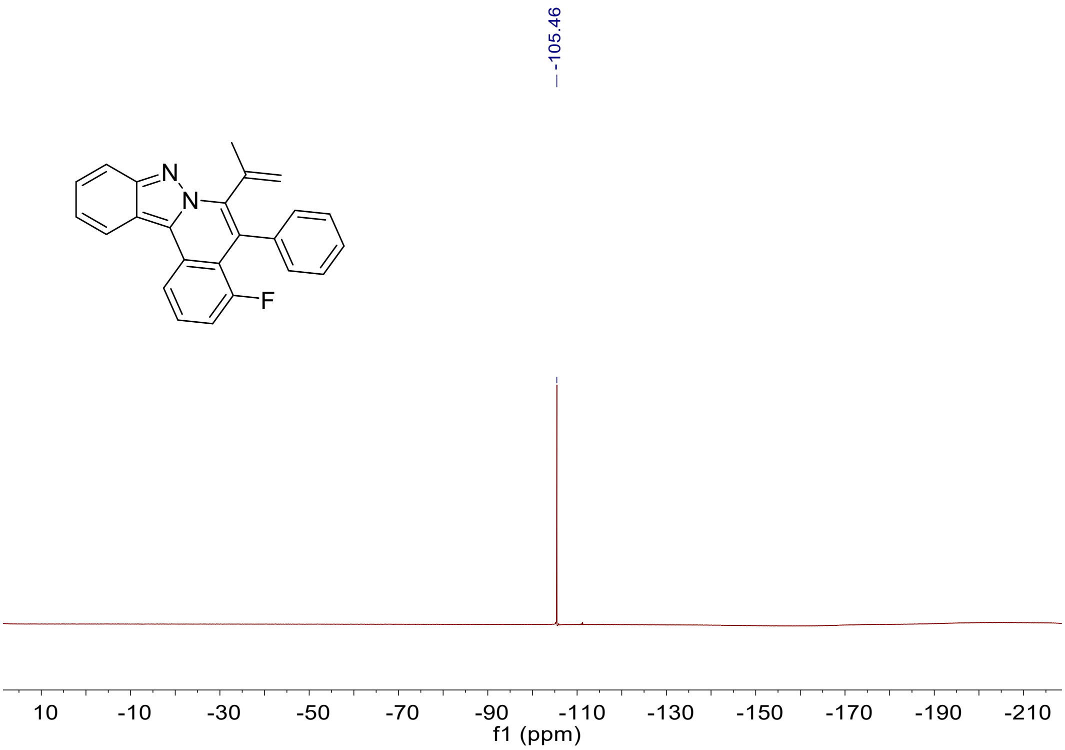
^{1}H NMR ($CDCl_3$) spectrum of **3ia**



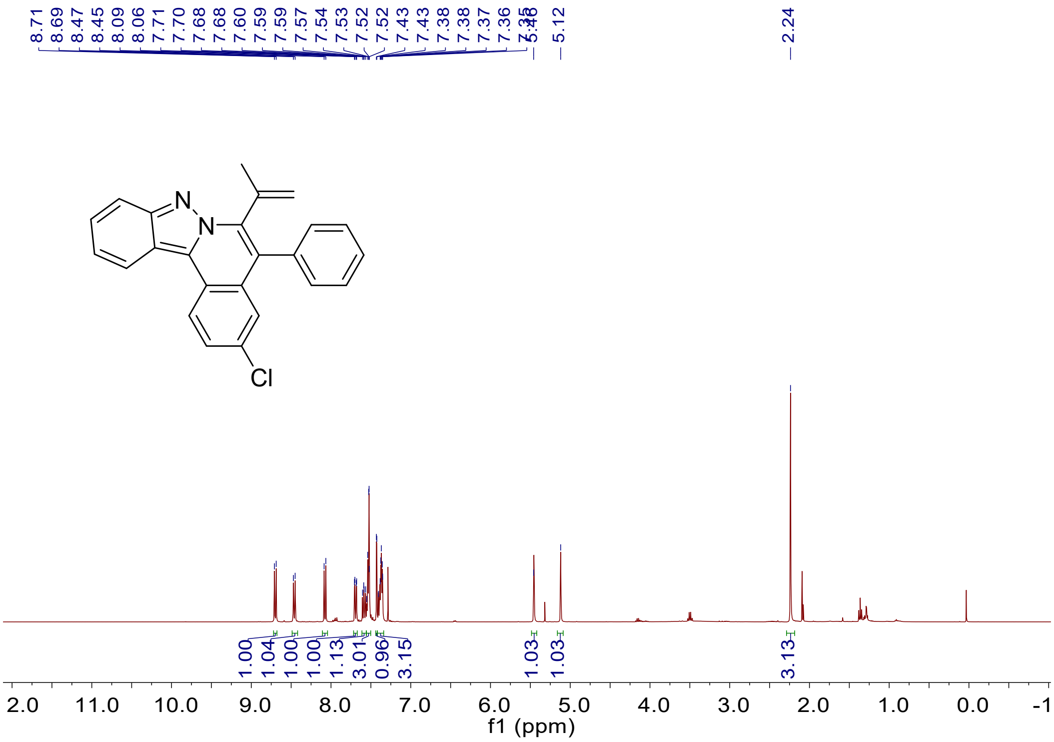
^{13}C NMR ($CDCl_3$) spectrum of **3ia**



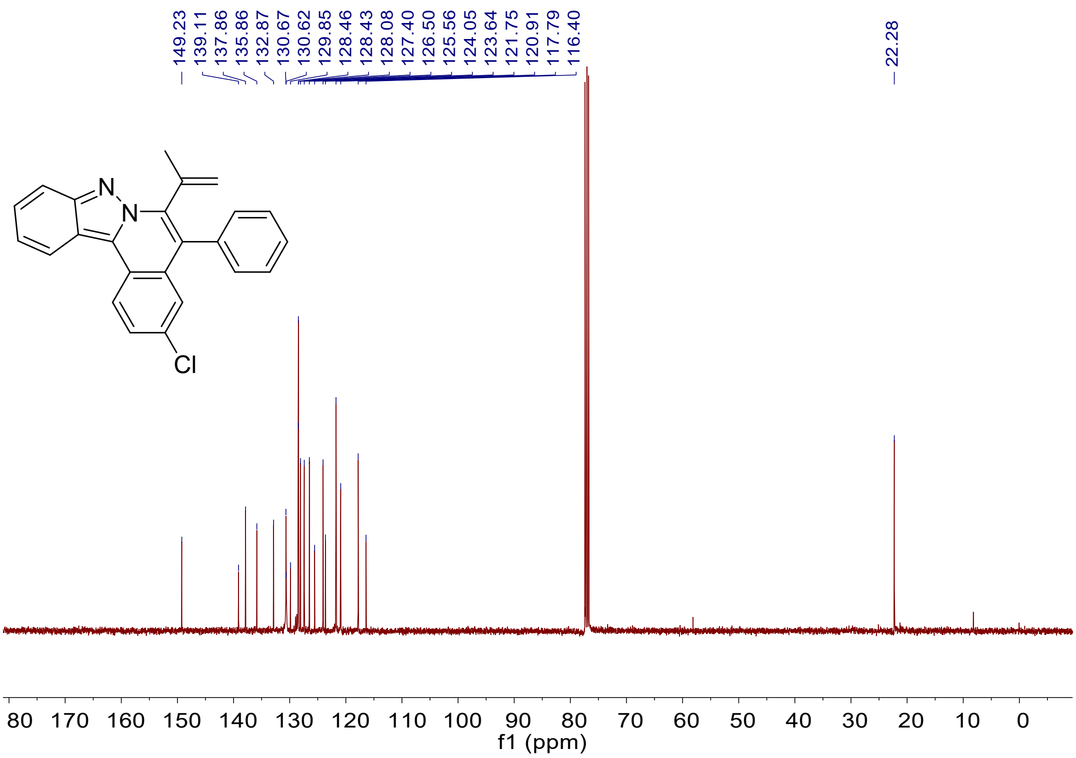
^{19}F NMR ($CDCl_3$) spectrum of **3ia**



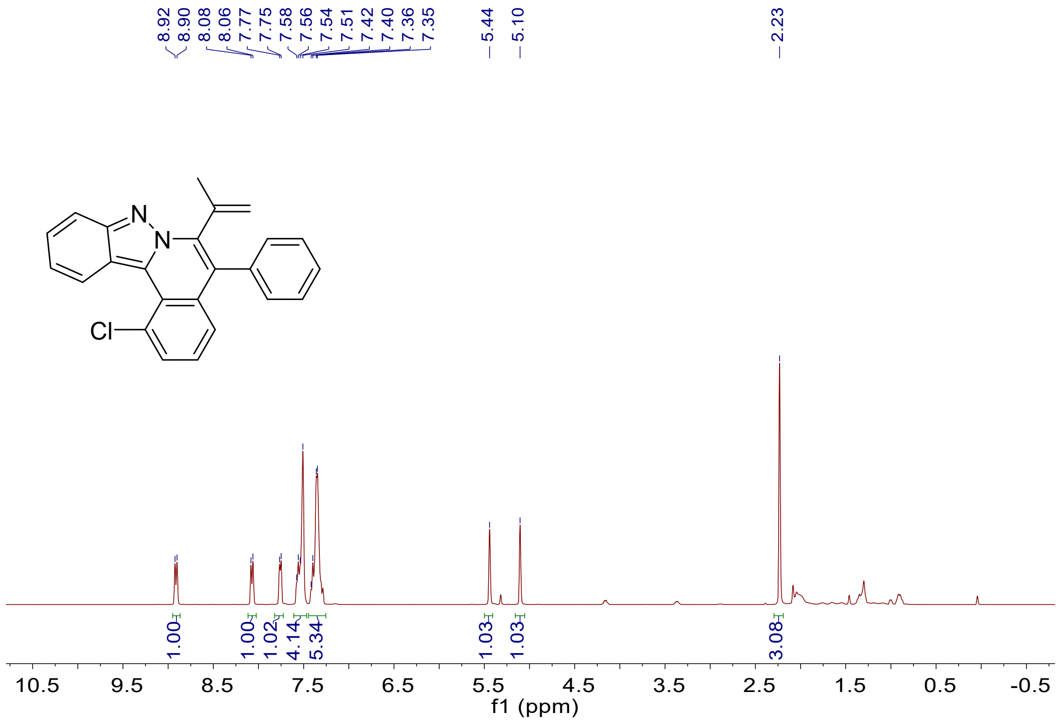
^{1}H NMR ($CDCl_3$) spectrum of **3ja**



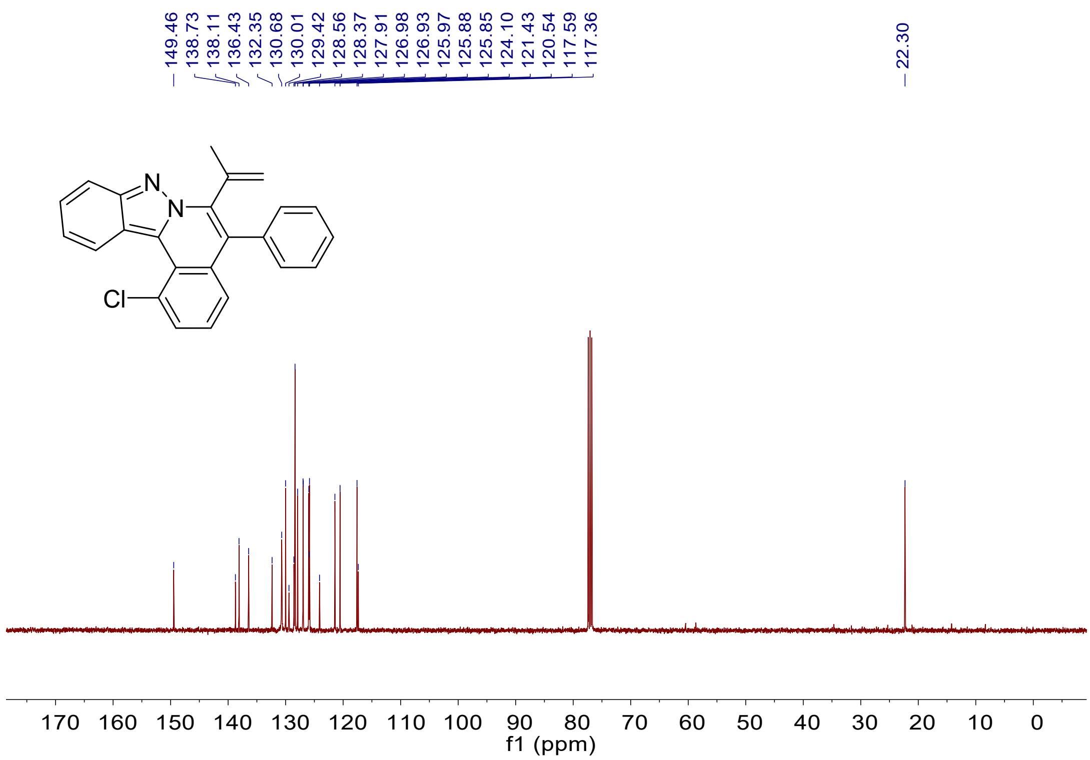
^{13}C NMR ($CDCl_3$) spectrum of **3ja**



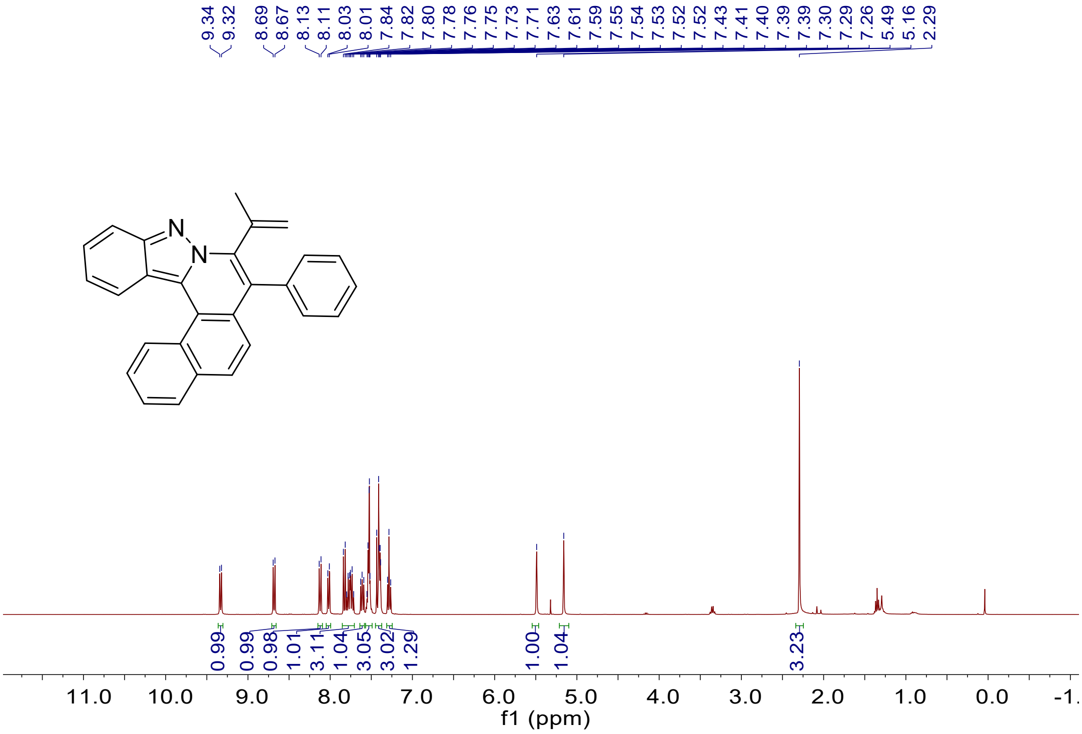
^1H NMR ($CDCl_3$) spectrum of **3ka**



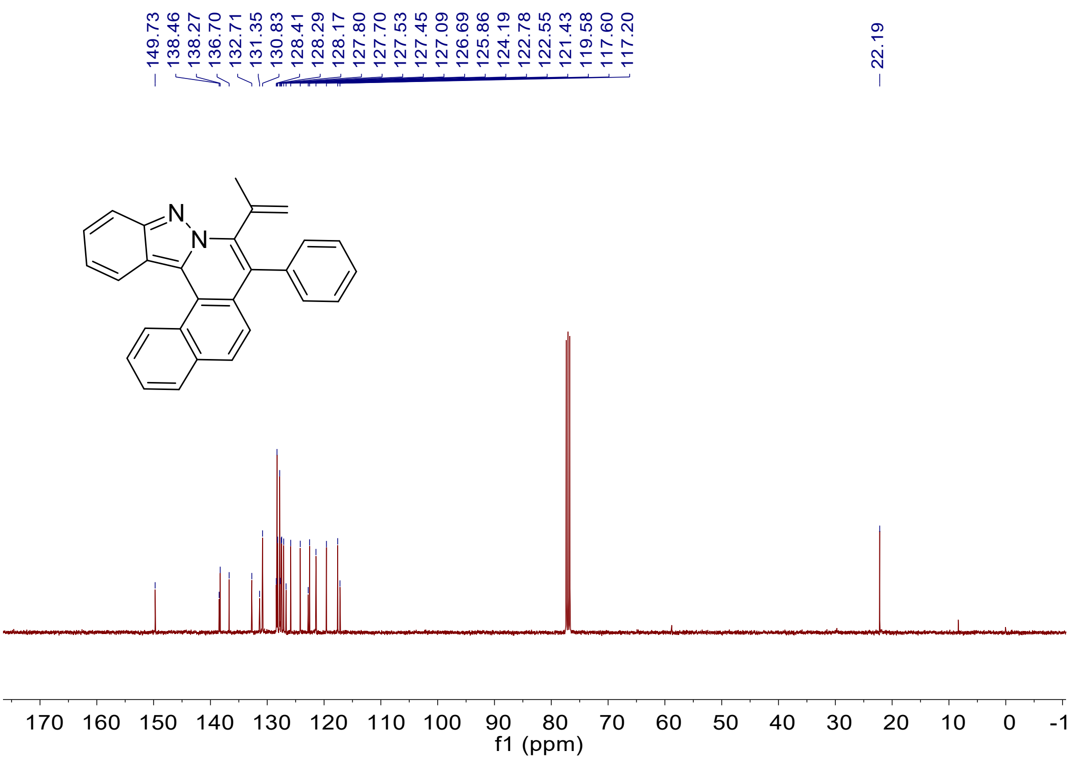
^{13}C NMR ($CDCl_3$) spectrum of **3ka**



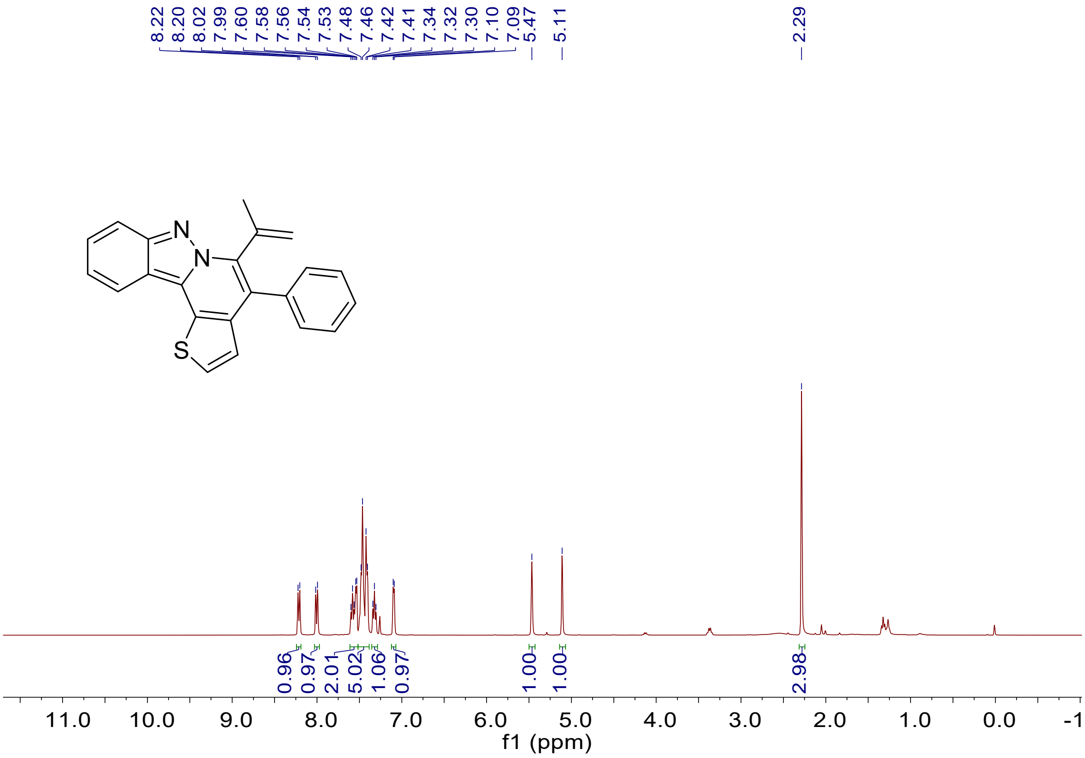
^{1}H NMR ($CDCl_3$) spectrum of **3la**



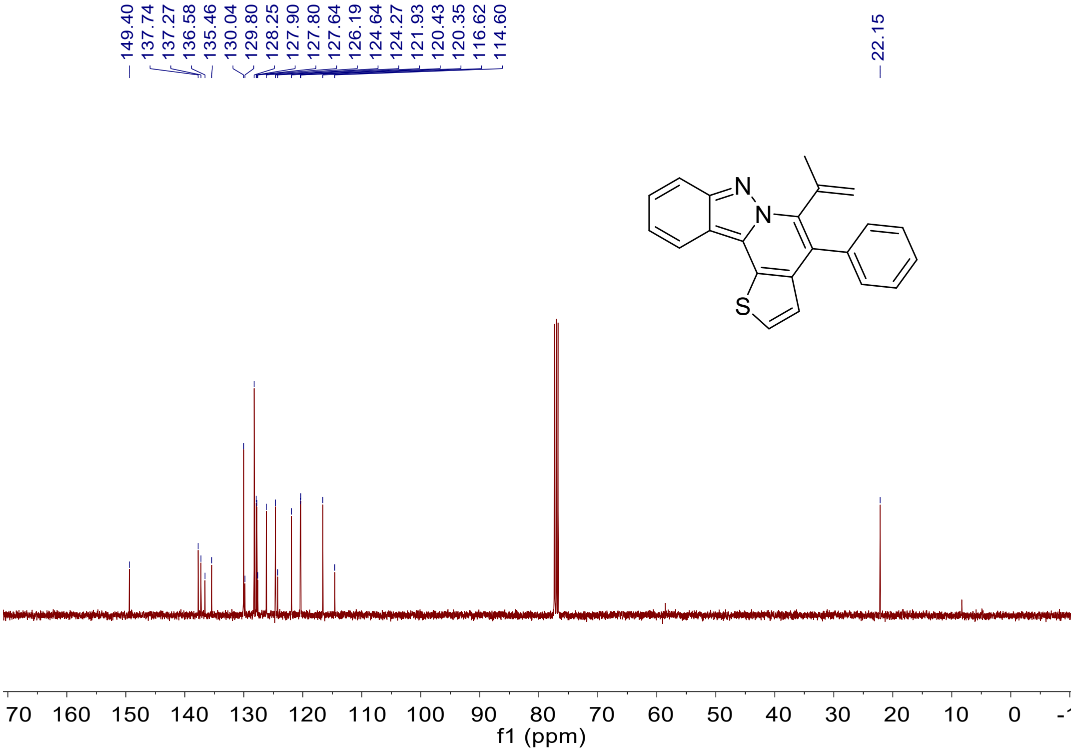
^{13}C NMR ($CDCl_3$) spectrum of **3la**



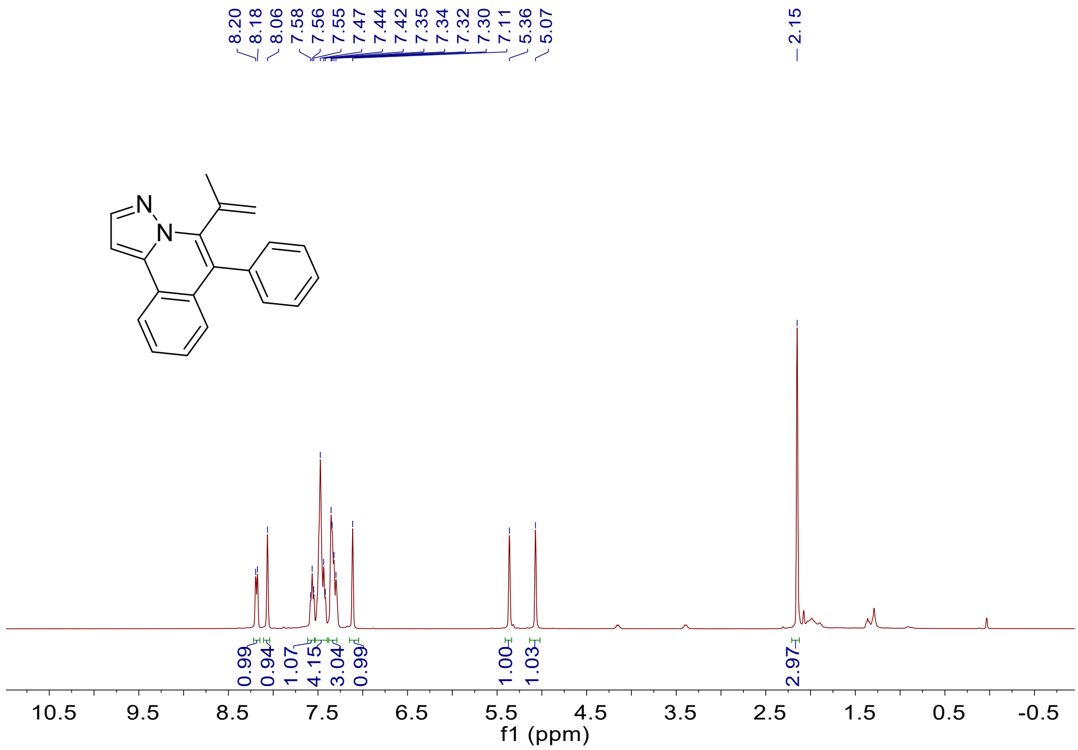
^{1}H NMR ($CDCl_3$) spectrum of **3ma**



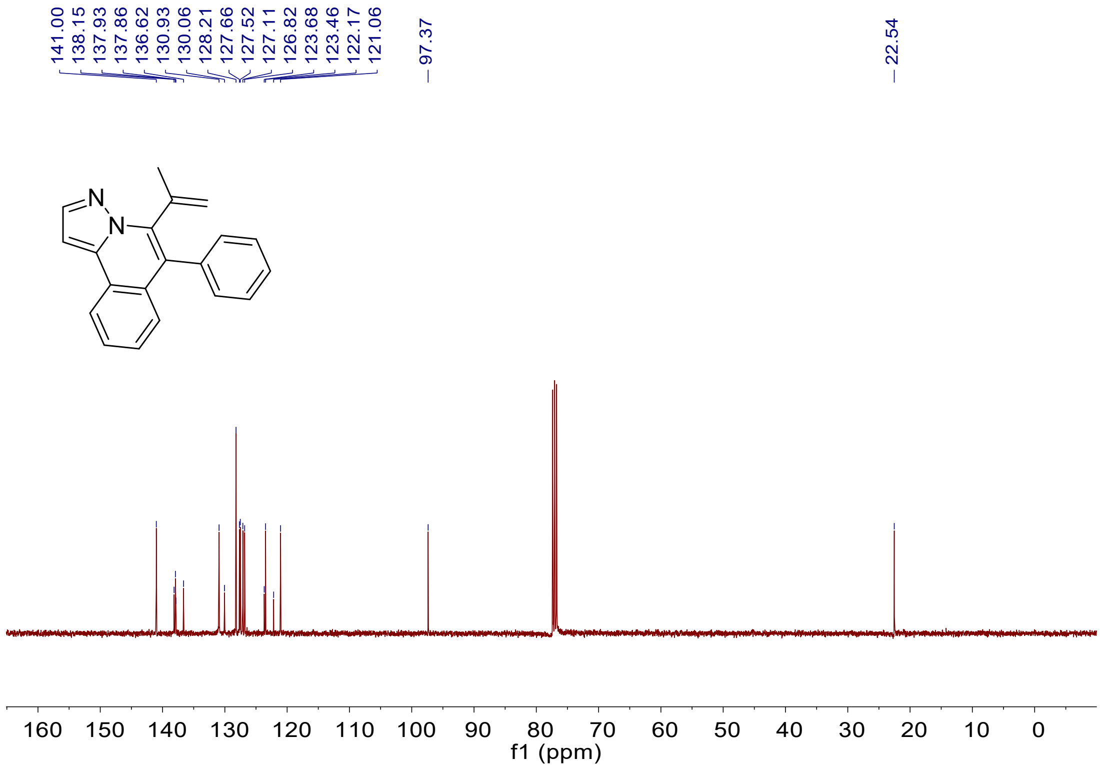
^{13}C NMR ($CDCl_3$) spectrum of **3ma**



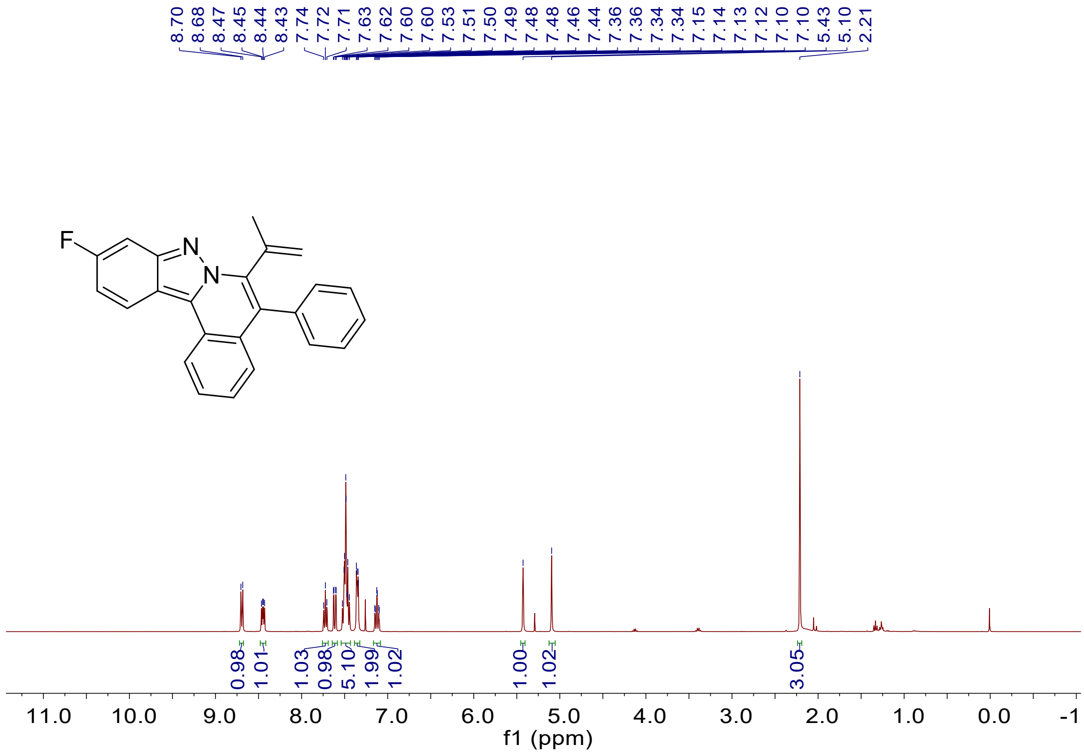
^{1}H NMR ($CDCl_3$) spectrum of **3na**



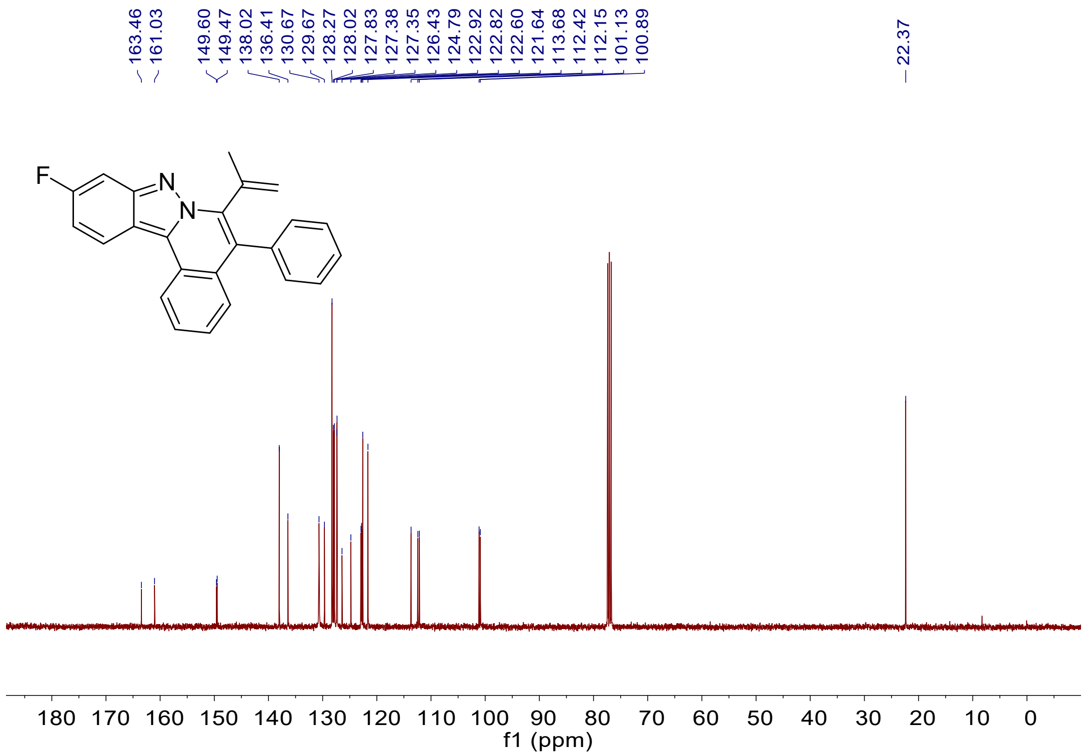
^{13}C NMR ($CDCl_3$) spectrum of **3na**



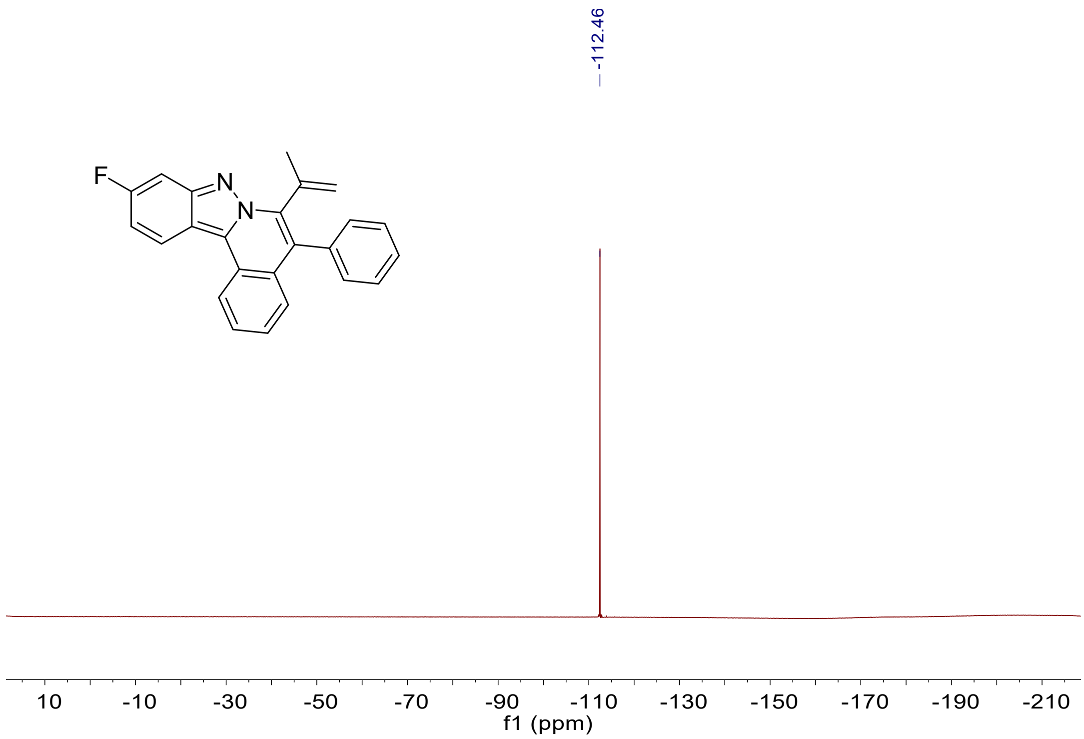
^{1}H NMR ($CDCl_3$) spectrum of **3oa**



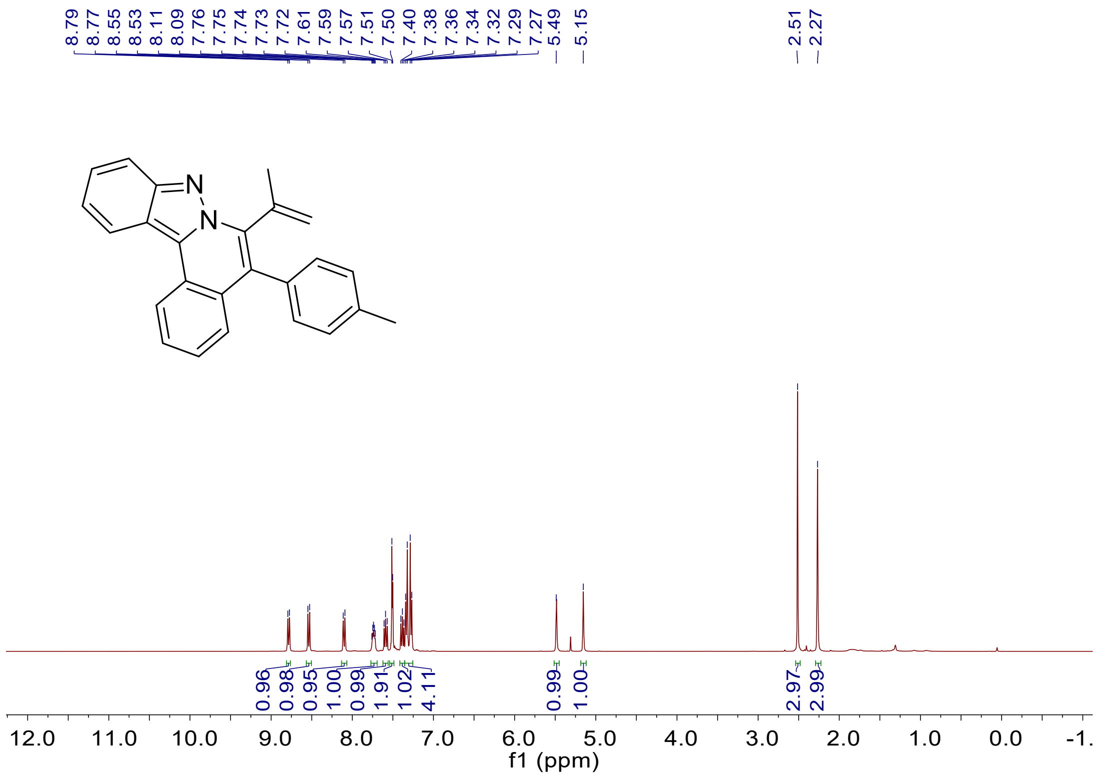
^{13}C NMR ($CDCl_3$) spectrum of **3oa**



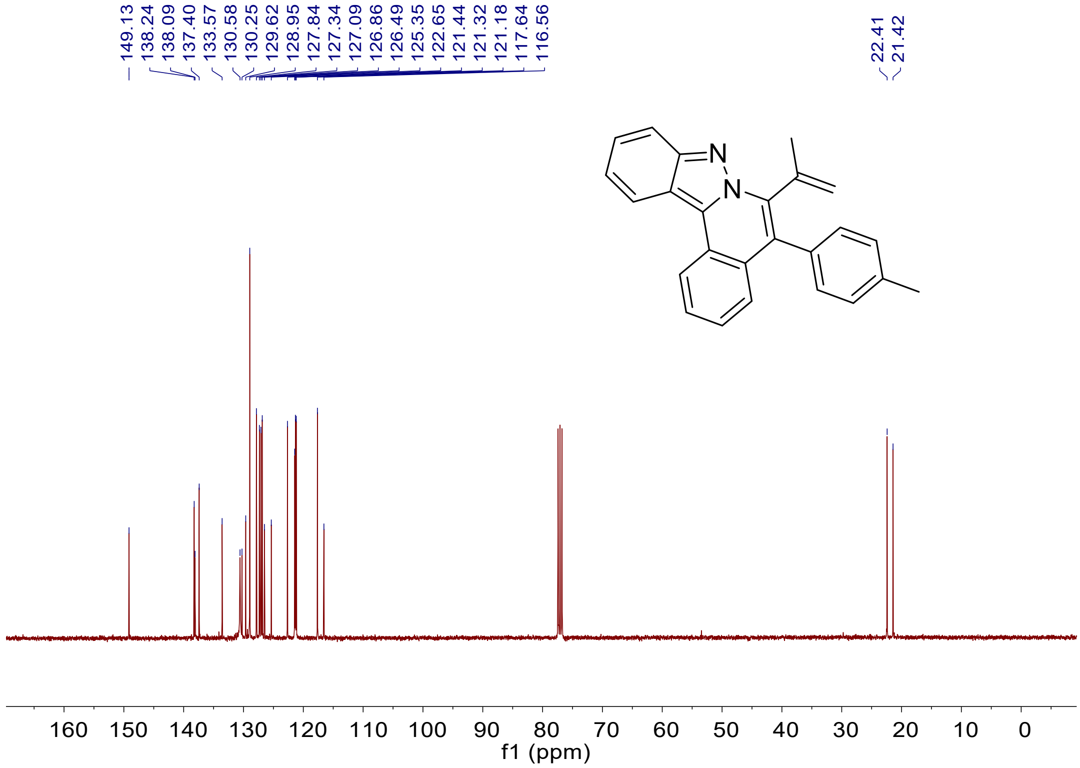
^{19}F NMR ($CDCl_3$) spectrum of **3oa**



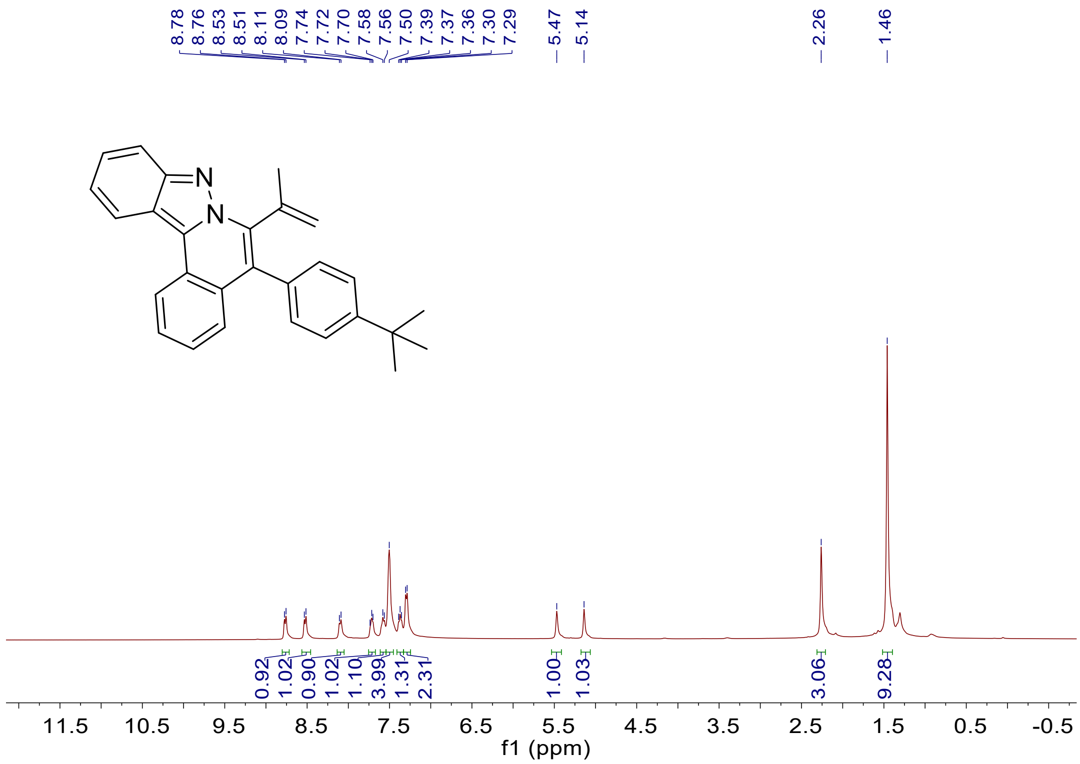
^{1}H NMR ($CDCl_3$) spectrum of **3ab**



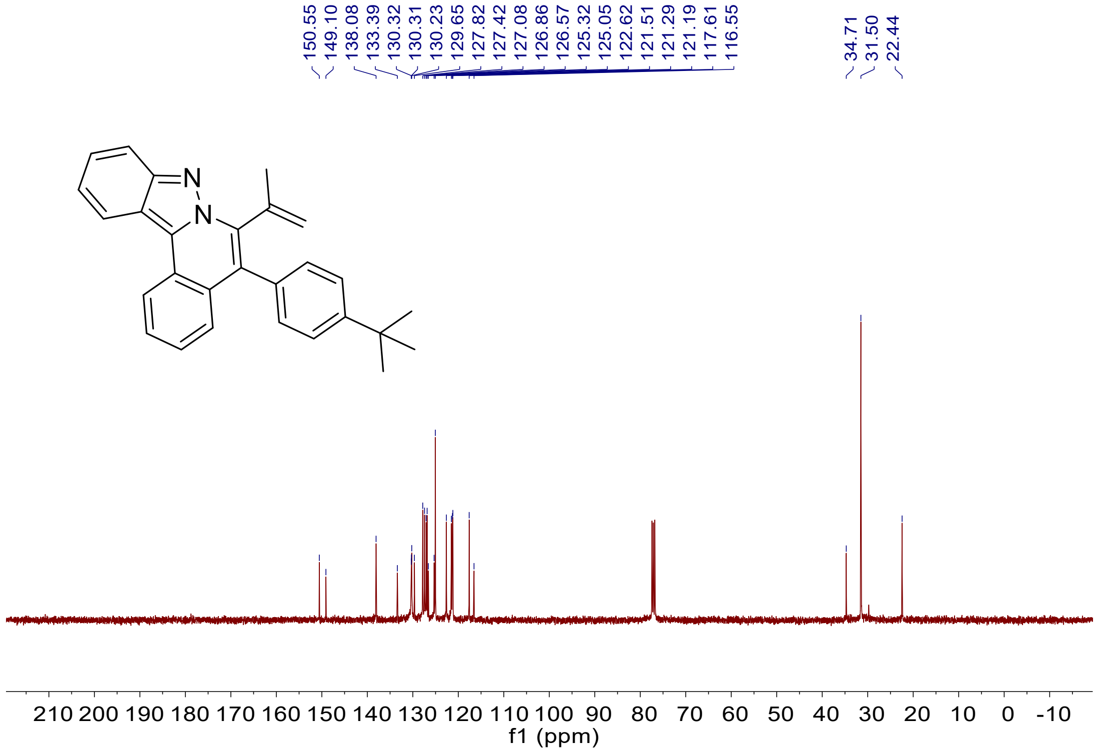
^{13}C NMR ($CDCl_3$) spectrum of **3ab**



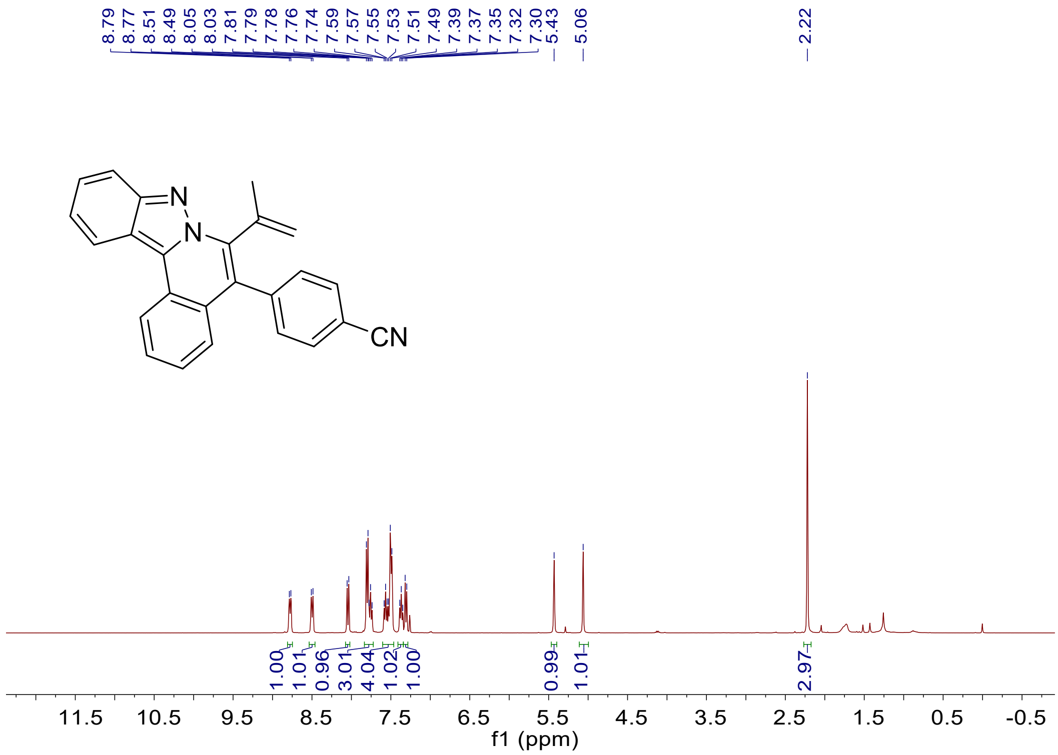
^{1}H NMR ($CDCl_3$) spectrum of **3ac**



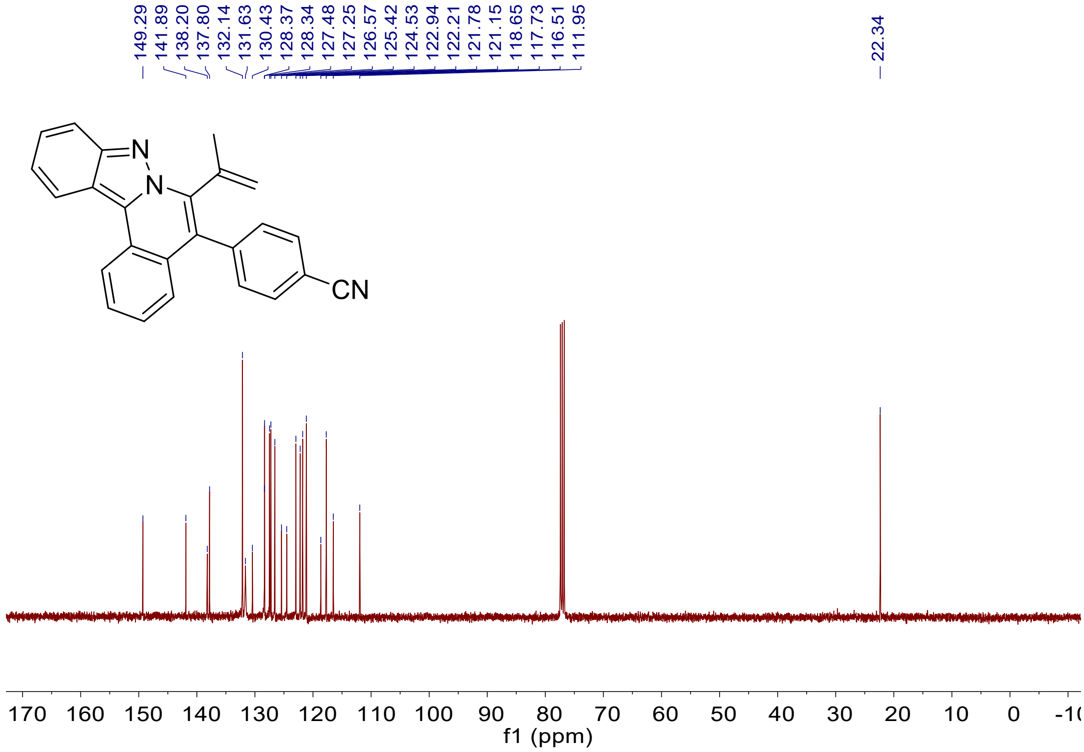
^{13}C NMR ($CDCl_3$) spectrum of **3ac**



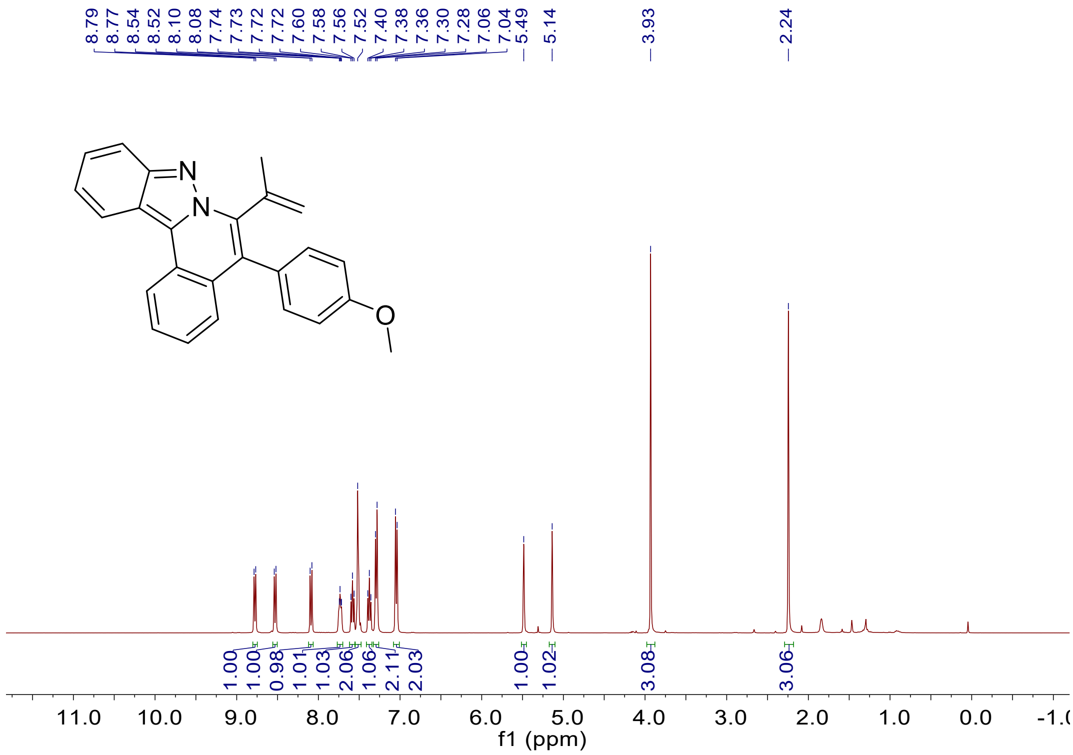
^{1}H NMR ($CDCl_3$) spectrum of **3ad**



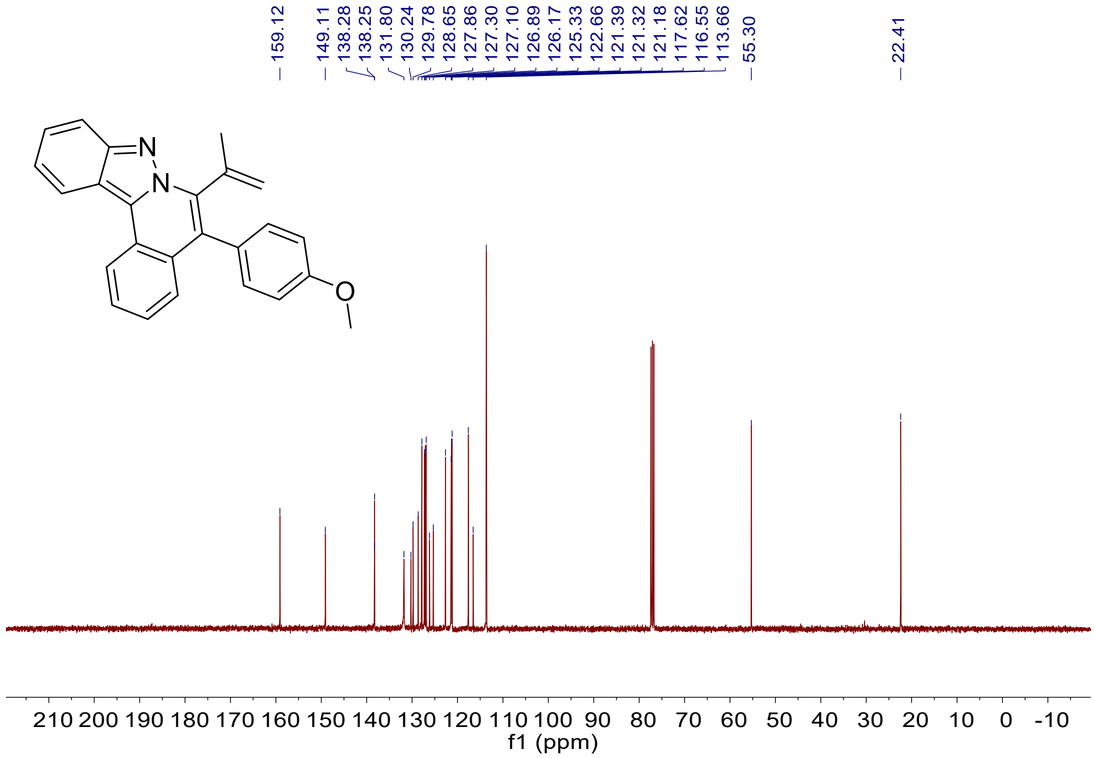
[13]C NMR ($CDCl_3$) spectrum of **3ad**



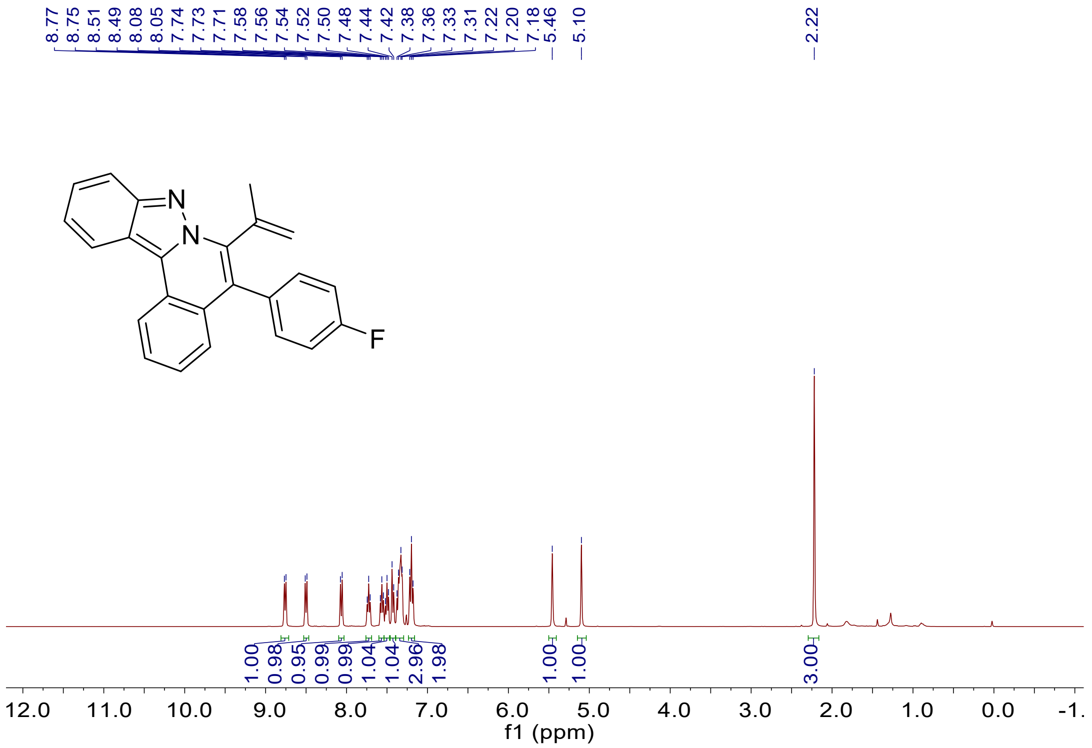
[1]H NMR ($CDCl_3$) spectrum of **3ae**



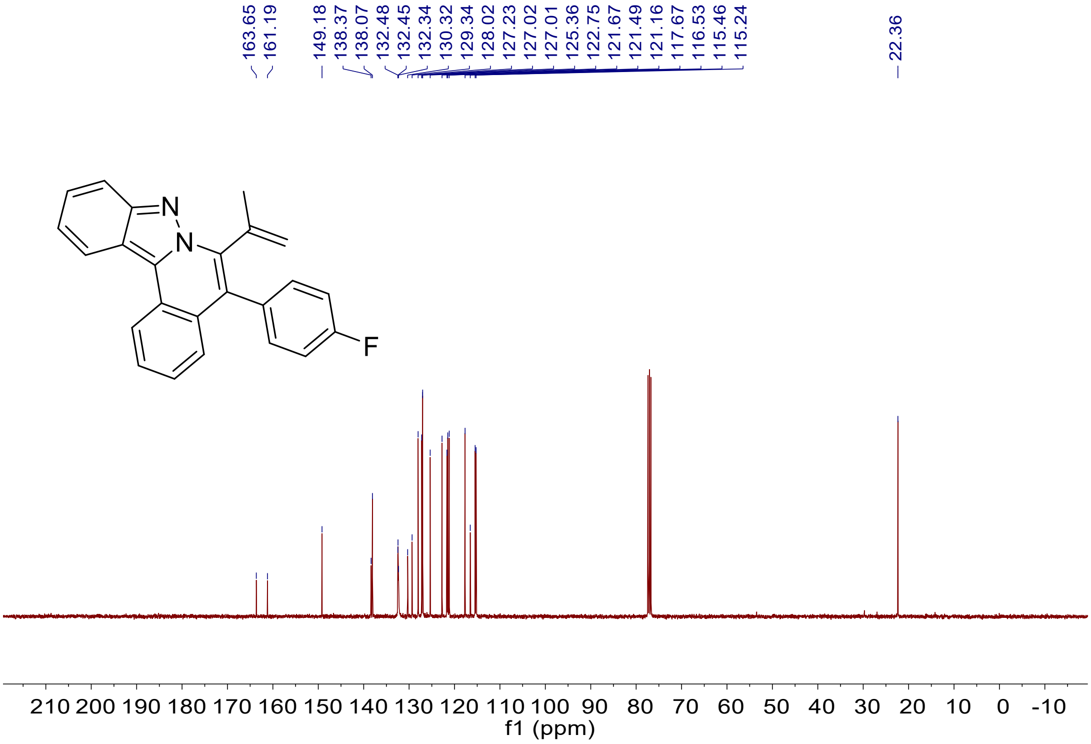
^{13}C NMR ($CDCl_3$) spectrum of **3ae**



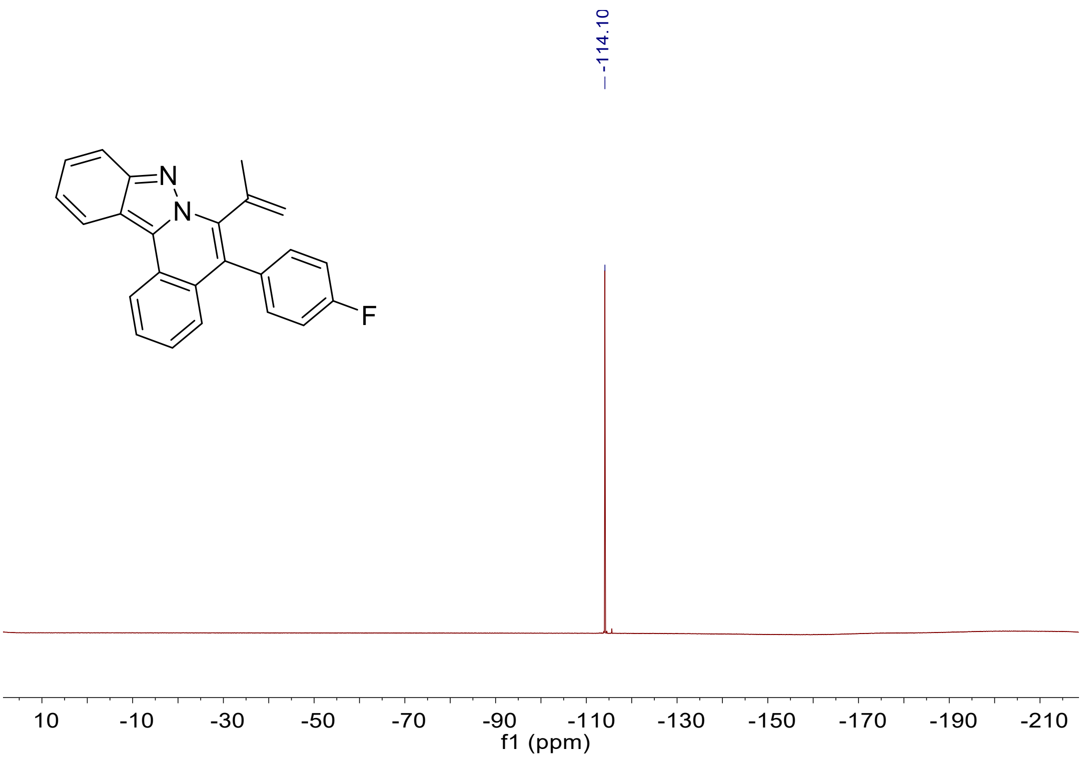
^{1}H NMR ($CDCl_3$) spectrum of **3af**



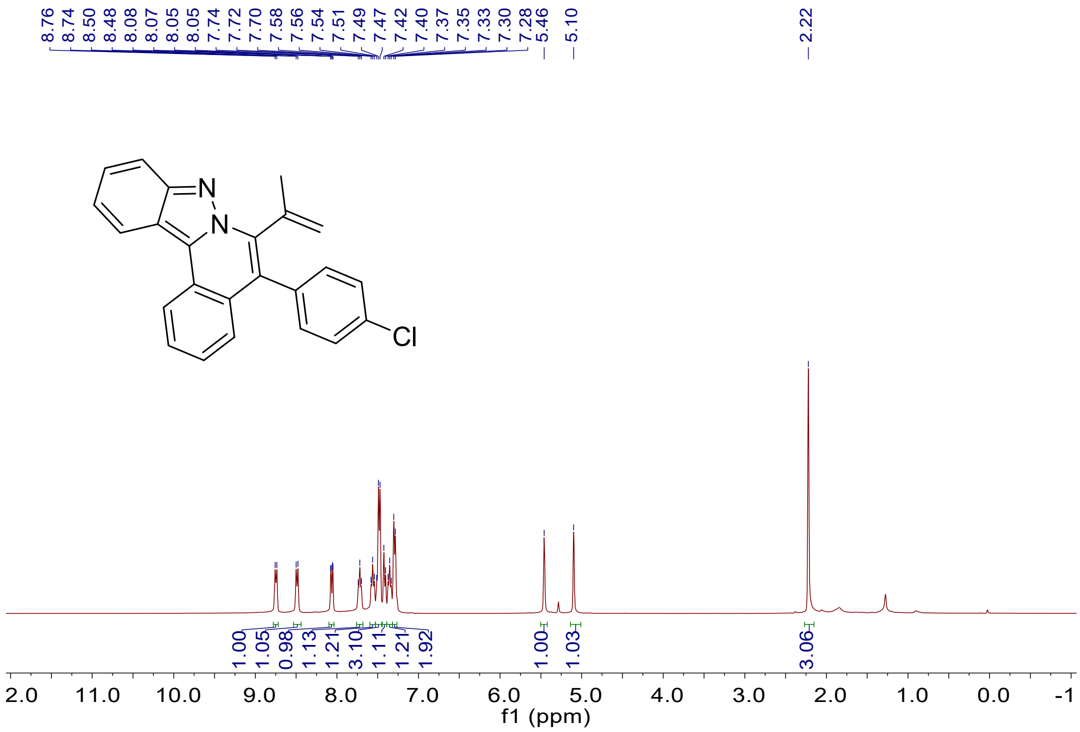
^{13}C NMR ($CDCl_3$) spectrum of **3af**



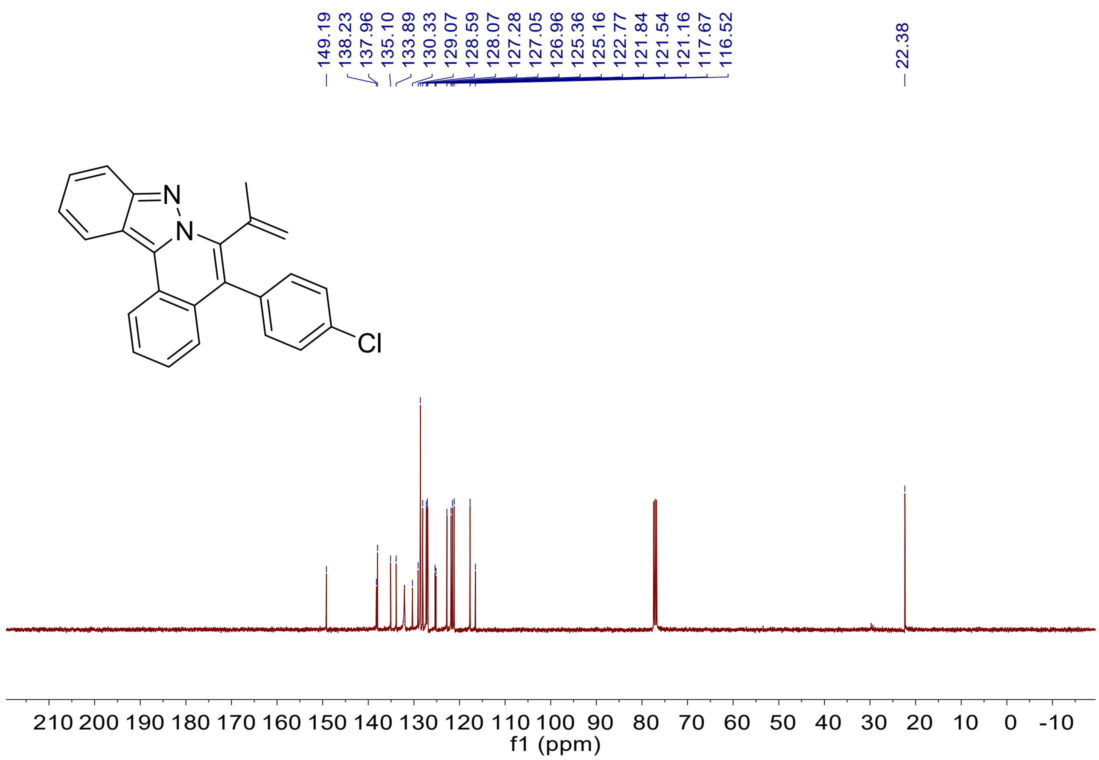
^{19}F NMR ($CDCl_3$) spectrum of **3af**



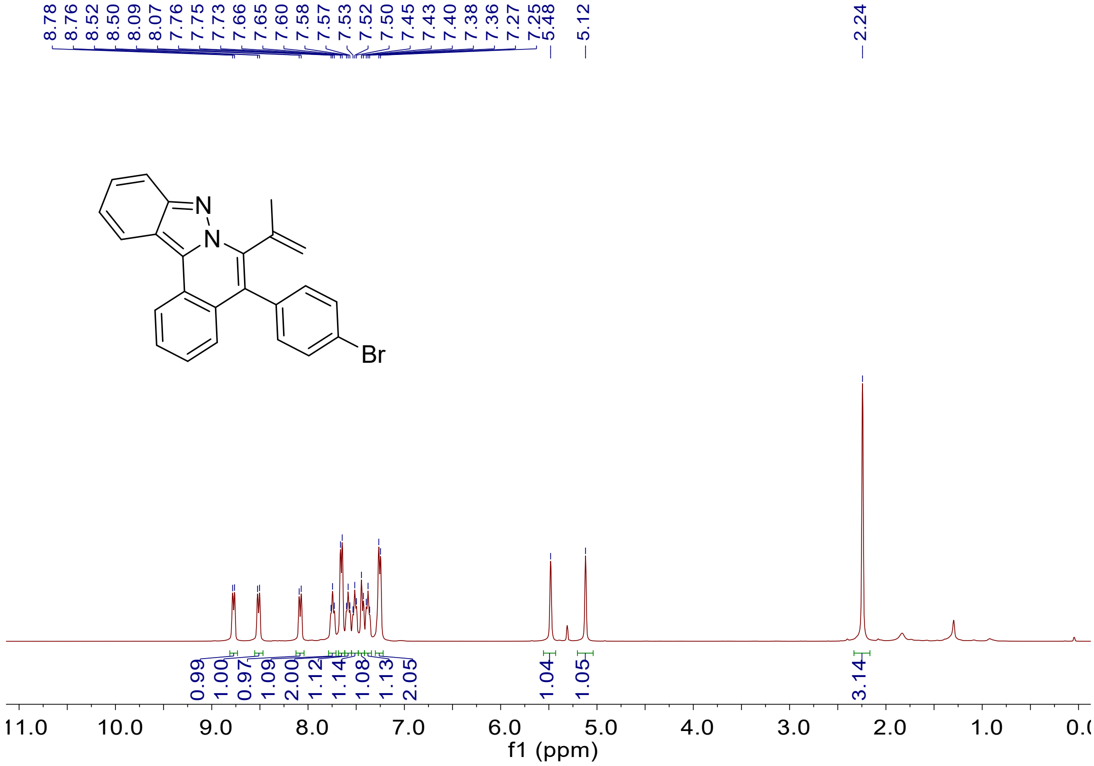
^{1}H NMR ($CDCl_3$) spectrum of **3ag**



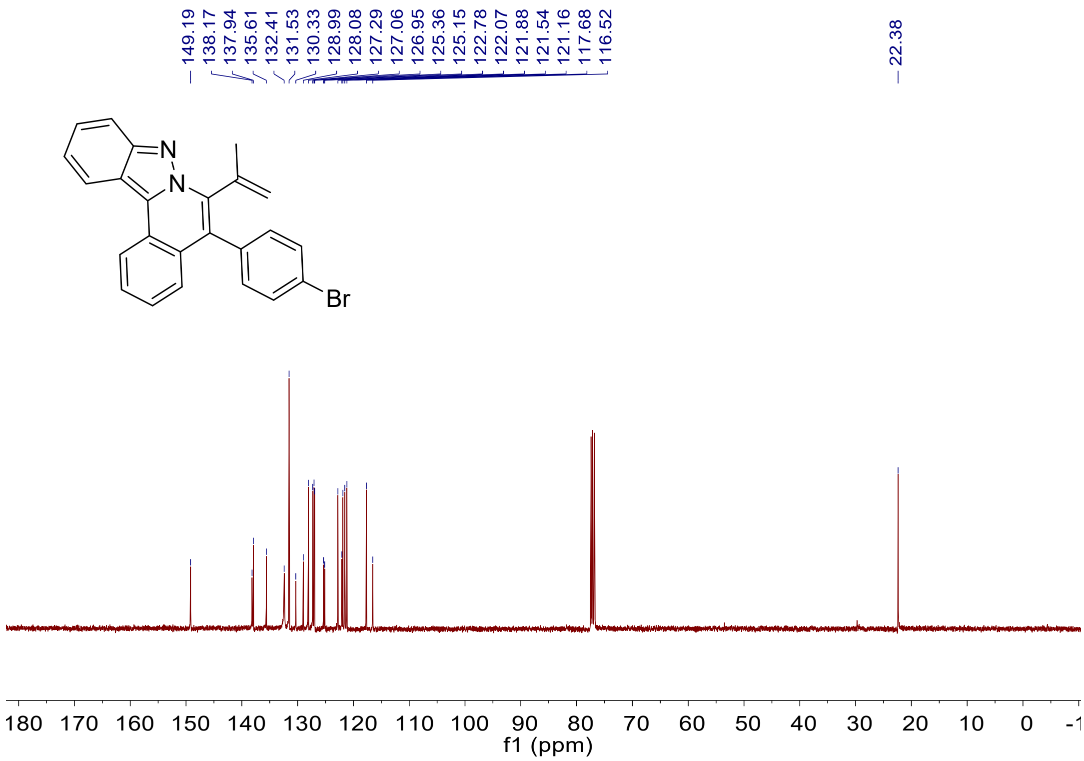
^{13}C NMR ($CDCl_3$) spectrum of **3ag**



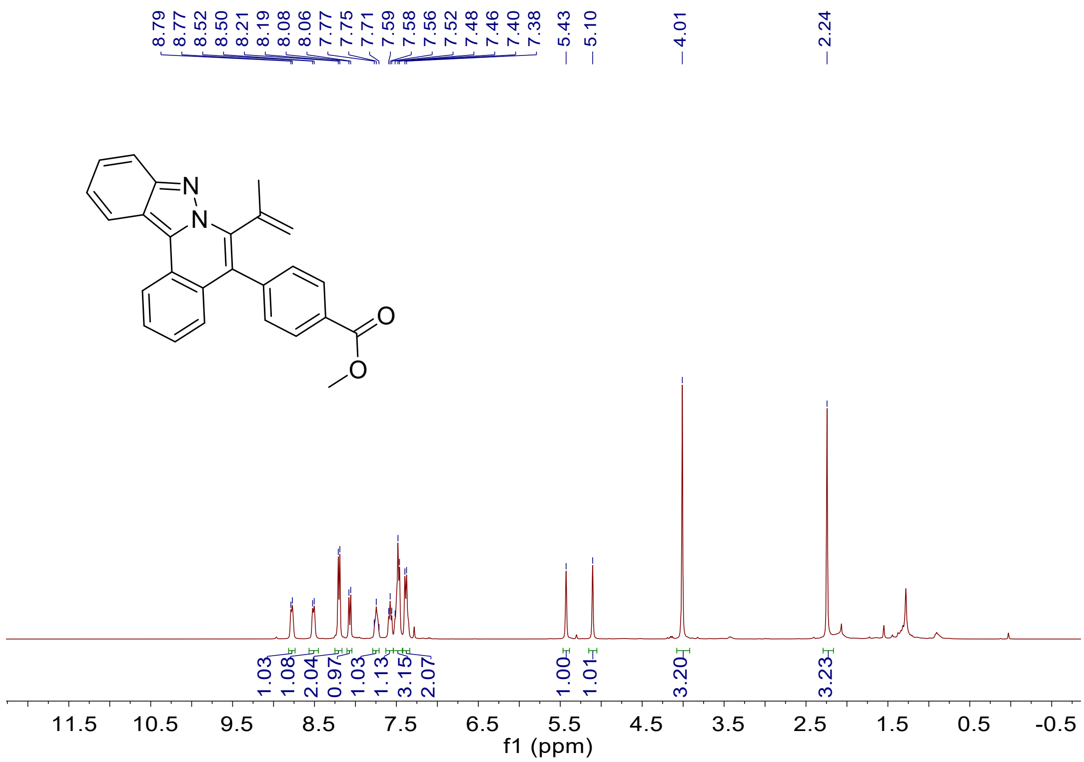
[1]H NMR ($CDCl_3$) spectrum of **3ah**



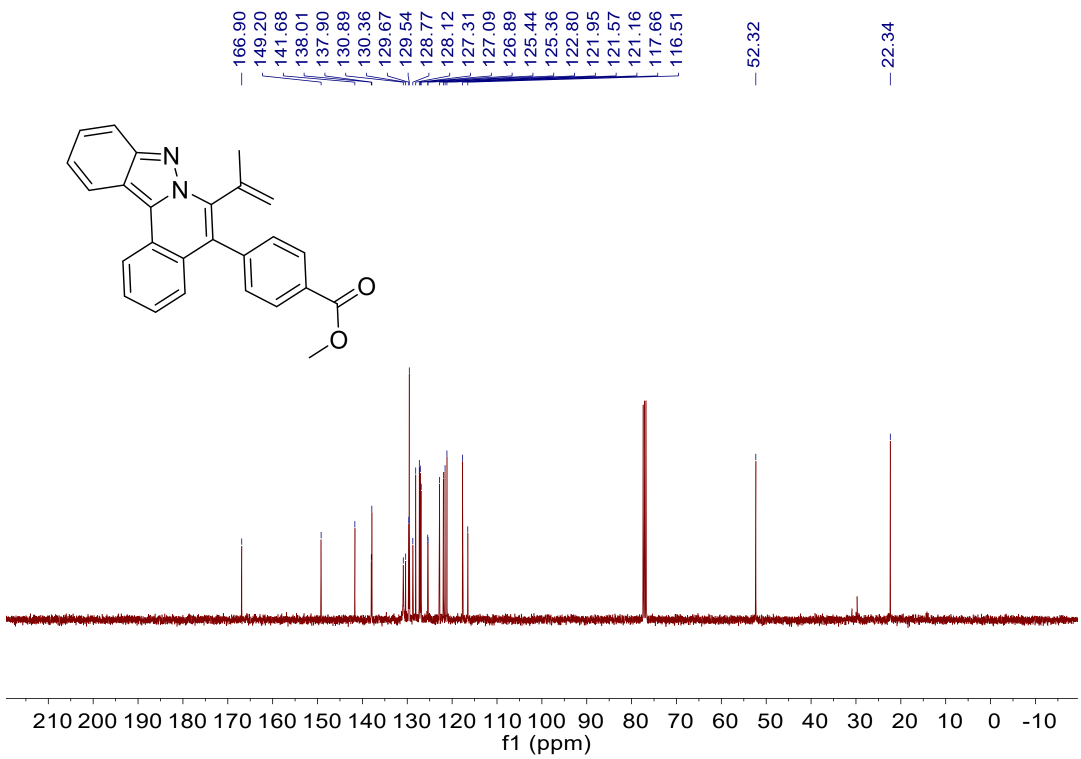
[13]C NMR ($CDCl_3$) spectrum of **3ah**



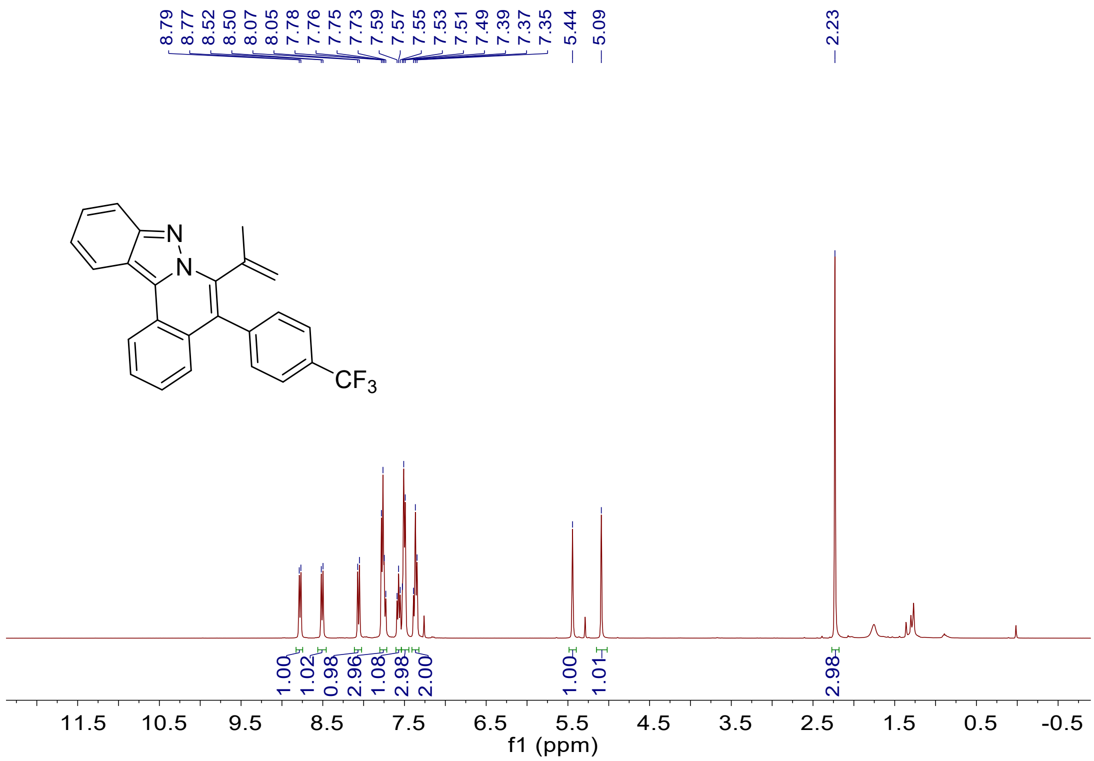
^{1}H NMR ($CDCl_3$) spectrum of **3ai**



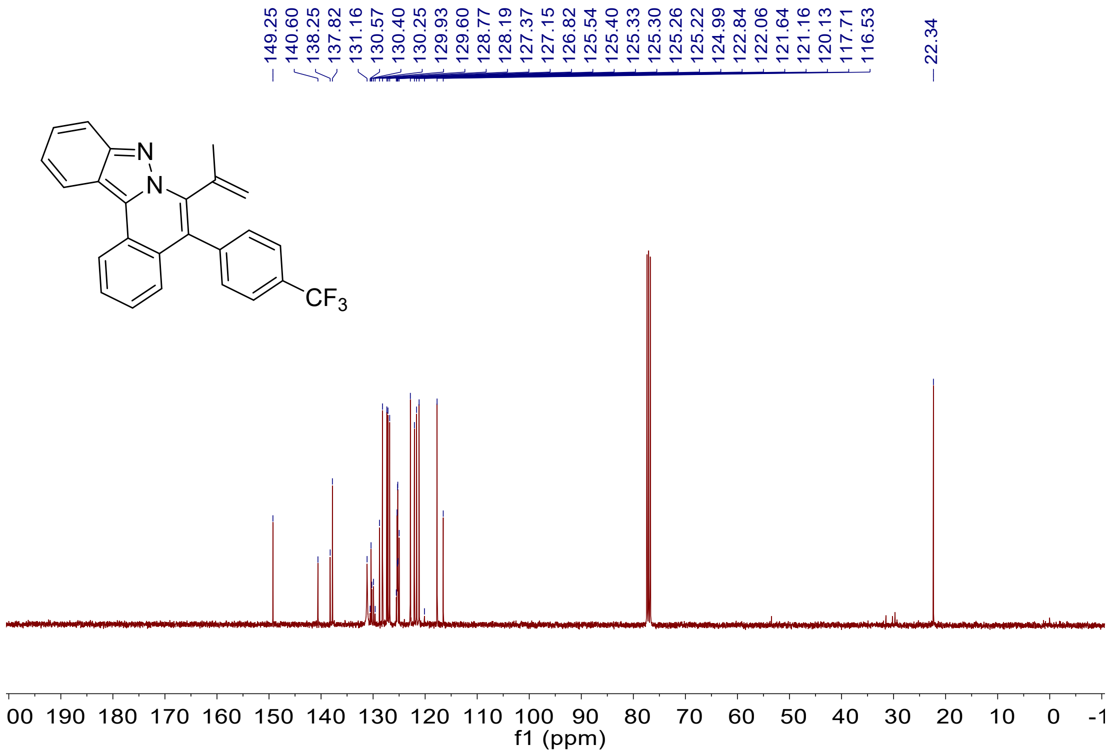
^{13}C NMR ($CDCl_3$) spectrum of **3ai**



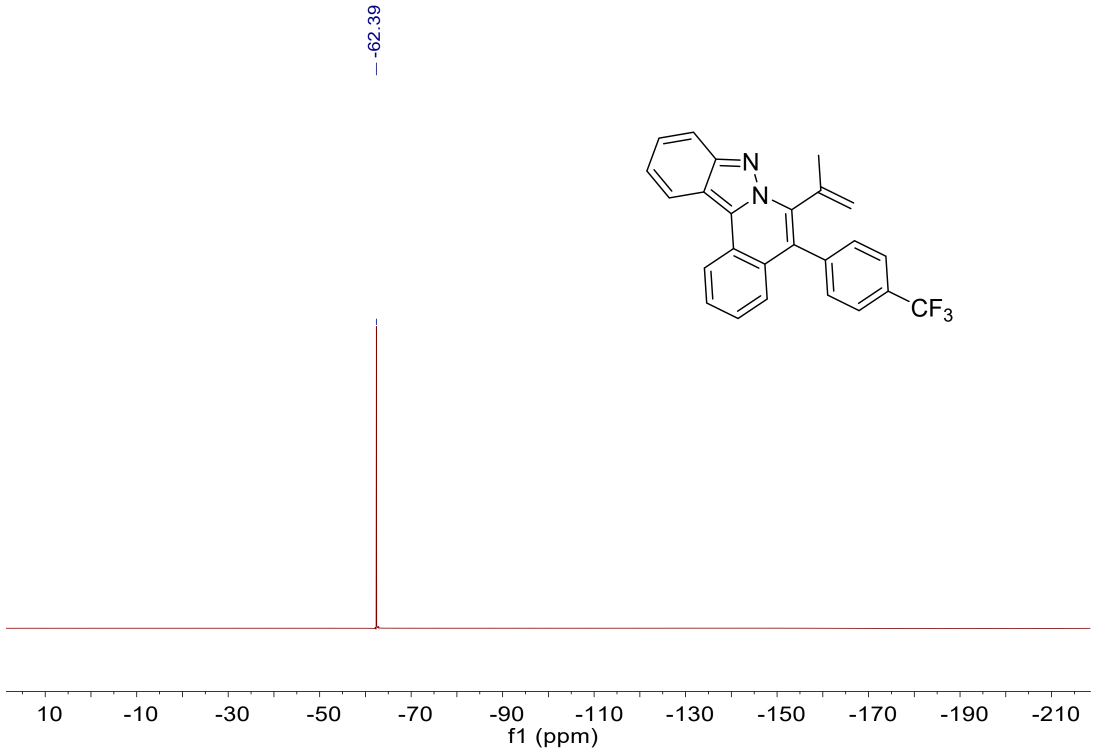
^{1}H NMR ($CDCl_3$) spectrum of **3aj**



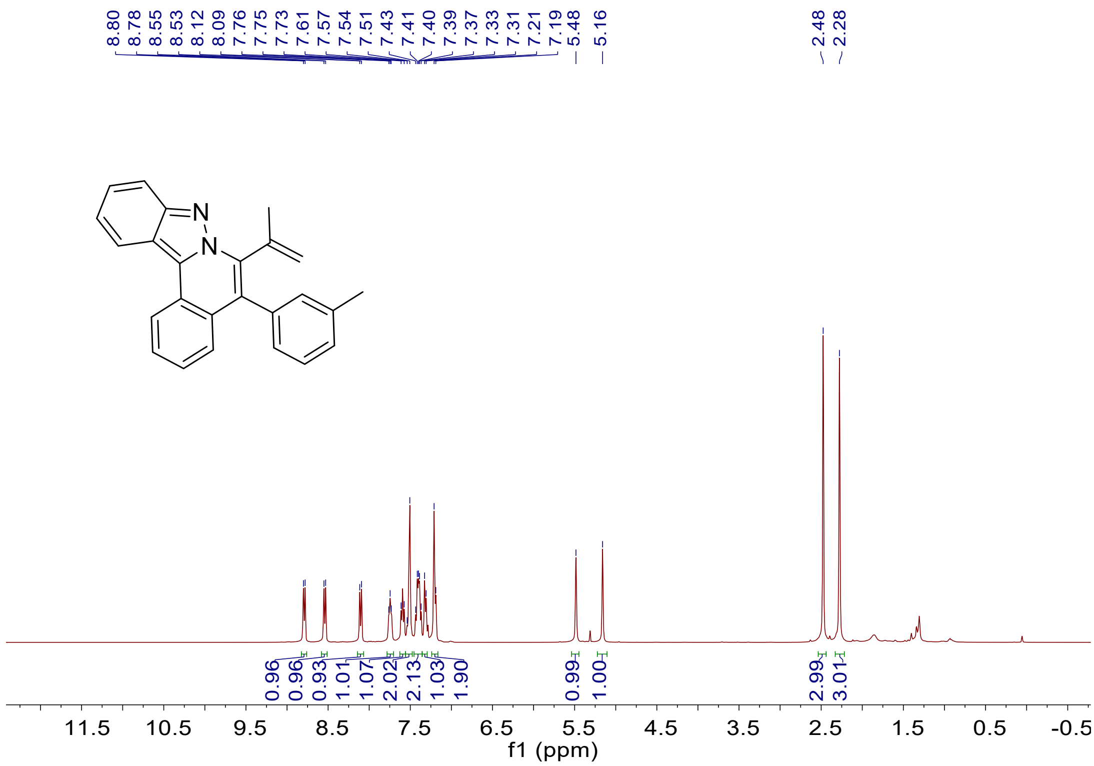
^{13}C NMR ($CDCl_3$) spectrum of **3aj**



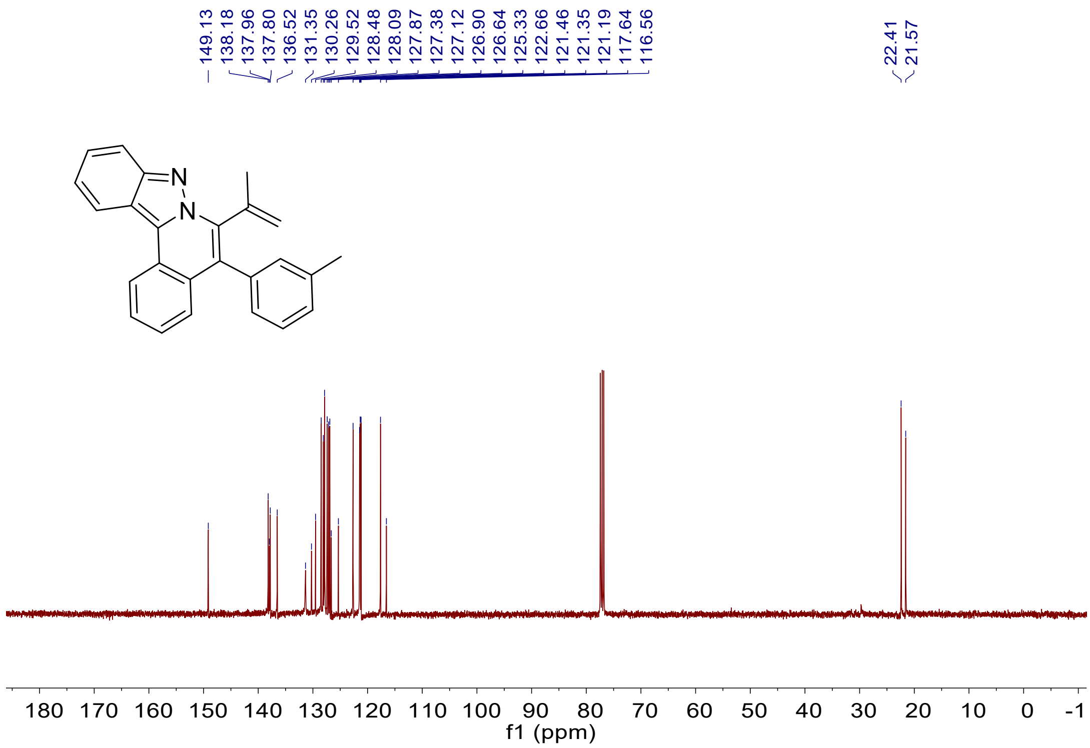
^{19}F NMR ($CDCl_3$) spectrum of **3aj**



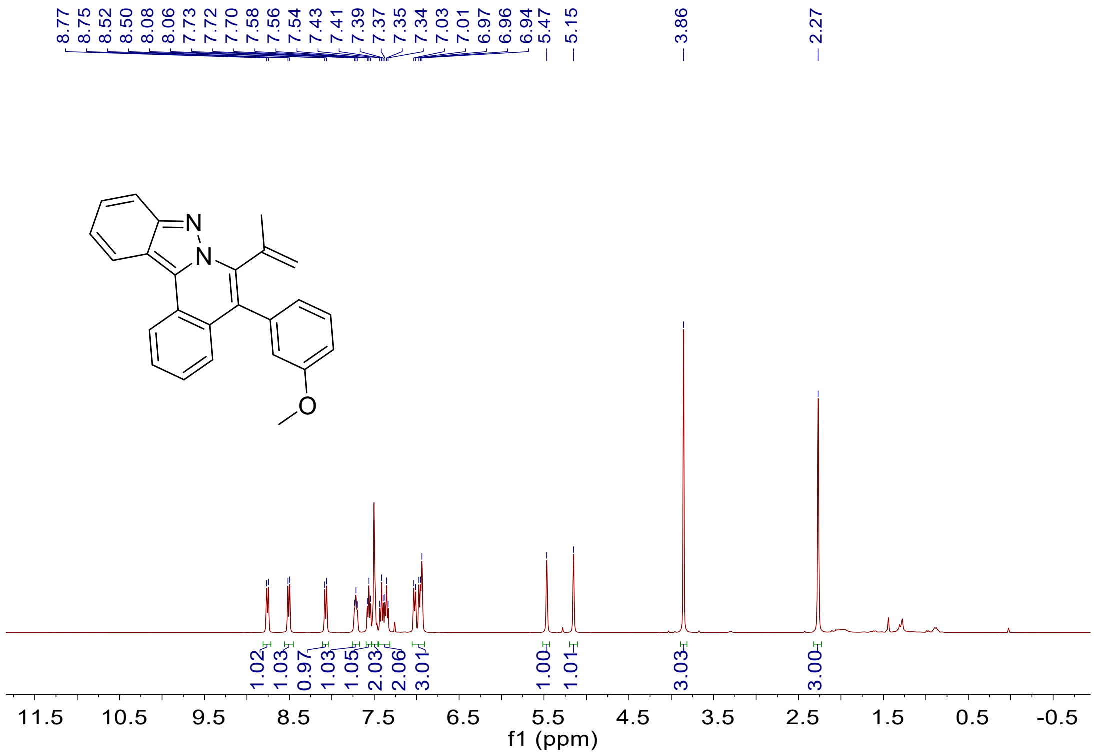
^{1}H NMR ($CDCl_3$) spectrum of **3ak**



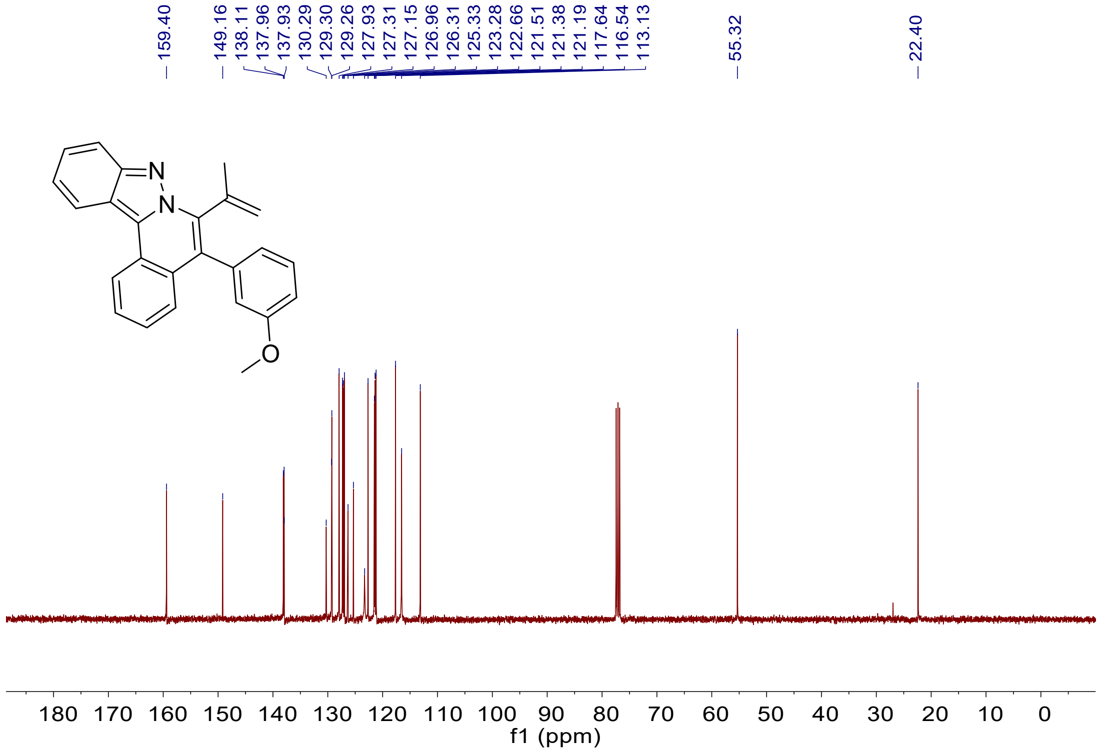
^{13}C NMR ($CDCl_3$) spectrum of **3ak**



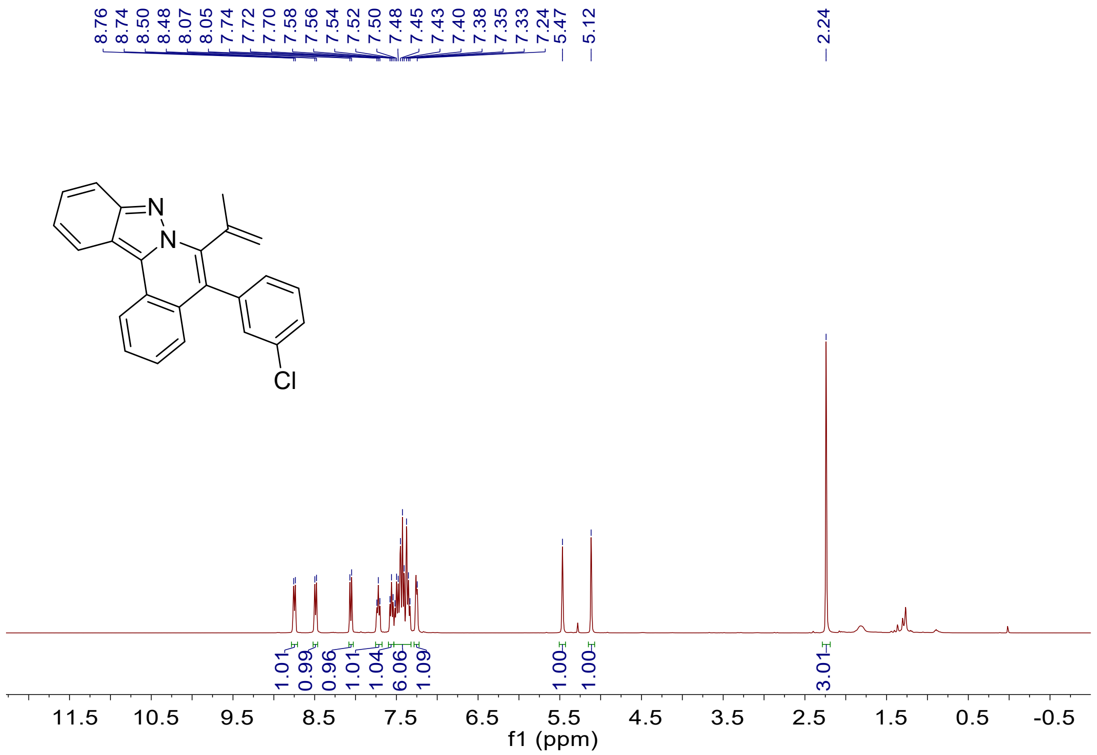
^{1}H NMR ($CDCl_3$) spectrum of **3al**



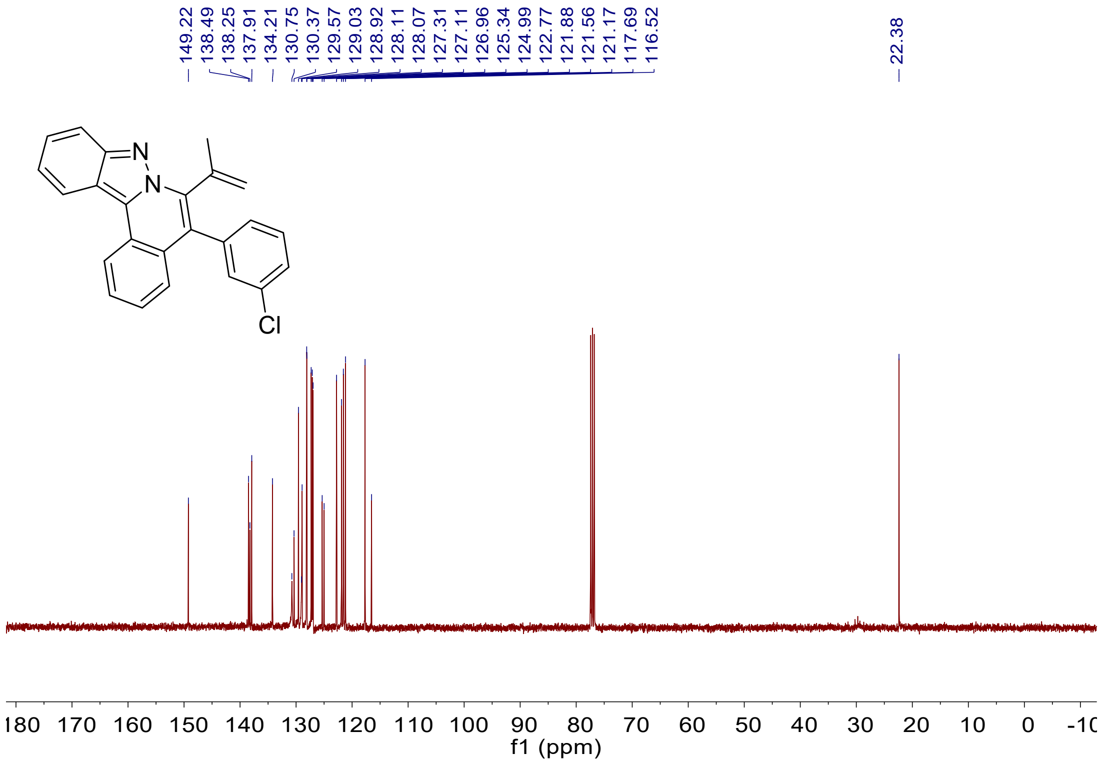
^{13}C NMR ($CDCl_3$) spectrum of **3al**



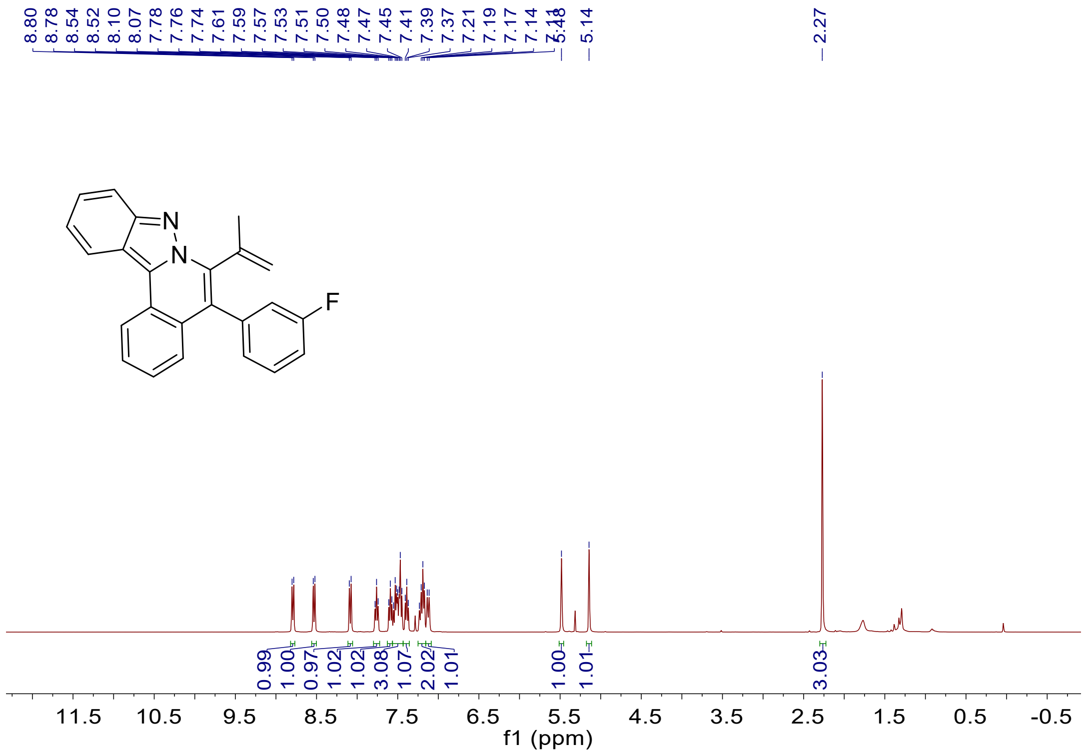
^{1}H NMR ($CDCl_3$) spectrum of **3am**



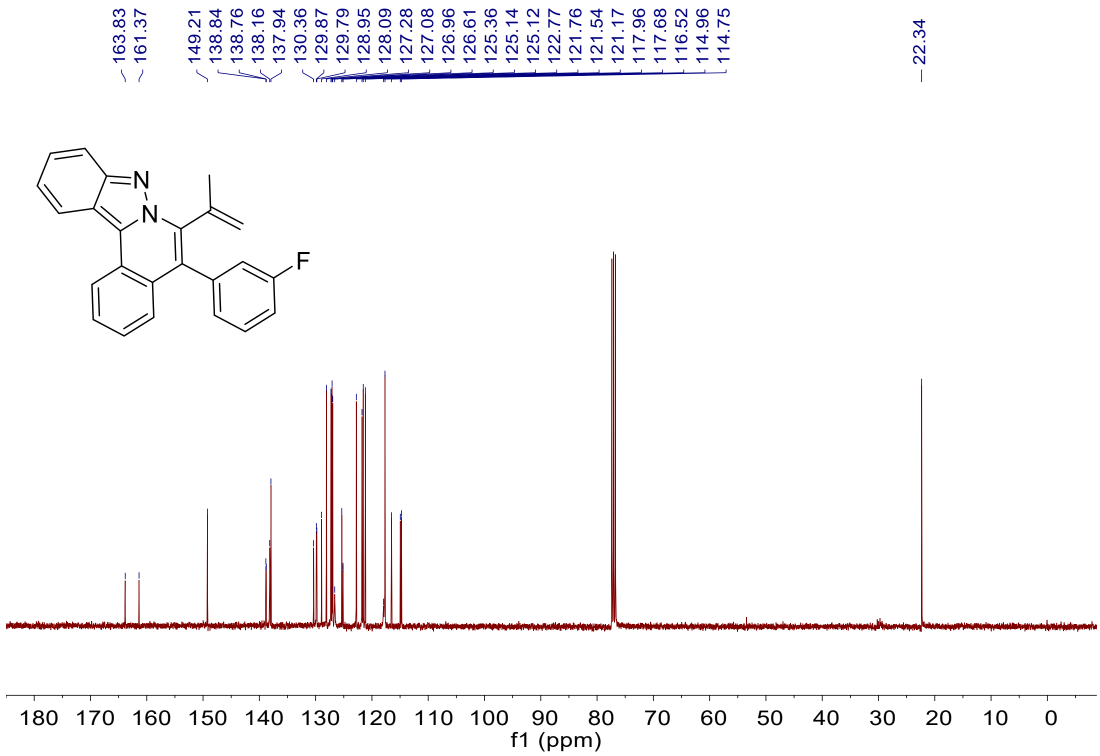
^{13}C NMR ($CDCl_3$) spectrum of **3am**



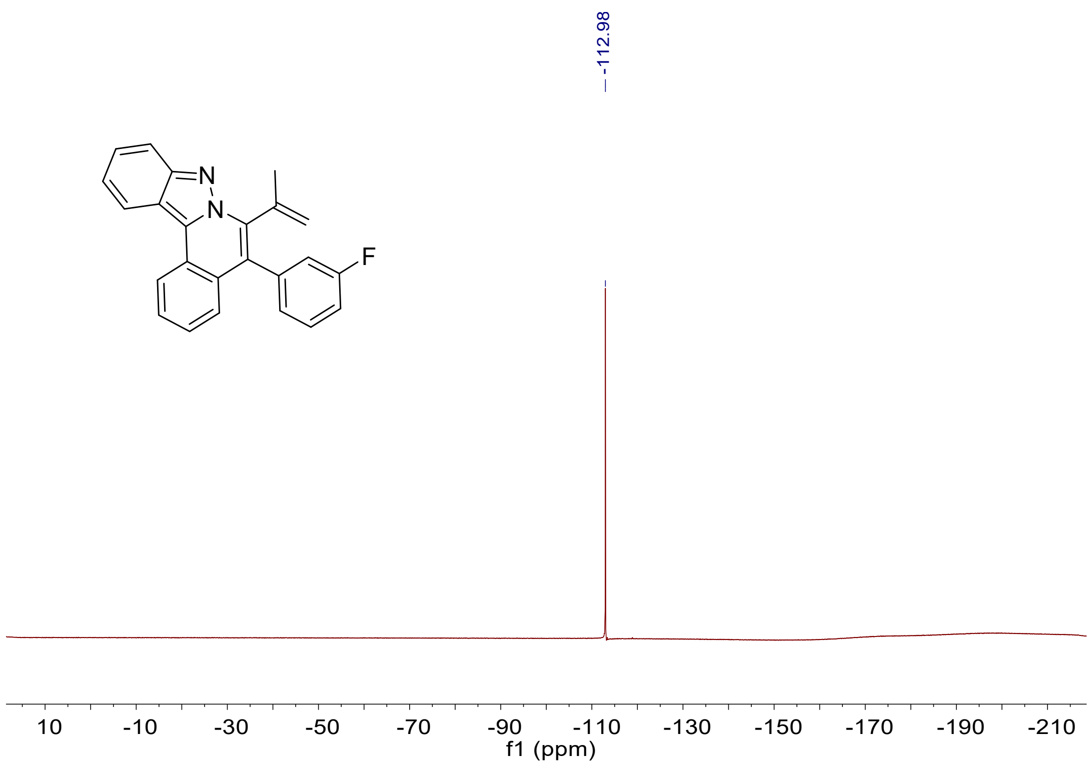
^{1}H NMR ($CDCl_3$) spectrum of **3an**



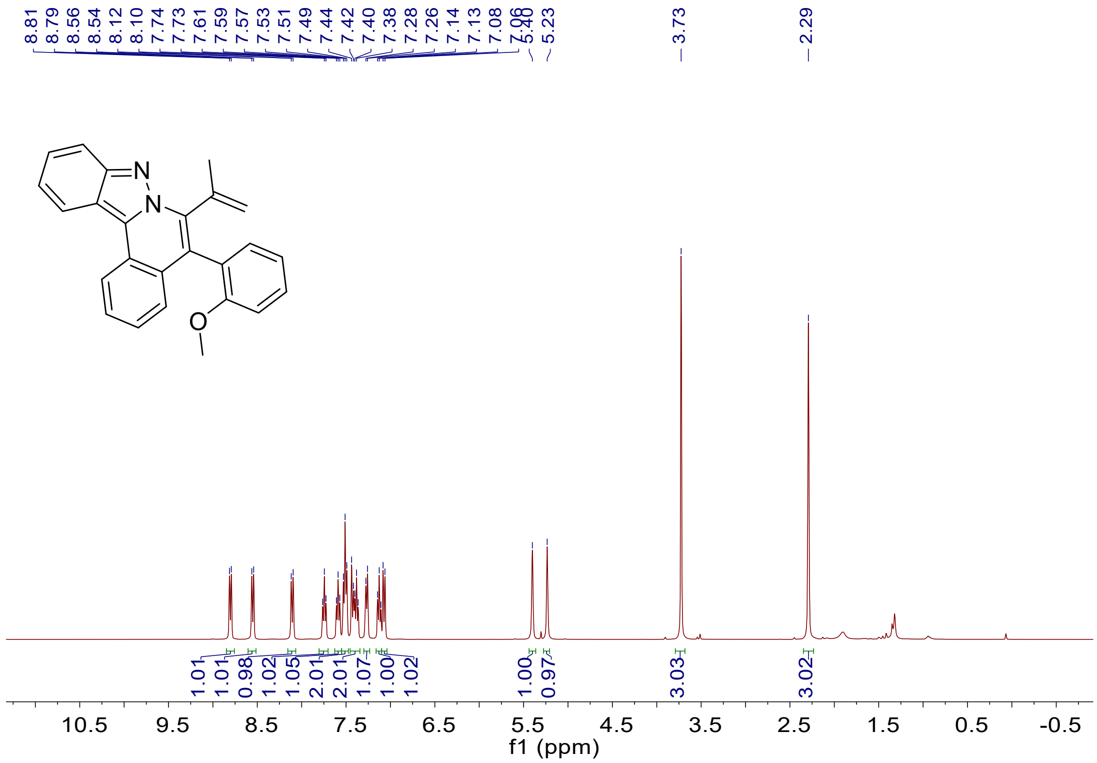
^{13}C NMR ($CDCl_3$) spectrum of **3an**



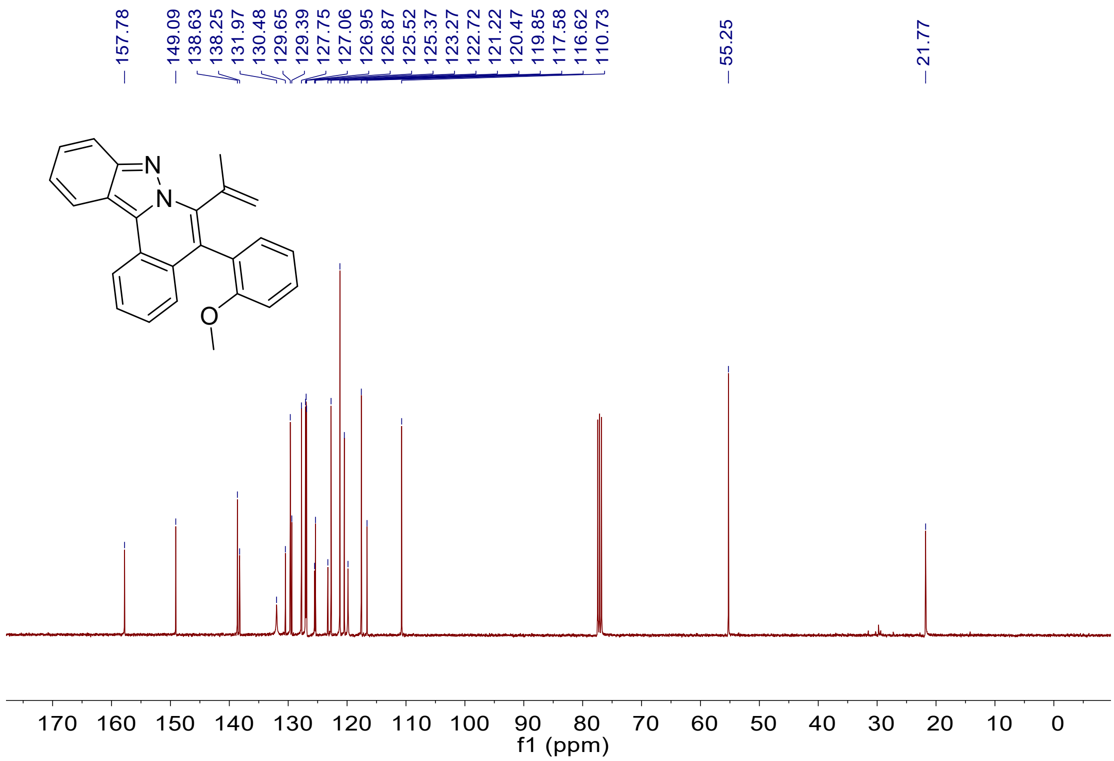
^{19}F NMR ($CDCl_3$) spectrum of **3an**



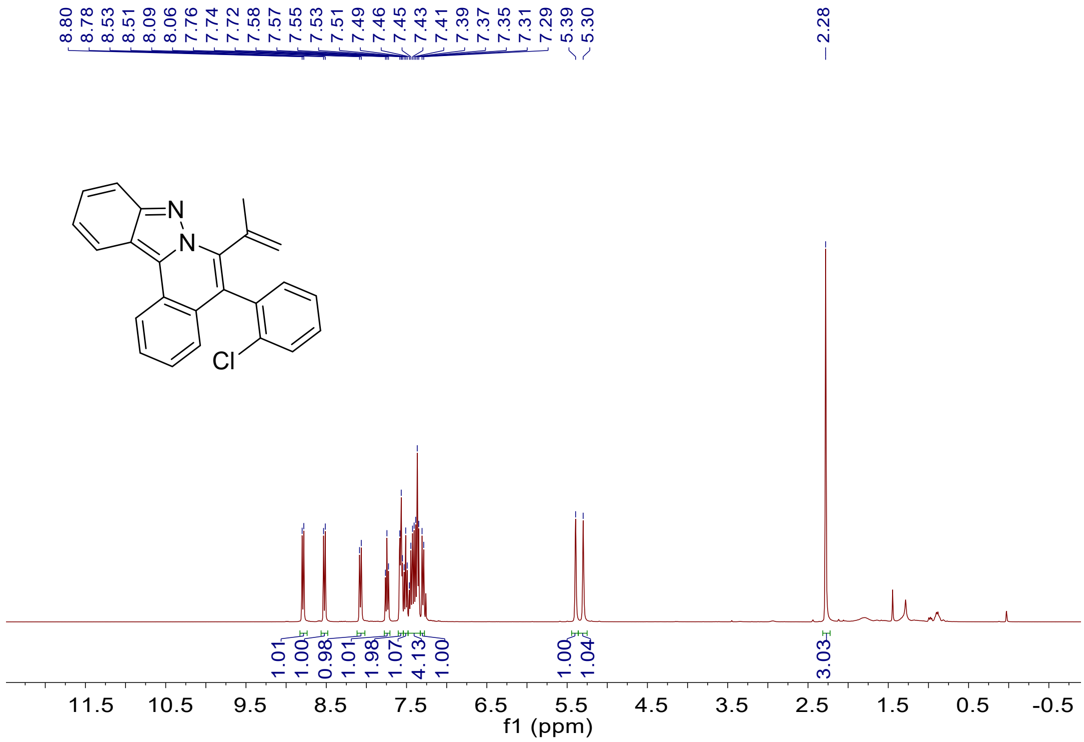
^{1}H NMR ($CDCl_3$) spectrum of **3ao**



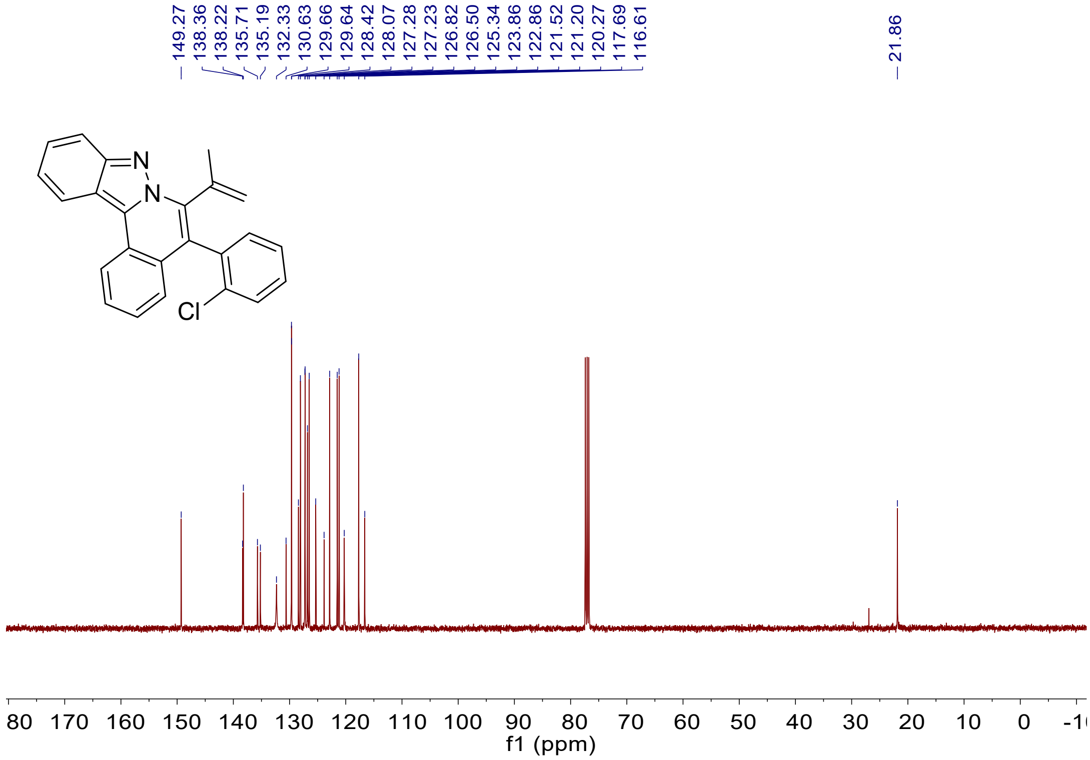
^{13}C NMR ($CDCl_3$) spectrum of **3ao**



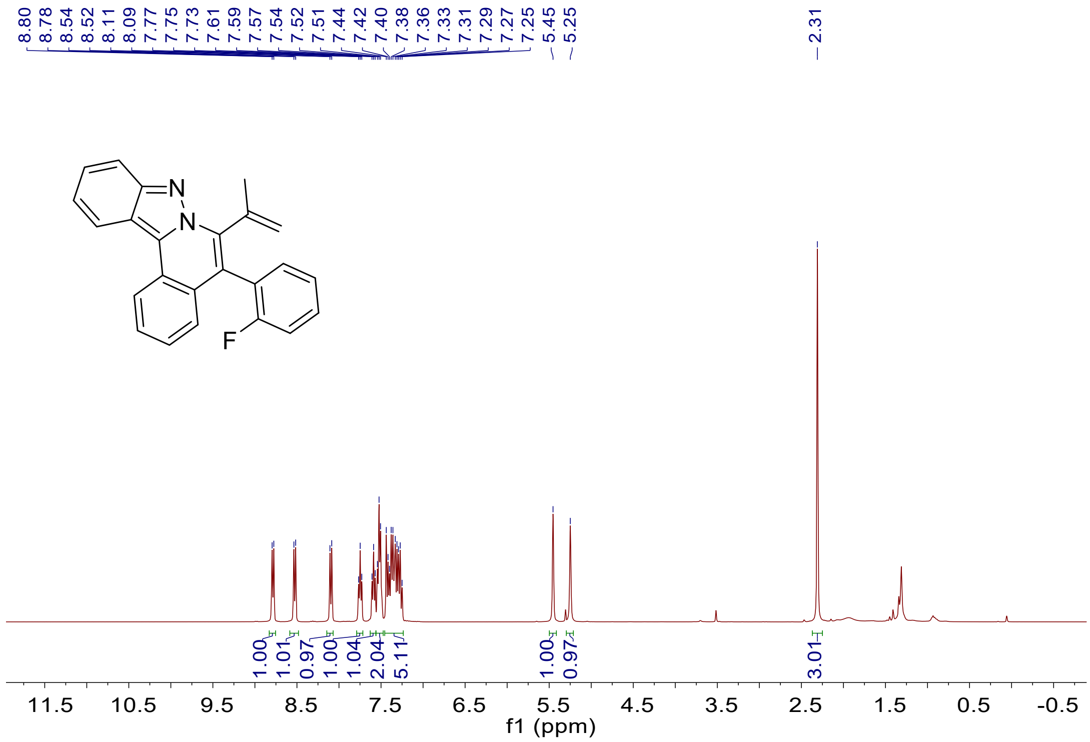
[1]H NMR ($CDCl_3$) spectrum of **3ap**



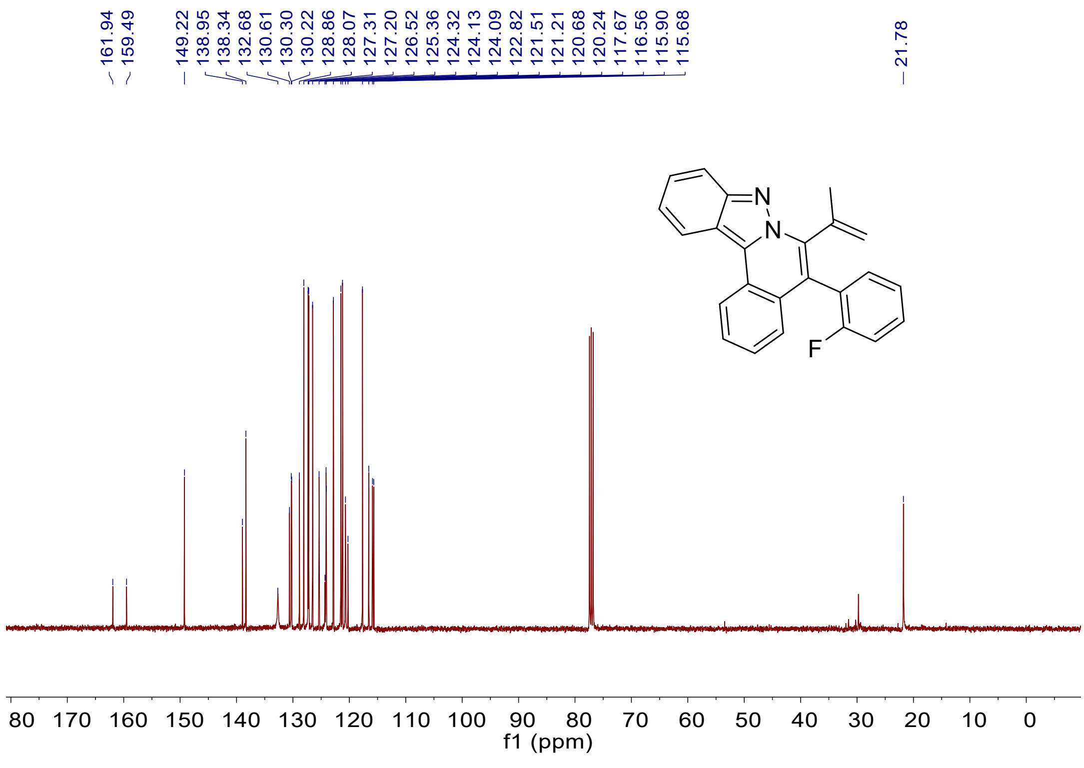
[13]C NMR ($CDCl_3$) spectrum of **3ap**



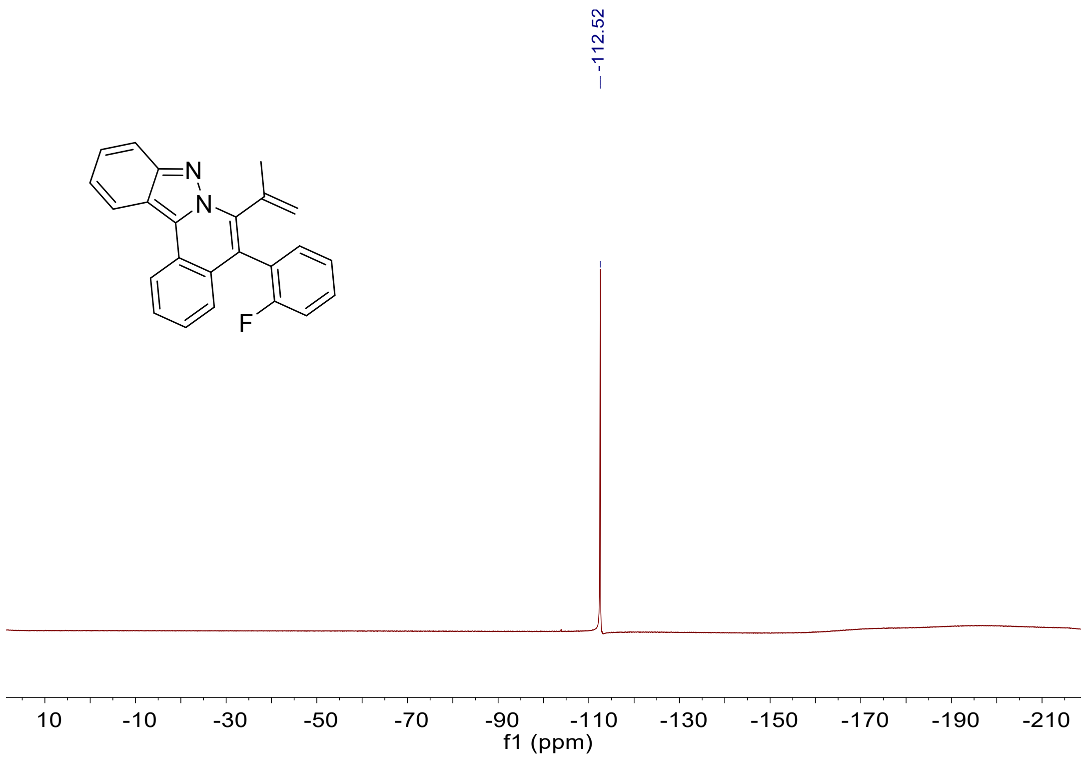
^{1}H NMR ($CDCl_3$) spectrum of **3aq**



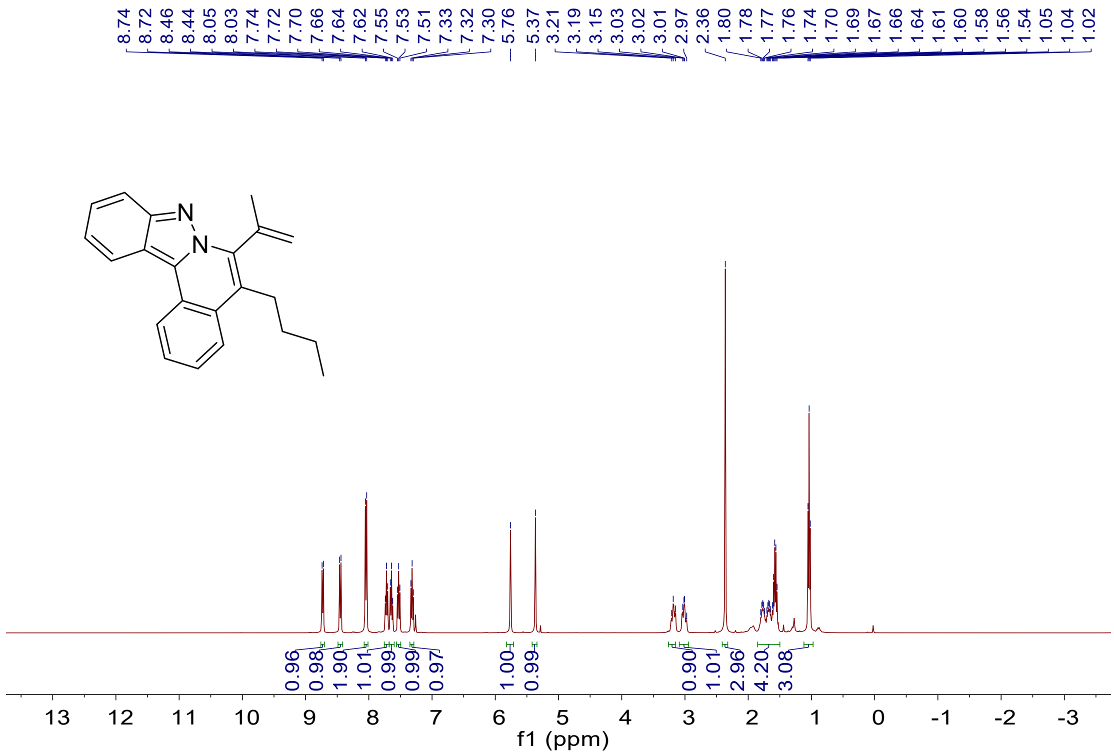
^{13}C NMR ($CDCl_3$) spectrum of **3aq**



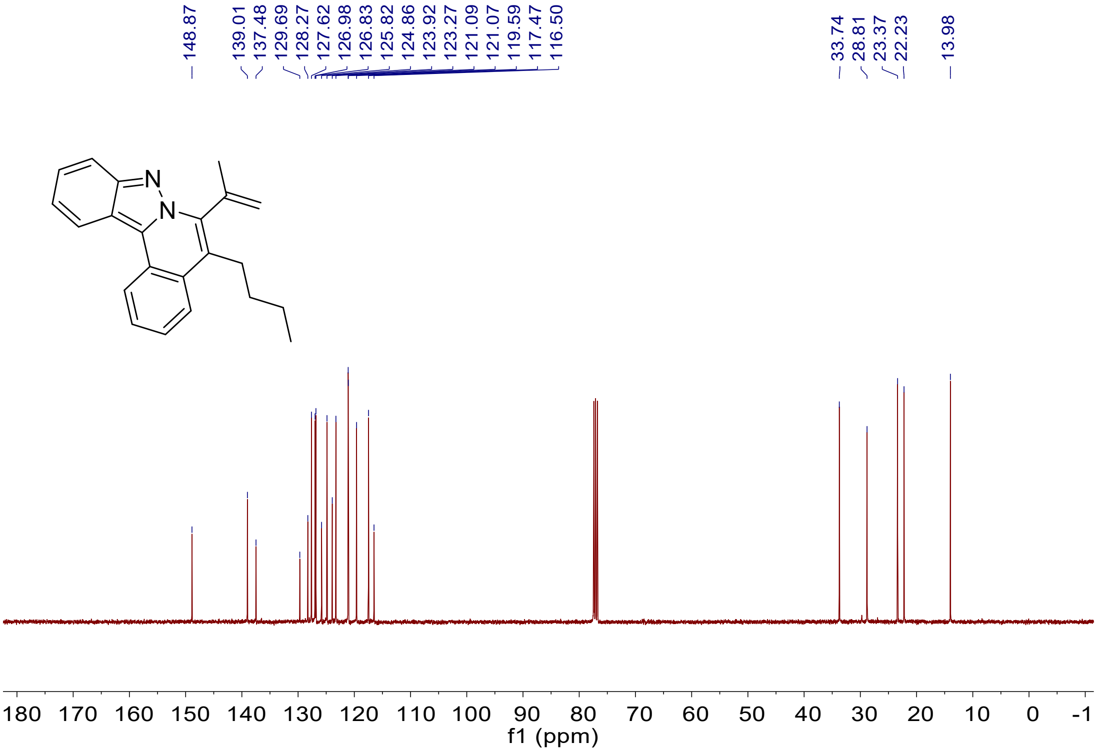
^{19}F NMR ($CDCl_3$) spectrum of **3aq**



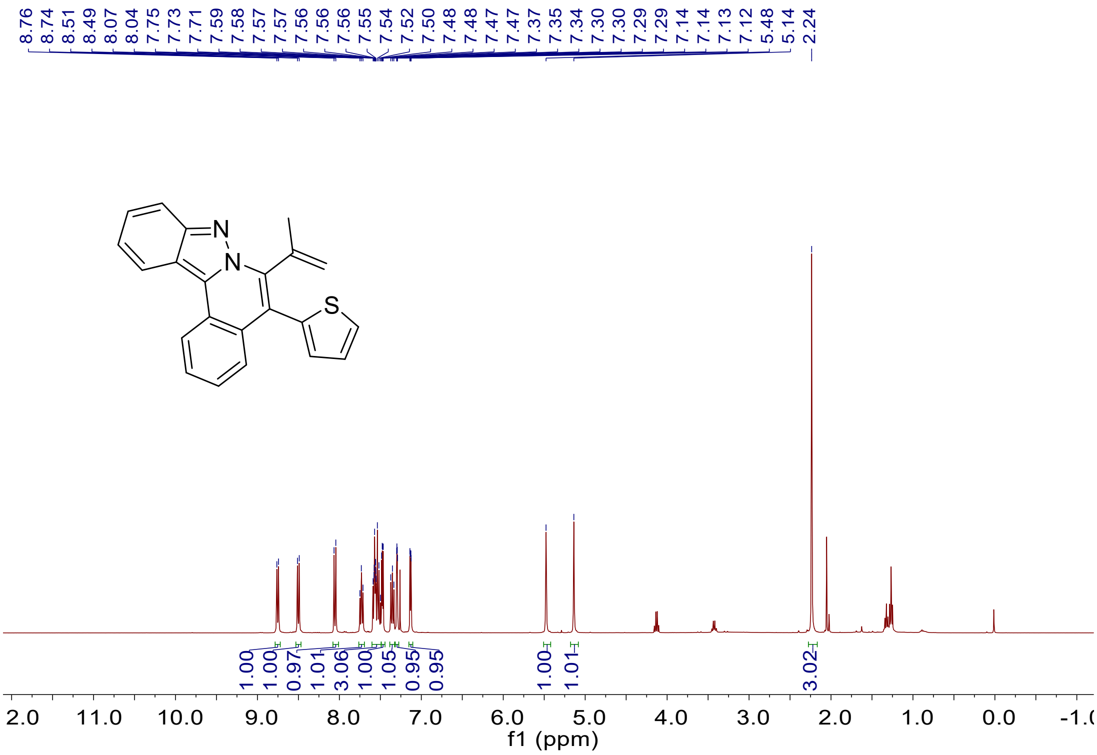
^{1}H NMR ($CDCl_3$) spectrum of **3ar**



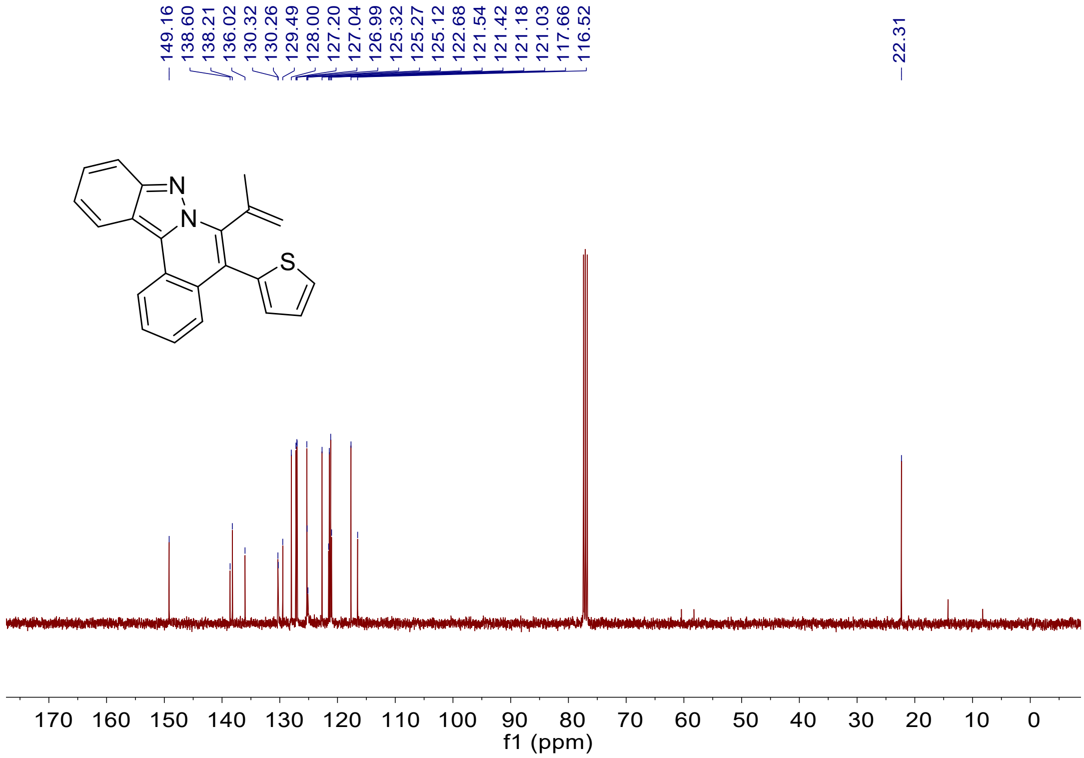
^{13}C NMR ($CDCl_3$) spectrum of **3ar**



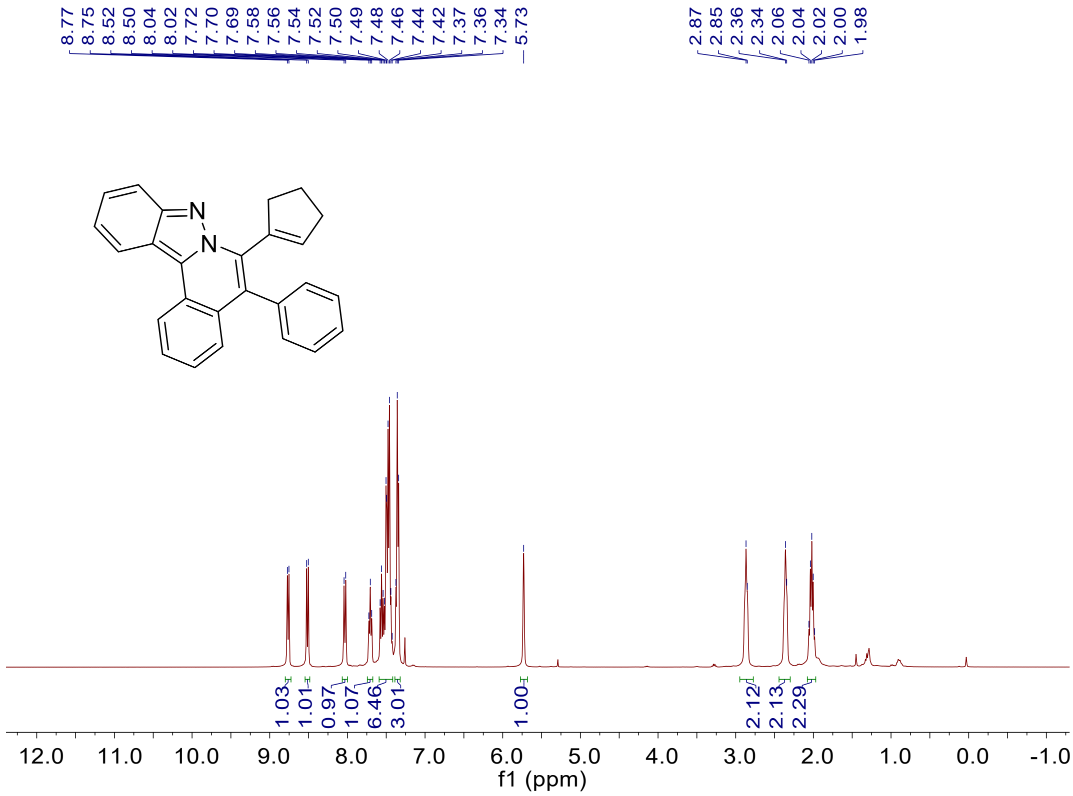
^{1}H NMR ($CDCl_3$) spectrum of **3as**



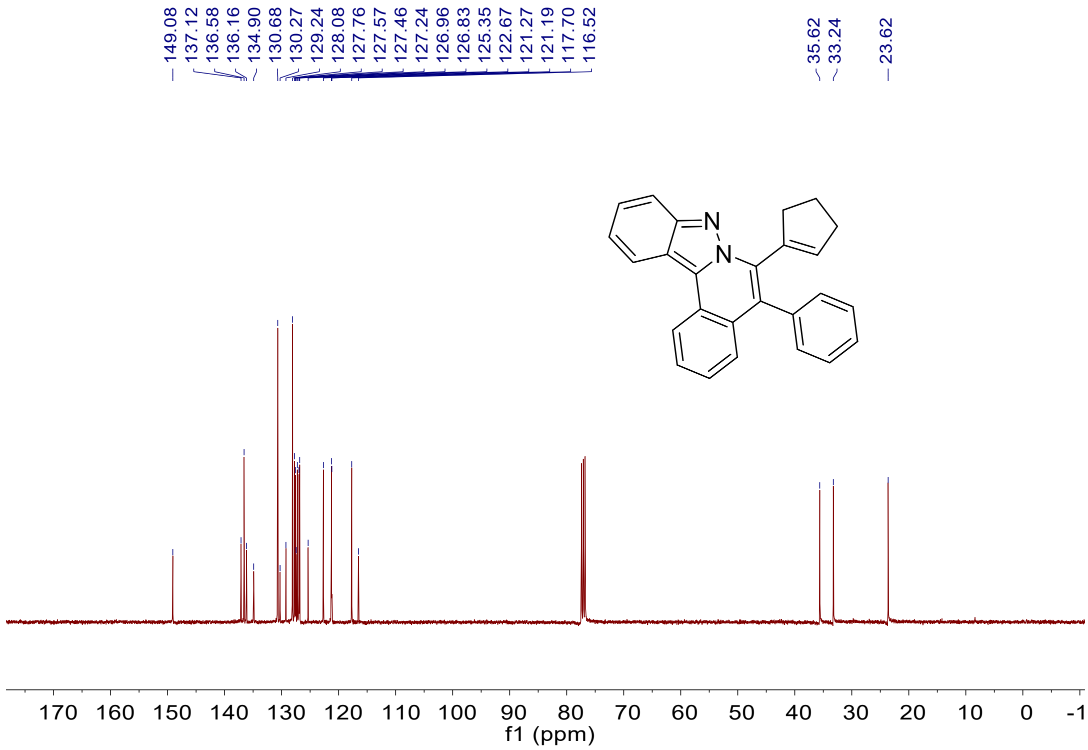
^{13}C NMR ($CDCl_3$) spectrum of **3as**



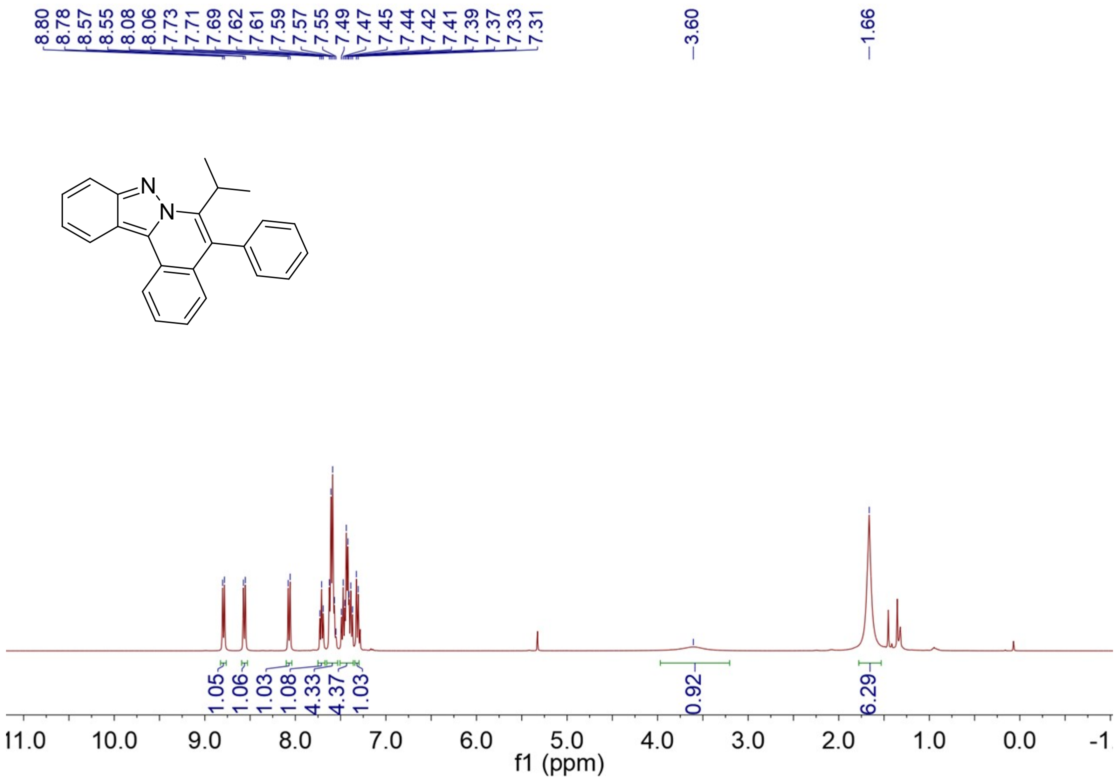
^{1}H NMR ($CDCl_3$) spectrum of **3at**



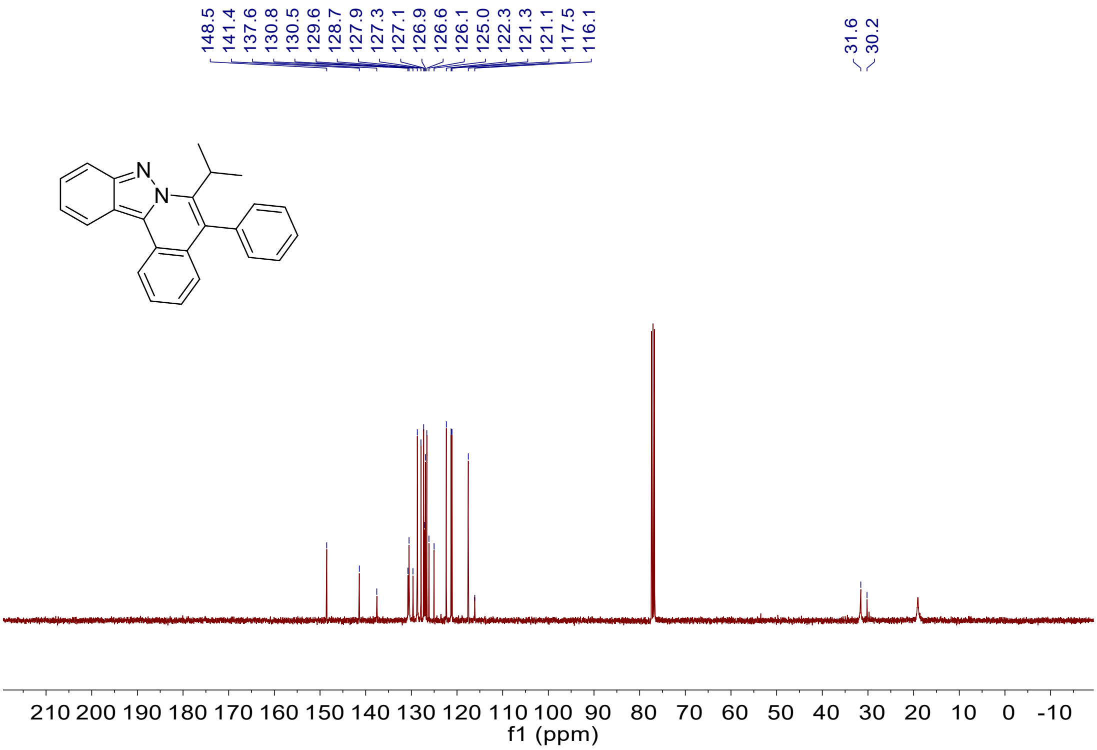
^{13}C NMR ($CDCl_3$) spectrum of **3at**



^{1}H NMR ($CDCl_3$) spectrum of **4aa**

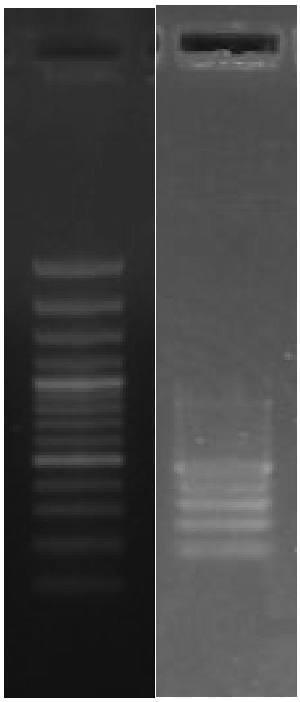


^{13}C NMR ($CDCl_3$) spectrum of **4aa**



8. Agarose gel electrophoresis[4]

The neat and clear strips of nucleic acids (DNA strands) were observed by using agarose gel electrophoresis, applying **3fa** as nucleic acid dye.



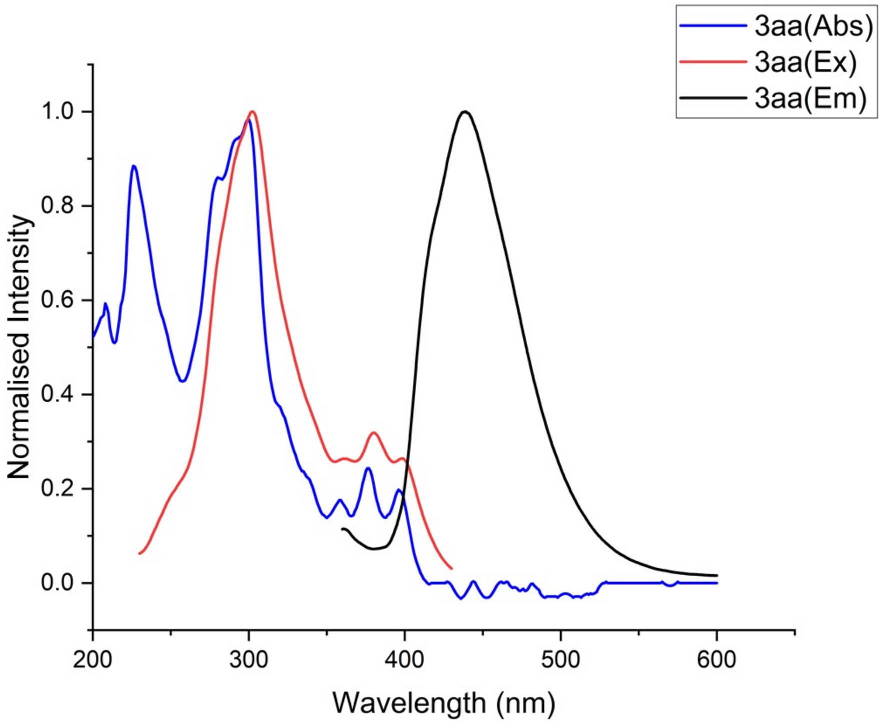
4S Red Plus **3fa**

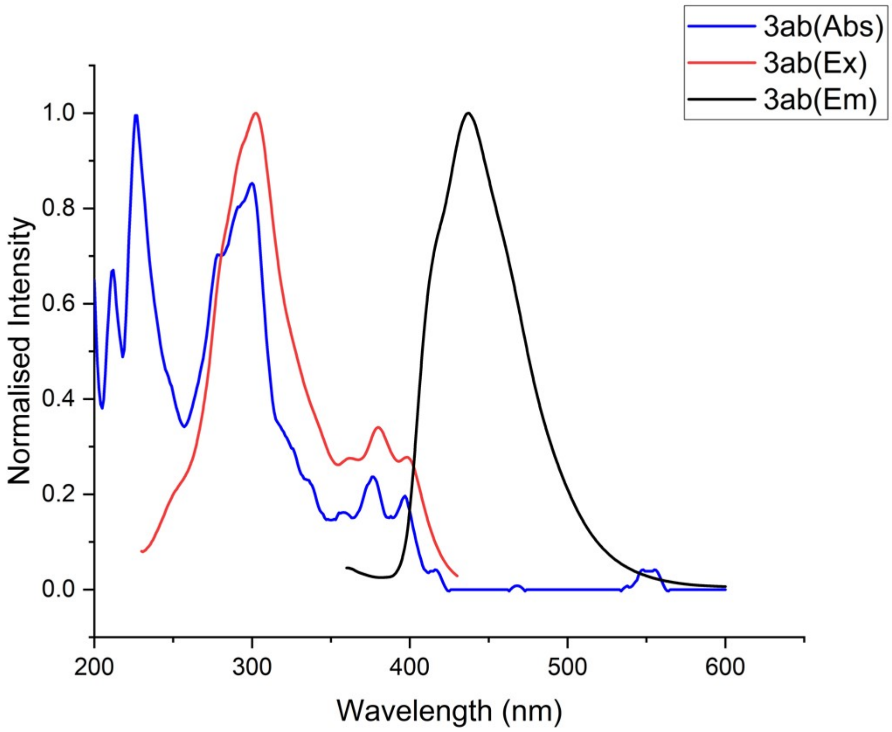
9. UV and fluorescence spectra

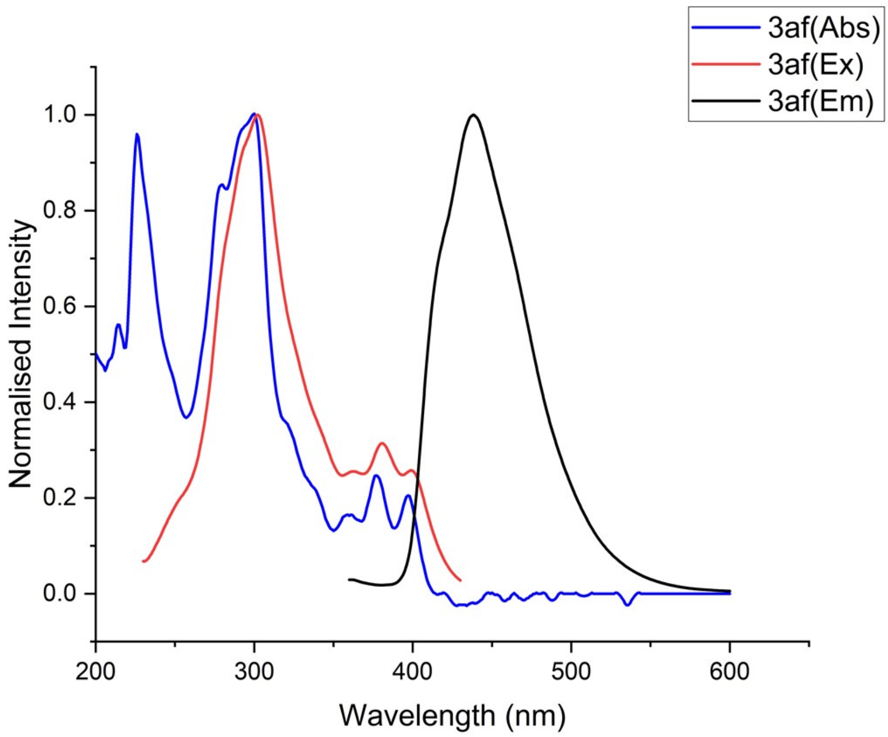
Table S3 Excitation maxima, emission maxima of 6-alkenylindazolo[3,2-a]isoquinolines in DCM

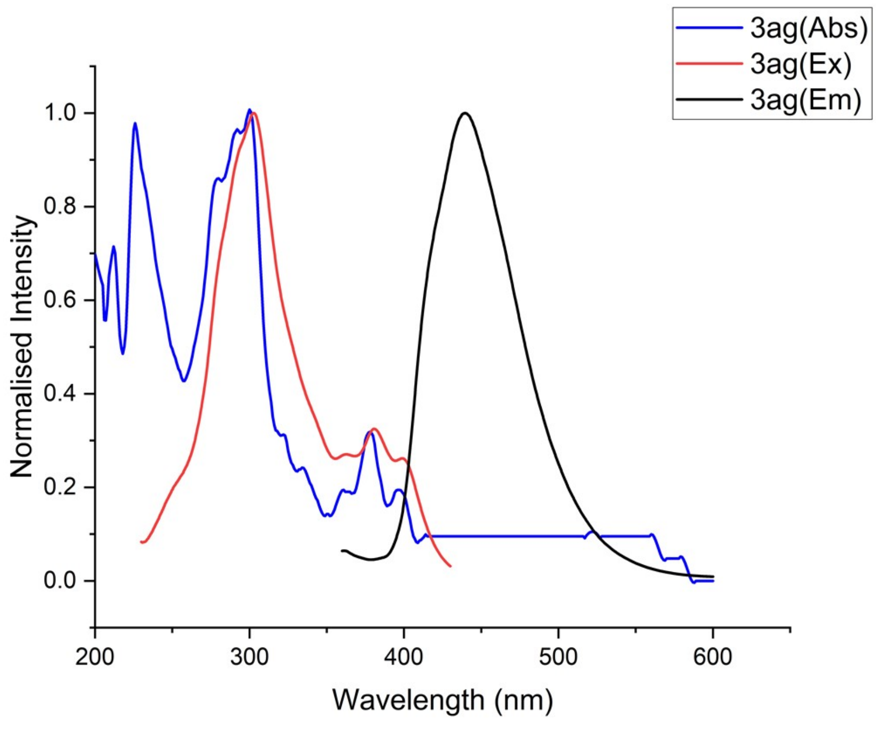
Compound	λ_{em} (nm)^{a} in CH_2Cl_2	λ_{ex} (nm)^{b} in CH_2Cl_2	$(\Phi^{f})^{c}$ in CH_2Cl_2	Stokes shift^{d}/nm
3aa	442	302	8.03	140
3ba	441	307	5.82	134
3da	439	304	5.22	135
3ea	445	295	10.37	150
3fa	442	303	18.12	139
3ia	436	304	3.83	132
3ja	442	305	6.73	137
3ab	441	302	7.85	139
3af	436	302	11.22	134
3ag	439	303	10.69	136
3aj	442	303	10.19	139

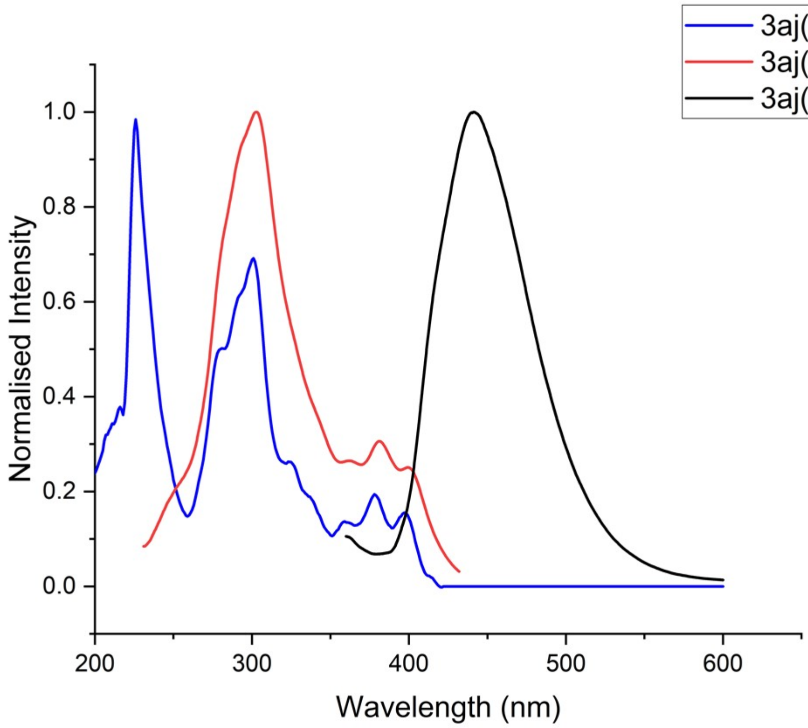
^{a} Excitation maxima in CH_2Cl_2 (10^{-5}M). ^{b} emission maxima in CH_2Cl_2 (10^{-3}M). ^{C} Relative quantum yield determined in CH_2Cl_2 with an integrating sphere system. ^{d} Stokes shift = λ_{em} - λ_{ex}


3aa(Abs)
3aa(Ex)
3aa(Em)
Normalised Intensity
Wavelength (nm)
1.0
0.8
0.6
0.4
0.2
0.0
200
300
400
500
600

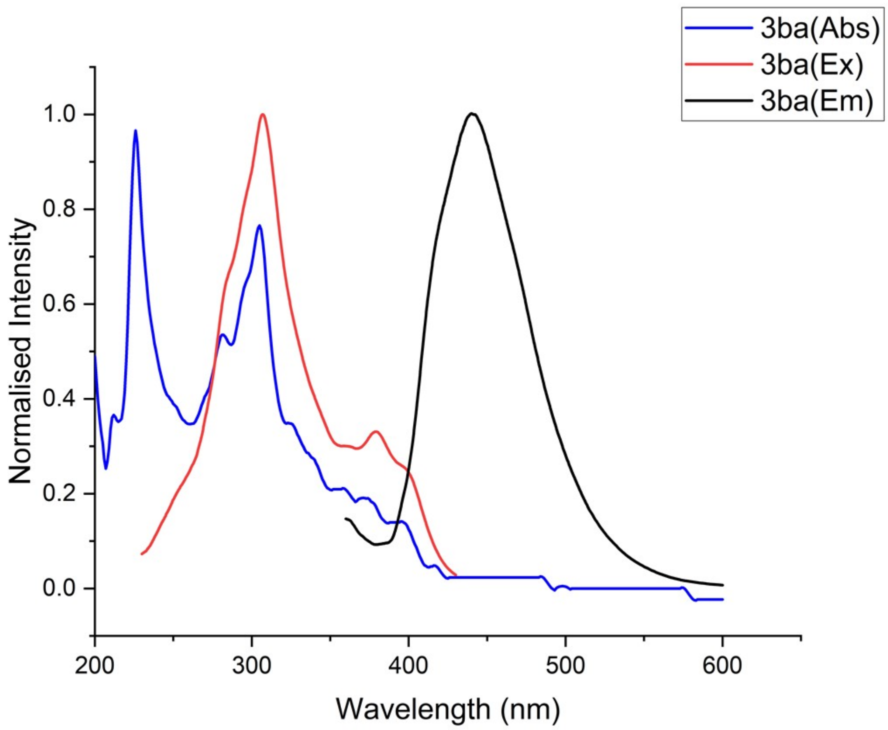

3ab(Abs)
3ab(Ex)
3ab(Em)
Normalised Intensity
Wavelength (nm)
1.0
0.8
0.6
0.4
0.2
0.0
200
300
400
500
600


3af(Abs)
3af(Ex)
3af(Em)
Normalised Intensity
Wavelength (nm)
1.0
0.8
0.6
0.4
0.2
0.0
200
300
400
500
600

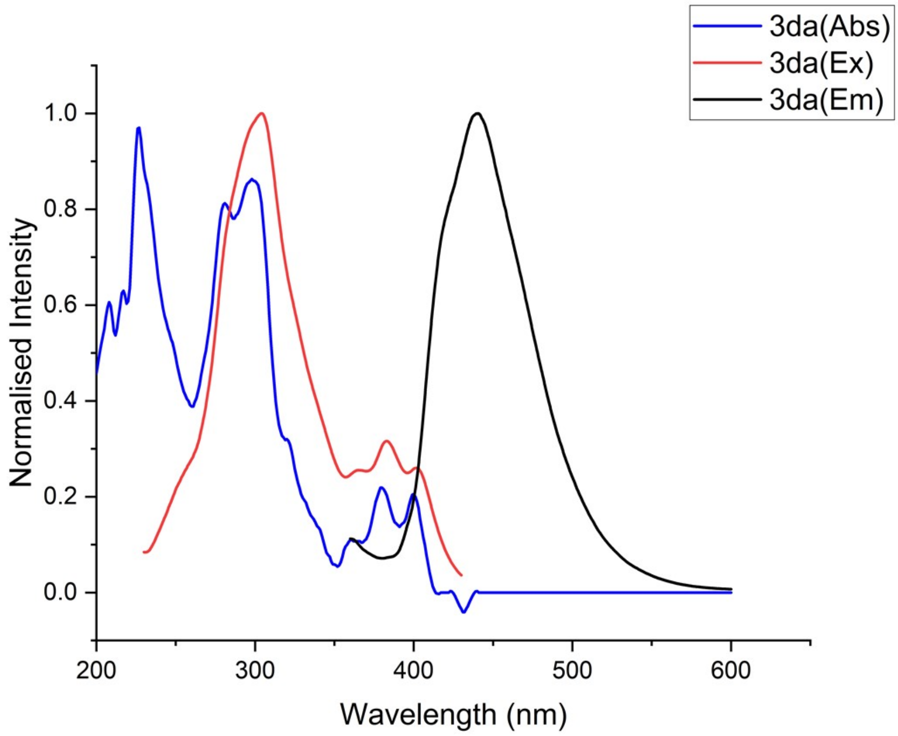

3ag(Abs)
3ag(Ex)
3ag(Em)
Normalised Intensity
Wavelength (nm)
1.0
0.8
0.6
0.4
0.2
0.0
200
300
400
500
600



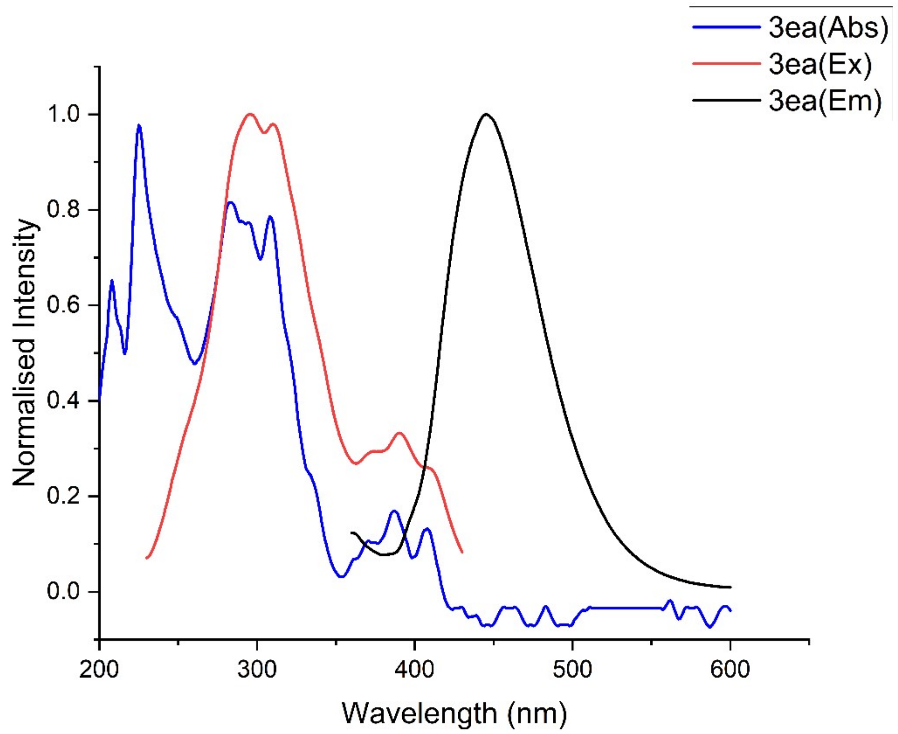
3aj(Abs)
3aj(Ex)
3aj(Em)
Normalised Intensity
1.0
0.8
0.6
0.4
0.2
0.0
200
300
400
500
600
Wavelength (nm)



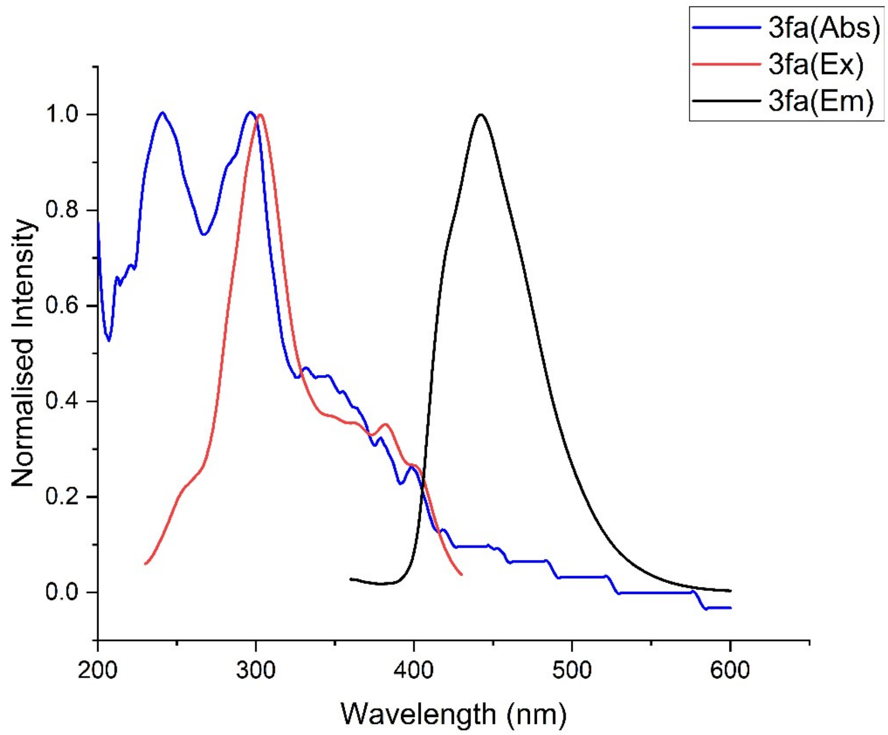
3ba(Abs)
3ba(Ex)
3ba(Em)
Normalised Intensity
1.0
0.8
0.6
0.4
0.2
0.0
200
300
400
500
600
Wavelength (nm)

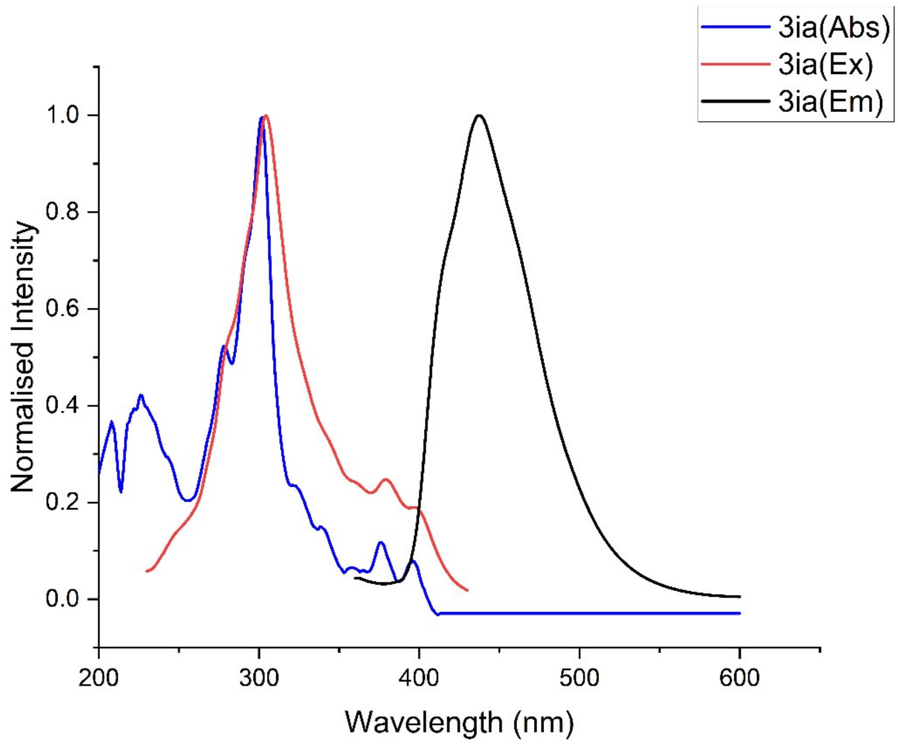


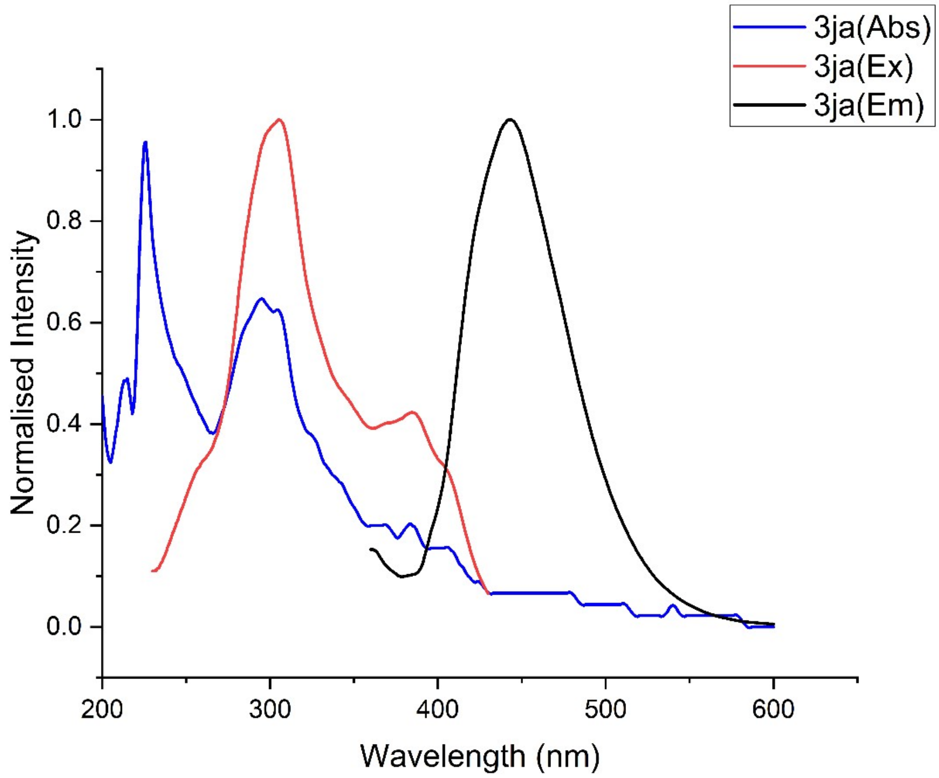
3da(Abs)
3da(Ex)
3da(Em)
Normalised Intensity
Wavelength (nm)



3ea(Abs)
3ea(Ex)
3ea(Em)
Normalised Intensity
Wavelength (nm)


3fa(Abs)
3fa(Ex)
3fa(Em)
Normalised Intensity
Wavelength (nm)


3ia(Abs)
3ia(Ex)
3ia(Em)
Normalised Intensity
Wavelength (nm)



10. Fluorescence labeling

The fluorescence labeling performance of **3aa** in zebrafish embryos was assayed in a 6-well plate. And zebrafish embryos were exposed to **3aa** from a 1 g/L DMSO stock to final concentrations ranging from 1×10^{-2} g/L to 1×10^{-3} g/L. After treating for each 24 h, the supernatant was removed and a solution of the same concentration was added to each well. The fluorescence labeling performance was observed using stereo fluorescence microscope under 405 nm UV light for visualization after incubating for 72 h at 28 °C. Compared with blank control which cultured zebrafish in water, the product **3aa** accumulated at the yolk of the zebrafish larvae.

1×10^{-2} g/L　　1×10^{-3} g/L　　water