# Electrochemical Direct Site-Selective Selenation of Carbazoles

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## 1. General information

**General.**

Unless otherwise noted, all reagents and solvents were purchased from commercial sources (Adamas-beta, Energy Chemical) and used without further purification.

**NMR spectra**

$^{1}H$ and $^{13}C$ NMR spectra were collected on 600 MHz NMR spectrometer (Bruker Avance NEO 600). Chemical shifts for protons were reported in parts per million (ppm) downfield from tetramethylsilane and were referenced to residual protium in the NMR solvents ($CDCl_3$ = δ(ppm) = 7.26). The following abbreviations are used to explain the multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, dd = doublet of doublets, h = heptet. Coupling constants *J* were reported in hertz (Hz).

**HRMS**

High-resolution mass spectra (HRMS) were recorded on Thermo Fisher Scientific QExactive.

**Melting point**

Melting point (M.P.) was recorded on BÜCHI (M-560).

**UV light**

Visualization of TLC was achieved by the use of UV light (254 nm).

**Materials.**

All the chemical reagents were purchased from commercial sources and used as received unless otherwise indicated. Diselenides[1] were synthesized according to the reported method.

**The Electrochemical Reaction Instrument.**

Cyclic voltammetry (CV) was carried out on a CHI660E electrochemical workstation (CH Instruments, Inc).

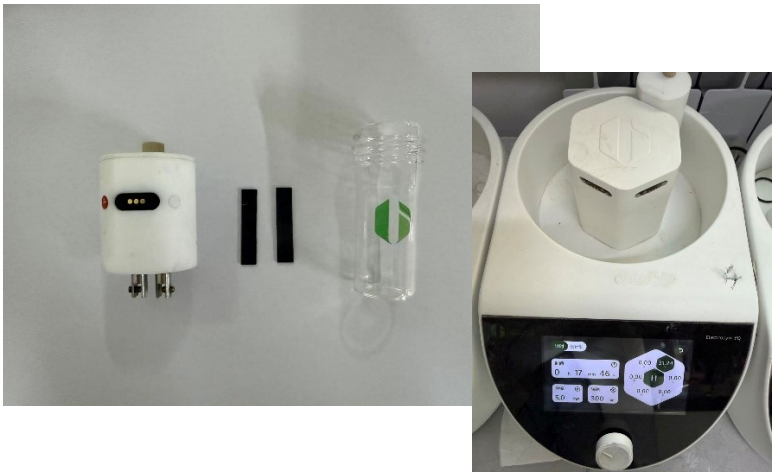
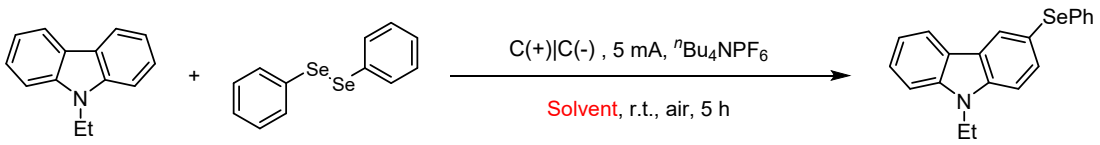


**Fig. S1** Diagram of the electrochemical reaction device

## 2. Experimental procedures

## 2.1 Optimization of the reaction conditions for carbazole selenation

### 2.1.1 Table S1 Screening of solvents[a]

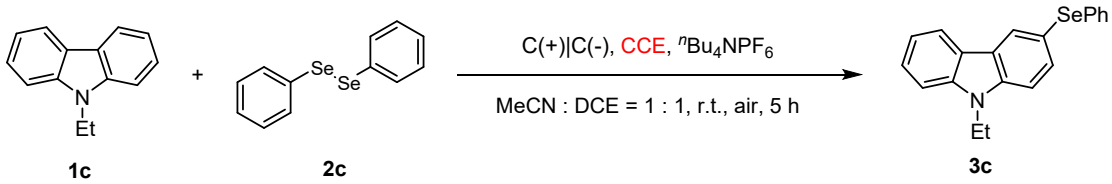



**1c** **2c** **3c**

| Entry | Solvent | Yield [%][b] |
|---|---|---|
| 1 | THF | 12 |
| 2 | EtOAc | N.R. |
| 3 | $H_2O$ | N.R. |
| 4 | MeCN | 62 |
| 5 | DCE | 55 |
| 6 | $CHCl_3$ | trace |
| 7 | 1,4-dioxane | N.D. |
| 8 | MeCN:$H_2O$ = 1:1 | N.D. |
| 9 | MeCN:MeOH = 1:1 | trace |
| 10 | MeCN:DCM = 1:1 | 37 |
| 11 | MeCN:$CHCl_3$ = 1:1 | 38 |
| 12 | MeCN:DCE = 1:10 | 46 |
| 13 | MeCN:DCE = 1:5 | 49 |
| 14 | MeCN:DCE = 1:3 | 61 |
| 15 | MeCN:DCE = 1:1 | 71 |
| 16 | MeCN:DCE = 5:1 | 53 |
| 17 | MeCN:DCE = 3:1 | 56 |

[a]Reaction conditions: **1c** (0.1 mmol), **2c** (0.2 mmol), $^{n}Bu_4NPF_6$ (0.1 mmol), solvent (4 mL), graphitic carbon anode (immersed surface area 8×5 $mm^2$), graphitic carbon cathode (immersed surface area 8×5 $mm^2$), the distance between the electrodes (5 mm), constant current = 5 mA, 5 h, room temperature, under air, undivided cell. [b]Isolated yields. N.R. = no reaction, N.D. = not detected.

### 2.1.2 Table S2 Screening of constant currents[a]

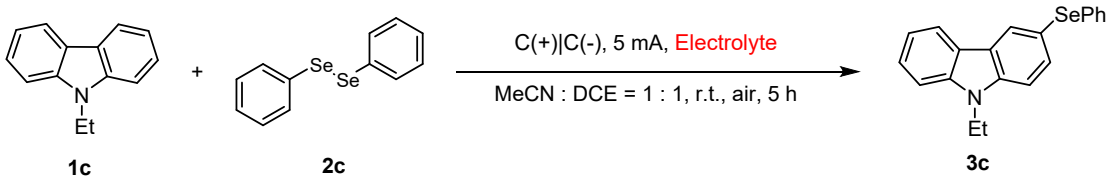



**1c** **2c** **3c**

| Entry | CCE [mA] | Yield [%][b] |
|---|---|---|
| 1 | 3 | 54 |
| 2 | 5 | 71 |
| 3 | 7 | 59 |
| 4 | 10 | 50 |

[a]Reaction conditions: **1c** (0.1 mmol), **2c** (0.2 mmol), $^{n}Bu_4NPF_6$ (0.1 mmol), MeCN:DCE = 1:1 (4 mL), graphitic carbon anode (immersed surface area 8×5 $mm^2$), graphitic carbon cathode (immersed surface area 8×5 $mm^2$), the distance between the electrodes (5 mm), constant current = x mA, 5 h, room temperature, under air, undivided cell. [b]Isolated yields. CCE = constant current electrolysis.

### 2.1.3 Table S3 Screening of electrolytes[a]

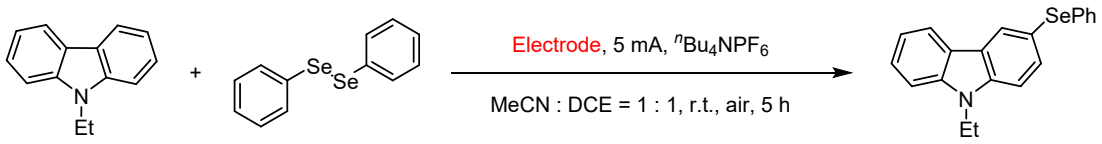



**1c** **2c** **3c**

| Entry | Electrolyte | Yield [%][b] |
|---|---|---|
| 1 | $^{n}Bu_4NOAc$ | 58 |
| 2 | $^{n}Bu_4NClO_4$ | trace |
| 3 | $^{n}Et_4NBF_4$ | 37 |
| 4 | $^{n}Bu_4NPF_6$ | 71 |
| 5 | $^{n}Et_4NPF_6$ | 61 |

[a]Reaction conditions: **1c** (0.1 mmol), **2c** (0.2 mmol), electrolyte (0.1 mmol), MeCN:DCE = 1:1 (4 mL), graphitic carbon anode (immersed surface area 8×5 $mm^2$), graphitic carbon cathode (immersed surface area 8×5 $mm^2$), the distance between the electrodes (5 mm), constant current = 5 mA, 5 h, room temperature, under air, undivided cell. [b]Isolated yields.

### 2.1.4 Table S4 Screening of electrodes[a]

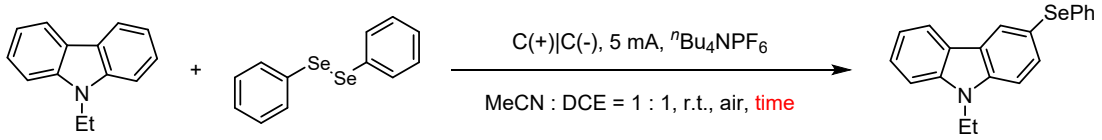



**1c** **2c** **3c**

| Entry | Electrode | Yield [%][b] |
|---|---|---|
| 1 | C/Mg | 54 |
| 2 | C/Cu | 38 |
| 3 | C/Ni | 60 |
| 4 | C/C | 71 |
| 5 | Mg/C | trace |
| 6 | Al/C | 22 |
| 7 | Ni/C | 17 |
| 8 | Pt/C | 61 |

[a]Reaction conditions: **1c** (0.1 mmol), **2c** (0.2 mmol), $^{n}Bu_4NPF_6$ (0.1 mmol), MeCN:DCE = 1:1 (4 mL), anode (immersed surface area 8×5 $mm^2$), cathode (immersed surface area 8×5 $mm^2$), the distance between the electrodes (5 mm), constant current = 5 mA, 5 h, room temperature, under air, undivided cell. [b]Isolated yields.

### 2.1.5 Table S5 Screening of reaction time[a]

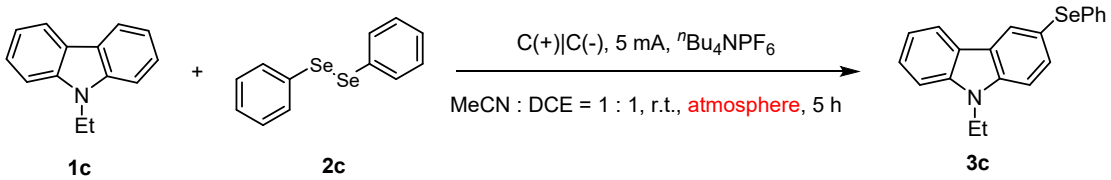



**1c** **2c** **3c**

| Entry | Time [h] | Yield [%][b] |
|---|---|---|
| 1 | 3 | 60 |
| 2 | 5 | 71 |
| 3 | 7 | 62 |

[a]Reaction conditions: **1c** (0.1 mmol), **2c** (0.2 mmol), $^{n}Bu_4NPF_6$ (0.1 mmol), MeCN:DCE = 1:1 (4 mL), graphitic carbon anode (immersed surface area 8×5 $mm^2$), graphitic carbon cathode (immersed surface area 8×5 $mm^2$), the distance between the electrodes (5 mm), constant current = 5 mA, time, room temperature, under air, undivided cell. [b]Isolated yields.

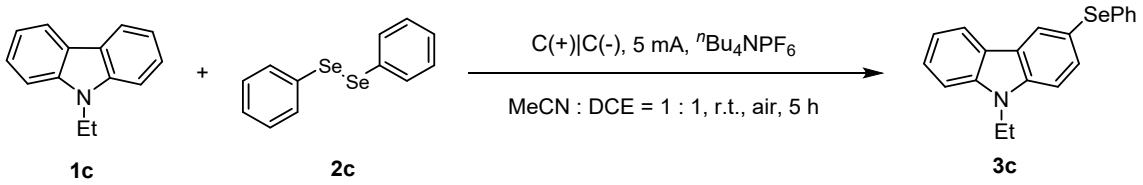
### 2.1.6 Table S6 Screening of atmosphere[a]




| Entry | Atmosphere | Yield [%][b] |
|---|---|---|
| 1 | air | 71 |
| 2 | $N_2$ | 65 |

[a]Reaction conditions: **1c** (0.1 mmol), **2c** (0.2 mmol), $^{n}Bu_4NPF_6$ (0.1 mmol), MeCN:DCE = 1:1 (4 mL), graphitic carbon anode (immersed surface area 8×5 $mm^2$), graphitic carbon cathode (immersed surface area 8×5 $mm^2$), the distance between the electrodes (5 mm), constant current = 5 mA, 5 h, room temperature, atmosphere, undivided cell. [b]Isolated yields.

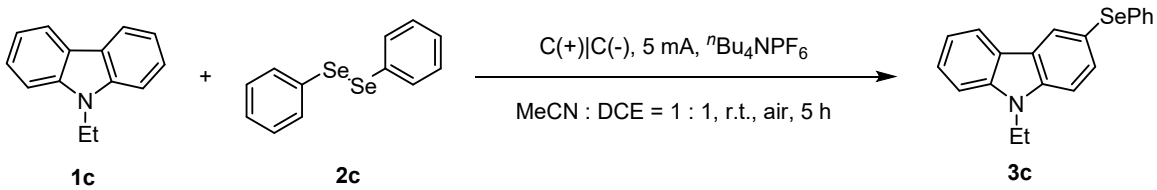
### 2.1.7 Table S7 Screening of substrate ratio[a]




| Entry | 1c:2c [mmol] | Yield [%][b] |
|---|---|---|
| 1 | 0.1:0.2 | 71 |
| 2 | 0.15:0.3 | 62 |
| 3 | 0.2:0.4 | 73 |
| 4 | 0.3:0.6 | 51 |

[a]Reaction conditions: **1c** (x mmol), **2c** (2x mmol), $^{n}Bu_4NPF_6$ (1 eq.), MeCN:DCE = 1:1 (4 mL), graphitic carbon anode (immersed surface area 8×5 $mm^2$), graphitic carbon cathode (immersed surface area 8×5 $mm^2$), the distance between the electrodes (5 mm), constant current = 5 mA, 5 h, room temperature, under air, undivided cell. [b]Isolated yields.

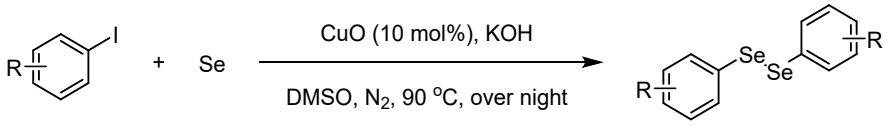
### 2.1.8 The general procedure for the direct selenation of carbazole




Taking the synthesis of **3c** as an example, under air, a mixture of **1c** (39.1 mg, 0.2 mmol), **2c** (124.9 mg, 0.4 mmol), $^{n}Bu_4NPF_6$ (77.5 mg, 0.2 mmol) and MeCN:DCE = 1:1 (4 mL) was added to an oven-dried undivided vial (10 mL). The vial was equipped with graphite carbon rods as the anode and the cathode. The resulting mixture was stirred and electrolyzed in a constant current mode with

a constant current of 5 mA at ambient temperature for 5 h. When the reaction was finished, the reaction mixture was dried over anhydrous sodium sulfate followed by suction filtration and all the volatiles were evaporated under reduced pressure. The resultant residue was purified by silica gel column chromatography (eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v) to afford the desired product **3c** as a white solid (51.2 mg, 73% yield).

## 2.2 Table S8 General procedure for the synthesis of diselenides[1]



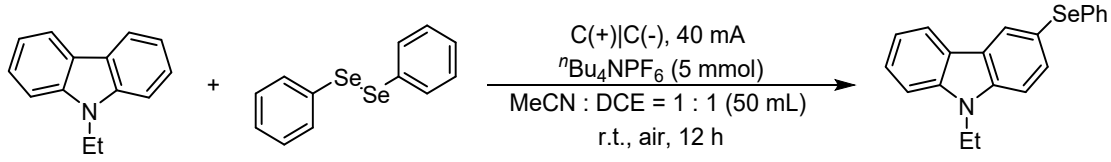

**1** **2**

Under nitrogen atmosphere, to a stirred solution of Se powder (6.0 mmol) and aryl iodides (3.0 mmol) in dry DMSO (6.0 mL) was added CuO nanoparticles (10 mol%), followed by KOH (2.0 eq.), at 90 °C. The progress of the reaction was monitored by TLC. After the reaction was complete, the reaction mixture was allowed to cool. The resultant residue was purified by silica gel column chromatography using petroleum ether as the eluent to afford the desired product.

| Entry | Product | Yield [%] |
|---|---|---|
| 1 | **2ab** | 99 |
| 2 | **2ac** | 93 |
| 3 | **2ad** | 96 |
| 4 | **2ae** | 92 |
| 5 | **2af** | 88 |
| 6 | **2ag** | 91 |
| 7 | **2ah** | 95 |
| 8 | **2ai** | 84 |
| 9 | **2aj** | 91 |
| 10 | **2ak** | 26 |

## 2.3 Gram-scale reaction, continuous-flow process and product derivatization

### 2.3.1 Gram-scale selenation of carbazole in batch




**1c,** 5 mmol, 0.98 g **2c,** 10 mmol, 3.12 g **3c,** 61% yield, 1.07 g

Under air, *N*-ethylcarbazole **1c** (0.98 g, 5 mmol), diphenyldiselenide **2c** (3.12 g, 10 mmol), $^{n}Bu_4NPF_6$ (1.94 g, 5 mmol), and MeCN:DCE = 1:1 (40 mL) were added to a dried 100 mL round-bottom flask (RBF). The RBF was equipped with a graphite carbon anode (27 mm×15.0 mm×1 mm) and a graphite carbon cathode (27 mm×15.0 mm×1 mm). The mixture was subjected to electrolysis at room temperature, with the current set to 40 mA, and the reaction was allowed to proceed for 12 hours. After the reaction, the solvent and all volatile substances were removed by

rotary evaporation under reduced pressure. The resulting residue was purified by silica gel column chromatography, using a petroleum ether (60-90 °C)/EtOAc = 100:1 (v:v) eluent. The target product **3c** was obtained as a white solid (1.07 g, 61% yield). 2.23 g of unreacted diphenyldiselenide was recovered from the reaction system.

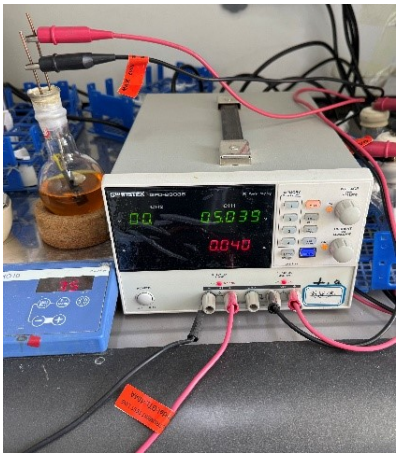
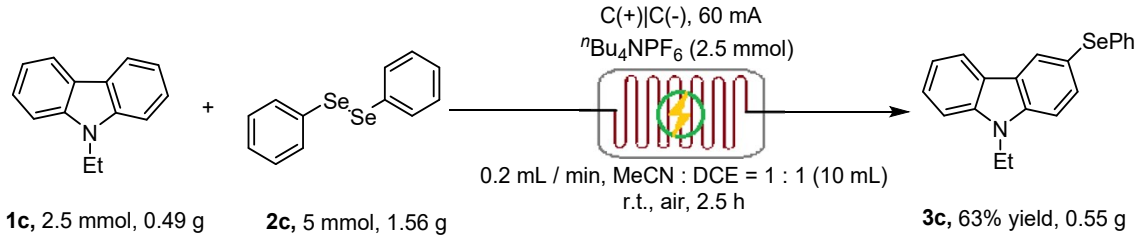


**Fig. S2** Scale-up experimental reaction setup

**2.3.2 Scale-up selenation of carbazole under continuous-flow condition**

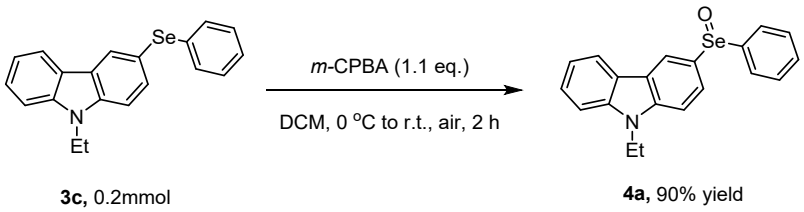



**1c,** 2.5 mmol, 0.49 g **2c,** 5 mmol, 1.56 g **3c,** 63% yield, 0.55 g

Under air, **1c** (0.49 g, 2.5 mmol), **2c** (1.56 g, 5 mmol), $^{n}Bu_4NPF_6$ (0.97 g, 5 mmol), and MeCN:DCE = 1:1 (10 mL) were mixed and then aspirated into a syringe. A flow electrochemical reactor, equipped with graphite plates as both the anode and cathode, was used, with the surface area of the graphite plates measuring 8 cm×6 cm. The mixture underwent flow electrolysis at room temperature under a constant current mode, with a current of 60 mA and a flow rate of 0.2 mL/min for 2.5 hours. Upon completion of the reaction, the solvent and all volatile substances were evaporated under reduced pressure. The resultant residue was purified by silica gel column chromatography (eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v), yielding the target product **3c** as a white solid (0.55 g, 63% yield).


**Fig. S3** Flow electrochemical reactor for scale-up experiment

### 2.3.3 Product derivatization



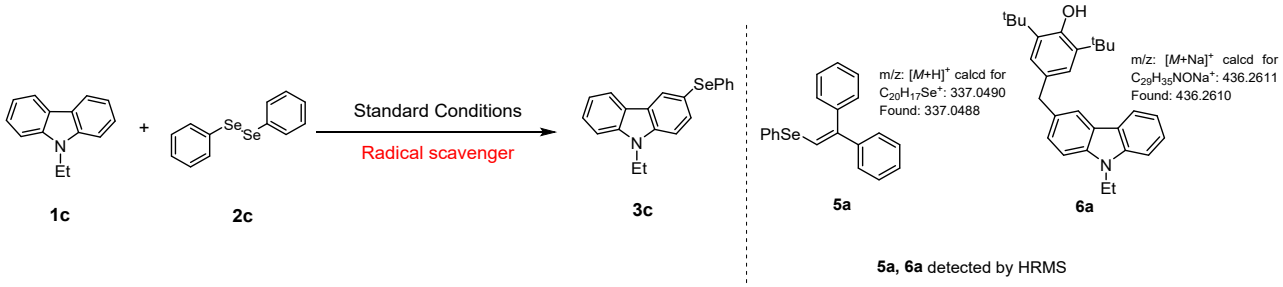

**3c,** 0.2mmol **4a,** 90% yield

Under air, 3c (70 mg, 0.2 mmol) was dissolved in 2 mL of DCM. The reaction mixture was cooled to 0 °C, and *m*-CPBA (38 mg, 0.22 mmol) was added in one portion. The mixture was stirred at 0 °C for 1 hour and at room temperature for an additional 1 hour. Upon completion of the reaction, the organic phase was washed with saturated aqueous potassium carbonate solution (10 mL) and the aqueous phase was extracted with DCM. The organic layers were combined and concentrated under reduced pressure. The residue was purified by column chromatography (EtOAc then DCM/MeOH, 20:1 (v:v)) to obtain the target product **4a** with 90% isolated yield.

## 3. Mechanistic studies

### 3.1 Radical trapping experiments

#### 3.1.1 Table S9 The radical capture experiment[a]




**1c** **2c** **3c** **5a** **6a**

**5a, 6a** detected by HRMS

| Entry | Radical scavenger (mmol) | Yield [%][b] |
|---|---|---|
| 1 | none | 73 |
| 2 | BHT (0.4) | 35 |
| 3 | BHT (0.6) | 17 |
| 4 | DPE (0.6) | 23 |
| 5 | TEMPO (0.6) | N.R. |

[a]Reaction conditions: **1c** (0.2 mmol), **2c** (0.4 mmol), $^{n}Bu_4NPF_6$ (0.2 mmol), MeCN:DCE = 1:1 (4 mL), radical scavenger, graphitic carbon anode (immersed surface area 8×5 $mm^2$), graphitic carbon cathode (immersed surface area 8×5 $mm^2$), the distance between the electrodes (5 mm), constant current = 5 mA, 5 h, room temperature, under air, undivided cell. [b]Isolated yields. DPE = 1,1-diphenylethylene, BHT = butylated hydroxytoluene. TEMPO = 2,2,6,6-tetramethylpiperidinooxy. N.R. = no reaction.

### 3.1.2 The HRMS spectra of compound 5a and 6a

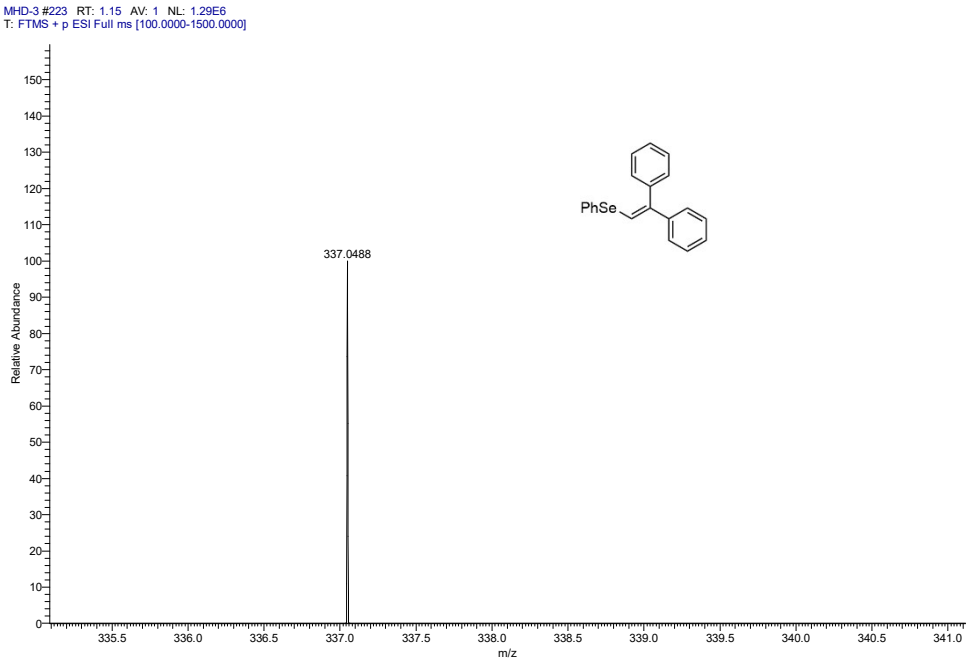



**Fig. S4** The HRMS spectra of compound **5a**

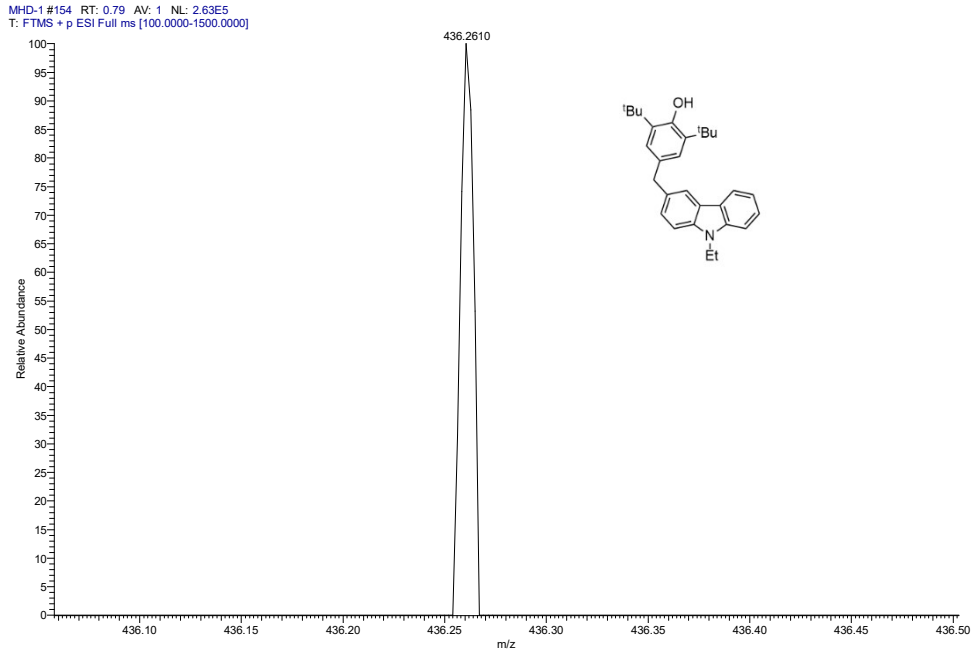
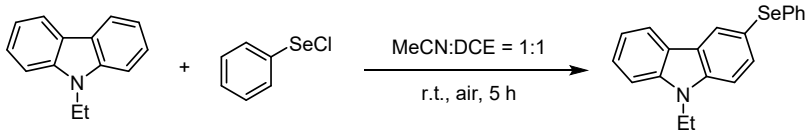



**Fig. S5** The HRMS spectra of compound **6a**

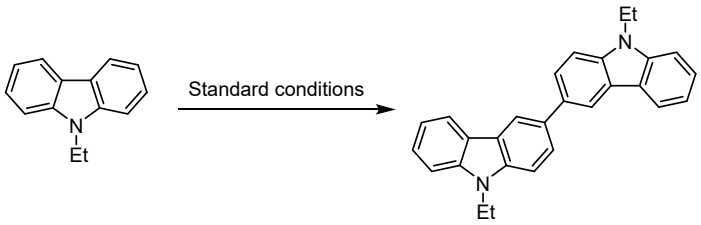
## 3.2 Control and radical coupling experiments.

**(a) Control experiment**[a,b]




**1c** **7a** **3c,** 54% yield

**(b) Radical coupling experiment**[c,b]

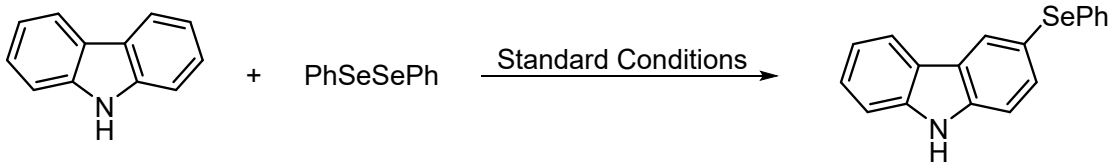



**1c** **8a,** 42% yield

[a]Reaction conditions: **1c** (0.2 mmol), **7a** (0.4 mmol), MeCN:DCE = 1:1 (4 mL), 5 h, room temperature, under air. [c]Reaction conditions: **1c** (0.2 mmol), $^{n}Bu_4NPF_6$ (0.2 mmol), MeCN:DCE = 1:1 (4 mL), graphitic carbon anode (immersed surface area 8×5 $mm^2$), graphitic carbon cathode (immersed surface area 8×5 $mm^2$), the distance between the electrodes (5 mm), constant current = 5 mA, 5 h, room temperature, under air. [b]Isolated yield.

### 3.3 Table S10 KIE experiment[a]

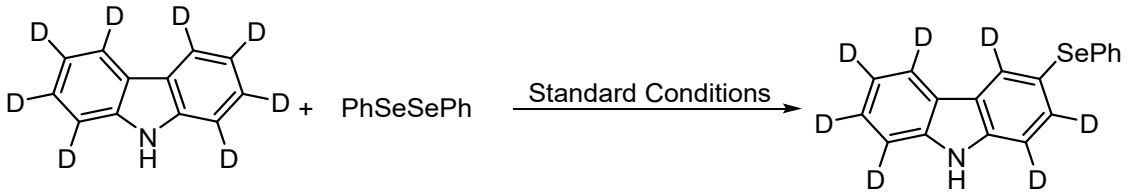
**$K_H/K_D$ = 5.94/6.40 = 0.93**




**1a** **2c** **3a**

| Entry | Time [h] | Yield [%][b] |
|---|---|---|
| 1 | 0.5 | 28 |
| 2 | 1 | 33 |
| 3 | 2 | 38 |
| 4 | 3 | 46 |
| 5 | 5 | 55 |

[a]Reaction conditions: **1a** (0.2 mmol), **2c** (0.4 mmol), $^{n}Bu_4NPF_6$ (0.2 mmol), MeCN:DCE = 1:1 (4 mL), graphitic carbon anode (immersed surface area 8×5 $mm^2$), graphitic carbon cathode (immersed surface area 8×5 $mm^2$), the distance between the electrodes (5 mm), constant current = 5 mA, room temperature, under air, time, undivided cell. [b]Isolated yields.




**1a-$d_8$** **2c** **3a-$d_7$**

| Entry | Time [h] | Yield [%][b] |
|---|---|---|
| 1 | 0.5 | 5 |
| 2 | 1 | 7 |
| 3 | 2 | 12 |
| 4 | 3 | 17 |
| 5 | 5 | 34 |

[a]Reaction conditions: **1a-$d_8$** (0.2 mmol), **2c** (0.4 mmol), $^{n}Bu_4NPF_6$ (0.2 mmol), MeCN:DCE = 1:1 (4 mL), graphitic carbon anode (immersed surface area 8×5 $mm^2$), graphitic carbon cathode (immersed surface area 8×5 $mm^2$), the distance between the electrodes (5 mm), constant current = 5 mA, room temperature, under air, time, undivided cell. [b]Isolated yields.

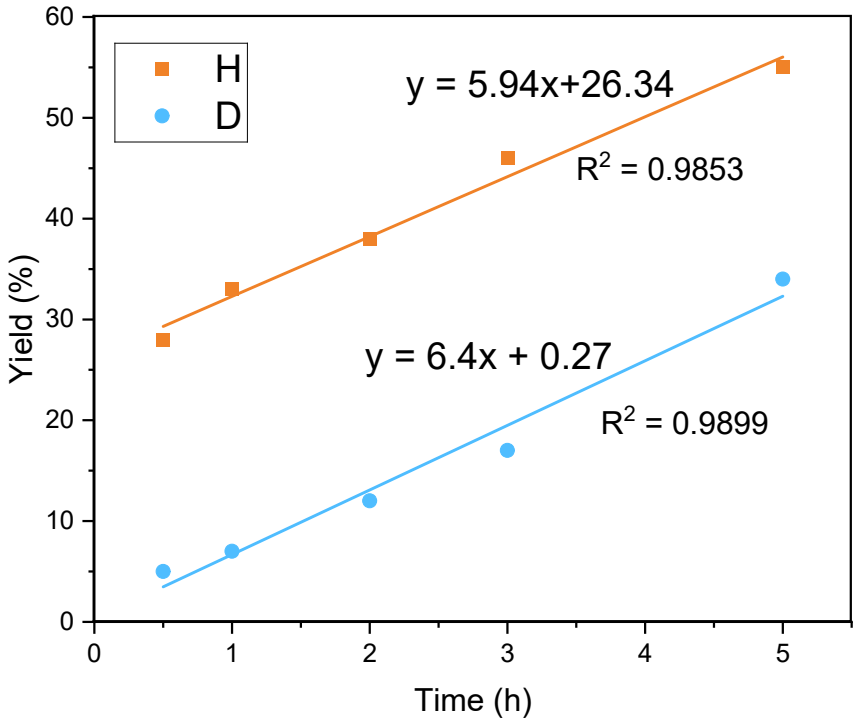



**Fig. S6** KIE experiments.

### 3.4 The cyclic voltammetry of 1c and 2c

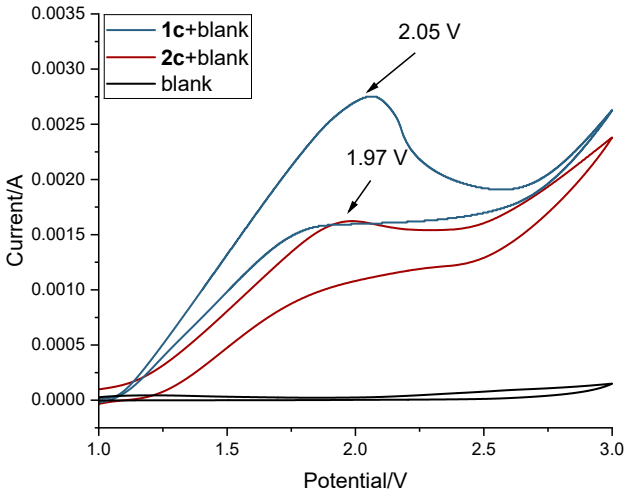



**Fig. S7** CV experiments. Cyclic voltammetry of **1c** (0.2 mmol), **2c** (0.4 mmol), $^{n}Bu_4NPF_6$ (0.2 mmol) in MeCN:DCE = 1:1 (4 mL) under air. A glassy carbon disk (R = 5.5 mm, h = 10 mm) was used as the working electrode. A Pt disk (R = 5.5 mm, h = 10 mm) and Ag/AgCl (R = 5.0 mm, h = 10 mm) were used as the counter and reference electrodes, respectively, blank = solvent + $^{n}Bu_4NPF_6$.

## 3.5 The cyclic voltammetry of 4c and 5c

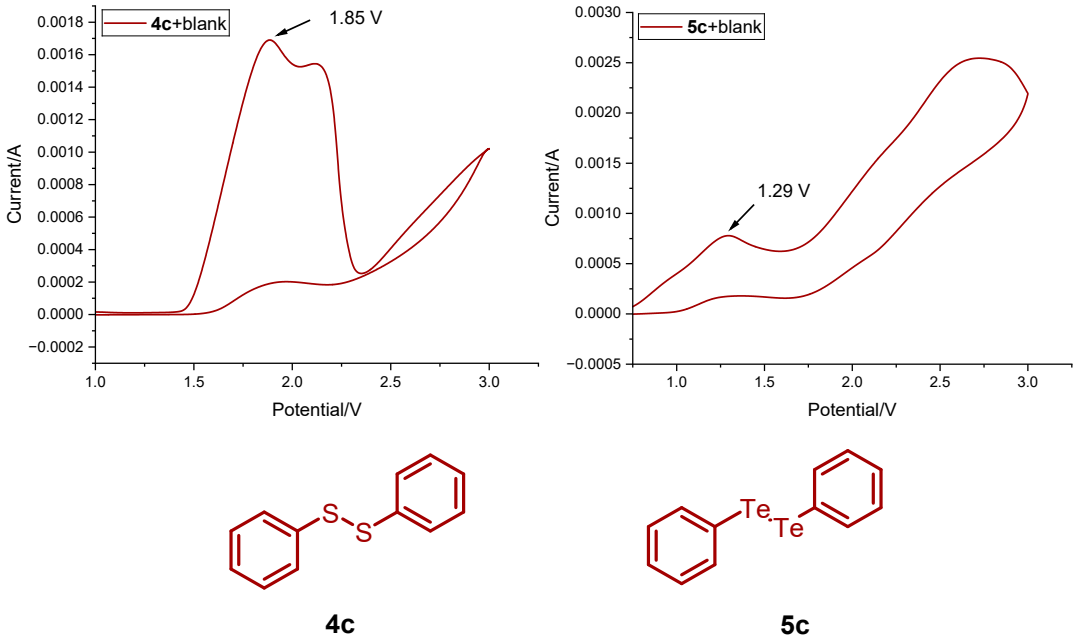
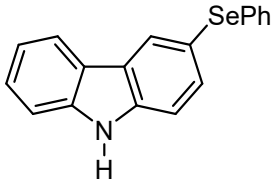
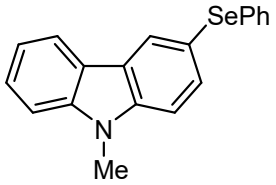



**Fig. S8** CV experiments. Cyclic voltammetry of **4c** (0.2 mmol), **5c** (0.2 mmol), $^{n}Bu_4NPF_6$ (0.2 mmol) in MeCN:DCE = 1:1 (4 mL) under air. A glassy carbon disk (R = 5.5 mm, h = 10 mm) was used as the working electrode. A Pt disk (R = 5.5 mm, h = 10 mm) and Ag/AgCl (R = 5.0 mm, h = 10 mm) were used as the counter and reference electrodes, respectively, blank = solvent + $^{n}Bu_4NPF_6$.

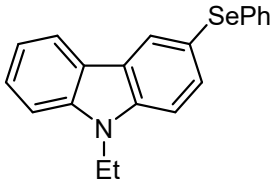
## 4. Analytical data



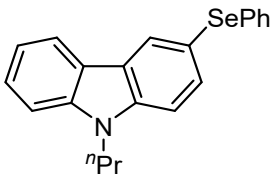

**3-(phenylselanyl)-9*H*-carbazole (3a)**, 55% yield (35.5 mg), known compound[2]. (Eluent: petroleum ether (60-90 °C)/EtOAc = 50:1, v:v). White solid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.38 (s, 1H), 8.13 (br, 1H), 8.04 (d, *J* = 7.8 Hz, 1H), 7.66 (dd, *J* = 8.2, 1.6 Hz, 1H), 7.46-7.43 (m, 2H), 7.40 (d, *J* = 8.2 Hz, 1H), 7.36-7.32 (m, 2H), 7.26-7.24 (m, 1H), 7.22-7.14 (m, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 139.80, 139.5, 134.3, 133.4, 130.5, 129.3, 128.3, 126.6, 126.3, 124.8, 122.9, 120.7, 120.1, 118.5, 111.8, 110.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{18}H_{13}NSe$: 323.0208; Found 323.0207.



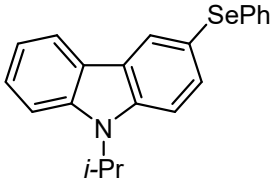

**9-methyl-3-(phenylselanyl)-9*H*-carbazole (3b)**, 63% yield (42.4 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow solid, m.p.: 96.3-96.9 °C. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.41 (d, *J* = 1.7 Hz, 1H), 8.07 (d, *J* = 7.7 Hz, 1H), 7.73 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.52-7.50 (m, 1H), 7.42 (d, *J* = 8.3 Hz, 1H), 7.38 (d, *J* = 8.4 Hz, 1H), 7.34-7.30 (m, 2H), 7.27 (d, *J* = 1.0 Hz, 1H), 7.21-7.13 (m, 3H), 3.87 (s, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.3, 141.0, 134.5, 133.4, 130.3, 129.2, 128.4, 126.4, 126.2, 124.2, 122.3, 120.7, 119.5, 117.6, 109.7, 108.8, 29.3. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{19}H_{15}NSe$: 337.0364; Found 337.0364.



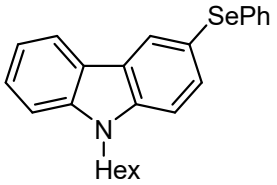

**9-ethyl-3-(phenylselanyl)-9*H*-carbazole (3c)**, 73% yield (51.2 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). White solid, m.p.: 138.6-139.0 °C. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.41 (d, *J* = 2.0 Hz, 1H), 8.07 (d, J = 8.6 Hz, 1H), 7.72 (d, *J* = 10.7 Hz, 1H), 7.49 (t, *J* = 7.7 Hz, 1H), 7.43 (d, *J* = 8.0 Hz, 1H), 7.38 (d, *J* = 8.4 Hz, 1H), 7.34 (d, *J* = 7.3 Hz, 2H), 7.26-7.23 (m, 1H), 7.21-7.14 (m, 3H), 4.37 (q, *J* = 7.3 Hz, 2H), 1.45 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 140.3, 139.9, 134.5, 133.3, 130.3, 129.2, 128.5, 126.3, 126.2, 124.3, 122.5, 120.8, 119.5, 117.5, 109.7, 108.8, 37.8, 14.0. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{20}H_{17}NSe$: 351.0521; Found 351.0521.



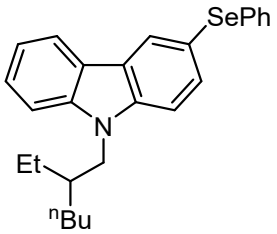
**3-(phenylselanyl)-9-propyl-9*H*-carbazole (3d)**, 70% yield (50.8 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.34 (d, *J* = 1.8 Hz, 1H), 7.98 (d, *J* = 7.7 Hz, 1H), 7.63 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.40 (t, *J* = 7.0 Hz, 1H), 7.32 (d, *J* = 8.3 Hz, 1H), 7.30-7.26 (m, 3H), 7.16 (t, *J* = 7.4 Hz, 1H), 7.13-7.06 (m, 3H), 4.15 (t, *J* = 7.2 Hz, 2H), 1.85-1.79 (m, 2H), 0.90 (t, *J* = 7.4 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 140.8, 140.4, 134.5, 133.2, 130.3, 129.2, 128.3, 126.2, 126.2, 124.2, 122.3, 120.6, 119.4, 117.4, 109.9, 109.0, 44.8, 22.4, 11.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{21}H_{19}NSe$: 365.0677; Found 365.0677.




**9-isopropyl-3-(phenylselanyl)-9*H*-carbazole (3e)**, 68% yield (49.3 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.43 (s, 1H), 8.09 (d, *J* = 7.8 Hz, 1H), 7.70 (d, *J* = 10.2 Hz, 1H), 7.55 (d, *J* = 8.4 Hz, 1H), 7.50-7.46 (m, 2H), 7.37 (d, *J* = 7.4 Hz, 2H), 7.25-7.16 (m, 4H), 5.00 (h, *J* = 7.1 Hz, 1H), 1.73 (d, *J* = 7.1 Hz, 6H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 139.8, 139.4, 134.4, 133.0, 130.3, 129.2, 128.3, 126.2, 126.0, 124.7, 122.8, 120.6, 119.2, 117.3, 111.2, 110.3, 47.0, 21.0. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{21}H_{19}NSe$: 365.0677; Found 365.0677.

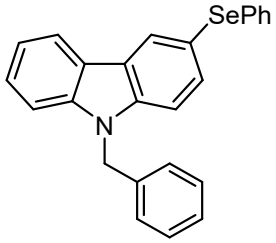



**1-(3-(phenylselanyl)-9H-carbazol-9-yl) hexan-1-one (3f)**, 70% yield (56.7 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 200:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.41 (d, *J* = 1.2 Hz, 1H), 8.07 (d, *J* = 7.7 Hz, 1H), 7.72 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.51-7.48 (m, 1H), 7.43 (d, *J* = 8.3 Hz, 1H), 7.38-7.34 (m, 3H), 7.26-7.24 (m, 1H), 7.22-7.15 (m, 3H), 4.30 (t, *J* = 7.4 Hz, 2H), 1.91-1.86 (m, 2H), 1.43-1.39 (m, 2H), 1.35-1.28 (m, 4H), 0.88 (t, *J* = 7.2 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 140.8, 140.4, 134.5, 133.3, 130.3, 129.2, 128.4, 126.3, 126.2, 124.2, 122.4, 120.7, 119.4, 117.4, 109.9, 109.0, 43.4, 31.7, 29.0, 27.1, 22.7, 14.1. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{24}H_{25}NSe$: 407.1147; Found 407.1147.

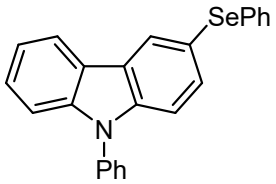



**9-(2-ethylhexyl)-3-(phenylselanyl)-9*H*-carbazole (3g)**, 67% yield (58.3 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 200:1, v:v). White solid, m.p.: 119.1-119.7 °C. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.41 (d, *J* = 1.7 Hz, 1H), 8.07 (d, *J* = 7.7 Hz, 1H), 7.71 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.50-7.47 (m, 1H), 7.41 (d, *J* = 8.3 Hz, 1H), 7.36 (dd, *J* = 8.4, 1.4 Hz, 3H), 7.26-7.15 (m, 4H), 4.20-4.12 (m, 2H), 2.10-2.05 (m, 1H), 1.45-1.26 (m, 8H), 0.94 (t, *J* = 7.4 Hz, 3H), 0.88 (t, *J* =

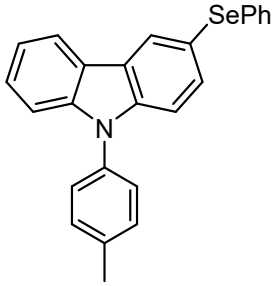
7.2 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.2, 140.9, 134.4, 133.2, 130.4, 129.2, 128.3, 126.2, 126.2, 124.2, 122.3, 120.6, 119.4, 117.5, 110.2, 109.3, 47.6, 39.5, 31.1, 28.9, 24.6, 23.2, 14.2, 11.0. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{26}H_{29}NSe$: 435.1460; Found 435.1460.



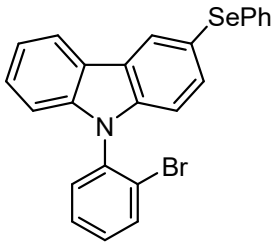

**9-benzyl-3-(phenylselanyl)-9*H*-carbazole (3h)**, 58% yield (47.6 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow solid, m.p.: 53.6-55.0 °C. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.39 (d, *J* = 1.7 Hz, 1H), 8.06 (d, *J* = 7.6 Hz, 1H), 7.64 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.44-7.41 (m, 1H), 7.37-7.32 (m, 3H), 7.30 (d, *J* = 8.4 Hz, 1H), 7.26-7.22 (m, 4H), 7.19-7.12 (m, 5H), 5.48 (s, 2H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.0, 140.6, 136.9, 134.2, 133.4, 130.6, 129.3, 129.0, 128.2, 127.8, 126.6, 126.3, 124.4, 122.6, 120.7, 119.9, 118.3, 110.1, 109.3, 46.8. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{25}H_{19}NSe$: 413.0677; Found 413.0677.



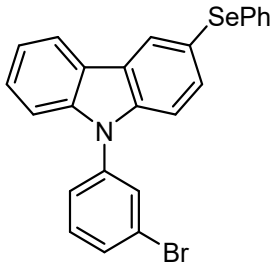

**9-phenyl-3-(phenylselanyl)-9*H*-carbazole (3i)**, 69% yield (54.8 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.47 (d, *J* = 2.3 Hz, 1H), 8.13 (d, *J* = 7.8 Hz, 1H), 7.67 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.65-7.62 (m, 2H), 7.58 (dd, *J* = 8.5, 1.4 Hz, 2H), 7.50 (t, *J* = 7.4 Hz, 1H), 7.47-7.43 (m, 2H), 7.40-7.38 (m, 3H), 7.34-7.31 (m, 1H), 7.26-7.18 (m, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.3, 140.9, 137.4, 134.2, 133.4, 130.5, 130.1, 129.3, 128.1, 127.9, 127.2, 126.6, 126.3, 124.7, 122.8, 120.6, 120.5, 119.0, 111.0, 110.1. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{24}H_{17}NSe$: 399.0521; Found 399.0521.



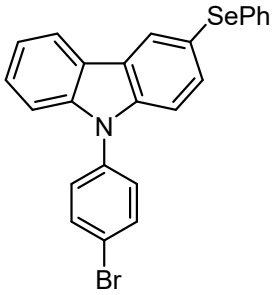

**3-(phenylselanyl)-9-(p-tolyl)-9*H*-carbazole (3j)**, 56% yield (46.1 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). White solid, m.p.: 96.1-96.8 °C. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.43 (d, *J* = 1.2 Hz, 1H), 8.08 (d, *J* = 7.6 Hz, 1H), 7.62 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.40-7.33 (m, 8H), 7.31 (d, *J* = 8.4 Hz, 1H), 7.27-7.25 (m, 1H), 7.19-7.16 (m, 2H), 7.15-7.12 (m, 1H), 2.46 (s, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.4, 141.0, 137.8, 134.7, 134.3, 133.4, 130.7, 130.4, 129.2, 128.1, 127.0, 126.5, 126.3, 124.6, 122.7, 120.6, 120.3, 118.7, 111.0, 110.1, 21.4. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{25}H_{19}NSe$: 413.0677; Found 413.0677.



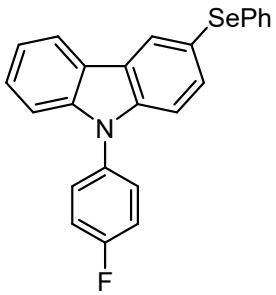

**9-(2-bromophenyl)-3-(phenylselanyl)-9*H*-carbazole (3k)**, 42% yield (39.8 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.42 (s, 1H), 8.08 (d, *J* = 7.8 Hz, 1H), 7.83 (d, *J* = 8.1 Hz, 1H), 7.61 (d, *J* = 8.4 Hz, 1H), 7.52-7.47 (m, 1H), 7.45 (dd, *J* = 7.9, 1.8 Hz, 1H), 7.41-7.34 (m, 4H), 7.27 (t, *J* = 7.5 Hz, 1H), 7.20-7.17 (m, 2H), 7.16-7.12 (m, 1H), 7.05 (d, *J* = 7.8 Hz, 1H), 7.00 (d, *J* = 8.4 Hz, 1H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.2, 140.8, 136.5, 134.4, 134.0, 133.3, 131.1, 130.7, 130.5, 129.3, 129.0, 128.0, 126.6, 126.4, 124.6, 123.8, 122.7, 120.7, 120.6, 119.2, 111.2, 110.4. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{24}H_{16}BrNSe$: 476.9626; Found 476.9626.



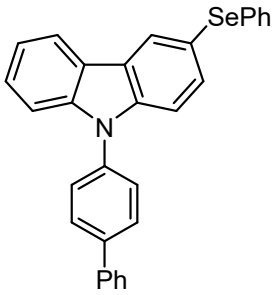

**9-(3-bromophenyl)-3-(phenylselanyl)-9*H*-carbazole (3l)**, 48% yield (45.6 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.37 (d, *J* = 1.1 Hz, 1H), 8.04 (d, *J* = 7.6 Hz, 1H), 7.68 (t, *J* = 1.9 Hz, 1H), 7.60 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.58-7.56 (m, 1H), 7.47-7.30 (m, 7H), 7.27-7.25 (m, 1H), 7.19-7.12 (m, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 140.9, 140.5, 138.8, 134.0, 133.5, 131.3, 130.9, 130.7, 130.2, 129.3, 128.0, 126.8, 126.4, 125.8, 124.9, 123.4, 123.0, 120.9, 120.7, 119.7, 110.8, 109.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{24}H_{16}BrNSe$: 476.9626; Found 476.9626.



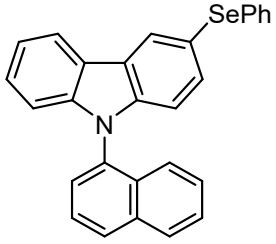

**9-(4-bromophenyl)-3-(phenylselanyl)-9*H*-carbazole (3m)**, 43% yield (41.1 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). White solid, m.p.: 110.2-111.7 °C. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.38 (d, *J* = 1.1 Hz, 1H), 8.05 (d, *J* = 7.4 Hz, 1H), 7.70-7.67 (m, 2H), 7.60 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.40-7.37 (m, 3H), 7.34-7.31 (m, 3H), 7.28-7.24 (m, 2H), 7.19-7.11 (m, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.0, 140.5, 136.5, 134.0, 133.5, 133.3, 130.7, 129.3, 128.8, 128.1, 126.7, 126.4, 124.8, 122.9, 121.4, 120.8, 120.7, 119.5, 110.8, 109.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{24}H_{16}BrNSe$: 476.9626; Found 476.9627.




**9-(4-fluorophenyl)-3-(phenylselanyl)-9*H*-carbazole (3n)**, 58% yield (48.3 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.41 (d, *J* = 1.7 Hz, 1H), 8.06 (d, *J* = 7.7 Hz, 1H), 7.61 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.48-7.46 (m, 2H), 7.41-7.38 (m, 1H), 7.35-7.33 (m, 2H), 7.30-7.23 (m, 5H), 7.19-7.12 (m, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 161.9 (d, $^1J_{C\text{-}F}$ = 247.64 Hz), 141.4, 141.0, 134.1, 133.5, 133.3 (d, $^2J_{C\text{-}F}$ = 3.02 Hz), 130.6, 129.3, 129.1 ($^3J_{C\text{-}F}$ = 9.06 Hz), 128.1, 126.7, 126.4, 124.7, 122.7, 120.7, 120.6, 119.2, 117.1 (d, $^4J_{C\text{-}F}$ = 22.65 Hz), 110.7, 109.8. **$^{19}$F NMR (565 MHz, $CDCl_3$)** δ 35.23. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{24}H_{16}FNSe$: 417.0427; Found 417.0426.

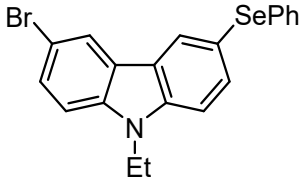



**9-([1,1'-biphenyl]-4-yl)-3-(phenylselanyl)-9*H*-carbazole (3o)**, 42% yield (39.4 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.41 (d, *J* = 2.3 Hz, 1H), 8.06 (d, *J* = 7.7 Hz, 1H), 7.76 (d, *J* = 8.5 Hz, 2H), 7.64-7.61 (m, 3H), 7.56 (d, *J* = 8.5 Hz, 2H), 7.47-7.32 (m, 8H), 7.27-7.25 (m, 1H), 7.17-7.12 (m, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.2, 140.8, 140.7, 140.2, 136.5, 134.2, 133.5, 130.5, 129.3, 129.1, 128.7, 128.1, 127.9, 127.4, 127.6, 126.6, 126.3, 124.8, 122.9, 120.6, 120.6, 119.1, 111.1, 110.2. **HRMS (ESI)** m/z: $[M+K]^+$ calcd for $C_{30}H_{21}NSeK$: 514.0471; Found 514.0471.

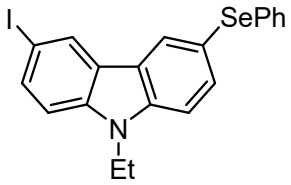



**9-(naphthalen-1-yl)-3-(phenylselanyl)-9*H*-carbazole (3p)**, 63% yield (56.3 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 150:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.47 (d, *J* = 1.7 Hz, 1H), 8.11 (d, *J* = 7.9 Hz, 1H), 7.97 (d, *J* = 7.9 Hz, 1H), 7.94 (d, *J* = 8.4 Hz, 1H), 7.59-7.54 (m, 2H), 7.52 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.49-7.44 (m, 1H), 7.36-7.34 (m, 2H), 7.29-7.23 (m, 4H), 7.16-7.14 (m, 2H), 7.12-7.09 (m, 1H), 6.94 (d, *J* = 8.0 Hz, 1H), 6.90 (d, *J* = 8.4 Hz, 1H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 142.5, 142.0, 134.9, 134.1, 133.7, 133.4, 130.9, 130.6, 129.3, 129.2, 128.6, 128.0, 127.2, 126.9, 126.8, 126.6, 126.3, 126.0, 124.6, 123.4,

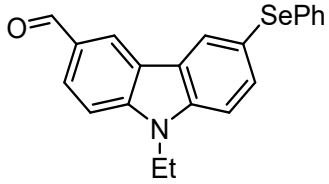
122.6, 120.6, 120.4, 119.0, 111.4, 110.5. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{28}H_{19}NSe$: 449.0677; Found 449.0677.



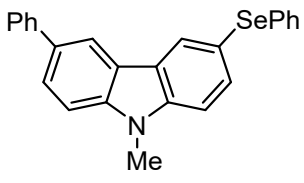

**3-bromo-9-ethyl-6-(phenylselanyl)-9*H*-carbazole (3s)**, 59% yield (50.6 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Brown solid, m.p.: 160.8-162.4 °C. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.18 (d, *J* = 1.7 Hz, 1H), 8.00 (d, *J* = 1.9 Hz, 1H), 7.59 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.40 (dd, *J* = 8.7, 2.0 Hz, 1H), 7.26 (dd, *J* = 8.3, 1.3 Hz, 2H), 7.18 (d, *J* = 8.4 Hz, 1H), 7.11-7.04 (m, 4H), 4.13 (q, *J* = 7.3 Hz, 2H), 1.27 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 140.0, 138.7, 134.0, 133.7, 130.7, 129.2, 128.8, 128.2, 126.4, 124.0, 123.4, 123.1, 118.4, 112.1, 110.1, 109.8, 37.8, 13.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{20}H_{16}BrNSe$: 428.9626; Found 428.9626.



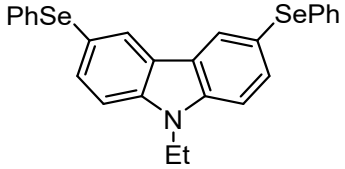

**9-ethyl-3-iodo-6-(phenylselanyl)-9*H*-carbazole (3t)**, 55% yield (52.4 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.32 (d, *J* = 1.7 Hz, 1H), 7.97 (d, *J* = 7.7 Hz, 1H), 7.62 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.40-7.38 (m, 1H), 7.30 (d, *J* = 8.3 Hz, 1H), 7.27-7.24 (m, 2H), 7.17-7.14 (m, 1H), 7.11-7.09 (m, 2H), 7.07-7.06 (m, 1H), 4.22 (q, *J* = 7.3 Hz, 2H), 1.33 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 140.2, 139.9, 134.5, 133.3, 130.3, 129.2, 128.4, 126.3, 126.2, 124.3, 122.4, 120.7, 119.4, 117.5, 109.6, 108.8, 37.2, 13.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{20}H_{16}INSe$: 476.9487; Found 476.9488.



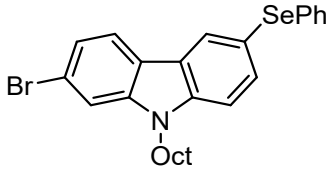

**9-ethyl-6-(phenylselanyl)-9*H*-carbazole-3-carbaldehyde (3u)**, 53% yield (40.1 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 10:1, v:v). Brown solid, m.p.: 147.9-149.4 °C. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 10.07 (s, 1H), 8.53 (d, *J* = 2.2 Hz, 1H), 8.39 (d, *J* = 1.6 Hz, 1H), 8.02 (dd, *J* = 8.5, 1.6 Hz, 1H), 7.75 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.47 (d, *J* = 8.5 Hz, 1H), 7.41-7.39 (m, 3H), 7.25-7.19 (m, 3H), 4.38 (q, *J* = 7.3 Hz, 2H), 1.47 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 191.7, 143.8, 140.5, 133.7, 133.5, 131.2, 129.4, 129.0, 127.9, 127.4, 126.7, 124.5, 124.4, 122.6, 120.2, 110.3, 109.1, 38.2, 14.0. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{21}H_{17}NOSe$: 379.0470; Found 379.0470.



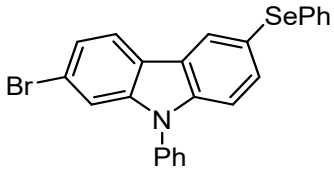
**9-methyl-3-phenyl-6-(phenylselanyl)-9*H*-carbazole (3v)**, 60% yield (49.5 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.39 (s, 1H), 8.21 (s, 1H), 7.68 (d, *J* = 8.4 Hz, 2H), 7.65 (d, *J* = 7.0 Hz, 2H), 7.42 (t, *J* = 7.7 Hz, 2H), 7.35 (d, *J* = 8.4 Hz, 1H), 7.32-7.26 (m, 4H), 7.16-7.10 (m, 3H), 3.74 (s, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.9, 141.3, 140.7, 134.4, 133.4, 132.9, 130.4, 129.2, 128.9, 128.3, 127.3, 126.6, 126.2, 125.8, 124.2, 122.7, 119.0, 117.9, 109.8, 109.0, 29.3. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{25}H_{19}NSe$: 413.0677; Found 413.0677.



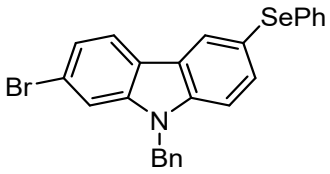

**9-ethyl-3,6-bis(phenylselanyl)-9*H*-carbazole (3w)**, 41% yield (41.5 mg), known compound[3]. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). White solid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.37 (s, 2H), 7.75 (d, *J* = 8.4 Hz, 2H), 7.38 (t, *J* = 7.3 Hz, 6H), 7.24-7.19 (m, 6H), 4.35 (q, *J* = 7.3 Hz, 2H), 1.47 (t, *J* = 7.2 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 140.0, 134.0, 133.5, 130.6, 129.2, 128.3, 126.3, 123.6, 118.5, 109.8, 37.9, 14.0. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{26}H_{21}NSe_2$: 506.9999; Found 506.9998.



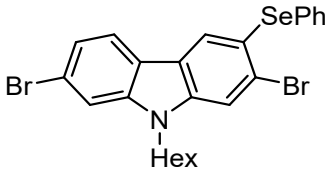

**1-(2-bromo-6-(phenylselanyl)-9*H*-carbazol-9-yl)octan-1-one (3x)**, 61% yield (64.2 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.30 (d, *J* = 1.7 Hz, 1H), 7.83 (d, *J* = 8.3 Hz, 1H), 7.68 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.51 (d, *J* = 1.7 Hz, 1H), 7.36-7.33 (m, 2H), 7.31-7.28 (m, 2H), 7.21-7.13 (m, 3H), 4.16 (t, *J* = 7.4 Hz, 2H), 1.83-1.78 (m, 2H), 1.36-1.22 (m, 10H), 0.86 (t, *J* = 7.1 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.5, 140.4, 134.0, 133.4, 130.7, 129.2, 128.0, 126.4, 123.6, 122.5, 121.7, 121.3, 119.9, 118.5, 112.1, 110.0, 43.4, 31.9, 29.4, 29.3, 29.0, 27.3, 22.7, 14.2. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{26}H_{28}BrNSe$: 513.0565; Found 513.0564.



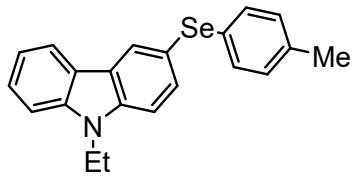

**2-bromo-9-phenyl-6-(phenylselanyl)-9*H*-carbazole (3y)**, 55% yield (51.7 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.39 (d, *J* = 2.2 Hz, 1H), 7.94 (d, *J* = 8.2 Hz, 1H), 7.67-7.61 (m, 3H), 7.53 (dd, *J* = 8.1, 1.2 Hz, 4H), 7.41-7.38 (m, 3H), 7.32 (d, *J* = 7.8 Hz, 1H), 7.24-7.19 (m, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 142.0, 141.0, 136.8, 133.8, 133.6, 130.9, 130.3, 129.3, 128.3, 127.8, 127.2, 126.5, 124.1, 123.7, 121.8, 121.7, 120.2, 119.9, 113.1, 111.2. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{24}H_{16}BrNSe$: 476.9626; Found 476.9626.



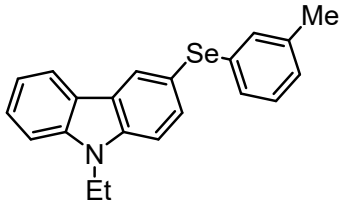

**9-benzyl-2-bromo-6-(phenylselanyl)-9*H*-carbazole (3z)**, 40% yield (39.0 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). White solid, m.p.: 128.3-128.6 °C. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.23 (d, *J* = 1.8 Hz, 1H), 7.77 (d, *J* = 8.3 Hz, 1H), 7.55-7.53 (m, 1H), 7.39 (d, *J* = 1.7 Hz, 1H), 7.27-7.23 (m, 3H), 7.17-7.14 (m, 4H), 7.12-7.05 (m, 3H), 7.00 (dd, *J* = 8.0, 1.6 Hz, 2H), 5.29 (s, 2H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.8, 140.7, 136.3, 133.7, 133.5, 130.9, 129.3, 129.1, 127.9, 127.8, 126.5, 126.4, 123.9, 123.1, 121.8, 121.5, 120.2, 119.3, 112.3, 110.3, 46.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{25}H_{18}BrNSe$: 490.9782; Found 490.9782.




**2,7-dibromo-9-hexyl-3-(phenylselanyl)-9*H*-carbazole (3aa)**, 29% yield (32.6 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.01 (s, 1H), 7.71 (d, *J* = 8.4 Hz, 1H), 7.65 (s, 1H), 7.49-7.47 (m, 2H), 7.41 (dd, *J* = 7.4, 2.0 Hz, 1H), 7.30-7.27 (m, 3H), 7.23 (d, *J* = 7.2 Hz, 1H), 4.15 (t, *J* = 7.4 Hz, 2H), 1.81 (q, *J* = 7.4 Hz, 2H), 1.38-1.25 (m, 6H), 0.87 (t, *J* = 7.0 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 141.6, 140.9, 133.2, 133.0, 129.7, 129.3, 127.6, 127.4, 126.5, 124.9, 122.9, 121.8, 120.8, 120.3, 113.5, 112.2, 43.6, 31.6, 28.9, 27.0, 22.7, 14.1. **HRMS (ESI)** m/z: $[M+H]^+$ calcd for $C_{24}H_{23}Br_2NSe$: 565.9415; Found 565.9422.

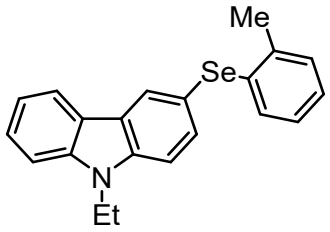



**9-ethyl-3-(*p*-tolylselanyl)-9*H*-carbazole (3ab)**, 66% yield (48.2 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.35 (d, *J* = 1.7 Hz, 1H), 8.02 (d, *J* = 7.5 Hz, 1H), 7.65 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.46-7.43 (m, 1H), 7.36 (d, *J* = 7.4 Hz, 1H), 7.30-7.26 (m, 3H), 7.22-7.18 (m, 1H), 6.99 (d, *J* = 7.8 Hz, 2H), 4.28 (q, *J* = 7.2 Hz, 2H), 2.25 (s, 3H), 1.38 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 140.2, 139.7, 136.3, 132.8, 131.1, 130.3, 130.0, 127.8, 126.2, 124.2, 122.4, 120.7, 119.3, 118.4, 109.5, 108.7, 37.7, 21.1, 13.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{21}H_{19}NSe$: 365.0677; Found 365.0677.

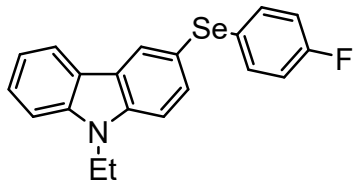



**9-ethyl-3-(*m*-tolylselanyl)-9*H*-carbazole (3ac)**, 42% yield (30.5 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)**

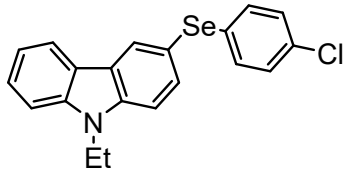
δ 8.28 (d, *J* = 1.8 Hz, 1H), 7.94 (d, *J* = 7.7 Hz, 1H), 7.58 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.36 (t, *J* = 7.7 Hz, 1H), 7.29 (d, *J* = 8.3 Hz, 1H), 7.23 (d, *J* = 8.4 Hz, 1H), 7.12 (t, *J* = 6.4 Hz, 1H), 7.08 (s, 1H), 7.01 (d, *J* = 7.9 Hz, 1H), 6.96 (t, *J* = 7.6 Hz, 1H), 6.85 (d, *J* = 7.4 Hz, 1H), 4.23 (q, *J* = 7.3 Hz, 2H), 2.13 (s, 3H), 1.31 (t, *J* = 7.3 Hz, 3H). **13C NMR (151 MHz, $CDCl_3$)** δ 140.2, 139.9, 137.3, 135.3, 133.5, 130.0, 129.9, 128.7, 126.7, 126.3, 126.1, 124.4, 122.4, 120.7, 119.4, 116.7, 109.7, 108.8, 37.7, 21.9, 13.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{21}H_{19}NSe$: 365.0677; Found 365.0677.




**9-ethyl-3-(*o*-tolylselanyl)-9*H*-carbazole (3ad)**, 53% yield (38.6 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.44 (d, *J* = 1.6 Hz, 1H), 8.11 (d, *J* = 7.7 Hz, 1H), 7.73 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.56-7.52 (m, 1H), 7.46 (d, *J* = 8.2 Hz, 1H), 7.42 (d, *J* = 8.5 Hz, 1H), 7.30 (t, *J* = 7.4 Hz, 1H), 7.23 (d, *J* = 8.3 Hz, 1H), 7.15-7.12 (m, 1H), 7.09 (d, *J* = 8.0 Hz, 1H), 7.01 (t, *J* = 8.4 Hz, 1H), 4.39 (q, *J* = 7.3 Hz, 2H), 2.51 (s, 3H), 1.49 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** $^{13}$C NMR (151 MHz, $CDCl_3$) δ 140.6, 139.9, 139.0, 134.1, 133.2, 131.0, 129.0, 128.3, 127.5, 127.2, 126.3, 124.3, 122.5, 120.7, 119.4, 117.7, 109.6, 108.8, 37.8, 21.4, 14.0. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{21}H_{19}NSe$: 365.0677; Found 365.0678.

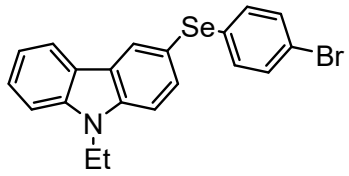



**9-ethyl-3-((4-fluorophenyl)selanyl)-9*H*-carbazole (3ae)**, 61% yield (44.8 mg), new compound**.** (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Brown solid, m.p.: 92.0-92.4 °C. **1H NMR (600 MHz, $CDCl_3$)** δ 8.42 (s, 1H), 8.11 (d, *J* = 7.8 Hz, 1H), 7.72 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.55-7.52 (m, 1H), 7.44 (d, *J* = 8.3 Hz, 1H), 7.41-7.37 (m, 3H), 7.29 (t, *J* = 7.4 Hz, 1H), 6.96 (t, *J* = 8.9 Hz, 2H), 4.36 (q, *J* = 7.3 Hz, 2H), 1.46 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 161.9 (d, $^1J_{C\text{-}F}$ = 246.1 Hz), 140.2, 139.8, 132.8 (d, $^2J_{C\text{-}F}$ = 4.5 Hz), 132.7, 128.6 ($^3J_{C\text{-}F}$ = 3.0 Hz), 127.9, 126.3, 124.3, 122.4, 120.7, 119.4, 118.1, 116.3 (d, $^4J_{C\text{-}F}$ = 9.1 Hz), 109.7, 108.8, 37.7, 13.9. **$^{19}$F NMR (565 MHz, $CDCl_3$)** δ 38.37. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{20}H_{16}FNSe$: 369.0427; Found 369.0427.

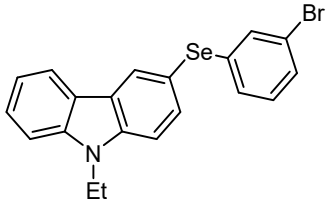



**3-((4-chlorophenyl)selanyl)-9-ethyl-9*H*-carbazole (3af)**, 57% yield (43.9 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Brown solid, m.p.: 84.2-86.3 °C. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.37 (s, 1H), 8.05 (dt, *J* = 7.8, 1.1 Hz, 1H), 7.67 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.49-7.46 (m, 1H), 7.40 (d, *J* = 8.3 Hz, 1H), 7.34 (d, *J* = 8.9 Hz, 1H), 7.25-7.21 (m, 3H), 7.14-7.12

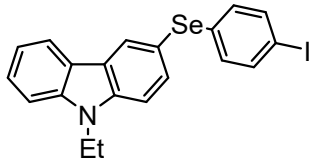
(m, 2H), 4.33 (q, *J* = 7.3 Hz, 2H), 1.42 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, CDCl$_3$)** δ 140.2, 139.9, 133.2, 132.8, 132.1, 131.5, 129.2, 128.4, 126.3, 124.3, 122.3, 120.7, 119.5, 117.1, 109.7, 108.8, 37.7, 13.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{20}H_{16}ClNSe$: 385.0131; Found 385.0131.



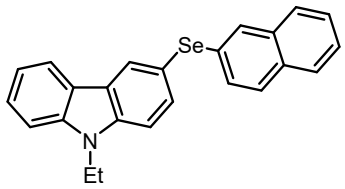

**3-((4-bromophenyl)selanyl)-9-ethyl-9*H*-carbazole (3ag)**, 55% yield (47.2 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). White solid, m.p.: 118.8-119.9 °C. **$^1$H NMR (600 MHz, CDCl$_3$)** δ 8.35 (d, *J* = 1.8 Hz, 1H), 8.03 (d, *J* = 7.7 Hz, 1H), 7.65 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.48-7.44 (m, 1H), 7.38 (d, *J* = 8.3 Hz, 1H), 7.32 (d, *J* = 8.4 Hz, 1H), 7.26-7.24 (m, 2H), 7.23-7.19 (m, 1H), 7.13 (d, *J* = 8.5 Hz, 2H), 4.31 (q, *J* = 7.3 Hz, 2H), 1.40 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, CDCl$_3$)** δ 140.2, 140.0, 133.6, 133.3, 132.1, 131.7, 128.5, 126.4, 124.3, 122.3, 120.7, 120.0, 119.5, 116.9, 109.7, 108.8, 37.7, 13.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{20}H_{16}BrNSe$: 428.9626; Found 428.9626.



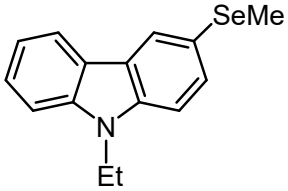

**3-((3-bromophenyl)selanyl)-9-ethyl-9*H*-carbazole (3ah)**, 56% yield (48 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). White solid, m.p.: 87.6-89.3 °C. **$^1$H NMR (600 MHz, CDCl$_3$)** δ 8.44 (d, *J* = 1.8 Hz, 1H), 8.11 (d, *J* = 7.7 Hz, 1H), 7.73 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.54-7.52 (m, 1H), 7.48 (t, *J* = 1.8 Hz, 1H), 7.45 (d, *J* = 8.2 Hz, 1H), 7.40 (d, *J* = 8.4 Hz, 1H), 7.30-7.28 (m, 2H), 7.23 (d, *J* = 7.9 Hz, 1H), 7.05 (t, *J* = 7.9 Hz, 1H), 4.38 (q, *J* = 7.3 Hz, 2H), 1.47 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, CDCl$_3$)** δ 140.3, 140.1, 137.0, 133.5, 132.2, 130.4, 129.1, 128.9, 128.4, 126.4, 124.4, 123.3, 122.4, 120.8, 119.5, 116.4, 109.8, 108.8, 37.8, 14.0. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{20}H_{16}BrNSe$: 428.9626; Found 428.9625.



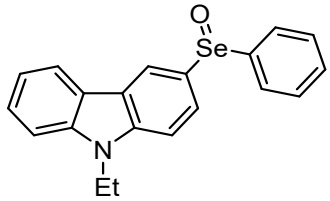

**9-ethyl-3-((4-iodophenyl)selanyl)-9*H*-carbazole (3ai)**, 50% yield (47.5 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Yellow oily liquid. **$^1$H NMR (600 MHz, CDCl$_3$)** δ 8.38 (s, 1H), 8.06 (d, *J* = 8.8 Hz, 1H), 7.68 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.51-7.45 (m, 3H), 7.42 (d, *J* = 8.3 Hz, 1H), 7.36 (d, *J* = 8.4 Hz, 1H), 7.26-7.23 (m, 1H), 7.02 (d, *J* = 8.4 Hz, 2H), 4.36 (q, *J* = 7.3 Hz, 2H), 1.44 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, CDCl$_3$)** δ 140.2, 138.0, 134.7, 134.0, 133.3, 131.8, 128.6, 126.3, 124.3, 122.3, 120.7, 119.5, 116.7, 109.7, 108.8, 91.0, 37.7, 13.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{20}H_{16}INSe$: 476.9487; Found 476.9487.



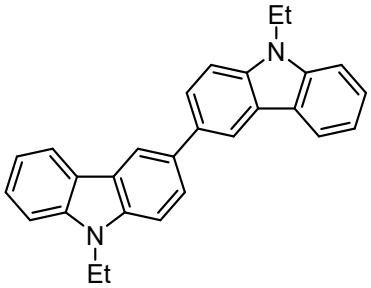

**9-ethyl-3-(naphthalen-2-ylselanyl)-9*H*-carbazole (3aj)**, 76% yield (60.8 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). White solid, m.p.: 103.8-104.6 °C. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.46 (d, *J* = 1.9 Hz, 1H), 8.07 (d, *J* = 7.7 Hz, 1H), 7.82 (s, 1H), 7.75 (dd, *J* = 8.4, 1.7 Hz, 2H), 7.65 (t, *J* = 8.4 Hz, 2H), 7.51-7.48 (m, 1H), 7.47-7.42 (m, 2H), 7.42-7.39 (m, 2H), 7.37 (d, *J* = 8.4 Hz, 1H), 7.26-7.23 (m, 1H), 4.36 (q, *J* = 7.3 Hz, 2H), 1.45 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 140.2, 139.9, 134.1, 133.2, 132.0, 131.9, 128.7, 128.5, 128.5, 128.3, 127.8, 127.2, 126.4, 126.2, 125.6, 124.3, 122.4, 120.7, 119.4, 117.6, 109.6, 108.7, 37.7, 13.9. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{24}H_{19}NSe$: 401.0677; Found 401.0677.




**9-ethyl-3-(methylselanyl)-9*H*-carbazole (3am)**, 21% yield (12.1 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 100:1, v:v). Brown oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.27 (s, 1H), 8.07 (d, *J* = 7.8 Hz, 1H), 7.63 (dd, *J* = 8.4, 1.7 Hz, 1H), 7.47 (t, *J* = 8.3 Hz, 1H), 7.40 (d, *J* = 8.2 Hz, 1H), 7.32 (d, *J* = 8.4 Hz, 1H), 7.23 (t, *J* = 7.9 Hz, 1H), 4.35 (q, *J* = 7.3 Hz, 2H), 2.41 (s, 3H), 1.42 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 140.1, 139.1, 130.4, 126.0, 125.0, 123.9, 122.3, 120.5, 119.5, 119.1, 109.1, 108.6, 37.6, 13.8, 9.6. **HRMS (ESI)** m/z: $[M]^+$ calcd for $C_{15}H_{15}NSe$: 289.0364; Found 289.0363




**9-ethyl-3-(phenylseleninyl)-9*H*-carbazole (4a)**, 90% yield (33 mg), new compound. (Eluent: petroleum ether (60-90 °C)/EtOAc = 20:1, v:v). Brown oily liquid. **$^1$H NMR (600 MHz, $CDCl_3$)** δ 8.46 (d, *J* = 1.7 Hz, 1H), 8.07 (d, *J* = 7.7 Hz, 1H), 7.71 (d, *J* = 6.5 Hz, 2H), 7.64 (dd, *J* = 8.5, 1.7 Hz, 1H), 7.46 (t, *J* = 7.7 Hz, 1H), 7.42-7.35 (m, 5H), 7.23 (t, *J* = 7.5 Hz, 1H), 4.26 (q, *J* = 7.3 Hz, 2H), 1.34 (t, *J* = 7.3 Hz, 3H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 143.7, 141.4, 140.4, 131.9, 131.0, 129.6, 126.8, 126.3, 123.7, 123.4, 122.2, 120.9, 119.8, 119.2, 109.6, 108.9, 37.7, 13.8. **HRMS (ESI)** m/z: $[M+H]^+$ calcd for $C_{20}H_{18}NOSe$: 368.0548; Found 368.0548.



**9,9'-diethyl-9*H*,9'*H*-3,3'-bicarbazole (8a)**, 42% yield (16.3 mg), known compound[4]. (Eluent: petroleum ether (60-90 °C)/EtOAc = 50:1, v:v). White solid. **$^{1}$H NMR (600 MHz, $CDCl_3$)** δ 8.41 (s, 2H), 8.19 (d, *J* = 7.7 Hz, 2H), 7.83 (dd, *J* = 8.4, 2.0 Hz, 2H), 7.53-7.46 (m, 4H), 7.43 (d, *J* = 8.2 Hz, 2H), 7.25 (t, *J* = 7.4 Hz, 2H), 4.40 (q, *J* = 7.3 Hz, 4H), 1.47 (t, *J* = 7.3 Hz, 6H). **$^{13}$C NMR (151 MHz, $CDCl_3$)** δ 140.6, 139.2, 133.6, 125.8, 125.7, 123.7, 123.3, 120.7, 119.2, 118.9, 108.8, 108.7, 37.8, 14.0.

## 5. References

[1] D. Singh; A. M. Deobald; L. R. S. Camargo; G. Tabarelli; O. E. D. Rodrigues; A. L. Braga. *Org. Lett*., 2010, **12**, 3288-3291.

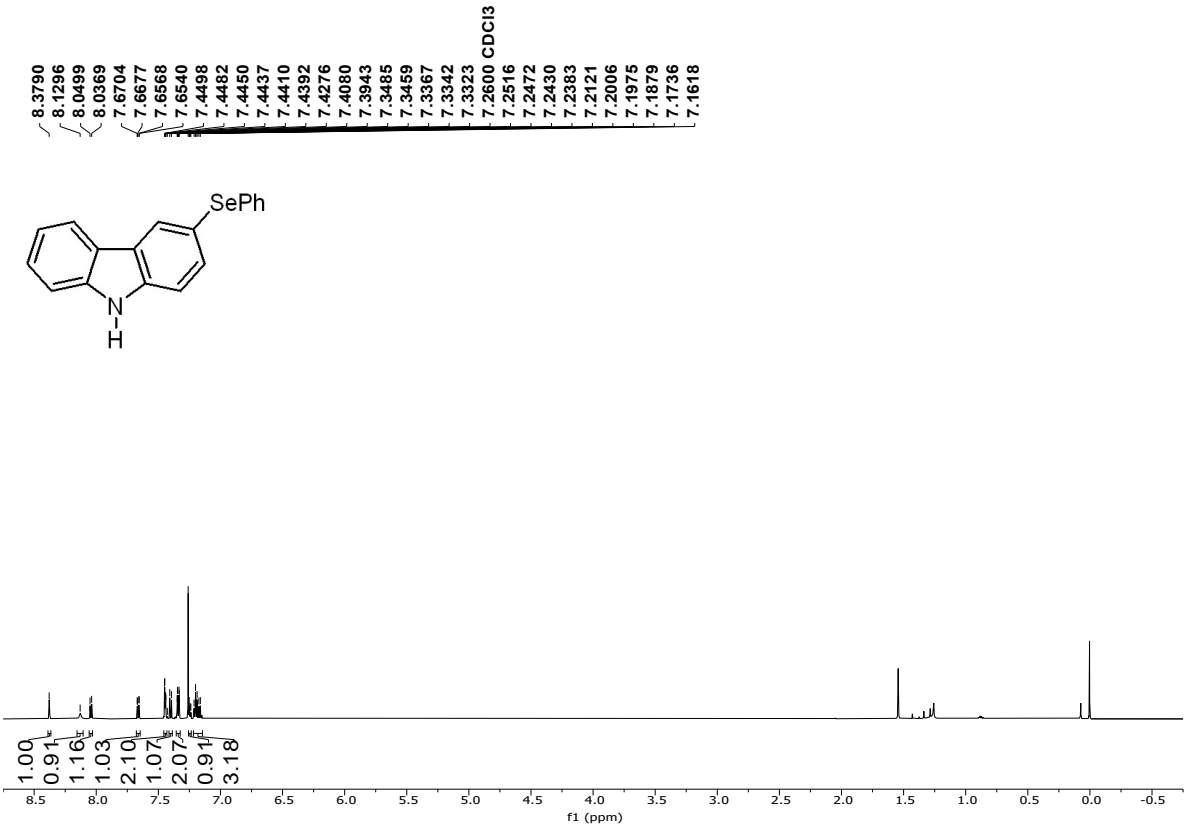
[2] B. Paul; S. Das; I. Chatterjee. *Org. Lett*., 2023, **25**, 653-658.

[3] J. Yin; P. Chen; L.-W. Miao; J. Wang; Y.-J. Jiang. *Eur. J. Org. Chem*., 2023, **26**, e202300290.

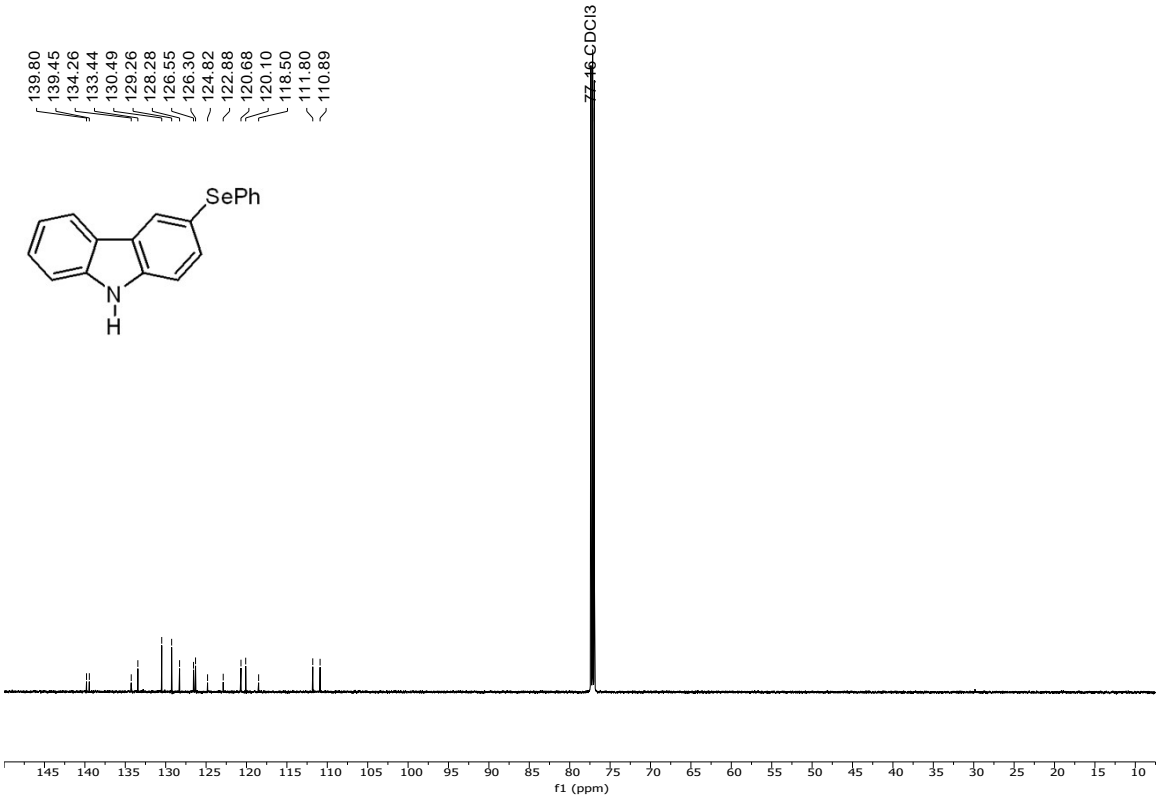
[4] S. Mallick; S. Maddala; K. Kollimalayan; P. Venkatakrishnan. *J. Org. Chem*., 2019, **84**, 73-93.

## 6. Copies of NMR Spectra

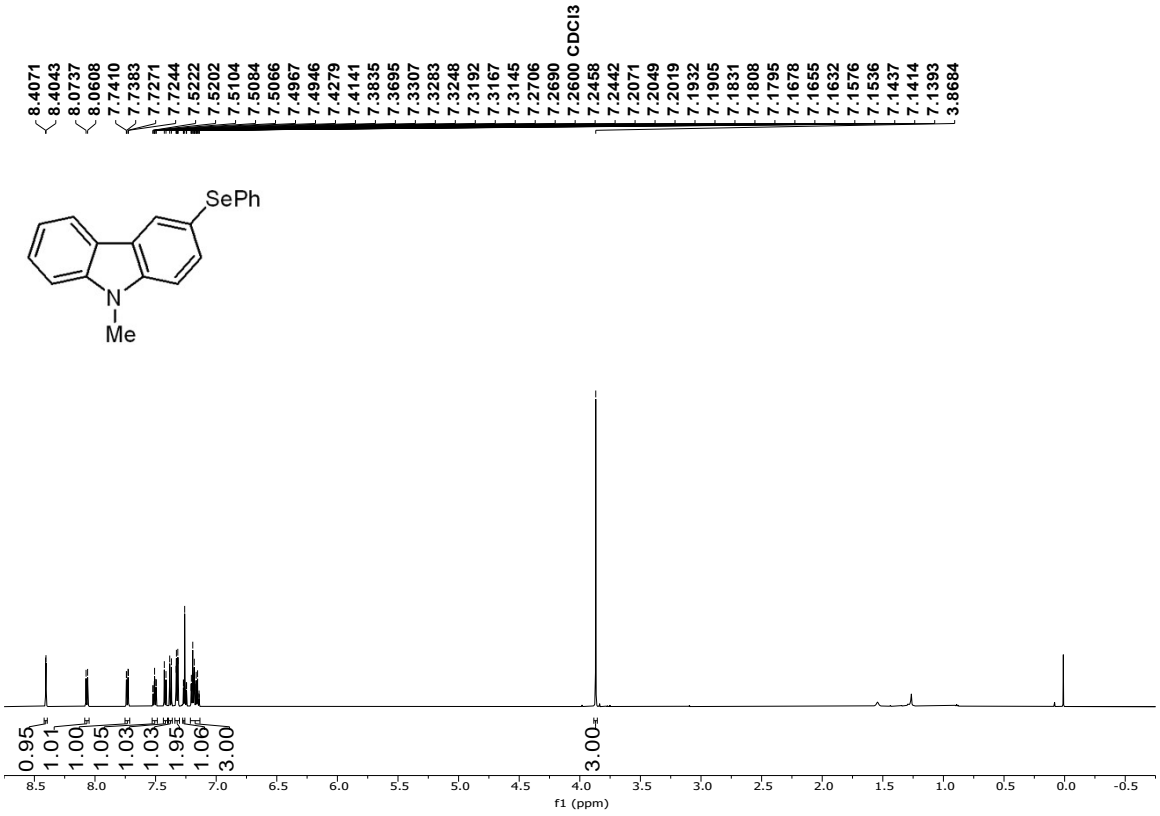
**$^{1}$H NMR of product 3a in $CDCl_3$ (600 MHz)**



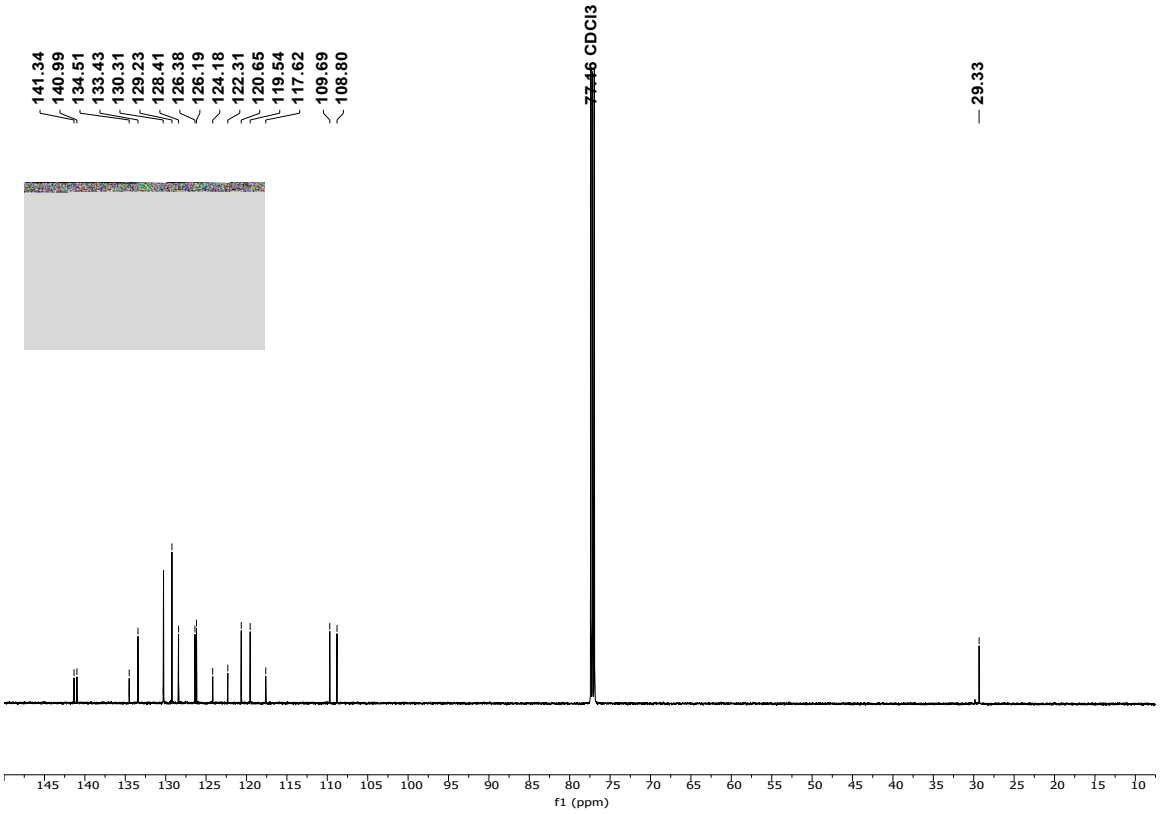

**$^{13}$C NMR of product 3a in $CDCl_3$ (151 MHz)**



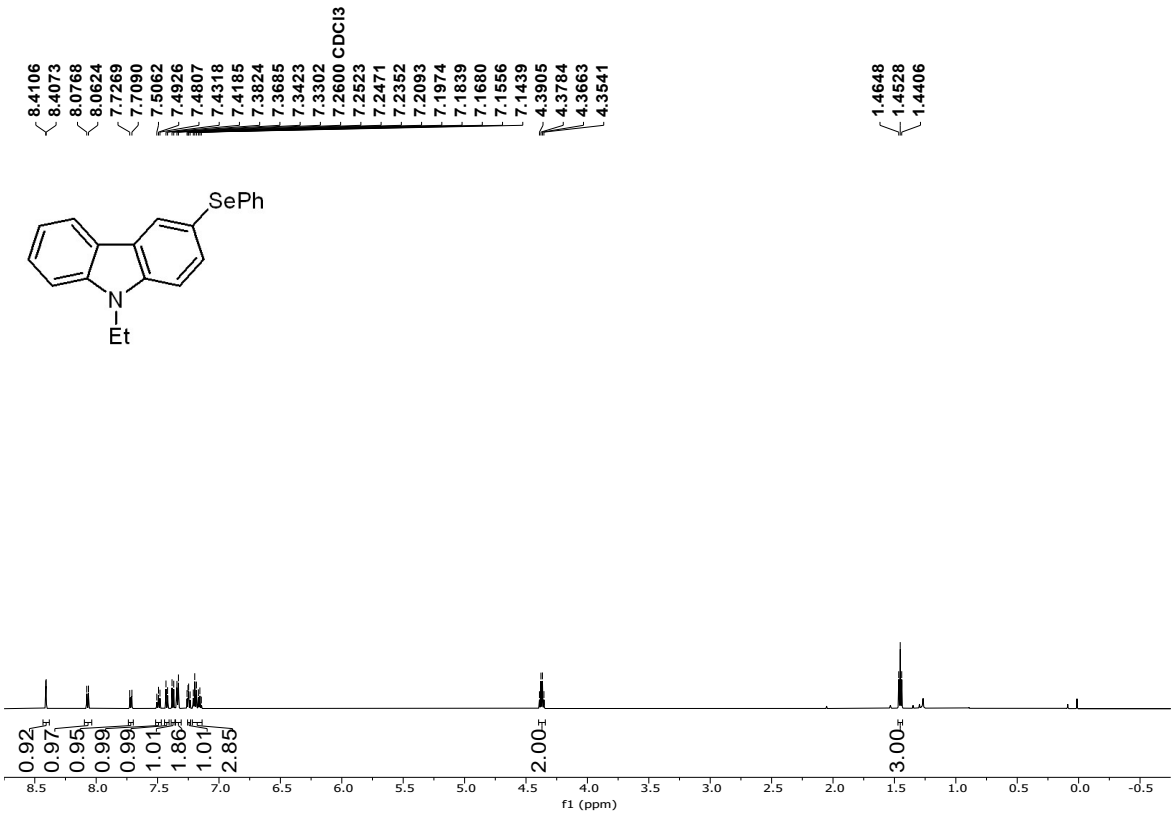

**$^1$H NMR of product 3b in $CDCl_3$ (600 MHz)**



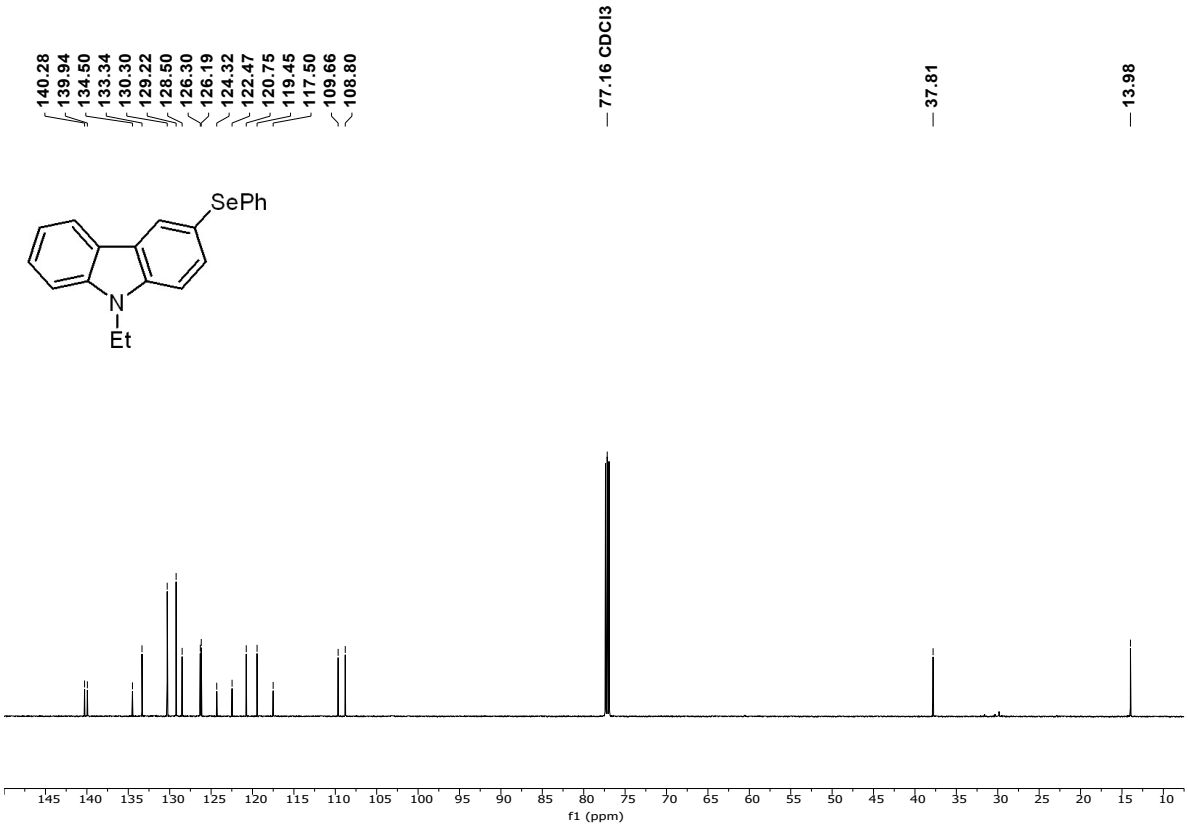
**$^{13}$C NMR of product 3b in $CDCl_3$ (151 MHz)**



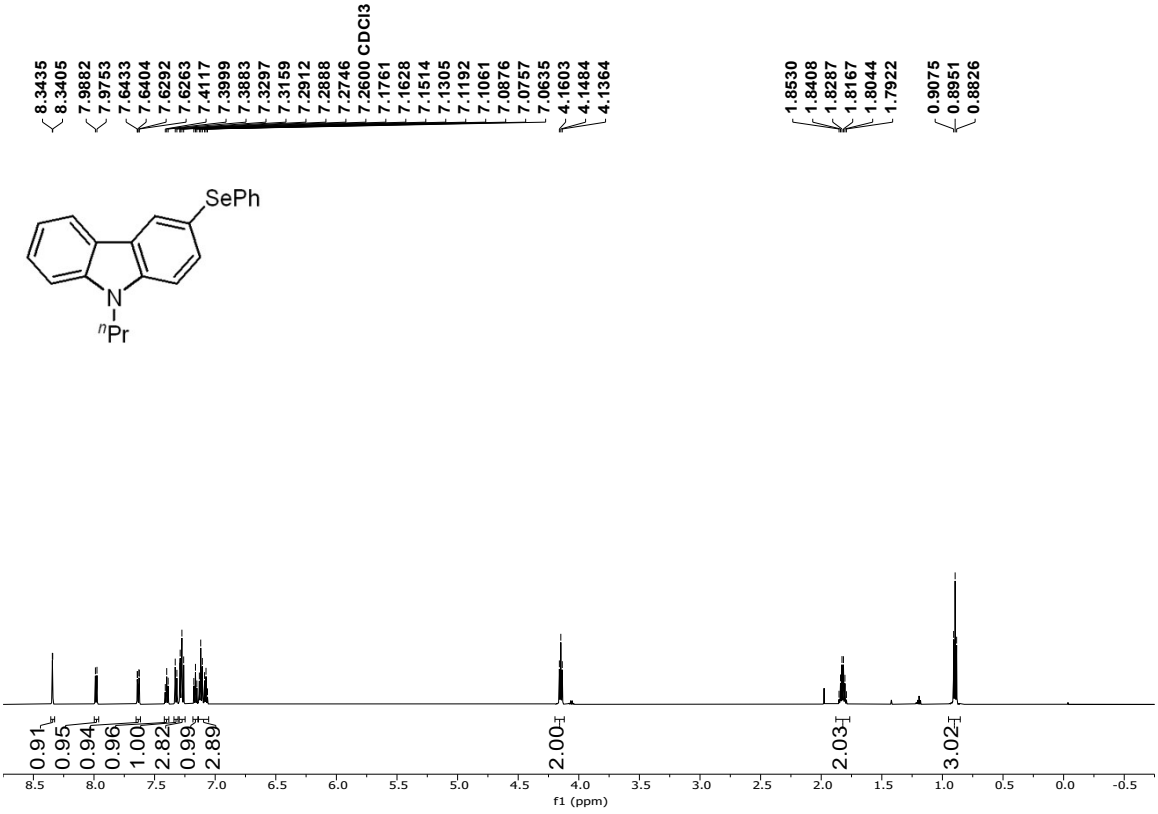

**$^{1}$H NMR of product 3c in $CDCl_3$ (600 MHz)**



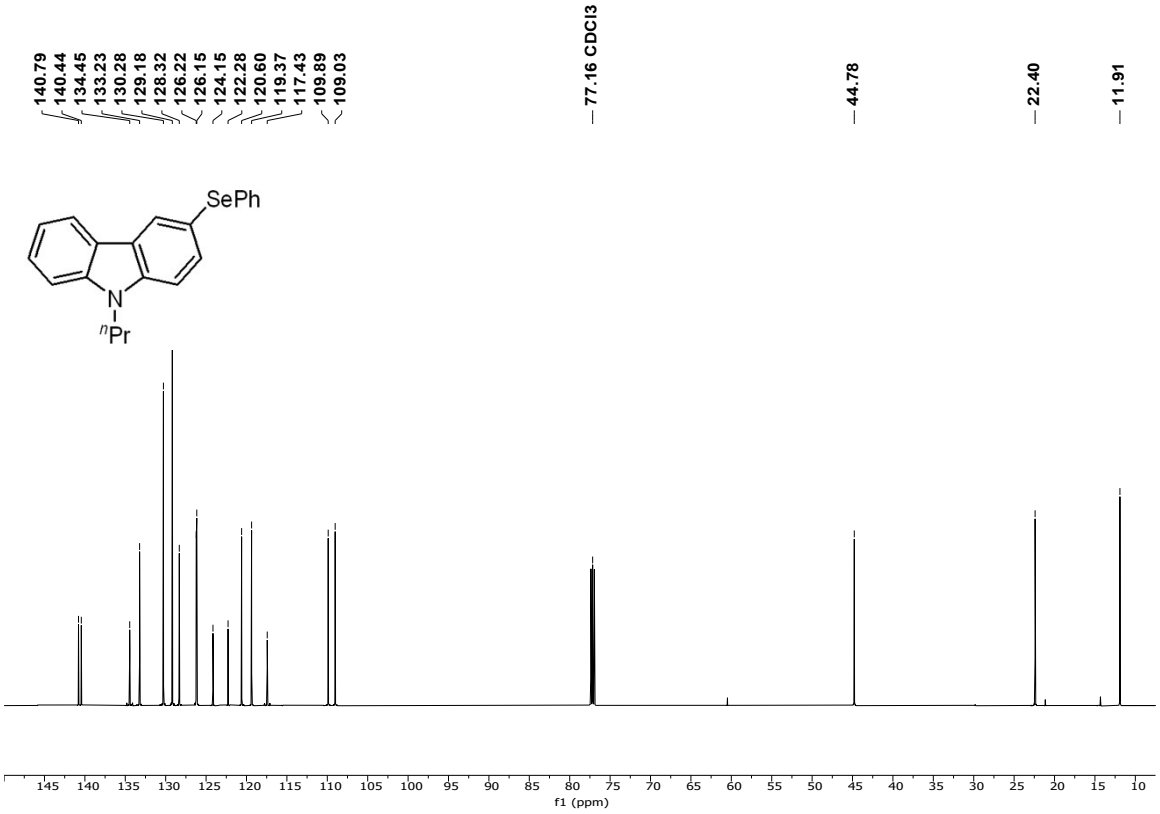

**$^{13}$C NMR of product 3c in $CDCl_3$ (151 MHz)**



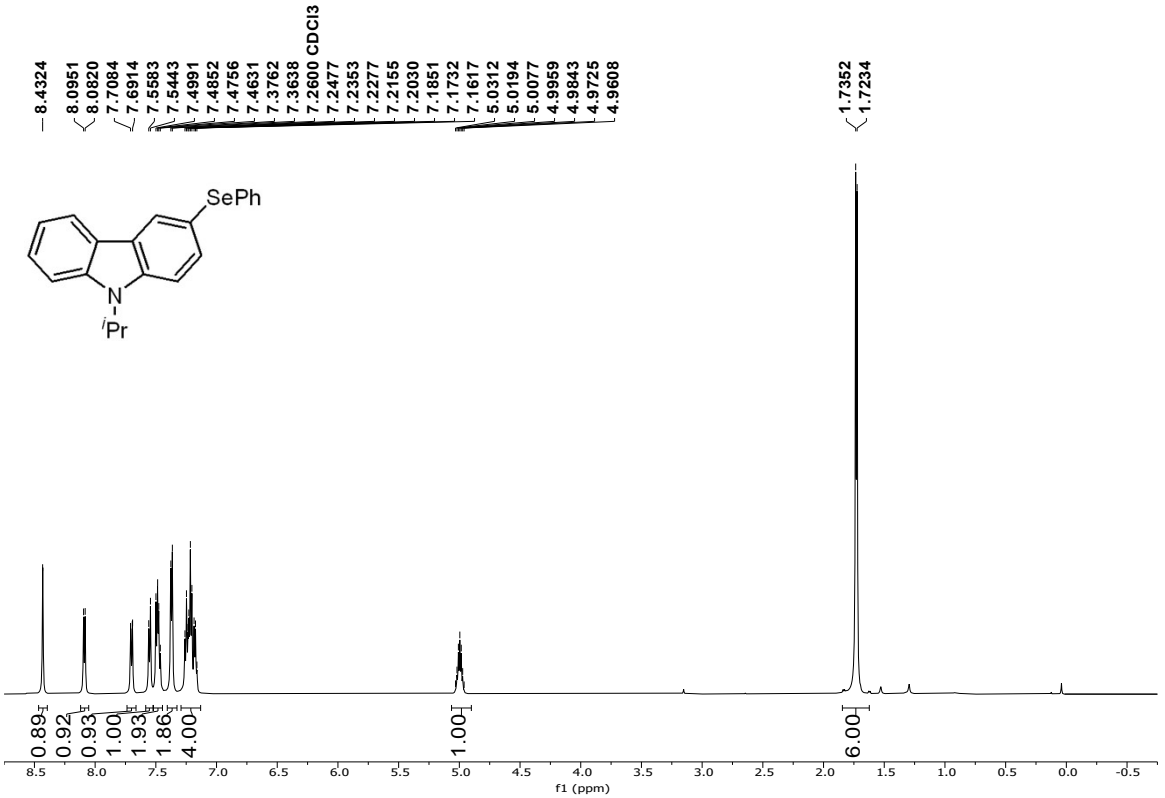
**$^{1}$H NMR of product 3d in $CDCl_3$ (600 MHz)**



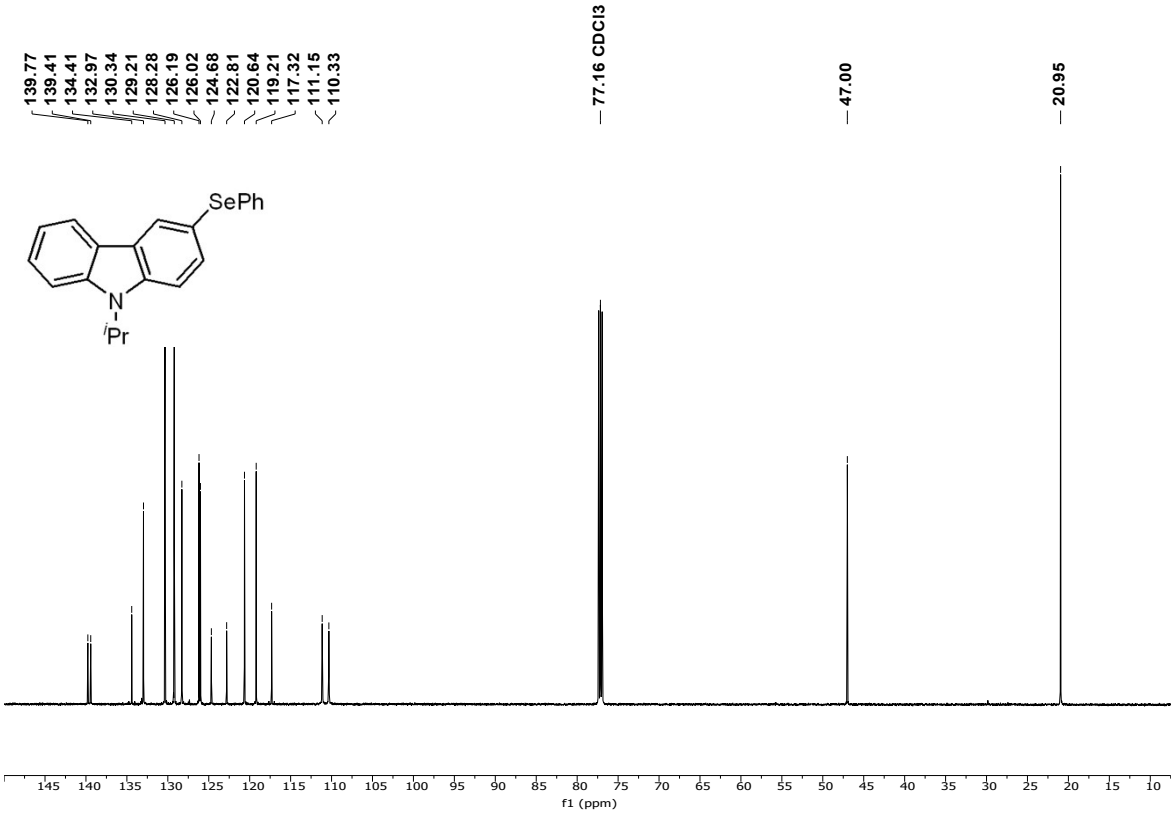

**$^{13}$C NMR of product 3d in $CDCl_3$ (151 MHz)**



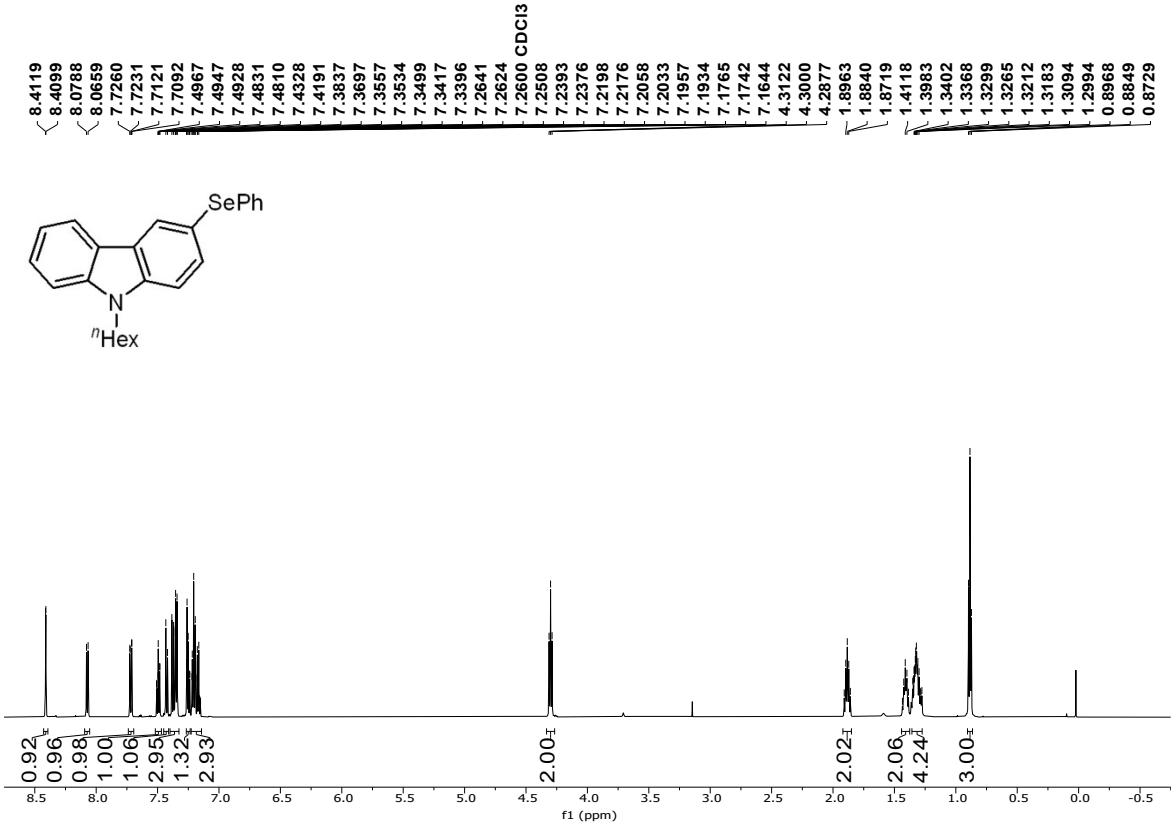

**$^{1}$H NMR of product 3e in $CDCl_3$ (600 MHz)**



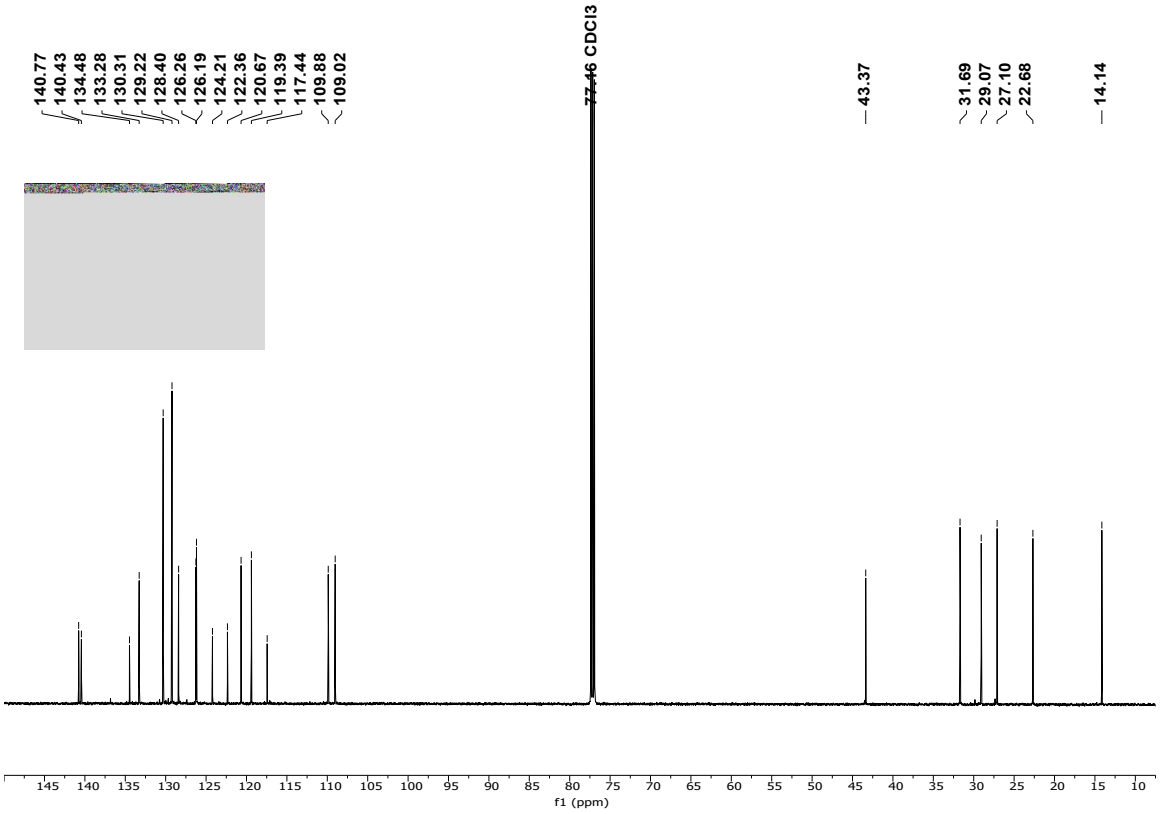

**$^{13}$C NMR of product 3e in $CDCl_3$ (151 MHz)**



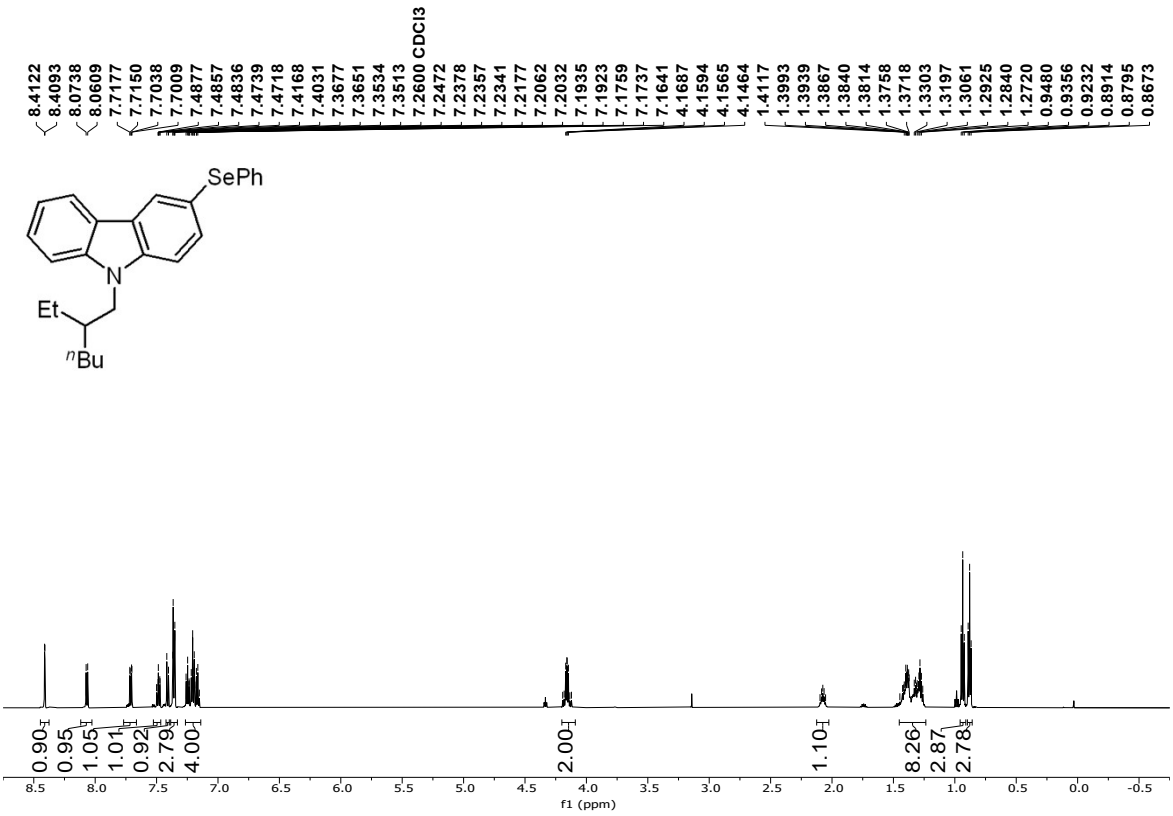
**$^{1}$H NMR of product 3f in $CDCl_3$ (600 MHz)**



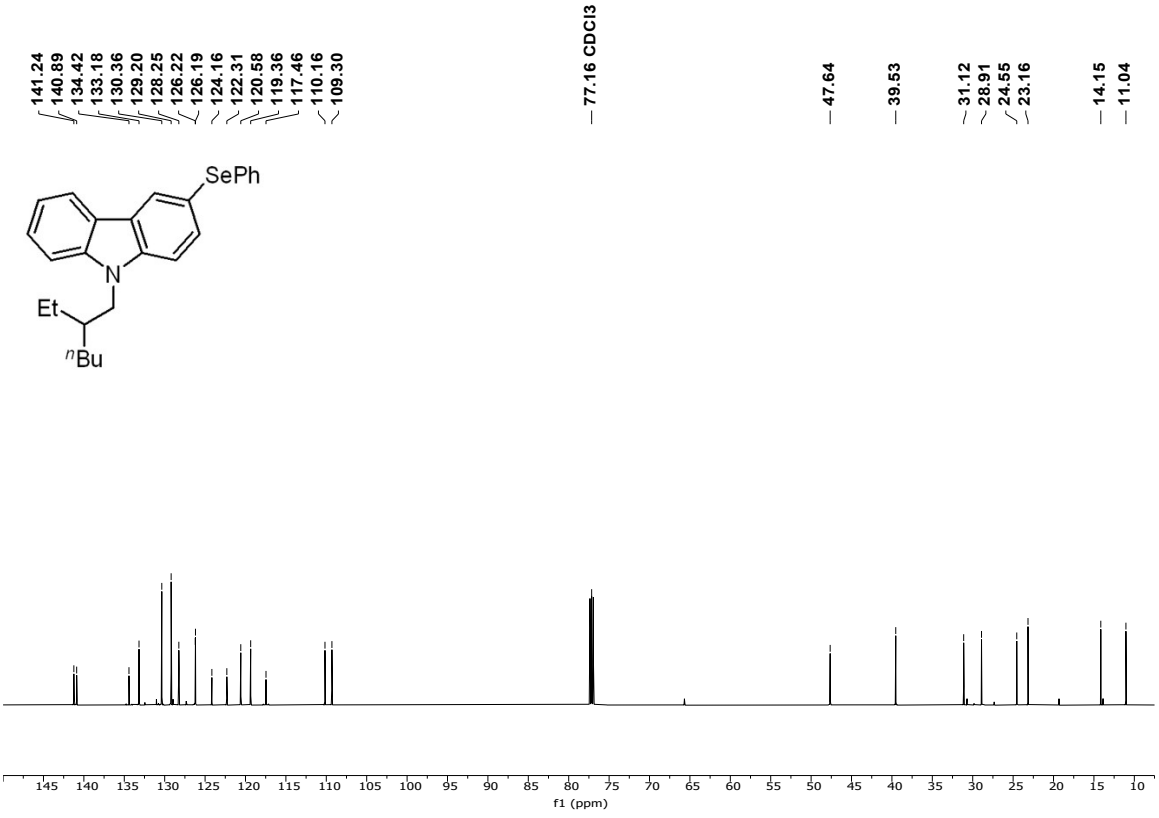

**$^{13}$C NMR of product 3f in $CDCl_3$ (151 MHz)**



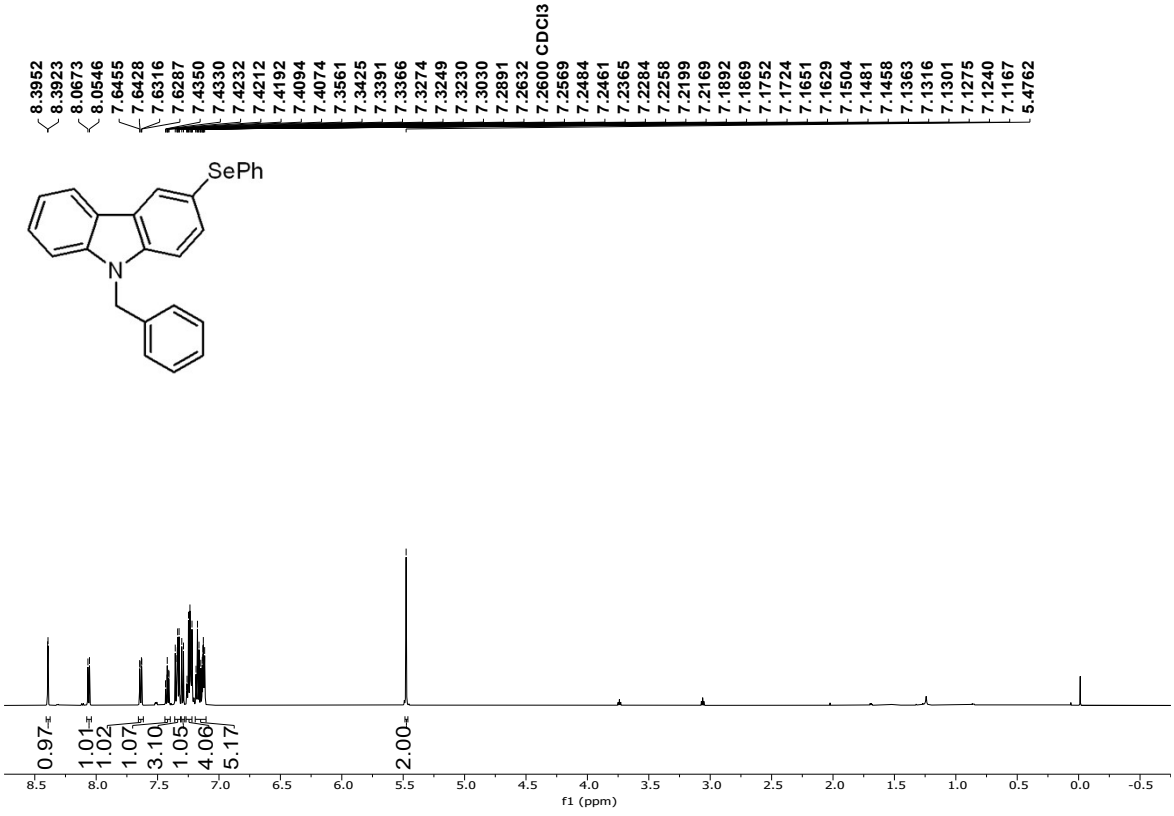

**$^{1}$H NMR of product 3g in $CDCl_3$ (600 MHz)**



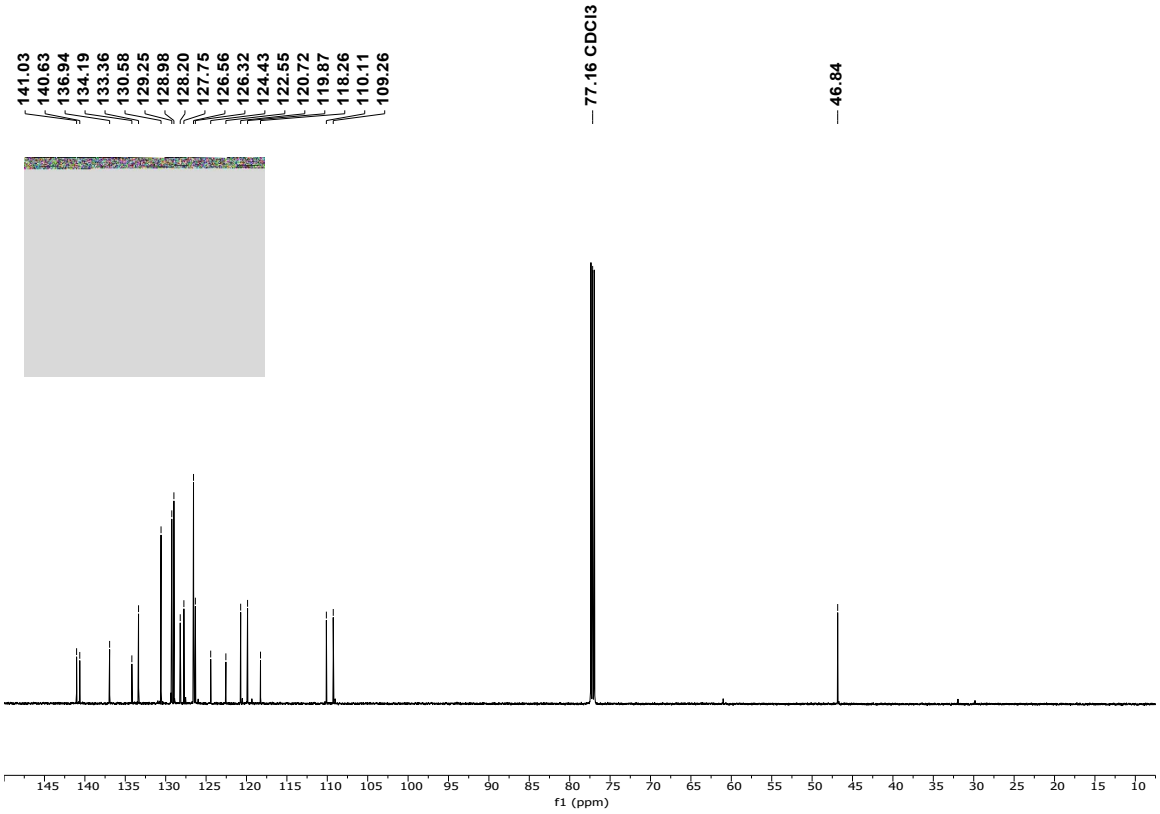

**$^{13}$C NMR of product 3g in $CDCl_3$ (151 MHz)**



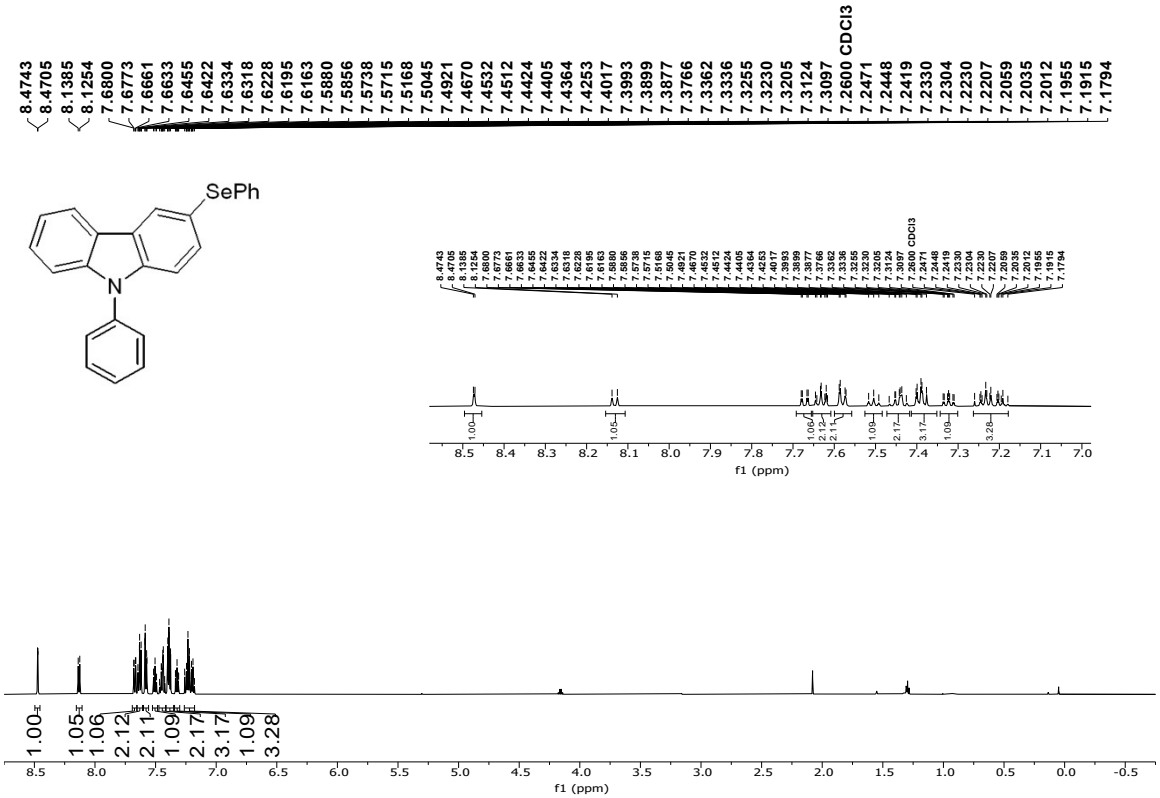
**$^{1}$H NMR of product 3h in $CDCl_3$ (600 MHz)**



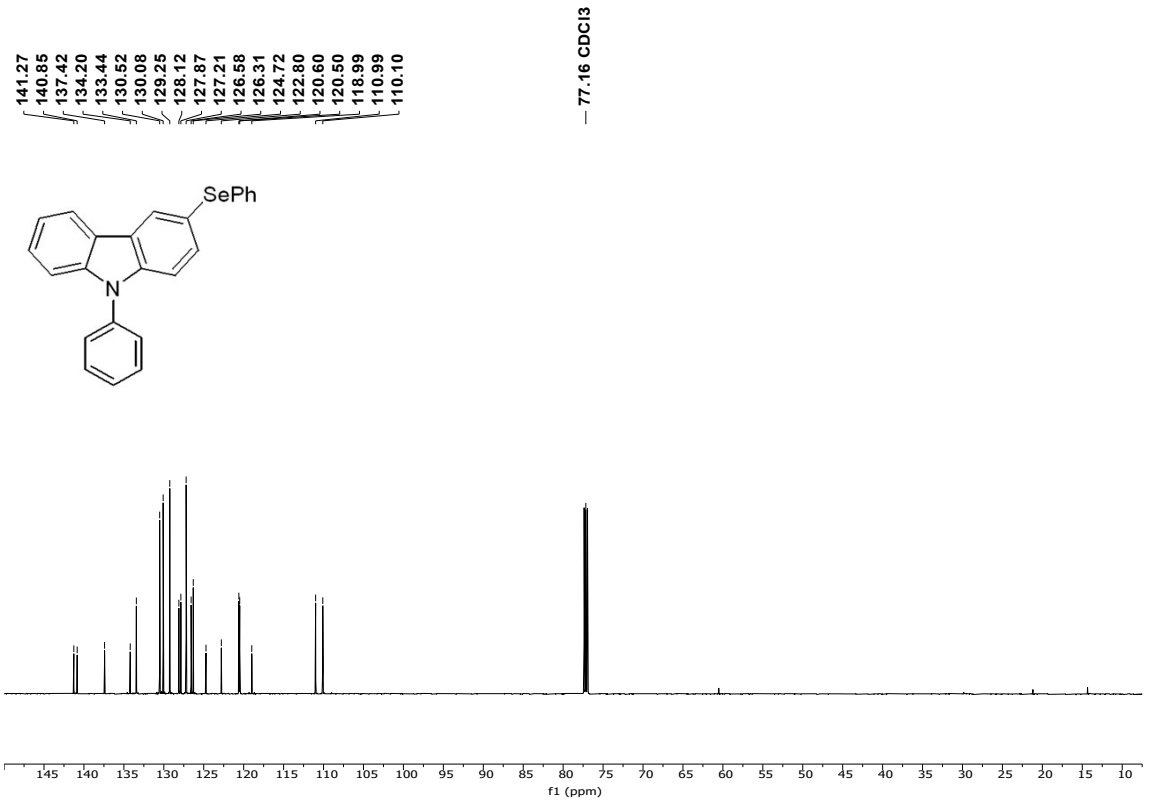

**$^{13}$C NMR of product 3h in $CDCl_3$ (151 MHz)**



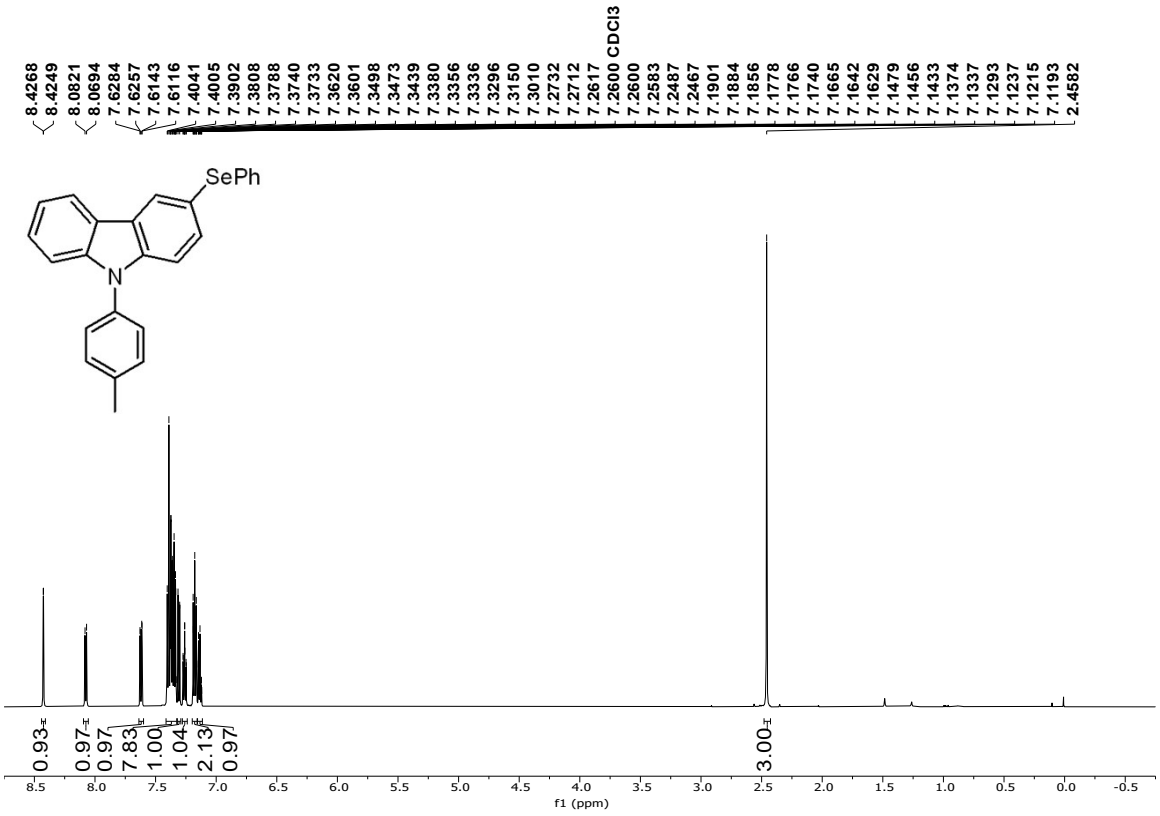

**$^{1}$H NMR of product 3i in $CDCl_3$ (600 MHz)**



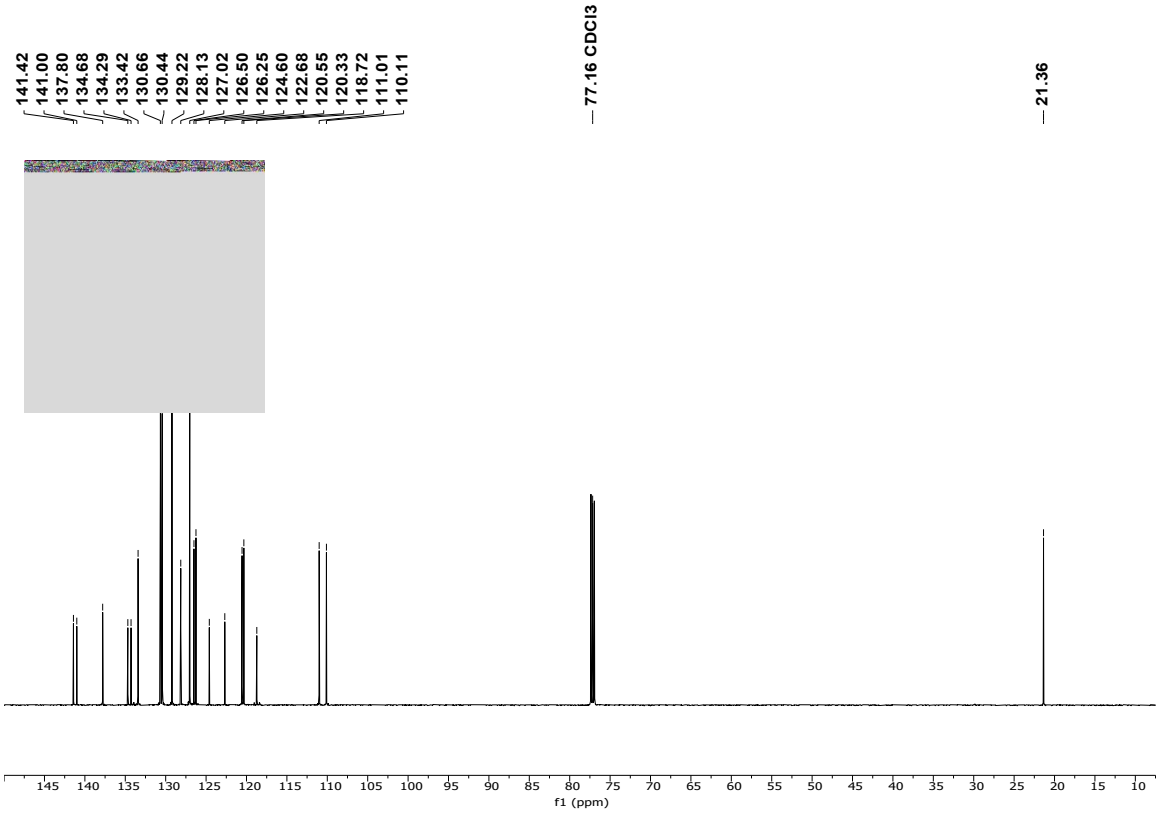

## $^{13}$C NMR of product 3i in $CDCl_3$ (151 MHz)



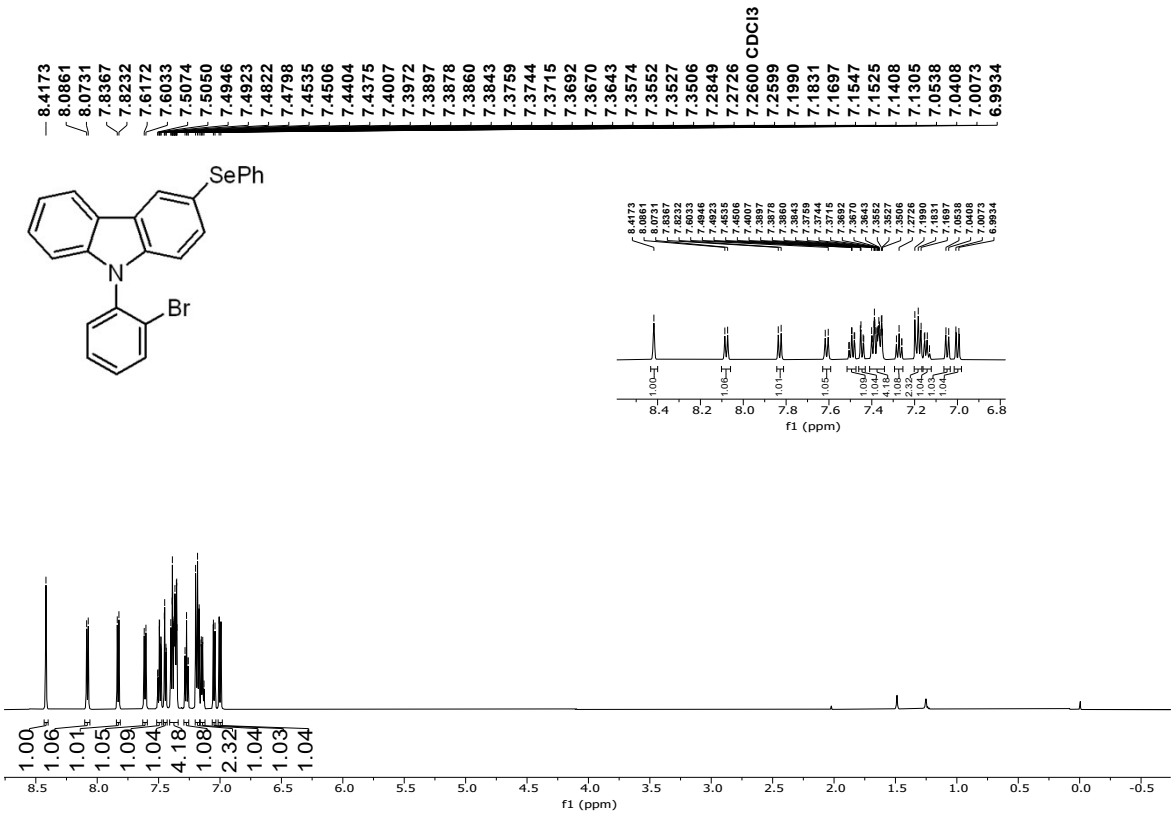
**$^{1}$H NMR of product 3j in $CDCl_3$ (600 MHz)**



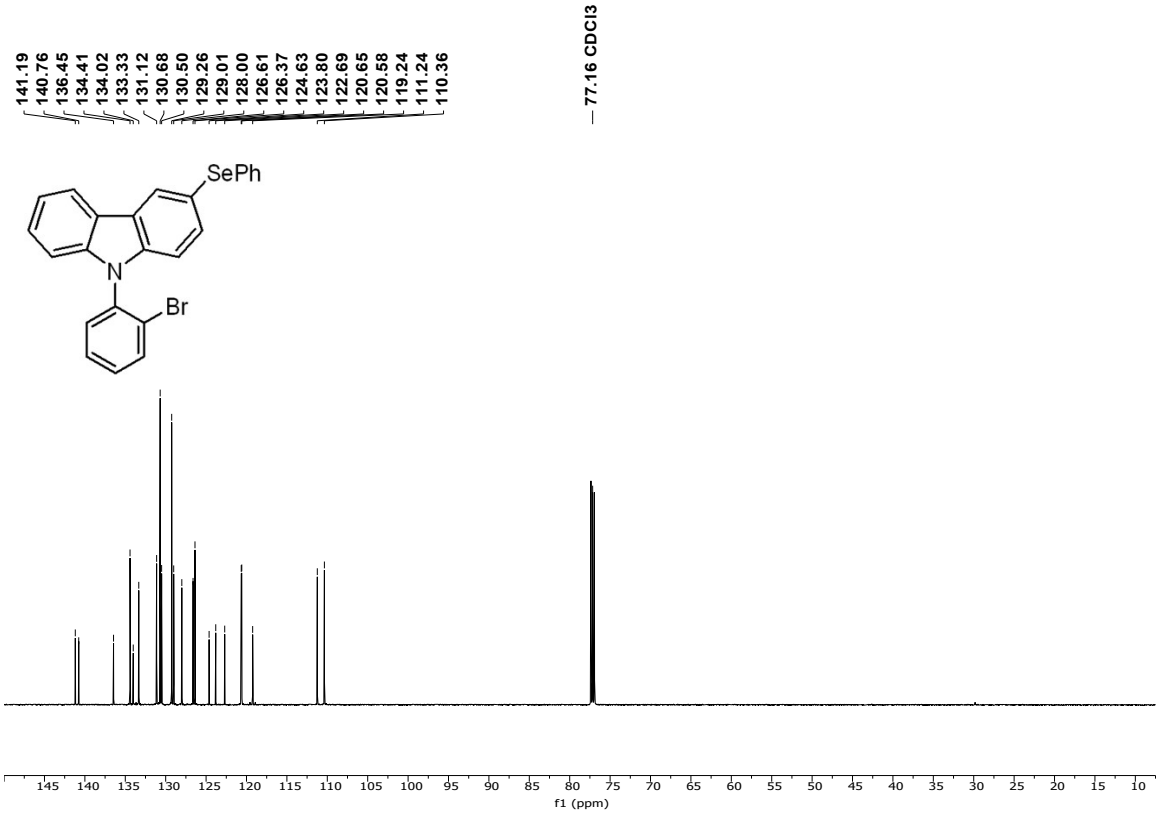

**$^{13}$C NMR of product 3j in $CDCl_3$ (151 MHz)**



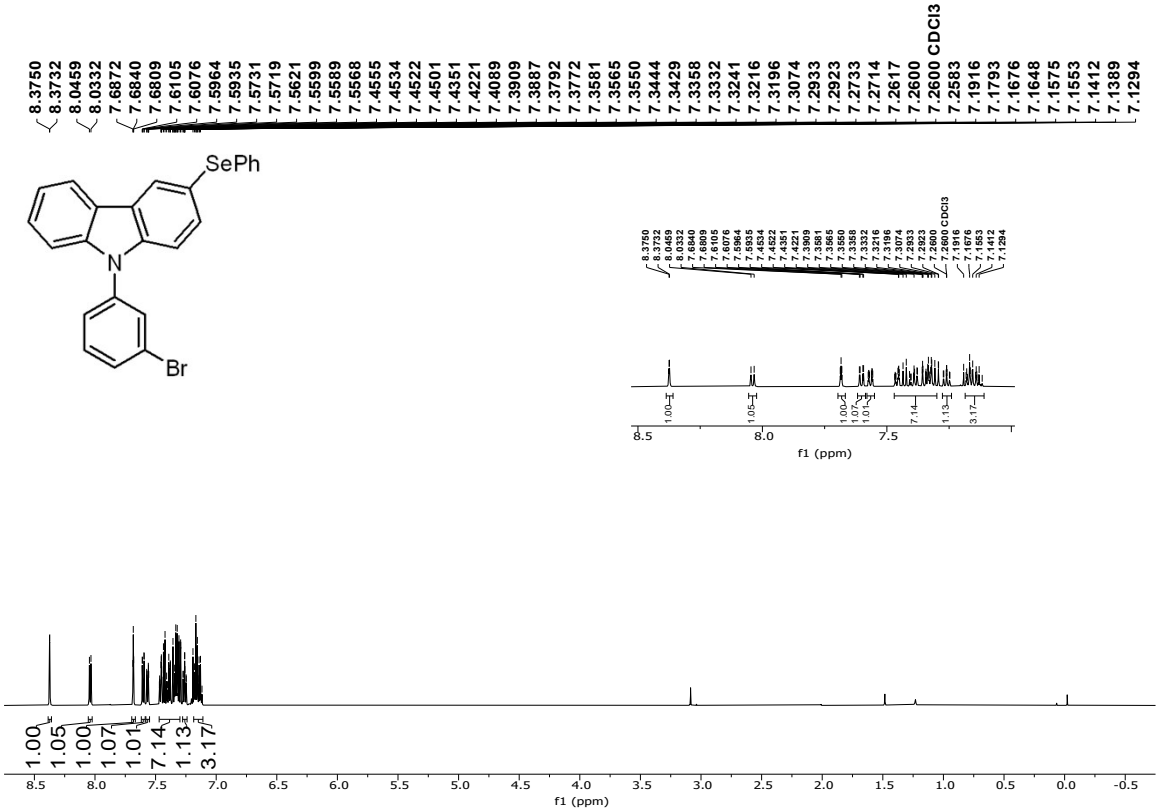

**$^{1}$H NMR of product 3k in $CDCl_3$ (600 MHz)**



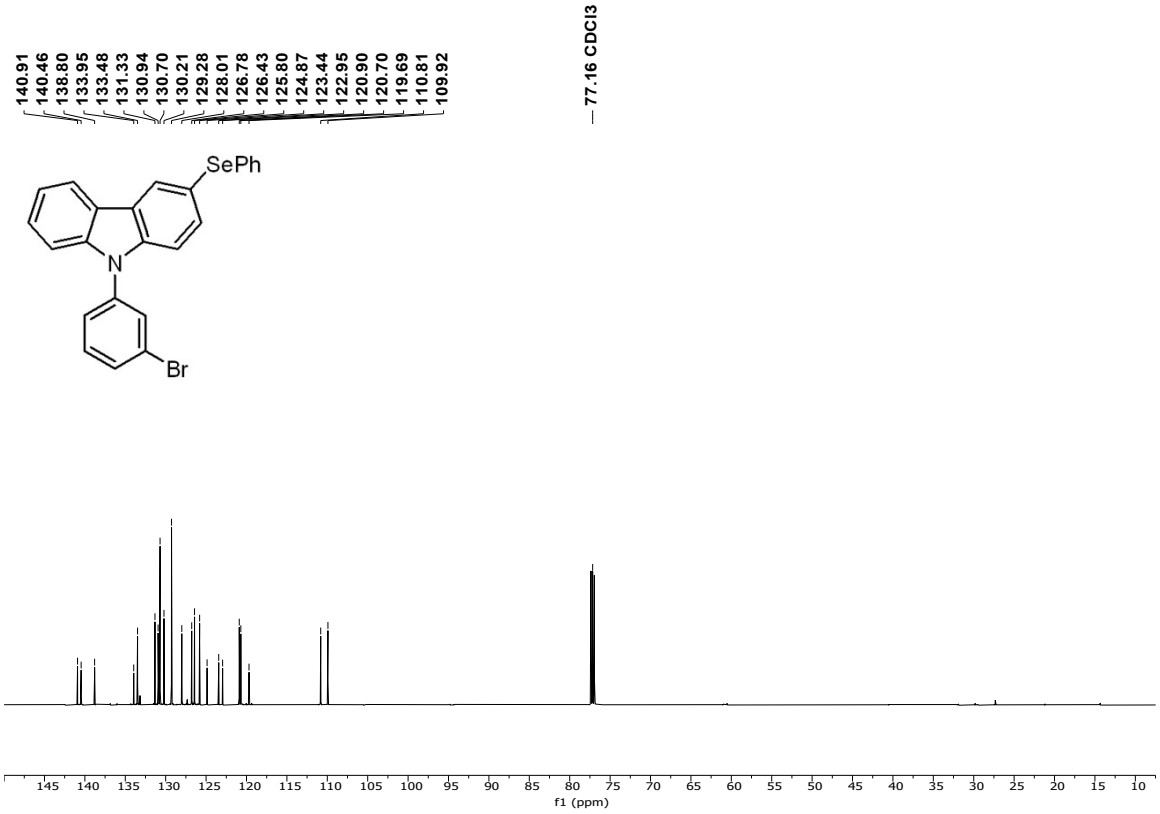

## $^{13}C$ NMR of product 3k in $CDCl_3$ (151 MHz)



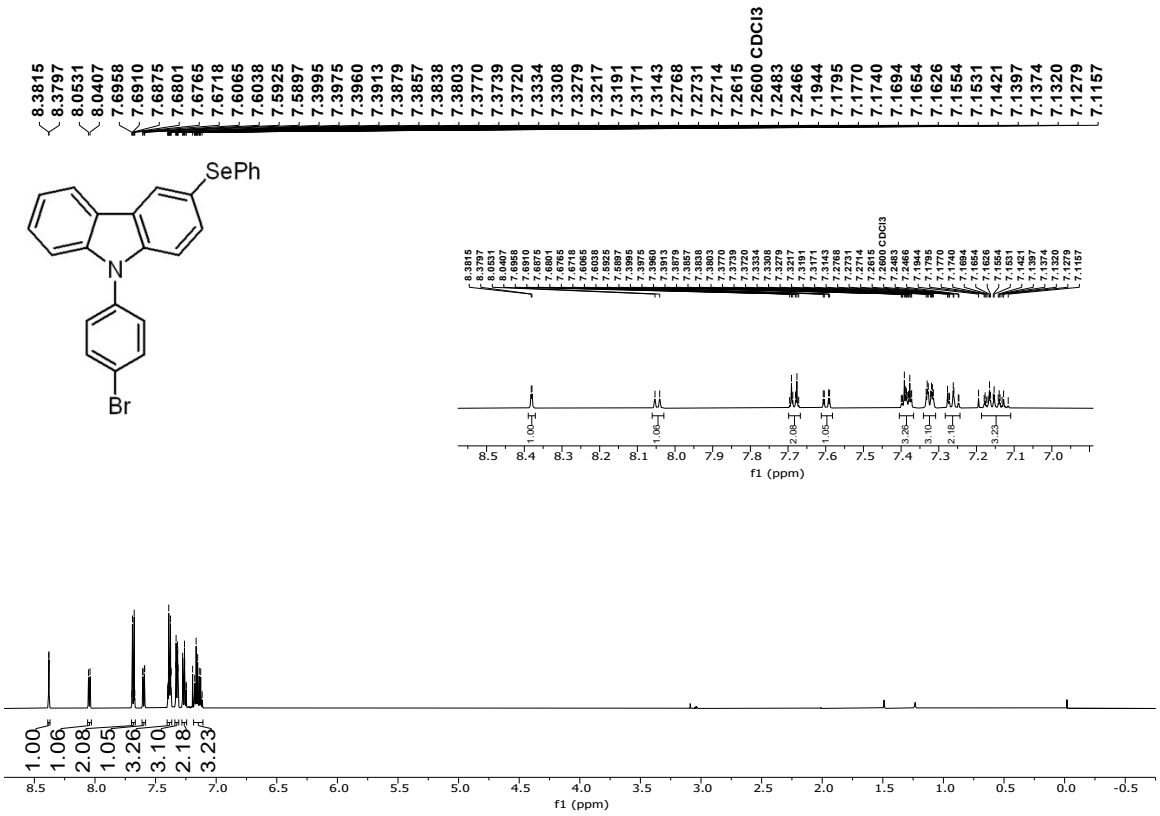
**$^{1}$H NMR of product 3l in $CDCl_3$ (600 MHz)**



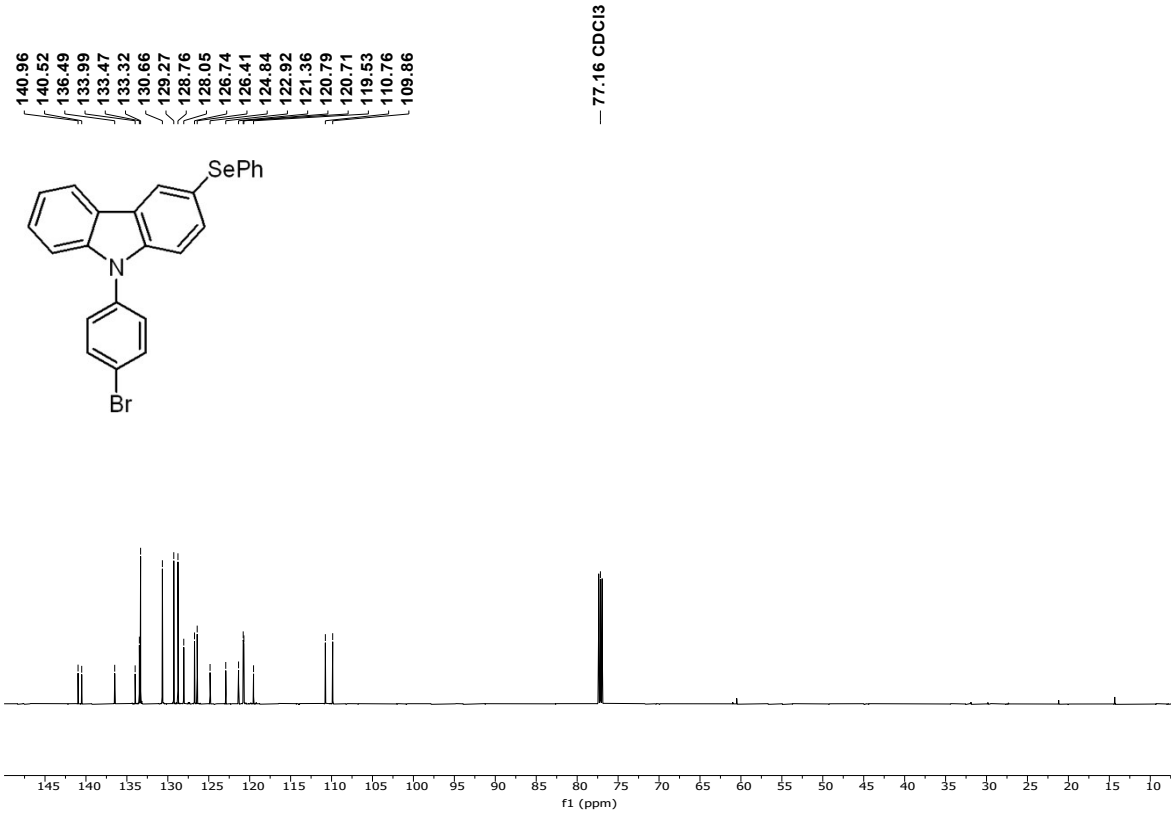

**$^{13}$C NMR of product 3l in $CDCl_3$ (151 MHz)**



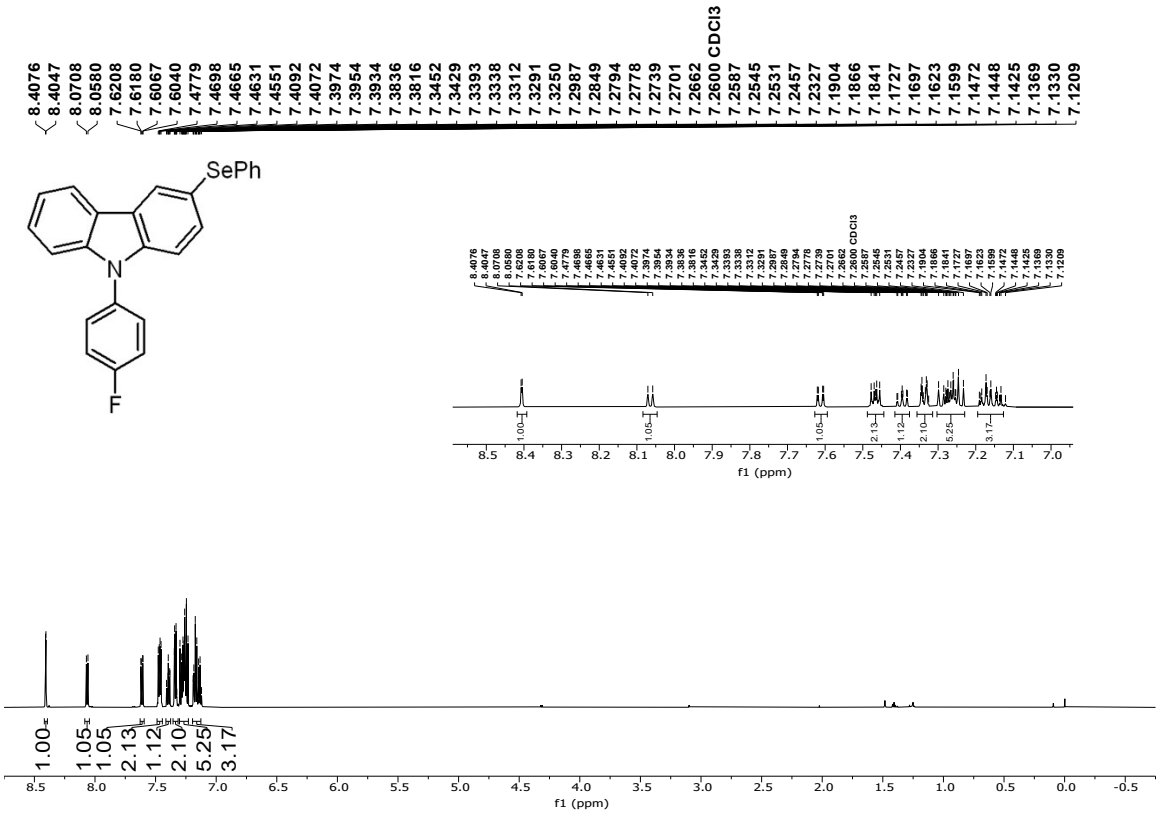

**$^{1}$H NMR of product 3m in $CDCl_3$ (600 MHz)**



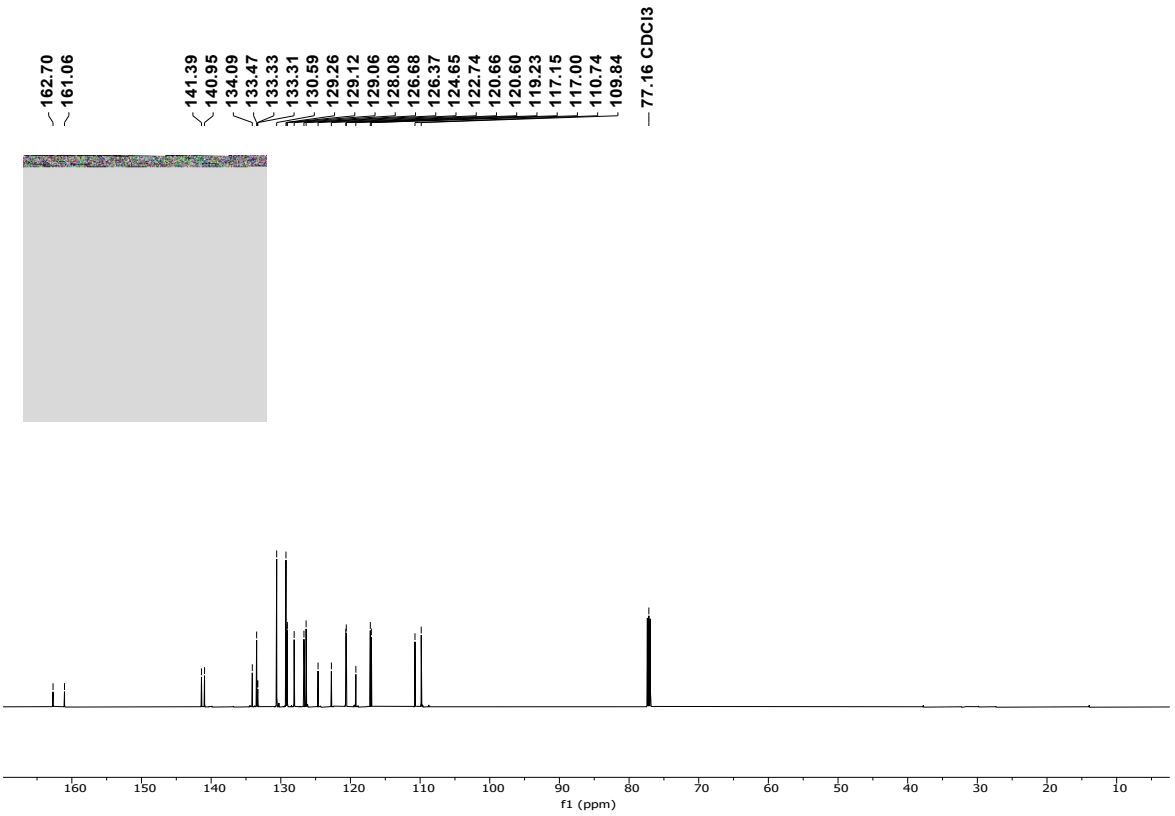

## $^{13}$C NMR of product 3m in $CDCl_3$ (151 MHz)



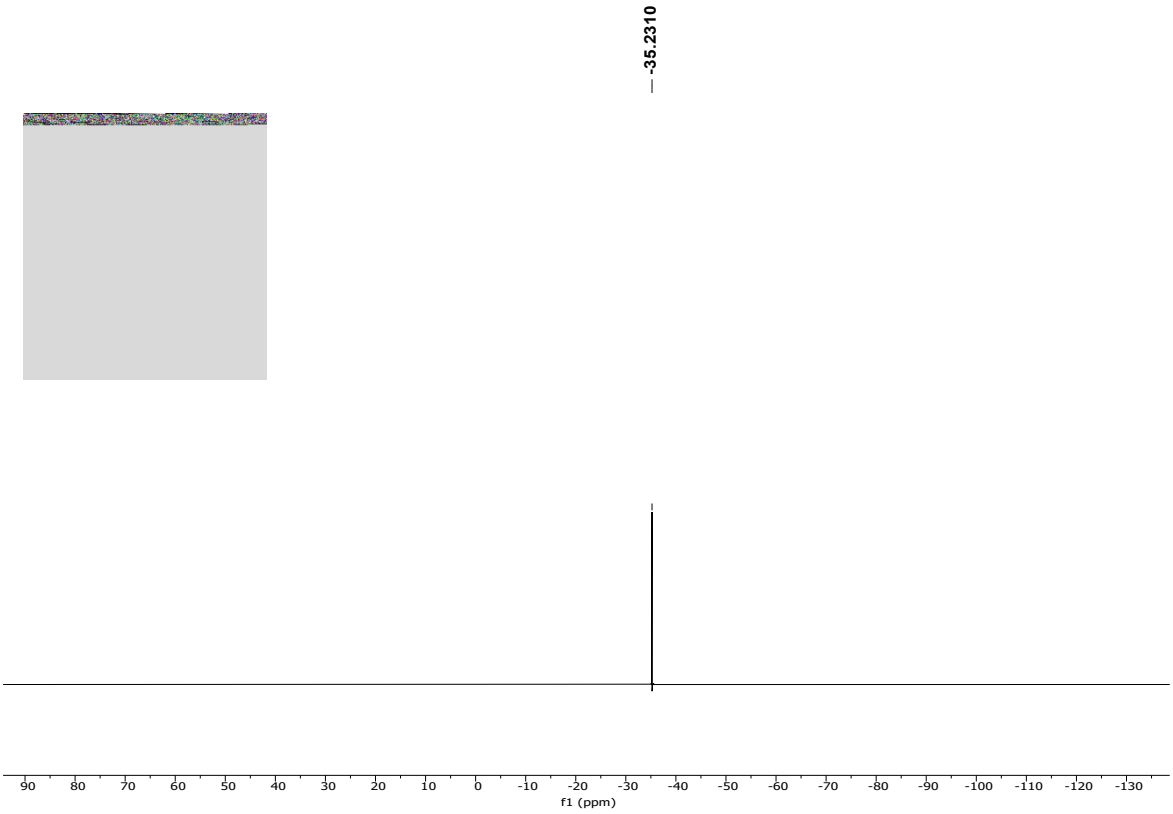
**$^{1}$H NMR of product 3n in $CDCl_3$ (600 MHz)**



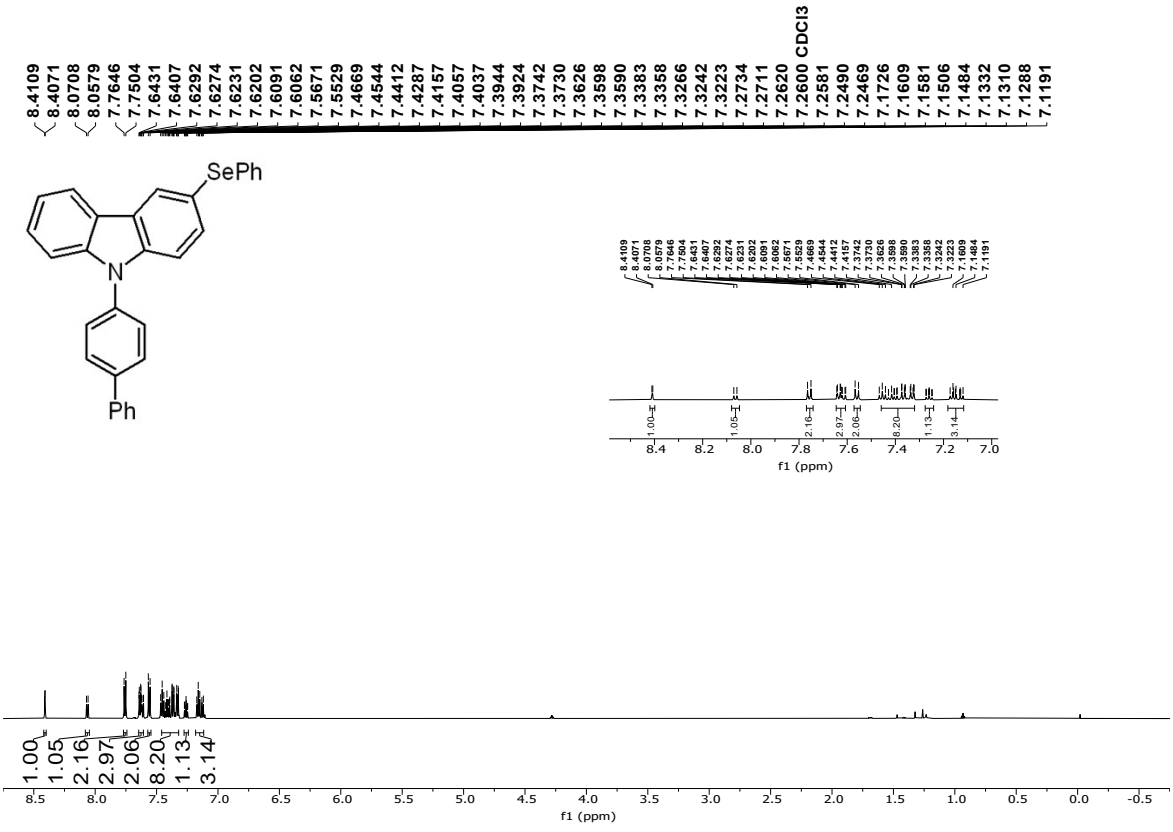

**$^{13}$C NMR of product 3n in $CDCl_3$ (151 MHz)**



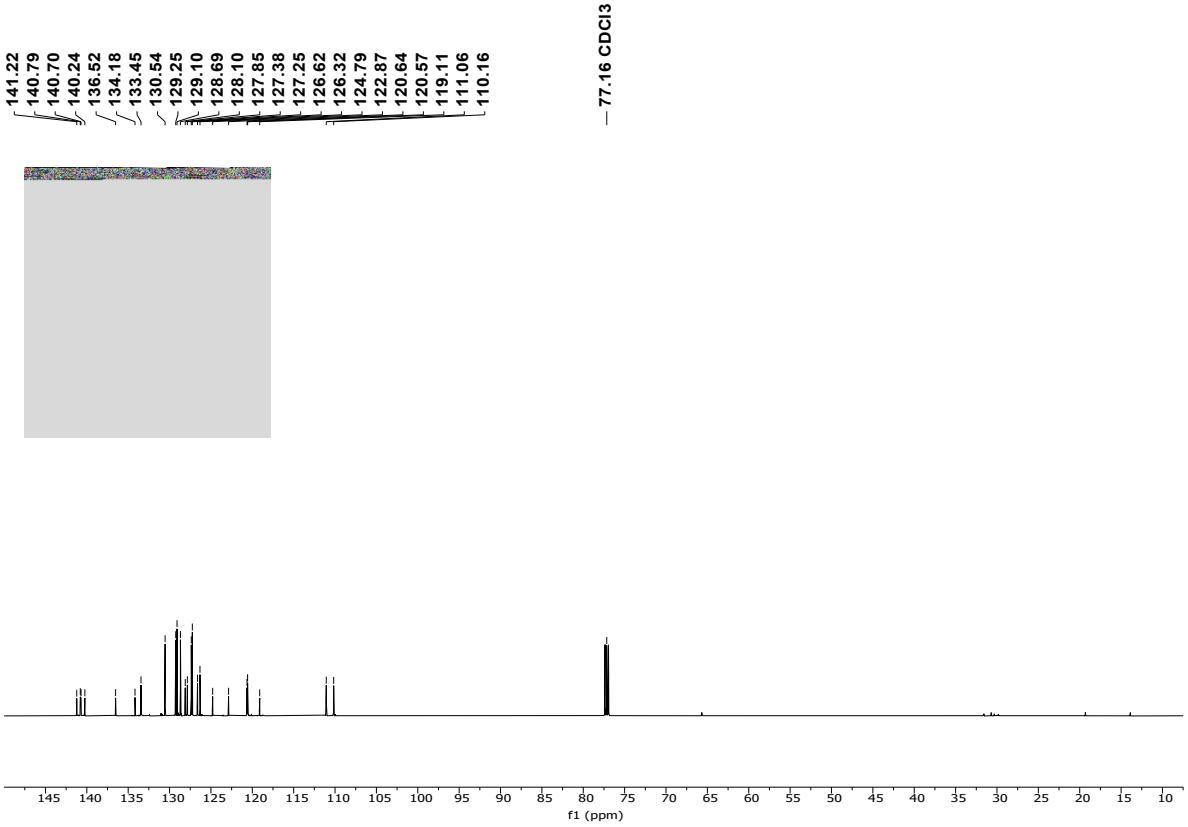

**$^{19}$F NMR of product 3n in $CDCl_3$ (565 MHz)**



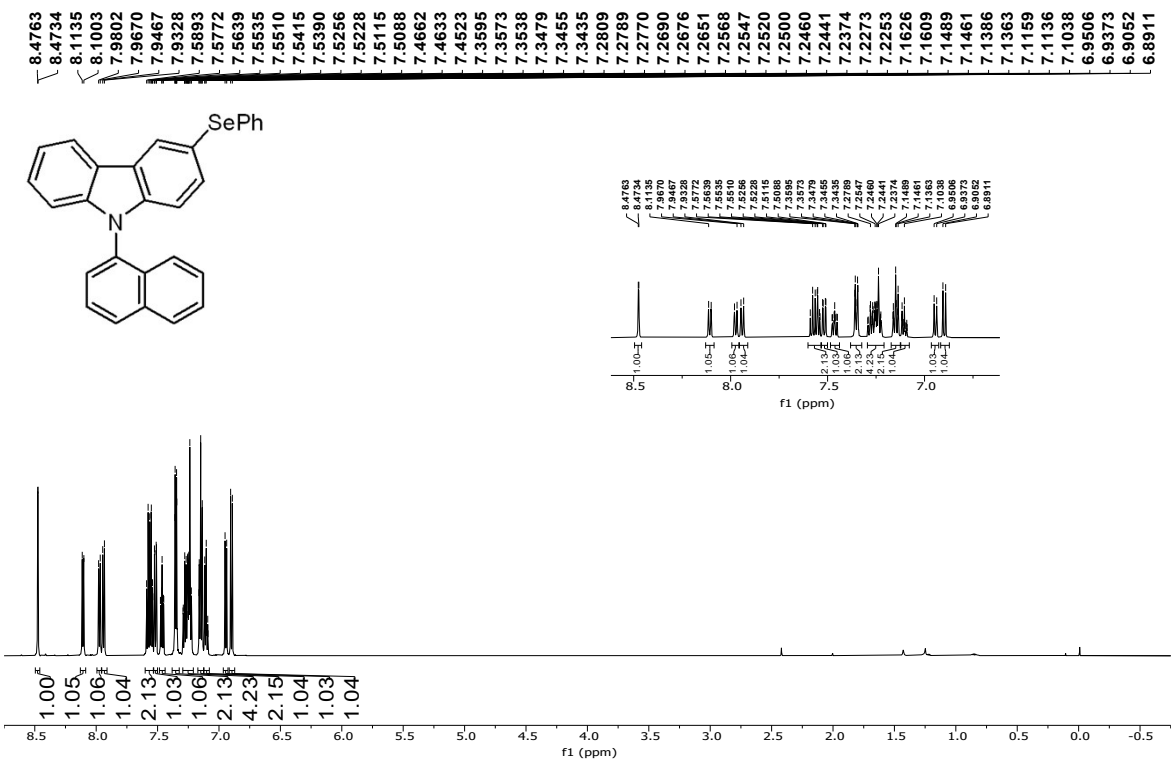

**$^1$H NMR of product 3o in $CDCl_3$ (600 MHz)**



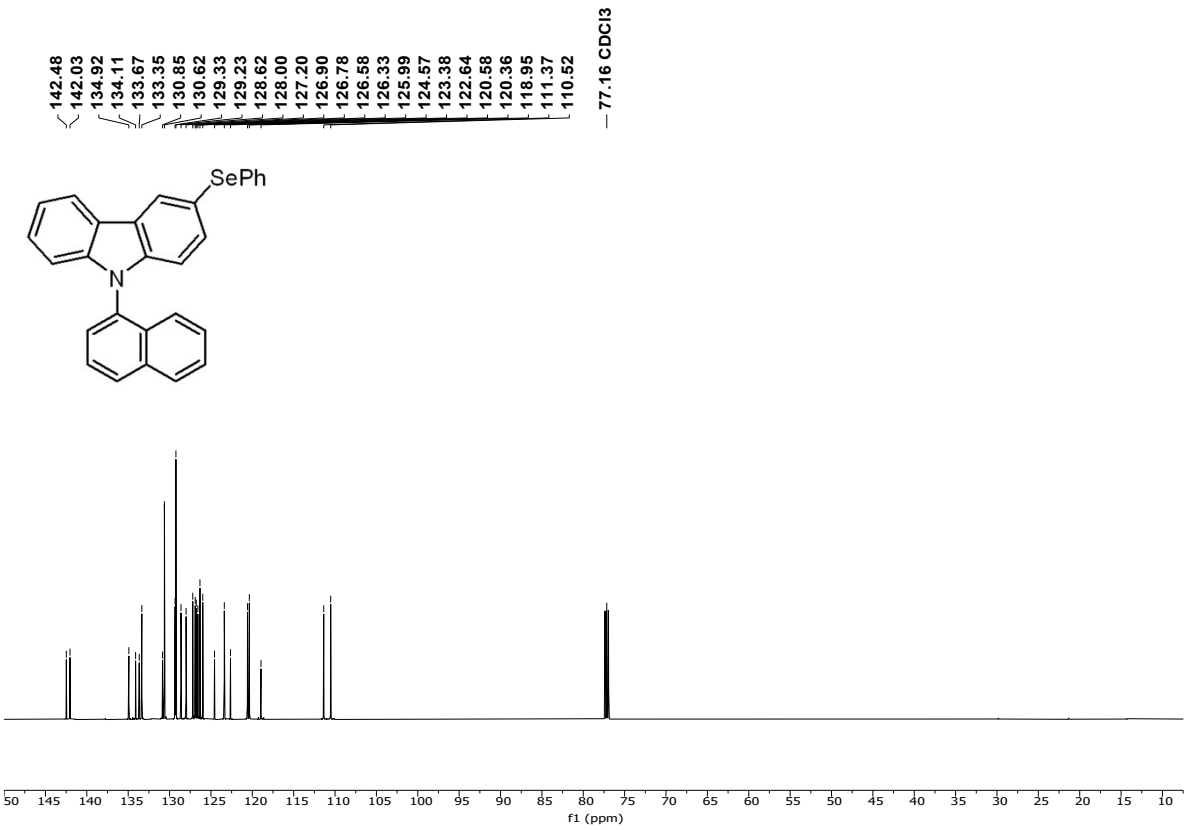
**$^{13}$C NMR of product 3o in $CDCl_3$ (151 MHz)**



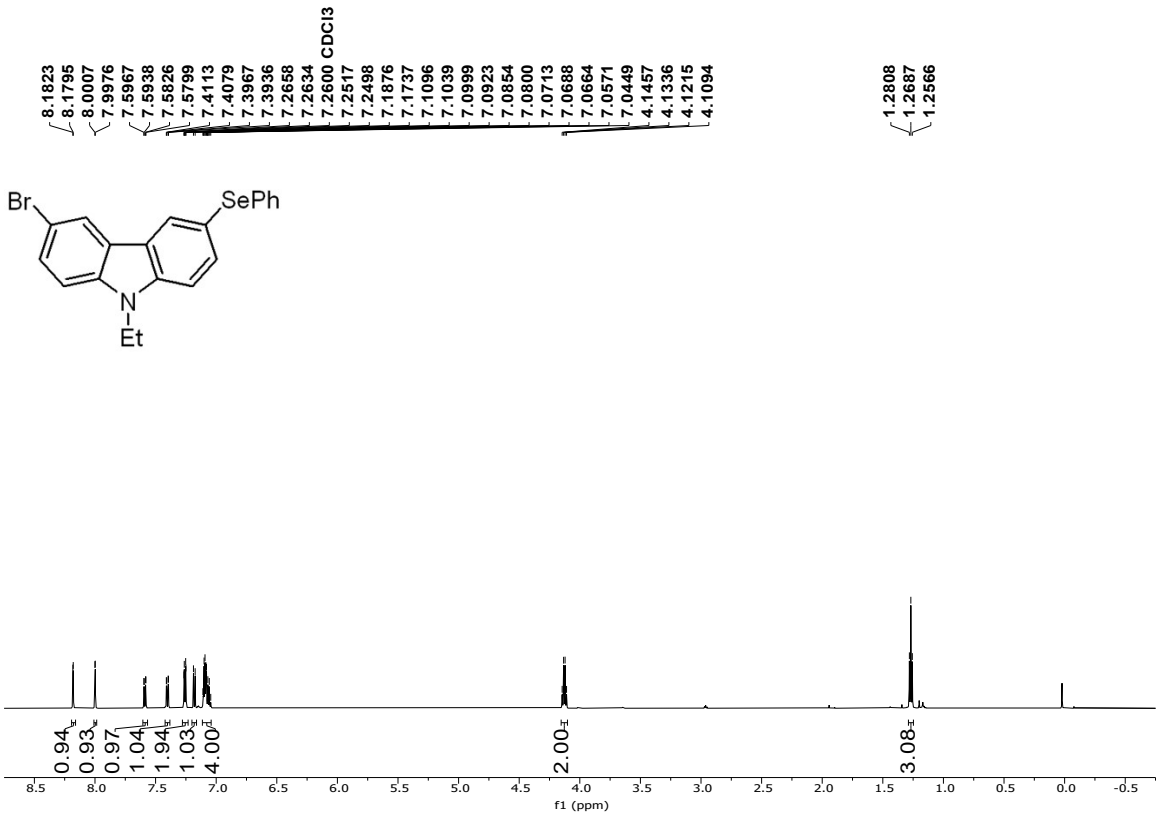

**$^{1}$H NMR of product 3p in $CDCl_3$ (600 MHz)**



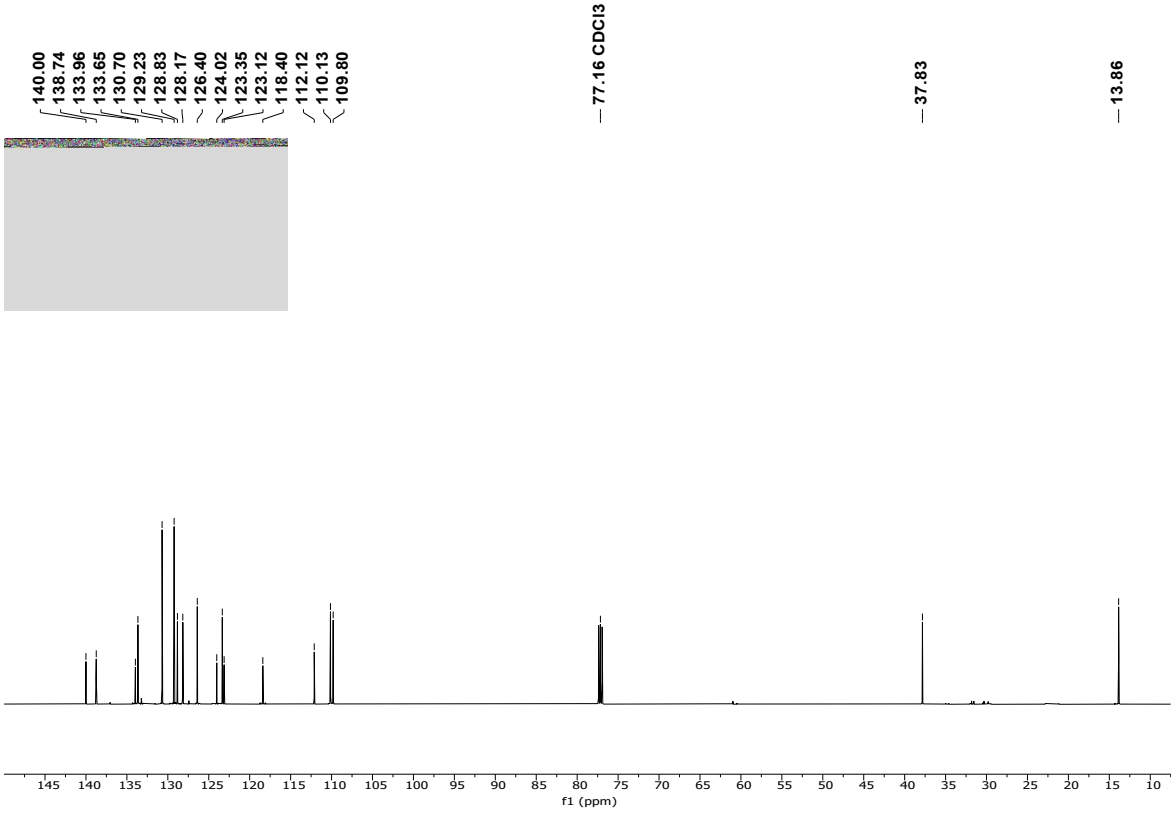

**$^{13}$C NMR of product 3p in $CDCl_3$ (151 MHz)**



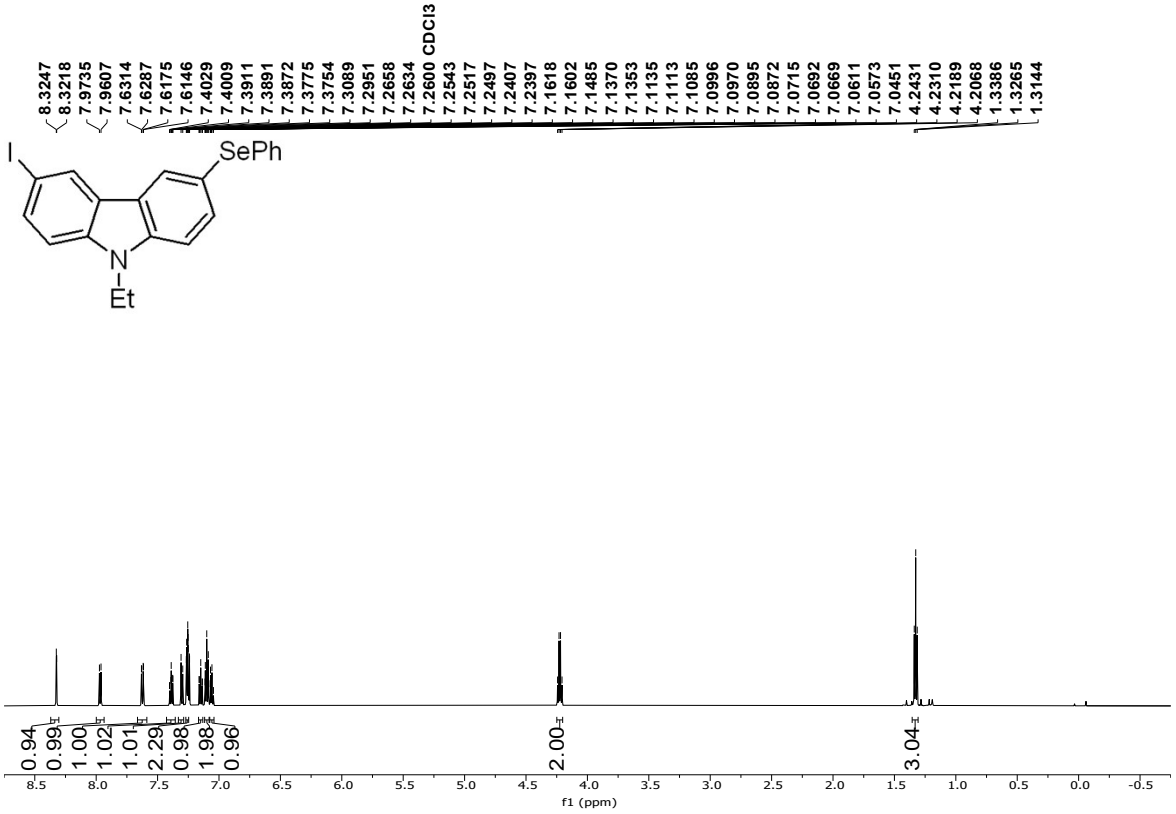

**$^1$H NMR of product 3s in $CDCl_3$ (600 MHz)**



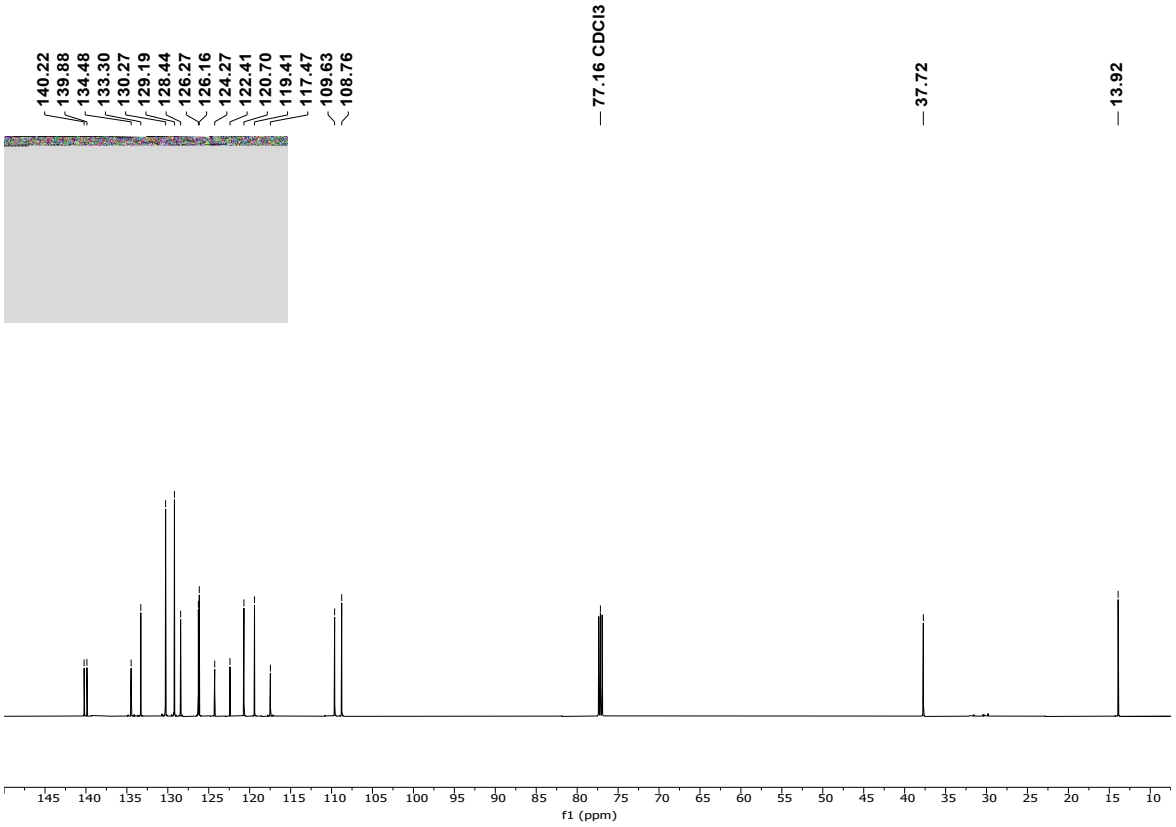
**$^{13}C$ NMR of product 3s in $CDCl_3$ (151 MHz)**



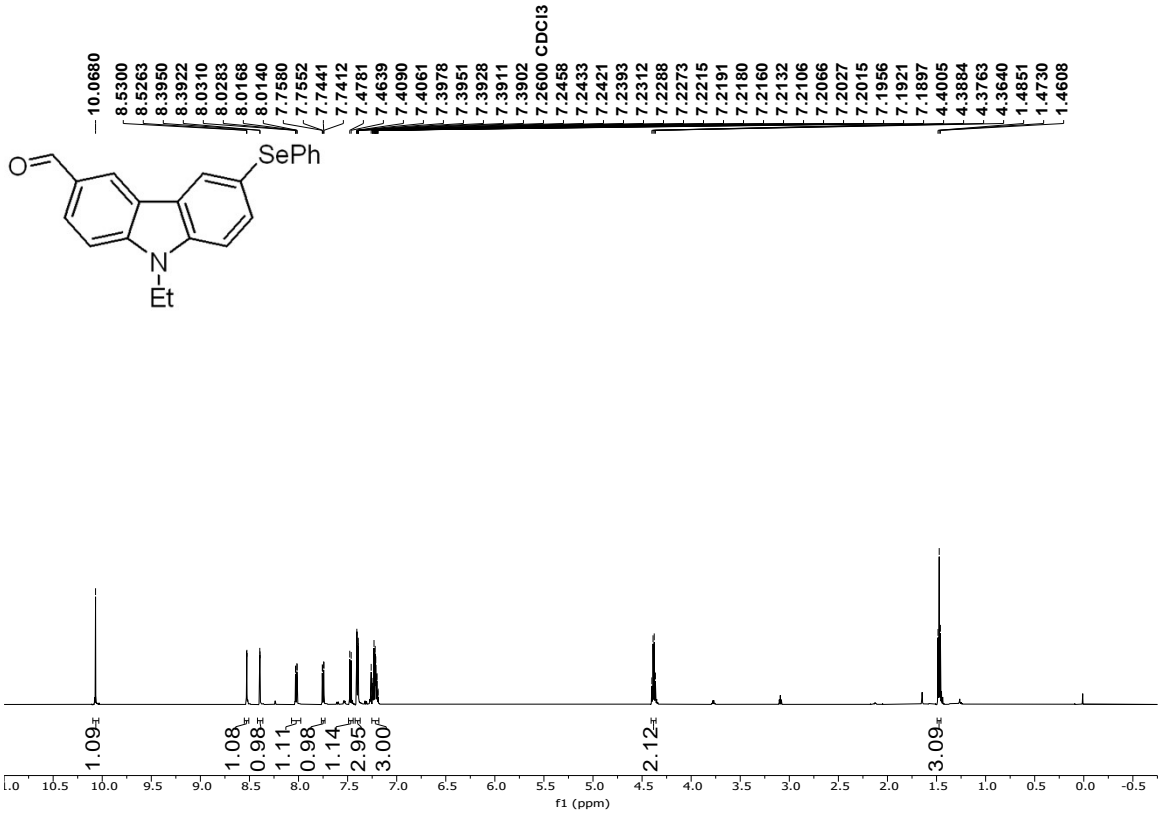
**$^{1}$H NMR of product 3t in $CDCl_3$ (600 MHz)**



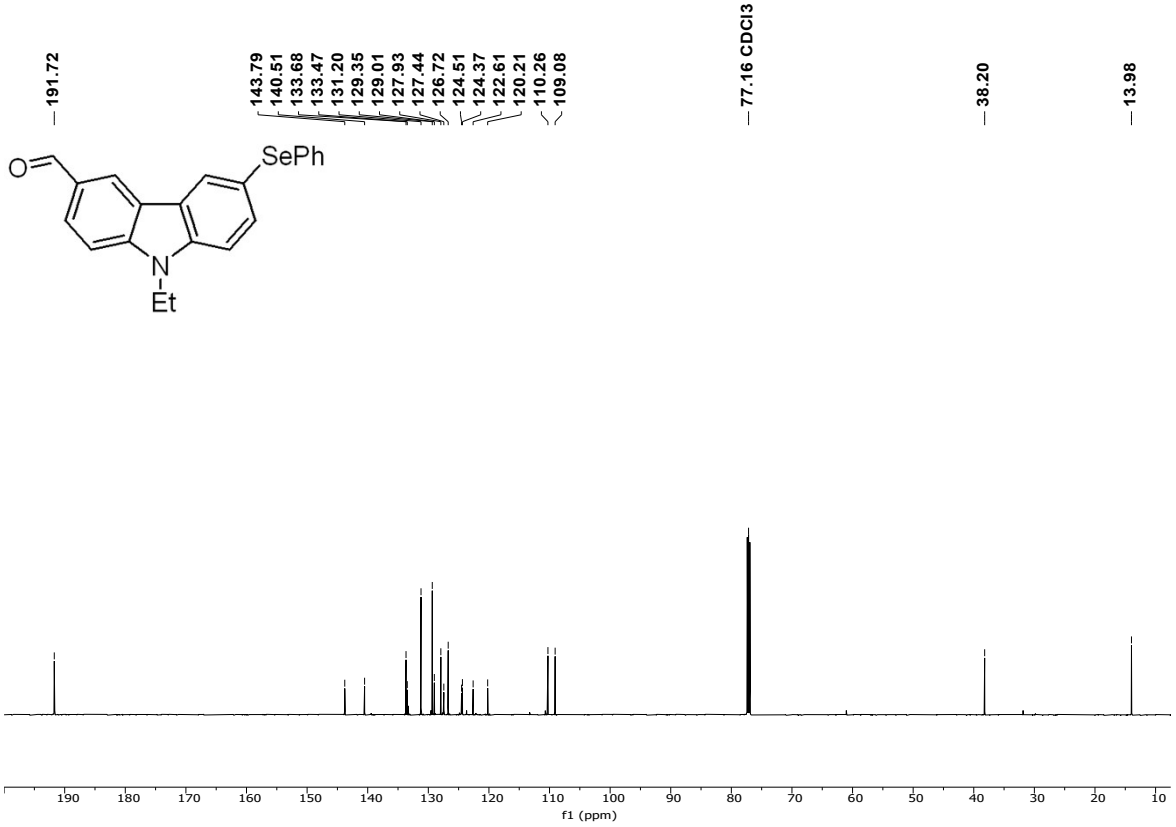

**$^{13}$C NMR of product 3t in $CDCl_3$ (151 MHz)**



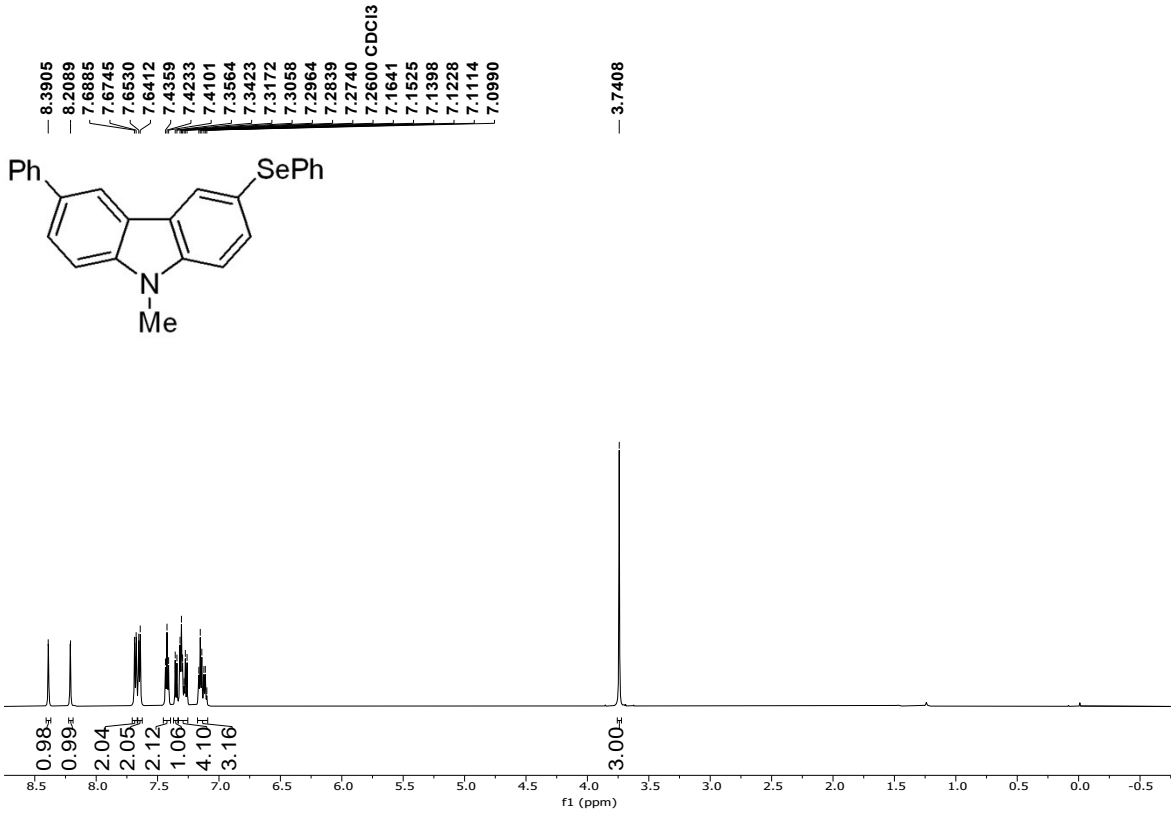

**$^1$H NMR of product 3u in $CDCl_3$ (600 MHz)**



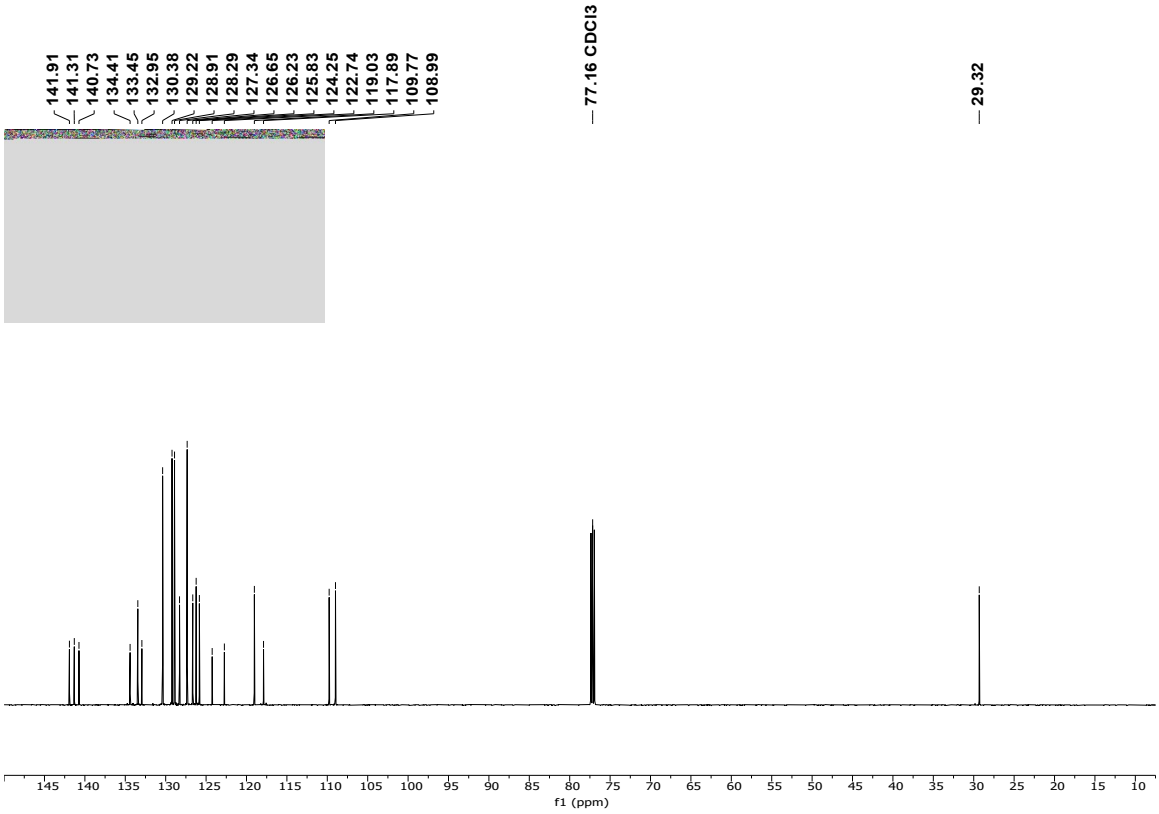
**$^{13}$C NMR of product 3u in $CDCl_3$ (151 MHz)**



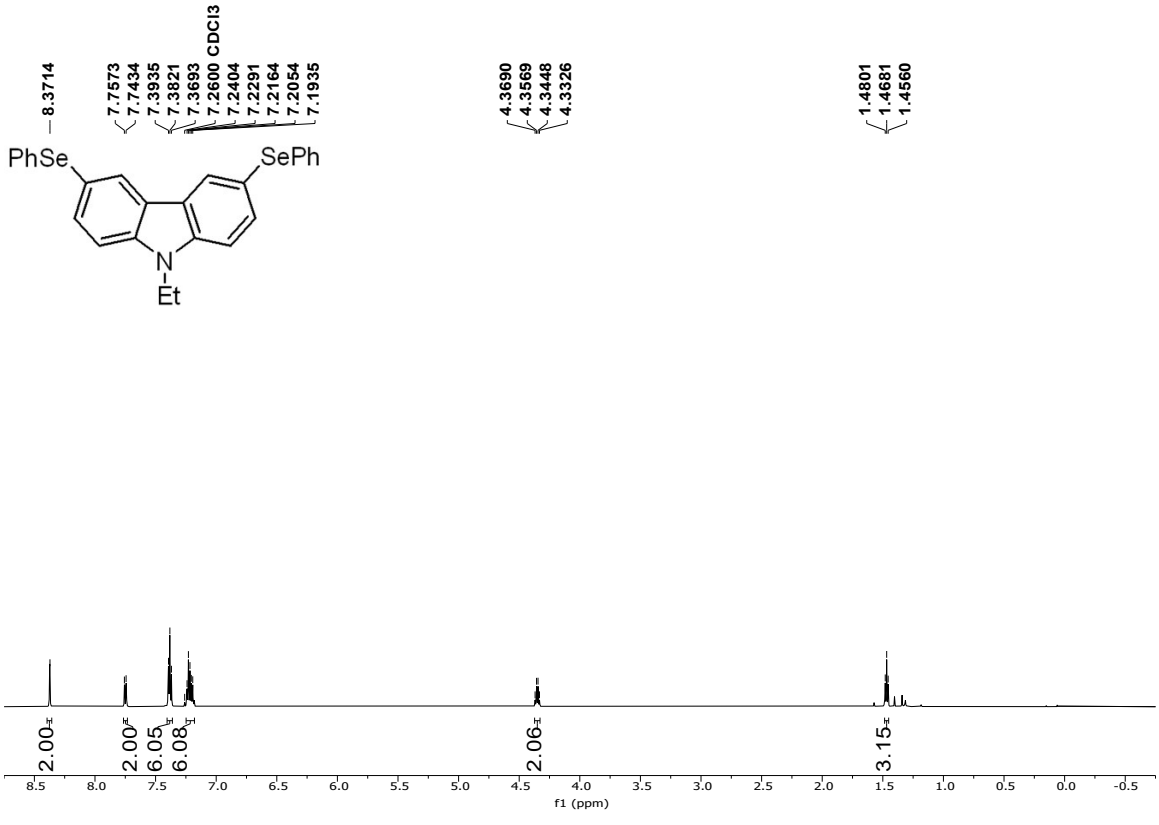

**$^{1}$H NMR of product 3v in $CDCl_3$ (600 MHz)**



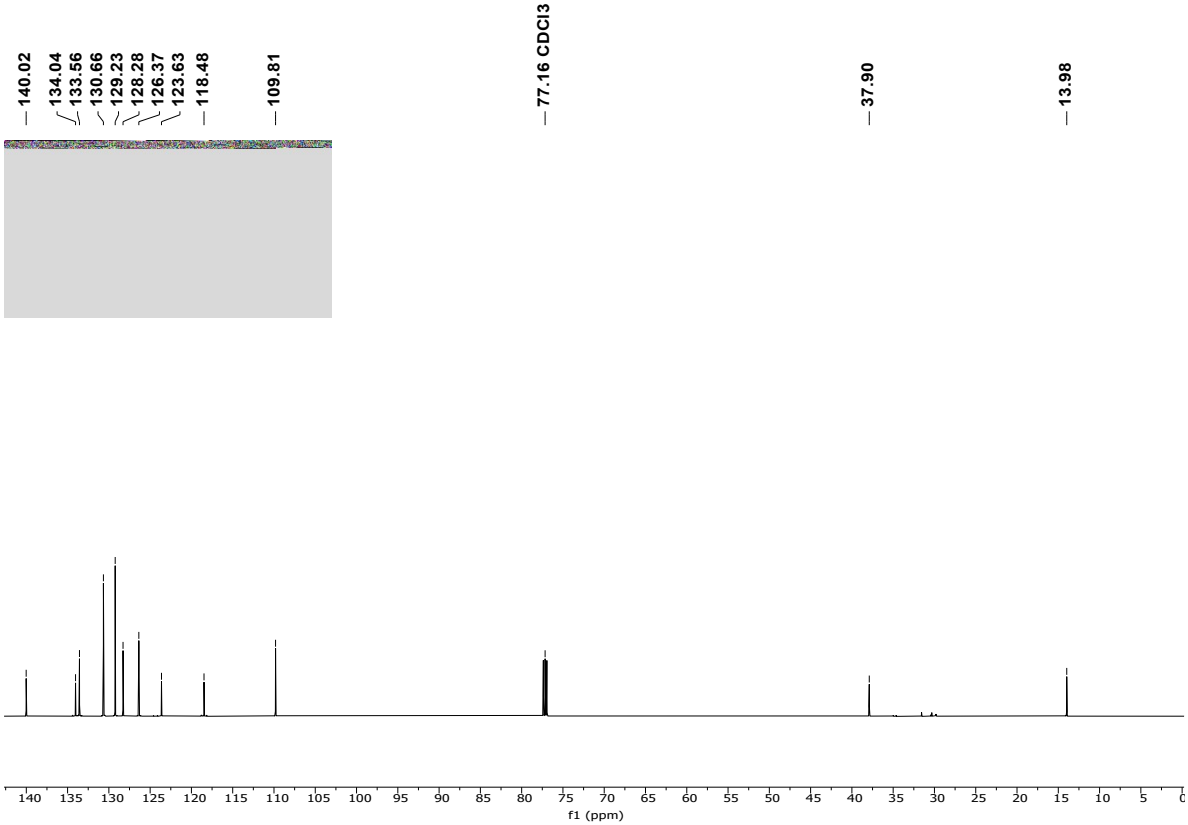

**$^{13}$C NMR of product 3v in $CDCl_3$ (151 MHz)**



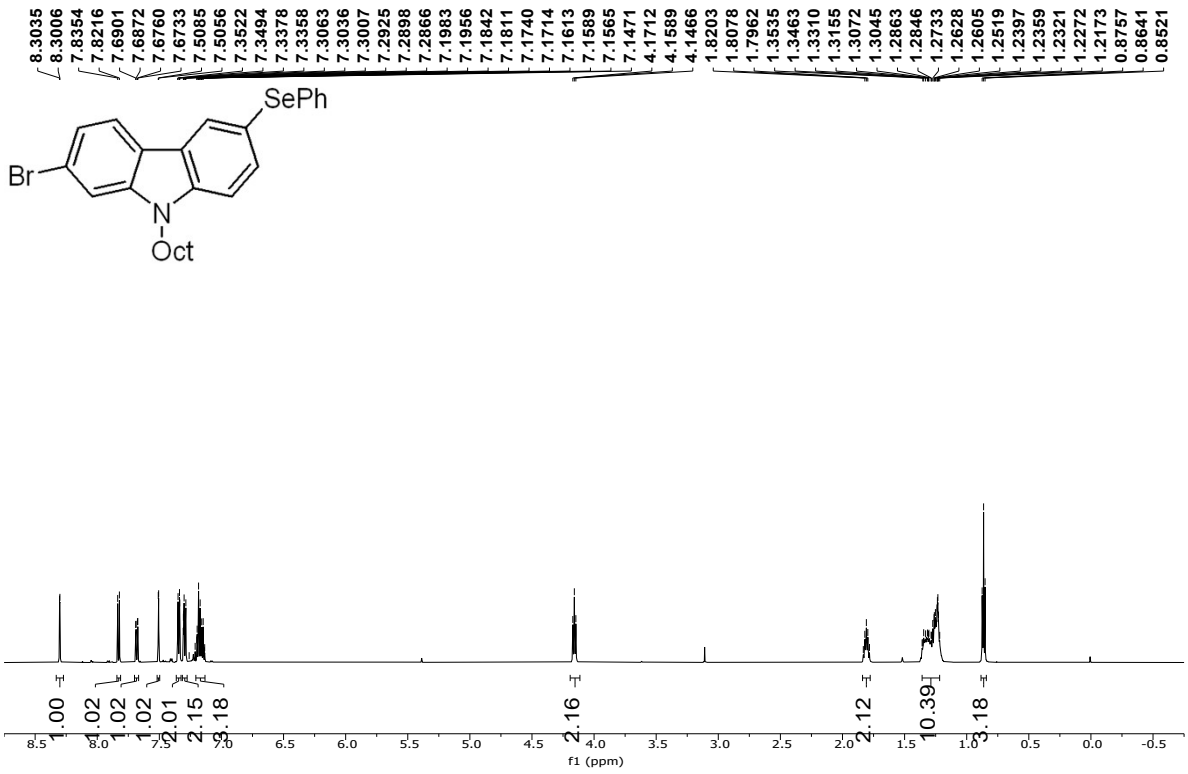

**$^1$H NMR of product 3w in $CDCl_3$ (600 MHz)**



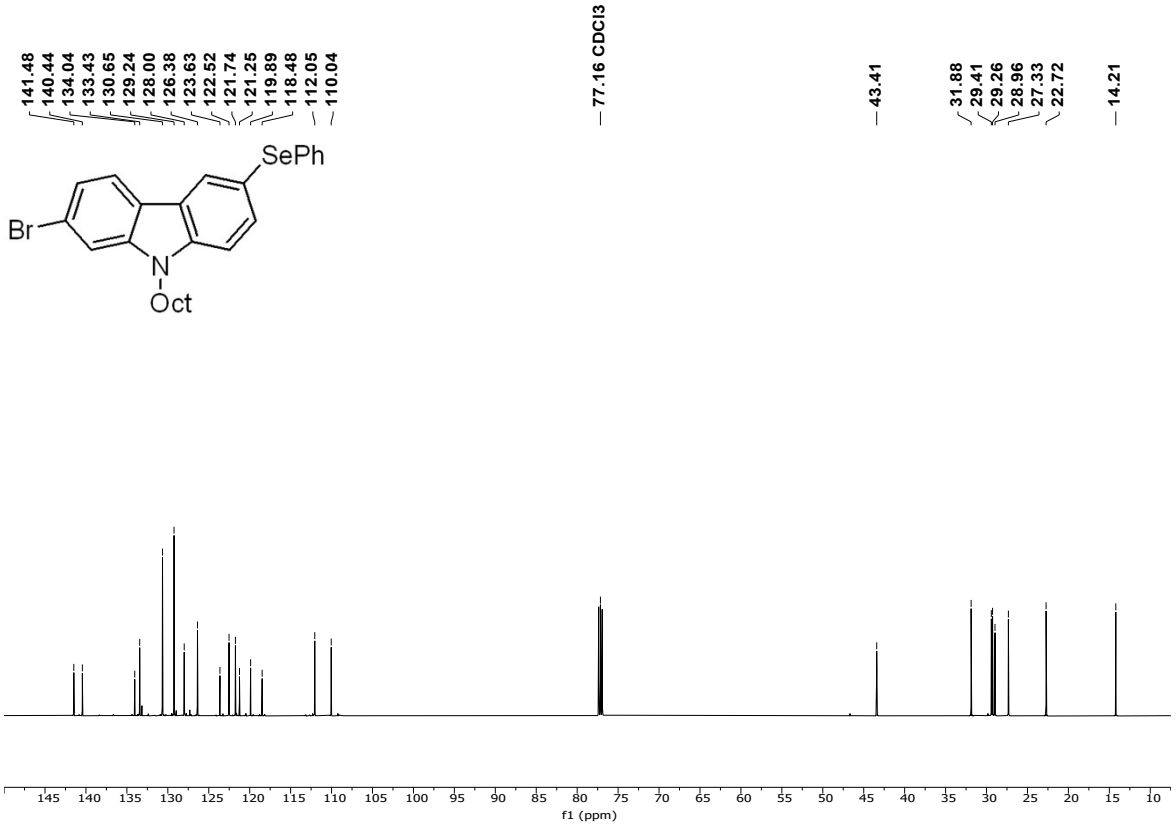
**$^{13}C$ NMR of product 3w in $CDCl_3$ (151 MHz)**



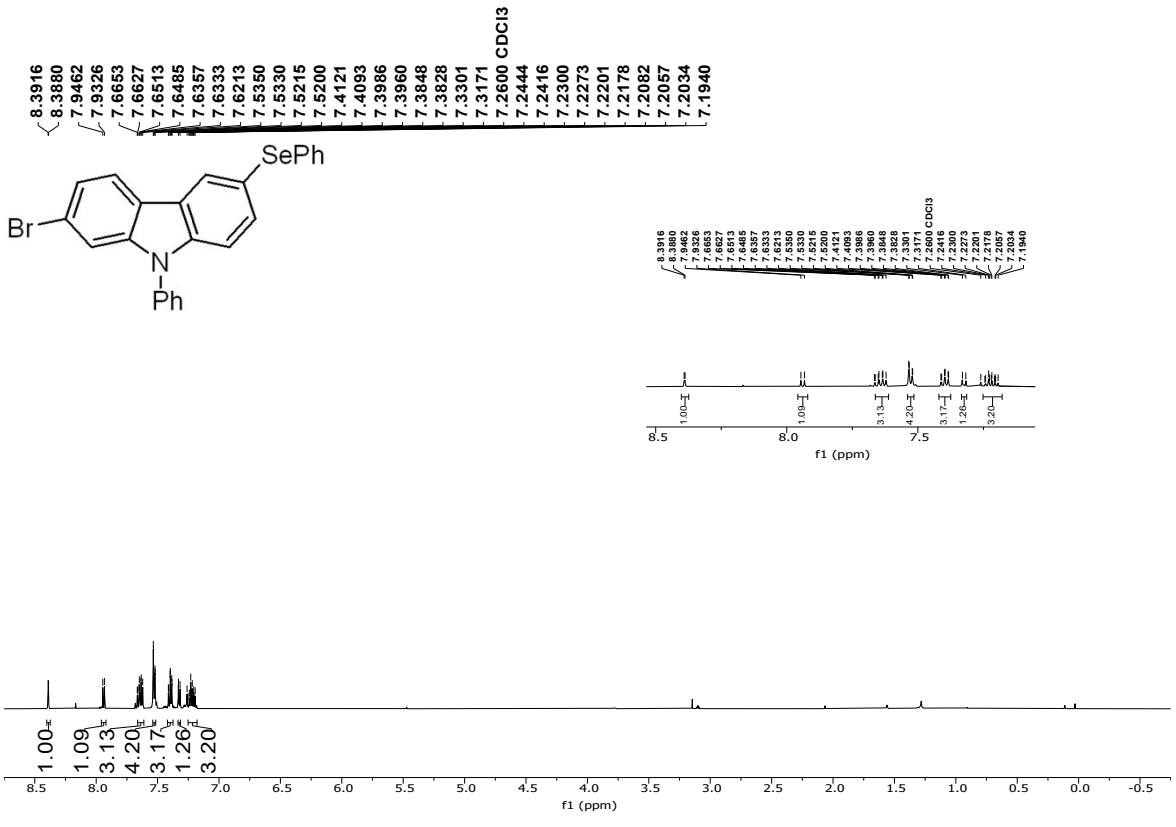
**$^{1}$H NMR of product 3x in $CDCl_3$ (600 MHz)**



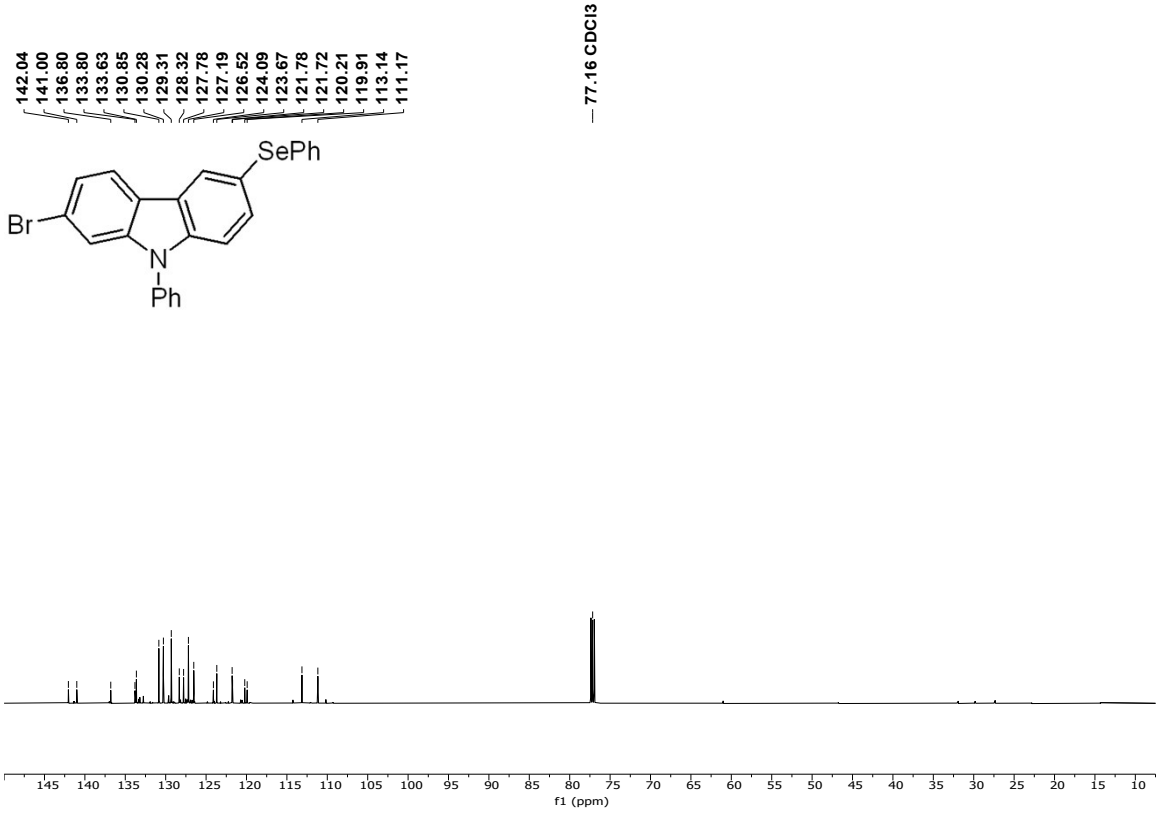

**$^{13}$C NMR of product 3x in $CDCl_3$ (151 MHz)**



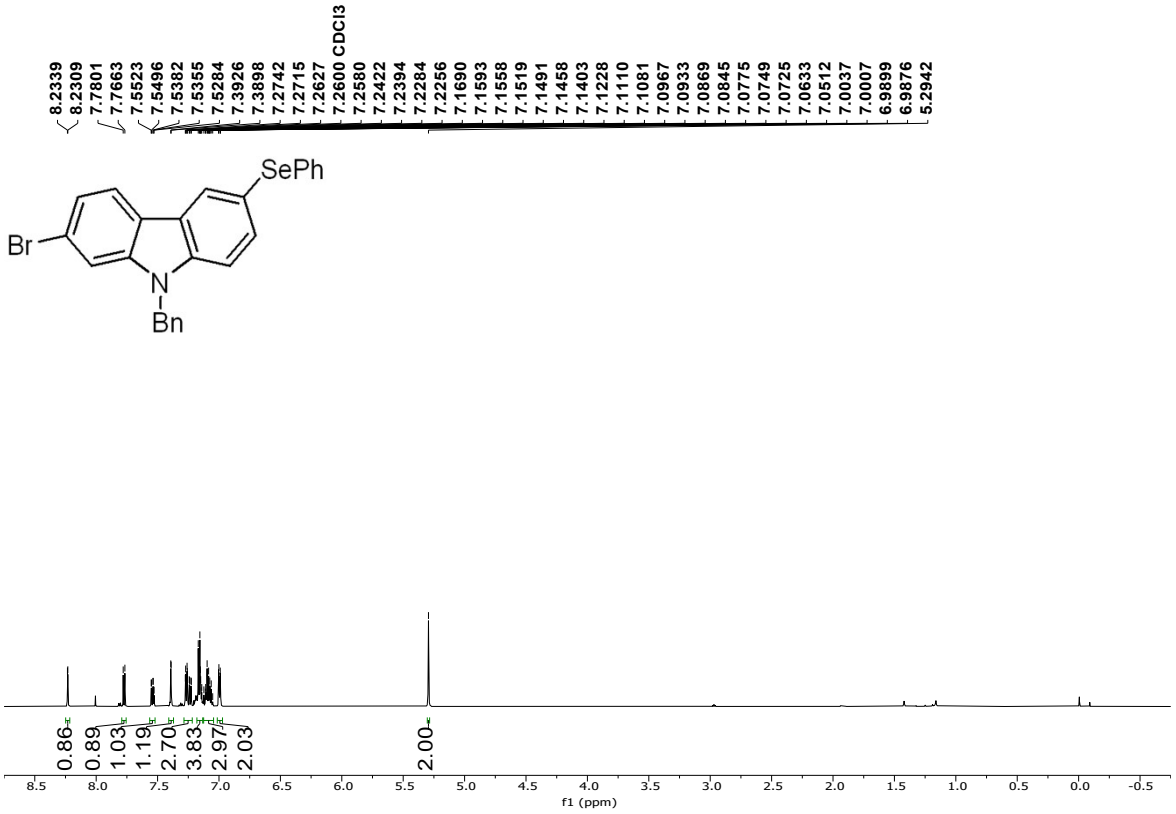

**$^1$H NMR of product 3y in $CDCl_3$ (600 MHz)**



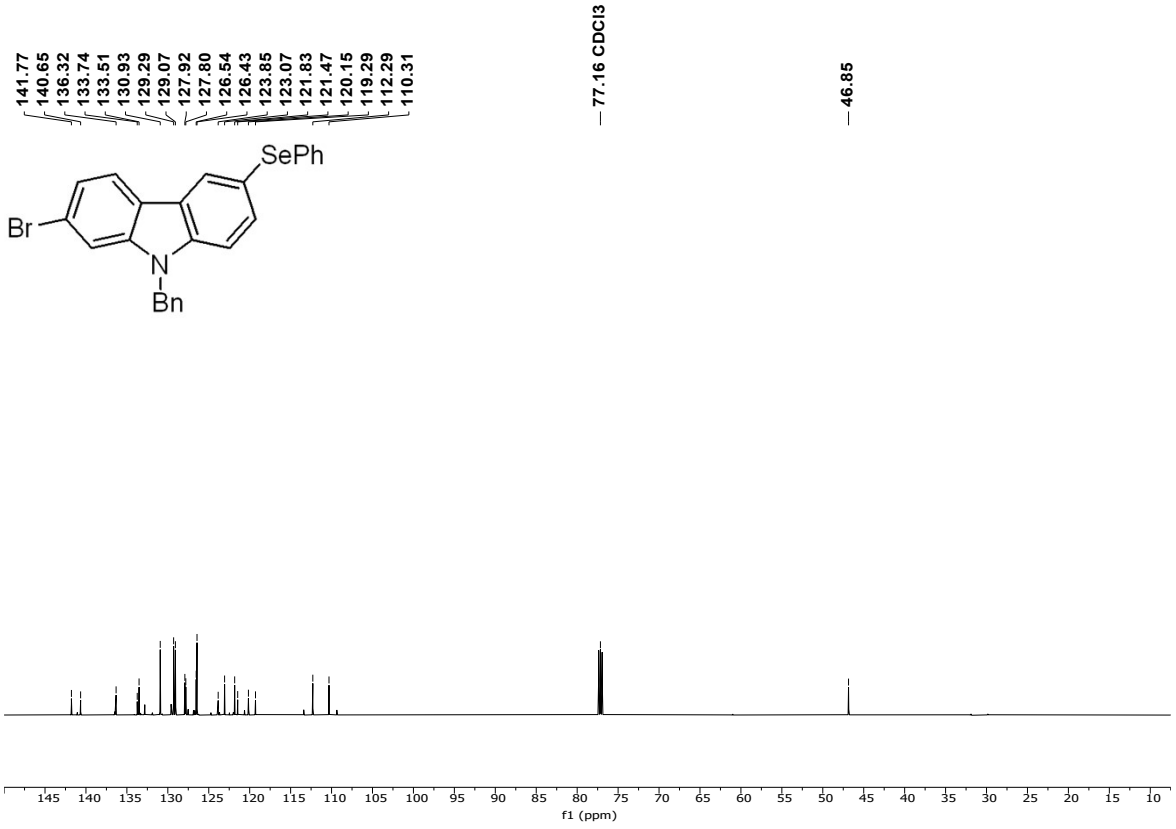
**$^{13}$C NMR of product 3y in $CDCl_3$ (151 MHz)**



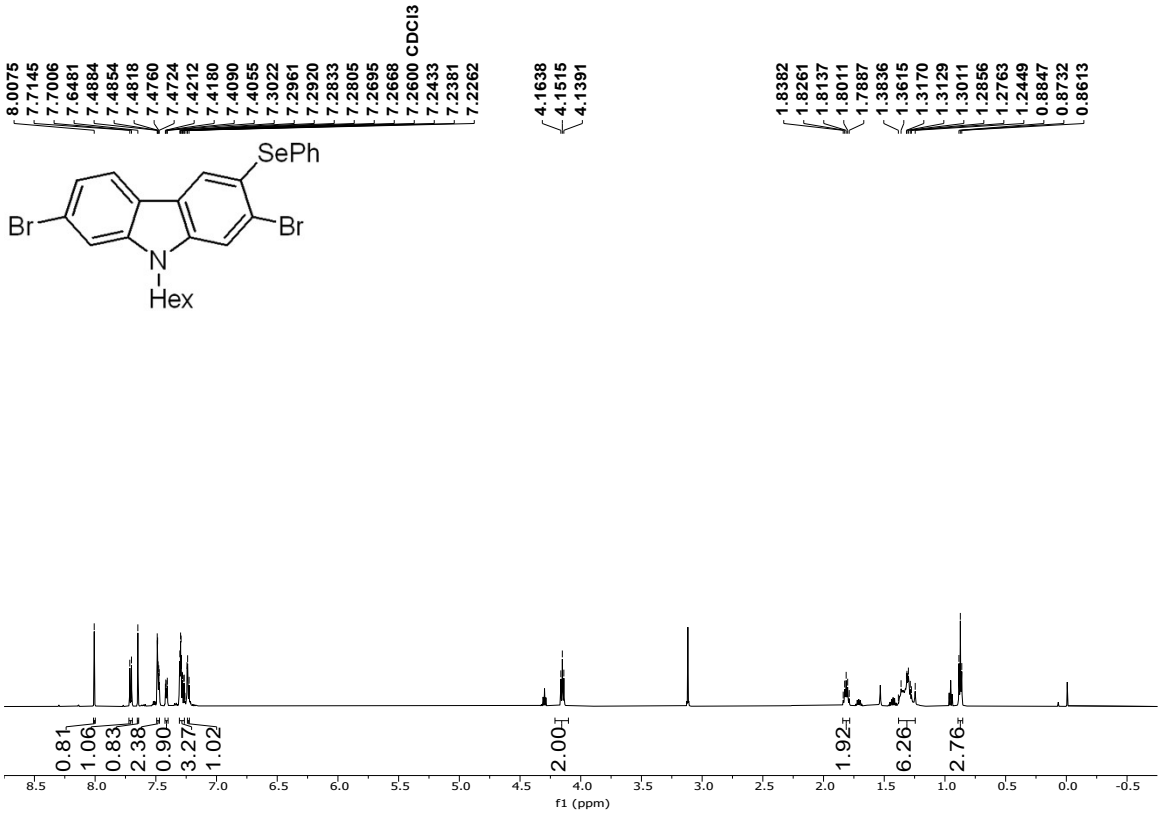

**$^{1}$H NMR of product 3z in $CDCl_3$ (600 MHz)**



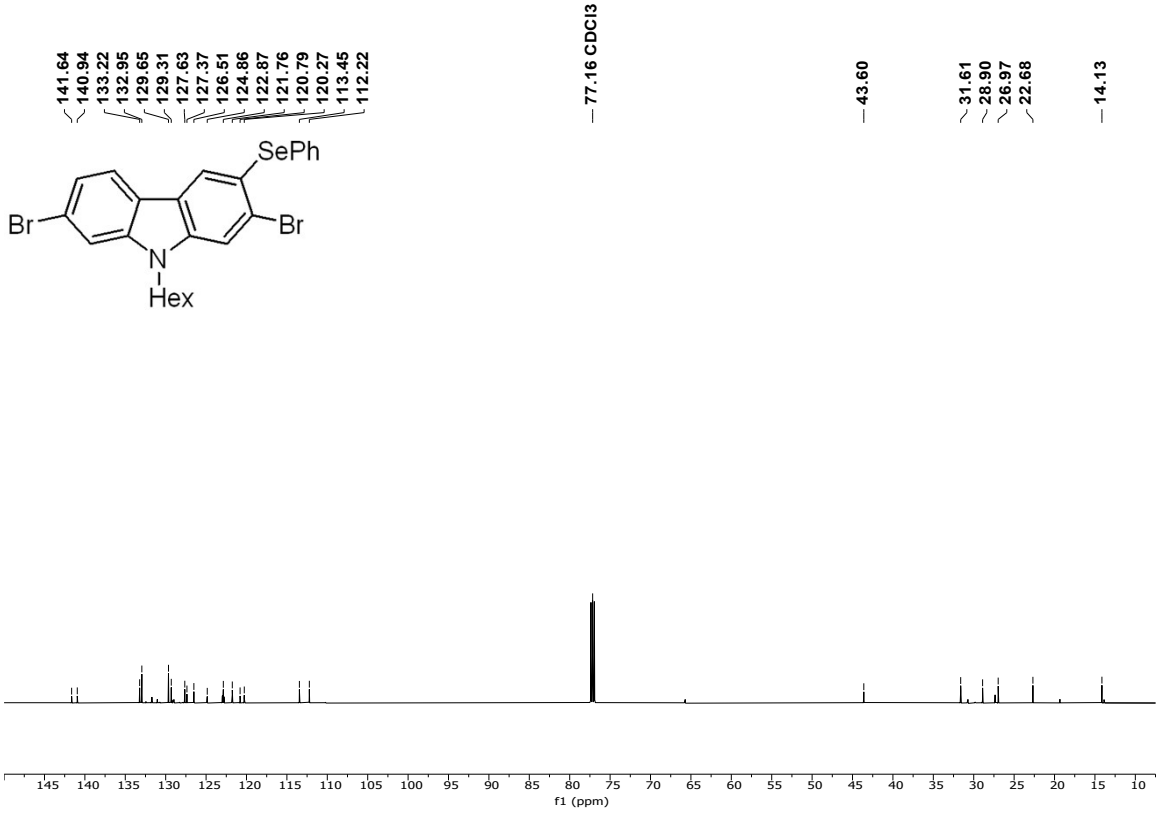

**$^{13}$C NMR of product 3z in $CDCl_3$ (151 MHz)**



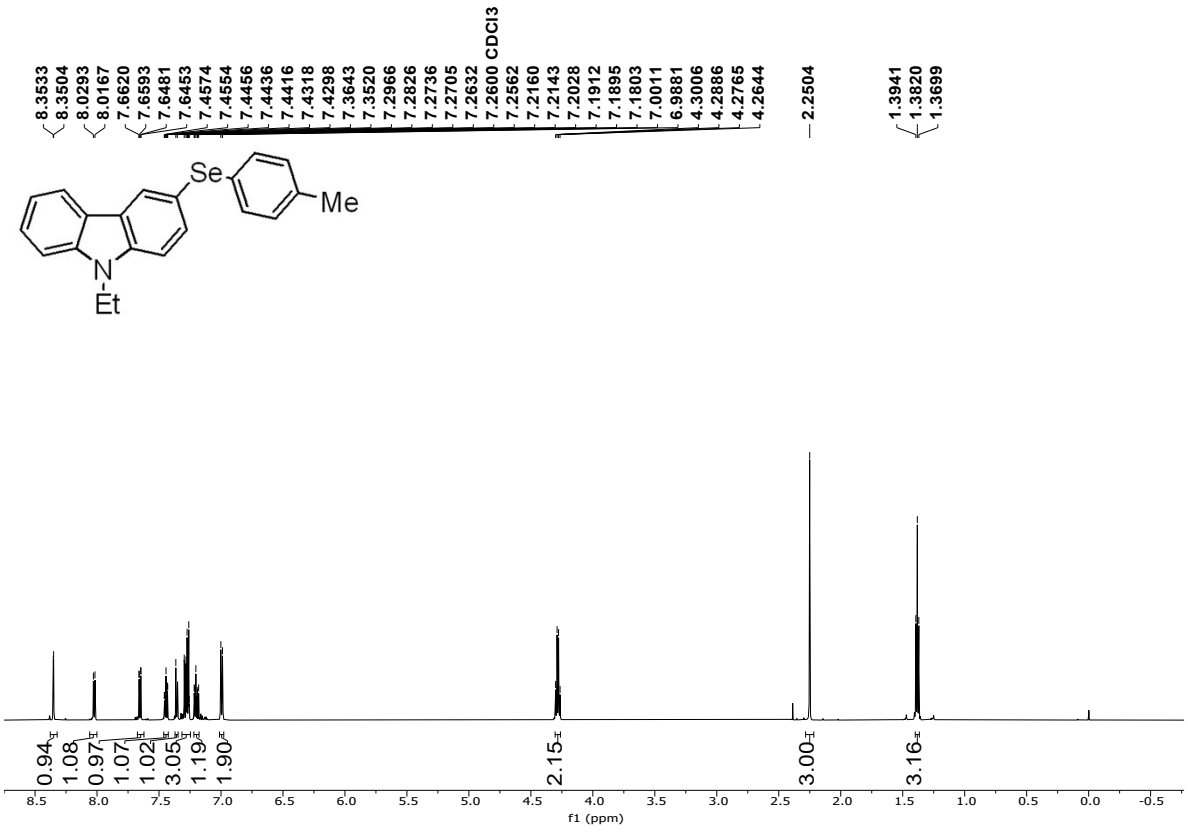

**$^{1}$H NMR of product 3aa in $CDCl_3$ (600 MHz)**



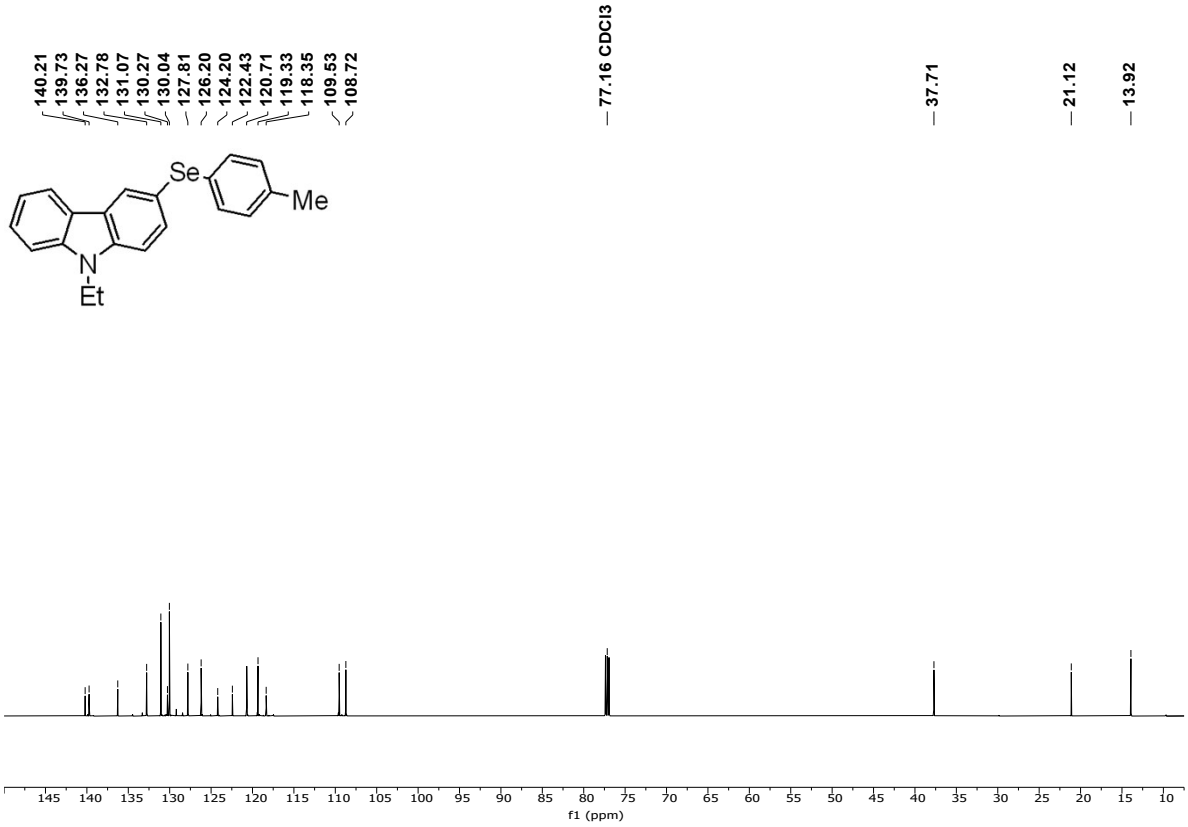
**$^{13}$C NMR of product 3aa in $CDCl_3$ (151 MHz)**



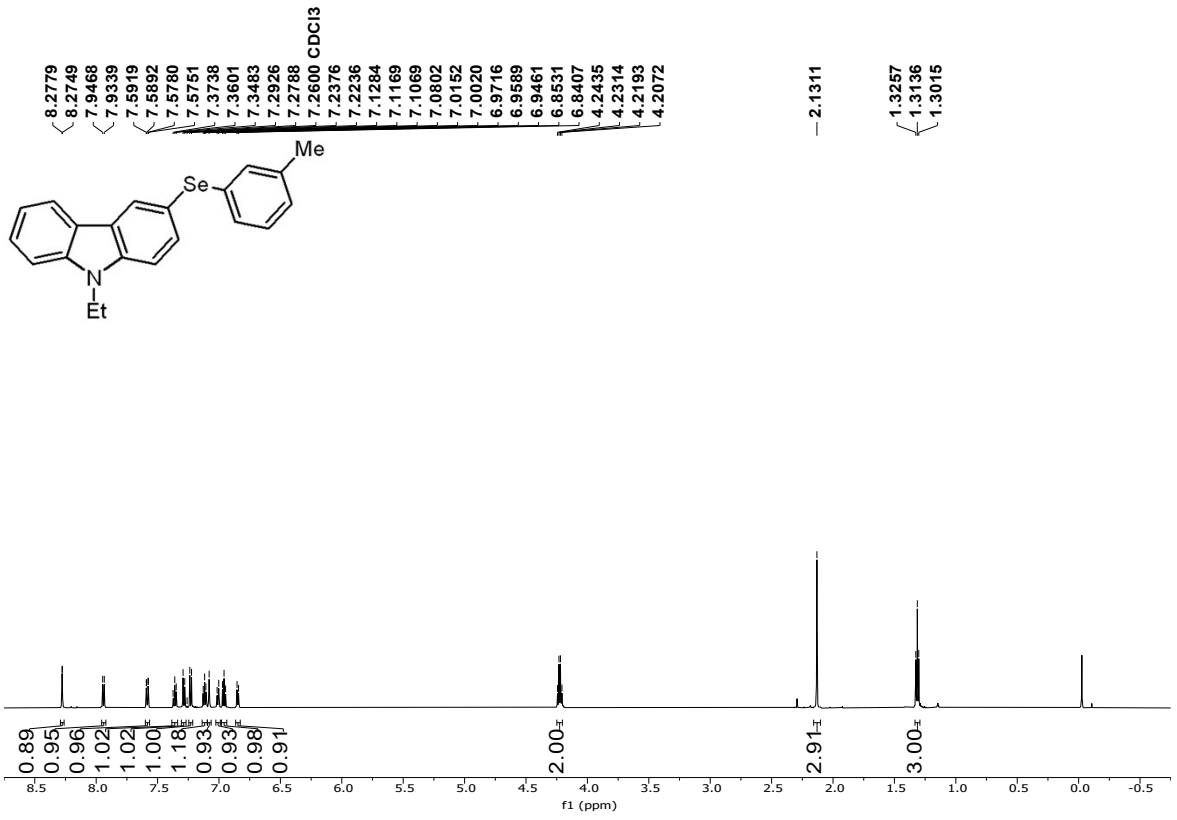

**$^{1}$H NMR of product 3ab in $CDCl_3$ (600 MHz)**



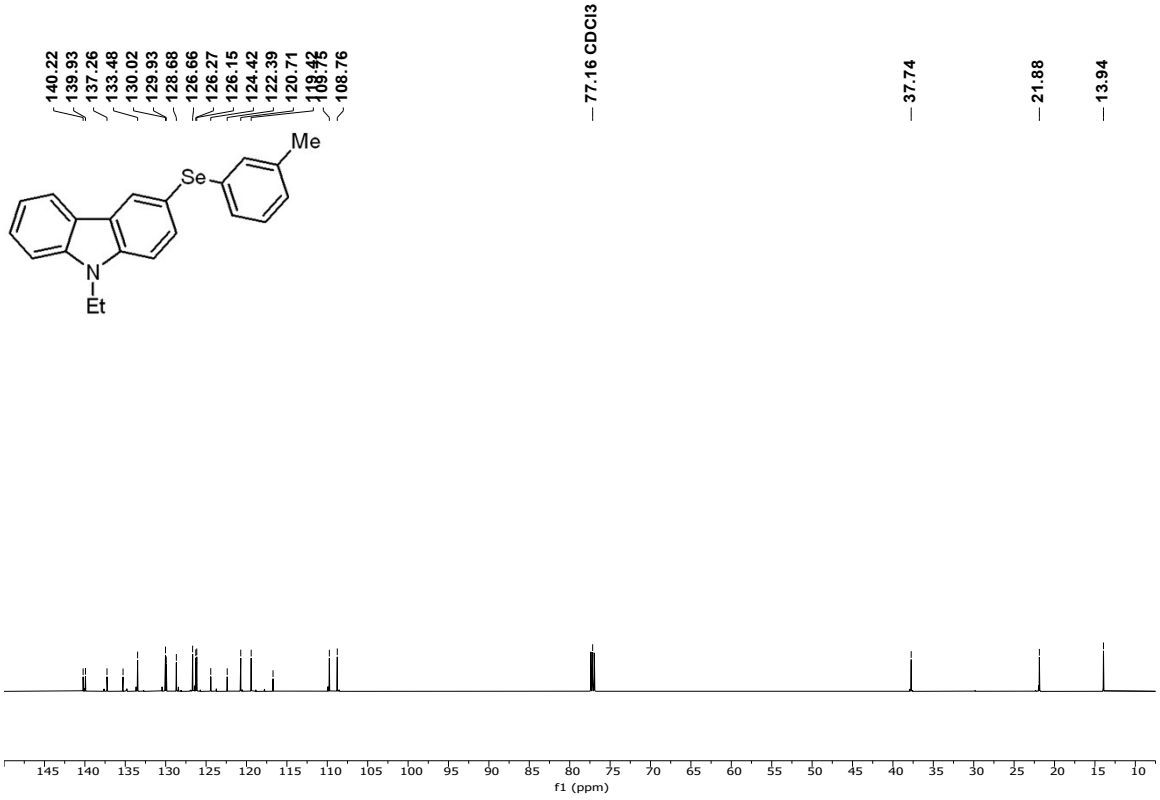

**$^{13}$C NMR of product 3ab in $CDCl_3$ (151 MHz)**



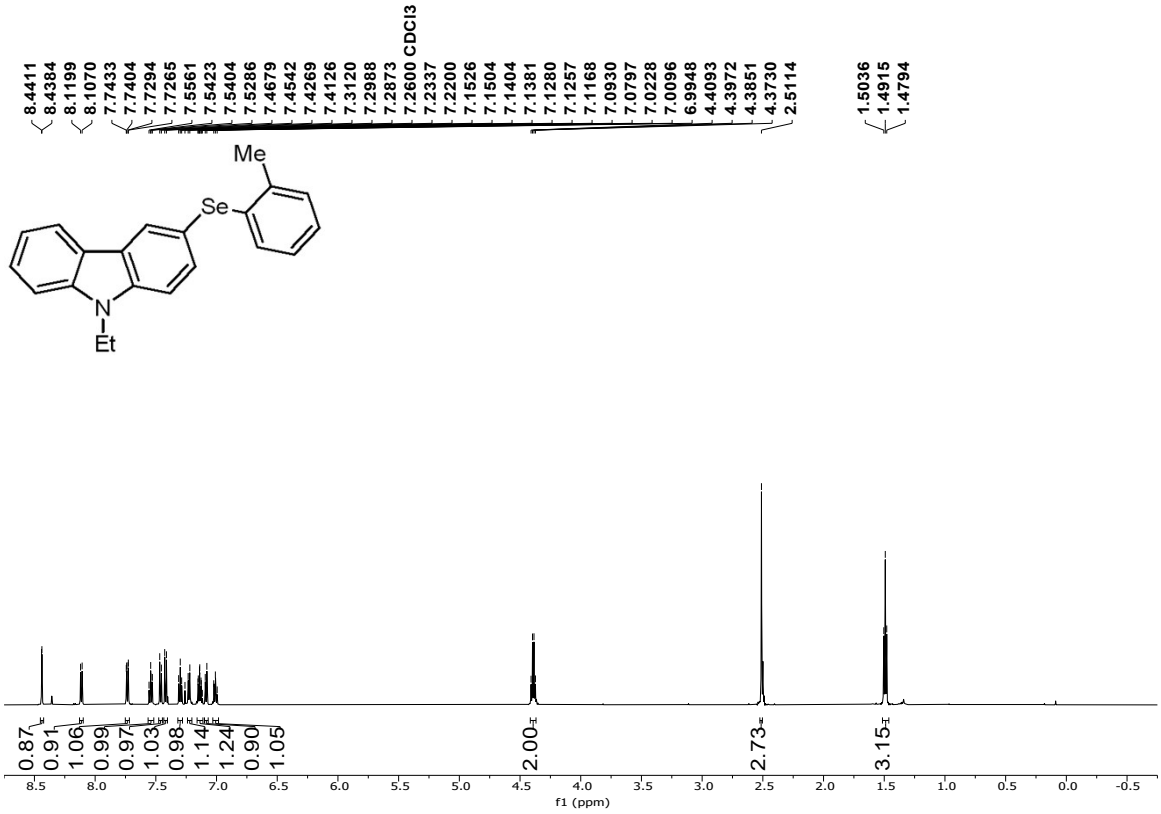

**$^1$H NMR of product 3ac in $CDCl_3$ (600 MHz)**



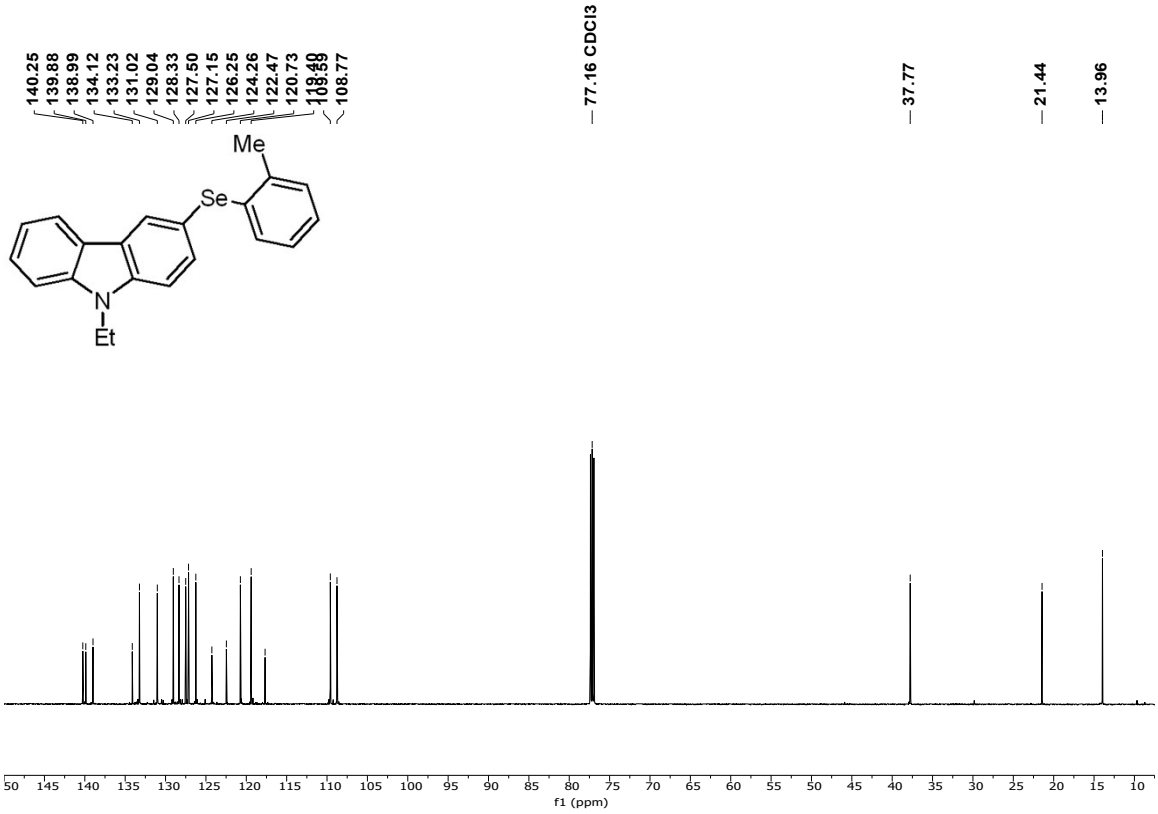
**$^{13}$C NMR of product 3ac in $CDCl_3$ (151 MHz)**



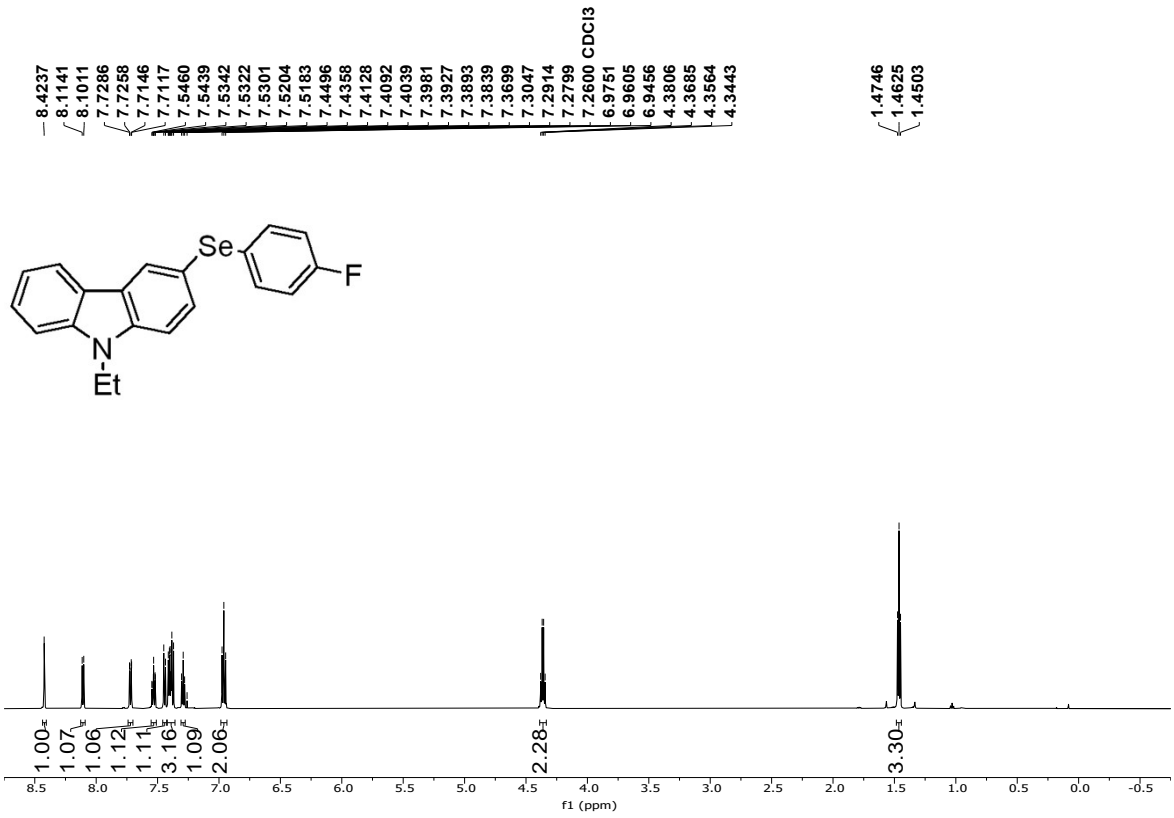

**$^{1}$H NMR of product 3ad in $CDCl_3$ (600 MHz)**



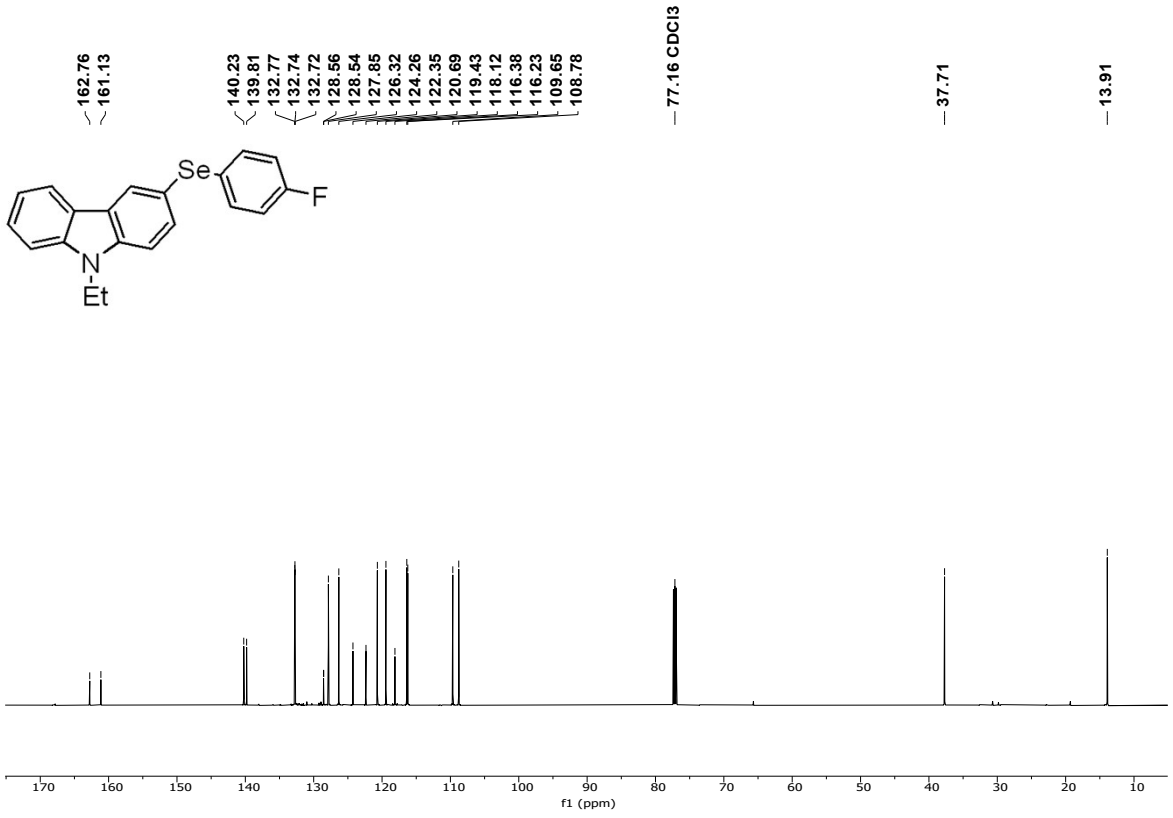

**$^{13}$C NMR of product 3ad in $CDCl_3$ (151 MHz)**



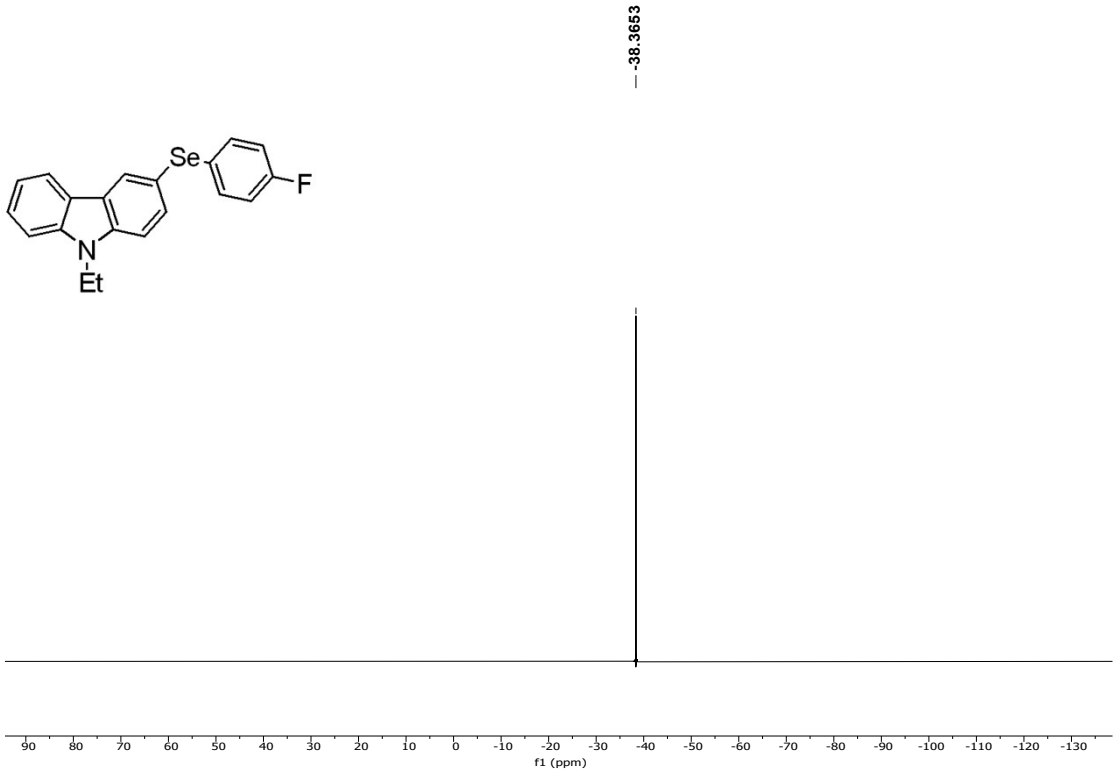

**$^1$H NMR of product 3ae in $CDCl_3$ (600 MHz)**



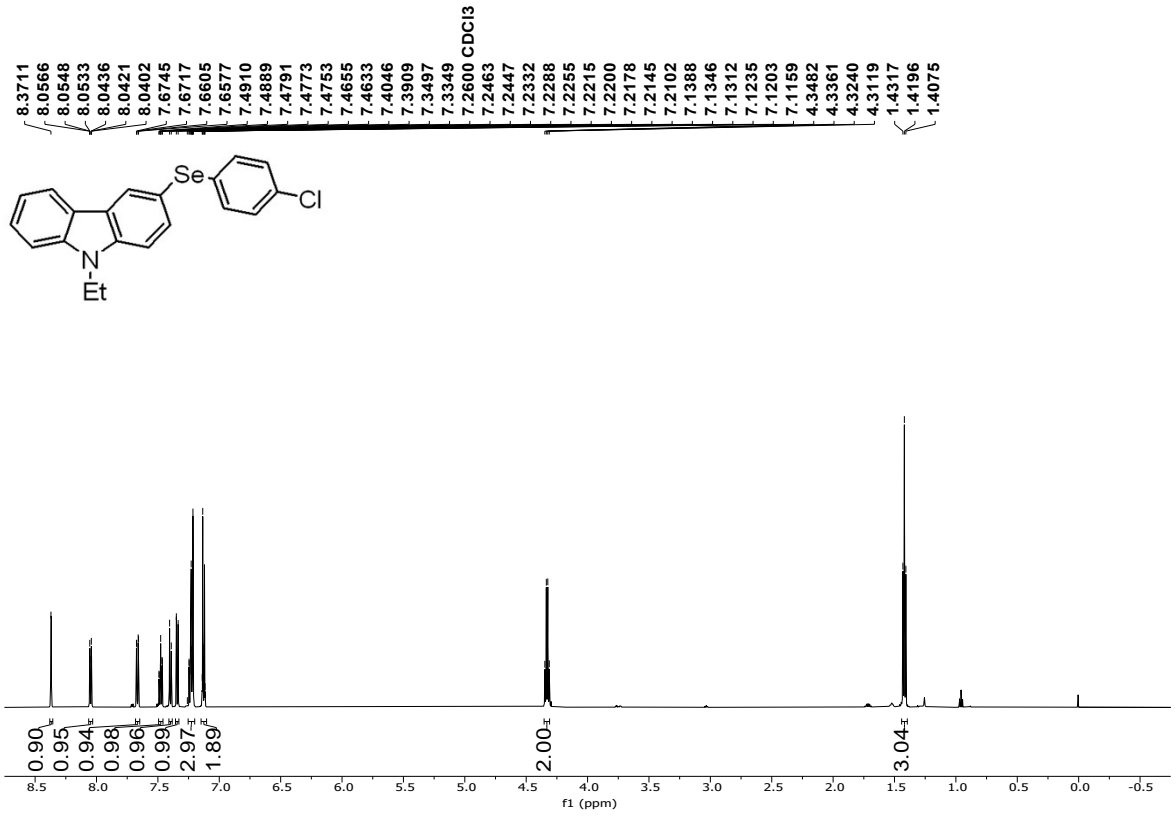
**$^{13}$C NMR of product 3ae in $CDCl_3$ (151 MHz)**



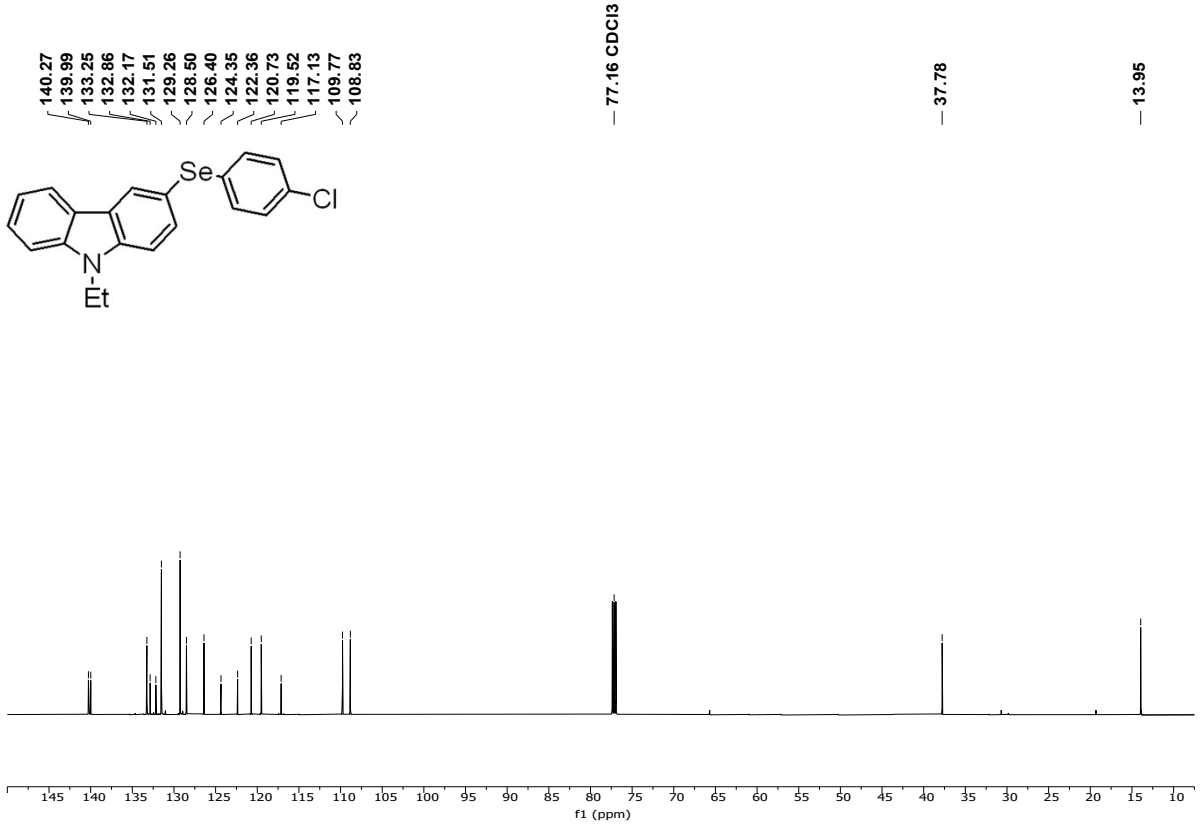

**$^{19}$F NMR of product 3ae in $CDCl_3$ (565 MHz)**



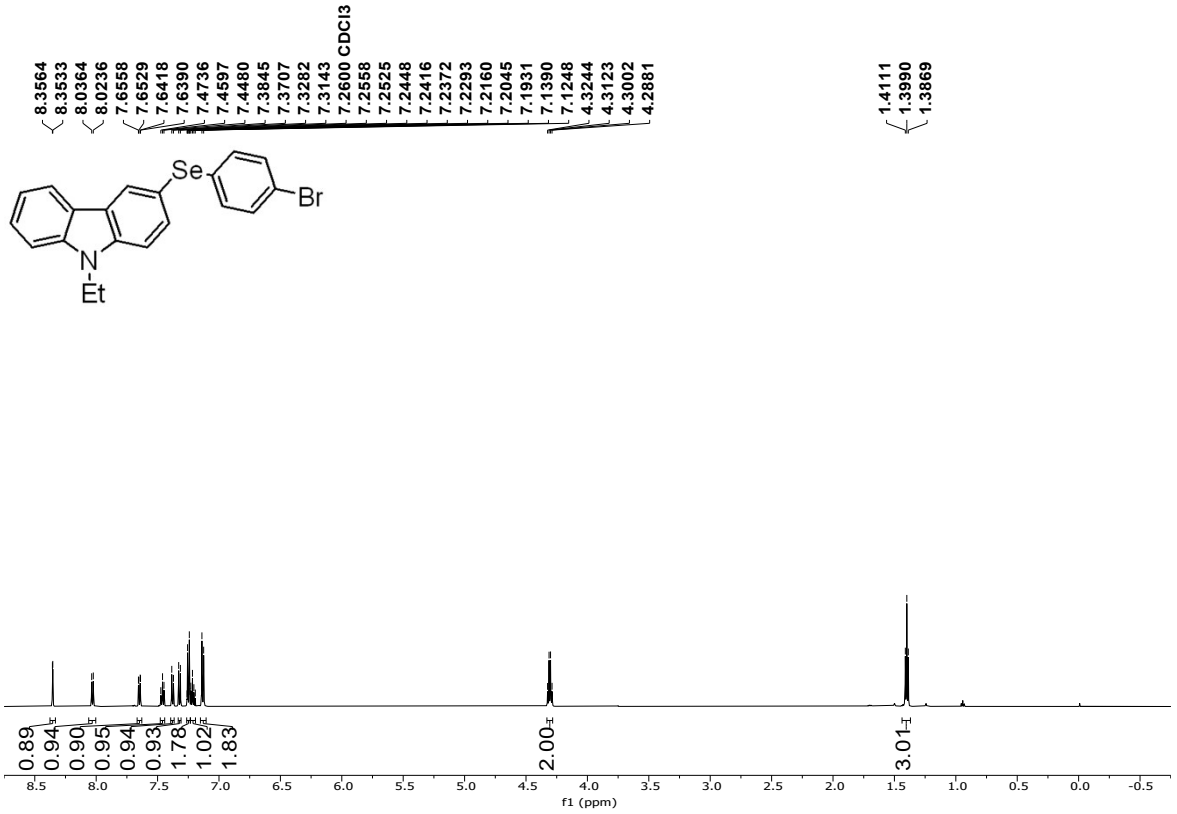

**$^{1}$H NMR of product 3af in $CDCl_3$ (600 MHz)**



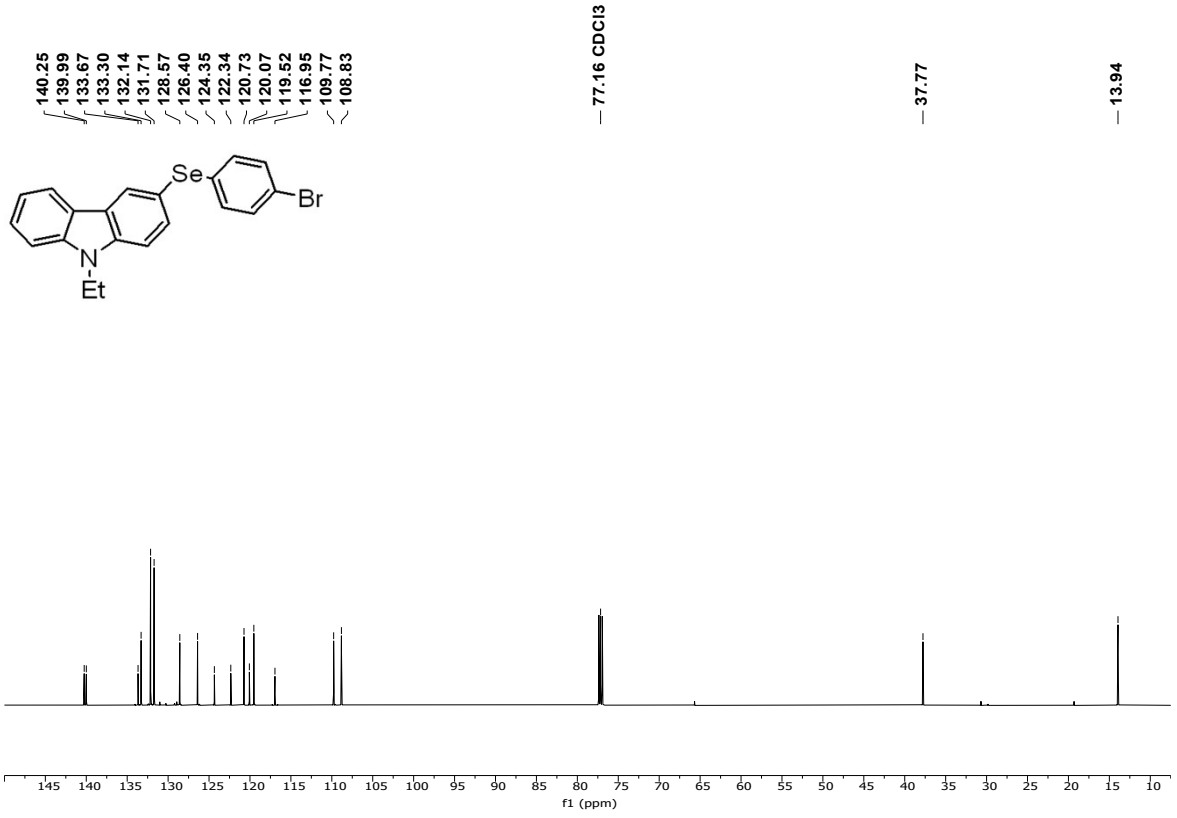
**$^{13}$C NMR of product 3af in $CDCl_3$ (151 MHz)**



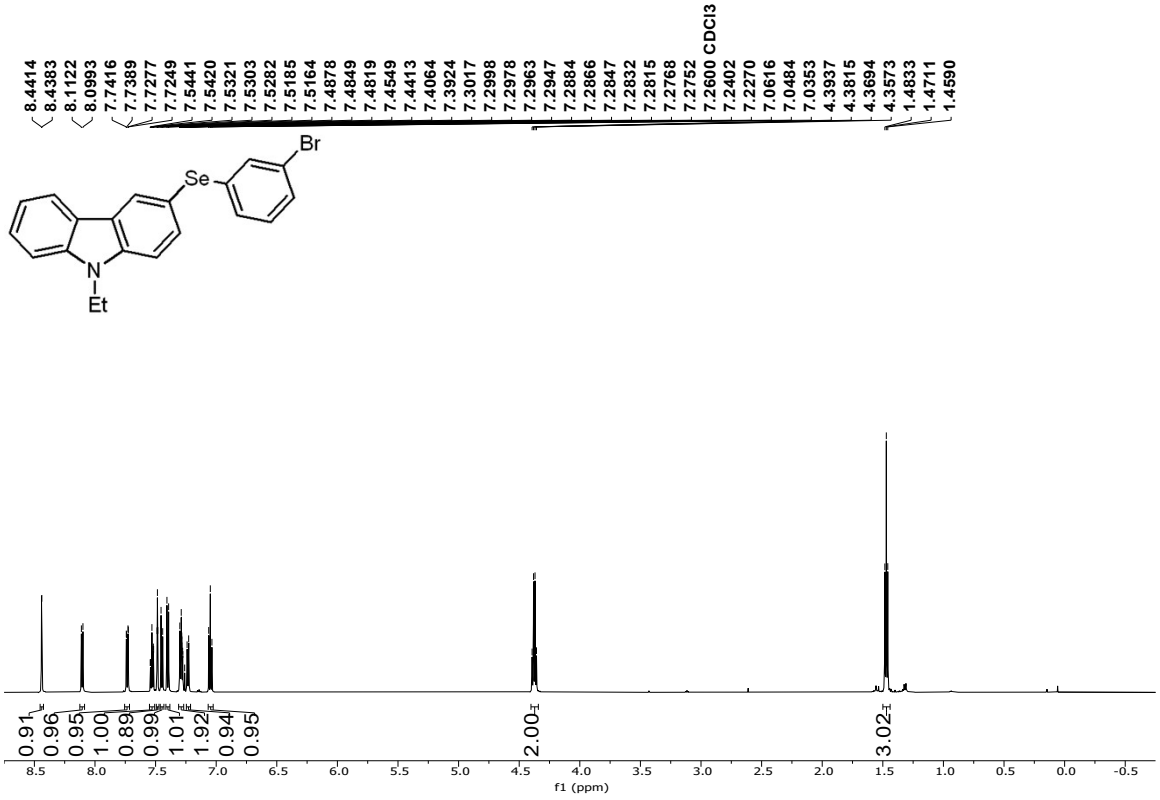

**$^{1}$H NMR of product 3ag in $CDCl_3$ (600 MHz)**



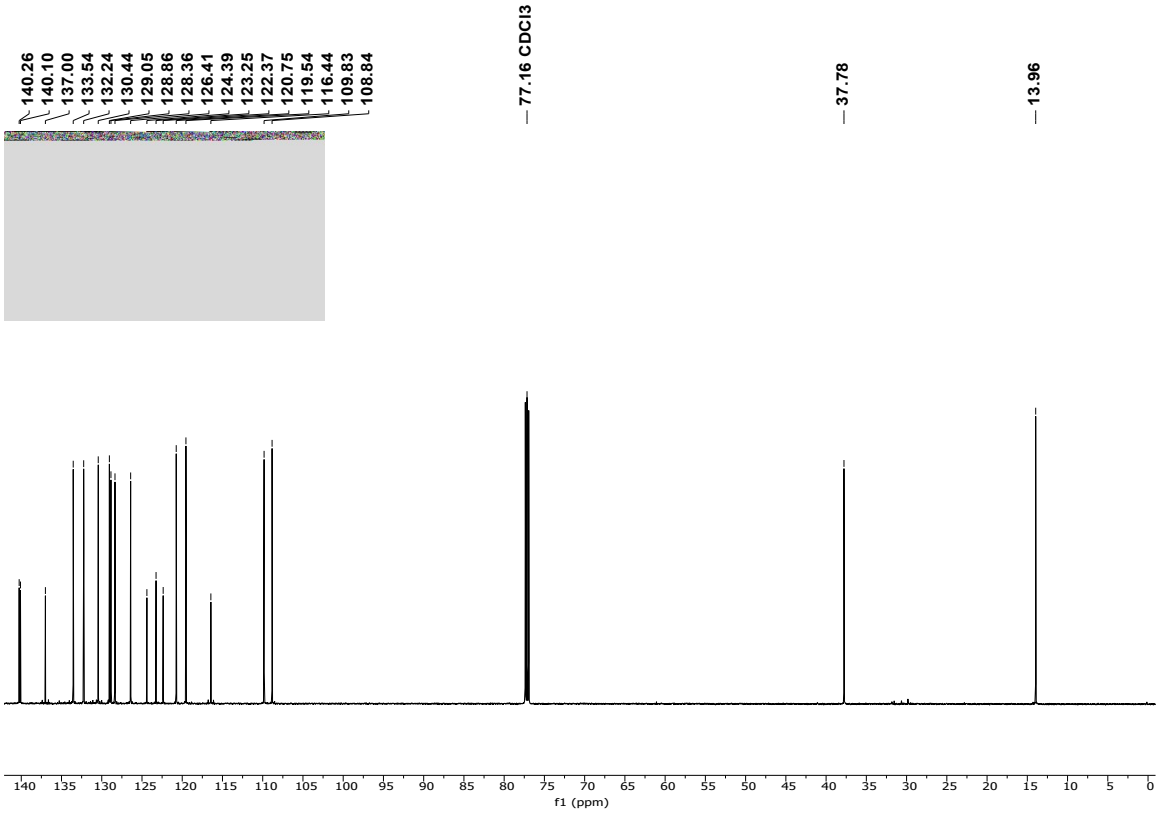

**$^{13}$C NMR of product 3ag in $CDCl_3$ (151 MHz)**



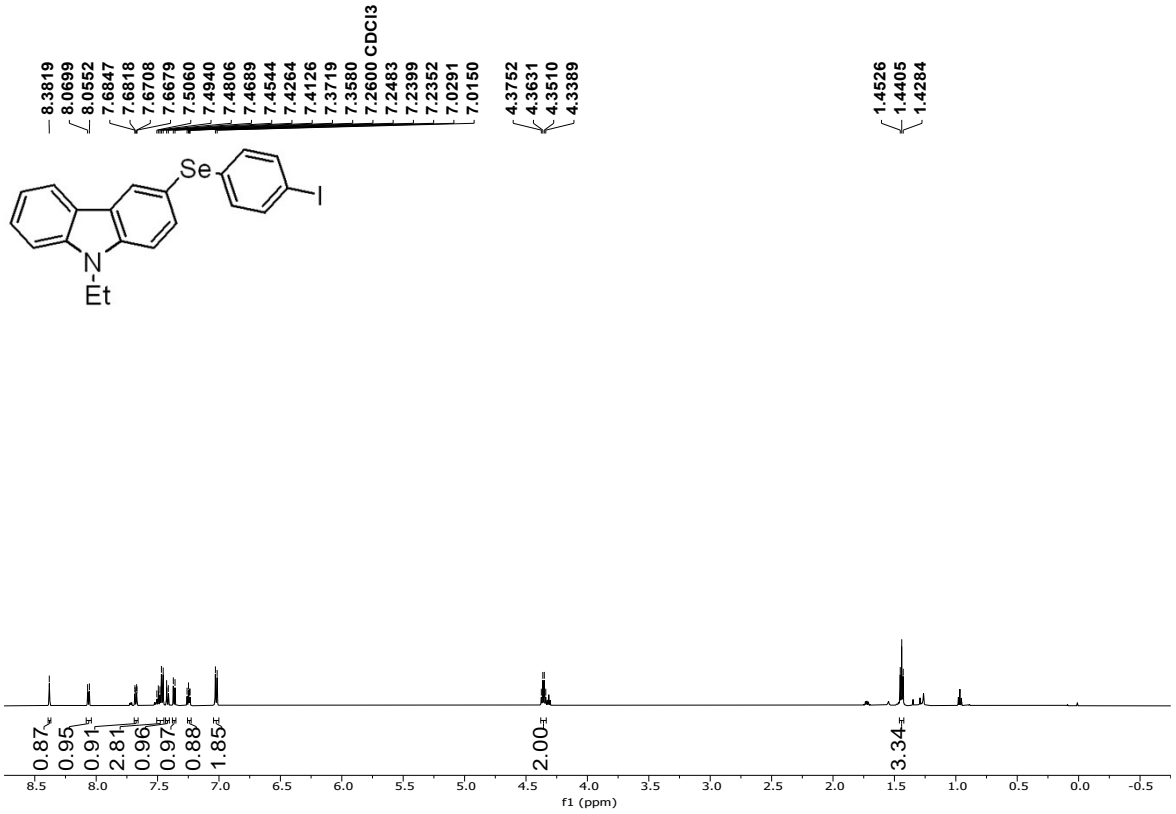
**$^{1}$H NMR of product 3ah in $CDCl_3$ (600 MHz)**



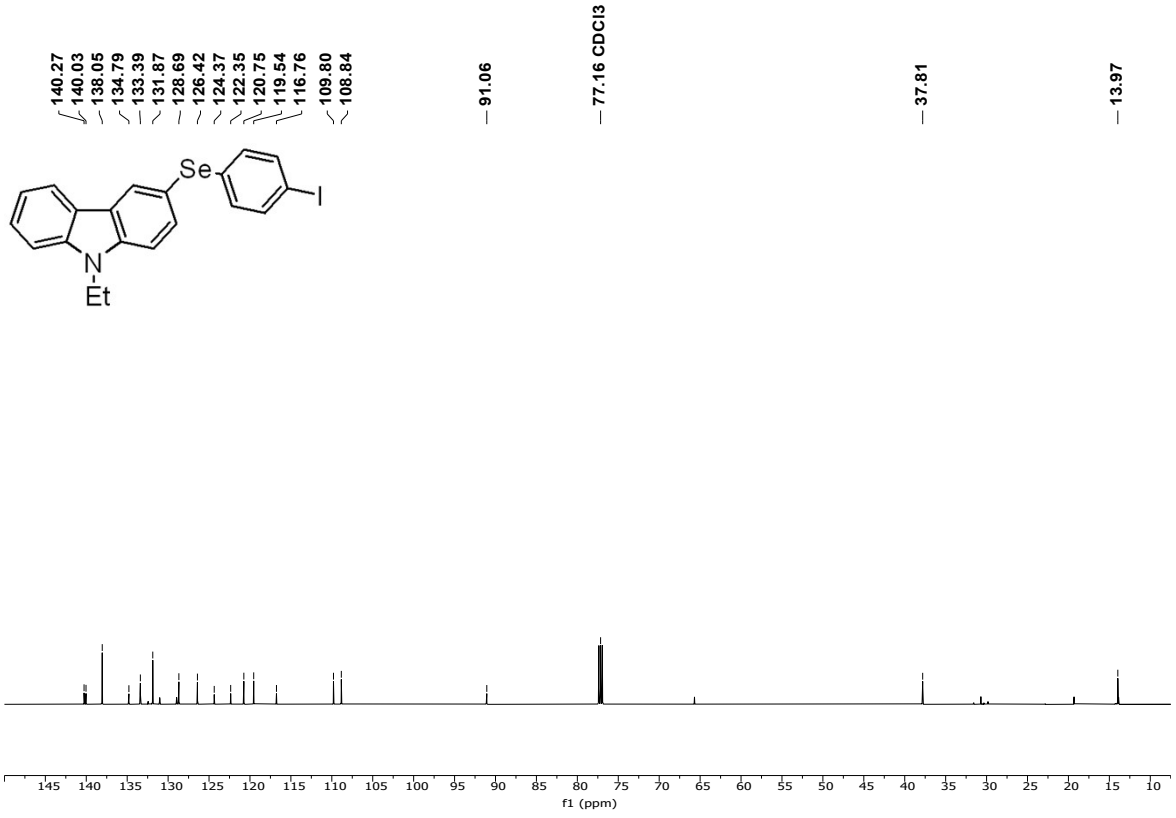

**$^{13}$C NMR of product 3ah in $CDCl_3$ (151 MHz)**




**$^{1}$H NMR of product 3ai in $CDCl_3$ (600 MHz)**

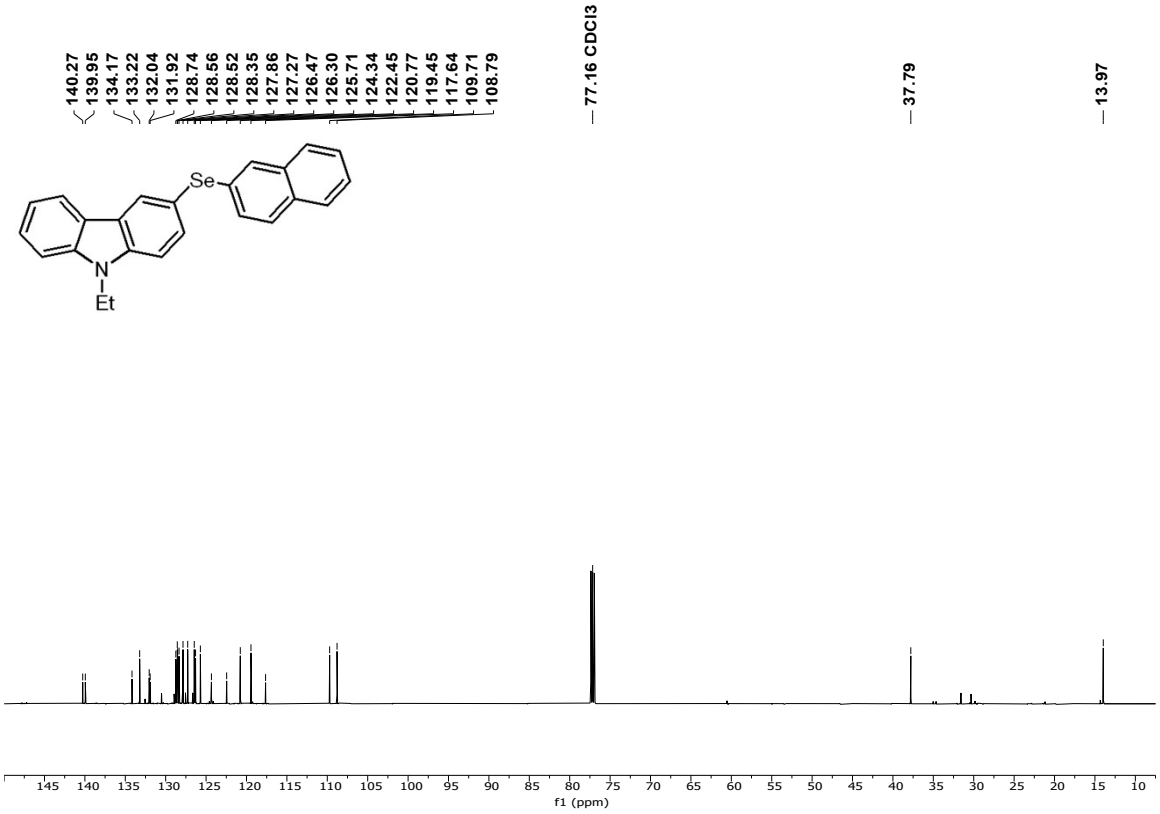



**$^{13}$C NMR of product 3ai in $CDCl_3$ (151 MHz)**

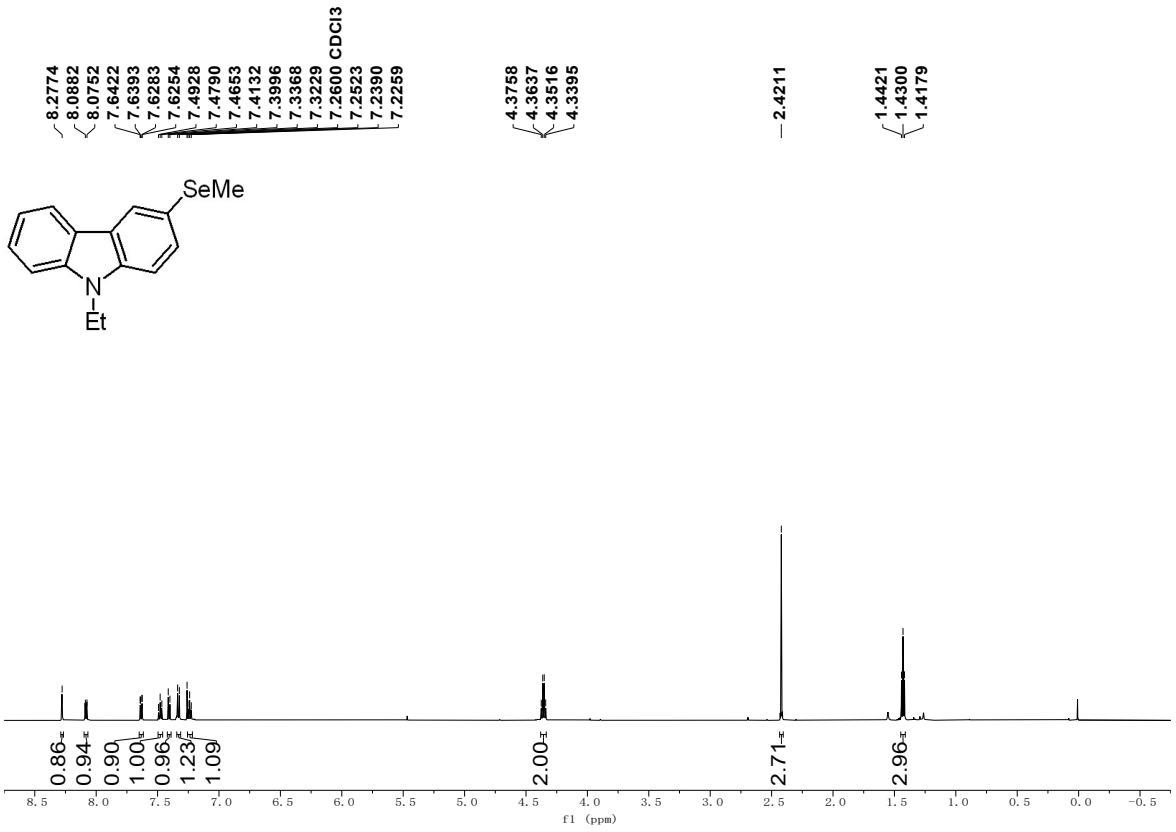


**$^{1}$H NMR of product 3aj in $CDCl_3$ (600 MHz)**

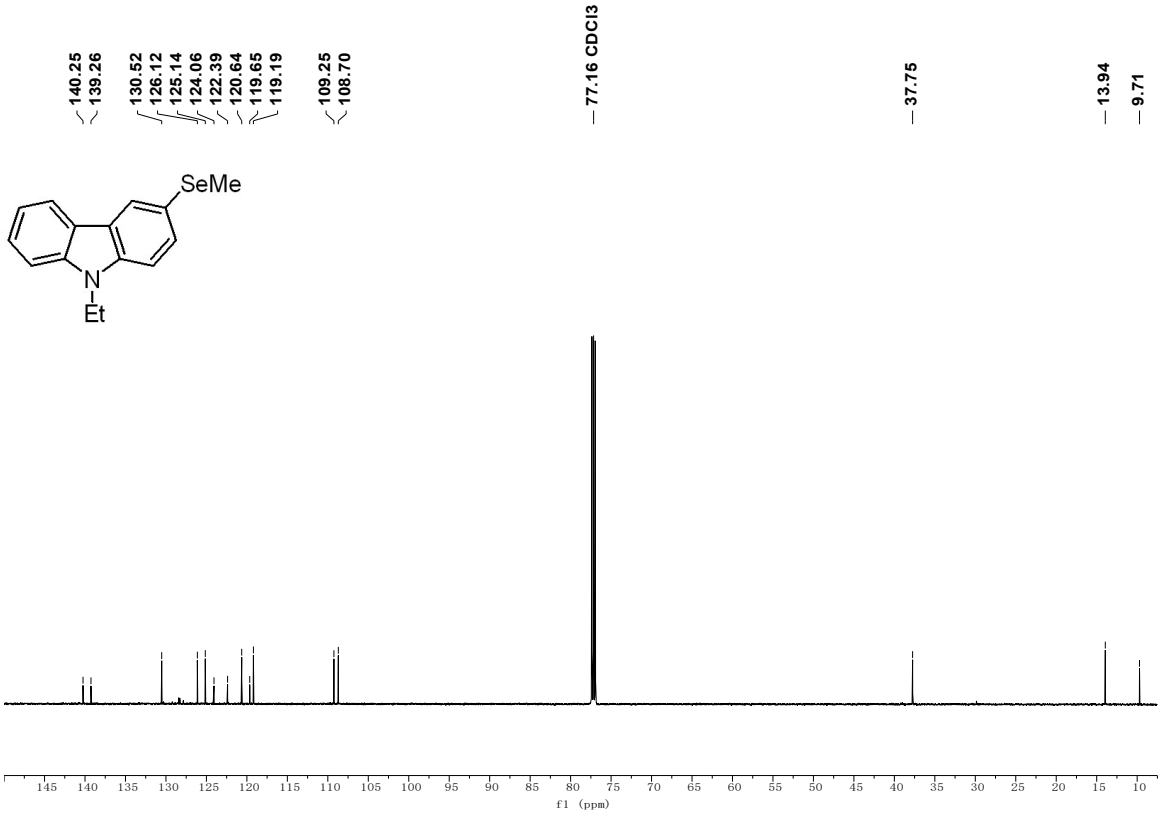

**$^{13}$C NMR of product 3aj in $CDCl_3$ (151 MHz)**



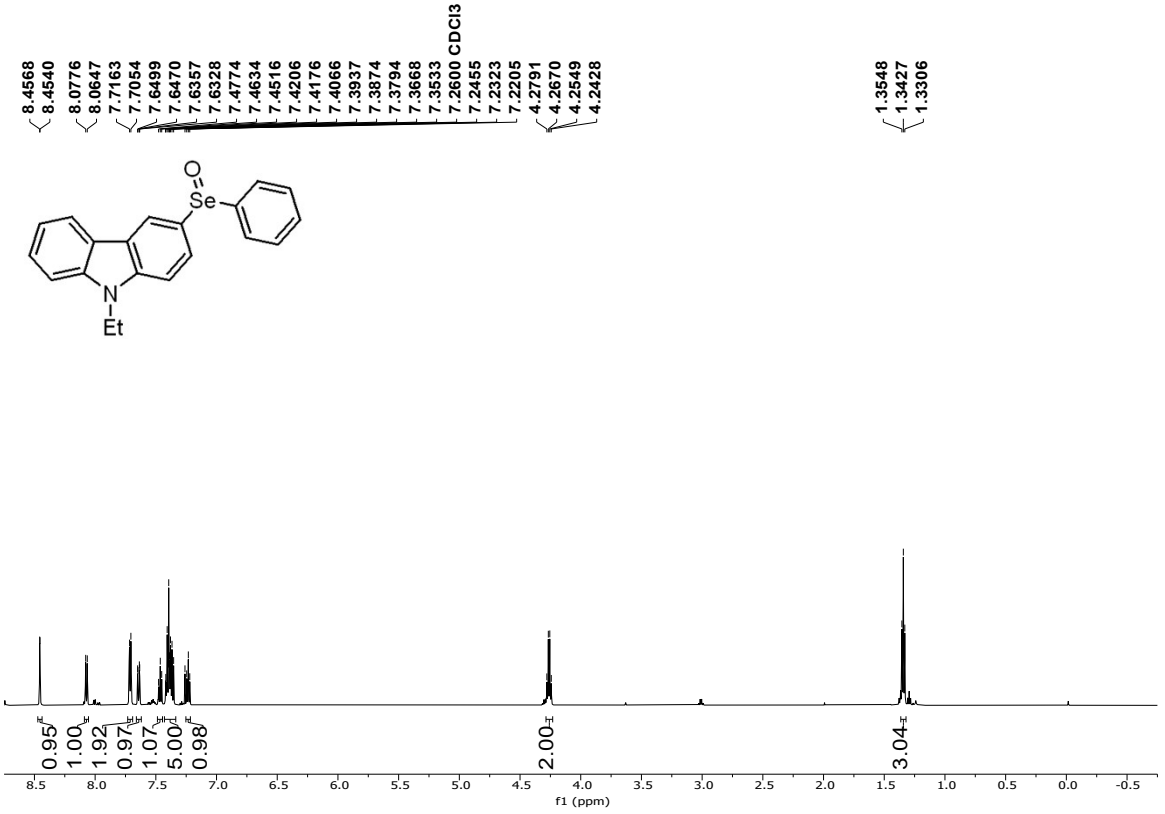

**$^{1}$H NMR of product 3am in $CDCl_3$ (600 MHz)**



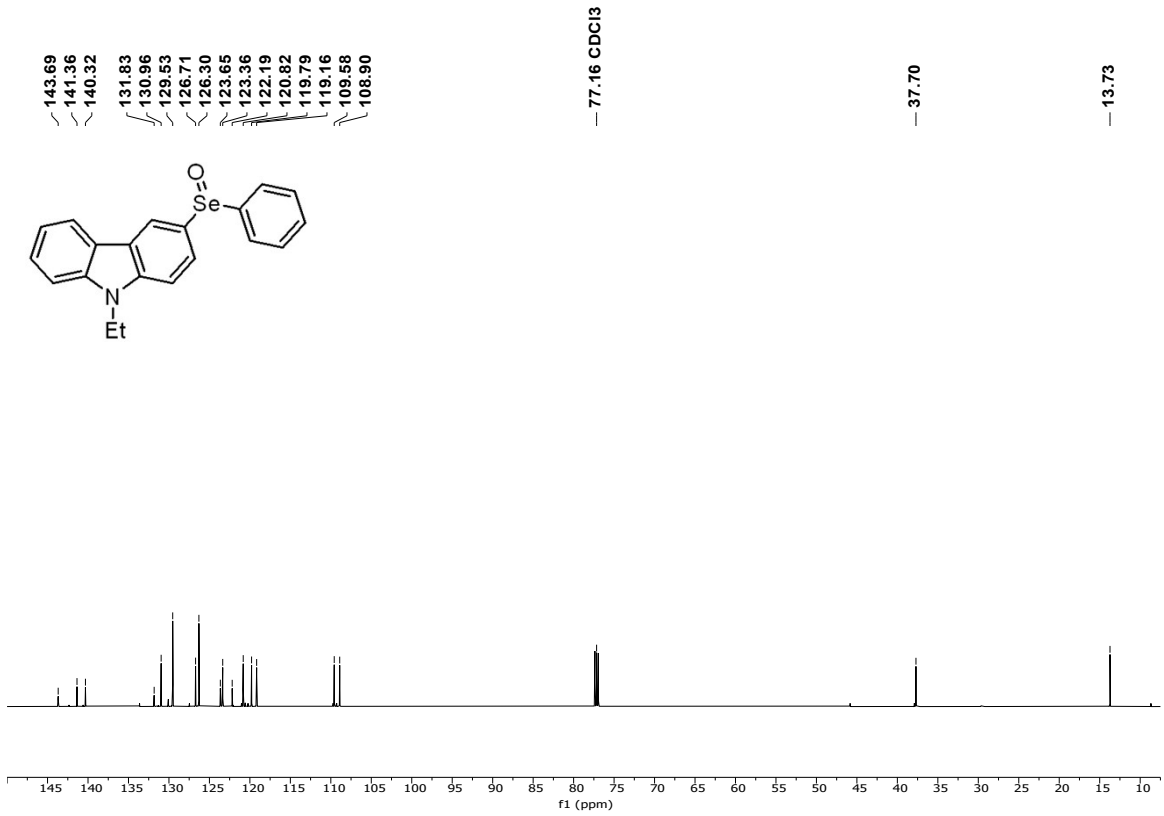

**$^{13}$C NMR of product 3am in $CDCl_3$ (151 MHz)**



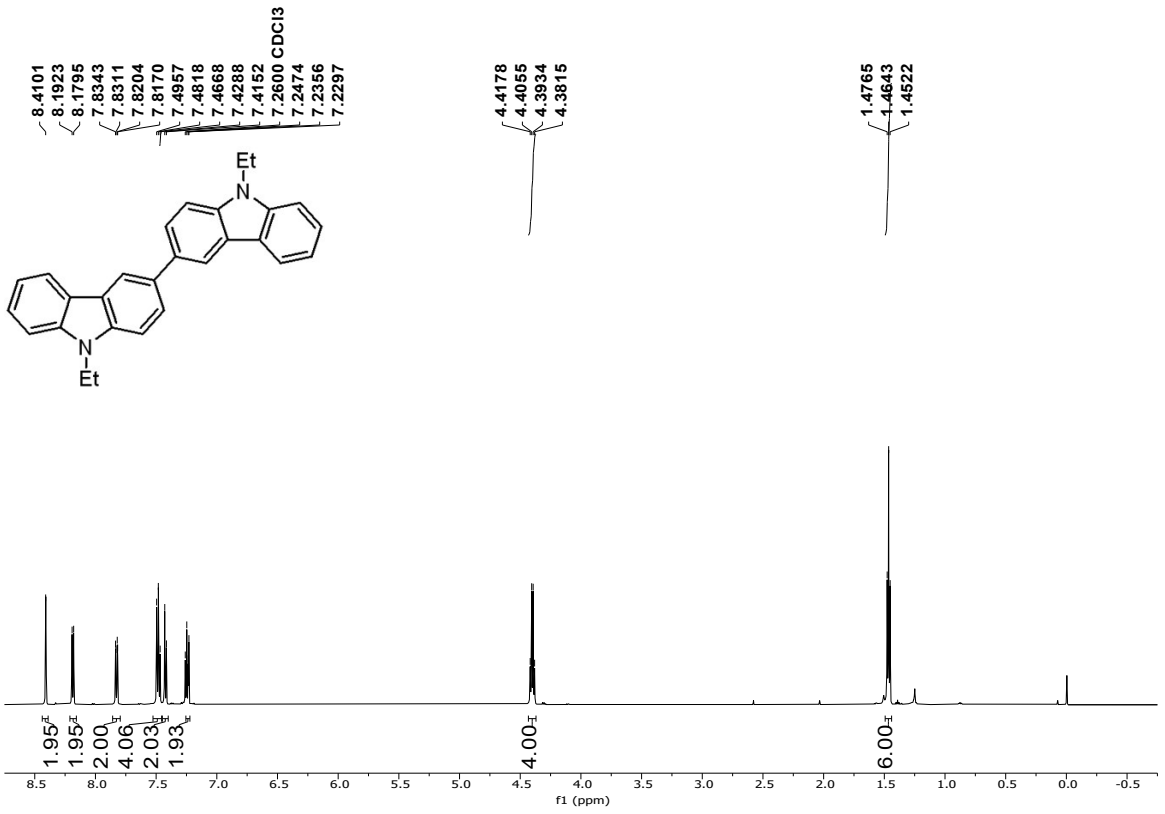
**$^{1}$H NMR of product 4a in $CDCl_3$ (600 MHz)**




**$^{13}$C NMR of product 4a in $CDCl_3$ (151 MHz)**




**$^{1}$H NMR of product 8a in $CDCl_3$ (600 MHz)**




**$^{13}$C NMR of product 8a in $CDCl_3$ (151 MHz)**