Supporting Information

Palladium-Catalyzed Cascade 5-*Exo-Trig* Radical Cyclization /Aromatic C−H Alkylation with Unactivated Alkyl Iodides

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1. General Information

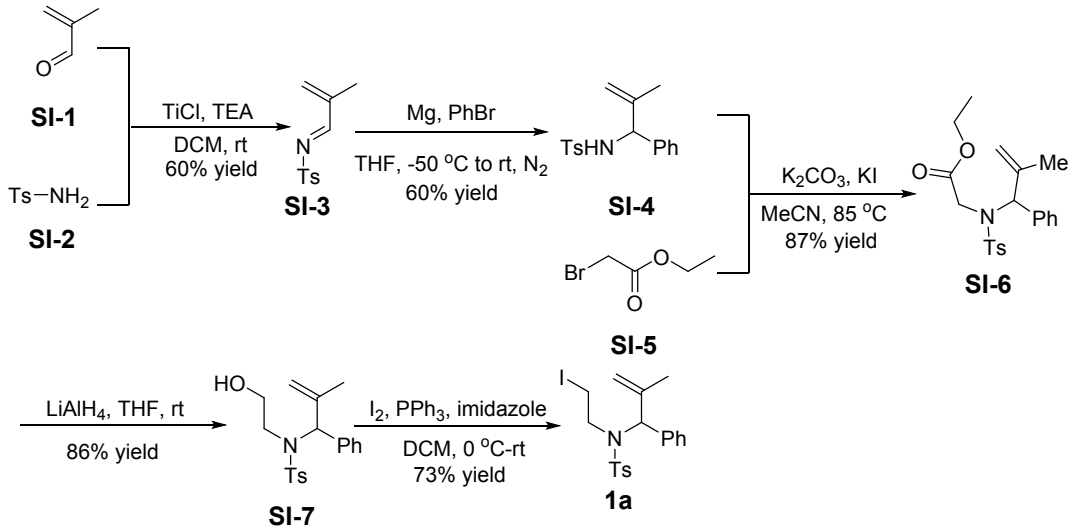
Organic solvents (Aldrich) were used without further purification. Purifications of reactions products were carried out by flash chromatography using Merck silica gel (40-63 μm). ^{1}H NMR (400 MHz), ^{13}C NMR (100 MHz) were measured on a Brucker Avance 400 MHz spectrometer. Chemical shifts are reported in parts per million (ppm, δ) downfield from residual solvents peaks and coupling constants are reported as Hertz (Hz). Splitting patterns are designated as singlet (s), doublet (d), triplet (t). Splitting patterns that could not be interpreted or easily visualized are designated as multiplet (m). Electrospray mass spectra were obtained using an ESI/TOF Mariner Mass Spectrometer.

All commercially available reagents were bought from Macklin, Aladdin and used without further purification. Dry THF was steamed with metal sodium. Cesium carbonate was directly purchased from Macklin.

Reactions were conducted in dry solvents under Nitrogen atmosphere unless otherwise stated. The abbreviation "rt" refers to reactions carried out approximately at 23-27 ºC. Reaction mixtures were stirred using Teflon-coated Magnetic stirring rotor. Thin-layer chromatography (TLC) was performed on silica gel plates and components were visualized by observation under UV light, flash chromatography was carried out on silica gel unless otherwise stated. Dryings were performed with anhydrous Na_2SO_4 or $MgSO_4$. Concentration refers to the removal of volatile solvents via distillation using a Büchi rotary evaporator, followed by residual solvent removal under high vacuum. The reactions were monitored by TLC or GC-MS.

2. Preparation of Starting Material.

General Procedure I:



Preparation of *N*-Tosyl-2-methylpropenimin SI-3: A solution of **SI-1** methacrolein (65 mmol, 5.36 mL), 4-methylbenzenesulfonamide **SI-2** (65 mmol, 11.13 g), and triethylamine (195 mmol, 27.1 mL) in dichloromethane (120 mL) was cooled to 0 °C with stirring under nitrogen, a solution of titanium tetrachloride (45.5 mmol, 5.0 mL) in 20 mL of dichloromethane was added, and the mixture was stirred at 0 °C for 90 min. The mixture was then filtered through Celite, and the solvents were evaporated to give a solid crystalline mass. The solids were broken up and refluxed with stirring for 10 min with 70mL of ether. The ether solution was decanted off the residual solid, filtered through Celite, and then evaporated to give the imine **SI-3** (8.71 g, 39mmol, 60% yield) as white solid.

Preparation of benzenesulfonamide SI-4: Imine **SI-3** (4.47 g, 20 mmol, 1.0 equiv.) was dissolved in THF under nitrogen and cooled to –50 °C. Afterwards the Grignard compound (2.0 equiv.) was added dropwise and the reaction mixture was stirred for 2 h at -50 °C, allowed to warm up to r.t. and then stirred for 2 h. The reaction was quenched by adding saturated aqueous NH_4Cl. Then the organic layer was exacted three times with AcOEt (40 mL). Drying over Na_2SO_4 and concentration in vacuo afforded the crude material, which was then purified by silica gel column chromatography (PE:EA, 5:1) to give the benzenesulfonamide **SI-4** (3.62 g, 12 mmol, 60% yield) as white solid.

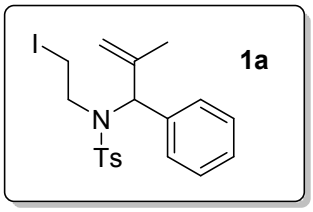
Preparation of ester SI-6: benzenesulfonamide **SI-4** (3.01 g, 10 mmol, 1.0 equiv.) in MeCN (80 mL) was added to a stirred mixture of **SI-5** ethyl bromoacetate (5.01 g, 30 mmol, 3.0 equiv.), K_2CO_3 (9.67 g, 70 mmol) and KI (0.83g, 5 mmol). The mixture was heated to reflux

for 12 h. Then the reaction system was quenched with water, the organic layer was exacted three times with EtOAc (20 mL). Drying over Na_2SO_4 and concentration in vacuo afforded the crude material, which was then purified by silica gel column chromatography (PE:EA, 5:1) to give the ester **SI-6** (3.37 g, 8.7 mmol, 87% yield) as a pale yellow oil.

Preparation of alcohol SI-7: $LiAlH_4$ (0.61 g, 16 mmol) was suspended in THF (10 mL) and a solution of ester **SI-6** (3.1 g, 8 mmol) in THF (60 mL) was then slowly added at 0 °C. The reaction mixture was stirred at room temperature for 12 h. The reaction mixture was slowly quenched with H_2O (5 mL), 10% aqueous NaOH (5 mL), H_2O (5 mL) at 0 °C, filtered through a small pad of celite. The filtrate was extracted with ethyl acetate (3 × 40 mL), washed with brine (40 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The alcohol **SI-7** (2.38 g, 6.88 mmol) was afforded as a colourless oil without further purification.

Preparation of alkyl iodide 1a: To a solution of **SI-7** (1.72 g, 5 mmol, 1.0 equiv) in 60 mL DCM was cooled to 0 °C. PPh_3 (3.93 g, 15 mmol, 3.0 equiv), imidazole (1.02 g, 15 mmol, 3.0 equiv), I_2 (3.81 g, 15 mmol, 3.0 equiv) was added successively. Then the reaction mixture was warmed to room temperature and stirred for 2 h. The precipitate was removed by filtration. After the concentration of the filtrate in vacuo, purification by column chromatography (PE:EA, 20:1) afforded the iodide **1a** (1.66 g, 3.65 mmol, 73% yield) as a white solid.

Analytical Data:



***N*-(2-iodoethyl)-4-methyl-*N*-(2-methyl-1-phenylallyl)benzenesulfonamide**

$C_{19}H_{22}INO_2S$

The title compound was prepared according to **general procedure I**.

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.68 (d, *J* = 8.0 Hz, 2H), 7.32 (s, 1H), 7.31 (d, *J* = 1.6 Hz, 2H), 7.27(d, *J* = 2.4 Hz, 2H), 7.17-7.15 (m, 2H), 5.6 (s, 1H), 4.96 (s, 1H), 4.47 (s, 1H), 3.62 (td, *J* = 15.2, 4.8 Hz, 1H), 3.40 (td, *J* = 12.8, 4.4Hz. 1H), 3.1-3.04 (m, 1H), 2.42 (s, 3H), 2.15-2.08 (m, 1H), 1.64 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 143.5, 140.9, 137.1, 137.0, 129.5, 128.9, 128.8, 128.4, 127.4, 114.7, 66.0, 48.4, 21.6, 3.6.

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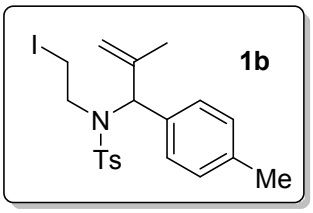

***N*-(2-iodoethyl)-4-methyl-*N*-(2-methyl-1-(*p*-tolyl)allyl)benzenesulfonamide**

$C_{20}H_{24}INO_2S$

The title compound was prepared according to **general procedure I**.

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.61 (d, *J* = 8.0 Hz, 2H), 7.18 (d, *J* = 8.0 Hz, 2H), 7.04 (d, *J* = 8.0 Hz, 2H), 6.97 (d, *J* = 7.6 Hz, 2H), 5.48 (s, 1H), 4.86 (s, 1H), 4.39 (s, 1H), 3.53 (td, *J* = 15.6, 4.8 Hz, 1H), 3.31 (td, *J* = 13.2, 4.4Hz, 1H), 3.02-2.96 (m, 1H), 2.34 (s, 3H), 2.26 (s, 3H), 2.08-2.02 (m, 1H), 1.53 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 143.4, 141.0, 138.2, 137.1, 134.0, 129.6, 129.5, 128.8, 127.4, 114.4, 65.8, 48.3, 21.6, 21.5, 21.2, 3.8.

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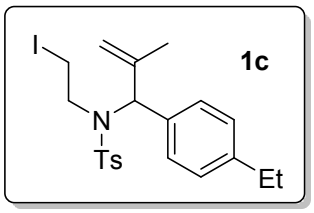

***N*-(1-(4-ethylphenyl)-2-methylallyl)-*N*-(2-iodoethyl)-4-methylbenzenesulfonamide**

$C_{21}H_{26}INO_2S$

The title compound was prepared according to **general procedure I**.

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.60 (d, *J* = 7.6 Hz, 2H), 7.16 (d, *J* = 8.0 Hz, 2H), 7.05 (d, *J* = 7.6 Hz, 2H), 6.98 (d, *J* = 7.6 Hz, 2H), 5.48 (s, 1H), 4.86 (s, 1H), 4.40 (s, 1H), 3.54 (td, *J* = 16, 4.0 Hz, 1H), 3.30 (td, *J* = 15.6, 3.6 Hz, 1H), 3.00-2.94 (m, 1H), 2.55 (q, *J* = 7.6 Hz, 2H), 2.32 (s, 3H), 2.06-2.00 (m, 1H), 1.54 (s, 3H), 1.13 (t, *J* = 7.6 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 144.6, 143.4, 141.1, 137.1, 134.2, 129.5, 128.8, 128.4, 127.4, 114.5, 48.4, 28.5, 21.6, 15.6, 3.6.

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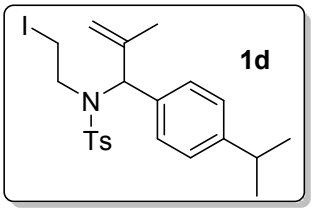

***N*-(2-iodoethyl)-*N*-(1-(4-isopropylphenyl)-2-methylallyl)-4-methylbenzenesulfonamide**

$C_{22}H_{28}INO_2S$

The title compound was prepared according to **general procedure I**.

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.60 (d, *J* = 7.6 Hz, 2H), 7.18 (d, *J* = 8.4 Hz, 2H), 7.08, (d, *J* = 7.6 Hz, 2H), 6.99 (d, *J* = 7.6 Hz, 2H), 5.49 (s, 1H), 4.87 (s, 1H), 4.40 (s, 1H), 3.53 (td, *J* = 15.2, 4.8 Hz, 1H), 3.29 (td, *J* = 13.2, 4.0 Hz, 1H), 3.0-2.93 (m, 1H), 2.86-2.77 (m, 1H), 2.35 (s, 3H), 2.03-1.97 (m, 1H), 1.57 (s, 3H), 1.16 (dd, *J* = 6.8 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 149.3, 143.4, 141.4, 137.1, 134.3, 129.5, 128.8, 127.4, 126.9, 114.5, 65.9, 48.3, 33.8, 24.1, 23.9, 21.6, 3.5.

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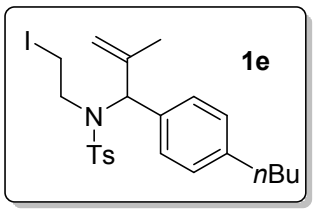

***N*-(1-(4-butylphenyl)-2-methylallyl)-*N*-(2-iodoethyl)-4-methylbenzenesulfonamide**

$C_{23}H_{30}INO_2S$

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.68 (d, *J* = 7.6 Hz, 2H), 7.25 (d, *J* = 7.6 Hz, 2H), 7.12 (d, *J* = 7.6 Hz, 2H), 7.06 (d, *J* = 7.6 Hz, 2H), 5.57 (s, 1H), 4.94 (s, 1H), 4.46 (s, 1H), 3.61 (td, *J* = 15.6, 4.8 Hz, 1H), 3.36 (td, *J* = 15.6, 4.4 Hz, 1H), 3.08-3.01 (m, 1H), 2.60 (t, *J* = 7.6 Hz, 2H), 2.42 (s, 3H), 2.09-2.03 (m, 1H), 1.63 (s, 3H), 1.61-1.54 (m, 2H), 1.37-1.30 (m, 2H), 0.92 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 143.4, 143.3, 141.1, 137.1, 134.2, 129.5, 129.0, 128.7, 127.4, 114.4, 65.8, 48.3, 35.2, 33.5, 22.2, 21.6, 21.5, 14.0, 3.6.

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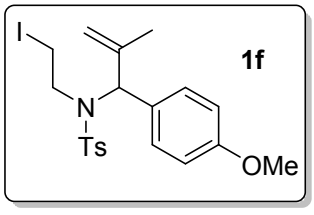

***N*-(2-iodoethyl)-*N*-(1-(4-methoxyphenyl)-2-methylallyl)-4-methylbenzenesulfonamide**

$C_{20}H_{24}INO_3S$

The title compound was prepared according to **general procedure I**.

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.69 (d, *J* = 7.6 Hz, 2H), 7.26 (d, *J* = 7.6 Hz, 2H), 7.09 (d, *J* = 8.4 Hz, 2H), 6.84 (d, *J* = 8.0 Hz, 2H), 5.55 (s, 1H), 4.92 (s, 1H), 4.45 (s, 1H), 3.81 (s, 3H), 3.61 (td, *J* = 15.6, 4.8 Hz, 1H), 3.36 (td, *J* = 15.6, 4.0 Hz, 1H), 3.11-3.05 (m, 1H), 2.42 (s, 3H), 2.15-2.09 (m, 1H), 1.60 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 159.5, 143.4, 141.1, 137.1, 130.1, 129.5, 128.9, 127.4, 114.3, 114.2, 65.5, 55.3, 48.3, 21.6, 21.5, 3.8.

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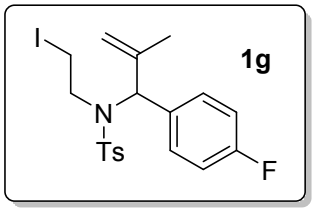

***N*-(1-(4-fluorophenyl)-2-methylallyl)-*N*-(2-iodoethyl)-4-methylbenzenesulfonamide**

$C_{19}H_{21}FINO_2S$

The title compound was prepared according to **general procedure I**.

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.59 (d, *J*= 7.6 Hz, 2H), 7.19 (d, *J* = 7.6 Hz, 2H), 7.06 (t, *J* = 7.2 Hz, 2H), 6.93 (t, *J* = 8.4 Hz, 2H), 5.50 (s, 1H), 4.89 (s, 1H), 4.39 (s, 1H), 3.54 (td, *J* = 15.6, 4.8 Hz, 1H), 3.31 (td, *J* = 13.2, 4.0 Hz, 1H), 3.07-3.01 (m, 1H), 2.35 (s, 3H), 2.18-2.12 (m, 1H), 1.55 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 162.4 (d, *J* = 246.6 Hz), 143.6, 140.9, 136.9, 130.5 (d, *J* = 8.1 Hz), 129.6, 128.5 (d, *J* = 12.3 Hz), 127.3, 115.9 (d, *J* = 21.4 Hz), 115.1, 65.3, 48.4, 21.6, 3.3.

^{19}F NMR (376 MHz, $CDCl_3$, δ ppm): -133.1 (s, 1F).

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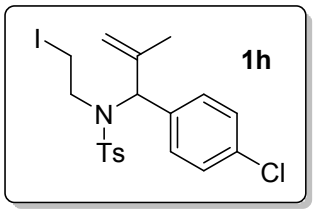

***N*-(1-(4-chlorophenyl)-2-methylallyl)-*N*-(2-iodoethyl)-4-methylbenzenesulfonamide**

$C_{19}H_{21}ClINO_2S$

The title compound was prepared according to **general procedure I**.

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.66 (d, *J* = 7.2 Hz, 2H), 7.27 (t, *J* = 8.0 Hz, 4H), 7.07 (d, *J* = 7.6 Hz, 2H), 5.55 (s, 1H), 4.99 (s, 1H), 4.48 (s, 1H), 3.61 (td, *J* = 15.6, 4.0 Hz, 1H), 3.42 (td, *J* = 15.6, 4.0 Hz, 1H), 3.16-3.09 (m, 1H), 2.42 (s, 3H), 2.38-2.32 (m, 1H), 1.64 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 143.7, 140.9, 136.8, 135.8, 134.1, 130.0, 129.6, 129.0, 127.3, 115.6, 65.4, 48.4, 21.6, 3.3.

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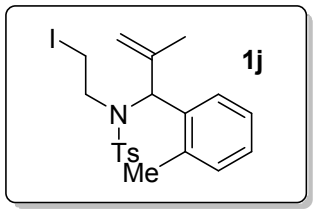


***N*-(2-iodoethyl)-4-methyl-*N*-(2-methyl-1-(*o*-tolyl)allyl)benzenesulfonamide**

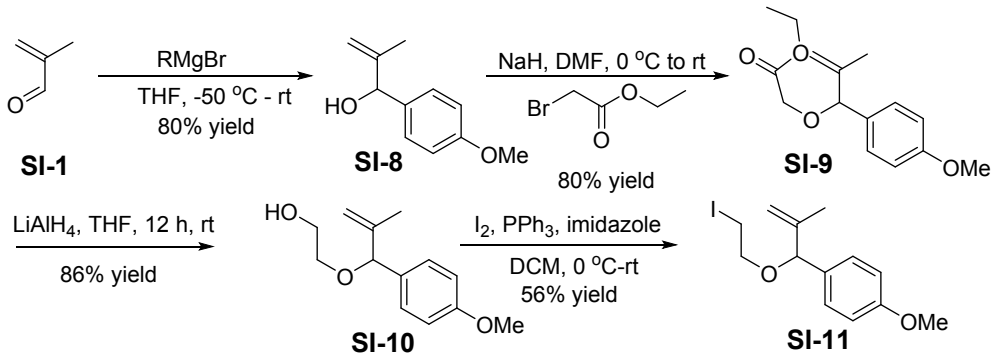
$C_{20}H_{24}INO_2S$

The title compound was prepared according to **general procedure I**.

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.66 (d, *J* = 7.6 Hz, 2H), 7.26 (d, *J* = 3.6 Hz, 2H), 7.22 (d, *J* = 6 Hz, 2H), 7.11 (t, *J* = 6.8 Hz, 1H), 6.99 (d, *J* = 7.6 Hz, 1H), 5.81 (s, 1H), 4.89 (s, 1H), 4.22 (s, 1H), 3.55 (td, *J* = 15.6, 4.4 Hz, 1H), 3.35 (td, *J* = 15.6, 4.4 Hz, 1H), 3.09-3.03 (m, 1H), 2.48 (s, 3H), 2.42 (s, 3H), 1.99-1.93 (m, 1H), 1.62 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 143.5, 141.0, 138.2, 136.5, 134.9, 131.1, 129.3, 128.5, 127.8, 127.7, 126.3, 114.4, 63.1, 48.6, 21.6, 19.5, 3.3.

General Procedure II:



Preparation of alcohol SI-8: SI-1 methacrolein (30 mmol, 2.10 g, 1.0 equiv.) was dissolved in THF under under nitrogen and cooled to –50 °C. Afterwards the Grignard compound (2.0 equiv.) was added dropwise and the reaction mixture was stirred for 2 h at -50 °C, allowed to warm up to r.t. and then stirred for 2 h. The reaction was quenched by adding saturated aqueous NH_4Cl. Then the organic layer was exacted three times with AcOEt (40 mL). Drying over Na_2SO_4 and concentration in vacuo afforded the crude material, which was then purified by silica gel column chromatography (PE:EA, 5:1) to give the alcohol **SI-8** (4.28 g, 24 mmol, 80% yield) as a colorless oil.

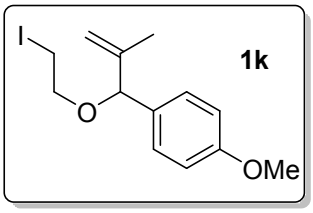
Preparation of ester SI-9: To a solution of **SI-8** (1.78 g, 10 mmol, 1.0 equiv.), was added NaH (0.36 g, 60% in mineral oil, 15 mmol, 1.5 equiv.) in portions in DMF (20 mL) at 0 °C. After stirring for 20 min, ethyl bromoacetate (5.01 g, 30 mmol, 3.33 mL, 3.0 equiv.) in DMF was added dropwise and the reaction mixture was stirred at room temperature overnight. The reaction was quenched with water. The residue was extracted with EtOAc twice, and the organic phase was washed with brine, dried over anhydrous Na_2SO_4, filtered and concentrated, and the residue was purified by column chromatography on silica gel (PE/EtOAc = 5: 1) to afford the ester **SI-9**as pale yellow oil (2.11 g, 80% yield).

Preparation of alcohol SI-10: $LiAlH_4$ (0.38 g, 10 mmol) was suspended in THF (10 mL) and a solution of ester **SI-9** (1.32 g, 5 mmol) in THF (40 mL) was then slowly added at 0 °C. The reaction mixture was stirred at room temperature for 12 h. The reaction mixture was slowly quenched with H_2O (5 mL), 10% aqueous NaOH (5 mL), H_2O (5 mL) at 0 °C, filtered through a small pad of celite. The filtrate was extracted with ethyl acetate (3 × 40 mL), washed with brine (40 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The alcohol **SI-10** (0.96 g, 4.3 mmol) was afforded as a colourless oil without further purification.

Preparation of alkyl iodide SI-11: To a solution of **SI-10** (0.45 g, 2.0 mmol, 1.0 equiv.) in 30 mL DCM was cooled to 0 °C. PPh_3 (1.57 g, 6 mmol, 3.0 equiv.), imidazole (0.408 g, 6 mmol, 3.0 equiv.), I_2 (1.52 g, 6 mmol, 3.0 equiv.) was added successively. Then the reaction

mixture was warmed to room temperature and stirred for 2 h. Then the precipitate was removed by filtration. After the concentration of the filtrate in *vacuo*, purification by column chromatography (PE:EA, 10:1) afforded the iodide **SI-11** (0.37 g, 1.12 mmol, 56% yield) as a colorless oil.

Analytical Data:



1-(1-(2-iodoethoxy)-2-methylallyl)-4-methoxybenzene

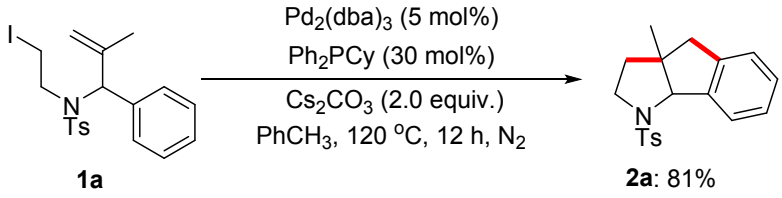
$C_{13}H_{17}IO_2$

The title compound was prepared according to **general procedure II**.

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.19 (d, *J* = 8.4 Hz, 2H), 6.79 (d, *J* = 8.4 Hz, 2H), 5.03 (s, 1H), 4.88 (s, 1H), 4.64 (s, 1H), 3.71 (s, 3H), 3.64-3.50 (m, 2H), 3.20 (t, *J* = 6.8 Hz, 2H), 1.51 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 157.9, 143.9, 131.1, 126.8, 112.5, 111.9, 83.8, 68.0, 54.2, 16.9, 2.4.

3. Typical Procedure and Analytical Data for Palladium-Catalyzed Radical Cyclization Reaction.

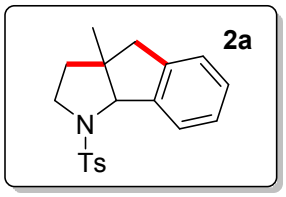


Typical Procedure:

Unactivated alkyl iodide **1a** (91.1 mg, 0.20 mmol, 1.0 equiv.), $Pd_2(dba)_3$ (9.2 mg, 0.01 mmol, 0.05 equiv.), Ph_2PCy (16.1 mg, 0.06 mmol, 0.3 equiv.) and Cs_2CO_3 (130.3 mg, 0.40 mmol, 2.0 equiv.) were added to a reaction tube and vacuum purged three times, backfilling with N_2. Then the toluene (2 mL) was added under nitrogen atmosphere. The resulting mixture was stirred at 120 °C for 12 h. After cooling the reaction mixture at rt, it was quenched with a saturated aqueous solution of NH_4Cl. The aqueous layer was extracted with EtOAc (10 mL × 3). The combined organic phase was sequentially washed with saturated aqueous solution of NaCl and then concentrated *in vacuo*. The mixture was purified by silica gel column

chromatography (PE:EA, 20:1) to give the corresponding product **2a** (53.1 mg, 0.16 mmol, 81% yield).

Analytical Data:



3a-methyl-1-tosyl-1,2,3,3a,4,8b-hexahydroindeno[1,2-*b*]pyrrole

$C_{19}H_{21}NO_2S$ **MW:** 327.44 g·mol^{-1}

White Solid

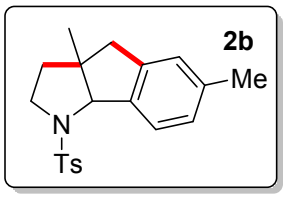
Isolated Amount: 53.0 mg **Yield:** 81%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.80 (t, *J* = 8.0 Hz, 3H), 7.34 (d, *J* = 8.0 Hz, 2H), 7.28 (d, *J* = 7.2 Hz, 1H), 7.23 (d, *J* = 6.8 Hz, 1H), 7.12 (d, *J* = 7.2 Hz, 1H), 4.67 (s, 1H), 3.49-3.44 (m, 1H), 3.31-3.24 (m, 1H), 2.84 (d, *J* = 16.0 Hz, 1H), 2.73 (d, *J* = 16.0 Hz, 1H), 2.45 (s, 3H), 1.85-1.77 (m, 1H), 1.60-1.55 (m, 1H), 0.73 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 143.5, 142.8, 140.7, 134.5, 129.6, 128.2, 127.7, 127.3, 126.8, 124.9, 74.5, 49.9, 48.5, 43.2, 37.3, 23.3, 21.6.

HRMS (ESI) calcd for $C_{19}H_{21}NO_2SNa$ $[M+Na]^+$ 350.1191, found 350.1193**.**

……



3a,6-dimethyl-1-tosyl-1,2,3,3a,4,8b-hexahydroindeno[1,2-*b*]pyrrole

$C_{20}H_{23}NO_2S$ **MW:** 341.47 g·mol^{-1}

White Solid

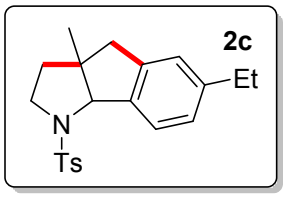
Isolated Amount: 52.6 mg **Yield:** 77%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.8 (d, *J* = 8.0 Hz, 2H), 7.65 (d, *J* = 7.6 Hz, 1H), 7.34 (d, *J* = 8.0 Hz, 2H), 7.09 (d, *J* = 7.6 Hz, 1H), 6.93 (s, 1H), 4.63 (s, 1H), 3.47-3.42 (m, 1H), 3.30-3.23 (m, 1H), 2.80 (d, *J* = 16.0 Hz, 1H), 2.68 (d, *J* = 16.0 Hz, 1H), 2.45 (s, 3H), 2.33 (s, 3H), 1.84-1.76 (m, 1H), 1.59-1.53 (m, 1H), 0.73 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 143.4, 140.9, 139.8, 138.0, 134.6, 129.6, 128.3, 127.7, 126.5, 125.5, 74.3, 50.1, 48.5, 43.2, 37.4, 23.4, 21.6, 21.4.

HRMS (ESI) calcd for $C_{20}H_{23}NO_2SNa$ $[M+Na]^+$ 364.1347, found 364.1350**.**

……



6-ethyl-3a-methyl-1-tosyl-1,2,3,3a,4,8b-hexahydroindeno[1,2-*b*]pyrrole

$C_{21}H_{25}NO_2S$ **MW:** 355.50 g·mol^{-1}

White Solid

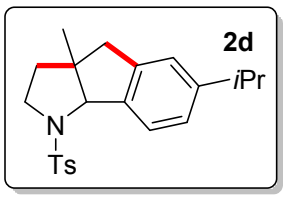
Isolated Amount: 57.6 mg **Yield:** 81%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.80 (d, *J* = 7.6 Hz, 2H), 7.68 (d, *J* = 8.0 Hz, 1H), 7.34 (d, *J* = 7.6 Hz, 2H), 7.11 (d, *J* = 7.6 Hz, 1H), 6.95 (s, 1H), 4.63 (s, 1H), 3.47-3.43 (m, 1H), 3.30-3.23 (m, 1H), 2.81 (d, *J* = 16.0 Hz, 1H), 2.70 (d, *J* = 16.0 Hz, 1H), 2.70 (d, *J* = 16.0 Hz, 1H), 2.63 (q, *J* = 7.6 Hz, 2H), 2.45 (s, 3H), 1.85-1.78 (m, 1H), 1.57-1.54 (m, 1H), 1.22 (t, *J* = 7.6 Hz, 3H), 0.73 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 144.6, 143.4, 140.9, 140.1, 134.6, 129.6, 127.7, 127.2, 126.6, 124.2, 74.3, 50.1, 48.5, 43.2, 37.4, 28.8, 23.4, 21.6, 15.9.

HRMS (ESI) calcd for $C_{21}H_{25}NO_2SNa$ $[M+Na]^+$ 378.1504, found 378.1505**.**

……



6-isopropyl-3a-methyl-1-tosyl-1,2,3,3a,4,8b-hexahydroindeno[1,2-*b*]pyrrole

$C_{22}H_{27}NO_2S$ **MW:** 369.52 g·mol^{-1}

White Solid

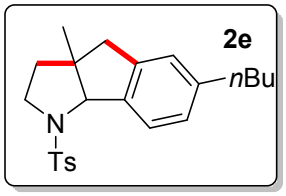
Isolated Amount: 59.1 mg **Yield**: 80%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.79 (d, *J* = 7.6 Hz, 2H), 7.68 (d, *J* = 8.0 Hz, 1H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.14 (d, *J* = 7.6 Hz, 1H), 6.98 (s, 1H), 4.63 (s, 1H), 3.48-3.43 (m, 1H), 3.30-3.24 (m, 1H), 2.92-2.87 (m, 1H), 2.82 (d, *J* = 16.0 Hz, 1H), 2.70 (d, *J* = 16.8 Hz, 1H), 2.45 (s, 3H), 1.86-1.79 (m, 1H), 1.59-1.54 (m, 1H), 1.24 (d, *J* = 6.8 Hz, 6H), 0.73 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 149.3, 143.4, 140.9, 140.2, 134.6, 129.6, 127.7, 126.6, 125.8, 122.7, 74.3, 50.0, 48.5, 43.3, 37.4, 34.1, 24.2, 23.5, 21.6.

HRMS (ESI) calcd for $C_{22}H_{27}NO_2SNa$ $[M+Na]^+$ 392.1660, found 392.1664**.**

……



6-butyl-3a-methyl-1-tosyl-1,2,3,3a,4,8b-hexahydroindeno[1,2-*b*]pyrrole

$C_{23}H_{29}NO_2S$ **MW:** 383.55 g·mol^{-1}

Yellow Oil

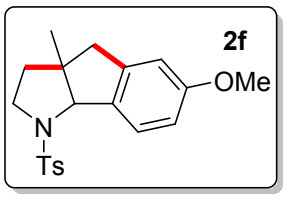
Isolated Amount: 62.9 mg **Yield:** 82%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.80 (d, *J* = 7.6 Hz, 2H), 7.66 (d, *J* = 7.6 Hz, 1H), 7.33 (d, *J* = 7.6 Hz, 2H), 7.09 (d, *J* = 8.0 Hz, 1H), 6.93 (s, 1H), 4.63 (s, 1H), 3.45 (t, *J* = 7.6 Hz, 1H), 3.30-3.23 (m, 1H), 2.80 (d, *J* = 16.0 Hz, 1H), 2.69 (d, *J* = 16.0 Hz, 1H), 2.58 (t, *J* = 7.6 Hz, 2H), 2.45 (s, 3H), 1.62-1.54 (m, 3H), 1.40-1.32 (m, 3H), 0.92 (t, *J* = 7.2 Hz, 3H), 0.73 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 143.4, 143.2, 140.8, 140.0, 134.6, 129.6, 127.7, 126.5, 124.8, 74.3, 60.4, 50.1, 48.5, 43.2, 37.4, 35.6, 33.9, 23.4, 22.4, 21.6, 14.0.

HRMS (ESI) calcd for $C_{23}H_{29}NO_2SNa$ $[M+Na]^+$ 406.1817, found 406.1818**.**

……



6-methoxy-3a-methyl-1-tosyl-1,2,3,3a,4,8b-hexahydroindeno[1,2-*b*]pyrrole

$C_{20}H_{23}NO_3S$ **MW:** 357.47 g·mol^{-1}

White Solid

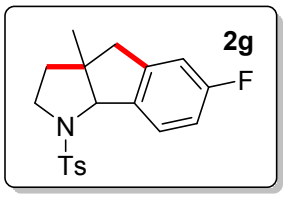
Isolated Amount: 51.5 mg **Yield:** 72%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.80 (d, *J* = 8.0 Hz, 2H), 7.67 (d, *J* = 8.4 Hz, 1H), 7.34 (d, *J* = 8.0 Hz, 2H), 6.82 (d, *J* = 8.4 Hz, 1H), 6.65 (s, 1H), 4.61 (s, 1H), 3.79 (s, 3H), 3.48-3.43 (m, 1H), 3.30-3.23 (m, 1H), 2.80 (d, *J* = 16.0 Hz, 1H), 2.69 (d, *J* = 16.0 Hz, 1H), 2.45 (s, 3H), 1.85-1.77 (m, 1H), 1.57-1.53 (m, 1H), 0.74 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 160.1, 143.4, 142.4, 134.9, 134.7, 129.6, 127.7, 127.6, 113.4, 109.9, 74.0, 55.4, 50.4, 48.5, 43.4, 37.5, 23.5, 21.6.

HRMS (ESI) calcd for $C_{20}H_{23}NO_3SNa$ $[M+Na]^+$ 380.1296, found 380.1298**.**

……



6-fluoro-3a-methyl-1-tosyl-1,2,3,3a,4,8b-hexahydroindeno[1,2-*b*]pyrrole

$C_{19}H_{20}FNO_2S$ **MW:** 345.43 g·mol^{-1}

White Solid

Isolated Amount: 25.6 mg **Yield:** 37%

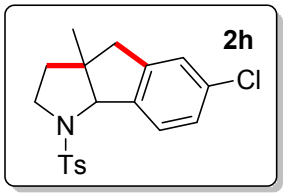
^{1}H NMR (600 MHz, $CDCl_3$, δ ppm): 7.79 (d, *J* = 8.4 Hz, 2H), 7.72 (dd, *J* = 8.4, 5.4 Hz, 1H), 7.34 (d, *J* = 8.4 Hz, 2H), 6.94 (td, *J* = 9.0, 2.4 Hz, 1H), 6.79 (d, *J* = 9.0 Hz, 1H), 4.95 (s, 1H), 3.47-3.44 (m, 1H), 3.28-3.23 (m, 1H), 2.81 (d, *J* = 16.2 Hz, 1H), 2.70 (d, *J* = 16.2 Hz, 1H), 2.44 (s, 3H), 1.81-1.76 (m, 1H), 1.60-1.56 (m, 1H), 0.73 (s, H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 163.2 (d, *J* = 162.5 Hz), 143.6, 142.9 (d, *J* = 5.5 Hz), 138.3 (d, *J* = 1.6 Hz), 134.3, 129.6, 128.1 (d, *J* = 6.0 Hz), 127.6, 114.4 (d, *J* = 14.8 Hz), 111.5 (d, *J* = 14.5 Hz), 73.6, 50.5, 48.4, 43.1, 37.2, 23.2, 21.5.

^{19}F NMR (376 MHz, $CDCl_3$, δ ppm): -114.9 (s, 1F).

HRMS (ESI) calcd for $C_{19}H_{20}FNO_2SNa$ $[M+Na]^+$ 368.1096, found 368.1110**.**

……



6-chloro-3a-methyl-1-tosyl-1,2,3,3a,4,8b-hexahydroindeno[1,2-*b*]pyrrole

$C_{19}H_{20}ClNO_2S$ **MW**: 361.88 g·mol^{-1}

White Solid

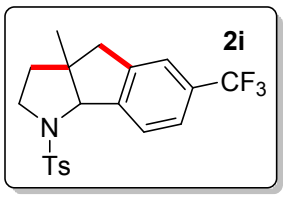
Isolated Amount: 39.1 mg **Yield**: 54%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.80 (d, *J* = 8.0 Hz, 2H), 7.71 (d, *J* = 8.4 Hz, 1H), 7.35 (d, *J* = 8.0 Hz, 2H), 7.24, (d, *J* = 8.4 Hz, 1H), 7.10 (s, 1H), 4.60 (s, 1H), 3.49-3.44 (m, 1H), 3.29-3.22 (m, 1H), 2.81 (d, *J* = 16.4 Hz, 1H), 2.70 (d, *J* = 16.4 Hz, 1H), 2.45 (s, 3H), 1.83-1.75 (m, 1H), 1.61-1.58 (m, 1H), 0.73 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 143.7, 142.6, 141.3, 134.3, 134.0, 129.7, 128.1, 127.7, 125.0, 73.8, 50.3, 48.4, 42.9, 37.3, 23.2, 21.6.

HRMS (ESI) calcd for $C_{19}H_{20}ClNO_2SNa$ $[M+Na]^+$ 384.0801 found 384.0802**.**

……..



3a-methyl-1-tosyl-6-(trifluoromethyl)-1,2,3,3a,4,8b-hexahydroindeno[1,2-*b*]pyrrole

$C_{20}H_{20}F_3NO_2S$ **MW**: 395.44 g·mol^{-1}

Yellow Oil

Isolated Amount: 31.6 mg **Yield**: 40%

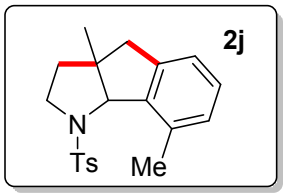
^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.90 (d, *J* = 8.0 Hz, 1H), 7.81 (d, *J* = 8.0 Hz, 2H), 7.53 (d, *J* = 8.0 Hz, 1H), 7.36 (d, *J* = 8.0 Hz, 2H), 7.21 (dd, *J* = 20.0, 8.0 Hz, 1H), 4.66 (s, 1H), 3.48 (t, *J* = 8.0 Hz, 1H), 3.27 (dd, *J* = 16.8, 10.0 Hz, 1H), 2.89 (d, *J* = 6.4 Hz, 1H), 2.77 (d, *J* = 16.4 Hz, 1H), 2.46 (s, 3H), 1.83-1.75 (m, 1H), 1.64-1.60 (m,1 H), 0.75 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 146.8, 143.8, 141.4, 134.1, 129.7 (d, *J* = 3.7 Hz), 128.9, 127.7, 127.3, 126.7, 124.5 (q, *J* = 3.7 Hz), 121.9 (q, *J* = 3.5 Hz), 73.9, 50.2, 48.5, 42.9, 37.1, 23.1, 21.6.

^{19}F NMR (376 MHz, $CDCl_3$, δ ppm): -62.1 (s, 3F).

HRMS (ESI) calcd for $C_{20}H_{20}F_3NO_2SNa$ $[M+Na]^+$ 418.1065 found 418.1067**.**

……



3a,8-dimethyl-1-tosyl-1,2,3,3a,4,8b-hexahydroindeno[1,2-*b*]pyrrole

$C_{20}H_{23}NO_2S$ **MW:** 341.47 g·mol^{-1}

White Solid

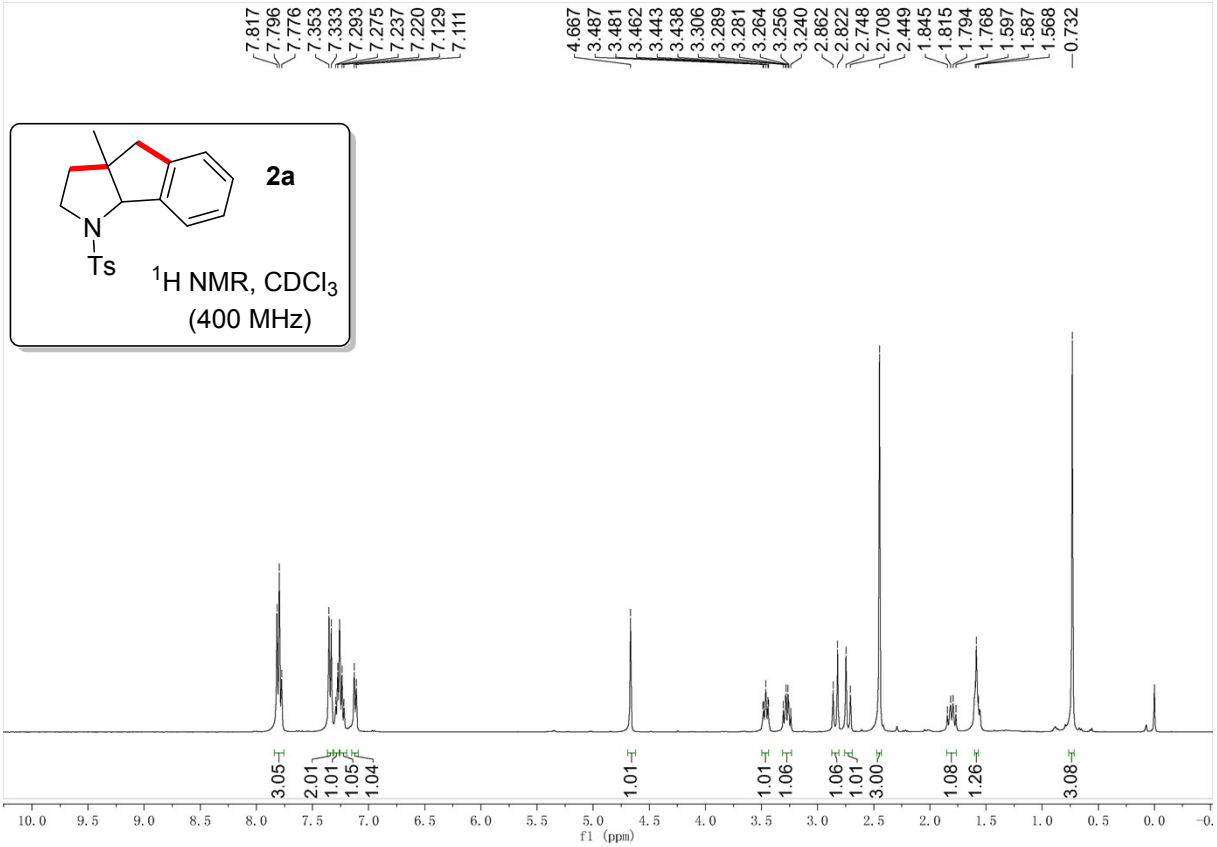
Isolated Amount: 45.1 mg **Yield:** 66%

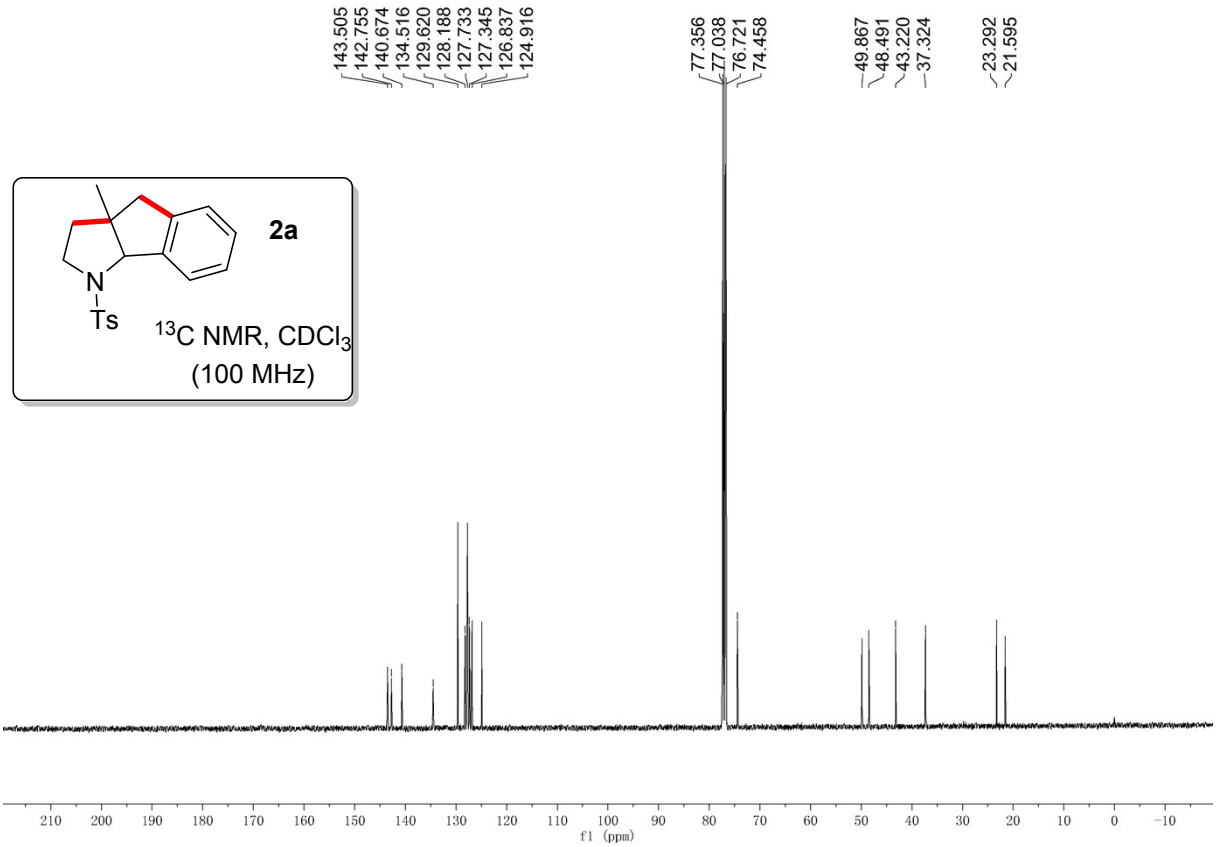
^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.79 (d, *J* = 7.6 Hz, 2H), 7.31(d, *J* = 7.6 Hz, 2H), 7.15 (t, *J* = 7.6 Hz, 1H), 7.02 (d, *J* = 7.2 Hz, 1H), 6.94 (d, *J* = 7.2 Hz, 1H), 5.12 (s, 1H), 3.60-3.54 (m, 1H), 3.15-3.08 (m, 1H), 2.89 (d, *J* = 16.4 Hz, 1H), 2.76 (d, *J* = 16.4 Hz, 1H), 2.59 (s, 3H), 2.44 (s, 3H), 1.71-1.65 (m, 1H), 1.47-1.40 (m, 1H), 0.97 (s, 3H).

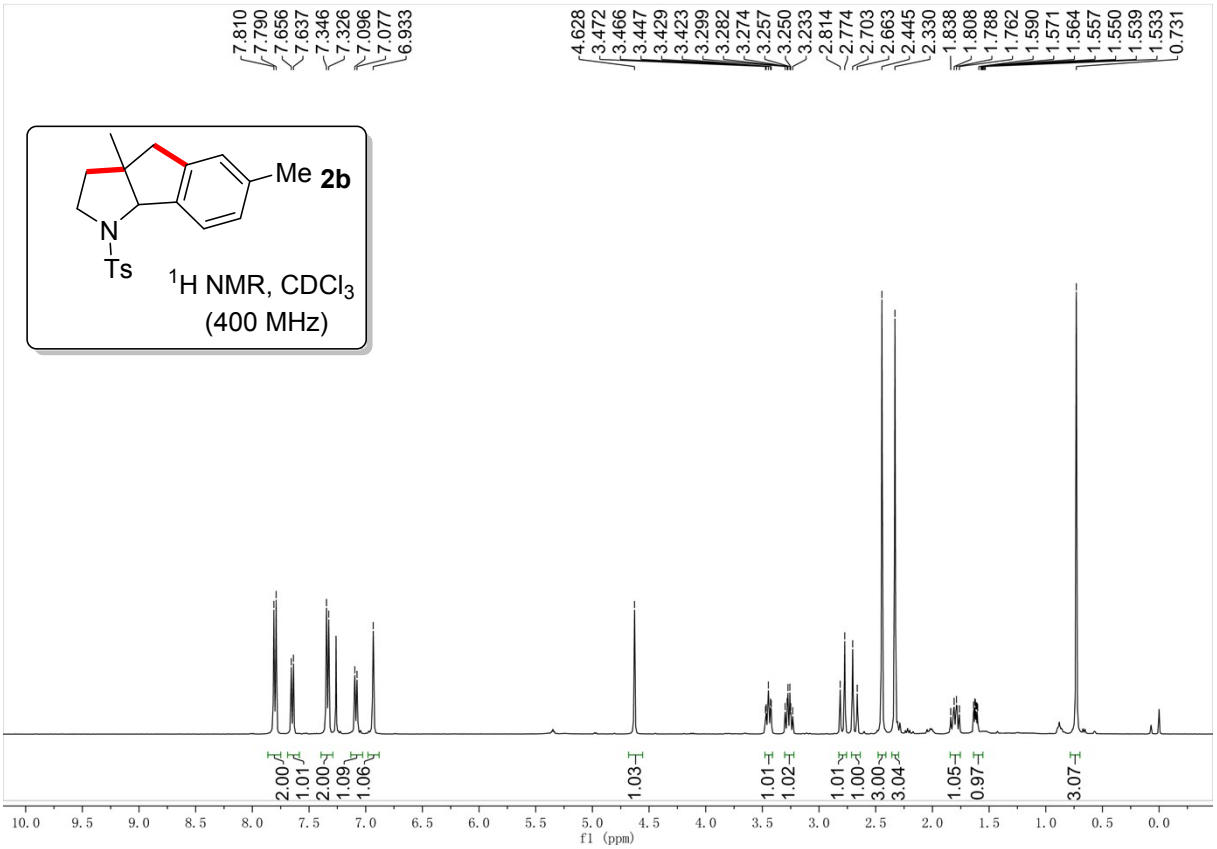
^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 143.5, 142.6, 138.9, 137.6, 136.5, 129.6, 129.1, 128.6, 127.9, 122.1, 75.3, 49.9, 48.4, 45.1, 39.5, 25.4, 21.6, 19.7.

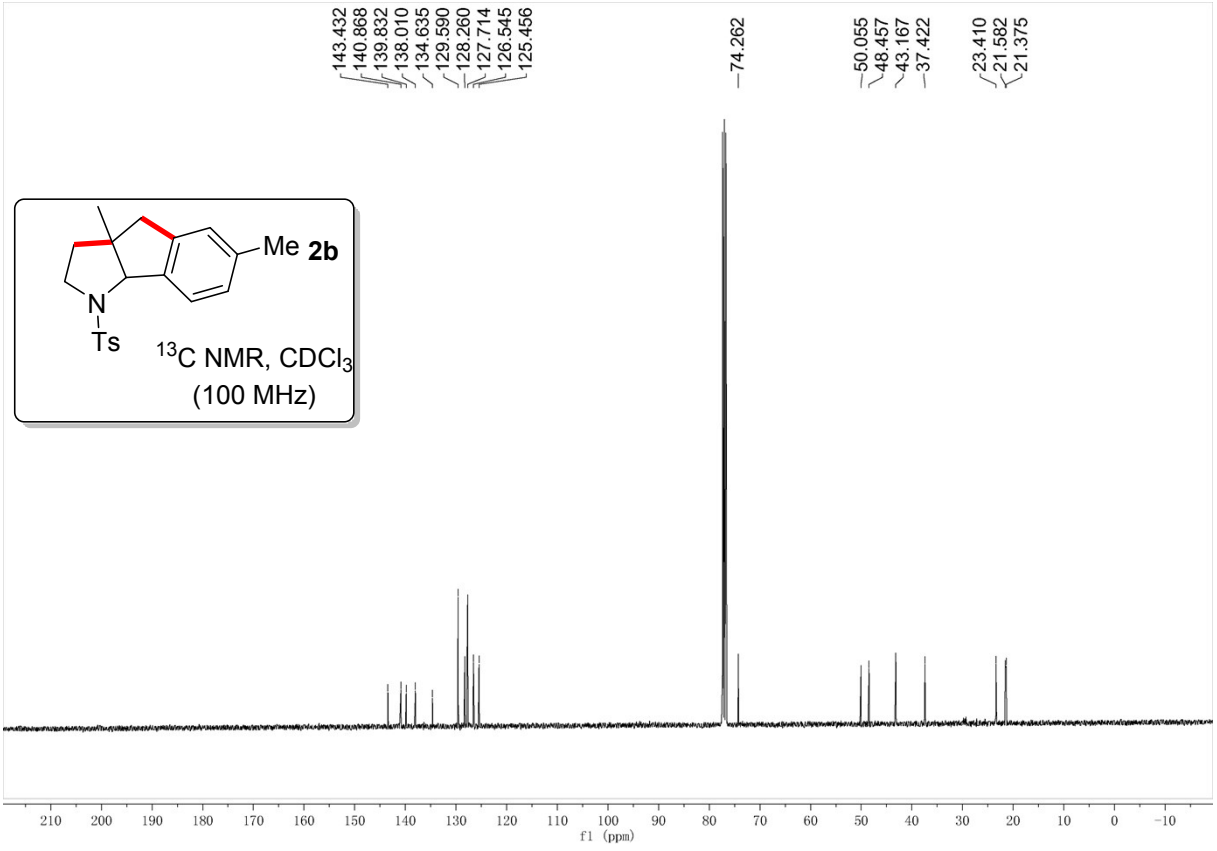
HRMS (ESI) calcd for $C_{20}H_{23}NO_2SNa$ $[M+Na]^+$ 364.1347 found 364.1350**.**

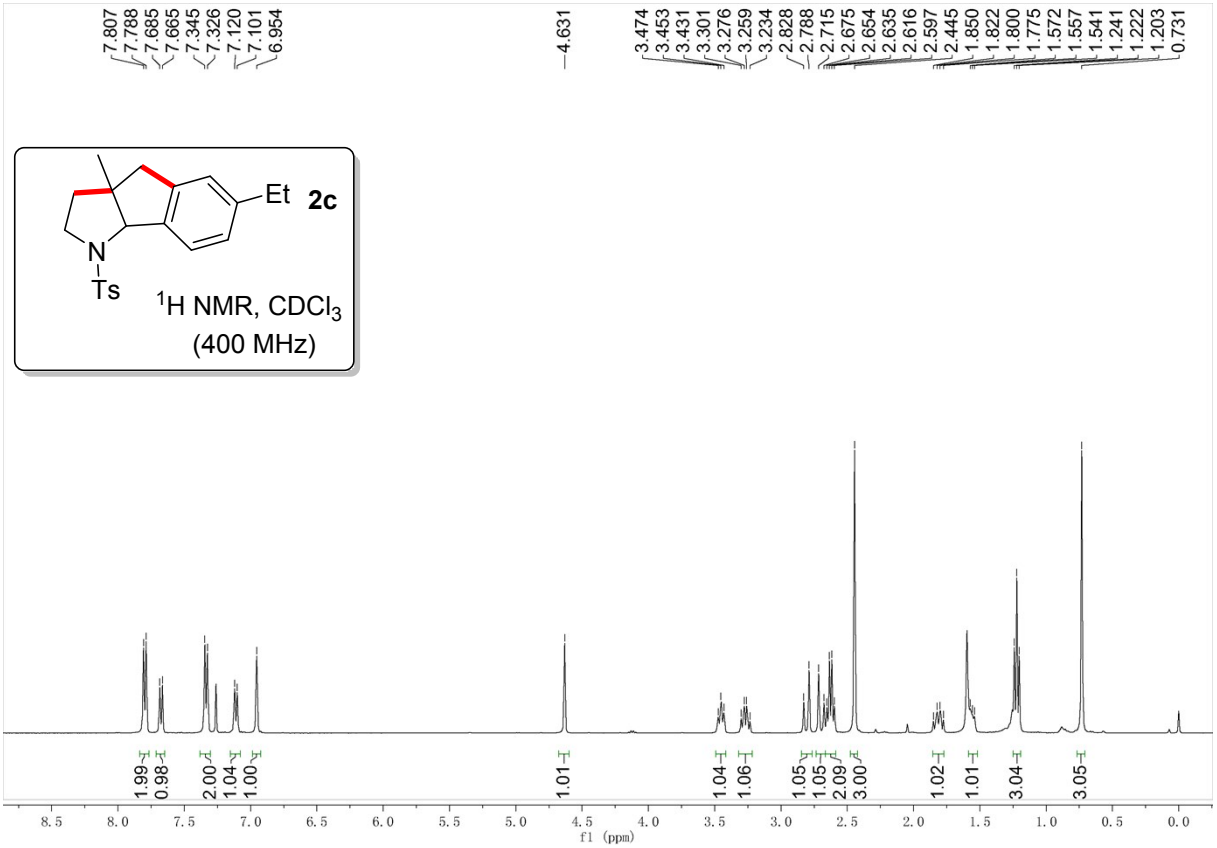
4. Copies of the ^{1}H NMR and ^{13}C NMR for Cyclization Products.






7.810
7.790
7.656
7.637
7.346
7.326
7.096
7.077
6.933
4.628
3.472
3.466
3.447
3.429
3.423
3.299
3.282
3.274
3.257
3.250
3.233
2.814
2.774
2.703
2.663
2.445
2.330
1.838
1.808
1.788
1.762
1.590
1.571
1.564
1.557
1.550
1.539
1.533
0.731
Me 2b
N
Ts
1H NMR, CDCl3
(400 MHz)
2.00
1.01
2.00
1.09
1.06
1.03
1.01
1.02
1.01
1.00
3.00
3.04
1.05
0.97
3.07
f1 (ppm)


143.432
140.868
139.832
138.010
134.635
129.590
128.260
127.714
126.545
125.456
74.262
50.055
48.457
43.167
37.422
23.410
21.582
21.375
Me 2b
N
Ts
13C NMR, CDCl3
(100 MHz)
f1 (ppm)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7.788
7.685
7.665
7.345
7.326
7.120
7.101
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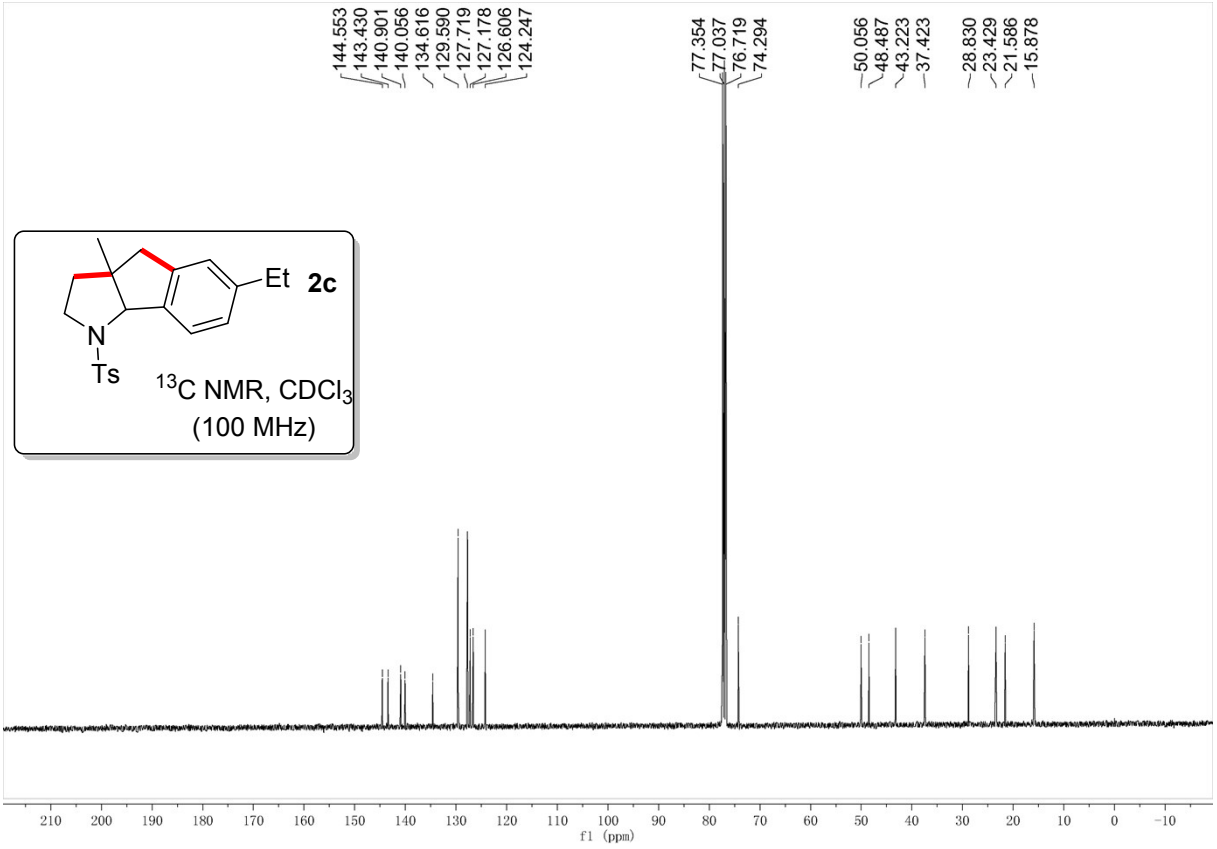
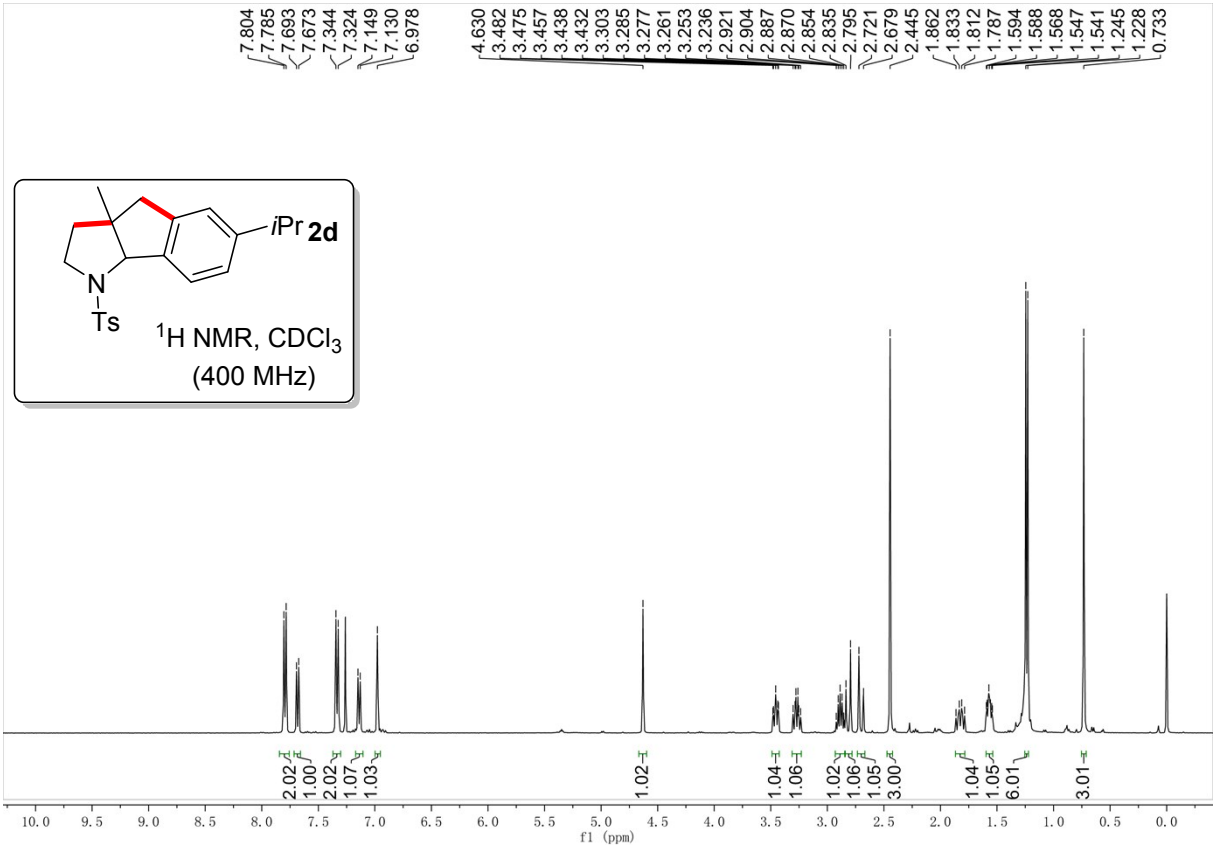
4.631
3.474
3.453
3.431
3.301
3.276
3.259
3.234
2.828
2.788
2.715
2.675
2.654
2.635
2.616
2.597
2.445
1.850
1.822
1.800
1.775
1.572
1.557
1.541
1.241
1.222
1.203
0.731
Et
2c
N
Ts
^{1}H NMR, CDCl$_3$
(400 MHz)
1.99
0.98
2.00
1.04
1.00
1.01
1.04
1.06
1.05
1.05
2.09
3.00
1.02
1.01
3.04
3.05
f1 (ppm)


144.553
143.430
140.901
140.056
134.616
129.590
127.719
127.178
126.606
124.247
77.354
77.037
76.719
74.294
50.056
48.487
43.223
37.423
28.830
23.429
21.586
15.878
Et
2c
N
Ts
^{13}C NMR, CDCl$_3$
(100 MHz)
f1 (ppm)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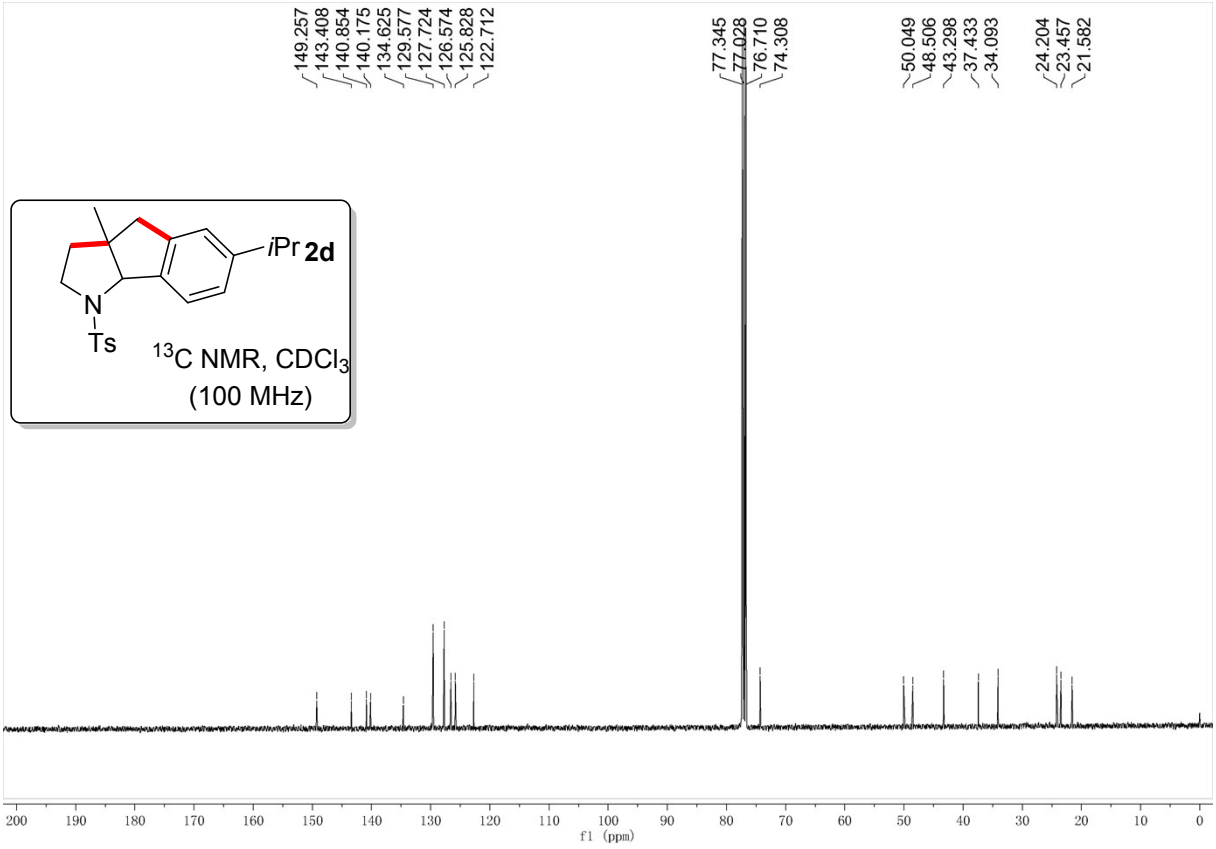
7.785
7.693
7.673
7.344
7.324
7.149
7.130
6.978
4.630
3.482
3.475
3.457
3.438
3.432
3.303
3.285
3.277
3.261
3.253
3.236
2.921
2.904
2.887
2.870
2.854
2.835
2.795
2.721
2.679
2.445
1.862
1.833
1.812
1.787
1.594
1.588
1.568
1.547
1.541
1.245
1.228
0.733
iPr 2d
N
Ts
1H NMR, CDCl3
(400 MHz)
2.02
1.00
2.02
1.07
1.03
1.02
1.04
1.06
1.02
1.06
1.05
3.00
1.04
1.05
6.01
3.01
f1 (ppm)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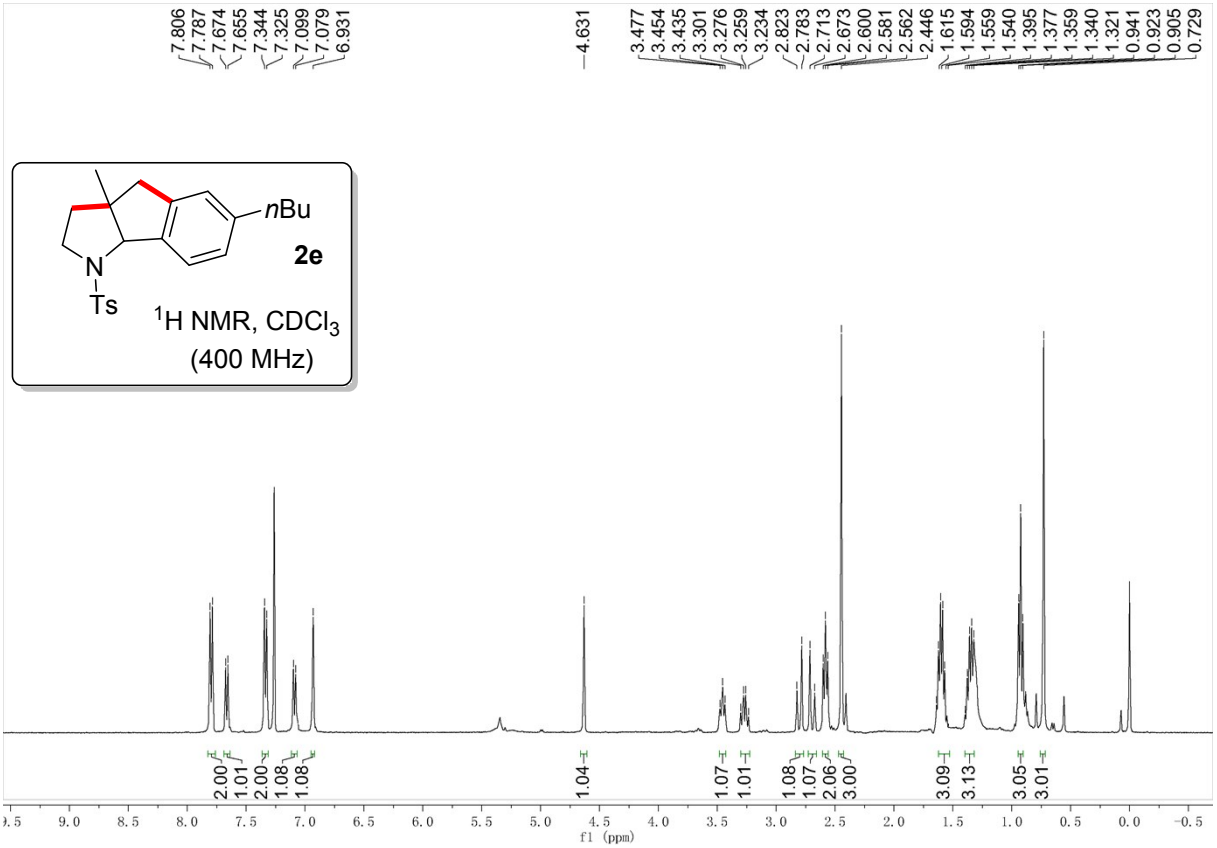
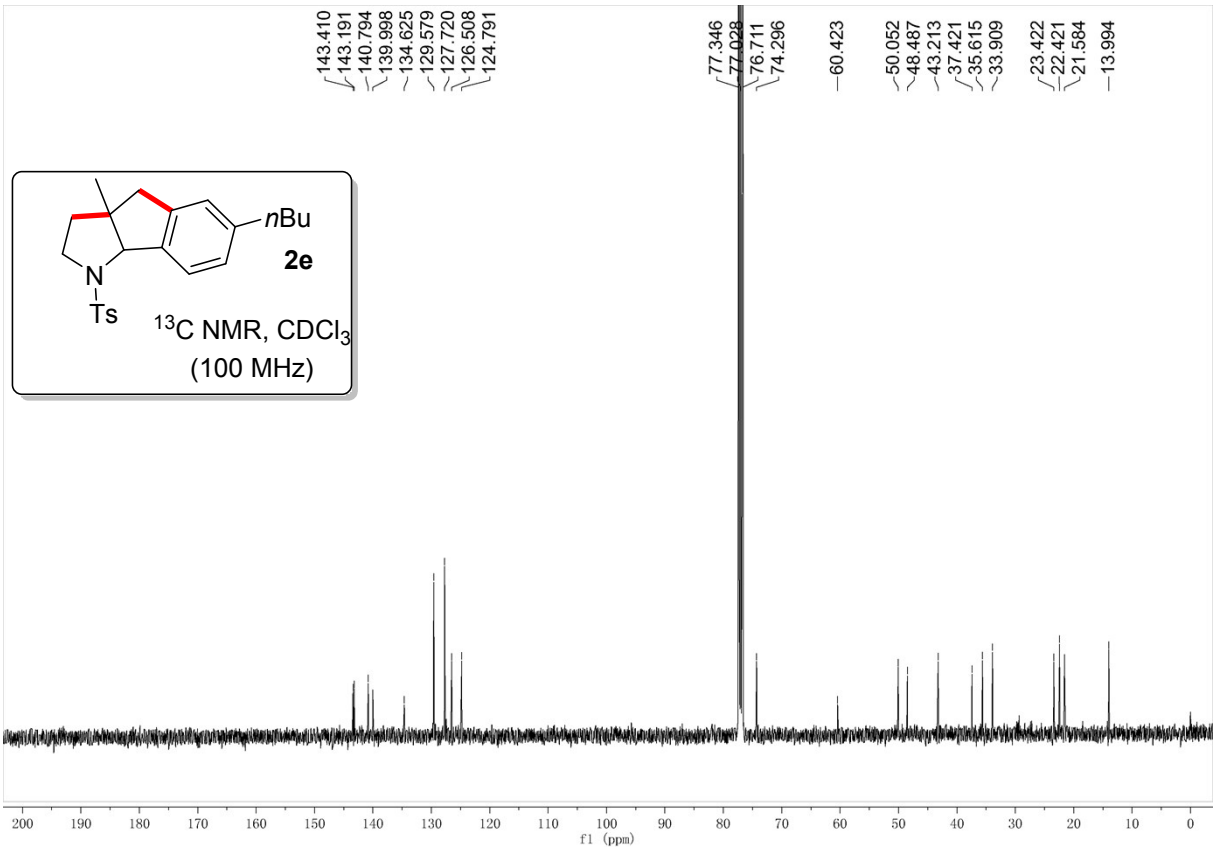
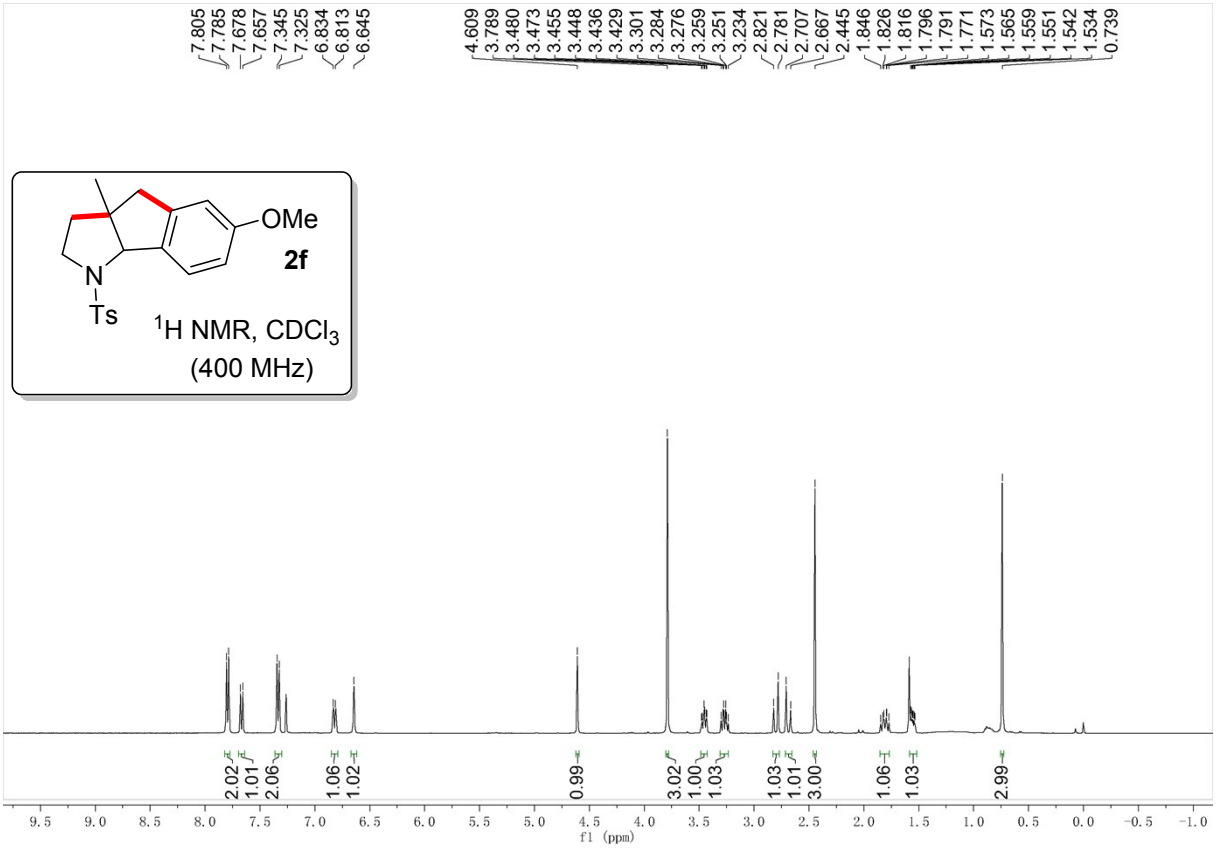
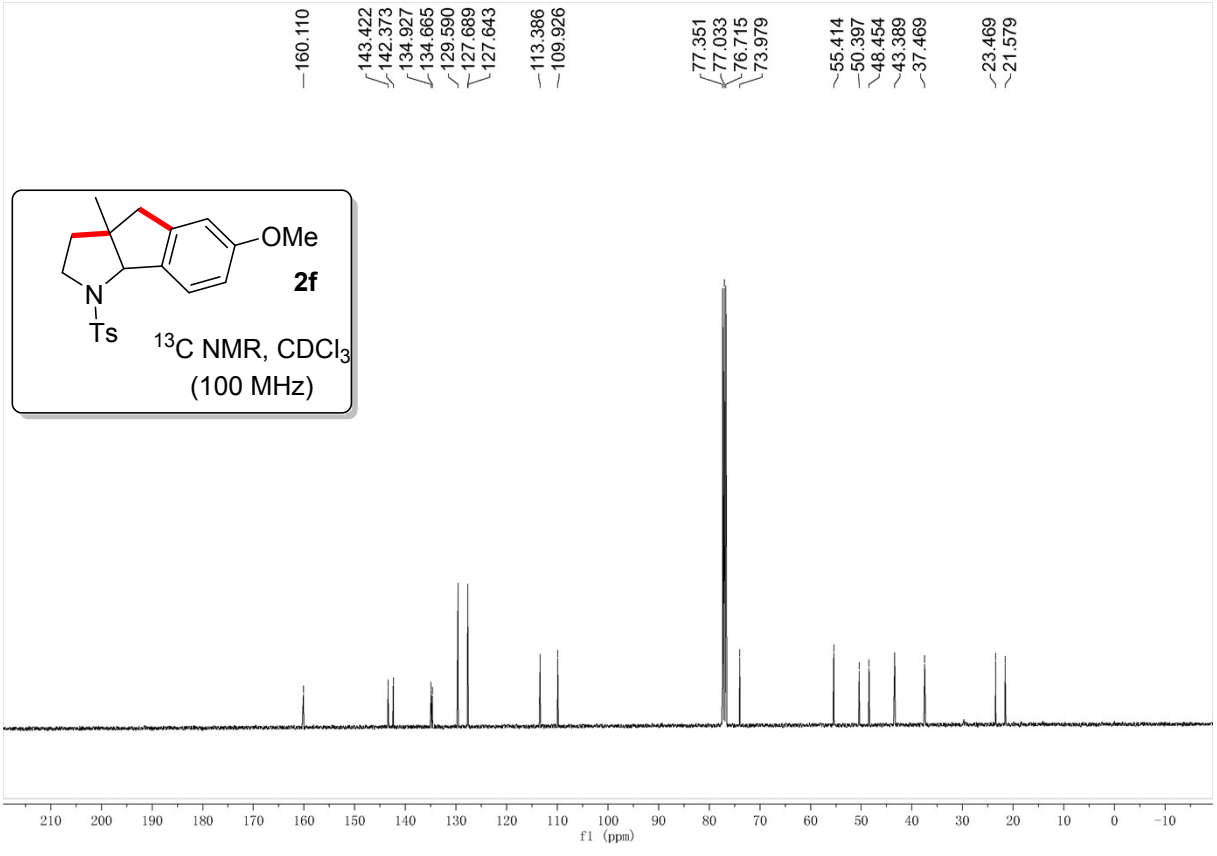
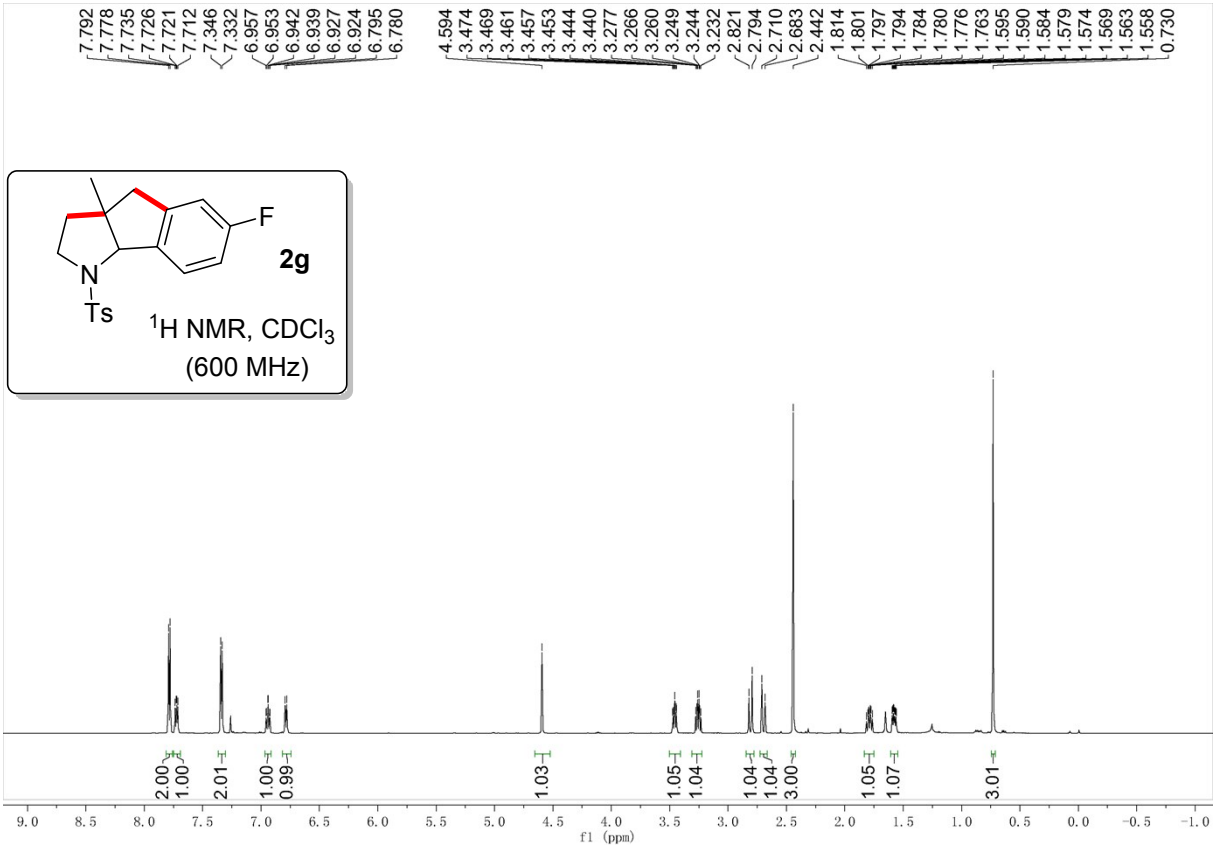
143.408
140.854
140.175
134.625
129.577
127.724
126.574
125.828
122.712
77.345
77.028
76.710
74.308
50.049
48.506
43.298
37.433
34.093
24.204
23.457
21.582
iPr 2d
N
Ts
13C NMR, CDCl3
(100 MHz)
f1 (ppm)

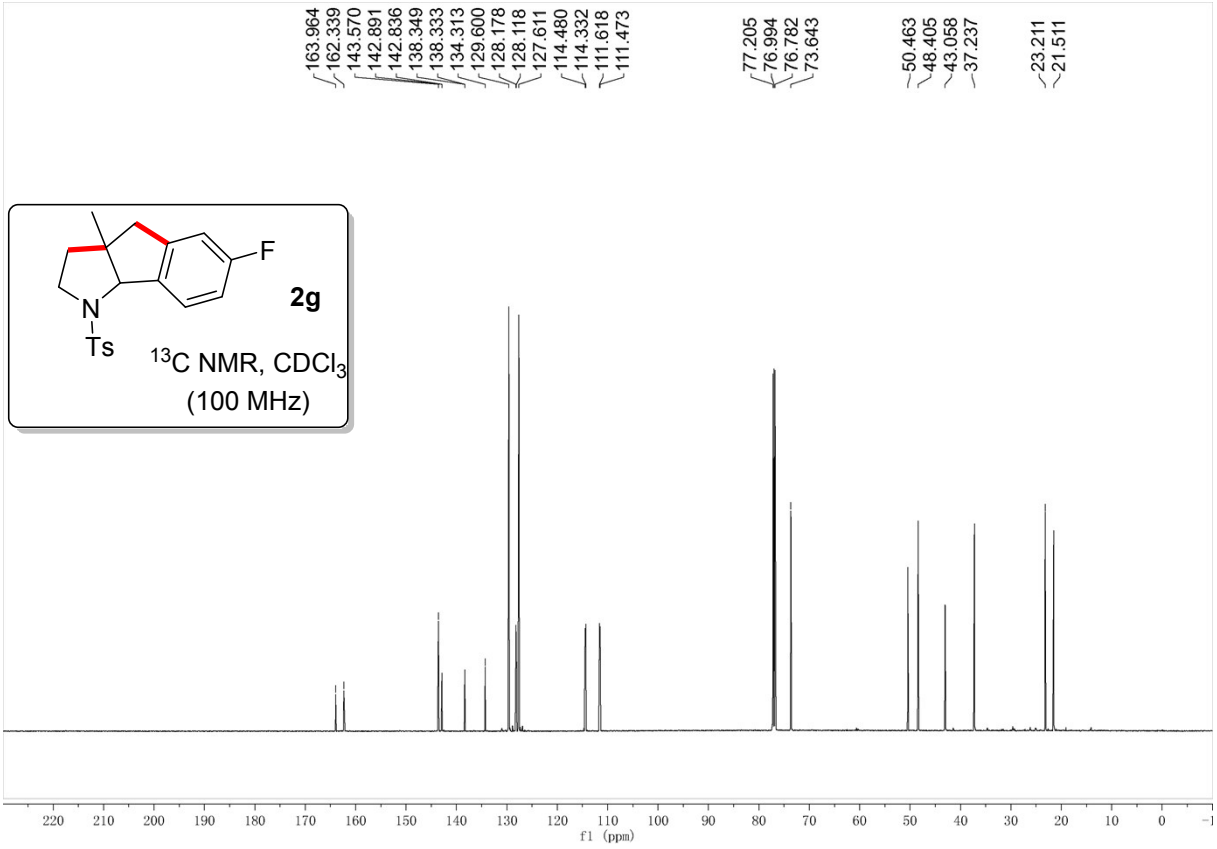

7.806
7.787
7.674
7.655
7.344
7.325
7.099
7.079
6.931
4.631
3.477
3.454
3.435
3.301
3.276
3.259
3.234
2.823
2.783
2.713
2.673
2.600
2.581
2.562
2.446
1.615
1.594
1.559
1.540
1.395
1.377
1.359
1.340
1.321
0.941
0.923
0.905
0.729
nBu
2e
N
Ts
1H NMR, CDCl3
(400 MHz)
2.00
1.01
2.00
1.08
1.08
1.04
1.07
1.01
1.08
1.07
2.06
3.00
3.09
3.13
3.05
3.01
f1 (ppm)

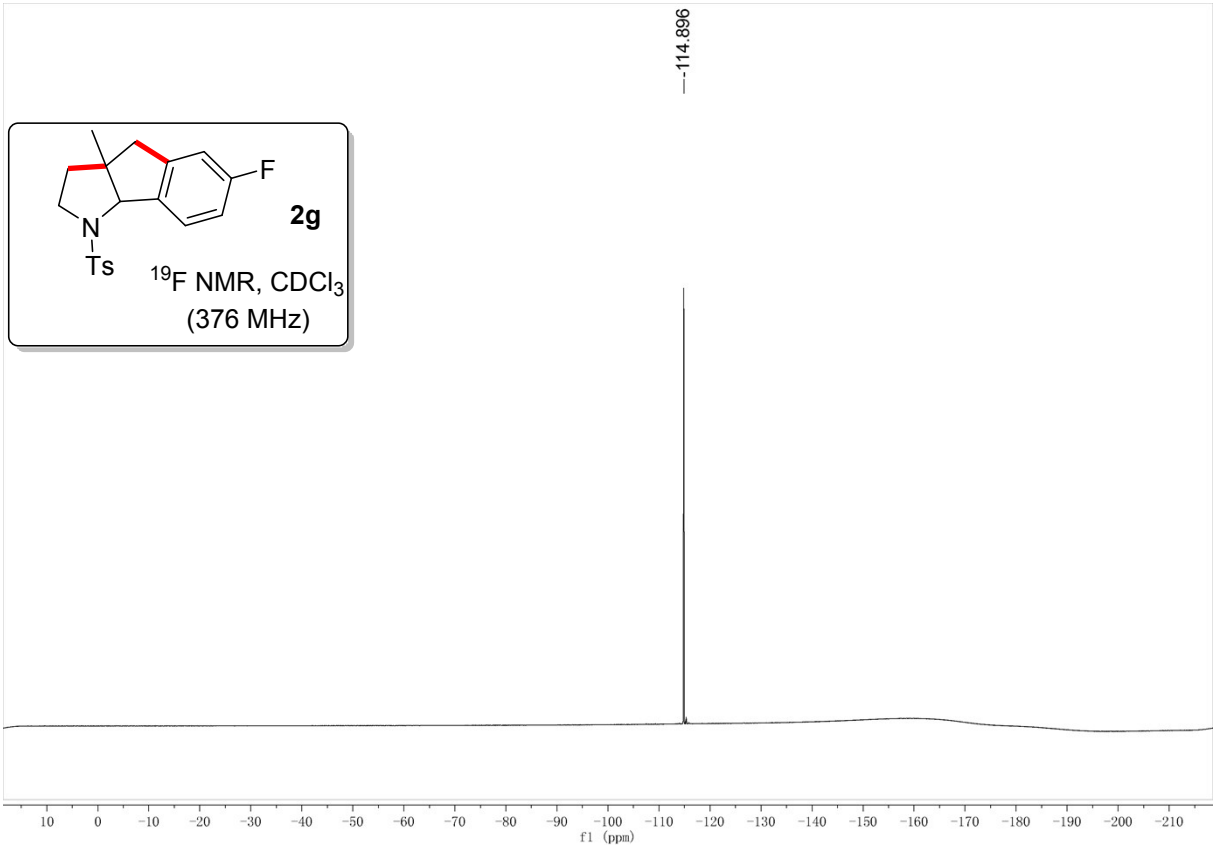

143.410
143.191
140.794
139.998
134.625
129.579
127.720
126.508
124.791
77.346
77.028
76.711
74.296
60.423
50.052
48.487
43.213
37.421
35.615
33.909
23.422
22.421
21.584
13.994
nBu
2e
N
Ts
13C NMR, CDCl3
(100 MHz)
f1 (ppm)

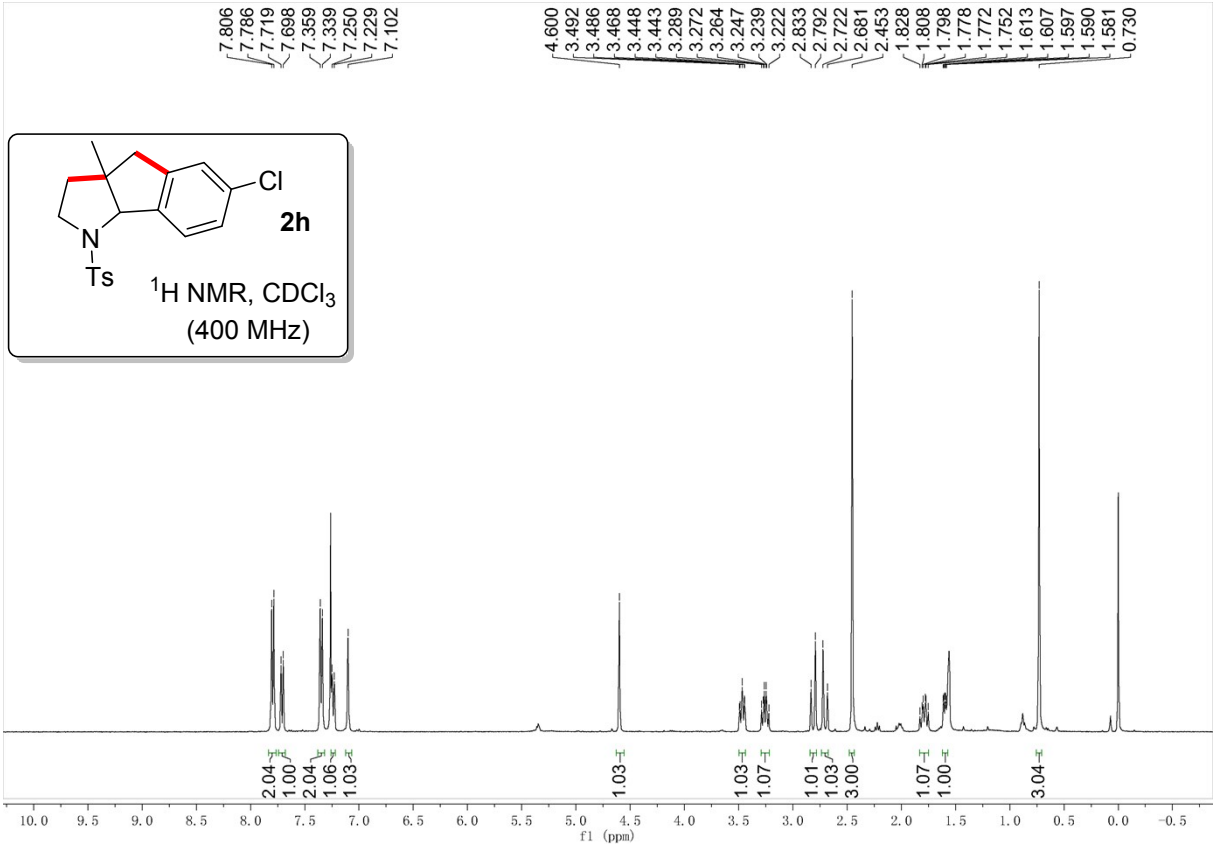

7.805
7.785
7.678
7.657
7.345
7.325
6.834
6.813
6.645
4.609
3.789
3.480
3.473
3.455
3.448
3.436
3.429
3.301
3.284
3.276
3.259
3.251
3.234
2.821
2.781
2.707
2.667
2.445
1.846
1.826
1.816
1.796
1.791
1.771
1.573
1.565
1.559
1.551
1.542
1.534
0.739
OMe
2f
N
Ts
1H NMR, CDCl3
(400 MHz)
2.02
1.01
2.06
1.06
1.02
0.99
3.02
1.00
1.03
1.03
1.01
3.00
1.06
1.03
2.99
f1 (ppm)

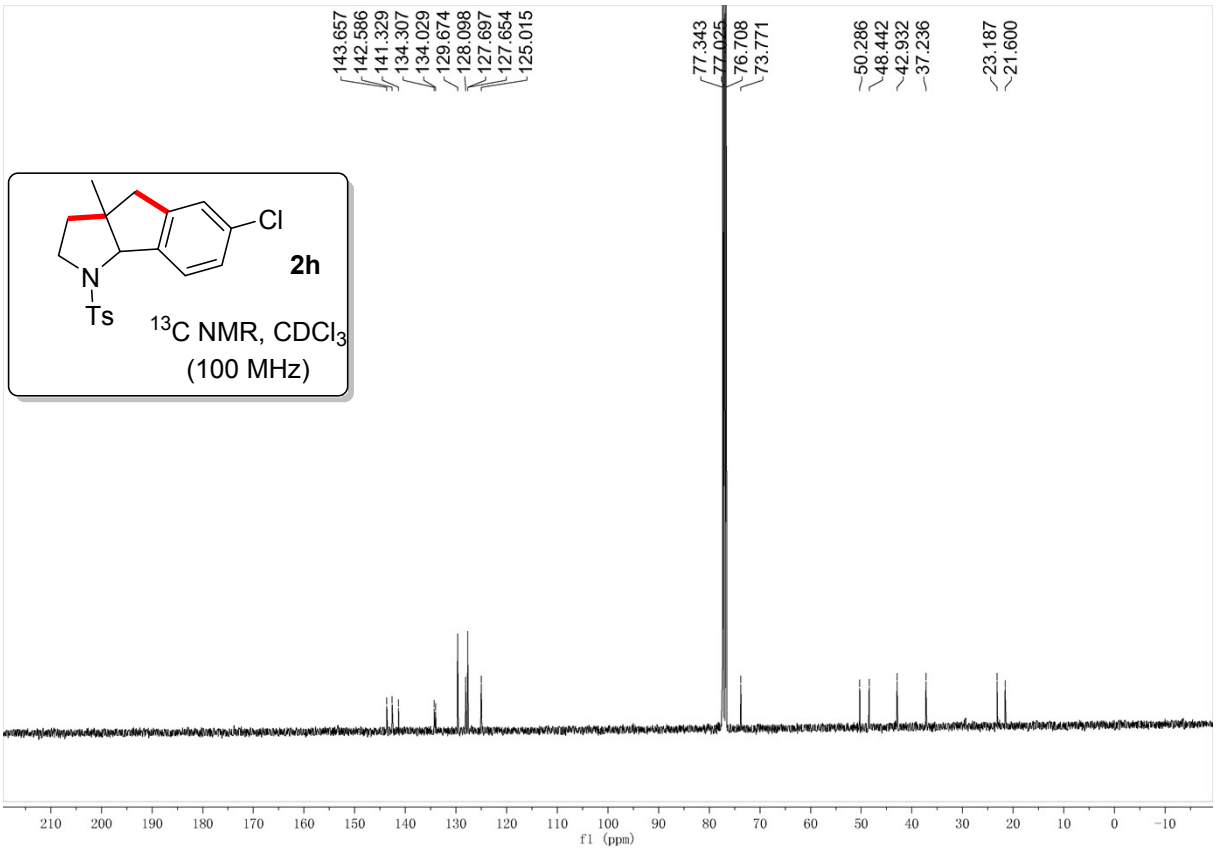

160.110
143.422
142.373
134.927
134.665
129.590
127.689
127.643
113.386
109.926
77.351
77.033
76.715
73.979
55.414
50.397
48.454
43.389
37.469
23.469
21.579
OMe
2f
N
Ts
13C NMR, CDCl3
(100 MHz)
f1 (ppm)

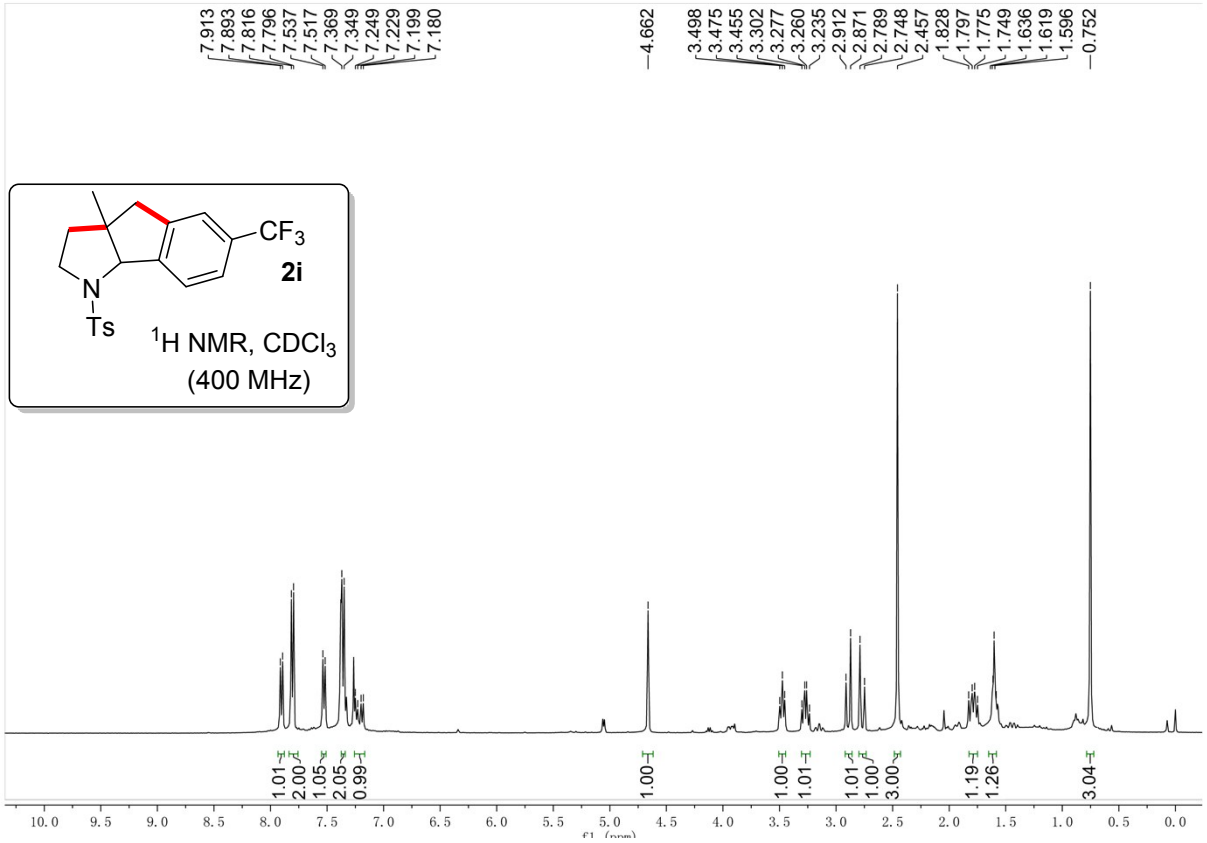

7.792
7.778
7.735
7.726
7.721
7.712
7.346
7.332
6.957
6.953
6.942
6.939
6.927
6.924
6.795
6.780
4.594
3.474
3.469
3.461
3.457
3.453
3.444
3.440
3.277
3.266
3.260
3.249
3.244
3.232
2.821
2.794
2.710
2.683
2.442
1.814
1.801
1.797
1.794
1.784
1.780
1.776
1.763
1.595
1.590
1.584
1.579
1.574
1.569
1.563
1.558
0.730
F
N
Ts
2g
^{1}H NMR, CDCl$_3$
(600 MHz)
2.00
1.00
2.01
1.00
0.99
1.03
1.05
1.04
1.04
1.04
3.00
1.05
1.07
3.01
f1 (ppm)

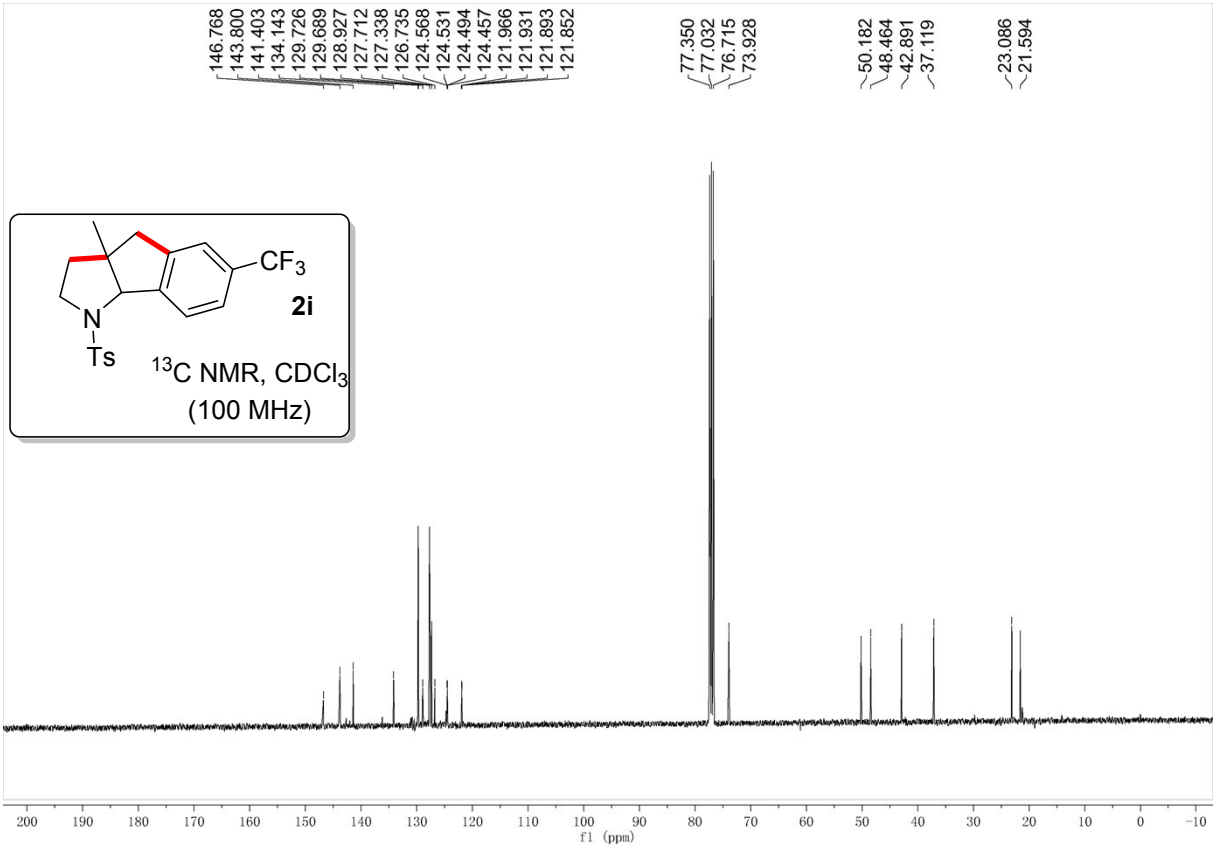

163.964
162.339
143.570
142.891
142.836
138.349
138.333
134.313
129.600
128.178
128.118
127.611
114.480
114.332
111.618
111.473
77.205
76.994
76.782
73.643
50.463
48.405
43.058
37.237
23.211
21.511
F
N
Ts
2g
^{13}C NMR, CDCl$_3$
(100 MHz)
f1 (ppm)

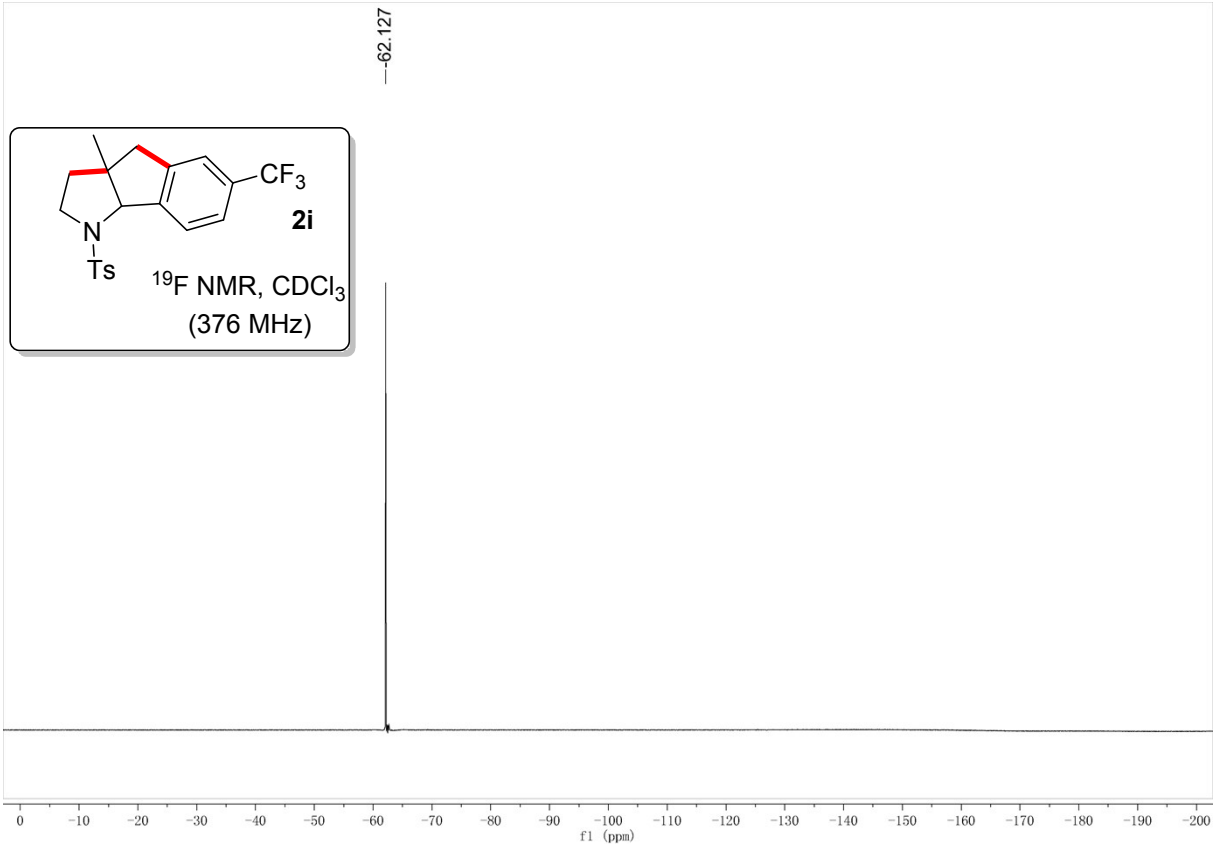

F
N
Ts
2g
^{19}F NMR, $CDCl_3$
(376 MHz)
-114.896
f1 (ppm)

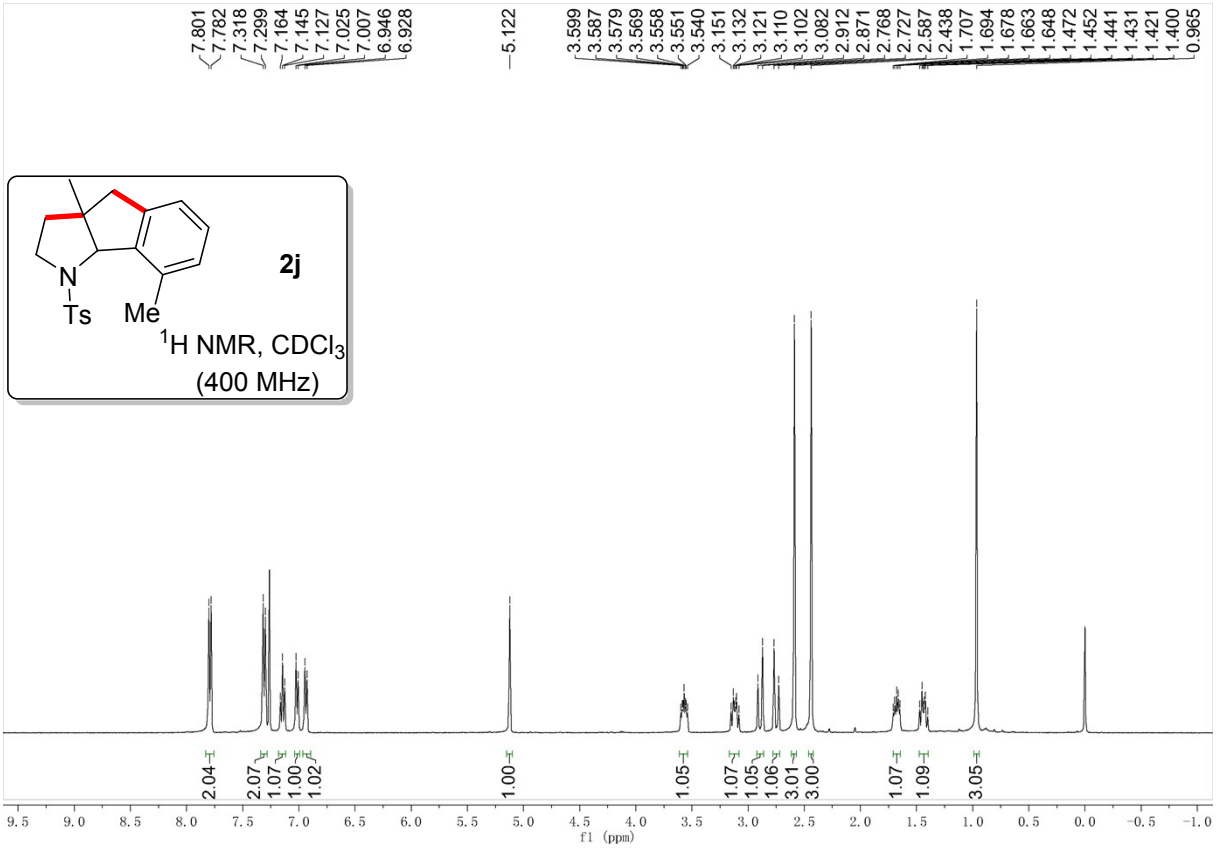

Cl
N
Ts
2h
^{1}H NMR, $CDCl_3$
(400 MHz)
7.806
7.786
7.719
7.698
7.359
7.339
7.250
7.229
7.102
4.600
3.492
3.486
3.468
3.448
3.443
3.289
3.272
3.264
3.247
3.239
3.222
2.833
2.792
2.722
2.681
2.453
1.828
1.808
1.798
1.778
1.772
1.752
1.613
1.607
1.597
1.590
1.581
0.730
2.04
1.00
2.04
1.06
1.03
1.03
1.07
1.01
1.03
3.00
1.07
1.00
3.04
f1 (ppm)

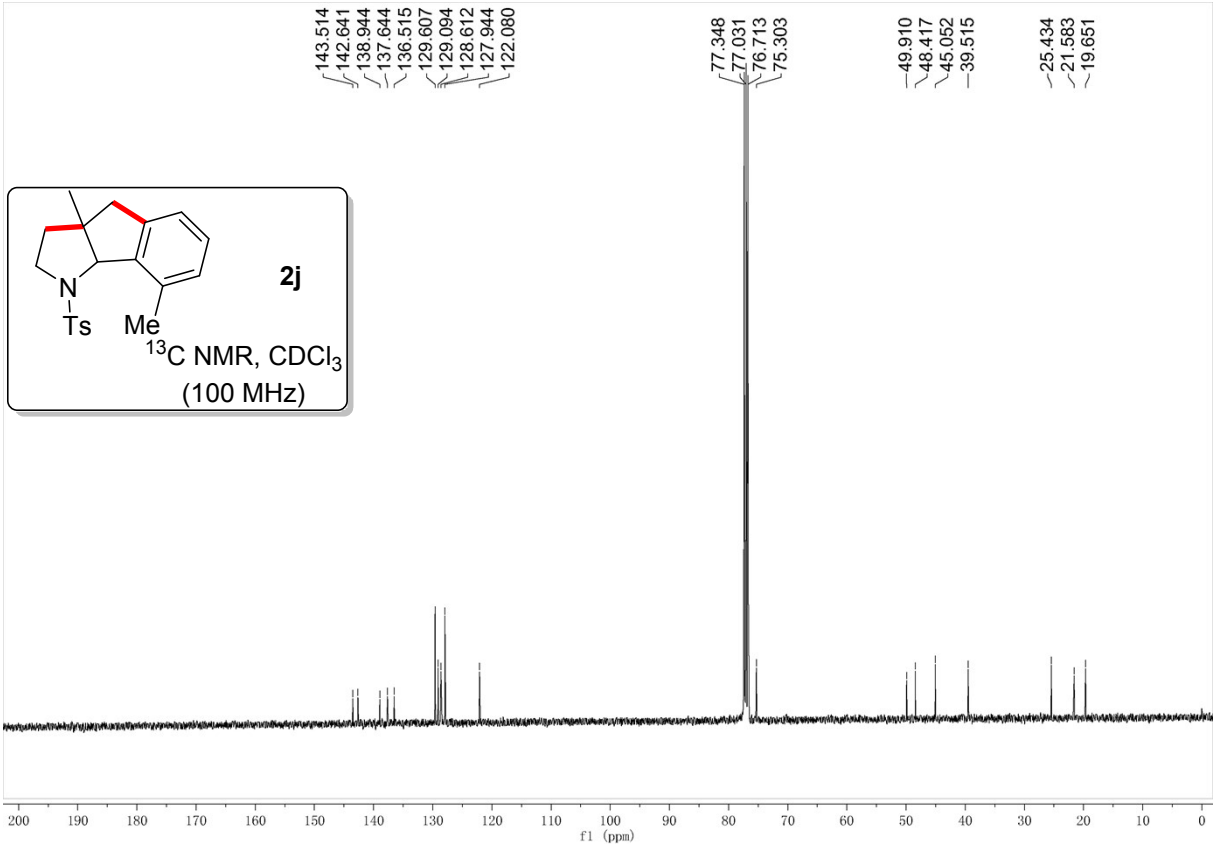

143.657
142.586
141.329
134.307
134.029
129.674
128.098
127.697
127.654
125.015
77.343
77.025
76.708
73.771
50.286
48.442
42.932
37.236
23.187
21.600
Cl
2h
N
Ts
13C NMR, CDCl3
(100 MHz)
f1 (ppm)


7.913
7.893
7.816
7.796
7.537
7.517
7.369
7.349
7.249
7.229
7.199
7.180
4.662
3.498
3.475
3.455
3.302
3.277
3.260
3.235
2.912
2.871
2.789
2.748
2.457
1.828
1.797
1.775
1.749
1.636
1.619
1.596
0.752
CF3
2i
N
Ts
1H NMR, CDCl3
(400 MHz)
1.01
2.00
1.05
2.05
0.99
1.00
1.00
1.01
1.01
1.00
3.00
1.19
1.26
3.04

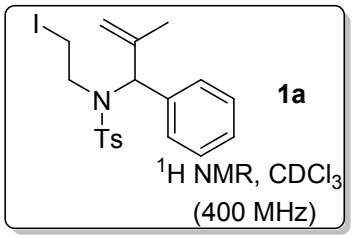

146.768
143.800
141.403
134.143
129.726
129.689
128.927
127.712
127.338
126.735
124.568
124.531
124.494
124.457
121.966
121.931
121.893
121.852
77.350
77.032
76.715
73.928
50.182
48.464
42.891
37.119
23.086
21.594
CF3
2i
N
Ts
13C NMR, CDCl3
(100 MHz)
f1 (ppm)

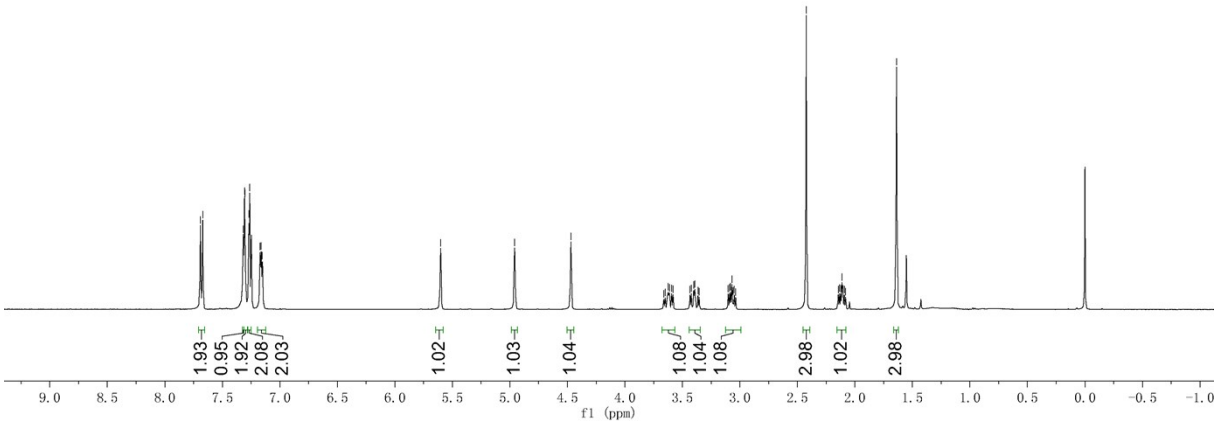

-62.127
CF3
2i
N
Ts
19F NMR, CDCl3
(376 MHz)
f1 (ppm)

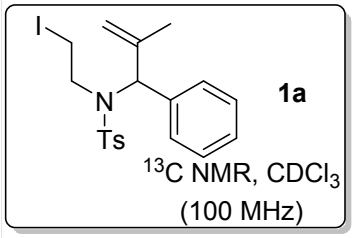

7.801
7.782
7.318
7.299
7.164
7.145
7.127
7.025
7.007
6.946
6.928
5.122
3.599
3.587
3.579
3.569
3.558
3.551
3.540
3.151
3.132
3.121
3.110
3.102
3.082
2.912
2.871
2.768
2.727
2.587
2.438
1.707
1.694
1.678
1.663
1.648
1.472
1.452
1.441
1.431
1.421
1.400
0.965
2j
N
Ts
Me
1H NMR, CDCl3
(400 MHz)
2.04
2.07
1.07
1.00
1.02
1.00
1.05
1.07
1.05
1.06
3.01
3.00
1.07
1.09
3.05
f1 (ppm)

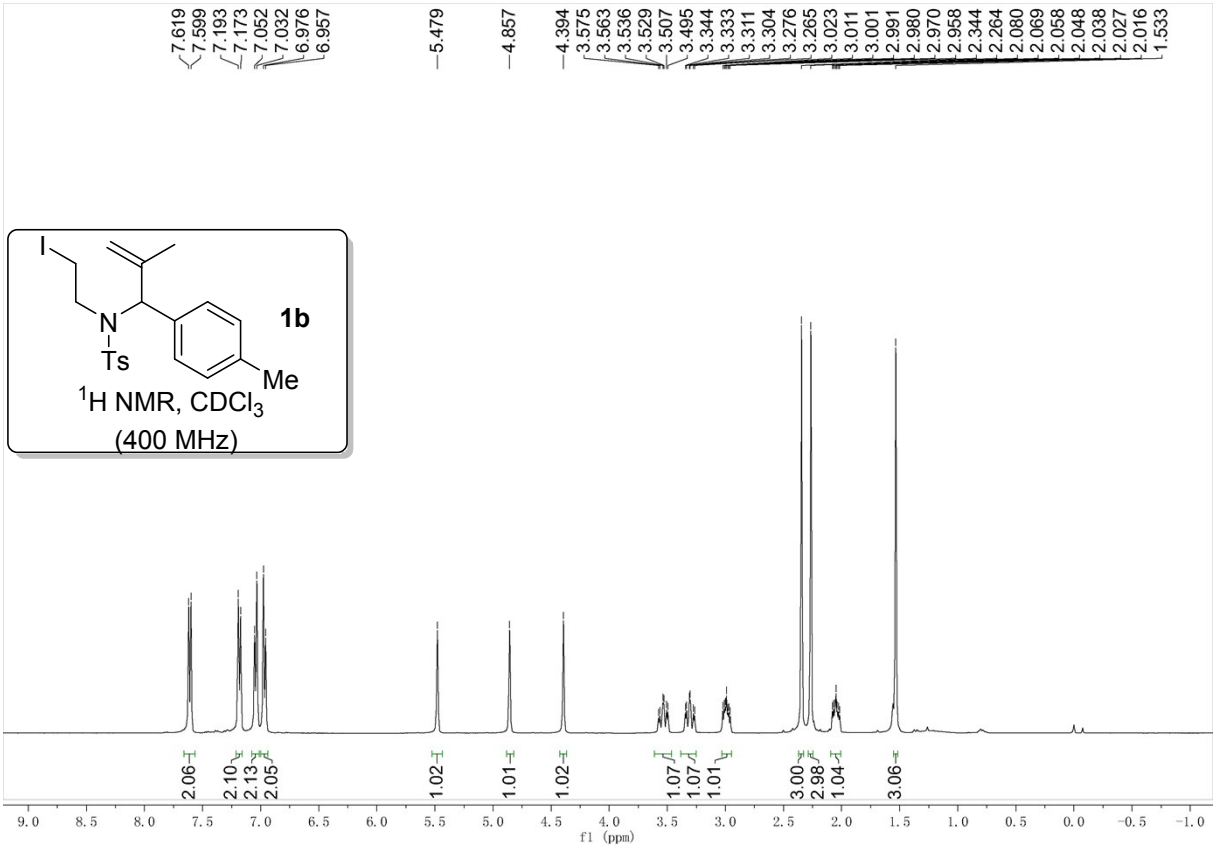

143.514
142.641
138.944
137.644
136.515
129.607
129.094
128.612
127.944
122.080
77.348
77.031
76.713
75.303
49.910
48.417
45.052
39.515
25.434
21.583
19.651
2j
N
Ts
Me
13C NMR, CDCl3
(100 MHz)
f1 (ppm)

5. Copies of the ^{1}H NMR and ^{13}C NMR for Starting Material





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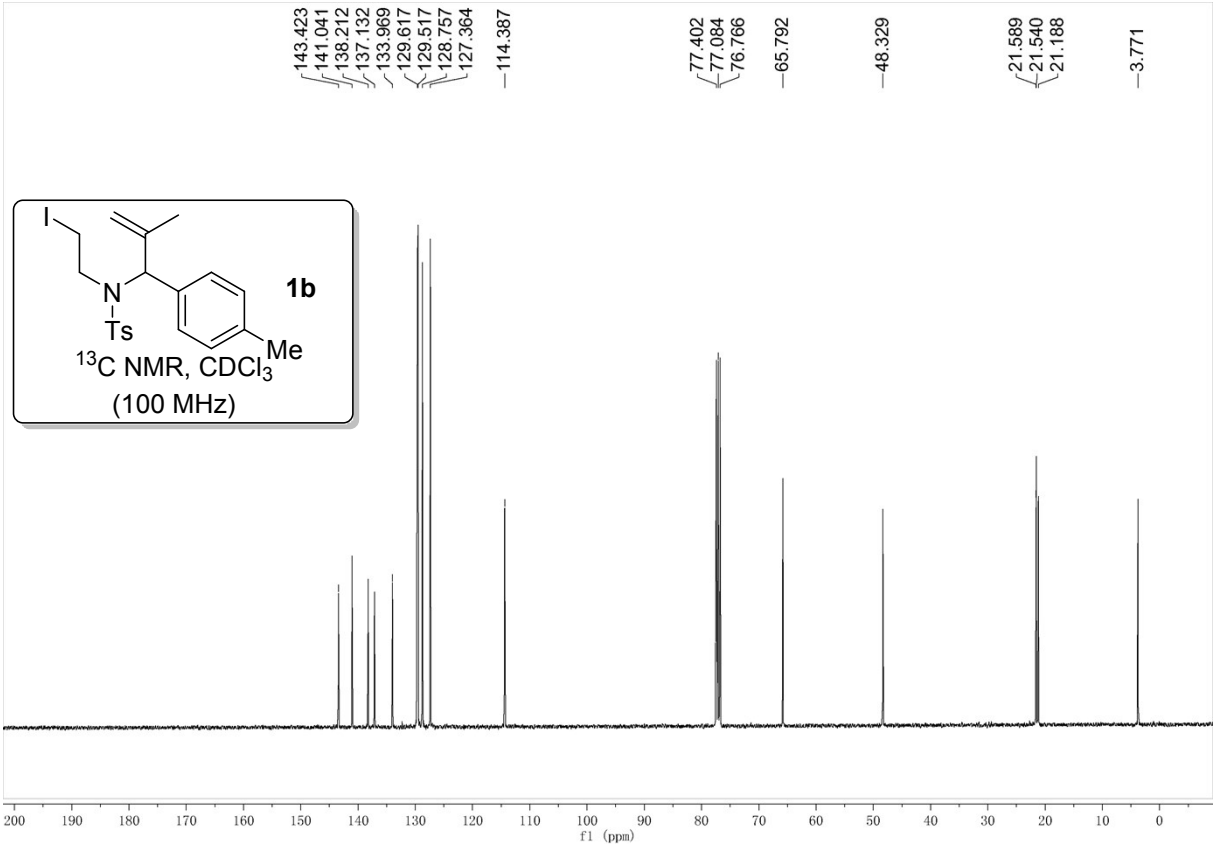
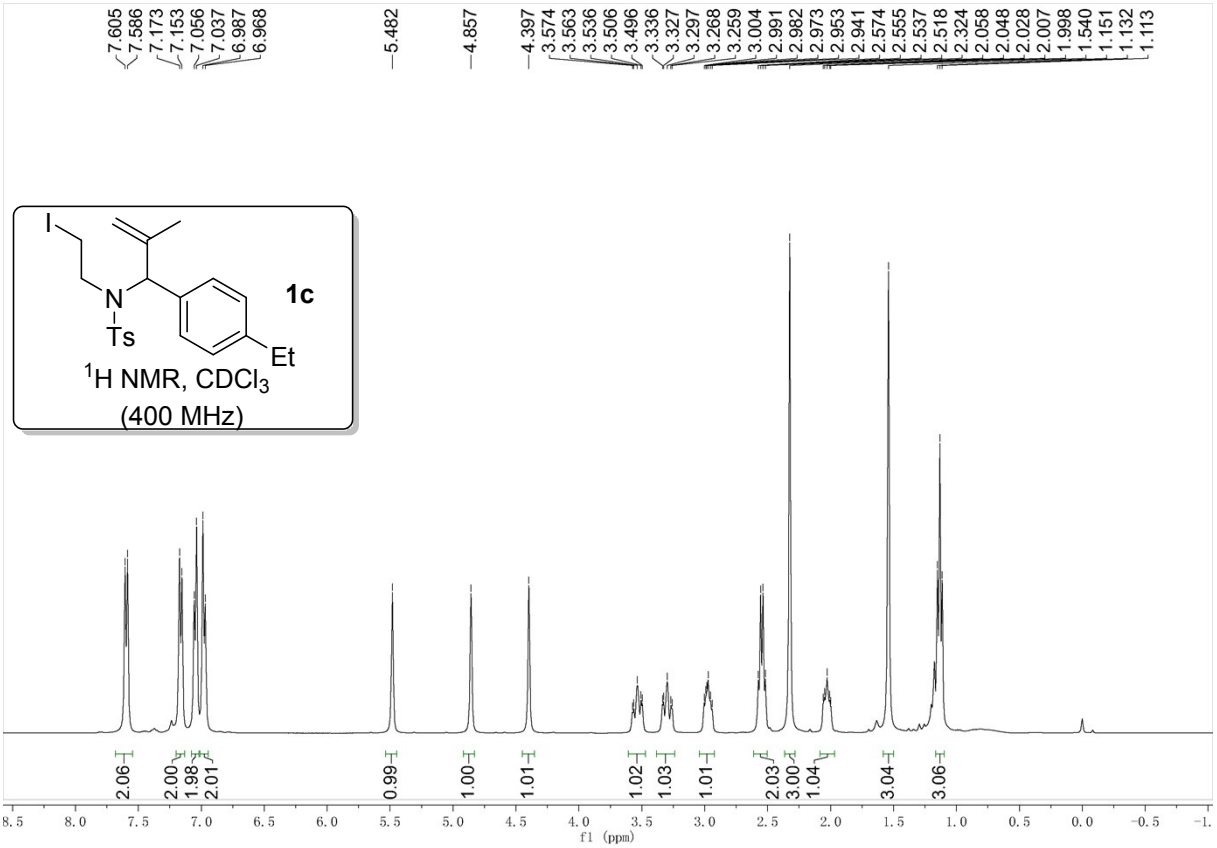
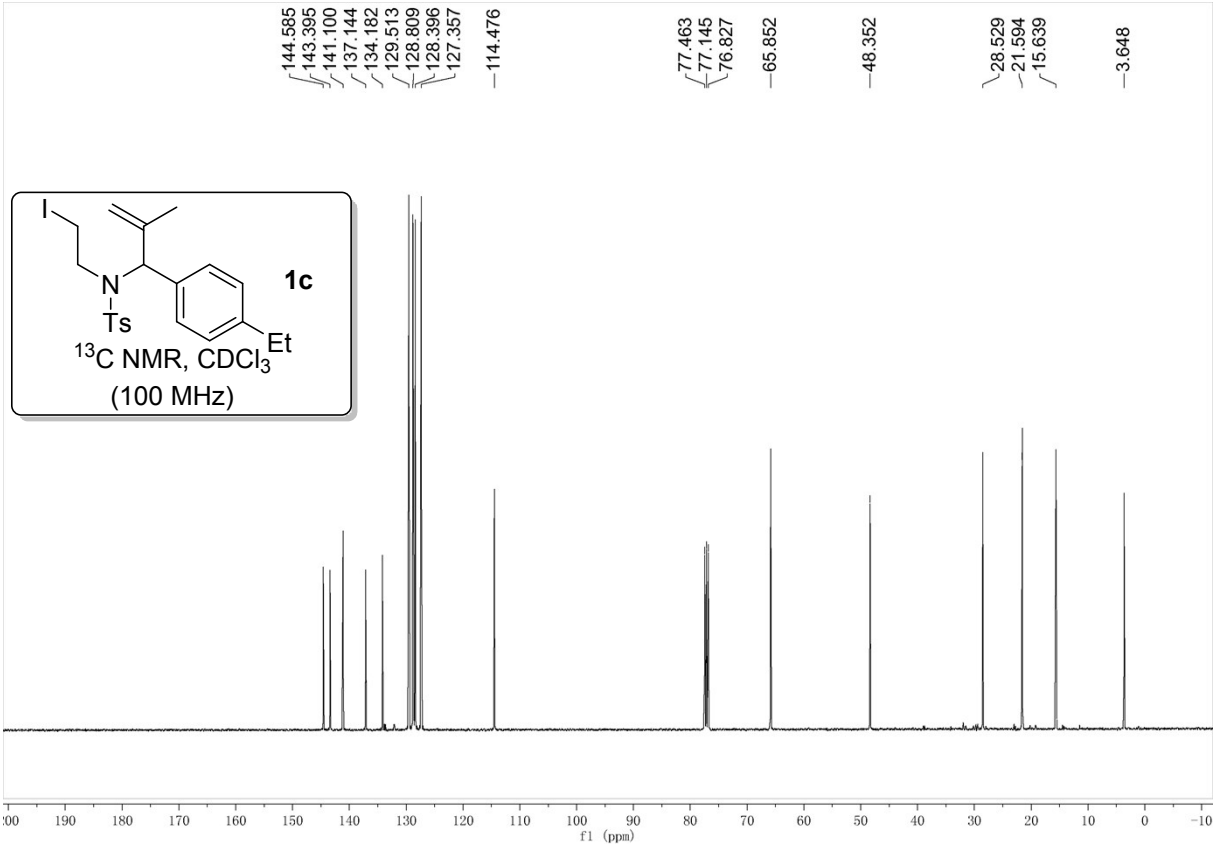
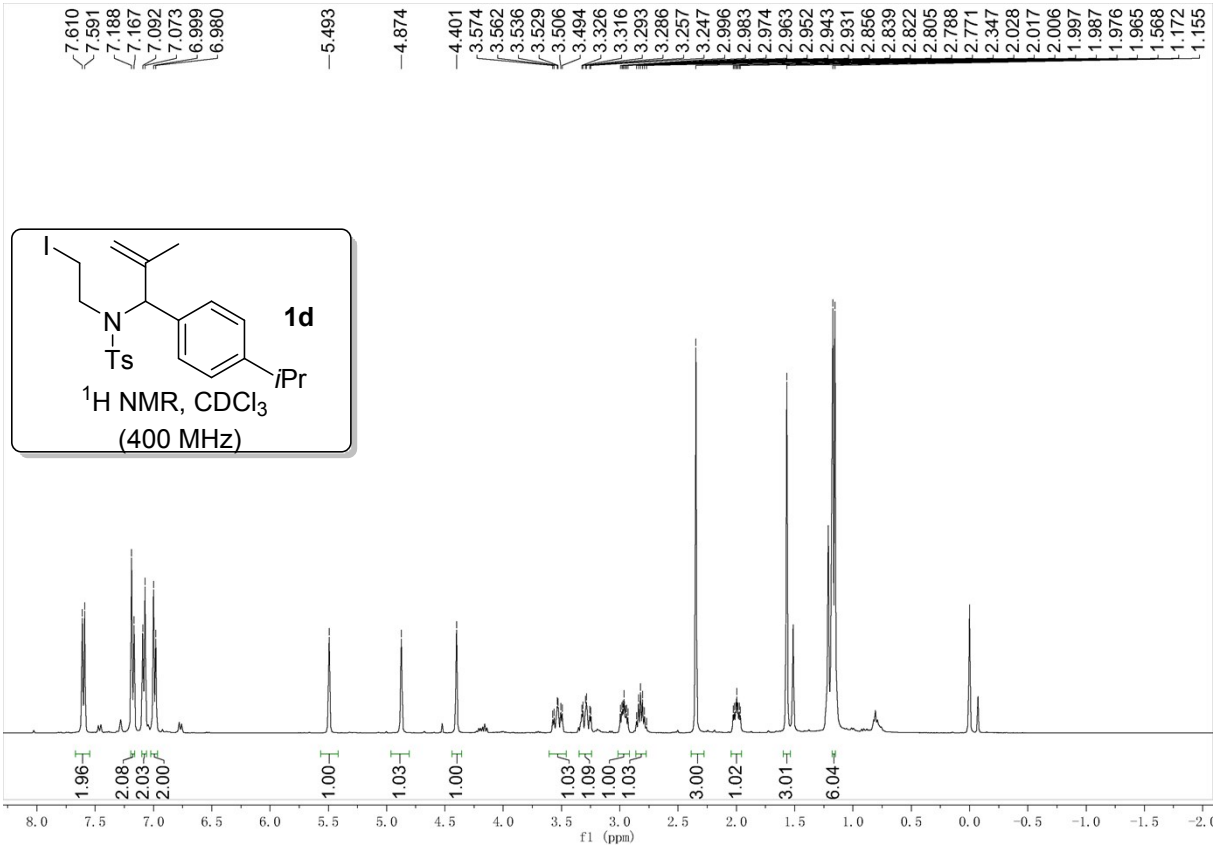
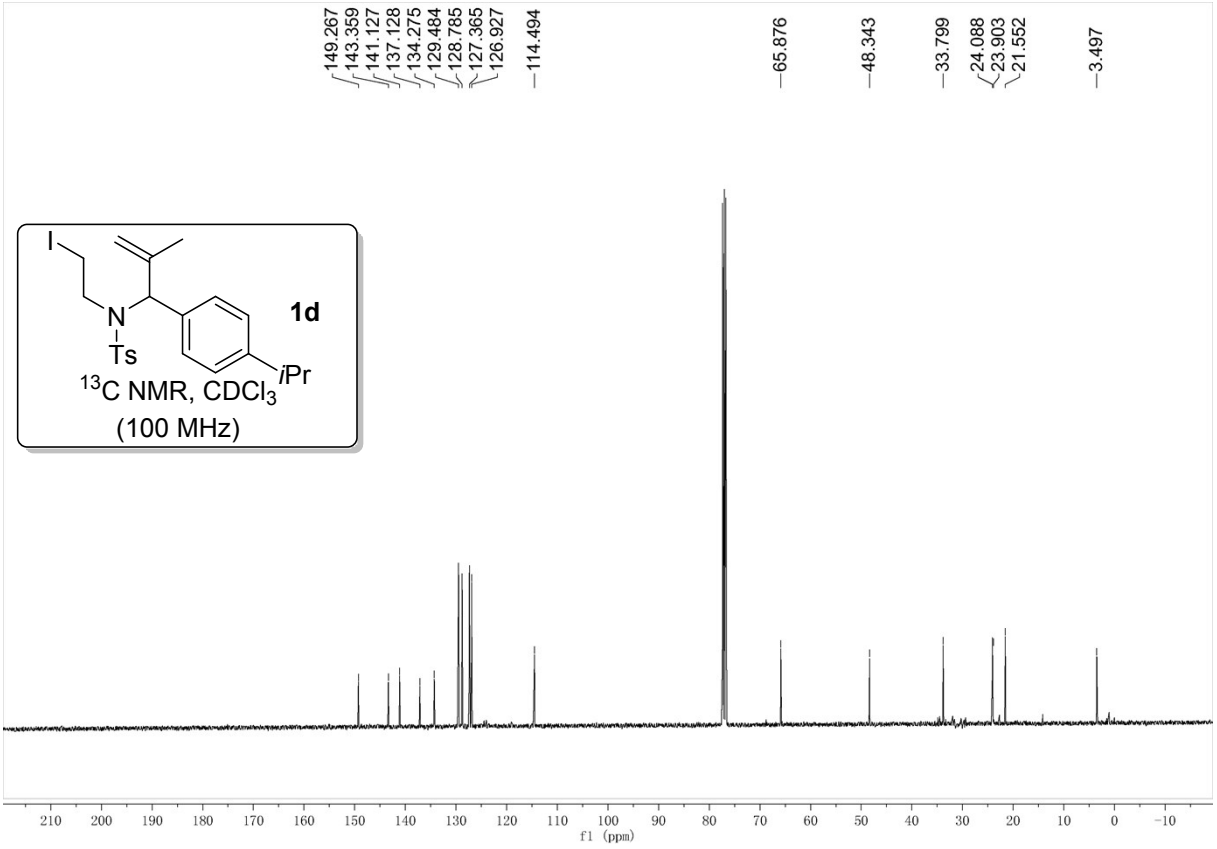
7.193
7.173
7.052
7.032
6.976
6.957
5.479
4.857
4.394
3.575
3.563
3.536
3.529
3.507
3.495
3.344
3.333
3.311
3.304
3.276
3.265
3.023
3.011
3.001
2.991
2.980
2.970
2.958
2.344
2.264
2.080
2.069
2.058
2.048
2.038
2.027
2.016
1.533
I
N
Ts
Me
1b
1H NMR, CDCl3
(400 MHz)
2.06
2.10
2.13
2.05
1.02
1.01
1.02
1.07
1.07
1.01
3.00
2.98
1.04
3.06
f1 (ppm)

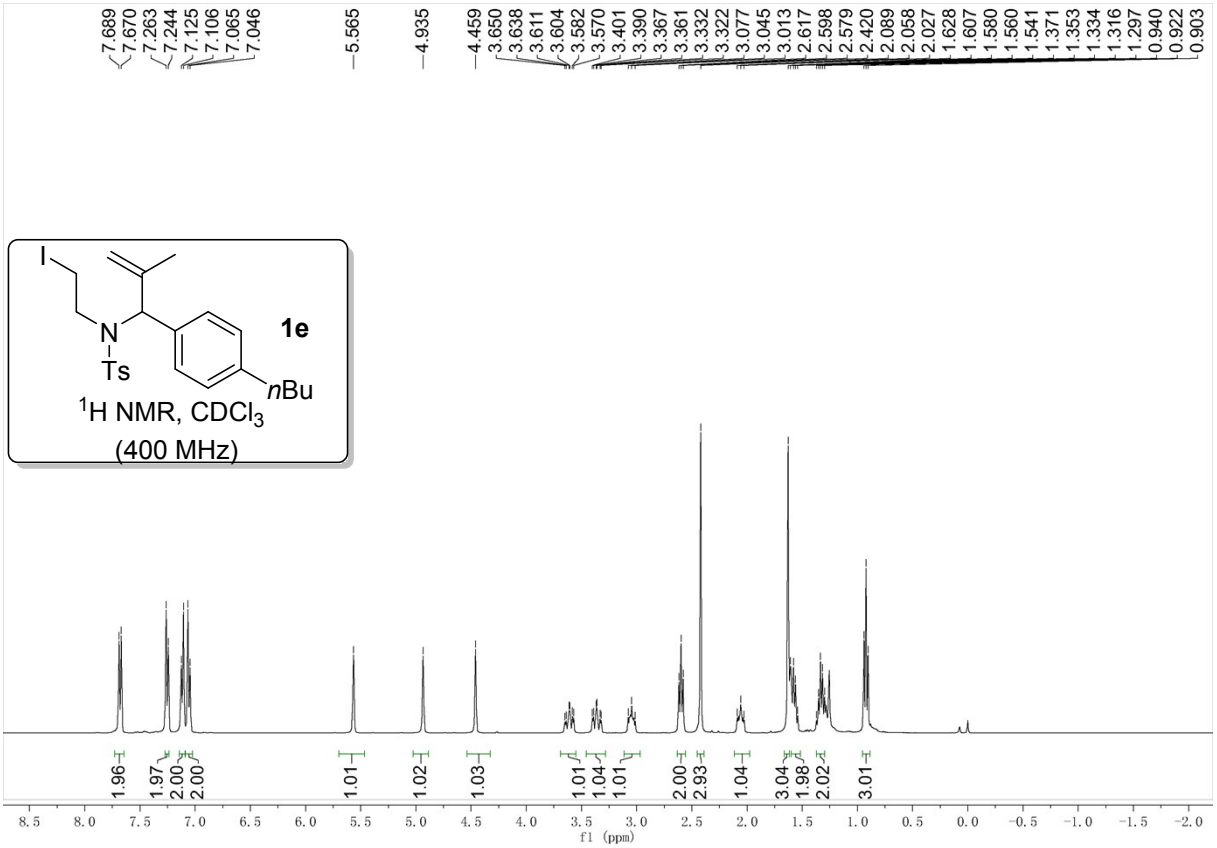

143.423
141.041
138.212
137.132
133.969
129.617
129.517
128.757
127.364
114.387
77.402
77.084
76.766
65.792
48.329
21.589
21.540
21.188
3.771
I
N
Ts
Me
1b
13C NMR, CDCl3
(100 MHz)
f1 (ppm)


7.605
7.586
7.173
7.153
7.056
7.037
6.987
6.968
5.482
4.857
4.397
3.574
3.563
3.536
3.506
3.496
3.336
3.327
3.297
3.268
3.259
3.004
2.991
2.982
2.973
2.953
2.941
2.574
2.555
2.537
2.518
2.324
2.058
2.048
2.028
2.007
1.998
1.540
1.151
1.132
1.113
I
N
Ts
Et
1c
1H NMR, CDCl3
(400 MHz)
2.06
2.00
1.98
2.01
0.99
1.00
1.01
1.02
1.03
1.01
2.03
3.00
1.04
3.04
3.06
f1 (ppm)


144.585
143.395
141.100
137.144
134.182
129.513
128.809
128.396
127.357
114.476
77.463
77.145
76.827
65.852
48.352
28.529
21.594
15.639
3.648
I
N
Ts
Et
1c
13C NMR, CDCl3
(100 MHz)
f1 (ppm)


1d
Ts
iPr
1H NMR, CDCl3
(400 MHz)
f1 (ppm)


1d
Ts
iPr
13C NMR, CDCl3
(100 MHz)
f1 (ppm)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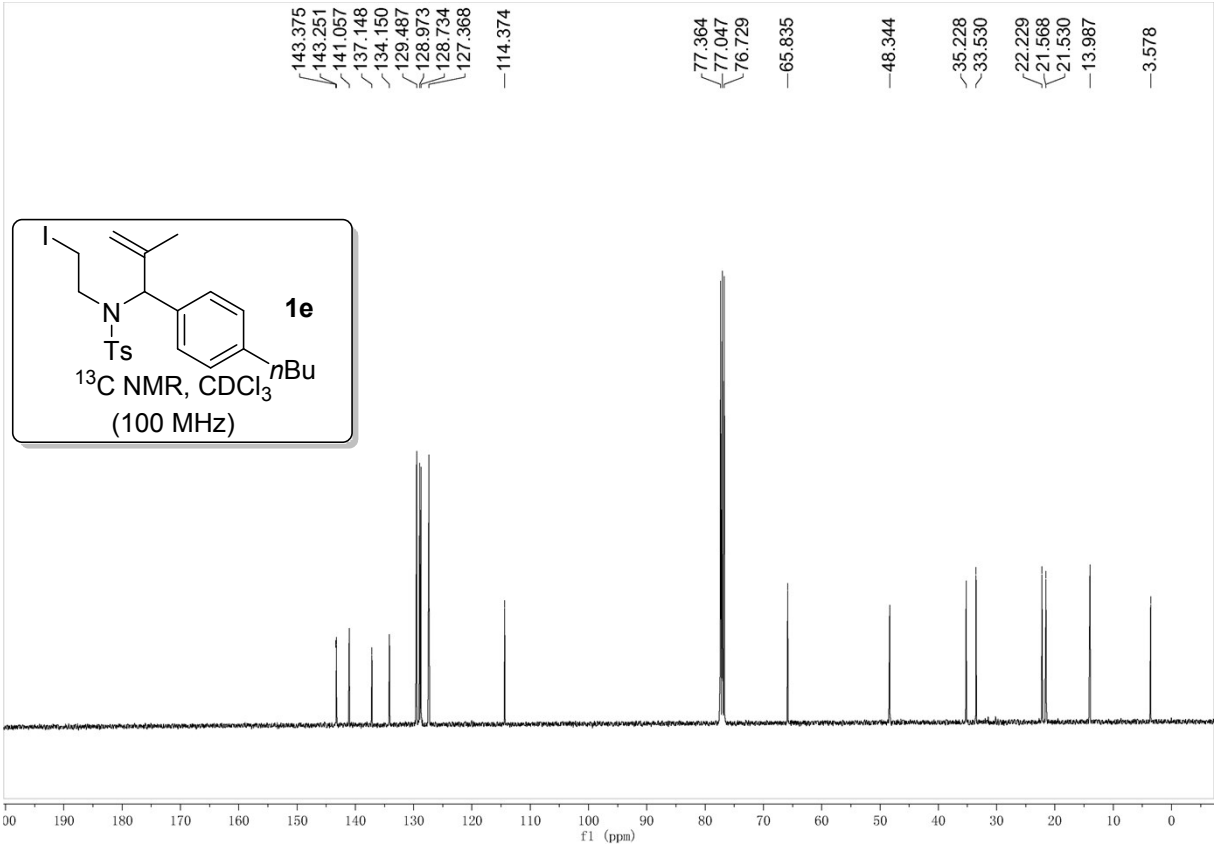
7.670
7.263
7.244
7.125
7.106
7.065
7.046
5.565
4.935
4.459
3.650
3.638
3.611
3.604
3.582
3.570
3.401
3.390
3.367
3.361
3.332
3.322
3.077
3.045
3.013
2.617
2.598
2.579
2.420
2.089
2.058
2.027
1.628
1.607
1.580
1.560
1.541
1.371
1.353
1.334
1.316
1.297
0.940
0.922
0.903
I
N
Ts
1e
nBu
1H NMR, CDCl3
(400 MHz)
1.96
1.97
2.00
2.00
1.01
1.02
1.03
1.01
1.04
1.01
2.00
2.93
1.04
3.04
1.98
2.02
3.01
f1 (ppm)


143.375
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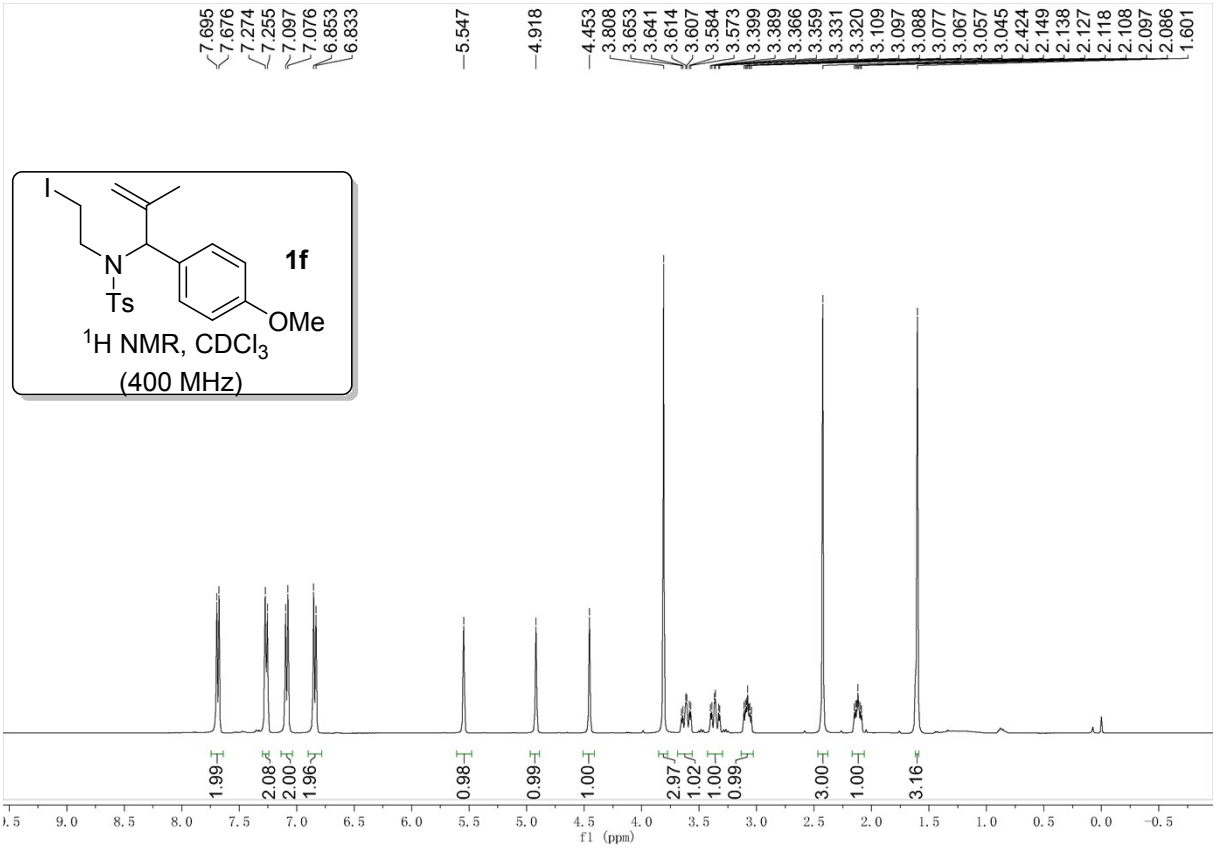
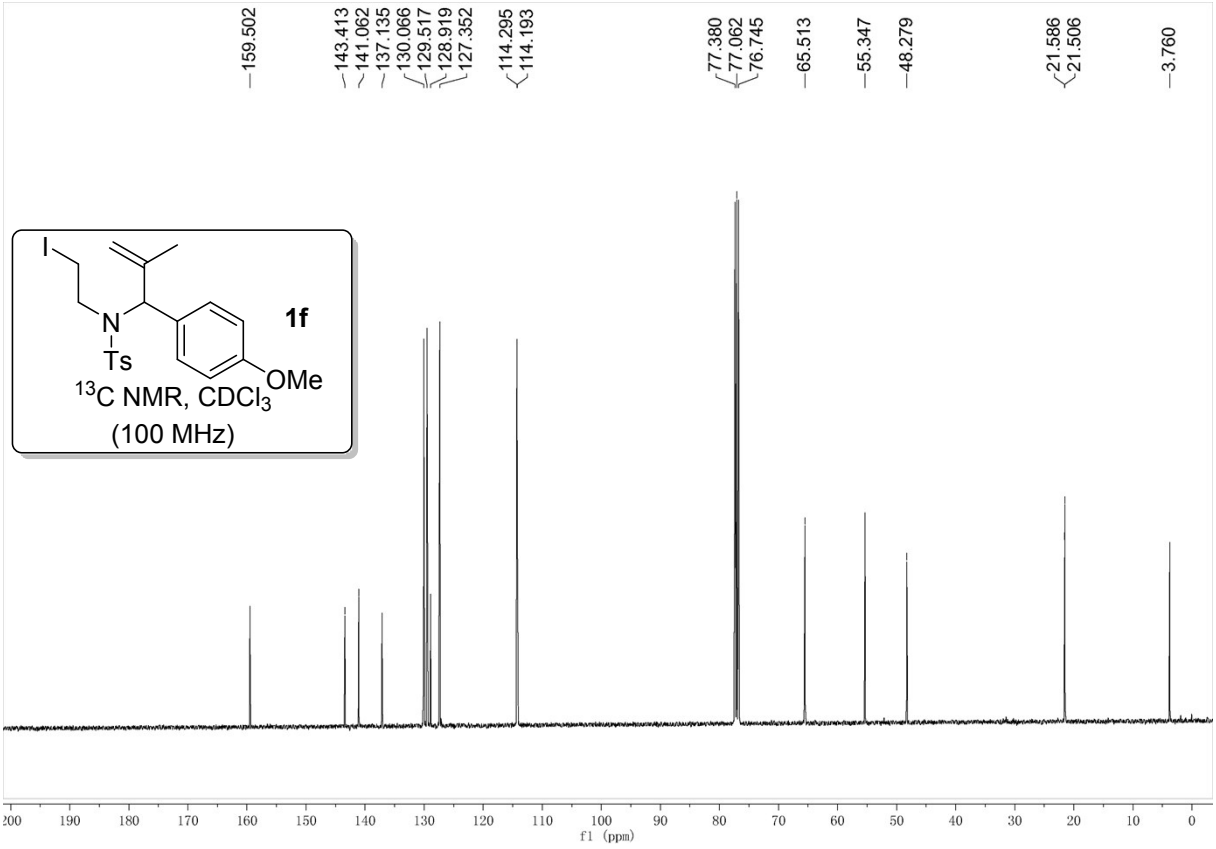
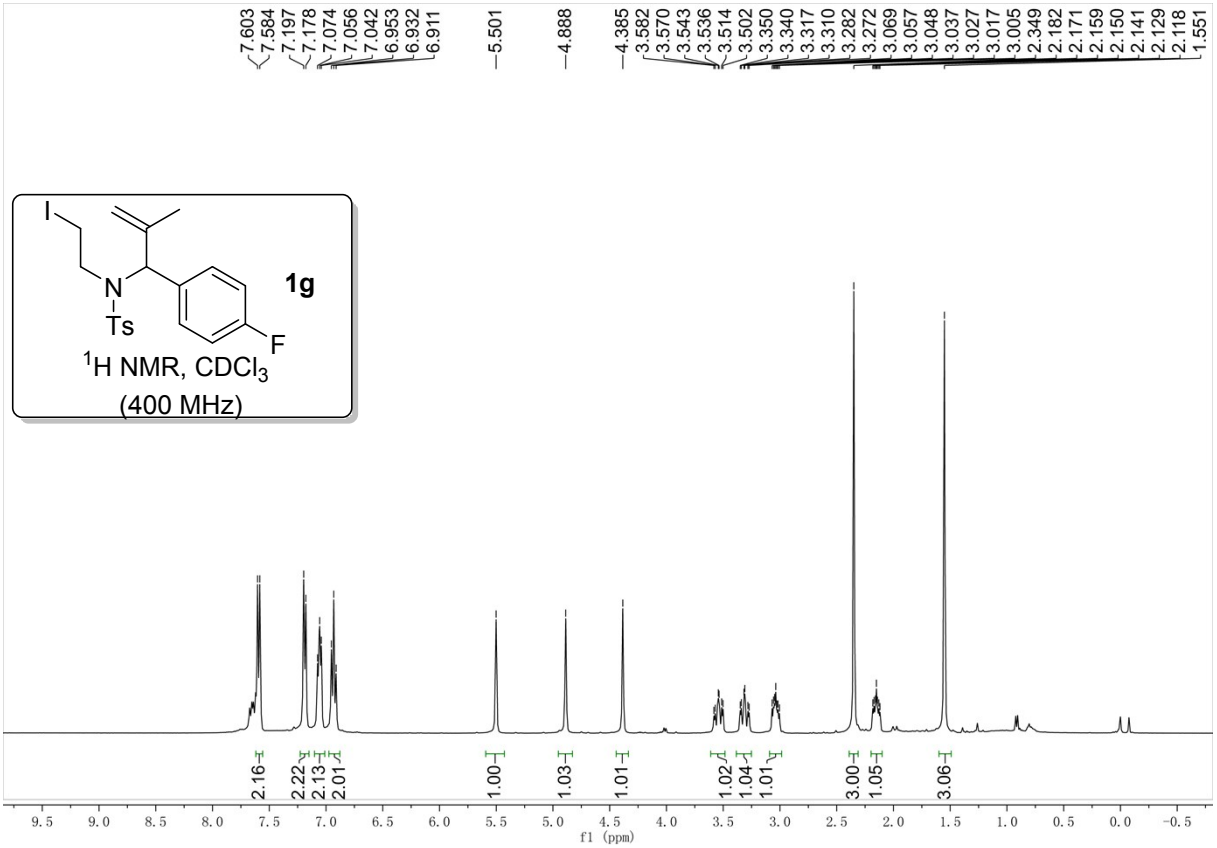
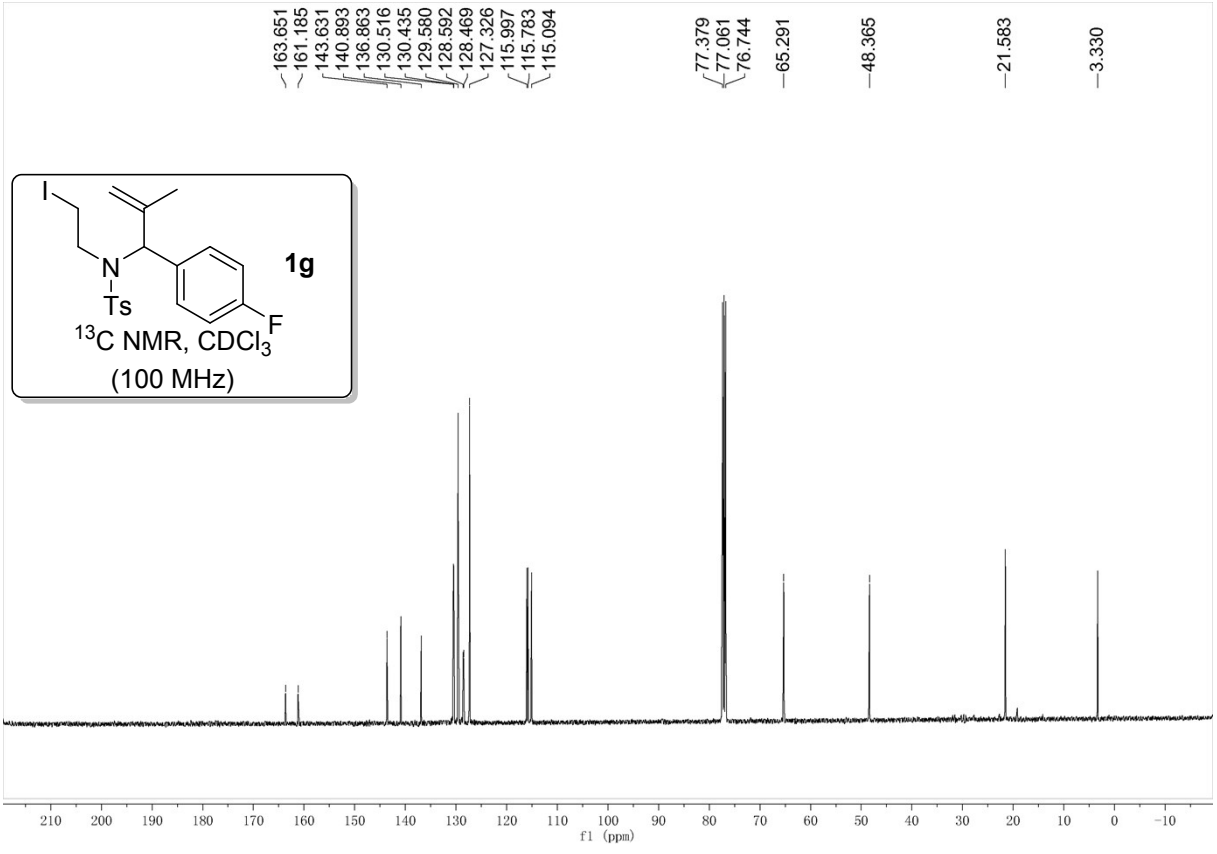
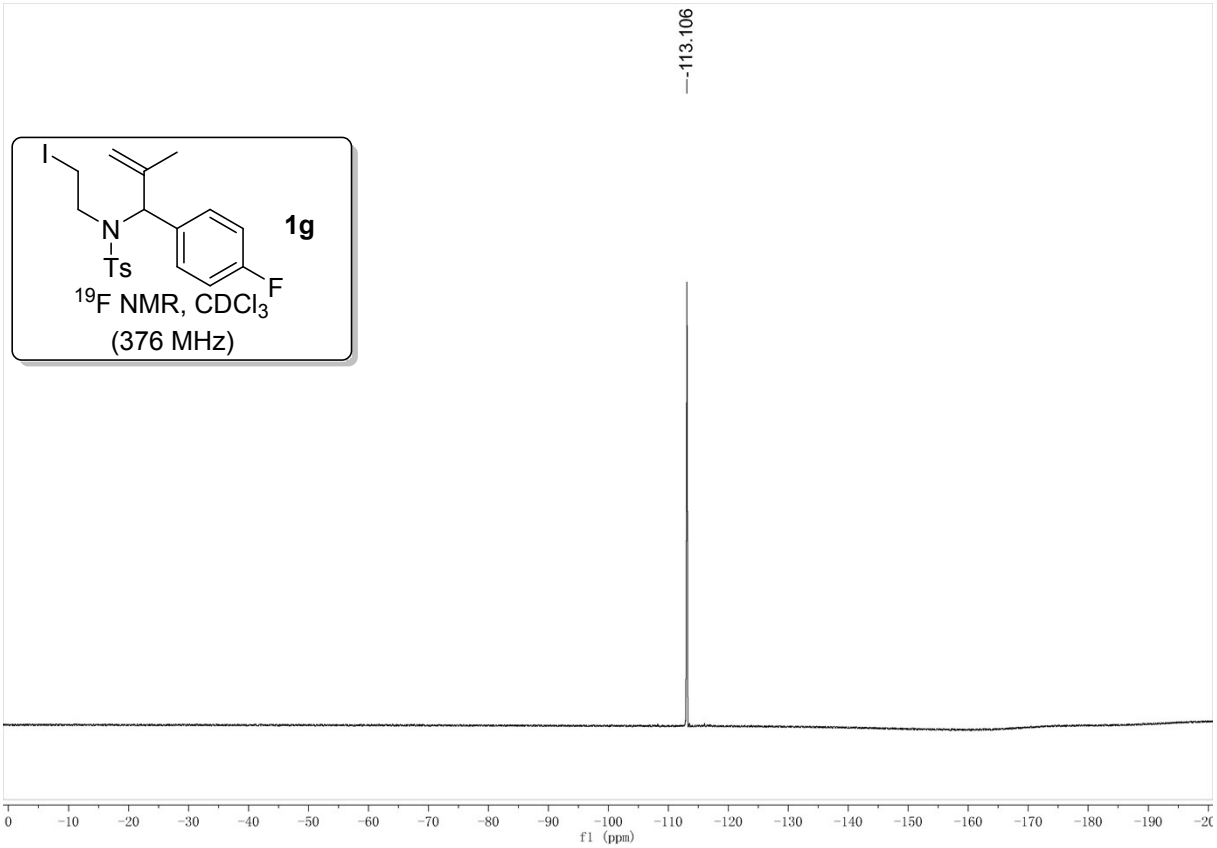
141.057
137.148
134.150
129.487
128.973
128.734
127.368
114.374
77.364
77.047
76.729
65.835
48.344
35.228
33.530
22.229
21.568
21.530
13.987
3.578
I
N
Ts
1e
nBu
13C NMR, CDCl3
(100 MHz)
f1 (ppm)

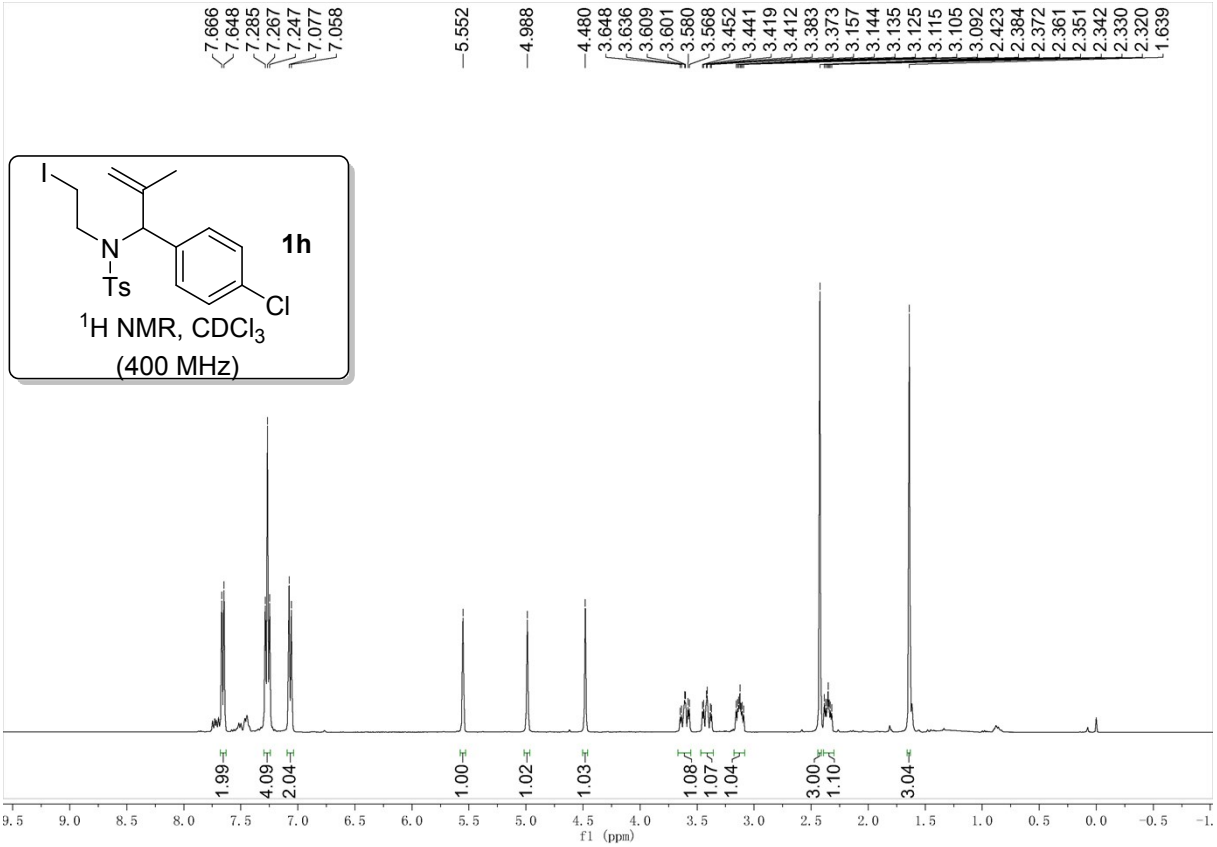

7.695
7.676
7.274
7.255
7.097
7.076
6.853
6.833
5.547
4.918
4.453
3.808
3.653
3.641
3.614
3.607
3.584
3.573
3.399
3.389
3.366
3.359
3.331
3.320
3.109
3.097
3.088
3.077
3.067
3.057
3.045
2.424
2.149
2.138
2.127
2.118
2.108
2.097
2.086
1.601
1.99
2.08
2.00
1.96
0.98
0.99
1.00
2.97
1.02
1.00
0.99
3.00
1.00
3.16
I
N
Ts
1f
OMe
^{1}H NMR, $CDCl_3$
(400 MHz)
f1 (ppm)

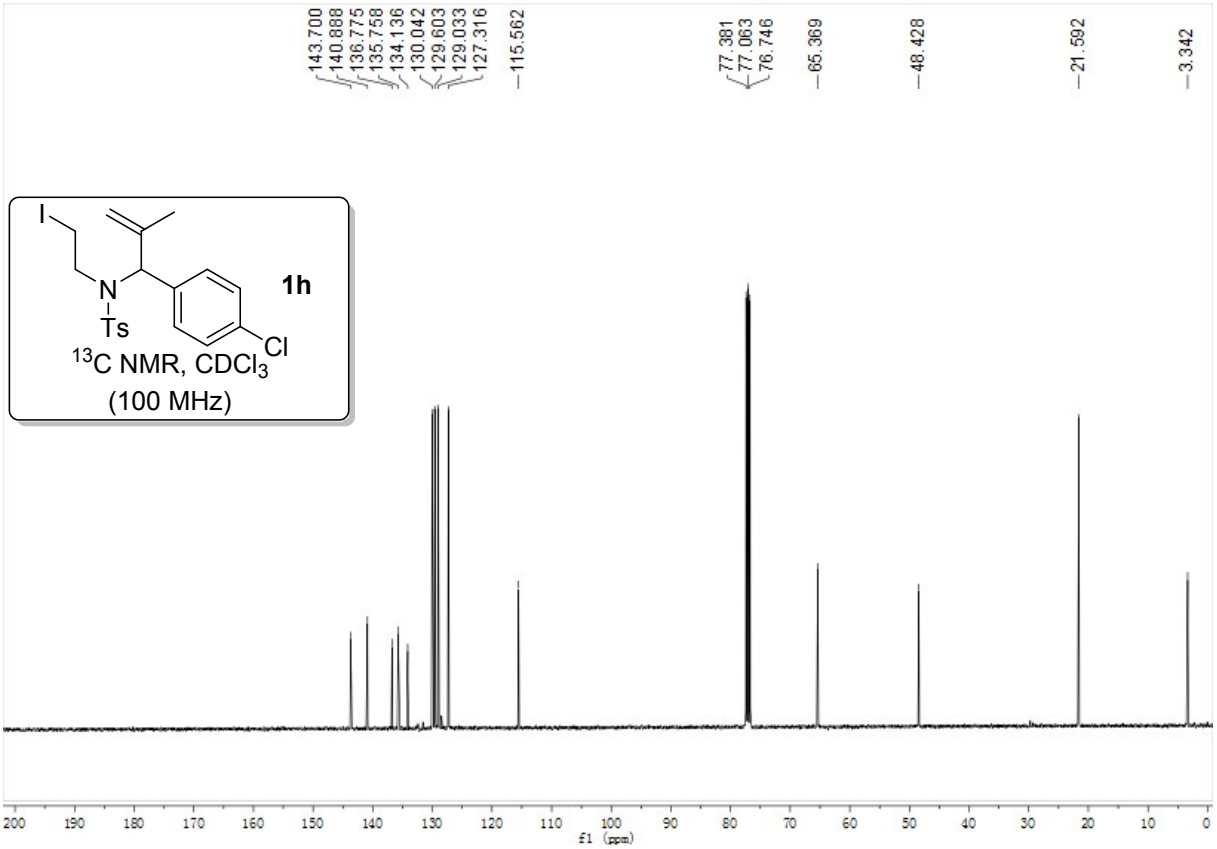

159.502
143.413
141.062
137.135
130.066
129.517
128.919
127.352
114.295
114.193
77.380
77.062
76.745
65.513
55.347
48.279
21.586
21.506
3.760
I
N
Ts
1f
OMe
^{13}C NMR, $CDCl_3$
(100 MHz)
f1 (ppm)

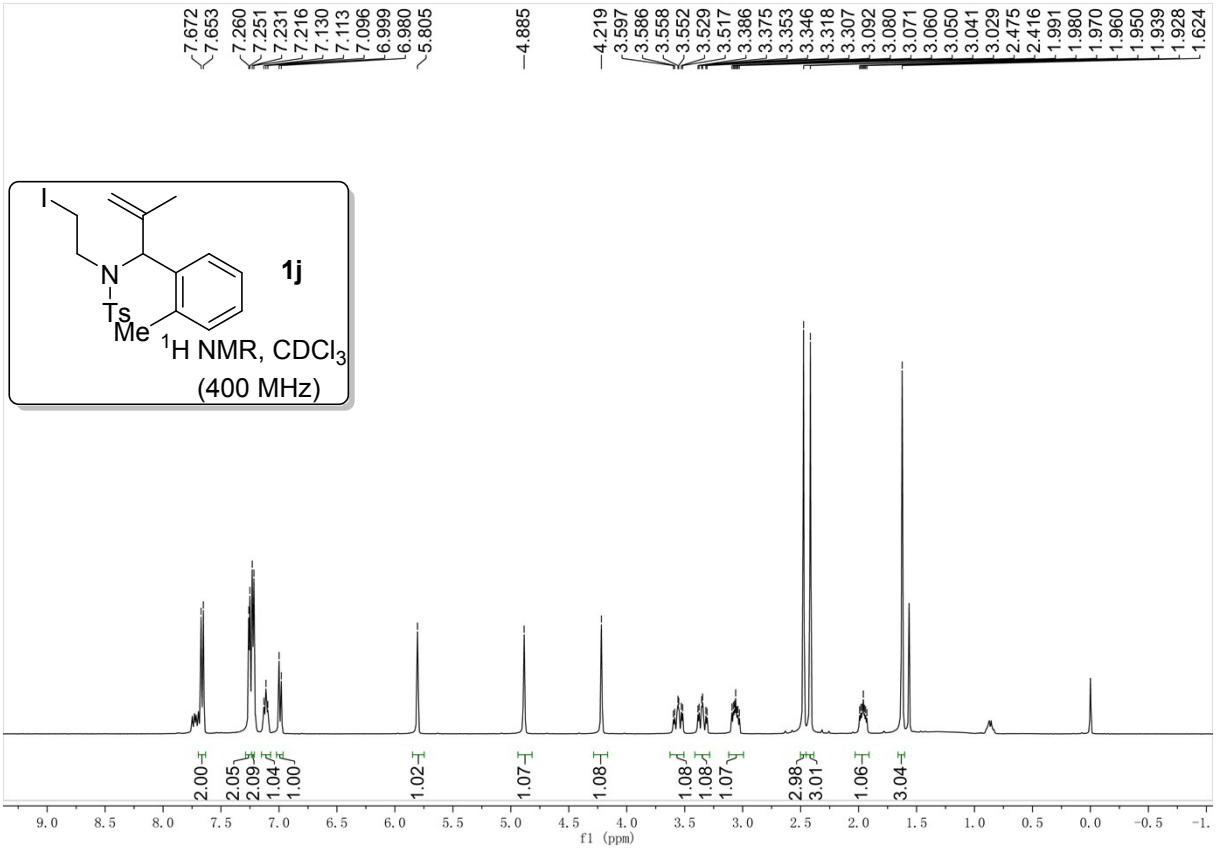

7.603
7.584
7.197
7.178
7.074
7.056
7.042
6.953
6.932
6.911
5.501
4.888
4.385
3.582
3.570
3.543
3.536
3.514
3.502
3.350
3.340
3.317
3.310
3.282
3.272
3.069
3.057
3.048
3.037
3.027
3.017
3.005
2.349
2.182
2.171
2.159
2.150
2.141
2.129
2.118
1.551
I
N
Ts
F
1g
^{1}H NMR, CDCl$_3$
(400 MHz)
2.16
2.22
2.13
2.01
1.00
1.03
1.01
1.02
1.04
1.01
3.00
1.05
3.06
f1 (ppm)

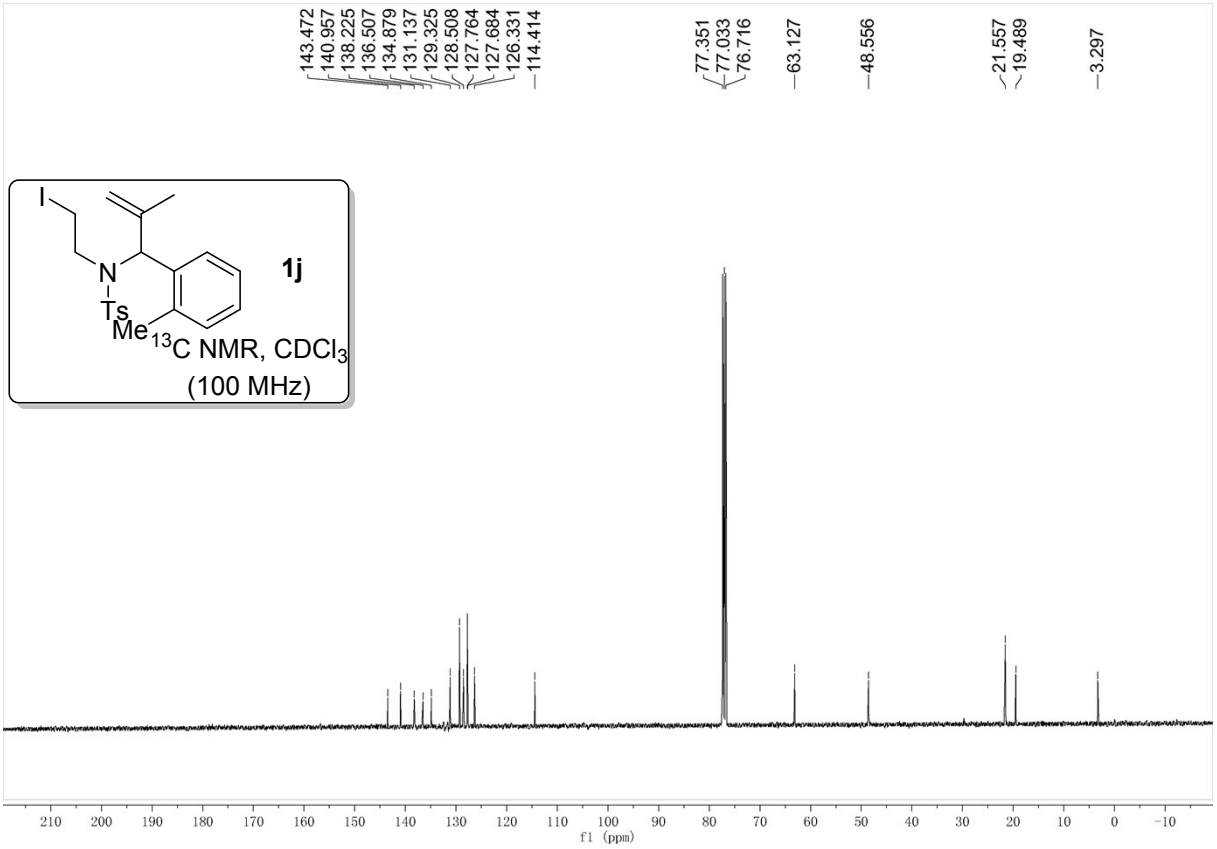

163.651
161.185
143.631
140.893
136.863
130.516
130.435
129.580
128.592
128.469
127.326
115.997
115.783
115.094
77.379
77.061
76.744
65.291
48.365
21.583
3.330
I
N
Ts
F
1g
^{13}C NMR, CDCl$_3$
(100 MHz)
f1 (ppm)

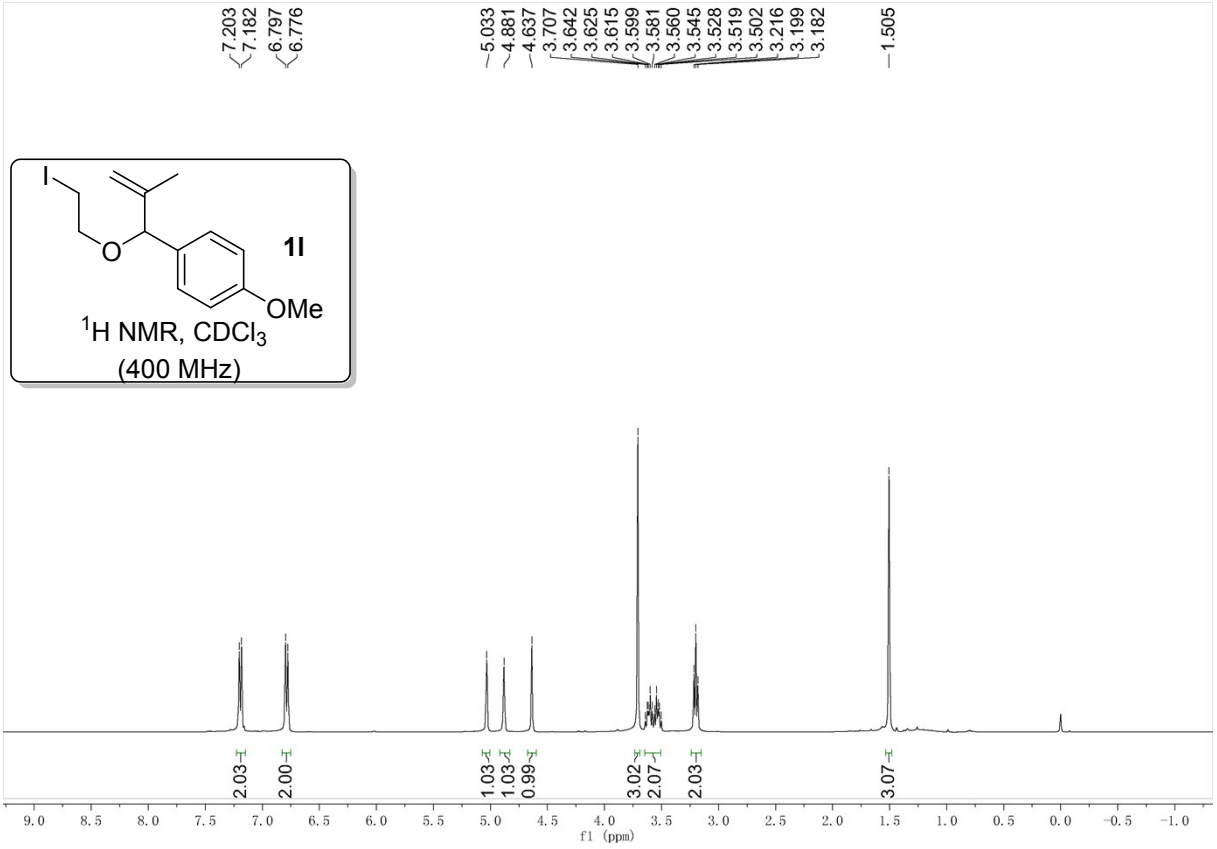

-113.106
1g
^{19}F NMR, $CDCl_3$
(376 MHz)
f1 (ppm)

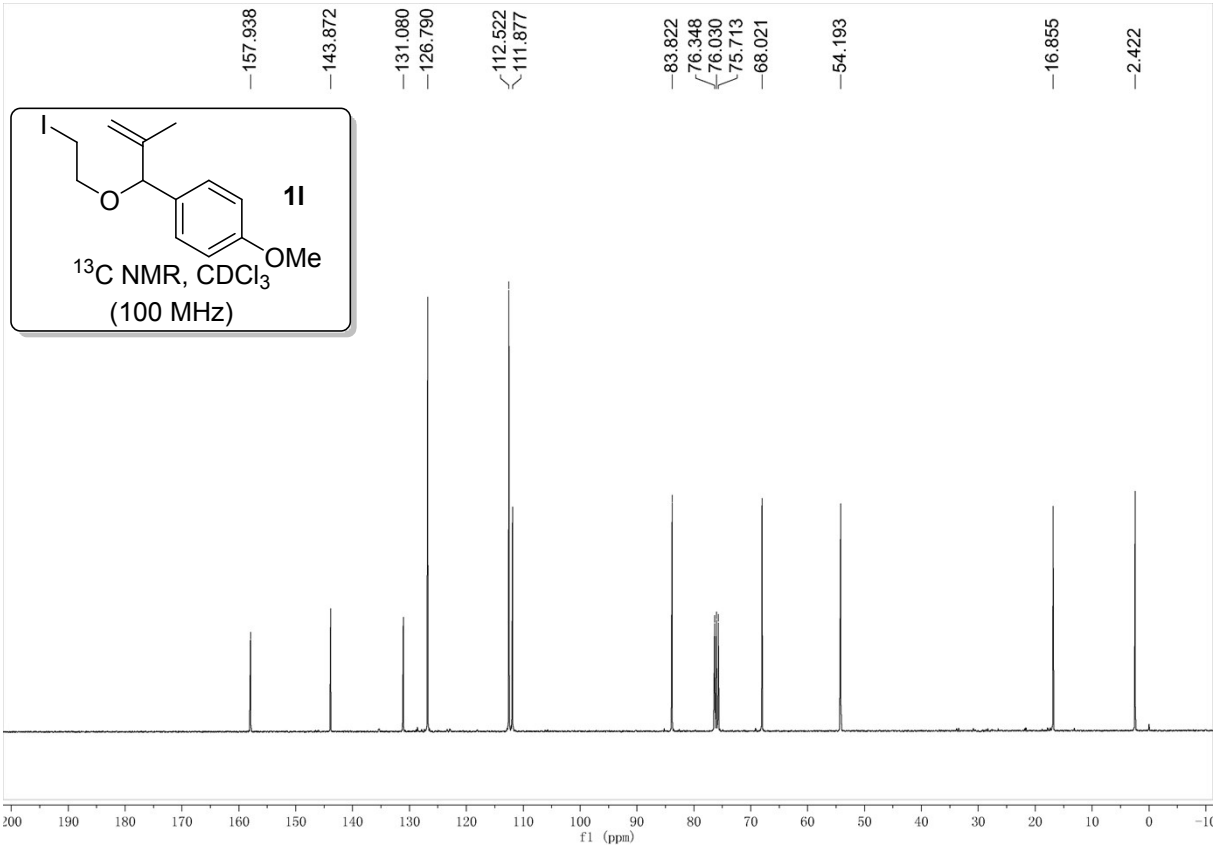

7.666
7.648
7.285
7.267
7.247
7.077
7.058
5.552
4.988
4.480
3.648
3.636
3.609
3.601
3.580
3.568
3.452
3.441
3.419
3.412
3.383
3.373
3.157
3.144
3.135
3.125
3.115
3.105
3.092
2.423
2.384
2.372
2.361
2.351
2.342
2.330
2.320
1.639
1h
^{1}H NMR, $CDCl_3$
(400 MHz)
1.99
4.09
2.04
1.00
1.02
1.03
1.08
1.07
1.04
3.00
1.10
3.04
f1 (ppm)


143.700
140.888
136.775
135.758
134.136
130.042
129.603
129.033
127.316
115.562
77.381
77.063
76.746
65.369
48.428
21.592
3.342
I
N
Ts
Cl
1h
^{13}C NMR, CDCl$_3$
(100 MHz)
f1 (ppm)


7.672
7.653
7.260
7.251
7.231
7.216
7.130
7.113
7.096
6.999
6.980
5.805
4.885
4.219
3.597
3.586
3.558
3.552
3.529
3.517
3.386
3.375
3.353
3.346
3.318
3.307
3.092
3.080
3.071
3.060
3.050
3.041
3.029
2.475
2.416
1.991
1.980
1.970
1.960
1.950
1.939
1.928
1.624
I
N
Ts
Me
1j
^{1}H NMR, CDCl$_3$
(400 MHz)
2.00
2.05
2.09
1.04
1.00
1.02
1.07
1.08
1.08
1.08
1.07
2.98
3.01
1.06
3.04
f1 (ppm)


143.472
140.957
138.225
136.507
134.879
131.137
129.325
128.508
127.764
127.684
126.331
114.414
77.351
77.033
76.716
63.127
48.556
21.557
19.489
3.297
I
N
Ts
Me
1j
13C NMR, CDCl3
(100 MHz)
f1 (ppm)


7.203
7.182
6.797
6.776
5.033
4.881
4.637
3.707
3.642
3.625
3.615
3.599
3.581
3.560
3.545
3.528
3.519
3.502
3.216
3.199
3.182
1.505
I
O
OMe
1l
1H NMR, CDCl3
(400 MHz)
2.03
2.00
1.03
1.03
0.99
3.02
2.07
2.03
3.07
f1 (ppm)


157.938
143.872
131.080
126.790
112.522
111.877
83.822
76.348
76.030
75.713
68.021
54.193
16.855
2.422
I
O
1l
OMe
13C NMR, CDCl3
(100 MHz)
f1 (ppm)