Supporting Information

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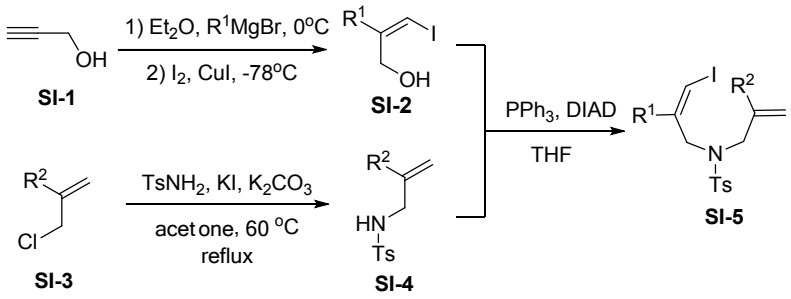
I. General Information

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). Unless otherwise noted, all other commercially available reagents and solvents were used without further purification.

II. The General Synthetic Procedure for substrates Vinyl Iodide SI-5 and SI-6, N-Tosyl Hydrazones SI-8

General Procedure:

Vinyl iodides **SI-5** were prepared through Mitsunobu reaction from vinyl iodiel alcohols **SI-2** and allyl amine **SI-4**.

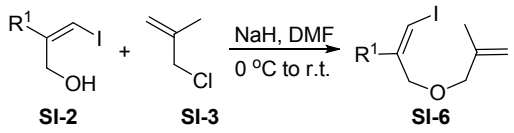


Preparation of SI-2: Compounds **SI-2** were prepared as described in the literature[1]. To a stirred solution of propargyl alcohol **SI-1** (50 mmol, 1.0 equiv) in anhydrous THF (100 mL) under N_2 atmosphere was added CuI (5 mmol, 10 mol%) and the mixture was cooled to -78°C. Grignard reagent **SI-2** (125 mmol, 2.5 equiv), which had been freshly prepared in THF, was then added via constant pressure funnel maintain the temperature below -60°C for 1h. Then, the mixture was allowed to warm up to room temperture and vigorously stirred overnight. The reaction was cooled again to -78°C and treated with I_2 (55 mmol, 1.1 equiv) in anhydrous THF (100 mL). After warming up to room temperature and stirring at r.t. for additional 1h, the reaction mixture was kept in refrigerator at about 0-3°C overnight. The mixture was cooled to 0°C and was quenched with saturated aqueous NH_4Cl (50 mL). The two phase mixture was poured through a separatory funnel and cambined organic layers were washed extracted with saturated aqueous $Na_2S_2O_3$ (2 x 50 mL) and saturated aqueous NaCl (100 mL), and dried over Na_2SO_4. It was purified by column chromatography to give **SI-2**.

Preparation of SI-4: Compounds **SI-4** were prepared as described in the literature.[2] Dropwise adding 3-Chloro-2-methylpropene **SI-3**(10 mmol, 1.0 equiv) to the mixture of Tosylamide (30 mmol, 3.0 equiv), K_2CO_3 (25 mmol, 2.5 equiv), KI (5 mmol, 0.5

equiv) and acetone (50 mL). The mixture was stirred with reflux at 60 °C for 5 h. The precipitate that had formed was filtered off and then organic layer was dried over Na_2SO_4 and evaporated. The crude product was purified by column chromatography (PE:EA, 15:1) to give the **SI-4** as a white solid.

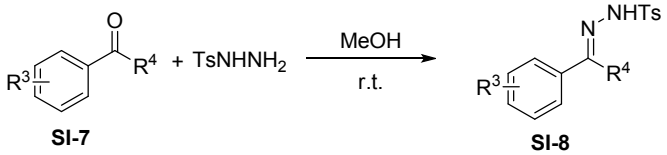
Preparation of SI-5: Compounds **SI-5** were prepared as described in the literature.[3] To a solution of **SI-4** (6.0 mmol, 1.2 equiv) in THF (15 mL) at room temperature was added PPh_3 (6.0 mmol, 1.2 equiv) and DIAD (6.0 mmol, 1.2 equiv). Then a solution of **SI-2** (5.0 mmol, 1.0 equiv) in 10 mL THF was added by constant pressure funnel under moderate stirring. Then the mixture was stirred overnight. After washed with water (50 mL x 3) and 1N HCl (20 mL), then the organic layer was dried over Na_2SO_4 and purification by column chromatography to give **SI-5**.



SI-2 **SI-3** **SI-6**

Preparation of SI-6: Compounds **SI-6** were prepared through the way described in the literature.[4] To a solution of **SI-2** (10.0 mmol, 1.0 equiv) in DMF (15 mL) at 0 °C was added NaH (12 mmol, 1.2 equiv) for 50 min. Then a solution of **SI-3** (12 mmol, 1.2 equiv) in 5 mL DMF was added dropwise by constant pressure funnel under vigorous stirring. Then the mixture was stirred and refluxed at r.t. for 1 h. After washed with water (50 mL x 3) and then the organic layer was dried over Na_2SO_4 and purification by column chromatography (PE:EA, 5:1) to give **SI-6**.

Preparation of SI-8:

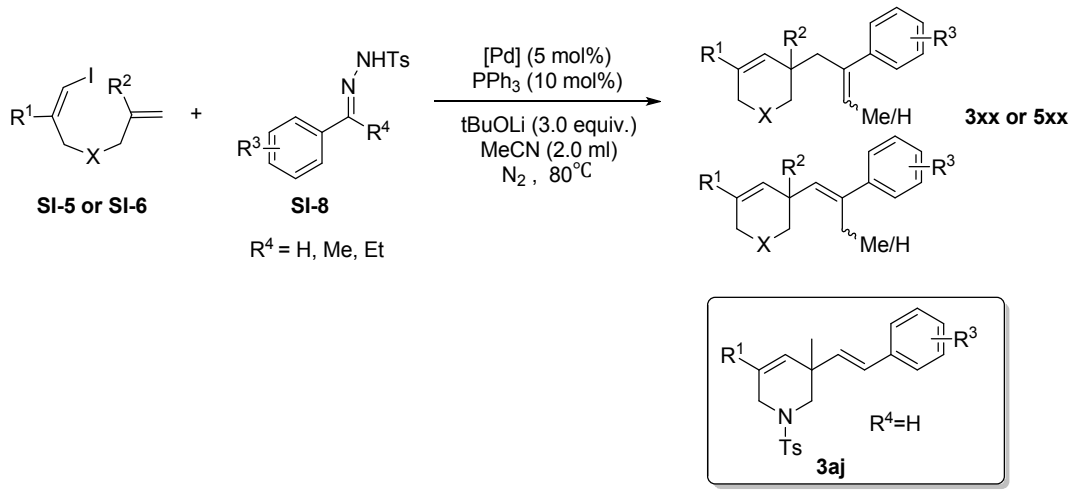


SI-7 **SI-8**

[5]To a solution of p-Toluenesulfonyl hydrazide (5.0 mmol) in 12mL MeOH, **SI-7** (5.0 mmol) was added dropwise. The solution was stirred in room temperature for 3 hours, and then cooled to 0 °C. The solid in solution was filtrated and washed by a little cooled MeOH. Then N-Tosyl Hydrazones **SI-8** was synthesized.

III. The General Synthetic Procedure and Analytical Data for products

General Procedure:

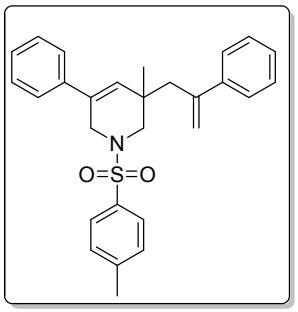


SI-5 or SI-6 **SI-8**

R^4 = H, Me, Et

To the solution of vinyl iodide **SI-5** or **SI-6** (0.2 mmol, 1.0 equiv.), N-Tosyl Hydrazones **SI-8** (0.24 mmol, 1.2 equiv.), $Pd(dba)_2$ (0.01 mmol, 5 mol%), PPh_3 (0.02 mmol, 10 mol%) and *t*BuOLi (0.6 mmol, 3.0 equiv.) in 2.0 mL MeCN under N_2 atmosphere. The reactions were operated in sealed tube at 80 °C. After stirring for 3 hours, the mixture was evaporated and purified by flash chromatography to give product **3 or 5**.

Analytical Data:



3aa

$C_{28}H_{29}NO_2S$

MW: 443.60 g.mol^{-1}

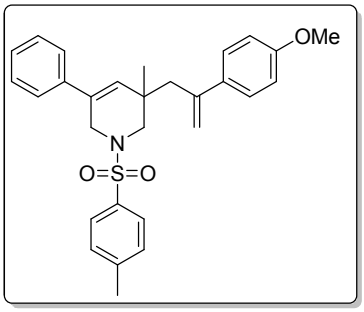
Yellow liquid

Yield: 88%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): δ 7.73 (d, *J* = 8.0 Hz, 0.58H), 7.61 (d, *J* = 8.0 Hz, 2H), 7.38 – 7.29 (m, 9H), 7.22-7.20 (m, 3H), 6.96 – 6.94 (m, 2H), 6.18(s, 0.14H), 5.78(s, 0.14H), 5.61 (s, 1H), 5.34 (d, *J* = 1.2 Hz, 1H), 5.18 (s, 1H), 3.75 (dd, *J* = 51.6, 15.6 Hz, 2.4H), 2.97 – 2.87 (m, 2.4H), 2.68 (dd, *J* = 14.0, 11.6 Hz, 2H), 2.42 (s, 3.86H), 2.06 (s, 0.7H), 1.43 (s, 0.7H), 1.03 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 145.5, 143.6, 143.0, 138.4, 133.1, 132.2, 130.7, 129.7, 128.5, 128.5, 128.3, 127.7, 127.2, 126.6, 125.2, 118.0, 53.7, 46.5, 45.5, 37.4, 24.7, 21.6.

HRMS (ESI): Calcd for $C_{28}H_{29}NO_2S$+H 444.1977, found 444.1980。



3ab

$C_{29}H_{31}NO_3S$

MW: 473.63 g.mol^{-1}

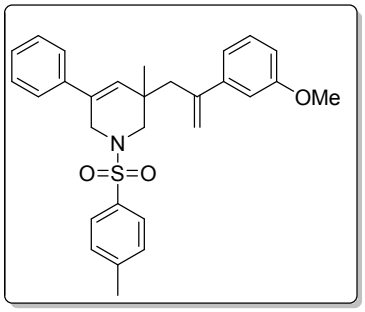
Brown liquid

Yield: 86%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.5 (d, *J* = 8.4 Hz, 0.5H), 7.52 (d, *J* = 8.2 Hz, 2H), 7.27 (d, *J* = 4.0 Hz, 1H) 7.23 – 7.21 (m, 5H), 7.15-7.14 (m, 2H), 6.92 -6.90 (m, 2H), 6.78 -6.75 (m, 2.5H), 6.10(s, 0.21H), 5.65(s, 0.21H), 5.54 (s, 1H), 5.20 (d, *J* = 1.6 Hz, 1H), 5.02 (d, *J* =0.8Hz, 1H), 3.80 – 3.76 (m, 1H), 3.73 (s, 3.7H), 3.62 – 3.58 (m, 1.3H), 2.81 (dd, *J* = 27.3, 12.3 Hz, 2.39H), 2.59 (dd, *J* = 37.1, 12.3 Hz, 2H), 2.35 (s, 3.6H), 1.95 (s, 0.62H), 1.35 (s, 0.65H), 0.96 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 159.0, 144.8, 143.5, 138.4, 135.4, 132.9, 132.3, 130.5, 129.7, 128.3, 127.7, 127.6, 125.2, 116.4, 113.8, 55.3, 53.7, 46.4, 45.6, 37.4, 24.7, 21.5.

HRMS (ESI): Calcd for $C_{29}H_{31}NO_3S$+H 474.2103, found 474.2106



3ac

$C_{29}H_{31}NO_3S$

MW: 473.63 g.mol^{-1}

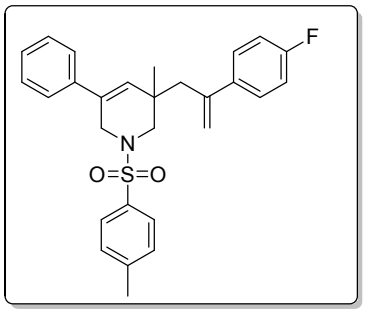
Brown liquid

Yield: 77%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.72 (d, *J* = 7.6 Hz, 0.5H), 7.61 (d, *J* = 7.8 Hz, 2H), 7.34 – 7.20 (m, 8H), 7.00 – 6.95 (m, 3H), 6.9 (s, 1H), 6.80 (d, *J* = 7.6 Hz, 1H), 6.18 (s, 0.19H), 5.79 (s, 0.19H), 5.63 (s, 1H), 5.35 (s, 1H), 5.17 (s, 1H), 3.81 (t, *J* = 7.7 Hz, 1.63H), 3.76 (s, 3H), 3.70 (d, *J* = 15.4 Hz, 1H), 2.91 (dd, *J* = 44.5, 12.3 Hz, 2.52H), 2.68 (dd, *J* = 28.0, 12.3 Hz, 2H), 2.42 (s, 3.83H), 2.04 (s, 0.72H), 1.43 (s, 0.76H), 1.03 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 159.6, 145.4, 144.5, 143.6, 138.4, 132.8, 132.2, 130.7, 129.7, 129.4, 128.6, 128.3, 127.7, 125.2, 119.2, 118.0, 112.7, 112.4, 55.3, 53.6, 46.5, 45.5, 37.4, 24.7, 21.6.

HRMS (ESI): Calcd for $C_{29}H_{31}NO_3S$+H 474.2103, found 474.2106



3ad

$C_{28}H_{28}FNO_2S$

MW: 416.59 g.mol^{-1}

Brown liquid

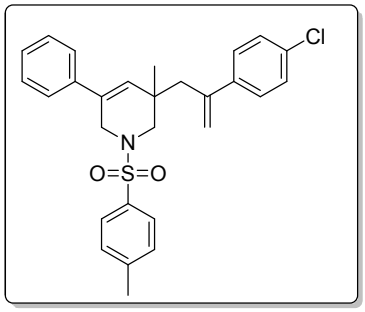
Yield: 73%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.72 (d, *J* = 7.6Hz, 0.5H), 7.60 (d, *J* = 7.6 Hz, 2H), 7.34 – 7.30 (m, 6H), 7.25 – 7.23(m, 3H), 6.99 (d, *J* = 7.3 Hz, 4H), 6.17 (s, 0.19H), 5.73 (s, 0.19H), 5.59 (s, 1H), 5.30 (s, 1H), 5.17 (s, 1H), 3.85 - 3.70 (m, 2.65H), 3.08 – 2.79 (m, 2.47H), 2.64 (dd, *J* = 11.8, 7.2 Hz, 2H), 2.42 (s, 3.83H), 2.04 (s, 0.75H), 1.42 (s, 0.73H), 1.02 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 162.2 (d, *J* = 197), 144.4, 143.7, 139.1, 138.3, 132.7, 132.0, 130.8, 129.7, 128.7, 128.4, 128.2, 127.7(d, *J* = 4Hz), 125.2, 118.0, 115.2 (d, *J* = 17Hz)), 53.6, 46.5, 45.7, 37.4, 24.8, 21.6, 21.6.

^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$, δ ppm): 110.0。

HRMS(ESI): Calcd for $C_{28}H_{28}FNO_2S$+H 462.1903, found 412.1900。



3ae

$C_{28}H_{28}ClNO_2S$

MW: 478.05 g.mol^{-1}

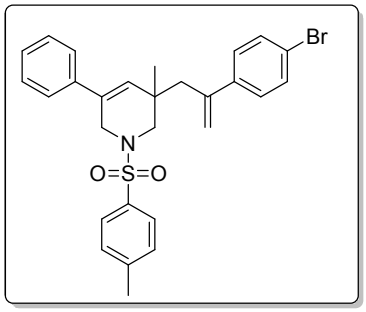
Brown liquid

Yield: 76%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.72 (d, *J* = 7.6 Hz, 0.5H), 7.60 (d, *J* = 7.7 Hz, 2H), 7.32 (d, *J* = 8.4 Hz, 3.6H), 7.28 - 7.23 (m, 7H), 6.95 (d, *J* = 6.6 Hz, 2H), 6.17 (s, 0.18H), 5.77 (s, 0.18), 5.56 (s, 1H), 5.33 (s, 1H), 5.20 (s, 1H), 3.85 - 3.68 (m, 2.52H), 3.23-2.84 (m, 2.5H), 2.64 (dd, *J* = 12.0, 6.1 Hz, 2H), 2.43 (s, 3.65H), 2.04 (s, 0.84H), 1.41 (s, 0.72H), 1.02 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 144.4, 143.7, 141.5, 138.2, 133.1, 132.7, 132.0, 130.9, 129.7, 128.6, 128.4, 128.0, 127.7, 127.7, 125.2, 118.5, 53.6, 46.5, 45.6, 37.4, 24.7, 21.6.

HRMS(ESI): Calcd for $C_{28}H_{28}ClNO_2S$+H 478.1608, found 478.1605。



3af

$C_{28}H_{28}BrNO_2S$

MW: 522.50 g.mol^{-1}

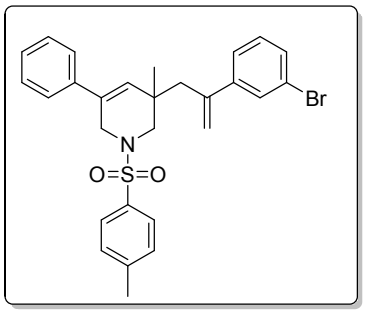
Brown liquid

Yield: 53%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): .7.73 (t, *J* = 5.6Hz, 0.7H), 7.60 (d, *J* = 7.5 Hz, 2H), 7.42 (d, *J* = 7.7 Hz, 3H), 7.32 (d, *J* = 7.9 Hz, 4H), 7.26 – 7.21 (m, 5H), 6.94 (d, *J* = 6.6 Hz, 2H), 6.16 (s, 0.21H), 5.83 (s, 0.21H), 5.55 (s, 1H), 5.34 (s, 1H), 5.20 (s, 1H), 3.74 (q, *J* = 15.5 Hz, 2.58H), 3.00 – 2.85 (m, 2.52H), 2.67 – 2.61 (m, 2H), 2.43 (s, 3.89H), 2.04 (s, 0.76H), 1.41 (s, 0.86H), 1.03 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 144.4, 143.7, 141.9, 138.2, 132.7, 132.0, 131.5, 129.8, 128.4, 128.3, 127.7, 127.7, 125.2, 121.3, 118.5, 53.6, 46.5, 45.6, 37.4, 24.7, 21.6.

HRMS(ESI): Calcd for $C_{28}H_{28}BrNO_2S$+H 522.1102, found 522.1105。



3ag

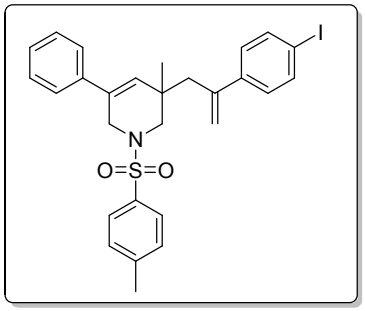
$C_{28}H_{28}BrNO_2S$

MW: 522.50 g.mol^{-1}

Brown liquid

Yield: 57%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.73 (d, *J* = 7.6 Hz, 0.5H), 7.62 (d, *J* = 7.7 Hz, 2H), 7.50 (s, 1H), 7.30 (m, 10H), 7.15 (t, *J* = 7.4 Hz, 1H), 7.00 (d, *J* = 6.2 Hz, 2H), 6.15 (s,0.19H), 5.76 (s,0.19H), 5.60 (s, 1H), 5.35 (s, 1H), 5.23 (s, 1H), 3.76-3.71 (s, 2.34H), 2.93 (dd, *J* = 62.2, 12.3 Hz, 2.35H), 2.64 (dd, *J* = 11.9, 5.2 Hz, 2H), 2.43 (s, 3.76H), 2.04 (s, 0.82H), 1.42 (s, 0.61H), 1.01 (s, 3H).
^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 145.2, 144.2, 143.6, 138.2, 132.7, 131.8, 131.0, 130.2, 130.0, 129.8, 129.6, 128.4, 127.7, 127.6, 125.3, 125.2, 122.6, 119.1, 53.5, 46.5, 45.3, 37.4, 24.8, 21.6.
HRMS(ESI): Calcd for $C_{28}H_{28}BrNO_2S$+H 522.1102, found 522.1105。



3ah

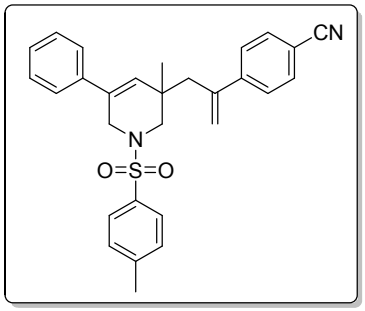
$C_{28}H_{28}INO_2S$

MW: 569.50 g.mol^{-1}

Brown liquid

Yield: 42%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.73 (dd, *J* = 8.4 Hz, *J* = 6.0 Hz, 0.8H), 7.61 (t, *J* = 8.4 Hz, 4.5H), 7.34 – 7.31 (m, 5H), 7.25 - 7.23 (m, 2H), 7.10 (dt, *J* = 8.4 Hz, *J* = 2.4 Hz, 2H), 6.91 (dt, *J* = 6.4, *J* = 1.6 Hz, 2H), 6.16 (s, 0.2 H), 5.77 (s, 0.2H), 5.53 (s, 1H), 5.34 (d, *J* = 1.6 Hz, 1H), 5.20 (s, 1H), 3.74 (q, *J* = 16.0 Hz, 2.6H), 2.52 (dd, *J* = 28.0, 9.6 Hz, 0.45H), 2.92 (dd, *J* = 38.4, 11.2 Hz, 2 H), 2.63 (t, *J* = 12.4 Hz, 2H), 2.44 (s, 3H),2.42 (s, 0.8H), 2.03 (d, *J* = 1.2 Hz, 0.62H), 1.41 (s, 0.61H), 1.02 (s, 3H).
^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 144.5, 143.7, 142.6, 138.3, 137.5, 132.7, 131.9, 130.9, 129.8, 128.6, 128.5, 127.8, 127.7, 125.1, 118.4, 92.73, 53.60, 46.5, 45.5, 37.4, 24.7, 21.6.
HRMS(ESI): Calcd for $C_{28}H_{28}INO_2S$+H 570.0964, found 570.0961



3ai

$C_{29}H_{28}N_2O_2S$

MW: 468.61 g.mol^{-1}

Brown liquid

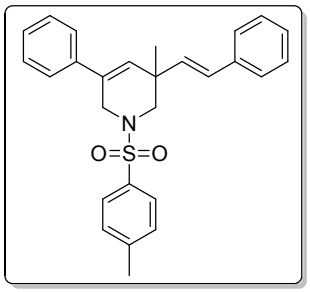
Yield: 45%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.72 (d, *J* = 8.0Hz, 0.5H), 7.64 (d, *J* = 8.2 Hz, 2H), 7.58 (d, *J* = 8.4 Hz, 2H), 7.48 (d, *J* = 8.4 Hz, 2H), 7.36 – 7.31 (m, 4H), 7.26 –

7.20 (m, 3H), 6.91 (dd, *J* = 6.4, 3.1 Hz, 2H), 6.18 (s, 0.18), 5.67 (s, 0.18), 5.49 (s, 1H), 5.45 (s, 1H), 5.36 (s, 1H), 3.92 – 3.86 (m, 1.56H), 3.61 (dd, *J* = 15.6, 1.7 Hz, 1H), 3.19 (d, *J* = 11.3 Hz, 1H), 3.10 (q, *J* = 11.3 Hz, 0.63H), 2.96 (d, *J* = 13.5 Hz, 1H), 2.67 – 2.50 (m, 2H), 2.44 (s, 3.76H), 2.09 (s, 0.61H), 1.42 (s, 0.61H), 0.98 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 147.6, 144.2, 143.8, 138.0, 132.8, 131.56, 131.3, 129.8, 128.4, 127.9, 127.7, 127.3, 125.0, 120.6, 118.8, 110.7, 53.3, 46.4, 45.1, 37.4, 24.8, 21.6.

HRMS(ESI): Calcd for $C_{29}H_{28}N_2O_2S$+H 469.1950, found 469.1953



3aj

$C_{27}H_{27}NO_2S$

MW: 429.57 g.mol^{-1}

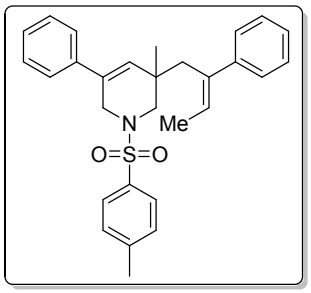
Brown liquid

Yield: 87%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.71 (d, *J* = 8.2 Hz, 2H), 7.34 (d, *J* = 3.6 Hz, 4H), 7.32 – 7.27 (m, 6H), 7.02 (dd, *J* = 8.6, 2.9 Hz, 2H), 6.42 (d, *J* = 16.2 Hz, 1H), 6.24 (d, *J* = 16.2 Hz, 1H), 5.93 (s, 1H), 3.94 (dd, *J* = 5.6, 1.9 Hz, 2H), 3.09 (dd, *J* = 74.2, 11.3 Hz, 2H), 2.40 (s, 3H), 1.35 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 143.7, 138.2, 137.1, 134.8, 133.2, 132.4, 130.2, 129.8, 129.2, 128.6, 128.5, 128.0, 127.8, 127.5, 126.4, 125.4, 53.5, 46.3, 39.4, 24.7, 21.6.

HRMS(ESI): Calcd for $C_{27}H_{27}NO_2S$+H 430.1841, found 430.1844。



3ak

$C_{29}H_{31}NO_2S$

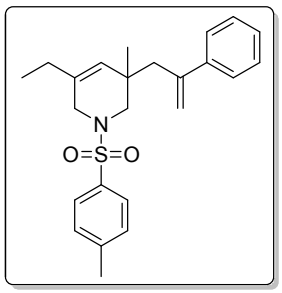
MW: 457.62 g.mol^{-1}

Brown liquid

Yield: 83%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.73 (t, *J* = 6.8 Hz, 0.35H),7.57 (d, *J* = 7.6 Hz, 2H), 7.30 – 7.19 (m, 11H), 6.89 (d, *J* = 5.1 Hz, 2H), 5.79 (q, *J* = 7.4 Hz, 1H), 5.59 (d, *J* = 2.4 Hz, 1H), 5.59 (s, 0.09H), 3.73 (dd, *J* = 138.1, 15.4 Hz, 2.4H), 2.79 (dd, *J* = 30.4, 11.2 Hz, 2.2H), 2.79 (dd, *J* = 112.8, 13.6 Hz, 2H), 2.42 (s, 3.4H), 2.03 (s, 0.46H), 1.80 (d, *J* = 6.8 Hz, 3H), 1.59 (s, 0.30H), 1.05 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 145.5, 143.5, 138.4, 137.9, 132.9, 132.5, 132.3, 130.4, 129.7, 129.6, 128.4, 127.7, 126.7, 125.3, 125.1, 54.3, 46.3, 39.4, 38.5, 25.0, 21.5, 15.2.
HRMS(ESI): Calcd for $C_{29}H_{31}NO_2S$+H 458.2154, found 458.2151。



3ba

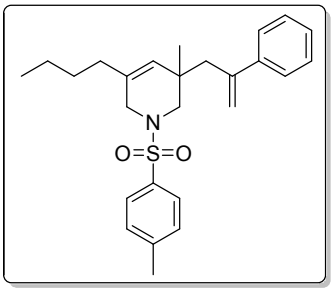
$C_{24}H_{29}NO_2S$

MW: 395.56 g.mol^{-1}

Yellow liquid

Yield: 91%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.69 (d, *J* = 7.6 Hz, 0.5H), 7.55 (d, *J* = 7.8 Hz, 2H), 7.34 – 7.26 (m, 9H), 5.70 (s, 0.20H), 5.55 (s, 0.19H), 5.30 (s, 1H), 5.13 (s, 1H), 4.96 (s, 1H), 3.33 – 3.12 (m, 2.54H), 2.81 (dd, *J* = 42.4, 12.2 Hz, 2.46H), 2.58 – 2.50 (m, 2H), 2.43 (s, 3.8H), 2.01 (s, 0.76H), 1.74 (p, *J* = 7.2 Hz, 2H), 1.56 (s, 0.78H), 0.89 (s, 3H), 0.76 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 145.7, 143.3, 143.1, 132.9, 132.6, 129.6, 129.5, 128.2, 127.8, 127.7, 126.6, 117.5, 53.9, 47.4, 45.4, 36.7, 26.9, 24.8, 21.5, 11.7.
HRMS(ESI): Calcd for $C_{24}H_{29}NO_2S$+H 396.1997, found 396.1994。



3ca

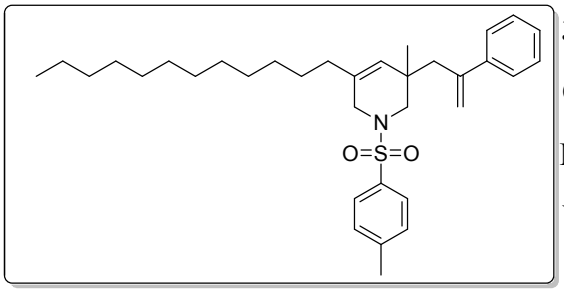
$C_{26}H_{33}NO_2S$

MW: 423.61 g.mol^{-1}

Yellow liquid

Yield: 82%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.67 – 7.59 (m, 1H), 7.47 (d, *J* = 8.2 Hz, 2H), 7.26 – 7.19 (m, 8H), 5.63 (s, *J* = 1.2H, 0.17H), 5.48 (s, 0.18H), 5.23 (d, *J* = 1.8 Hz, 1H), 5.06 (d, *J* = 1.7 Hz, 1H), 4.92 (s, 1H), 3.23 – 3.09 (m, 2.42H), 2.78 – 2.65 (m, 2.41H), 2.47 (dd, *J* = 12.2, 8.0 Hz, 2H), 2.36 (s, 3.9H), 1.94 (d, *J* = 1.1 Hz, 0.66H), 1.64 (dd, *J* = 12.4, 6.6 Hz, 2.2H), 1.54 (s, 0.45H）1.24 – 1.21 (m, 2.3H), 1.10 – 1.06 (m, 22H), 0.81 (s, 3H), 0.76 (t, *J* = 6.9 Hz, 3.2H).
^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 145.7, 143.3, 143.2, 132.9, 131.4, 129.6, 128.2, 127.7, 127.1, 126.6, 125.9, 117.6, 53.9, 47.4, 45.3, 36.8, 34.0, 29.5, 24.7, 22.3, 21.5, 13.9.
HRMS(ESI): Calcd for $C_{26}H_{33}NO_2S$+H 424.2310, found 424.2313。



3da

$C_{34}H_{49}NO_2S$

MW: 535.82 g.mol^{-1}

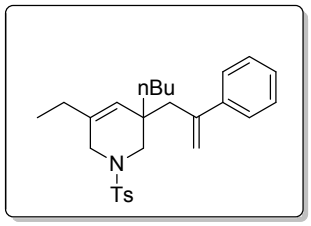
Yellow liquid

Yield: 79%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.68 (d, *J* = 7.6 Hz, 0.38H), 7.54 (d, *J* = 7.6 Hz, 2H), 7.29 (m, 9H), 5.70(s, 0.12H), 5.55 (s, 0.13H), 5.29 (s, 1H), 5.12 (s, 1H), 4.99 (s, 1H), 3.32 – 3.11 (m, 2.32H), 2.79 (dd, *J* = 42.0, 12.2 Hz, 2.30H), 2.54 (dd, *J* = 11.8, 5.4 Hz, 2H), 2.42 (s, 3.41H), 2.01 (s, 0.39H), 1.71(d, *J* = 4.8Hz, 2H), 1.58 (s, 0.40H), 1.24 (d, *J* = 17.1 Hz, 20H), 1.14 (s, 3H), 0.88 (s, 3.3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 145.6, 143.3, 143.2, 132.7, 131.4, 129.6, 128.9, 128.2, 127.7, 127.1, 126.6, 117.7, 53.9, 47.4, 45.3, 36.8, 34.3, 32.0, 29.7, 29.7, 29.6, 29.4, 29.4, 29.3, 27.3, 24.7, 22.8, 21.6, 14.2.

HRMS(ESI): Calcd for $C_{34}H_{49}NO_2S$+H 536.3562, found 536.3565。



3ea

$C_{27}H_{35}NO_2S$

MW: 437.64 g.mol^{-1}

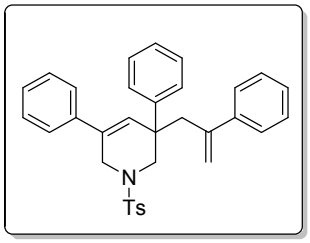
Yellow liquid

Yield: 68%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.68 (d, *J* = 8.4 Hz, 1H), 7.53 (d, *J* = 8.4 Hz, 2H), 7.32 – 7.31 (m, 2H), 7.29 – 7.24 (m, 7.2H), 5.67 (s, 0.24H), 5.60 (s, 0.24H), 5.24 (d, *J* = 2.0 Hz, 1H), 5.08 (d, *J* = 1.6 Hz, 1H), 4.93 (s, 1H), 3.26 – 3.23 (m, 2.75H), 2.86 – 2.70 (m, 2.55H), 2.66 – 2.53 (m, 2H), 2.42 (s, 4.2H), 1.98 (d, *J* = 1.2 Hz, 2H), 1.78 – 1.66 (m, 2.78H), 1.30 – 1.23 (m, 2.7H), 1.14 – 1.11 (m, 2.77H), 1.03 (t, *J* = 7.6 Hz, 1H), 0.91 – 0.87 (m, 2.3H), 0.81 (t, *J* = 6.4 Hz, 3H), 0.74 (t, *J* = 7.6 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 146.0, 143.3, 143.2, 138.1, 132.9, 129.6, 128.1, 127.7, 127.0, 126.7, 125.9, 117.5, 52.4, 47.4, 42.9, 41.5, 39.3, 37.1, 27.0, 25.9, 23.3, 21.6, 14.1, 11.7.

HRMS(ESI): Calcd for $C_{27}H_{35}NO_2S$+H 438.2467, found 438.2470。



3fa

$C_{33}H_{31}NO_2S$

MW: 505.67 g.mol^{-1}

Yellow liquid

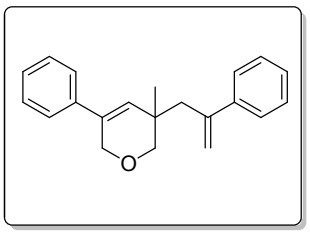
Yield: 24%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.51 (d, *J* = 8.4 Hz, 2H), 7.32 – 7.16 (m, 16.6H), 6.96 (dd, *J* = 6.4, 2.8Hz, 2H), 6.14 (s, 1H), 5.29 (s, 0.13H), 5.14 (d, *J* = 1.2 Hz, 1H), 4.86 (s, 1H), 3.80 (t, *J* = 2.4 Hz, 2.16H), 3.26 (s, 2H), 3.26 (dd, *J* = 52.8, 14Hz, 2H), 2.39 (s, 3.25H), 1.57 (s, 0.87H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 144.9, 143.9, 143.5, 143.0 138.4, 132.9, 132.4, 129.8, 129.7, 128.4, 128.4, 128.3, 127.8, 127.7, 127.1, 126.9, 126.6, 126.5, 125.3, 118.1, 53.5, 46.4, 45.8, 45.0, 21.5.

HRMS(ESI): Calcd for $C_{33}H_{31}NO_2S$+H 506.2154, found 506.2151。

5aa



$C_{21}H_{22}O$

MW: 290.40 g.mol^{-1}

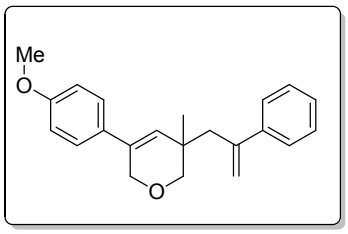
Yellow liquid

Yield: 90%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.93 - 7.90 (m, 0.35H), 7.42 – 7.39 (m, 2H), 7.36 – 7.27 (m, 5H), 7.22 (d, *J* = 7.6 Hz, 3H), 6.96 (dd, *J* = 7.7, 1.7 Hz, 2H), 6.26 (s, 0.29H), 5.74 (d, *J* = 0.8Hz, 0.29H), 5.70 (s, 1H), 5.33 (d, *J* = 1.8 Hz, 1H), 5.12 (s, 1H), 4.54 (dd, *J* = 24.0, 1.2 Hz, 0.43H), 4.49 – 4.30 (m, 2.0H), 3.70 (dd, *J* = 44.4, 10.8 Hz, 0.65H), 3.46 (dd, *J* = 104.8, 10.8 Hz, 2H), 2.74 (dd, *J* = 70.8, 13.2 Hz, 2H), 2.17 (dd, *J* = 1.2 Hz, 0.88H), 1.38 (s, 0.86H), 0.95 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 146.1, 143.0, 138.1, 133.3, 131.2, 128.3, 128.2, 127.3, 126.6, 125.9, 124.8, 117.1, 74.3, 66.9, 44.8, 35.6, 23.7.

HRMS(ESI): Calcd for $C_{21}H_{22}O$+H 291.1749, found 291.1752。



5ba

$C_{22}H_{24}O_2$

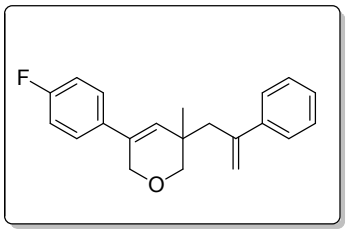
MW: 320.42 g.mol^{-1}

Yellow liquid

Yield: 80%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.41 – 7.36 (m, 3H), 7.32 – 7.25 (m, 5H), 6.90 (d, *J* = 6.9 Hz, 2H), 6.76 (d, *J* = 7.8 Hz, 2H), 6.16 (s, 0.31H), 5.74 (s, 0.31H), 5.60 (s, 1H), 5.32 (s, 1H), 5.11 (s, 1H), 4.36 (dd, *J* = 44.0, 16.0Hz, 2.4H), 3.81 (s, 0.86H), 3.78 (s, 3H), 3.63 (d, *J* = 10.8 Hz, 0.53H), 3.57 (d, *J* = 12Hz, 1H), 3.31 (d, *J* = 12 Hz, 1H), 2.72 (dd, *J* = 64, 16 Hz, 2H), 2.16 (s, 0.86H), 1.37 (s, 0.86H), 0.94 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 158.9, 146.1, 143.1, 132.7, 130.7, 129.8, 129.6, 128.4, 126.6, 12.6, 117.1, 113.8, 74.3, 67.0, 55.2, 44.9, 35.6, 23.9.
HRMS: Calcd for $C_{22}H_{24}O_2$+H 321.1855, found 321.1852。



5ca

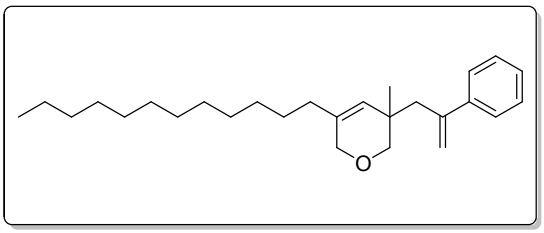
$C_{21}H_{21}FO$

MW: 308.39 g.mol^{-1}

Yellow liquid

Yield: 89%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.40 (d, *J* = 7.6 Hz, 2H), 7.30 (t, *J* = 7.4 Hz, 2H), 7.26 (s, 1.5H),6.92 - 6.88 (m, 4H), 6.19 (s, 0.09H), 5.73 (s, 0.09H), 5.60 (s, 1H), 5.32 (s, 1H), 5.11 (s, 1H), 4.34 (dd, *J* = 48.0, 16.0 Hz, 2.2H), 3.46 (dd, *J* = 104.0, 12.0 Hz, 2.2H), 2.74 (dd, *J* = 80.0, 12.0 Hz, 2H), 2.16 (s, 0.21H), 1.55 (s, 0.44H), 0.95 (s, 3H).
^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 163.1, 161.1, 146.0, 143.0, 132.4, 131.2, 128.4, 127.2, 126.5 (d, *J* = 22.0 Hz), 126.3, 117.2, 115.1 (d, *J* = 17.0 Hz), 74.3, 66.9, 44.9, 35.6, 23.7.
^{19}F{^{1}H} NMR (376 MHz, $CDCl_3$, δ ppm):115.7。
HRMS(ESI): Calcd for $C_{21}H_{21}FO$+H 309.1655, found 309.1658。



5da

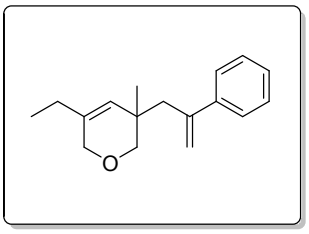
$C_{27}H_{42}O$

MW: 382.6218 g.mol^{-1}

Yellow liquid

Yield: 82%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.37 - 7.26 (m, 5H), 7.23 (d, *J* = 6.3 Hz, 1H), 5.67 (s, 0.19H), 5.59 (s, 0.19H), 5.27 (s, 1H), 5.06 (s, 1H), 5.05 (s, 1H), 4.04 (s, 0.39H), 3.89 (s, 2H), 3.58 (dd, *J* = 50.4, 10.9 Hz, 0.52H), 3.31 (dd, *J* = 115.6, 10.8 Hz, 2H), 2.61 (dd, *J* = 37.2, 13.2 Hz,2H), 2.13 (s, 0.63H), 1.93 (t, J = 8.0 Hz, 0.43H), 1.70 (d, *J* = 4.0 Hz, 2H), 1.42 (s, 0.66H), 1.26 (s, 20H), 0.88 (t, *J* = 6.0 Hz, 3.7H), 0.81 (s, 3H).
^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 146.3, 143.2, 134.6, 128.1, 127.1, 126.6, 125.9, 116.8, 74.3, 68.0, 44.6, 35.2, 32.7, 32.0, 29.7, 29.7, 29.6, 29.5, 29.4, 29.4, 27.3, 23.8, 22.8, 14.2.
HRMS(ESI): Calcd for $C_{27}H_{42}O$+H 383.3314, found 383.3311。



5ea

$C_{17}H_{22}O$

MW: 242.36 g.mol^{-1}

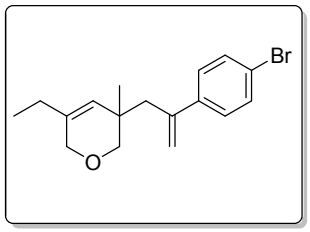
Yellow liquid

Yield: 86%

^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.91 (d, *J* = 6.0 Hz, 0.45H), 7.36 (d, *J* = 7.3 Hz, 2H), 7.30 – 7.22 (m, 4H), 5.67 (s, 0.23H), 5.59 (s, 0.23H), 5.27 (s, 1H), 5.06 (s, 1H), 5.04 (s, 1H), 4.05 (s, 0.5H), 3.89 (s, 2H), 3.66 – 3.50 (m, 0.66H), 3.33 (dd, *J* = 115.4, 10.8 Hz, 2H), 2.73 – 2.51 (m, 2H), 2.12 (s, 0.76H), 1.96 – 1.93 (m, 0.64H), 1.71 (p, *J* = 7.2 Hz, 2H), 1.33 (s, 0.59H), 1.05 (t, *J* = 7.2 Hz, 0.86H), 0.82 (s, 3H), 0.79 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 146.4, 143.2, 135.8, 128.1, 127.0, 126.6, 116.7, 74.4, 68.0, 44.7, 35.0, 25.2, 23.7, 11.5.

HRMS(ESI): Calcd for $C_{17}H_{22}O$+H 243.1749, found 243.1746。



5eb

$C_{17}H_{21}BrO$

MW: 321.25 g.mol^{-1}

Yellow liquid

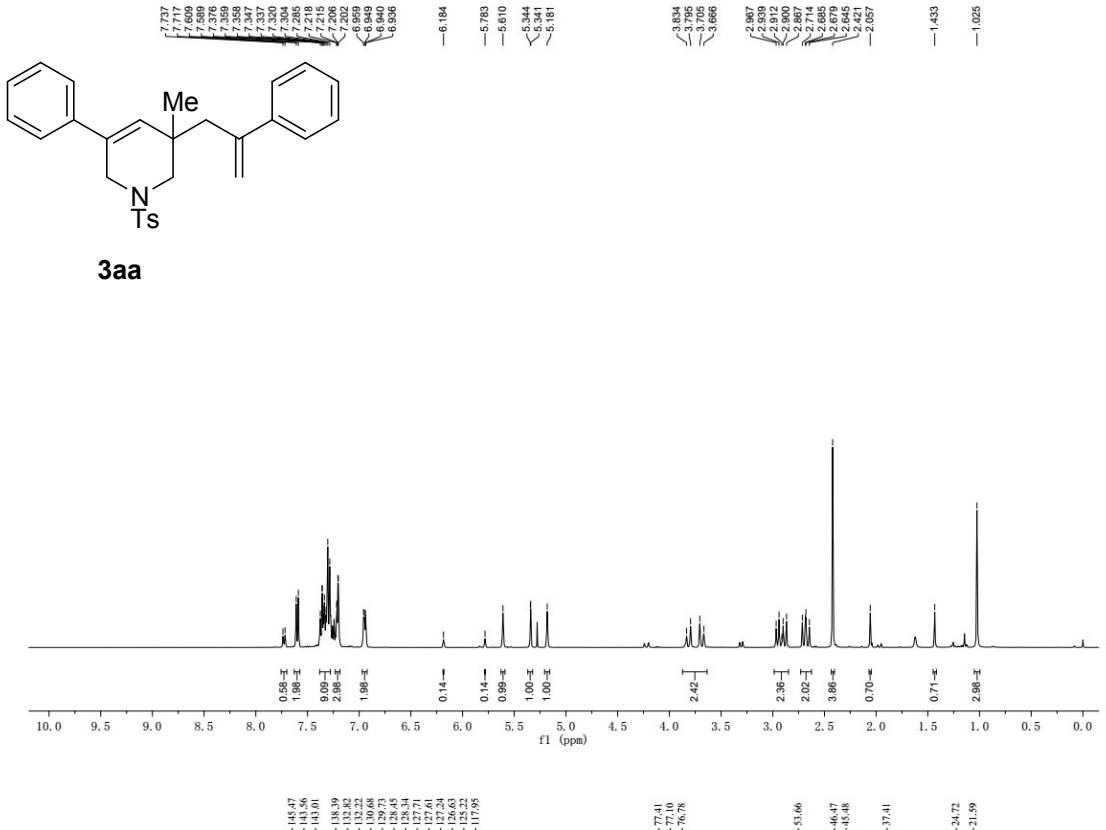
Yield: 75%

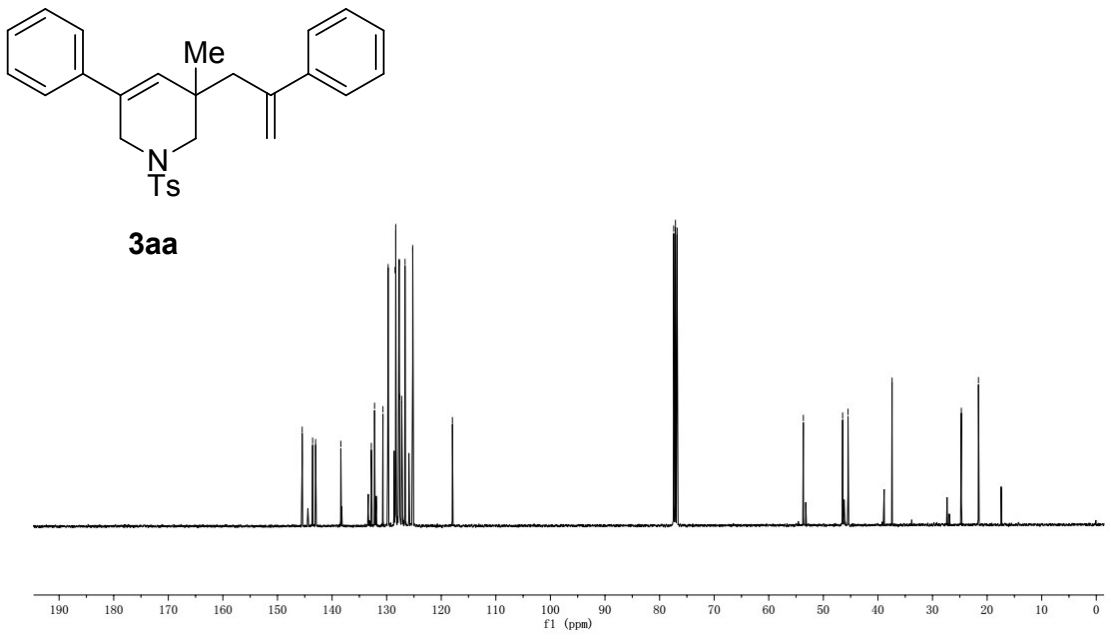
^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.91 (d, *J* = 5.2 Hz, 0.41H), 7.36 (d, *J* = 7.2 Hz, 2H), 7.28 (t, *J* = 7.3 Hz, 2H), 7.23 (d, *J* = 7.2 Hz, 1H), 5.67(s, 0.25H), 5.59(s, 0.25H), 5.27 (s, 1H), 5.05 (s, 1H), 5.04 (s, 1H), 4.05 (s, 0.52H), 3.89 (s, 2H), 3.67 – 3.50 (m, 0.71H), 3.33 (dd, *J* = 115.8, 10.8 Hz, 2H), 2.62 (dd, *J* = 48.4, 13.2 Hz, 2H), 2.12 (s, 0.83H), 2.00 – 1.92 (m, 0.56H), 1.71 (p, *J* = 7.3 Hz, 2H), 1.35 (s, 0.46H), 1.05 (t, *J* = 7.4 Hz, 0.87H), 0.82 (s, 3H), 0.78 (t, *J* = 7.4 Hz, 3H).

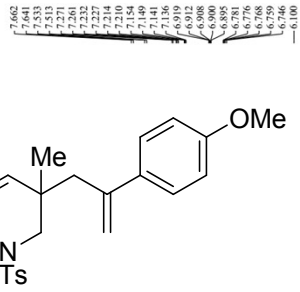
^{13}C NMR (100 MHz, $CDCl_3$, δ ppm): 146.4, 143.2, 135.8, 128.1, 127.0, 126.6, 116.7, 74.4, 68.0, 44.7, 35.0, 25.2, 23.9, 11.6.

HRMS(ESI): Calcd for $C_{17}H_{21}BrO$+H 321.0854, found 321.0851。

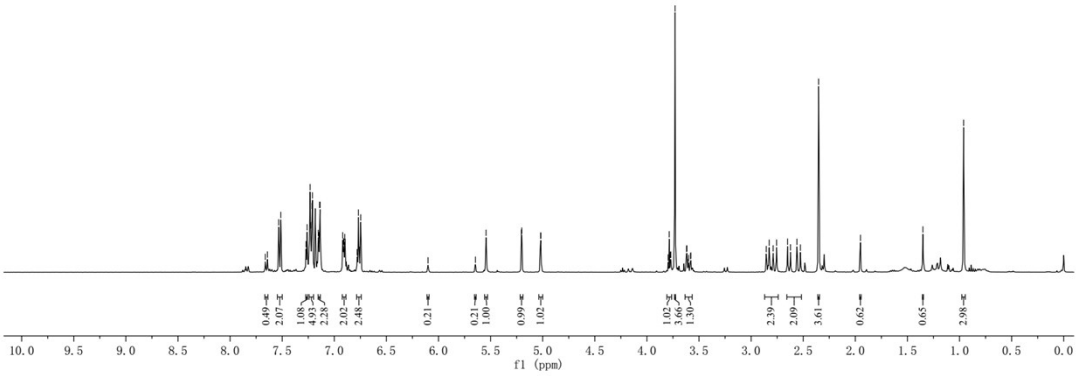
IV Copies of the ^{1}H NMR, ^{13}C NMR

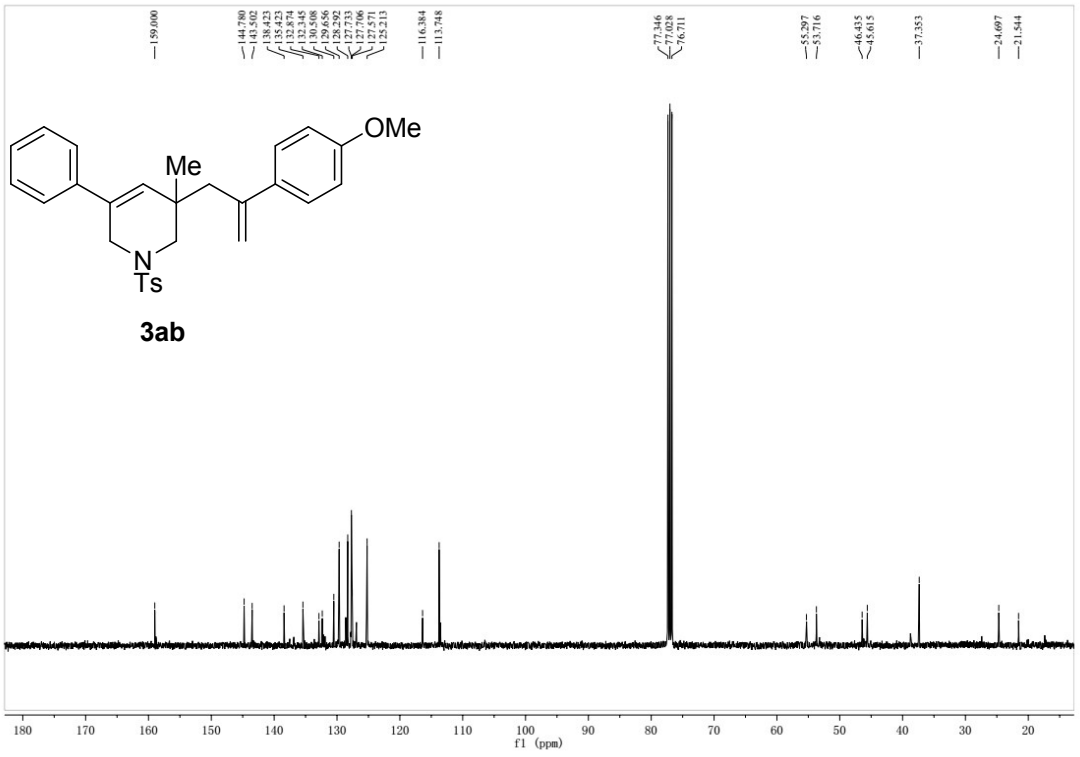




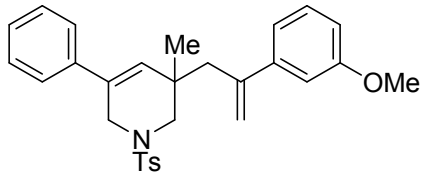


3ab

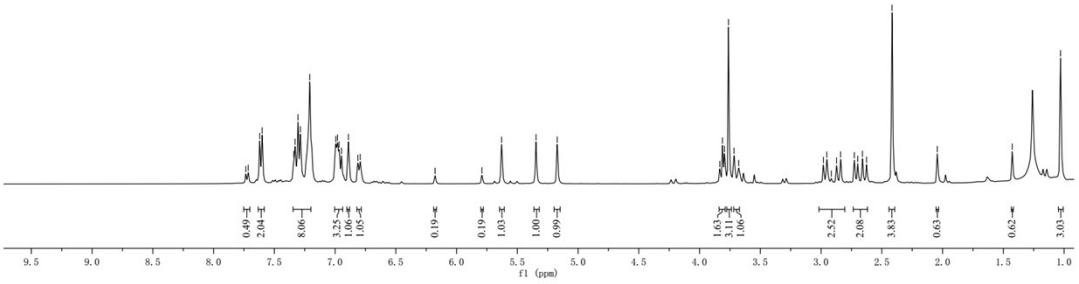


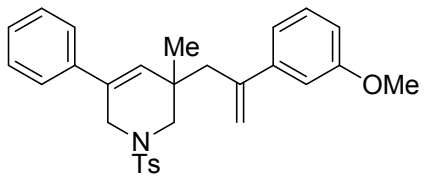


3ab

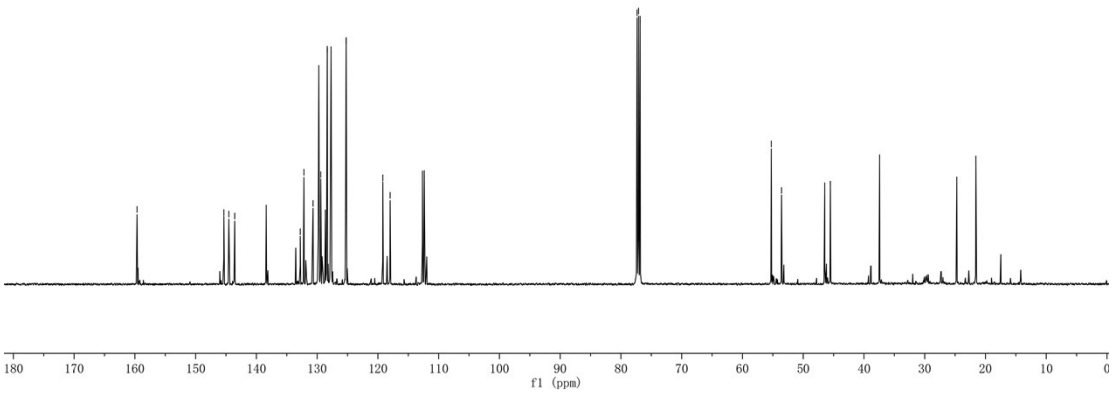


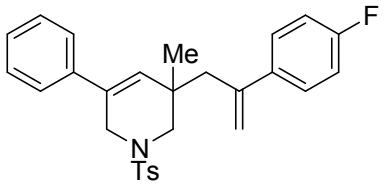
3ac





3ac





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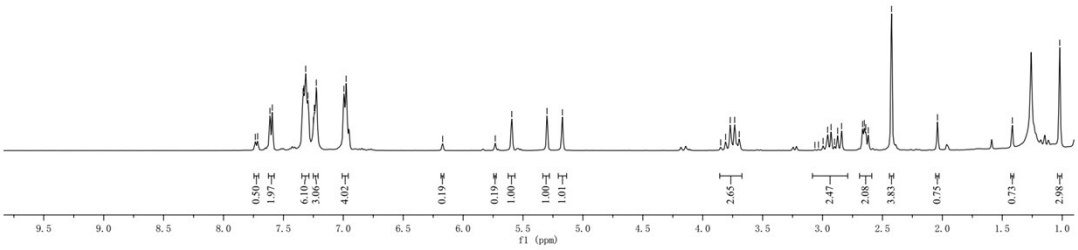
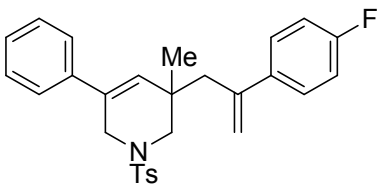
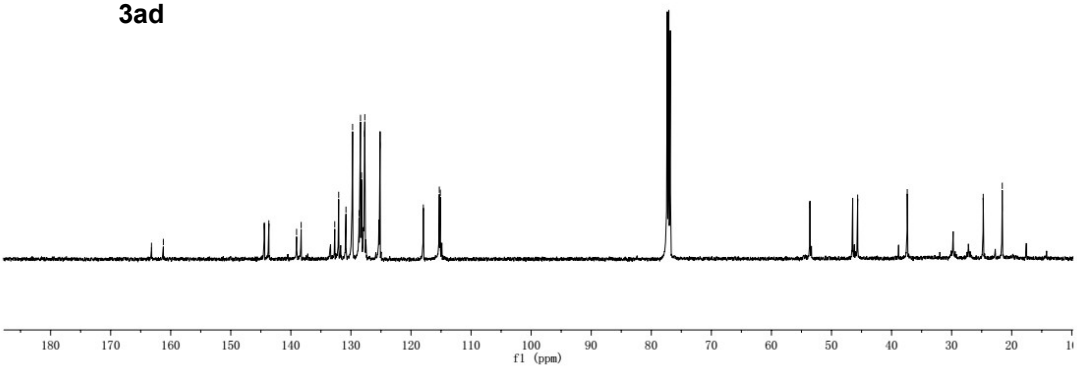
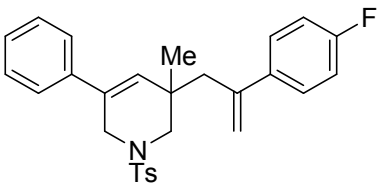




3ad




F
Me
N
Ts

3af

110.02
f1 (ppm)
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7.712
7.665
7.646
7.328
7.307
7.283
7.268
7.249
7.230
6.958
6.942
6.166
5.766
5.562
5.333
5.200
3.849
3.805
3.766
3.722
3.682
3.229
3.201
3.184
2.955
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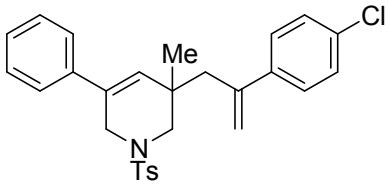
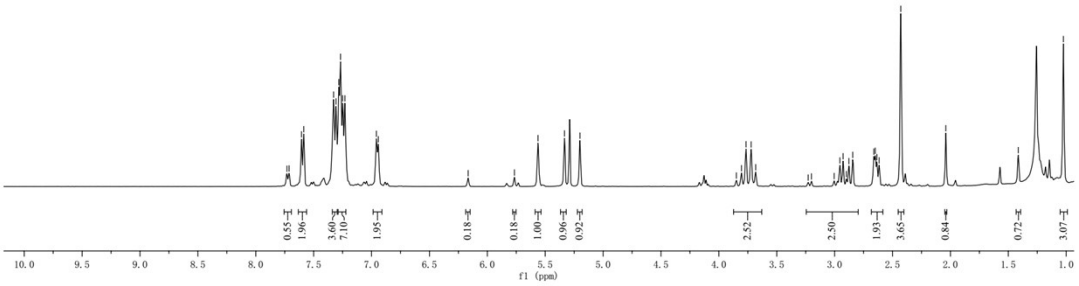
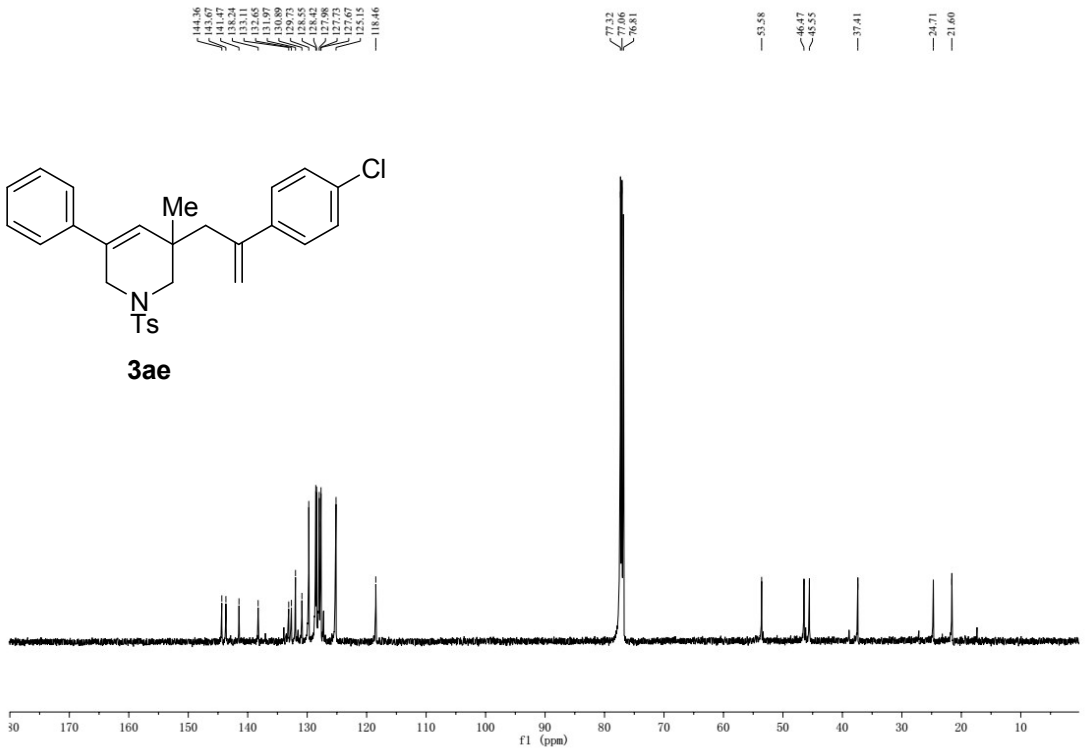
2.635
2.616
2.429
2.040
1.414
1.024

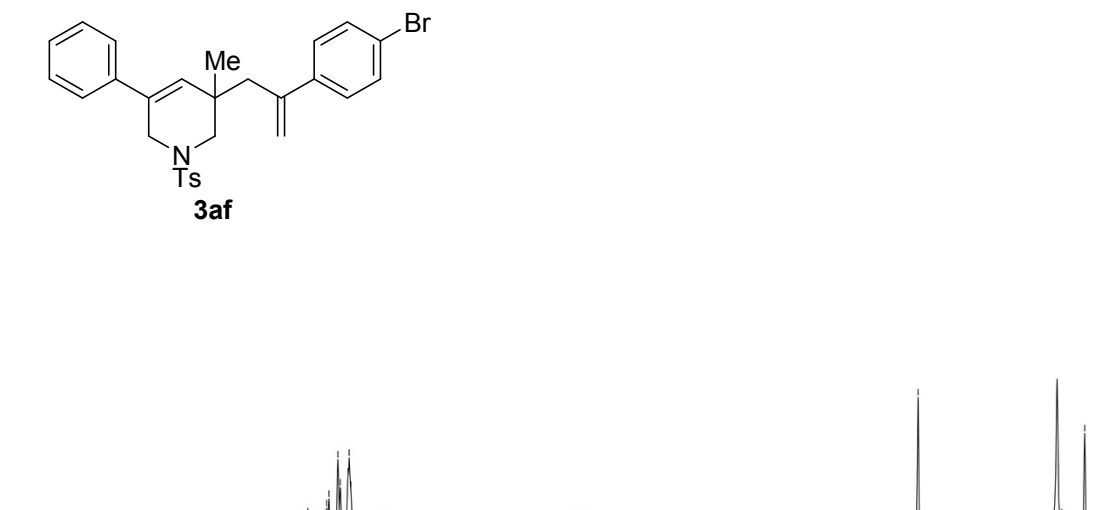

Cl
Me
N
Ts

3ae

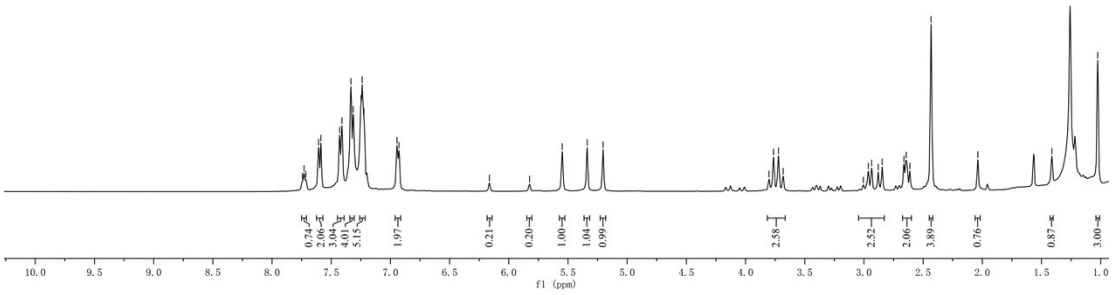

0.55
1.96
3.60
7.10
1.95
0.18
0.18
1.00
0.96
0.92
2.52
2.50
1.93
3.65
0.84
0.72
3.07
f1 (ppm)

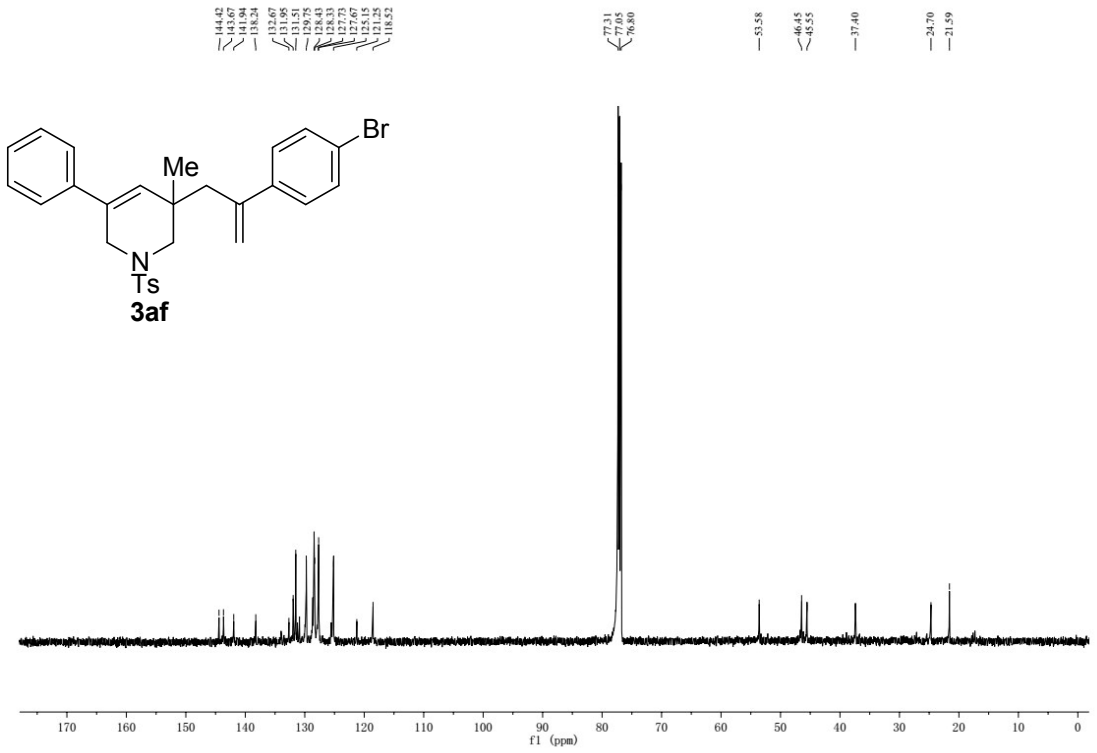


3ae



3af

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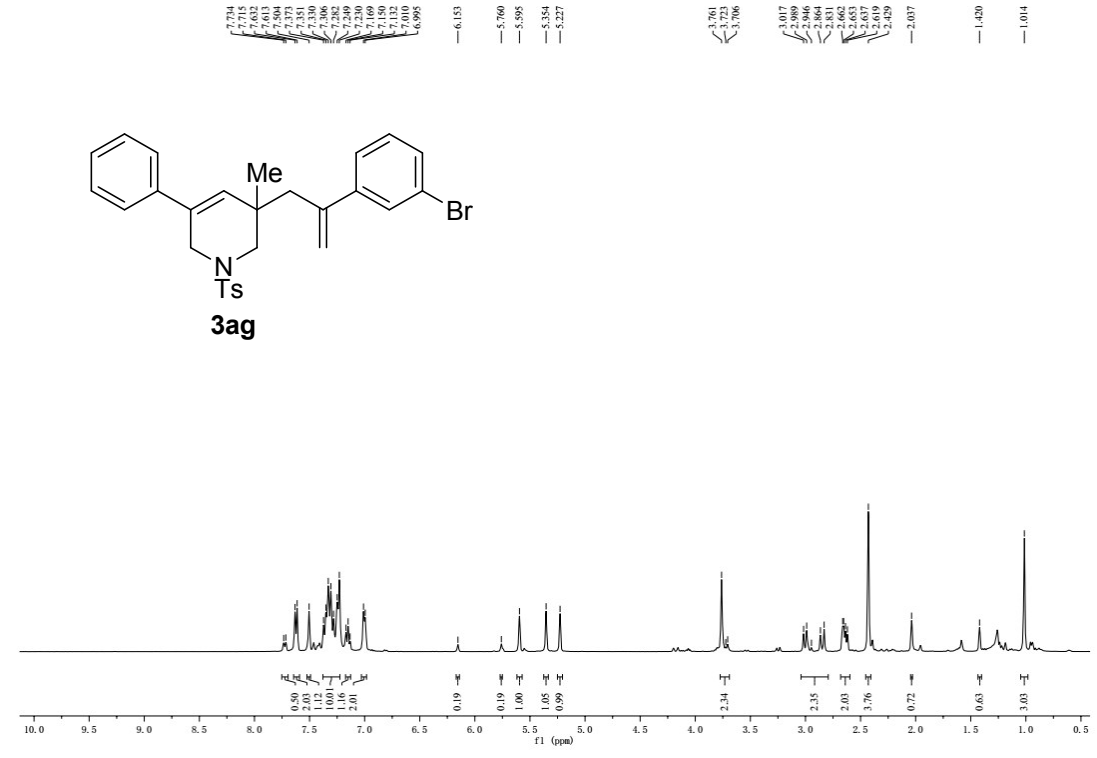
143.67
141.94
138.24
132.67
131.95
131.51
129.35
128.45
128.33
127.73
127.67
125.15
121.25
118.52
77.31
77.05
76.80
53.58
46.45
45.55
37.40
24.70
21.59
Br
Me
N
Ts
3af
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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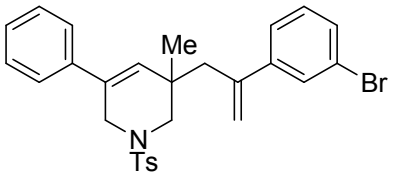
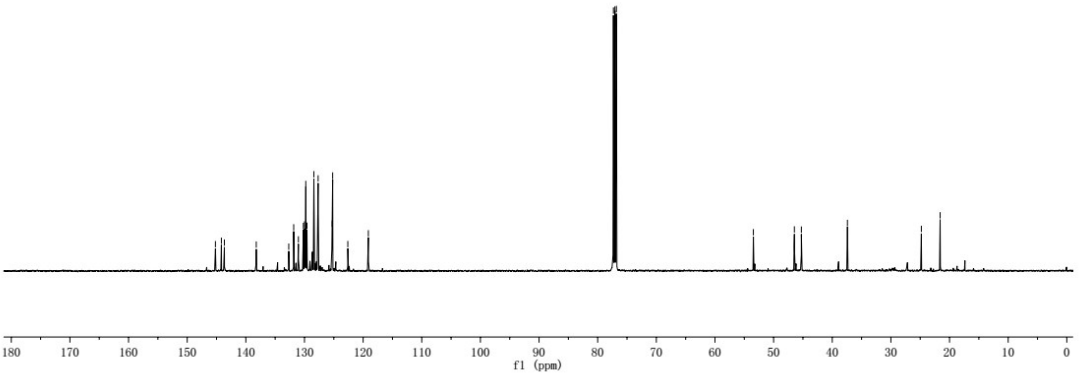
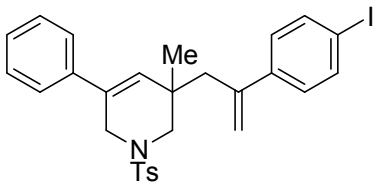
7.715
7.632
7.613
7.594
7.373
7.351
7.330
7.306
7.282
7.249
7.230
7.169
7.150
7.132
7.090
6.995
6.153
5.760
5.595
5.354
5.227
3.761
3.723
3.706
3.017
2.989
2.946
2.864
2.831
2.662
2.645
2.637
2.619
2.429
2.037
1.420
1.014
Me
Br
N
Ts
3ag
0.50
2.40
2.12
10.01
1.16
2.01
0.19
0.19
1.00
1.05
0.99
2.34
2.35
2.03
3.76
0.72
0.63
3.03
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

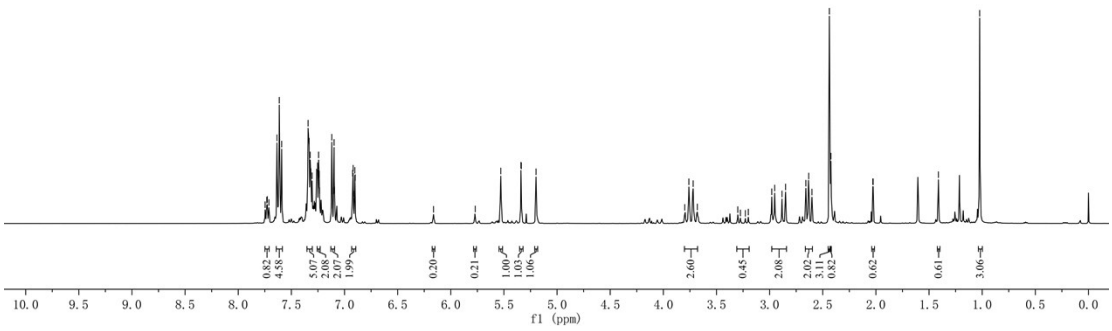


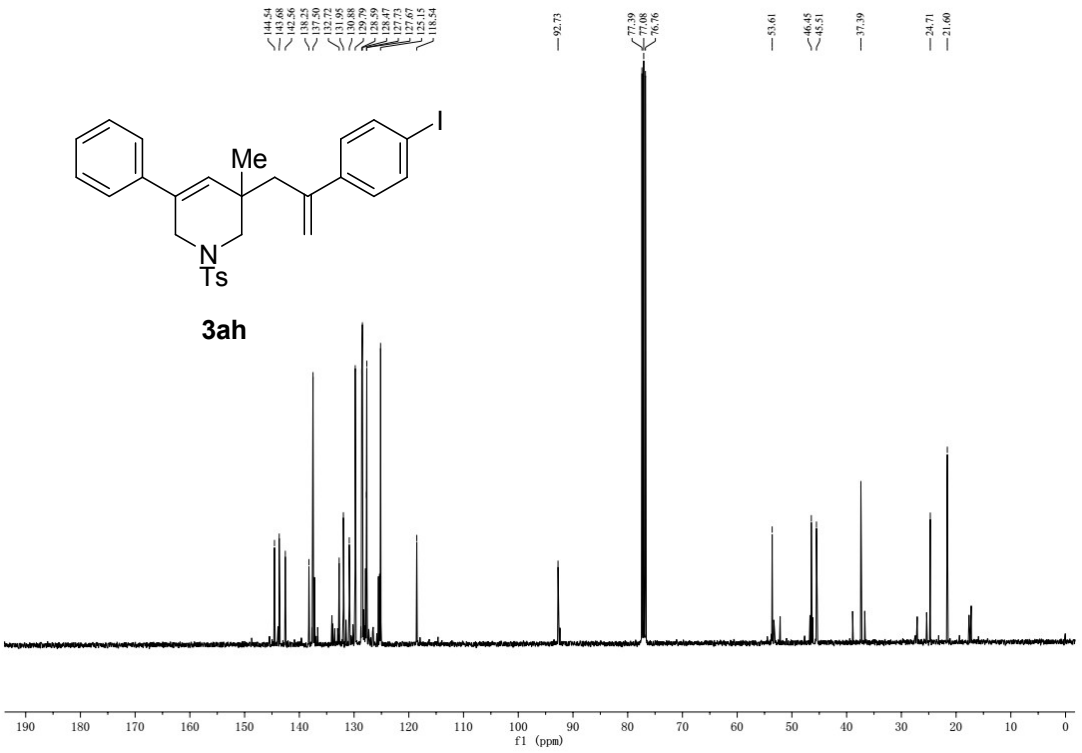
3ag



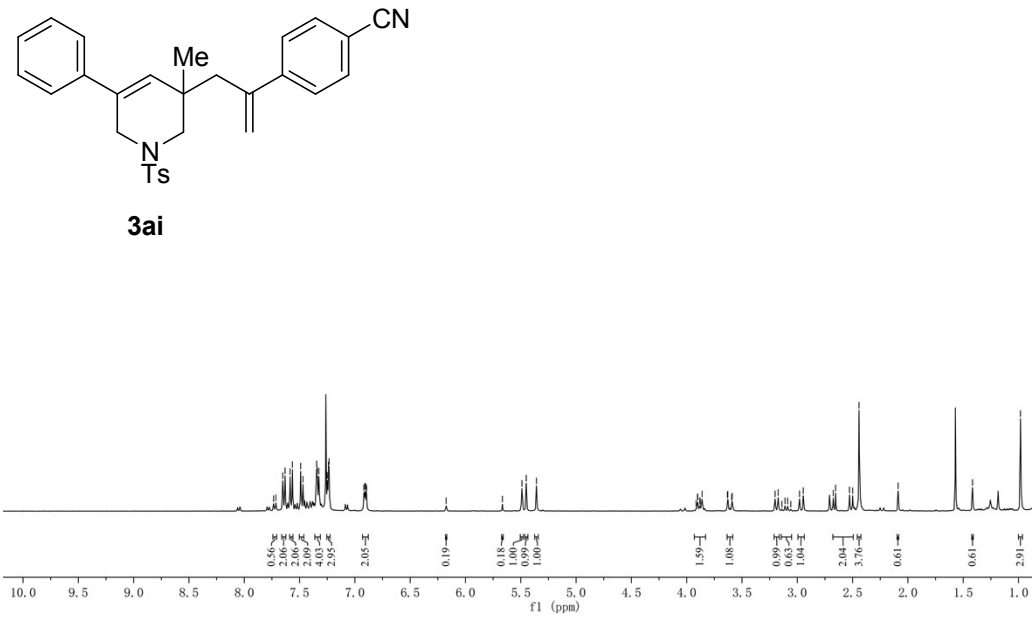


3ah

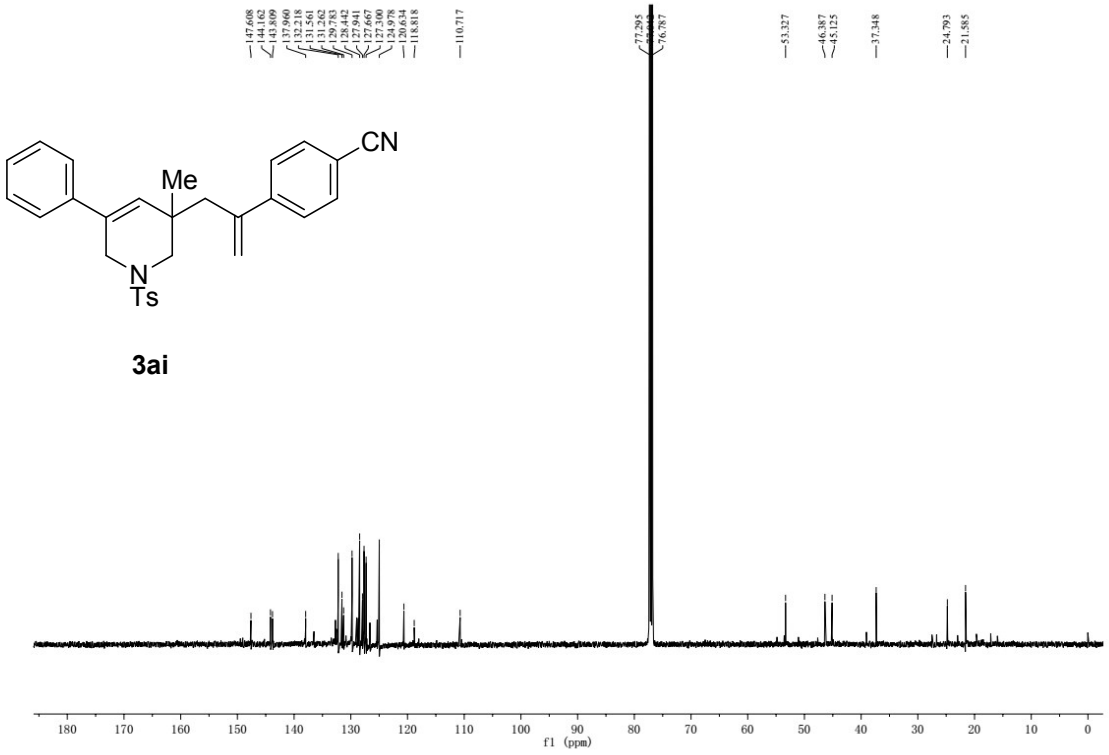




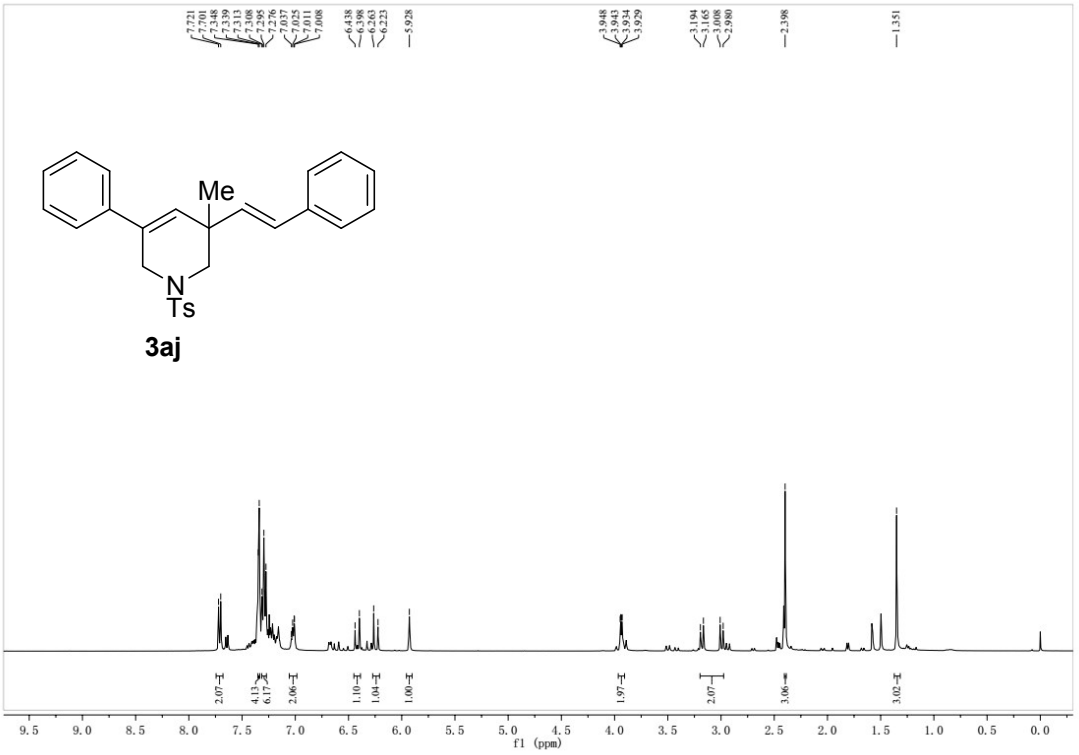
3ah



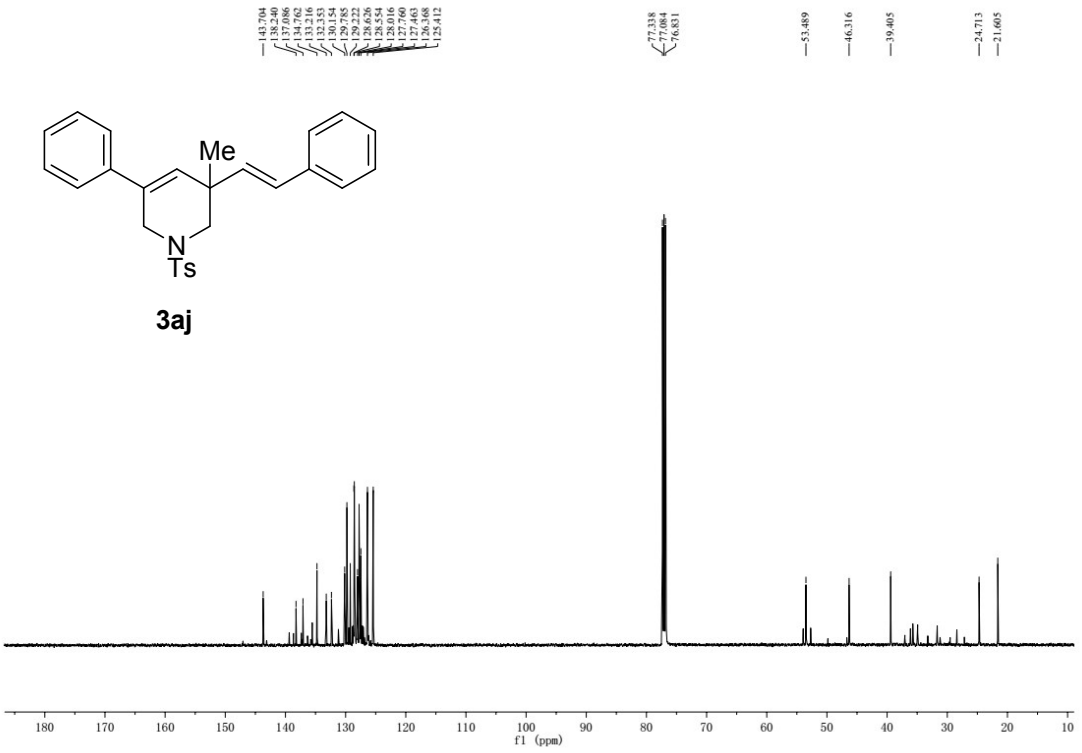
3ai



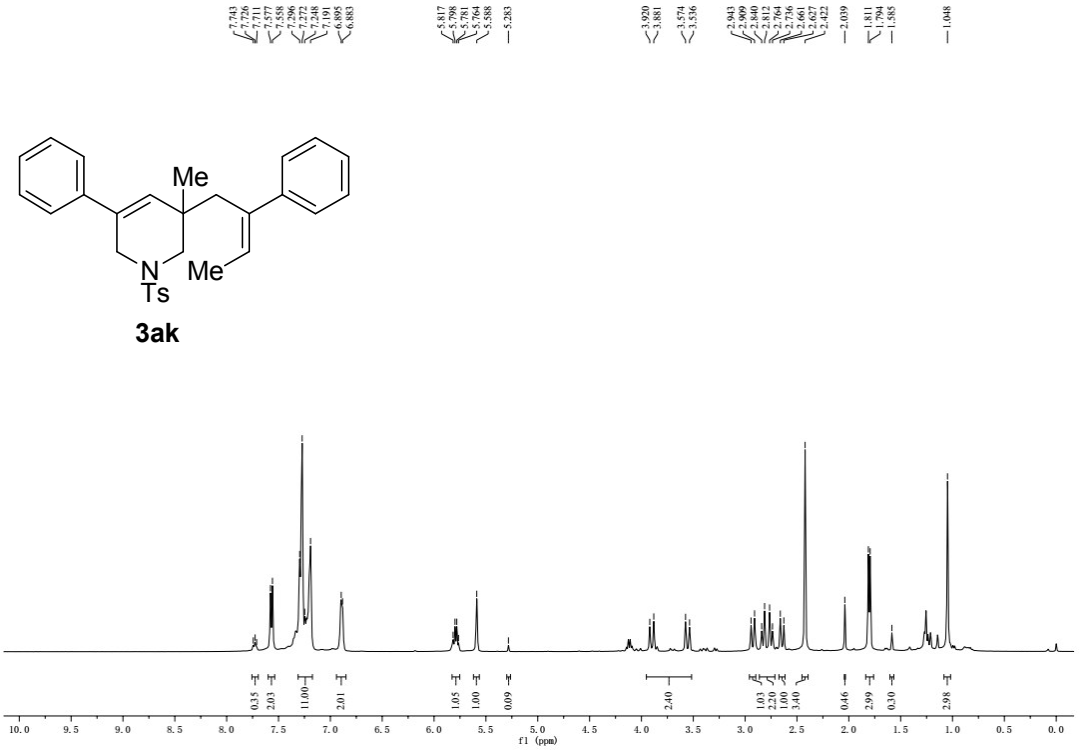
3ai



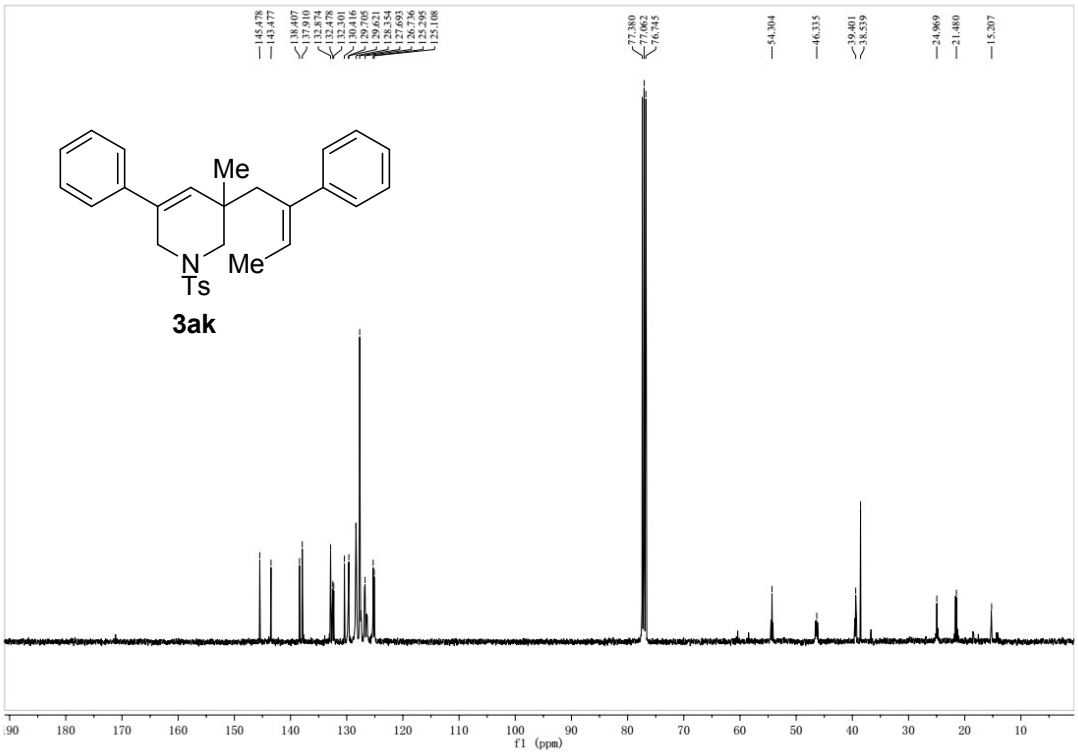
3aj



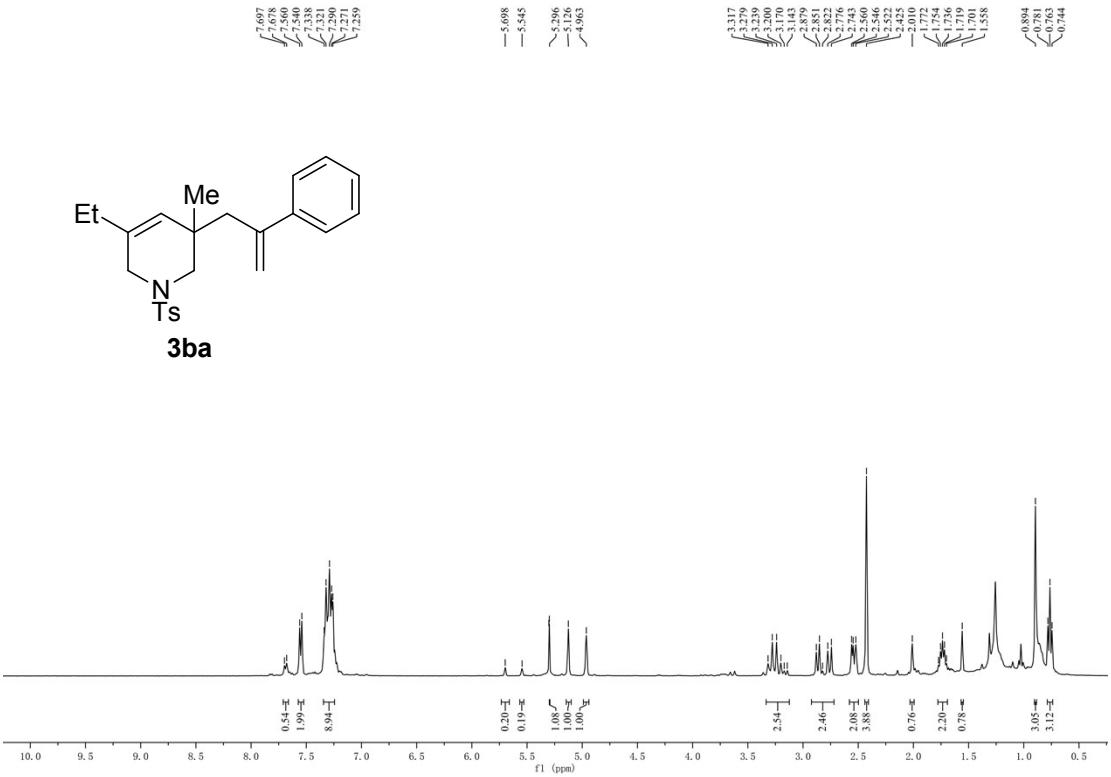
3aj



3ak



3ak



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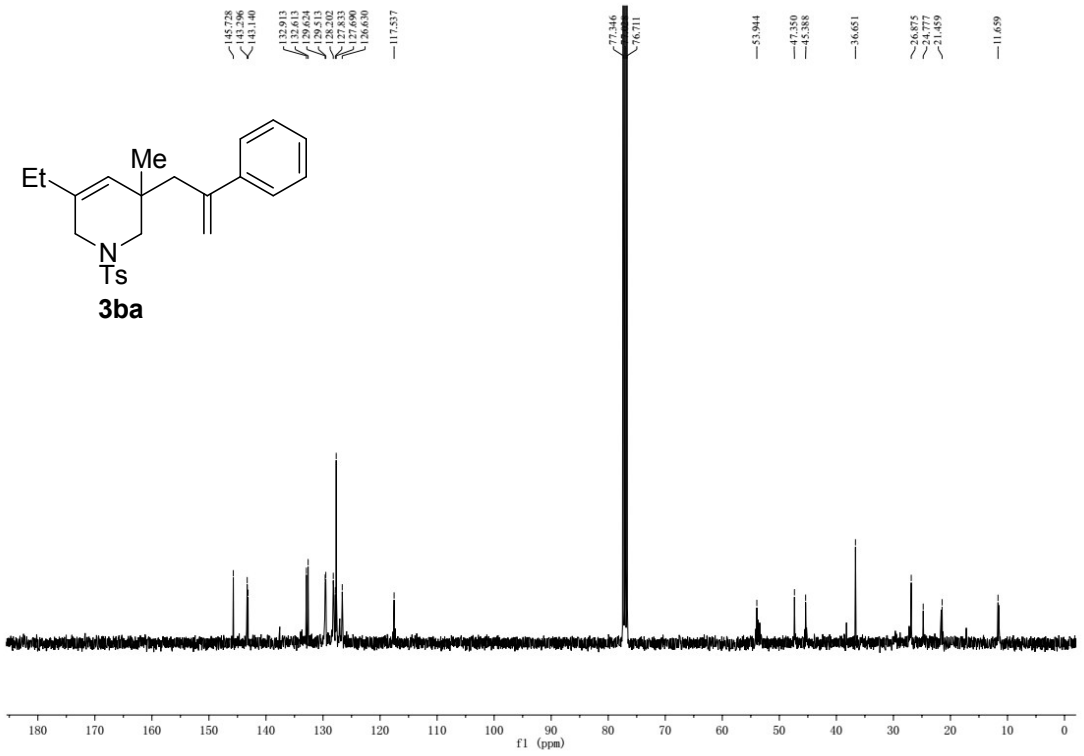
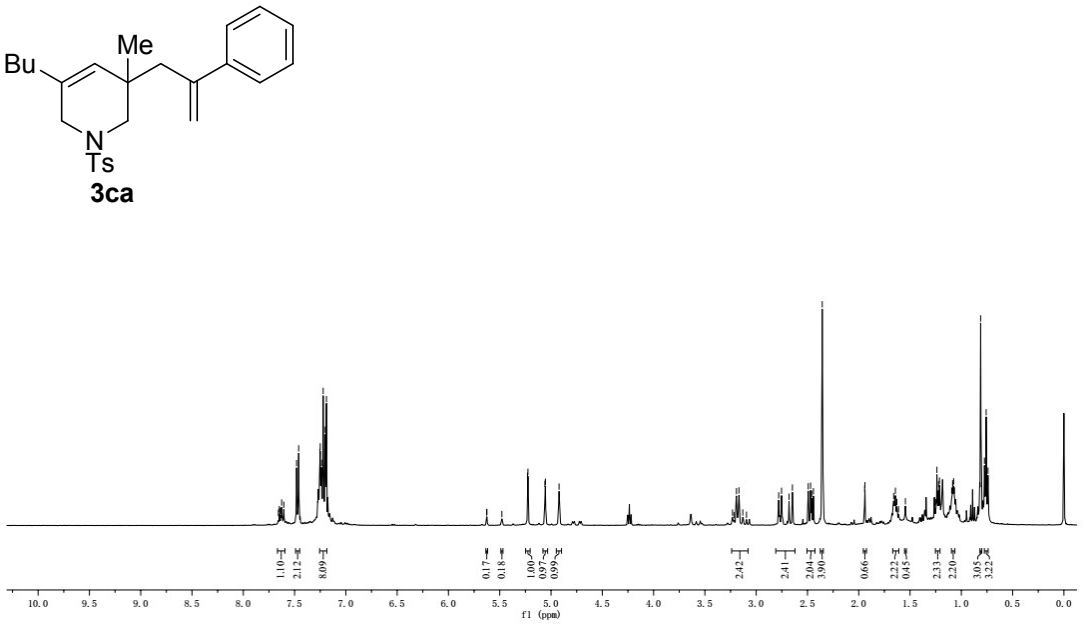
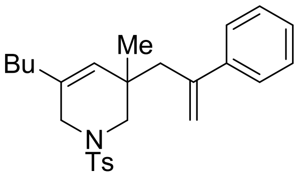


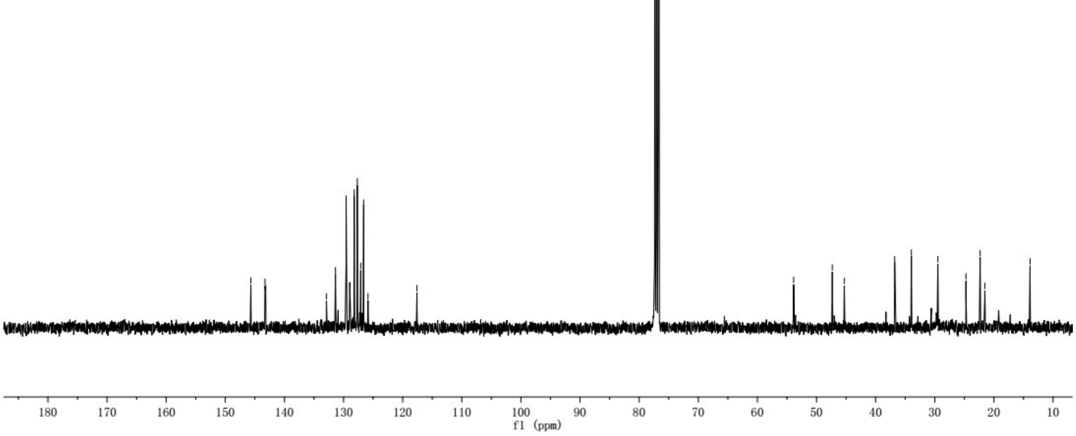
3ba

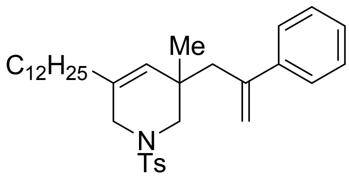


3ca

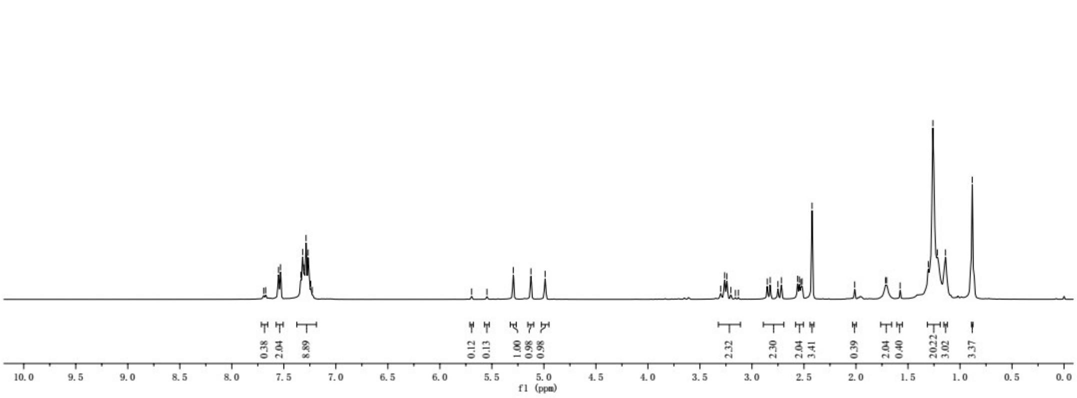

Bu
Me
N
Ts

3ca


145.679
143.287
143.169
132.901
131.369
129.566
128.199
127.676
127.094
126.603
125.867
117.584
77.343
76.709
53.871
47.336
45.309
36.788
33.960
29.487
24.725
22.336
21.539
13.886
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


$C_{12}H_{25}$
Me
N
Ts

3da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7.675
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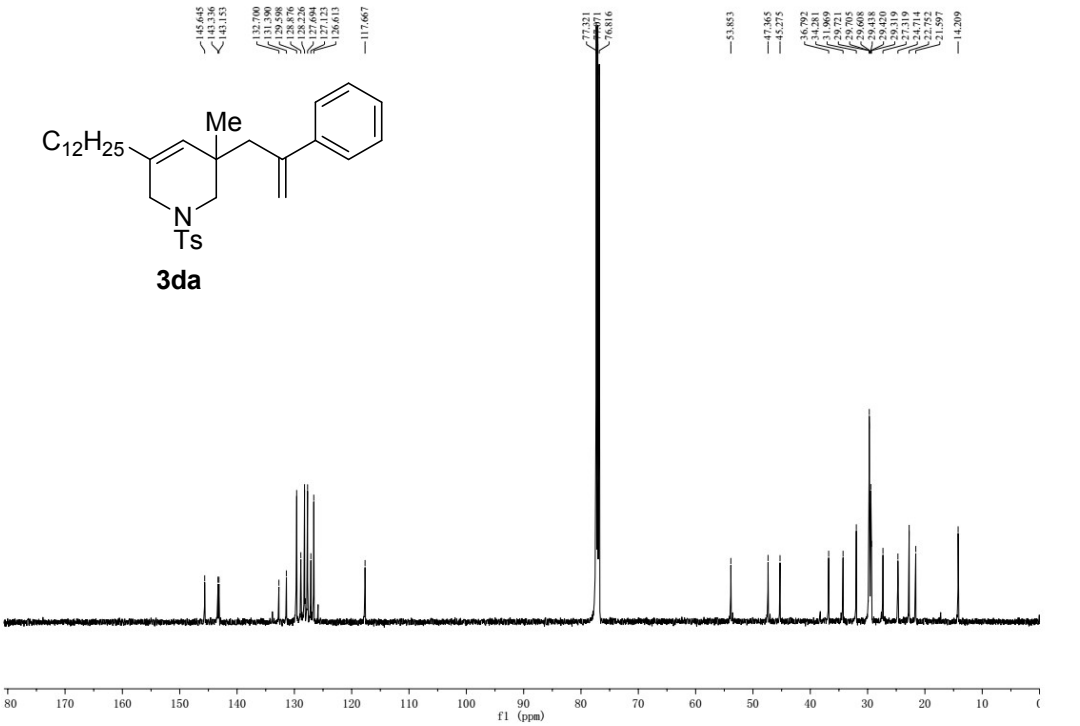
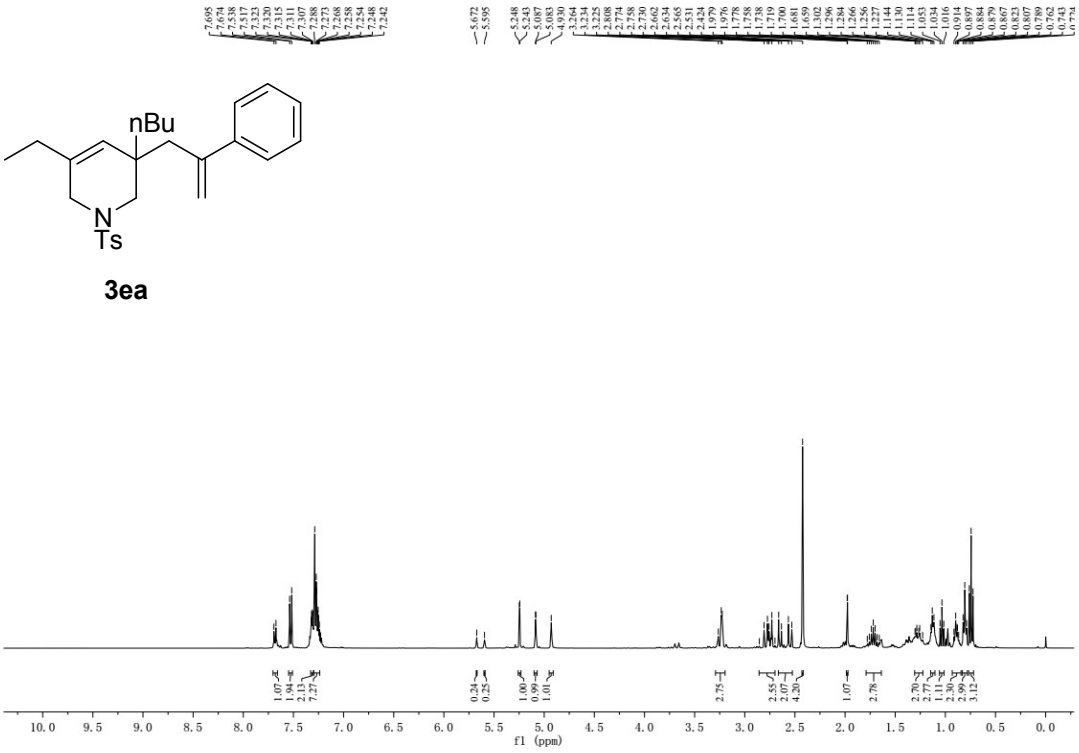
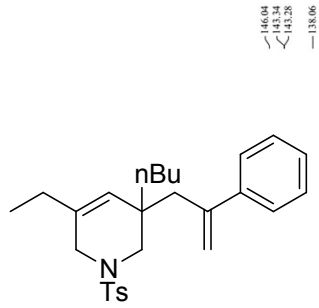
7.532
7.335
7.319
7.305
7.286
7.267
7.242
7.227
5.695
5.547
5.294
5.125
4.988
3.301
3.263
3.241
3.202
3.159
3.130
2.852
2.825
2.750
2.717
2.562
2.544
2.528
2.519
2.422
2.013
1.716
1.704
1.576
1.304
1.260
1.218
1.140
0.882
0.38 2.04 8.89 0.12 0.13 1.00 0.98 0.98 2.32 2.30 2.04 3.41 0.39 2.04 0.40 20.22 3.02 3.37
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)



3da

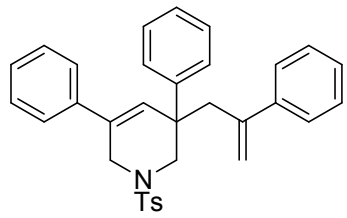


3ea


nBu
N
Ts

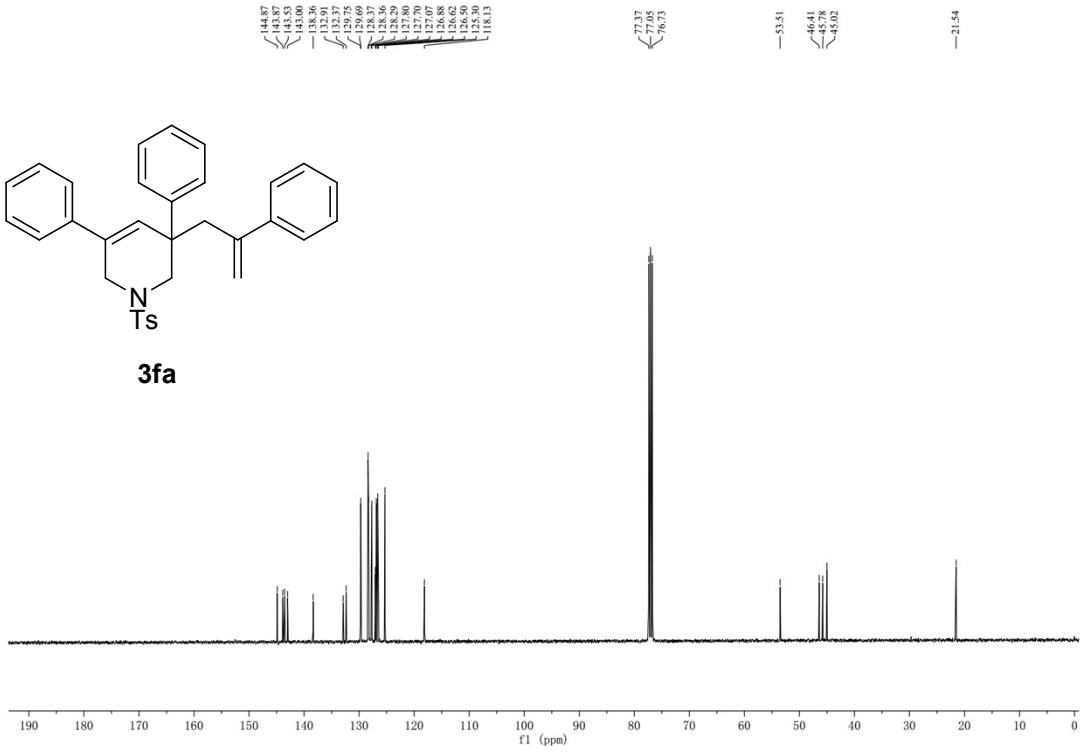
3ea

146.04
143.34
143.28
138.06
132.90
129.58
128.11
127.66
127.04
126.69
125.91
117.47
77.39
77.07
76.75
52.42
47.36
42.92
41.48
39.27
37.08
26.97
25.91
23.30
21.56
14.06
11.65
f1 (ppm)


N
Ts

3fa

7.518
7.497
7.324
7.310
7.302
7.280
7.262
7.250
7.240
7.225
7.197
7.180
7.162
6.969
6.962
6.955
6.945
6.141
5.288
5.144
5.141
4.855
3.802
3.796
3.790
3.304
3.269
3.255
3.171
3.136
2.394
1.569
2.10
16.67
2.06
1.00
0.13
1.01
1.00
2.16
1.08
1.95
1.06
3.25
0.87
f1 (ppm)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143.87
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132.91
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129.75
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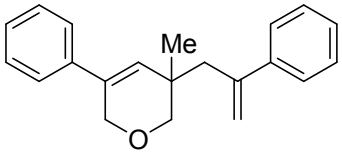
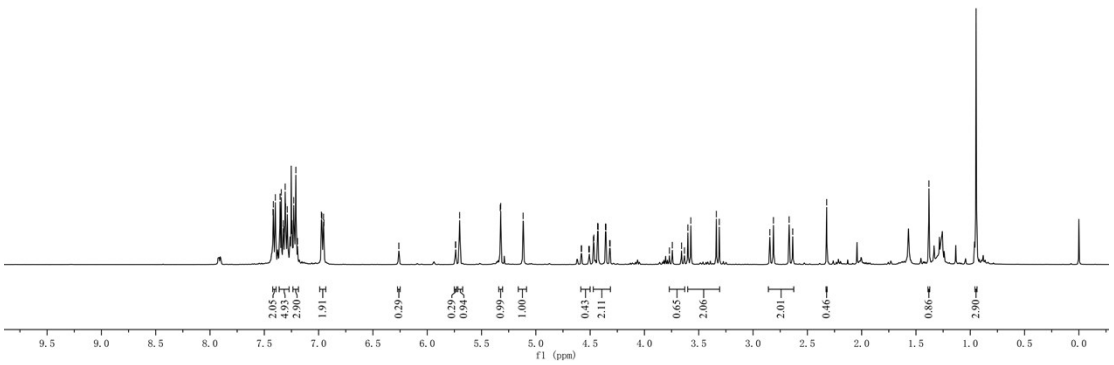
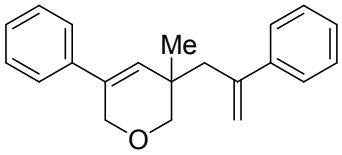
128.37
128.36
128.29
127.89
127.70
127.07
126.88
126.62
125.60
125.30
118.13
77.37
77.05
76.73
53.51
46.41
45.78
45.02
21.54
N
Ts
3fa
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

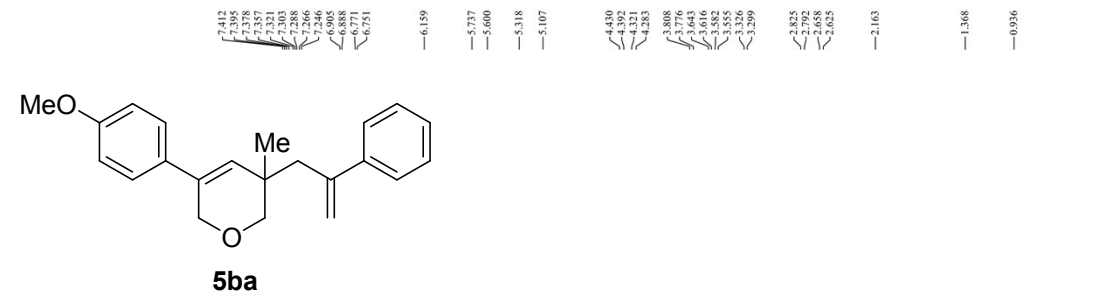


5aa





5aa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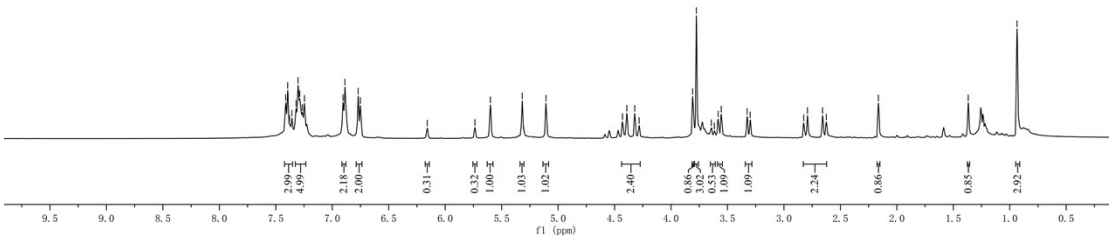
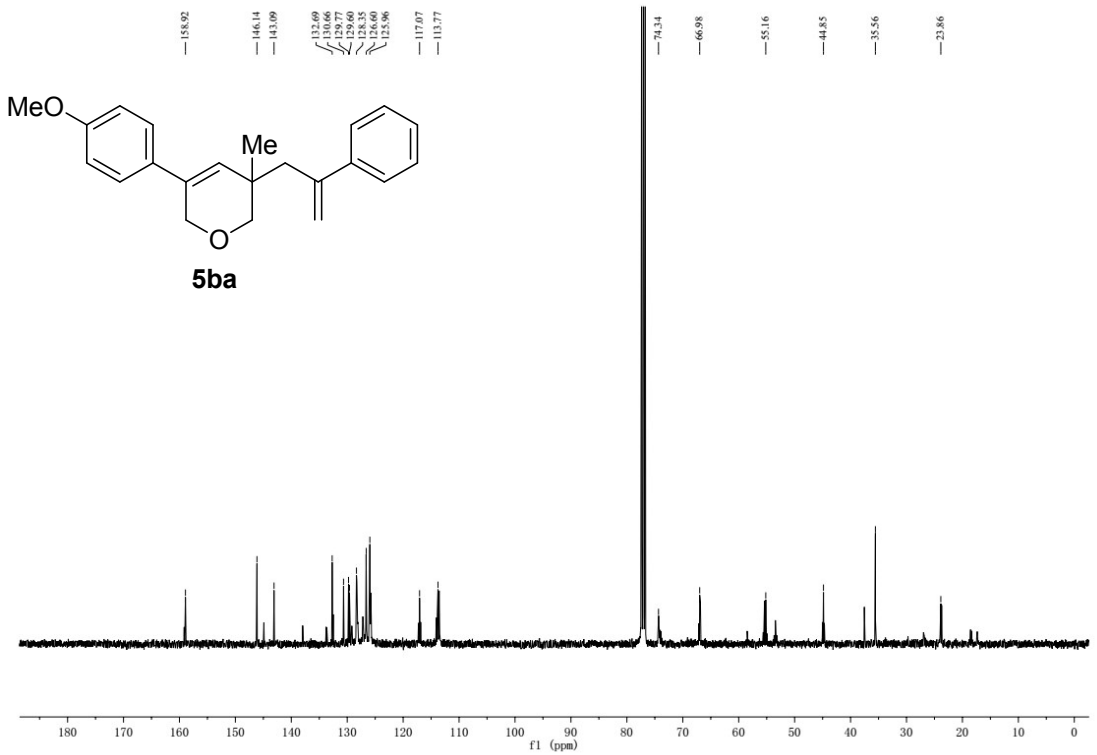
7.321
7.303
7.288
7.266
7.246
6.905
6.888
6.771
6.751
6.159
5.737
5.600
5.318
5.107
4.430
4.392
4.321
4.283
3.808
3.776
3.643
3.616
3.582
3.555
3.326
3.299
2.825
2.792
2.658
2.625
2.163
1.368
0.936

MeO
Me
O

5ba

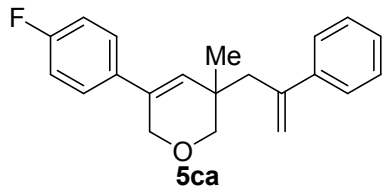

2.99
4.99
2.18
2.00
0.31
0.32
1.00
1.03
1.02
2.40
0.86
3.02
0.53
1.09
1.09
2.24
0.86
0.85
2.92
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


158.92
146.14
143.09
132.69
130.66
129.77
129.60
128.35
126.60
125.96
117.07
113.77
74.34
66.98
55.16
44.85
35.56
23.86
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

MeO
Me
O

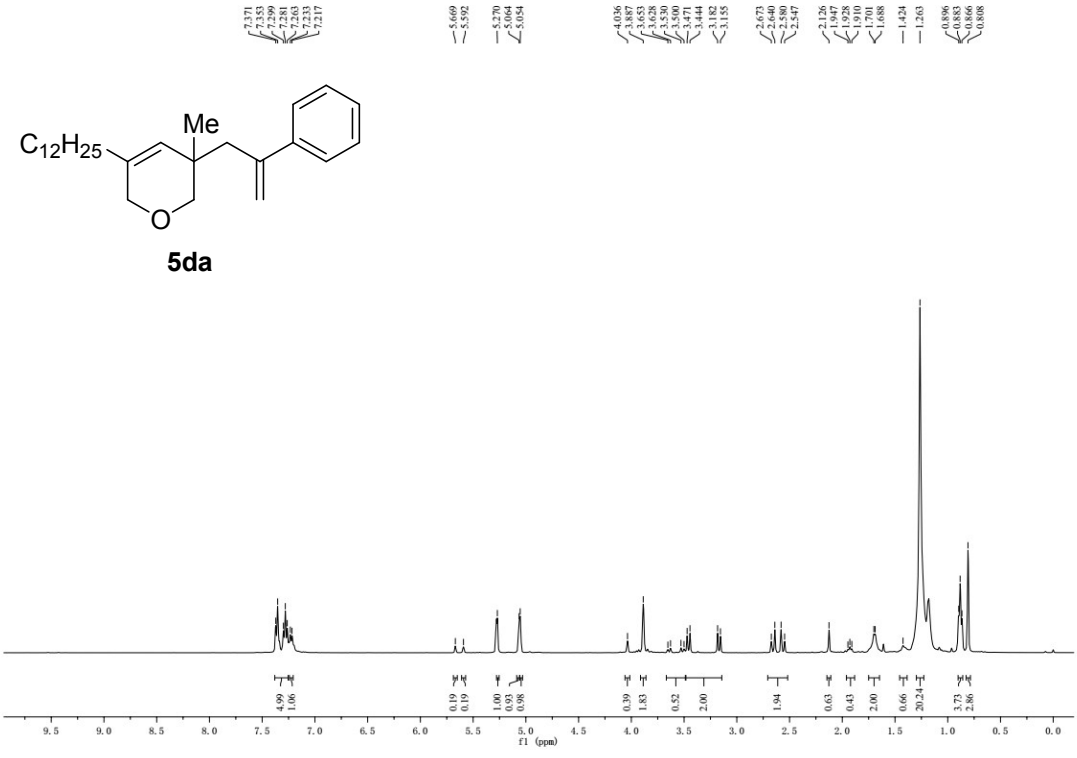
5ba


7.411
7.392
7.322
7.304
7.285
7.238
6.921
6.901
6.883
6.194
5.731
5.603
5.324
5.113
4.417
4.379
4.299
4.261
3.601
3.574
3.340
3.313
2.852
2.820
2.652
2.618
2.161
1.551
0.954
F
Me
O
5ca
2.04
2.11
1.58
4.08
0.09
0.09
1.00
1.00
1.00
2.22
2.22
2.06
0.21
0.44
3.08
f1 (ppm)
163.08
161.12
146.01
143.02
132.36
131.16
128.37
127.22
126.60
126.38
126.32
117.22
115.17
115.00
74.25
66.88
44.90
35.59
23.71
F
Me
O
5ca
f1 (ppm)


F
Me
O

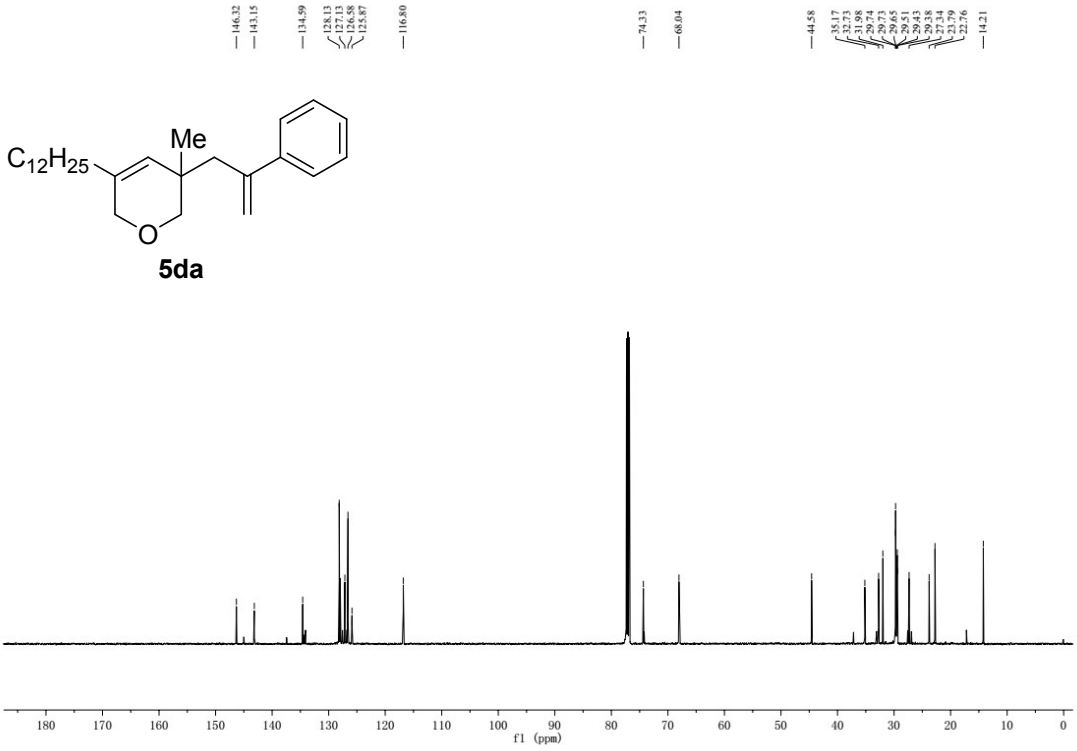
5ca

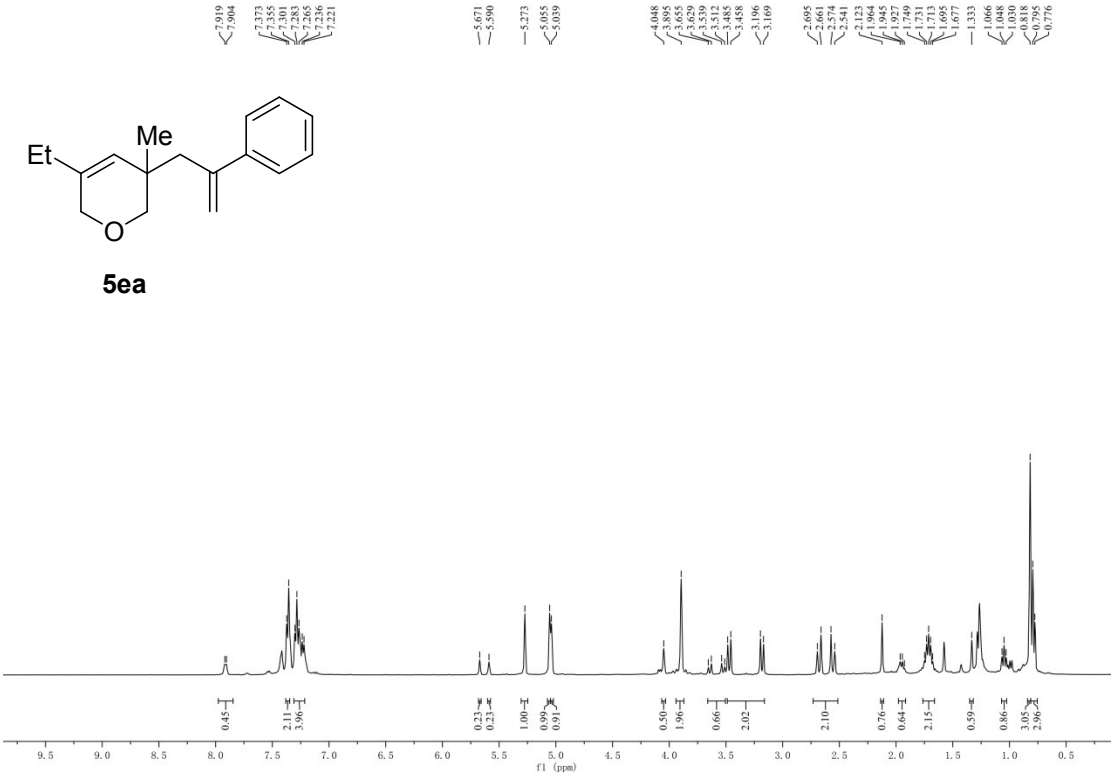
-115.69
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

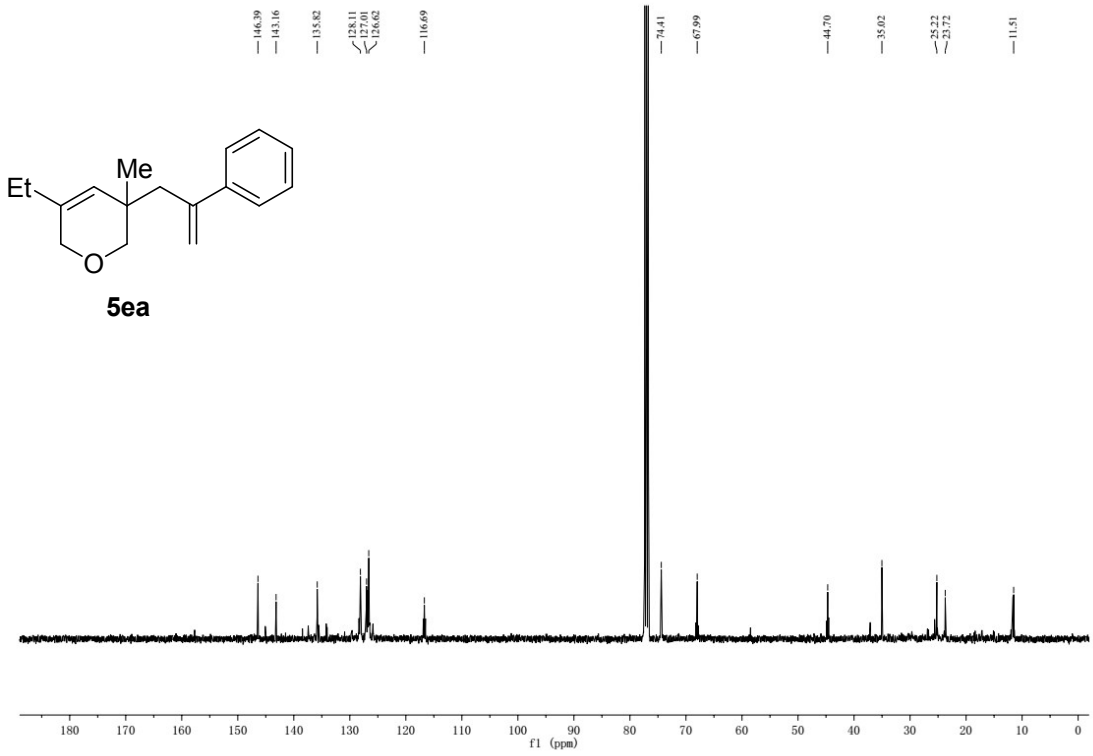

7.371
7.353
7.299
7.281
7.263
7.233
7.217
5.669
5.592
5.270
5.064
5.054
4.036
3.887
3.855
3.628
3.530
3.500
3.471
3.444
3.182
3.155
2.673
2.640
2.580
2.547
2.126
1.947
1.928
1.910
1.701
1.688
1.424
1.263
0.896
0.883
0.866
0.808
4.99
1.06
0.19
0.19
1.00
0.93
0.98
0.39
1.83
0.52
2.00
1.94
0.63
0.43
2.00
0.66
20.24
3.73
2.86
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

Me
$C_{12}H_{25}$
O

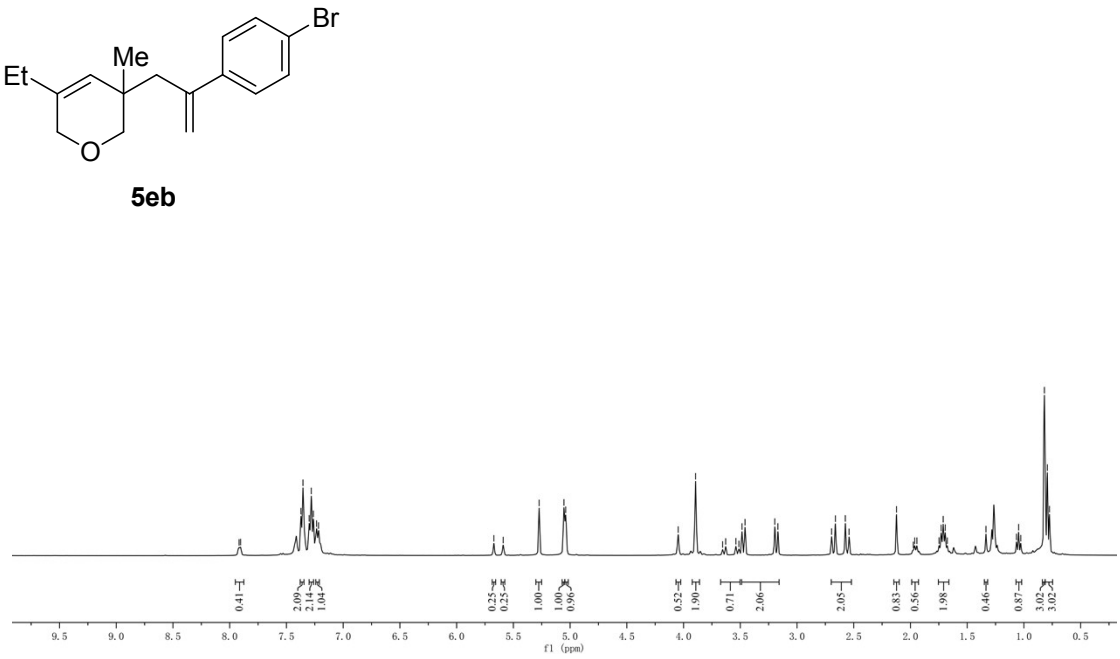
5da


146.32
143.15
134.59
128.13
127.13
126.58
125.87
116.80
74.33
68.04
44.58
35.17
32.73
31.98
29.74
29.73
29.65
29.51
29.43
29.38
27.34
23.79
22.76
14.21
Me
C12H25
O
5da
f1 (ppm)

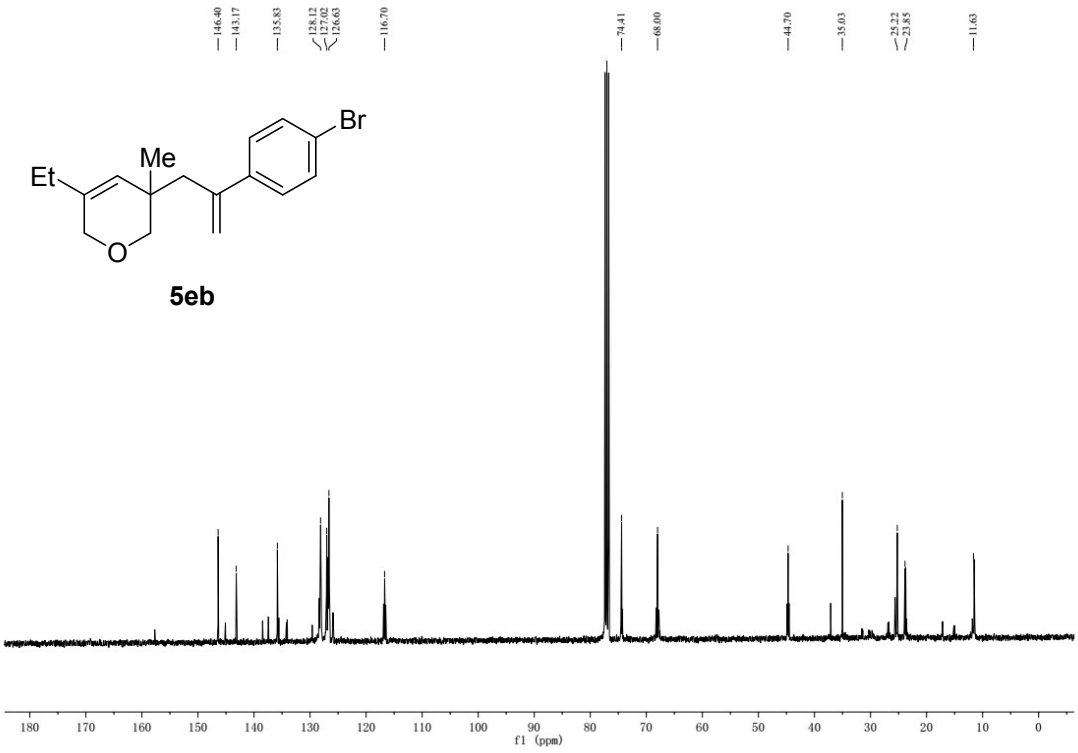

7.919
7.904
7.373
7.355
7.301
7.288
7.265
7.236
7.221
5.671
5.590
5.273
5.055
5.039
4.048
3.895
3.655
3.629
3.539
3.512
3.485
3.458
3.196
3.169
2.695
2.661
2.574
2.541
2.123
1.964
1.945
1.927
1.749
1.731
1.713
1.695
1.677
1.333
1.066
1.048
1.030
0.818
0.795
0.776
Me
Et
O
5ea
0.45
2.11
3.96
0.23
0.23
1.00
0.99
0.91
0.50
1.96
0.66
2.02
2.10
0.76
0.64
2.15
0.59
0.86
3.05
2.96
f1 (ppm)


Et
Me
O
146.39
143.16
135.82
128.11
127.01
126.62
116.69
74.41
67.99
44.70
35.02
25.22
23.72
11.51
f1 (ppm)

5ea

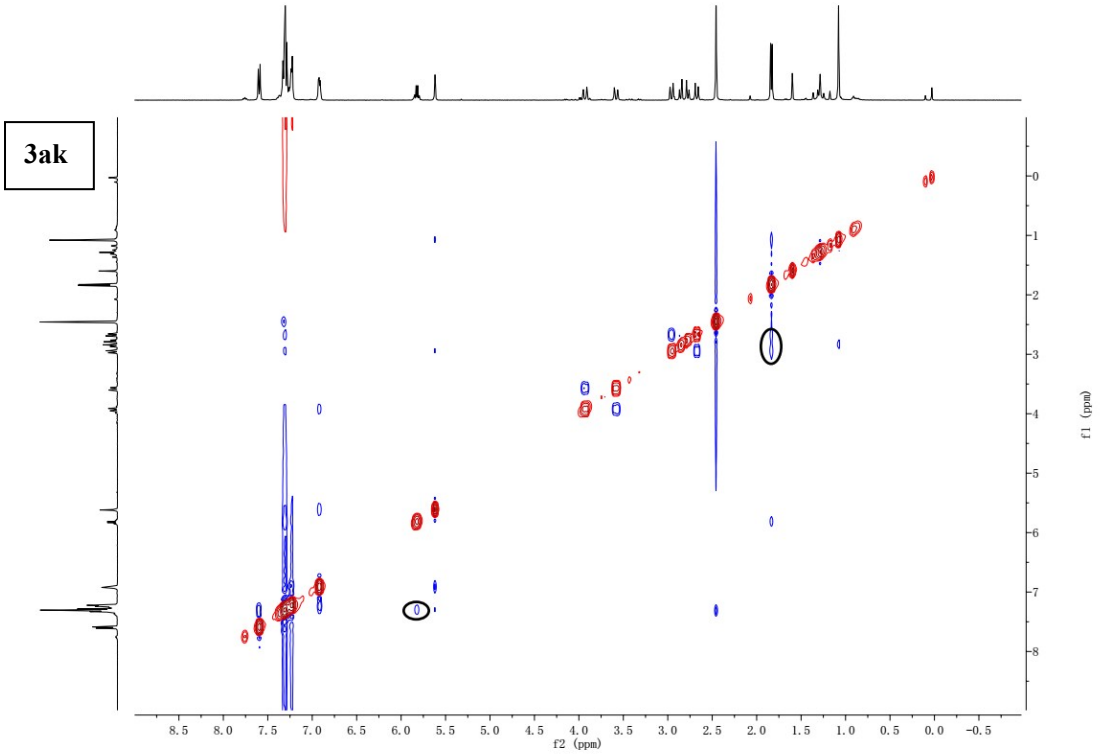

Br
Et
Me
O
7.917
7.904
7.372
7.354
7.300
7.281
7.263
7.235
7.217
5.672
5.589
5.273
5.054
5.039
4.047
3.894
3.656
3.629
3.539
3.512
3.485
3.458
3.196
3.169
2.695
2.662
2.574
2.541
2.123
1.974
1.962
1.943
1.748
1.730
1.712
1.694
1.675
1.335
1.065
1.047
1.028
0.820
0.794
0.775
0.41
2.09
2.14
1.04
0.25
0.25
1.00
1.00
0.96
0.52
1.90
0.71
2.06
2.05
0.83
0.56
1.98
0.46
0.87
3.02
3.02
f1 (ppm)

5eb

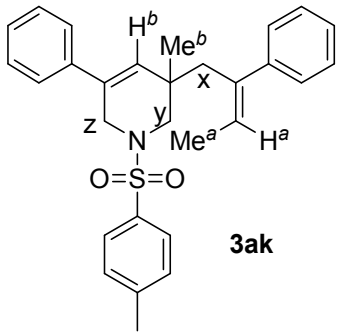

146.40
143.17
135.83
128.12
127.02
126.63
116.70
74.41
68.00
44.70
35.03
25.22
23.85
11.63
Br
Me
Et
O
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

5eb

V. Copies of the NOESY for Product 3ak



From the view of the spectrum **3ak**, there was signal between protons of the allyl (H^a, 5.79) and phenyl (7.30). There were signals between protons of methyl (Me^a, 1.80) and methylene (x, dd, 2.96 and 2.68). On the contrast, there were no signals between H^a and methylene hydrogen (x), or methyl hydrogen (Me^a) and phenyl. So, the isomer of product **3ak** should be in E configuration as below.



3ak

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[4] Adele Casaschi, Ronald Grigg, Jose M. Sansano, Tetrahedron, 2000, 56, 38, 7553 – 7560.

[5] Abadh Kishor Jha, Nidhi Jain, Chemical Communications, 2016, 52, 1831 – 1834.