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Supporting Information

Palladium-Catalyzed Catellani-Type Selective C-H Silylation of Aryl-TT salts

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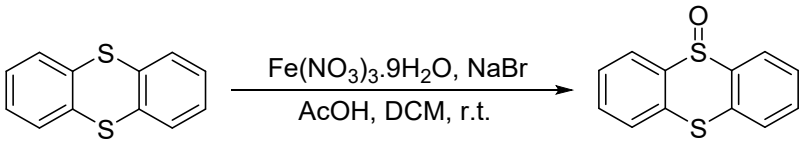
I. General remark

NMR spectra of materials and products were recorded on 300 MHz and 75 MHz (VARIAN 300 M), 400 MHz and 100 MHz (BRUKER 400 M or JNM-ECS 400 M), 600 MHz and 150 MHz (BRUKER 600 M). Corresponding solvents were $CDCl_3$. All chemical shifts are given as δ value (ppm) with reference to tetramethylsilane (TMS) as an internal standard. All compounds were further characterized by HRMS; copies of ^1H NMR, ^{13}C NMR, and ^{19}F NMR spectra were provided. Products were purified by flash chromatography on 200-300 mesh silica gels. All melting points were determined without correction. All reactions were carried out under air in oven-dried glassware, unless otherwise noted. Commercially available reagents and solvents were used without further purification, unless otherwise noted.

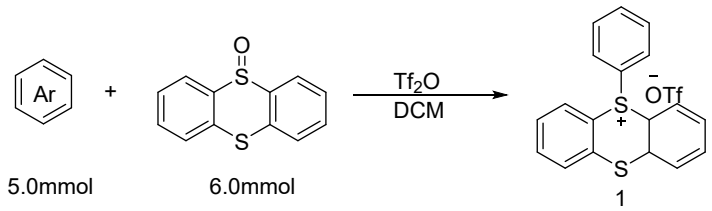
II. Experimental Procedures

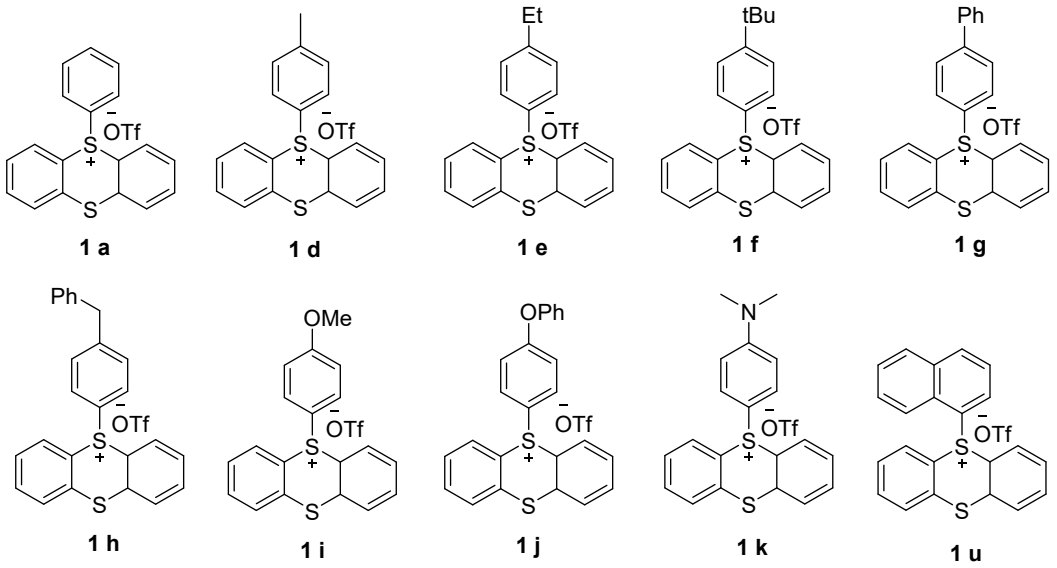
General Procedures for the Preparation of thianthrene S-oxide [1,2,3]



A 100mL round-bottom flask was charged with thianthrene (21.6 g, 100 mmol, 1.0 equiv), $Fe(NO_3)_3 \cdot 9H_2O$ (40.4 g, 100 mmol, 1.0 equiv), NaBr (408 mg, 4 mmol, 4.0 mol%). DCM (200 mL), and AcOH (4.0 mL) were then injected. The reaction mixture was stirred at room temperature and monitored by TLC until thianthrene was consumed. After that, the reaction was dilute with DCM, and then washed with water. The organic phase was dried over anhydrous Na_2SO_4, filtered and concentrated under vacuum. The grayish-white solid obtained is thianthrene S-oxide.

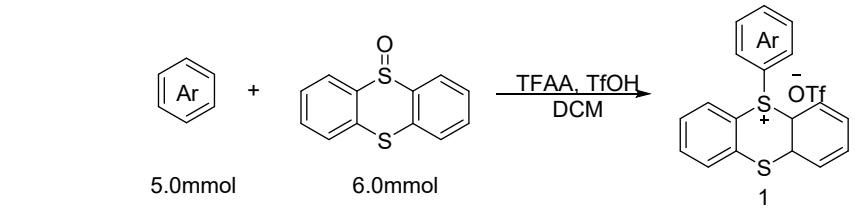
General Procedures A for the Preparation of Aryl Sulfonium Salts.[1,2,3]



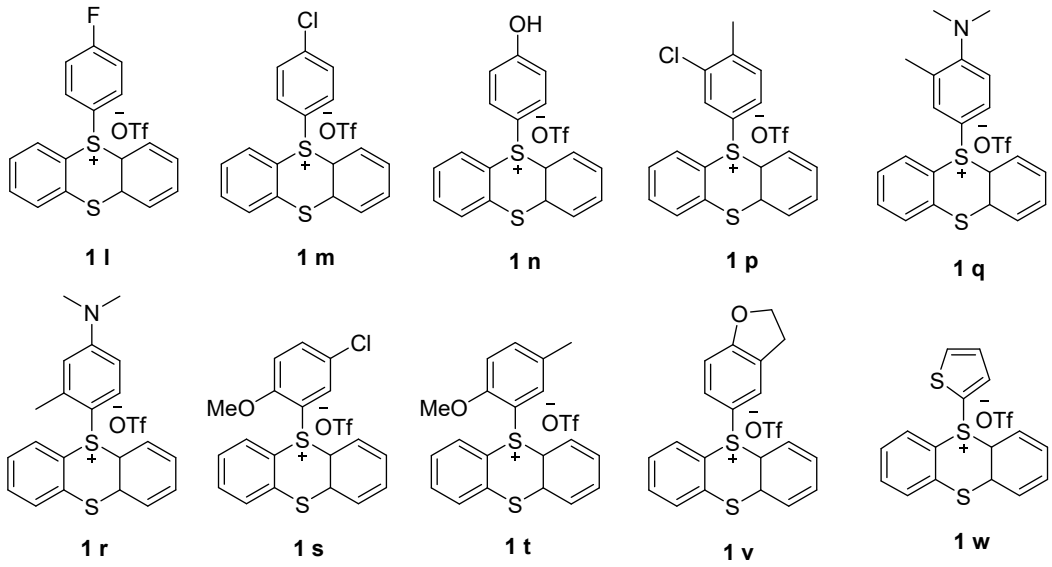


A 50 mL schlenk tube was charged with thianthrene S-oxide (6.0 mmol, 1.2 equiv), DCM (15 mL) and arenes (5.0 mmol, 1.0 equiv) under an argon atmosphere. The reaction mixture was then cooled to -40 °C and stirred at this temperature. Tf_2O (2.4 mmol, 1.2 equiv) was added dropwise. The reaction mixture was stirred at -40 °C for 30 min, and then allowed to stir at room temperature for 12 h, neutralized by a saturated aqueous $NaHCO_3$ solution, and extracted with DCM, and then washed with water. The combined organic layers were dried over anhydrous Na_2SO_4 and concentrated to dryness under reduced pressure. The crude product was purified by crystallization from DCM / Et_2O system as a white solid (**1a, 1d-1k, 1u**).

General Procedures B for the Preparation of Aryl Sulfonium Salts.[1,2,3]



5.0mmol 6.0mmol 1

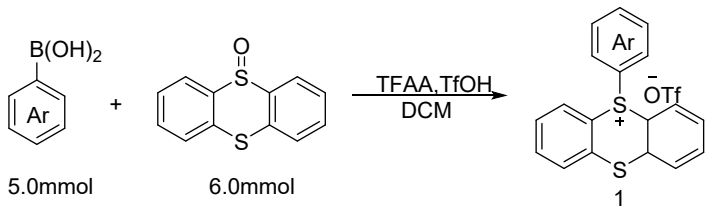


1 l **1 m** **1 n** **1 p** **1 q**

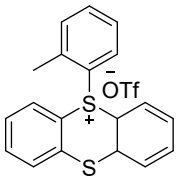
1 r **1 s** **1 t** **1 v** **1 w**

A 50 mL schlenk tube was charged with thianthrene S-oxide (6.0 mmol, 1.2 equiv), DCM (15 mL) and arenes (5.0 mmol, 1.0 equiv) under an argon atmosphere. The reaction mixture was then cooled to -40 °C and stirred at this temperature. Trifluoroacetic anhydride (TFAA, 15.0mmol, 3.0 equiv) and trifluoromethanesulfonic acid (TfOH, 7.5 mmol, 1.5 equiv) were added dropwise. The reaction mixture was stirred at -40 °C for 30 min, and then allowed to stir at room temperature for 12 h, neutralized by a saturated aqueous $NaHCO_3$ solution, and extracted with DCM. The combined organic layers were washed with aqueous NaOTf solution (3 × 20 mL, 5%(w/w)), dried over anhydrous Na_2SO_4, and concentrated to dryness under reduced pressure. The crude product was purified by crystallization from DCM / Et_2O system as a white solid (**1l-1n, 1p-1t, 1v, 1w**).

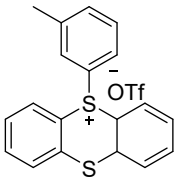
General Procedures C for the Preparation of Aryl Sulfonium Salts.[4]



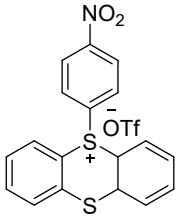
5.0mmol 6.0mmol 1



1 b



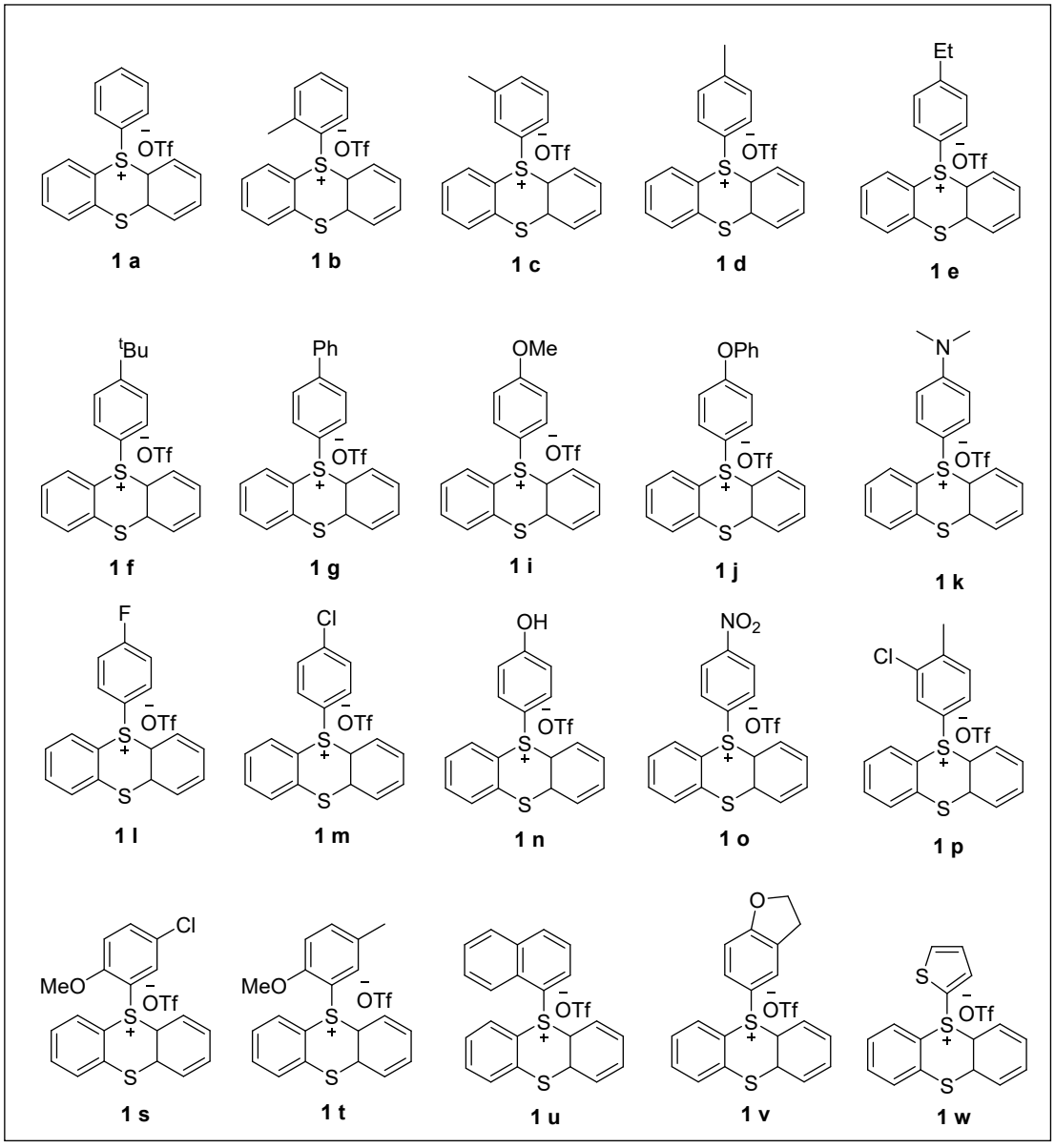
1 c



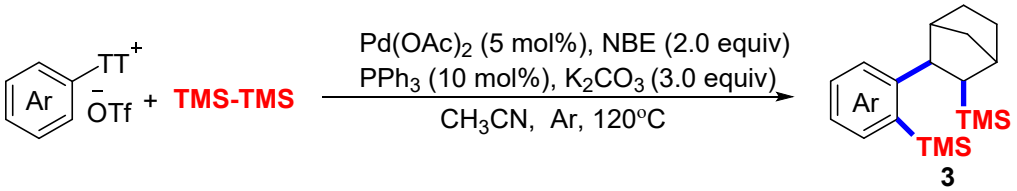
1 o

A 50 mL schlenk tube was charged with tolylboronic acid (5 mmol, 1.0 equiv), DCM (15.0 mL) and thianthrene S-oxide (6 mmol, 1.2 equiv), under an argon atmosphere. The reaction mixture was then cooled to -40 °C and stirred at this temperature. Trifluoroacetic anhydride (TFAA, 15.0 mmol, 3.0 equiv) and trifluoromethanesulfonic acid (TfOH, 7.5 mmol, 1.5 equiv) were added dropwise. The reaction mixture was stirred at -40 °C for 30 min, and then allowed to stir at room temperature for 12 h, neutralized by a saturated aqueous $NaHCO_3$ solution, and extracted with DCM, and then washed with water. The combined organic layers were dried over anhydrous Na_2SO_4 and concentrated to dryness under reduced pressure. The crude product was purified by crystallization from DCM/Et_2O system as a white solid (**1b, 1c, 1o**).

Following compounds are known in the literature and were prepared following the reported procedure.[5]



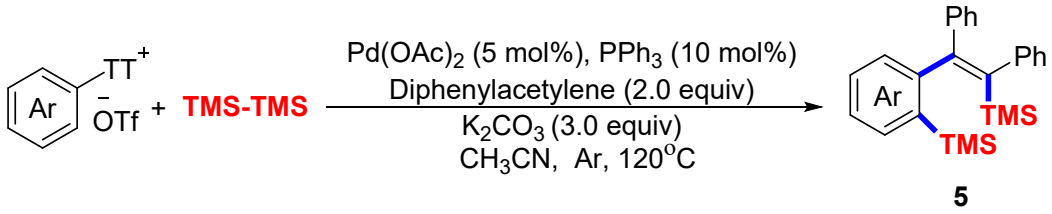
General Procedures D for the Synthesis of 3a-3m, 3p-3w, 5a-5i.



To a Schlenk tube were added aryl-TT salts (0.5 mmol, 1.0 equiv), hexamethyldisilane (1.0 mmol, 2.0 equiv), norbornene (1.0 mmol, 2.0 equiv), $Pd(OAc)_2$ (0.025 mmol, 5 mol%), PPh_3 (0.05 mmol, 10mol%), K_2CO_3 (1.5 mmol, 3.0 equiv), and

CH_3CN (5 mL). Then, the tube was charged with argon and stirred at 120 °C (oil bath temperature) for the indicated time until complete consumption of starting material, as monitored by TLC analysis. After the completion of the reaction, the reaction mixture was cooled to room temperature, extracted with EtOAc three times, washed with small amounts of water. The combined organic layers were dried with anhydrous Na_2SO_4 and the solvent was removed in vacuo to afford a residue. The residue was purified by column chromatography on silica gel using petroleum ether/EtOAc as eluent to provide the desired compounds **3**.

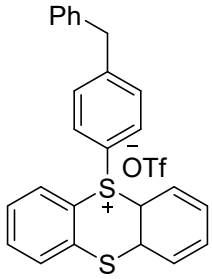
General Procedures E for the Synthesis of 5a-5i.



5

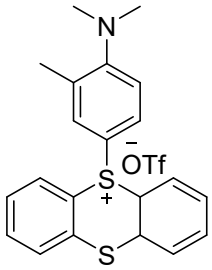
To a Schlenk tube were added aryl-TT salts (0.5 mmol, 1.0 equiv), hexamethyldisilane (1.0 mmol, 2.0 equiv), diphenylacetylene (1.0 mmol, 2.0 equiv), $Pd(OAc)_2$ (0.025 mmol, 5 mol%), PPh_3 (0.05 mmol, 10mol%), K_2CO_3 (1.5 mmol, 3.0 equiv), and CH_3CN (5 mL). Then, the tube was charged with argon and stirred at 120 °C (oil bath temperature) for the indicated time until complete consumption of starting material, as monitored by TLC analysis. After the completion of the reaction, the reaction mixture was cooled to room temperature, extracted with EtOAc three times, washed with small amounts of water. The combined organic layers were dried with anhydrous Na_2SO_4 and the solvent was removed in vacuo to afford a residue. The residue was purified by column chromatography on silica gel using petroleum ether/EtOAc as eluent to provide the desired compounds **5**.

III. The data of products



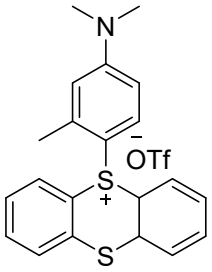
5-(4-benzylphenyl)-4a,10a-dihydro-5H-thianthren-5-ium trifluoromethanesulfonate (1h)

According to general procedure A, **1h** was obtained as a white solid (2.2 g, 82% yield). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.55(d, *J* = 7.6 Hz, 2 H), 7.78-7.85(m, 4 H), 7.71-7.75(m, 4 H), 7.22-7.25(m, 4 H), 7.19(d, *J*= 7.6 Hz, 1 H), 7.07-7.11(m, 4 H), 3.94(s, 1 H). ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 147.3, 138.6, 136.4, 135.1, 134.9, 131.0, 130.2, 130.1, 128.9, 128.7, 128.1, 126.7, 121.1, 118.6, 41.3. HRMS calcd for $C_{26}H_{22}F_3O_3S_3$ $[M+H]^+$ 535.0678; found: 535.0664.



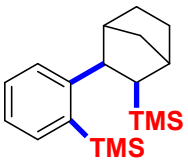
5-(4-(dimethylamino)-3-methylphenyl)-4a,10a-dihydro-5H-thianthren-5-ium trifluoromethanesulfonate (1q)

According to general procedure B, **1q** was obtained as a white solid (1.9 g, 71% yield). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.37(d, *J* = 7.6 Hz, 2 H), 7.79-7.81(m, 2 H), 7.72-7.76(m, 2 H), 7.68-7.70(m, 2 H), 7.11(s, 1 H), 7.04-7.07(m, 1 H), 6.89(d, *J*= 8.8 Hz, 1 H), 2.72(s, 6 H), 2.21(s, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 157.4, 135.6, 134.4, 133.8, 133.5, 133.1, 131.7, 131.2, 130.1, 122.4, 119.7, 111.7, 42.9, 19.8. HRMS calcd for $C_{22}H_{23}F_3NO_3S_3$ $[M+H]^+$ 502.0787; found: 502.0813.



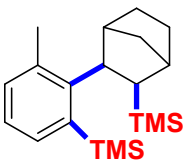
5-(4-(dimethylamino)-2-methylphenyl)-4a,10a-dihydro-5H-thianthren-5-ium trifluoromethanesulfonate (1r)

According to general procedure B, **1r** was obtained as a white solid (2.0 g, 75% yield). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ =7.85(d, *J* = 7.6 Hz, 2 H), 7.76(d, *J* = 8.0 Hz, 2 H), 7.70(d, *J* = 7.6 Hz, 2 H), 7.66(d, *J* = 7.6 Hz, 2 H), 7.12(d, *J* = 8.8 Hz, 1 H),6.71-6.74 (m, 2 H), 3.11(s, 6 H), 2.62(s, 3 H). ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 154.4, 144.0, 133.6, 133.3, 130.2, 129.9, 123.9, 119.1, 114.9, 114.8, 112.3, 97.7, 40.1, 20.8. HRMS calcd for $C_{19}H_{33}Si_2$ $[M+H]^+$ 317.2116; found: HRMS calcd for $C_{22}H_{23}F_3NO_3S_3$ $[M+H]^+$ 502.0787; found: 502.0813.



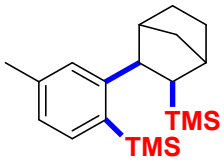
trimethyl(2-((2R,3R)-3-(trimethylsilyl)bicyclo[2.2.1]heptan-2-yl)phenyl)silane (3a)

Yellow oil (139.1 mg, 88% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.39(d, *J* = 7.6 Hz, 2 H), 7.27-7.31(m, 1 H), 7.11-7.15(m, 1 H), 3.15(d, *J* = 10.4 Hz, 1 H), 2.32-2.36(m, 1 H), 1.96-1.99(m, 1 H), 1.73-1.78(m, 1 H), 1.57-1.62(m, 1 H), 1.42-1.45(m, 1 H), 1.35-1.38(m, 2 H), 1.25-1.28(m, 1 H), 0.32(s, 9 H), -0.37(s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.8, 138.9, 134.2, 129.3, 126.6, 125.1, 51.2, 44.9, 43.5, 38.9, 38.6, 32.8, 32.2, 1.0, -0.8. HRMS calcd for $C_{19}H_{33}Si_2$ $[M+H]^+$ 317.2116; found: 317.2112.



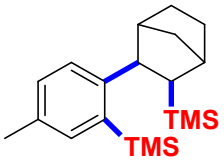
trimethyl(3-methyl-2-((2R,3R)-3-(trimethylsilyl)bicyclo[2.2.1]heptan-2-yl)phenyl)silane (3b)

Colorless oil (125.4 mg, 76% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.31-7.34(m, 1 H), 7.05-7.09(m,2 H), 3.46(d, *J* = 11.2 Hz, 1 H), 2.68(s, 1 H), 2.49(s, 3 H), 2.35(d, *J* = 4.4 Hz, 1 H), 1.96(d, *J* = 10.0 Hz, 1 H), 1.80-1.84(m, 1 H), 1.55-1.61(m, 1 H), 1.47-1.50(m, 1 H), 1.40-1.43(m, 2 H), 1.31-1.34(m, 1 H), 0.34(s, 9 H), -0.40(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 148.5, 142.1, 135.2, 134.2, 133.1, 125.3, 53.9, 44.9, 41.0, 39.8, 38.9, 33.5, 32.2, 23.1, 2.1, -0.7. HRMS calcd for $C_{20}H_{35}Si_2$ $[M+H]^+$ 331.2272; found: 331.2265.



trimethyl(4-methyl-2-((2R,3R)-3-(trimethylsilyl)bicyclo[2.2.1]heptan-2-yl)phenyl)silane (3c)

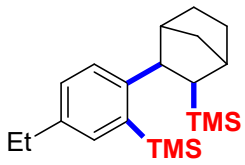
Colorless solid (128.7 mg,78% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.29(d, *J* = 7.6 Hz, 1 H), 7.20(s, 1 H), 6.95(d, *J* = 7.6 Hz, 1 H), 3.13(d, *J* = 10.4 Hz, 1 H), 2.35(d, *J* = 5.2 Hz, 1 H), 2.29-2.33(m, 4 H), 1.99(d, *J* = 10.0 Hz, 1 H), 1.72-1.76(m, 1 H), 1.56-1.62(m, 1 H), 1.41-1.44(m, 1 H), 1.35-1.38(m, 2 H), 1.24-1.27(m, 2 H), 0.31(s, 9 H), -0.37(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.8, 138.8, 135.3, 134.3, 127.7, 125.9, 51.0, 44.9, 43.6, 39.0, 38.5, 32.8, 32.2, 21.4, 1.0, -0.8. HRMS calcd for $C_{20}H_{35}Si_2$ $[M+H]^+$ 331.2272; found: 331.2269.



Trimethyl (5-methyl-2- (3- (trimethylsilyl) bicyclo[2.2.1]heptan-2-yl) phenyl)silane (3d)

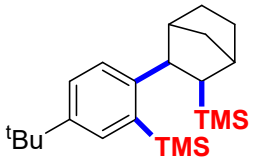
Colorless oil (150.2 mg, 90% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.28(d, *J* = 8.0 Hz ,1 H), 7.18(s, 1 H), 7.95(d, *J* = 6.0 Hz, 1 H), 3.12(d, *J*=10.4 Hz, 1 H), 1.96(d, *J* = 9.6 Hz, 1 H), 1.71-1.75(m, 1 H), 1.55-1.61(m, 1 H), 1.38-1.43(m, 1 H), 1.32-1.36(m, 2 H), 1.23-1.26(m, 2 H), 0.31(s, 9 H), -0.36(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 149.8, 138.7, 134.9, 134.2, 129.8, 126.5, 50.8, 45.1,

43.6, 38.8, 38.6, 32.8, 32.2, 21.1, 1.0, -0.7. HRMS calcd for $C_{20}H_{35}Si_2$ $[M+H]^+$ 331.2272; found: 331.2264.



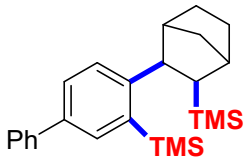
(5-ethyl-2-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) phenyl) trimethylsilane (3e)

Yellow oil (137.6 mg, 80% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.30(d, *J* = 8.0 Hz, 1 H), 7.21(s, 1 H), 7.12(d, *J* = 6.8 Hz, 1 H), 3.13(d, *J* = 10.4 Hz, 1 H), 2.56-2.62(m, 2 H), 2.30-2.35(m, 2 H), 1.97(d, *J* = 9.2 Hz, 1 H), 1.71-1.75(m, 1 H), 1.55-1.61(m, 1 H), 1.38-1.44(m, 1 H), 1.34(d, *J* = 9.6 Hz, 2 H), 1.26(s, 1 H), 1.19-1.23(m, 3 H), 0.32(s, 9 H), -0.37(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 150.0, 140.6, 138.7, 133.7, 128.7, 126.6, 50.7, 45.0, 43.5, 38.9, 38.6, 32.8, 32.2, 28.5, 15.8, 1.1, -0.7. HRMS calcd for $C_{21}H_{37}Si_2$ $[M+H]^+$ 345.2429; found: 345.2412.



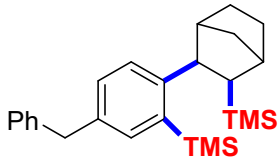
(5-(tert-butyl)-2-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) phenyl) trimethylsilane (3f)

Colorless oil (148.8 mg, 80% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.42(s, 1 H), 7.30-7.31(m, 2 H), 3.13(d, *J* = 10.0 Hz, 1 H), 2.34(s, 2 H), 1.97(d, *J* = 9.6 Hz, 1 H), 1.72-1.75(m, 1 H), 1.55-1.61(m, 1 H), 1.41-1.42(m, 1 H), 1.35(d, *J* = 9.2 Hz, 2 H), 1.30(s, 9 H), 1.24(d, *J* = 10.4 Hz, 1 H), 0.33(s, 1 H), -0.39(s, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) :δ = 149.7, 147.4, 138.1, 130.9, 126.2, 126.1, 50.6, 44.8, 43.6, 38.9, 38.6, 34.4, 32.8, 32.2, 31.5, 1.1, -0.8. HRMS calcd for $C_{23}H_{41}Si_2$ $[M+H]^+$ 373.2742; found: 373.2726.



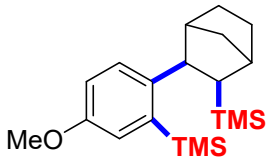
trimethyl((2R,3R)-3-(3-(trimethylsilyl)-[1,1'-biphenyl]-4-yl) bicyclo[2.2.1] heptan-2-yl) silane (3g)

Colorless solid (166.6 mg, 85% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm):δ = 7.63(d, *J* = 2.0 Hz, 1 H), 7.59(s, 1 H), 7.57(s, 1 H), 7.52-7.55(m, 1 H), 7.47(d, *J* = 8.0 Hz, 1 H), 7.39-7.43(m, 2 H), 7.28-7.32(m, 1 H), 7.20(d, *J* = 10.4 Hz, 1 H), 2.37(t, *J* = 10.0 Hz, 2 H), 2.00(d, *J* = 10.4 Hz, 1 H), 1.73-1.80(m, 1 H), 1.59-1.65(m, 1 H), 1.44-1.47(m, 1 H), 1.35-1.41(m, 2 H), 1.28-1.31(m, 1 H), 0.37(s, 9 H), -0.34(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.0, 141.5, 139.5, 137.7, 132.9, 128.7, 127.9, 127.1, 127.0, 126.9, 50.9, 45.0, 43.6, 38.9, 38.6, 32.8, 32.2, 1.0, -0.7. HRMS calcd for $C_{25}H_{37}Si_2$ $[M+H]^+$ 393.2429; found: 393.2433.



(5-benzyl-2-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) phenyl) trimethylsilane (3h)

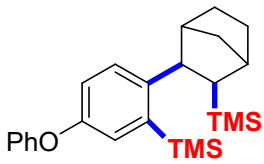
Colorless oil (144.2 mg, 71% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.30(d, *J* = 8.0 Hz, 1 H), 7.22-7.27(m, 3 H), 7.14-7.17(m, 3 H), 7.07-7.09(m, 1 H), 3.93(s, 2 H), 3.13(d, *J* = 10.4 Hz, 1 H), 2.29-2.34(m, 2 H), 1.92-1.96(m, 1 H), 1.70-1.77(m, 1 H), 1.55-1.61(m, 1 H), 1.38-1.43(m, 1 H), 1.33(d, *J* = 9.6 Hz, 2 H), 1.24-1.27(m, 1 H), 0.30(s, 9 H), -0.36(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 150.5, 141.5, 138.9, 137.3, 134.9, 129.9, 128.8, 126.7, 125.8, 50.8, 44.9, 43.6, 41.6, 38.9, 38.6, 32.8, 32.2, 1.0, -0.7. HRMS calcd for $C_{26}H_{39}Si_2$ $[M+H]^+$ 407.2585; found: 407.2589.



(5-methoxy-2-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) phenyl) trimethylsilane (3i)

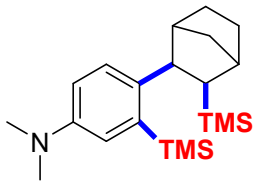
Yellow oil (141.8 mg, 86% yield, eluent: petroleum ether: ethyl acetate= 100:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.31(d, *J* = 8.8 Hz, 1 H), 6.96(d, *J*=2.8 Hz, 1 H), 6.82-6.85(m, 1 H), 3.78(s, 3 H), 3.10(d, *J* = 10.0 Hz, 1 H), 2.34(d, *J* = 4.4 Hz, 1 H), 2.27(d, *J* = 3.2 Hz, 1 H), 1.94(d, *J* = 10.0 Hz, 1 H), 1.72-1.77(m, 1 H), 1.55-1.61(m, 1

H), 1.40-1.43(m, 1 H), 1.34(d, *J* = 10.4 Hz, 2 H), 1.22-1.25(m, 2 H), 0.32(s, 9 H), -0.35(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 156.9, 145.0, 140.1, 127.6, 119.9, 113.8, 55.1, 50.3, 45.1, 43.5, 38.7, 38.5, 32.8, 32.1, 0.9, -0.7. HRMS calcd for $C_{20}H_{35}OSi_2$ $[M+H]^+$ 347.2221; found: 347.2218.



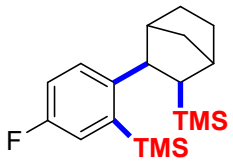
trimethyl(5-phenoxy-2-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) phenyl) silane (3j)

Yellow oil (159.1 mg, 82% yield, eluent: petroleum ether: ethyl acetate= 100:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.35(d, *J* = 8.4 Hz, 1 H), 7.27-7.31(m, 2 H), 7.10(t, *J* = 4.8 Hz, 1 H), 7.02-7.05(m, 1 H), 6.92-6.97(m, 3 H), 3.15(d, *J* = 10.4 Hz, 1 H), 2.36(s, 1 H), 2.31(s, 1 H), 1.94(d, *J* = 10.4 Hz, 1 H), 1.72-1.78(m, 1 H), 1.57-1.63(m, 1 H), 1.42-1.44(m, 1 H), 1.34-1.39(m, 2 H), 1.27(d, *J* = 10.4 Hz, 1 H), 0.30(s, 9 H), -0.32(s, 9 H). ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 158.0, 154.0, 148.1, 141.3, 129.6, 127.9, 125.0, 122.5, 119.9, 117.9, 50.5, 45.0, 43.6, 38.8, 38.6, 32.7, 32.2, 0.8, -0.6. HRMS calcd for $C_{25}H_{37}OSi_2$ $[M+H]^+$ 409.2378; found: 409.2363.



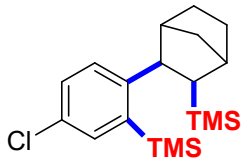
N,N-dimethyl-3-(trimethylsilyl)-4-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) aniline (3k)

Yellow oil (129.2 mg, 72% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.26(d, *J* = 8.4 Hz, 1 H), 6.83(d, *J* = 2.8 Hz, 1 H), 6.71-6.74(m, 1 H), 3.07(d, *J* = 10.0 Hz, 1 H), 2.82-2.90(m, 6 H), 1.94(d, *J* = 8.8 Hz，1 H), 1.70-1.76(m, 1 H), 1.54-1.60(m, 1 H), 1.39-1.42(m, 1 H), 1.32(d, *J* = 9.6 Hz, 2 H), 1.20-1.23(m, 1 H), 0.32(s, 9 H), -0.34(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 148.1, 141.4, 139.2, 127.3, 118.9, 114.1, 50.1, 45.0, 43.5, 41.0, 38.7, 38.5, 32.8, 32.1, 1.0, -0.7. HRMS calcd for $C_{21}H_{38}NSi_2$ $[M+H]^+$ 360.2538; found: 360.2536.



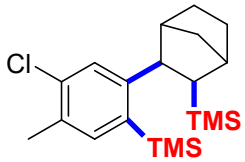
(5-fluoro-2-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) phenyl) trimethylsilane (3l)

Colorless oil (121.9 mg, 77% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.33-7.36(m, 1 H), 7.06-7.09(m, 1 H), 6.93-6.98(m, 1 H), 3.13(d, *J* = 10.4 Hz, 1 H), 2.35(d, *J* = 2.8 Hz, 1 H), 2.27(d, *J* = 2.4 Hz, 1 H), 1.91-1.94(m, 1 H), 1.72-1.76(m, 1 H), 1.57-1.62(m, 1 H), 1.40-1.43(m, 1 H), 1.34-1.37(m, 2 H), 1.24-1.27(m, 1 H), 0.32(s, 9 H), -0.35(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ =160.8, 148.4, 141.9, 128.1, 120.3, 115.7, 50.5, 45.1, 43.5, 38.7, 38.6, 32.7, 32.2, 0.7, -0.7. ^{19}F NMR (400 MHz, $CDCl_3$) δ= -118.6. HRMS calcd for $C_{19}H_{32}FSi_2$ $[M+H]^+$ 335.2021; found: 335.2018.



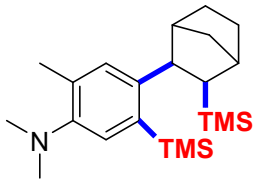
(5-chloro-2-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) phenyl) trimethylsilane (3m)

Yellow oil (126.2 mg, 76% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.31-7.33(m, 2 H), 7.23-7.26(m, 1 H), 3.11(d, *J* = 10.4 Hz, 1 H), 2.35(d, *J* = 3.6 Hz, 1 H), 2.26(d, *J* = 2.4 Hz, 1 H), 1.91(d, *J* = 10.0 Hz, 1 H), 1.72-1.76(m, 1 H), 1.56-1.62(m, 1 H), 1.40-1.43(m, 1 H), 1.34-1.37(m, 2 H), 1.23-1.27(m, 1 H), 0.32(s, 9 H), -0.34(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 151.1, 141.8, 133.7, 131.3, 129.0, 128.1, 50.6, 45.0, 43.5, 38.8, 38.6, 32.7, 32.1, 0.8, -0.7. HRMS calcd for $C_{19}H_{32}ClSi_2$ $[M+H]^+$ 351.1726; found: 351.1737.



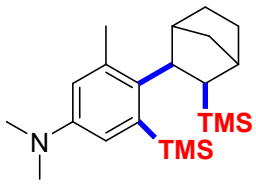
(5-chloro-4-methyl-2-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) phenyl) trimethylsilane(3p)

Colorless solid (143.8 mg, 79% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.30(s, 1 H), 7.23(s, 1 H), 3.08(d, *J* = 10.4 Hz, 1 H), 2.32-2.36(m, 4 H), 2.73(s, 1 H), 1.94(d, *J* = 9.6 Hz, 1 H), 1.72-1.76(m, 1 H), 1.56-1.62(m, 1 H), 1.40-1.43(m, 1 H), 1.32-1.37(m, 2 H), 1.22-1.26(m, 1 H), 0.31(s, 9 H), -0.35(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 151.2, 138.6, 136.4, 134.3, 131.5, 129.6, 50.5, 45.0, 43.6, 38.8, 38.5, 32.7, 32.1, 20.0, 0.8, -0.7. HRMS calcd for $C_{20}H_{34}ClSi_2$ $[M+H]^+$ 365.1882; found: 365.1872.



N,N,2-trimethyl-5-(trimethylsilyl)-4-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) aniline (3q)

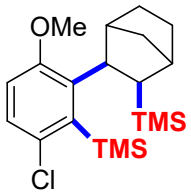
Yellow solid (126.8 mg, 68% yield, eluent: petroleum ether: ethyl acetate=200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ =7.16(s, 1 H), 7.06(s, 1 H), 3.08(d, *J* = 10.0 Hz, 1 H), 2.67(s, 6 H), 2.34(d, *J* = 4.0 Hz, 1 H), 2.31(d, *J* = 3.6 Hz, 1 H), 2.29(s, 3 H), 1.97(d, *J* = 10.0 Hz, 1 H), 1.70-1.77(m, 1 H), 1.55-1.61(m, 1 H), 1.39-1.42(m, 1 H), 1.32-1.35(m, 2 H), 1.20-1.23(m, 1 H), 0.31(s, 9 H), -0.38(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 149.7, 147.0, 136.3, 132.8, 129.6, 123.8, 50.4, 44.8, 44.4, 43.6, 38.8, 38.5, 32.8, 32.2, 18.2, 1.0, -0.8. HRMS calcd for $C_{22}H_{40}NSi_2$ $[M+H]^+$ 374.2694; found: 374.2690.



N,N,3-trimethyl-4-(trimethylsilyl)-5-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) aniline (3r)

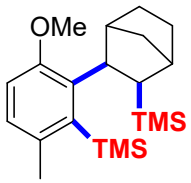
Yellow oil (121.3 mg, 65% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 6.80(d, *J*=2.8 Hz, 1 H), 6.49(d, *J* = 2.8 Hz, 1 H), 3.38(d, *J* = 10.8 Hz, 1 H), 2.88(s, 6 H), 2.61(s, 1 H), 2.46(s, 3 H), 2.33(d, *J* = 4.8 Hz, 1 H), 1.94-1.97(m, 1 H), 1.78-1.83(m, 1 H), 1.53-1.58(m, 1 H), 1.43-1.48(m, 1 H), 1.39(d, *J* = 2.0 Hz, 1 H), 1.32-1.36(m, 2 H), 1.29(d, *J* = 10.4 Hz, 1 H), 0.34(s, 9 H), -0.37(s, 9

H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 148.2, 142.4, 137.4, 135.7, 118.6, 118.6, 52.7, 45.0, 41.4, 41.0, 39.7, 38.9, 33.5, 32.3, 23.6, 2.1, -0.6. HRMS calcd for $C_{22}H_{40}NSi_2$ $[M+H]^+$ 374.2694; found: 374.2689.



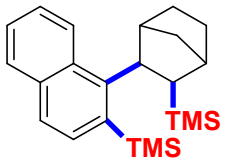
((2R,3R)-3-(6-chloro-3-methoxy-2-(trimethylsilyl)phenyl) bicyclo[2.2.1] heptan-2-yl) trimethylsilane (3s)

Colorless solid (153.9 mg, 81% yield, eluent: petroleum ether: ethyl acetate= 100:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.14(d, *J* = 8.4 Hz, 1 H), 6.71(d, *J* = 8.8 Hz, 1 H), 3.70(s, 3 H), 3.43(d, *J* = 10.8 Hz, 1 H), 2.43(s, 1 H), 2.30(d, *J* = 4.8 Hz, 1 H), 2.12(d, *J* = 9.2 Hz, 1 H), 1.73-1.80(m, 1 H), 1.45-1.53(m, 1 H), 1.33-1.36(m, 1 H), 1.21-1.26(m, 2 H), 1.16(d, *J* = 9.2 Hz, 1 H), 0.50(s, 9 H), -0.4(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 156.5, 141.1, 140.4, 132.7, 128.7, 112.8, 54.2, 49.5, 44.5, 42.7, 39.3, 39.2, 33.0, 32.4, 4.2, -0.7. HRMS calcd for $C_{20}H_{34}ClOSi_2$ $[M+H]^+$ 381.1831; found: 381.1819.



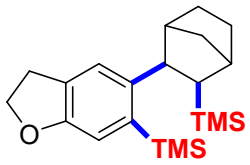
(6-methoxy-3-methyl-2-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) phenyl) trimethylsilane (3t)

Yellow oil (129.6 mg, 72% yield, eluent: petroleum ether: ethyl acetate= 100:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 6.94(d, *J* = 8.4 Hz, 1 H), 6.70(d, *J* = 8.0 Hz, 1 H), 3.69(s, 3 H), 3.38(d, *J* = 10.8 Hz, 1 H), 2.43(s, 1 H), 2.38(s, 3 H), 2.29(d, *J* = 4.8 Hz, 1 H), 2.21(d, *J* = 9.2 Hz, 1 H), 1.74-1.80(m, 1 H), 1.49-1.54(m, 1 H), 1.36-1.41(m, 1 H), 1.20-1.23(m, 2 H), 1.15(d, *J* = 9.6 Hz, 1 H), 0.43(s, 9 H), -0.40(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 156.0, 141.0, 139.2, 135.6, 129.6, 111.7, 53.8, 50.1, 44.4, 42.8, 39.3, 39.2, 33.0, 32.6, 24.4, 4.9, -0.8. HRMS calcd for $C_{21}H_{37}OSi_2$ $[M+H]^+$ 361.2378; found: 361.2383.



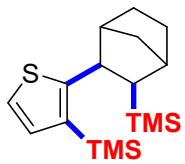
trimethyl(3-((2R,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) naphthalen-2-yl) silane (3u)

Yellow solid (131.8 mg, 72% yield, eluent: petroleum ether: ethyl acetate= 100:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ =9.03(d, *J* = 9.6 Hz, 1 H), 8.20(d, *J* = 9.2 Hz, 1 H), 8.08(d, *J* = 8.4 Hz, 1 H), 7.97(d, *J* = 8.4 Hz, 1 H), 7.82-7.82(m, 3 H), 4.23(d, *J* = 10.8 Hz, 1 H), 3.49(s, 1 H), 2.86(s, 1 H), 2.75(d, *J* = 9.6 Hz, 1 H), 2.30-2.35(m, 1 H), 2.10-2.11(m, 1 H), 2.02-2.05(m, 1 H), 1.98(d, *J* = 10.4 Hz, 1 H), 1.85-1.88(m, 2 H), 0.84(s, 9 H), -0.30(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 148.4, 139.0, 135.3, 132.2, 131.4, 128.6, 126.7, 126.1, 125.5, 124.4, 54.2, 45.6, 42.7, 40.4, 39.3, 34.0, 32.2, 2.1, -1.0. HRMS calcd for $C_{23}H_{35}Si_2$ $[M+H]^+$ 367.2272; found: 367.2263.



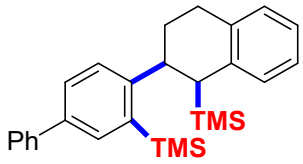
trimethyl((2R,3R)-3-(5-(trimethylsilyl)-2,3-dihydrobenzofuran-6-yl) bicyclo[2.2.1] heptan-2-yl) silane (3v)

Colorless solid (125.3 mg, 70% yield, eluent: petroleum ether: ethyl acetate= 100:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.16-7.24(m, 1 H), 6.73-6.85(m, 1 H), 4.43-4.55(m, 2 H), 3.11-3.19(m, 3 H), 2.34(s, 1 H), 2.27(s, 1 H), 1.94(d, *J* = 10.0 Hz, 1 H), 1.70-1.77(m, 1 H), 1.55-1.61(m, 1 H), 1.40-1.43(m, 1 H), 1.33-1.37(m, 2 H), 1.24(d, *J* = 9.6 Hz, 1 H), 0.30(s, 9 H), -0.34(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ =157.7, 145.1, 138.7, 127.9, 123.4, 114.1, 50.3, 45.0, 43.8, 38.8, 38.5, 32.8, 32.1, 29.9, 1.0, -0.7. HRMS calcd for $C_{21}H_{35}OSi_2$ $[M+H]^+$ 359.2221; found: 359.2226.



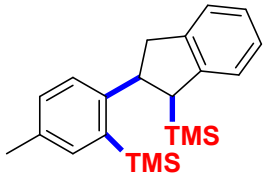
trimethyl(2-((2S,3R)-3-(trimethylsilyl) bicyclo[2.2.1] heptan-2-yl) thiophen-3-yl) silane (3w)

Colorless oil (117.6 mg, 73% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.09(d, *J* = 4.8 Hz, 1 H), 6.88(d, *J* = 5.2 Hz, 1 H), 3.49(d, *J* = 10.4 Hz, 1 H), 2.32(d, *J* = 4.0 Hz, 1 H), 2.28(d, *J* = 2.8 Hz, 1 H), 1.90(d, *J* = 10.4 Hz, 1 H), 1.67-1.73(m, 1 H), 1.61-1.66(m, 1 H), 1.35-1.38(m, 1 H), 1.29-1.34(m, 2 H), 1.17-1.20(m, 2 H), 0.28(s, 9 H), -0.24(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 157.9, 135.7, 131.4, 121.9, 48.3, 46.1, 41.9, 39.1, 37.6, 32.7, 31.2, 0.6, -1.1. HRMS calcd for $C_{17}H_{40}SSi_2$ $[M+H]^+$ 323.1680; found: 323.1679.



trimethyl(4-((1S,2R)-1-(trimethylsilyl)-1,2,3,4-tetrahydronaphthalen-2-yl)-[1,1'-biphenyl]-3-yl)silane (3x)

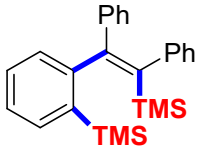
Colorless oil (128.6 mg, 63% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.77(d, *J* = 2.0 Hz, 1 H), 7.61(d, *J* = 7.6 Hz, 2 H), 7.54-7.56(m, 1 H), 7.41-7.47(m, 3 H), 7.32-7.36(m, 1 H), 7.13(d, *J* = 6.4 Hz, 1 H), 7.06-7.08(m, 2 H), 6.92-6.94(m, 1 H), 3.55-3.58(m, 1 H), 3.00-3.09(m, 2 H), 2.66(d, *J* = 2.8 Hz, 1 H), 2.42-2.48(m, 1 H), 2.18-2.22(m, 1 H), 0.33(s, 9 H), -0.23(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 150.3, 141.4, 140.2, 139.7, 138.2, 135.6, 134.1, 129.3, 129.1, 128.7, 127.7, 127.3, 127.0, 124.7, 124.5, 42.4, 40.8, 28.8, 26.9, 1.4, 0.7. HRMS calcd for $C_{28}H_{36}Si_2$ $[M+H]^+$ 429.2429; found: 429.2410.



trimethyl(5-methyl-2-((1S,2R)-1-(trimethylsilyl)-2,3-dihydro-1H-inden-2-yl)phenyl)silane (3y)

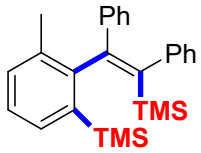
Colorless oil (116.2 mg, 66% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.29-73.1(m, 2 H), 7.22-7.24(m, 1 H), 7.14-7.15(m, 2 H),7.10-7.12(m, 1 H), 7.07-7.09(m, 1 H), 4.12-4.18(m, 1 H), 3.26-3.32(m, 1 H), 3.11-3.17(m, 1 H), 2.90(d, *J* = 8.8 Hz, 1 H), 0.34(s, 9 H), -0.24(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$,

ppm): δ = 146.2, 146.2, 142.6, 138.9, 135.8, 135.0, 129.6, 126.5, 125.9, 125.0, 124.4, 123.8, 49.1, 43.3, 40.1, 21.2, 1.2, -0.9. HRMS calcd for $C_{22}H_{32}Si_2$ $[M+H]^+$ 353.2116; found: 353.2108.



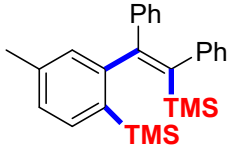
(Z)-(1,2-diphenyl-2-(2-(trimethylsilyl) phenyl) vinyl) trimethylsilane (5a)

Colorless solid (166.1 mg, 83% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.67(d, *J* = 7.2 Hz, 1 H), 7.54-7.56(m, 2 H), 7.22-7.48(m, 6 H), 7.04-7.06(m, 3 H), 6.97-6.99(m, 2 H), 0.12(s, 9 H), -0.15(s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.7, 149.7, 144.0, 143.9, 141.4, 138.8, 135.1, 131.8, 131.6, 130.8, 128.3, 128.2, 126.9, 126.6, 126.4, 125.2, 0.1, 0.0. HRMS calcd for $C_{26}H_{33}Si_2$ $[M+H]^+$ 401.2116; found: 401.2116.



(Z)-(2-(1,2-diphenyl-2-(trimethylsilyl) vinyl)-3-methylphenyl) trimethylsilane (5b)

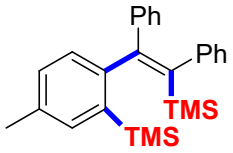
Colorless oil (169.8 mg, 82% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.42-7.46(m, 3 H), 7.31-7.37(m, 3 H), 7.16-7.25(m, 2 H), 7.03-7.06(m, 3 H), 6.97-6.99(m, 2 H), 2.52(s, 3 H), 0.10(s, 9 H), -0.15(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.8, 146.9, 144.0, 143.9, 141.7, 138.4, 135.8, 132.8, 131.8, 131.6, 130.8, 128.8, 127.1, 126.9, 126.3, 125.2, 21.4, 0.1, 0.1. HRMS calcd for $C_{27}H_{35}Si_2$ $[M+H]^+$ 415.2272; found: 415.2270.



(Z)-(2-(1,2-diphenyl-2-(trimethylsilyl) vinyl)-4-methylphenyl) trimethylsilane (5c)

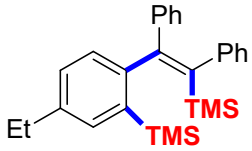
Colorless oil (173.9 mg, 84% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ =7.56(d, *J* = 7.2 Hz, 1 H), 7.43-7.46(m, 1 H), 7.23-

7.37(m, 6 H), 7.03-7.05(m, 3 H), 6.99-7.01(m, 2 H), 2.57(s, 3 H), 0.10(s, 9 H), -0.15(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.0, 149.7, 144.0, 143.8, 141.4, 137.8, 135.1, 135.1, 132.9, 131.6, 130.8, 128.3, 127.3, 126.9, 126.3, 125.2, 21.3, 0.1. HRMS calcd for $C_{27}H_{35}Si_2$ $[M+H]^+$ 415.2272; found: 415.2277.



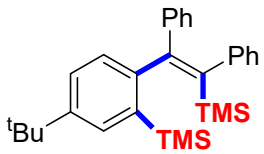
(Z)-(2-(1,2-diphenyl-2-(trimethylsilyl) vinyl)-5-methylphenyl) trimethylsilane (5d)

Colorless oil (192.5 mg, 93% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.44-7.46(m, 2 H), 7.42(d, *J* = 7.6 Hz, 1 H), 7.32-7.37(m, 2 H), 7.15-7.30(m, 3 H), 7.02-7.04(m, 3 H), 6.98-7.00(m, 2 H), 2.52(s, 3 H), 0.10(s, 9 H), -0.15(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.8, 146.9, 144.0, 143.9, 141.7, 138.4, 135.8, 131.8, 131.6, 130.8, 128.8, 128.3, 128.2 ,126.9, 126.3, 125.2, 21.4, 0.1, 0.1. HRMS calcd for $C_{27}H_{35}Si_2$ $[M+H]^+$ 415.2272; found: 415.2269.



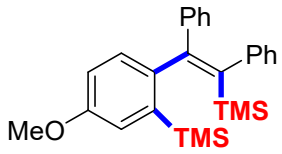
(Z)-(2-(1,2-diphenyl-2-(trimethylsilyl) vinyl)-5-ethylphenyl) trimethylsilane (5e)

Colorless oil (194.4 mg, 79% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.48-7.51(m, 2 H), 7.35-7.43(m, 3H), 7.21-7.29(m, 3 H), 7.07-7.09(m, 3 H), 7.02-7.05(m, 2 H), 2.86(dd, *J* = 7.2 Hz, 2 H), 1.45(t, *J* = 7.6 Hz, 3 H), 0.15(s, 9 H), -0.12(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.8, 147.1, 144.0, 143.9, 142.2, 141.7, 138.3, 134.7, 131.8, 131.6, 130.8, 128.3, 127.5, 126.9, 126.2, 125.1, 28.7, 15.7, 0.1, 0.0. HRMS calcd for $C_{28}H_{37}Si_2$ $[M+H]^+$ 429.2429; found: 429.2415.



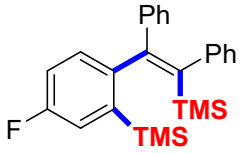
(Z)-(5-(tert-butyl)-2-(1,2-diphenyl-2-(trimethylsilyl)vinyl) phenyl) trimethylsilane (5f)

Colorless solid (180.2 mg, 79% yield, eluent: petroleum ether: ethyl acetate= 100:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.71(d, *J* = 2.0 Hz, 1 H), 7.57-7.59(m, 1 H), 7.48(d, *J* = 7.6 Hz, 1 H), 7.34-7.40(m, 2 H), 7.20-7.28(m, 3 H), 7.07-7.09(m, 3 H), 7.02-7.04(m, 3 H), 1.52(s, 9 H), 0.15(s, 9 H), -0.15(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.8, 149.0, 146.7, 144.1, 141.7 137.7, 131.8, 131.5, 130.8, 129.6, 127.7, 126.9, 126.2, 125.1, 125.0, 34.6, 31.5, 0.2, -0.1. HRMS calcd for $C_{30}H_{41}Si_2$ $[M+H]^+$ 457.2742; found: 457.2750.



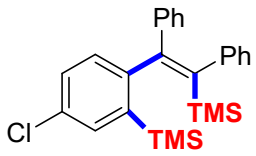
(Z)-(2-(1,2-diphenyl-2-(trimethylsilyl)vinyl)-5-methoxyphenyl) trimethylsilane(5g)

Colorless solid (189.2 mg, 88% yield, eluent: petroleum ether: ethyl acetate= 40:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.44(d, *J* = 8.4 Hz, 1 H), 7.28-7.34(m, 2 H), 7.13-7.23(m, 4 H), 7.00-7.06(m, 4 H), 6.94-6.97(m, 2 H), 3.96(s, 3 H), 0.08(s, 9 H), -0.15(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 158.1, 152.5, 144.2, 144.0, 142.3, 141.8, 140.4, 133.0, 130.9, 129.5, 127.7, 126.9, 126.3, 125.2, 121.5, 112.1, 55.1, 0.1, -0.1. HRMS calcd for $C_{27}H_{35}OSi_2$ $[M+H]^+$ 431.2221; found: 431.2221.

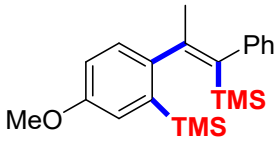


(Z)-(2-(1,2-diphenyl-2-(trimethylsilyl) vinyl)-5-fluorophenyl) trimethylsilane (5h)

Colorless solid (146.3 mg, 70% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.48(dd, *J* = 8.0 Hz, 1 H), 7.29-7.35(m, 3 H), 7.13-7.24(m, 4 H), 7.01-7.04(m, 3 H), 6.92-6.95(m, 2 H), 0.09(s, 9 H), -0.15(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 161.8, 151.7, 145.7, 144.7, 143.7, 142.1, 141.3, 133.4, 131.6, 130.8, 128.3, 127.0, 126.5, 125.3, 121.6, 114.7, 0.1, -0.2. ^{19}F NMR (400 MHz, $CDCl_3$) δ= -116.0. HRMS calcd for $C_{26}H_{32}FSi_2$ $[M+H]^+$ 419.2021; found: 419.2019.

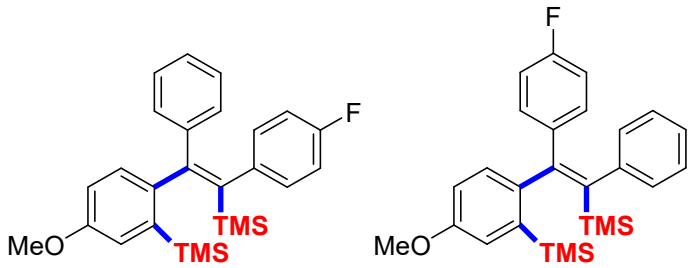


(Z)-(5-chloro-2-(1,2-diphenyl-2-(trimethylsilyl) vinyl)phenyl)trimethylsilane (5i)

White solid (160.6 mg, 74% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.59(d, *J* = 2.4 Hz, 1 H), 7.51-7.53(m, 1 H), 7.43-7.46(m, 2 H), 7.29-7.35(m, 2 H), 7.20-7.24(m, 1 H), 7.01-7.05(m, 4 H), 6.91-6.93(m, 2 H), 0.09(s, 9 H), -0.15(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 151.5, 148.0, 144.7, 143.6, 141.7, 141.0, 134.9, 133.2, 133.1, 131.6, 130.8, 128.3, 128.1, 127.0, 126.6, 125.4, 0.1, -0.2. HRMS calcd for $C_{26}H_{32}ClSi_2$ $[M+H]^+$ 435.1726; found: 435.1734. 

(Z)-(5-methoxy-2-(1-phenyl-1-(trimethylsilyl)prop-1-en-2-yl)phenyl)trimethylsilane (5j)[6]

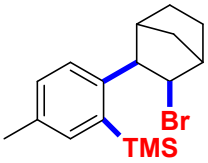
Colorless oil (138.4mg, 75% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.46-7.50(m, 1 H), 7.31-7.35(m, 2 H), 7.17-7.21(m, 1 H), 7.09 (t, *J* = 2.8 Hz, 1 H), 7.03-7.06(m, 2 H), 6.83-6.86(m, 1 H), 3.83(s, 3 H), 1.73(s, 3 H) 0.35(s, 9 H), -0.34(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 157.6, 150.6, 144.9, 144.1, 141.3, 131.8, 130.2, 128.1, 127.9, 125.1, 121.0, 112.8, 55.1, 26.1, 0.1, -0.1. HRMS calcd for $C_{22}H_{32}OSi_2$ $[M+H]^+$ 369.2065; found: 369.2048.



(Z)-(2-(2-(4-fluorophenyl)-1-phenyl-2-(trimethylsilyl)vinyl)-5-methoxyphenyl) trimethylsilane (5k)

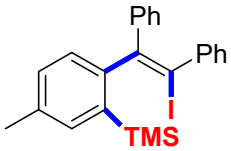
(Z)-(2-(4-fluorophenyl)-2-(4-methoxy-2-(trimethylsilyl)phenyl)-1-phenylvinyl) trimethylsilane (5k')

White solid (157.9 mg, 70% yield, regioisomer ratio ≈ 1:1, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.31(d, *J* = 8.0 Hz, 1 H), 7.20-7.23(m, 1 H), 7.09-7.14(m, 2 H), 6.94-6.96(m, 5 H), 6.81-6.84(m, 2 H), 6.62(t, *J* = 8.8 Hz, 1 H), 3.87(s, 3 H), -0.03--0.01(m, 9 H), -0.25(s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ =162.3, 159.9, 158.2, 158.2, 153.3, 151.3, 144.3, 143.9, 143.1, 142.1, 142.1, 141.7, 140.4, 140.4, 139.8, 139.8, 138.0, 132.9, 132.5, 132.4, 130.9, 127.0, 126.4, 125.3, 121.6, 121.5, 113.9, 113.7, 112.2, 112.1, 55.1, 0.1, -0.1, -0.1. ^{19}F NMR (400 MHz, $CDCl_3$) δ= -115.6, -118.1. HRMS calcd for $C_{27}H_{33}FOSi_2$ $[M+H]^+$ 449.2127; found: 449.2104.



(2-((2R)-3-bromobicyclo[2.2.1]heptan-2-yl)-5-methylphenyl)trimethylsilane (6)

Colorless solid (147.8 mg, 88% yield, eluent: petroleum ether). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.59(s, 1H), 7.53(d, *J* = 7.6 Hz, 1 H), 7.31(d, *J* = 8.8 Hz, 1 H), 3.65(d, *J* = 10.4 Hz, 1 H), 2.64(d, *J* = 5.2 Hz, 2 H), 7.31(s, 3 H), 2.10(d, *J* = 9.6 Hz, 1 H), 1.98-2.04(m, 1 H), 1.86-1.92(m, 1 H), 1.62-1.73(m, 4 H), 0.00(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 142.2, 137.0, 132.8, 127.9, 127.8, 126.6, 49.2, 43.6, 40.3, 39.0, 38.3, 32.4, 32.1, 20.5, -0.5. HRMS calcd for $C_{17}H_{26}BrSi$ $[M+H]^+$ 337.0982; found: 337.0988.



(Z)-(2-(2-iodo-1,2-diphenylvinyl)-5-methylphenyl)trimethylsilane (7)

colorless oil (170.8 mg, 73% yield, eluent: petroleum ether: ethyl acetate= 200:1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.87(s, 1H), 7.65-7.67(m, 1 H), 7.53(d, *J* = 7.6 Hz, 1 H), 7.40-7.42(m, 2 H), 7.36-7.38(m, 1 H), 7.32-7.34(m, 1 H), 7.21-7.24(m, 4 H), 7.13-7.15(m, 2 H), 2.51(s, 3 H), 0.00(s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.5, 145.4, 144.9, 143.6, 140.9, 139.8, 138.8, 135.6, 130.5, 128.8, 127.7, 127.6, 127.0,

126.1, 125.2, 101.3, 20.6, 0.0. HRMS calcd for $C_{24}H_{26}ISi$ $[M+H]^+$ 469.0843; found: 469.0839.

IV.References

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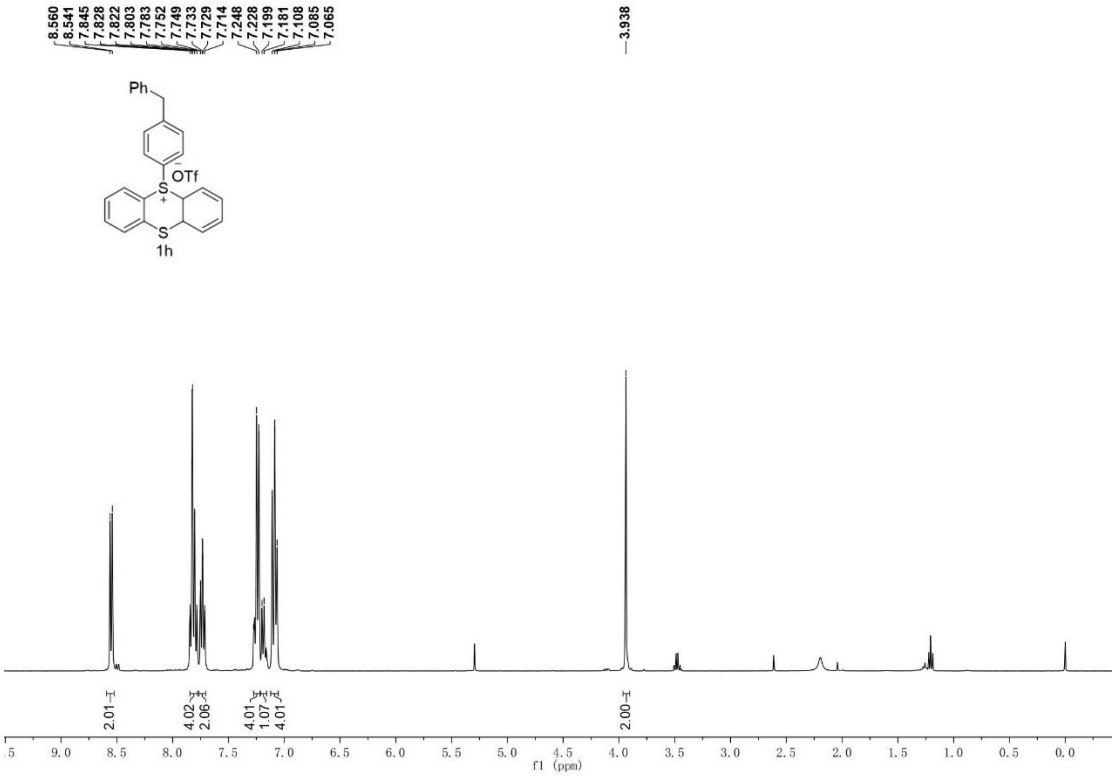
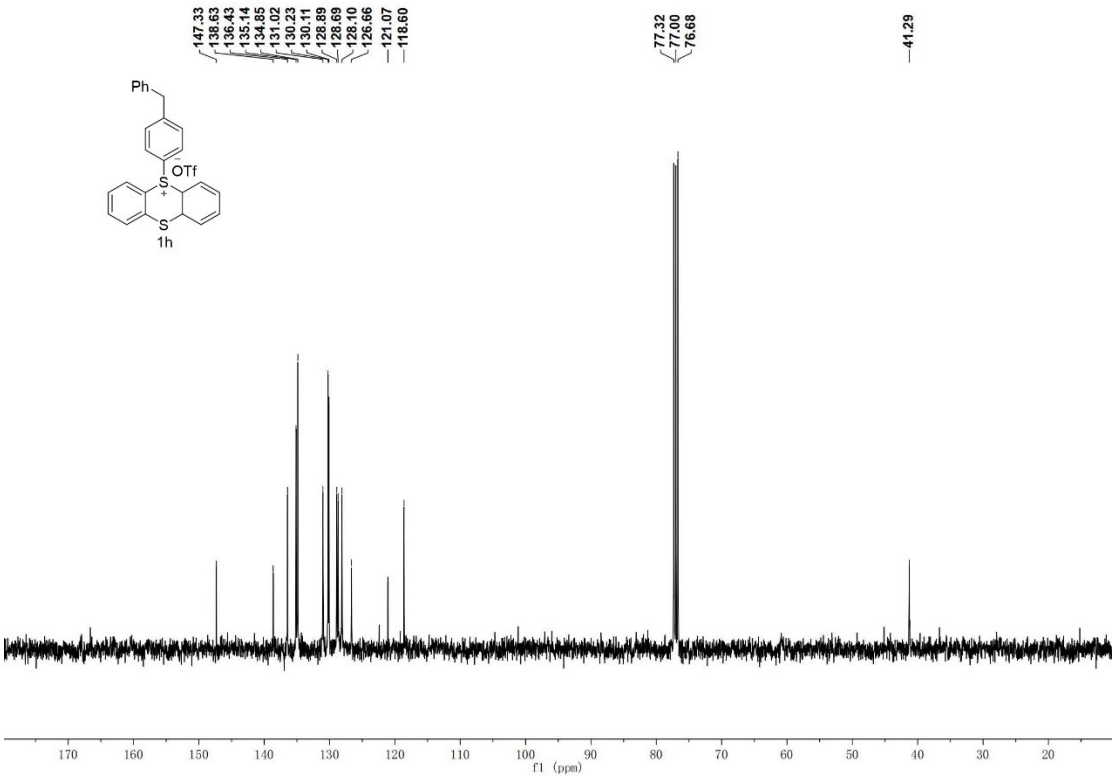
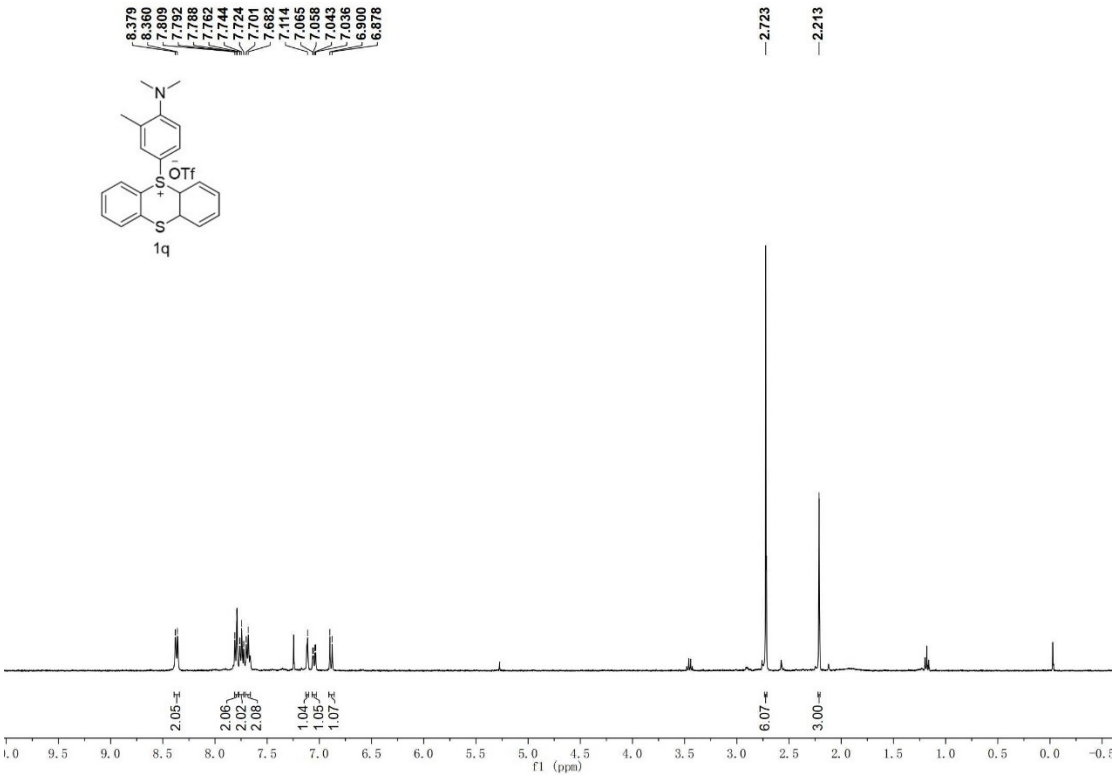
V.NMR spectra



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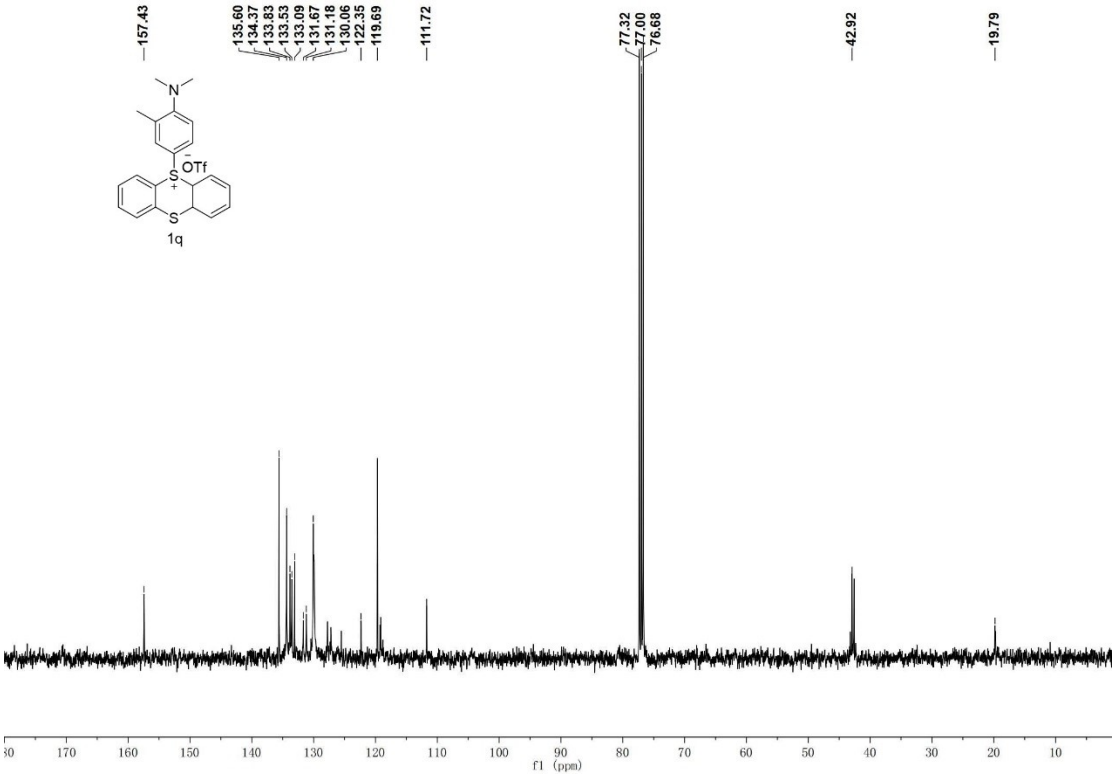
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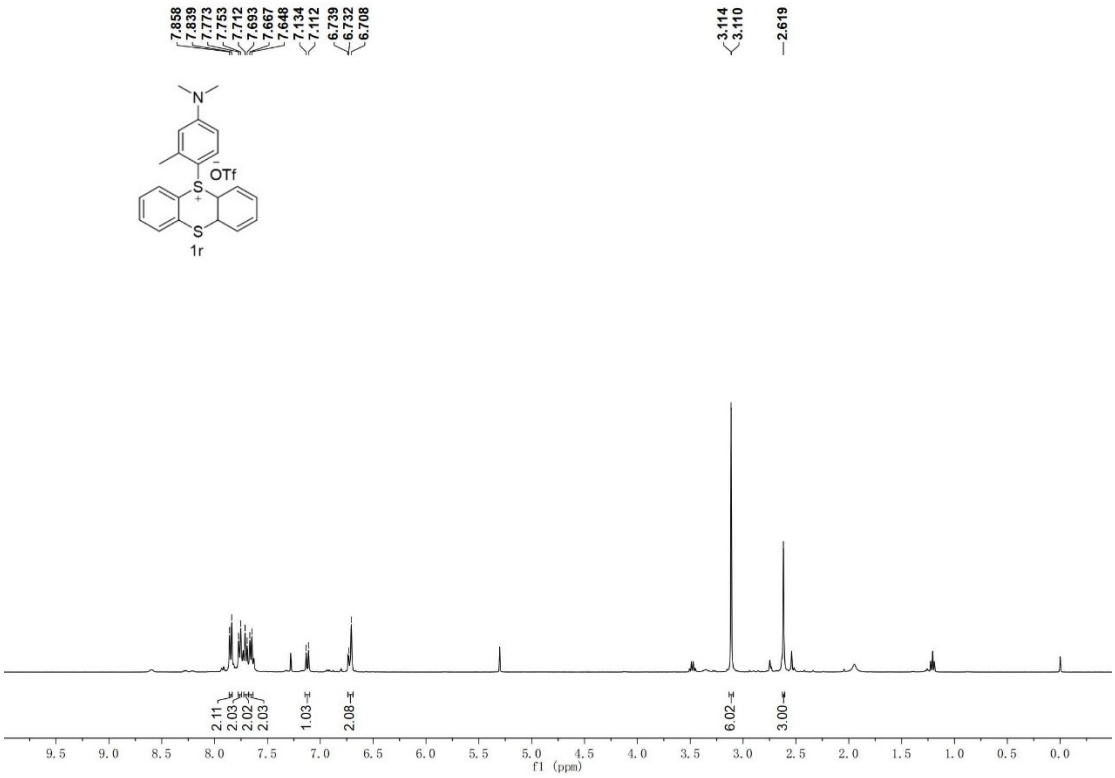
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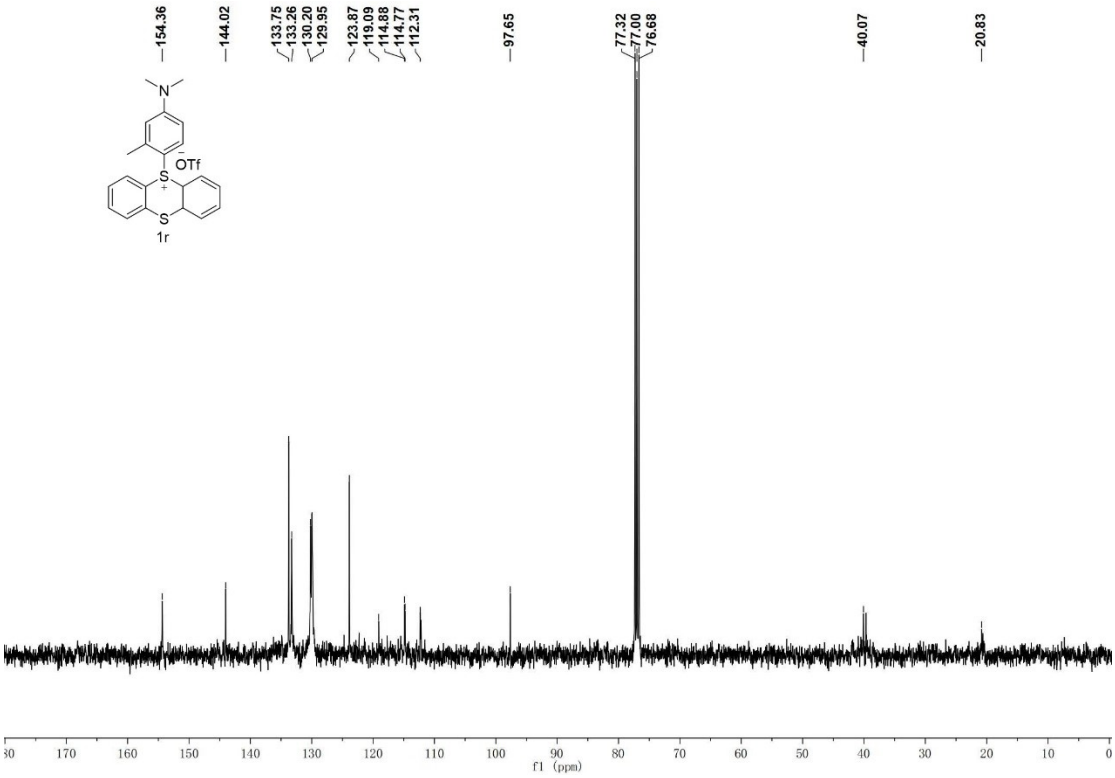
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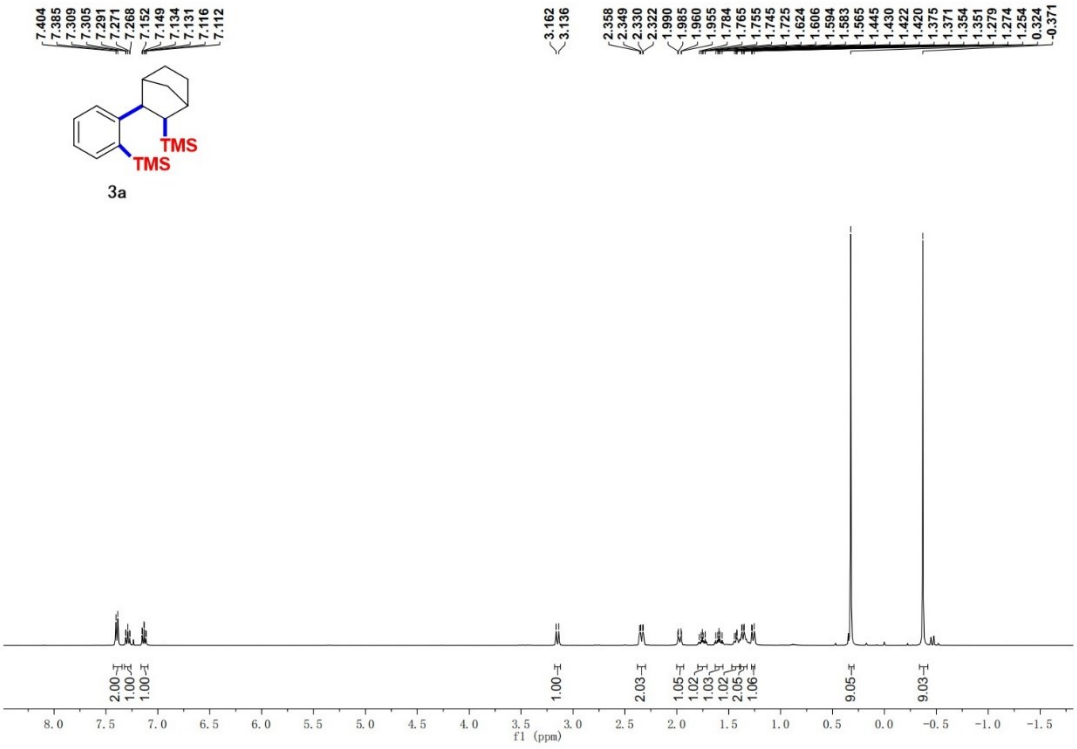
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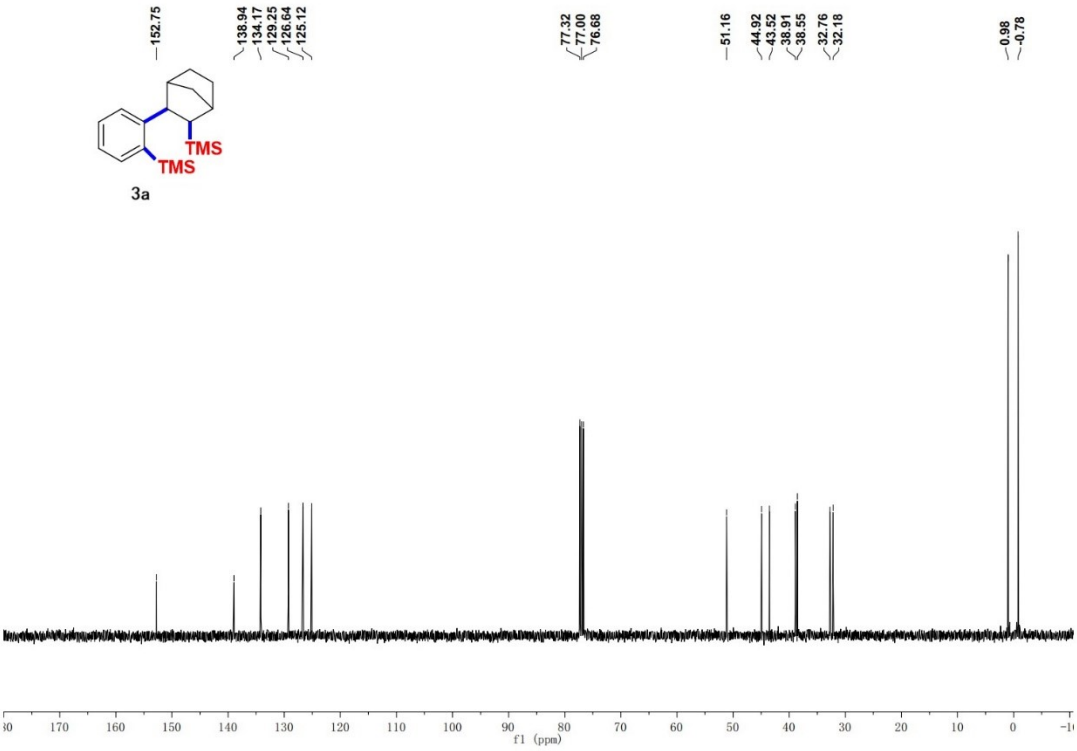
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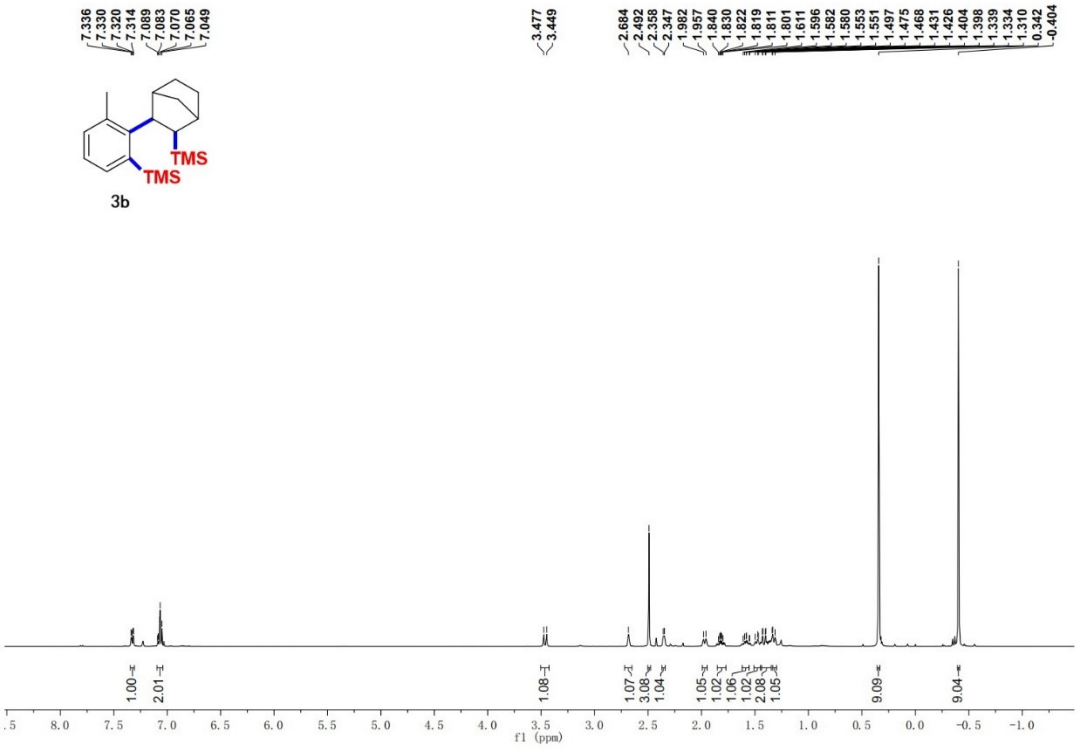
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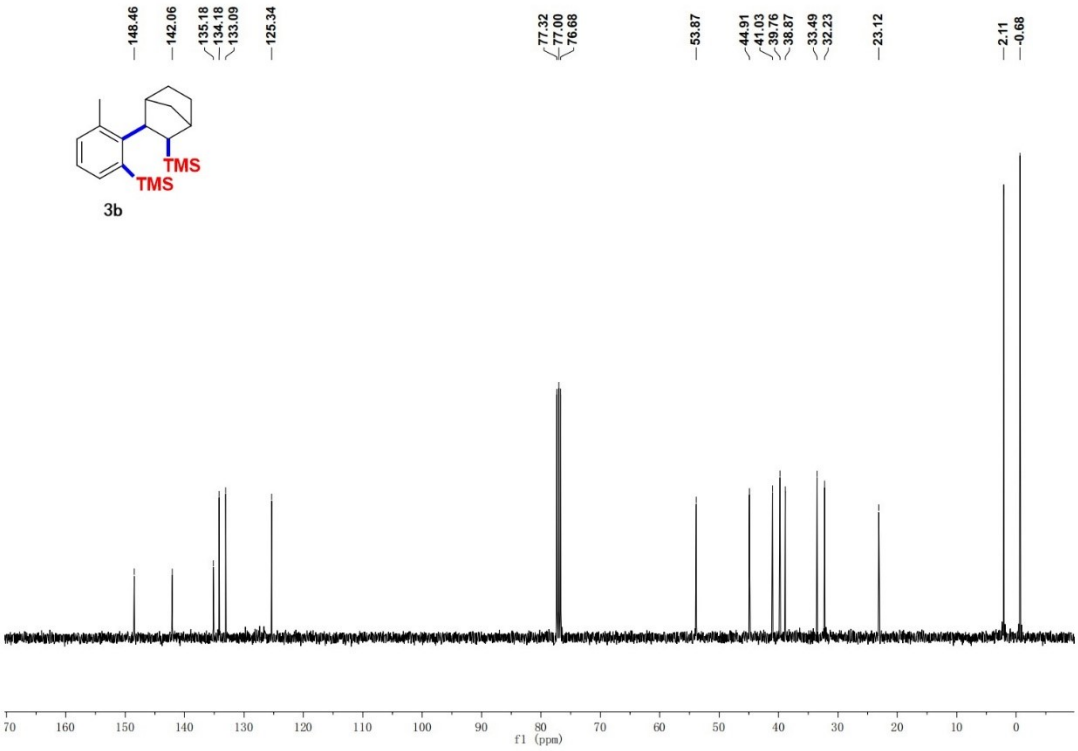
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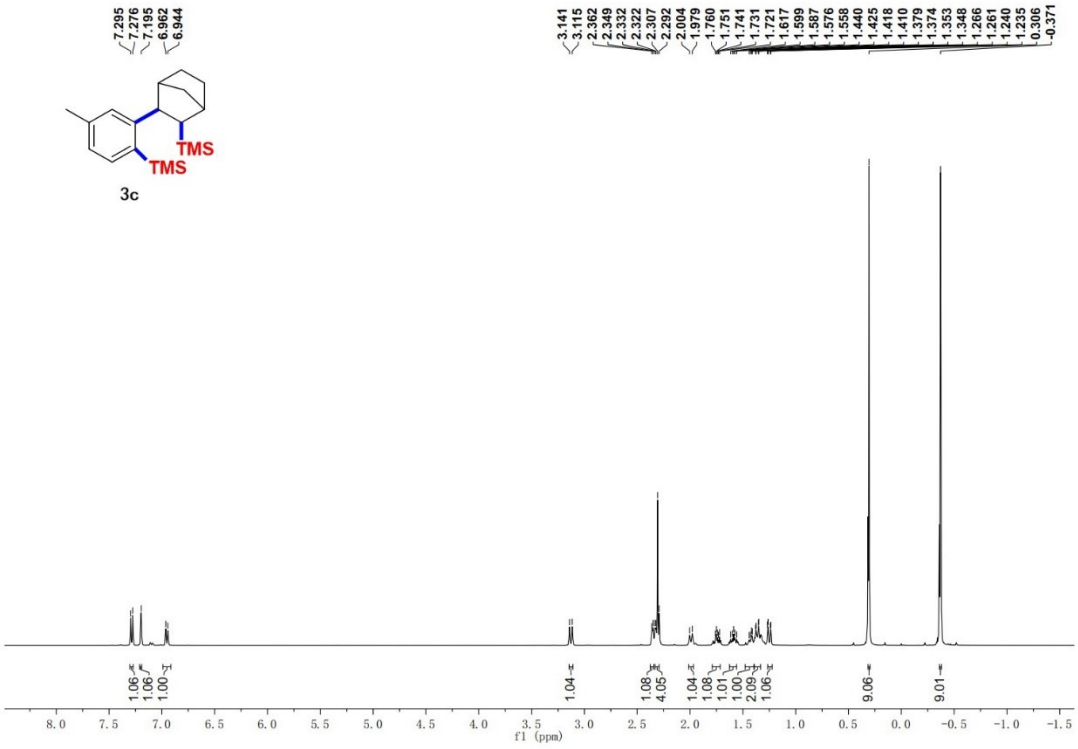
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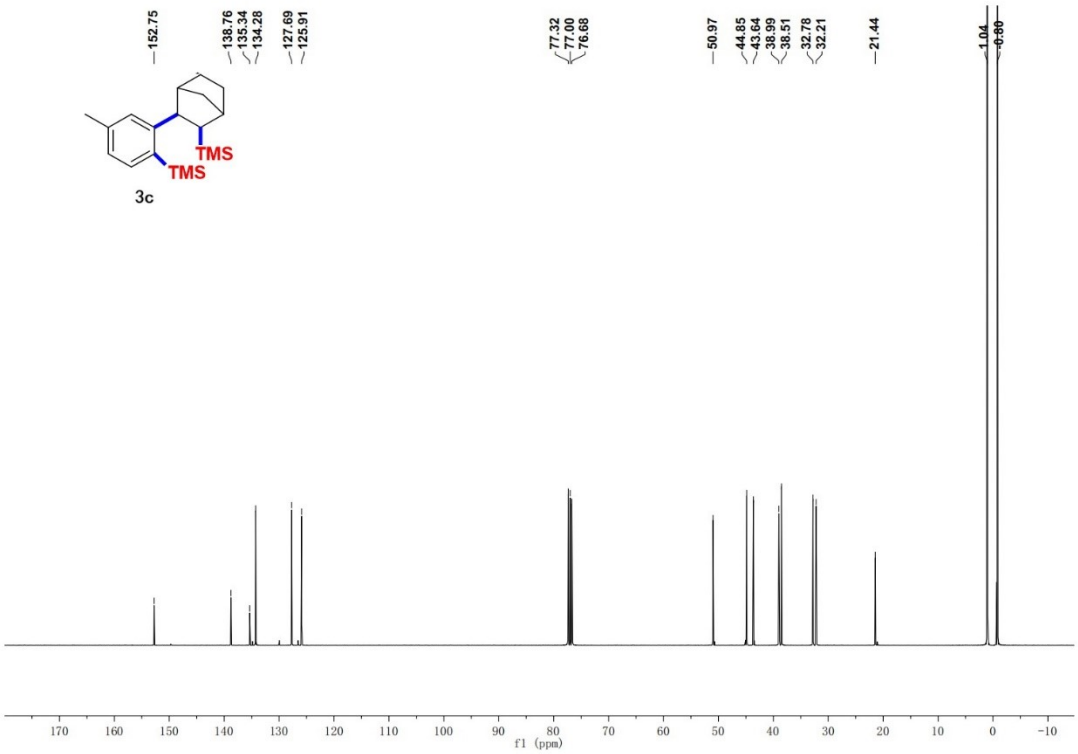
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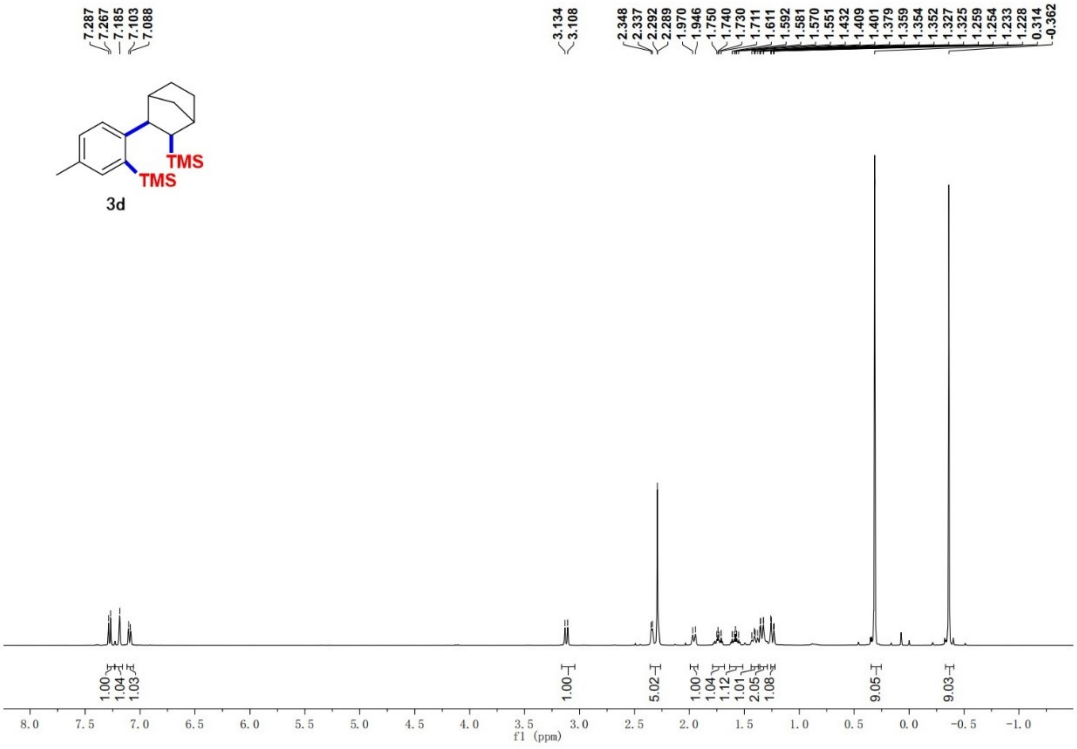
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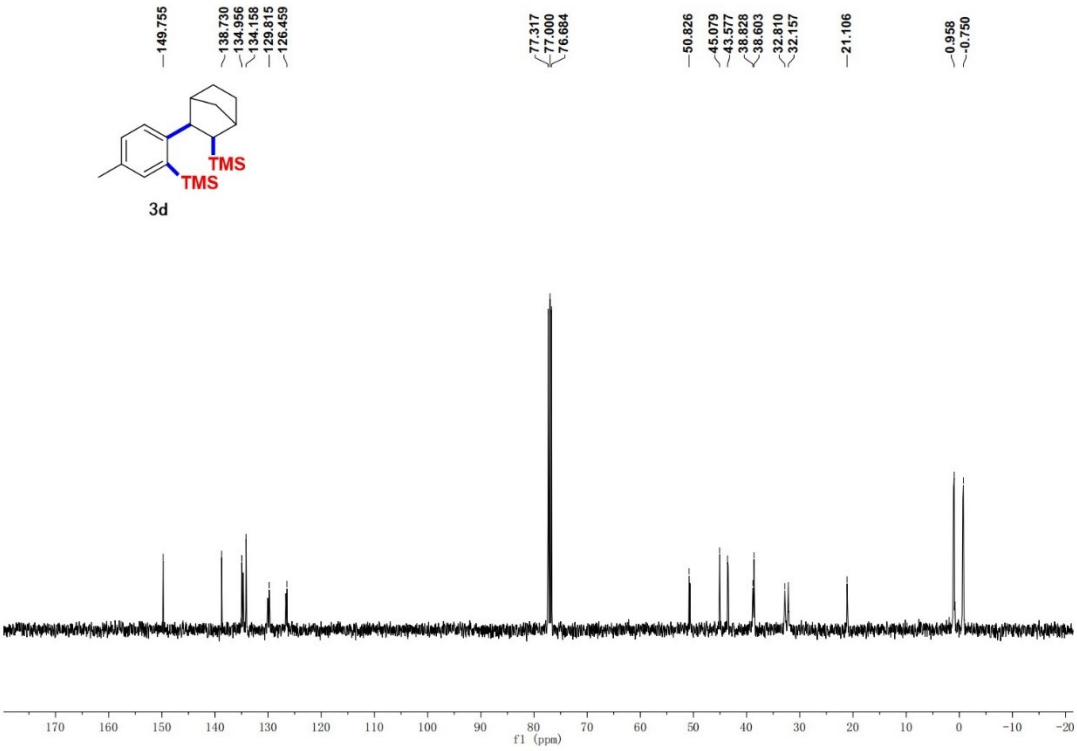
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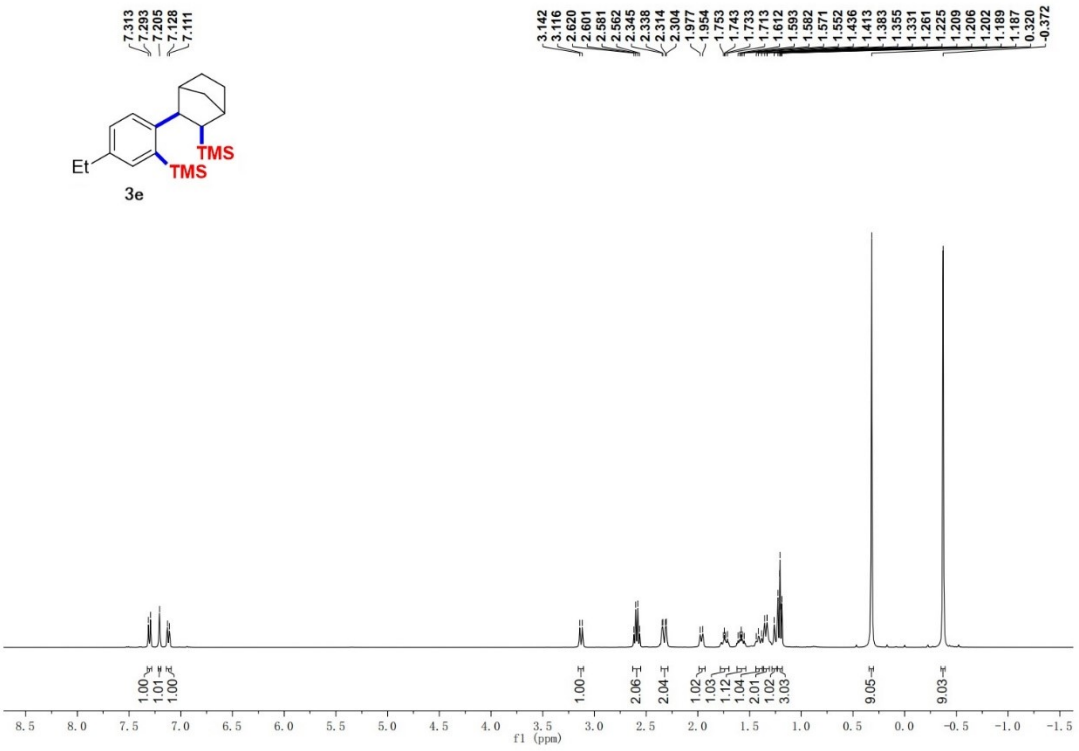
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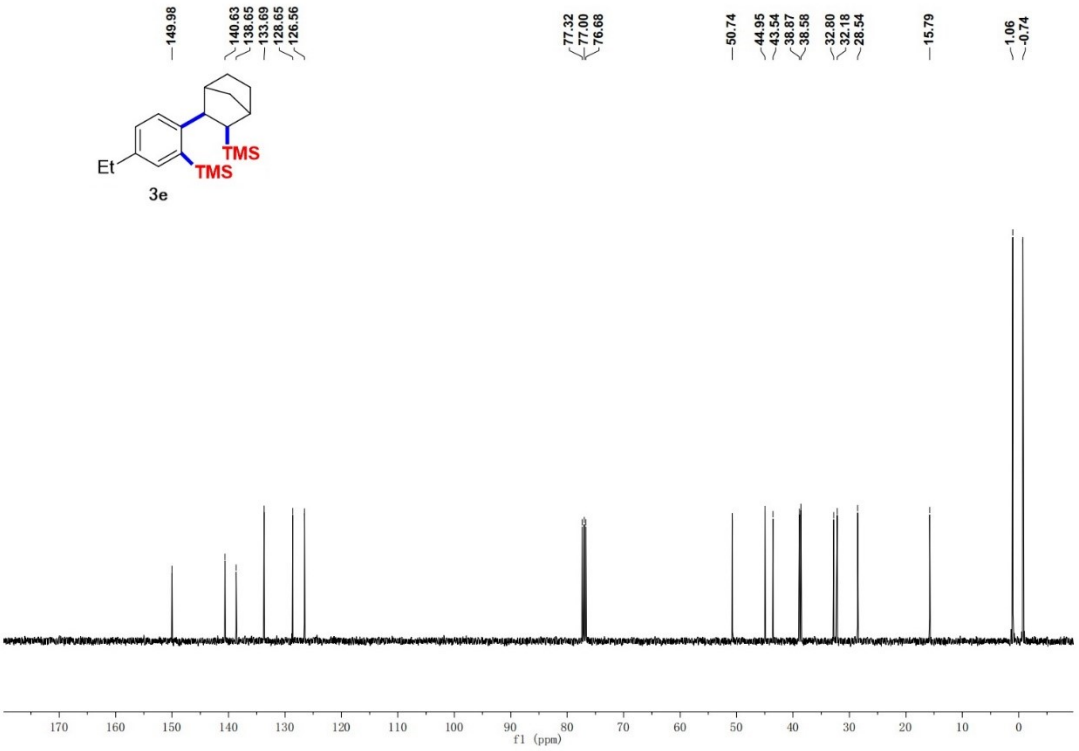
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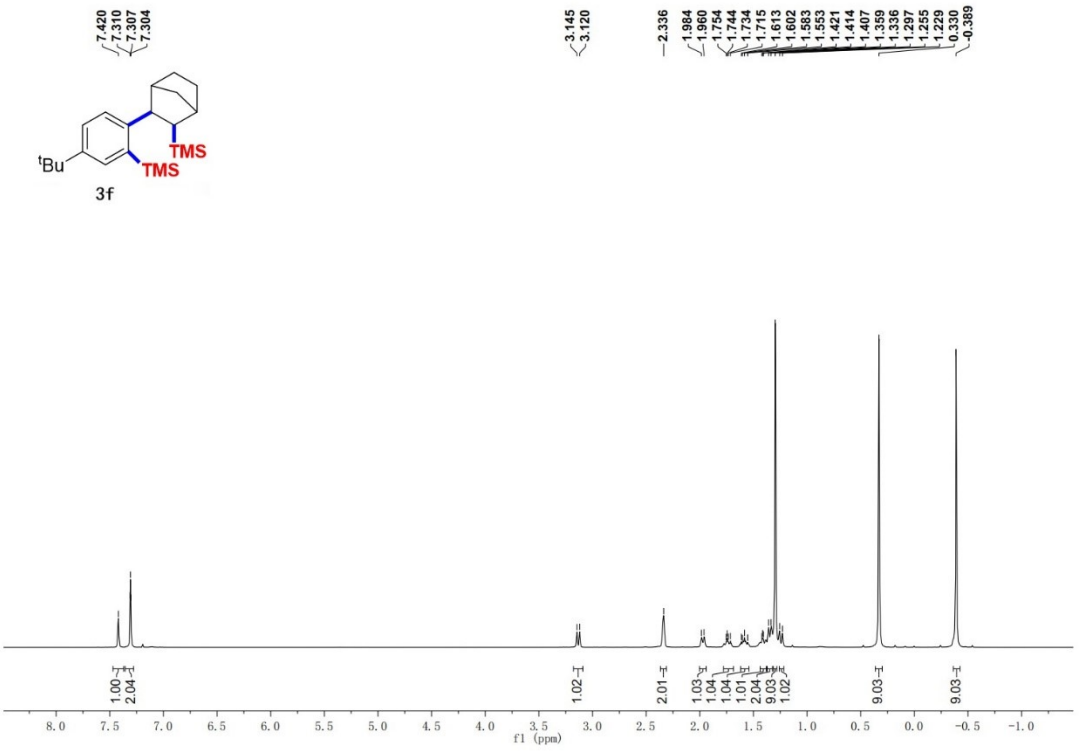
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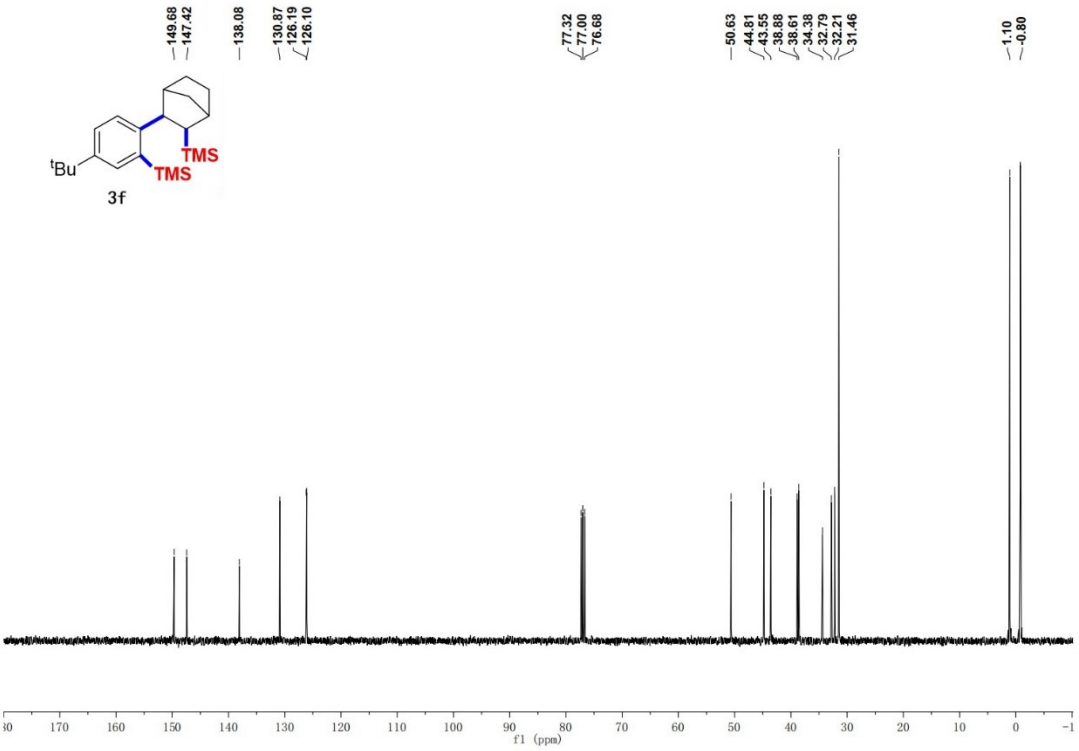
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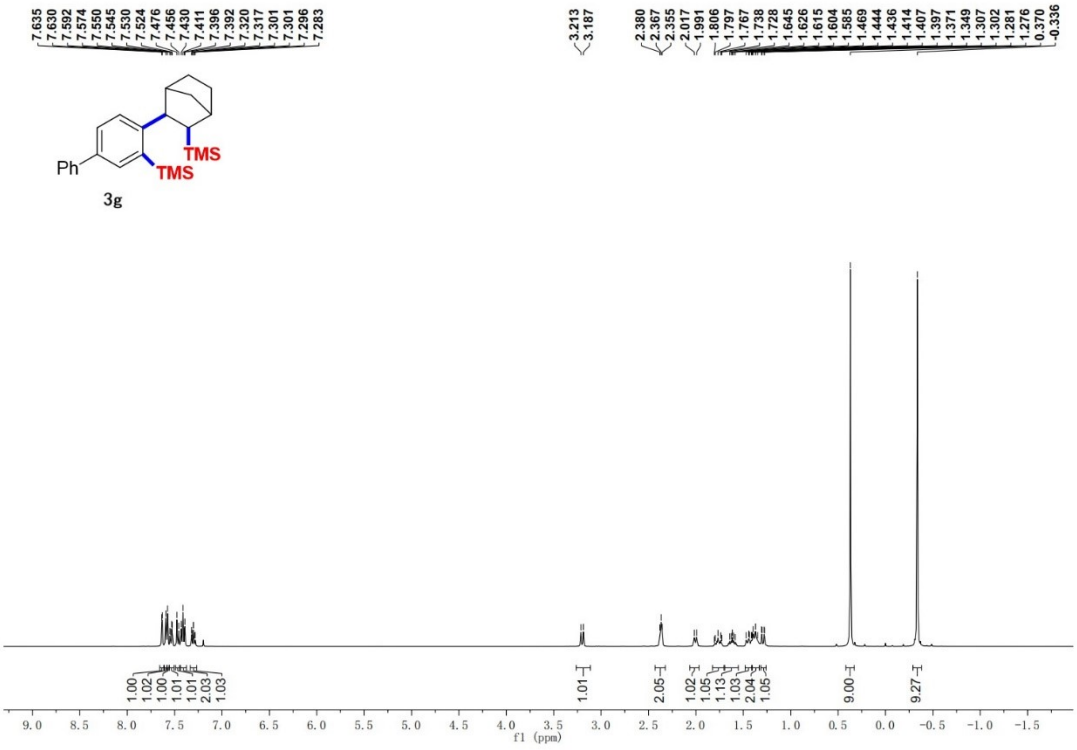
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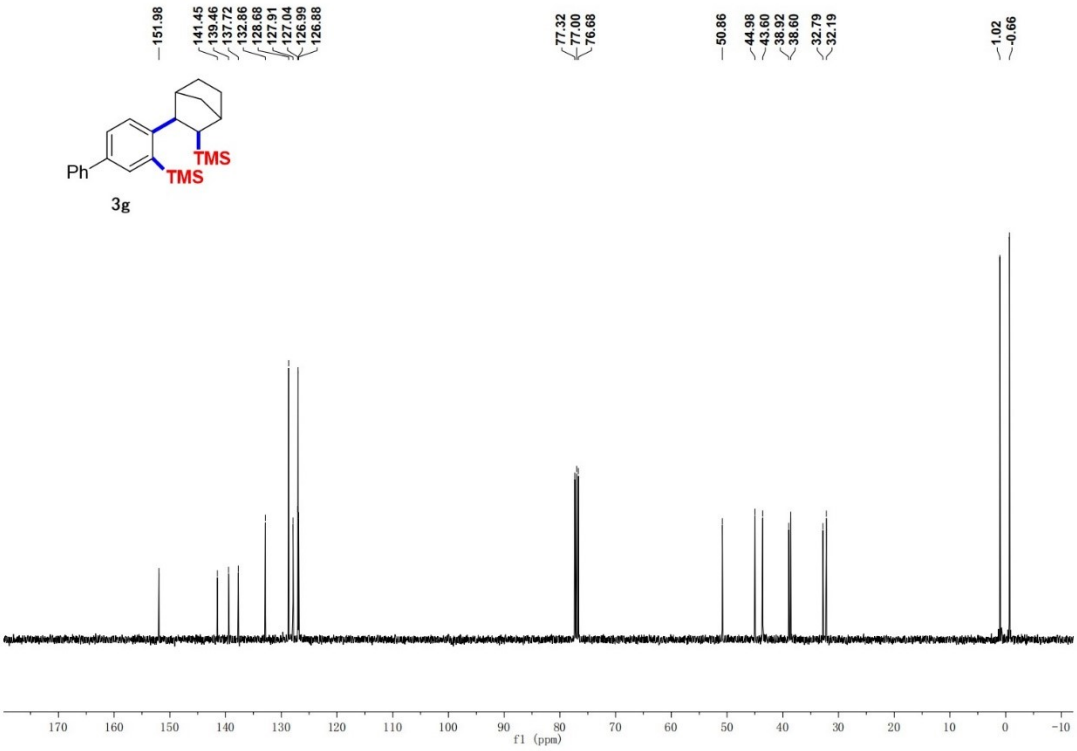
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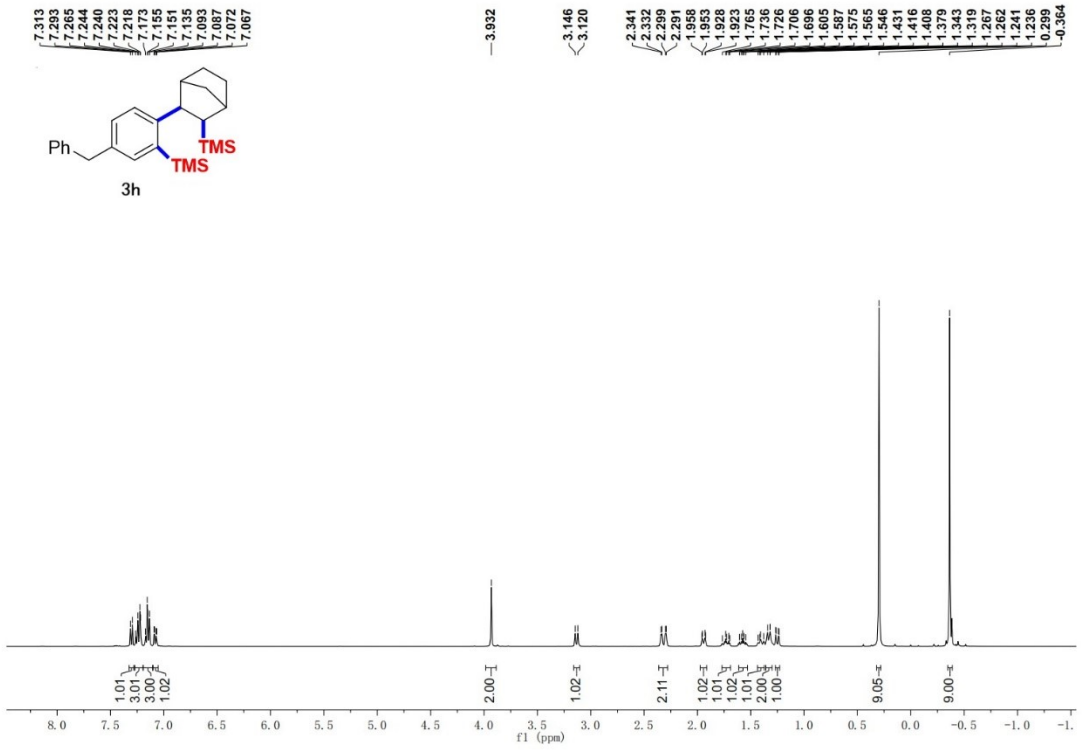
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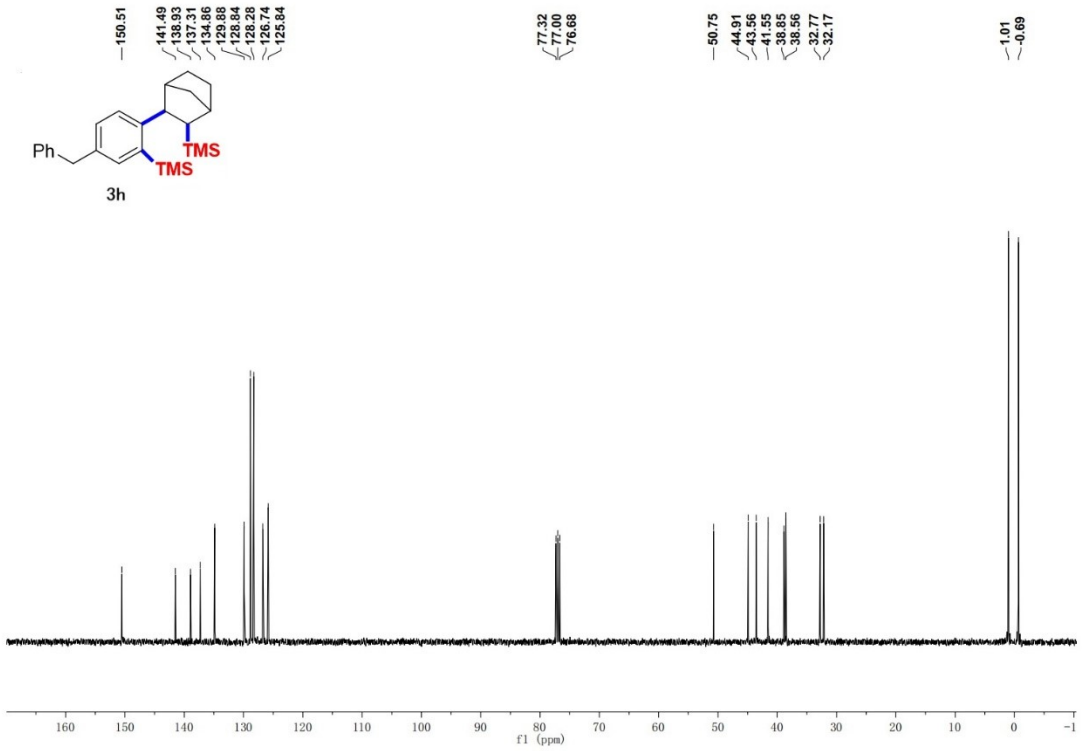
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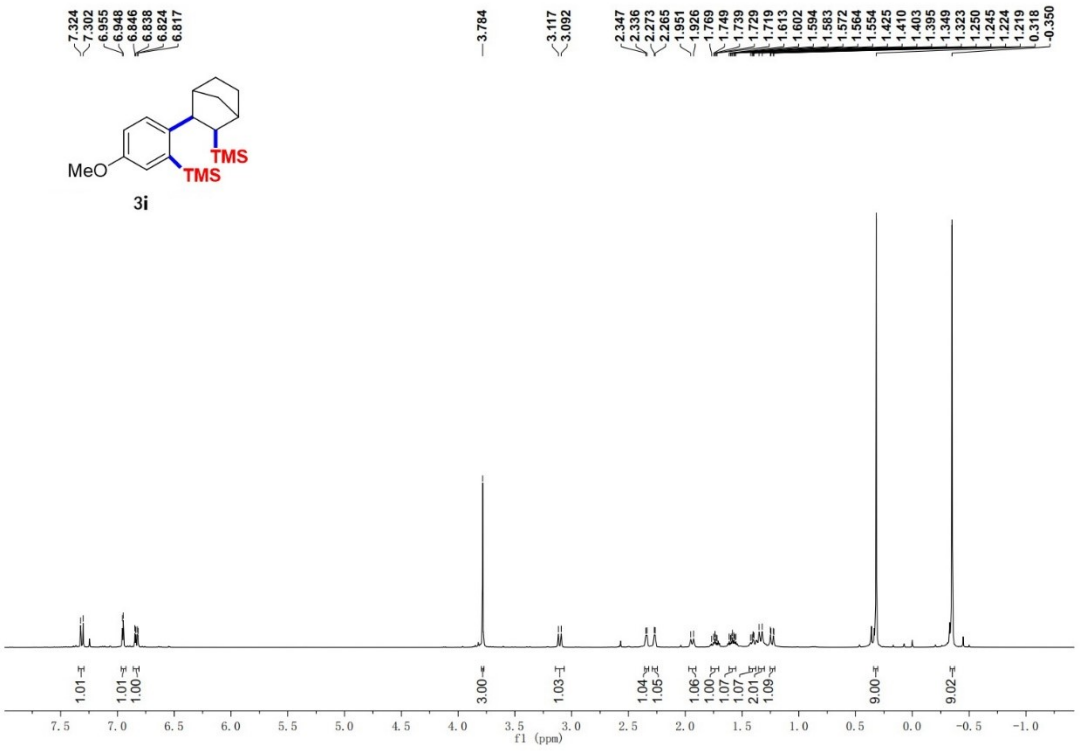
f1 (ppm)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6.824
6.817
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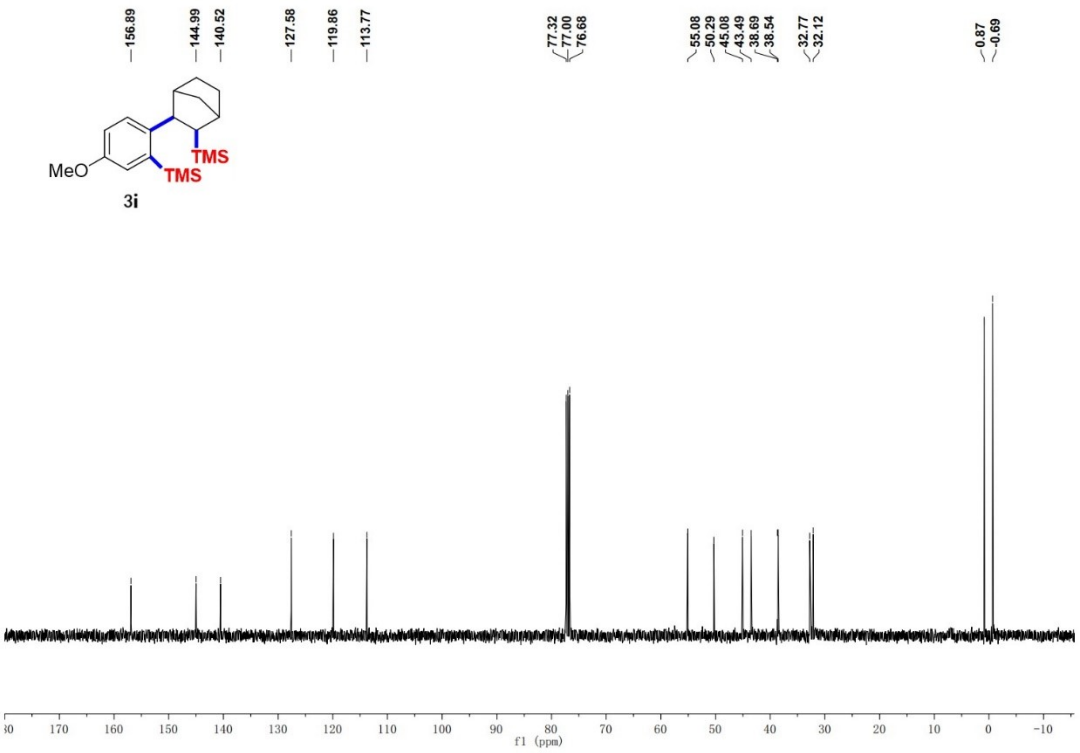
3.117
3.092
2.347
2.336
2.273
2.265
1.951
1.926
1.769
1.749
1.739
1.729
1.719
1.613
1.602
1.594
1.583
1.572
1.564
1.554
1.425
1.410
1.403
1.395
1.349
1.323
1.250
1.245
1.224
1.219
0.318
-0.350
MeO
TMS
TMS
3i
1.01
1.01
1.00
3.00
1.03
1.04
1.05
1.06
1.00
1.07
1.07
2.01
1.09
9.00
9.02
f1 (ppm)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77.32
77.00
76.68
55.08
50.29
45.08
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38.54
32.77
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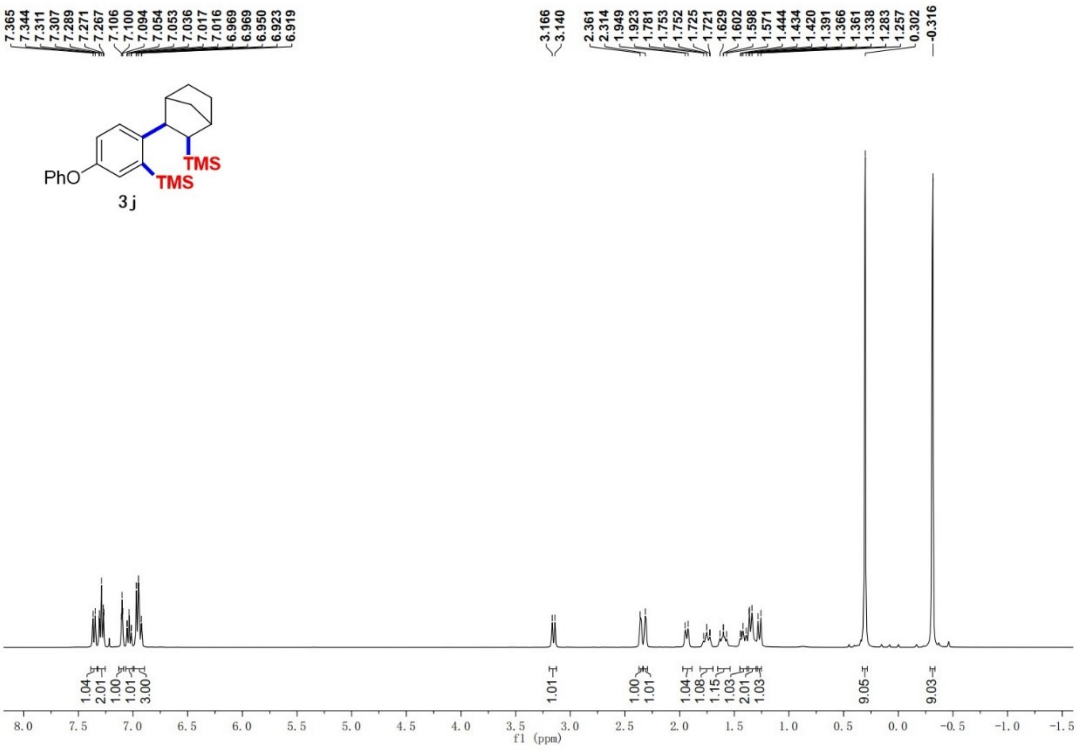
0.87
-0.69
MeO
TMS
TMS
3i
f1 (ppm)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7.267
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7.094
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7.053
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7.017
7.016
6.969
6.969
6.950
6.923
6.919
3.166
3.140
2.361
2.314
1.949
1.923
1.781
1.753
1.752
1.725
1.721
1.629
1.602
1.598
1.571
1.444
1.434
1.420
1.391
1.366
1.361
1.338
1.283
1.257
0.302
-0.316
PhO
TMS
TMS
3j
1.04
2.01
1.00
1.01
3.00
1.01
1.00
1.01
1.04
1.08
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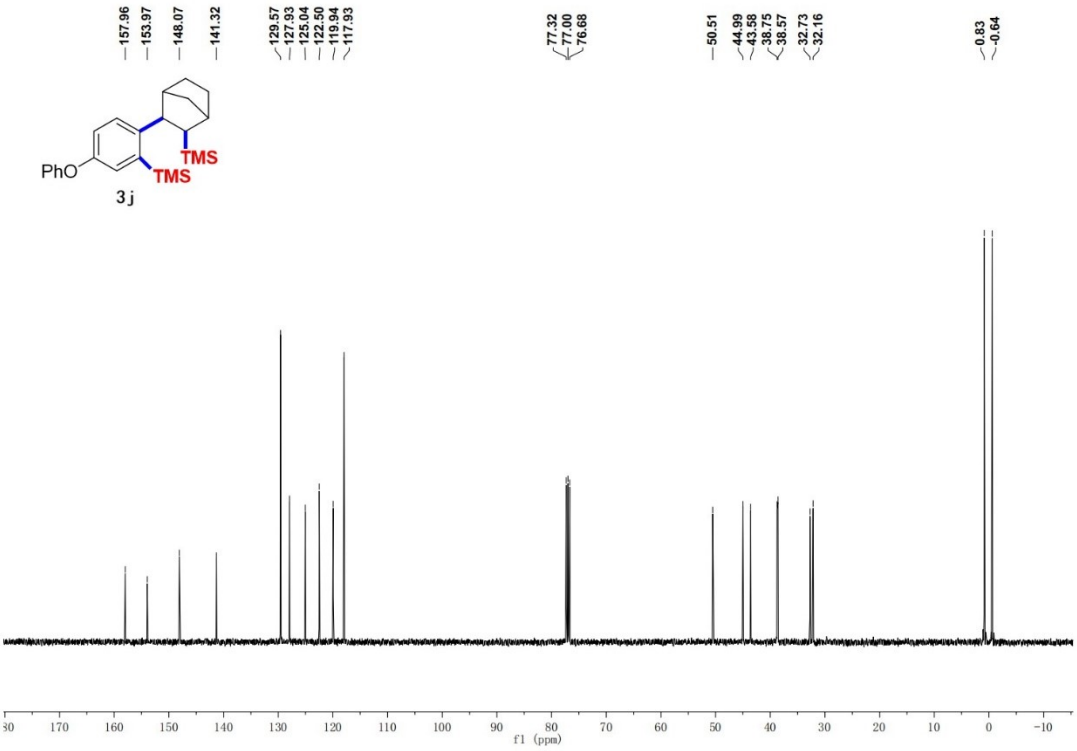
1.03
2.01
1.03
9.05
9.03
f1 (ppm)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122.50
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117.93
77.32
77.00
76.68
50.51
44.99
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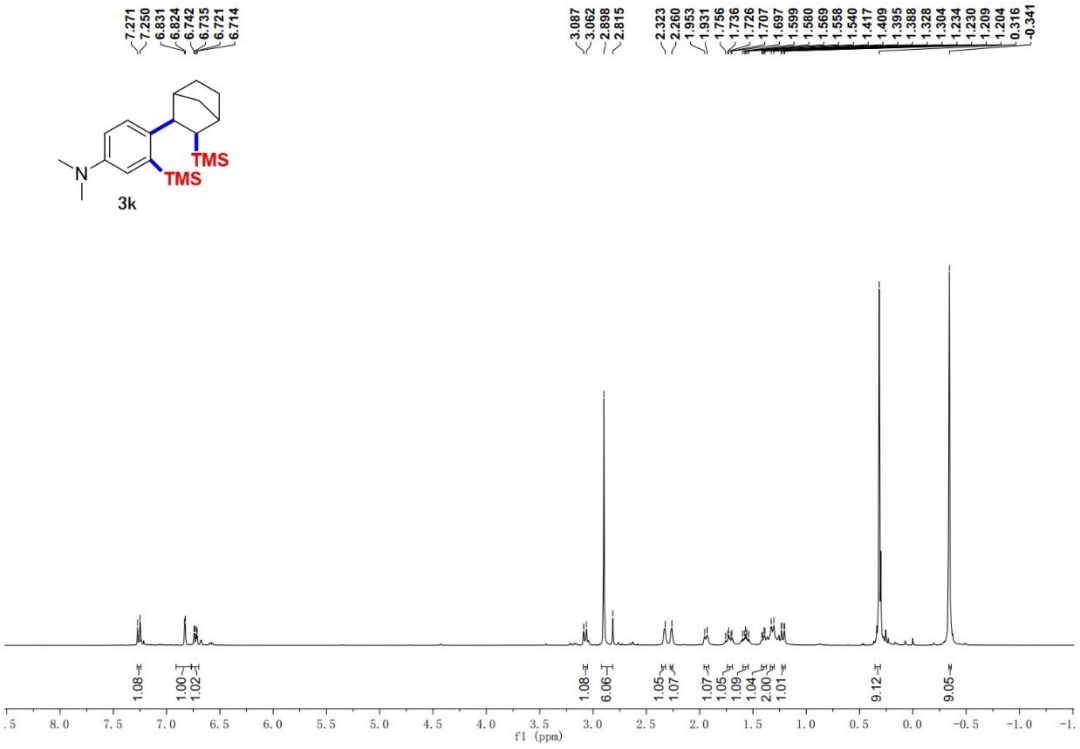
38.57
32.73
32.16
0.83
-0.64
PhO
TMS
TMS
3j
f1 (ppm)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6.735
6.721
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3.062
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2.323
2.260
1.953
1.931
1.756
1.736
1.726
1.707
1.697
1.599
1.580
1.569
1.558
1.540
1.417
1.409
1.395
1.388
1.328
1.304
1.234
1.230
1.209
1.204
0.316
-0.341
TMS
TMS
3k
1.08
1.00
1.02
1.08
6.06
1.05
1.07
1.07
1.05
1.09
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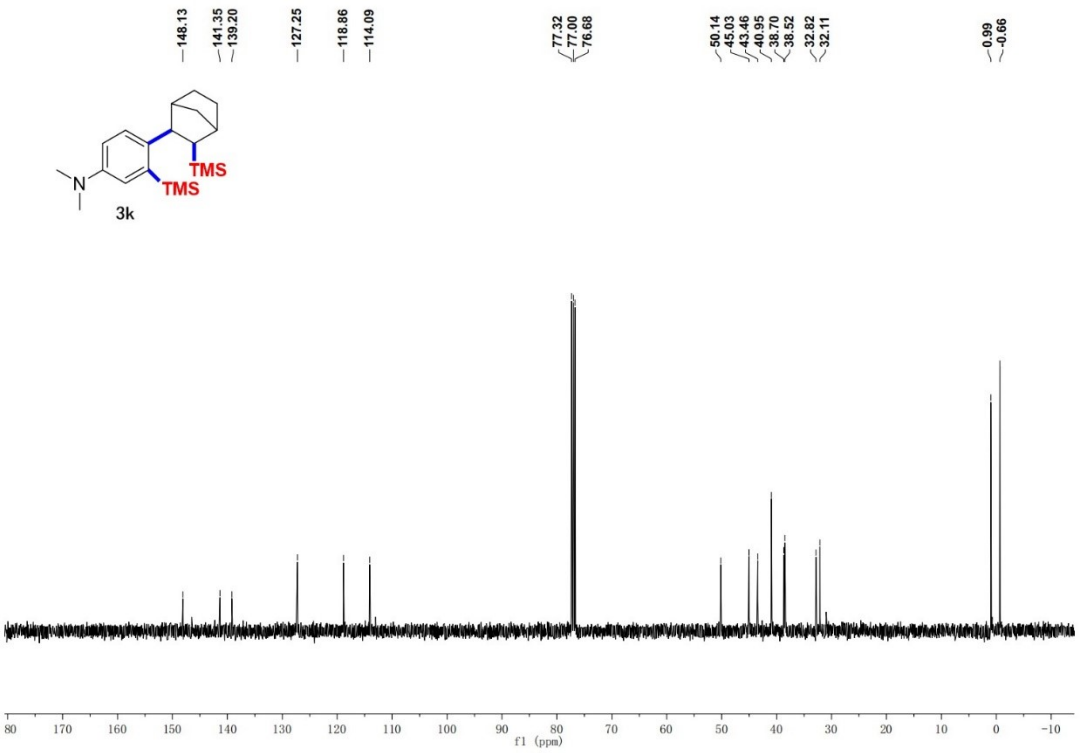
2.00
1.01
9.12
9.05
f1 (ppm)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77.00
76.68
50.14
45.03
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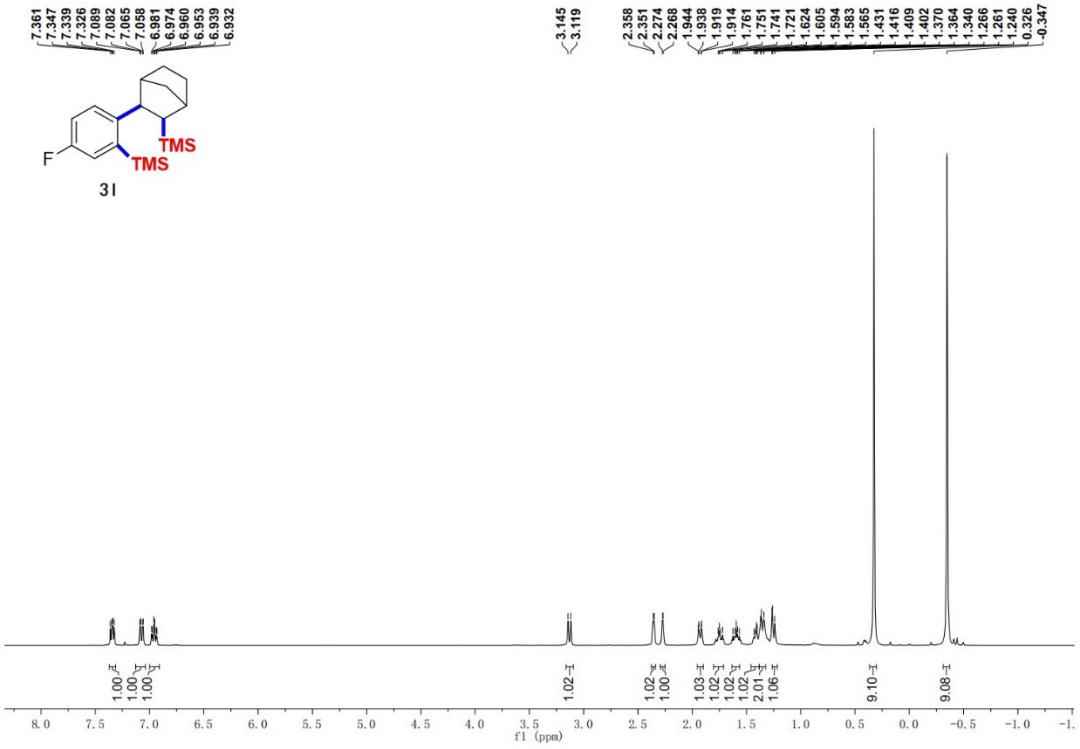
38.52
32.82
32.11
0.99
-0.66
TMS
TMS
3k
f1 (ppm)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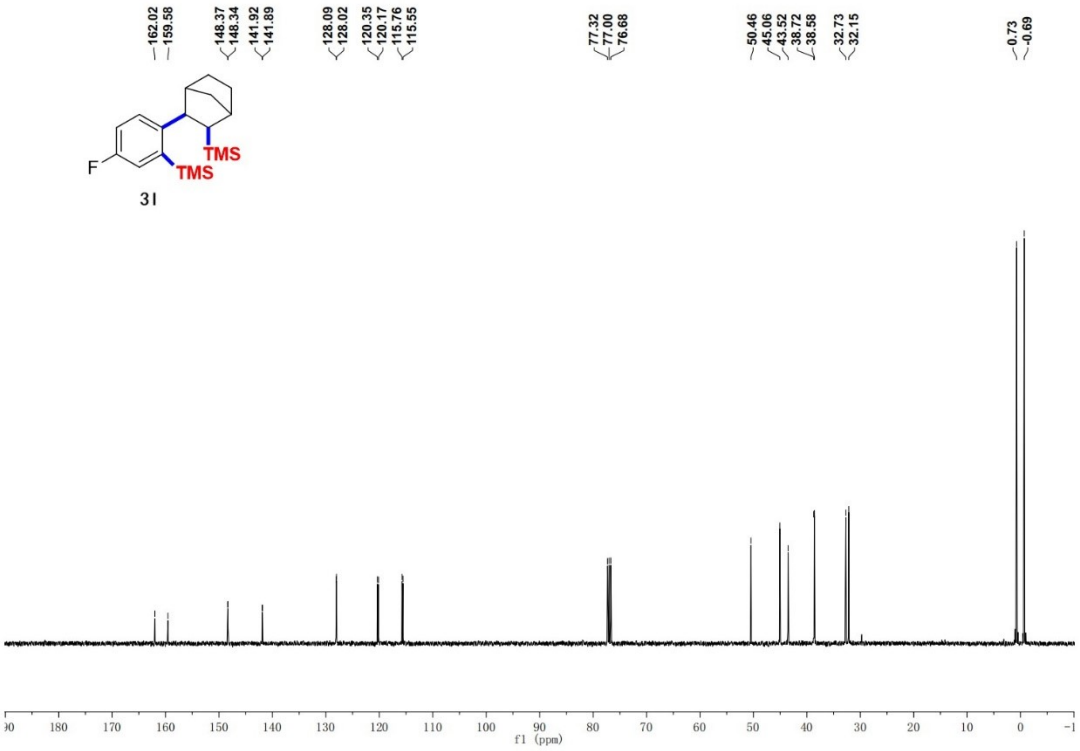
7.065
7.058
6.981
6.974
6.960
6.953
6.939
6.932
3.145
3.119
2.358
2.351
2.274
2.268
1.944
1.938
1.919
1.914
1.761
1.751
1.741
1.721
1.624
1.605
1.594
1.583
1.565
1.431
1.416
1.409
1.402
1.370
1.364
1.340
1.266
1.261
1.240
0.326
-0.347
TMS
TMS
F
3l
1.00
1.00
1.00
1.02
1.02
1.00
1.03
1.02
1.02
1.02
2.01
1.06
9.10
9.08
f1 (ppm)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148.37
148.34
141.92
141.89
128.09
128.02
120.35
120.17
115.76
115.55
77.32
77.00
76.68
50.46
45.06
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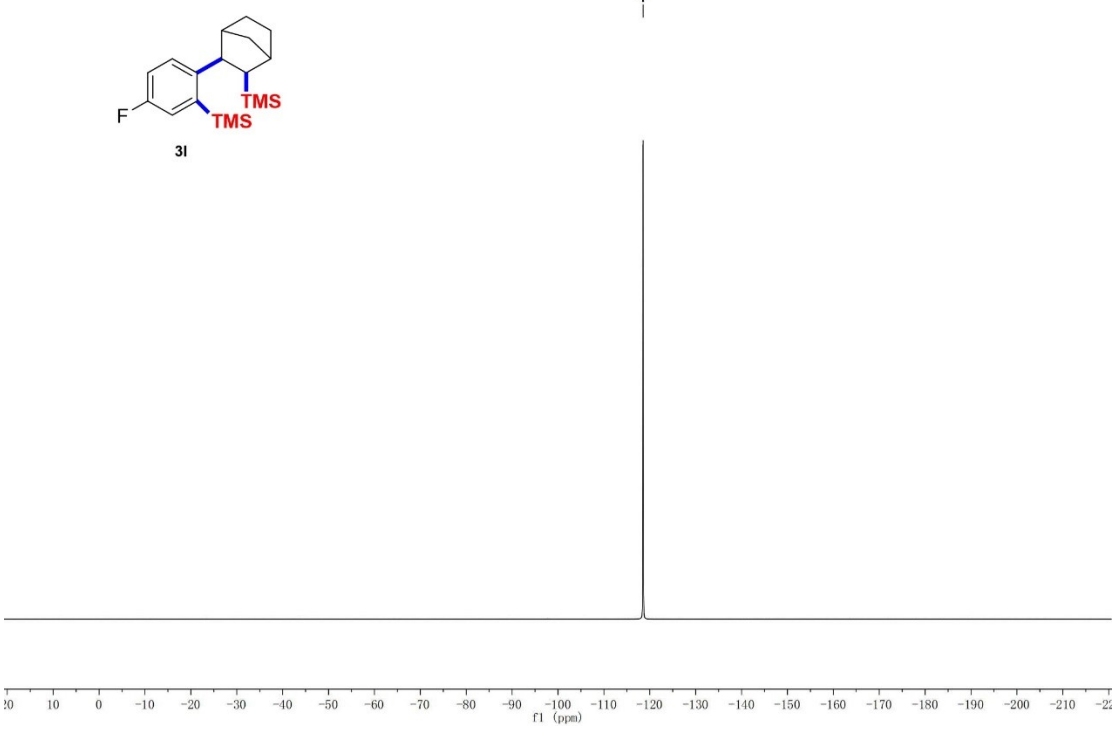
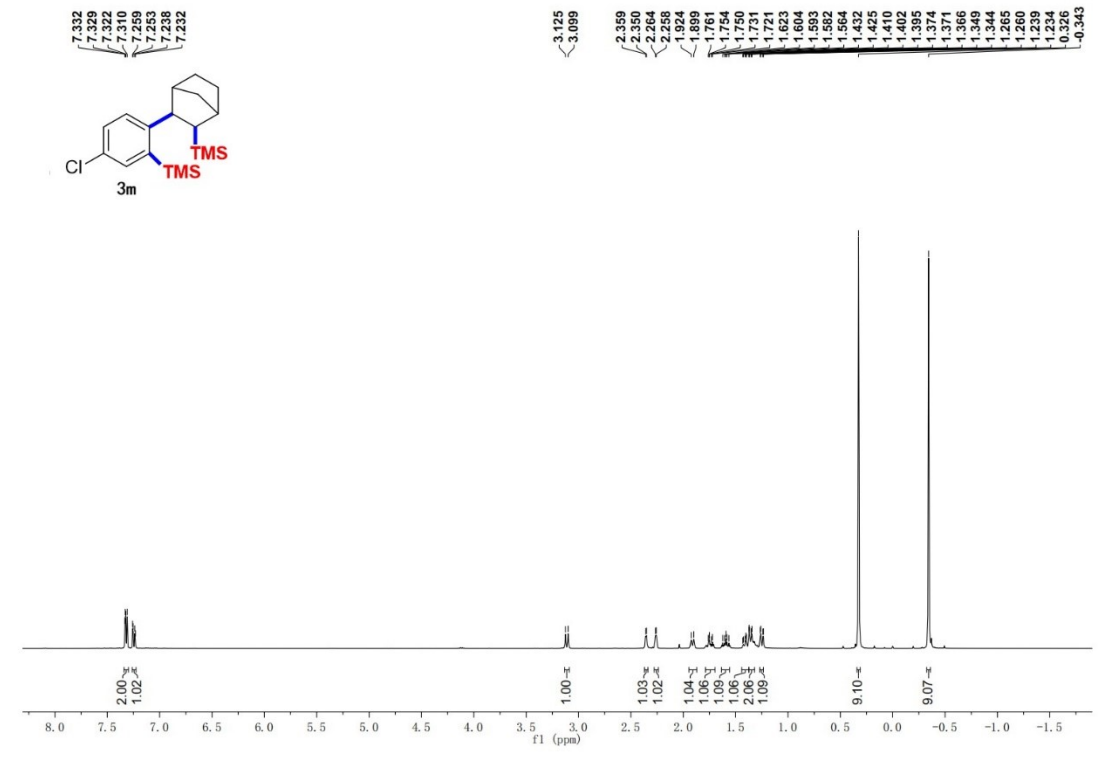
38.58
32.73
32.15
0.73
-0.69
TMS
TMS
F
3l
f1 (ppm)


F
TMS
TMS
3l
-118.55
f1 (ppm)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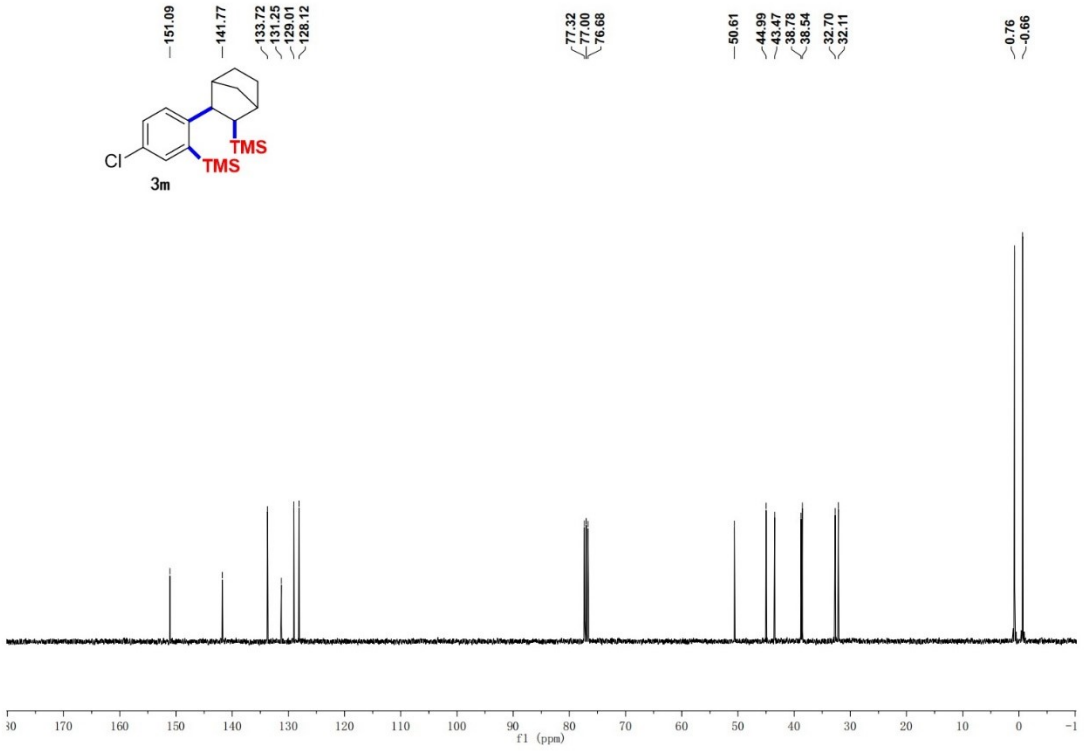
7.322
7.310
7.259
7.253
7.238
7.232
3.125
3.099
2.359
2.350
2.264
2.258
1.924
1.899
1.761
1.754
1.750
1.731
1.721
1.623
1.604
1.593
1.582
1.564
1.432
1.425
1.410
1.402
1.395
1.374
1.371
1.366
1.349
1.344
1.265
1.260
1.239
1.234
0.326
-0.343
Cl
TMS
TMS
3m
2.00
1.02
1.00
1.03
1.02
1.04
1.06
1.09
1.06
2.06
1.09
9.10
9.07
f1 (ppm)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133.72
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129.01
128.12
77.32
77.00
76.68
50.61
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38.54
32.70
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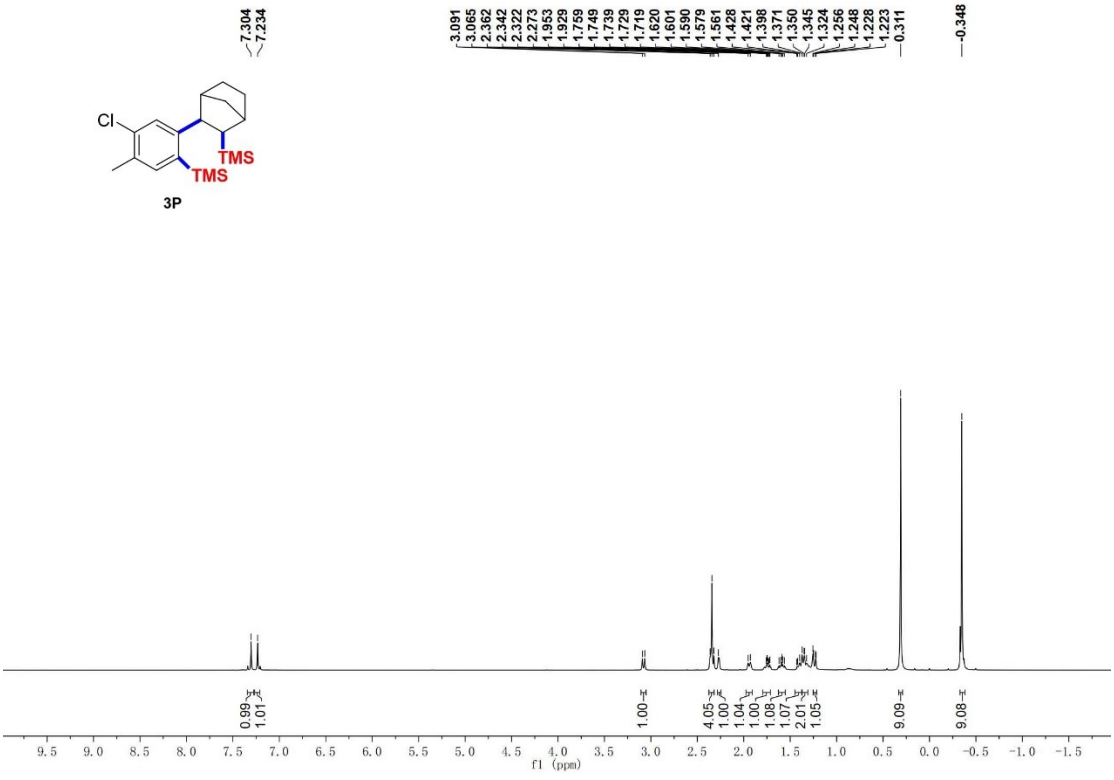
-0.66
Cl
TMS
TMS
3m
f1 (ppm)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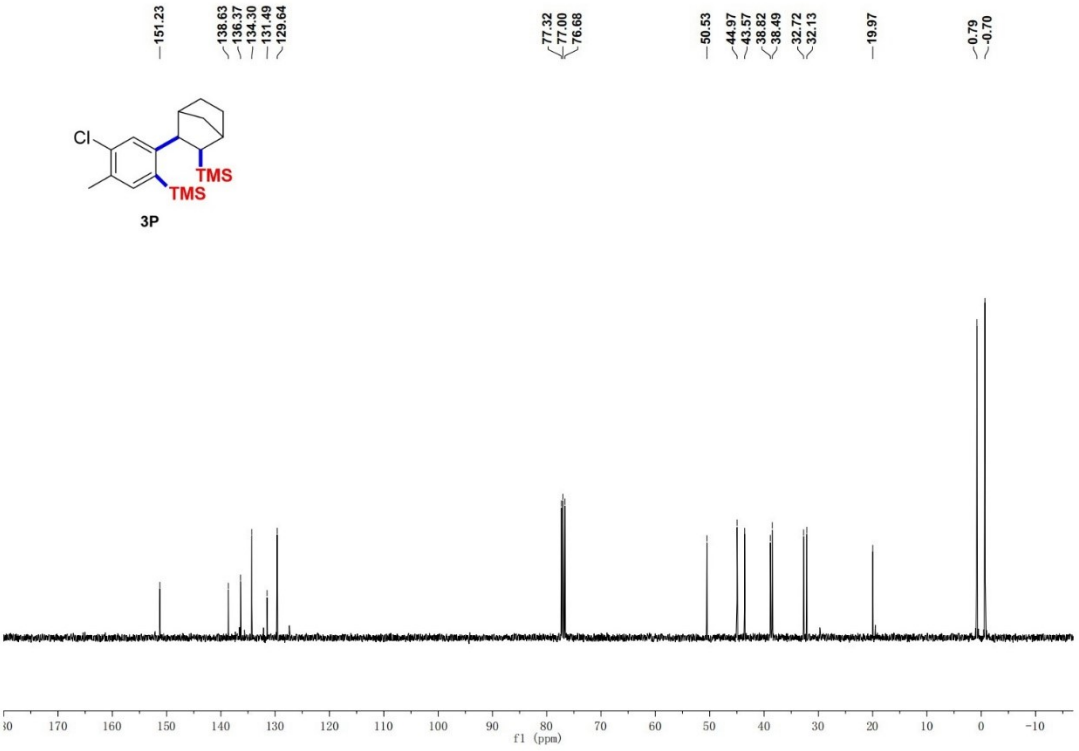
2.362
2.342
2.322
2.273
1.953
1.929
1.759
1.749
1.739
1.729
1.719
1.620
1.601
1.590
1.579
1.561
1.428
1.421
1.398
1.371
1.350
1.345
1.324
1.256
1.248
1.228
1.223
0.311
-0.348
Cl
TMS
TMS
3P
0.99
1.01
1.00
4.05
1.00
1.04
1.00
1.08
1.07
2.01
1.05
9.09
9.08
f1 (ppm)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129.64
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50.53
44.97
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32.13
19.97
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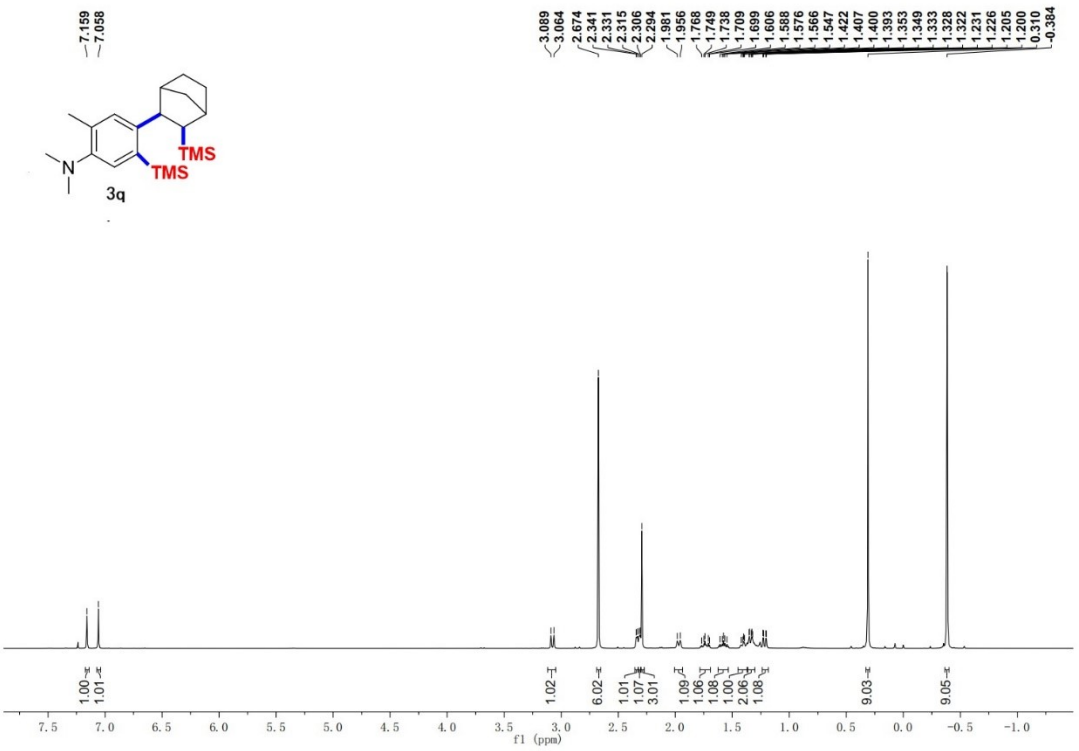
-0.70
Cl
TMS
TMS
3P
f1 (ppm)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1.768
1.749
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1.606
1.588
1.576
1.566
1.547
1.422
1.407
1.400
1.393
1.353
1.349
1.333
1.328
1.322
1.231
1.226
1.205
1.200
0.310
-0.384
TMS
TMS
3q
1.00
1.01
1.02
6.02
1.01
1.07
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1.09
1.06
1.08
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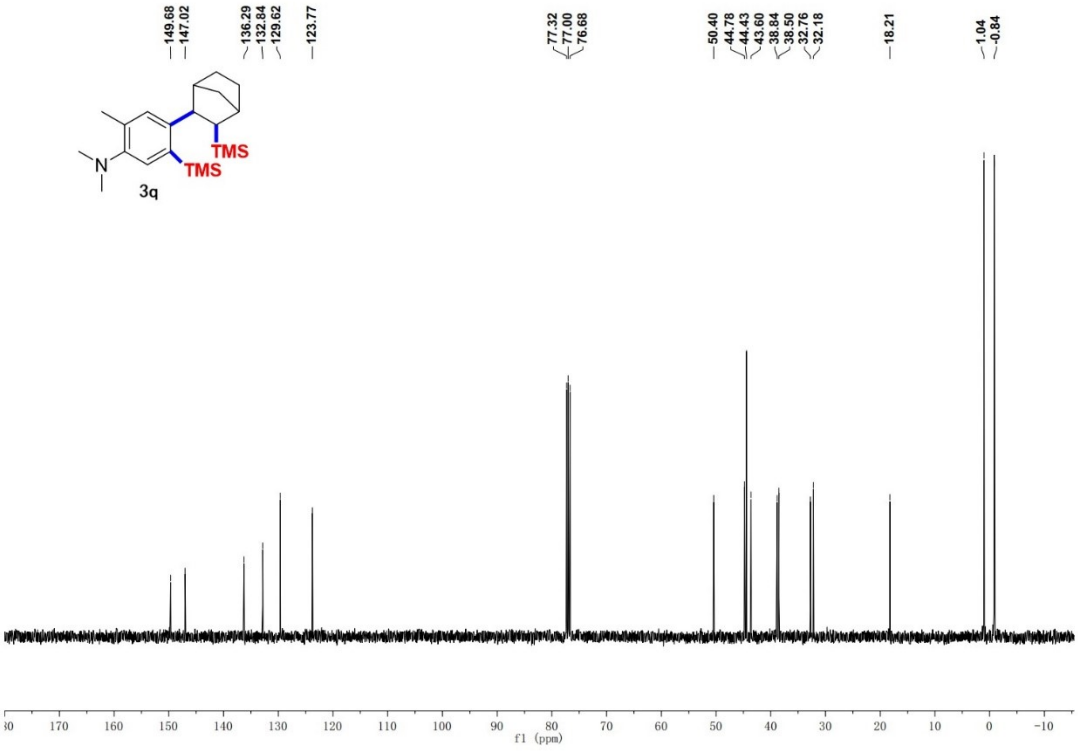
2.06
1.08
9.03
9.05
f1 (ppm)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77.32
77.00
76.68
50.40
44.78
44.43
43.60
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32.76
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18.21
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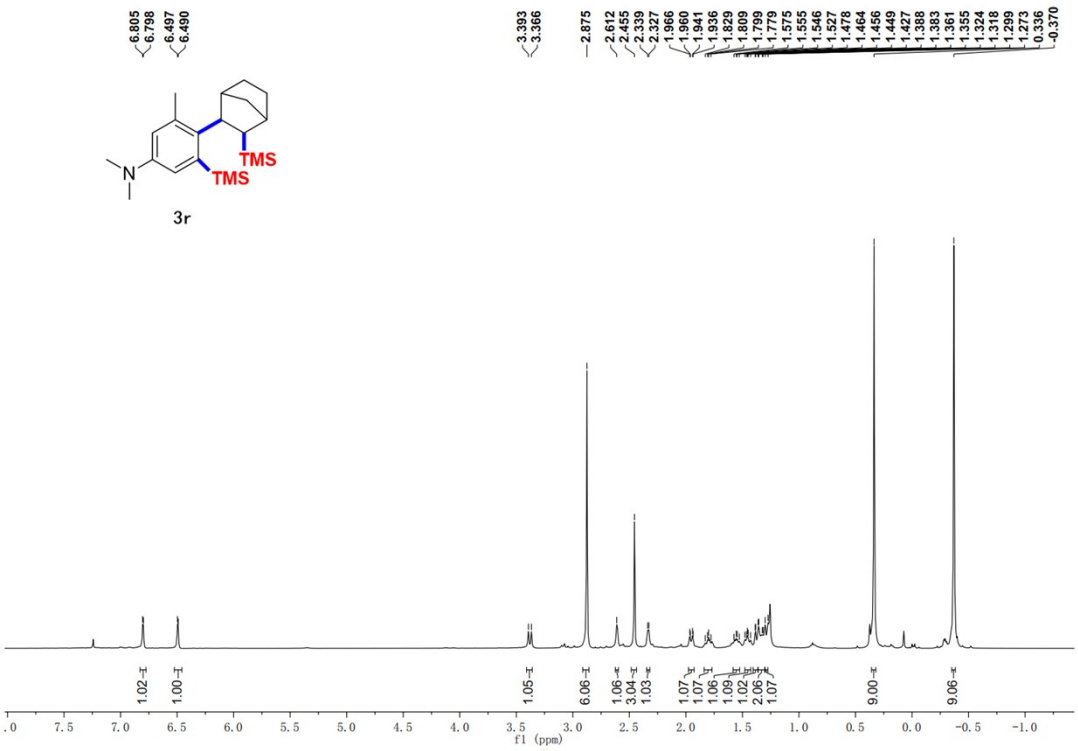
-0.84
TMS
TMS
3q
f1 (ppm)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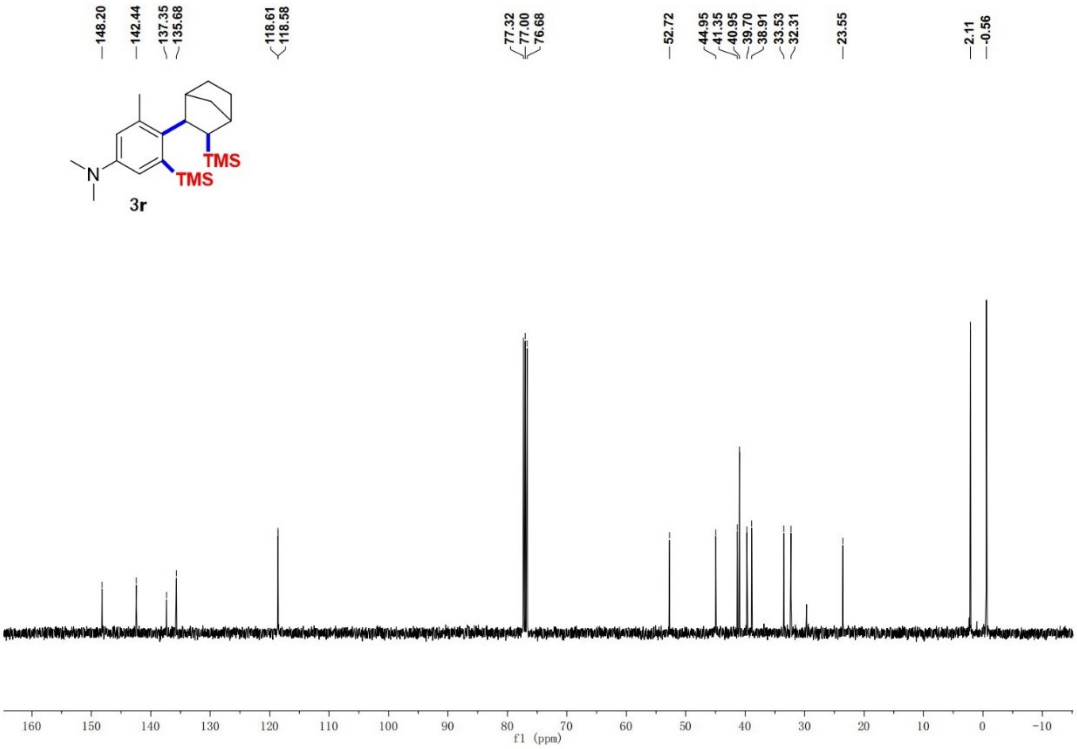
1.960
1.941
1.936
1.829
1.809
1.799
1.779
1.575
1.555
1.546
1.527
1.478
1.464
1.456
1.449
1.427
1.388
1.383
1.361
1.355
1.324
1.318
1.299
1.273
0.336
-0.370
TMS
TMS
3r
1.02
1.00
1.05
6.06
1.06
3.04
1.03
1.07
1.07
1.06
1.09
1.02
2.06
1.07
9.00
9.06
f1 (ppm)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118.58
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77.00
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41.35
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32.31
23.55
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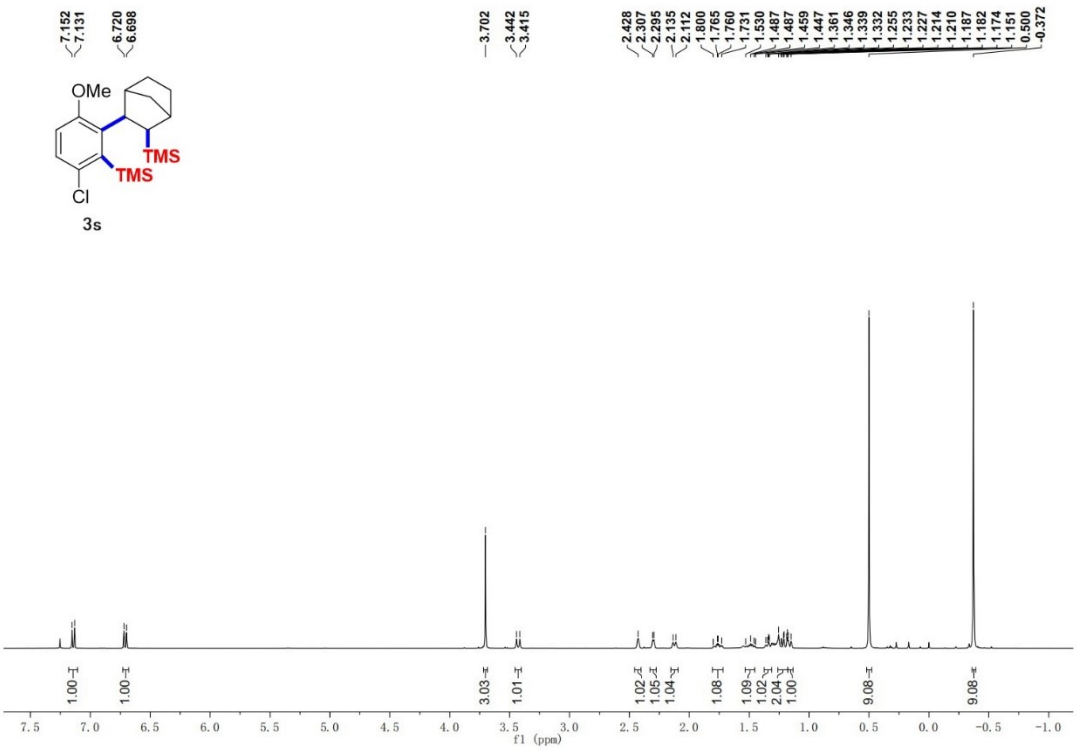
TMS
TMS
N
3r
f1 (ppm)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2.428
2.307
2.295
2.135
2.112
1.800
1.765
1.760
1.731
1.530
1.487
1.487
1.459
1.447
1.361
1.346
1.339
1.332
1.255
1.233
1.227
1.214
1.210
1.187
1.182
1.174
1.151
0.500
-0.372
OMe
TMS
TMS
Cl
3s
1.00
1.00
3.03
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1.02
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1.04
1.08
1.09
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1.00
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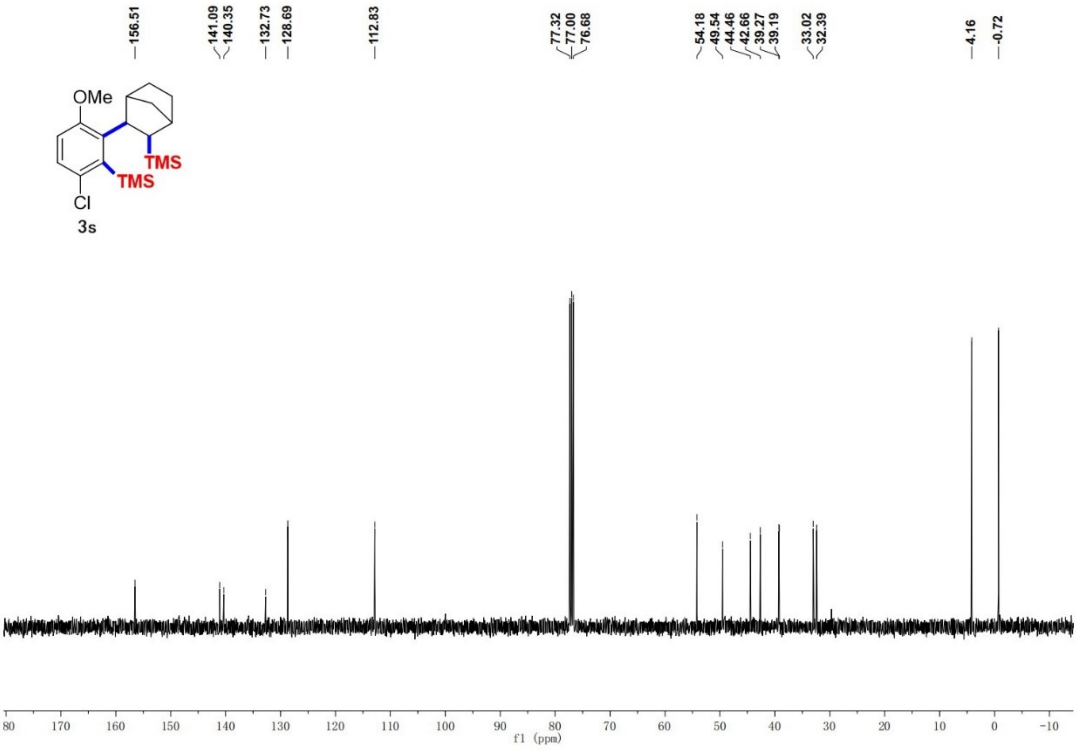
9.08
f1 (ppm)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49.54
44.46
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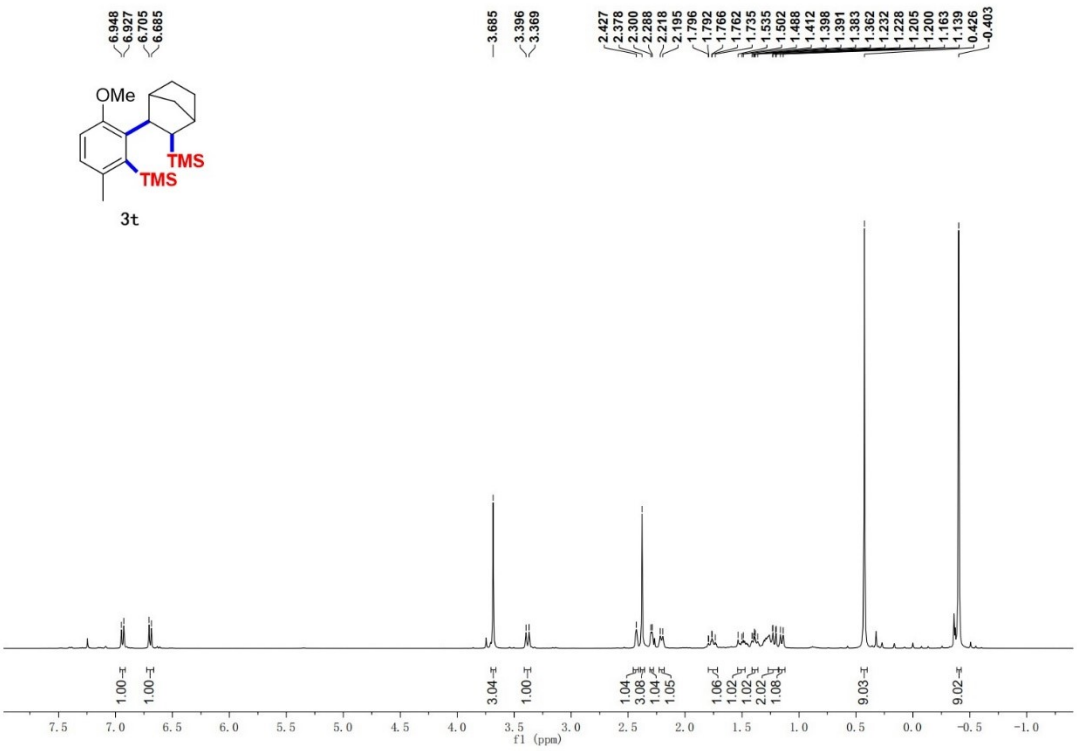
OMe
TMS
TMS
Cl
3s
f1 (ppm)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2.195
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1.792
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1.762
1.735
1.535
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1.488
1.412
1.398
1.391
1.383
1.362
1.232
1.228
1.205
1.200
1.163
1.139
0.426
-0.403
OMe
TMS
TMS
3t
1.00
1.00
3.04
1.00
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1.05
1.06
1.02
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1.08
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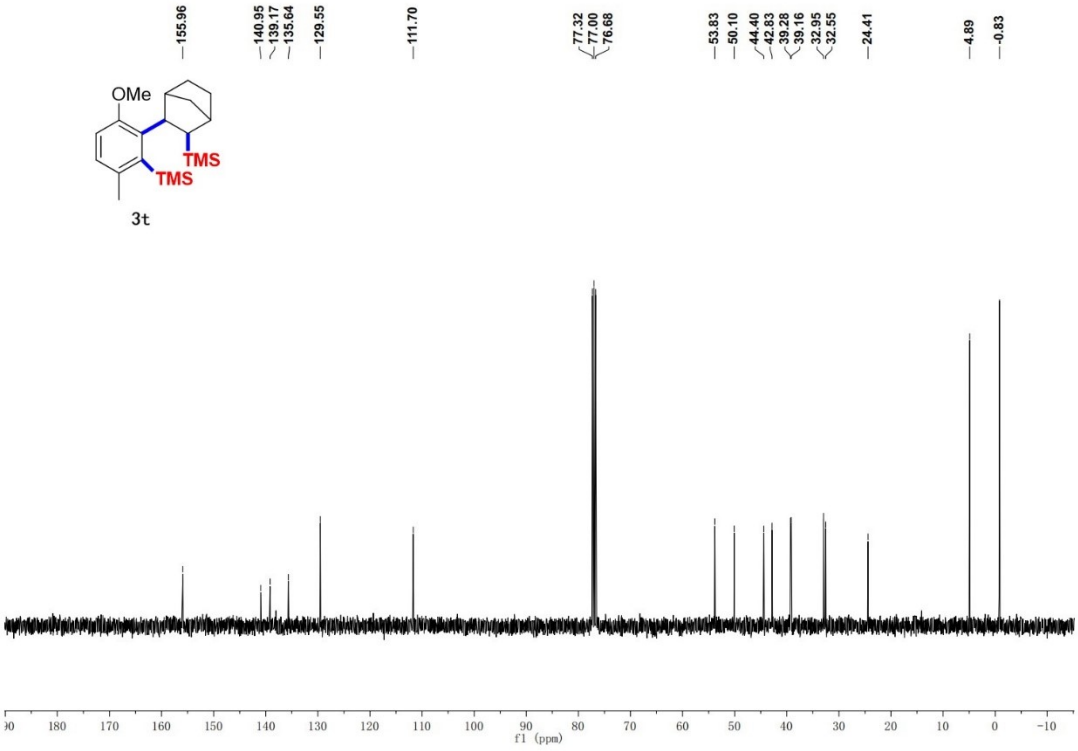
9.02
f1 (ppm)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77.00
76.68
53.83
50.10
44.40
42.83
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32.55
24.41
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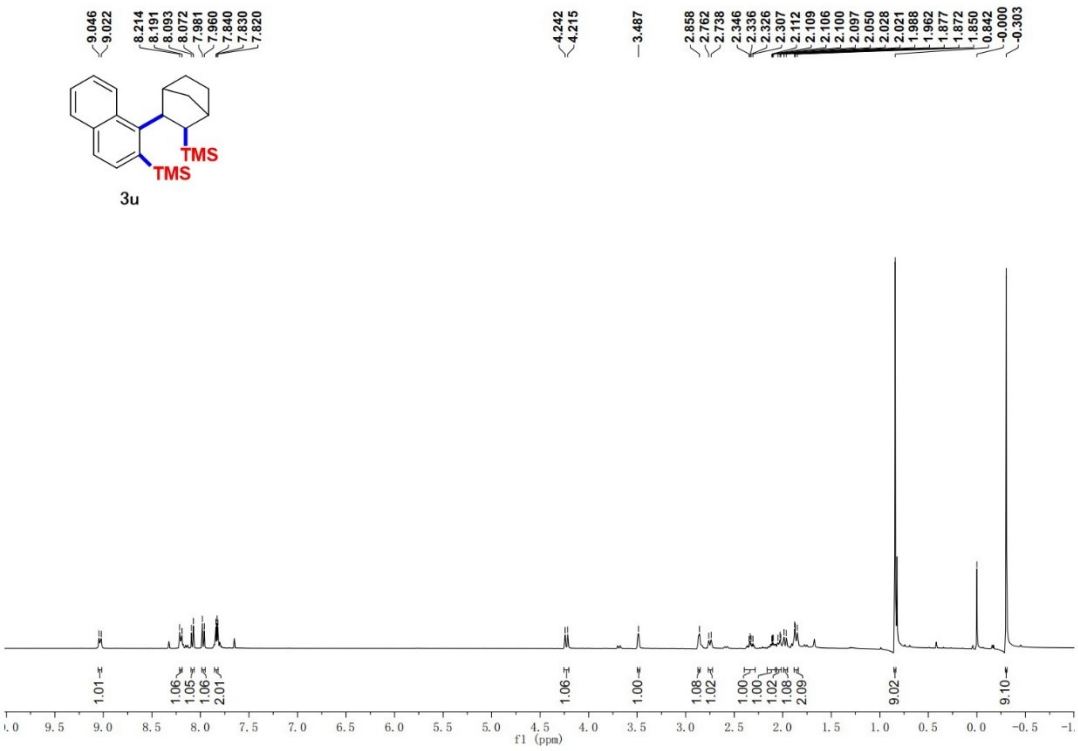
OMe
TMS
TMS
3t
f1 (ppm)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4.242
4.215
3.487
2.858
2.762
2.738
2.346
2.336
2.326
2.307
2.112
2.109
2.106
2.100
2.097
2.050
2.028
2.021
1.988
1.962
1.877
1.872
1.850
0.842
0.000
-0.303
TMS
TMS
3u
1.01
1.06
1.05
1.06
2.01
1.06
1.00
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1.02
1.00
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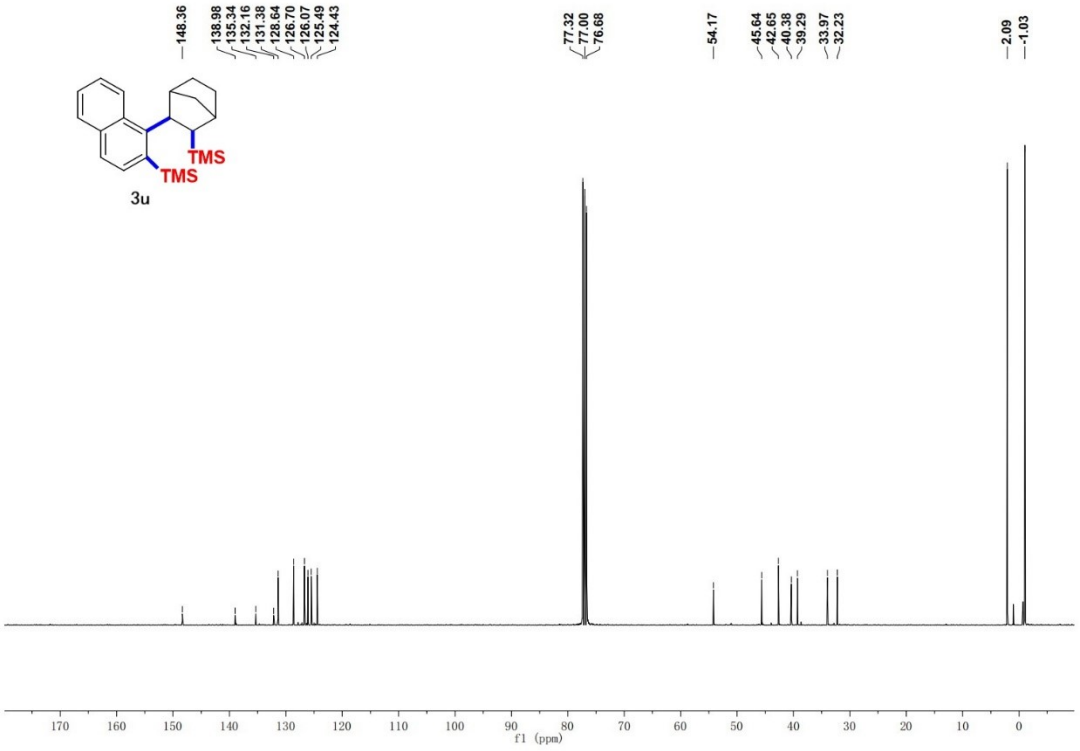
9.10
f1 (ppm)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126.07
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77.00
76.68
54.17
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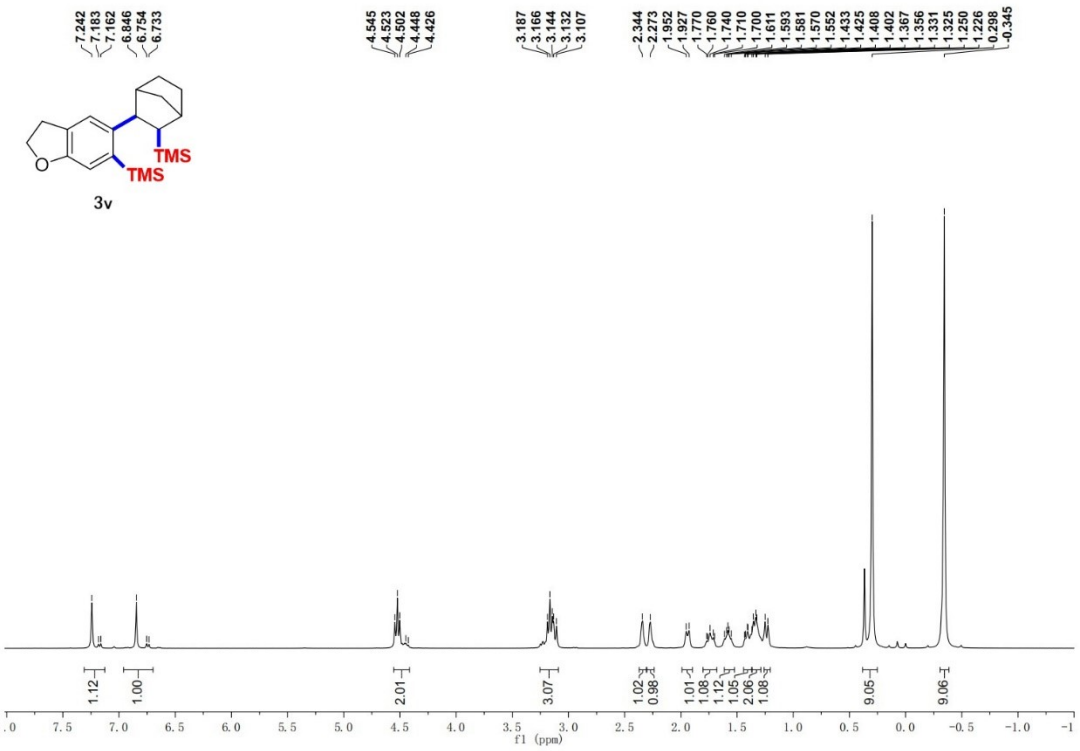
42.65
40.38
39.29
33.97
32.23
2.09
1.03
TMS
TMS
3u
f1 (ppm)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1.367
1.356
1.331
1.325
1.250
1.226
0.298
-0.345
TMS
TMS
3v
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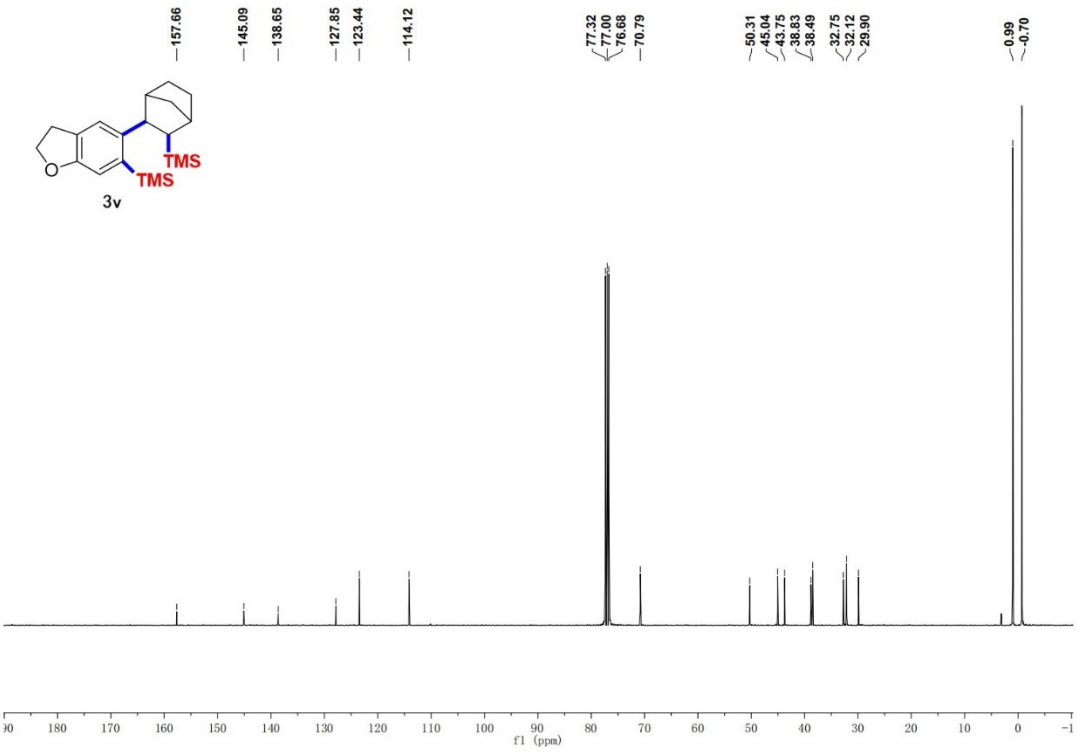
3.07
1.02
0.98
1.01
1.08
1.12
1.05
2.06
1.08
9.05
9.06
f1 (ppm)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114.12
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77.00
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70.79
50.31
45.04
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38.49
32.75
32.12
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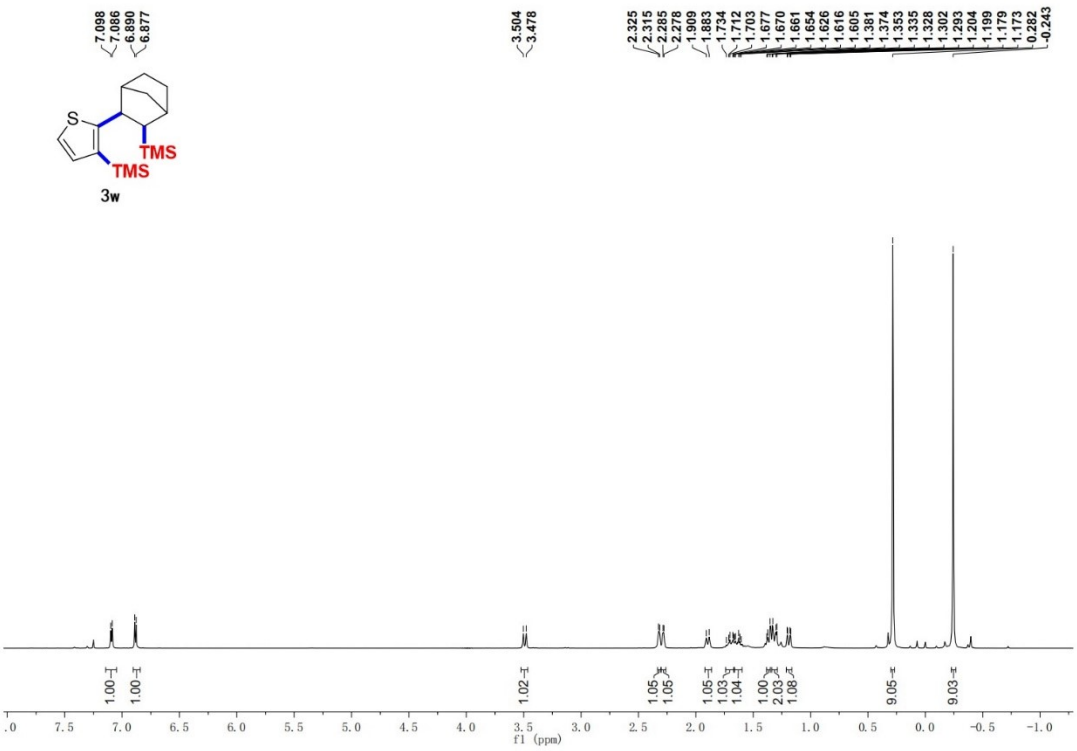
TMS
3v
f1 (ppm)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2.315
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2.278
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1.883
1.734
1.712
1.703
1.677
1.670
1.661
1.654
1.626
1.616
1.605
1.381
1.374
1.353
1.335
1.328
1.302
1.293
1.204
1.199
1.179
1.173
0.282
-0.243
TMS
TMS
3w
1.00
1.00
1.02
1.05
1.05
1.05
1.03
1.04
1.00
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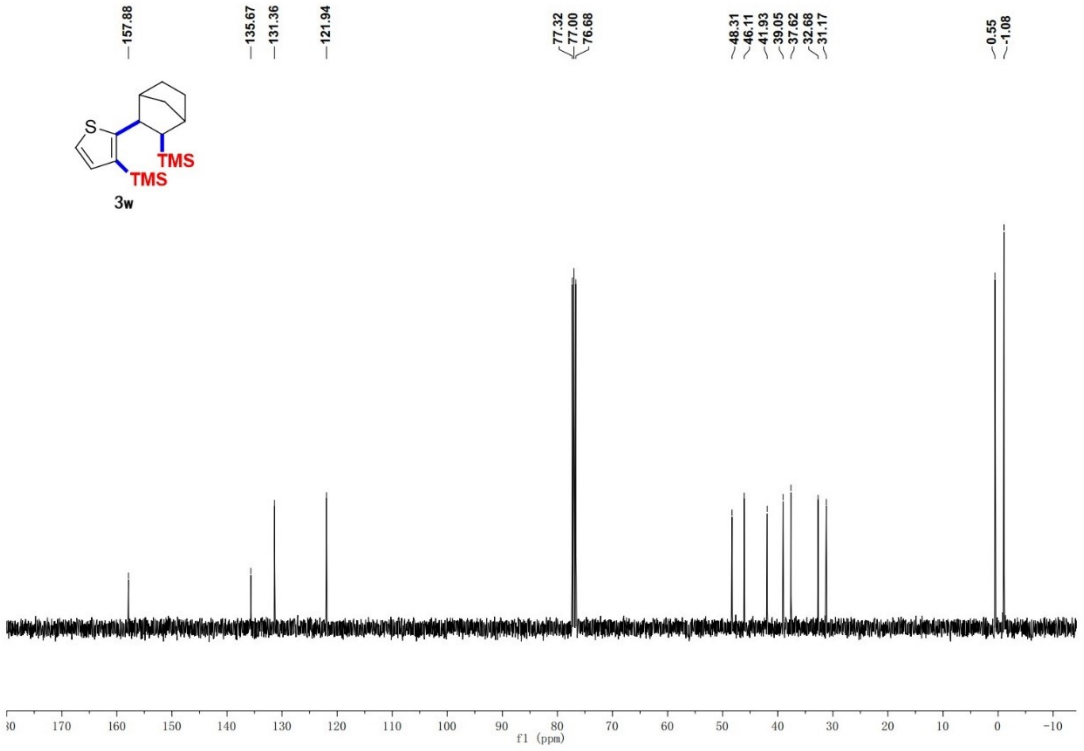
9.03
f1 (ppm)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48.31
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32.68
31.17
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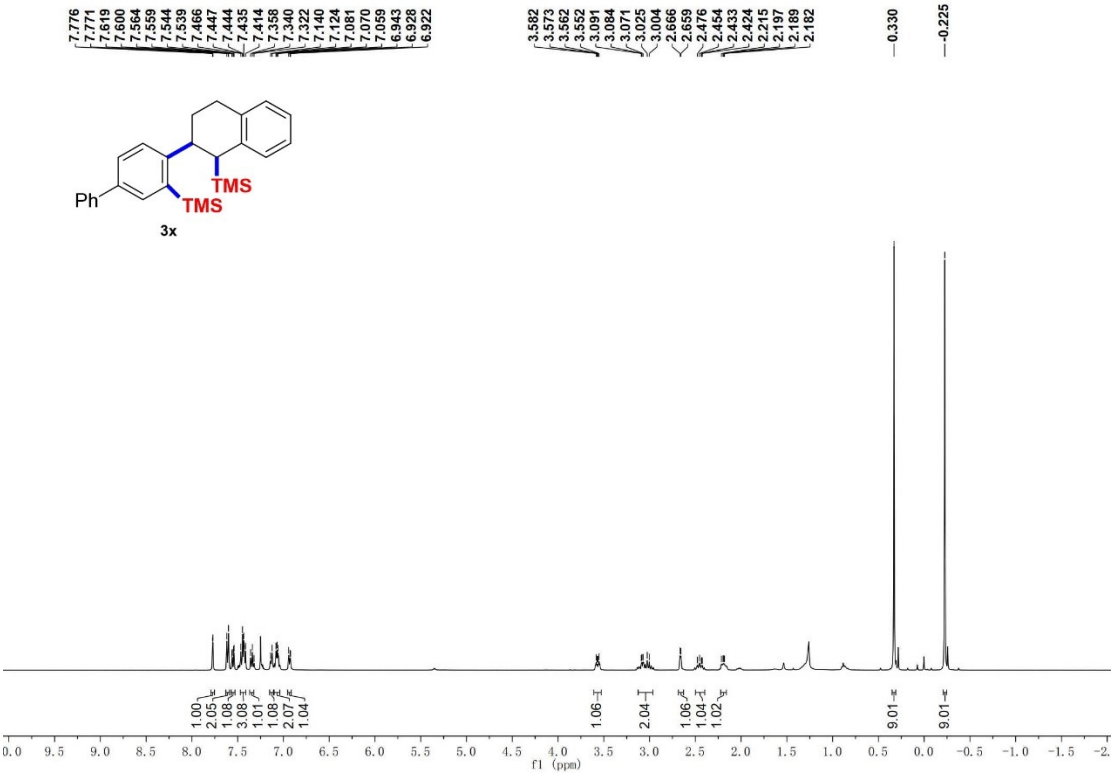
-1.08
S
TMS
TMS
3w
f1 (ppm)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7.340
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7.140
7.124
7.081
7.070
7.059
6.943
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6.922
3.582
3.573
3.562
3.552
3.091
3.084
3.071
3.025
3.004
2.666
2.659
2.476
2.454
2.433
2.424
2.215
2.197
2.189
2.182
0.330
-0.225
Ph
TMS
TMS
3x
1.00
2.05
1.08
3.08
1.01
1.08
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1.04
1.06
2.04
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1.04
1.02
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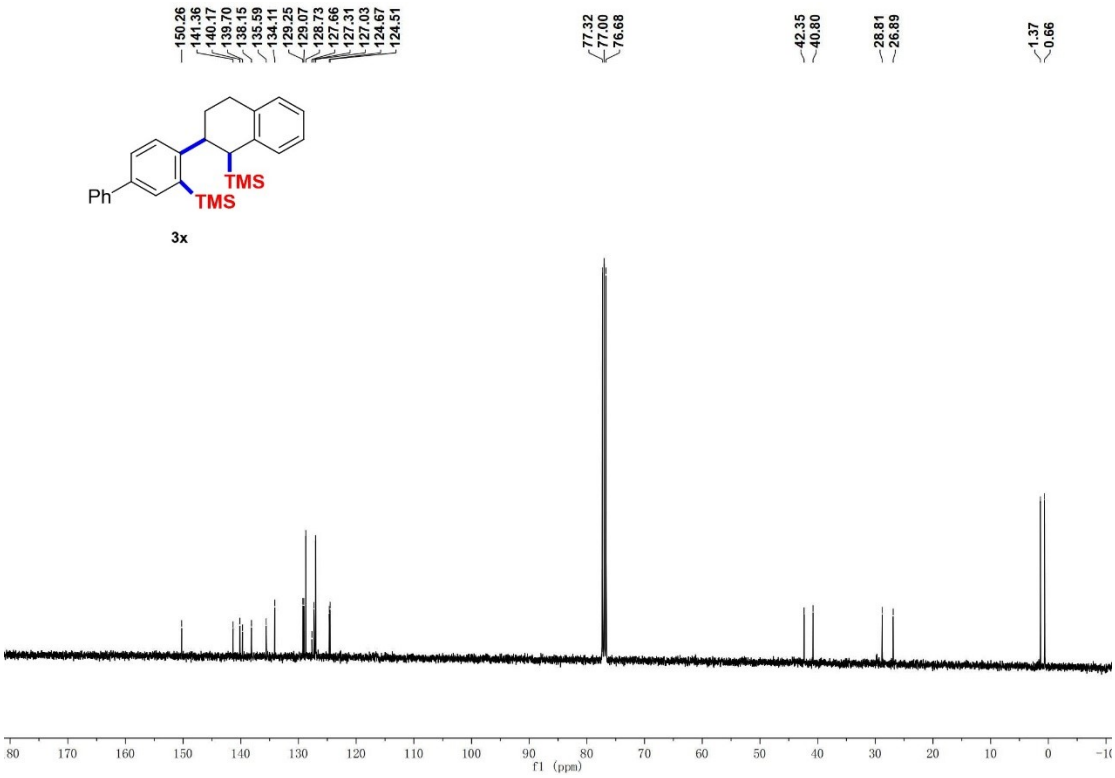
9.01
f1 (ppm)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129.25
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128.73
127.66
127.31
127.03
124.67
124.51
77.32
77.00
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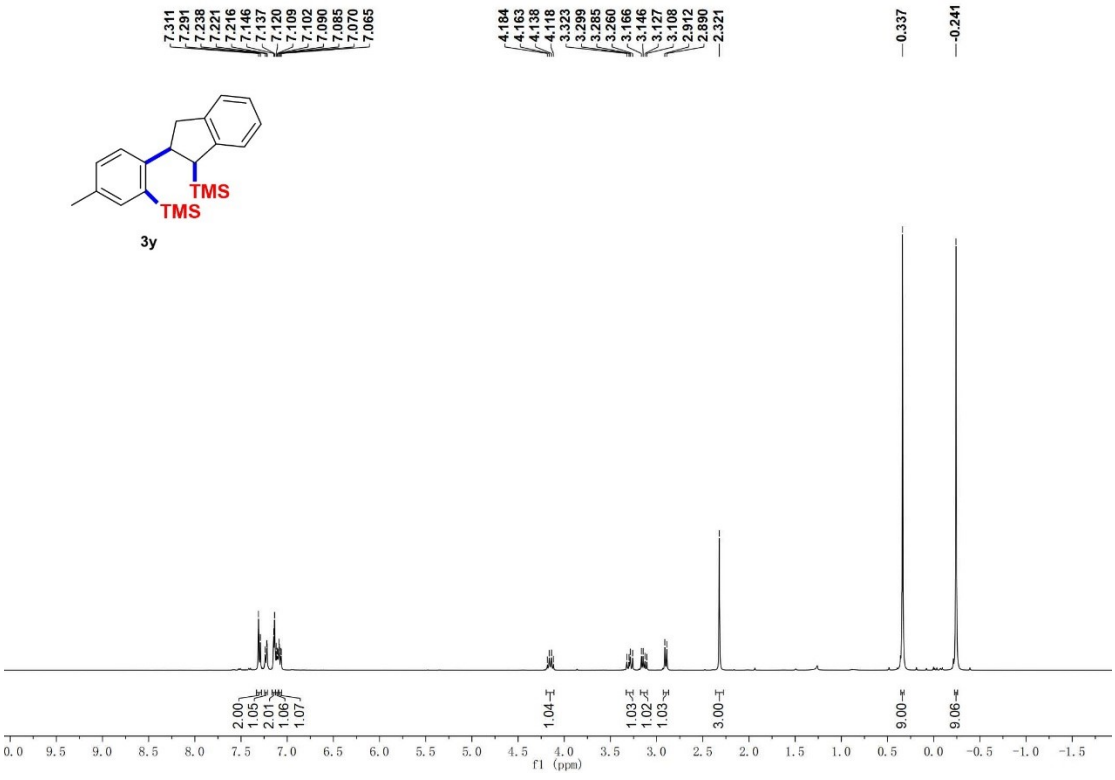
40.80
28.81
26.89
1.37
0.66
Ph
TMS
TMS
3x
f1 (ppm)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7.120
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7.102
7.090
7.085
7.070
7.065
4.184
4.163
4.138
4.118
3.323
3.299
3.285
3.260
3.166
3.146
3.127
3.108
2.912
2.890
2.321
0.337
0.241
TMS
TMS
3y
2.00
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1.03
3.00
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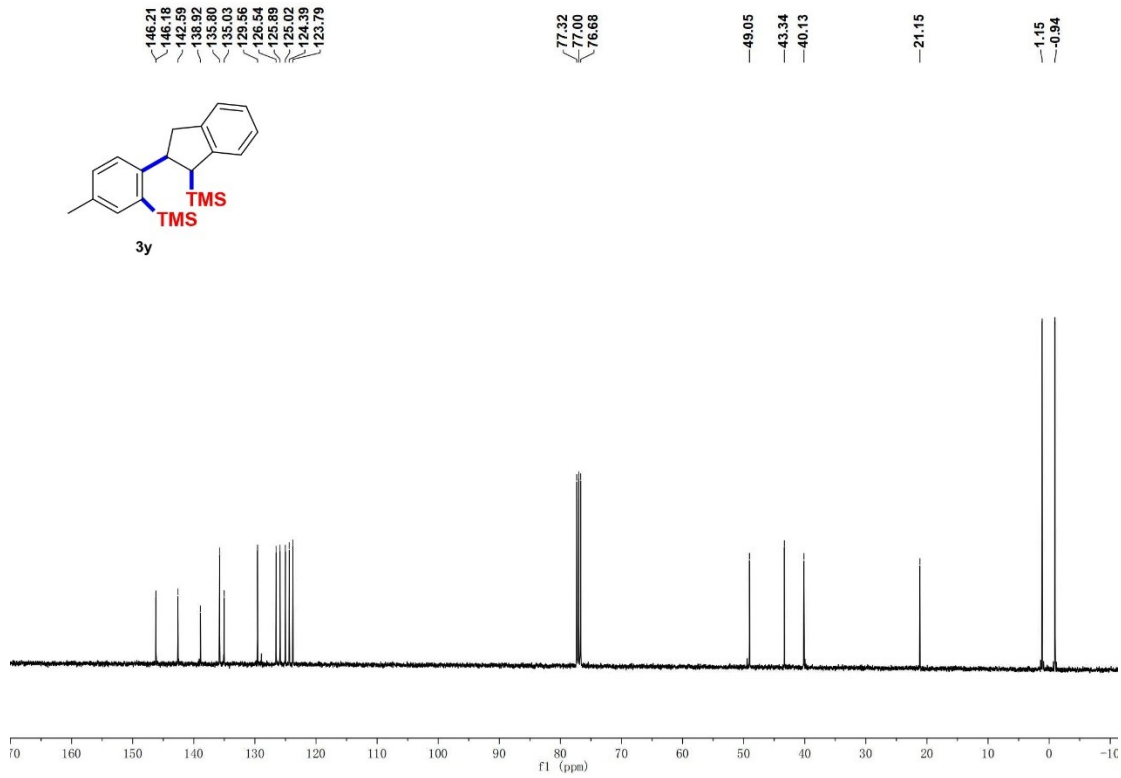
f1 (ppm)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138.92
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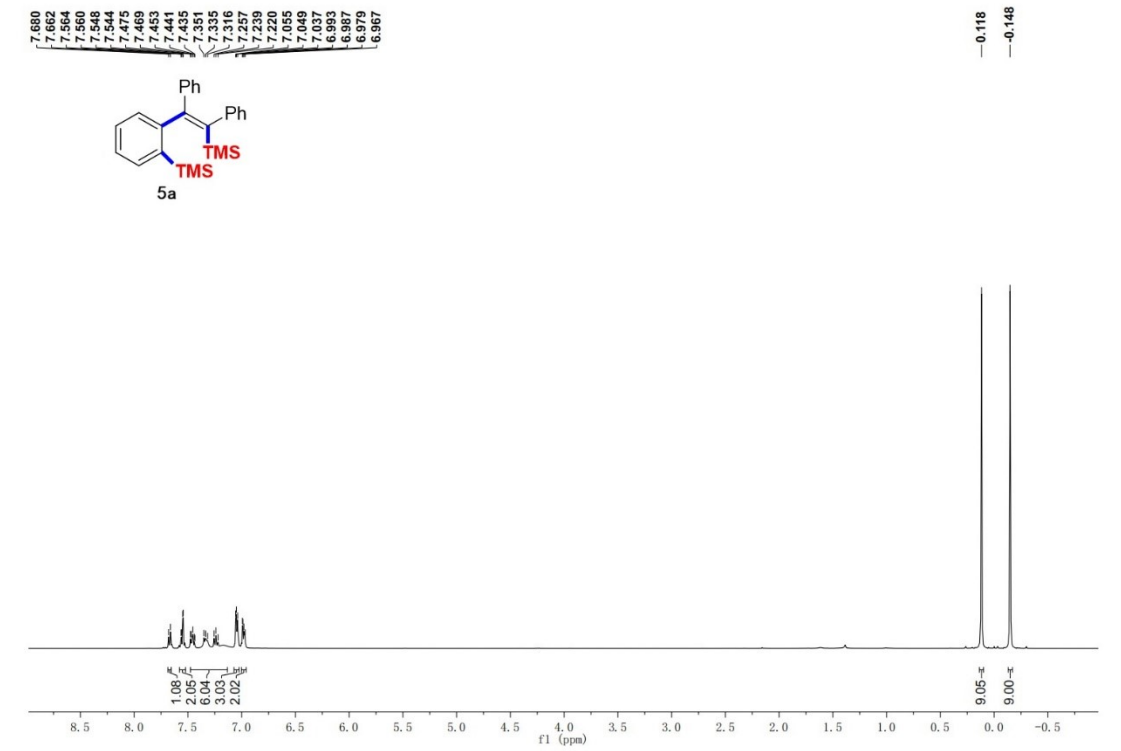
135.03
129.56
126.54
125.89
125.02
124.39
123.79
77.32
77.00
76.68
49.05
43.34
40.13
21.15
1.15
-0.94
TMS
TMS
3y
f1 (ppm)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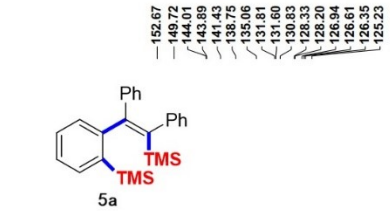
7.351
7.335
7.316
7.257
7.239
7.220
7.055
7.049
7.037
6.993
6.987
6.979
6.967
0.118
-0.148
Ph
Ph
TMS
TMS
5a
1.08
2.05
6.04
3.03
2.02
9.05
9.00
f1 (ppm)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131.81
131.60
130.83
128.33
128.20
126.94
126.61
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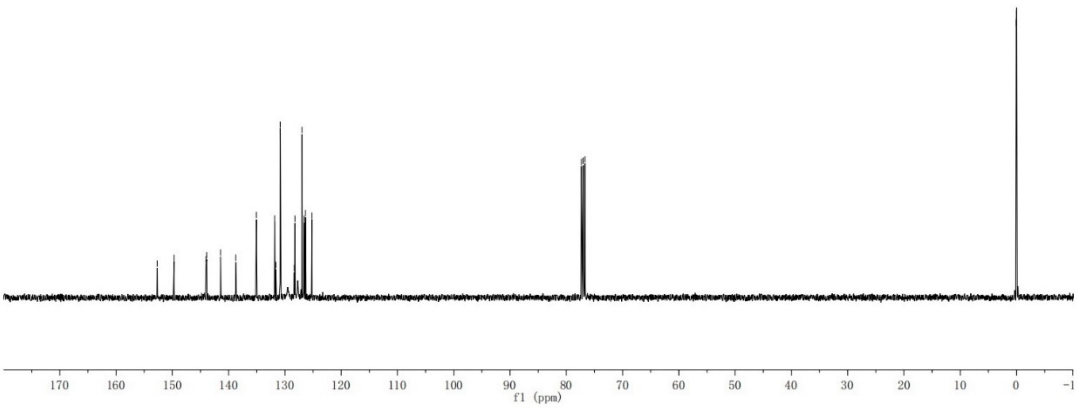
125.23
77.32
77.00
76.68
0.05
-0.00
Ph
Ph
TMS
TMS

5a


170
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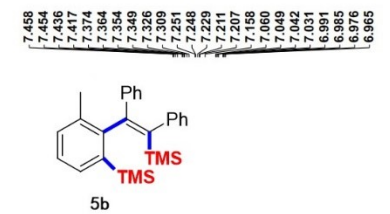
120
110
100
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)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7.309
7.251
7.248
7.229
7.211
7.207
7.158
7.060
7.049
7.042
7.031
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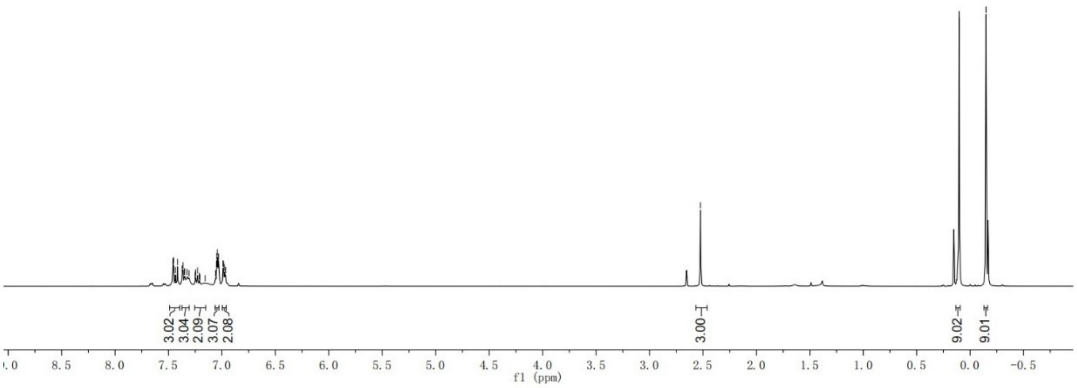
6.976
6.965
2.523
0.103
-0.148
Ph
Ph
TMS
TMS

5b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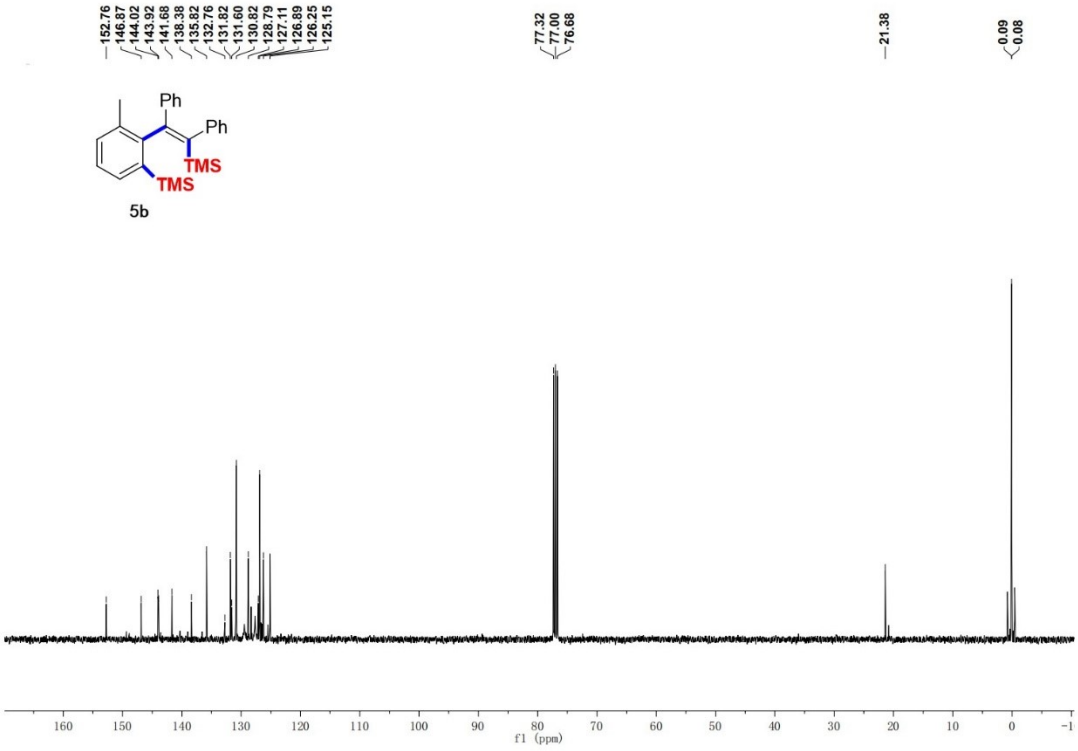
3.04
2.09
3.07
2.08
3.00
9.02
9.01
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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132.76
131.82
131.60
130.82
128.79
127.11
126.89
126.25
125.15
77.32
77.00
76.68
21.38
0.09
0.08
Ph
Ph
TMS
TMS
5b
160
150
140
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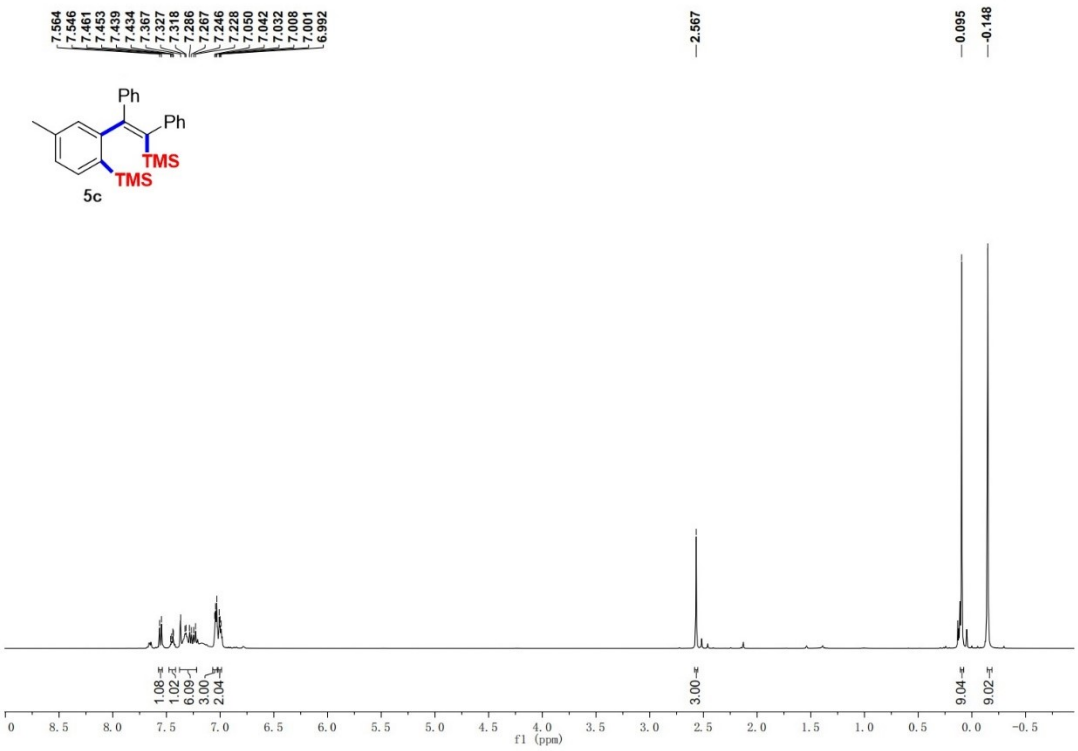
120
110
100
90
80
70
60
50
40
30
20
10
0
-1
f1 (ppm)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7.267
7.246
7.228
7.050
7.042
7.032
7.008
7.001
6.992
2.567
0.095
-0.148
Ph
Ph
TMS
TMS
5c
1.08
1.02
6.09
3.00
2.04
3.00
9.04
9.02
0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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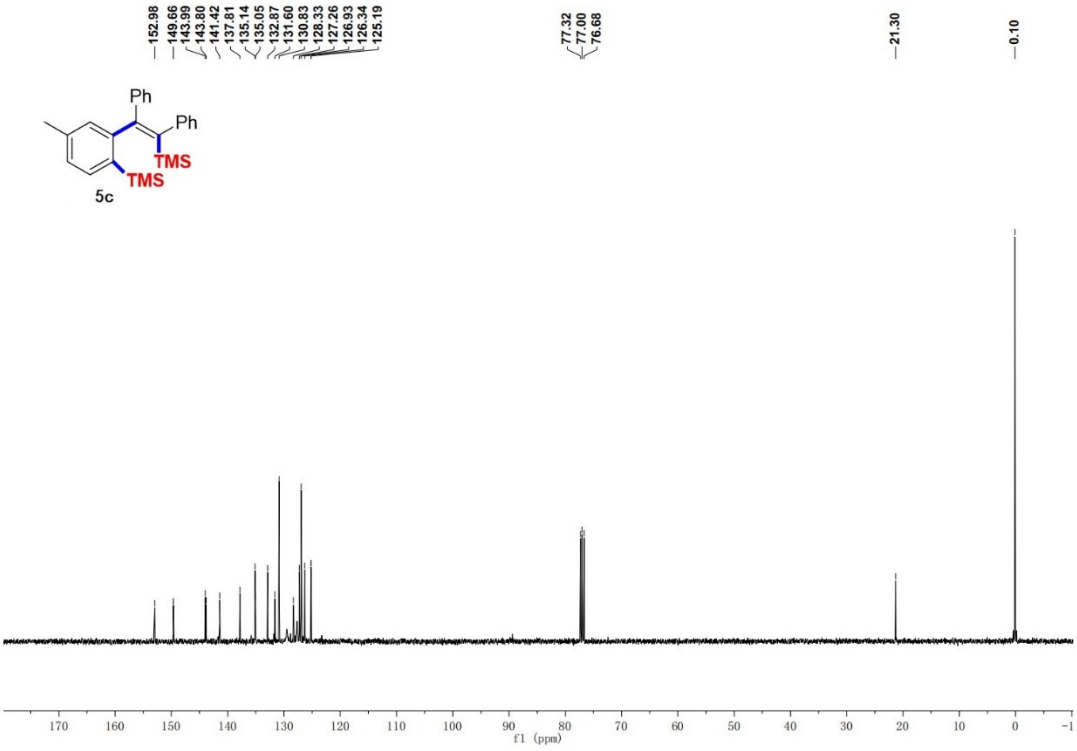
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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127.26
126.93
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Ph
Ph
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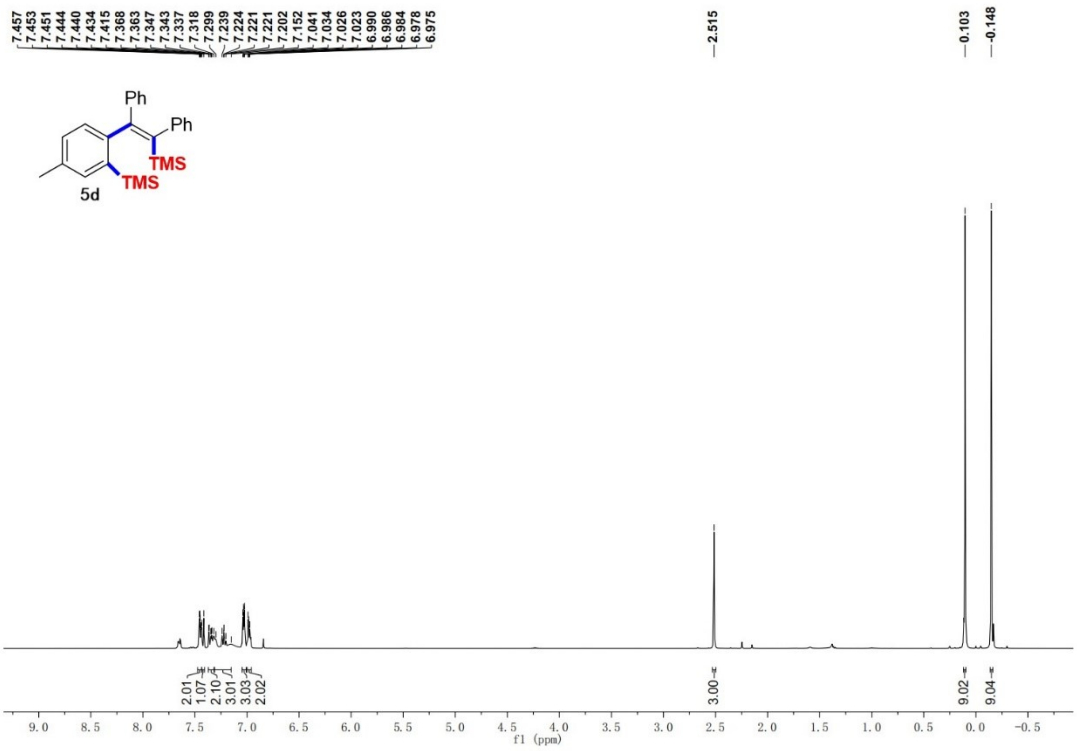
TMS
5c
f1 (ppm)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7.299
7.239
7.224
7.221
7.221
7.202
7.152
7.041
7.034
7.026
7.023
6.990
6.986
6.984
6.978
6.975
2.515
0.103
0.148
Ph
Ph
TMS
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9.04
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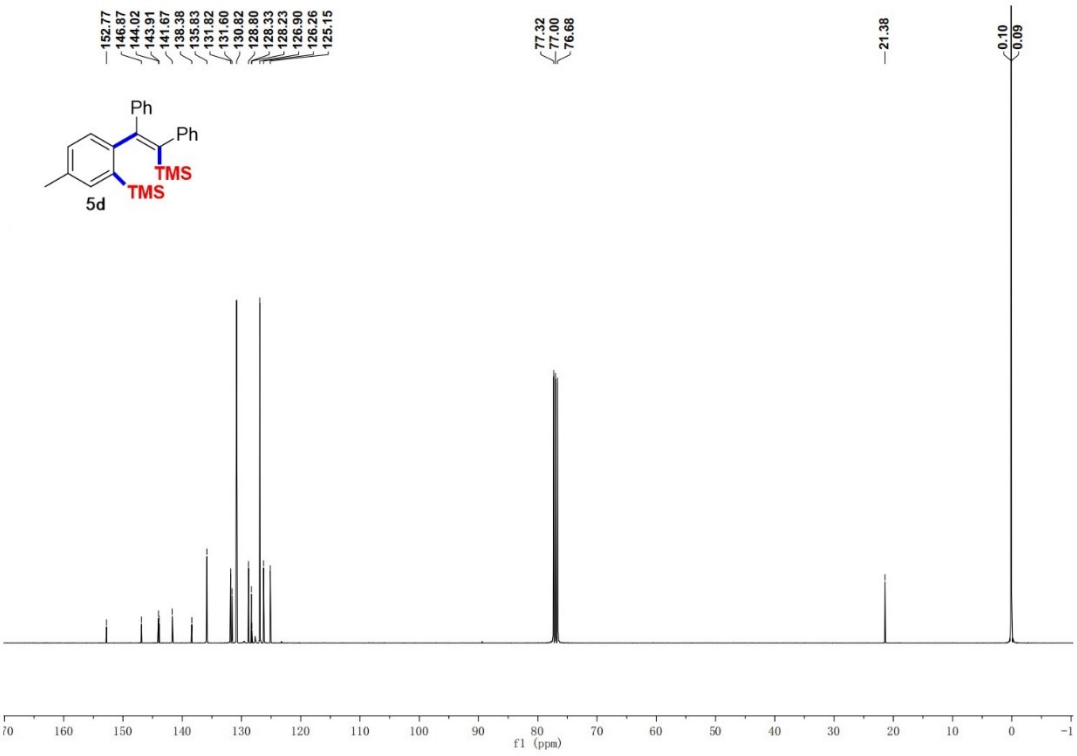
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128.33
128.23
126.90
126.26
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76.68
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Ph
Ph
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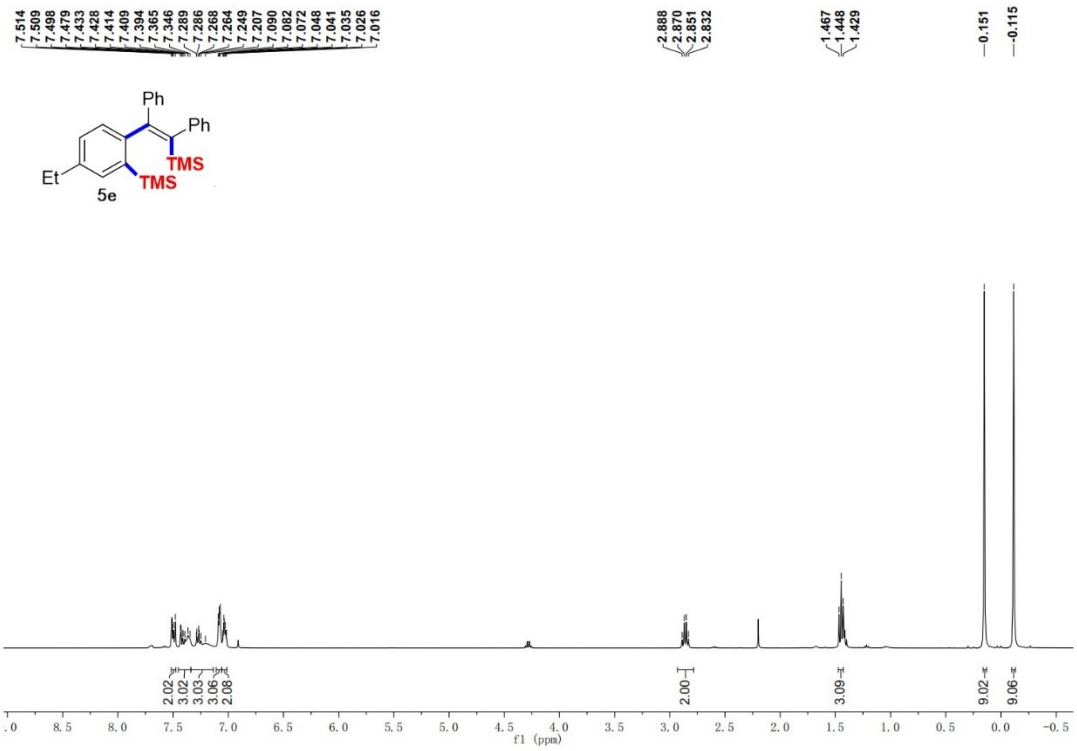
TMS
5d
f1 (ppm)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7.286
7.268
7.264
7.249
7.207
7.090
7.082
7.072
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7.041
7.035
7.026
7.016
2.888
2.870
2.851
2.832
1.467
1.448
1.429
0.151
0.115
Ph
Ph
TMS
TMS
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3.02
3.03
3.06
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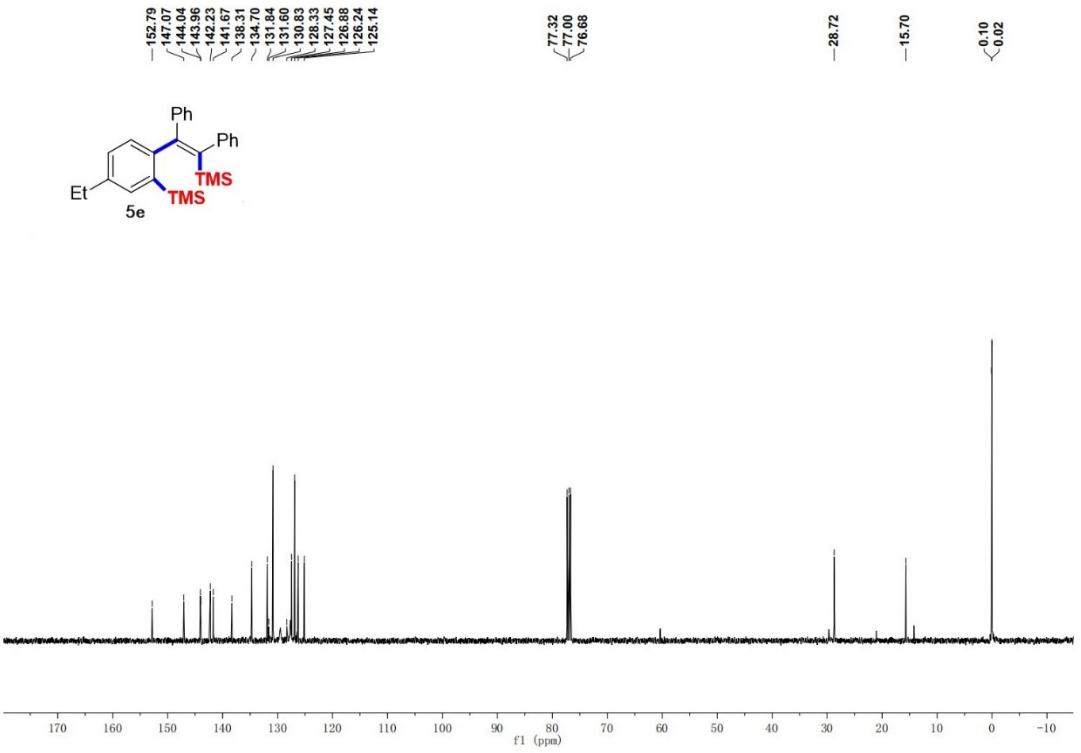
9.06
f1 (ppm)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126.24
125.14
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Ph
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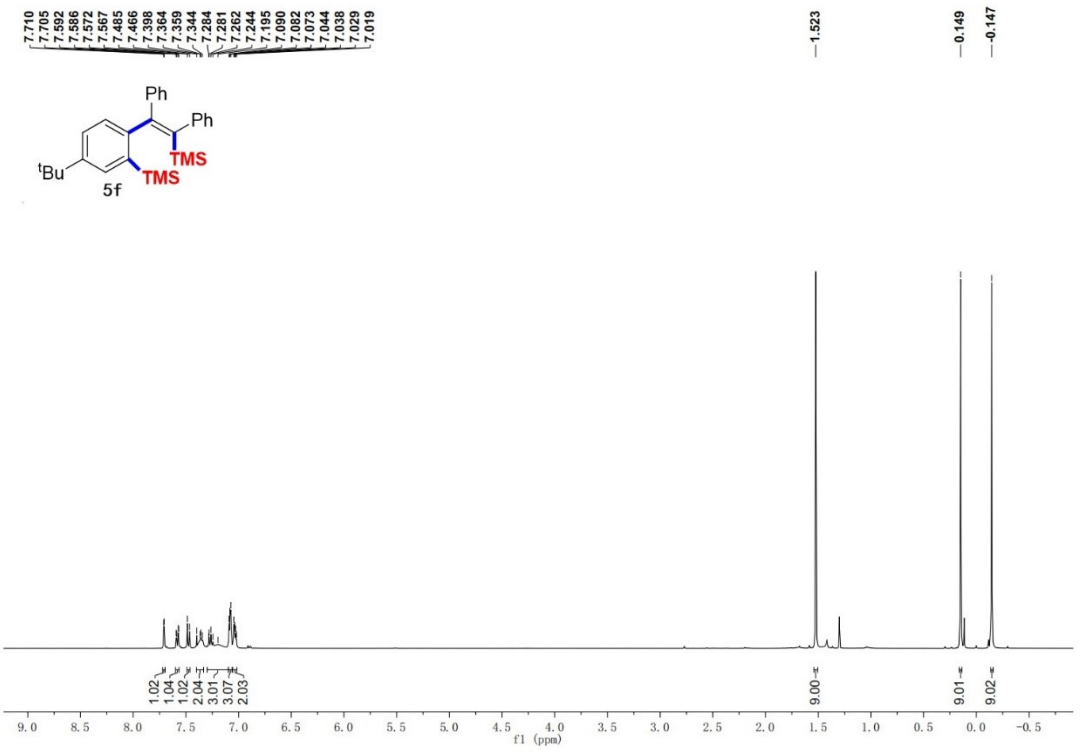
Et
5e
f1 (ppm)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7.281
7.262
7.244
7.195
7.090
7.082
7.073
7.044
7.038
7.029
7.019
1.523
0.149
0.147
Ph
Ph
TMS
TMS
tBu
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1.04
1.02
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3.01
3.07
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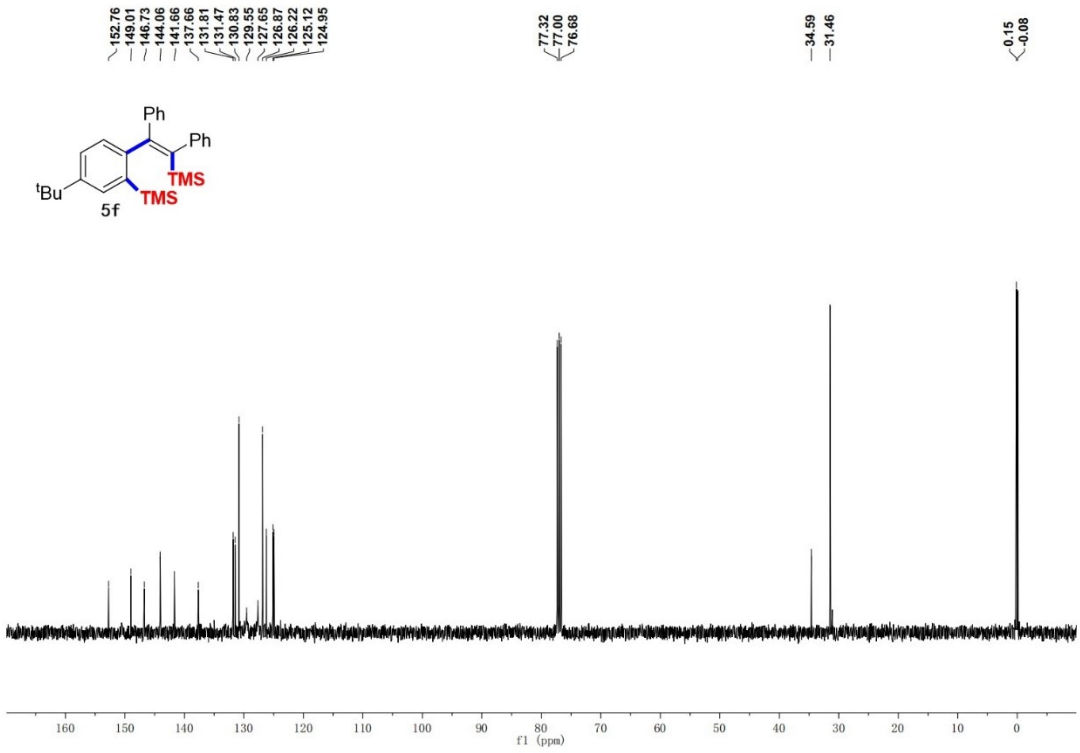
9.00
9.01
9.02
f1 (ppm)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124.95
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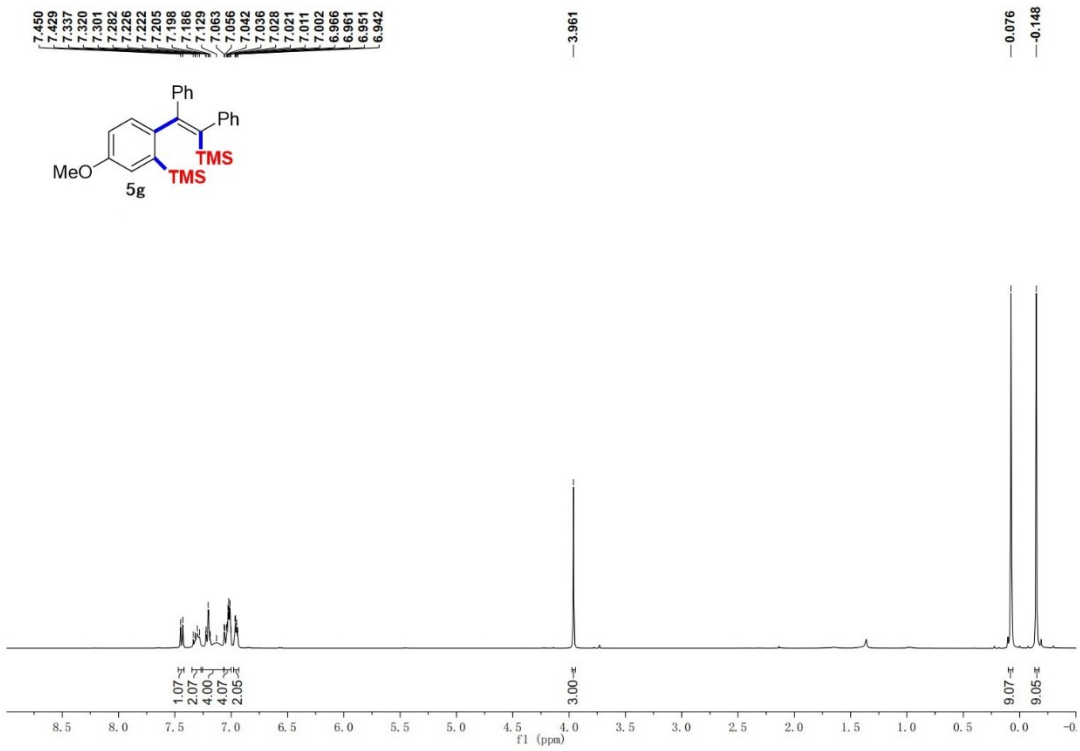
tBu
5f
f1 (ppm)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7.056
7.042
7.036
7.028
7.021
7.011
7.002
6.966
6.961
6.951
6.942
3.961
0.076
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Ph
Ph
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TMS
MeO
5g
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4.00
4.07
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3.00
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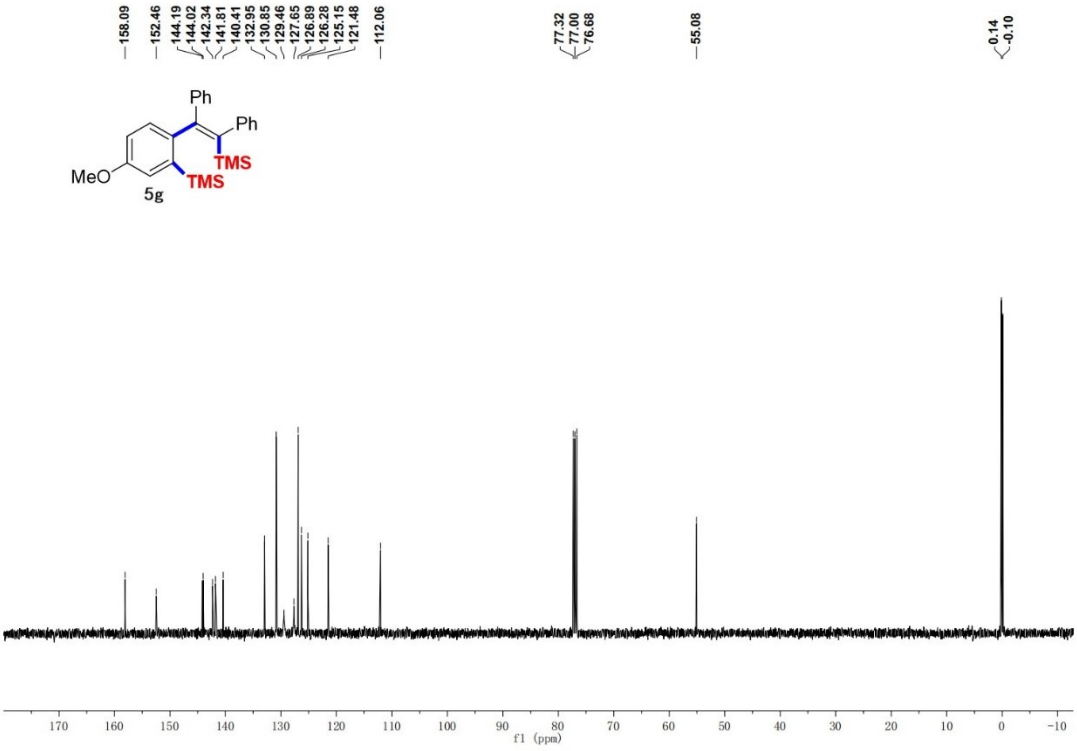
9.05
f1 (ppm)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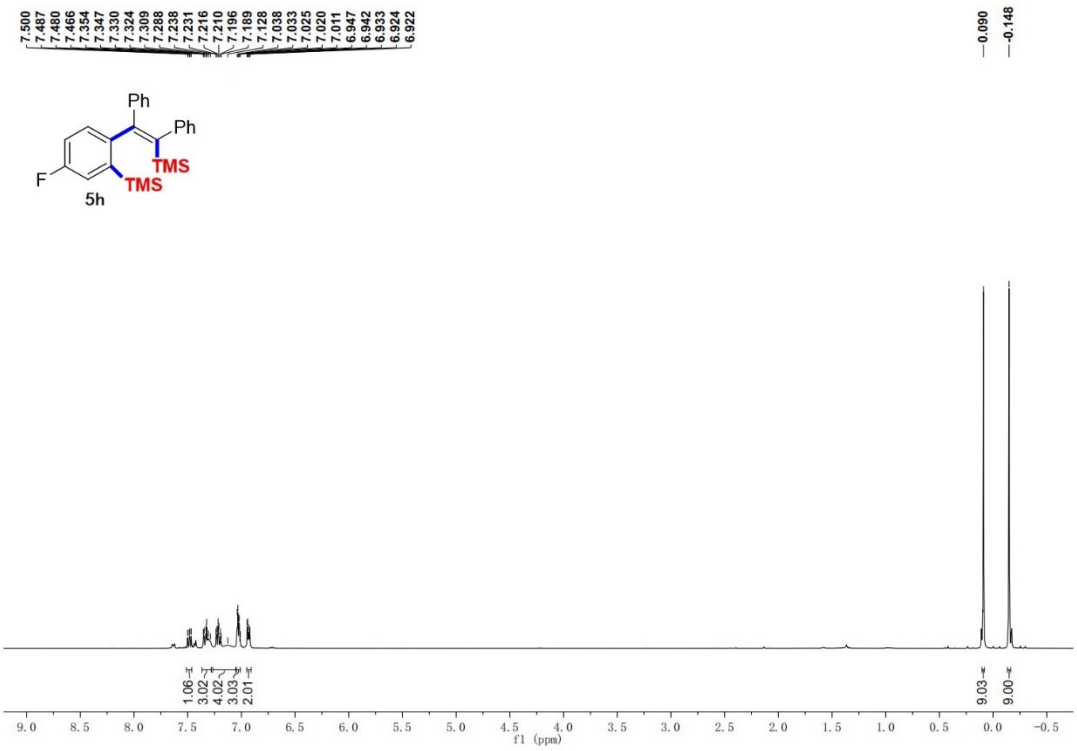
Ph
TMS
TMS
MeO
5g
f1 (ppm)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7.128
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7.020
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F
5h
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4.02
3.03
2.01
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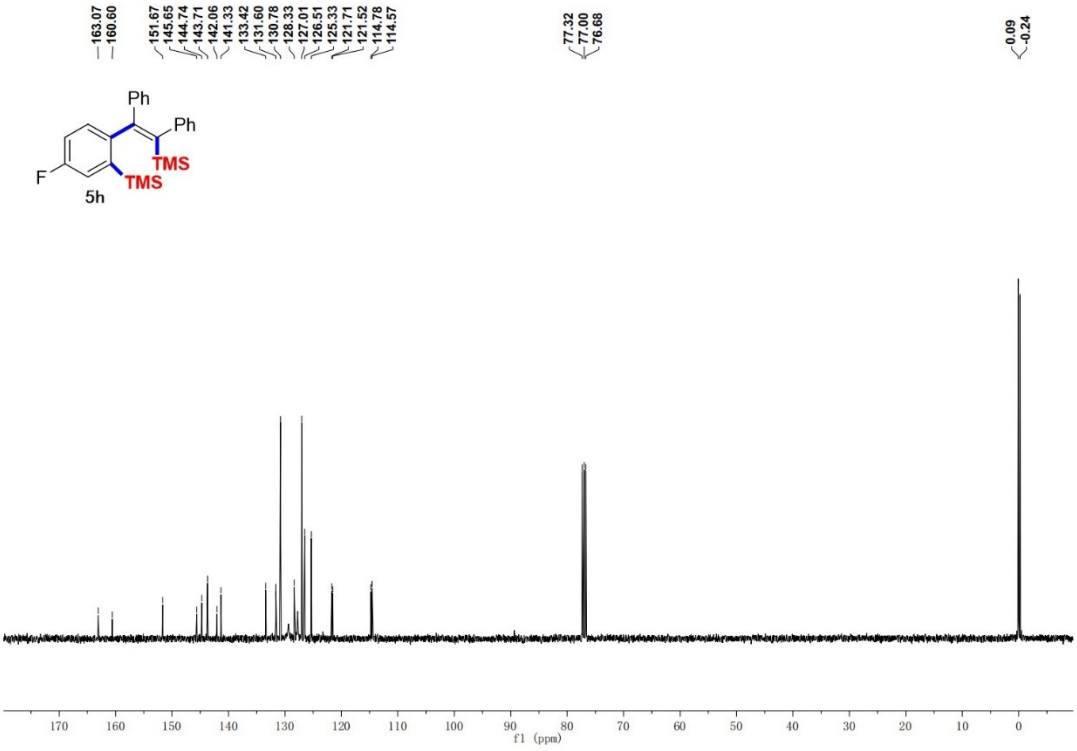
9.00
f1 (ppm)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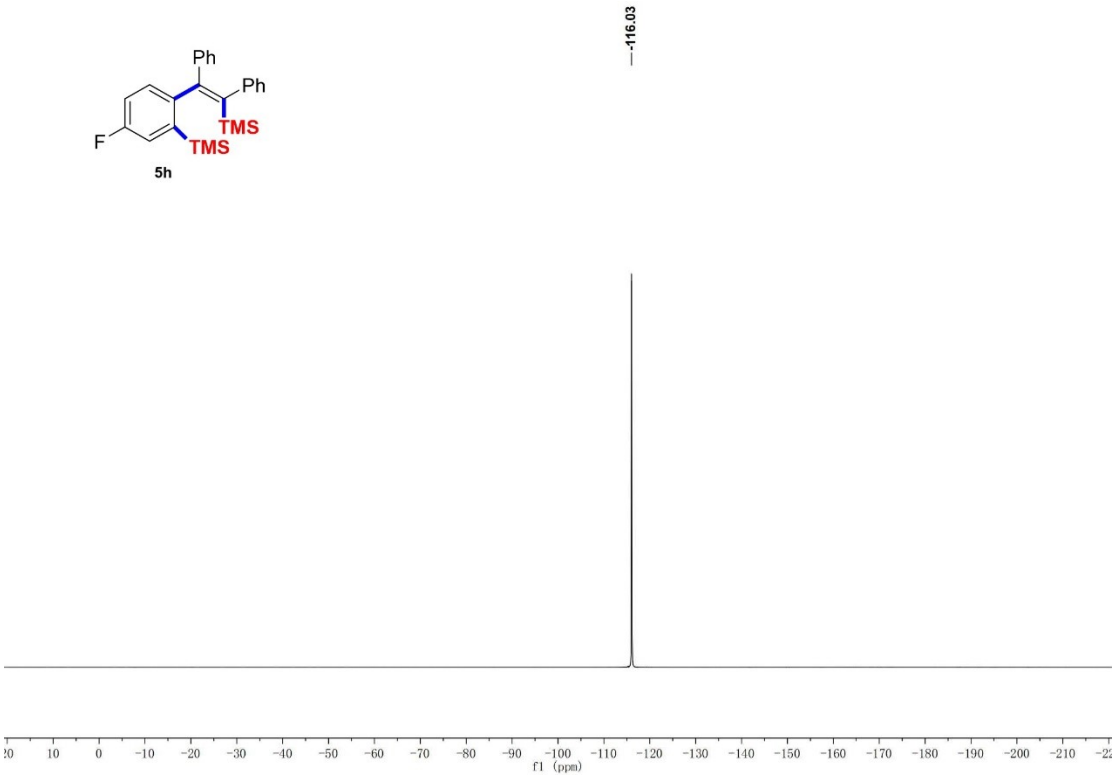
TMS
TMS
F
5h
f1 (ppm)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Ph
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F
5h
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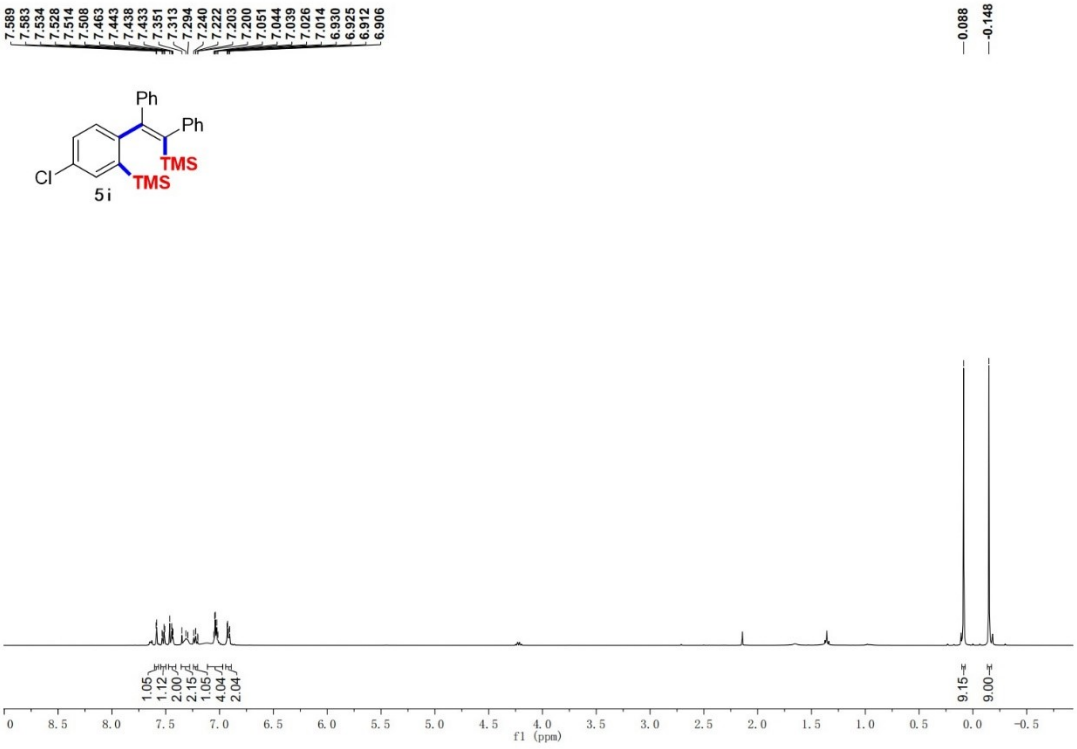
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7.203
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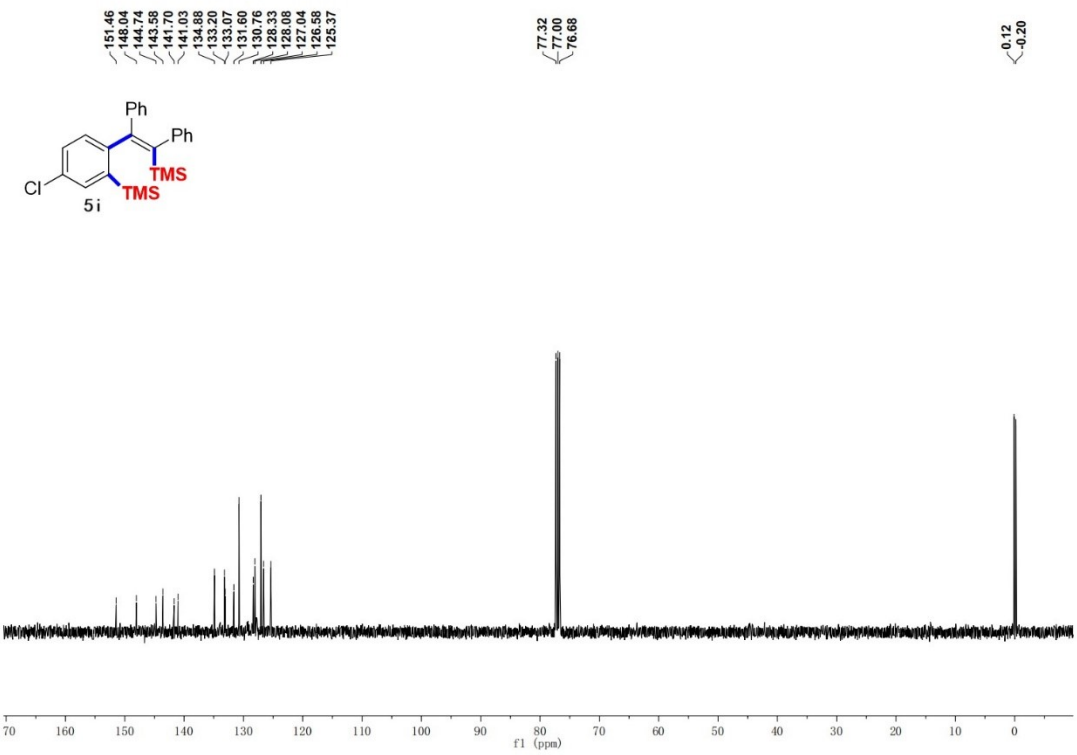
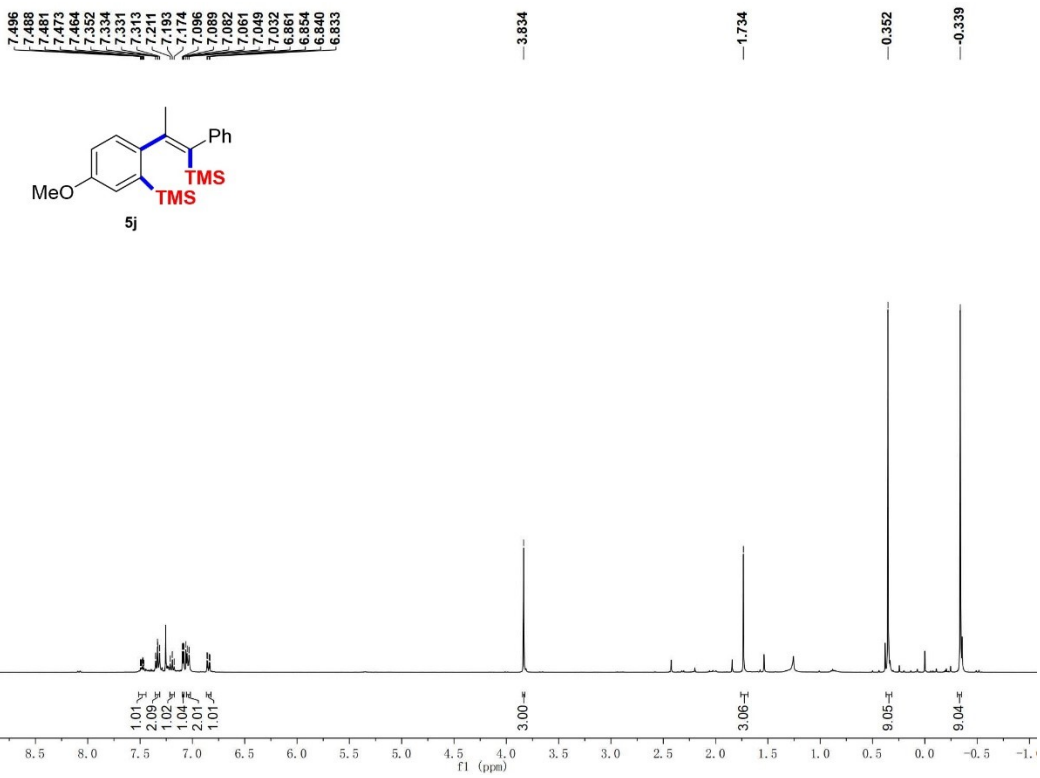
7.051
7.044
7.039
7.026
7.014
6.930
6.925
6.912
6.906
0.088
-0.148
Ph
Ph
TMS
TMS
Cl
5i
1.05
1.12
2.00
2.15
1.05
4.04
2.04
9.15
9.00
f1 (ppm)


151.46
148.04
144.74
143.58
141.70
141.03
134.88
133.20
133.07
131.60
130.76
128.33
128.08
127.04
126.58
125.37
77.32
77.00
76.68
0.12
-0.20
Ph
Ph
TMS
TMS
Cl
5i
f1 (ppm)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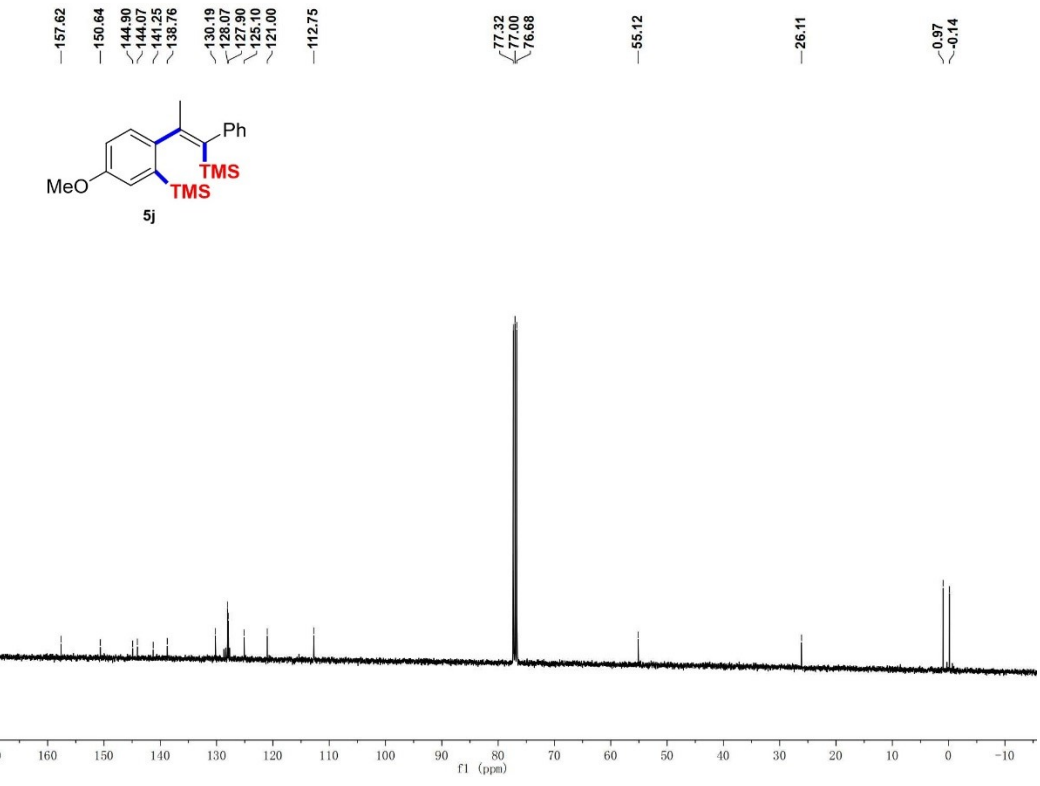
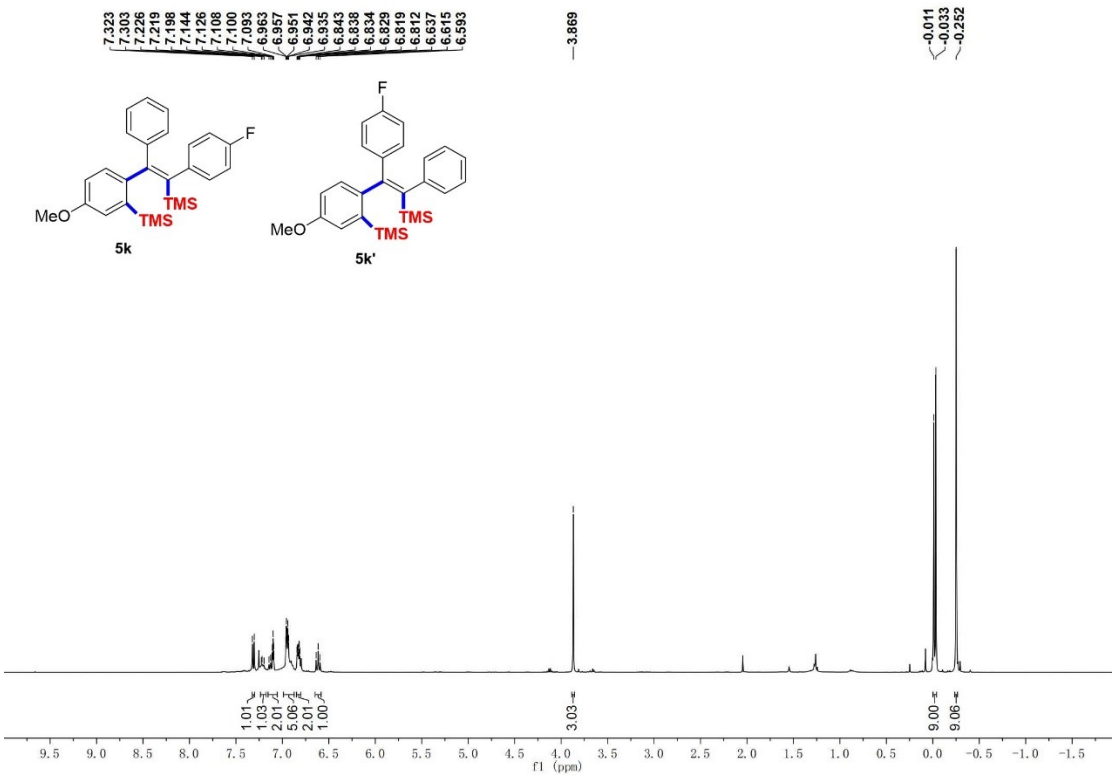
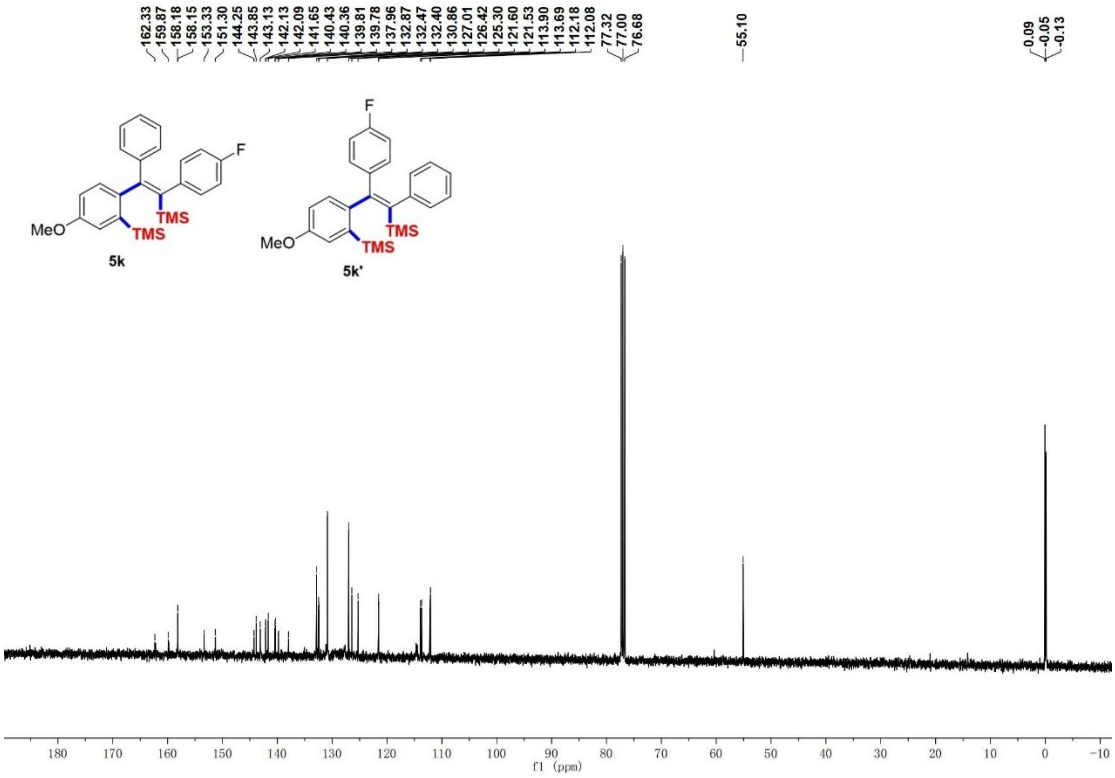
7.481
7.473
7.464
7.352
7.334
7.331
7.313
7.211
7.193
7.174
7.096
7.089
7.082
7.061
7.049
7.032
6.861
6.854
6.840
6.833
3.834
1.734
0.352
-0.339
Ph
TMS
TMS
MeO
5j
1.01
2.09
1.02
1.04
2.01
1.01
3.00
3.06
9.05
9.04
f1 (ppm)


157.62
150.64
144.90
144.07
141.25
138.76
130.19
128.07
127.90
125.10
121.00
112.75
77.32
77.00
76.68
55.12
26.11
0.97
-0.14
Ph
TMS
TMS
MeO
5j
f1 (ppm)


7.323
7.303
7.226
7.219
7.198
7.144
7.126
7.108
7.100
7.093
6.963
6.957
6.951
6.942
6.935
6.843
6.838
6.834
6.829
6.819
6.812
6.637
6.615
6.593
3.869
-0.011
-0.033
-0.252
F
MeO
TMS
TMS
5k
5k'
1.01
1.03
2.01
5.06
2.01
1.00
3.03
9.00
9.06
f1 (ppm)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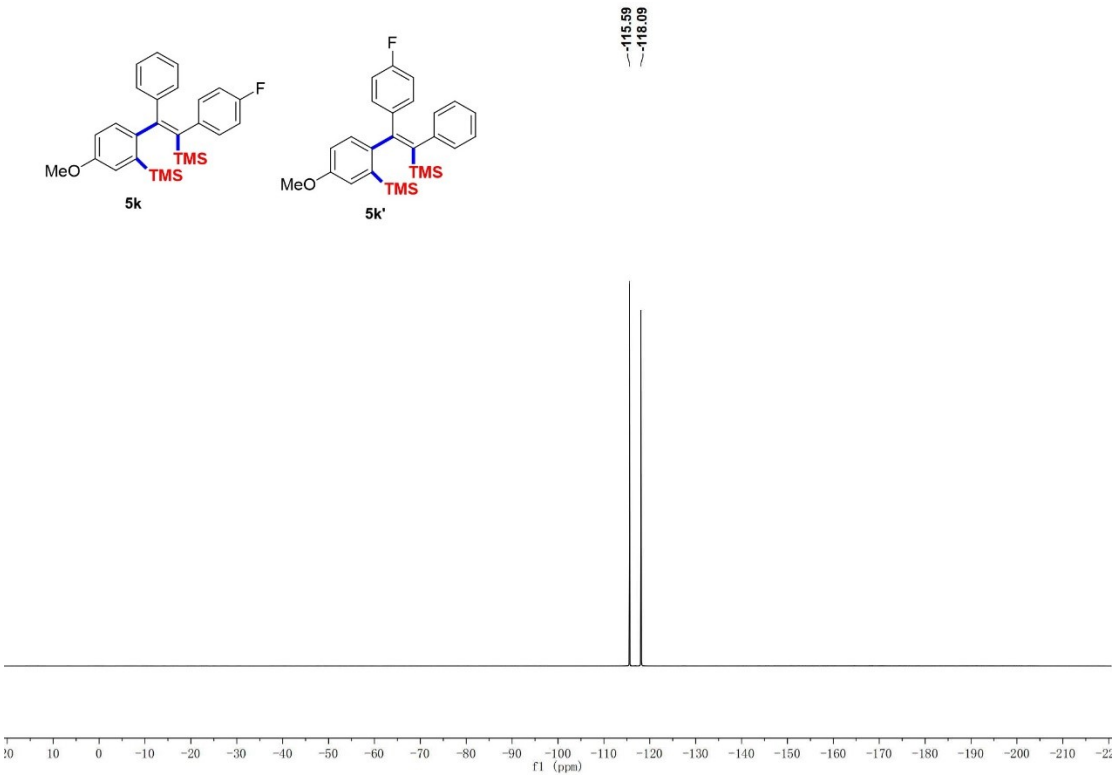
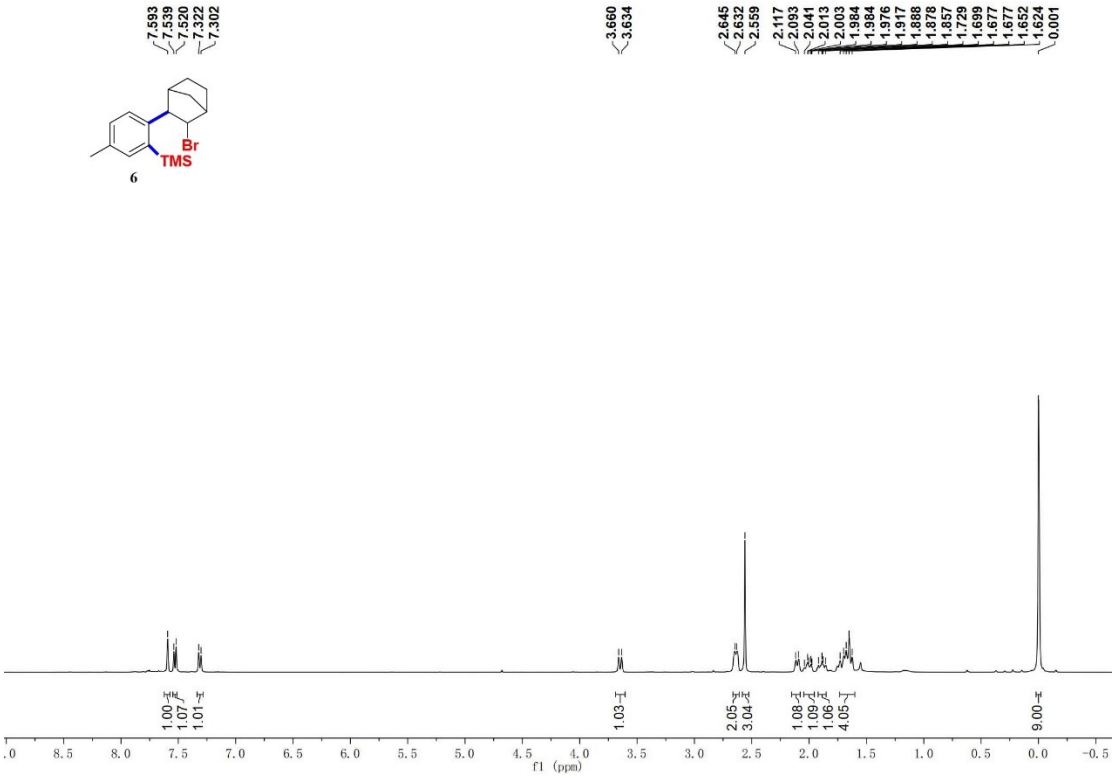
158.18
158.15
153.33
151.30
144.25
143.85
143.13
142.13
142.09
141.65
140.43
140.36
139.81
139.78
137.96
132.87
132.47
132.40
130.86
127.01
126.42
125.30
121.60
121.53
113.90
113.69
112.18
112.08
77.32
77.00
76.68
55.10
0.09
-0.05
-0.13
F
MeO
TMS
TMS
5k
5k'
f1 (ppm)

MeO
TMS
TMS
F
5k
MeO
TMS
TMS
F
5k'


-115.59
-118.09
f1 (ppm)

Br
TMS
6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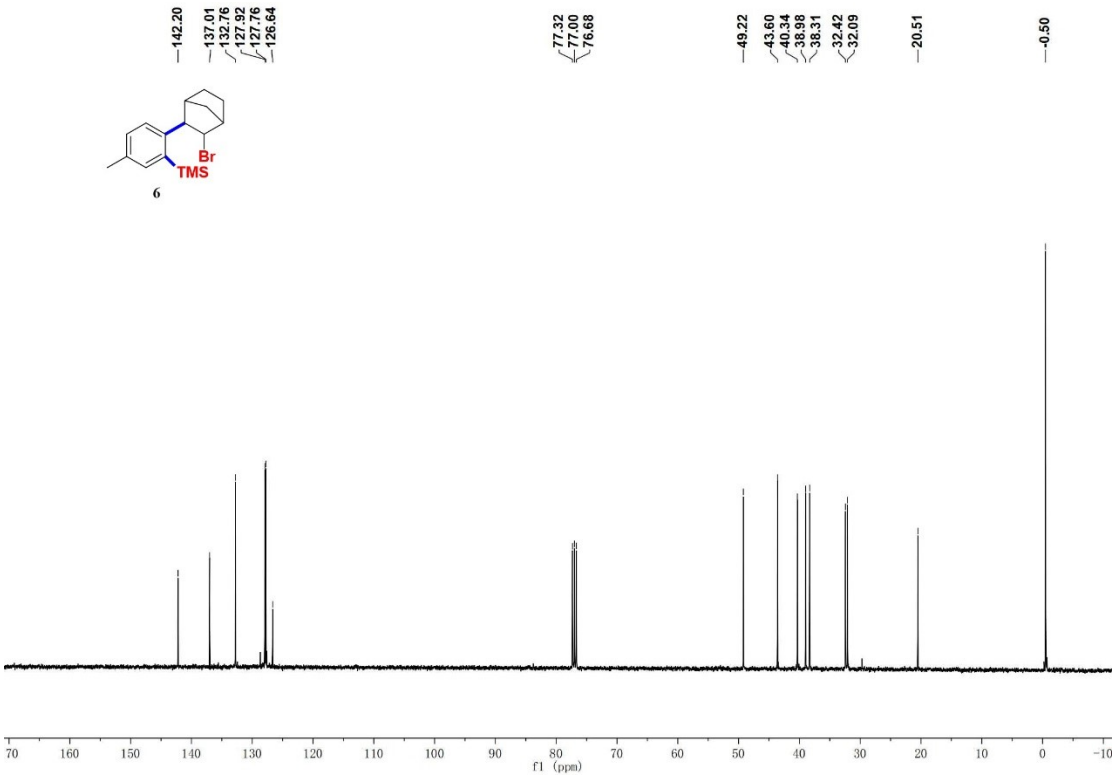
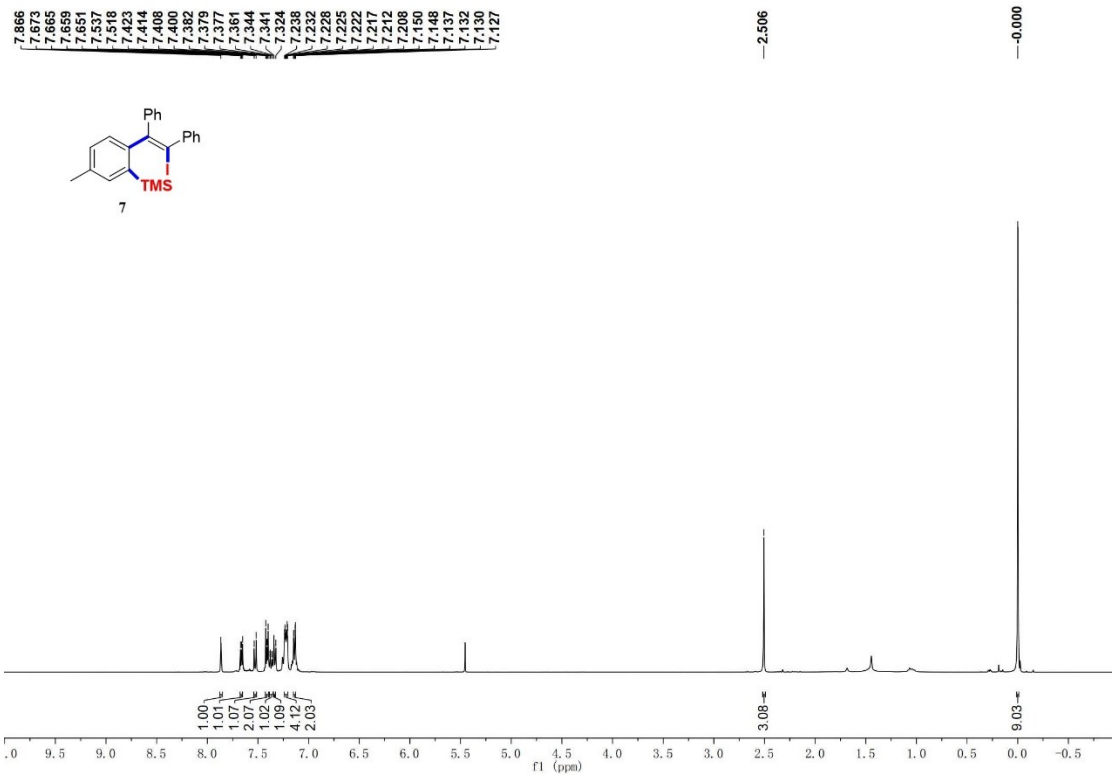
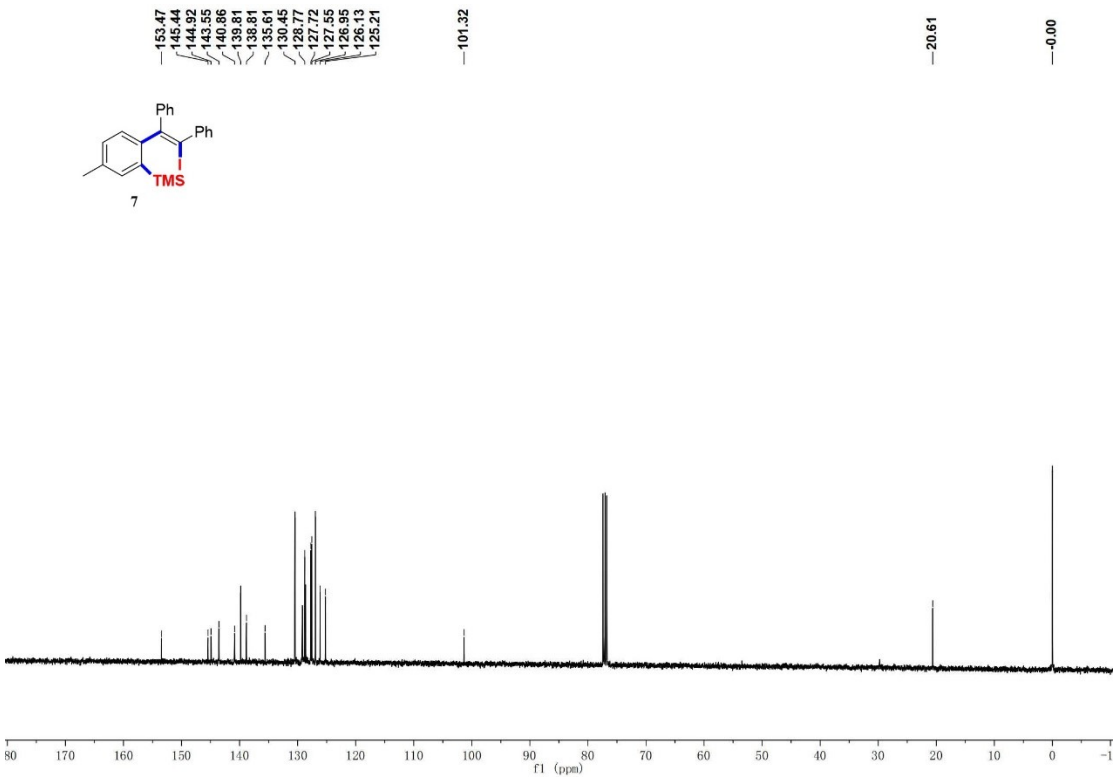
7.539
7.520
7.322
7.302
3.660
3.634
2.645
2.632
2.559
2.117
2.093
2.041
2.013
2.003
1.984
1.984
1.976
1.917
1.888
1.878
1.857
1.729
1.699
1.677
1.677
1.652
1.624
0.001
1.00
1.07
1.01
1.03
2.05
3.04
1.08
1.09
1.06
4.05
9.00
f1 (ppm)


142.20
137.01
132.76
127.92
127.76
126.64
77.32
77.00
76.68
49.22
43.60
40.34
38.98
38.31
32.42
32.09
20.51
0.50
Br
TMS
6
f1 (ppm)


7.866
7.673
7.665
7.659
7.651
7.537
7.518
7.423
7.414
7.408
7.400
7.382
7.379
7.377
7.361
7.344
7.341
7.324
7.238
7.232
7.228
7.225
7.222
7.217
7.212
7.208
7.150
7.148
7.137
7.132
7.130
7.127
2.506
0.000
Ph
Ph
TMS
7
1.00
1.01
1.07
2.07
1.02
1.09
4.12
2.03
3.08
9.03
f1 (ppm)


153.47
145.44
144.92
143.55
140.86
139.81
138.81
135.61
130.45
128.77
127.72
127.55
126.95
126.13
125.21
101.32
20.61
0.00
Ph
Ph
TMS
7
f1 (ppm)