Department of Chemistry, Fudan University, 2005 Songhu Road, Shanghai 200438, China.

Supplementary Information

Cascade Alkyl Migration in 2-Alkynylanilines for the Synthesis of Benzenoid Ring Multi-functionalized Indoles

Jiwen He‡, Xiaohua Li‡, Qiuqin He* and Renhua Fan*

‡These authors contributed equally to this work.

Correspondence author. Email: rhfan@fudan.edu.cn

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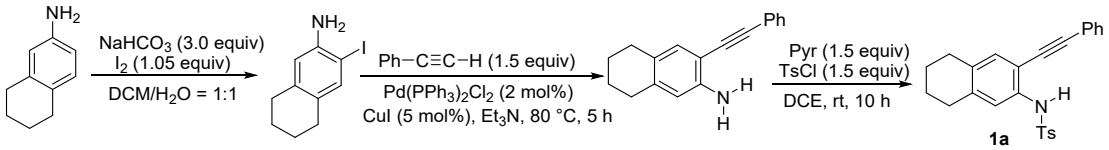
1. General Experimental Procedures

1.1 General Information

All reactions were performed in a 25 mL of test tubes under air atmosphere. Flash column chromatography was performed using silica gel (60-Å pore size, 32-63 μm, standard grade). Analytical thin-layer chromatography was performed using glass plates pre-coated with 0.25 mm 230-400 mesh silica gel impregnated with a fluorescent indicator (254 nm). Thin layer chromatography plates were visualized by exposure to ultraviolet light. Organic solutions were concentrated on rotary evaporators at ~20 Torr (house vacuum) at 35-40 °C. Commercial reagents and solvents were used as received. Nuclear magnetic resonance (NMR) spectra are recorded in parts per million from internal tetramethylsilane on the δ scale. High Resolution Mass spectra was recorded by Bruker MicroTOF II (ESI^+).

1.2 Synthesis of Compound 1a[1]

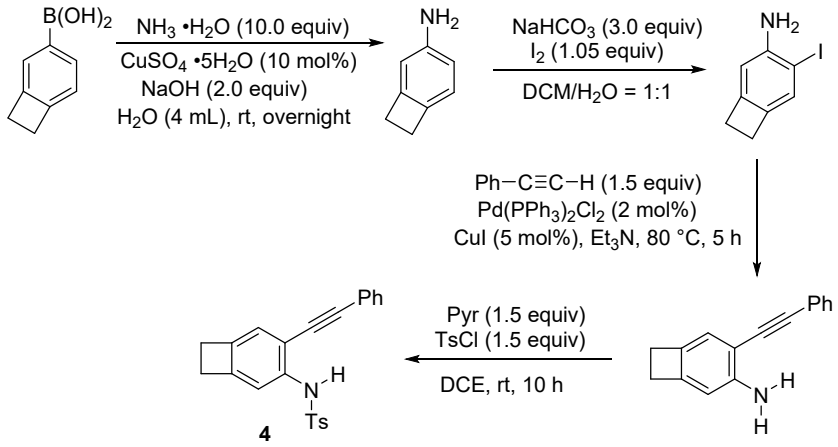


5,6,7,8-tetrahydronaphthalen-2-amine (1.47 g, 10 mmol), I_2 (2.67 g, 10.5 mmol), and $NaHCO_3$ (2.52 g, 30 mmol) were diluted on DCM (20 mL) and H_2O (20 mL). The resulting mixture was stirred at room temperature for 20 h. Then, the two phases were separated, and the aqueous layer was extracted with DCM (2 x 40 mL). The combined organic layer was washed with brine (20 mL), dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. The crude compound was devoted to next step without further purification.

3-iodo-5,6,7,8-tetrahydronaphthalen-2-amine (1.36 g, 5 mmol), $Pd(PPh_3)_2Cl_2$ (70.2 mg, 0.1 mmol), CuI (47.75 mg, 0.25 mmol) and Phenylacetylene (765 mg, 7.5 mmol) were solubilized in triethylamine (20 mL). The resulting mixture was stirred 80 °C for 5 h. The reaction mixture was quenched with H_2O (20 mL). Triethylamine was removed under reduced pressure. The aqueous layer was extracted with EA (3 x 30 mL). The combined organic phase was washed with brine (20 mL), dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. The crude material was purified by flash column chromatography on silica gel (PE/EA = 5:1).

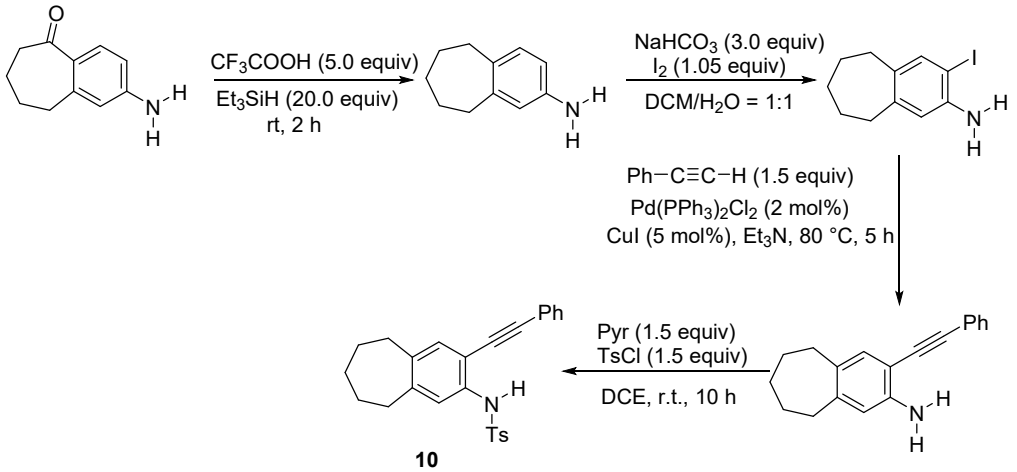
3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-amine (1.24 g, 5 mmol), pyridine (592.5 mg, 7.5 mmol), and 4-methylbenzenesulfonyl chloride (1.43 g, 7.5 mmol) were solubilized in DCE (20 mL). The resulting mixture was stirred at room temperature for 10 h and then quenched with H_2O (20 mL) and brine (20 mL), dried over anhydrous Na_2SO_4, concentrated under reduced pressure and purified by flash column chromatography on silica gel (PE/EA = 10:1).

1.3 Synthesis of Compound 4[2]



bicyclo[4.2.0]octa-1,3,5-trien-3-ylboronic acid (1.47 g, 10 mmol), $CuSO_4{\cdot}5H_2O$ (0.25 g, 1 mmol), NaOH (0.80g, 20 mmol), H_2O (4 mL) and aqueous ammonia (50 mL) were added to a round-bottom flask (100 mL). The resulting mixture was stirred at room temperature overnight. After completion of the reaction, the mixture was extracted with EA (3 x 30 mL). The combined organic phase was washed with brine (20 mL), dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. The crude was purified by flash column chromatography on silica gel (PE/EA = 5:1). The following steps are the same as above.

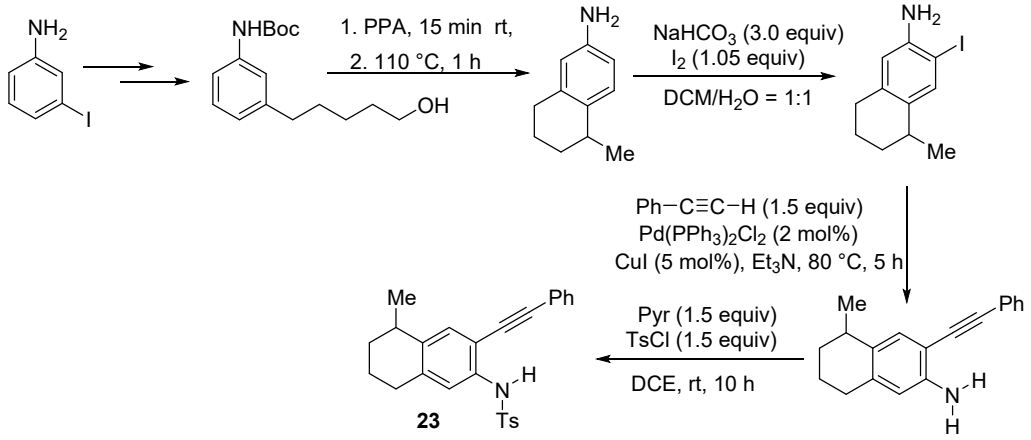
1.4 Synthesis of Compound 10[3]



2-amino-6,7,8,9-tetrahydro-5*H*-benzo[7]annulen-5-one (0.35 g, 2 mmol), CF_3COOH (1.14g, 10 mmol) and Et_3SiH (4.64 g, 40 mmol) were stirred at room temperature for 2 h. The reaction mixture was quenched with saturated $NaHCO_3$ (30

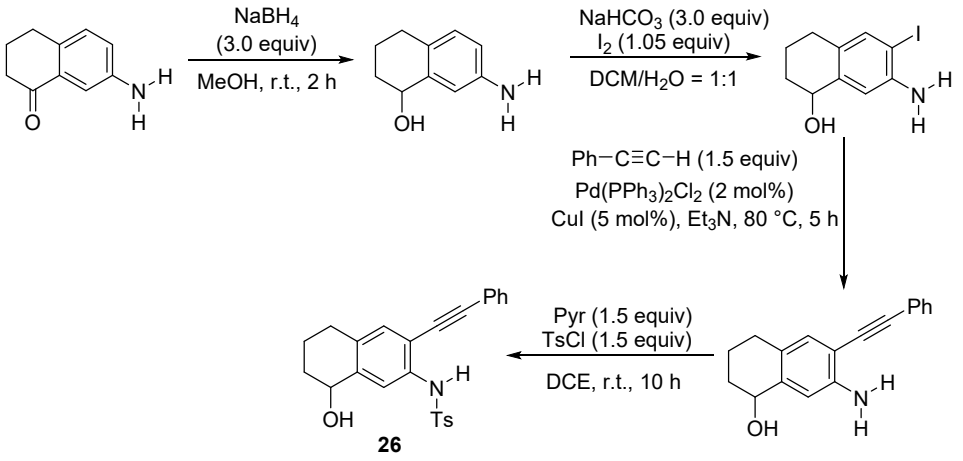
mL) and brine (20 mL), dried over Na_2SO_4, concentrated under reduced pressure and purified by flash column chromatography on silica gel (PE/EA = 10:1). The following steps are the same as above.

1.5 Synthesis of Compound 23[4]



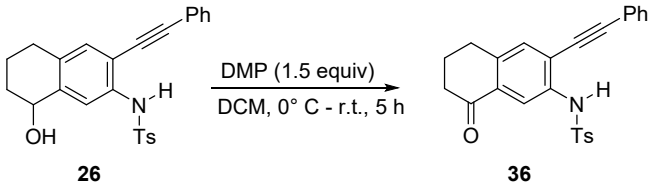
Tert-butyl (3-(5-hydroxypentyl)phenyl)carbamate (279 mg, 1 mmol) was dissolved in 550 mg of polyphosphoric acid (PPA) at room temperature and further heated to 110℃ for 1 h with stirring. The reaction mixture was poured to ice-cold water and stirred for 30 min. A 1.0 M NaOH (pH 7-8) solution was added to the mixture and then extracted with EA (3 x 30 mL). Then the EA layer was washed with deionized water (30 mL) followed by brine (50 mL), dried over Na_2SO_4, concentrated under reduced pressure and purified by flash column chromatography on silica gel (PE/EA = 10:1). The following steps are the same as above.

1.6 Synthesis of Compound 26



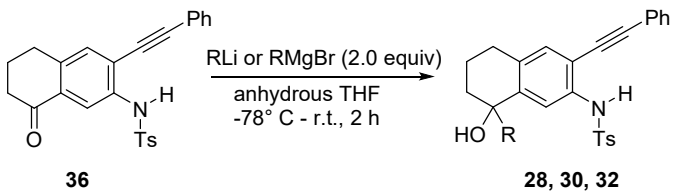
The procedures are the same as above.

1.7 Synthesis of Compound 36



Compound **26** (41.7 mg, 0.1 mmol) was dissolved in DCM (2 mL) at 0 ℃ for 10 min, and added DMP (63.6 mg, 0.15 mmol). Then the reaction mixture was further heated to room temperature for 5 h with stirring. Saturated $NaHCO_3$ solution was added to this mixture and then extracted with EA (3 x 10 mL), dried over Na_2SO_4, concentrated under reduced pressure and purified by flash column chromatography on silica gel (PE/EA = 5:1).

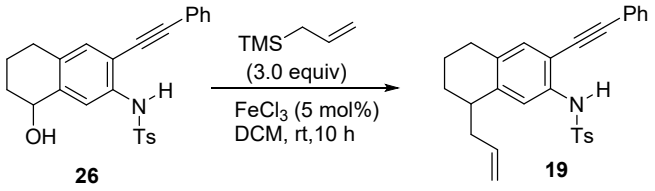
1.8 Synthesis of Compounds 28, 30, 32[5]



Compound **36** (41.5 mg, 0.1 mmol) was dissolved in anhydrous THF (2 mL) under

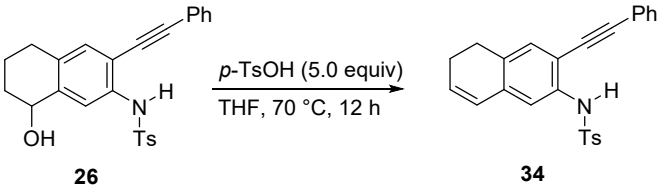
argon atmosphere at -78 °C for 10 minutes. Then Grignard or Lithium reagent was added to the solution (1.6 M). The reaction mixture was further heated slowly to at room temperature for 2 h with stirring. Saturated NH_4Cl was added to this mixture and then extracted with EA (3 x 10 mL), dried over Na_2SO_4 and concentrated under reduced pressure and purified by flash column chromatography on silica gel (PE/EA = 5:1).

1.9 Synthesis of Compound 19[6]



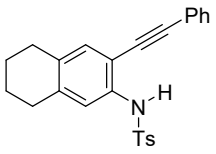
Compound **26** (41.7 mg, 0.1 mmol) was dissolved in DCM (2 mL), then added trimethylsilyl chloride (48 μL, 0.3 mmol) and iron(III) chloride (1.35 mg, 0.005 mmol). The reaction mixture was stirred at room temperature for 10 h. The mixture was concentrated under reduced pressure and purified by flash column chromatography on silica gel (PE/EA = 10:1).

1.10 Synthesis of Compound 34[7]



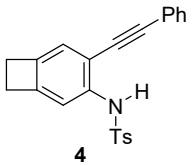
Compound **26** (41.7 mg, 0.1 mmol) and *p*-TsOH (86 mg, 0.5 mmol) were dissolved in THF (2 mL). The reaction mixture was heated at 70 ℃ for 12 h with stirring and concentrated under reduced pressure and purified by flash column chromatography on silica gel (PE/EA = 10:1).

Analytical Data



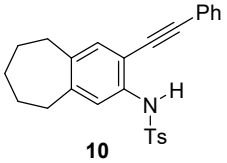
1a

4-methyl-*N*-(3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)benzenesulfonamide 1a (eluent: petroleum ether/ethyl acetate 10:1), 56.1 mg, 70% yield; white solid; mp: 158-159 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, J = 8.0 Hz, 2H), 7.44 – 7.32 (m, 6H), 7.12 (d, J = 7.8 Hz, 2H), 7.05 (s, 2H), 2.74 (s, 2H), 2.62 (s, 2H), 2.29 (s, 3H), 1.73 (s, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 139.4, 136.2, 134.5, 134.0, 132.1, 131.3, 129.5, 128.6, 128.4, 127.1, 122.3, 121.4, 112.2, 94.7, 84.1, 29.5, 28.5, 22.7, 22.6, 21.4. HRMS (ESI-TOF) m/z: Calcd for ($[M+H]^+$): $C_{25}H_{24}NO_2S$ 402.1522; Found : 402.1528.



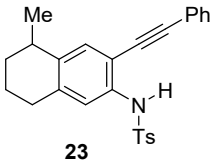
4

4-methyl-N-(4-(phenylethynyl)bicyclo[4.2.0]octa-1,3,5-trien-3-yl)benzenesulfonamide 4 (eluent: petroleum ether/ethyl acetate 10:1), 67.3 mg, 90% yield; yellow solid, mp: 126-127 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, J = 8.3 Hz, 2H), 7.44 – 7.41 (m, 2H), 7.38 – 7.36 (m, 3H), 7.35 (s, 1H), 7.17 (s, 1H), 7.15 (d, J = 8.2 Hz, 2H), 7.02 (s, 1H), 3.17 – 3.15 (m, 2H), 3.11 – 3.09 (m, 2H), 2.33 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.7, 143.8, 142.1, 136.8, 136.2, 131.4, 129.5, 128.8, 128.5, 127.2, 125.7, 122.3, 116.4, 113.8, 95.2, 84.8, 29.7, 29.0, 21.5. HRMS (ESI-TOF) m/z: Calcd for ($[M+H]^+$): $C_{23}H_{20}NO_2S$ 374.1209; Found : 374.1213.



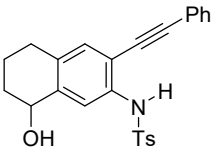
10

4-methyl-*N*-(3-(phenylethynyl)-6,7,8,9-tetrahydro-5*H*-benzo[7]annulen-2-yl)benzenesulfonamide 10 (eluent: petroleum ether/ethyl acetate 10:1), 83.0 mg, 100% yield; white solid, mp: 152-153 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, J = 8.3 Hz, 2H), 7.44 – 7.40 (m, 2H), 7.38 (s, 1H), 7.38 – 7.34 (m, 3H), 7.14 (d, J = 8.3 Hz, 2H), 7.09 (s, 1H), 7.04 (s, 1H), 2.78 – 2.76 (m, 2H), 2.69 – 2.67 (m, 2H), 2.32 (s, 3H), 1.82 – 1.77 (m, 2H), 1.63 – 1.56(m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.8, 143.7, 140.4, 136.2, 135.2, 132.0, 131.4, 129.5, 128.7, 128.4, 127.2, 122.3, 121.7, 112.1, 95.0, 84.1, 36.7, 35.8, 32.4, 28.2, 28.1, 21.5. HRMS (ESI-TOF) m/z: Calcd for ([M+H]$^+$): $C_{26}H_{26}NO_2S$ 416.1679; Found : 416.1684.



23

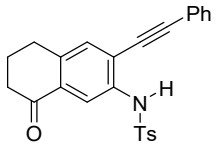
4-methyl-*N*-(5-methyl-3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)benzenesulfonamide 23 (eluent: petroleum ether/ethyl acetate 10:1), 74.7 mg, 90% yield; white solid; mp: 158-159 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, J = 8.3 Hz, 2H), 7.44 – 7.42 (m, 2H), 7.39 – 7.36 (m, 3H), 7.31 (s, 1H), 7.20 (s, 1H), 7.16 (d, J = 8.1 Hz, 2H), 7.03 (s, 1H), 2.81 – 2.72 (m, 3H), 2.33 (s, 3H), 1.92 – 1.83 (m, 2H), 1.72 – 1.68 (m, 1H), 1.52 – 1.43 (m, 1H), 1.23 (d, J = 7.0 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 139.4, 139.1, 136.4, 134.5, 131.5, 131.4, 129.5, 128.7, 128.5, 127.2, 122.4, 121.0, 112.2, 94.8, 84.3, 31.9, 31.2, 30.2, 22.5, 21.5, 20.2. HRMS (ESI-TOF) m/z: Calcd for ([M+H]$^+$): $C_{26}H_{26}NO_2S$ 416.1679; Found : 416.1684.



26

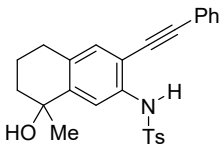
***N*-(8-hydroxy-3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)-4-methylbenzenesulfonamide 26** (eluent: petroleum ether/ethyl acetate 2:1), 83.4 mg, 100% yield; white solid; mp: 150-151 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, J = 8.2 Hz, 3H), 7.44 – 7.42 (m, 2H), 7.39 – 7.35 (m, 3H), 7.14 (d, J = 8.1 Hz, 2H), 7.11

(s, 1H), 7.10 (s, 1H), 4.75 (t, J = 4.7 Hz, 1H), 2.77 – 2.55 (m, 2H), 2.31 (s, 3H), 2.24 (s, 1H), 2.01 – 1.82 (m, 3H), 1.79 – 1.67 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.8, 140.9, 136.2, 135.2, 133.8, 132.2, 131.5, 129.6, 128.9, 128.4, 127.2, 122.1, 120.9, 114.2, 95.4, 83.9, 67.8, 31.8, 28.4, 21.5, 18.7. HRMS (ESI-TOF) m/z: Calcd for ($[M+H]^+$): $C_{25}H_{24}NO_3S$ 418.1471; Found : 418.1470.



36

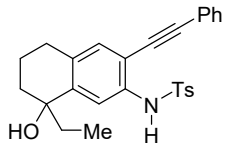
4-methyl-*N*-(8-oxo-3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)benzenesulfonamide 36 (eluent: petroleum ether/ethyl acetate 5:1), 83.0 mg, 100% yield; white solid; mp: 165-166 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (s, 1H), 7.74 (d, J = 8.3 Hz, 2H), 7.53 – 7.46 (m, 2H), 7.44 – 7.36 (m, 3H), 7.30 (s, 1H), 7.21 (s, 1H), 7.19 (d, J = 8.1 Hz, 2H), 2.85 (t, J = 6.0 Hz, 2H), 2.62 (t, J = 6.2 Hz, 2H), 2.33 (s, 3H), 2.06 (p, J = 6.5 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.7, 144.1, 140.0, 136.1, 136.0, 132.9, 132.3, 131.7, 129.7, 129.5, 128.6, 127.4, 121.5, 119.2, 117.8, 98.7, 83.4, 38.8, 28.8, 22.9, 21.5. HRMS (ESI-TOF) m/z: Calcd for ($[M+H]^+$): $C_{25}H_{22}NO_3S$ 416.1315; Found : 416.1320.



28

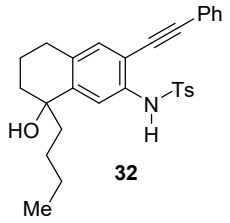
***N*-(8-hydroxy-8-methyl-3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)-4-methylbenzenesulfonamide 28** (eluent: petroleum ether/ethyl acetate 2:1), 81.9 mg, 95% yield; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (s, 1H), 7.67 (d, J = 8.1 Hz, 2H), 7.45 – 7.43 (m, 2H), 7.38 – 7.364 (m, 3H), 7.15 (d, J = 8.0 Hz, 2H), 7.10 (s, 1H), 7.08 (s, 1H), 2.74 – 2.59 (m, 2H), 2.31 (s, 3H), 2.12 (s, 1H), 1.91 – 1.87 (s, 3H), 1.81 – 1.72 (m, 1H), 1.52 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.8, 143.8, 136.1, 135.4, 132.9, 132.1, 131.5, 129.5, 128.9, 128.5, 127.4, 122.1, 118.6, 113.7, 95.4, 83.8, 70.4,

39.1, 30.7, 29.0, 21.5, 20.1. HRMS (ESI-TOF) m/z: Calcd for ([M+H]$^+$): $C_{26}H_{26}NO_3S$ 432.1628; Found : 432.1630.



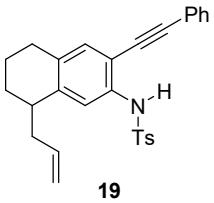
30

***N*-(8-ethyl-8-hydroxy-3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)-4-methylbenzenesulfonamide 30** (eluent: petroleum ether/ethyl acetate 2:1), 40.1 mg, 45% yield; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (s, 1H), 7.66 (d, J = 7.5 Hz, 2H), 7.47 – 7.42 (m, 2H), 7.39 – 7.30 (s, 3H), 7.15 (d, J = 7.8 Hz, 2H), 7.10 (s, 2H), 2.71 – 2.59 (m, 2H), 2.32 (s, 3H), 2.03 – 1.92 (m, 2H), 1.87 – 1.76 (m, 5H), 0.84 (t, J = 7.3 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.0, 143.8, 136.0, 135.3, 133.7, 132.2, 131.5, 129.5, 128.9, 128.5, 127.4, 122.1, 118.7, 113.7, 95.4, 83.8, 72.4, 34.9, 34.8, 29.0, 21.5, 19.4, 8.5. HRMS (ESI-TOF) m/z: Calcd for ([M+H]$^+$): $C_{27}H_{28}NO_3S$ 446.1784; Found : 446.1781.



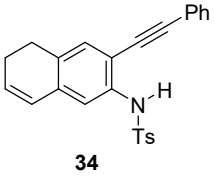
32

***N*-(8-butyl-8-hydroxy-3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)-4-methylbenzenesulfonamide 32** (eluent: petroleum ether/ethyl acetate 2:1), 28.4 mg, 30% yield; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (s, 1H), 7.68 (d, J = 8.3 Hz, 2H), 7.47 – 7.43 (m, 2H), 7.39 – 7.40 (m, 3H), 7.16 (d, J = 8.0 Hz, 2H), 7.10 (s, 2H), 2.73 – 2.58 (m, 2H), 2.33 (s, 3H), 2.00 - 1.93 (m, 1H), 1.87 – 1.72 (m, 6H), 1.36 – 1.24 (m, 3H), 1.17 – 1.07 (m, 1H), 0.90 (t, J = 7.1 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.3, 143.8, 136.2, 135.4, 133.5, 132.2, 131.5, 129.5, 128.9, 128.5, 127.4, 122.1, 118.4, 113.6, 95.5, 83.8, 72.3, 42.2, 35.5, 29.0, 26.3, 23.1, 21.5, 19.4, 14.1. HRMS (ESI-TOF) m/z: Calcd for ([M+H]$^+$): $C_{29}H_{32}NO_3S$ 474.2097; Found : 474.2092.



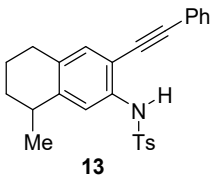
19

***N*-(8-allyl-3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)-4-methylbenzenesulfonamide 19** (eluent: petroleum ether/ethyl acetate 10:1), 83.8 mg, 95% yield; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, J = 8.3 Hz, 2H), 7.45 (s, 1H), 7.44 – 7.42 (m, 2H), 7.38 – 7.36 (m, 3H), 7.15 (d, J = 8.1 Hz, 2H), 7.07 (s, 1H), 7.04 (s, 1H), 5.83 – 5.70 (m, 1H), 5.07 (d, J = 6.8 Hz, 1H), 5.05 (d, J = 10.2 Hz, 1H), 2.89 – 2.85 (m, 1H), 2.67 – 2.57 (s, 2H), 2.48 – 2.42 (m, 1H), 2.34 – 2.27 (m, 4H), 1.81 – 1.76 (m, 2H), 1.71 – 1.64 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.8, 142.8, 136.6, 136.2, 134.7, 134.2, 132.2, 131.5, 129.5, 128.8, 128.5, 127.3, 122.3, 120.9, 116.6, 112.3, 94.9, 84.1, 40.9, 37.4, 29.0, 26.8, 21.5, 19.5. HRMS (ESI-TOF) m/z: Calcd for ($[M+H]^+$): $C_{28}H_{28}NO_2S$ 442.1835; Found : 442.1838.



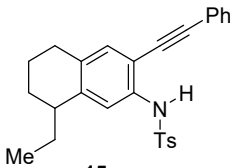
34

4-methyl-*N*-(3-(phenylethynyl)-5,6-dihydronaphthalen-2-yl)benzenesulfonamide 34 (eluent: petroleum ether/ethyl acetate 10:1), 75.8 mg, 95% yield; yellow solid; mp: 98-99 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, J = 8.2 Hz, 2H), 7.44 – 7.41 (m, 2H), 7.39 – 7.35 (m, 3H), 7.30 (s, 1H), 7.15 (d, J = 8.1 Hz, 2H), 7.08 (s, 1H), 7.06 (s, 1H), 6.46 (d, J = 9.6 Hz, 1H), 6.14 – 6.06 (m, 1H), 2.70 (t, J = 8.2 Hz, 2H), 2.32 (s, 3H), 2.31 – 2.25 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.8, 136.2, 135.9, 135.5, 132.0, 131.4, 130.9, 130.5, 129.5, 128.8, 128.5, 127.4, 127.2, 122.3, 118.5, 112.9, 95.8, 84.4, 26.5, 23.1, 21.5. HRMS (ESI-TOF) m/z: Calcd for ($[M+H]^+$): $C_{25}H_{22}NO_2S$ 400.1366; Found : 400.1369.



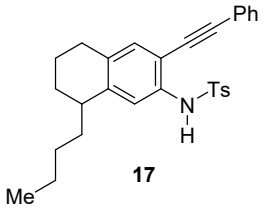
13

4-methyl-*N*-(8-methyl-3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)benzenesulfonamide 13 (eluent: petroleum ether/ethyl acetate 10:1), 74.7 mg, 90% yield; white solid; mp: 106-107 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, J = 8.2 Hz, 2H), 7.44 (s, 1H), 7.44 – 7.40 (m, 2H), 7.39 – 7.33 (m, 3H), 7.15 (d, J = 8.1 Hz, 2H), 7.05 (s, 1H), 7.04 (s, 1H), 2.93 – 2.85 (m, 1H), 2.69 – 2.57 (m, 2H), 2.32 (s, 3H), 1.93 – 1.76 (m, 2H), 1.73 – 1.63 (m, 1H), 1.53 – 1.46 (m, 1H), 1.26 (d, J = 7.0 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.5, 143.8, 136.1, 134.8, 133.6, 132.1, 131.5, 129.5, 128.7, 128.4, 127.3, 122.3, 120.5, 112.1, 94.8, 84.1, 32.7, 30.9, 29.1, 22.7, 21.5, 20.1. HRMS (ESI-TOF) m/z: Calcd for ([M+H]$^+$): $C_{26}H_{26}NO_2S$ 416.1679; Found : 416.1684.



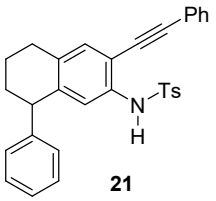
15

***N*-(8-ethyl-3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)-4-methylbenzenesulfonamide 15** (eluent: petroleum ether/ethyl acetate 10:1), 77.2 mg, 90% yield; white solid; mp: 112-113 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, J = 8.2 Hz, 2H), 7.43 (s, 1H), 7.43 – 7.40 (m, 2H), 7.37 – 7.32 (m, 3H), 7.12 (d, J = 8.1 Hz, 2H), 7.07 (s, 1H), 7.04 (s, 1H), 2.69 – 2.66 (m, 1H), 2.61 (t, J = 5.0 Hz, 2H), 2.29 (s, 3H), 1.84 – 1.67 (m, 3H), 1.64 – 1.50 (m, 3H), 0.93 (t, J = 7.4 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 143.5, 136.1, 134.5, 134.0, 132.0, 131.4, 129.4, 128.6, 128.4, 127.2, 122.3, 121.0, 112.1, 94.7, 84.1, 39.1, 29.0, 28.9, 26.5, 21.4, 19.7, 11.5. HRMS (ESI-TOF) m/z: Calcd for ([M+H]$^+$): $C_{27}H_{28}NO_2S$ 430.1835; Found : 430.1841.



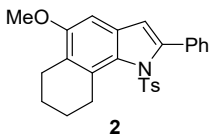
17

***N*-(8-butyl-3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)-4-methylbenzenesulfonamide 17** (eluent: petroleum ether/ethyl acetate 10:1), 73.1 mg, 80% yield; white oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, J = 8.3 Hz, 2H), 7.44 – 7.42 (m, 2H), 7.40 (s, 1H), 7.37 – 7.36 (m, 3H), 7.15 (d, J = 8.1 Hz, 2H), 7.06 (s, 1H), 7.04 (s, 1H), 2.81 – 2.70 (m, 1H), 2.64 – 2.62 (m, 2H), 2.33 (s, 3H), 1.82 – 1.77 (m, 2H), 1.67 – 1.48 (m, 4H), 1.40 – 1.28 (m, 4H), 0.94 (t, J = 6.7 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.0, 143.7, 136.2, 134.7, 133.9, 132.1, 131.5, 129.5, 128.7, 128.5, 127.3, 122.4, 120.8, 112.0, 94.8, 84.2, 37.7, 36.4, 29.3, 29.0, 27.1, 22.9, 21.5, 19.7, 14.1. HRMS (ESI-TOF) m/z: Calcd for ([M+H]$^+$): $C_{29}H_{31}NO_2S$ 458.2148; Found : 458.2150.



21

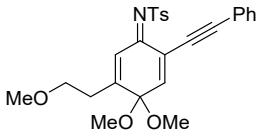
4-methyl-*N*-(8-phenyl-3-(phenylethynyl)-5,6,7,8-tetrahydronaphthalen-2-yl)benzenesulfonamide 21 (eluent: petroleum ether/ethyl acetate 10:1), 51.5 mg, 54% yield; white oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.45 (m, 2H), 7.43 (d, J = 8.3 Hz, 2H), 7.38 – 7.35 (m, 3H), 7.32 – 7.24 (m, 3H), 7.15 (s, 1H), 7.08 – 7.05 (m, 4H), 7.01 – 6.99 (m, 2H), 4.09 (t, J = 7.2 Hz, 1H), 2.80 – 2.67 (m, 2H), 2.32 (s, 3H), 2.16 – 2.09 (m, 1H), 1.87 – 1.79 (m, 2H), 1.75 – 1.62 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.5, 143.6, 141.6, 135.8, 134.9, 133.9, 132.2, 131.5, 129.4, 128.8, 128.7, 128.5, 128.3, 127.3, 126.1, 122.2, 121.1, 112.0, 95.3, 84.0, 45.5, 32.6, 28.9, 21.5, 20.5. HRMS (ESI-TOF) m/z: Calcd for $C_{31}H_{28}NO_2S$ ([M+H]$^+$): 478.1835; Found : 478.1840.



2

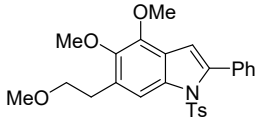
5-methoxy-2-phenyl-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 2 (eluent: petroleum ether/ethyl acetate 5:1), 38.8 mg, 90% yield, white solid; mp: 166-167 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.43 (m, 2H), 7.36 – 7.35 (m, 3H), 6.94 – 6.89

(m, 4H), 6.60 (s, 1H), 6.37 (s, 1H), 3.80 (s, 3H), 3.37 (t, J = 5.6 Hz, 2H), 2.78 (t, J = 6.5 Hz, 2H), 2.28 (s, 3H), 1.96 – 1.89 (m, 2H), 1.74 – 1.71 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 145.8, 143.9, 135.0, 133.0, 132.9, 132.6, 132.0, 128.8, 128.2, 128.2, 127.7, 127.2, 124.7, 116.9, 98.7, 55.3, 29.4, 24.1, 22.7, 22.6, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{26}NO_3S$ ($[M+H]^+$): 432.1628; Found : 432.1630.



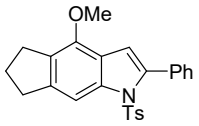
5

(Z)-N-(4,4-dimethoxy-5-(2-methoxyethyl)-2-(phenylethynyl)cyclohexa-2,5-dien-1-ylidene)-4-methylbenzenesulfonamide 5 (eluent: petroleum ether/ethyl acetate 5:1), 27.9 mg, 60% yield, yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 (d, J = 8.0 Hz, 2H), 7.64 (s, 1H), 7.35 – 7.30 (m, 7H), 6.97 (s, 1H), 3.70 (t, J = 6.3 Hz, 2H), 3.42 (s, 3H), 3.25 (s, 6H), 2.66 (t, J = 6.3 Hz, 2H), 2.45 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.2, 156.6, 144.6, 143.5, 138.7, 131.8, 129.3, 129.0, 128.3, 128.2, 127.4, 127.2 122.5, 122.2 95.1, 82.7, 69.5, 58.7, 51.2, 29.8, 21.6.



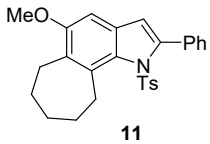
6

4,5-dimethoxy-6-(2-methoxyethyl)-2-phenyl-1-tosyl-1H-indole 6 (eluent: petroleum ether/ethyl acetate 10:1), 36.0 mg, 81% yield, white oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (s, 1H), 7.49 – 7.47 (m, 2H), 7.42 – 7.40 (m, 3H), 7.28 (d, J = 8.3 Hz, 2H), 7.05 (d, J = 8.2 Hz, 2H), 6.60 (s, 1H), 3.92 (s, 3H), 3.86 (s, 3H), 3.67 (t, J = 7.1 Hz, 2H), 3.43 (s, 3H), 3.05 (t, J = 7.1 Hz, 2H), 2.30 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.1, 144.5, 141.4, 135.2, 134.5, 132.5, 130.4, 130.2, 129.1, 128.6, 127.5, 126.9, 125.0, 123.6, 113.0, 110.5, 73.1, 61.0, 60.7, 58.6, 32.2, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{28}NO_5S$ ($[M+H]^+$): 466.1683; Found : 446.1690.



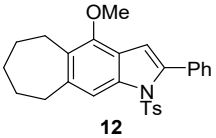
9

4-methoxy-2-phenyl-1-tosyl-1,5,6,7-tetrahydrocyclopenta[*f*]indole 9 (eluent: petroleum ether/ethyl acetate 10:1), 20.9 mg, 50% yield; yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (s, 1H), 7.49 – 7.47(m, 2H), 7.41 – 7.39 (m, 3H), 7.27 (d, J = 8.3 Hz, 2H), 7.04 (d, J = 8.2 Hz, 2H), 6.61 (s, 1H), 3.90 (s, 3H), 3.04 (t, J = 7.4 Hz, 2H), 2.98 (t, J = 7.3 Hz, 2H), 2.29 (s, 3H), 2.16 – 2.09 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.2, 144.3, 144.3, 140.4, 139.4, 134.7, 132.8, 130.2, 129.2, 129.1, 128.3, 127.4, 126.8, 121.6, 110.8, 107.6, 60.0, 33.4, 29.6, 26.0, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{25}H_{24}NO_3S$ ($[M+H]^+$): 418.1471; Found : 418.1470.



11

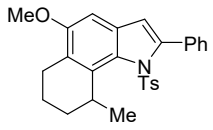
5-methoxy-2-phenyl-1-tosyl-1,6,7,8,9,10-hexahydrocyclohepta[*g*]indole 11 (eluent: petroleum ether/ethyl acetate 10:1), 28.5 mg, 64% yield, White solid; mp: 134-135 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.46 (m, 2H), 7.41 – 7.36 (m, 3H), 6.93 (d, J = 8.2 Hz, 2H), 6.84 (d, J = 8.3 Hz, 2H), 6.62 (s, 1H), 6.36 (s, 1H), 3.81 (s, 3H), 3.45 - 3.43(m, 2H), 3.05 – 3.02 (m, 2H), 2.30 (s, 3H), 1.96 – 1.87 (m, 2H), 1.85 – 1.77 (m, 2H), 1.72 – 1.62 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.6, 146.3, 143.9, 138.7, 135.1, 132.9, 132.7, 132.1, 131.4, 128.8, 128.3, 128.1, 127.7, 127.5, 117.2, 100.0, 56.0, 32.6, 32.5, 28.1, 27.5, 26.5, 21.6. HRMS (ESI-TOF) m/z: Calcd for $C_{27}H_{28}NO_3S$ ($[M+H]^+$): 446.1784; Found : 446.1786.



12

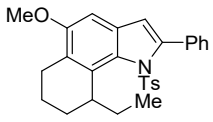
4-methoxy-2-phenyl-1-tosyl-1,5,6,7,8,9-hexahydrocyclohepta[*f*]indole 12 (eluent: petroleum ether/ethyl acetate 10:1), 5.8 mg, 13% yield, White solid; mp: 138-139 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (s, 1H), 7.49 – 7.46 (m, 2H), 7.41 – 7.39 (m, 3H), 7.27 (d, J = 8.3 Hz, 2H), 7.03 (d, J = 8.1 Hz, 2H), 6.57 (s, 1H), 3.77 (s, 3H), 2.97 – 2.94 (m, 2H), 2.91 – 2.89 (m, 2H), 2.29 (s, 3H), 1.87 – 1.81 (m, 2H), 1.72 – 1.69 (m, 2H),

1.66 – 1.59 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.5, 144.4, 143.0, 140.7, 137.7, 134.7, 132.6, 131.3, 130.2, 129.1, 128.4, 127.4, 126.8, 122.0, 112.6, 110.7, 61.8, 37.4, 32.5, 28.9, 28.4, 26.0, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{27}H_{28}NO_3S$ ($[M+H]^+$): 446.1784; Found : 446.1786.



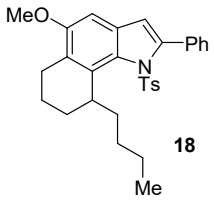
14

5-methoxy-9-methyl-2-phenyl-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 14 (eluent: petroleum ether/ethyl acetate 10:1), 33.4 mg, 75% yield, White solid, mp: 160-161 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.46 (m, 2H), 7.40 – 7.33 (m, 3H), 6.92 (d, J = 8.2 Hz, 2H), 6.87 (d, J = 8.2 Hz, 2H), 6.56 (s, 1H), 6.37 (s, 1H), 4.39 – 4.31 (m, 1H), 3.80 (s, 3H), 2.83 – 2.69 (m, 2H), 2.29 (s, 3H), 2.15 – 2.08 (m, 1H), 2.0 – 1.91 (m, 1H), 1.84 – 1.74 (m, 1H), 1.49 – 1.41 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.2, 146.1, 143.9, 137.6, 134.7, 133.0, 133.1, 132.1, 128.6, 128.2, 128.1, 127.8, 127.3, 125.4, 117.2, 98.7, 55.4, 31.8, 31.0, 24.9, 21.5, 20.9, 20.0. HRMS (ESI-TOF) m/z: Calcd for $C_{27}H_{28}NO_3S$ ($[M+H]^+$): 446.1784; Found : 446.1790.



16

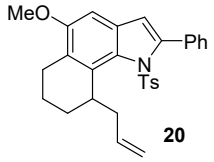
5-methoxy-9-methyl-2-phenyl-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 16 (eluent: petroleum ether/ethyl acetate 10:1), 29.8 mg, 65% yield, White solid, mp: 157-158 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.45 (m, 2H), 7.41 – 7.35 (m, 3H), 6.92 (d, J = 8.1 Hz, 2H), 6.87 (d, J = 8.4 Hz, 2H), 6.55 (s, 1H), 6.37 (s, 1H), 4.31 – 4.24 (m, 1H), 3.80 (s, 3H), 2.83 – 2.69 (m, 2H), 2.29 (s, 3H), 2.11 – 2.01 (m, 1H), 2.00 – 1.90 (m, 1H), 1.82 – 1.62 (m, 4H), 0.87 (t, J = 7.4 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.2, 146.1, 143.9, 136.7, 134.8, 133.1, 132.7, 132.1, 128.6, 128.2, 128.1, 127.8, 127.4, 125.6, 117.2, 98.7, 55.4, 36.5, 27.1, 26.9, 24.4, 21.5, 19.3, 11.4. HRMS (ESI-TOF) m/z: Calcd for $C_{28}H_{30}NO_3S$ ($[M+H]^+$): 460.1941; Found : 460.1946.



18

9-butyl-5-methoxy-2-phenyl-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[g]indole 18

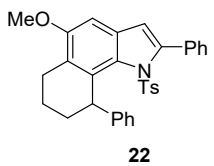
(eluent: petroleum ether/ethyl acetate 10:1), 23.4 mg, 46% yield, white oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.45 (m, 2H), 7.41 – 7.35 (m, 3H), 6.93 (d, J = 8.2 Hz, 2H), 6.86 (d, J = 8.3 Hz, 2H), 6.55 (s, 1H), 6.38 (s, 1H), 4.38 – 4.32 (m, 1H), 3.81 (s, 3H), 2.76 (t, J = 6.4 Hz, 2H), 2.30 (s, 3H), 2.11 – 2.05 (m, 1H), 1.99 – 1.91 (m, 2H), 1.83 – 1.74 (m, 1H), 1.72 – 1.60 (m, 2H), 1.42 – 1.33 (m, 2H), 1.32 – 1.20 (m, 2H), 0.92 (t, J = 7.2 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.2, 146.1, 143.9, 137.2, 134.7, 133.1, 132.8, 132.1, 128.6, 128.2, 128.1, 127.8, 127.4, 125.5, 117.2, 98.6 55.4, 35.0, 34.2, 29.1, 27.2, 24.3, 23.1, 21.6, 19.2, 14.2. HRMS (ESI-TOF) m/z: Calcd for $C_{30}H_{33}NO_3SNa$ ($[M+Na]^+$): 510.2073; Found : 510.2072.



20

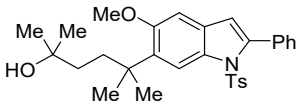
9-allyl-5-methoxy-2-phenyl-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 20

(eluent: petroleum ether/ethyl acetate 10:1), 28.8 mg, 61% yield, yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.47 (m, 2H), 7.41 – 7.35 (m, 3H), 6.93 (d, J = 8.3 Hz, 2H), 6.88 (d, J = 8.3 Hz, 2H), 6.56 (s, 1H), 6.39 (s, 1H), 5.81 – 5.71 (m, 1H), 4.98 (d, J =17.0 Hz, 1H), 4.92 (d, J =10.1 Hz, 1H), 4.45 – 4.39 (m, 1H), 3.81 (s, 3H), 2.90 – 2.83 (m, 1H), 2.81 – 2.69 (m, 2H), 2.57 – 2.50 (m, 1H), 2.30 (s, 3H), 2.09 – 2.01 (m, 1H), 1.99 – 1.90 (m, 1H), 1.82 – 1.72 (m, 1H), 1.67 – 1.62 (m, 1H).^{13}C NMR (100 MHz, $CDCl_3$) δ 156.2, 146.1, 144.0, 137.5, 135.8, 134.6, 133.0, 132.9, 132.0, 128.6, 128.2, 128.1, 127.8, 127.4, 125.9, 117.2, 115.6, 98.9, 55.4, 38.4, 35.2, 27.5, 24.6, 21.6, 19.5. HRMS (ESI-TOF) m/z: Calcd for $C_{29}H_{30}NO_3S$ ($[M+H]^+$): 472.1941; Found : 472.1946.



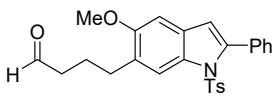
22

5-methoxy-2,9-diphenyl-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 22 (eluent: petroleum ether/ethyl acetate 10:1), 12.7 mg, 25% yield, white oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 – 7.22 (m, 6H), 7.03 – 7.02 (m, 2H), 6.92 – 6.90 (m, 4H), 6.78 (d, J = 8.3 Hz, 2H), 6.63 (s, 1H), 6.22 (s, 1H), 5.39 (dd, J = 9.4, 6.1 Hz, 1H), 3.87 (s, 3H), 2.99 – 2.92 (m, 1H), 2.84 – 2.76 (m, 1H), 2.35 – 2.29 (m, 4H), 2.04 – 2.00 (m, 1H), 1.95 – 1.86 (m, 1H), 1.68 – 1.61 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.2, 147.2, 146.1, 143.7, 135.4, 135.2, 133.3, 132.5, 132.3, 128.7, 128.5, 128.1, 128.1, 127.8, 127.5, 127.2, 126.5, 125.3, 116.6, 99.1, 55.5, 44.0, 34.5, 25.0, 21.5, 21.1. HRMS (ESI-TOF) m/z: Calcd for $C_{32}H_{29}NO_3SNa$ ($[M+Na]^+$): 530.1760; Found : 530.1761.



25

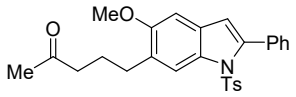
5-(5-methoxy-2-phenyl-1-tosyl-1*H*-indol-6-yl)-2,5-dimethylhexan-2-ol 25 (eluent: petroleum ether/ethyl acetate 10:1), 26.8 mg, 53% yield, white oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.19 (s, 1H), 7.59 – 7.57 (m, 2H), 7.47 – 7.45 (m, 3H), 7.29 (d, J = 8.1 Hz, 2H), 7.06 (d, J = 8.1 Hz, 2H), 6.86 (s, 1H), 6.50 (s, 1H), 3.84 (s, 3H), 2.29 (s, 3H), 2.02 – 1.97 (m, 2H), 1.51 (s, 6H), 1.32 (s, 3H), 1.30 – 1.28 (m, 1H), 1.26 (s, 3H), 1.25 – 1.23 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 144.3, 142.7, 134.0, 134.0, 132.8, 132.6, 130.0, 129.6, 129.0, 128.4, 127.5, 126.8, 116.3, 113.7, 101.9, 55.1, 38.5, 37.5, 37.2, 34.8, 34.7, 28.9, 26.6, 26.3, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{30}H_{35}NO_4SNa$ ($[M+Na]^+$) 528.2179; Found : 528.2185.



27

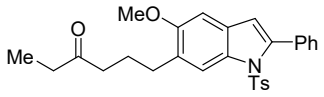
4-(5-methoxy-2-phenyl-1-tosyl-1*H*-indol-6-yl)butanal 27 (eluent: petroleum ether/ethyl acetate 10:1), 27.3 mg, 70% yield, grey solid; mp: 87-88 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.78 (s, 1H), 8.03 (s, 1H), 7.50 - 7.48 (m, 2H), 7.42 – 7.40 (m, 3H), 7.24 (d, J = 8.3 Hz, 2H), 7.03 (d, J = 8.2 Hz, 2H), 6.82 (s, 1H), 6.46 (s, 1H), 3.81 (s, 3H), 2.81 (t, J = 7.4 Hz, 2H), 2.46 (td, J = 7.5, 1.3 Hz, 2H), 2.28 (s, 3H), 2.04 – 1.97 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 202.7, 155.2, 144.4, 142.2, 134.4, 132.5, 132.4,

130.1, 129.9, 129.1, 128.5, 127.9, 127.5, 126.7, 118.0, 113.8, 101.0, 55.4, 43.3, 30.4, 22.8, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{26}NO_4S$ ($[M+H]^+$): 448.1577; Found : 448.1583.



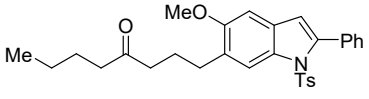
29

5-(5-methoxy-2-phenyl-1-tosyl-1*H*-indol-6-yl)pentan-2-one 29 (eluent: petroleum ether/ethyl acetate 10:1), 27.7 mg, 60% yield, white solid; mp: 101-102 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (s, 1H), 7.50 – 7.48 (m, 2H), 7.42 – 7.40 (m, 3H), 7.24 (d, J = 8.3 Hz, 2H), 7.03 (d, J = 8.1 Hz, 2H), 6.82 (s, 1H), 6.46 (s, 1H), 3.81 (s, 3H), 2.77 (t, J = 7.4 Hz, 2H), 2.48 (t, J = 7.5 Hz, 2H), 2.28 (s, 3H), 2.16 (s, 3H), 1.98 – 1.91 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 209.1, 155.3, 144.4, 142.2, 134.4, 132.6, 132.5, 130.1, 129.7, 129.1, 128.5, 128.3, 127.5, 126.8, 118.0, 113.8, 101.0, 55.4, 43.3, 30.4, 29.8, 24.4, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{27}H_{28}NO_4S$ ($[M+H]^+$): 462.1734; Found : 462.1739.



31

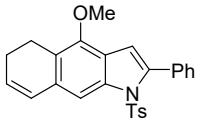
6-(5-methoxy-2-phenyl-1-tosyl-1*H*-indol-6-yl)hexan-3-one 31 (eluent: petroleum ether/ethyl acetate 10:1), 27.6 mg, 58% yield, white solid; mp: 125-126 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (s, 1H), 7.50 – 7.48 (m, 2H), 7.46 – 7.38 (m, 3H), 7.24 (d, J = 7.9 Hz, 2H), 7.03 (d, J = 8.0 Hz, 2H), 6.81 (s, 1H), 6.46 (s, 1H), 3.80 (s, 3H), 2.76 (t, J = 7.4 Hz, 2H), 2.48 – 2.43 (m, 4H), 2.28 (s, 3H), 1.98 – 1.91 (m, 2H), 1.07 (t, J = 7.3 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 211.7, 155.3, 144.3, 142.1, 134.4, 132.6, 132.5, 130.1, 129.7, 129.1, 128.5, 128.4, 127.5, 126.8, 118.0, 113.9, 101.0, 55.4, 42.0, 35.8, 30.5, 24.5, 21.5, 7.8. HRMS (ESI-TOF) m/z: Calcd for $C_{28}H_{30}NO_4S$ ($[M+H]^+$): 476.1890; Found : 476.1895.



33

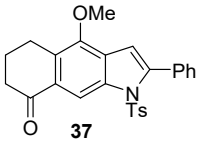
1-(5-methoxy-2-phenyl-1-tosyl-1*H*-indol-6-yl)octan-4-one 33 (eluent: petroleum ether/ethyl acetate 10:1), 30.7 mg, 61% yield, white solid; mp: 130-131 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (s, 1H), 7.51 – 7.48 (m, 2H), 7.43 – 7.40 (m, 3H), 7.24 (d, J

= 8.3 Hz, 2H), 7.03 (d, *J* = 8.1 Hz, 2H), 6.81 (s, 1H), 6.45 (s, 1H), 3.81 (s, 3H), 2.76 (t, *J* = 7.5 Hz, 2H), 2.48 – 2.40 (m, 4H), 2.28 (s, 3H), 1.98 – 1.92 (m, 2H), 1.61 – 1.53 (m, 2H), 1.37 – 1.28 (m, 2H), 0.91 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 211.4, 155.3, 144.3, 142.1, 134.4, 132.6, 132.5, 130.1, 129.7, 129.1, 128.5, 128.4, 127.5, 126.8, 118.0, 113.9, 101.0, 55.4, 42.5, 42.4, 30.6, 26.0, 24.5, 22.4, 21.5, 13.9. HRMS (ESI-TOF) m/z: Calcd for $C_{30}H_{34}NO_4S$ ($[M+H]^+$): 504.2203; Found : 504.2205.



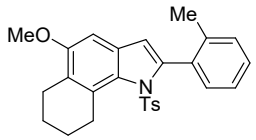
35

4-methoxy-2-phenyl-1-tosyl-7,8-dihydro-1*H*-benzo[*f*]indole 35 (eluent: petroleum ether/ethyl acetate 10:1), 26.6 mg, 62% yield, yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 7.77 (s, 1H), 7.49 – 7.47 (m, 2H), 7.42 – 7.39 (m, 3H), 7.27 (d, *J* = 8.3 Hz, 2H), 7.04 (d, *J* = 8.2 Hz, 2H), 6.63 (d, *J* = 9.7 Hz, 1H), 6.60 (s, 1H), 6.10 – 6.05 (m, 1H), 3.82 (s, 3H), 2.87 (t, *J* = 8.0 Hz, 2H), 2.35 – 2.30 (m, 2H), 2.29 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 149.1, 144.5, 141.0, 138.3, 134.7, 132.9, 132.5, 130.3, 129.2, 128.6, 128.5, 127.5, 126.8, 126.7, 122.9, 122.8, 110.8, 110.2, 60.9, 22.9, 21.5, 20.2. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{24}NO_3S$ ($[M+H]^+$): 430.1471; Found : 430.1481.



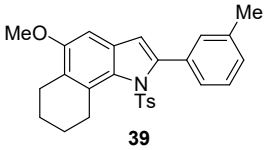
37

4-methoxy-2-phenyl-1-tosyl-1,6,7,8-tetrahydro-5*H*-benzo[*f*]indol-5-one 37 (eluent: petroleum ether/ethyl acetate 10:1), 24.9 mg, 56% yield, white oil; ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 8.77 (s, 1H), 7.53 – 7.50 (m, 2H), 7.47 – 7.43 (m, 3H), 7.33 (d, *J* = 8.4 Hz, 2H), 7.06 (d, *J* = 8.1 Hz, 2H), 6.65 (s, 1H), 3.89 (s, 3H), 2.99 (t, *J* = 6.1 Hz, 2H), 2.70 (t, *J* = 6.1 Hz, 2H), 2.30 (s, 3H), 2.16 – 2.09 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 197.9, 149.4, 144.8, 144.6, 137.8, 134.6, 131.9, 131.0, 130.7, 130.3, 129.4, 129.1, 127.6, 127.2, 127.0, 111.2, 109.7, 60.9, 39.2, 23.1, 22.8, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{24}NO_4S$ ($[M+H]^+$): 446.1421; Found : 446.1426.



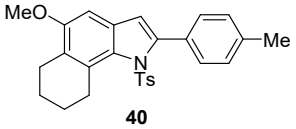
38

5-methoxy-2-(*o*-tolyl)-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 38 (eluent: petroleum ether/ethyl acetate 10:1), 38.8 mg, 86% yield, grey solid; mp: 174-175 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 – 7.24 (m, 1H), 7.20 (d, J = 7.2 Hz, 1H), 7.16 (d, J = 7.3 Hz, 1H), 7.10 (d, J = 7.4 Hz, 1H), 6.98 (d, J = 8.5 Hz, 2H), 6.95 (d, J = 8.5 Hz, 2H), 6.67 (s, 1H), 6.32 (s, 1H), 3.83 (s, 3H), 3.36 (t, J = 5.5 Hz, 2H), 2.80 (t, J = 6.4 Hz, 2H), 2.31 (s, 6H), 1.95 – 1.89 (m, 2H), 1.77 – 1.67 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.1, 144.3, 144.0, 137.9, 134.5, 133.8, 132.5, 132.4, 131.7, 130.4, 130.2, 128.5, 128.4, 127.0, 124.9, 124.7, 117.8, 98.6, 55.4, 29.7, 24.2, 22.8, 22.6, 21.5, 20.9. HRMS (ESI-TOF) m/z: Calcd for $C_{27}H_{28}NO_3S$ ($[M+H]^+$): 446.1784; Found : 446.1780.



39

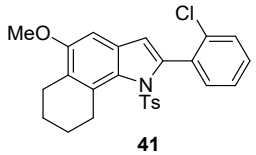
5-methoxy-2-(*m*-tolyl)-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 39 (eluent: petroleum ether/ethyl acetate 5:1), 33.4 mg, 75% yield, grey solid; mp: 180-181 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 – 7.22 (m, 3H), 7.17 – 7.14 (m, 1H), 6.95 – 6.91 (m, 4H), 6.60 (s, 1H), 6.36 (s, 1H), 3.81 (s, 3H), 3.37 (t, J = 5.9 Hz, 2H), 2.78 (t, J = 6.7 Hz, 2H), 2.38 (s, 3H), 2.29 (s, 3H), 1.95 – 1.89 (m, 2H), 1.75 – 1.68 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 146.0, 143.9, 137.2, 135.0, 132.9, 132.9, 132.8, 132.0, 129.5, 129.0, 128.2, 127.6, 127.3, 125.9, 124.6, 116.5, 98.7, 55.4, 29.4, 24.1, 22.7, 22.6, 21.5, 21.4. HRMS (ESI-TOF) m/z: Calcd for $C_{27}H_{28}NO_3S$ ($[M+H]^+$): 446.1784; Found : 446.1779.



40

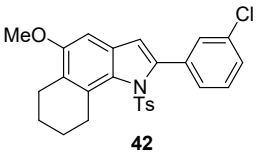
5-methoxy-2-(*p*-tolyl)-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 40 (eluent: petroleum ether/ethyl acetate 5:1), 37.4 mg, 84% yield, grey solid; mp: 167-168 ℃. ^{1}H

NMR (400 MHz, $CDCl_3$) δ 7.34 (d, J = 8.0 Hz, 2H), 7.18 (d, J = 7.9 Hz, 2H), 6.95 – 6.90 (m, 4H), 6.59 (s, 1H), 6.33 (s, 1H), 3.81 (s, 3H), 3.36 (t, J = 5.8 Hz, 2H), 2.78 (t, J = 6.7 Hz, 2H), 2.40 (s, 3H), 2.29 (s, 3H), 1.95 – 1.89 (m, 2H), 1.75 – 1.69 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 146.0, 143.9, 138.2, 134.9, 133.0, 132.5, 132.3, 130.3, 128.7, 128.5, 128.2, 127.3, 124.5, 116.4, 98.6, 55.4, 29.4, 24.1, 22.7, 22.6, 21.5, 21.4. HRMS (ESI-TOF) m/z: Calcd for $C_{27}H_{28}NO_3S$ ($[M+H]^+$): 446.1784; Found : 446.1783.



41

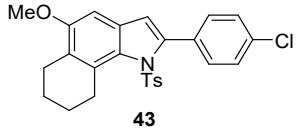
2-(2-chlorophenyl)-5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 41 (eluent: petroleum ether/ethyl acetate 5:1), 45.1 mg, 97% yield, grey solid; mp: 161-162 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, J = 6.9 Hz, 1H), 7.41 (d, J = 7.5 Hz, 1H), 7.32 – 7.25 (m, 2H), 7.06 (d, J = 8.1 Hz, 2H), 6.98 (d, J = 8.0 Hz, 2H), 6.73 (s, 1H), 6.65 (s, 1H), 3.81 (s, 3H), 3.36 (t, J = 5.4 Hz, 2H), 2.78 (t, J = 6.3 Hz, 2H), 2.29 (s, 3H), 1.98 – 1.85 (m, 2H), 1.81 – 1.65 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.2, 144.1, 141.0, 134.5, 133.4, 132.9, 132.4, 132.4, 131.6, 131.5, 129.9, 128.9, 128.6, 127.3, 125.9, 125.3, 119.9, 98.9, 55.4, 29.5, 24.3, 22.8, 22.5, 21.6. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{25}ClNO_3S$ ($[M+H]^+$): 466.1238; Found : 466.1244.



42

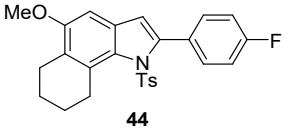
2-(3-chlorophenyl)-5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 42 (eluent: petroleum ether/ethyl acetate 5:1), 38.6 mg, 83% yield, faint yellow solid; mp: 187-188 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.37 (m, 1H), 7.33 – 7.30 (m, 3H), 6.96 (d, J = 8.3 Hz, 2H), 6.92 (d, J = 8.3 Hz, 2H), 6.61 (s, 1H), 6.40 (s, 1H), 3.81 (s, 3H), 3.35 (t, J = 5.9 Hz, 2H), 2.78 (t, J = 6.7 Hz, 2H), 2.31 (s, 3H), 1.96 – 1.89 (m, 2H), 1.75 – 1.69 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.4, 144.23, 144.2, 135.2 134.7, 133.6, 132.9, 132.5, 131.7, 128.9, 128.3, 128.2, 128.0, 127.2, 127.2, 125.3, 117.6, 98.8,

55.4, 29.4, 24.1, 22.7, 22.5, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{25}ClNO_3S$ ($[M+H]^+$): 466.1238; Found : 466.1241.



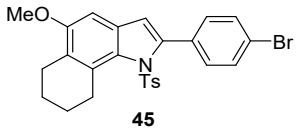
43

2-(4-chlorophenyl)-5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 43 (eluent: petroleum ether/ethyl acetate 5:1), 39.1 mg, 84% yield, grey solid; mp: 173-174 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 (d, J = 8.5 Hz, 2H), 7.34 (d, J = 8.6 Hz, 2H), 6.95 (d, J = 8.2 Hz, 2H), 6.90 (d, J = 8.3 Hz, 2H), 6.60 (s, 1H), 6.37 (s, 1H), 3.81 (s, 3H), 3.35 (t, J = 5.8 Hz, 2H), 2.78 (t, J = 6.6 Hz, 2H), 2.30 (s, 3H), 1.96 – 1.89 (m, 2H), 1.74 – 1.69 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.4, 144.5, 144.1, 135.1, 134.1, 133.1, 132.4, 132.0, 131.5, 129.9, 128.3, 128.0, 127.2, 125.2, 117.3, 98.7, 55.4, 29.39 (s), 24.1, 22.7, 22.5, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{25}ClNO_3S$ ($[M+H]^+$): 466.1238; Found : 466.1238.



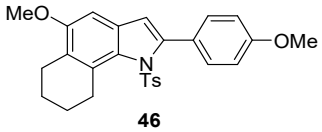
44

2-(4-fluorophenyl)-5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 44 (eluent: petroleum ether/ethyl acetate 5:1), 37.4 mg, 76% yield, grey solid; mp: 183-184 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.38 (m, 2H), 7.05 (t, J = 8.7 Hz, 2H), 6.95 (d, J = 8.3 Hz, 2H), 6.89 (d, J = 8.3 Hz, 2H), 6.60 (s, 1H), 6.33 (s, 1H), 3.81 (s, 3H), 3.35 (t, J = 6.0 Hz, 2H), 2.78 (t, J = 6.7 Hz, 2H), 2.29 (s, 3H), 1.95 – 1.89 (m, 2H), 1.74 – 1.68 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.0 (d, $^1J_{C\text{-}F}$ = 248.4 Hz), 156.4, 144.6, 144.1, 134.9, 133.0, 132.5, 132.0, 130.5 (d, $^3J_{C\text{-}F}$ = 8.1 Hz), 129.2 (d, $^4J_{C\text{-}F}$ = 3.1 Hz), 128.3, 127.2, 124.9, 116.7, 114.9 (d, $^2J_{C\text{-}F}$ = 21.8 Hz), 98.7, 55.4, 29.4, 24.1, 22.7, 22.5, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{25}FNO_3S$ ($[M+H]^+$): 450.1534; Found : 450.1539.



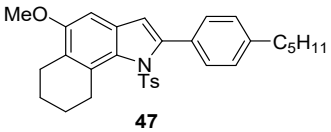
45

2-(4-bromophenyl)-5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 45 (eluent: petroleum ether/ethyl acetate 5:1), 44.3 mg, 87% yield; grey solid; mp: 182-183 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (d, J = 8.4 Hz, 2H), 7.31 (d, J = 8.4 Hz, 2H), 6.95 (d, J = 8.3 Hz, 2H), 6.90 (d, J = 8.4 Hz, 2H), 6.60 (s, 1H), 6.38 (s, 1H), 3.80 (s, 3H), 3.34 (t, J = 5.9 Hz, 2H), 2.78 (t, J = 6.7 Hz, 2H), 2.29 (s, 3H), 1.95 – 1.89 (m, 2H), 1.74 – 1.68 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.5, 144.6, 144.2, 135.1, 133.1, 132.3, 132.0, 132.0, 131.0, 130.2, 128.4, 127.2, 125.3, 122.5, 117.5, 98.8, 55.4, 29.5, 24.2, 22.8, 22.6, 21.6. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{25}BrNO_3S$ ($[M+H]^+$): 510.0733; Found : 510.0739.



46

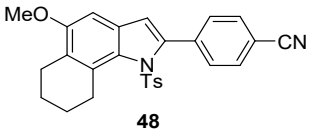
5-methoxy-2-(4-methoxyphenyl)-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 46 (eluent: petroleum ether/ethyl acetate 5:1), 41.9 mg, 91% yield, grey solid; mp: 182-183 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 (d, J = 8.7 Hz, 2H), 6.96 – 6.90 (m, 6H), 6.61 (s, 1H), 6.29 (s, 1H), 3.87 (s, 3H), 3.82 (s, 3H), 3.37 (t, J = 6.0 Hz, 2H), 2.80 (t, J = 6.7 Hz, 2H), 2.31 (s, 3H), 1.97 – 1.91 (m, 2H), 1.76 – 1.70 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.8, 156.3, 145.7, 143.9, 134.7, 133.0, 132.6, 132.3, 130.1, 128.2, 127.2, 125.7, 124.3, 115.5, 113.2, 98.5, 55.3, 55.3, 29.4, 24.1, 22.7, 22.6, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{27}H_{28}NO_4S$ ($[M+H]^+$): 462.1734; Found : 462.1739.



47

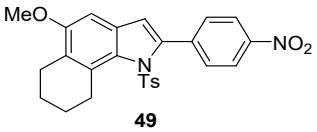
5-methoxy-2-(4-pentylphenyl)-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 47 (eluent: petroleum ether/ethyl acetate 5:1), 39.1 mg, 78% yield; faint yellow solid; mp: 120-121 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (d, J = 8.0 Hz, 2H), 7.17 (d, J = 7.9 Hz, 2H), 6.93 – 6.89 (m, 4H), 6.59 (s, 1H), 6.33 (s, 1H), 3.80 (s, 3H), 3.36 (t, J = 5.8 Hz, 2H), 2.78 (t, J = 6.6 Hz, 2H), 2.64 (t, J = 7.6 Hz, 2H), 2.28 (s, 3H), 1.94 – 1.91 (m,

2H), 1.73 – 1.64 (m, 4H), 1.38 – 1.36 (m, 4H), 0.92 (t, J = 6.5 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.2, 146.0, 143.8, 143.2, 134.9, 132.9, 132.8, 132.1, 130.4, 128.7, 128.2, 127.7, 127.3, 124.5, 116.1, 98.6, 55.3, 35.8, 31.6, 31.0, 29.4, 24.1, 22.7, 22.6, 22.5, 21.5, 14.0. HRMS (ESI-TOF) m/z: Calcd for $C_{31}H_{36}NO_3S$ ($[M+H]^+$): 502.2410; Found : 502.2416.



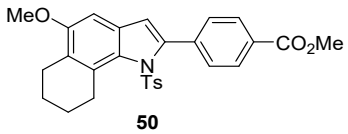
48

4-(5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indol-2-yl)benzonitrile 48 (eluent: petroleum ether/ethyl acetate 2:1), 41.9 mg, 80% yield, grey solid; mp: 192-193 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, J = 8.3 Hz, 2H), 7.58 (d, J = 8.3 Hz, 2H), 6.97 (d, J = 8.2 Hz, 2H), 6.90 (d, J = 8.3 Hz, 2H), 6.62 (s, 1H), 6.52 (s, 1H), 3.82 (s, 3H), 3.35 (t, J = 5.9 Hz, 2H), 2.79 (t, J = 6.7 Hz, 2H), 2.31 (s, 3H), 1.96 – 1.90 (m, 2H), 1.75 – 1.70 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.6, 144.4, 143.7, 137.3, 135.5, 133.1, 131.9, 131.7, 131.6, 128.9, 128.4, 127.2, 126.2, 119.5, 118.9, 111.3, 99.0, 55.4, 29.3, 24.2, 22.6, 22.5, 21.6. HRMS (ESI-TOF) m/z: Calcd for $C_{27}H_{25}N_2O_3S$ ($[M+H]^+$): 457.1580; Found : 457.1586.



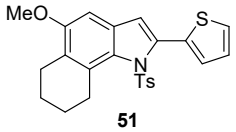
49

5-methoxy-2-(4-nitrophenyl)-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 49 (eluent: petroleum ether/ethyl acetate 2:1), 40.0 mg, 84% yield, white solid; mp: 300-301 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.24 (d, J = 7.7 Hz, 2H), 7.64 (d, J = 7.7 Hz, 2H), 6.98 (d, J = 7.8 Hz, 2H), 6.91 (d, J = 7.8 Hz, 2H), 6.63 (s, 1H), 6.58 (s, 1H), 3.82 (s, 3H), 3.35 (t, J = 5.5 Hz, 2H), 2.79 (t, J = 6.4 Hz, 2H), 2.31 (s, 3H), 1.99 – 1.88 (m, 2H), 1.78 – 1.66 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.6, 147.0, 144.5, 143.3, 139.1, 135.6, 133.1, 131.7, 131.7, 129.0, 128.5, 127.1, 126.4, 123.1, 120.2, 99.0, 55.4, 29.3, 24.2, 22.6, 22.4, 21.6. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{25}N_2O_5S$ ($[M+H]^+$): 477.1479; Found : 477.1484.



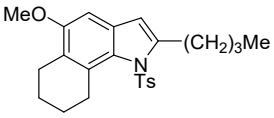
50

methyl 4-(5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indol-2-yl)benzoate 50 (eluent: petroleum ether/ethyl acetate 2:1), 41.6 mg, 85% yield, grey solid; mp: 310-311 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (d, J = 8.2 Hz, 2H), 7.53 (d, J = 8.2 Hz, 2H), 6.95 (d, J = 8.2 Hz, 2H), 6.90 (d, J = 8.2 Hz, 2H), 6.62 (s, 1H), 6.49 (s, 1H), 3.95 (s, 3H), 3.82 (s, 3H), 3.36 (t, J = 5.7 Hz, 2H), 2.79 (t, J = 6.6 Hz, 2H), 2.30 (s, 3H), 1.99 – 1.88 (m, 2H), 1.79 – 1.68 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.9, 156.4, 144.7, 144.2, 137.2, 135.4, 133.1, 132.2, 131.9, 129.4, 129.1, 128.5, 128.3, 127.2, 125.6, 118.6, 98.9, 55.4, 52.1, 29.4, 24.2, 22.7, 22.5, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{28}H_{28}NO_5S$ ($[M+H]^+$): 490.1683; Found : 490.1688.



51

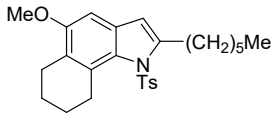
5-methoxy-2-(thiophen-2-yl)-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 51 (eluent: petroleum ether/ethyl acetate 5:1), 41.9 mg, 86% yield, green solid; mp: 151-152 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 – 7.24 (m, 2H), 7.06 – 7.04 (m, 1H), 6.97 – 6.94 (m, 4H), 6.59 (s, 1H), 6.36 (s, 1H), 3.80 (s, 3H), 3.33 (t, J = 5.8 Hz, 2H), 2.78 (t, J = 6.6 Hz, 2H), 2.28 (s, 3H), 1.95 – 1.88 (m, 2H), 1.73 – 1.68 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 143.9, 138.6, 134.7, 132.9, 132.7, 131.7, 128.7), 128.3, 127.2, 127.1, 125.9, 124.9, 116.2, 98.5, 55.3, 29.4, 24.0, 22.6, 22.4, 21.4. HRMS (ESI-TOF) m/z: Calcd for$C_{24}H_{24}NO_3S_2$ ($[M+H]^+$):438.1192; Found :438.1198.



52

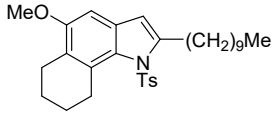
2-butyl-5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 52 (eluent: petroleum ether/ethyl acetate 10:1), 26.7 mg, 65% yield, white solid; mp: 117-118℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (d, J = 8.3 Hz, 2H), 7.04 (d, J = 8.1 Hz, 2H), 6.55 (s, 1H), 6.13 (s, 1H), 3.80 (s, 3H), 3.24 (t, J = 6.0 Hz, 2H), 2.81 (t, J = 7.6 Hz, 2H), 2.75 (t, J = 6.8 Hz, 2H), 2.31 (s, 3H), 1.91 – 1.84 (m, 2H), 1.66 – 1.59 (m, 4H), 1.38 – 1.31

(m, 2H), 0.91 (t, J = 7.3 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.9, 146.3, 143.8, 134.3, 133.8, 132.1, 131.9, 128.8, 126.3, 123.6, 115.1, 98.2, 55.3, 31.3, 30.2, 29.8, 24.1, 22.8, 22.5, 22.4, 21.5, 13.9. HRMS (ESI-TOF) m/z: Calcd for $C_{24}H_{30}NO_3S$ ($[M+H]^+$): 412.1941; Found : 412.1927.



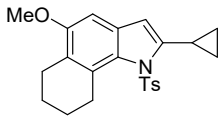
53

2-hexyl-5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 53 (eluent: petroleum ether/ethyl acetate 10:1), 22.4 mg, 51% yield, yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 (d, J = 8.2 Hz, 2H), 7.03 (d, J = 8.1 Hz, 2H), 6.55 (s, 1H), 6.13 (s, 1H), 3.80 (s, 3H), 3.24 (t, J = 5.9 Hz, 2H), 2.80 (t, J = 7.6 Hz, 2H), 2.75 (t, J = 6.7 Hz, 2H), 2.31 (s, 3H), 1.91 – 1.84 (m, 2H), 1.67 – 1.58 (m, 4H), 1.34 – 1.26 (m, 6H), 0.87 (t, J = 6.5 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.9, 146.3, 143.8, 134.3, 133.9, 132.1, 131.9, 128.8, 126.3, 123.6, 115.0, 98.2, 55.3, 31.6, 30.5, 29.8, 29.2, 29.0, 24.1, 22.8, 22.5, 22.5, 21.5, 14.1. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{34}NO_3S$ ($[M+H]^+$): 440.2254; Found : 440.2255.



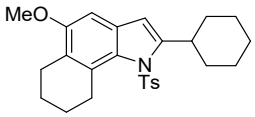
54

2-decyl-5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 54 (eluent: petroleum ether/ethyl acetate 10:1), 20.8 mg, 42% yield, yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 (d, J = 8.2 Hz, 2H), 7.03 (d, J = 8.1 Hz, 2H), 6.55 (s, 1H), 6.13 (s, 1H), 3.80 (s, 3H), 3.24 (t, J = 5.9 Hz, 2H), 2.81 (d, J = 7.5 Hz, 2H), 2.75 (t, J = 6.7 Hz, 2H), 2.30 (s, 3H), 1.90 – 1.84 (m, 2H), 1.67 – 1.59 (m, 4H), 1.34 – 1.25 (m, 14H), 0.88 (t, J = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.9, 146.3, 143.8, 134.3, 133.9, 132.1, 131.9, 128.8, 126.3, 123.6, 115.1, 98.2, 55.3, 31.9, 30.5, 29.7, 29.6, 29.5, 29.4, 29.3, 29.2, 29.1, 24.1, 22.8, 22.7, 22.5, 21.5, 14.1. HRMS (ESI-TOF) m/z: Calcd for $C_{30}H_{42}NO_3S$ ($[M+H]^+$): 496.2880; Found : 496.2885.



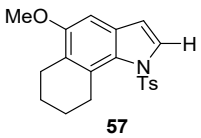
55

2-cyclopropyl-5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 55 (eluent: petroleum ether/ethyl acetate 10:1), 34.4 mg, 87% yield, white solid; mp: 122-123 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (d, J = 8.3 Hz, 2H), 7.07 (d, J = 8.0 Hz, 2H), 6.53 (s, 1H), 5.89 (d, J = 0.7 Hz, 1H), 3.79 (s, 3H), 3.22 (t, J = 6.0 Hz, 2H), 2.74 (t, J = 6.8 Hz, 2H), 2.40 – 2.35 (m, 1H), 2.32 (s, 3H), 1.90 – 1.83 (m, 2H), 1.66 -1.60 (m, 2H), 0.98 - 0.93 (m, 2H), 0.52 – 0.48 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.9, 148.5, 143.8, 134.4, 133.9, 131.7, 131.5, 128.7, 126.6, 123.6, 110.7, 98.2, 55.3, 29.8, 24.1, 22.8, 22.5, 21.5, 10.6, 9.9. HRMS (ESI-TOF) m/z: Calcd for $C_{23}H_{26}NO_3S$ ($[M+H]^+$): 396.1628; Found : 396.1633.



56

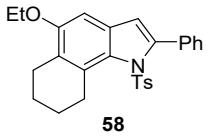
2-cyclohexyl-5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 56 (eluent: petroleum ether/ethyl acetate 10:1), 24.9 mg, 57% yield, white solid; mp: 139-140 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.18 (d, J = 8.3 Hz, 2H), 7.05 (d, J = 8.1 Hz, 2H), 6.59 (s, 1H), 6.11 (d, J = 1.0 Hz, 1H), 3.83 (s, 3H), 3.28 (t, J = 6.0 Hz, 2H), 3.16 – 3.10 (m, 1H), 2.78 (t, J = 6.8 Hz, 2H), 2.33 (s, 3H), 2.02 – 1.99 (m, 2H), 1.94 – 1.88 (m, 2H), 1.82 – 1.74 (m, 3H), 1.71 – 1.65 (m, 2H), 1.51 – 1.42 (m, 2H), 1.23 – 1.10 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.0, 151.8, 143.7, 134.6, 133.7, 132.5, 132.2, 128.7, 126.3, 123.6, 113.1, 98.4, 55.3, 38.4, 33.4, 29.7, 26.4, 26.3, 24.1, 22.8, 22.5, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{32}NO_3S$ ($[M+H]^+$): 438.2097; Found : 438.2100.



57

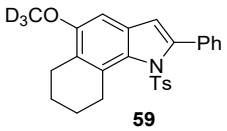
5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 57 (eluent: petroleum ether/ethyl acetate 10:1), 11.0 mg, 31% yield, white solid; mp: 128-129 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (d, J = 3.7 Hz, 1H), 7.50 (d, J = 8.4 Hz, 2H), 7.17 (d, J = 8.1

Hz, 2H), 6.75 (s, 1H), 6.56 (d, *J* = 3.7 Hz, 1H), 3.80 (s, 3H), 3.05 (t, *J* = 6.1 Hz, 2H), 2.68 (t, *J* = 6.5 Hz, 2H), 2.35 (s, 3H), 1.77 – 1.71 (m, 2H), 1.66 – 1.61 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.9, 144.2, 136.5, 130.8, 130.4, 130.3, 129.6, 127.2, 126.4, 124.4, 110.0, 98.6, 55.3, 28.3, 24.3, 22.6, 22.1, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{20}H_{22}NO_3S$ ($[M+H]^+$): 356.1315; Found : 356.1320.



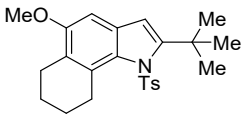
58

5-ethoxy-2-phenyl-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 58 (eluent: petroleum ether/ethyl acetate 10:1), 23.2 mg, 52% yield, white solid; mp: 150-151 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.43 (m, 2H), 7.39 – 7.34 (m, 3H), 6.95 – 6.90 (m, 4H), 6.59 (s, 1H), 6.36 (s, 1H), 4.00 (q, *J* = 6.9 Hz, 2H), 3.36 (t, *J* = 6.0 Hz, 2H), 2.80 (t, *J* = 6.7 Hz, 2H), 2.29 (s, 3H), 1.94 – 1.90 (m, 2H), 1.75 – 1.70 (m, 2H), 1.43 (t, *J* = 6.9 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.6, 145.8, 143.9, 134.9, 133.1, 133.0, 132.6, 132.0, 128.8, 128.2, 128.1, 127.7, 127.3, 125.0, 117.0, 99.6, 63.5, 29.4, 24.2, 22.8, 22.6, 21.5, 14.9. HRMS (ESI-TOF) m/z: Calcd for $C_{27}H_{28}NO_3S$ ($[M+H]^+$): 446.1784; Found : 446.1790.



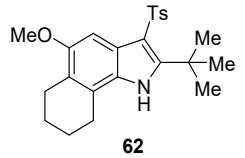
59

5-(methoxy-d$_3$)-2-phenyl-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 59 (eluent: petroleum ether/ethyl acetate 10:1), 35.6 mg, 82% yield, white solid; mp: 142-143 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.41 (m, 2H), 7.39 – 7.32 (m, 3H), 6.95 – 6.90 (m, 4H), 6.61 (s, 1H), 6.38 (s, 1H), 3.36 (t, *J* = 5.9 Hz, 2H), 2.79 (t, *J* = 6.7 Hz, 2H), 2.30 (s, 3H), 1.96 – 1.90 (m, 2H), 1.75 – 1.70 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.3, 145.8, 143.9, 135.0, 133.0, 133.0, 132.6, 132.0, 128.8, 128.2, 128.2, 127.7, 127.3, 124.8, 116.9, 98.7, 29.4, 24.1, 22.7, 22.6, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{23}D_3NO_3S$ ($[M+H]^+$): 435.1816; Found : 435.1805.



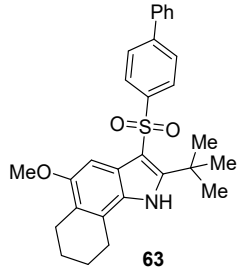
61

2-(*tert*-butyl)-5-methoxy-1-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole I-22 (eluent: petroleum ether/ethyl acetate 10:1), 33.3 mg, 81% yield, white solid; mp: 147-148 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.11 (d, J = 8.1 Hz, 2H), 6.94 (d, J = 8.1 Hz, 2H), 6.43 (s, 1H), 6.35 (s, 1H), 3.75 (s, 3H), 3.24 (t, J = 5.9 Hz, 2H), 2.72 (t, J = 6.7 Hz, 2H), 2.27 (s, 3H), 1.91 – 1.84 (m, 2H), 1.68 – 1.62 (m, 2H), 1.49 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.8, 156.2, 143.5, 136.3, 132.7, 131.8, 129.2, 128.0, 127.6, 123.8, 119.8, 98.7, 55.4, 35.8, 32.1, 29.2, 23.9, 22.7, 22.6, 21.5. HRMS (ESI-TOF) m/z: Calcd for $C_{24}H_{30}NO_3S$ ($[M+H]^+$): 412.1941; Found : 412.1942.



62

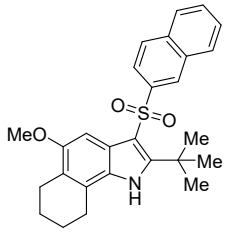
2-(*tert*-butyl)-5-methoxy-3-tosyl-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 62 (eluent: petroleum ether/ethyl acetate 2:1), 26.7 mg, 65% yield, yellow solid; mp: 193-194 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25 (s, 1H), 7.79 (d, J = 8.0 Hz, 2H), 7.34 (s, 1H), 7.17 (d, J = 8.0 Hz, 2H), 3.83 (s, 3H), 2.79 (t, J = 5.3 Hz, 2H), 2.70 (t, J = 5.4 Hz, 2H), 2.34 (s, 3H), 1.82 – 1.78 (m, 4H), 1.60 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.1, 149.8, 142.5, 142.4, 129.2, 126.1, 126.0, 124.8, 122.8, 120.3, 110.1, 97.8, 55.6, 34.2, 30.0, 24.1, 23.2, 22.6, 21.9, 21.4. HRMS (ESI-TOF) m/z: Calcd for $C_{24}H_{30}NO_3S$ ($[M+H]^+$): 412.1941; Found : 412.1946.



63

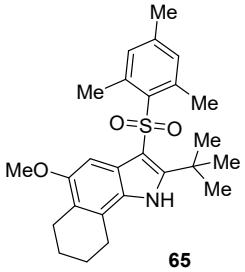
3-([1,1'-biphenyl]-4-ylsulfonyl)-2-(tert-butyl)-5-methoxy-6,7,8,9-tetrahydro-1*H*-benzo[g]indole 63 (eluent: petroleum ether/ethyl acetate 10:1), 27.9 mg, 59% yield,

yellow solid; mp: 169-170 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.30 (s, 1H), 7.97 (d, J = 8.4 Hz, 2H), 7.59 (d, J = 8.4 Hz, 2H), 7.53 - 7.51 (m, 2H), 7.44 – 7.34 (m, 4H), 3.85 (s, 3H), 2.80 (t, J = 5.5 Hz, 2H), 2.70 (t, J = 5.6 Hz, 2H), 1.91 – 1.78 (m, 4H), 1.62 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.2, 150.0, 144.8, 143.9, 139.5, 128.9, 128.2, 127.3, 127.2, 126.4, 126.1, 124.9, 122.9, 120.4, 109.9, 97.8, 55.7, 34.2, 30.1, 24.1, 23.2, 22.6, 21.9. HRMS (ESI-TOF) m/z: Calcd for $C_{29}H_{32}NO_3S$ ($[M+H]^+$): 474.2097; Found : 474.2099.



64

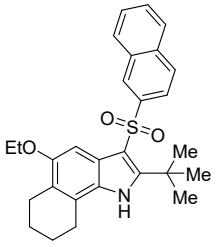
2-(*tert*-butyl)-5-methoxy-3-(naphthalen-1-ylsulfonyl)-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 64 (eluent: petroleum ether/ethyl acetate 10:1), 38.9 mg, 87% yield, yellow oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 (d, J = 0.8 Hz, 1H), 8.30 (s, 1H), 7.90 – 7.84 (m, 2H), 7.82 – 7.78 (m, 2H), 7.58 – 7.50 (m, 2H), 7.40 (s, 1H), 3.81 (s, 3H), 2.79 (t, J = 5.6 Hz, 2H), 2.68 (t, J = 5.6 Hz, 2H), 1.90 - 1.78 (m, 4H), 1.62 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.1, 150.1, 142.1, 134.5, 132.0, 129.2, 129.0, 128.3, 127.8, 127.2, 126.6, 126.1, 124.9, 122.9, 121.9, 120.4, 109.8, 97.7, 55.6, 34.2, 30.1, 24.1, 23.2, 22.6, 21.9. HRMS (ESI-TOF) m/z: Calcd for $C_{27}H_{30}NO_3S$ ($[M+H]^+$): 448.1941; Found : 448.1946.



65

2-(*tert*-butyl)-3-(mesitylsulfonyl)-5-methoxy-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole 65 (eluent: petroleum ether/ethyl acetate 10:1), 29.9 mg, 68% yield, white solid; mp: 190-191 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (s, 1H), 6.93 (s, 2H), 6.12 (s, 1H), 3.45 (s, 3H), 2.77 (t, J = 5.8 Hz, 2H), 2.61 (t, J = 5.9 Hz, 2H), 2.57 (s,

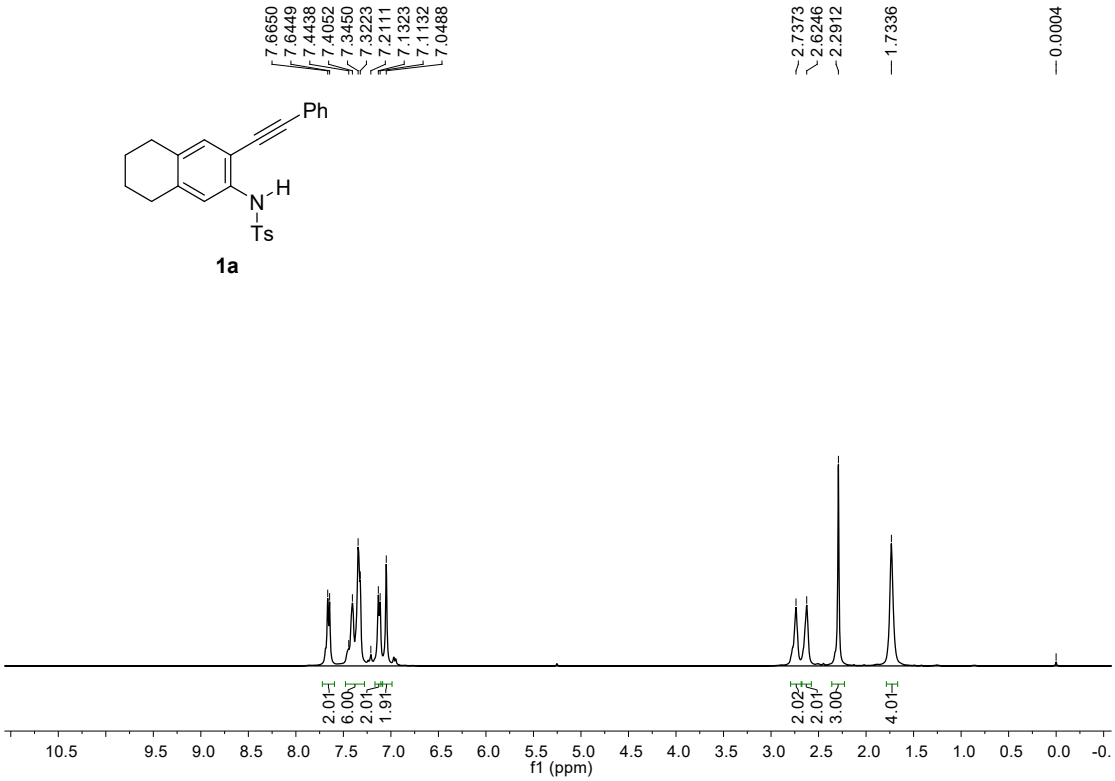
6H), 2.28 (s, 3H), 1.86 – 1.78 (m, 4H), 1.64 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.3, 147.8, 142.2, 139.6, 137.8, 132.0, 125.9, 122.7, 122.1, 120.1, 114.4, 96.1, 54.9, 34.2, 29.7, 24.1, 23.1, 22.6, 22.5, 21.9, 20.9. HRMS (ESI-TOF) m/z: Calcd for $C_{26}H_{34}NO_3S$ ([M+H]$^+$): 440.2254; Found : 440.2255.

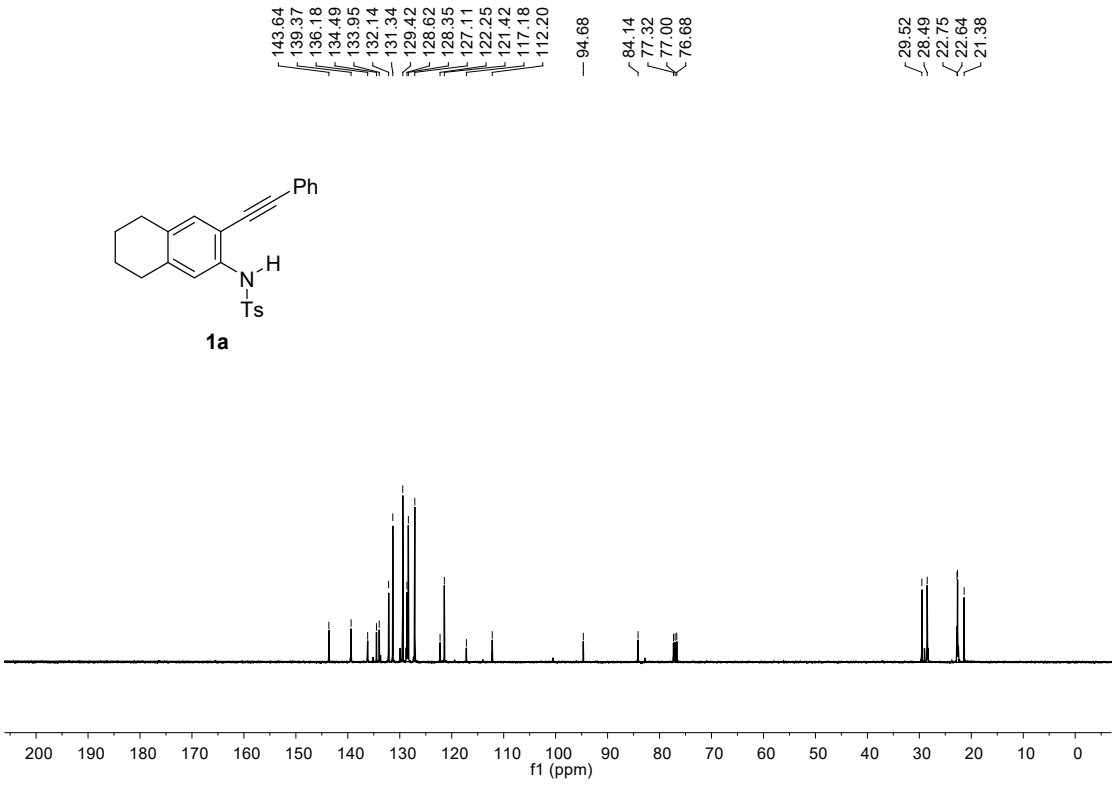


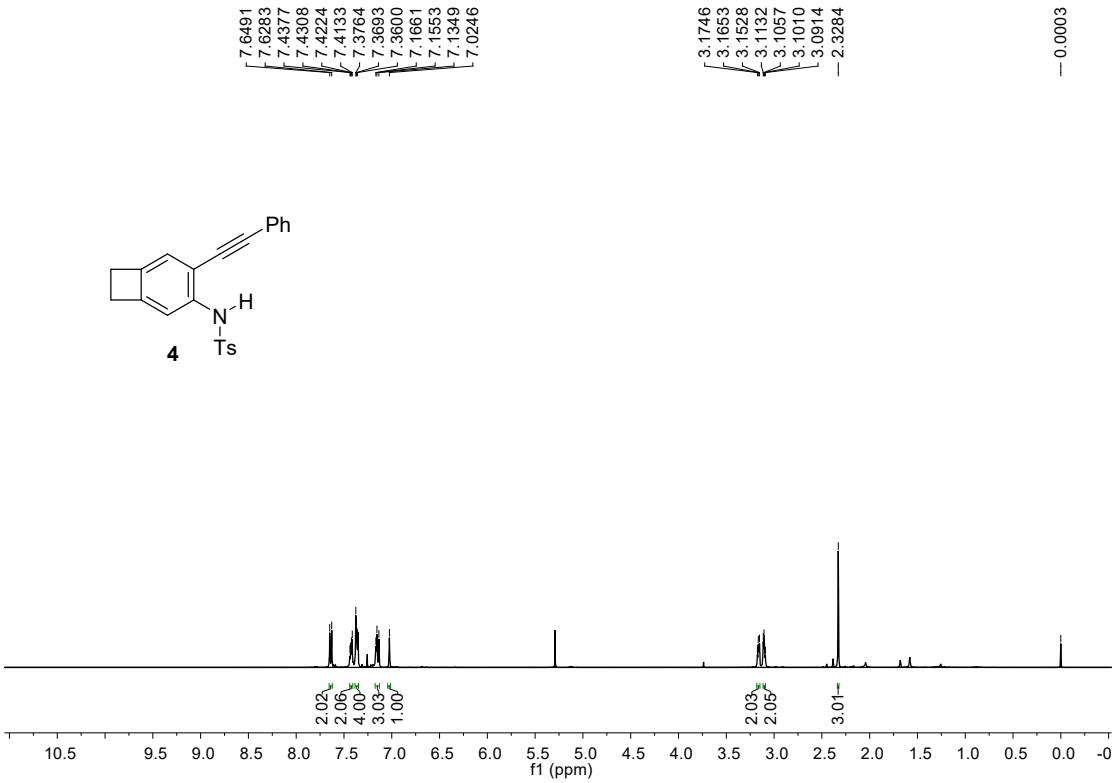
67

2-(*tert*-butyl)-5-ethoxy-3-(naphthalen-2-ylsulfonyl)-6,7,8,9-tetrahydro-1*H*-benzo[*g*]indole **67** (eluent: petroleum ether/ethyl acetate 10:1), 22.1 mg, 48% yield, colorless oil; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.51 (d, J = 1.8 Hz, 1H), 8.28 (s, 1H), 7.91 – 7.83 (m, 2H), 7.82 – 7.77 (m, 2H), 7.58 – 7.50 (m, 2H), 7.39 (s, 1H), 4.02 (q, J = 6.9 Hz, 2H), 2.79 (t, J = 5.8 Hz, 2H), 2.70 (t, J = 5.8 Hz, 2H), 1.88 – 1.78 (m, 5H), 1.62 (s, 9H), 1.37 (t, J = 6.9 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.4, 150.0, 142.1, 134.5, 132.0, 129.2, 128.9, 128.3, 127.7, 127.1, 126.6, 126.1, 124.9, 123.1, 121.9, 120.3, 109.7, 98.8, 63.8, 34.2, 30.1, 24.1, 23.3, 22.6, 22.0, 14.8. HRMS (ESI-TOF) m/z: Calcd for $C_{28}H_{32}NO_3S$ ([M+H]$^+$): 462.2097; Found : 462.2098.

3. Spectra of ^{1}H NMR and ^{13}C NMR



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7.4308
7.4224
7.4133
7.3764
7.3693
7.3600
7.1661
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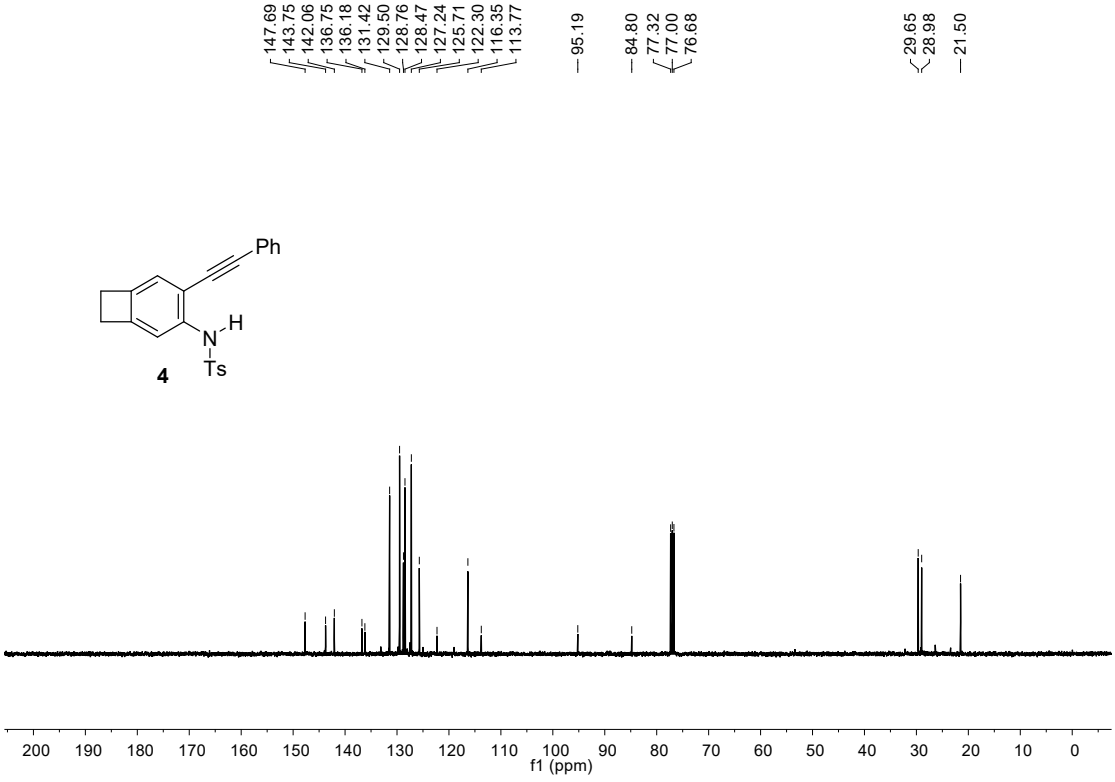
7.1349
7.0246
3.1746
3.1653
3.1528
3.1132
3.1057
3.1010
3.0914
2.3284
0.0003
Ph
N
H
Ts
4
2.02
2.06
4.00
3.03
1.00
2.03
2.05
3.01
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0
f1 (ppm)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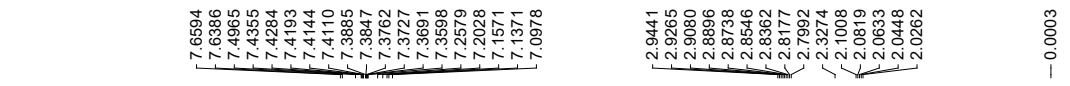
143.75
142.06
136.75
136.18
131.42
129.50
128.76
128.47
127.24
125.71
122.30
116.35
113.77
95.19
84.80
77.32
77.00
76.68
29.65
28.98
21.50
Ph
N
H
Ts
4
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.4355
7.4284
7.4193
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7.3762
7.3727
7.3691
7.3598
7.2579
7.2028
7.1571
7.1371
7.0978
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2.9080
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2.8546
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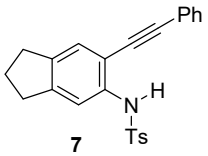
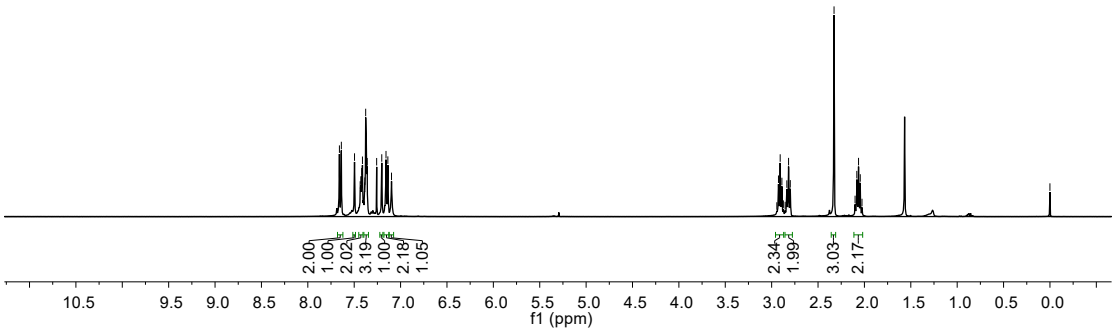

Ph
H
N
Ts

7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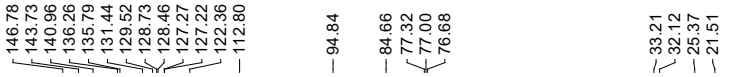
3.19
1.00
2.18
1.05
2.34
1.99
3.03
2.17
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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143.73
140.96
136.26
135.79
131.44
129.52
128.73
128.46
127.27
127.22
122.36
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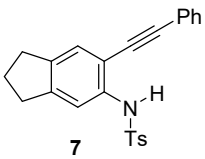
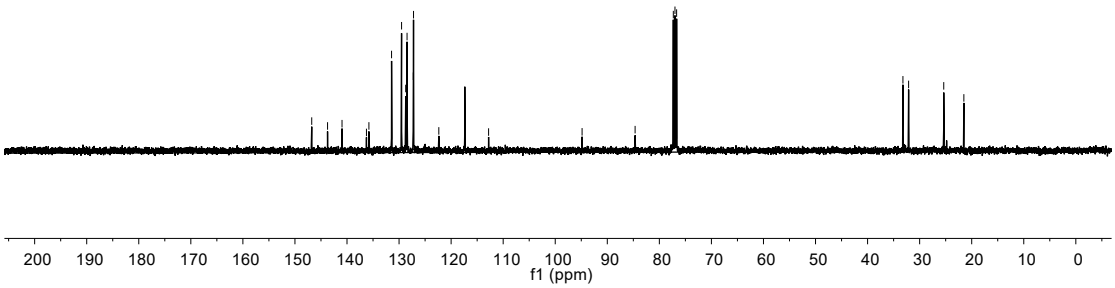
77.00
76.68
33.21
32.12
25.37
21.51


Ph
H
N
Ts

7


200
190
180
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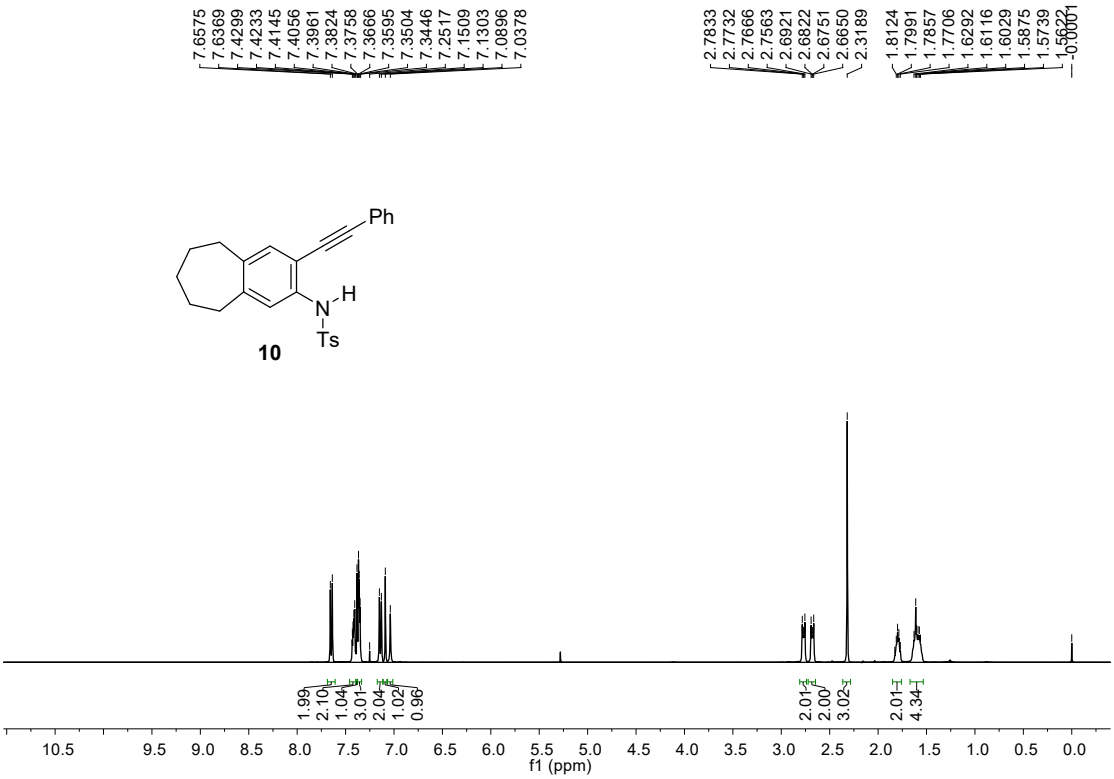
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.3961
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7.3758
7.3666
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7.3504
7.3446
7.2517
7.1509
7.1303
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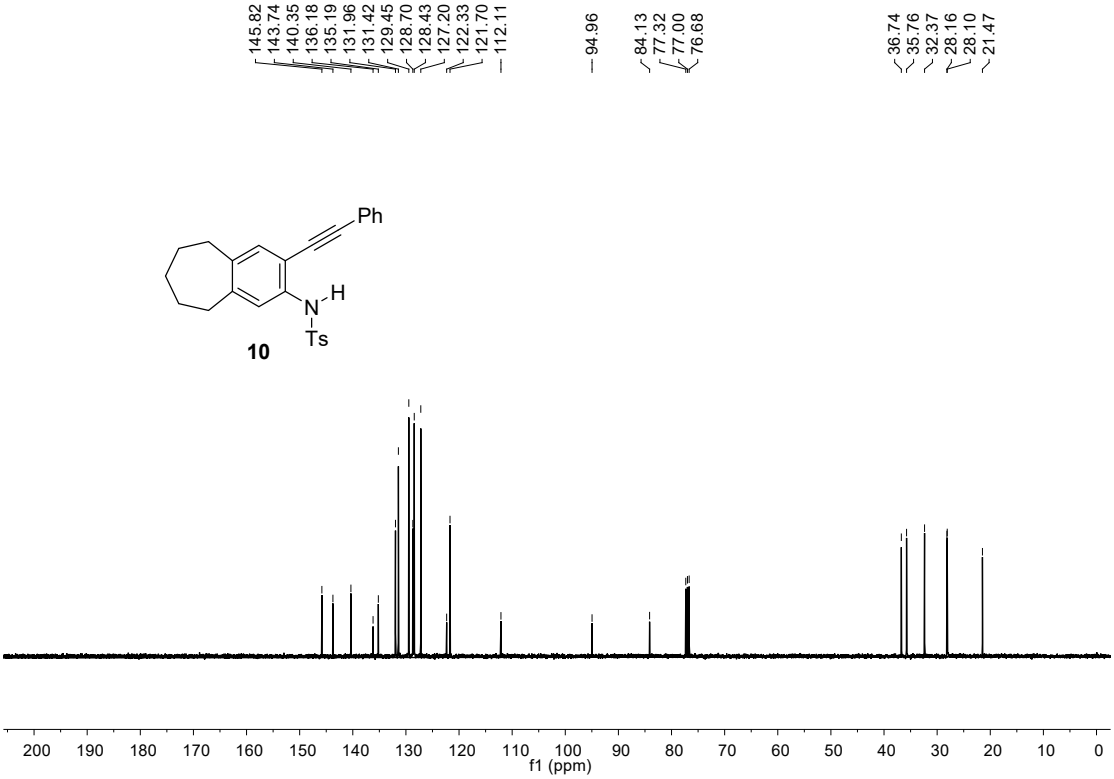
1.8124
1.7991
1.7857
1.7706
1.6292
1.6116
1.6029
1.5875
1.5739
1.5622
0.0001
Ph
N
H
Ts
10
1.99
2.10
1.04
3.01
2.04
1.02
0.96
2.01
2.00
3.02
2.01
4.34
f1 (ppm)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140.35
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135.19
131.96
131.42
129.45
128.70
128.43
127.20
122.33
121.70
112.11
94.96
84.13
77.32
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H
Ts
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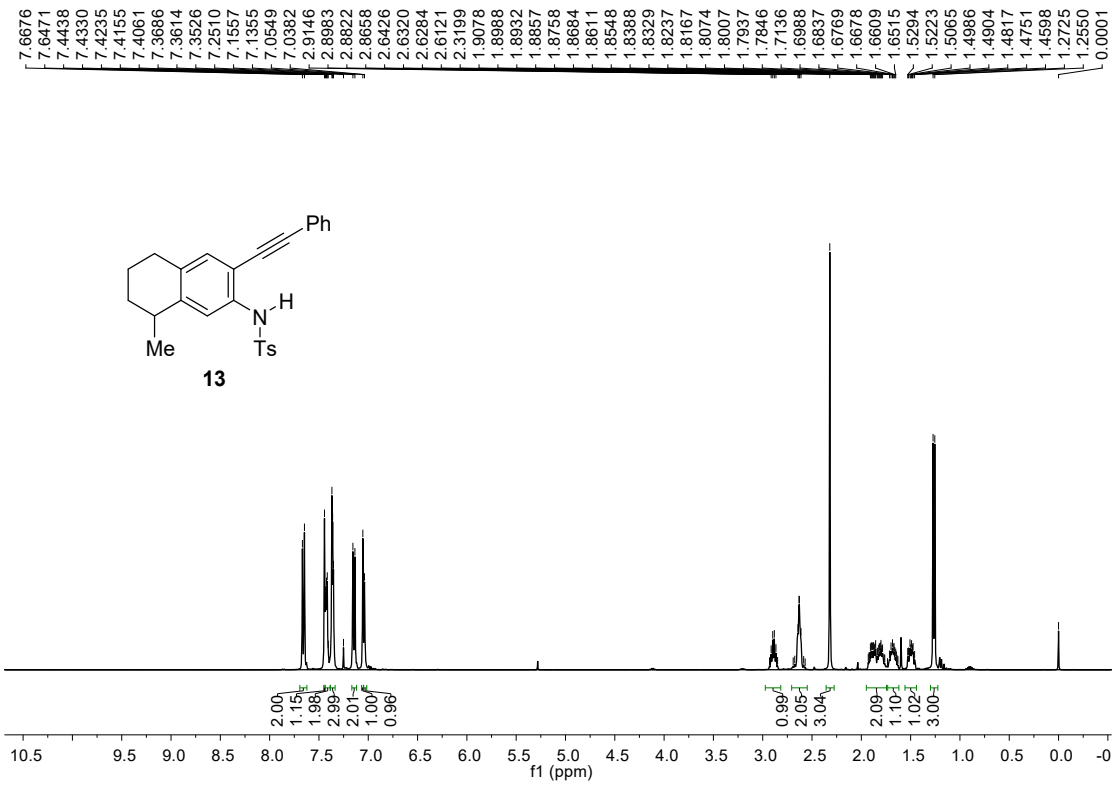
f1 (ppm)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1.2550
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Ph
N
H
Me
Ts
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1.15
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2.99
2.01
1.00
0.96
0.99
2.05
3.04
2.09
1.10
1.02
3.00
10.5
9.5
9.0
8.5
8.0
7.5
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6.0
5.5
5.0
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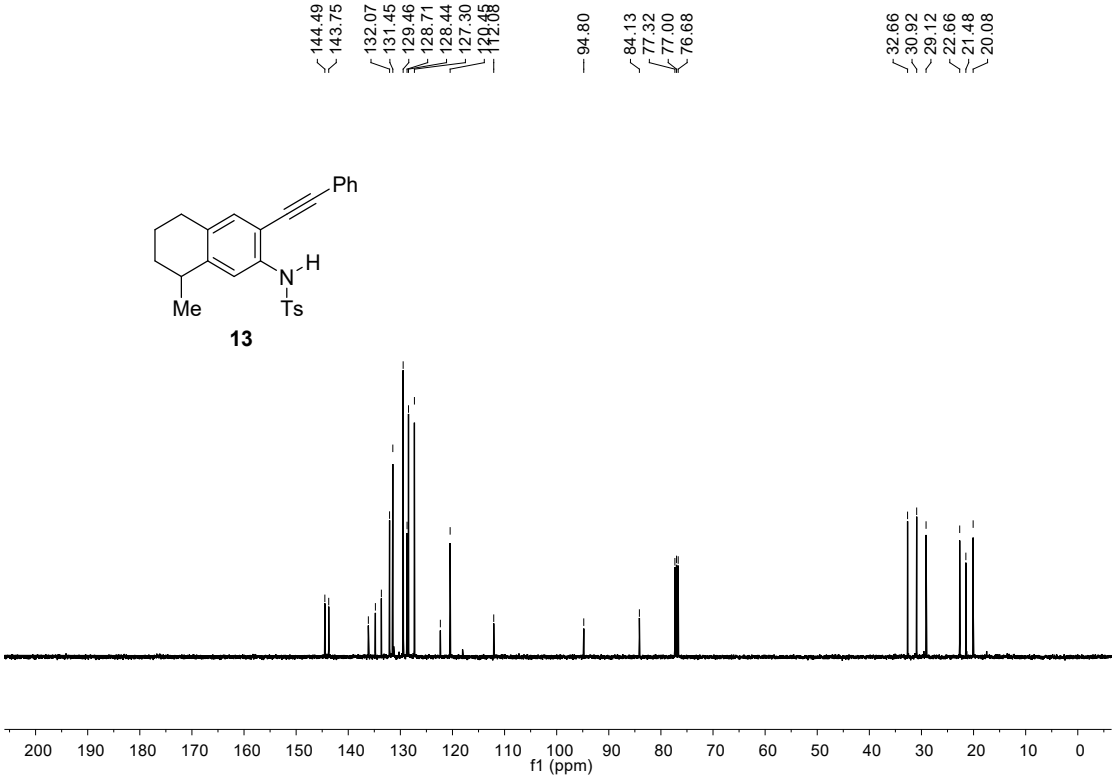
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30.92
29.12
22.66
21.48
20.08
Ph
N
H
Me
Ts
13
200
190
180
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90
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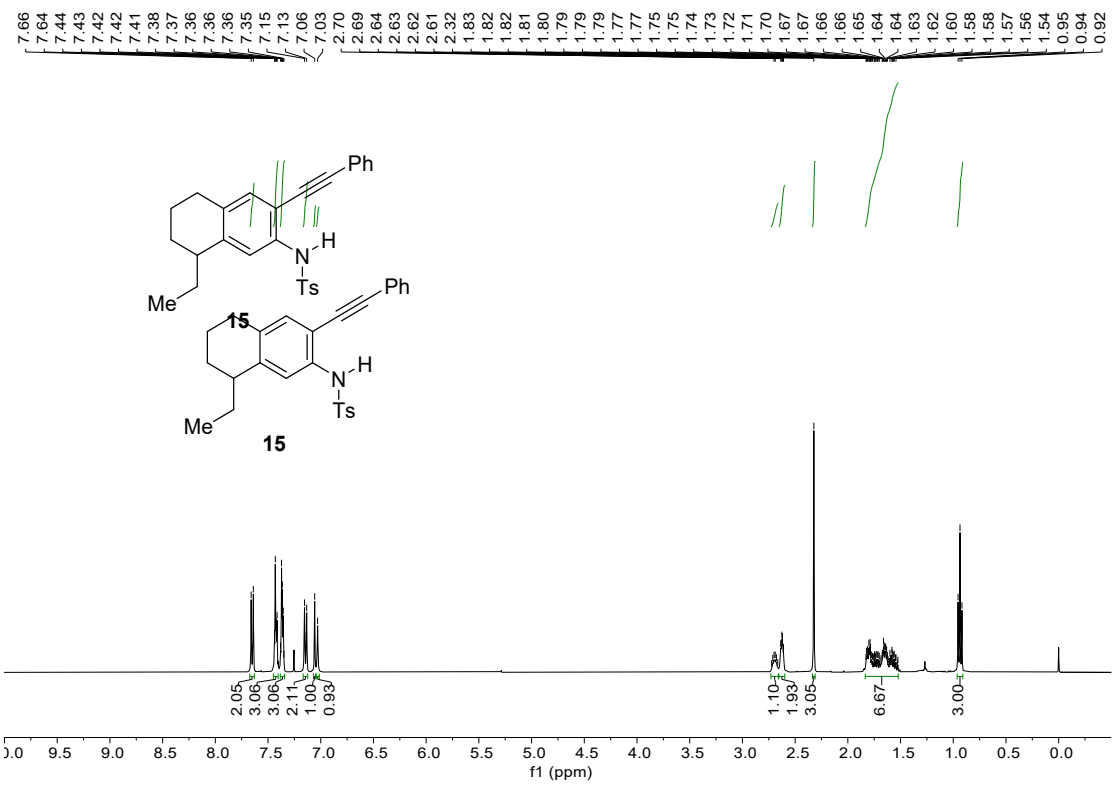
f1 (ppm)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Ph
N H
Ts
Me
15
Ph
N H
Ts
Me
15
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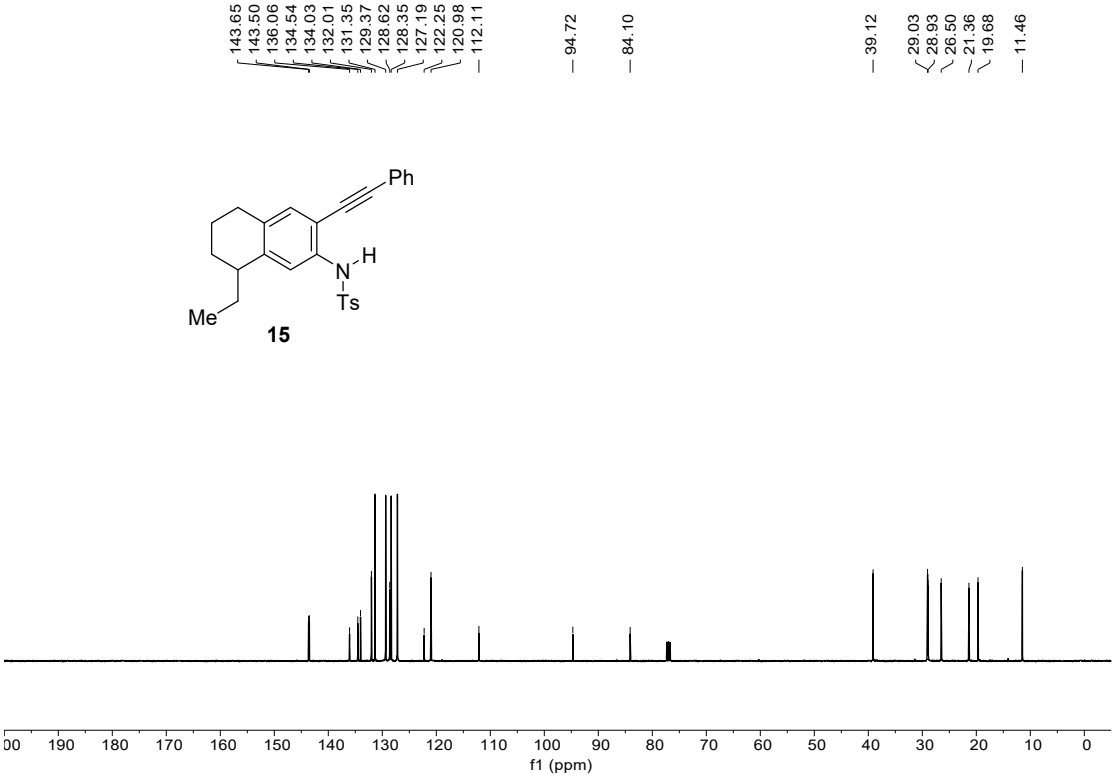
f1 (ppm)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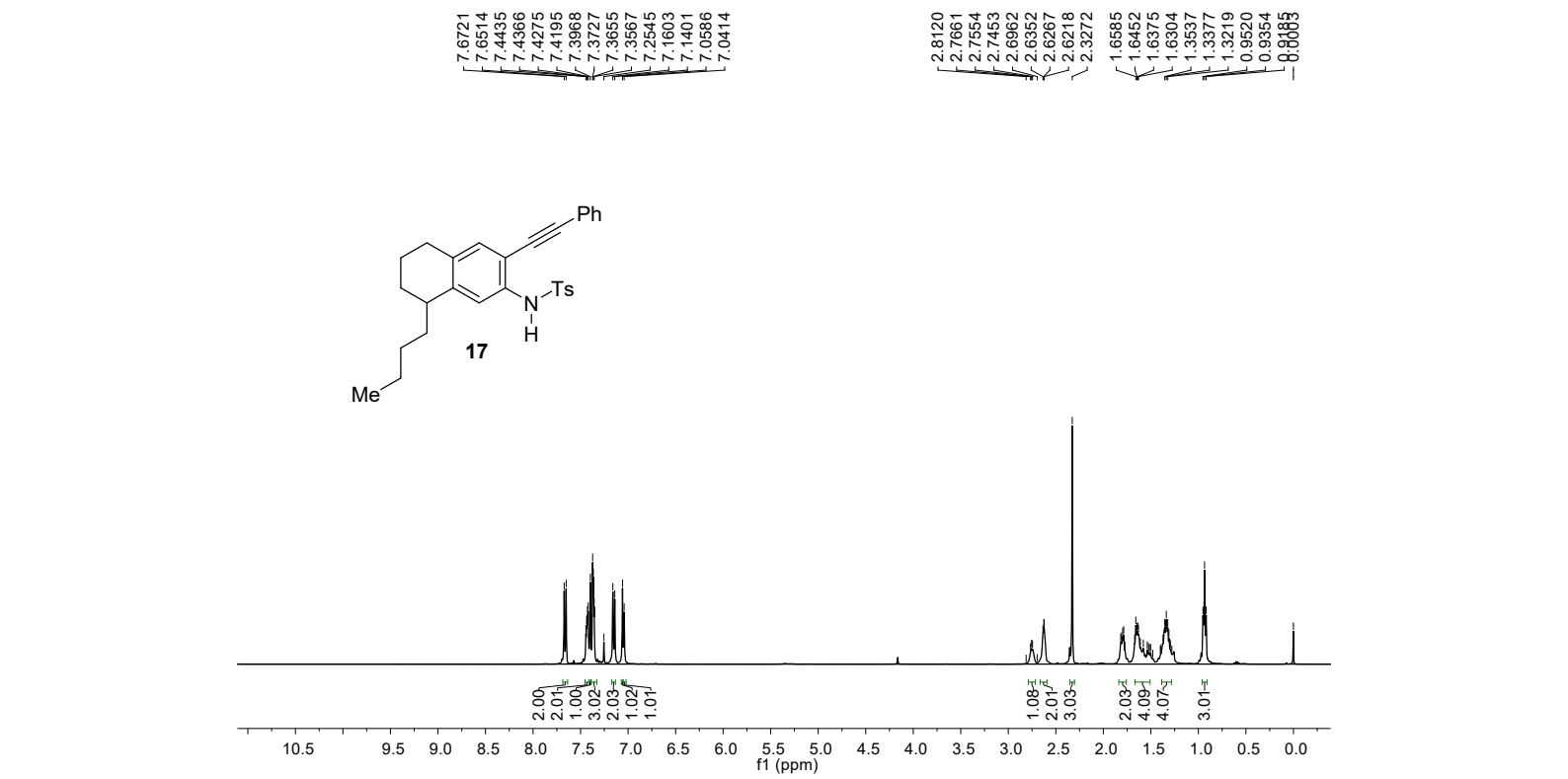
Ph
N H
Ts
Me
15
f1 (ppm)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2.7554
2.7453
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2.6267
2.6218
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1.6304
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1.3219
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0.9354
Ph
Ts
N
H
17
Me
2.00
2.01
1.00
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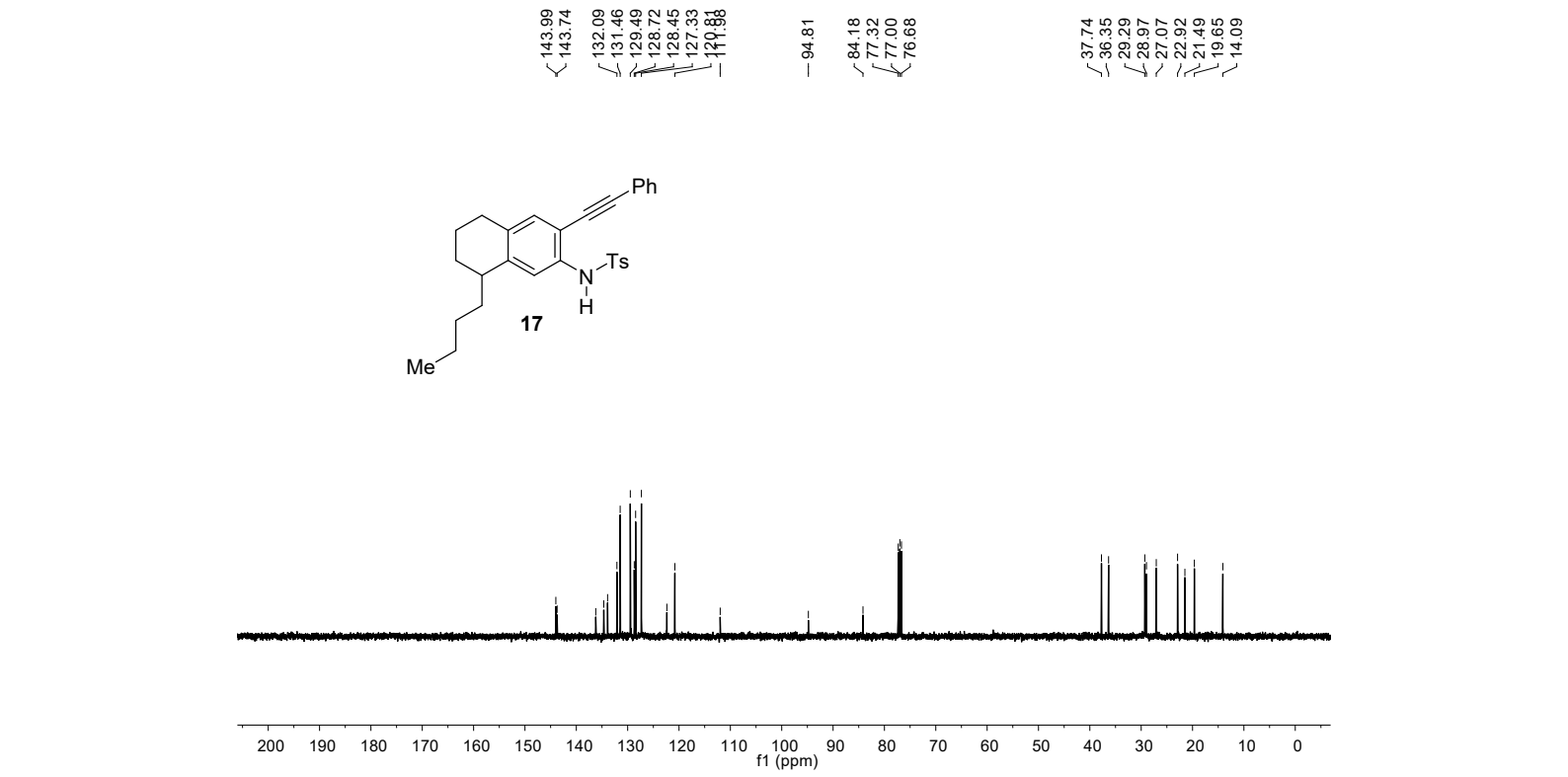
1.01
1.08
2.01
3.03
2.03
4.09
4.07
3.01
f1 (ppm)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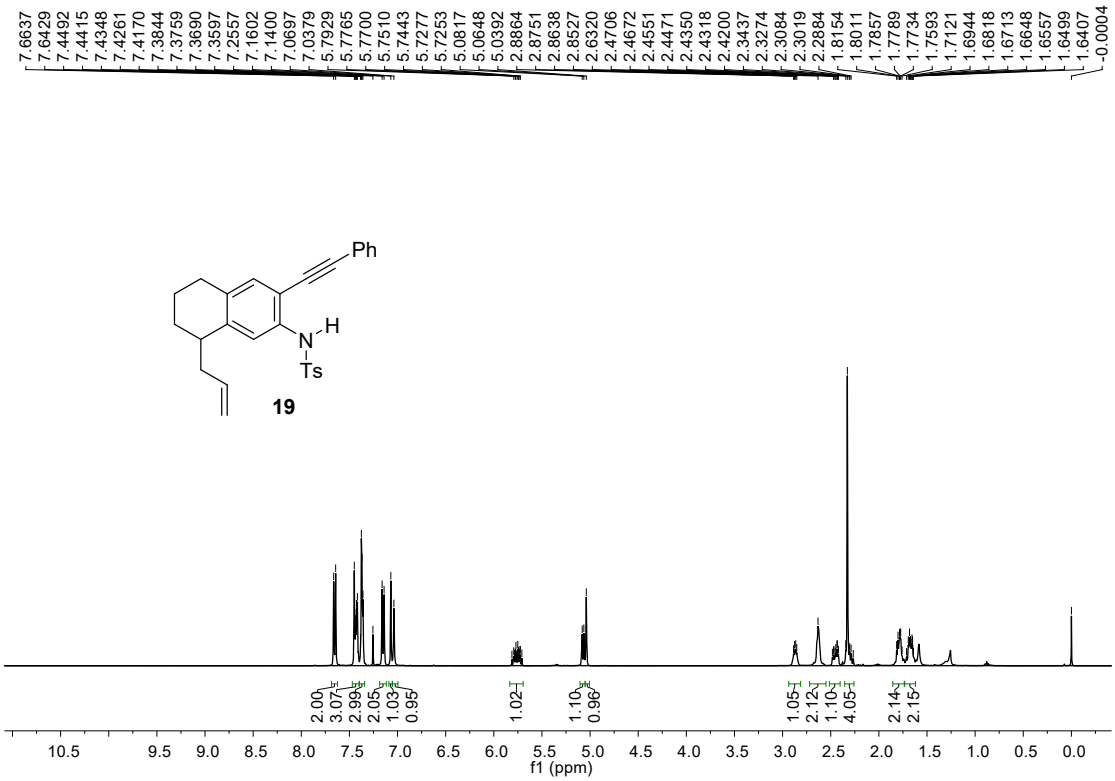
127.33
94.81
84.18
77.32
77.00
76.68
37.74
36.35
29.29
28.97
27.07
22.92
21.49
19.65
14.09
Ph
Ts
N
H
17
Me
f1 (ppm)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7.3597
7.2557
7.1602
7.1400
7.0697
7.0379
5.7929
5.7765
5.7700
5.7510
5.7443
5.7277
5.7253
5.0817
5.0648
5.0392
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2.8751
2.8638
2.8527
2.6320
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2.4672
2.4551
2.4471
2.4350
2.4318
2.4200
2.3437
2.3274
2.3084
2.3019
2.2884
1.8154
1.8011
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Ph
N
H
Ts
19
2.00
3.07
2.99
2.05
1.03
0.95
1.02
1.10
0.96
1.05
2.12
1.10
4.05
2.14
2.15
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
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3.5
3.0
2.5
2.0
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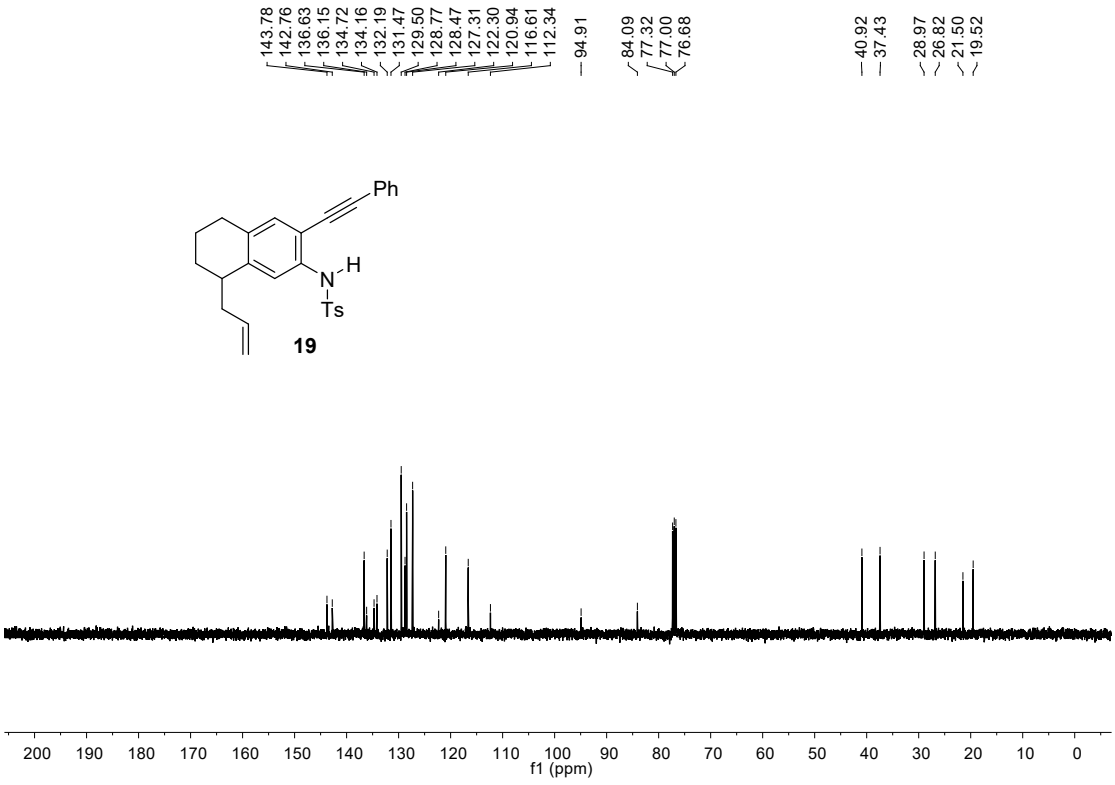
1.0
0.5
0.0
f1 (ppm)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128.47
127.31
122.30
120.94
116.61
112.34
94.91
84.09
77.32
77.00
76.68
40.92
37.43
28.97
26.82
21.50
19.52
Ph
N
H
Ts
19
200
190
180
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120
110
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90
80
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50
40
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10
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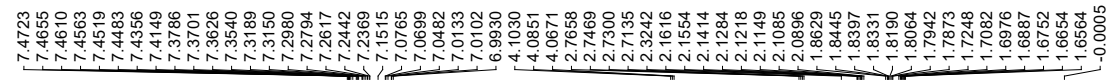
f1 (ppm)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7.3540
7.3189
7.3150
7.2980
7.2794
7.2617
7.2442
7.2369
7.1515
7.0765
7.0699
7.0482
7.0133
7.0102
6.9930
4.1030
4.0851
4.0671
2.7658
2.7469
2.7300
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2.3242
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2.1554
2.1414
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2.1218
2.1149
2.1085
2.0896
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1.8190
1.8064
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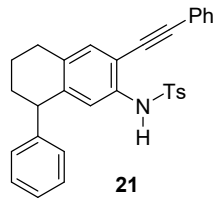
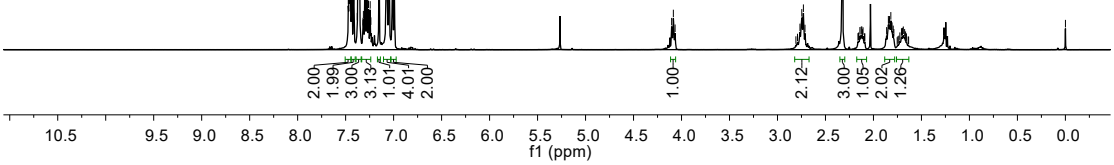

Ph
Ts
N
H

21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4.01
2.00
1.00
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3.00
1.05
2.02
1.26
10.5
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)


146.45
143.56
141.58
135.83
134.89
133.90
132.17
131.48
129.42
128.79
128.69
128.46
128.28
127.30
126.14
122.23
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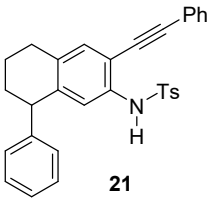
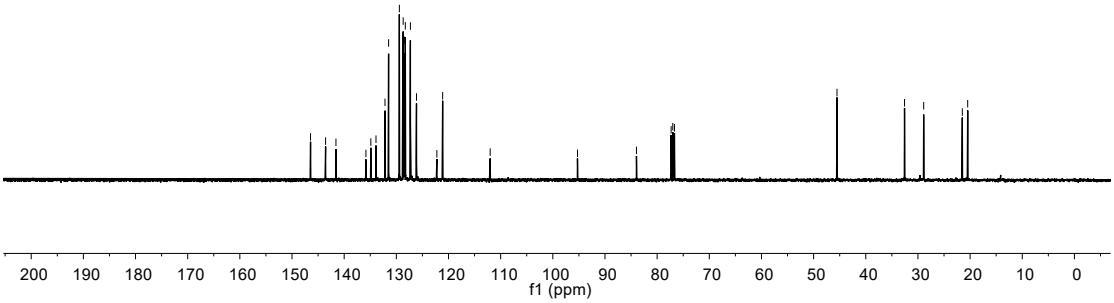
20.46


Ph
Ts
N
H

21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190
180
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120
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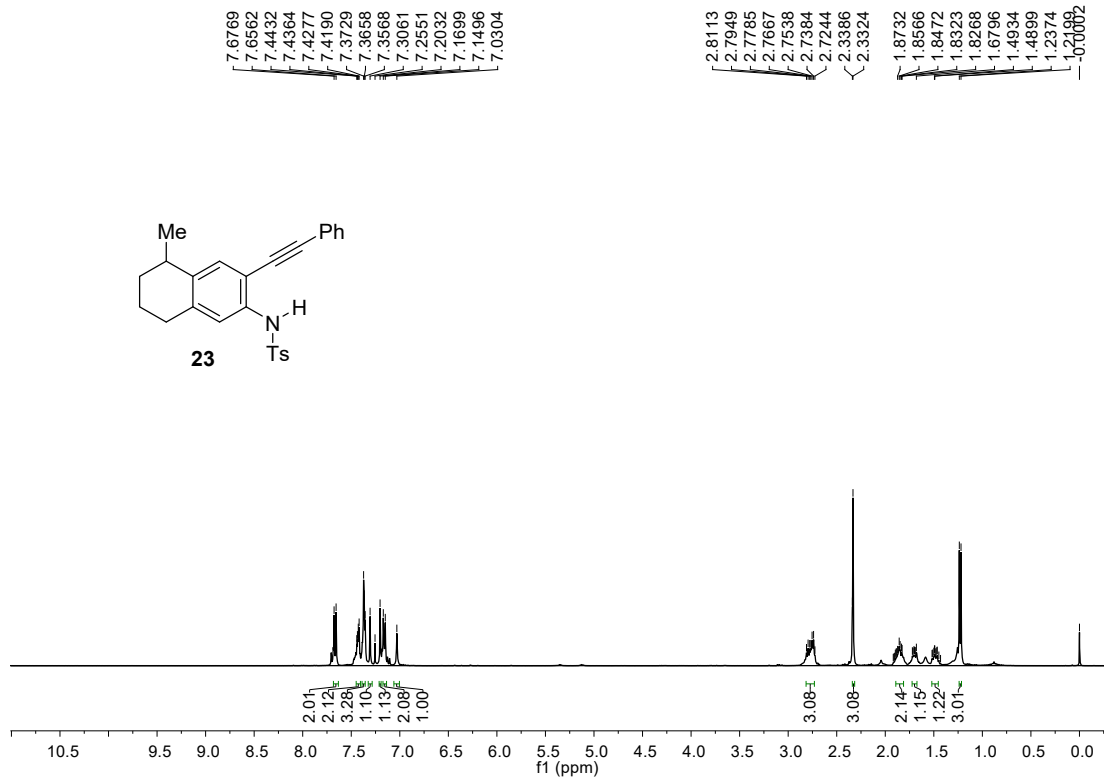
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.1496
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1.4899
1.2374
1.2199
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Me
Ph
N
H
Ts
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2.12
3.28
1.10
1.13
2.08
1.00
3.08
3.08
2.14
1.15
1.22
3.01
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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3.0
2.5
2.0
1.5
1.0
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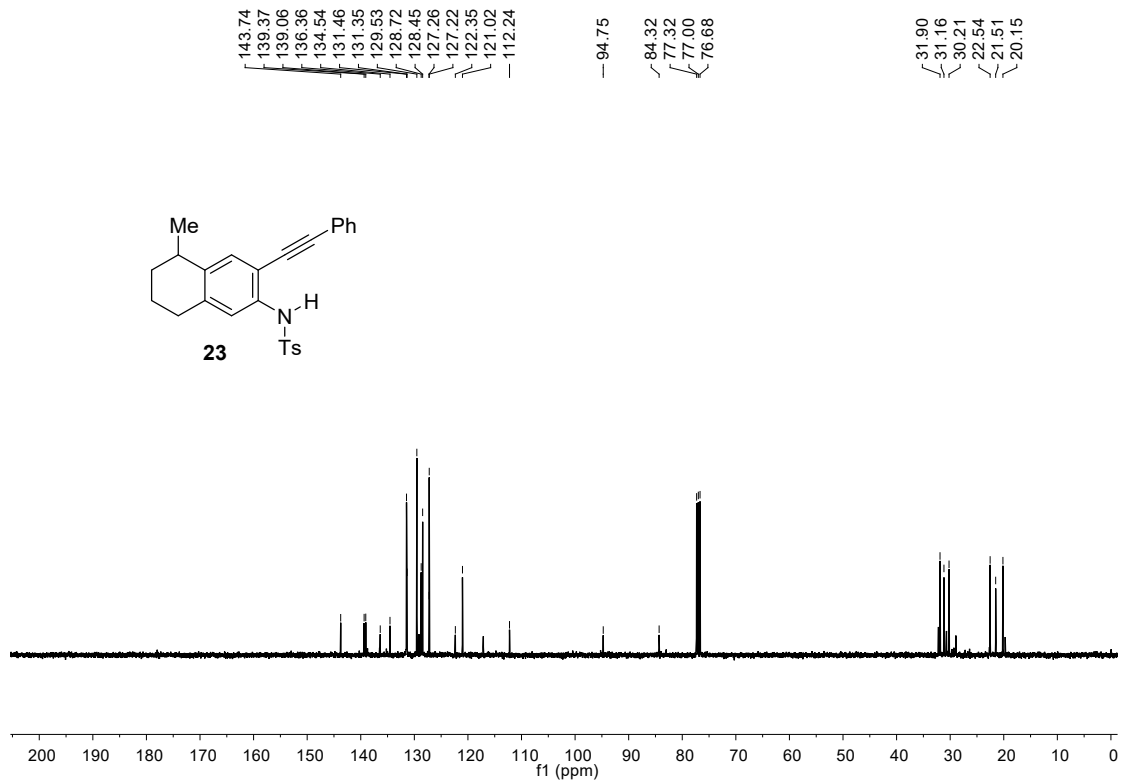
0.0
f1 (ppm)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121.02
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84.32
77.32
77.00
76.68
31.90
31.16
30.21
22.54
21.51
20.15
Me
Ph
N
H
Ts
23
200
190
180
170
160
150
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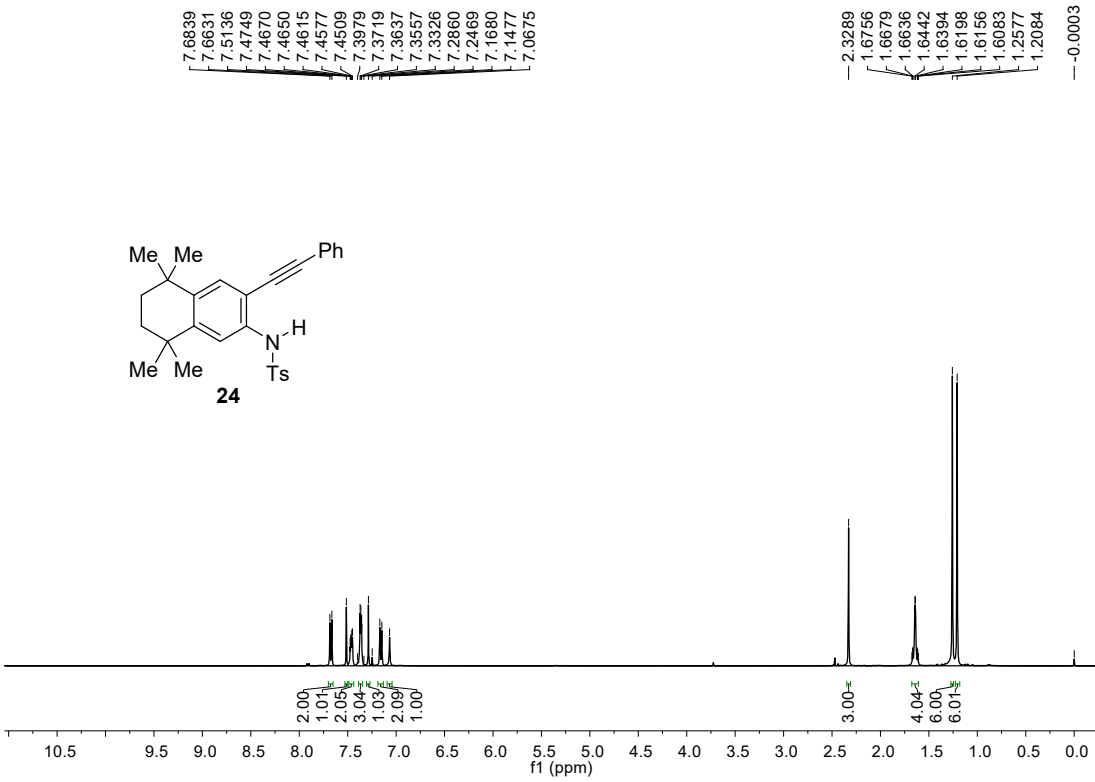
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.1477
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1.6679
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1.6394
1.6198
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1.2577
1.2084
-0.0003
Me Me
Ph
N H
Ts
Me Me
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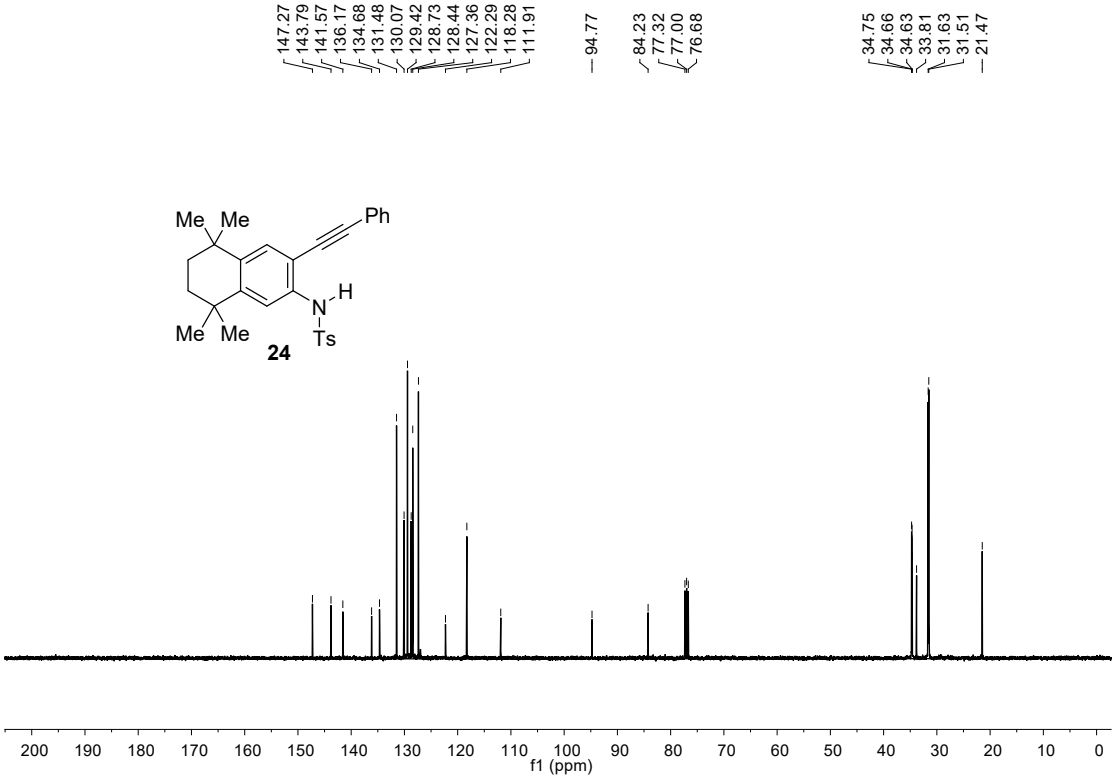
1.01
2.05
3.04
1.03
2.09
1.00
3.00
4.04
6.00
6.01
10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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111.91
94.77
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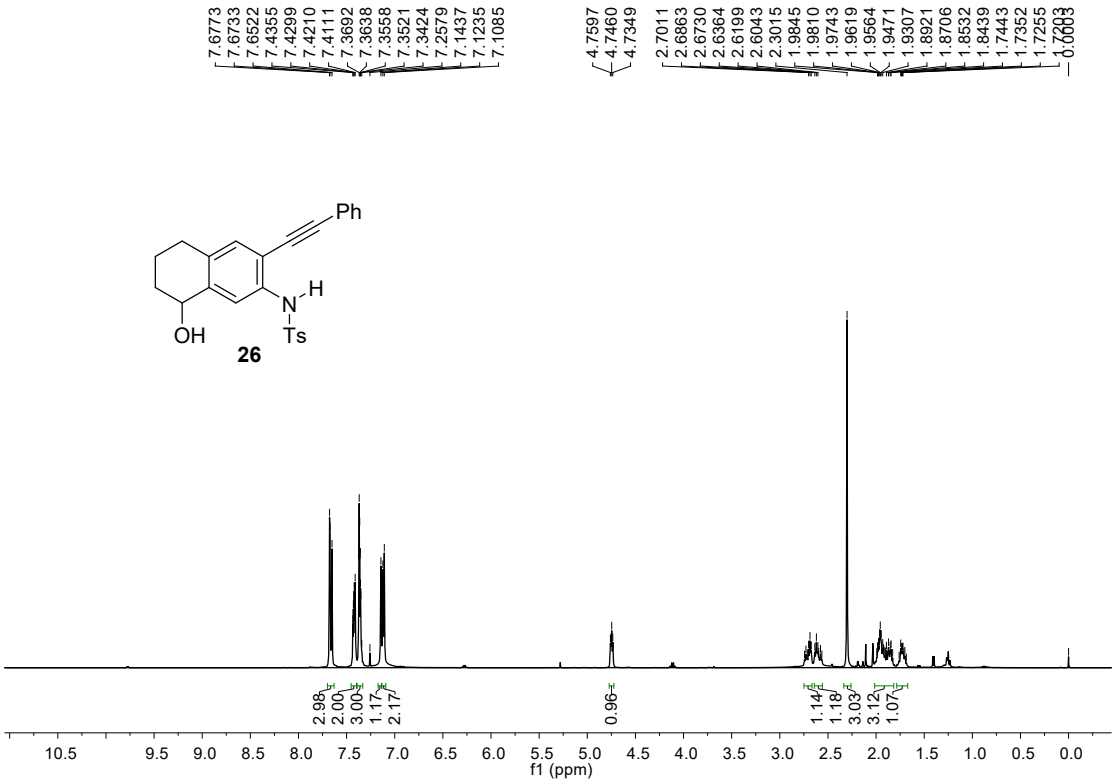
77.32
77.00
76.68
34.75
34.66
34.63
33.81
31.63
31.51
21.47
Me Me
Ph
N H
Ts
Me Me
24
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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1.7443
1.7352
1.7255
Ph
N
H
OH
Ts
26
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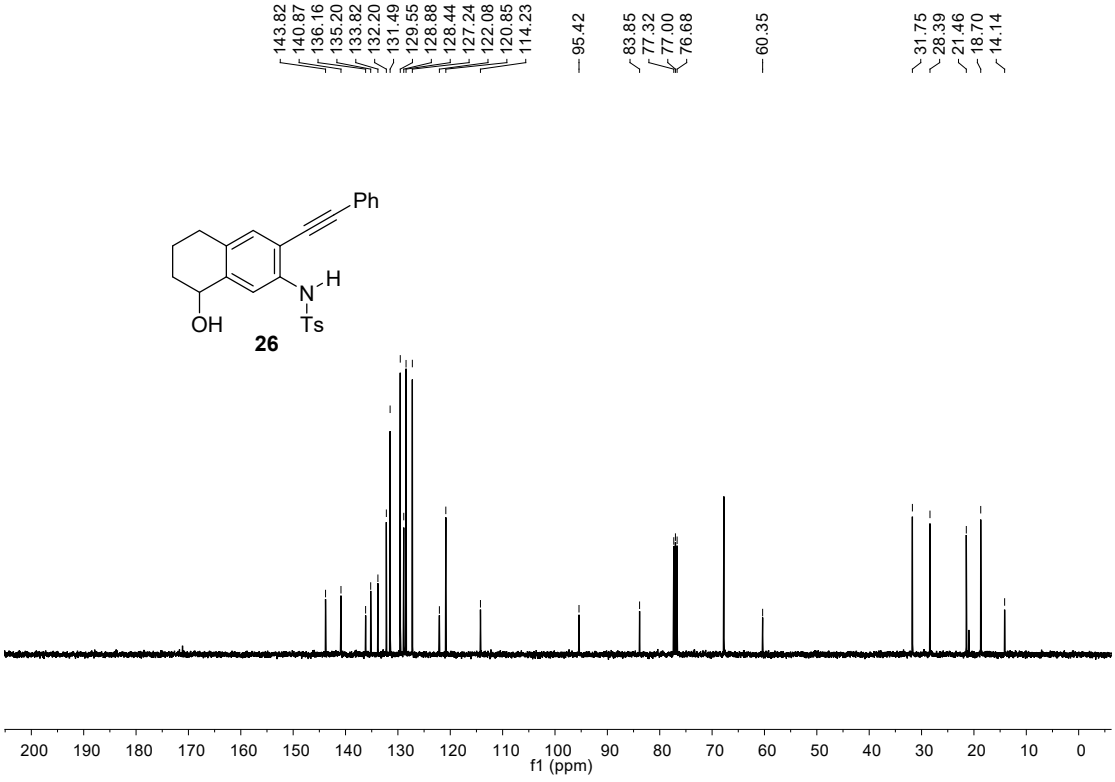
1.18
3.03
3.12
1.07
f1 (ppm)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122.08
120.85
114.23
95.42
83.85
77.32
77.00
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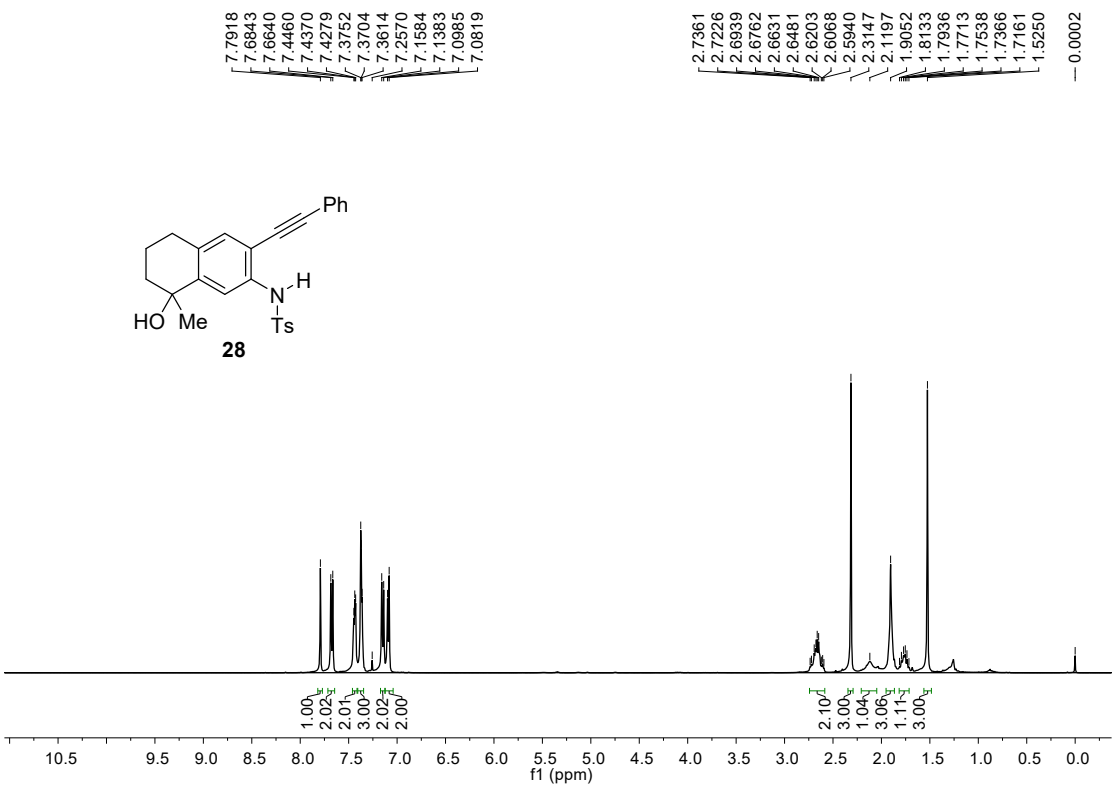
28.39
21.46
18.70
14.14
Ph
N
H
OH
Ts
26
f1 (ppm)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7.0819
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2.6203
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1.7366
1.7161
1.5250
0.0002
Ph
N
H
HO
Me
Ts
28
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2.02
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3.00
2.02
2.00
2.10
3.00
1.04
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1.11
3.00
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8.0
7.5
7.0
6.5
6.0
5.5
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2.5
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1.0
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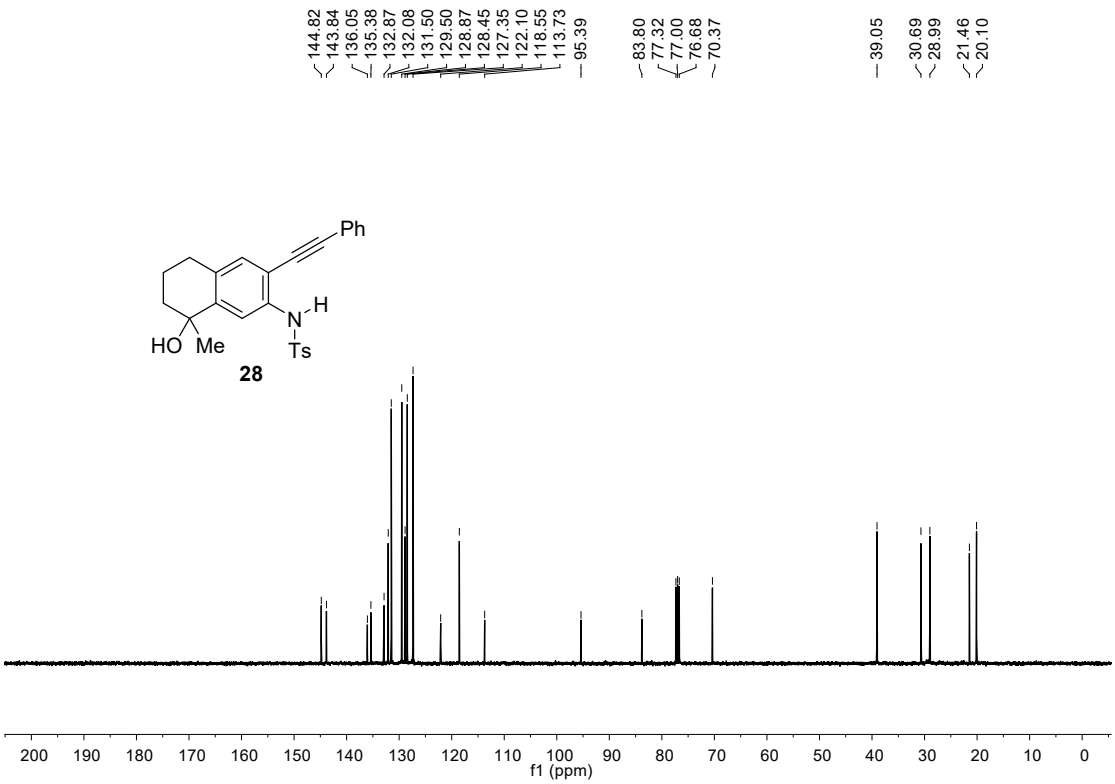
0.0
f1 (ppm)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113.73
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83.80
77.32
77.00
76.68
70.37
39.05
30.69
28.99
21.46
20.10
Ph
N
H
HO
Me
Ts
28
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
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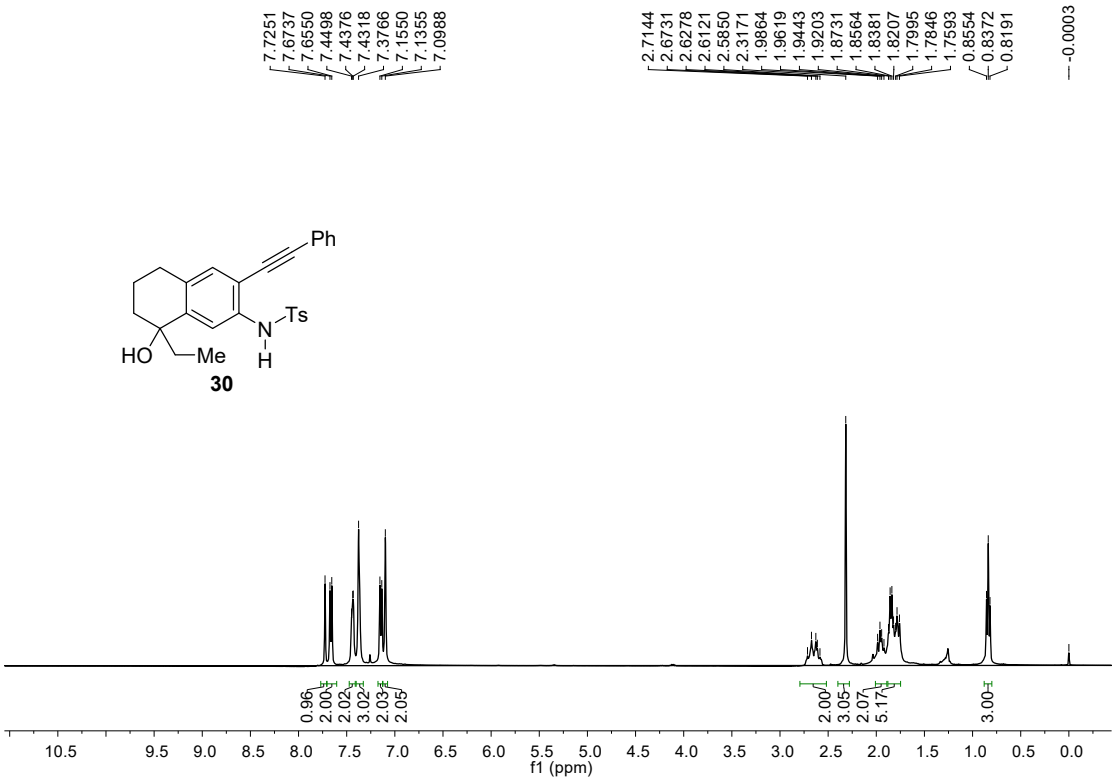
f1 (ppm)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H
HO
Me
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3.02
2.03
2.05
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3.05
2.07
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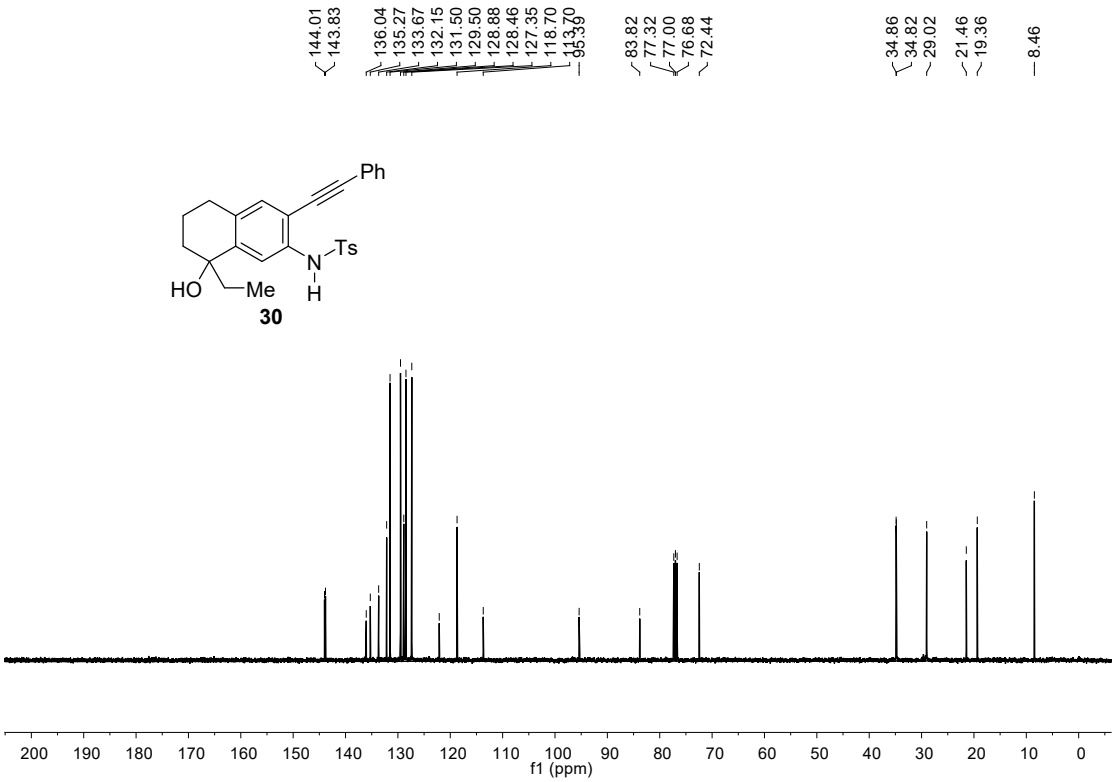
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19.36
8.46
Ph
Ts
N
H
HO
Me
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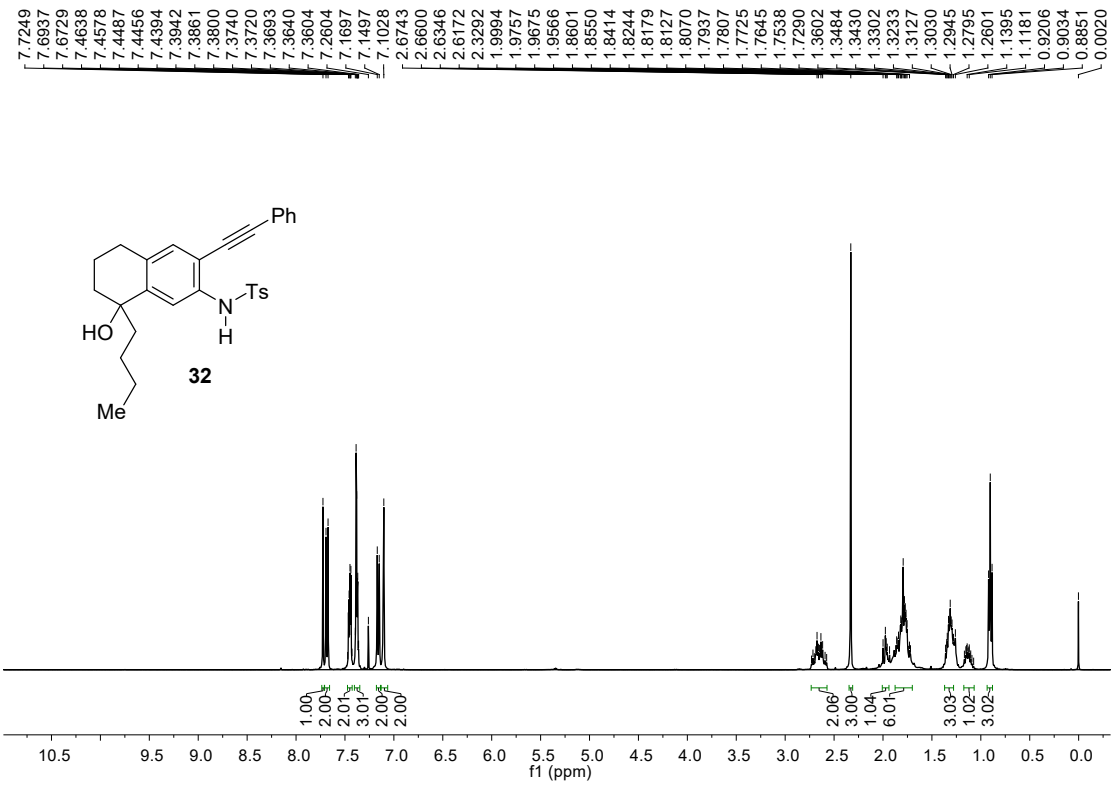
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1.8127
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1.7725
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H
HO
Me
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3.03
1.02
3.02
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8.0
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6.0
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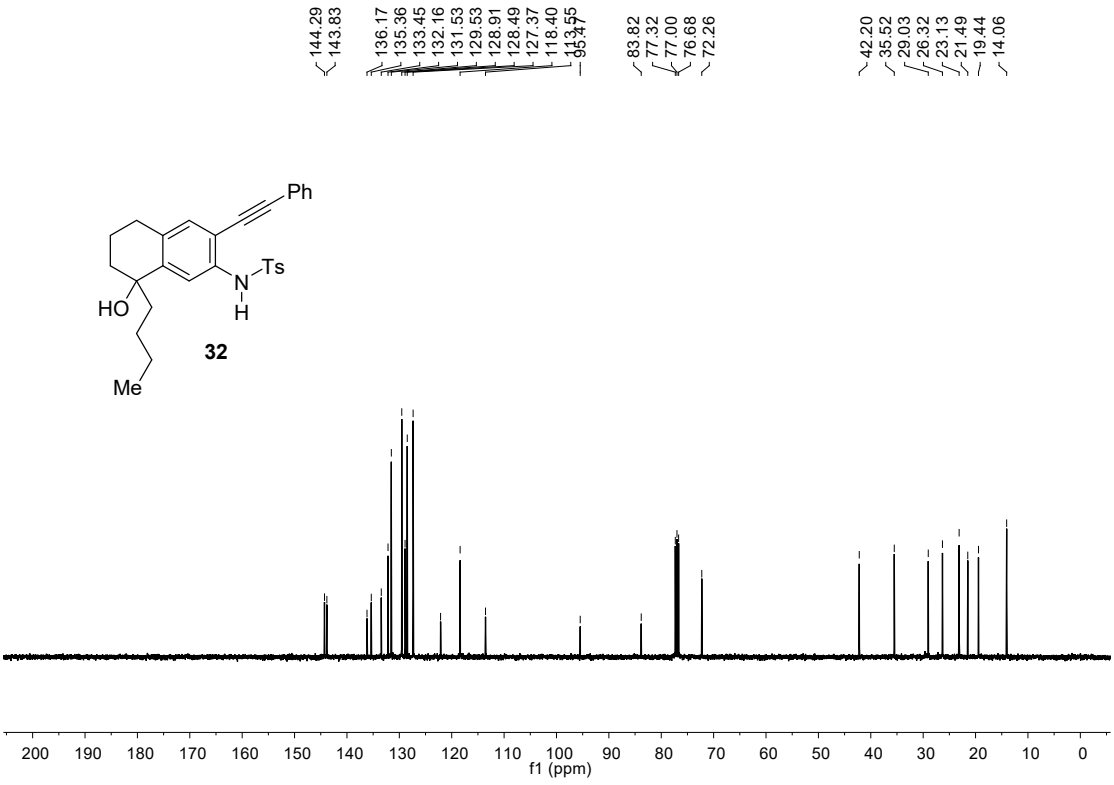
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77.00
76.68
72.26
42.20
35.52
29.03
26.32
23.13
21.49
19.44
14.06
Ph
Ts
N
H
HO
Me
32
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180
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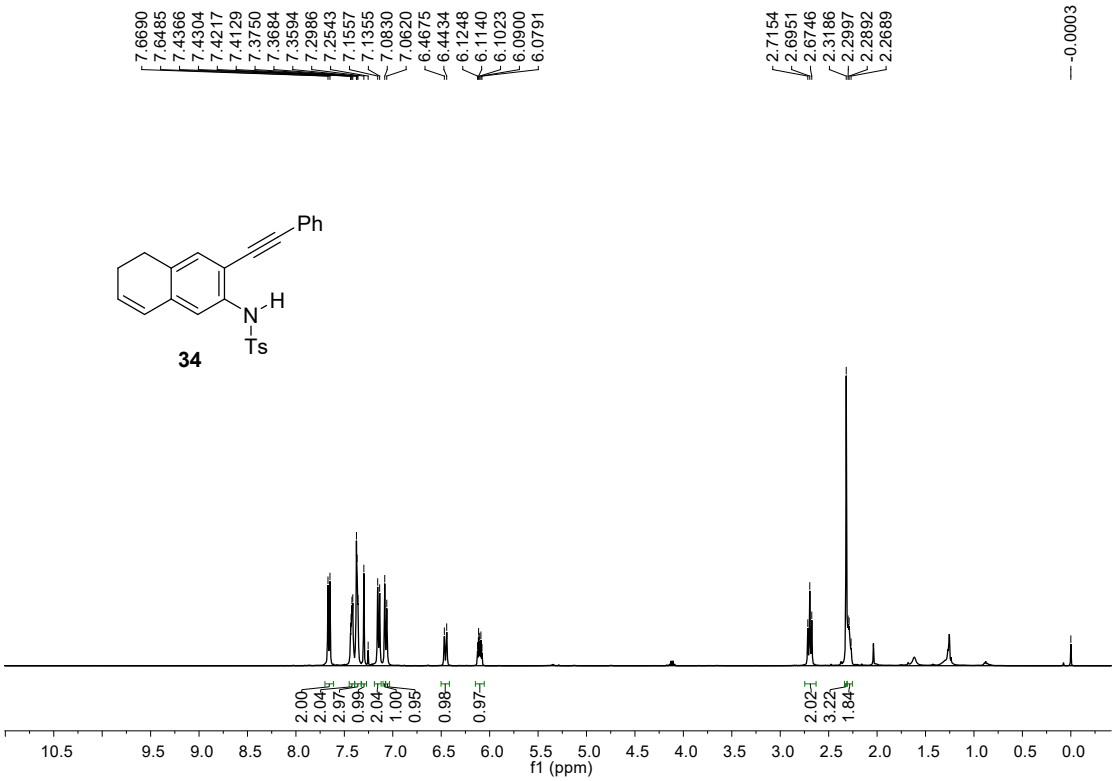
f1 (ppm)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7.0620
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6.4434
6.1248
6.1140
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6.0791
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H
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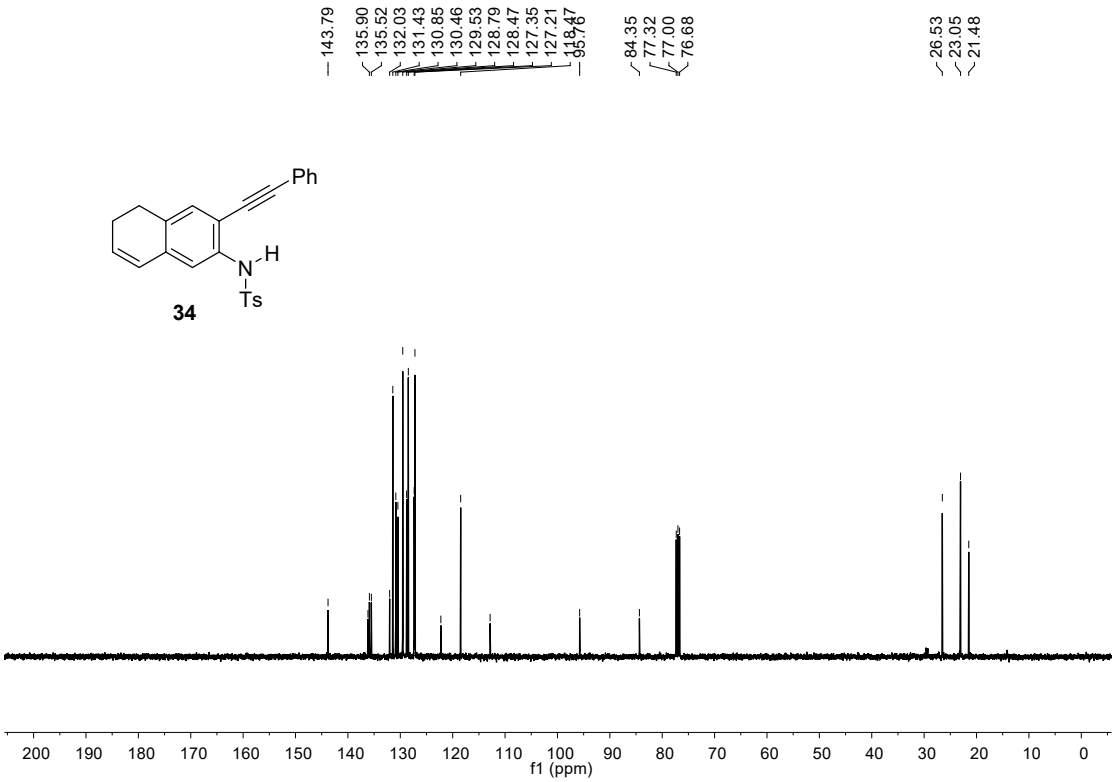
f1 (ppm)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127.21
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26.53
23.05
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Ph
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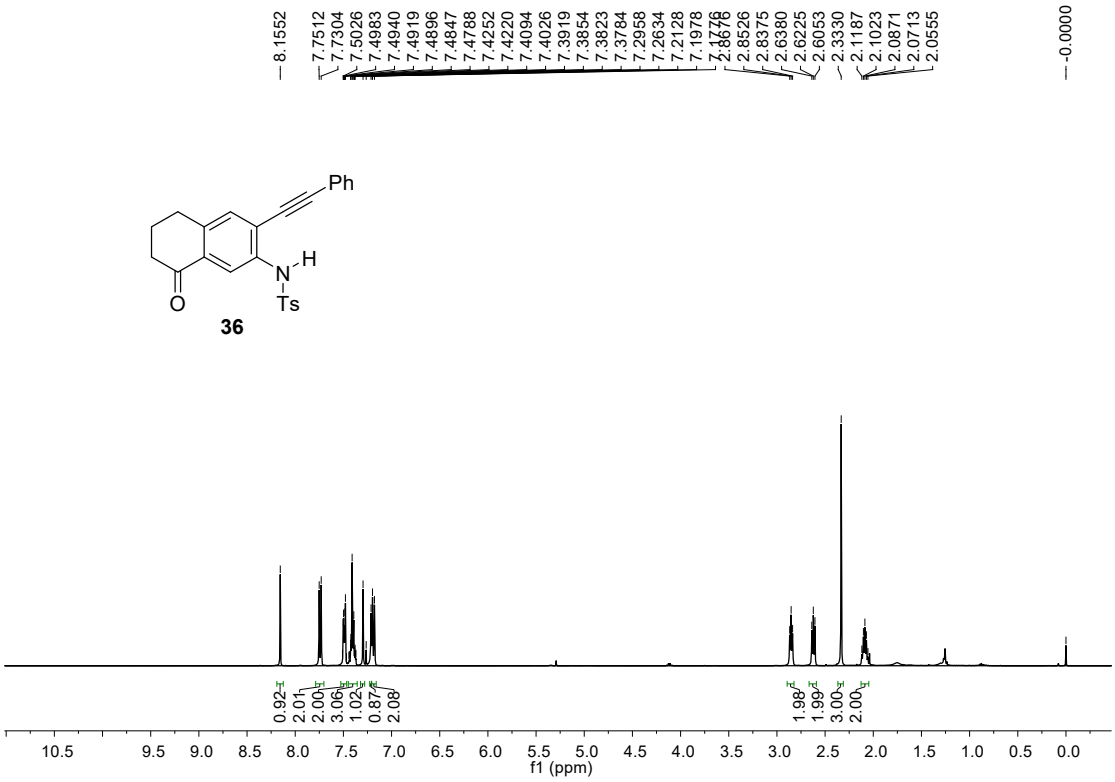
H
Ts
34
f1 (ppm)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7.2128
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Ph
N
H
Ts
O
36
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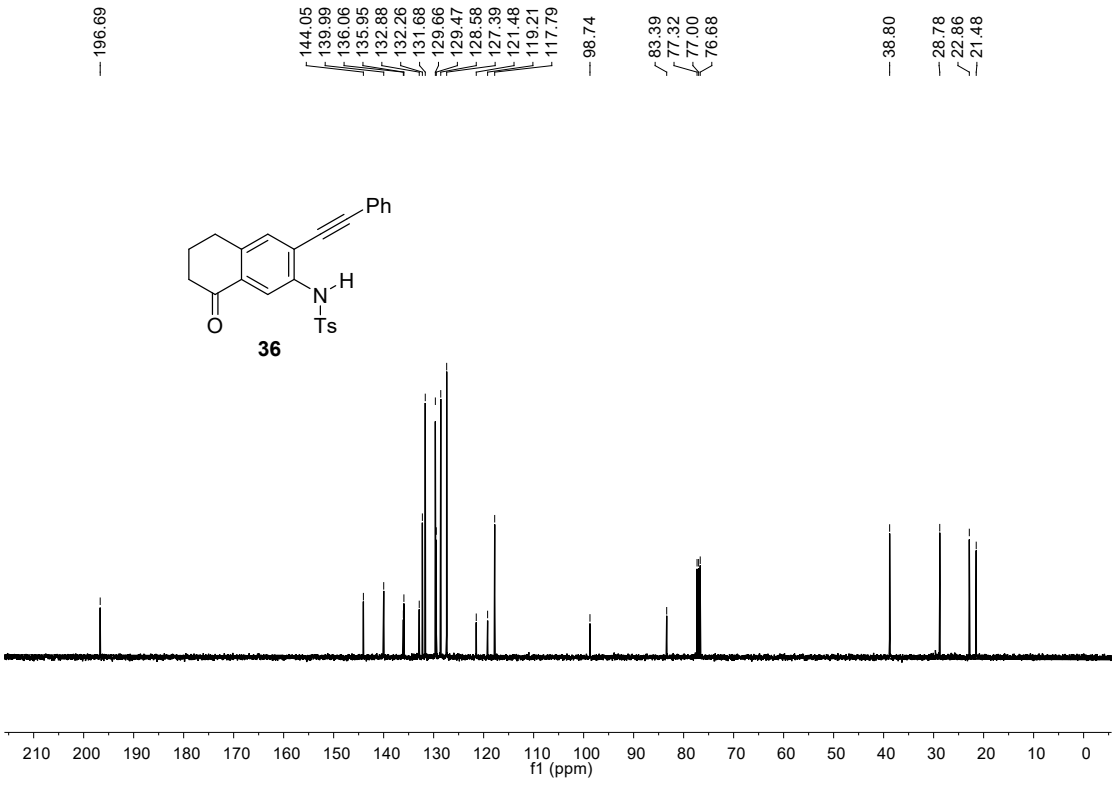
2.00
f1 (ppm)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117.79
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83.39
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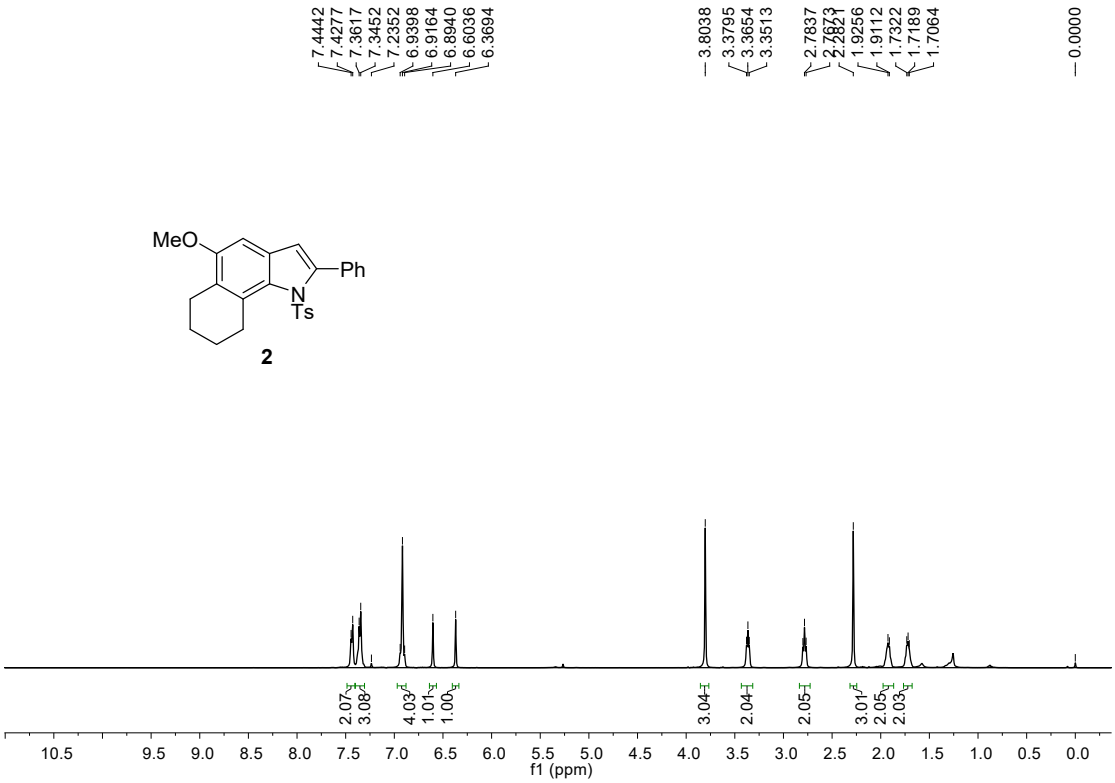
22.86
21.48
Ph
N
H
Ts
O
36
f1 (ppm)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MeO
Ph
N
Ts
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1.01
1.00
3.04
2.04
2.05
3.01
2.05
2.03
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8.0
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7.0
6.5
6.0
5.5
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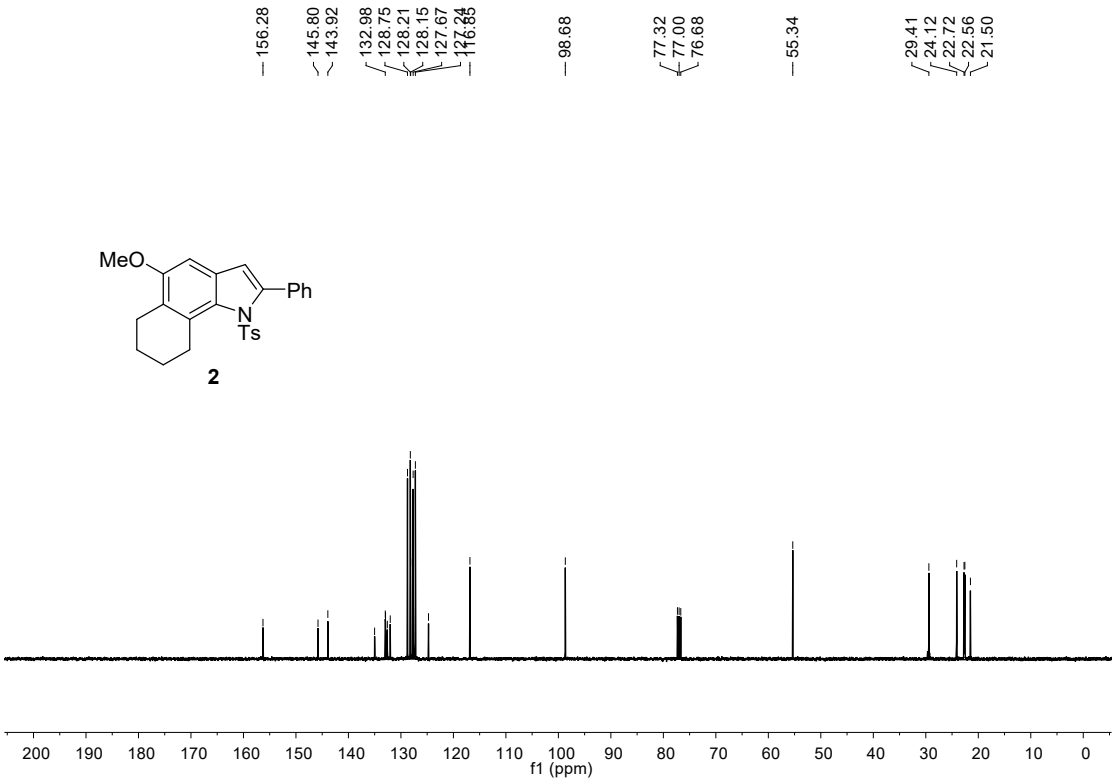
0.0
f1 (ppm)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24.12
22.72
22.56
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MeO
Ph
N
Ts
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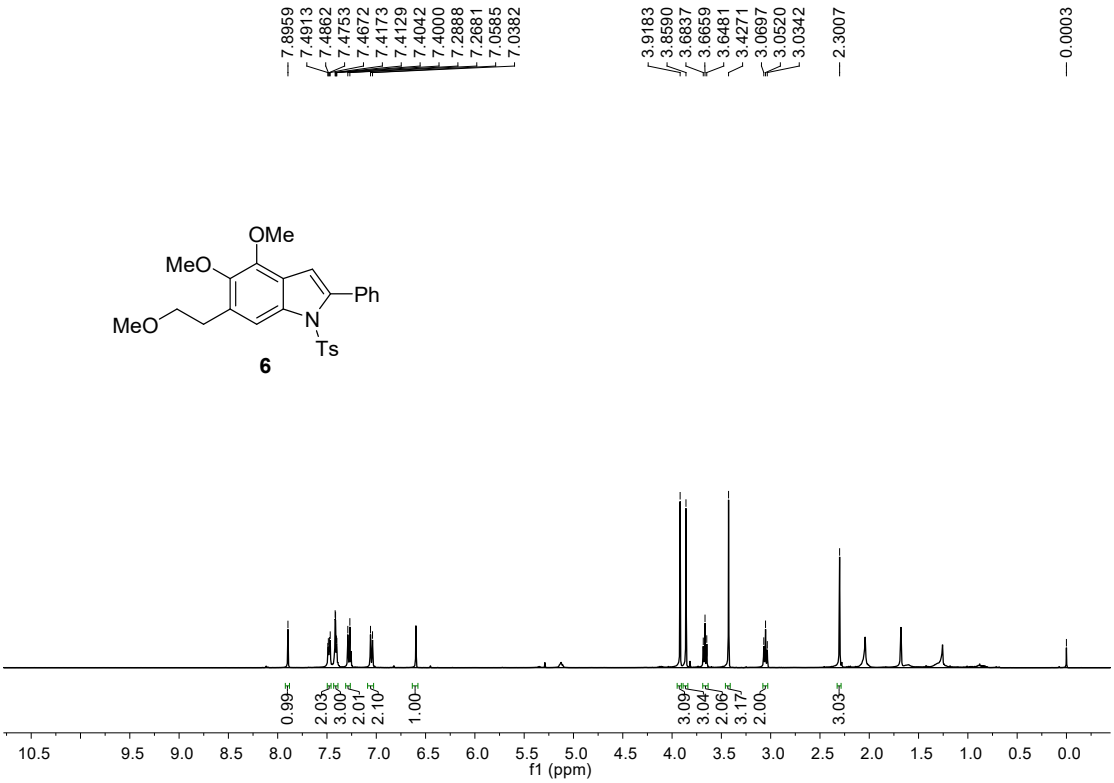
f1 (ppm)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OMe
MeO
Ph
MeO
N
Ts
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2.10
1.00
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2.06
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7.5
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6.5
6.0
5.5
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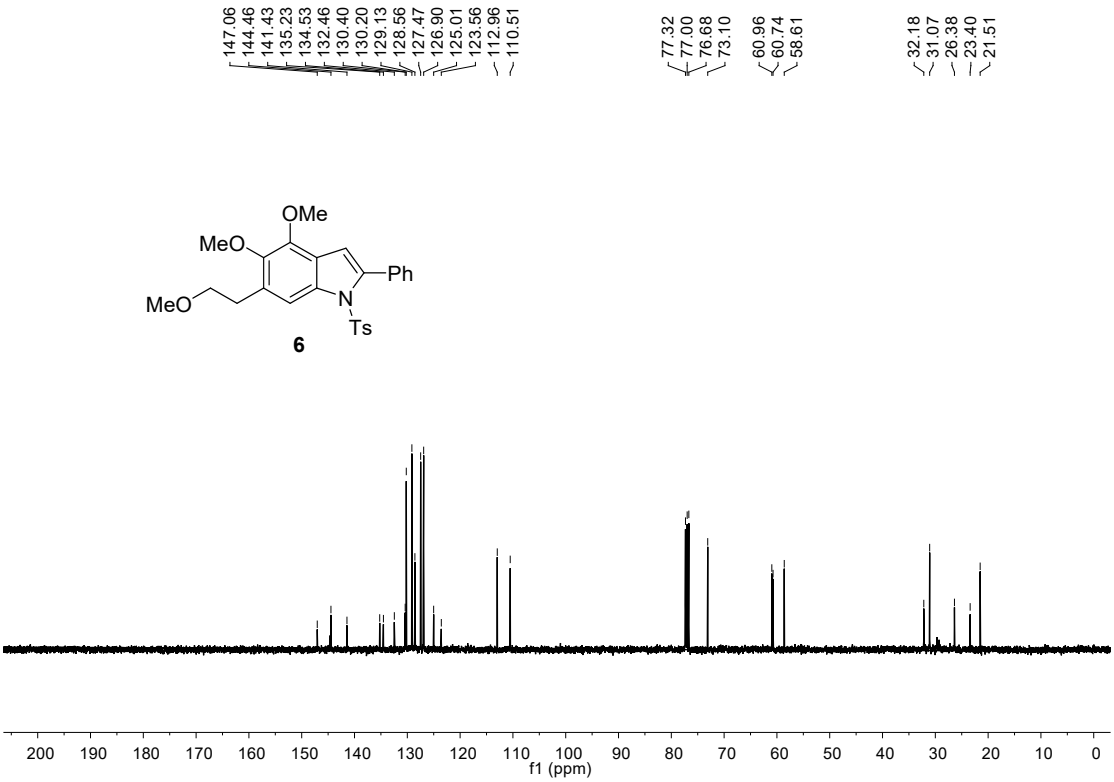
f1 (ppm)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23.40
21.51
OMe
MeO
Ph
MeO
N
Ts
6
200
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180
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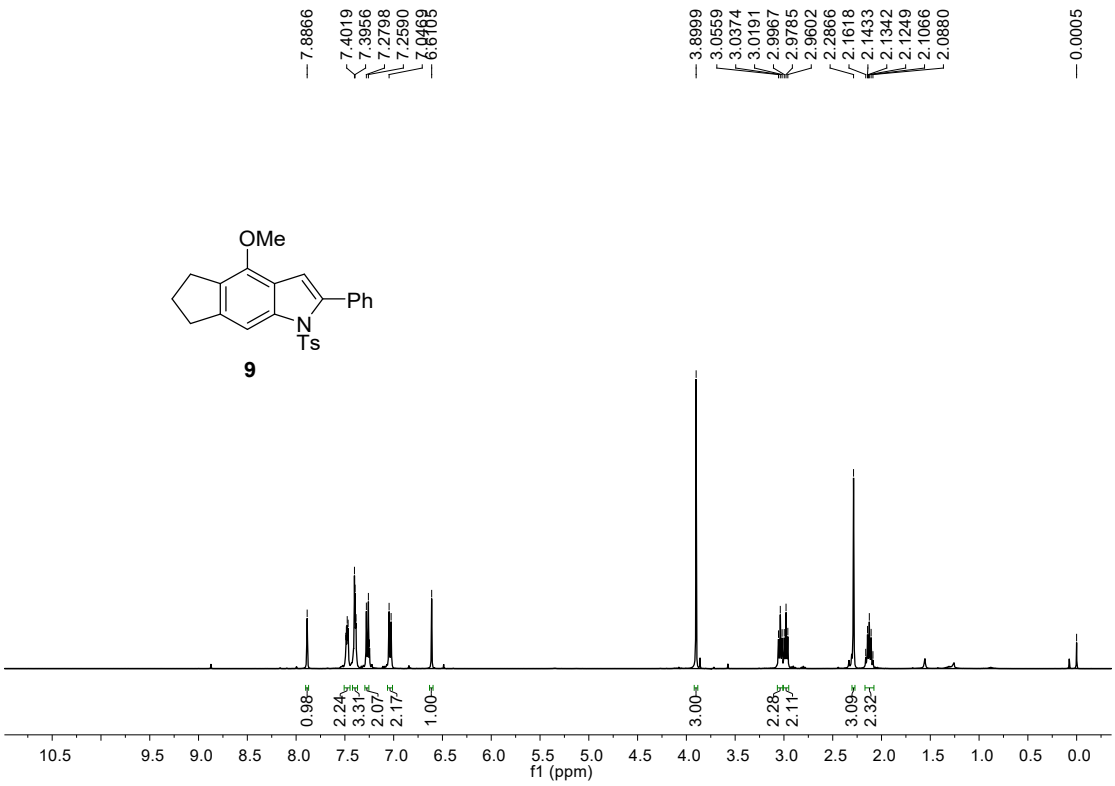
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Ph
N
Ts
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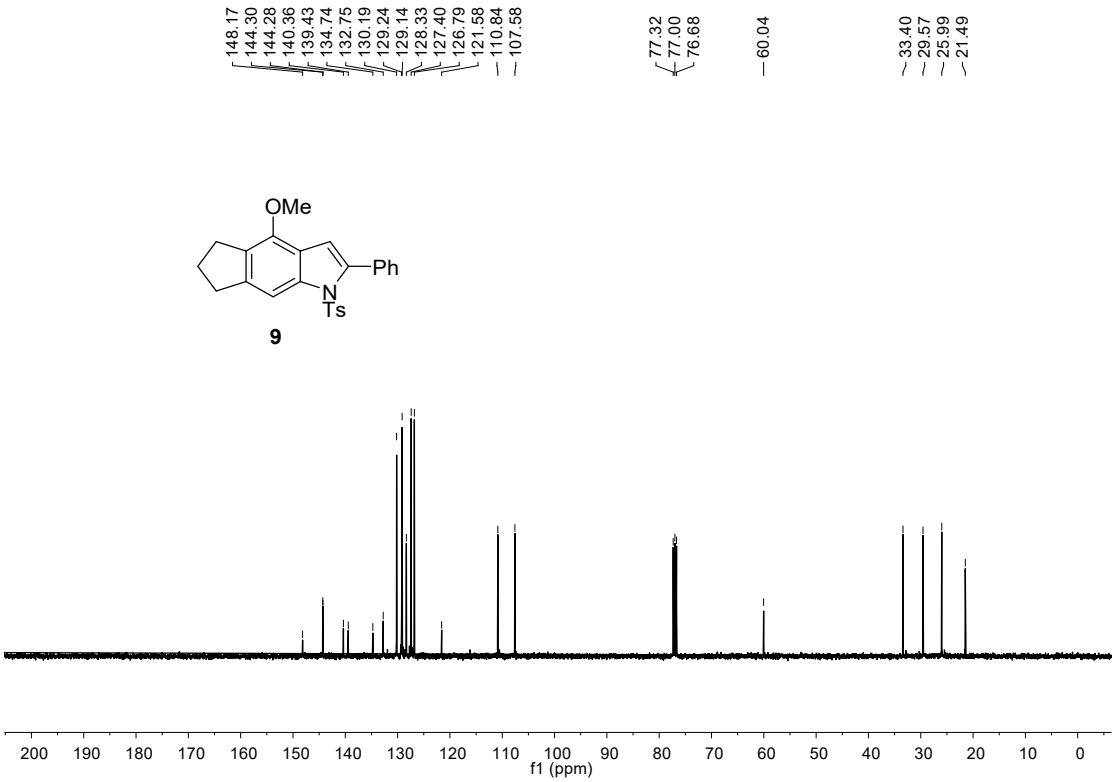
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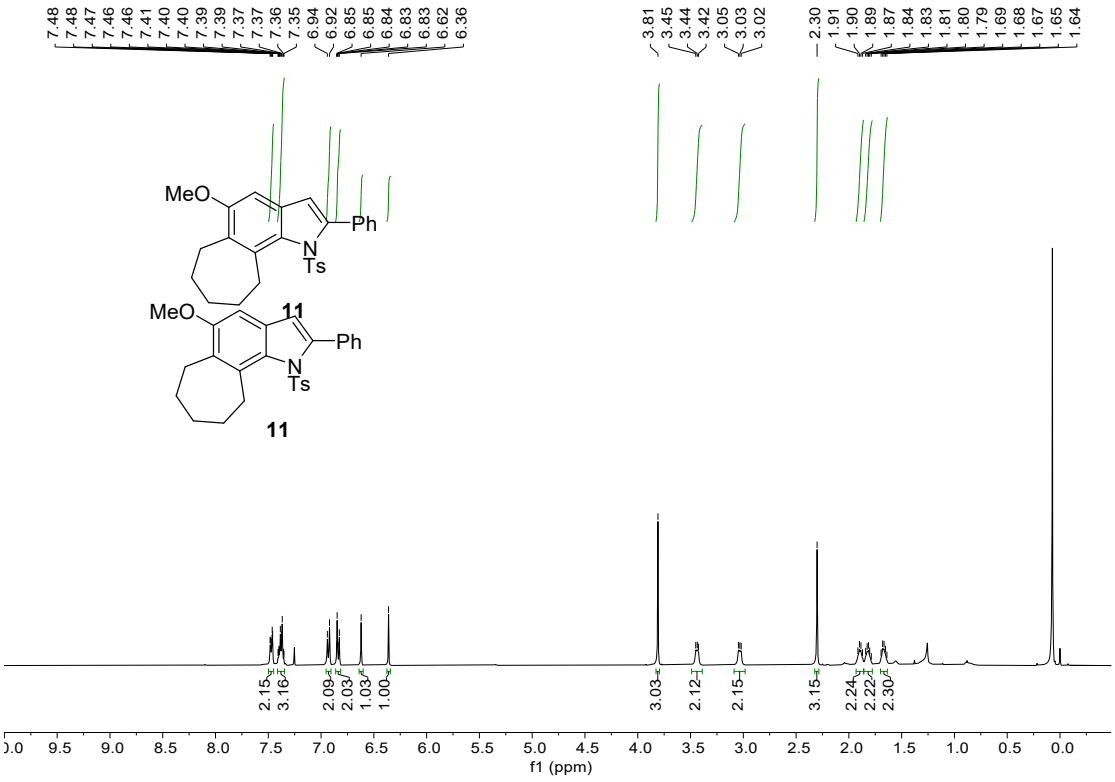
N
Ts
9
f1 (ppm)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6.36
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3.42
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3.03
3.02
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1.83
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1.68
1.67
1.65
1.64
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MeO
Ph
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Ts
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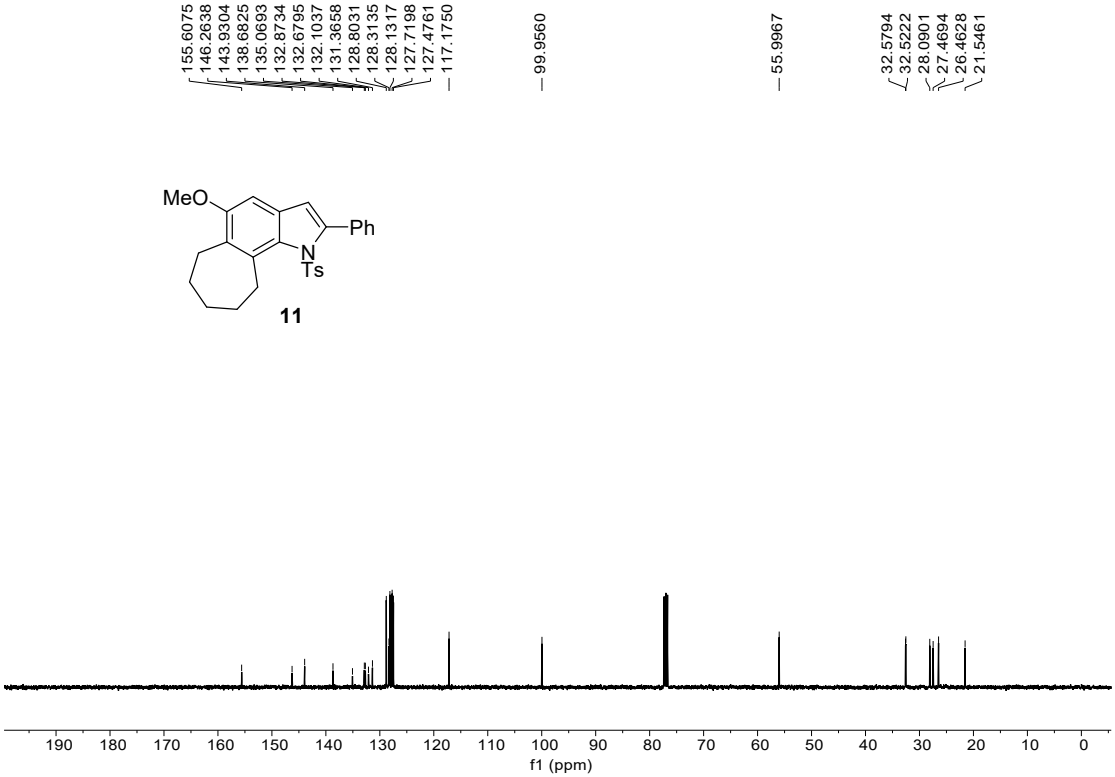
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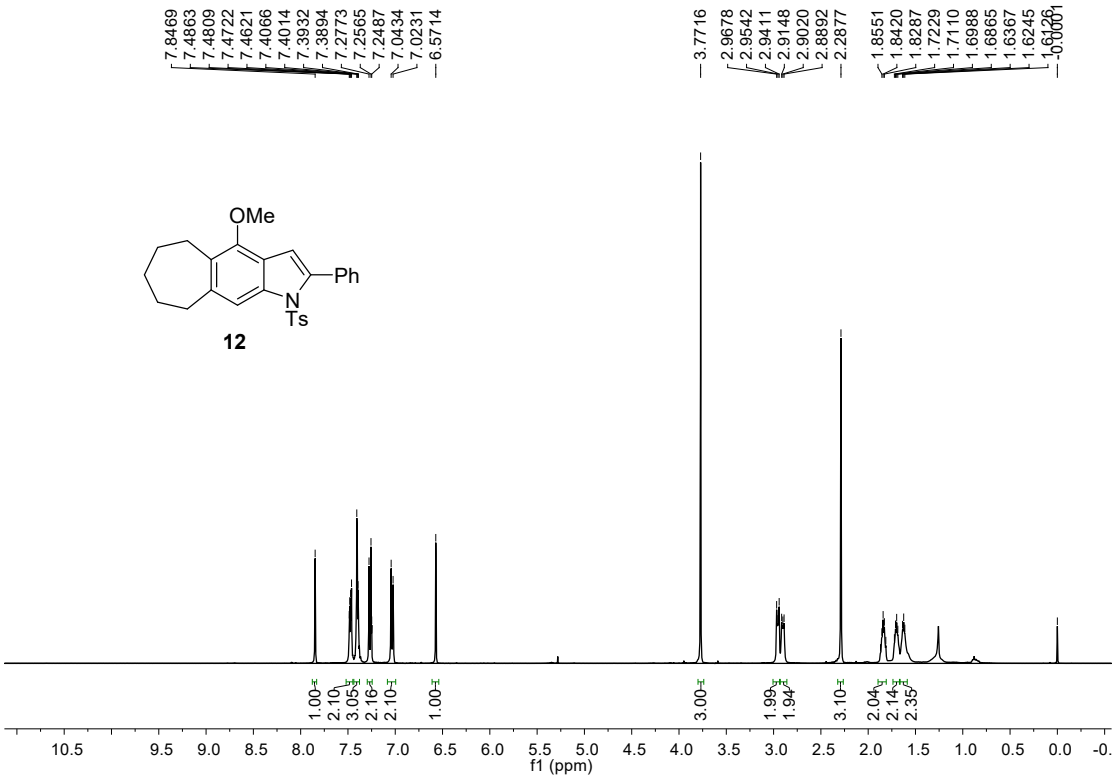
Ts
11
f1 (ppm)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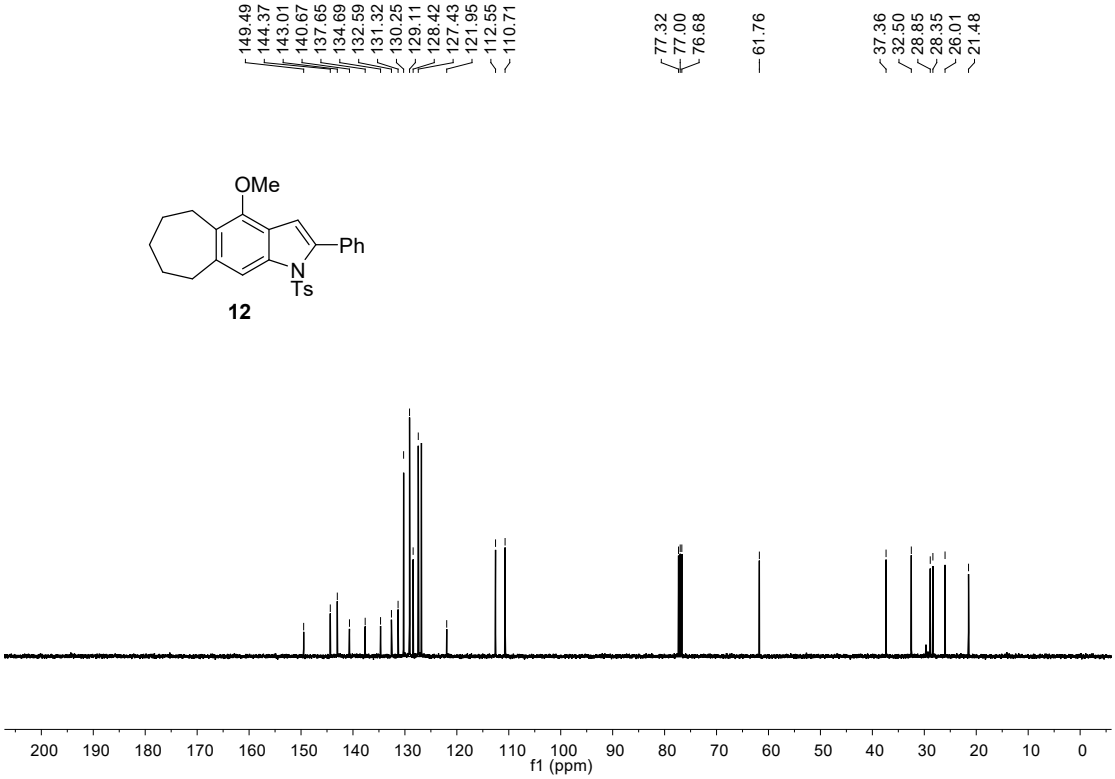
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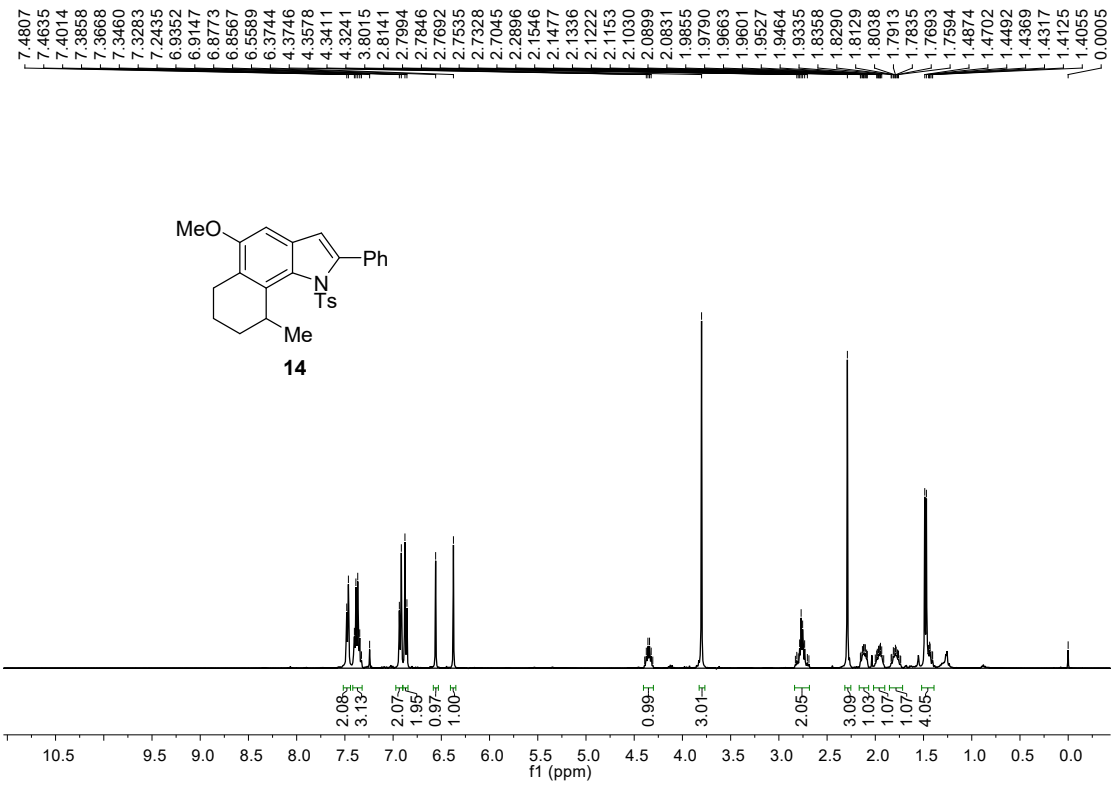
OMe
Ph
N
Ts
12
f1 (ppm)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Ts
Me
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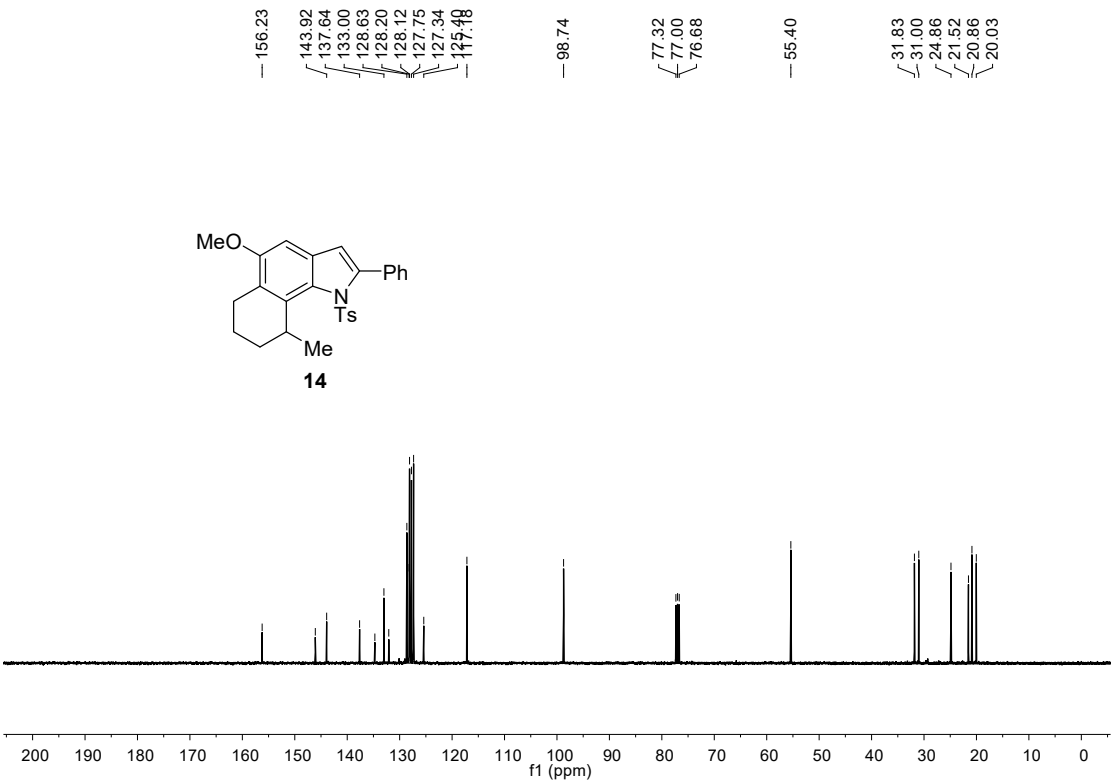
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55.40
31.83
31.00
24.86
21.52
20.86
20.03
MeO
Ph
N
Ts
Me
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200
190
180
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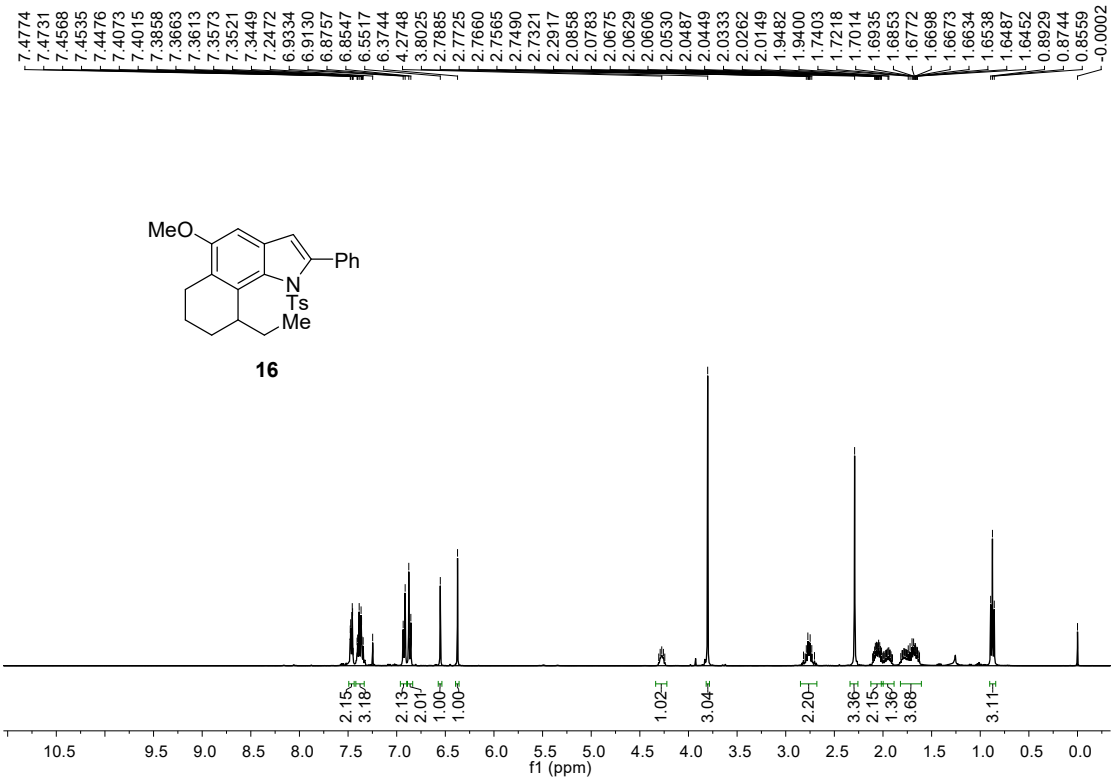
f1 (ppm)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6.5517
6.3744
4.2748
3.8025
2.7885
2.7725
2.7660
2.7565
2.7490
2.7321
2.2917
2.0858
2.0783
2.0675
2.0629
2.0606
2.0530
2.0487
2.0449
2.0333
2.0262
2.0149
1.9482
1.9400
1.7403
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1.7014
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1.6673
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1.6538
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0.8559
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MeO
Ph
N
Ts
Me
16
2.15
3.18
2.13
2.01
1.00
1.00
1.02
3.04
2.20
3.36
2.15
1.36
3.68
3.11
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
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3.0
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1.0
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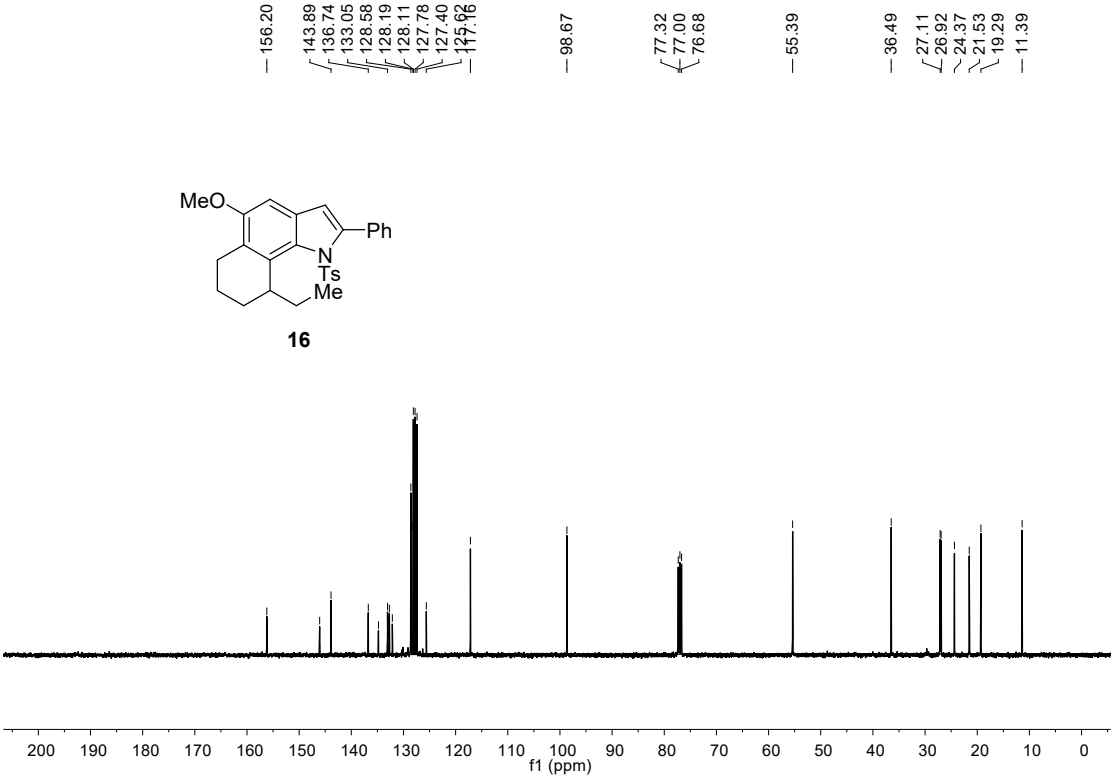
0.0
f1 (ppm)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128.19
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127.78
127.40
125.62
117.16
98.67
77.32
77.00
76.68
55.39
36.49
27.11
26.92
24.37
21.53
19.29
11.39
MeO
Ph
N
Ts
Me
16
200
190
180
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90
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10
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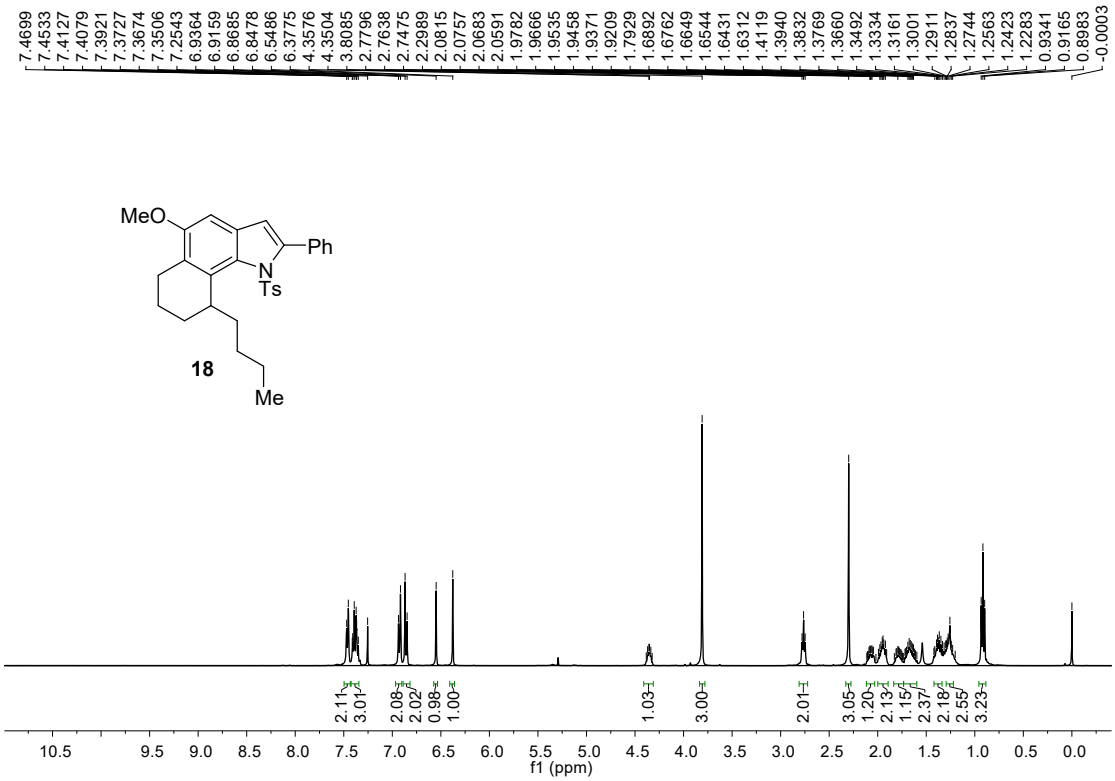
f1 (ppm)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6.8685
6.8478
6.5486
6.3775
4.3576
4.3504
3.8085
2.7796
2.7638
2.7475
2.2989
2.0815
2.0757
2.0683
2.0591
1.9782
1.9666
1.9535
1.9458
1.9371
1.9209
1.7929
1.6892
1.6762
1.6649
1.6544
1.6431
1.6312
1.4119
1.3940
1.3832
1.3769
1.3660
1.3492
1.3334
1.3161
1.3001
1.2911
1.2837
1.2744
1.2563
1.2423
1.2283
0.9341
0.9165
0.8983
-0.0003
MeO
Ph
N
Ts
18
Me
2.11
3.01
2.08
2.02
0.98
1.00
1.03
3.00
2.01
3.05
1.20
2.13
1.15
2.37
2.18
2.55
3.23
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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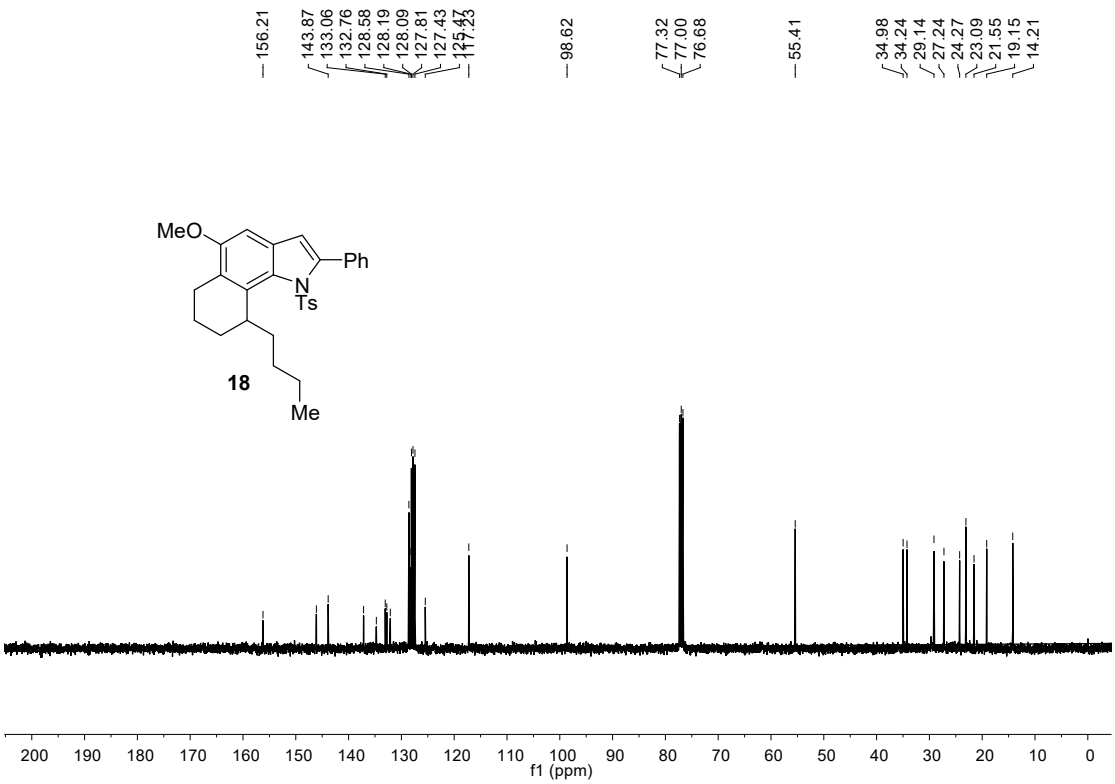
0.0
f1 (ppm)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128.19
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127.81
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125.47
117.23
98.62
77.32
77.00
76.68
55.41
34.98
34.24
29.14
27.24
24.27
23.09
21.55
19.15
14.21
MeO
Ph
N
Ts
18
Me
200
190
180
170
160
150
140
130
120
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90
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70
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50
40
30
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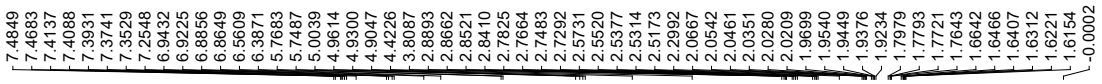
10
0
f1 (ppm)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7.4088
7.3931
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7.3529
7.2548
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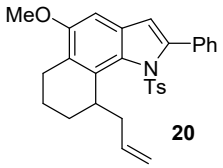
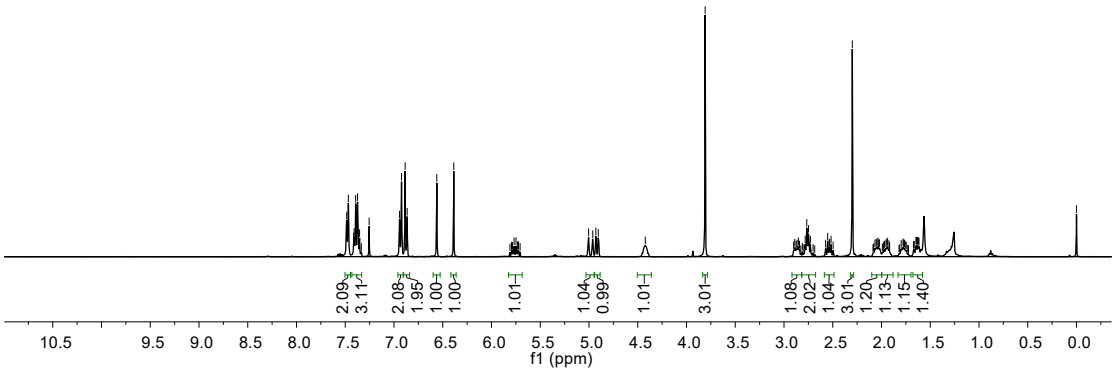
6.9225
6.8856
6.8649
6.5609
6.3871
5.7683
5.7487
5.0039
4.9614
4.9300
4.9047
4.4226
3.8087
2.8893
2.8662
2.8521
2.8410
2.7825
2.7664
2.7483
2.7292
2.5731
2.5520
2.5377
2.5314
2.5173
2.2992
2.0667
2.0542
2.0461
2.0351
2.0280
2.0209
1.9699
1.9540
1.9449
1.9376
1.9234
1.7979
1.7793
1.7721
1.7643
1.6642
1.6466
1.6407
1.6312
1.6221
1.6154
-0.0002


MeO
Ph
N
Ts

20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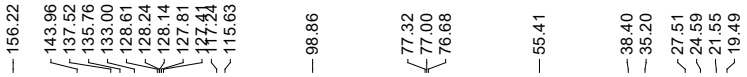
3.11
2.08
1.95
1.00
1.00
1.01
1.04
0.99
1.01
3.01
1.08
2.02
1.04
3.01
1.20
1.13
1.15
1.40
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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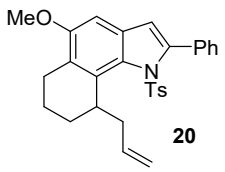
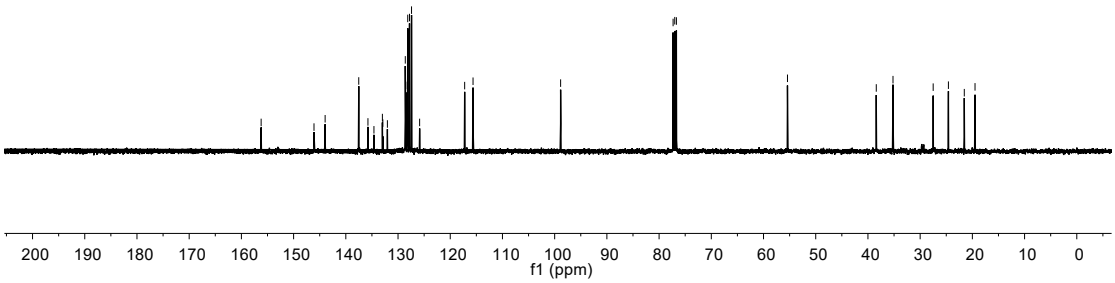
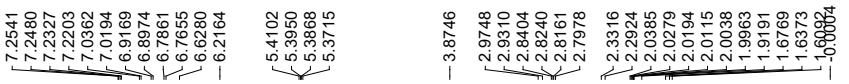
143.96
137.52
135.76
133.00
128.61
128.24
128.14
127.81
127.41
127.24
115.63
98.86
77.32
77.00
76.68
55.41
38.40
35.20
27.51
24.59
21.55
19.49


MeO
Ph
N
Ts

20


200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.2480
7.2327
7.2203
7.0362
7.0194
6.9169
6.8974
6.7861
6.7655
6.6280
6.2164
5.4102
5.3950
5.3868
5.3715
3.8746
2.9748
2.9310
2.8404
2.8240
2.8161
2.7978
2.3316
2.2924
2.0385
2.0279
2.0194
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1.6769
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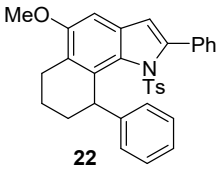
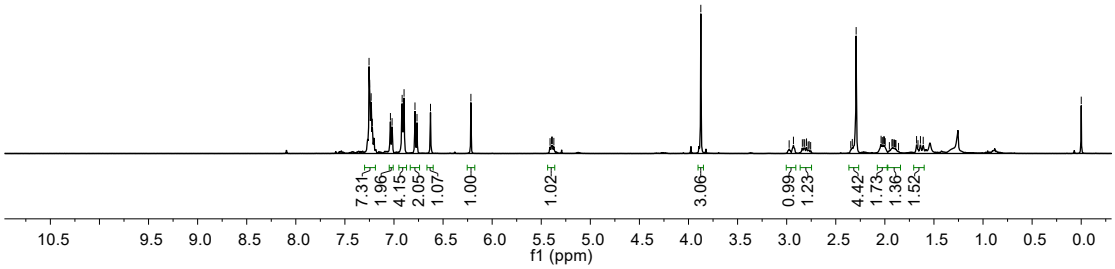
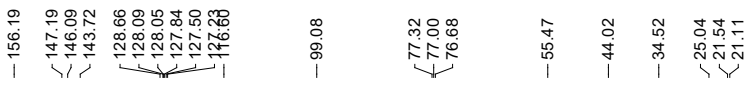
1.6092
-0.0004


MeO
Ph
N
Ts

22


7.31
1.96
4.15
2.05
1.07
1.00
1.02
3.06
0.99
1.23
4.42
1.73
1.36
1.52
10.5
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)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147.19
146.09
143.72
128.66
128.09
128.05
127.84
127.50
99.08
77.32
77.00
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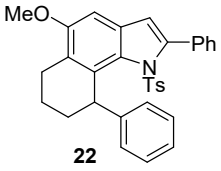
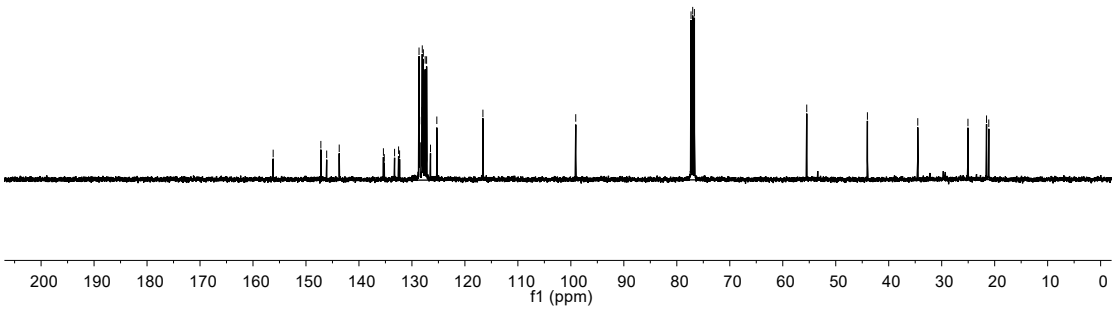
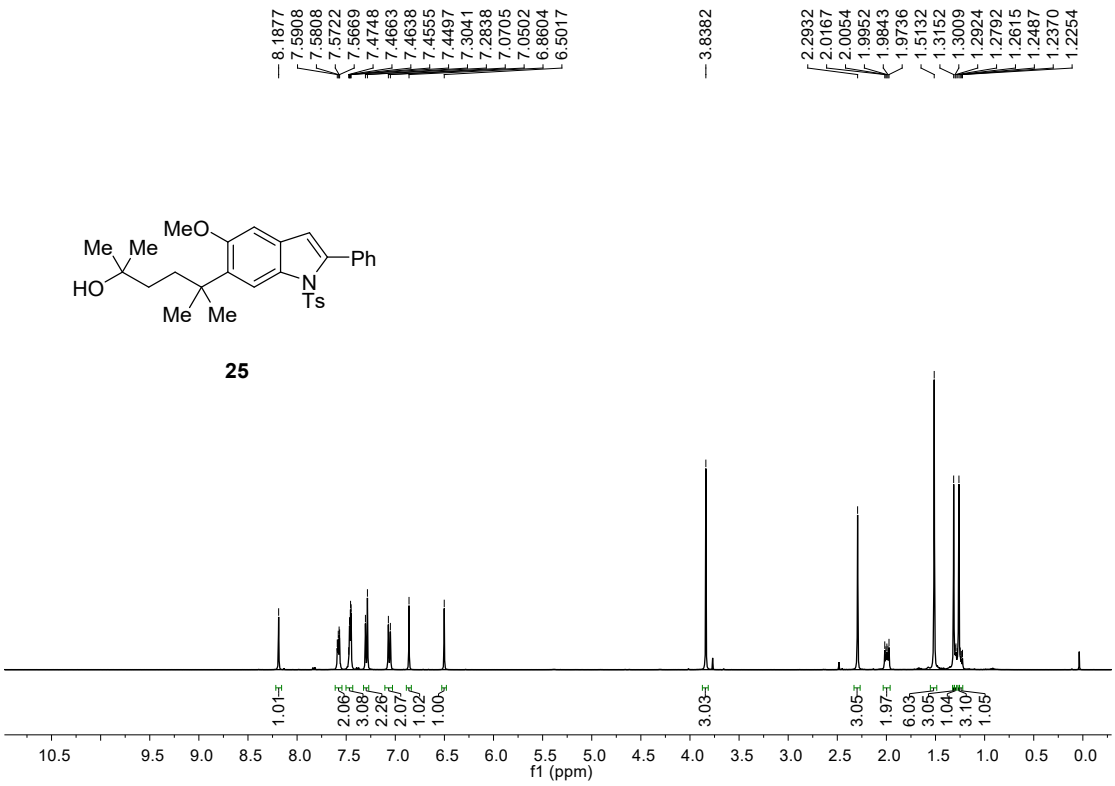
55.47
44.02
34.52
25.04
21.54
21.11


MeO
Ph
N
Ts

22


200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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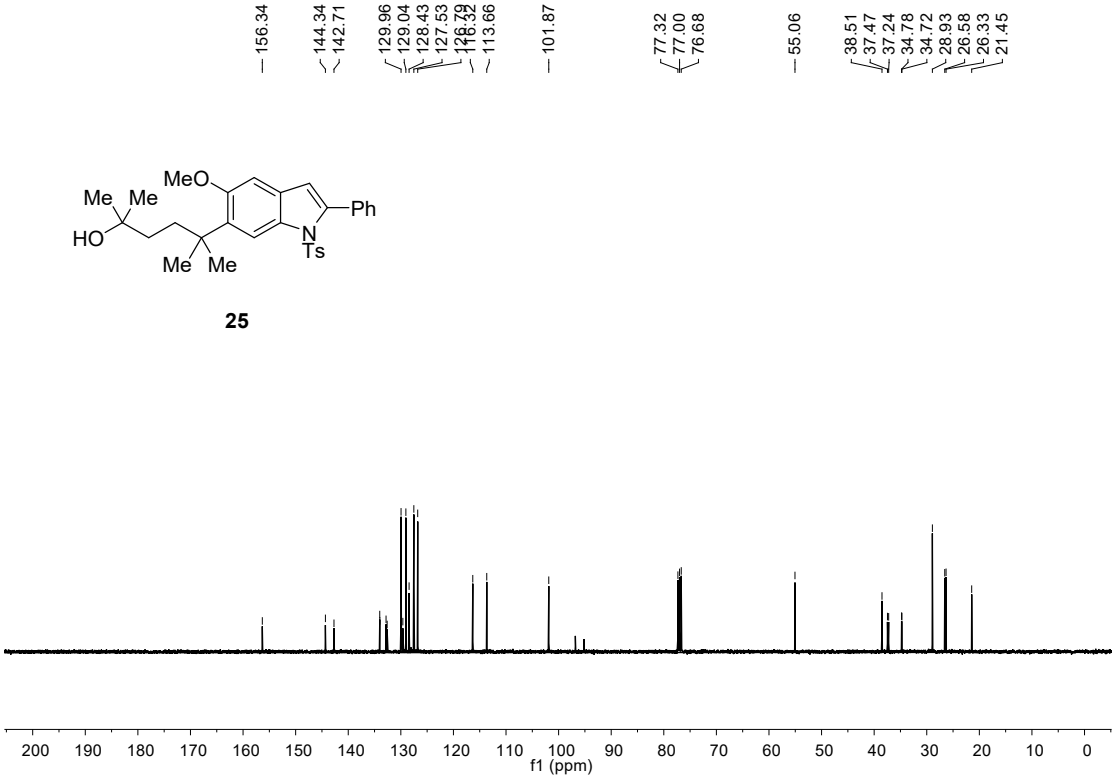
7.5669
7.4748
7.4663
7.4638
7.4555
7.4497
7.3041
7.2838
7.0705
7.0502
6.8604
6.5017
3.8382
2.2932
2.0167
2.0054
1.9952
1.9843
1.9736
1.5132
1.3152
1.3009
1.2924
1.2792
1.2615
1.2487
1.2370
1.2254
MeO
Me Me
HO
Ph
N
Ts
Me Me
1.01
2.06
3.08
2.20
2.07
1.02
1.00
3.03
3.05
1.97
6.03
3.05
1.04
3.10
1.05
10.5 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)

25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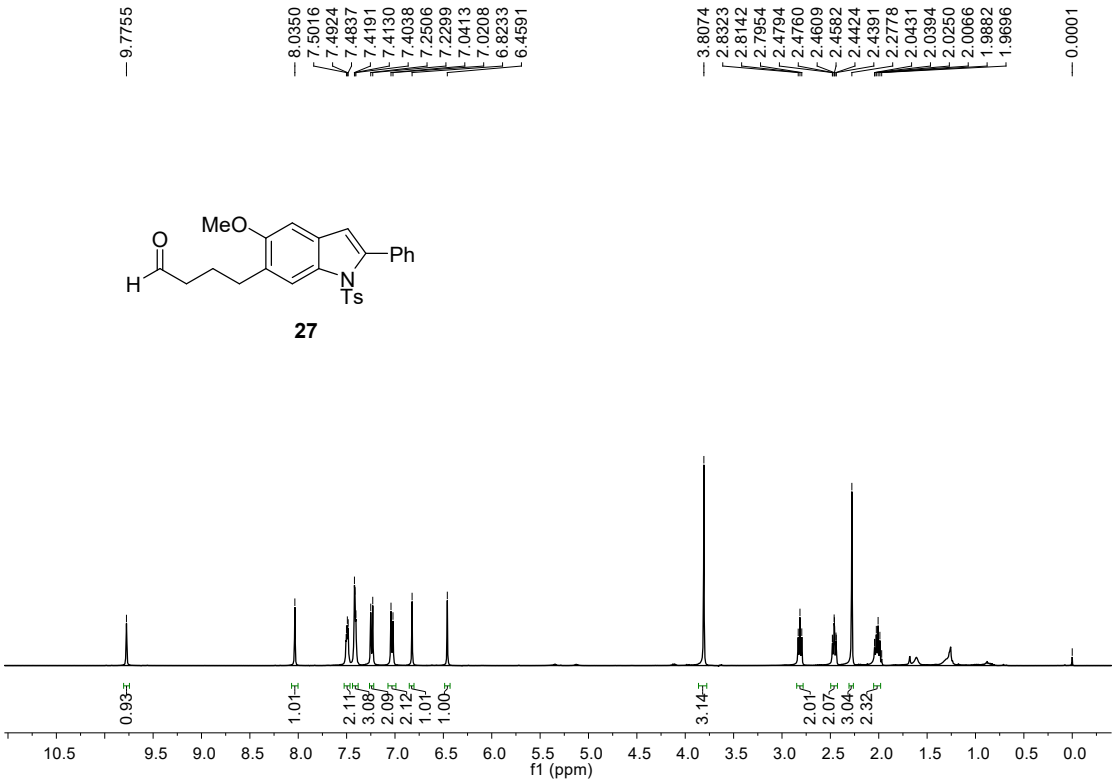
144.34
142.71
129.96
129.04
128.43
127.53
126.79
116.32
113.66
101.87
77.32
77.00
76.68
55.06
38.51
37.47
37.24
34.78
34.72
28.93
26.58
26.33
21.45
MeO
Me Me
HO
Ph
N
Ts
Me Me
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

25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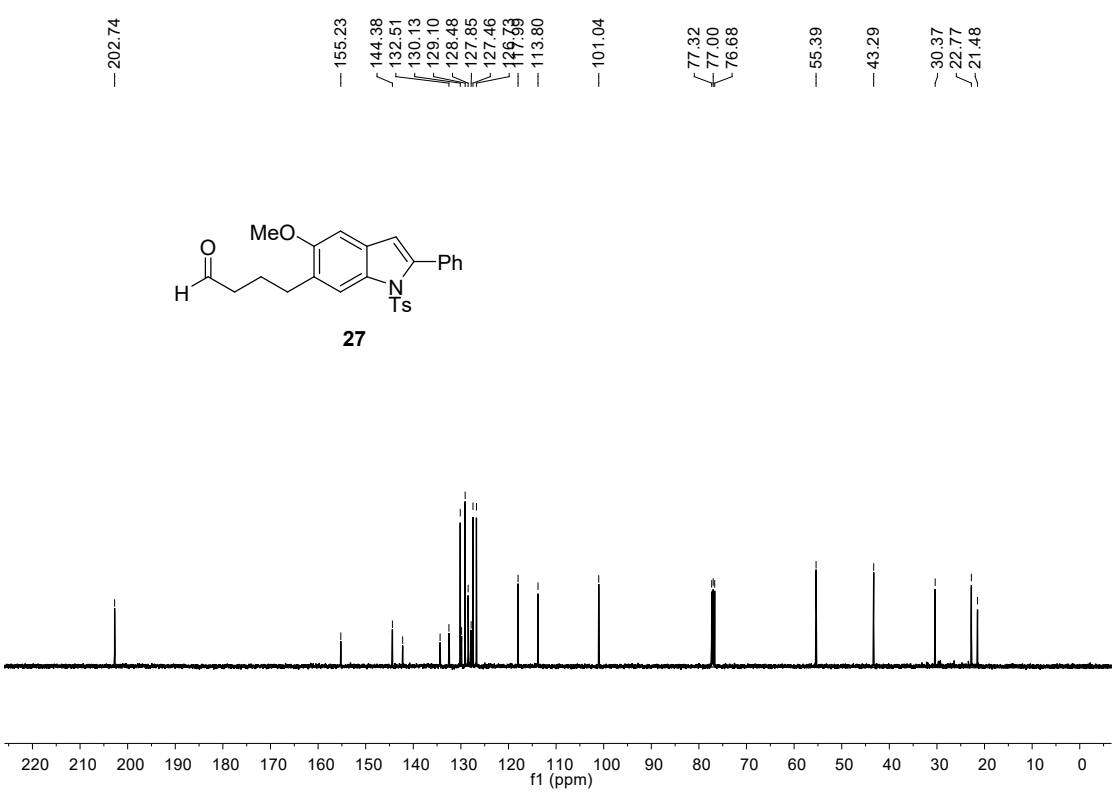
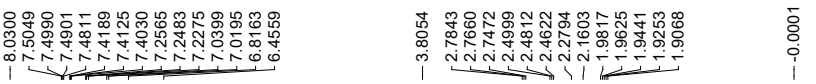
7.4924
7.4837
7.4191
7.4130
7.4038
7.2506
7.2299
7.0413
7.0208
6.8233
6.4591
3.8074
2.8323
2.8142
2.7954
2.4794
2.4760
2.4609
2.4582
2.4424
2.4391
2.2778
2.0431
2.0394
2.0250
2.0066
1.9882
1.9696
0.0001
MeO
O
H
Ph
N
Ts
0.93
1.01
2.11
3.08
2.09
2.12
1.01
1.00
3.14
2.01
2.07
3.04
2.32
f1 (ppm)

27


202.74
155.23
144.38
132.51
130.13
129.10
128.48
127.85
127.46
113.80
101.04
77.32
77.00
76.68
55.39
43.29
30.37
22.77
21.48
MeO
O
H
Ph
N
Ts
f1 (ppm)

27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7.4990
7.4901
7.4811
7.4189
7.4125
7.4030
7.2565
7.2483
7.2275
7.0399
7.0195
6.8163
6.4559
3.8054
2.7843
2.7660
2.7472
2.4999
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2.2794
2.1603
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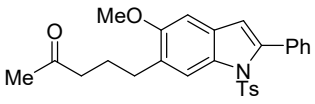
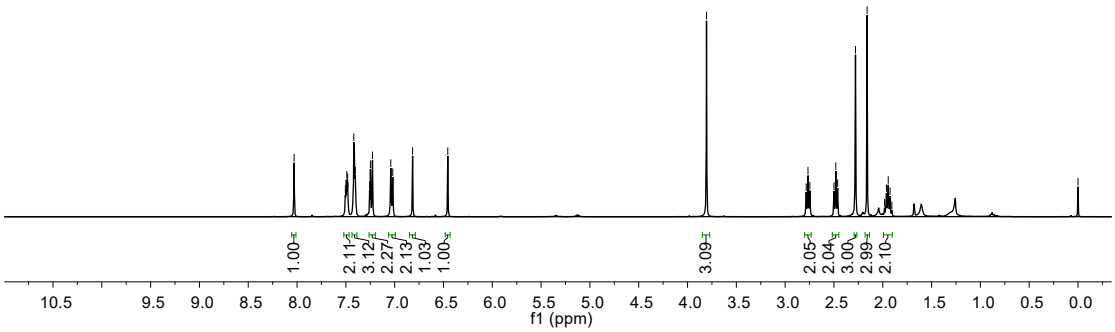
1.9625
1.9441
1.9253
1.9068
-0.0001


MeO
O
Me
Ph
N
Ts

29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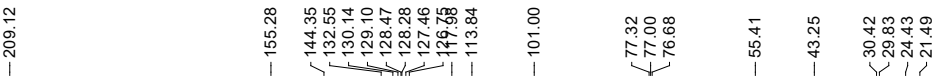
2.11
3.12
2.27
2.13
1.03
1.00
3.09
2.05
2.04
3.00
2.99
2.10
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


209.12
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129.10
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128.28
127.46
126.75
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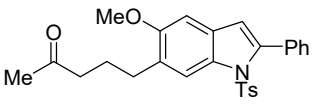
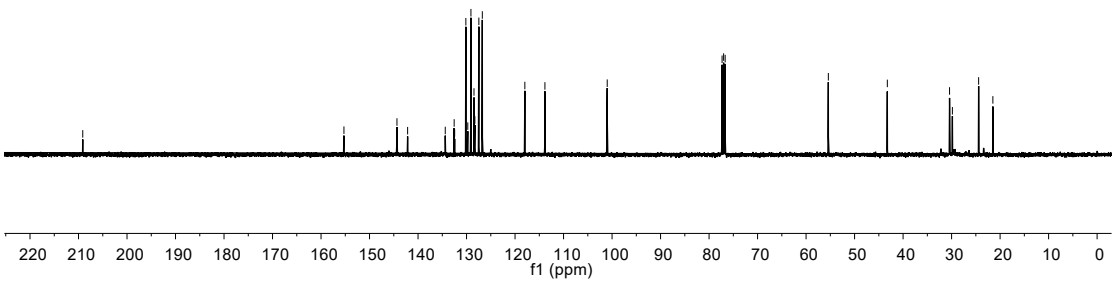
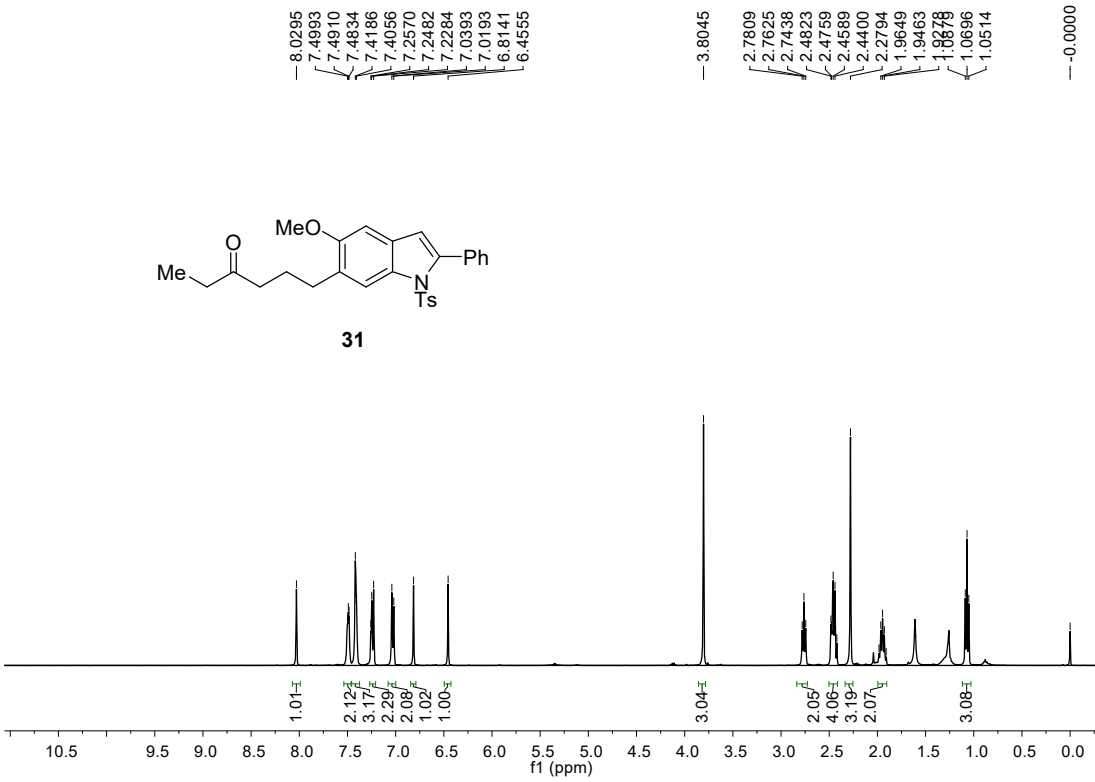
77.00
76.68
55.41
43.25
30.42
29.83
24.43
21.49


MeO
O
Me
Ph
N
Ts

29


220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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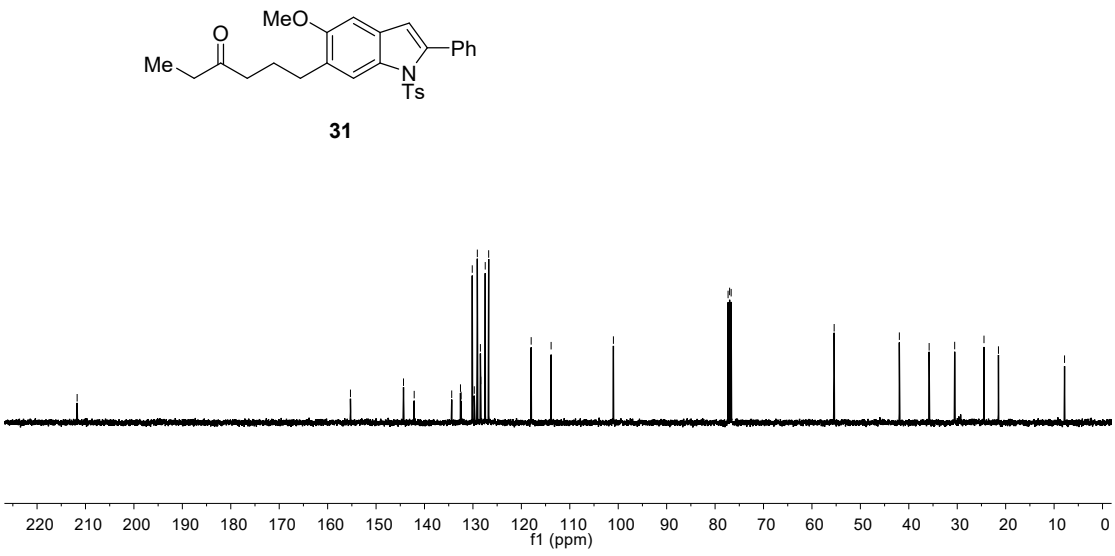
7.4910
7.4834
7.4186
7.4056
7.2570
7.2482
7.2284
7.0393
7.0193
6.8141
6.4555
3.8045
2.7809
2.7625
2.7438
2.4823
2.4759
2.4589
2.4400
2.2794
1.9649
1.9463
1.0696
1.0514
-0.0000
MeO
O
Me
Ph
N
Ts
1.01
2.12
3.17
2.29
2.08
1.02
1.00
3.04
2.05
4.06
3.19
2.07
3.08
f1 (ppm)

31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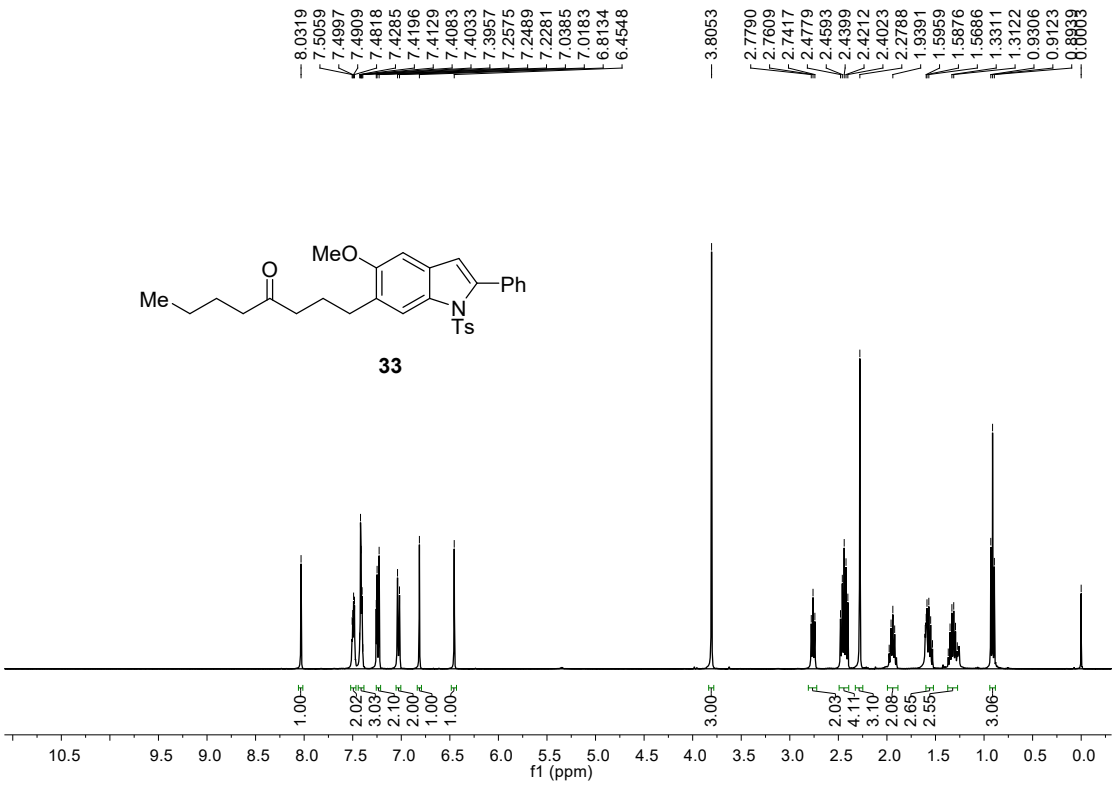
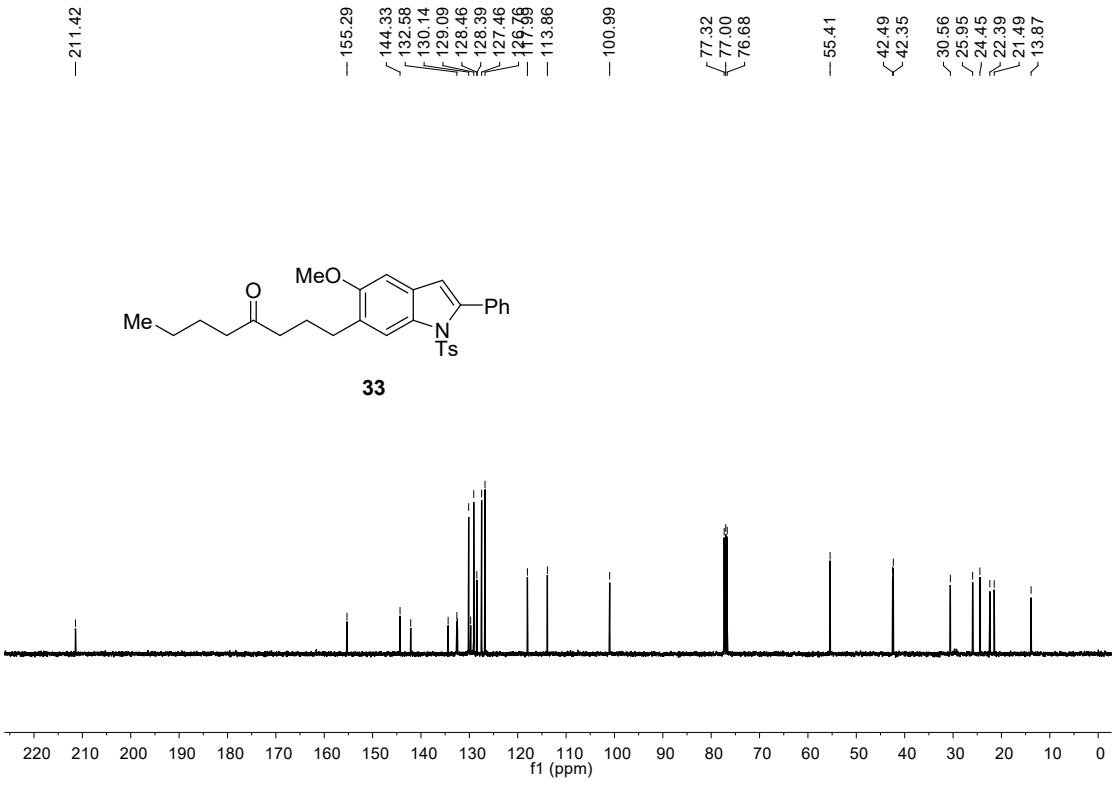
132.57
130.14
129.09
128.46
128.38
127.46
113.86
100.99
77.32
77.00
76.68
55.41
41.95
35.80
30.53
24.48
21.49
7.84
MeO
O
Me
Ph
N
Ts
f1 (ppm)

31


8.0319
7.5059
7.4997
7.4909
7.4818
7.4285
7.4196
7.4129
7.4083
7.4033
7.3957
7.2575
7.2489
7.2281
7.0385
7.0183
6.8134
6.4548
3.8053
2.7790
2.7609
2.7417
2.4779
2.4593
2.4399
2.4212
2.4023
2.2788
1.9391
1.5959
1.5876
1.5686
1.3311
1.3122
0.9306
0.9123
MeO
O
Me
Ph
N
Ts
1.00
2.02
3.03
2.10
2.00
1.00
1.00
3.00
2.03
4.11
3.10
2.08
2.65
2.55
3.06
10.5
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)

33


211.42
155.29
144.33
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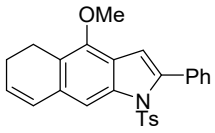
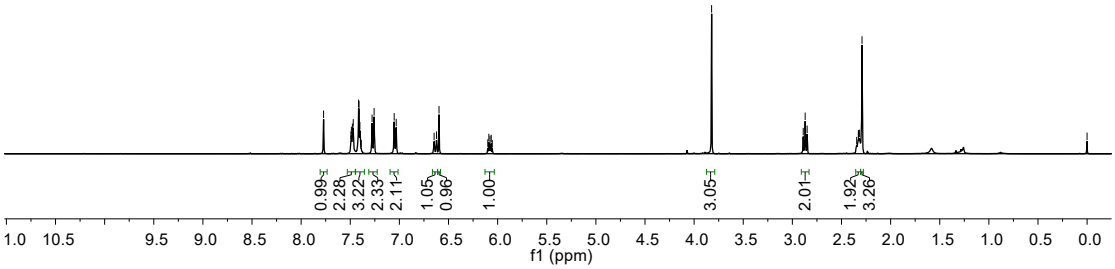
130.14
129.09
128.46
128.39
127.46
126.76
113.86
100.99
77.32
77.00
76.68
55.41
42.49
42.35
30.56
25.95
24.45
22.39
21.49
13.87
MeO
O
Me
Ph
N
Ts
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

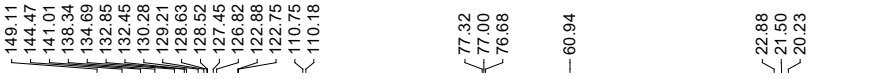
33


7.7716
7.4932
7.4884
7.4783
7.4696
7.4151
7.4110
7.4019
7.3879
7.2779
7.2572
7.0528
7.0324
6.6224
6.5966
6.1002
6.0893
6.0774
6.0653
6.0544
3.8220
2.8897
2.8697
2.8495
2.3454
2.3286
2.3253
2.3180
2.2909
0.0004


OMe
Ph
N
Ts

35


0.99
2.28
3.22
2.33
2.11
1.05
0.96
1.00
3.05
2.01
1.92
3.26
1.0 10.5 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)


149.11
144.47
141.01
138.34
134.69
132.85
132.45
130.28
129.21
128.63
128.52
127.45
126.82
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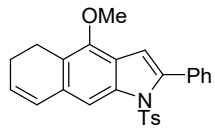
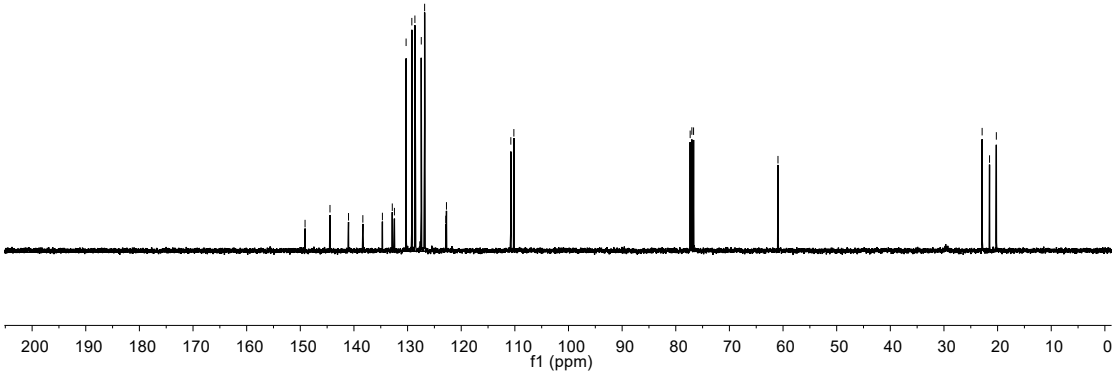
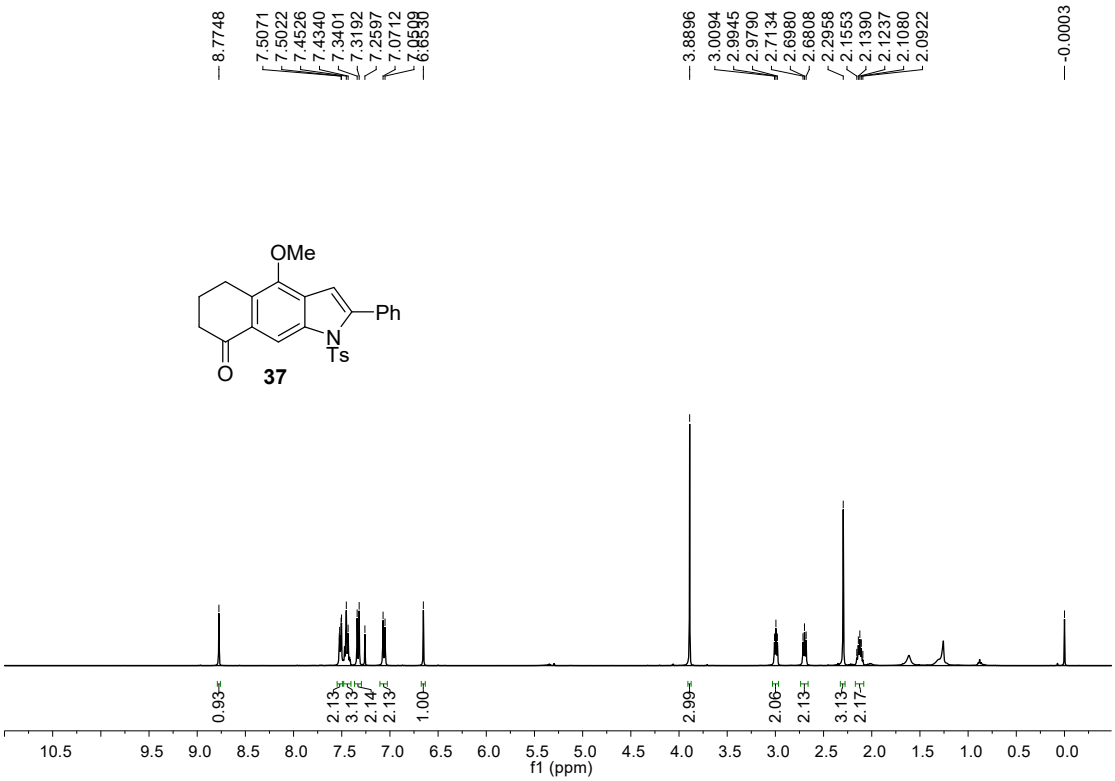
122.75
110.75
110.18
77.32
77.00
76.68
60.94
22.88
21.50
20.23


OMe
Ph
N
Ts

35


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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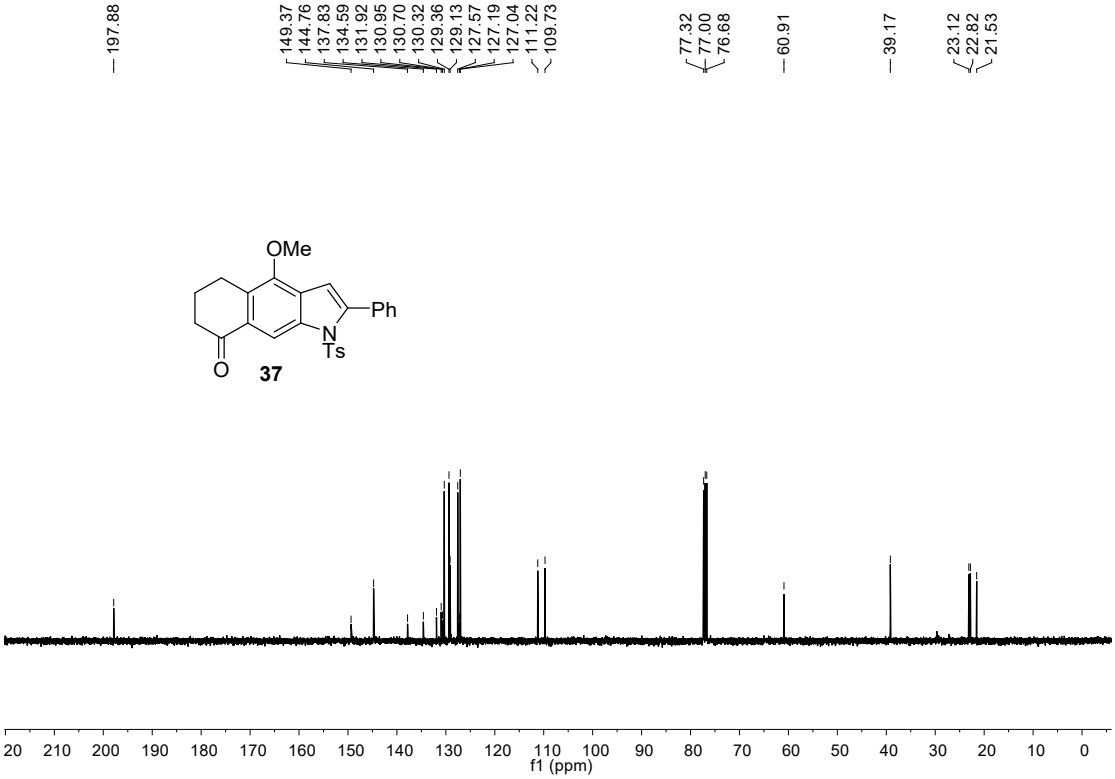
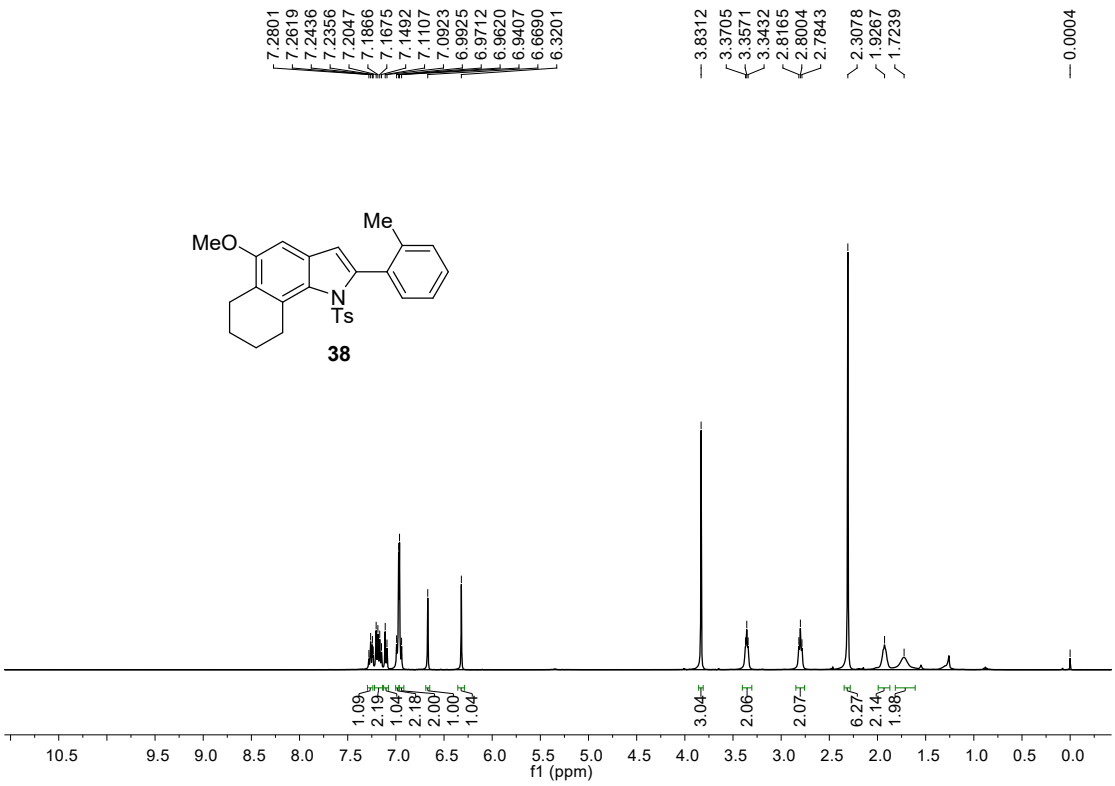
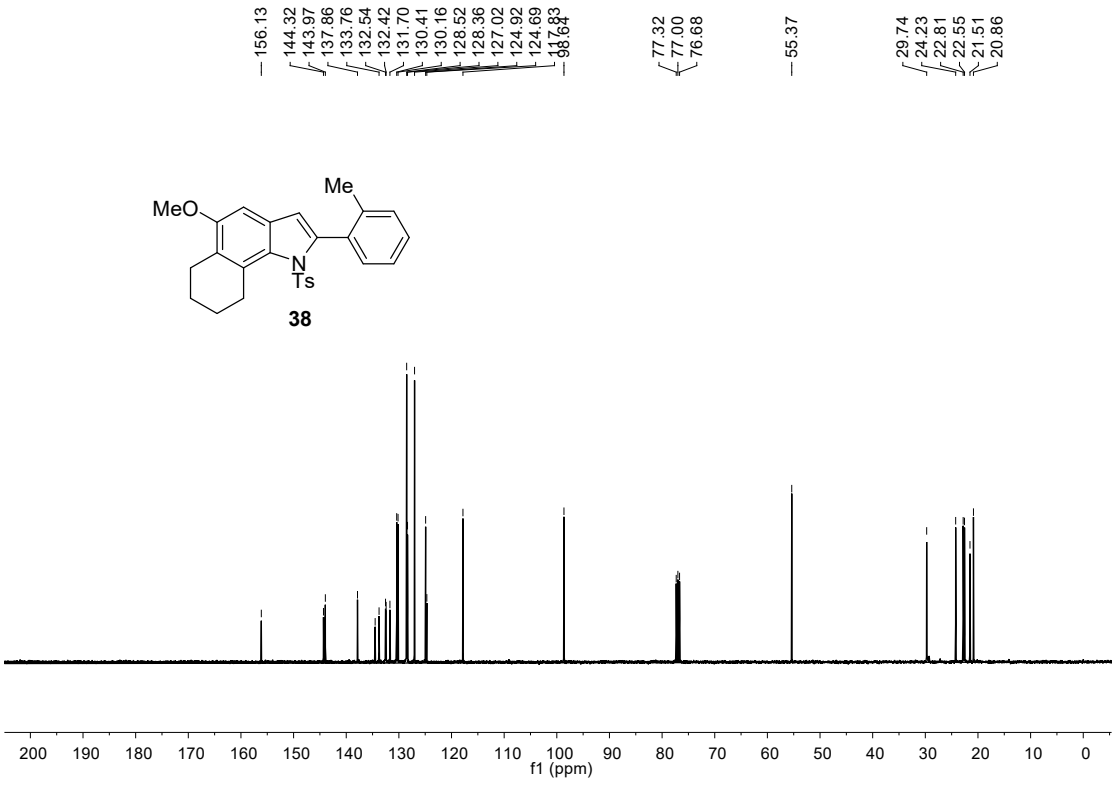
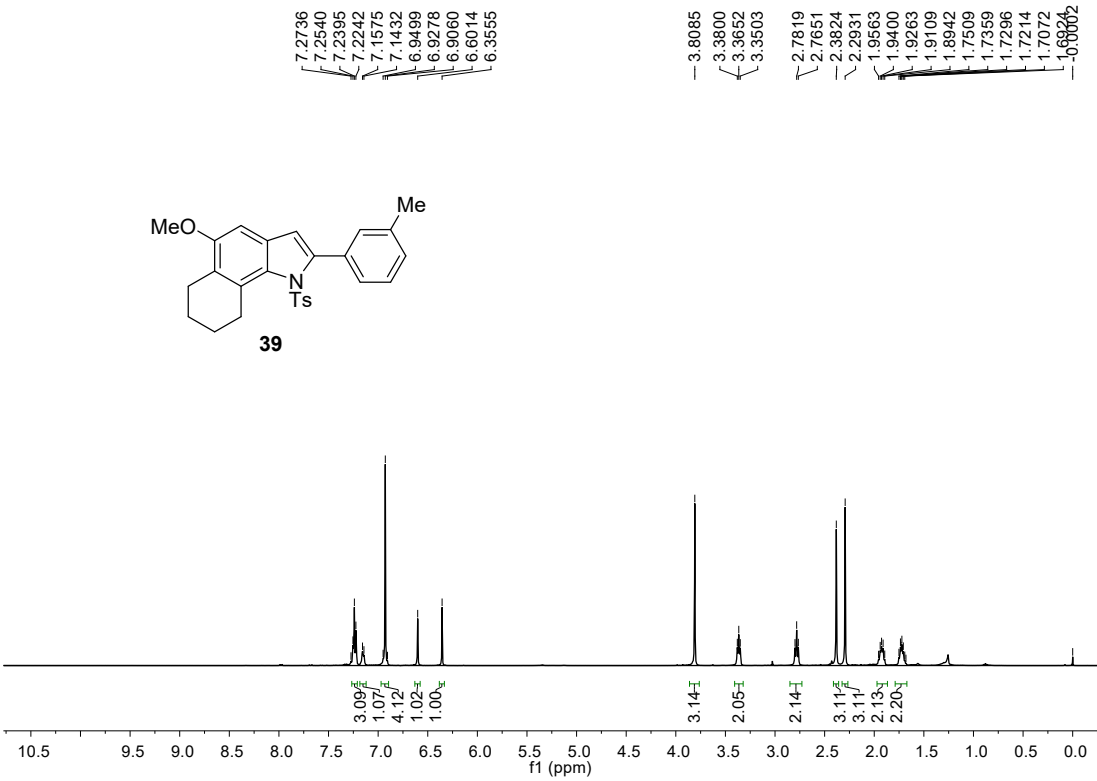
7.5071
7.5022
7.4526
7.4340
7.3401
7.3192
7.2597
7.0712
6.8530
3.8896
3.0094
2.9945
2.9790
2.7134
2.6980
2.6808
2.2958
2.1553
2.1390
2.1237
2.1080
2.0922
-0.0003
OMe
Ph
N
Ts
O
37
0.93
2.13
3.13
2.14
2.13
1.00
2.99
2.06
2.13
3.13
2.17
f1 (ppm)


197.88
149.37
144.76
137.83
134.59
131.92
130.95
130.70
130.32
129.36
129.13
127.57
127.19
127.04
111.22
109.73
77.32
77.00
76.68
60.91
39.17
23.12
22.82
21.53
OMe
Ph
N
Ts
O
37
f1 (ppm)


7.2801
7.2619
7.2436
7.2356
7.2047
7.1866
7.1675
7.1492
7.1107
7.0923
6.9925
6.9712
6.9620
6.9407
6.6690
6.3201
3.8312
3.3705
3.3571
3.3432
2.8165
2.8004
2.7843
2.3078
1.9267
1.7239
0.0004
Me
MeO
N
Ts
38
1.09
2.19
1.04
2.18
2.00
1.00
1.04
3.04
2.06
2.07
6.27
2.14
1.98
f1 (ppm)


156.13
144.32
143.97
137.86
133.76
132.54
132.42
131.70
130.41
130.16
128.52
128.36
127.02
124.92
124.69
98.64
77.32
77.00
76.68
55.37
29.74
24.23
22.81
22.55
21.51
20.86
Me
MeO
N
Ts
38
f1 (ppm)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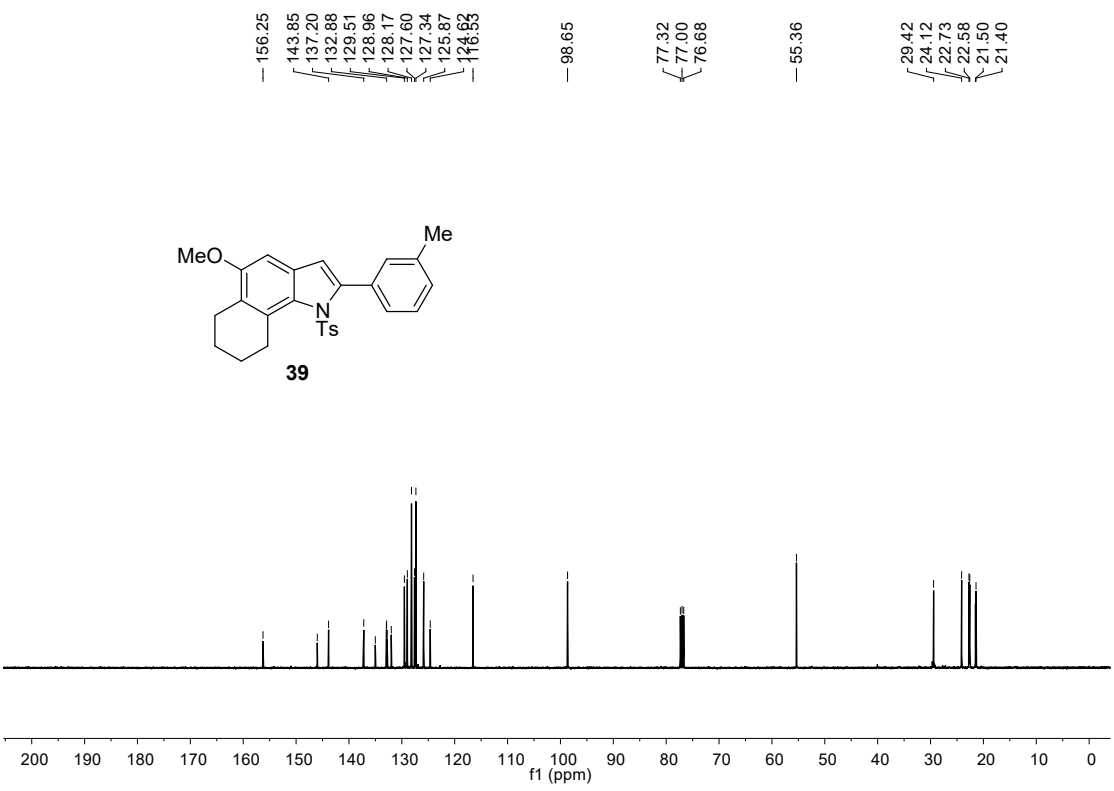
7.2395
7.2242
7.1575
7.1432
6.9499
6.9278
6.9060
6.6014
6.3555
3.8085
3.3800
3.3652
3.3503
2.7819
2.7651
2.3824
2.2931
1.9563
1.9400
1.9263
1.9109
1.8942
1.7509
1.7359
1.7296
1.7214
1.7072
1.6924
0.0002
MeO
Me
N
Ts
39
3.09
1.07
4.12
1.02
1.00
3.14
2.05
2.14
3.11
3.11
2.13
2.20
10.5
9.5
9.0
8.5
8.0
7.5
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)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137.20
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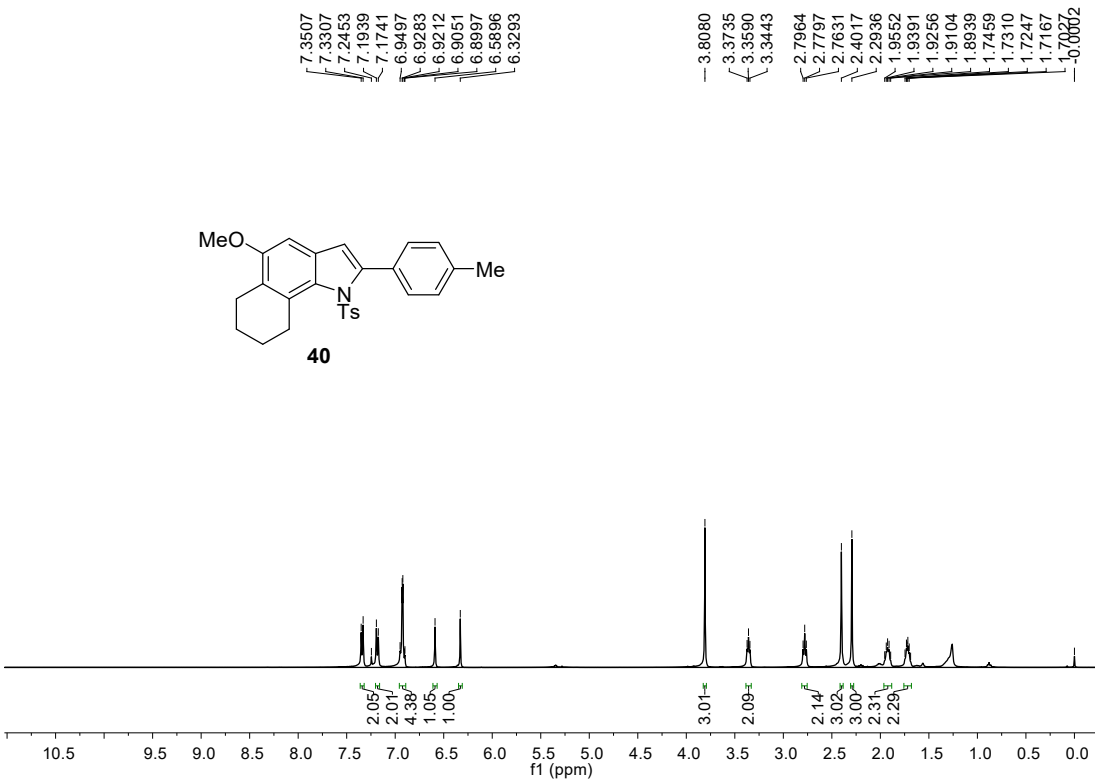
129.51
128.96
128.17
127.60
127.34
125.87
124.62
116.53
98.65
77.32
77.00
76.68
55.36
29.42
24.12
22.73
22.58
21.50
21.40
MeO
Me
N
Ts
39
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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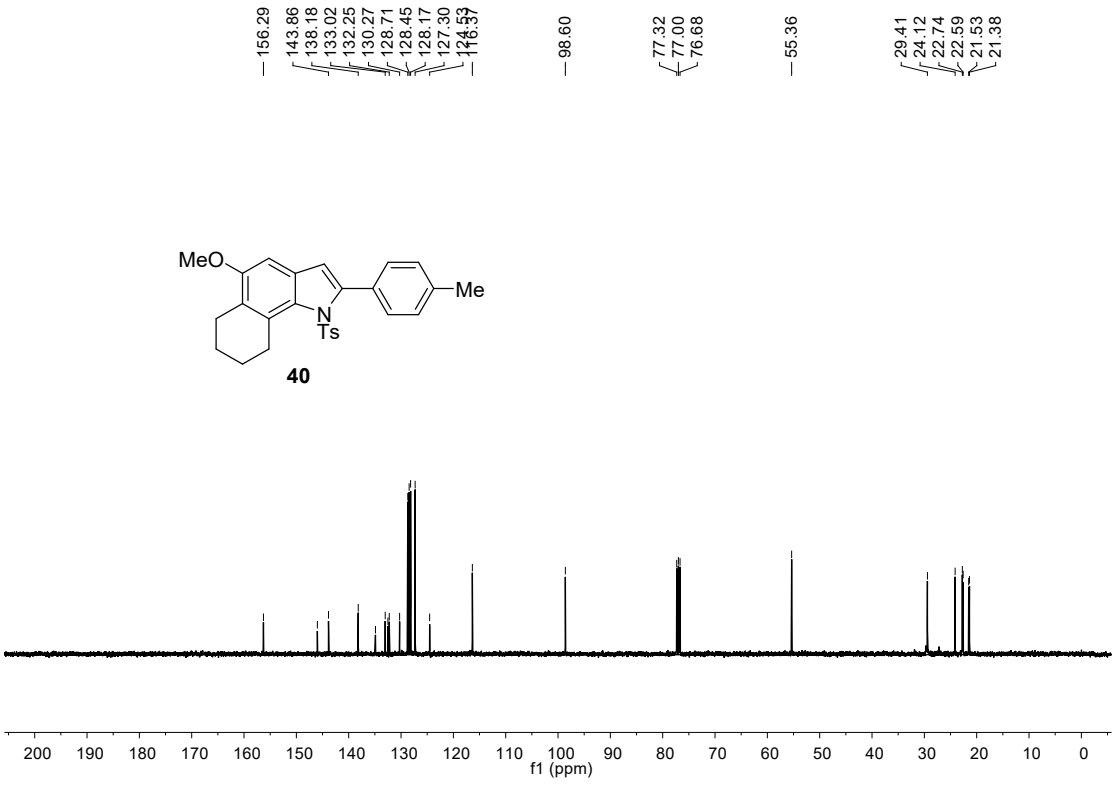
7.3307
7.2453
7.1939
7.1741
6.9497
6.9283
6.9212
6.9051
6.8997
6.5896
6.3293
3.8080
3.3735
3.3590
3.3443
2.7964
2.7797
2.7631
2.4017
2.2936
1.9552
1.9391
1.9256
1.9104
1.8939
1.7459
1.7310
1.7247
1.7167
1.7027
-0.0002
MeO
Me
N
Ts
40
2.05
2.01
4.38
1.05
1.00
3.01
2.09
2.14
3.02
3.00
2.31
2.29
f1 (ppm)


156.29
143.86
138.18
133.02
132.25
130.27
128.71
128.45
128.17
127.30
124.53
98.60
77.32
77.00
76.68
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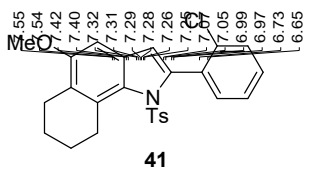
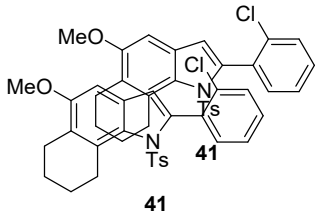
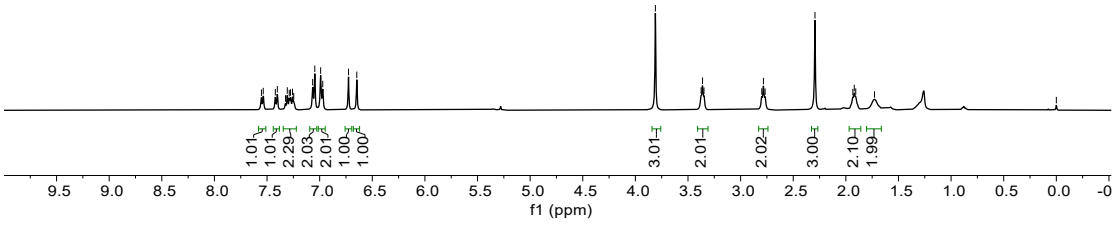
MeO
Me
N
Ts
40
f1 (ppm)

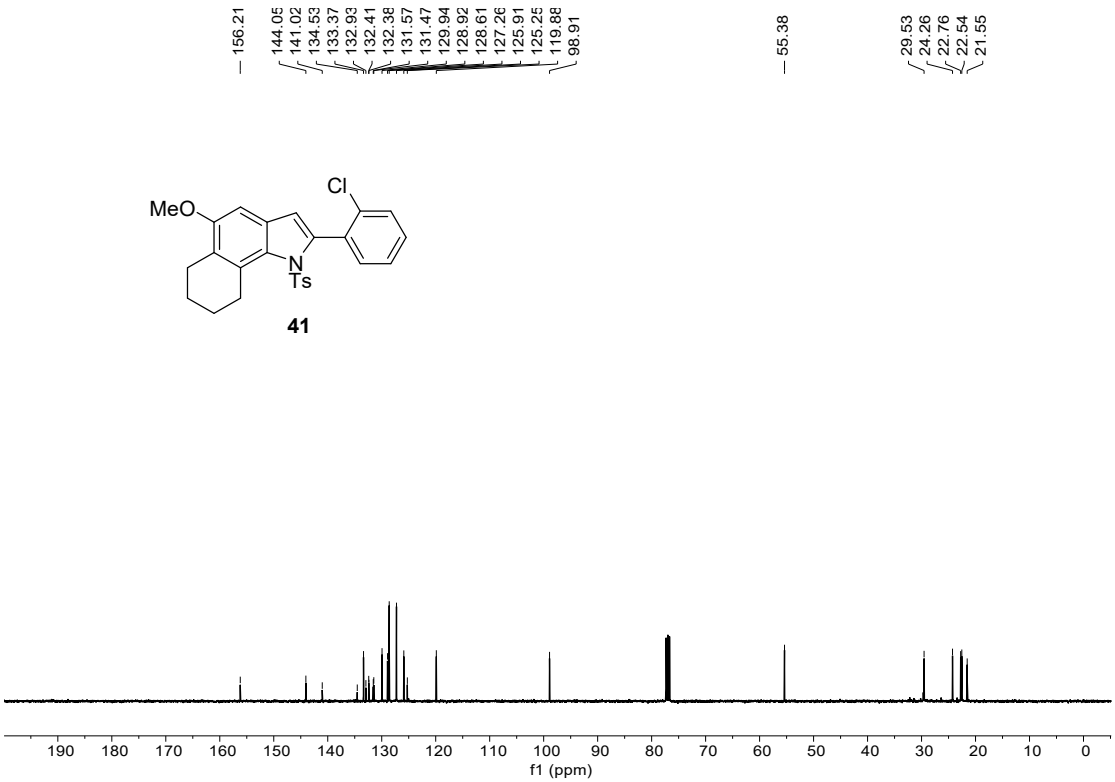

MeO
N
Ts

41


MeO
MeO
Cl
Cl
N
Ts
N
Ts

41


1.01
1.01
2.29
2.03
2.01
1.00
1.00
3.01
2.01
2.02
3.00
2.10
1.99
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 -0
f1 (ppm)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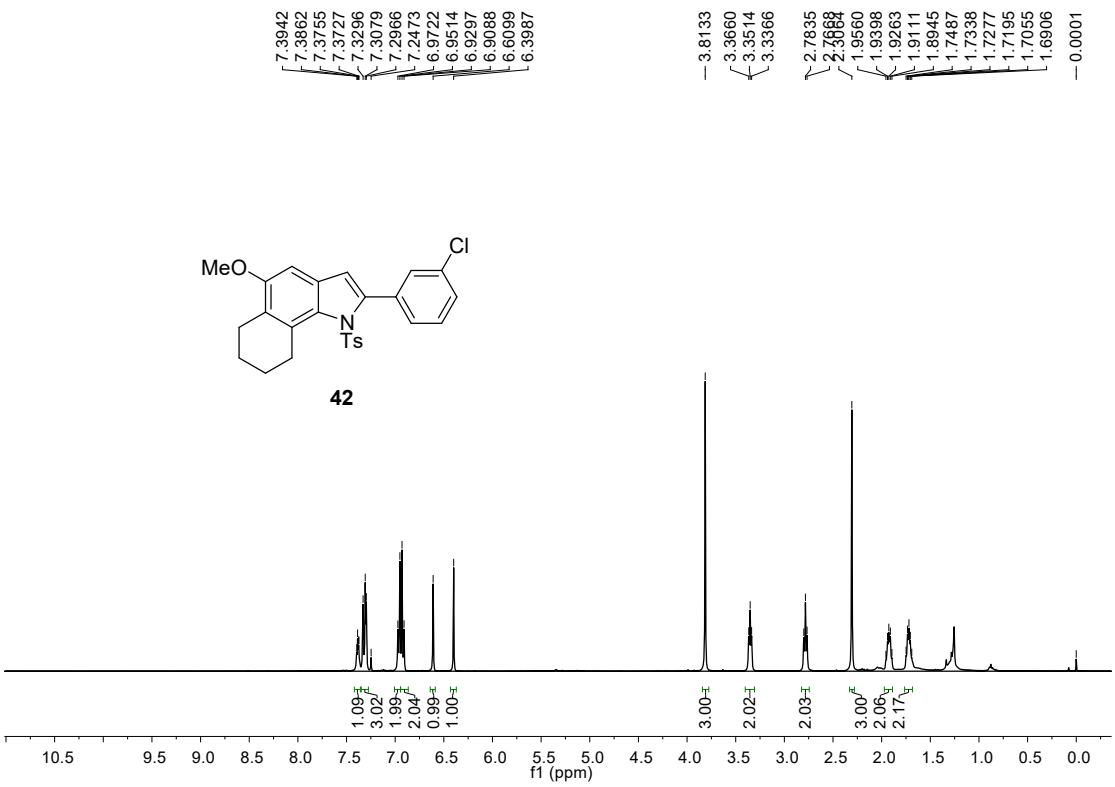
141.02
134.53
133.37
132.93
132.41
132.38
131.57
131.47
129.94
128.92
128.61
127.26
125.91
125.25
119.88
98.91
55.38
29.53
24.26
22.76
22.54
21.55
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

MeO
Cl
N
Ts

41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7.3079
7.2966
7.2473
6.9722
6.9514
6.9297
6.9088
6.6099
6.3987
3.8133
3.3660
3.3514
3.3366
2.7835
1.9560
1.9398
1.9263
1.9111
1.8945
1.7487
1.7338
1.7277
1.7195
1.7055
1.6906
0.0001
MeO
Cl
N
Ts
42
1.09
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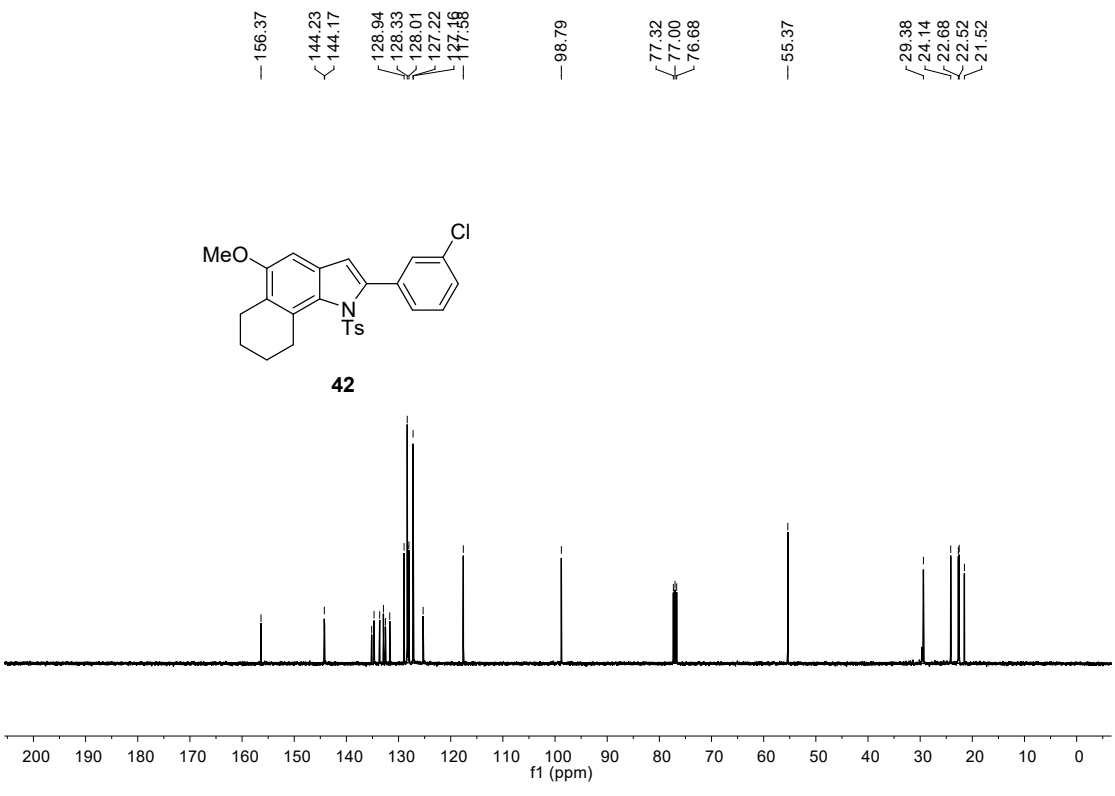
1.99
2.04
0.99
1.00
3.00
2.02
2.03
3.00
2.06
2.17
f1 (ppm)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128.33
128.01
127.22
98.79
77.32
77.00
76.68
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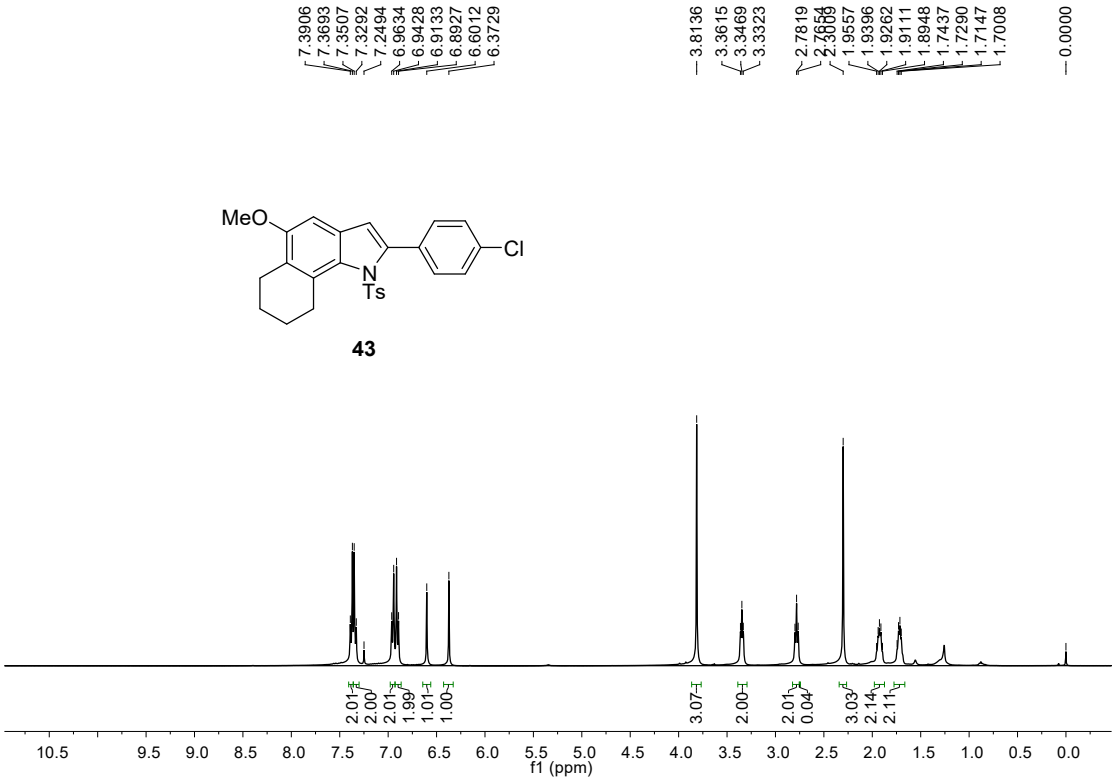
29.38
24.14
22.68
22.52
21.52
MeO
Cl
N
Ts
42
f1 (ppm)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6.9634
6.9428
6.9133
6.8927
6.6012
6.3729
3.8136
3.3615
3.3469
3.3323
2.7819
1.9557
1.9396
1.9262
1.9111
1.8948
1.7437
1.7290
1.7147
1.7008
0.0000
MeO
Cl
N
Ts
2.01
2.00
2.01
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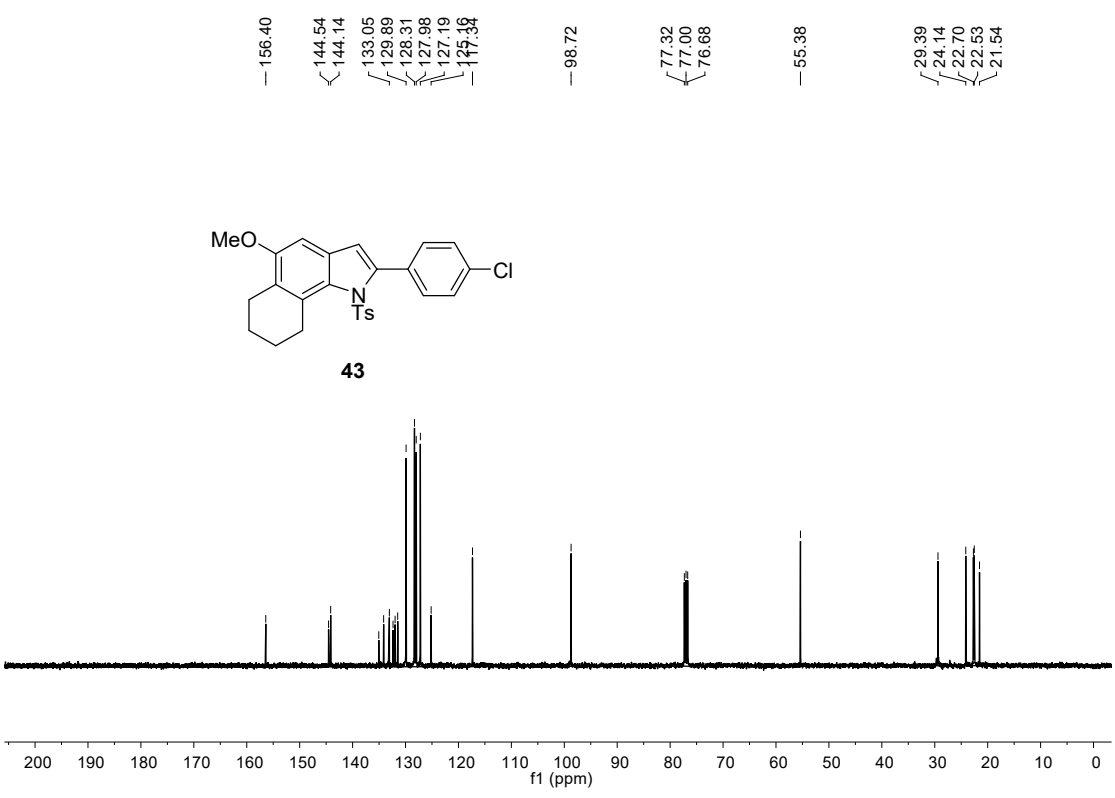
1.01
1.00
3.07
2.00
2.01
0.04
3.03
2.14
2.11
f1 (ppm)

43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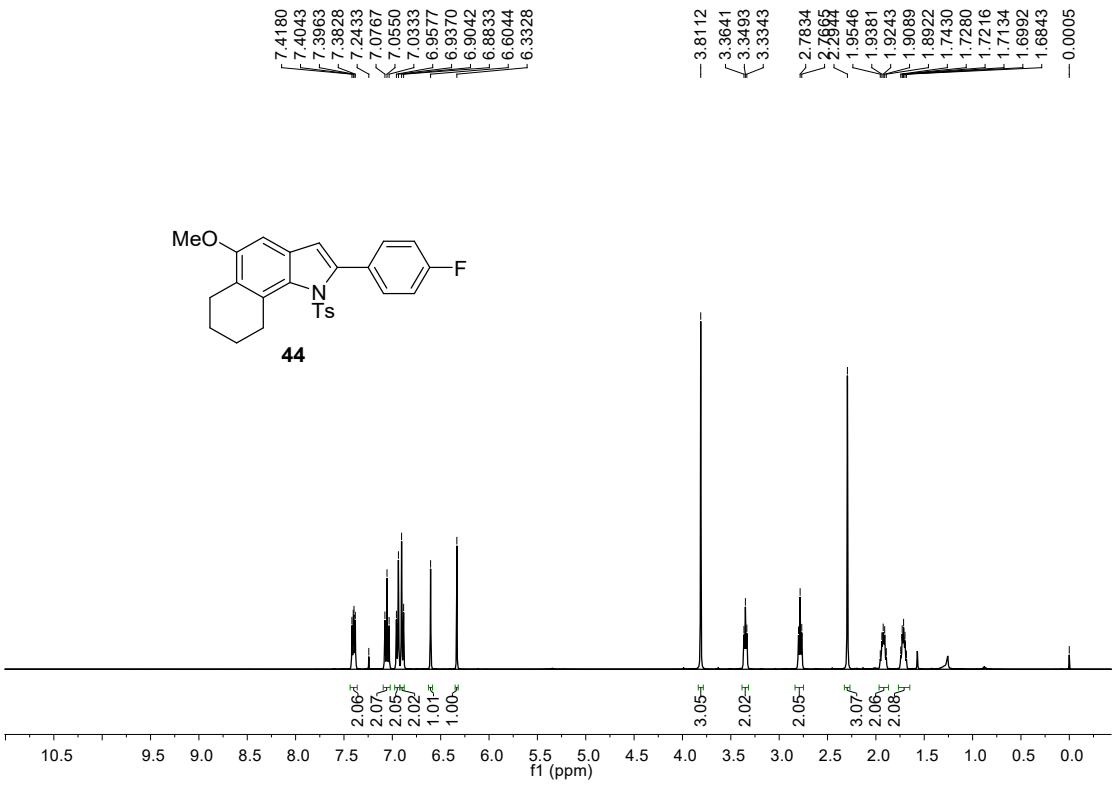
127.19
125.16
117.34
98.72
77.32
77.00
76.68
55.38
29.39
24.14
22.70
22.53
21.54
MeO
Cl
N
Ts
f1 (ppm)

43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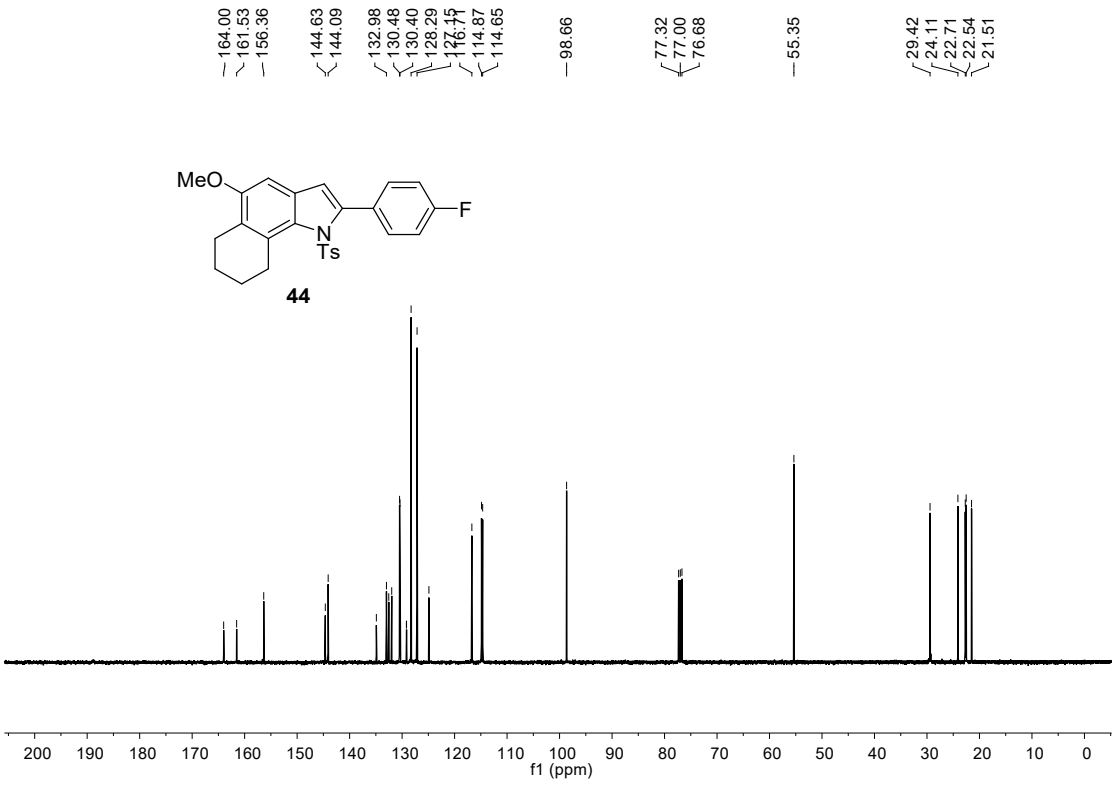
6.9370
6.9042
6.8833
6.6044
6.3328
3.8112
3.3641
3.3493
3.3343
2.7834
1.9546
1.9381
1.9243
1.9089
1.8922
1.7430
1.7280
1.7216
1.7134
1.6992
1.6843
0.0005
MeO
F
N
Ts
44
2.06
2.07
2.05
2.02
1.01
1.00
3.05
2.02
2.05
3.07
2.06
2.08
f1 (ppm)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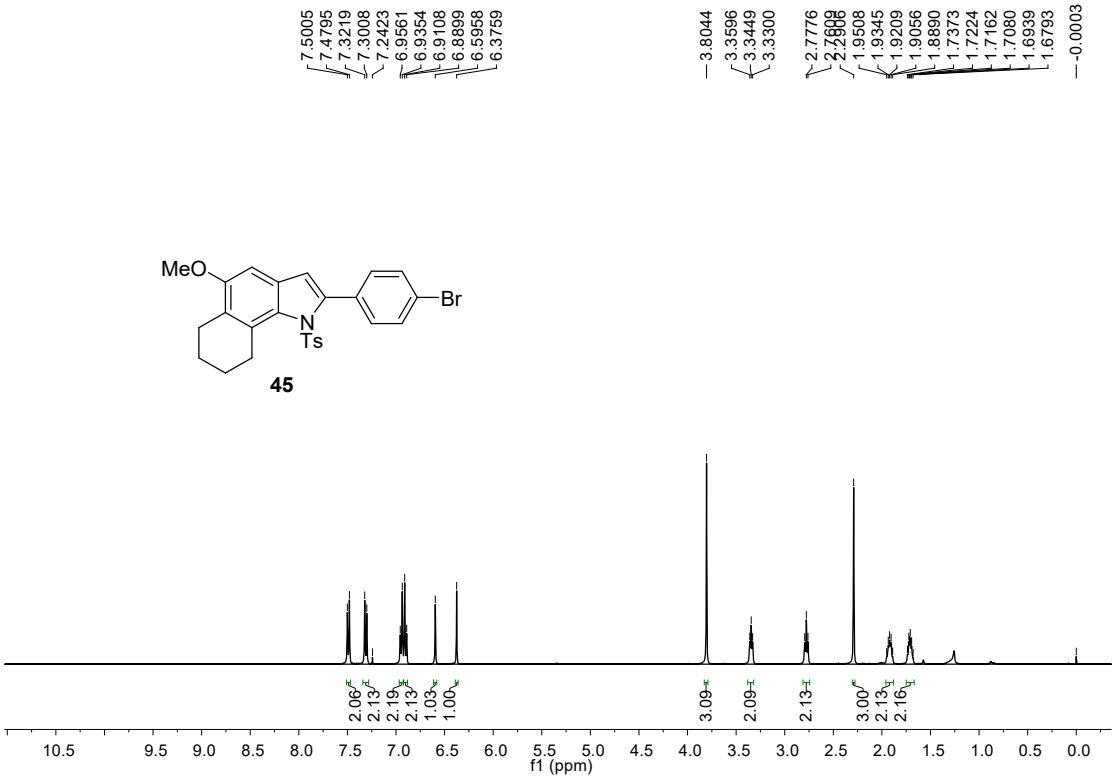
144.63
144.09
132.98
130.48
130.40
128.29
114.87
114.65
98.66
77.32
77.00
76.68
55.35
29.42
24.11
22.71
22.54
21.51
MeO
F
N
Ts
44
f1 (ppm)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7.3219
7.3008
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6.9561
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6.8899
6.5958
6.3759
3.8044
3.3596
3.3449
3.3300
2.7776
1.9508
1.9345
1.9209
1.9056
1.8890
1.7373
1.7224
1.7162
1.7080
1.6939
1.6793
-0.0003
MeO
Br
N
Ts
45
2.06
2.13
2.19
2.13
1.03
1.00
3.09
2.09
2.13
3.00
2.13
2.16
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
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3.5
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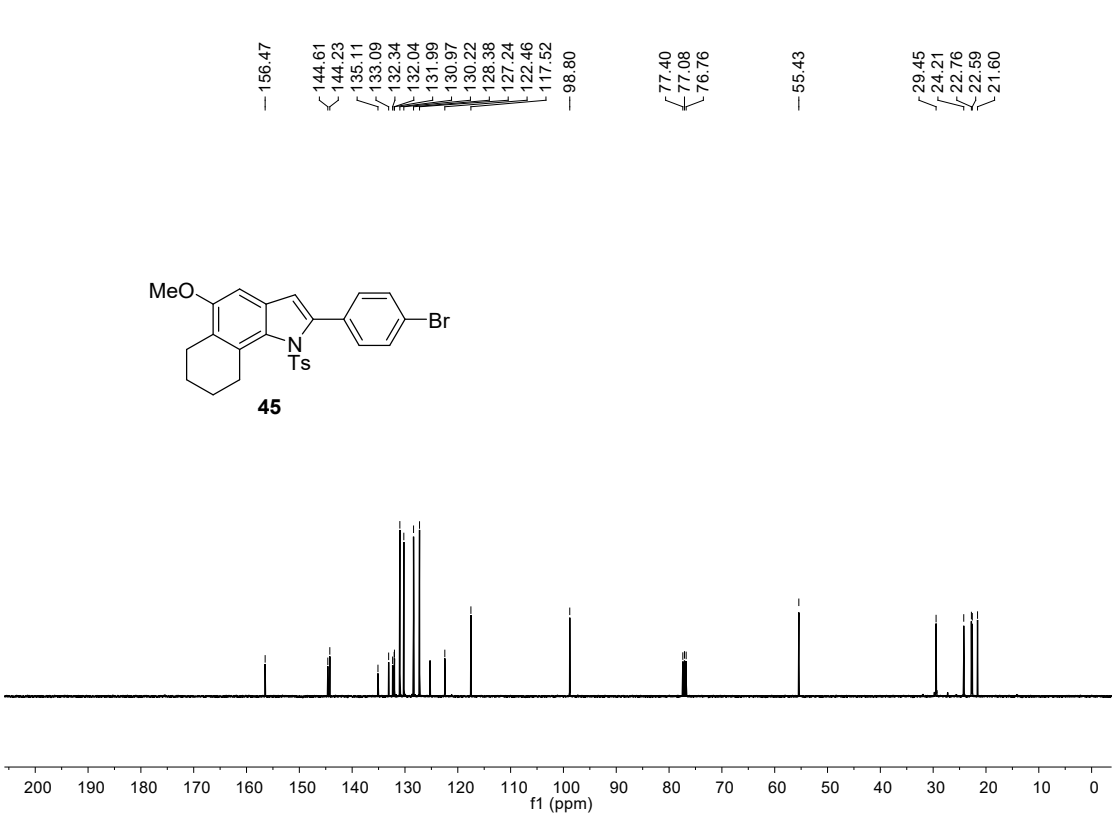
f1 (ppm)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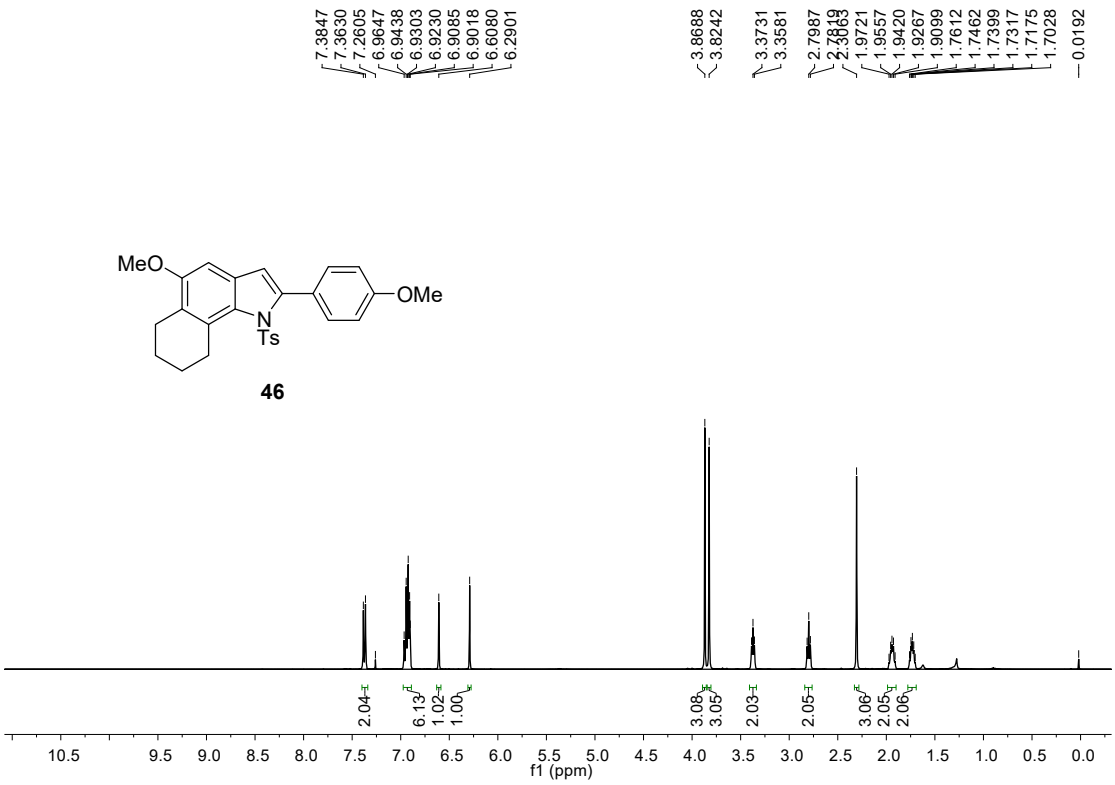
132.34
132.04
131.99
130.97
130.22
128.38
127.24
122.46
117.52
98.80
77.40
77.08
76.76
55.43
29.45
24.21
22.76
22.59
21.60
MeO
Br
N
Ts
45
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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6.9230
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6.9018
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6.2901
3.8688
3.8242
3.3731
3.3581
2.7987
2.3063
1.9721
1.9557
1.9420
1.9267
1.9099
1.7612
1.7462
1.7399
1.7317
1.7175
1.7028
0.0192
MeO
OMe
N
Ts
46
2.04
6.13
1.02
1.00
3.08
3.05
2.03
2.05
3.06
2.05
2.06
10.5
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9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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3.0
2.5
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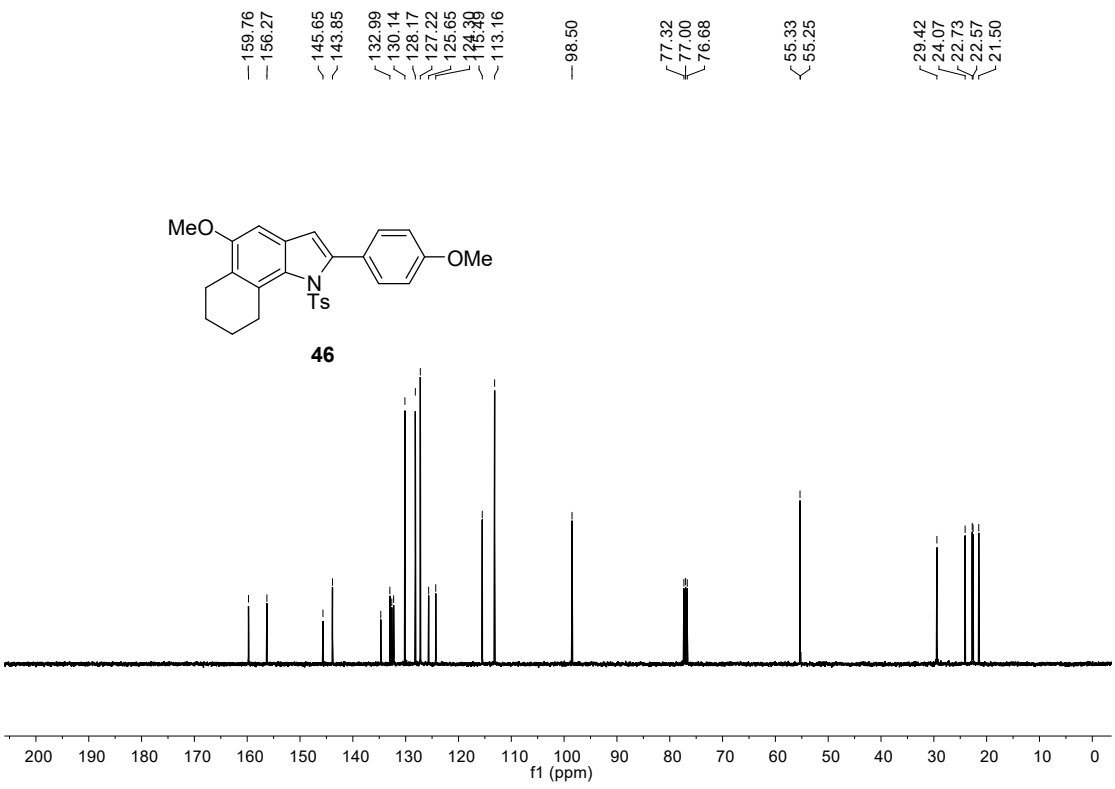
f1 (ppm)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127.22
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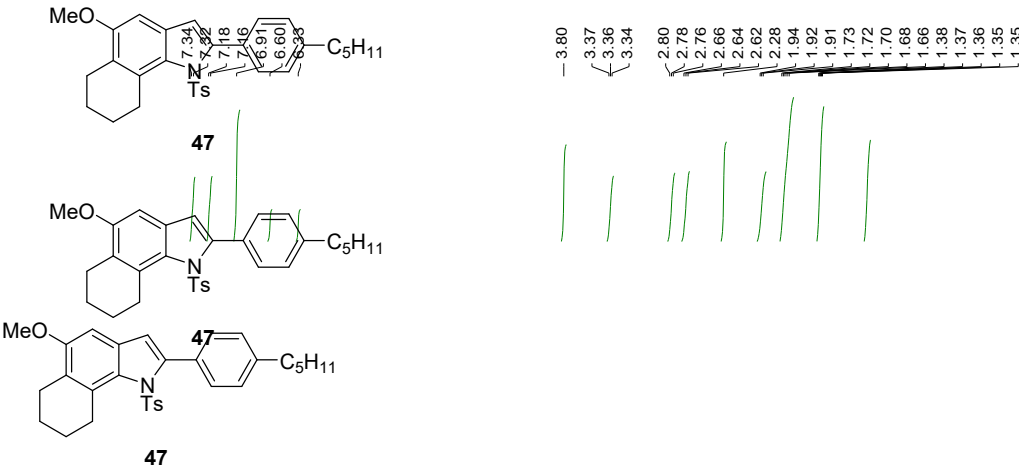
113.16
98.50
77.32
77.00
76.68
55.33
55.25
29.42
24.07
22.73
22.57
21.50
MeO
OMe
N
Ts
46
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


MeO
C5H11
N
Ts
47
MeO
C5H11
N
Ts
47
MeO
C5H11
N
Ts
47
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7.32
7.18
7.16
6.91
6.60
6.33
3.80
3.37
3.36
3.34
2.80
2.78
2.76
2.66
2.64
2.62
2.28
1.94
1.92
1.91
1.73
1.72
1.70
1.68
1.66
1.38
1.37
1.36
1.35
2.00
2.03
4.08
1.00
1.00
3.01
2.04
2.13
2.18
3.09
2.17
4.48
4.19
3.15
f1 (ppm)
156.24
146.00
143.81
143.19
134.90
132.91
132.75
132.11
130.37
128.68
128.16
127.73
127.29
124.47
116.09
98.59
55.34
35.77
31.57
31.02
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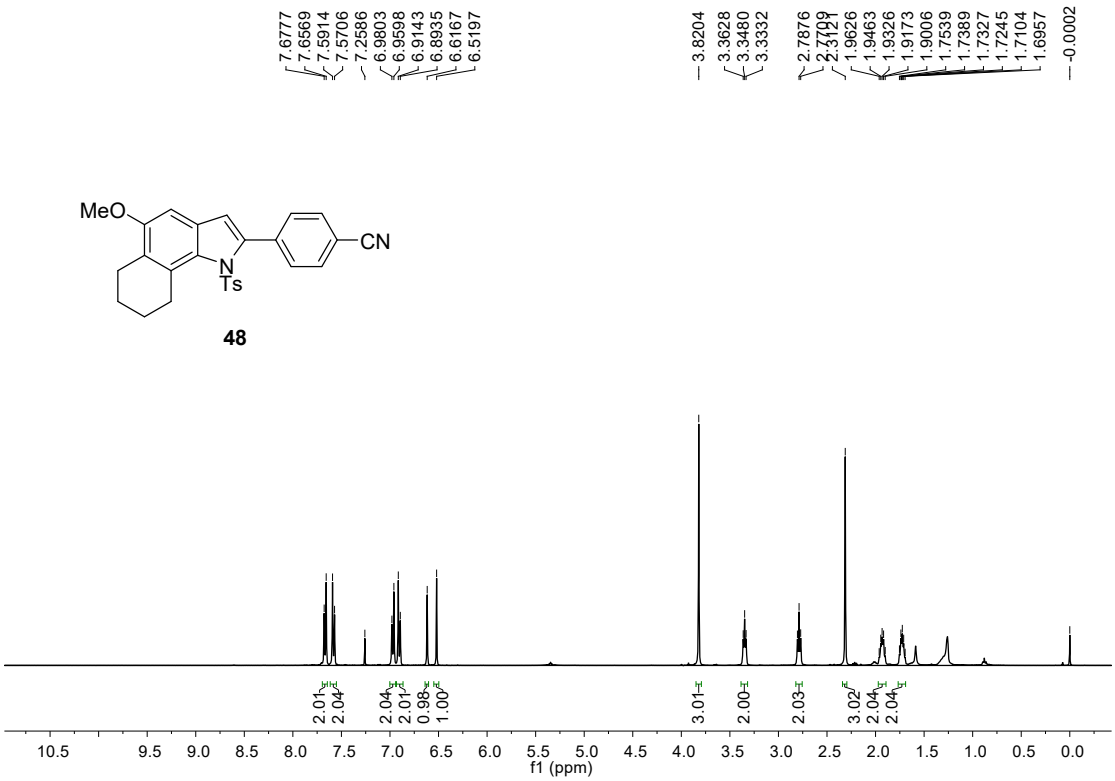
22.58
22.53
21.50
14.02
MeO
C5H11
N
Ts
47
f1 (ppm)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6.9143
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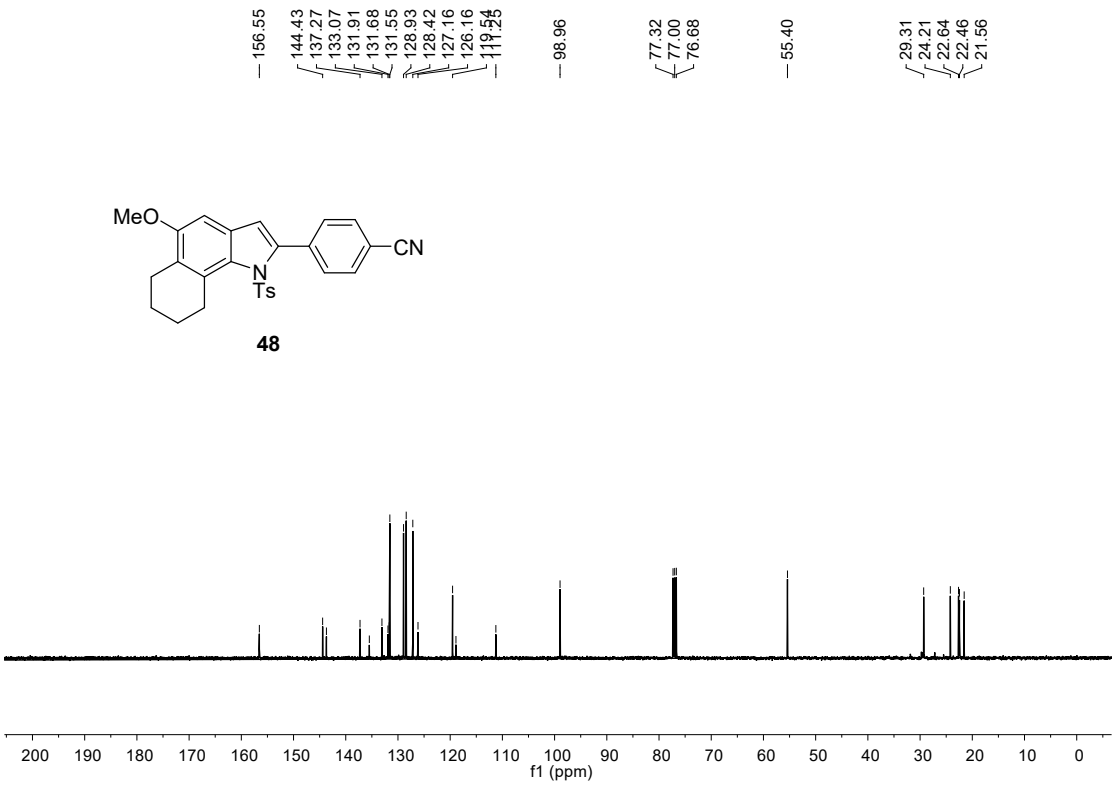
6.6167
6.5197
3.8204
3.3628
3.3480
3.3332
2.7876
2.7709
2.3121
1.9626
1.9463
1.9326
1.9173
1.9006
1.7539
1.7389
1.7327
1.7245
1.7104
1.6957
-0.0002
MeO
CN
N
Ts
2.01
2.04
2.04
2.01
0.98
1.00
3.01
2.00
2.03
3.02
2.04
2.04
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

48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137.27
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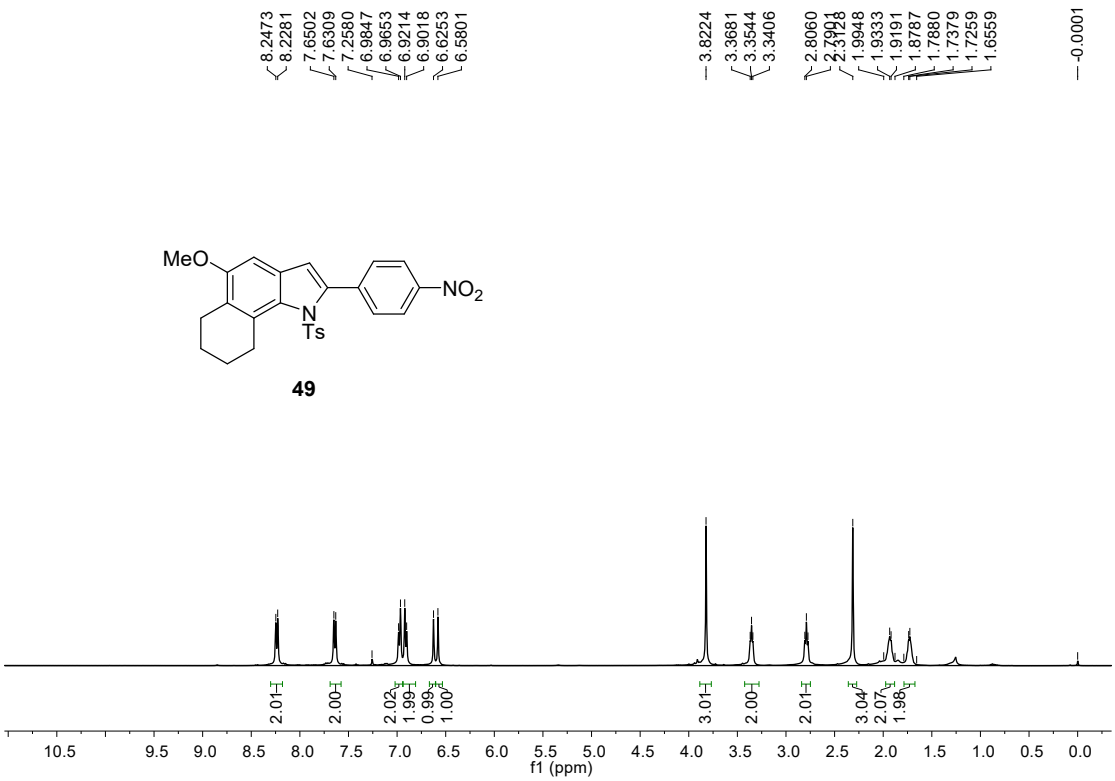
131.68
131.55
128.93
128.42
127.16
126.16
119.54
111.25
98.96
77.32
77.00
76.68
55.40
29.31
24.21
22.64
22.46
21.56
MeO
CN
N
Ts
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

48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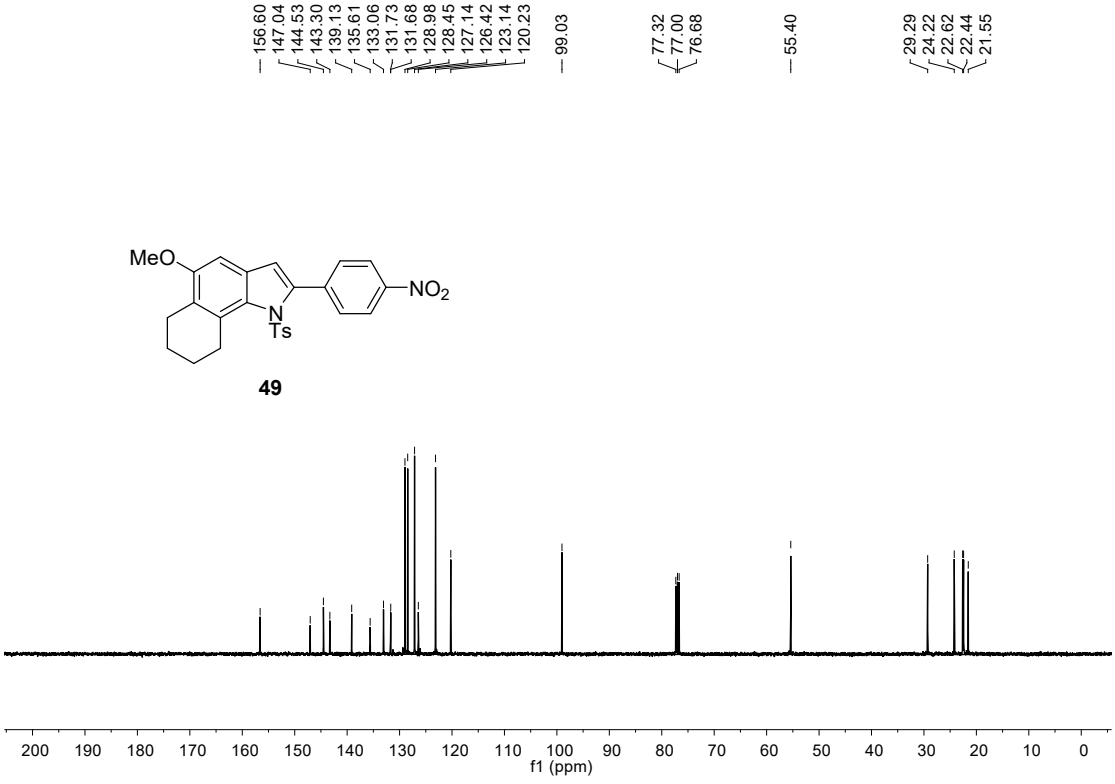
8.2281
7.6502
7.6309
7.2580
6.9847
6.9653
6.9214
6.9018
6.6253
6.5801
3.8224
3.3681
3.3544
3.3406
2.8060
2.7914
2.3128
1.9948
1.9333
1.9191
1.8787
1.7880
1.7379
1.7259
1.6559
-0.0001
MeO
NO2
N
Ts
49
2.01
2.00
2.02
1.99
0.99
1.00
3.01
2.00
2.01
3.04
2.07
1.98
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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131.68
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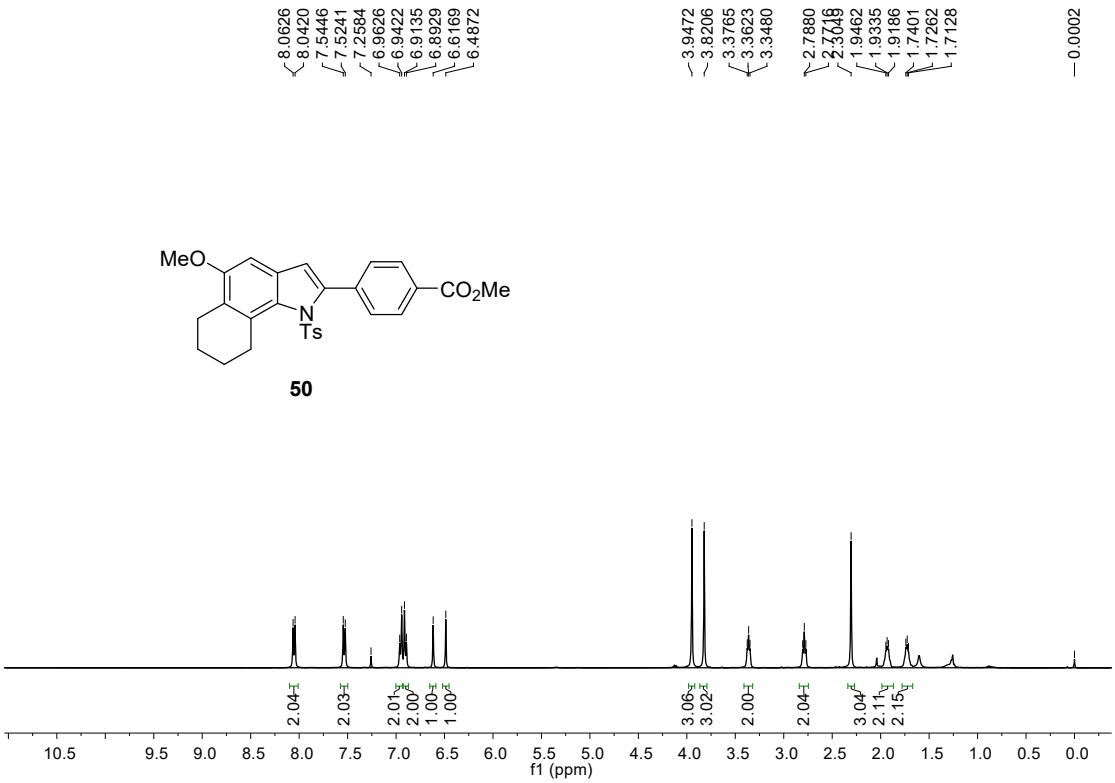
128.45
127.14
126.42
123.14
120.23
99.03
77.32
77.00
76.68
55.40
29.29
24.22
22.62
22.44
21.55
MeO
NO2
N
Ts
49
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.5241
7.2584
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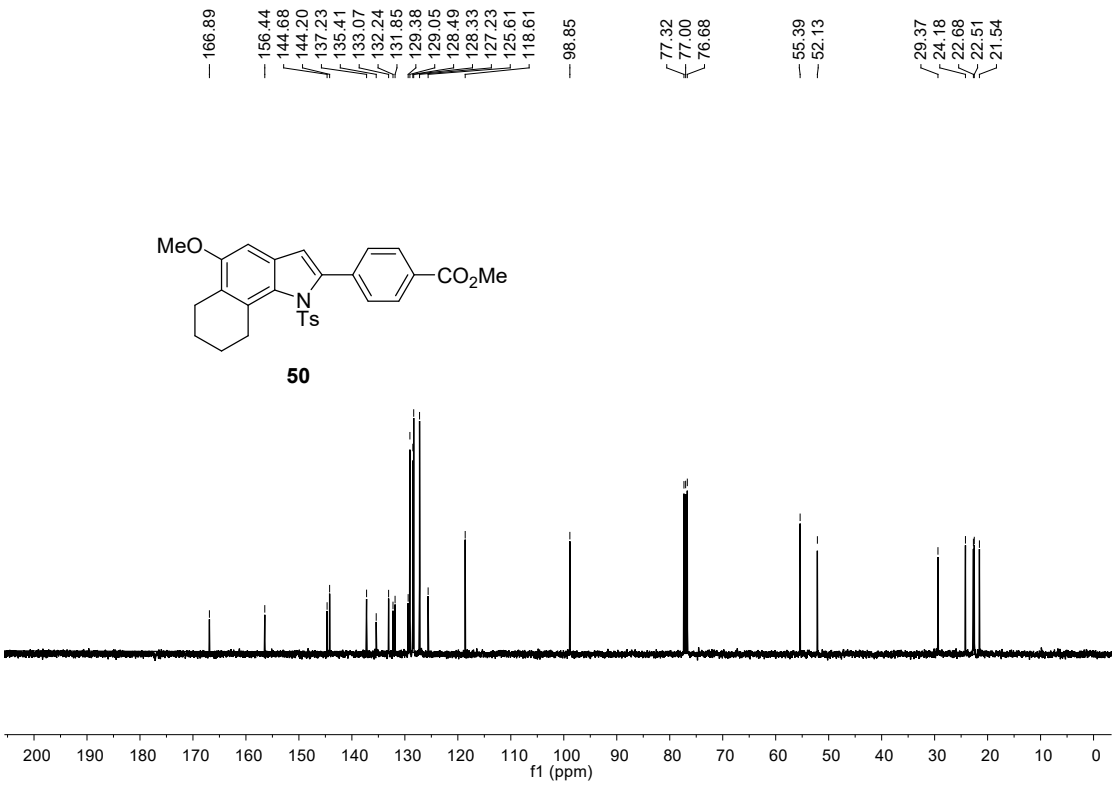
6.9422
6.9135
6.8929
6.6169
6.4872
3.9472
3.8206
3.3765
3.3623
3.3480
2.7880
2.7716
2.3048
1.9462
1.9335
1.9186
1.7401
1.7262
1.7128
0.0002
MeO
CO2Me
N
Ts
50
2.04
2.03
2.01
2.00
1.00
1.00
3.06
3.02
2.00
2.04
3.04
2.11
2.15
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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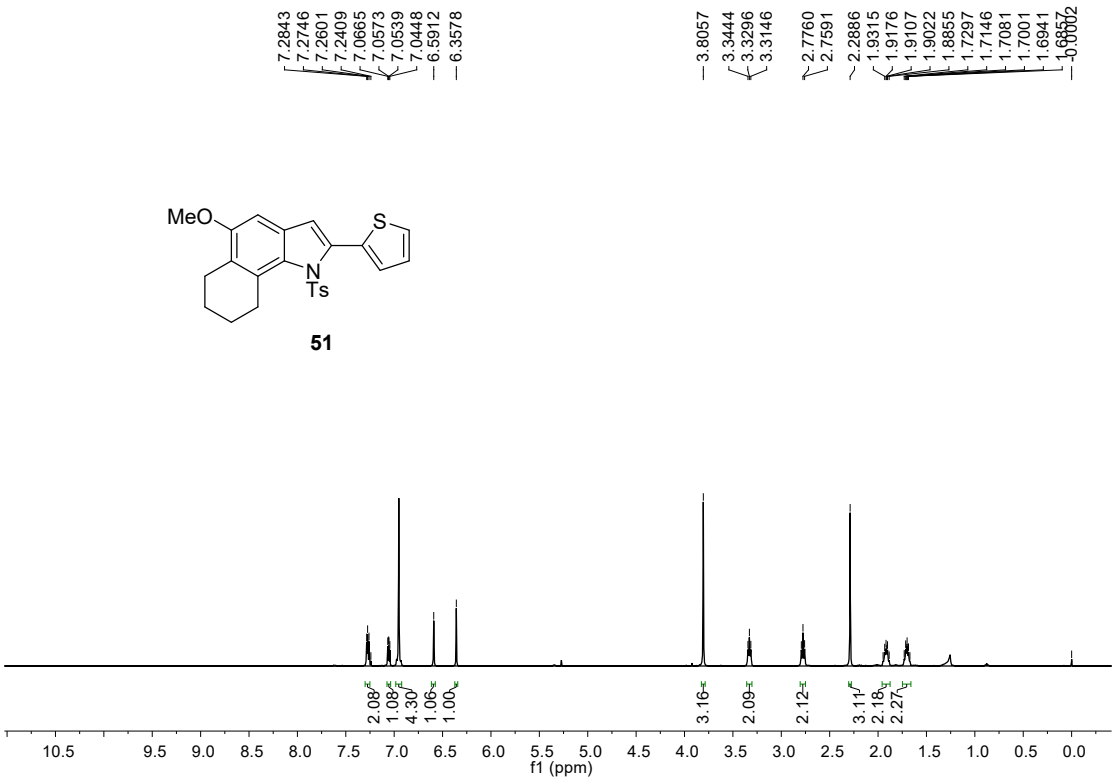
129.38
129.05
128.49
128.33
127.23
125.61
118.61
98.85
77.32
77.00
76.68
55.39
52.13
29.37
24.18
22.68
22.51
21.54
MeO
CO2Me
N
Ts
50
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.2409
7.0665
7.0573
7.0539
7.0448
6.5912
6.3578
3.8057
3.3444
3.3296
3.3146
2.7760
2.7591
2.2886
1.9315
1.9176
1.9107
1.9022
1.8855
1.7297
1.7146
1.7081
1.7001
1.6941
1.6857
0.1002
MeO
S
N
Ts
51
2.08
1.08
4.30
1.06
1.00
3.16
2.09
2.12
3.11
2.18
2.27
10.5
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
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1.0
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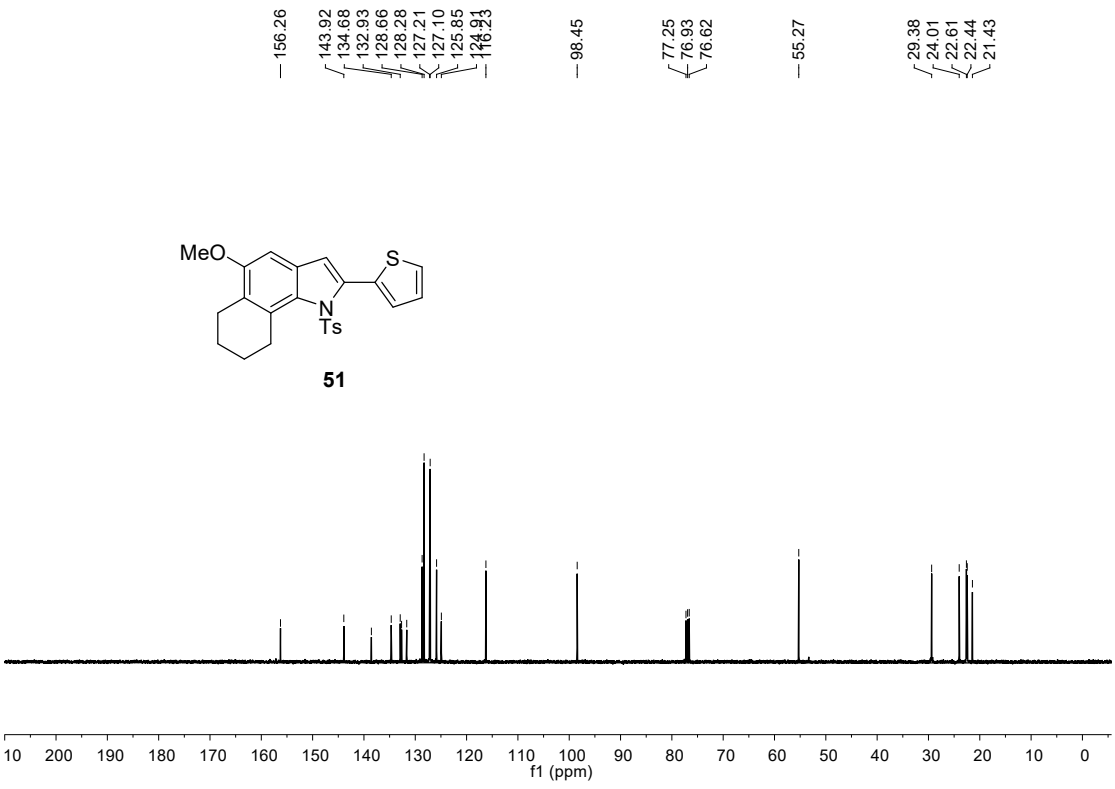
0.0
f1 (ppm)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127.10
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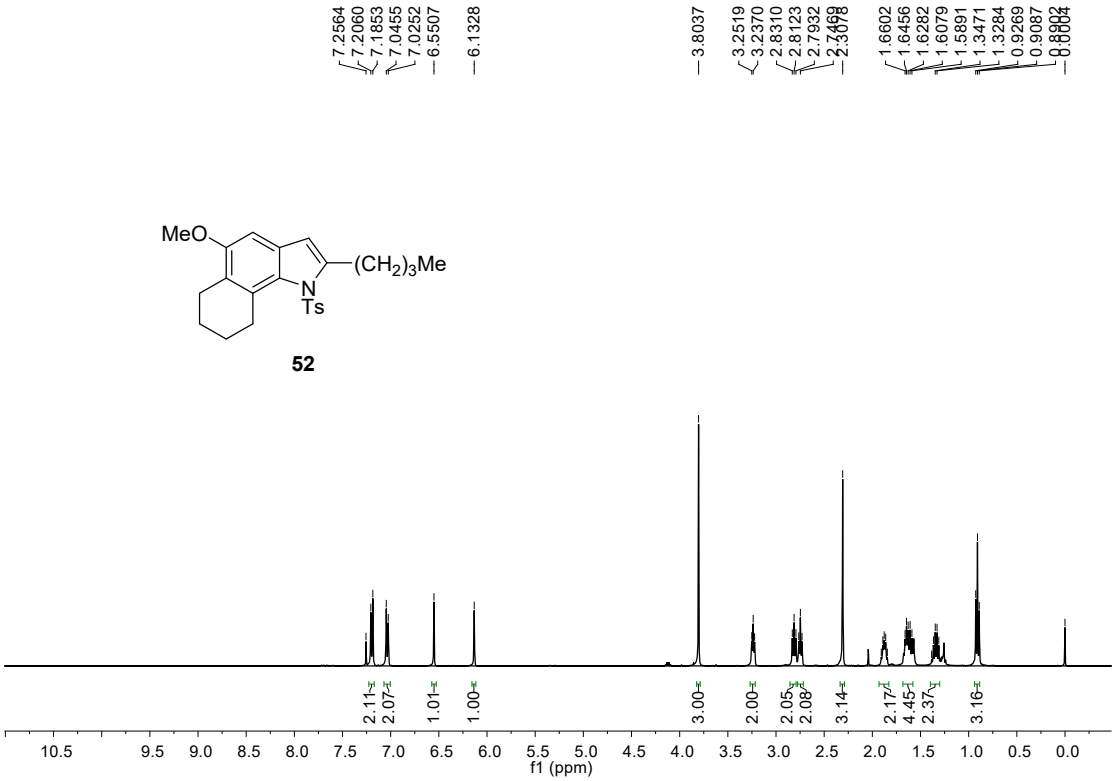
124.91
116.23
98.45
77.25
76.93
76.62
55.27
29.38
24.01
22.61
22.44
21.43
MeO
S
N
Ts
51
10
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.1853
7.0455
7.0252
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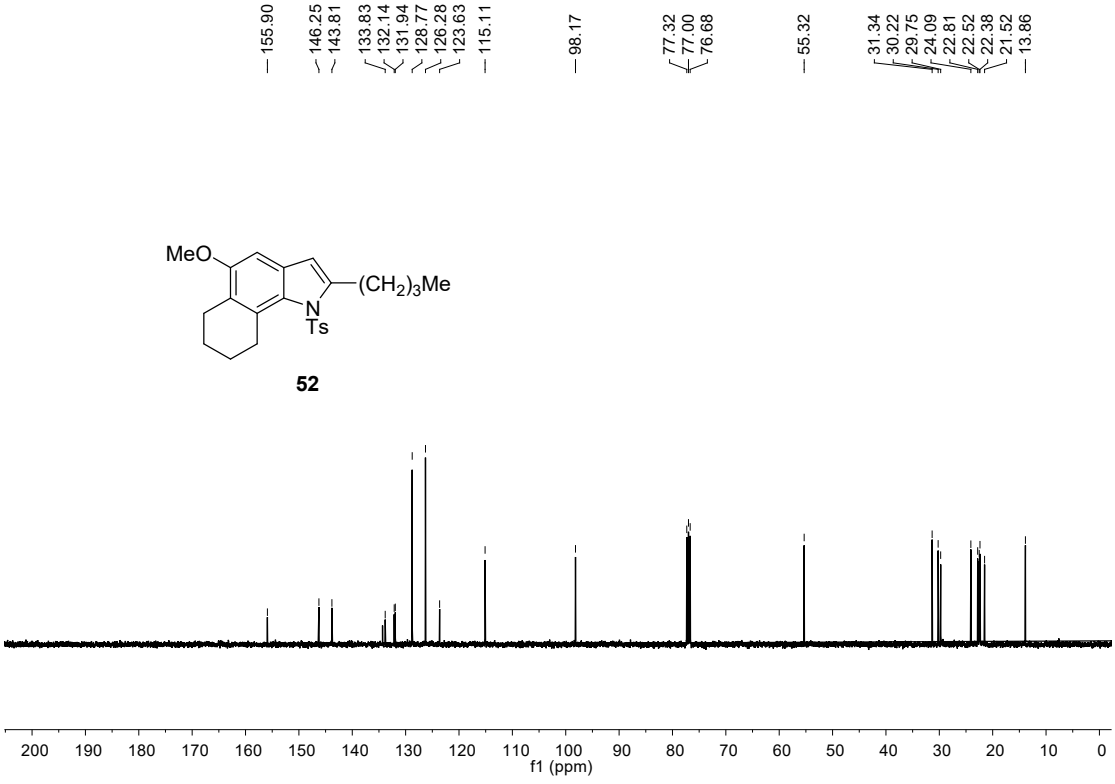
6.1328
3.8037
3.2519
3.2370
2.8310
2.8123
2.7932
2.3078
1.6602
1.6456
1.6282
1.6079
1.5891
1.3471
1.3284
0.9269
0.9087
MeO
(CH2)3Me
N
Ts
2.11
2.07
1.01
1.00
3.00
2.00
2.05
2.08
3.14
2.17
4.45
2.37
3.16
f1 (ppm)

52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131.94
128.77
126.28
123.63
115.11
98.17
77.32
77.00
76.68
55.32
31.34
30.22
29.75
24.09
22.81
22.52
22.38
21.52
13.86
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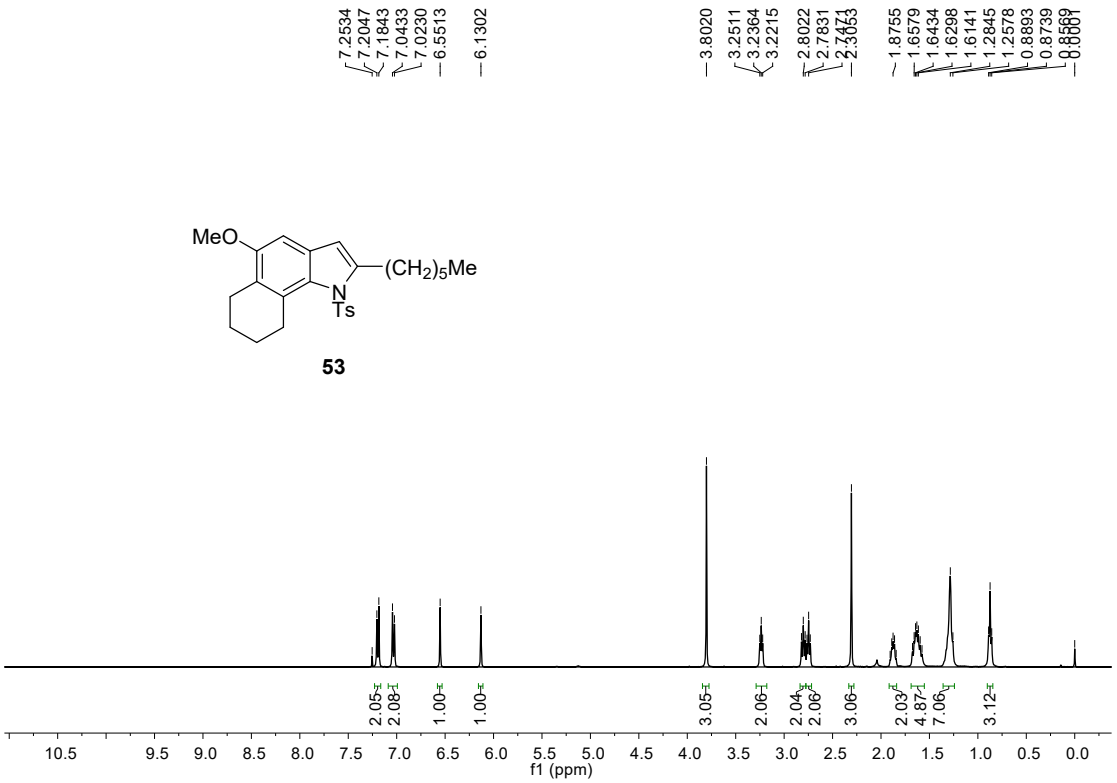
(CH2)3Me
N
Ts
f1 (ppm)

52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7.0230
6.5513
6.1302
3.8020
3.2511
3.2364
3.2215
2.8022
2.7831
2.7471
2.3053
1.8755
1.6579
1.6434
1.6298
1.6141
1.2845
1.2578
0.8893
0.8739
0.8569
0.8501
MeO
(CH2)5Me
N
Ts
53
2.05
2.08
1.00
1.00
3.05
2.06
2.04
2.06
3.06
2.03
4.87
7.06
3.12
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.0
3.5
3.0
2.5
2.0
1.5
1.0
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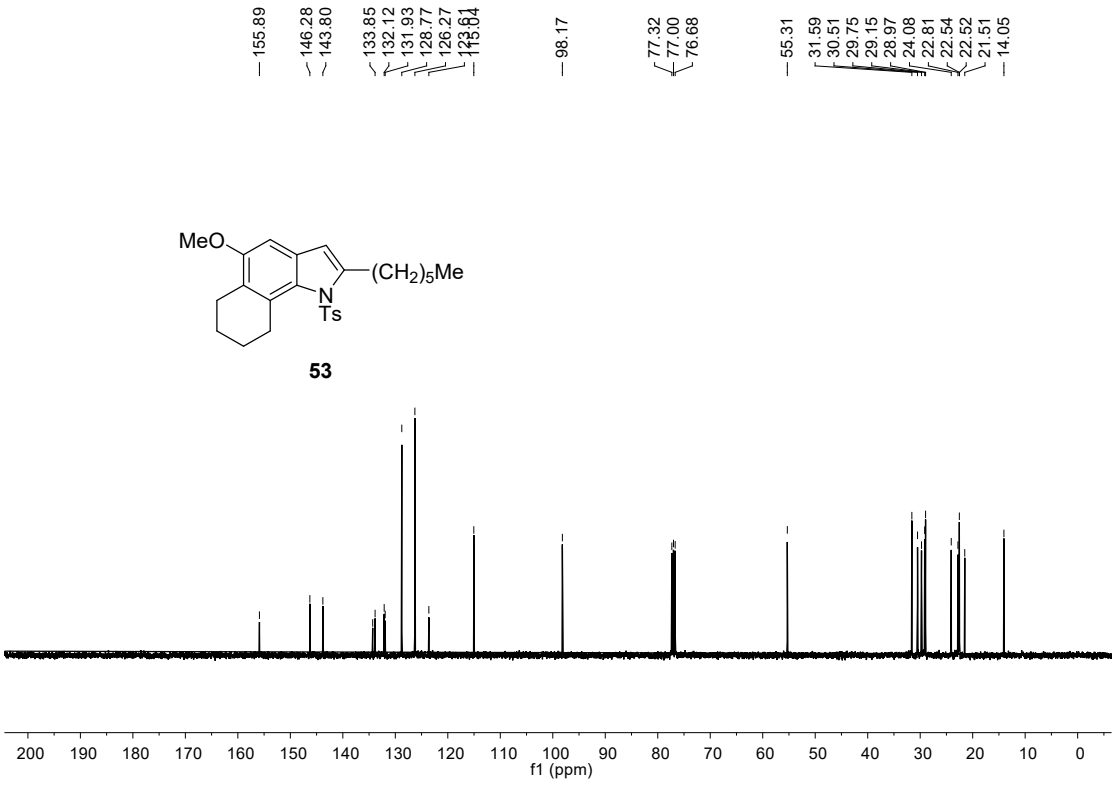
f1 (ppm)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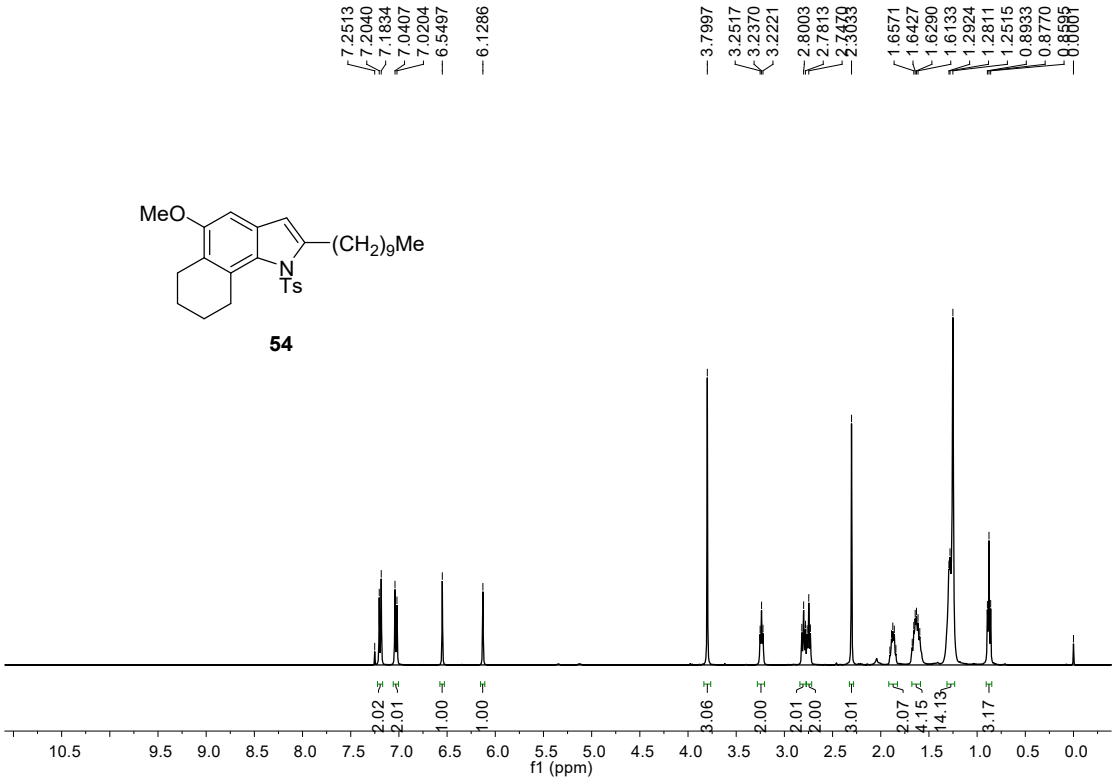
77.32
77.00
76.68
55.31
31.59
30.51
29.75
29.15
28.97
24.08
22.81
22.54
22.52
21.51
14.05
MeO
(CH2)5Me
N
Ts
53
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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3.2370
3.2221
2.8003
2.7813
2.7470
2.3033
1.6571
1.6427
1.6290
1.6133
1.2924
1.2811
1.2515
0.8933
0.8770
0.8595
0.8001
MeO
(CH2)9Me
N
Ts
54
2.02
2.01
1.00
1.00
3.06
2.00
2.01
2.00
3.01
2.07
4.15
14.13
3.17
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
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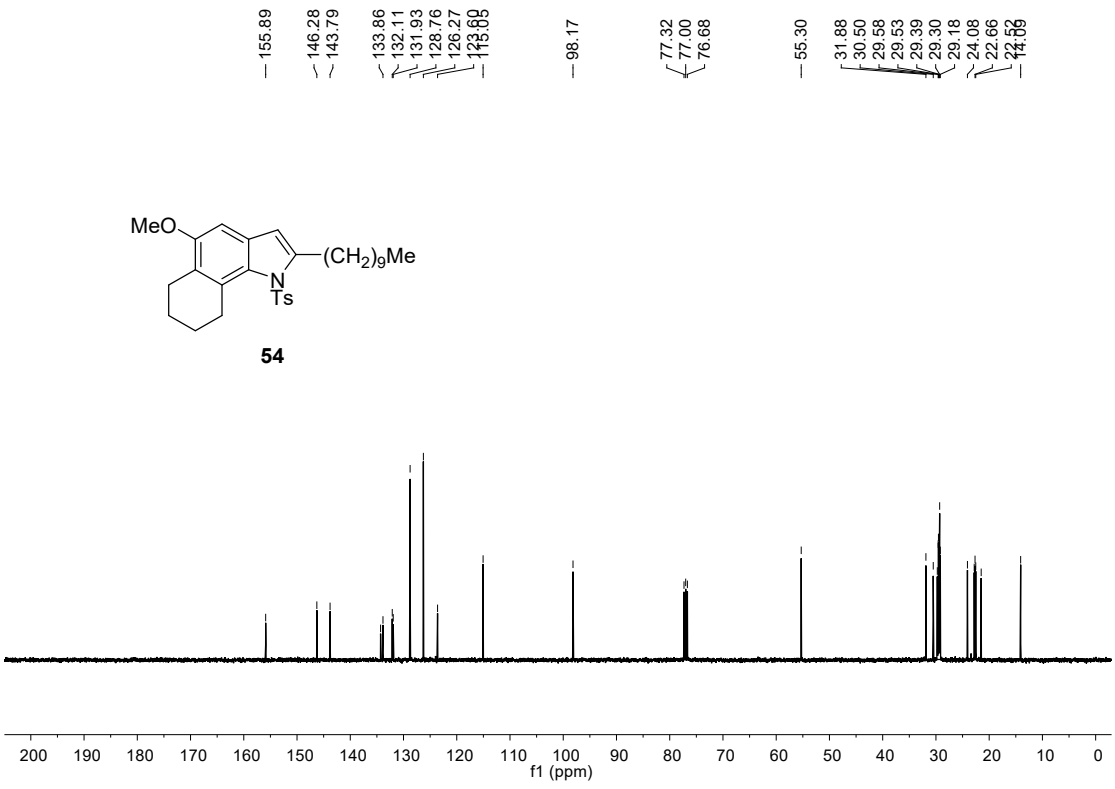
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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77.00
76.68
55.30
31.88
30.50
29.58
29.53
29.39
29.30
29.18
24.08
22.66
MeO
(CH2)9Me
N
Ts
54
200
190
180
170
160
150
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130
120
110
100
90
80
70
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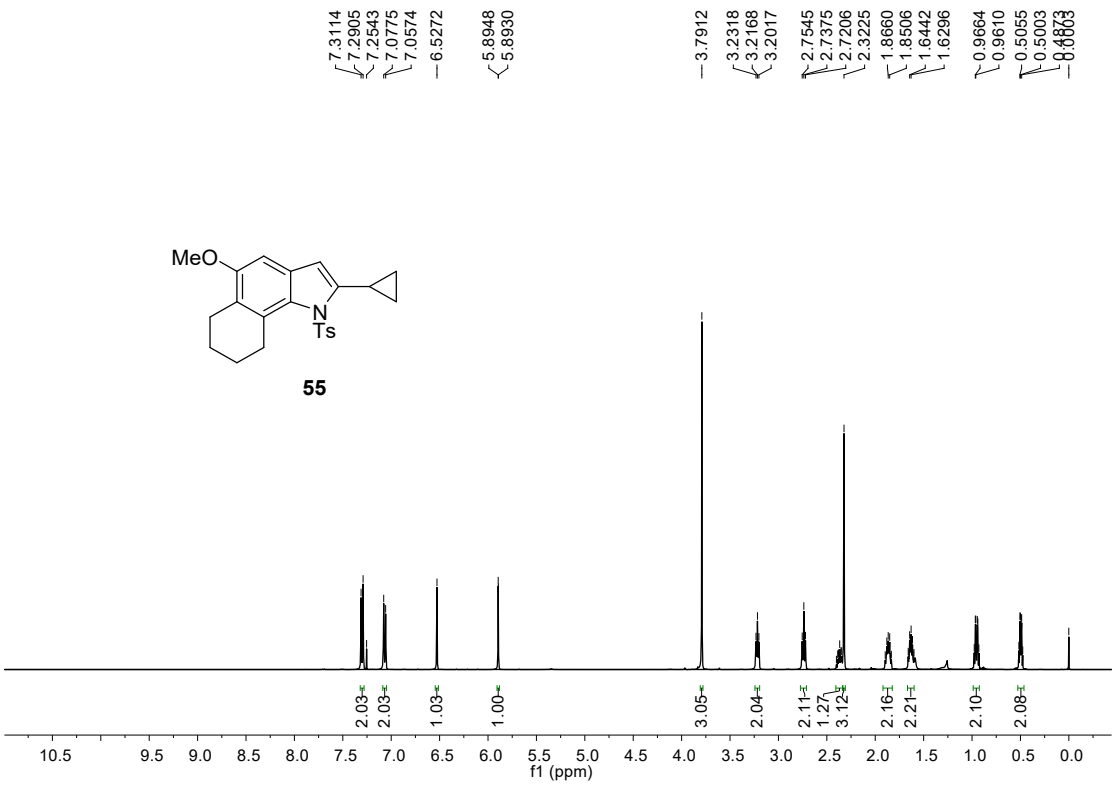
50
40
30
20
10
0
f1 (ppm)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3.7912
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3.2168
3.2017
2.7545
2.7375
2.7206
2.3225
1.8660
1.8506
1.6442
1.6296
0.9664
0.9610
0.5055
0.5003
MeO
N
Ts
55
2.03
2.03
1.03
1.00
3.05
2.04
2.11
1.27
3.12
2.16
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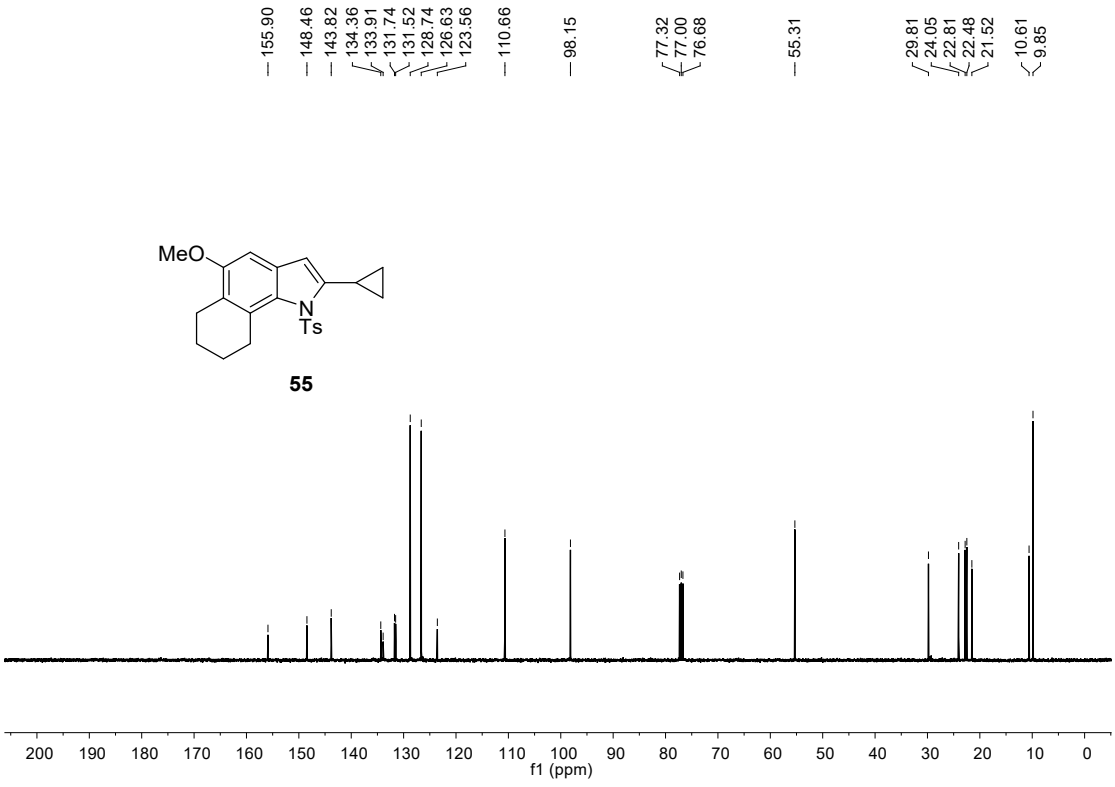
2.10
2.08
f1 (ppm)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98.15
77.32
77.00
76.68
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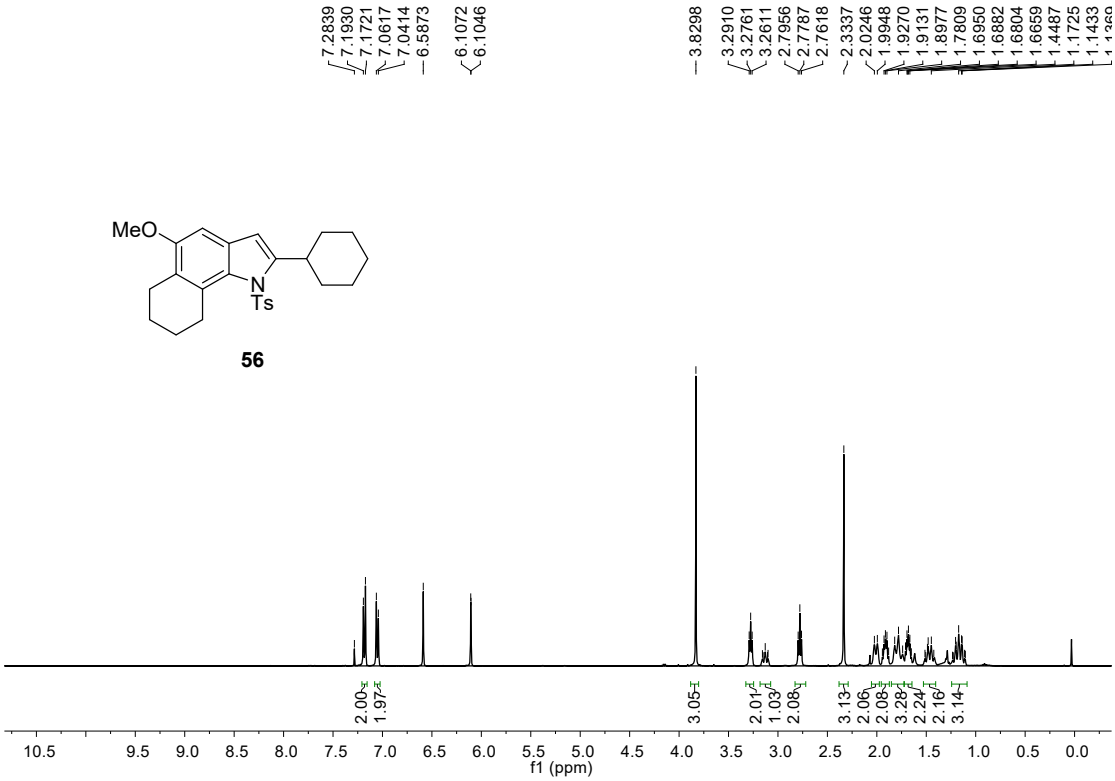
22.81
22.48
21.52
10.61
9.85
MeO
N
Ts
55
f1 (ppm)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6.1046
3.8298
3.2910
3.2761
3.2611
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2.7787
2.7618
2.3337
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1.9270
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1.6804
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MeO
N
Ts
56
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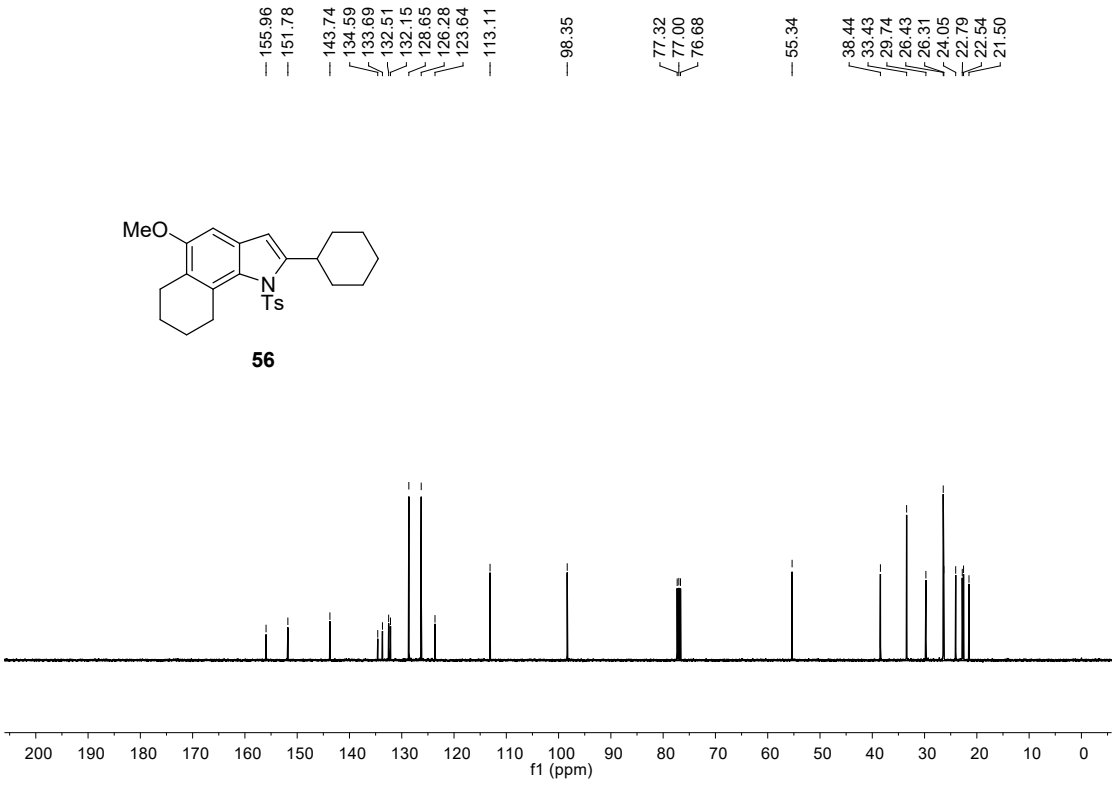
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76.68
55.34
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Ts
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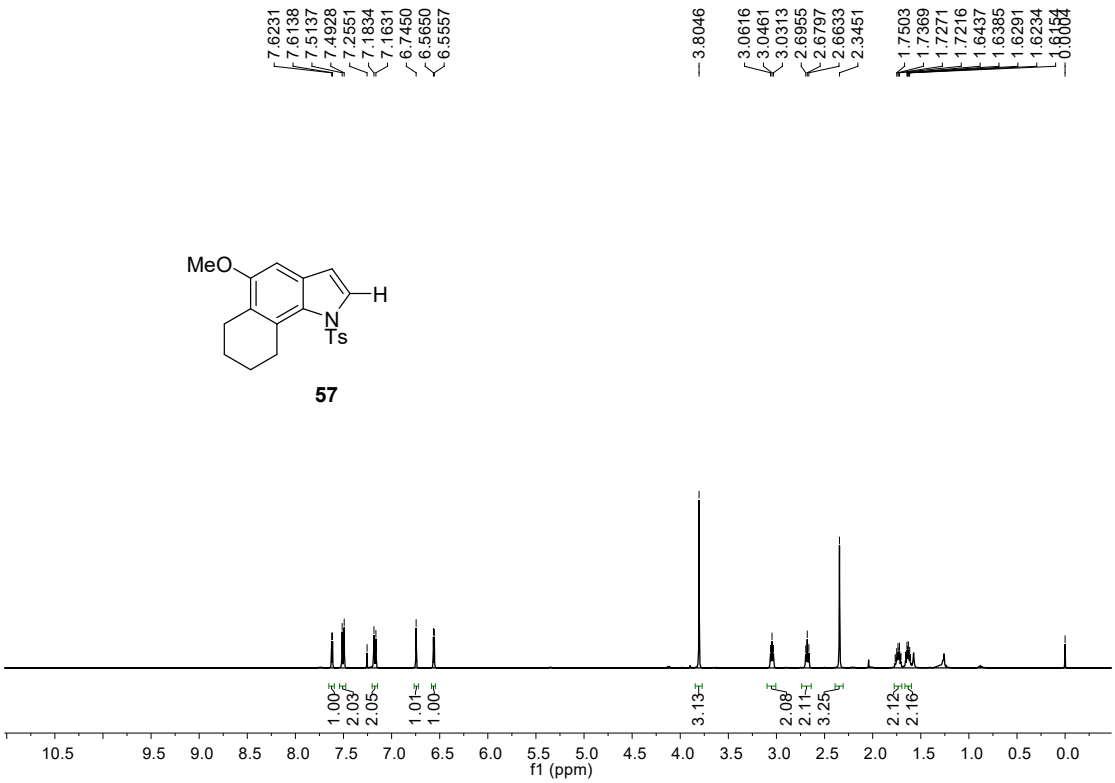
f1 (ppm)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3.0616
3.0461
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1.6291
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H
N
Ts
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1.00
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2.08
2.11
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f1 (ppm)

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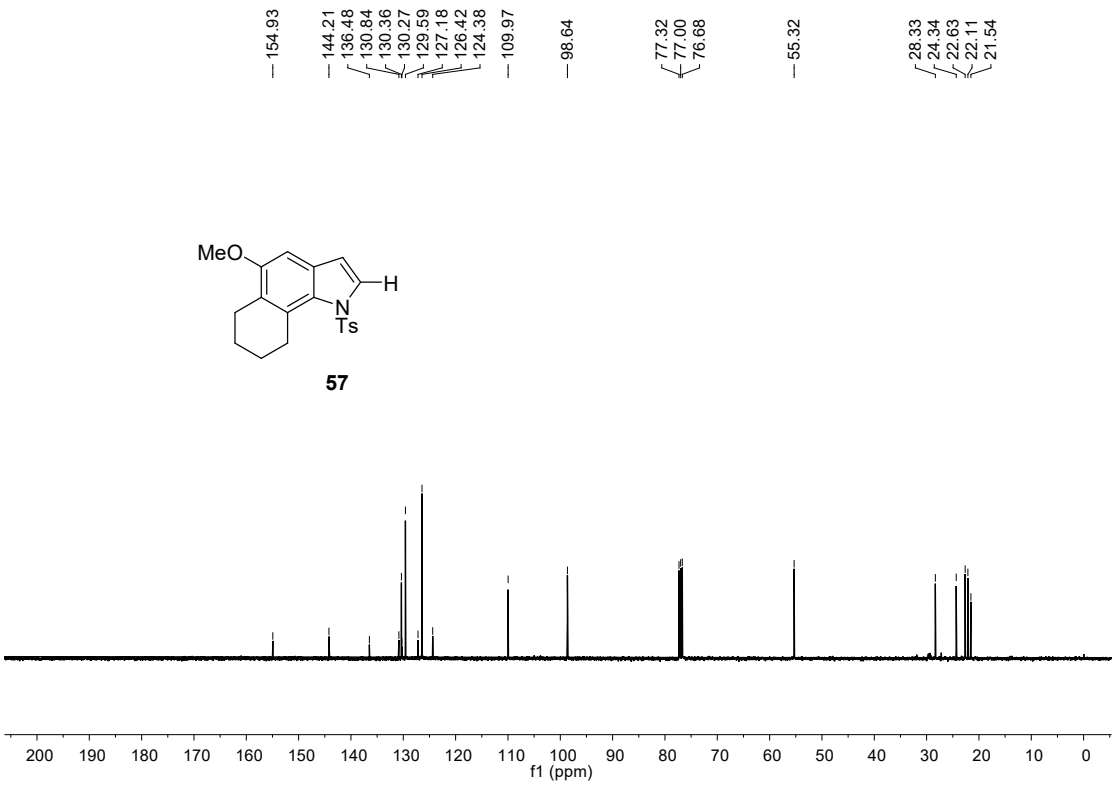
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77.32
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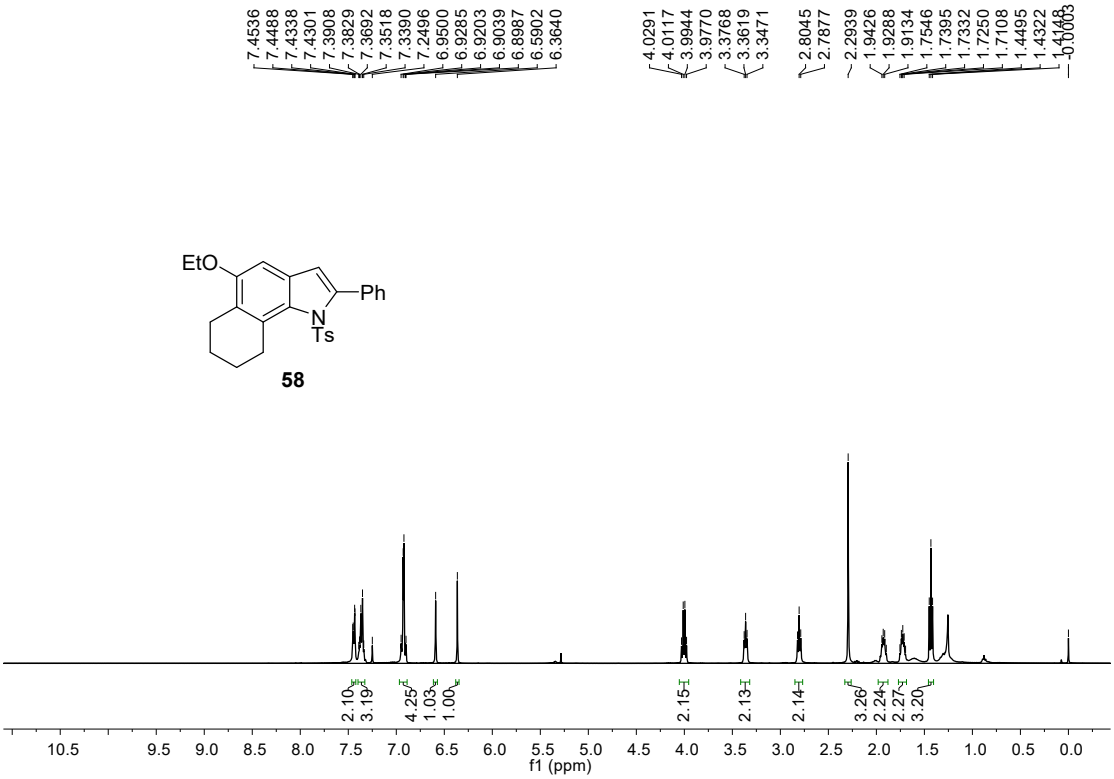
MeO
H
N
Ts
f1 (ppm)

57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4.0117
3.9944
3.9770
3.3768
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3.3471
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2.2939
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1.9288
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1.7108
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EtO
Ph
N
Ts
58
2.10
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2.13
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3.26
2.24
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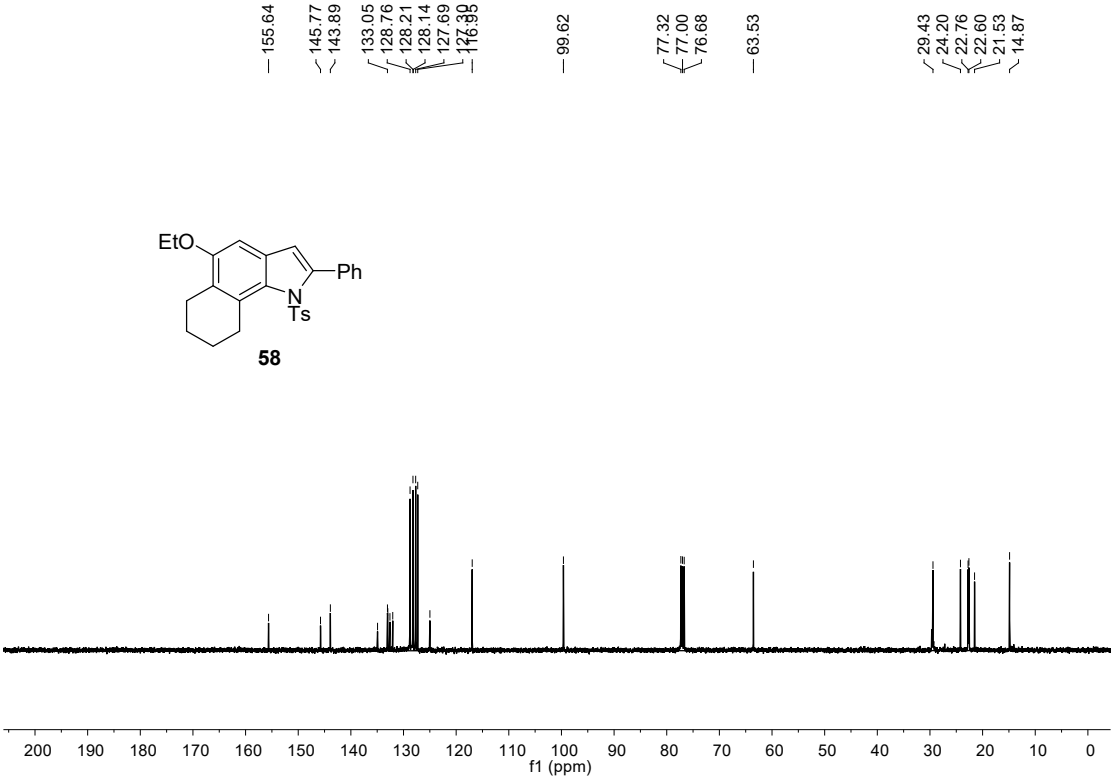
f1 (ppm)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29.43
24.20
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22.60
21.53
14.87
EtO
Ph
N
Ts
58
f1 (ppm)


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7.4469
7.4321
7.4283
7.4106
7.3920
7.3835
7.3782
7.3703
7.3544
7.3418
7.3258
7.3220
7.2505
6.9526
6.9313
6.9199
6.8985
6.6054
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3.3792
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2.7856
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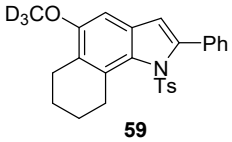
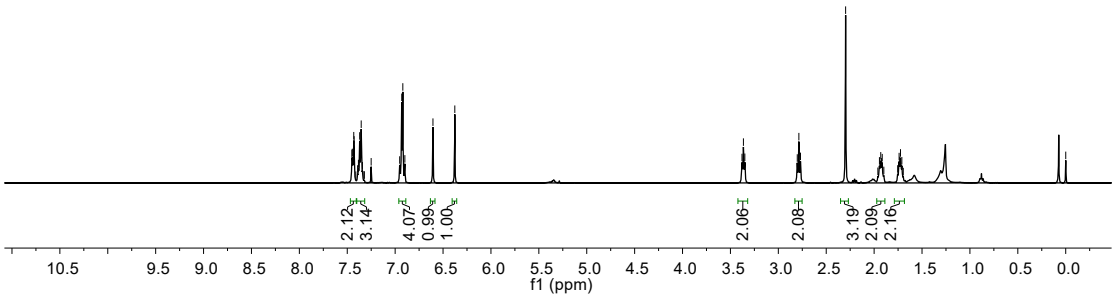

D3CO
Ph
N
Ts

59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2.09
2.16
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
4.0
3.5
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2.5
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1.0
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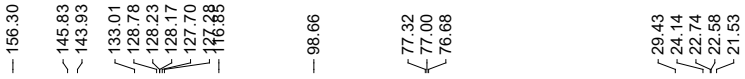
0.0
f1 (ppm)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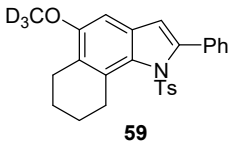
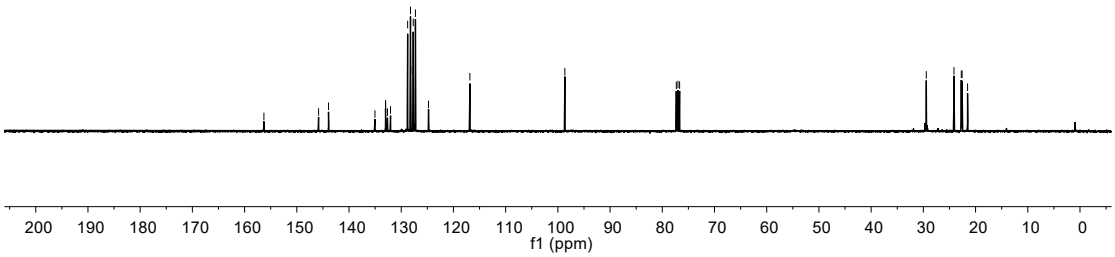
29.43
24.14
22.74
22.58
21.53


D3CO
Ph
N
Ts

59


200
190
180
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140
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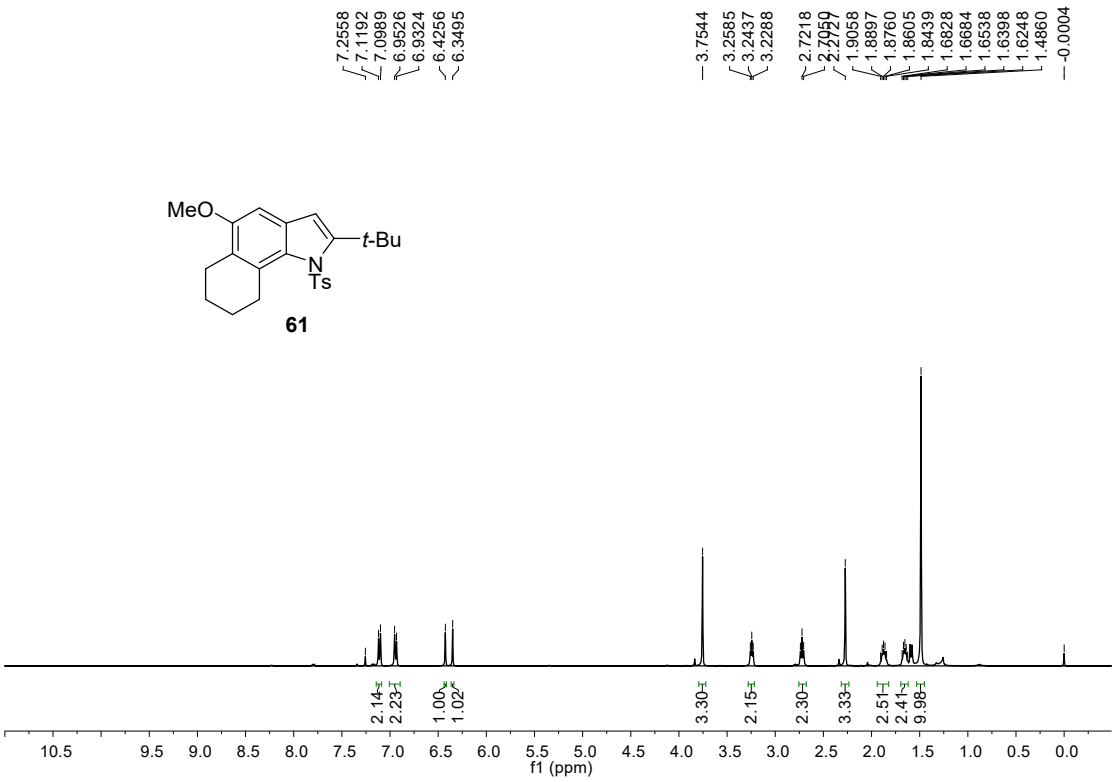
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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6.9324
6.4256
6.3495
3.7544
3.2585
3.2437
3.2288
2.7218
2.7050
2.7027
1.9058
1.8897
1.8760
1.8605
1.8439
1.6828
1.6684
1.6538
1.6398
1.6248
1.4860
-0.0004
MeO
t-Bu
N
Ts
61
2.14
2.23
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1.02
3.30
2.15
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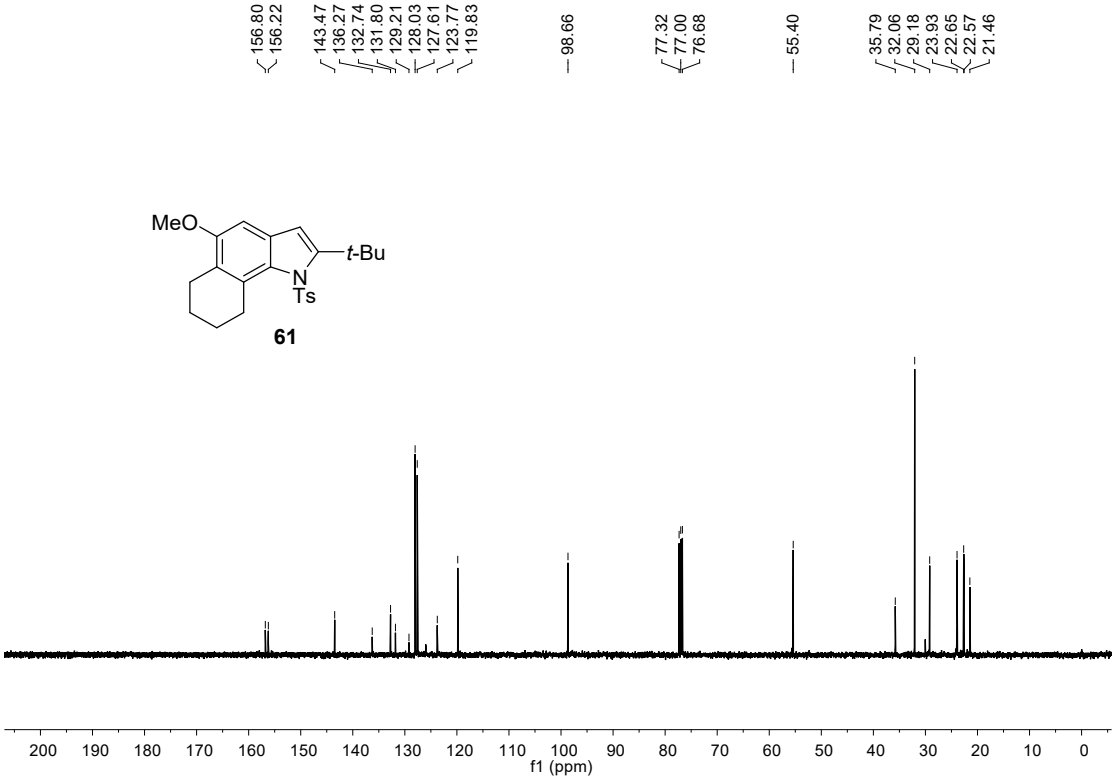
3.33
2.51
2.41
9.98
f1 (ppm)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77.32
77.00
76.68
55.40
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29.18
23.93
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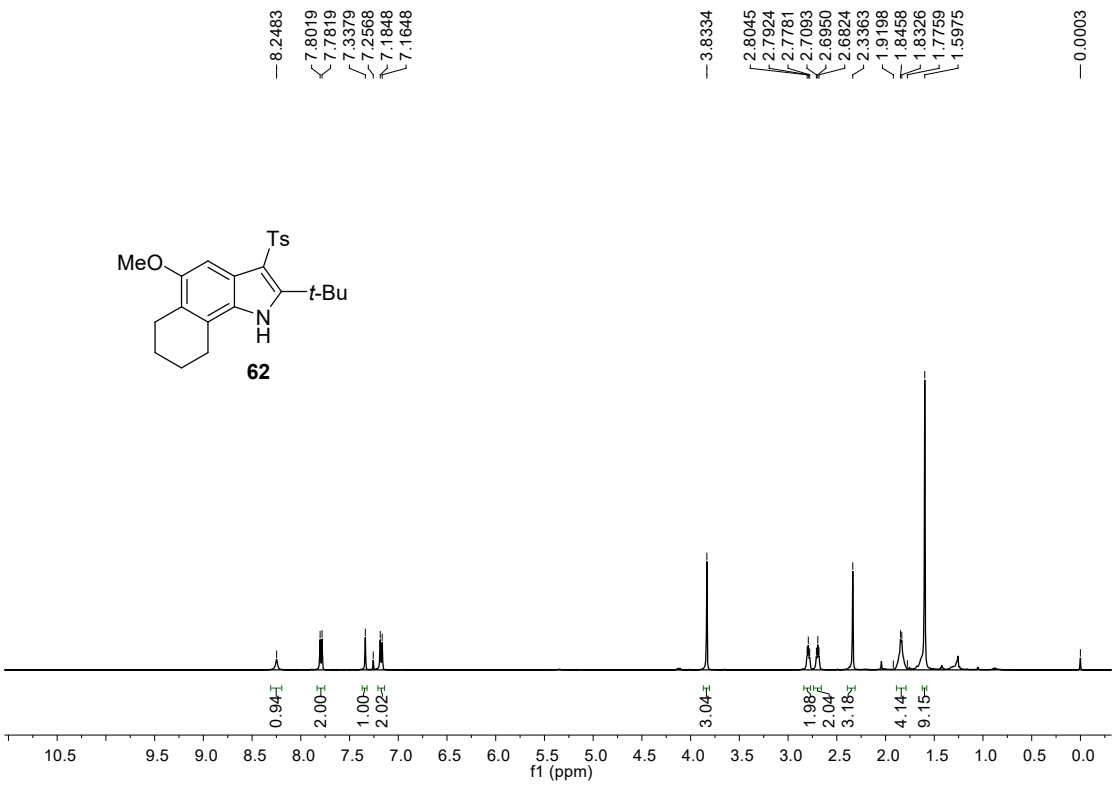
21.46
MeO
t-Bu
N
Ts
61
f1 (ppm)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2.7781
2.7093
2.6950
2.6824
2.3363
1.9198
1.8458
1.8326
1.7759
1.5975
0.0003
Ts
MeO
t-Bu
N
H
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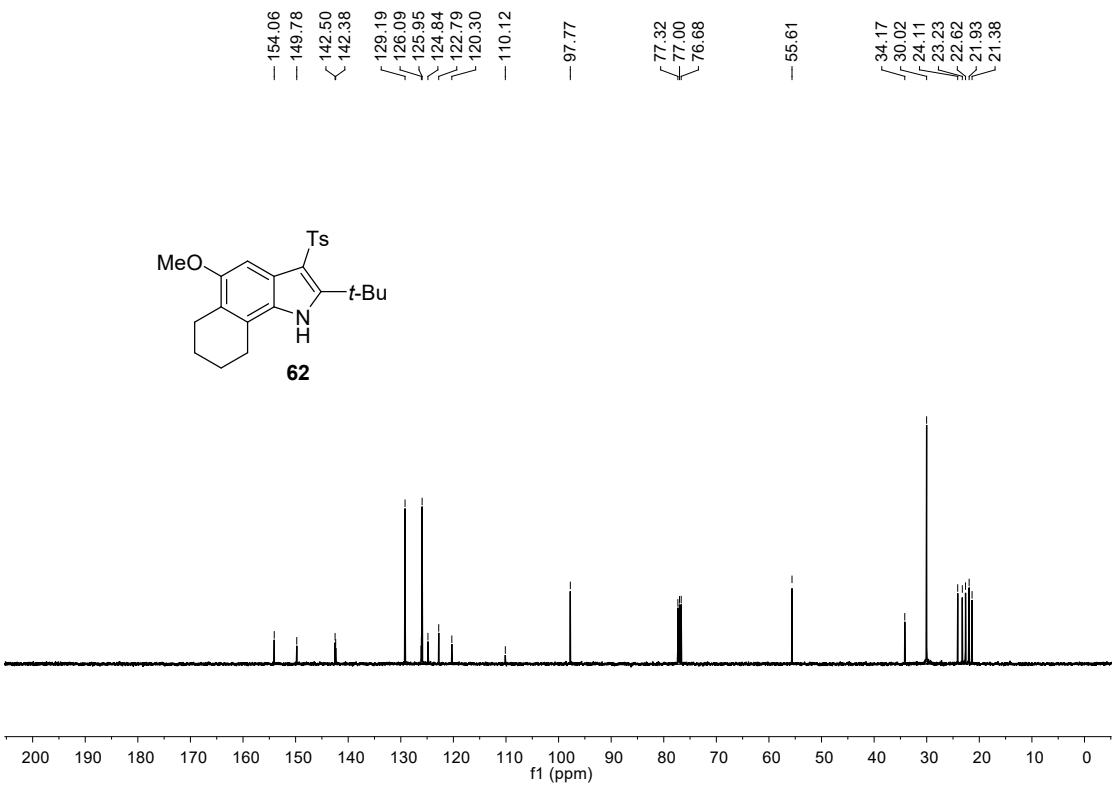
1.00
2.02
3.04
1.98
2.04
3.18
4.14
9.15
f1 (ppm)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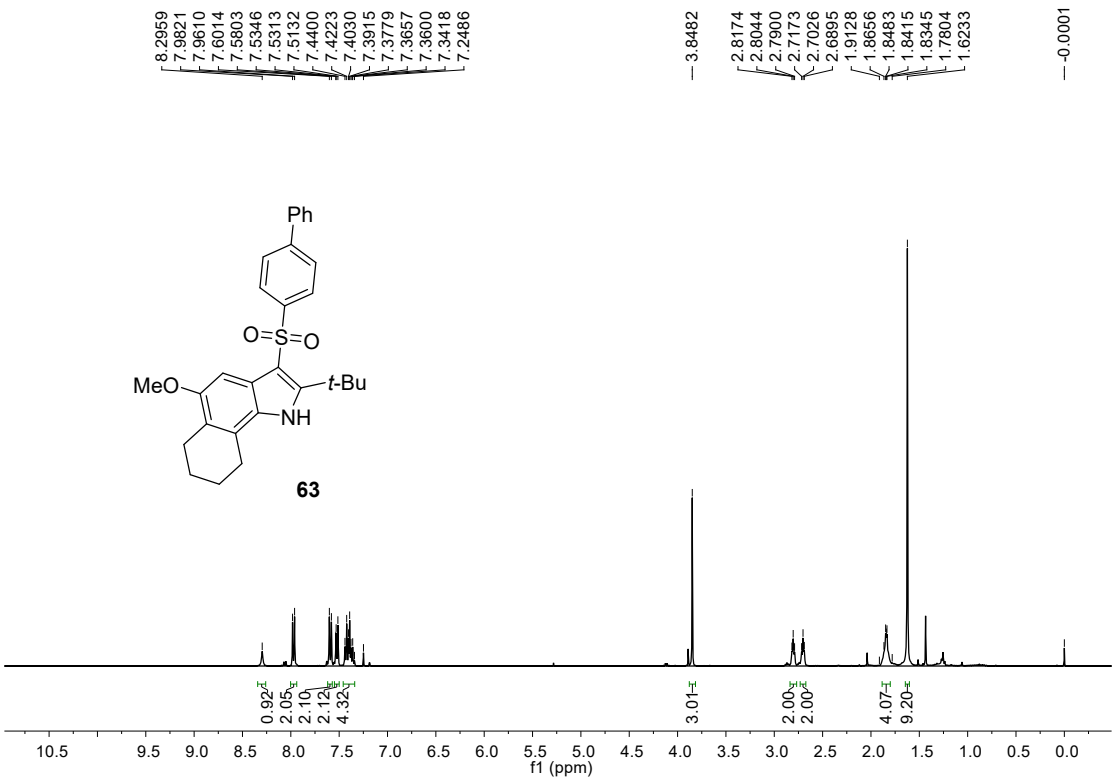
120.30
110.12
97.77
77.32
77.00
76.68
55.61
34.17
30.02
24.11
23.23
22.62
21.93
21.38
Ts
MeO
t-Bu
N
H
62
f1 (ppm)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7.3657
7.3600
7.3418
7.2486
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2.7900
2.7173
2.7026
2.6895
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1.8656
1.8483
1.8415
1.8345
1.7804
1.6233
-0.0001
Ph
O=S=O
MeO
t-Bu
NH
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2.00
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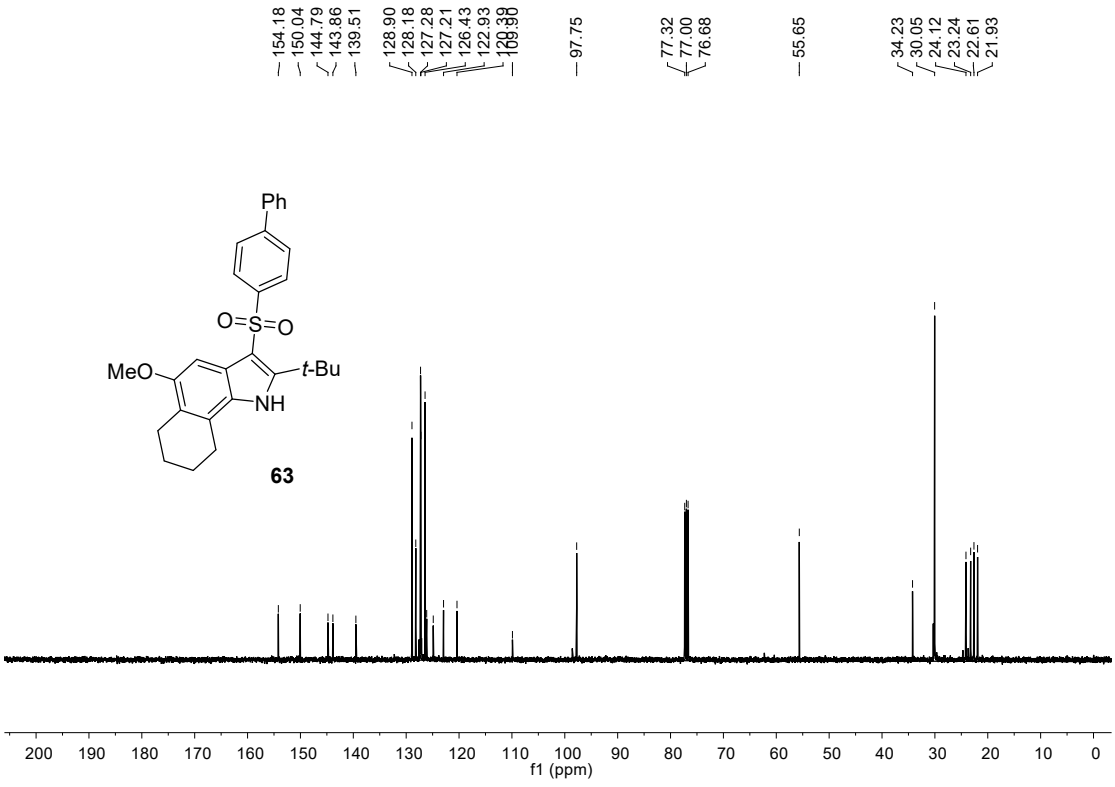
9.20
f1 (ppm)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97.75
77.32
77.00
76.68
55.65
34.23
30.05
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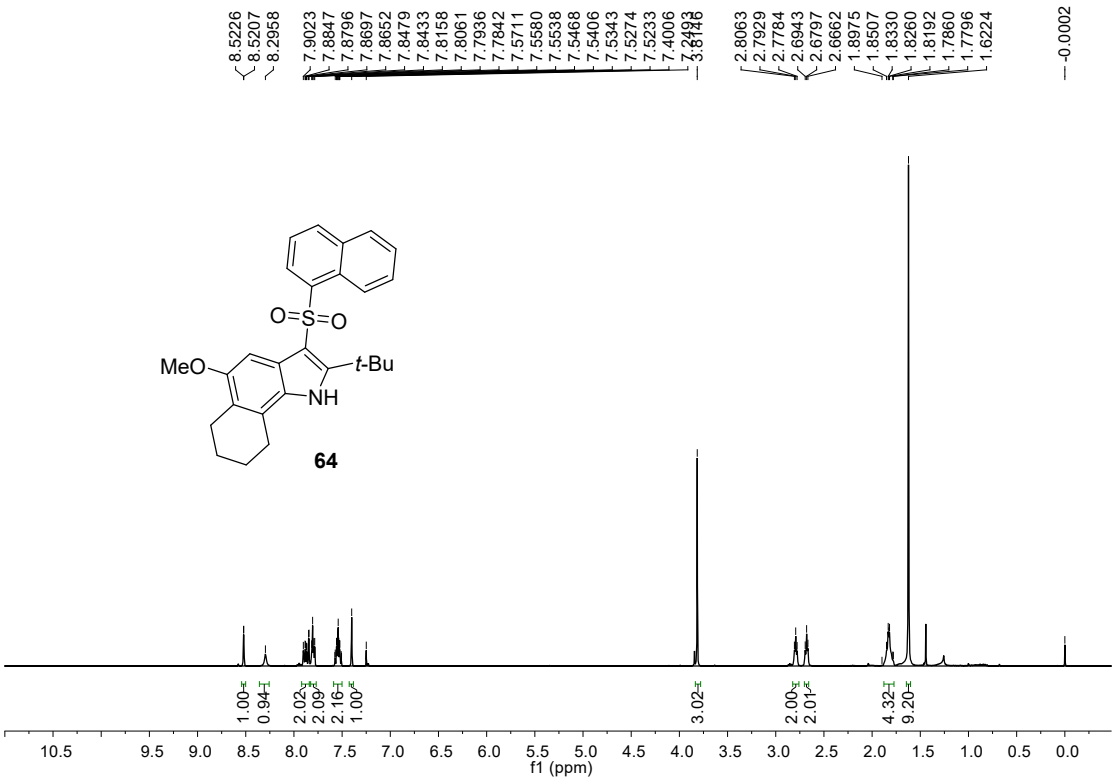
23.24
22.61
21.93
Ph
O=S=O
MeO
t-Bu
NH
63
f1 (ppm)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7.8697
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7.8433
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7.7936
7.7842
7.5711
7.5580
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7.5468
7.5406
7.5343
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2.7929
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2.6797
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1.8507
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1.6224
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MeO
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NH
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2.09
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1.00
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2.01
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10.5
9.5
9.0
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8.0
7.5
7.0
6.5
6.0
5.5
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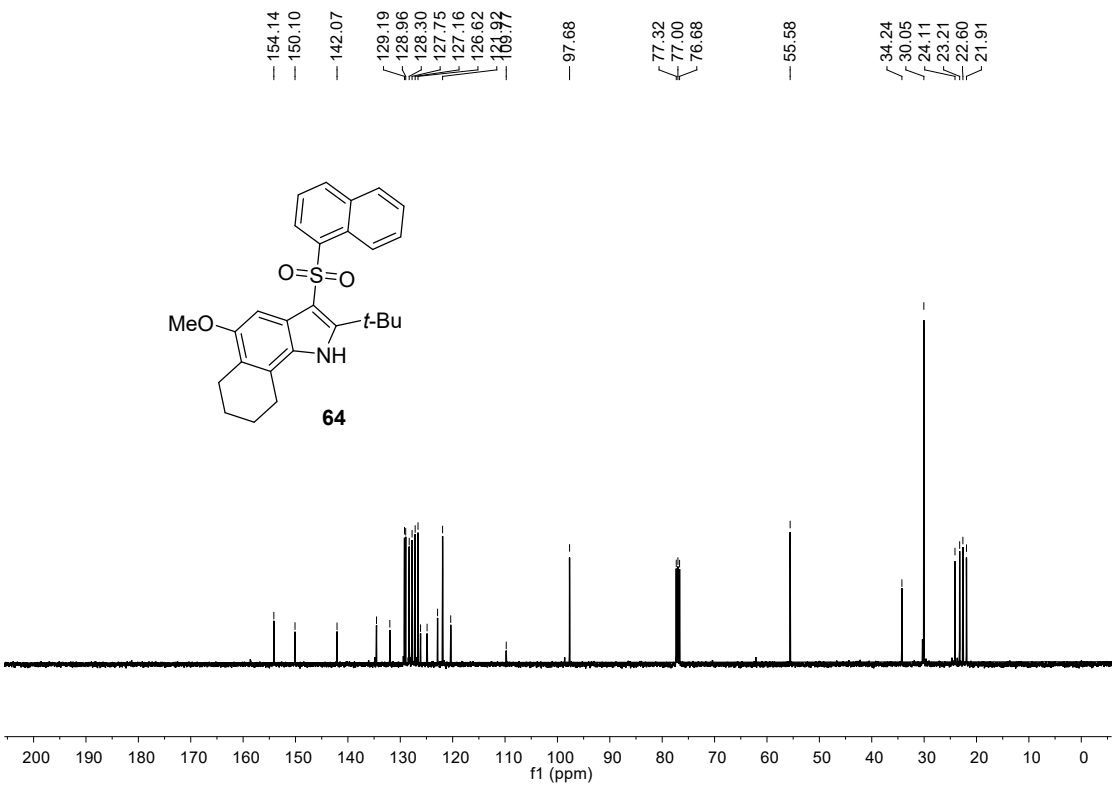
f1 (ppm)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128.30
127.75
127.16
126.62
97.68
77.32
77.00
76.68
55.58
34.24
30.05
24.11
23.21
22.60
21.91
O=S=O
MeO
t-Bu
NH
64
200
190
180
170
160
150
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130
120
110
100
90
80
70
60
50
40
30
20
10
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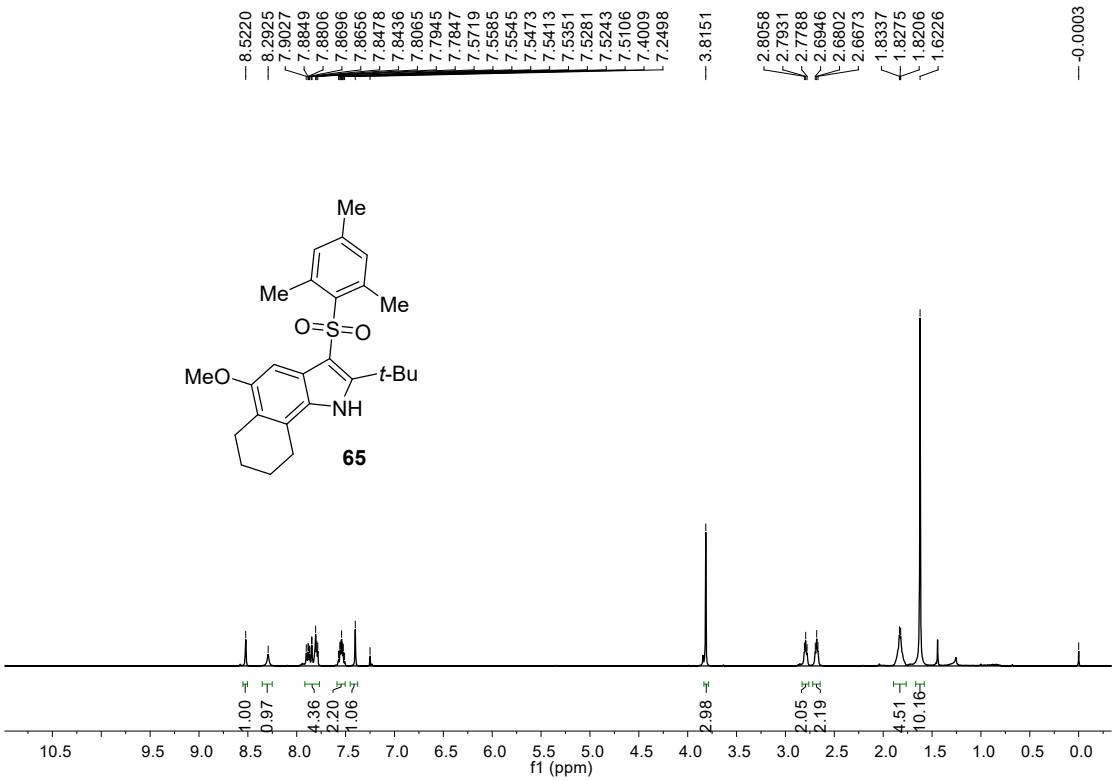
f1 (ppm)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7.7847
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7.5545
7.5473
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7.4009
7.2498
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2.6946
2.6802
2.6673
1.8337
1.8275
1.8206
1.6226
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Me
Me
O=S=O
MeO
t-Bu
NH
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2.05
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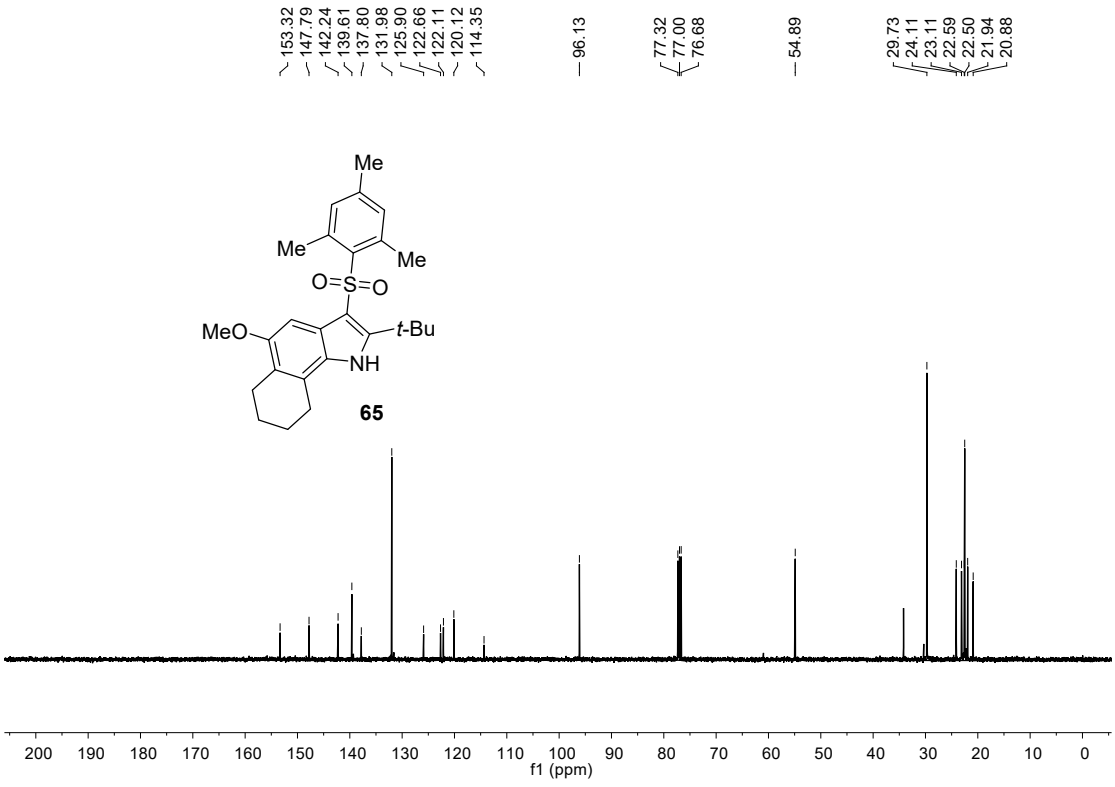
f1 (ppm)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77.00
76.68
54.89
29.73
24.11
23.11
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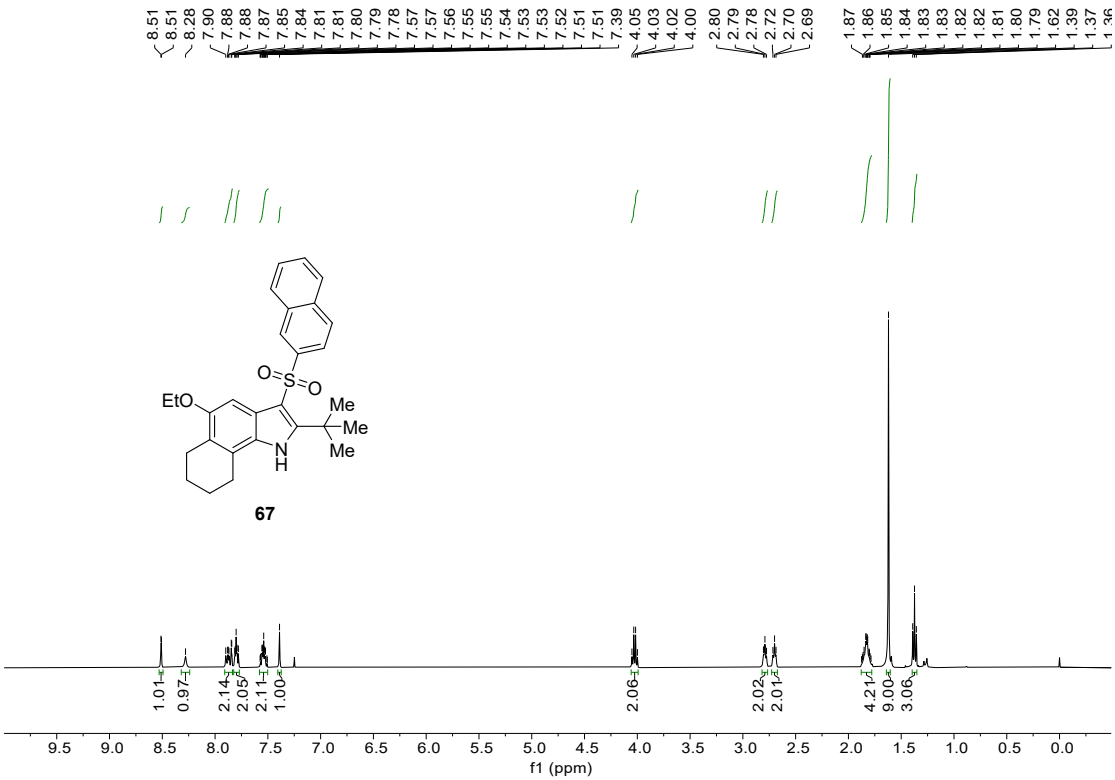
21.94
20.88
Me
Me
Me
O=S=O
MeO
t-Bu
NH
65
f1 (ppm)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7.79
7.78
7.57
7.57
7.56
7.55
7.55
7.54
7.53
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7.52
7.51
7.51
7.39
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4.02
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1.80
1.79
1.62
1.39
1.37
EtO
Me
Me
Me
N
H
O
S
O
67
1.01
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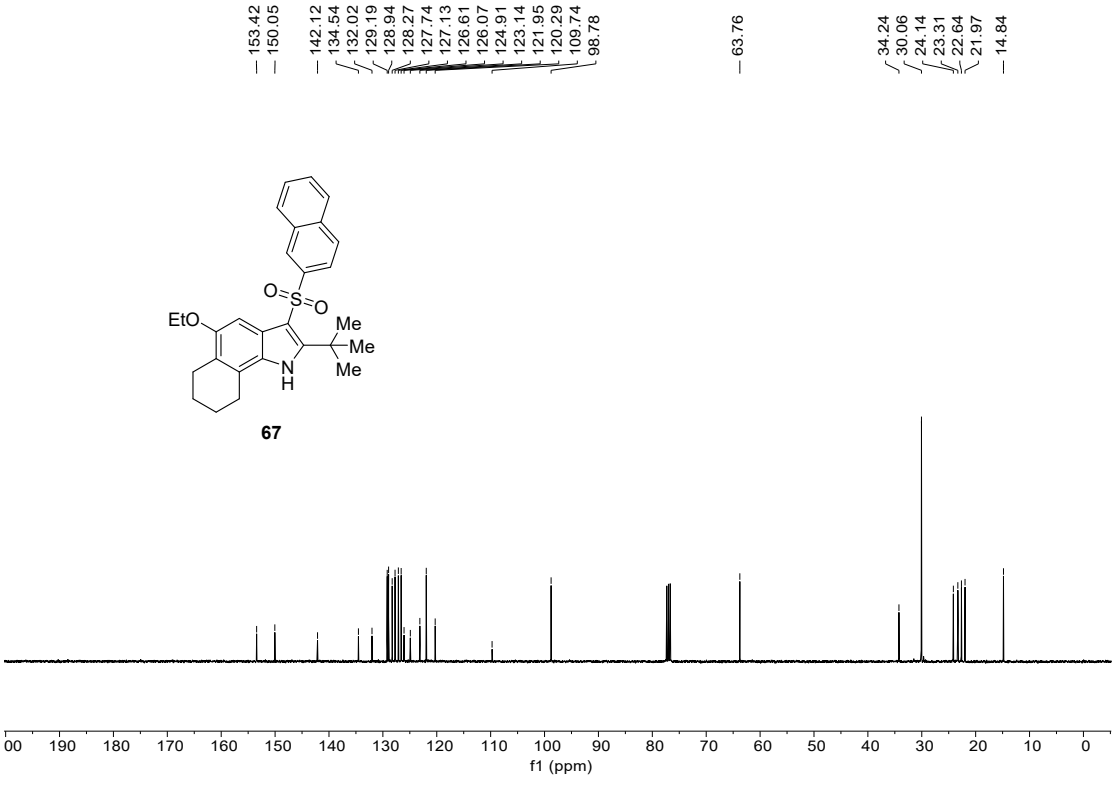
f1 (ppm)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120.29
109.74
98.78
63.76
34.24
30.06
24.14
23.31
22.64
21.97
14.84
EtO
Me
Me
Me
N
H
O
S
O
67
f1 (ppm)

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