Supporting Information for

Cascade Reaction Involving Diels-Alder Cascade: Modular Synthesis of Amino α-Pyrones, Indolines and Anilines

Yangyong Shen,[a] Chaorong Wang,[a] Wei Chen,*[,b] and Sunliang Cui*[,a]

[a] *Institute of Drug Discovery and Design, College of Pharmaceutical Sciences, Zhejiang University, Hangzhou 310058, China*

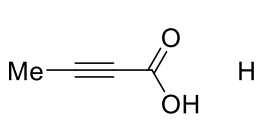
[b] *Department of Food Science and Nutrition, Zhejiang University, Hangzhou 310058, China*

Contents

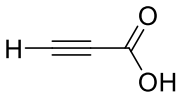
1. General Information

Infrared spectra were obtained on a FTIR spectrometer. ^{1}H NMR and ^{13}C NMRspectra were recorded on a WNMR-I-400 spectrometer and a BRUKER AVANCE III 600 spectrometer. $CDCl_3$ was used as solvent. Chemical shifts were referenced relative to residual solvent. The following abbreviations are used to describe peak patterns where appropriate: s = singlet, d = doublet, t = triplet, and coupling constants (*J*) are reported in Hertz (Hz). The HRMS were performed on Waters GCT Premier Time of Flight Mass Spectrometer (EI). Melting points were measured with micro melting point apparatus.

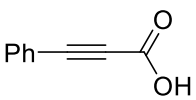
CH_2Cl_2, ethyl acetate (EA), acetonitrile, toluene, petroleum ether (PE) were commercial available, propiolic acids (**1a-1j**)[1] and ynamides (**2a-2u**)[2], [3], [4], [5] were prepared according to the reported literature.



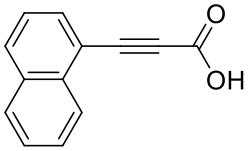
1a



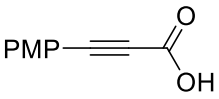
1b



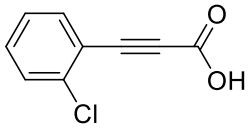
1c



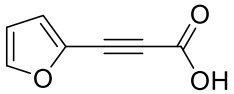
1d



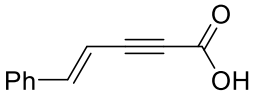
1e



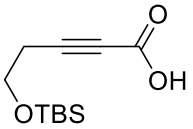
1f



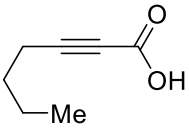
1g



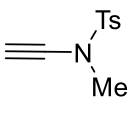
1h



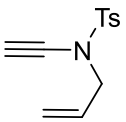
1i



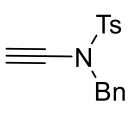
1j



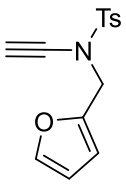
2a



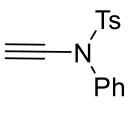
2b



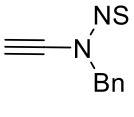
2c



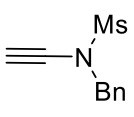
2d



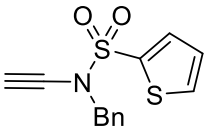
2e



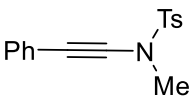
2f



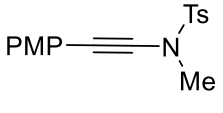
2g



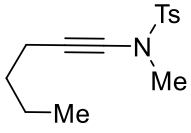
2h



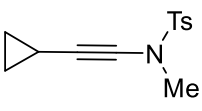
2i



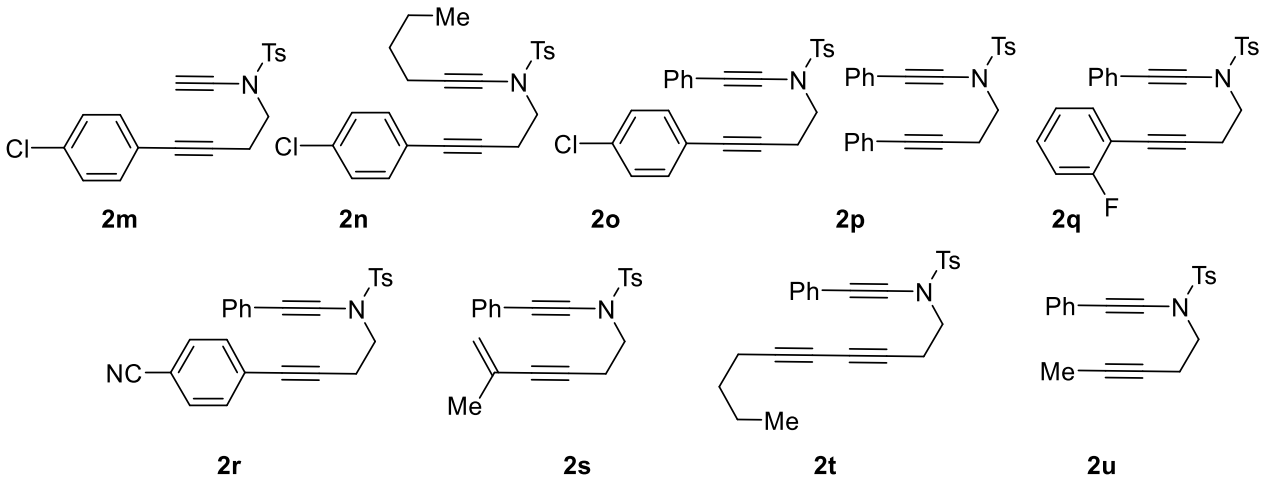
2j



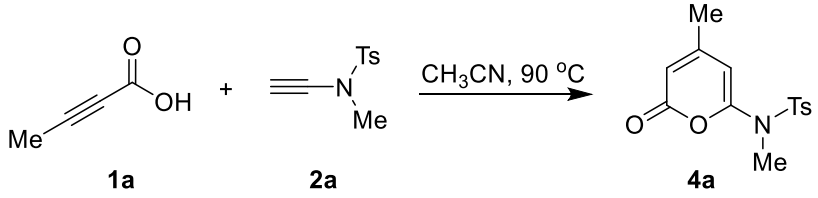
2k



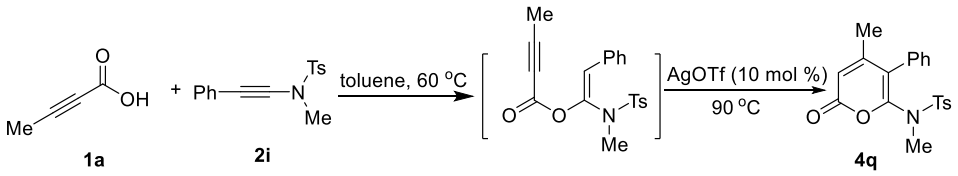
2l



2. Typical Procedure for the Synthesis of 4a and 4q

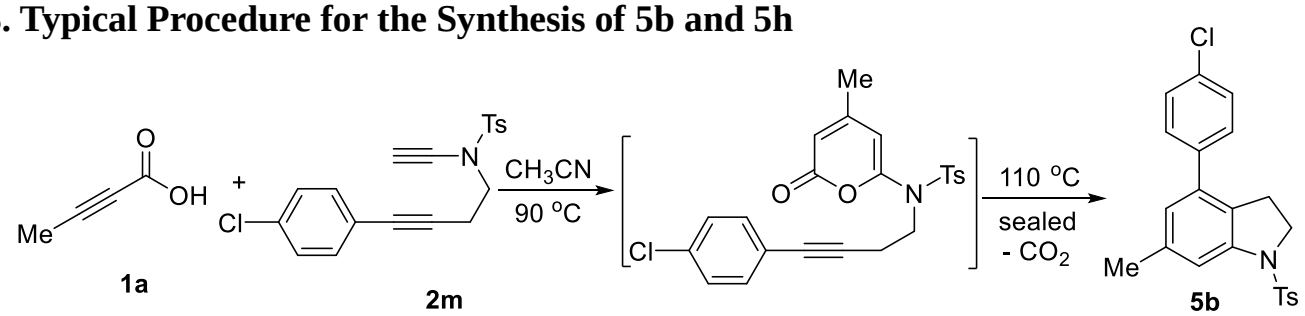


Condition A: To a schlenk tube was added but-2-ynoic acid **1a** (16.8 mg, 0.2 mmol), ynamide **2a** (41.8 mg, 0.2 mmol), CH_3CN (2 mL) as solvent. The solution was stirred under 90 °C until the starting material was fully consumed about 8 hours. Then the solution was concentrated. The residue was subject to flash column chromatography on silica gel using ethyl acetate/ petroleum ether (v/v, 1:8) as eluent to give **4a** as a white solid (53 mg, 90% yield).

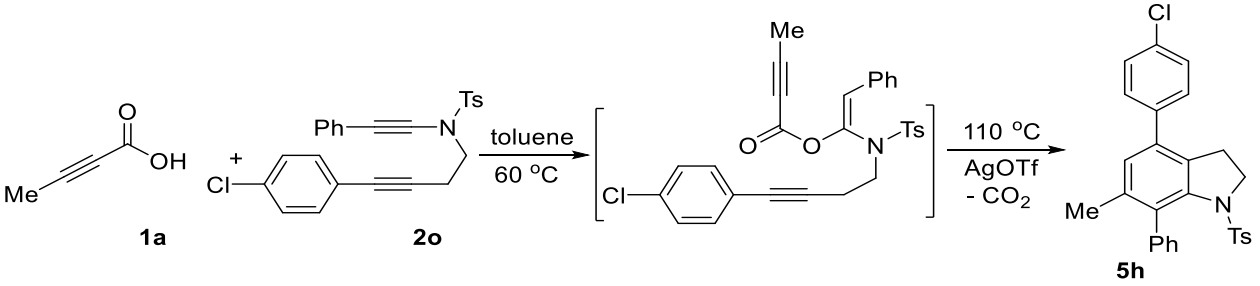


Condition B: To a schlenk tube was added but-2-ynoic acid **1a** (16.8 mg, 0.2 mmol), ynamide **2i** (57 mg, 0.2 mmol), toluene (2 mL, dry) as solvent. The solution was stirred under 60 °C until the starting material was fully converted to the intermediate product. AgOTf (5 mg, 10 mol %) was added, and temperature was raised to 90 °C for another 8 hours. Then the solution was concentrated. The residue was subject to flash column chromatography on silica gel using ethyl acetate/ petroleum ether (v/v, 1:8) as eluent to give **4q** as a white solid (63 mg, 85% yield).

3. Typical Procedure for the Synthesis of 5b and 5h

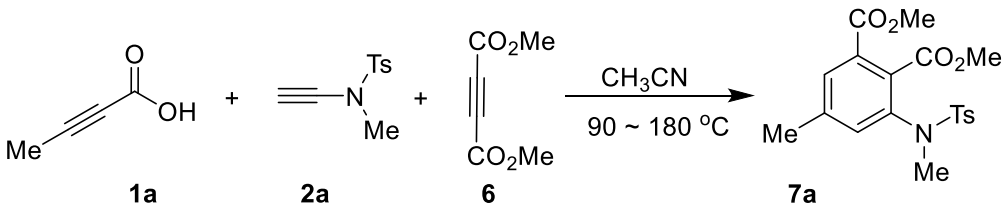


Condition A: To a schlenk tube was added but-2-ynoic acid **1a** (16.8 mg, 0.2 mmol), ynamide **2m** (71.5 mg, 0.2 mmol) and CH_3CN (2 mL). The solution was sealed to stir under 90 °C until the starting material was fully consumed about 8 hours. Afterword, the schlenk tube was heated under 110 °C for 24 hours. Then the solution was concentrated. The residue was subject to flash column chromatography on silica gel using ethyl acetate/ petroleum ether (v/v, 1:15) as eluent to give **5b** as a white solid (70 mg, 88% yield).



Condition B: To a schlenk tube was added but-2-ynoic acid **1a** (16.8 mg, 0.2 mmol), ynamide **2o** (86.8 mg, 0.2 mmol) and toluene (2 mL, dry). The solution was stirred under 60 °C until the starting material was fully consumed about 2 hours. Afterword, the schlenk tube was added AgOTf (5 mg, 10%) and continued for 24 hours under 110 °C. Then the solution was concentrated. The residue was subject to flash column chromatography on silica gel using ethyl acetate/ petroleum ether (v/v, 1:15) as eluent to give **5h** as a white solid (69 mg, 73% yield).

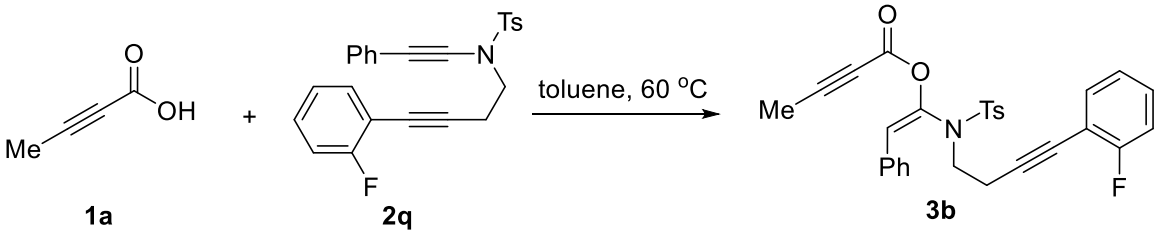
4. Typical Procedure for the Synthesis of 7a



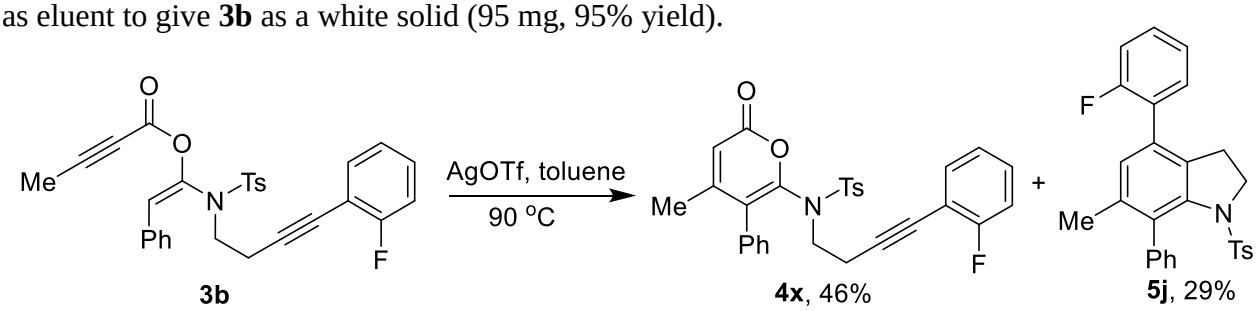
To a schlenk tube was added but-2-ynoic acid **1a** (16.8 mg, 0.2 mmol), ynamide **2a** (41.8 mg,

0.2 mmol), dimethyl acetylenedicarboxylate **6** (57 mg, 0.4 mmoL) and CH_3CN (2 mL). The solution was sealed to stir under 90 ^oC until the **1a** and **2a** was fully consumed about 8 hours, subsequently 180 ^oC for 48 hours. Then the solution was concentrated. The residue was subject to flash column chromatography on silica gel using ethyl acetate/ petroleum ether (v/v, 1:5) as eluent to give **7a** as white solid (57 mg, 73% yield).

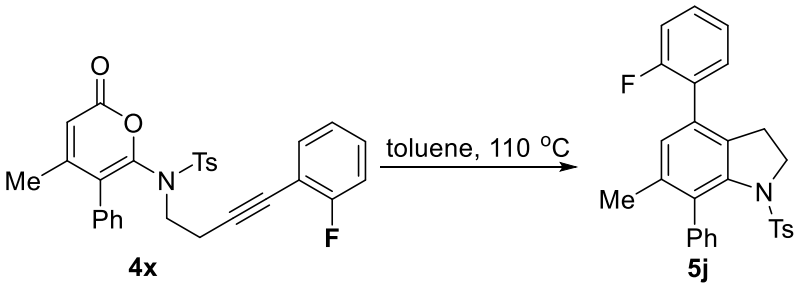
5. Control Experiments



To a schlenk tube was added but-2-ynoic acid **1a** (16.8 mg, 0.2 mmol), ynamide **2q** (83.4 mg, 0.2 mmol), toluene (2 mL) as solvent. The solution was stirred under 60 ^oC until the starting material was fully converted to the intermediate product. Then the solution was concentrated. The residue was subject to flash column chromatography on silica gel using ethyl acetate/ petroleum ether (v/v, 1:8) as eluent to give **3b** as a white solid (95 mg, 95% yield).



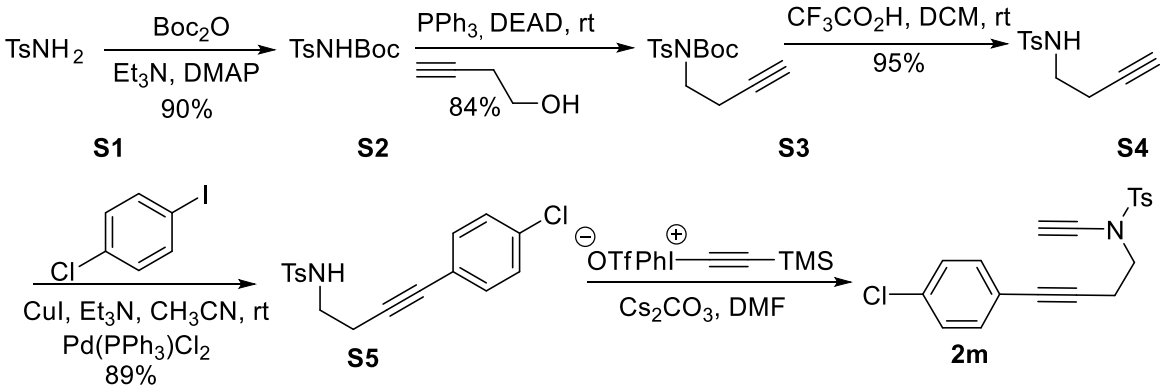
To a schlenk tube was added **3b** (50 mg, 0.1 mmol), AgOTf (3 mg, 10%), toluene (2 mL, dry) as solvent. The solution was stirred under 90 ^oC for 4 hours. Then the solution was concentrated. The residue was subject to flash column chromatography on silica gel using ethyl acetate/ petroleum ether (v/v, 1:20, 1:5) as eluent to give **4x** (23 mg, 46% yield) and **5j** (13 mg, 29% yield) as white solid .



4x **5j**

To a schlenk tube was added **4x** (50 mg, 0.1 mmol), toluene (2 mL, dry) as solvent. The solution was stirred under 110 °C for 4 hours. Then the solution was concentrated. The residue was subject to flash column chromatography on silica gel using ethyl acetate/ petroleum ether (v/v, 1:20) as eluent to give **5j** (42 mg, 92% yield) as white solid.

6. Procedure for the Synthesis of 2



S2: A solution of Boc_2O (13.2 mL, 57.5 mmol) in dichloromethane (15 mL) was added dropwise at room temperature to a solution of triethylamine (7.6 mL, 55.0 mmol), DMAP (0.6 g, 5.0 mmol) and p-toluenesulfonamide **S1** (8.55 g, 50.0 mmol) in dichloromethane (60 mL). The colorless reaction mixture was stirred at room temperature for 5 h. After completion the solvent was removed under vacuum, the residue was diluted with ethyl acetate (60 mL) and 1N HCl (40 mL). An organic layer was washed with water, brine and then dried over $MgSO_4$ and concentrated on a rotary evaporator to give a white solid. Crystallization from hot hexane (50 mL) gave **S2** (12.2 g, 90%).

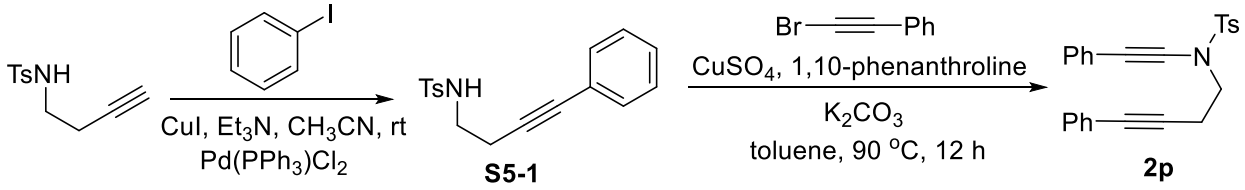
S3: A solution of triphenylphosphine (1.44 g, 5.5 mmol), but-3-yn-1-ol (0.39 g, 5 mmol) and **S2** (1.35g, 5 mmol) in dry THF (15 mL) was stirred for 10 minutes. Diethyl azodicarboxylate (0.96 g, 5.5 mmol) was then added at 0 °C. The reaction mixture was stirred at 25 °C for 8 h. The solvent was removed by a rotary evaporator and the residue was purified by silica gel flash chromatography (1:10 ethyl acetate/ petroleum ether) to afford the desired substrate **S3** (1.49 g, 84%).

S4: To a solution of **S3** (1 g, 3.1 mmol) in DCM (5 mL) was added TFA (1.15 mL, 15.5 mmol)

and the mixture was stirred at room temperature for 3 h. The reaction was quenched by saturated aqueous $NaHCO_3$ solution and was extracted with DCM. The combined organic layers were washed with brine, dried over $MgSO_4$ and concentrated under vacuo. The residue was purified by flash chromatography (1:5 ethyl acetate/ petroleum ether) to afford the desired substrate **S4** (0.66 g, 95%).

S5: To a solution of **S4** (0.5 g, 2.2 mmol) in CH_3CN (5 mL) was added iodobenzene (0.6 g , 2.5 mmol), $Pd(PPh_3)_4Cl_2$ (38 mg, 0.055 mmol), CuI (15 mg, 0.079 mmol), Et_3N (0.68 g, 6.6 mmol) and the mixture was stirred at room temperature for 12 h. The reaction was quenched by H_2O and was extracted with EA. The combined organic layers were washed with brine, dried over $MgSO_4$ and concentrated in vacuo. The residue was purified by flash chromatography (1:5 ethyl acetate/ petroleum ether) to afford the desired substrate **S5** (0.73 g, 95%).

2m: To a solution of **S5** (0.67 g, 2 mmol) in DMF (5 mL) was added Cs_2CO_3 (0.72 g , 2.2 mmol), trifluoromethanesulfonate iodonium was added dropwise to the solution sllowly under room temperature. The reaction was continue stirred for 2 h and then quenched by water, extracted with EA, The combined organic layers were washed with brine, dried over $MgSO_4$ and concentrated in vacuo. The residue was purified by flash chromatography (1:10 ethyl acetate/ petroleum ether) to afford the desired substrate **2m** (0.39 g, 55%). Light yellow oil; **^{1}H NMR ($CDCl_3$, 600MHz)** δ 7.82 (d, *J* = 8.4 Hz, 2H), 7.32 (d, *J* = 8.4 Hz, 2H), 7.29-7.24 (m, 4H), 3.59 (t, *J* = 7.2 Hz, 2H), 2.80 (s, 1H), 2.76 (t, *J* = 7.2 Hz, 2H), 2.42 (s, 3H). **^{13}C NMR ($CDCl_3$, 151MHz)** δ 145.1, 134.7, 134.1, 132.98, 130.0, 128.7, 127.8, 121.8, 88.3, 81.7, 75.6, 59.8, 50.1, 21.8, 19.4.

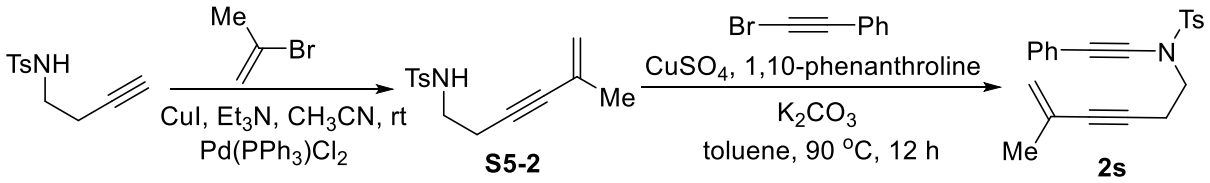


2p: To a mixture of **S5-1** (0.6 g, 2 mmol), K_2CO_3 (0.55 g, 4 mmol), $CuSO_4.5H_2O$ (50 mg, 0.2 mmol) and 1,10-phenanthroline (72 mg, 0.4 mmol) in a reaction vial was added a solution of 1-bromoalkyne (0.44 g, 2.4 mmol) in toluene. The reaction mixture was capped and heated in an oil bath at 90 °C for 12 h while being monitored with TLC analysis. Upon completion, the reaction mixture was cooled to room temperature and diluted with EtOAc and filtered through Celite, and the filtrate was concentrated under vacuum. The crude products were purified by silica gel flash column to afford the desired substrate **2p** (0.56 g, 70%). Light yellow oil; **^{1}H NMR ($CDCl_3$, 600MHz)** δ

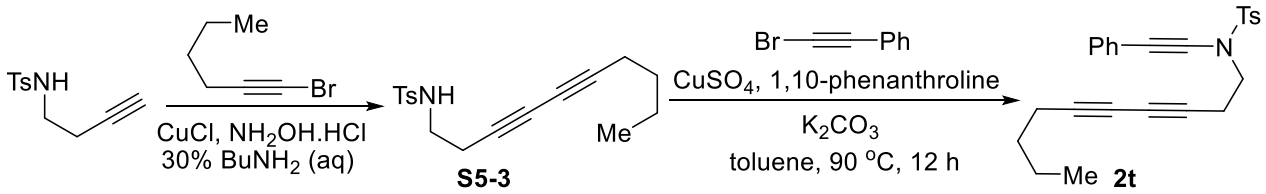
7.87 (d, *J* = 8.4 Hz, 2H), 7.38-7.33 (m, 6H), 7.30-7.26 (m, 6H), 3.70 (t, *J* = 7.8 Hz, 2H), 2.83 (t, *J* = 7.2 Hz, 2H), 2.43 (s, 3H). **^{13}C NMR ($CDCl_3$, 151MHz)** δ 144.9, 134.8, 131.8, 131.6, 130.0, 128.4, 128.3, 128.12, 128.06, 127.83, 85.4, 82.8, 82.0, 71.3, 50.6, 21.8, 19.7.

2n, 2o, **2q**, **2r** were synthesised analogously to the **2p**.

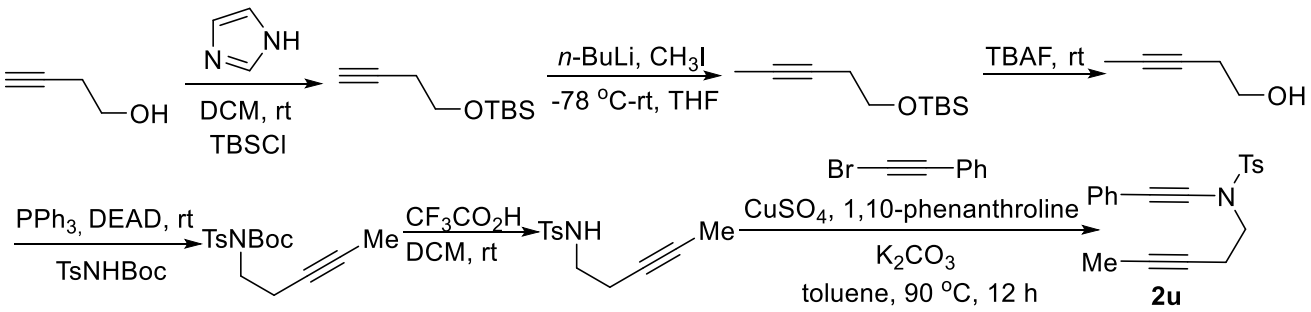
2n Light yellow oil; **^{1}H NMR ($CDCl_3$, 600MHz)** δ 7.80 (d, *J* = 8.4 Hz, 2H), 7.32-7.24 (m, 6H), 3.54 (t, *J* = 7.8 Hz, 2H), 2.73 (t, *J* = 7.2 Hz, 2H), 2.43 (s, 3H), 2.26 (t, *J* = 6.6 Hz, 2H), 1.48-1.43 (m, 2H), 1.39-1.33 (m, 2H), 0.89 (t, *J* = 7.2 Hz, 3H). **^{13}C NMR ($CDCl_3$, 151MHz)** δ 144.6, 134.9, 134.1, 133.0, 129.8, 128.7, 127.8, 121.9, 86.7, 81.5, 72.6, 71.0, 50.3, 31.1, 22.0, 21.8, 19.5, 18.3, 13.7.



2s Light yellow oil; **^{1}H NMR ($CDCl_3$, 600MHz)** δ 7.86 (d, *J* = 8.4 Hz, 2H), 7.38-7.35 (m, 4H), 7.30-7.29 (m, 3H), 5.22 (s, 1H), 5.17 (s, 1H), 3.61 (t, *J* = 7.2 Hz, 2H), 2.72 (t, *J* = 7.2 Hz, 2H), 2.45 (s, 3H), 1.84 (s, 3H). **^{13}C NMR ($CDCl_3$, 151MHz)** δ 144.9, 134.7, 131.5, 130.0, 128.4, 128.0, 127.8, 126.8, 122.7, 121.6, 84.3, 84.0, 81.9, 71.2, 50.6, 23.6, 21.8, 19.5.

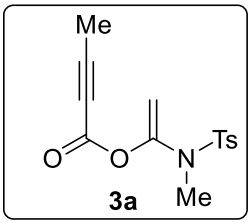


2t Light yellow oil; **^{1}H NMR ($CDCl_3$, 600MHz)** δ 8.15 (d, *J* = 7.8 Hz, 1H), 7.93 (s, 1H), 7.80 (d, *J* = 7.2 Hz, 1H), 7.74 (d, *J* = 8.4 Hz, 2H), 7.46-7.41 (m, 2H), 7.20 (d, *J* = 8.4 Hz, 2H), 3.40 (t, *J* = 7.8 Hz, 2H), 3.15 (t, *J* = 8.4 Hz, 2H), 2.55 (t, *J* = 7.2 Hz, 2H), 2.34 (s, 3H), 1.67-1.63 (m, 2H), 1.56-1.50 (m, 2H), 0.97 (t, *J* = 7.2 Hz, 3H). **^{13}C NMR ($CDCl_3$, 151MHz)** δ 144.4, 139.7, 135.7, 134.0, 133.7, 130.8, 129.9, 128.1, 127.4, 126.4, 125.6, 125.3, 118.2, 110.5, 100.1, 76.1, 49.9, 31.1, 28.0, 22.1, 21.6, 19.6, 13.7.



2u Light yellow oil; **^{1}H NMR ($CDCl_3$, 600MHz)** δ 7.85 (d, *J* = 8.4 Hz, 2H), 7.37-7.35 (m, 4H), 7.31-7.27 (m, 3H), 3.55 (t, *J* = 7.8 Hz, 2H), 2.22-2.51 (m, 2H), 2.45 (s, 3H), 1.73 (t, *J* = 3.0 Hz, 3H). **^{13}C NMR ($CDCl_3$, 151MHz)** δ 144.8, 134.7, 131.4, 129.9, 128.3, 127.9, 127.7, 122.8, 81.9, 78.1, 74.6, 71.1, 50.8, 21.7, 18.8, 3.52.

7. Characterization of 3, 4, 5, 7



1-((*N*,4-Dimethylphenyl)sulfonamido)vinyl but-2-ynoate (3a)

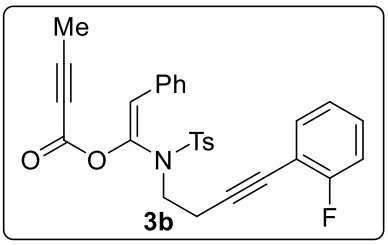
White solid, m. p. 80-82 ^{o}C (56 mg, 95 % yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:10).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.71 (d, *J* = 8.4 Hz, 2H), 7.31 (d, *J* = 8.4 Hz, 2H), 4.88 (d, *J* = 2.4 Hz, 1H), 4.70 (d, *J* = 2.4 Hz, 1H), 3.00 (s, 3H), 2.42 (s, 3H), 1.99 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 151.7, 146.5, 144.2, 133.9, 129.7, 128.1, 101.5, 88.8, 71.5, 37.3, 21.7, 4.0.

IR (KBr) *v* 2250, 1635, 1532, 1366, 1160, 966, 898, 751 cm^{-1}.

HRMS (EI) calcd for $C_{14}H_{15}NO_4S$ (M^+): 293.0722; Found: 293.0722.



1-((*N*-(4-(2-Fluorophenyl)but-3-yn-1-yl)-4-methylphenyl)sulfonamido)-2-phenylvinyl but-2-ynoate (3b)

Light yellow solid, m. p. 123-125 ^{o}C (97 mg, 95 % yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:10).

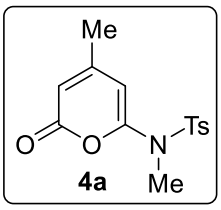
^{1}H NMR ($CDCl_3$, 600MHz) δ 7.85 (d, *J* = 8.4 Hz, 2H), 7.59 (, *J* = 8.4 Hz, 2H), 7.33-7.22 (m, 7H), 7.04-6.99 (m, 2H), 6.51 (s, 1H), 3.52 (t, *J* = 5.2 Hz, 2H), 2.63 (t, *J* = 5.2 Hz, 2H), 2.39 (s, 3H), 2.00 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 163.6 (d, $^1J_{C\text{-}F}$ = 250.7 Hz), 151.1, 144.3, 136.5, 135.9, 133.7,

131.5, 129.7, 129.6, 129.0, 128.8, 128.6, 128.3, 123.8 (d, $^{3}J_{C\text{-}F}$ = 3.6 Hz), 123.6, 115.3 (d, $^{2}J_{C\text{-}F}$ = 21.0 Hz), 111.8 (d, $^{2}J_{C\text{-}F}$ = 15.7 Hz), 91.3 (d, $^{3}J_{C\text{-}F}$ = 2.9 Hz), 89.0, 75.7, 71.5, 47.8, 21.6, 19.6, 3.9.

IR (KBr) *v* 1734, 1660, 1530, 1358, 1041, 842, 745 cm^{-1}.

HRMS (EI) calcd for $C_{29}H_{24}FNO_4S$ (M^+): 501.1410; Found: 501.1411.



N,4-Dimethyl-*N*-(4-methyl-2-oxo-2*H*-pyran-6-yl)benzenesulfonamide (4a)

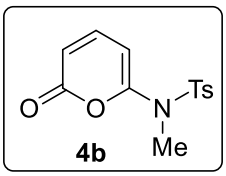
White solid, m. p. 102-104 ^{o}C (53 mg, 90 % yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.64 (d, *J* = 8.4 Hz, 2H), 7.31 (d, *J* = 8.4 Hz, 2H), 6.24 (s, 1H), 5.89 (s, 1H), 3.17 (s, 3H), 2.42 (s, 3H), 2.19 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 161.0, 158.0, 152.5, 145.1, 134.3, 130.2, 127.6, 109.5, 101.9, 34.7, 22.0, 21.8.

IR (KBr) *v* 1750, 1633, 1533, 1364, 1163, 962, 890, 751 cm^{-1}.

HRMS (EI) calcd for $C_{14}H_{15}NO_4S$ (M^+): 293.0722; Found: 293.0722.



N,4-Dimethyl-*N*-(2-oxo-2*H*-pyran-6-yl)benzenesulfonamide (4b)

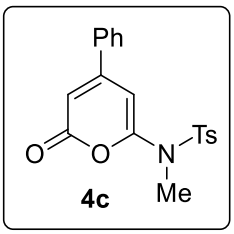
White solid, m. p. 95-98 ^{o}C (35 mg, 63% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.65 (d, *J* = 8.0 Hz, 2H), 7.39-7.30 (m, 3H), 6.36 (d, *J* = 7.2 Hz, 1H), 6.07 (d, *J* = 9.2 Hz, 1H), 3.21(s, 3H), 2.42 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 160.7, 154.0, 145.2, 134.3, 130.2, 127.6, 111.4, 98.2, 34.7, 21.7.

IR (KBr) *v* 1740, 1630, 1535, 1355, 1161, 969, 892, 751 cm^{-1}.

HRMS (EI) calcd for $C_{13}H_{13}NO_4S$ (M^+): 279.0565; Found: 279.0565.



N,4-Dimethyl-*N*-(2-oxo-4-phenyl-2*H*-pyran-6-yl)benzenesulfonamide (4c)

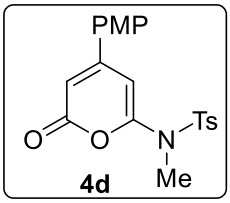
White solid, m. p. 115-117 ^{o}C (60 mg, 85% yield), R_f = 0.3 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.69 (d, *J* = 8.4 Hz, 2H), 7.62-7.60 (m, 2H), 7.52-7.48 (m, 3H), 7.33 (d, *J* = 8.4 Hz, 2H), 6.73 (s, 1H), 6.30 (s, 1H), 3.26 (s, 3H), 2.44 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 161.4, 157.1, 153.2, 145.3, 135.6, 134.2, 131.1, 130.2, 129.4, 127.6, 127.0, 106.8, 99.1, 34.8, 21.8.

IR (KBr) *v* 1729, 1633, 1522, 1359, 1169, 1083, 840, 757 cm^{-1}.

HRMS (EI) calcd for $C_{19}H_{17}NO_4S$ (M^+): 355.0878; Found: 355.0878.



N-(4-(4-Methoxyphenyl)-2-oxo-2*H*-pyran-6-yl)-*N*,4-dimethylbenzenesulfonamide (4d)

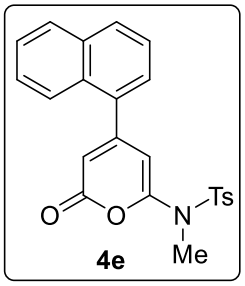
White solid, m. p. 118-121 ^{o}C (66 mg, 86% yield), R_f = 0.3 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.67 (d, *J* = 8.4 Hz, 2H), 7.58 (d, *J* = 9.0 Hz, 2H), 7.31 (d, *J* = 7.8 Hz, 2H), 6.99 (d, *J* = 9.0 Hz, 2H), 6.71 (s, 1H), 6.24 (s, 1H), 3.86 (s, 3H), 3.23 (s, 3H), 2.42 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 162.2, 161.6, 156.2, 152.9, 145.1, 134.3, 130.1, 128.5, 127.6, 127.5, 114.7, 105.1, 98.9, 55.6, 34.8, 21.7.

IR (KBr) *v* 1757, 1650, 1531, 1371, 1186, 1079, 861, 752 cm^{-1}.

HRMS (EI) calcd for $C_{20}H_{19}NO_5S$ (M^+): 385.0984; Found: 385.0980.



N,4-Dimethyl-*N*-(4-(naphthalen-1-yl)-2-oxo-2*H*-pyran-6-yl)benzenesulfonamide (4e)

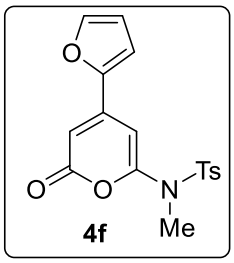
White solid, m. p. 124-126 ^{o}C (52 mg, 64% yield), R_f = 0.3 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) 7.97-7.23 (m, 3H), 7.74 (d, *J* = 8.0 Hz, 2H), 7.58-7.45 (m, 4H), 7.37 (d, *J* = 8.0 Hz, 2H), 6.58 (s, 1H), 6.24 (s, 1H), 3.30 (s, 3H), 2.47 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 161.09, 158.52, 152.72, 145.31, 135.09, 134.35, 133.86, 130.50, 130.25, 129.90, 128.93, 127.72, 127.28, 126.70, 126.30, 125.38, 124.85, 110.45, 101.60, 34.85, 21.84.

IR (KBr) *v* 1755, 1643, 1532, 1361, 1162, 1081, 838, 755 cm^{-1}.

HRMS (EI) calcd for $C_{23}H_{19}NO_4S$ (M^+): 405.1035; Found: 405.1033.



N-(4-(Furan-2-yl)-2-oxo-2*H*-pyran-6-yl)-*N*,4-dimethylbenzenesulfonamide (4f)

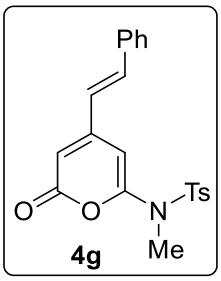
White solid, m. p. 109-102 ^{o}C (60 mg, 87% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 400MHz) 7.67 (d, *J* = 8.4 Hz, 2H), 7.62 (s, 1H), 7.31 (d, *J* = 8.4 Hz, 2H), 6.99 (d, *J* = 3.6 Hz, 1H), 6.67 (s, 1H), 6.59-6.58 (m, 1H), 6.33 (s, 1H), 3.22 (s, 3H), 2.43 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 161.4, 153.3, 149.2, 146.2, 145.2, 144.6, 134.2, 130.2, 127.6, 113.8, 113.0, 101.9, 95.9, 34.7, 21.8.

IR (KBr) *v* 1745, 1641, 1528, 1363, 1169, 1123, 1085, 839, 757 cm^{-1}.

HRMS (EI) calcd for $C_{17}H_{15}NO_5S$ (M^+): 345.0671; Found: 345.0677.



(*E*)-*N*,4-Dimethyl-*N*-(2-oxo-4-styryl-2*H*-pyran-6-yl)benzenesulfonamide4-nitrobe nzoate (4g)

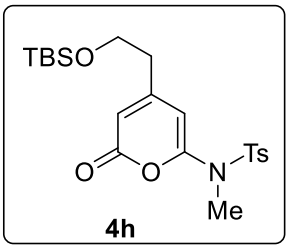
White solid, m. p.104-107 ^{o}C (54 mg, 71% yield), R_f = 0.3 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) 7.67 (d, *J* = 8.4 Hz, 2H), 7.56 (d, *J* = 7.2 Hz, 2H), 7.43-7.38 (m, 3H), 7.33-7.28 (m, 3H), 6.86 (d, *J* = 16.2 Hz, 1H), 6.70 (s, 1H), 6.06 (s, 1H), 3.22 (s, 3H), 2.43 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 161.6, 153.2, 152.7, 145.2, 137.9, 135.3, 134.2, 130.2, 130.0, 129.2, 127.8, 127.6, 124.2, 108.3, 97.2, 34.8, 21.8.

IR (KBr) *v* 1739, 1635, 1522, 1360, 1167, 1087, 841, 753 cm^{-1}.

HRMS (EI) calcd for $C_{21}H_{19}NO_4S$ (M^+): 381.1035; Found:381.1033.



N-(4-(2-((*tert*-Butyldimethylsilyl)oxy)ethyl)-2-oxo-2*H*-pyran-6-yl)-*N*,4-dimethylbe nzenesulfonamide (4h)

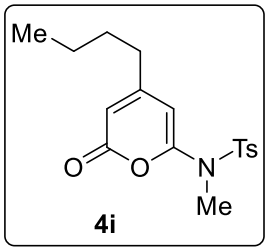
White solid, m. p. 95-96 ^{o}C (80 mg, 92% yield), R_f = 0.3 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.64 (d, *J* = 7.8 Hz, 2H), 7.30 (d, *J* = 8.4 Hz, 2H), 6.30 (s, 1H), 5.95 (s, 1H), 3.84 (t, *J* = 6.0 Hz, 2H), 3.17 (s, 3H), 2.63 (t, *J* = 6.0 Hz, 2H), 2.42 (s, 3H), 0.87 (s, 9H), 0.04 (s, 6H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 161.1, 159.4, 152.6, 145.1, 134.4, 130.1, 127.6, 110.0, 101.5, 61.4, 39.1, 34.8, 26.0, 21.8, 18.4, 5.3.

IR (KBr) *v* 1732, 1633, 1525, 1369, 1159, 1083, 1064, 851, 747 cm^{-1}.

HRMS (EI) calcd for $C_{21}H_{31}NO_5SSi$ (M^+): 437.1692; Found: 437.1691.



N-(4-Butyl-2-oxo-2*H*-pyran-6-yl)-*N*,4-dimethylbenzenesulfonamide (4i)

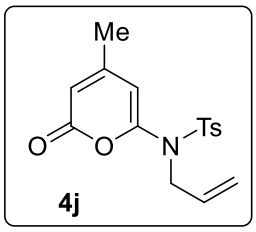
White solid, m. p. 116-118 ^oC (62 mg, 87% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.63 (d, *J* = 8.4 Hz, 2H), 7.31 (d, *J* = 8.4 Hz, 2H), 6.27 (s, 1H), 5.88 (s, 1H), 3.19 (s, 3H), 2.45-2.40 (m, 5H), 1.60-1.54 (m, 2H), 1.40-1.34 (m, 2H), 0.95 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 162.4, 161.4, 152.5, 145.2, 134.2, 130.1, 127.6, 108.7, 101.2, 35.5, 34.7, 30.5, 22.3, 21.8, 13.9.

IR (KBr) *v* 1730, 1632, 1525, 1360, 1179, 1083, 840, 741 cm^{-1}.

HRMS (EI) calcd for $C_{17}H_{21}NO_4S$ (M^+): 355.1191; Found: 355.1195.



N-Allyl-4-methyl-*N*-(4-methyl-2-oxo-2*H*-pyran-6-yl)benzenesulfonamide (4j)

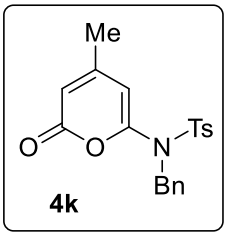
White solid, m. p. 99-101 ^oC (55 mg, 86% yield), R_f = 0.2(EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.66 (d, *J* = 8.4 Hz, 2H), 7.31 (d, *J* = 8.0 Hz, 2H), 6.21 (s, 1H), 5.91 (s, 1H), 5.84-5.74 (m, 1H), 5.29-5.18 (m, 2H), 4.18 (d, *J* = 6.0 Hz, 2H), 2.43 (s, 3H), 2.18 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 161.2, 157.5, 151.2, 145.1, 135.5, 131.7, 130.1, 127.7, 120.3, 110.7, 104.9, 50.4, 21.9, 21.8.

IR (KBr) *v* 1730, 1632, 1524, 1410, 1359, 1182, 1083, 869, 739 cm^{-1}.

HRMS (EI) calcd for $C_{16}H_{17}NO_4S$ (M^+): 319.0878; Found: 319.0878.



N-Benzyl-4-methyl-*N*-(4-methyl-2-oxo-2*H*-pyran-6-yl)benzenesulfonamide (4k)

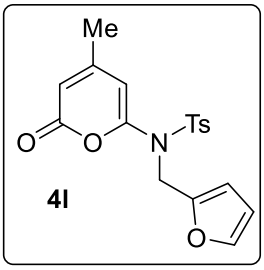
White solid, m. p. 117-119 ^{o}C (64 mg, 87% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.60 (d, *J* = 8.0 Hz, 2H), 7.26-7.19 (m, 7H), 6.03 (s, 1H), 5.77 (s, 1H), 4.66 (s, 2H), 2.37 (s, 3H), 2.01 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 161.0, 157.4, 151.6, 145.0, 135.4, 134.8, 130.2, 128.8, 128.7, 128.2, 127.6, 110.6, 105.6, 51.2, 21.7.

IR (KBr) *v* 1730, 1632, 1524, 1410, 1359, 1182, 1083, 829, 739 cm^{-1}.

HRMS (EI) calcd for $C_{20}H_{19}NO_4S$ (M^+): 369.1035; Found: 369.1036.



N-(Furan-2-ylmethyl)-4-methyl-*N*-(4-methyl-2-oxo-2*H*-pyran-6-yl)benzenesulfonamide (4l)

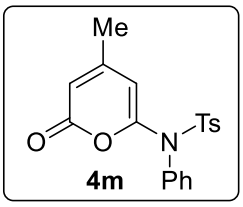
White solid, m. p. 95-98 ^{o}C (57 mg, 80% yield), R_f = 0.3 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.65 (d, *J* = 8.4 Hz, 2H), 7.33-7.29 (m, 3H), 6.30-6.27 (m, 2H), 6.11 (s, 1H), 5.89 (s, 1H), 4.78 (s, 2H), 2.42 (s, 3H), 2.12 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 161.1, 157.6, 151.1, 148.5, 144.8, 143.0, 135.5, 130.1, 127.7, 110.7, 110.6, 110.5, 104.3, 44.4, 21.8, 21.7.

IR (KBr) *v* 1734, 1644, 1523, 1359, 1164, 814, 746 cm^{-1}.

HRMS (EI) calcd for $C_{18}H_{17}NO_5S$ (M^+): 359.0827; Found: 359.0827.



4-Methyl-*N*-(4-methyl-2-oxo-2*H*-pyran-6-yl)-*N*-phenylbenzenesulfonamide (4m)

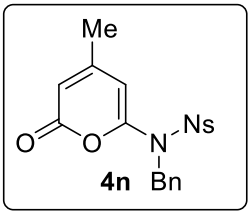
White solid, m. p. 100-102 ^{o}C (50 mg, 70% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:3).

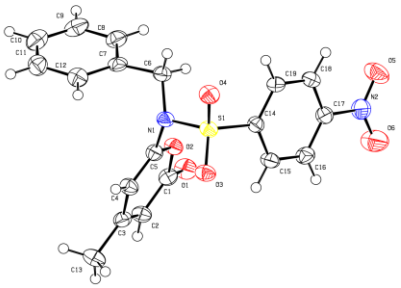
^{1}H NMR ($CDCl_3$, 400MHz) δ 7.65 (d, *J* = 8.0 Hz, 2H), 7.33-7.19 (m, 7H), 5.86 (s, 1H), 5.82 (s, 1H), 2.38 (s, 3H), 2.05 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 160.9, 157.6, 153.0, 144.9, 137.4, 135.7, 129.8, 129.7, 129.5, 128.6, 110.3, 103.0, 21.8.

IR (KBr) *v* 1732, 1641, 1523, 1415, 1358, 1156, 834, 749 cm^{-1}.

HRMS (EI) calcd for $C_{19}H_{17}NO_4S$ (M^+): 355.0878; Found: 355.0876.





***N*-Benzyl-*N*-(4-methyl-2-oxo-2*H*-pyran-6-yl)-4-nitrobenzenesulfonamide (4n)**

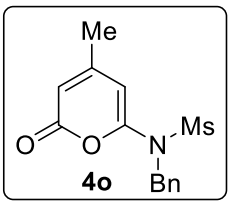
White solid, m. p. 173-176 ^{o}C (67 mg, 84 % yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:4).

^{1}H NMR ($CDCl_3$, 400MHz) δ 8.37 (d, *J* = 8.8 Hz, 2H), 7.98 (d, *J* = 8.8 Hz, 2H), 7.30 (s, 5H), 6.03 (s, 1H), 5.93 (s, 1H), 4.75 (s, 2H), 2.11 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 160.5, 157.2, 150.7, 149.8, 144.2, 134.1, 129.04, 129.00, 128.8, 128.7, 124.7, 111.7, 106.4, 52.4, 21.8.

IR (KBr) *v* 1734, 1650, 1528, 1369, 1174, 1042, 851, 740 cm^{-1}.

HRMS (EI) calcd for $C_{19}H_{16}N_2O_6S$ (M^+): 400.0729; Found: 400.0731.



***N*-Benzyl-*N*-(4-methyl-2-oxo-2*H*-pyran-6-yl)methanesulfonamide (4o)**

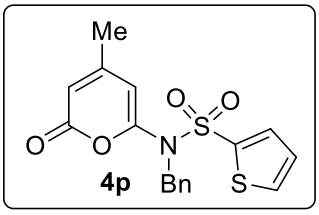
White solid, m. p. 129-131 ºC (51 mg, 87% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.34-7.28 (m, 5H), 5.93 (s, 1H), 5.92 (s, 1H), 4.84 (s, 2H),3.09 (s, 3H), 2.07 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 161.0, 157.5, 151.9, 134.7, 128.9, 128.6, 128.5, 110.9, 104.8, 52.1, 40.6, 21.7.

IR (KBr) *v* 1735, 1647, 1523, 1358, 1167, 824, 750 cm^{-1}.

HRMS (EI) calcd for $C_{14}H_{15}NO_4S$ (M^+): 293.0722; Found: 293.0725.



N-Benzyl-*N*-(4-methyl-2-oxo-2*H*-pyran-6-yl)thiophene-2-sulfonamide (4p)

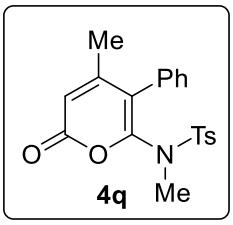
White solid, m. p. 142-144 ºC (60 mg, 83% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:4).

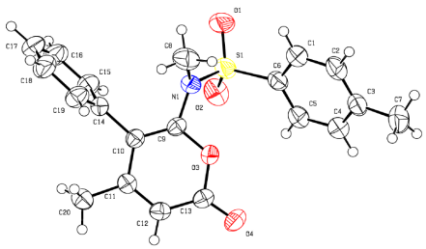
^{1}H NMR ($CDCl_3$, 400MHz) δ 7.62-7.56 (m, 2H), 7.25-7.19 (m, 5H), 7.07 (t, *J* = 4.4 Hz, 1H), 6.03 (s, 1H), 5.82 (s, 1H), 4.71 (s, 2H), 2.03 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 161.0, 157.4, 151.1, 138.1, 134.7, 133.8, 133.7, 128.84, 128.81, 128.4, 127.9, 111.4, 106.6, 51.6, 21.8.

IR (KBr) *v* 1734, 1655, 1559, 1369, 1164, 1032, 746 cm^{-1}.

HRMS (EI) calcd for $C_{17}H_{15}NO_4S_2$ (M^+): 361.0442; Found: 361.0442.





N,4-Dimethyl-*N*-(4-methyl-2-oxo-5-phenyl-2*H*-pyran-6-yl)benzenesulfonamide (4q)

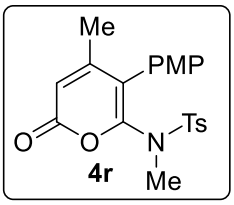
White solid, m. p. 152-154 ºC (54 mg, 73% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.66 (d, *J* = 8.0 Hz, 2H), 7.48-7.40 (m, 3H), 7.32-7.30 (m, 4H), 6.25 (s, 1H), 2.77 (s, 3H), 2.43 (s, 3H), 1.96 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 160.9, 157.8, 149.8, 144.5, 135.0, 132.4, 129.9, 129.8, 128.8, 128.53, 128.49, 121.0, 114.5, 36.6, 21.7, 21.6.

IR (KBr) *v* 1733, 1648, 1533, 1359, 1164, 1028, 818, 746 cm^{-1}.

HRMS (EI) calcd for $C_{20}H_{19}NO_4S$ (M^+): 369.1035; Found: 369.1035.



N-(5-(4-Methoxyphenyl)-4-methyl-2-oxo-2*H*-pyran-6-yl)-*N*,4-dimethylbenzenesulfonamide (4r)

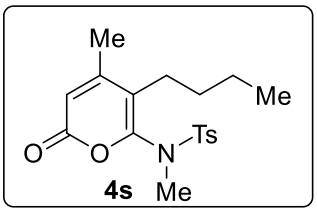
White solid, m. p. 160-162 ºC (52 mg, 65 % yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.68 (d, *J* = 8.4 Hz, 2H), 7.30 (d, *J* = 7.8 Hz, 2H), 7.22 (d, *J* = 8.4 Hz, 2H), 6.97 (d, *J* = 9.0 Hz, 2H), 6.22 (s, 1H), 3.85 (s, 3H), 2.76 (s, 3H), 2.42 (s, 3H), 1.95 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 160.9, 159.6, 158.3, 149.7, 144.5, 135.0, 131.0, 129.8, 128.4, 124.3, 120.4, 114.2, 114.2, 55.3, 36.5, 21.7, 21.6.

IR (KBr) *v* 1738, 1652, 1531, 1359, 1158, 835, 747 cm^{-1}.

HRMS (EI) calcd for $C_{21}H_{21}NO_5S$ (M^+): 399.1140; Found: 399.1141.



N-(5-Butyl-4-methyl-2-oxo-2*H*-pyran-6-yl)-*N*,4-dimethylbenzenesulfonamide (4s)

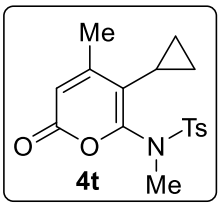
White solid, m. p. 138-140 ºC (37 mg, 53 % yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.70 (d, *J* = 8.4 Hz, 2H), 7.34 (d, *J* = 7.8 Hz, 2H), 6.13 (s, 1H), 3.00 (s, 3H), 2.64-2.59 (m, 2H), 2.44 (s, 3H), 2.24 (s, 3H), 1.50-1.38 (m, 4H), 0.97 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 161.1, 158.2, 148.7, 144.8, 134.0, 130.0, 128.5, 119.8, 115.3, 36.8, 31.7, 26.4, 22.9, 21.8, 20.2, 13.9.

IR (KBr) *v* 1732, 1649, 1558, 1359, 1161, 839, 750 cm^{-1}.

HRMS (EI) calcd for $C_{18}H_{23}NO_4S$ (M^+): 349.1348; Found: 349.1347.



N-(5-Cyclopropyl-4-methyl-2-oxo-2*H*-pyran-6-yl)-*N*,4-dimethylbenzenesulfonamide (4t)

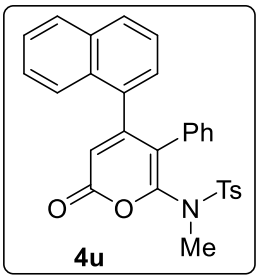
White solid, m. p. 130-133 ^oC (38 mg, 57% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.63 (d, *J* = 8.0 Hz, 2H), 7.30 (d, *J* = 8.0 Hz, 2H), 6.19 (s, 1H), 3.12 (s, 3H), 2.42 (s, 3H), 2.29 (s, 3H), 1.54-1.47 (m, 1H), 0.93-0.88 (m, 2H), 0.82-0.78 (m, 2H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 161.3, 154.4, 149.7, 145.0, 134.4, 130.2, 127.9, 122.1, 104.5, 35.0, 21.8, 20.2, 9.3, 6.8.

IR (KBr) *v* 1734, 1652, 1533, 1352, 1157, 840, 751 cm^{-1}.

HRMS (EI) calcd for $C_{17}H_{19}NO_4S$ (M^+): 333.1035; Found: 333.1035.



N,4-Dimethyl-*N*-(4-(naphthalen-1-yl)-2-oxo-5-phenyl-2*H*-pyran-6-yl)benzenesulfonamide (4u)

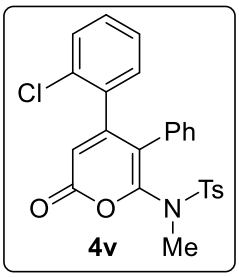
White solid, m. p.165-167 ^oC (85 mg, 88% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.79-7.71 (m, 5H), 7.44-7.41 (m, 2H), 7.36-7.31 (m, 3H), 7.17-7.16 (m, 1H), 7.05-6.98 (m, 5H), 6.46 (s, 1H), 2.81 (s, 3H), 2.45 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 160.6, 159.4, 151.6, 144.7, 135.0, 134.1, 133.2, 132.1, 130.2, 129.93, 129.90, 129.3, 128.6, 128.4, 127.9, 127.8, 126.7, 126.5, 126.3, 125.3, 124.7, 120.4, 116.7, 36.6, 21.8.

IR (KBr) *v* 1735, 1652, 1533, 1359, 1159, 841, 747 cm^{-1}.

HRMS (EI) calcd for $C_{29}H_{23}NO_4S$ (M^+): 481.1348; Found: 481.1345.



N-(4-(2-Chlorophenyl)-2-oxo-5-phenyl-2*H*-pyran-6-yl)-*N*,4-dimethylbenzenesulfonamide (4v)

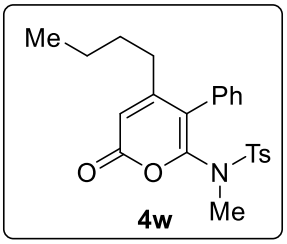
White solid, m. p. 175-177 ^oC (74mg, 80% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.71 (d, *J* = 8.4 Hz, 2H), 7.32 (d, *J* = 8.4 Hz, 2H), 7.25-7.24 (m, 1H), 7.19-7.11 (m, 7H), 7.04-7.02 (m, 1H), 6.34 (s, 1H), 2.80 (s, 3H), 2.44 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 160.5, 157.6, 151.6, 144.6, 135.4, 134.9, 131.79, 131.75, 130.2, 130.1, 129.9, 129.84, 129.80, 129.6, 128.5, 128.1, 126.5, 119.6, 116.4, 36.6, 21.7.

IR (KBr) *v* 1734, 1652, 1529, 1367, 1158, 1038, 846, 744 cm^{-1}.

HRMS (EI) calcd for $C_{25}H_{20}ClNO_4S$ (M^+): 465.0802; Found: 465.0802.



N-(4-Butyl-2-oxo-5-phenyl-2*H*-pyran-6-yl)-*N*,4-dimethylbenzenesulfonamide (4w)

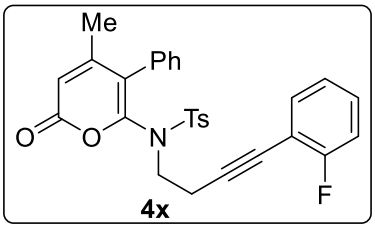
White solid, m. p. 151-153 ^oC (58 mg, 71 % yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.66 (d, *J* = 8.4 Hz, 2H), 7.46-7.41 (m, 3H), 7.32-7.29 (m, 4H), 6.23 (s, 1H), 2.75 (s, 3H), 2.42 (s, 3H), 2.22 (t, *J* = 7.2 Hz, 2H), 1.38-1.33 (m, 2H), 1.22-1.16 (m, 2H), 0.76 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 161.9, 161.3, 149.6, 144.5, 134.9, 132.2, 130.1, 129.8, 128.7, 128.5, 128.5, 120.9, 113.2, 36.6, 33.4, 30.2, 22.2, 21.7, 13.7.

IR (KBr) *v* 1734, 1657, 1534, 1358, 1041, 842, 746 cm^{-1}.

HRMS (EI) calcd for $C_{23}H_{25}NO_4S$ (M^+): 411.1504; Found: 411.1508.



N-(4-(2-Fluorophenyl)but-3-yn-1-yl)-4-methyl-*N*-(4-methyl-2-oxo-5-phenyl-2*H*-pyran-6-yl)benzenesulfonamide (4x)

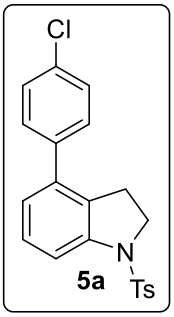
Light yellow solid, m. p. 116-118 ^{o}C, R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.73 (d, *J* = 8.4 Hz, 2H), 7.48-7.41 (m, 5H), 7.30 (d, *J* = 7.8 Hz, 2H), 7.28-7.23 (m, 3H), 7.05-7.00 (m, 2H), 6.16 (s, 1H), 3.32 (t, *J* = 7.2 Hz, 2H), 2.40-2.35 (m, 5H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 162.8 (d, $^{1}J_{C\text{-}F}$ = 250.8 Hz), 160.9, 157.8, 147.6, 144.8, 135.5, 133.8, 132.2, 130.1, 130.0, 129.8 (d, $^{3}J_{C\text{-}F}$ = 7.9 Hz), 128.8, 128.7, 128.5, 124.0 (d, $^{3}J_{C\text{-}F}$ = 3.6 Hz), 122.3, 115.4 (d, $^{2}J_{C\text{-}F}$ = 21.0 Hz), 114.8, 111.5 (d, $^{2}J_{C\text{-}F}$ =15.6 Hz), 90.9, 76.0, 47.7, 21.8, 21.6, 19.6.

IR (KBr) *v* 1719, 1653, 1533, 1360, 1032, 842, 746 cm^{-1}.

HRMS (EI) calcd for $C_{29}H_{24}FNO_4S$ (M^+): 501.1410; Found: 501.1410.



4-(4-Chlorophenyl)-1-tosylindoline (5a)

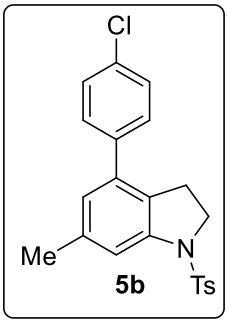
White solid, m. p. 120-122 ^{o}C (73 mg, 95 % yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.69 (d, *J* = 8.0 Hz, 2H), 7.63 (d, *J* = 8.0 Hz, 1H), 7.32 (d, *J* = 8.4 Hz, 2H), 7.24-7.18 (m, 5H), 6.94 (d, *J* = 7.6 Hz, 1H), 3.87 (t, *J* = 8.4 Hz, 2H), 2.88 (t, *J* = 8.4 Hz, 2H), 2.36 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 144.3, 142.7, 138.5, 137.9, 134.1, 133.6, 129.8, 129.6, 129.5, 128.8, 128.5, 127.6, 124.2, 114.1, 50.2, 27.9, 21.7.

IR (KBr) *v* 2929, 2363, 2210, 1604, 1466, 1354, 1079, 693, 561 cm^{-1}.

HRMS (EI) calcd for $C_{21}H_{18}ClNO_2S$ (M^+): 383.0747; Found: 383.0747.



4-(4-Chlorophenyl)-6-methyl-1-tosylindoline (5b)

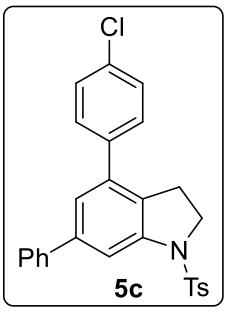
White solid, m. p. 145-147 ^{o}C (70 mg, 88% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.71 (d, *J* = 8.4 Hz, 2H), 7.50 (s, 1H), 7.34 (d, *J* = 8.4 Hz, 2H), 7.26 (d, *J* = 7.8 Hz, 2H), 7.21 (d, *J* = 8.4 Hz, 2H), 6.80 (s, 1H), 3.89 (t, *J* = 8.4 Hz, 2H), 2.85 (t, *J* = 8.4 Hz, 2H), 2.40 (s, 3H), 2.39 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 144.2, 142.8, 138.62, 138.58, 137.5, 134.1, 133.4, 129.8, 129.6, 128.7, 127.5, 126.6, 125.0, 114.9, 50.5, 27.5, 21.8, 21.7.

IR (KBr) *v* 2925, 2363, 2216, 1605, 1467, 1359, 1091, 701, 558 cm^{-1}.

HRMS (EI) calcd for $C_{22}H_{20}ClNO_2S$ (M^+): 397.0903; Found: 397.0904.



4-(4-Chlorophenyl)-6-phenyl-1-tosylindoline (5c)

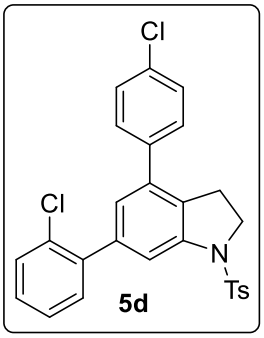
White solid, m. p. 174-176 ^{o}C (81 mg, 88% yield), R_f = 0.3 (EtOAc/ Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.71 (s, 1H), 7.61 (d, *J* = 8.4 Hz, 2H), 7.50 (d, *J* = 7.6 Hz, 2H), 7.33 (t, *J* = 8.4 Hz, 2H), 7.23 (d, *J* = 8.4 Hz, 3H), 7.14-7.11 (m, 4H),7.01 (s, 1H), 3.82 (t, *J* = 8.4 Hz, 2H), 2.80 (t, *J* = 8.4 Hz, 2H), 2.24 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 144.4, 143.3, 142.0, 140.7, 138.5, 138.1, 134.1, 133.7, 129.9, 129.6, 129.0, 128.8, 128.5, 127.8, 127.5, 127.3, 123.3, 112.7, 50.5, 27.6, 21.7.

IR (KBr) *v* 2933, 2361, 2220, 1610, 1471, 1354, 1079, 699, 563 cm^{-1}.

HRMS (EI) calcd for $C_{27}H_{22}ClNO_2S$ (M^+): 459.1060; Found: 459.1059.



6-(2-Chlorophenyl)-4-(4-chlorophenyl)-1-tosylindoline (5d)

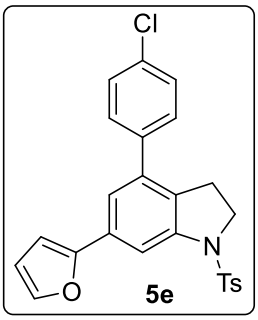
White solid, m. p. 179-181 ºC (76 mg, 77% yield), R_f = 0.3 (EtOAc/ Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.71 (d, *J* = 7.8 Hz, 2H), 7.67 (s, 1H), 7.43-7.42 (m, 1H), 7.30-7.17 (m, 9H), 6.97 (s, 1H), 3.88 (t, *J* = 8.4 Hz, 2H), 2.91 (t, *J* = 8.4 Hz, 2H), 2.32 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 144.4, 142.6, 140.14, 140.07, 138.2, 137.5, 133.9, 133.7, 132.6, 131.5, 130.1, 129.9, 129.7, 129.0, 128.82, 128.77, 127.7, 127.1, 125.4, 115.0, 50.4, 27.7, 21.7.

IR (KBr) *v* 2927, 2364, 2223, 1605, 1468, 1358, 1081, 696, 554 cm^{-1}.

HRMS (EI) calcd for $C_{27}H_{21}Cl_2NO_2S$ (M^+): 493.0670; Found: 493.0671.



4-(4-Chlorophenyl)-6-(furan-3-yl)-1-tosylindoline (5e)

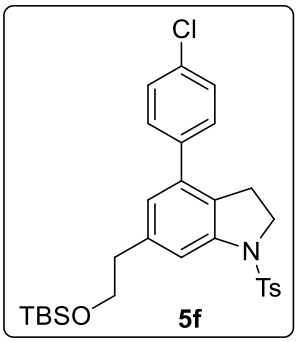
White solid, m. p. 164-67 ºC (58 mg, 65% yield), R_f = 0.3 (EtOAc/ Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.85 (s, 1H), 7.75 (d, *J* = 8.4 Hz, 2H), 7.40-7.36 (m, 4H), 7.30-7.25 (m, 5H), 7.13 (s, 1H), 3.92 (t, *J* = 8.4 Hz, 2H), 2.90 (t, *J* = 8.4 Hz, 2H), 2.39 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 144.4, 143.3, 138.4, 138.1, 138.0, 137.2, 134.1, 133.7, 129.9, 129.6, 128.9, 128.8, 128.2, 128.0, 127.5, 126.7, 123.0, 111.7, 50.4, 27.7, 21.7.

IR (KBr) *v* 2929, 2363, 2218, 1614, 1459, 1354, 1138, 702, 572 cm^{-1}.

HRMS (EI) calcd for $C_{25}H_{20}ClNO_3S$ (M^+): 449.0852; Found: 449.0852.



6-(2-((*tert*-Butyldimethylsilyl)oxy)ethyl)-4-(4-chlorophenyl)-1-tosylindoline (5f)

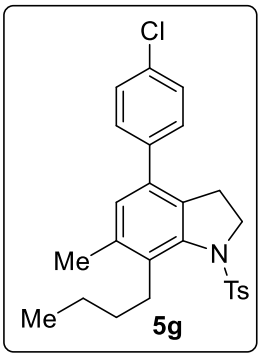
White solid, m. p. 155-156 ^{o}C (99 mg, 92% yield), R_f = 0.3 (EtOAc/ Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.71 (d, *J* = 8.4 Hz, 2H), 7.51 (s, 1H), 7.34 (d, *J* = 8.4 Hz, 2H), 7.25 (d, *J* = 8.4 Hz, 2H), 7.21 (d, *J* = 8.4 Hz, 2H), 6.84 (s, 1H), 3.89 (t, *J* = 8.4 Hz, 2H), 3.83 (t, *J* = 7.2 Hz, 2H), 2.88-2.84 (m, 4H), 2.39 (s, 3H), 0.88 (s, 9H), 0.02 (s, 6H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 144.2, 142.8, 140.0, 138.6, 137.5, 134.2, 133.5, 129.8, 129.6, 128.7, 127.6, 127.4, 125.3, 114.8, 64.6, 50.5, 39.8, 27.5, 26.1, 21.7, 18.5, -5.2.

IR (KBr) *v* 2930, 2364, 2221, 1609, 1462, 1355, 1079, 693, 568 cm^{-1}.

HRMS (EI) calcd for $C_{29}H_{36}ClNO_3SSi$ (M^+): 541.1874; Found:541.1874.



7-Butyl-4-(4-chlorophenyl)-6-methyl-1-tosylindoline (5g)

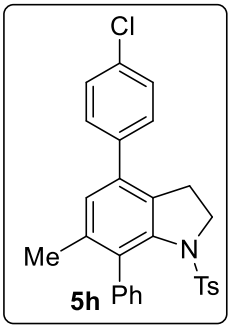
White solid, m. p. 183-185 ^{o}C (58 mg, 64% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.41 (d, *J* = 8.4 Hz, 2H), 7.28 (d, *J* = 8.4 Hz, 2H), 7.20 (d, *J* = 7.6 Hz, 2H), 7.01 (s, 1H), 6.95 (d, *J* = 8.4 Hz, 2H), 3.89 (t, *J* = 7.2 Hz, 2H), 3.17 (t, *J* = 7.2 Hz, 2H), 2.44 (s, 3H), 2.43 (s, 3H), 1.98 (t, *J* = 7.2 Hz, 2H), 1.54-1.49 (m, 2H), 1.43-1.37 (m, 2H), 0.95 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 144.2, 142.6, 138.7, 137.4, 136.4, 134.6, 134.2, 133.5, 133.2, 129.6, 129.44, 129.39, 128.6, 128.2, 53.1, 31.8, 29.1, 28.8, 23.1, 21.7, 19.9, 14.2.

IR (KBr) *v* 2932, 2363, 1467, 1361, 1162, 1085, 831, 688, 572 cm^{-1}.

HRMS (EI) calcd for $C_{26}H_{28}ClNO_2S$ (M^+): 453.1529; Found:453.1530.



4-(4-Chlorophenyl)-6-methyl-7-phenyl-1-tosylindoline (5h)

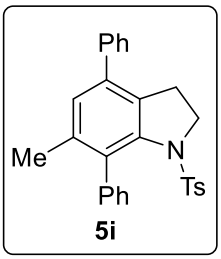
White solid, m. p. 203-205 ^oC (69 mg, 73 % yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.43-7.35 (m, 7H), 7.23 (d, *J* = 8.4 Hz, 2H), 7.18-7.14 (m, 5H), 3.93 (t, *J* = 7.2 Hz, 2H), 2.50 (t, *J* = 7.2 Hz, 2H), 2.40 (s, 3H), 2.27 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 143.8, 141.9, 138.6, 138.5, 137.0, 136.2, 135.8, 135.4, 133.6, 133.5, 130.7, 129.5, 129.3, 129.1, 128.8, 127.9, 127.7, 126.9, 53.0, 29.8, 21.7, 21.1.

IR (KBr) *v* 2933, 2362, 1465, 1359, 1164, 1084, 831, 688, 578 cm^{-1}.

HRMS (EI) calcd for $C_{28}H_{24}ClNO_2S$ (M^+): 473.1216; Found: 473.1218.



6-Methyl-4,7-diphenyl-1-tosylindoline (5i)

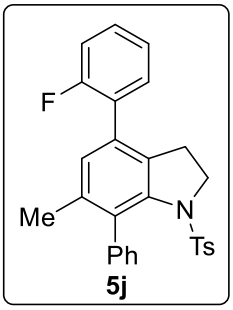
White solid, m. p. 166-168 ^oC (68 mg, 77 % yield), R_f = 0.2 (EtOAc/Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.32-7.23 (m, 8H), 7.17-7.13 (m, 4H), 7.10 (s, 1H), 7.06-7.48 (m, 2H), 3.83 (s, 2H), 2.39 (s, 2H), 2.31 (s, 3H), 2.18 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 143.7, 141.8, 140.1, 138.7, 137.4, 136.7, 135.8, 135.0, 133.6, 130.7, 129.3, 129.3, 128.5, 128.2, 127.8, 127.7, 127.4, 126.8, 53.0, 29.8, 21.6, 21.1.

IR (KBr) *v* 2933, 2362, 1465, 1359, 1164, 1084, 831, 689, 575 cm^{-1}.

HRMS (EI) calcd for $C_{28}H_{25}NO_2S$ (M^+): 439.1606; Found: 439.1605.



4-(2-Fuorophenyl)-6-methyl-7-phenyl-1-tosylindoline (5j)

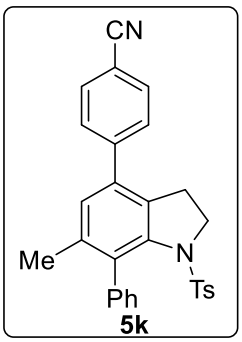
White solid, m. p. 170-173 ^{o}C (57 mg, 62% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.44-7.43 (m, 4H), 7.7.34-7.28 (m, 4H), 7.21-7.14 (m, 5H), 7.19 (t, *J* = 9.0 Hz, 1H), 3.95 (t, *J* = 7.2 Hz, 2H), 2.41 (s, 3H), 2.32 (t, *J* = 7.2 Hz, 2H), 2.29 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 159.5 (d, $^{1}J_{C\text{-}F}$ = 247.6 Hz), 143.7, 141.5, 138.7, 136.5, 135.6, 135.4, 135.1, 131.7, 131.1 (d, $^{3}J_{C\text{-}F}$ = 4.5 Hz), 130.6, 130.1, 129.5 (d, $^{3}J_{C\text{-}F}$ = 9.1 Hz), 129.4, 127.8, 127.53, 127.5 (d, $^{2}J_{C\text{-}F}$ =15.1 Hz), 126.9, 124.2 (d, $^{3}J_{C\text{-}F}$ = 3.6 Hz), 115.9 (d, $^{2}J_{C\text{-}F}$ = 22.3 Hz), 52.9, 29.3, 21.6, 21.1.

IR (KBr) *v* 2933, 2363, 1466, 1359, 1167, 1079, 821, 690, 574 cm^{-1}.

HRMS (EI) calcd for $C_{28}H_{24}FNO_2S$ (M^+): 457.1512; Found:457.1510.



4-(6-Methyl-7-phenyl-1-tosylindolin-4-yl)benzonitrile (5k)

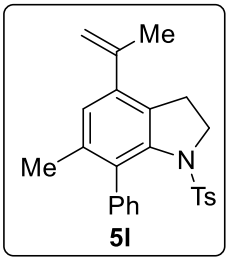
White solid, m. p. 224-226 ^{o}C (77 mg, 83% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:10).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.69 (d, *J* = 8.4 Hz, 2H), 7.43-7.34 (m, 7H), 7.21 (d, *J* = 8.4 Hz, 2H), 7.17 (s, 1H), 7.15 (d, *J* = 8.4 Hz, 2H), 3.94 (t, *J* = 7.2 Hz, 2H), 2.56 (t, *J* = 7.2 Hz, 2H), 2.40 (s, 3H), 2.27 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 144.8, 143.8, 142.3, 138.4, 137.4, 136.2, 135.94, 135.5, 133.7, 132.4, 130.6, 129.4, 129.0, 128.9, 127.9, 127.6, 127.1, 118.8, 111.2, 53.0, 30.0, 21.7, 21.1.

IR (KBr) *v* 2927, 2362, 2220, 1602, 1464, 1354, 1164, 1079, 693, 551 cm^{-1}.

HRMS (EI) calcd for $C_{29}H_{24}N_2O_2S$ (M^+): 464.1558; Found: 464.1558.



6-Methyl-7-phenyl-4-(prop-1-en-2-yl)-1-tosylindoline (5l)

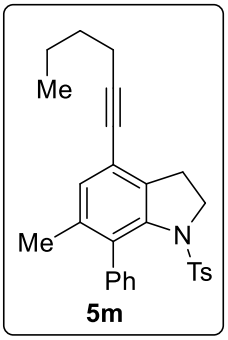
White solid, m. p. 151-152 ^oC (72 mg, 89% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.42-7.31 (m, 5H), 7.22 (d, *J* = 8.4 Hz, 2H), 7.10 (d, *J* = 8.4 Hz, 2H), 7.05 (s, 1H), 5.12 (s, 1H), 4.79 (s, 1H), 3.91 (t, *J* = 7.2 Hz, 2H), 2.42 (t, *J* = 7.2 Hz, 2H), 2.37 (s, 3H), 2.22 (s, 3H), 1.98 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 143.6, 143.4, 141.5, 138.8, 138.7, 136.3, 135.7, 134.8, 132.9, 130.7, 129.3, 127.76, 127.72, 127.68, 126.8, 115.3, 52.9, 30.0, 23.1, 21.6, 21.1.

IR (KBr) *v* 2929, 2362, 1465, 1358, 1164, 1083, 831, 689, 577 cm^{-1}.

HRMS (EI) calcd for $C_{25}H_{25}NO_2S$ (M^+): 403.1606; Found: 403.1609.



4-(Hex-1-yn-1-yl)-6-methyl-7-phenyl-1-tosylindoline (5m)

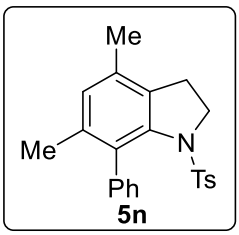
White solid, m. p. 197-199 ^oC (76 mg, 86% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:20).

^{1}H NMR ($CDCl_3$, 600MHz) δ 7.40-7.31 (m, 5H), 7.21 (d, *J* = 7.8 Hz, 2H), 7.13-7.11 (m, 3H), 3.95 (t, *J* = 7.2 Hz, 2H), 2.53 (t, *J* = 7.2 Hz, 2H), 2.40-2.38 (m, 5H), 2.17 (s, 3H), 1.57-1.53 (m, 2H), 1.48-1.42 (m, 2H), 0.93 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 143.7, 141.1, 138.6, 138.0, 136.5, 135.9, 135.2, 131.5, 130.6, 129.4, 127.8, 127.5, 126.9, 119.6, 94.0, 78.2, 52.8, 30.9, 29.8, 22.0, 21.7, 20.9, 19.3, 13.7.

IR (KBr) *v* 3434, 2922, 2358, 1358, 1169, 693, 677, 582 cm^{-1}.

HRMS (EI) calcd for $C_{28}H_{29}NO_2S$ (M^+): 443.1919; Found: 443.1919.



4,6-Dimethyl-7-phenyl-1-tosylindoline (5n)

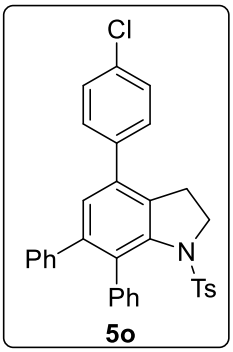
White solid, m. p. 165-167 ^oC (65 mg, 86% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:20).

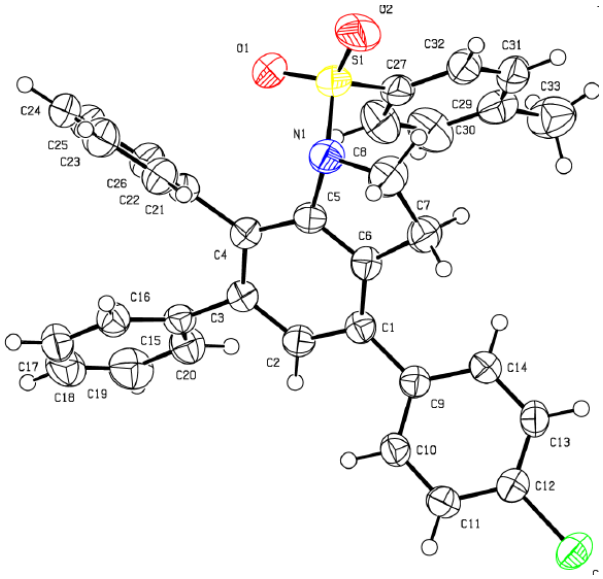
^{1}H NMR ($CDCl_3$, 600MHz) δ 7.40-7.30 (m, 5H), 7.20 (d, *J* = 8.4 Hz, 2H), 7.10 (d, *J* = 8.4 Hz, 2H), 6.94 (s, 1H), 3.95 (t, *J* = 7.2 Hz, 2H), 2.40 (t, *J* = 7.2 Hz, 2H), 2.37 (s, 3H), 2.19 (s, 3H), 2.13 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 143.5, 140.9, 139.0, 136.2, 136.0, 134.3, 133.1, 132.9, 130.8, 130.0, 129.2, 127.7, 127.6, 126.6, 52.8, 28.7, 21.7, 20.9, 18.8.

IR (KBr) *v* 2930, 2360, 1466, 1359, 1161, 1084, 831, 678, 578 cm^{-1}.

HRMS (EI) calcd for $C_{23}H_{23}NO_2S$ (M^+): 377.1449; Found:377.1445.





4-(4-Chlorophenyl)-6,7-diphenyl-1-tosylindoline (5o)

White solid, m. p. 220-222 ^oC (79 mg, 74% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:20).

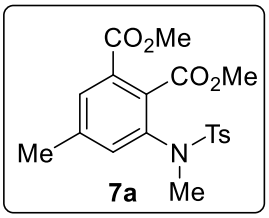
^{1}H NMR ($CDCl_3$, 600MHz) δ 7.36 (d, *J* = 8.4 Hz, 2H), 7.29 (s, 1H), 7.27-7.25 (m, 3H), 7.22-7.17 (m, 11H), 7.05-7.04 (m, 2H), 4.02 (t, *J* = 7.2 Hz, 2H), 2.64 (t, *J* = 7.2 Hz, 2H), 2.42 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 143.8, 142.3, 142.2, 141.2, 138.3, 138.1, 136.3, 135.9, 135.4,

134.2, 133.7, 131.4, 130.0, 129.9, 129.6, 129.4, 128.9, 127.8, 127.6, 126.7, 53.0, 30.2, 21.7.

IR (KBr) *v* 2935, 2362, 1467, 1359, 1168, 1085, 841, 675, 573 cm^{-1}.

HRMS (EI) calcd for $C_{33}H_{26}ClNO_2S$ (M^+): 535.1373; Found: 535.1373.



Dimethyl 3-((*N*,4-dimethylphenyl)sulfonamido)-5-methylphthalate (7a)

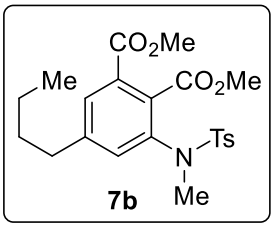
White solid, m. p. 131-133 ^oC (57 mg, 73% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:5).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.79 (s, 1H), 7.69 (d, *J* = 8.0 Hz, 2H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.06 (s, 1H), 3.87 (s, 3H), 3.83 (s, 3H), 3.11 (s, 3H), 2.45 (s, 3H), 2.34 (s, 3H).

^{13}C NMR ($CDCl_3$, 100MHz) δ 167.8, 165.7, 144.0, 140.8, 139.5, 135.7, 133.9, 133.3, 130.9, 129.7, 129.6, 128.4, 52.8, 39.8, 21.7, 21.3.

IR (KBr) *v* 2948, 2358, 1734, 1602, 1438, 1285, 1105, 789 cm^{-1}.

HRMS (EI) calcd for $C_{19}H_{21}NO_6S$ (M^+): 391.1090; Found: 391.1092.



Dimethyl 5-butyl-3-((*N*,4-dimethylphenyl)sulfonamido)phthalate (7b)

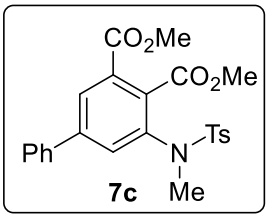
Light yellow oil (56 mg, 65% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:4).

^{1}H NMR ($CDCl_3$, 400MHz) δ 7.78 (s, 1H), 7.68 (d, *J* = 8.0 Hz, 2H), 7.32 (d, *J* = 8.0 Hz, 2H), 6.95 (s, 1H), 3.88 (s, 3H), 3.86 (s, 3H), 3.14 (s, 3H), 2.56 (t, *J* = 8.0 Hz, 2H), 2.46 (s, 3H), 1.54-1.47 (m, 2H), 1.35-1.26 (m, 2H), 0.92 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 167.8, 165.7, 145.7, 144.1, 139.5, 135.4, 134.2, 132.4, 130.3, 129.7, 129.6, 128.3, 52.9, 52.8, 40.0, 35.1, 33.1, 22.3, 21.7, 14.0.

IR (filter) *v* 2961, 1738, 1604, 1441, 1290, 1113, 792 cm^{-1}.

HRMS (EI) calcd for $C_{22}H_{27}NO_6S$ (M^+): 433.1559; Found: 433.1559.



Dimethyl 5-((*N*,4-dimethylphenyl)sulfonamido)-[1,1'-biphenyl]-3,4-dicarboxylate (7c)

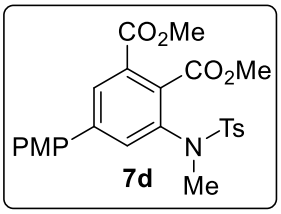
White solid, m. p. 148-151 ^{o}C (71 mg, 78% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:4).

^{1}H NMR ($CDCl_3$, 600MHz) δ 8.20 (d, *J* = 1.8 Hz, 1H), 7.73 (d, *J* = 8.4 Hz, 2H), 7.44-7.39 (m, 5H), 7.36-7.34 (m, 3H), 3.92 (s, 3H), 3.90 (s, 3H), 3.20 (s, 3H), 2.47 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 167.6, 165.5, 144.2, 143.4, 140.1, 138.2, 135.4, 135.3, 131.0, 130.3, 129.8, 129.2, 128.76, 128.74, 128.4, 127.2, 52.98, 52.97, 40.2, 21.7.

IR (KBr) *v* 2952, 2359, 1735, 1602, 1439, 1285, 1107, 791 cm^{-1}.

HRMS (EI) calcd for $C_{24}H_{23}NO_6S$ (M^+): 453.1246; Found: 453.1243.



Dimethyl 5-((*N*,4-dimethylphenyl)sulfonamido)-4'-methoxy-[1,1'-biphenyl]-3,4-dicarboxylate (7d)

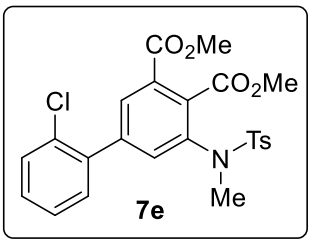
Light yellow oil (60 mg, 62% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:4).

^{1}H NMR ($CDCl_3$, 400MHz) δ 8.15 (s, 1H), 7.73 (d, *J* = 8.0 Hz, 2H), 7.38 (d, *J* = 8.8 Hz, 2H), 7.35 (d, *J* = 9.2 Hz, 2H), 7.28 (s, 1H), 6.95 (d, *J* = 8.4 Hz, 2H), 3.91 (s, 3H), 3.89 (s, 3H), 3.86 (s, 3H), 3.19 (s, 3H), 2.47 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 167.7, 165.6, 160.2, 144.2, 143.0, 140.1, 135.5, 134.5, 130.5, 130.4, 130.2, 129.8, 128.4, 128.3, 128.2, 114.6, 55.6, 53.0, 40.1, 21.8.

IR (filter) *v* 2950, 2356, 1729, 1600, 1437, 1286, 1131, 799 cm^{-1}.

HRMS (EI) calcd for $C_{25}H_{25}NO_7S$ (M^+): 483.1352; Found: 483.1352.



Dimethyl 2'-chloro-5-((*N*,4-dimethylphenyl)sulfonamido)-[1,1'-biphenyl]-3,4-dicarboxylate (7e)

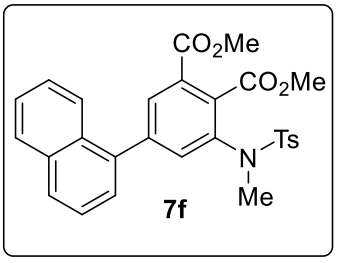
Light yellow oil (69 mg, 71% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:4).

^{1}H NMR ($CDCl_3$, 600MHz) δ 8.06 (s, 1H), 7.72 (d, *J* = 7.8 Hz, 2H), 7.48-7.46 (m, 1H), 7.34-7.30 (m, 4H), 7.28 (s, 1H), 7.24-7.22 (m, 1H), 3.92 (s, 3H), 3.90 (s, 3H), 3.18 (s, 3H), 2.43 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 167.5, 165.4, 144.2, 141.7, 139.5, 137.7, 135.9, 135.4, 133.6, 132.4, 131.3, 131.2, 130.3, 129.9, 129.8, 129.6, 128.3, 127.2, 53.04, 52.99, 40.0, 21.7.

IR (filter) *v* 2952, 1738, 1604, 1437, 1290, 1109, 829, 791 cm^{-1}.

HRMS (EI) calcd for $C_{24}H_{22}ClNO_6S$ (M^+): 487.0856; Found: 487.0856.



Dimethyl 3-((*N*,4-dimethylphenyl)sulfonamido)-5-(naphthalen-1-yl)phthalate (7b)

Light yellow oil (57 mg, 57% yield), R_f = 0.2 (EtOAc/ Petroleum ether 1:4).

^{1}H NMR ($CDCl_3$, 600MHz) δ 8.12 (s, 1H), 7.93-7.90 (m, 2H), 7.74 (d, *J* = 10.6 Hz, 2H), 7.71 (d, *J* = 8.4 Hz, 1H), 7.55-7.48 (m, 3H), 7.33-7.30 (m, 2H), 7.27 (d, *J* = 7.2 Hz, 2H), 3.95 (s, 3H), 3.90 (s, 3H), 3.20 (s, 3H), 2.37 (s, 3H).

^{13}C NMR ($CDCl_3$, 151MHz) δ 167.6, 165.5, 144.1, 143.2, 139.7, 137.2, 135.6, 135.4, 134.0, 133.8, 131.7, 131.1, 129.8, 129.0, 128.6, 128.2, 127.4, 127.2, 126.9, 126.3, 125.3, 125.2, 53.1, 53.0, 40.1, 21.7.

IR (filter) *v* 2950, 1737, 1603, 1441, 1291, 1131, 786 cm^{-1}.

HRMS (EI) calcd for $C_{28}H_{25}NO_6S$ (M^+): 503.1403; Found: 503.1403

8. References

1 E. D. Slack, C. M. Gabriel, B. H. Lipshutz, *Angew. Chem., Int. Ed.*, 2014, **53**, 14051.

2 K. A. DeKorver, H. Li, A. G. Lohse, R. Hayashi, Z. Lu, Y. Zhang, R. P. Hsung, *Chem. Rev.*, 2010, **110**, 5064.

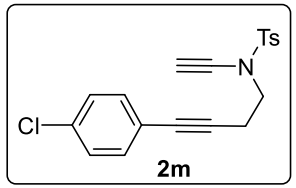
3 P. Mamidipalli, S. Y. Yun, K.-P. Wang, T. Zhou, Y. Xia, D. Lee, *Chem. Sci.*, 2014, **5**, 2362.

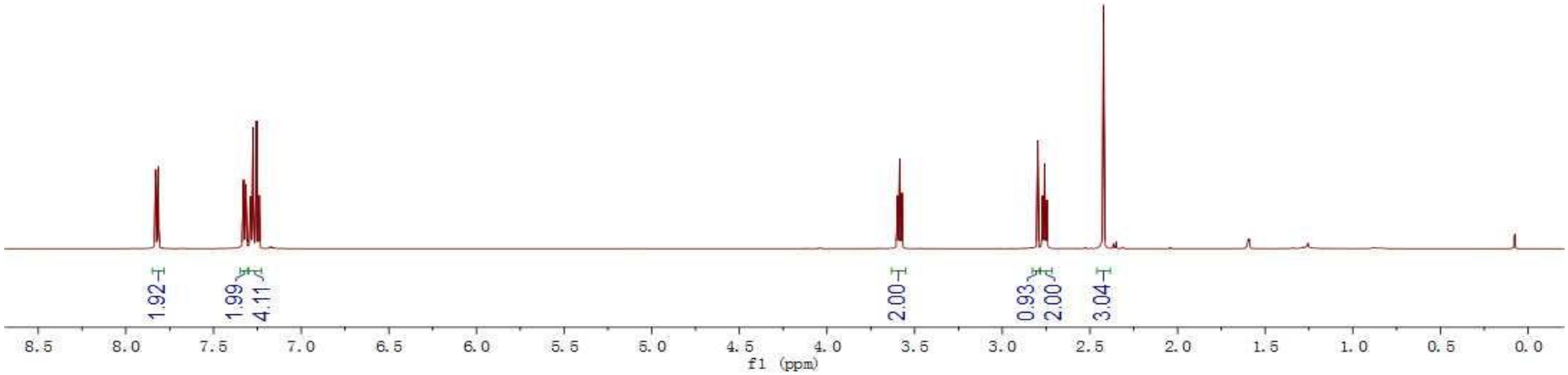
4 R. Liu, G. N. Winstonmcpherson, Z.-Y. Yang, X. Zhou, W. Song, I. A. Guzei, X. Xu, W. Tang, *J. Am. Chem. Soc.*, 2013, **135**, 8201.

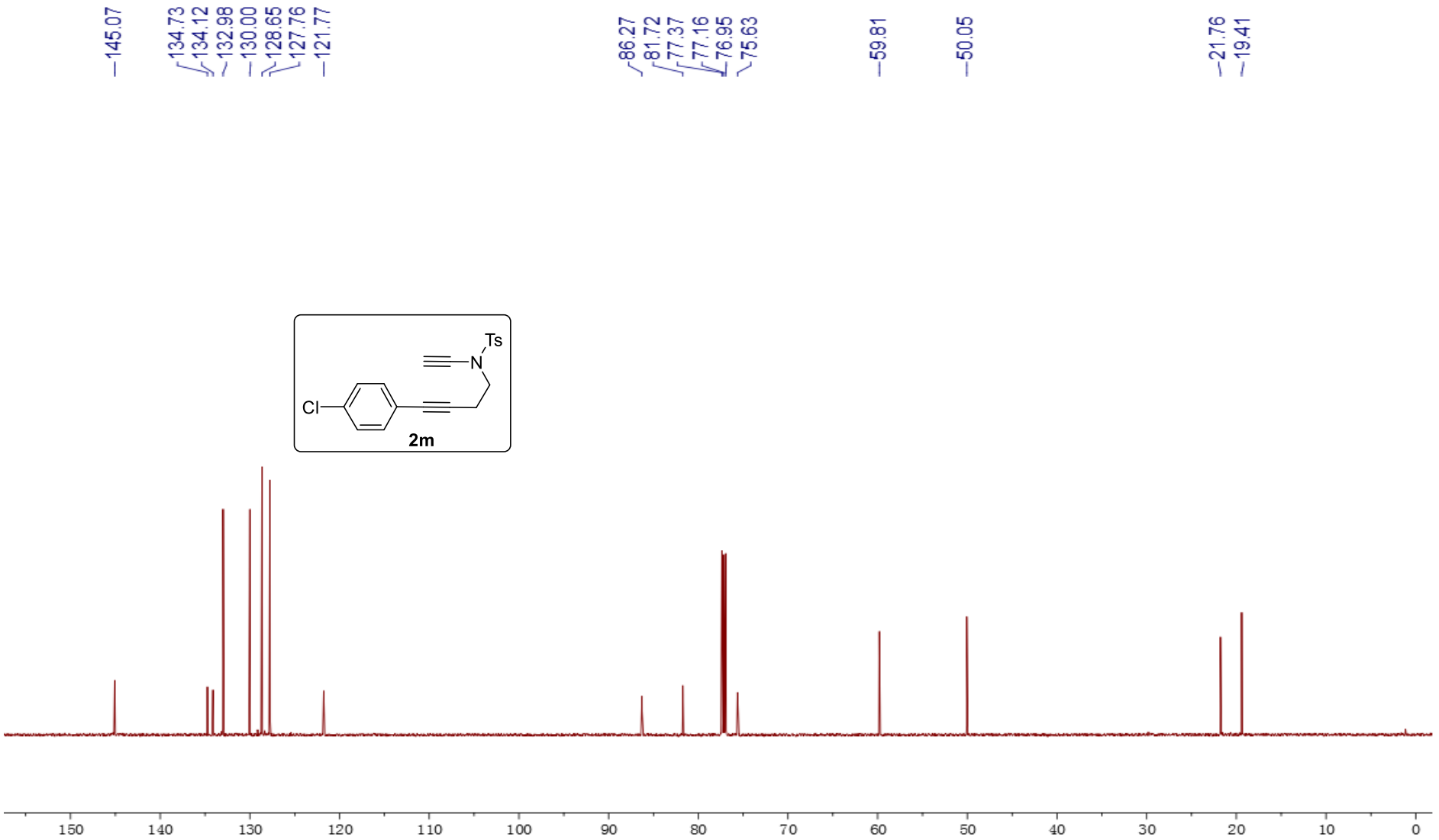
5 J. R. Dunetz, R. L. Danheiser, *J. Am. Chem. Soc*., 2005, **127**, 5776.

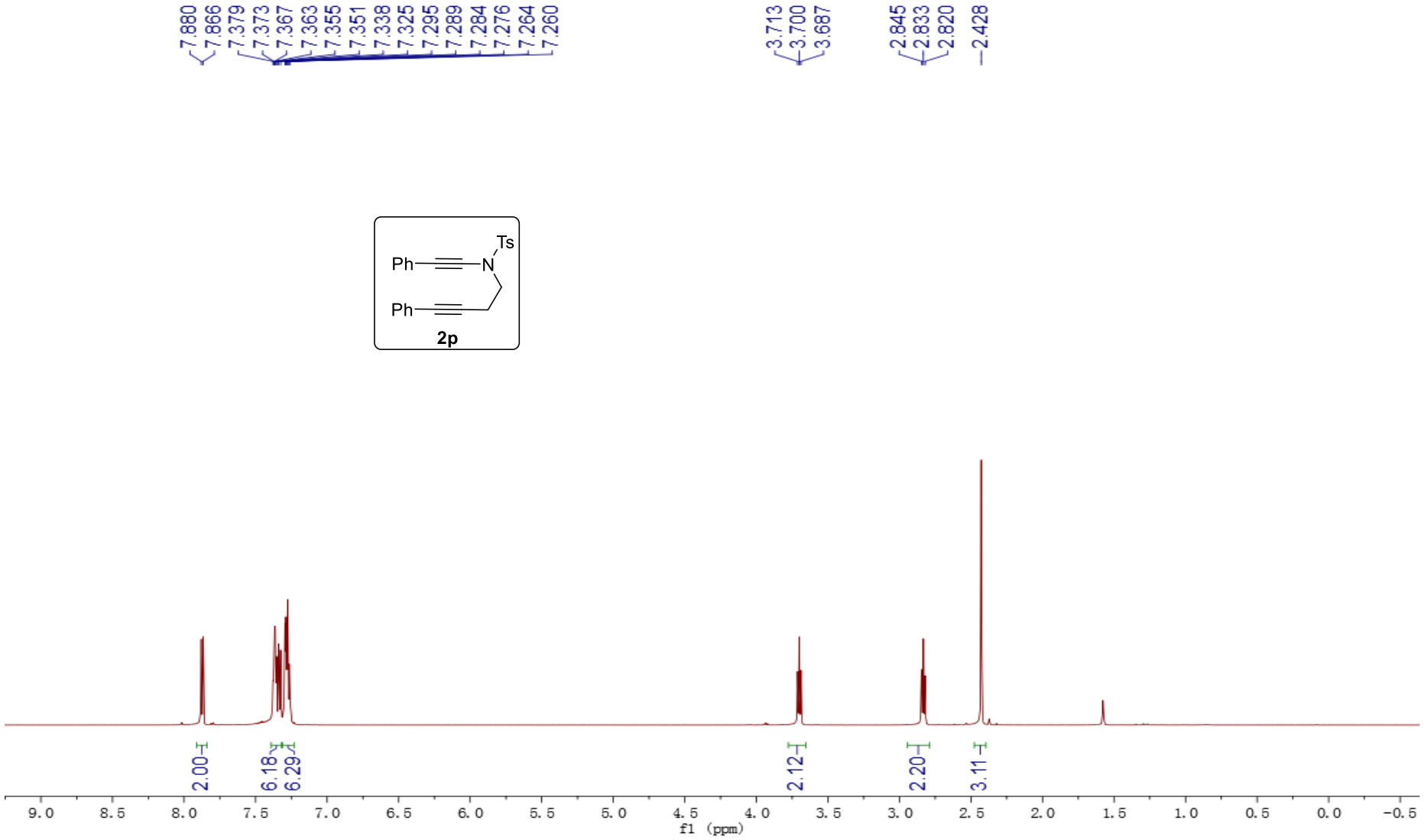

7.829
7.815
7.329
7.315
7.289
7.285
7.278
7.274
7.260
7.254
7.251
7.243
7.240

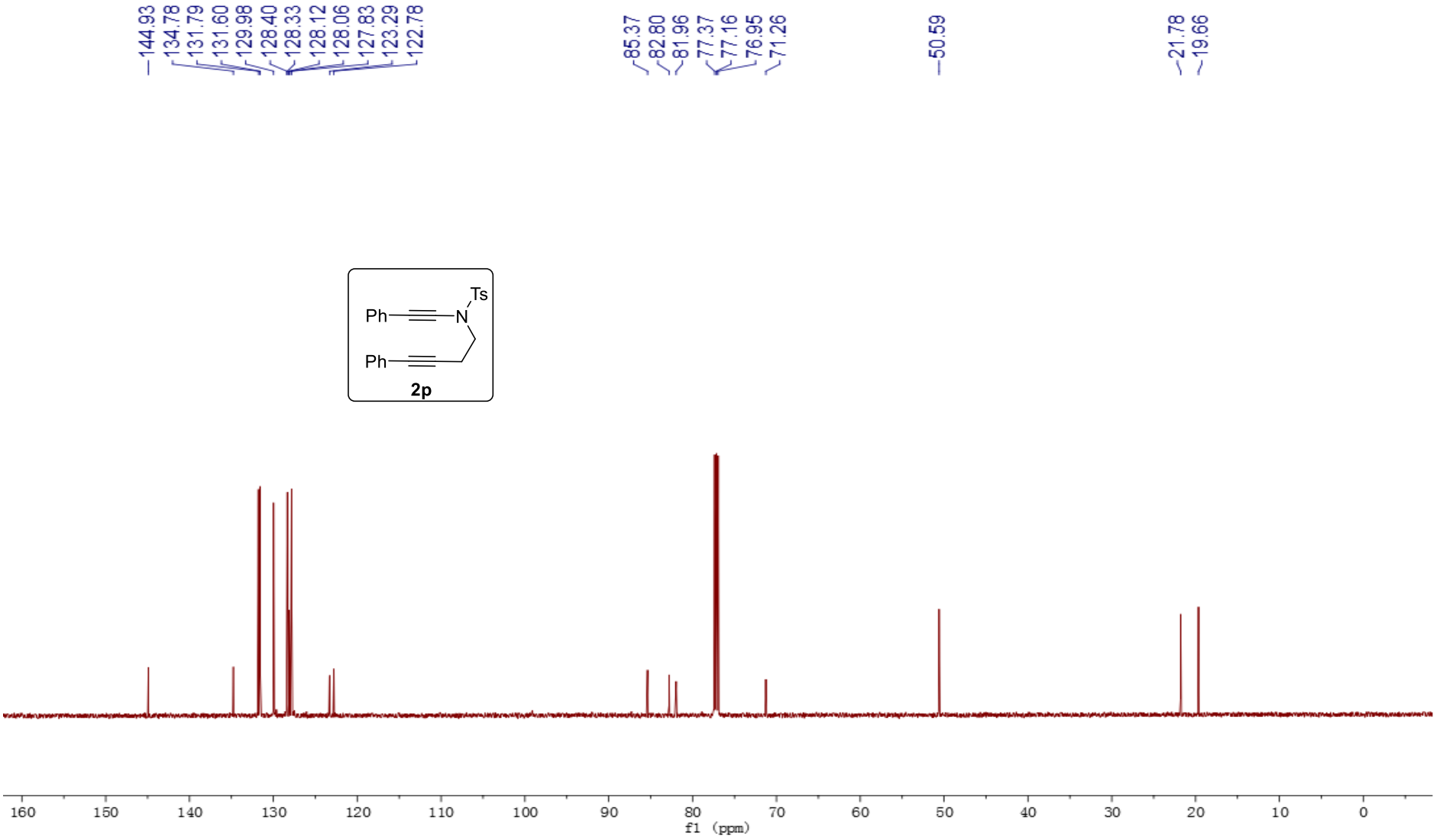

3.597
3.585
3.573
2.797
2.770
2.758
2.745
2.422

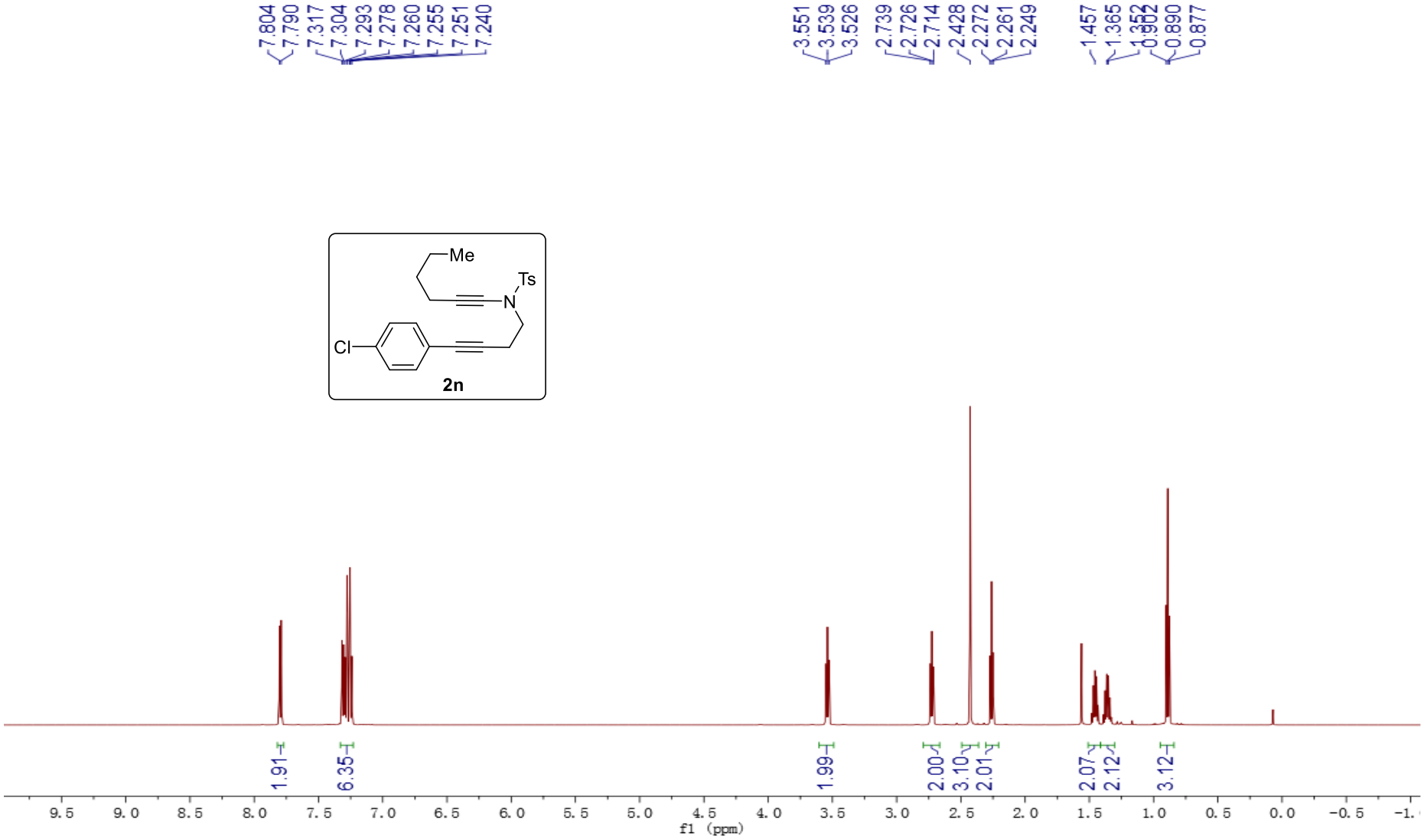

Ts
N
Cl
2m

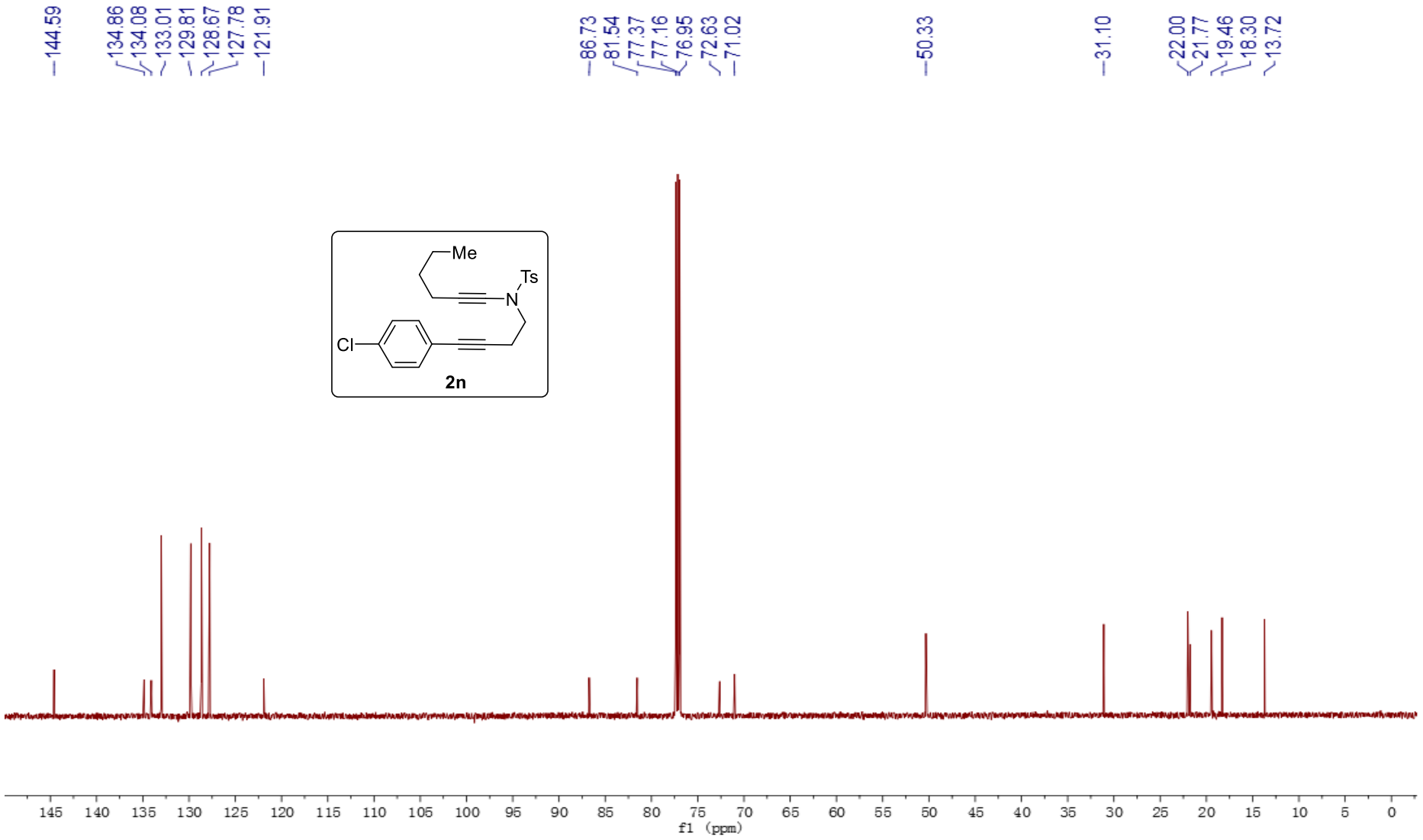

1.92
1.99
4.11
2.00
0.93
2.00
3.04
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

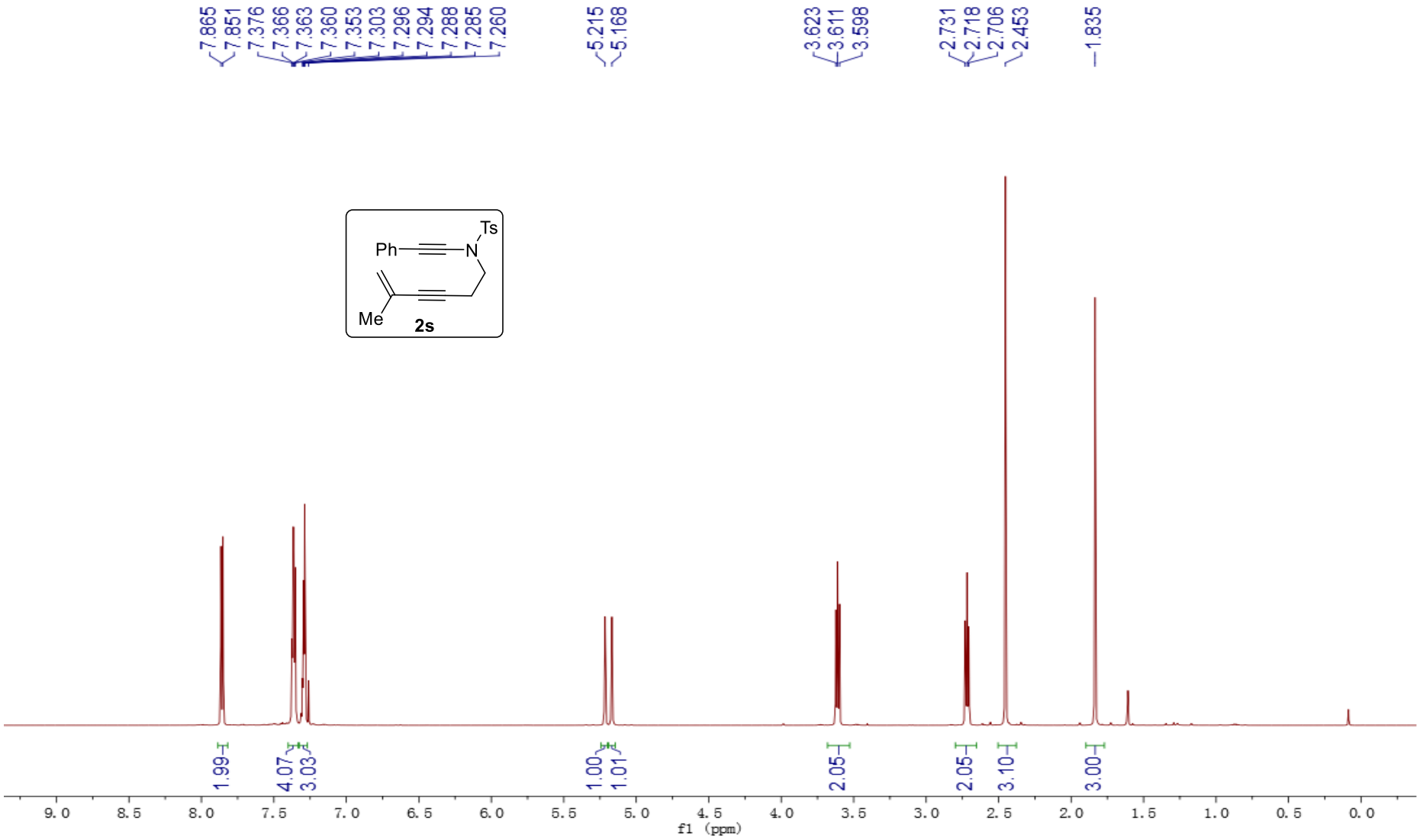

145.07
134.73
134.12
132.98
130.00
128.65
127.76
121.77
86.27
81.72
77.37
77.16
76.95
75.63
59.81
50.05
21.76
19.41
Ts
N
Cl
2m
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

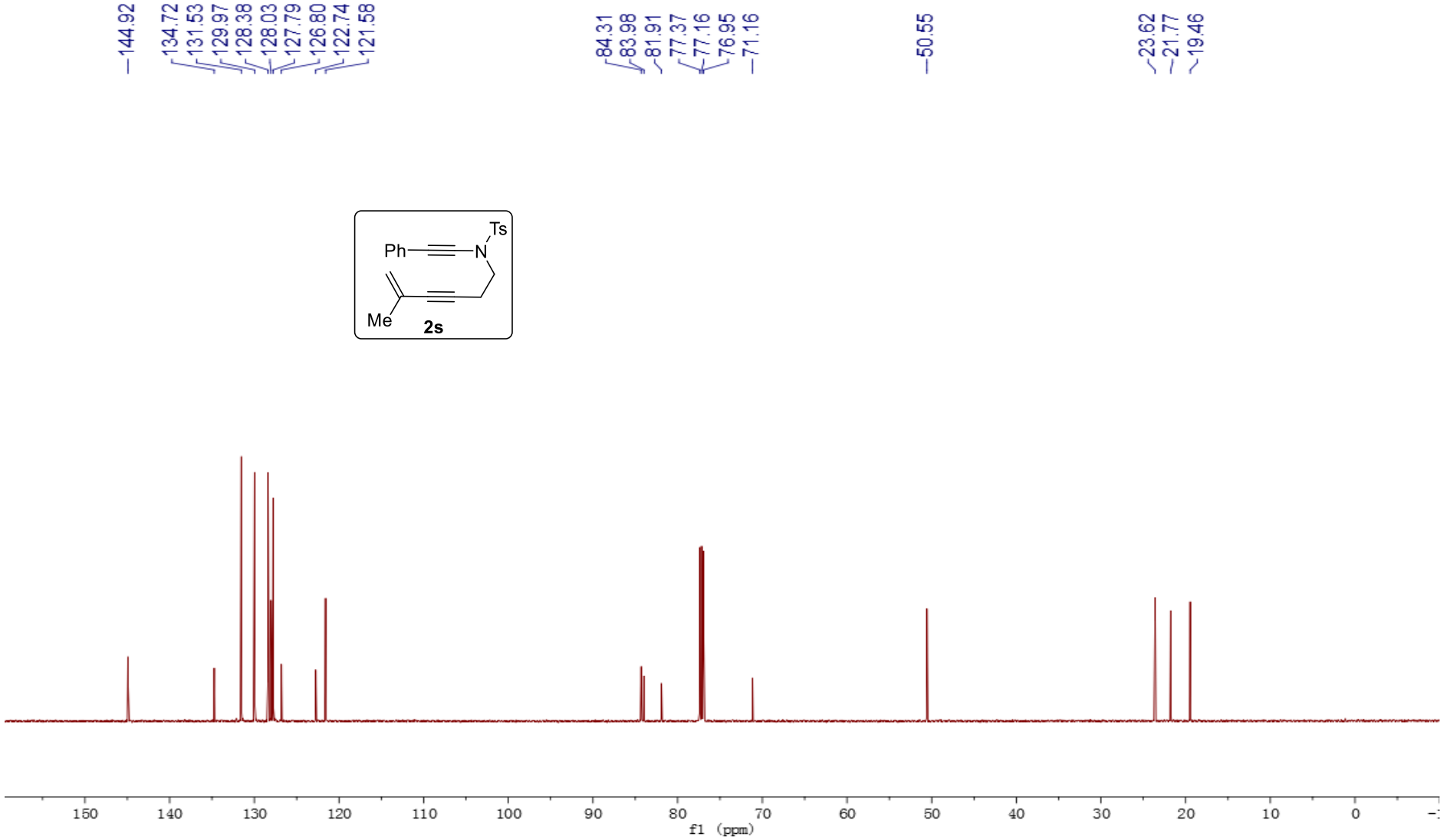

7.880
7.866
7.379
7.373
7.367
7.363
7.355
7.351
7.338
7.325
7.295
7.289
7.284
7.276
7.264
7.260
3.713
3.700
3.687
2.845
2.833
2.820
2.428
Ts
N
Ph
Ph
2p
2.00
6.18
6.29
2.12
2.20
3.11
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

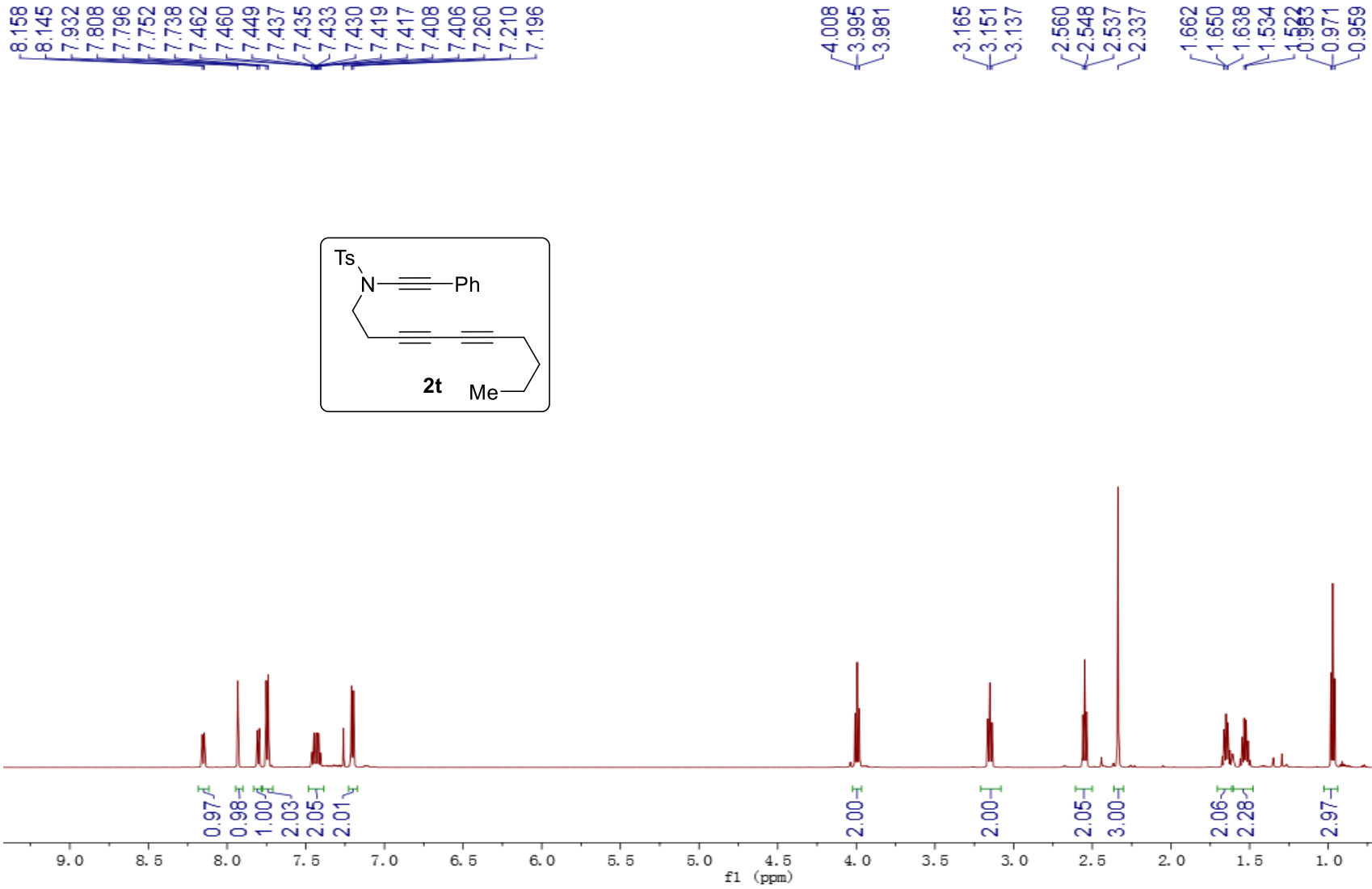

144.93
134.78
131.79
131.60
129.98
128.40
128.33
128.12
128.06
127.83
123.29
122.78
85.37
82.80
81.96
77.37
77.16
76.95
71.26
50.59
21.78
19.66
Ts
N
Ph
Ph
2p
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

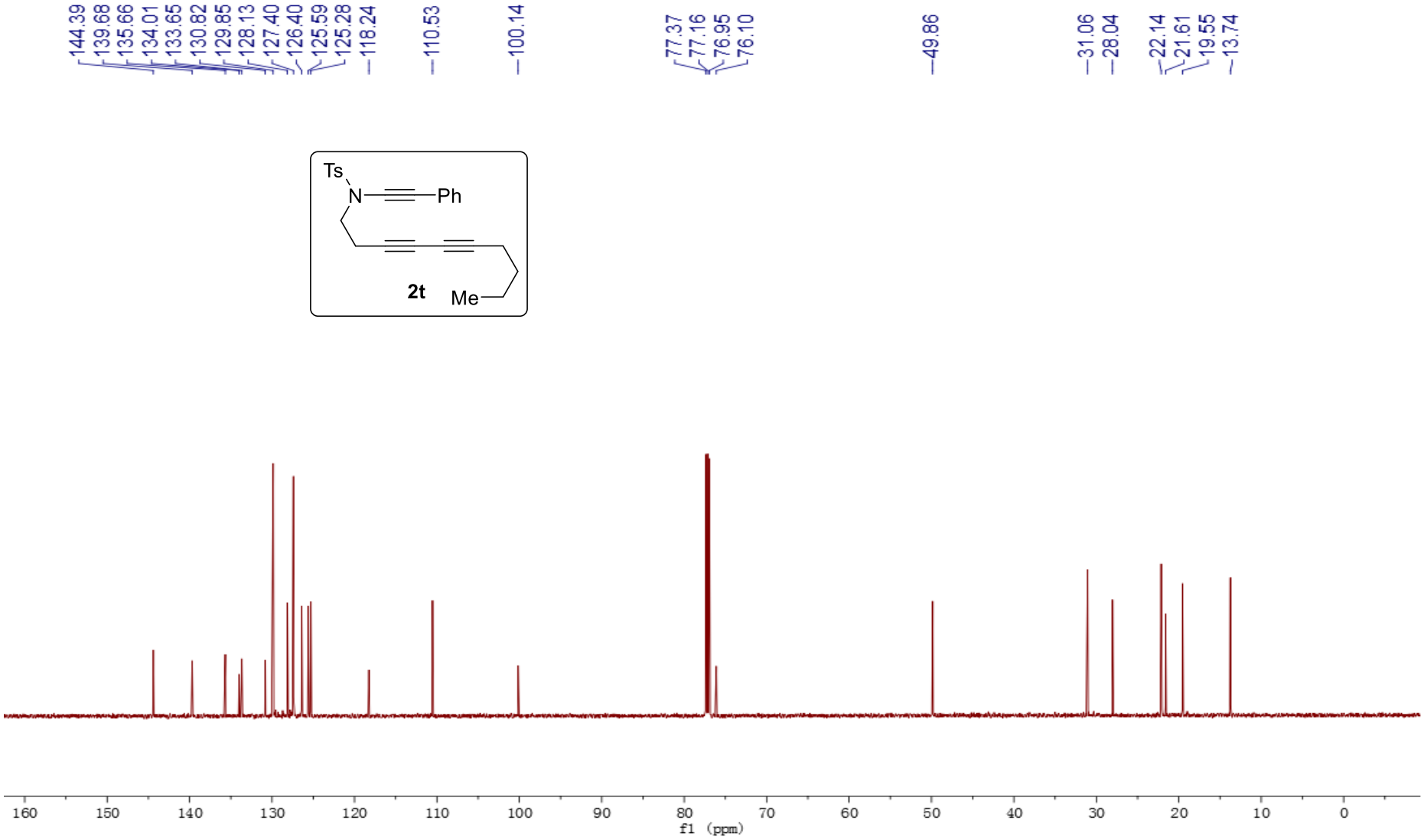

7.804
7.790
7.317
7.304
7.293
7.278
7.260
7.255
7.251
7.240
3.551
3.539
3.526
2.739
2.726
2.714
2.428
2.272
2.261
2.249
1.457
1.365
1.352
0.890
0.877
Me
Ts
N
Cl
2n
1.91
6.35
1.99
2.00
3.10
2.01
2.07
2.12
3.12
f1 (ppm)

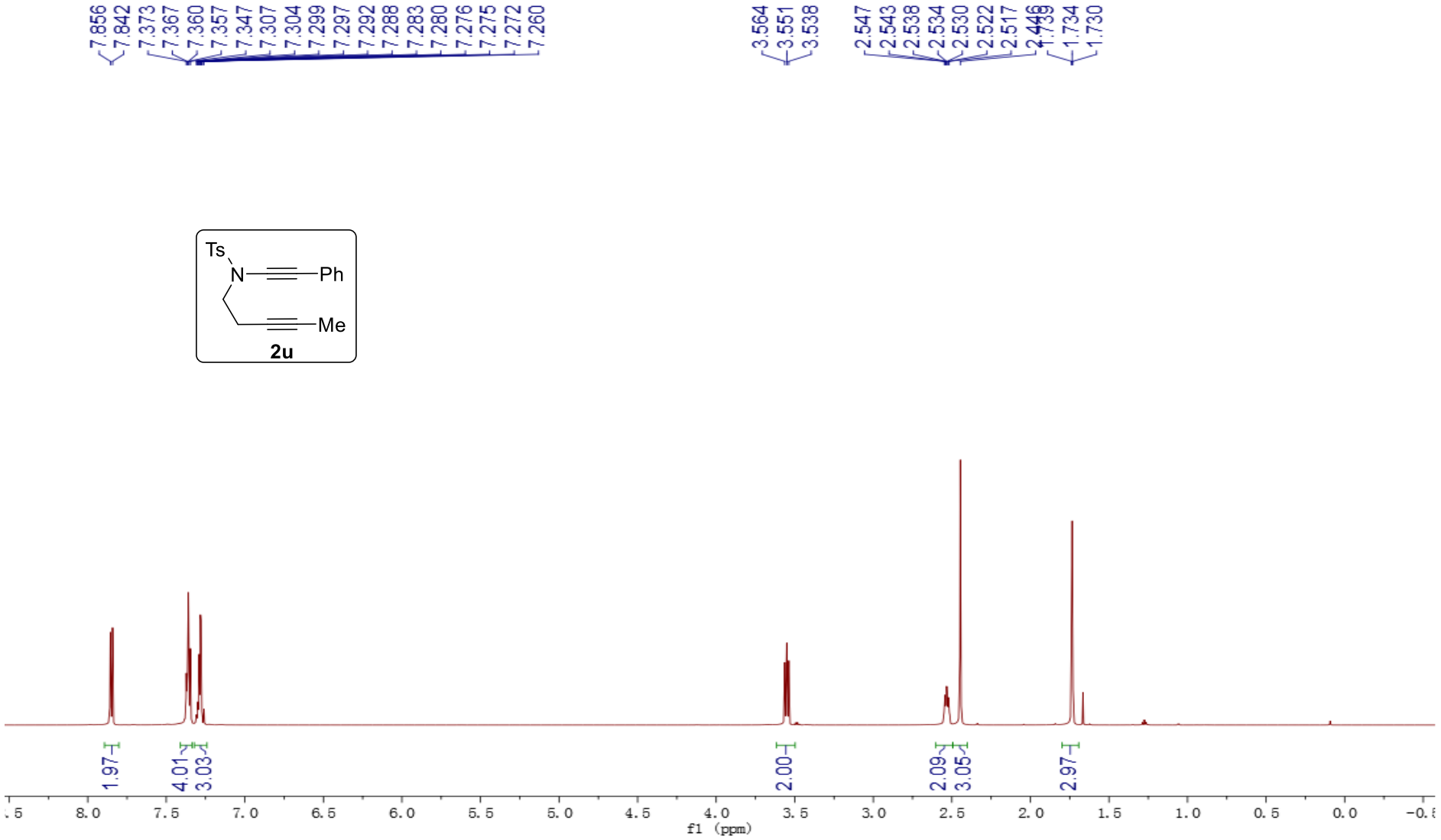

144.59
134.86
134.08
133.01
129.81
128.67
127.78
121.91
86.73
81.54
77.37
77.16
76.95
72.63
71.02
50.33
31.10
22.00
21.77
19.46
18.30
13.72
Me
Ts
N
Cl
2n
145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0
f1 (ppm)

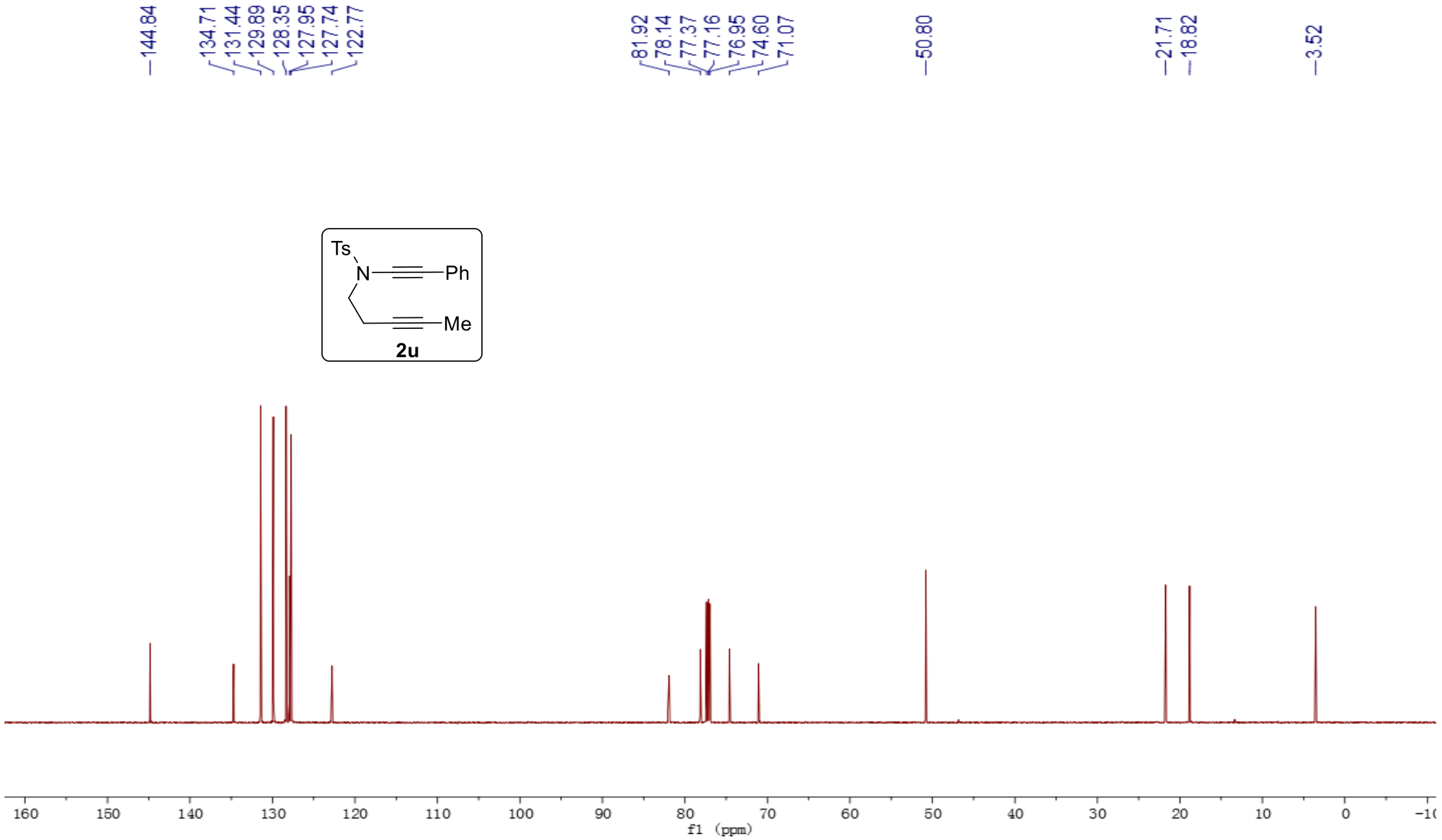

7.865
7.851
7.376
7.366
7.363
7.360
7.353
7.303
7.296
7.294
7.288
7.285
7.260
5.215
5.168
3.623
3.611
3.598
2.731
2.718
2.706
2.453
1.835
Ts
N
Ph
Me
2s
1.99
4.07
3.03
1.00
1.01
2.05
2.05
3.10
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

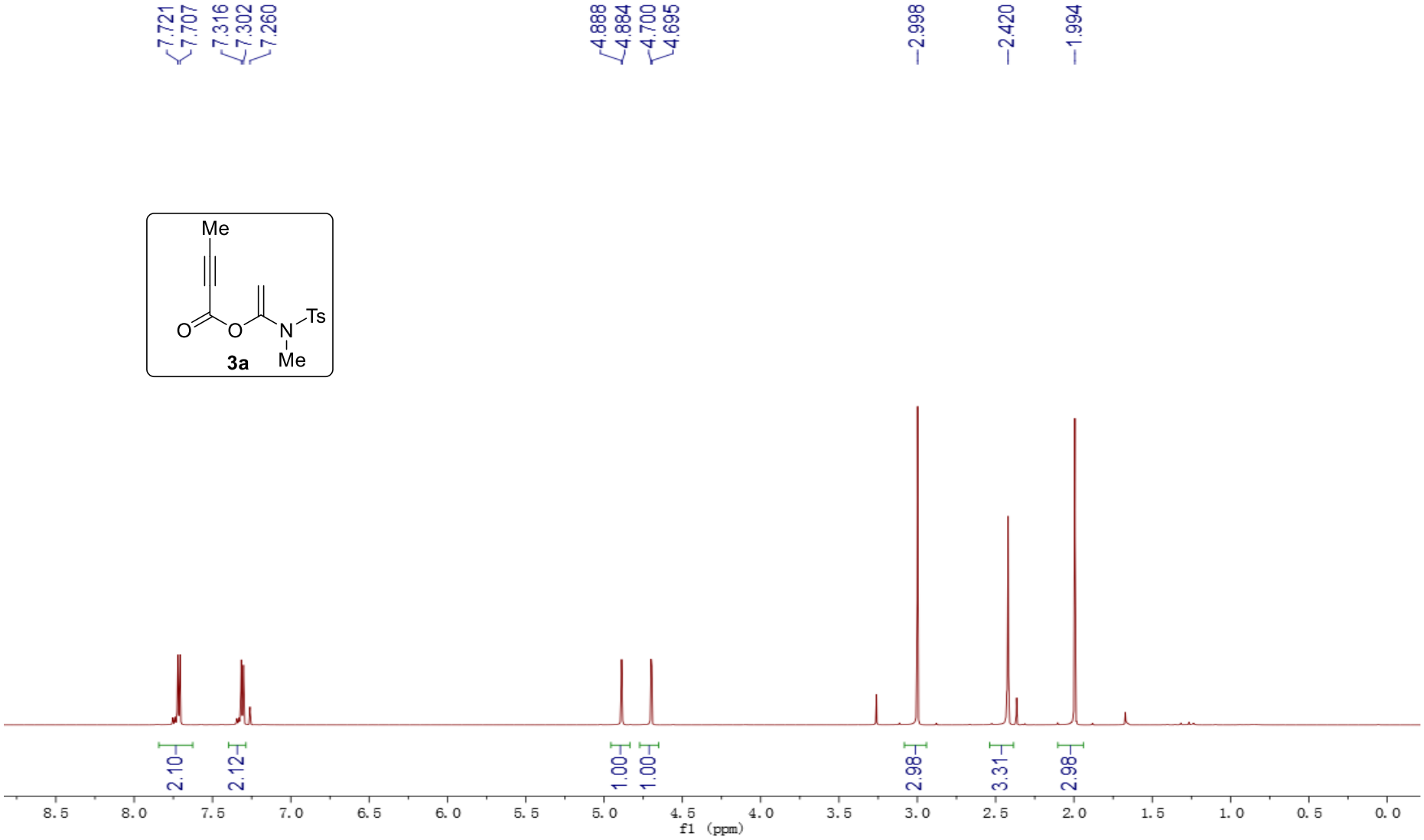

144.92
134.72
131.53
129.97
128.38
128.03
127.79
126.80
122.74
121.58
84.31
83.98
81.91
77.37
77.16
76.95
71.16
50.55
23.62
21.77
19.46
Ts
Ph
N
Me
2s
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

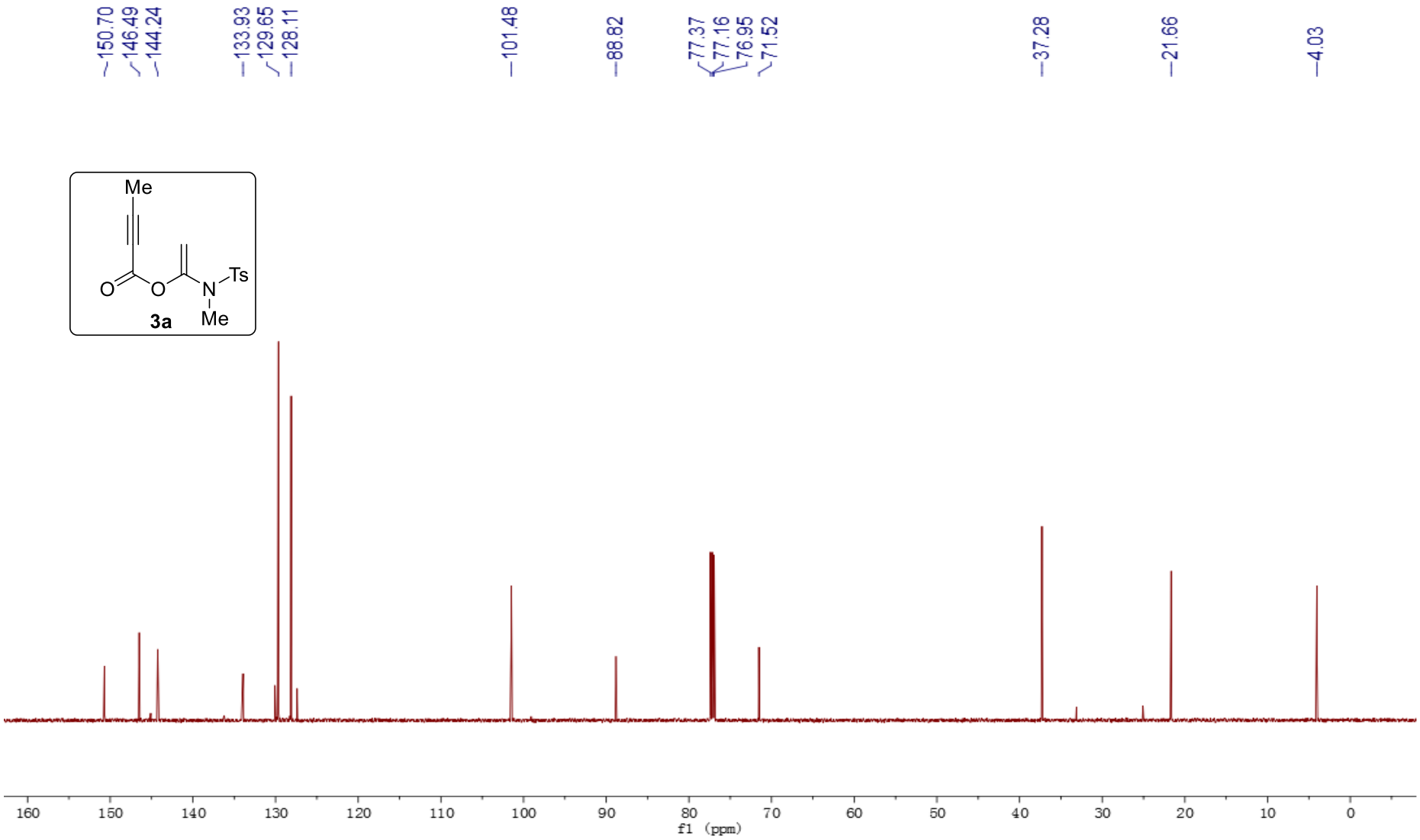

8.158
8.145
7.932
7.808
7.796
7.752
7.738
7.462
7.460
7.449
7.437
7.435
7.433
7.430
7.419
7.417
7.408
7.406
7.260
7.210
7.196
4.008
3.995
3.981
3.165
3.151
3.137
2.560
2.548
2.537
2.337
1.662
1.650
1.638
1.534
1.522
0.983
0.971
0.959
Ts
N
Ph
2t
Me
0.97
0.98
1.00
2.03
2.05
2.01
2.00
2.00
2.05
3.00
2.06
2.28
2.97
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)

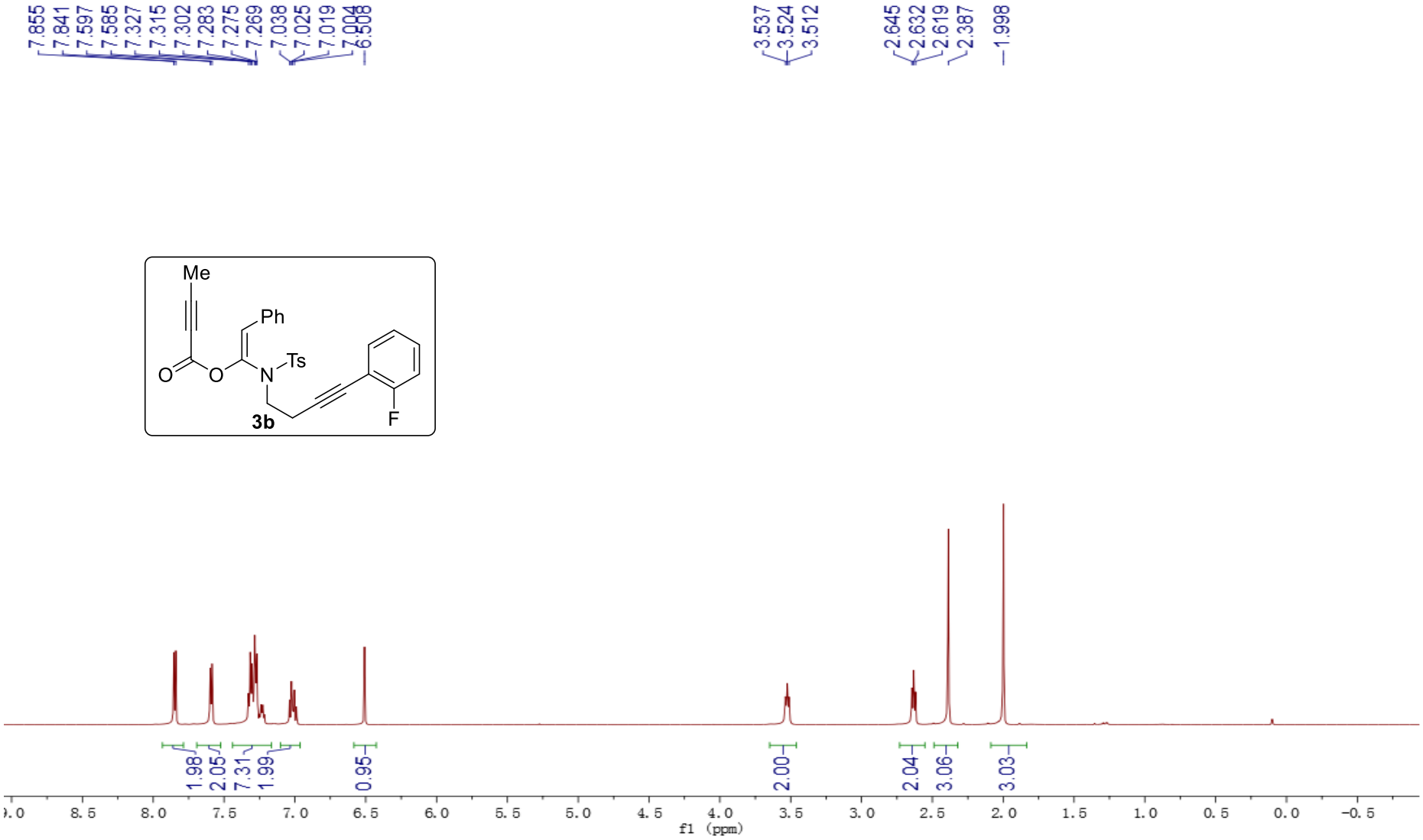

144.39
139.68
135.66
134.01
133.65
130.82
129.85
128.13
127.40
126.40
125.59
125.28
118.24
110.53
100.14
77.37
77.16
76.95
76.10
49.86
31.06
28.04
22.14
21.61
19.55
13.74
Ts
N
Ph
2t
Me
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

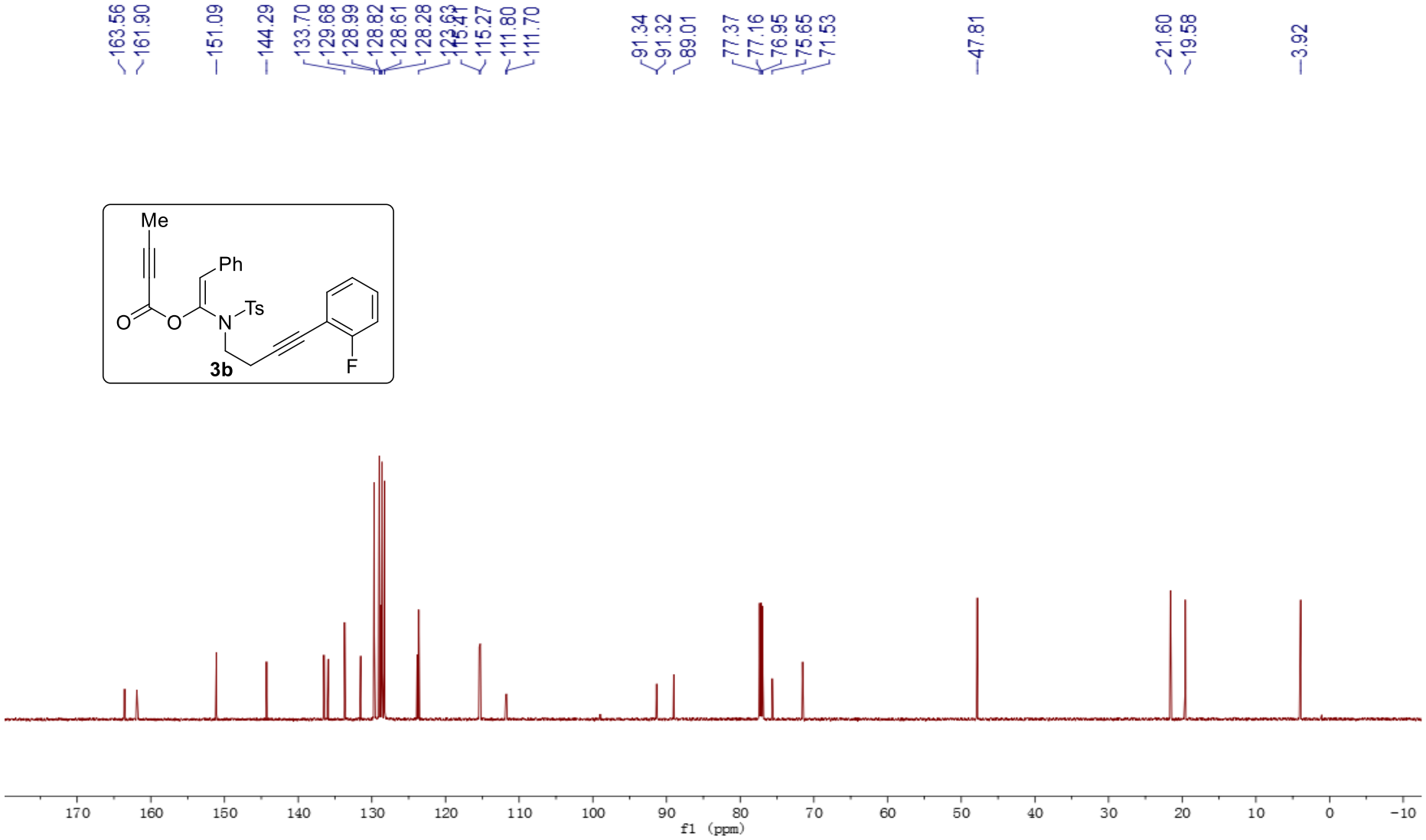

7.856
7.842
7.373
7.367
7.360
7.357
7.347
7.307
7.304
7.299
7.297
7.292
7.288
7.283
7.280
7.276
7.275
7.272
7.260
3.564
3.551
3.538
2.547
2.543
2.538
2.534
2.530
2.522
2.517
1.734
1.730
Ts
N
Ph
Me
2u
1.97
4.01
3.03
2.00
2.09
3.05
2.97
f1 (ppm)

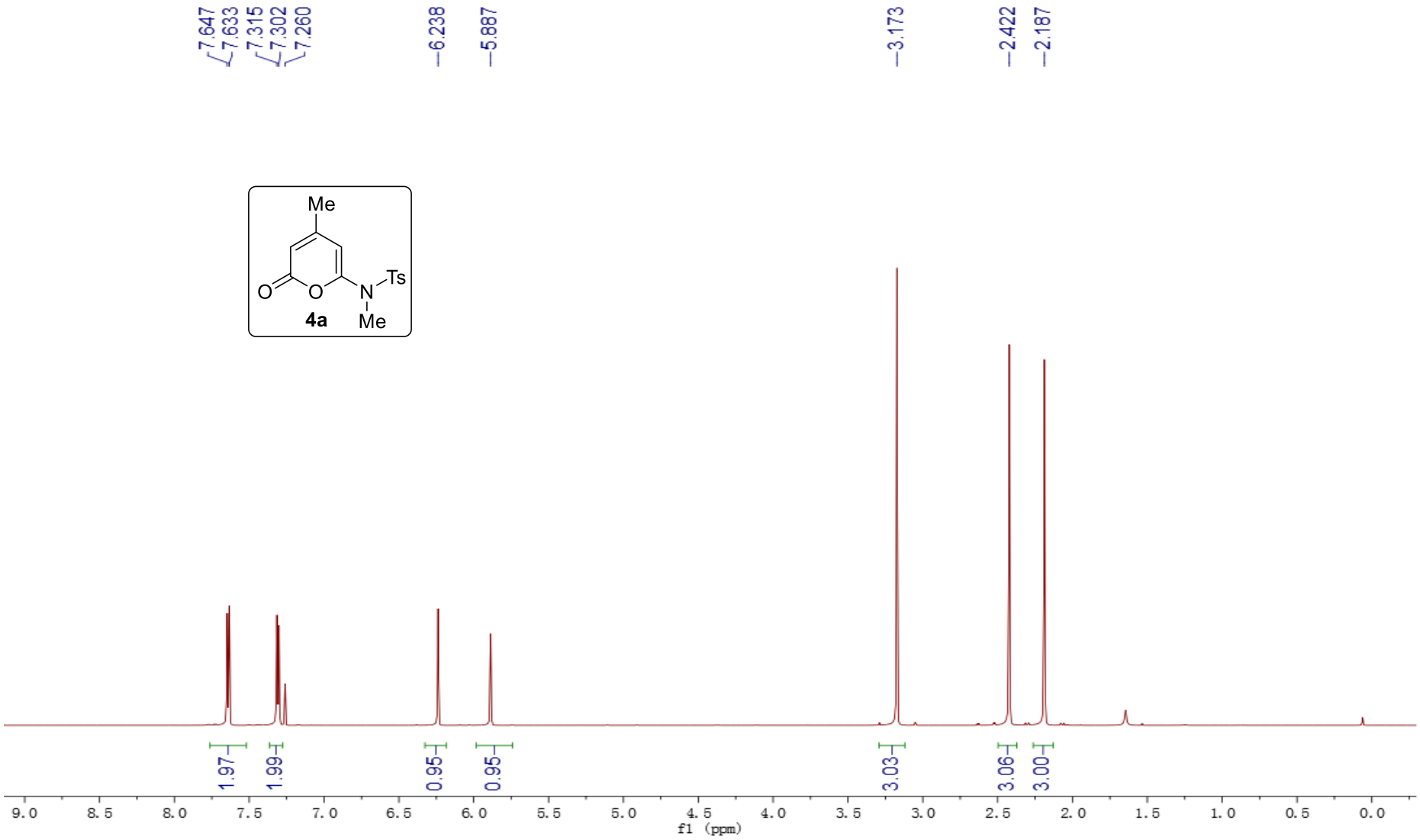

144.84
134.71
131.44
129.89
128.35
127.95
127.74
122.77
81.92
78.14
77.37
77.16
76.95
74.60
71.07
50.80
21.71
18.82
3.52
Ts
N
Ph
Me
2u
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

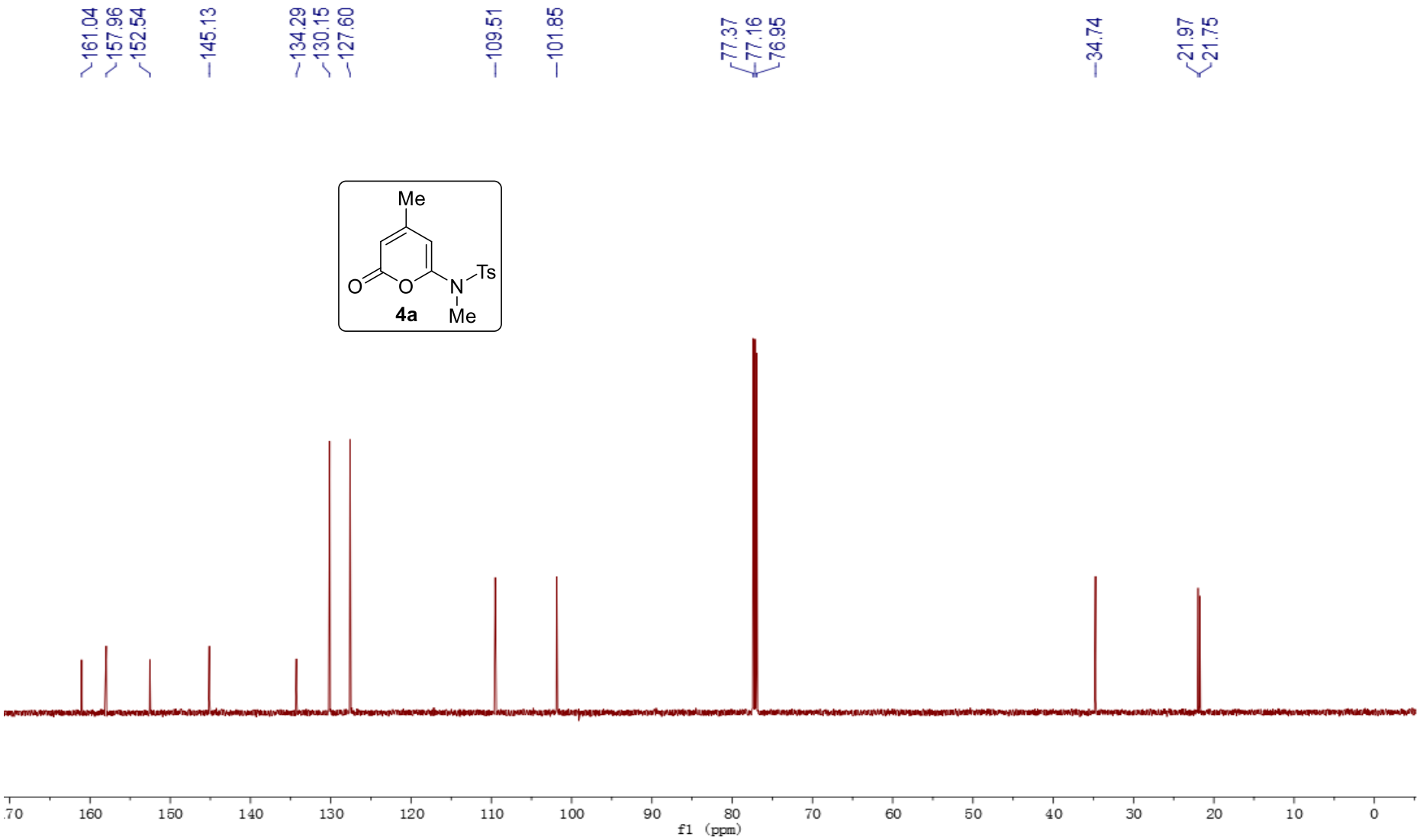

7.721
7.707
7.316
7.302
7.260
4.888
4.884
4.700
4.695
2.998
2.420
1.994
Me
O
O
N
Ts
Me
3a
2.10
2.12
1.00
1.00
2.98
3.31
2.98
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

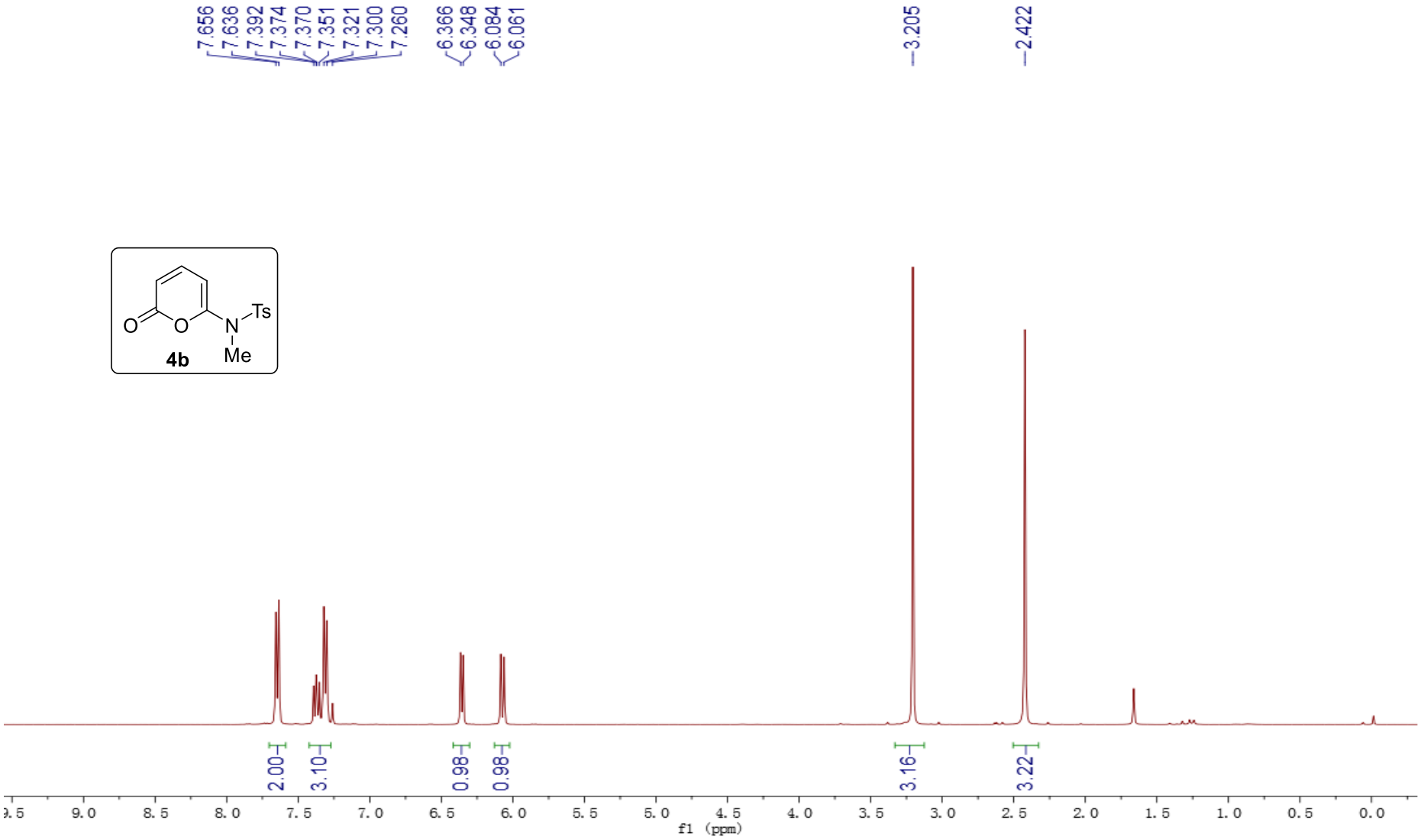

150.70
146.49
144.24
133.93
129.65
128.11
101.48
88.82
77.37
77.16
76.95
71.52
37.28
21.66
4.03
Me
O
O
N
Ts
Me
3a
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

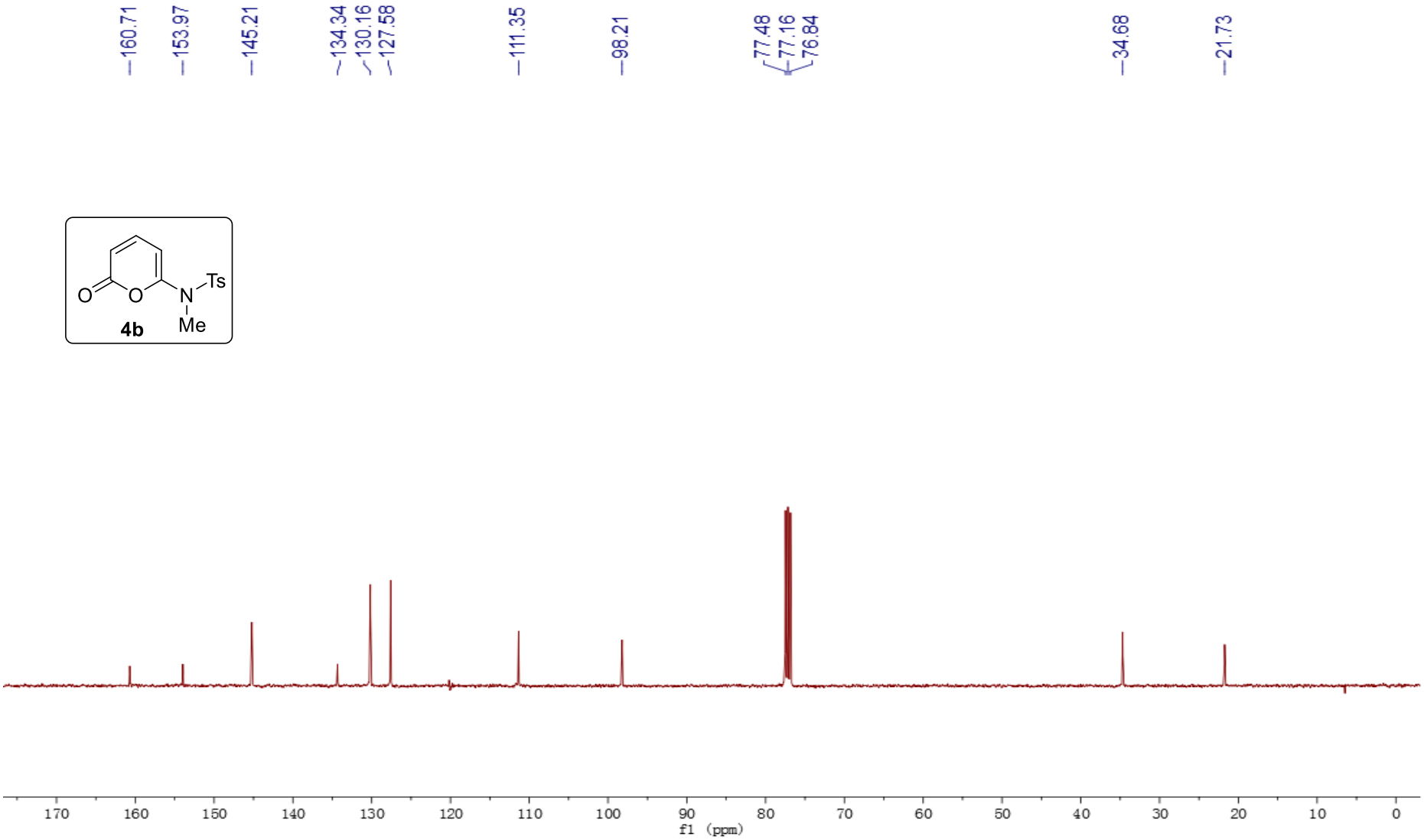

7.855
7.841
7.597
7.585
7.327
7.315
7.302
7.283
7.275
7.269
7.038
7.025
7.019
7.004
6.508
3.537
3.524
3.512
2.645
2.632
2.619
2.387
1.998
Me
Ph
Ts
O
O
N
F
3b
1.98
2.05
7.31
1.99
0.95
2.00
2.04
3.06
3.03
f1 (ppm)

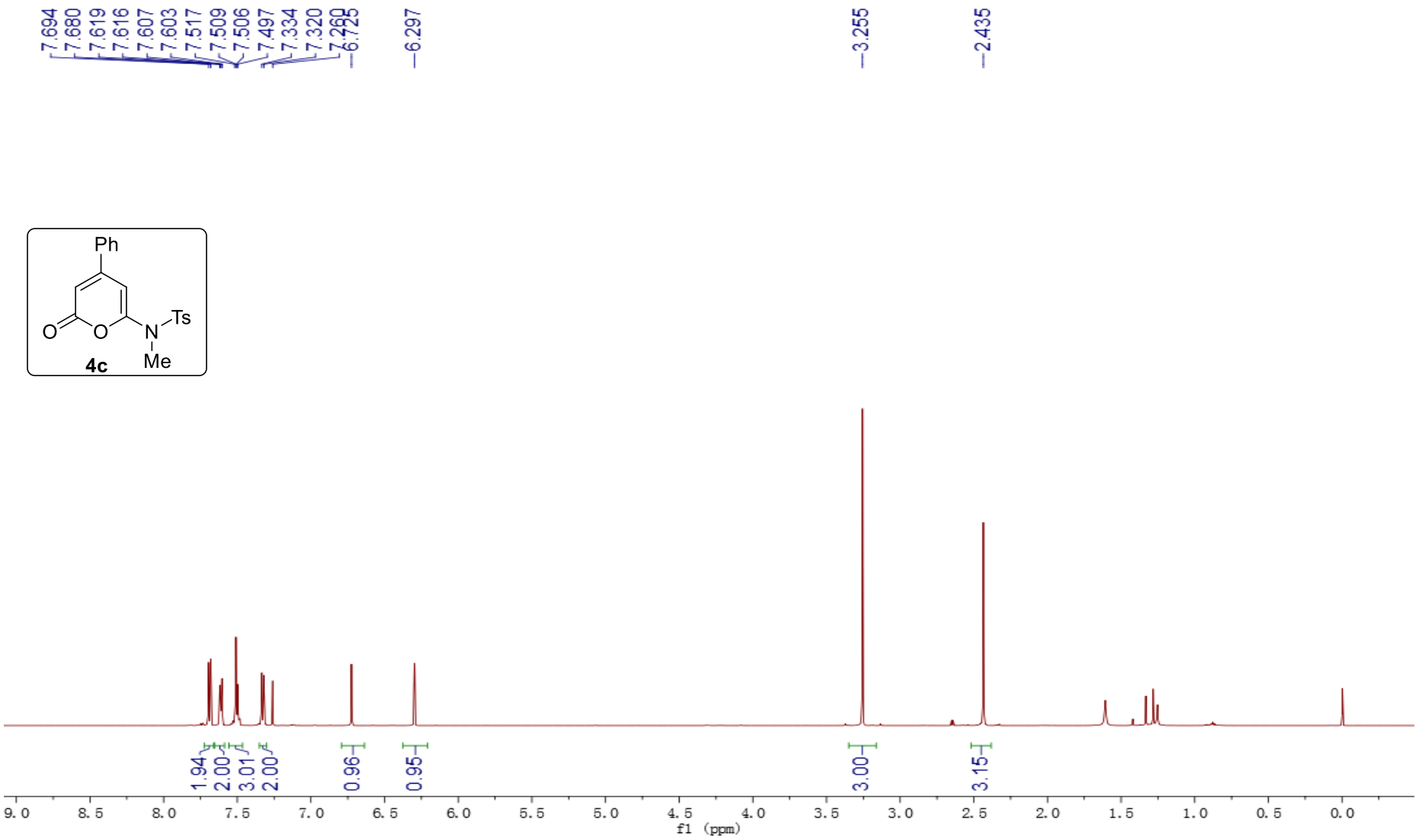

163.56
161.90
151.09
144.29
133.70
129.68
128.99
128.82
128.61
128.28
115.27
111.80
111.70
91.34
91.32
89.01
77.37
77.16
76.95
75.65
71.53
47.81
21.60
19.58
3.92
Me
Ph
Ts
N
O
O
F
3b
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)

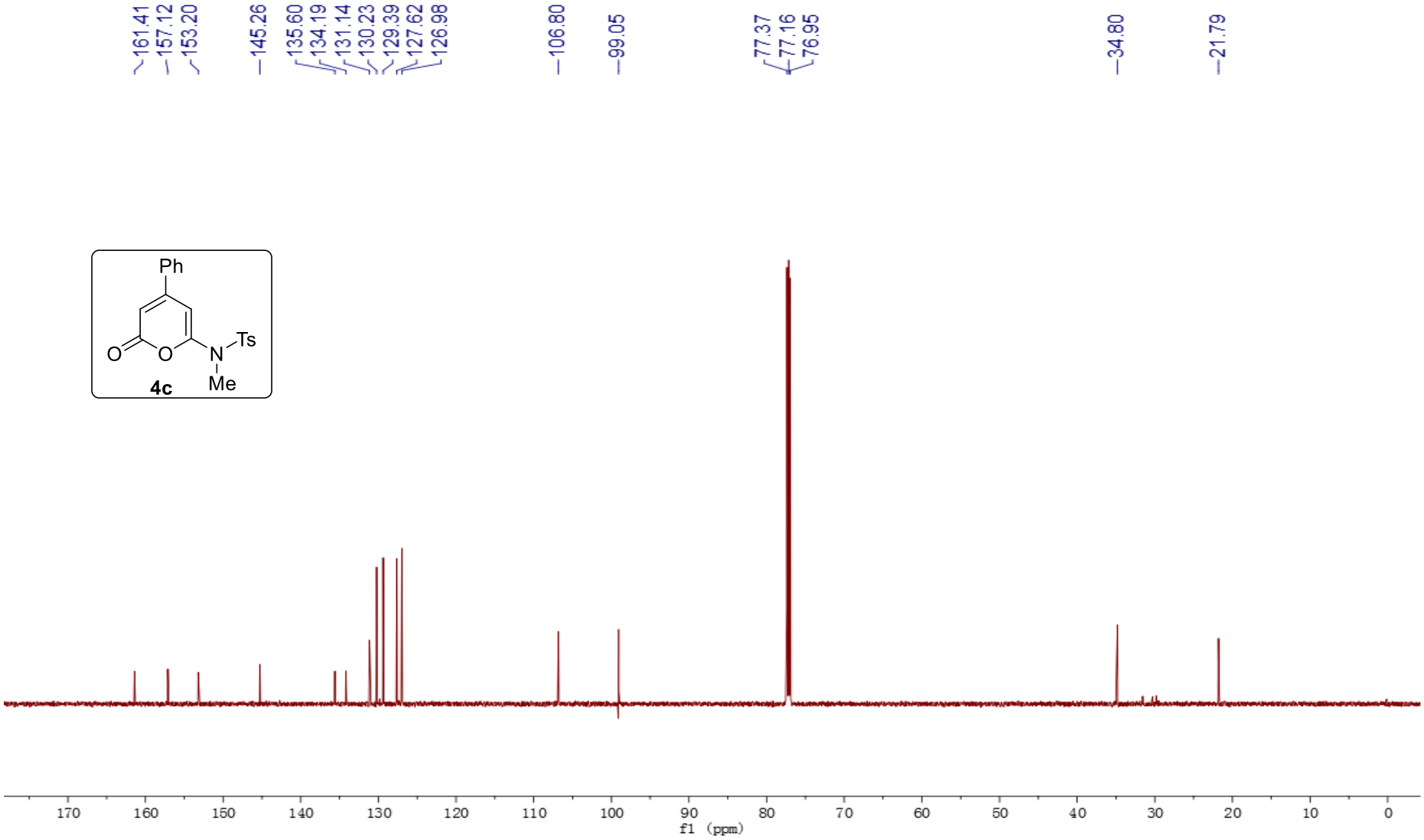

7.647
7.633
7.315
7.302
7.260
6.238
5.887
3.173
2.422
2.187
Me
O
O
N
Ts
Me
4a
1.97
1.99
0.95
0.95
3.03
3.06
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

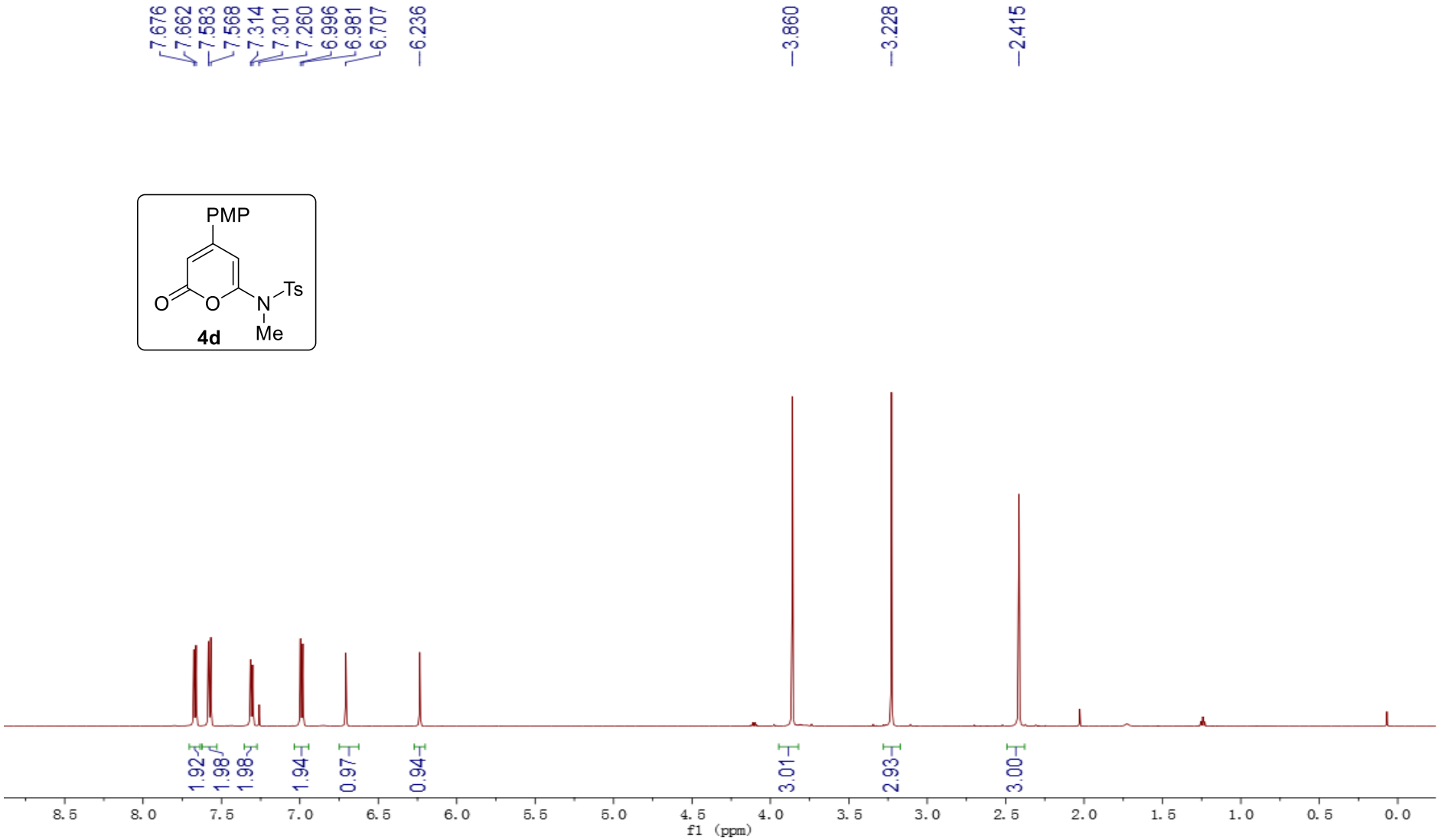

161.04
157.96
152.54
145.13
134.29
130.15
127.60
109.51
101.85
77.37
77.16
76.95
34.74
21.97
21.75
Me
O
O
N
Ts
Me
4a
70
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

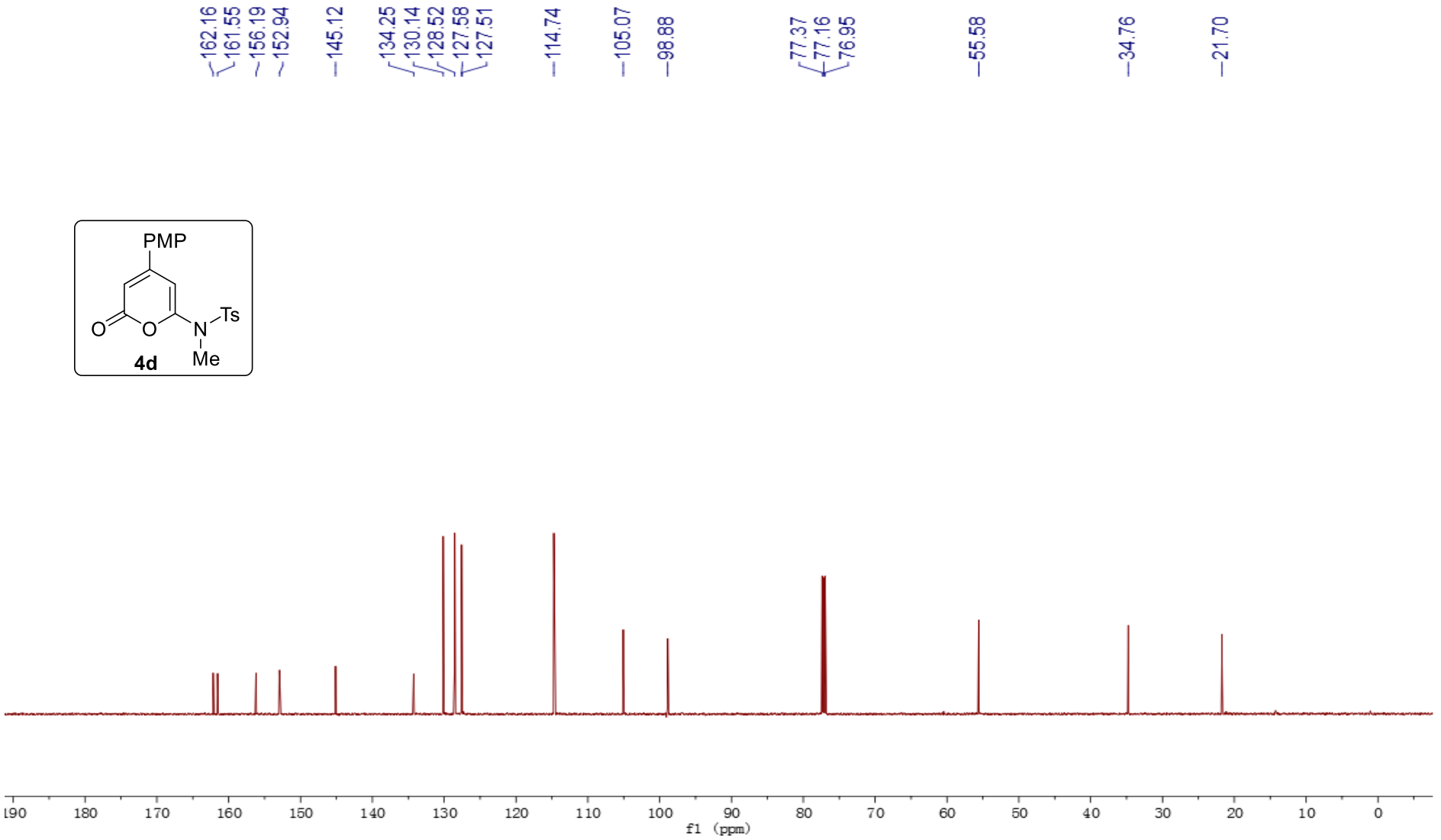

7.656
7.636
7.392
7.374
7.370
7.351
7.321
7.300
7.260
6.366
6.348
6.084
6.061
3.205
2.422
O
O
N
Ts
Me
4b
2.00
3.10
0.98
0.98
3.16
3.22
f1 (ppm)

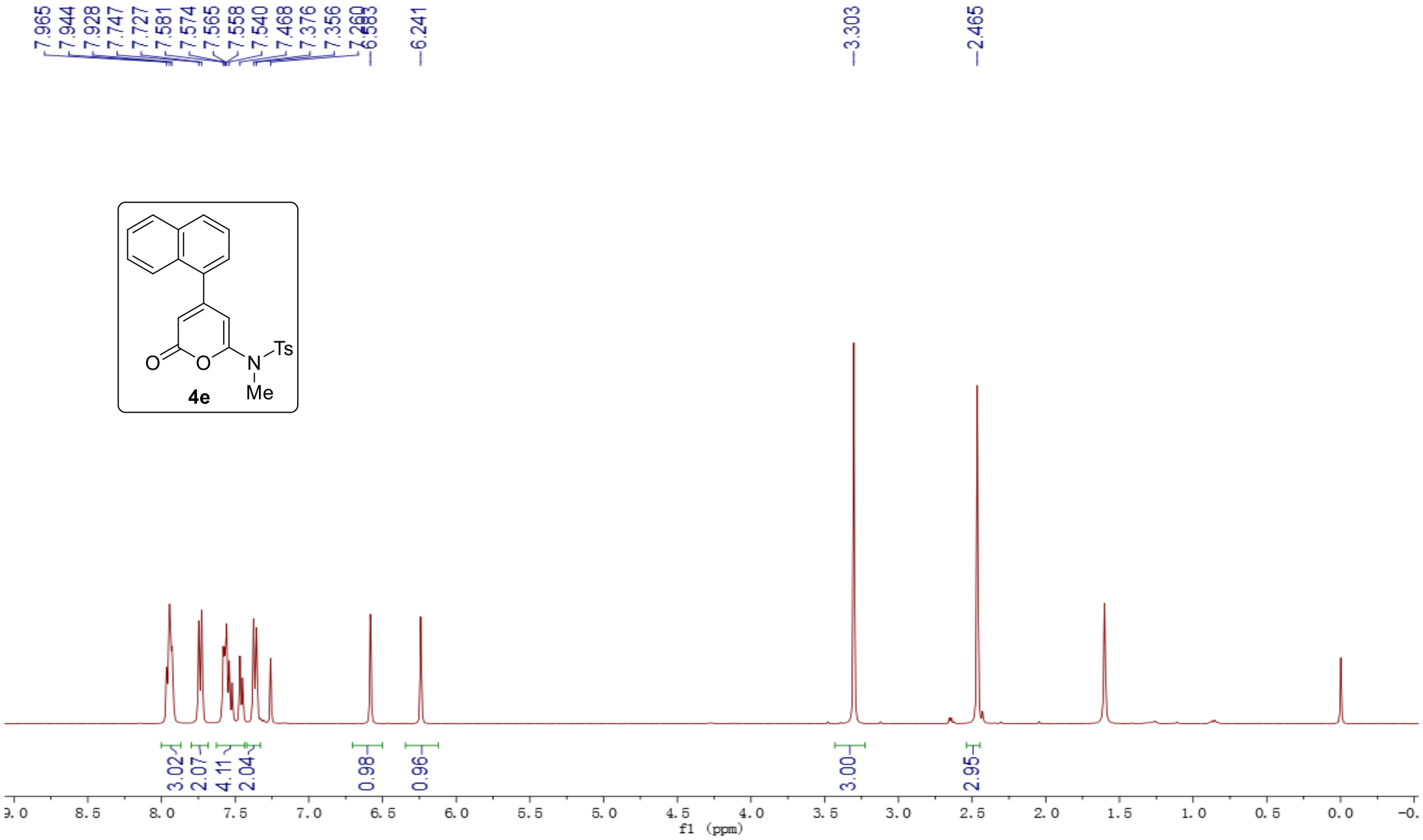

160.71
153.97
145.21
134.34
130.16
127.58
111.35
98.21
77.48
77.16
76.84
34.68
21.73
O
O
N
Ts
Me
4b
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

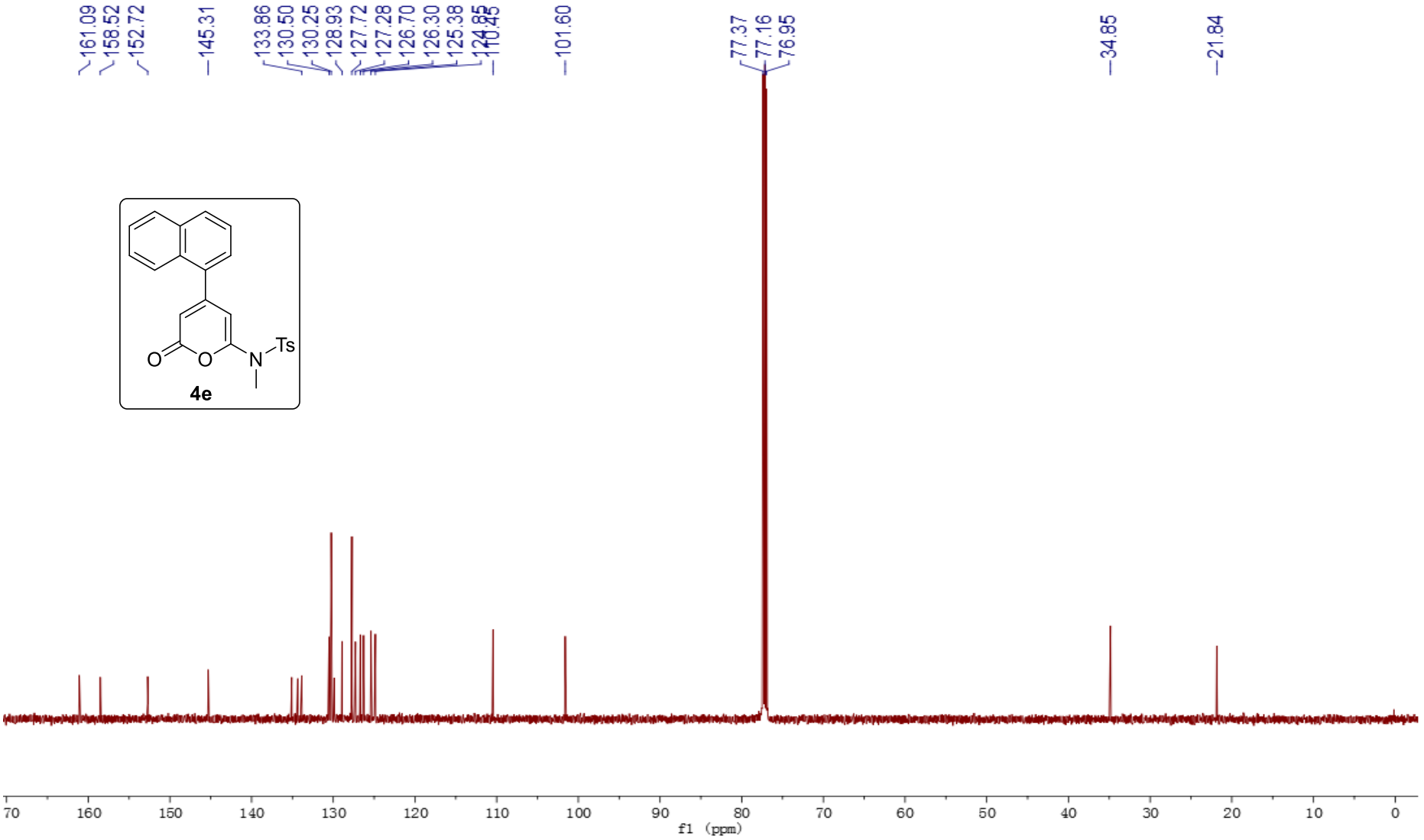

7.694
7.680
7.619
7.616
7.607
7.603
7.517
7.509
7.506
7.497
7.334
7.320
7.260
6.725
6.297
3.255
2.435
Ph
O
O
N
Ts
Me
4c
1.94
2.00
3.01
2.00
0.96
0.95
3.00
3.15
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

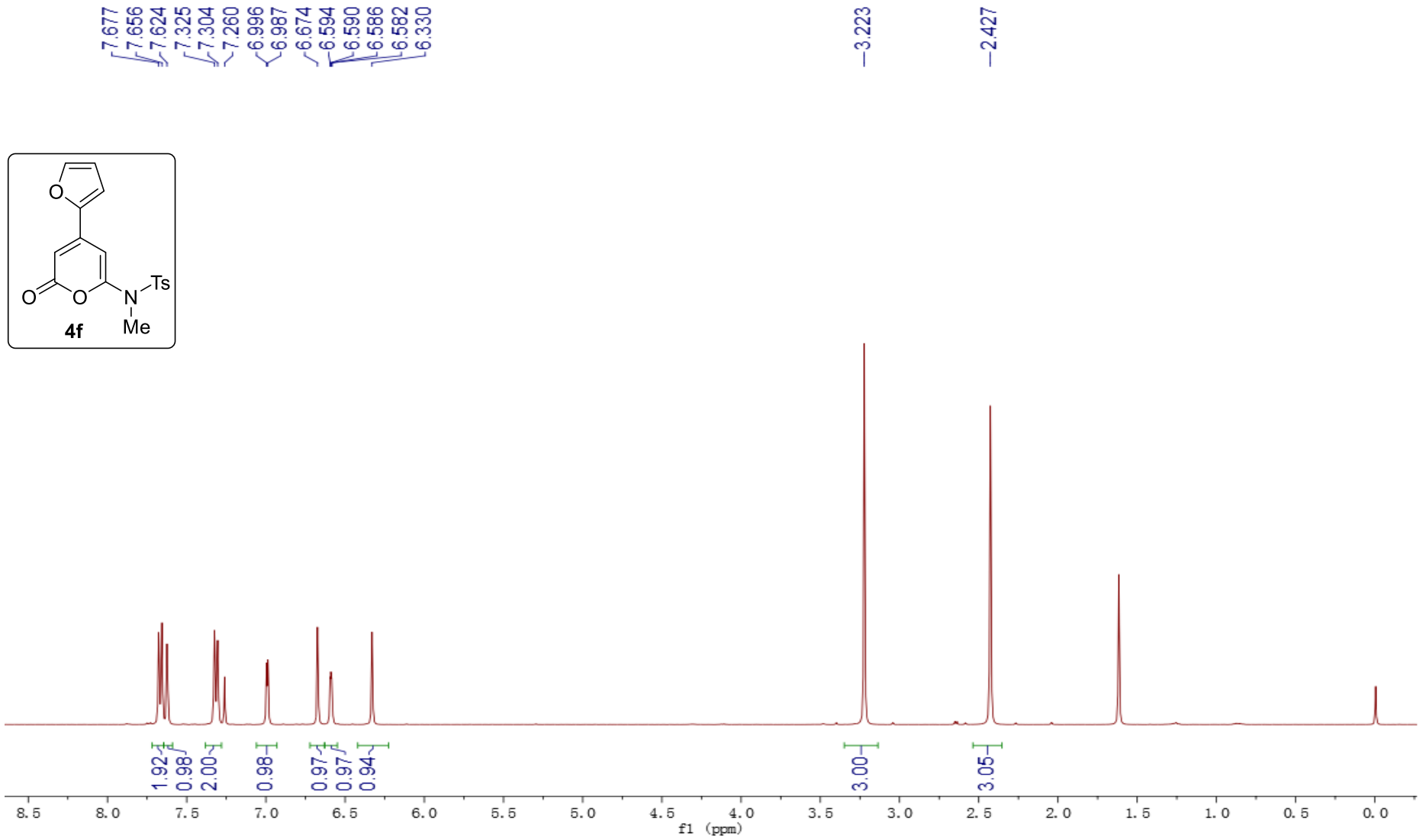

161.41
157.12
153.20
145.26
135.60
134.19
131.14
130.23
129.39
127.62
126.98
106.80
99.05
77.37
77.16
76.95
34.80
21.79
Ph
O
O
N
Ts
Me
4c
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

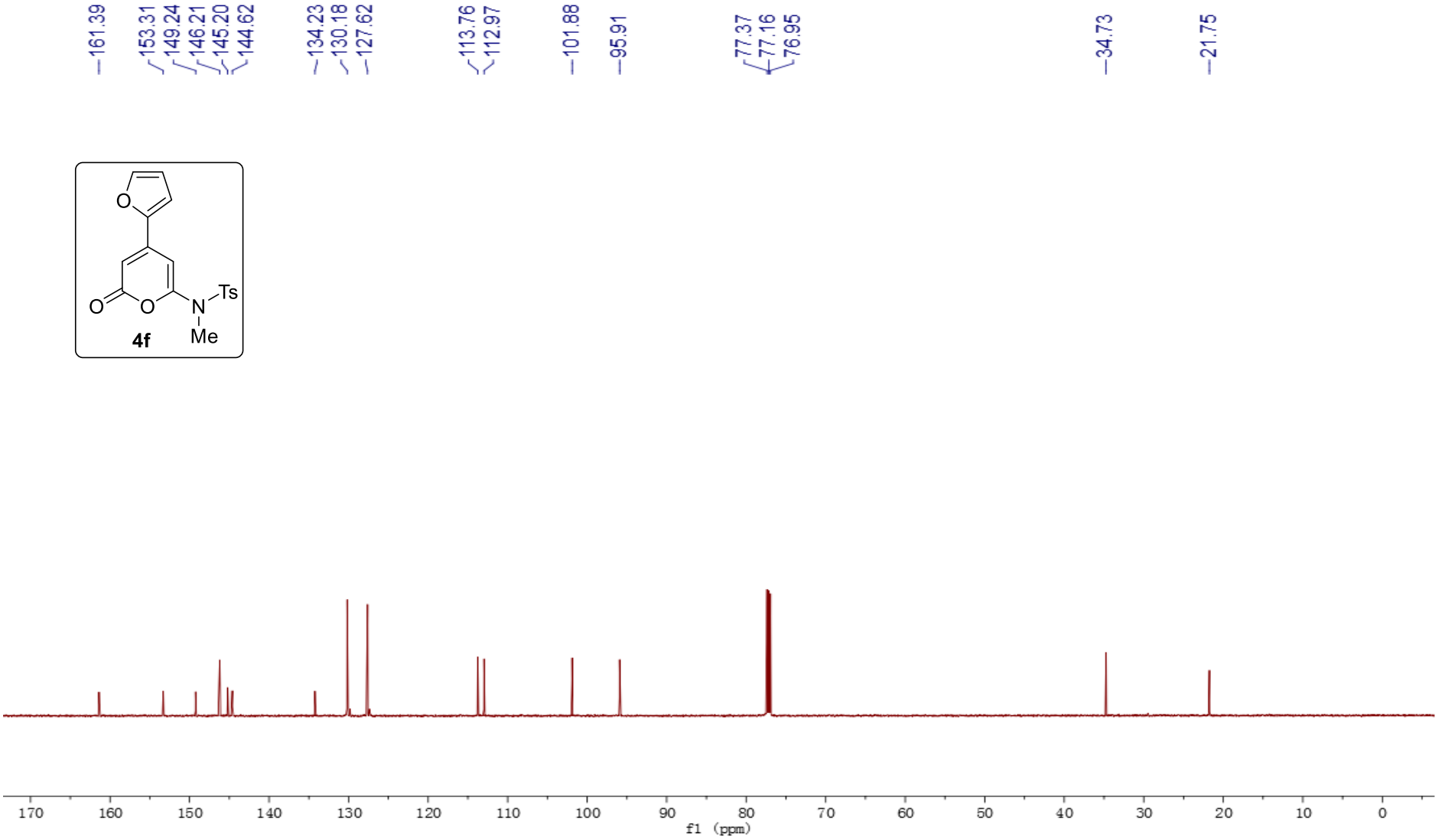

7.676
7.662
7.583
7.568
7.314
7.301
7.260
6.996
6.981
6.707
6.236
3.860
3.228
2.415
PMP
O
O
N
Ts
Me
4d
1.92
1.98
1.98
1.94
0.97
0.94
3.01
2.93
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

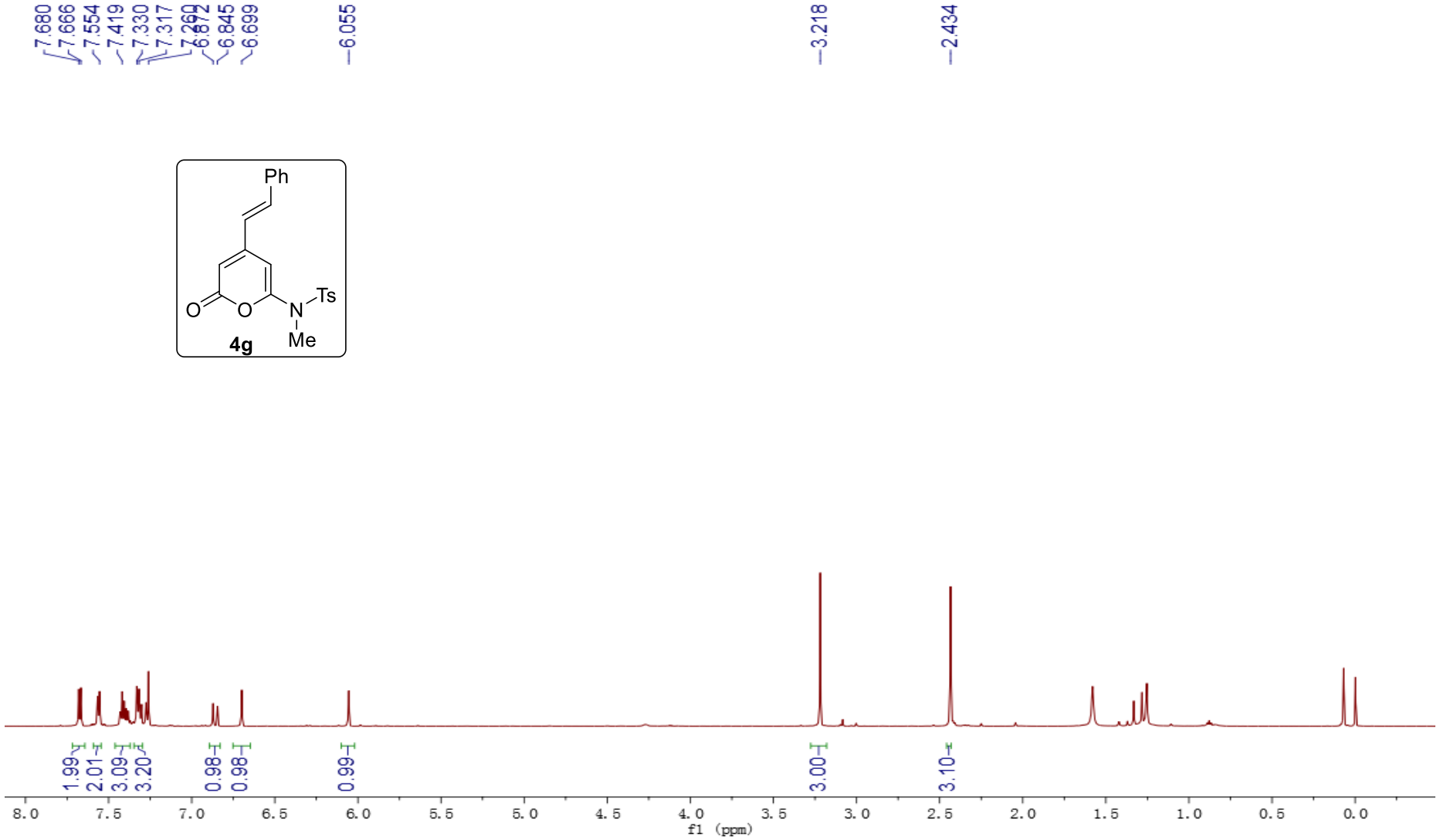

162.16
161.55
156.19
152.94
145.12
134.25
130.14
128.52
127.58
127.51
114.74
105.07
98.88
77.37
77.16
76.95
55.58
34.76
21.70
PMP
O
O
N
Ts
Me
4d
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

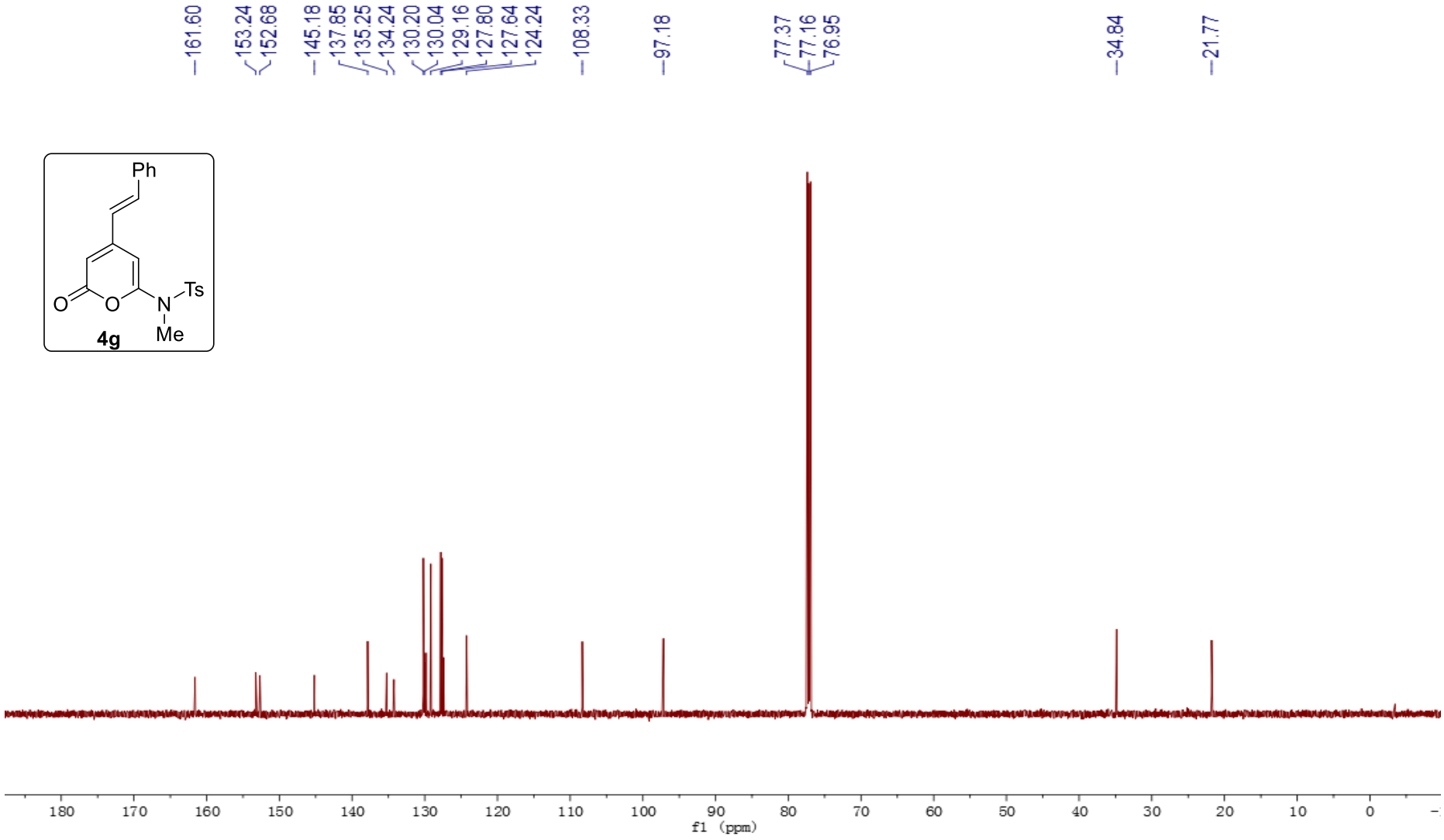

7.965
7.944
7.928
7.747
7.727
7.581
7.574
7.565
7.558
7.540
7.468
7.376
7.356
6.241
3.303
2.465
O
O
N
Ts
Me
4e
3.02
2.07
4.11
2.04
0.98
0.96
3.00
2.95
f1 (ppm)

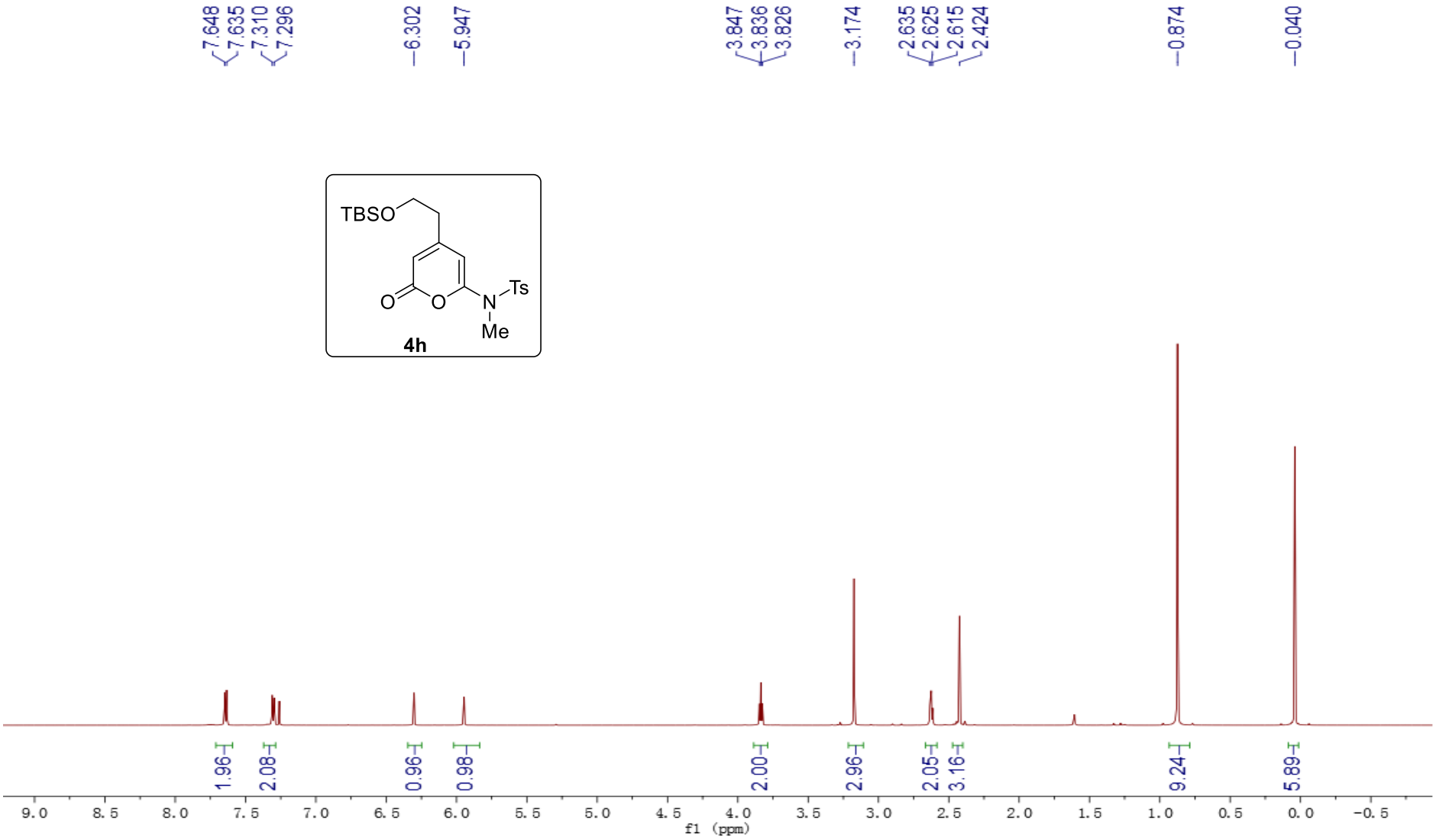

161.09
158.52
152.72
145.31
133.86
130.50
130.25
128.93
127.72
127.28
126.70
126.30
125.38
124.85
110.45
101.60
77.37
77.16
76.95
34.85
21.84
O
O
N
Ts
4e
70
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

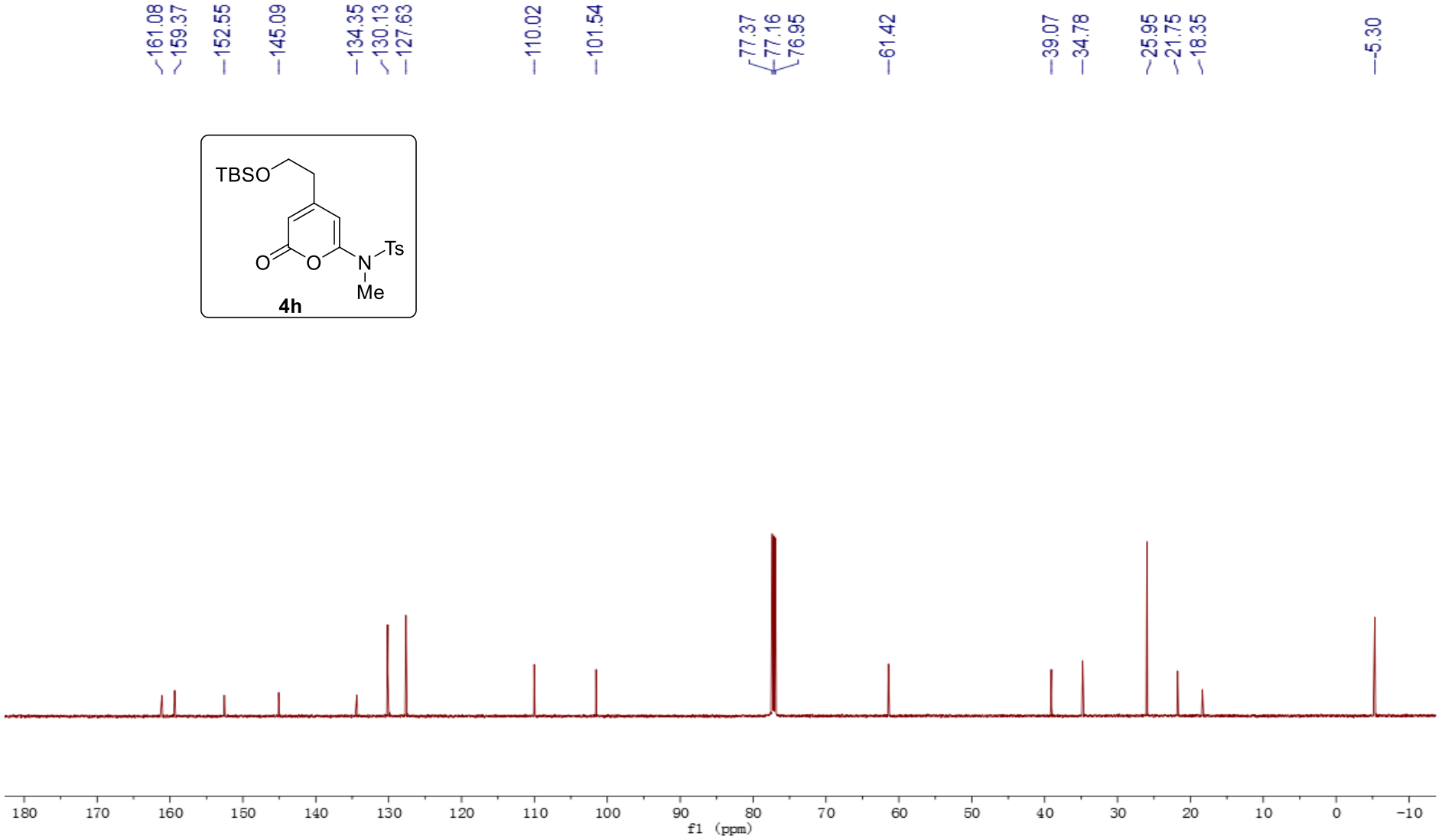

7.677
7.656
7.624
7.325
7.304
7.260
6.996
6.987
6.674
6.594
6.590
6.586
6.582
6.330
3.223
2.427
O
O
O
N
Ts
Me
4f
1.92
0.98
2.00
0.98
0.97
0.97
0.94
3.00
3.05
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

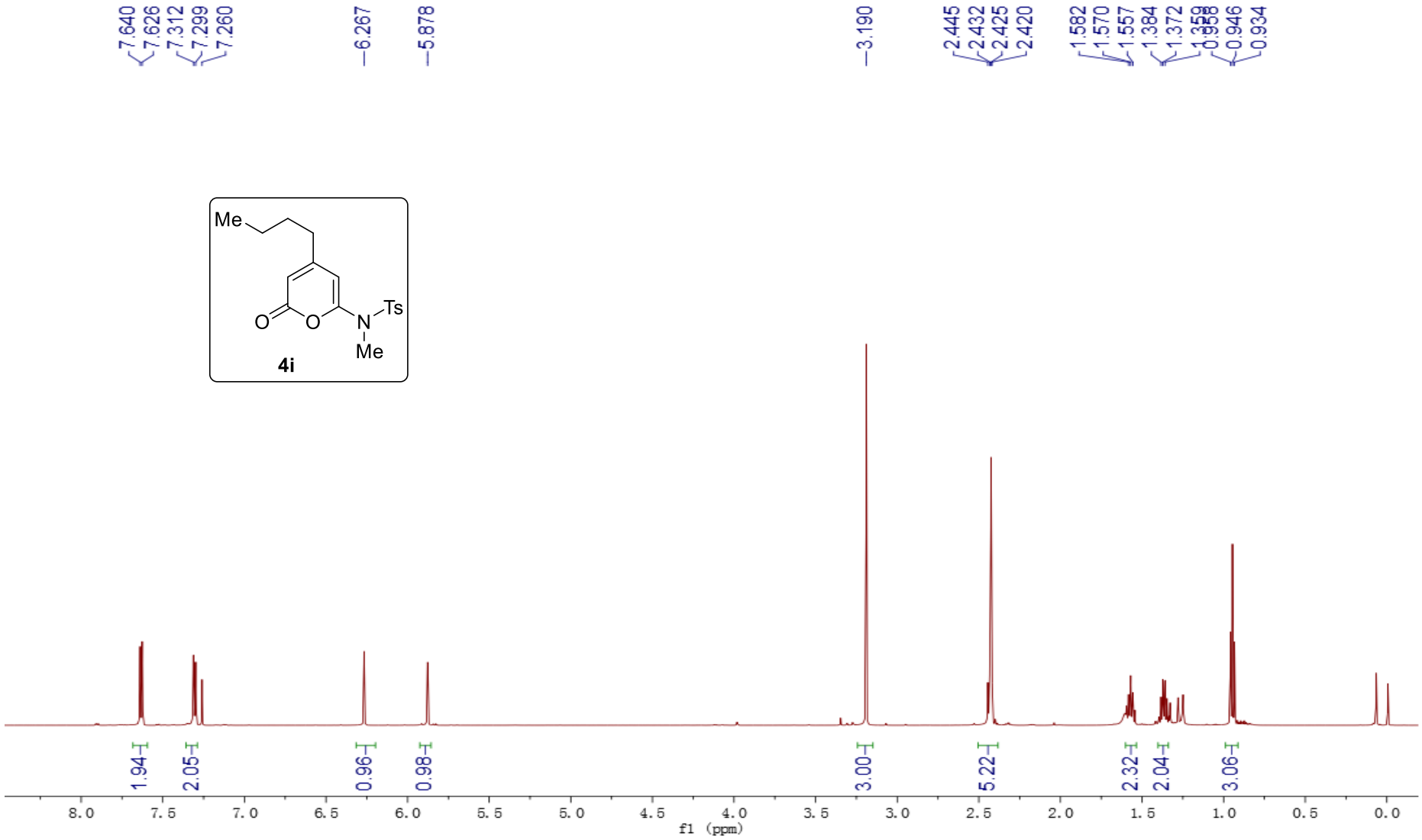

161.39
153.31
149.24
146.21
145.20
144.62
134.23
130.18
127.62
113.76
112.97
101.88
95.91
77.37
77.16
76.95
34.73
21.75
O
O
O
N
Ts
Me
4f
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

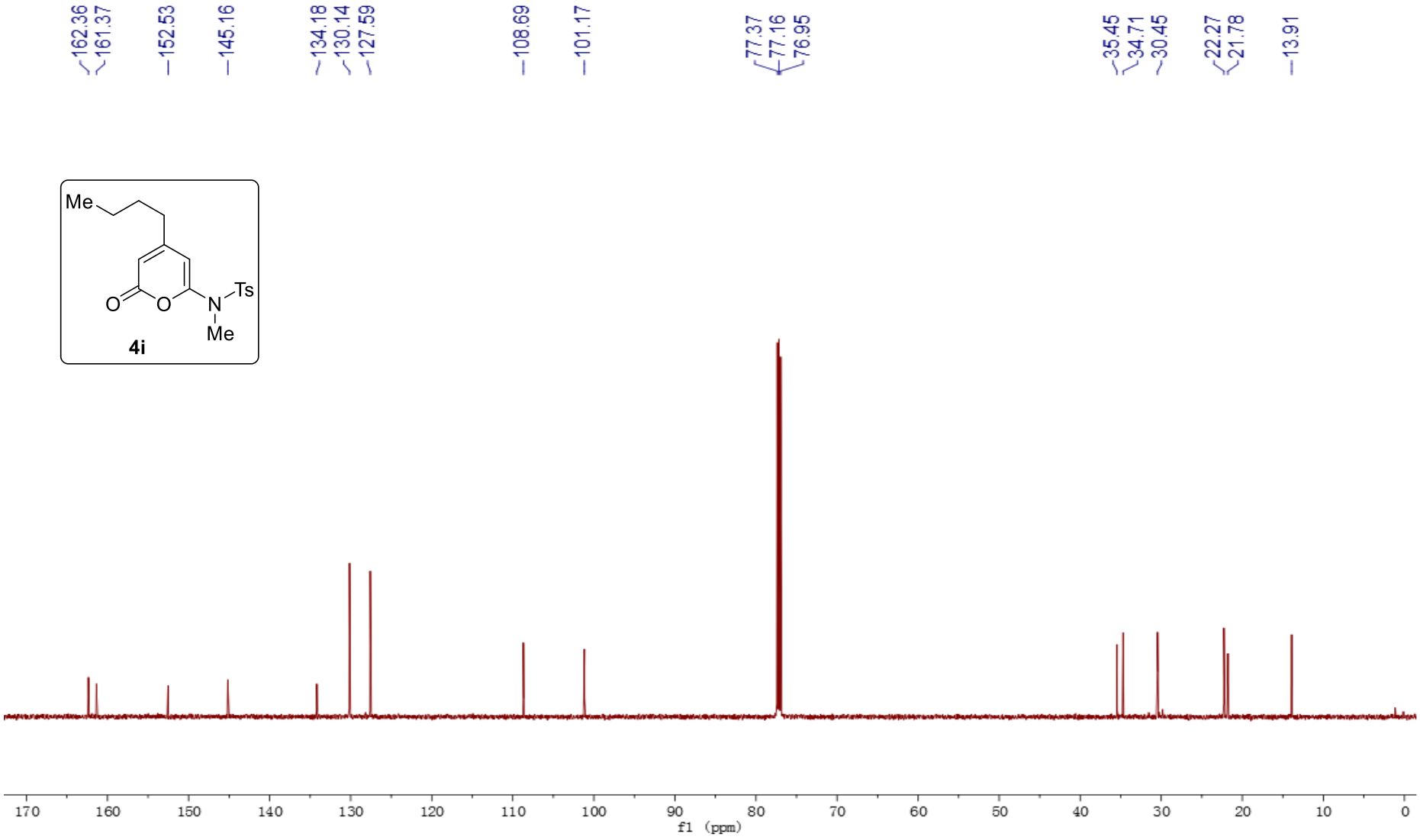

7.680
7.666
7.554
7.419
7.330
7.317
7.260
6.872
6.845
6.699
6.055
3.218
2.434
Ph
O
O
N
Ts
Me
4g
1.99
2.01
3.09
3.20
0.98
0.98
0.99
3.00
3.10
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

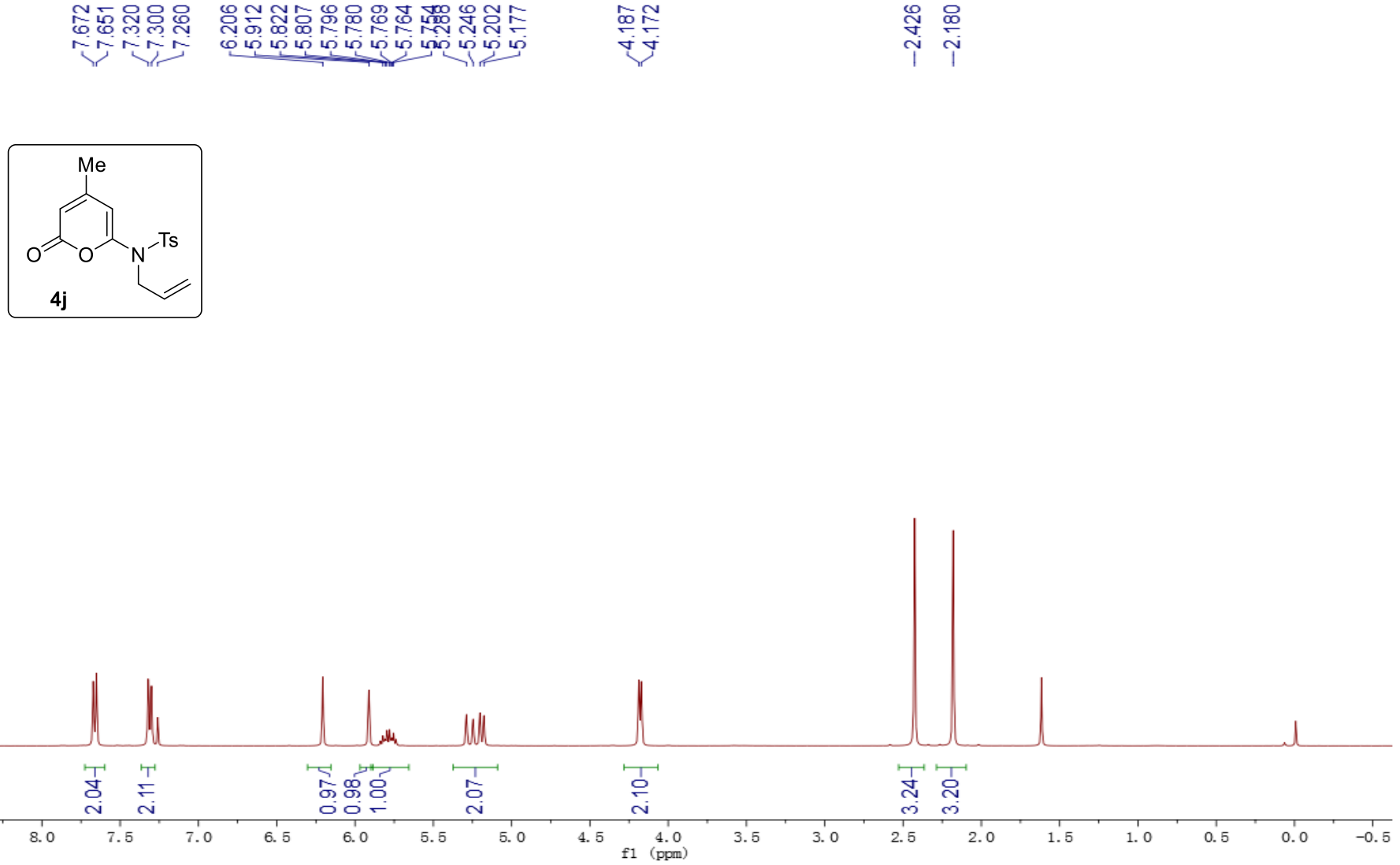

161.60
153.24
152.68
145.18
137.85
135.25
134.24
130.20
130.04
129.16
127.80
127.64
124.24
108.33
97.18
77.37
77.16
76.95
34.84
21.77
Ph
O
O
N
Ts
Me
4g
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

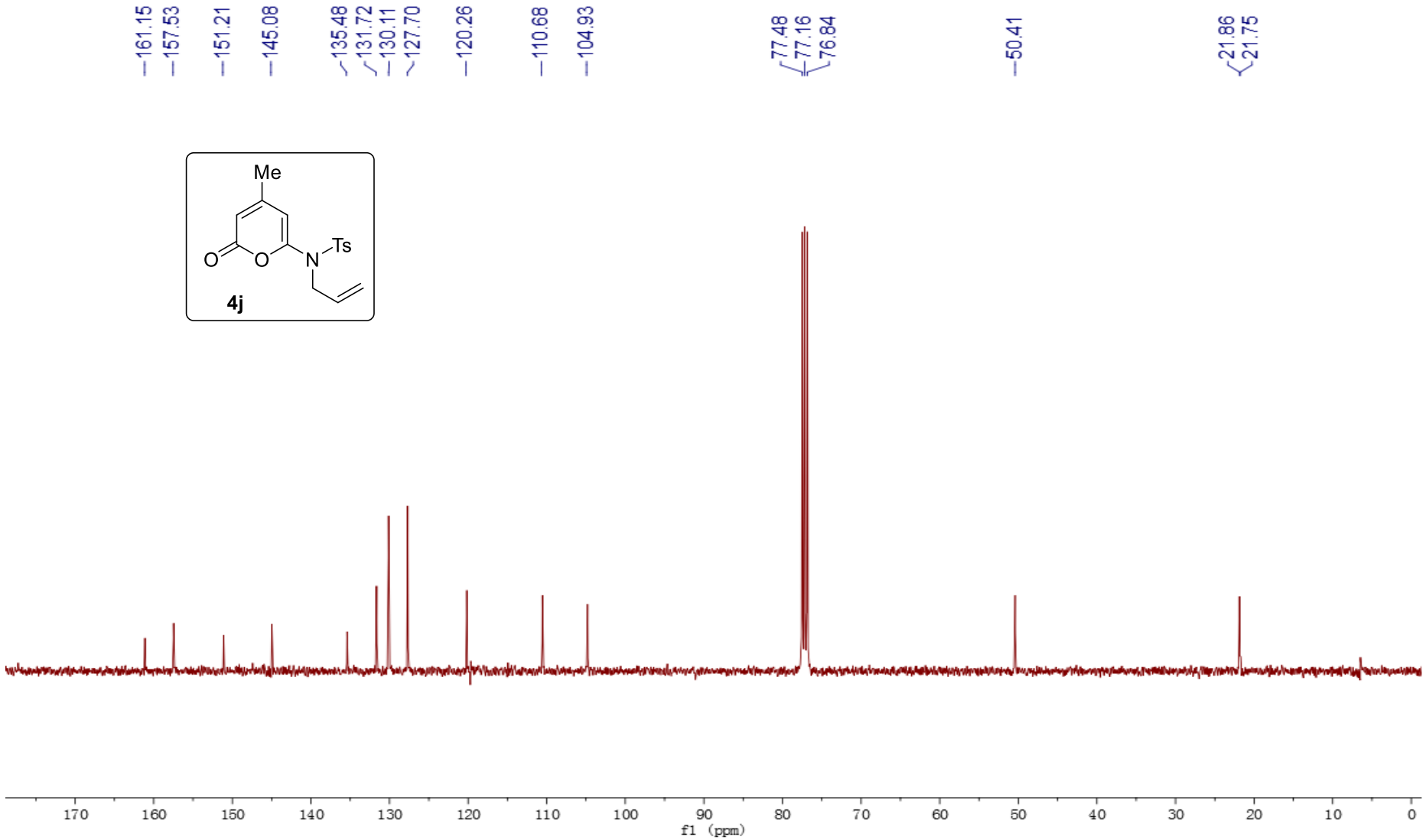

7.648
7.635
7.310
7.296
6.302
5.947
3.847
3.836
3.826
3.174
2.635
2.625
2.615
2.424
0.874
0.040
TBSO
O
O
N
Ts
Me
4h
1.96
2.08
0.96
0.98
2.00
2.96
2.05
3.16
9.24
5.89
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

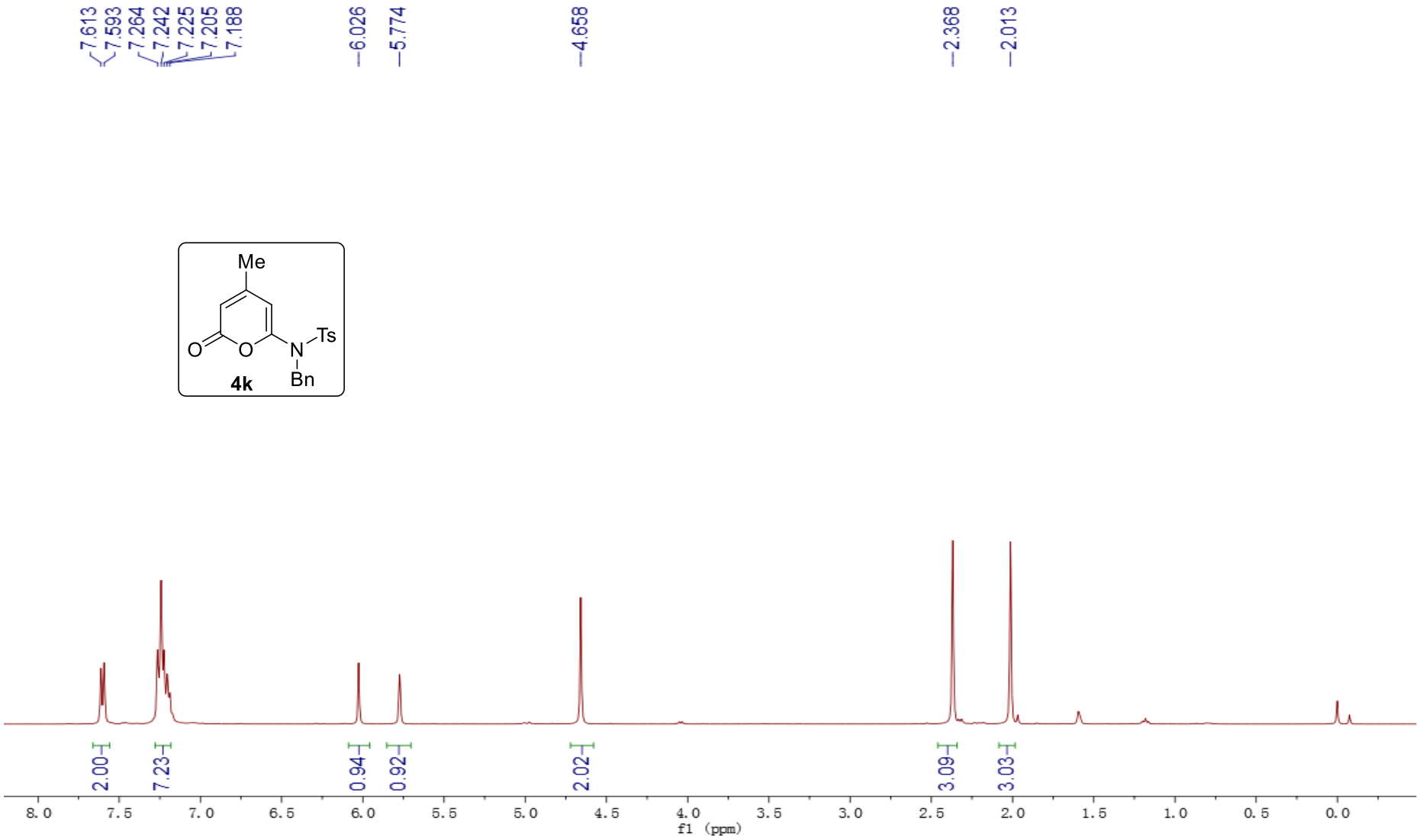

161.08
159.37
152.55
145.09
134.35
130.13
127.63
110.02
101.54
77.37
77.16
76.95
61.42
39.07
34.78
25.95
21.75
18.35
-5.30
TBSO
O
O
N
Ts
Me
4h
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

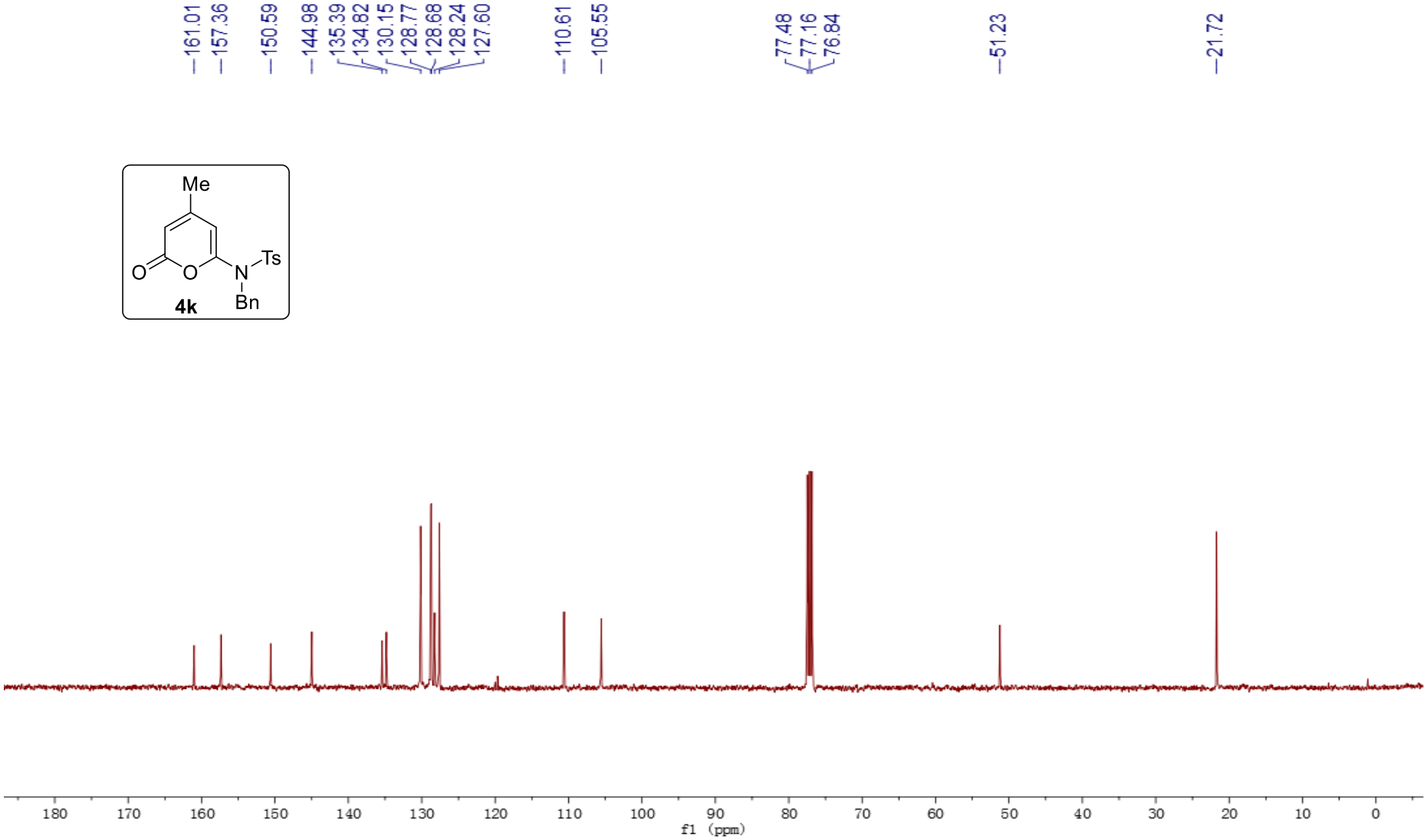

7.640
7.626
7.312
7.299
7.260
6.267
5.878
3.190
2.445
2.432
2.425
2.420
1.582
1.570
1.557
1.384
1.372
0.946
0.934
Me
O
O
N
Ts
Me
4i
1.94
2.05
0.96
0.98
3.00
5.22
2.32
2.04
3.06
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

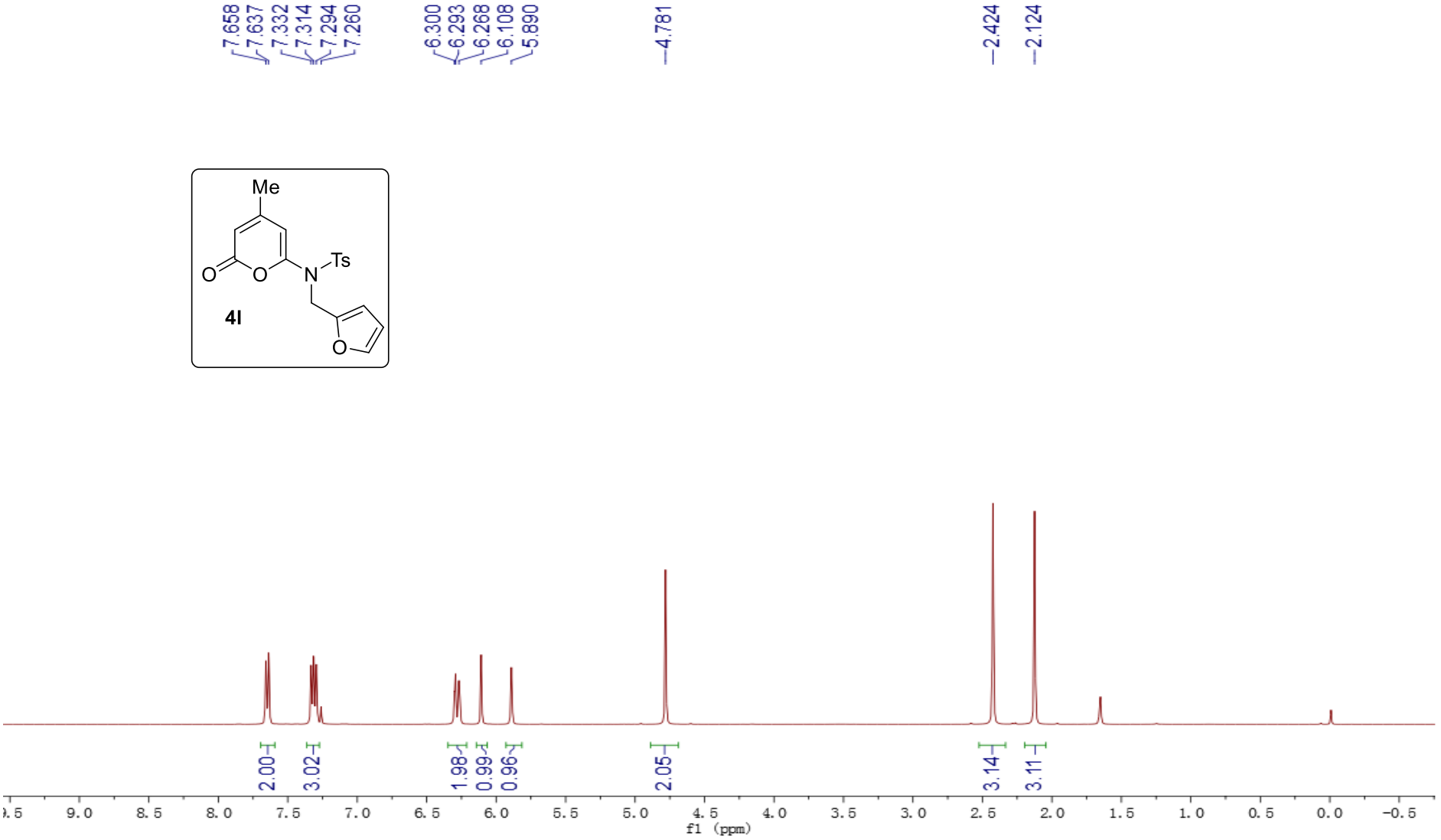

162.36
161.37
152.53
145.16
134.18
130.14
127.59
108.69
101.17
77.37
77.16
76.95
35.45
34.71
30.45
22.27
21.78
13.91
Me
O
O
N
Ts
Me
4i
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

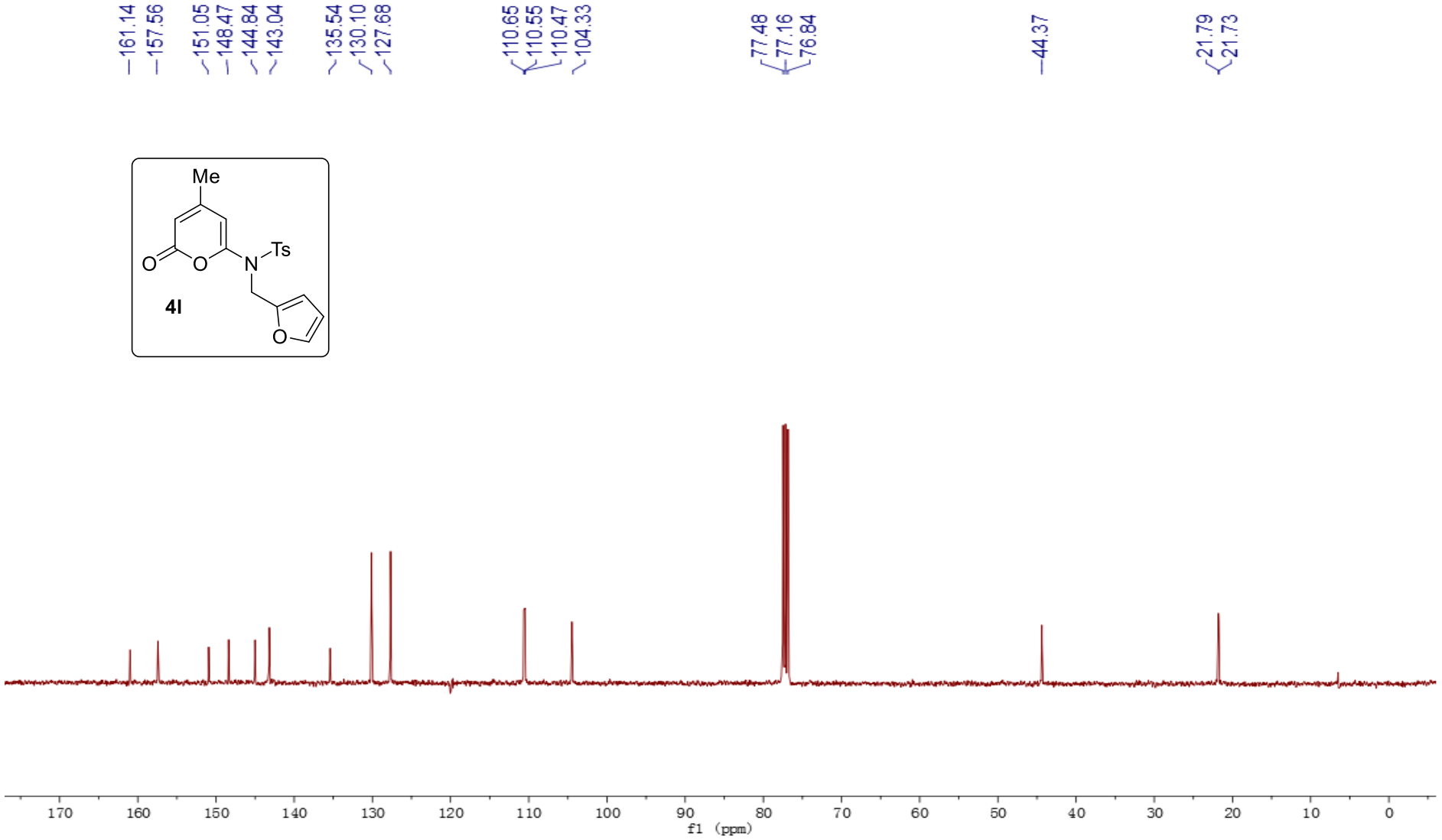

7.672
7.651
7.320
7.300
7.260
6.206
5.912
5.822
5.807
5.796
5.780
5.769
5.764
5.754
5.246
5.202
5.177
4.187
4.172
2.426
2.180
Me
O
O
N
Ts
4j
2.04
2.11
0.97
0.98
1.00
2.07
2.10
3.24
3.20
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

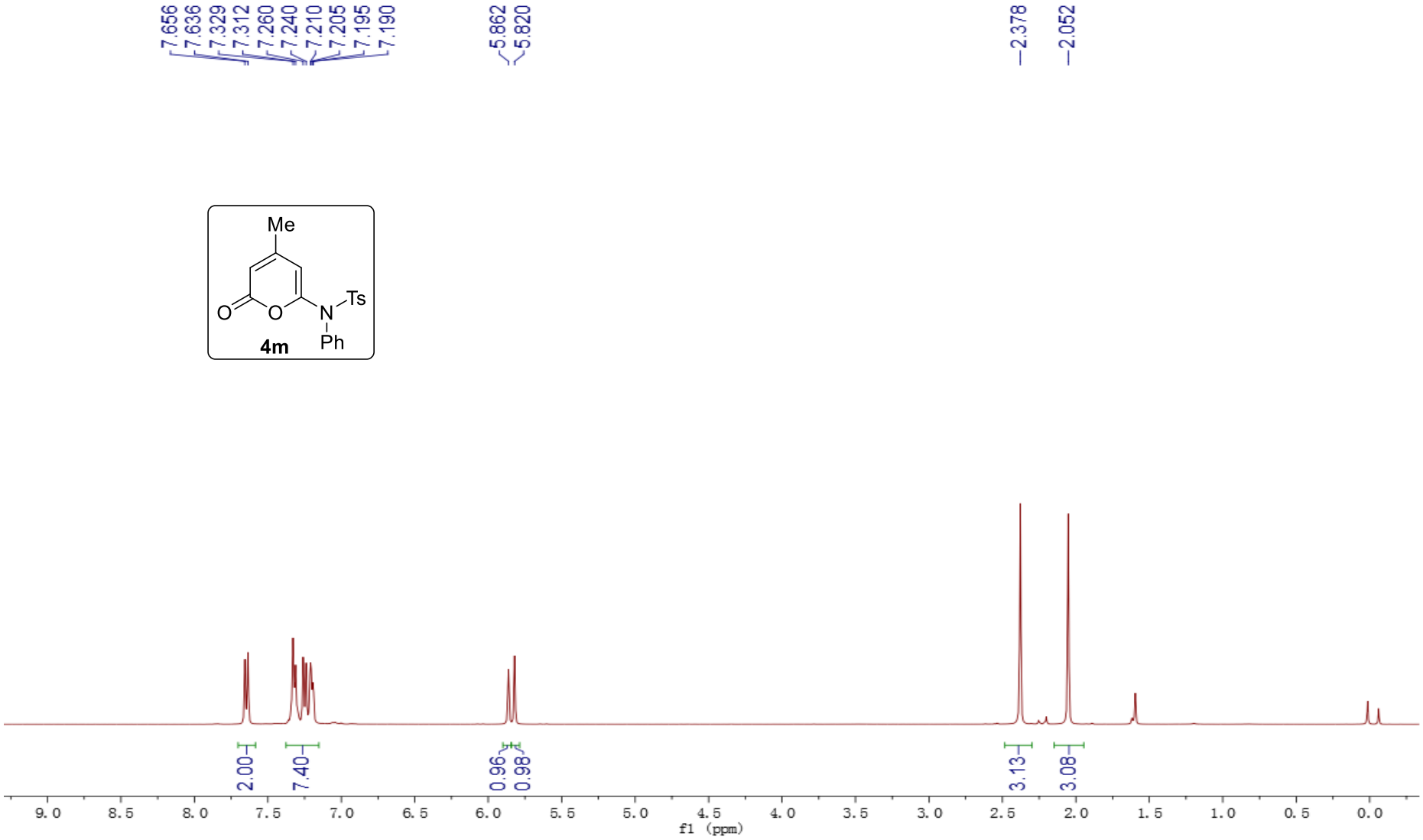

161.15
157.53
151.21
145.08
135.48
131.72
130.11
127.70
120.26
110.68
104.93
77.48
77.16
76.84
50.41
21.86
21.75
Me
O
O
N
Ts
4j
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

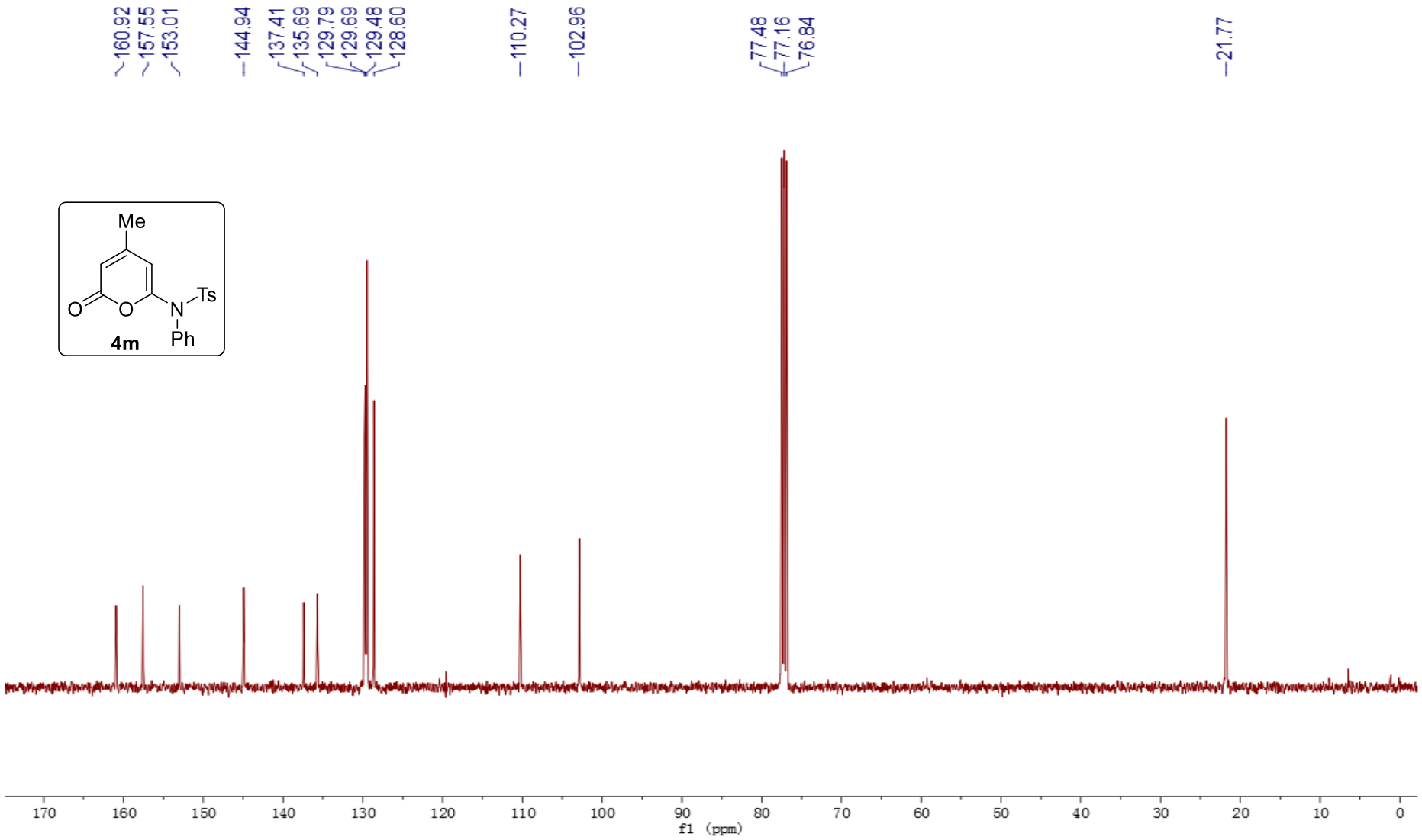

7.613
7.593
7.264
7.242
7.225
7.205
7.188
6.026
5.774
4.658
2.368
2.013
Me
O
O
N
Ts
Bn
4k
2.00
7.23
0.94
0.92
2.02
3.09
3.03
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

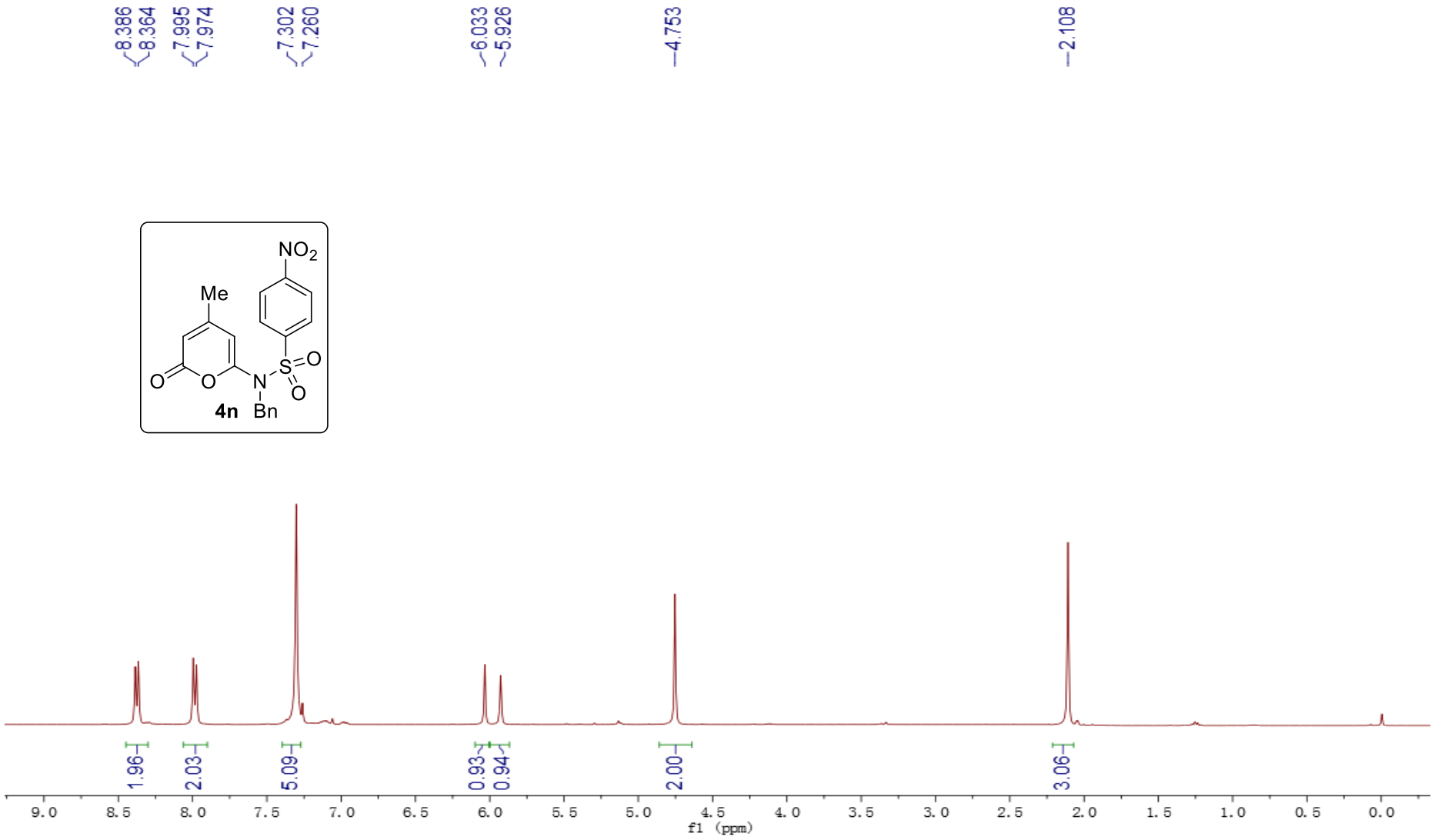

161.01
157.36
150.59
144.98
135.39
134.82
130.15
128.77
128.68
128.24
127.60
110.61
105.55
77.48
77.16
76.84
51.23
21.72
Me
O
O
N
Ts
Bn
4k
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

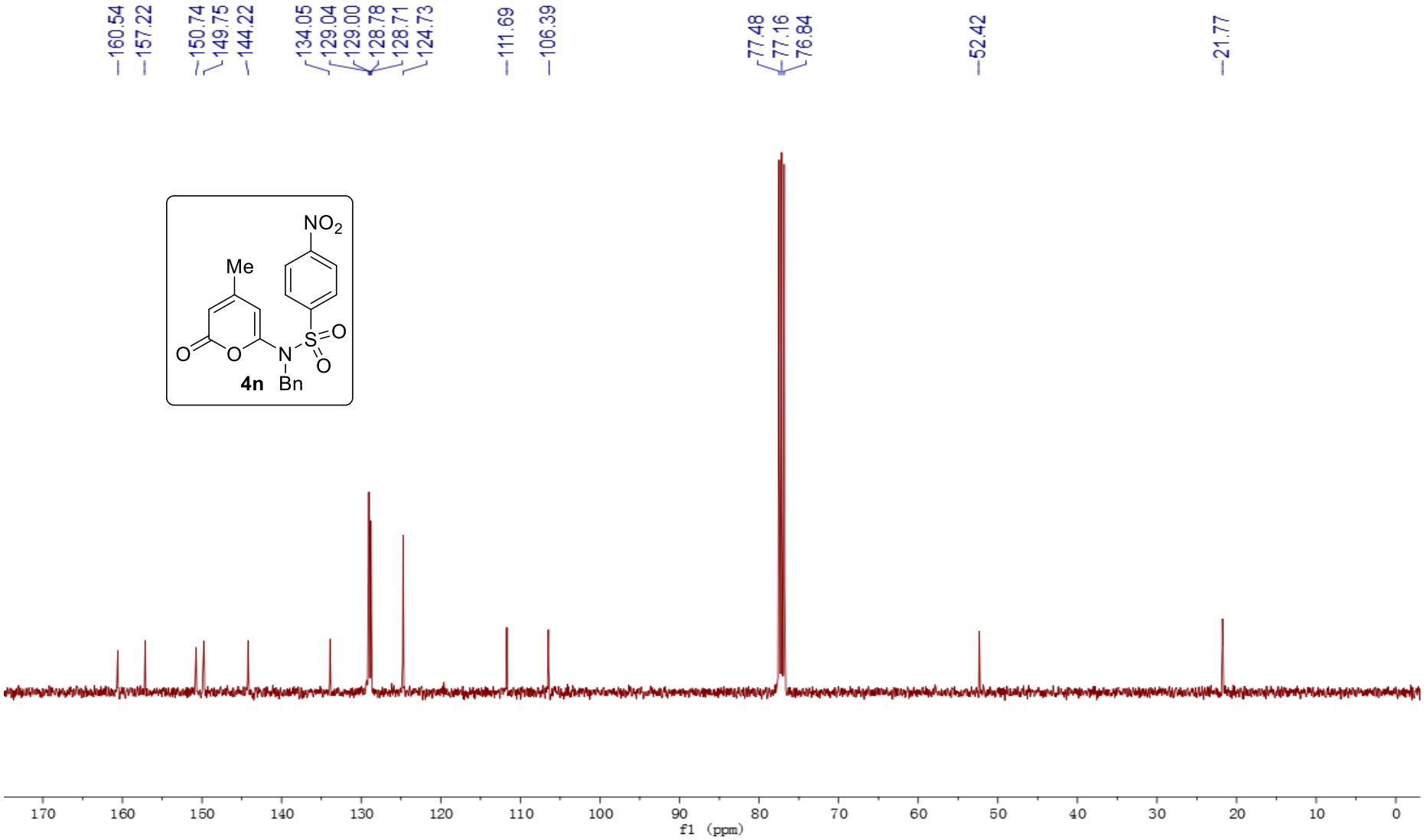

7.658
7.637
7.332
7.314
7.294
7.260
6.300
6.293
6.268
6.108
5.890
4.781
2.424
2.124
Me
O
O
N
Ts
O
4l
2.00
3.02
1.98
0.99
0.96
2.05
3.14
3.11
f1 (ppm)

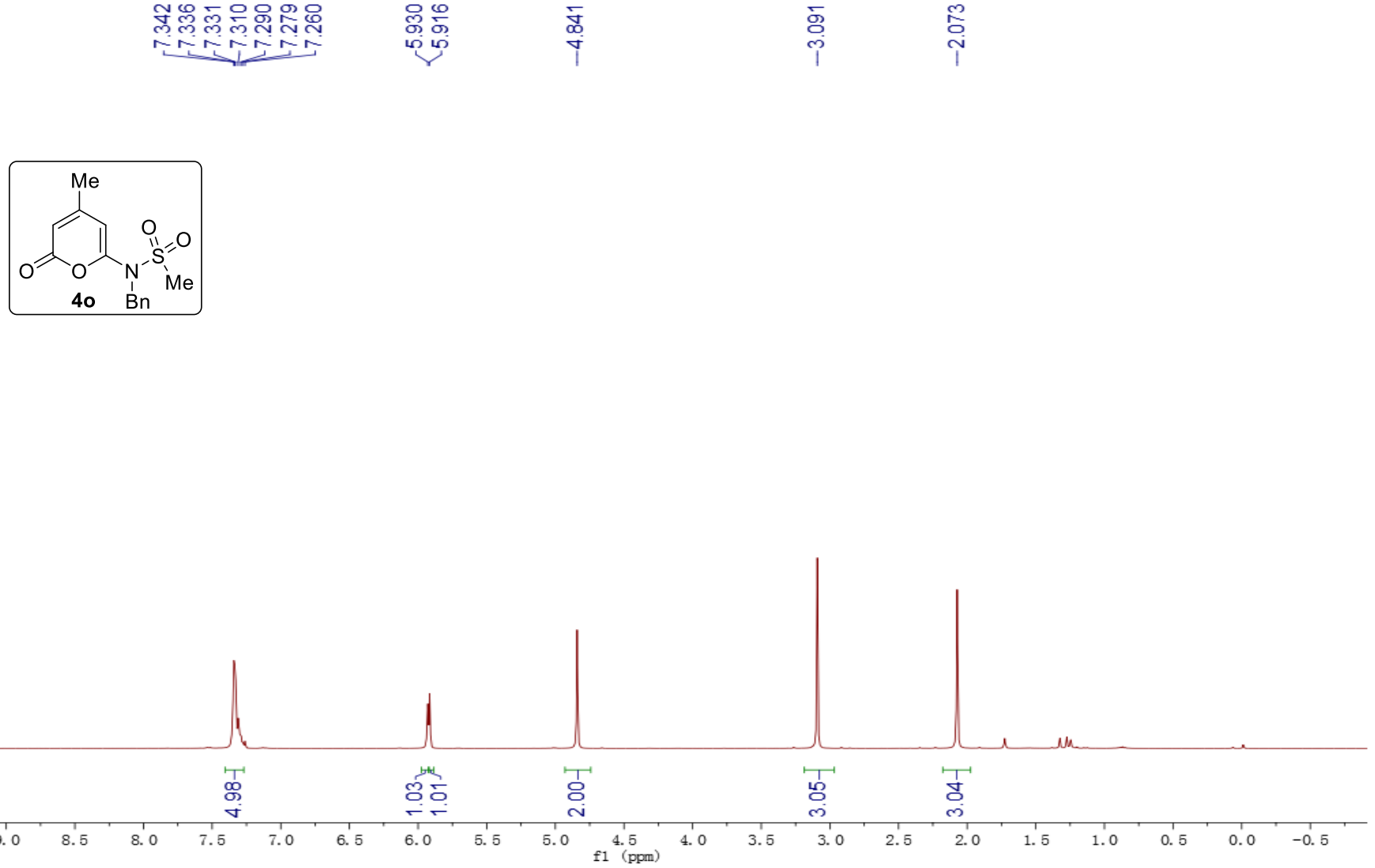

161.14
157.56
151.05
148.47
144.84
143.04
135.54
130.10
127.68
110.65
110.55
110.47
104.33
77.48
77.16
76.84
44.37
21.79
21.73
Me
O
O
N
Ts
O
4l
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

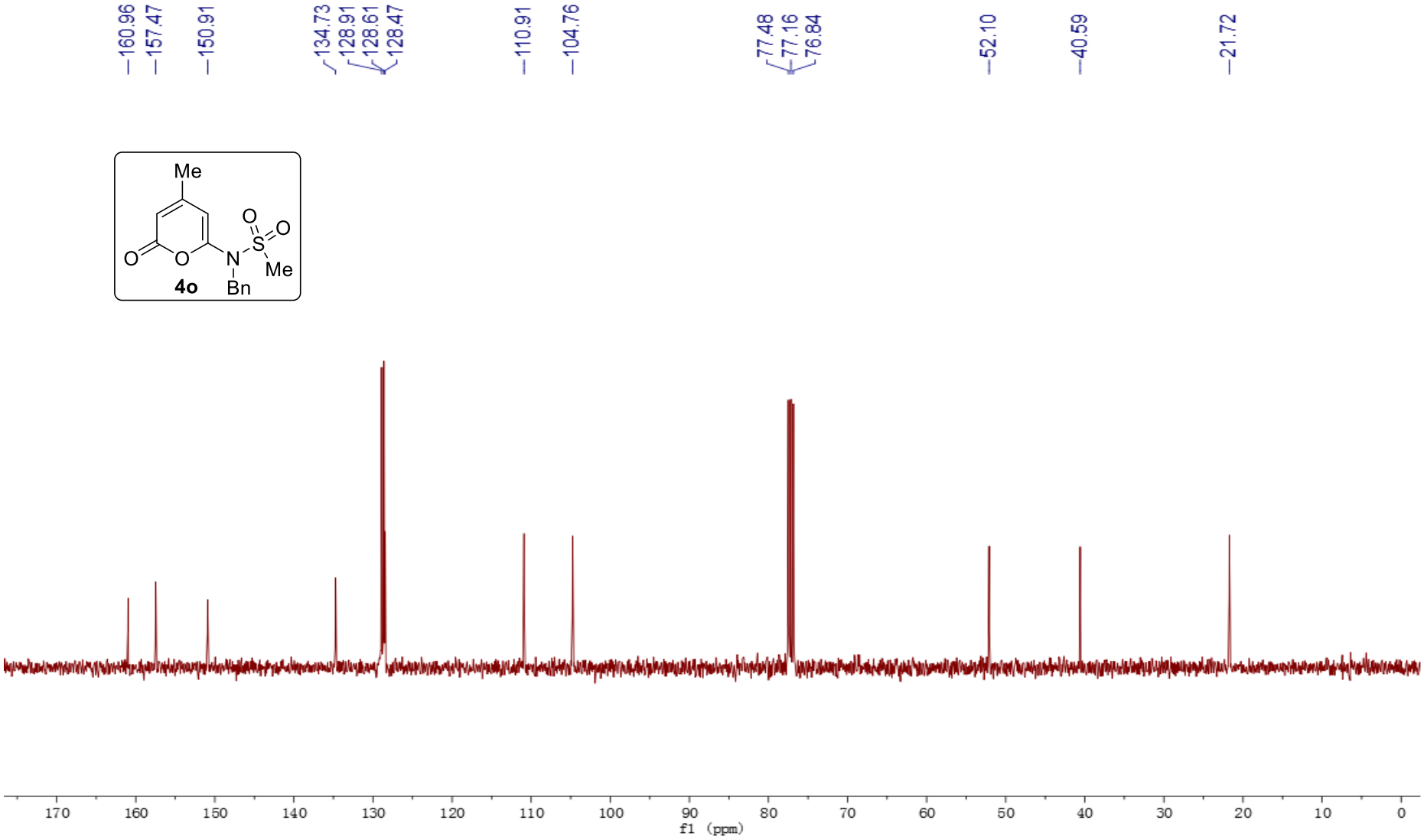

7.656
7.636
7.329
7.312
7.260
7.240
7.210
7.205
7.195
7.190
5.862
5.820
2.378
2.052
Me
O
O
N
Ts
Ph
4m
2.00
7.40
0.96
0.98
3.13
3.08
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

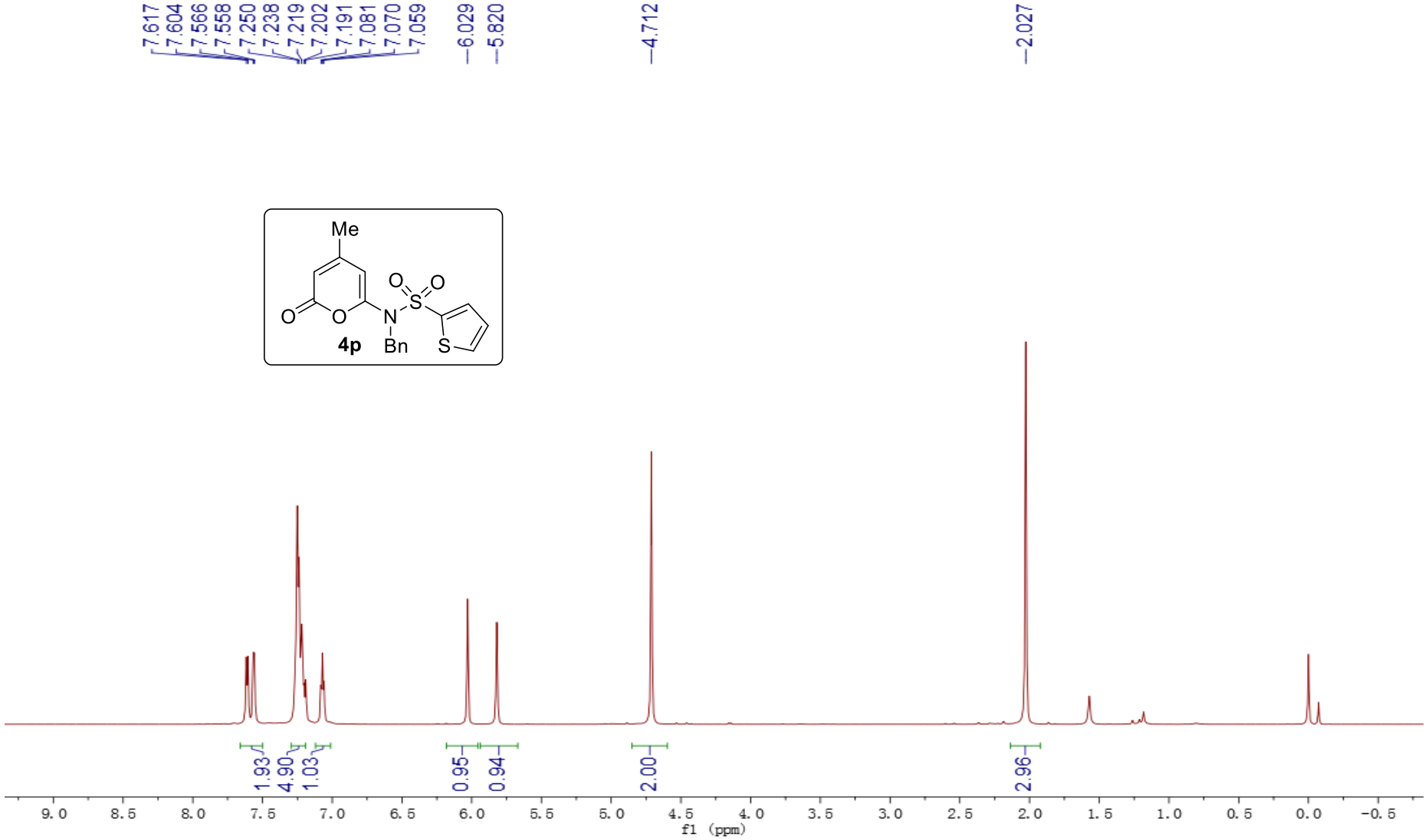

160.92
157.55
153.01
144.94
137.41
135.69
129.79
129.69
129.48
128.60
110.27
102.96
77.48
77.16
76.84
21.77
Me
O
O
N
Ts
Ph
4m
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

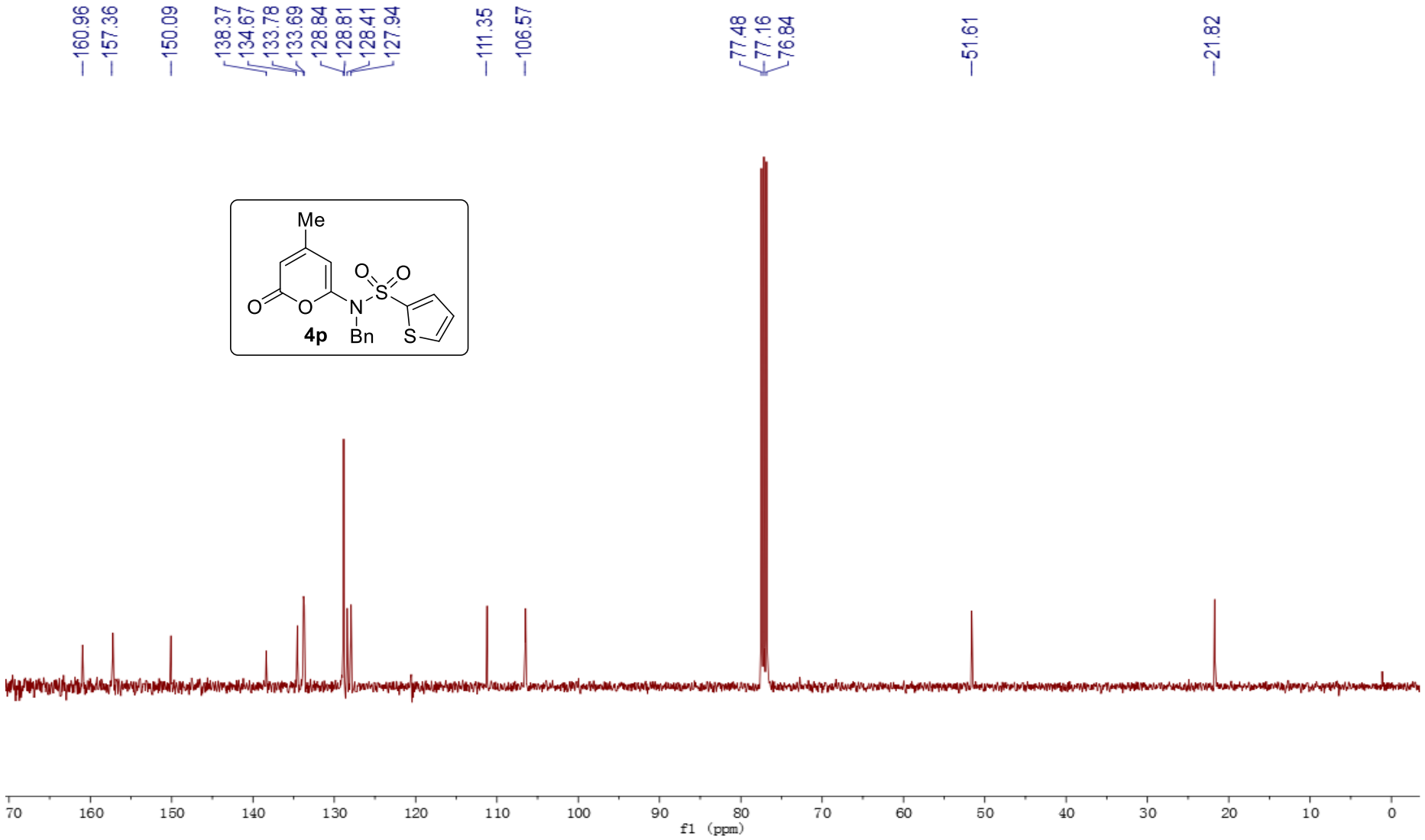

8.386
8.364
7.995
7.974
7.302
7.260
6.033
5.926
4.753
2.108
NO2
Me
O
O
N
S
O
O
4n Bn
1.96
2.03
5.09
0.93
0.94
2.00
3.06
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

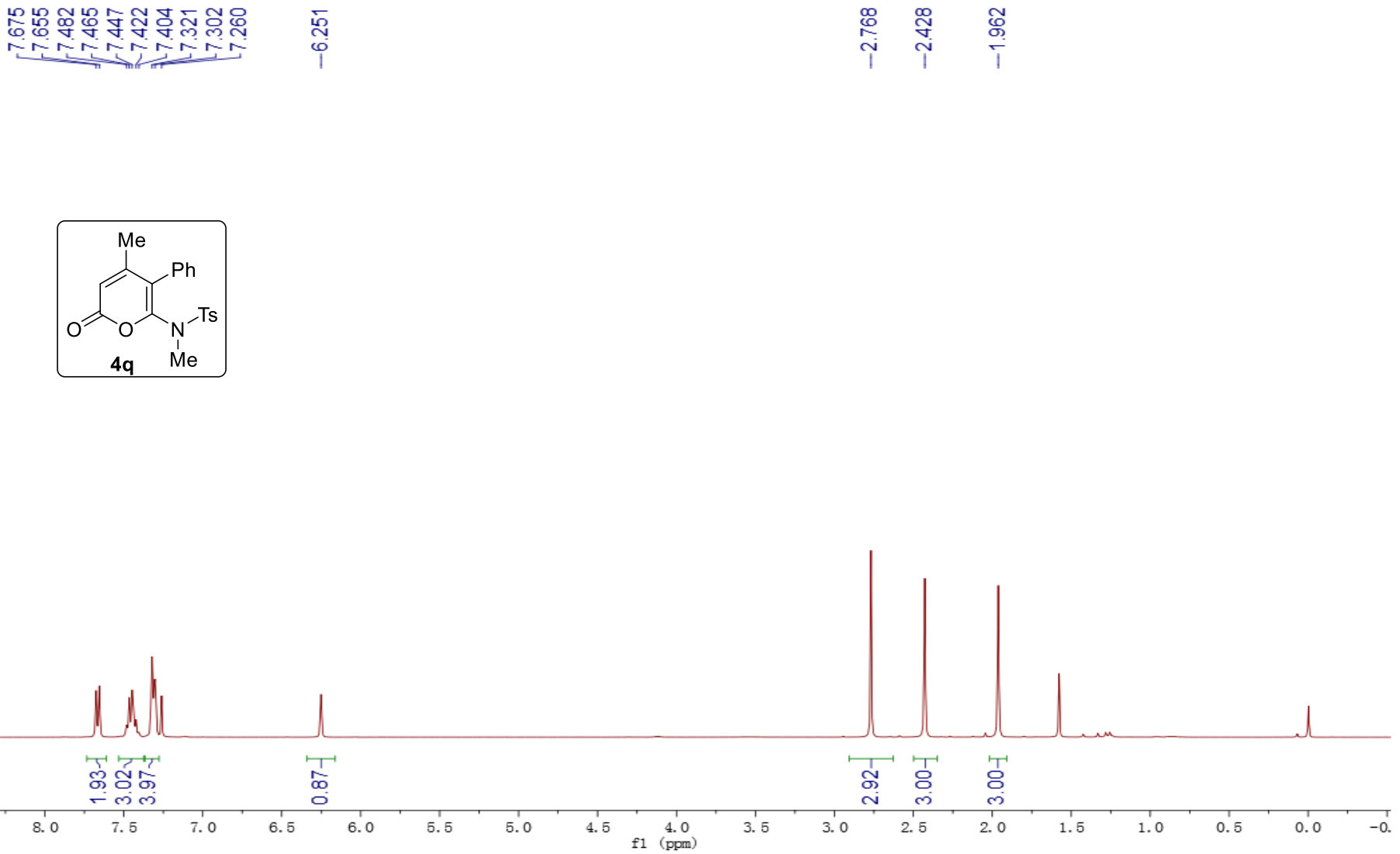

160.54
157.22
150.74
149.75
144.22
134.05
129.04
129.00
128.78
128.71
124.73
111.69
106.39
77.48
77.16
76.84
52.42
21.77
NO2
Me
O
O
N
S
O
O
4n Bn
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

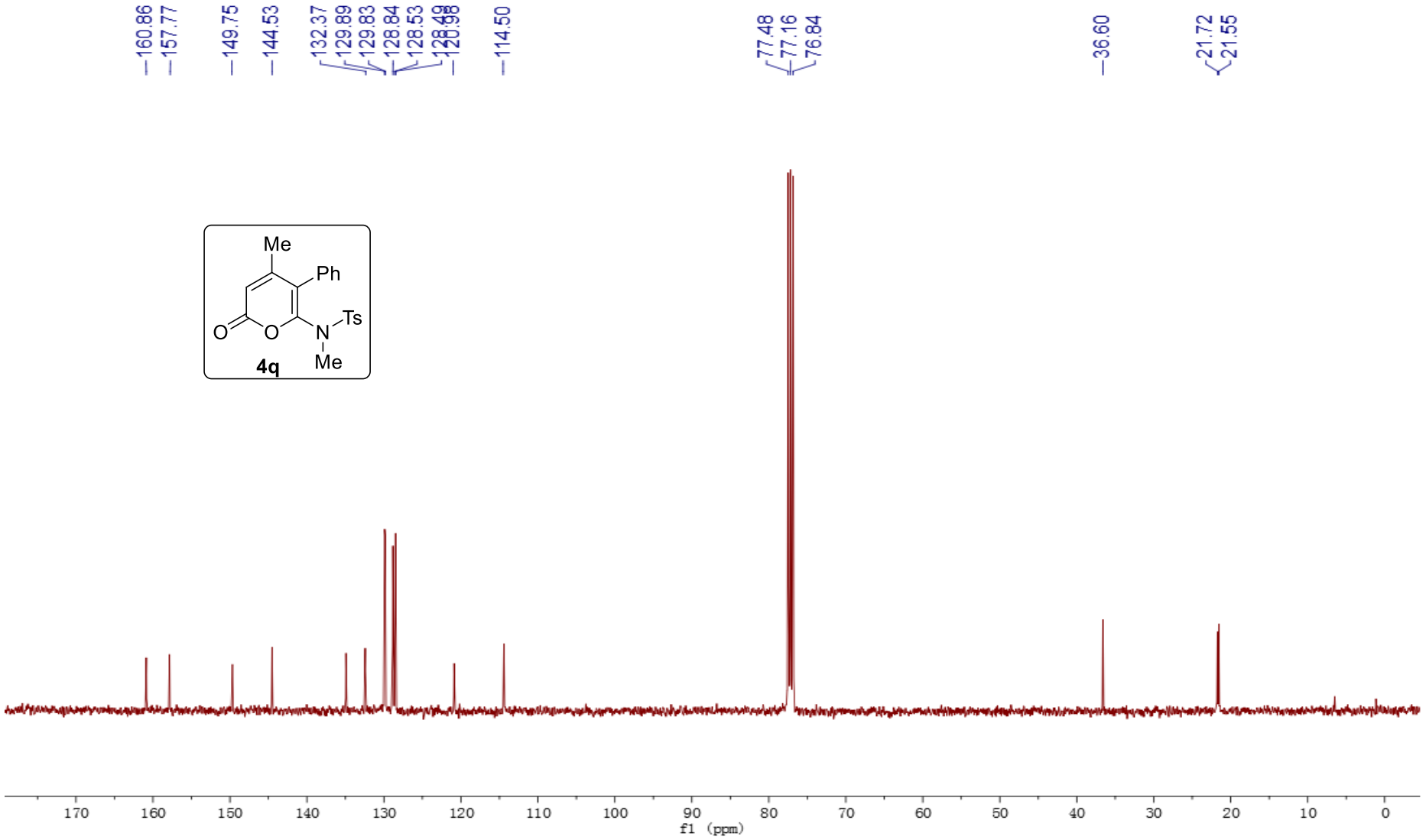

7.342
7.336
7.331
7.310
7.290
7.279
7.260
5.930
5.916
4.841
3.091
2.073
Me
O
O
O
O
N
S
Me
Bn
4o
4.98
1.03
1.01
2.00
3.05
3.04
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

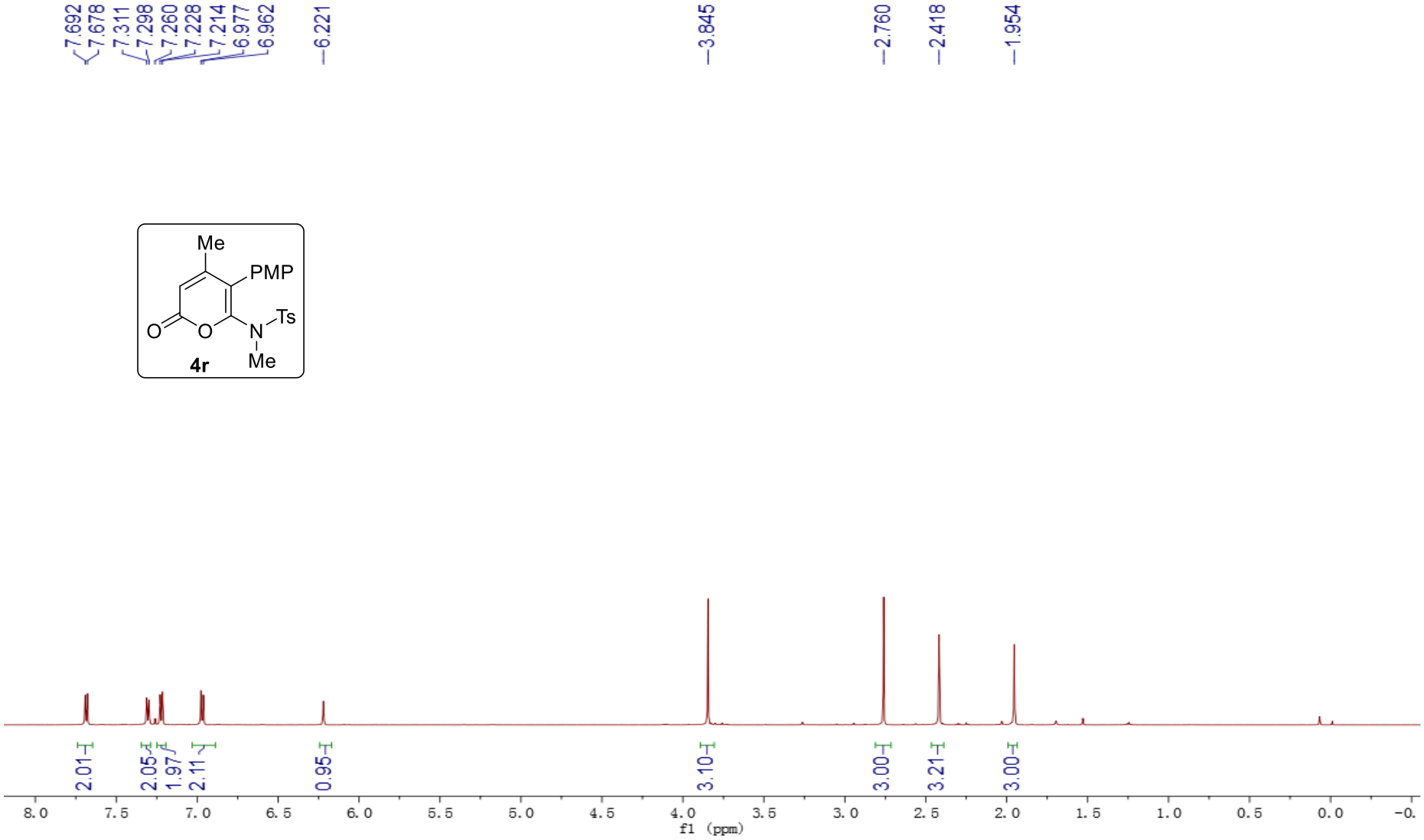

160.96
157.47
150.91
134.73
128.91
128.61
128.47
110.91
104.76
77.48
77.16
76.84
52.10
40.59
21.72
Me
O
O
O
O
S
N
Me
Bn
4o
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

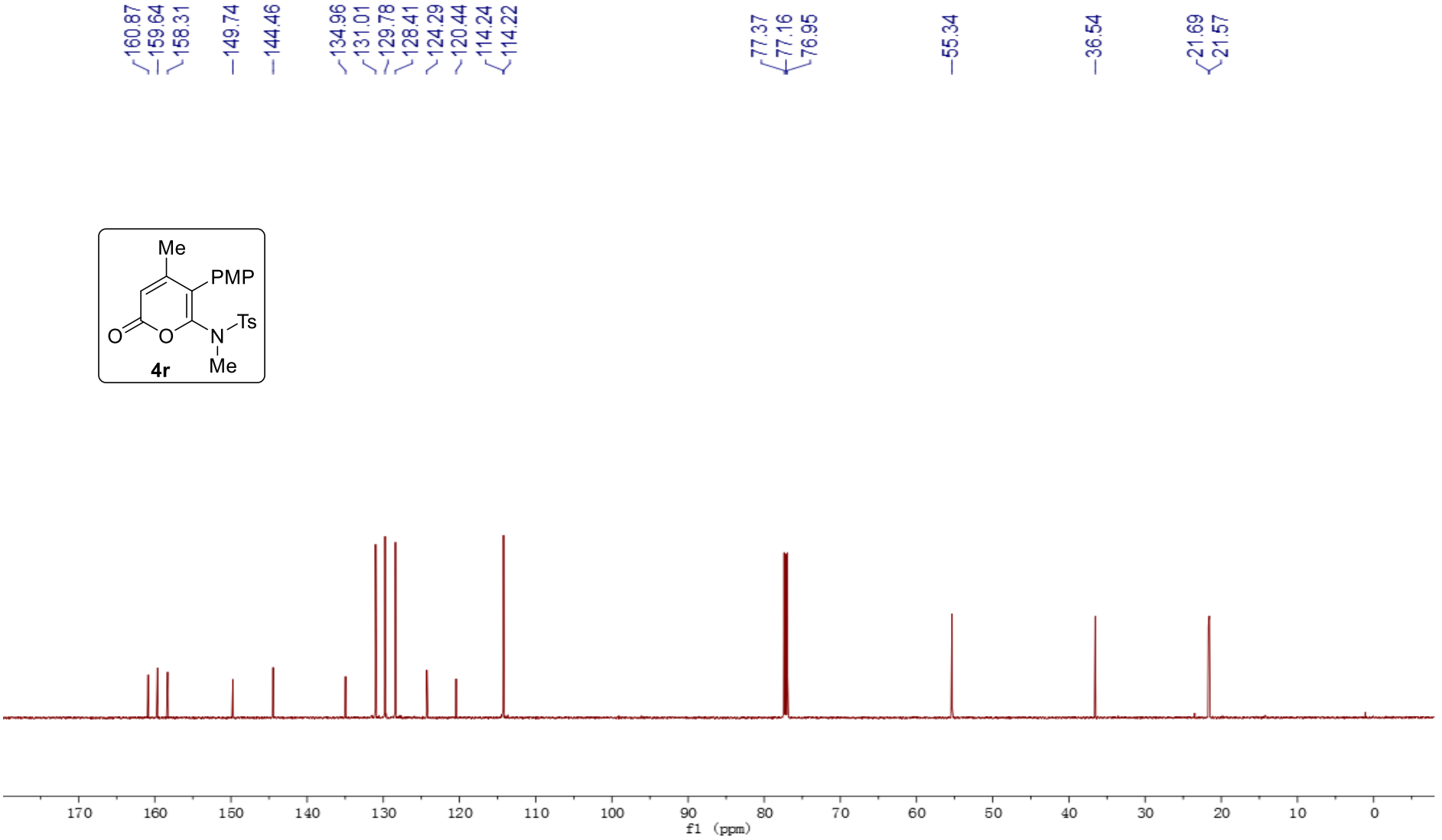

7.617
7.604
7.566
7.558
7.250
7.238
7.219
7.202
7.191
7.081
7.070
7.059
6.029
5.820
4.712
2.027
Me
O
O
O
S
O
N
Bn
S
4p
1.93
4.90
1.03
0.95
0.94
2.00
2.96
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

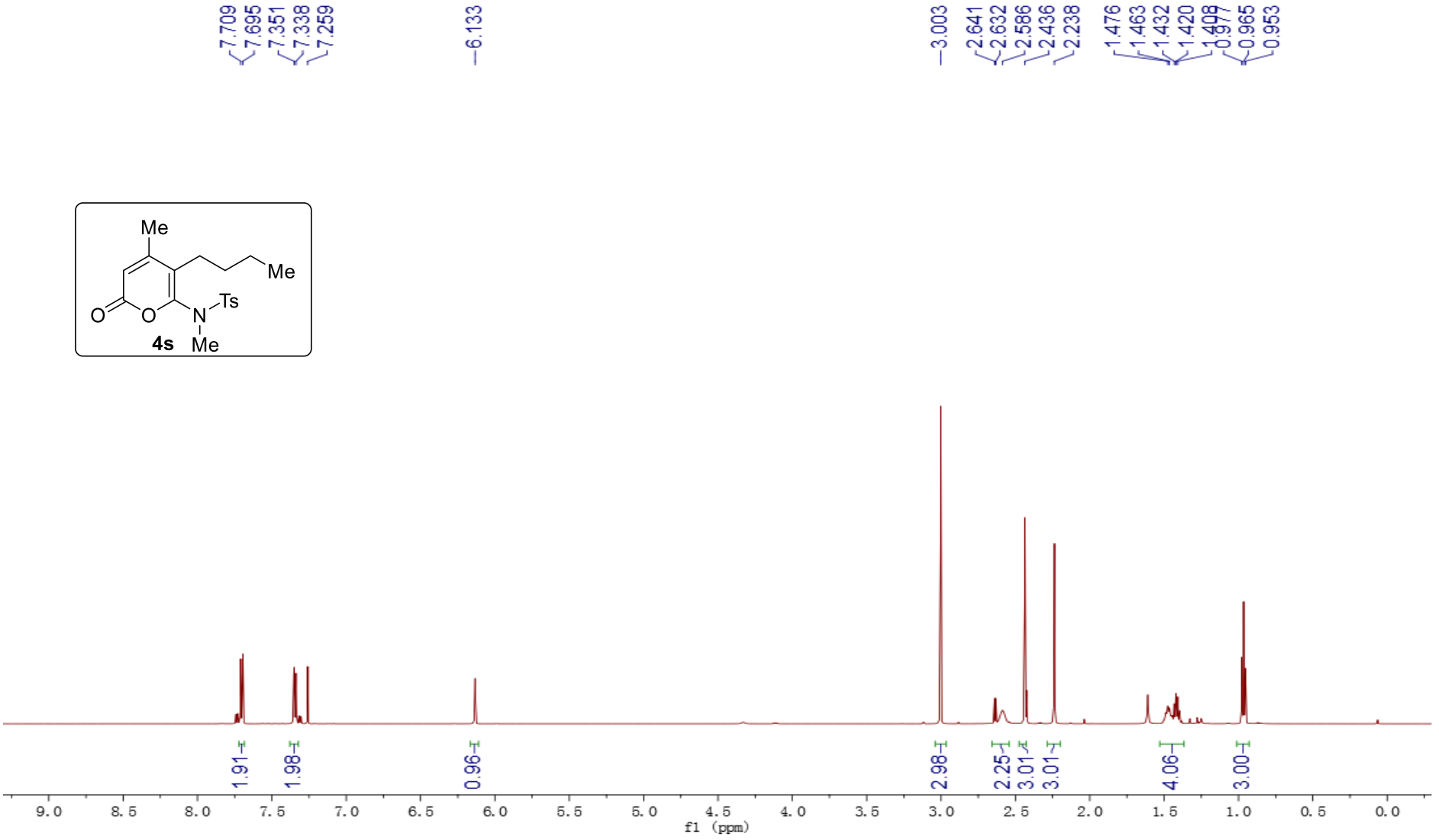

160.96
157.36
150.09
138.37
134.67
133.78
133.69
128.84
128.81
128.41
127.94
111.35
106.57
77.48
77.16
76.84
51.61
21.82
Me
O
O
O
S
O
N
Bn
S
4p
70
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

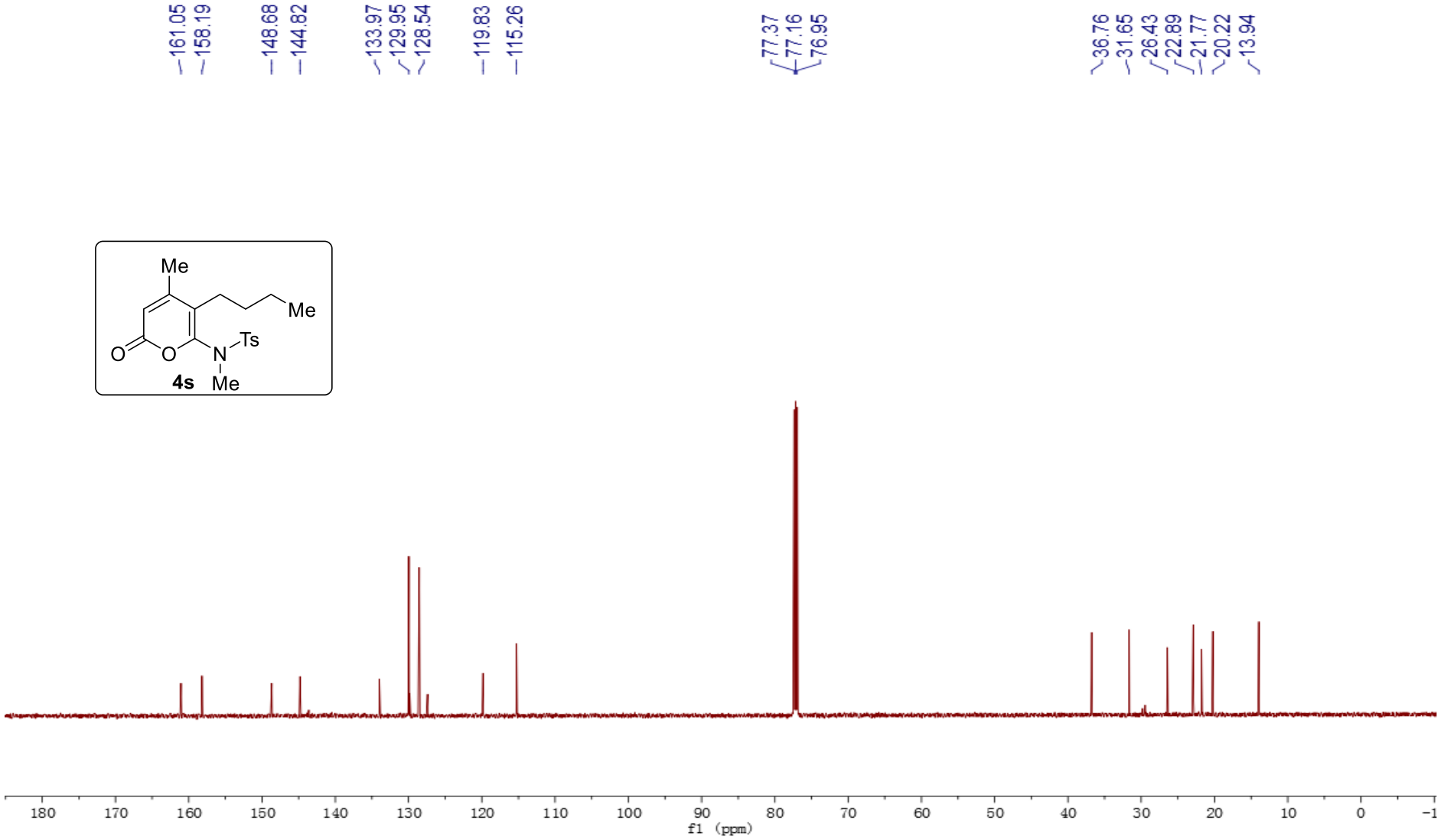

7.675
7.655
7.482
7.465
7.447
7.422
7.404
7.321
7.302
7.260
6.251
2.768
2.428
1.962
Me
Ph
Ts
N
O
O
Me
4q
1.93
3.02
3.97
0.87
2.92
3.00
3.00
f1 (ppm)

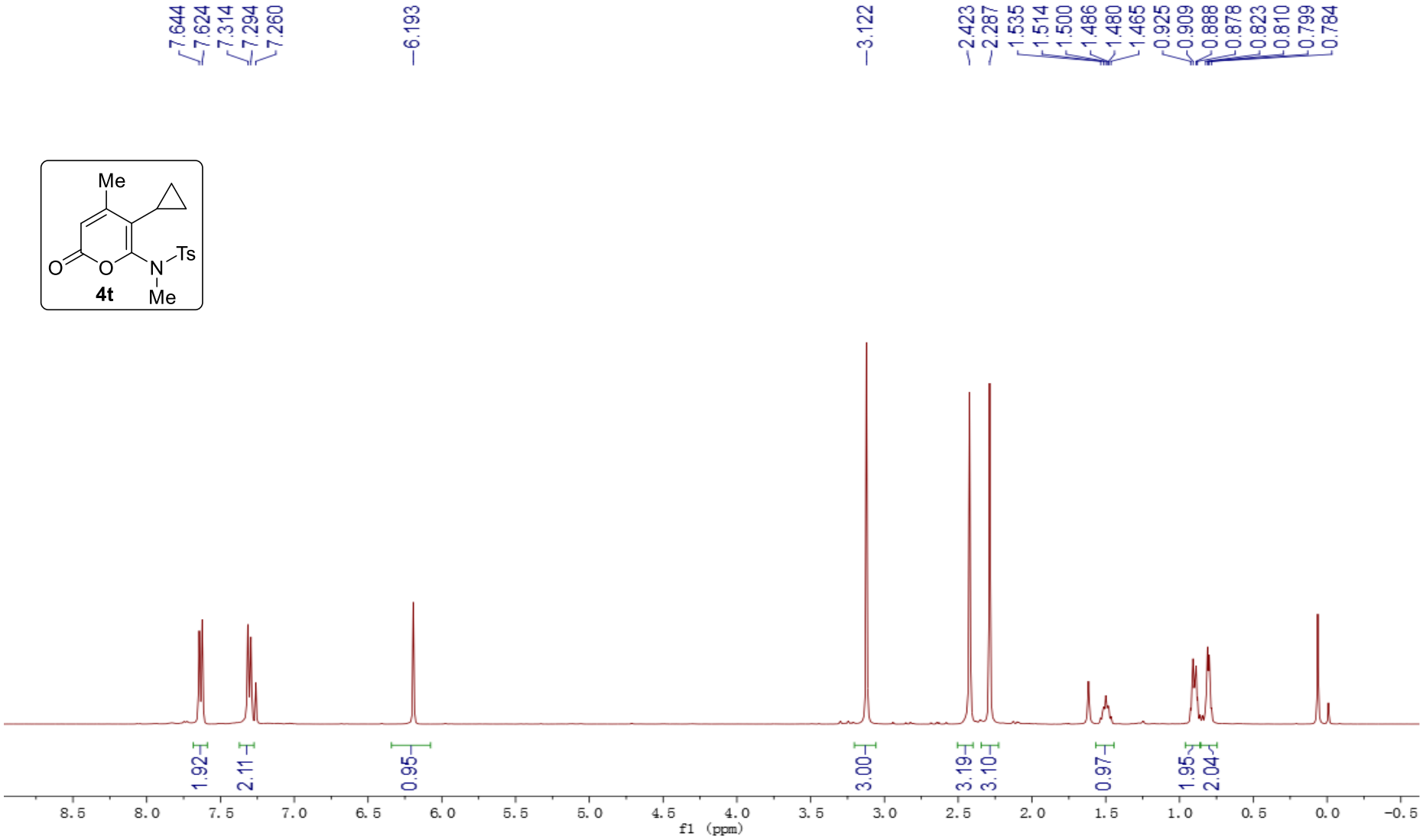

160.86
157.77
149.75
144.53
132.37
129.89
129.83
128.84
128.53
114.50
77.48
77.16
76.84
36.60
21.72
21.55
Me
Ph
Ts
N
O
O
Me
4q
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

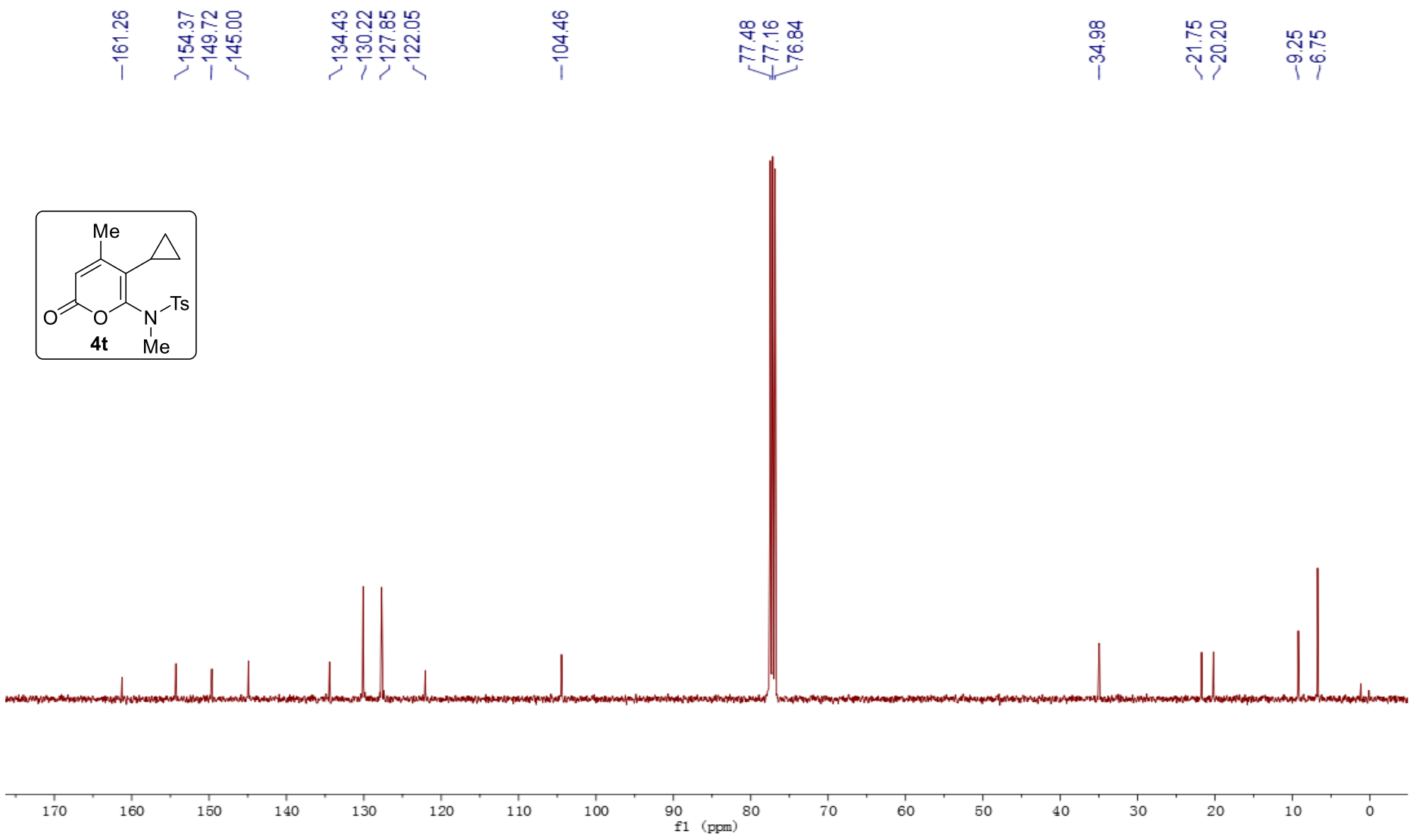

7.692
7.678
7.311
7.298
7.260
7.228
7.214
6.977
6.962
6.221
3.845
2.760
2.418
1.954
Me
PMP
Ts
N
Me
O
O
4r
2.01
2.05
1.97
2.11
0.95
3.10
3.00
3.21
3.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

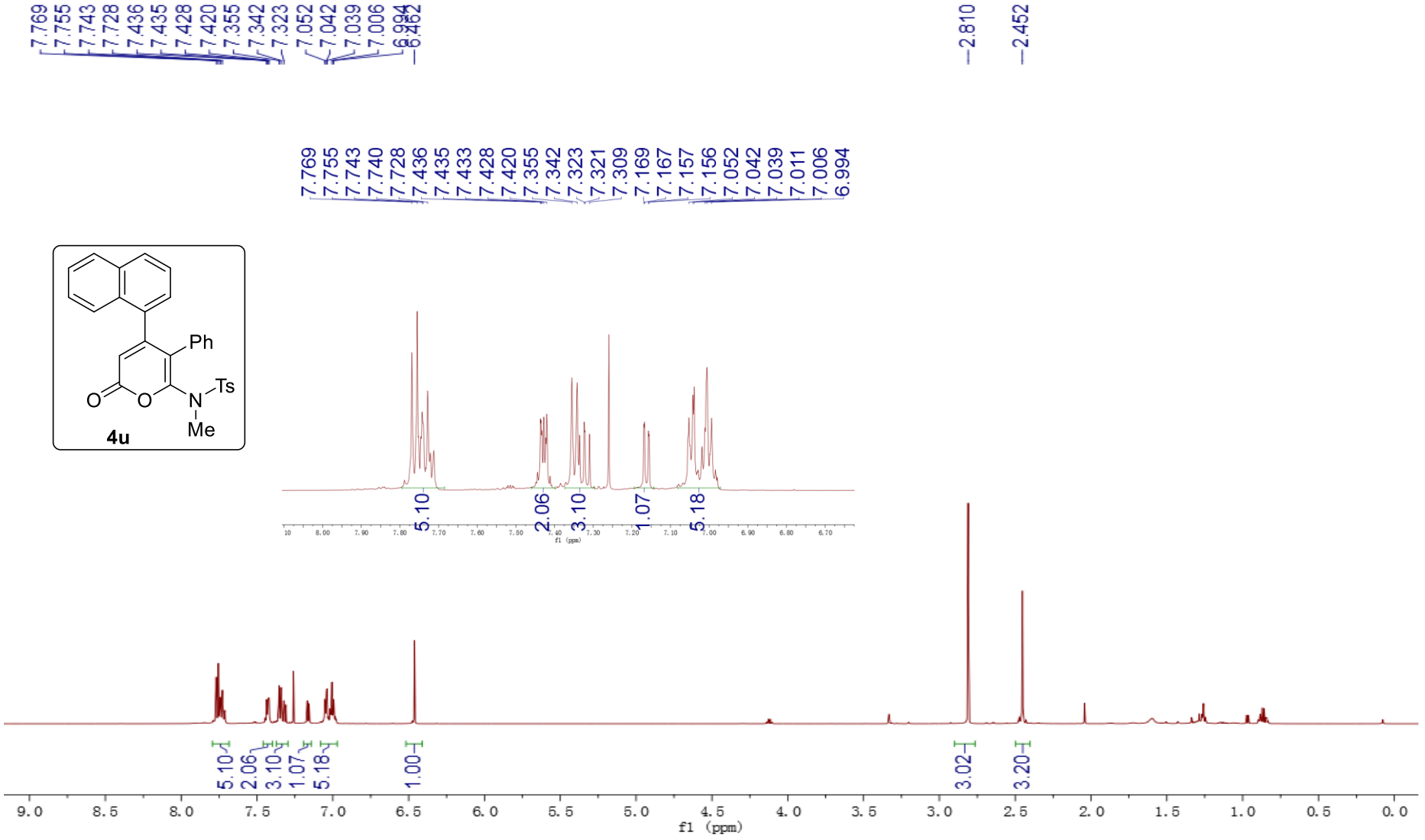

160.87
159.64
158.31
149.74
144.46
134.96
131.01
129.78
128.41
124.29
120.44
114.24
114.22
77.37
77.16
76.95
55.34
36.54
21.69
21.57
Me
PMP
Ts
O
O
N
Me
4r
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

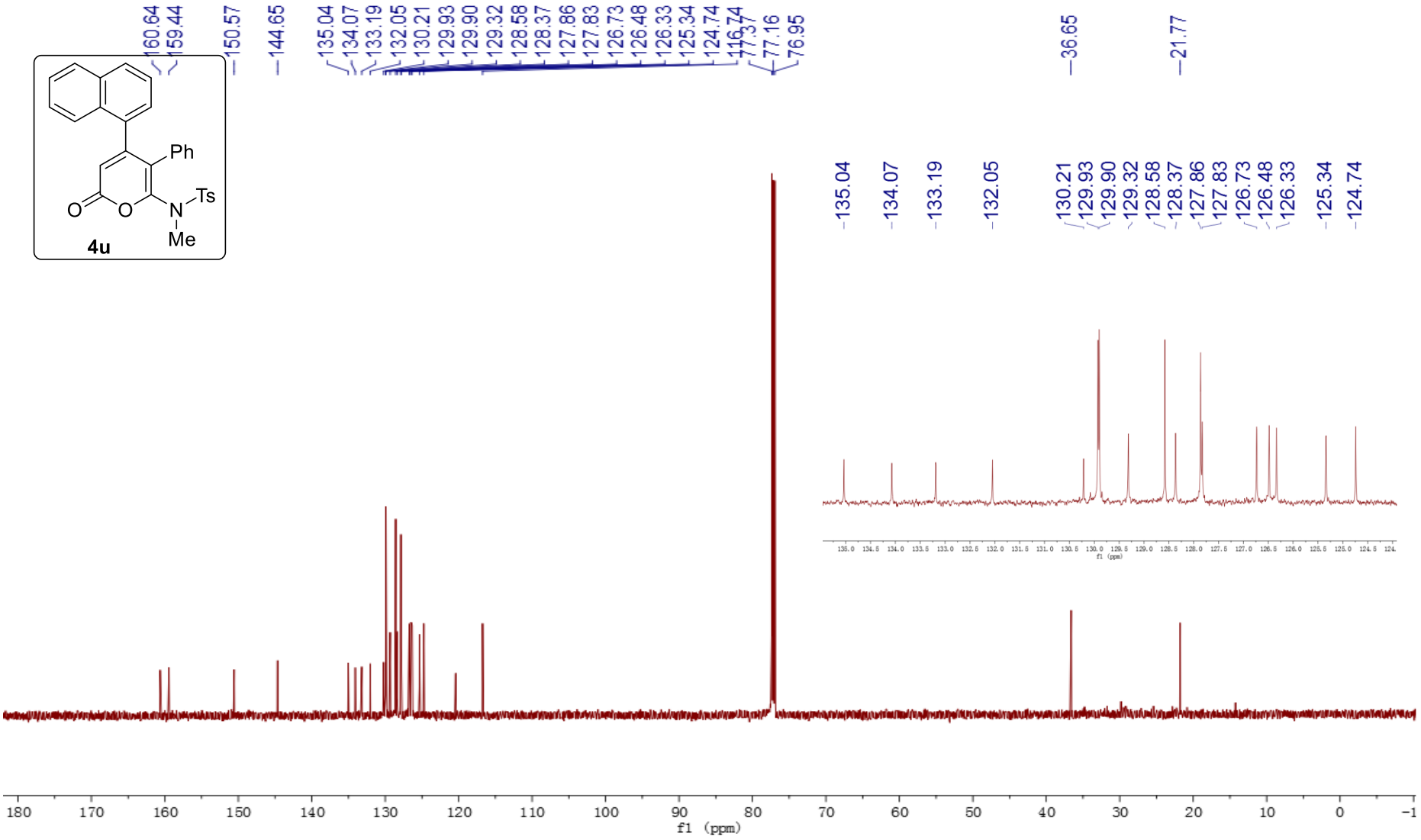

7.709
7.695
7.351
7.338
7.259
6.133
3.003
2.641
2.632
2.586
2.436
2.238
1.476
1.463
1.432
1.420
1.408
0.977
0.965
0.953
Me
Me
Ts
O
O
N
Me
4s
1.91
1.98
0.96
2.98
2.25
3.01
3.01
4.06
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

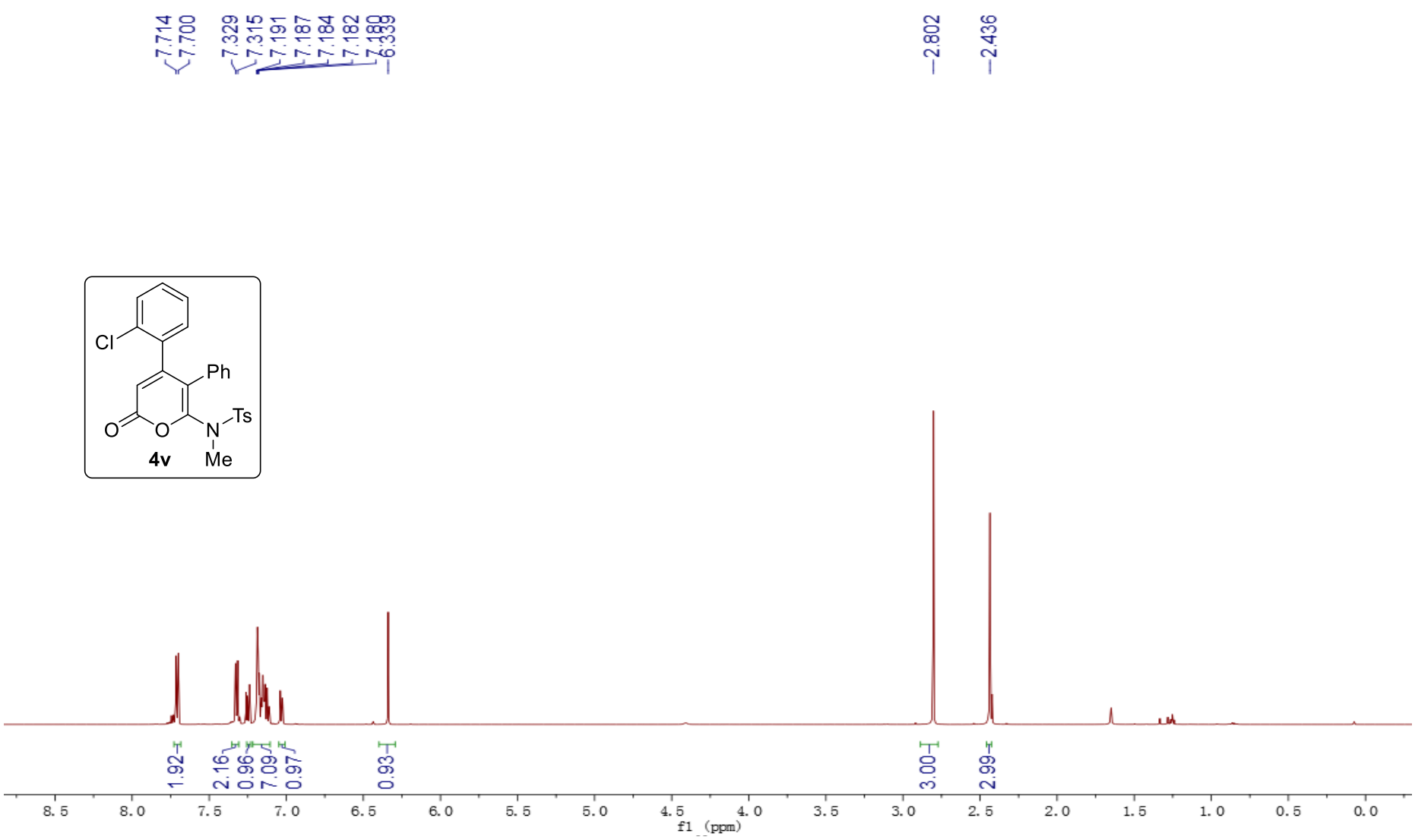

161.05
158.19
148.68
144.82
133.97
129.95
128.54
119.83
115.26
77.37
77.16
76.95
36.76
31.65
26.43
22.89
21.77
20.22
13.94
Me
Me
Ts
O
O
N
Me
4s
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−1
f1 (ppm)

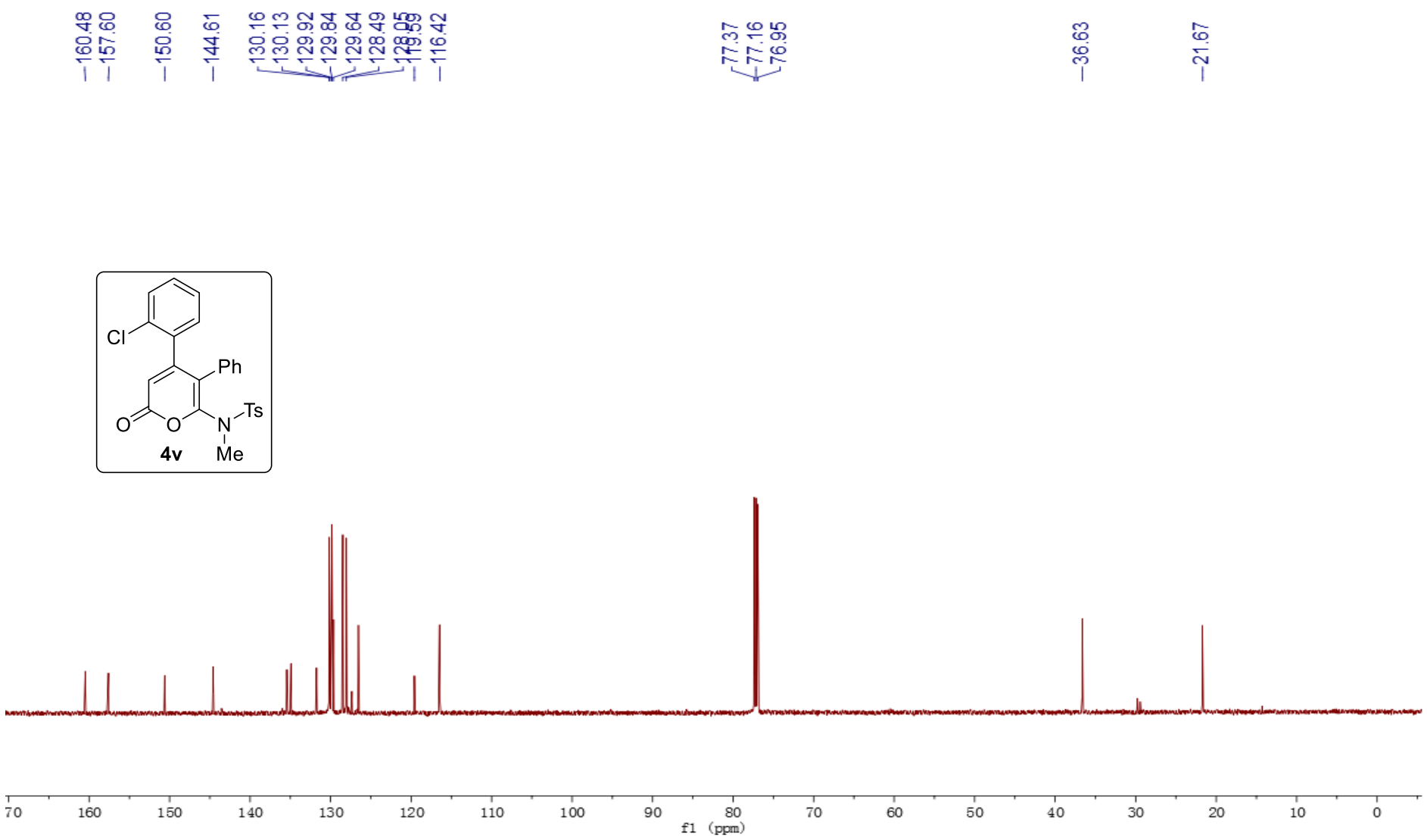

7.644
7.624
7.314
7.294
7.260
6.193
3.122
2.423
2.287
1.535
1.514
1.500
1.486
1.480
1.465
0.925
0.909
0.888
0.878
0.823
0.810
0.799
0.784
Me
Ts
O
O
N
Me
4t
1.92
2.11
0.95
3.00
3.19
3.10
0.97
1.95
2.04
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

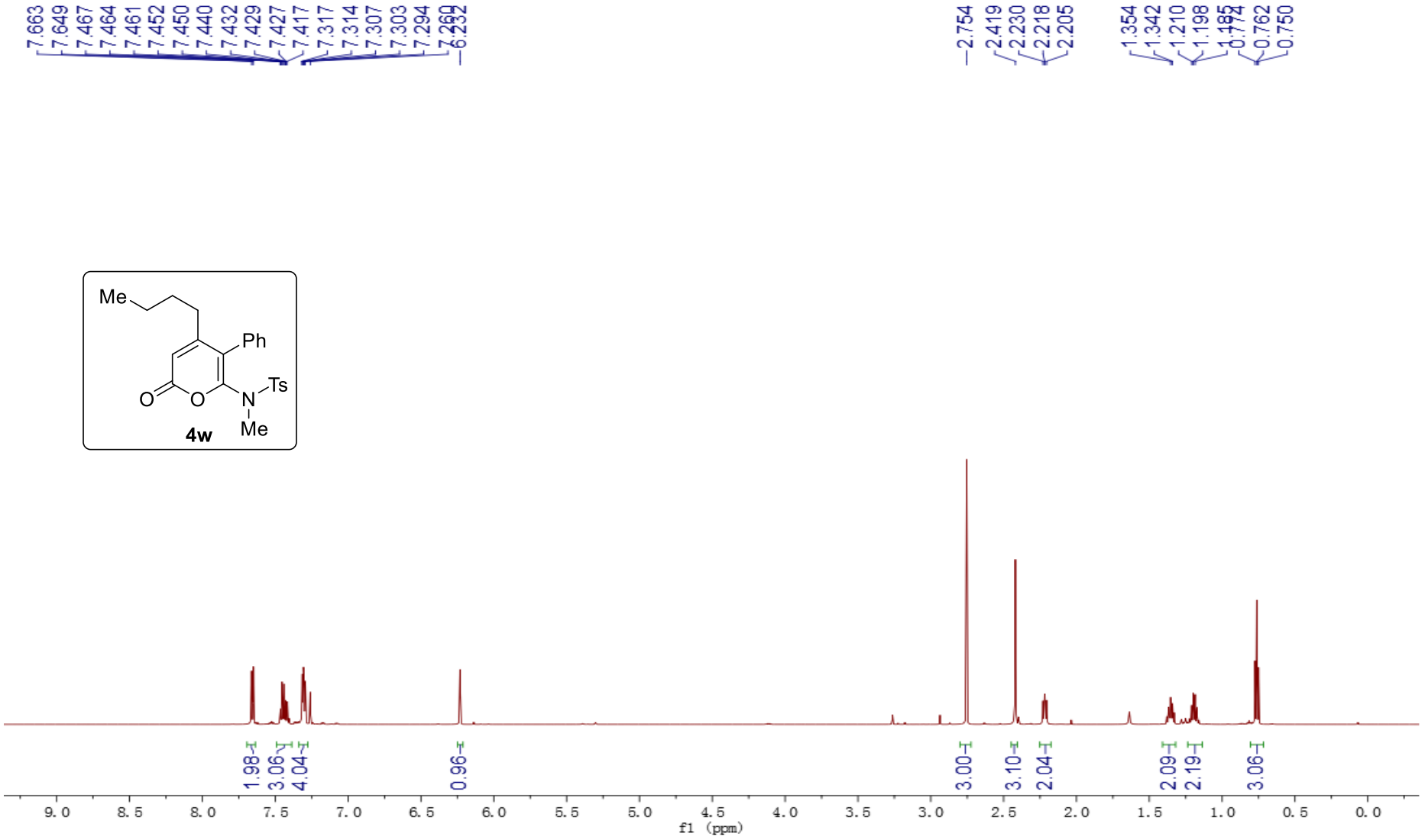

161.26
154.37
149.72
145.00
134.43
130.22
127.85
122.05
104.46
77.48
77.16
76.84
34.98
21.75
20.20
9.25
6.75
Me
O
O
N
Ts
Me
4t
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

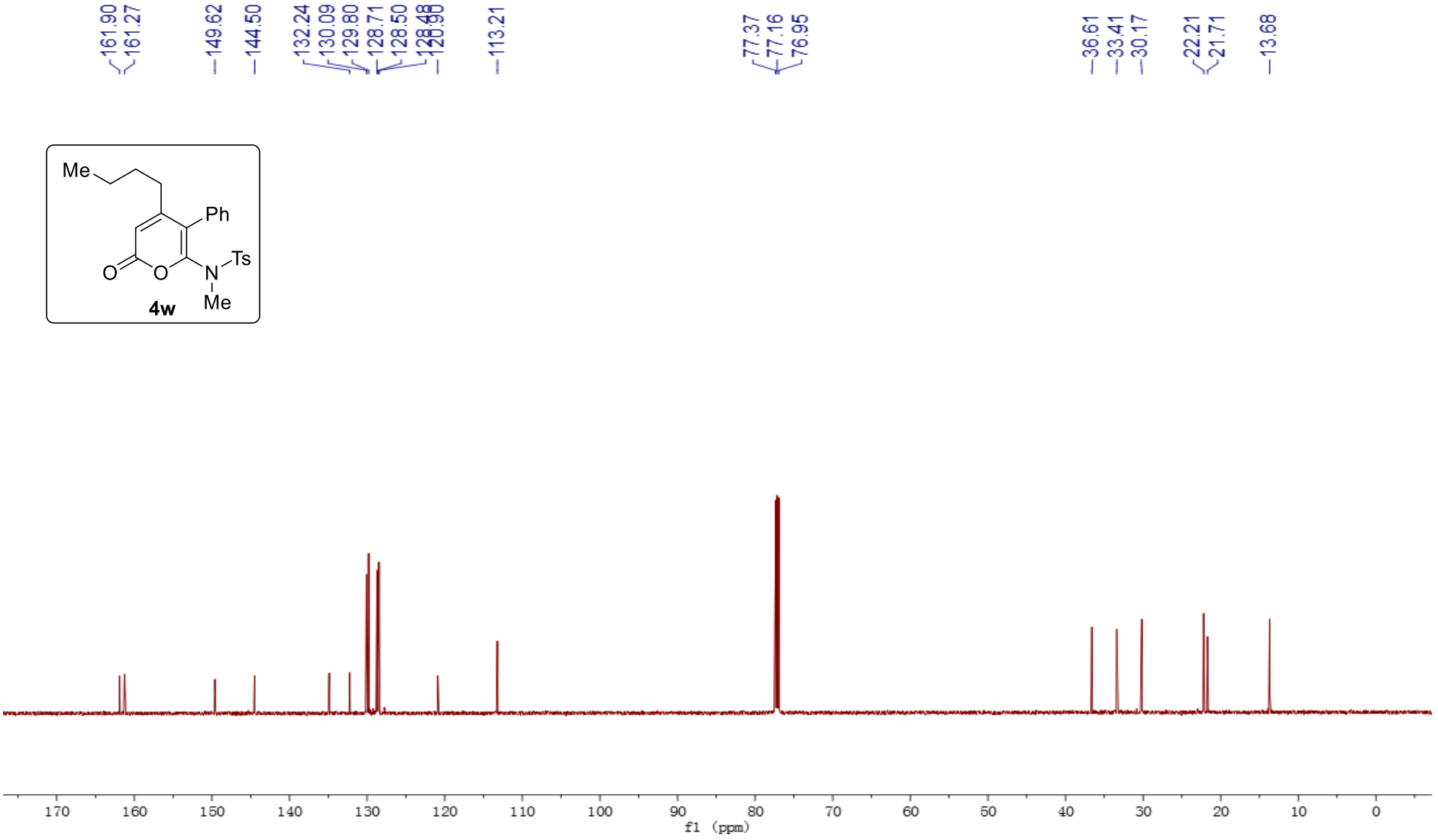

7.769
7.755
7.743
7.728
7.436
7.435
7.428
7.420
7.355
7.342
7.323
7.052
7.042
7.039
7.006
2.810
2.452
Ph
Ts
N
Me
O
O
4u
5.10
2.06
3.10
1.07
5.18
1.00
3.02
3.20
f1 (ppm)


160.64
159.44
150.57
144.65
135.04
134.07
133.19
132.05
130.21
129.93
129.90
129.32
128.58
128.37
127.86
127.83
126.73
126.48
126.33
125.34
124.74
77.16
76.95
36.65
21.77
Ph
Ts
N
Me
O
O
4u
f1 (ppm)


7.714
7.700
7.329
7.315
7.191
7.187
7.184
7.182
6.339
2.802
2.436
Cl
Ph
Ts
O
O
N
Me
4v
1.92
2.16
0.96
7.09
0.97
0.93
3.00
2.99
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)

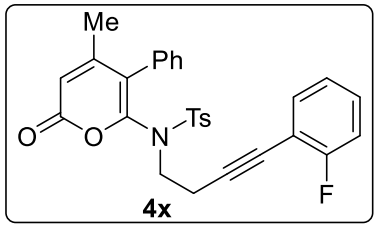

160.48
157.60
150.60
144.61
130.16
130.13
129.92
129.84
129.64
128.49
116.42
77.37
77.16
76.95
36.63
21.67
Cl
Ph
Ts
N
Me
O
O
4v
70
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

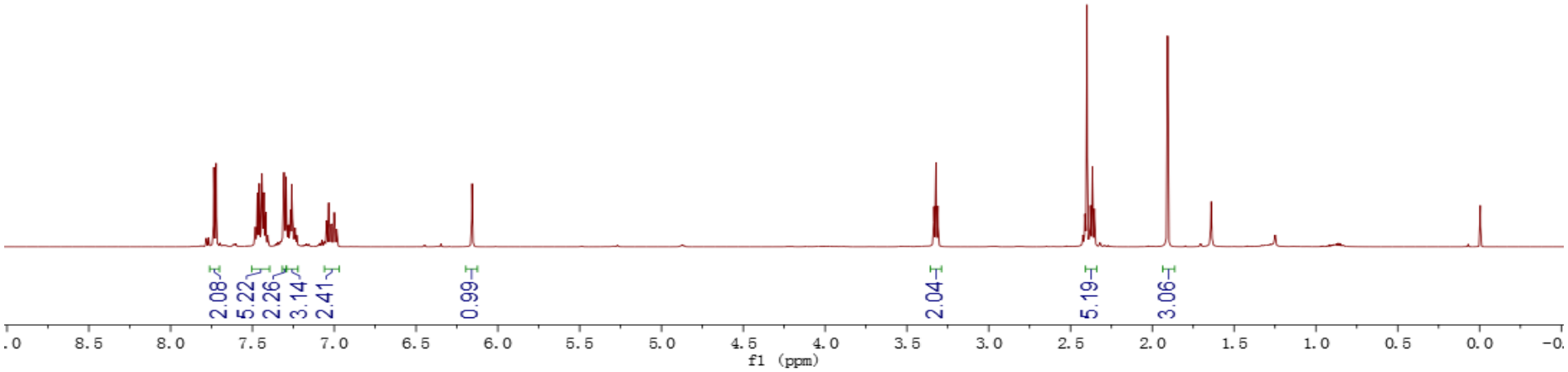

7.663
7.649
7.467
7.464
7.461
7.452
7.450
7.440
7.432
7.429
7.427
7.417
7.317
7.314
7.307
7.303
7.294
2.754
2.419
2.230
2.218
2.205
1.354
1.342
1.210
1.198
0.774
0.762
0.750
Me
Ph
Ts
N
Me
O
O
4w
1.98
3.06
4.04
0.96
3.00
3.10
2.04
2.09
2.19
3.06
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

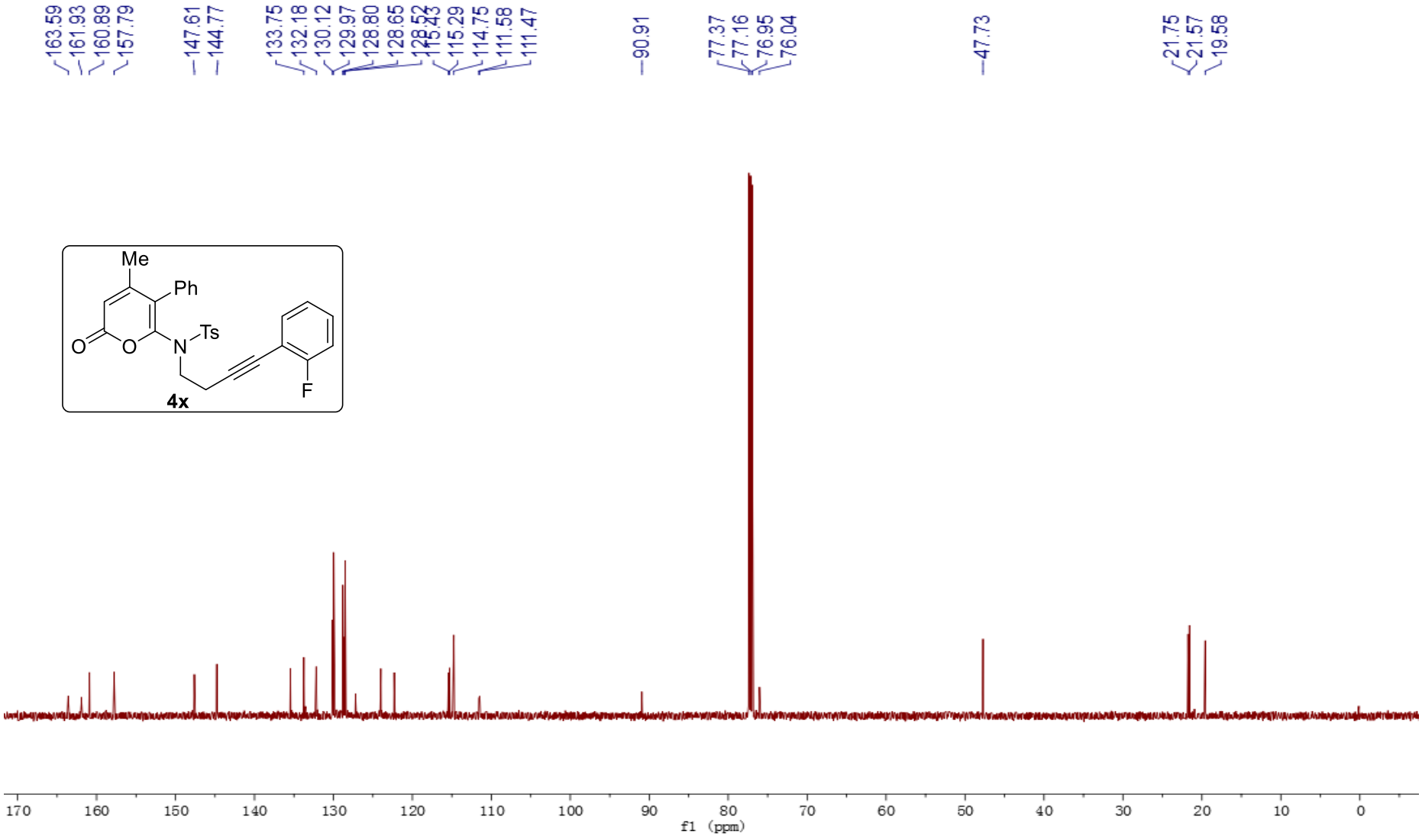

161.90
161.27
149.62
144.50
132.24
130.09
129.80
128.71
128.50
113.21
77.37
77.16
76.95
36.61
33.41
30.17
22.21
21.71
13.68
Me
Ph
Ts
N
Me
O
O
4w
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

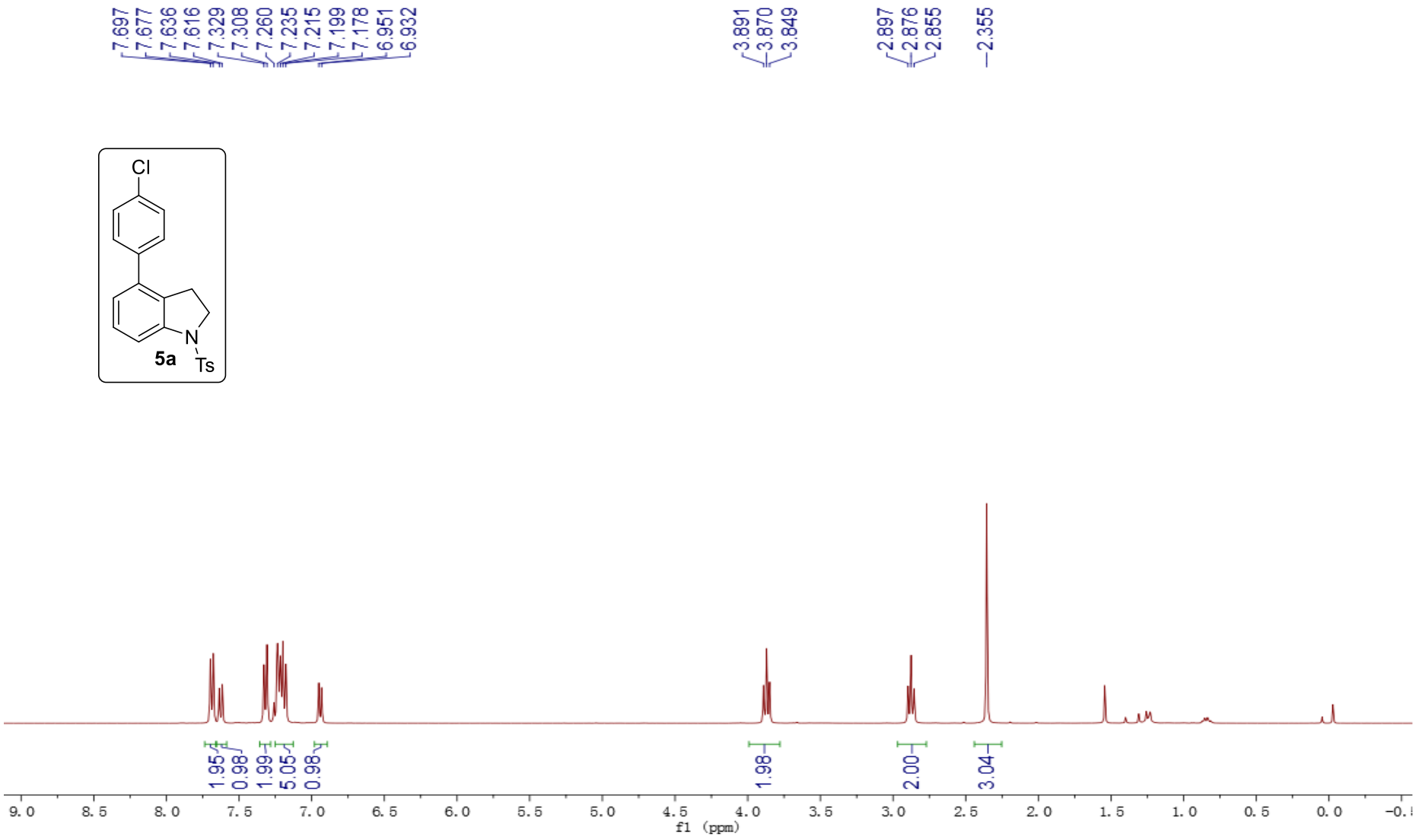

7.736
7.722
7.470
7.458
7.442
7.430
7.418
7.307
7.294
7.270
7.260
7.255
7.253
7.047
7.034
7.015
7.000
6.157

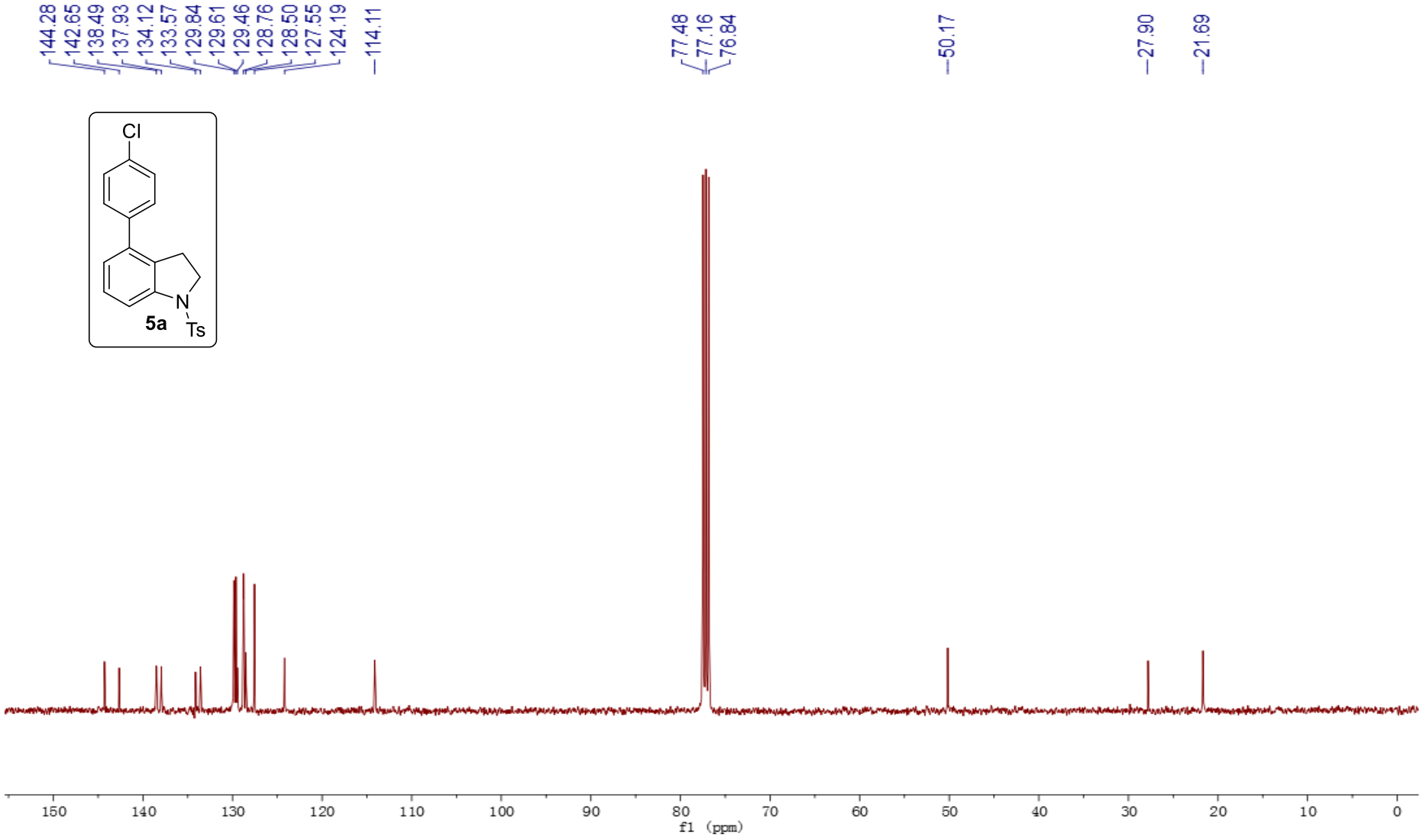

3.334
3.322
3.311
2.399
2.378
2.366
2.354

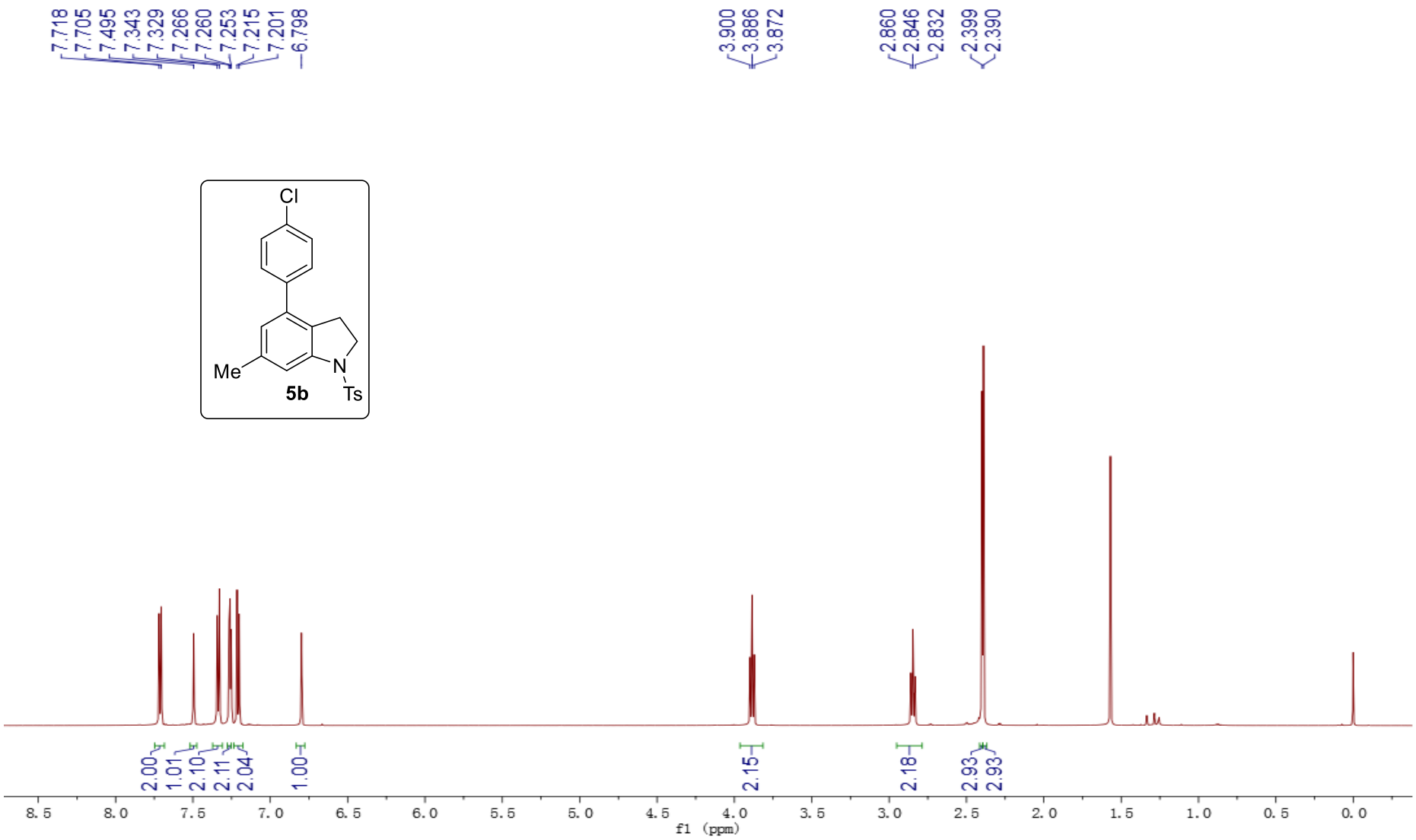

Me
Ph
Ts
N
O
O
F
4x

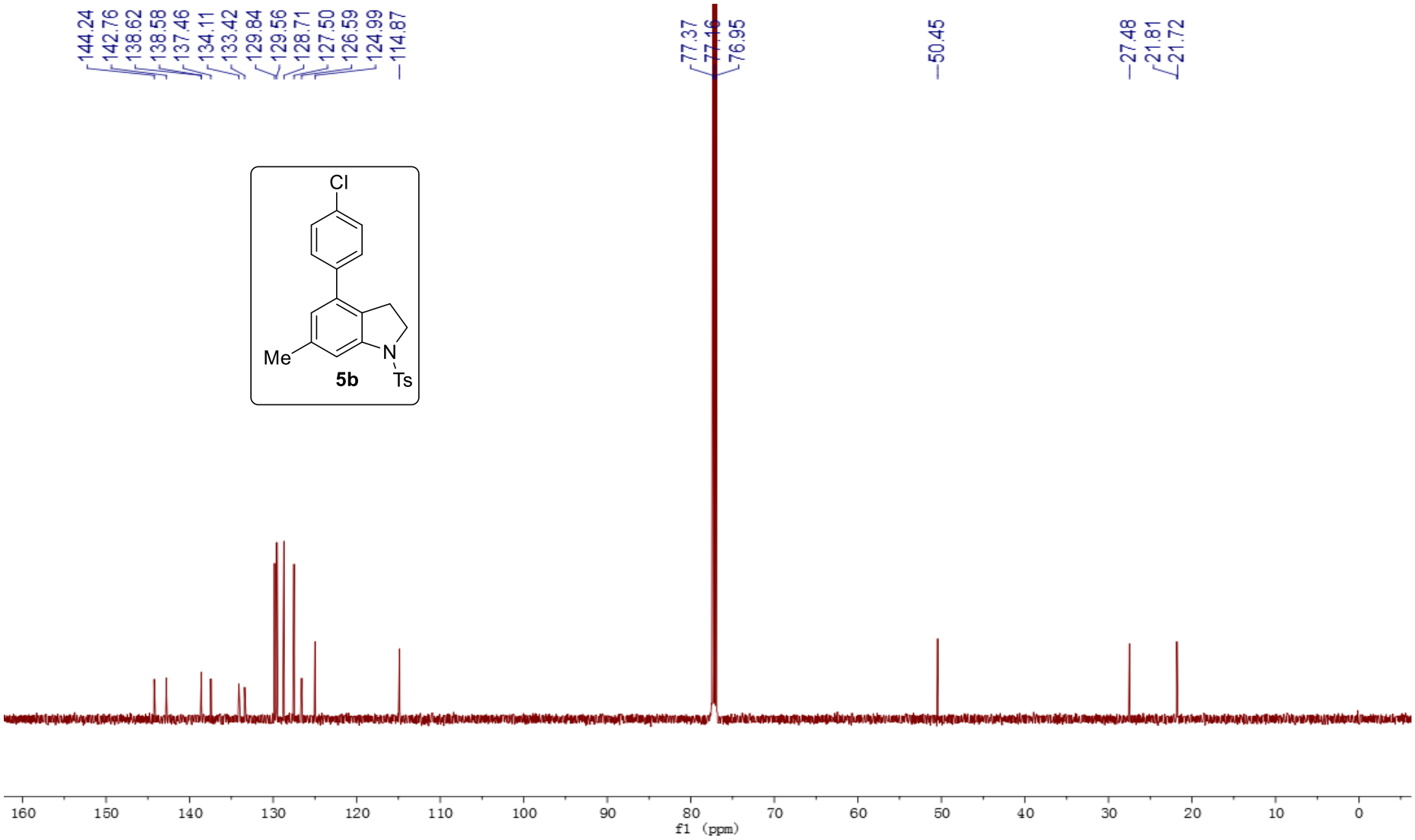

2.08
5.22
2.26
3.14
2.41
0.99
2.04
5.19
3.06
f1 (ppm)

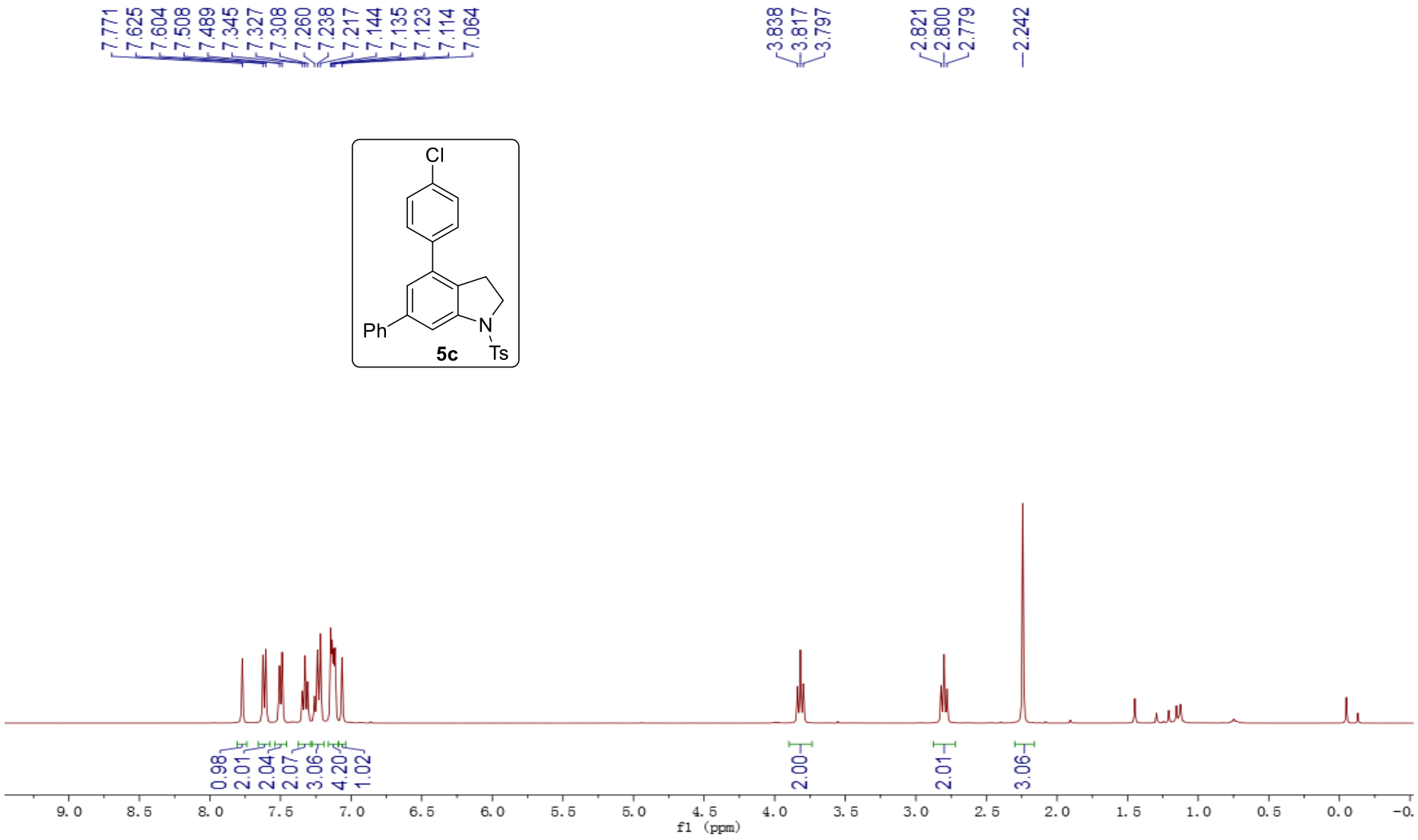

163.59
161.93
160.89
157.79
147.61
144.77
133.75
132.18
130.12
129.97
128.80
128.65
128.52
115.43
115.29
114.75
111.58
111.47
90.91
77.37
77.16
76.95
76.04
47.73
21.75
21.57
19.58
Me
Ph
Ts
N
O
O
F
4x
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

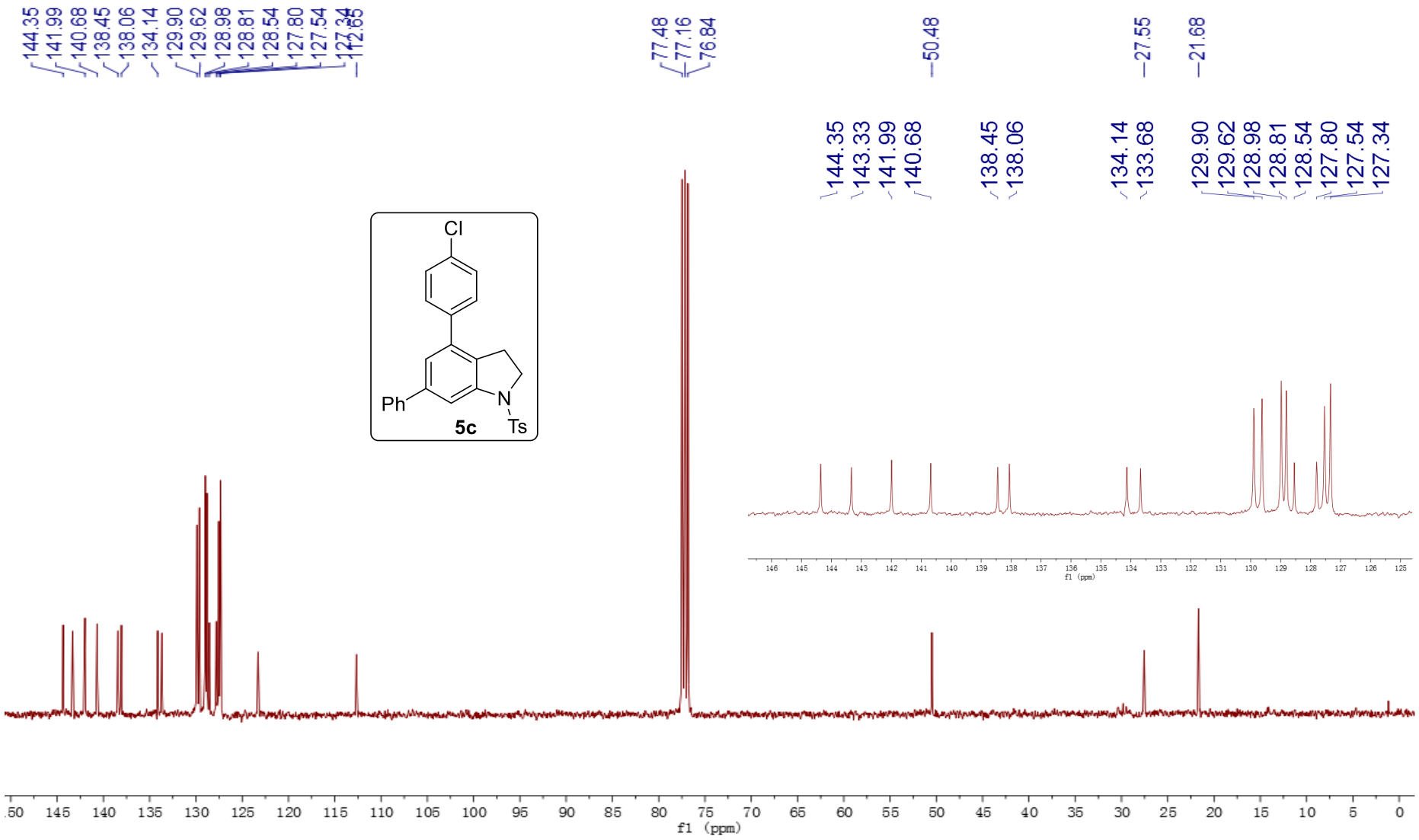

7.697
7.677
7.636
7.616
7.329
7.308
7.260
7.235
7.215
7.199
7.178
6.951
6.932
3.891
3.870
3.849
2.897
2.876
2.855
2.355
Cl
N
Ts
5a
1.95
0.98
1.99
5.05
0.98
1.98
2.00
3.04
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

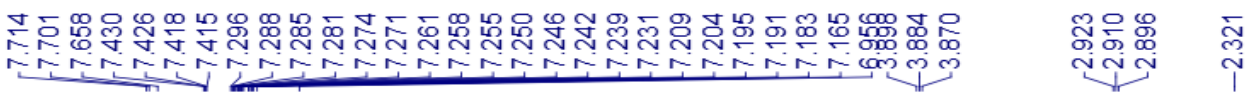

144.28
142.65
138.49
137.93
134.12
133.57
129.84
129.61
129.46
128.76
128.50
127.55
124.19
114.11
77.48
77.16
76.84
50.17
27.90
21.69
Cl
N
Ts
5a
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

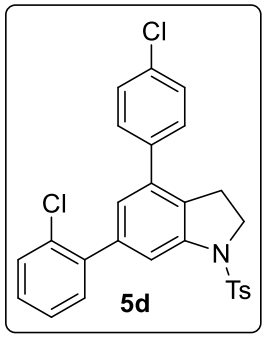

7.718
7.705
7.495
7.343
7.329
7.266
7.260
7.253
7.215
7.201
6.798
3.900
3.886
3.872
2.860
2.846
2.832
2.399
2.390
Cl
Me
N
Ts
5b
2.00
1.01
2.10
2.11
2.04
1.00
2.15
2.18
2.93
2.93
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

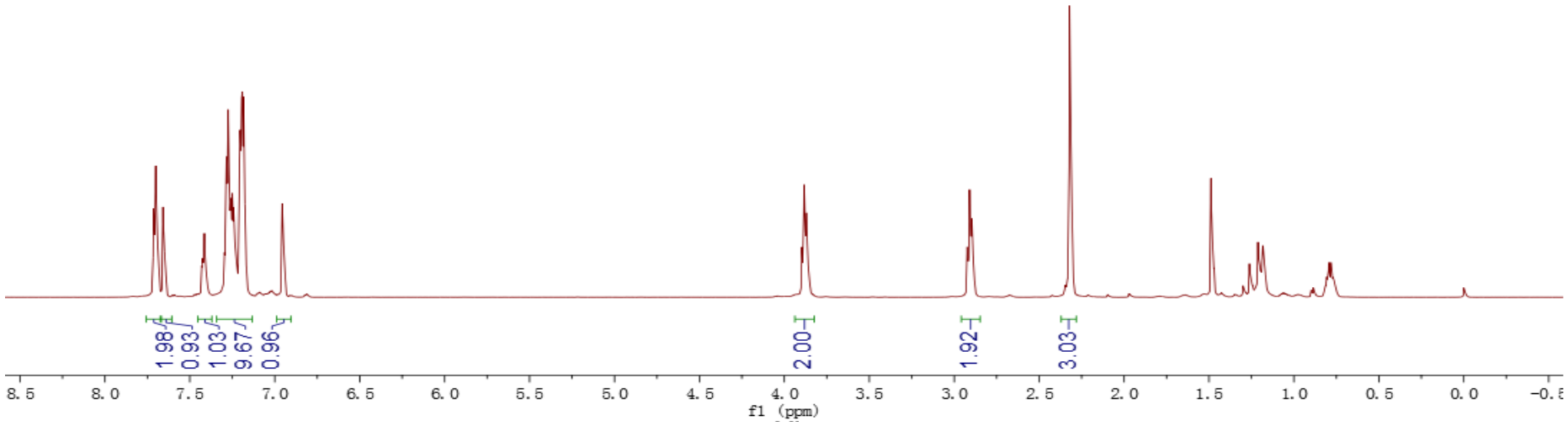

144.24
142.76
138.62
138.58
137.46
134.11
133.42
129.84
129.56
128.71
127.50
126.59
124.99
114.87
77.37
77.16
76.95
50.45
27.48
21.81
21.72
Cl
Me
N
Ts
5b
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

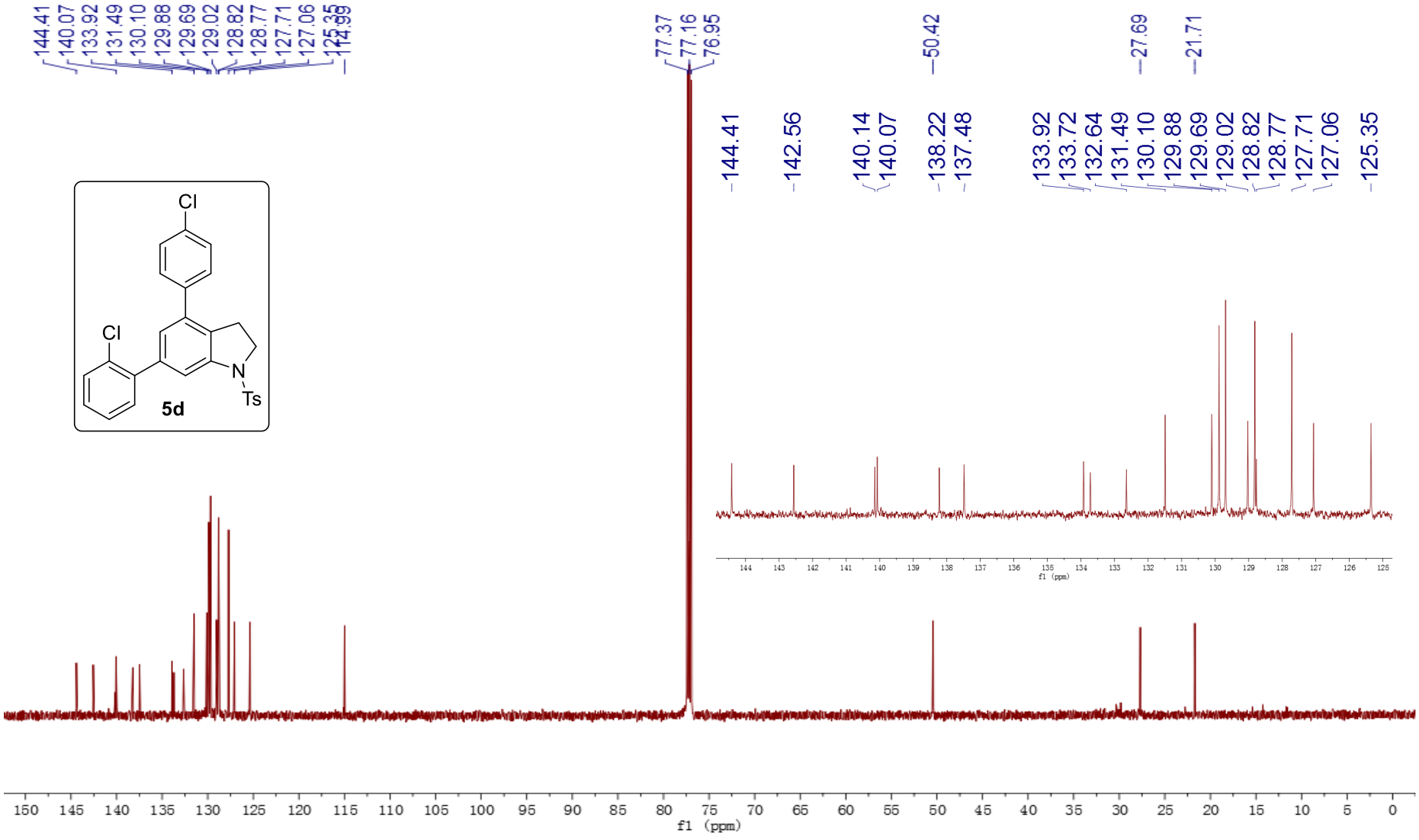

7.771
7.625
7.604
7.508
7.489
7.345
7.327
7.308
7.260
7.238
7.217
7.144
7.135
7.123
7.114
7.064
3.838
3.817
3.797
2.821
2.800
2.779
2.242
Cl
Ph
N
Ts
5c
0.98
2.01
2.04
2.07
3.06
4.20
1.02
2.00
2.01
3.06
f1 (ppm)

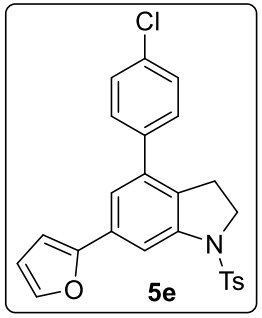

144.35
141.99
140.68
138.45
138.06
134.14
129.90
129.62
128.98
128.81
128.54
127.80
127.54
127.34
77.48
77.16
76.84
50.48
27.55
21.68
144.35
143.33
141.99
140.68
138.45
138.06
134.14
133.68
129.90
129.62
128.98
128.81
128.54
127.80
127.54
127.34
Cl
Ph
N
Ts
5c
f1 (ppm)


7.714
7.701
7.658
7.430
7.426
7.418
7.415
7.296
7.288
7.285
7.281
7.274
7.271
7.261
7.258
7.255
7.250
7.246
7.242
7.239
7.231
7.209
7.204
7.195
7.191
7.183
7.165
6.956
3.898
3.884
3.870
2.923
2.910
2.896
2.321

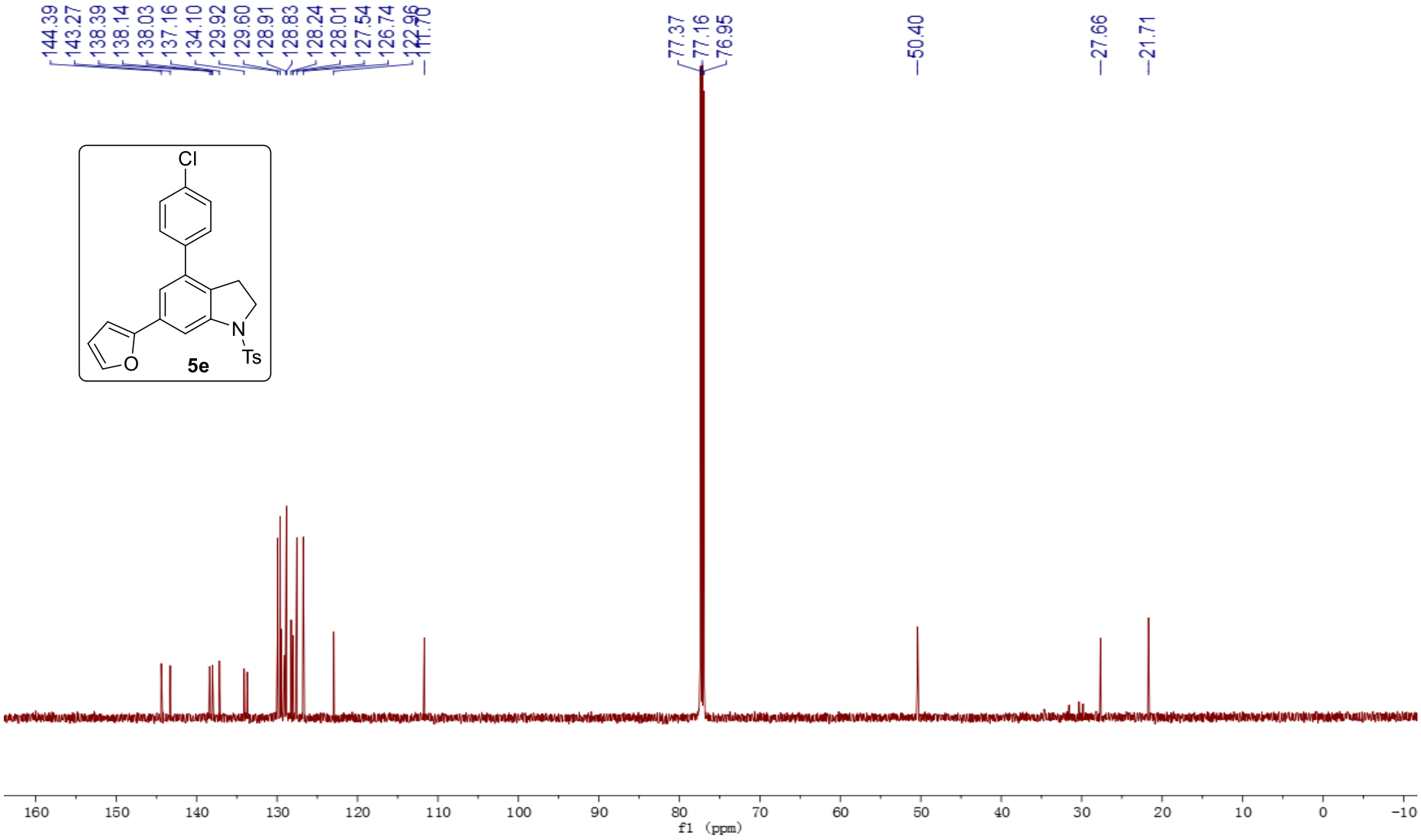

Cl
Cl
N
Ts
5d


1.98
0.93
1.03
9.67
0.96
2.00
1.92
3.03
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)

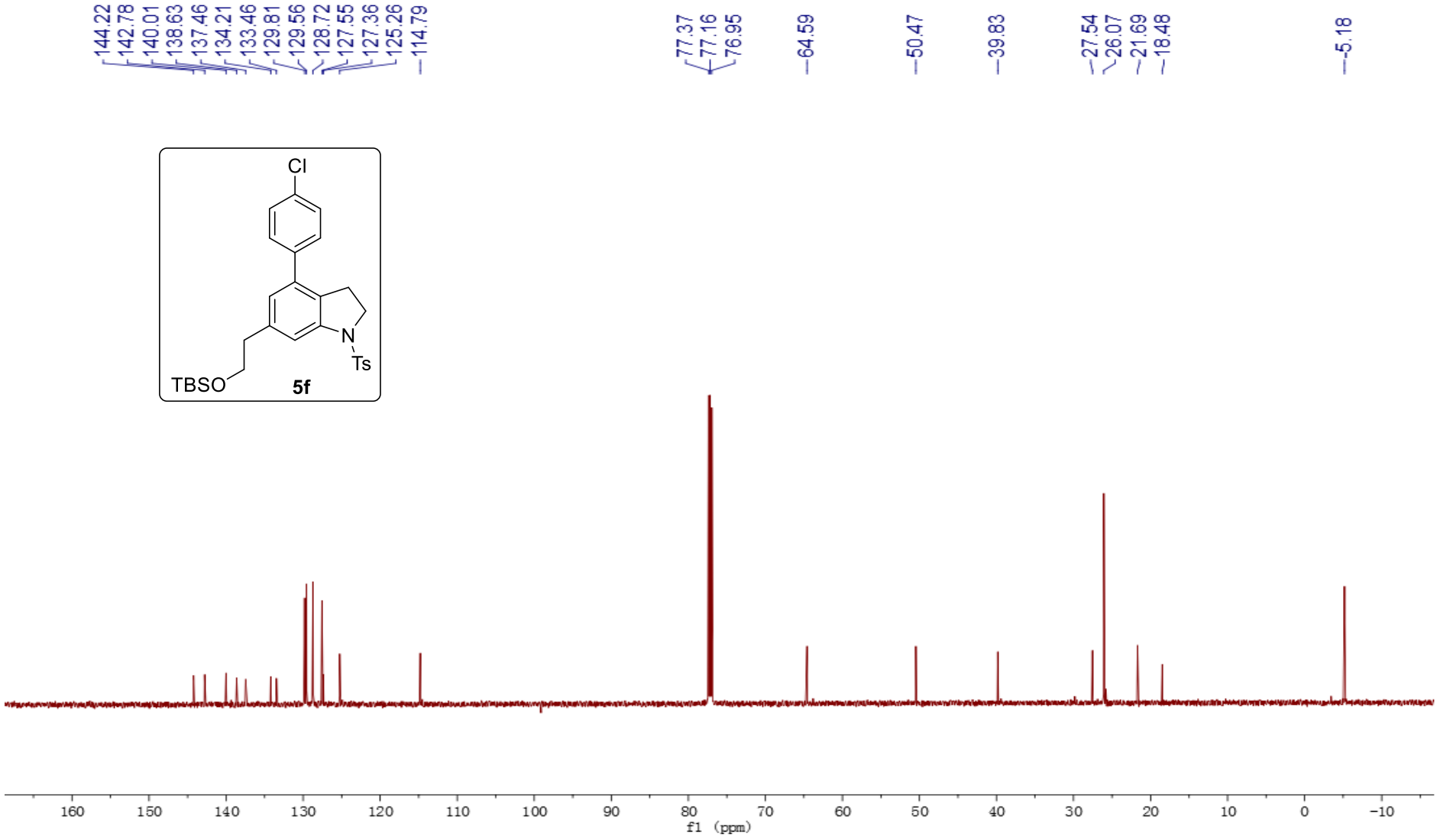

144.41
140.07
133.92
131.49
130.10
129.88
129.69
129.02
128.82
128.77
127.71
127.06
125.35
77.37
77.16
76.95
50.42
27.69
21.71
144.41
142.56
140.14
140.07
138.22
137.48
133.92
133.72
132.64
131.49
130.10
129.88
129.69
129.02
128.82
128.77
127.71
127.06
125.35
Cl
Cl
N
Ts
5d
f1 (ppm)
f1 (ppm)

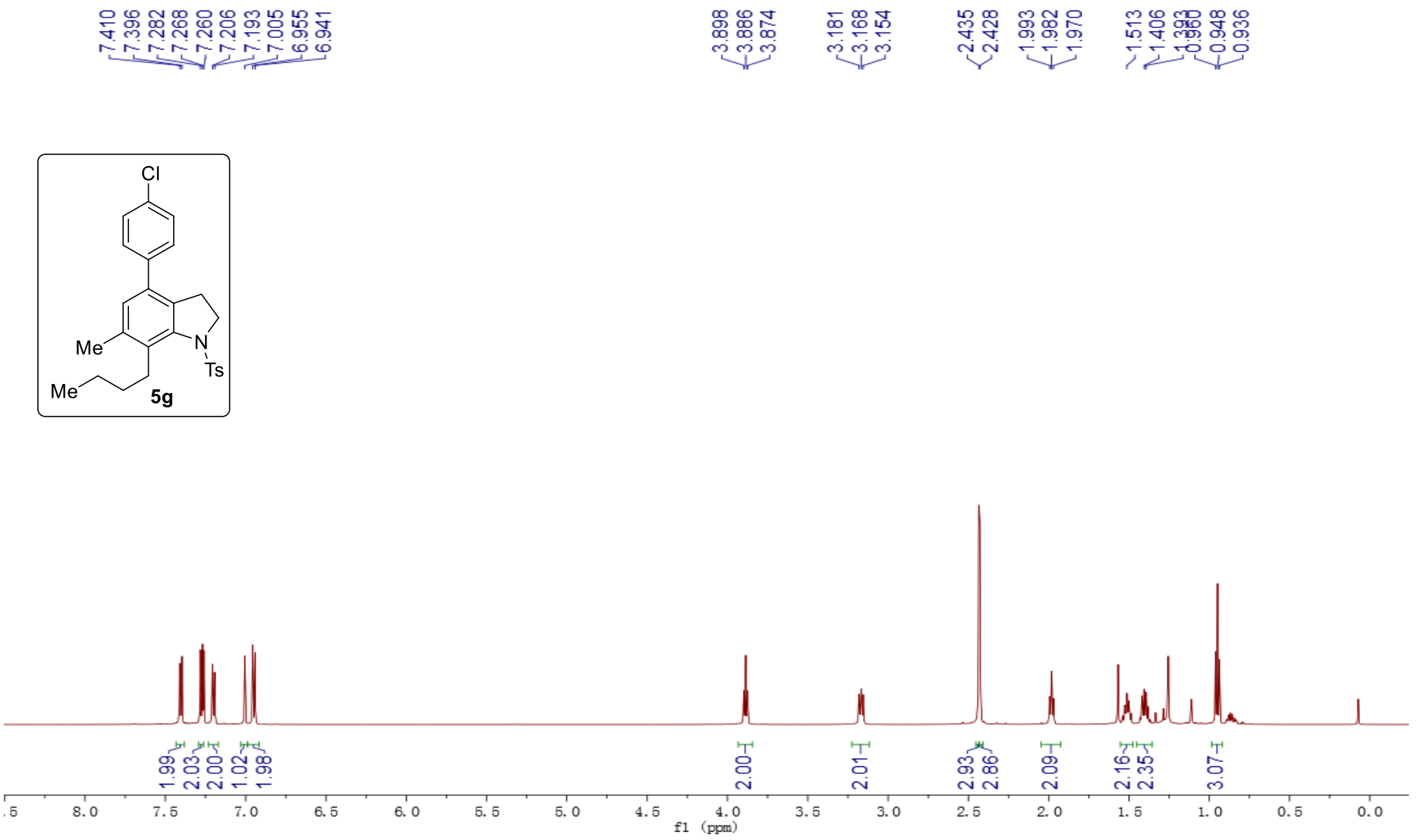

Cl
N
Ts
O
5e

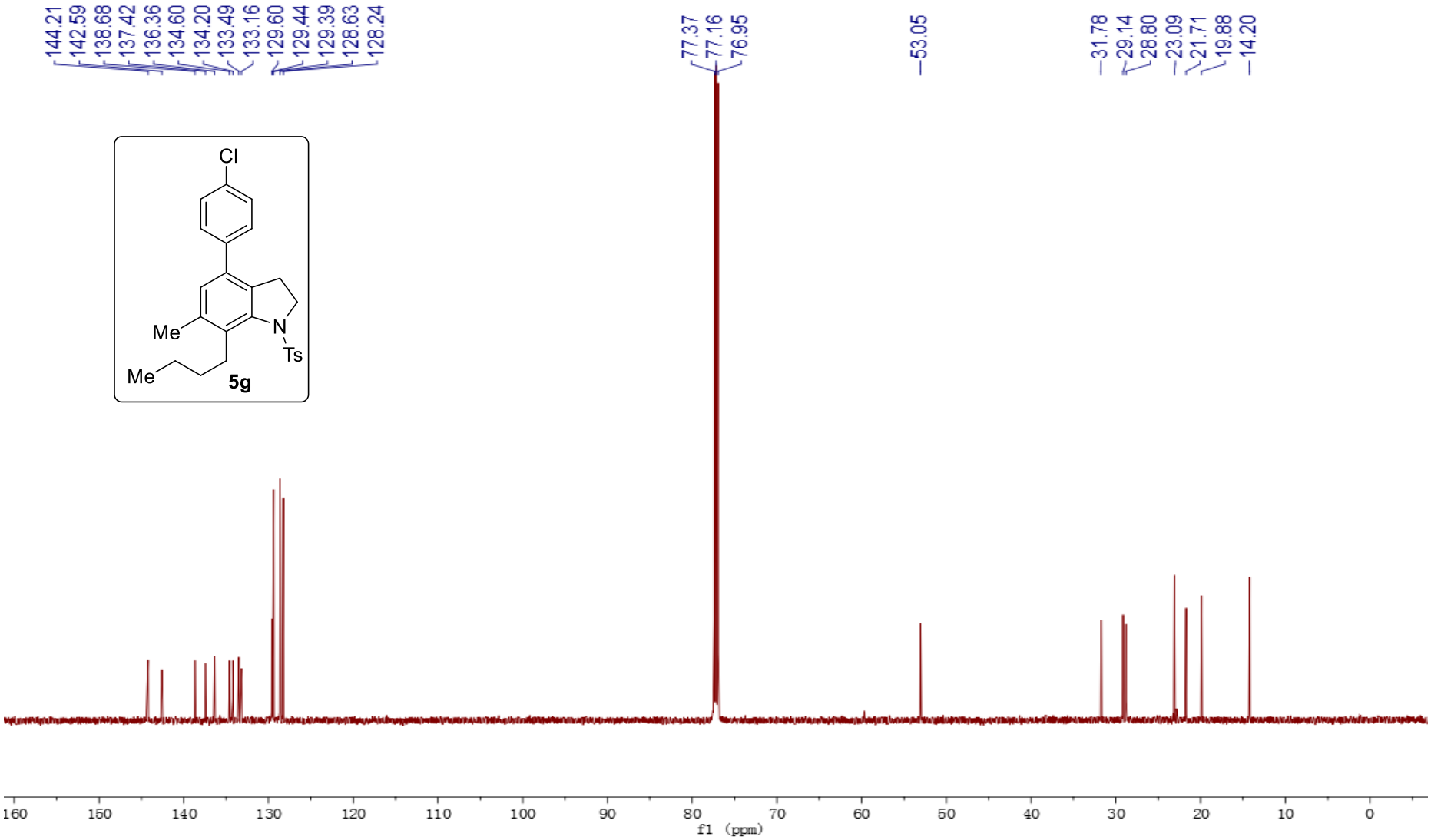
7.847
7.754
7.740
7.399
7.386
7.380
7.377
7.373
7.369
7.366
7.362
7.300
7.288
7.277
7.270
7.266
7.263
7.260
7.255
7.252
7.248
7.127
3.938
3.924
3.910
2.910
2.896
2.882
2.389
0.99
1.95
4.08
5.67
1.19
2.00
2.02
2.98
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

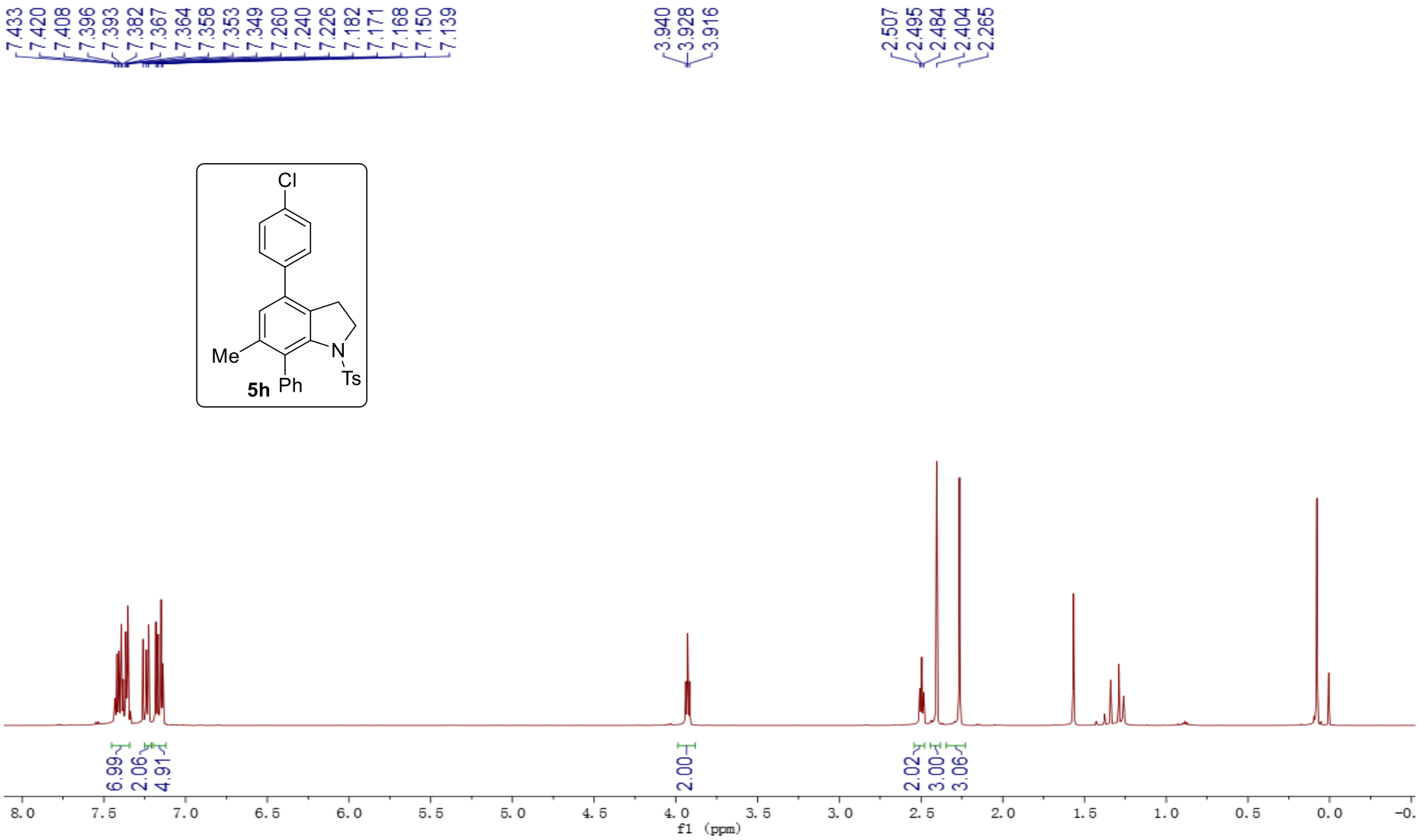

144.39
143.27
138.39
138.14
138.03
137.16
134.10
129.92
129.60
128.91
128.83
128.24
128.01
127.54
126.74
77.37
77.16
76.95
50.40
27.66
21.71
Cl
N
Ts
O
5e
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)

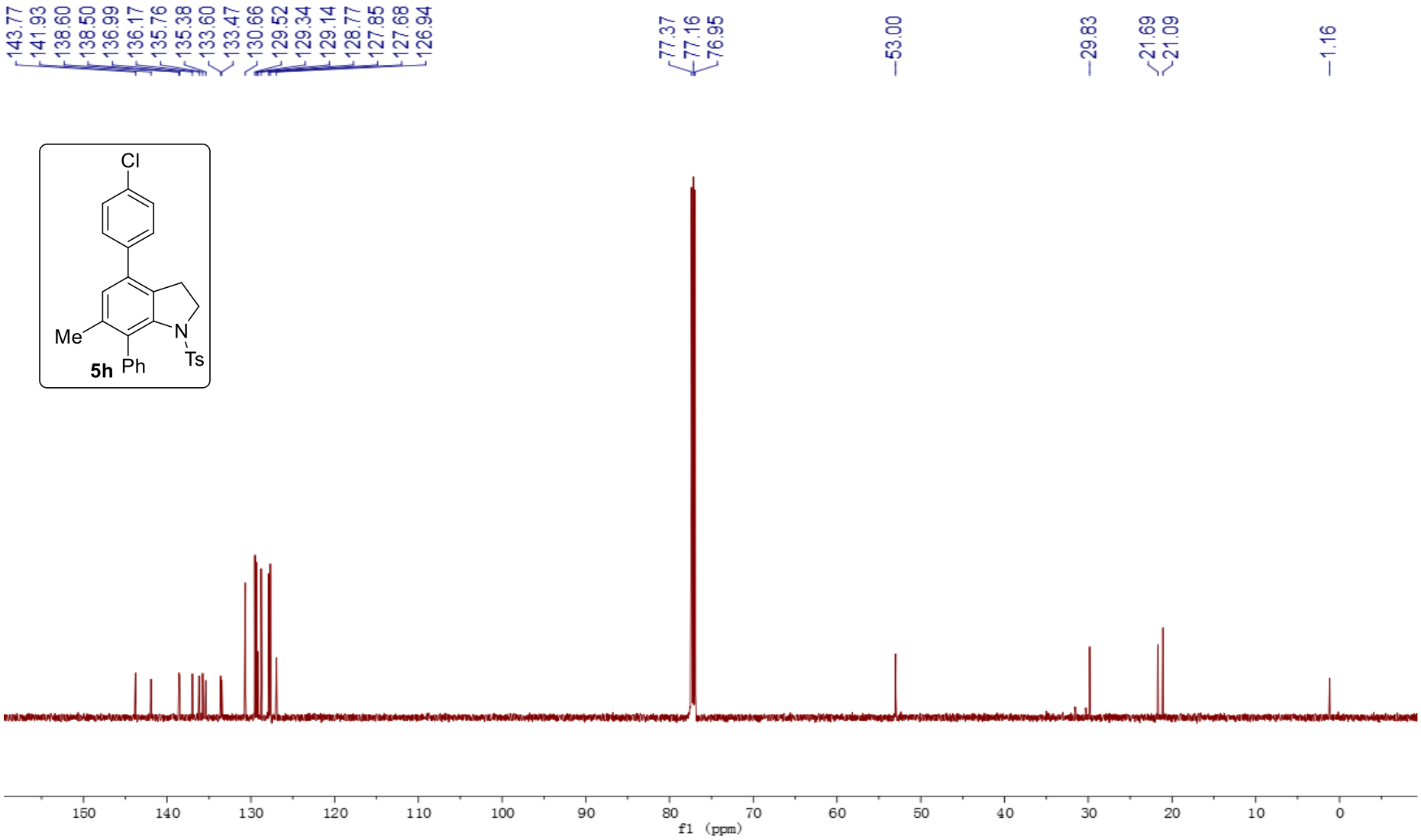
7.715
7.701
7.345
7.331
7.260
7.255
7.241
7.214
3.906
3.892
3.878
3.846
3.834
3.823
2.876
2.870
2.864
2.857
2.843
2.388
0.882
0.024
Cl
N
Ts
TBSO
5f
2.14
0.99
2.33
1.95
1.99
1.07
2.14
2.00
4.06
3.23
9.15
5.80
f1 (ppm)

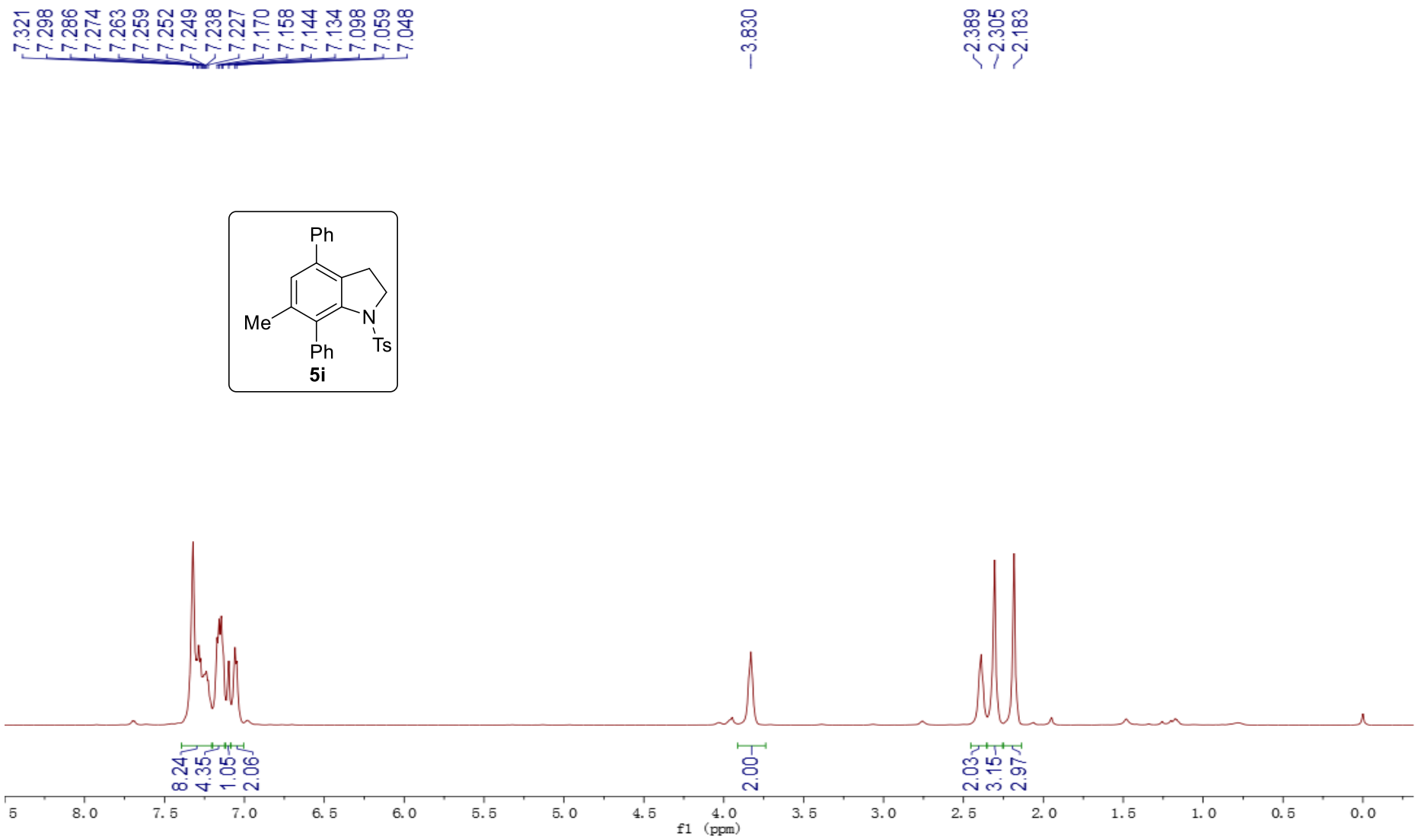

144.22
142.78
140.01
138.63
137.46
134.21
133.46
129.81
129.56
128.72
127.55
127.36
125.26
114.79
77.37
77.16
76.95
64.59
50.47
39.83
27.54
26.07
21.69
18.48
-5.18
Cl
N
Ts
TBSO
5f
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

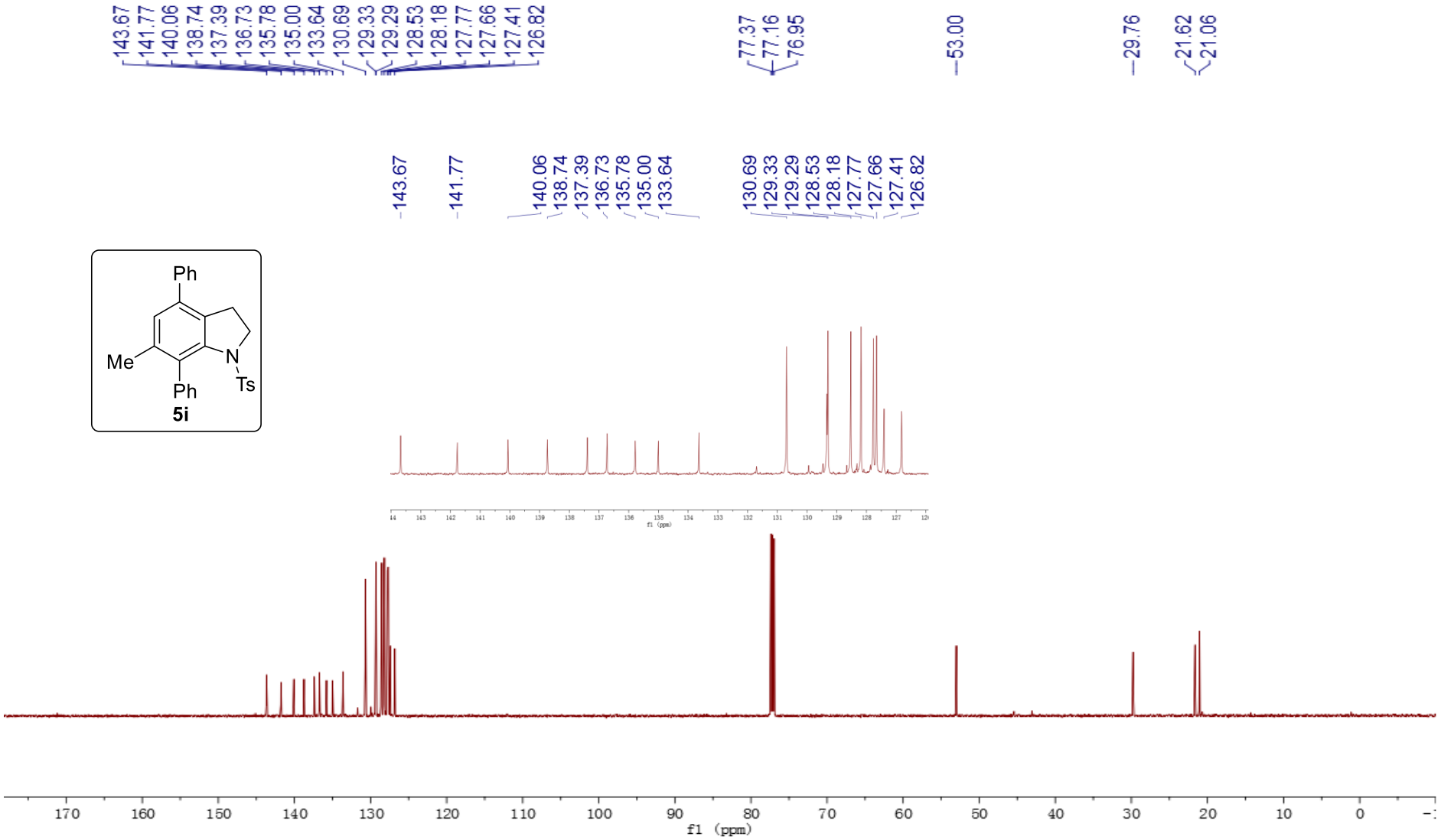

7.410
7.396
7.282
7.268
7.260
7.206
7.193
7.005
6.955
6.941
3.898
3.886
3.874
3.181
3.168
3.154
2.435
2.428
1.993
1.982
1.970
1.513
1.406
0.948
0.936
Cl
Me
N
Ts
Me
5g
1.99
2.03
2.00
1.02
1.98
2.00
2.01
2.93
2.86
2.09
2.16
2.35
3.07
f1 (ppm)

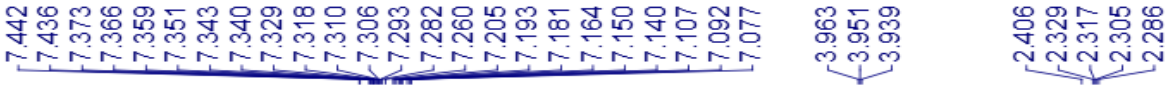

144.21
142.59
138.68
137.42
136.36
134.60
134.20
133.49
133.16
129.60
129.44
129.39
128.63
128.24
77.37
77.16
76.95
53.05
31.78
29.14
28.80
23.09
21.71
19.88
14.20
Cl
Me
N
Ts
Me
5g
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

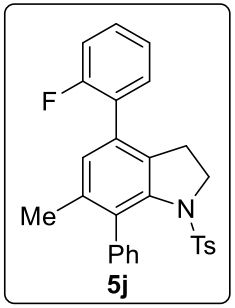

7.433
7.420
7.408
7.396
7.393
7.382
7.367
7.364
7.358
7.353
7.349
7.260
7.240
7.226
7.182
7.171
7.168
7.150
7.139
3.940
3.928
3.916
2.507
2.495
2.484
2.404
2.265
Cl
Me
N
Ts
Ph
5h
6.99
2.06
4.91
2.00
2.02
3.00
3.06
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.
f1 (ppm)


143.77
141.93
138.60
138.50
136.99
136.17
135.76
135.38
133.60
133.47
130.66
129.52
129.34
129.14
128.77
127.85
127.68
126.94
77.37
77.16
76.95
53.00
29.83
21.69
21.09
1.16
Cl
Me
Ph
N
Ts
5h
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

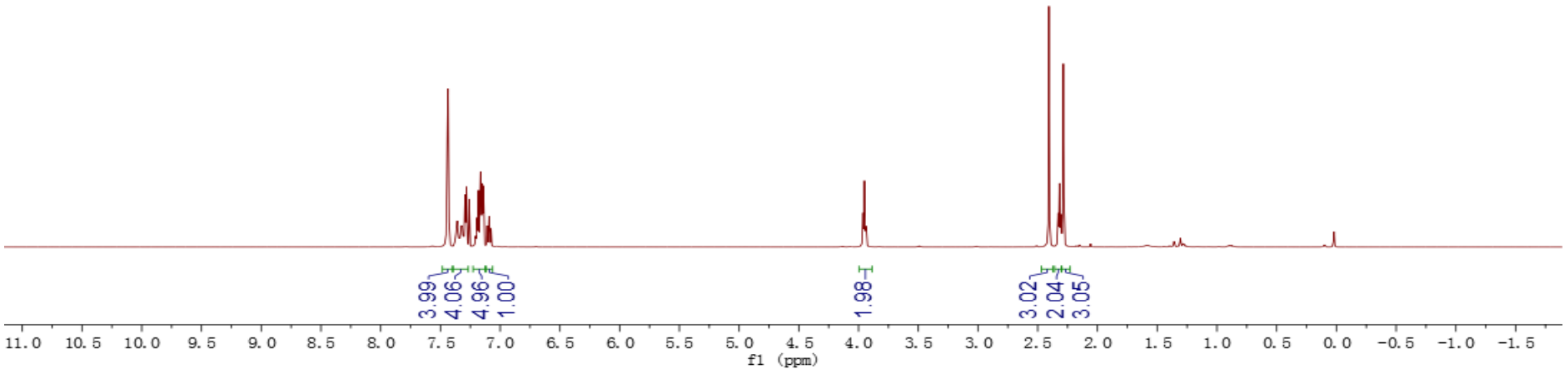

7.321
7.298
7.286
7.274
7.263
7.259
7.252
7.249
7.238
7.227
7.170
7.158
7.144
7.134
7.098
7.059
7.048
3.830
2.389
2.305
2.183
Ph
Me
N
Ts
Ph
5i
8.24
4.35
1.05
2.06
2.00
2.03
3.15
2.97
f1 (ppm)

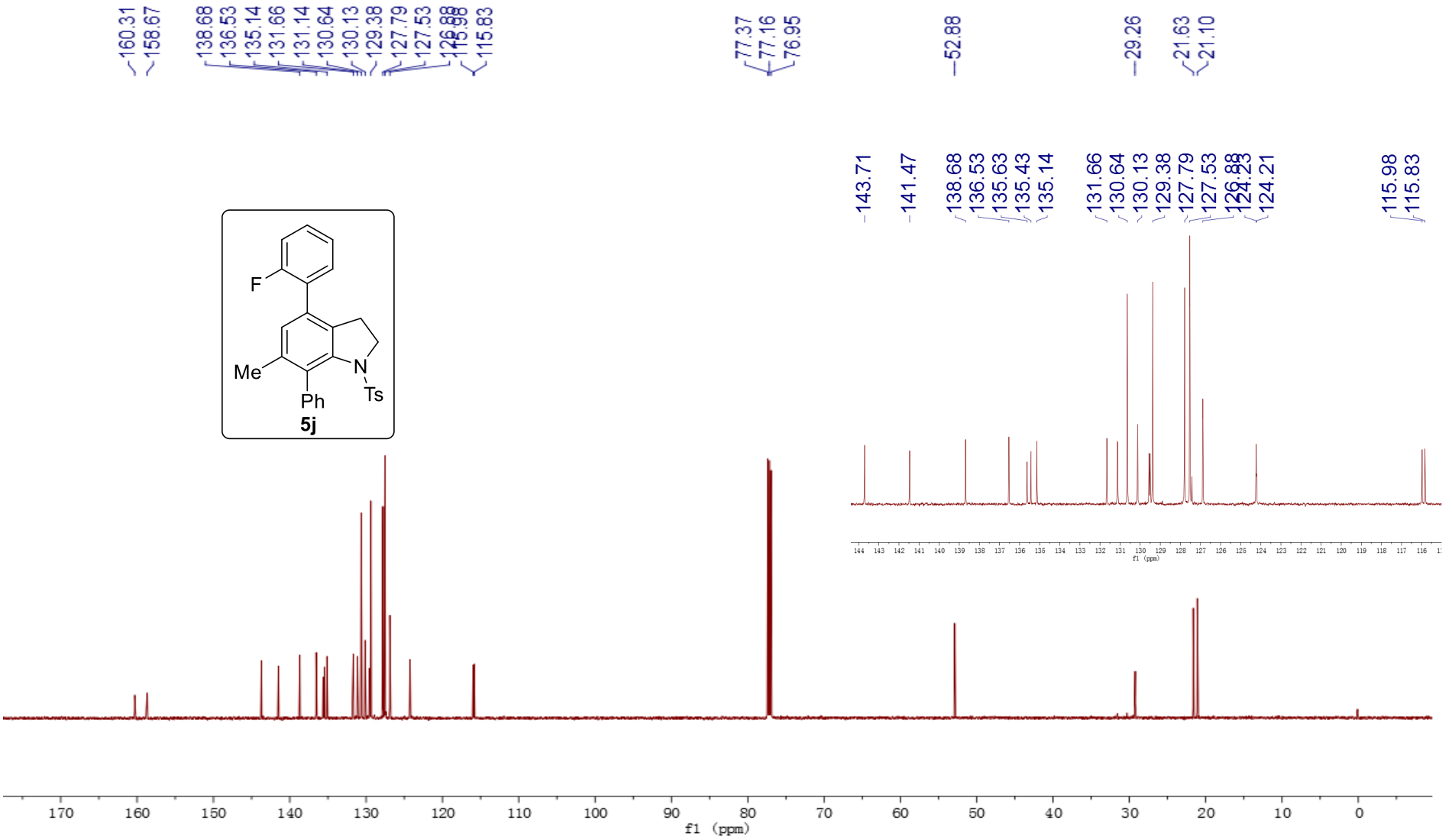

143.67
141.77
140.06
138.74
137.39
136.73
135.78
135.00
133.64
130.69
129.33
129.29
128.53
128.18
127.77
127.66
127.41
126.82
77.37
77.16
76.95
53.00
29.76
21.62
21.06
Ph
Me
N
Ts
Ph
5i
f1 (ppm)

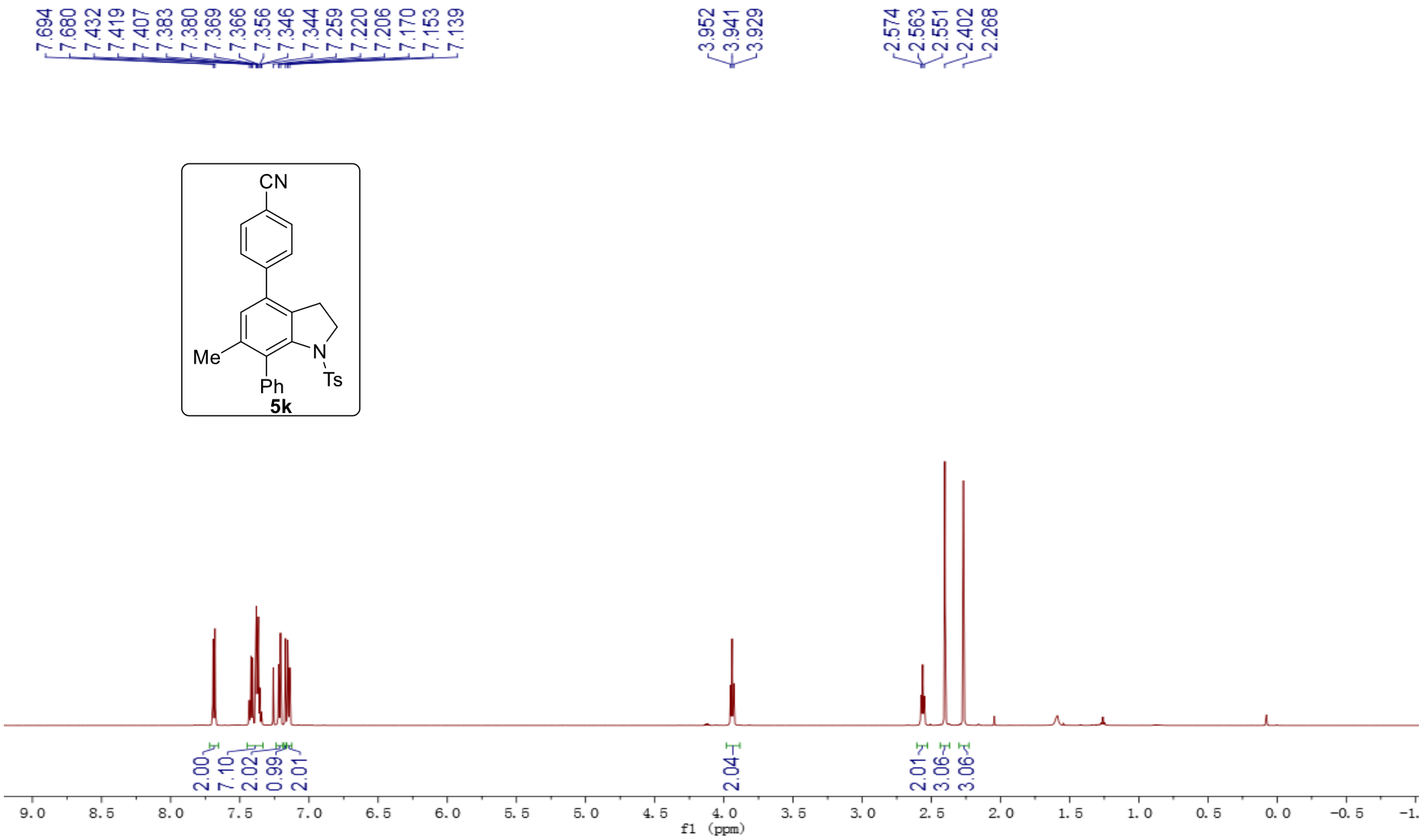

7.442
7.436
7.373
7.366
7.359
7.351
7.343
7.340
7.329
7.318
7.310
7.306
7.293
7.282
7.260
7.205
7.193
7.181
7.164
7.150
7.140
7.107
7.092
7.077
3.963
3.951
3.939
2.406
2.329
2.317
2.305
2.286

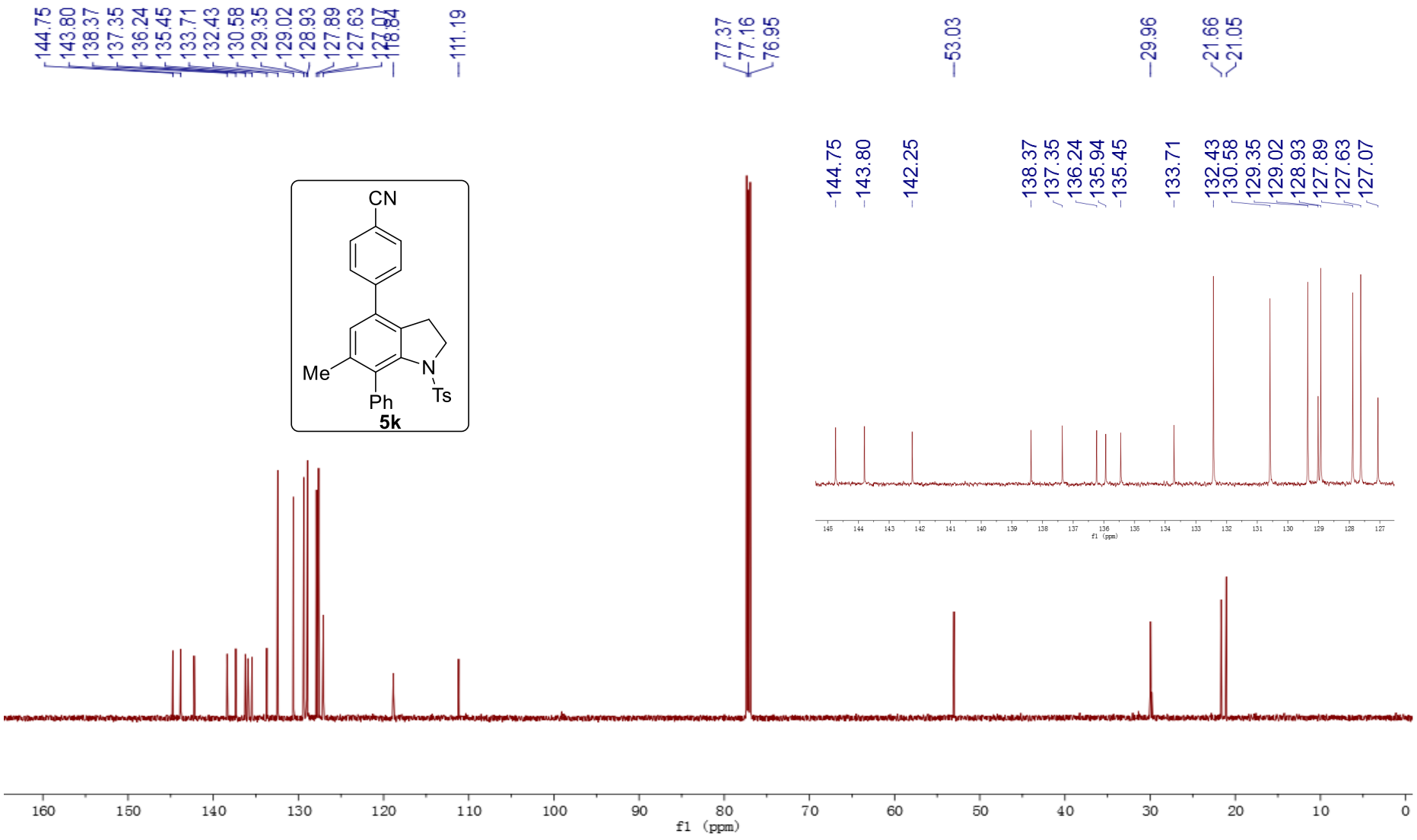

F
Me
N
Ts
Ph

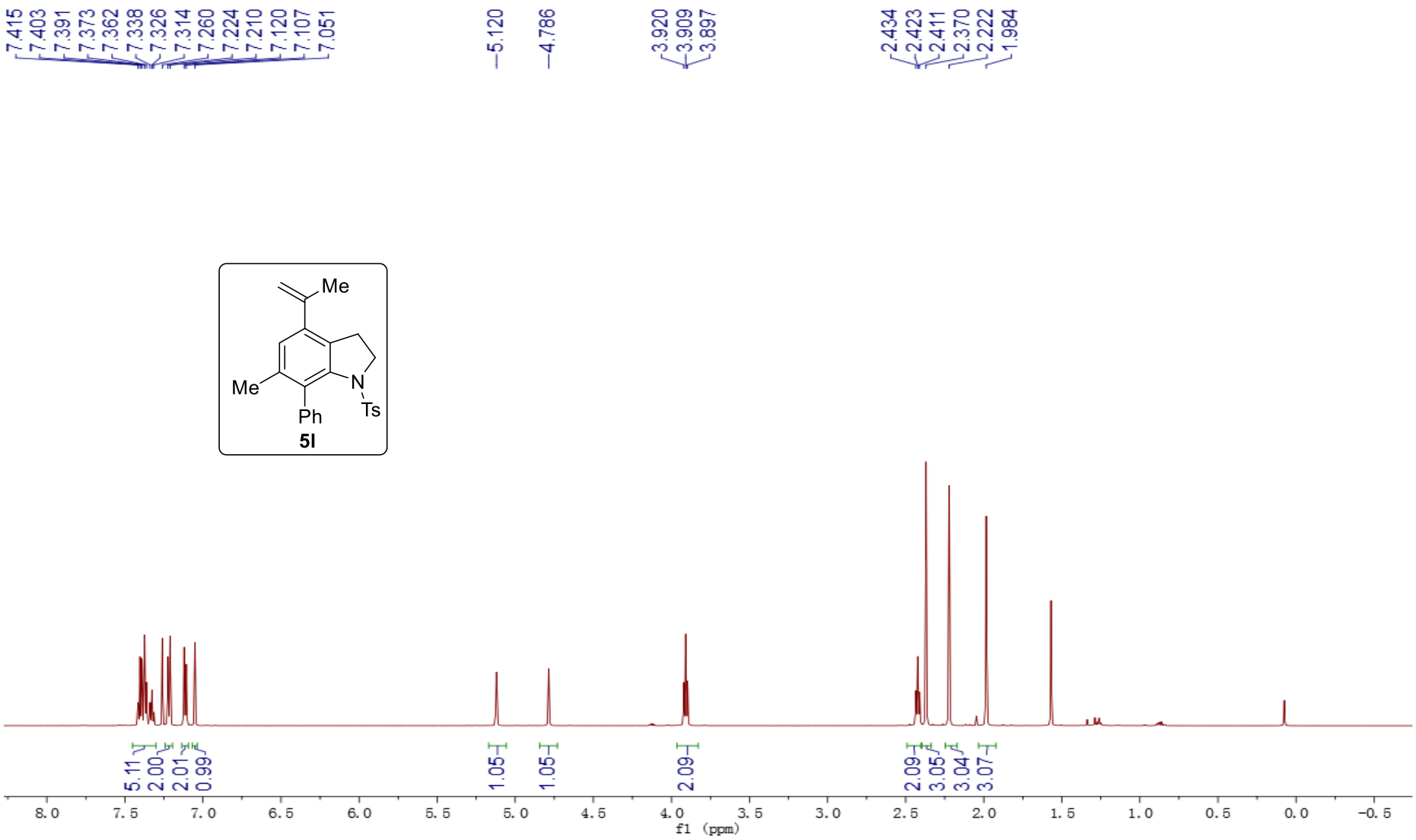
5j

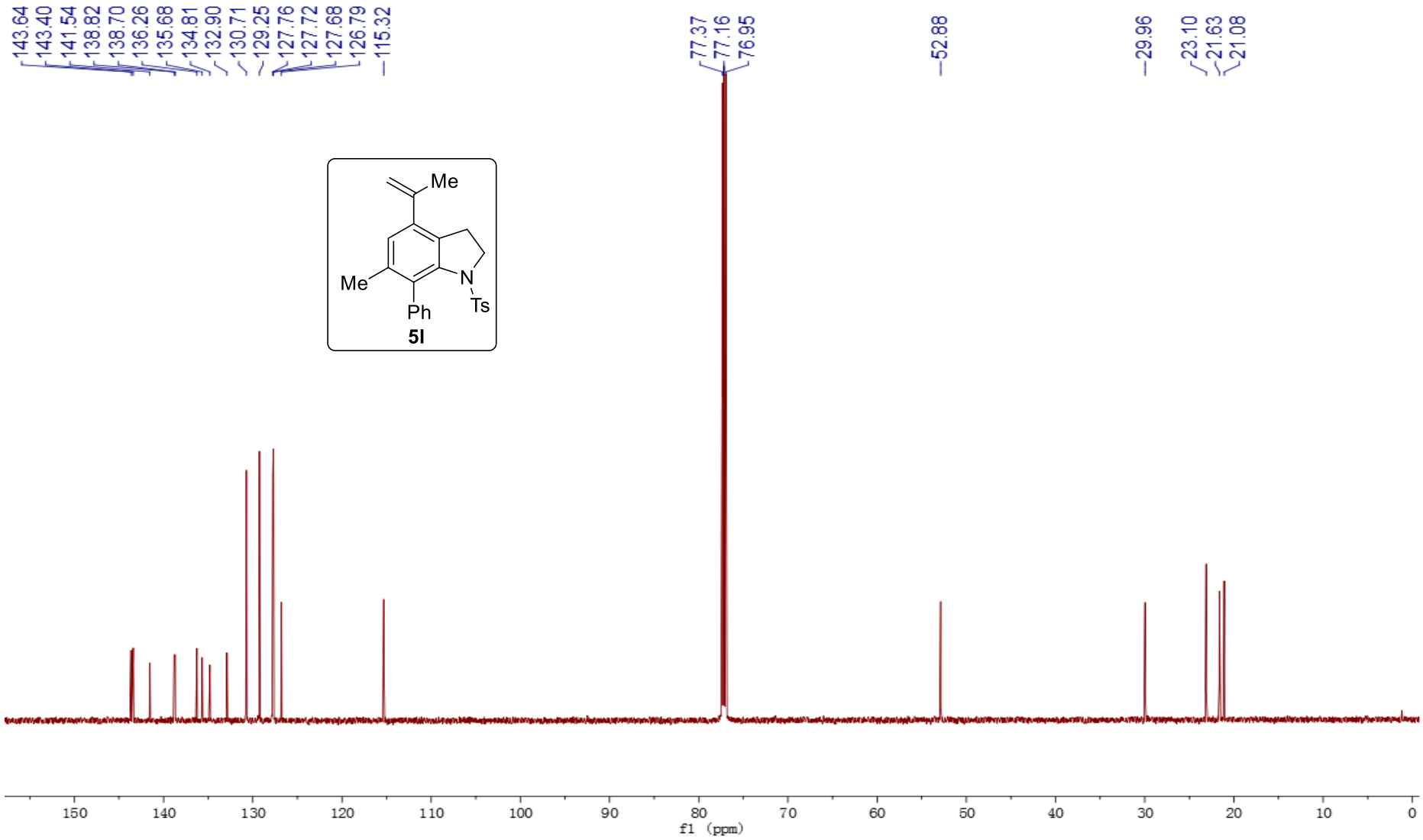

3.99
4.06
4.96
1.00
1.98
3.02
2.04
3.05
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
f1 (ppm)

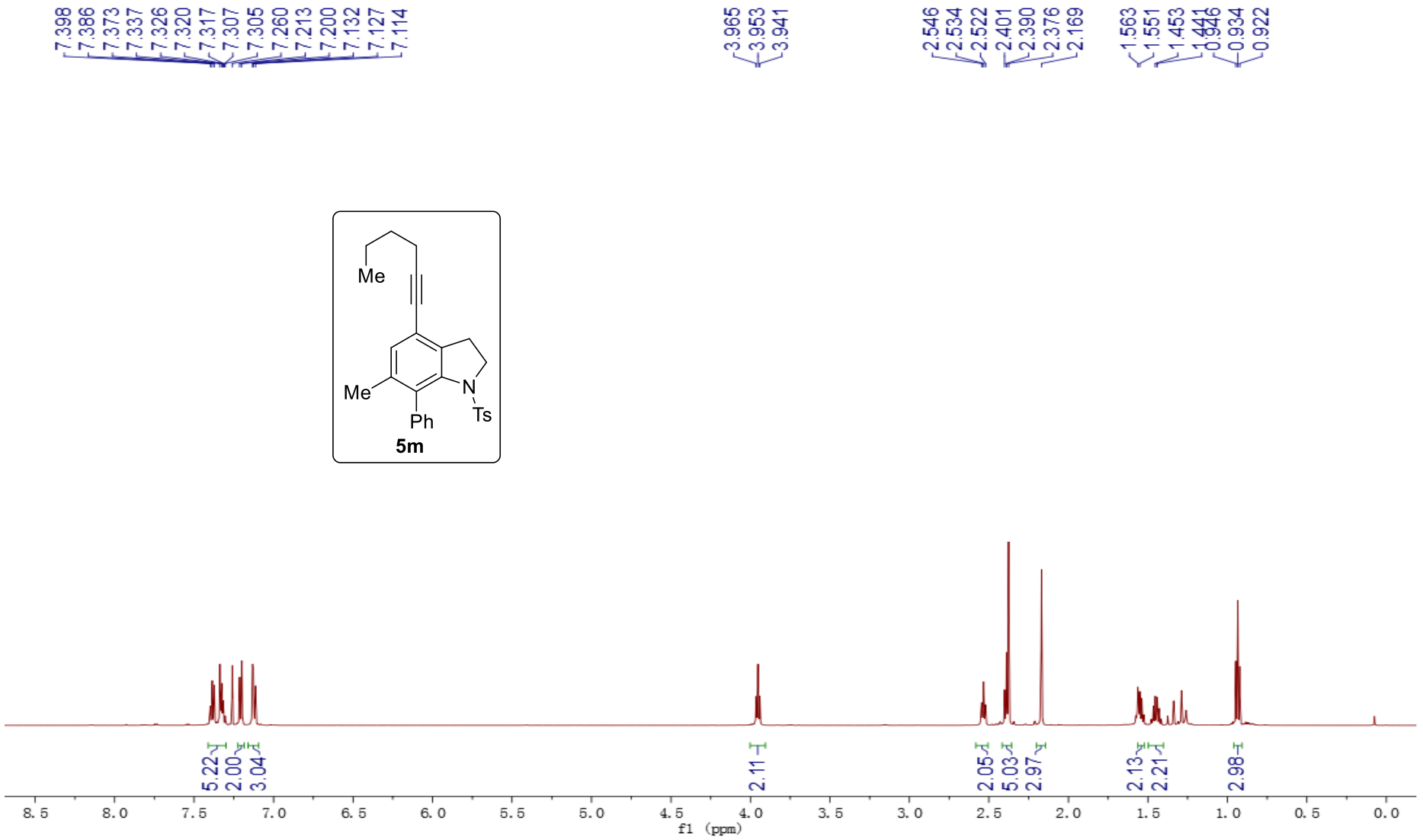

160.31
158.67
138.68
136.53
135.14
131.66
131.14
130.64
130.13
129.38
127.79
127.53
115.83
77.37
77.16
76.95
52.88
29.26
21.63
21.10
143.71
141.47
138.68
136.53
135.63
135.43
135.14
131.66
130.64
130.13
129.38
127.79
127.53
124.21
115.98
115.83
F
Me
N
Ts
Ph
5j
f1 (ppm)

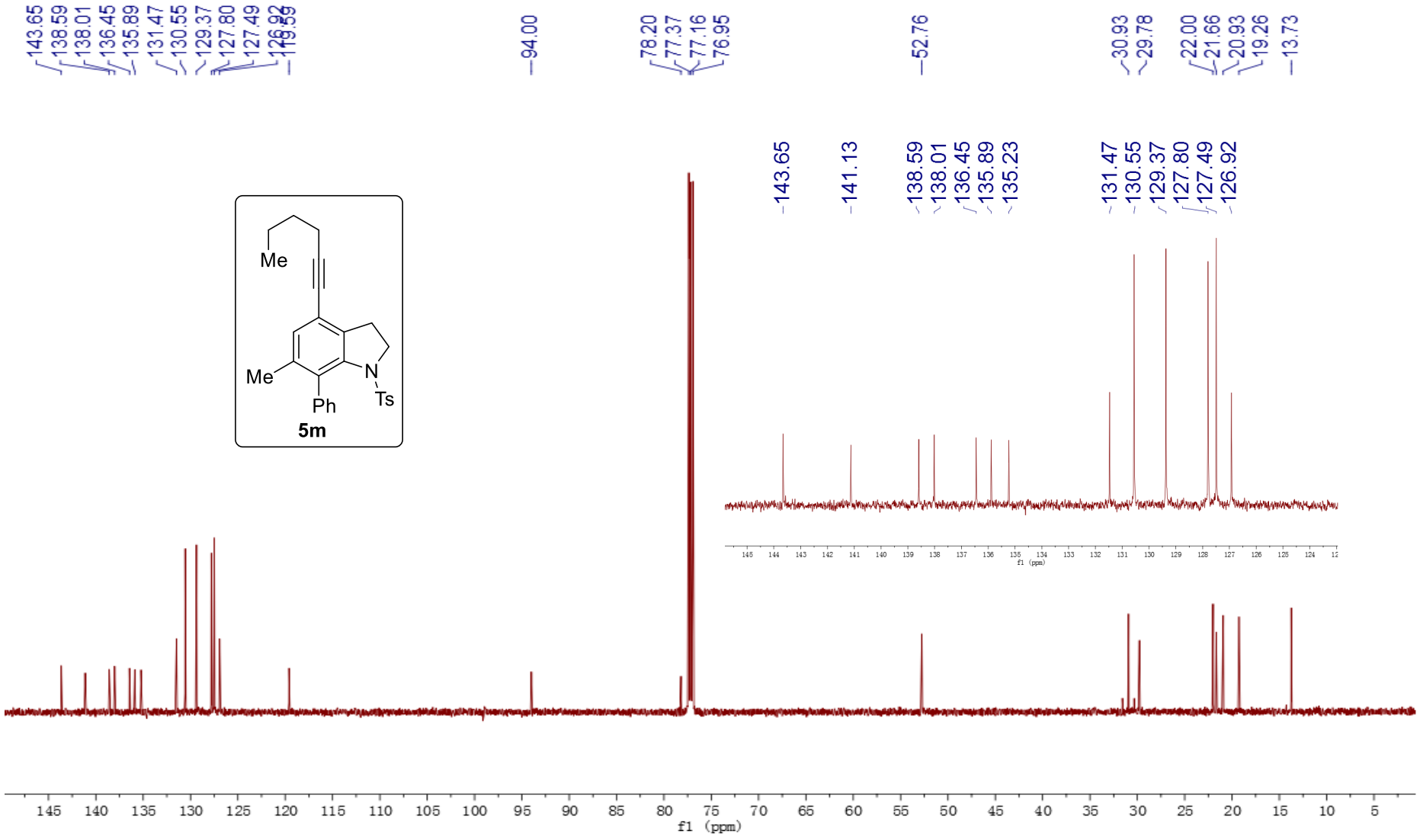

7.694
7.680
7.432
7.419
7.407
7.383
7.380
7.369
7.366
7.356
7.346
7.344
7.259
7.220
7.206
7.170
7.153
7.139
3.952
3.941
3.929
2.574
2.563
2.551
2.402
2.268
CN
Me
Ph
N
Ts
5k
2.00
7.10
2.02
0.99
2.01
2.04
2.01
3.06
3.06
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.
f1 (ppm)


144.75
143.80
138.37
137.35
136.24
135.45
133.71
132.43
130.58
129.35
129.02
128.93
127.89
127.63
127.07
111.19
77.37
77.16
76.95
53.03
29.96
21.66
21.05
CN
Me
N
Ts
Ph
5k
f1 (ppm)


7.415
7.403
7.391
7.373
7.362
7.338
7.326
7.314
7.260
7.224
7.210
7.120
7.107
7.051
5.120
4.786
3.920
3.909
3.897
2.434
2.423
2.411
2.370
2.222
1.984
Me
Me
N
Ts
Ph
5l
5.11
2.00
2.01
0.99
1.05
1.05
2.09
2.09
3.05
3.04
3.07
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

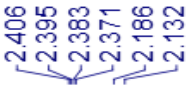

143.64
143.40
141.54
138.82
138.70
136.26
135.68
134.81
132.90
130.71
129.25
127.76
127.72
127.68
126.79
115.32
77.37
77.16
76.95
52.88
29.96
23.10
21.63
21.08
Me
Me
N
Ts
Ph
5l
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

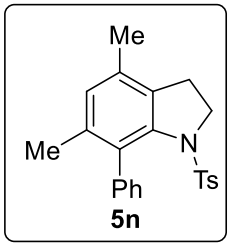

7.398
7.386
7.373
7.337
7.326
7.320
7.317
7.307
7.305
7.260
7.213
7.200
7.132
7.127
7.114
3.965
3.953
3.941
2.546
2.534
2.522
2.401
2.390
2.376
2.169
1.563
1.551
1.453
1.441
0.946
0.934
0.922
Me
Me
N
Ts
Ph
5m
5.22
2.00
3.04
2.11
2.05
5.03
2.97
2.13
2.21
2.98
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

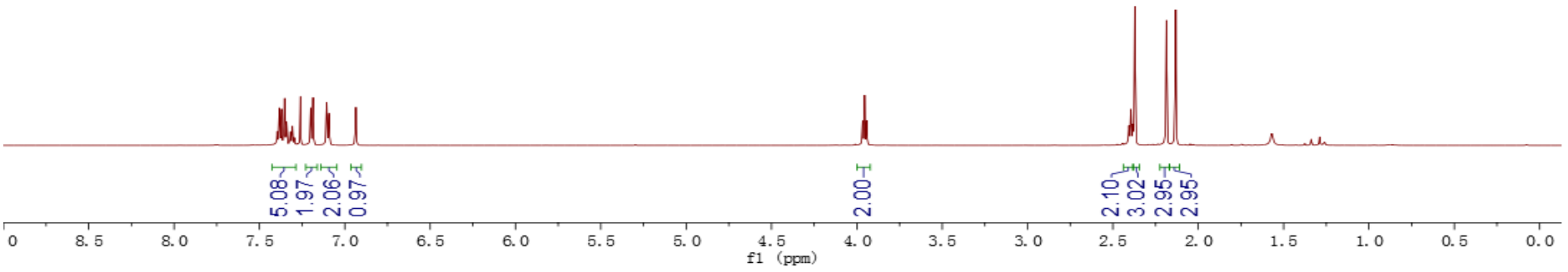

143.65
138.59
138.01
136.45
135.89
131.47
130.55
129.37
127.80
127.49
126.92
94.00
78.20
77.37
77.16
76.95
52.76
30.93
29.78
22.00
21.66
20.93
19.26
13.73
143.65
141.13
138.59
138.01
136.45
135.89
135.23
131.47
130.55
129.37
127.80
127.49
126.92
Me
Me
Ph
N
Ts
5m
f1 (ppm)

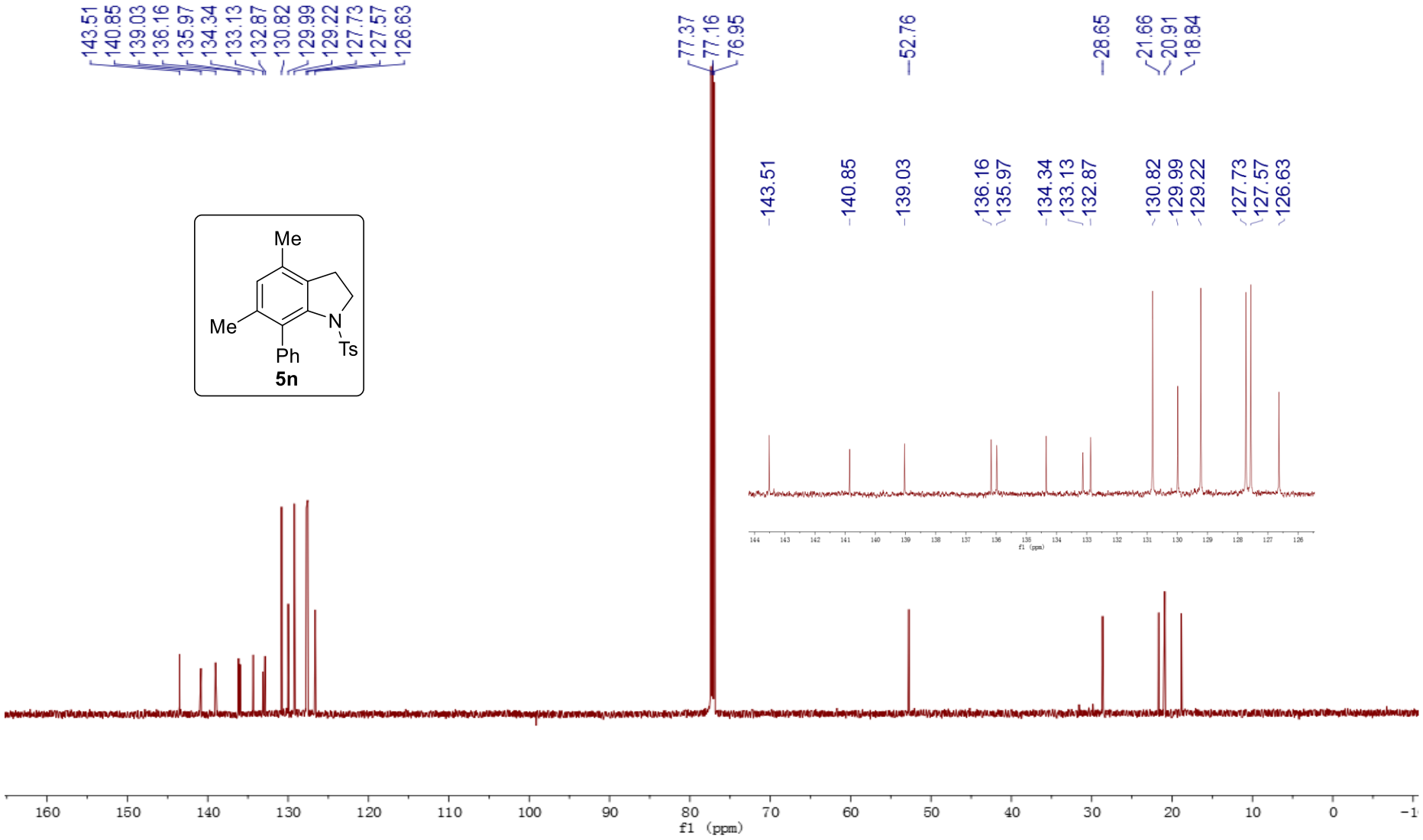

7.395
7.383
7.371
7.355
7.352
7.341
7.321
7.319
7.307
7.298
7.295
7.260
7.200
7.186
7.106
7.093
6.935

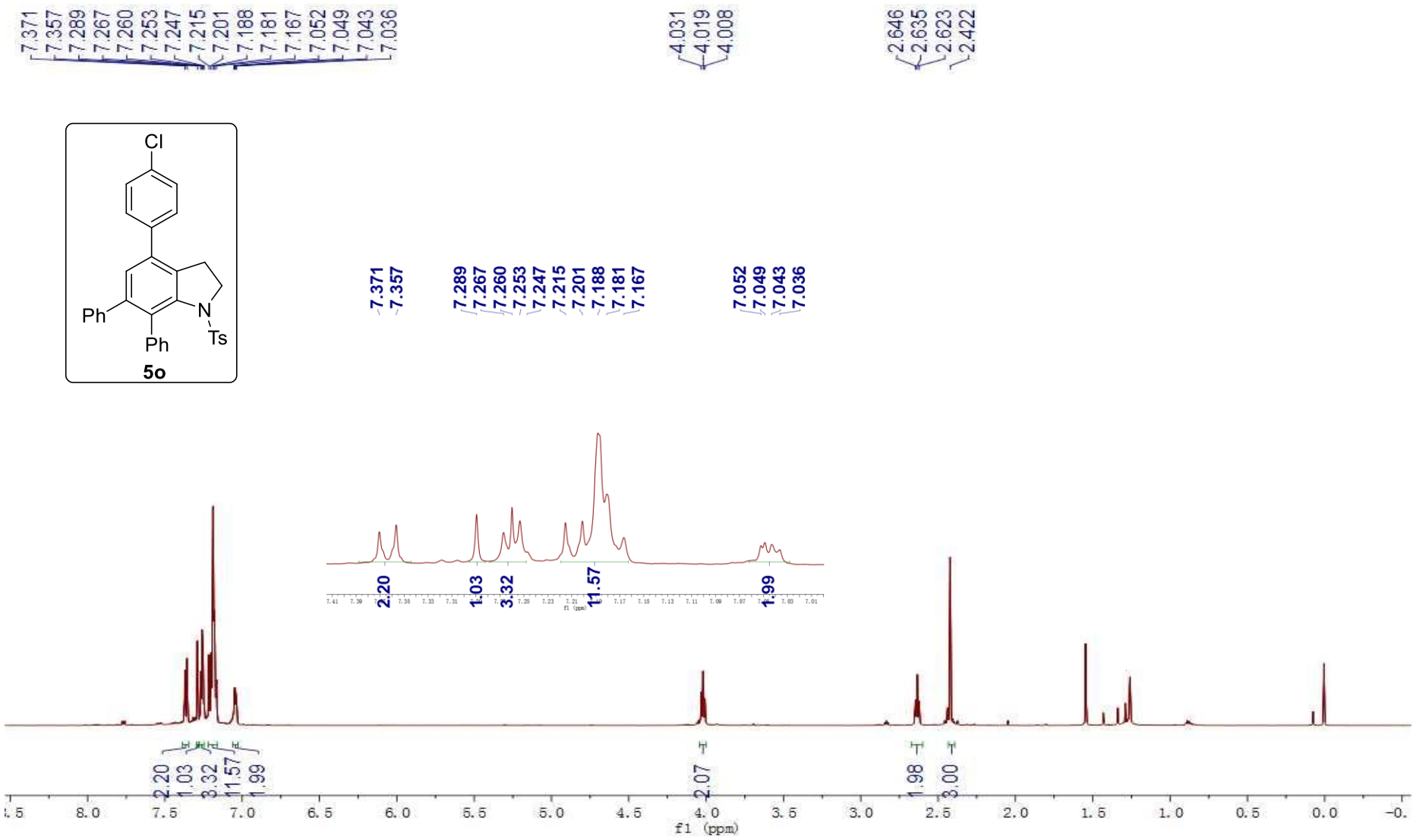

3.966
3.954
3.943

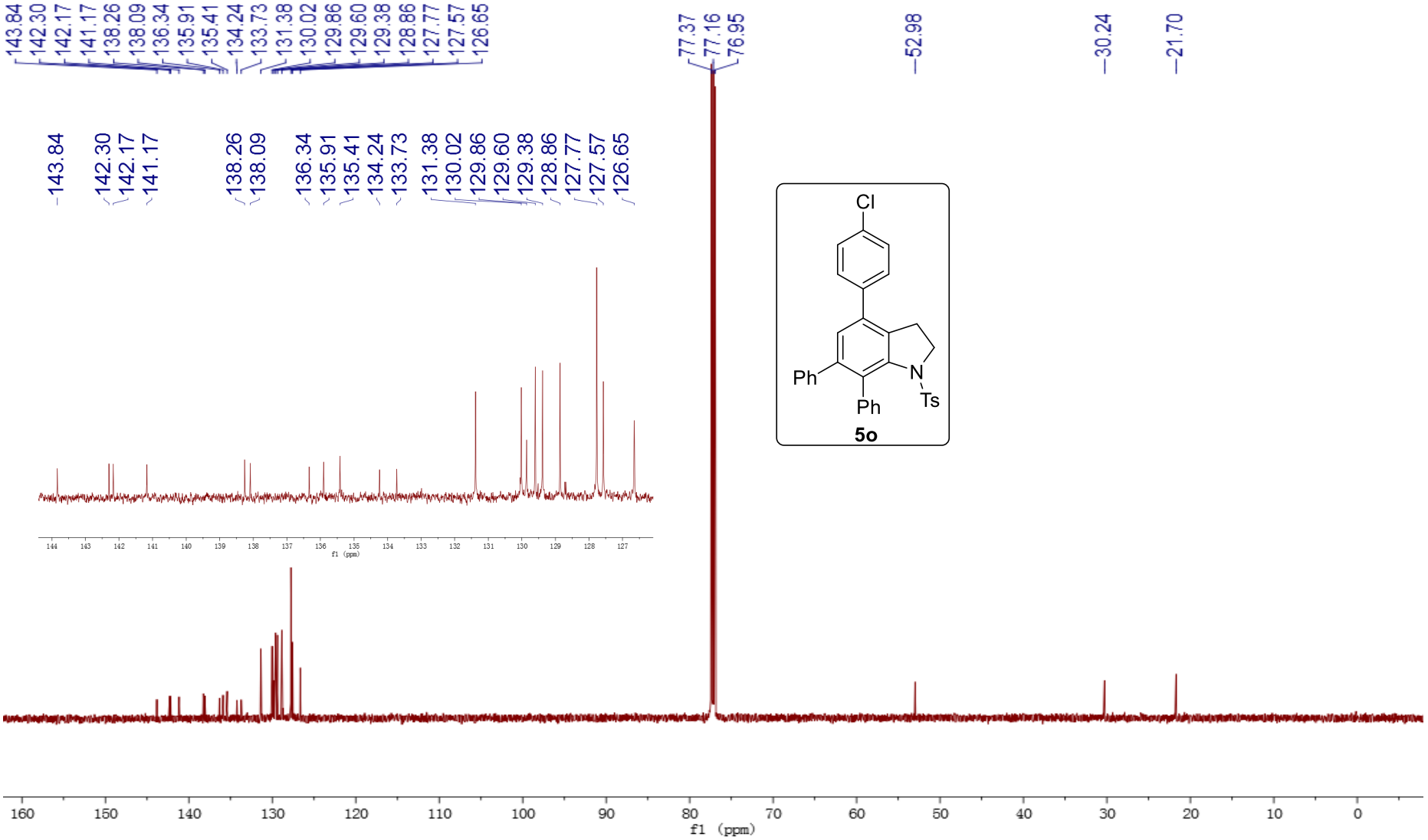

2.406
2.395
2.383
2.371
2.186
2.132

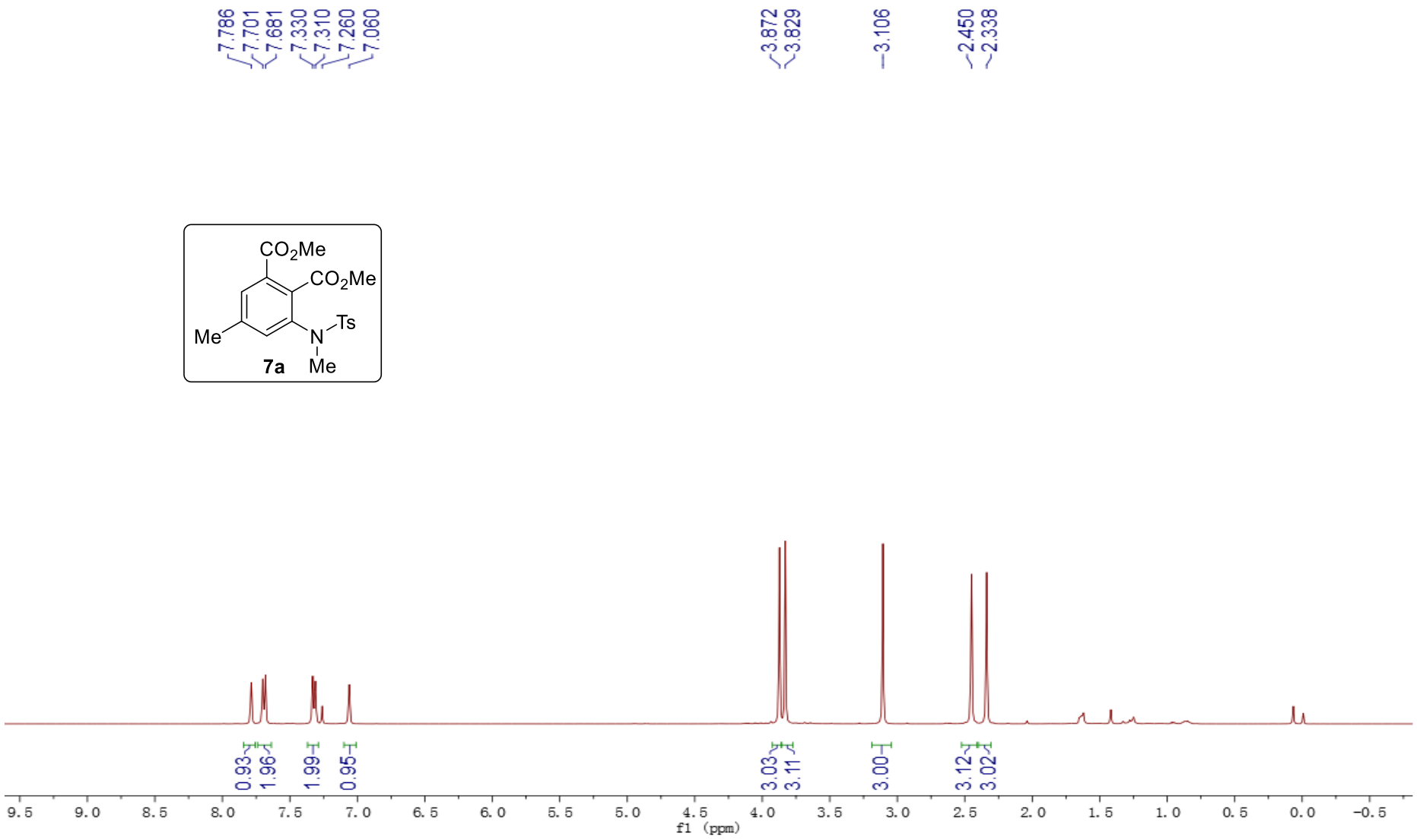

Me
Me
N
Ts
Ph
5n

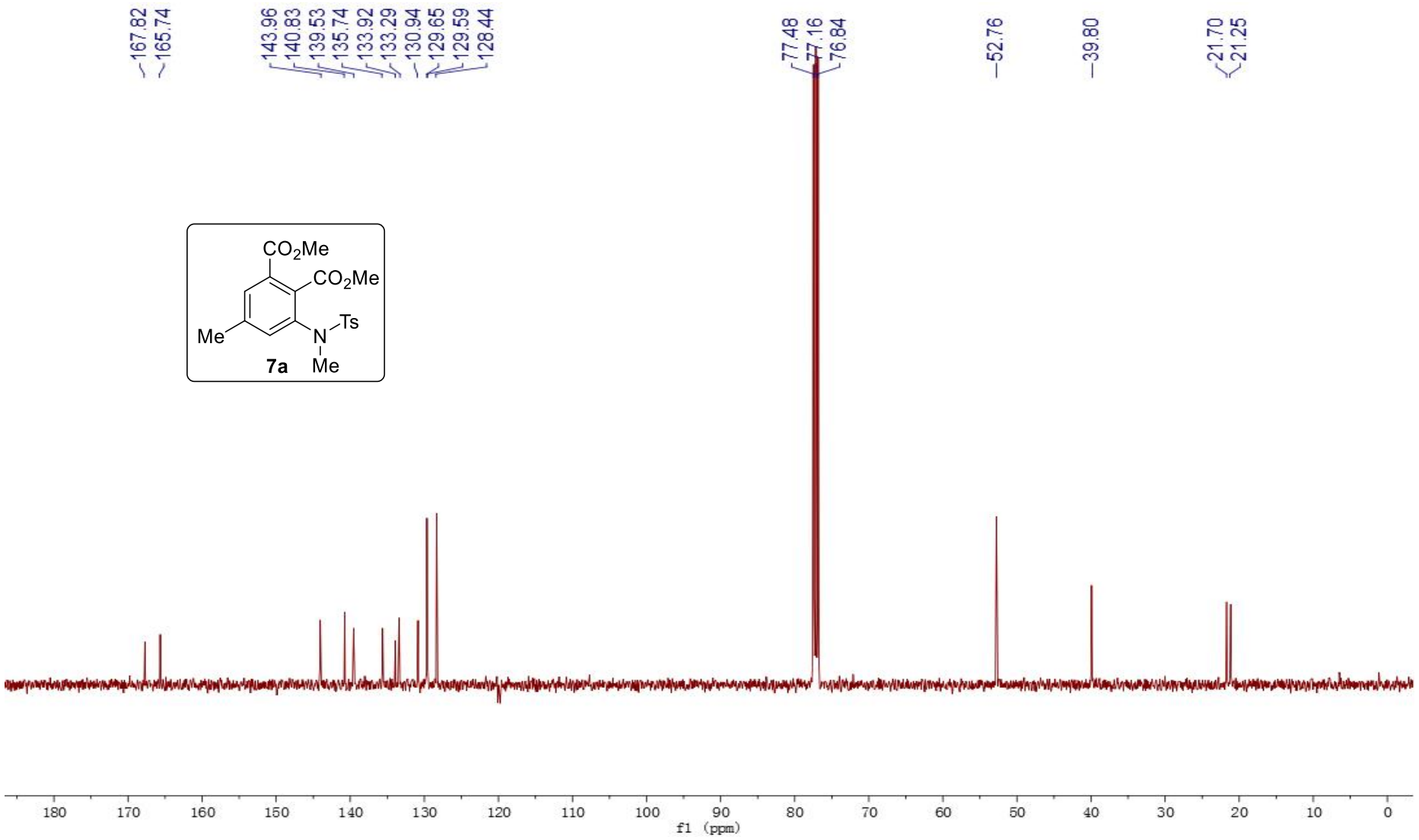

5.08
1.97
2.06
0.97
2.00
2.10
3.02
2.95
2.95
0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

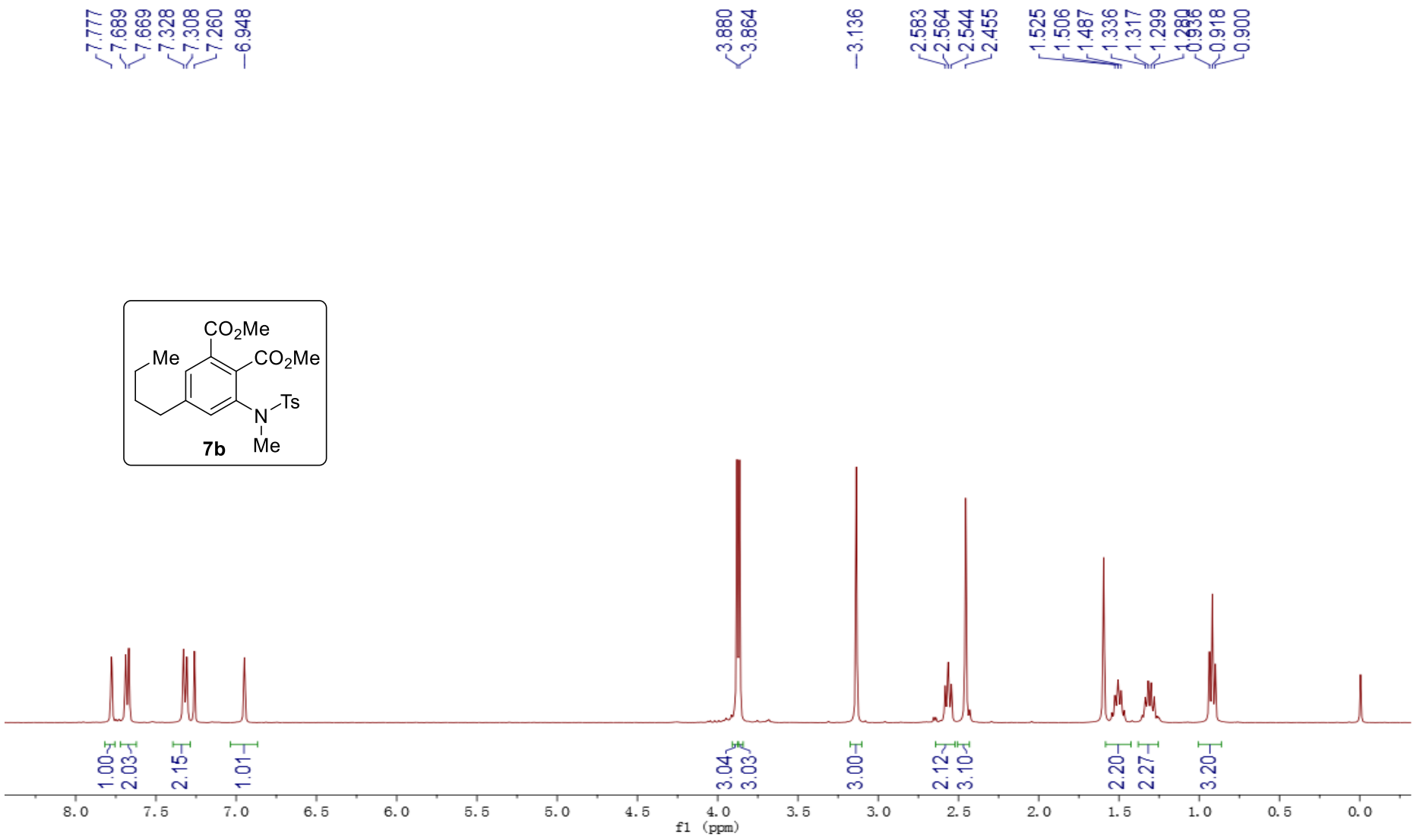

143.51
140.85
139.03
136.16
135.97
134.34
133.13
132.87
130.82
129.99
129.22
127.73
127.57
126.63
77.37
77.16
76.95
52.76
28.65
21.66
20.91
18.84
Me
Me
N
Ts
Ph
5n
f1 (ppm)

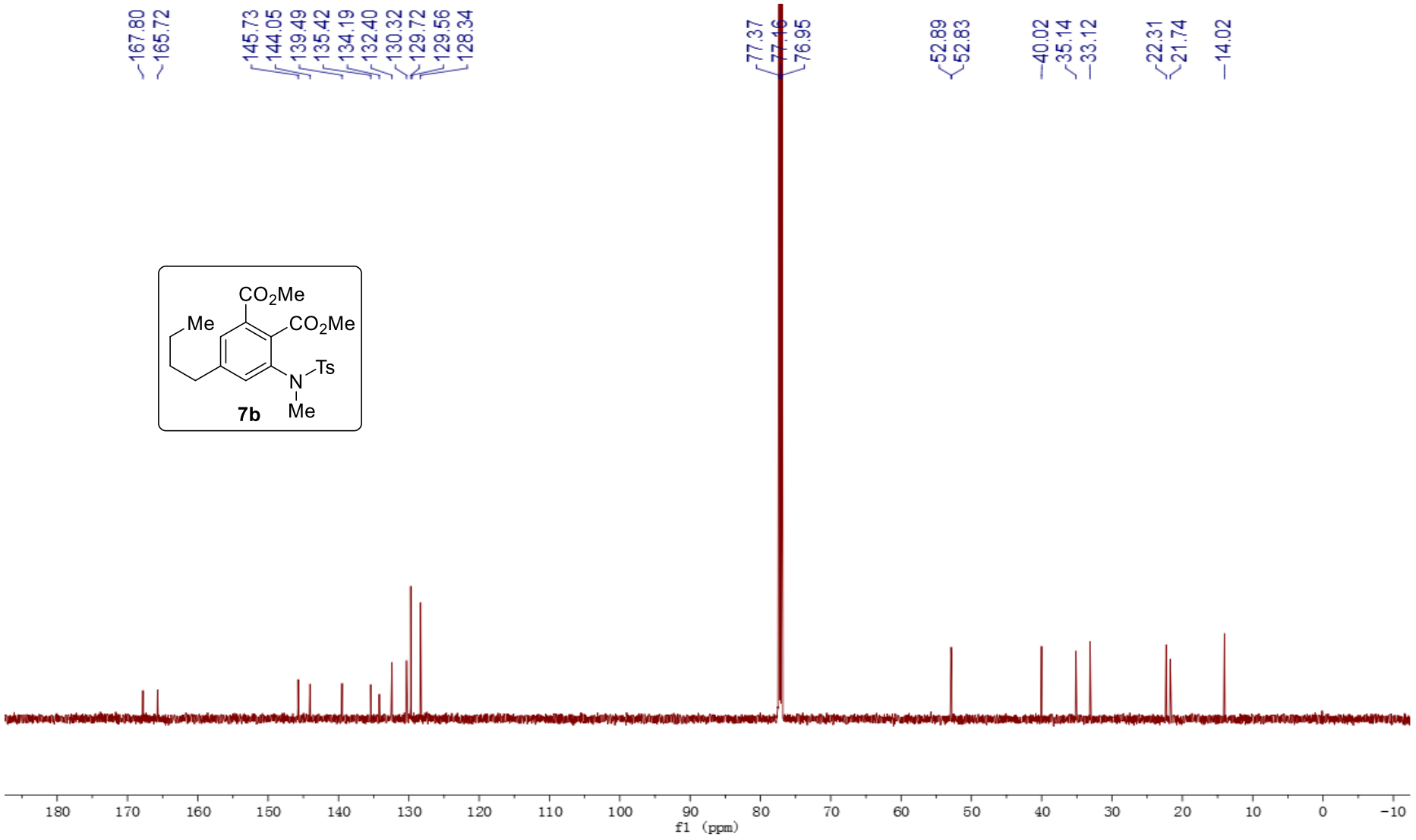

7.371
7.357
7.289
7.267
7.260
7.253
7.247
7.215
7.201
7.188
7.181
7.167
7.052
7.049
7.043
7.036
4.031
4.019
4.008
2.646
2.635
2.623
2.422
Cl
Ph
Ph
N
Ts
5o
2.20
1.03
3.32
11.57
1.99
2.07
1.98
3.00
f1 (ppm)

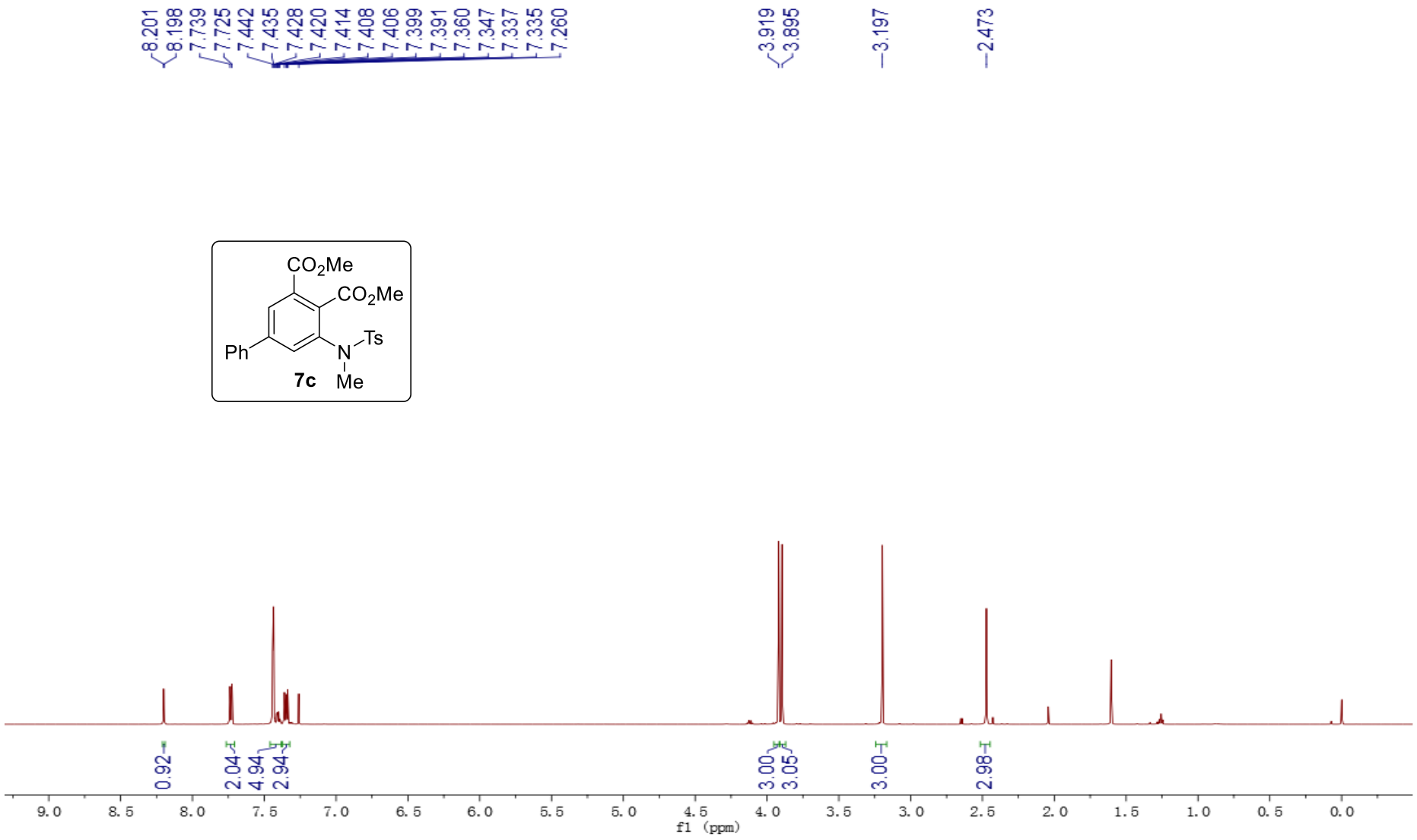

143.84
142.30
142.17
141.17
138.26
138.09
136.34
135.91
135.41
134.24
133.73
131.38
130.02
129.86
129.60
129.38
128.86
127.77
127.57
126.65
77.37
77.16
76.95
52.98
30.24
21.70
Cl
Ph
Ph
N
Ts
5o
f1 (ppm)

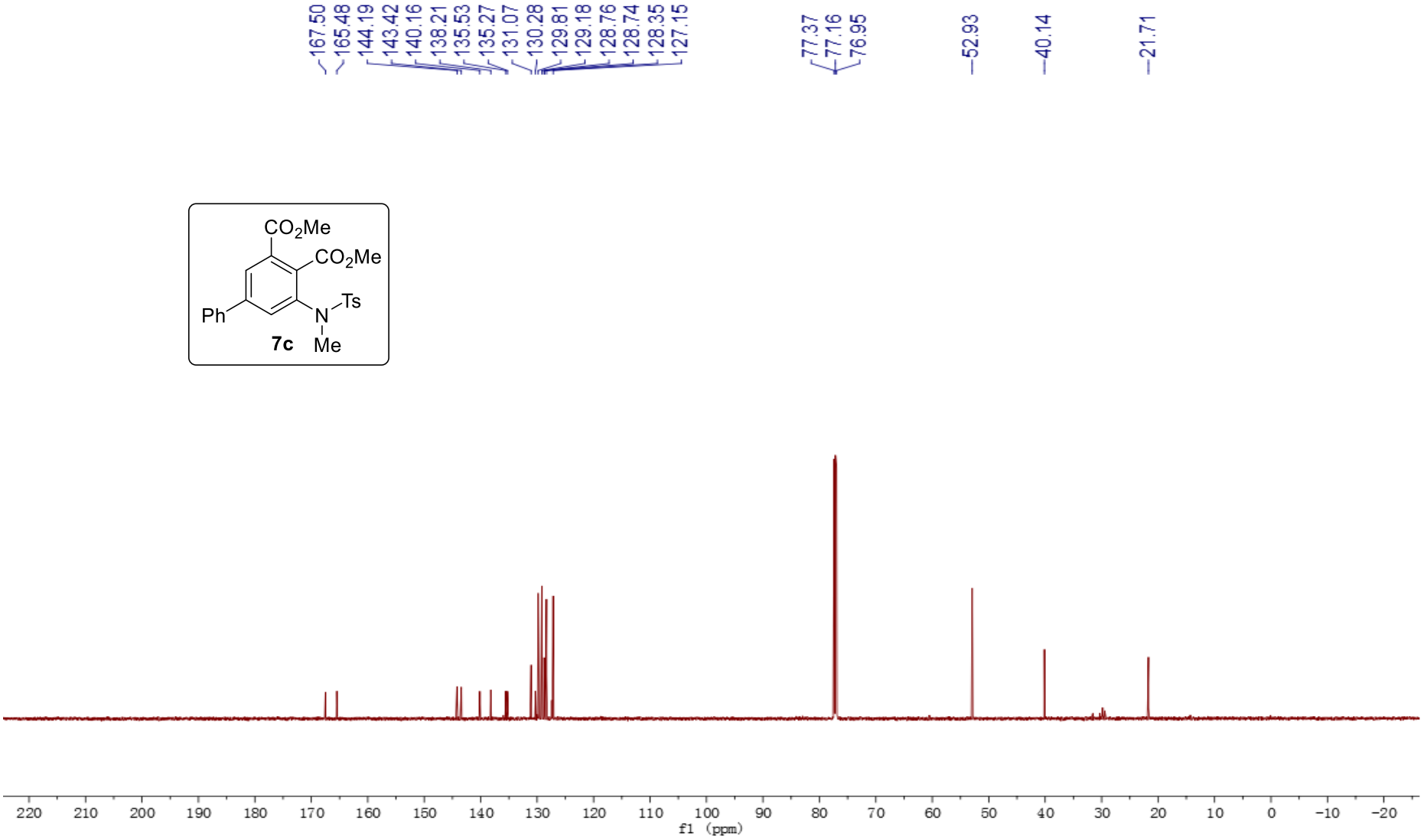

7.786
7.701
7.681
7.330
7.310
7.260
7.060
3.872
3.829
3.106
2.450
2.338
CO2Me
CO2Me
Me
N
Ts
Me
7a
0.93
1.96
1.99
0.95
3.03
3.11
3.00
3.12
3.02
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

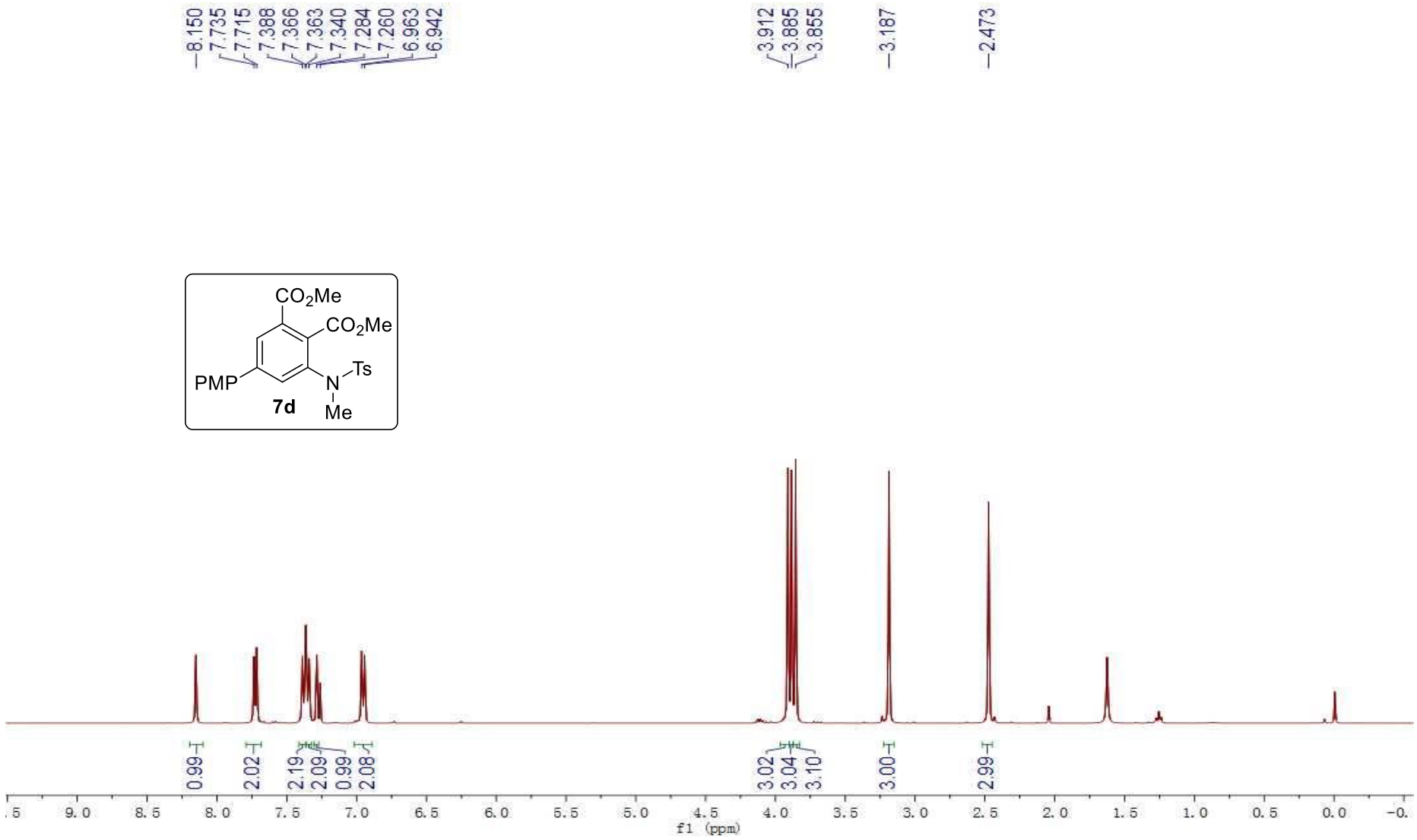

167.82
165.74
143.96
140.83
139.53
135.74
133.92
133.29
130.94
129.65
129.59
128.44
77.48
77.16
76.84
52.76
39.80
21.70
21.25
CO2Me
CO2Me
Me
N
Ts
Me
7a
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

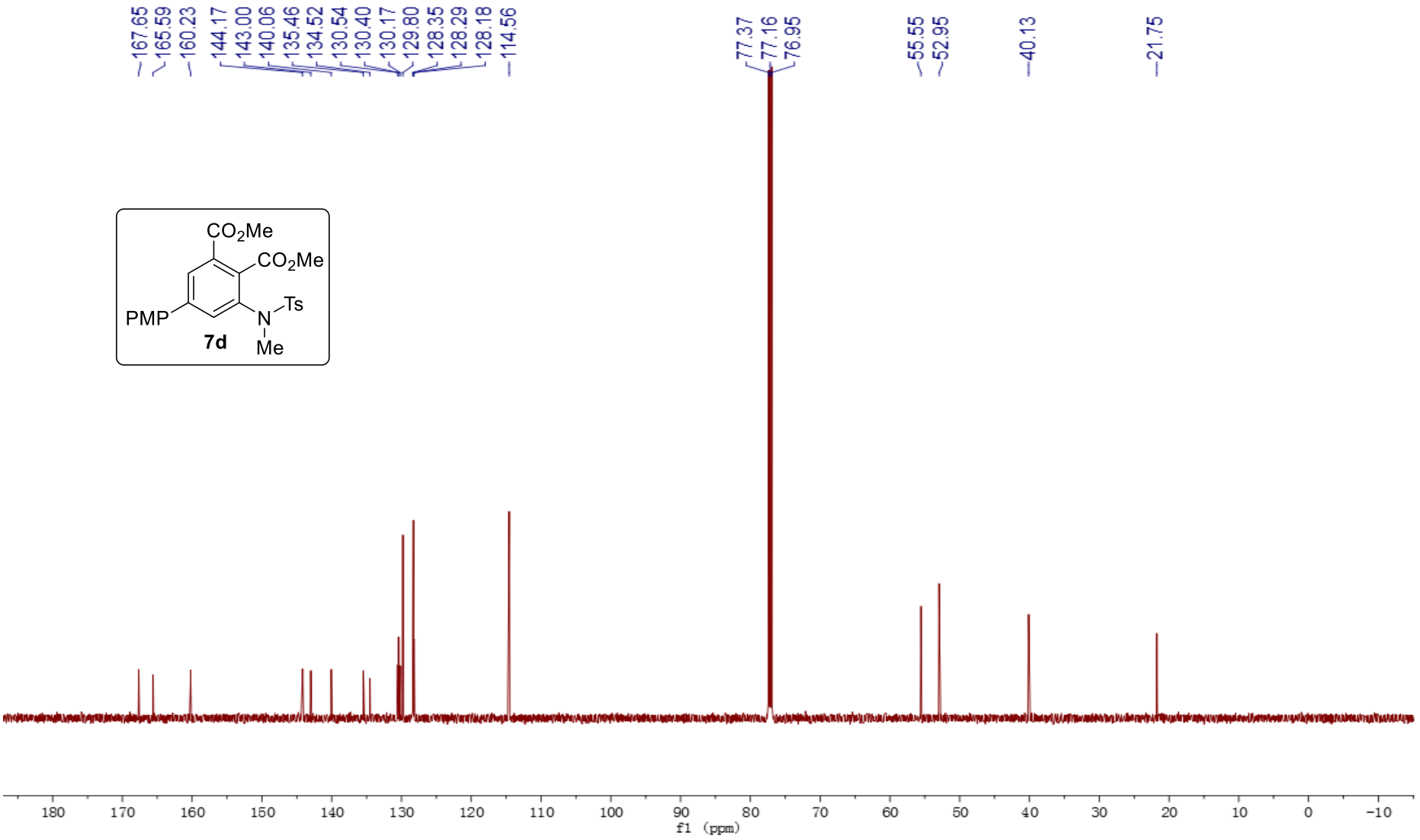

7.777
7.689
7.669
7.328
7.308
7.260
6.948
3.880
3.864
3.136
2.583
2.564
2.544
2.455
1.525
1.506
1.487
1.336
1.317
1.299
0.938
0.918
0.900
CO2Me
Me
CO2Me
Ts
N
Me
7b
1.00
2.03
2.15
1.01
3.04
3.03
3.00
2.12
3.10
2.20
2.27
3.20
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

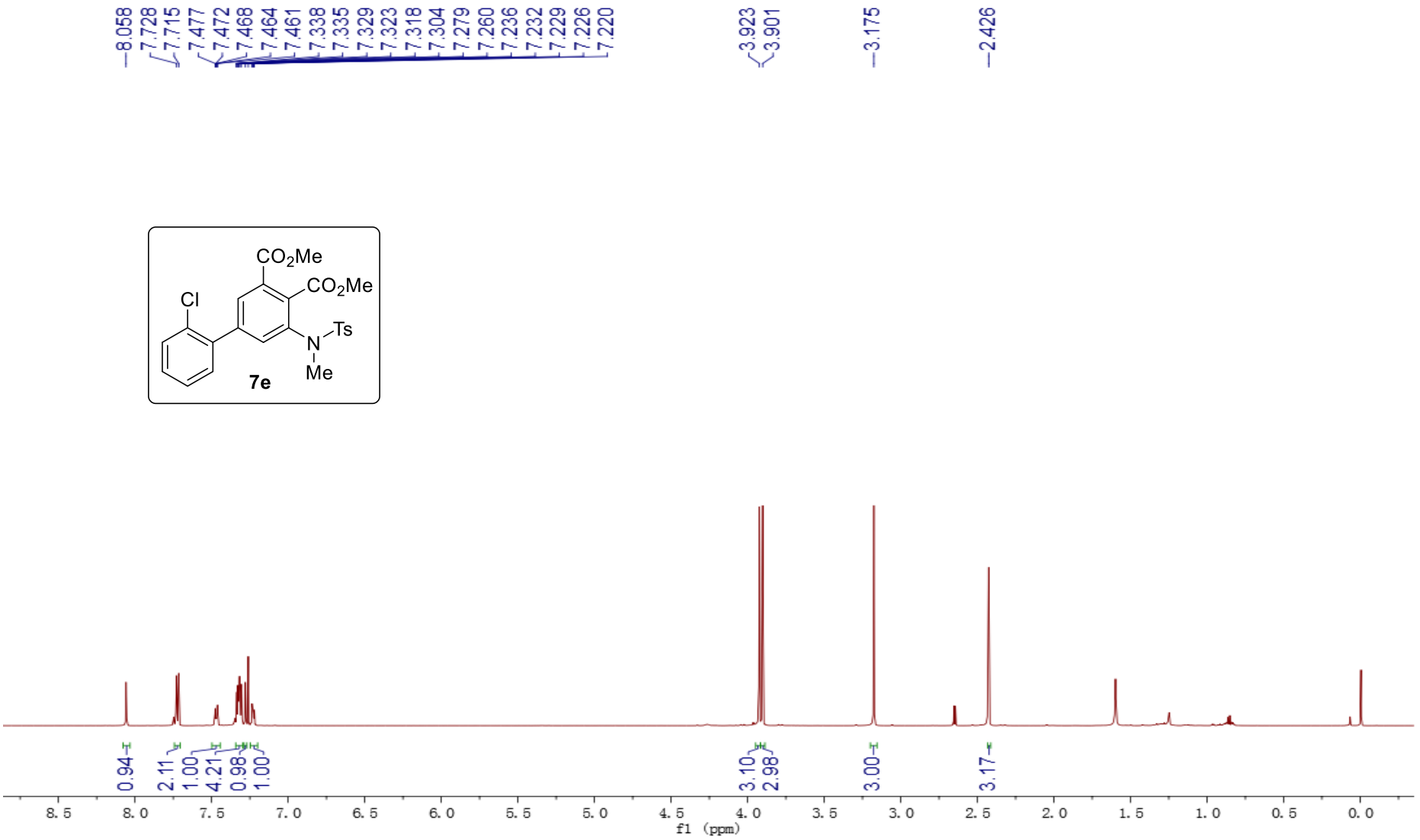

167.80
165.72
145.73
144.05
139.49
135.42
134.19
132.40
130.32
129.72
129.56
128.34
77.37
77.16
76.95
52.89
52.83
40.02
35.14
33.12
22.31
21.74
14.02
CO2Me
Me
CO2Me
Ts
N
Me
7b
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)

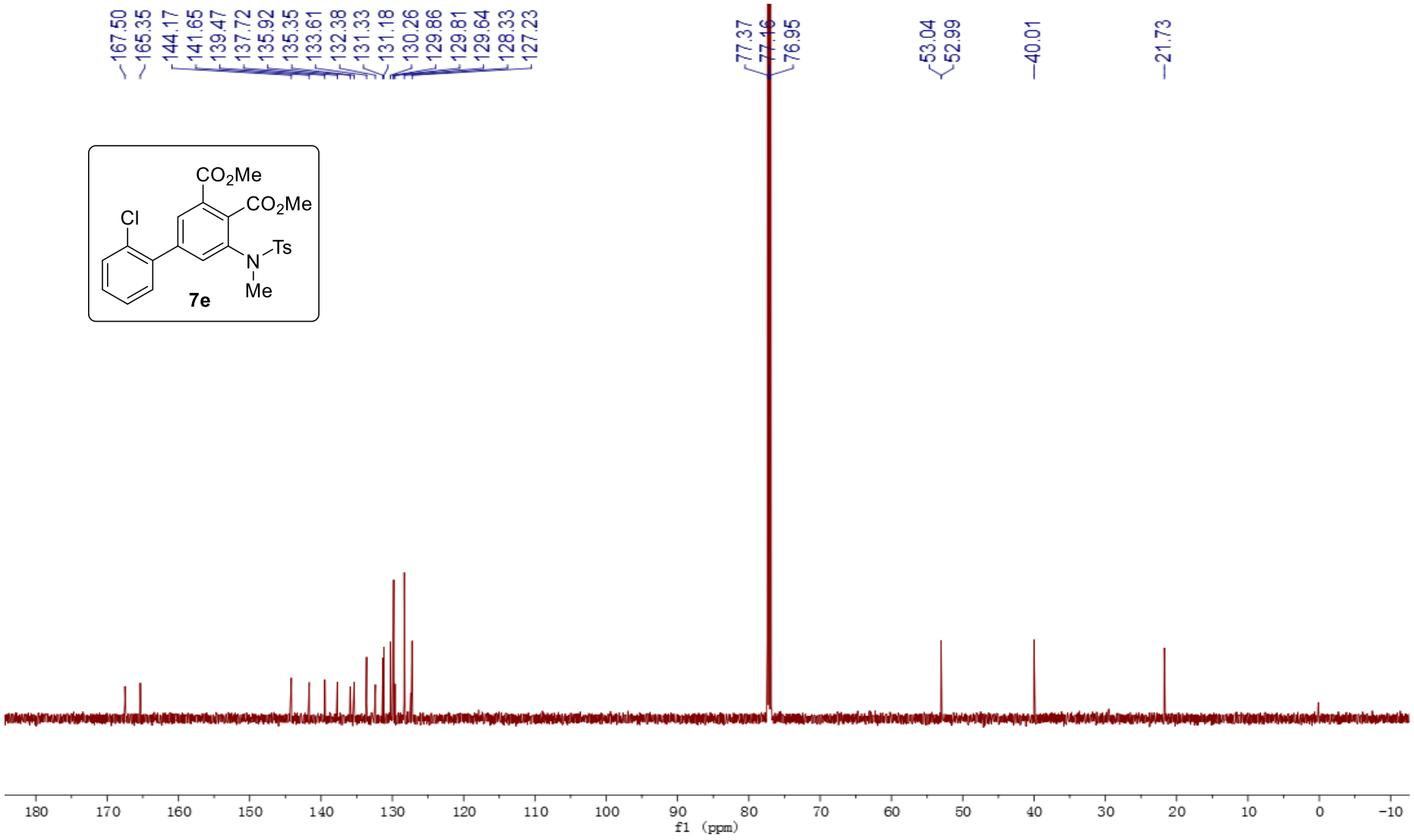

8.201
8.198
7.739
7.725
7.442
7.435
7.428
7.420
7.414
7.408
7.406
7.399
7.391
7.360
7.347
7.337
7.335
7.260
3.919
3.895
3.197
2.473
CO2Me
CO2Me
Ph
N
Ts
Me
7c
0.92
2.04
4.94
2.94
3.00
3.05
3.00
2.98
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


167.50
165.48
144.19
143.42
140.16
138.21
135.53
135.27
131.07
130.28
129.81
129.18
128.76
128.74
128.35
127.15
77.37
77.16
76.95
52.93
40.14
21.71
CO2Me
CO2Me
Ph
N
Ts
Me
7c
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
f1 (ppm)

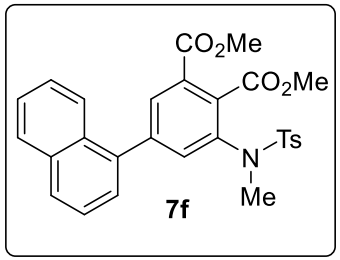

8.150
7.735
7.715
7.388
7.366
7.363
7.340
7.284
7.260
6.963
6.942
3.912
3.885
3.855
3.187
2.473
CO2Me
CO2Me
PMP
N
Ts
Me
7d
0.99
2.02
2.19
2.09
0.99
2.08
3.02
3.04
3.10
3.00
2.99
f1 (ppm)


167.65
165.59
160.23
144.17
143.00
140.06
135.46
134.52
130.54
130.40
130.17
129.80
128.35
128.29
128.18
114.56
77.37
77.16
76.95
55.55
52.95
40.13
21.75
CO2Me
CO2Me
PMP
N
Ts
Me
7d
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

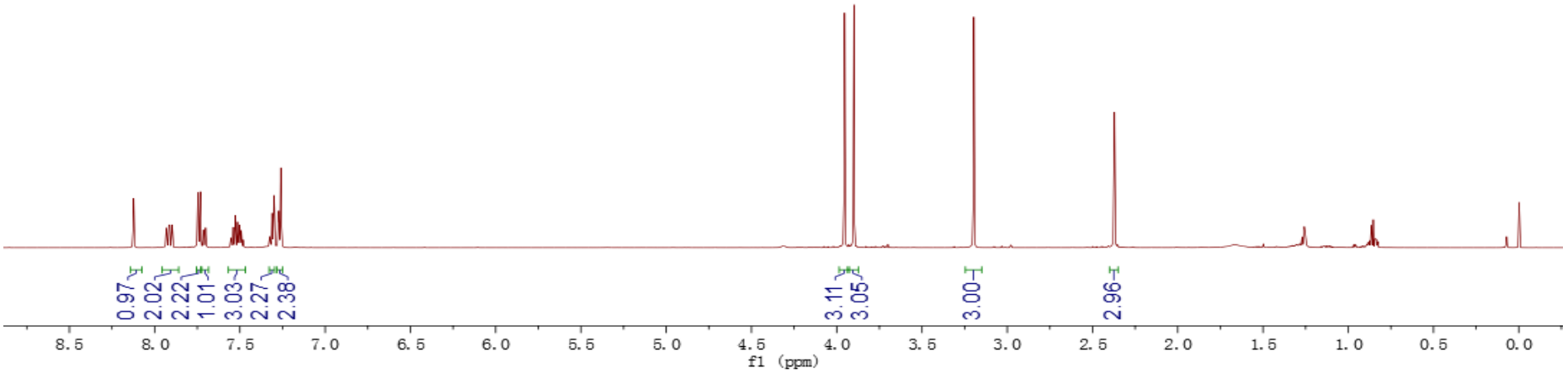

8.058
7.728
7.715
7.477
7.472
7.468
7.464
7.461
7.338
7.335
7.329
7.323
7.318
7.304
7.279
7.260
7.236
7.232
7.229
7.226
7.220
3.923
3.901
3.175
2.426
CO2Me
CO2Me
Cl
Ts
N
Me
7e
0.94
2.11
1.00
4.21
0.98
1.00
3.10
2.98
3.00
3.17
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

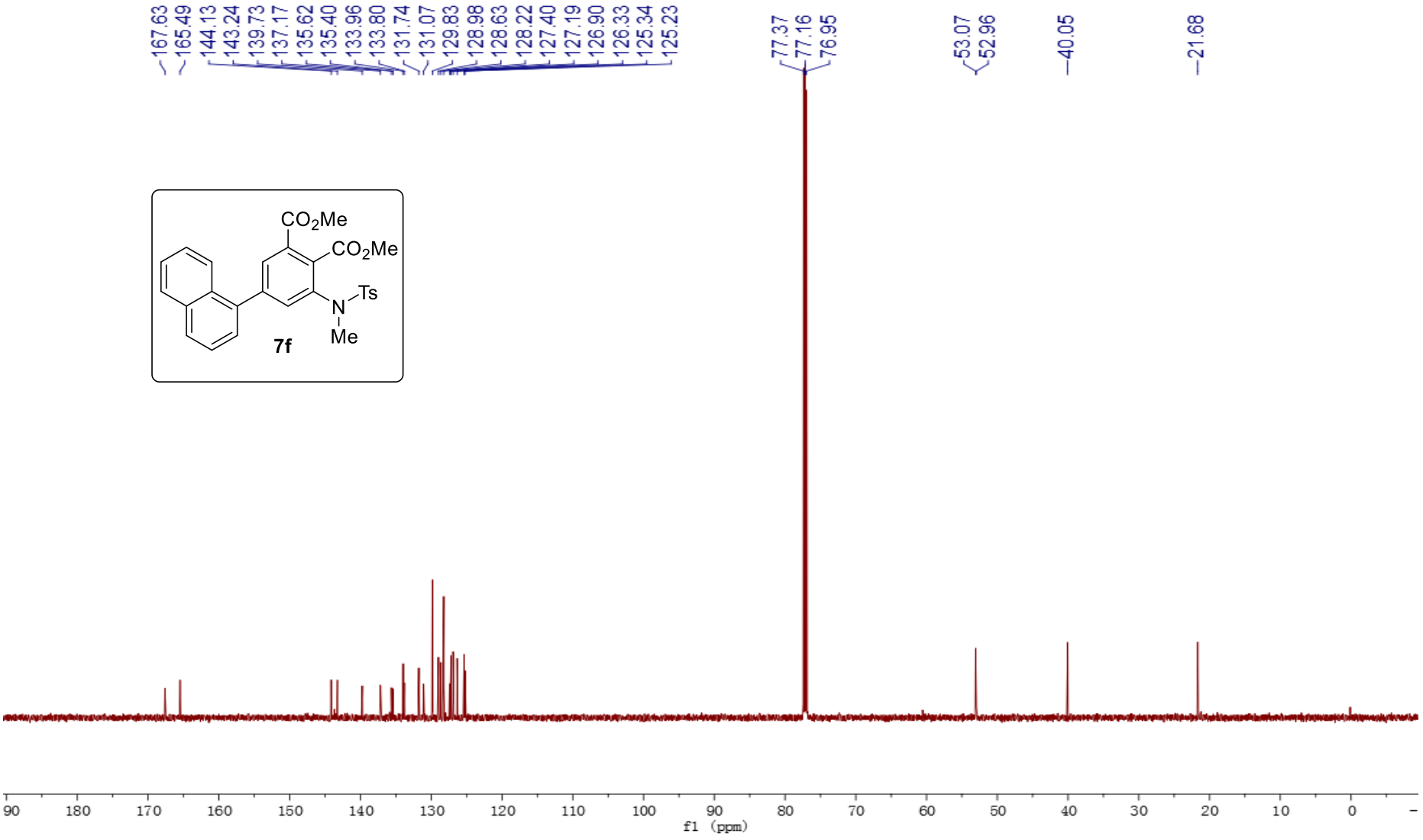

167.50
165.35
144.17
141.65
139.47
137.72
135.92
135.35
133.61
132.38
131.33
131.18
130.26
129.86
129.81
129.64
128.33
127.23
77.37
77.16
76.95
53.04
52.99
40.01
21.73
CO2Me
CO2Me
Cl
Ts
N
Me
7e
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)


8.123
7.930
7.916
7.911
7.897
7.746
7.732
7.715
7.701
7.552
7.551
7.541
7.539
7.526
7.514
7.512
7.506
7.504
7.501
7.493
7.490
7.481
7.479
7.325
7.311
7.299
7.272
7.260
3.954
3.899
3.196
2.371


CO2Me
CO2Me
Ts
N
Me

7f


0.97
2.02
2.22
1.01
3.03
2.27
2.38
3.11
3.05
3.00
2.96
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)


167.63
165.49
144.13
143.24
139.73
137.17
135.62
135.40
133.96
133.80
131.74
131.07
129.83
128.98
128.63
128.22
127.40
127.19
126.90
126.33
125.34
125.23
77.37
77.16
76.95
53.07
52.96
40.05
21.68
CO2Me
CO2Me
Ts
N
Me
7f
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)