Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

Supporting Information

Method for Accessing Sulfanylfurans from Homopropargylic Alcohols and Sulfonyl Hydrazides

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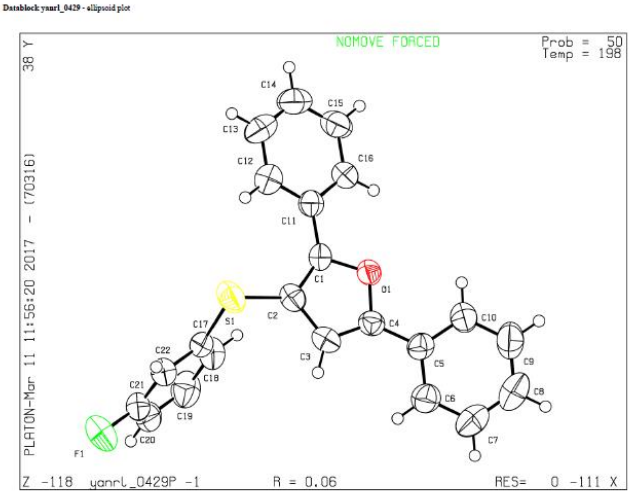
General remark

^{1}H NMR and ^{13}C NMR spectra were recorded on 400MHz and 100MHz in $CDCl_3$ (BRUKER 400M or JNM-ECS 400M). All chemical shifts are given as δ value (ppm) with reference to tetramethylsilane (TMS) as an internal standard. All compounds were further characterized by HRMS; copies of their ^{1}H NMR and ^{13}C NMR spectra are provided. Products were purified by flash chromatography on 200–300 mesh silica gels. All melting points were determined without correction. Unless otherwise noted, commercially available reagents and solvents were used without further purification.

The x-ray structure of **3ag**

Crystal **3ag** Growth with the Volatilization Method
An amount of 20 mg **3ag** were dissolved in tetrahydrofuran (2 mL) on the brown small reagent bottle (5 mL), which acted as good solvent, and a layer of ether was injected on the surface of tetrahydrofuran, and the cap is covered with a thin film, white crystals will be presented after three days.



Datablock: yanrl_0429

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Bond precision:  C-C = 0.0050 A          Wavelength=0.71073

Cell:          a=5.7144(13)       b=12.030(3)       c=12.5875(12)
               alpha=92.050(14)   beta=92.677(13)   gamma=90.37(2)
Temperature:   198 K

                Calculated                Reported
Volume          863.8(3)                  863.8(3)
Space group     P -1                      P -1
Hall group      -P 1                      -P 1
Moiety formula  C22 H15 F O S             C22 H15 F O S
Sum formula     C22 H15 F O S             C22 H15 F O S
Mr              346.40                    346.40
Dx,g cm-3       1.332                     1.332
Z               2                         2
Mu (mm-1)       0.203                     0.203
F000            360.0                     360.0
F000'           360.41
h,k,lmax        7,14,15                   7,14,15
Nref            3398                      3389
Tmin,Tmax       0.966,0.976               0.650,1.000
Tmin'           0.958

Correction method= # Reported T Limits: Tmin=0.650 Tmax=1.000
AbsCorr = MULTI-SCAN

Data completeness= 0.997          Theta(max)= 26.022

R(reflections)= 0.0619( 1775)     wR2(reflections)= 0.1656( 3389)

S = 1.061                 Npar= 226
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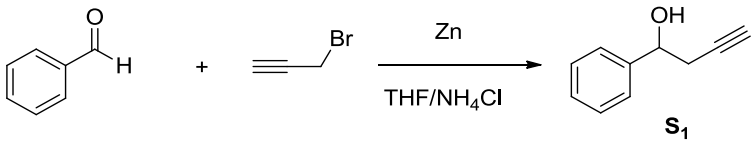
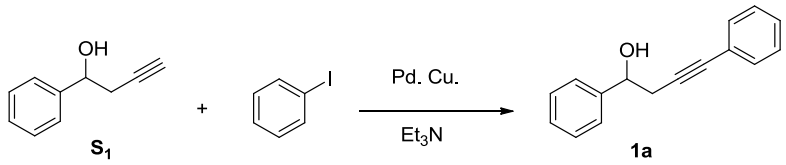
General procedure for the synthesis of homopropargylic alcohols[1-2]:



S_1

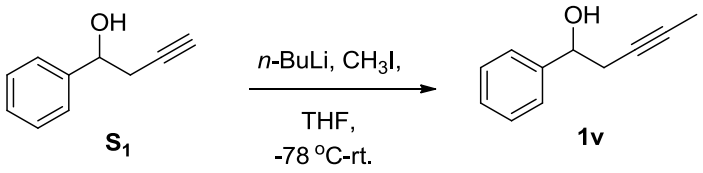
1) Aldehyde (1.0 equiv.) was dissolved in anhydrous THF. A sample was taken out for analysis and propargyl bromide (2.0 equiv.) was added. Another sample was taken out for analysis and saturated aqueous NH_4Cl was added. Portions of activated zinc dust (2.0 equiv.) were added slowly on at 0℃ and the resulting suspension was stirred overnight at this temperature. The THF layer was separated from the aqueous layer, which was extracted with diethyl ether for 3 times. The combined organic layers were washed with brine, dried over Na_2SO_4, filtered and concentrated in vacuo. The crude product was directly used in the next step

without further purification; the residue was purified by column chromatography (silica gel, appropriate mixture of *n*-hexane/ethyl acetate) to obtain **S_1**.



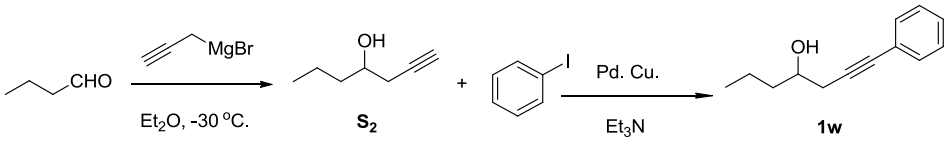
2) To a dried schlenk flask was added $Pd(PPh_3)_2Cl_2$ (0.2 mmol), CuI (0.2 mmol), iodoarene (11.0 mmol), **S_1** (10.0 mmol) and freshly distilled Et_3N under argon. The resulting mixture was stirred for 16 h at rt. 50 mL of EtOAc were added and the mixture filtered. After removal of solvent using rotary evaporator, the crude compound was purified by SiO_2 chromatography to give **1a-1u**.

1v were prepared in the method[3]



n-BuLi (2.5 M in hexanes, 6 mL, 15 mmol) was slowly added to a stirred solution of the propargyl alcohol (876 mg, 6 mmol) prepared in dry THF (20 mL) at -78 °C under Ar. After being stirred at -78 °C for 1 h, the reaction mixture was treated with CH_3I (1.12 mL, 18 mmol) and then allowed to warm to rt over night. The reaction mixture was then cooled to -78 °C again, quenched with sat NH_4Cl (aq) (10 mL) and extracted with Et_2O (3 * 20 mL). The combined organic phases were dried over Na_2SO4, filtered and concentrated in vacuo. The residue was purified by column chromatography on silica gel to give 1t as yellow oil.

1w were prepared in the method[4]

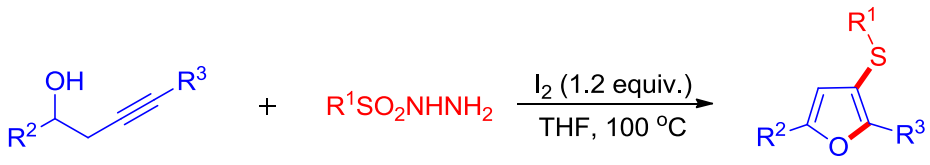


Under an argon atmosphere, magnesium turnings (0.67 g, 27.5 mmol) and mercury chloride (0.34 g, 1.3 mmol) were mixed in dry diethyl ether (40 mL) in a 250 mL round-bottom flask. To the solution, propargyl bromide (2.0 mL, 25 mmol) was then

added dropwise at 60 °C over about 1 h. The reaction was kept at the same temperature until the yellow solution turned cloudy. This solution was cooled to -30 °C and a solution of butyraldehyde (6 mmol) in Et_2O (12 ml) was added dropwise. After addition the reaction was moved to room temperature for further 30 min then quenched with sat. NH_4Cl (aq). The aqueous layer was extracted with ether and the extracts were combined with the above organic layer. The combined solution was dried over Na_2SO_4. After evaporation of the solvent the residue was purified by column chromatography (silica gel, appropriate mixture of *n*-hexane/ethyl acetate) to afford S_2.

To a dried schlenk flask was added S_2 (10.0 mmol), $Pd(PPh_3)_2Cl_2$ (0.2 mmol), CuI (0.4 mmol), iodoarene (11.0 mmol) and freshly distilled Et_3N (50 ml) under argon. The resulting mixture was stirred for 16 h at rt. The reaction mixture was quenched with sat. NH_4Cl (aq) and 50 mL of ethyl acetate were added and the mixture filtered. After removal of solvent using rotary evaporator, the crude compound was purified by column chromatography on silica gel to give **1w**.

General procedure for synthesis of *S*-substituted furans from homopropargylic alcohols and sulfonylhydrazines:

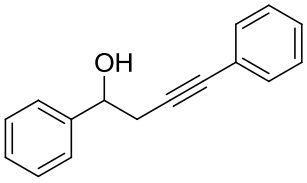


1 **2** **3**

The homopropargylic alcohols (**1**, 0.3 mmol), sulfonylhydrazines (**2**, 0.45 mmol), iodine (0.36 mmol), were mixed in THF (2 mL) and this mixture was carried out under N_2 at 100 °C for 12 h. The reaction mixture was cooled to room temperature and then washed with saturated sodium thiosulfate (5 mL), extracted with ethyl acetate (15 ml×3). The combined organic phase was dried over anhydrous Na_2SO_4. The solvent was evaporated in vacuo and the crude product was purified by column

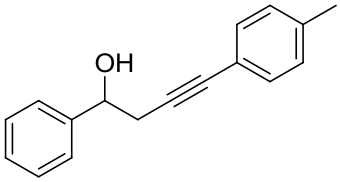
chromatography, eluting with petroleum ether/EtOAc (40:1) to afford the desired Sulfanylfurans **3**.

The data of products:



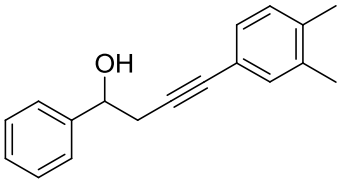
1,4-diphenylbut-3-yn-1-ol (1a)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.42-7.25 (m, 10 H), 4.92-4.89 (m, 1 H), 2.82 (d, *J* = 4.0 Hz, 2 H), 2.61 (s, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 142.78, 131.72, 128.49, 128.31, 128.04, 127.96, 125.88, 123.33, 86.12, 83.24, 72.66, 30.61.



1-phenyl-4-(p-tolyl)but-3-yn-1-ol (1b)

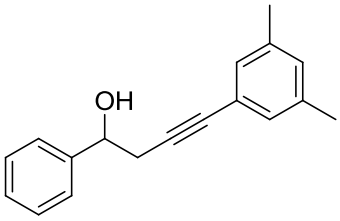
Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.43-7.41 (m, 2 H), 7.38-7.34 (m, 2 H), 7.31-7.28 (m, 3 H), 7.08 (d, *J* = 8.0 Hz, 2 H), 4.94-4.90 (m, 1 H), 2.83 (d, *J* = 4.0 Hz, 2 H), 2.59 (d, *J* = 4.0 Hz, 1 H), 2.33 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 142.85, 138.16, 131.70, 131.63, 129.16, 129.08, 128.56, 127.98, 125.93, 120.27, 85.32, 83.43, 72.81, 30.77, 21.57.



4-(3,4-dimethylphenyl)-1-phenylbut-3-yn-1-ol (1c)

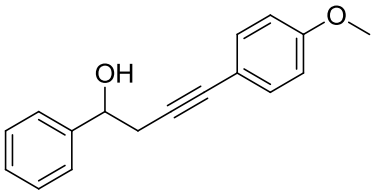
Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.44-7.41 (m, 2 H), 7.38-7.36 (m, 2 H), 7.35-7.30 (m, 1 H), 7.17-7.10 (m, 1 H), 7.14-7.12 (m, 1 H) 7.04 (d, *J* = 8.0 Hz, 1 H), 4.93-4.91 (m, 1 H), 2.84-2.82 (m, 2 H), 2.57 (s, 1 H), 2.24 (s, 3 H), 2.21 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 142.85, 136.97, 136.66, 132.82, 129.67,

129.18, 128.53, 127.97, 125.92, 120.54, 84.99, 83.57, 72.77, 30.81, 19.82, 19.67.



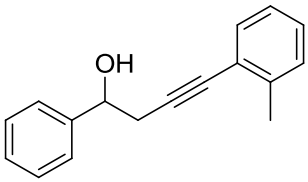
4-(3,5-dimethylphenyl)-1-phenylbut-3-yn-1-ol (1d)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.41 (d, *J* = 4.0 Hz, 2 H), 7.37-7.34 (m, 2 H), 7.31-7.29 (m, 1 H), 7.02 (s, 2 H), 6.91 (s, 1 H), 4.92-4.84 (m, 1 H), 2.82 (d, *J* = 4.0 Hz, 2 H), 2.58-2.55 (m, 1 H), 2.26 (s, 6 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 142.84, 137.91, 130.04, 129.47, 128.54, 127.98, 125.92, 122.94, 85.30, 83.63, 72.76, 30.77, 21.20.



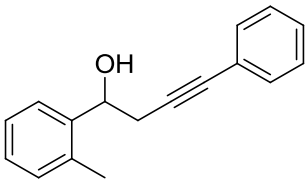
4-(4-methoxyphenyl)-1-phenylbut-3-yn-1-ol (1e)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.43-7.41 (m, 2 H), 7.37-7.32 (m, 2 H), 7.30-7.23 (m, 3 H), 6.80 (d, *J* = 8.8 Hz, 2 H), 4.93-4.89 (m, 1 H), 3.77 (s, 3 H) 2.83-2.81 (m, 2 H), 2.54 (d, *J* = 3.2 Hz, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 159.39, 142.79, 133.06, 128.44, 127.89, 125.83, 115.39, 113.90, 84.40, 83.08, 72.66, 55.28, 30.70.



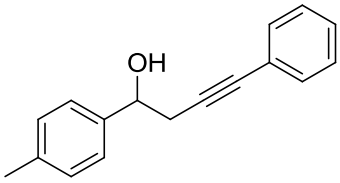
1-phenyl-4-(o-tolyl)but-3-yn-1-ol (1f)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.43 (d, *J* = 8.0 Hz, 2 H), 7.37-7.28 (m, 3 H), 7.22-7.19 (m, 1 H), 7.17-7.10 (m, 2 H), 7.09-7.07 (m, 1 H), 4.95-4.91 (m, 1 H), 2.91 (d, *J* = 6.0 Hz, 2 H), 2.49 (d, *J* = 3.2 Hz, 1 H), 2.32 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 142.73, 140.16, 132.02, 129.38, 128.48, 128.00, 127.94, 125.92, 125.50, 123.06, 89.75, 82.16, 72.70, 30.64, 20.71.



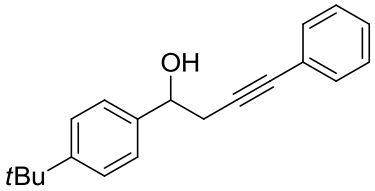
4-phenyl-1-(o-tolyl)but-3-yn-1-ol (1g)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.46 (d, *J* = 8.0 Hz, 1 H), 7.31-7.29 (m, 2 H), 7.19-7.04 (m, 6 H), 5.09-5.06 (m, 1 H), 2.72 (d, *J* = 4.0 Hz, 2 H), 2.51 (s, 1 H), 2.28 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 140.92, 134.75, 131.87, 131.74, 130.60, 130.42, 128.32, 126.38, 125.37, 125.42, 86.40, 83.06, 69.25, 29.51, 19.32.



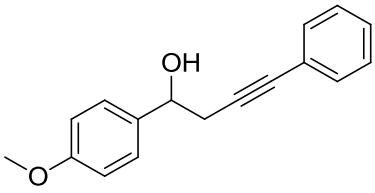
4-phenyl-1-(p-tolyl)but-3-yn-1-ol (1h)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.40-7.37 (m, 2 H), 7.32 (d, *J* = 8.0 Hz, 2 H), 7.29-7.27 (m, 3 H), 7.24-7.17 (m, 2 H), 4.94-4.92 (m, 1 H), 2.84 (d, *J* = 8.0 Hz, 2 H), 2.42 (d, *J* = 4.0 Hz, 1 H), 2.35 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 139.85, 137.72, 131.93, 131.59, 129.45, 128.99, 128.55, 128.13, 127.85, 126.02, 125.64, 123.39, 86.21, 83.21, 72.82, 30.69.



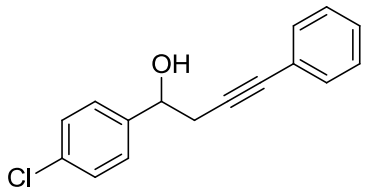
1-(4-(tert-butyl)phenyl)-4-phenylbut-3-yn-1-ol (1i)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.41-7.36 (m, 6 H), 7.29-7.27 (m, 3 H), 4.95-4.91 (m, 1 H), 2.86 (d, *J* = 6.4 Hz, 2 H), 2.40 (d, *J* = 3.6 Hz, 1 H), 1.32 (s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 150.92, 139.3, 131.68, 128.24, 127.97, 125.55, 125.39, 123.34, 86.26, 83.13, 72.45, 34.57, 31.36, 30.48.



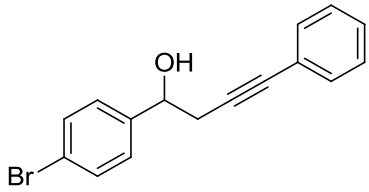
1-(4-methoxyphenyl)-4-phenylbut-3-yn-1-ol (1j)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.40-7.35 (m, 4 H), 7.29-7.27 (m, 3 H), 6.92-6.89 (m, 2 H), 4.93-4.89 (m, 1 H), 3.81(s, 3 H), 2.85-2.83 (m, 2 H), 2.41 (s, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 159.38, 135.00, 131.79, 128.36, 127.20, 127.10, 113.95, 113.87, 86.21, 83.21, 72.48, 55.46, 30.67.



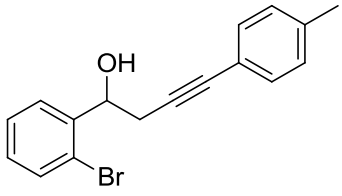
1-(4-chlorophenyl)-4-phenylbut-3-yn-1-ol (1k)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.36-7.26 (m, 9 H), 4.90-4.87 (m, 1 H), 2.80 (d, *J* = 6.4 Hz, 2 H), 2.67 (d, *J* = 2.0 Hz, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 141.20, 133.59, 131.67, 128.58, 128.33, 128.15, 127.28, 123.11, 85.54, 83.51, 71.94, 30.58.



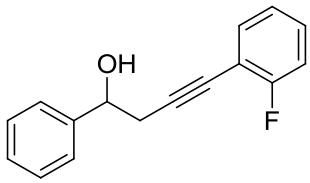
1-(4-bromophenyl)-4-phenylbut-3-yn-1-ol (1l)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.49 (d, *J* = 8.4 Hz, 2 H), 7.38-7.36 (m, 2 H), 7.31-7.27 (m, 5 H), 4.93-4.87 (m, 1 H), 2.83-2.81 (m, 2 H), 2.53 (d, *J* = 3.6 Hz, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 141.68, 131.67, 131.53, 128.32, 128.15, 127.59, 123.07, 121.75, 85.41, 83.57, 71.97, 30.56.



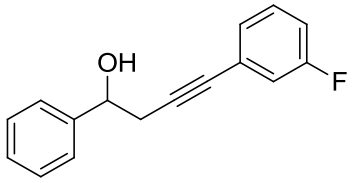
1-(2-bromophenyl)-4-(p-tolyl)but-3-yn-1-ol (1m)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.68-7.65 (m, 1 H), 7.55-7.53 (m, 1 H), 7.39-7.35 (m, 1 H), 7.31 (d, *J* = 8.0 Hz, 2 H), 7.19-7.17 (m, 1 H), 7.16-7.09 (m, 2 H), 5.32-5.28 (m, 1 H), 3.06-3.00 (m, 1 H), 2.79 (s, 3 H), 2.64-2.63 (m, 1 H), 2.34 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 141.55, 138.23, 132.82, 132.63, 131.81, 131.54, 129.27, 128.97, 127.56, 121.90, 120.13, 84.66, 83.67, 71.14, 29.02, 21.59.



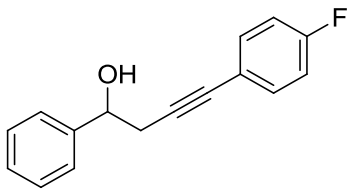
4-(2-fluorophenyl)-1-phenylbut-3-yn-1-ol (1n)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.45-7.31 (m, 7 H), 7.01- 6.96 (m, 2 H), 4.97-4.93 (m, 1 H), 2.95 (d, *J* = 6.4 Hz, 2 H), 2.47 (d, *J* = 2.4 Hz, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 162.32 (d, *J* = 248 Hz, 1 C), 142.69, 133.50 (d, *J* = 8 Hz, 2 C), 128.49, 127.99, 125.80, 119.36，119.33, 115.50 (d, *J* = 23 Hz, 2 C), 85.70 (d, *J* = 2 Hz, 1 C), 82.11, 72.63, 30.49.



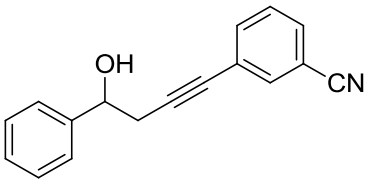
4-(3-fluorophenyl)-1-phenylbut-3-yn-1-ol (1o)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.43-7.37 (m, 4 H), 7.35-7.31 (m, 1 H), 7.29-7.20 (m, 1 H), 7.15 (d, *J* = 8.0 Hz, 1 H), 7.06 (d, *J* = 2.4 Hz, 1 H) 7.01-6.97 (m, 1 H), 4.95-4.91 (m, 1 H), 2.85 (d, *J* = 8.0 Hz, 2 H), 2.60 (s, 1 H), 2.02 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 162.41 (d, *J* = 245 Hz, 1 C), 142.74, 129.90, 128.60, 128.12, 127.61, 125.92, 125.25 (d, *J* = 10 Hz, 1 C), 118.74, 118.63, 118.46 (d, *J* = 10 Hz, 1 C), 115.43 (d, *J* = 25 Hz, 1 C), 87.36, 82.04, 72.68 (d, *J*= 5 Hz, 1 C), 30.51.



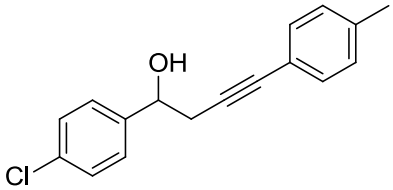
4-(4-fluorophenyl)-1-phenylbut-3-yn-1-ol (1p)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.45-7.31 (m, 7 H), 7.01- 6.96 (m, 2 H), 4.97-4.93 (m, 1 H), 2.85 (d, *J* = 6.4 Hz, 2 H), 2.47 (d, *J* = 2.4 Hz, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 162.32 (d, *J* = 248 Hz, 1 C), 142.69, 133.50 (d, *J* = 8 Hz, 1 C), 128.49, 127.99, 125.80, 119.34 (d, *J* = 3 Hz, 1 C), 115.49 (d, *J* = 23 Hz, 2 C), 85.70 (d, *J* = 2 Hz, 1 C), 82.11, 72.63, 30.49.



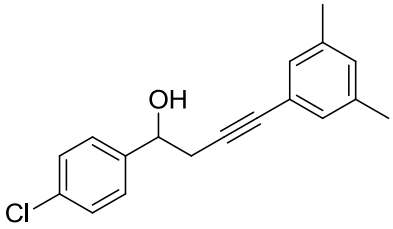
3-(4-hydroxy-4-phenylbut-1-yn-1-yl)benzonitrile (1q)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.60 (d, *J*=12.0 Hz, 1 H), 7.44-7.55(m, 2 H), 7.37-7.42 (m, 5 H), 7.31-7.34(m, 1 H), 4.95-4.98 (m, 1 H), 2.87-2.89 (m, 2 H), 2.46(s, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 142.64, 135.82, 135.14, 135.04, 131.19, 129.17, 128.55, 125.95, 125.04, 118.22, 112.76, 89.20, 80.88, 72.74, 30.40.



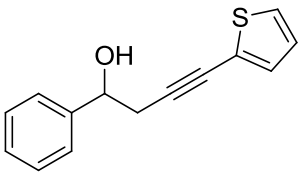
1-(4-chlorophenyl)-4-(p-tolyl)but-3-yn-1-ol (1r)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.35-7.32 (m, 4 H), 7.27 (d, *J* = 8.0 Hz, 2 H), 7.10 (d, *J* = 8.0 Hz, 2 H),4.93-4.91 (m, 1 H), 2.82-2.80 (m, 2 H), 2.58 (s, 1 H), 2.34 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 141.27, 138.31, 133.63, 131.74, 131.49, 129.29, 129.02, 128.77, 128.51, 127.45, 127.20, 120.04, 84.72, 83.73, 72.16, 30.76, 21.59.



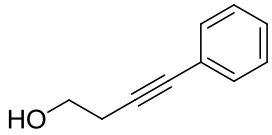
1-(4-chlorophenyl)-4-(3,5-dimethylphenyl)but-3-yn-1-ol (1s)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.38-7.32 (m, 4 H), 7.01 (s, 2 H), 6.94 (s, 1 H), 4.92-4.88 (m, 1 H), 2.82-2.80 (m, 2 H), 2.54 (s, 1 H), 2.28 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 141.26, 137.96, 133.63, 130.20, 129.49, 129.38, 128.66, 127.31, 122.71, 84.70, 83.95, 72.35, 30.75, 21.20.



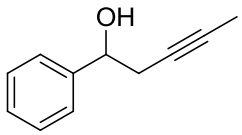
1-phenyl-4-(thiophen-2-yl)but-3-yn-1-ol (**1t**)

Yellow solid. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.44-7.31 (m, 5 H), 7.20-7.14 (m, 2 H), 6.95-6.93 (m, 1 H), 4.94-4.92 (m, 1 H), 2.87 (d, *J* =6.0 Hz, 1 H), 2.54 (s, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 142.64, 131.64, 128.51, 128.00, 126.85, 126.53, 125.80, 95.23, 90.23, 72.55, 30.86.



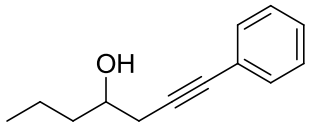
4-phenylbut-3-yn-1-ol (**1u**)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.43-7.40 (m, 2 H), 7.29-7.28 (m, 3 H), 3.82-4.79 (m, 2 H), 2.70-2.67 (m, 2 H), 2.11 (s, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 131.67, 128.27, 127.95, 123.35, 86.40, 82.46, 61.17, 23.82.



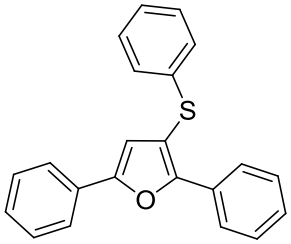
1-phenylpent-3-yn-1-ol (1**v**)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.38-7.32 (m, 4 H), 7.30-7.27 (m, 1 H), 4.81-4.78 (m, 1 H), 2.58-2.54 (m, 2 H), 2.51 (s, 1 H), 1.81-1.79 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 142.81, 128.35, 127.71, 125.68, 78.63, 75.23, 72.58, 29.96, 3.49.



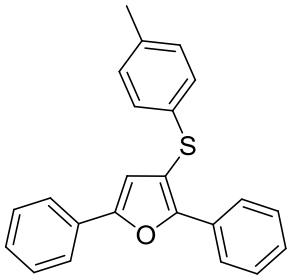
1-phenylhept-1-yn-4-ol (**1w**)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.42-7.40 (m, 2 H), 7.29-7.27 (m, 3 H), 3.87-3.81 (m, 1 H), 2.67-2.51 (m, 2 H), 2.06 (d, *J* = 4.4 Hz, 1 H), 1.61-1.34 (m, 4 H), 0.97-0.94 (m, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 131.67, 128.26, 127.91, 123.43, 86.26, 83.01, 69.97, 38.55, 28.44, 18.88, 14.03.



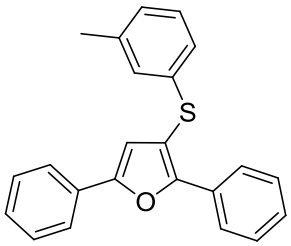
2,5-diphenyl-3-(phenylthio)furan (3aa)

colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.09-8.07 (m, 2 H), 7.73-7.71 (m, 2 H), 7.43-7.39 (m, 4 H), 7.33-7.24 (m, 6 H), 7.17-7.14 (m, 1 H), 6.71 (s, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.60, 152.84, 136.77, 130.10, 129.99, 129.13, 128.81, 128.72, 128.54, 128.18, 127.98, 125.97, 125.86, 123.91, 112.68, 111.63; HRMS calcd for $C_{22}H_{16}OS$ $[M+H]^+$329.0995; found: 329.0999.



2,5-diphenyl-3-(p-tolylthio)furan (3ab)

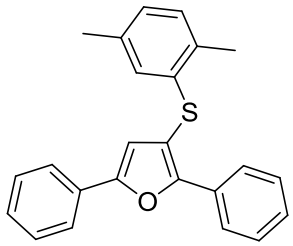
Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.07 (d, *J* = 7.2 Hz, 2 H), 7.69 (d, *J* = 7.2 Hz, 2 H), 7.42-7.36 (m, 4 H), 7.31-7.29 (m, 2 H), 7.25-7.19 (m, 2 H), 7.07 (d, *J* = 8.0 Hz, 2 H), 6.66 (s, 1 H), 2.29 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.87, 152.71, 136.08, 132.85, 130.23, 130.05, 129.94, 128.79, 128.54, 128.16, 128.03, 127.92, 125.90, 123.89, 112.76, 112.39，21.00; HRMS calcd for $C_{23}H_{18}OS$ $[M+H]^+$343.1151; found: 343.1157.



2,5-diphenyl-3-(m-tolylthio)furan (3ac)

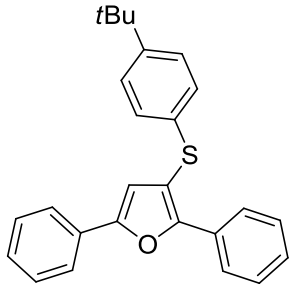
Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.09-8.07 (m, 2 H), 7.73-7.71 (m, 2 H), 7.42-7.27 (m, 6 H), 7.22-7.07 (m, 3 H), 6.96 (d, *J* = 8.0 Hz, 1 H), 6.71 (s, 1 H), 2.28 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.56, 152.87, 139.11, 136.55, 130.24, 130.12, 128.96, 128.81, 128.16, 127.92, 127.05, 126.81，126.00,

124.72, 123.99, 112.87, 112.76, 111.90, 21.49; HRMS calcd for $C_{23}H_{18}OS$ $[M+H]^+$343.1151; found: 343.1156.



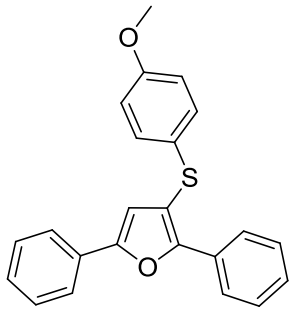
3-((2,5-dimethylphenyl)thio)-2,5-diphenylfuran (3ad)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.06-8.04 (m, 2 H), 7.71-7.69 (m, 2 H), 7.41-7.39 (m, 4 H), 7.37-7.30 (m, 2 H), 7.28-7.22 (m, 1 H), 7.21 (s, 1 H), 7.05 (d, *J* = 8.0 Hz, 1 H), 6.61 (s, 1 H), 2.38 (s, 3 H), 2.19 (s, 3 H) ; ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.98, 152.87, 136.46, 135.04, 133.68, 130.35, 130.16, 128.83, 128.55, 128.42, 128.01, 127.07, 125.96, 123.99, 112.41, 112.27, 21.15, 19.86; HRMS calcd for $C_{24}H_{20}OS$ $[M+H]^+$357.1308; found: 357.1301.



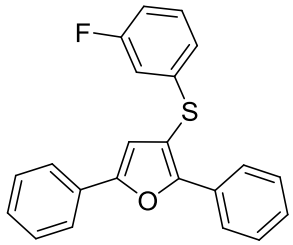
3-((4-(tert-butyl)phenyl)thio)-2,5-diphenylfuran (3ae)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.10 (d, *J* = 8.0 Hz, 2 H), 7.71 (d, *J* = 8.0 Hz, 2 H), 7.43-7.40 (m, 4 H), 7.31-7.28 (m, 4 H), 7.24-7.22 (m, 2 H), 6.70 (s, 1 H), 1.28 (s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ =153.2, 152.80, 149.29, 133.12, 130.31, 128.88, 128.61,128.15, 128.00, 127.60, 126.30, 126.02, 123.98, 112.68, 112.44, 34.55, 31.38; HRMS calcd for $C_{26}H_{24}OS$ $[M+H]^+$385.1621; found: 385.1618.



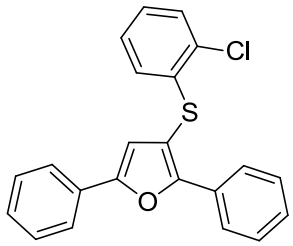
3-((4-methoxyphenyl)thio)-2,5-diphenylfuran (3af)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.07 (d, *J* = 7.2 Hz, 2 H), 7.68 (d, *J* = 7.2 Hz, 2 H), 7.45-7.40 (m, 4 H), 7.38-7.31 (m, 3 H), 7.28 (d, *J* = 7.6 Hz, 1 H) 6.84 (d, *J* = 8.8 Hz, 2 H), 6.59 (s, 1 H), 3.77 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 158.88, 152.58, 151.53, 131.21, 130.36, 130.05, 128.76, 128.54, 127.86, 127.84, 126.39, 125.76, 123.87, 114.89, 114.59, 111.67, 55.38; HRMS calcd for $C_{23}H_{18}O_2S$ $[M+H]^+$359.1101; found: 359.1107.



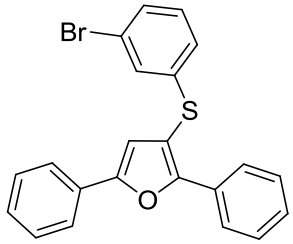
3-((3-fluorophenyl)thio)-2,5-diphenylfuran (3ag)

White solid. melting point: 84-86 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.06 (d, *J* = 7.2 Hz, 2 H), 7.73 (d, *J* = 7.2 Hz, 2 H), 7.44-7.40 (m, 4 H), 7.34-7.29 (m, 2 H), 7.24-7.18 (m, 1 H), 7.05-7.04 (m, 1 H), 7.03-6.93 (m, 1 H), 6.85-6.80 (m, 1 H), 6.75 (s, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 163.19 (d, *J* = 247 Hz, 1 C), 154.33, 153.11, 139.55 (d, *J* = 7 Hz, 1 C), 130.41, 130.32, 129.84, 128.84, 128.59, 128.44, 128.13, 136.05, 123.96, 122.31 (d, *J* = 3 Hz, 1 C), 113.66 (d, *J* = 24 Hz, 2 C), 112.74 (d, *J* = 4 Hz, 1 C), 110.18; HRMS calcd for $C_{22}H_{15}FOS$ $[M+H]^+$347.0901; found: 347.0905.



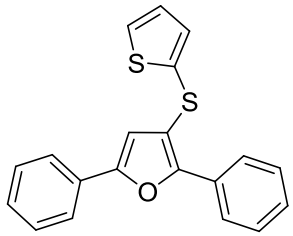
3-((2-chlorophenyl)thio)-2,5-diphenylfuran (3ah)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.06-8.04 (m, 2 H), 7.44-7.42 (m, 2 H), 7.40-7.32 (m, 5 H), 7.31-7.29 (m, 2 H), 7.08-7.01 (m, 3 H), 6.74 (s, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 154.96, 153.20, 136.42, 131.20, 129.85, 129.78, 129.65, 128.78, 128.62, 128.49, 128.14, 127.35, 127.00, 126.28, 126.04, 123.94, 113.00, 109.46; HRMS calcd for $C_{22}H_{15}ClOS$ $[M+H]^+$363.0605; found: 363.0601.



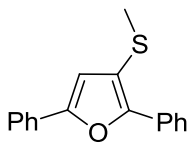
3-((3-bromophenyl)thio)-2,5-diphenylfuran (3ai)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.07-8.05 (m, 2 H), 7.75-7.73 (m, 2 H), 7.45-7.32 (m, 8 H), 7.17-7.11 (m, 2 H), 6.74 (s, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 154.35, 153.21, 139.54, 130.49, 129.90, 129.37, 128.94, 128.86, 128.69, 128.53, 128.22, 126.12, 125.42, 124.04, 123.81, 123.23, 112.69, 110.21; HRMS calcd for $C_{22}H_{15}BrOS$ $[M+H]^+$407.0100; found: 407.0108.



2,5-diphenyl-3-(thiophen-2-ylthio)furan (3ak)

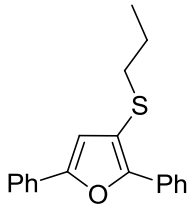
Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.06 (d, *J* = 7.2 Hz, 2 H), 7.67 (d, *J* = 7.2 Hz, 2 H), 7.49-7.40 (m, 2 H), 7.38-7.29 (m, 4 H), 7.27-7.26 (m, 1 H)，7.24-7.23 (m, 1 H)，7.10-6.99 (m, 1 H), 6.61 (s, 1 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.49, 150.23, 133.34, 132.88, 130.26, 129.98, 129.49, 128.72, 128.57, 127.88, 127.59, 125.82, 123.89, 116.19, 110.60; HRMS calcd for $C_{20}H_{14}OS_2$ $[M+H]^+$335.0559; found: 335.0553.



3-(methylthio)-2,5-diphenylfuran (**3al**)

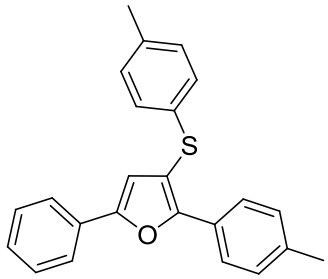
Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.03-8.01 (m, 2 H), 7.74-7.72 (m,

2 H), 7.46-7.39 (m, 5 H), 7.31-7.27 (m, 1 H), 6.78 (s, 1 H), 2.47 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.42, 149.49, 130.71, 128.78, 128.75, 128.50, 127.79, 127.37, 125.46, 123.84, 116.95, 109.75, 18.27; HRMS calcd for $C_{17}H_{14}OS$ $[M+H]^+$267.0838; found: 267.0839.



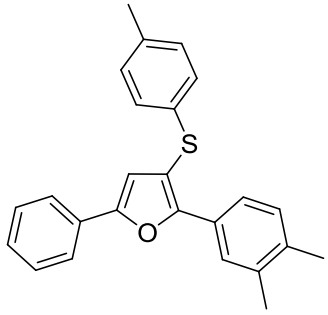
2,5-diphenyl-3-(propylthio)furan (**3am**)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.11-8.09 (m, 2 H), 7.73-7.71 (m, 2 H), 7.45-7.38 (m, 4 H), 7.31-7.27 (m, 2 H), 6.76 (s, 1 H), 2.84-2.80 (m, 2 H), 1.71-1.61 (m, 2 H), 7.31-7.27 (m, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.26, 150.86, 130.78, 130.21, 128.77, 128.43, 127.76, 127.45, 125.64, 123.84, 115.64, 111.17, 107.23 37.45, 22.90, 13.33; HRMS calcd for $C_{19}H_{18}OS$ $[M+H]^+$295.1151; found: 295.1157.



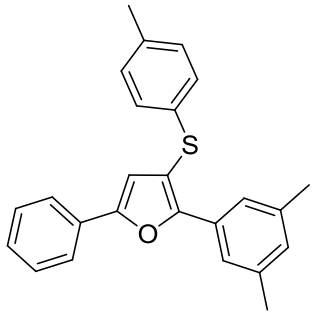
5-phenyl-2-(p-tolyl)-3-(p-tolylthio)furan (3bb)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.01 (d, *J* = 8.4 Hz, 2 H), 7.74 (d, *J* = 7.2 Hz, 2 H), 7.45-7.41 (m, 2 H), 7.33-7.32 (m, 5 H), 7.11 (d, *J* = 8.0 Hz, 2 H), 6.71 (s, 1 H)，2.41 (s, 3 H), 2.33 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.42, 152.36, 138.08, 135.89, 133.11, 130.13, 129.88, 129.22, 128.76, 127.91, 127.78, 127.47, 125.88, 123.81, 112.44, 111.69, 21.39, 20.98; HRMS calcd for $C_{24}H_{20}OS$ $[M+H]^+$357.1308; found: 357.1304.



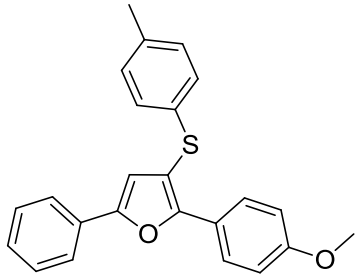
2-(3,4-dimethylphenyl)-5-phenyl-3-(p-tolylthio)furan (3cb)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.82 (d, *J* = 8.0 Hz, 2 H), 7.71-7.69 (m, 2 H), 7.41-7.37 (m, 3 H), 7.29-7.27 (m, 1 H), 7.23-7.16 (m, 3 H), 7.10-7.07 (m, 2 H)，6.67 (s, 1 H), 2.29-2.28 (m, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.54, 152.36, 136.95, 135.97, 135.29, 130.26, 130.11, 129.66, 129.01，128.69, 128.35, 127.88, 127.62, 127.06, 123.89, 112.60, 111.80, 21.09, 20.08, 19.80; HRMS calcd for $C_{25}H_{22}OS$ $[M+H]^+$371.1464; found: 371.1469.



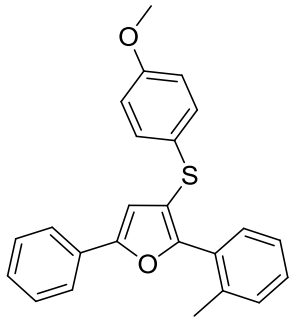
2-(3,5-dimethylphenyl)-5-phenyl-3-(p-tolylthio)furan (3db)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.71-7.69 (m, 4 H), 7.41-7.36 (m, 2 H), 7.28 (d, *J* = 8.0 Hz, 1 H), 7.22 (d, *J* = 8.0 Hz, 2 H), 7.09 (d, *J* = 6.8 Hz, 2 H), 6.95 (s, 1 H), 6.64 (s, 1 H), 2.35 (s, 6 H), 2.30 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.99, 152.45, 138.00, 136.09, 133.00, 130.15, 130.09, 129.89, 129.84, 128.76, 128.47, 127.80, 123.87, 123.76, 112.78, 112.23, 21.51, 21.01; HRMS calcd for $C_{25}H_{22}OS$ $[M+H]^+$371.1464; found: 371.1468.



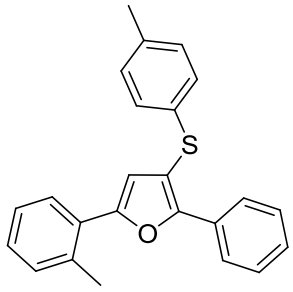
2-(4-methoxyphenyl)-5-phenyl-3-(p-tolylthio)furan (3eb)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.02-8.00 (m, 2 H), 7.69-7.67 (m, 2 H), 7.40-7.36 (m, 2 H), 7.28-7.23 (m, 1 H), 7.17 (d, *J* = 8.4 Hz, 2 H), 7.06 (d, *J* = 8.0 Hz, 2 H), 6.93 (d, *J* = 9.2 Hz, 2 H), 6.67 (s, 1 H), 3.82 (s, 3 H), 2.28 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 159.54, 153.65, 152.09, 135.75, 133.32, 130.17, 129.89, 128.77, 127.69, 127.59, 127.51, 123.74, 123.11, 113.99, 112.58, 110.36, 55.33, 20.97; HRMS calcd for $C_{24}H_{20}O_2S$ $[M+H]^+$373.1257; found: 373.1261.



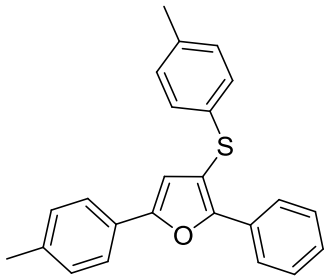
3-((4-methoxyphenyl)thio)-5-phenyl-2-(o-tolyl)furan (3ff)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.65 (d, *J* = 7.6 Hz, 2 H), 7.51 (d, *J* = 7.6 Hz, 1 H), 7.38 (d, *J* = 7.6 Hz, 2 H), 7.30-7.26 (m, 6 H), 6.82 (d, *J* = 8.8 Hz, 2 H), 6.65 (s, 1 H)，3.78 (s, 3 H)，2.47 (s, 3 H)，; ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 158.68, 154.01, 153.19, 137.50, 130.91, 130.75, 130.40, 130.26, 129.27, 128.99, 128.75, 127.75, 127.06, 125.48, 123.68, 115.35, 114.74, 110.29, 55.37, 20.89; HRMS calcd for $C_{24}H_{20}O_2S$ $[M+H]^+$373.1257; found: 373.1251.



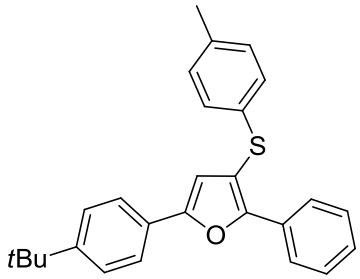
2-phenyl-5-(o-tolyl)-3-(p-tolylthio)furan (3gb)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.08 (d, *J* = 7.2 Hz, 2 H), 7.77 (d, *J* = 7.6 Hz, 1 H), 7.42-7.38 (m, 2 H), 7.32-7.27 (m, 2 H), 7.24-7.19 (m, 4 H), 7.07 (d, *J* = 8.0 Hz, 2 H), 6.59 (s, 1 H), 2.52 (s, 3 H), 2.29 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.85, 152.46, 135.88, 134.73, 133.08, 131.37, 130.22， 129.92, 129.34, 128.55, 128.05, 127.96, 127.76, 126.87, 126.14, 125.91, 116.02, 111.93, 22.09, 20.98; HRMS calcd for $C_{24}H_{20}OS$ $[M+H]^+$357.1308; found: 357.1302.



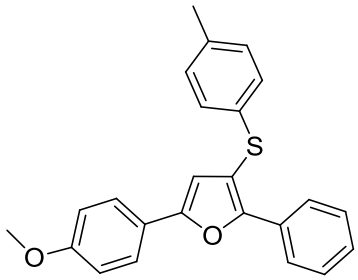
2-phenyl-5-(p-tolyl)-3-(p-tolylthio)furan (3hb)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.09-8.07 (m, 2 H), 7.60 (d, *J* = 8.4 Hz, 2 H), 7.44-7.40 (m, 2 H), 7.32 (d, *J* = 7.6 Hz, 1 H), 7.23-7.19 (m, 4 H), 7.09 (d, *J* = 8.0 Hz, 2 H), 6.62 (s, 1 H), 2.38 (s, 3 H), 2.31 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.96, 152.51, 137.87, 136.00, 132.93, 130.31, 129.90, 129.46, 128.50, 128.10, 127.89, 127.37, 125.83, 123.86, 112.59, 111.67, 21.35, 20.98; HRMS calcd for $C_{24}H_{20}OS$ $[M+H]^+$357.1308; found: 357.1314.



5-(4-(tert-butyl)phenyl)-2-phenyl-3-(p-tolylthio)furan (3ib)

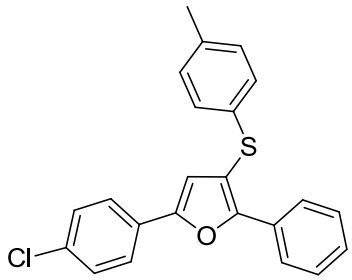
Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.07 (d, *J* = 7.2 Hz, 2 H), 7.64 (d, *J* = 8.4 Hz, 2 H), 7.44-7.39 (m, 4 H), 7.34-7.28 (m, 1 H), 7.20 (d, *J* = 8.4 Hz, 2 H), 7.07 (d, *J* = 8.0 Hz, 2 H), 6.63 (s, 1 H), 2.30 (s, 3 H), 1.34 (s, 9 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.93, 152.66, 151.14, 135.93, 132.99, 130.31, 129.88, 128.50, 127.95, 127.89, 127.33, 125.83, 125.70, 123.72, 112.47, 111.85, 34.71, 31.26, 20.97; HRMS calcd for $C_{27}H_{26}OS$ $[M+H]^+$399.1777; found: 399.1782.



5-(4-methoxyphenyl)-2-phenyl-3-(p-tolylthio)furan (3jb)

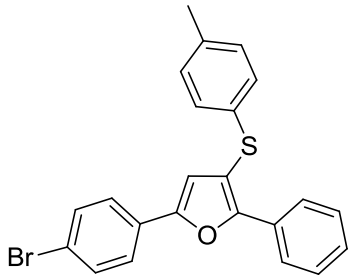
Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.02 (d, *J* = 8.8 Hz, 2 H), 7.69 (d, *J* = 8.0 Hz, 2 H), 7.41-7.37 (m, 2 H), 7.27-7.24 (m, 1 H), 7.18 (d, *J* = 8.0 Hz, 2 H),

7.07 (d, *J* = 8.0 Hz, 2 H), 6.94 (d, *J* = 8.0 Hz, 2 H), 6.68 (s, 1 H), 3.83 (s, 3 H), 2.29 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 159.54, 153.65, 152.09, 135.75, 133.31, 130.17, 129.89, 128.77, 127.69, 127.59, 127.51, 123.74, 123.11, 113.99, 112.58, 110.36, 55.33, 20.97; HRMS calcd for $C_{24}H_{20}O_2S$ $[M+H]^+$373.1257; found: 373.1251.



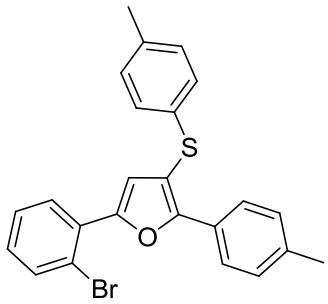
5-(4-chlorophenyl)-2-phenyl-3-(p-tolylthio)furan (3kb)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.06 (d, *J* = 7.2 Hz, 2 H), 7.60 (d, *J* = 8.4 Hz, 2 H), 7.43-7.39 (m, 2 H), 7.37-7.31 (m, 3 H), 7.21 (d, *J* = 8.4 Hz, 2 H), 7.08 (d, *J* = 8.0 Hz, 2 H), 6.63 (s, 1 H), 2.30 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.98, 151.61, 136.27, 133.56, 132.60, 129.98, 129.02, 128.58, 128.38, 128.19, 125.91, 125.09, 124.92, 123.79, 113.13, 112.72, 21.03; HRMS calcd for $C_{23}H_{17}ClOS$ $[M+H]^+$377.0762; found: 377.0768.



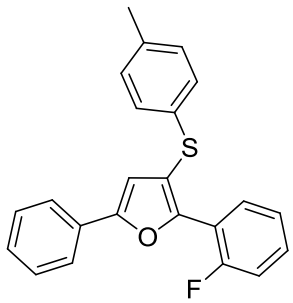
5-(4-bromophenyl)-2-phenyl-3-(p-tolylthio)furan (3lb)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.07-8.04 (m, 2 H), 7.52-7.50 (m, 4 H), 7.43-7.36 (m, 2 H), 7.34-7.30 (m, 1 H), 7.21 (d, *J* = 8.4 Hz, 2 H), 7.10-7.07 (m, 2 H), 6.65 (s, 1 H), 2.23 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.02, 151.61, 136.28, 132.55, 131.93, 129.96, 129.79, 128.94, 128.56, 128.38, 128.19, 125.91, 125.33, 121.69, 113.17, 112.80, 21.00; HRMS calcd for $C_{23}H_{17}BrOS$ $[M+H]^+$421.0256; found: 421.0250.



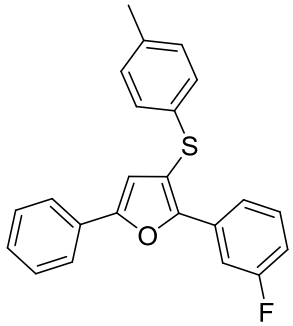
5-(2-bromophenyl)-2-(p-tolyl)-3-(p-tolylthio)furan (3mb)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.98 (d, *J* = 8.0 Hz, 2 H), 7.89-7.87 (m, 1 H), 7.65-7.63 (m, 1 H), 7.40-7.36 (m, 1 H), 7.22-7.18 (m, 5 H), 7.15-7.11 (m, 1 H), 7.07 (d, *J* = 8.0 Hz, 2 H), 2.37 (s, 3 H), 2.29 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.82, 149.70, 138.38, 135.78, 134.29, 133.15, 130.54, 129.89, 129.26, 128.71, 128.55, 127.63, 127.43, 127.23, 126.07, 119.67, 118.15, 111.13, 21.41, 20.97; HRMS calcd for $C_{24}H_{19}BrOS$ $[M+H]^+$435.0413; found: 435.0416.



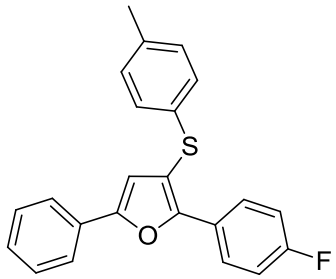
2-(2-fluorophenyl)-5-phenyl-3-(p-tolylthio)furan (3nb)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.76-7.74 (m, 3 H), 7.72-7.68 (m, 4 H), 7.40-7.29 (m, 4 H), 7.23-7.7.07 (m, 2 H), 6.68 (s, 1 H), 2.30 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 159.65 (d, *J* = 244 Hz, 1 C)， 154.12， 149.17， 136.16， 132.92， 130.42 (d, *J* = 3 Hz, 1 C)， 130.31， 130.01， 129.87， 128.77， 128.52， 128.03， 123.94 (d, *J* = 5 Hz, 1 C)， 118.13(d, *J* = 13 Hz, 1 C)，116.32 (d, *J* = 24 Hz, 2 C)，115.68，111.04，21.00; HRMS calcd for $C_{23}H_{17}FOS$ $[M+H]^+$361.1057; found: 361.1062.



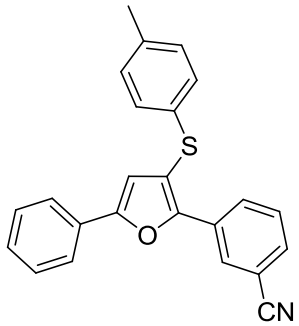
2-(3-fluorophenyl)-5-phenyl-3-(p-tolylthio)furan (3ob)

White solid. melting point: 93-95 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.92-7.88 (m, 1 H), 7.83-7.79 (m, 1 H), 7.71-7.68 (m, 2 H), 7.42-7.38 (m, 3 H), 7.36-7.34 (m, 1 H), 7.32-7.28 (m, 2 H), 7.23 (d, *J* = 8.0 Hz, 2 H), 7.10-7.08 (m, 1 H), 7.02-6.97 (m, 1 H), 6.65 (s, 1 H), 2.31 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 162.88 (d, *J* = 244 Hz, 1 C), 153.06, 150.99, 136.46, 132.18, 130.09 (d, *J* = 9 Hz, 2 C), 130.00, 129.78, 128.82, 128.60, 128.15, 123.99, 121.37 (d, *J* = 3 Hz, 1 C), 114.71 (d, *J* = 22 Hz, 1 C), 114.46, 112.41 (d, *J* = 24 Hz, 1 C), 112.29, 21.00; HRMS calcd for $C_{23}H_{17}FOS$ $[M+H]^+$361.1057; found: 361.1050.



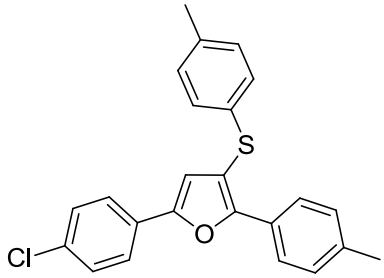
2-(4-fluorophenyl)-5-phenyl-3-(p-tolylthio)furan (3pb)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.08-8.04 (m, 2 H), 7.71-7.68 (m, 2 H), 7.42-7.38 (m, 2 H), 7.31-7.28 (m, 1 H), 7.19 (d, *J* = 8.0 Hz, 2 H), 7.12-7.07 (m, 4 H), 6.68 (s, 1 H), 2.30 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 162.39 (d, *J* = 248 Hz, 1 C), 152.64, 152.19, 136.08, 132.66, 129.90 (d, *J* = 5 Hz, 1 C), 128.77, 127.91, 127.83 (d, *J* = 10 Hz, 2 C), 127.81, 126.49, 126.46, 123.82, 115.55 (d, *J* = 21 Hz, 2 C), 112.39, 112.14, 20.94; HRMS calcd for $C_{23}H_{17}FOS$ $[M+H]^+$361.1057; found: 361.1063.



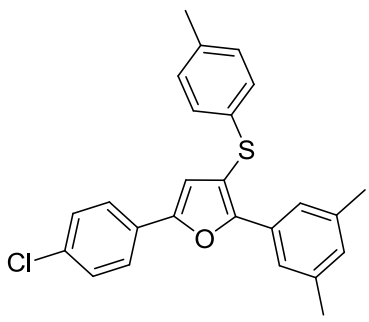
3-(5-phenyl-3-(p-tolylthio)furan-2-yl)benzonitrile (3qb)

White solid. melting point: 75-77 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.35 (s, 1 H), 8.31 (d, *J* = 8.0 Hz, 1 H), 7.70-7.54 (m, 2 H), 7.52-7.48 (m, 2 H), 7.43-7.39 (m, 2 H), 7.33-7.30 (m, 1 H), 7.25-7.21 (m, 3 H), 7.10 (d, *J* = 8.0 Hz, 2 H), 6.65 (s, 1 H), 2.31 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.73, 149.43, 136.86, 131.53, 131.40, 130.74, 130.12, 129.49, 129.44, 129.38, 128.95, 128.89, 128.45, 124.09, 118.72, 115.96, 112.89, 112.22, 21.02; HRMS calcd for $C_{24}H_{17}NOS$ $[M+H]^+$368.1204; found: 368.1209.



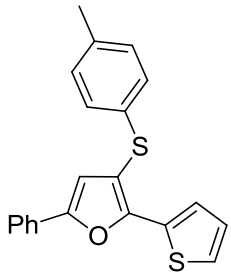
5-(4-chlorophenyl)-2-(p-tolyl)-3-(p-tolylthio)furan (3rb)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.95 (d, *J* = 8.0 Hz, 2 H), 7.62-7.59 (m, 2 H), 7.36-7.34 (m, 2 H), 7.23-7.20 (m, 4 H), 7.18-7.08 (m, 2 H), 6.64 (s, 1 H), 2.37 (s, 3 H), 2.29 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.63, 151.35, 138.35, 136.15, 133.48, 132.93, 130.06, 129.95, 129.39, 129.28, 129.01, 128.68, 128.12, 127.35, 125.96, 125.07, 112.87, 112.13, 21.51, 21.06; HRMS calcd for $C_{24}H_{19}ClOS$ $[M+H]^+$391.0918; found: 391.0923.



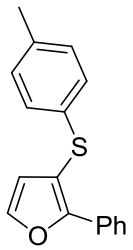
5-(4-chlorophenyl)-2-(3,5-dimethylphenyl)-3-(p-tolylthio)furan (3sb)

White solid. melting point: 112-113 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.67 (s, 2 H), 7.65 (d, *J* = 8.8 Hz, 2 H), 7.39 (d, *J* = 8.4 Hz, 2 H), 7.27 (d, *J* = 6.4 Hz, 2 H), 7.12 (d, *J* = 8.0 Hz, 2 H), 7.00 (s, 1 H), 6.65 (s, 1 H), 2.39 (s, 3 H), 2.34 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.11, 151.35, 138.03, 136.27, 133.42, 132.72, 129.97, 129.90, 129.88, 128.96, 128.68, 128.62, 125.07, 123.75, 113.14, 112.53, 21.48, 21.00; HRMS calcd for $C_{25}H_{21}ClOS$ $[M+H]^+$405.1076; found: 405.1069.



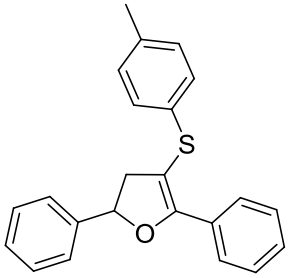
5-phenyl-2-(thiophen-2-yl)-3-(p-tolylthio)furan (**3tb**)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.71-7.66 (m, 3 H), 7.42-7.38 (m, 3 H), 7.31-7.29 (m, 2 H), 7.20 (d, *J* = 8.0 Hz, 2 H), 7.07 (d, *J* = 7.6 Hz, 2 H), 6.70 (s, 1 H), 2.30 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 152.50, 150.44, 136.06, 132.58, 131.81, 131.33, 129.89, 128.79, 127.97, 127.33, 126.84, 125.93, 125.02, 123.84, 112.11, 111.47, 20.97; HRMS calcd for $C_{21}H_{16}OS_2$ $[M+H]^+$349.0716; found: 349.0711.



2-phenyl-3-(p-tolylthio)furan (**3ub**)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 7.99 (d, *J* = 7.6 Hz, 2 H), 7.47 (d, *J* = 1.6 Hz, 1 H), 7.41-7.37 (m, 2 H), 7.31-7.27 (m, 1 H), 7.15 (d, *J* = 8.0 Hz, 2 H), 7.07 (d, *J* = 8.4 Hz, 2 H), 6.42 (d, *J* = 2.0 Hz, 1H), 2.29 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 153.76, 141.68, 135.91, 133.07, 130.21, 129.85, 128.47, 128.05, 127.93, 125.95, 117.29, 110.39, 20.96; HRMS calcd for $C_{17}H_{14}OS$ $[M+H]^+$267.0838; found: 267.0842.



2,5-diphenyl-4-(p-tolylthio)-2,3-dihydrofuran (4ab)

Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$, ppm): δ = 8.04-8.01 (m, 2 H), 7.41-7.32 (m, 7 H), 7.31-7.28 (m, 1 H), 7.18 (d, *J* = 8.4 Hz, 2 H), 7.06 (d, *J* = 8.0 Hz, 2 H), 5.71-5.66 (m, 1 H), 3.38-3.31 (m, 1 H), 2.91-2.85 (m, 1 H), 2.29 (s, 3 H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm): δ = 157.19, 142.33, 135.78, 132.25, 130.18, 129.83, 129.27, 128.64, 128.10, 127.88, 127.78, 127.62, 125.58, 98.48, 80.92, 44.15, 20.96; HRMS calcd for $C_{23}H_{20}OS$ $[M+H]^+$345.1307; found: 345.1303.

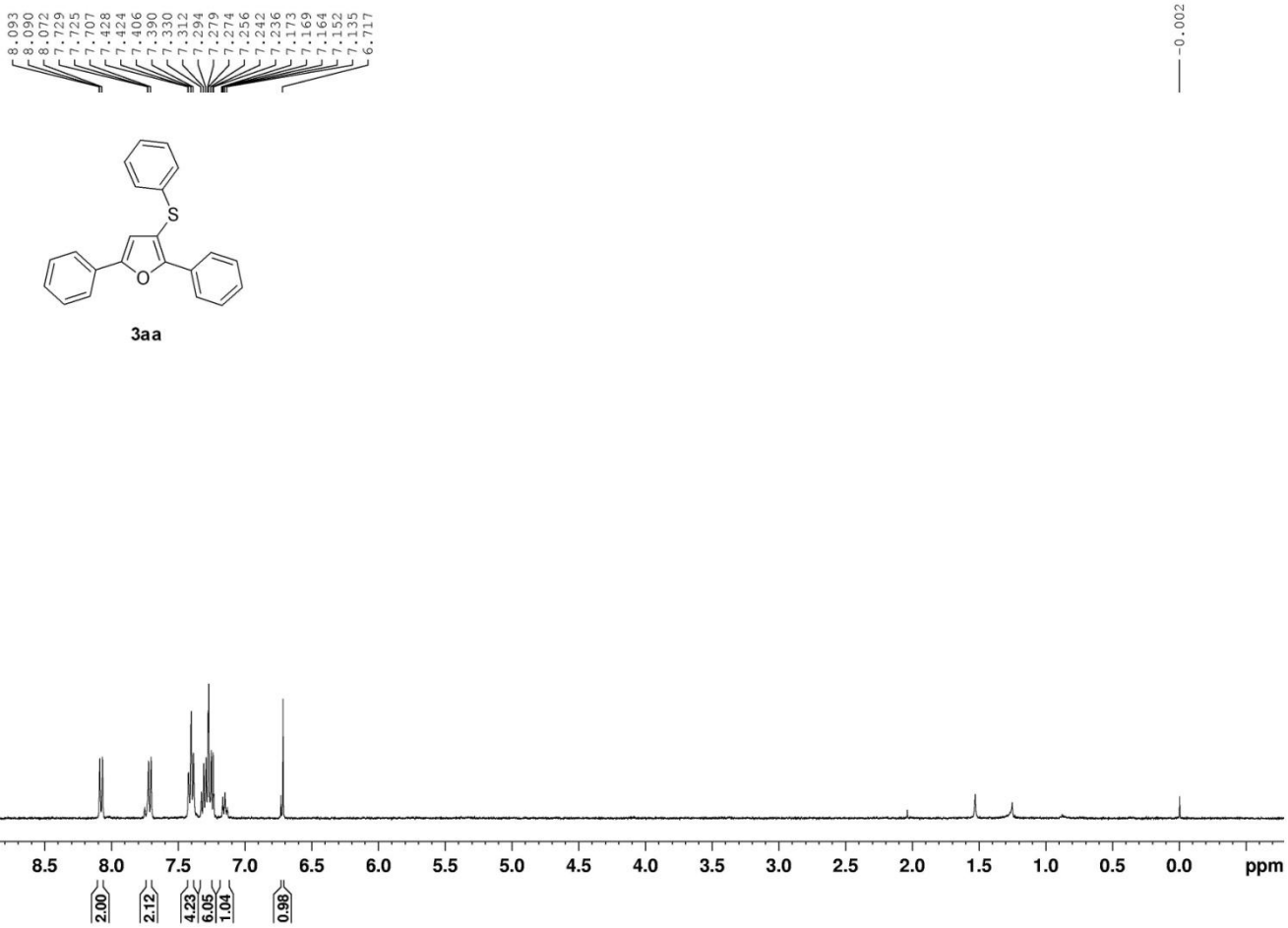
Refrence:

[1] P. Gao, Y. -W. Shen, R. Fang, X.-H. Hao, Z.-H. Qiu, F. Yang, X.-B. Yan, Q. Wang, X.-J. Gong, X.-Y. Liu and Y. -M. Liang, *Angew. Chem., Int. Ed.* **2014**, ***53***, 7629.

[2] D.-Q. Chen, P. Gao, P.-X. Zhou, X.-R. Song, Y.-F. Qiu, X.-Y. Liu and Y.-M. Liang, *Chem. Commun.* **2015**, *51*, 6637.

[3]. Y .-Z. Chen, L.-Z. Wu, M.-L. Peng, D. Zhang, L.-P. Zhang and C.-H. Tung, *Tetrahedron.* **2006**, *62*, 10688.

[4]. A. Arrault, F. Touzeau, G. Guillaumet, J.-Y. Mérour, *Synthesis.* **1999**, ***7***, 1241.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7.294
7.279
7.274
7.256
7.242
7.236
7.173
7.169
7.164
7.152
7.135
6.717
-0.002
S
O
3aa
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
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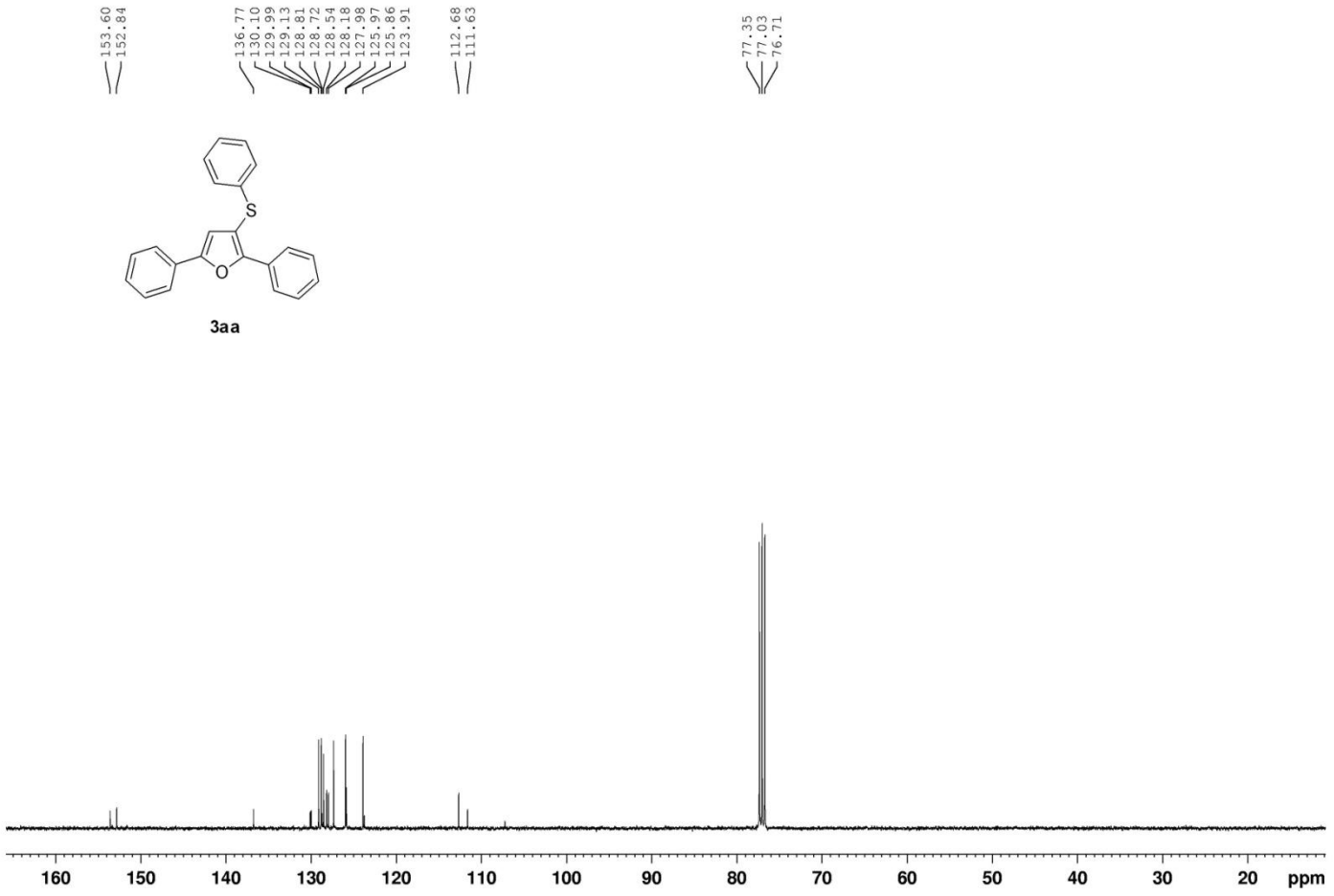
0.98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123.91
112.68
111.63
77.35
77.03
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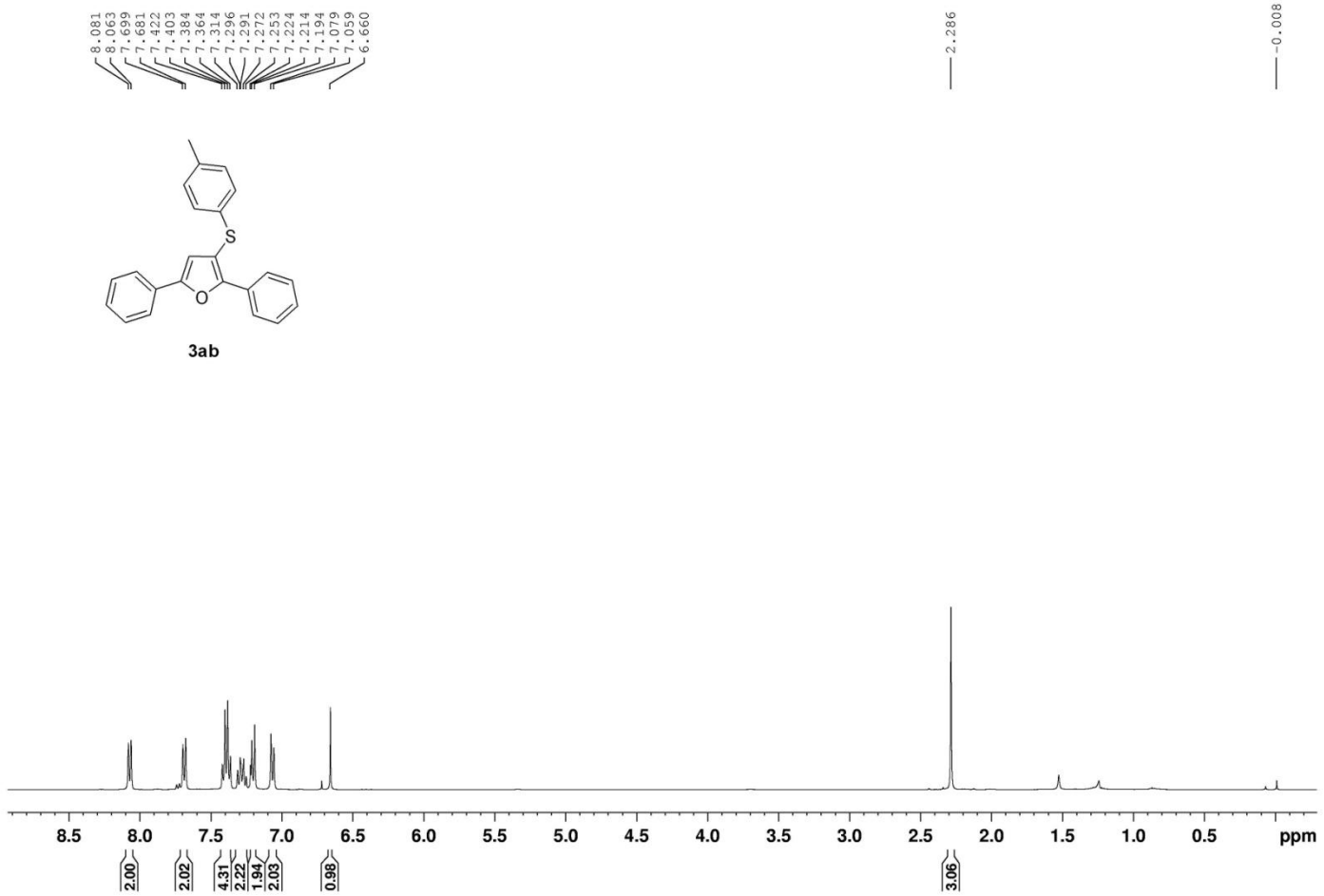
20
ppm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7.253
7.224
7.214
7.194
7.079
7.059
6.660
2.286
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O
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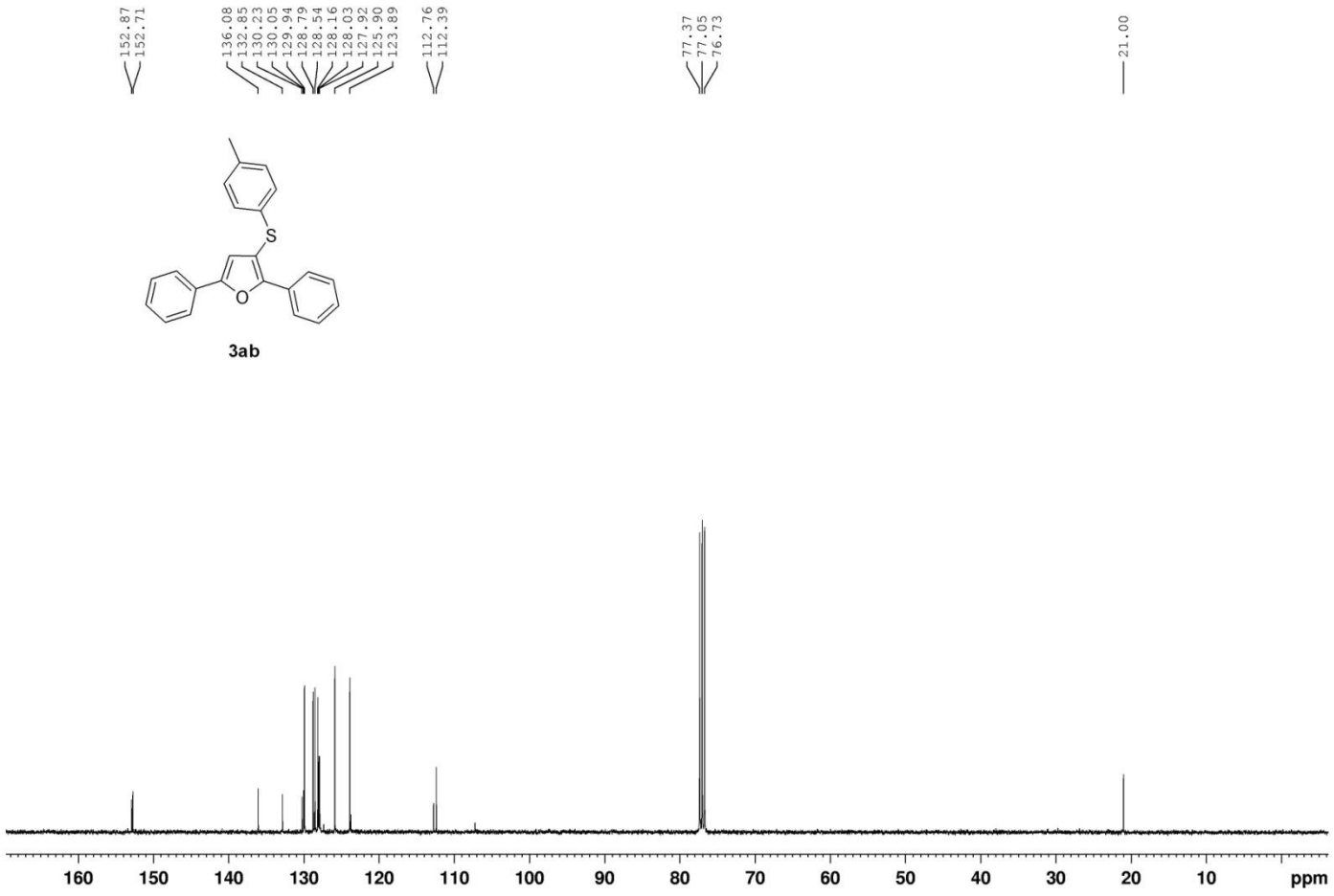
3.06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21.00
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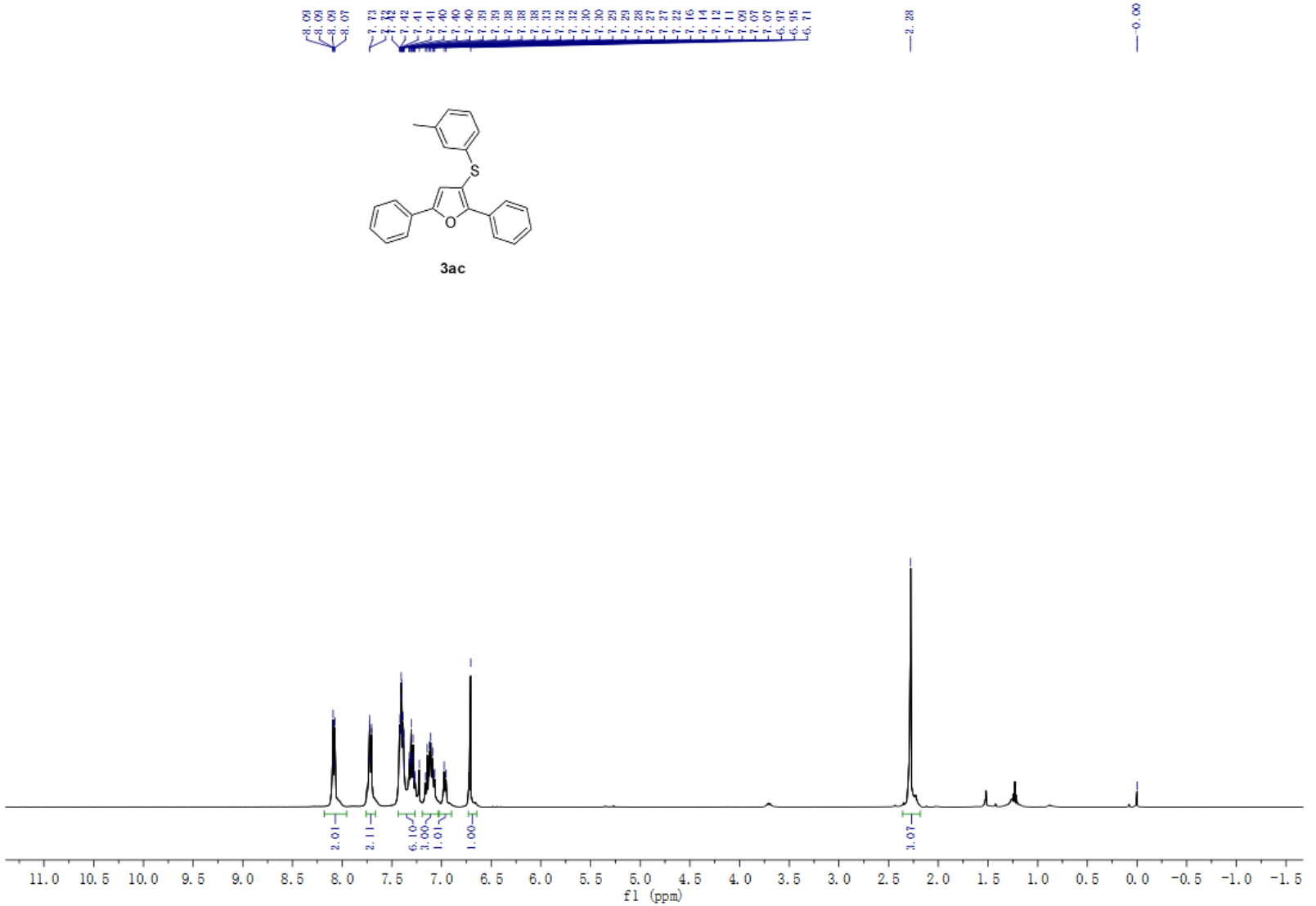
10
ppm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7.27
7.22
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7.14
7.12
7.11
7.09
7.07
6.97
6.95
6.71
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S
O
3ac
2.01
2.11
6.10
3.00
1.01
1.00
3.07
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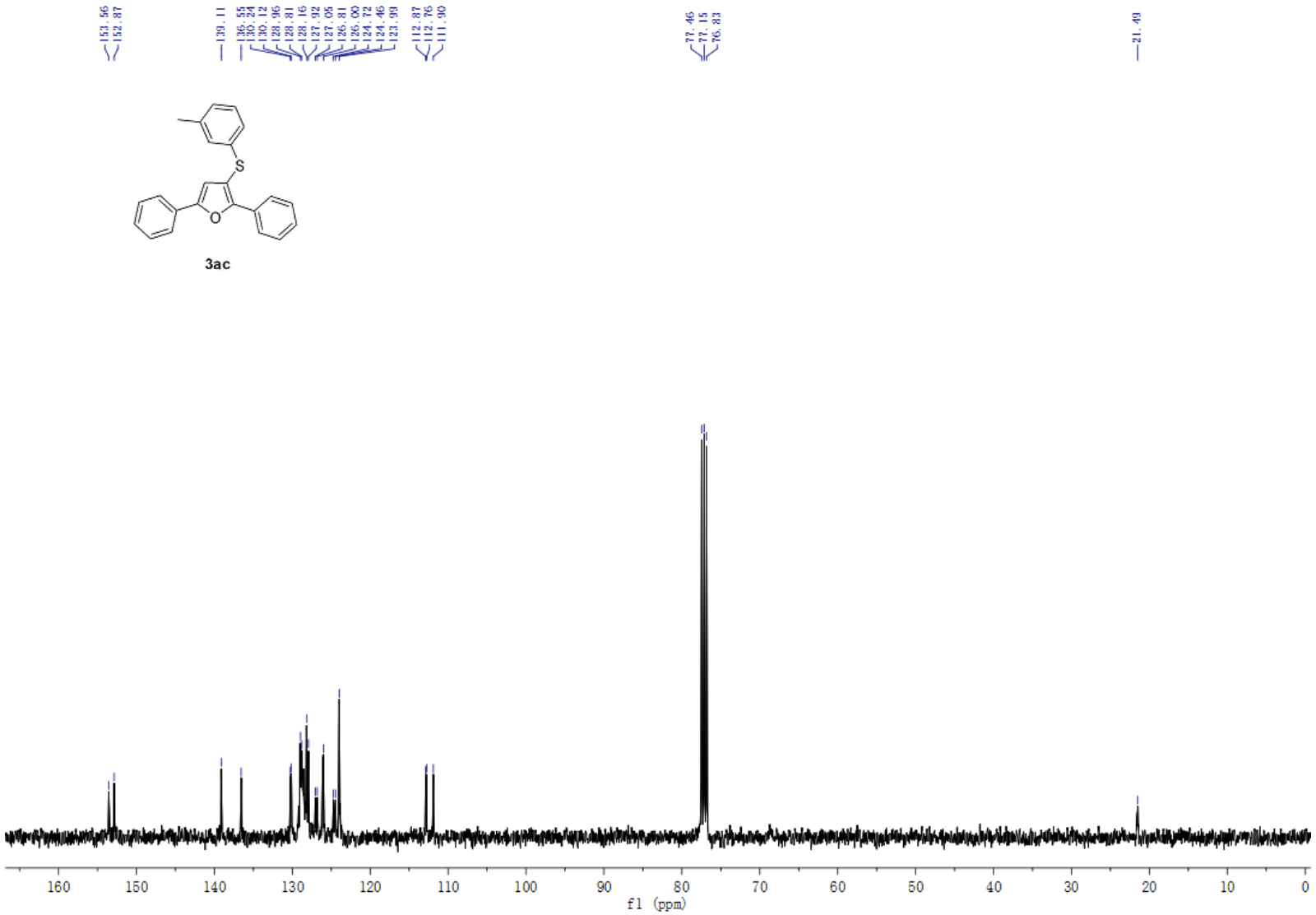
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O
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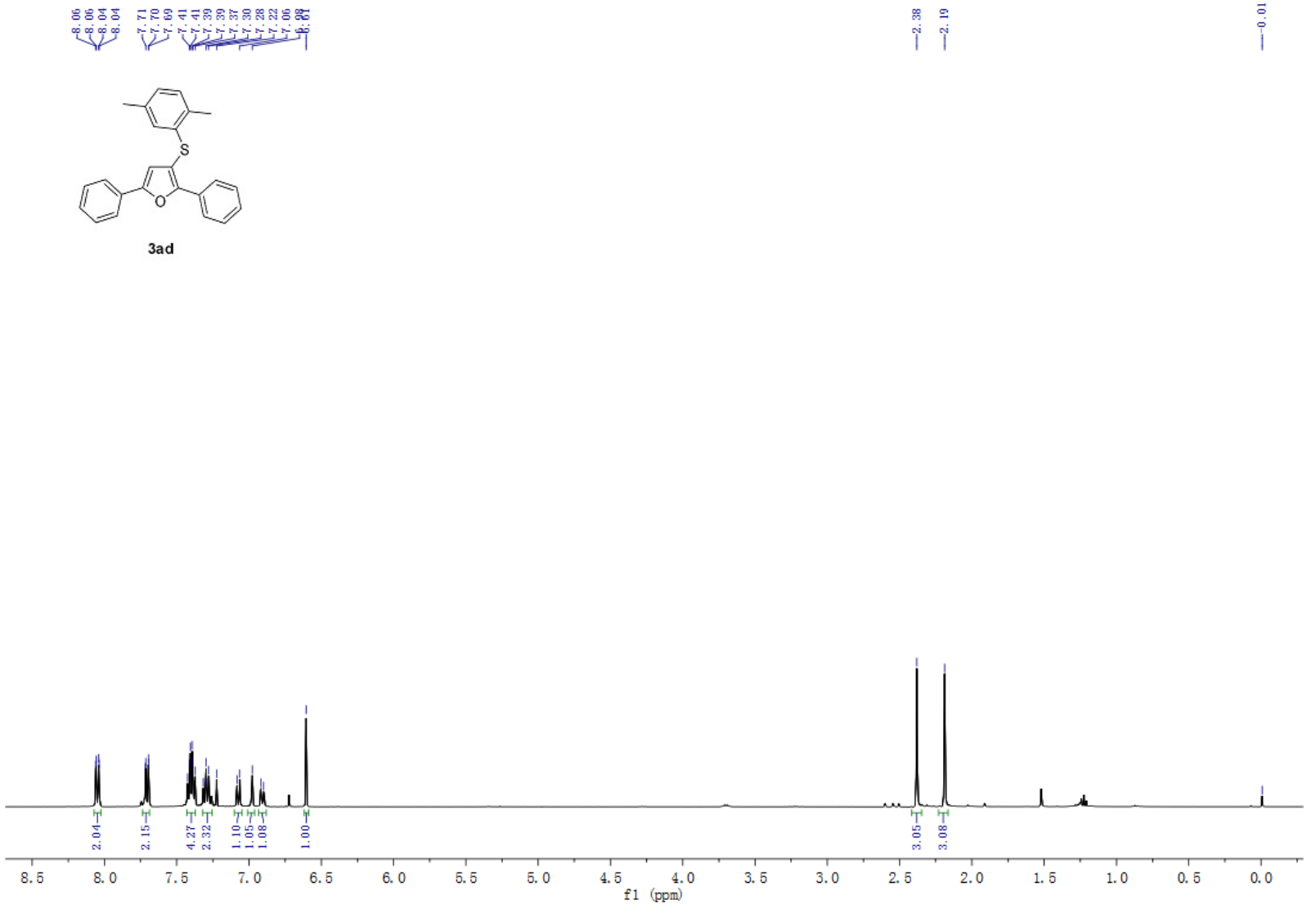
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7.28
7.22
7.06
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2.15
4.27
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1.10
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1.08
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3.05
3.08
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7.0
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f1 (ppm)

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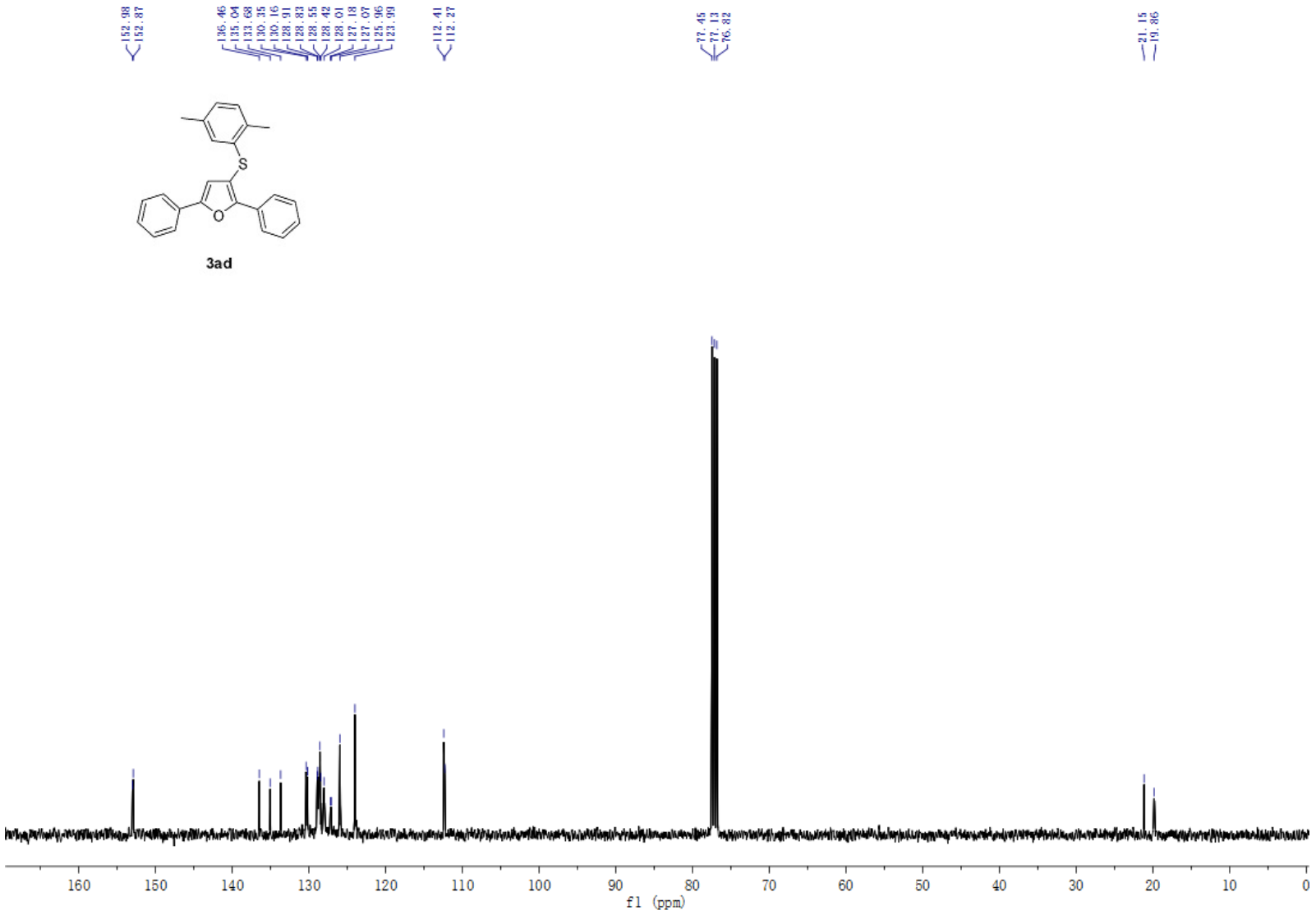
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O
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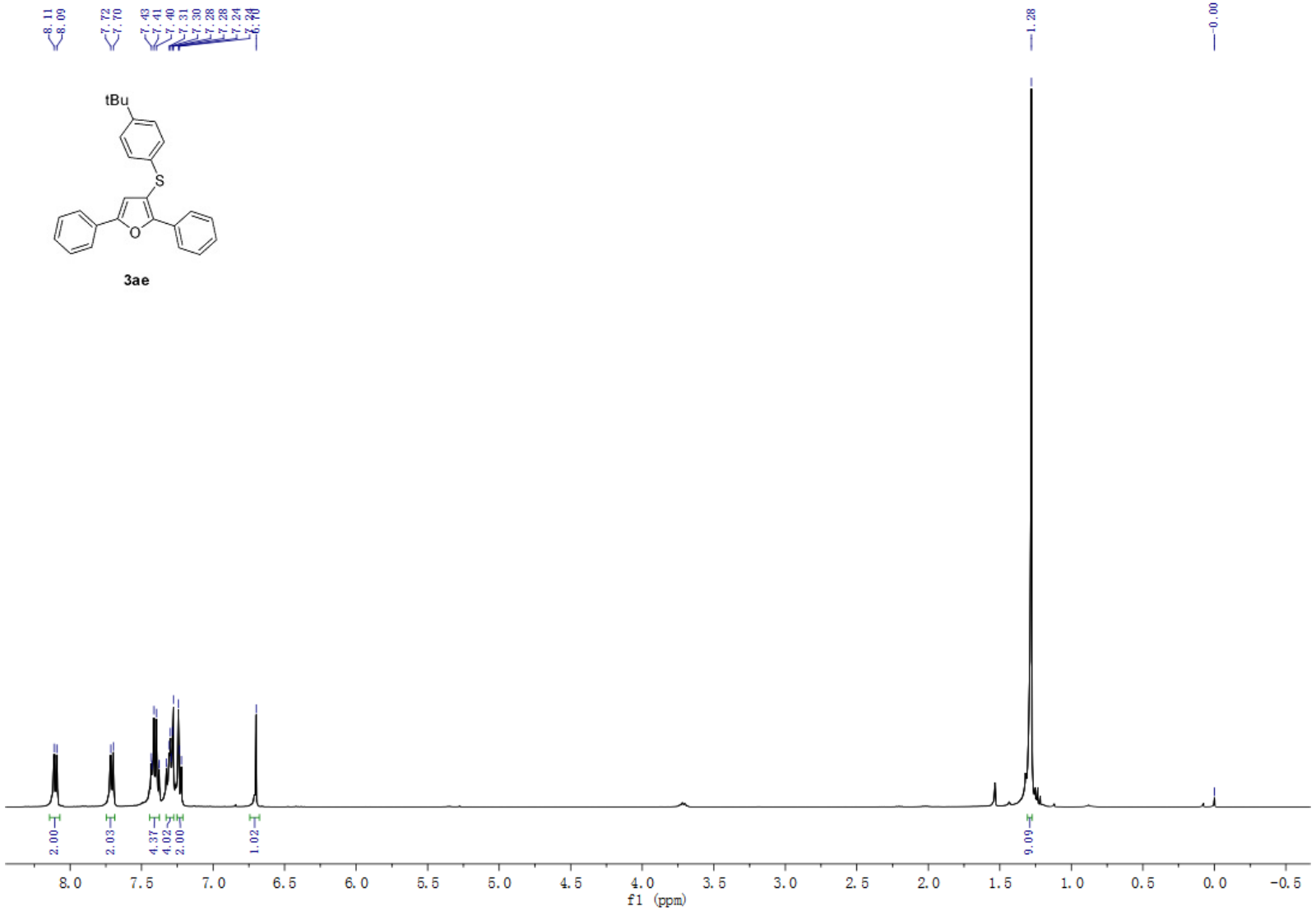
f1 (ppm)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O
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2.03
4.37
4.02
2.00
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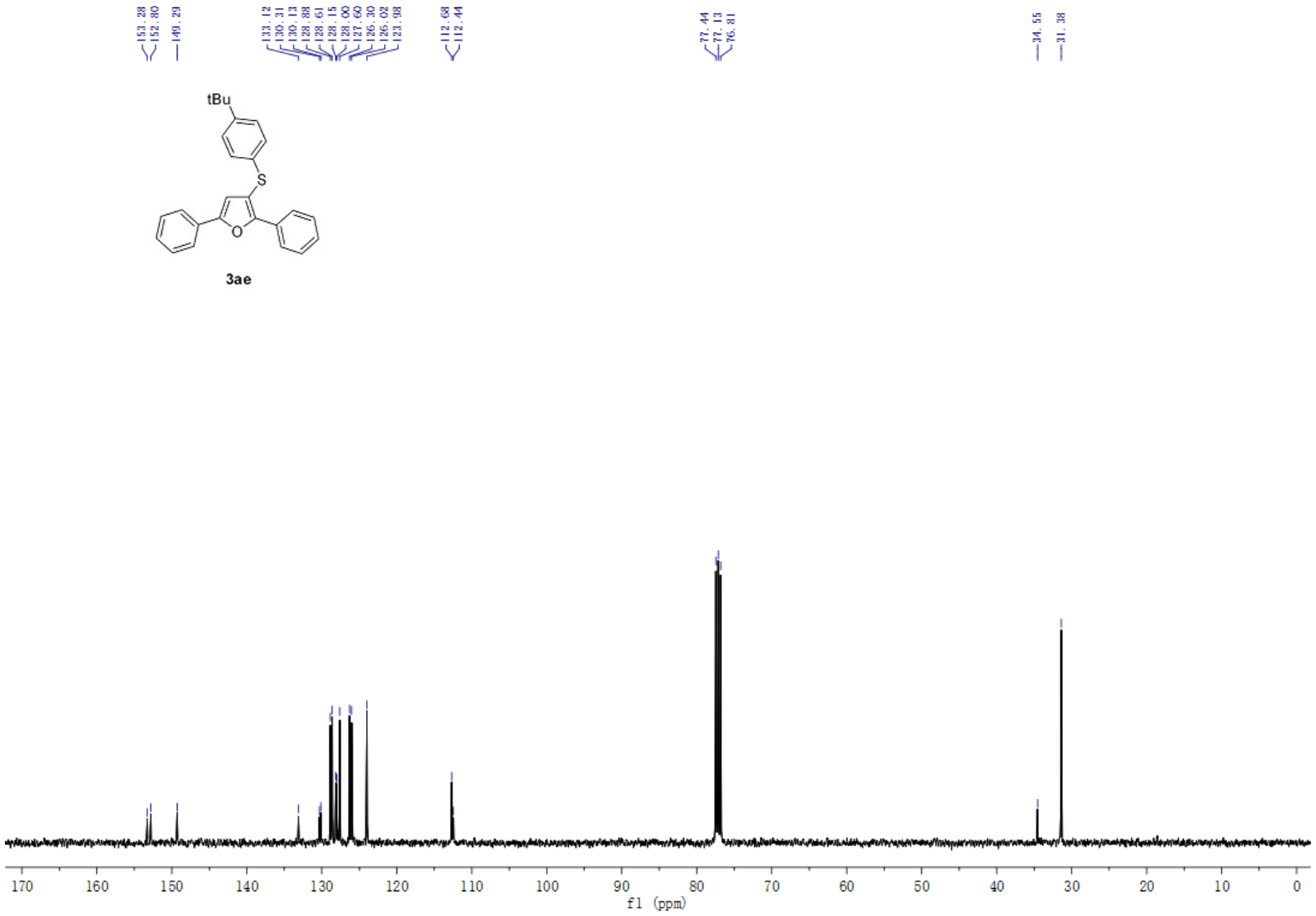
f1 (ppm)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tBu
S
O
3ae
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50
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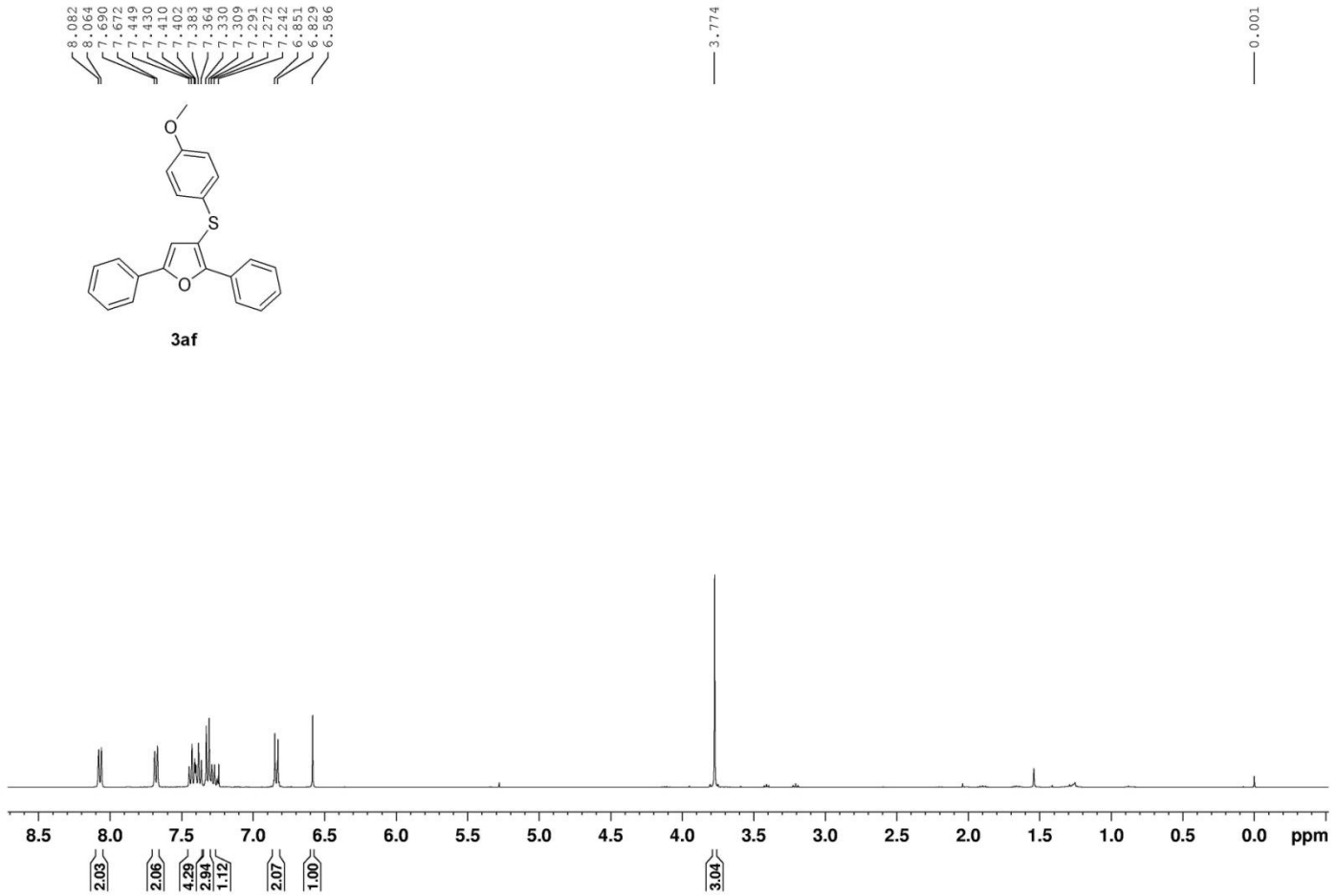
30
20
10
0
f1 (ppm)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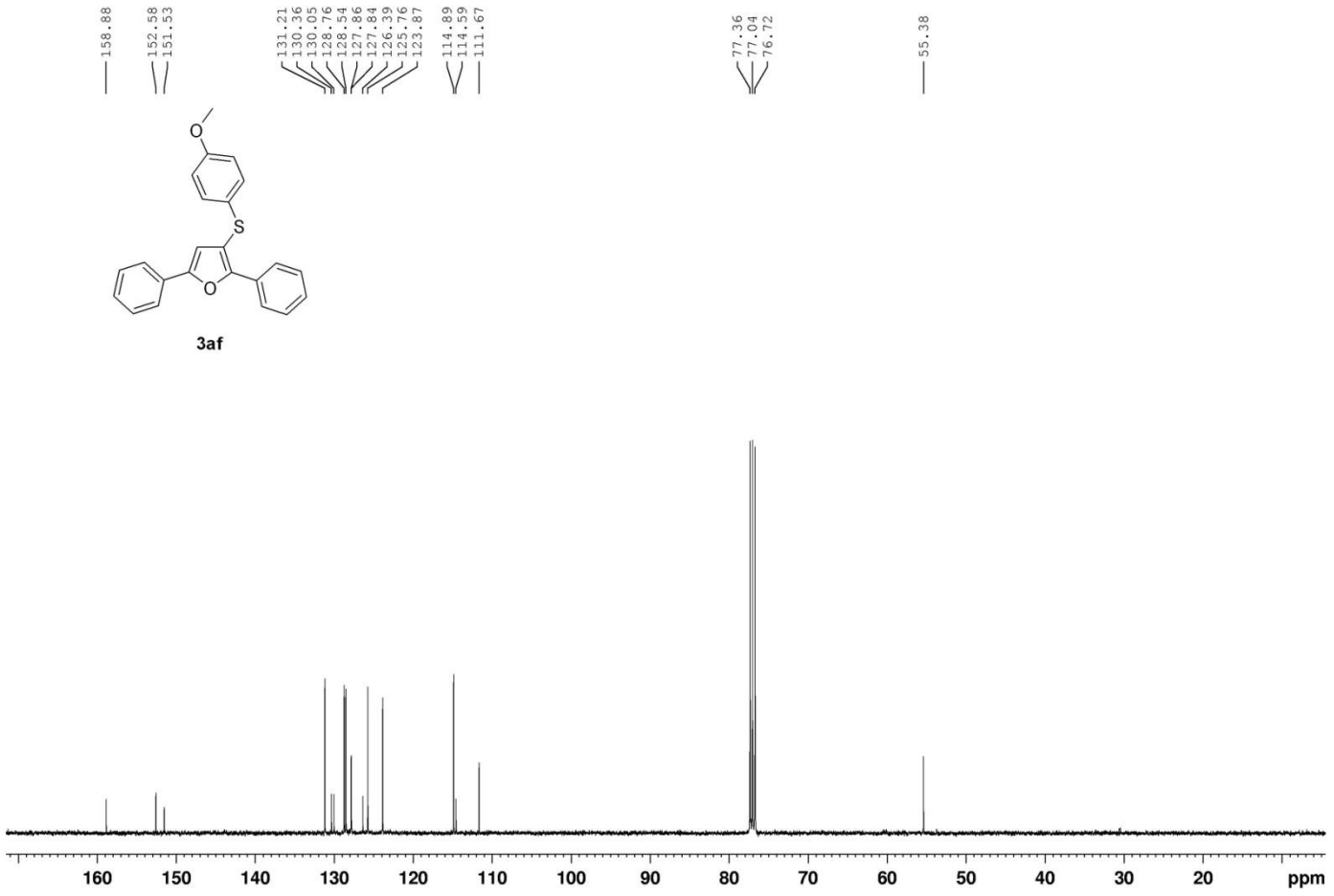
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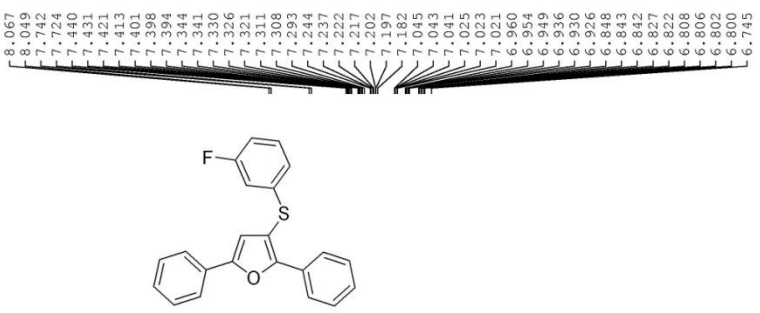
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S
O

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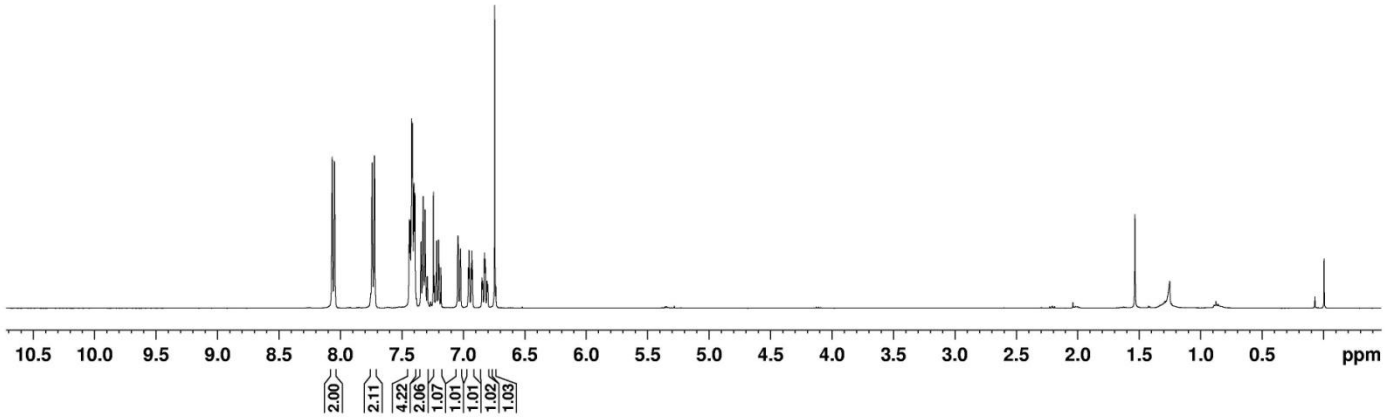
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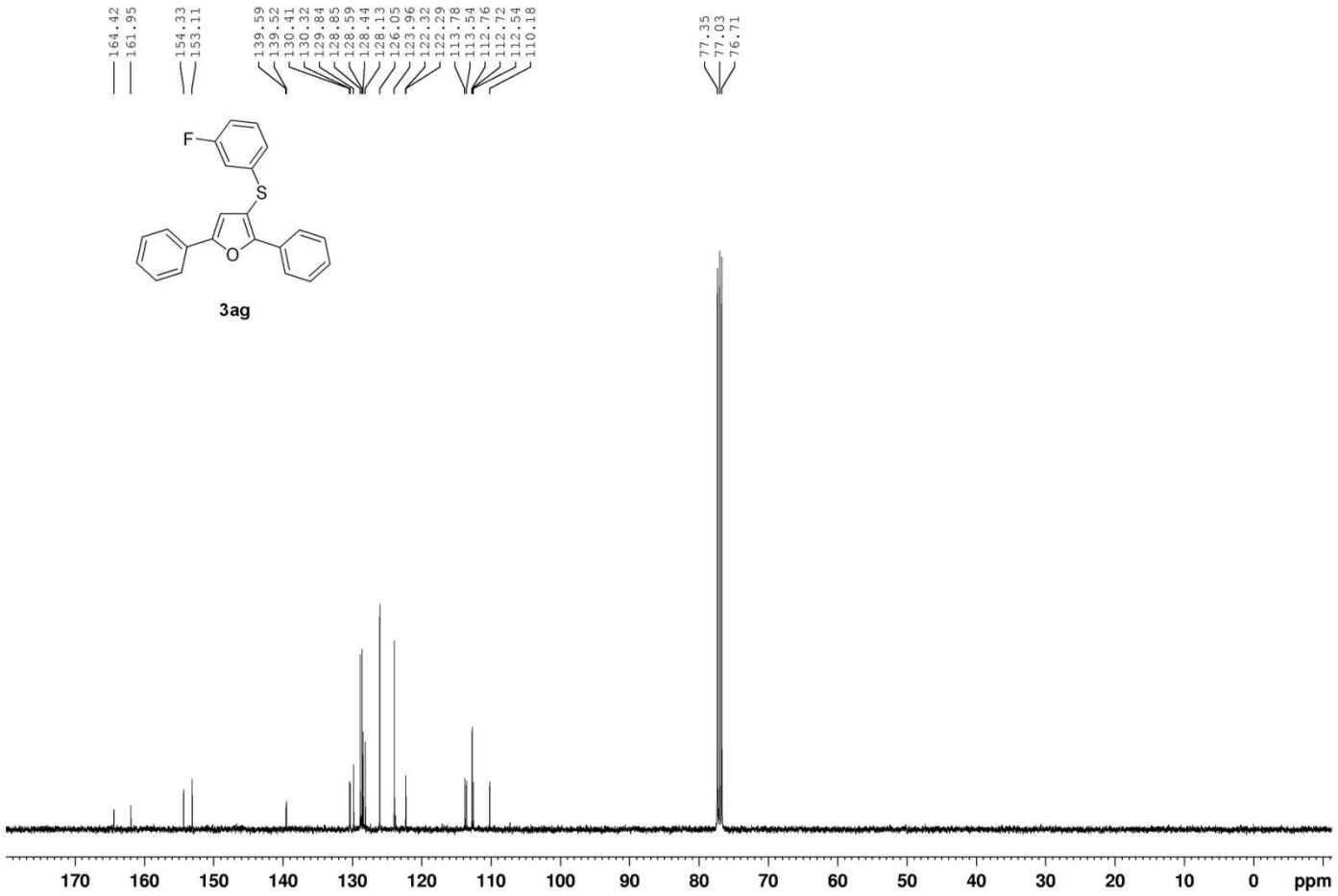
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O
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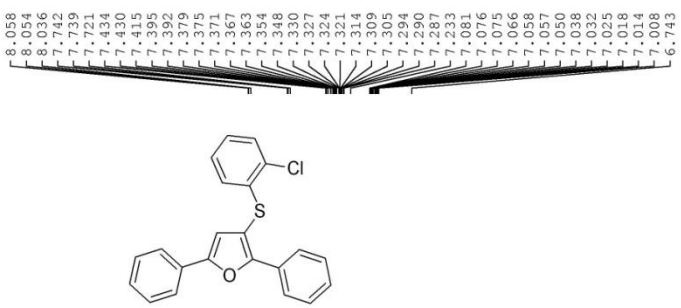
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Cl
S
O

3ah

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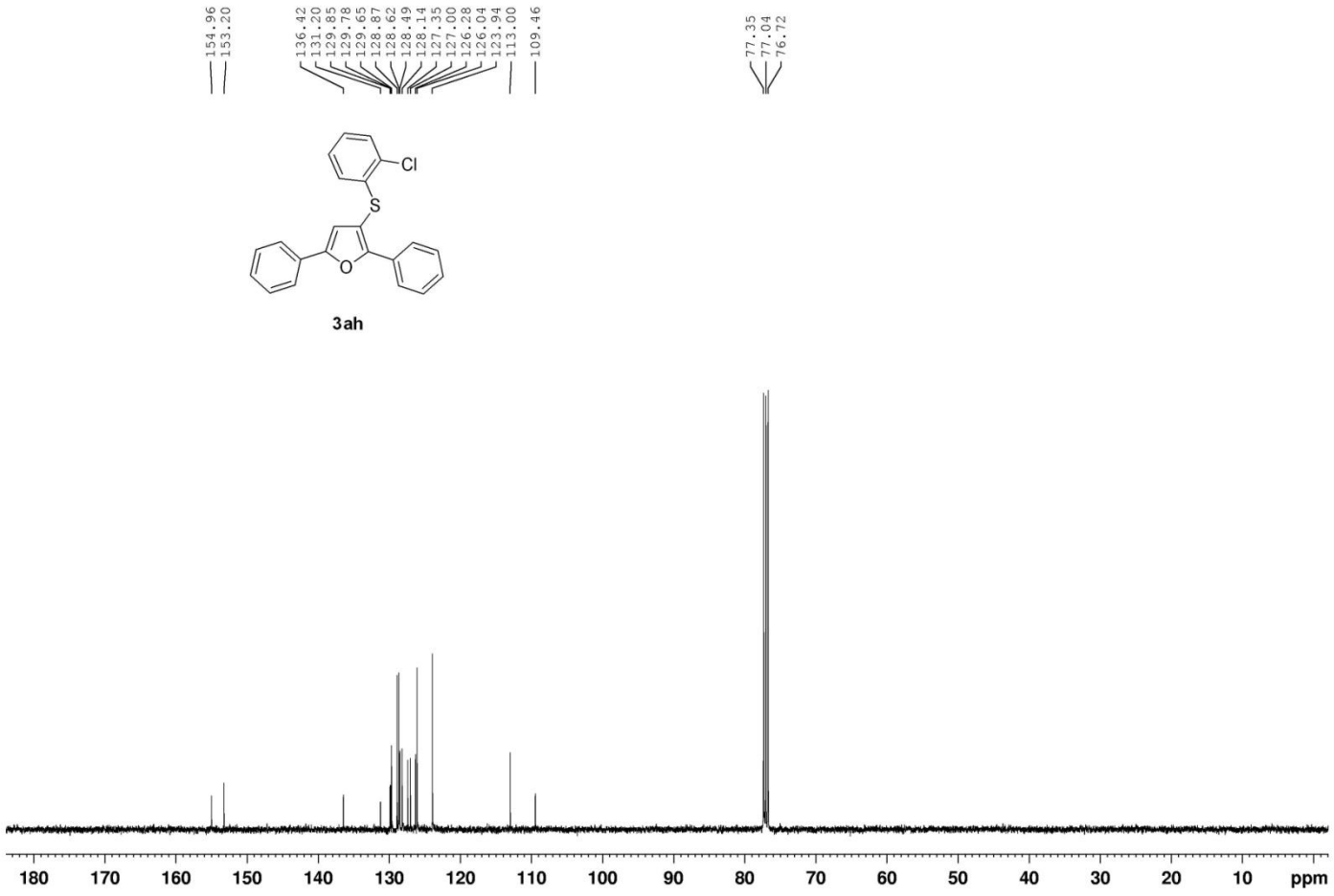
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Cl
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O
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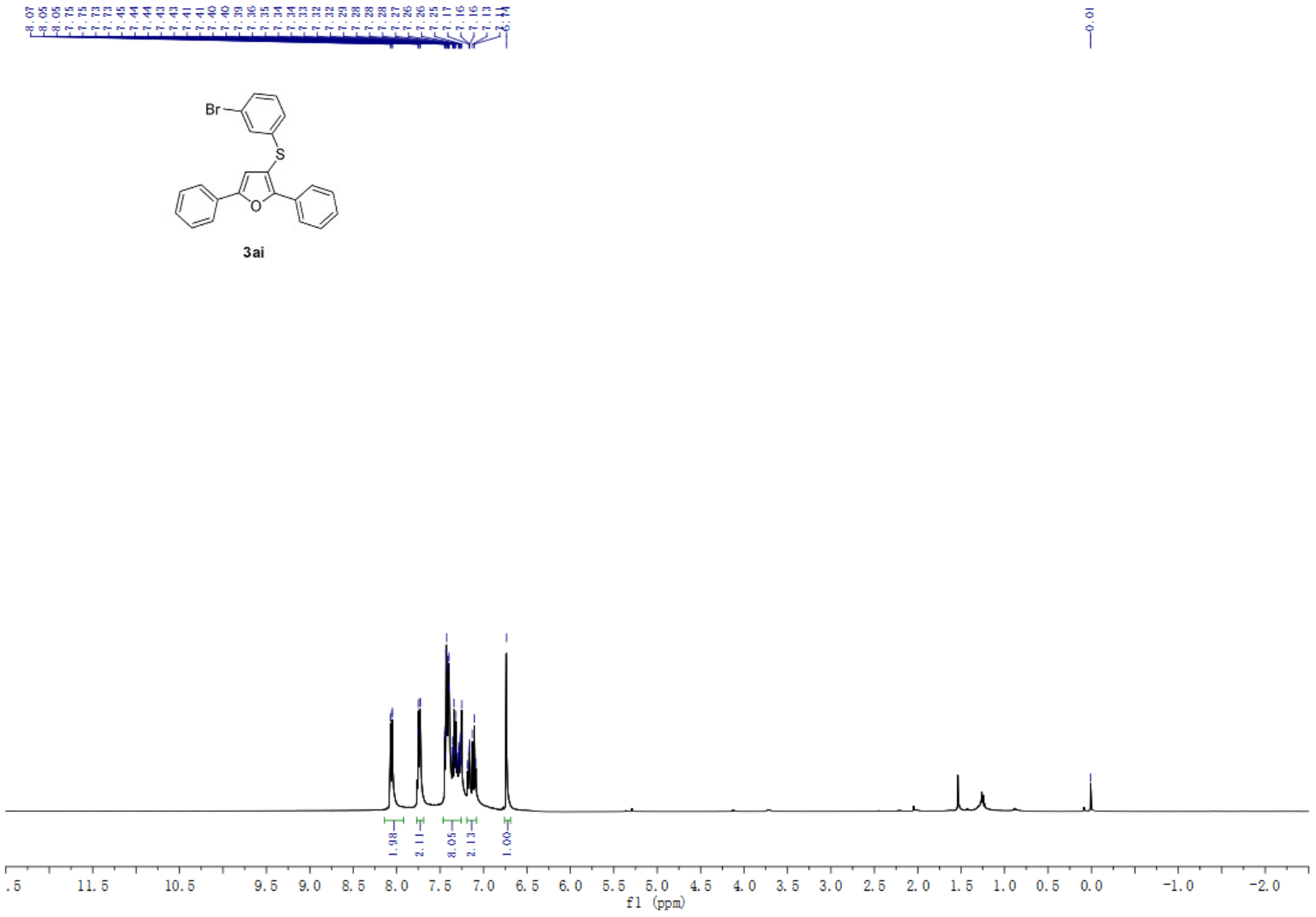
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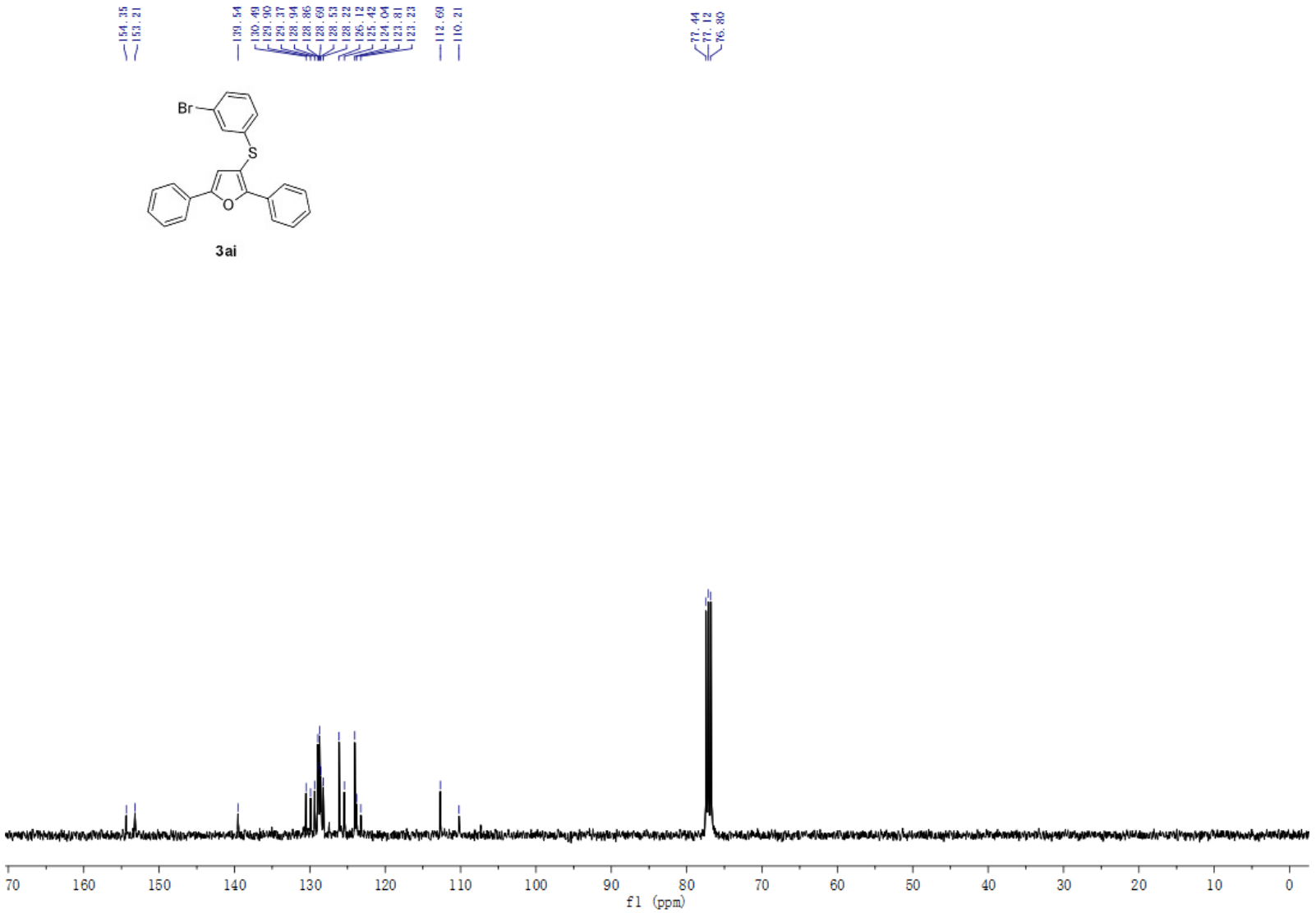
f1 (ppm)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77.44
77.12
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S
O
3ai
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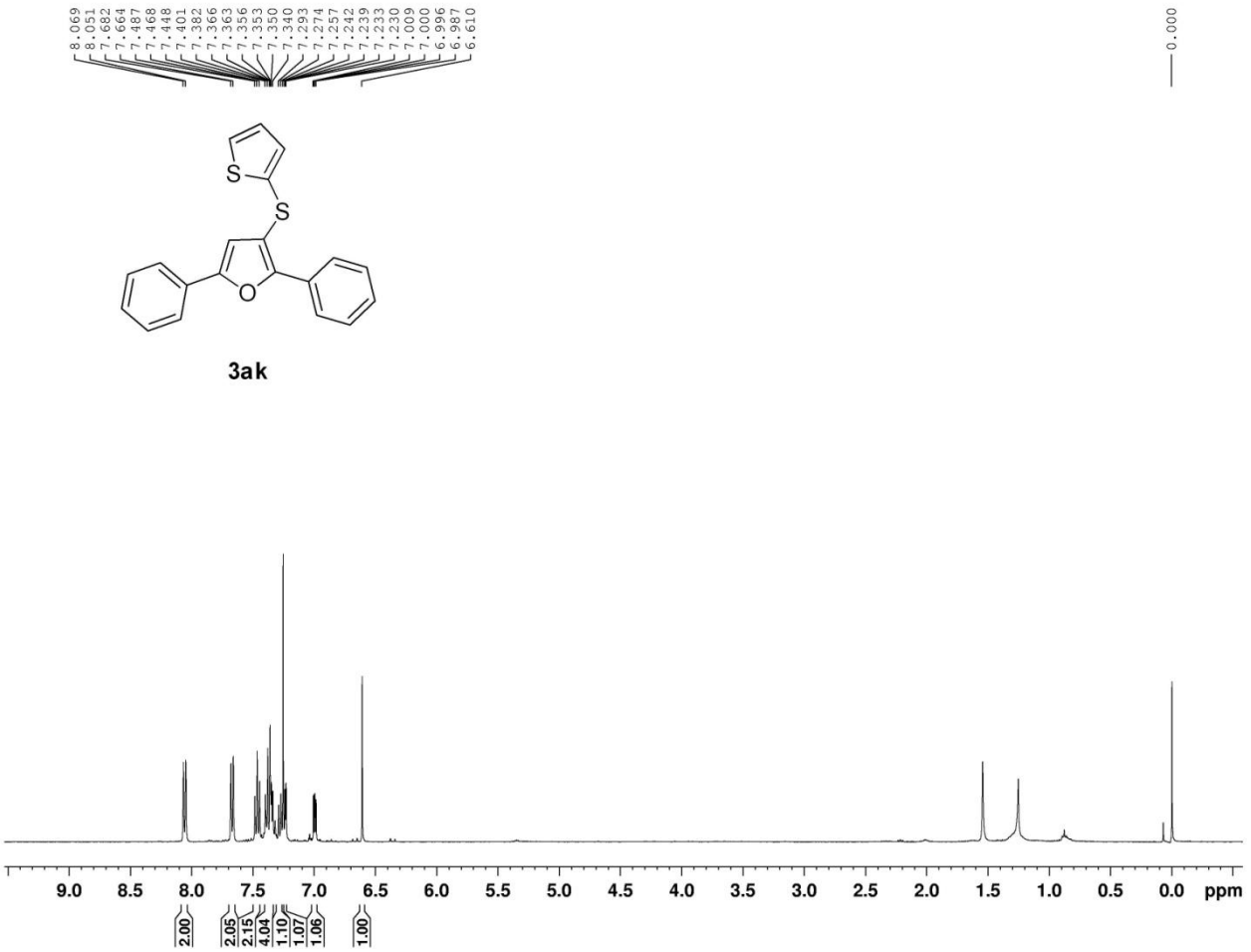
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.363
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7.353
7.350
7.340
7.293
7.274
7.257
7.242
7.239
7.233
7.230
7.009
7.000
6.996
6.987
6.610
0.000
S
S
O
3ak
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
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ppm
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2.05
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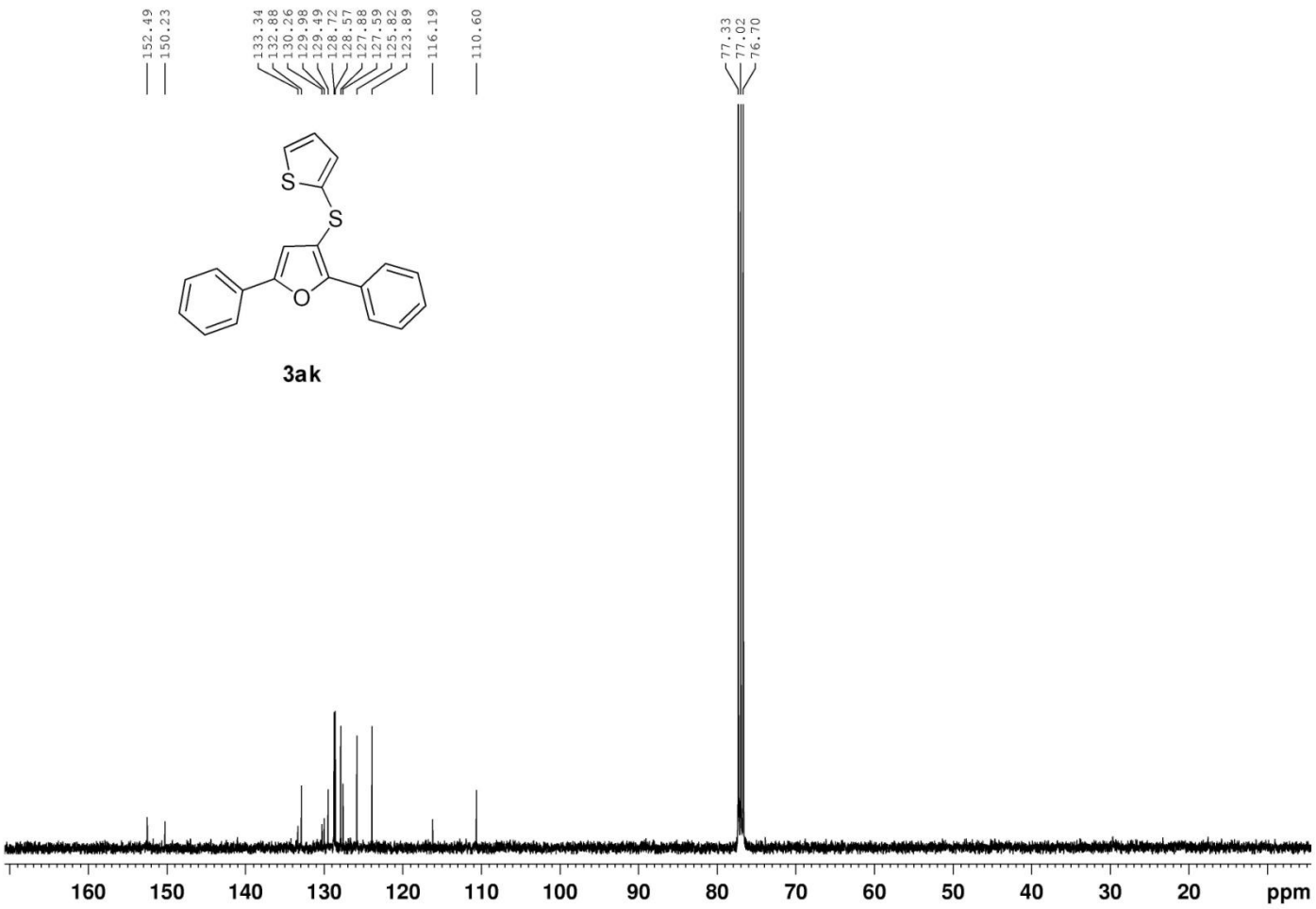
4.04
1.10
1.07
1.06
1.00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129.98
129.49
128.72
128.57
127.88
127.59
125.82
123.89
116.19
110.60
77.33
77.02
76.70
S
S
O
3ak
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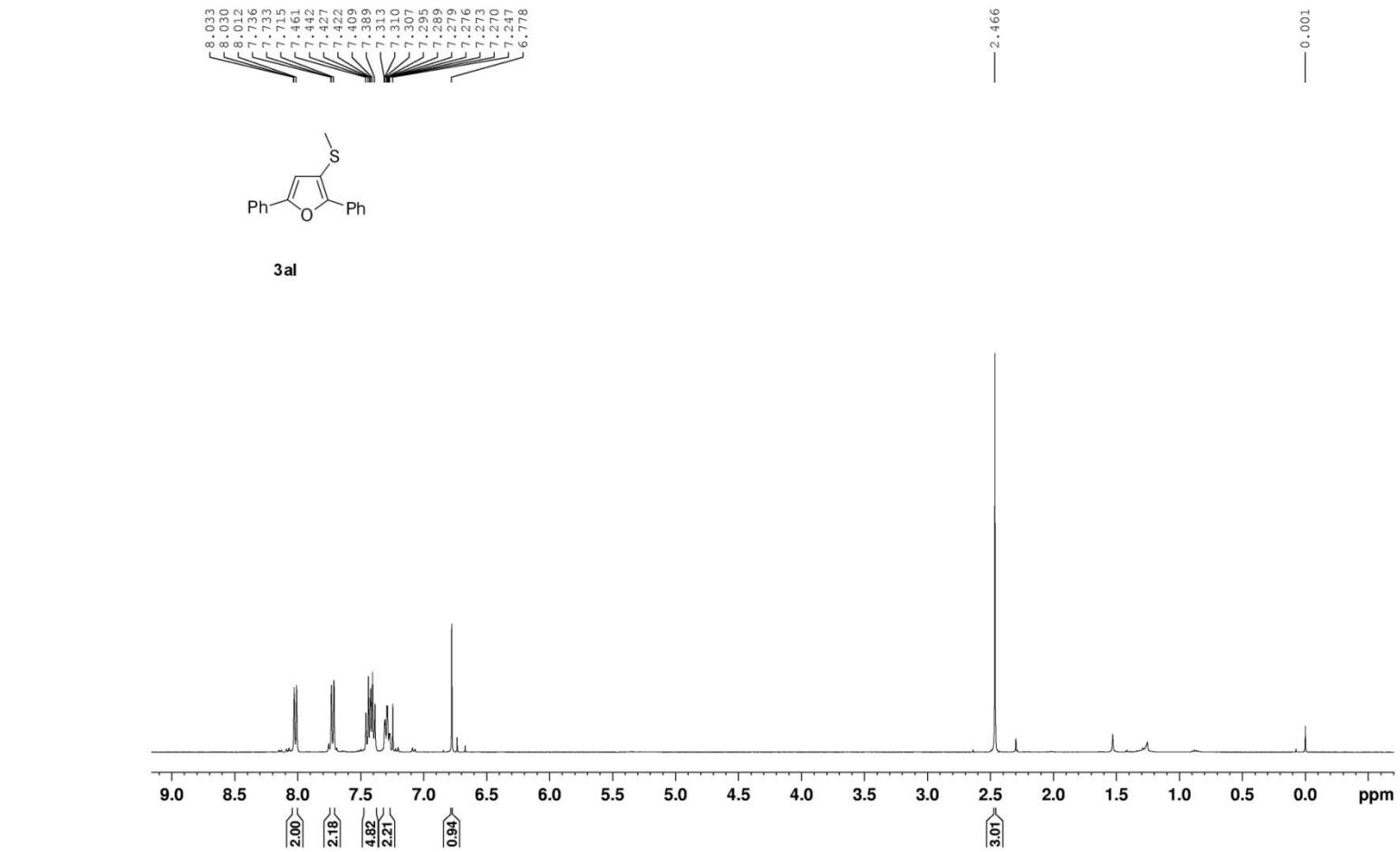
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm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7.442
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7.422
7.409
7.389
7.313
7.310
7.307
7.295
7.289
7.279
7.276
7.273
7.270
7.247
6.778
2.466
0.001
S
Ph
O
Ph
3al
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
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1.0
0.5
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ppm
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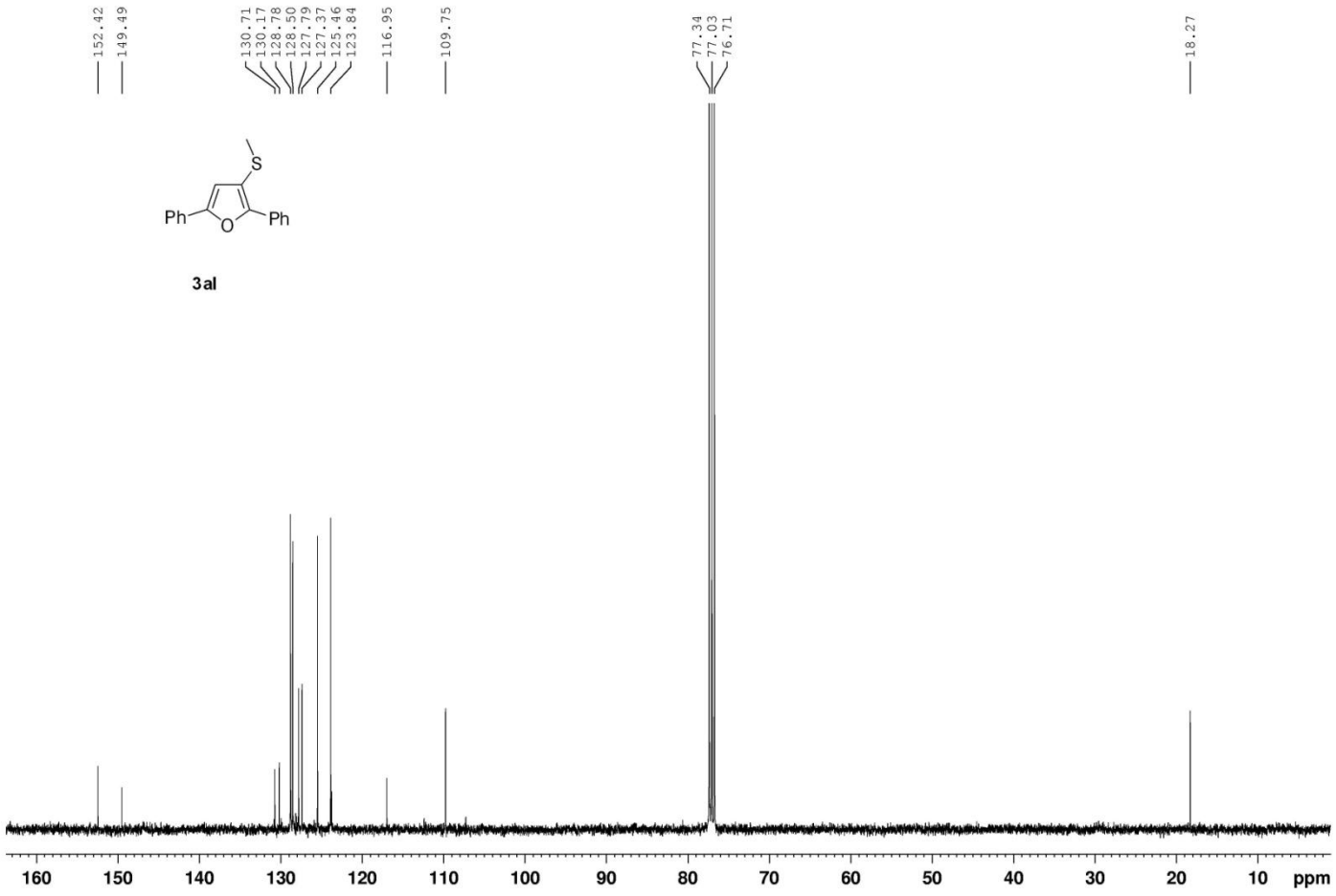
4.82
2.21
0.94
3.01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128.50
127.79
127.37
125.46
123.84
116.95
109.75
77.34
77.03
76.71
18.27
S
Ph
O
Ph
3al
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150
140
130
120
110
100
90
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70
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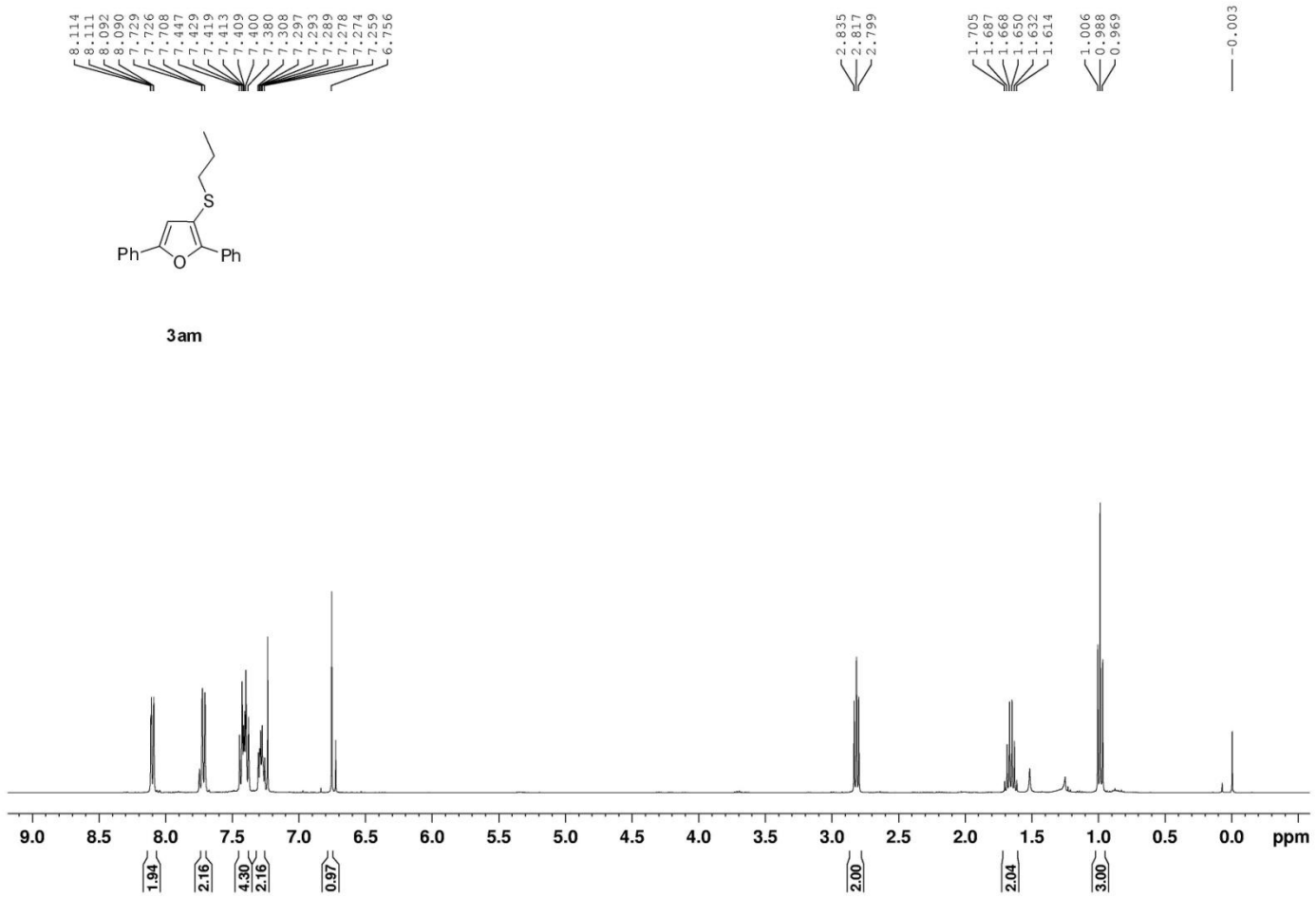
50
40
30
20
10
ppm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8.092
8.090
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7.726
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7.447
7.429
7.419
7.413
7.409
7.400
7.380
7.308
7.297
7.293
7.289
7.278
7.274
7.259
6.756
2.835
2.817
2.799
1.705
1.687
1.668
1.650
1.632
1.614
1.006
0.988
0.969
-0.003
S
Ph
O
Ph
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
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4.30
2.16
0.97
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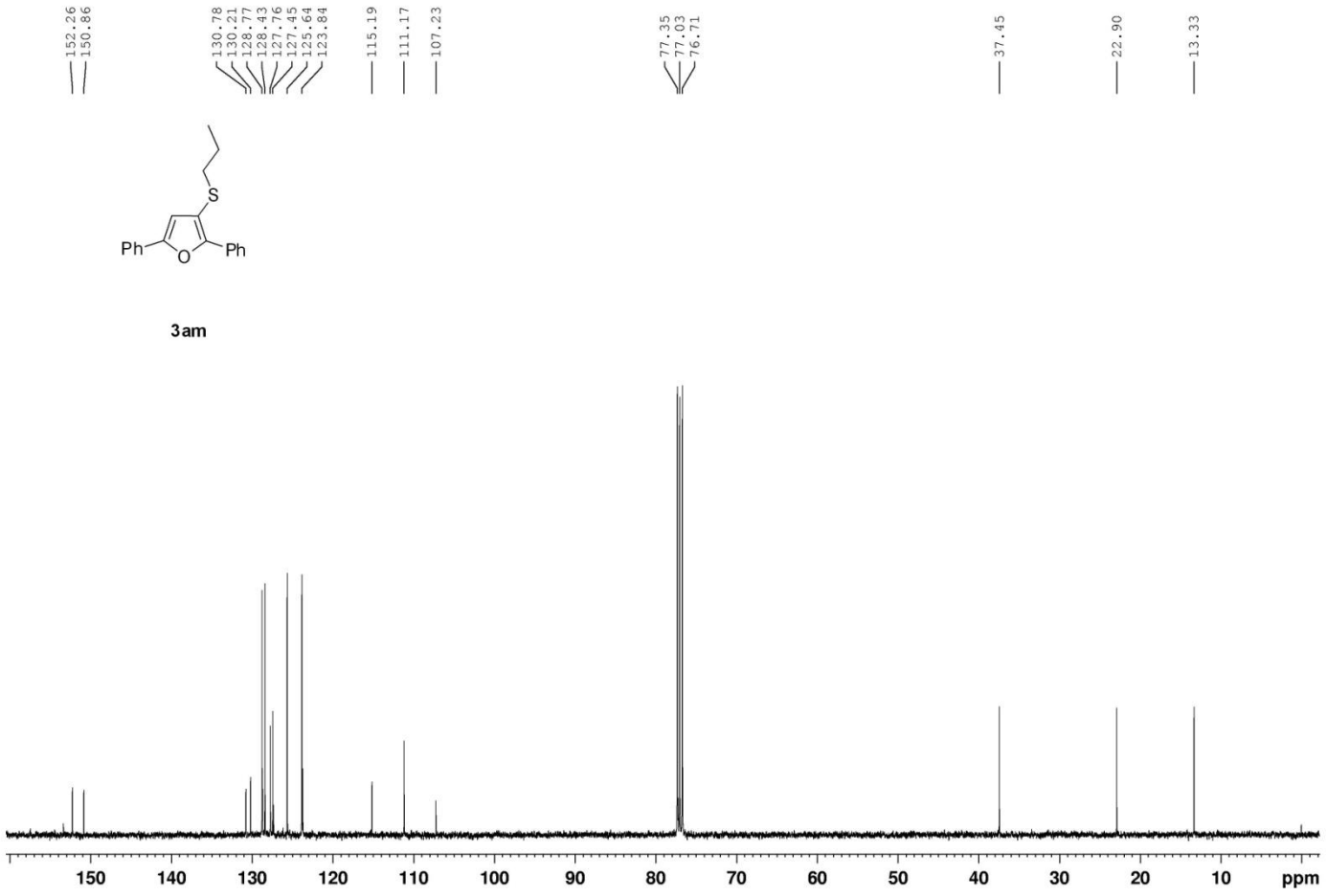
2.04
3.00

3am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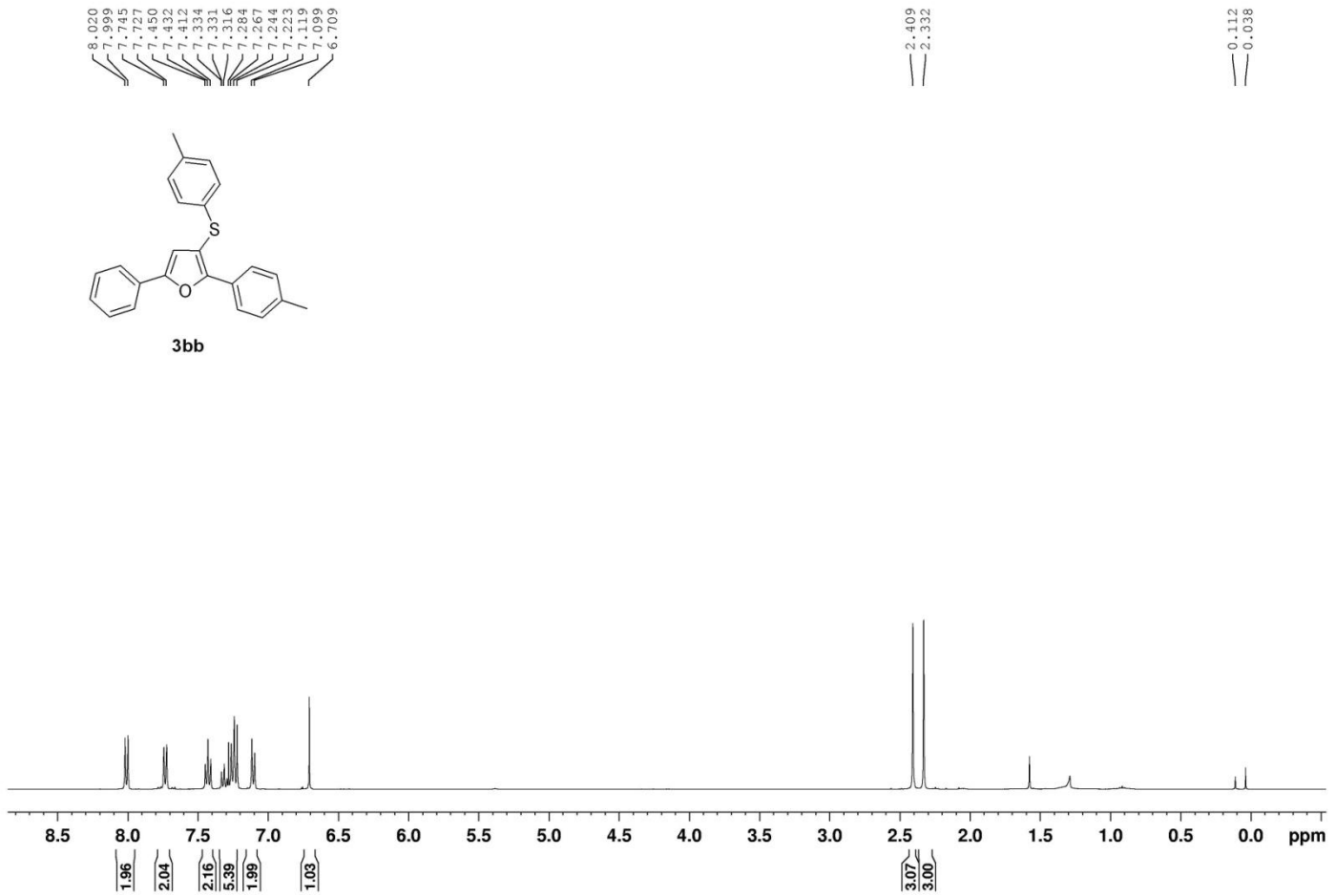
127.76
127.45
125.64
123.84
115.19
111.17
107.23
77.35
77.03
76.71
37.45
22.90
13.33
S
Ph
O
Ph
3am
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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7.727
7.450
7.432
7.412
7.334
7.331
7.316
7.284
7.267
7.244
7.223
7.119
7.099
6.709
2.409
2.332
0.112
0.038
S
O
3bb
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
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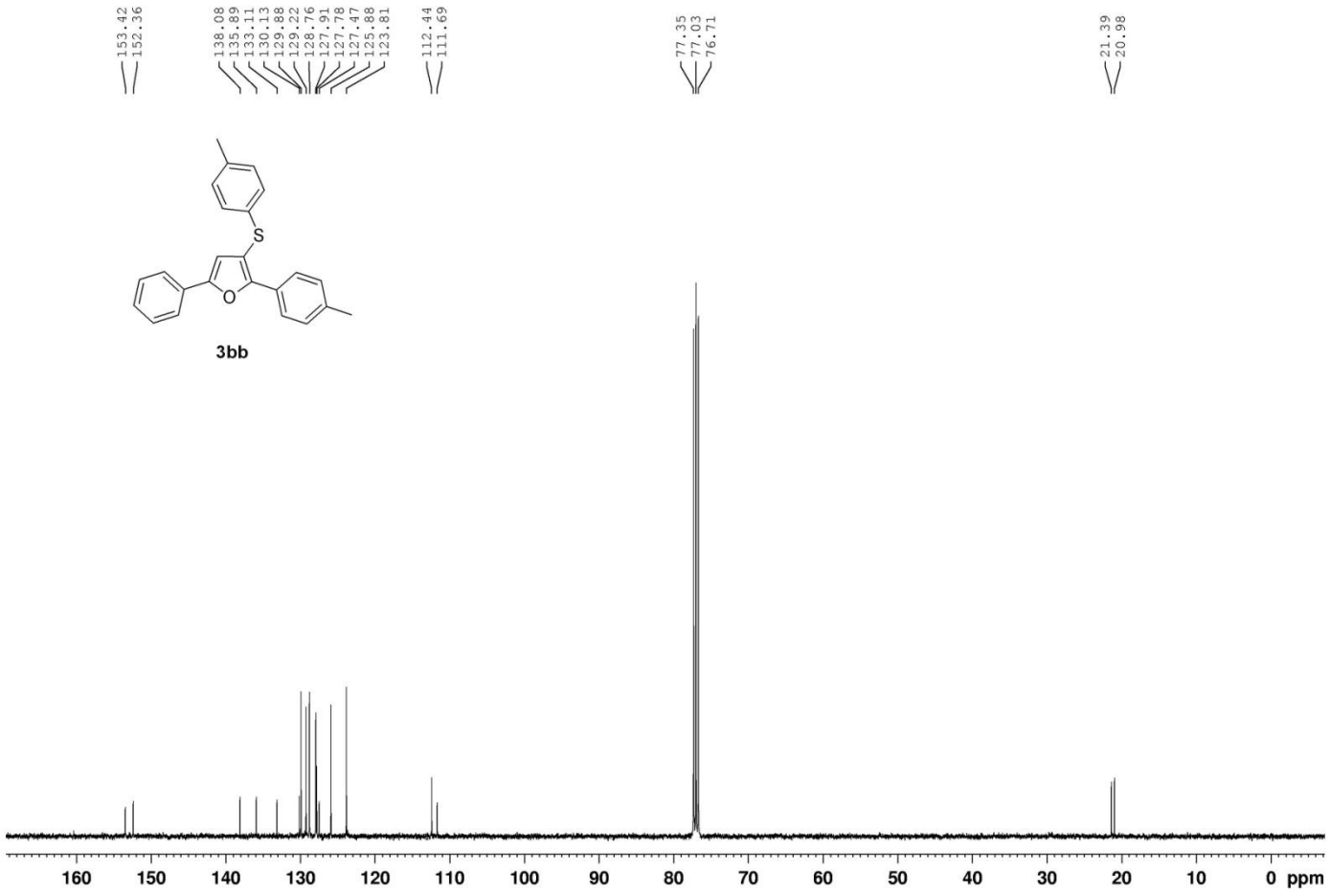
0.0
ppm
1.96
2.04
2.16
5.39
1.99
1.03
3.07
3.00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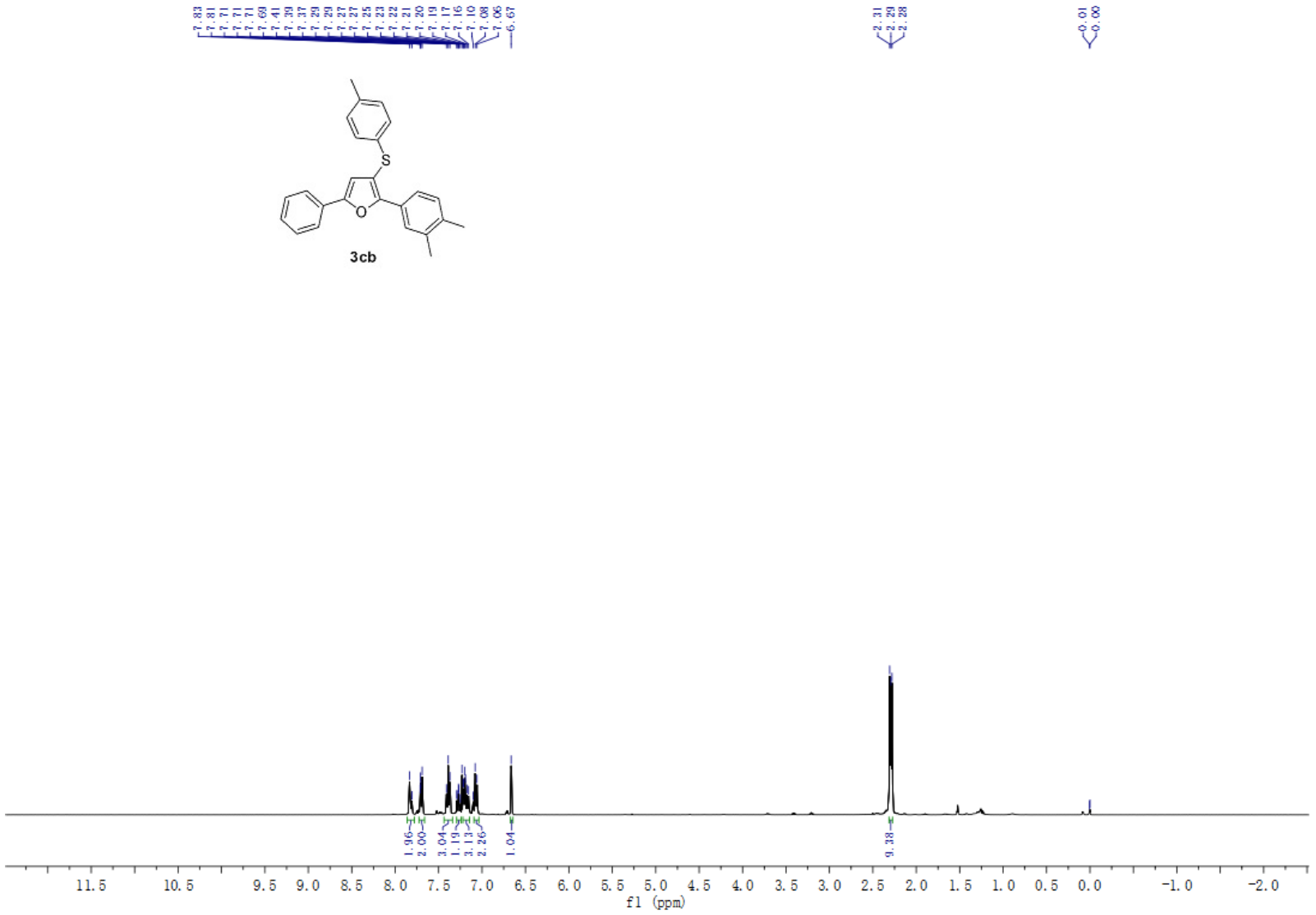
129.88
129.22
128.76
127.91
127.78
127.47
125.88
123.81
112.44
111.69
77.35
77.03
76.71
21.39
20.98
S
O
3bb
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0 ppm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7.29
7.29
7.27
7.27
7.25
7.23
7.22
7.21
7.20
7.19
7.17
7.16
7.10
7.08
7.06
6.67
2.31
2.29
2.28
0.01
0.00
S
O
3cb
1.96
2.00
3.04
1.19
3.13
2.26
1.04
9.38
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
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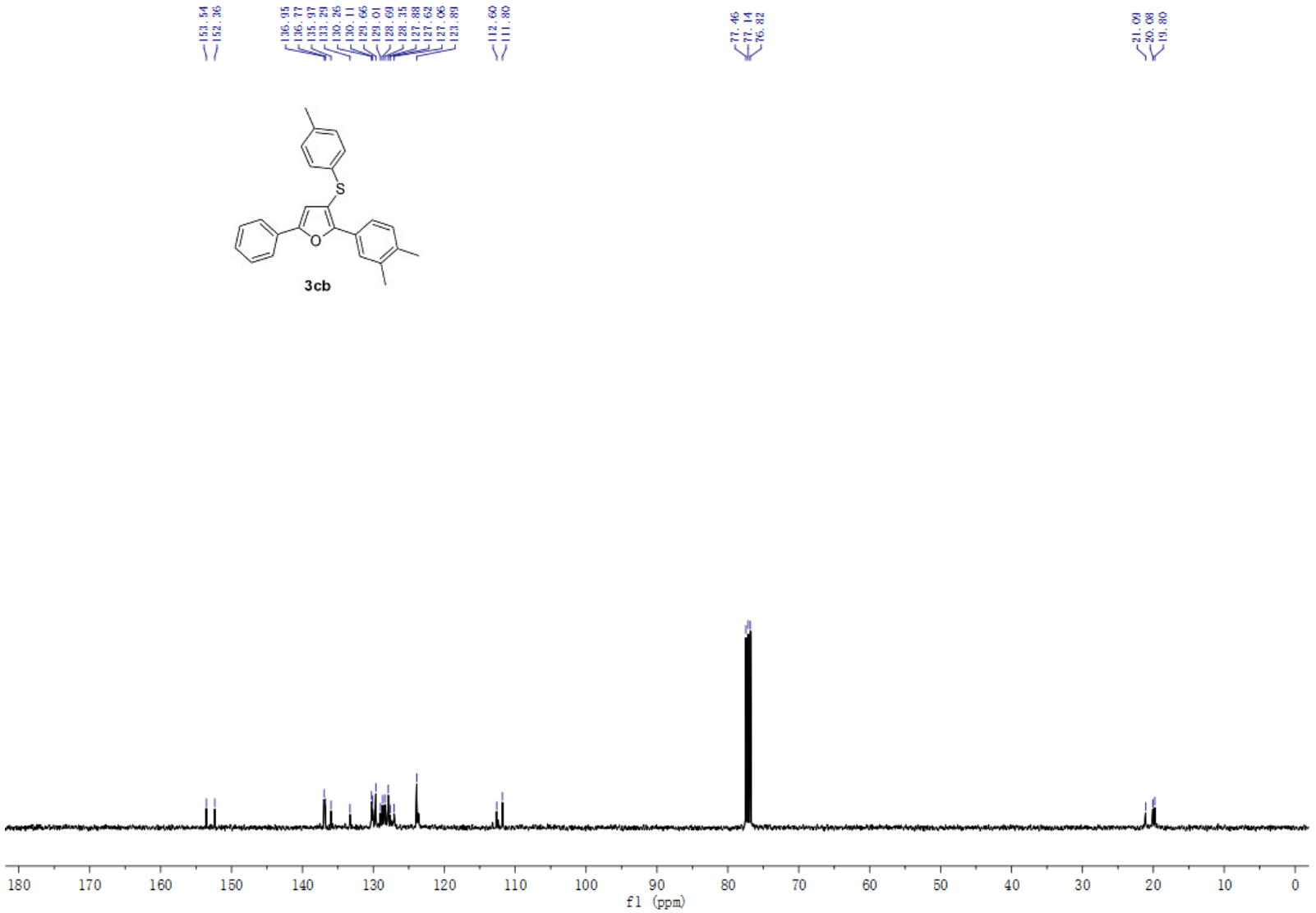
-2.0
f1 (ppm)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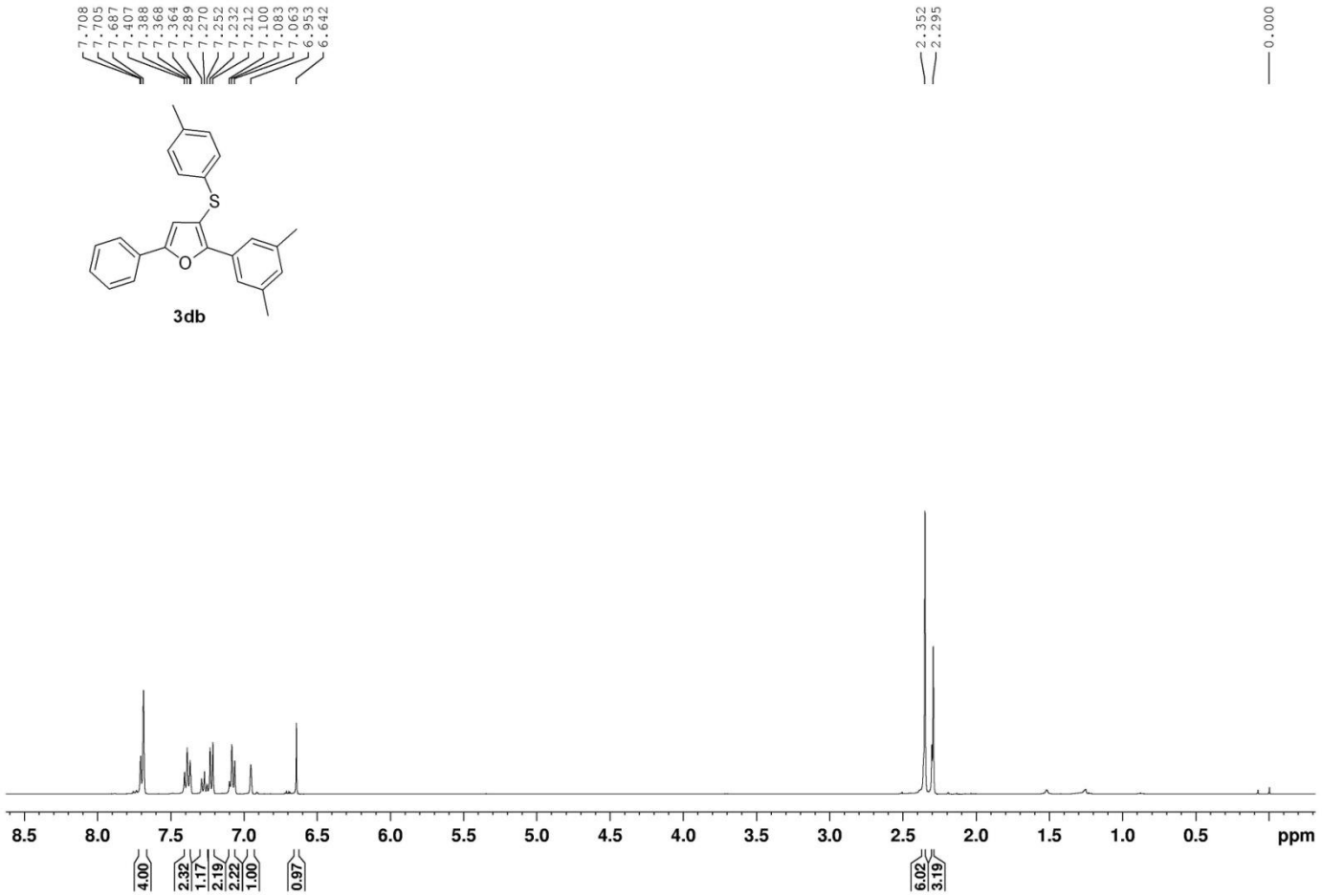
130.26
130.11
129.66
129.01
128.69
128.35
127.88
127.62
127.06
123.89
112.60
111.80
77.46
77.14
76.82
21.09
20.08
19.80
S
O
3cb
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.368
7.364
7.289
7.270
7.252
7.232
7.212
7.100
7.083
7.063
6.953
6.642
2.352
2.295
0.000
S
O
3db
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
ppm
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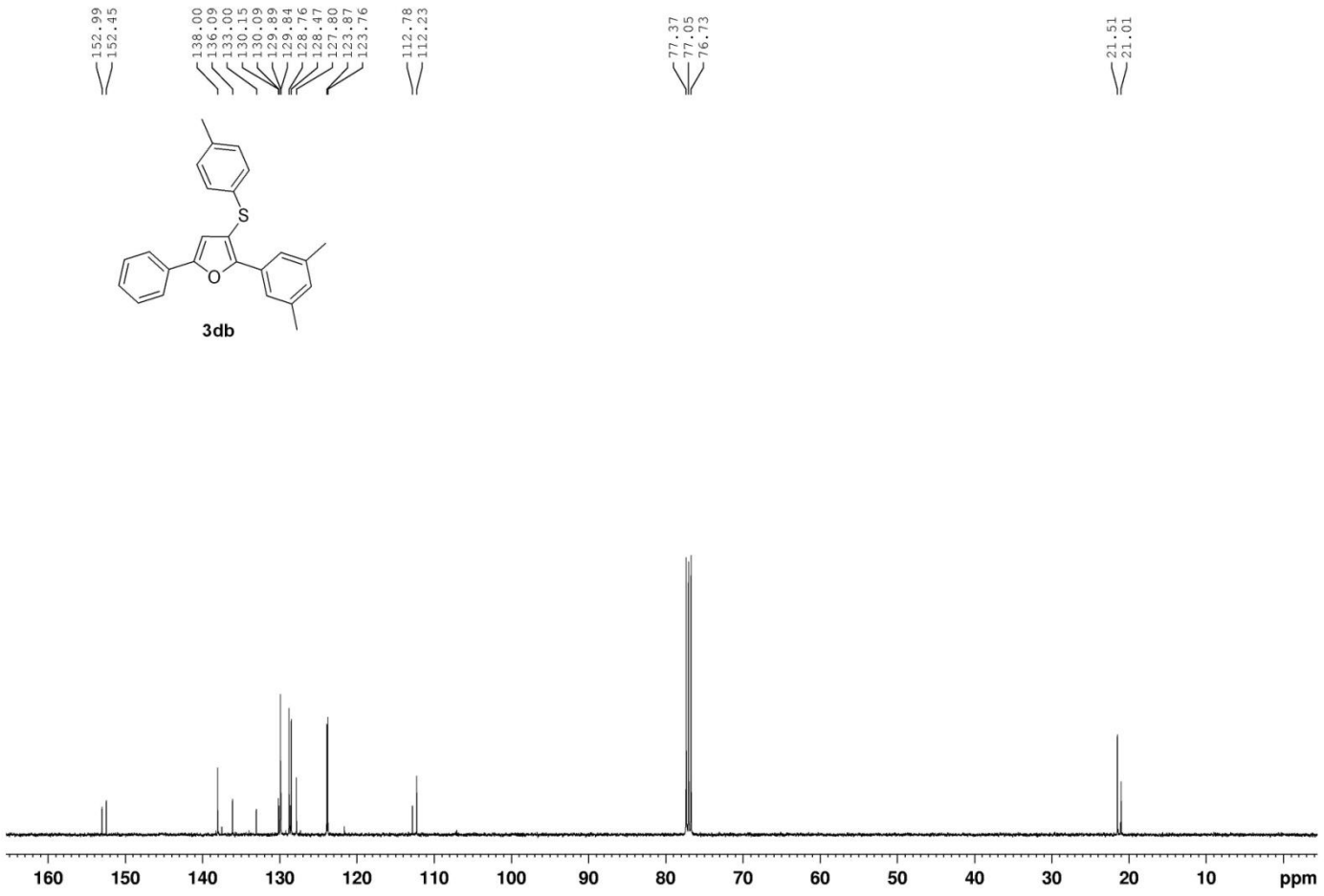
1.17
2.19
2.22
1.00
0.97
6.02
3.19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133.00
130.15
130.09
129.89
129.84
128.76
128.47
127.80
123.87
123.76
112.78
112.23
77.37
77.05
76.73
21.51
21.01
S
O
3db
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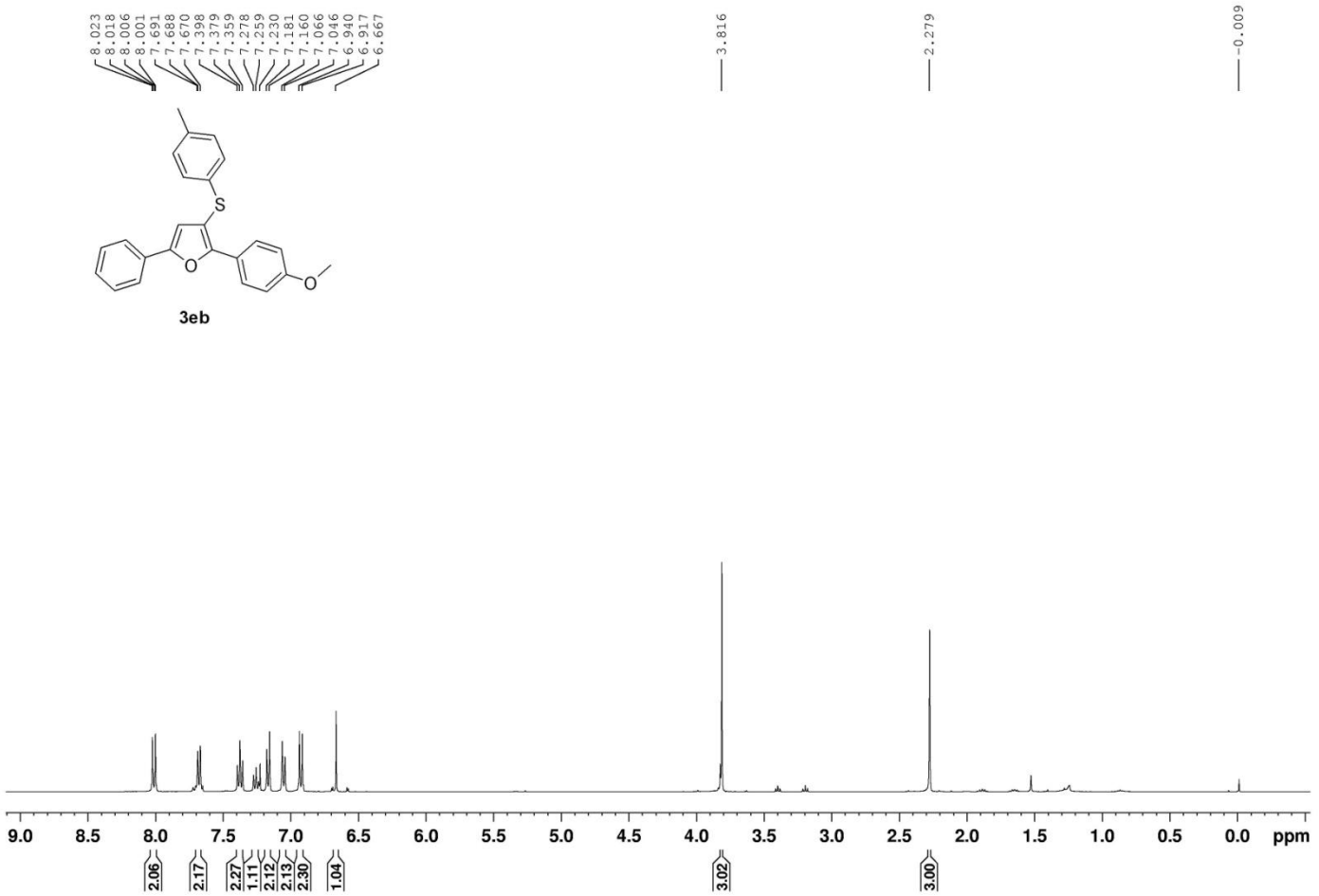
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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7.359
7.278
7.259
7.230
7.181
7.160
7.066
7.046
6.940
6.917
6.667
3.816
2.279
-0.009
S
O
O
3eb
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
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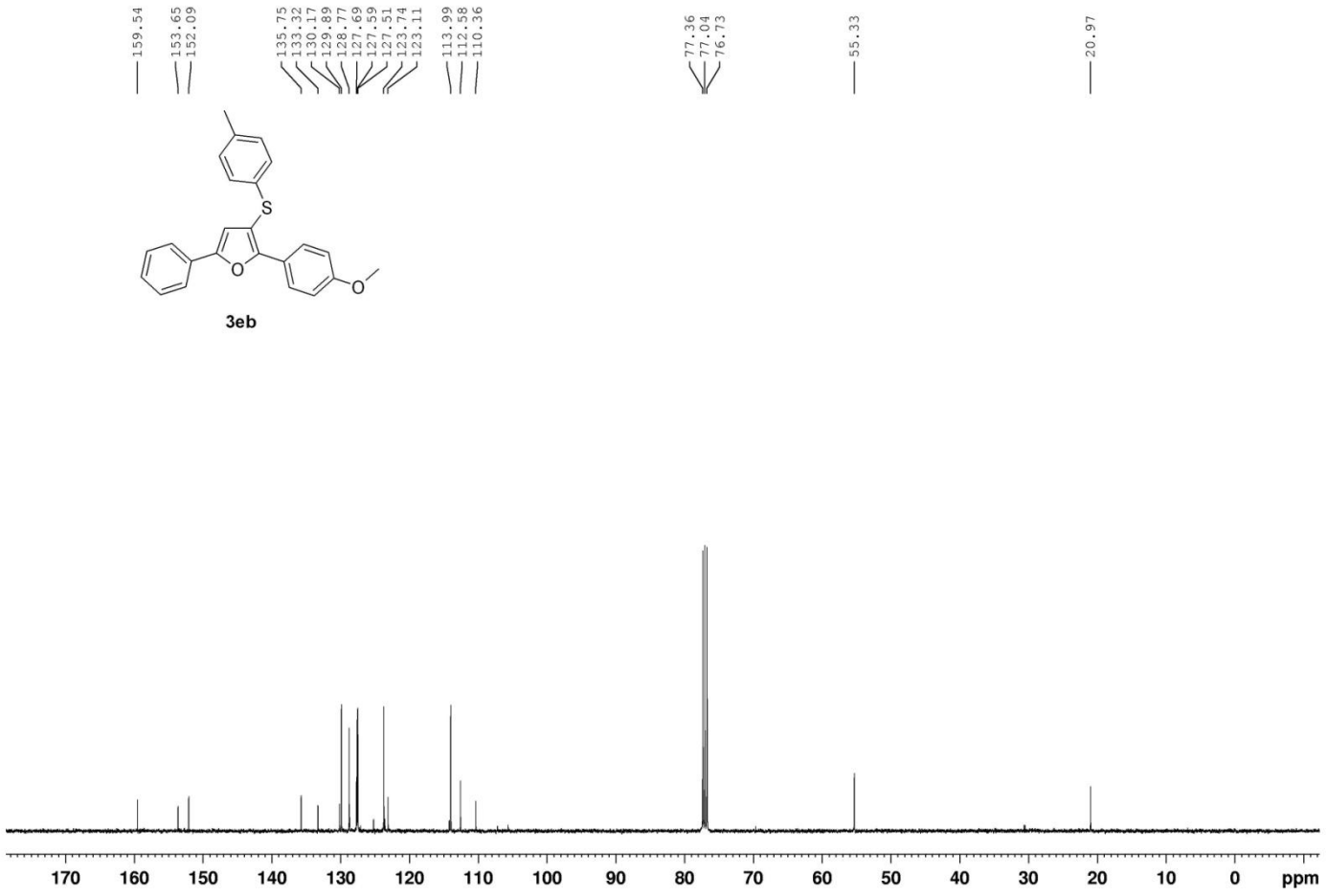
2.17
2.27
1.11
2.12
2.13
2.30
1.04
3.02
3.00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128.77
127.69
127.59
127.51
123.74
123.11
113.99
112.58
110.36
77.36
77.04
76.73
55.33
20.97
S
O
O
3eb
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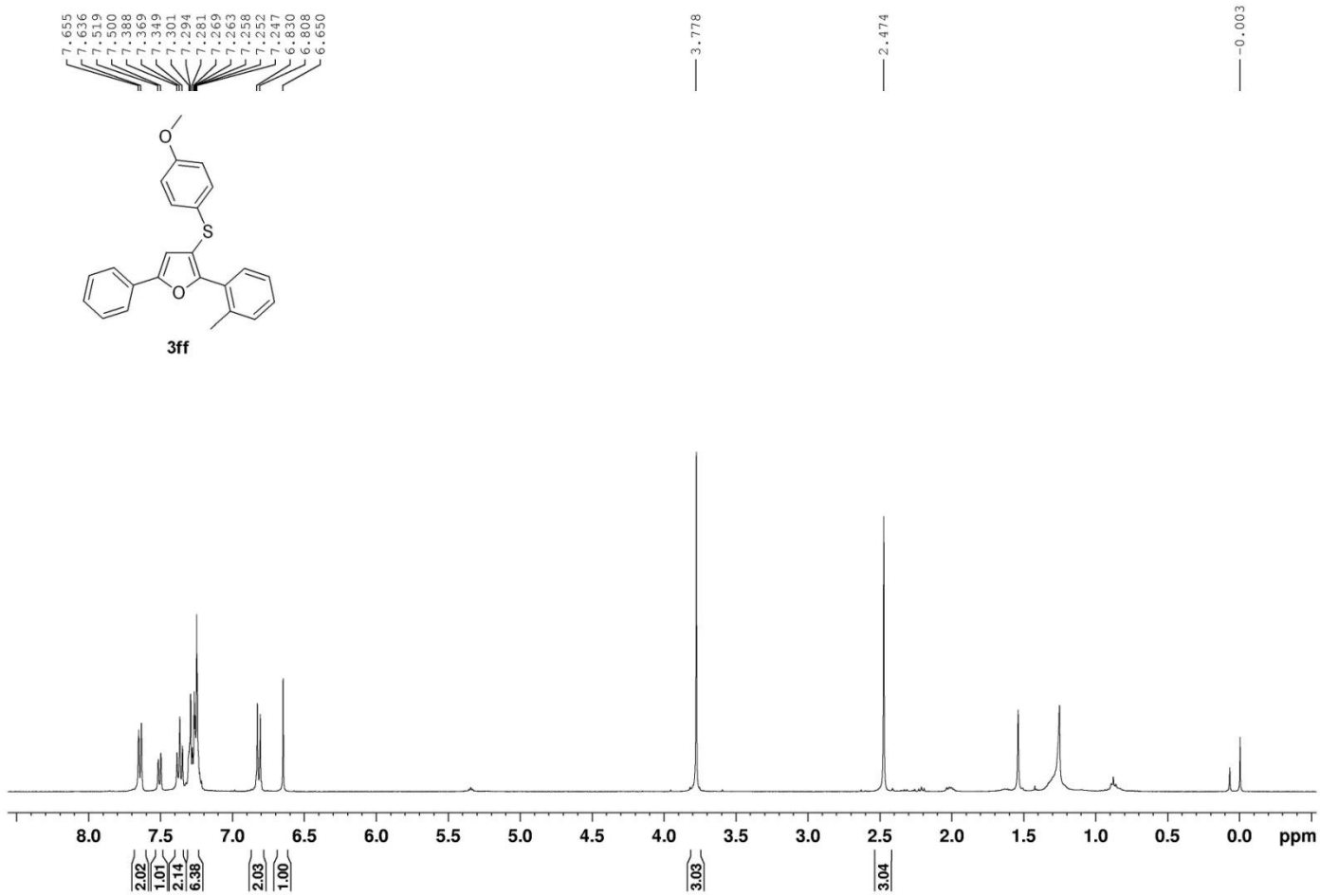
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm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7.301
7.294
7.281
7.269
7.263
7.258
7.252
7.247
6.830
6.808
6.650
3.778
2.474
-0.003
O
S
O
3ff
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ppm
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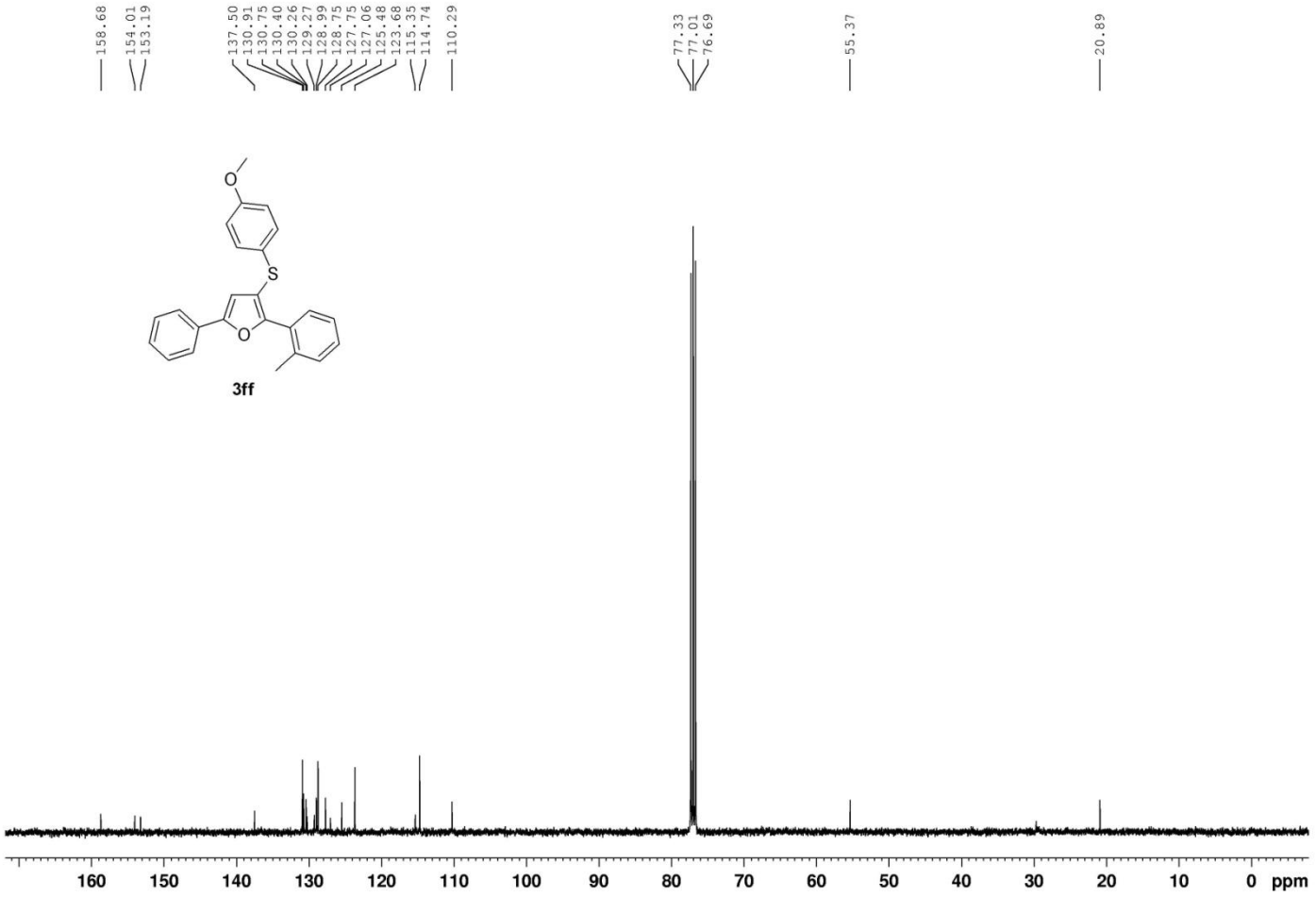
1.01
2.14
6.38
2.03
1.00
3.03
3.04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130.75
130.40
130.26
129.27
128.99
128.75
127.75
127.06
125.48
123.68
115.35
114.74
110.29
77.33
77.01
76.69
55.37
20.89
O
S
O
3ff
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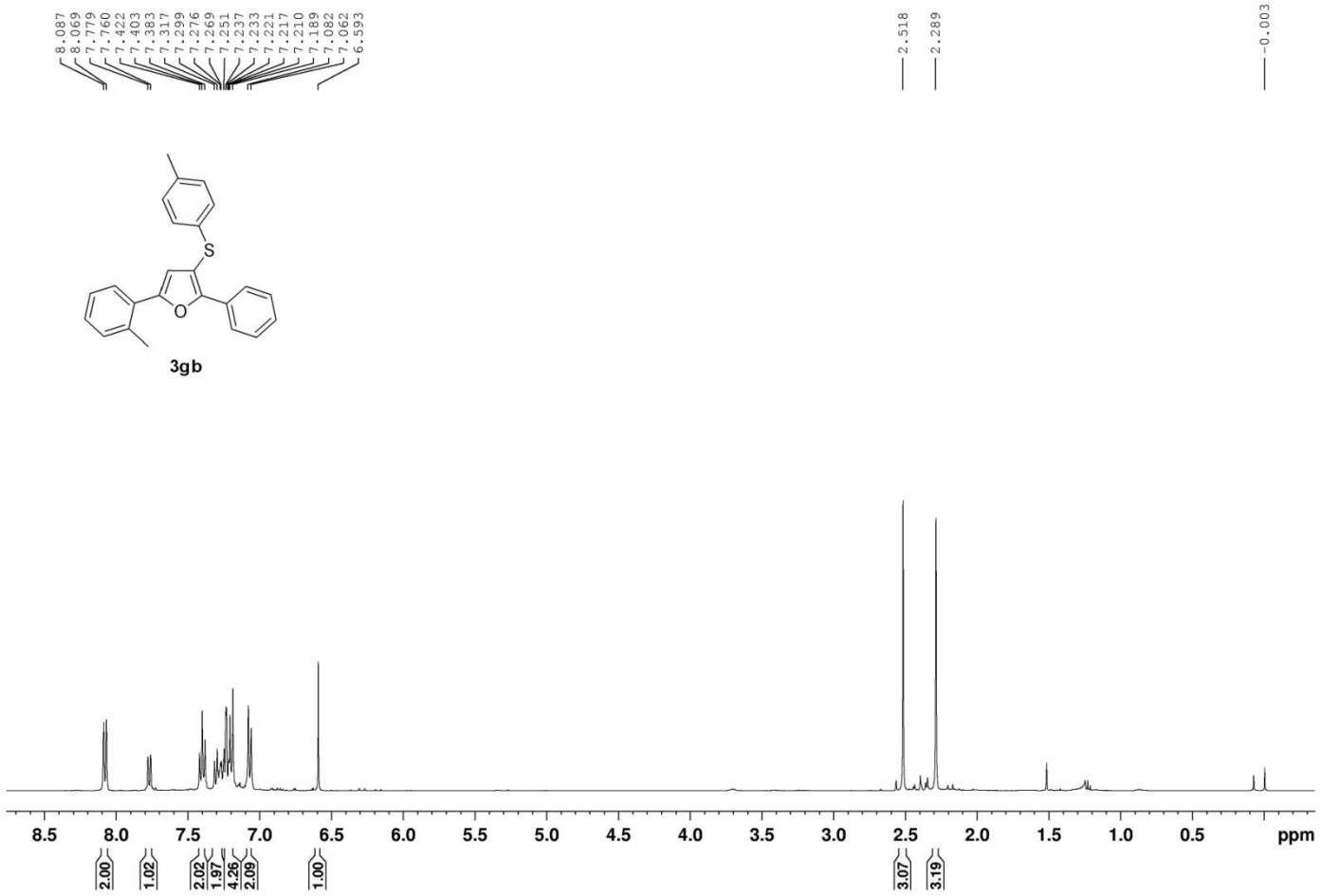
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm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7.276
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7.251
7.237
7.233
7.221
7.217
7.210
7.189
7.082
7.062
6.593
2.518
2.289
0.003
S
O
3gb
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
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ppm
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2.02
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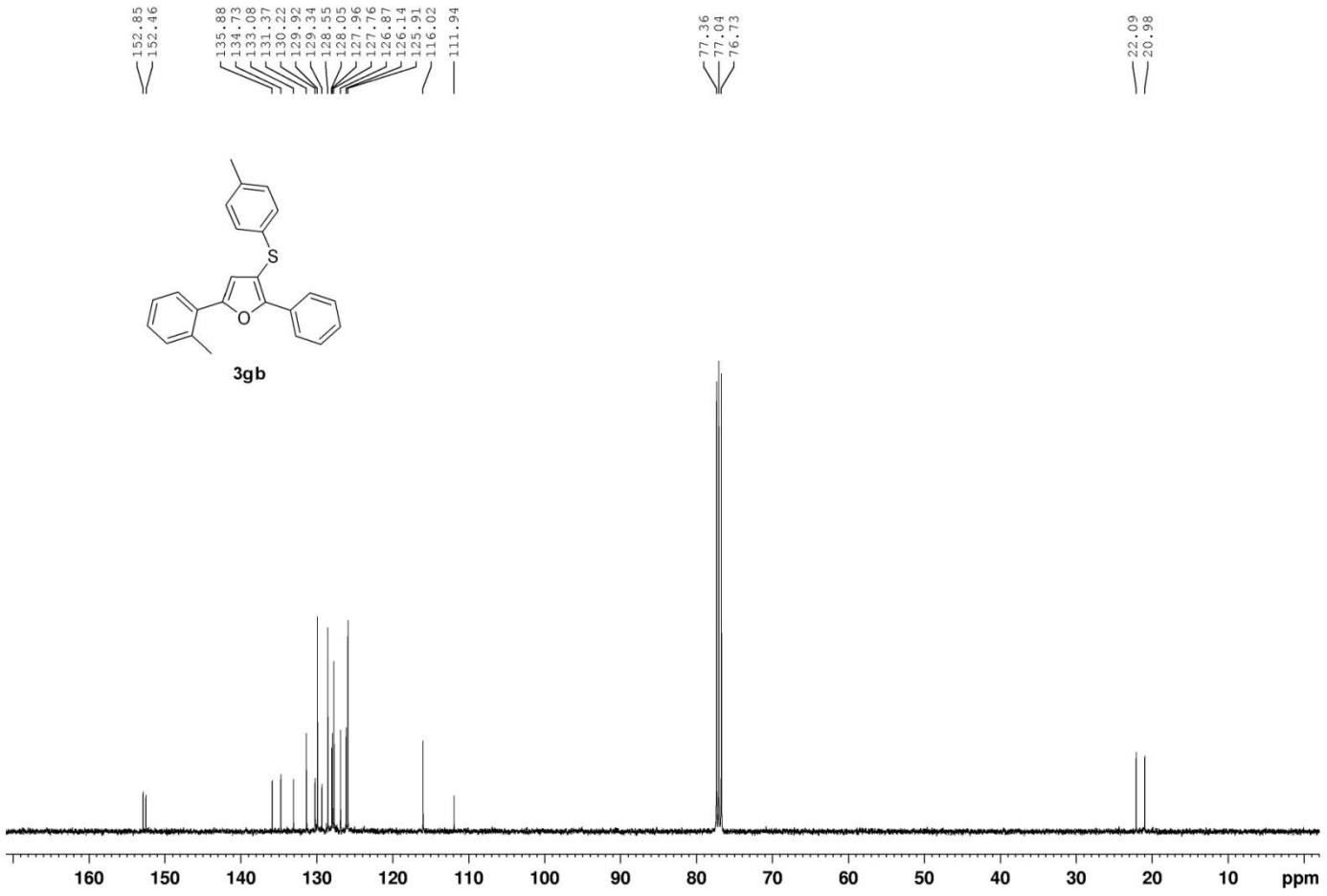
4.26
2.09
1.00
3.07
3.19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128.05
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127.76
126.87
126.14
125.91
116.02
111.94
77.36
77.04
76.73
22.09
20.98
S
O
3gb
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150
140
130
120
110
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90
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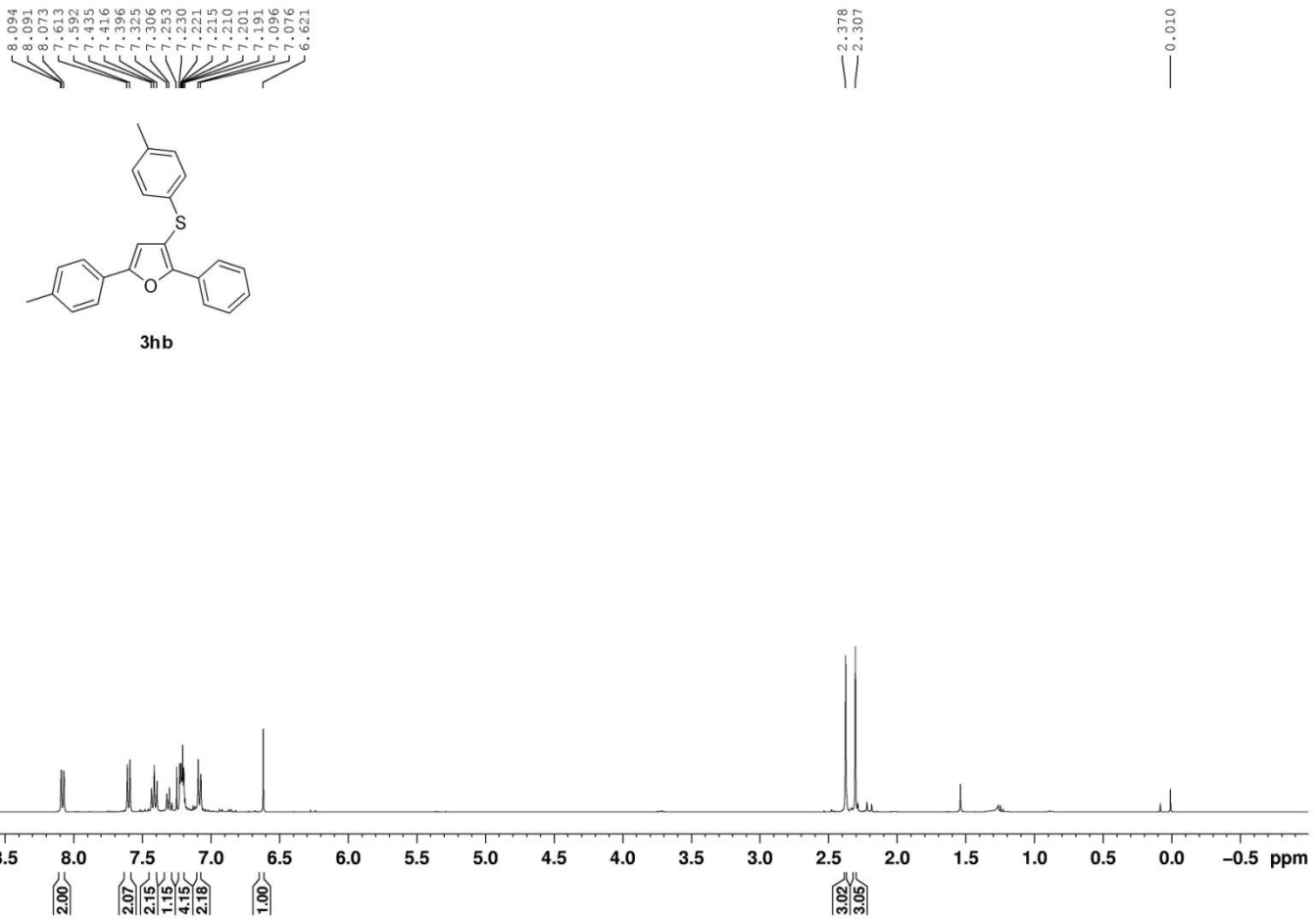
70
60
50
40
30
20
10
ppm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7.416
7.396
7.325
7.306
7.253
7.230
7.221
7.215
7.210
7.201
7.191
7.096
7.076
6.621
2.378
2.307
0.010
S
O
3hb
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
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1.15
4.15
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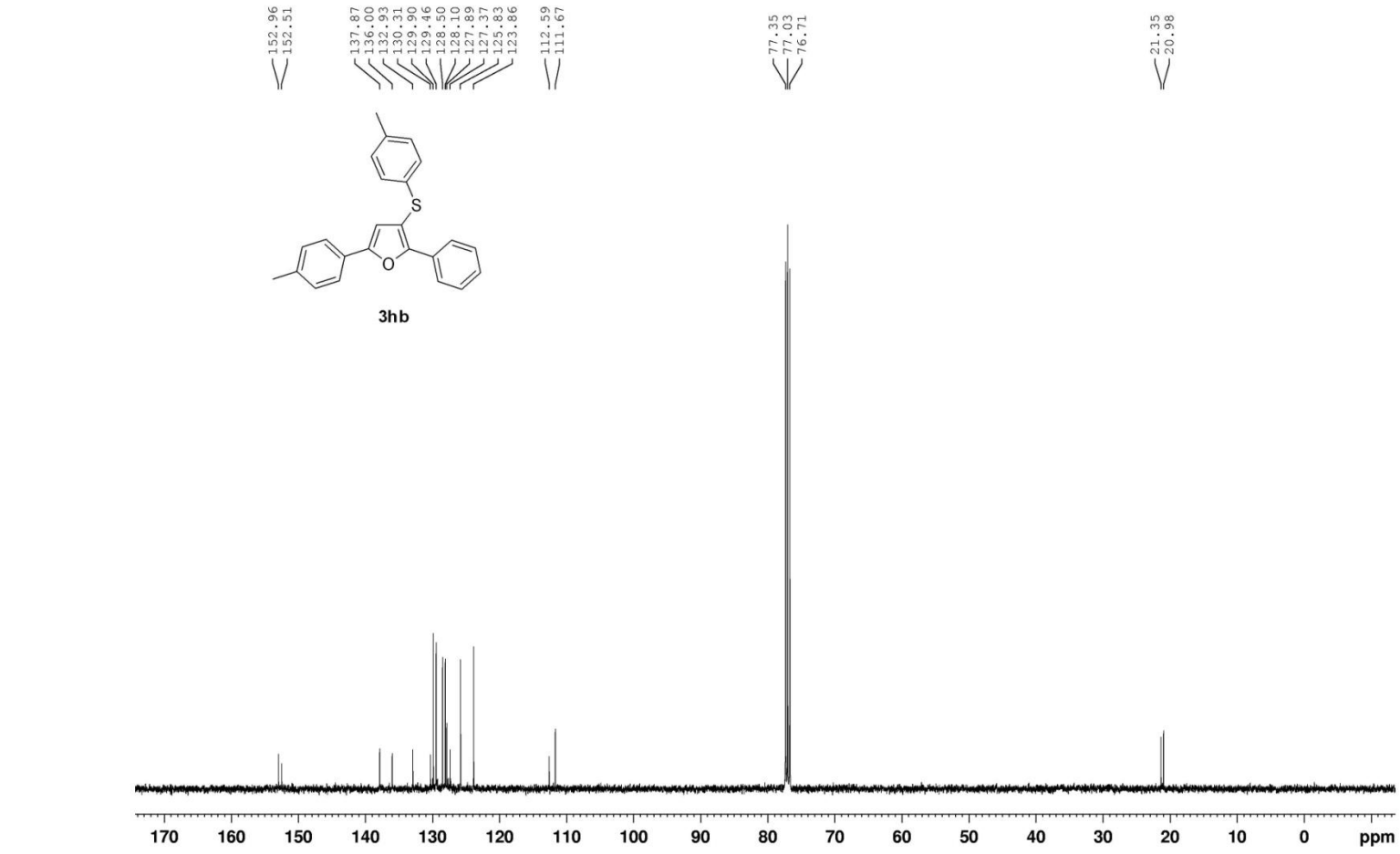
1.00
3.02
3.05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129.46
128.50
128.10
127.89
127.37
125.83
123.86
112.59
111.67
77.35
77.03
76.71
21.35
20.98
S
O
3hb
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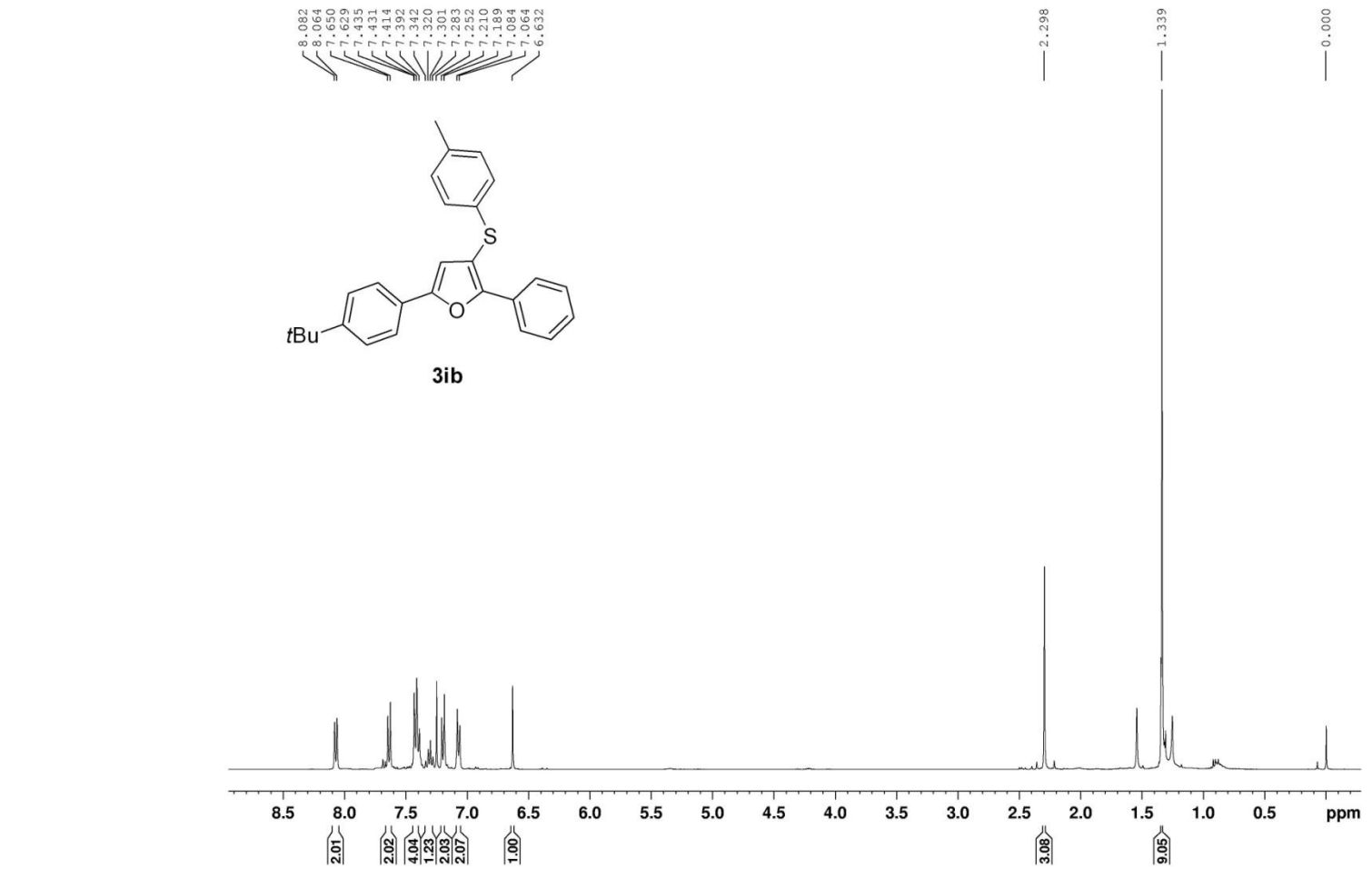
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm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7.431
7.414
7.392
7.342
7.320
7.301
7.283
7.252
7.210
7.189
7.084
7.064
6.632
2.298
1.339
0.000
S
O
tBu
3ib
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
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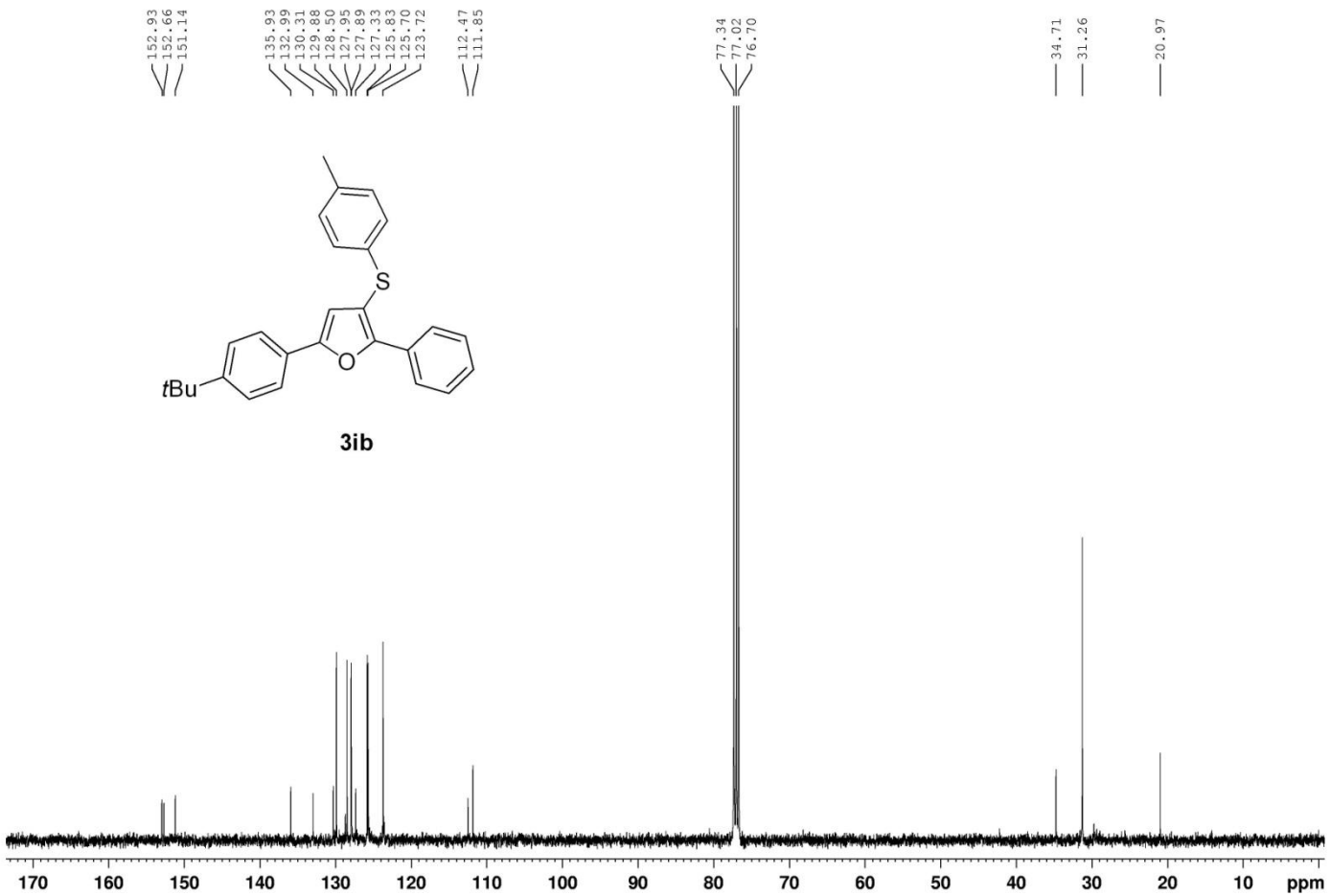
0.5
ppm
2.01
2.02
4.04
1.23
2.03
2.07
1.00
3.08
9.05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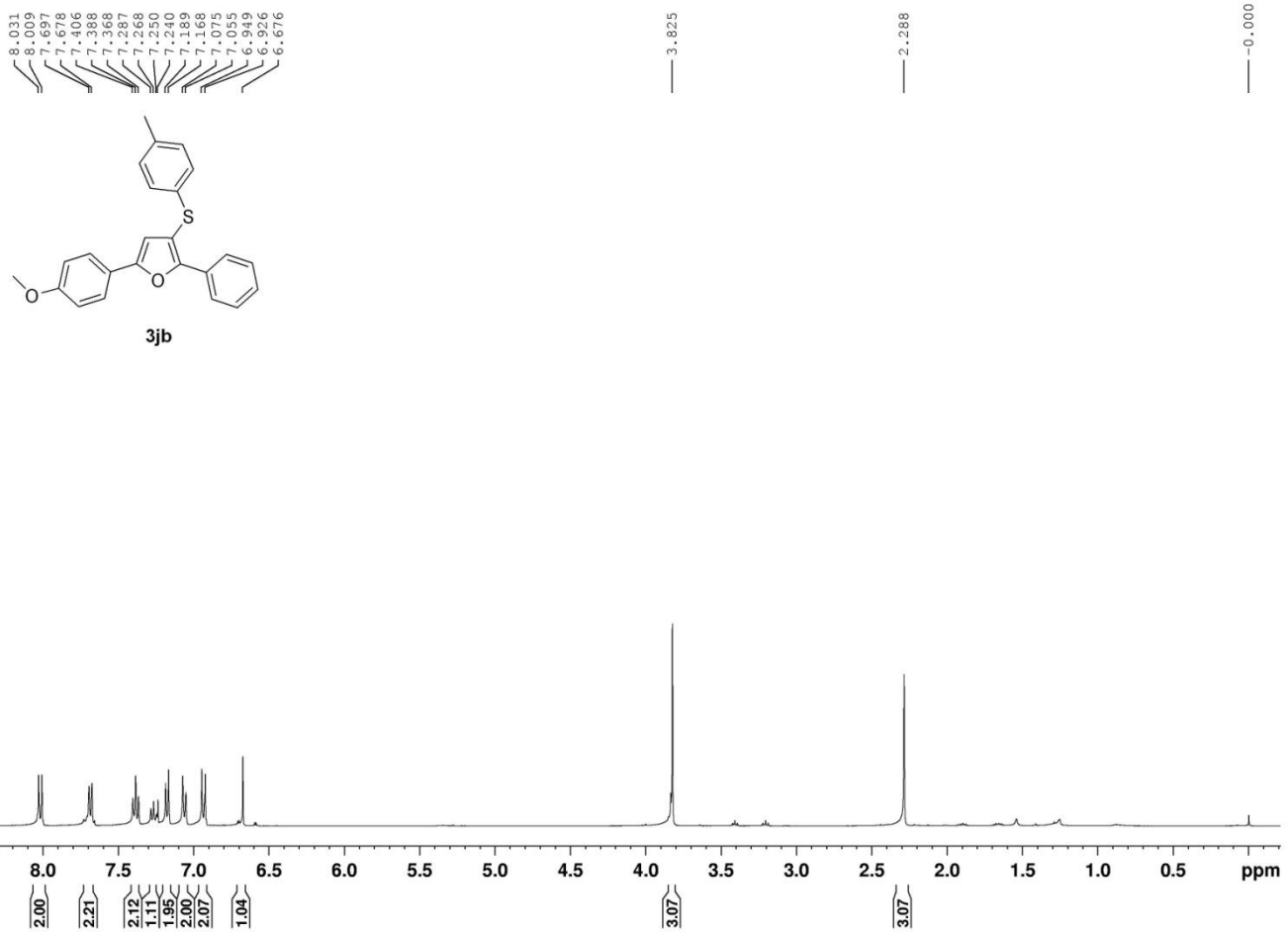
152.66
151.14
135.93
132.99
130.31
129.88
128.50
127.95
127.89
127.33
125.83
125.70
123.72
112.47
111.85
77.34
77.02
76.70
34.71
31.26
20.97
S
O
tBu
3ib
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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7.678
7.406
7.388
7.368
7.287
7.268
7.250
7.240
7.189
7.168
7.075
7.055
6.949
6.926
6.676
3.825
2.288
0.000
S
O
O
3jb
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
ppm
2.00
2.21
2.12
1.11
1.95
2.00
2.07
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3.07
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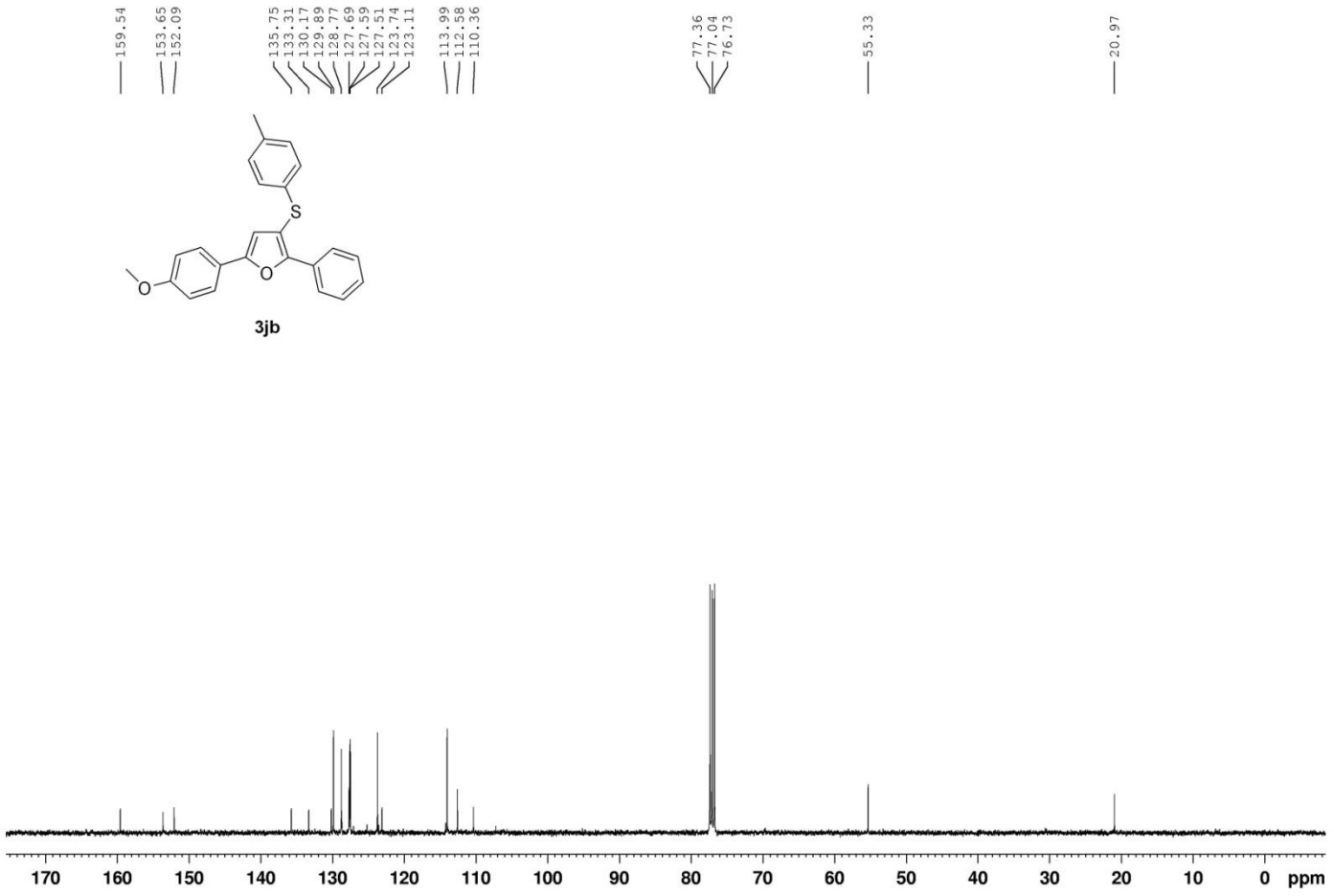
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112.58
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77.36
77.04
76.73
55.33
20.97
S
O
O
3jb
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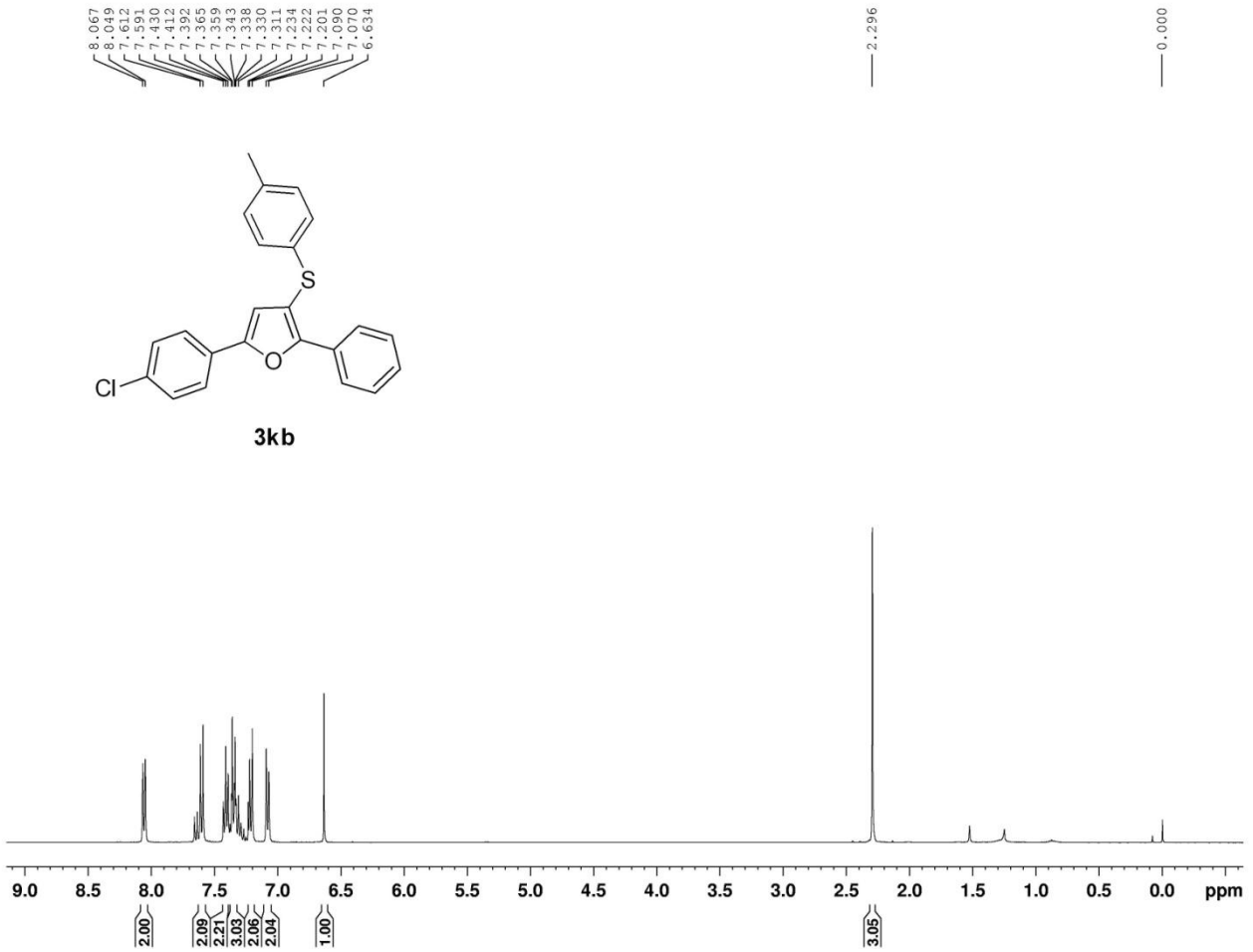
ppm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7.201
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7.070
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O
Cl
3kb
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8.0
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6.5
6.0
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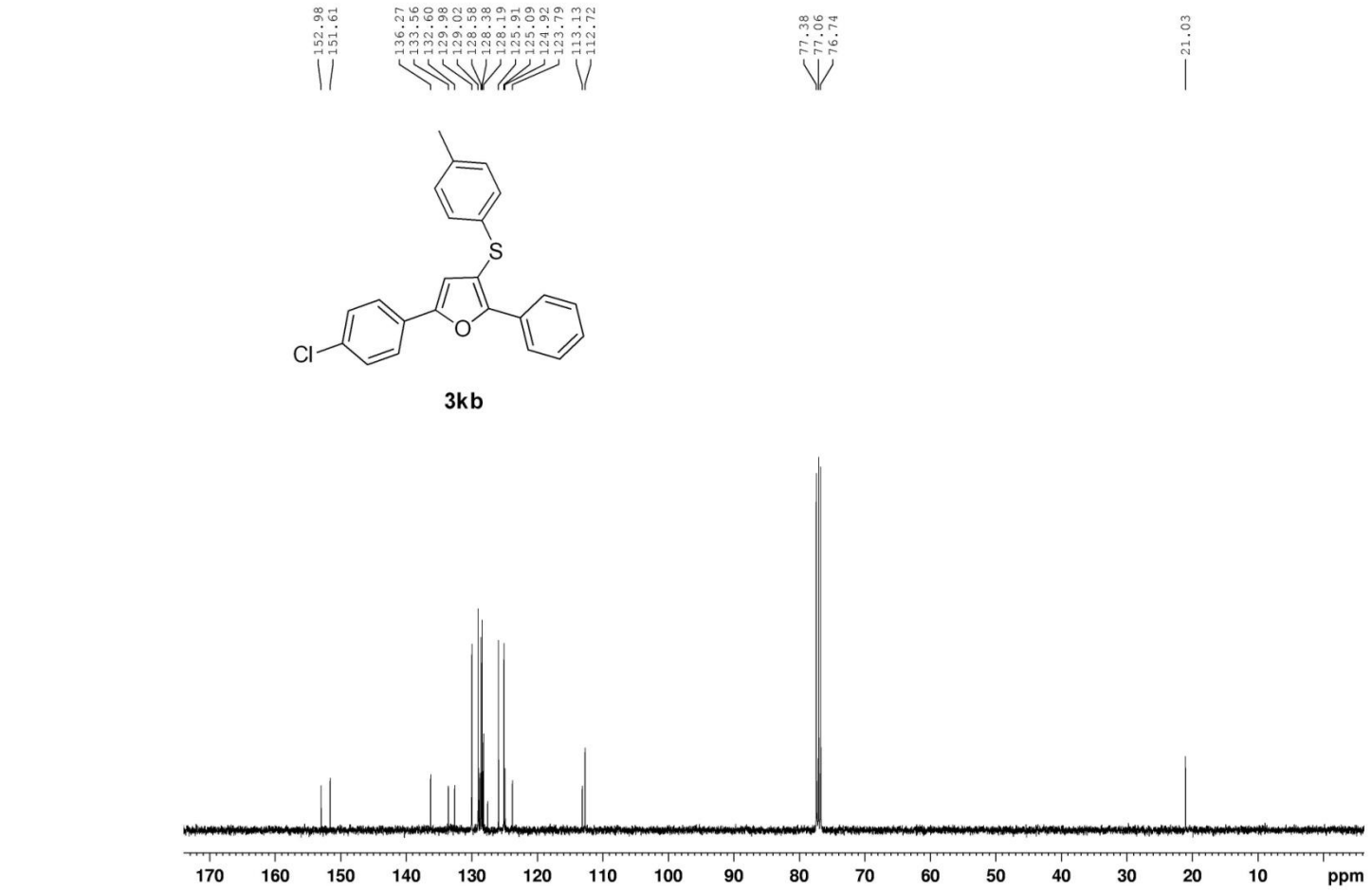
3.05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113.13
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77.38
77.06
76.74
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S
O
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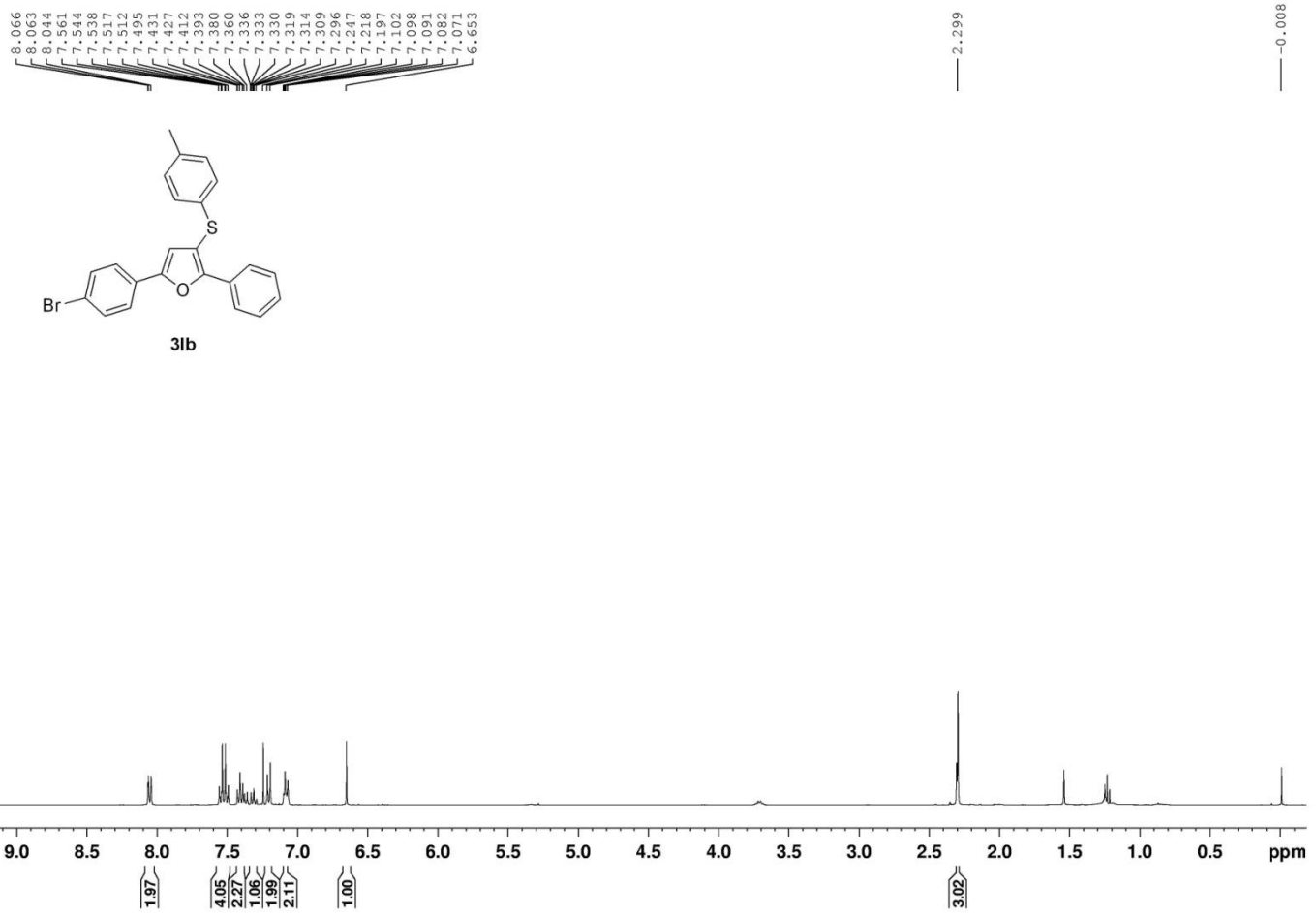
ppm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7.412
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7.360
7.336
7.333
7.330
7.319
7.314
7.309
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7.247
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7.197
7.102
7.098
7.091
7.082
7.071
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S
O
Br
3Ib
9.0
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8.0
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6.5
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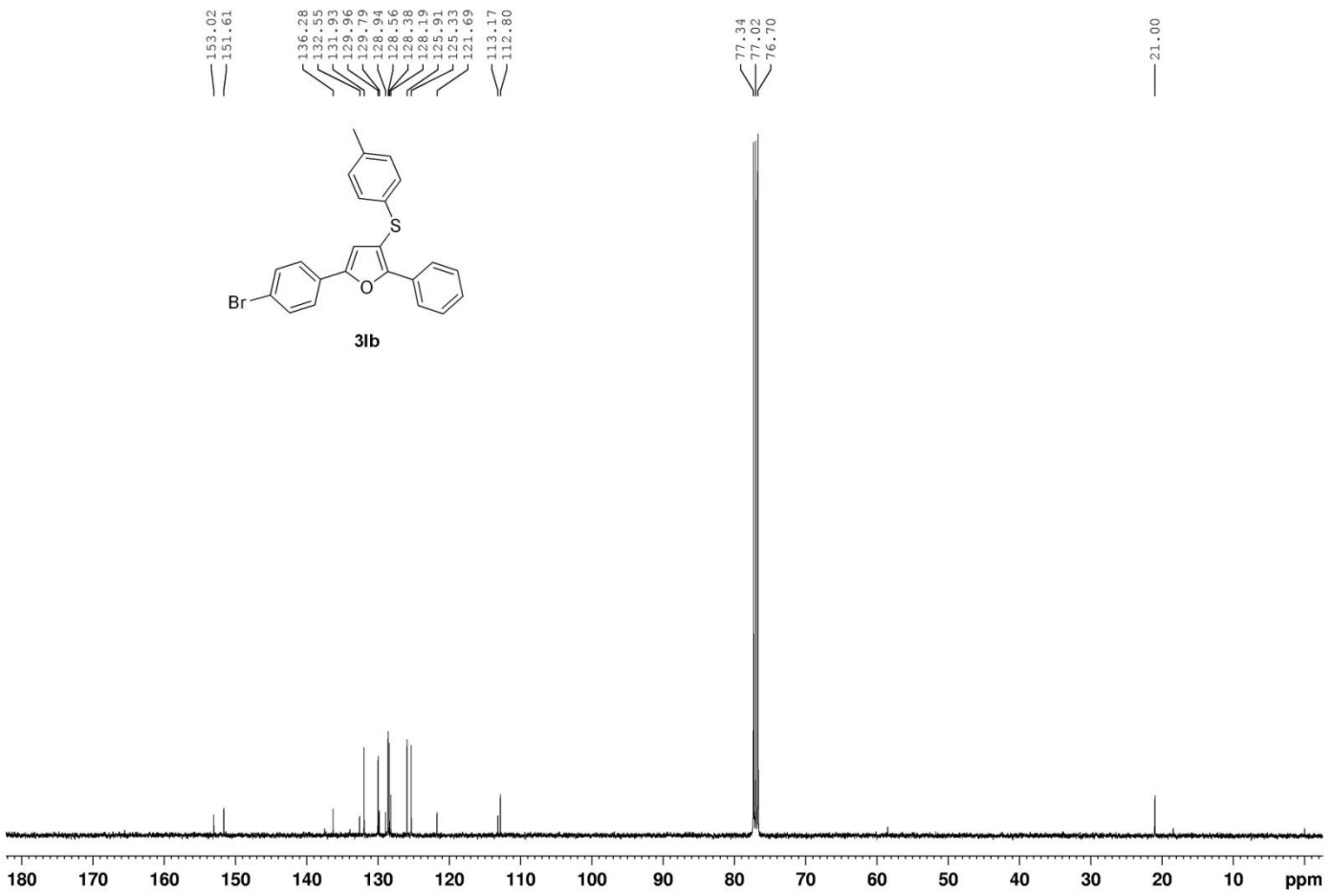
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21.00
S
O
Br
3Ib
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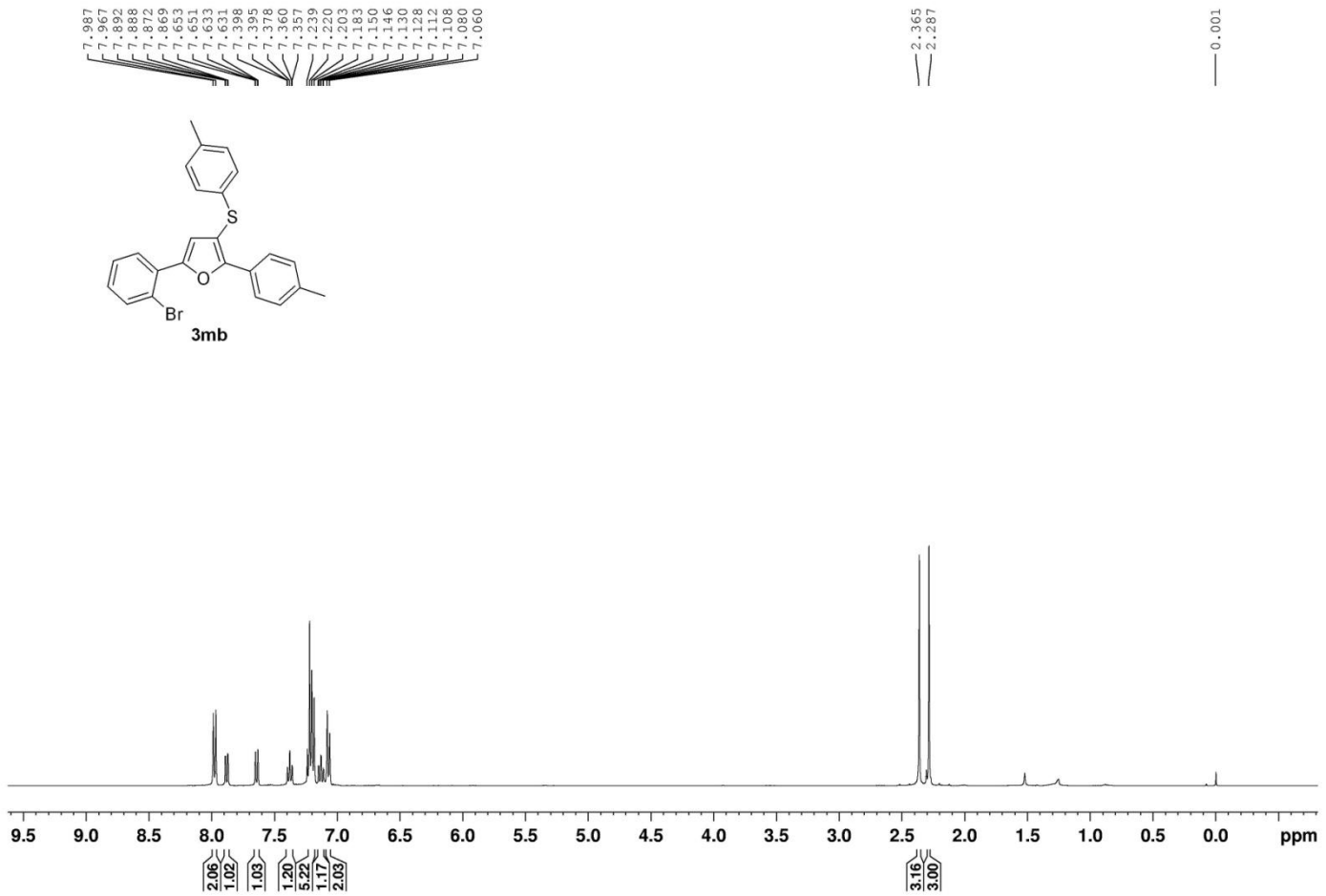
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7.112
7.108
7.080
7.060
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O
Br
3mb
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8.0
7.5
7.0
6.5
6.0
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4.5
4.0
3.5
3.0
2.5
2.0
1.5
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1.03
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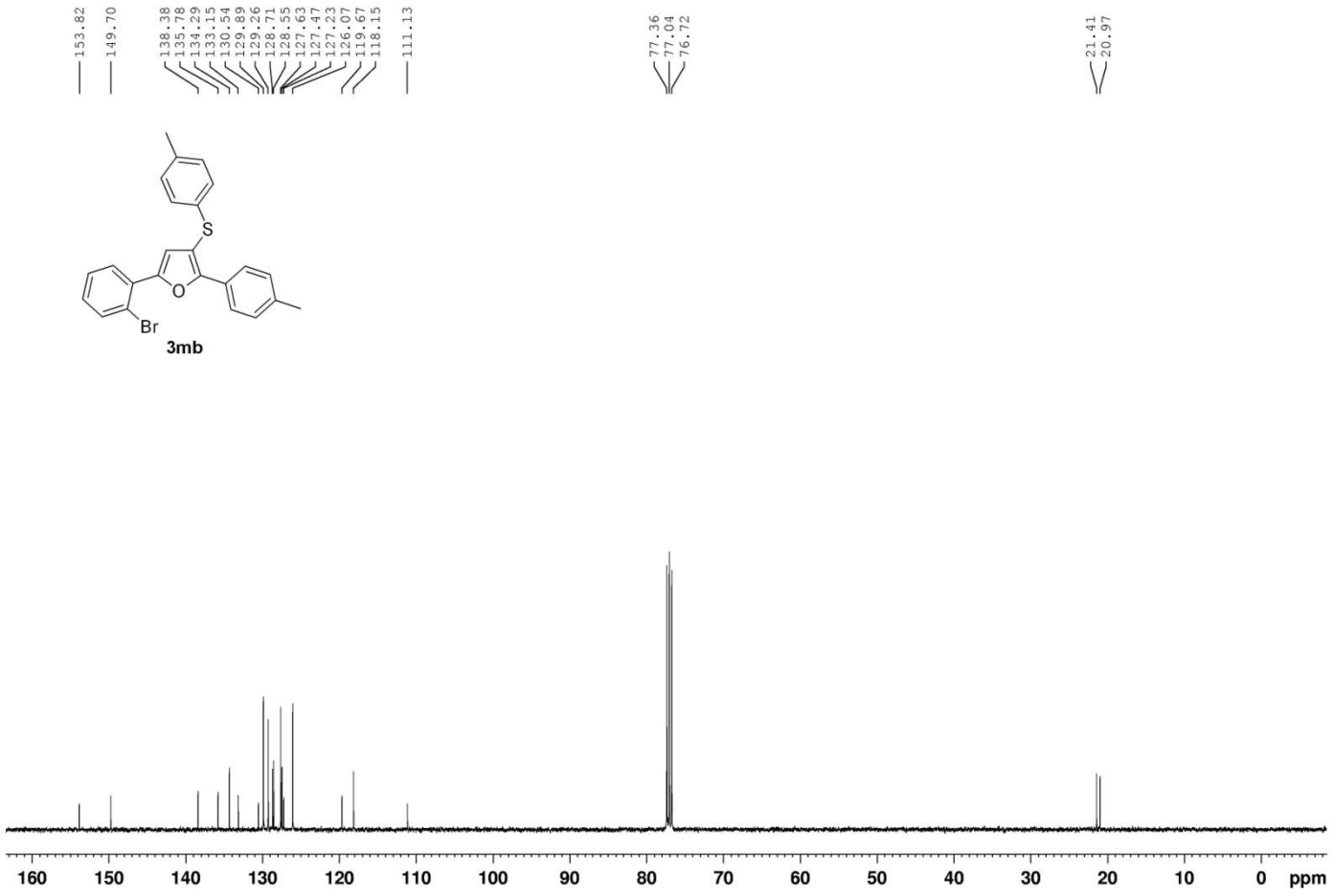
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127.47
127.23
126.07
119.67
118.15
111.13
77.36
77.04
76.72
21.41
20.97
S
O
Br
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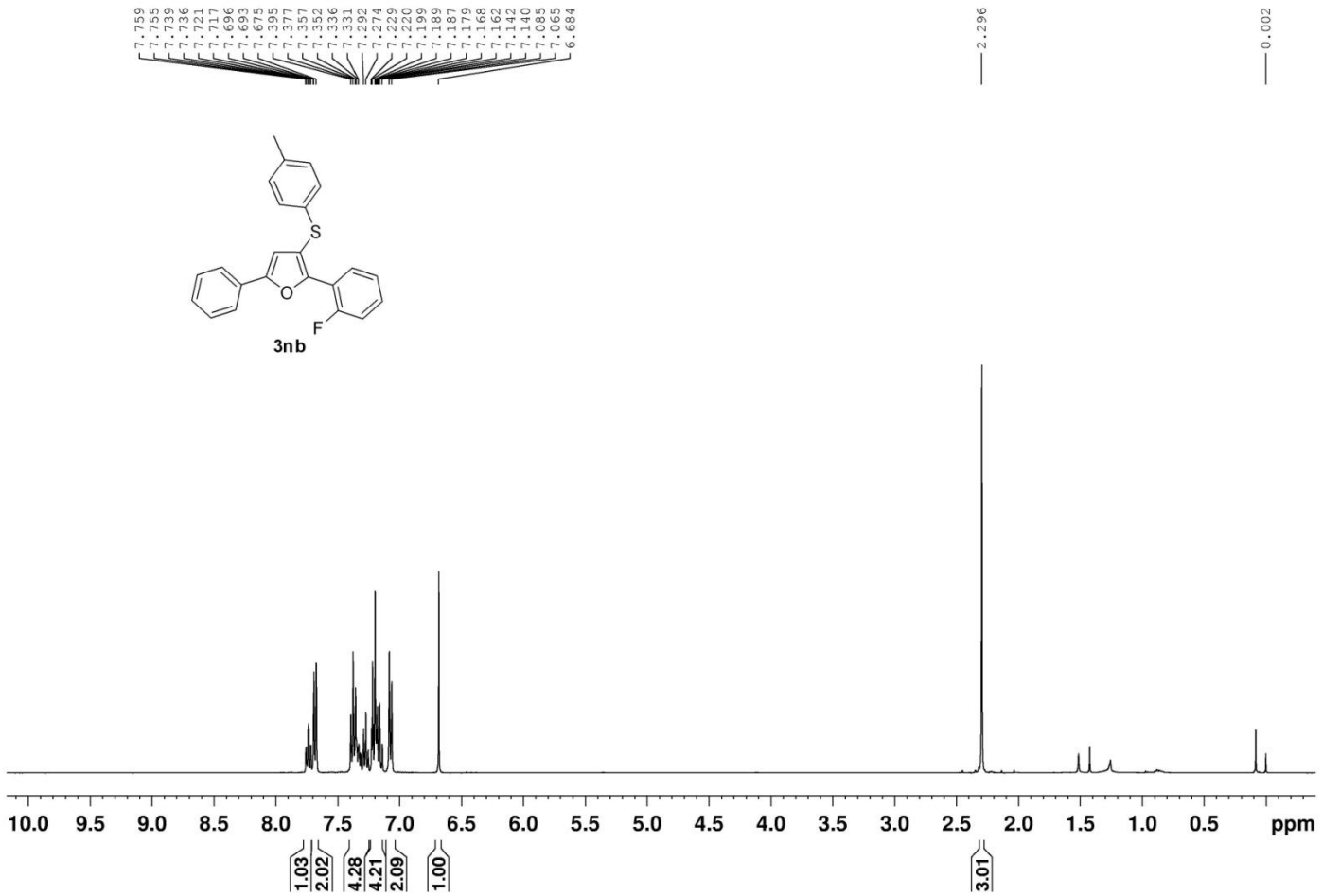
0
ppm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7.675
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7.377
7.357
7.352
7.336
7.331
7.292
7.274
7.229
7.220
7.199
7.189
7.187
7.179
7.168
7.162
7.142
7.140
7.085
7.065
6.684
2.296
0.002
S
O
F
3nb
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
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4.28
4.21
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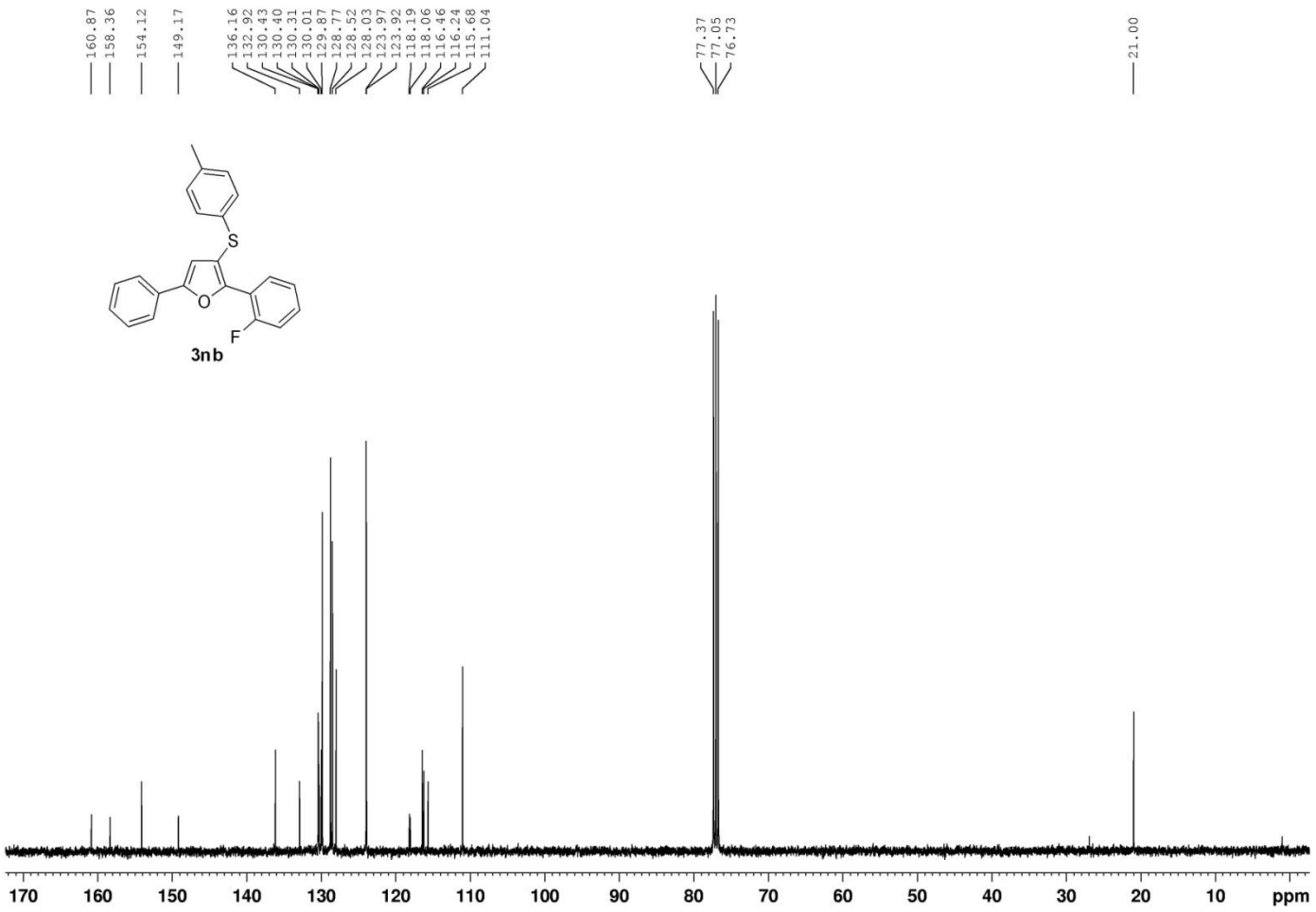
1.00
3.01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128.52
128.03
123.97
123.92
118.19
118.06
116.46
116.24
115.68
111.04
77.37
77.05
76.73
21.00
S
O
F
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140
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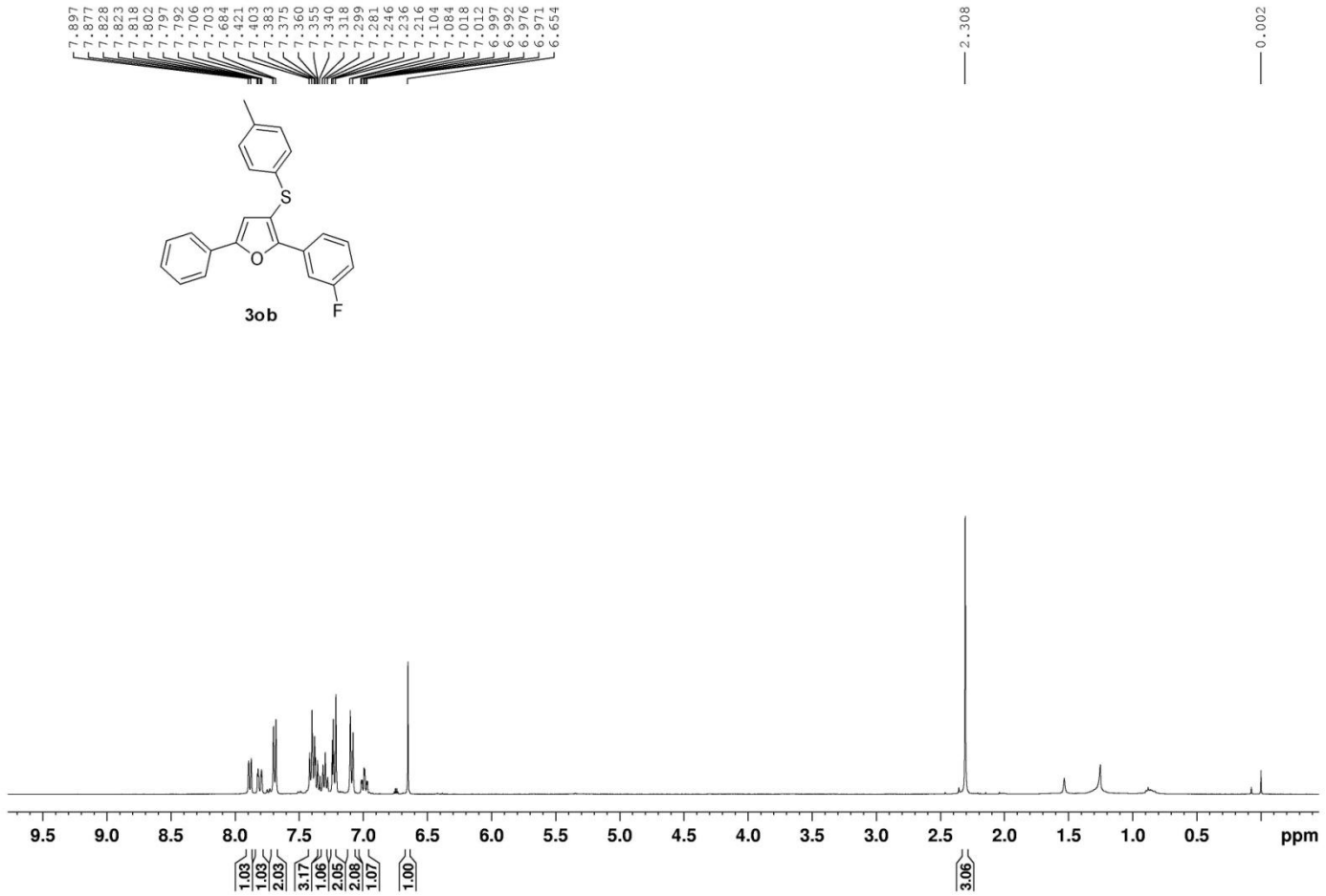
10
ppm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7.403
7.383
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7.360
7.355
7.340
7.318
7.299
7.281
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7.084
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7.012
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6.992
6.976
6.971
6.654
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O
F
3ob
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8.0
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7.0
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6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
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1.03
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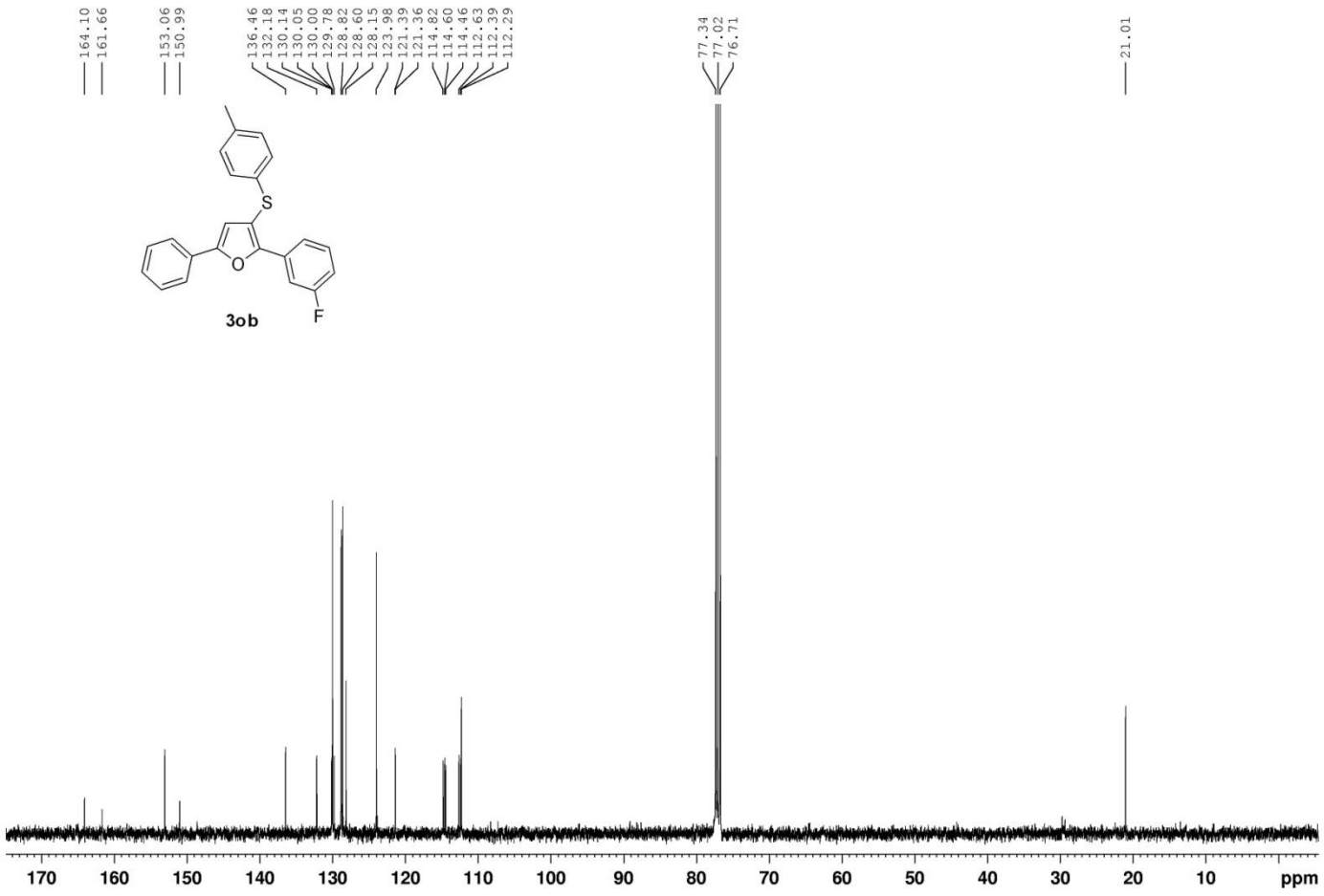
2.05
2.08
1.07
1.00
3.06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112.63
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77.34
77.02
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21.01
S
O
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10
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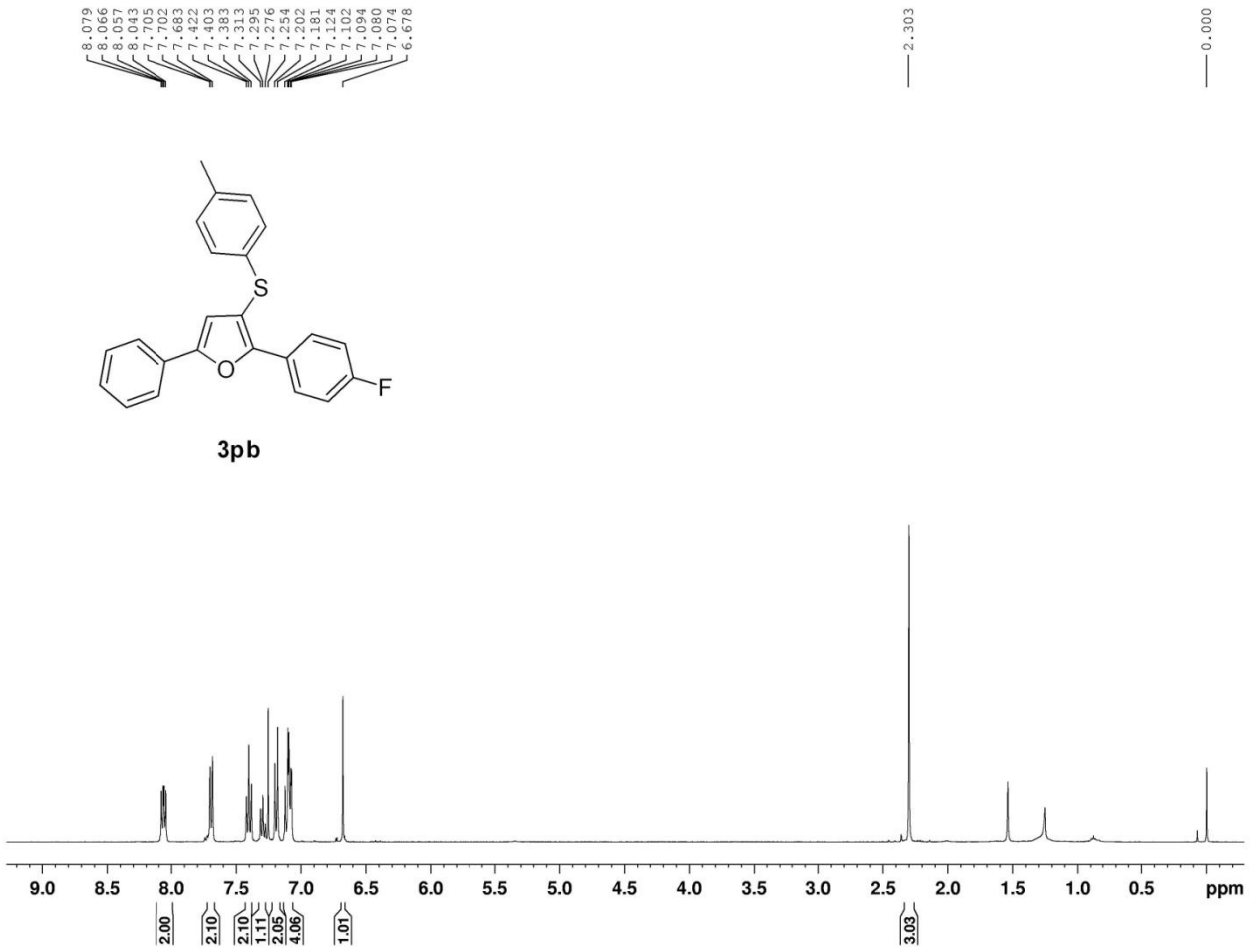
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7.276
7.254
7.202
7.181
7.124
7.102
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7.080
7.074
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S
O
F
3pb
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8.5
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6.5
6.0
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5.0
4.5
4.0
3.5
3.0
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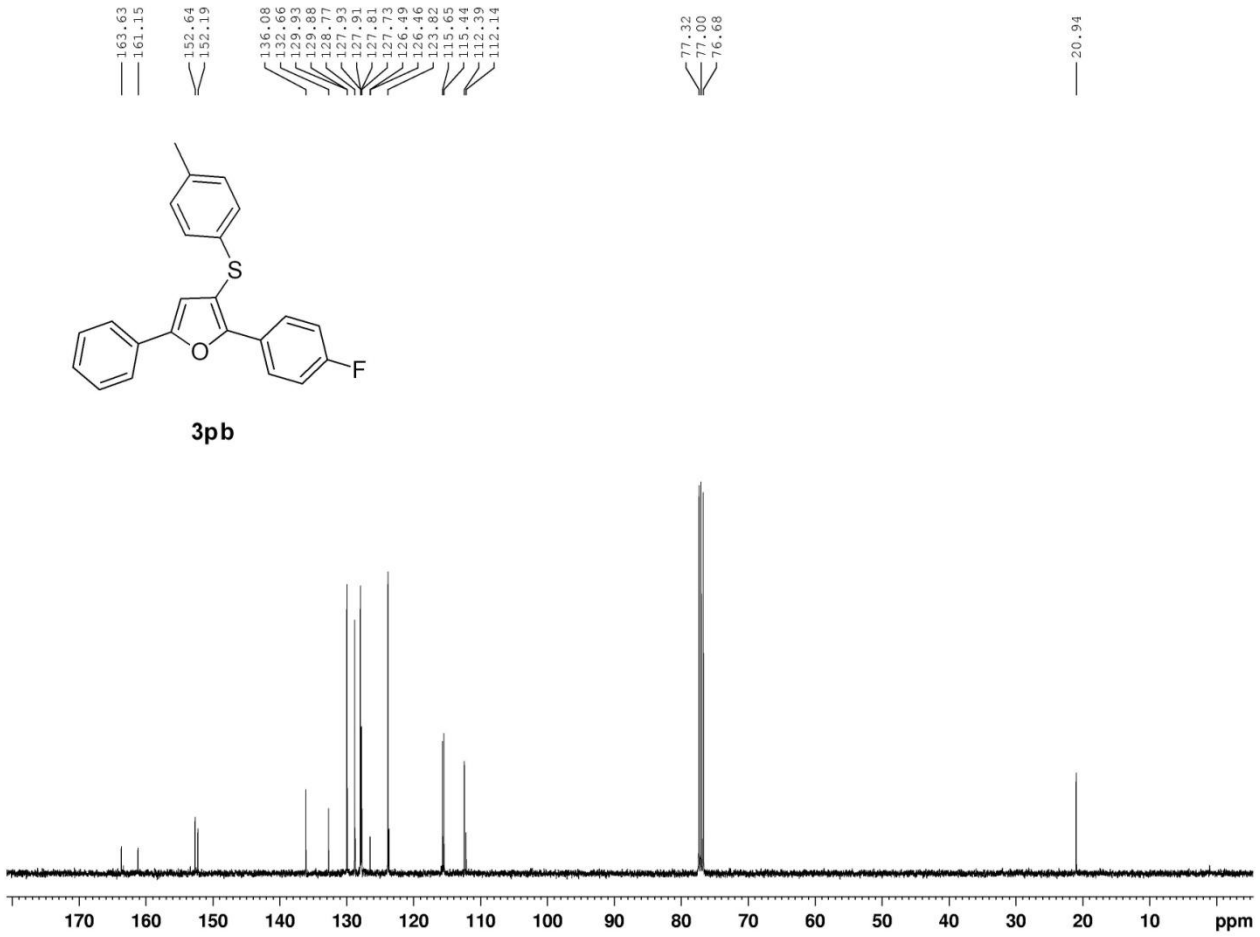
1.01
3.03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127.73
126.49
126.46
123.82
115.65
115.44
112.39
112.14
77.32
77.00
76.68
20.94
S
O
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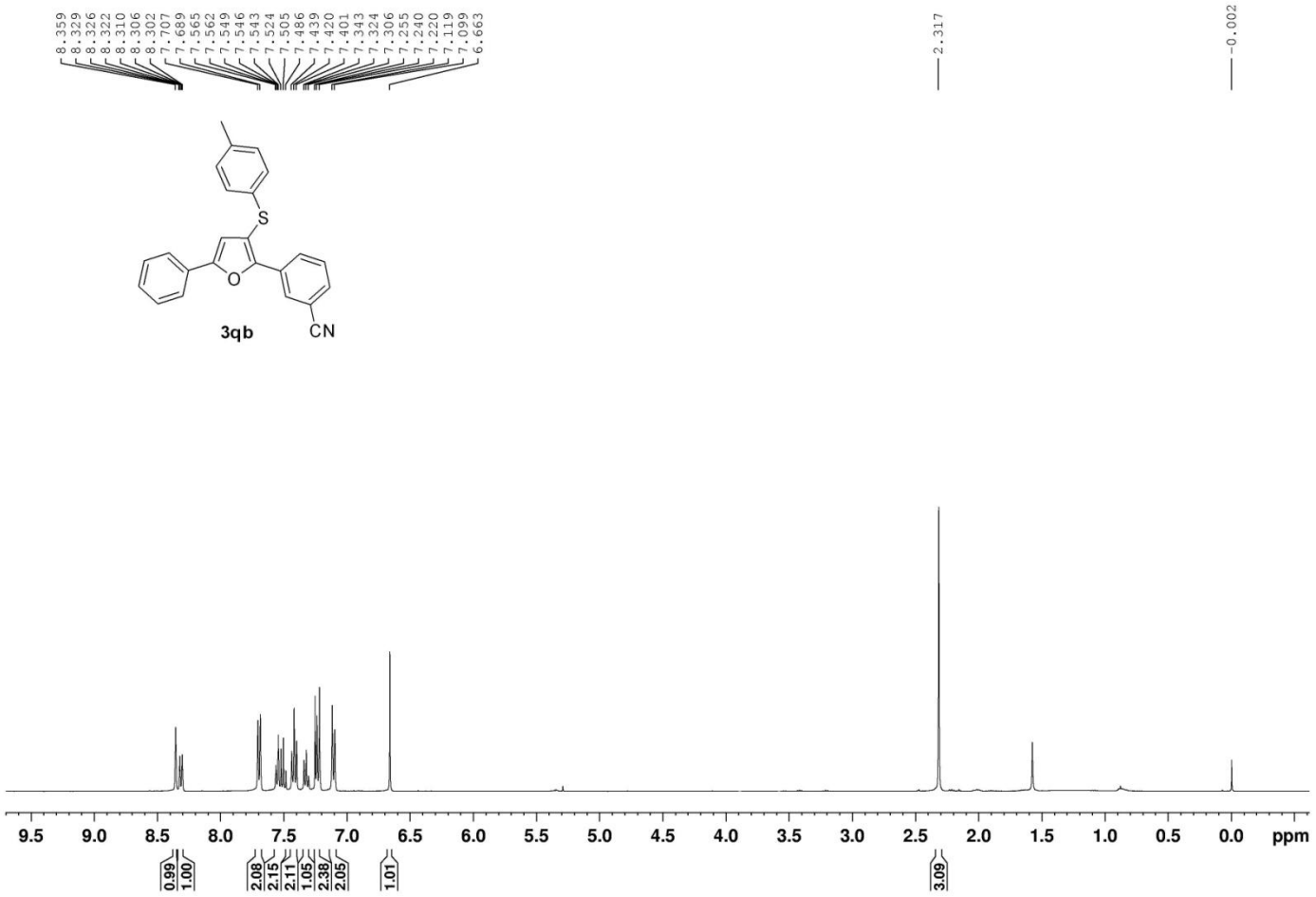
20
10
ppm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7.524
7.505
7.486
7.439
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7.401
7.343
7.324
7.306
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O
CN
3qb
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8.5
8.0
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7.0
6.5
6.0
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4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
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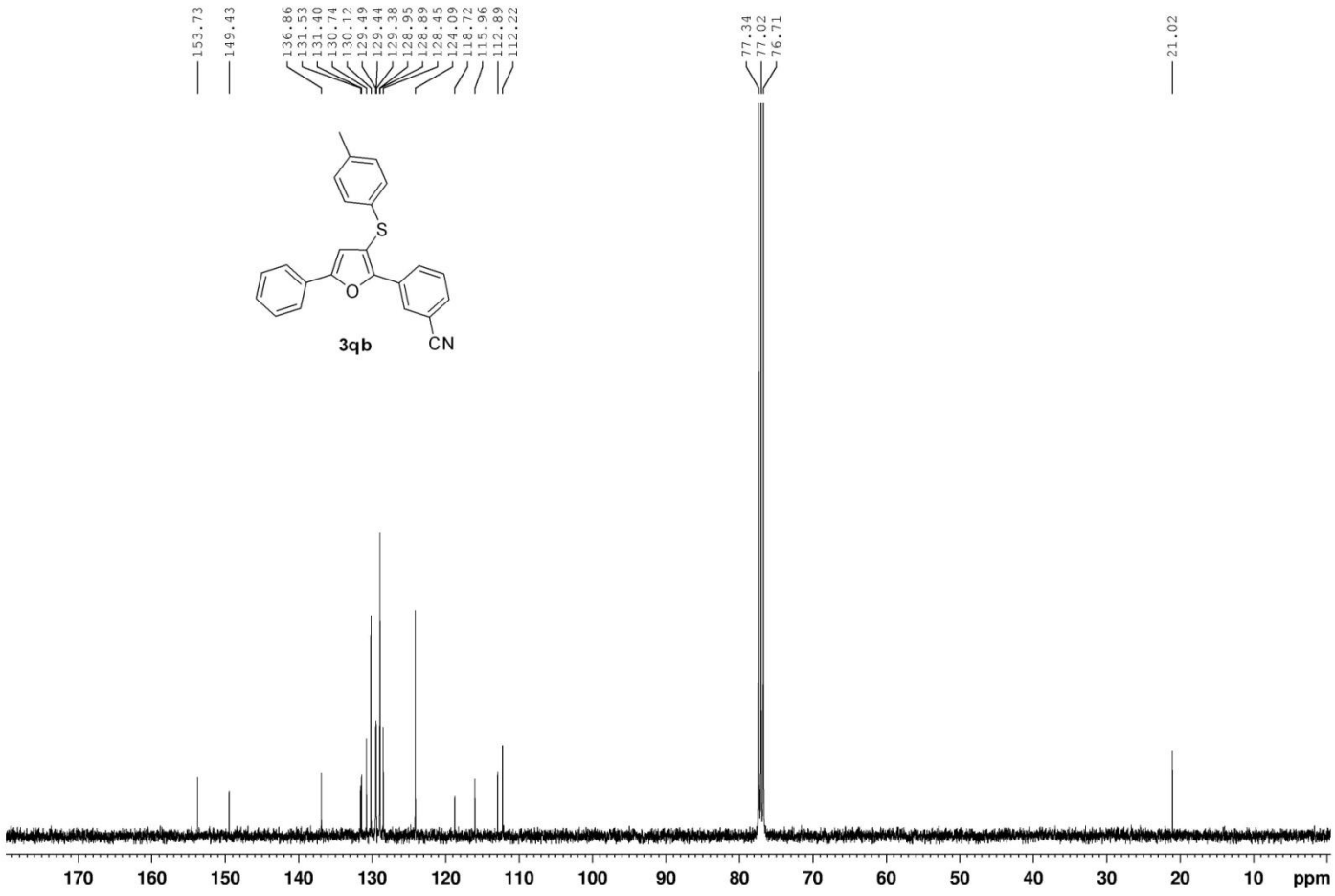
3.09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115.96
112.89
112.22
77.34
77.02
76.71
21.02
S
O
CN
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150
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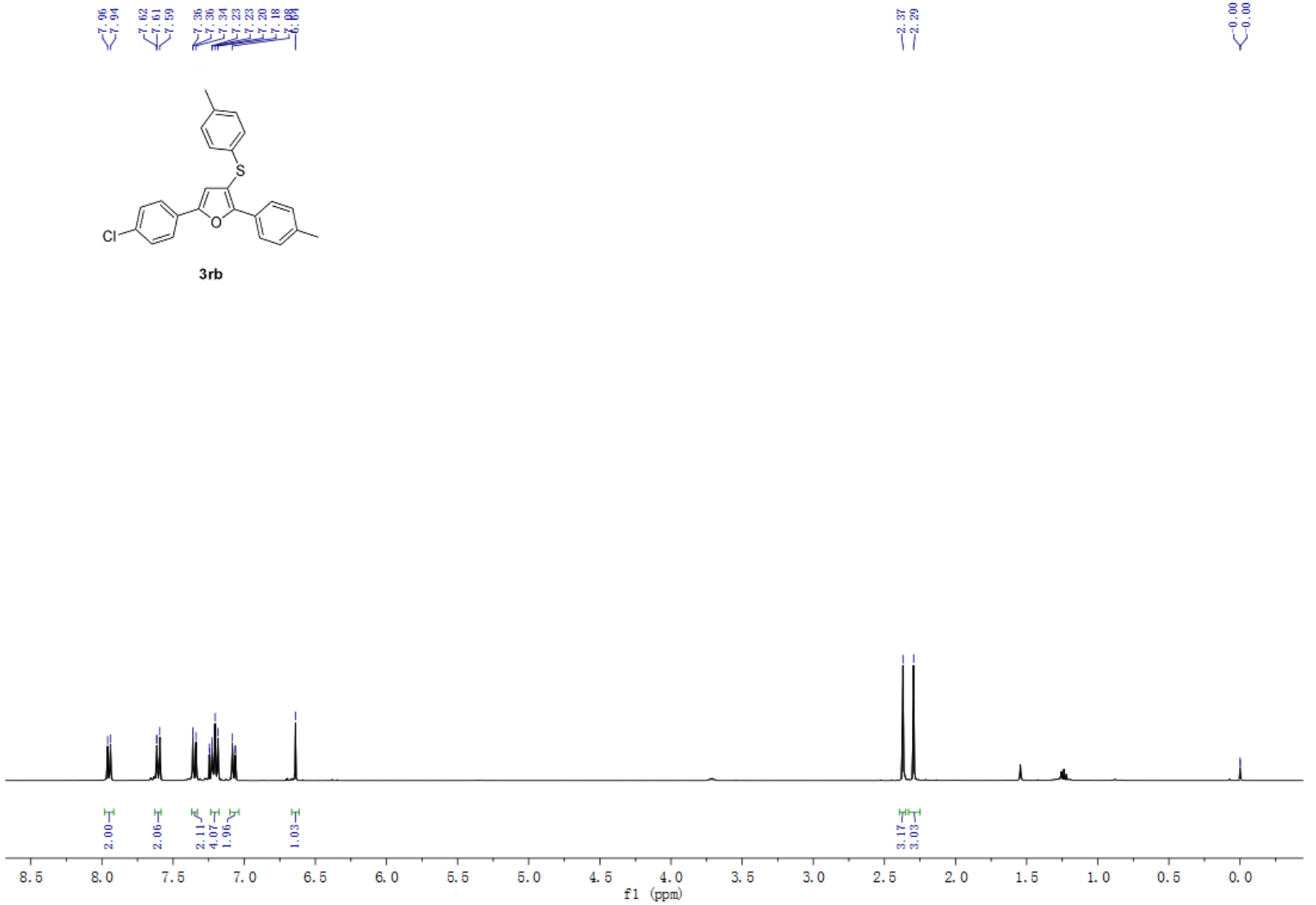
20
10
ppm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7.36
7.34
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7.20
7.18
2.37
2.29
0.00
0.00
S
O
Cl
3rb
2.00
2.06
2.11
4.07
1.96
1.03
3.17
3.03
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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1.0
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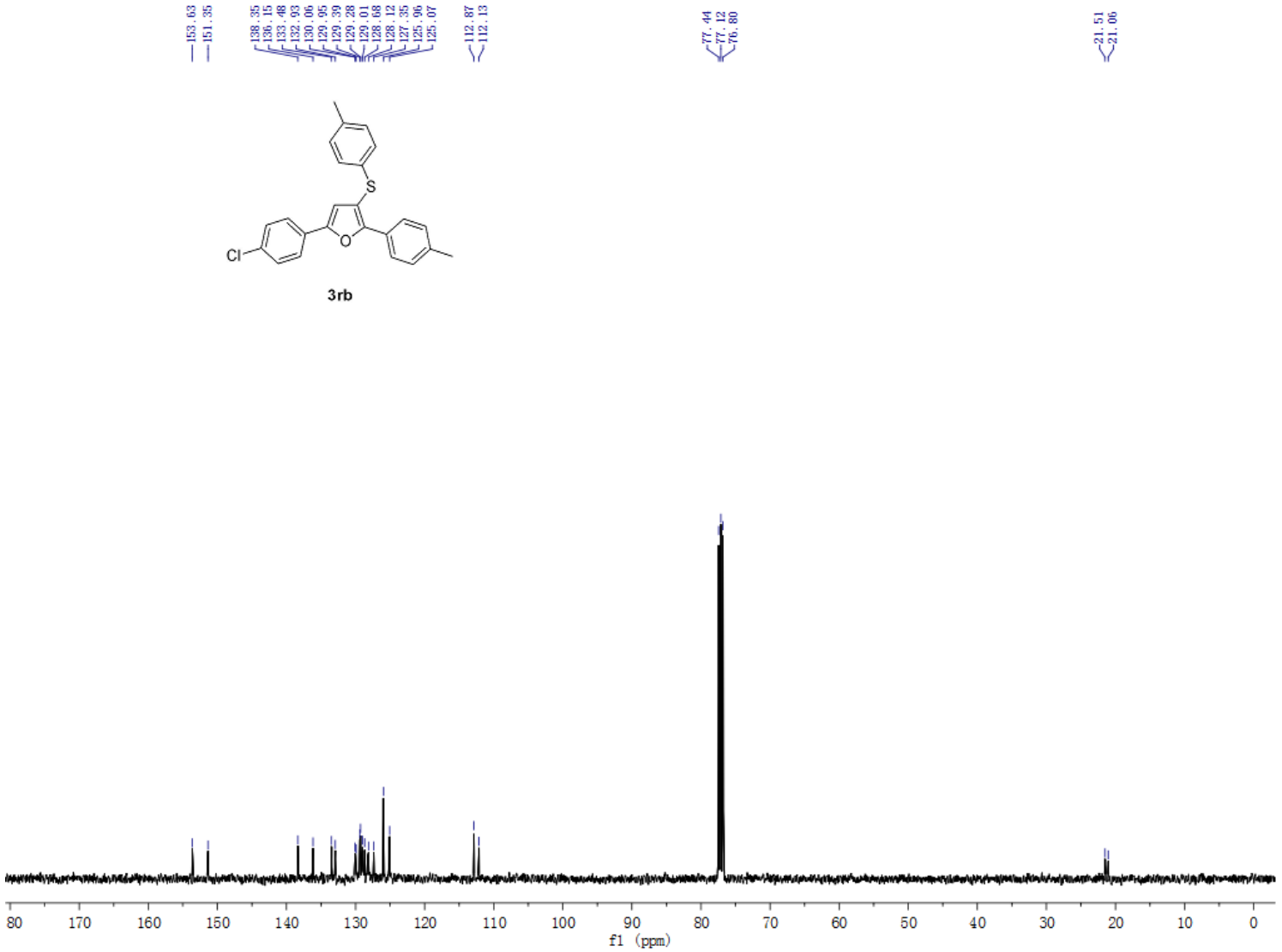
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127.35
125.96
125.07
112.87
112.13
77.44
77.12
76.80
21.51
21.06
S
O
Cl
3rb
80
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50
40
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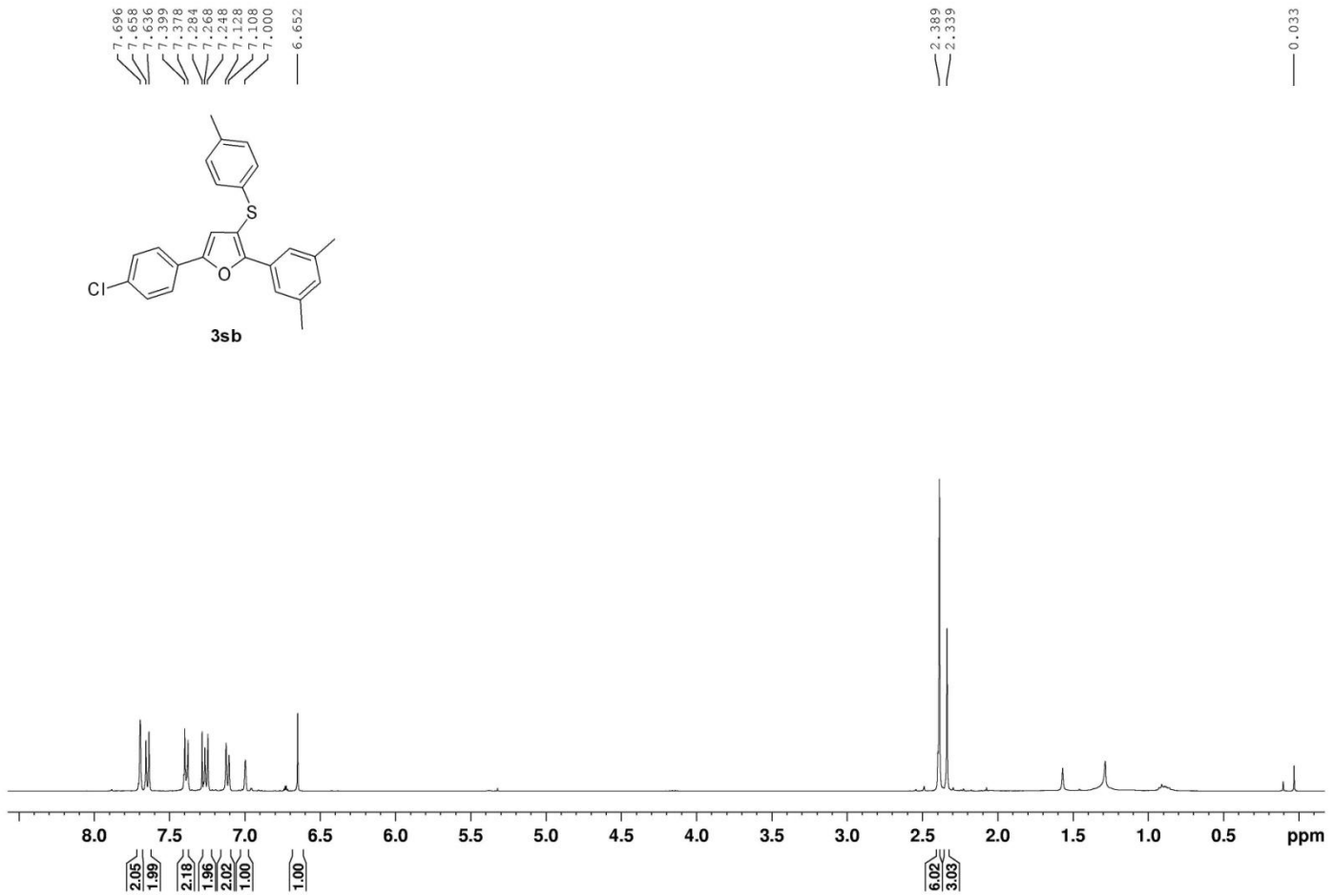
10
0
f1 (ppm)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7.000
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O
Cl
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6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
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1.00
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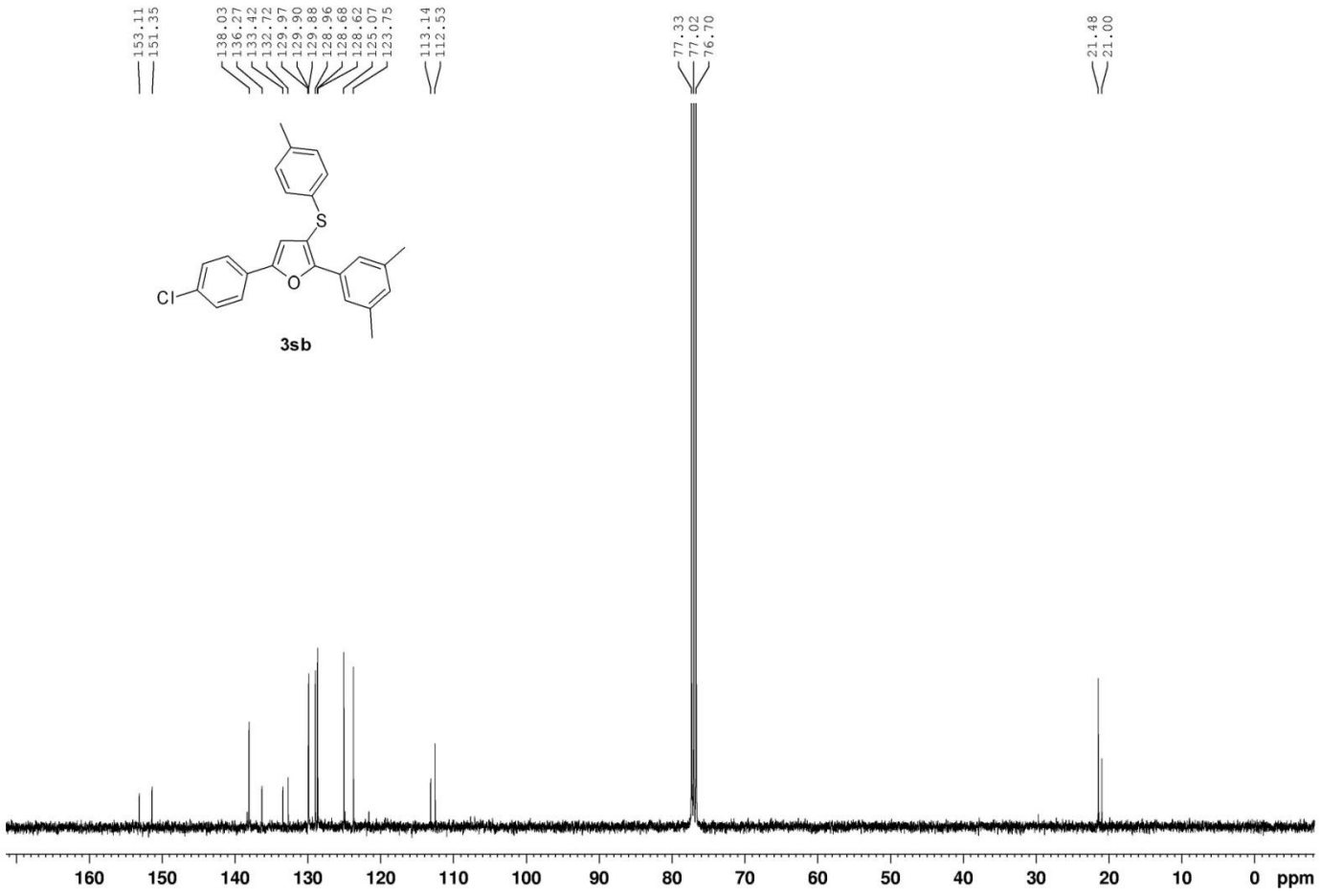
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128.68
128.62
125.07
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113.14
112.53
77.33
77.02
76.70
21.48
21.00
S
O
Cl
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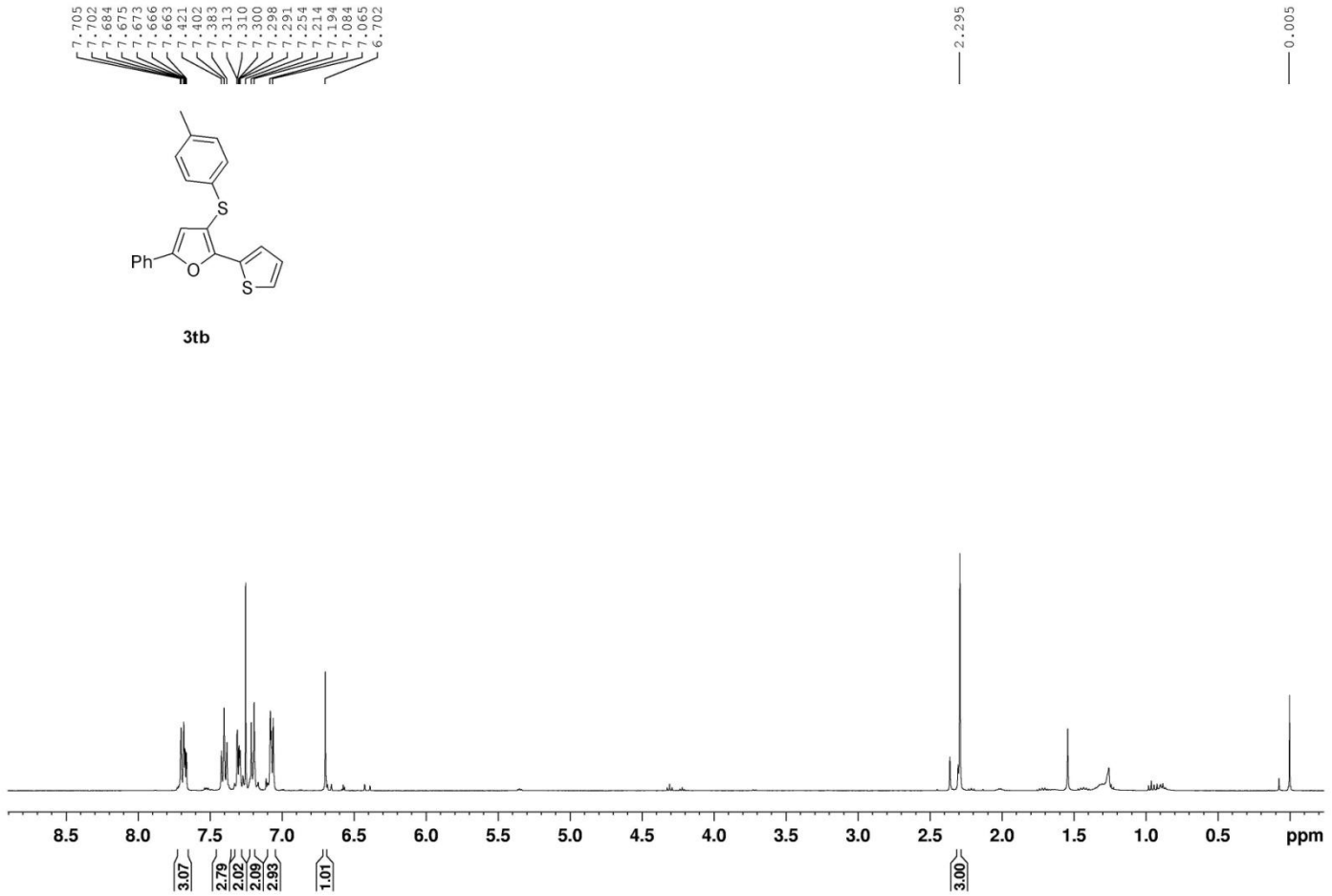
0
ppm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7.298
7.291
7.254
7.214
7.194
7.084
7.065
6.702
2.295
0.005
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Ph
O
S
3tb
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8.0
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7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
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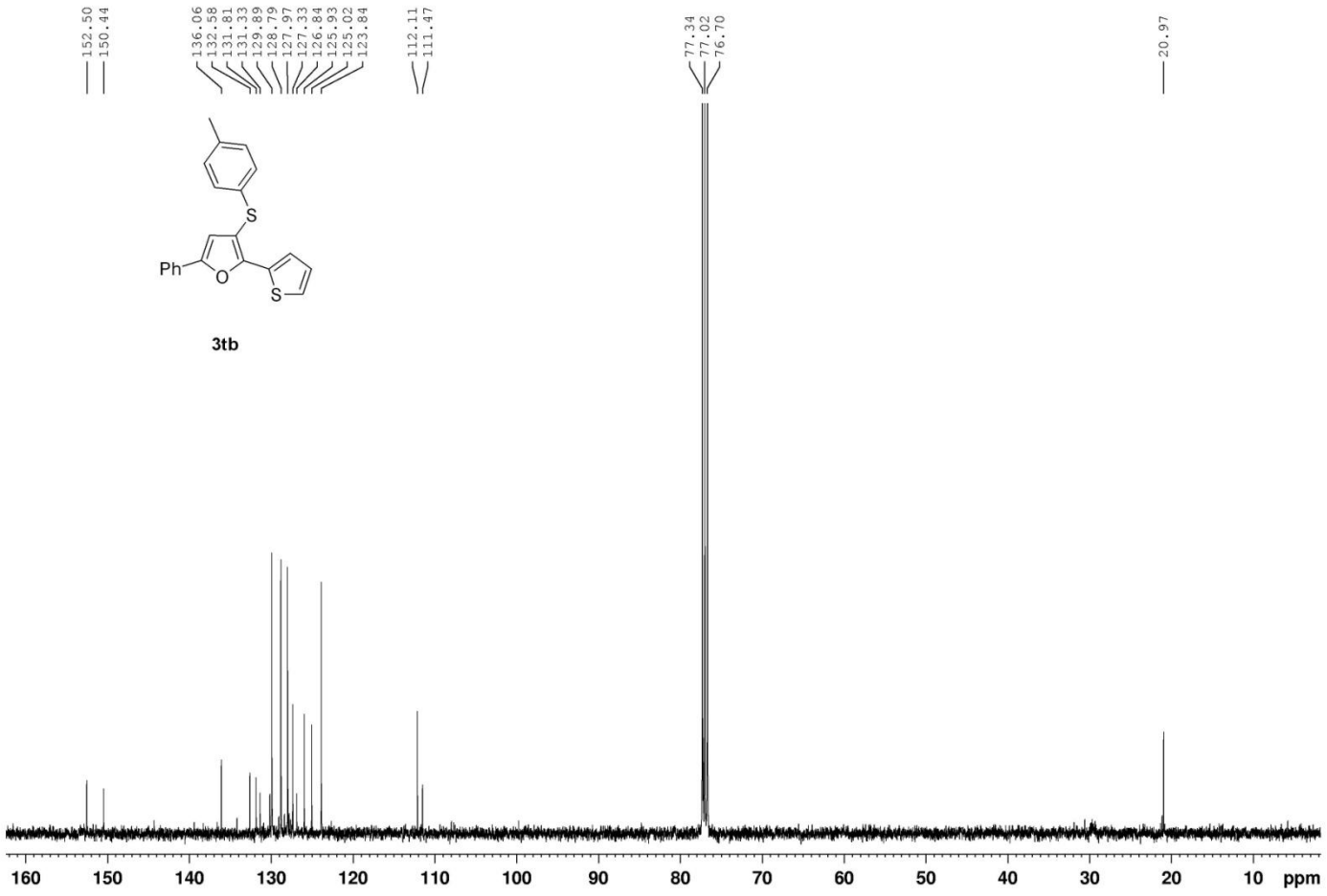
3.00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123.84
112.11
111.47
77.34
77.02
76.70
20.97
S
Ph
O
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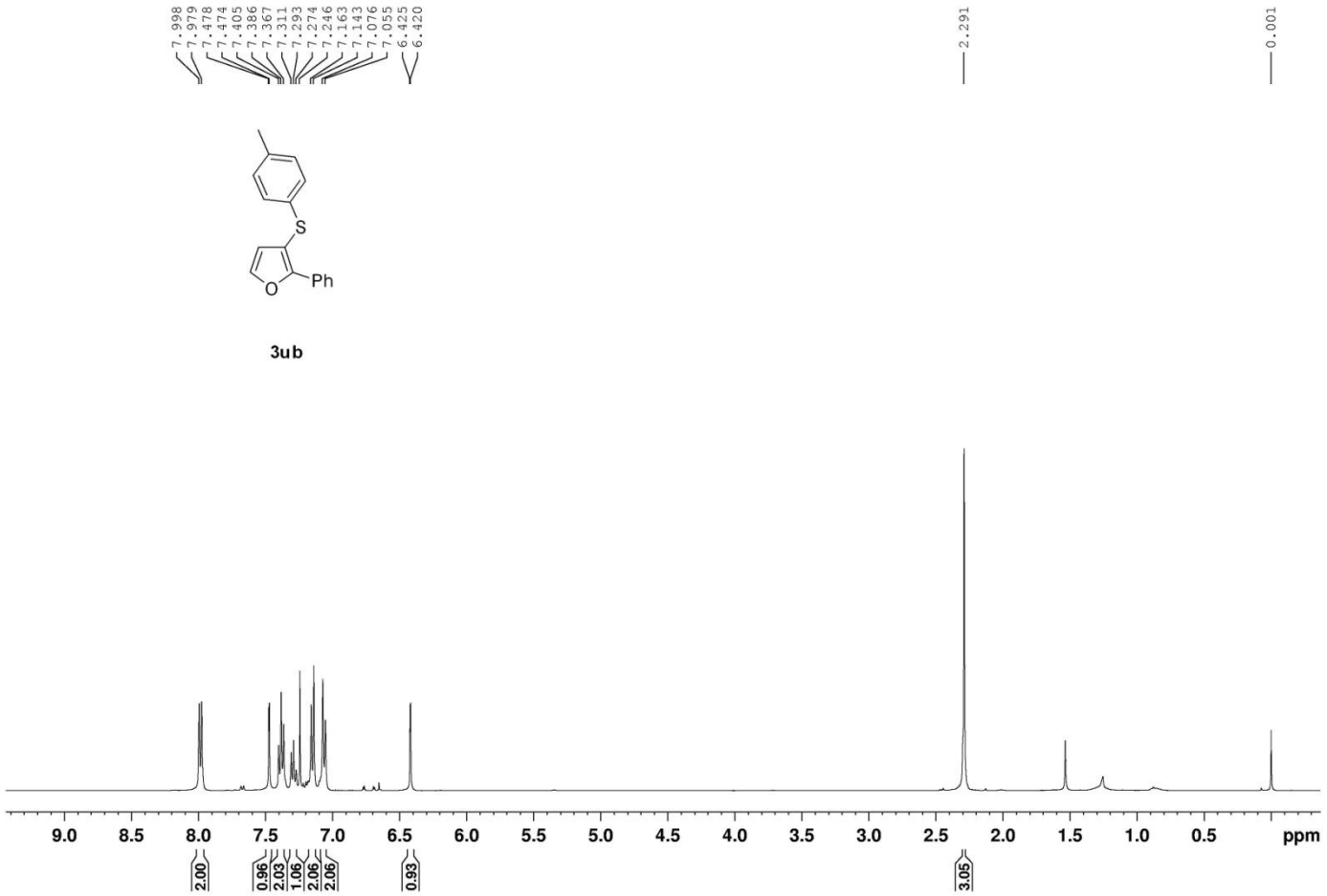
10
ppm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7.143
7.076
7.055
6.425
6.420
2.291
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S
Ph
O
3ub
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8.5
8.0
7.5
7.0
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6.0
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4.5
4.0
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ppm
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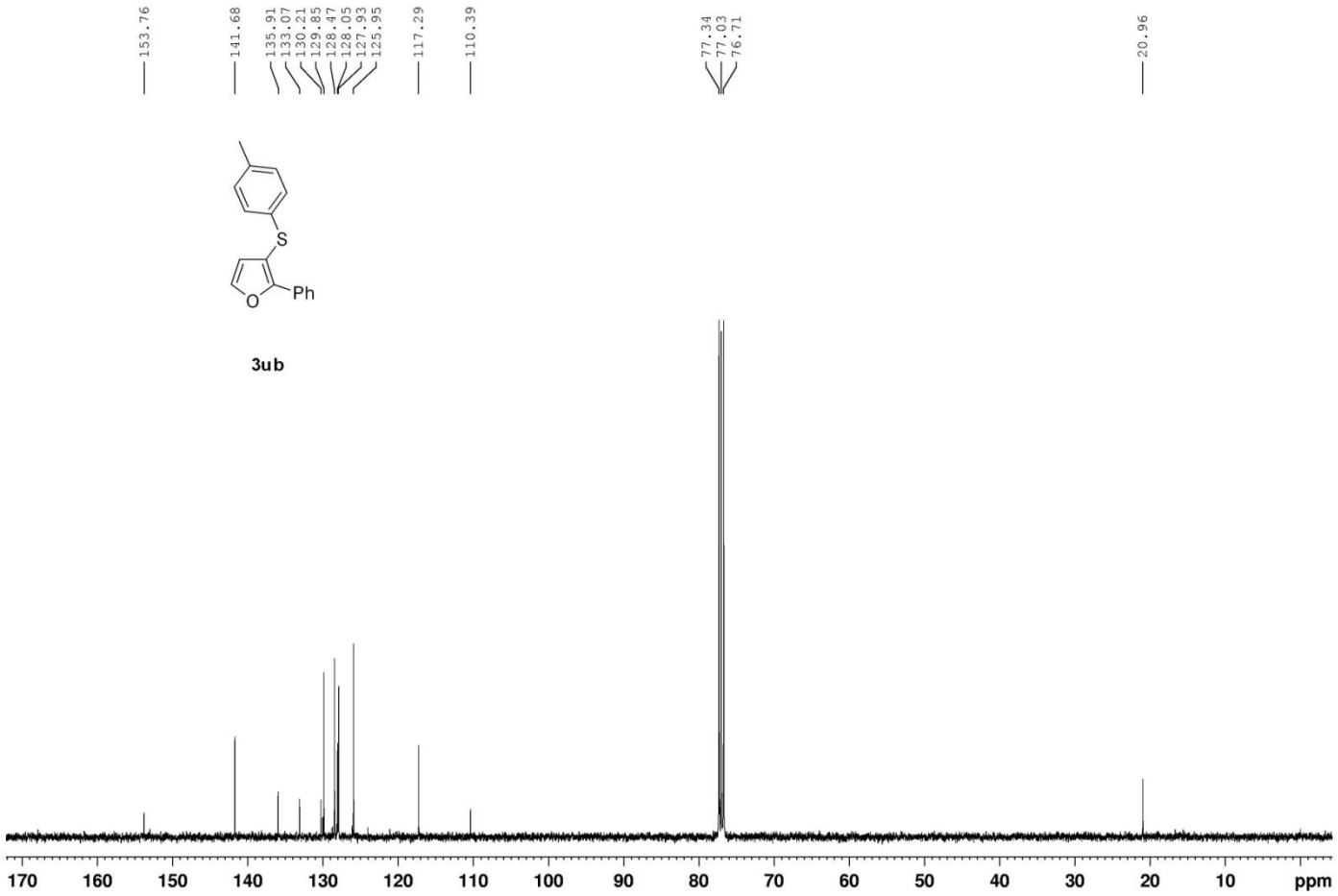
3.05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77.03
76.71
20.96
S
Ph
O
3ub
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140
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100
90
80
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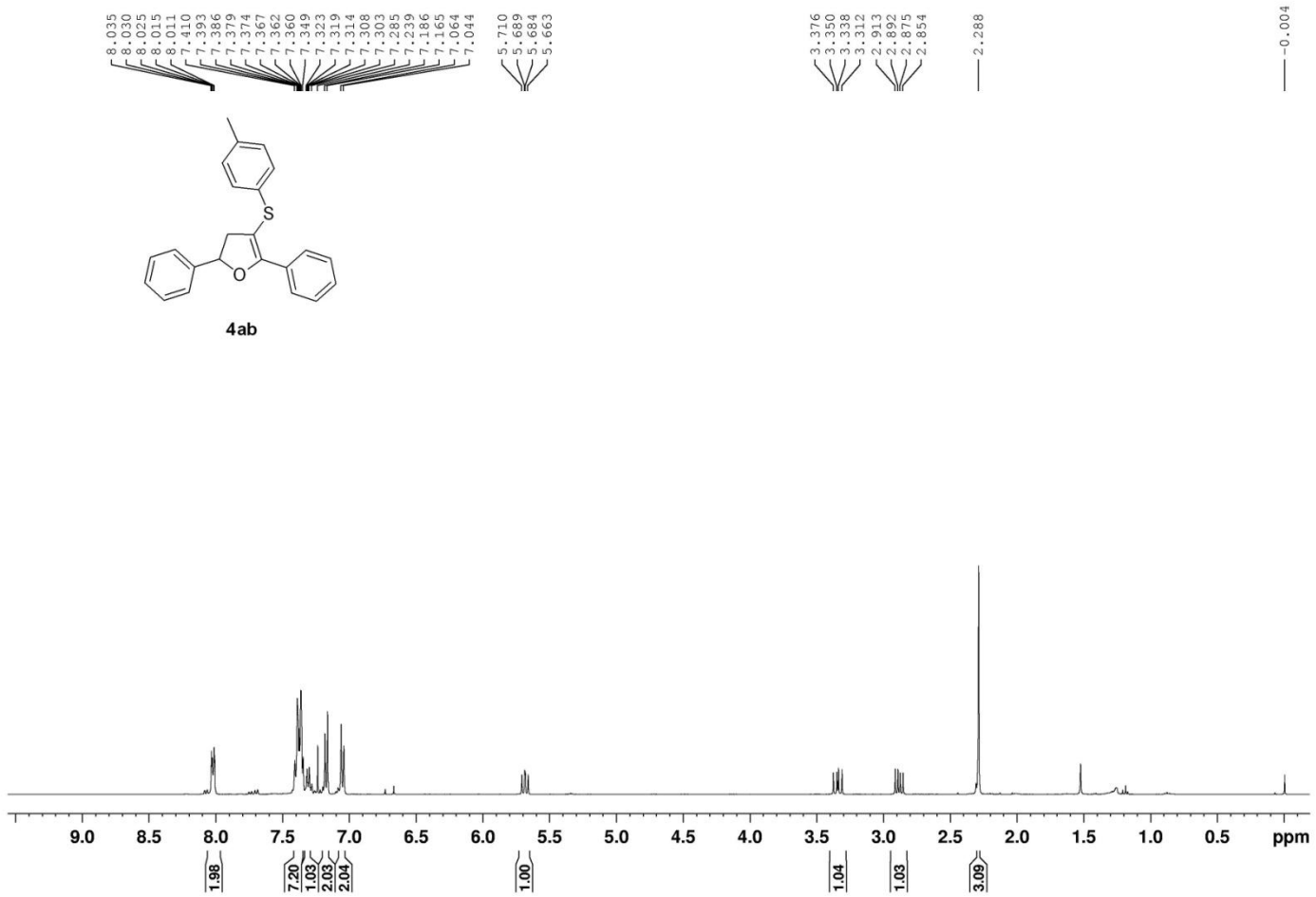
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7.349
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7.319
7.314
7.308
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7.285
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7.186
7.165
7.064
7.044
5.710
5.689
5.684
5.663
3.376
3.350
3.338
3.312
2.913
2.892
2.875
2.854
2.288
-0.004
S
O
4ab
9.0
8.5
8.0
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3.5
3.0
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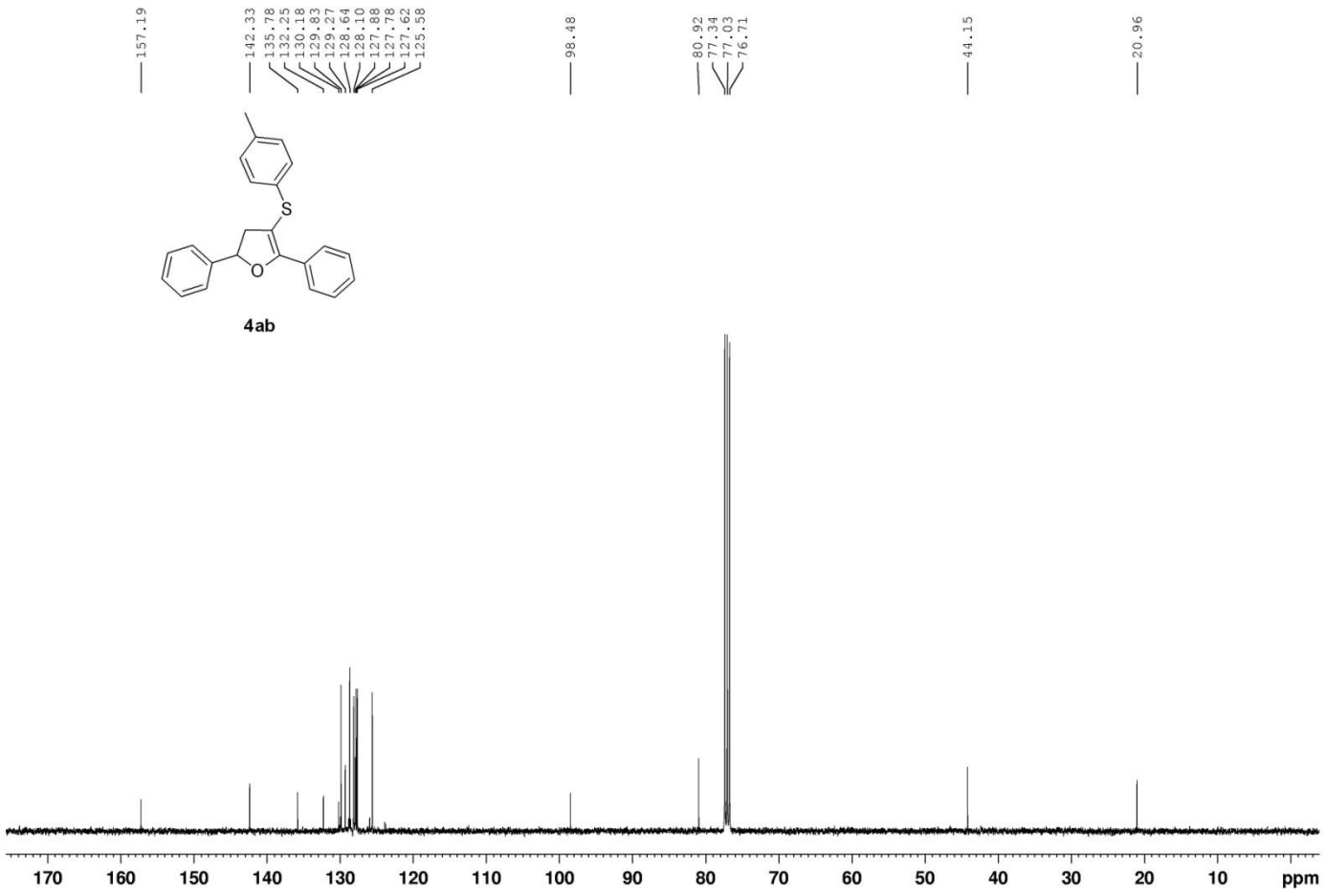
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98.48
80.92
77.34
77.03
76.71
44.15
20.96
S
O
4ab
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm