Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supplementary Information:

Efficient and Practical Synthesis of Unsymmetrical Disulfides via Base-Catalyzed Aerobic Oxidative Dehydrogenative Heterocoupling of Thiols

Xu Qiu, Xiaoxue Yang, Yiqun Zhang, Song Song,* and Ning Jiao.

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General Remarks

Cs_2CO_3 (99.9%) and K_2CO_3 (99.9%) were purchased from J&K Scientific and used as received. Other commercially available compounds were purchased from Alfa-Aesar Acros, Sigma-Aldrich, Beijing Chemical Works and J&K Scientific, Ltd. Unless otherwise noted, materials obtained from commercial suppliers were used without further purification. All reactions were conducted with test tube. ^{1}H-NMR spectra were recorded on a Bruker AVIII-400 spectrometers. Chemical shifts (in ppm) were calibrated with $CDCl_3$ (δ = 7.26 ppm). ^{13}C-NMR spectra were obtained by using the same NMR spectrometers and were calibrated with $CDCl_3$ (δ = 77.16 ppm). ^{19}F-NMR spectra were obtained by using the same NMR spectrometers and were calibrated with $CDCl_3$. HR-ESIMS spectra were measured on a Fourier Transform Ion Cyclotron Resonance Mass spectrometer (APEX IV, Bruker). HR-EI-MS spectra were recorded on a GCT-MS Micromass UK spectrometer. Unless otherwise noted, materials obtained from commercial suppliers were used without further purification.

General procedure

Typical procedure for the K_2CO_3-catalyzed aerobic CDC reaction of aryl thiols with alkyl thiols

K_2CO_3 (0.01 mmol, 1.4 mg) was added to a 25 mL tube with a magnetic bar, MeCN (1 mL), aryl thiols **1** (0.2 mmol) and alkyl thiols **2** (0.2 mmol) were added and then the mixture was stirred at 30℃ under air and monitored by TLC. The solution was diluted with ethyl acetate (10 mL), and evaporated under vacuum. The residue was purified by column chromatograhy on silica gel (petroleum ether/ethyl acetate) to afford product **3**.

Typical procedure for the Cs_2CO_3-catalyzed aerobic CDC reaction of alkyl thiols

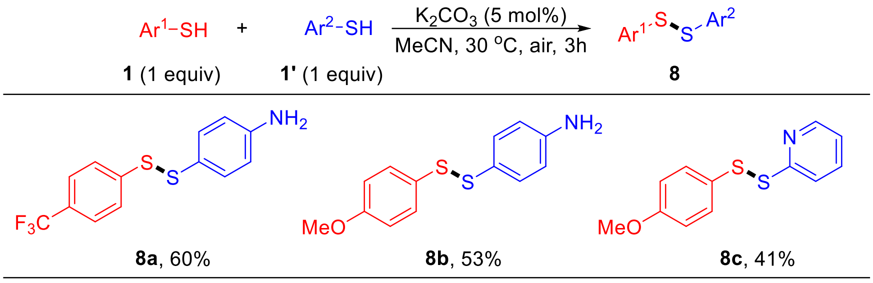
Cs_2CO_3 (0.04 mmol, 13 mg) was added to a 25 mL tube with a magnetic bar. MeCN (1 mL), alkyl thiols **2** (0.2 mmol) and alkyl thiols **2‘** (0.2 mmol) were added and then the mixture was stirred at 60℃ under air and monitored by TLC. After cooling down to room temperature, the solution was diluted with ethyl acetate (10 mL), and evaporate under vacuum. The residue was purified by column chromatograhy on silica gel (petroleum ether/ethyl acetate) to afford the product **5**.

Typical procedure for the M_2CO_3-catalyzed aerobic CDC reaction of thiols

For Aryl thiols: K_2CO_3 (0.01 mmol, 1.4 mg) was added to a 25 mL tube with a magnetic bar. MeCN (1 mL) and aryl thiols **1** (0.4 mmol) were added and then the mixture was stirred at 30℃ under air and monitored by TLC. The solution was diluted with ethyl acetate (10 mL), and evaporated under vacuum. The crude reaction mixture was purified by column chromatograhy on silica gel (petroleum ether/ethyl acetate) to afford product **4**.

For Alkyl thiols: Cs_2CO_3 (0.08 mmol, 26.1 mg) was added to a 25 mL tube with a magnetic bar, MeCN (1 mL) and alkyl thiols **2** (0.4 mmol) were added and then the mixture was stirred at 60℃ under air and monitored by TLC. After cooling down to room temperature, the solution was diluted with ethyl acetate (10 mL), and evaporated under vacuum. The crude reaction mixture was purified by column chromatograhy on silica gel (petroleum ether/ethyl acetate) to afford product **6**.

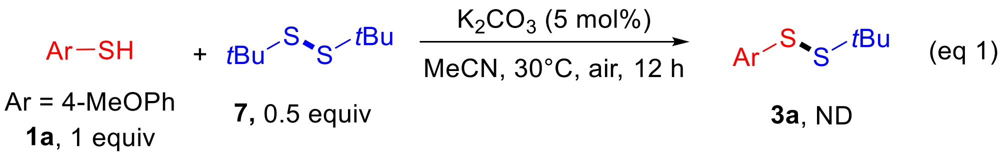
Table S1. The synthesis of unsymmetrical di-aryl disulfides



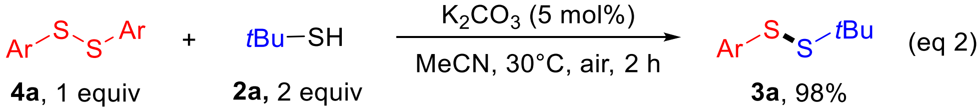
Typical procedure for the K_2CO_3-catalyzed aerobic CDC reaction of aryl thiols

K_2CO_3 (0.01 mmol, 1.4 mg) was added to a 25 mL tube with a magnetic bar, MeCN (1 mL), aryl thiols **1** (0.2 mmol) and aryl thiols **1'** (0.2 mmol) were added and then the mixture was stirred at 30°C under air and monitored by TLC. The solution was diluted with ethyl acetate (10 mL), and evaporated under vacuum. The residue was purified by column chromatograhy on silica gel (petroleum ether/ethyl acetate) to afford product **8**.

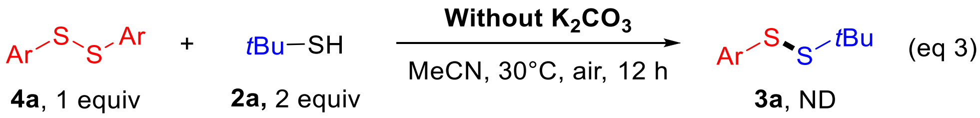
Mechanism Studies



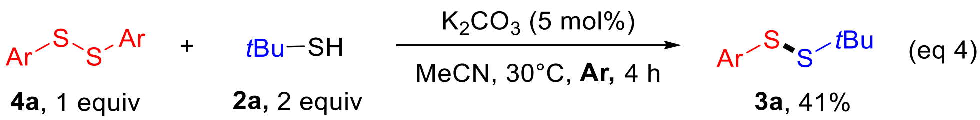
The reaction of 4-methoxybenzenethiol **1a** (0.2 mmol, 28.0 mg), 2-methylpropane-2-thiol **7** (0.1 mmol, 17.8 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 12 h, the desired product **3a** was not detected by ^{1}H-NMR and TLC.



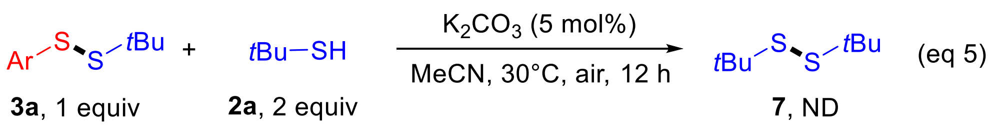
The reaction of 1,2-bis(4-methoxyphenyl)disulfane **4a** (0.1 mmol, 27.8 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, 98% yield of **3a** was detected by ^{1}H-NMR with 1,1,2,2-tetrachloroethane (0.2 mmol, 33.6 mg) as internal standard.



The reaction of 1,2-bis(4-methoxyphenyl)disulfane **4a** (0.1 mmol, 27.8 mg) and 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg) in CH_3CN (1 mL) under air at 30 °C for 12 h, the desired product **3a** was not detected by ^{1}H-NMR and TLC.



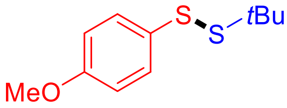
The reaction of 1,2-bis(4-methoxyphenyl)disulfane **4a** (0.1 mmol, 27.8 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under Ar at 30 °C for 4 h, 41% yield of **3a** was detected by ^{1}H-NMR with 1,1,2,2-tetrachloroethane (0.2 mmol, 33.6 mg) as internal standard.



The reaction of 1-(tert-butyl)-2-(4-methoxyphenyl)disulfane **3a** (0.1 mmol, 22.8 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 12 h, the desired product **7** was not detected by ^{1}H-NMR and TLC.

Analytical data for products

1-(tert-butyl)-2-(4-methoxyphenyl)disulfane (3a)[1]



3a

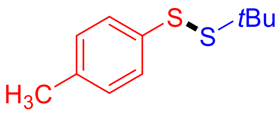
The reaction of 4-methoxybenzenethiol **1a** (0.2 mmol, 28.0 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 1 h, afforded 42.5 mg (93%) of **3a** as colorless oil.

Gram-scale experiments: The reaction of 4-methoxybenzenethiol **1a** (10 mmol, 1.40 g), 2-methylpropane-2-thiol **2a** (10 mmol, 902 mg), K_2CO_3 (0.25 mmol, 34.5 mg) in CH_3CN (10 mL) under air at 30 °C for 8 h, afforded 1.88 g (83%) of **3a** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.51 – 7.47 (m, 2H), 6.86 – 6.82 (m, 2H), 3.79 (s, 3H), 1.29 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 158.9, 130.3, 129.8, 114.4, 55.4, 49.0, 29.9.

1-(tert-butyl)-2-(p-tolyl)disulfane (3b) [1]



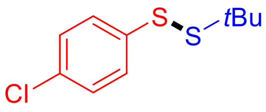
3b

The reaction of 4-methylbenzenethiol **1b** (0.2 mmol, 24.8 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 3 h, afforded 40.0 mg (94%) of **3b** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.46 (d, *J* = 8.2 Hz, 2H), 7.11 (d, *J* = 8.0 Hz, 2H), 2.33 (s, 3H), 1.31 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 136.3, 135.4, 129.5, 127.4, 49.1, 29.9, 21.0.

1-(tert-butyl)-2-(4-chlorophenyl)disulfane (3c) [1]



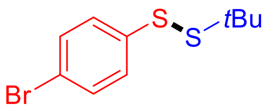
3c

The reaction of 4-chlorobenzenethiol **1c** (0.2 mmol, 28.9 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 8 h, afforded 45.3 mg (97%) of **3c** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.51 – 7.46 (m, 2H), 7.28 – 7.23 (m, 2H), 1.30 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 137.5, 132.1, 128.8, 128.1, 49.4, 29.8.

1-(4-bromophenyl)-2-(tert-butyl)disulfane (3d) [1]



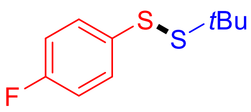
3d

The reaction of 4-bromobenzenethiol **1d** (0.2 mmol, 37.8 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 7 h, afforded 50.1 mg (90%) of **3d** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.46 – 7.37 (m, 4H), 1.30 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 138.2, 131.7, 128.3, 119.9, 49.5, 29.8.

1-(tert-butyl)-2-(4-fluorophenyl)disulfane (3e)



3e

The reaction of 4-fluorobenzenethiol **1e** (0.2 mmol, 25.6 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 6 h, afforded 31.8 mg (73%) of **3e** as colorless oil.

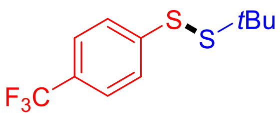
^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.57 – 7.49 (m, 2H), 7.03 – 6.95 (m, 2H), 1.30 (s, 9H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ = 161.8 (d, $^1J_{C\text{-}F}$ = 246.0 Hz), 134.0 (d, $^4J_{C\text{-}F}$ = 3.2 Hz), 129.3 (d, $^3J_{C\text{-}F}$ =8.0 Hz), 115.8 (d, $^2J_{C\text{-}F}$ = 22.2 Hz), 49.3, 29.8.

[19]F NMR (376 MHz, $CDCl_3$) δ = -116.0.

HRMS (EI) exact mass calc'd for $C_{10}H_{13}S_2F$ ($[M]^+$): 216.0443; found m/z: 216.0441.

1-(tert-butyl)-2-(4-(trifluoromethyl)phenyl)disulfane (3f)



3f

The reaction of 4-(trifluoromethyl)benzenethiol **1f** (0.2 mmol, 35.6 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 36 h, afforded 40.1 mg (75%) of **3f** as colorless oil.

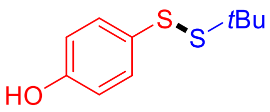
^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.70 – 7.62 (m, 2H), 7.57 – 7.50 (m, 2H), 1.32 (s, 9H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ = 143.9, 128.2 (q, $^2J_{C\text{-}F}$ = 32.6 Hz), 126.0, 125.6 (q, $^3J_{C\text{-}F}$ = 3.8 Hz), 124.1 (q, $^1J_{C\text{-}F}$ = 272.7 Hz), 49.7, 29.8.

^{19}F NMR (376 MHz, $CDCl_3$) δ = -62.3.

HRMS (EI) exact mass calc'd for $C_{11}H_{13}S_2F_3$ ($[M]^+$): 266.0411; found m/z: 266.0408.

4-(tert-butyldisulfaneyl)phenol (3g)



3g

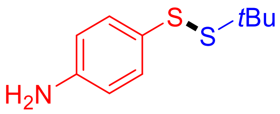
The reaction of 4-mercaptophenol **1g** (0.2 mmol, 25.2 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.21 mmol, 29.0 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 41.2 mg (96%) of **3g** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.51 – 7.36 (m, 2H), 6.85 – 6.72 (m, 2H), 5.40 (s, 1H), 1.29 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 154.9, 130.5, 130.0, 116.0, 49.0, 29.9.

HRMS (EI) exact mass calc'd for $C_{10}H_{14}OS_2$ ($[M]^+$): 214.0486; found m/z: 214.0490.

4-(tert-butyldisulfaneyl)aniline (3h)



3h

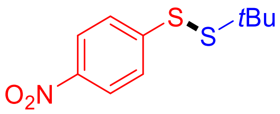
The reaction of 4-aminobenzenethiol **1h** (0.2 mmol, 25.0 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 40.9 mg (96%) of **3h** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-d) δ = 7.46 – 7.29 (m, 2H), 6.67 – 6.52 (m, 2H), 3.70 (s, 2H), 1.30 (s, 9H).

^{13}C NMR (101 MHz, CDCl3) δ = 146.0, 131.4, 126.9, 115.5, 48.8, 30.0.

HRMS (ESI) exact mass calc'd for $C_{10}H_{16}NS_2$ ($[M+H]^+$): 214.0724; found m/z: 214.0715.

1-(tert-butyl)-2-(4-nitrophenyl)disulfane (3i) [1]



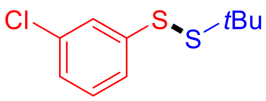
3i

The reaction of 4-nitrobenzenethiol **1i** (0.2 mmol, 31.0 mg), 2-methylpropane-2-thiol 2a (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 12 h, afforded 37.0 mg (76%) of **3i** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-d) δ = 8.18 – 8.10 (m, 2H), 7.73 – 7.65 (m, 2H), 1.33 (s, 9H).

^{13}C NMR (101 MHz, CDCl3) δ = 148.4, 146.0, 125.8, 123.8, 50.2, 29.8.

1-(tert-butyl)-2-(3-chlorophenyl)disulfane (3j)



3j

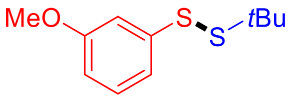
The reaction of 3-chlorobenzenethiol **1j** (0.2 mmol, 28.9 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 5 h, afforded 43.4 mg (93%) of **3j** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.56 (t, *J* = 1.9 Hz, 1H), 7.41 – 7.39 (m, 1H), 7.21 (t, *J* = 7.9 Hz, 1H), 7.15 – 7.12 (m, 1H), 1.31 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 141.0, 134.8, 129.7, 126.3, 126.2, 124.5, 49.5, 29.8.

HRMS (EI) exact mass calc'd for $C_{10}H_{13}S_2Cl$ ($[M]^+$): 232.0147; found m/z: 232.0144.

1-(tert-butyl)-2-(3-methoxyphenyl)disulfane (3k)



3k

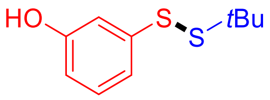
The reaction of 3-methoxybenzenethiol **1k** (0.2 mmol, 28.0 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 39.5 mg (87%) of **3k** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.20 (t, *J* = 7.9 Hz, 1H), 7.17 – 7.14 (m, 1H), 7.13 – 7.11 (m, 1H), 6.70 – 6.63 (m, 1H), 3.82 (s, 3H), 1.32 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 159.9, 140.2, 129.5, 118.9, 112.2, 111.8, 55.3, 49.2, 29.9.

HRMS (EI) exact mass calc'd for $C_{12}H_{16}OS_2$ ($[M]^+$): 228.0643; found m/z: 228.0640.

3-(tert-butyldisulfaneyl)phenol (3l)



3l

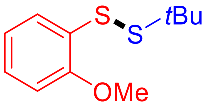
The reaction of 3-mercaptophenol **1l** (0.2 mmol, 25.2 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.21 mmol, 29.0 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 38.6 mg (90%) of **3l** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.18 – 7.12 (m, 1H), 7.12 – 7.07 (m, 2H), 6.66-6.63 (m, 1H), 5.05 (s, 1H), 1.31 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 155.9, 140.5, 129.8, 119.0, 113.4, 113.3, 49.3, 29.8.

HRMS (EI) exact mass calc'd for $C_{10}H_{14}OS_2$ ($[M]^+$): 214.0486; found m/z: 214.0488.

1-(tert-butyl)-2-(2-methoxyphenyl)disulfane (3m)



3m

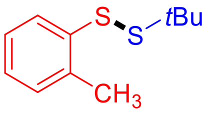
The reaction of 2-methoxybenzenethiol **1m** (0.2 mmol, 28.0 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 44.2 mg (97%) of **3m** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.77 (dd, *J* = 7.8 Hz, 1.7 Hz, 1H), 7.18 – 7.14 (m, 1H), 6.99 – 6.94 (m, 1H), 6.83 (dd, *J* = 8.1 Hz, 1.2 Hz, 1H), 3.90 (s, 3H), 1.33 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 156.1, 127.2, 127.1, 126.5, 121.0, 110.5, 55.9, 48.9, 29.9.

HRMS (EI) exact mass calc'd for $C_{11}H_{16}OS_2$ ($[M]^+$): 228.0643; found m/z: 228.0645.

1-(tert-butyl)-2-(o-tolyl)disulfane (3n)[2]



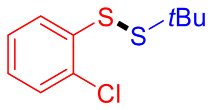
3n

The reaction of 2-methylbenzenethiol **1n** (0.2 mmol, 24.8 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 35.8 mg (84%) of **3n** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.79 (dd, *J* = 7.8 Hz, 1.2 Hz, 1H), 7.21 – 7.10 (m, 1H), 7.15 – 7.07 (m, 2H), 2.45 (s, 3H), 1.32 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 137.2, 135.9, 130.1, 127.2, 126.3, 126.2, 49.1, 29.9, 19.9.

1-(tert-butyl)-2-(2-chlorophenyl)disulfane (3o)



3o

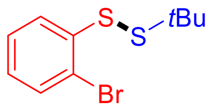
The reaction of 2-chlorobenzenethiol **1o** (0.2 mmol, 28.9 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 24 h, afforded 39.7 mg (85%) of **3o** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.85 (dd, *J* = 8.0 Hz, 1.6 Hz, 1H), 7.30 (dd, *J* = 7.9 Hz, 1.4 Hz, 1H), 7.28 – 7.23 (m, 1H), 7.13 – 7.09 (m, 1H), 1.33 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 137.3, 131.3, 129.4, 127.6, 126.9, 49.5, 29.8.

HRMS (EI) exact mass calc'd for $C_{10}H_{13}S_2Cl$ ($[M]^+$): 232.0147; found m/z: 232.0145.

1-(2-bromophenyl)-2-(tert-butyl)disulfane (3p) [2]



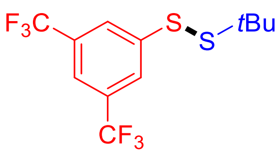
3p

The reaction of 2-bromobenzenethiol **1p** (0.2 mmol, 37.8 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 7 h, afforded 50.0 mg (90%) of **3p** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.84 (dd, *J* = 8.0 Hz, 1.6 Hz, 1H), 7.48 (dd, *J* = 7.9 Hz, 1.3 Hz, 1H), 7.33 – 7.29 (m, 1H), 7.07 – 7.00 (m, 1H), 1.33 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 139.1, 132.6, 127.5, 127.2, 120.8, 49.6, 29.9.

1-(3,5-bis(trifluoromethyl)phenyl)-2-(tert-butyl)disulfane (3q)



3q

The reaction of 2-bromobenzenethiol **3q** (0.2 mmol, 49.2 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 48.3 mg (73%) of **3q** as colorless oil.

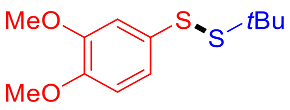
^{1}H NMR (400 MHz, Chloroform-*d*) δ = 8.03 – 8.00 (m, 2H), 7.66 – 7.64 (m, 1H), 1.33 (s, 9H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ = 142.7, 132.1 (q, $^{2}J_{C-F}$ =33.5), 125.8, 123.1 (q, $^{1}J_{C-F}$ = 273.0), 120.7 – 119.6 (m), 50.2, 29.7.

^{19}F NMR (376 MHz, $CDCl_3$) δ = -63.1.

HRMS (EI) exact mass calc'd for $C_{12}H_{12}F_6S_2$ ($[M]^+$): 334.0285; found m/z: 334.0283.

1-(tert-butyl)-2-(3,4-dimethoxyphenyl)disulfane (3r)



3r

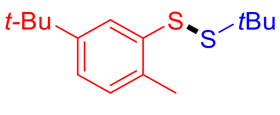
The reaction of 4-methoxy-3-(trifluoromethyl)benzenethiol **1r** (0.2 mmol, 41.6 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 ℃ for 2 h, afforded 50.1 mg (97%) of **3r** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.17 – 7.04 (m, 2H), 6.78 (d, *J* = 8.3 Hz, 1H), 3.89 (s, 3H), 3.85 (s, 3H), 1.30 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 149.2, 148.4, 130.1, 120.8, 111.8, 111.4, 56.0, 55.9, 49.0, 29.9.

HRMS (EI) exact mass calc'd for $C_{12}H_{18}O_2S_2$ ($[M]^+$): 258.0748; found m/z: 258.0750.

1-(tert-butyl)-2-(5-(tert-butyl)-2-methylphenyl)disulfane (3s)



3s

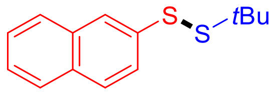
The reaction of 5-(tert-butyl)-2-methylbenzenethiol **1s** (0.2 mmol, 36.6 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 ℃ for 3 h, afforded 51.8 mg (93%) of **3s** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.88 (d, *J* = 2.0 Hz, 1H), 7.12 (dd, *J* = 7.9 Hz, 2.0 Hz, 1H), 7.06 (d, *J* = 7.9 Hz, 1H), 2.41 (s, 3H), 1.34 (s, 9H), 1.33 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 149.2, 136.2, 132.9, 129.8, 124.2, 123.1, 48.9, 34.8, 31.4, 30.0, 19.2.

HRMS (EI) exact mass calc'd for $C_{15}H_{24}S_2$ ($[M]^+$): 268.1319; found m/z: 268.1317.

1-(tert-butyl)-2-(naphthalen-2-yl)disulfane (3t) [2]



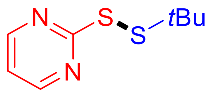
3t

The reaction of naphthalene-2-thiol **1t** (0.2 mmol, 36.0 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 5 h, afforded 48.7 mg (98%) of **3t** as colorless oil.

^1H NMR (400 MHz, Chloroform-*d*) δ = 8.03 (d, *J* = 1.9 Hz, 1H), 7.84 – 7.75 (m, 3H), 7.69 (dd, *J* = 8.7 Hz, 1.9 Hz, 1H), 7.58 – 7.36 (m, 2H), 1.35 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 136.2, 133.5, 132.1, 128.5, 127.8, 127.2, 126.6, 125.8, 125.2, 125.1, 49.4, 29.9.

2-(tert-butyldisulfaneyl)pyrimidine (3u) [1]



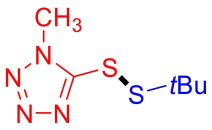
3u

The reaction of pyrimidine-2-thiol **1u** (0.2 mmol, 40.0 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 60 °C for 48 h, afforded 30.1 mg (75%) of **3u** as colorless oil.

^1H NMR (400 MHz, Chloroform-*d*) δ = 8.58 (d, *J* = 4.8 Hz, 2H), 7.05 (t, *J* = 4.8 Hz, 1H), 1.34 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.3, 157.7, 117.8, 49.1, 29.7.

5-(tert-butyldisulfaneyl)-1-methyl-1H-tetrazole (3v) [1]



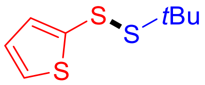
3v

The reaction of 1-methyl-1H-tetrazole-5-thiol **1v** (0.2 mmol, 23.2 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 24 h, afforded 24.6 mg (60%) of **3v** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 4.11 (s, 3H), 1.35 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 153.5, 50.5, 34.6, 29.6.

2-(tert-butyldisulfaneyl)thiophene (3w)[3]



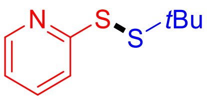
3w

The reaction of thiophene-2-thiol **1w** (0.2 mmol, 23.2 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 39.6 mg (97%) of **3w** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.33 (dd, *J* = 5.3 Hz, 1.3 Hz, 1H), 7.21 (dd, *J* = 3.6 Hz, 1.3 Hz, 1H), 6.93 (dd, *J* = 5.3 Hz, 3.6 Hz, 1H), 1.37 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 139.3, 132.6, 129.5, 127.3, 49.0, 30.0.

2-(tert-butyldisulfaneyl)pyridine (3x) [1]



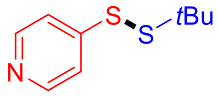
3x

The reaction of pyridine-2-thiol **1x** (0.2 mmol, 22.2 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 24 h, afforded 16.0 mg (40%) of **3x** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 8.44 – 8.41 (m, 1H), 7.80 – 7.77 (m, 1H), 7.63 – 7.59 (m, 1H), 7.06 – 7.02 (m, 1H), 1.33 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 161.7, 149.2, 136.8, 120.3, 119.6, 49.3, 29.8.

4-(tert-butyldisulfaneyl)pyridine(3y)[2]



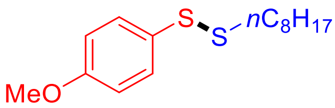
3y

The reaction of pyridine-4-thiol **1y** (0.2 mmol, 22.2 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 24 h, afforded 19.4 mg (49%) of **3y** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 8.45 – 8.43 (m, 2H), 7.49 – 7.46 (m, 2H), 1.32 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 150.3, 149.3, 120.1, 49.8, 29.8.

1-(4-methoxyphenyl)-2-octyldisulfane (3z)[4]



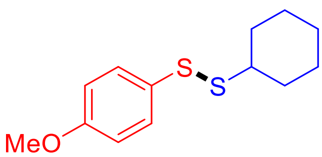
3z

The reaction of 4-methoxybenzenethiol **1a** (0.2 mmol, 28.0 mg), octane-1-thiol **2b** (0.3 mmol, 43.8 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 43.4 mg (71%) of **3z** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.51 – 7.44 (m, 2H), 6.89 – 6.82 (m, 2H), 3.80 (d, *J* = 1.6 Hz, 3H), 2.73 (t, *J* = 7.4 Hz, 2H), 1.70 – 1.63 (m, 2H), 1.34 – 1.20 (m, 10H), 0.88 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 159.5, 131.6, 128.6, 114.6, 55.4, 38.9, 31.8, 29.1, 28.7, 28.5, 22.6, 14.1.

1-cyclohexyl-2-(4-methoxyphenyl)disulfane (3aa)[5]



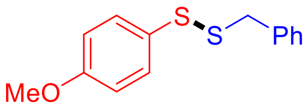
3aa

The reaction of 4-methoxybenzenethiol **1a** (0.2 mmol, 28.0 mg), cyclohexanethiol **2c** (0.3 mmol, 34.9 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 40.4 mg (71%) of **3aa** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.54 – 7.40 (m, 2H), 6.91 – 6.83 (m, 2H), 3.80 (s, 3H), 2.81 – 2.79 (m, 1H), 2.07 – 1.97 (m, 2H), 1.82 – 1.70 (m, 2H), 1.47 – 1.08 (m, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 159.1, 130.7, 129.4, 114.5, 55.4, 49.7, 32.6, 26.0, 25.7.

1-benzyl-2-(4-methoxyphenyl)disulfane (3ab)[6]



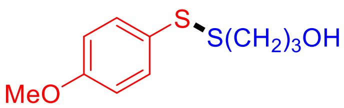
3ab

The reaction of 4-methoxybenzenethiol **1a** (0.2 mmol, 28.0 mg), phenylmethanethiol **2d** (0.2 mmol, 24.8 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 25.4 mg (48%) of **3ab** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.55 – 7.37 (m, 2H), 7.34 – 7.24 (m, 5H), 6.91 – 6.69 (m, 2H), 3.97 (s, 2H), 3.83 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 159.6, 136.8, 132.0, 129.4, 128.5, 128.0, 127.5, 114.6, 55.4, 43.3.

3-((4-methoxyphenyl)disulfaneyl)propan-1-ol (3ac)



3ac

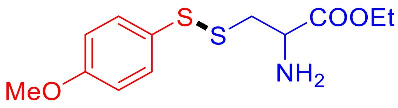
The reaction of 4-methoxybenzenethiol **1a** (0.2 mmol, 28.0 mg), 3-mercaptopropan-1-ol **2e** (0.3 mmol, 27.7 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 30.8 mg (67%) of **3ac** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.52 – 7.45 (m, 2H), 6.90 – 6.82 (m, 2H), 3.80 (s, 3H), 3.71 (t, *J*=6.1, 2H), 2.84 (t, *J*=7.1, 2H), 2.00 – 1.90 (m, 2H), 1.43 (s, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 159.7, 132.0, 128.2, 114.7, 61.1, 55.4, 35.0, 31.4.

HRMS (EI) exact mass calc'd for $C_{10}H_{14}O_2S_2$ ($[M]^+$): 230.0435; found m/z: 230.0432.

ethyl S-((4-methoxyphenyl)thio)cysteinate (3ad)



3ad

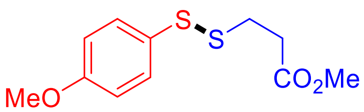
The reaction of 4-methoxybenzenethiol **1a** (0.2 mmol, 28.0 mg), L-Cysteine ethyl ester hydrochloride **2f** (0.3 mmol, 55.7 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 29.7 mg (52%) of **3ad** as cololess iol.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.49 (d, J = 8.8 Hz, 2H), 6.86 (d, J = 8.8 Hz, 2H), 4.18 (q, J = 7.1 Hz, 2H), 3.81 – 3.78 (m, 4H), 3.14 (dd, J = 13.6 Hz, 4.4 Hz, 1H), 2.87 (dd, J = 13.6 Hz, 8.1 Hz, 1H), 1.68 (s, 2H), 1.27 (t, J = 7.1 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 173.7, 160.0, 132.6, 127.6, 114.8, 61.3, 55.4, 53.4, 43.6, 14.2.

HRMS (ESI) exact mass calc'd for $C_{12}H_{18}NO_3S_2$ ($[M+H]^+$): 288.0728; found m/z: 288.0730.

methyl 3-((4-methoxyphenyl)disulfaneyl)propanoate (3ae)



3ae

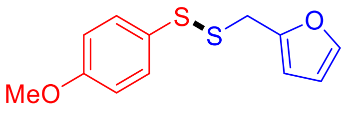
The reaction of 4-methoxybenzenethiol **1a** (0.2 mmol, 28.0 mg), methyl 3-mercaptopropanoate **2g** (0.3 mmol, 36.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 34.7 mg (67%) of **3ae** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.51 – 7.43 (m, 2H), 6.94 – 6.83 (m, 2H), 3.80 (s, 3H), 3.68 (s, 3H), 2.95 (t, J = 7.3 Hz, 2H), 2.74 (t, J = 7.3 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.2, 159.8, 132.0, 127.8, 114.8, 55.4, 51.8, 33.6, 33.0.

HRMS (EI) exact mass calc'd for $C_{11}H_{14}O_3S_2$ ($[M]^+$): 258.0384 ; found m/z: 258.0380.

2-(((4-methoxyphenyl)disulfaneyl)methyl)furan (3af)



3af

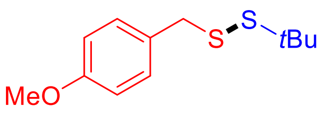
The reaction of 4-methoxybenzenethiol **1a** (0.2 mmol, 28.0 mg), furan-2-ylmethanethiol **2h** (0.2 mmol, 22.8 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 2 h, afforded 30.4 mg (60%) of **3af** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.42 – 7.35 (m, 2H), 7.32 (dd, *J* = 2.0 Hz, 0.9 Hz, 1H), 6.89 – 6.77 (m, 2H), 6.35 – 6.19 (m, 2H), 3.95 (s, 2H), 3.80 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 159.6, 150.1, 142.5, 131.9, 127.8, 114.6, 110.6, 109.1, 55.4, 35.5.

HRMS (ESI) exact mass calc'd for $C_{12}H_{13}O_2S_2$ ([M+H]$^+$): 253.0357; found m/z: 253.0351.

1-(tert-butyl)-2-(4-methoxybenzyl)disulfane (5a)



5a

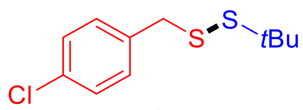
The reaction of 4-methoxyphenylmethanethiol **2i** (0.2 mmol, 30.8 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), Cs_2CO_3 (0.04 mmol, 13.0 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 46.1 mg (95%) of **5a** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.24 (d, *J* = 8.6 Hz, 2H), 6.86 (d, *J* = 8.6 Hz, 2H), 3.91 (s, 2H), 3.80 (s, 3H), 1.35(s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 159.0, 130.4, 129.4, 114.0, 55.3, 48.0, 45.2, 30.1.

HRMS (EI) exact mass calc'd for $C_{12}H_{18}OS_2$ ([M]$^+$): 242.0799; found m/z: 242.0796.

1-(tert-butyl)-2-(4-chlorobenzyl)disulfane (5b)



5b

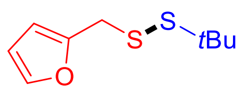
The reaction of 4-chlorophenylmethanethiol **2j** (0.2 mmol, 31.7 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), Cs_2CO_3 (0.04 mmol, 13.0 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 46.0 mg (93%) of **5b** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.32 – 7.27 (m, 2H), 7.26 – 7.20 (m, 2H), 3.88 (s, 2H), 1.34 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 136.0, 133.2, 130.6, 128.7, 48.2, 44.8, 30.0.

HRMS (EI) exact mass calc'd for $C_{11}H_{15}S_2Cl$ ($[M]^+$): 246.0304; found m/z: 246.0307.

2-((tert-butyldisulfaneyl)methyl)furan (5c)



5c

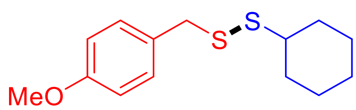
The reaction of furan-2-ylmethanethiol **2h** (0.2 mmol, 22.8 mg), 2-methylpropane-2-thiol **2a** (0.2 mmol, 18.0 mg), Cs_2CO_3 (0.04 mmol, 13.0 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 36.4 mg (90%) of **5c** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.37 (dd, *J* = 1.9 Hz, 0.9 Hz, 1H), 6.31 (dd, *J* = 3.3 Hz, 1.9 Hz, 1H), 6.26 – 6.22 (m, 1H), 3.94 (s, 2H), 1.32 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 150.7, 142.4, 110.6, 108.5, 48.1, 37.8, 29.9.

HRMS (ESI) exact mass calc'd for $C_9H_{15}OS_2$ ($[M+H]^+$): 203.0564; found m/z: 203.0569.

1-cyclohexyl-2-(4-methoxybenzyl)disulfane (5d)



5d

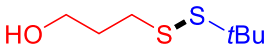
The reaction of 4-methoxyphenylmethanethiol **2i** (0.2 mmol, 30.8 mg), cyclohexanethiol **2c** (0.2 mmol, 23.2 mg), Cs_2CO_3 (0.04 mmol, 13.0 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 22.0 mg (41%) of **5d** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.26 – 7.20 (m, 2H), 6.88 – 6.82 (m, 2H), 3.86 (s, 2H), 3.80 (s, 3H), 2.47-2.43 (m, 1H), 1.99-1.93 (m, 2H), 1.80 – 1.70 (m, 2H), 1.35 – 1.16 (m, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 159.0, 130.4, 129.6, 113.9, 55.3, 49.4, 44.2, 32.8, 26.1, 25.6.

HRMS (EI) exact mass calc'd for $C_{14}H_{20}OS_2$ ($[M]^+$): 268.0956; found m/z: 268.0956.

3-(tert-butyldisulfaneyl)propan-1-ol (5e)



5e

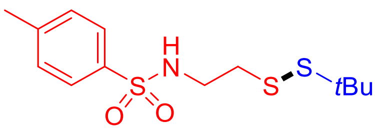
The reaction of 3-mercaptopropan-1-ol **2e** (0.2 mmol, 18.4 mg), 2-methylpropane-2-thiol **2c** (0.2 mmol, 18.0 mg), Cs_2CO_3 (0.04 mmol, 13.0 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 22.7 mg (63%) of **5e** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 3.75 (t, *J* = 6.1 Hz, 2H), 2.81 (t, *J* = 7.1 Hz, 2H), 1.93 (tt, *J* = 7.1 Hz, 6.1 Hz, 2H), 1.53 (s, 1H), 1.33 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 61.1, 47.9, 37.0, 32.0, 30.0.

HRMS (ESI) exact mass calc'd for $C_7H_{17}OS_2$ ($[M+H]^+$): 181.0721; found m/z: 181.0713.

N-(2-(tert-butyldisulfaneyl)ethyl)-4-methylbenzenesulfonamide (5f)



5f

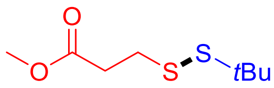
The reaction of 2-aminoethane-1-thiol **2k** (0.2 mmol, 15.4 mg), 2-methylpropane-2-thiol **2c** (0.2 mmol, 18.0 mg), Cs_2CO_3 (0.04 mmol, 13.0 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, after cooling to room temperature, Tosyl chloride (0.4 mmol, 76.3 mg) was added and stirred for 2 hours at room temperature, the solution was diluted with ethyl acetate (10 mL), and evaporate under vacuum. The crude reaction mixture was purified by column chromatograhy on silica gel (petroleum ether/ethyl acetate) to afforded 36.1 mg (57%) of **5f** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.79 – 7.70 (m, 2H), 7.35 – 7.28 (m, 2H), 4.97 (t, *J* = 6.2 Hz, 1H), 3.26 (td, *J* = 6.2 Hz, 6.4 Hz, 2H), 2.70 (t, *J* = 6.4 Hz, 2H), 2.42 (s, 3H), 1.27 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 143.6, 136.9, 129.8, 127.1, 48.2, 41.8, 39.1, 29.8, 21.5.

HRMS (ESI) exact mass calc'd for $C_{13}H_{22}NO_2S_3$ ($[M+H]^+$): 320.0813; found m/z: 320.0802.

methyl 3-(tert-butyldisulfaneyl)propanoate (5g)



5g

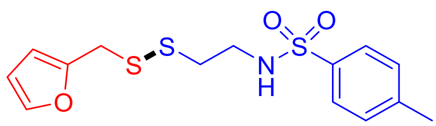
The reaction of methyl 3-mercaptopropanoate **2g** (0.2 mmol, 24.0 mg), 2-methylpropane-2-thiol **2c** (0.2 mmol, 18.0 mg), Cs_2CO_3 (0.04 mmol, 13.0 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 26.0 mg (63%) of **5g** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 3.69 (s, 3H), 2.92 (t, *J* = 7.3 Hz, 2H), 2.71 (t, *J* = 7.3 Hz, 2H), 1.33 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.3, 51.8, 48.0, 34.9, 34.1, 29.9.

HRMS (EI) exact mass calc'd for $C_8H_{16}O_2S_2$ ([M]+): 208.0592; found m/z: 208.0589.

N-(2-((furan-2-ylmethyl)disulfaneyl)ethyl)-4-methylbenzenesulfonamide (5h)



5h

The reaction of furan-2-ylmethanethiol **2h** (0.2 mmol, 22.8 mg), 2-aminoethane-1-thiol **2k** (0.2 mmol, 15.4 mg), Cs_2CO_3 (0.04 mmol, 13.0 mg) in CH_3CN (1 mL) under air at

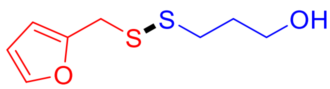
60 °C for 8 h, after cooling to room temperature, Tosyl chloride (0.4 mmol, 76.3 mg) was added and stirred for 2 hours at room temperature, the solution was diluted with ethyl acetate (10 mL), and evaporate under vacuum. The crude reaction mixture was purified by column chromatograhy on silica gel (petroleum ether/ethyl acetate) to afforded 34.2 mg (50%) of **5h** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.74 (d, *J* = 8.2 Hz, 2H), 7.35 (dd, *J* = 1.9 Hz, 0.8 Hz, 1H), 7.30 (d, *J* = 8.2 Hz, 2H), 6.31 (dd, *J* = 3.2 Hz, 1.9 Hz, 1H), 6.24 (dd, *J* = 3.2 Hz, 0.8 Hz, 1H), 4.88 (t, *J* = 6.2 Hz, 1H), 3.81 (s, 2H), 3.16 (t, *J* = 6.2 Hz, 2H), 2.45 – 2.40 (m, 5H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 149.9, 143.6, 142.6, 136.9, 129.8, 127.1, 110.9, 109.2, 41.3, 37.5, 35.5, 21.5.

HRMS (ESI) exact mass calc'd for $C_{14}H_{18}NO_3S_3$ ($[M+H]^+$): 344.0449; found m/z: 344.0442.

3-((furan-2-ylmethyl)disulfaneyl)propan-1-ol (5i)



5i

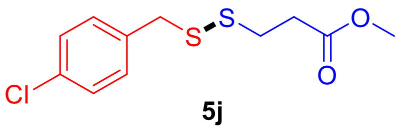
The reaction of furan-2-ylmethanethiol **2h** (0.2 mmol, 22.8 mg), 3-mercaptopropan-1-ol **2e** (0.2 mmol, 18.4 mg), Cs_2CO_3 (0.04 mmol, 13.0 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 19.0 mg (47%) of **5i** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.39 (dd, *J* = 1.9 Hz, 0.9 Hz, 1H), 6.33 (dd, *J* = 3.3 Hz, 1.9 Hz, 1H), 6.27 (d, *J* = 3.2 Hz, 1H), 3.90 (s, 2H), 3.69 (t, *J* = 5.0 Hz, 2H), 2.53 (t, *J* = 7.1 Hz, 2H), 1.88 – 1.82 (m, 2H), 1.46 (s, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 150.4, 142.5, 110.8, 108.9, 61.1, 35.9, 34.9, 31.7.

HRMS (ESI) exact mass calc'd for $C_8H_{13}O_2S_2$ ($[M+H]^+$): 205.0357; found m/z: 205.0348.

methyl 3-((4-chlorobenzyl)disulfaneyl)propanoate (5j)



5j

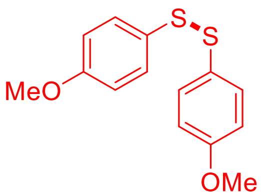
The reaction of (4-chlorophenyl)methanethiol **2j** (0.2 mmol, 31.7 mg), methyl 3-mercaptopropanoate **2g** (0.2 mmol, 24.0 mg), Cs_2CO_3 (0.04 mmol, 13.0 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 19.5 mg (44%) of **5j** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.30 (d, *J* = 8.6 Hz, 2H), 7.25 (d, *J* = 8.5 Hz, 2H), 3.85 (s, 2H), 3.69 (s, 3H), 2.67 (t, *J* = 6.4 Hz, 2H), 2.63 (t, *J* = 6.4 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.1, 135.9, 133.4, 130.6, 128.7, 51.9, 42.7, 33.8, 32.9.

HRMS (ESI) exact mass calc'd for $C_{11}H_{14}ClO_2S_2$ ($[M+H]^+$): 277.0124; found m/z: 277.115.

1,2-bis(4-methoxyphenyl)disulfane (4a)[7]



4a

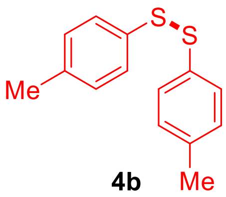
The reaction of 4-methoxybenzenethiol **1a** (0.4 mmol, 56.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 5 h, afforded 54.0 mg (97%) of **4a** as yellow solid.

Gram-scale experiments: The reaction of 4-methoxybenzenethiol **1a** (20 mmol, 2.80 g), K_2CO_3 (0.5 mmol, 69 mg) in CH_3CN (10 mL) under air at 30 °C for 8 h, afforded 2.76 g (99%) of **4a**.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.41 (d, *J* = 8.8 Hz, 4H), 6.84 (d, *J* = 8.8 Hz, 4H), 3.80 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 159.9, 132.7, 128.5, 114.7, 55.4.

1,2-di-p-tolyldisulfane (4b) [7]



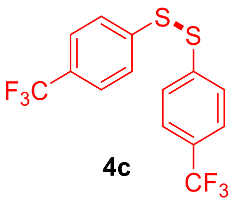
4b

The reaction of 4-methylbenzenethiol **1b** (0.4 mmol, 49.7 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 1 h, afforded 48.8mg (99%) of **4b** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.40 (d, J = 8.1 Hz, 4H), 7.12 (d, J = 8.1 Hz, 4H), 2.34 (s, 6H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ = 137.5, 134.0, 129.8, 128.6, 21.1.

1,2-bis(4-(trifluoromethyl)phenyl)disulfane (4c) [7]



4c

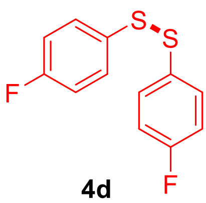
The reaction 4-(trifluoromethyl)benzenethiol **1f** (0.4 mmol, 71.3 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 12 h, afforded 51.8 mg (93%) of **4c** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.63 – 7.53 (m, 8H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ = 140.8, 129.4 (q, $^2J_{C\text{-}F}$ = 32.9 Hz), 126.6, 126.1 (q, J = 3.8 Hz), 123.8 (q, $^1J_{C\text{-}F}$ =272.0 Hz).

^{19}F NMR (376 MHz, Chloroform-*d*) δ = -62.6.

1,2-bis(4-fluorophenyl)disulfane (4d) [8]



4d

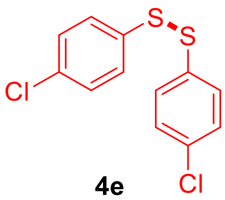
The reaction 4-fluorobenzenethiol **1f** (0.4 mmol, 51.3 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 8 h, afforded 44.3 mg (87%) of **4c** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.50 – 7.40 (m, 4H), 7.06 – 6.96 (m, 4H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ = 162.6 (d, $^1J_{C-F}$ =248.1 Hz), 132.2 (d, $^4J_{C-F}$ =3.3 Hz), 131.3 (d, $^3J_{C-F}$ =8.4 Hz), 116.3 (d, $^2J_{C-F}$ =22.2 Hz).

^{19}F NMR (376 MHz, Chloroform-*d*) δ = -113.5 (s, 2.

1,2-bis(4-chlorophenyl)disulfane (4e) [7]



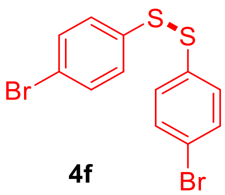
4e

The reaction 4-chlorobenzenethiol **1e** (0.4 mmol, 57.8 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 8 h, afforded 55.7 mg (97%) of **4e** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.45 – 7.36 (m, 4H), 7.31 – 7.23 (m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 135.2, 133.7, 129.4, 129.3.

1,2-bis(4-bromophenyl)disulfane(4f) [8]



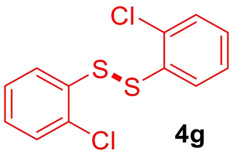
4f

The reaction 4-bromobenzenethiol **1d** (0.4 mmol, 75.6 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 8 h, afforded 73.8 mg (98%) of **4f** as light yellow solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.46 – 7.39 (m, 4H), 7.37 – 7.30 (m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 135.8, 132.3, 129.4, 121.6.

1,2-bis(2-chlorophenyl)disulfane (4g) [7]



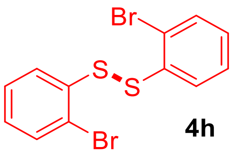
4g

The reaction 2-chlorobenzenethiol **1o** (0.4 mmol, 57.8 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 12 h, afforded 54.1 mg (94%) of **4g** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.54 (dd, *J* = 7.9 Hz, 1.4 Hz, 4H), 7.27 – 7.25(m, 2H), 7.12 – 7.04 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 136.2, 132.9, 128.2, 128.0, 127.0, 121.1.

1,2-bis(2-bromophenyl)disulfane (4h) [9]



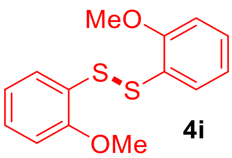
4h

The reaction 2-bromobenzenethiol **1p** (0.4 mmol, 75.6 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 4 h, afforded 70.2 mg (93%) of **4h** as white solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.57 (dd, *J* = 7.9 Hz, 1.7 Hz, 2H), 7.37 (dd, *J* = 7.9 Hz, 1.5 Hz, 2H), 7.18 – 7.14(m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 134.4, 131.9, 129.7, 127.8, 127.6, 127.2.

1,2-bis(2-methoxyphenyl)disulfane (4i) [7]



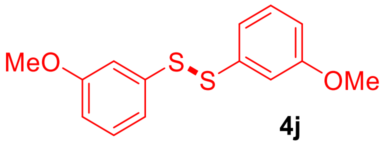
4i

The reaction 2-methoxybenzenethiol **1m** (0.4 mmol, 56.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 4 h, afforded 55.2 mg (99%) of **4i** as wihte solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.55 (dd, *J* = 7.8 Hz, 1.6 Hz, 2H), 7.22 – 7.18 (m, 2H), 6.94 – 6.92 (m, 2H), 6.86 (dd, *J* = 8.1 Hz, 1.1 Hz, 2H), 3.90 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 156.6, 127.8, 127.6, 124.6, 121.4, 110.6, 55.9.

1,2-bis(3-methoxyphenyl)disulfane (4j) [7]



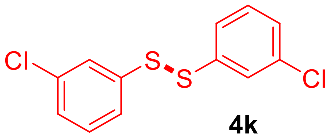
4j

The reaction 3-methoxybenzenethiol **1k** (0.4 mmol, 56.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 4 h, afforded 51.0 mg (92%) of **4j** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.22 (dd, *J* = 8.6 Hz, 7.4 Hz, 2H), 7.12 – 7.05 (m, 4H), 6.80 – 6.74 (m, 2H), 3.77 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 160.1, 138.3, 129.9, 119.6, 113.2, 112.6, 55.3.

1,2-bis(3-chlorophenyl)disulfane (4k) [10]



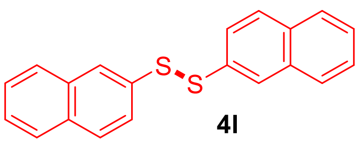
4k

The reaction 3-chlorobenzenethiol **1j** (0.4 mmol, 57.8 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 18 h, afforded 53.3 mg (93%) of **4k** as light yellow solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.48 (t, *J* = 1.7 Hz, 2H), 7.37 – 7.34 (m, 2H), 7.28 – 7.17 (m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 138.4, 135.1, 130.2, 127.6, 127.0, 125.4.

1,2-di(naphthalen-2-yl)disulfane (4l) [8]



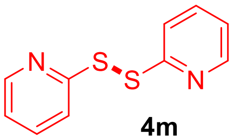
4l

The reaction naphthalene-2-thiol **1t** (0.4 mmol, 64.1 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 5 h, afforded 63.2mg (99%) of **4l** as light yellow solid.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 8.01 (d, *J* = 1.9 Hz, 2H), 7.80 (dd, *J* = 9.1 Hz, 3.0 Hz, 4H), 7.77 – 7.71 (m, 2H), 7.64 (dd, *J* = 8.7 Hz, 2.0 Hz, 2H), 7.51 – 7.42 (m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 134.3, 133.5, 132.5, 129.0, 127.8, 127.5, 126.8, 126.6, 126.3, 125.7.

1,2-di(pyridin-2-yl)disulfane (4m) [9]



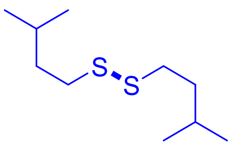
4m

The reaction pyridine-2-thiol **1x** (0.4 mmol, 44.5 mg), Cs_2CO_3 (0.08 mmol, 26.1 mg) in CH_3CN (1 mL) under air at 60 °C for 24 h, afforded 37.6 mg (85%) of **4l** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 8.45 (d, *J* = 4.8 Hz, 2H), 7.59 (d, *J* = 5.9 Hz, 4H), 7.14 – 7.01 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 159.0, 149.6, 137.4, 121.1, 119.7.

1,2-diisopentyldisulfane (6a) [11]



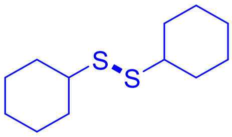
6a

The reaction 3-methylbutane-1-thiol **2h** (0.4 mmol, 41.7 mg), Cs_2CO_3 (0.08 mmol, 26.1 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 36.1 mg (87%) of **6a** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 2.73 – 2.65 (t, *J* = 13.0 Hz, 4H), 1.70 – 1.64 (m, 2H), 1.59 – 1.50 (m, 4H), 0.91 (d, *J* = 6.5 Hz, 12H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 38.3, 37.3, 27.2, 22.3.

1,2-dicyclohexyldisulfane (6b) [10]



6b

The reaction cyclohexanethiol **2c** (0.4 mmol, 46.5 mg), Cs_2CO_3 (0.08 mmol, 26.1 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 38.1 mg (83%) of **6b** as colorless oil.

Gram-scale experiments: The reaction cyclohexanethiol **2c** (20 mmol, 2.32 g), Cs_2CO_3 (4 mmol, 1.30 g) in CH_3CN (10 mL) under air at 60 °C for 16 h, afforded 1.95 mg (85%) of **6b** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 2.70 – 2.67 (m, 2H), 2.12 – 1.99 (m, 4H), 1.82 – 1.74 (m, 4H), 1.69 – 1.60 (m, 2H), 1.40 – 1.15 (m, 10H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 50.0, 32.9, 26.1, 25.7.

dimethyl 3,3'-disulfanediyldipropionate (6c) [12]

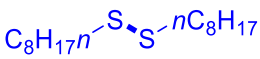
6c

The reaction methyl 3-mercaptopropanoate **2g** (0.4 mmol, 48.1 mg), Cs_2CO_3 (0.08 mmol, 26.1 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 36.9 mg (77%) of **6c** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 3.66 (s, 6H), 2.87 (t, *J* = 7.2 Hz, 4H), 2.69 (t, *J* = 7.2 Hz, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 172.1, 51.9, 33.9, 33.1.

1,2-dioctyldisulfane (6d) [13]



6**d**

The reaction octane-1-thiol **2b** (0.4 mmol, 58.5 mg), Cs_2CO_3 (0.08 mmol, 26.1 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 51.5 mg (89%) of **6d** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 2.73 – 2.62 (m, 4H), 1.69 – 1.65 (m, 4H), 1.40 – 1.22 (m, 20H), 0.92 – 0.84 (m, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 39.2, 31.8, 29.25, 29.22, 29.20, 28.6, 22.7, 14.1.

3,3'-disulfanediylbis(propan-1-ol) (6e) [14]

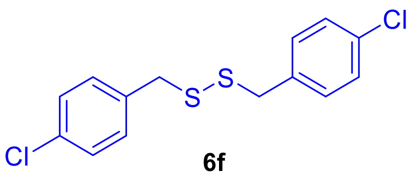
6e

The reaction 3-mercaptopropan-1-ol **2e** (0.4 mmol, 36.8 mg), Cs_2CO_3 (0.08 mmol, 26.1 mg) in CH_3CN (1 mL) under air at 60 °C for 8 h, afforded 27.1 mg (74%) of **6e** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 3.74 (t, *J* = 6.1 Hz, 4H), 2.81 (t, *J* = 7.1 Hz, 4H), 2.14 (s, 2H), 1.94 (tt, *J* = 7.1 Hz, 6.1 Hz, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 61.0, 35.2, 31.8.

1,2-bis(4-chlorobenzyl)disulfane (6f) [15]



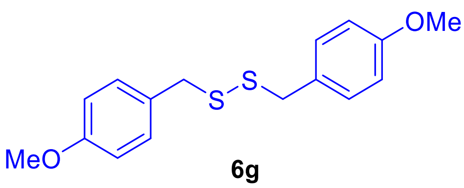
6f

The reaction (4-chlorophenyl)methanethiol **2j** (0.4 mmol, 63.0 mg), Cs_2CO_3 (0.08 mmol, 26.1 mg) in CH_3CN (1 mL) under air at 60 °C for 4 h, afforded 59.4 mg (94%) of **6f** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.33 – 7.27 (m, 4H), 7.18 – 7.12 (m, 4H), 3.58 (s, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 135.8, 133.4, 130.7, 128.7, 42.5.

1,2-bis(4-methoxybenzyl)disulfane (6g) [16]



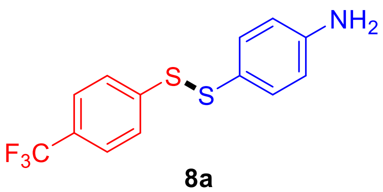
6g

The reaction (4-methoxyphenyl)methanethiol **2i** (0.4 mmol, 61.3 mg), Cs_2CO_3 (0.08 mmol, 26.1 mg) in CH_3CN (1 mL) under air at 60 °C for 4 h, afforded 60.7 mg (99%) of **6g** as pink crystal.

^{1}H NMR (400 MHz, Chloroform-*d*) δ = 7.22 – 7.13 (m, 4H), 6.91 – 6.83 (m, 4H), 3.81 (s, 6H), 3.61 (s, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ = 159.1, 130.5, 129.4, 113.9, 55.3, 42.8.

4-((4-(trifluoromethyl)phenyl)disulfaneyl)aniline (8a)



8a

The reaction of 4-(trifluoromethyl)benzenethiol **1f** (0.2 mmol, 35.6 mg), 4-aminobenzenethiol **1h** (0.2 mmol, 25.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 3 h, afforded 36.0 mg (60%) of **8a** as colorless oil.

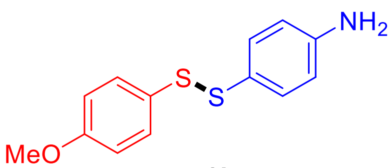
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.66 (d, J = 8.2 Hz, 2H), 7.58 (d, J = 8.3 Hz, 2H), 7.33 (d, J = 8.6 Hz, 2H), 6.61 (d, J = 8.6 Hz, 2H), 4.06 – 3.60 (s, 2H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 147.5, 142.8, 133.0, 128.7 (q, $^2J_{C-F}$ = 32.5 Hz), 127.2, 125.8 (q, $^3J_{C-F}$ = 3.9 Hz), 124.1 (q, $^1J_{C-F}$ = 271.8 Hz), 123.9, 115.5.

^{19}F NMR (376 MHz, $CDCl_3$) δ -62.38 (s, 3F).

HRMS (ESI) exact mass calc'd for $C_{13}H_{11}F_3NS_2$ ($[M+H]^+$): 302.0285; found m/z:302.0283.

4-((4-methoxyphenyl)disulfaneyl)aniline (8b) [17]



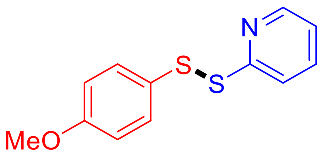
8b

The reaction of 4-methoxybenzenethiol **1a** (0.2 mmol, 28.0 mg), 4-aminobenzenethiol **1h** (0.2 mmol, 25.0 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 3 h, afforded 27.7 mg (53%) of **8b** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.43 (d, *J* = 8.8 Hz, 2H), 7.28 (d, *J* = 8.5 Hz, 2H), 6.86 (d, *J* = 8.8 Hz, 2H), 6.61 (d, *J* = 8.6 Hz, 2H), 3.82 (s, 3H), 3.80(s, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.9, 147.2, 133.7, 133.0, 128.8, 125.4, 115.4, 114.6, 55.4.

2-((4-methoxyphenyl)disulfaneyl)pyridine (8c) [17]



8c

The reaction of 4-methoxybenzenethiol **1a** (0.2 mmol, 28.0 mg), pyridine-2-thiol **1x** (0.2 mmol, 22.2 mg), K_2CO_3 (0.01 mmol, 1.4 mg) in CH_3CN (1 mL) under air at 30 °C for 3 h, afforded 20.3 mg (41%) of **8c** as colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.49 – 8.45 (m, 1H), 7.75 – 7.67 (m, 1H), 7.67 – 7.57 (m, 1H), 7.53 – 7.44 (m, 2H), 7.11 – 7.05 (m, 1H), 6.88 – 6.75 (m, 2H), 3.77 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.1, 159.8, 149.6, 137.2, 131.4, 127.2, 120.8, 119.8, 114.8, 55.4.

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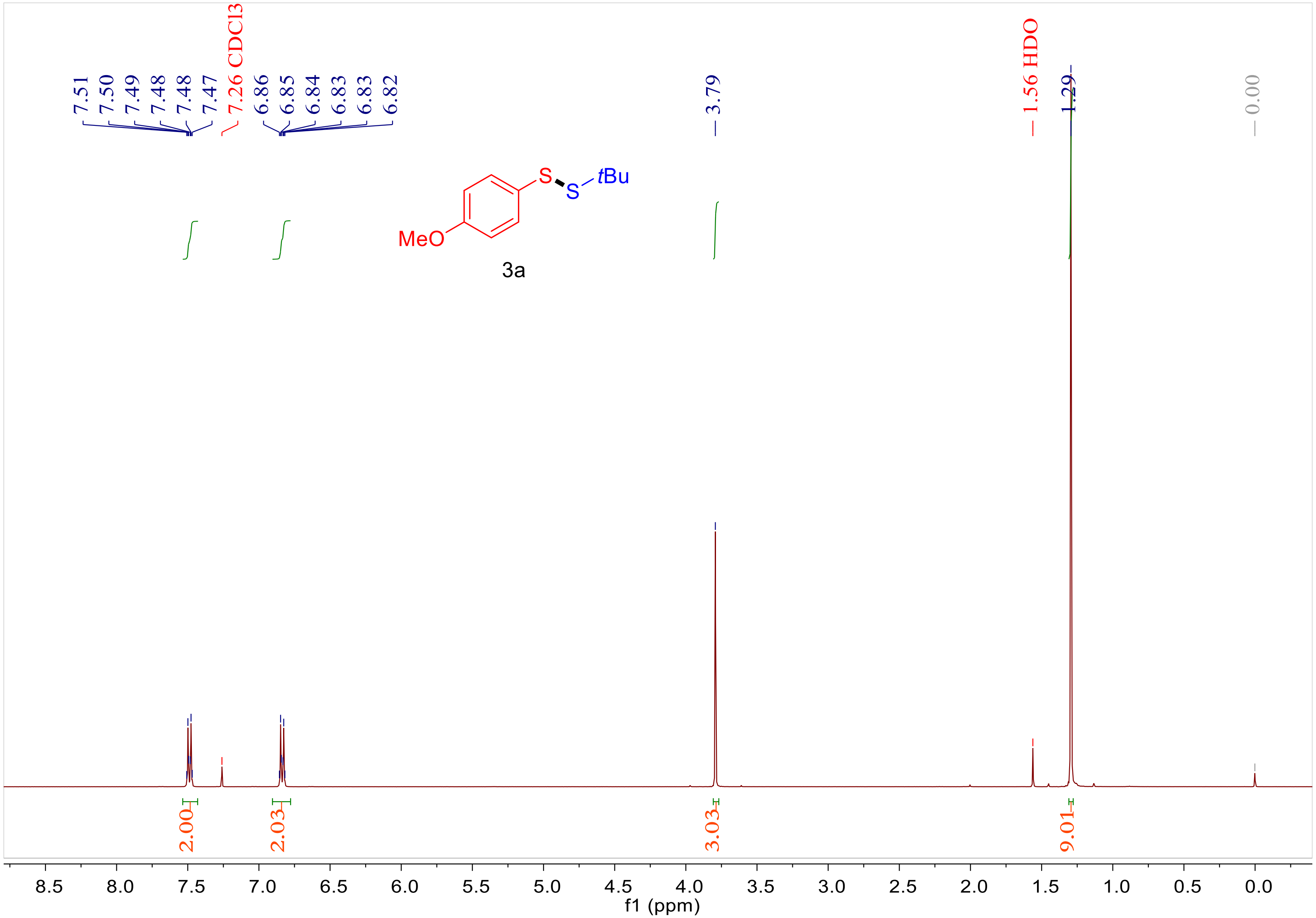
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6.85
6.84
6.83
6.83
6.82
3.79
1.56 HDO
1.29
0.00
MeO
S
S
tBu
3a
2.00
2.03
3.03
9.01
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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1.5
1.0
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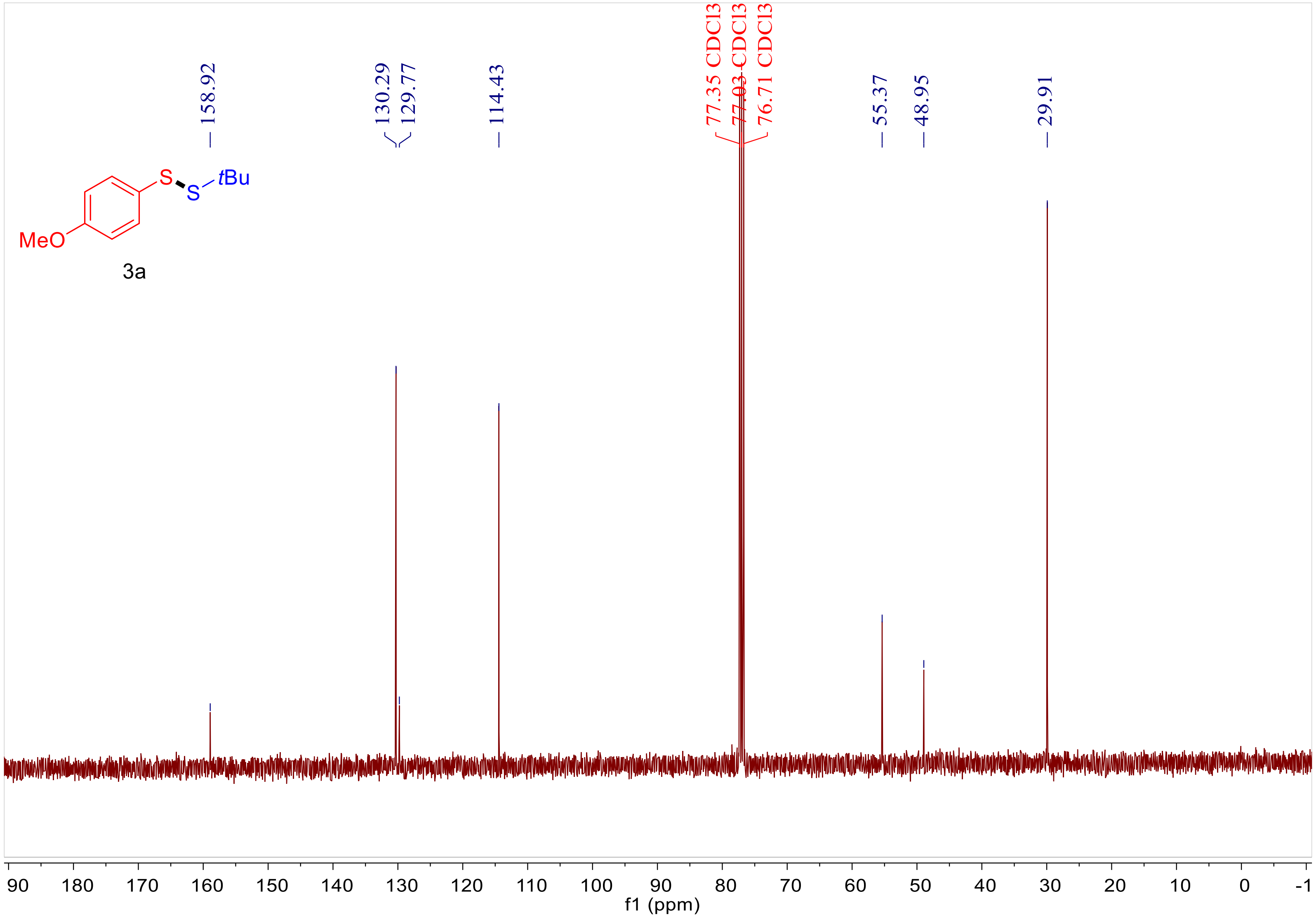
0.0
f1 (ppm)



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77.03 CDCl3
76.71 CDCl3
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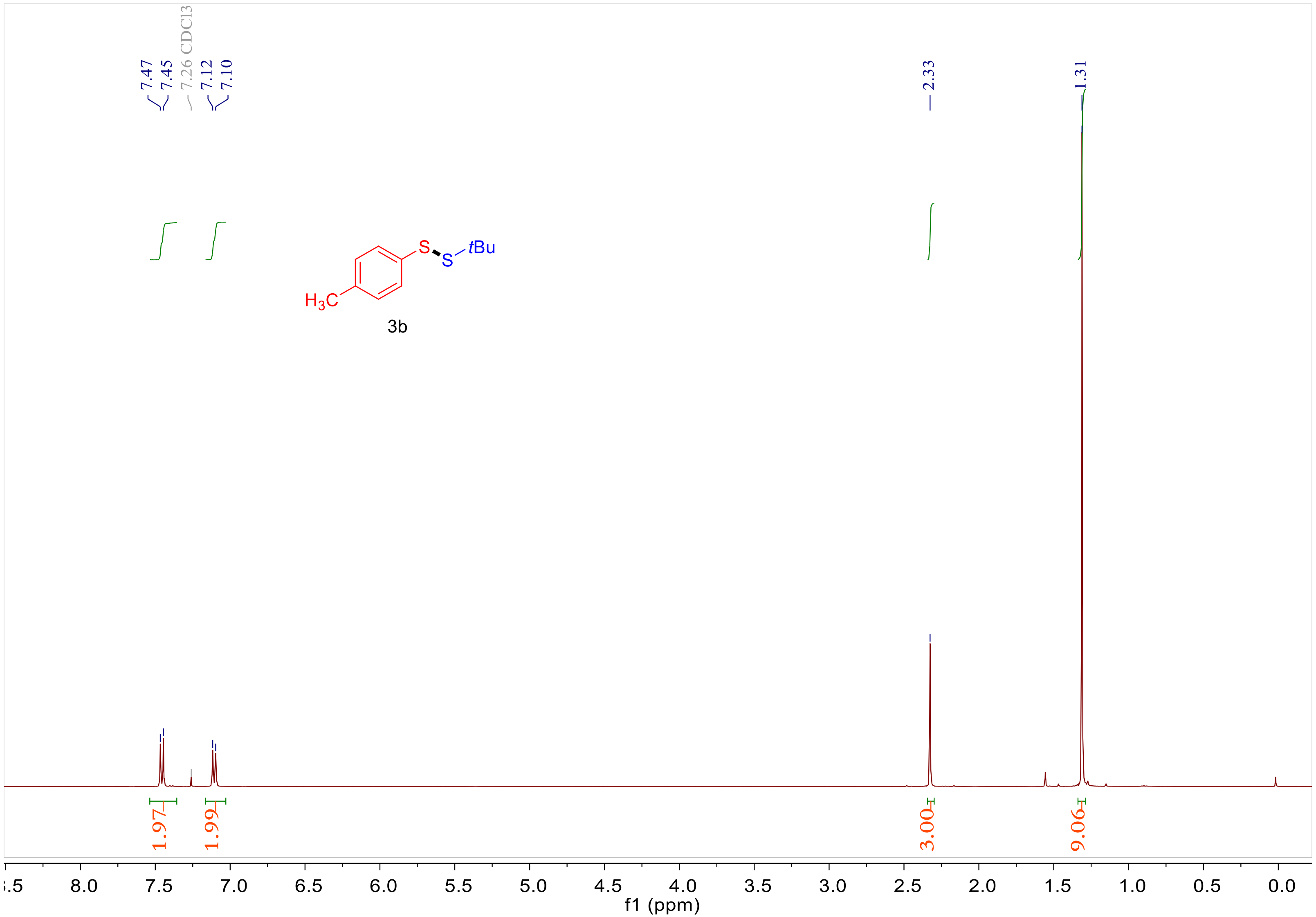
48.95
29.91
MeO
S
S
tBu
3a
f1 (ppm)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S
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3.00
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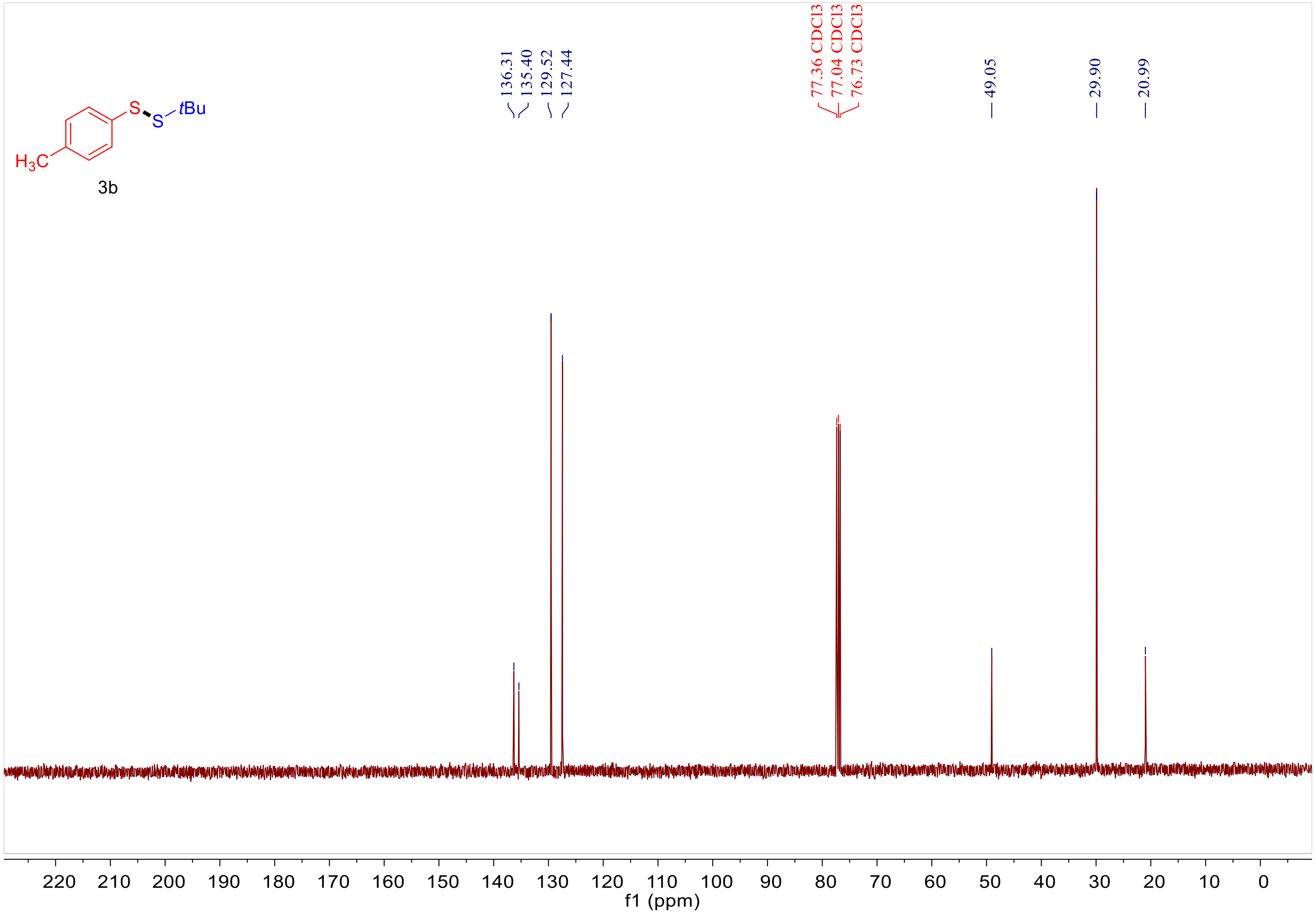
f1 (ppm)



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20.99
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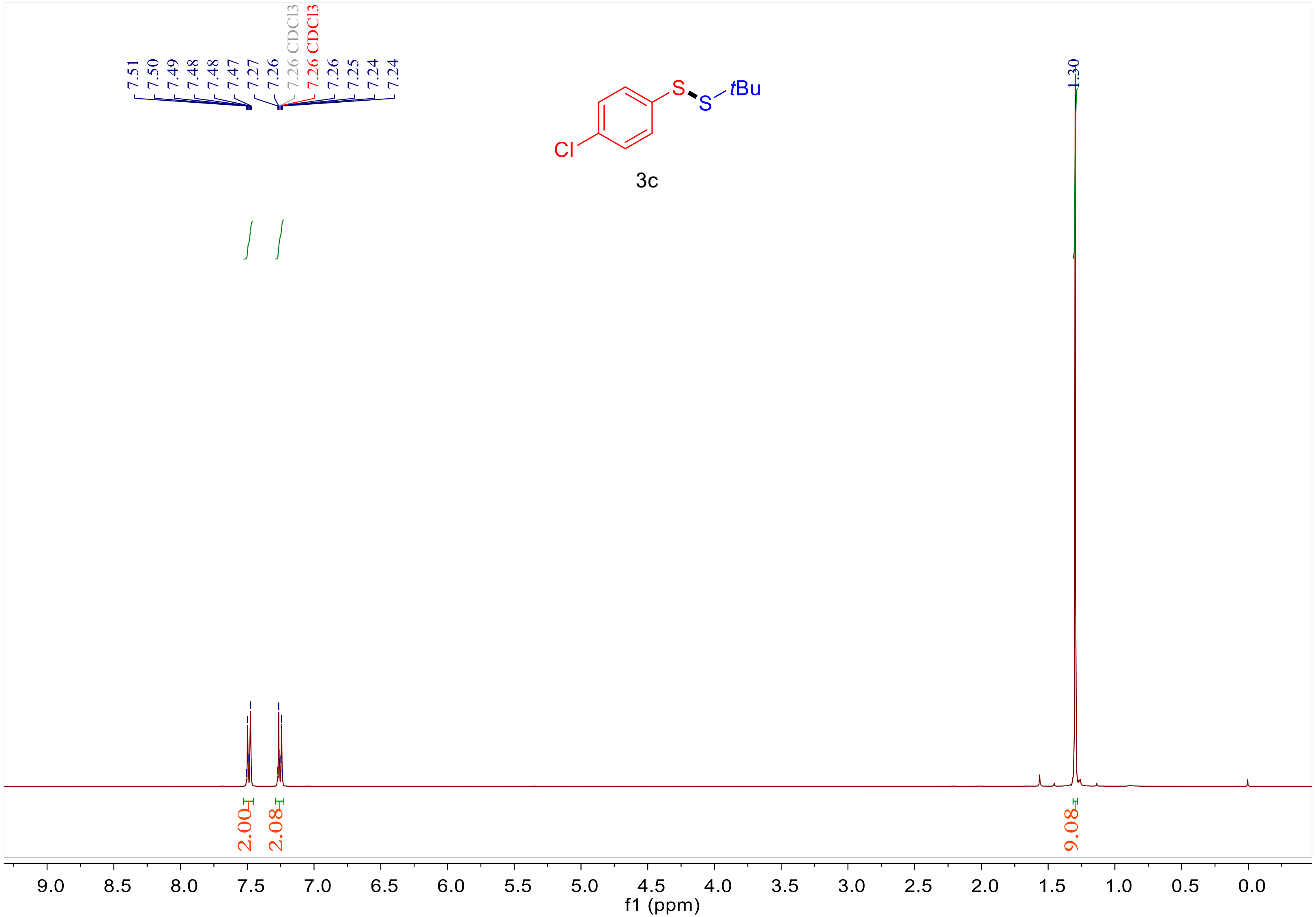
f1 (ppm)



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7.26 CDCl3
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7.25
7.24
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S
tBu
Cl
3c
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2.08
9.08
9.0
8.5
8.0
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6.0
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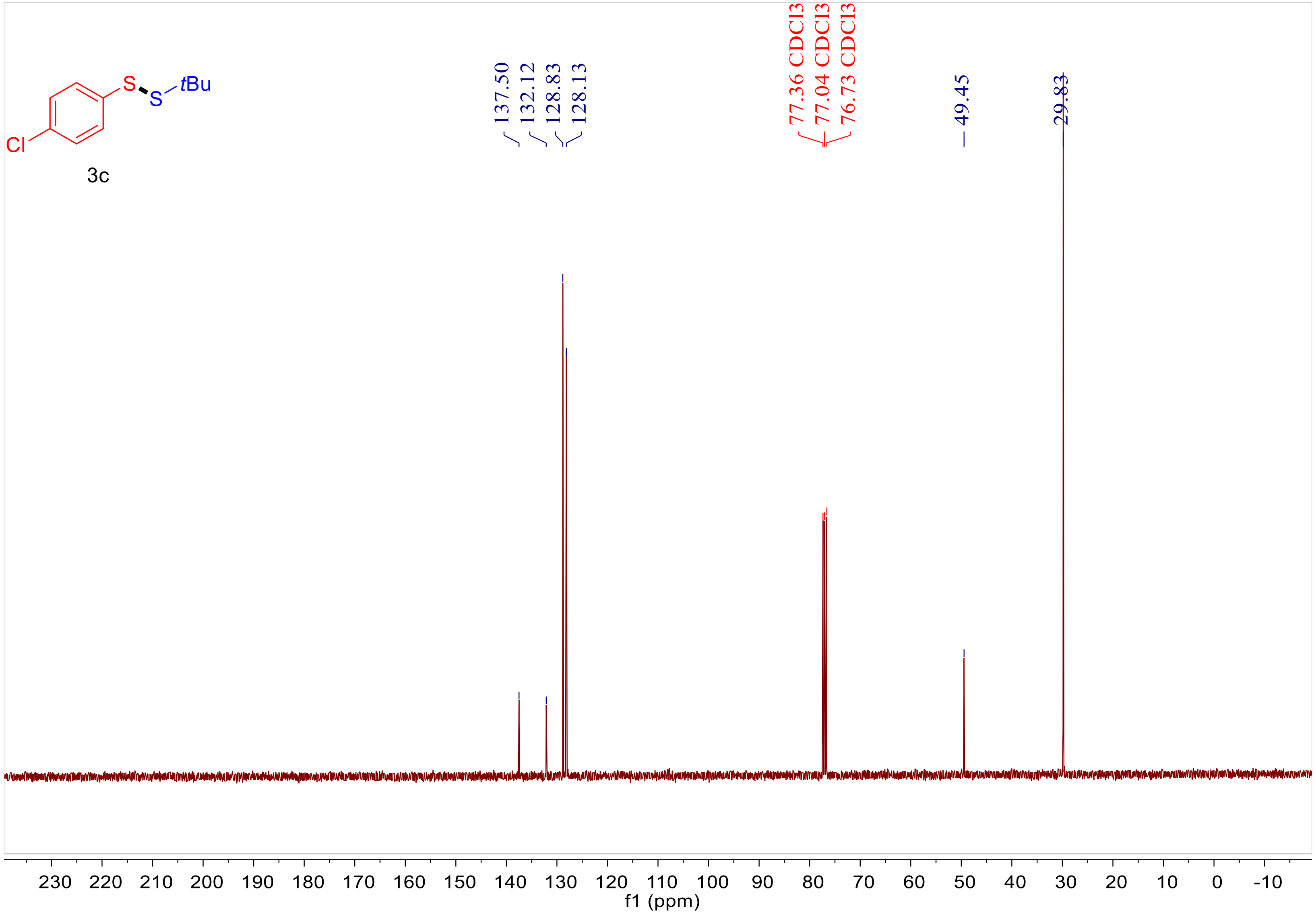
f1 (ppm)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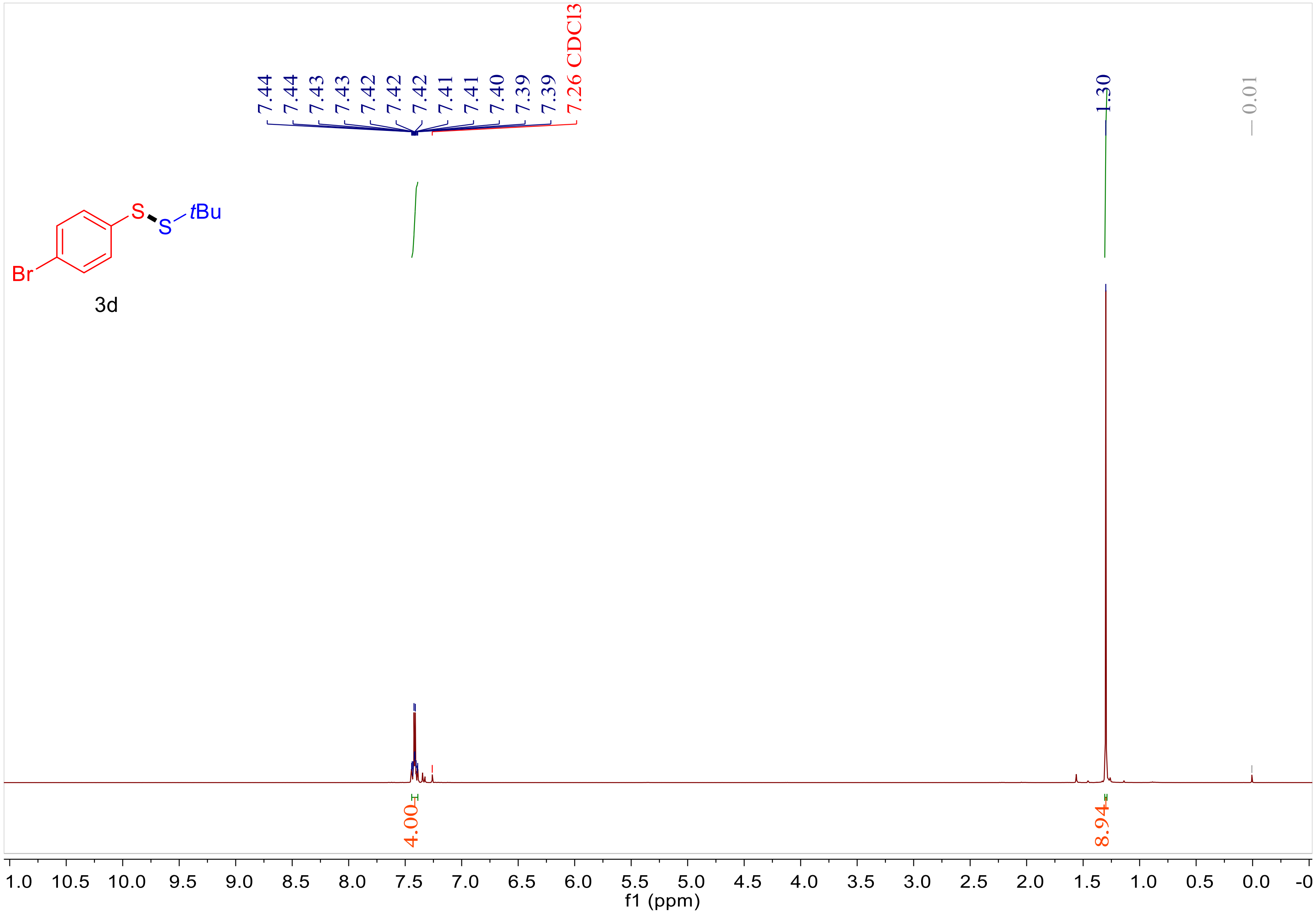
f1 (ppm)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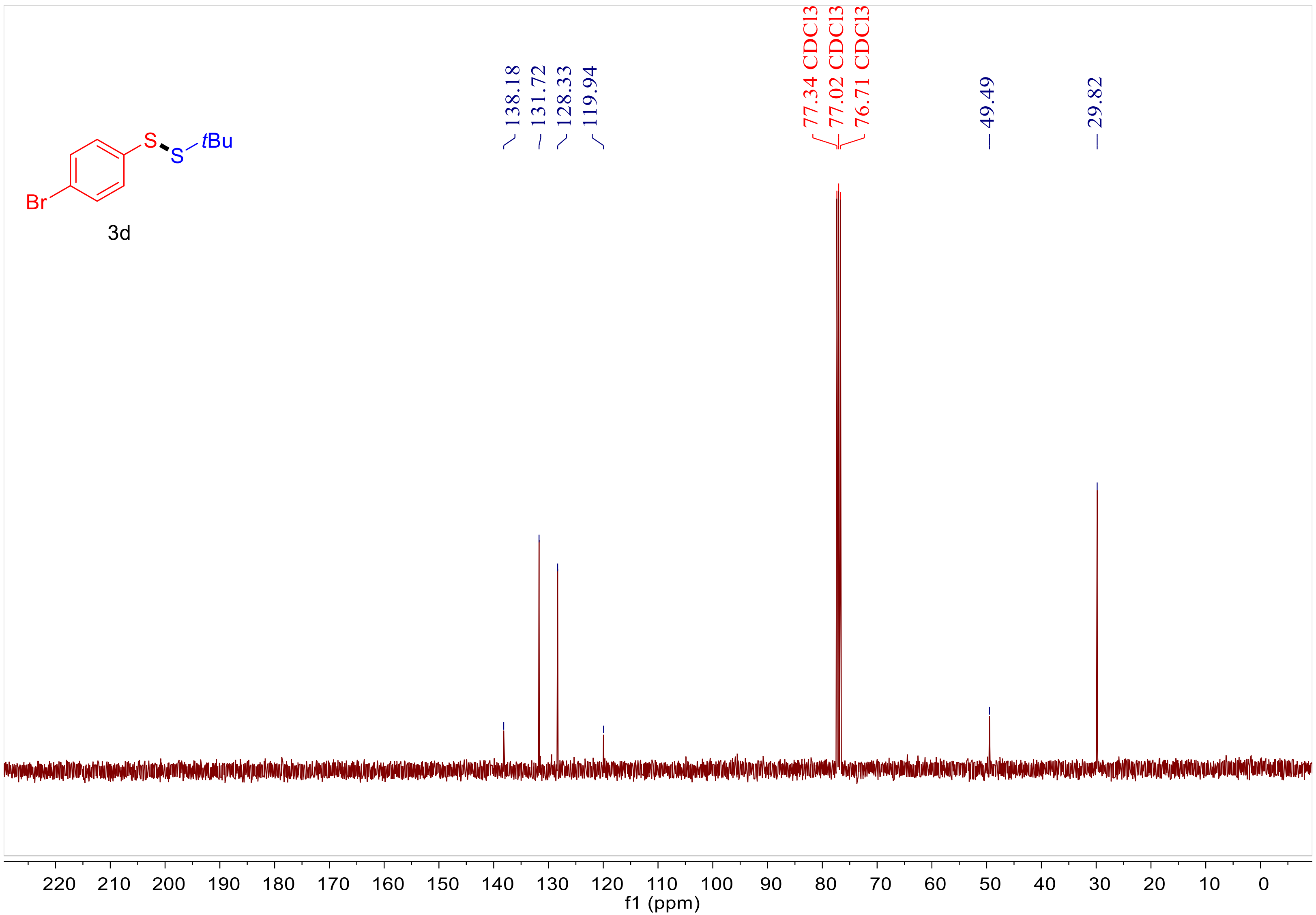
1.30
0.01
S
S
tBu
Br
3d
4.00
8.94
1.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0
f1 (ppm)



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Br
3d
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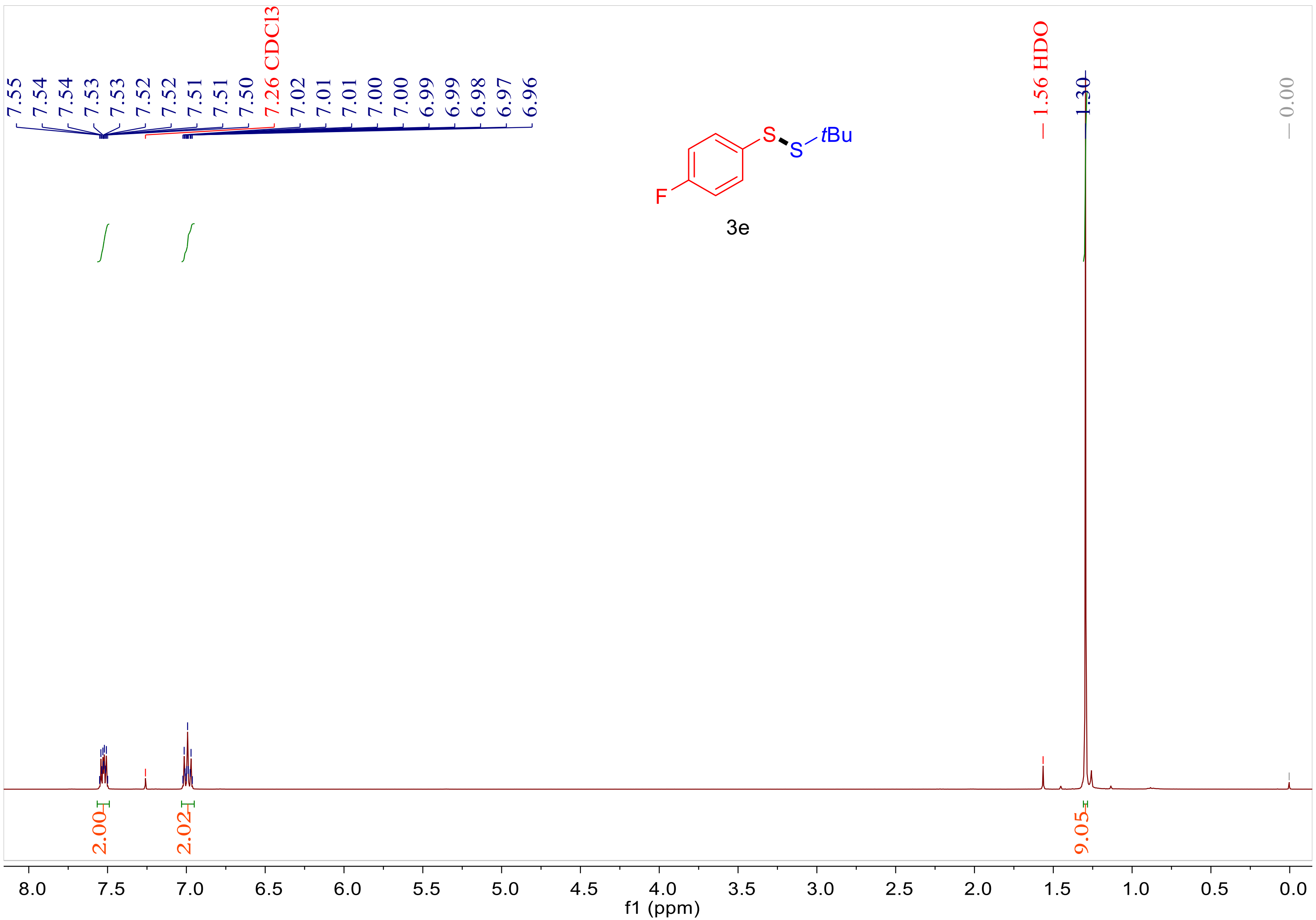
f1 (ppm)


7.55
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7.01
7.01
7.00
7.00
6.99
6.99
6.98
6.97
6.96
1.56 HDO
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S
S
tBu
F
3e
2.00
2.02
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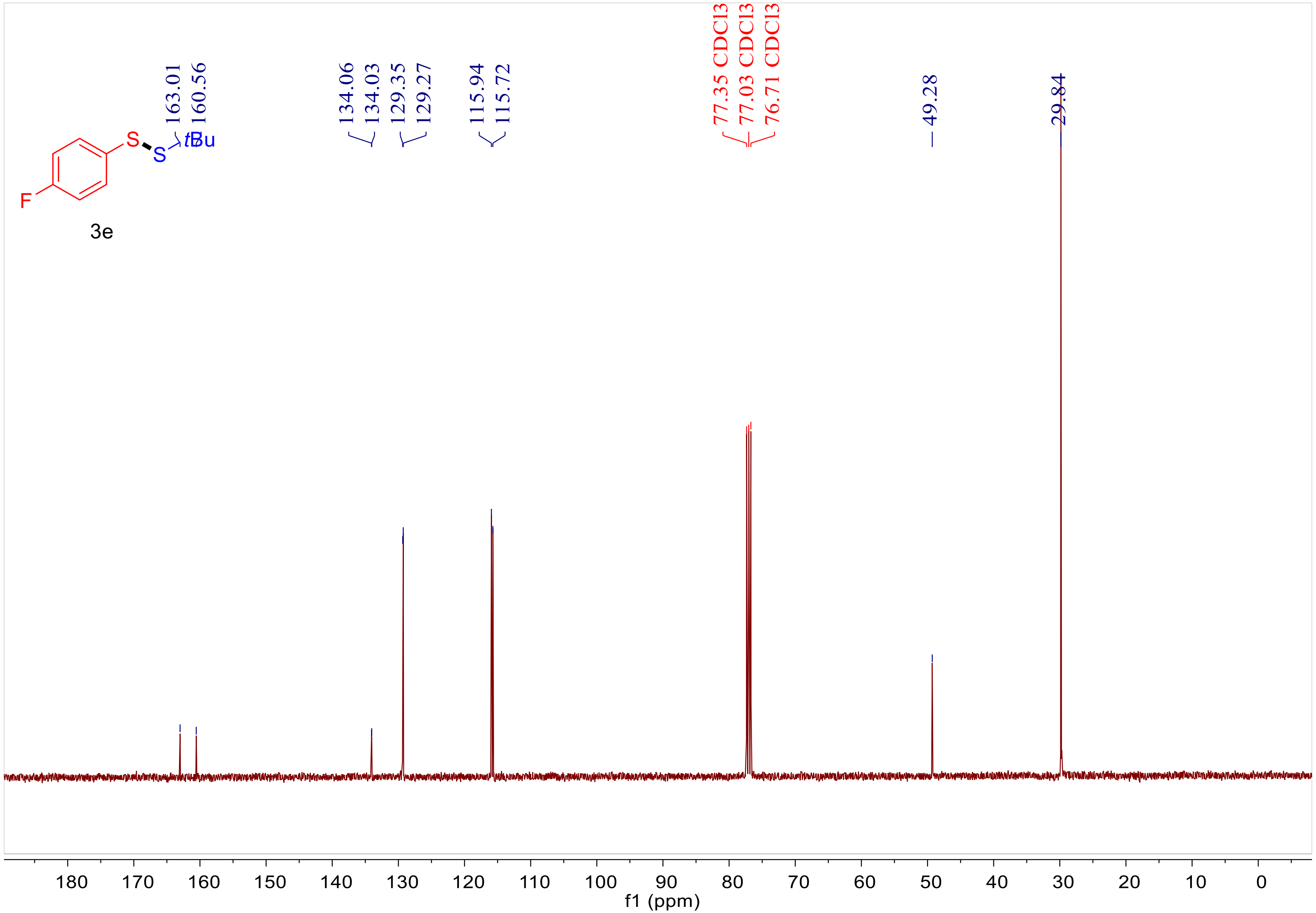
f1 (ppm)



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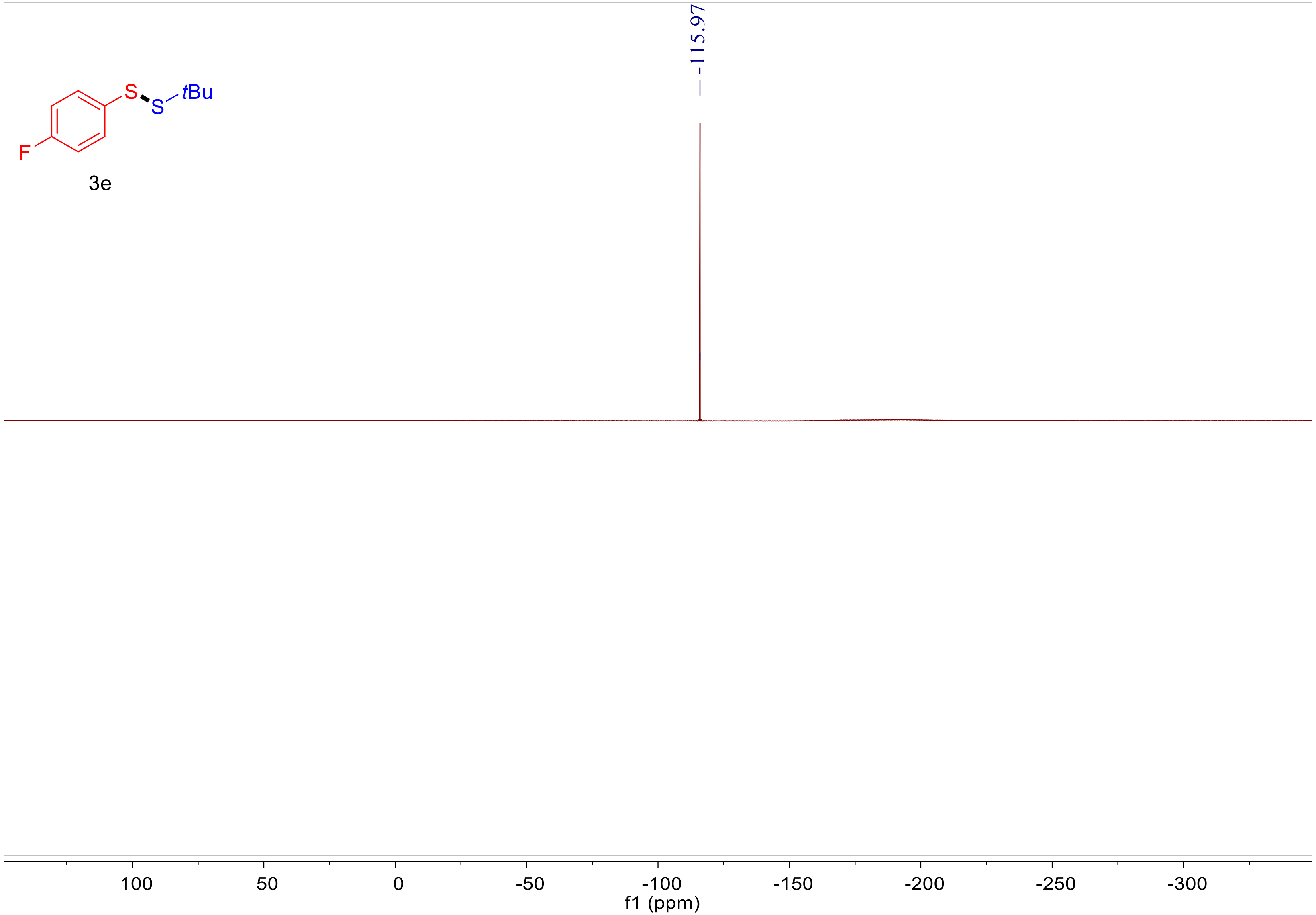
F
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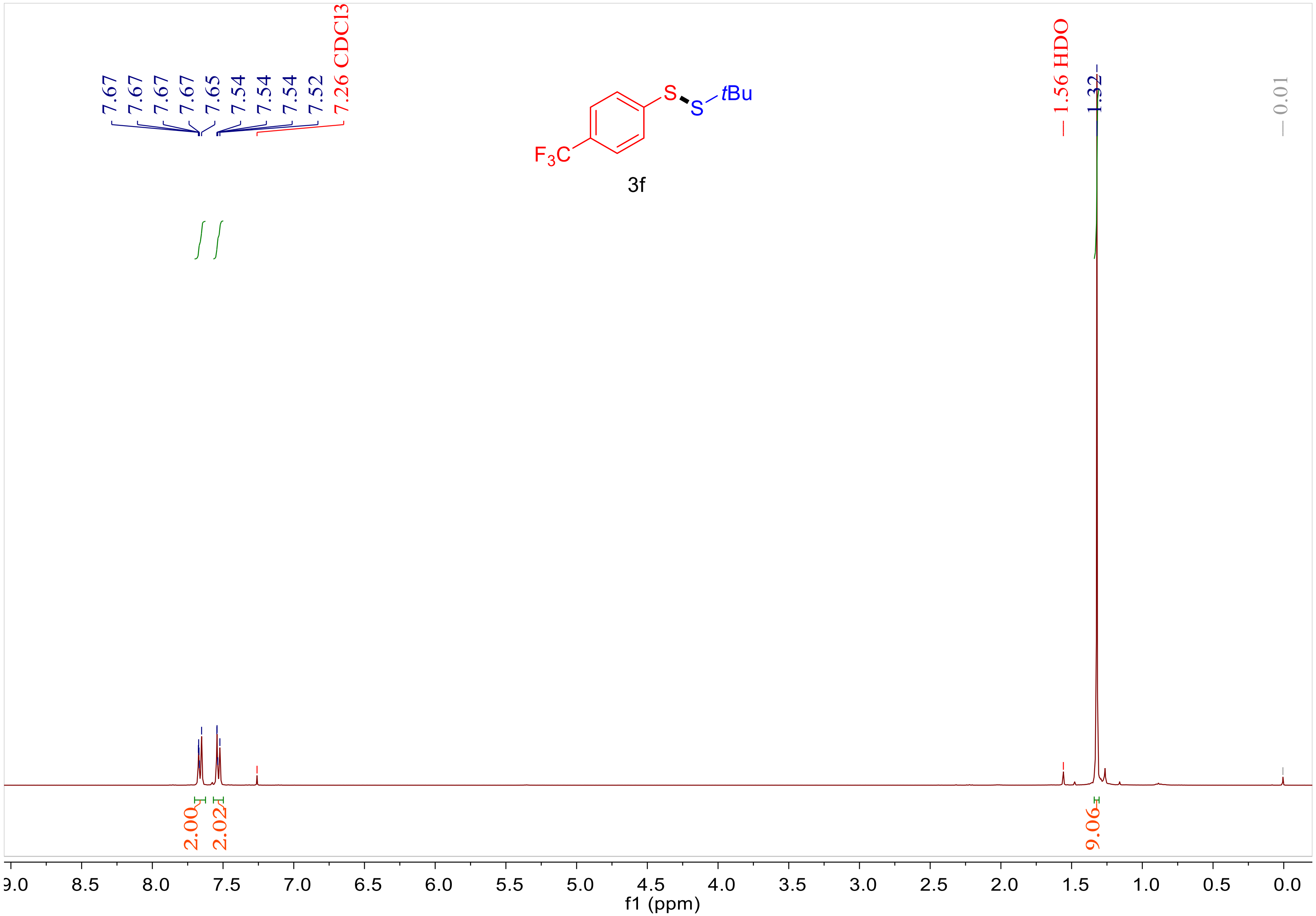
f1 (ppm)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3f
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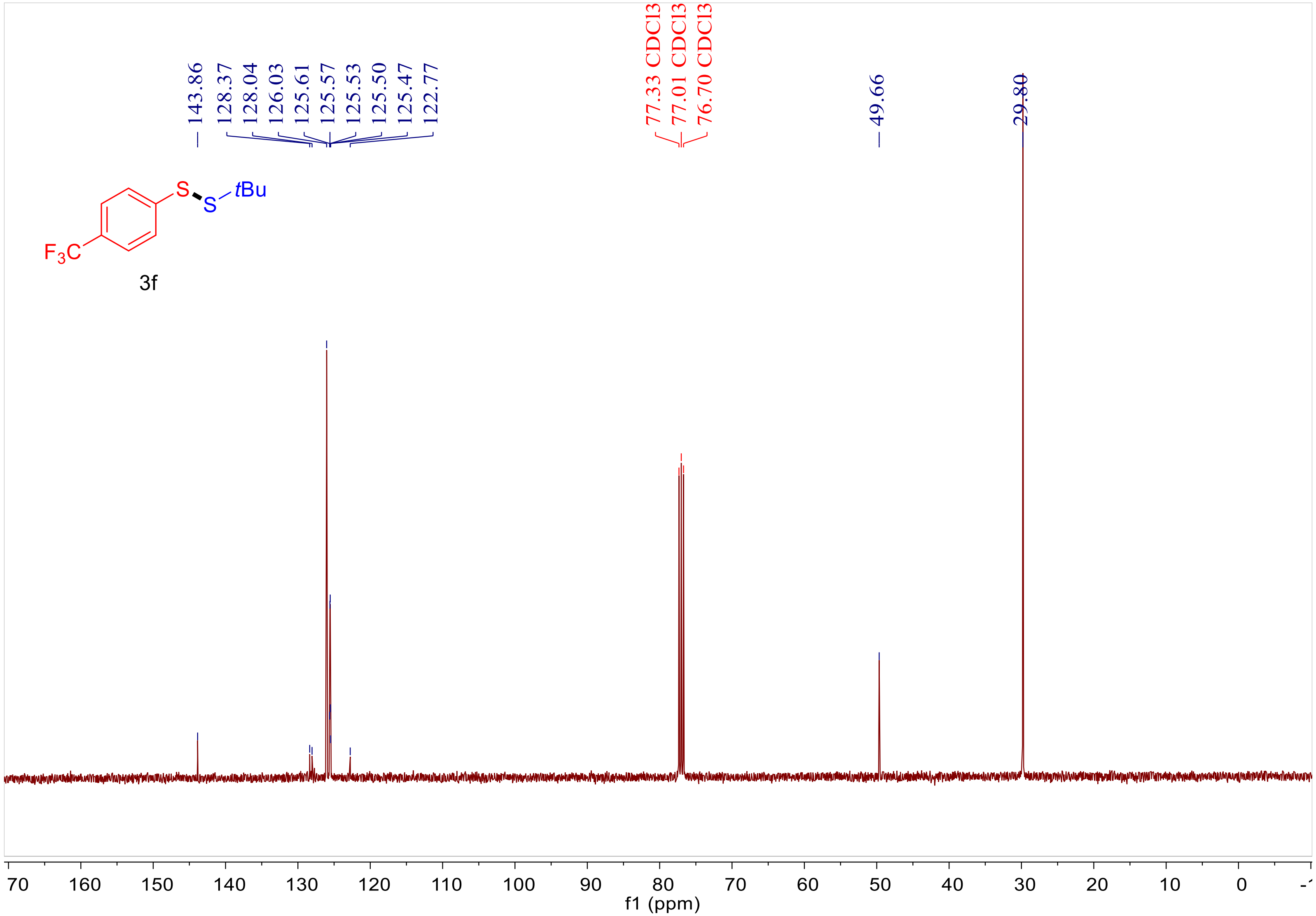

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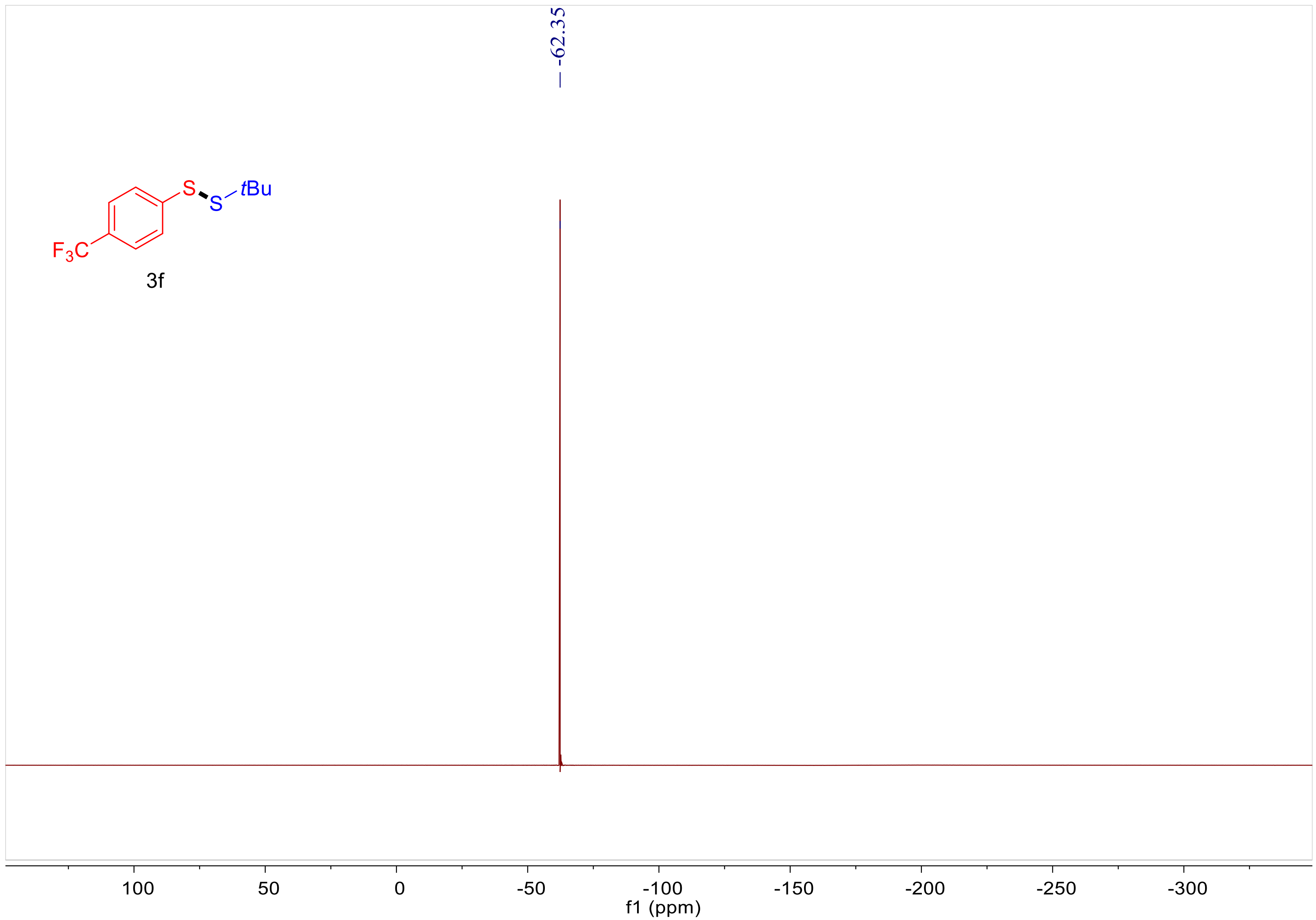

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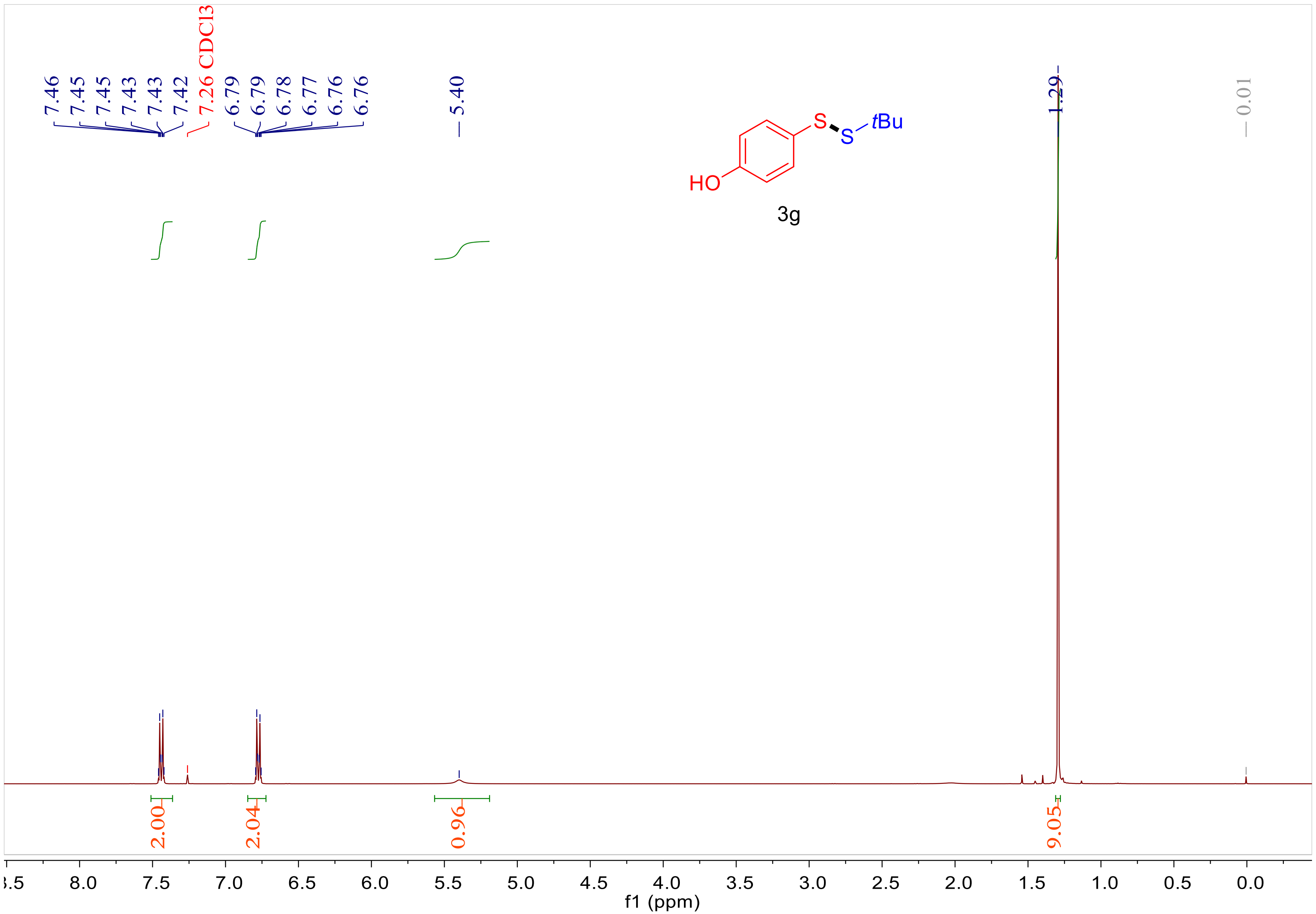

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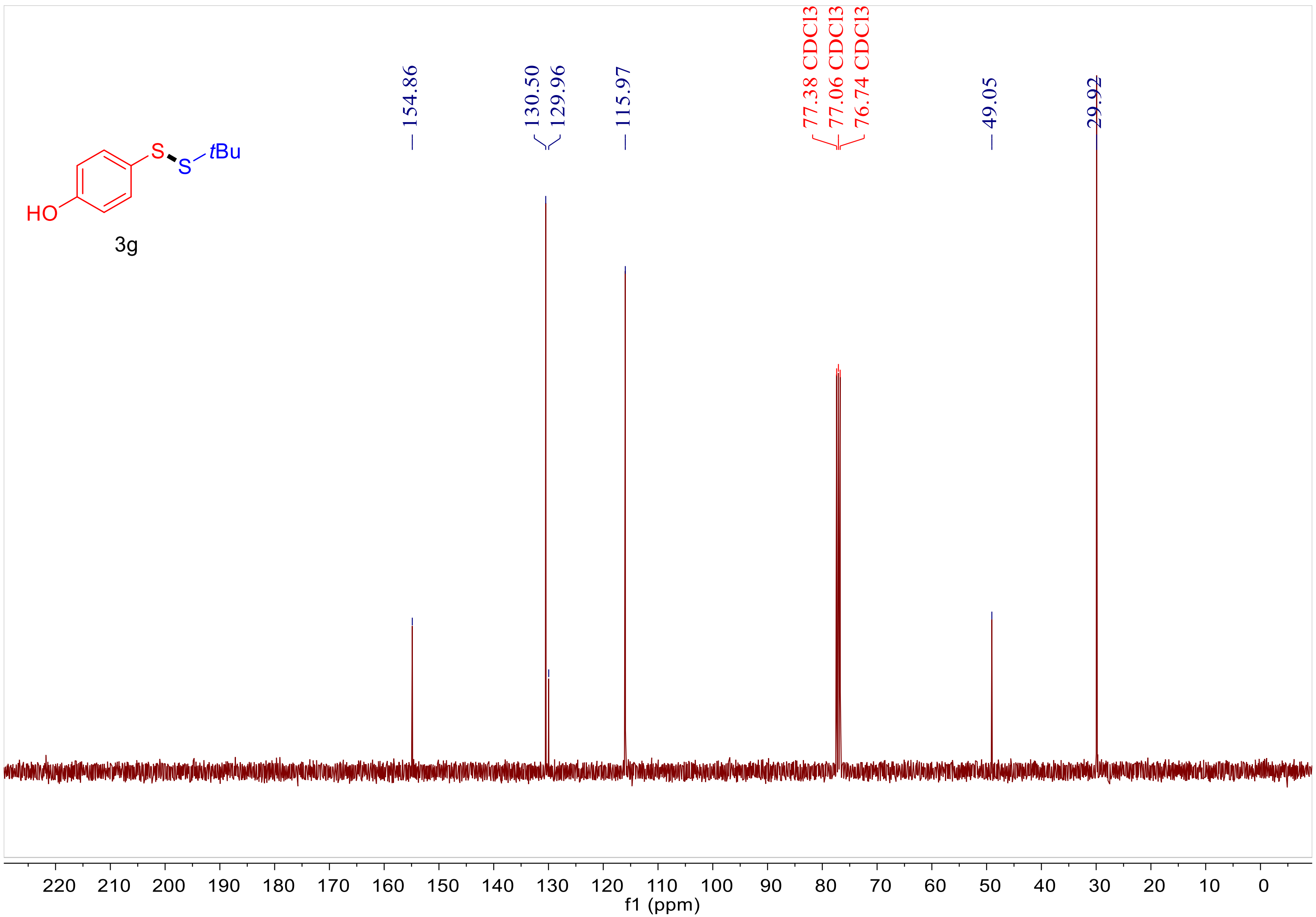
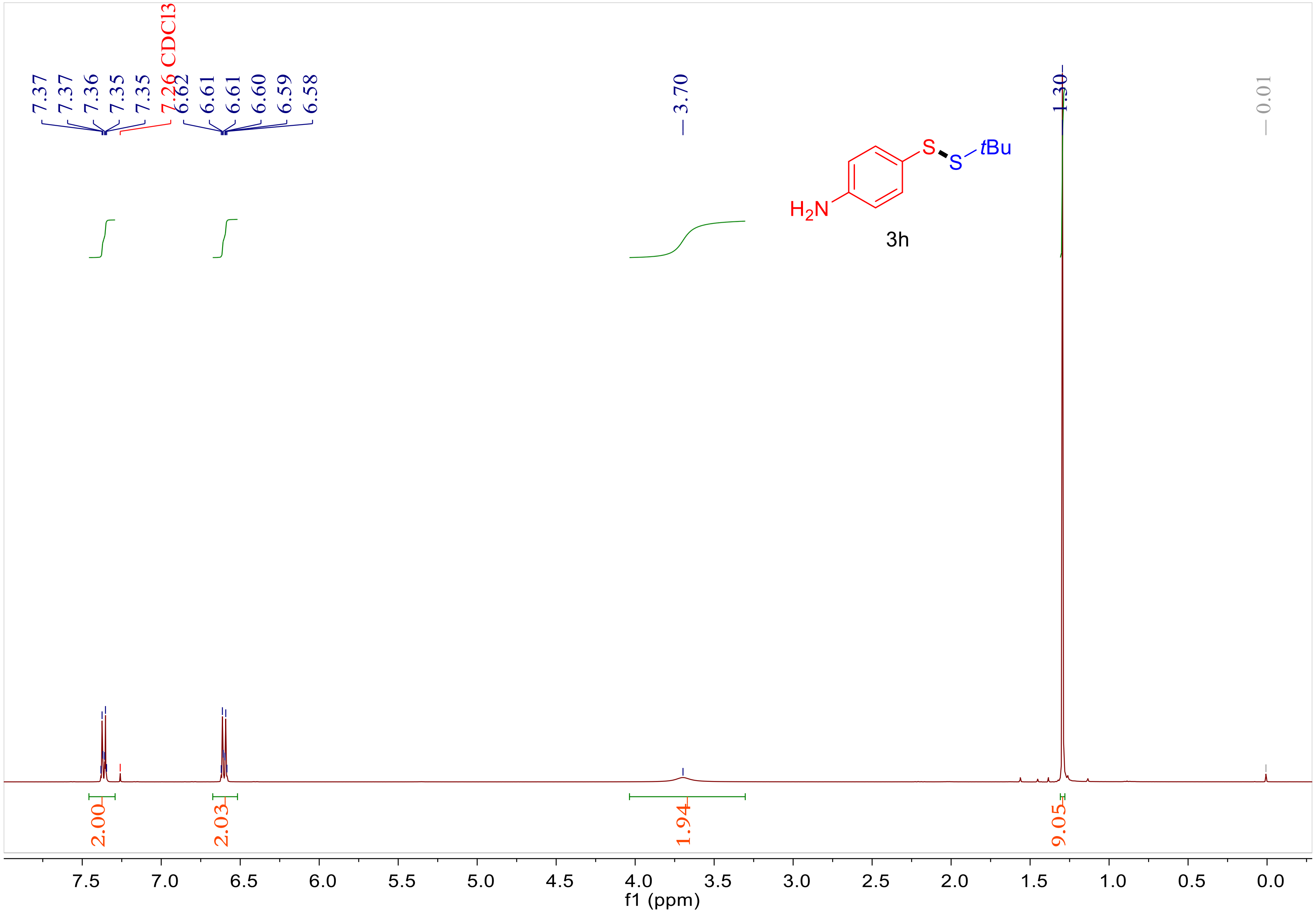
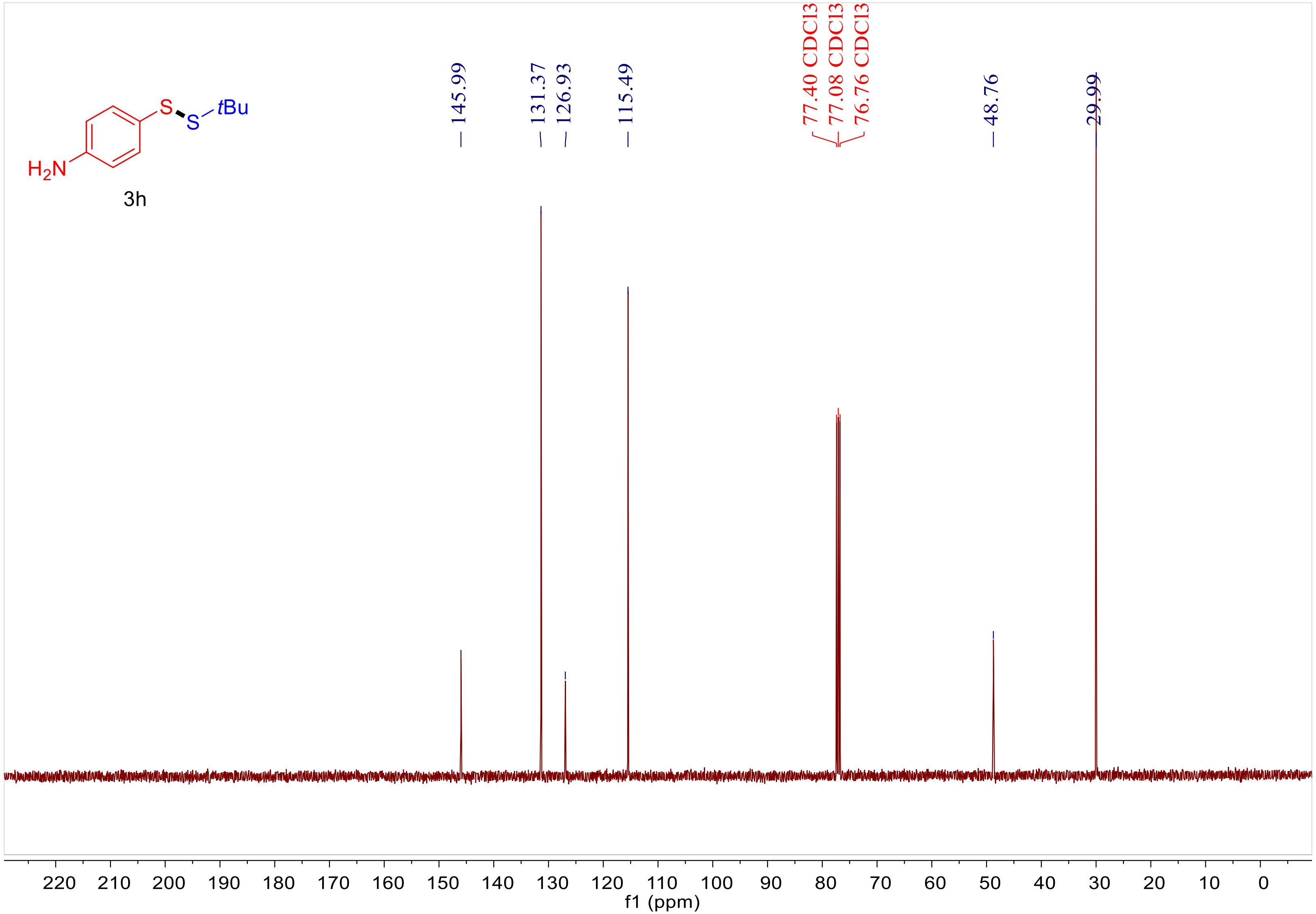
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


154.86
130.50
129.96
115.97
77.38 CDCl3
77.06 CDCl3
76.74 CDCl3
49.05
29.92
HO
S
S
tBu
3g
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

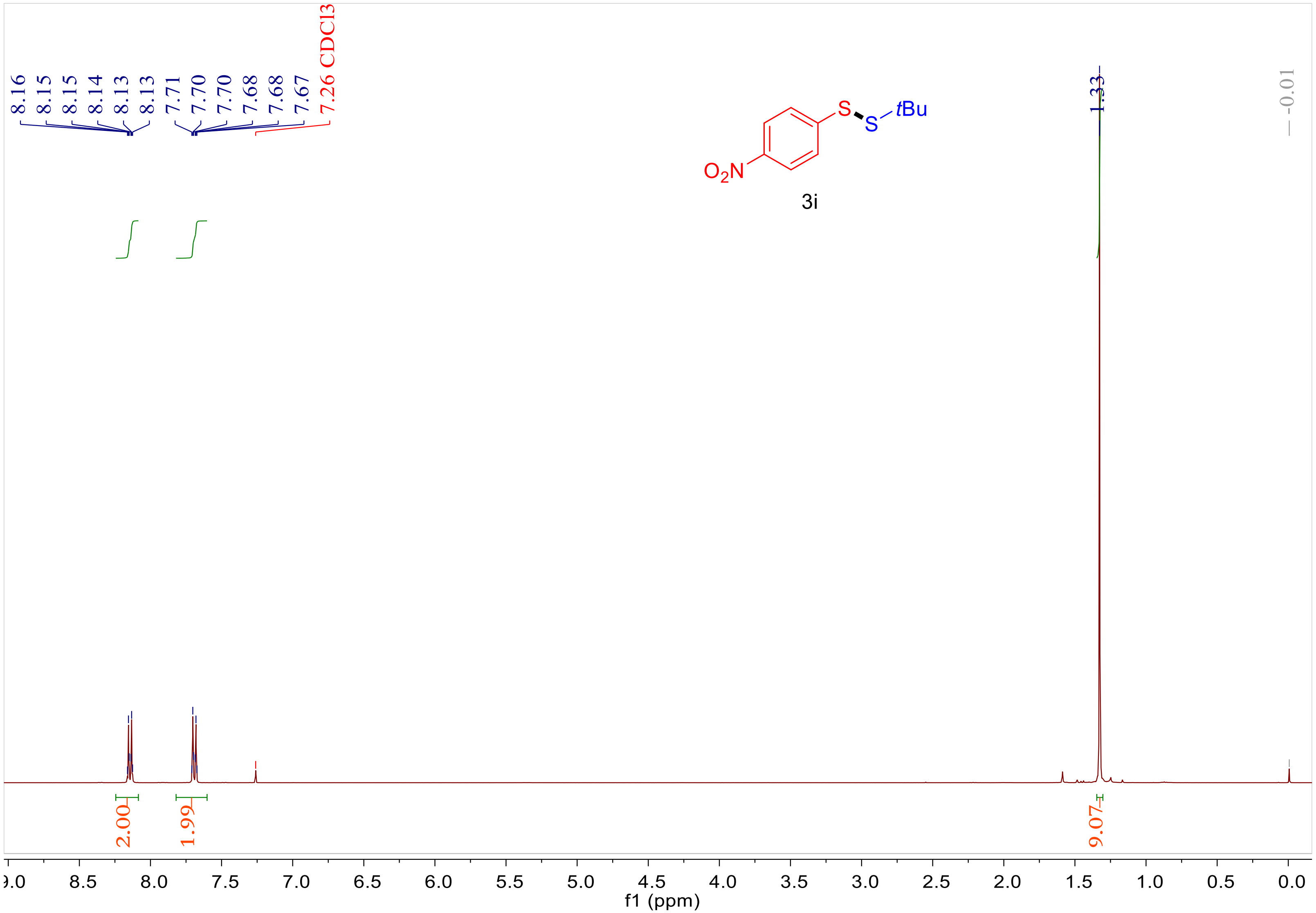


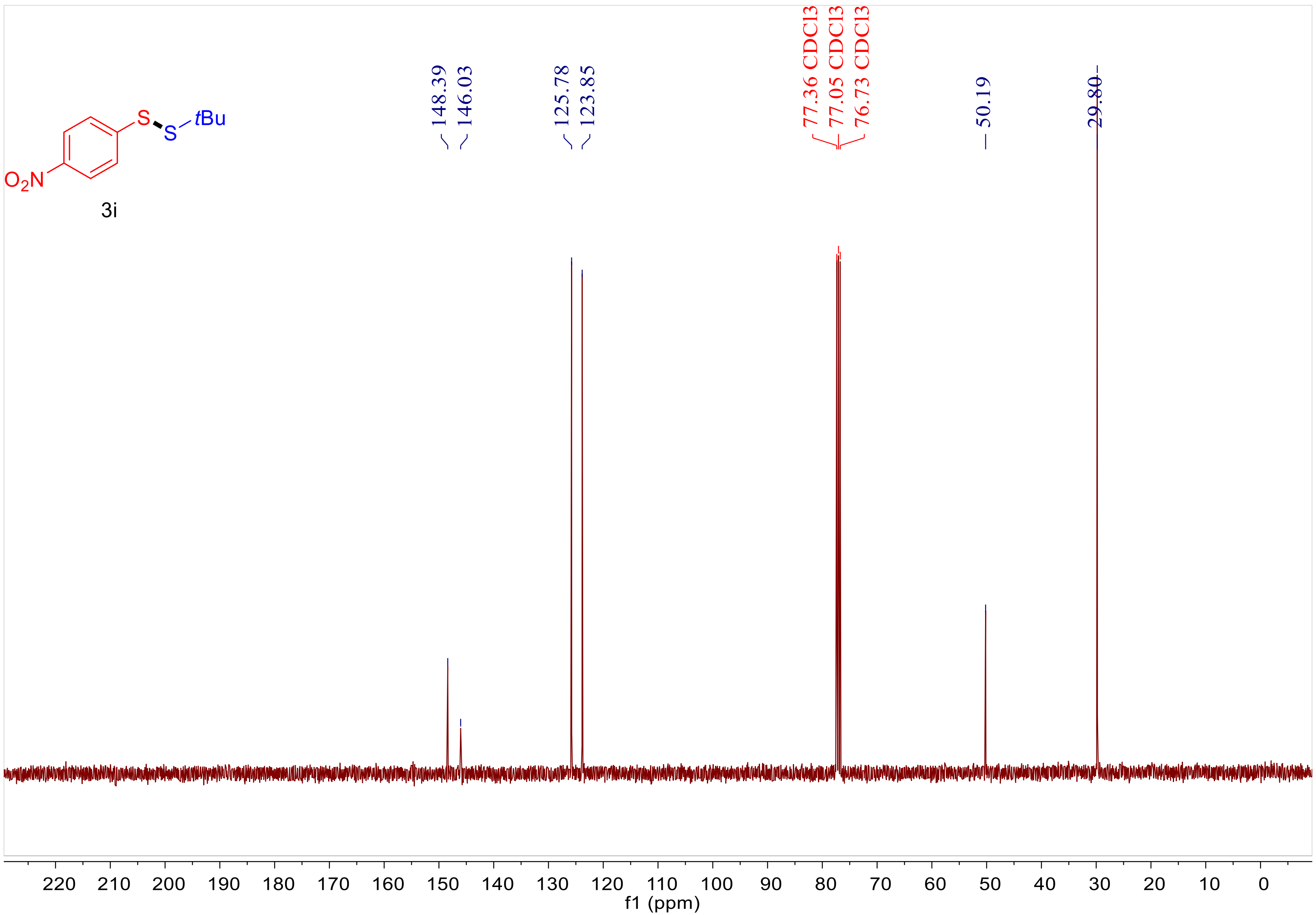
7.37
7.37
7.36
7.35
7.35
7.26 CDCl3
6.62
6.61
6.61
6.60
6.59
6.58
3.70
1.30
0.01
H2N
S
S
tBu
3h
2.00
2.03
1.94
9.05
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)



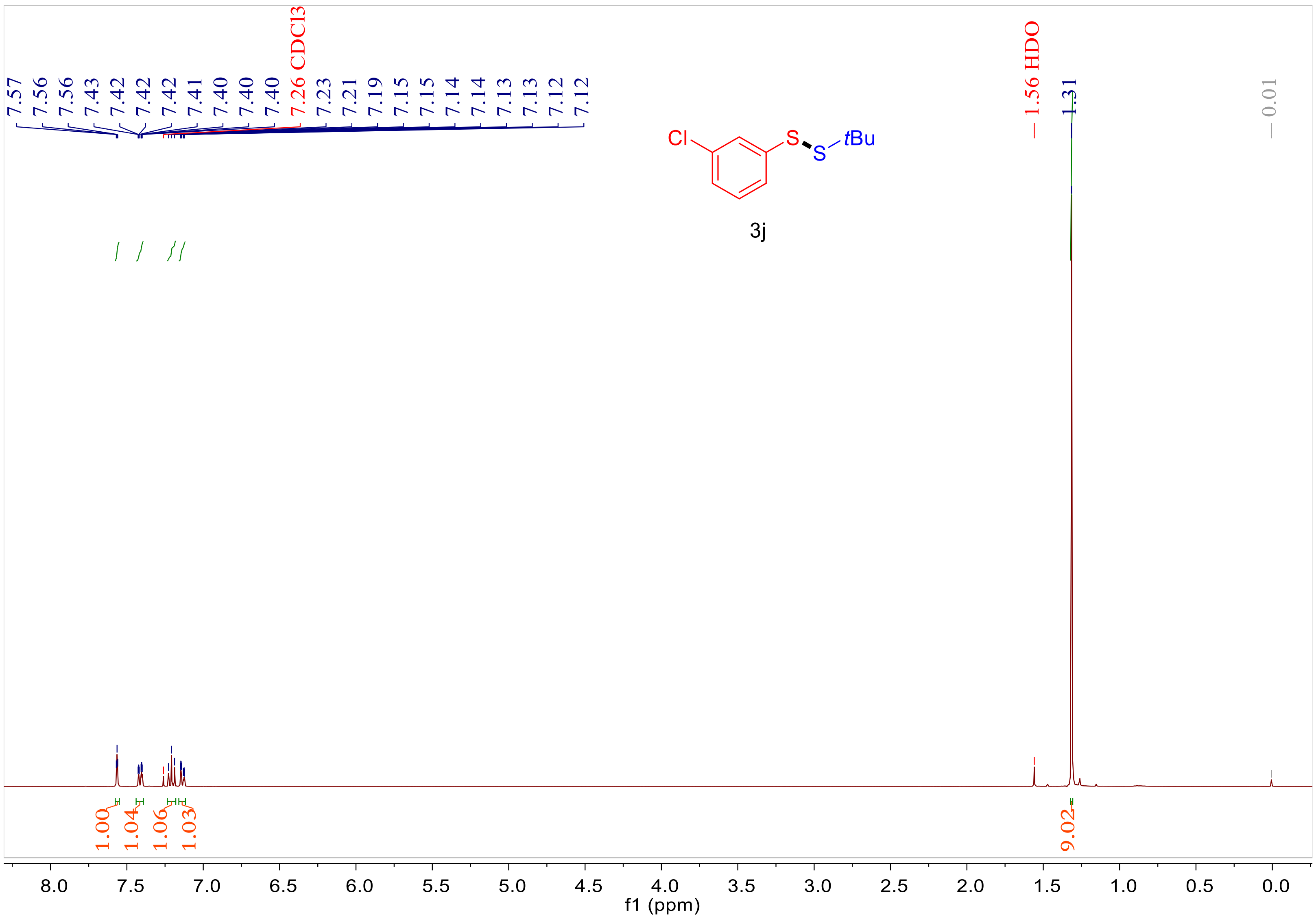
S
S
tBu
H2N
145.99
131.37
126.93
115.49
77.40 CDCl3
77.08 CDCl3
76.76 CDCl3
48.76
29.99
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

3h


8.16
8.15
8.15
8.14
8.13
8.13
7.71
7.70
7.70
7.68
7.68
7.67
7.26 CDCl3
1.33
-0.01
O_2N
S
S
tBu
3i
2.00
1.99
9.07
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)



O2N
S
S
tBu
3i
148.39
146.03
125.78
123.85
77.36 CDCl3
77.05 CDCl3
76.73 CDCl3
50.19
29.80
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.56
7.43
7.42
7.42
7.42
7.41
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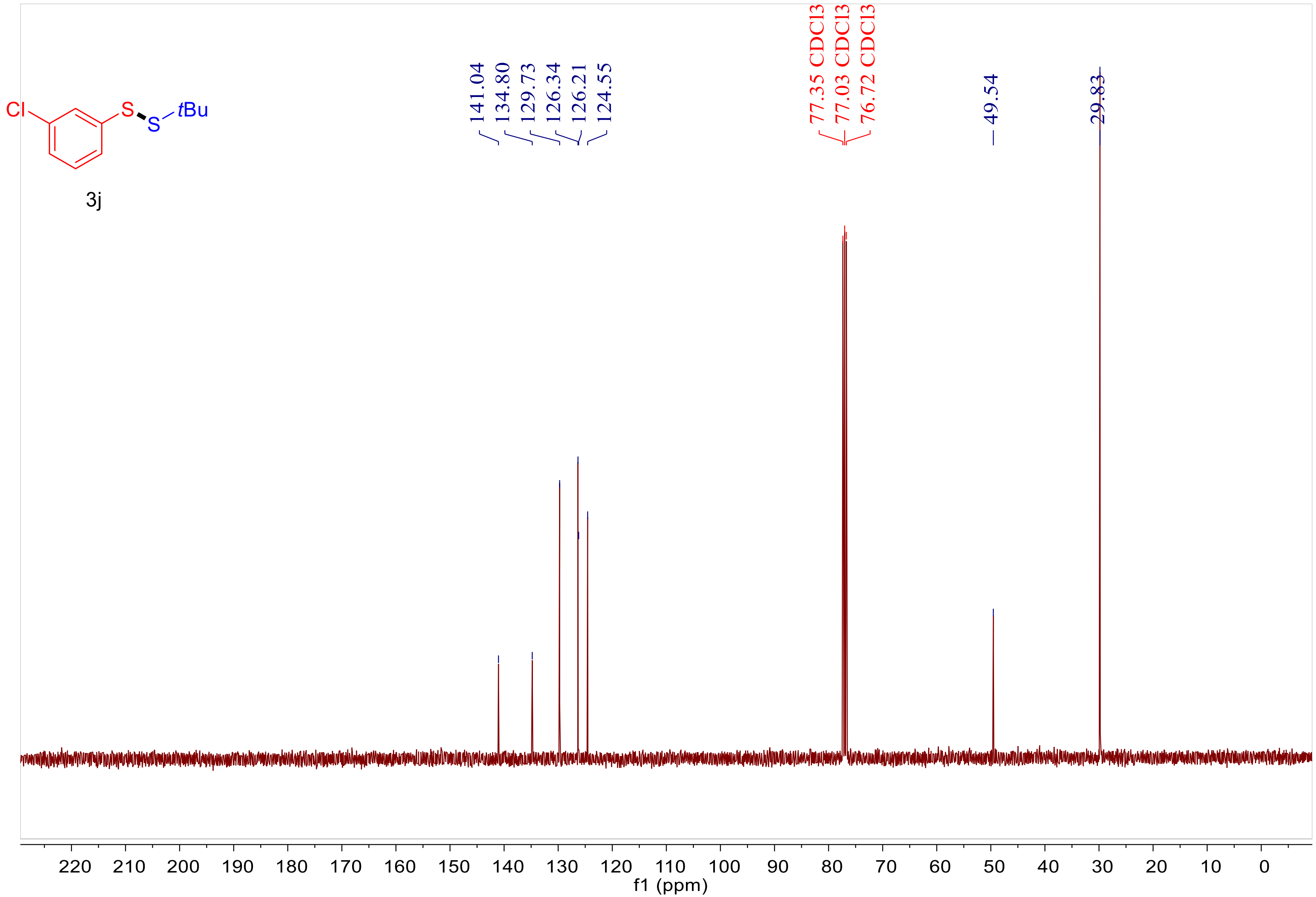
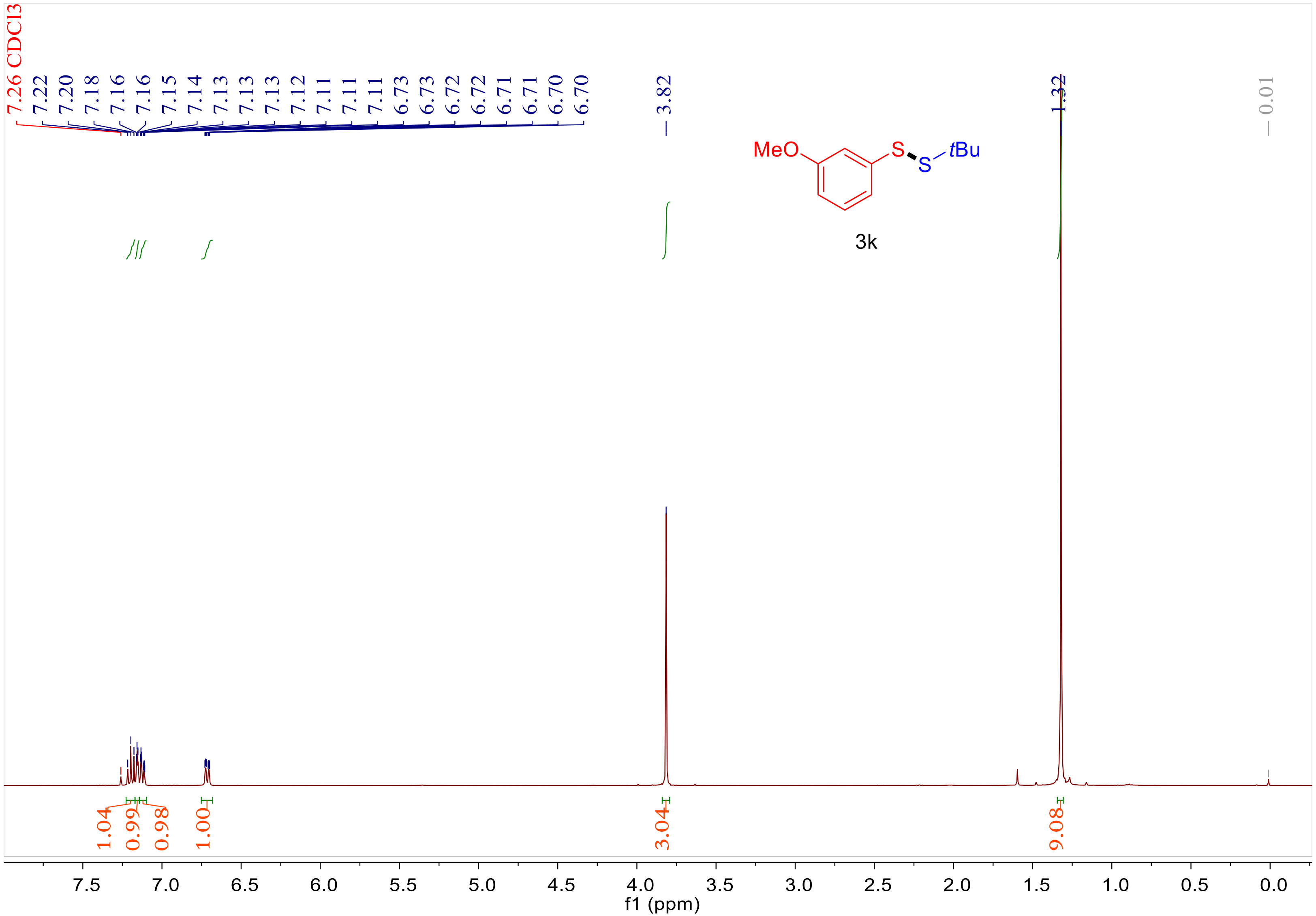
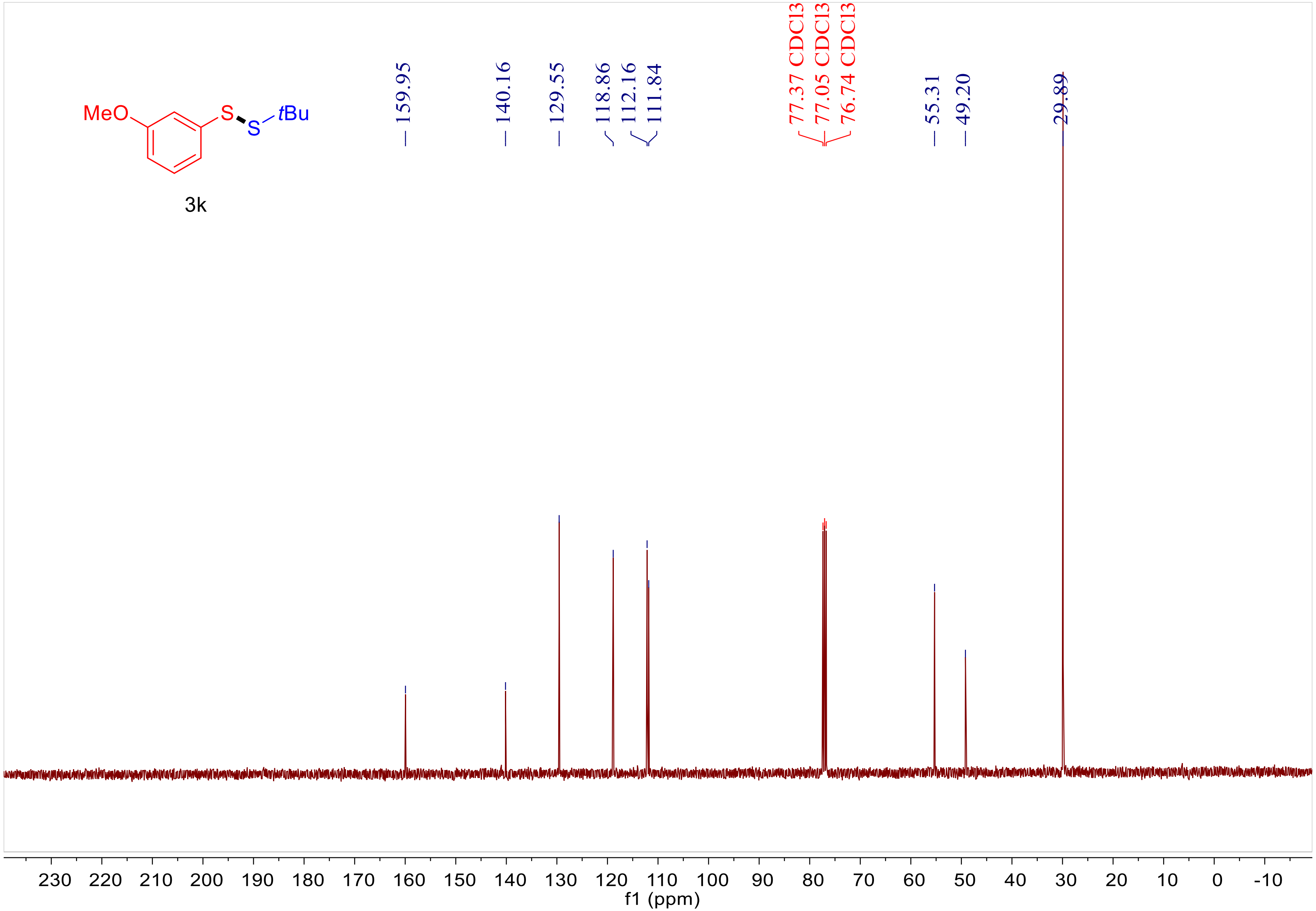
7.40
7.40
7.26 CDCl3
7.23
7.21
7.19
7.15
7.15
7.14
7.14
7.13
7.13
7.12
7.12
1.56 HDO
1.31
0.01
Cl
S
S
tBu
1.00
1.04
1.06
1.03
9.02
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

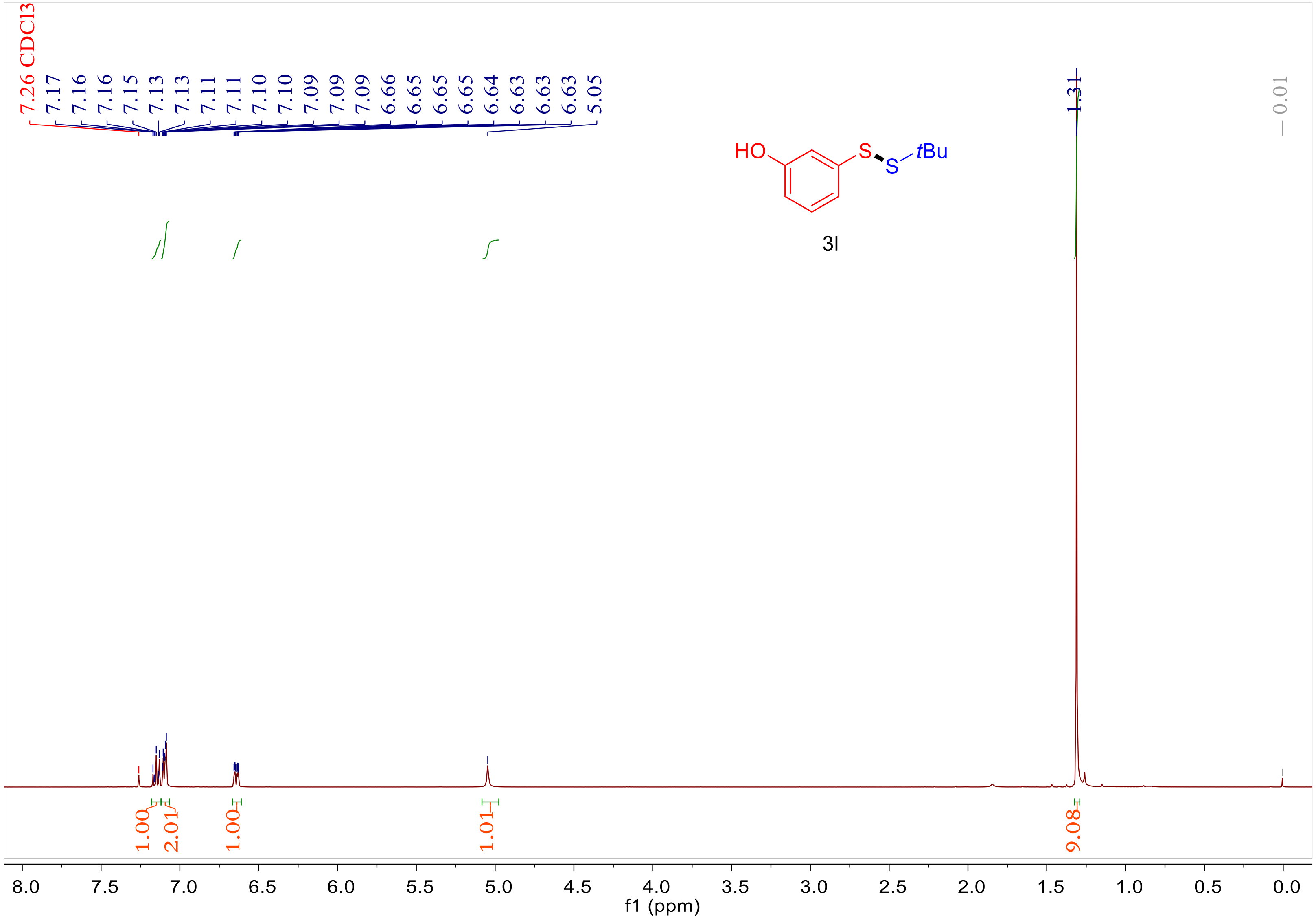
3j



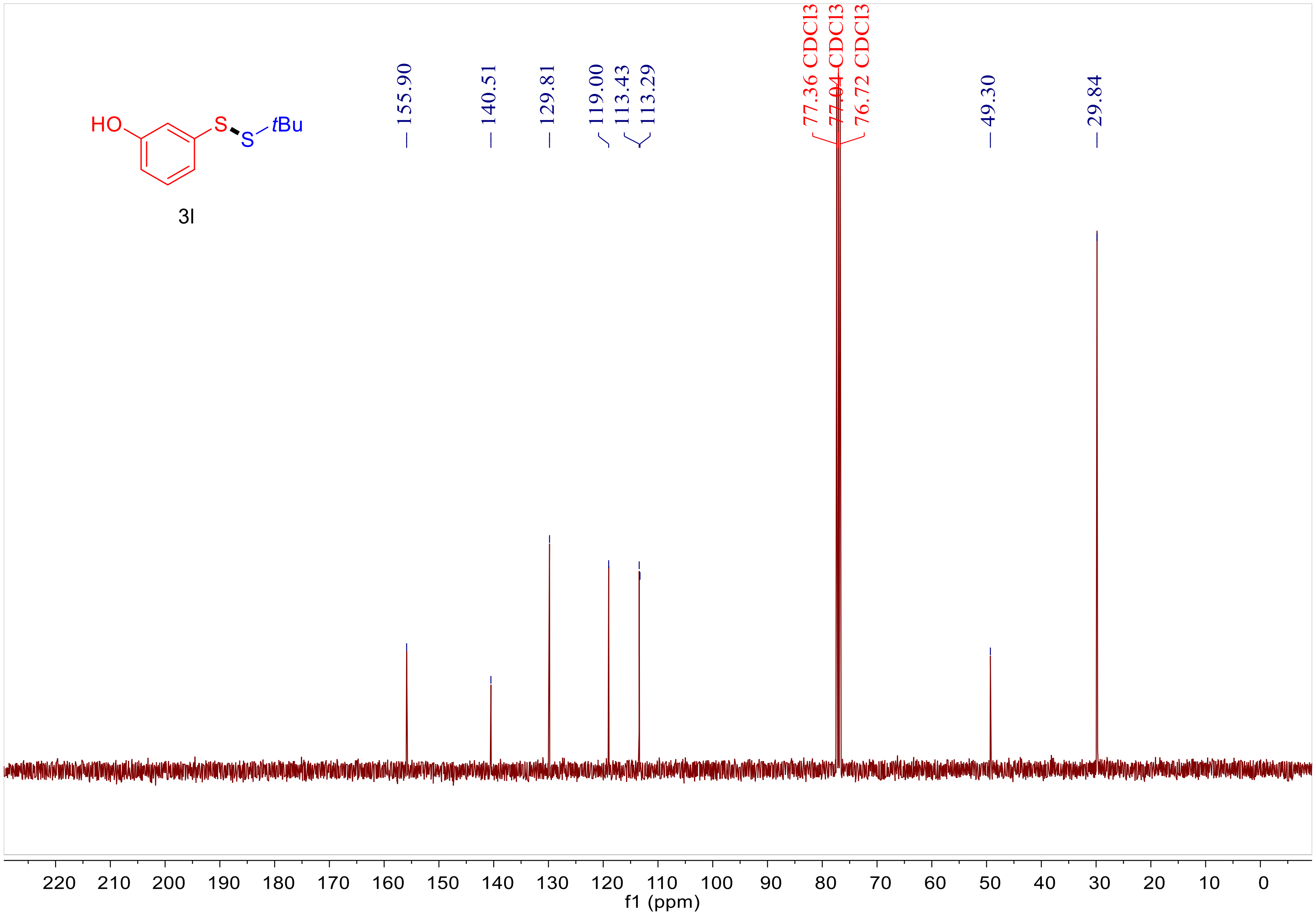
Cl
S
S
tBu
3j
141.04
134.80
129.73
126.34
126.21
124.55
77.35 CDCl3
77.03 CDCl3
76.72 CDCl3
49.54
29.83
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.26 CDCl3
7.22
7.20
7.18
7.16
7.16
7.15
7.14
7.13
7.13
7.13
7.12
7.11
7.11
7.11
6.73
6.73
6.72
6.72
6.71
6.71
6.70
6.70
3.82
1.32
0.01
MeO
S
S
tBu
3k
1.04
0.99
0.98
1.00
3.04
9.08
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)

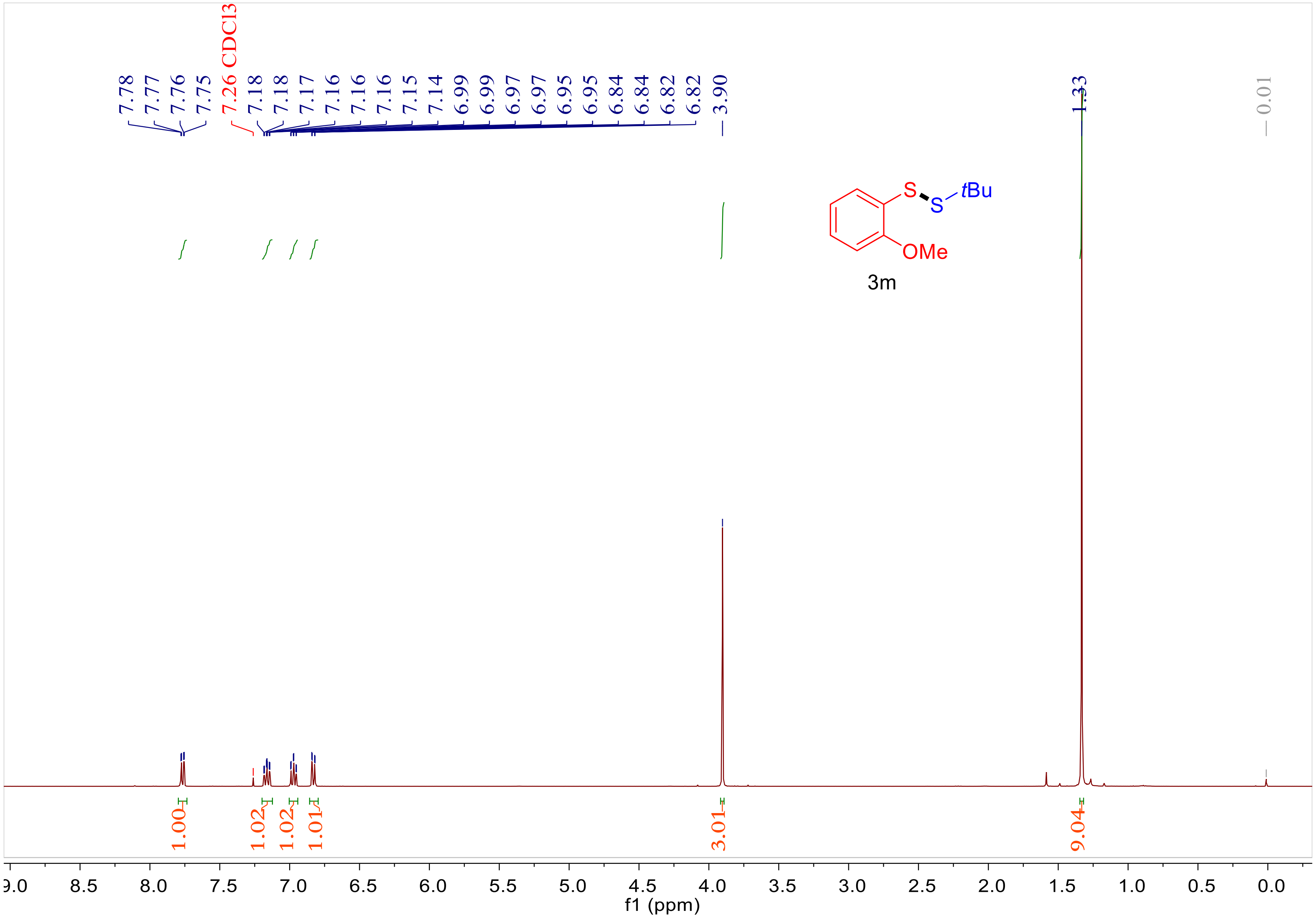

MeO
S
S
tBu
3k
159.95
140.16
129.55
118.86
112.16
111.84
77.37 CDCl3
77.05 CDCl3
76.74 CDCl3
55.31
49.20
29.89
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

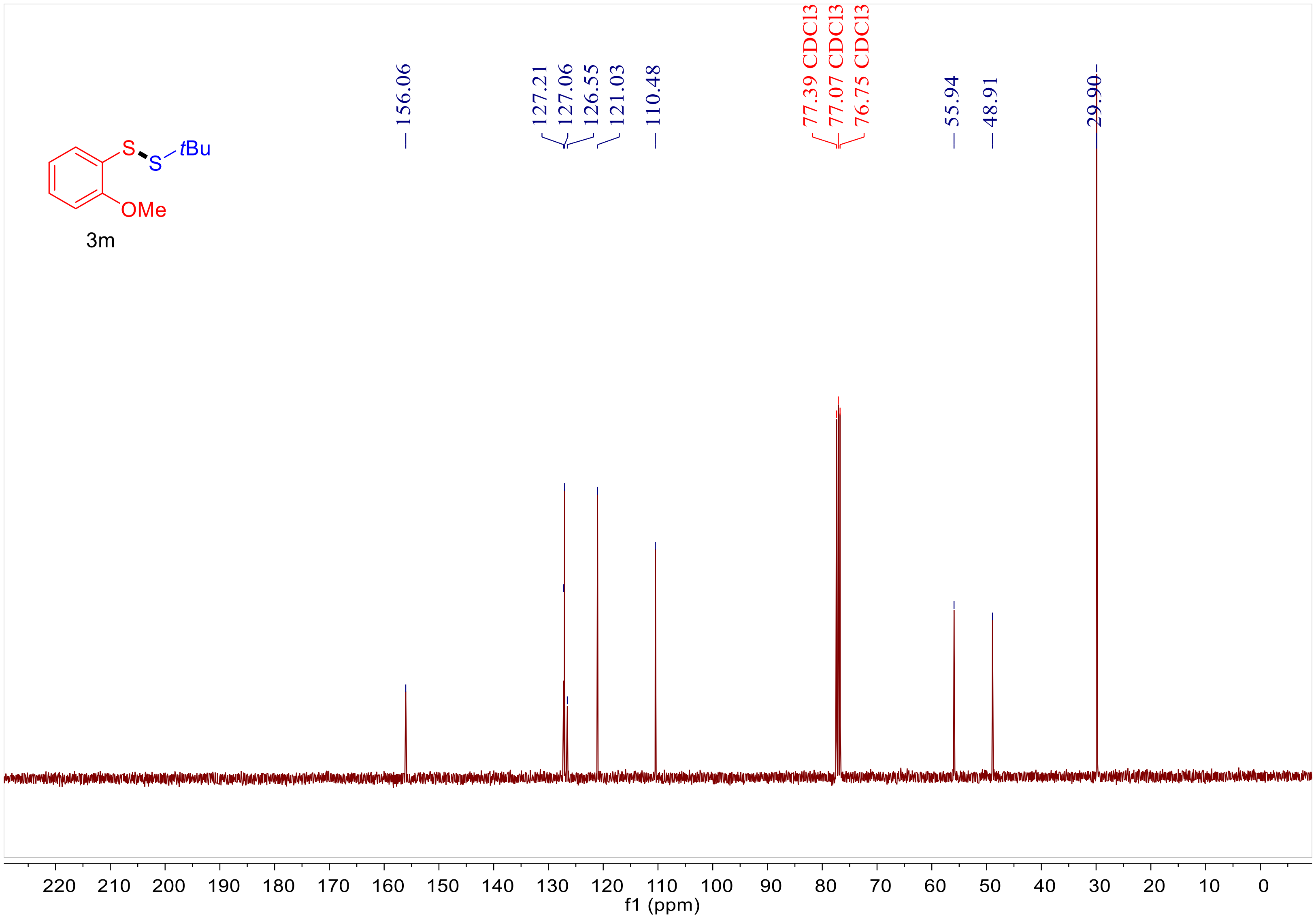


7.26 CDCl3
7.17
7.16
7.16
7.15
7.13
7.13
7.11
7.11
7.10
7.10
7.09
7.09
7.09
6.66
6.65
6.65
6.65
6.64
6.63
6.63
6.63
5.05
1.31
0.01
HO
S
S
tBu
3l
1.00
2.01
1.00
1.01
9.08
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

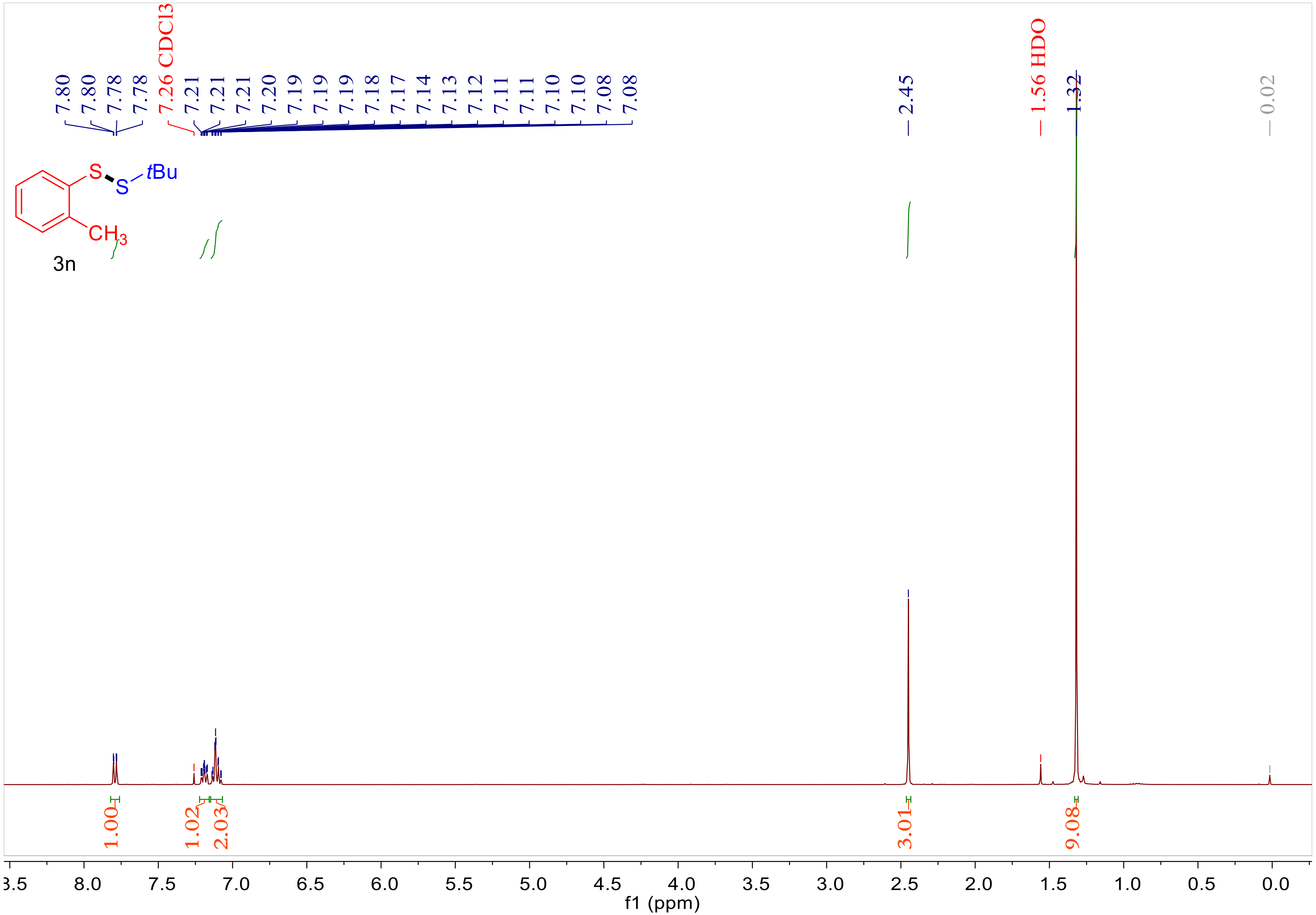


HO
S
S
tBu
3l
155.90
140.51
129.81
119.00
113.43
113.29
77.36 CDCl3
77.04 CDCl3
76.72 CDCl3
49.30
29.84
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

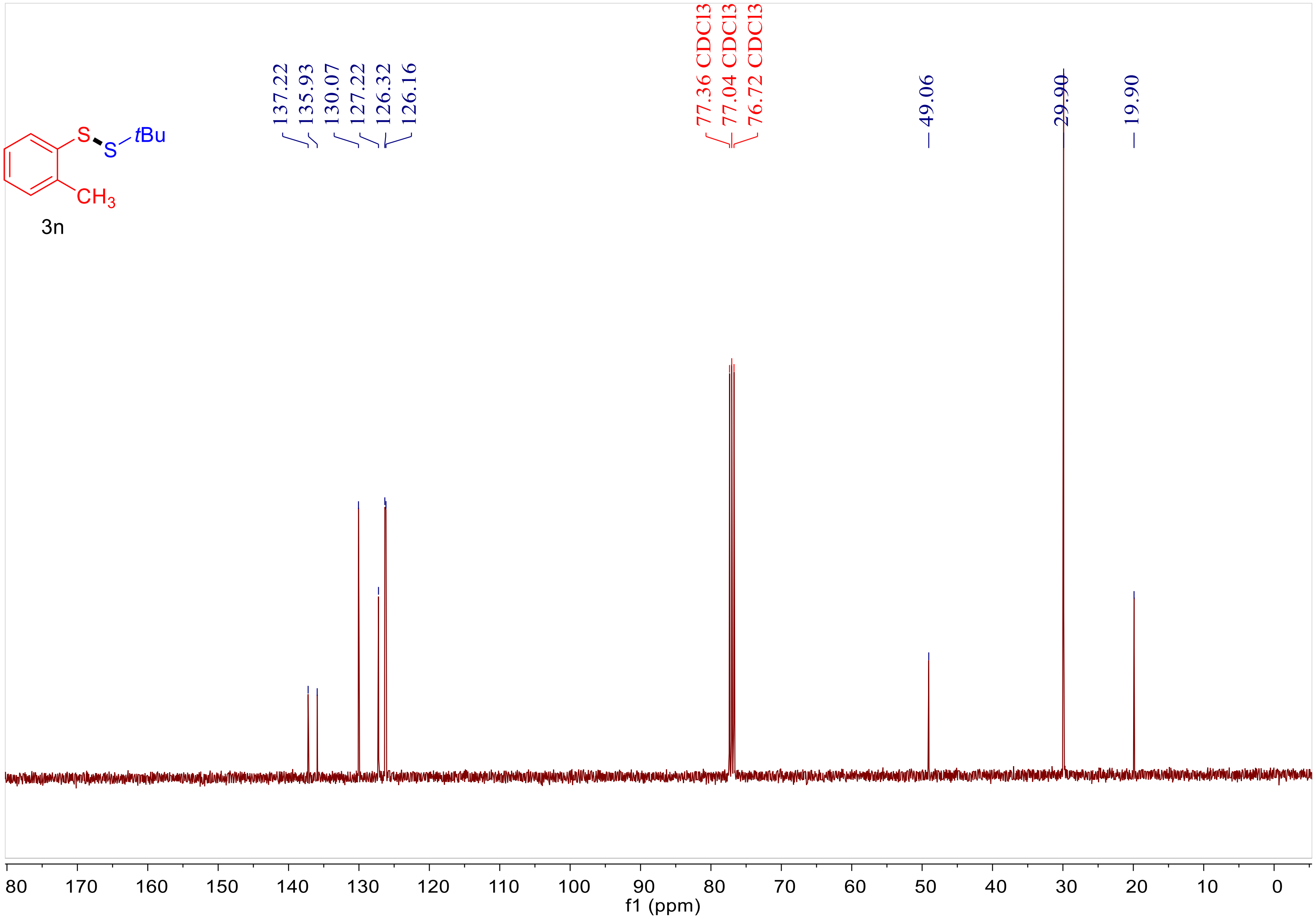

7.78
7.77
7.76
7.75
7.26 CDCl3
7.18
7.18
7.17
7.16
7.16
7.16
7.15
7.14
6.99
6.99
6.97
6.97
6.95
6.95
6.84
6.84
6.82
6.82
3.90
1.33
0.01
S
S
tBu
OMe
3m
1.00
1.02
1.02
1.01
3.01
9.04
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)



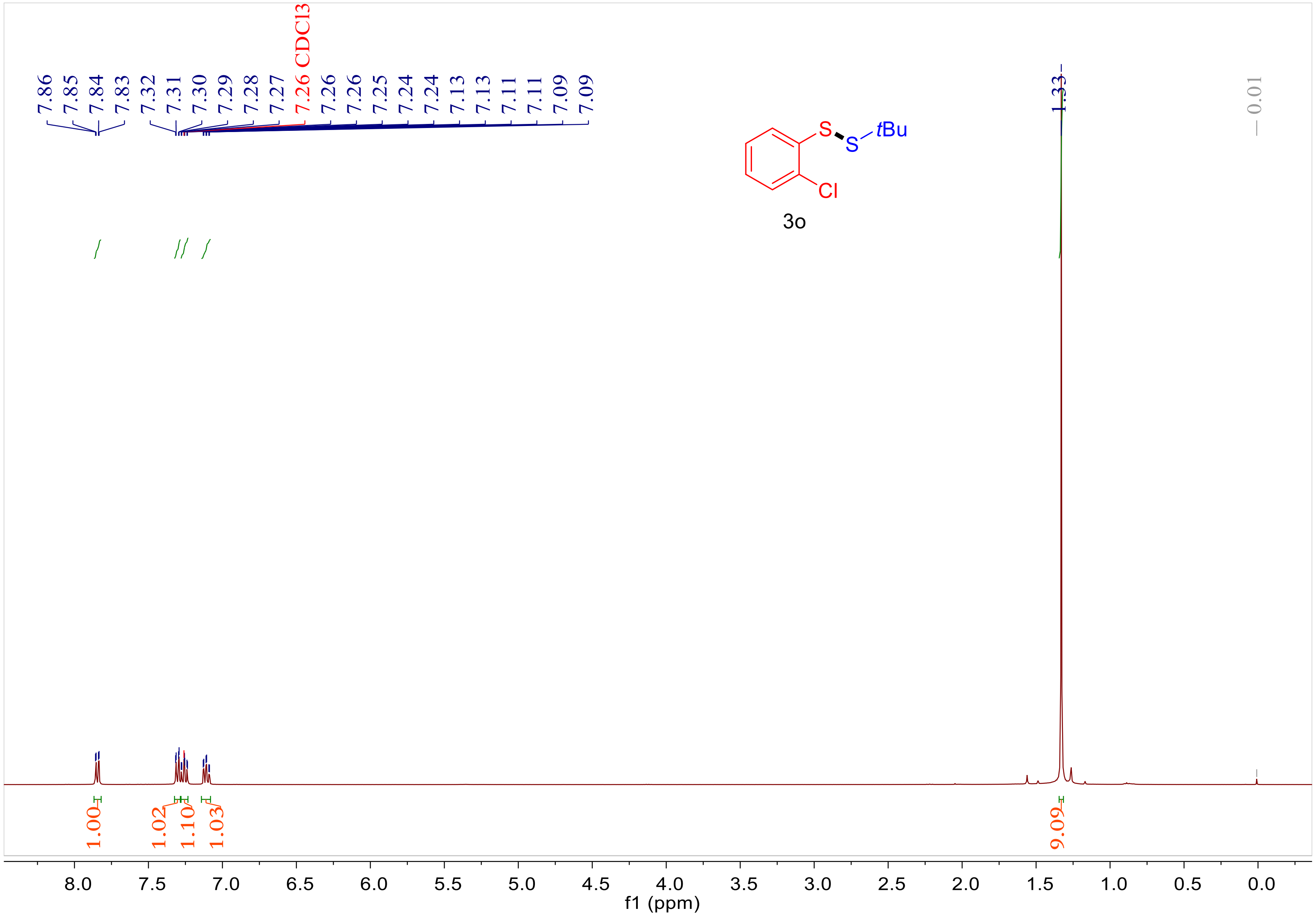
S
S
tBu
OMe
3m
156.06
127.21
127.06
126.55
121.03
110.48
77.39 CDCl3
77.07 CDCl3
76.75 CDCl3
55.94
48.91
29.90
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

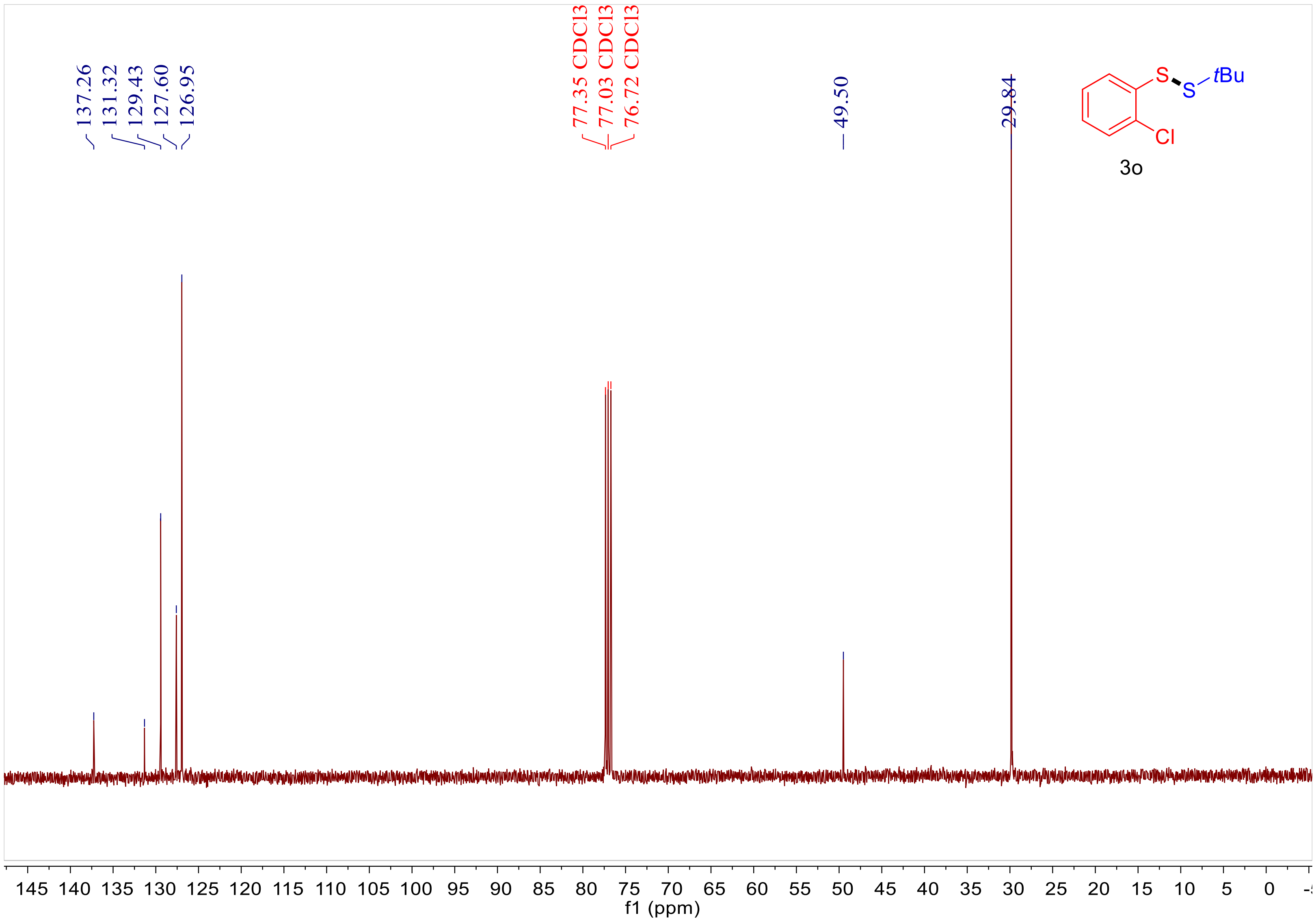


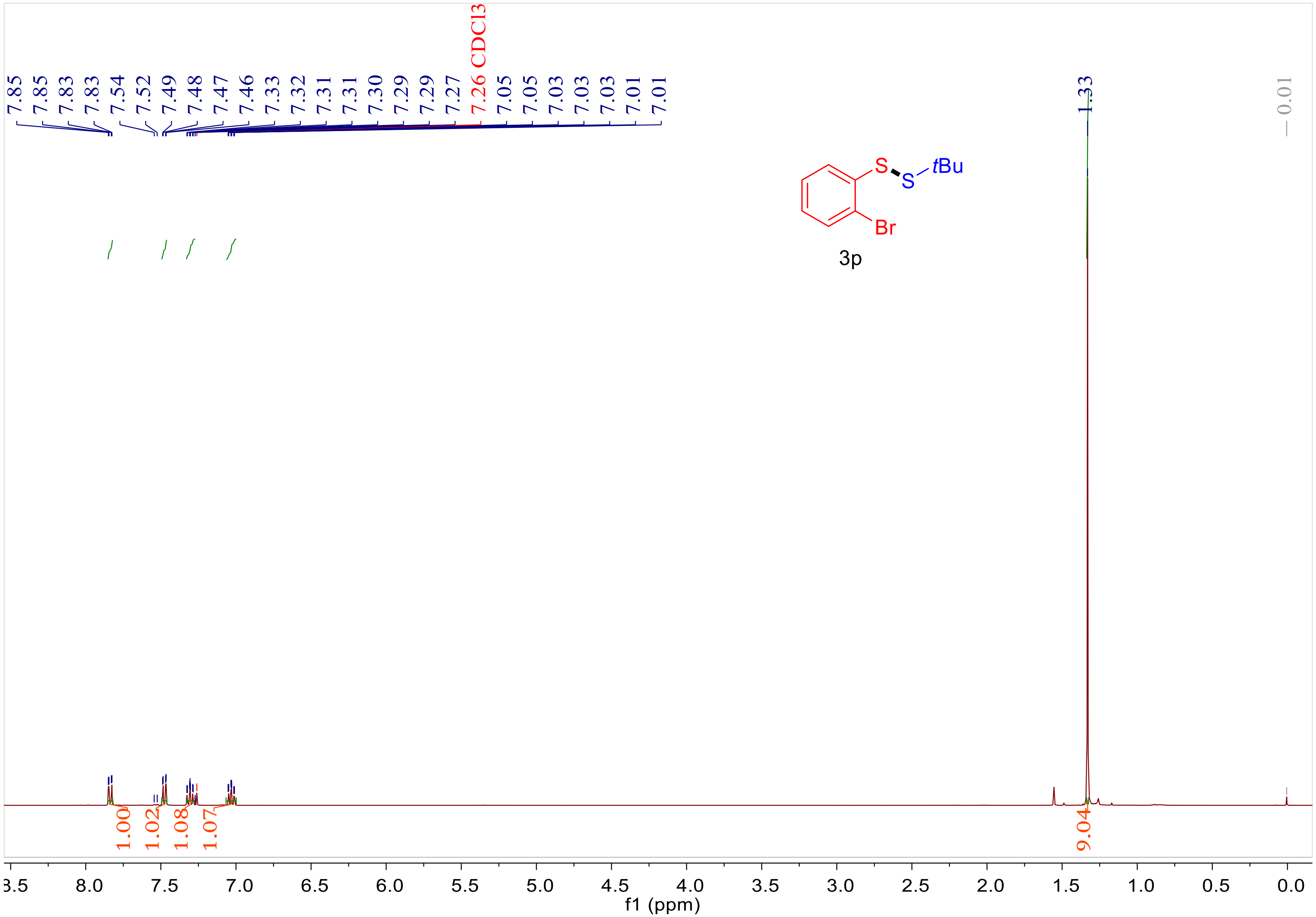
7.80
7.80
7.78
7.78
7.26 CDCl3
7.21
7.21
7.21
7.20
7.19
7.19
7.19
7.18
7.17
7.14
7.13
7.12
7.11
7.11
7.10
7.10
7.08
7.08
2.45
1.56 HDO
1.32
0.02
S
S
tBu
CH3
3n
1.00
1.02
2.03
3.01
9.08
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


S
S
tBu
CH3
137.22
135.93
130.07
127.22
126.32
126.16
77.36 CDCl3
77.04 CDCl3
76.72 CDCl3
49.06
29.90
19.90
f1 (ppm)

3n


7.86
7.85
7.84
7.83
7.32
7.31
7.30
7.29
7.28
7.27
7.26 CDCl3
7.26
7.26
7.25
7.24
7.24
7.13
7.13
7.11
7.11
7.09
7.09
1.33
0.01
S
S
tBu
Cl
3o
1.00
1.02
1.10
1.03
9.09
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)


137.26
131.32
129.43
127.60
126.95
77.35 CDCl3
77.03 CDCl3
76.72 CDCl3
49.50
29.84
S
S
tBu
Cl
3o
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)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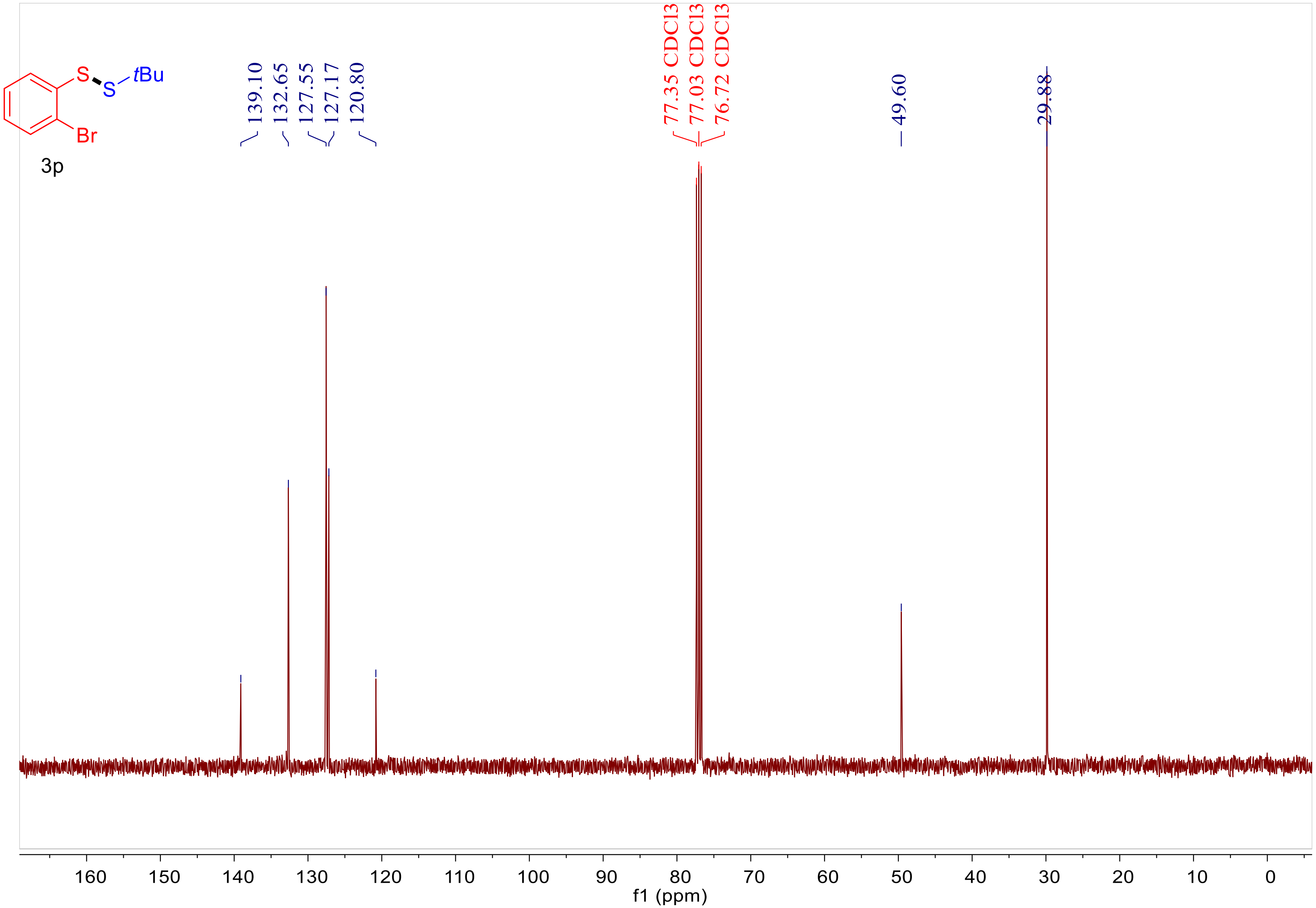
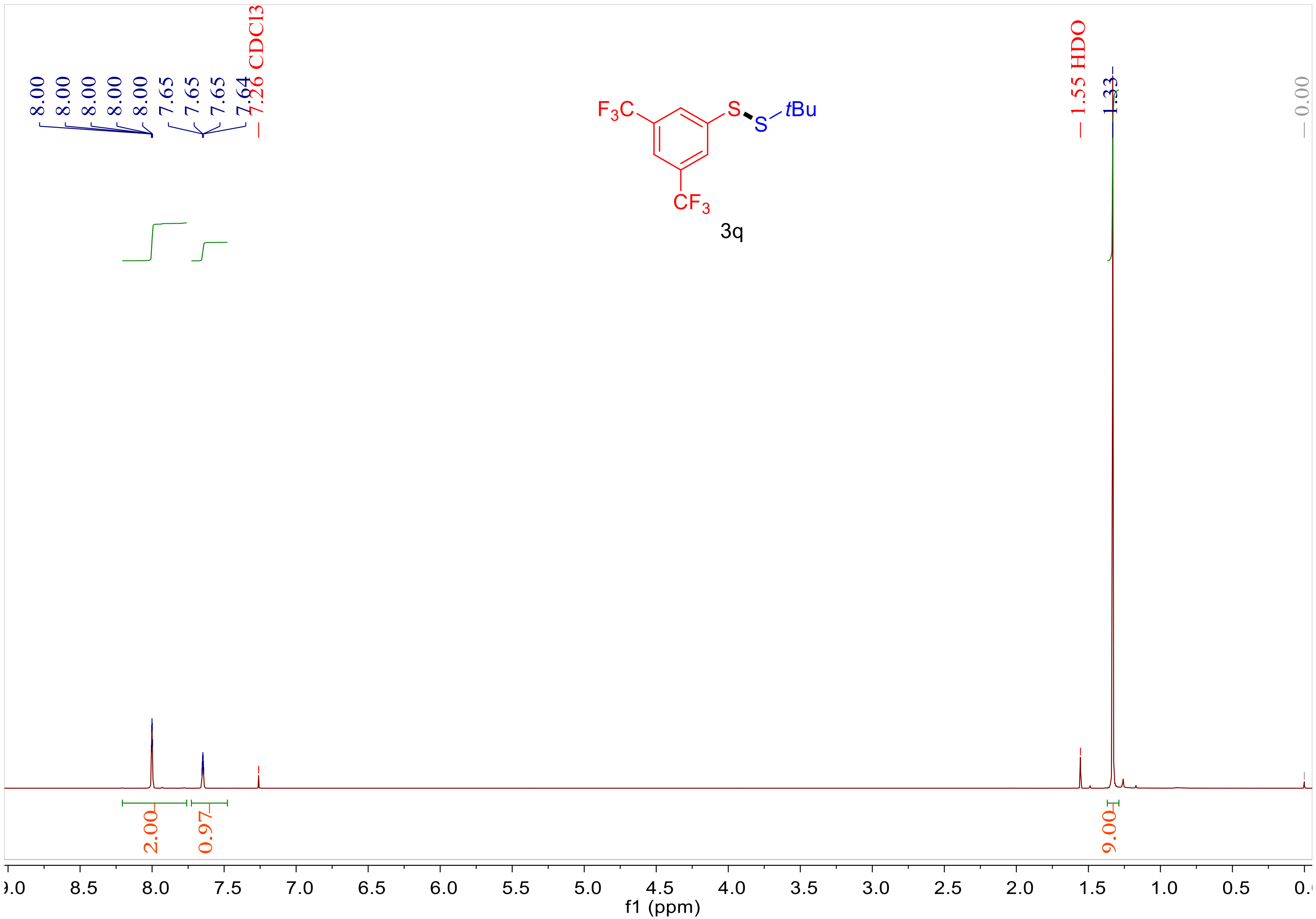
7.85
7.83
7.83
7.54
7.52
7.49
7.48
7.47
7.46
7.33
7.32
7.31
7.31
7.30
7.29
7.29
7.27
7.26 CDCl3
7.05
7.05
7.03
7.03
7.03
7.01
7.01
1.33
0.01
S
S
tBu
Br
3p
1.00
1.02
1.08
1.07
9.04
f1 (ppm)



S
S
tBu
Br
3p
139.10
132.65
127.55
127.17
120.80
77.35 CDCl3
77.03 CDCl3
76.72 CDCl3
49.60
29.88
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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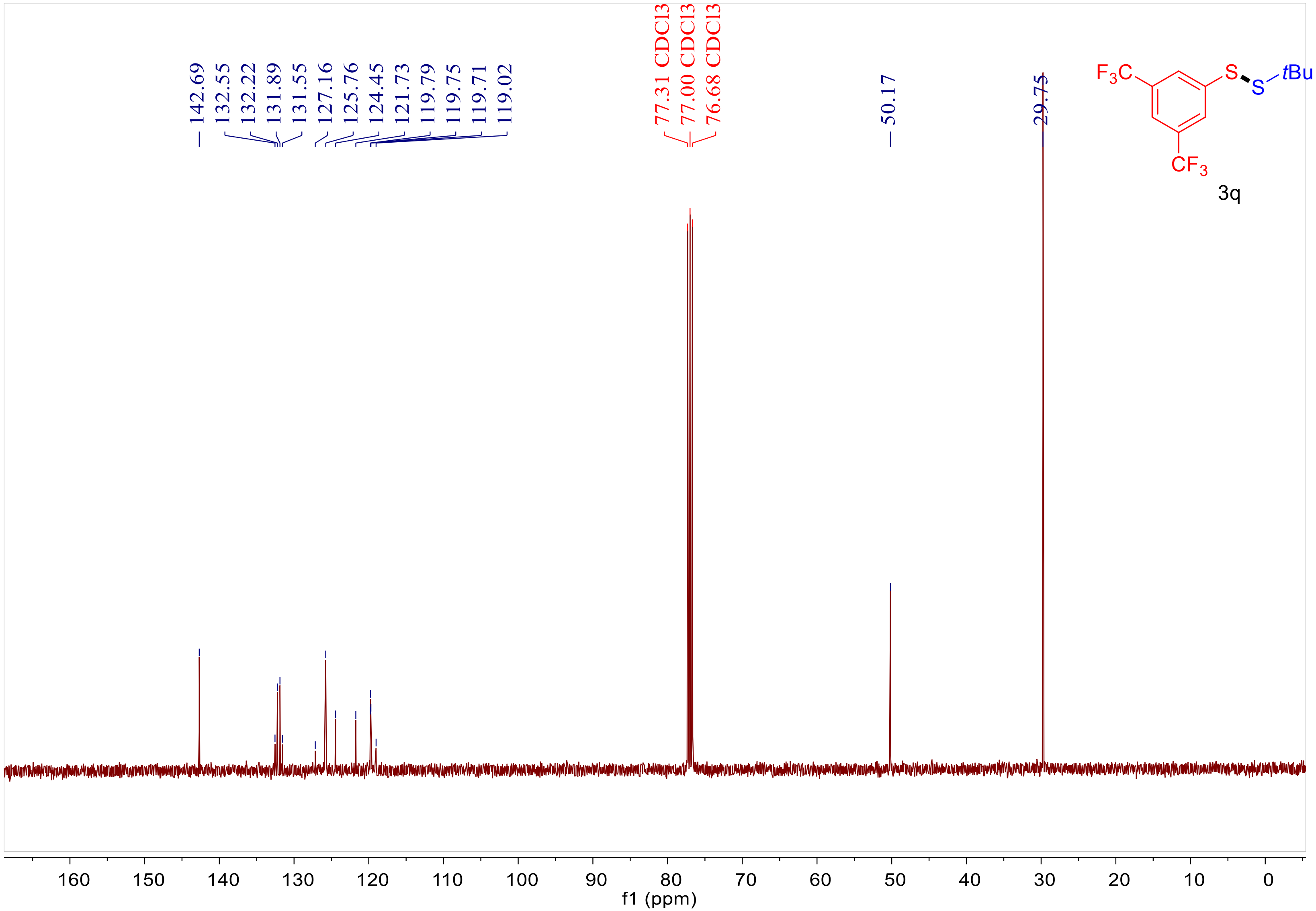
8.00
8.00
8.00
8.00
7.65
7.65
7.65
7.64
7.26 CDCl3
1.55 HDO
1.33
0.00
F3C
S
S
tBu
CF3
3q
2.00
0.97
9.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


142.69
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131.89
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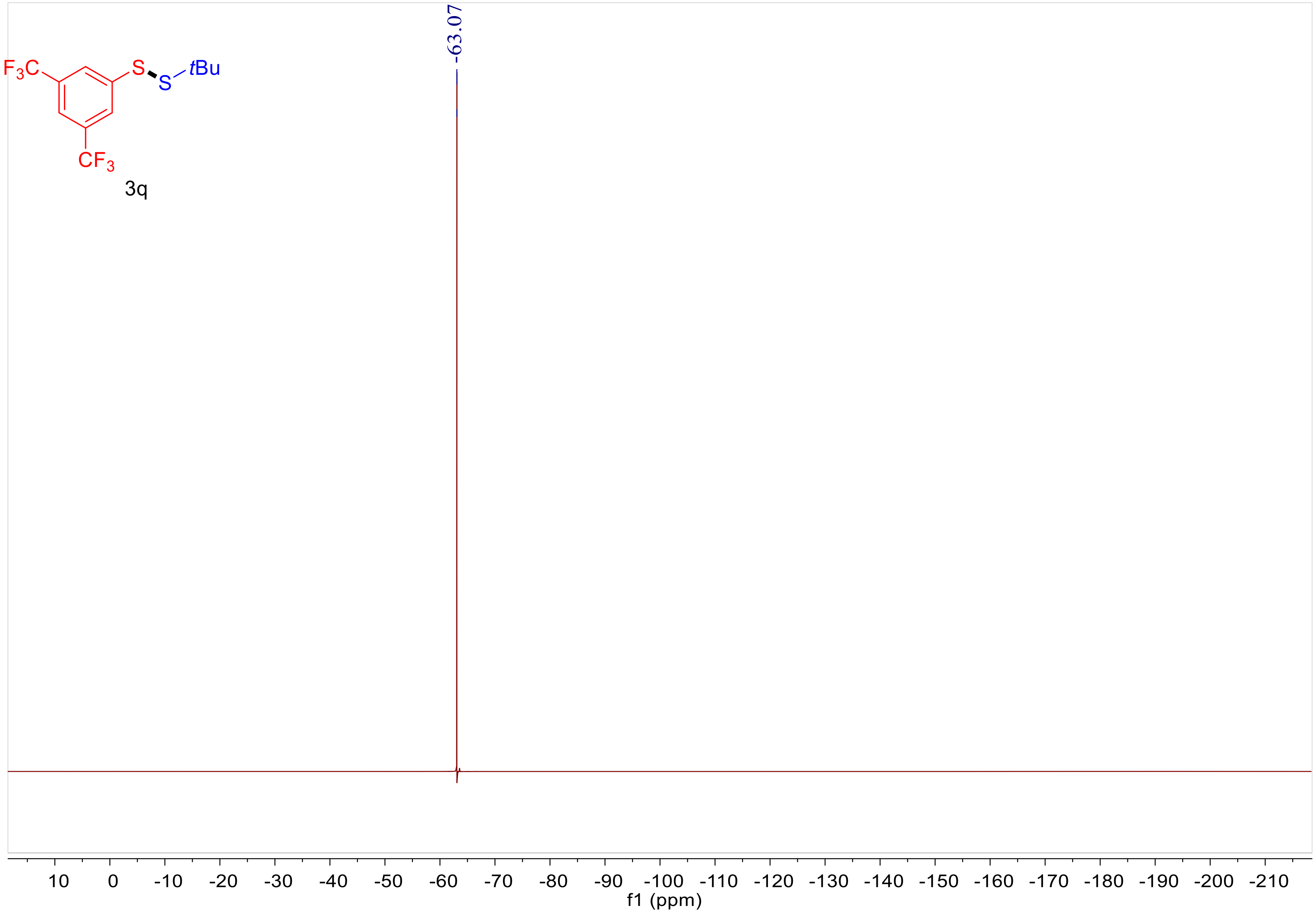
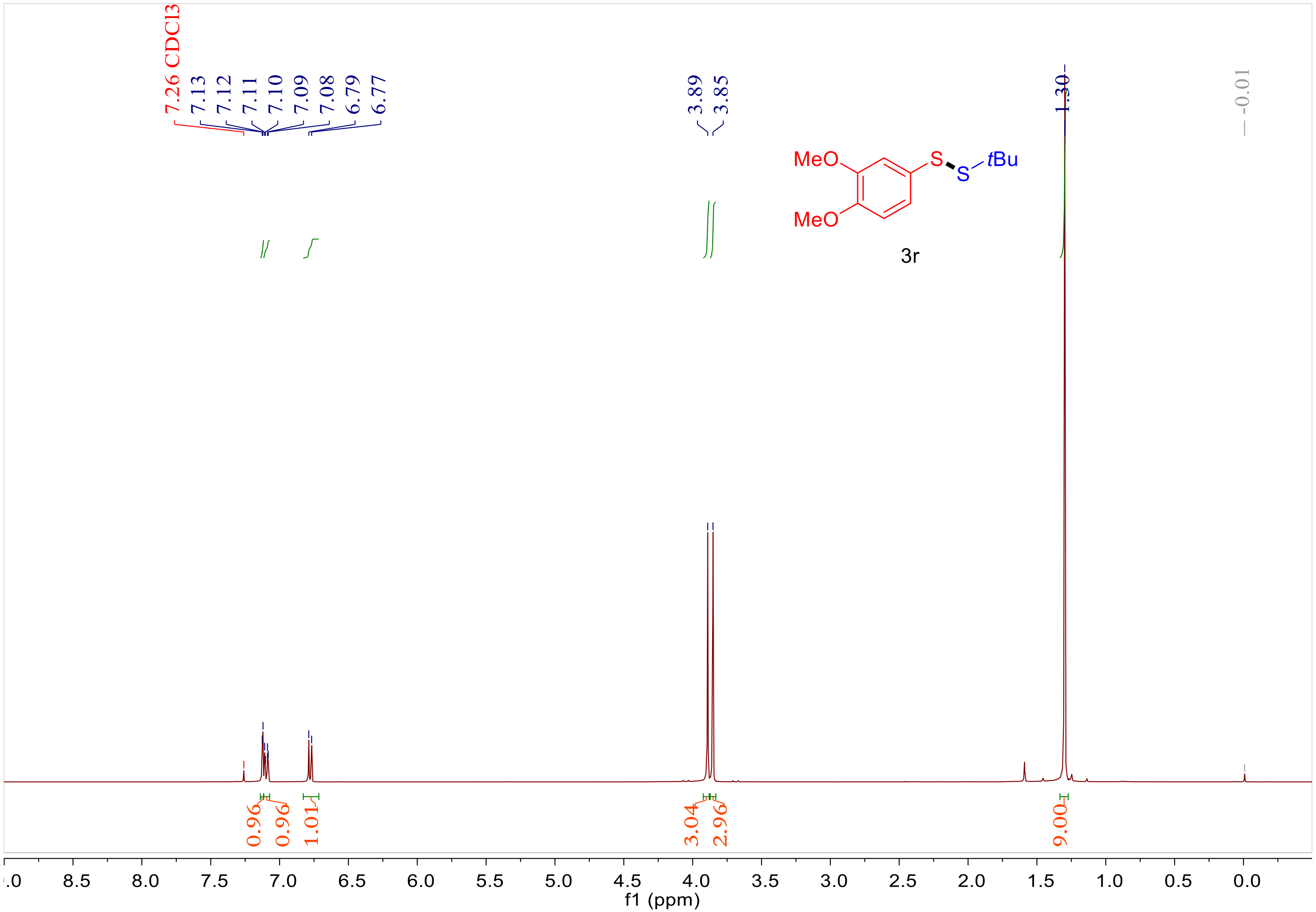
127.16
125.76
124.45
121.73
119.79
119.75
119.71
119.02
77.31 CDCl3
77.00 CDCl3
76.68 CDCl3
50.17
29.75
F_3C
S
S
tBu
CF_3
3q
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



-63.07
F3C
S
S
tBu
CF3
3q
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)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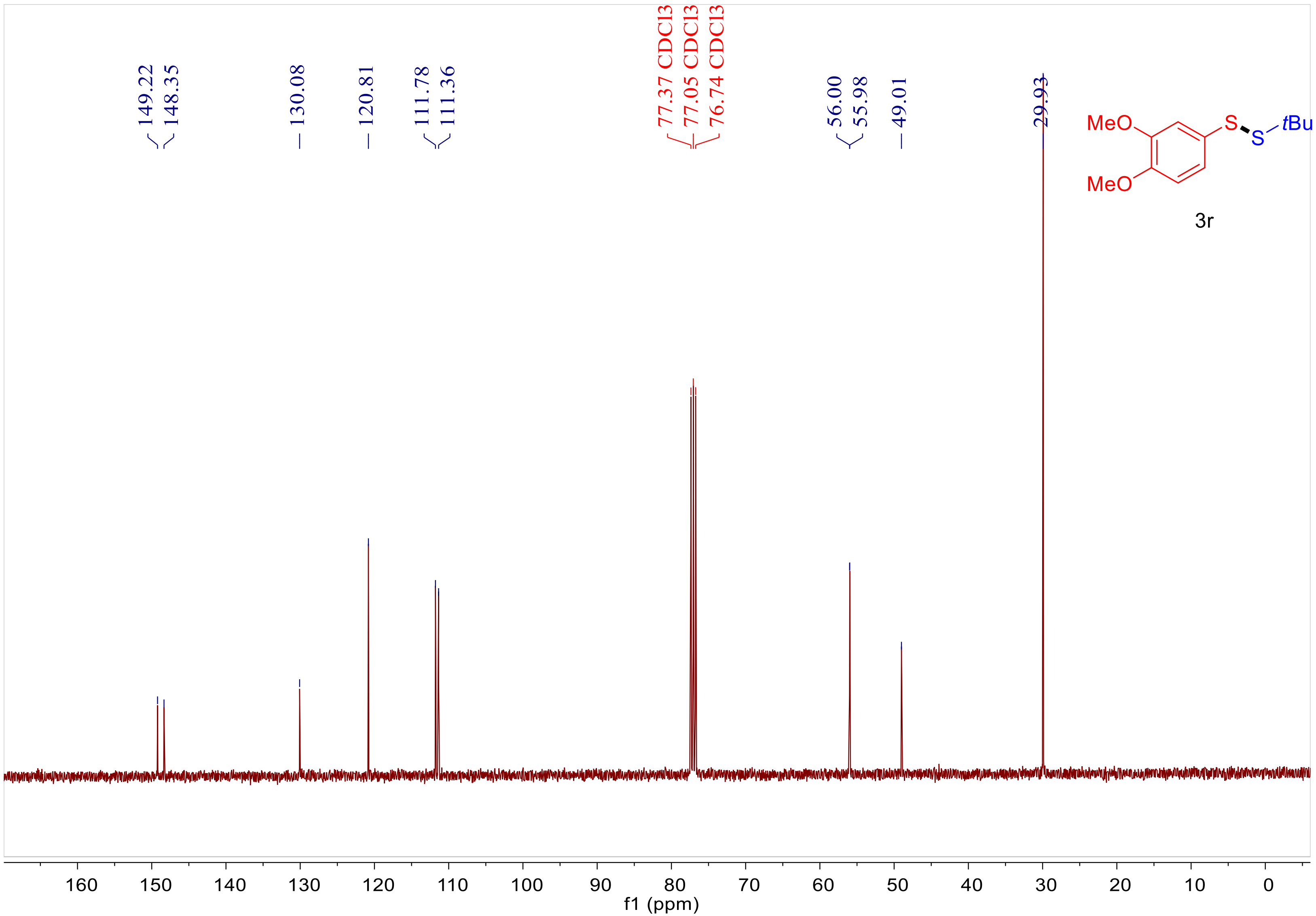
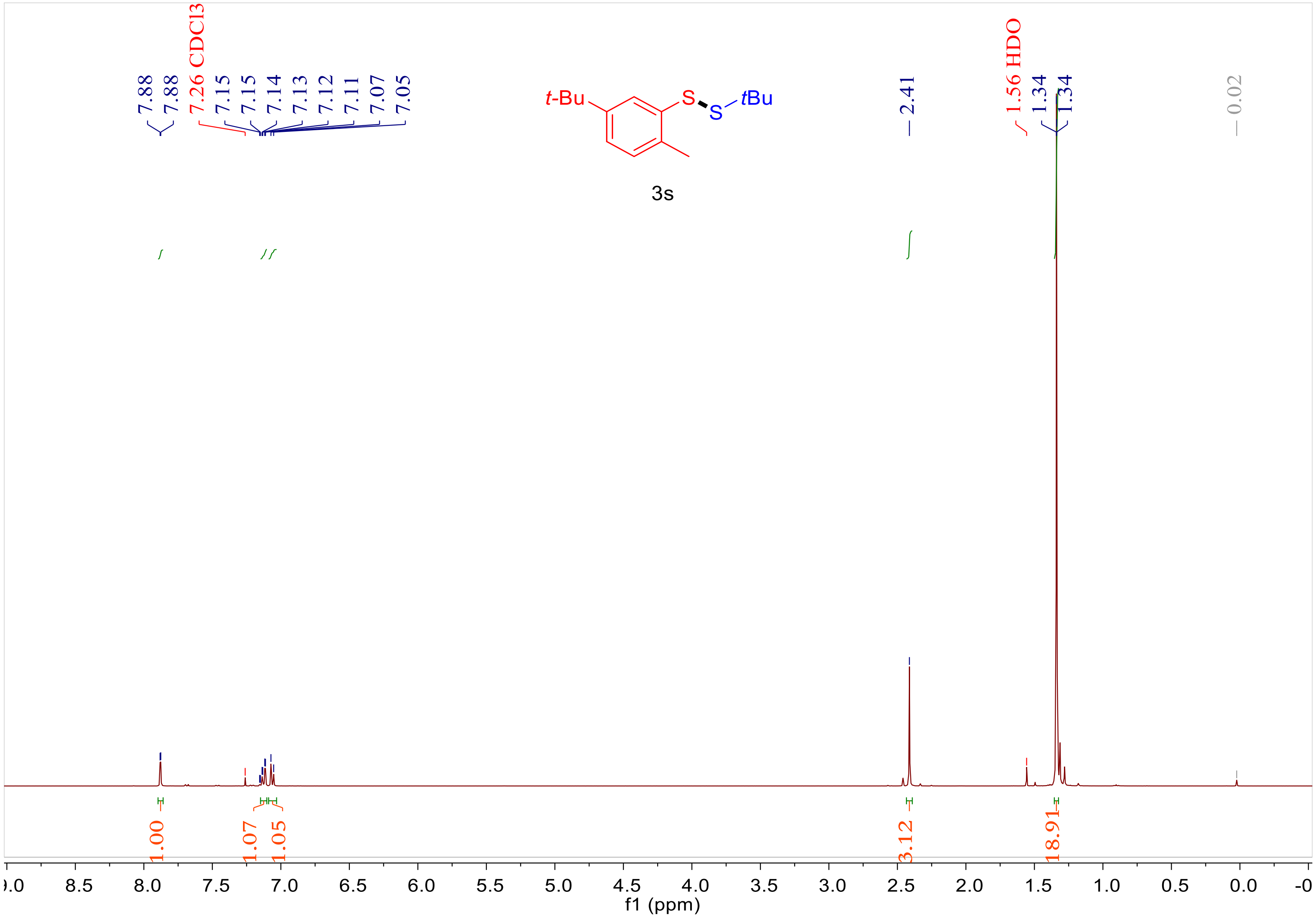
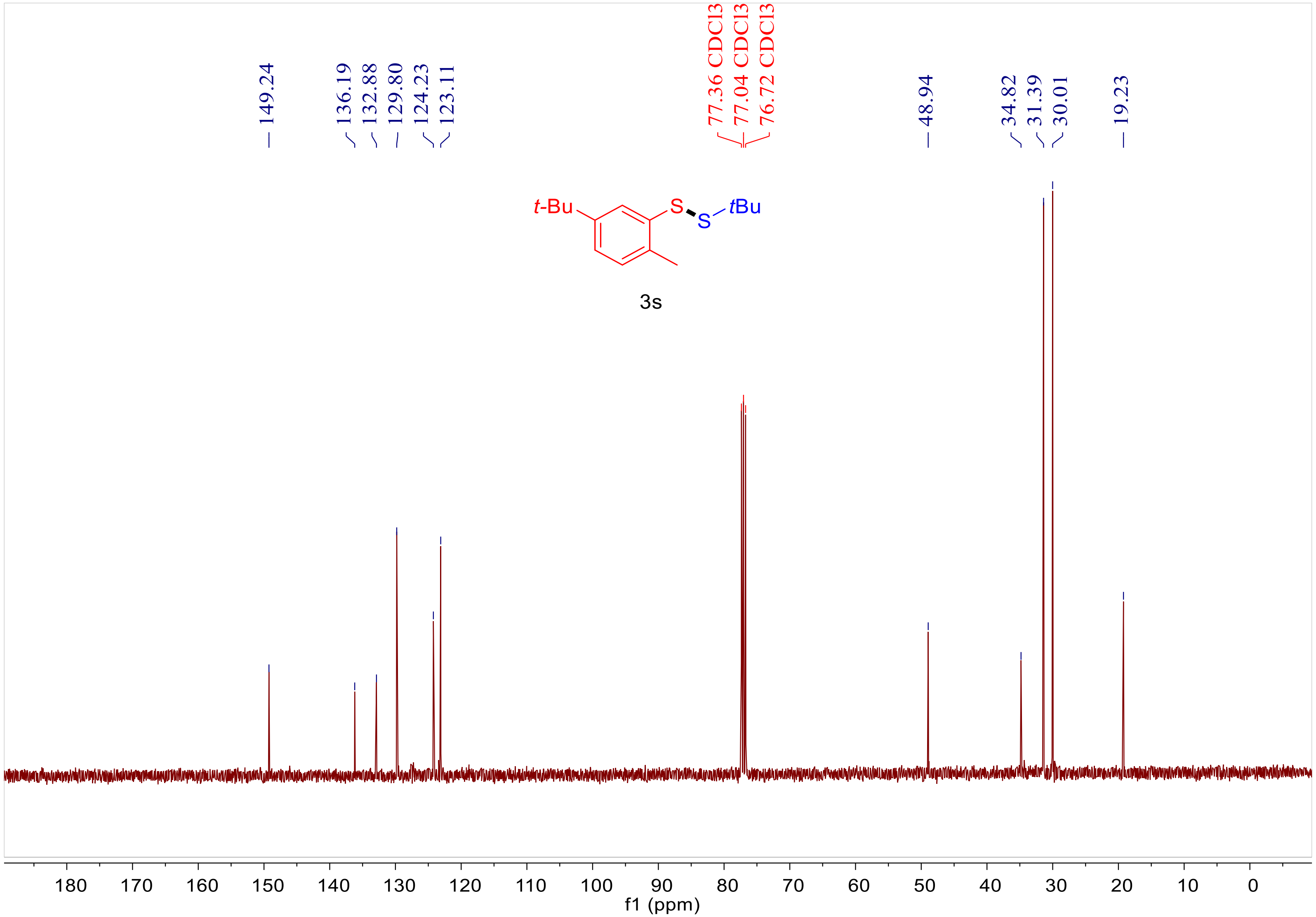
7.13
7.12
7.11
7.10
7.09
7.08
6.79
6.77
3.89
3.85
1.30
-0.01
MeO
MeO
S
S
tBu
3r
0.96
0.96
1.01
3.04
2.96
9.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


149.22
148.35
130.08
120.81
111.78
111.36
77.37 CDCl3
77.05 CDCl3
76.74 CDCl3
56.00
55.98
49.01
29.93
MeO
MeO
S
S
tBu
3r
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.88
7.88
7.26 CDCl3
7.15
7.15
7.14
7.13
7.12
7.11
7.07
7.05
t-Bu
S
S
tBu
3s
2.41
1.56 HDO
1.34
1.34
0.02
1.00
1.07
1.05
3.12
18.91
f1 (ppm)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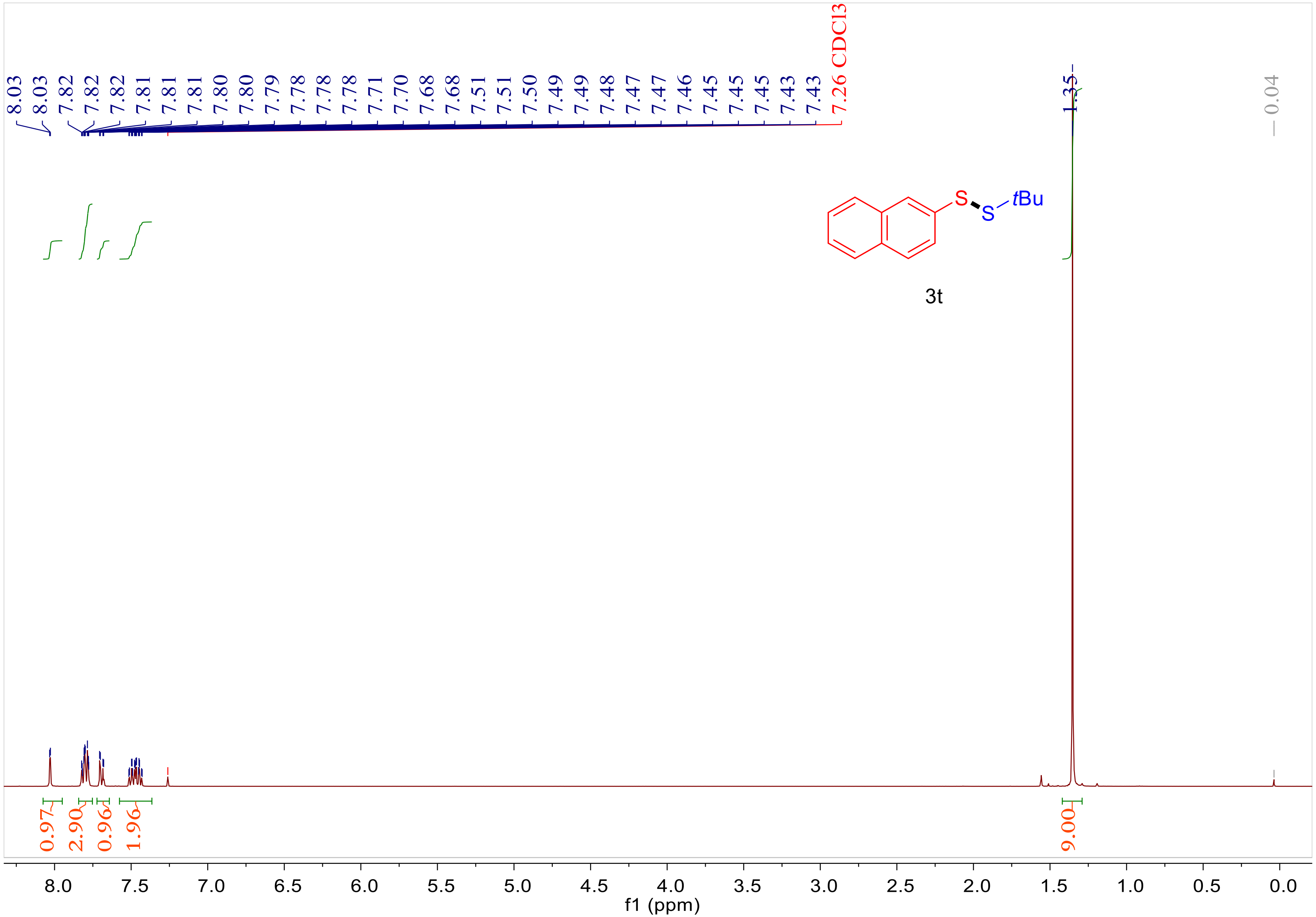
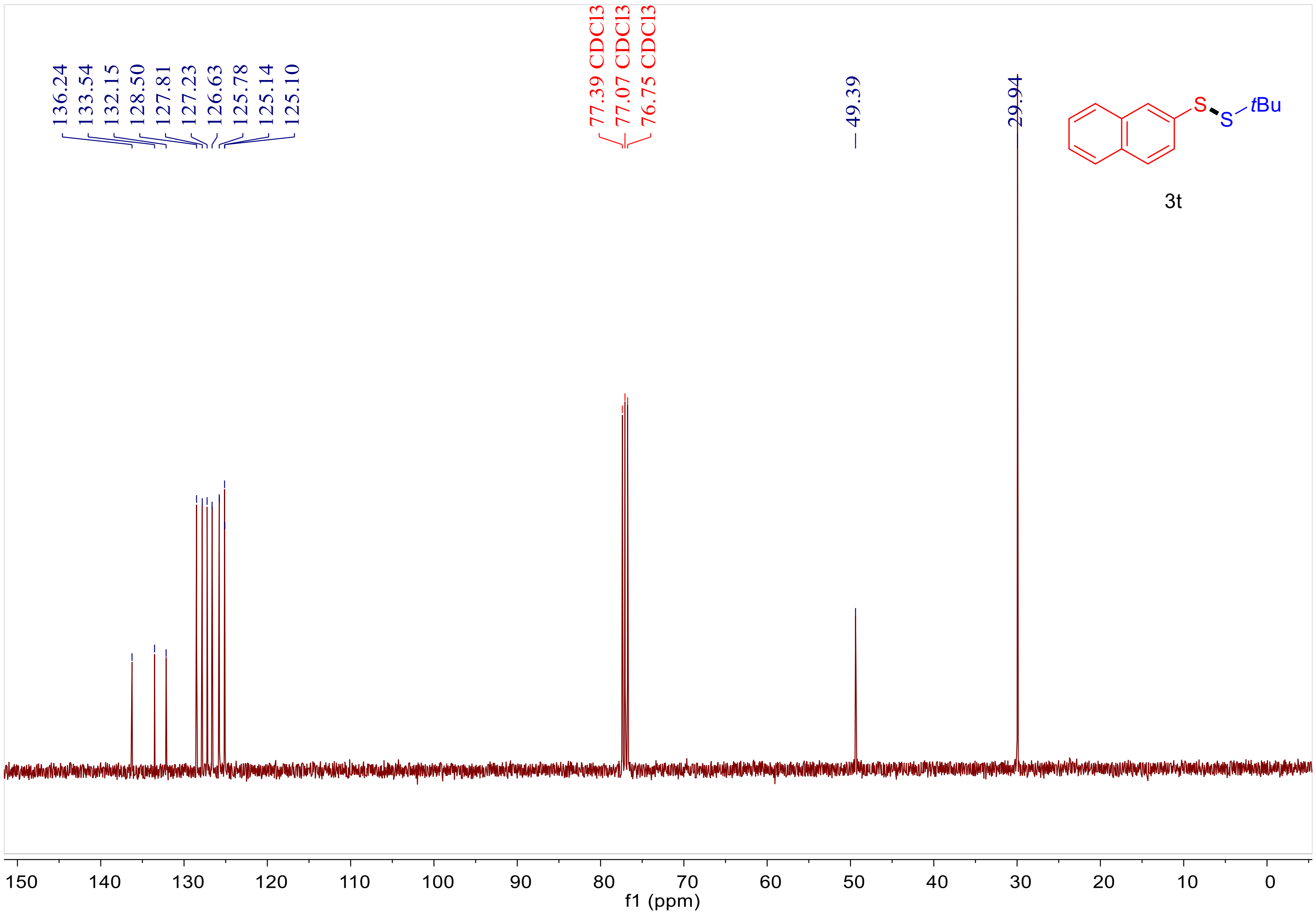
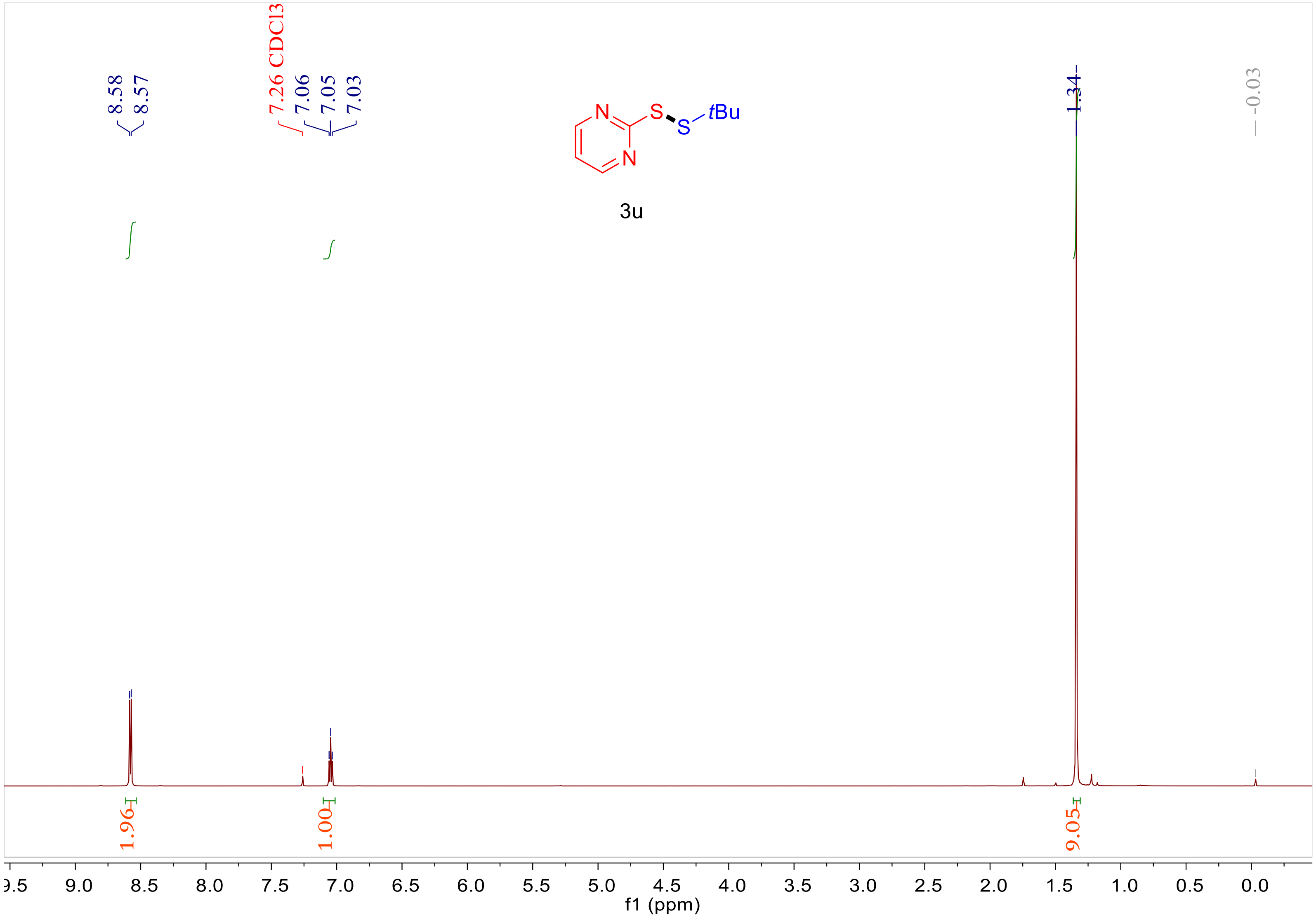
136.19
132.88
129.80
124.23
123.11
77.36 CDCl3
77.04 CDCl3
76.72 CDCl3
48.94
34.82
31.39
30.01
19.23
t-Bu
S
S
tBu
3s
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


8.03
8.03
7.82
7.82
7.82
7.81
7.81
7.81
7.80
7.80
7.79
7.78
7.78
7.78
7.71
7.70
7.68
7.68
7.51
7.51
7.50
7.49
7.49
7.48
7.47
7.47
7.46
7.45
7.45
7.45
7.43
7.43
7.26 CDCl3
1.35
0.04
S
S
tBu
3t
0.97
2.90
0.96
1.96
9.00
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)



136.24
133.54
132.15
128.50
127.81
127.23
126.63
125.78
125.14
125.10
77.39 CDCl3
77.07 CDCl3
76.75 CDCl3
49.39
29.94
S
S
tBu
3t
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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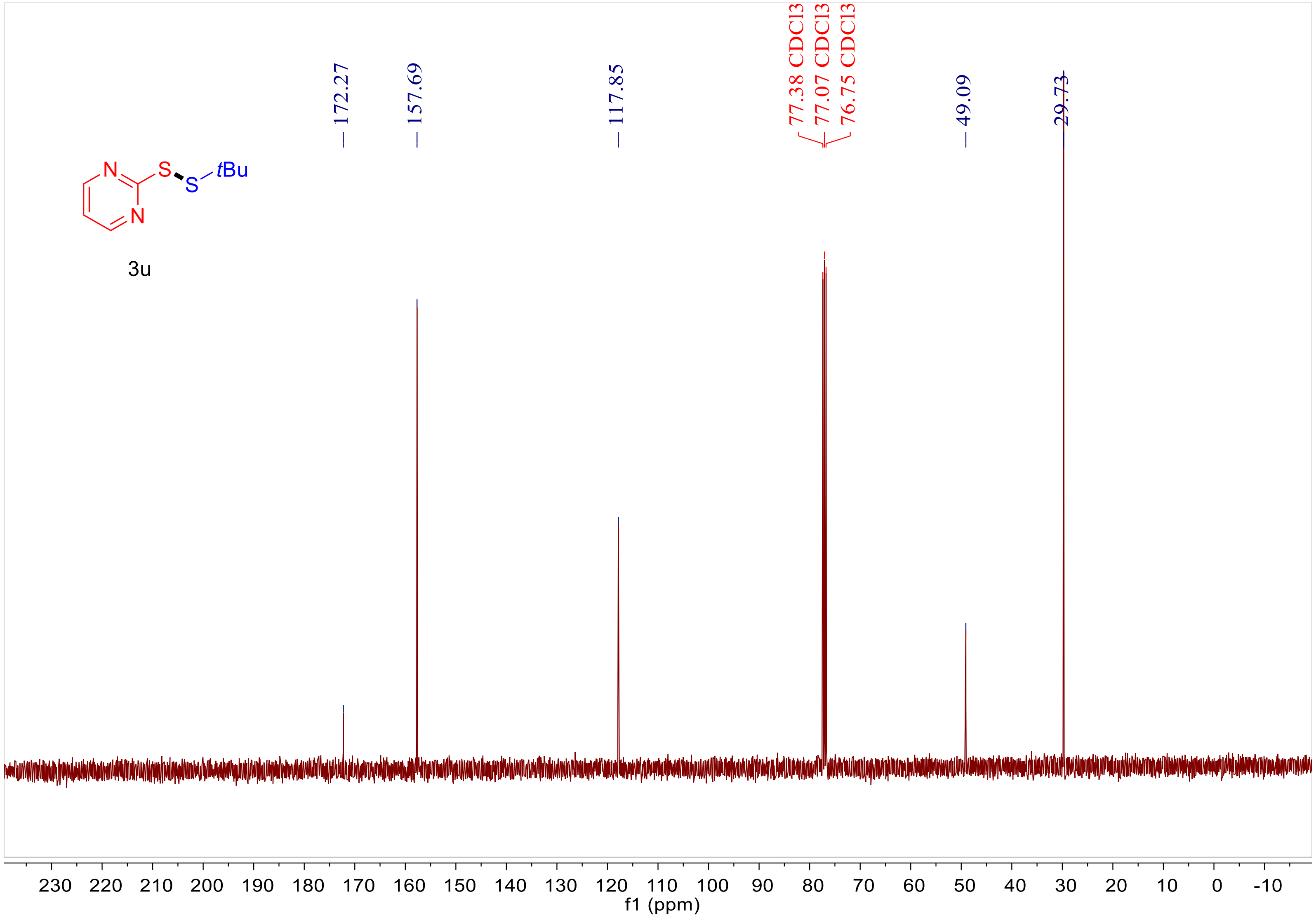
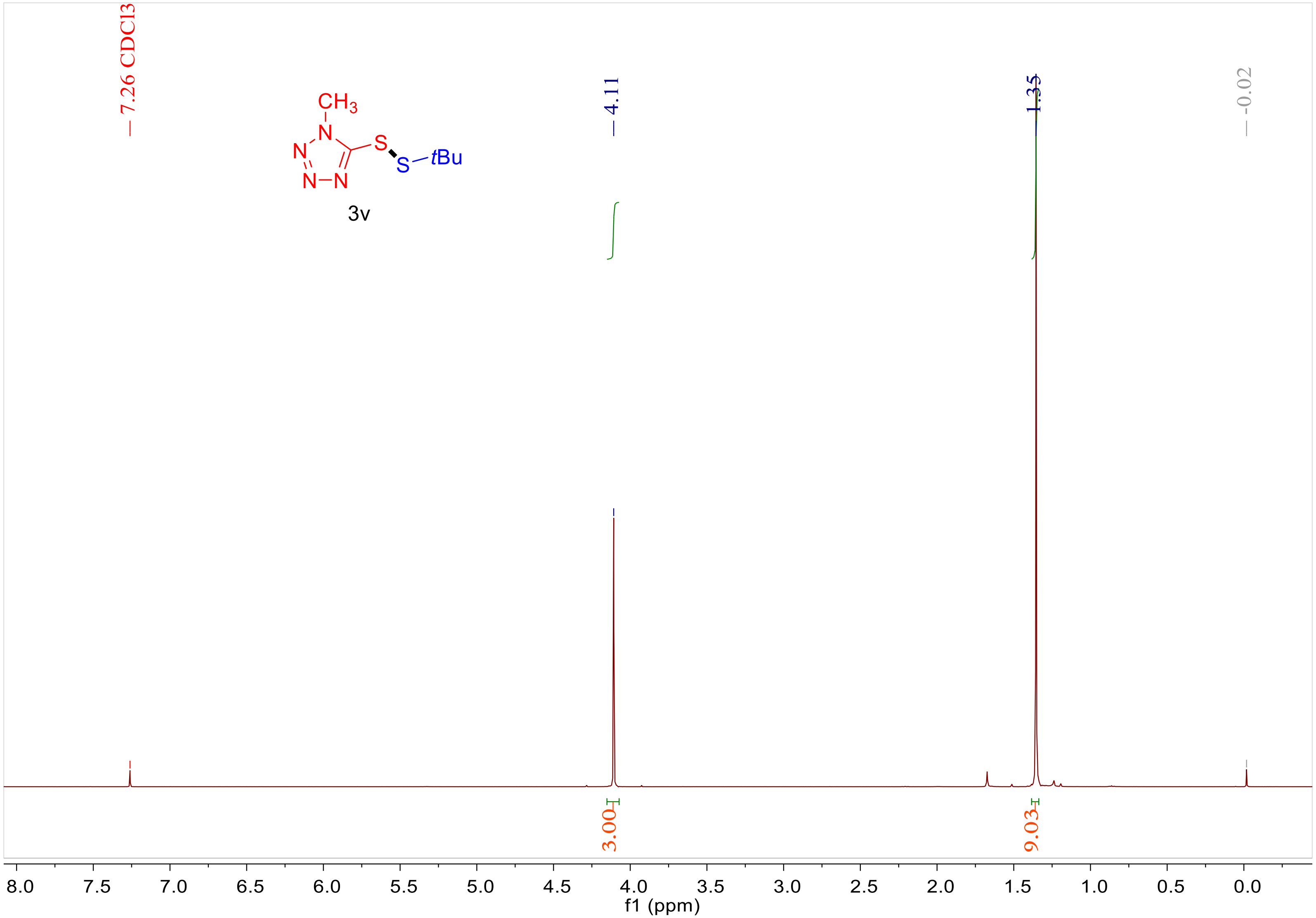
8.57
7.26 CDCl3
7.06
7.05
7.03
N
S
S
tBu
N
3u
1.34
-0.03
1.96
1.00
9.05
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)



N
S
S
tBu
N
3u
172.27
157.69
117.85
77.38 CDCl3
77.07 CDCl3
76.75 CDCl3
49.09
29.73
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.26 CDCl3
4.11
1.35
-0.02
CH3
N
N
N
N
S
S
tBu
3v
3.00
9.03
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
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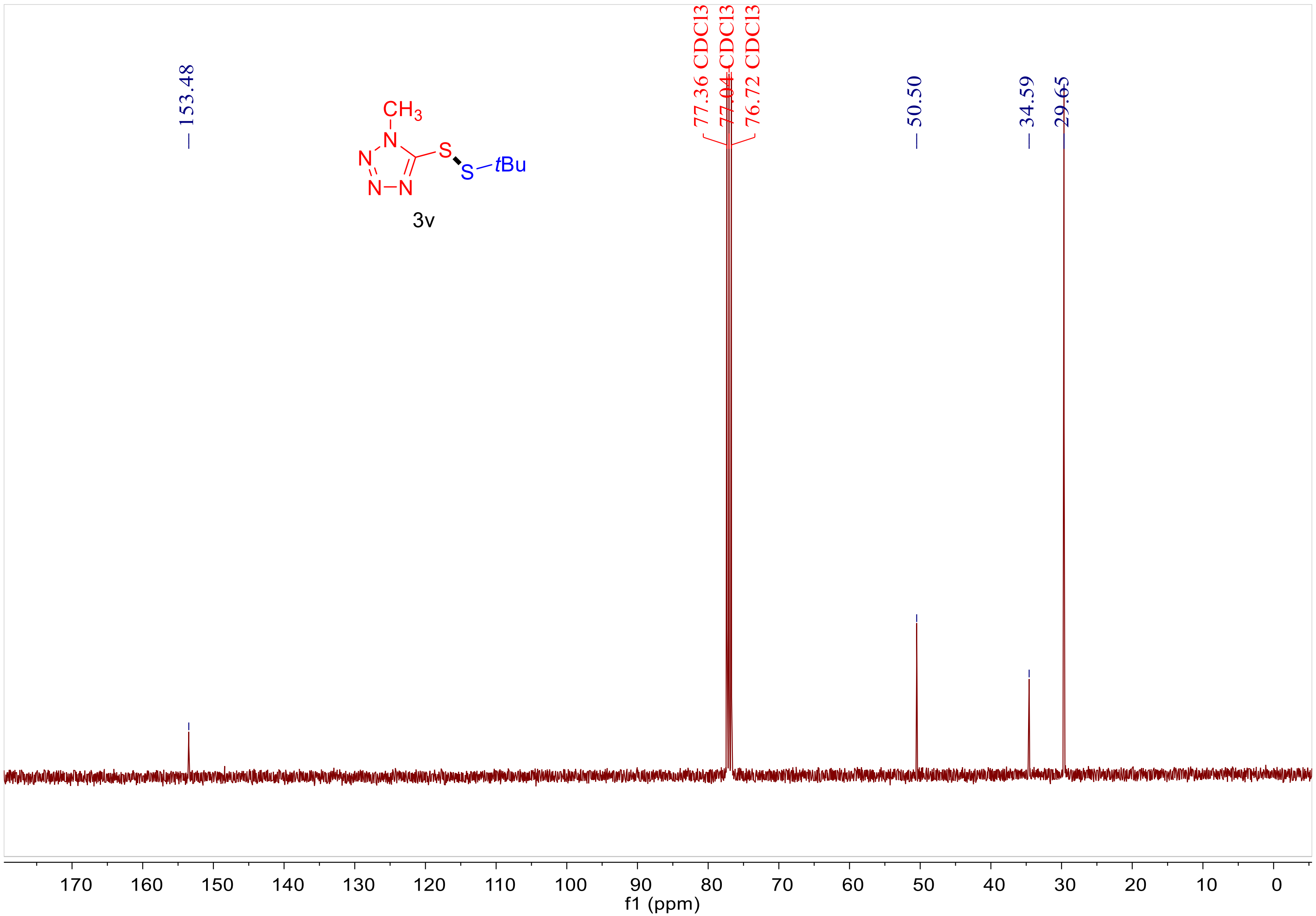
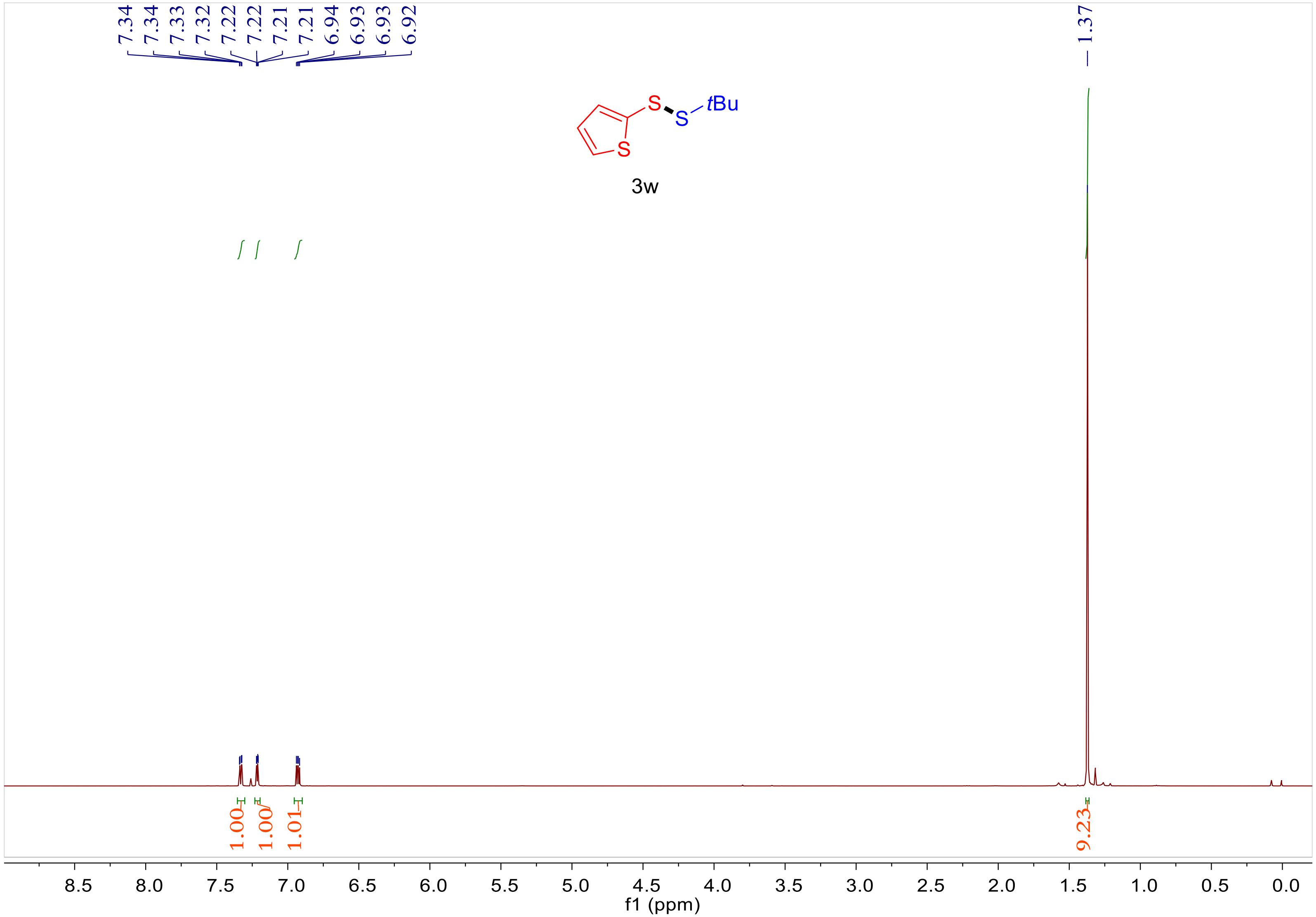
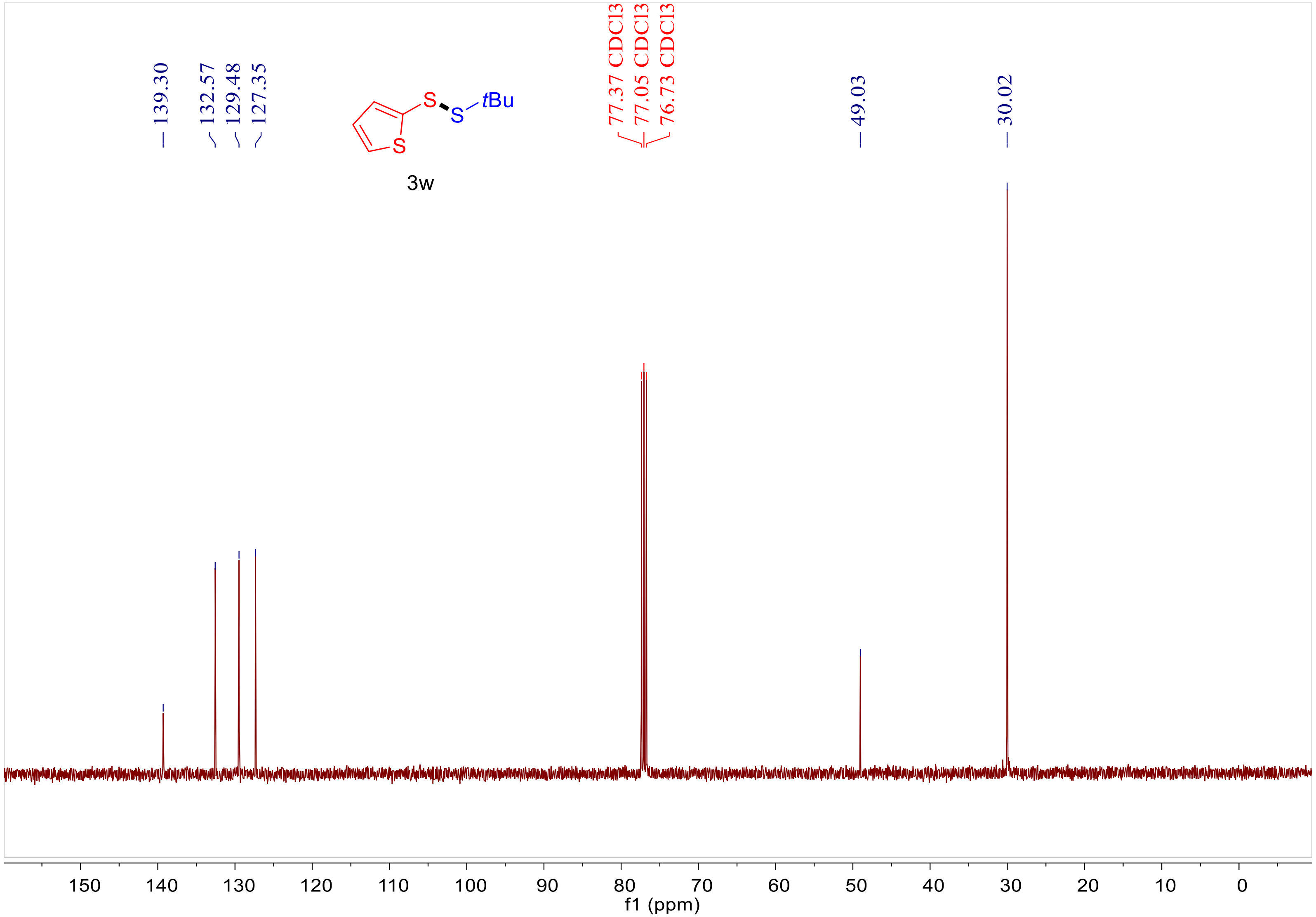
0.0
f1 (ppm)

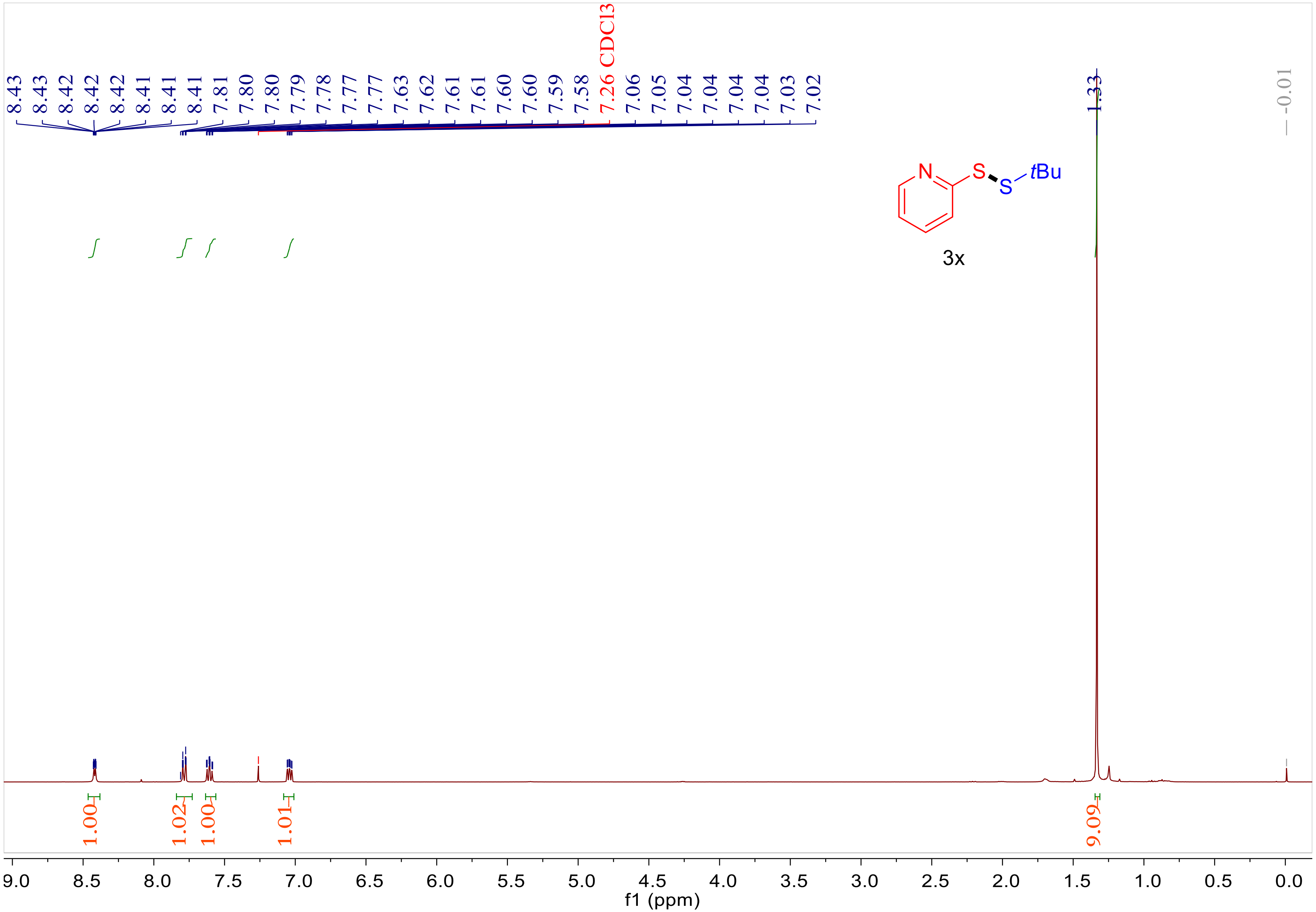

153.48
CH3
N
N
N
N
S
S
tBu
3v
77.36 CDCl3
77.04 CDCl3
76.72 CDCl3
50.50
34.59
29.65
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

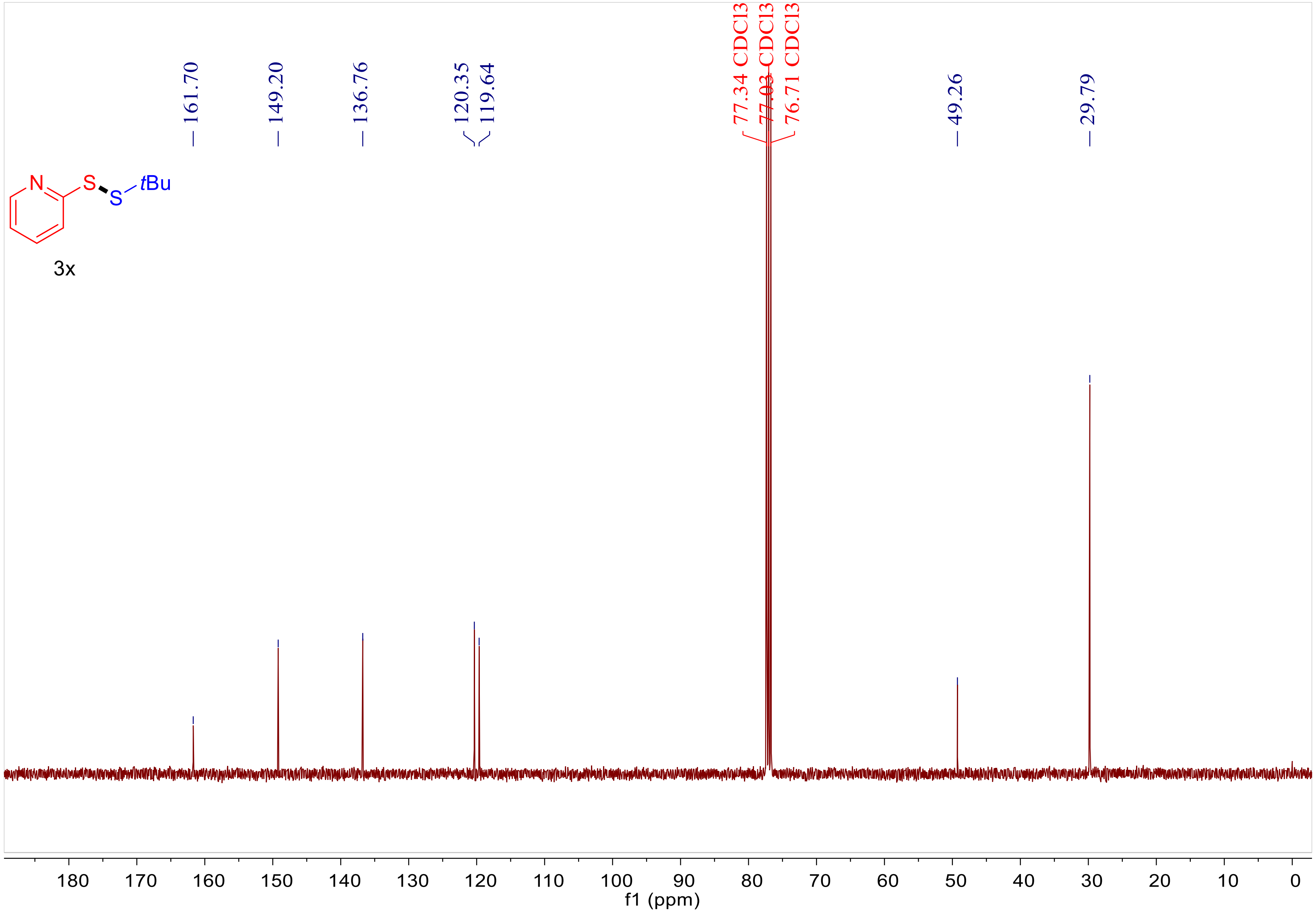


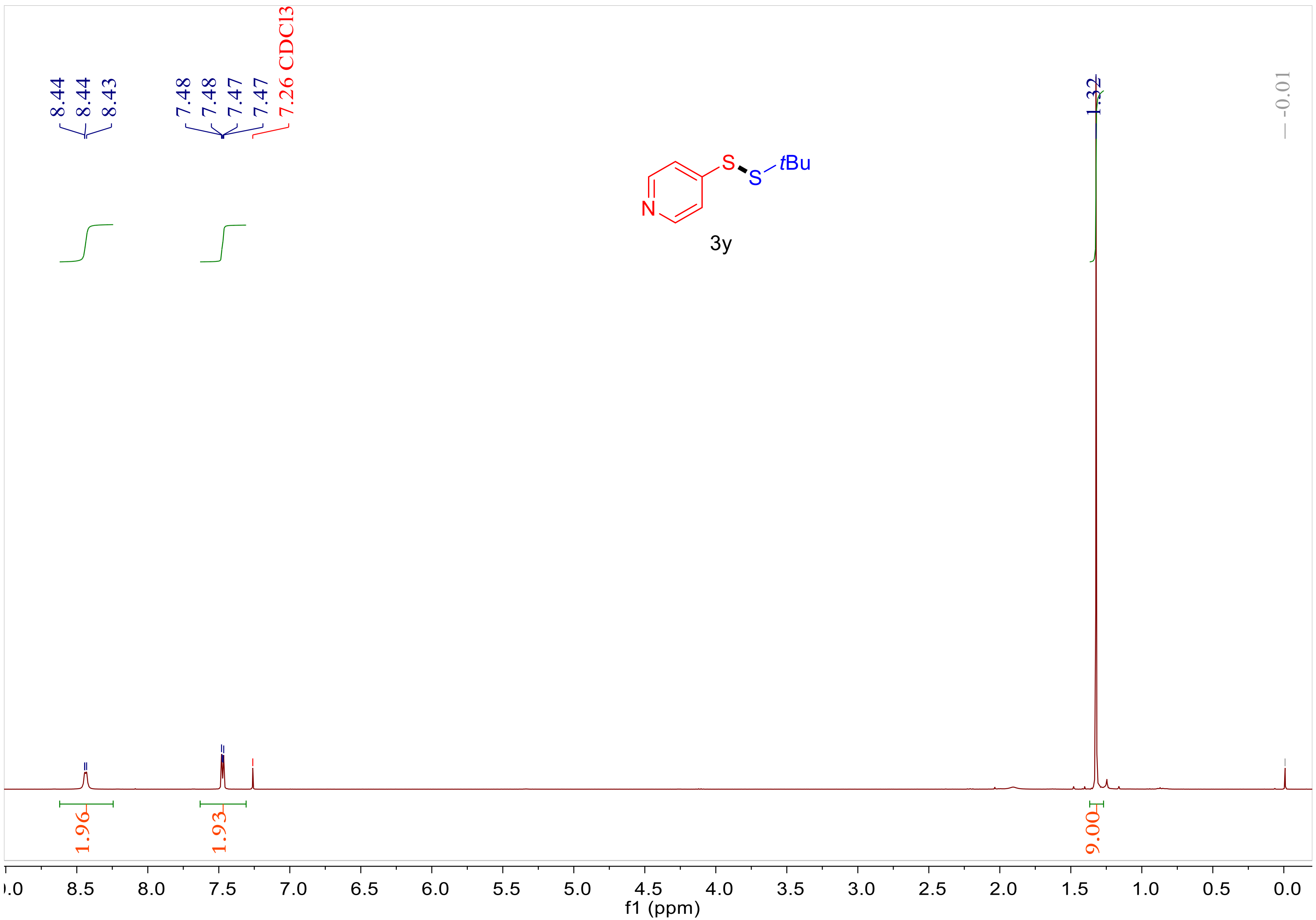
7.34
7.34
7.33
7.32
7.22
7.22
7.21
7.21
6.94
6.93
6.93
6.92
1.37
S
S
tBu
S
3w
1.00
1.00
1.01
9.23
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

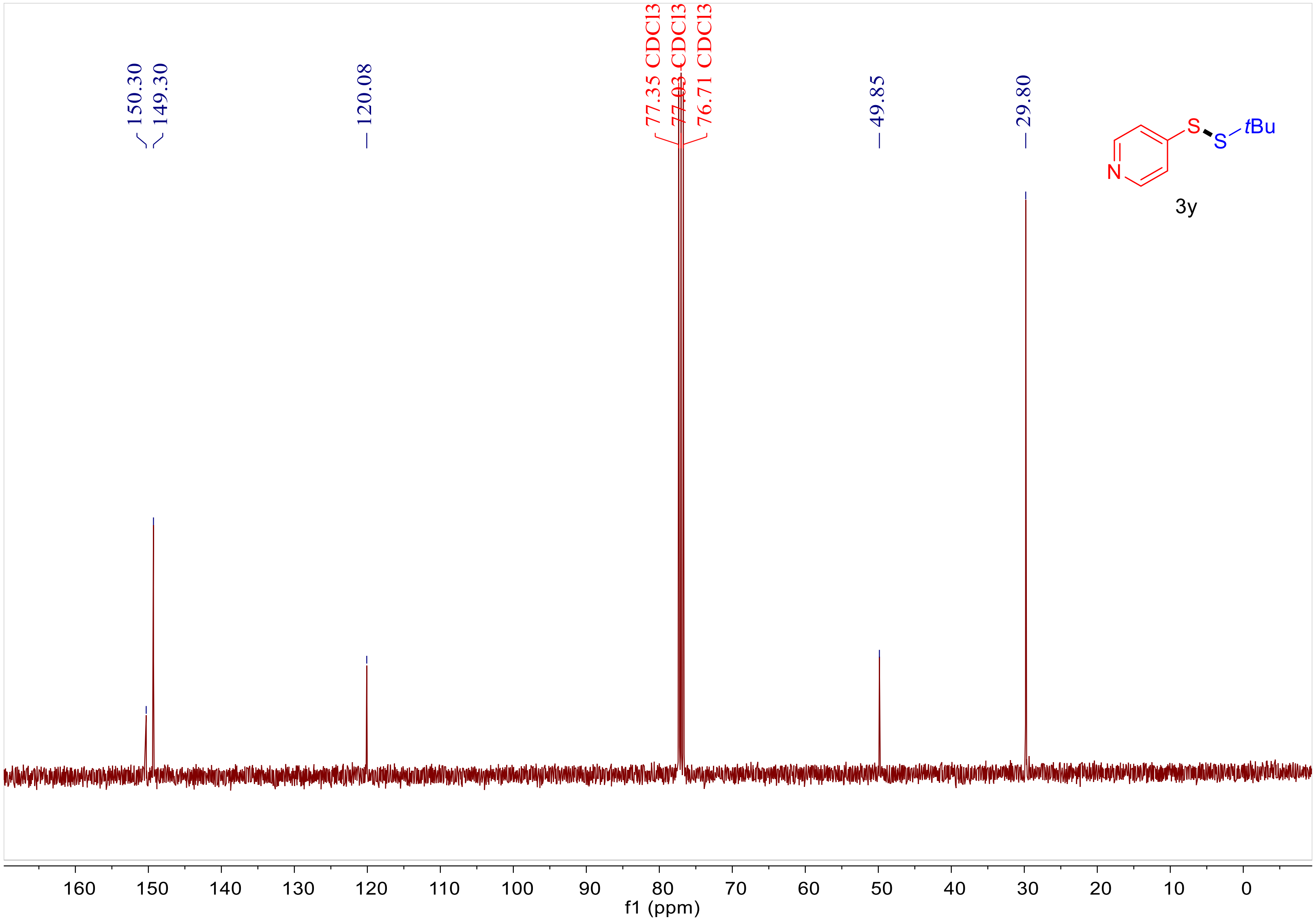


139.30
132.57
129.48
127.35
77.37 CDCl3
77.05 CDCl3
76.73 CDCl3
49.03
30.02
S
S
S
tBu
3w
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

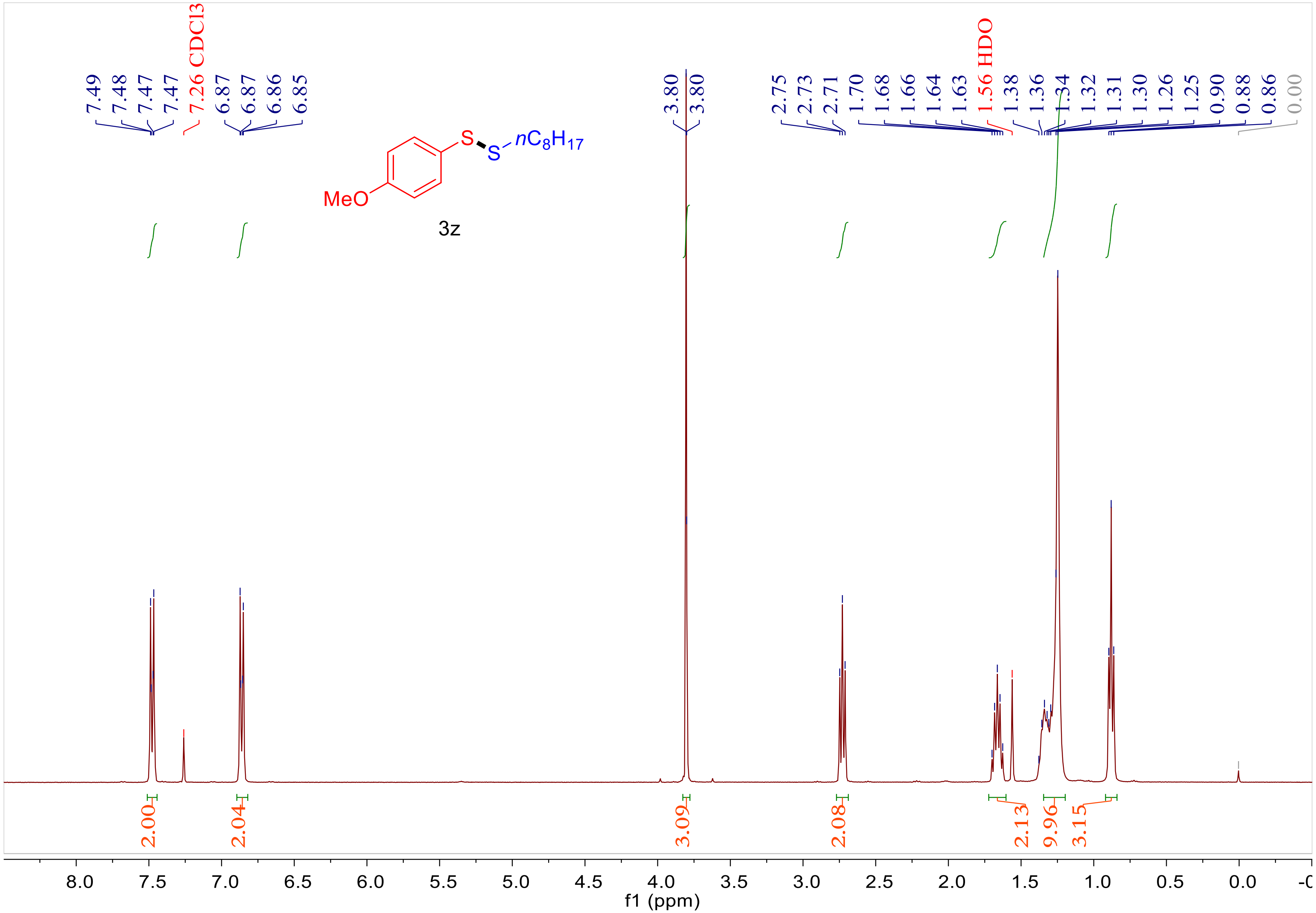

8.43 8.43 8.42 8.42 8.42 8.41 8.41 8.41 7.81 7.80 7.80 7.79 7.78 7.77 7.77 7.63 7.62 7.61 7.61 7.60 7.60 7.59 7.58 7.26 CDCl3 7.06 7.05 7.04 7.04 7.04 7.04 7.03 7.02
1.33
-0.01
N
S
S
tBu
3x
1.00
1.02
1.00
1.01
9.09
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

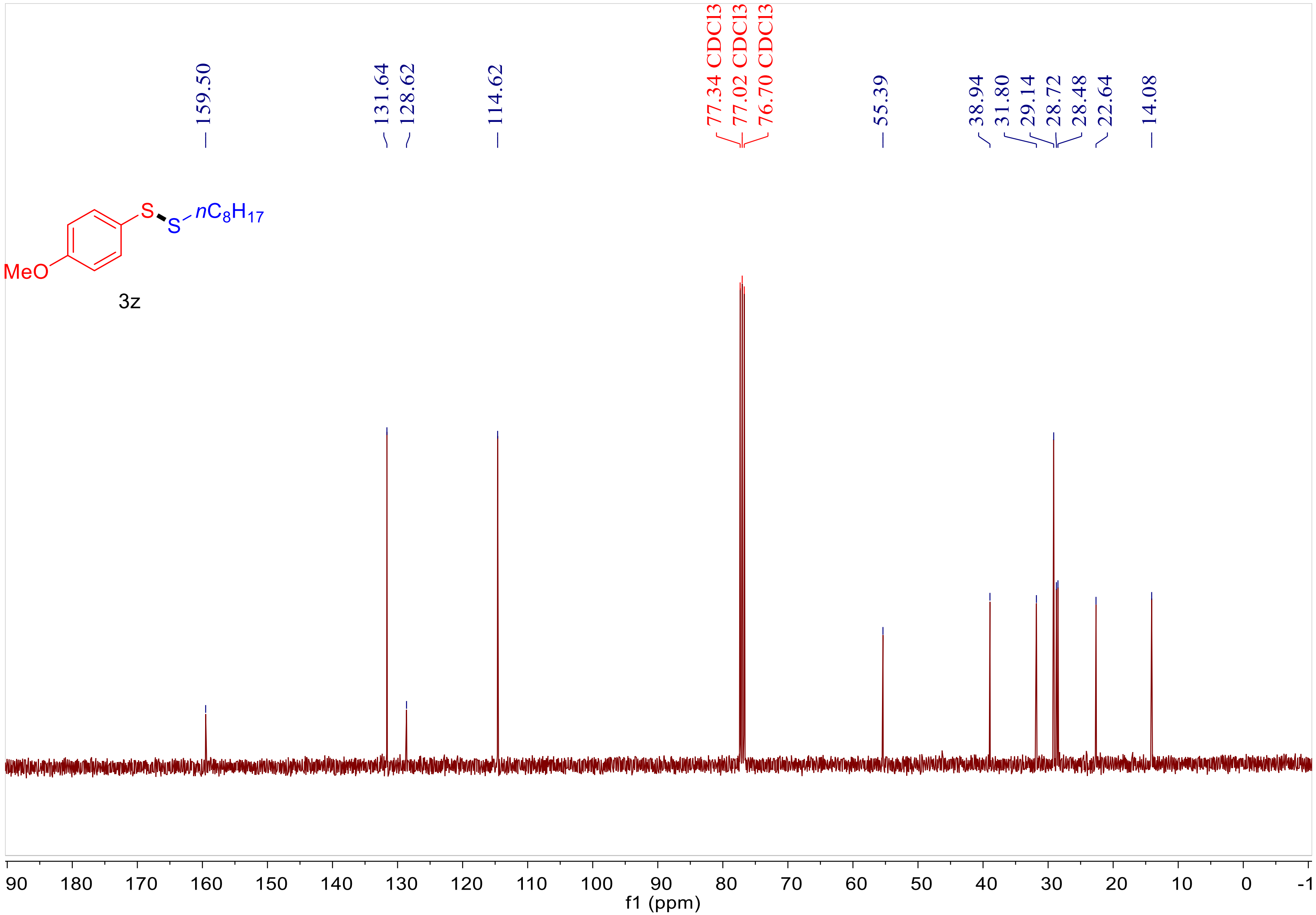

N
S
S
tBu
3x
161.70
149.20
136.76
120.35
119.64
77.34 CDCl3
77.03 CDCl3
76.71 CDCl3
49.26
29.79
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

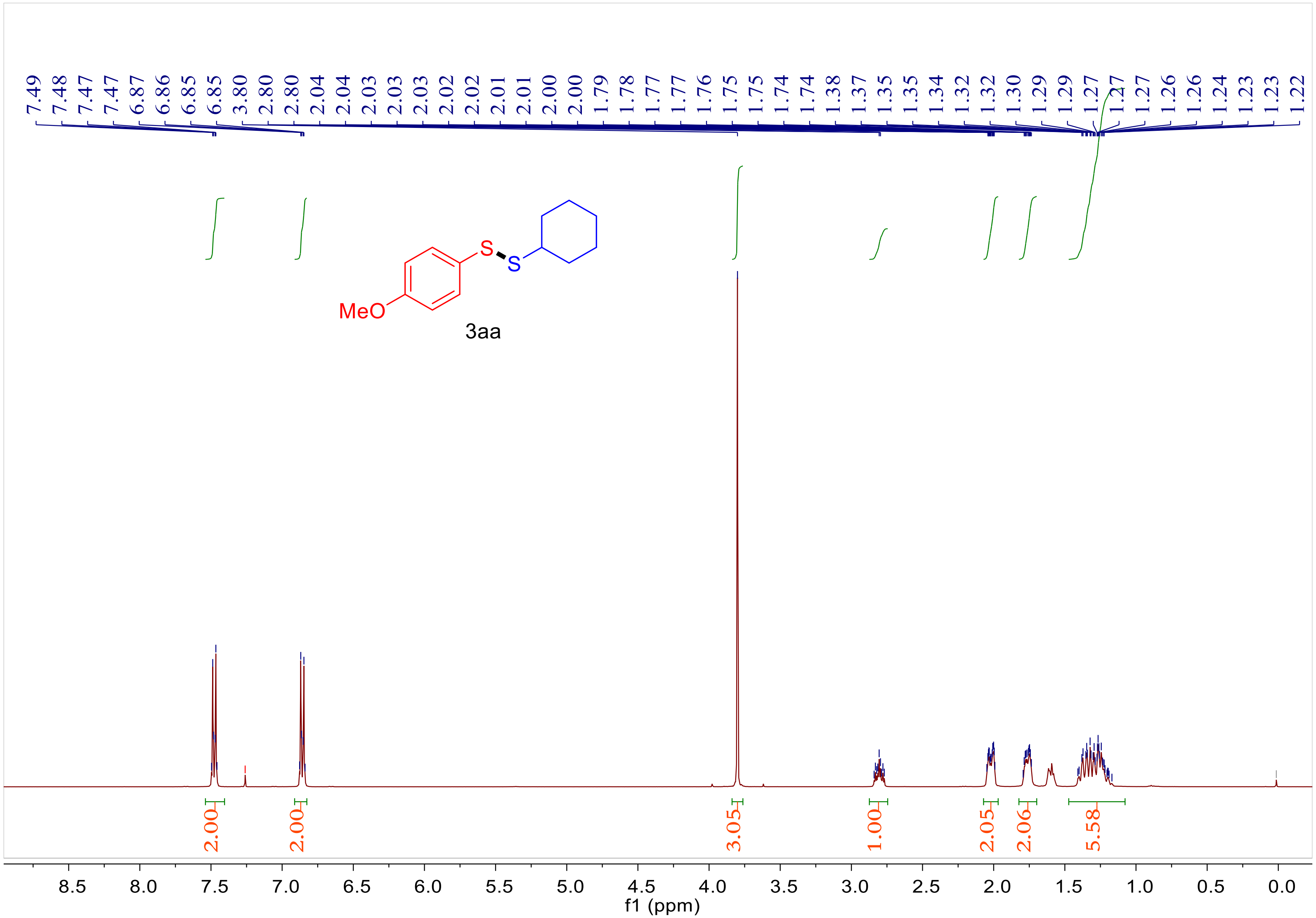

8.44
8.44
8.43
7.48
7.48
7.47
7.47
7.26 CDCl3
1.32
-0.01
S
S
tBu
N
3y
1.96
1.93
9.00
f1 (ppm)

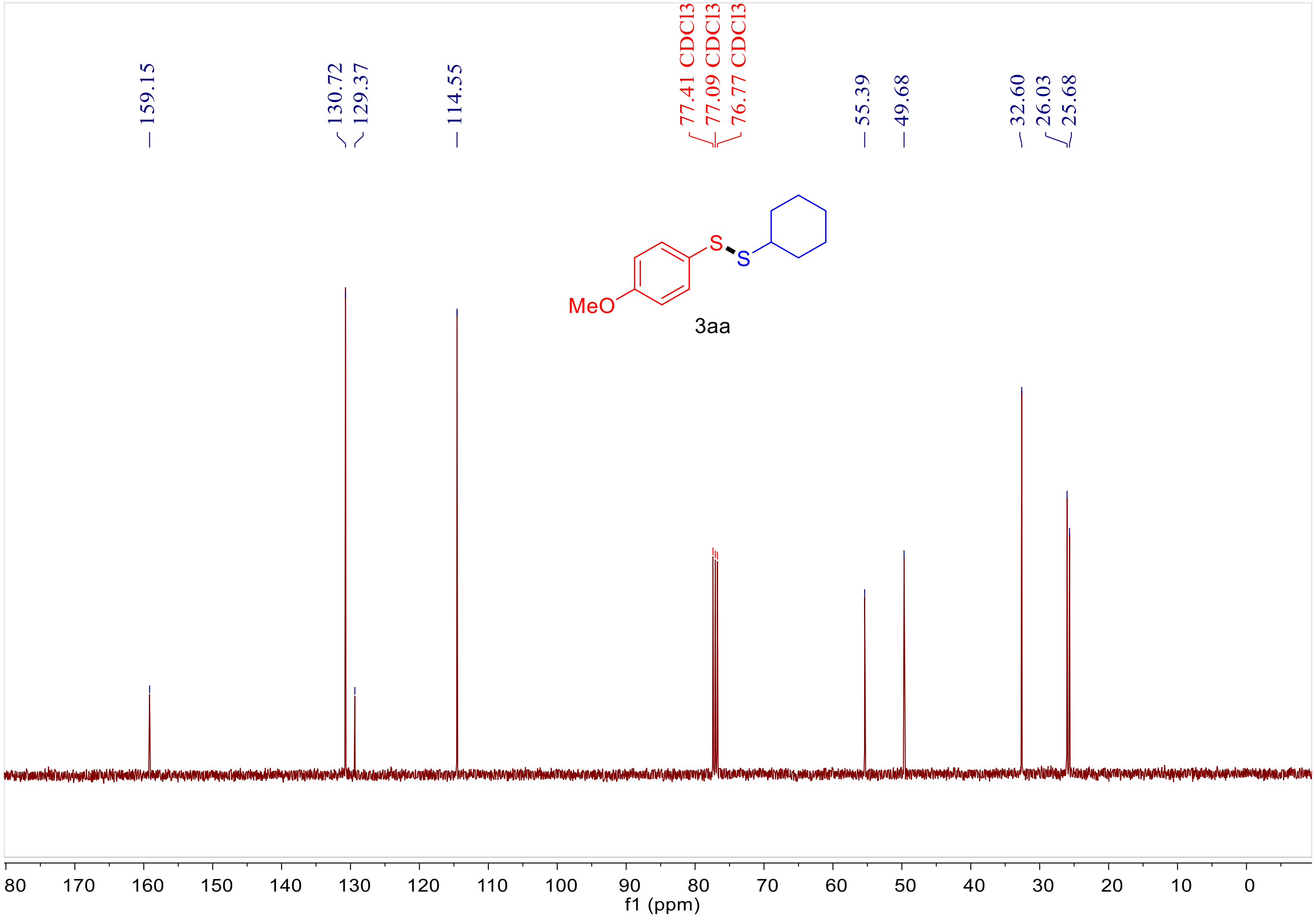


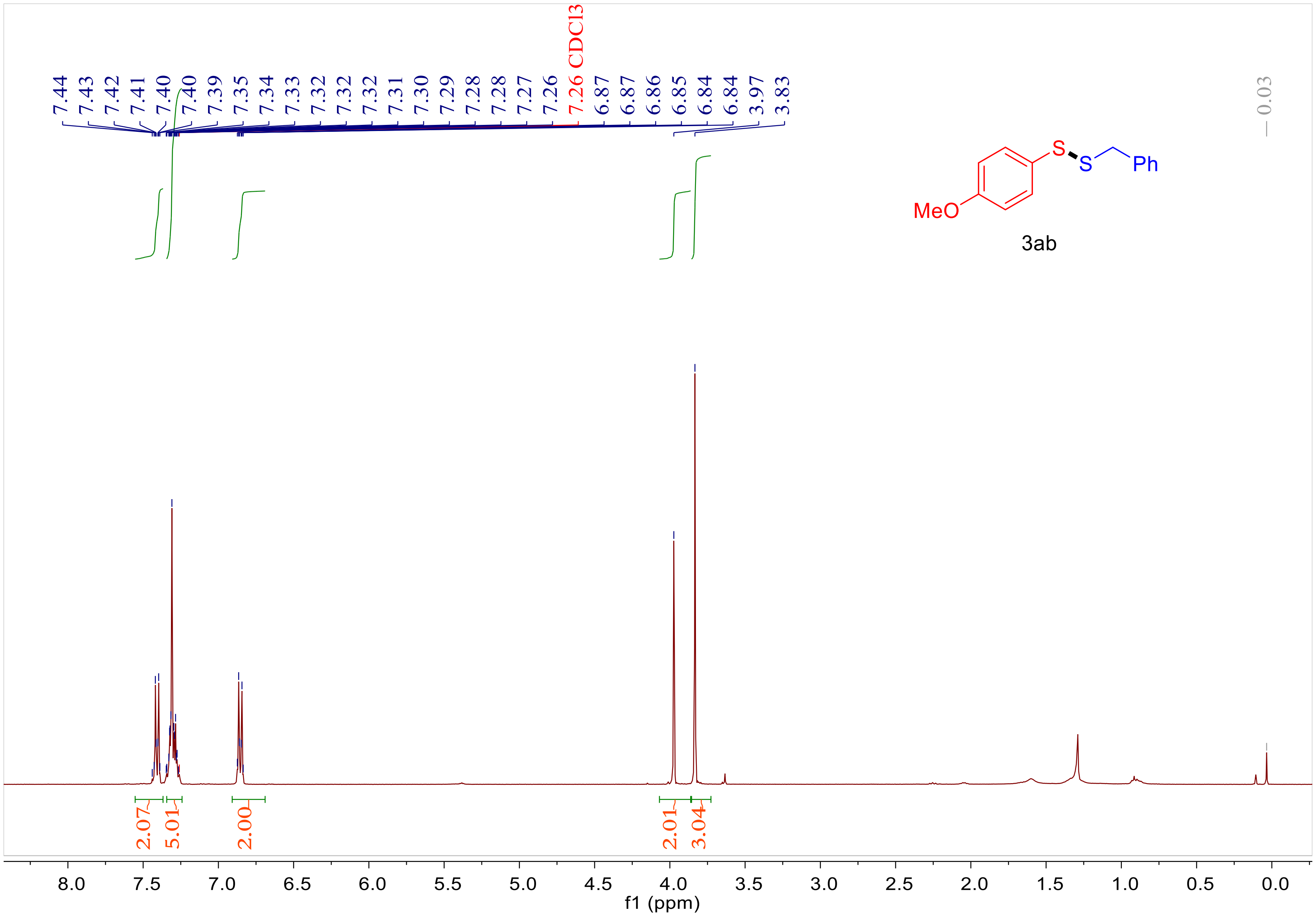
150.30
149.30
120.08
77.35 CDCl3
77.03 CDCl3
76.71 CDCl3
49.85
29.80
S
S
tBu
N
3y
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

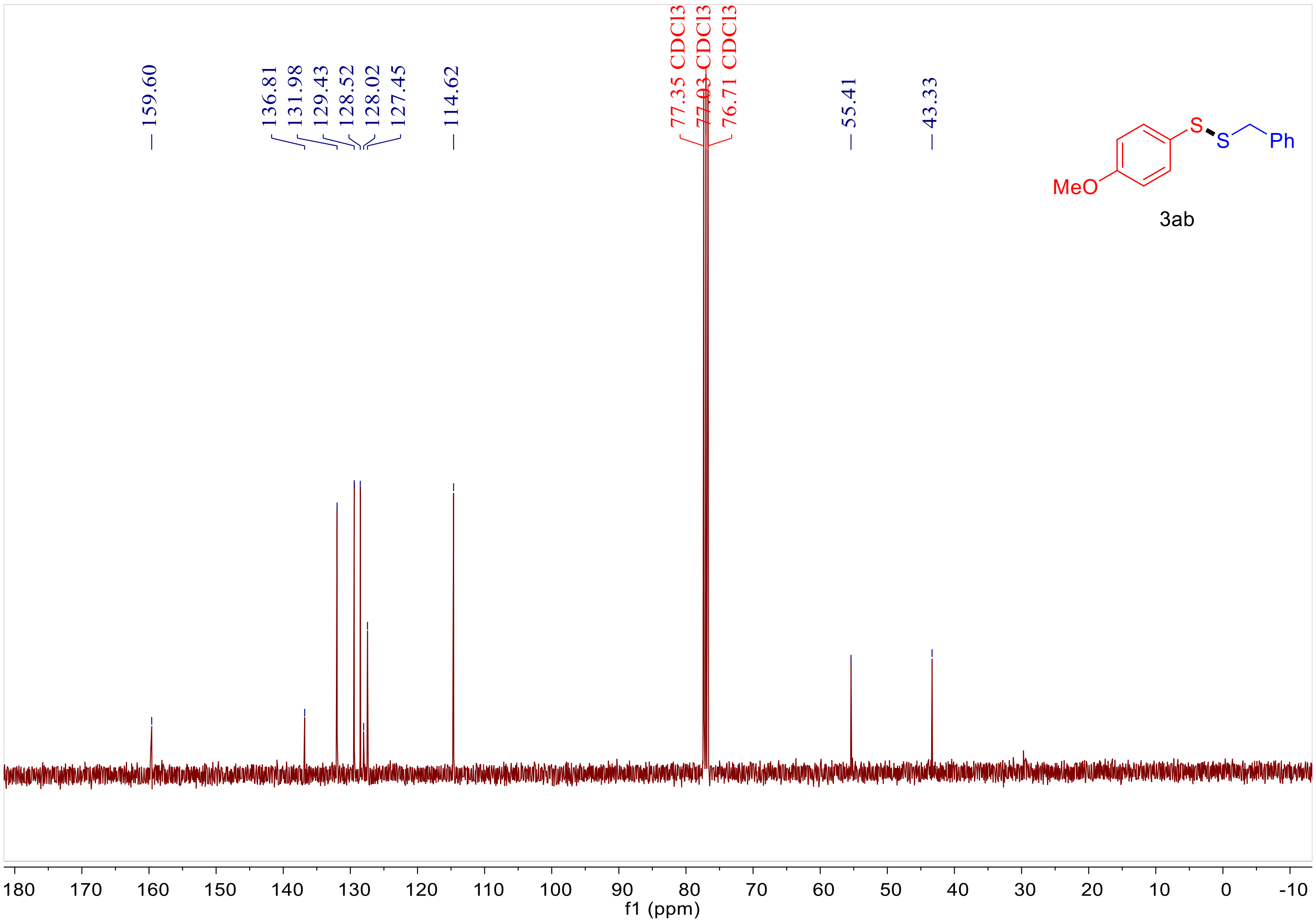

7.49
7.48
7.47
7.47
7.26 CDCl3
6.87
6.87
6.86
6.85
3.80
3.80
2.75
2.73
2.71
1.70
1.68
1.66
1.64
1.63
1.56 HDO
1.38
1.36
1.34
1.32
1.31
1.30
1.26
1.25
0.90
0.88
0.86
0.00
MeO
S
S
nC8H17
3z
2.00
2.04
3.09
2.08
2.13
9.96
3.15
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


159.50
131.64
128.62
114.62
77.34 CDCl3
77.02 CDCl3
76.70 CDCl3
55.39
38.94
31.80
29.14
28.72
28.48
22.64
14.08
MeO
S
S
nC8H17
3z
f1 (ppm)


7.49 7.48 7.47 7.47 6.87 6.86 6.85 6.85 3.80 2.80 2.80 2.04 2.04 2.03 2.03 2.03 2.02 2.02 2.01 2.01 2.00 2.00 1.79 1.78 1.77 1.77 1.76 1.75 1.75 1.74 1.74 1.38 1.37 1.35 1.35 1.34 1.32 1.32 1.30 1.29 1.29 1.27 1.27 1.27 1.26 1.26 1.24 1.23 1.23 1.22
MeO
S
S
3aa
2.00
2.00
3.05
1.00
2.05
2.06
5.58
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)

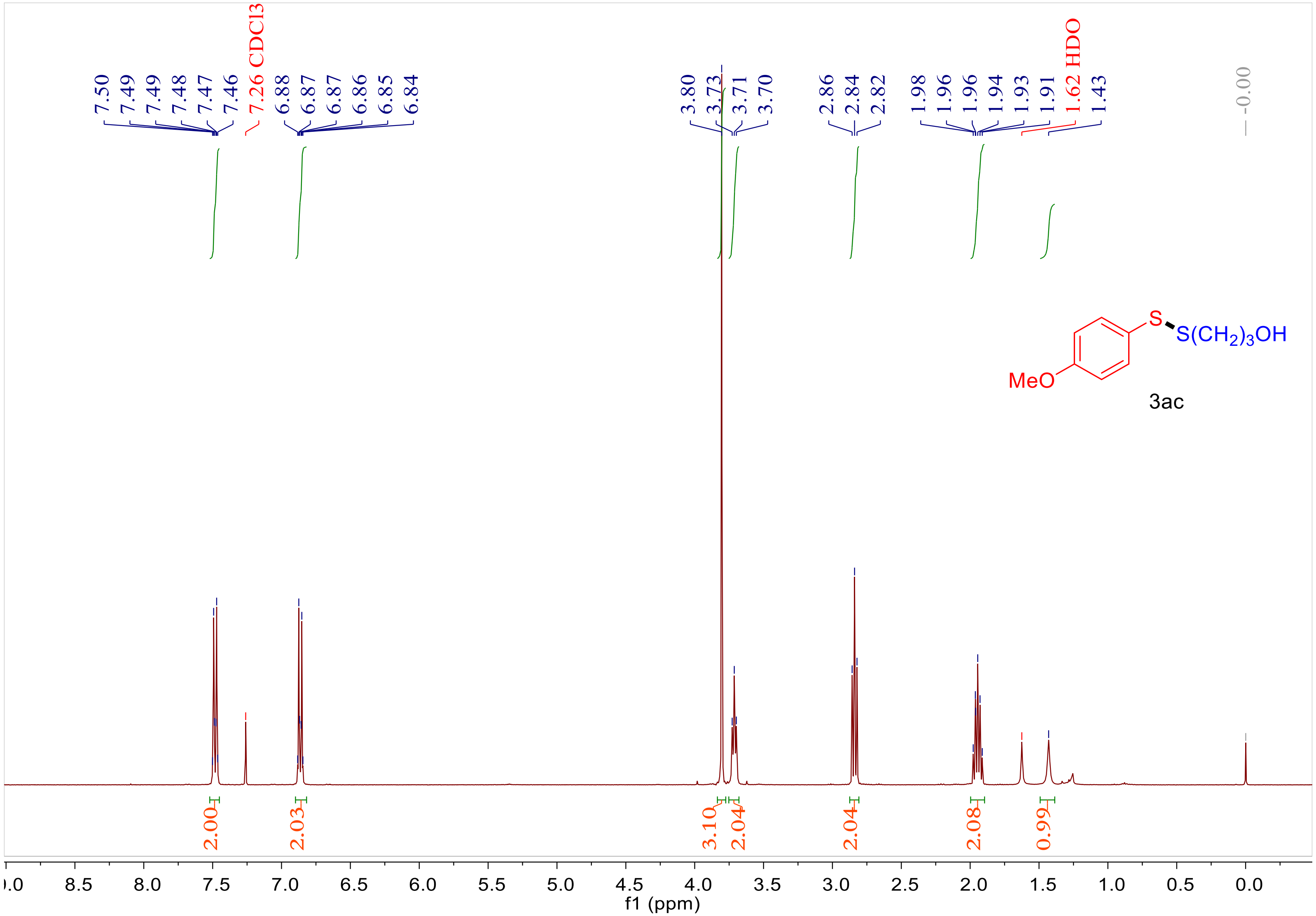

159.15
130.72
129.37
114.55
77.41 CDCl3
77.09 CDCl3
76.77 CDCl3
55.39
49.68
32.60
26.03
25.68
MeO
S
S
3aa
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.44
7.43
7.42
7.41
7.40
7.40
7.39
7.35
7.34
7.33
7.32
7.32
7.32
7.31
7.30
7.29
7.28
7.28
7.27
7.26
7.26 CDCl3
6.87
6.87
6.86
6.85
6.84
6.84
3.97
3.83
0.03
MeO
S
S
Ph
3ab
2.07
5.01
2.00
2.01
3.04
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)

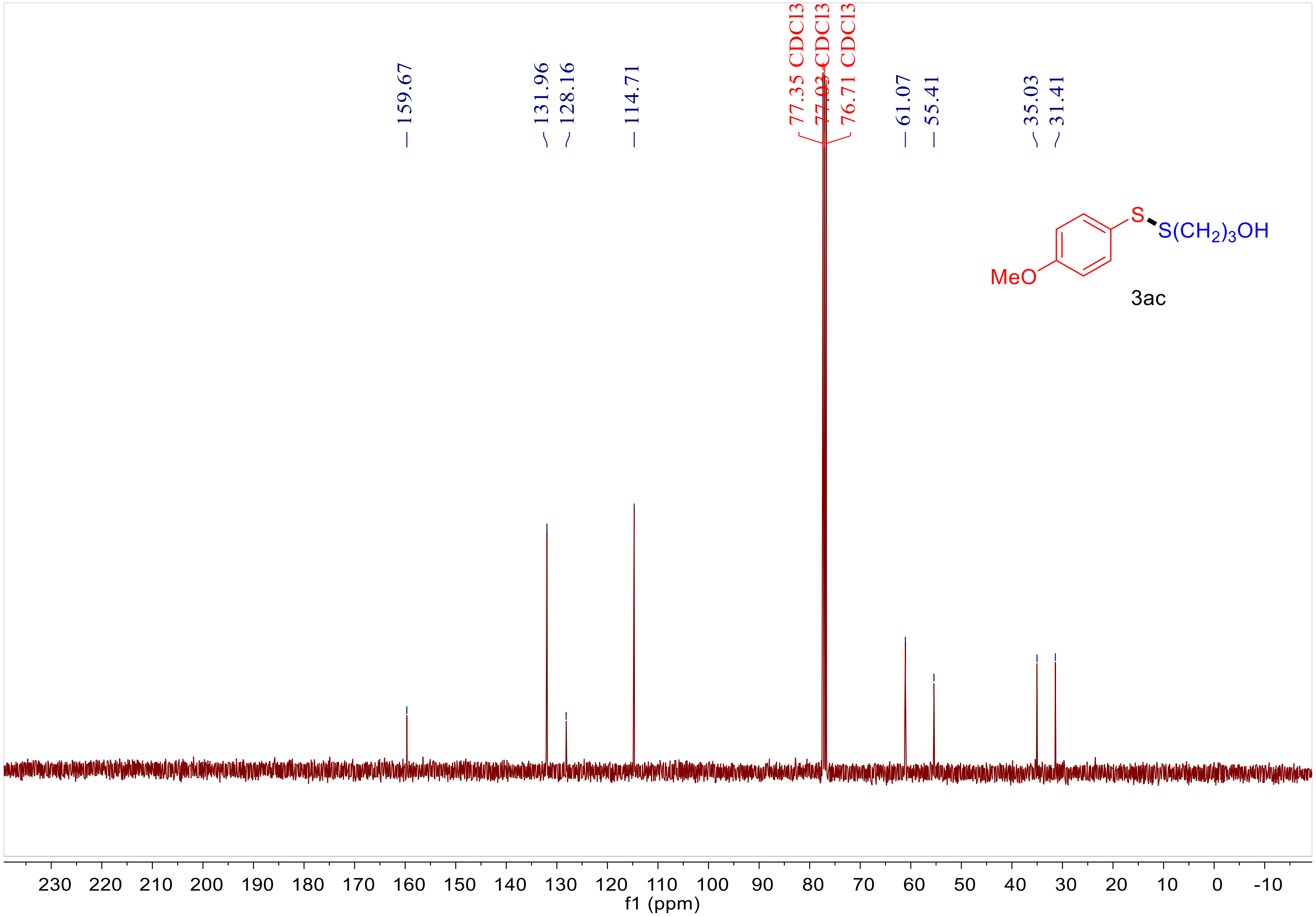


159.60
136.81
131.98
129.43
128.52
128.02
127.45
114.62
77.35 CDCl3
77.03 CDCl3
76.71 CDCl3
55.41
43.33
MeO
S
S
Ph
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

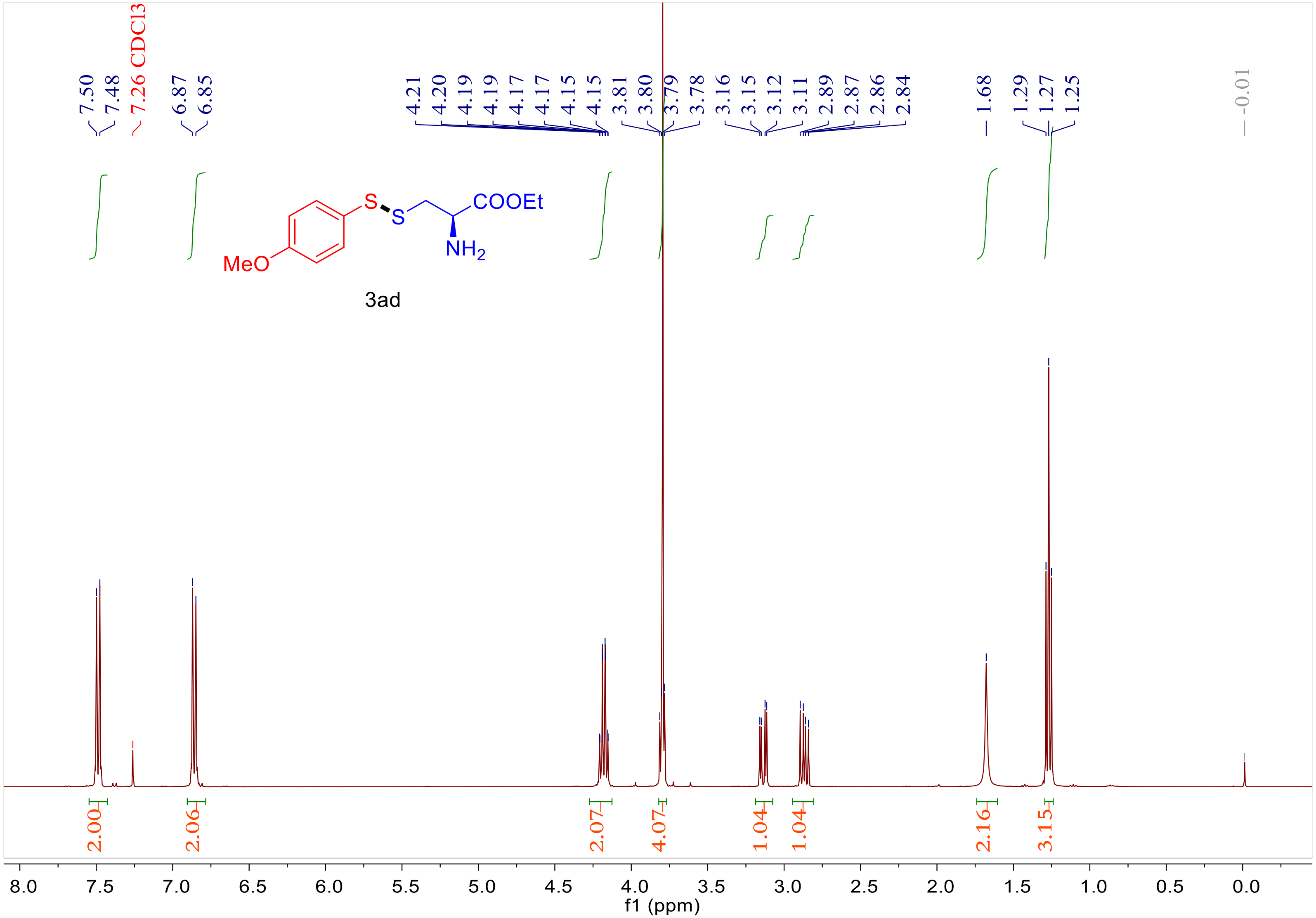
3ab



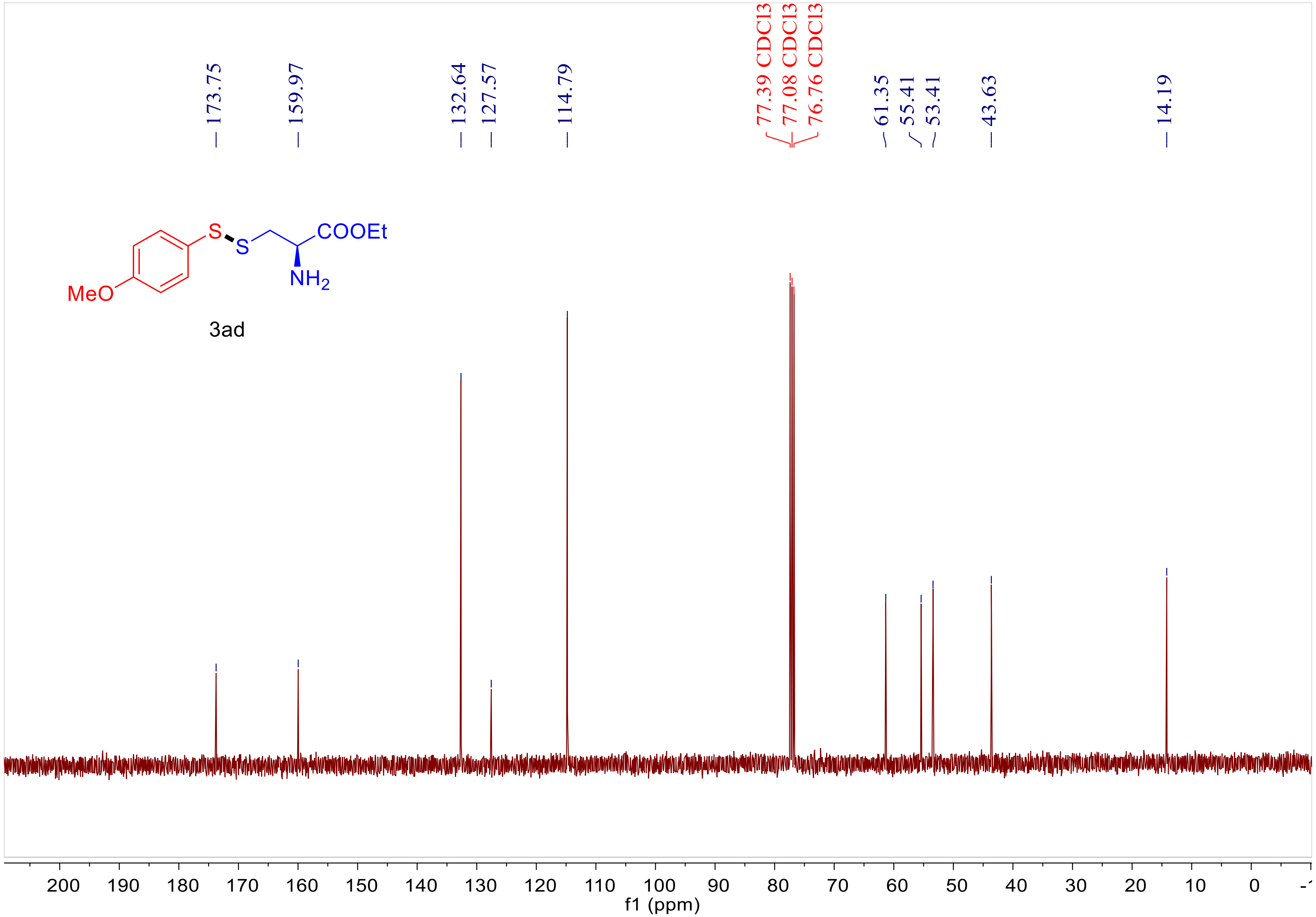
7.50
7.49
7.49
7.48
7.47
7.46
7.26 CDCl3
6.88
6.87
6.87
6.86
6.85
6.84
3.80
3.73
3.71
3.70
2.86
2.84
2.82
1.98
1.96
1.96
1.94
1.93
1.91
1.62 HDO
1.43
-0.00
S
S(CH2)3OH
MeO
3ac
2.00
2.03
3.10
2.04
2.04
2.08
0.99
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

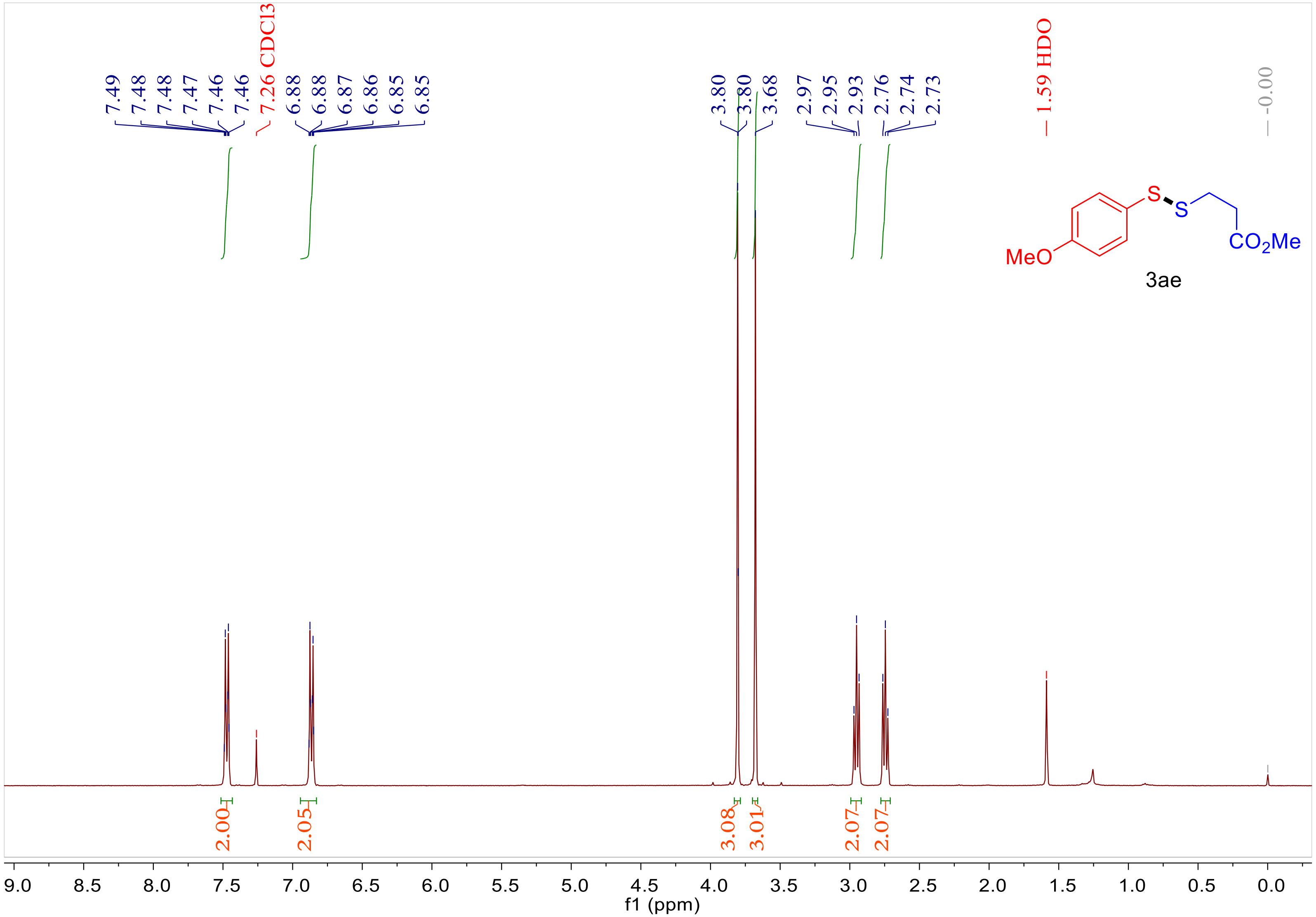


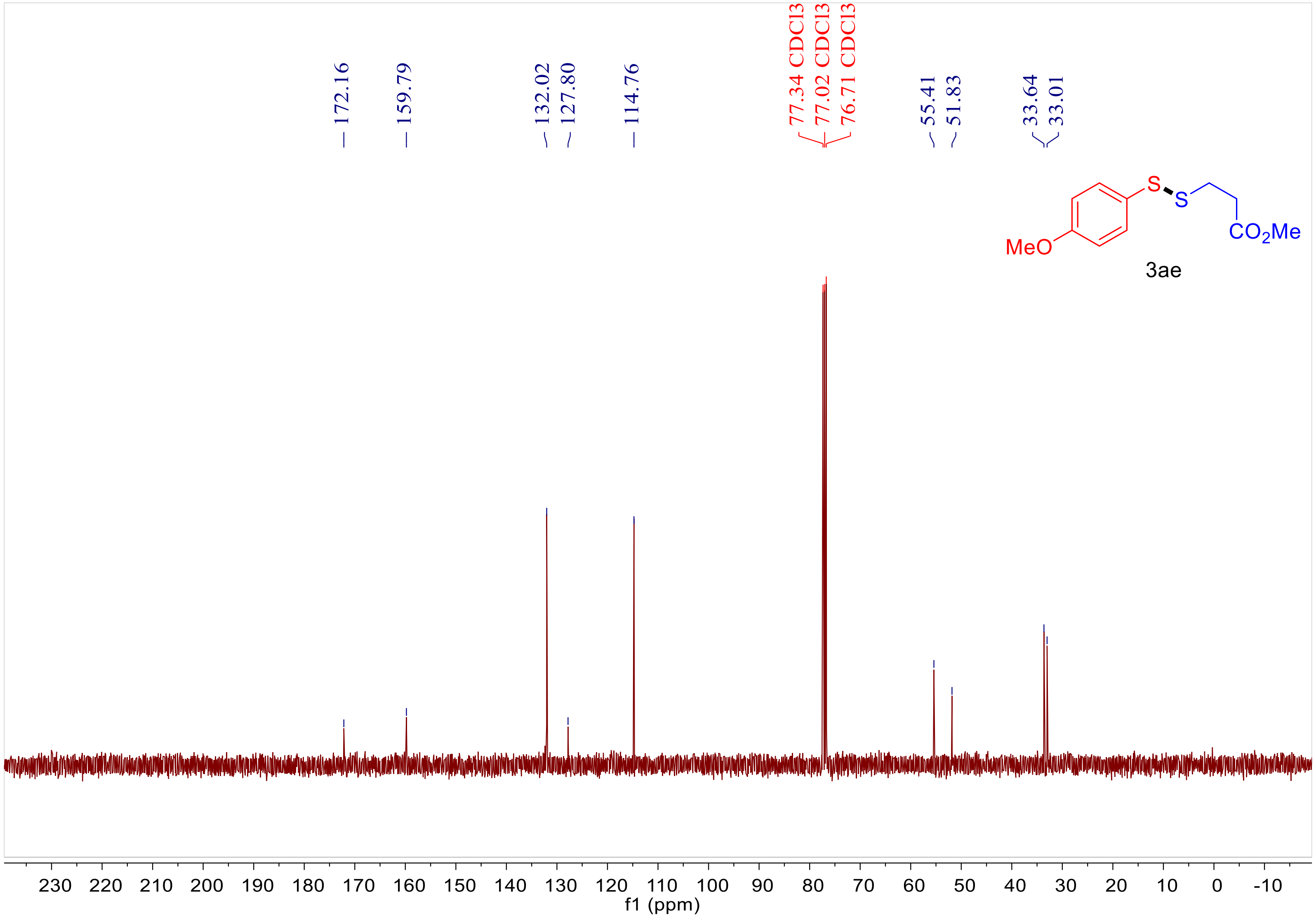
159.67
131.96
128.16
114.71
77.35 CDCl3
77.03 CDCl3
76.71 CDCl3
61.07
55.41
35.03
31.41
S
S(CH2)3OH
MeO
3ac
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



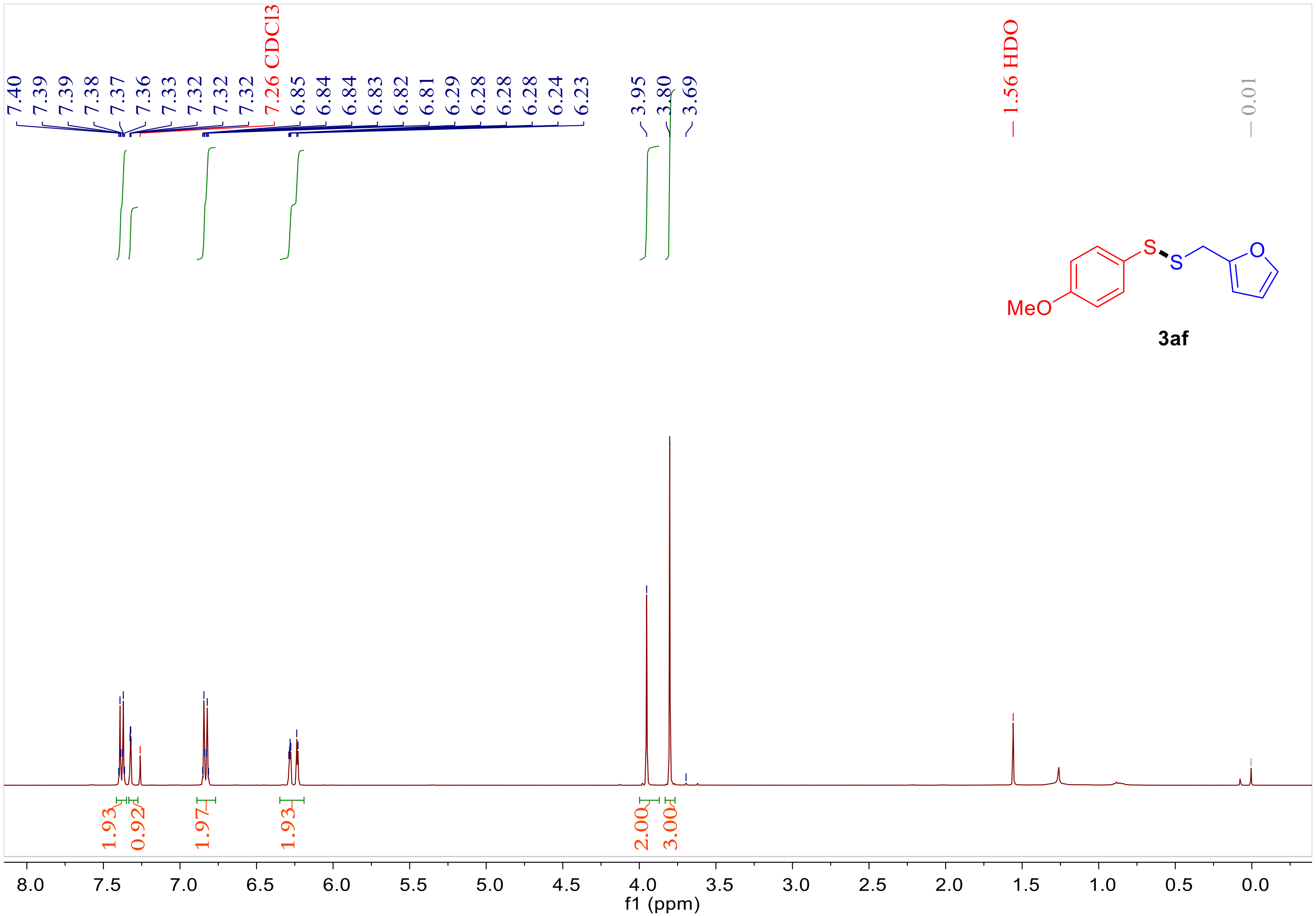
7.50
7.48
7.26 CDCl3
6.87
6.85
4.21
4.20
4.19
4.19
4.17
4.17
4.15
4.15
3.81
3.80
3.79
3.78
3.16
3.15
3.12
3.11
2.89
2.87
2.86
2.84
1.68
1.29
1.27
1.25
-0.01
MeO
S
S
COOEt
NH2
3ad
2.00
2.06
2.07
4.07
1.04
1.04
2.16
3.15
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


173.75
159.97
132.64
127.57
114.79
77.39 CDCl3
77.08 CDCl3
76.76 CDCl3
61.35
55.41
53.41
43.63
14.19
MeO
S
S
COOEt
NH2
3ad
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.49
7.48
7.48
7.47
7.46
7.46
7.26 CDCl3
6.88
6.88
6.87
6.86
6.85
6.85
3.80
3.80
3.68
2.97
2.95
2.93
2.76
2.74
2.73
1.59 HDO
-0.00
MeO
S
S
CO2Me
3ae
2.00
2.05
3.08
3.01
2.07
2.07
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)



172.16
159.79
132.02
127.80
114.76
77.34 CDCl3
77.02 CDCl3
76.71 CDCl3
55.41
51.83
33.64
33.01
MeO
S
S
CO2Me
3ae
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.39
7.39
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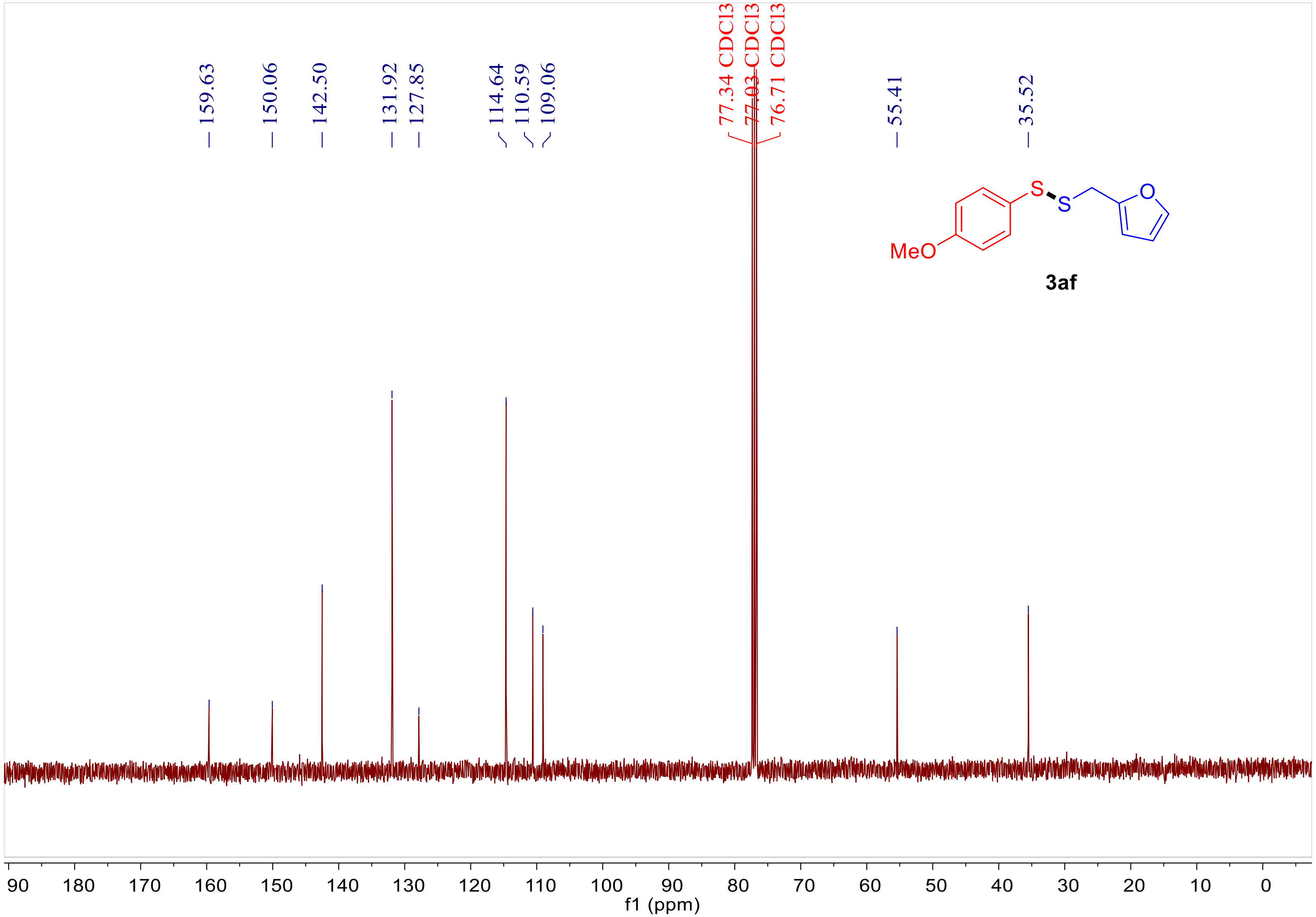
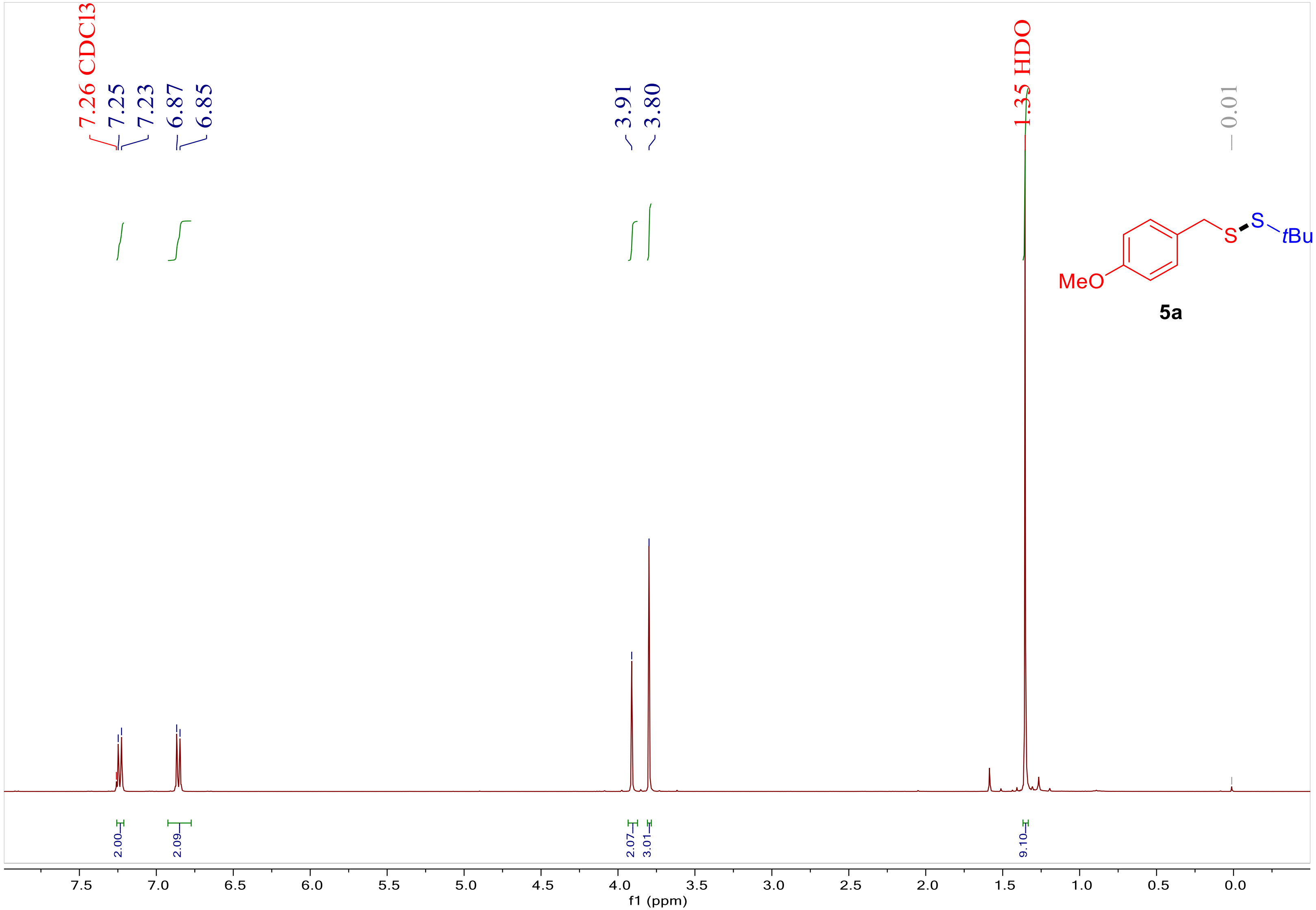
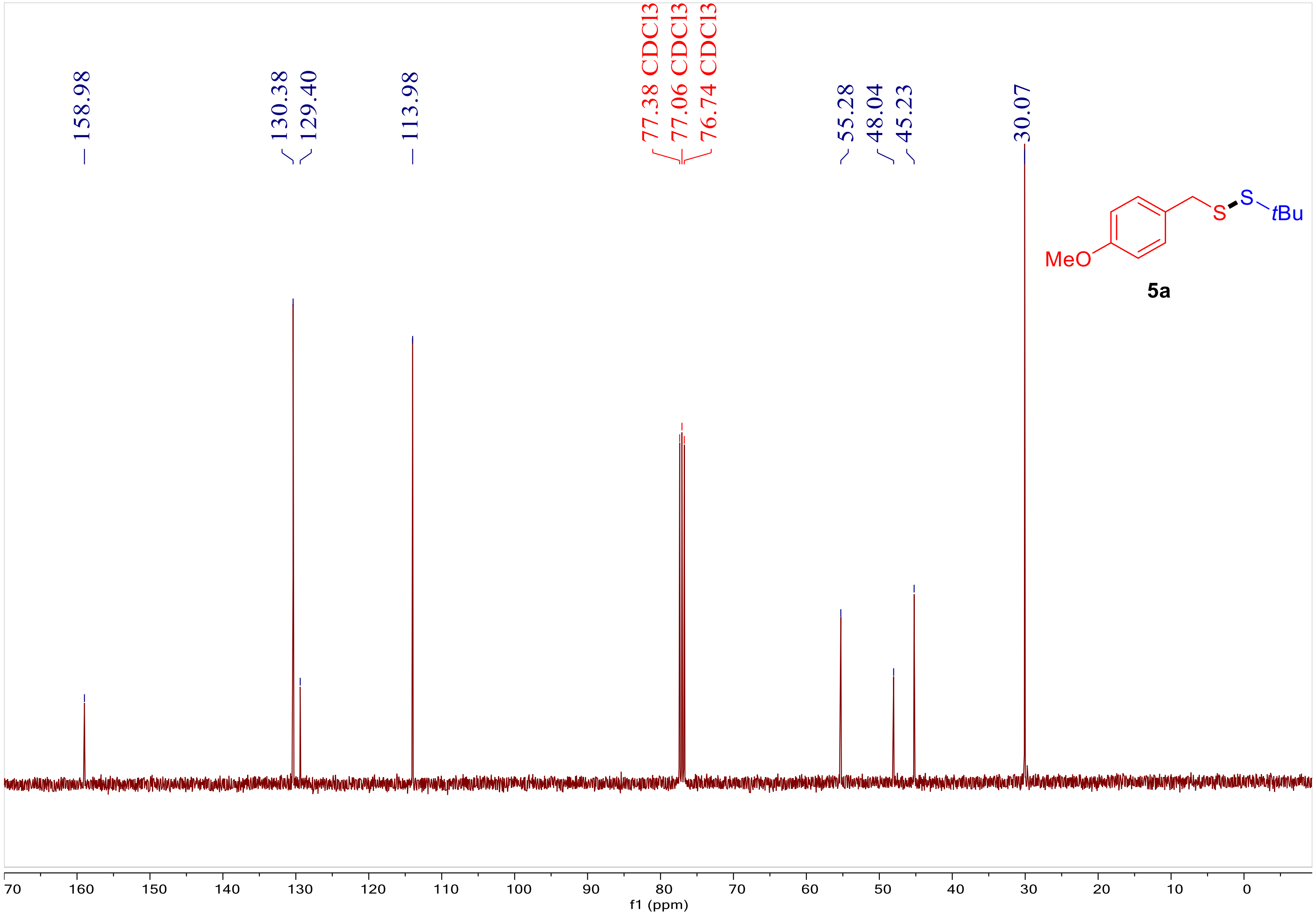
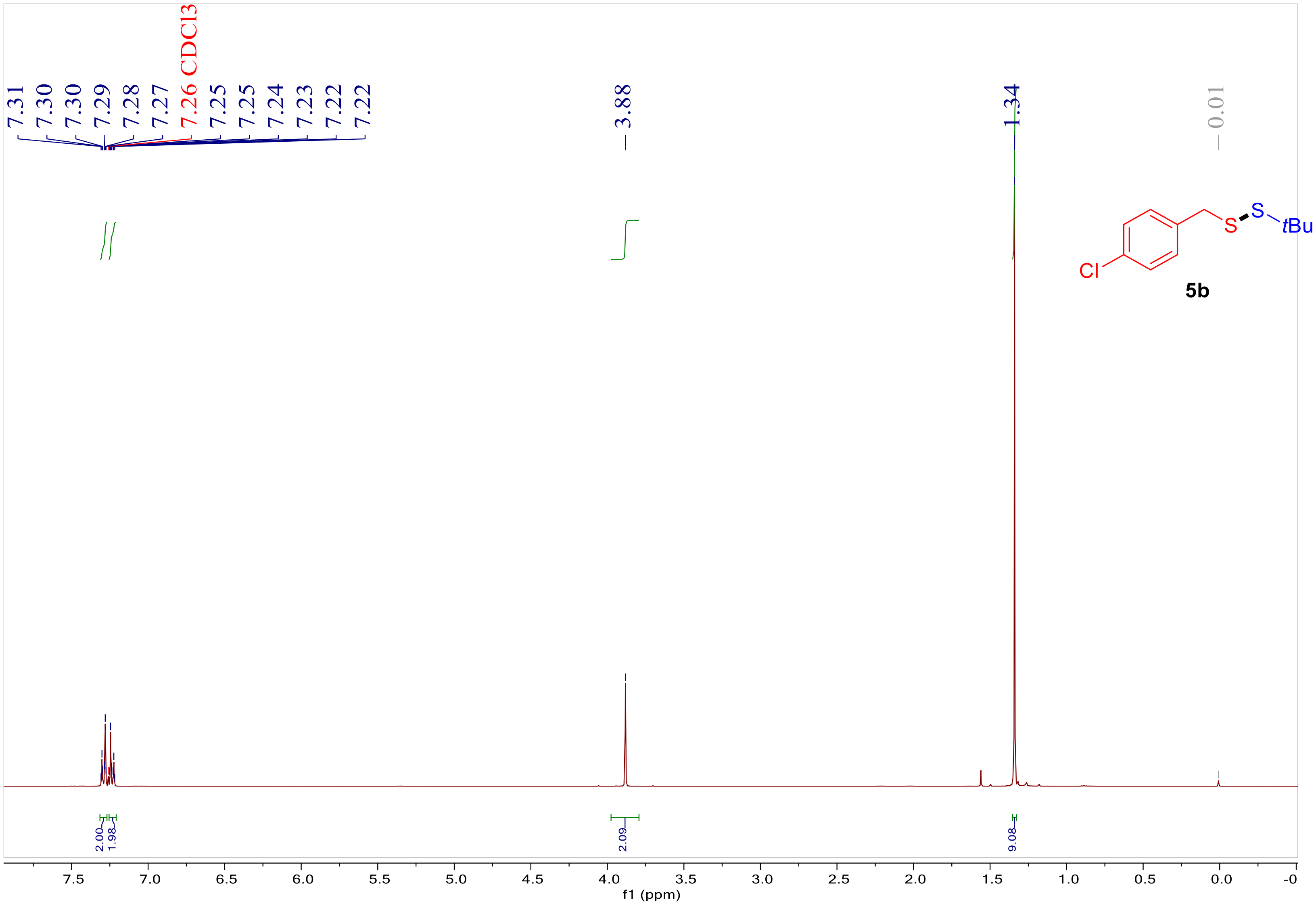
7.37
7.36
7.33
7.32
7.32
7.32
7.26 CDCl3
6.85
6.84
6.84
6.83
6.82
6.81
6.29
6.28
6.28
6.28
6.24
6.23
3.95
3.80
3.69
1.56 HDO
0.01
MeO
S
S
O
3af
1.93
0.92
1.97
1.93
2.00
3.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)



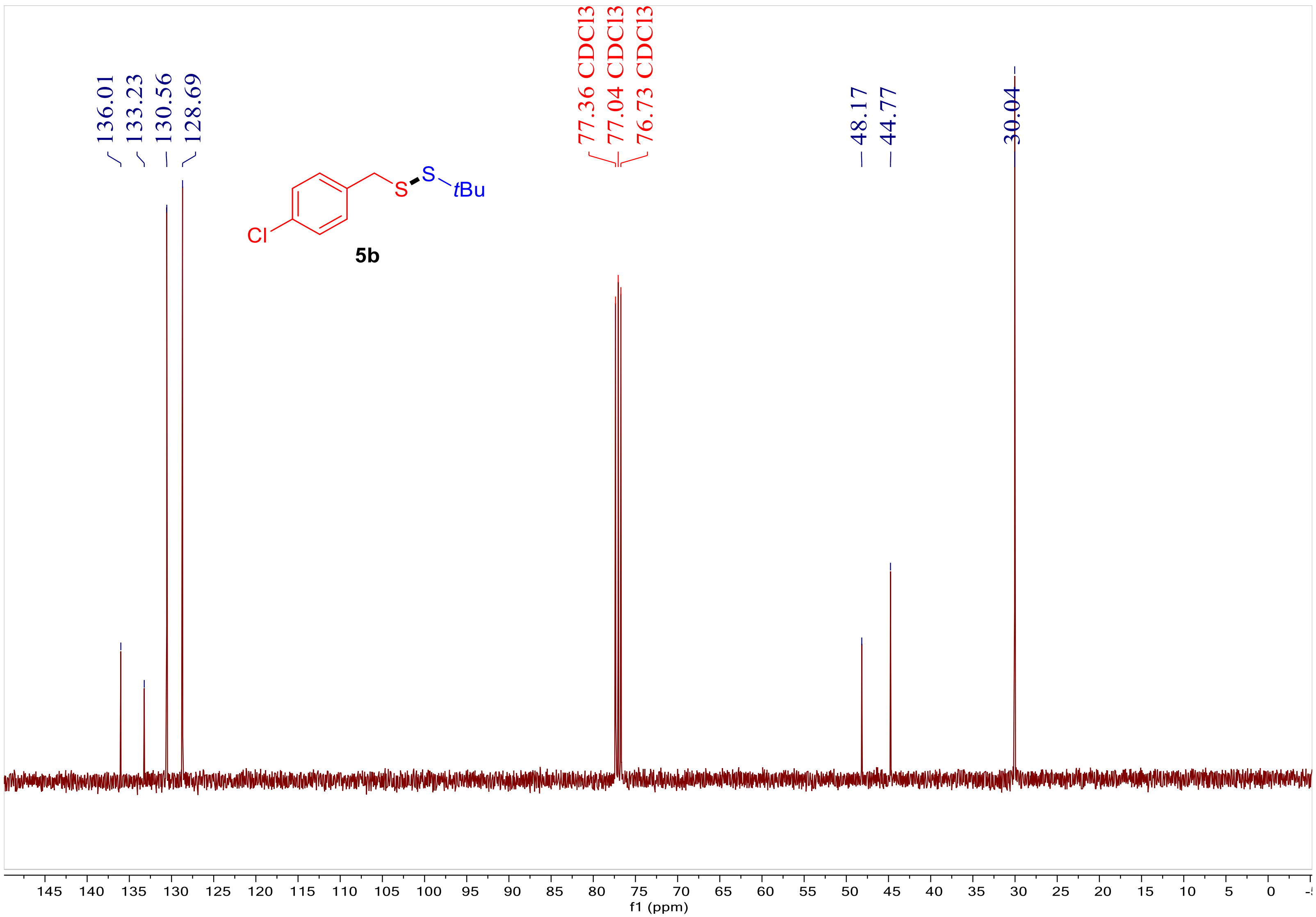
159.63
150.06
142.50
131.92
127.85
114.64
110.59
109.06
77.34 CDCl3
77.03 CDCl3
76.71 CDCl3
55.41
35.52
MeO
S
S
O
3af
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

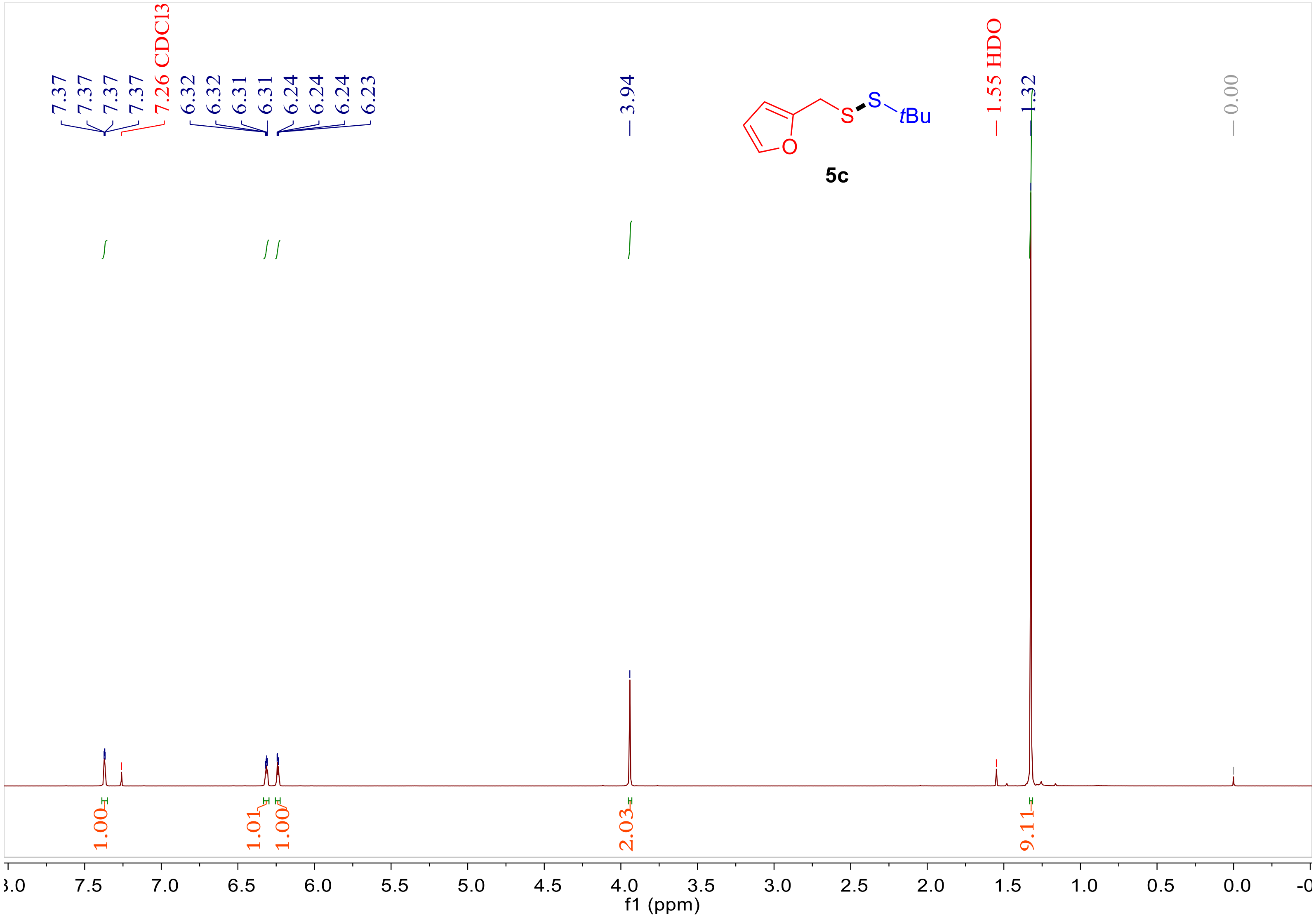

7.26 CDCl3
7.25
7.23
6.87
6.85
3.91
3.80
1.35 HDO
0.01
MeO
S
S
tBu
5a
2.00
2.09
2.07
3.01
9.10
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


158.98
130.38
129.40
113.98
77.38 CDCl3
77.06 CDCl3
76.74 CDCl3
55.28
48.04
45.23
30.07
MeO
S
S
tBu
5a
f1 (ppm)



7.31
7.30
7.30
7.29
7.28
7.27
7.26 CDCl3
7.25
7.25
7.24
7.23
7.22
7.22
3.88
1.34
0.01
Cl
S
S
tBu
5b
2.00
1.98
2.09
9.08
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)


136.01
133.23
130.56
128.69
77.36 CDCl3
77.04 CDCl3
76.73 CDCl3
48.17
44.77
30.04
Cl
S
S
tBu
5b
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)


7.37
7.37
7.37
7.37
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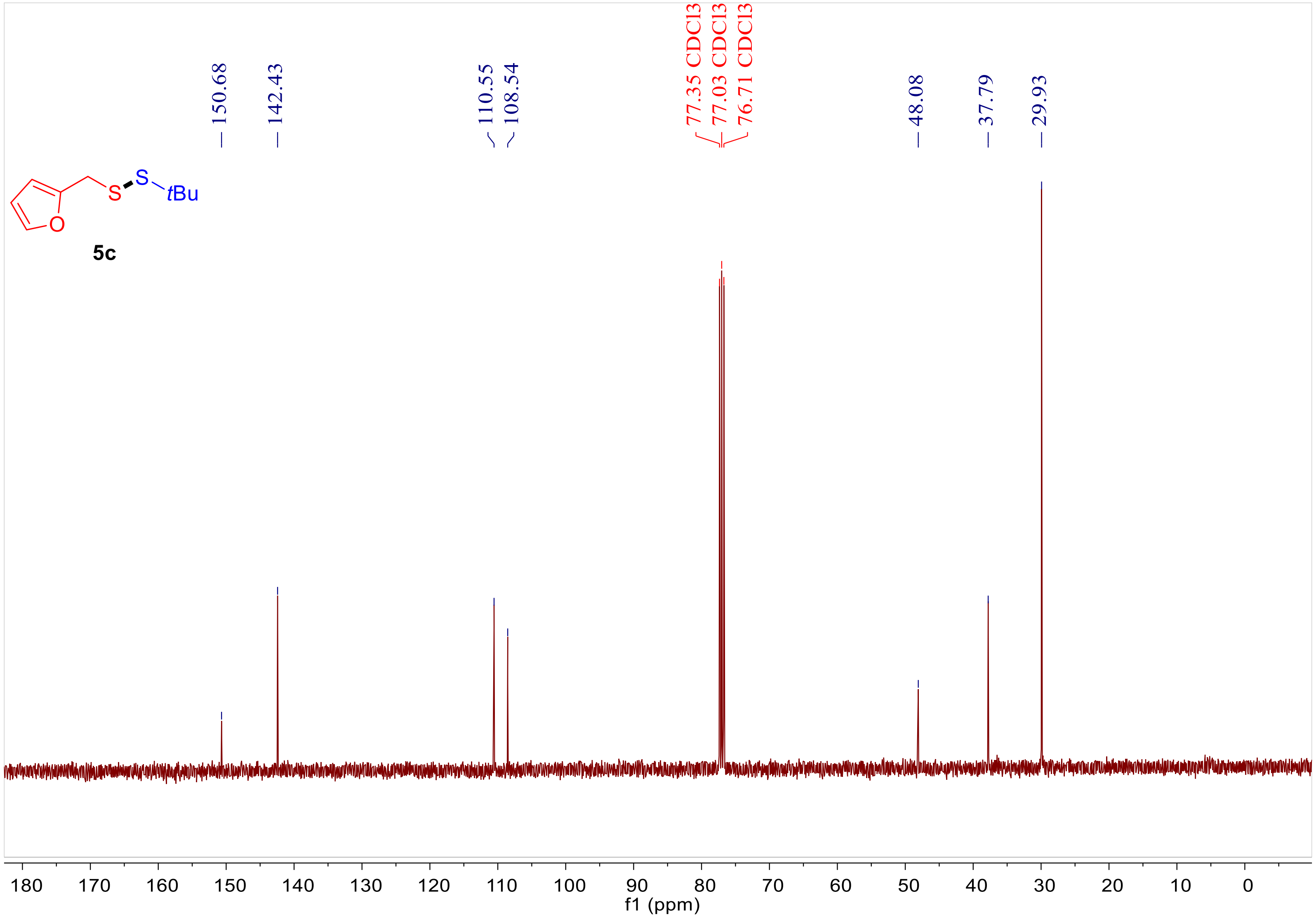
6.32
6.32
6.31
6.31
6.24
6.24
6.24
6.23
3.94
1.55 HDO
1.32
0.00
S
S
tBu
O
5c
1.00
1.01
1.00
2.03
9.11
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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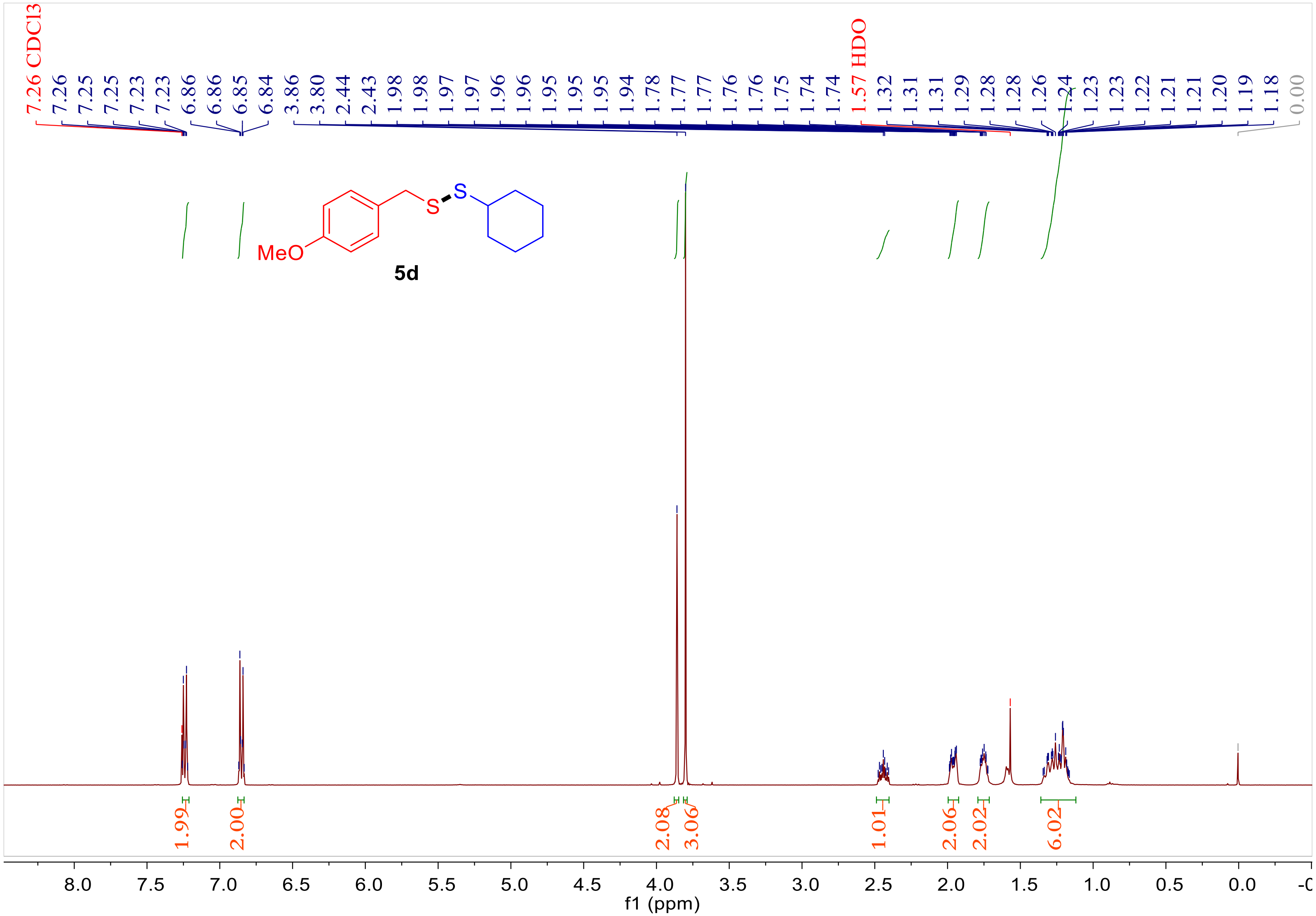
142.43
110.55
108.54
77.35 CDCl3
77.03 CDCl3
76.71 CDCl3
48.08
37.79
29.93
S
S
O
tBu
5c
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.26 CDCl3
7.26
7.25
7.25
7.23
7.23
6.86
6.86
6.85
6.84
3.86
3.80
2.44
2.43
1.98
1.98
1.97
1.97
1.96
1.96
1.95
1.95
1.95
1.94
1.78
1.77
1.77
1.76
1.76
1.75
1.74
1.74
1.57 HDO
1.32
1.31
1.31
1.29
1.28
1.28
1.26
1.24
1.23
1.23
1.22
1.21
1.21
1.20
1.19
1.18
0.00
MeO
S
S
5d
1.99
2.00
2.08
3.06
1.01
2.06
2.02
6.02
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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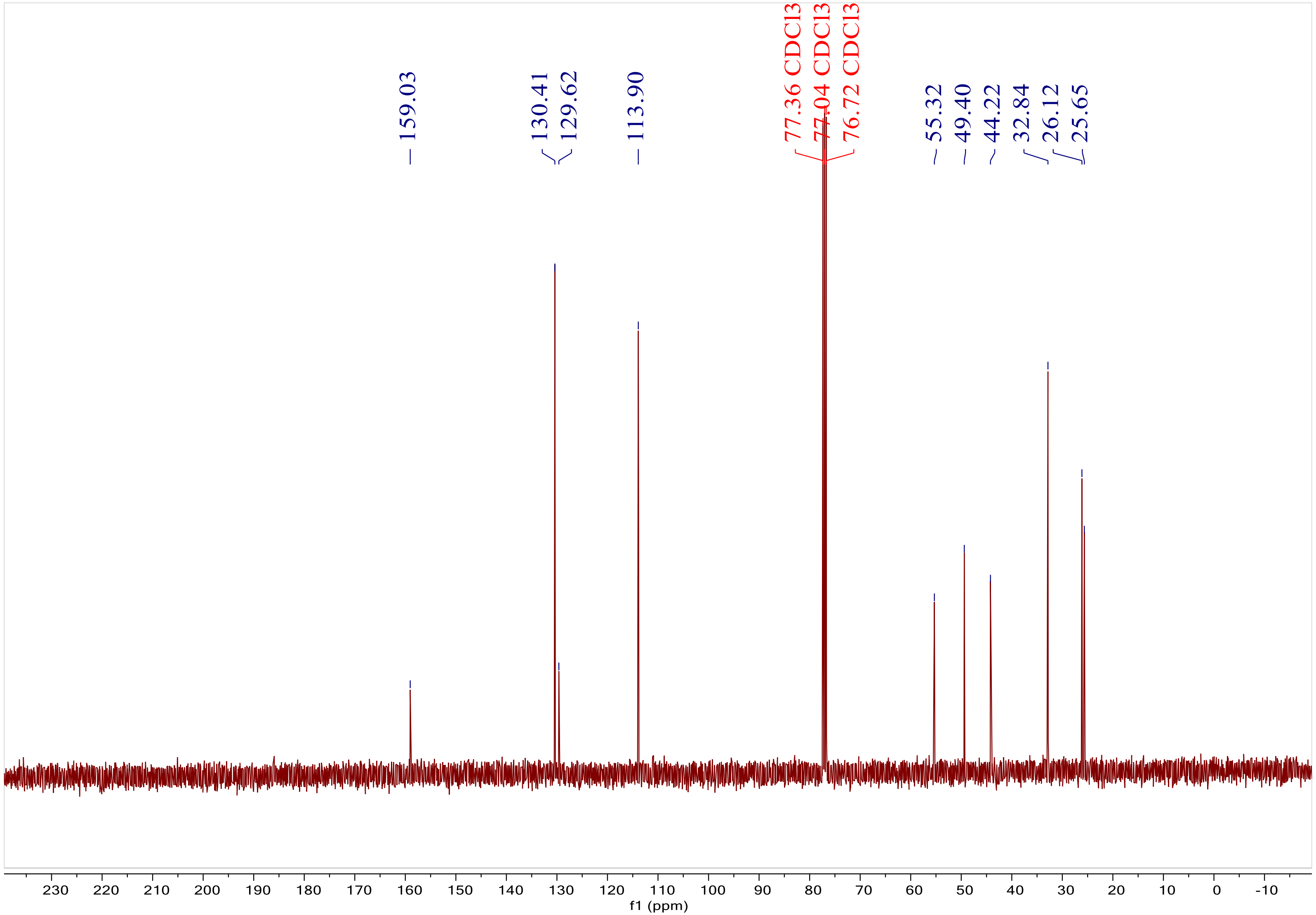
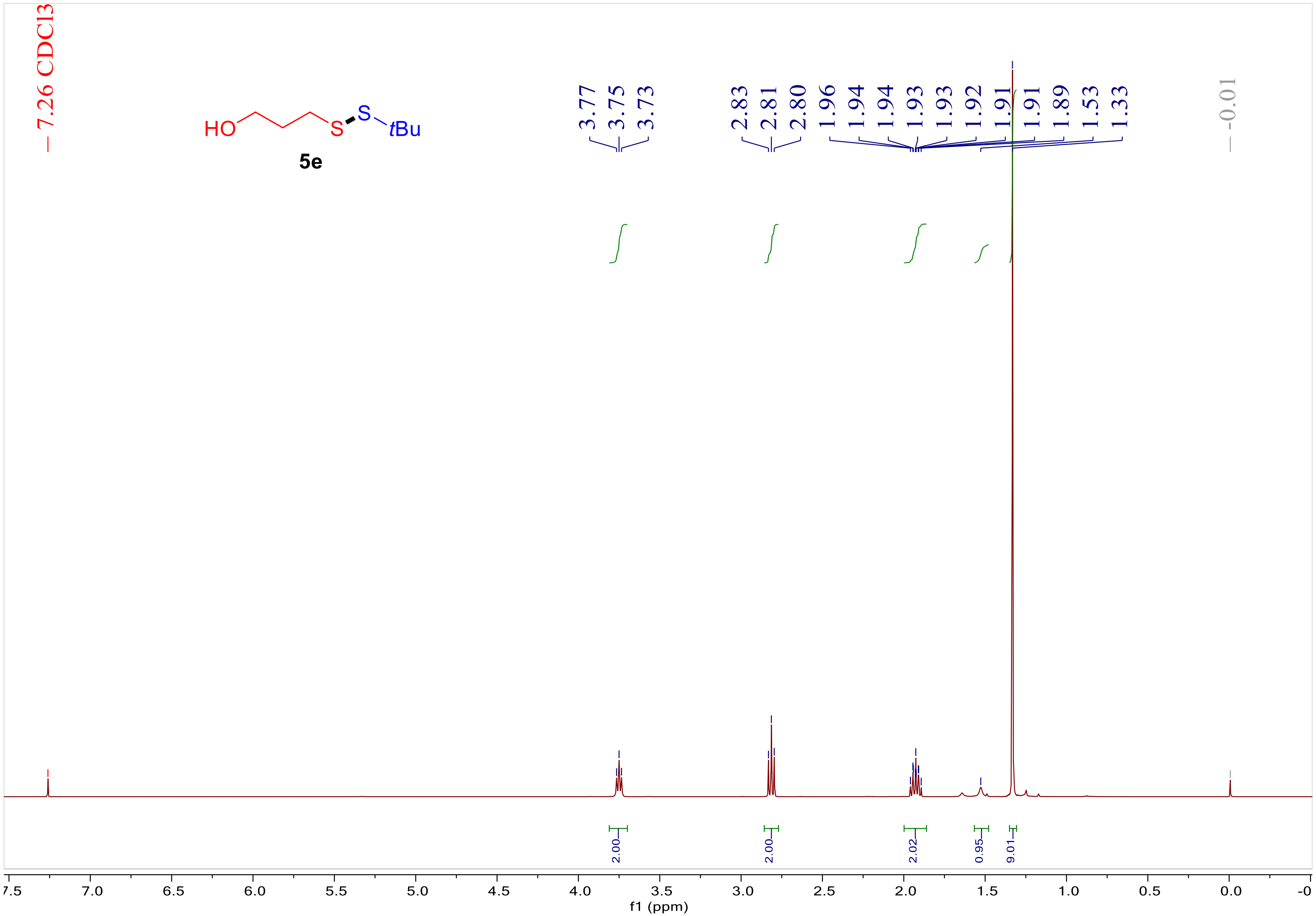
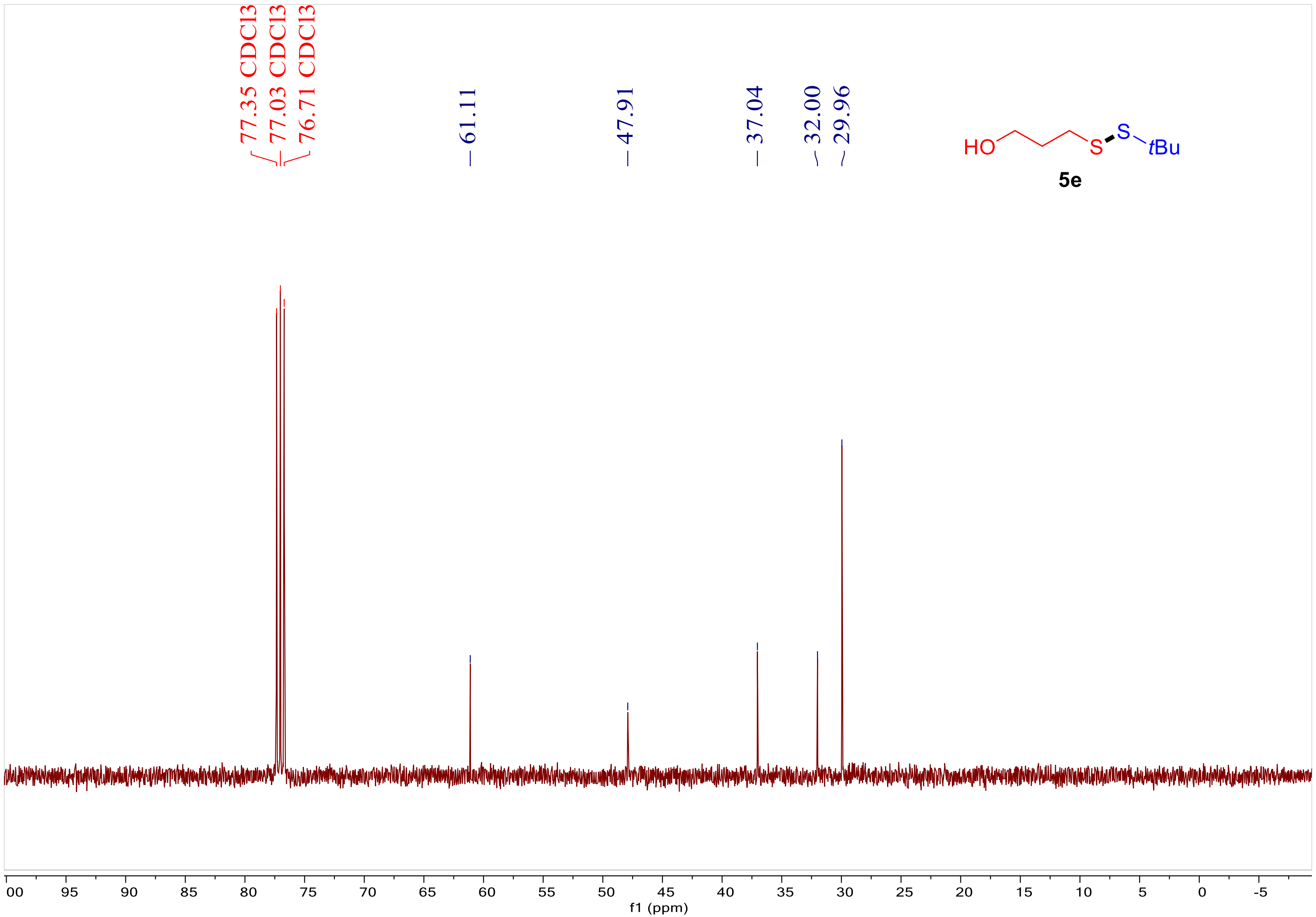
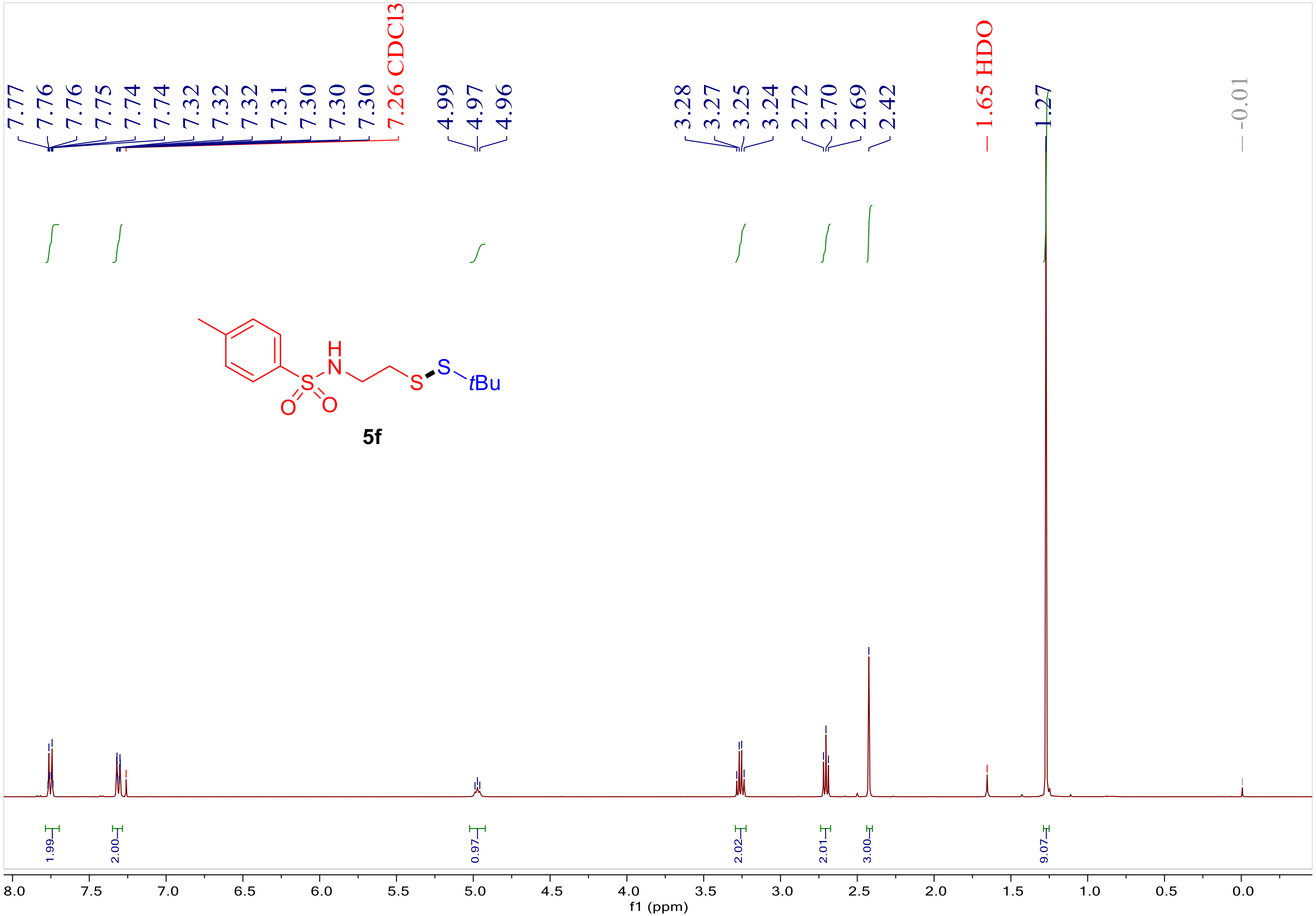
0.0
f1 (ppm)

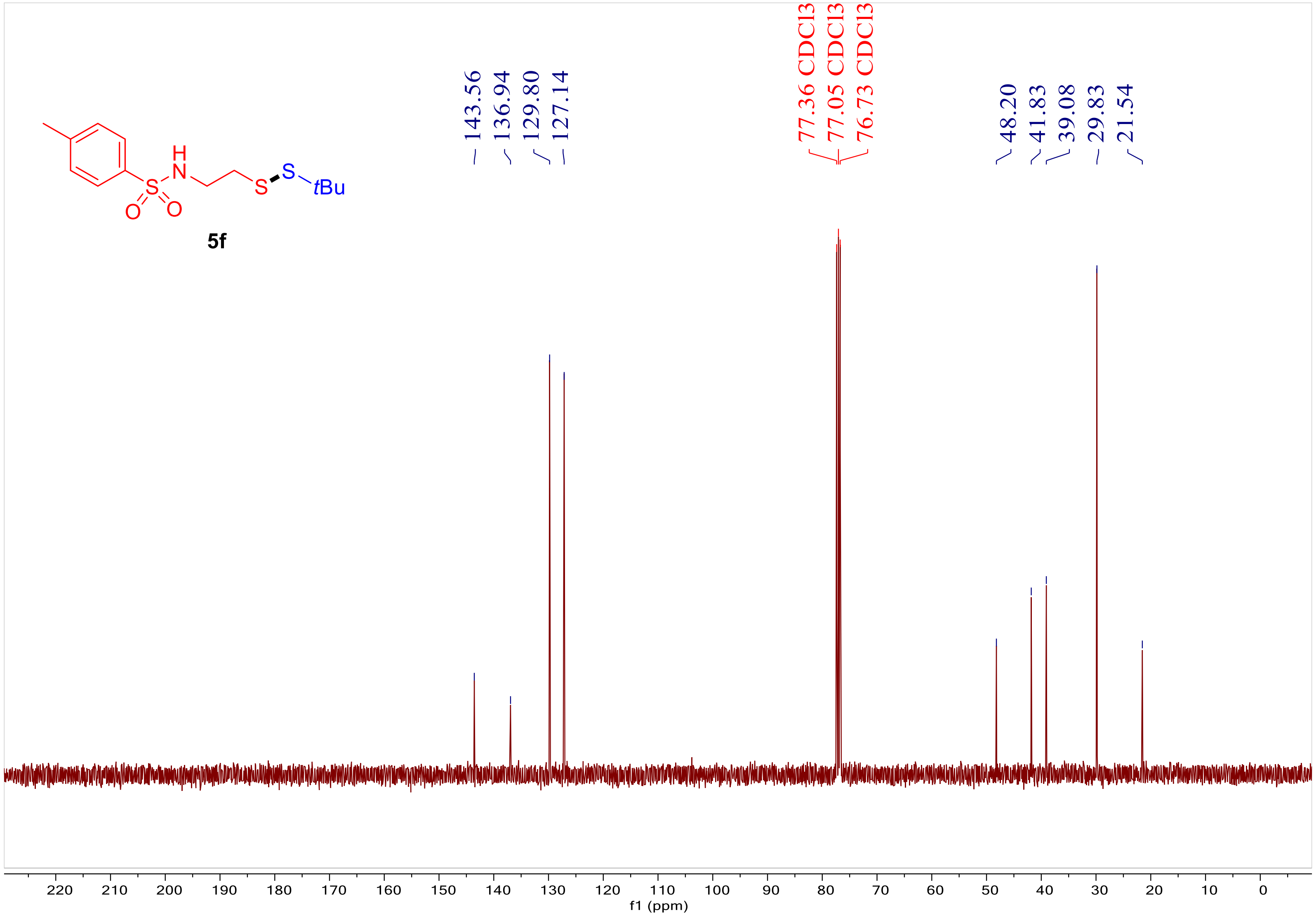

159.03
130.41
129.62
113.90
77.36 CDCl3
77.04 CDCl3
76.72 CDCl3
55.32
49.40
44.22
32.84
26.12
25.65
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

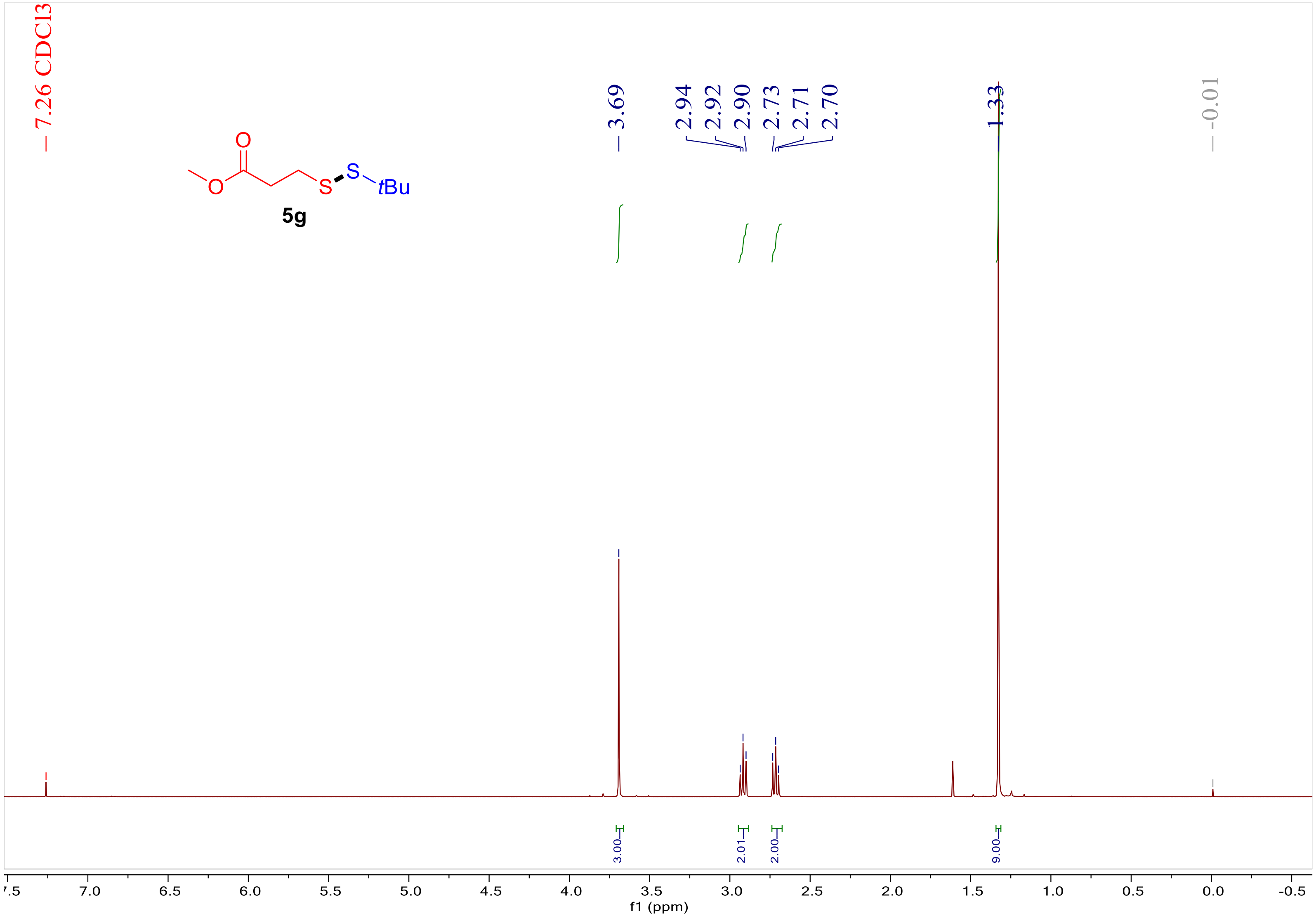


7.26 CDCl3
HO
S
S
tBu
5e
3.77
3.75
3.73
2.83
2.81
2.80
1.96
1.94
1.94
1.93
1.93
1.92
1.91
1.91
1.89
1.53
1.33
-0.01
2.00
2.00
2.02
0.95
9.01
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0
f1 (ppm)

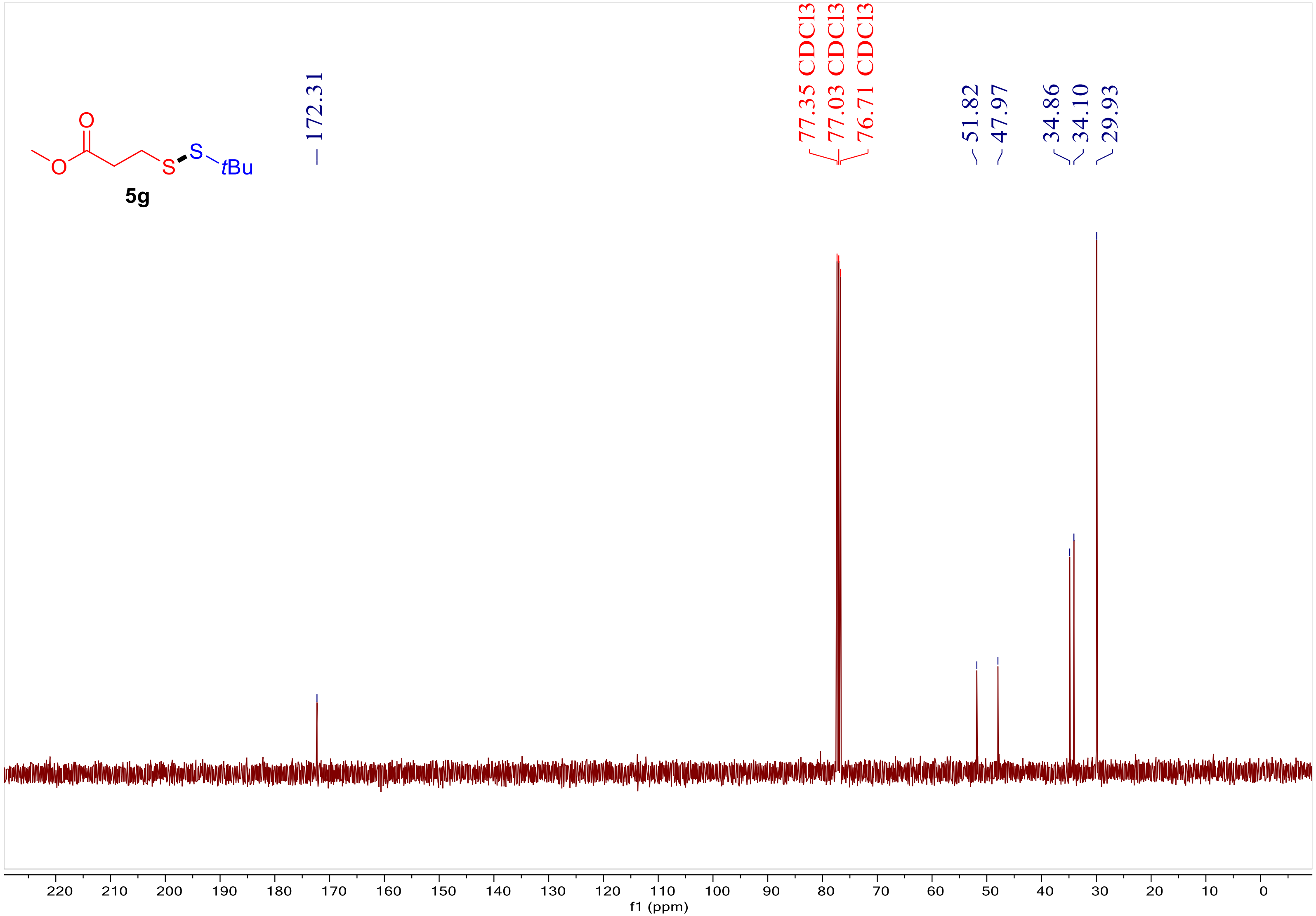

77.35 CDCl3
77.03 CDCl3
76.71 CDCl3
61.11
47.91
37.04
32.00
29.96
HO
S
S
tBu
5e
00
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
f1 (ppm)


7.77
7.76
7.76
7.75
7.74
7.74
7.32
7.32
7.32
7.31
7.30
7.30
7.30
7.26 CDCl3
4.99
4.97
4.96
3.28
3.27
3.25
3.24
2.72
2.70
2.69
2.42
1.65 HDO
1.27
-0.01
H
N
S
O
O
S
S
tBu
5f
1.99
2.00
0.97
2.02
2.01
3.00
9.07
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
f1 (ppm)

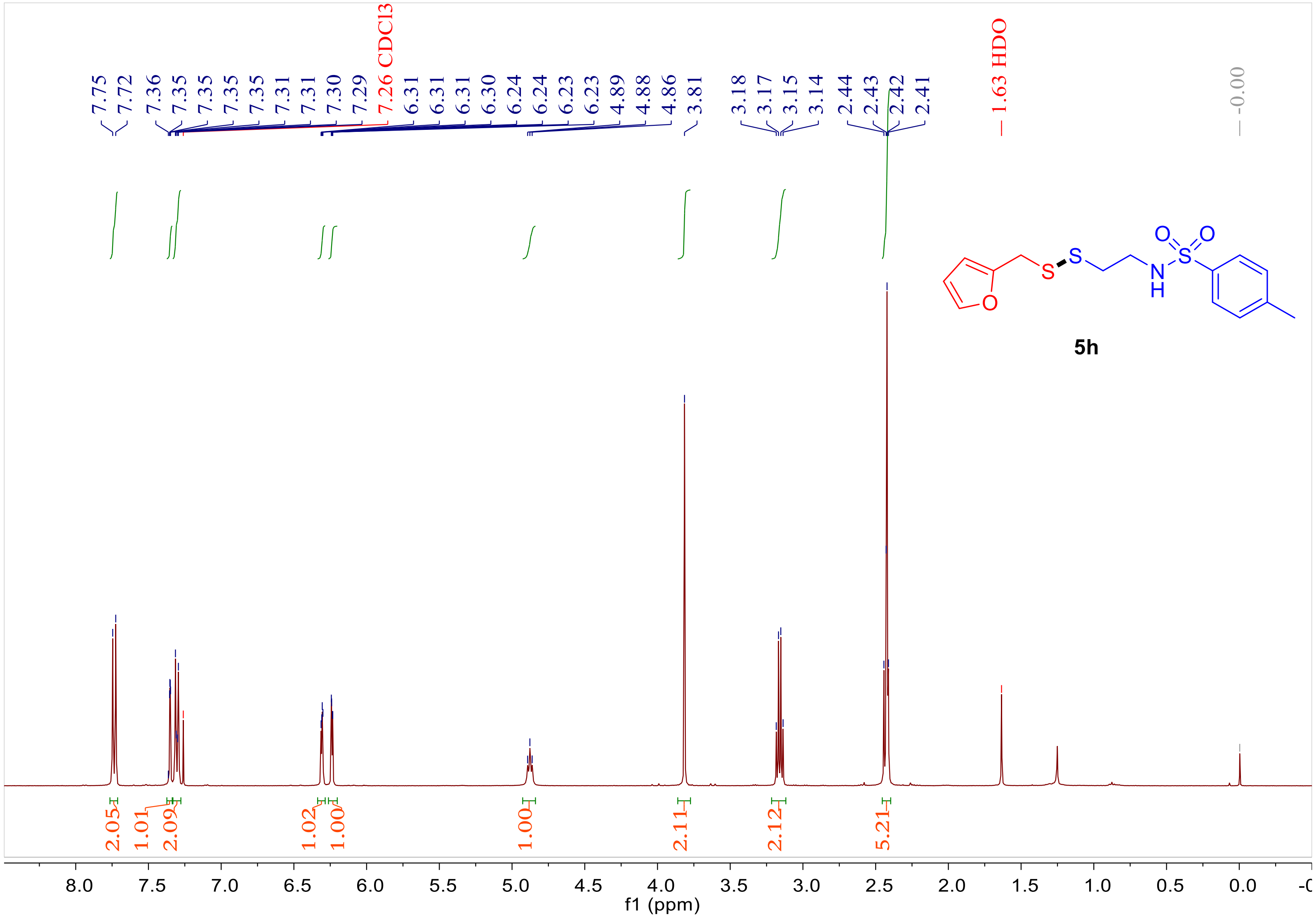

143.56
136.94
129.80
127.14
77.36 CDCl3
77.05 CDCl3
76.73 CDCl3
48.20
41.83
39.08
29.83
21.54
H
N
S
O
O
S
S
tBu
5f
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

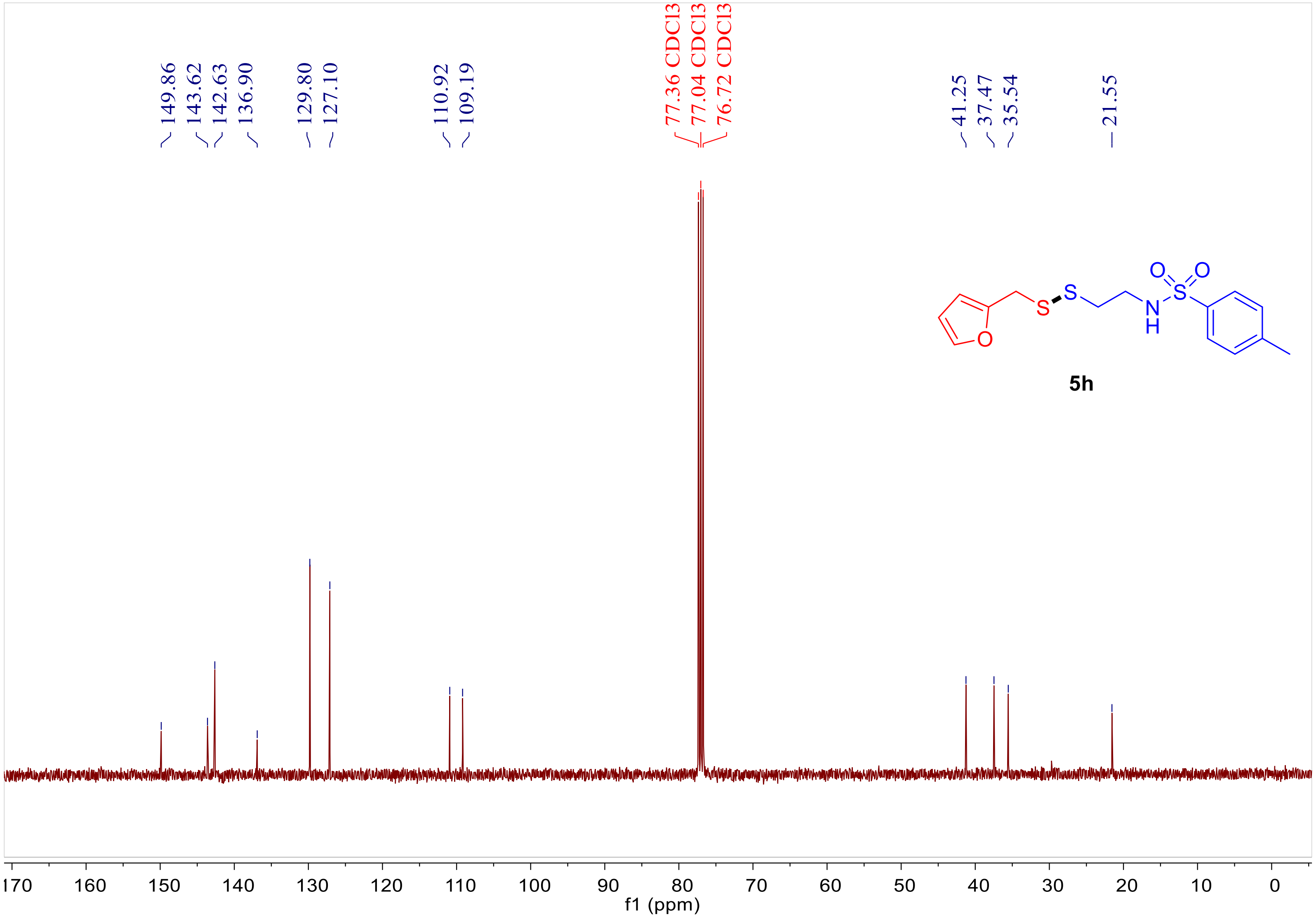


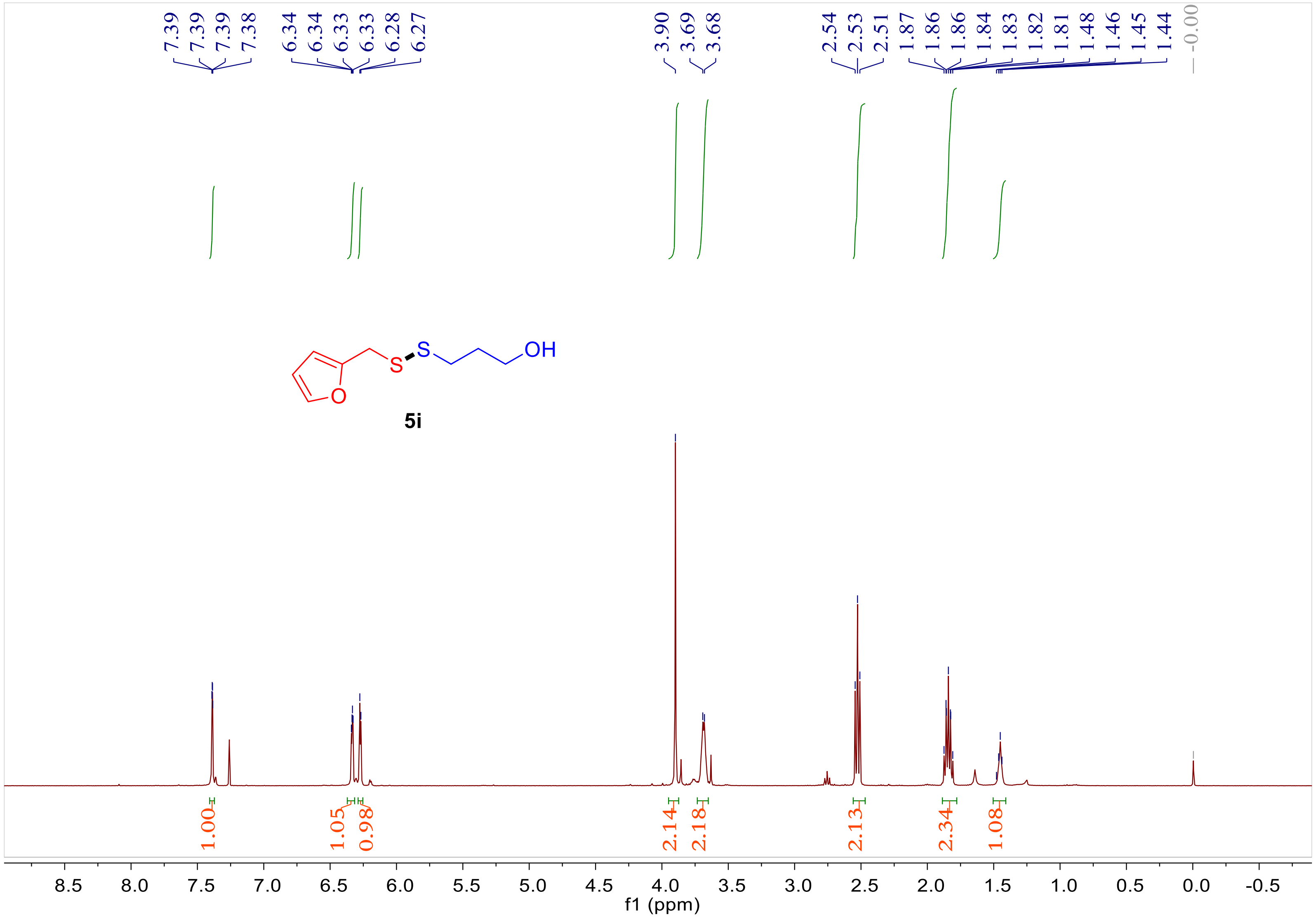
7.26 CDCl3
3.69
2.94
2.92
2.90
2.73
2.71
2.70
1.33
-0.01
O
O
S
S
tBu
5g
3.00
2.01
2.00
9.00
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

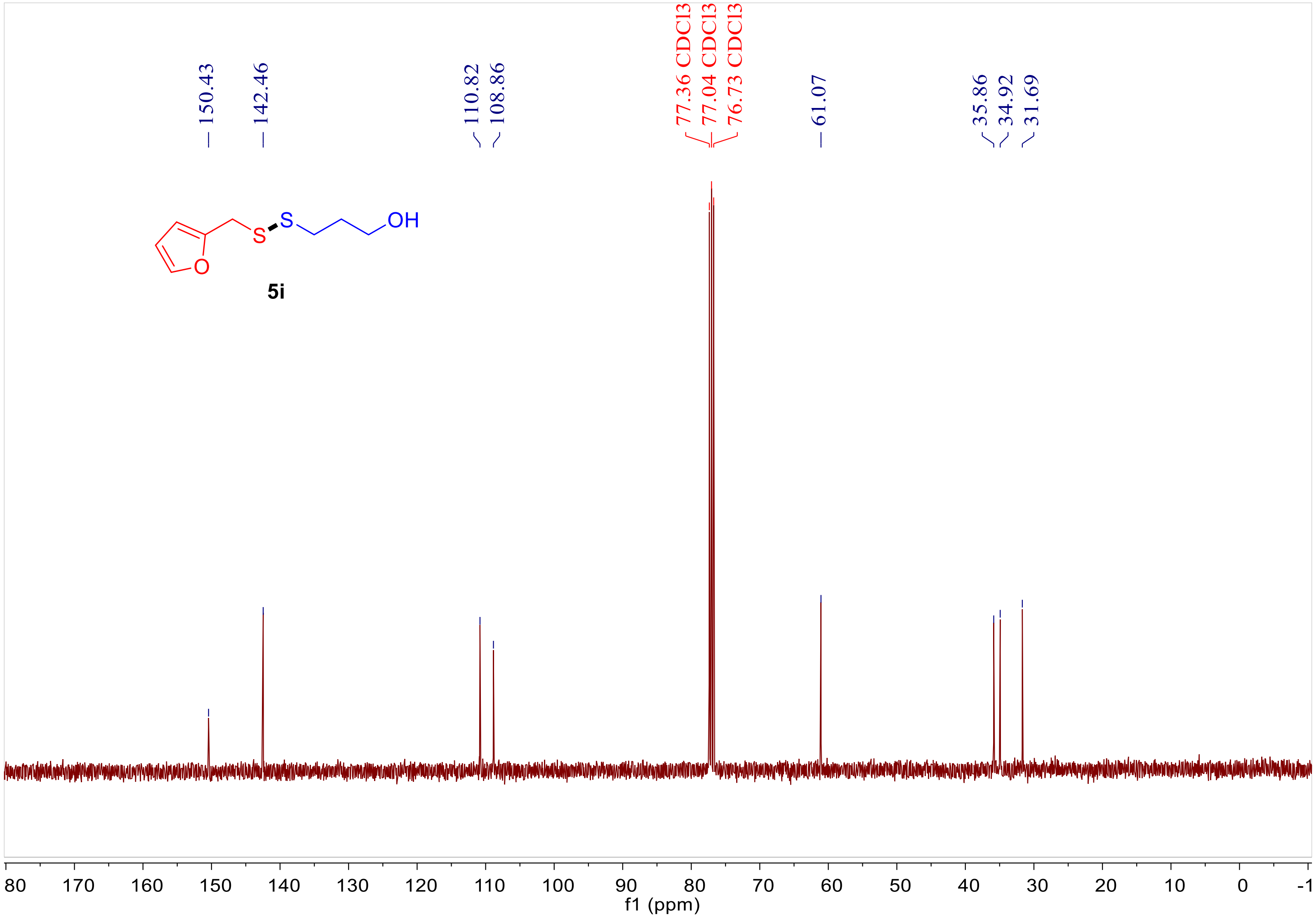


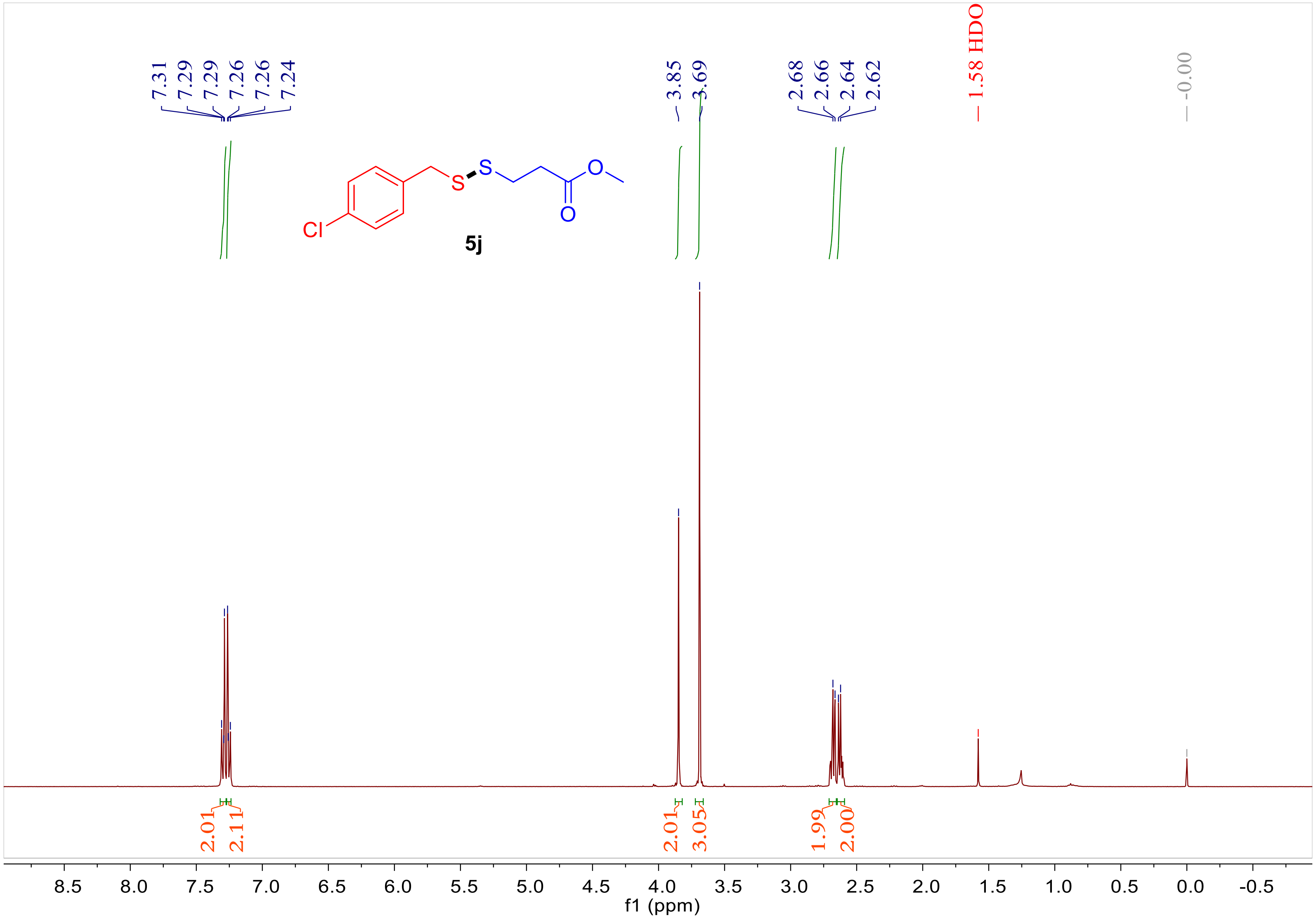
O
O
S
S
tBu
5g
172.31
77.35 CDCl3
77.03 CDCl3
76.71 CDCl3
51.82
47.97
34.86
34.10
29.93
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.75
7.72
7.36
7.35
7.35
7.35
7.35
7.31
7.31
7.30
7.29
7.26 CDCl3
6.31
6.31
6.31
6.30
6.24
6.24
6.23
6.23
4.89
4.88
4.86
3.81
3.18
3.17
3.15
3.14
2.44
2.43
2.42
2.41
1.63 HDO
-0.00
2.05
1.01
2.09
1.02
1.00
1.00
2.11
2.12
5.21
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)
5h

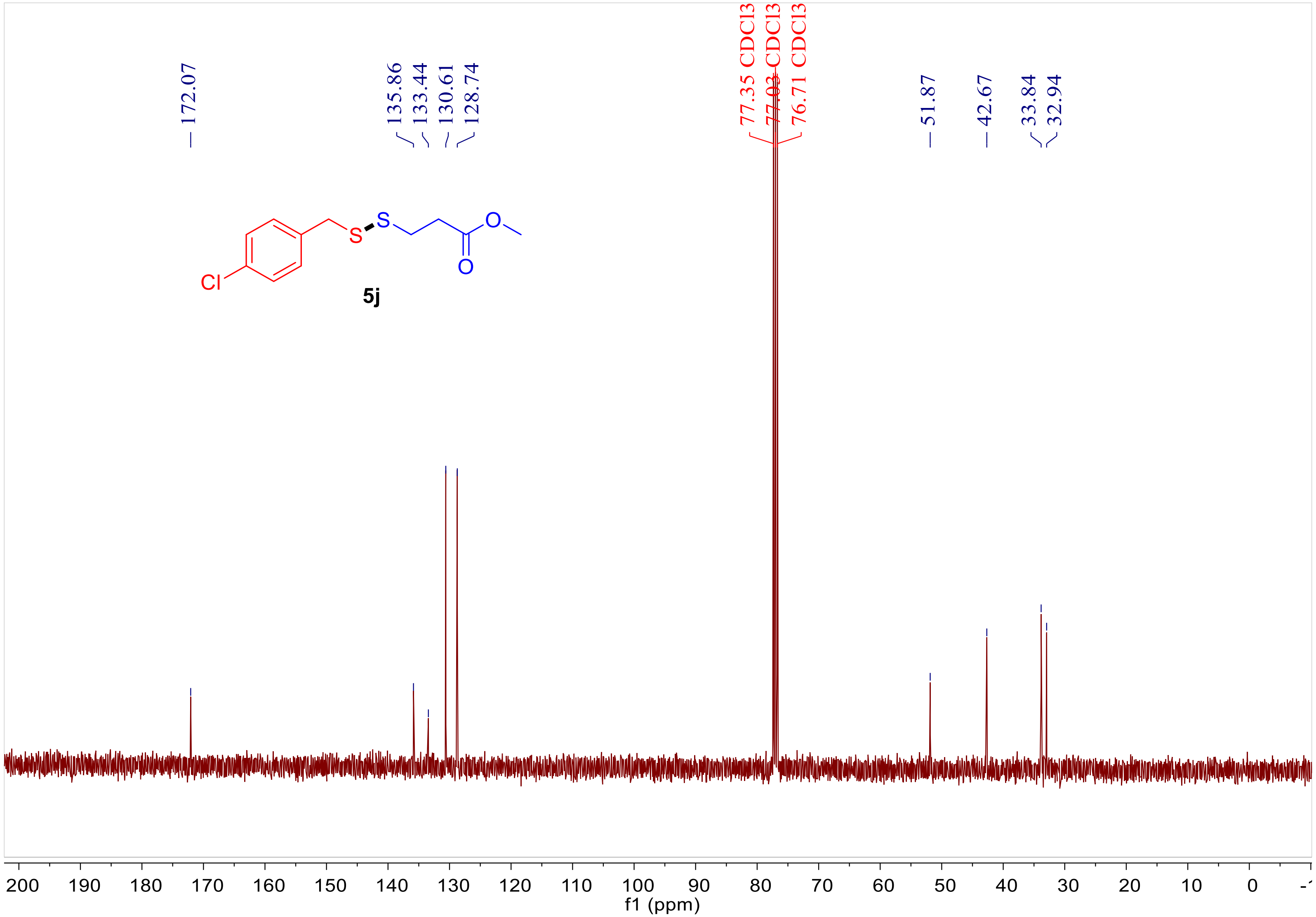

149.86
143.62
142.63
136.90
129.80
127.10
110.92
109.19
77.36 CDCl3
77.04 CDCl3
76.72 CDCl3
41.25
37.47
35.54
21.55
5h
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

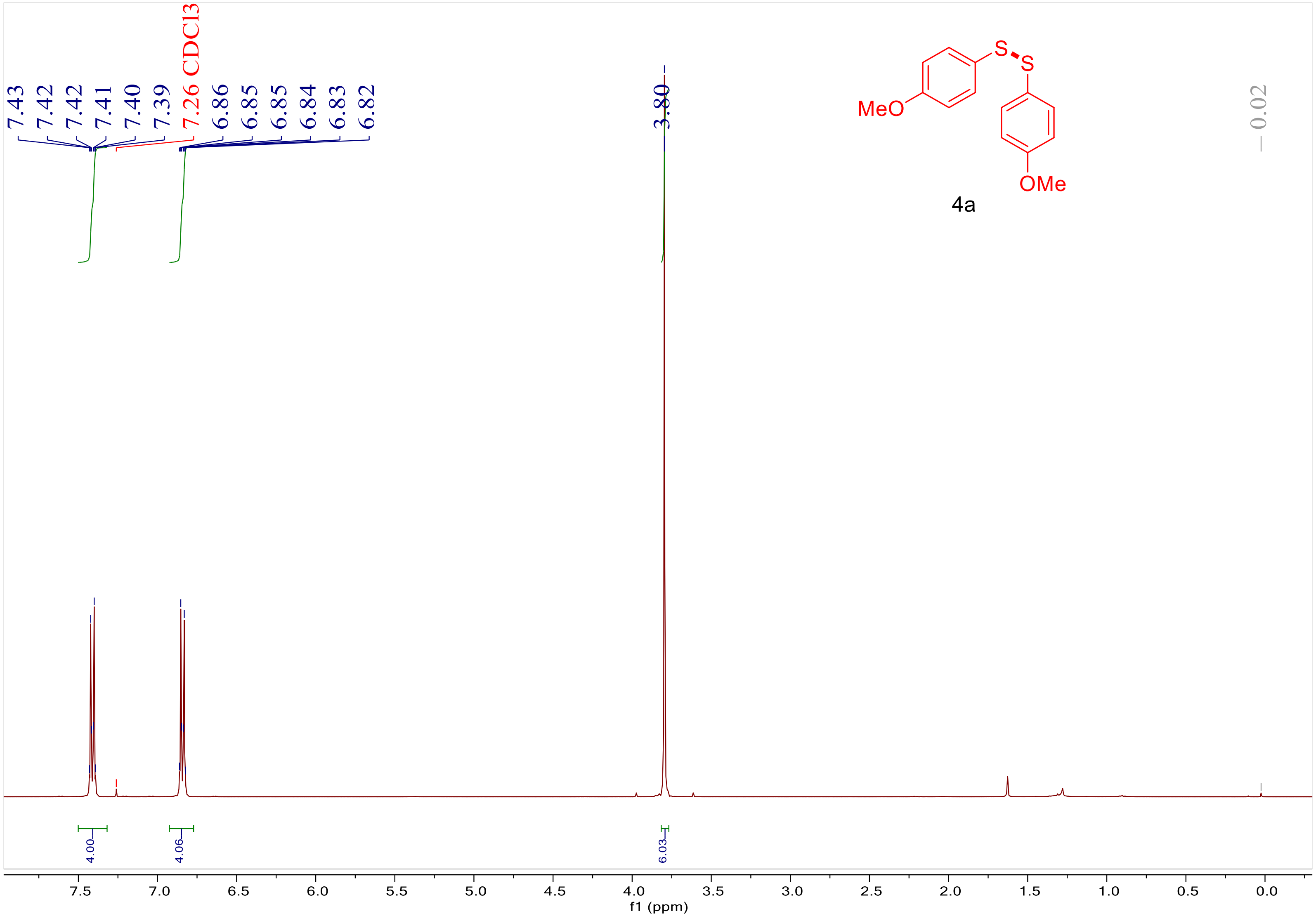

7.39
7.39
7.39
7.38
6.34
6.34
6.33
6.33
6.28
6.27
3.90
3.69
3.68
2.54
2.53
2.51
1.87
1.86
1.86
1.84
1.83
1.82
1.81
1.48
1.46
1.45
1.44
-0.00
S
S
OH
O
5i
1.00
1.05
0.98
2.14
2.18
2.13
2.34
1.08
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


150.43
142.46
110.82
108.86
77.36 CDCl3
77.04 CDCl3
76.73 CDCl3
61.07
35.86
34.92
31.69
S
S
OH
O
5i
f1 (ppm)

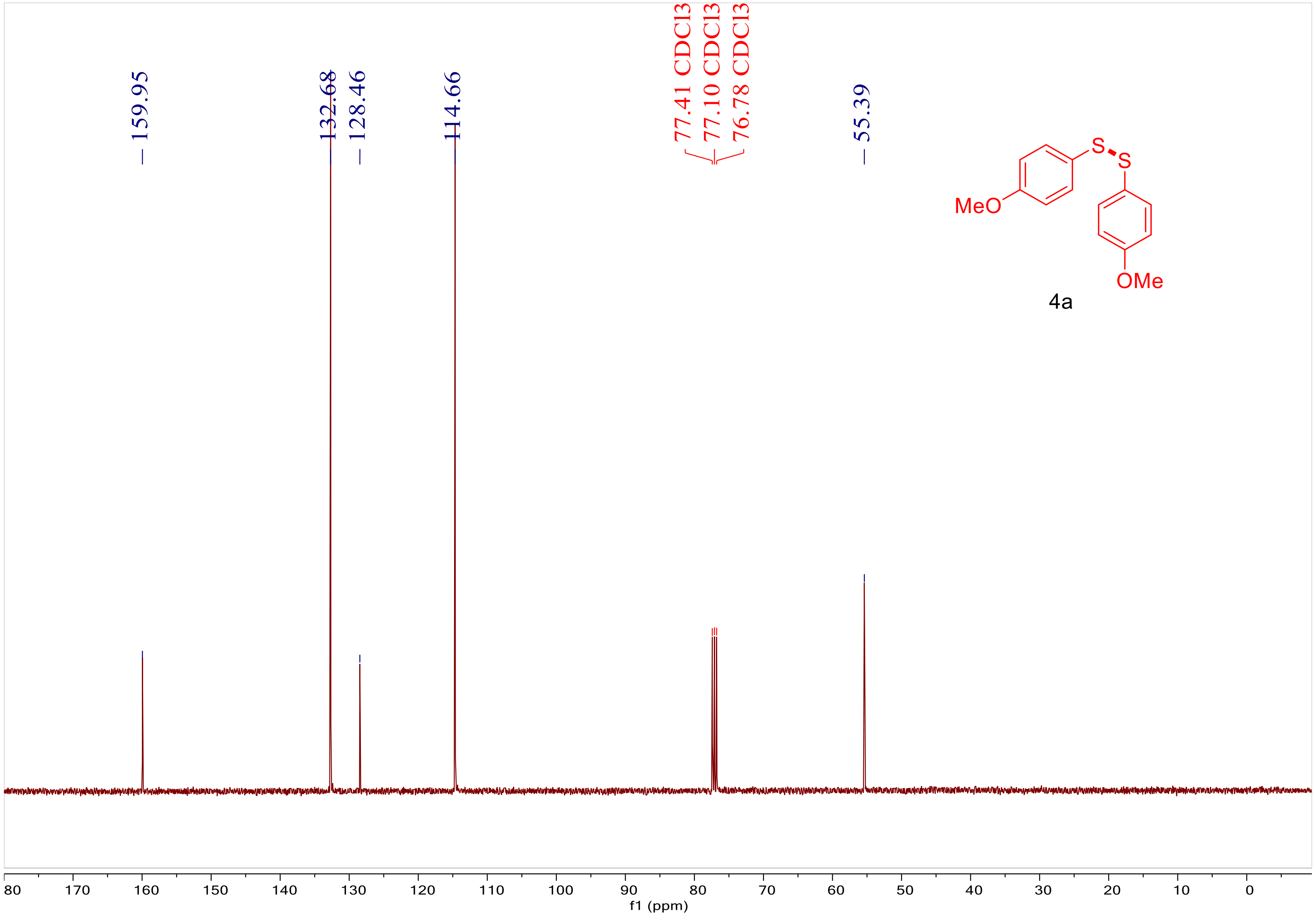


7.31
7.29
7.29
7.26
7.26
7.24
3.85
3.69
2.68
2.66
2.64
2.62
1.58 HDO
-0.00
Cl
S
S
O
O
5j
2.01
2.11
2.01
3.05
1.99
2.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

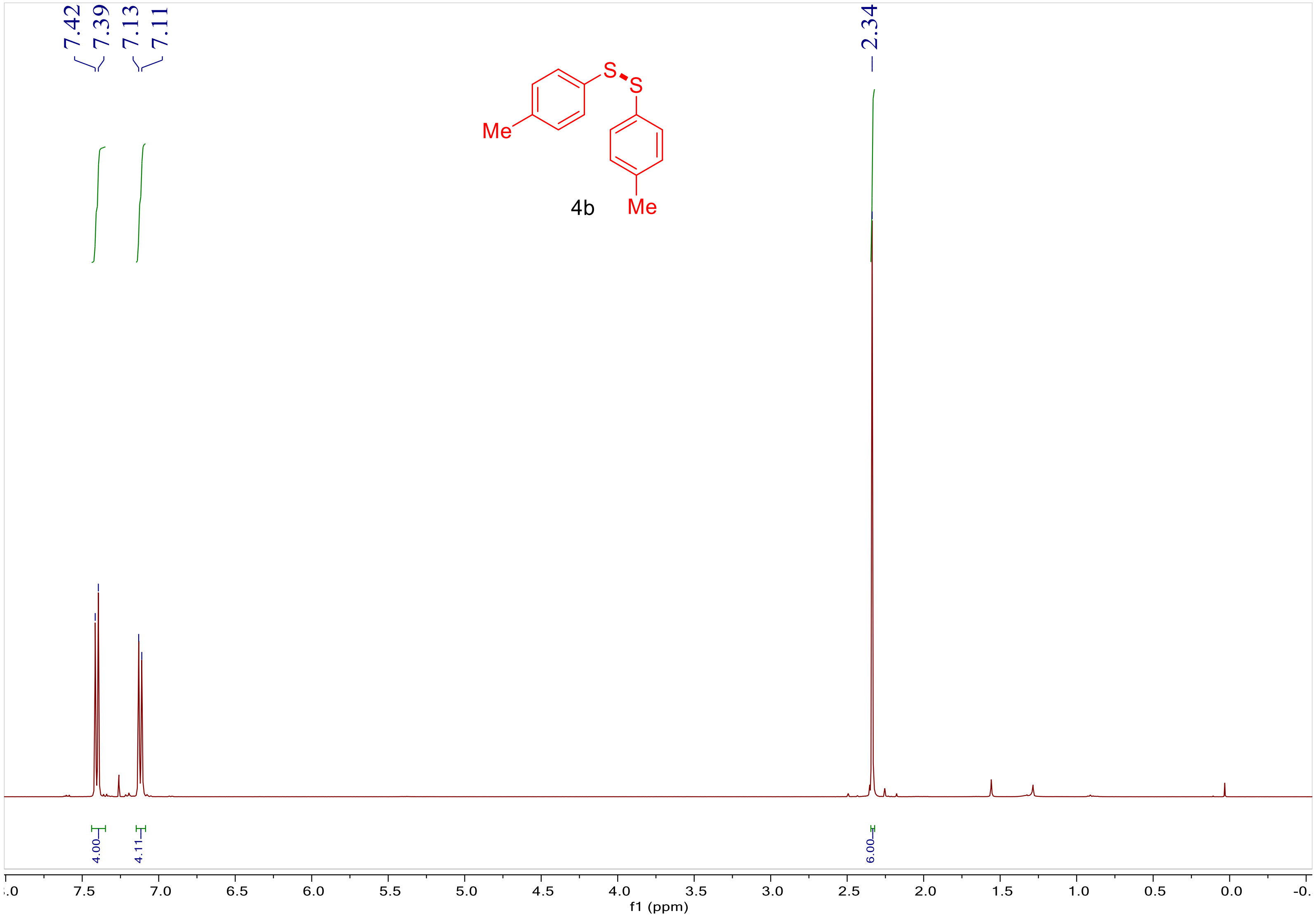

172.07
135.86
133.44
130.61
128.74
77.35 CDCl3
77.03 CDCl3
76.71 CDCl3
51.87
42.67
33.84
32.94
Cl
S
S
O
O
5j
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

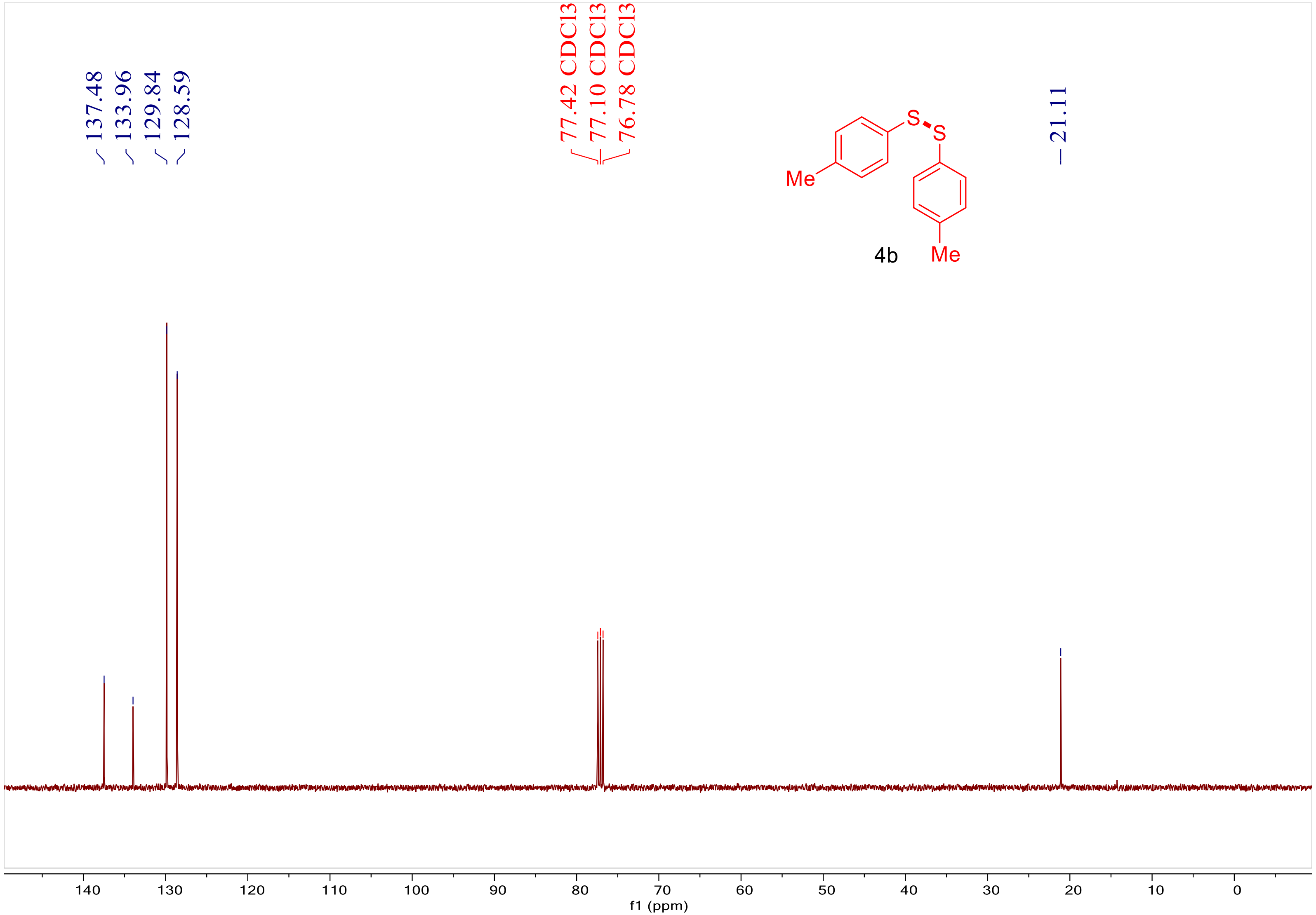


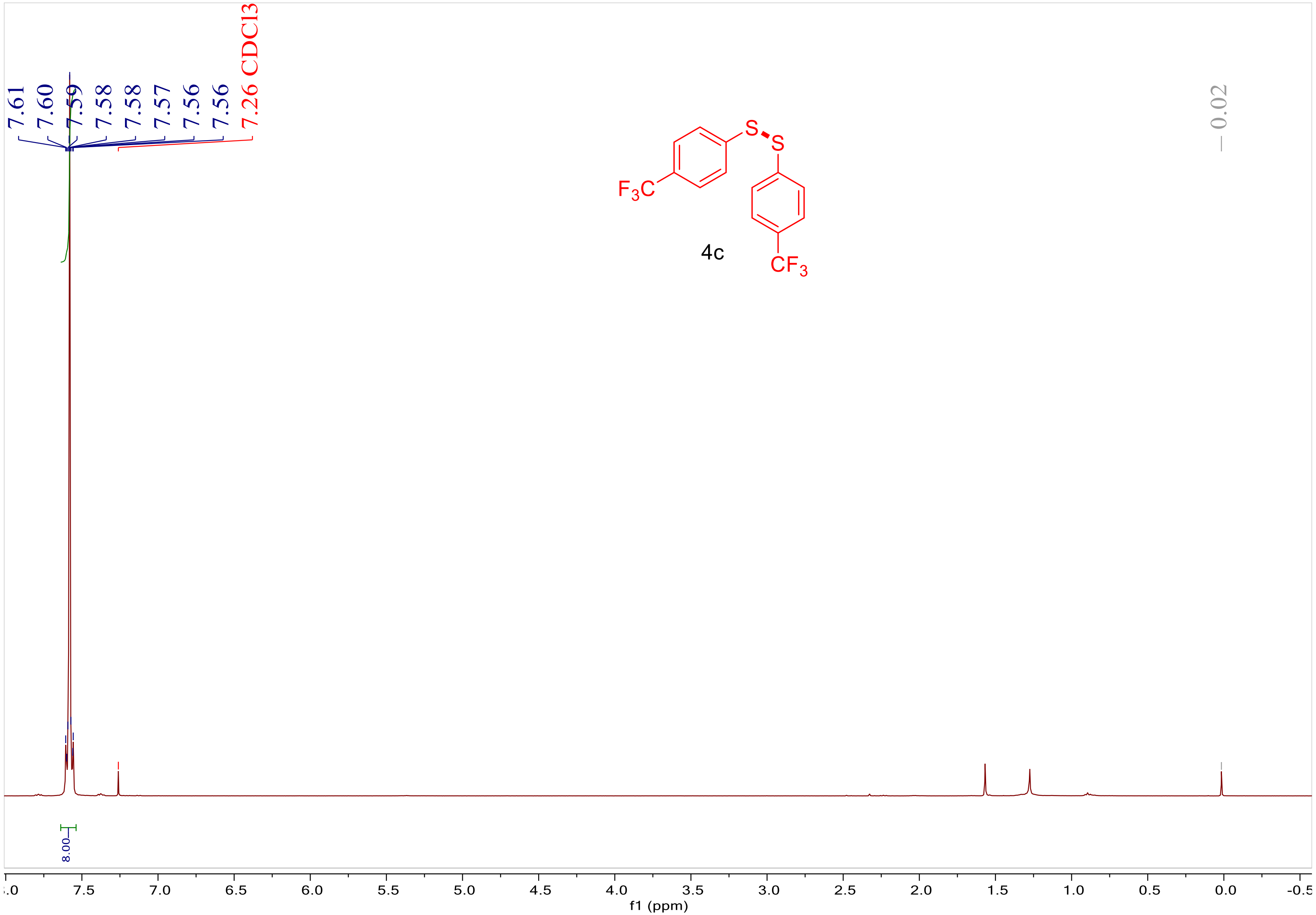
7.43
7.42
7.42
7.41
7.40
7.39
7.26 CDCl3
6.86
6.85
6.85
6.84
6.83
6.82
3.80
0.02
MeO
S
S
OMe
4a
4.00
4.06
6.03
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

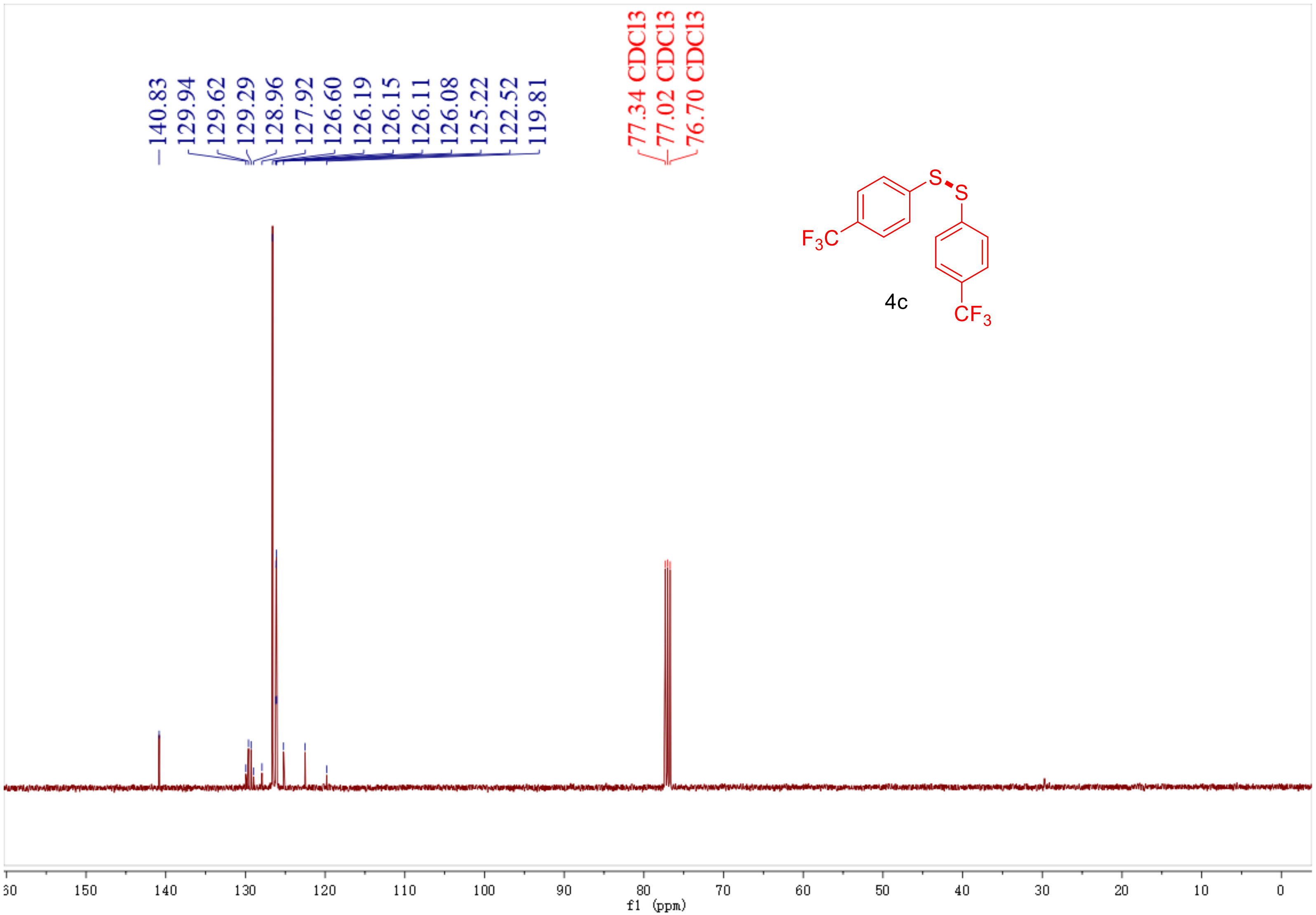


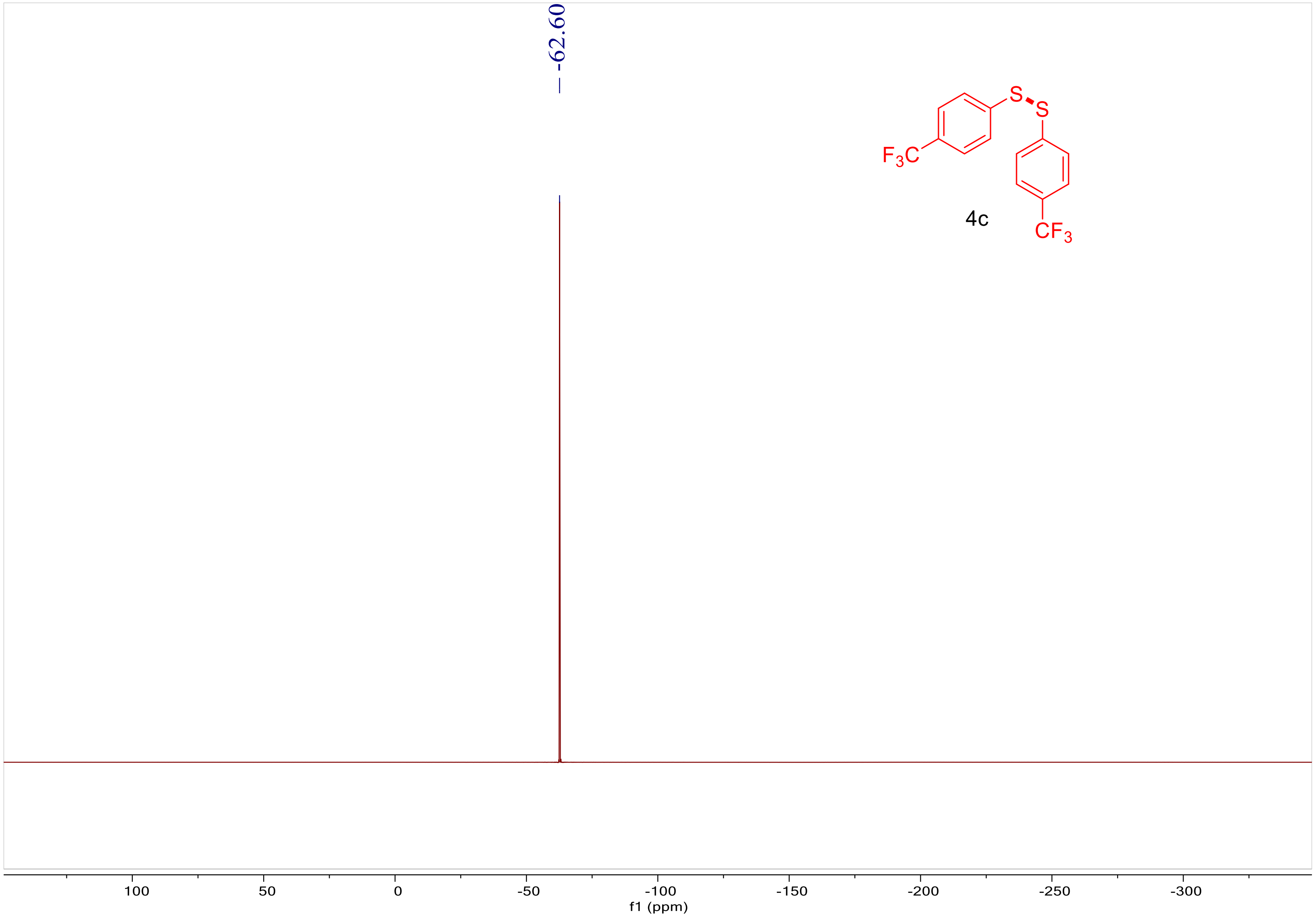
159.95
132.68
128.46
114.66
77.41 CDCl3
77.10 CDCl3
76.78 CDCl3
55.39
MeO
S
S
OMe
4a
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.42
7.39
7.13
7.11
2.34
S
S
Me
Me
4b
4.00
4.11
6.00
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)

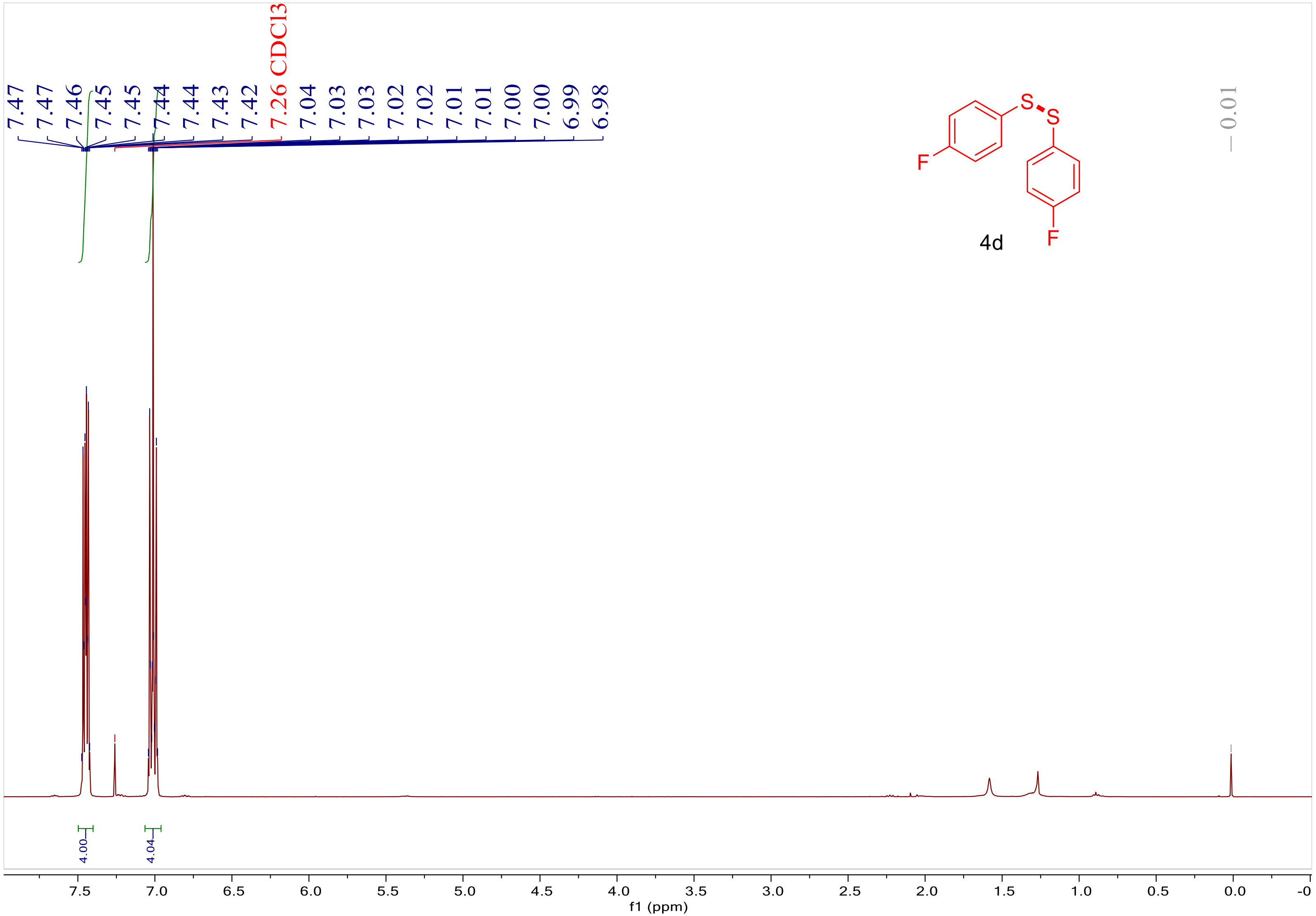

137.48
133.96
129.84
128.59
77.42 CDCl3
77.10 CDCl3
76.78 CDCl3
21.11
S
S
Me
Me
4b
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

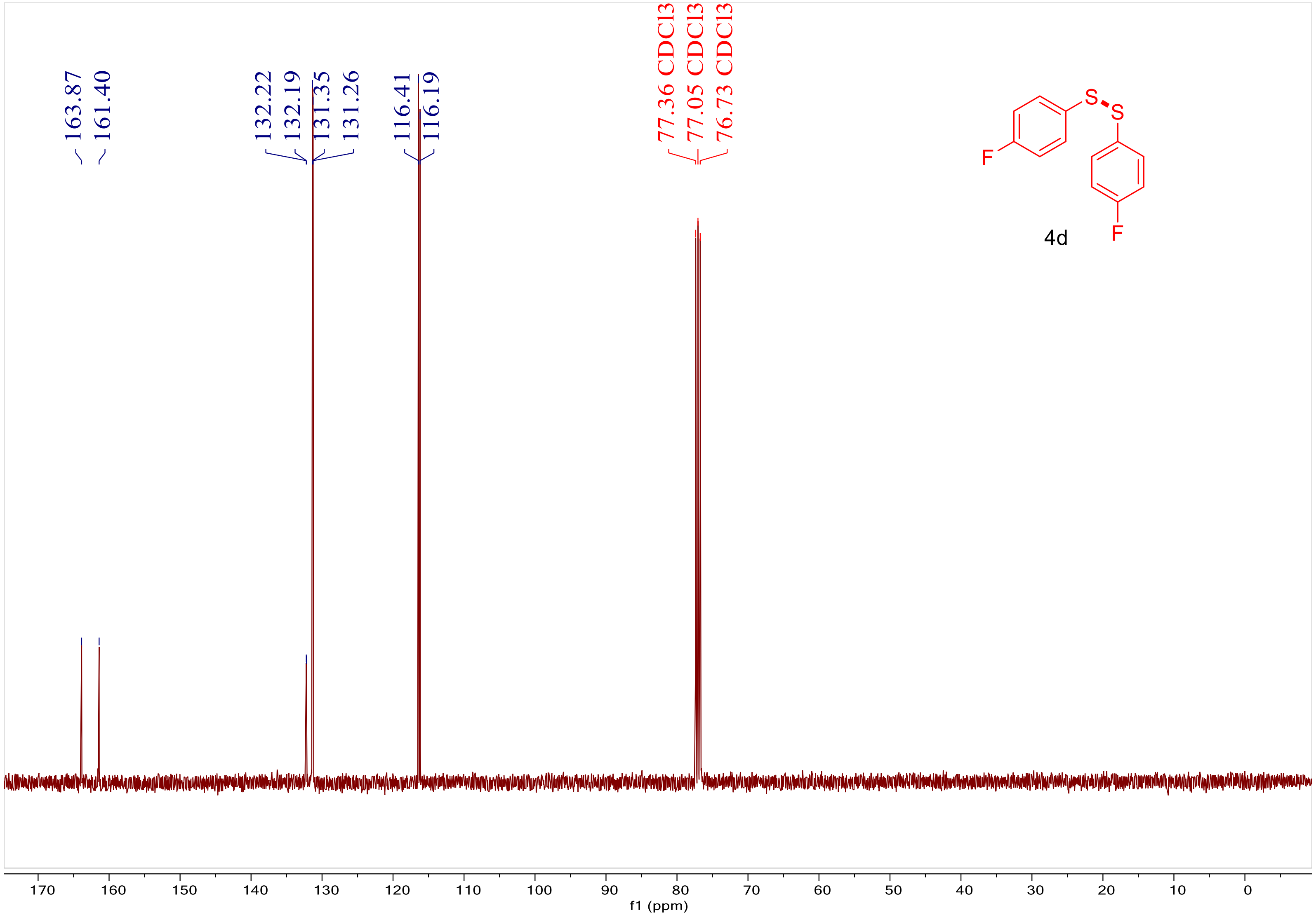

7.61
7.60
7.59
7.58
7.58
7.57
7.56
7.56
7.26 CDCl3
0.02
F3C
S
S
CF3
4c
8.00
f1 (ppm)


140.83
129.94
129.62
129.29
128.96
127.92
126.60
126.19
126.15
126.11
126.08
125.22
122.52
119.81
77.34 CDCl3
77.02 CDCl3
76.70 CDCl3
F3C
S
S
CF3
4c
f1 (ppm)

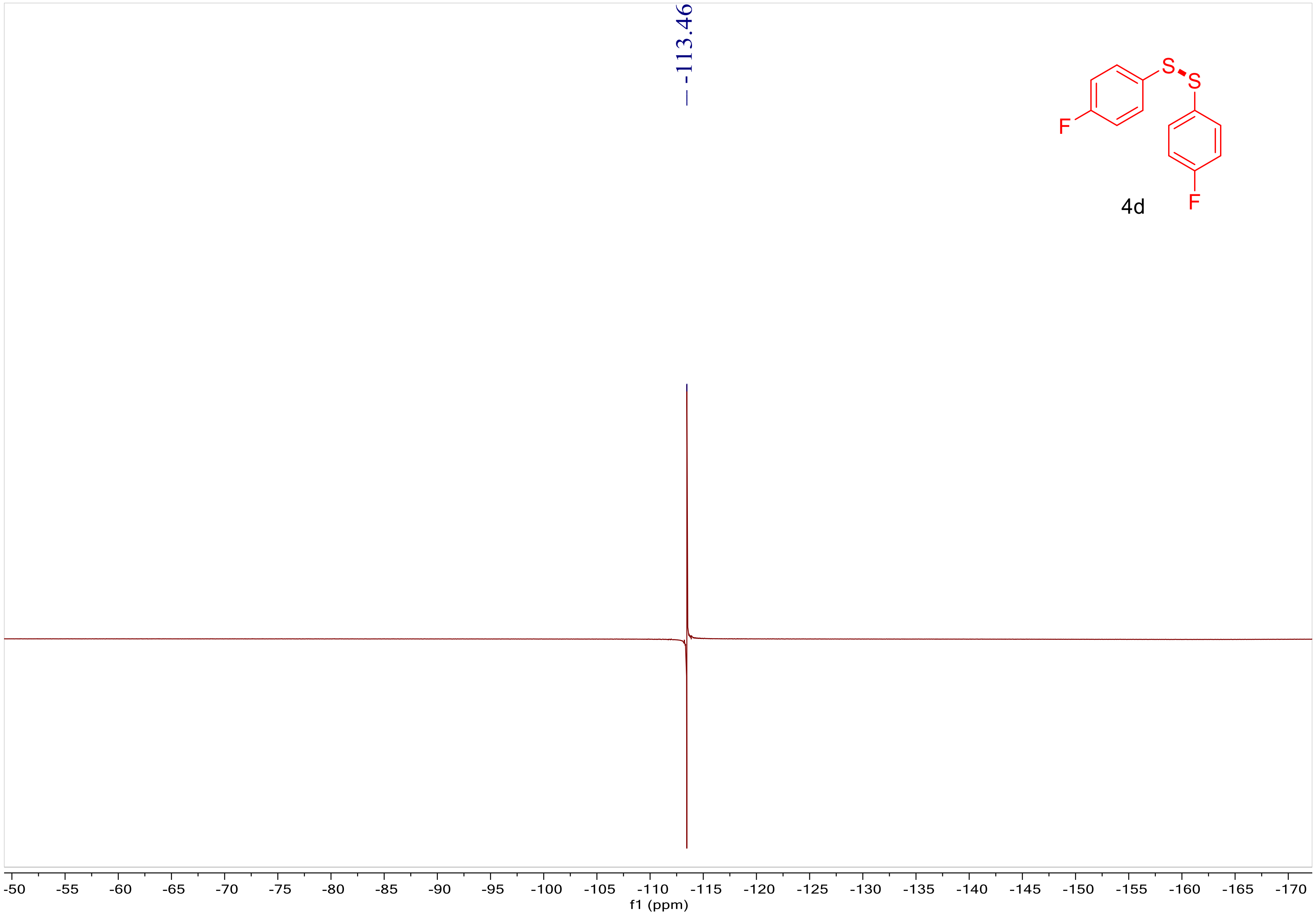


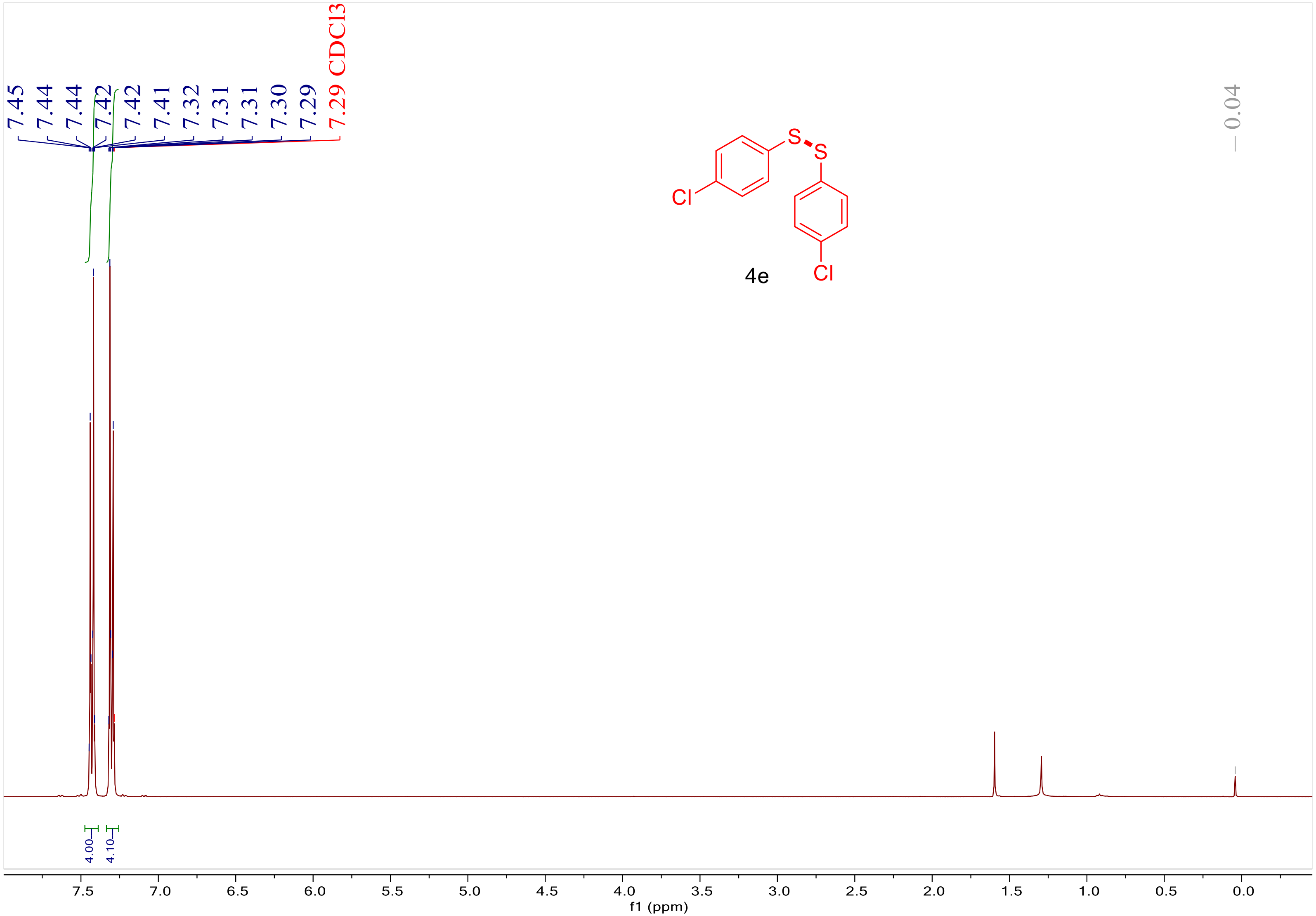
4c


7.47
7.47
7.46
7.45
7.45
7.44
7.44
7.43
7.42
7.26 CDCl3
7.04
7.03
7.03
7.02
7.02
7.01
7.01
7.00
7.00
6.99
6.98
-0.01
S
S
F
F
4d
4.00
4.04
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)

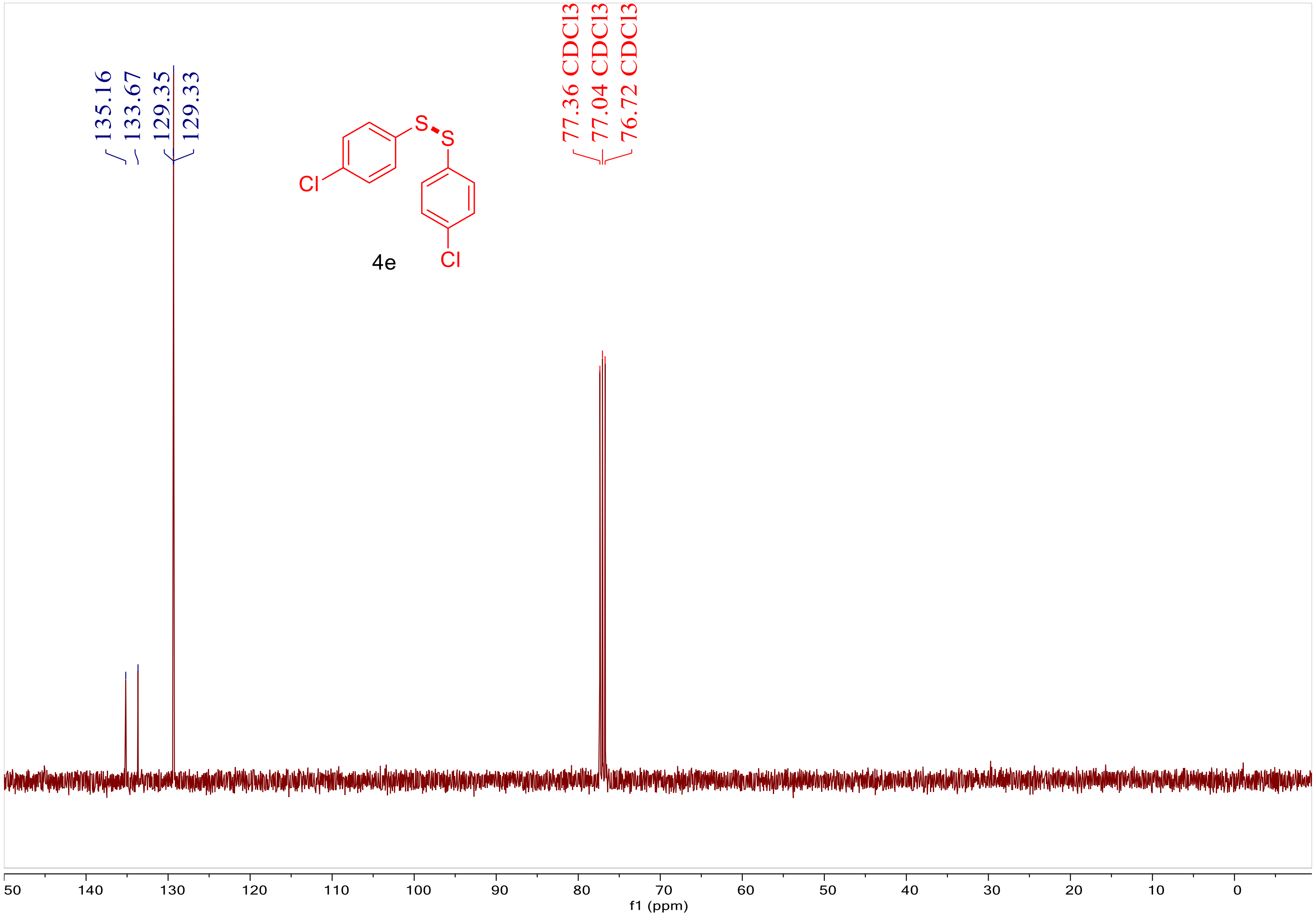


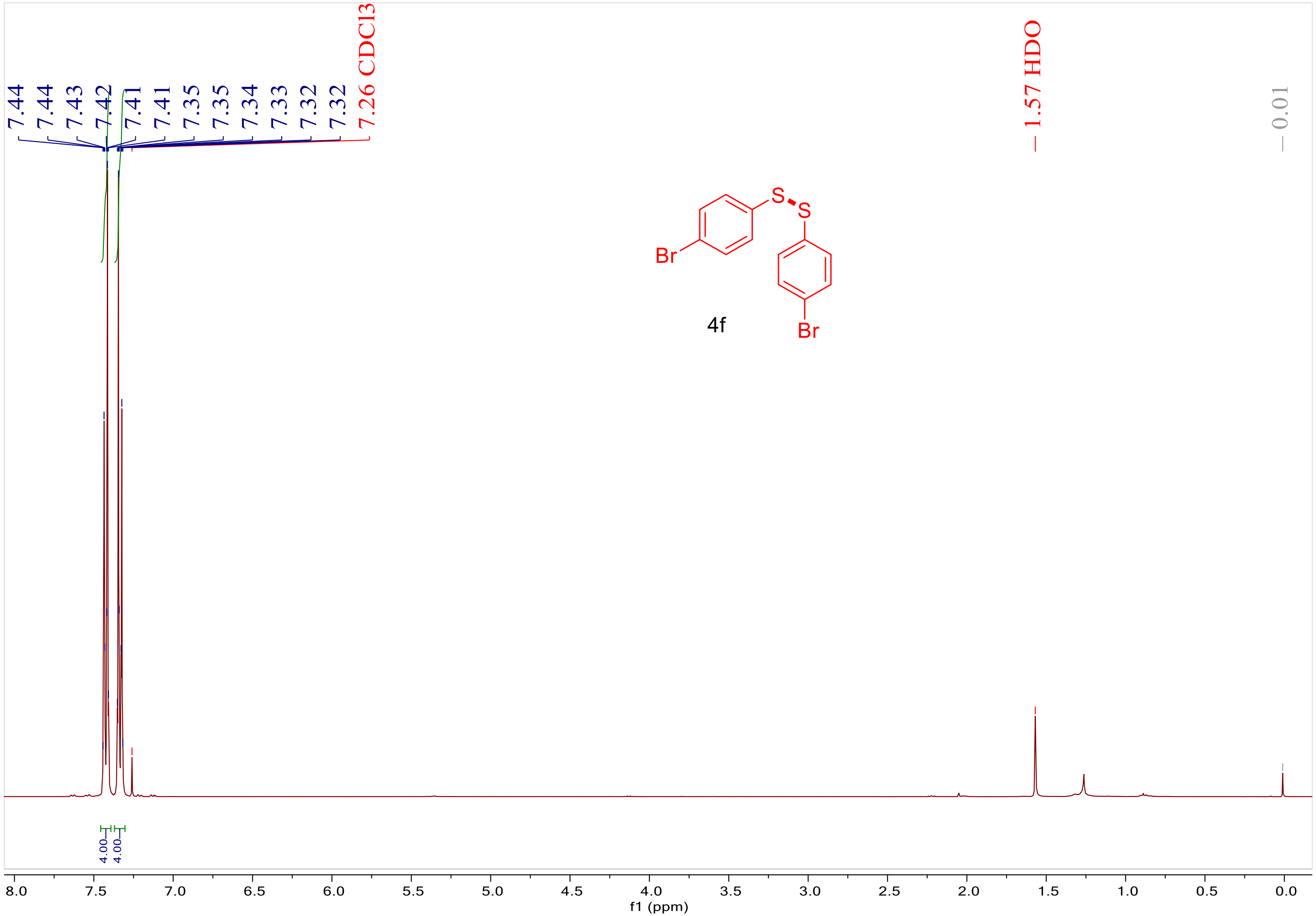
163.87
161.40
132.22
132.19
131.35
131.26
116.41
116.19
77.36 CDCl3
77.05 CDCl3
76.73 CDCl3
S
S
F
F
4d
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

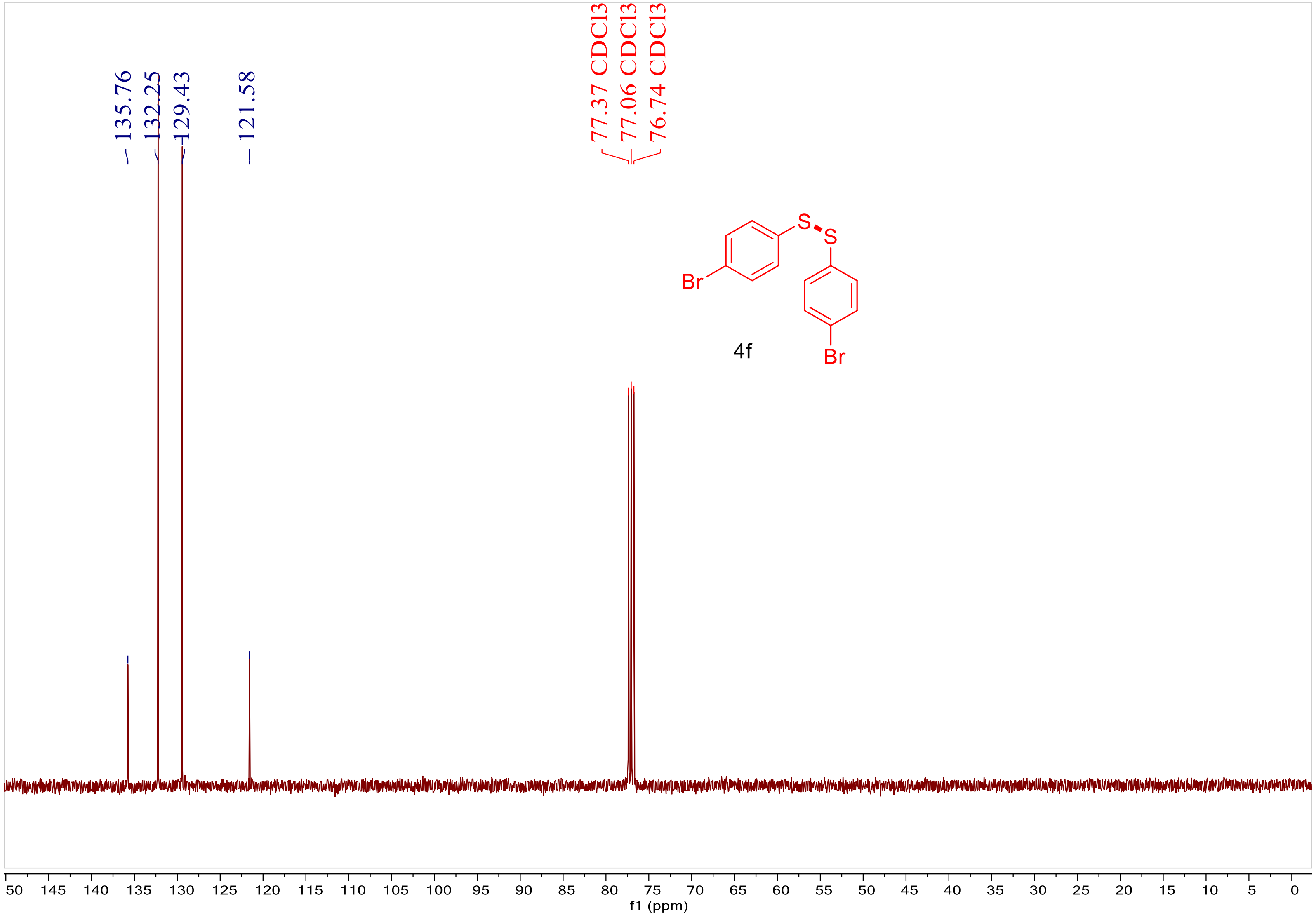

-113.46
F
S
S
F
4d
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
-145
-150
-155
-160
-165
-170
f1 (ppm)

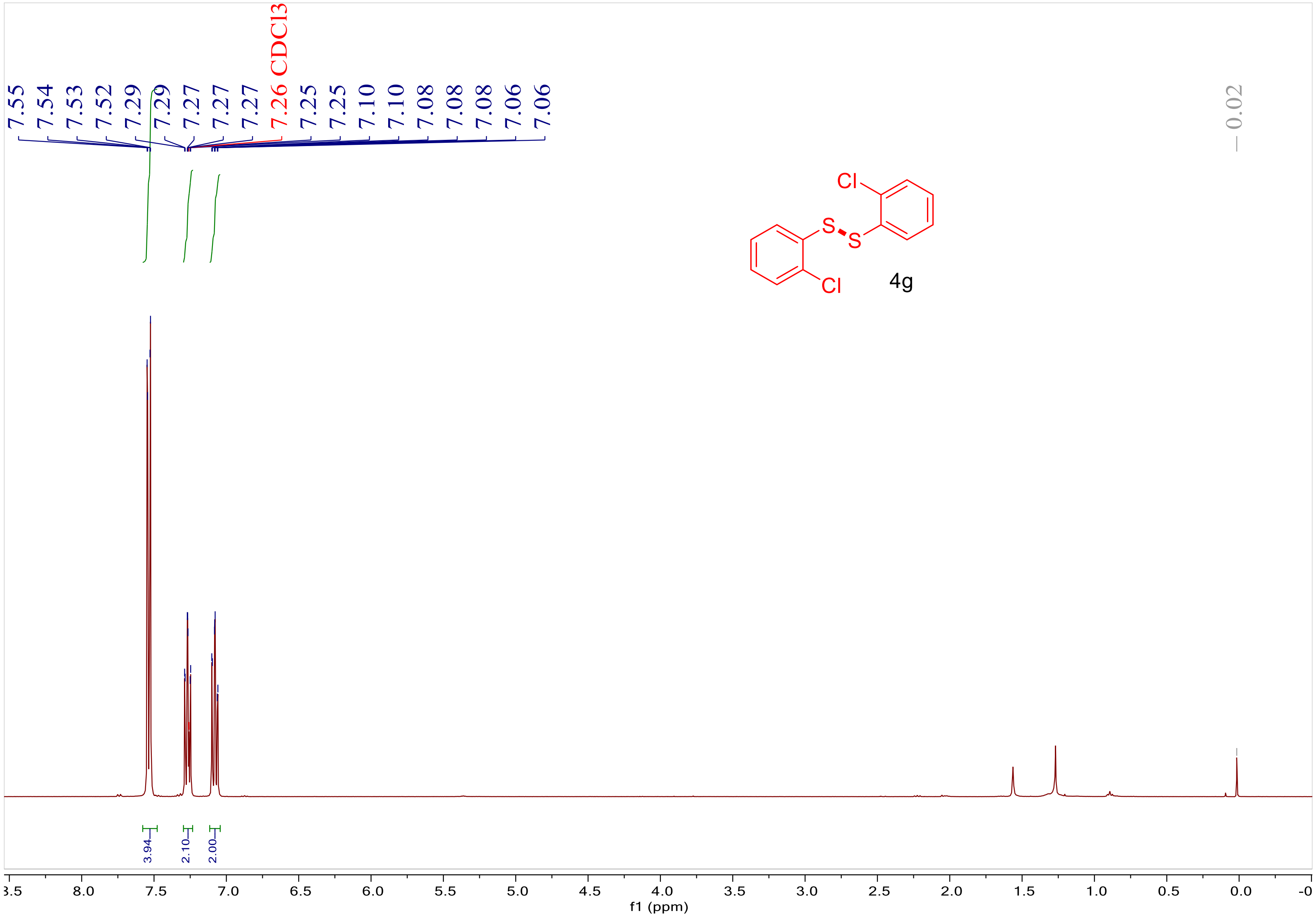


7.45
7.44
7.44
7.42
7.42
7.41
7.32
7.31
7.31
7.30
7.29
7.29 CDCl3
0.04
Cl
S
S
Cl
4e
4.00
4.10
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

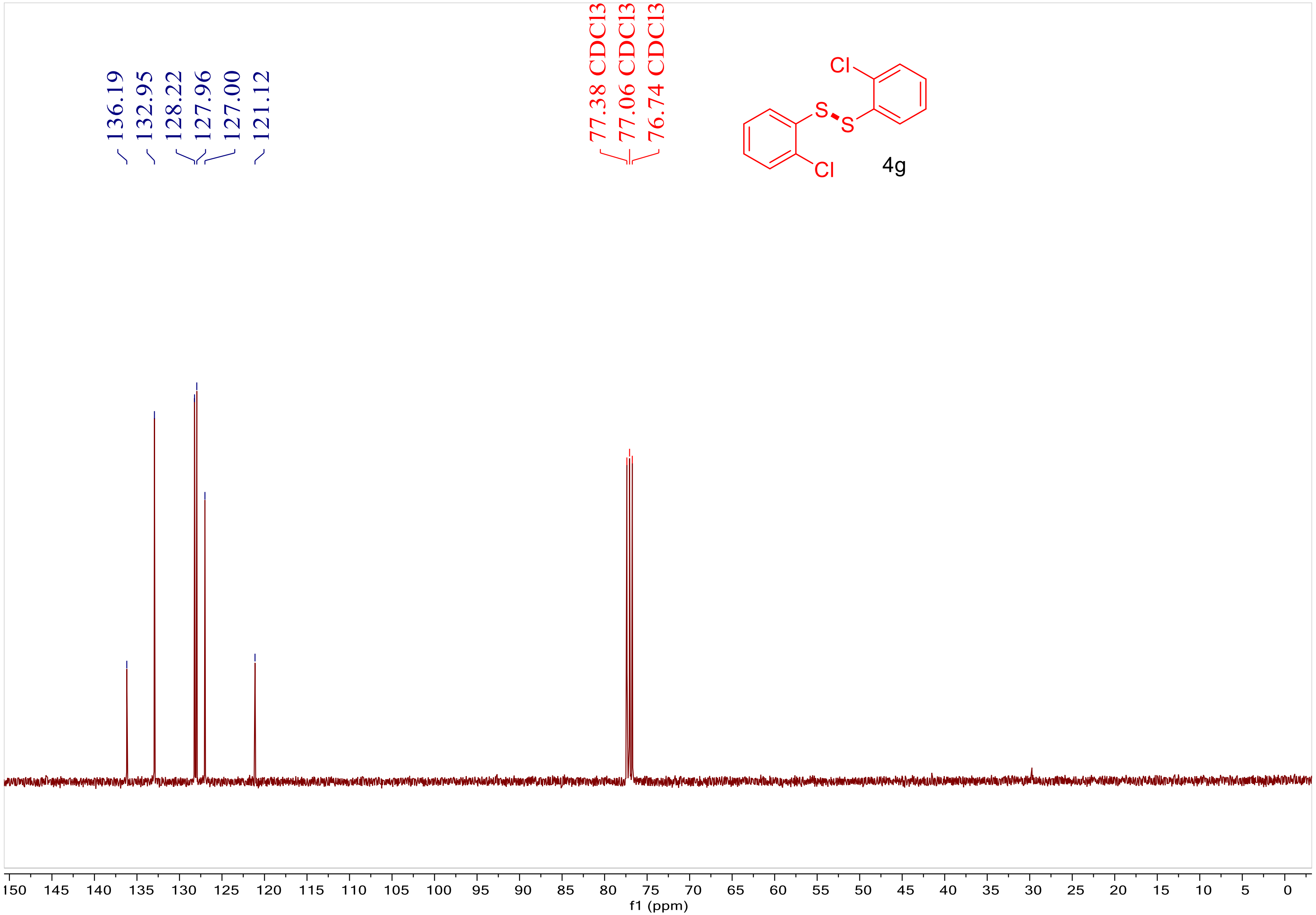

135.16
133.67
129.35
129.33
77.36 CDCl3
77.04 CDCl3
76.72 CDCl3
Cl
S
S
Cl
4e
50
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

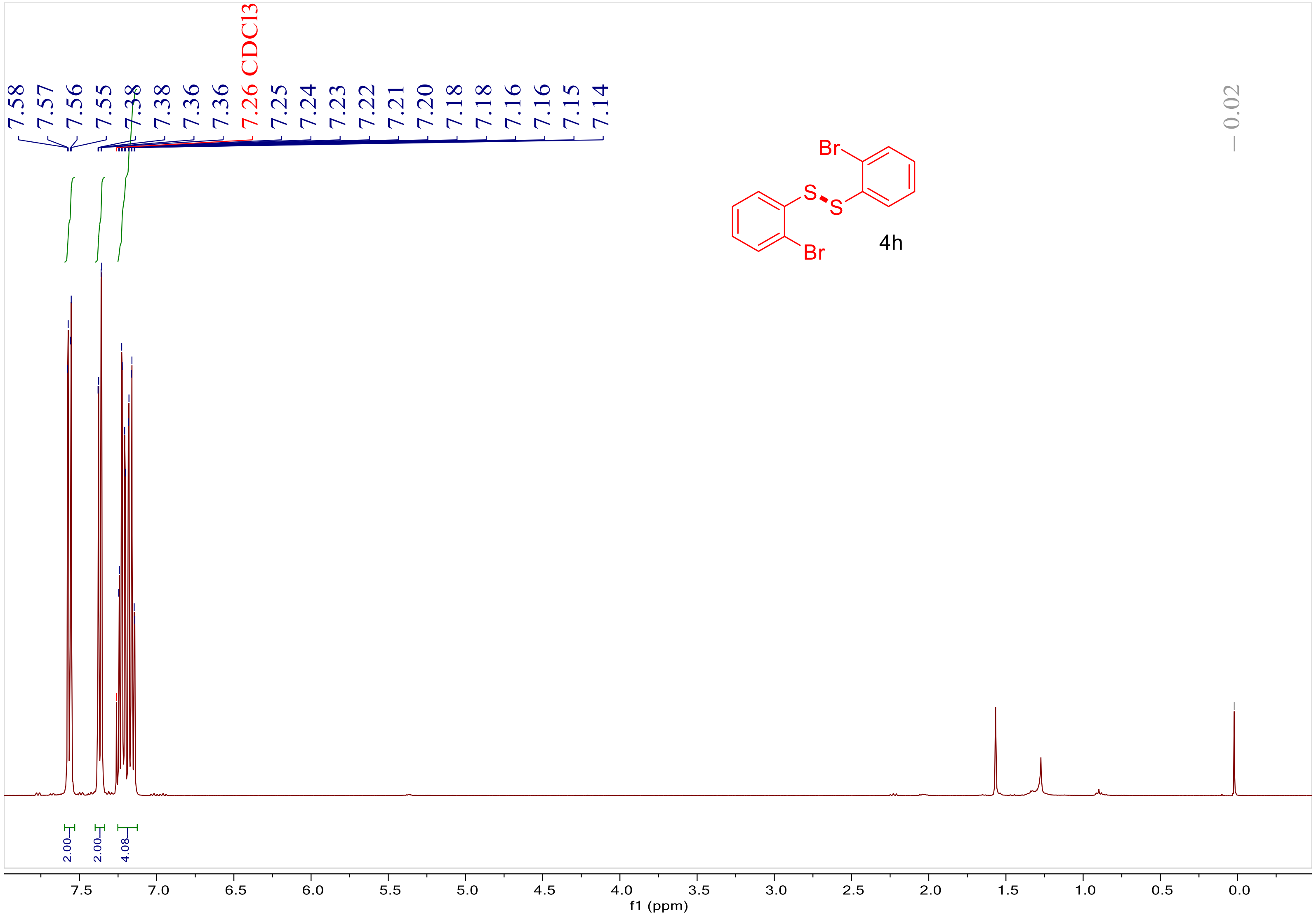

7.44
7.44
7.43
7.42
7.41
7.41
7.35
7.35
7.34
7.33
7.32
7.32
7.26 CDCl3
1.57 HDO
0.01
Br
S
S
Br
4f
4.00
4.00
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

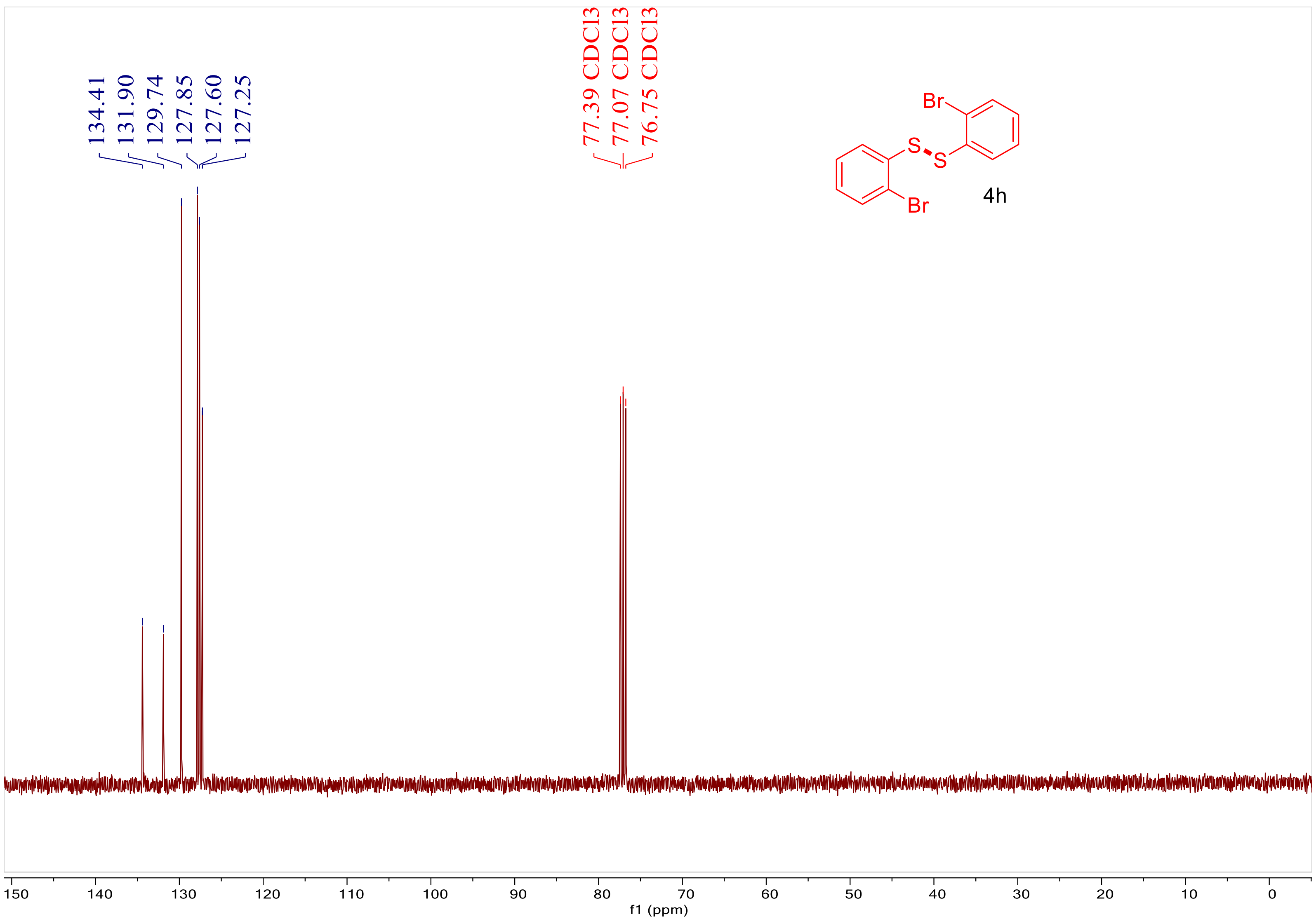

135.76
132.25
129.43
121.58
77.37 CDCl3
77.06 CDCl3
76.74 CDCl3
Br
S
S
Br
4f
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
f1 (ppm)

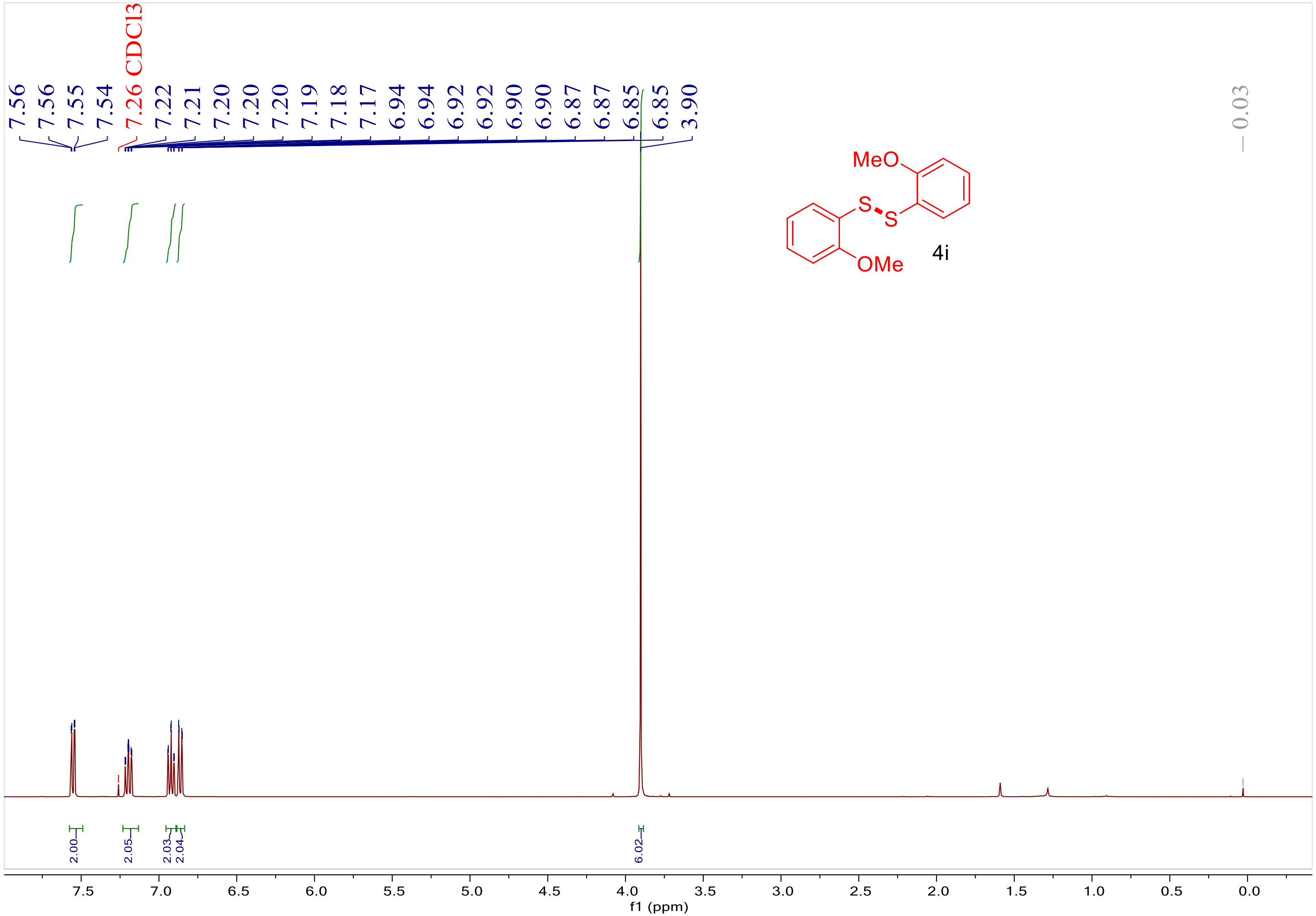

7.55
7.54
7.53
7.52
7.29
7.29
7.27
7.27
7.27
7.26 CDCl3
7.25
7.25
7.10
7.10
7.08
7.08
7.08
7.06
7.06
-0.02
Cl
S
S
Cl
3.94
2.10
2.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0
f1 (ppm)

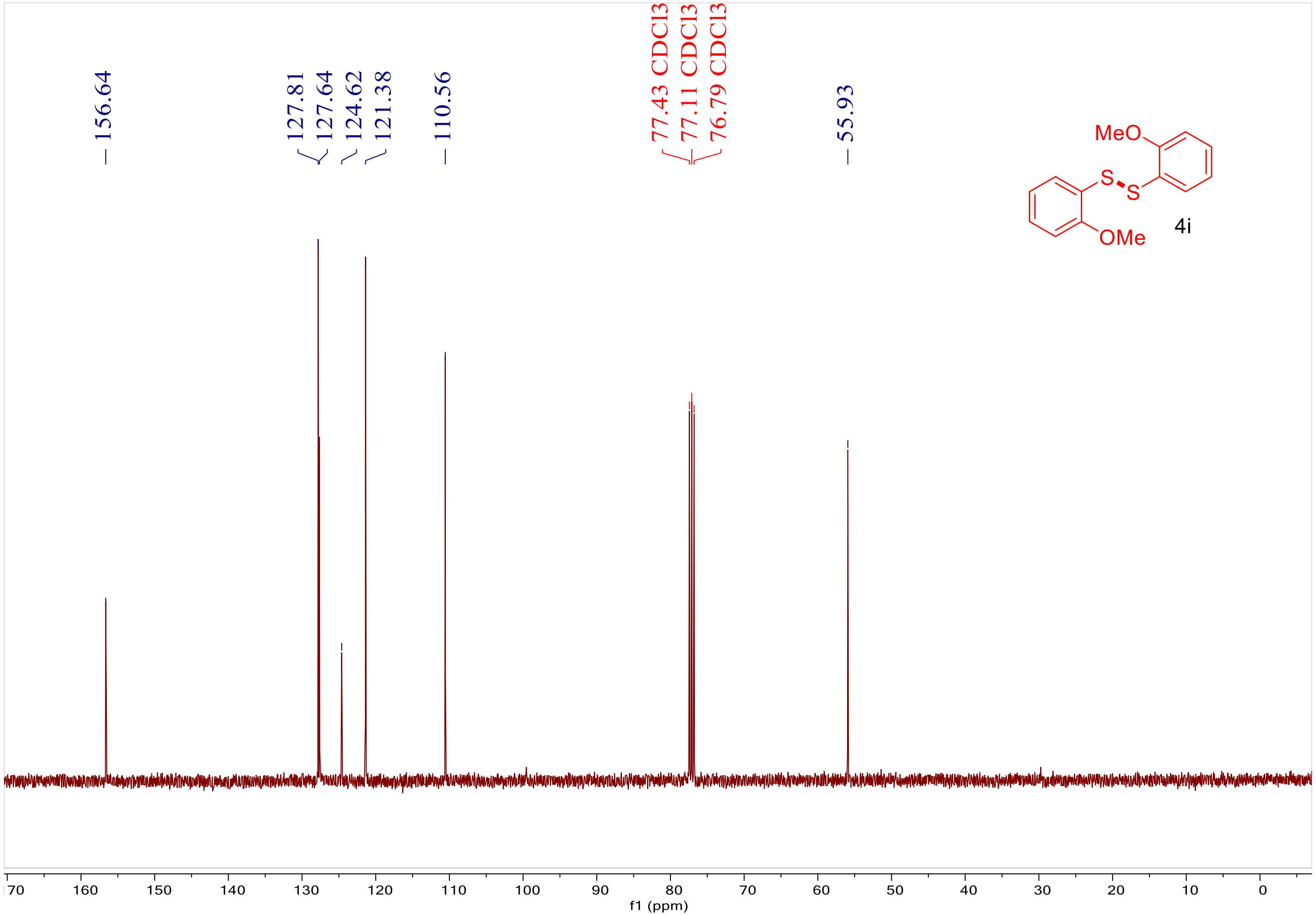
4g


136.19
132.95
128.22
127.96
127.00
121.12
77.38 CDCl3
77.06 CDCl3
76.74 CDCl3
Cl
S
S
Cl
4g
150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0
f1 (ppm)

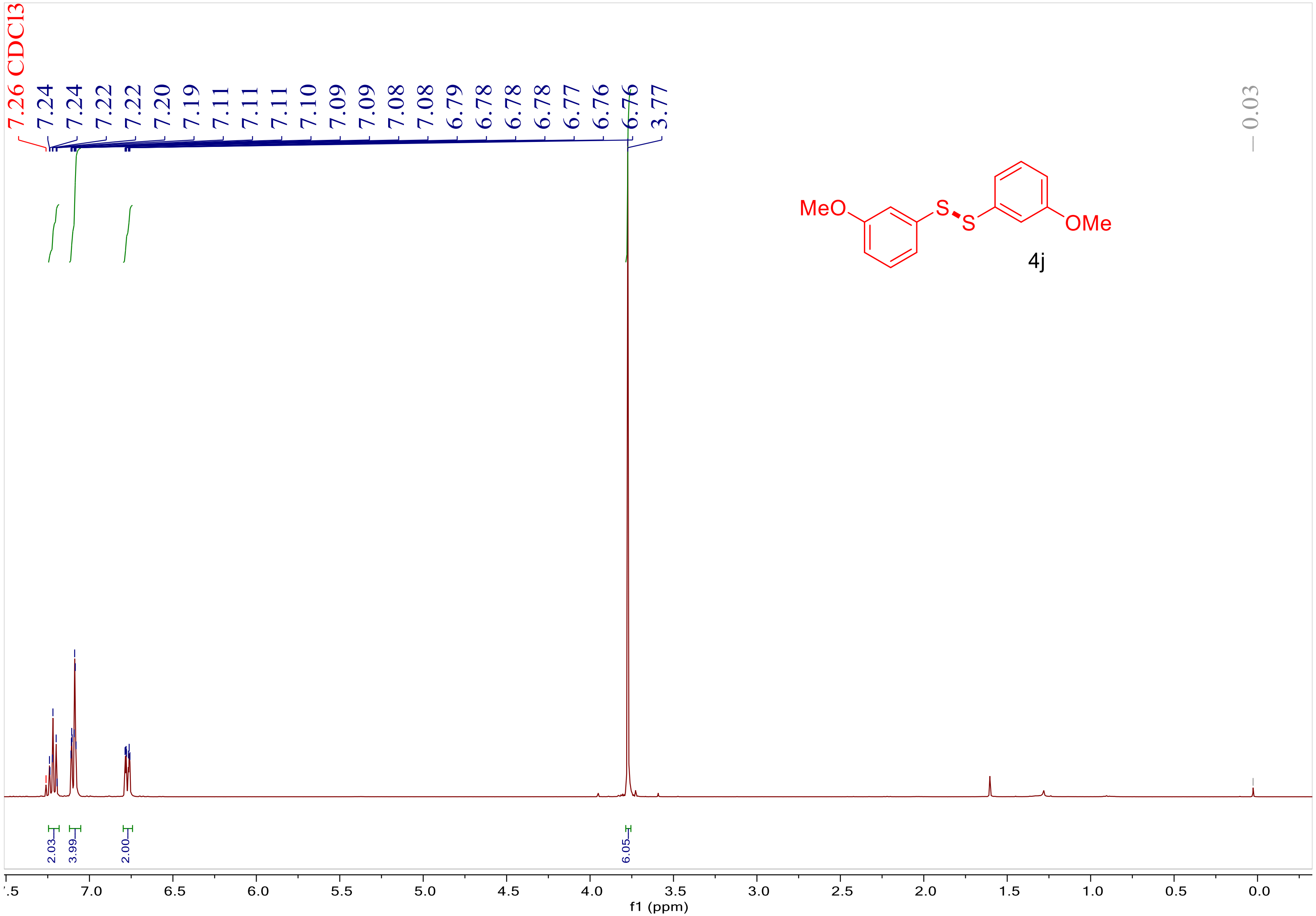

7.58
7.57
7.56
7.55
7.38
7.38
7.36
7.36
7.26 CDCl3
7.25
7.24
7.23
7.22
7.21
7.20
7.18
7.18
7.16
7.16
7.15
7.14
0.02
Br
S
S
Br
4h
2.00
2.00
4.08
f1 (ppm)

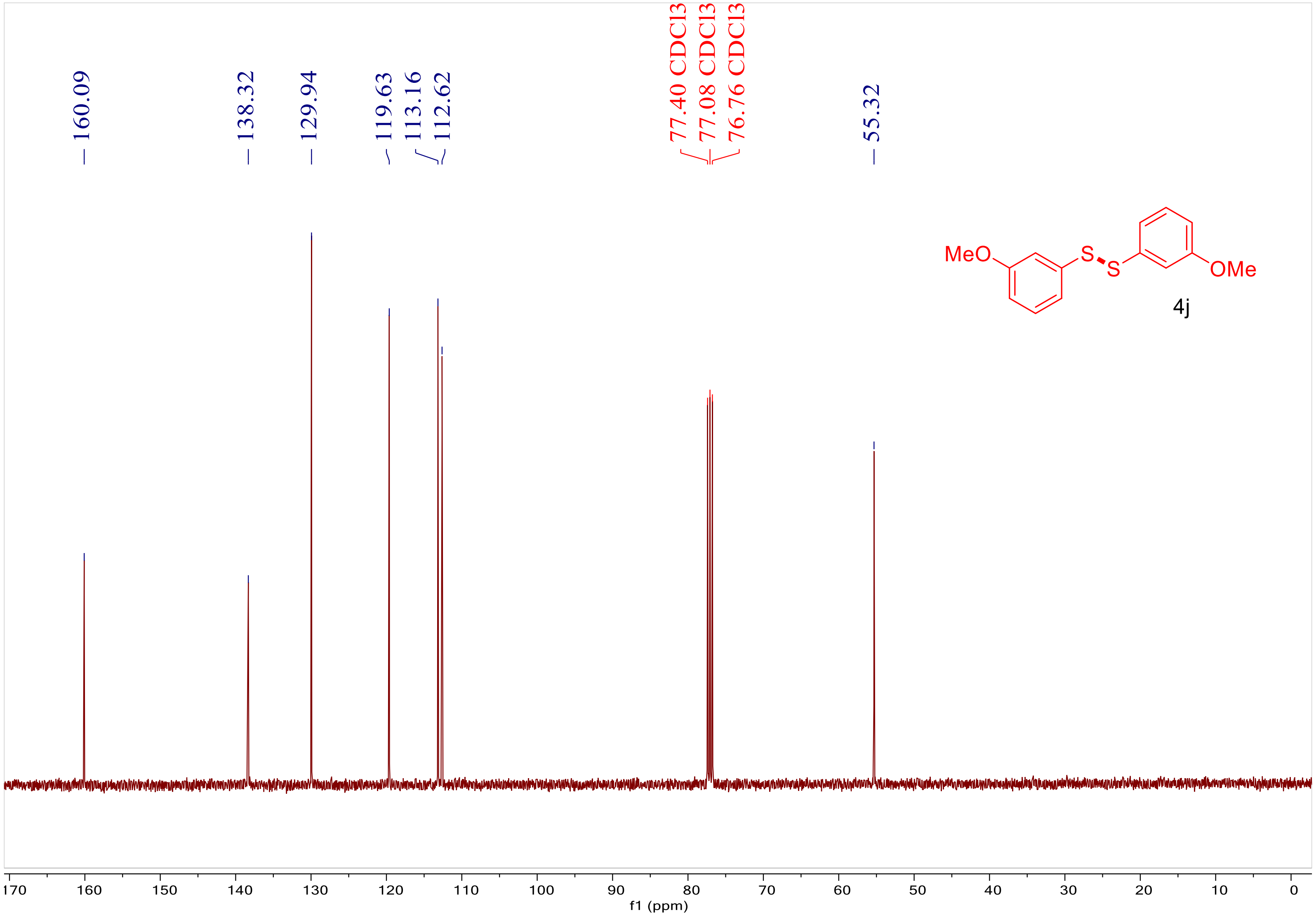

134.41
131.90
129.74
127.85
127.60
127.25
77.39 CDCl3
77.07 CDCl3
76.75 CDCl3
Br
S
S
Br
4h
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

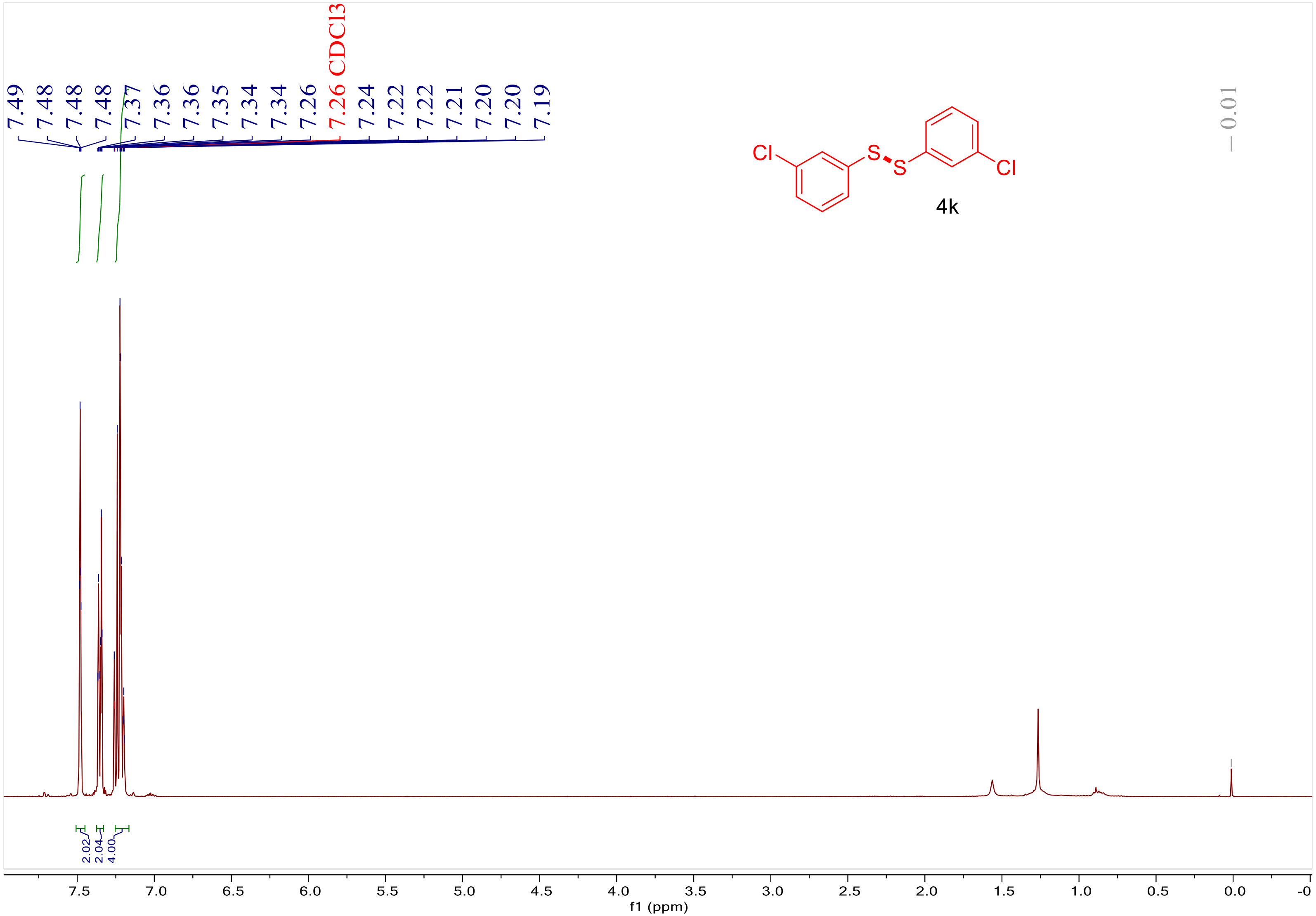

7.56
7.56
7.55
7.54
7.26 CDCl3
7.22
7.21
7.20
7.20
7.20
7.19
7.18
7.17
6.94
6.94
6.92
6.92
6.90
6.90
6.87
6.87
6.85
6.85
3.90
-0.03
MeO
S
S
OMe
4i
2.00
2.05
2.03
2.04
6.02
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

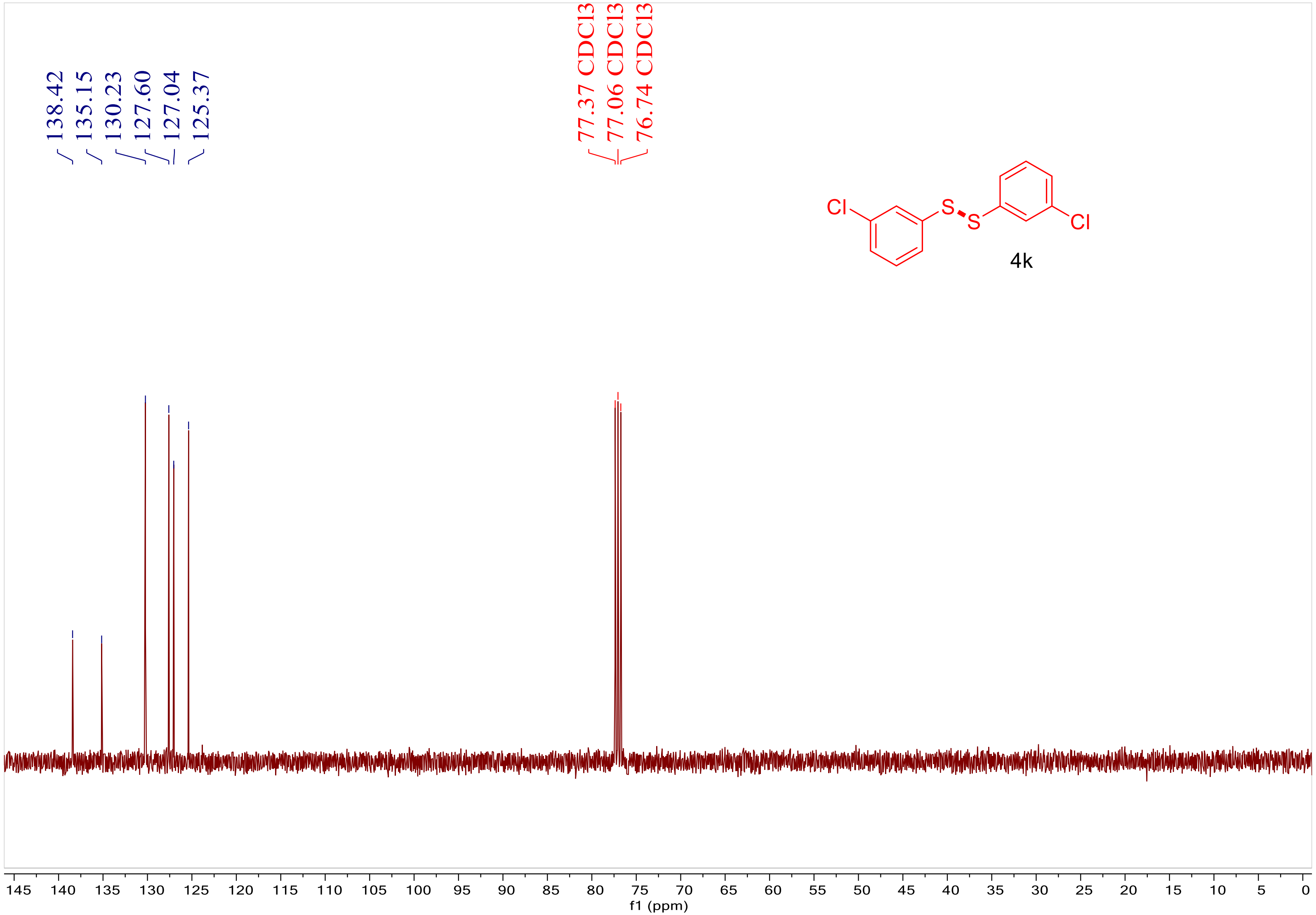


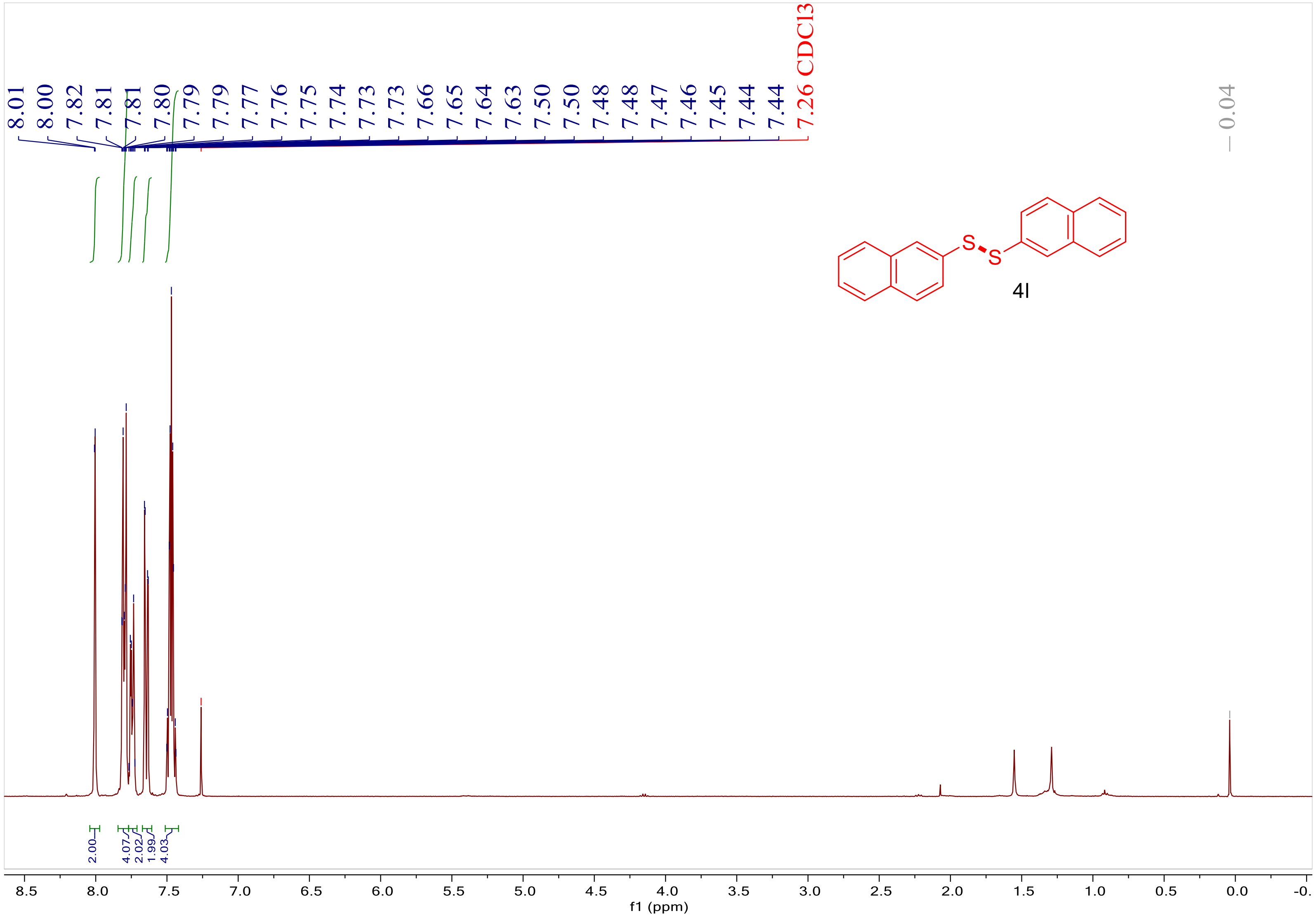
156.64
127.81
127.64
124.62
121.38
110.56
77.43 CDCl3
77.11 CDCl3
76.79 CDCl3
55.93
MeO
S
S
OMe
4i
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

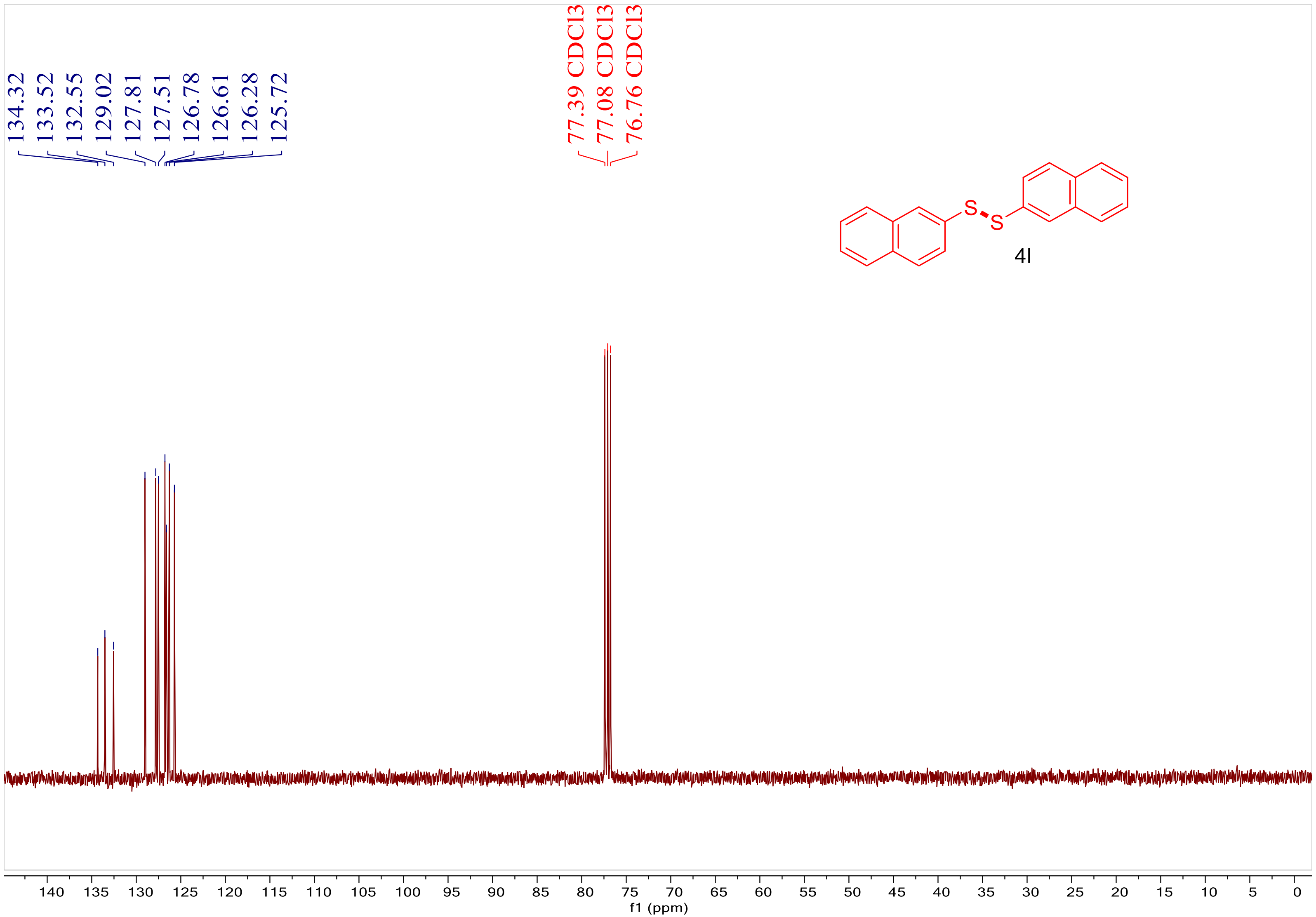

7.26 CDCl3
7.24
7.24
7.22
7.22
7.20
7.19
7.11
7.11
7.11
7.10
7.09
7.09
7.08
7.08
6.79
6.78
6.78
6.78
6.77
6.76
6.76
3.77
-0.03
MeO
S
S
OMe
4j
2.03
3.99
2.00
6.05
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

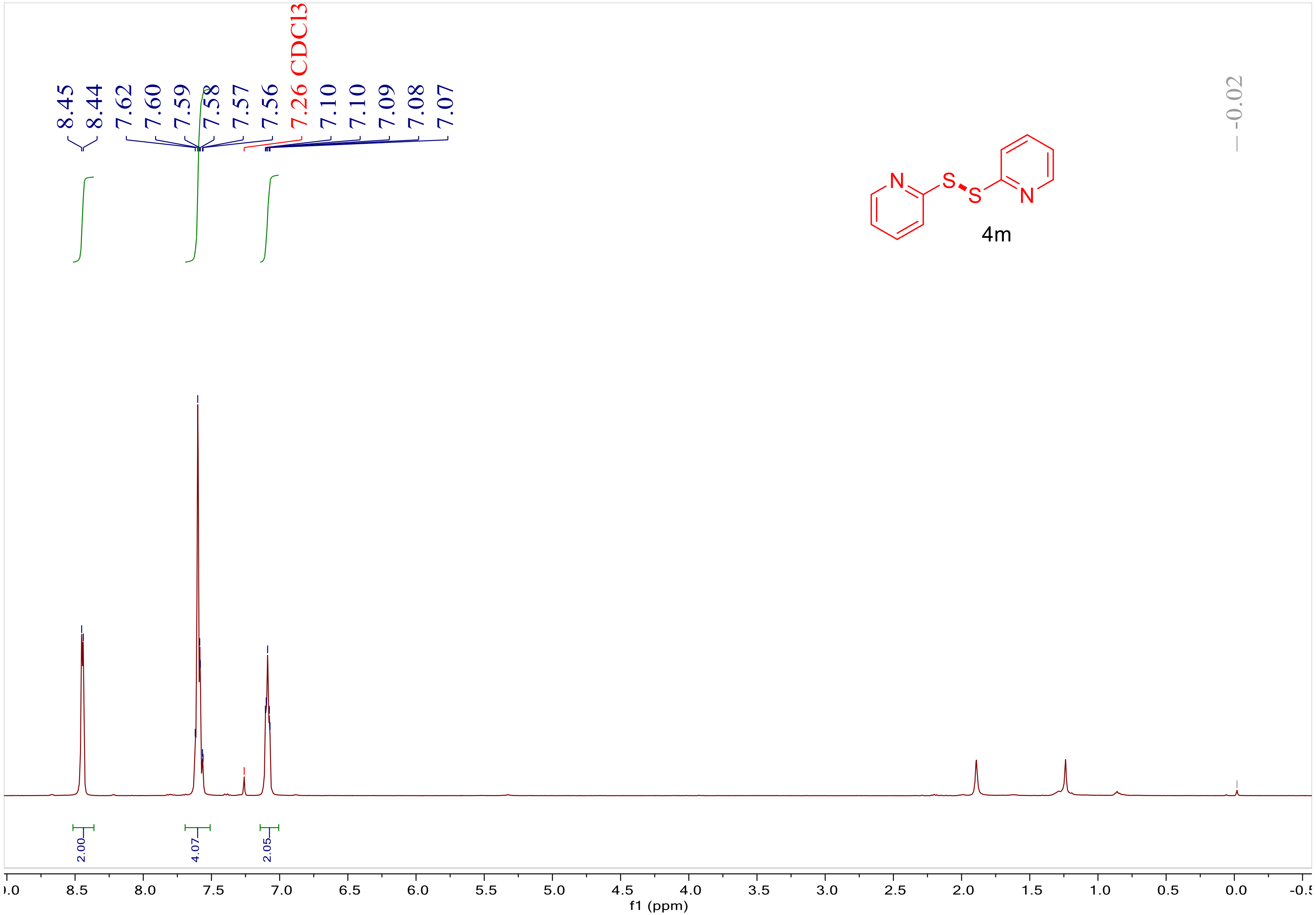

160.09
138.32
129.94
119.63
113.16
112.62
77.40 CDCl3
77.08 CDCl3
76.76 CDCl3
55.32
MeO
S
S
OMe
4j
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

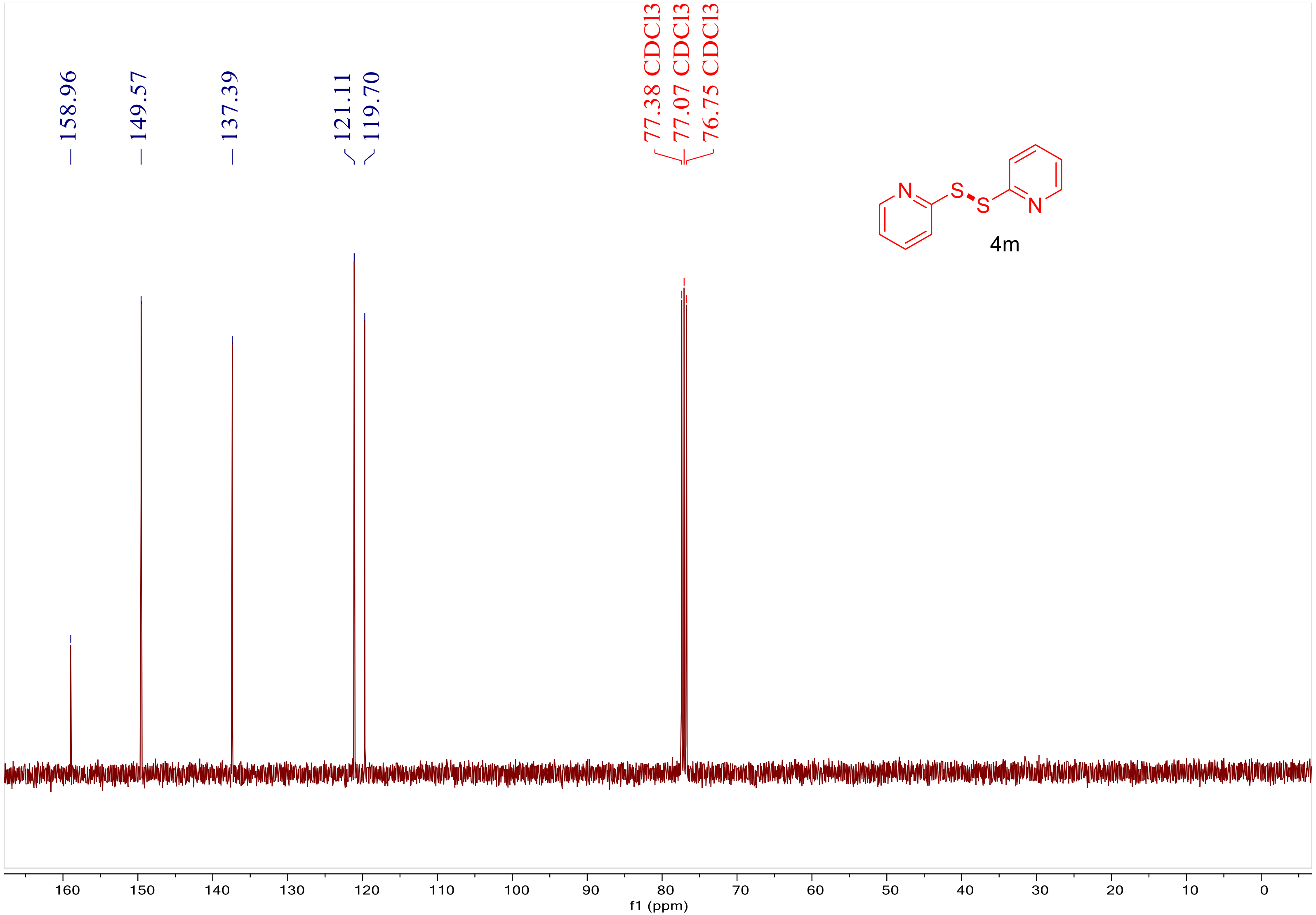

7.49
7.48
7.48
7.48
7.37
7.36
7.36
7.35
7.34
7.34
7.26
7.26 CDCl3
7.24
7.22
7.22
7.21
7.20
7.20
7.19
-0.01
Cl
S
S
Cl
4k
2.02
2.04
4.00
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0
f1 (ppm)


138.42
135.15
130.23
127.60
127.04
125.37
77.37 CDCl3
77.06 CDCl3
76.74 CDCl3
Cl
S
S
Cl
4k
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)

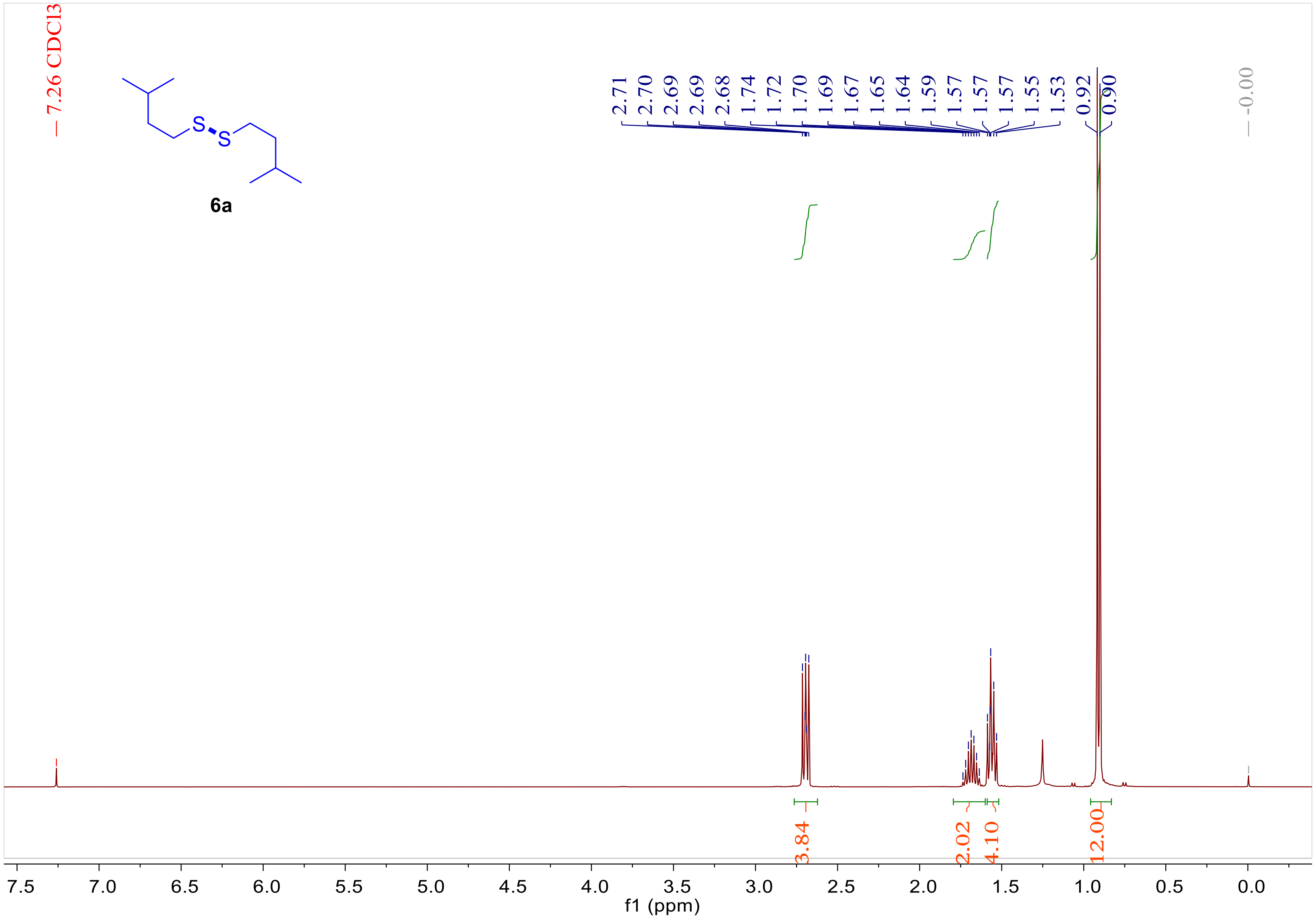

8.01
8.00
7.82
7.81
7.81
7.80
7.79
7.79
7.77
7.76
7.75
7.74
7.73
7.73
7.66
7.65
7.64
7.63
7.50
7.50
7.48
7.48
7.47
7.46
7.45
7.44
7.44
7.26 CDCl3
0.04
S
S
4l
2.00
4.07
2.02
1.99
4.03
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.
f1 (ppm)


134.32
133.52
132.55
129.02
127.81
127.51
126.78
126.61
126.28
125.72
77.39 CDCl3
77.08 CDCl3
76.76 CDCl3
S
S
4l
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)

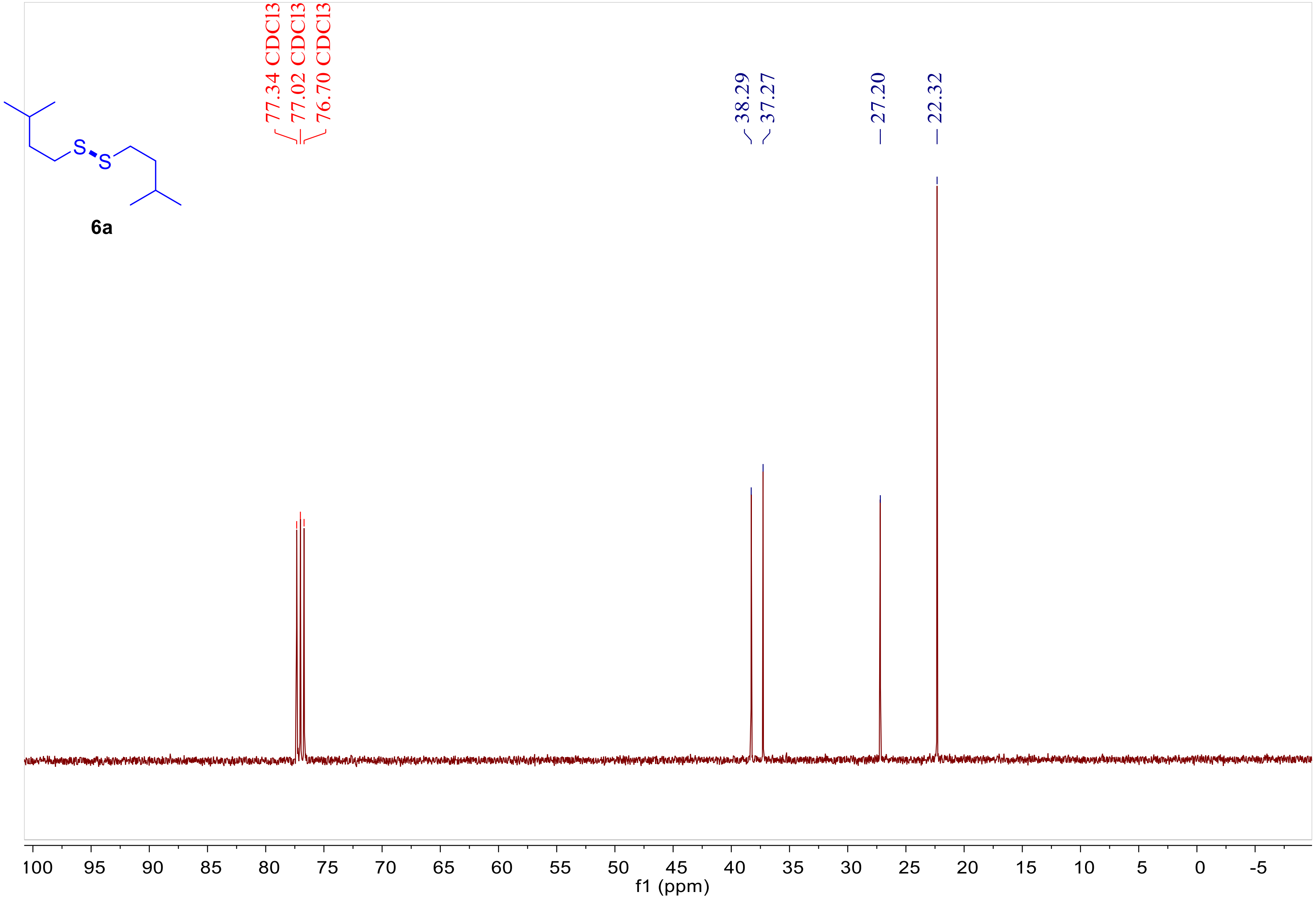

8.45
8.44
7.62
7.60
7.59
7.58
7.57
7.56
7.26 CDCl3
7.10
7.10
7.09
7.08
7.07
-0.02
N
S
S
N
4m
2.00
4.07
2.05
f1 (ppm)

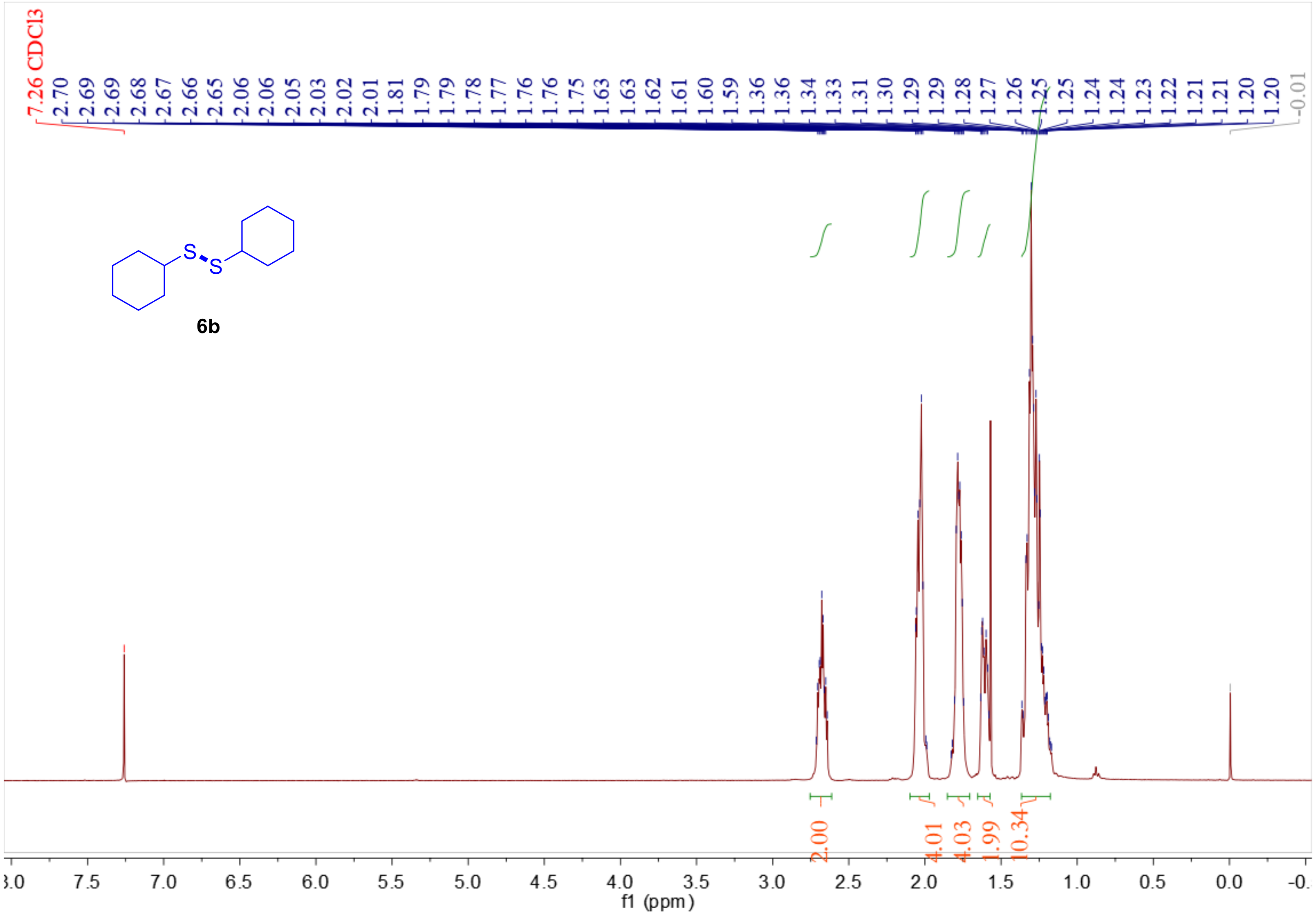


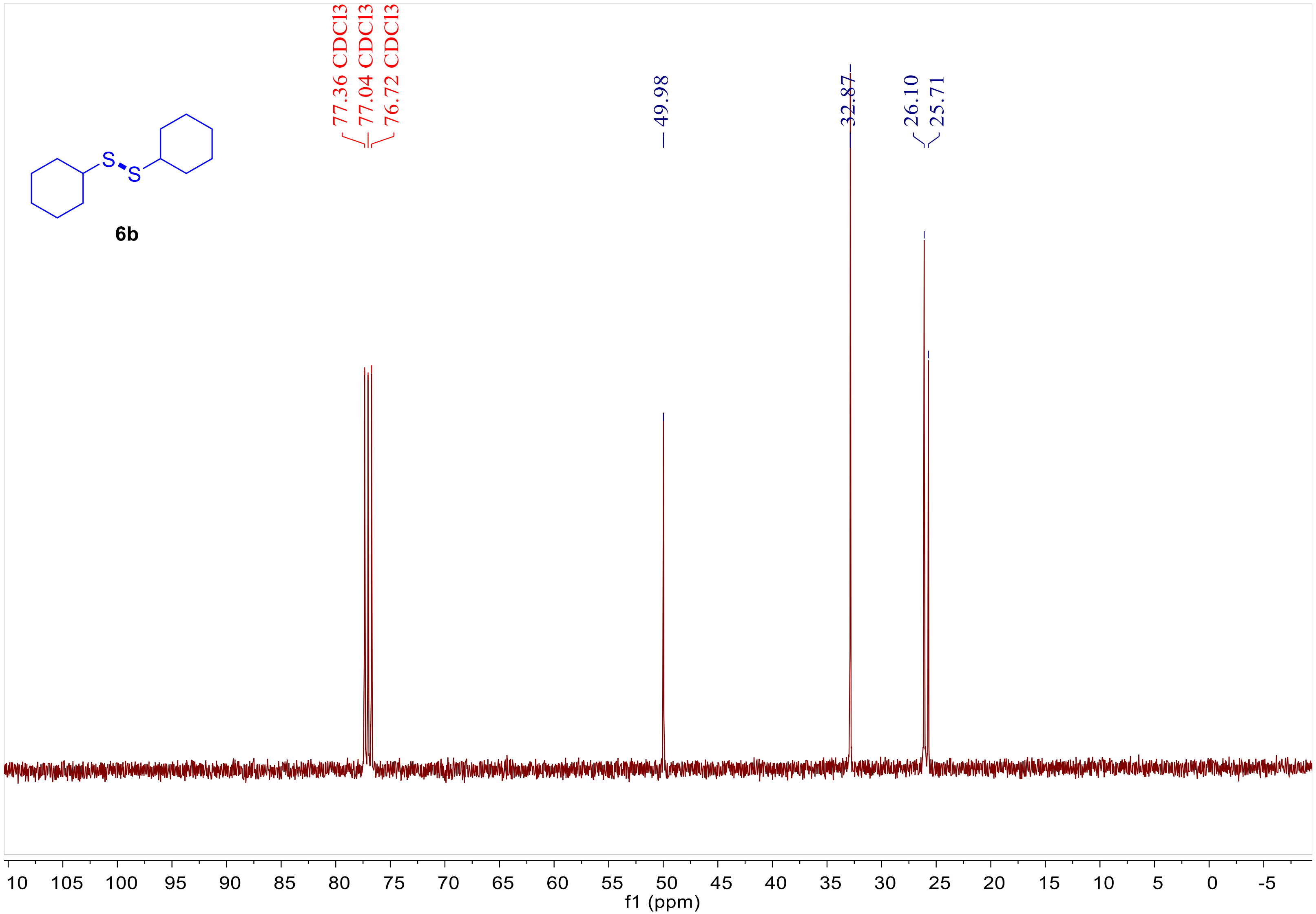
158.96
149.57
137.39
121.11
119.70
77.38 CDCl3
77.07 CDCl3
76.75 CDCl3
4m
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



7.26 CDCl3
S
S
6a
2.71
2.70
2.69
2.69
2.68
1.74
1.72
1.70
1.69
1.67
1.65
1.64
1.59
1.57
1.57
1.57
1.55
1.53
0.92
0.90
-0.00
3.84
2.02
4.10
12.00
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)

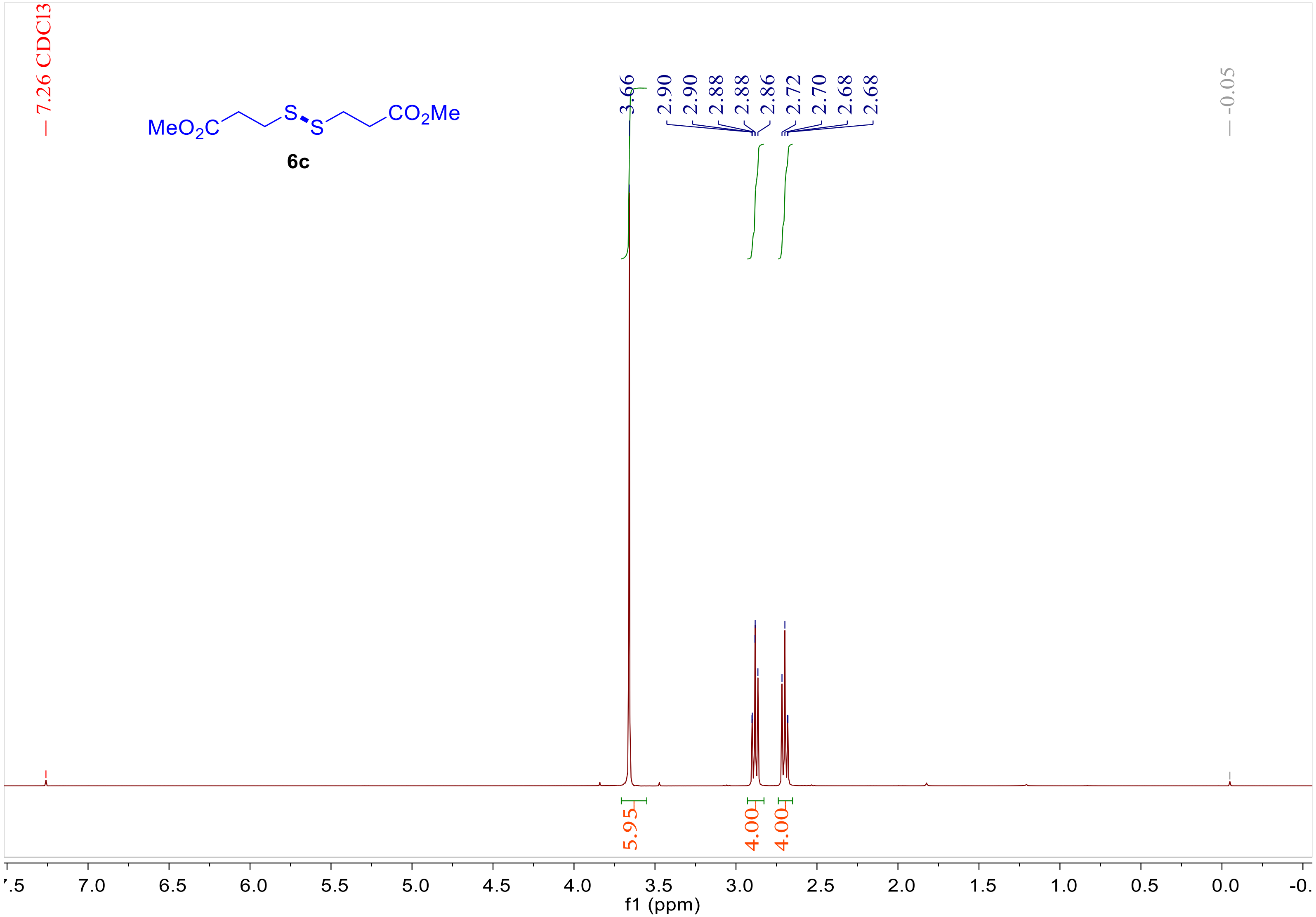

6a
77.34 CDCl3
77.02 CDCl3
76.70 CDCl3
38.29
37.27
27.20
22.32
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5
f1 (ppm)

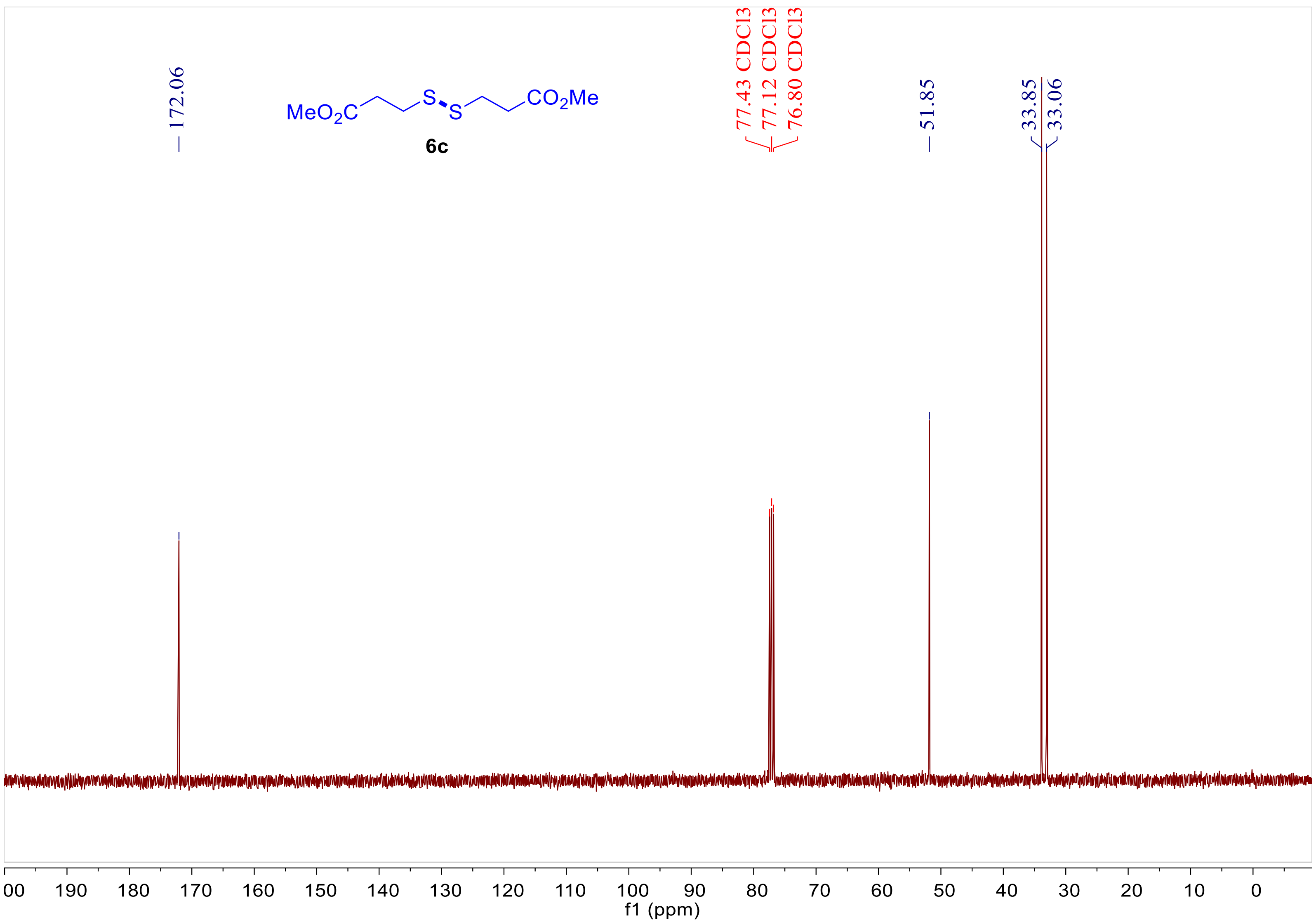

7.26 CDCl3
2.70
2.69
2.69
2.68
2.67
2.66
2.65
2.06
2.06
2.05
2.03
2.02
2.01
1.81
1.79
1.79
1.78
1.77
1.76
1.76
1.75
1.63
1.63
1.62
1.61
1.60
1.59
1.36
1.36
1.34
1.33
1.31
1.30
1.29
1.29
1.28
1.27
1.26
1.25
1.25
1.24
1.24
1.23
1.22
1.21
1.21
1.20
1.20
-0.01
S
S
6b
2.00
4.01
4.03
1.99
10.34
f1 (ppm)

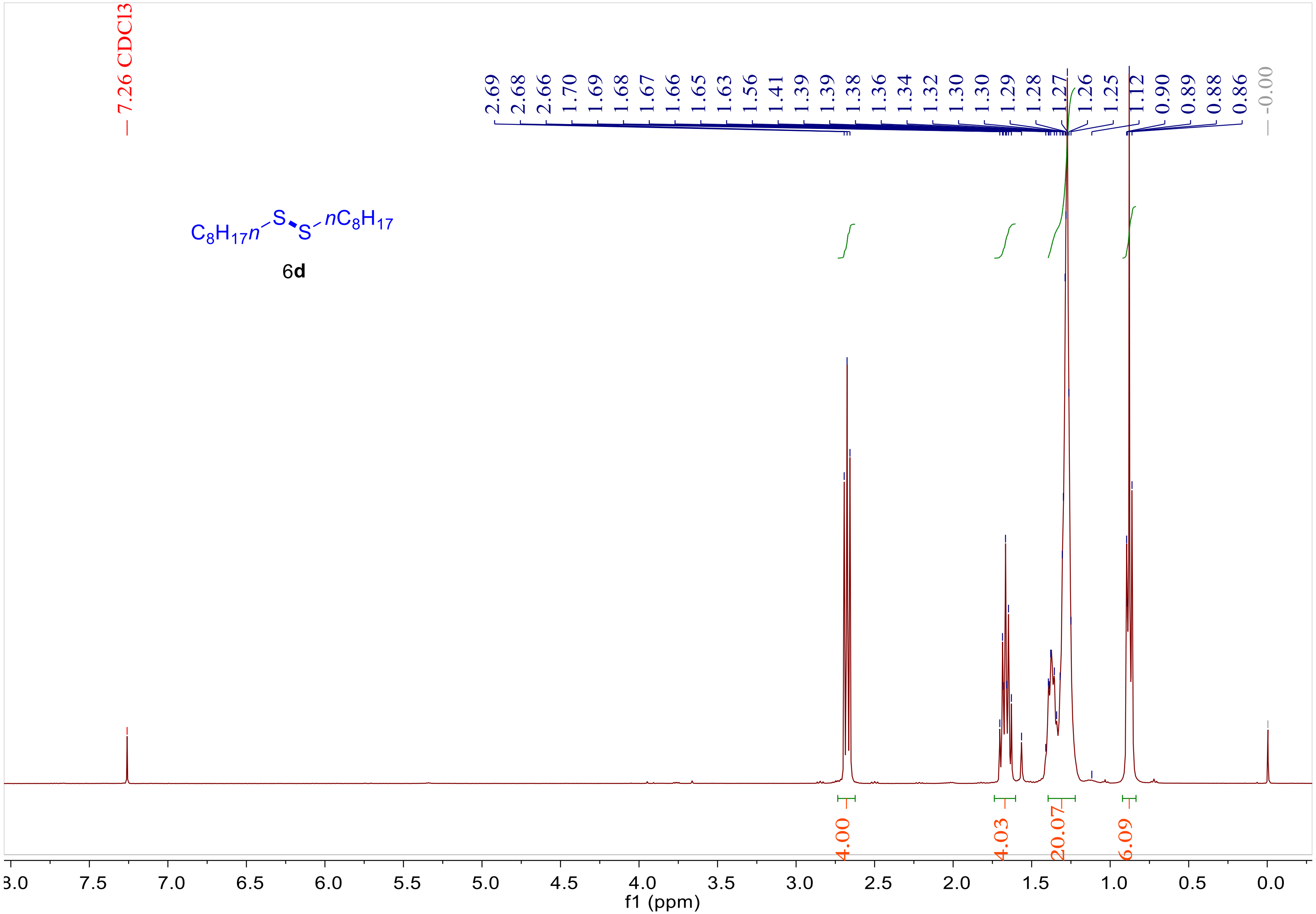


77.36 CDCl3
77.04 CDCl3
76.72 CDCl3
49.98
32.87
26.10
25.71
10
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
f1 (ppm)

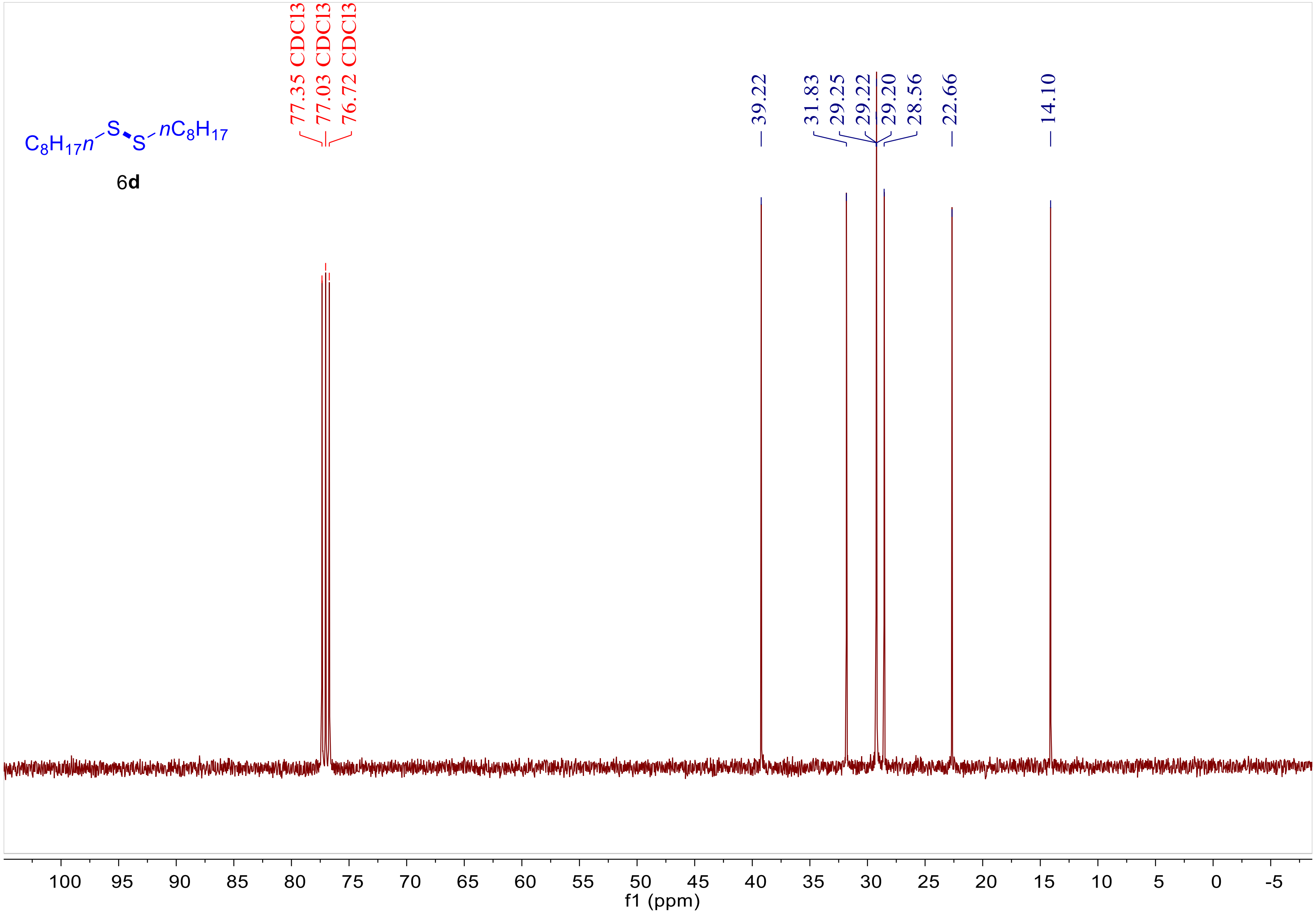
6b


7.26 CDCl3
MeO2C
S
S
CO2Me
6c
3.66
2.90
2.90
2.88
2.88
2.86
2.72
2.70
2.68
2.68
-0.05
5.95
4.00
4.00
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)


172.06
MeO2C
S
S
CO2Me
6c
77.43 CDCl3
77.12 CDCl3
76.80 CDCl3
51.85
33.85
33.06
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

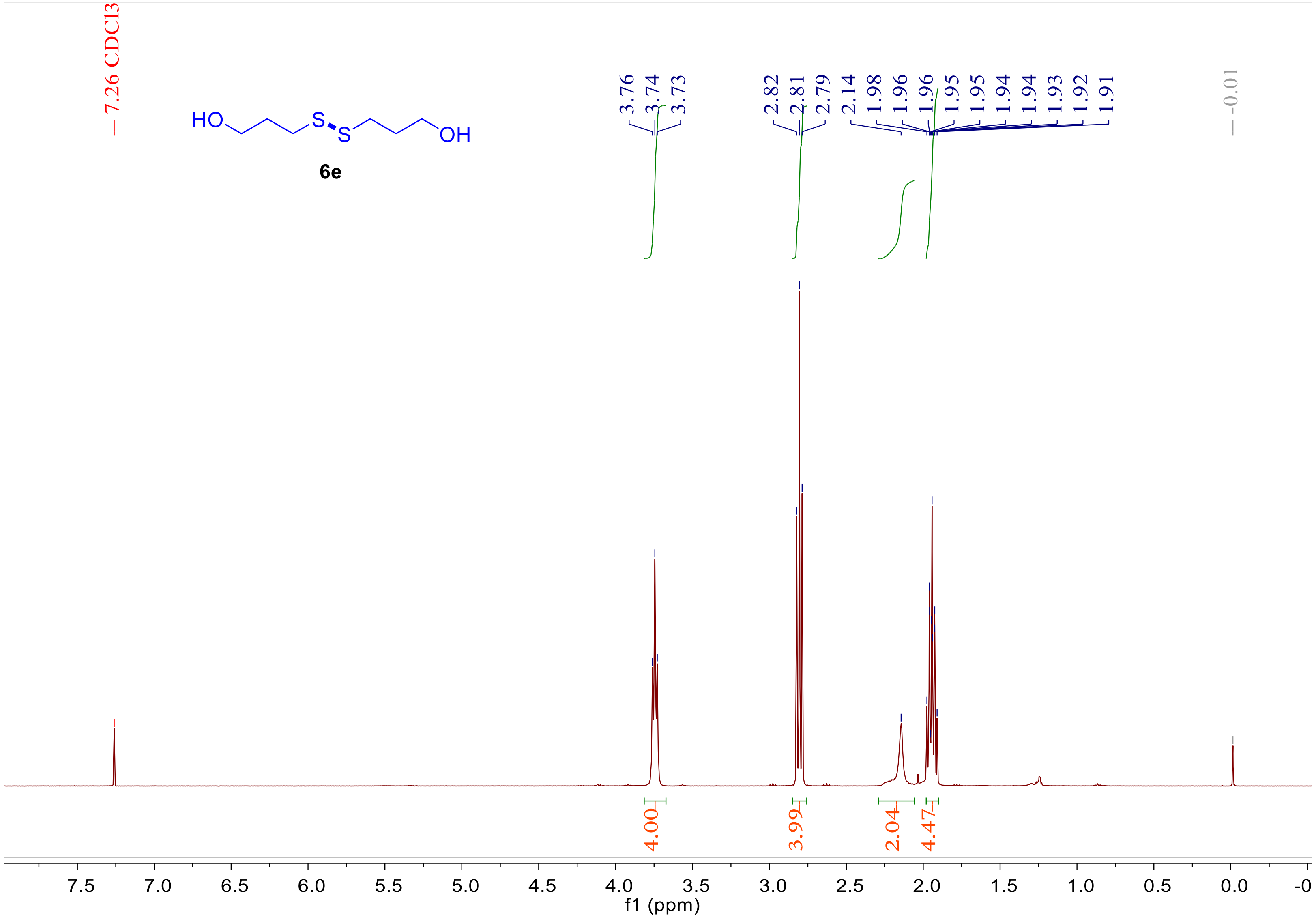


7.26 CDCl3
2.69
2.68
2.66
1.70
1.69
1.68
1.67
1.66
1.65
1.63
1.56
1.41
1.39
1.39
1.38
1.36
1.34
1.32
1.30
1.30
1.29
1.28
1.27
1.26
1.25
1.12
0.90
0.89
0.88
0.86
-0.00
6d
4.00
4.03
20.07
6.09
f1 (ppm)

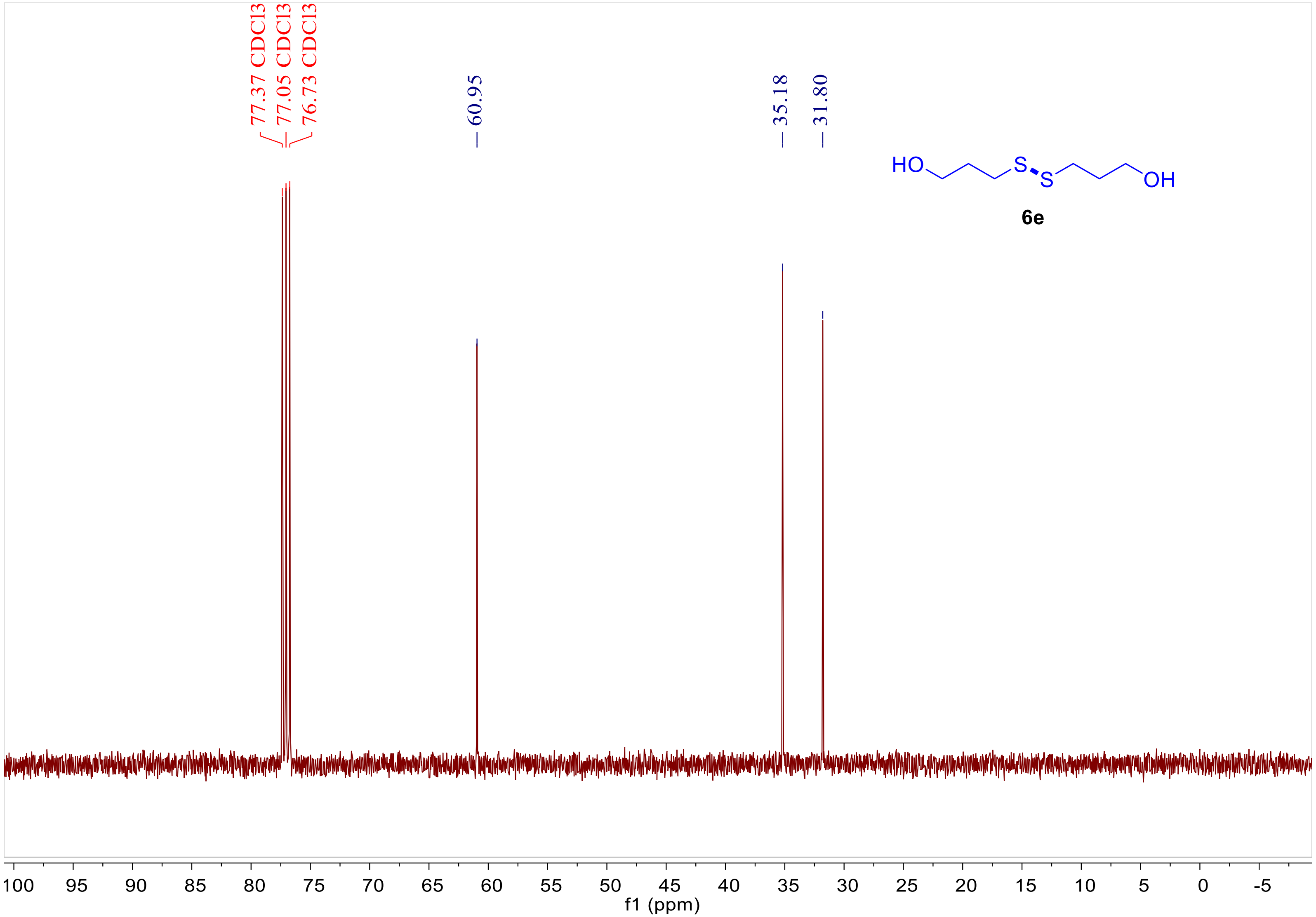


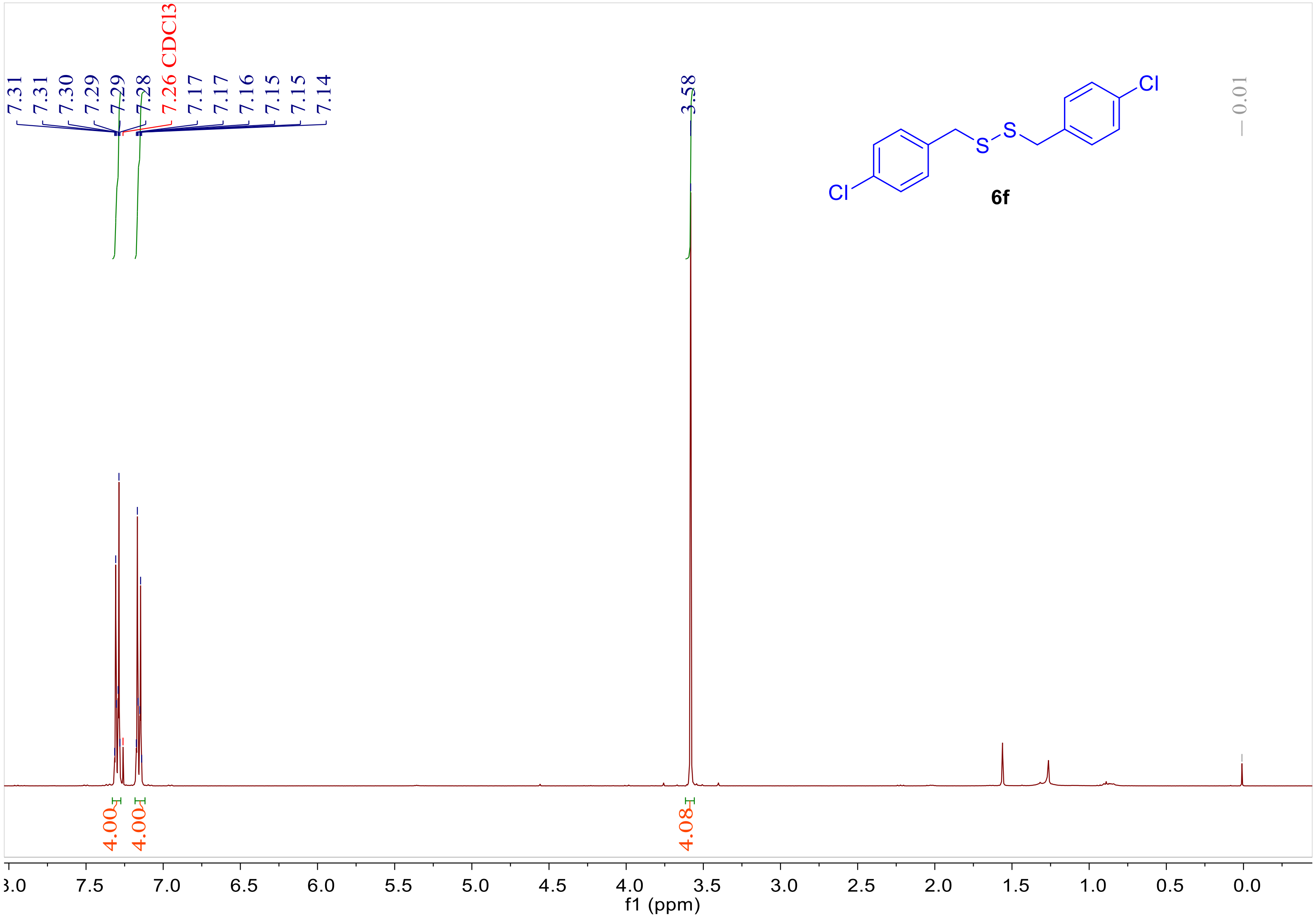
C8H17n S S nC8H17
77.35 CDCl3
77.03 CDCl3
76.72 CDCl3
39.22
31.83
29.25
29.22
29.20
28.56
22.66
14.10
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5
f1 (ppm)

6**d**

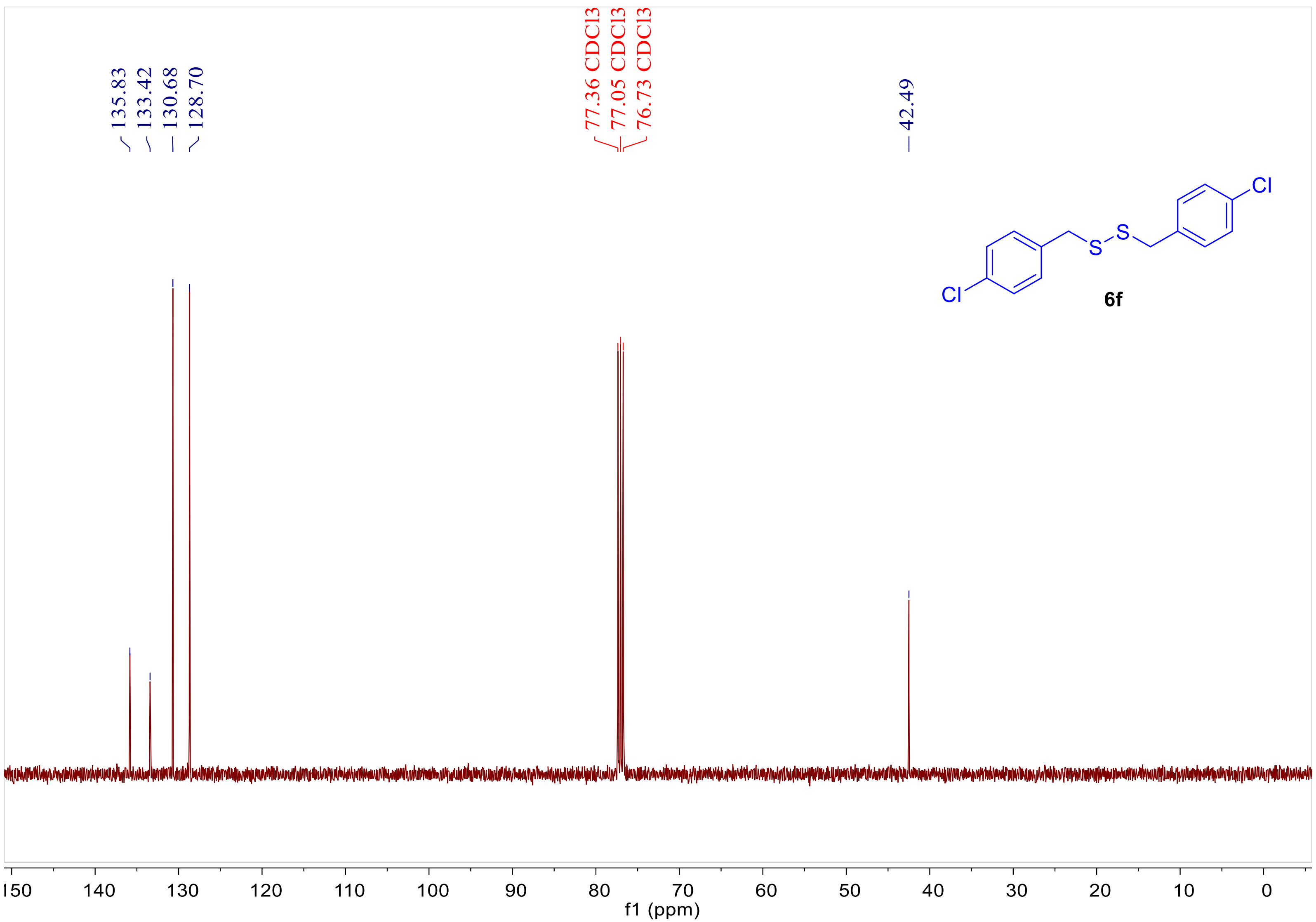


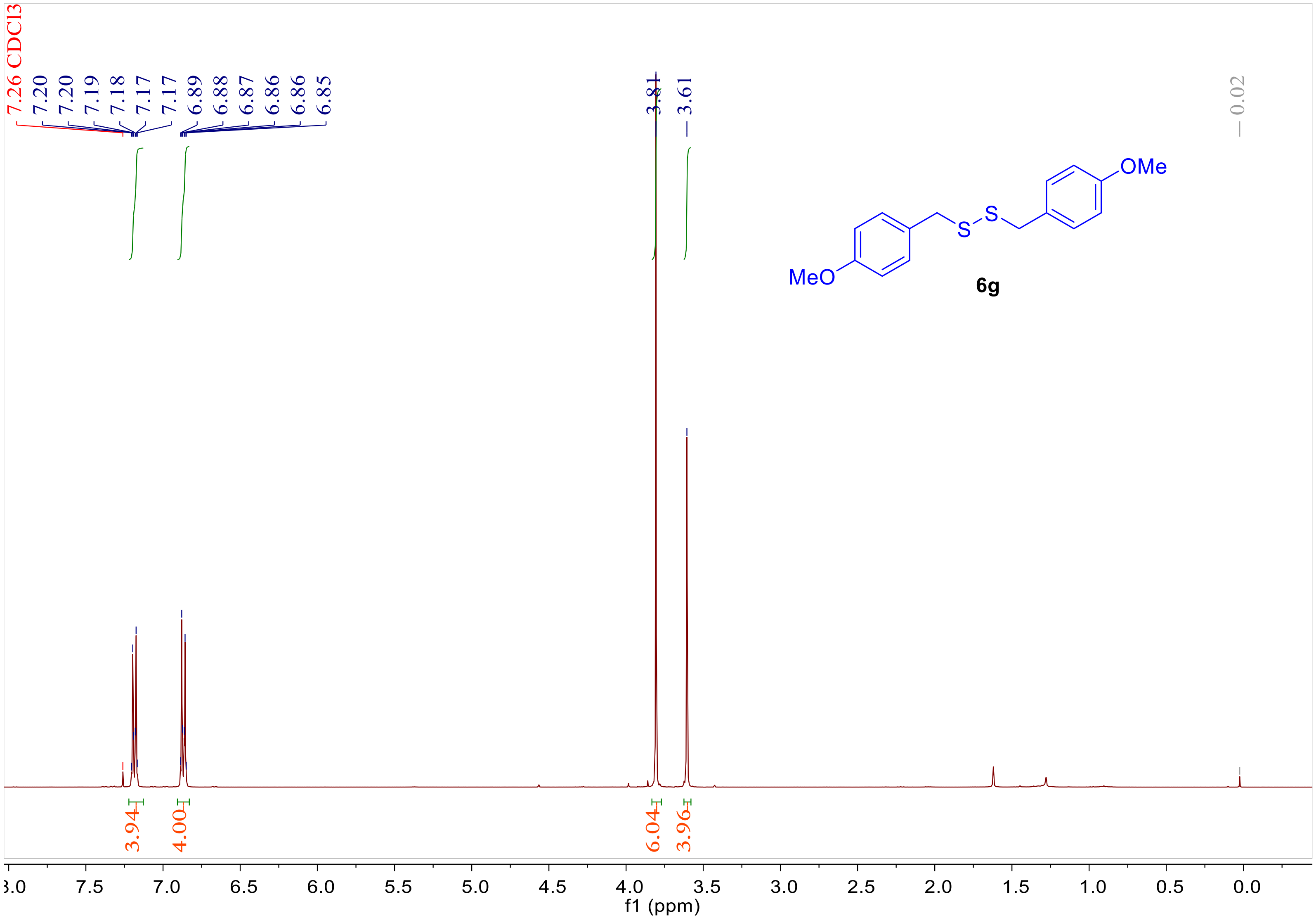
7.26 CDCl3
HO
S
S
OH
6e
3.76
3.74
3.73
2.82
2.81
2.79
2.14
1.98
1.96
1.96
1.95
1.95
1.94
1.94
1.93
1.92
1.91
-0.01
4.00
3.99
2.04
4.47
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0
f1 (ppm)


77.37 CDCl3
77.05 CDCl3
76.73 CDCl3
60.95
35.18
31.80
HO
S
S
OH
6e
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
f1 (ppm)

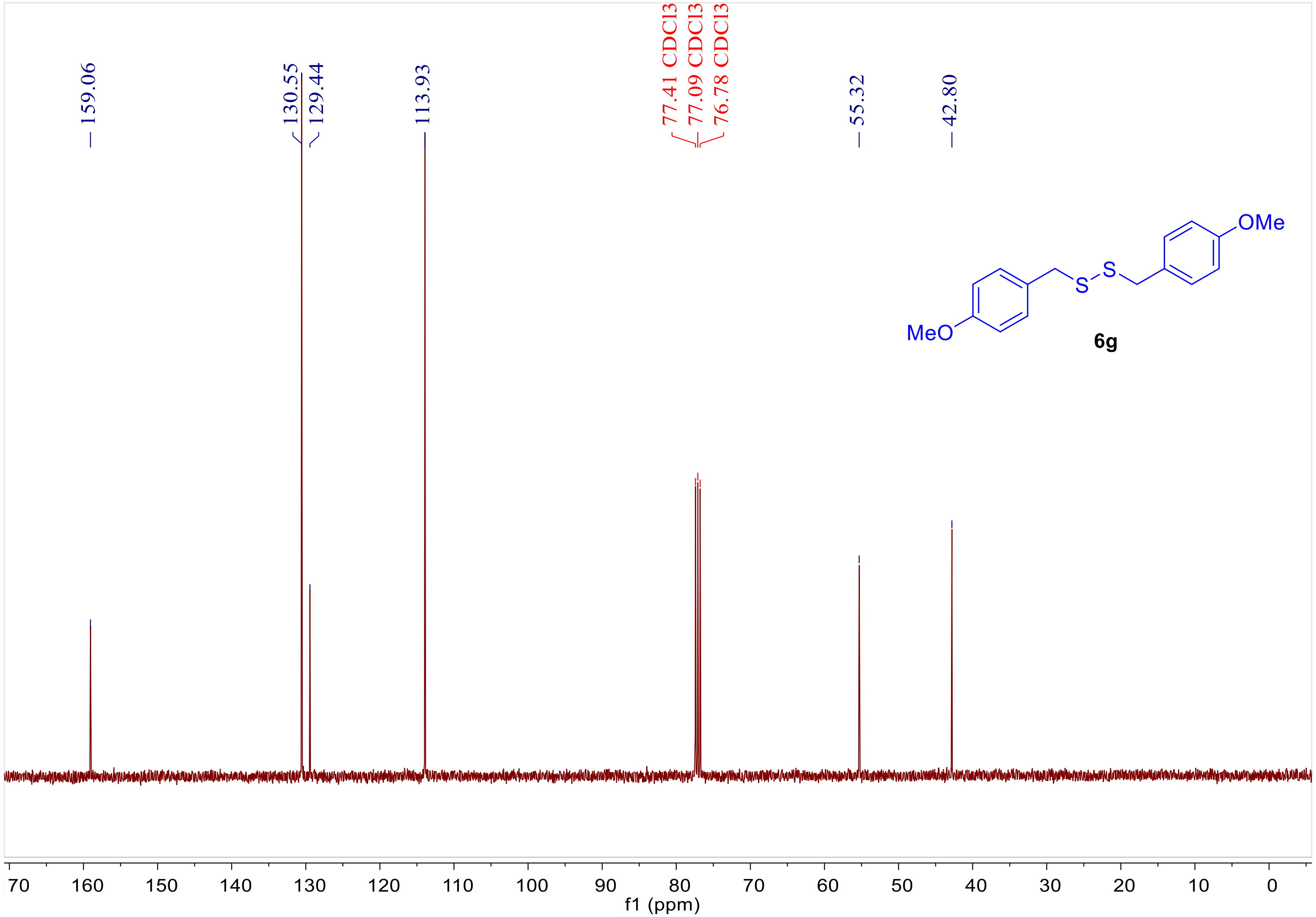


7.31
7.31
7.30
7.29
7.29
7.28
7.26 CDCl3
7.17
7.17
7.16
7.15
7.15
7.14
3.58
0.01
Cl
S
S
Cl
6f
4.00
4.00
4.08
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

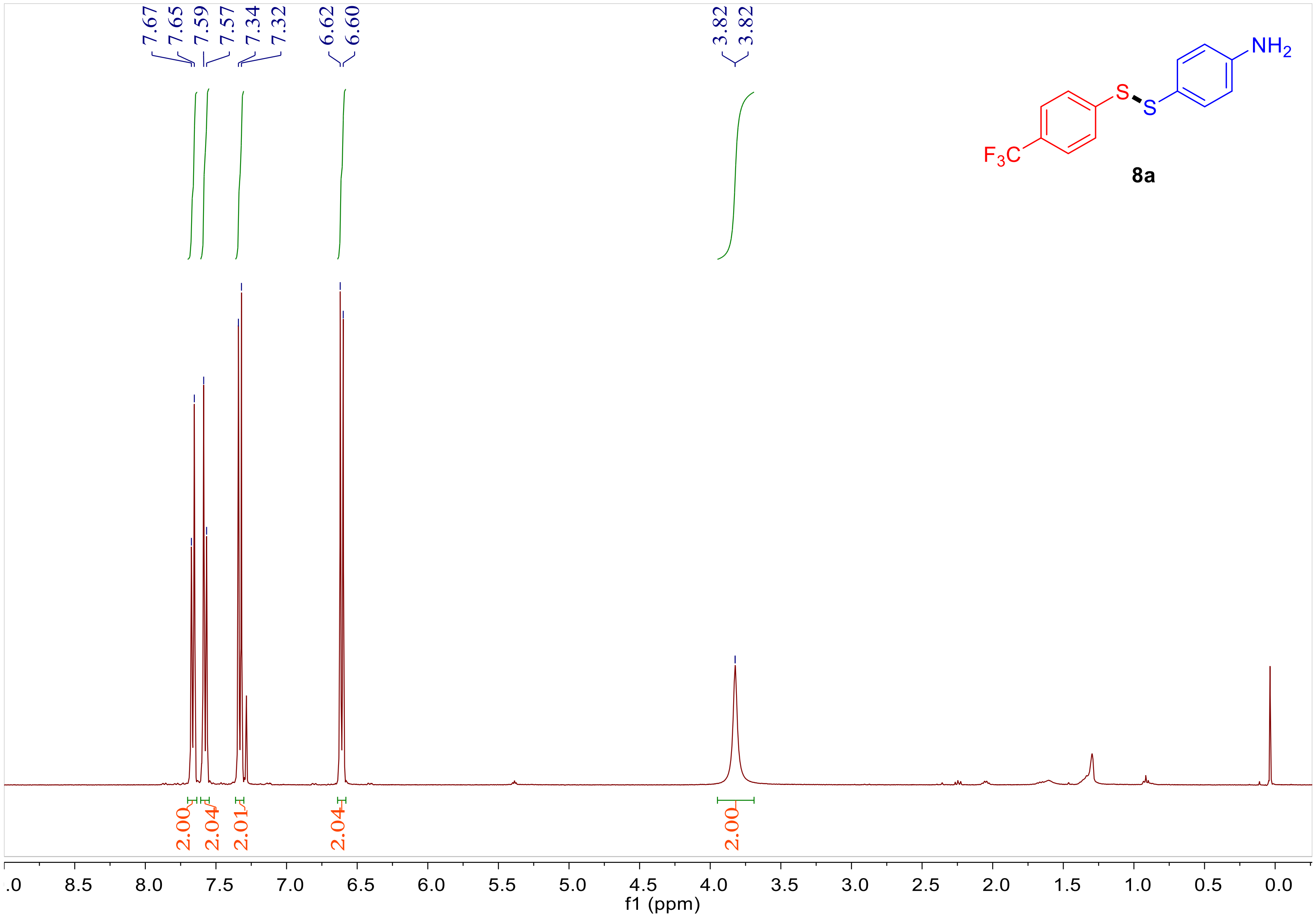

135.83
133.42
130.68
128.70
77.36 CDCl3
77.05 CDCl3
76.73 CDCl3
42.49
Cl
S
S
Cl
6f
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



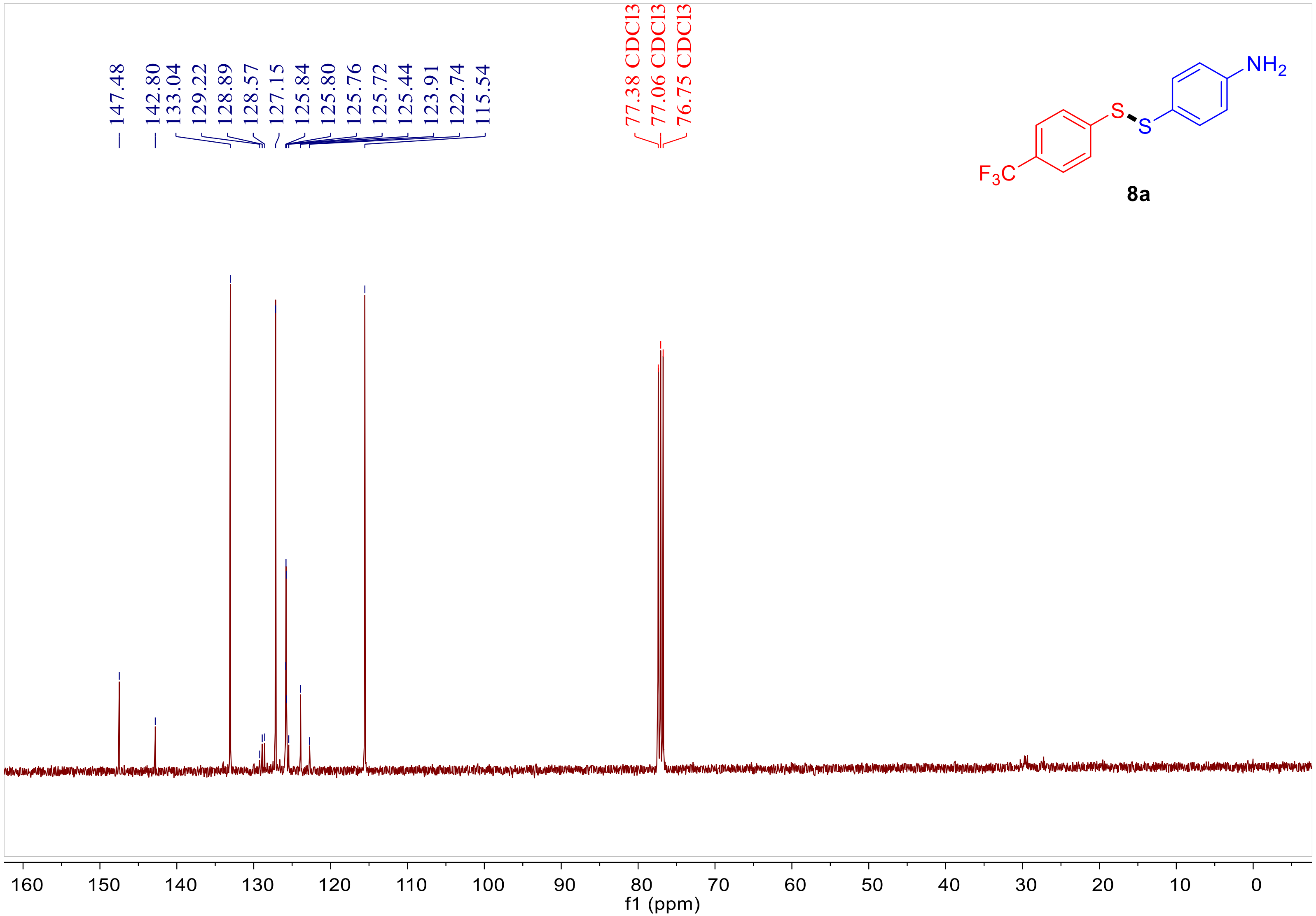
7.26 CDCl3
7.20
7.20
7.19
7.18
7.17
7.17
6.89
6.88
6.87
6.86
6.86
6.85
3.81
3.61
0.02
MeO
S
S
OMe
6g
3.94
4.00
6.04
3.96
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

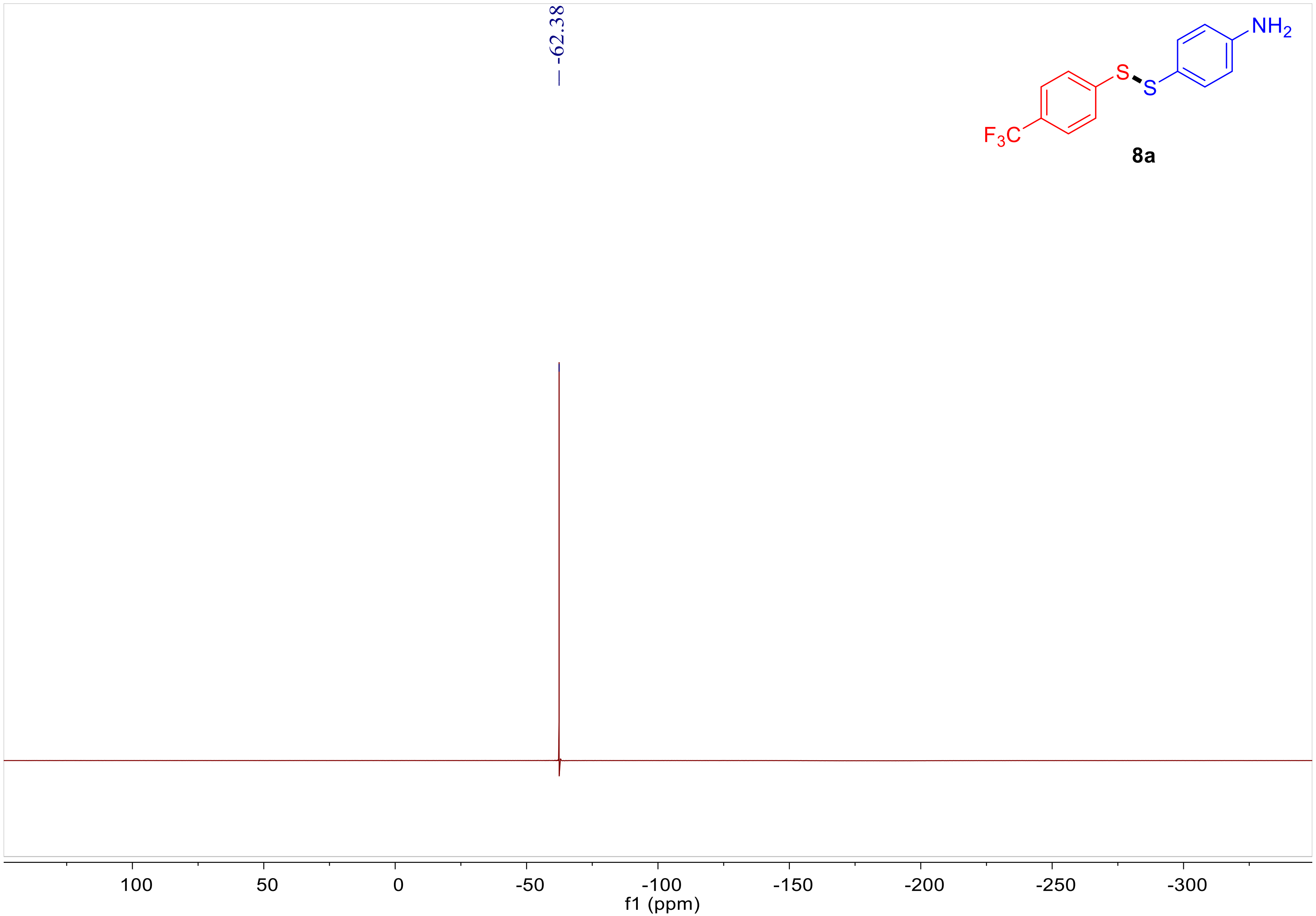


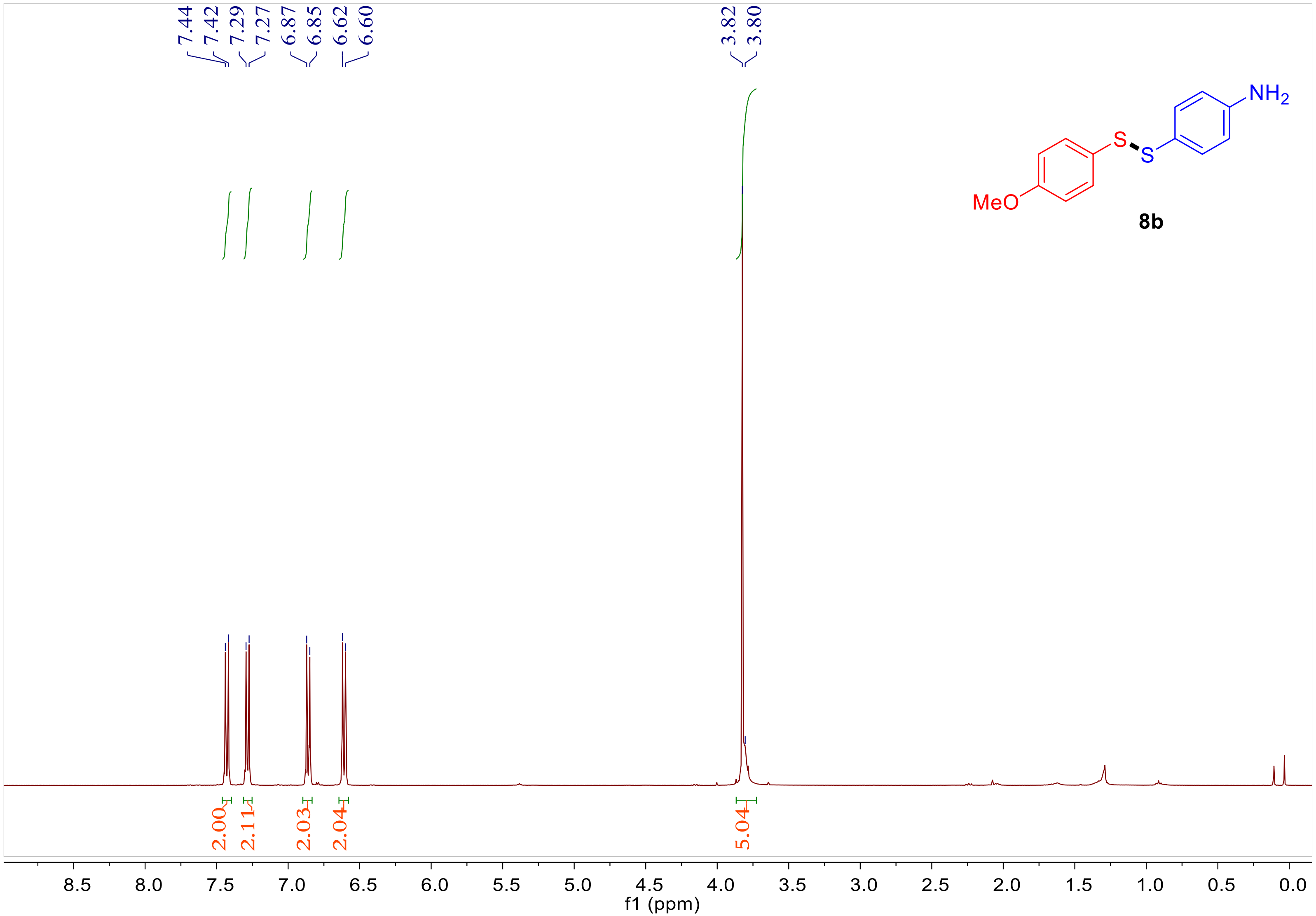
159.06
130.55
129.44
113.93
77.41 CDCl3
77.09 CDCl3
76.78 CDCl3
55.32
42.80
OMe
S
S
MeO
6g
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



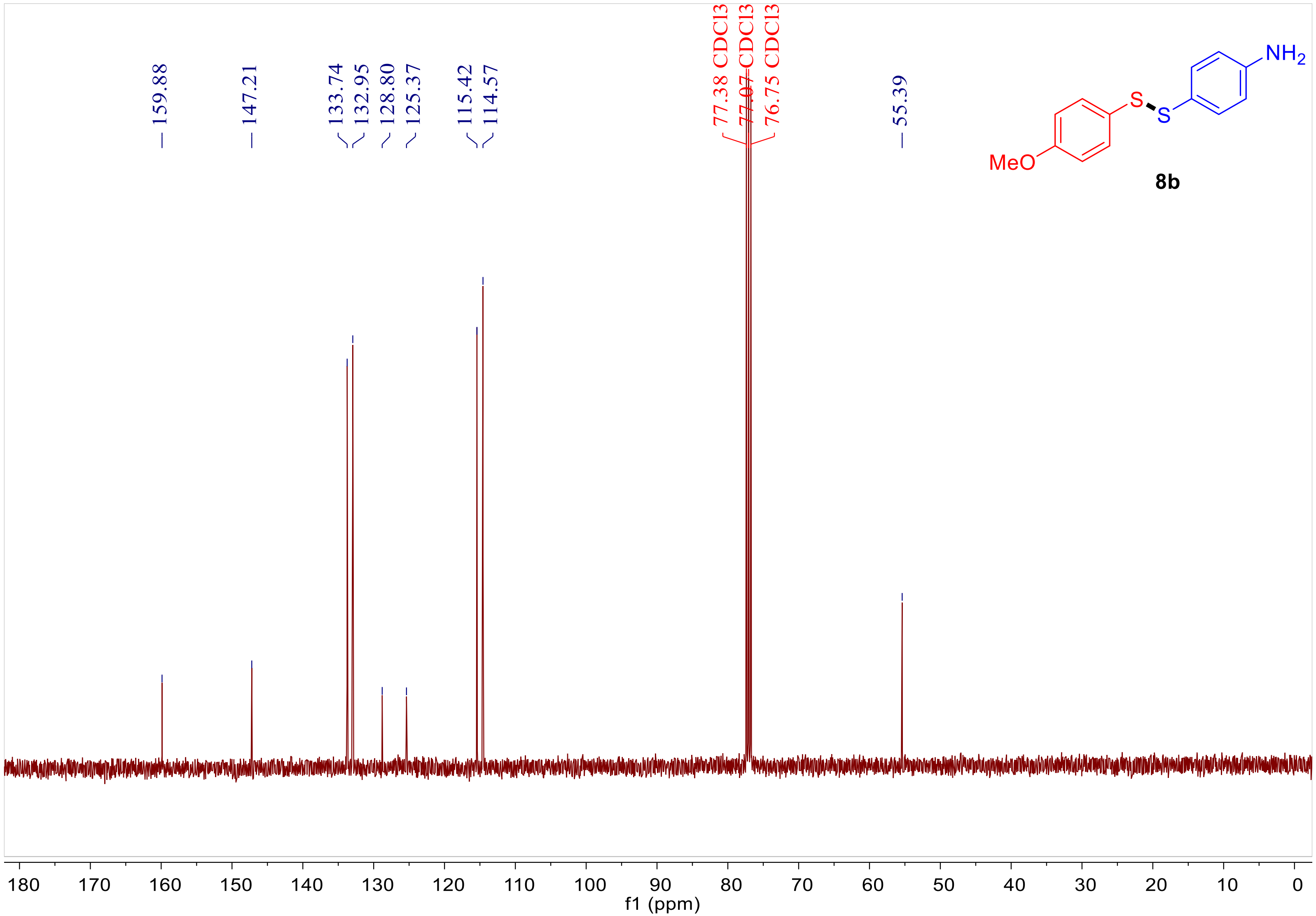
7.67
7.65
7.59
7.57
7.34
7.32
6.62
6.60
3.82
3.82
NH2
S
S
F3C
8a
2.00
2.04
2.01
2.04
2.00
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


147.48
142.80
133.04
129.22
128.89
128.57
127.15
125.84
125.80
125.76
125.72
125.44
123.91
122.74
115.54
77.38 CDCl3
77.06 CDCl3
76.75 CDCl3
F_3C
S
S
NH_2
8a
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

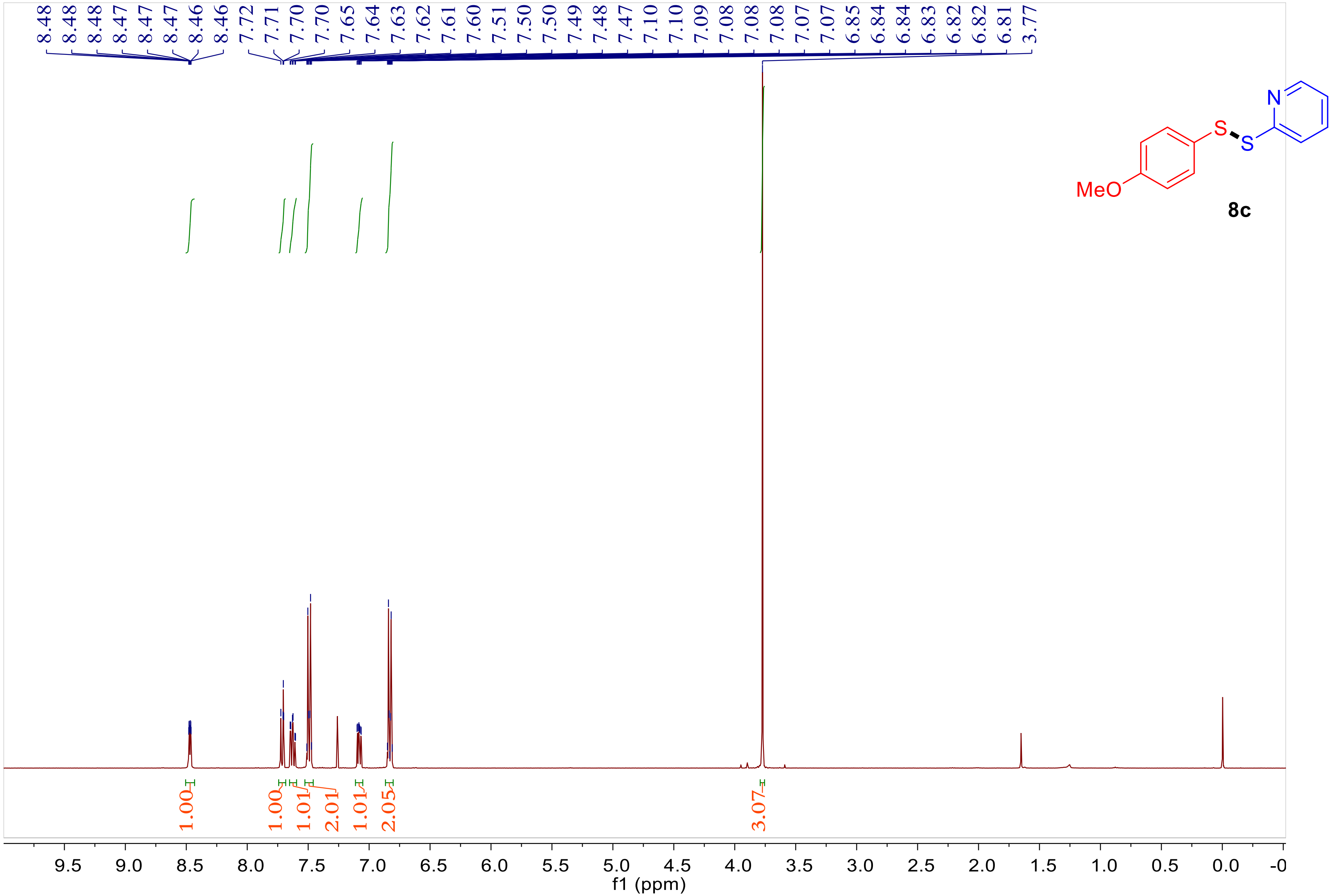

-62.38
NH2
S
S
F3C
8a
100
50
0
-50
-100
-150
-200
-250
-300
f1 (ppm)

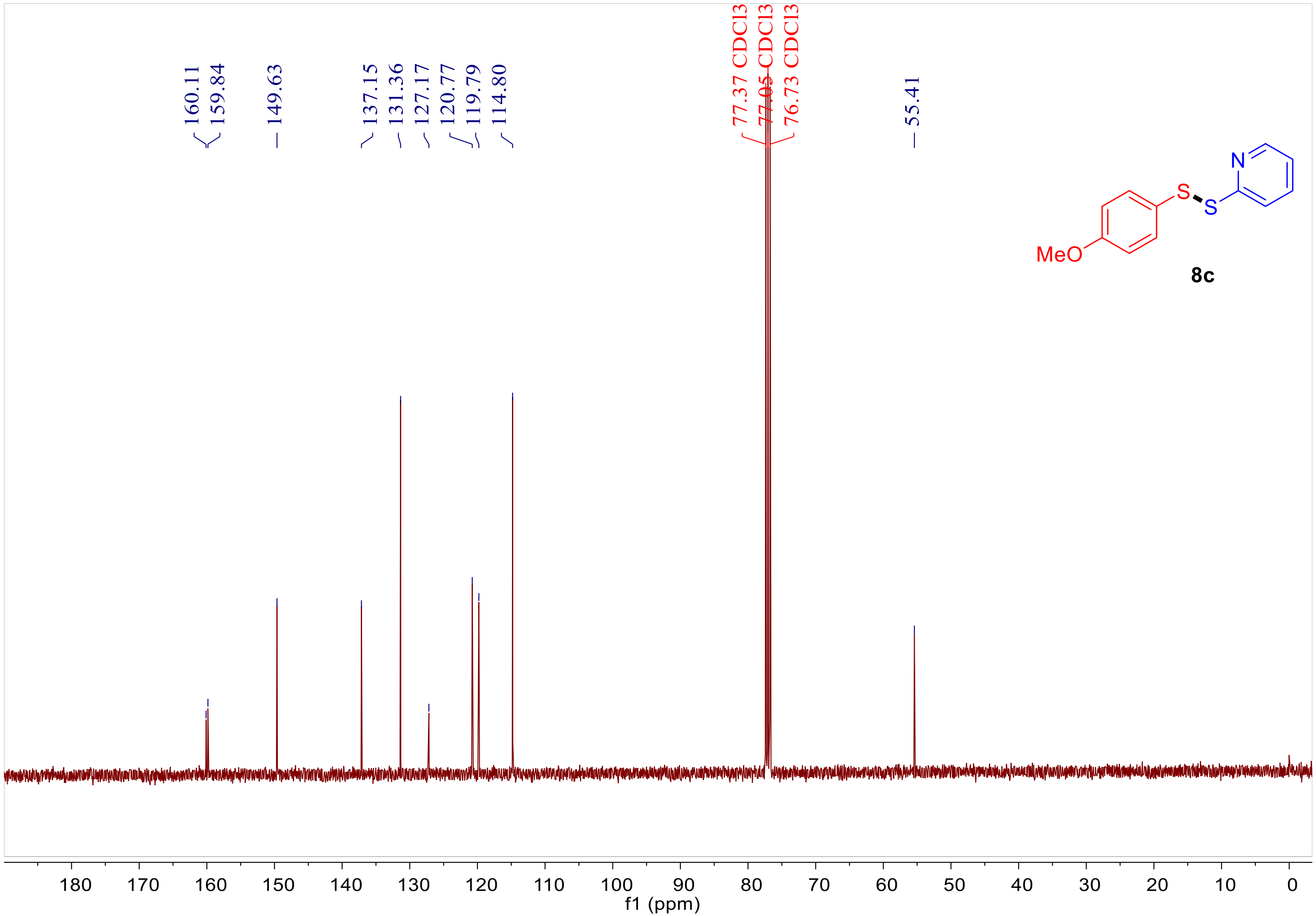


7.44
7.42
7.29
7.27
6.87
6.85
6.62
6.60
3.82
3.80
NH2
S
S
MeO
8b
2.00
2.11
2.03
2.04
5.04
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)



159.88
147.21
133.74
132.95
128.80
125.37
115.42
114.57
77.38 CDCl3
77.07 CDCl3
76.75 CDCl3
55.39
MeO
S
S
NH2
8b
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


8.48 8.48 8.48 8.47 8.47 8.47 8.46 8.46 7.72 7.71 7.70 7.70 7.65 7.64 7.63 7.62 7.61 7.60 7.51 7.50 7.50 7.49 7.48 7.47 7.10 7.10 7.09 7.08 7.08 7.08 7.07 7.07 6.85 6.84 6.84 6.83 6.82 6.82 6.81 3.77
1.00
1.00
1.01
2.01
1.01
2.05
3.07
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0
f1 (ppm)
N
S
S
MeO
8c


160.11
159.84
149.63
137.15
131.36
127.17
120.77
119.79
114.80
77.37 CDCl3
77.05 CDCl3
76.73 CDCl3
55.41
MeO
S
S
N
8c
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)