Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting information

Pyridine hydrochloride Catalyzed Thiolation of Alkenes: Divergent Synthesis of Allyl and Vinyl Sulfides

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Table of contents

1. General 3

2. General procedure for the preparation of *N*-thiosuccinimides 3

3. General procedure for the thiolation of alkenes 3

4. Characterization data of the products 4

5. X-ray Crystallographic Analysis of product 3ab 22

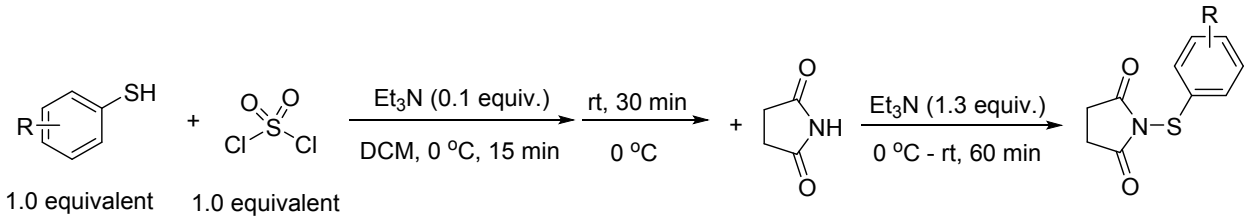
6. Copies of NMR Spectra 24

7. References 149

1. General

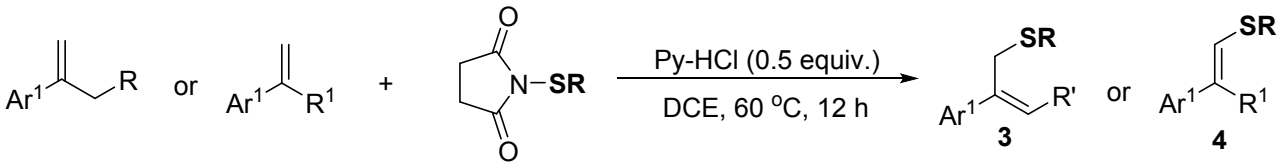
Commercial reagents and solvents were obtained from the commercial providers and used without further purification. The products were purified using a commercial flash chromatography system or a regular glass column. TLC was developed on silica gel 60 F254 glass plates. ^{1}H NMR (400 MHz) and ^{13}C NMR (100 MHz) spectra were recorded on a Bruker NMR apparatus. The chemical shifts are reported in δ (ppm) values (^{1}H and ^{13}C NMR relative to $CHCl_3$, δ 7.26 ppm for ^{1}H NMR and δ 77.0 ppm for ^{13}C NMR). Or alternatively, ^{1}H NMR chemical shifts were referenced to tetramethylsilane signal (0 ppm). Multiplicities are recorded by s (singlet), d (doublet), t (triplet), m (multiplet) and br (broad). Coupling constants (*J*), are reported in Hertz (Hz). GC analyses were performed using a Shimadzu GC-2010-ultra gas chromatography–mass spectrometry instrument equipped with a Shimadzu AOC-20s autosampler.

2. General procedure for the preparation of *N*-thiosuccinimides



Sulfuryl chloride (1.0 equivalent) was added dropwise to a solution of thiol (1.0 equivalent) and triethylamine (0.1 equivalents) in dichloromethane (1M) at 0 °C. After stirring for 15 minutes, the mixture was warmed to room temperature and stirred for 30 minutes and then cooled to 0 °C. The resulting solution was transferred dropwise via cannula to a solution of succinimide (1.0 equivalent) in dichloromethane (1M) and triethylamine (1.3 equivalents) at 0 °C, and the mixture was then warmed to room temperature over 1 hour. The solution was diluted with water and extracted with an equal volume of dichloromethane before being dried over sodium sulfate. Evaporation of the solvent gave a crude product that was purified by using flash column chromatography.[1]

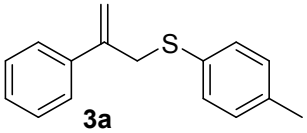
3. General procedure for the thiolation of alkenes



An oven-dried glass vial was charged with *N*-thiosuccinimides (0.24 mmol), Py-HCl (0.10 mmol), and

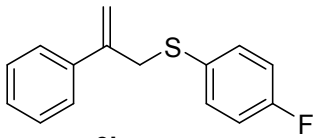
alkene (0.20 mmol). Then, DCE (2 mL) was added, and the mixture was heated to 60℃ and stirred for 12 h under air. After completion of the reaction, water was added to quench the reaction; the resulting aqueous mixture was extracted with ethyl acetate (3 x 5 mL). The combined organic layers were dried over Na_2SO_4 and concentrated. The crude product was further purified by silica gel column chromatography.

4. Characterization data of the products



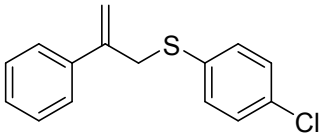
3a

(2-phenylallyl)(*p*-tolyl)sulfane (3a). Colorless oil (43 mg, 91%)[2]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.47 (d, *J* = 7.3 Hz, 2H), 7.36 (t, *J* = 7.5 Hz, 2H), 7.31 (t, *J* = 7.2 Hz, 1H), 7.26 (d, *J* = 7.0 Hz, 2H), 7.10 (d, *J* = 7.9 Hz, 2H), 5.38 (s, 1H), 5.13 (s, 1H), 3.94 (s, 2H), 2.33 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 143.28, 139.56, 136.71, 132.32, 131.26, 129.63, 128.42, 127.87, 126.32, 115.56, 40.23, 21.12.



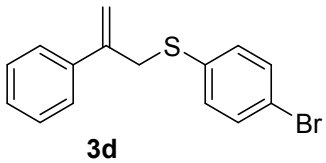
3b

(4-fluorophenyl)(2-phenylallyl)sulfane (3b). Colorless oil (42 mg, 87%)[2]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.45 (d, *J* = 7.4 Hz, 2H), 7.38-7.31 (m, 5H), 6.99 (t, *J* = 8.6 Hz, 2H), 5.35 (s, 1H), 5.04 (s, 1H), 3.91 (s, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 162.16 (d, *J* = 246.1 Hz), 143.13, 139.30, 133.95 (d, *J* = 8.1 Hz), 130.65, 128.45, 127.95, 126.32,, 115.85 (d, *J* = 39.8 Hz), 115.84, 40.89.



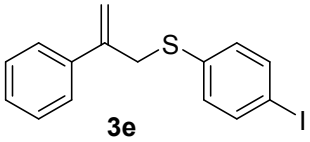
3c

(4-chlorophenyl)(2-phenylallyl)sulfane (3c). Colorless oil (46 mg, 90%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.44 – 7.43 (m, 2H), 7.38 – 7.34 (m, 2H), 7.32 (d, *J* = 7.2 Hz, 1H), 7.24 (d, *J* = 0.9 Hz, 4H), 5.38 (s, 1H), 5.14 (s, 1H), 3.94 (s, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 142.91, 139.30, 134.51, 132.62, 132.01, 128.94, 128.45, 127.99, 126.28, 115.87, 39.80. HRMS (EI) Calculated for $C_{15}H_{13}ClS$ (M^+) 260.0426, found 260.0422.



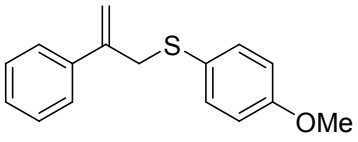
3d

(4-bromophenyl)(2-phenylallyl)sulfane (3d). Colorless oil (57 mg, 94%)[3]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.45 (d, *J* = 7.4 Hz, 2H), 7.42 – 7.32 (m, 5H), 7.19 (d, *J* = 8.4 Hz, 2H), 5.41 (s, 1H), 5.17 (s, 1H), 3.96 (s, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 142.83, 139.28, 135.26, 132.08, 131.88, 128.49, 128.03, 126.29, 120.51, 115.94, 39.56.



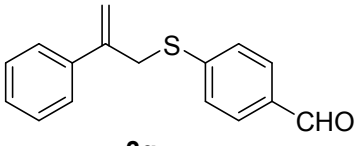
3e

(4-iodophenyl)(2-phenylallyl)sulfane (3e). Colorless oil (60 mg, 85%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.62 – 7.58 (m, 2H), 7.47 – 7.44 (m, 2H), 7.40 – 7.36 (m, 2H), 7.34 (d, *J* = 7.2 Hz, 1H), 7.09 – 7.05 (m, 2H), 5.42 (s, 1H), 5.21 (d, *J* = 0.9 Hz, 1H), 3.97 (d, *J* = 1.0 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 142.81, 139.30, 137.76, 136.25, 131.97, 128.46, 128.00, 126.26, 115.92, 91.44, 39.27. HRMS (EI) Calculated for $C_{15}H_{13}IS$ (M^+) 351.9783, found 351.9789.



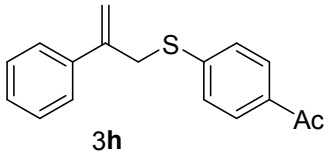
3f

(4-methoxyphenyl)(2-phenylallyl)sulfane (3f). Colorless oil (40 mg, 79%)[2]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.48 (d, *J* = 7.5 Hz, 2H), 7.44 – 7.31 (m, 6H), 6.85 (d, *J* = 8.6 Hz, 2H), 5.34 (s, 1H), 5.00 (s, 1H), 3.88 (s, 2H), 3.82 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 159.24, 143.41, 139.49, 134.54, 132.71, 128.38, 127.81, 126.35, 115.48, 114.40, 55.33, 41.62.



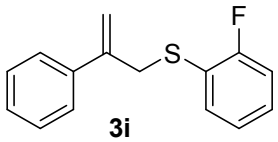
3g

4-((2-phenylallyl)thio)benzaldehyde (3g). Colorless oil (41 mg, 82%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.93 (s, 1H), 7.76 (d, *J* = 8.4 Hz, 2H), 7.45 (d, *J* = 7.4 Hz, 2H), 7.37 (t, *J* = 7.4 Hz, 4H), 7.35 – 7.31 (m, 1H), 5.50 (s, 1H), 5.39 (s, 1H), 4.09 (s, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 191.32, 146.14, 142.14, 139.20, 133.53, 130.00, 128.55, 128.20, 127.28, 126.19, 116.34, 37.28. HRMS (EI) Calculated for $C_{16}H_{14}OS$ (M^+) 254.0765, found 254.0761.



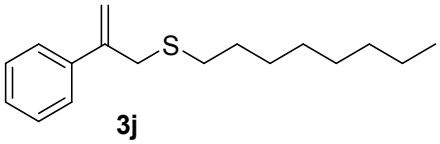
3h

1-(4-((2-phenylallyl)thio)phenyl)ethan-1-one (3h). Colorless oil (46 mg, 86%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.85 (d, *J* = 8.4 Hz, 2H), 7.45 (d, *J* = 7.2 Hz, 2H), 7.36 (t, *J* = 7.3 Hz, 2H), 7.34-7.31 (m, 3H), 5.48 (s, 1H), 5.36 (s, 1H), 4.07 (s, 2H), 2.57 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.26, 144.03, 142.34, 139.28, 134.23, 128.73, 128.53, 128.14, 127.36, 126.21, 116.21, 37.53, 26.51. HRMS (EI) Calculated for $C_{17}H_{16}OS$ (M^+) 268.0922, found 268.0920.



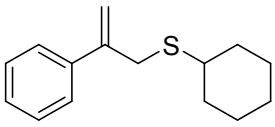
3i

(2-fluorophenyl)(2-phenylallyl)sulfane (3i). Colorless oil (40 mg, 85%)[2]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.47 – 7.44 (m, 2H), 7.39 – 7.35 (m, 2H), 7.34 – 7.29 (m, 2H), 7.28 – 7.24 (m, 1H), 7.10 – 7.05 (m, 2H), 5.35 (d, *J* = 0.9 Hz, 1H), 5.14 (d, *J* = 0.9 Hz, 1H), 3.99 (d, *J* = 0.9 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 162.03 (d, *J* = 246.1 Hz), 143.14, 139.34, 133.89 (d, *J* = 1.6 Hz), 129.11 (d, *J* = 8.0 Hz), 128.38, 127.89, 126.30, 124.31 (d, *J* = 3.7 Hz), 122.34 (d, *J* = 17.7 Hz), 115.80, 115.62 (d, *J* = 37.7 Hz), 38.78 (d, *J* = 2.8 Hz).



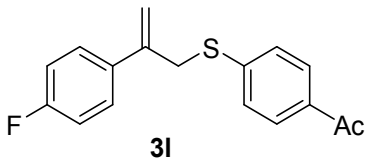
3j

octyl(2-phenylallyl)sulfane (3j). Colorless oil (40 mg, 76%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.51 –7.49 (m, 2H), 7.39 – 7.35 (m, 2H), 7.33 –7.32 (m, 1H), 5.46 (d, *J* = 1.1 Hz, 1H), 5.23 (d, *J* = 1.0 Hz, 1H), 3.62 (d, *J* = 0.8 Hz, 2H), 2.53 – 2.45 (m, 2H), 1.61 – 1.57 (m, 2H), 1.40 – 1.35 (m, 2H), 1.33 – 1.28 (m, 8H), 0.91 (t, *J* = 7.0 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 143.87, 139.52, 128.34, 127.80, 126.32, 114.74, 36.57, 31.84, 31.45, 29.22, 29.21, 28.96, 22.68, 14.12. HRMS (EI) Calculated for $C_{17}H_{26}S$ (M^+) 262.1755, found 262.1760.



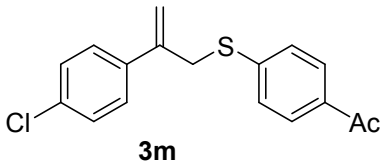
3k

Cyclohexyl(2-phenylallyl)sulfane (3k). Colorless oil (37 mg, 81%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.43 (m, 2H), 7.39 – 7.25 (m, 3H), 5.42 (s, 1H), 5.25 (s, 1H), 3.62 (s, 2H), 2.71 – 2.59 (m, 1H), 1.95 (d, *J* = 10.4 Hz, 2H), 1.80 – 1.70 (m, 2H), 1.64 – 1.57 (m, 1H), 1.30 (td, *J* = 20.4, 9.9 Hz, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 144.54, 139.83, 128.30, 127.73, 126.30, 114.56, 43.27, 34.99, 33.44, 26.08, 25.89. HRMS (EI) Calculated for $C_{15}H_{20}S$ (M^+) 232.1278, found 232.1276.



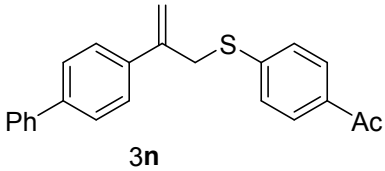
3l

1-(4-((2-(4-fluorophenyl)allyl)thio)phenyl)ethan-1-one (3l). Colorless oil (50 mg, 88%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.3 Hz, 2H), 7.43 (dd, *J* = 8.5, 5.4 Hz, 2H), 7.34 (d, *J* = 8.3 Hz, 2H), 7.06 (t, *J* = 8.6 Hz, 2H), 5.43 (s, 1H), 5.35 (s, 1H), 4.06 (s, 2H), 2.59 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.15, 162.63(d, *J* = 246.0 Hz), 143.67, 141.53, 135.33 (d, *J* = 3.4 Hz), 134.45, 128.72, 127.93 (d, *J* = 8.0 Hz), 127.63, 116.19, 115.37(d, *J* = 21.2 Hz), 37.87, 26.44. HRMS (EI) Calculated for $C_{17}H_{15}FOS$ (M^+) 286.0828, found 286.0820.



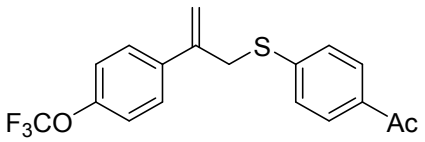
3m

1-(4-((2-(4-chlorophenyl)allyl)thio)phenyl)ethan-1-one (3m). Colorless oil (58 mg, 96%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 8.5 Hz, 2H), 7.39 – 7.34 (m, 2H), 7.34 – 7.29 (m, 4H), 5.44 (s, 1H), 5.34 (s, 1H), 4.03 (s, 2H), 2.57 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.13, 143.51, 141.48, 137.67, 134.51, 133.98, 128.73, 128.66, 127.73, 127.56, 116.70, 37.71, 26.45. HRMS (EI) Calculated for $C_{17}H_{15}ClOS$ (M^+) 302.0532, found 302.0537.



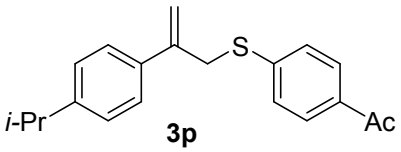
3n

1-(4-((2-([1, 1'-biphenyl]-4-yl)allyl)thio)phenyl)ethan-1-one (3n). Colorless oil (55 mg, 80%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 8.5 Hz, 2H), 7.59 (dd, *J* = 7.6, 4.7 Hz, 4H), 7.52 (d, *J* = 8.4 Hz, 2H), 7.44 (t, *J* = 7.6 Hz, 2H), 7.34 (t, *J* = 7.8 Hz, 3H), 5.53 (s, 1H), 5.37 (s, 1H), 4.09 (s, 2H), 2.55 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.25, 143.99, 141.85, 140.93, 140.49, 138.03, 134.28, 128.86, 128.76, 127.50, 127.44, 127.20, 127.03, 126.60, 116.17, 37.52, 26.51. HRMS (EI) Calculated for $C_{23}H_{20}OS$ (M^+) 344.1235, found 344.1231.



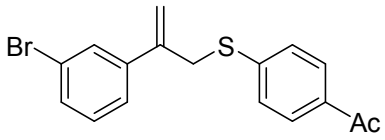
3o

1-(4-((2-(4-(trifluoromethoxy)phenyl)allyl)thio)phenyl)ethan-1-one (3o). Colorless oil (55 mg, 78%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 8.5 Hz, 2H), 7.45 (d, *J* = 8.8 Hz, 2H), 7.32 (d, *J* = 8.5 Hz, 2H), 7.19 (d, *J* = 8.2 Hz, 2H), 5.45 (s, 1H), 5.36 (s, 1H), 4.04 (s, 2H), 2.57 (s, 3H). ^{19}F NMR (377 MHz, $CDCl_3$) δ -57.80 (s). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.12, 148.98 (d, *J* = 1.8 Hz), 143.44, 141.36, 137.95, 134.55, 128.74, 127.76, 127.69, 121.30 (d, *J* = 258.5 Hz), 120.85, 117.03, 37.77, 26.43. HRMS (EI) Calculated for $C_{18}H_{15}F_3O_2S$ (M^+) 352.0745, found 352.0740.



3p

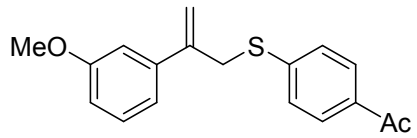
1-(4-((2-(4-isopropylphenyl)allyl)thio)phenyl)ethan-1-one (3p). Colorless oil (59 mg, 95%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 8.5 Hz, 2H), 7.39 (d, *J* = 8.2 Hz, 2H), 7.33 (d, *J* = 8.5 Hz, 2H), 7.22 (d, *J* = 8.1 Hz, 2H), 5.47 (s, 1H), 5.32 (s, 1H), 4.06 (s, 2H), 2.96 - 2.89 (m, 1H), 2.57 (s, 3H), 1.27 (d, *J* = 6.9 Hz, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.23, 148.94, 144.22, 142.03, 136.66, 134.16, 128.71, 127.24, 126.58, 126.07, 115.39, 37.47, 33.82, 26.49, 23.94. HRMS (EI) Calculated for $C_{20}H_{22}OS$ (M^+) 310.1391, found 310.1390.



3q

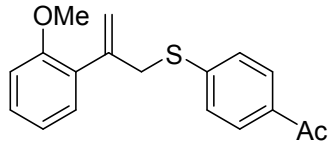
1-(4-((2-(3-bromophenyl)allyl)thio)phenyl)ethan-1-one (3q). Colorless oil (42 mg, 81%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.4 Hz, 2H), 7.58 (s, 1H), 7.47 (d, *J* = 7.9 Hz, 1H), 7.37 (d, *J* = 7.8 Hz, 1H), 7.34 (d, *J* = 8.4 Hz,

2H), 7.25 (t, *J* = 7.9 Hz, 1H), 5.48 (s, 1H), 5.39 (s, 1H), 4.04 (s, 2H), 2.60 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.24, 143.43, 141.46, 141.36, 134.48, 131.05, 130.02, 129.38, 128.76, 127.75, 124.88, 122.70, 117.36, 37.57, 26.51. HRMS (EI) Calculated for $C_{17}H_{15}BrOS$ (M^+) 346.0027, found 346.0020.



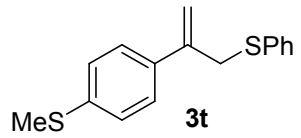
3r

1-(4-((2-(3-methoxyphenyl)allyl)thio)phenyl)ethan-1-one (3r). Colorless oil (50 mg, 84%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.85 (d, *J* = 8.4 Hz, 2H), 7.32 (d, *J* = 8.4 Hz, 2H), 7.28 (t, *J* = 8.0 Hz, 1H), 7.03 (d, *J* = 7.7 Hz, 1H), 6.99 – 6.96 (m, 1H), 6.88 – 6.86 (m, 1H), 5.47 (s, 1H), 5.35 (s, 1H), 4.04 (s, 2H), 3.82 (s, 3H), 2.57 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.25, 159.66, 144.00, 142.30, 140.85, 134.25, 129.52, 128.72, 127.39, 118.68, 116.36, 113.22, 112.35, 55.28, 37.59, 26.49. HRMS (EI) Calculated for $C_{18}H_{18}O_2S$ (M^+) 298.1028, found 298.1022.



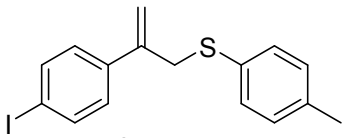
3s

1-(4-((2-(2-methoxyphenyl)allyl)thio)phenyl)ethan-1-one (3s). Colorless oil (45 mg, 76%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.82 (d, *J* = 8.5 Hz, 2H), 7.32 (d, *J* = 8.5 Hz, 2H), 7.31 – 7.28 (m, 1H), 7.12 – 7.11 (m, 1H), 6.99 – 6.88 (m, 2H), 5.43 (d, *J* = 1.2 Hz, 1H), 5.19 (s, 1H), 4.10 (s, 2H), 3.84 (s, 3H), 2.56 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.31, 156.51, 144.63, 143.44, 133.84, 130.53, 129.82, 129.26, 128.57, 127.01, 120.74, 117.46, 110.59, 55.42, 37.65, 26.47. HRMS (EI) Calculated for $C_{18}H_{18}O_2S$ (M^+) 298.1028, found 298.1022.



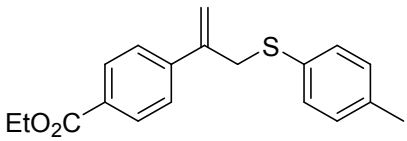
3t

Methyl(4-(3-(phenylthio)prop-1-en-2-yl)phenyl)sulfane (3t). Colorless oil (38 mg, 70%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.44 (m, 2H), 7.40 – 7.28 (m, 5H), 6.87 – 6.81 (m, 2H), 5.32 (d, *J* = 0.9 Hz, 1H), 4.99 (d, *J* = 0.8 Hz, 1H), 3.86 (s, 2H), 3.80 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.24, 142.47, 138.52, 133.43, 127.32, 126.75, 125.31, 125.08, 114.39, 113.39, 54.28, 40.58. HRMS (EI) Calculated for $C_{16}H_{16}S_2$ (M^+) 272.0693, found 272.0690.



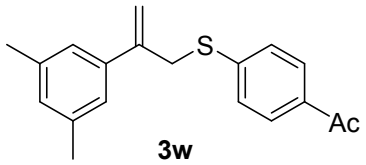
3u

(2-(4-iodophenyl)allyl)(p-tolyl)sulfane (3u). Colorless oil (62 mg, 86%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 – 7.64 (m, 2H), 7.24 – 7.20 (m, 2H), 7.19 – 7.16 (m, 2H), 7.08 (d, *J* = 7.9 Hz, 2H), 5.33 (d, *J* = 0.5 Hz, 1H), 5.09 (d, *J* = 0.7 Hz, 1H), 3.87 (d, *J* = 0.8 Hz, 2H), 2.32 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.50, 139.04, 137.45, 136.96, 131.90, 131.54, 129.64, 128.22, 116.09, 93.41, 40.16, 21.09. HRMS (EI) Calculated for $C_{16}H_{15}IS$ (M^+) 365.9939, found 365.9936.



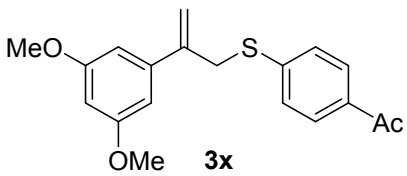
3v

Ethyl 4-(3-(p-tolylthio)prop-1-en-2-yl)benzoate (3v). Colorless oil (39 mg, 63%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (d, *J* = 8.5 Hz, 2H), 7.49 (d, *J* = 8.5 Hz, 2H), 7.22 (d, *J* = 8.1 Hz, 2H), 7.08 (d, *J* = 7.9 Hz, 2H), 5.42 (s, 1H), 5.17 (s, 1H), 4.38 (q, *J* = 7.1 Hz, 2H), 3.92 (s, 2H), 2.31 (s, 3H), 1.39 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.37, 143.97, 142.78, 136.98, 131.88, 131.59, 129.76, 129.65, 126.28, 117.19, 60.93, 40.19, 21.07, 14.36. HRMS (EI) Calculated for $C_{19}H_{20}O_2S$ (M^+) 312.1184, found 312.1188.



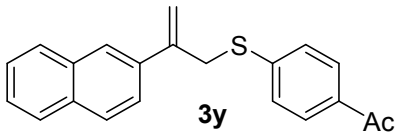
3w

1-(4-((2-(3, 5-dimethylphenyl)allyl)thio)phenyl)ethan-1-one (3w). Colorless oil (54 mg, 91%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.4 Hz, 2H), 7.35 (d, *J* = 8.4 Hz, 2H), 7.08 (s, 2H), 6.99 (s, 1H), 5.47 (s, 1H), 5.35 (s, 1H), 4.07 (s, 2H), 2.60 (s, 3H), 2.35 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.17, 144.27, 142.69, 139.41, 137.98, 134.23, 129.81, 128.68, 127.31, 124.09, 115.71, 37.63, 26.43, 21.39. HRMS (EI) Calculated for $C_{19}H_{20}OS$ (M^+) 296.1235, found 296.1233.



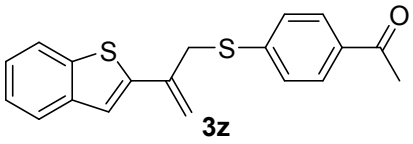
3x

1-(4-((2-(3, 5-dimethoxyphenyl)allyl)thio)phenyl)ethan-1-one (3x). Colorless oil (56 mg, 86%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.5 Hz, 2H), 7.32 (d, *J* = 8.5 Hz, 2H), 6.58 (d, *J* = 2.2 Hz, 2H), 6.44 - 6.43 (m, 1H), 5.46 (s, 1H), 5.34 (s, 1H), 4.02 (s, 2H), 3.80 (s, 6H), 2.57 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.25, 160.79, 143.99, 142.47, 141.60, 134.26, 128.72, 127.41, 116.43, 104.74, 99.75, 55.39, 37.62, 26.49. HRMS (EI) Calculated for $C_{19}H_{20}O_3S$ (M^+) 328.1133, found 328.1137.



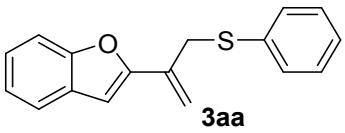
3y

1-(4-((2-(naphthalen-2-yl)allyl)thio)phenyl)ethan-1-one (3y). Colorless oil (50 mg, 79%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 - 7.81 (m, 6H), 7.59 - 7.57 (m, 1H), 7.50 – 7.44 (m, 2H), 7.33 (d, *J* = 8.4 Hz, 2H), 5.61 (s, 1H), 5.45 (s, 1H), 4.17 (s, 2H), 2.55 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.16, 143.98, 142.36, 136.49, 134.37, 133.29, 133.08, 128.73, 128.28, 128.15, 127.61, 127.57, 126.39, 126.26, 125.14, 124.34, 116.61, 37.71, 26.45. HRMS (EI) Calculated for $C_{21}H_{18}OS$ (M^+) 318.1078, found 318.1071.



3z

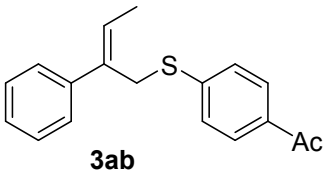
1-(4-((2-(benzo[b]thiophen-2-yl)allyl)thio)phenyl)ethan-1-one (3z). Colorless oil (44 mg, 68%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.4 Hz, 2H), 7.80 – 7.75 (m, 1H), 7.74 – 7.71 (m, 1H), 7.38 – 7.35 (m, 3H), 7.35 – 7.31 (m, 2H), 5.64 (s, 1H), 5.37 (s, 1H), 4.10 (s, 2H), 2.57 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.26, 143.49, 142.83, 140.10, 139.01, 136.34, 134.52, 128.82, 127.70, 125.06, 124.57, 123.84, 122.11, 121.19, 116.95, 37.13, 26.53. HRMS (EI) Calculated for $C_{19}H_{16}OS_2$ (M^+) 324.0643, found 324.0640.



3aa

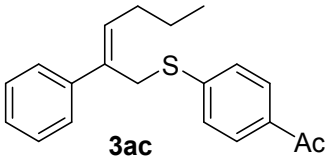
1-(4-((2-(benzofuran-2-yl)allyl)thio)phenyl)ethan-1-one (3aa). Colorless oil (32 mg, 60%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.55 (d, *J* = 7.6 Hz, 1H), 7.45 (d, *J* = 8.2 Hz, 1H), 7.38 (d, *J* = 7.5 Hz, 2H), 7.31 - 7.26 (m, 3H), 7.24 - 7.20 (m, 2H), 6.81 (s, 1H), 5.87 (s, 1H), 5.25 (s, 1H), 3.93 (s, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.80, 135.91, 133.18, 130.73,

128.92, 126.79, 124.78, 122.86, 121.18, 115.60, 111.04, 103.58, 37.46. HRMS (EI) Calculated for $C_{17}H_{14}OS$ (M^+) 266.0765, found 266.0761.



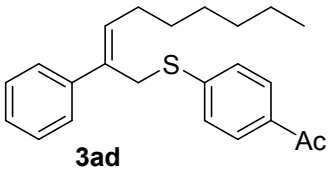
3ab

(Z)-1-(4-((2-phenylbut-2-en-1-yl)thio)phenyl)ethan-1-one (3ab). Colorless oil (48 mg, 86%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.4 Hz, 2H), 7.43 (d, *J* = 7.4 Hz, 2H), 7.38 – 7.29 (m, 5H), 6.06 (q, *J* = 7.0 Hz, 1H), 4.11 (s, 2H), 2.60 (s, 3H), 1.89 (d, *J* = 7.0 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.27, 145.02, 141.50, 134.44, 134.11, 128.70, 128.44, 128.15, 127.23, 123.20, 126.04, 32.64, 26.50, 14.59. HRMS (EI) Calculated for $C_{18}H_{18}OS$ (M^+) 282.1078, found 282.1070.



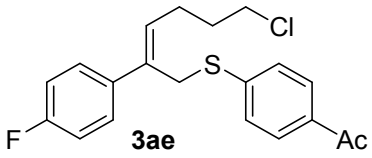
3ac

(Z)-1-(4-((2-phenylhex-2-en-1-yl)thio)phenyl)ethan-1-one (3ac). Colorless oil (57 mg, 92%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.3 Hz, 2H), 7.45 (d, *J* = 7.7 Hz, 2H), 7.35 (t, *J* = 7.7 Hz, 4H), 7.28 (s, 1H), 5.98 (t, *J* = 7.4 Hz, 1H), 4.11 (s, 2H), 2.60 (s, 3H), 2.26 (q, *J* = 7.4 Hz, 2H), 1.54 - 1.51 (m, 2H), 0.99 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.24, 145.14, 141.55, 134.16, 133.47, 128.71, 128.43, 127.25, 127.06, 127.00, 126.14, 32.88, 31.04, 26.50, 22.80, 13.96. HRMS (EI) Calculated for $C_{20}H_{22}OS$ (M^+) 310.1391, found 310.1398.



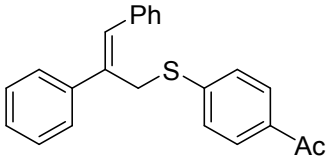
3ad

(Z)-1-(4-((2-phenylnon-2-en-1-yl)thio)phenyl)ethan-1-one (3ad). Colorless oil (62 mg, 88%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.86 (d, *J* = 8.4 Hz, 2H), 7.42 (d, *J* = 7.5 Hz, 2H), 7.32 (t, *J* = 8.4 Hz, 4H), 7.27 - 7.26 (m, 1H), 5.95 (t, *J* = 7.4 Hz, 1H), 4.08 (s, 2H), 2.58 (s, 3H), 2.24 (q, *J* = 7.4 Hz, 2H), 1.48 - 1.43 (m, 2H), 1.37 - 1.26 (m, 6H), 0.89 (t, *J* = 6.9 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.25, 145.13, 141.55, 134.41, 134.07, 133.25, 128.70, 128.42, 127.26, 127.11, 126.13, 32.90, 31.76, 29.57, 29.10, 29.05, 26.49, 22.65, 14.13. HRMS (EI) Calculated for $C_{23}H_{28}OS$ (M^+) 352.1861, found 352.1866.



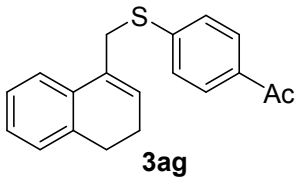
3ae

(Z)-1-(4-((6-chloro-2-(4-fluorophenyl)hex-2-en-1-yl)thio)phenyl)ethan-1-one (3ae). Colorless oil (55 mg, 76%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.4 Hz, 2H), 7.43 - 7.40 (mz, 2H), 7.35 (d, *J* = 8.4 Hz, 2H), 7.04 (t, *J* = 8.6 Hz, 2H), 5.90 (t, *J* = 7.3 Hz, 1H), 4.06 (d, *J* = 3.6 Hz, 2H), 3.62 (t, *J* = 6.7 Hz, 2H), 2.72 (q, *J* = 6.9 Hz, 2H), 2.60 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.20, 162.38 (d, *J* = 246.1 Hz), 144.02, 137.08, 135.75, 134.49, 128.89, 128.80, 127.94 (d, *J* = 8.0 Hz), 127.59, 115.37 (d, *J* = 21.1 Hz), 43.81, 33.31, 32.04, 26.52. HRMS (EI) Calculated for $C_{20}H_{20}ClFOS$ (M^+) 362.0907, found 362.0903.



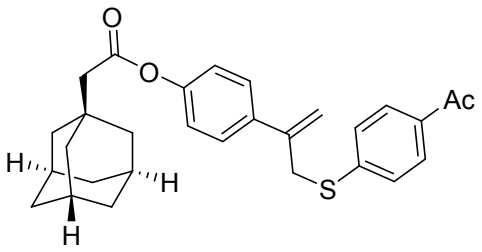
3af

(Z)-1-(4-((2, 3-diphenylallyl)thio)phenyl)ethan-1-one (3af). Colorless oil (62 mg, 91%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.4 Hz, 2H), 7.55 (d, *J* = 7.4 Hz, 2H), 7.45 (d, *J* = 7.5 Hz, 2H), 7.41 - 7.38 (m, 4H), 7.35 – 7.29 (m, 2H), 7.24 (d, *J* = 8.4 Hz, 2H), 7.00 (s, 1H), 4.30 (s, 2H), 2.57 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.22, 144.43, 140.85, 136.91, 135.53, 134.10, 132.07, 128.81, 128.73, 128.64, 128.63, 128.00, 127.55, 126.90, 126.51, 33.58, 26.50. HRMS (EI) Calculated for $C_{23}H_{20}OS$ (M^+) 344.1235, found 344.1231.



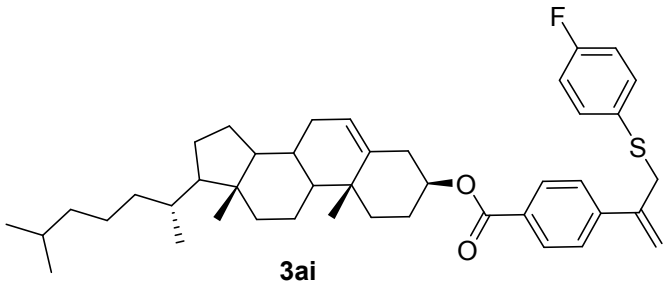
3ag

(4-fluorophenyl)(2-phenylallyl)sulfane (3ag). Colorless oil (48 mg, 82%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.86 (d, *J* = 8.4 Hz, 2H), 7.35 (t, *J* = 8.3 Hz, 3H), 7.23 (t, *J* = 7.4 Hz, 1H), 7.21 – 7.15 (m, 2H), 6.13–6.12 (m, 1H), 4.04 (s, 2H), 2.75 (t, *J* = 8.0 Hz, 2H), 2.57 (s, 3H), 2.30 – 2.27 (m, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.28, 144.57, 136.59, 134.15, 133.28, 130.81, 129.30, 128.70, 127.83, 127.36, 127.31, 126.52, 122.85, 35.46, 27.96, 26.50, 23.25. HRMS (EI) Calculated for $C_{19}H_{18}OS$ (M^+) 294.1078, found 294.1073.



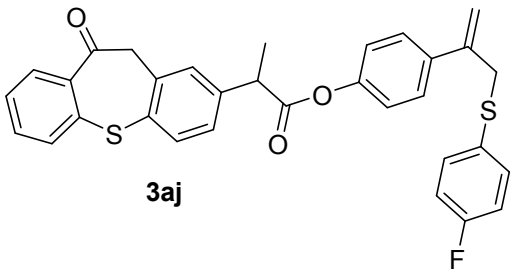
3ah

4-(3-((4-acetylphenyl)thio)prop-1-en-2-yl)phenyl 2-((3r,5r,7r)-adamantan-1-yl)acetate (3ah). Colorless oil (70 mg, 76%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.85 (d, *J* = 8.4 Hz, 2H), 7.44 (d, *J* = 8.6 Hz, 2H), 7.31 (d, *J* = 8.4 Hz, 2H), 7.08 (d, *J* = 8.6 Hz, 2H), 5.44 (s, 1H), 5.34 (s, 1H), 4.04 (s, 2H), 2.57 (s, 3H), 2.31 (s, 2H), 2.02 (s, 3H), 1.74 (d, *J* = 8.4 Hz, 9H), 1.68 - 1.66 (m, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 170.17, 150.51, 143.79, 141.57, 136.82, 134.33, 128.74, 127.51, 127.25, 121.74, 116.37, 48.76, 42.49, 37.63, 36.72, 33.29, 28.63, 26.49. HRMS (ESI) Calculated for $C_{29}H_{33}O_3S$ (M+H) 461.2145, found 461.2141.



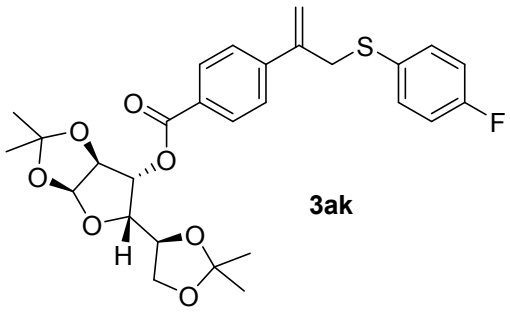
3ai

(3S, 10R, 13R)-10,13-dimethyl-17-((R)-6-methylheptan-2-yl)-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-3-yl 4-(3-((4-fluorophenyl)thio)prop-1-en-2-yl)benzoate (3ai). Colorless oil (67 mg, 51%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.04 (d, *J* = 8.4 Hz, 2H), 7.50 (d, *J* = 8.4 Hz, 2H), 7.34 – 7.28 (m, 2H), 7.00 (t, *J* = 8.6 Hz, 2H), 5.49 – 5.40 (m, 2H), 5.11 (s, 1H), 4.93 – 4.85 (m, 1H), 3.92 (s, 2H), 2.49 (d, *J* = 7.7 Hz, 2H), 2.08 – 1.99 (m, 3H), 1.98 – 1.92 (m, 1H), 1.91 – 1.82 (m, 1H), 1.81 – 1.72 (m, 1H), 1.58 – 1.34 (m, 8H), 1.31 – 1.08 (m, 12H), 1.07 – 0.99 (m, 3H), 0.95 (d, *J* = 6.5 Hz, 3H), 0.90 – 0.88 (m, 6H), 0.71 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 165.72, 162.28 (d, *J* = 246.1 Hz), 143.56, 142.53, 139.66, 134.23 (d, *J* = 8.4 Hz), 130.19 (d, *J* = 4.2 Hz), 129.71, 126.24 , 122.83, 117.36, 115.98 (d, *J* = 36.4 Hz), 74.64, 56.71, 56.15, 50.06, 42.34, 40.80, 39.76, 39.54, 38.24, 37.05, 36.68, 36.20, 35.82, 31.96, 31.90, 28.26, 28.04, 27.91, 24.32, 23.85, 22.84, 22.58, 21.07, 19.41, 18.74, 11.89. HRMS (ESI) Calculated for $C_{43}H_{57}FO_2SNa$ (M+Na) 679.3956, found 679.3949.



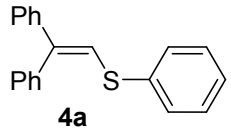
3aj

4-(3-((4-fluorophenyl)thio)prop-1-en-2-yl)phenyl 2-(10-oxo-10, 11-dihydrodibenzo[b, f] thiepin- 2-yl) propanoate (3aj). Colorless oil (75 mg, 70%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.22 - 8.21 (m, 1H), 7.65 (d, *J* = 8.0 Hz, 1H), 7.61 (d, *J* = 7.9 Hz, 1H), 7.49 (d, *J* = 1.5 Hz, 1H), 7.46 – 7.42 (m, 1H), 7.39 (d, *J* = 8.6 Hz, 2H), 7.34 – 7.25 (m, 5H), 6.99 – 6.95 (m, 4H), 5.28 (s, 1H), 5.00 (s, 1H), 4.40 (s, 2H), 3.97 (q, *J* = 7.1 Hz, 1H), 3.85 (s, 2H), 1.61 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 191.30, 172.39 , 162.19 (d, *J* =246.1 Hz), 150.32, 142.19 (d, *J* = 11.1 Hz), 140.12, 138.20, 137.05, 136.17, 134.04 (d, *J* = 8.1 Hz), 133.61, 132.60, 131.72, 131.57, 130.88, 130.44, 128.72 , 127.35, 127.04, 126.91, 126.36, 121.40, 121.21, 116.00 (s), 115.92 (d, *J* = 22.6 Hz), 51.09, 45.33, 40.90, 18.55. HRMS (ESI) Calculated for $C_{32}H_{26}FO_3S_2$ (M+H) 540.1302, found 541.1299.



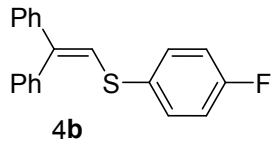
3ak

(3aS, 5S, 6R, 6aS)-5-((S)-2,2-dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyltetrahydrofuro[2,3-d][1,3]dioxol-6-yl 4-(3-((4-fluorophenyl)thio)prop-1-en-2-yl)benzoate (3ak). Colorless oil (48 mg, 46%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.00 (d, *J* = 8.3 Hz, 2H), 7.50 (d, *J* = 8.4 Hz, 2H), 7.31 – 7.29 (m, 2H), 6.98 (t, *J* = 8.6 Hz, 2H), 5.95 (d, *J* = 3.6 Hz, 1H), 5.50 (d, *J* = 2.7 Hz, 1H), 5.41 (s, 1H), 5.10 (s, 1H), 4.63 (d, *J* = 3.6 Hz, 1H), 4.39 – 4.35 (m, 1H), 4.33 (dd, *J* = 7.9, 2.8 Hz, 1H), 4.11 (dt, *J* = 8.5, 3.2 Hz, 2H), 3.90 (s, 2H), 1.60 (s, 3H), 1.42 (s, 4H), 1.33 (s, 3H), 1.28 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 164.92, 143.36 (d, *J* = 8.3 Hz), 134.31 (d, *J* =305.0 Hz), 129.90, 126.50, 117.80, 116.02 (d, *J* =22.6 Hz), 112.42, 109.45, 105.15, 83.40, 79.96, 76.65, 72.60, 67.26, 40.80, 26.87, 26.76, 26.23, 25.25. HRMS (EI) Calculated for $C_{28}H_{31}FO_7S$ (M^+) 530.1762, found 530.1761.



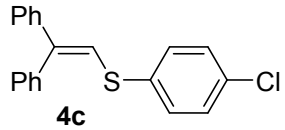
4a

(2, 2-diphenylvinyl)(pheny l)sulfane (4a). Colorless oil (50 mg, 88%)[4]. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 –7.43 (m, 4H), 7.41 – 7.26 (m, 11H), 6.88 (s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.52, 141.15, 139.24, 136.55, 129.80, 129.58, 129.15, 128.42, 128.35, 127.84, 127.33, 127.24, 126.82, 124.14.



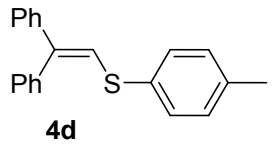
4b

(2, 2-diphenylvinyl)(4-fluorophenyl)sulfane (4b). Colorless oil (55 mg, 91%)[5]. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.41 (m, 4H), 7.37 (t, *J* = 7.7 Hz, 3H), 7.32 – 7.24 (m, 5H), 7.05 (t, *J* = 8.6 Hz, 2H), 6.77 (s, 1H). ^{19}F NMR (377 MHz, $CDCl_3$) δ -114.35 – -115.00 (m). ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.17 (d, *J* =246.2 Hz), 141.37, 140.93, 139.10, 132.10 (d, *J* = 8.1 Hz), 131.56 (d, *J* = 3.3 Hz), 129.75, 128.45, 128.36, 127.90, 127.38, 127.21, 124.65, 116.29 (d, *J* = 22.1 Hz).



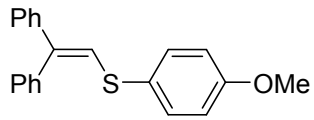
4c

(4-chlorophenyl)(2, 2-diphenylvinyl)sulfane (4c). Colorless oil (54 mg, 85%)[5]. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.40 (m, 2H), 7.39 – 7.31 (m, 5H), 7.30 – 7.23 (m, 7H), 6.77 (s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.06, 141.29, 139.04, 135.13, 132.87, 130.75, 129.70, 129.26, 128.42, 128.36, 127.94, 127.50, 127.23, 123.21.



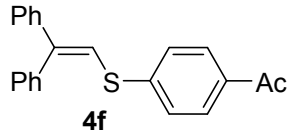
4d

(2, 2-diphenylvinyl)(p-tolyl)sulfane (4d). Colorless oil (55 mg, 92%)[5]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.43 –7.40 (m, 2H), 7.37 – 7.32 (m, 5H), 7.29 – 7.22 (m, 5H), 7.14 (d, *J* = 8.0 Hz, 2H), 6.81 (s, 1H), 2.33 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.60, 140.28, 139.30, 137.00, 132.89, 130.13, 129.89, 129.80, 128.37, 128.27, 127.71, 127.17, 125.25, 21.01.



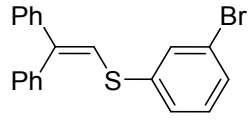
4e

(2, 2-diphenylvinyl)(4-methoxyphenyl)sulfane (4e). Colorless oil (51 mg, 81%)[5]. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.36 (m, 7H), 7.27 (s, 1H), 7.26 – 7.20 (m, 4H), 6.89 (d, *J* = 8.6 Hz, 2H), 6.77 (s, 1H), 3.82 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.32, 141.57, 139.31, 139.27, 132.57, 129.80, 128.339, 128.27, 127.71, 127.13, 127.08, 126.56, 114.82, 55.41.



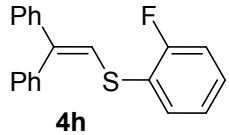
4f

1-(4-((2, 2-diphenylvinyl)thio)phenyl)ethan-1-one (4f). Colorless oil (50 mg, 77%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (d, *J* = 8.4 Hz, 2H), 7.48 – 7.28 (m, 12H), 6.89 (s, 1H), 2.59 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.08, 144.25, 143.63, 141.16, 138.91, 134.84, 129.70, 128.99, 128.45, 128.12, 127.84, 127.58, 127.37, 120.52, 26.50. HRMS (EI) Calculated for $C_{22}H_{18}OS$ 330.1078 (M^+), found 330.1077.



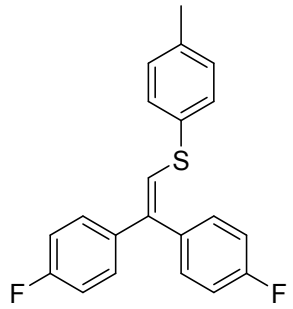
4g

(3-bromophenyl)(2, 2-diphenylvinyl)sulfane (4g). Colorless oil (60 mg, 82%)[5]. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (s, 1H), 7.46 – 7.26 (m, 12H), 7.19 (t, *J* = 7.9 Hz, 1H), 6.81 (s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.78, 141.22, 138.99, 131.62, 130.39, 129.72, 128.45, 128.41, 128.01, 127.69, 129.64, 127.31, 123.02, 122.25.



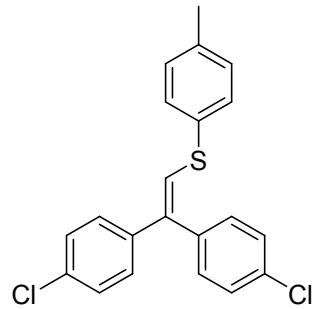
4h

(2, 2-diphenylvinyl)(2-fluorophenyl)sulfane (4h). Colorless oil (52 mg, 86%)[5]. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.41 (m, 3H), 7.41 – 7.35 (m, 3H), 7.32 – 7.24 (m, 6H), 7.16 – 7.07 (m, 2H), 6.76 (s, 1H). ^{19}F NMR (377 MHz, $CDCl_3$) δ -109.60 – -109.66 (m). ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.85 (d, *J* = 247.4 Hz), 142.05, 141.38, 138.95 131.93 (d, *J* = 1.4 Hz), 129.79, 128.93 (d, *J* = 7.8 Hz), 128.46, 128.33, 127.93, 127.46, 127.26, 124.73 (d, *J* = 3.8 Hz), 123.40 (d, J = 17.2 Hz), 122.57 (d, *J* = 1.9 Hz), 116.92 (d, *J* = 22.2 Hz).



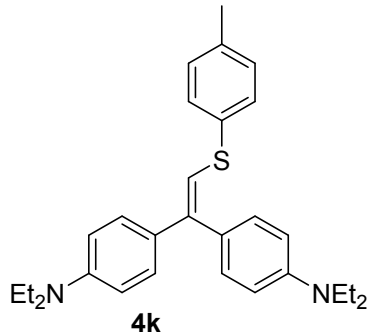
4i

(2, 2-bis(4-fluorophenyl)vinyl)(p-tolyl)sulfane (4i). Colorless oil (54 mg, 81%)[6]. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.28 (m, 4H), 7.21 – 7.07 (m, 6H), 7.00 – 6.92 (m, 2H), 6.73 (s, 1H), 2.34 (s, 3H). ^{19}F NMR (377 MHz, $CDCl_3$) δ -113.53 – -113.65 (m), -114.89 – -114.99 (m). ^{13}C NMR (151 MHz, $CDCl_3$) δ 162.26 (d, *J* =247.6 Hz), 162.21 (d, *J* =246.1 Hz), 138.08, 137.68 (d, *J* = 3.2 Hz), 137.31, 134.98 (d, *J* = 3.4 Hz), 132.40, 131.53 (d, *J* = 8.1 Hz), 130.24, 130.00, 128.75 (d, *J* = 7.9 Hz), 125.48, 115.49 (d, *J* = 19.4 Hz), 115.26 (d, *J* = 21.1 Hz), 21.09.



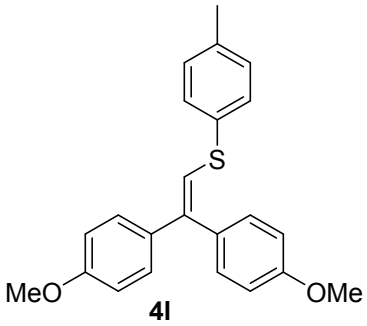
4j

(2, 2-bis(4-chlorophenyl)vinyl)(p-tolyl)sulfane (4j). Colorless oil (66 mg, 90%)[7]. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.37 (m, 2H), 7.36 – 7.31 (m, 2H), 7.30 – 7.26 (m, 2H), 7.25 – 7.21 (m, 2H), 7.18 – 7.10 (m, 4H), 6.80 (s, 1H), 2.35 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 139.68, 137.53, 137.41, 137.21, 133.78, 133.20, 132.10, 131.15, 130.41, 130.05, 128.81, 128.55, 128.34, 126.89, 21.11.



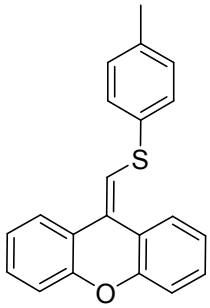
4k

4, 4'-(2-(p-tolylthio)ethene-1,1-diyl)bis(N, N-diethylaniline) (4k). Colorless oil (74 mg, 84%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (d, *J* = 8.1 Hz, 2H), 7.25 - 7.16 (m, 4H), 7.10 (d, *J* = 8.0 Hz, 2H), 6.67 (d, *J* = 8.8 Hz, 2H), 6.58 (d, *J* = 8.8 Hz, 2H), 6.46 (s, 1H), 3.40 - 3.31 (m, 8H), 2.32 (s, 3H), 1.17 (dt, *J* = 13.7, 7.0 Hz, 12H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 147.25, 147.10, 142.81, 135.85, 134.61, 131.07, 129.77, 129.65, 129.05, 128.77, 126.40, 116.99, 111.23, 110.85, 44.37, 44.26, 21.03, 12.76, 12.66. HRMS (EI) Calculated for $C_{29}H_{36}N_2S$ (M^+) 444.2599, found 444.2590.



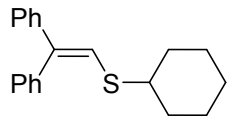
4l

(2, 2-bis(4-methoxyphenyl)vinyl)(p-tolyl)sulfane (4l). Colorless oil (63 mg, 87%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 – 7.18 (m, 4H), 7.13 – 7.08 (m, 2H), 7.05 (d, *J* = 8.0 Hz, 2H), 6.89 – 6.83 (m, 2H), 6.76 – 6.71 (m, 2H), 6.56 (s, 1H), 3.76 (s, 3H), 3.71 (s, 3H), 2.26 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 159.07, 159.01, 140.20, 136.71, 134.72, 133.30, 131.78, 131.07, 129.86, 129.77, 128.51, 122.07, 113.69, 113.66, 55.33, 55.26, 21.08. HRMS (EI) Calculated for $C_{23}H_{22}O_2S$ (M^+) 362.1341, found 362.1344.



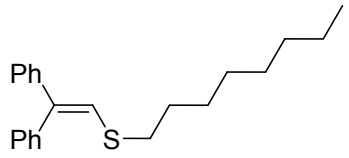
4m

(4-fluorophenyl)(2-phenylallyl)sulfane (4m). Colorless oil (52 mg, 84%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 7.8 Hz, 1H), 7.45 (d, *J* = 7.9 Hz, 1H), 7.37 (d, *J* = 8.1 Hz, 2H), 7.34 – 7.29 (m, 1H), 7.24 – 7.04 (m, 7H), 6.63 (s, 1H), 2.35 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 152.09, 150.64, 137.61, 133.10, 130.54, 130.01, 129.02, 128.35, 128.00, 124.63, 124.61, 123.77, 123.30, 122.75, 121.98, 119.78, 116.68, 116.31, 21.12. HRMS (EI) Calculated for $C_{21}H_{16}OS$ (M^+) 316.0922, found 316.0928.



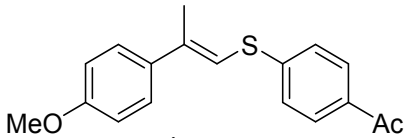
4o

Cyclohexyl(2,2-diphenylvinyl)sulfane (4o). Colorless oil (43 mg, 74%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 - 7.28 (m, 2H), 7.26 – 7.17 (m, 5H), 7.15 - 7.12 (m, 3H), 6.59 (s, 1H), 2.87 - 2.80 (m, 1H), 2.00 - 1.96 (m, 2H), 1.73 - 1.70 (m, 2H), 1.60 – 1.51 (m, 1H), 1.39 – 1.15 (m, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.28, 139.76, 138.26, 129.80, 128.25, 128.22, 127.37, 127.06, 126.74, 124.74, 46.84, 33.86, 26.09, 25.64. HRMS (EI) Calculated for $C_{20}H_{22}S$ (M^+) 294.1442, found 294.1447.



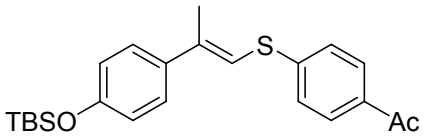
4p

(2, 2-diphenylvinyl)(octyl)sulfane (4p). Colorless oil (45 mg, 70%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.37 (m, 2H), 7.35 – 7.26 (m, 5H), 7.23 (t, J = 7.0 Hz, 3H), 6.60 (s, 1H), 2.77 (t, J = 7.4 Hz, 2H), 1.74 – 1.64 (m, 2H), 1.43–1.38 (m, 2H), 1.38 – 1.29 (m, 8H), 0.90 (t, J = 6.7 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.06, 139.68, 138.39, 129.76, 128.29, 128.24, 127.43, 127.03, 126.79, 126.43, 34.98, 31.82, 30.38, 29.18, 28.67, 22.66, 14.10. HRMS (EI) Calculated for $C_{22}H_{28}S$ (M^+) 324.1912, found 324.1918.



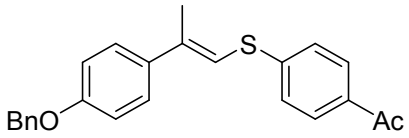
4q

(*E*)-1-(4-((2-(4-methoxyphenyl)prop-1-en-1-yl)thio)phenyl)ethan-1-one (4q). Colorless oil (50 mg, 84%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, J = 8.4 Hz, 2H), 7.41 - 7.38 (m, 4H), 6.90 (d, J = 8.7 Hz, 2H), 6.49 (s, 1H), 3.83 (s, 3H), 2.57 (s, 3H), 2.27 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.09, 159.47, 144.20, 141.63, 134.39, 133.97, 128.91, 126.83, 115.54, 113.91, 113.57, 55.36, 26.45, 18.04. HRMS (EI) Calculated for $C_{18}H_{18}O_2S$ (M^+) 298.1028, found 298.1031.



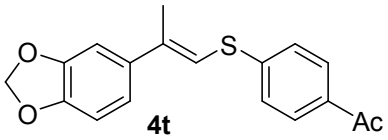
4r

(E)-1-(4-((2-(4-((tert-butyldimethylsilyl)oxy)phenyl)prop-1-en-1-yl)thio)phenyl)ethan-1-one (4r). Colorless oil (61 mg, 77%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.90 (d, *J* = 8.4 Hz, 2H), 7.41 (d, *J* = 8.4 Hz, 2H), 7.36 (d, *J* = 8.6 Hz, 2H), 6.85 (d, *J* = 8.6 Hz, 2H), 6.51 (s, 1H), 2.60 (s, 3H), 2.28 (s, 3H), 1.02 (s, 9H), 0.24 (s, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.19, 155.65, 144.24, 141.68, 134.44, 134.31, 128.92, 126.82, 126.75, 120.03, 115.53, 26.51, 25.69, 18.26, 18.03, -4.36. HRMS (EI) Calculated for $C_{23}H_{30}O_2SSi$ (M^+) 398.1730, found 398.1726.



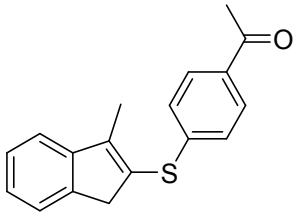
4s

(*E*)-1-(4-((2-(4-(benzyloxy)phenyl)prop-1-en-1-yl)thio)phenyl)ethan-1-one (4s). Colorless oil (51 mg, 69%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.6 Hz, 2H), 7.46 – 7.34 (m, 9H), 6.98 (d, *J* = 8.8 Hz, 2H), 6.49 (s, 1H), 5.10 (s, 2H), 2.58 (s, 3H), 2.27 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.21, 158.62, 144.19, 141.52, 136.83, 134.34, 134.18, 128.94, 128.66, 128.08, 127.48, 126.86, 126.83, 115.65, 114.83, 70.10, 26.52, 18.05. HRMS (EI) Calculated for $C_{24}H_{22}O_2S$ (M^+) 374.1341, found 374.1340.



4t

(*E*)-1-(4-((2-(benzo[d][1,3]dioxol-5-yl)prop-1-en-1-yl)thio)phenyl)ethan-1-one (4t). Colorless oil (50 mg, 81%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.5 Hz, 2H), 7.38 (d, *J* = 8.5 Hz, 2H), 6.96 – 6.91 (m, 2H), 6.80 (d, *J* = 7.9 Hz, 1H), 6.47 (d, *J* = 0.7 Hz, 1H), 5.97 (s, 2H), 2.57 (s, 3H), 2.24 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.07, 147.92, 147.37, 143.88, 141.18, 135.83, 134.50, 128.93, 126.97, 119.39, 116.52, 108.20, 106.16, 101.23, 26.46, 18.26. HRMS (EI) Calculated for $C_{18}H_{16}O_3S$ (M^+) 312.0808, found 312.0815.



4u

1-(4-(((1H-inden-3-yl)methyl)thio)phenyl)ethan-1-one (4u). Colorless oil (46 mg, 83%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.85 (d, *J* = 8.5 Hz, 2H), 7.44 (t, *J* = 6.9 Hz, 2H), 7.39 (t, *J* = 7.5 Hz, 1H), 7.33 – 7.29 (m, 1H), 7.26 (d, *J* = 8.5 Hz, 2H), 3.56 (d, *J* = 1.9 Hz, 2H), 2.58 (s, 3H), 2.31 (t, *J* = 2.1 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.19, 147.86, 145.04, 144.59, 143.51, 134.27, 128.97, 128.93, 126.99, 126.68, 126.04, 123.57, 119.75, 42.37, 26.50, 11.87. HRMS (EI) Calculated for $C_{18}H_{16}OS$ (M^+) 280.0919, found 280.0916.

5. X-ray Crystallographic Analysis of product 3ab

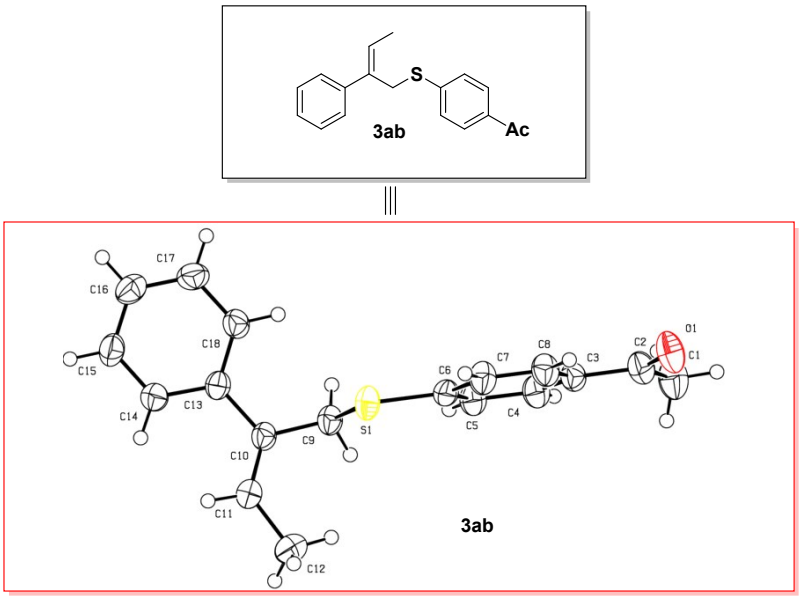
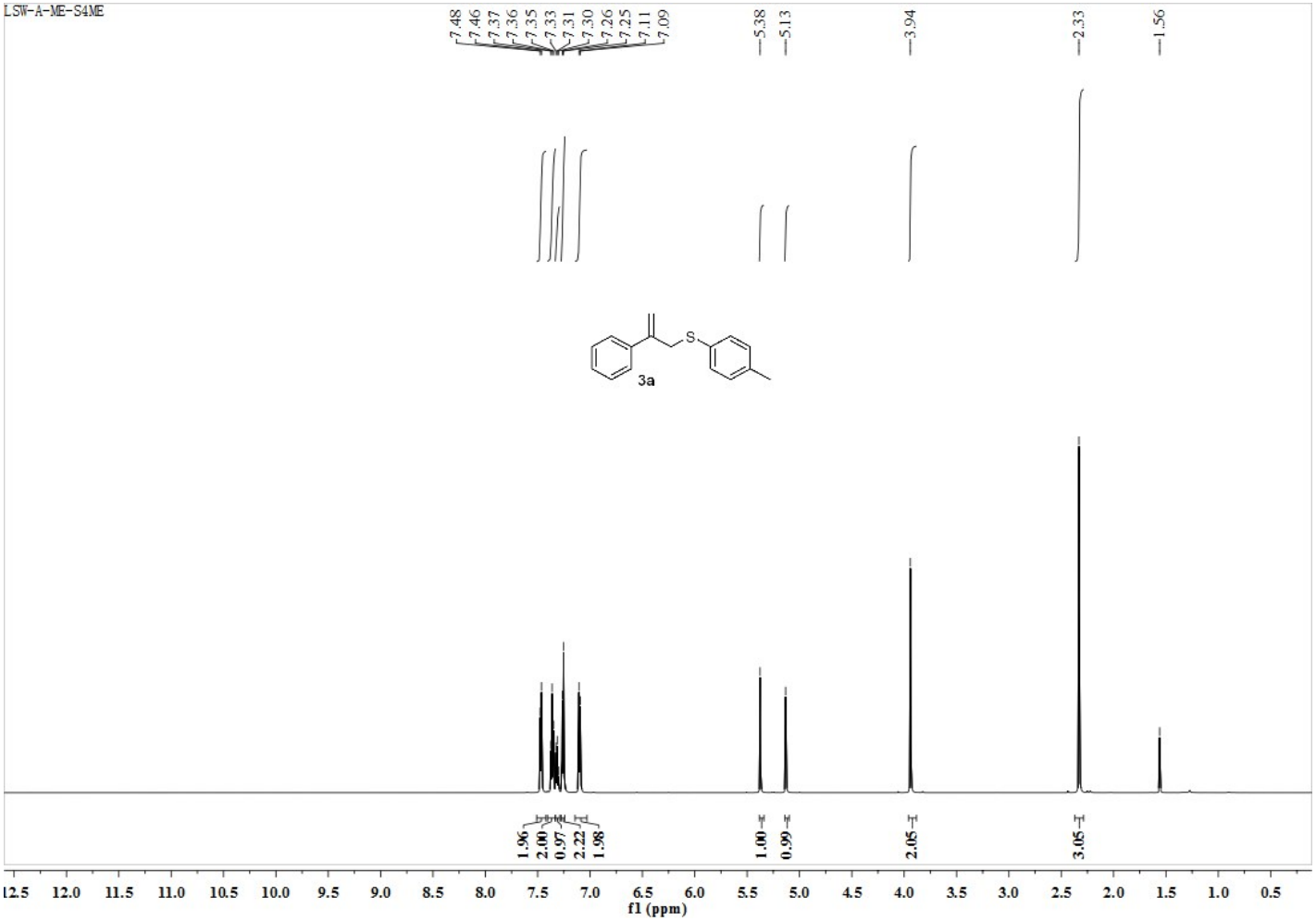


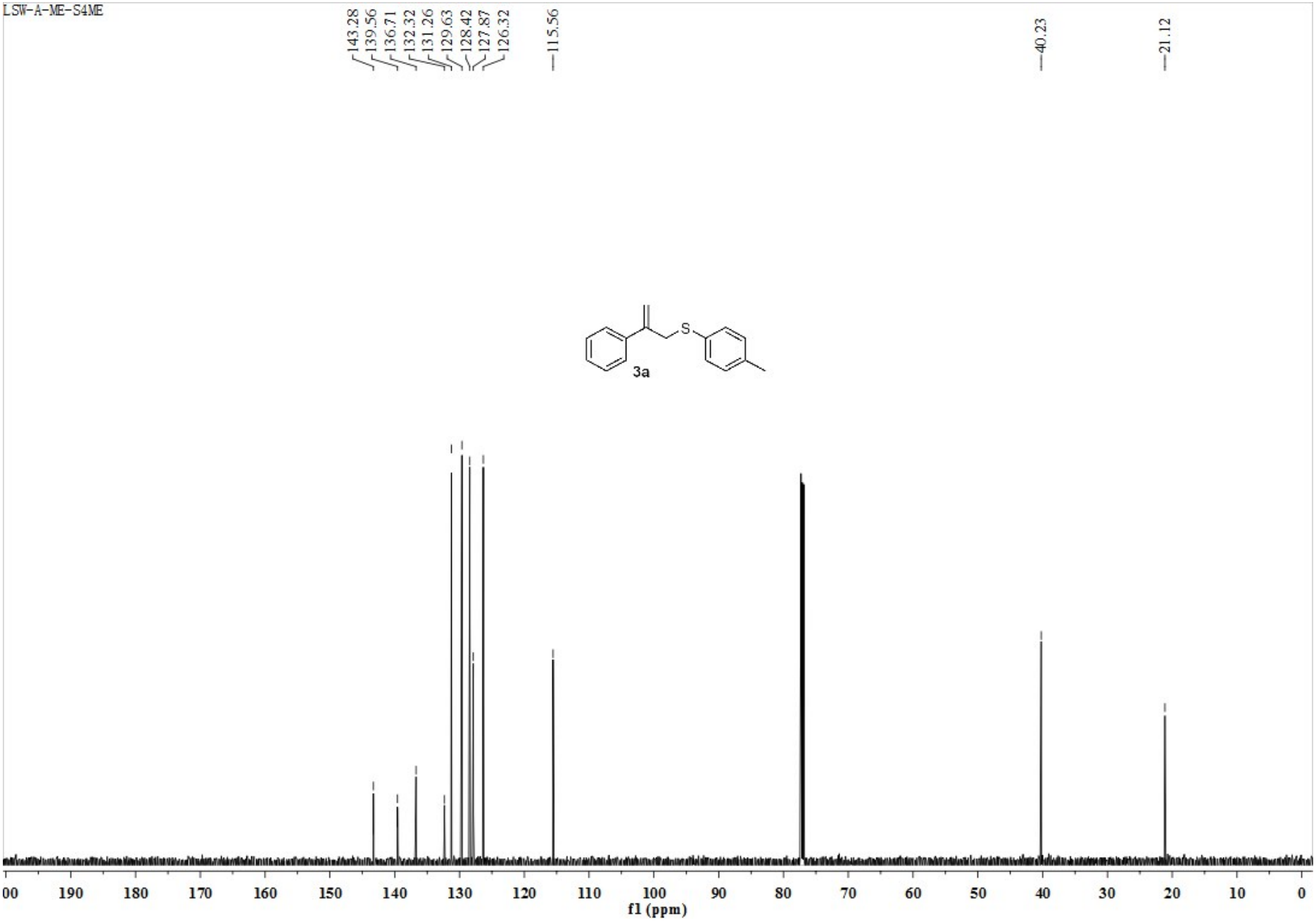
Table 1. Crystal data and structure refinement for 20200822LI_ZNZ6233_0m_a.

Identification code	20200822li_znz6233_0m_a
Empirical formula	$C_{18}H_{18}OS$
Formula weight	282.38
Temperature	296.15 K
Wavelength	0.71073 Å
Crystal system	Monoclinic

Space group	P 1 21/c 1	
Unit cell dimensions	a = 8.5247(14) Å	α= 90°.
	b = 21.621(3) Å	β= 115.939(4)°.
	c = 9.2060(14) Å	γ = 90°.
Volume	1525.8(4) $Å^3$	
Z	4	
Density (calculated)	1.229 Mg/m^3	
Absorption coefficient	0.205 mm^{-1}	
F(000)	600	
Crystal size	0.12 x 0.11 x 0.08 mm^3	
Theta range for data collection	2.635 to 27.530°.	
Index ranges	-8<=h<=11, -28<=k<=27, -11<=l<=11	
Reflections collected	13345	
Independent reflections	3504 [R(int) = 0.0543]	
Completeness to theta = 25.242°	100.0 %	
Absorption correction	None	
Max. and min. transmission	0.7456 and 0.6277	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	3504 / 0 / 183	
Goodness-of-fit on F^2	1.026	
Final R indices [I>2sigma(I)]	R1 = 0.0557, wR2 = 0.1161	
R indices (all data)	R1 = 0.1000, wR2 = 0.1409	
Extinction coefficient	n/a	
Largest diff. peak and hole	0.211 and -0.277 $e.Å^{-3}$	

6. Copies of NMR Spectra

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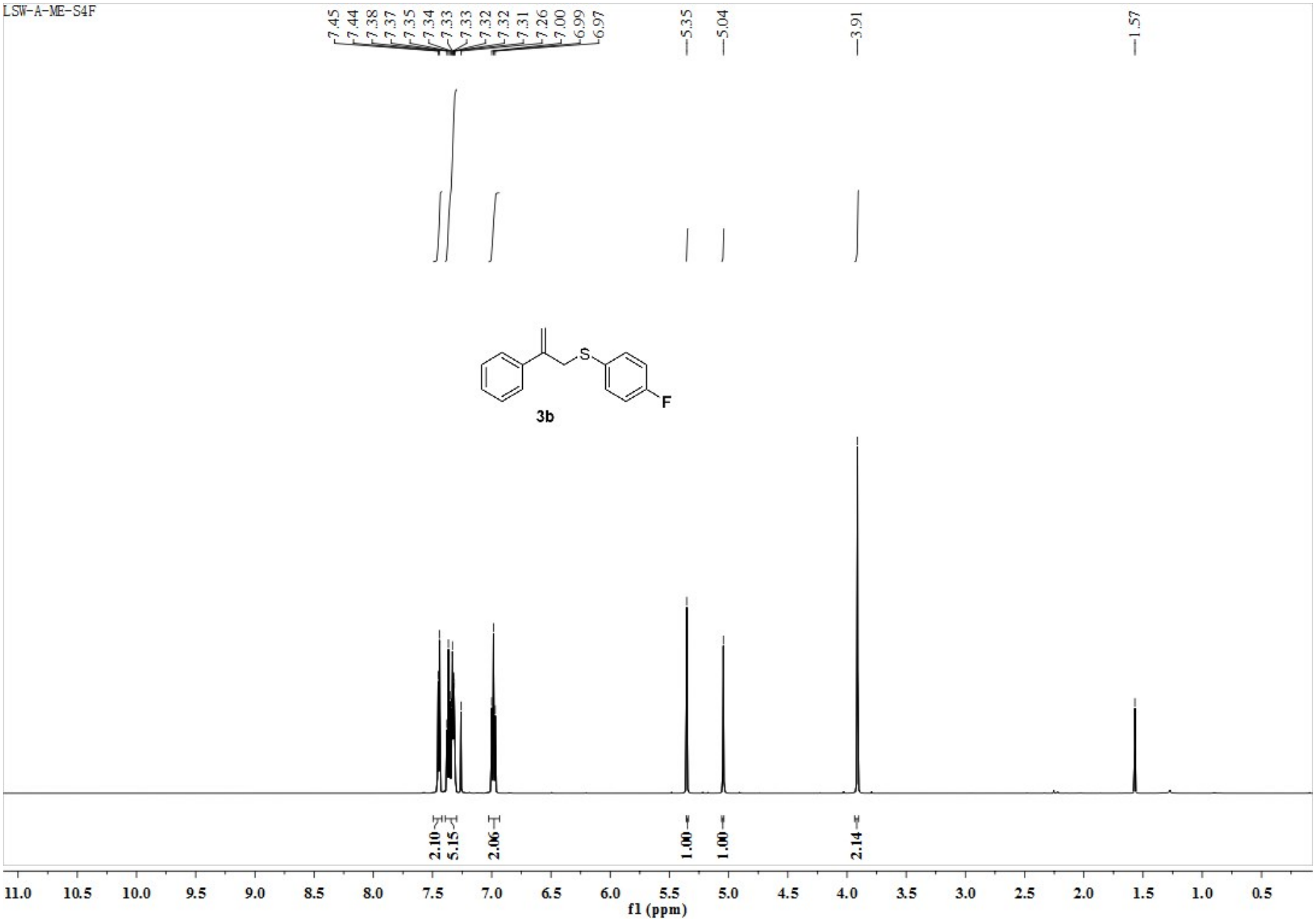
139.56
136.71
132.32
131.26
129.63
128.42
127.87
126.32
115.56
40.23
21.12
S
3a
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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7.34
7.33
7.33
7.32
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7.31
7.26
7.00
6.99
6.97
5.35
5.04
3.91
1.57
S
F
3b
2.10
5.15
2.06
1.00
1.00
2.14
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
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3.0
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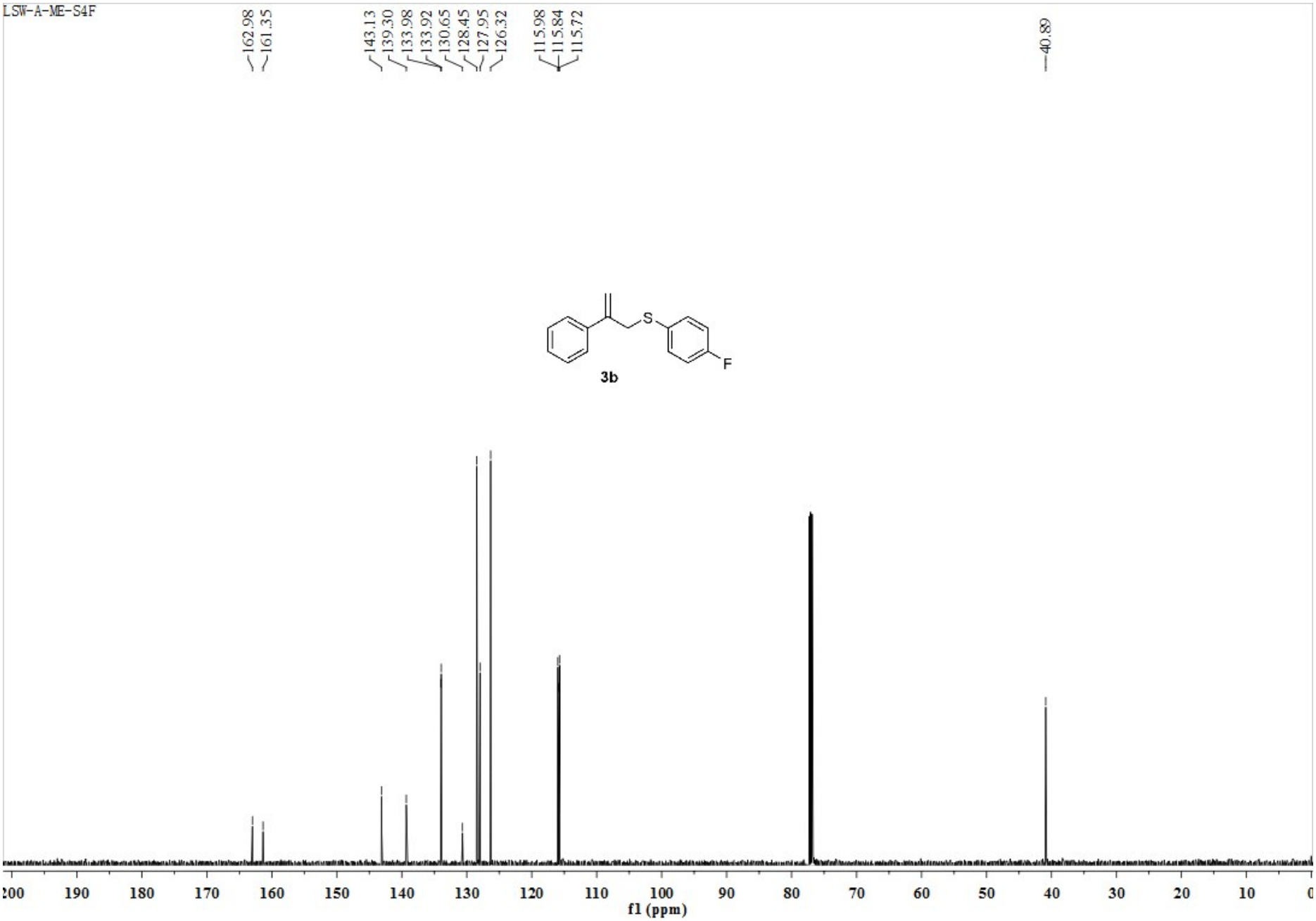
0.5
f1 (ppm)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162.98
161.35
143.13
139.30
133.98
133.92
130.65
128.45
127.95
126.32
115.98
115.84
115.72
40.89
S
F
3b
200
190
180
170
160
150
140
130
120
110
100
90
80
70
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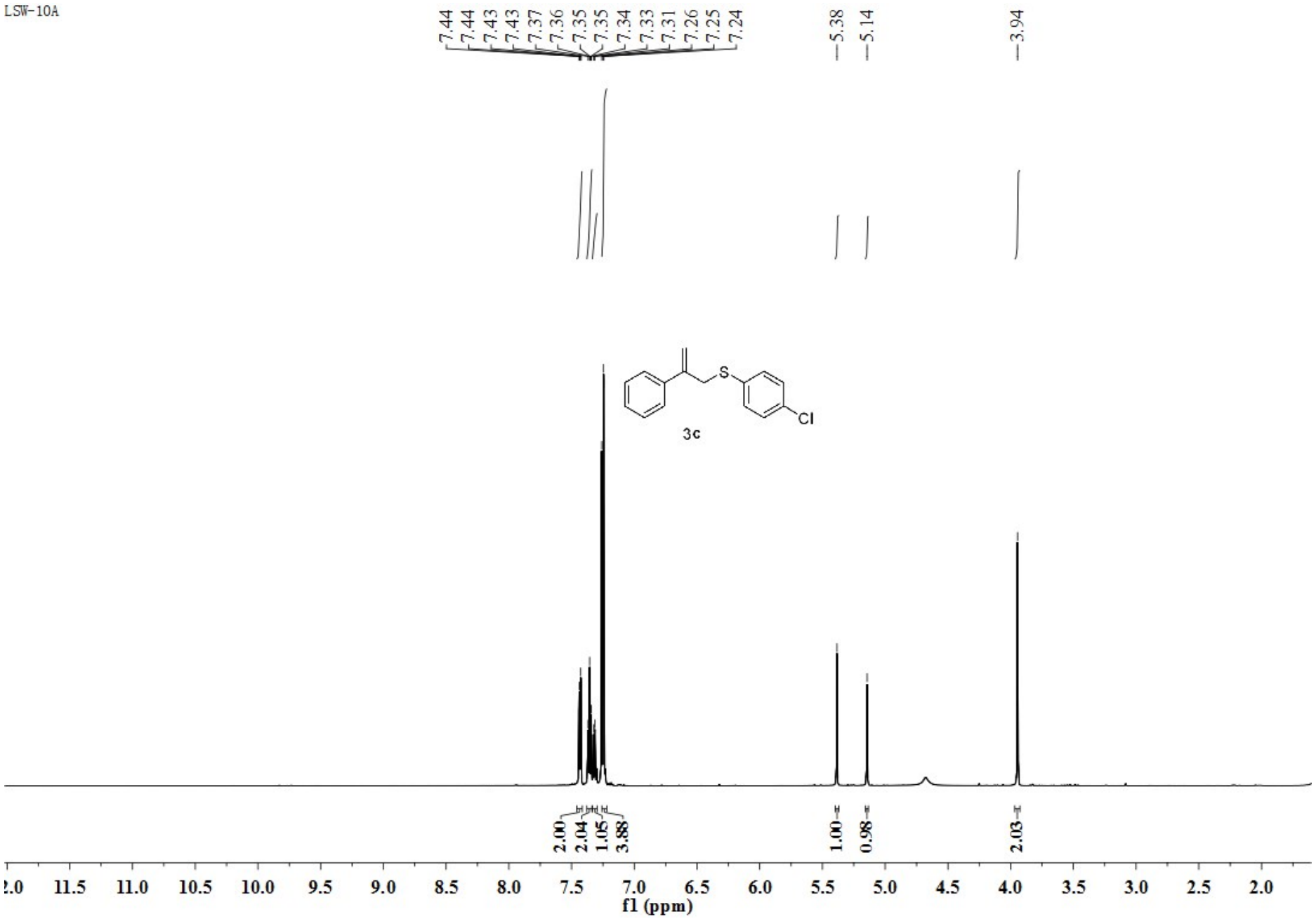
50
40
30
20
10
0
f1 (ppm)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7.44
7.43
7.43
7.37
7.36
7.35
7.35
7.34
7.33
7.31
7.26
7.25
7.24
5.38
5.14
3.94
S
Cl
3c
2.00
2.04
1.05
3.88
1.00
0.98
2.03
f1 (ppm)

LSW-10-A

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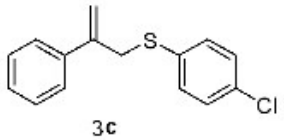
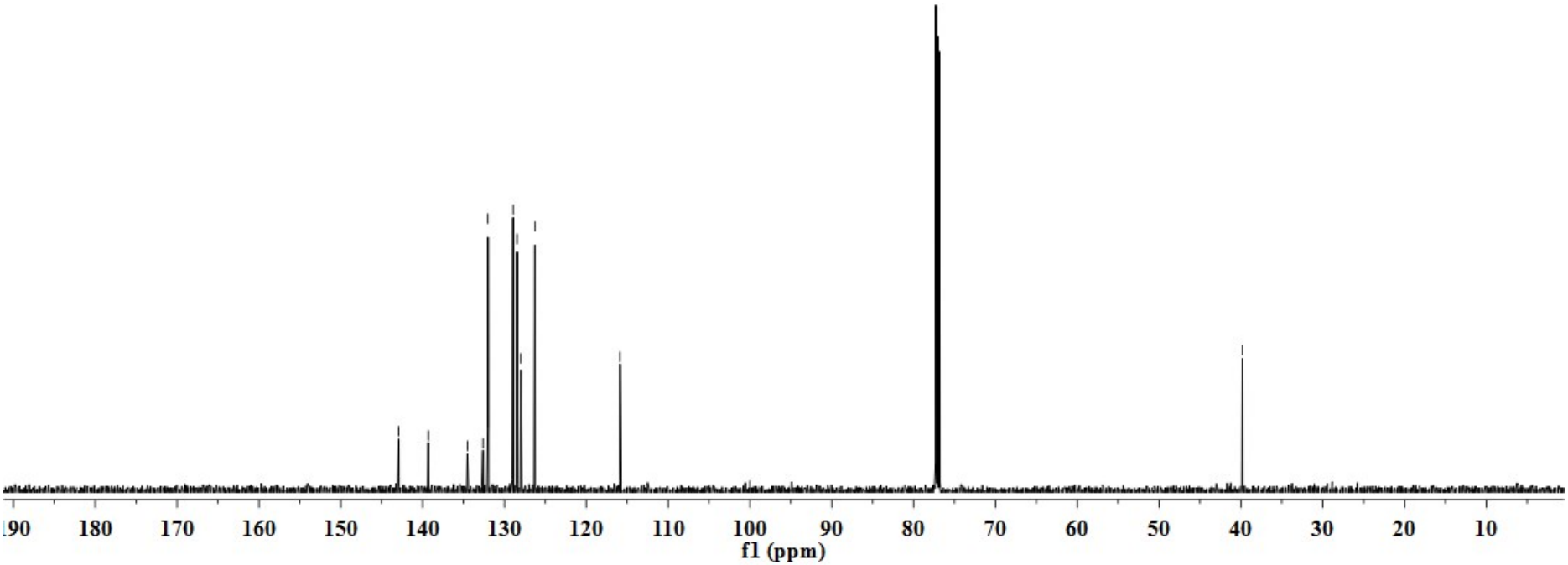
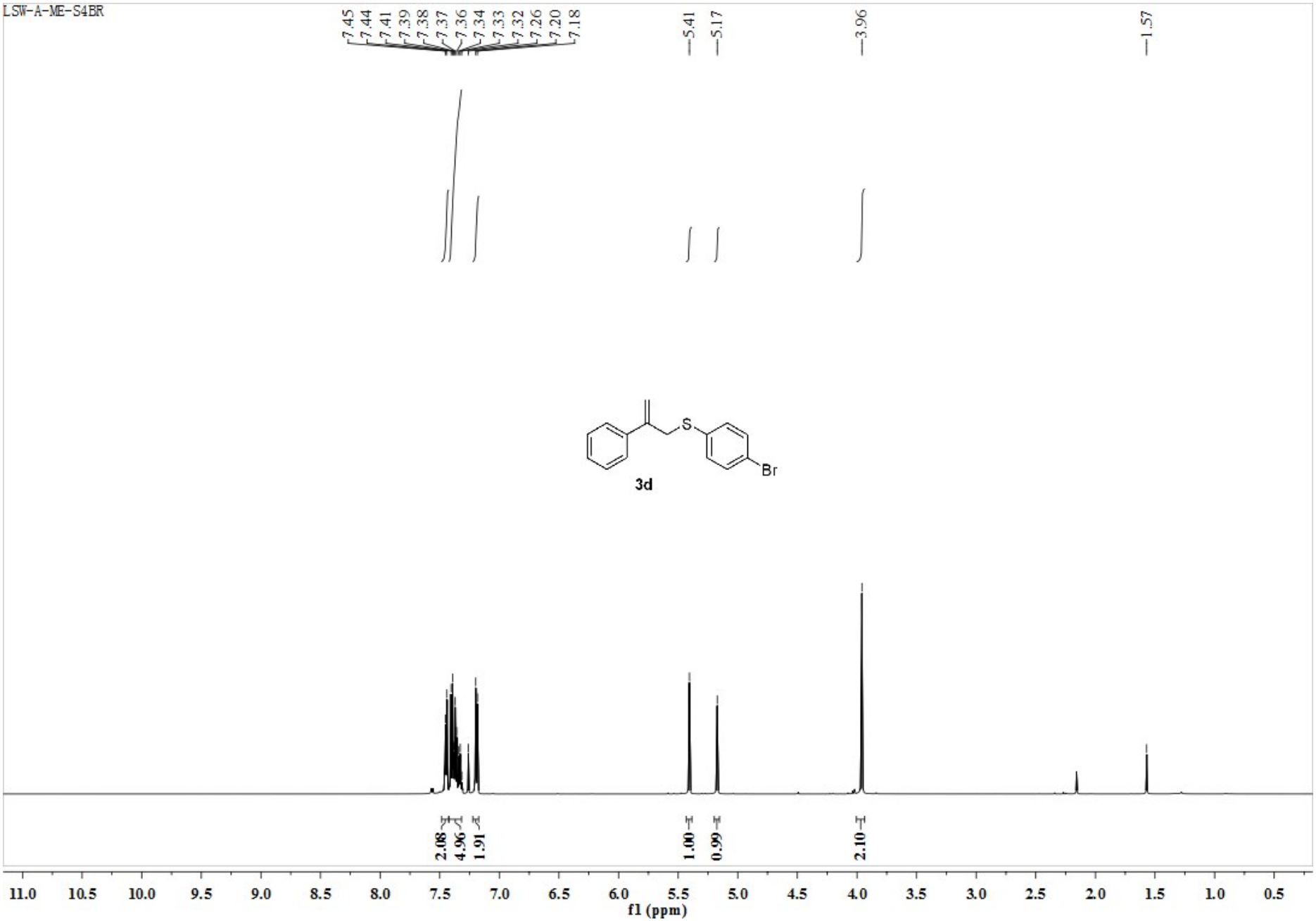
134.51
132.62
132.01
128.94
128.45
127.99
126.28
115.87
39.80



3c

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7.41
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7.36
7.34
7.33
7.32
7.26
7.20
7.18
5.41
5.17
3.96
1.57
S
Br
3d
2.08
4.96
1.91
1.00
0.99
2.10
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.0
3.5
3.0
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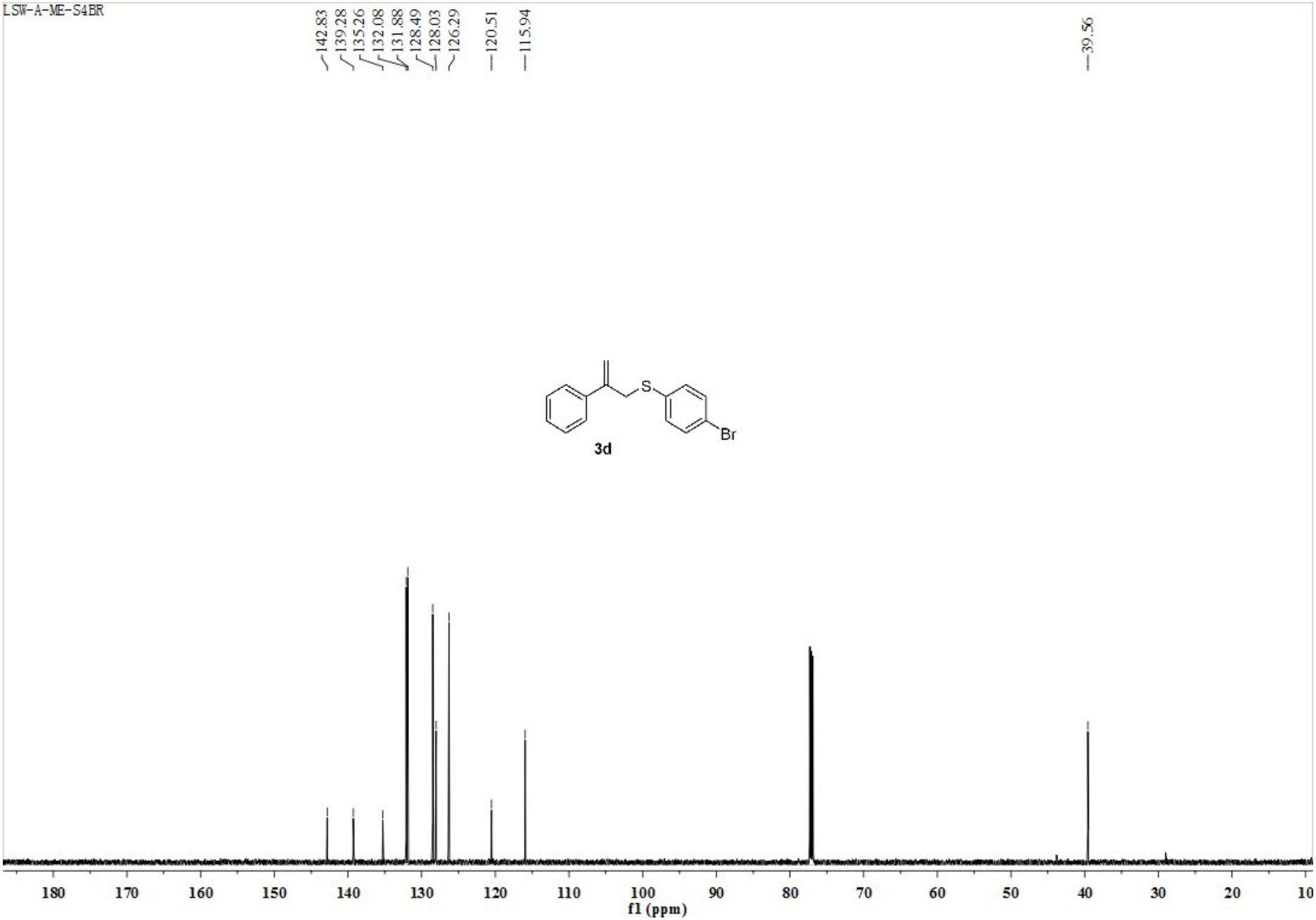
2.0
1.5
1.0
0.5
f1 (ppm)


LSW-A-ME-S4BR
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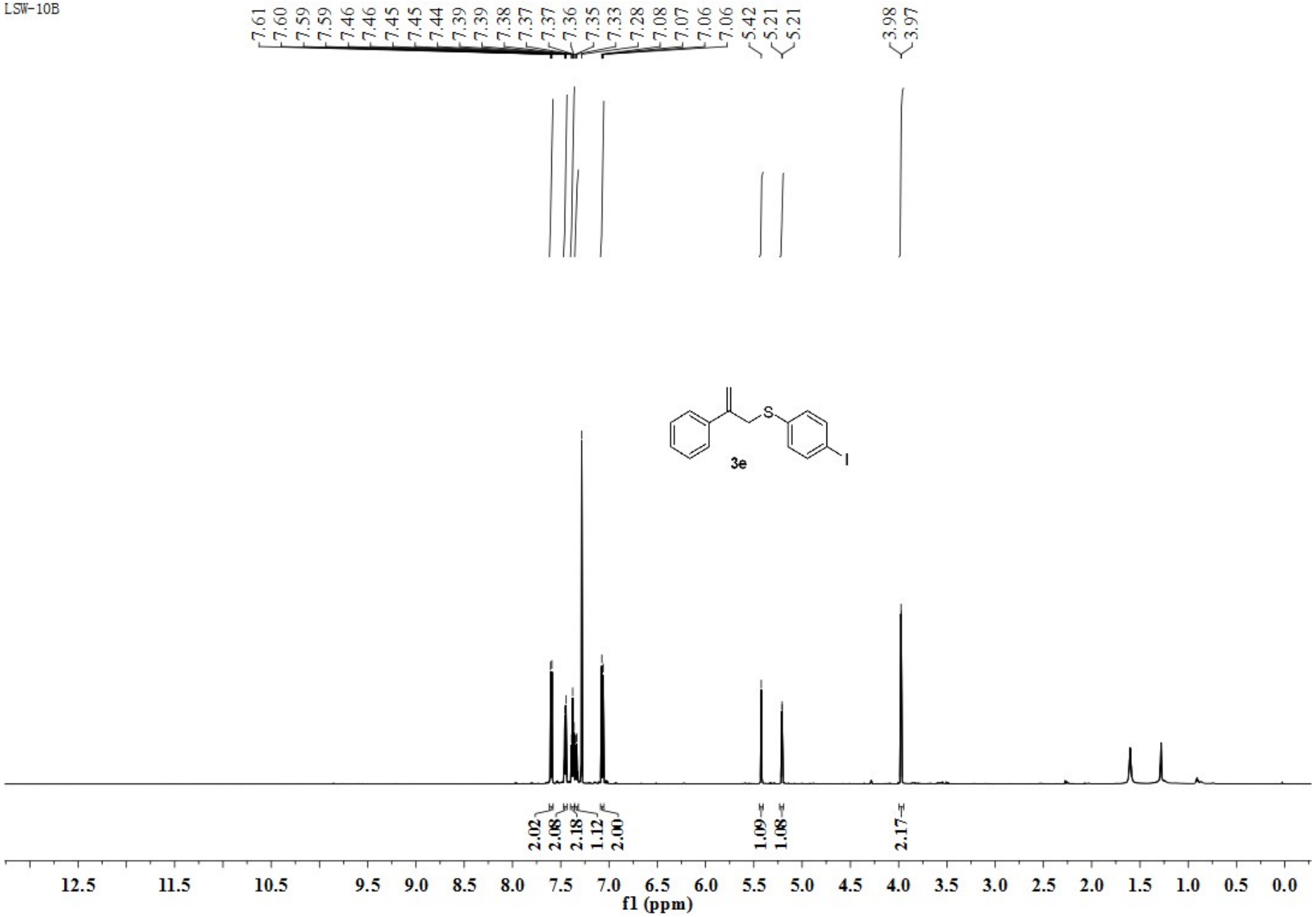
132.08
131.88
128.49
128.03
126.29
120.51
115.94
39.56
S
Br
3d
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

LSW-10B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7.60
7.59
7.59
7.46
7.46
7.45
7.45
7.44
7.39
7.39
7.38
7.37
7.37
7.36
7.35
7.33
7.28
7.08
7.07
7.06
7.06
5.42
5.21
5.21
3.98
3.97
S
I
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2.02
2.08
2.18
1.12
2.00
1.09
1.08
2.17
12.5
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

LSW-10-B

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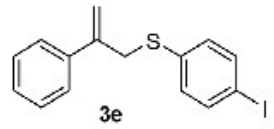
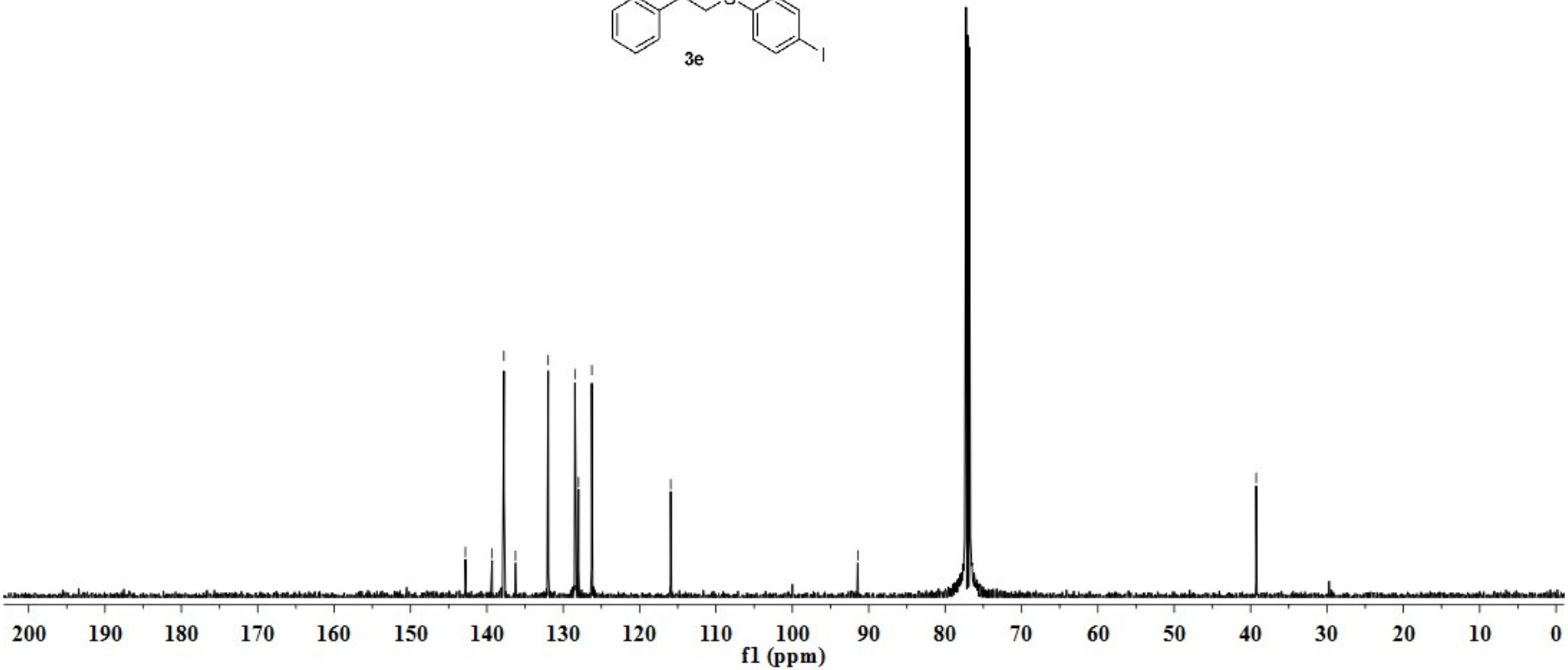
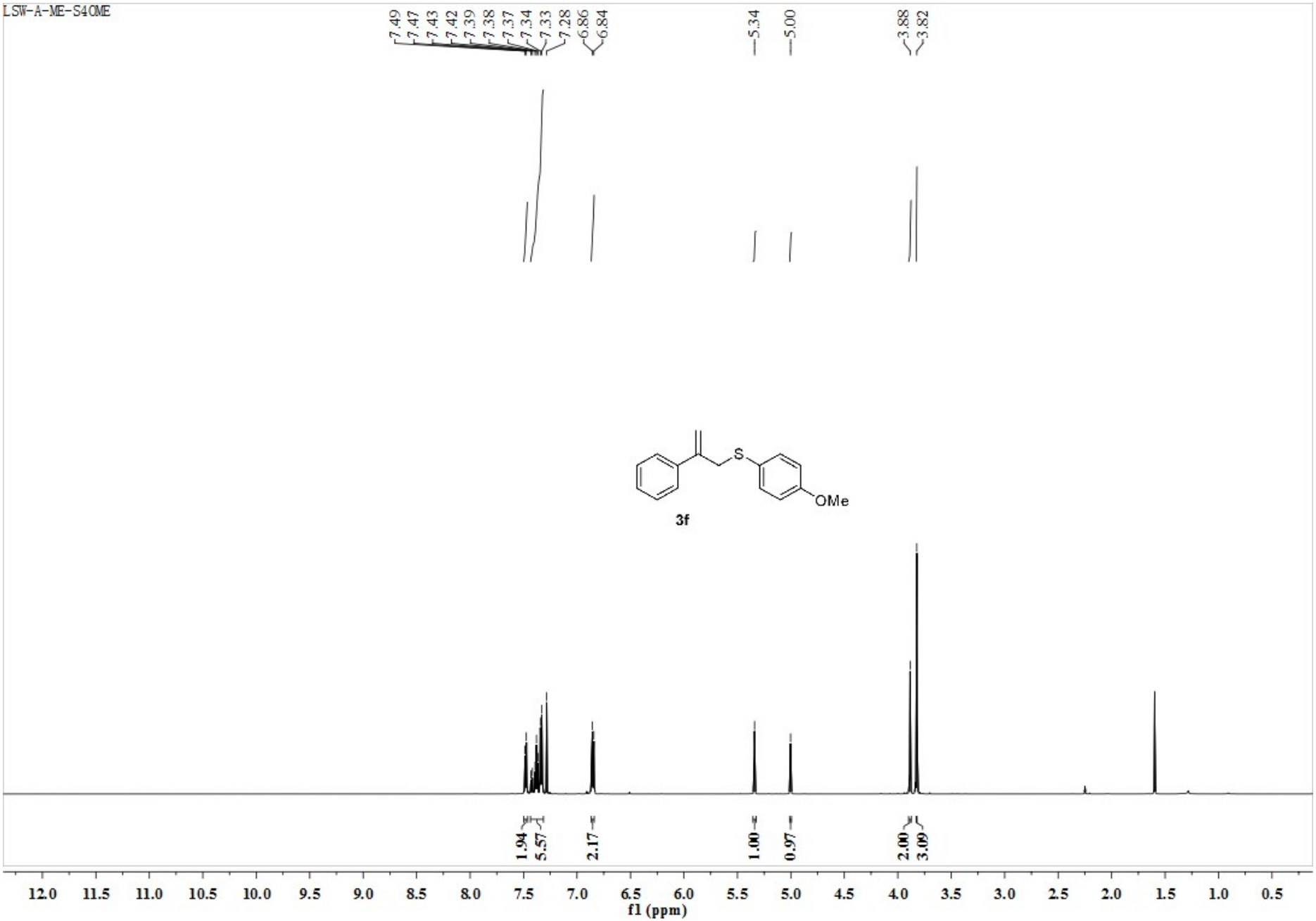
137.76
136.25
131.97
128.46
128.00
126.26
115.92
91.44
39.27



3e

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7.34
7.33
7.28
6.86
6.84
5.34
5.00
3.88
3.82
S
OMe
3f
1.94
5.57
2.17
1.00
0.97
2.00
3.09
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
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4.0
3.5
3.0
2.5
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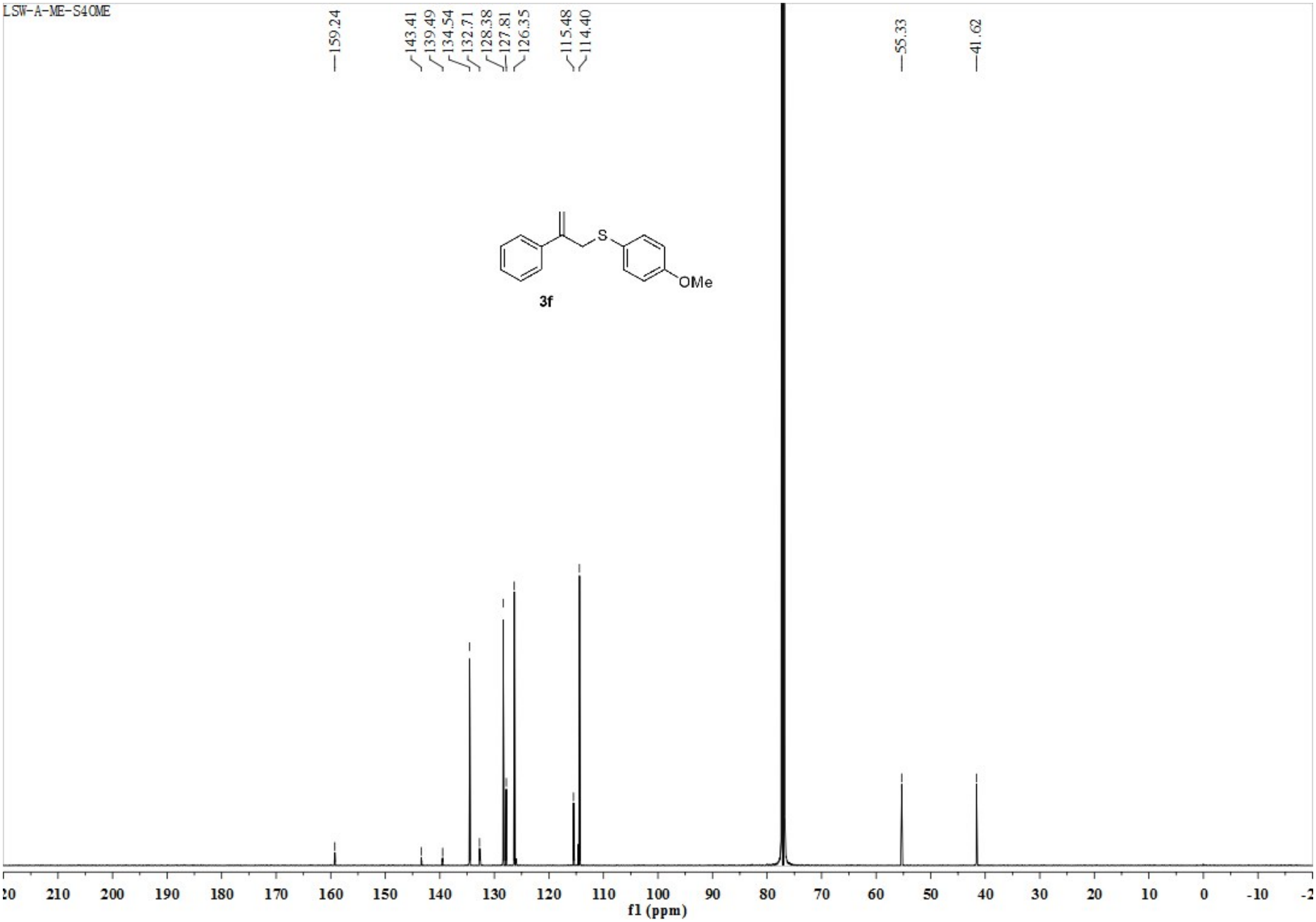
1.5
1.0
0.5
f1 (ppm)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134.54
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126.35
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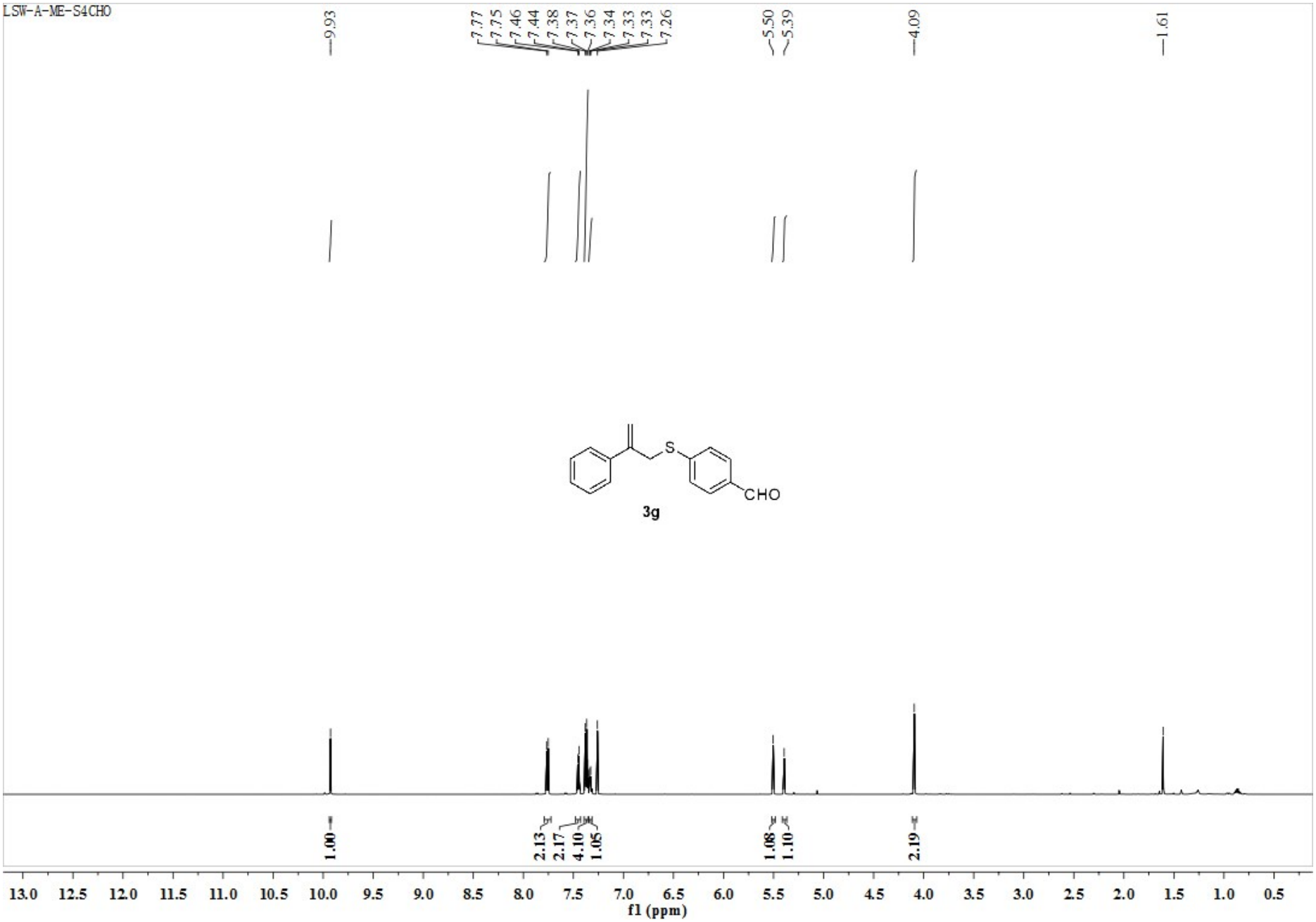
55.33
41.62
S
OMe
3f
f1 (ppm)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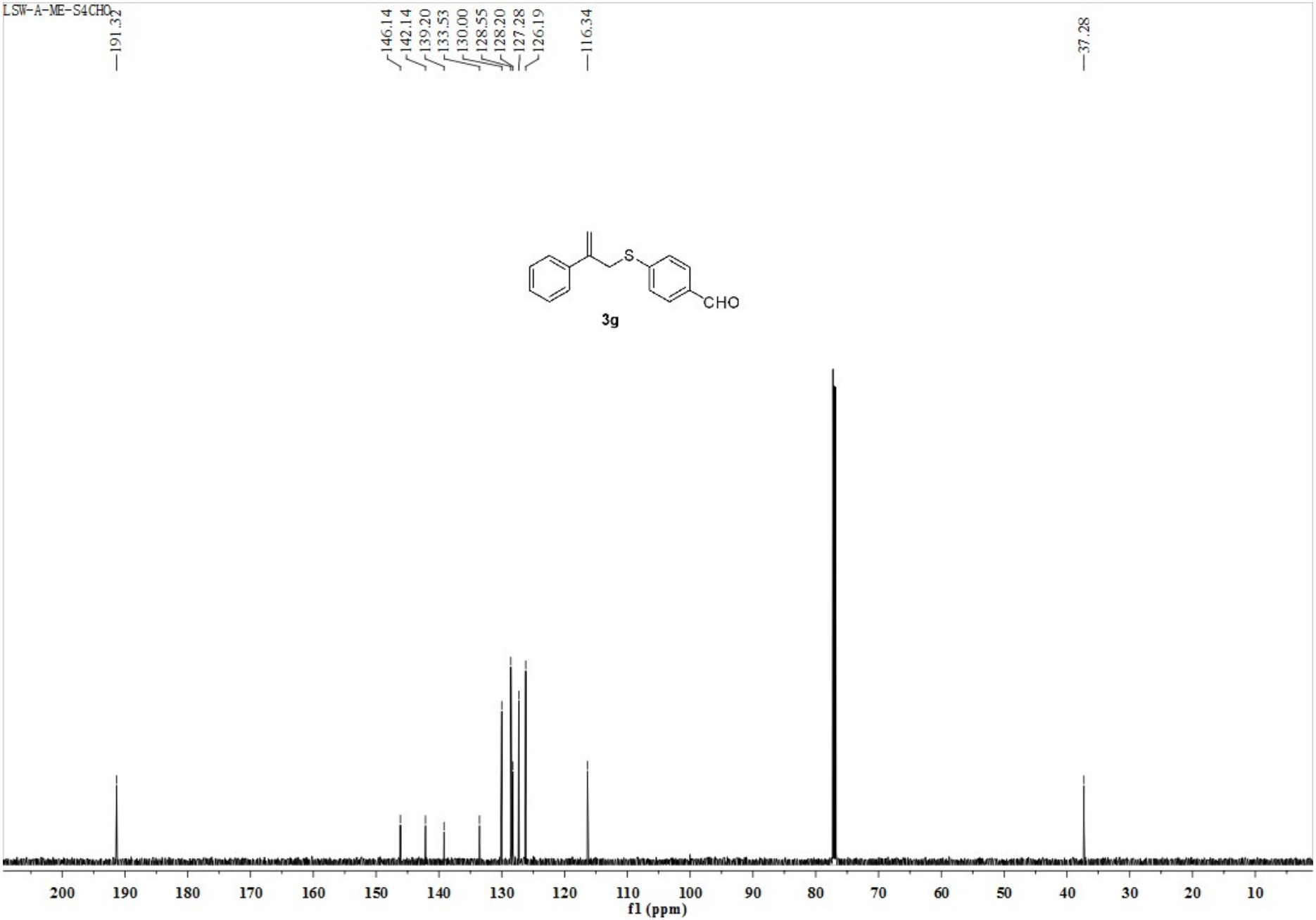
7.36
7.34
7.33
7.33
7.26
5.50
5.39
4.09
1.61
S
CHO
3g
1.00
2.13
2.17
4.10
1.05
1.08
1.10
2.19
13.0 12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)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139.20
133.53
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128.20
127.28
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37.28
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CHO
3g
200
190
180
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140
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120
110
100
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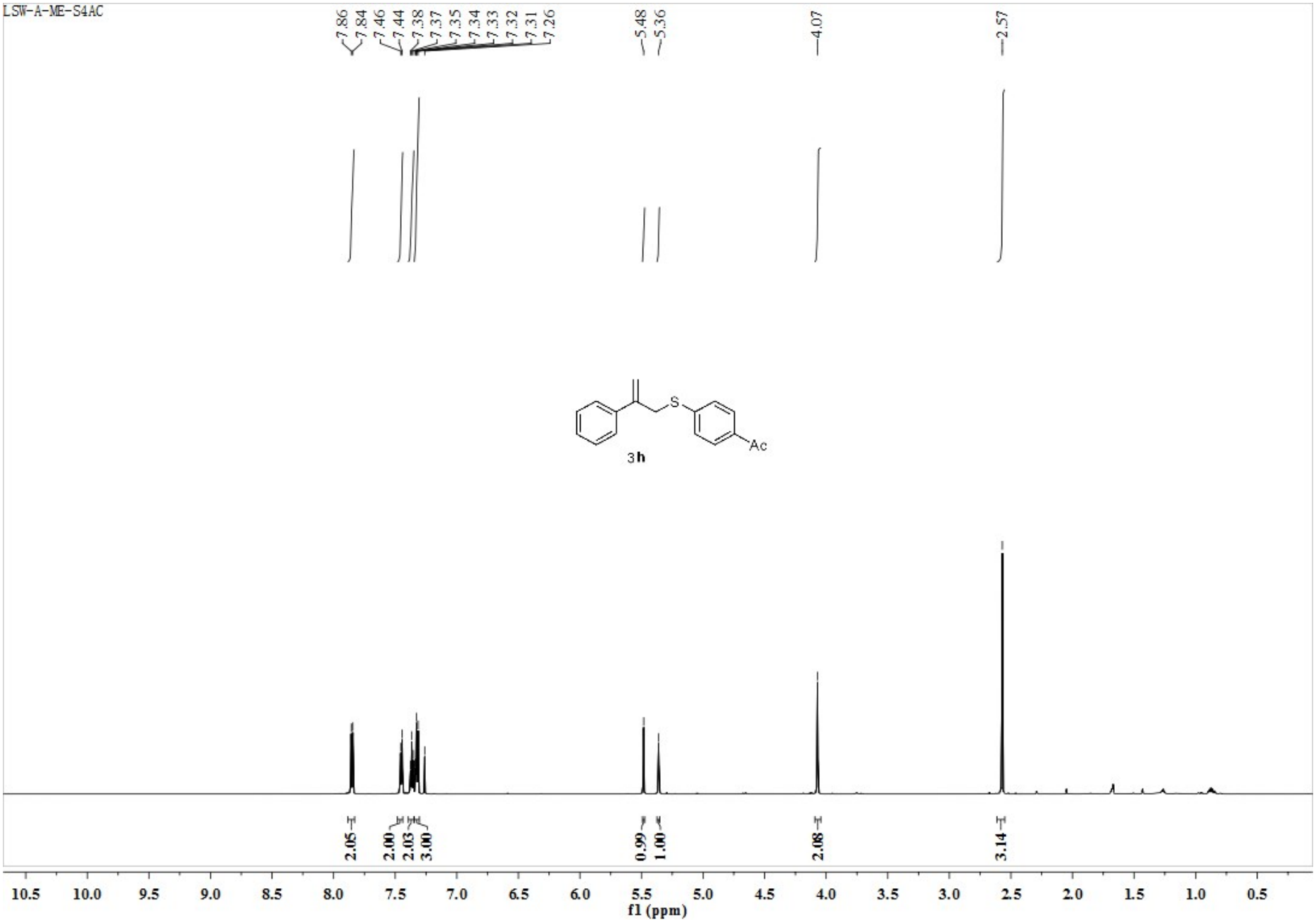
80
70
60
50
40
30
20
10
f1 (ppm)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7.31
7.26
5.48
5.36
4.07
2.57
S
Ac
3h
2.05
2.00
2.03
3.00
0.99
1.00
2.08
3.14
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
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5.0
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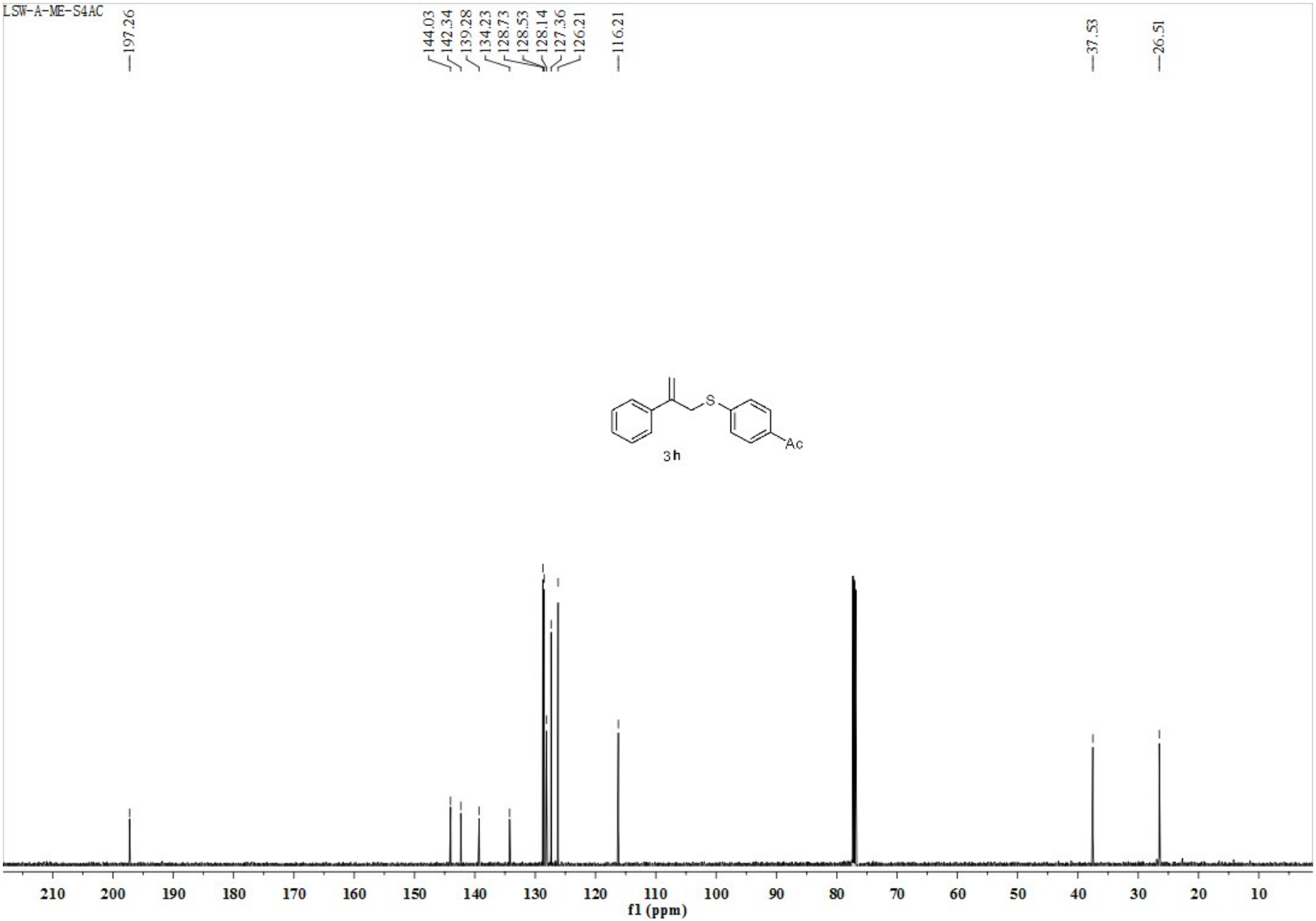
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)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128.14
127.36
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116.21
37.53
26.51
S
Ac
3h
210
200
190
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100
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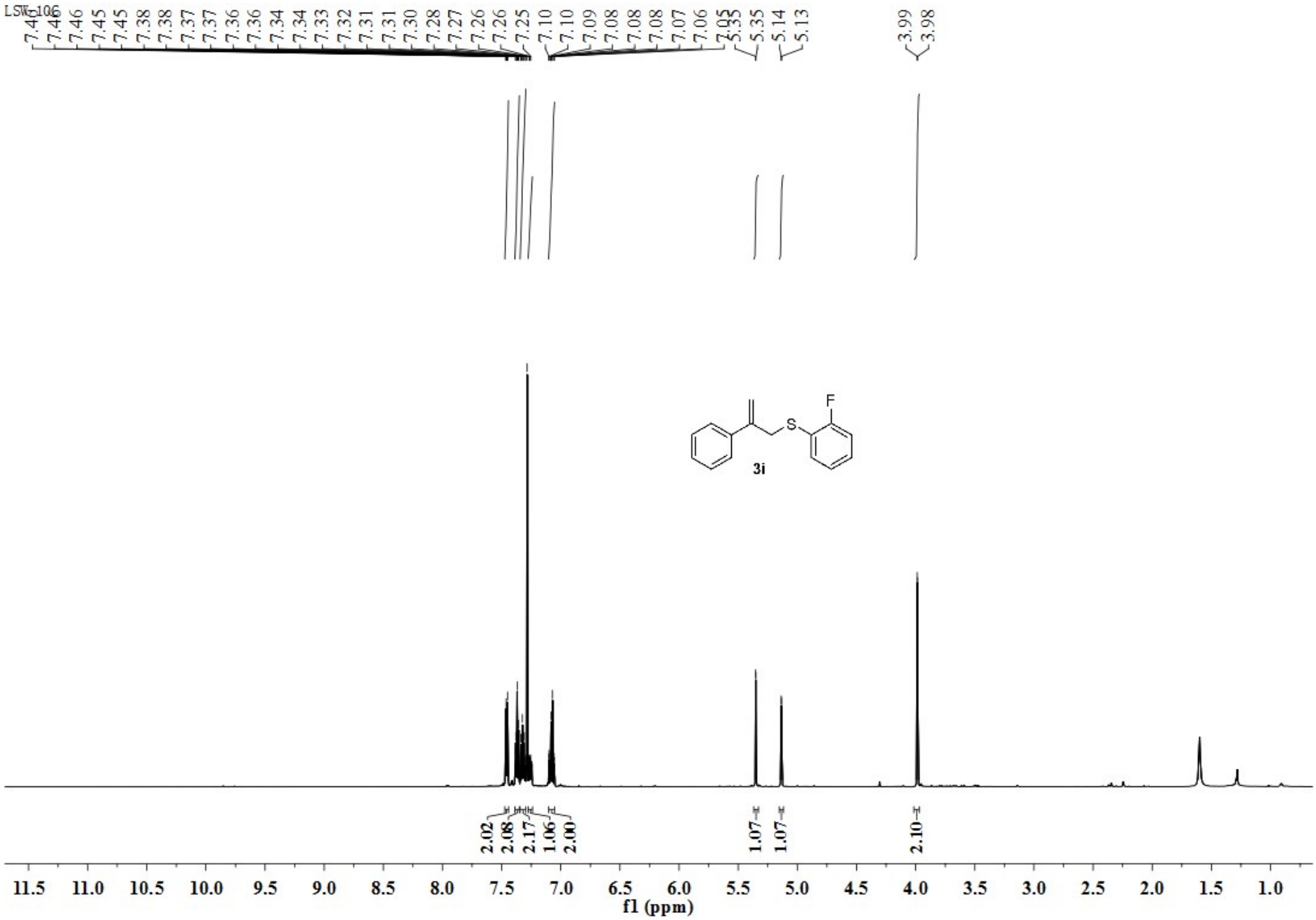
f1 (ppm)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1.07
1.07
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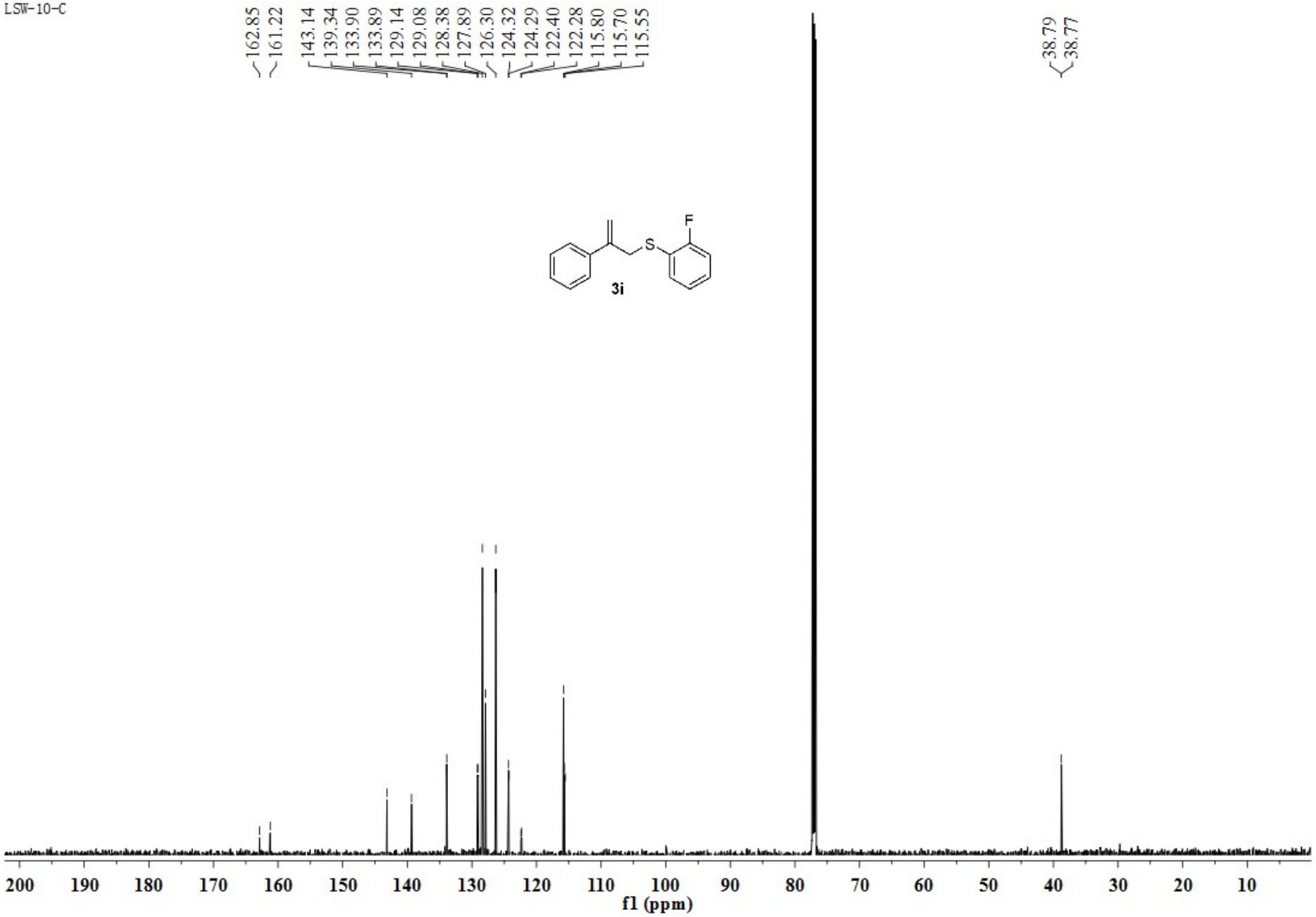
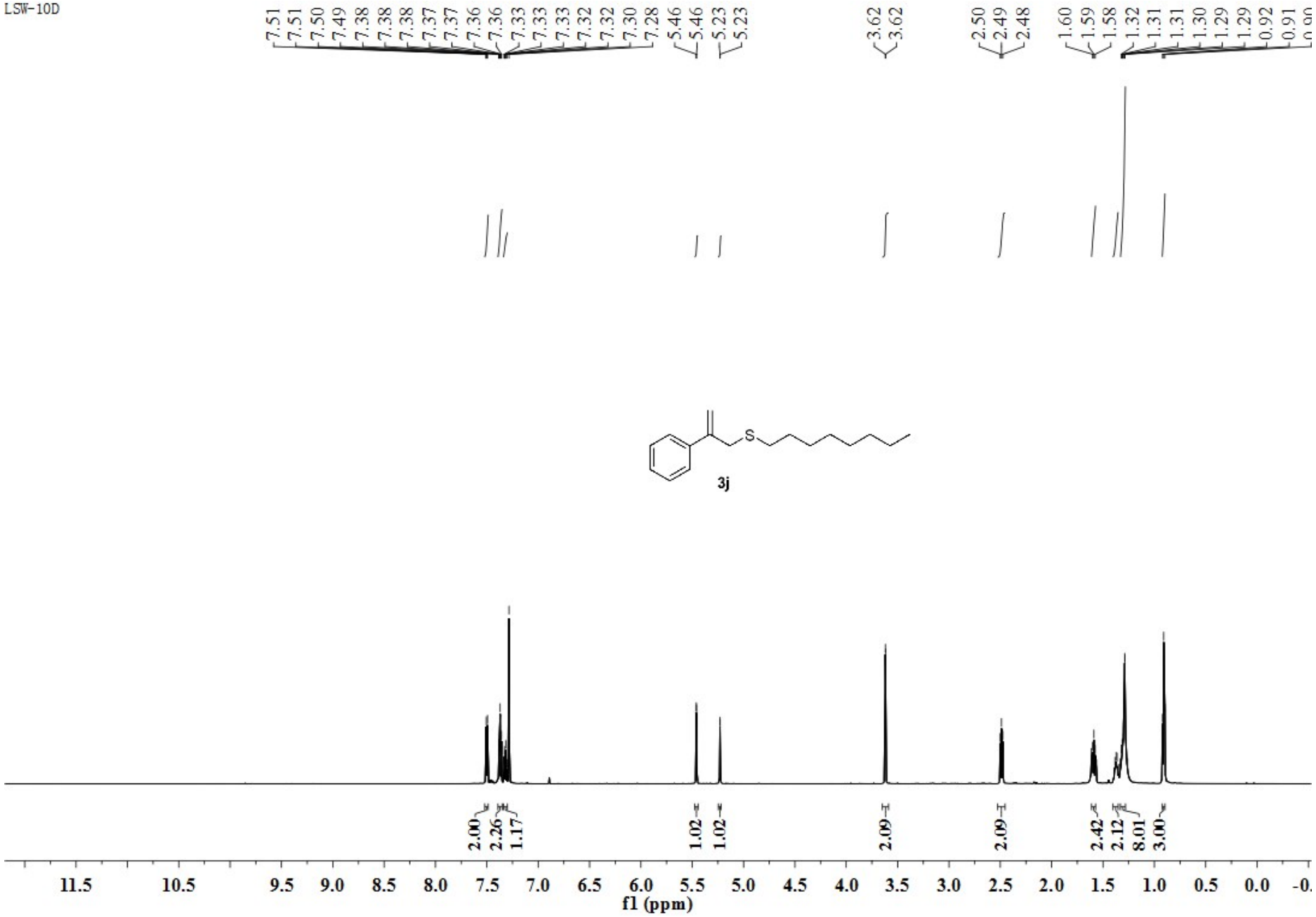
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
f1 (ppm)

LSW-10-C

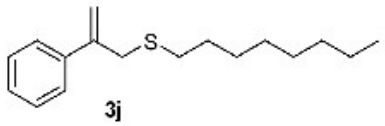

162.85
161.22
143.14
139.34
133.90
133.89
129.14
129.08
128.38
127.89
126.30
124.32
124.29
122.40
122.28
115.80
115.70
115.55
38.79
38.77
F
S
3i
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

LSW-10D

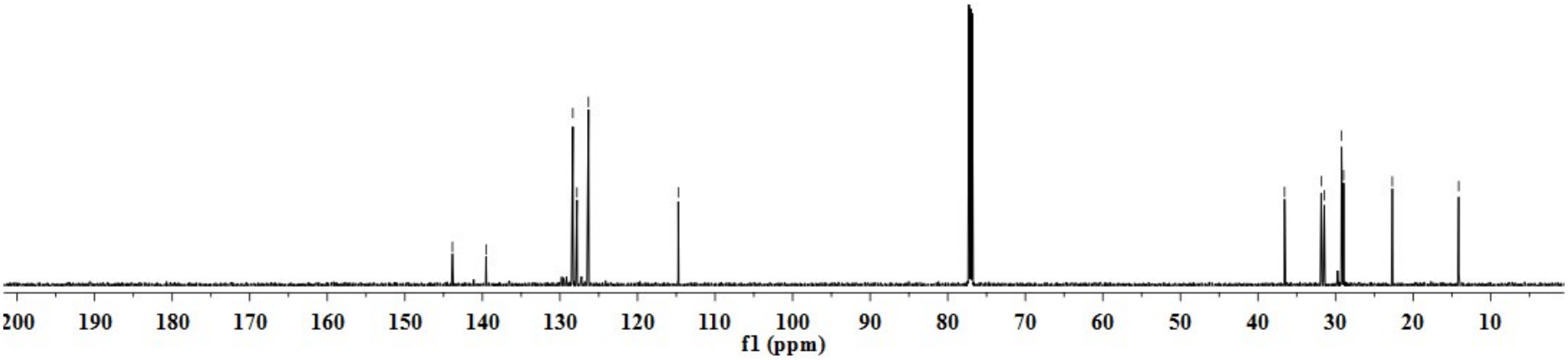

7.51
7.51
7.50
7.49
7.38
7.38
7.38
7.37
7.37
7.36
7.36
7.33
7.33
7.33
7.32
7.32
7.30
7.28
5.46
5.46
5.23
5.23
3.62
3.62
2.50
2.49
2.48
1.60
1.59
1.58
1.32
1.31
1.31
1.30
1.29
1.29
0.92
0.91
S
3j
2.00
2.26
1.17
1.02
1.02
2.09
2.09
2.42
2.12
8.01
3.00
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

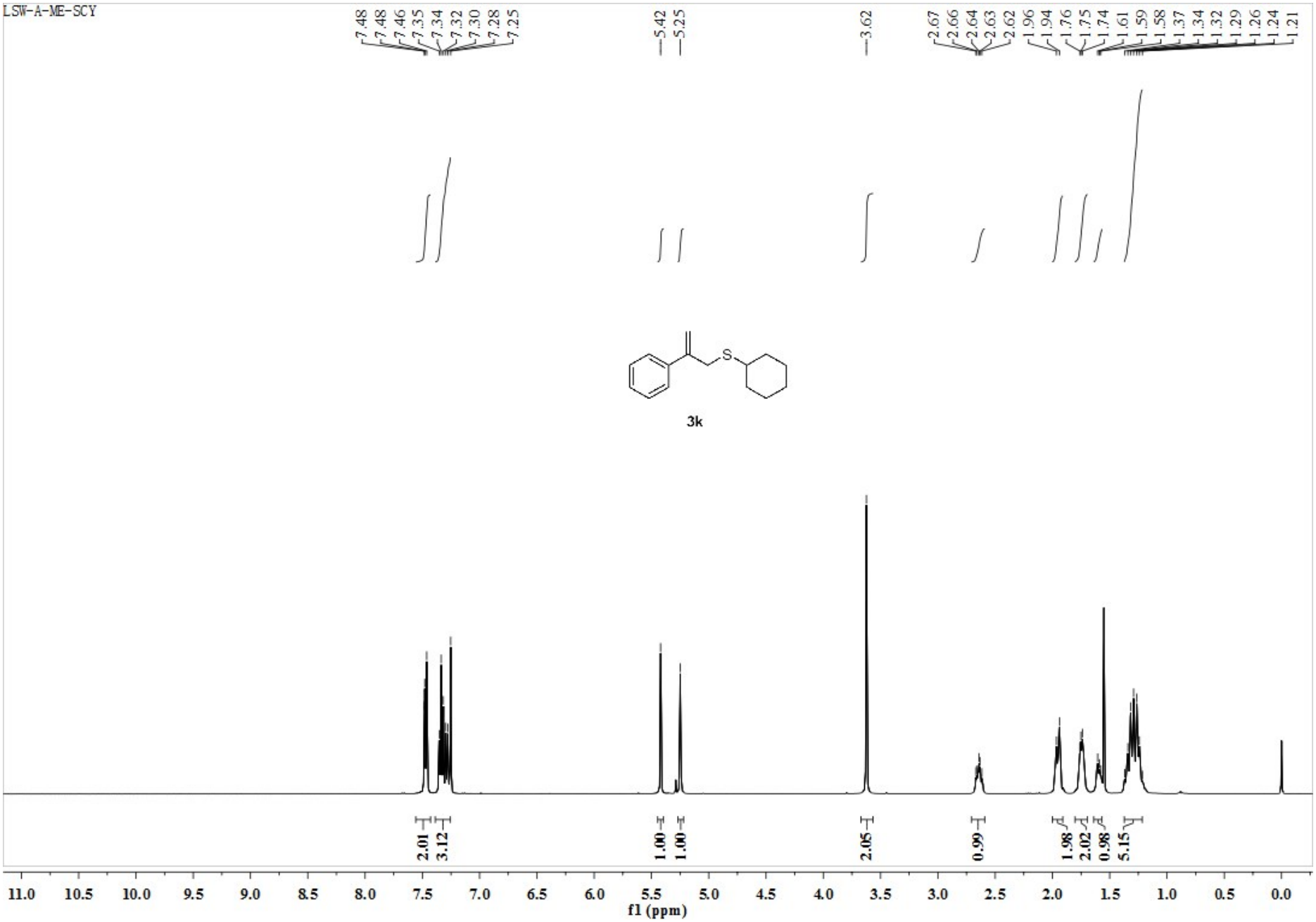
LSW-10-D

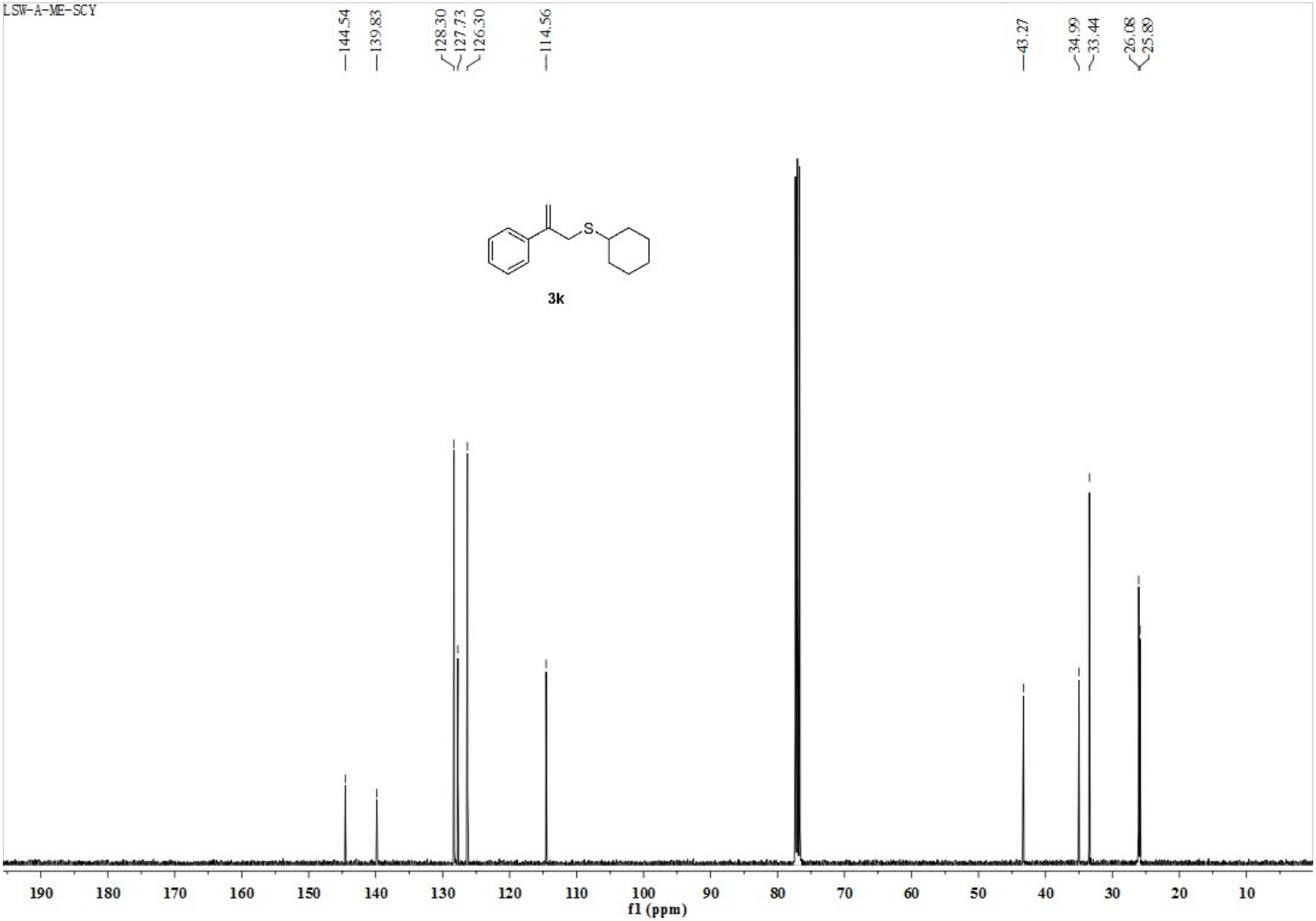
143.87
139.52
128.34
127.80
126.32
114.74
36.57
31.84
31.45
29.22
29.21
28.96
22.68
14.12

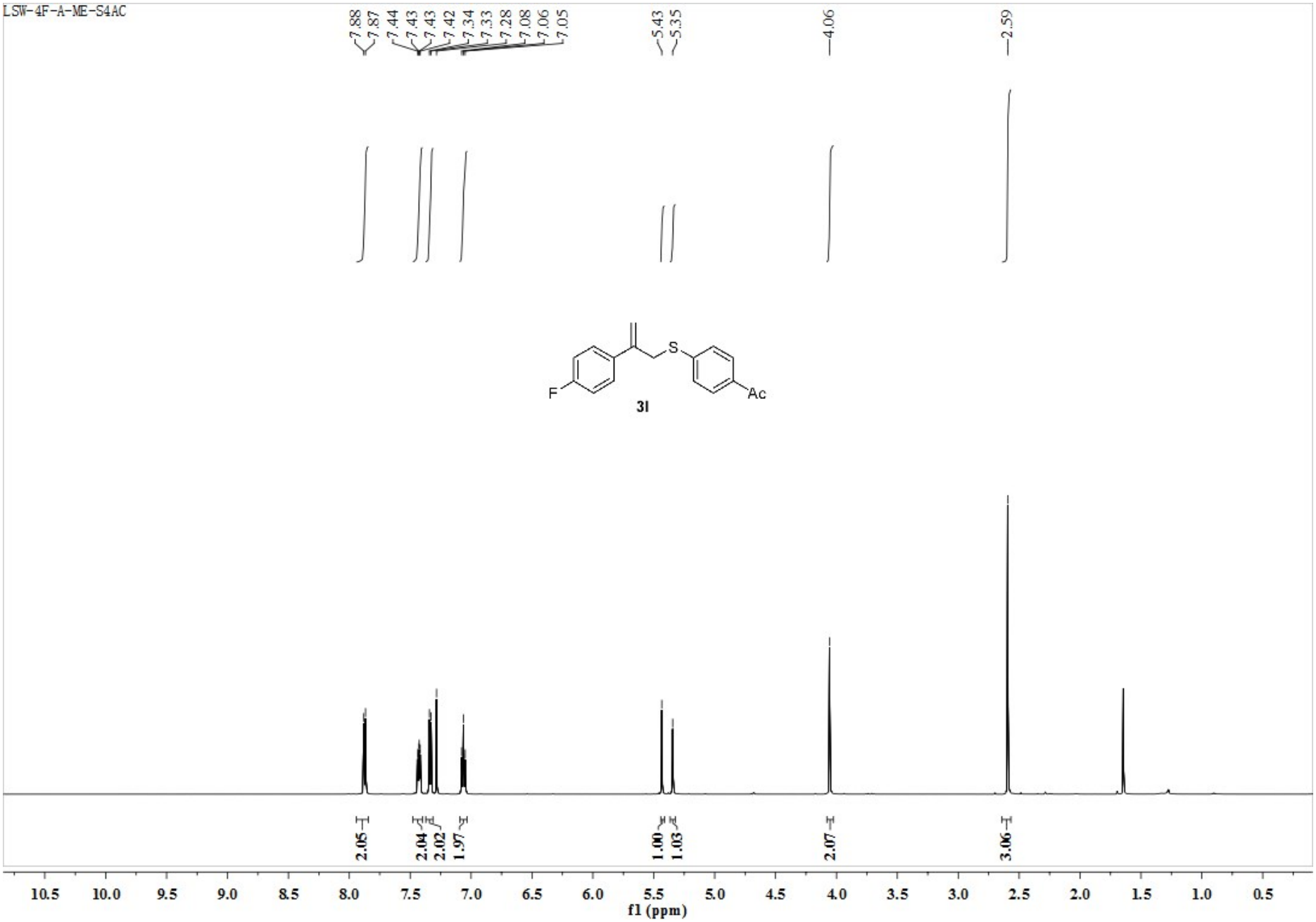


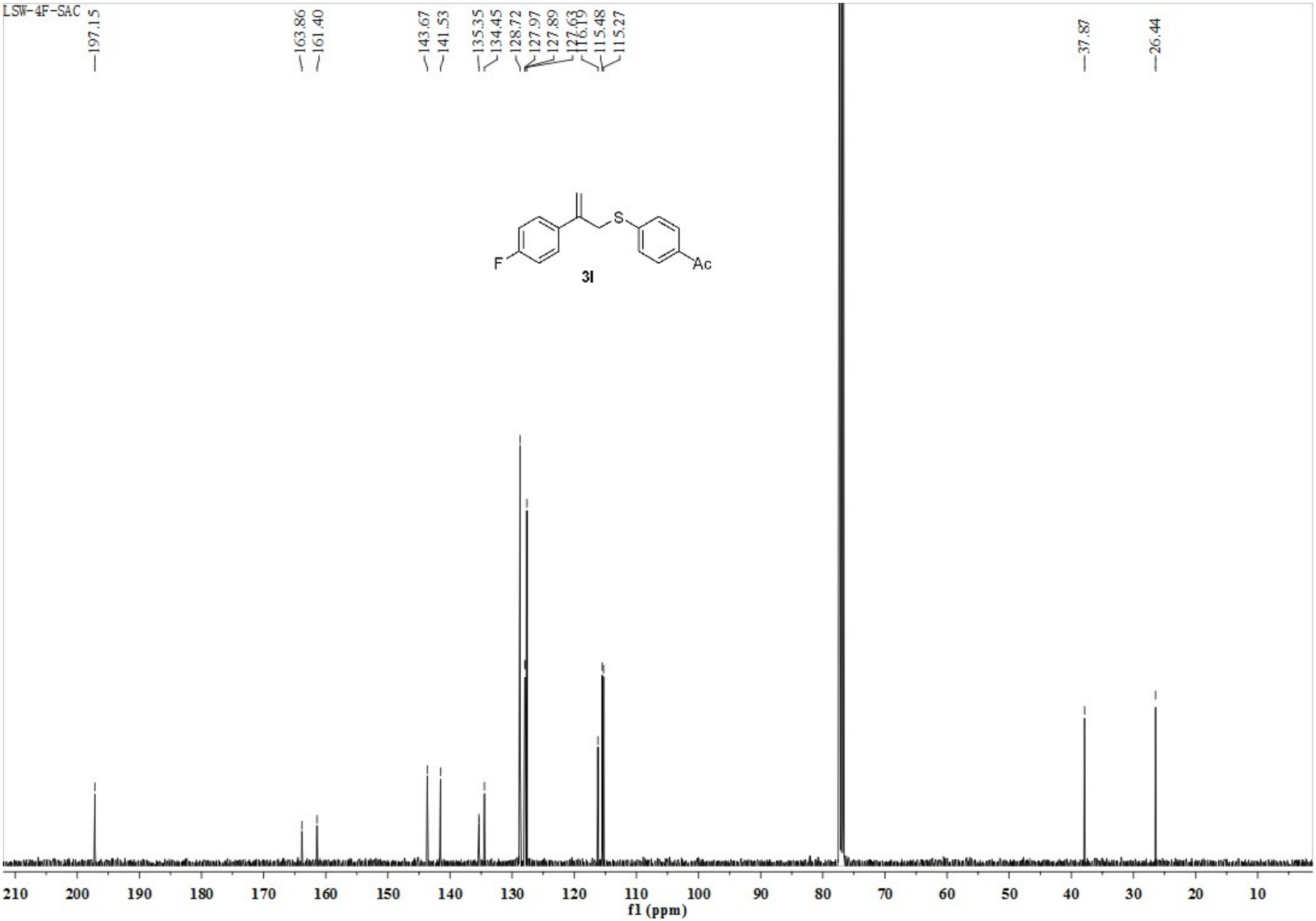
3j

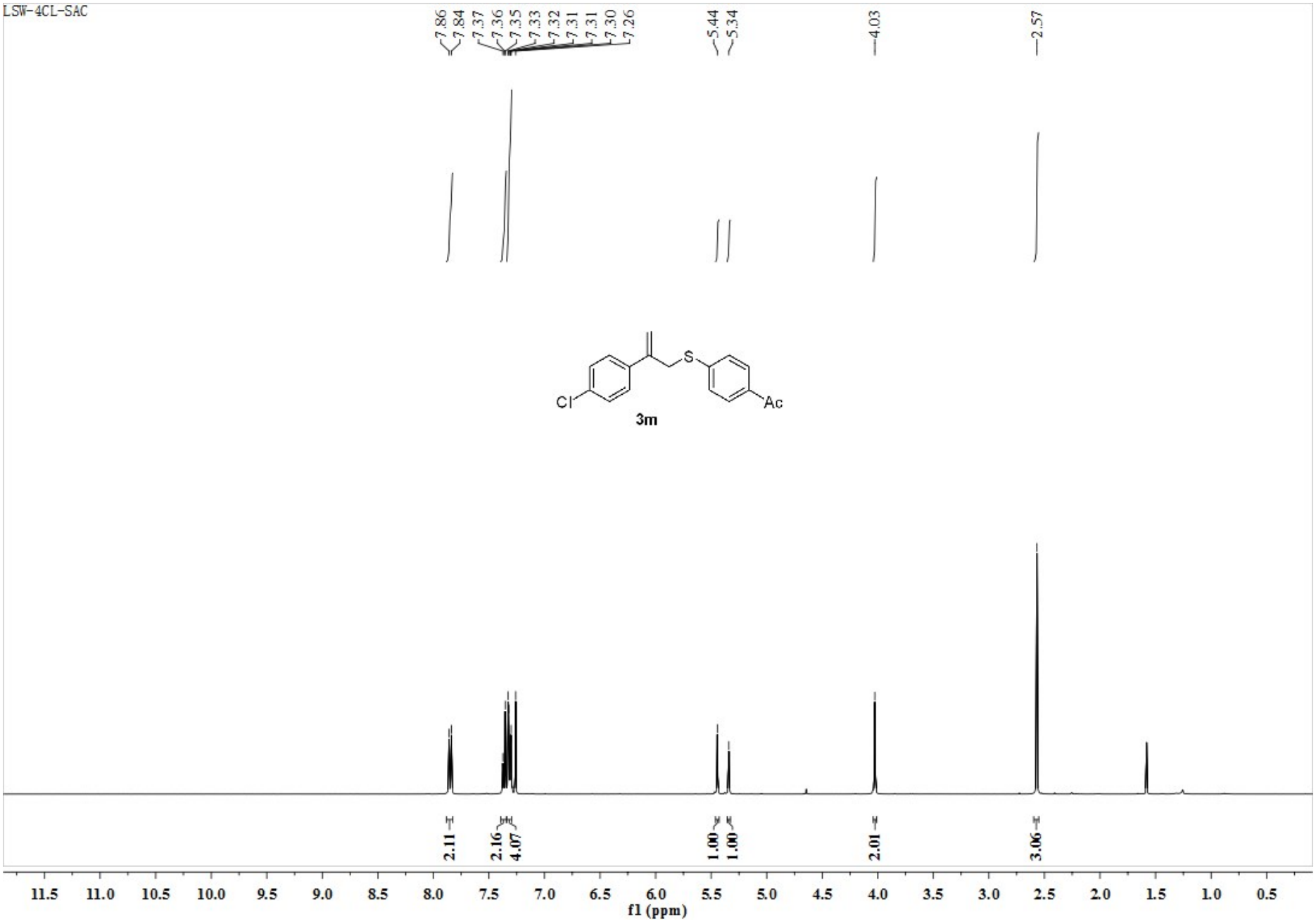


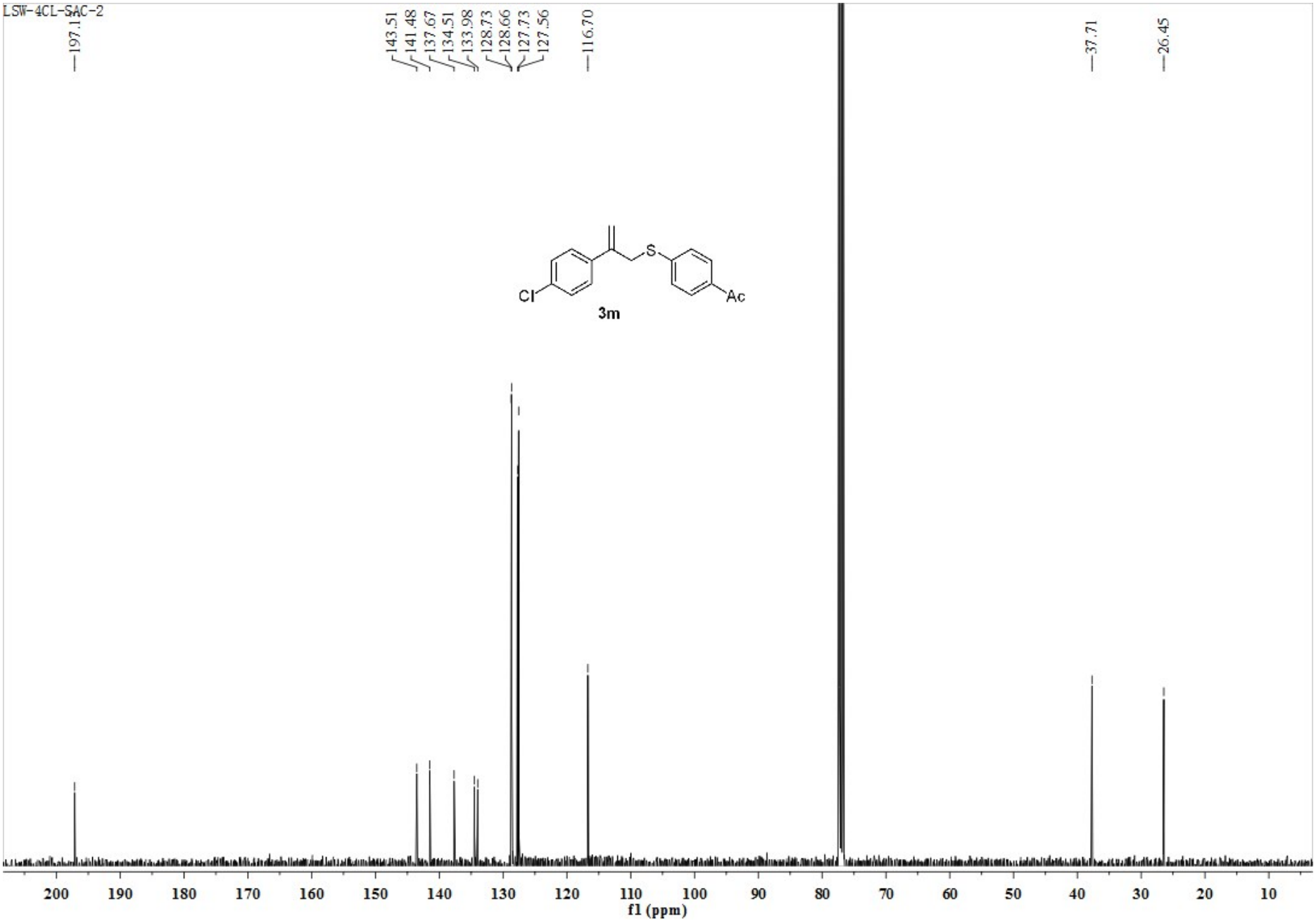

LSW-A-ME-SCY
7.48
7.48
7.46
7.35
7.34
7.32
7.30
7.28
7.25
5.42
5.25
3.62
2.67
2.66
2.64
2.63
2.62
1.96
1.94
1.76
1.75
1.74
1.61
1.59
1.58
1.37
1.34
1.32
1.29
1.26
1.24
1.21
S
3k
2.01
3.12
1.00
1.00
2.05
0.99
1.98
2.02
0.98
5.15
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

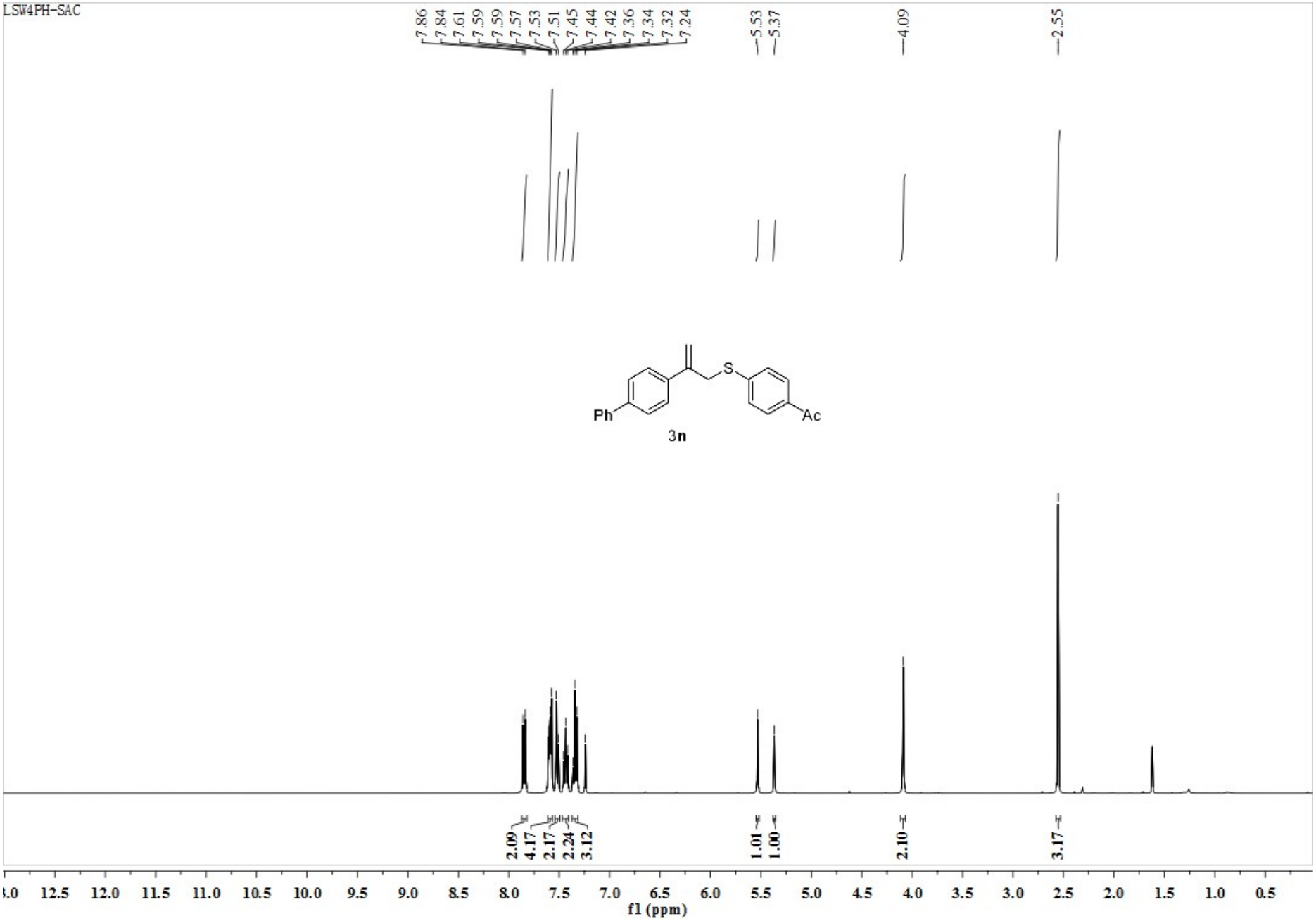

LSW-A-ME-SCY
144.54
139.83
128.30
127.73
126.30
114.56
43.27
34.99
33.44
26.08
25.89
S
3k
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

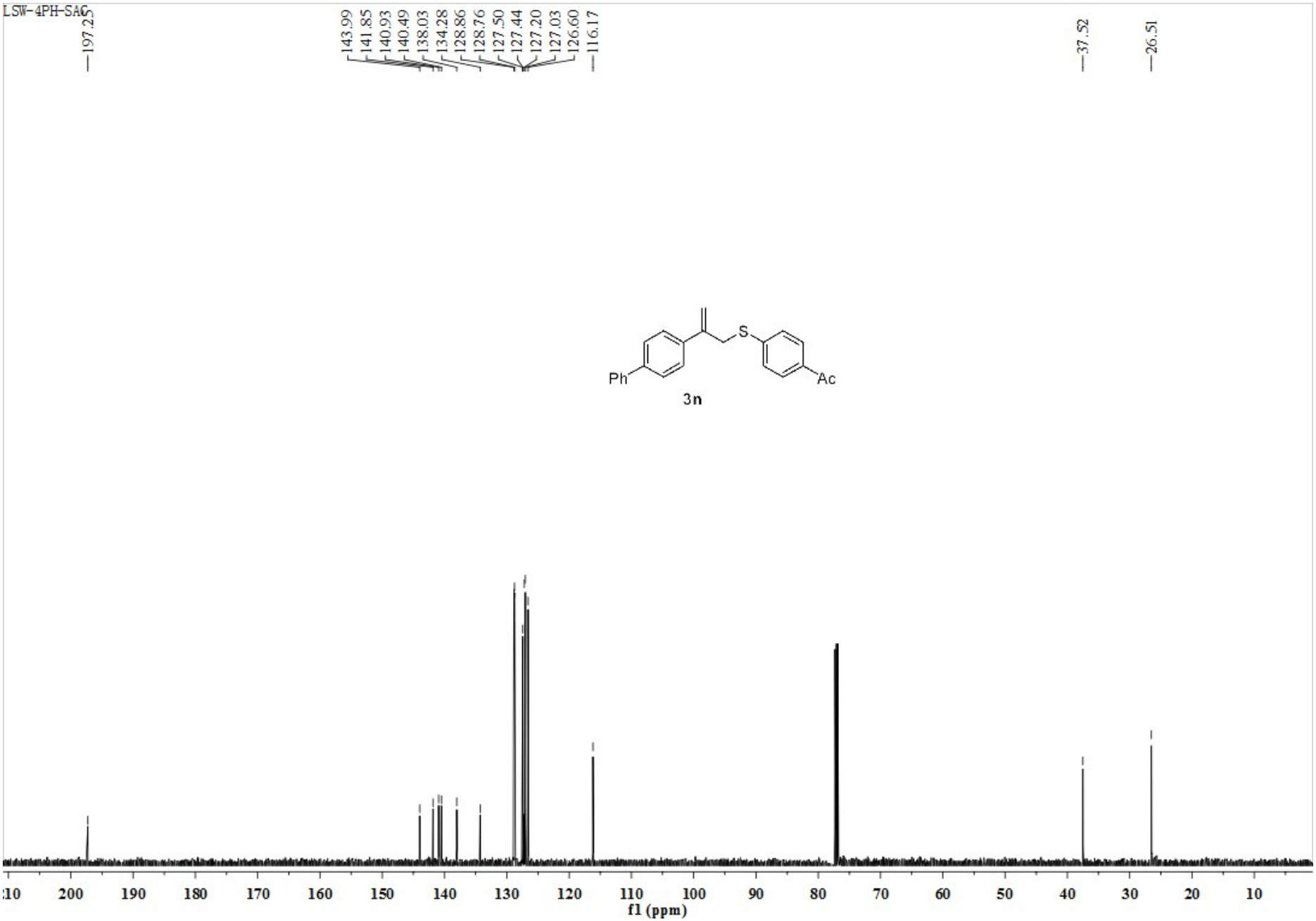

LSW-4F-A-ME-S4AC
7.88
7.87
7.44
7.43
7.43
7.42
7.34
7.33
7.28
7.08
7.06
7.05
5.43
5.35
4.06
2.59
S
F
Ac
3l
2.05
2.04
2.02
1.97
1.00
1.03
2.07
3.06
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

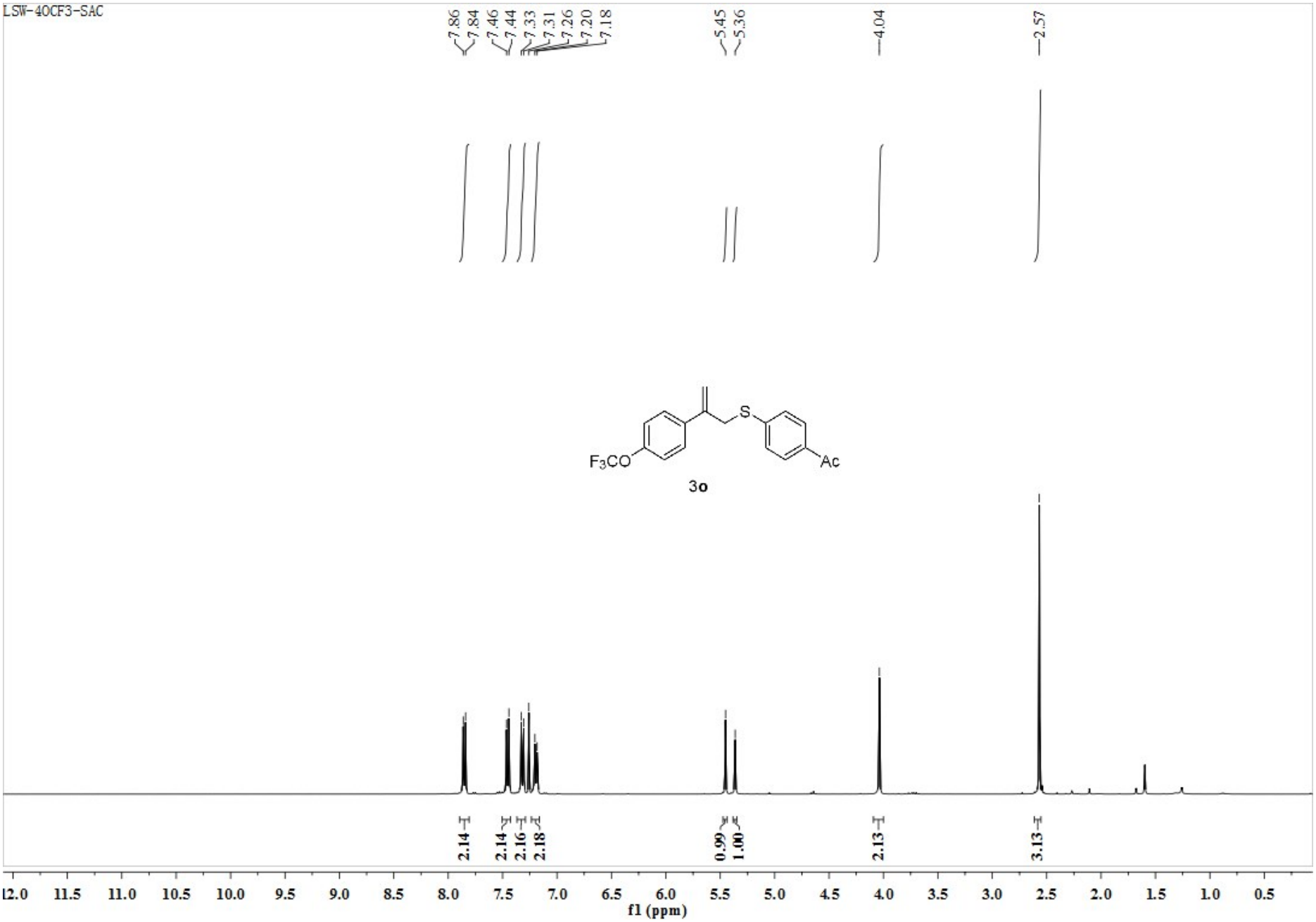

LSW-4F-SAC
197.15
163.86
161.40
143.67
141.53
135.35
134.45
128.72
127.97
127.89
127.63
127.19
115.48
115.27
37.87
26.44
S
F
Ac
3l
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


LSW-4CL-SAC
7.86
7.84
7.37
7.36
7.35
7.33
7.32
7.31
7.31
7.30
7.26
5.44
5.34
4.03
2.57
S
Cl
Ac
3m
2.11
2.16
4.07
1.00
1.00
2.01
3.06
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


LSW-4CL-SAC-2
197.1
143.51
141.48
137.67
134.51
133.98
128.73
128.66
127.73
127.56
116.70
37.71
26.45
S
Cl
Ac
3m
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

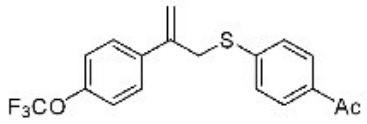

LSW4PH-SAC
7.86
7.84
7.61
7.59
7.59
7.57
7.53
7.51
7.45
7.44
7.42
7.36
7.34
7.32
7.24
5.53
5.37
4.09
2.55
S
Ph
Ac
3n
2.09
4.17
2.17
2.24
3.12
1.01
1.00
2.10
3.17
f1 (ppm)


LSW-4PH-SAC
197.25
143.99
141.85
140.93
140.49
138.03
134.28
128.86
128.76
127.50
127.44
127.20
127.03
126.60
116.17
37.52
26.51
S
Ph
Ac
3n
f1 (ppm)

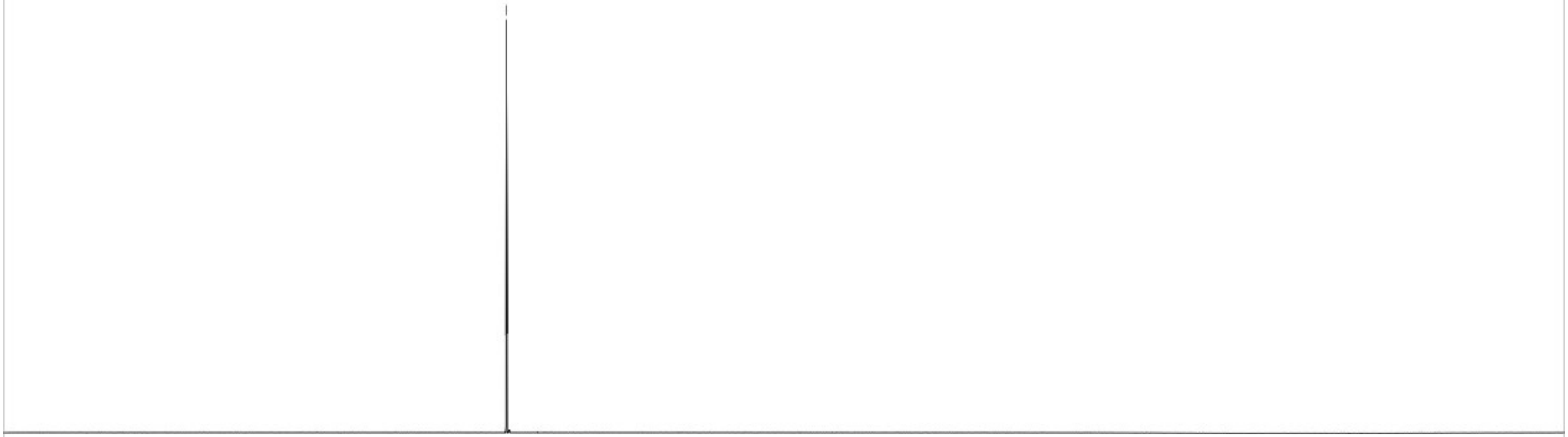

LSW-4OCF3-SAC
7.86
7.84
7.46
7.44
7.33
7.31
7.26
7.20
7.18
5.45
5.36
4.04
2.57
F3CO
S
Ac
3o
2.14
2.14
2.16
2.18
0.99
1.00
2.13
3.13
f1 (ppm)

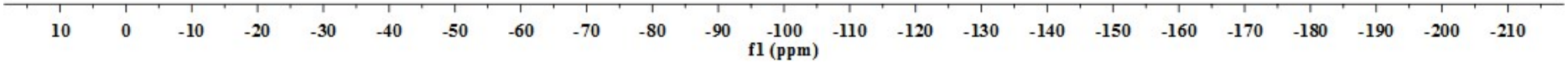
LSW-4OCF3-SAC

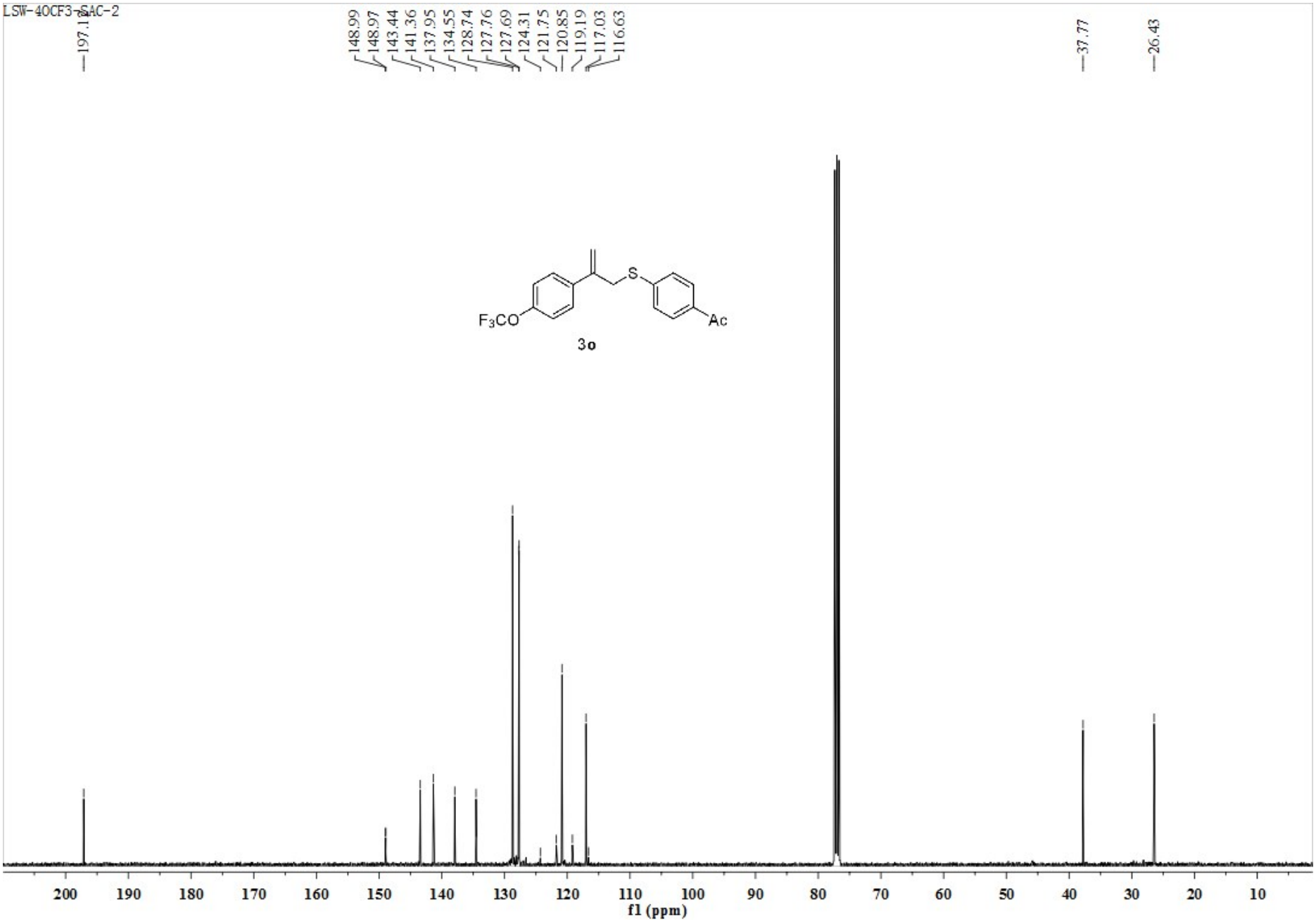
-57.80

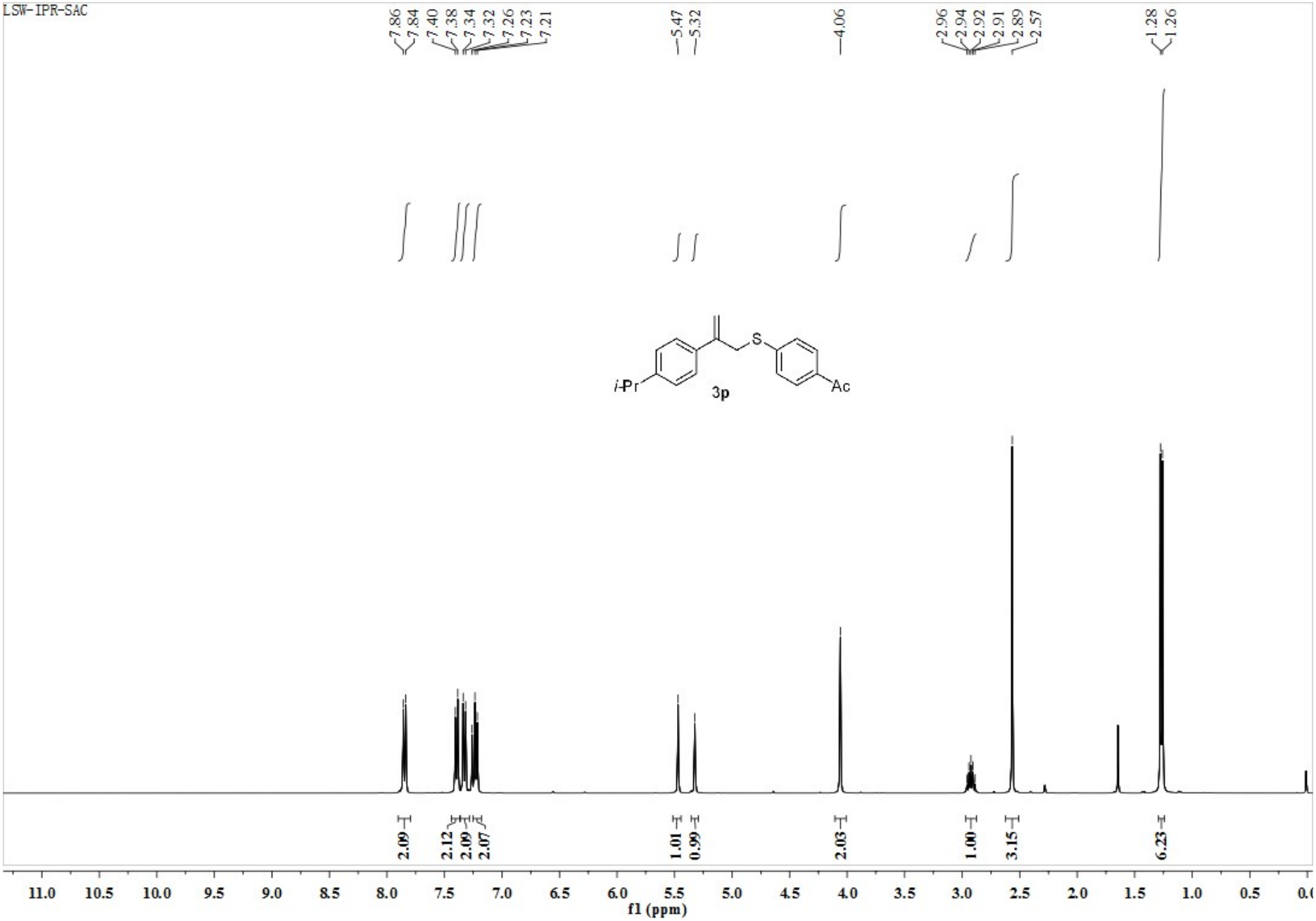


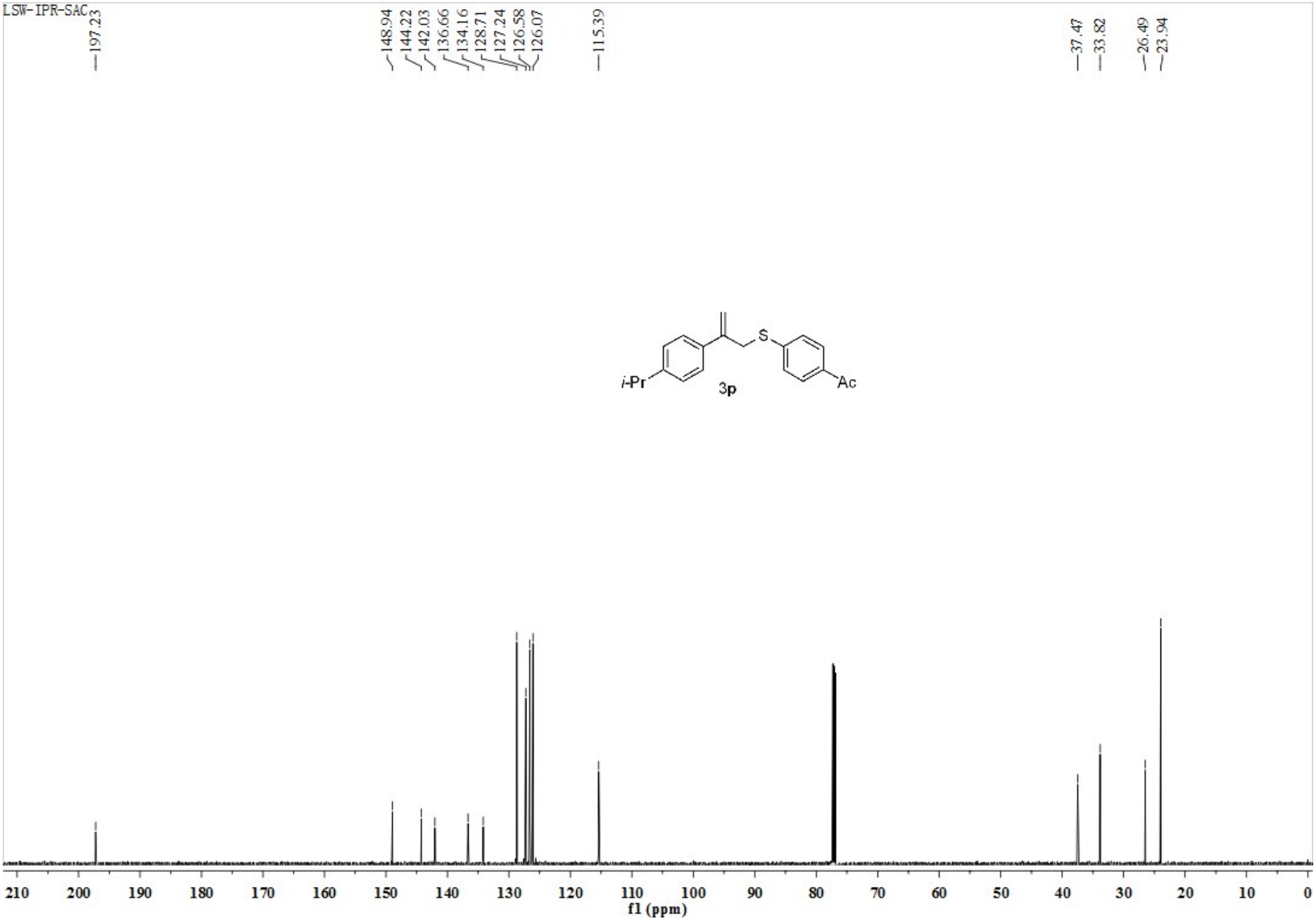
3o

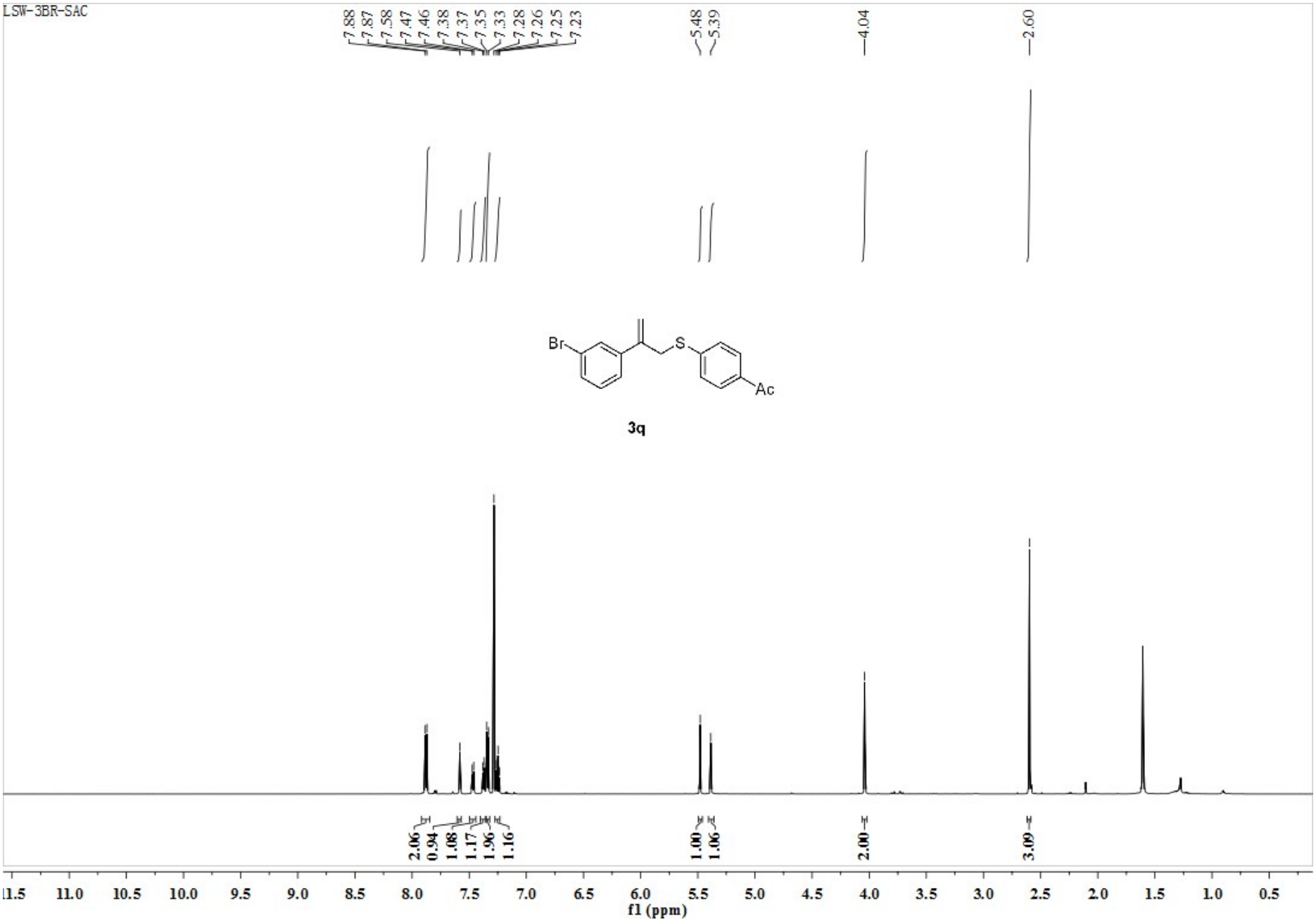


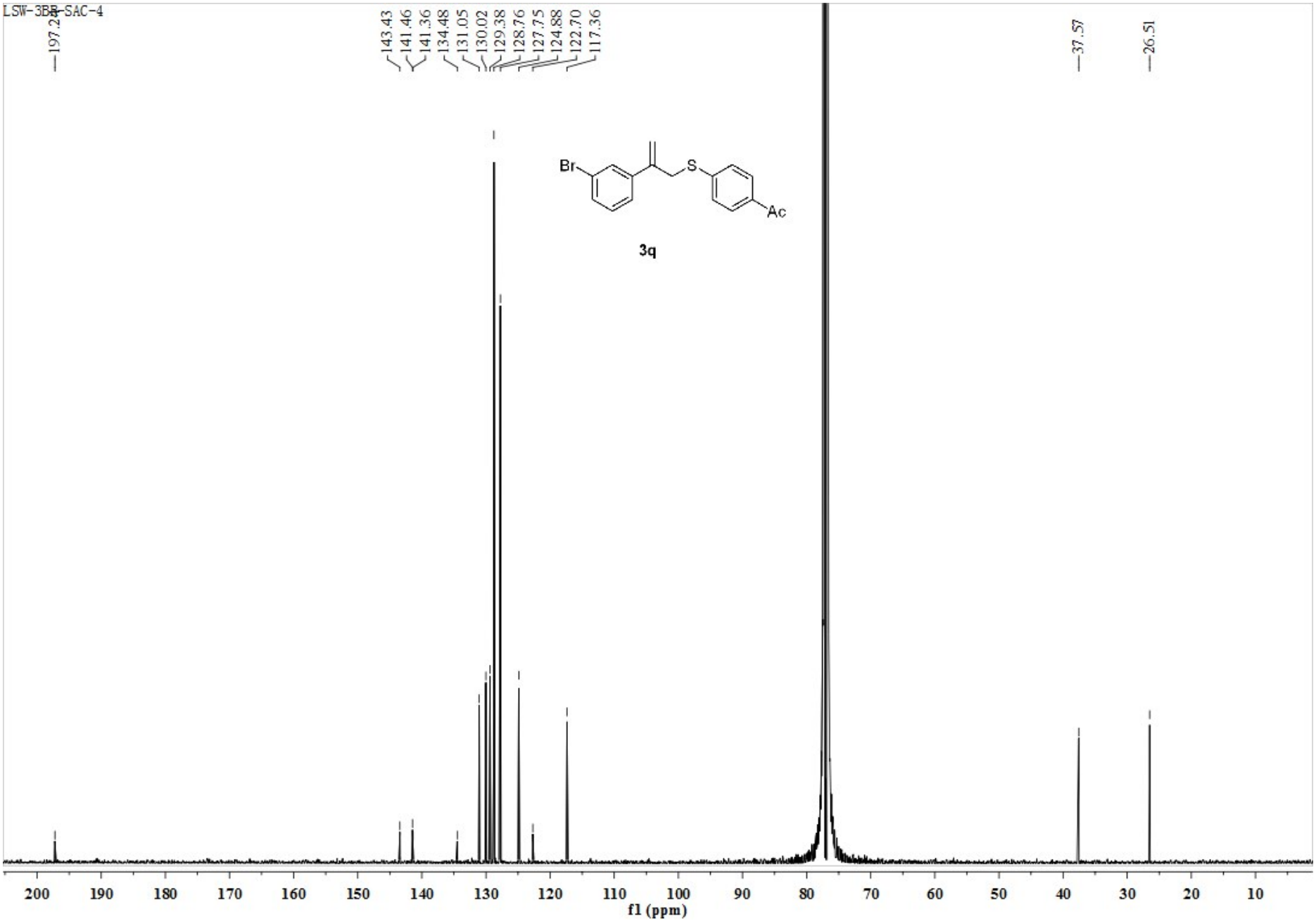


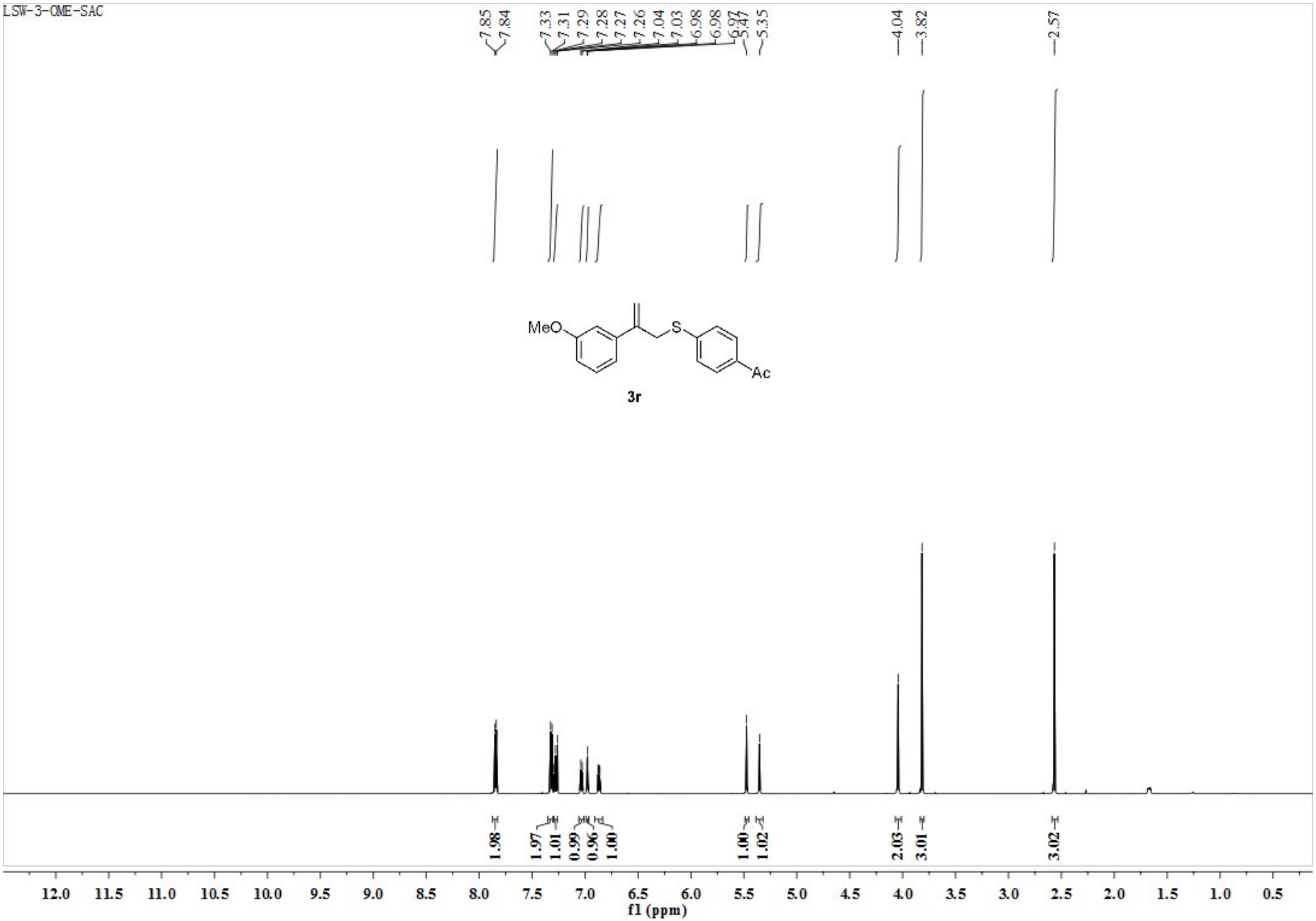

LSW-4OCF3-SAC-2
197.13
148.99
148.97
143.44
141.36
137.95
134.55
128.74
127.76
127.69
124.31
121.75
120.85
119.19
117.03
116.63
37.77
26.43
S
F3CO
Ac
3o
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

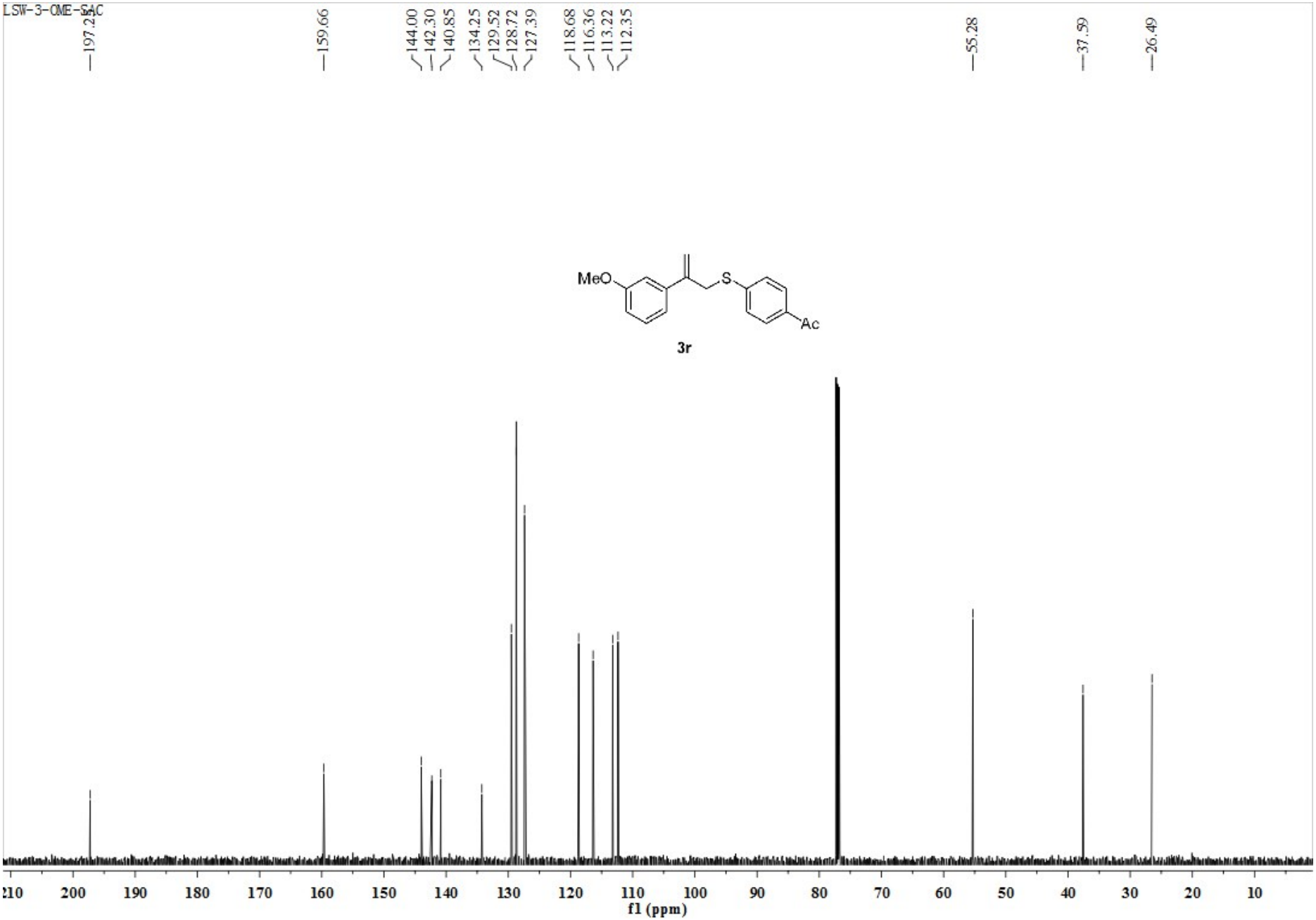

LSW-IPR-SAC
7.86
7.84
7.40
7.38
7.34
7.32
7.26
7.23
7.21
5.47
5.32
4.06
2.96
2.94
2.92
2.91
2.89
2.57
1.28
1.26
i-Pr
S
Ac
3p
2.09
2.12
2.09
2.07
1.01
0.99
2.03
1.00
3.15
6.23
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

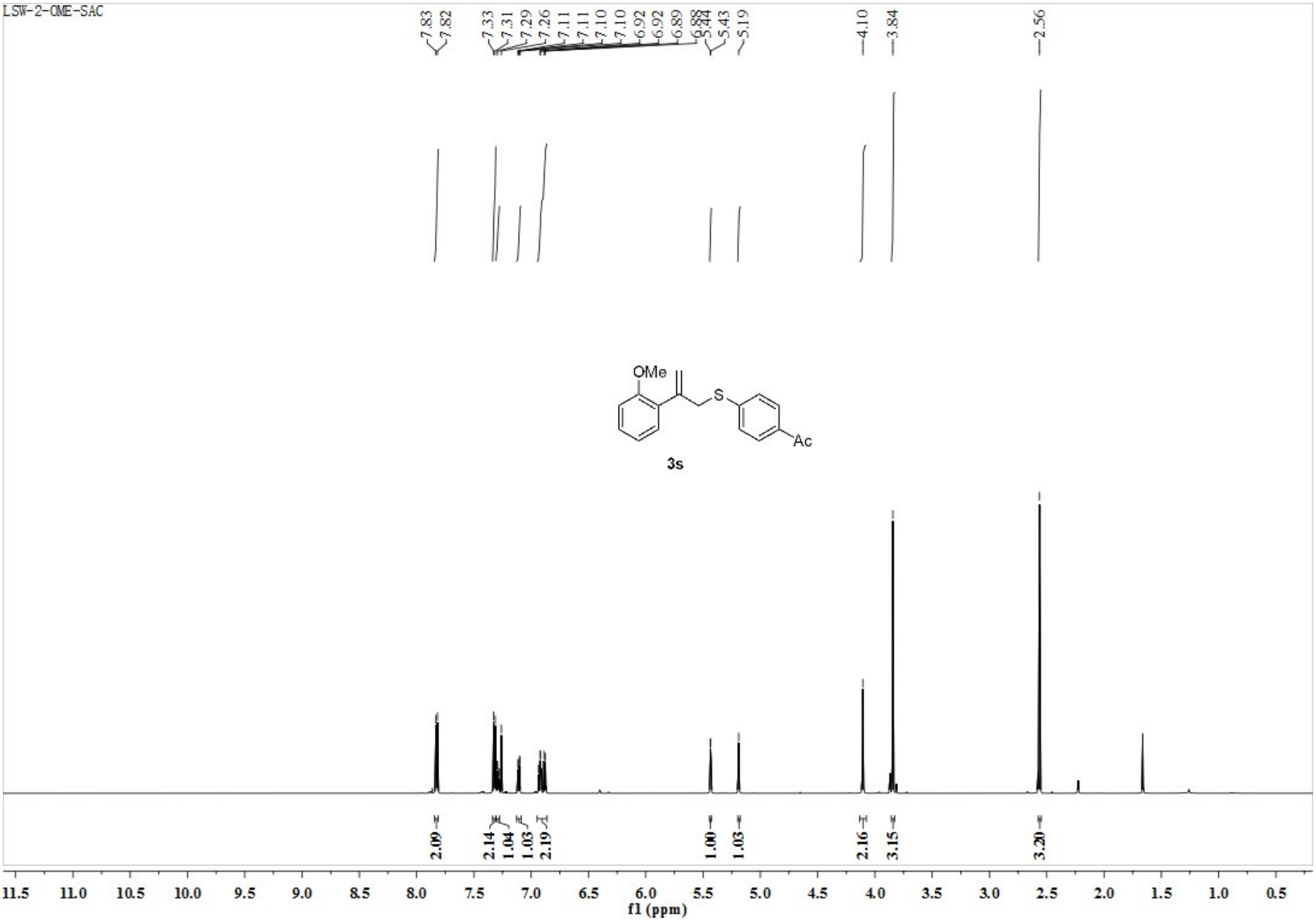

LSW-IPR-SAC
197.23
148.94
144.22
142.03
136.66
134.16
128.71
127.24
126.58
126.07
115.39
37.47
33.82
26.49
23.94
S
i-Pr
Ac
3p
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

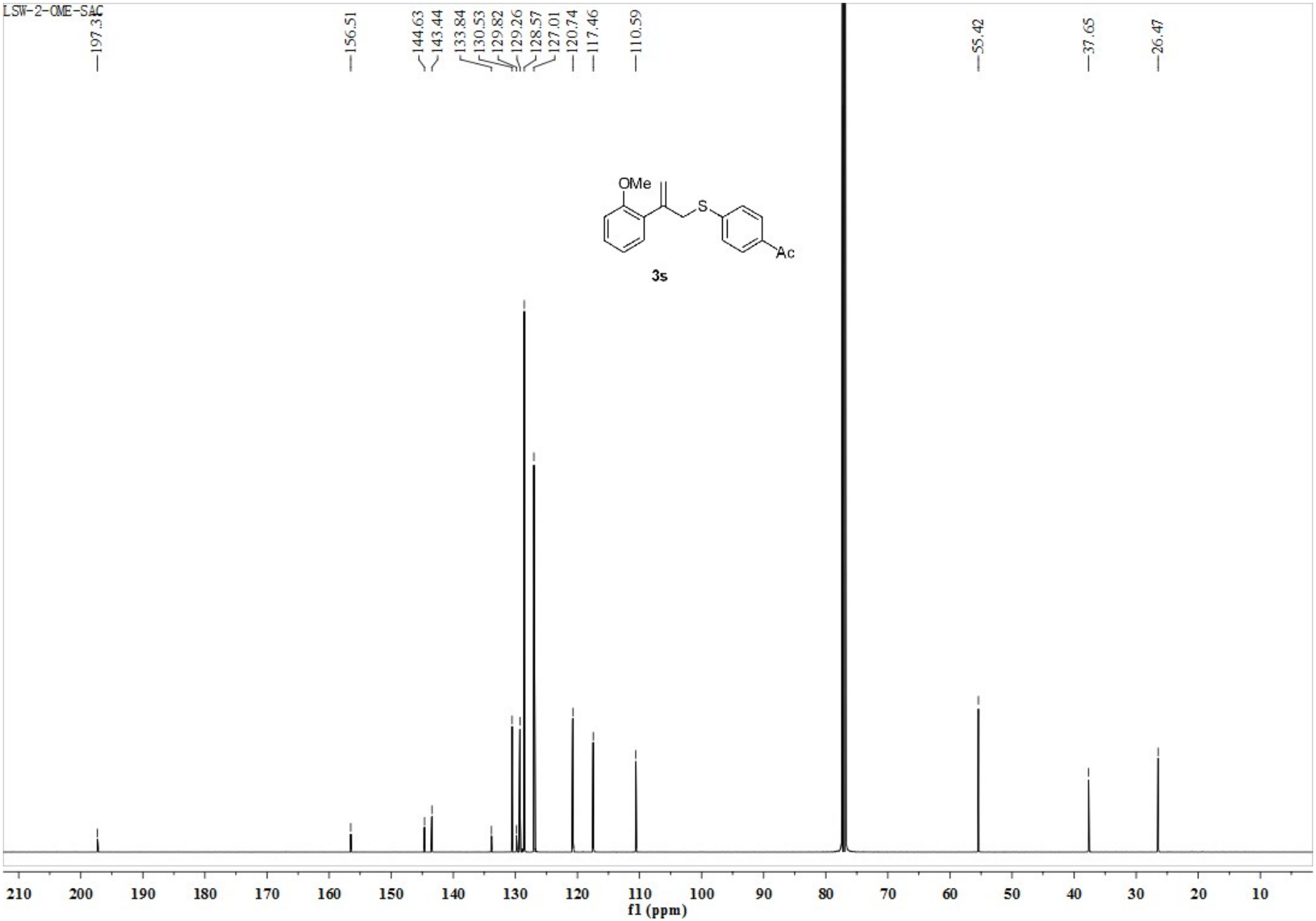

LSW-3BR-SAC
7.88
7.87
7.58
7.47
7.46
7.38
7.37
7.35
7.33
7.28
7.26
7.25
7.23
5.48
5.39
4.04
2.60
Br
S
Ac
3q
2.06
0.94
1.08
1.17
1.96
1.16
1.00
1.06
2.00
3.09
f1 (ppm)

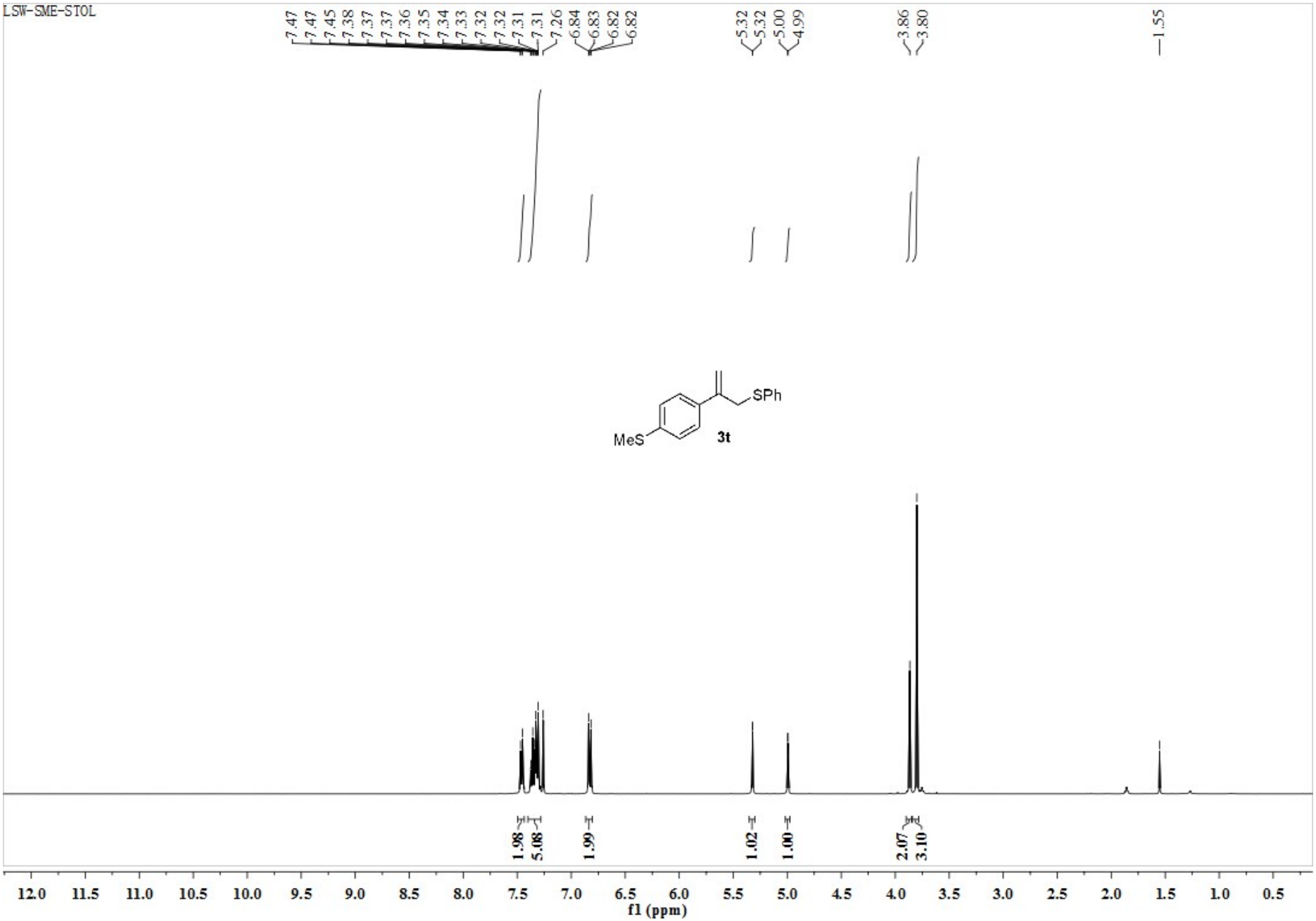

LSW-3BB-SAC-4
197.24
143.43
141.46
141.36
134.48
131.05
130.02
129.38
128.76
127.75
124.88
122.70
117.36
37.57
26.51
Br
S
Ac
3q
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

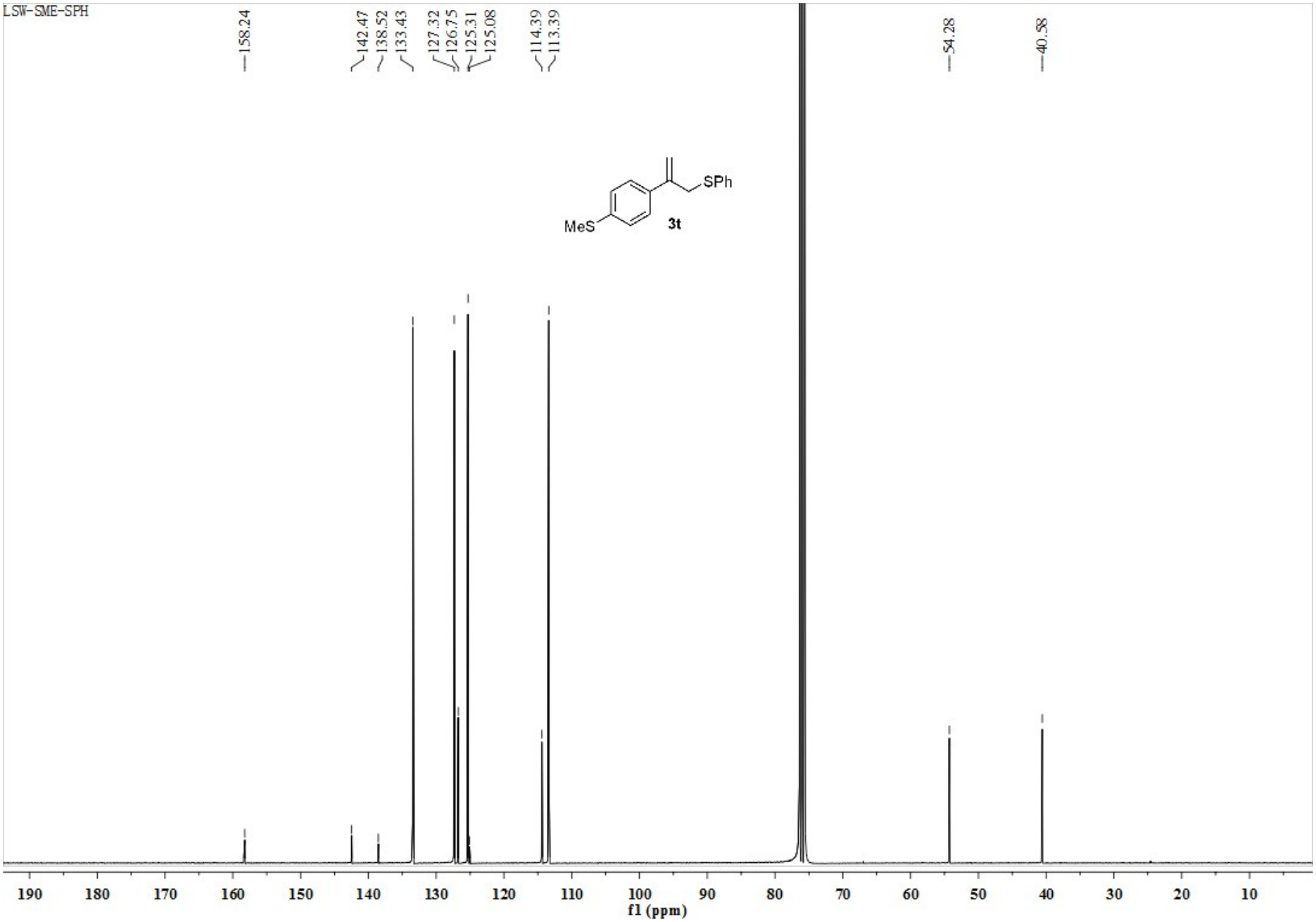

LSW-3-OME-SAC
7.85
7.84
7.33
7.31
7.29
7.28
7.27
7.26
7.04
7.03
6.98
6.98
6.97
5.47
5.35
4.04
3.82
2.57
MeO
S
Ac
3r
1.98
1.97
1.01
0.99
0.96
1.00
1.00
1.02
2.03
3.01
3.02
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


LSW-3-OME-SAC
197.25
159.66
144.00
142.30
140.85
134.25
129.52
128.72
127.39
118.68
116.36
113.22
112.35
55.28
37.59
26.49
MeO
S
Ac
3r
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

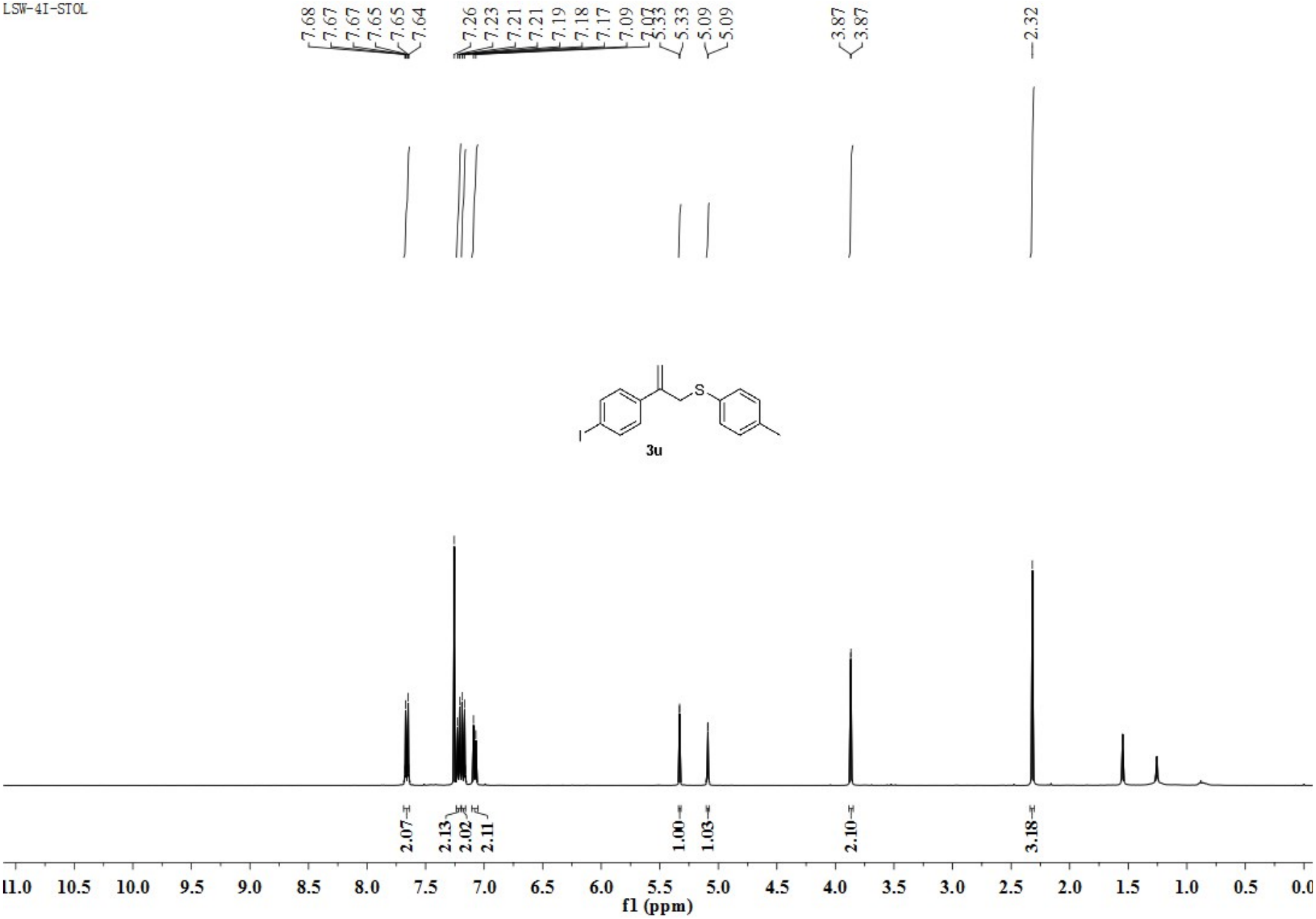

LSW-2-OME-SAC
7.83
7.82
7.33
7.31
7.29
7.26
7.11
7.11
7.10
7.10
6.92
6.92
6.89
6.88
5.44
5.43
5.19
4.10
3.84
2.56
OMe
S
Ac
3s
2.09
2.14
1.04
1.03
2.19
1.00
1.03
2.16
3.15
3.20
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

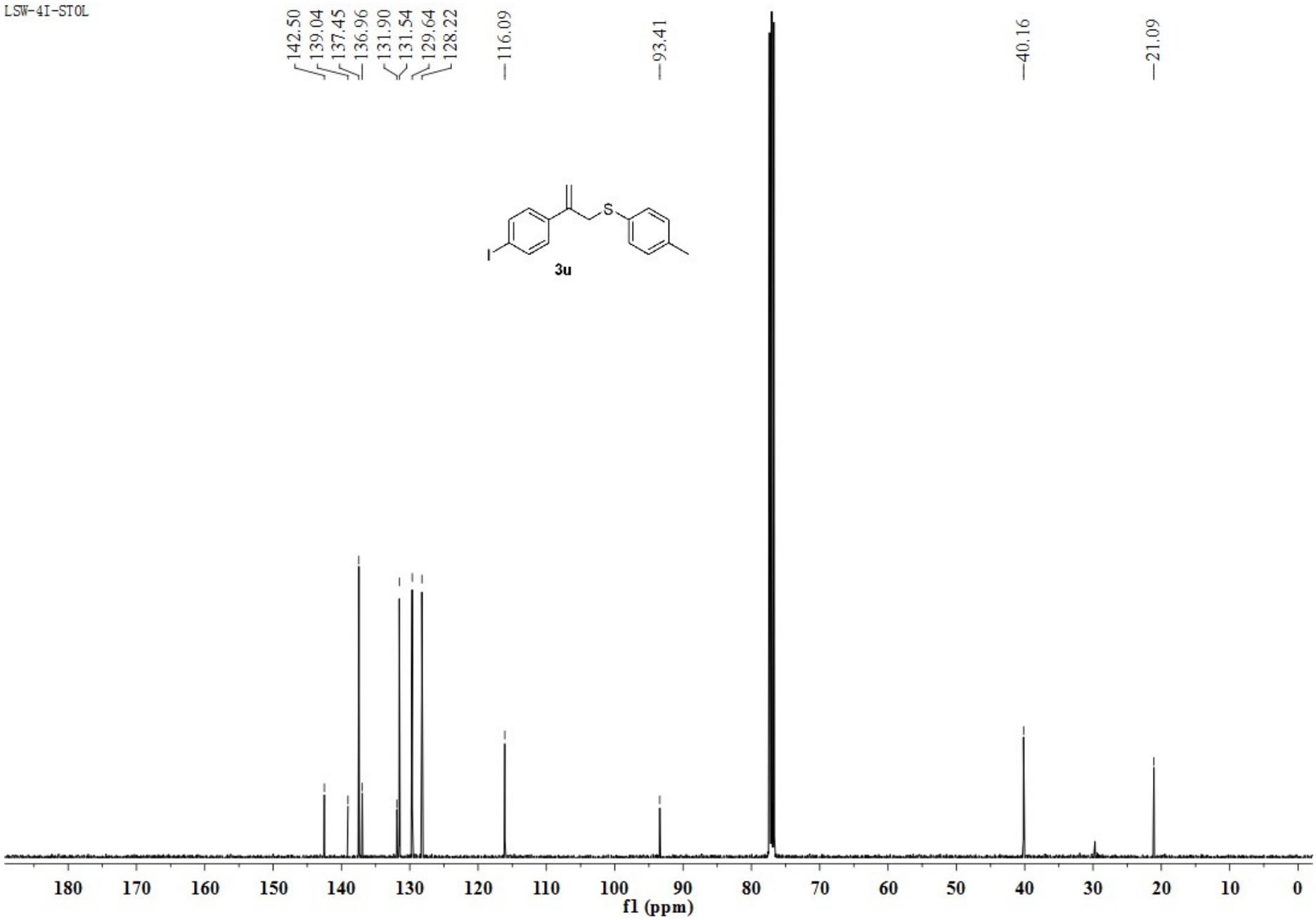

LSW-2-OME-SAC
197.30
156.51
144.63
143.44
133.84
130.53
129.82
129.26
128.57
127.01
120.74
117.46
110.59
55.42
37.65
26.47
OMe
S
Ac
3s
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

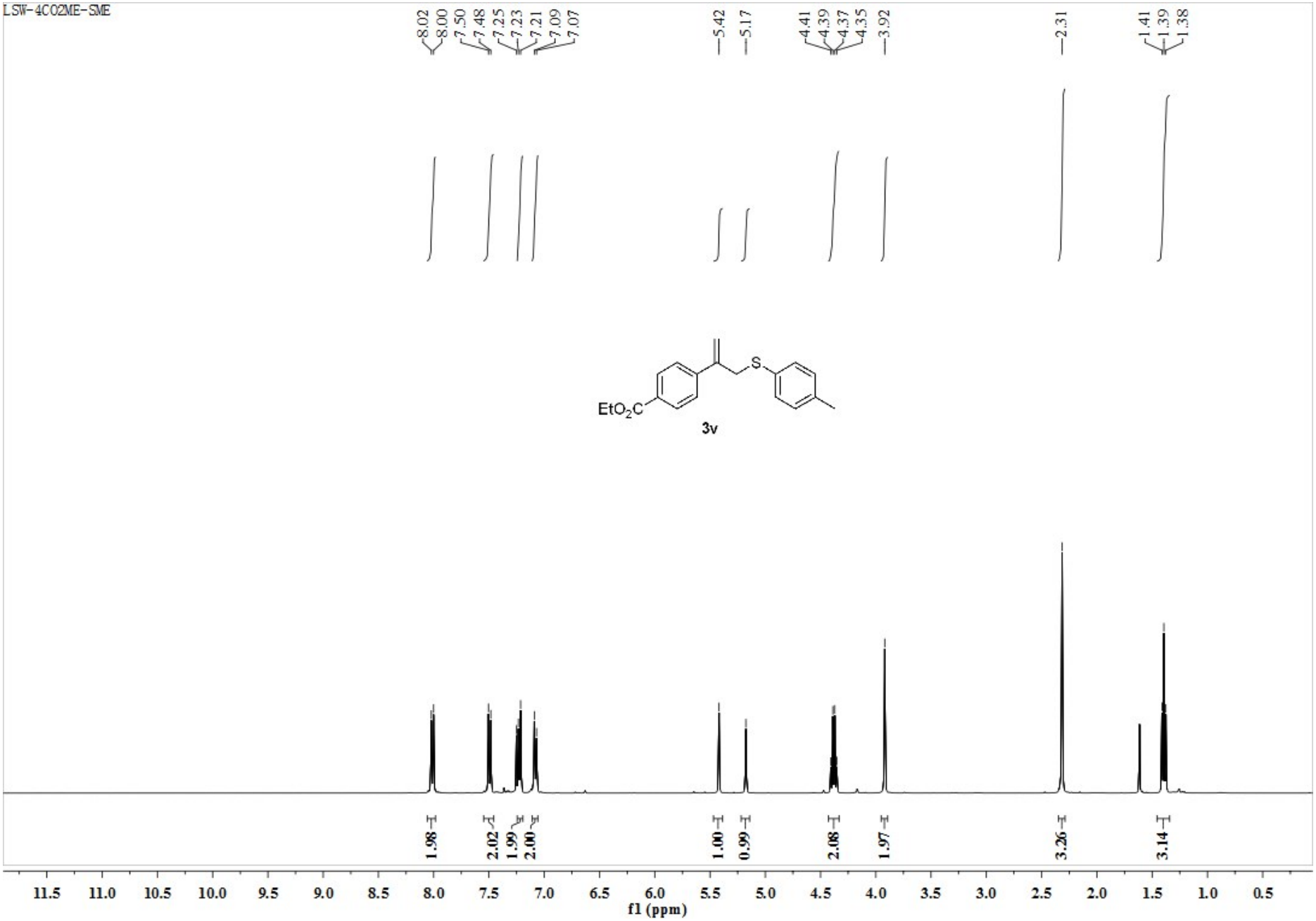

LSW-SME-STOL
7.47
7.47
7.45
7.38
7.37
7.37
7.36
7.35
7.34
7.33
7.32
7.32
7.31
7.31
7.26
6.84
6.83
6.82
6.82
5.32
5.32
5.00
4.99
3.86
3.80
1.55
SPh
MeS
3t
1.98
5.08
1.99
1.02
1.00
2.07
3.10
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

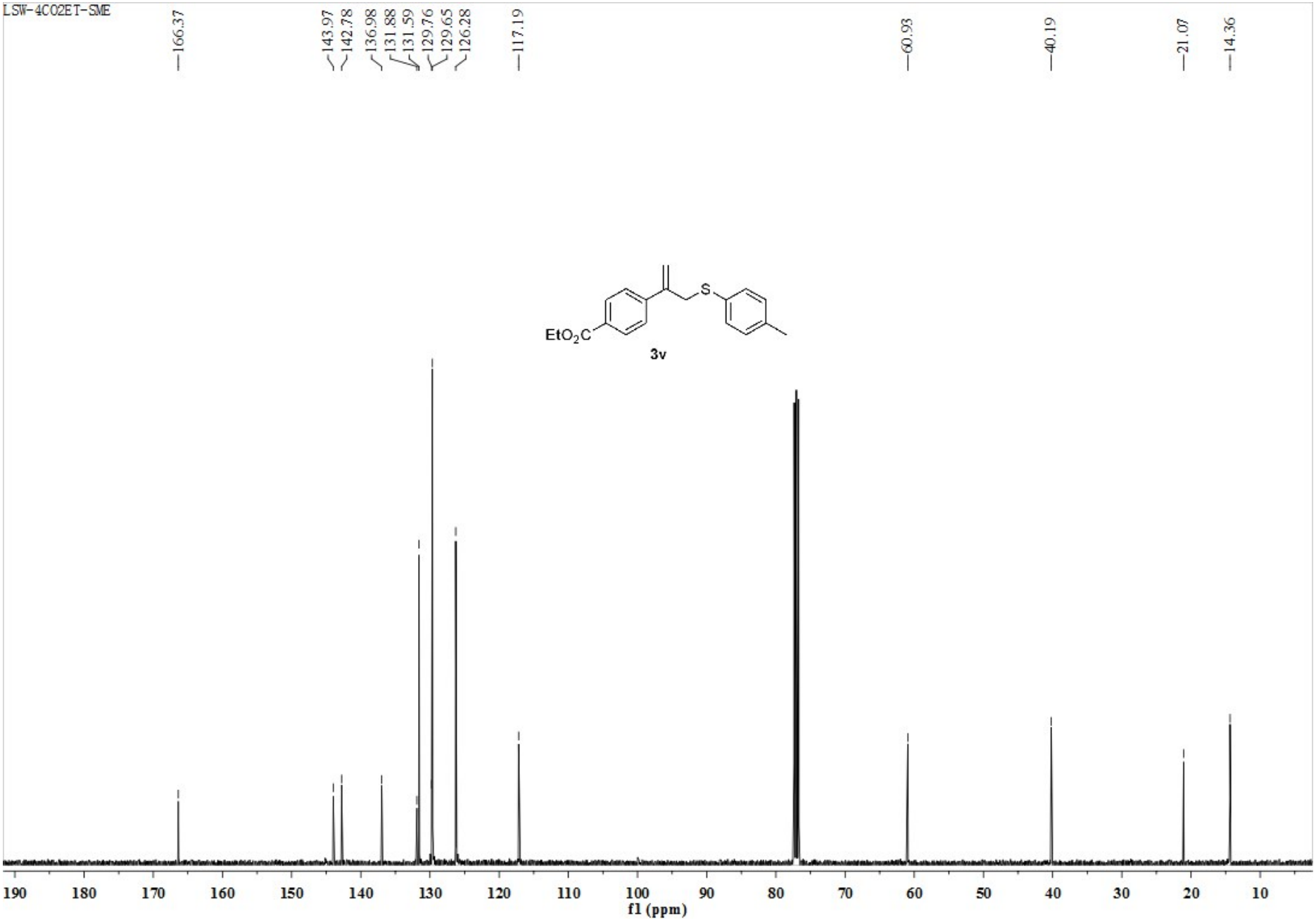

LSW-SME-SPH
158.24
142.47
138.52
133.43
127.32
126.75
125.31
125.08
114.39
113.39
54.28
40.38
SPh
MeS
3t
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

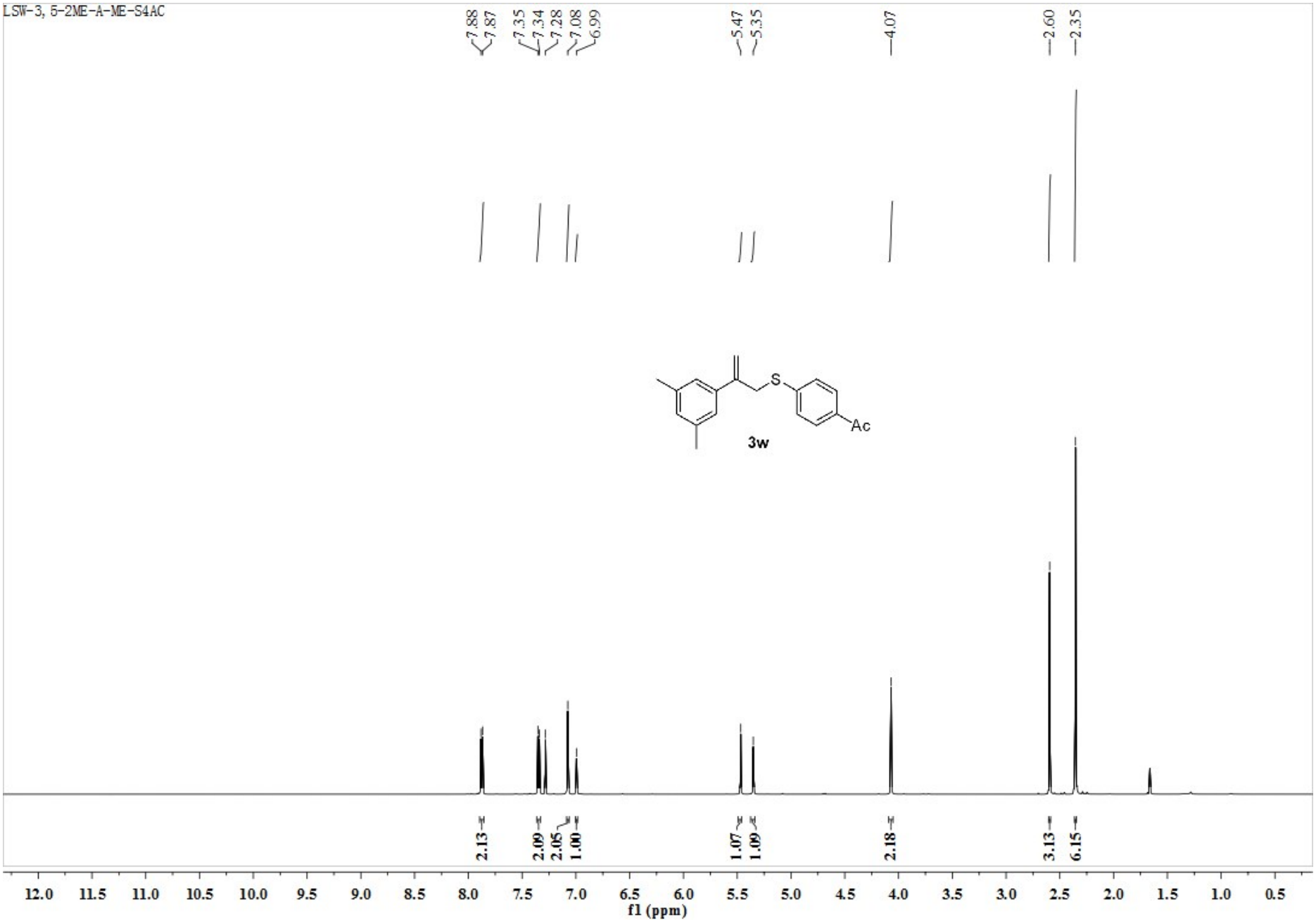
LSW-4I-STOL

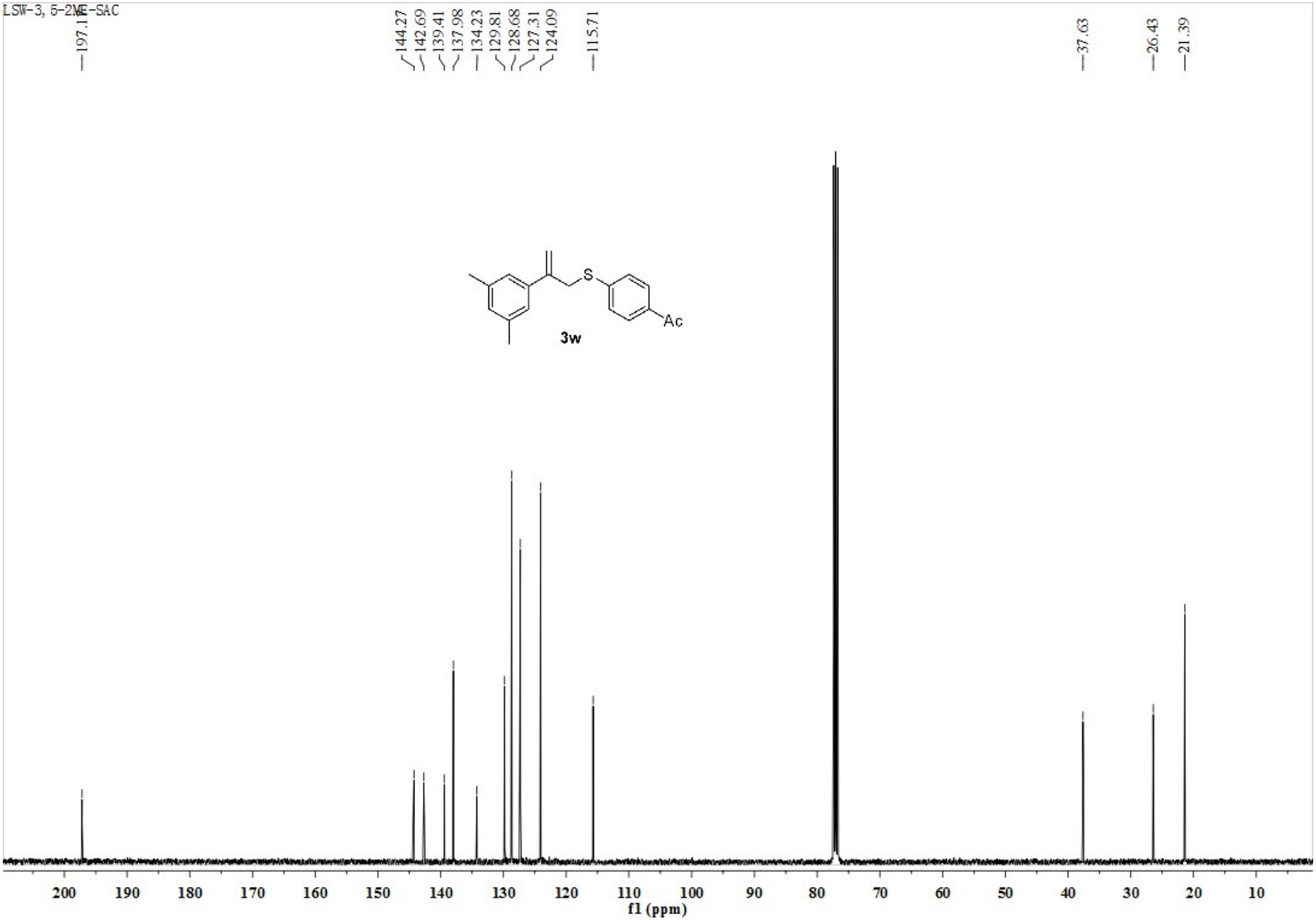

7.68
7.67
7.67
7.65
7.65
7.64
7.26
7.23
7.21
7.21
7.19
7.18
7.17
7.09
7.07
5.33
5.09
5.09
3.87
3.87
2.32
S
I
3u
2.07
2.13
2.02
2.11
1.00
1.03
2.10
3.18
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

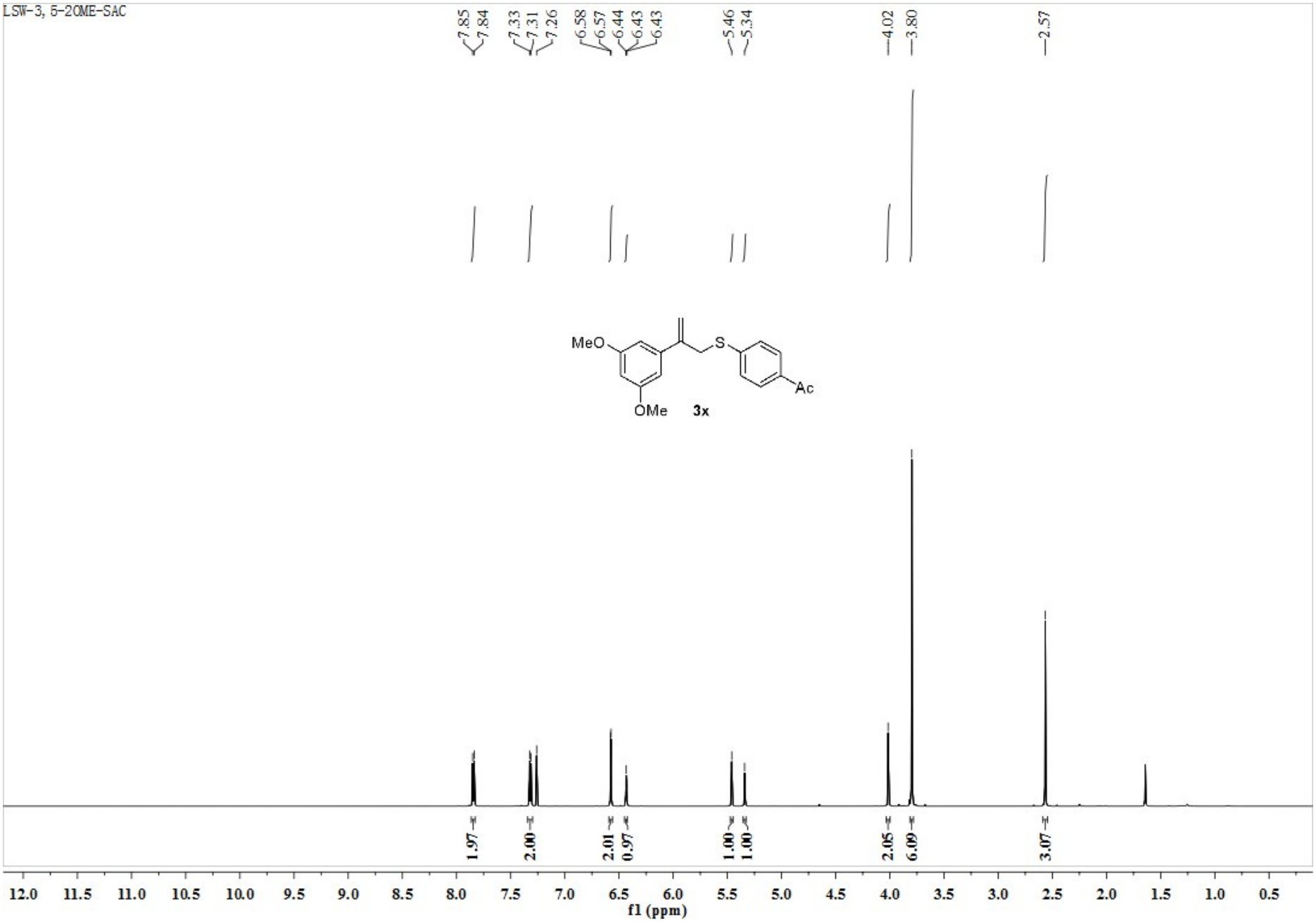

LSW-4I-STOL
142.50
139.04
137.45
136.96
131.90
131.54
129.64
128.22
116.09
93.41
40.16
21.09
S
I
3u
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

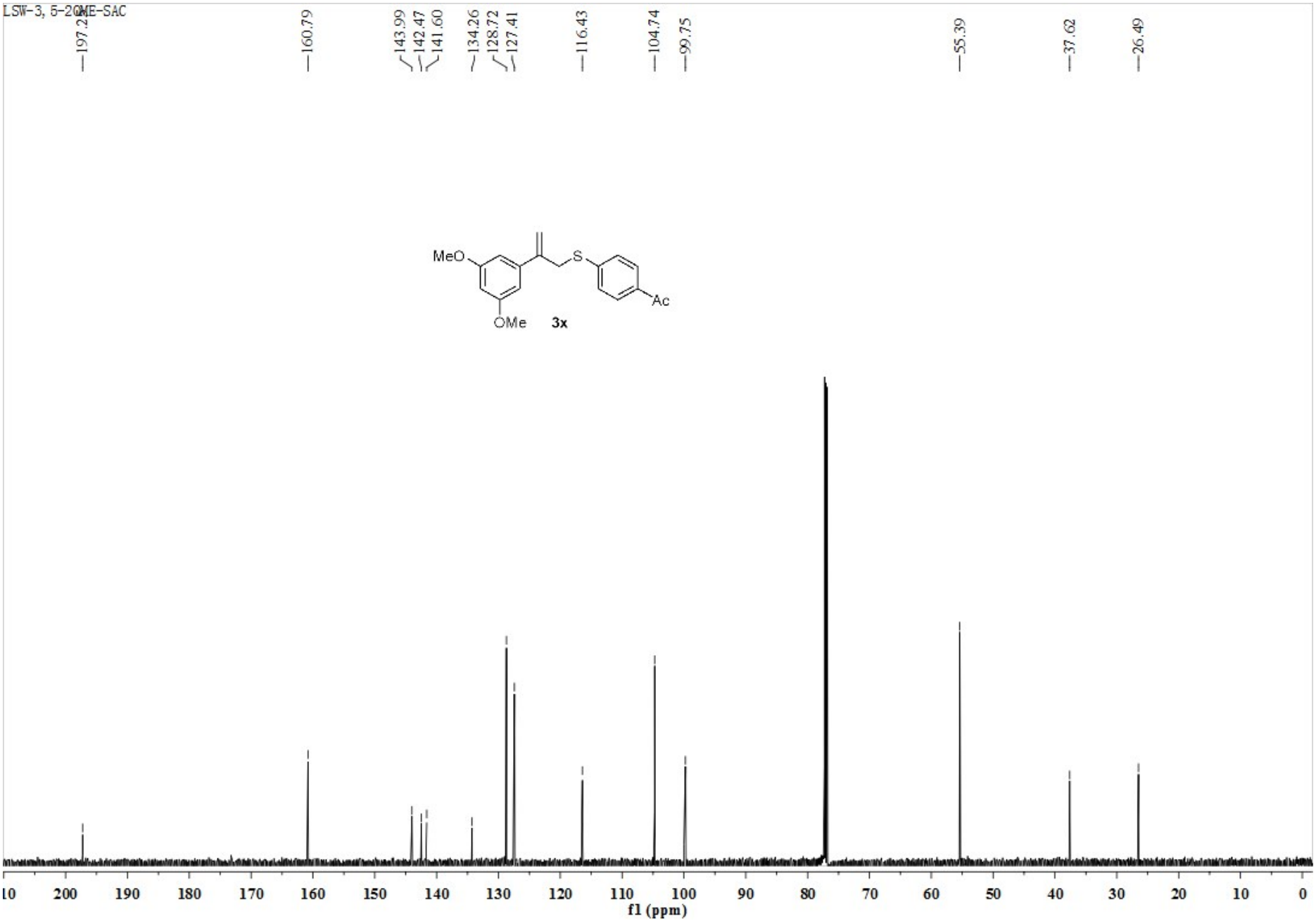

LSW-4CO2ME-SME
8.02
8.00
7.50
7.48
7.25
7.23
7.21
7.09
7.07
5.42
5.17
4.41
4.39
4.37
4.35
3.92
2.31
1.41
1.39
1.38
EtO2C
S
3v
1.98
2.02
1.99
2.00
1.00
0.99
2.08
1.97
3.26
3.14
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

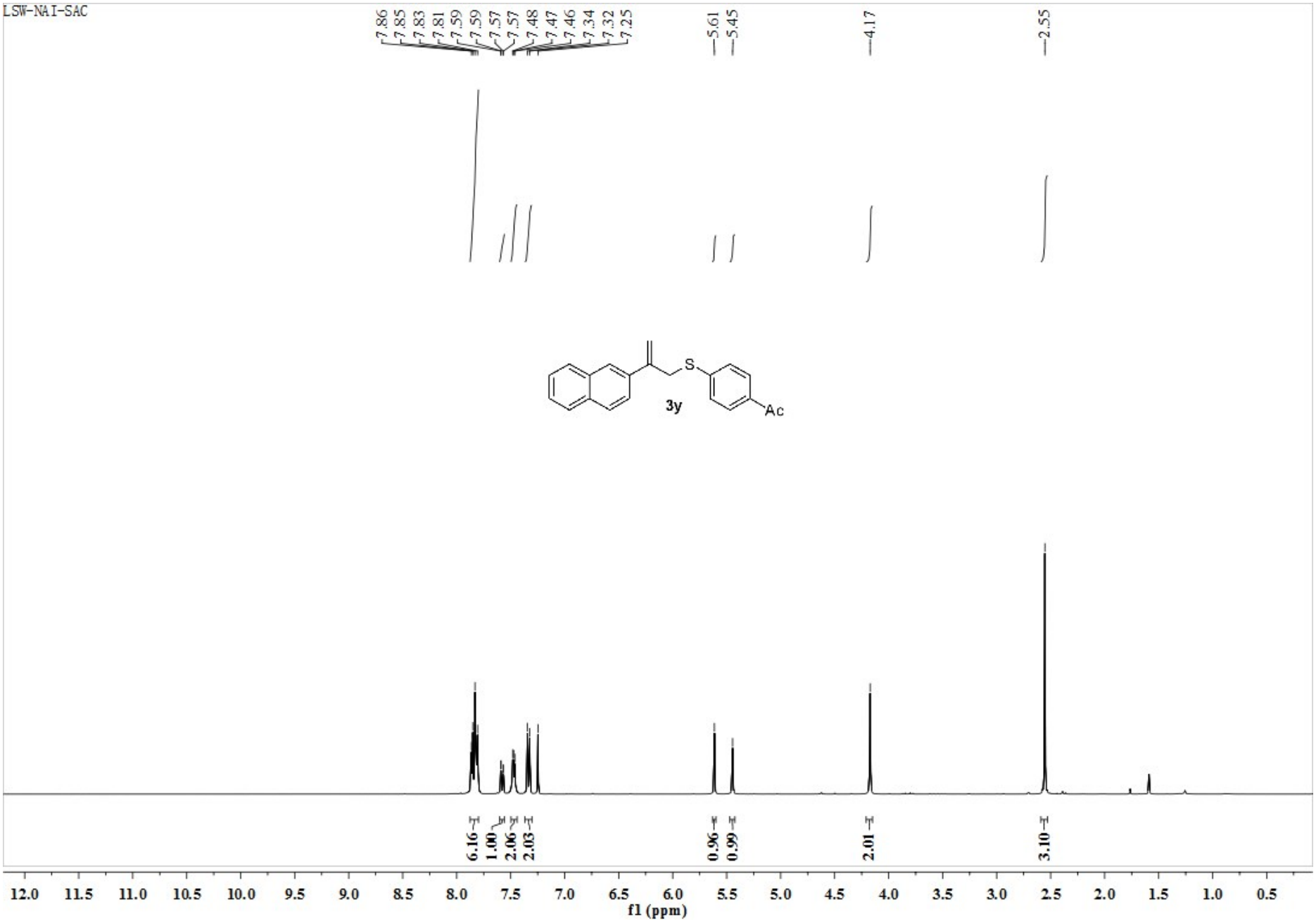

LSW-4CO2ET-SME
166.37
143.97
142.78
136.98
131.88
131.59
129.76
129.65
126.28
117.19
60.93
40.19
21.07
14.36
EtO2C
S
3v
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

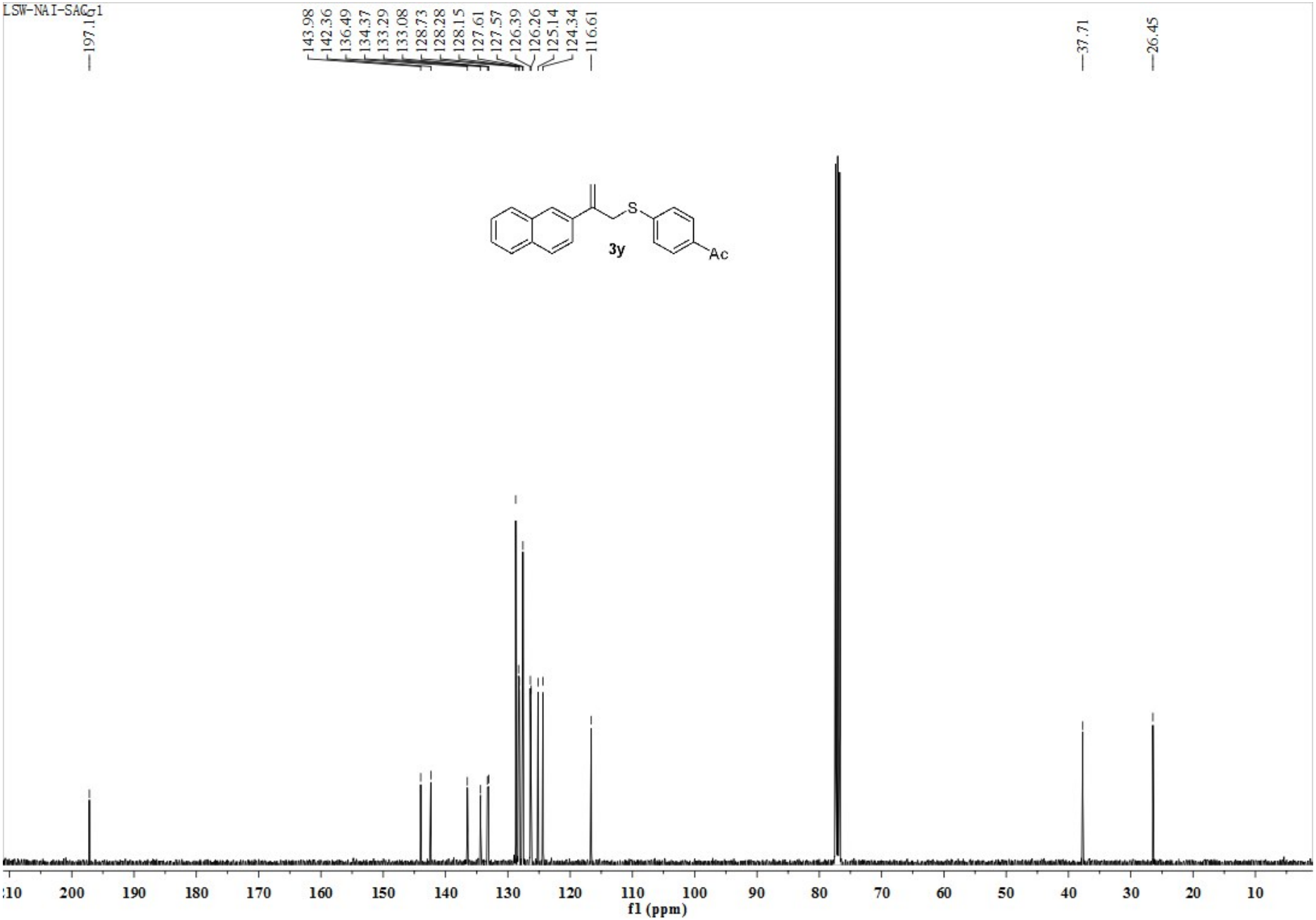

LSW-3, 5-2ME-A-ME-S4AC
7.88
7.87
7.35
7.34
7.28
7.08
6.99
5.47
5.35
4.07
2.60
2.35
S
Ac
3w
2.13
2.09
2.05
1.00
1.07
1.09
2.18
3.13
6.15
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

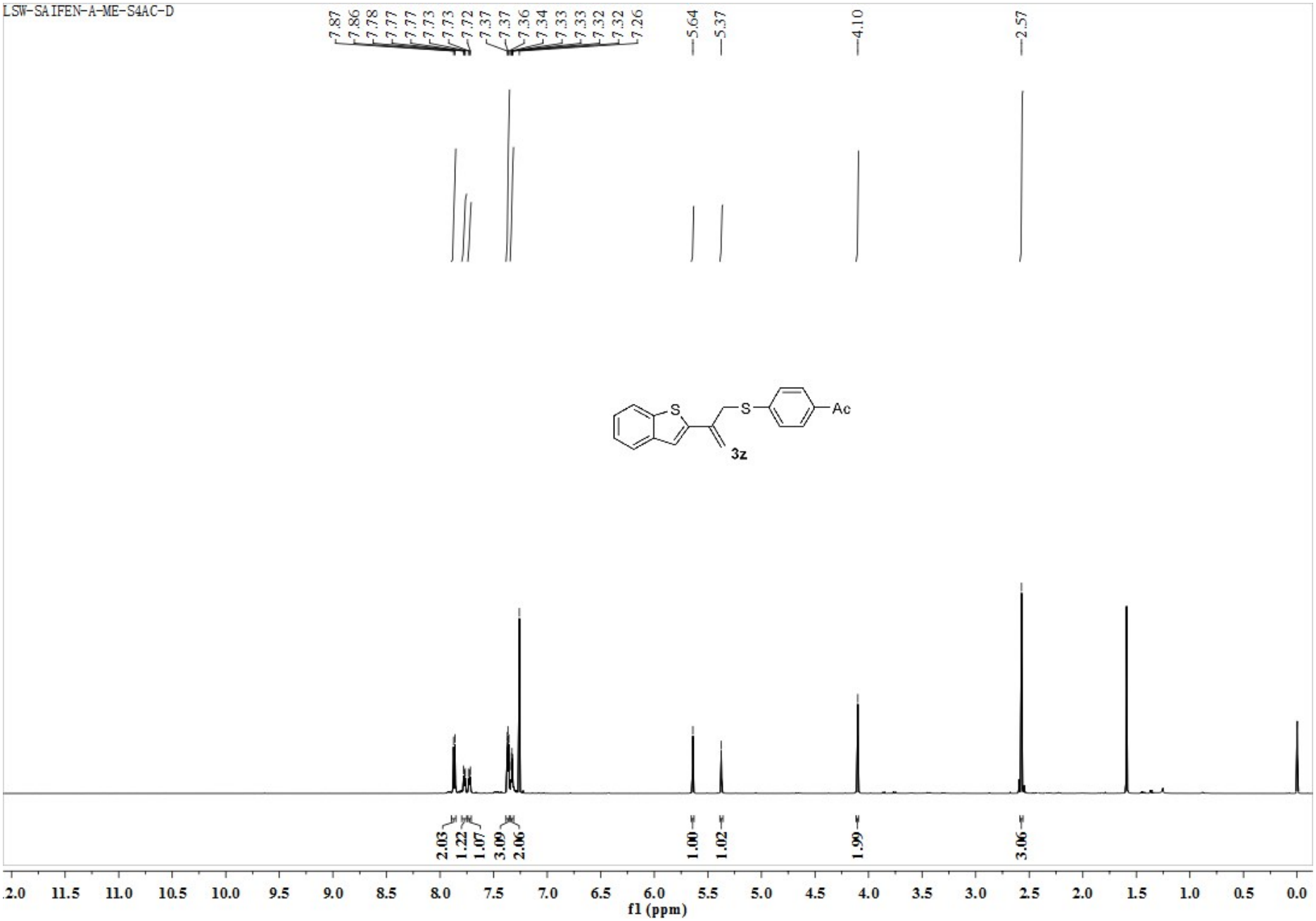

LSW-3, 5-2ME-SAC
197.1
144.27
142.69
139.41
137.98
134.23
129.81
128.68
127.31
124.09
115.71
37.63
26.43
21.39
S
Ac
3w
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

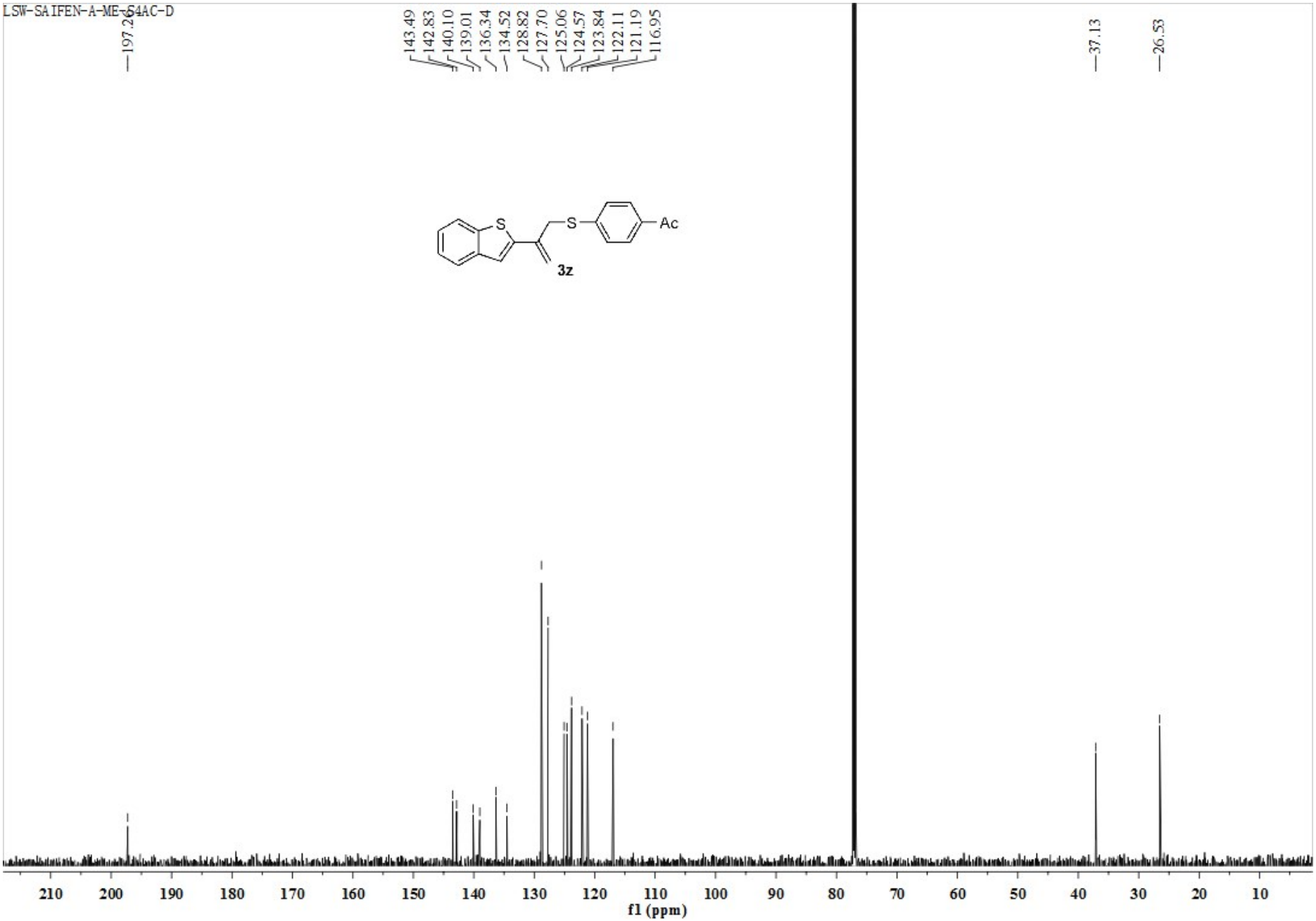

LSW-3, 5-2OME-SAC
7.85
7.84
7.33
7.31
7.26
6.58
6.57
6.44
6.43
6.43
5.46
5.34
4.02
3.80
2.57
MeO
S
Ac
OMe
3x
1.97
2.00
2.01
0.97
1.00
1.00
2.05
6.09
3.07
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

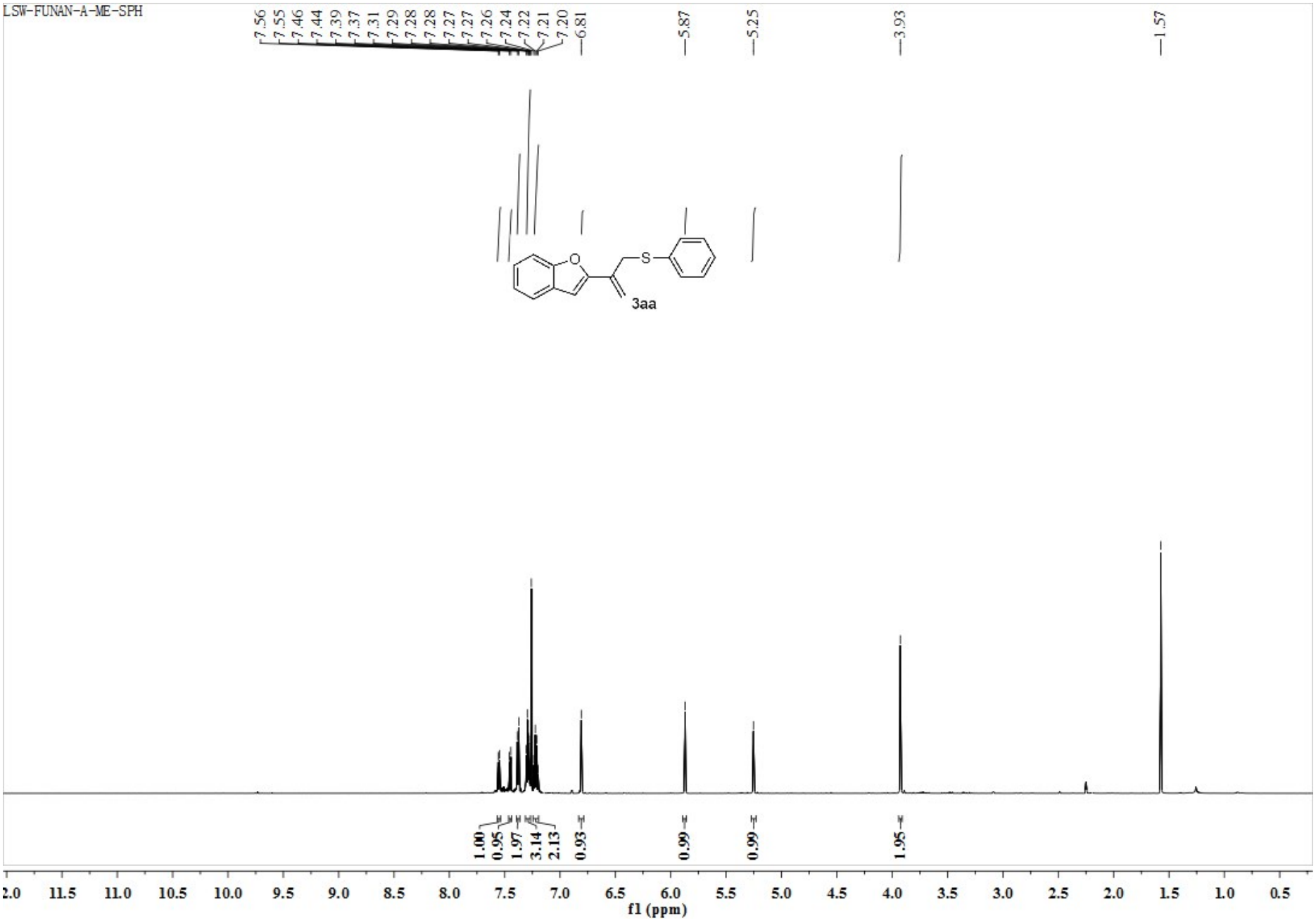

LSW-3, 5-20ME-SAC
197.25
160.79
143.99
142.47
141.60
134.26
128.72
127.41
116.43
104.74
99.75
55.39
37.62
26.49
MeO
OMe
S
Ac
3x
fl (ppm)

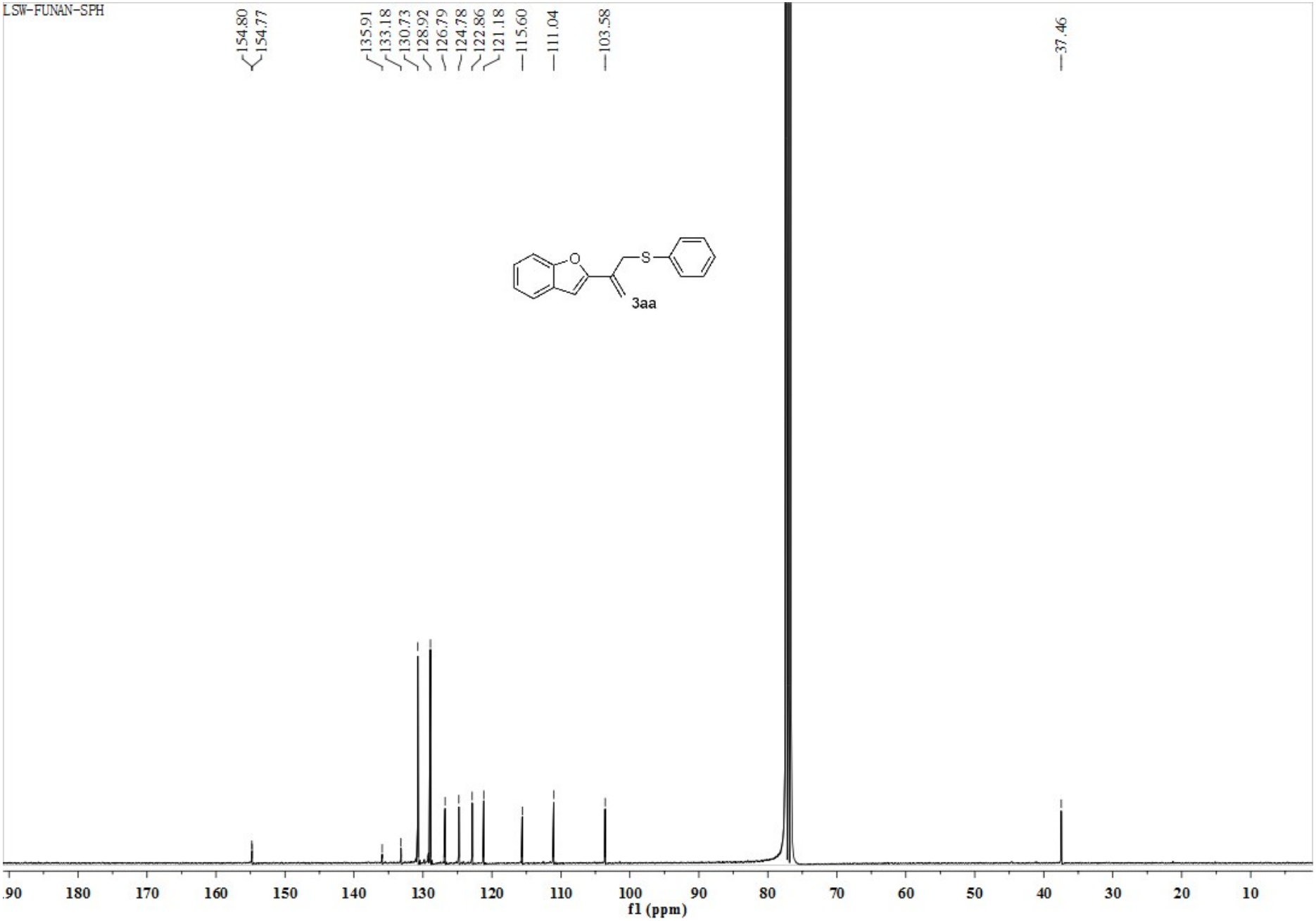

LSW-NAI-SAC
7.86
7.85
7.83
7.81
7.59
7.59
7.57
7.57
7.48
7.47
7.46
7.34
7.32
7.25
5.61
5.45
4.17
2.55
S
Ac
3y
6.16
1.00
2.06
2.03
0.96
0.99
2.01
3.10
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

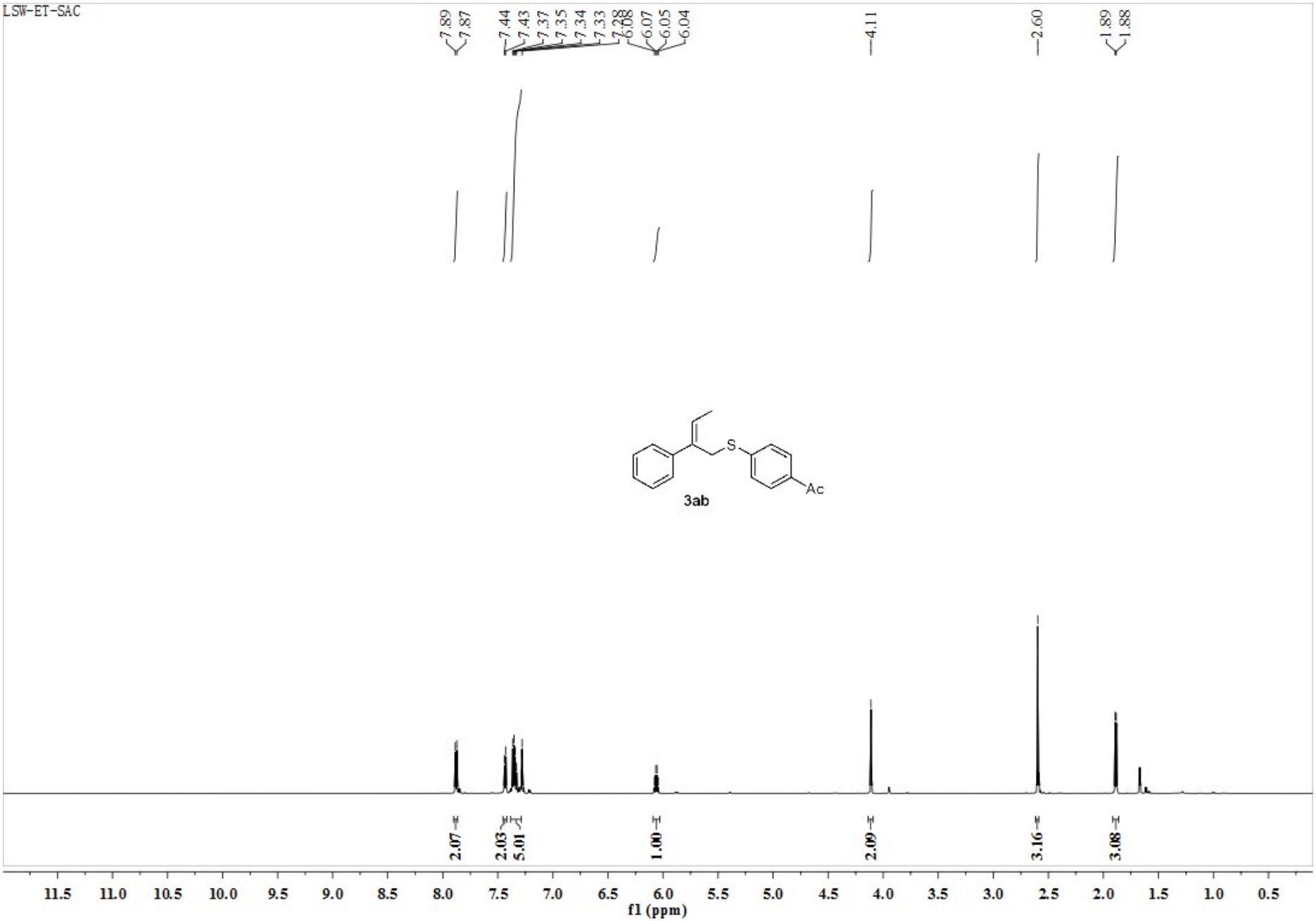

LSW-NAI-SAC-1
197.18
143.98
142.36
136.49
134.37
133.29
133.08
128.73
128.28
128.15
127.61
127.57
126.39
126.26
125.14
124.34
116.61
37.71
26.45
S
Ac
3y
f1 (ppm)

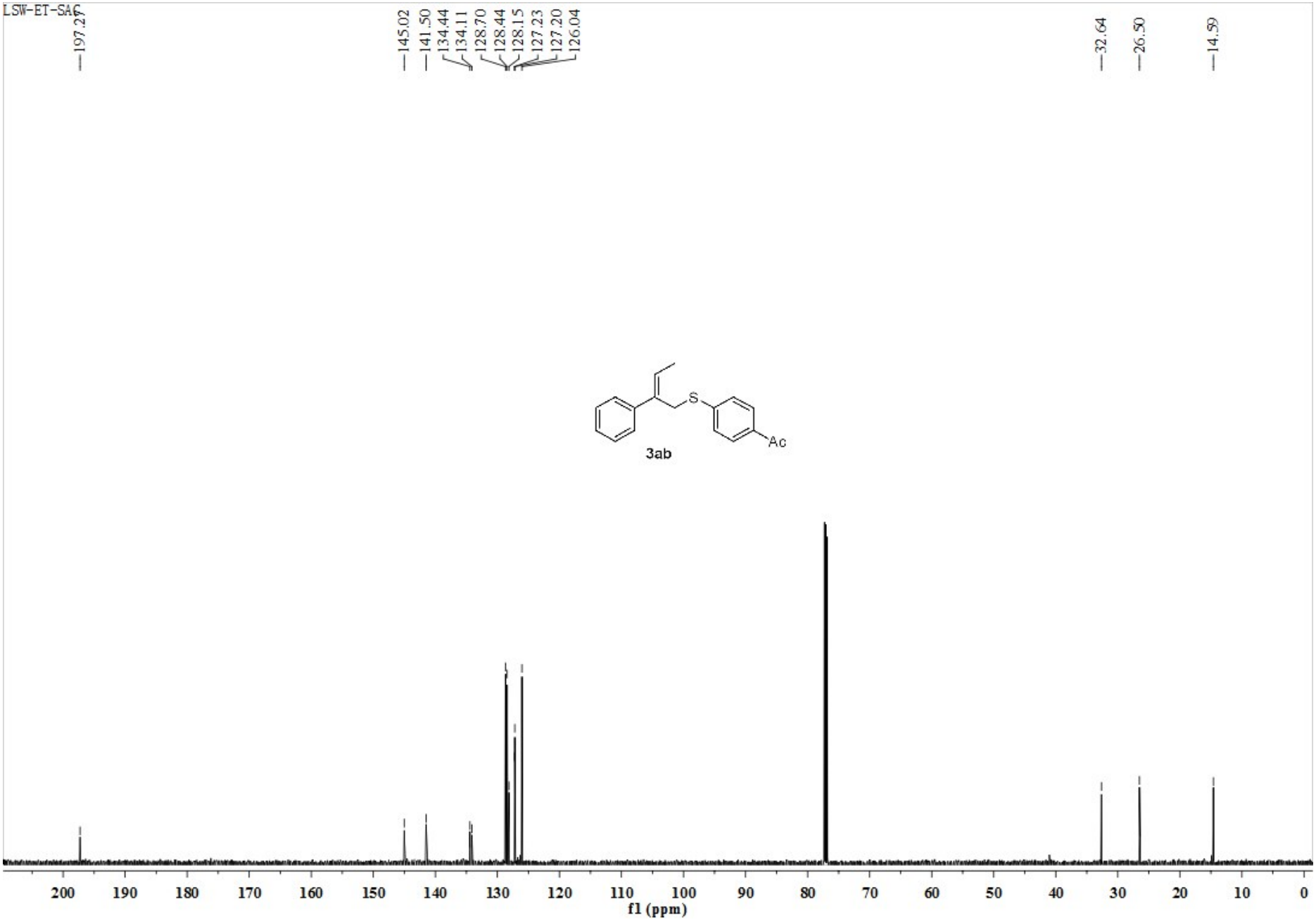

LSW-SAIFEN-A-ME-S4AC-D
7.87
7.86
7.78
7.77
7.77
7.73
7.73
7.72
7.37
7.37
7.36
7.34
7.33
7.33
7.32
7.32
7.26
5.64
5.37
4.10
2.57
S
S
Ac
3z
2.03
1.22
1.07
3.09
2.06
1.00
1.02
1.99
3.06
f1 (ppm)

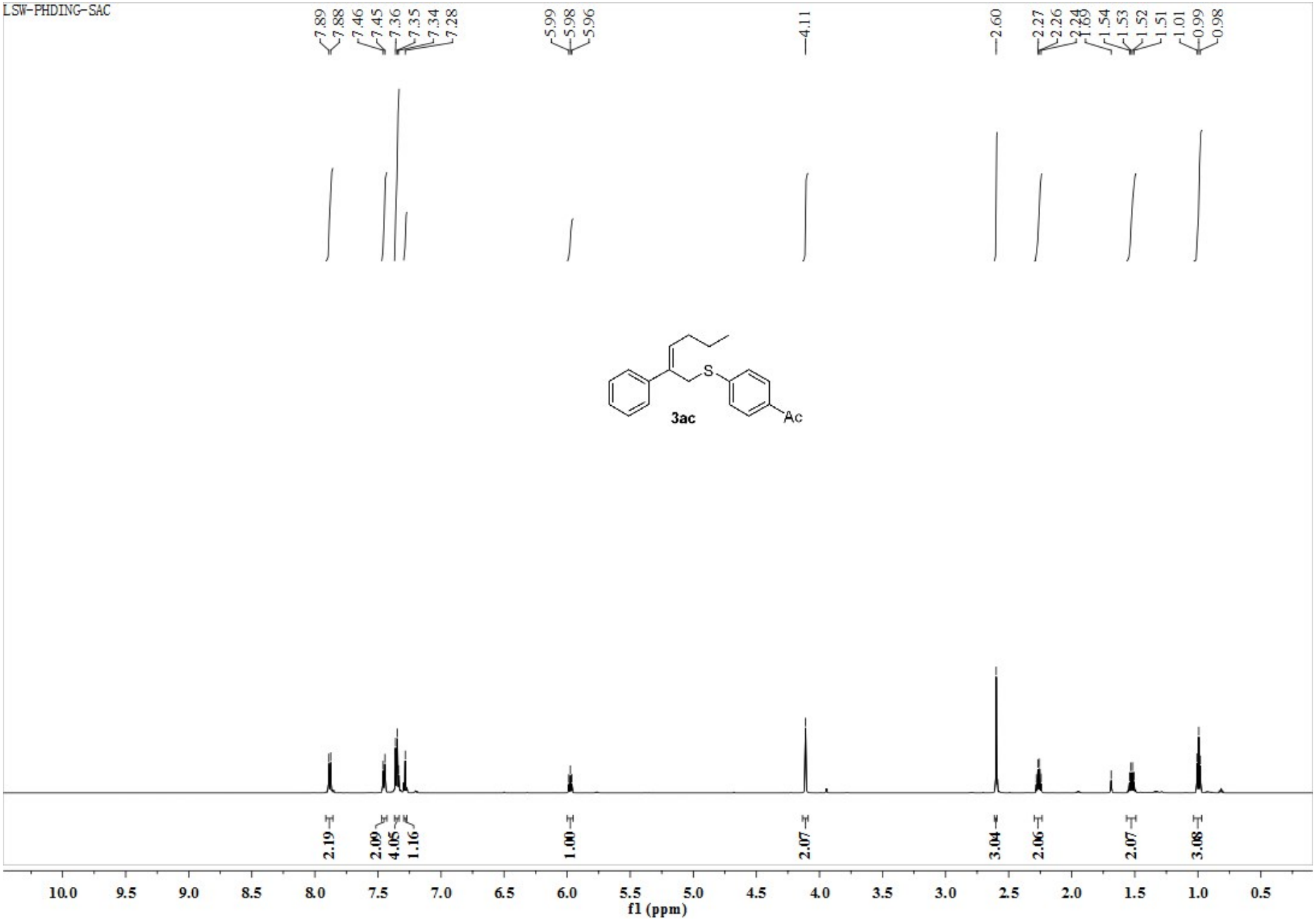

LSW-SAIFEN-A-ME-S4AC-D
197.26
143.49
142.83
140.10
139.01
136.34
134.52
128.82
127.70
125.06
124.57
123.84
122.11
121.19
116.95
37.13
26.53
S
S
Ac
3z
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

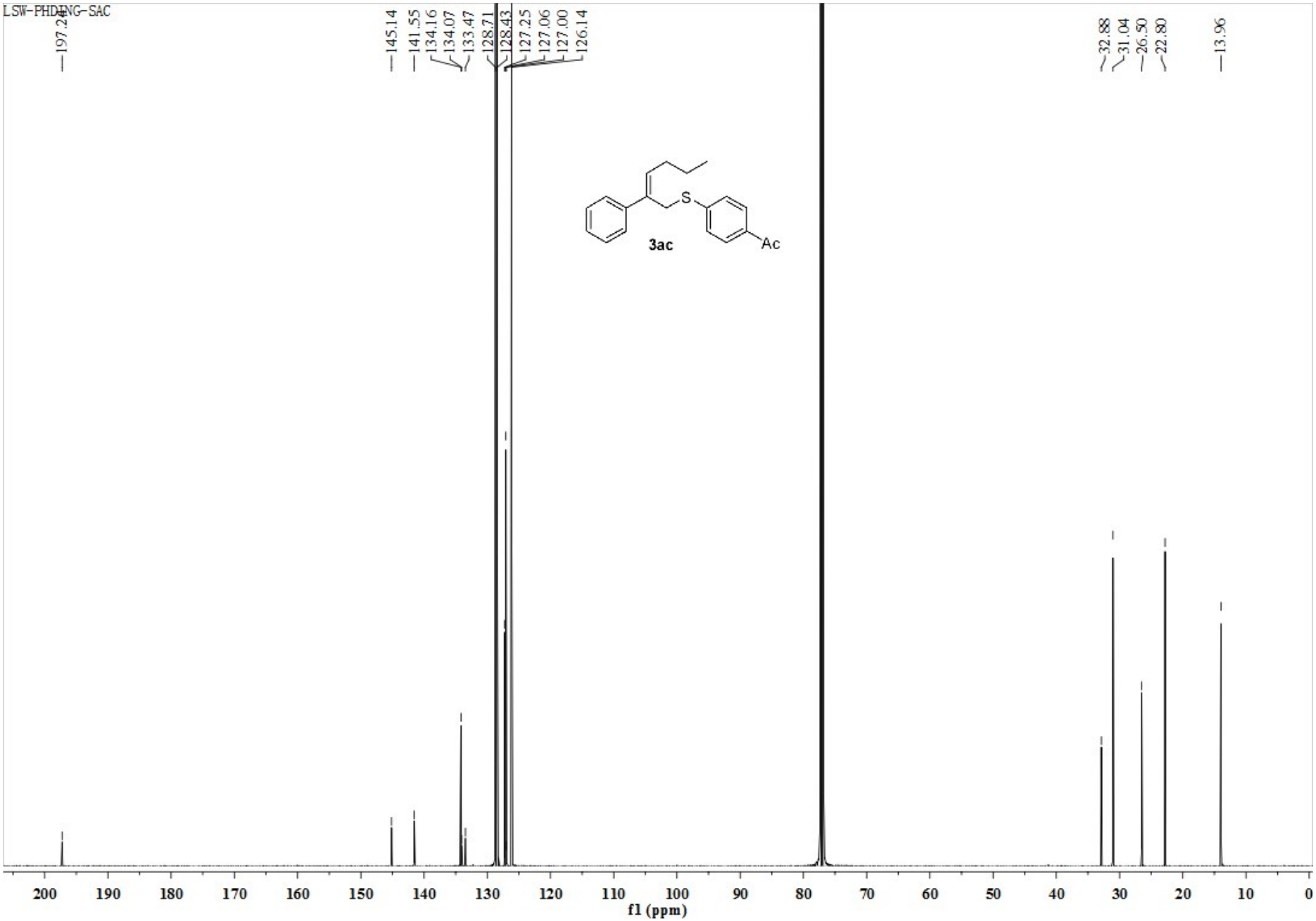

LSW-FUNAN-A-ME-SPH
7.56
7.55
7.46
7.44
7.39
7.37
7.31
7.29
7.28
7.28
7.27
7.27
7.26
7.24
7.22
7.21
7.20
6.81
5.87
5.25
3.93
1.57
O
S
3aa
1.00
0.95
1.97
3.14
2.13
0.93
0.99
0.99
1.95
f1 (ppm)

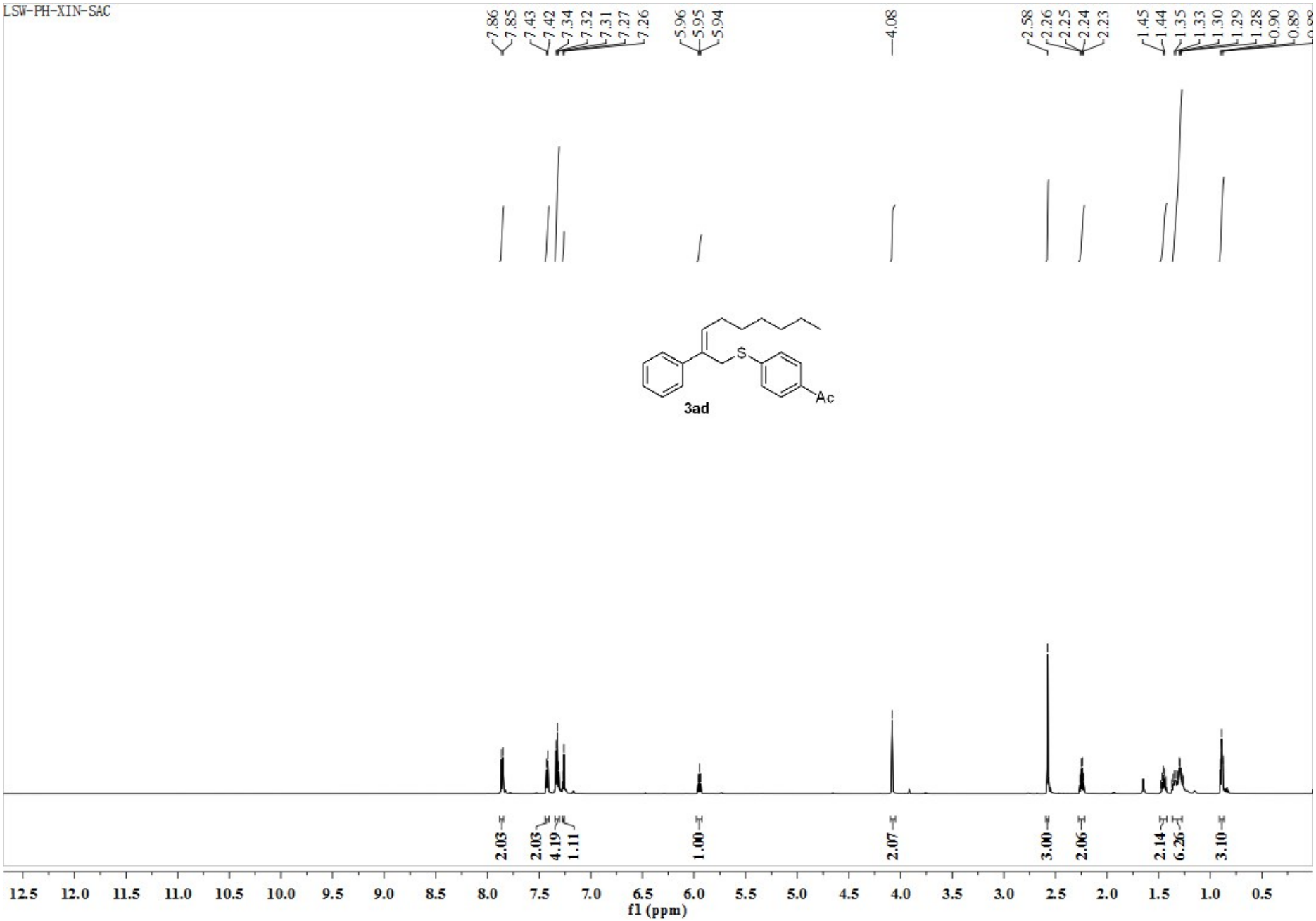

LSW-FUNAN-SPH
154.80
154.77
135.91
133.18
130.73
128.92
126.79
124.78
122.86
121.18
115.60
111.04
103.58
37.46
O
S
3aa
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

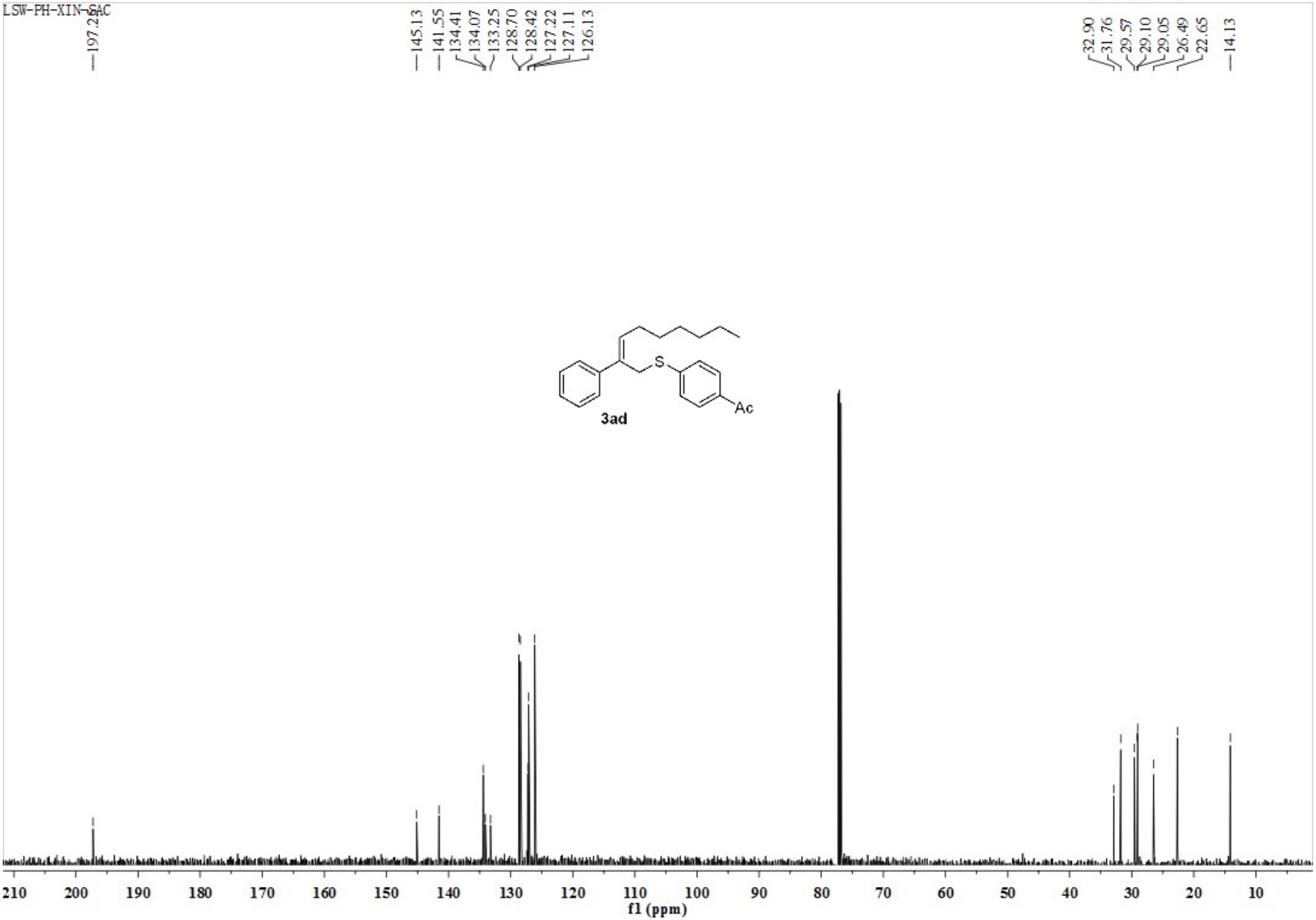

LSW-ET-SAC
7.89
7.87
7.44
7.43
7.37
7.35
7.34
7.33
7.28
6.08
6.07
6.05
6.04
4.11
2.60
1.89
1.88
S
Ac
3ab
2.07
2.03
5.01
1.00
2.09
3.16
3.08
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

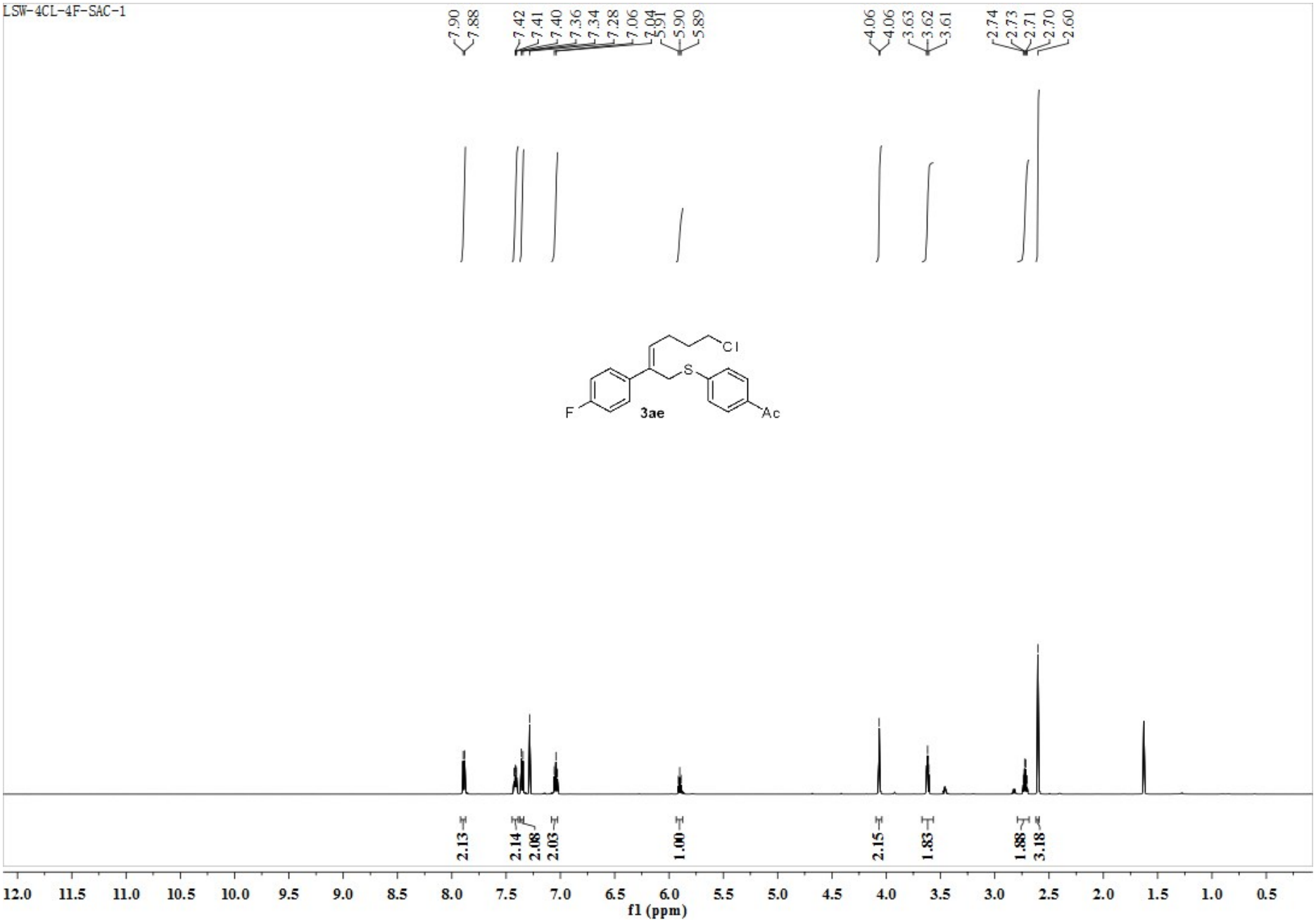

LSW-ET-SAC
197.27
145.02
141.50
134.44
134.11
128.70
128.44
128.15
127.23
127.20
126.04
32.64
26.50
14.59
S
Ac
3ab
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

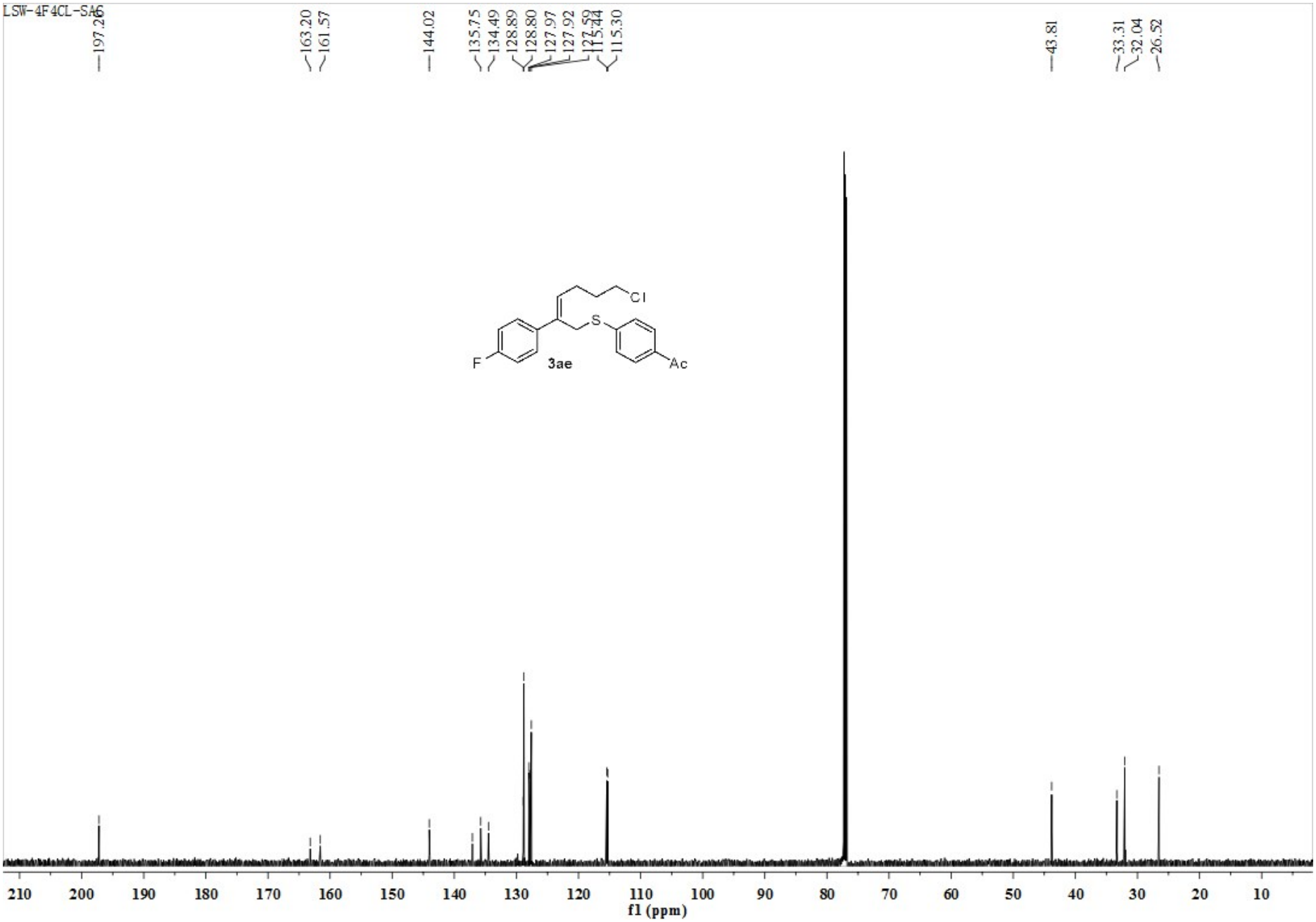

LSW-PHDING-SAC
7.89
7.88
7.46
7.45
7.36
7.35
7.34
7.28
5.99
5.98
5.96
4.11
2.60
2.27
2.26
2.24
1.63
1.54
1.53
1.52
1.51
1.01
0.99
0.98
S
Ac
3ac
2.19
2.09
4.05
1.16
1.00
2.07
3.04
2.06
2.07
3.08
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

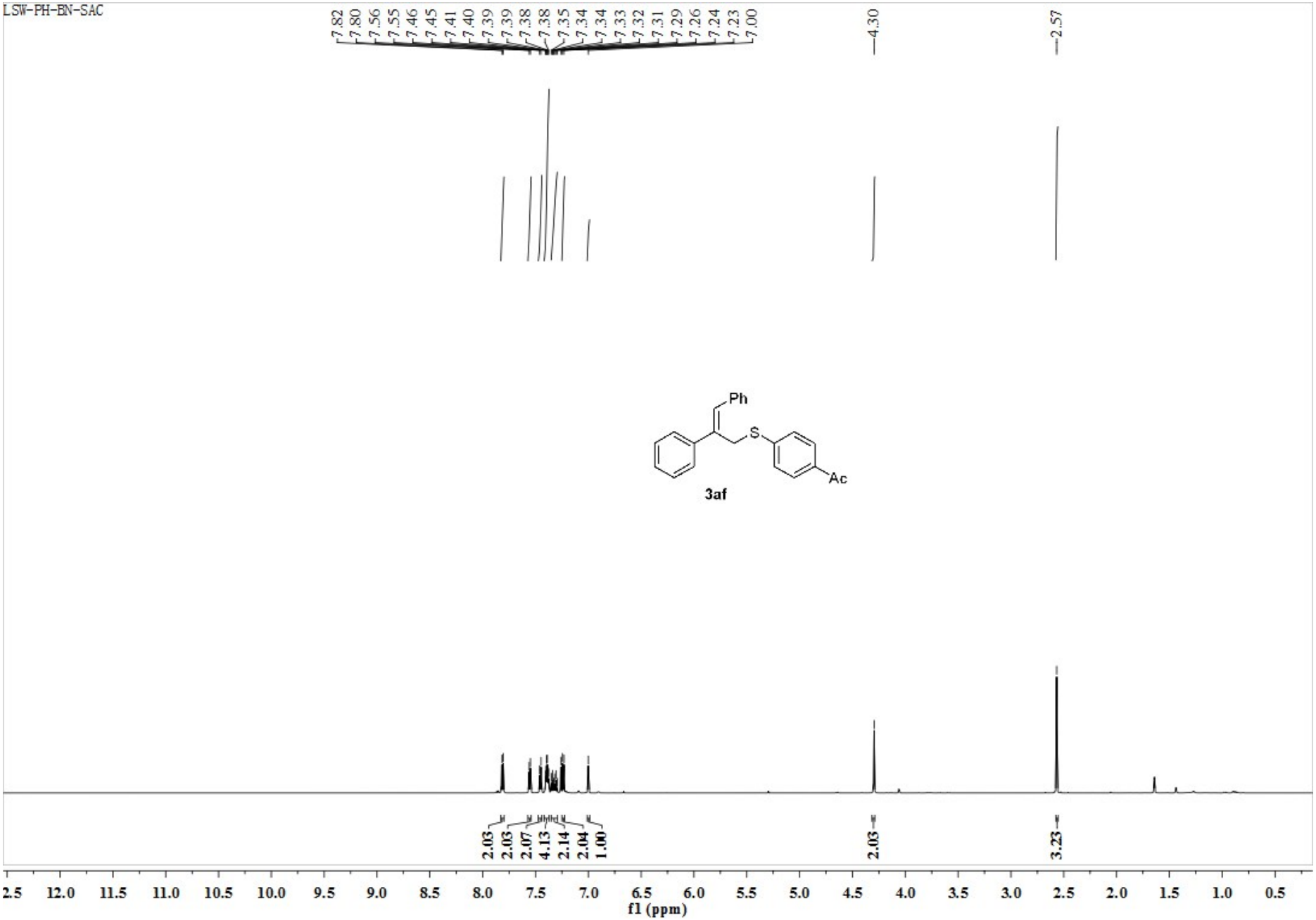

LSW-PHDING-SAC
197.24
145.14
141.55
134.16
134.07
133.47
128.71
128.43
127.25
127.06
127.00
126.14
32.88
31.04
26.50
22.80
13.96
S
Ac
3ac
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

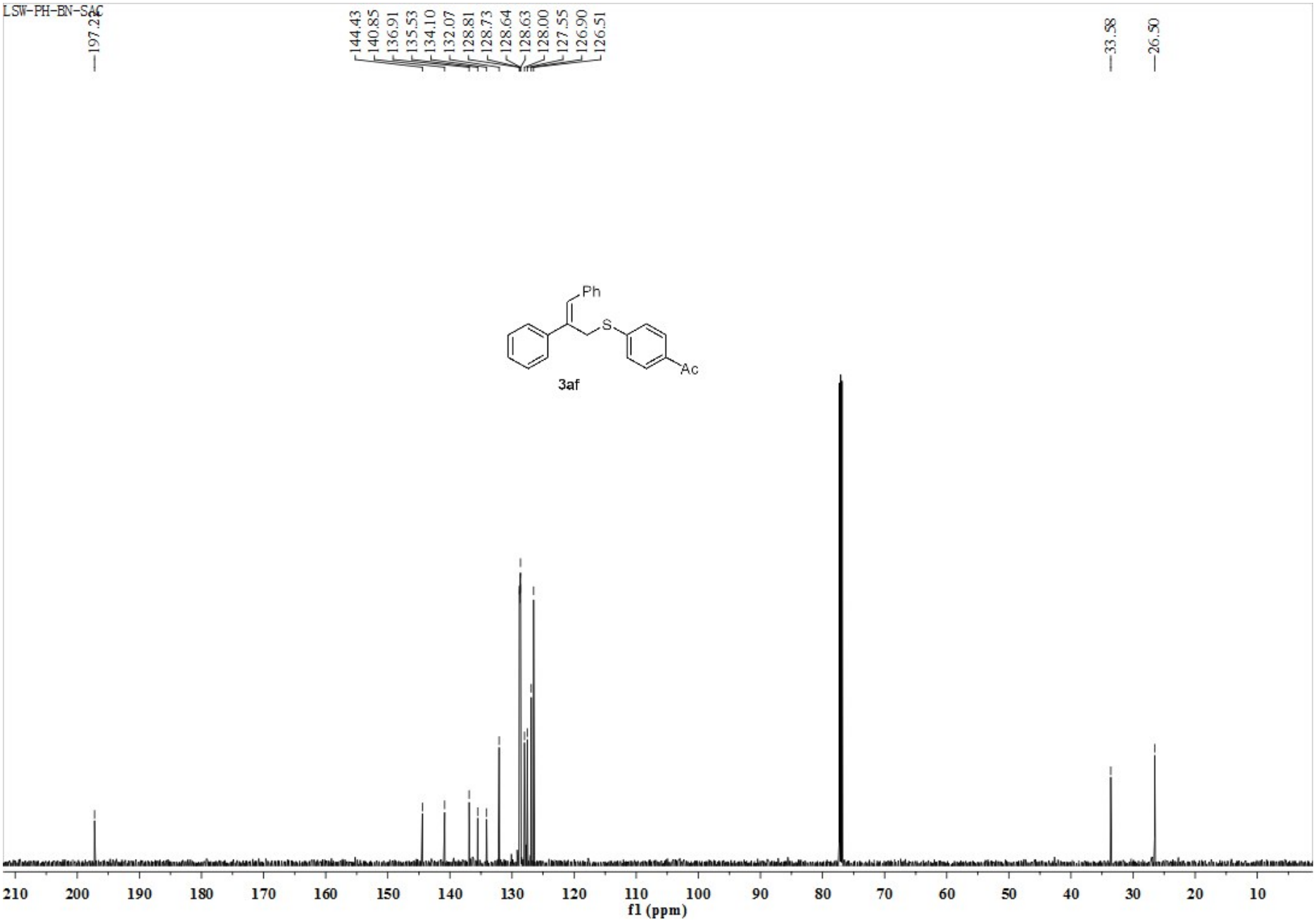

LSW-PH-XIN-SAC
7.86
7.85
7.43
7.42
7.34
7.32
7.31
7.27
7.26
5.96
5.95
5.94
4.08
2.58
2.26
2.25
2.24
2.23
1.45
1.44
1.35
1.33
1.30
1.29
1.28
0.90
0.89
S
Ac
3ad
2.03
2.03
4.19
1.11
1.00
2.07
3.00
2.06
2.14
6.26
3.10
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

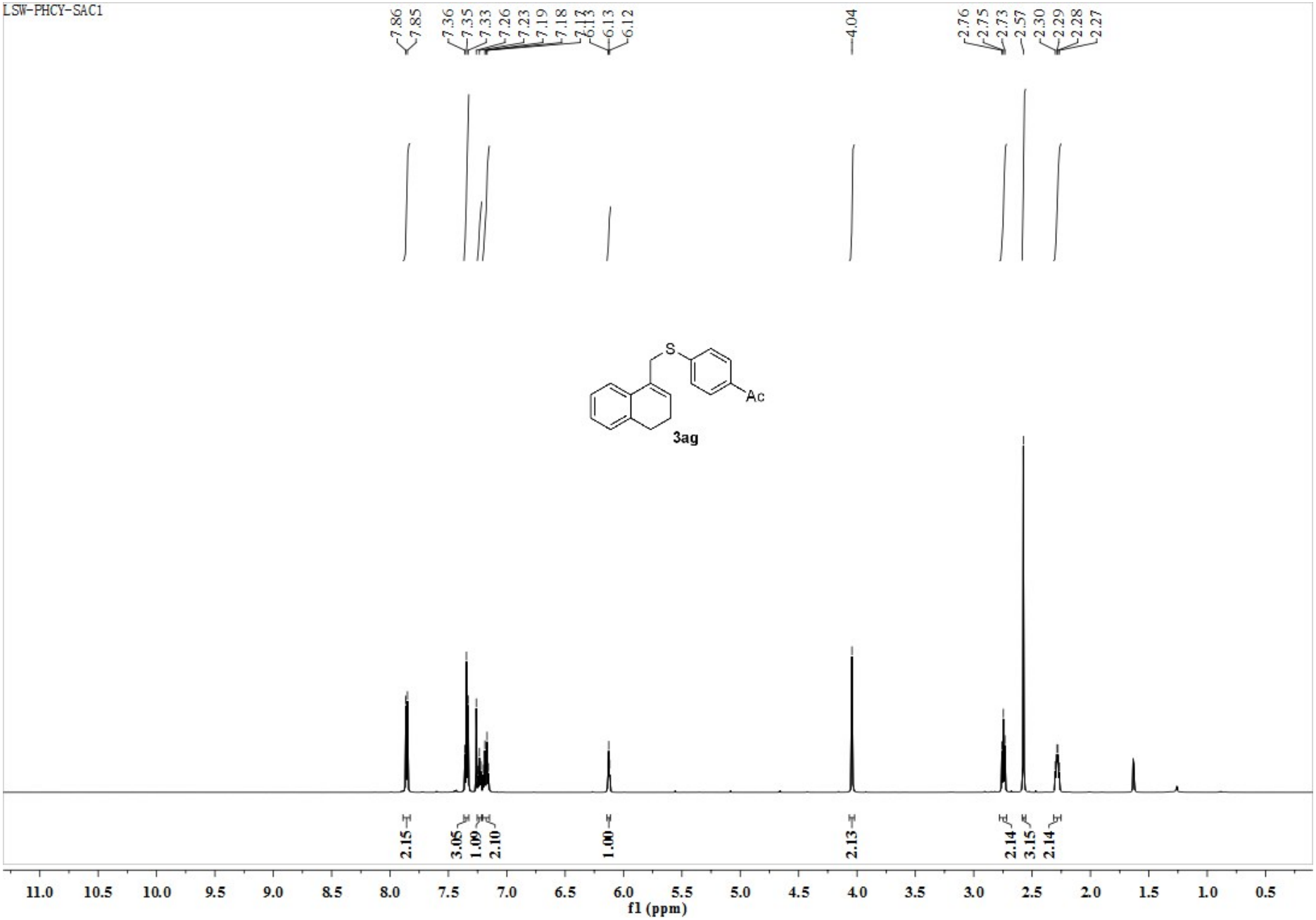

LSW-PH-XIN-SAC
197.28
145.13
141.55
134.41
134.07
133.25
128.70
128.42
127.22
127.11
126.13
32.90
31.76
29.57
29.10
29.05
26.49
22.65
14.13
S
Ac
3ad
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

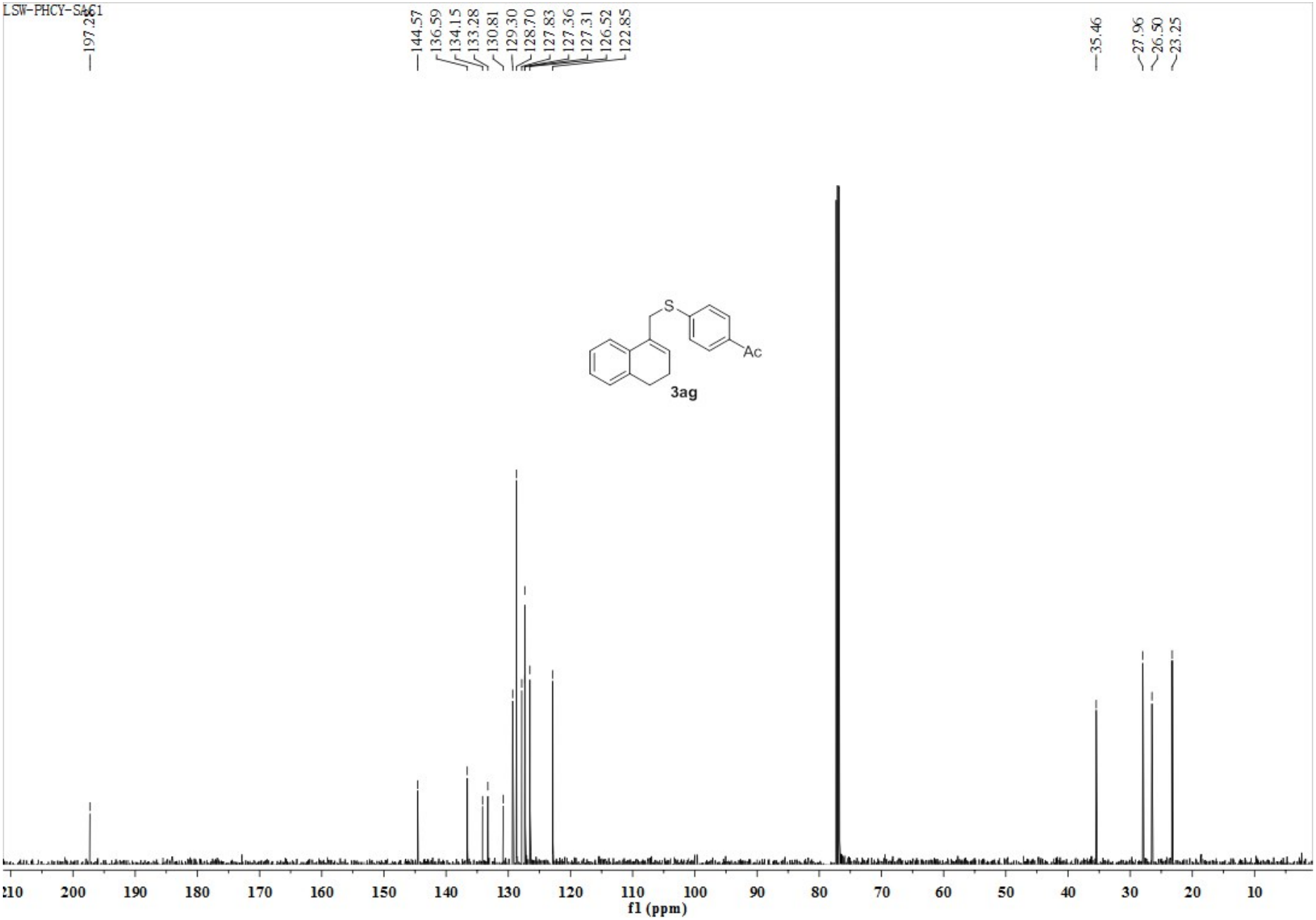

LSW-4CL-4F-SAC-1
7.90
7.88
7.42
7.41
7.40
7.36
7.34
7.28
7.06
7.04
5.91
5.90
5.89
4.06
4.06
3.63
3.62
3.61
2.74
2.73
2.71
2.70
2.60
Cl
S
F
Ac
3ae
2.13
2.14
2.08
2.03
1.00
2.15
1.83
1.88
3.18
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

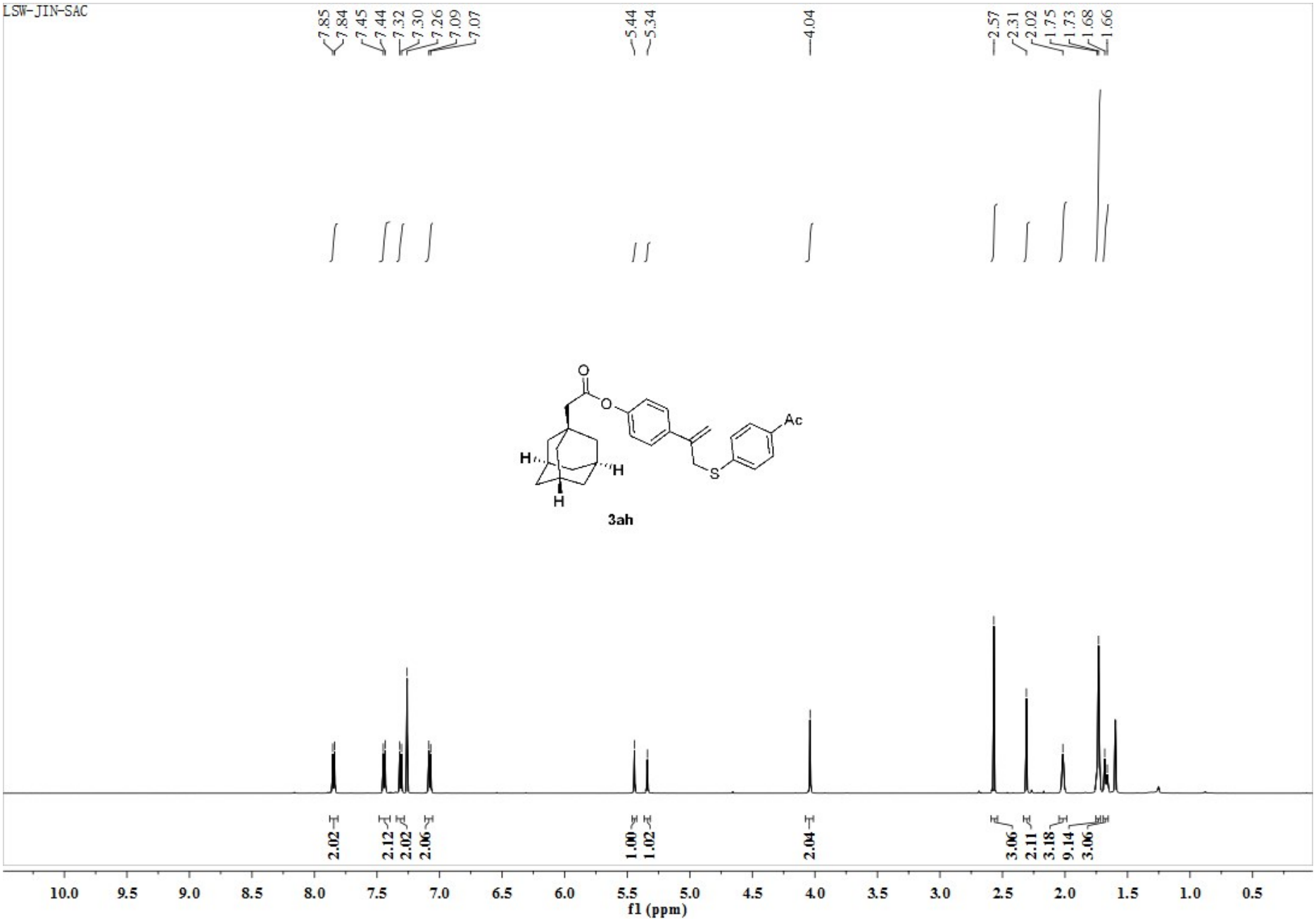

LSW-4F4CL-SA6
197.26
163.20
161.57
144.02
135.75
134.49
128.89
128.80
127.97
127.92
127.59
115.44
115.30
43.81
33.31
32.04
26.52
Cl
S
F
Ac
3ae
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

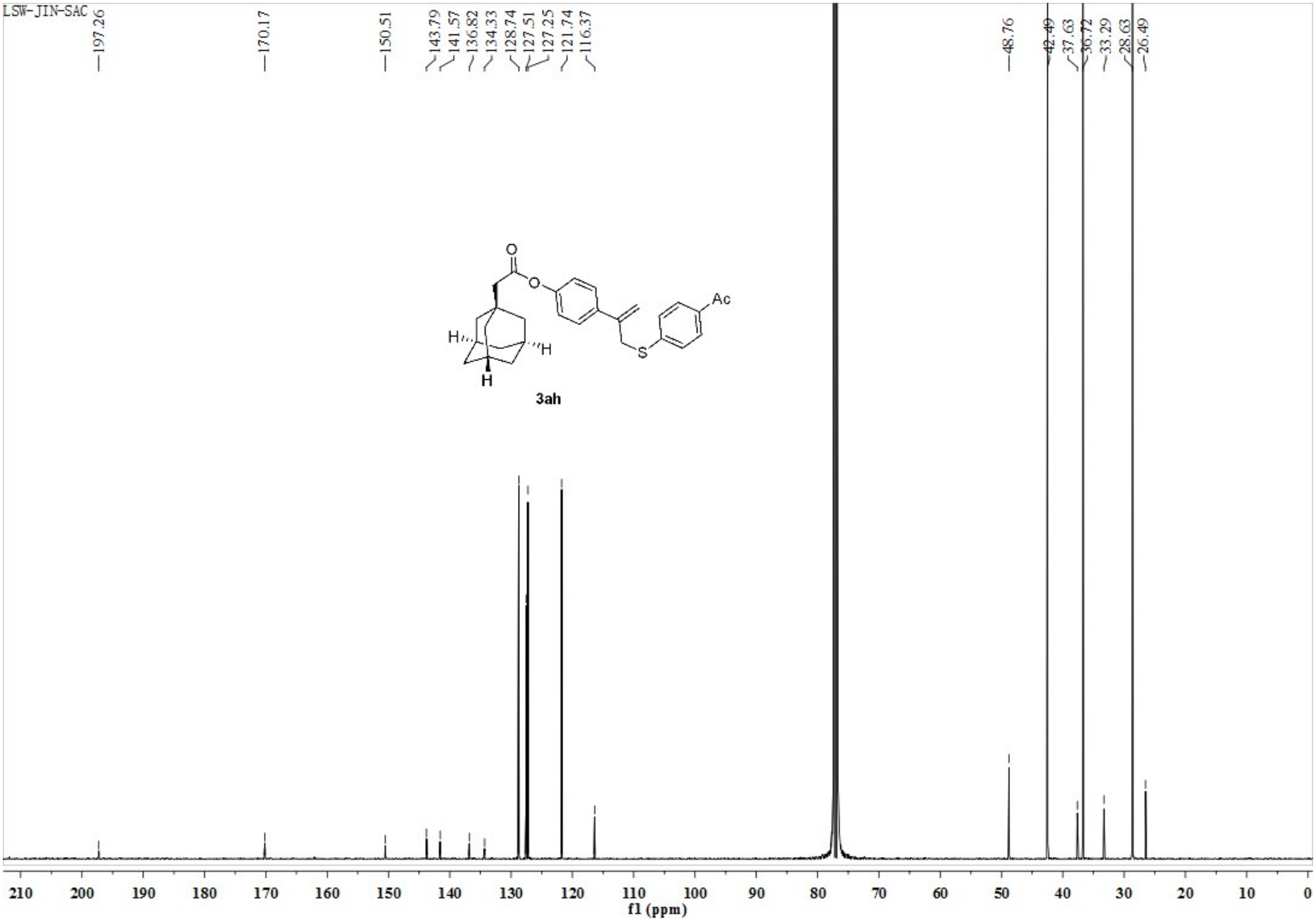

LSW-PH-BN-SAC
7.82
7.80
7.56
7.55
7.46
7.45
7.41
7.40
7.39
7.39
7.38
7.38
7.35
7.34
7.34
7.33
7.32
7.31
7.29
7.26
7.24
7.23
7.00
4.30
2.57
Ph
S
Ac
3af
2.03
2.03
2.07
4.13
2.14
2.04
1.00
2.03
3.23
f1 (ppm)

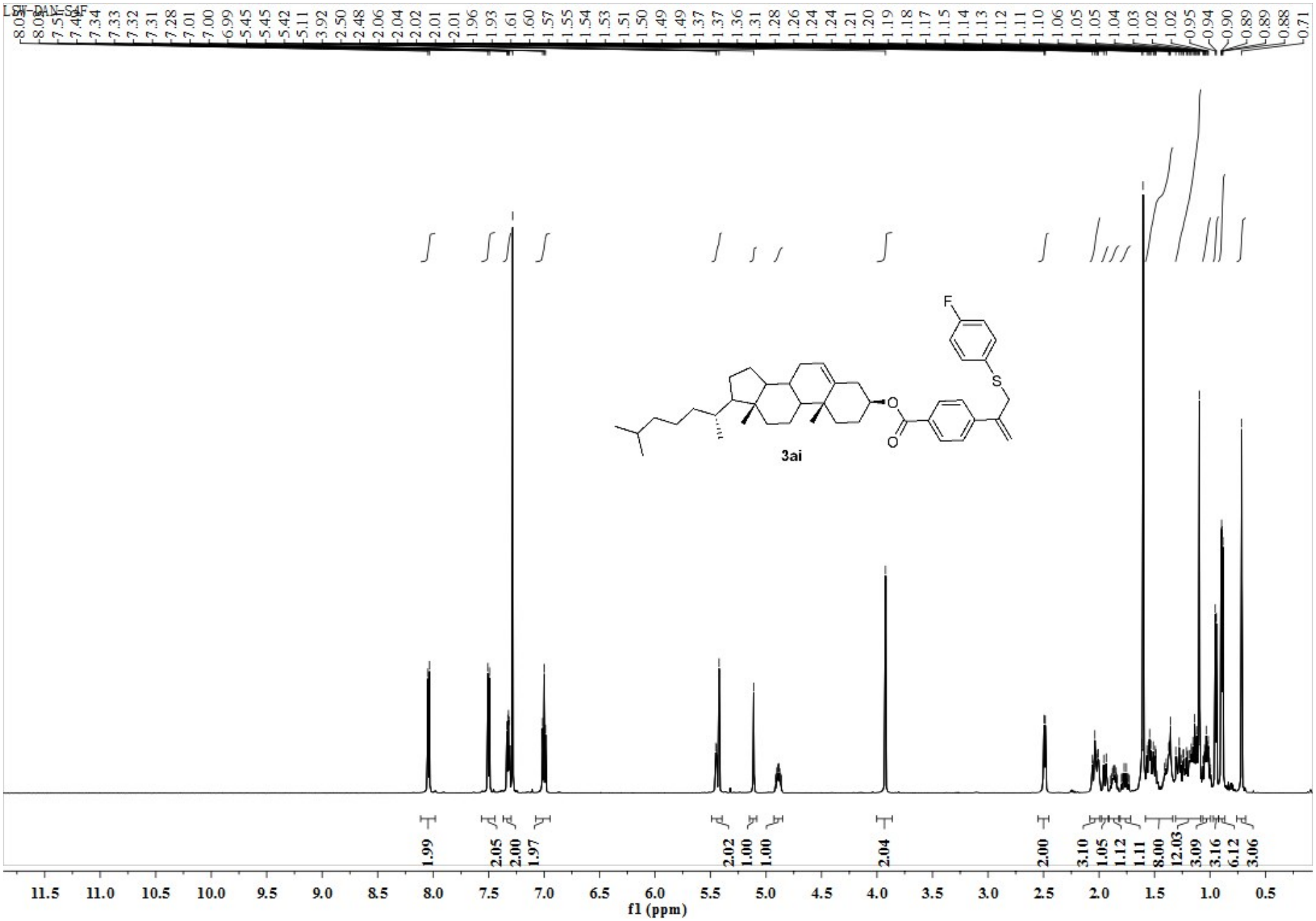

LSW-PH-BN-SAC
197.24
144.43
140.85
136.91
135.53
134.10
132.07
128.81
128.73
128.64
128.63
128.00
127.55
126.90
126.51
33.58
26.50
Ph
S
Ac
3af
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

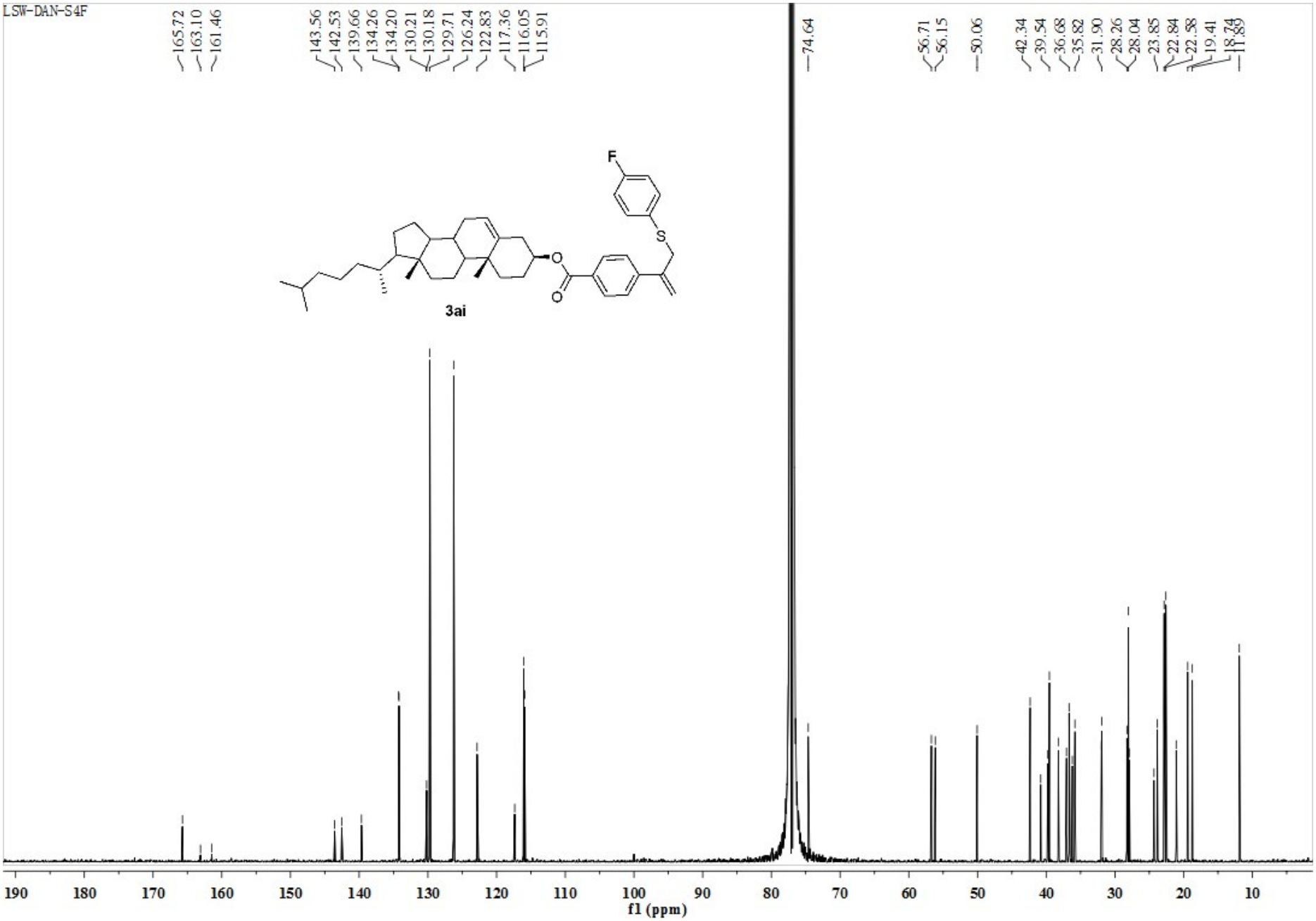

LSW-PHCY-SAC1
7.86
7.85
7.36
7.35
7.33
7.26
7.23
7.19
7.18
6.13
6.12
4.04
2.76
2.75
2.73
2.57
2.30
2.29
2.28
2.27
S
Ac
3ag
2.15
3.05
1.09
2.10
1.00
2.13
2.14
3.15
2.14
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


LSW-PHCY-SAC1
197.28
144.57
136.59
134.15
133.28
130.81
129.30
128.70
127.83
127.36
127.31
126.52
122.85
35.46
27.96
26.50
23.25
S
Ac
3ag
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


LSW-JIN-SAC
7.85
7.84
7.45
7.44
7.32
7.30
7.26
7.09
7.07
5.44
5.34
4.04
2.57
2.31
2.02
1.75
1.73
1.68
1.66
O
O
H
H
H
S
Ac
3ah
2.02
2.12
2.02
2.06
1.00
1.02
2.04
3.06
2.11
3.18
9.14
3.06
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
f1 (ppm)

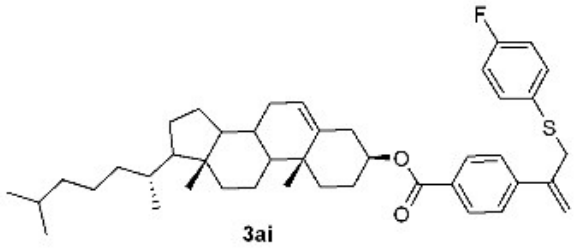

LSW-JIN-SAC
197.26
170.17
150.51
143.79
141.57
136.82
134.33
128.74
127.51
127.25
121.74
116.37
48.76
42.49
37.63
36.72
33.29
28.63
26.49
O
O
Ac
S
H
H
H
3ah
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


F
S
O
O
3ai
1.99
2.05
2.00
1.97
2.02
1.00
1.00
2.04
2.00
3.10
1.05
1.12
1.11
8.00
12.03
3.09
3.16
6.12
3.06
f1 (ppm)


LSW-DAN-S4F
165.72
163.10
161.46
143.56
142.53
139.66
134.26
134.20
130.21
130.18
129.71
126.24
122.83
117.36
116.05
115.91
74.64
56.71
56.15
50.06
42.34
39.54
36.68
35.82
31.90
28.26
28.04
23.85
22.84
22.58
19.41
18.74
11.89
F
S
O
O
3ai
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

LSW-DAN-S4F

-114.30
-114.31
-114.31
-114.32
-114.33
-114.33
-114.34
-114.35

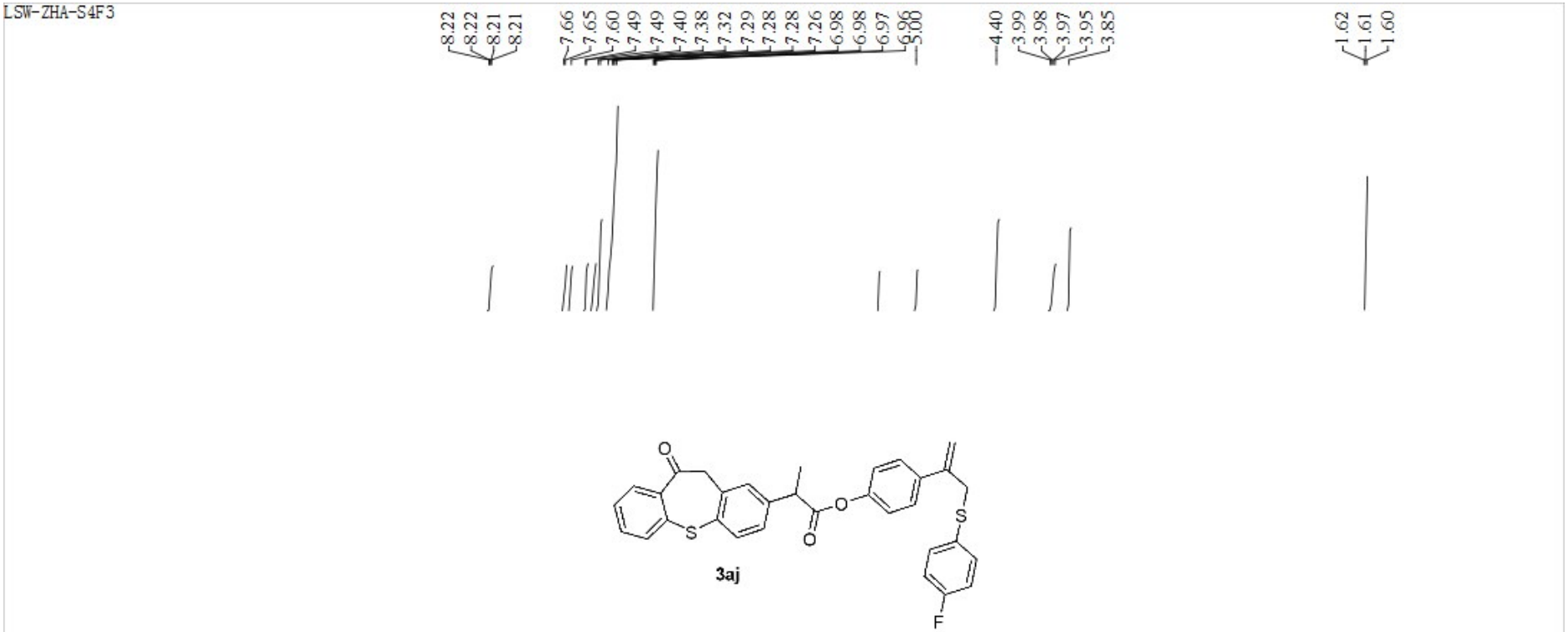


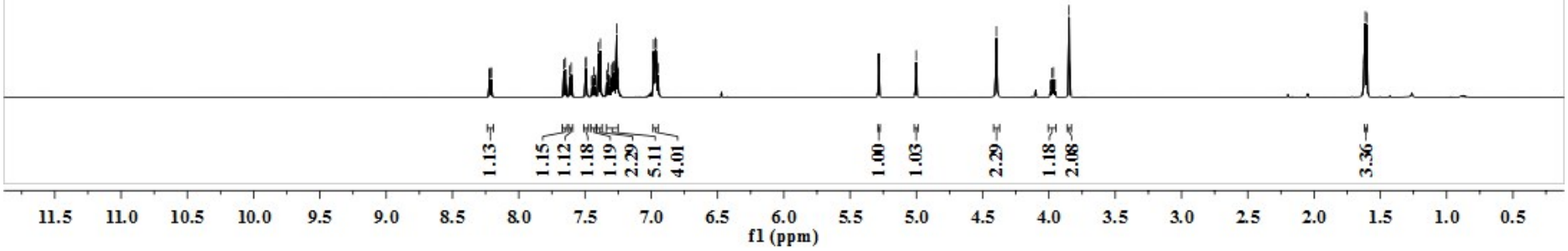
3ai

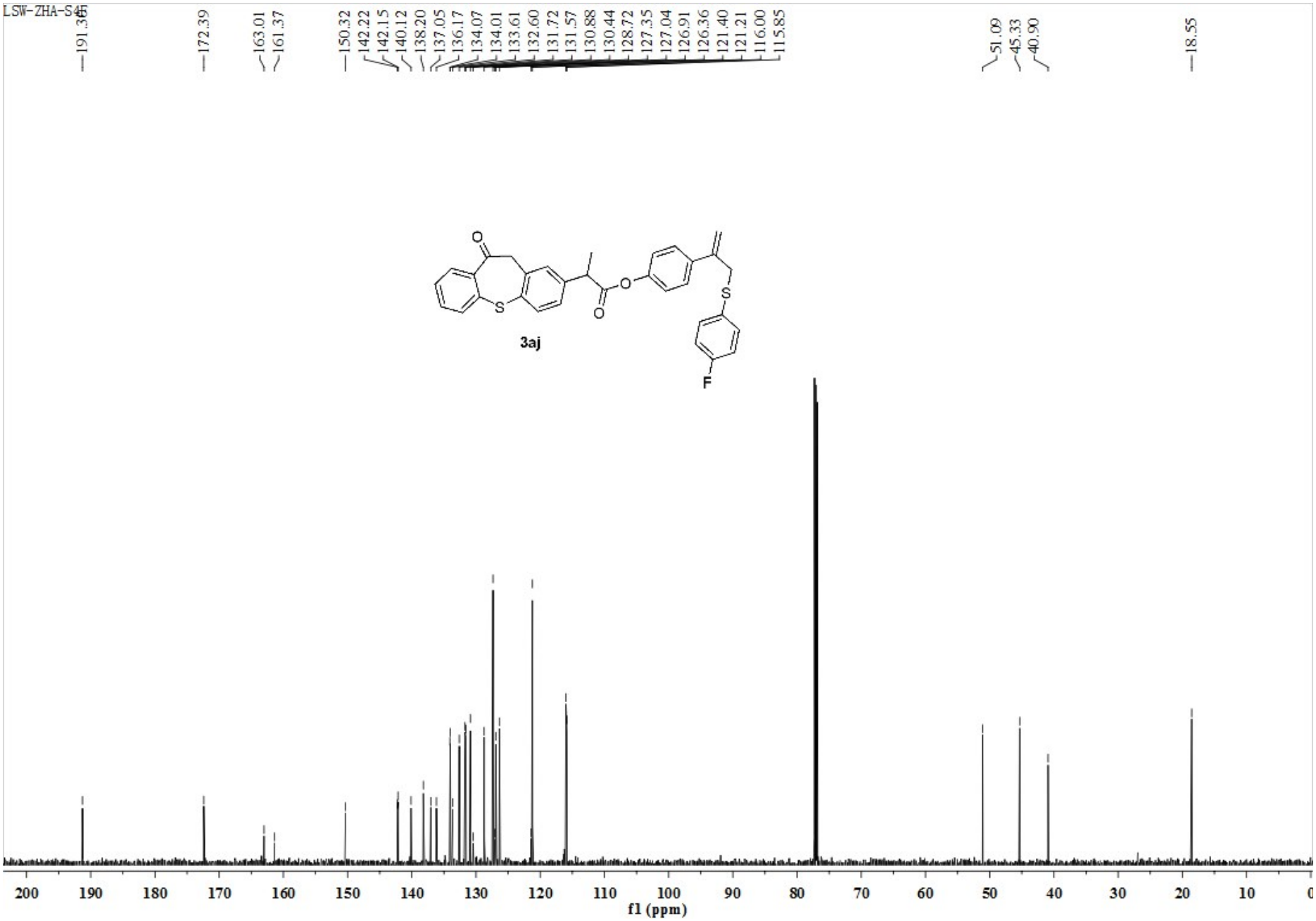
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210

f1 (ppm)

LSW-ZHA-S4F3

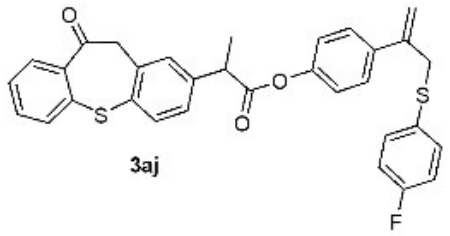

8.22
8.22
8.21
8.21
7.66
7.65
7.60
7.49
7.49
7.40
7.38
7.32
7.29
7.28
7.28
7.26
6.98
6.98
6.97
6.96
5.00
4.40
3.99
3.98
3.97
3.95
3.85
1.62
1.61
1.60
O
S
O
O
S
F
3aj


1.13
1.15
1.12
1.18
1.19
2.29
5.11
4.01
1.00
1.03
2.29
1.18
2.08
3.36
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


LSW-ZHA-S45
191.36
172.39
163.01
161.37
150.32
142.22
142.15
140.12
138.20
137.05
136.17
134.07
134.01
133.61
132.60
131.72
131.57
130.88
130.44
128.72
127.35
127.04
126.91
126.36
121.40
121.21
116.00
115.85
51.09
45.33
40.90
18.55
O
S
O
O
S
F
3aj
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

LSW-ZHA-S4F

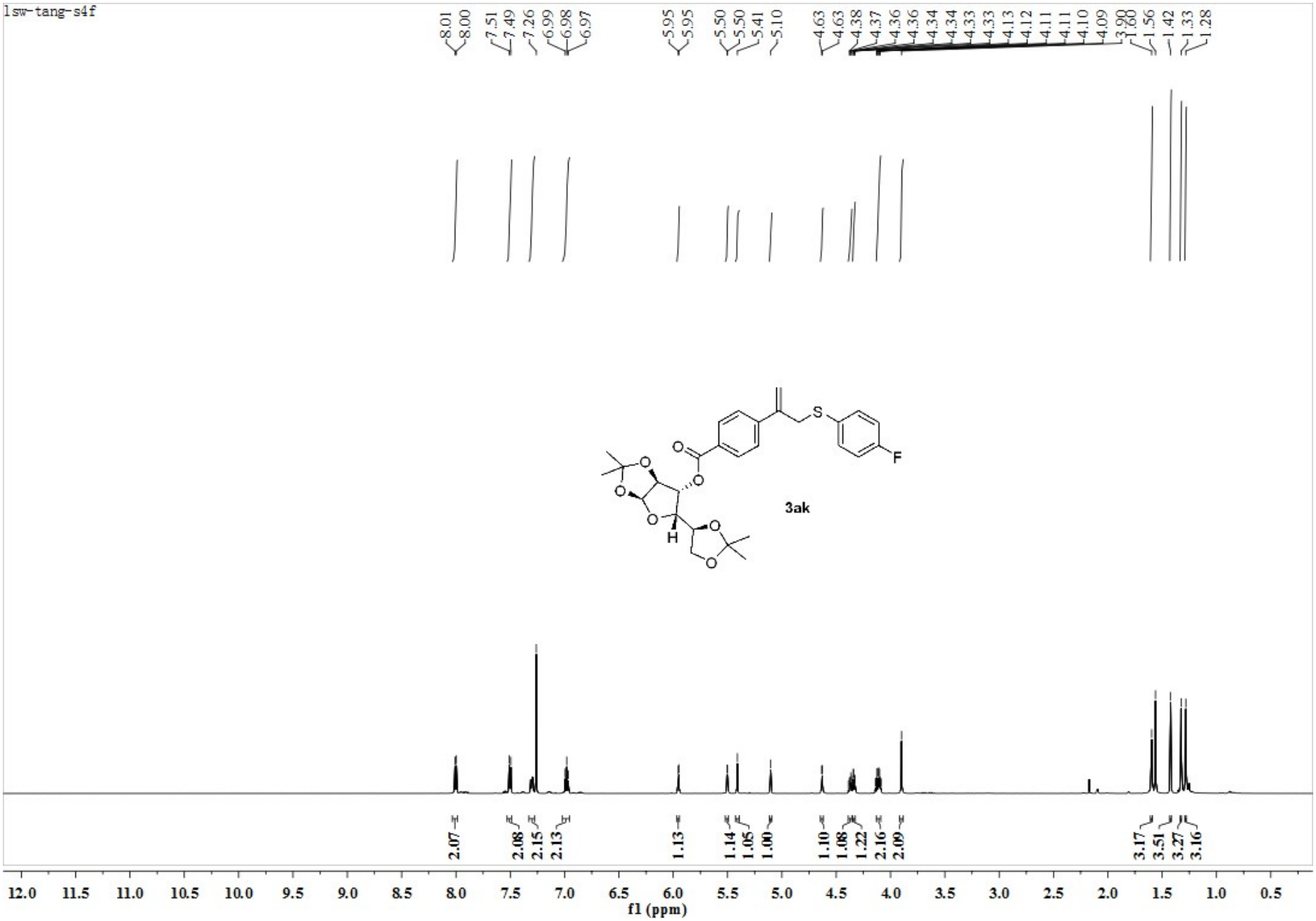
-114.53
-114.54
-114.55
-114.56
-114.57
-114.58
-114.59

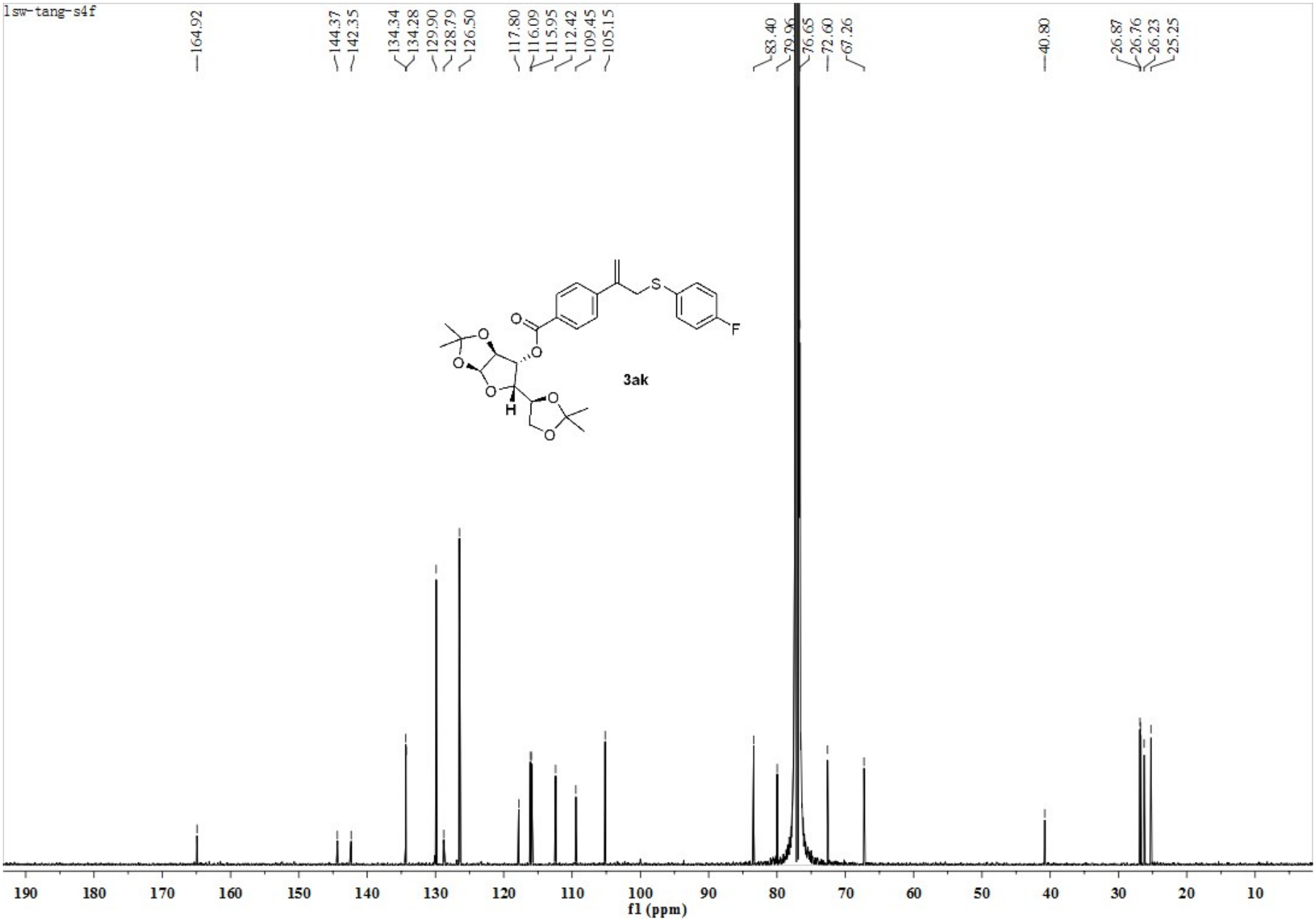


3aj

10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210

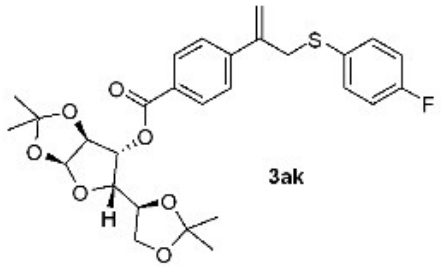
f1 (ppm)


lsw-tang-s4f
8.01
8.00
7.51
7.49
7.26
6.99
6.98
6.97
5.95
5.95
5.50
5.50
5.41
5.10
4.63
4.63
4.38
4.37
4.36
4.36
4.34
4.34
4.33
4.33
4.13
4.12
4.11
4.11
4.10
4.09
3.90
1.60
1.56
1.42
1.33
1.28
S
F
O
O
O
O
O
O
H
3ak
2.07
2.08
2.15
2.13
1.13
1.14
1.05
1.00
1.10
1.08
1.22
2.16
2.09
3.17
3.51
3.27
3.16
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


lsw-tang-s4f
164.92
144.37
142.35
134.34
134.28
129.90
128.79
126.50
117.80
116.09
115.95
112.42
109.45
105.15
83.40
79.96
76.65
72.60
67.26
40.80
26.87
26.76
26.23
25.25
3ak
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

lsw-tang-s4f

-114.11
-114.12
-114.13
-114.14
-114.15
-114.15
-114.16
-114.17

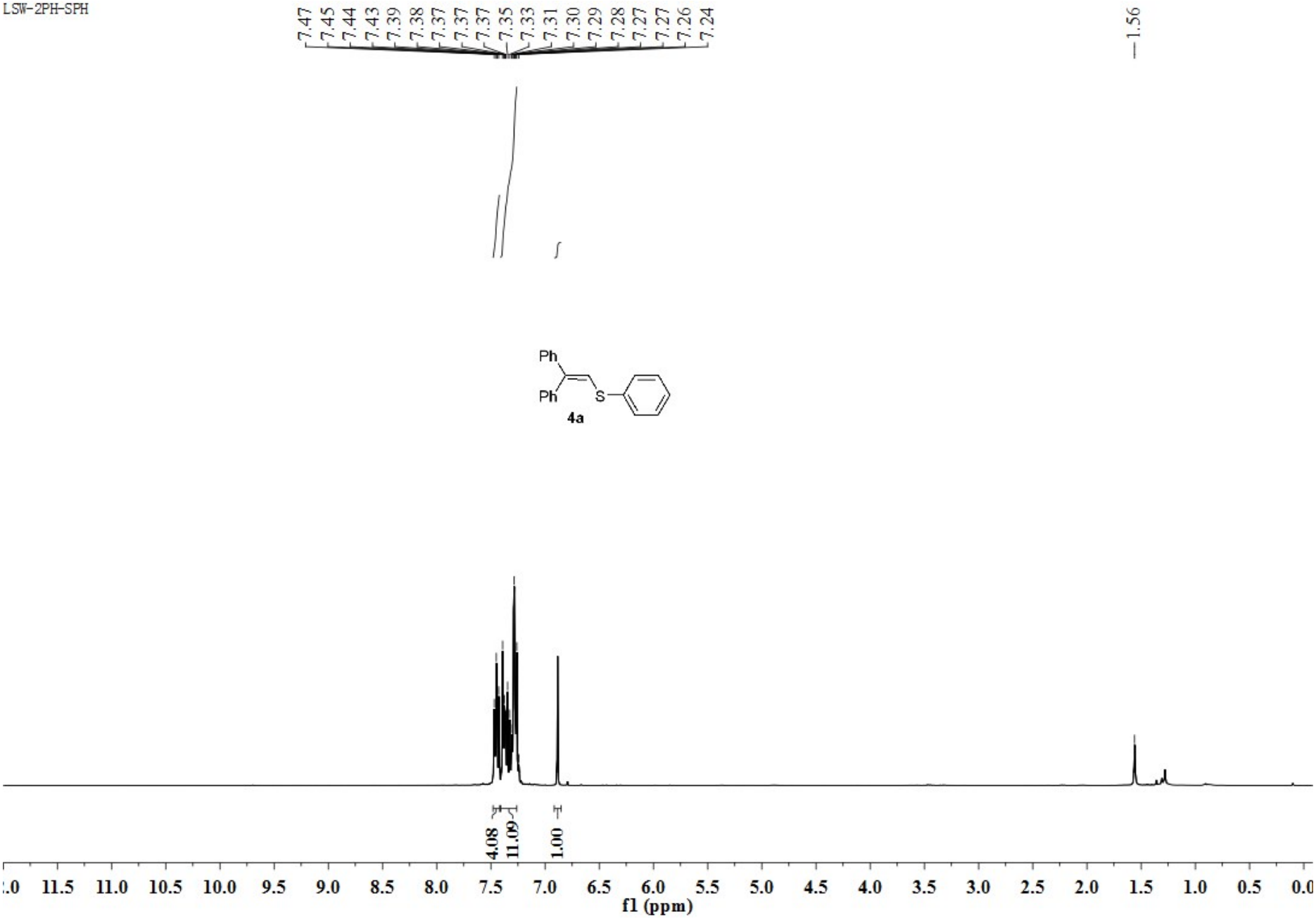


3ak

10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210

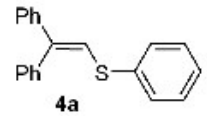
f1 (ppm)

LSW-2PH-SPH

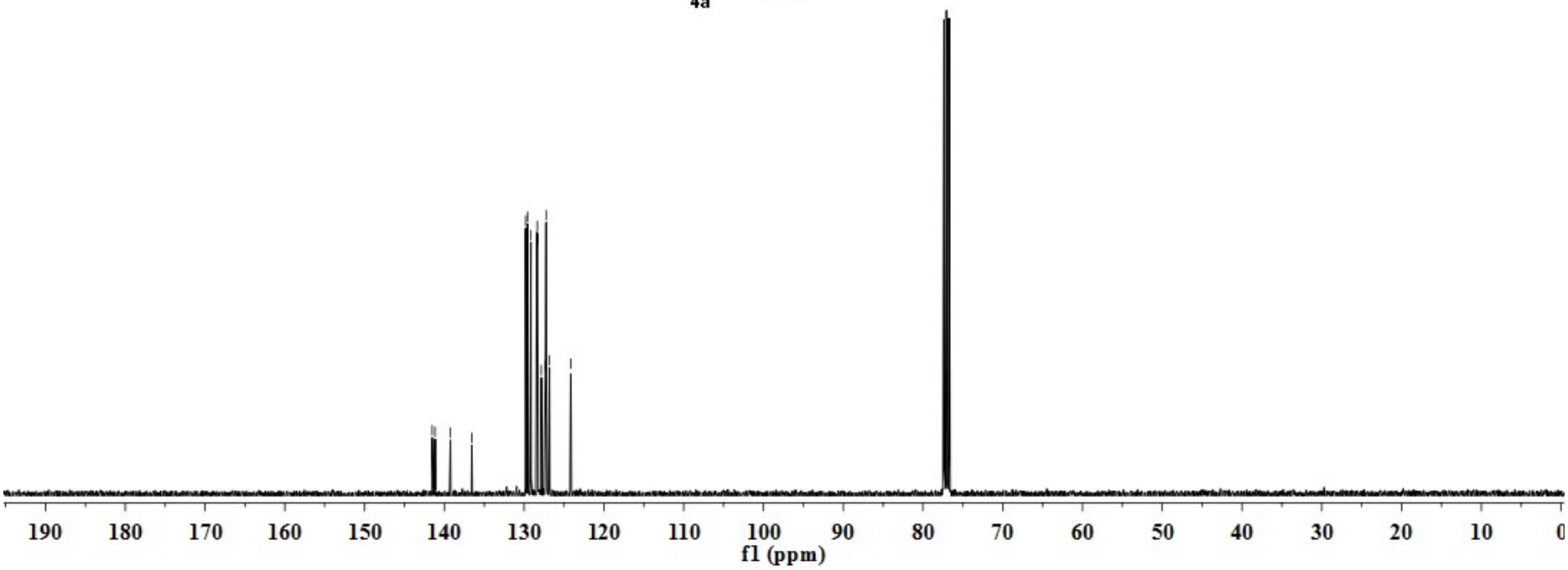

7.47
7.45
7.44
7.43
7.39
7.38
7.37
7.37
7.37
7.35
7.33
7.31
7.30
7.29
7.28
7.27
7.27
7.26
7.24
1.56
Ph
Ph
S
4a
4.08
11.09
1.00
fl (ppm)

LSW-2PH-SPH

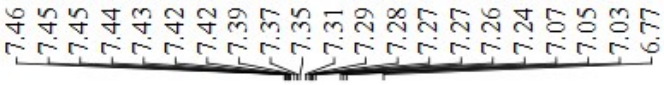
141.52
141.15
139.24
136.55
129.80
129.58
129.15
128.42
128.35
127.84
127.33
127.24
126.82
124.14

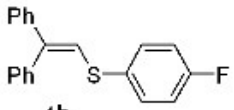


4a

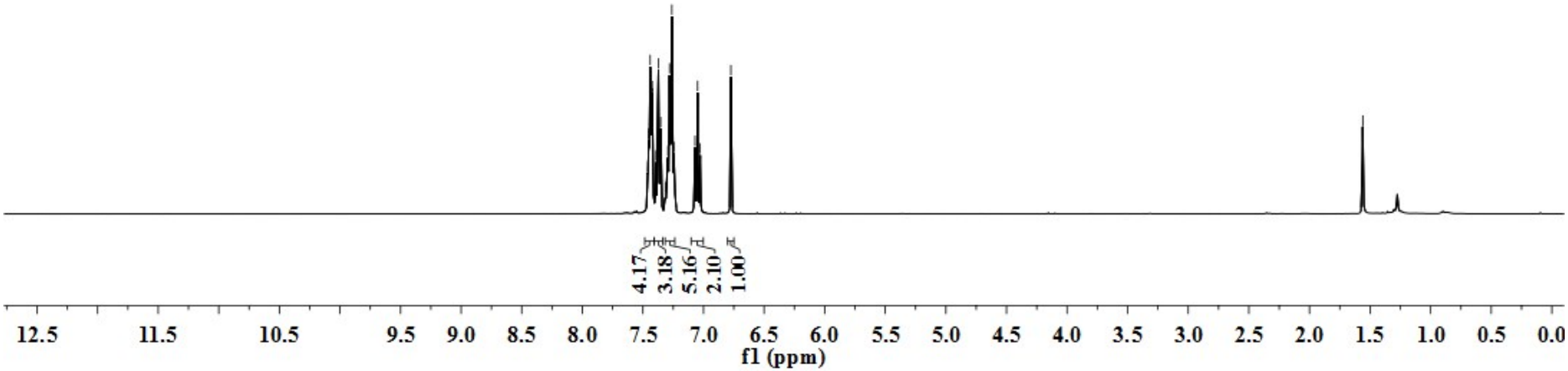


LSW-2PH-S4F

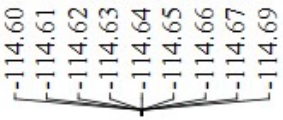


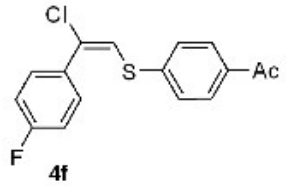


4b

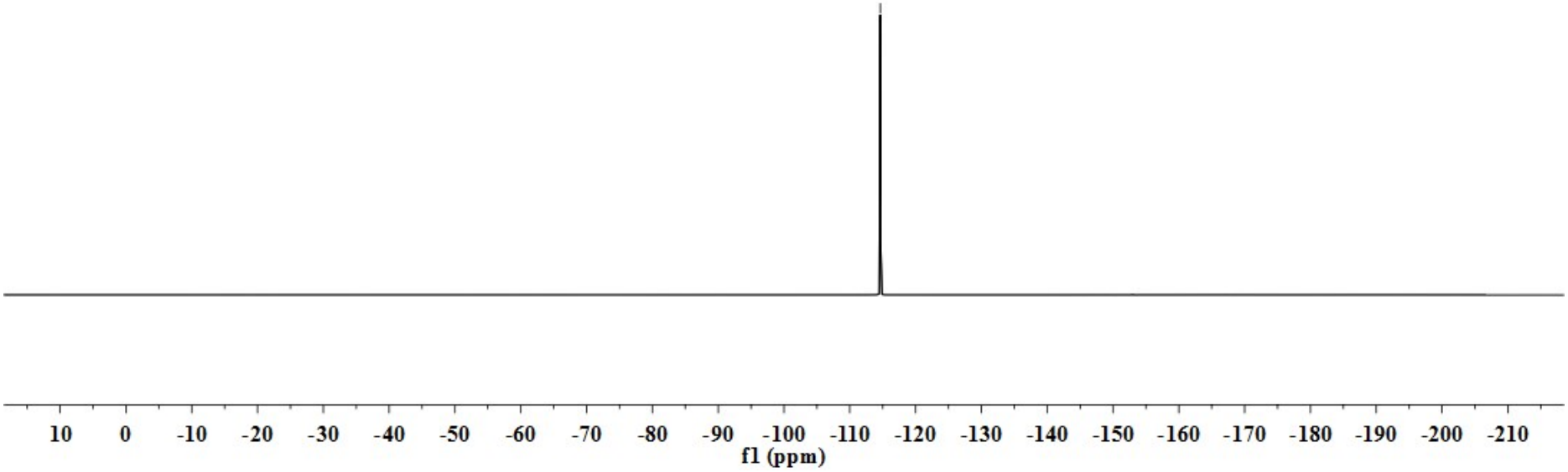


LSW-2PH-S4F



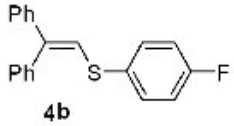


4f

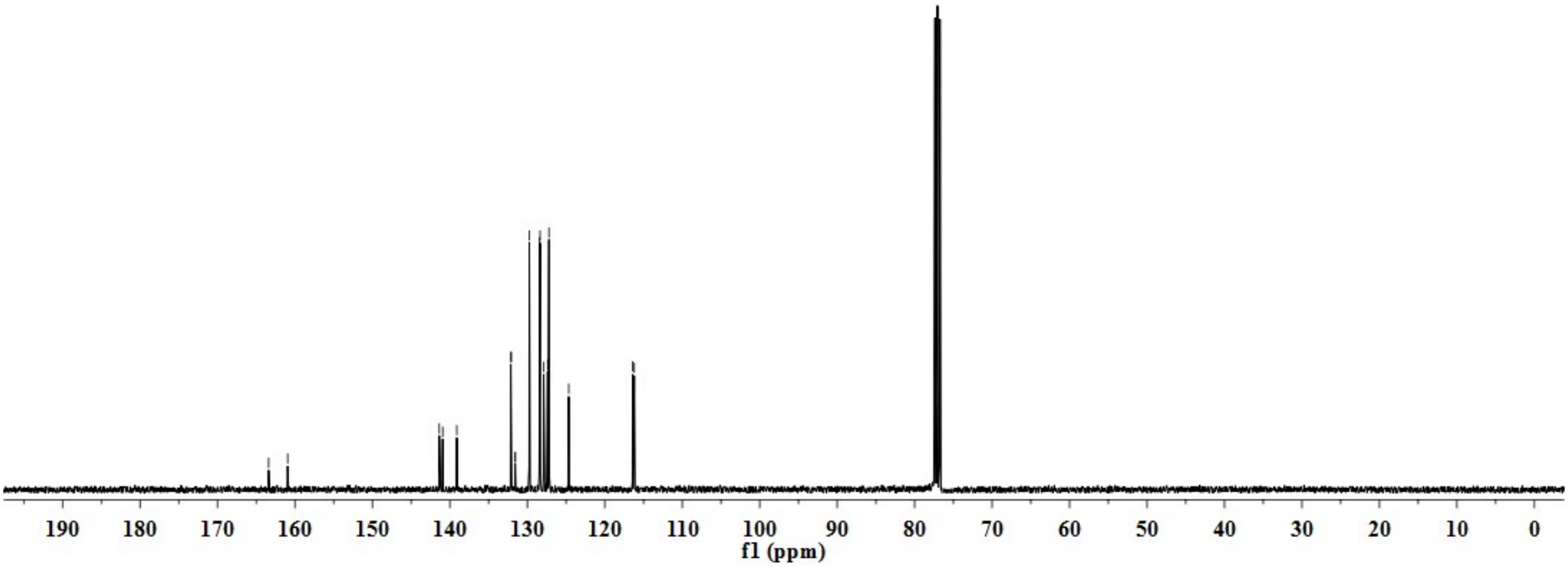


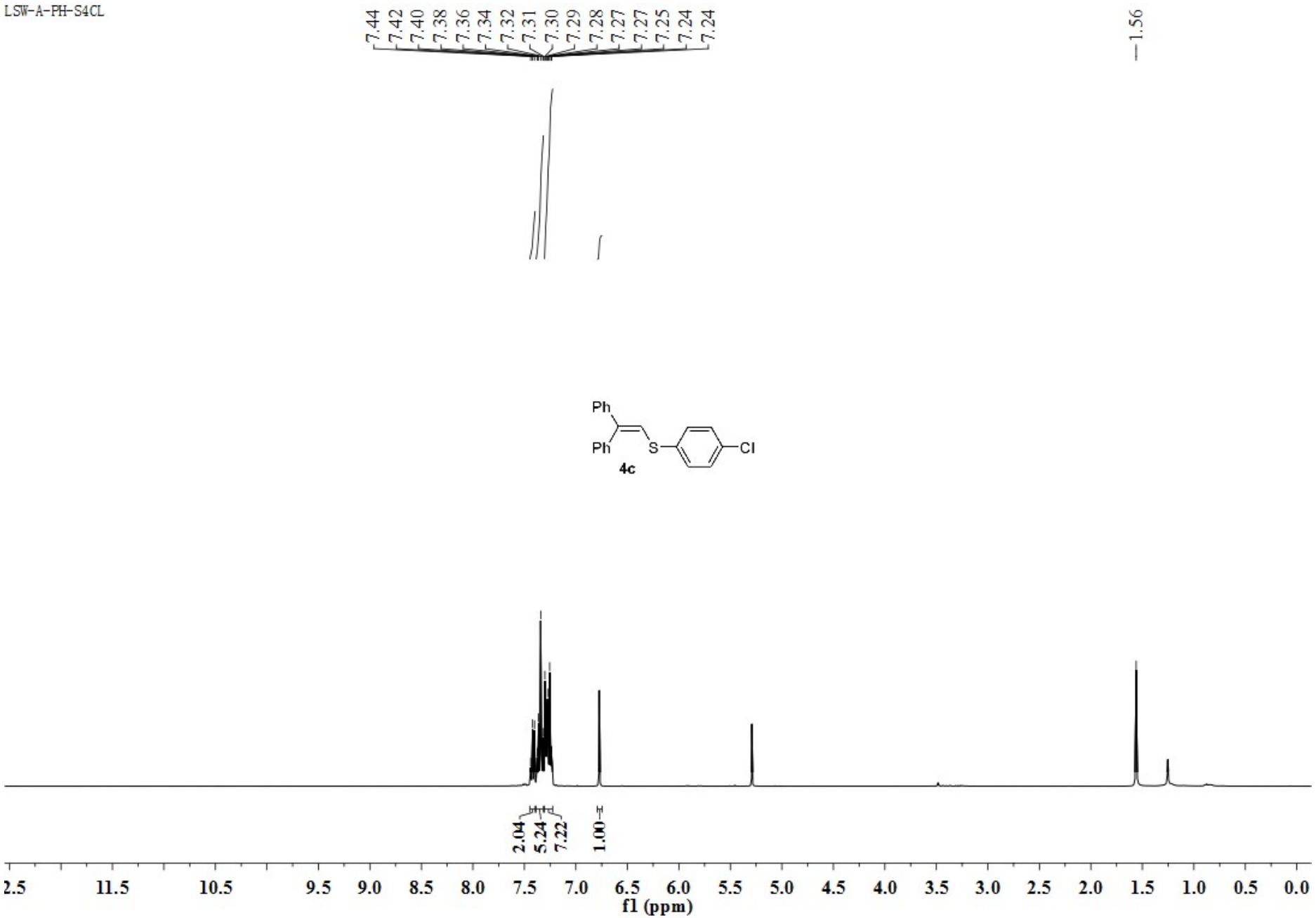
LSW-2PH-S4F

163.40
160.94
141.37
140.93
139.10
129.75
128.45
128.36
127.21
116.40
116.18



4b

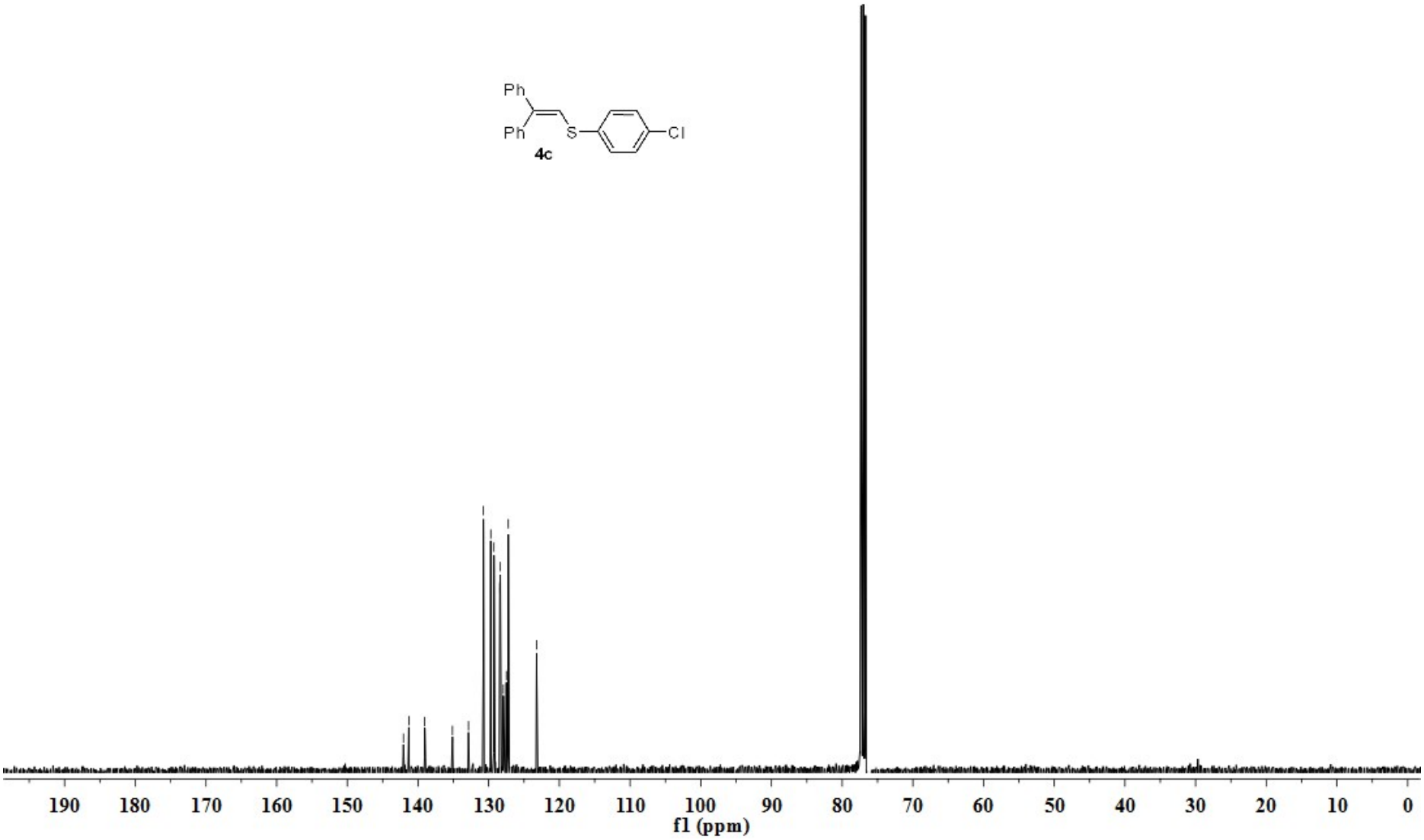



LSW-A-PH-S4CL
7.44
7.42
7.40
7.38
7.36
7.34
7.32
7.31
7.30
7.29
7.28
7.27
7.27
7.25
7.24
7.24
1.56
Ph
Ph
S
Cl
4c
2.04
5.24
7.22
1.00
2.5
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

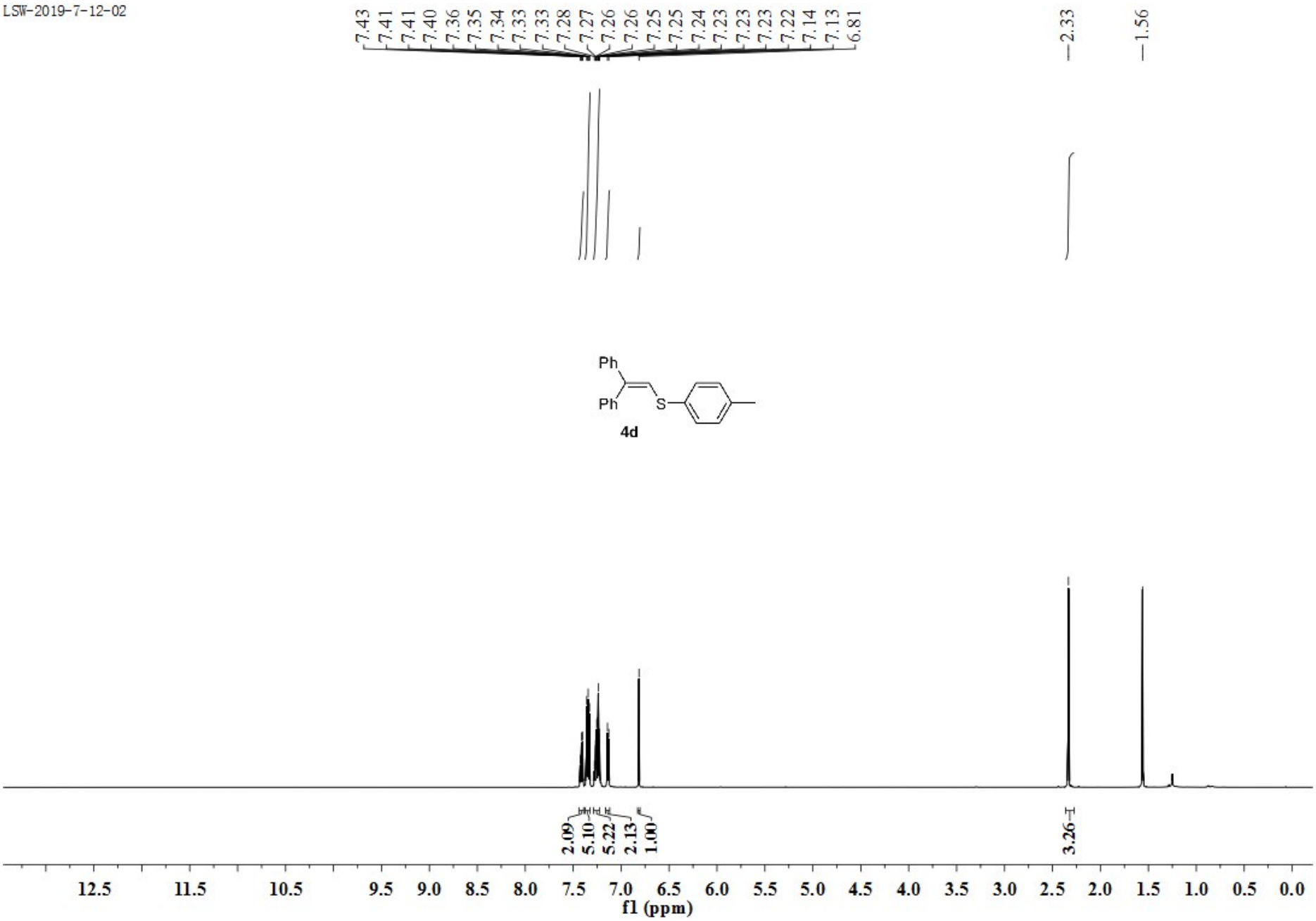
LSW-A-PH-S4CL

142.06
141.29
139.04
135.13
132.87
130.75
129.70
129.26
128.42
128.36
127.94
127.50
127.23
123.21

4c



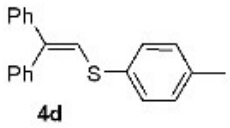
LSW-2019-7-12-02



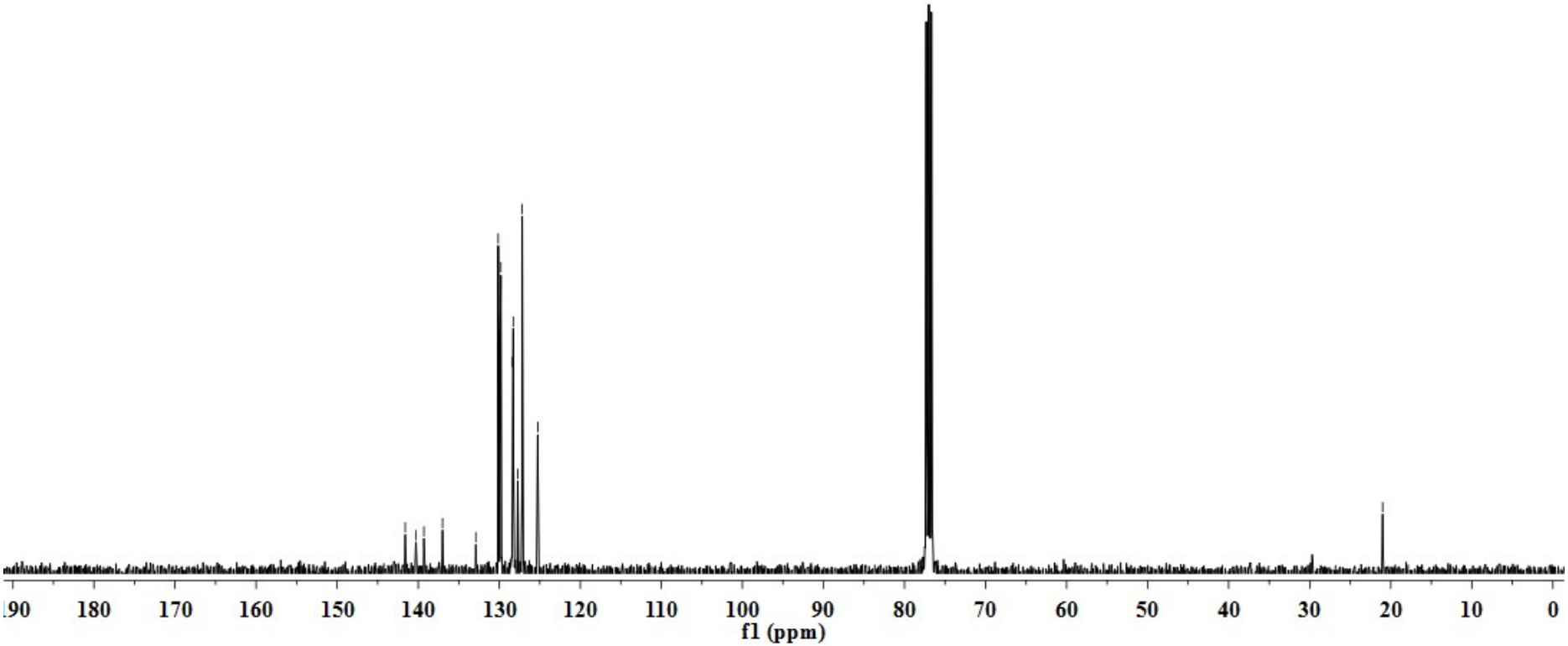
LSW-A-PH-SME-C

141.60
140.28
139.30
137.00
132.89
130.13
129.89
129.80
128.37
128.27
127.71
127.17
125.25

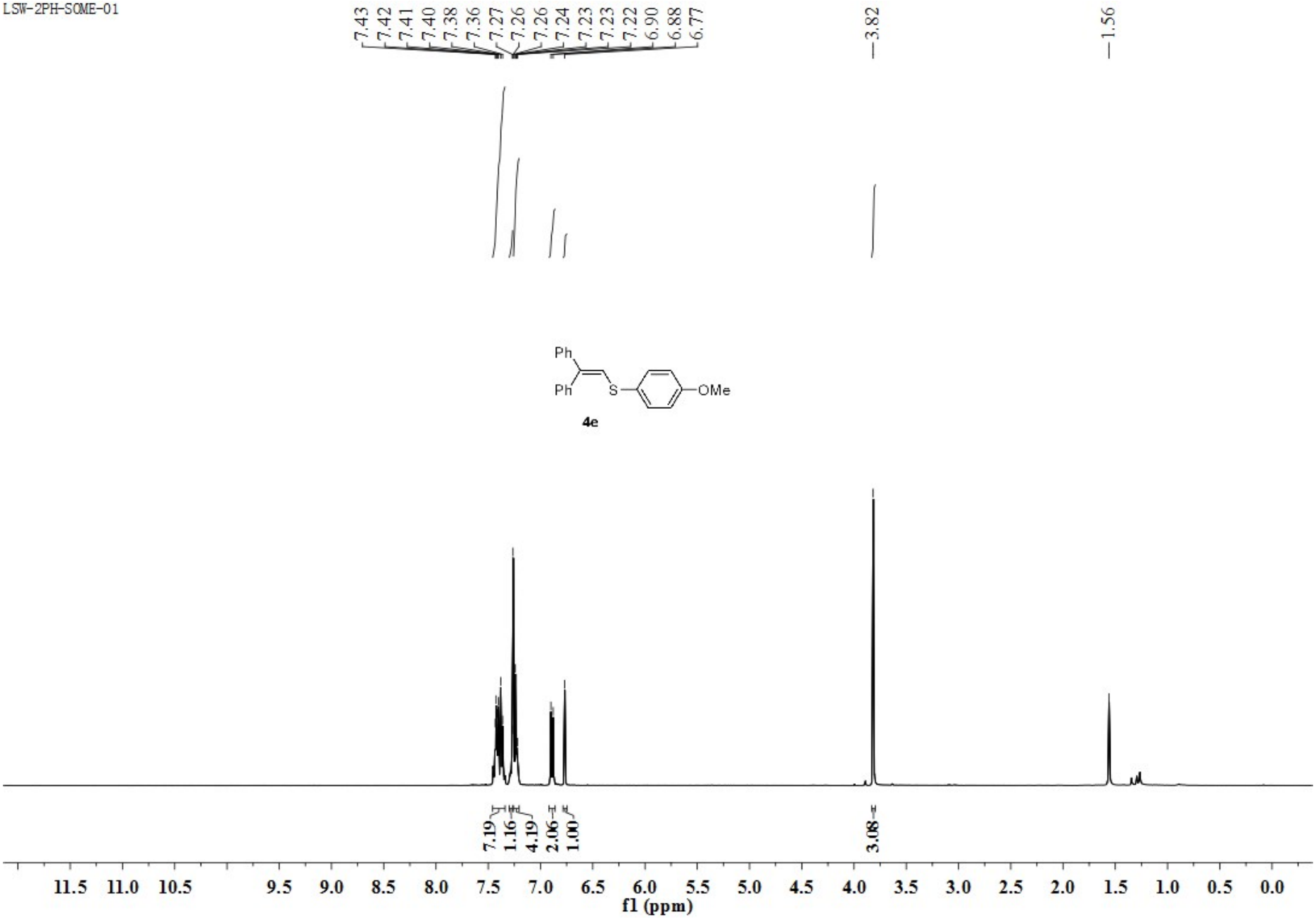
21.01

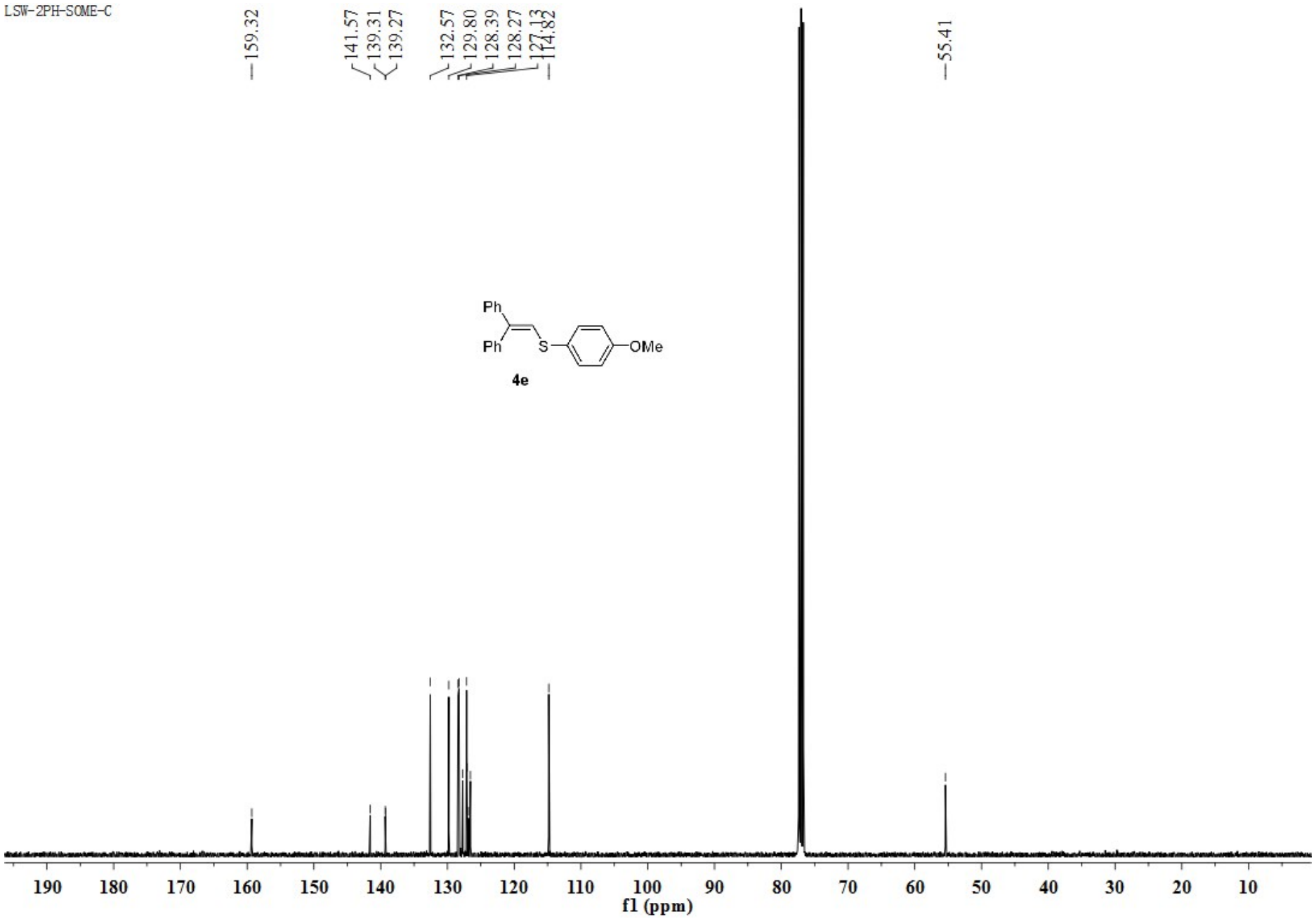


4d

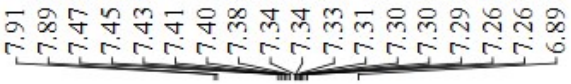


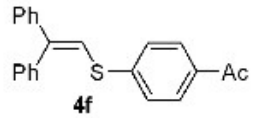
LSW-2PH-SOME-01



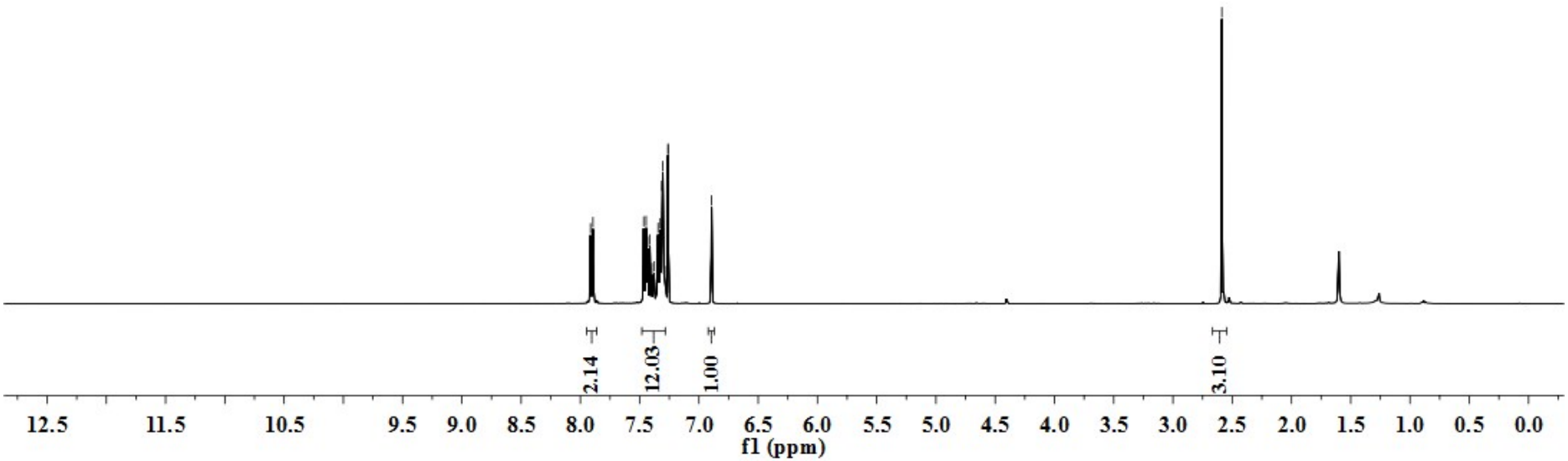

LSW-2PH-SOME-C
159.32
141.57
139.31
139.27
132.57
129.80
128.39
128.27
127.13
114.82
55.41
Ph
Ph
S
OMe
4e
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

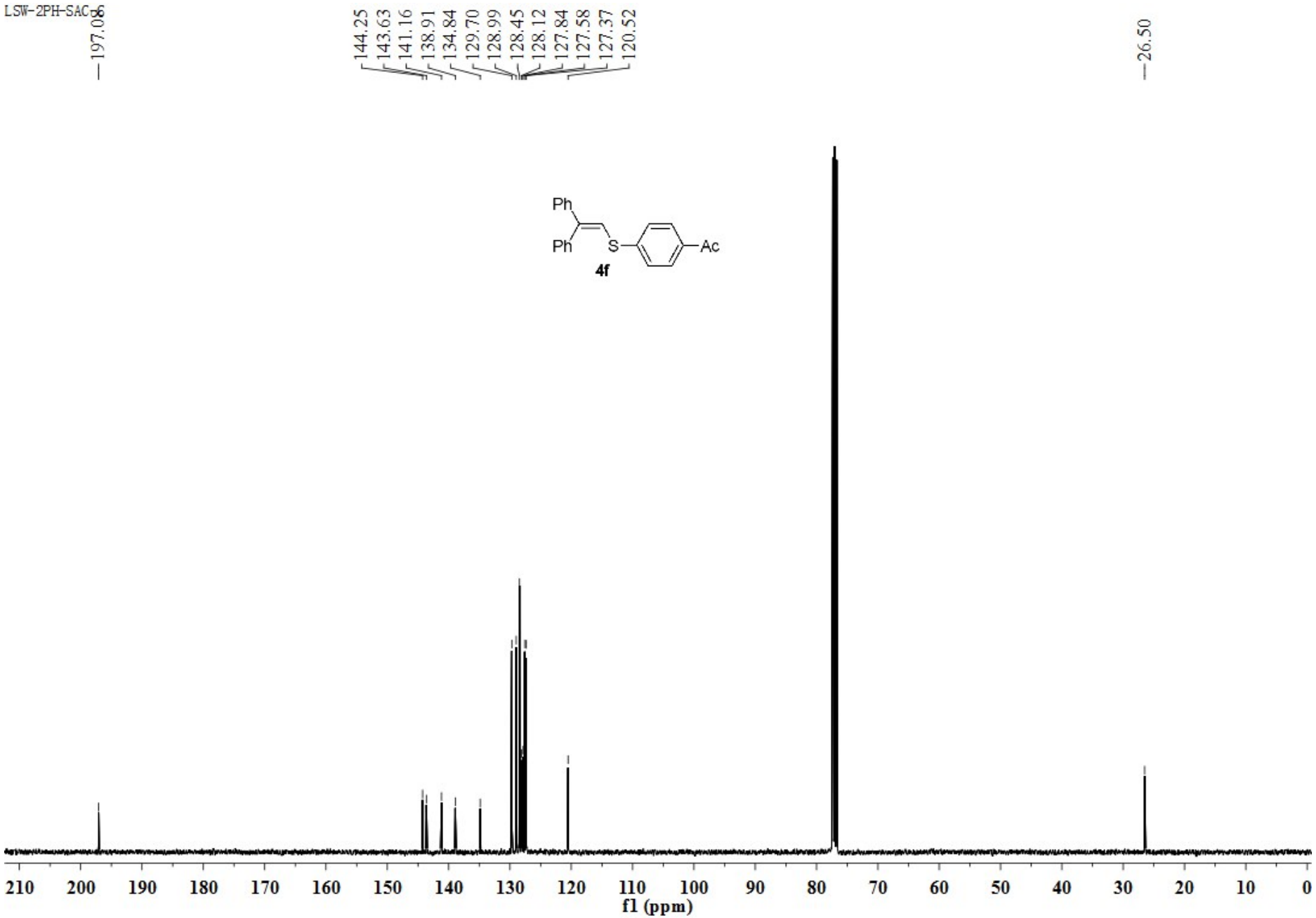
LSW-2PH-SAC



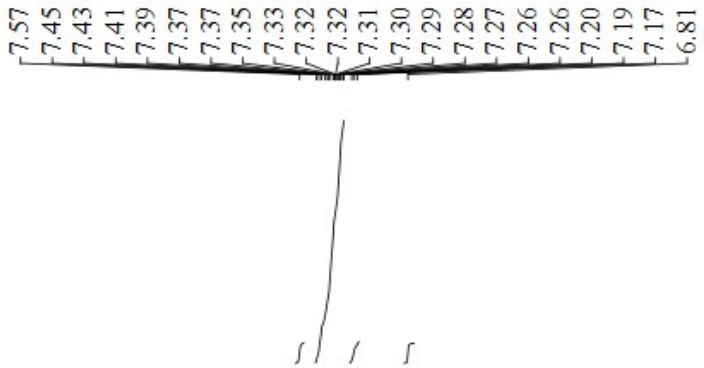


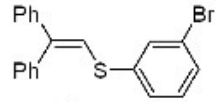
4f



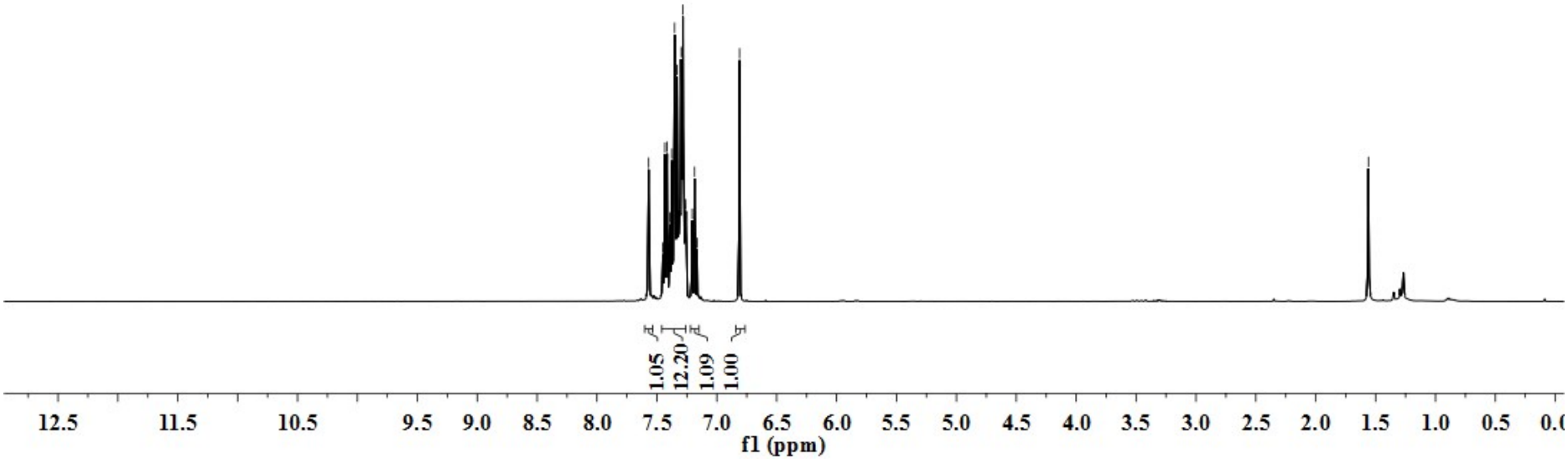

LSW-2PH-SAC-6
197.08
144.25
143.63
141.16
138.91
134.84
129.70
128.99
128.45
128.12
127.84
127.58
127.37
120.52
26.50
Ph
Ph
S
Ac
4f
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

LSW-2-PH-S3BR



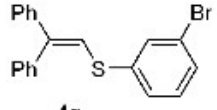


4g

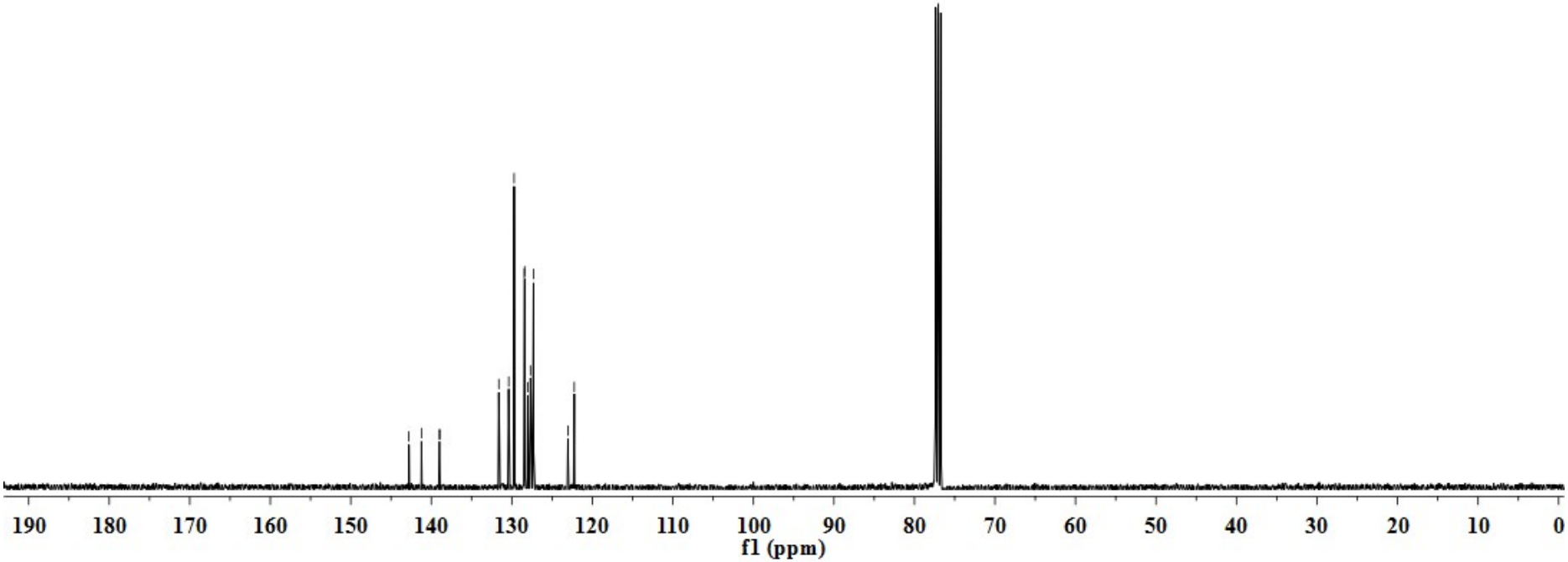


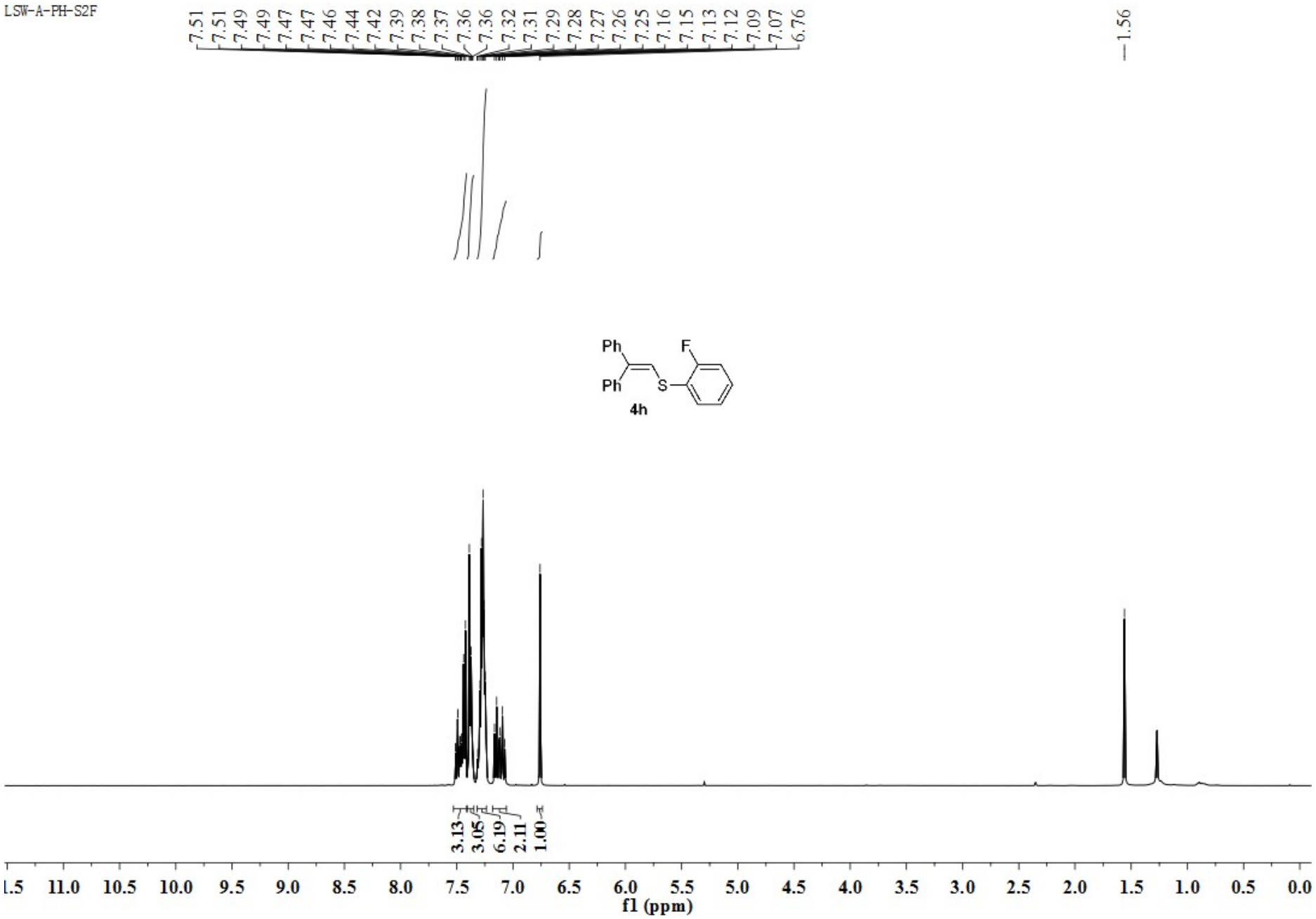
LSW-2-PH-S3BR

142.78
141.22
138.99
138.94
131.62
130.39
129.72
128.45
128.41
128.01
127.69
127.64
127.31
123.02
122.25



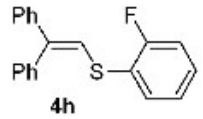
4g



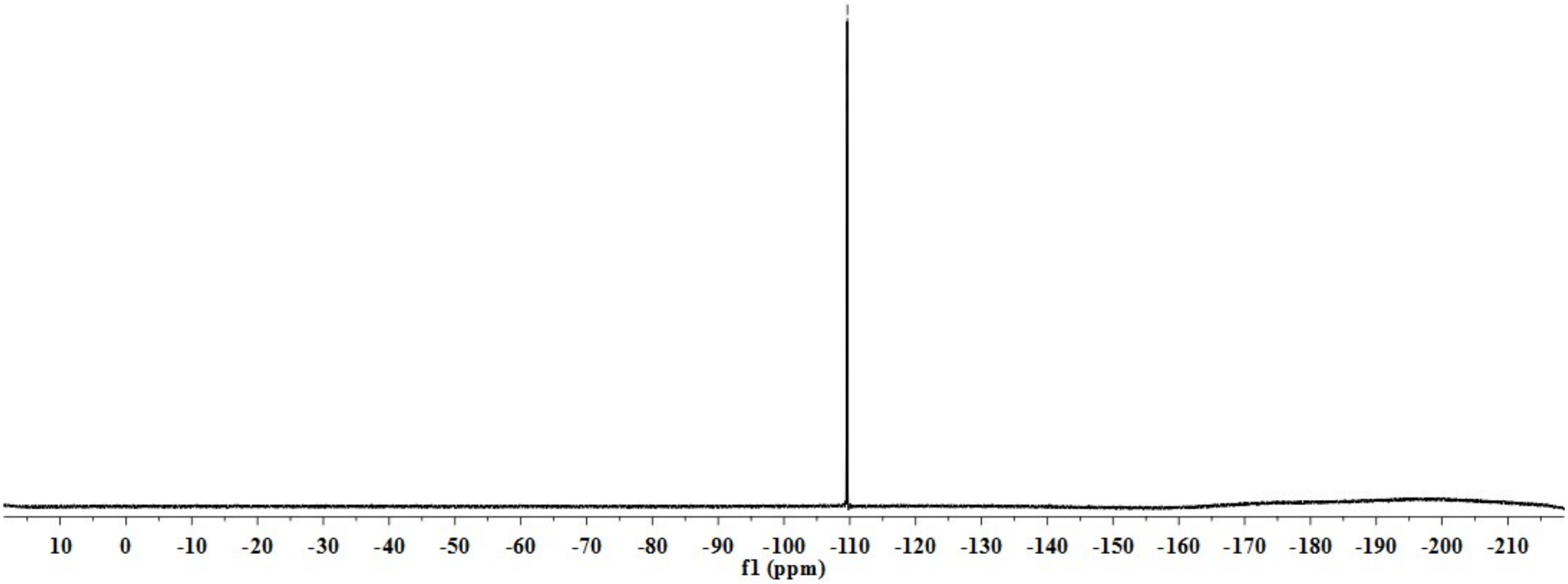

LSW-A-PH-S2F
7.51
7.51
7.49
7.49
7.47
7.47
7.46
7.44
7.42
7.39
7.38
7.37
7.36
7.36
7.32
7.31
7.29
7.28
7.27
7.26
7.25
7.16
7.15
7.13
7.12
7.09
7.07
6.76
1.56
Ph
Ph
S
F
4h
3.13
3.05
6.19
2.11
1.00
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

LSW-A-PH-S2F

109.60
109.61
109.62
109.62
109.63
109.64
109.64
109.66



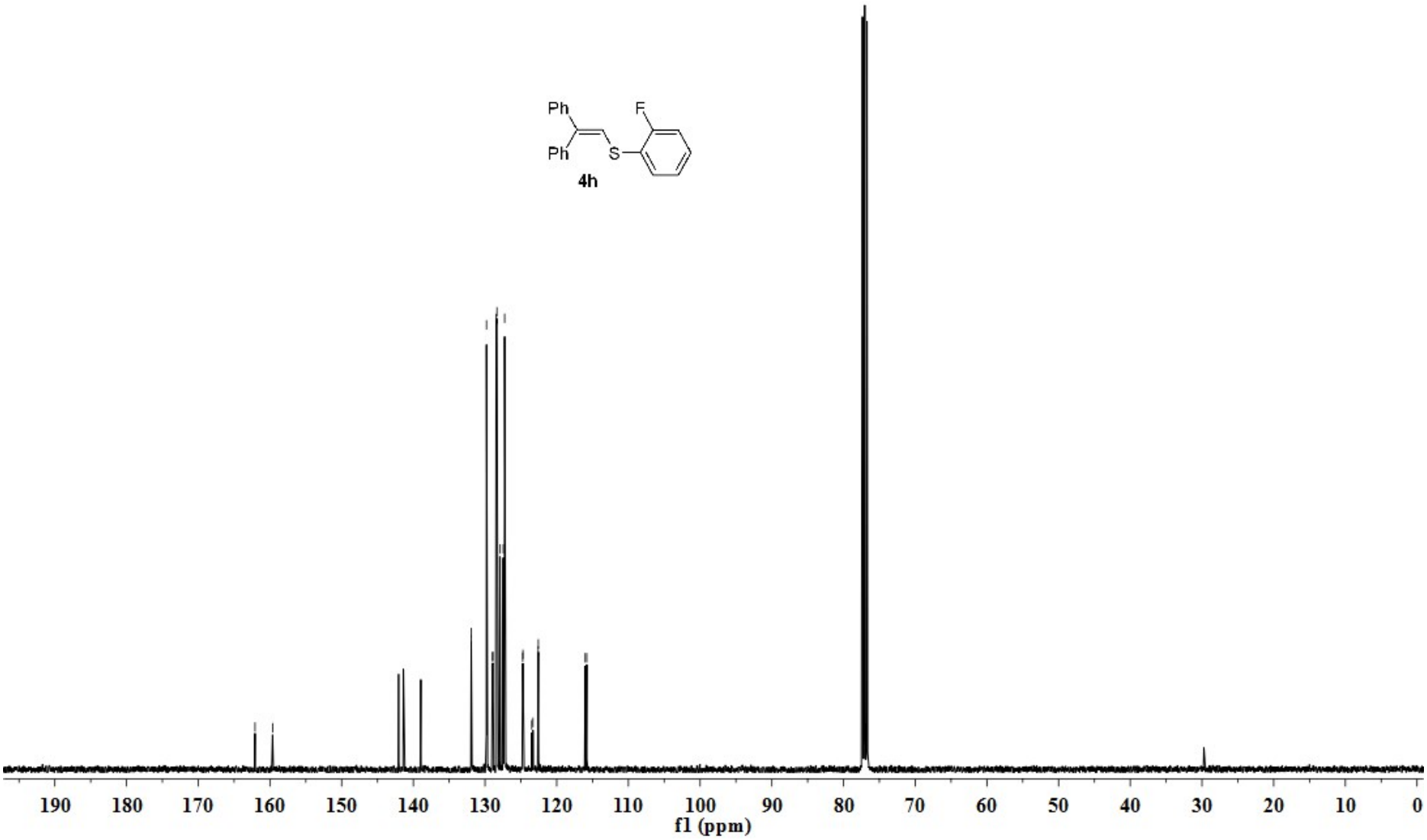
4h



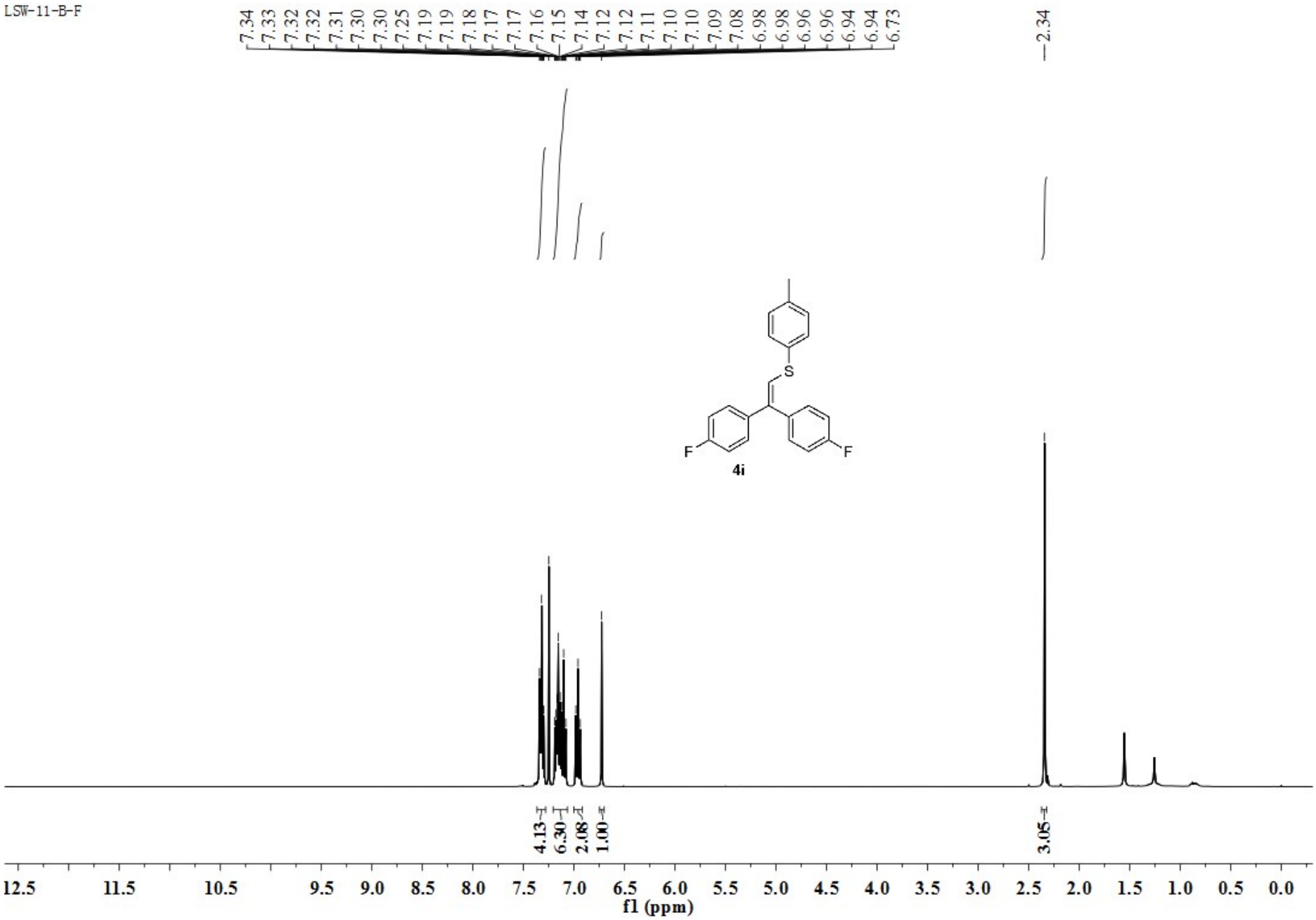
LSW-2PH-S2F-C

162.08
159.63
131.94
131.92
129.79
128.97
128.89
128.46
128.33
127.93
127.46
127.26
124.74
124.71
123.48
123.31
122.58
122.56
116.03
115.81

4h

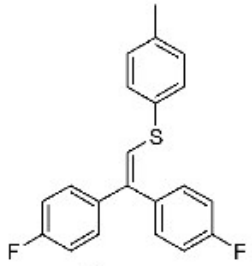


LSW-11-B-F

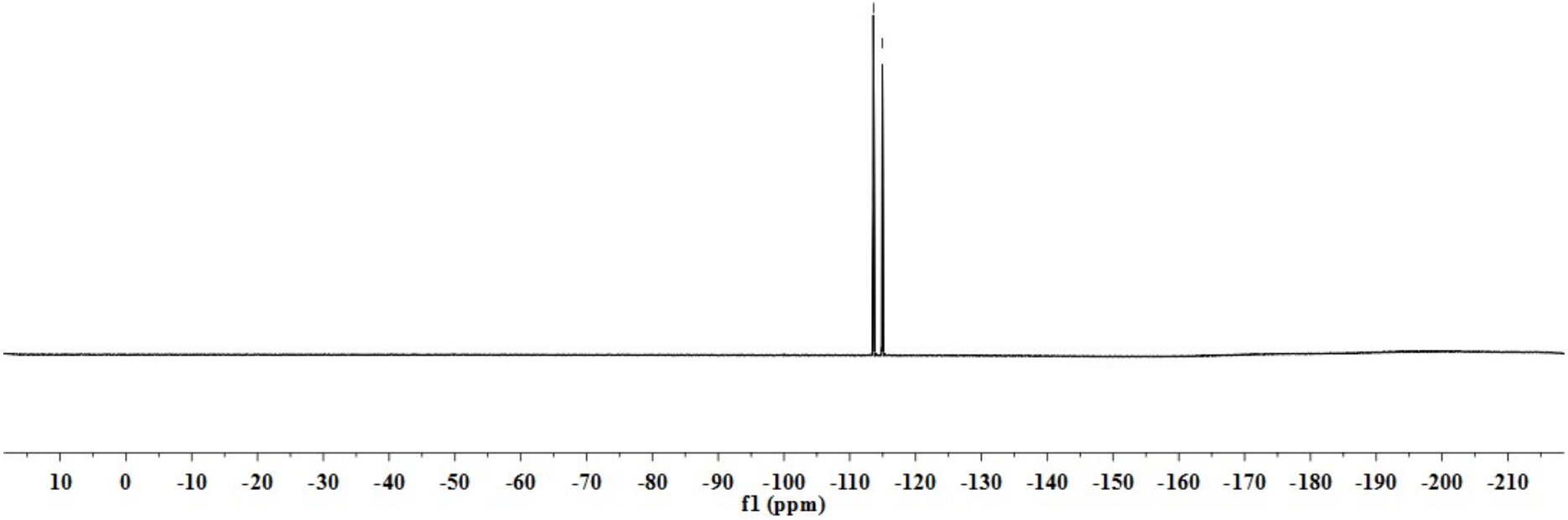

7.34
7.33
7.32
7.32
7.31
7.30
7.30
7.25
7.19
7.19
7.18
7.17
7.17
7.16
7.15
7.14
7.12
7.12
7.11
7.10
7.10
7.09
7.08
6.98
6.98
6.96
6.96
6.94
6.94
6.73
2.34
S
F
F
4i
4.13
6.30
2.08
1.00
3.05
12.5
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

LSW-11-B-F

-113.58
-113.59
-113.60
-113.62
-113.63
-114.92
-114.92
-114.94
-114.95
-114.96

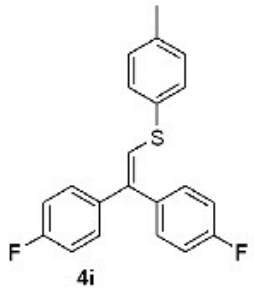


4i

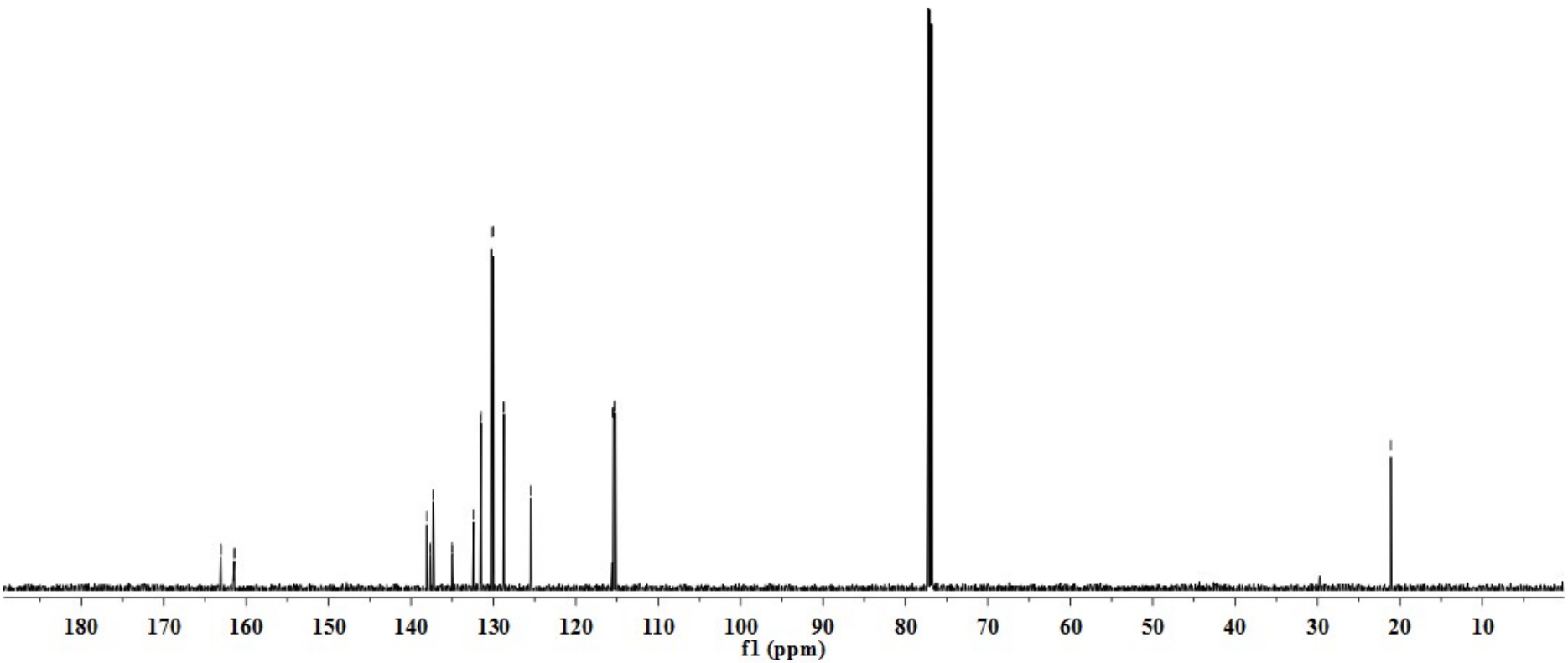


LSW-11-B

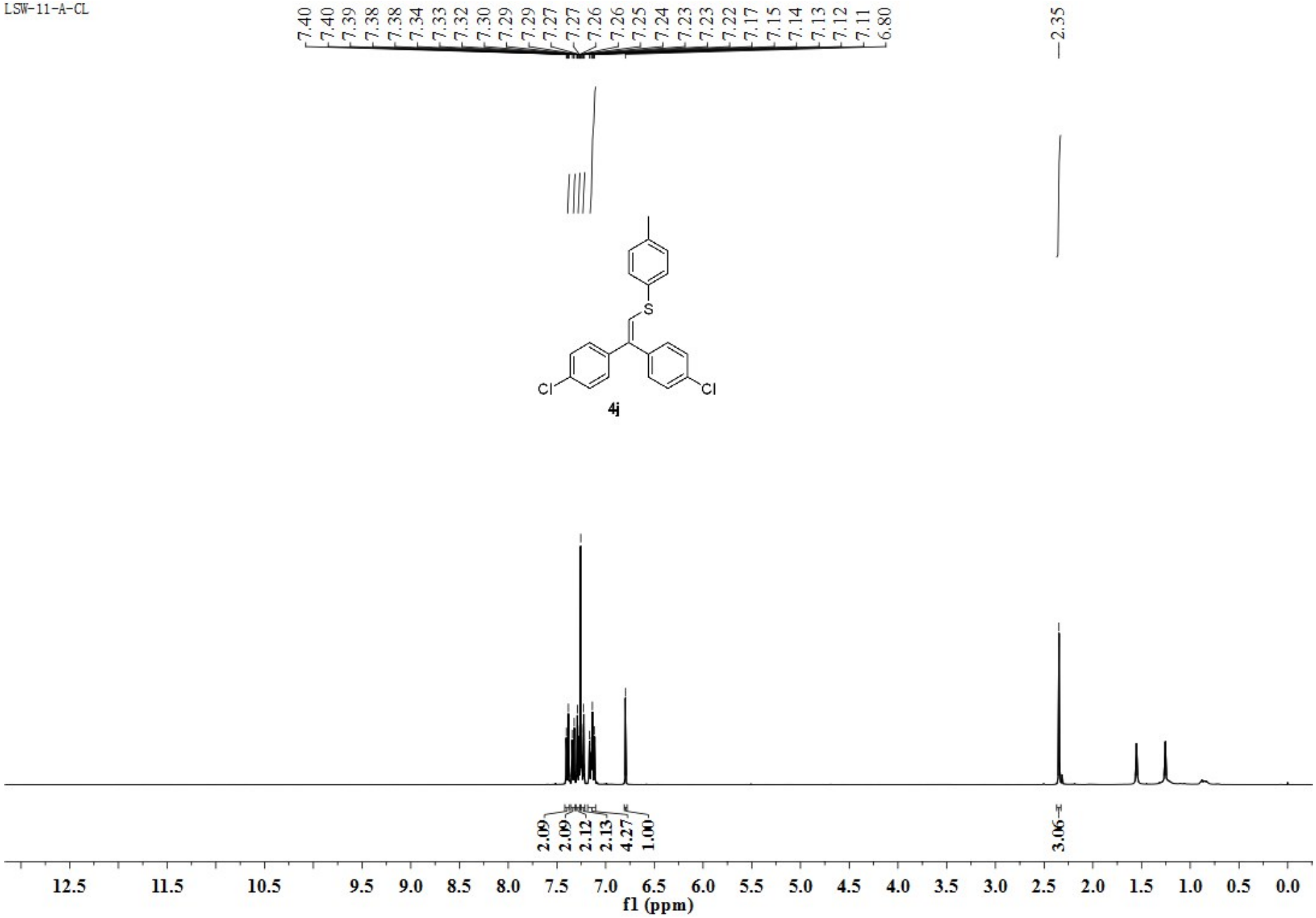
163.08
163.03
161.44
161.40
138.08
137.31
132.40
131.55
131.50
130.24
130.00
128.77
128.72
125.48
115.57
115.42
115.33
115.19
21.09



4i



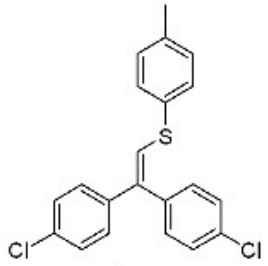
LSW-11-A-CL


7.40
7.40
7.39
7.38
7.38
7.34
7.33
7.32
7.30
7.29
7.29
7.27
7.27
7.26
7.26
7.25
7.24
7.23
7.23
7.22
7.17
7.15
7.14
7.13
7.12
7.11
6.80
2.35
S
Cl
Cl
4j
2.09
2.09
2.12
2.13
4.27
1.00
3.06
12.5
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

LSW-11-A

139.68
137.53
137.41
137.21
133.78
133.20
132.10
131.15
130.41
130.05
128.81
128.55
128.34
126.89

21.11

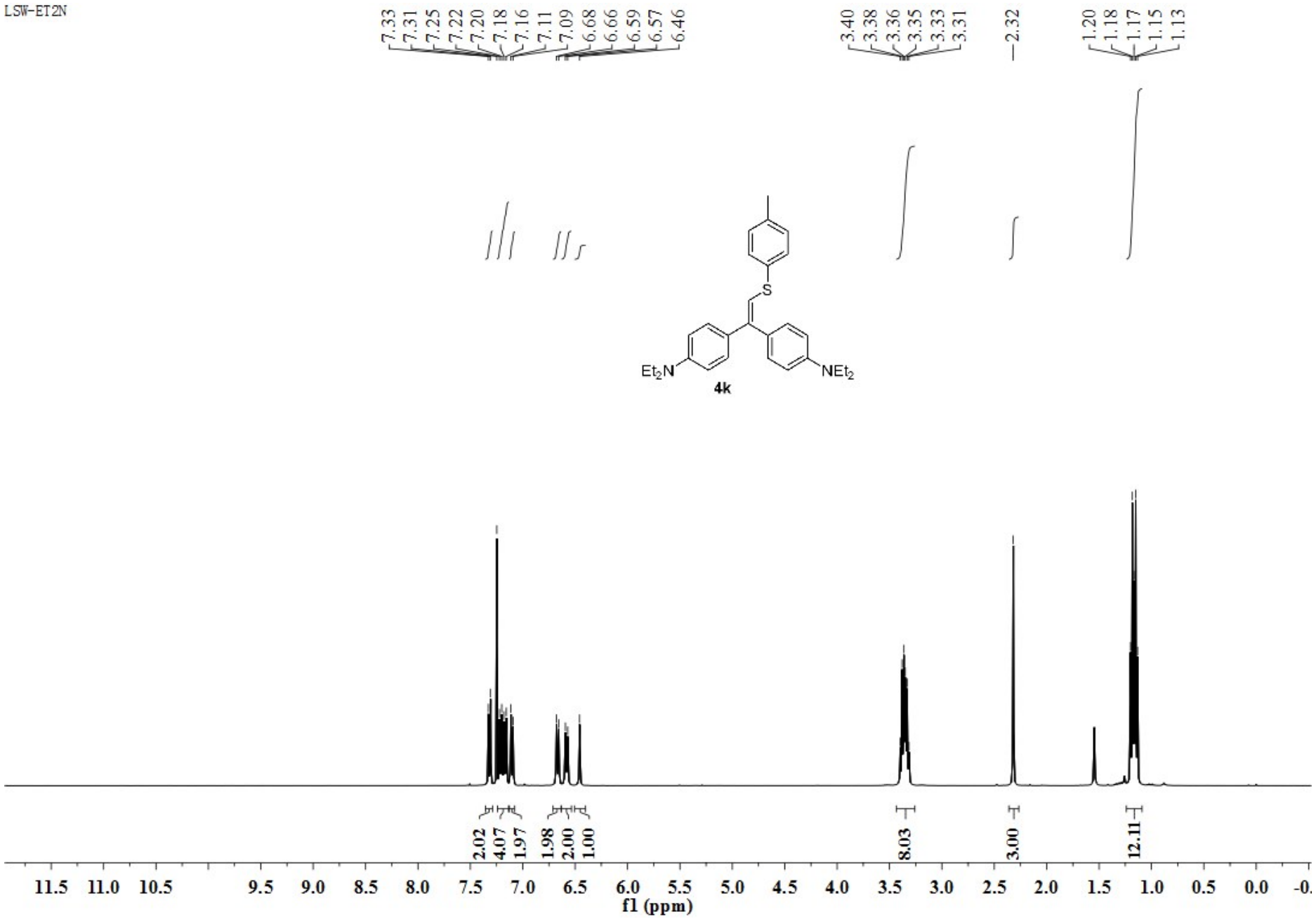


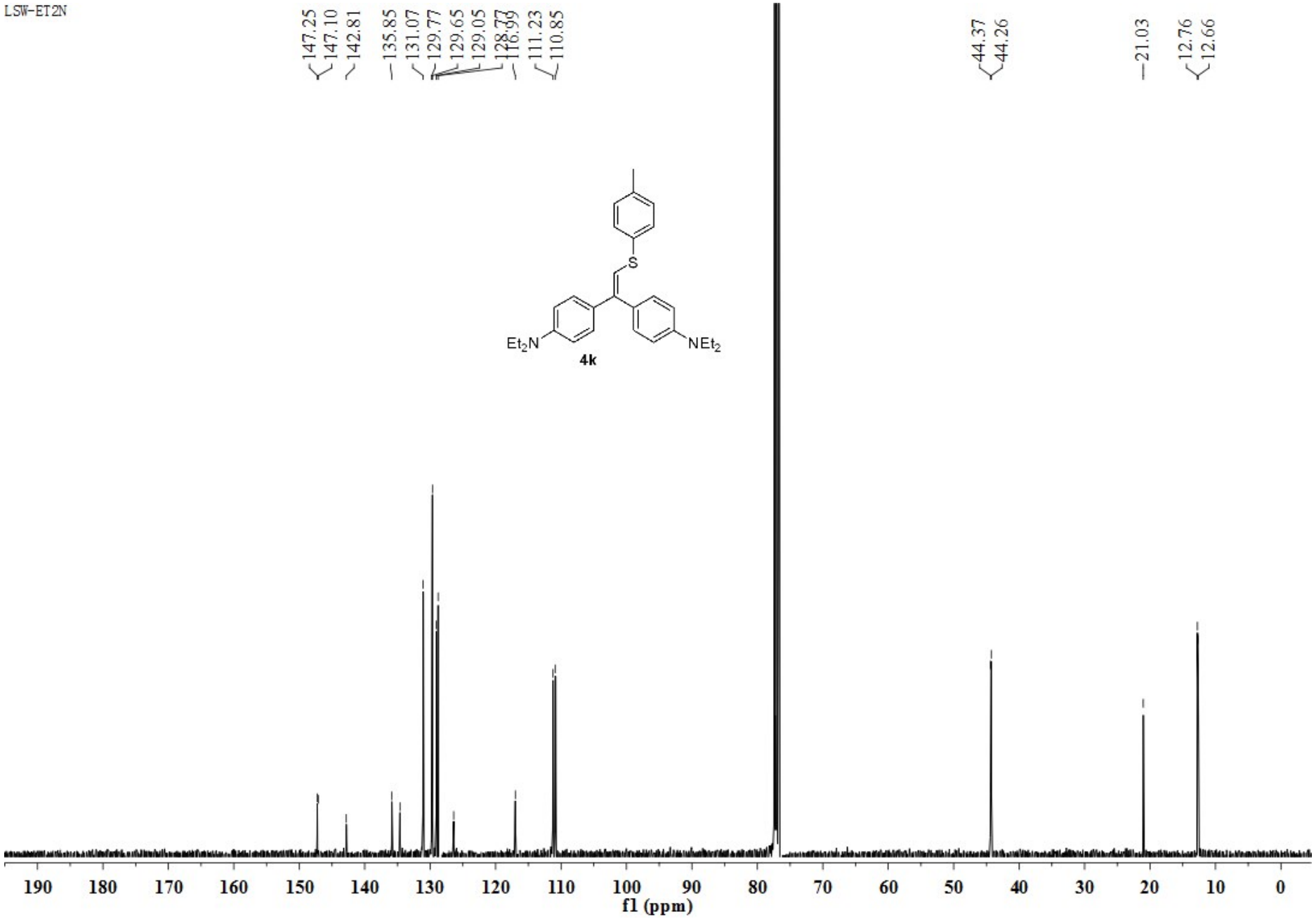
4j

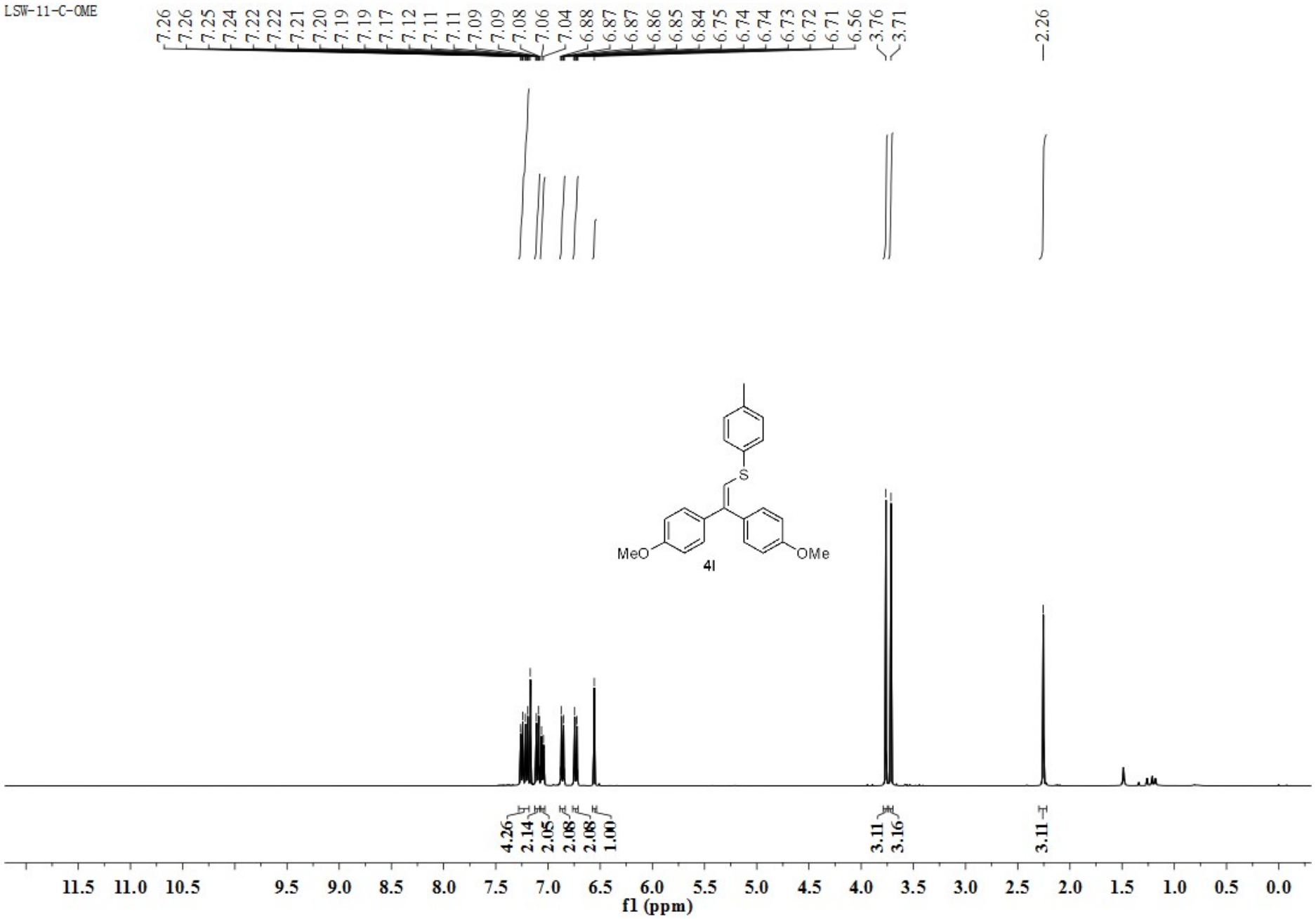
90 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

f1 (ppm)

LSW-ET2N

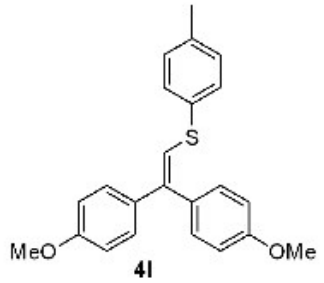

7.33
7.31
7.25
7.22
7.20
7.18
7.16
7.11
7.09
6.68
6.66
6.59
6.57
6.46
3.40
3.38
3.36
3.35
3.33
3.31
2.32
1.20
1.18
1.17
1.15
1.13
S
Et2N
NEt2
4k
2.02
4.07
1.97
1.98
2.00
1.00
8.03
3.00
12.11
11.5 11.0 10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


LSW-ET2N
147.25
147.10
142.81
135.85
131.07
129.77
129.65
129.05
128.77
116.99
111.23
110.85
44.37
44.26
21.03
12.76
12.66
S
Et2N
NEt2
4k
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

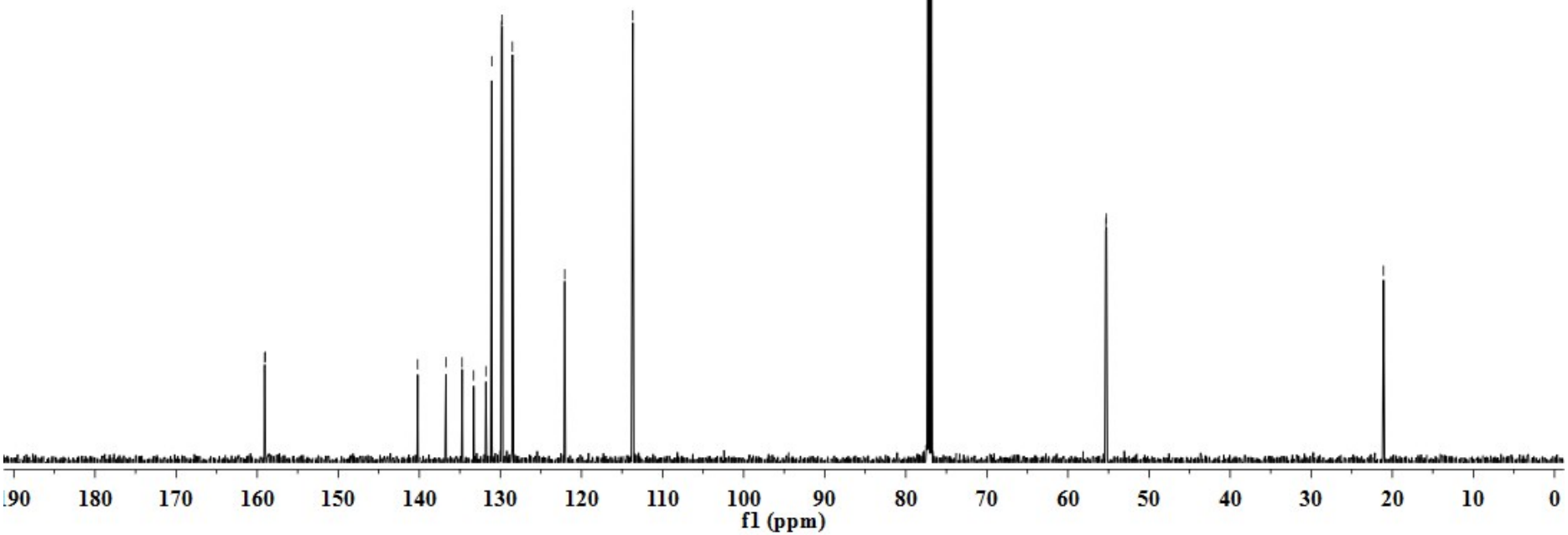

LSW-11-C-OME
7.26
7.26
7.25
7.24
7.22
7.22
7.21
7.20
7.19
7.19
7.17
7.12
7.11
7.11
7.09
7.09
7.08
7.06
7.04
6.88
6.87
6.87
6.86
6.85
6.84
6.75
6.74
6.74
6.73
6.72
6.71
6.56
3.76
3.71
2.26
S
MeO
OMe
4l
4.26
2.14
2.05
2.08
2.08
1.00
3.11
3.16
3.11
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

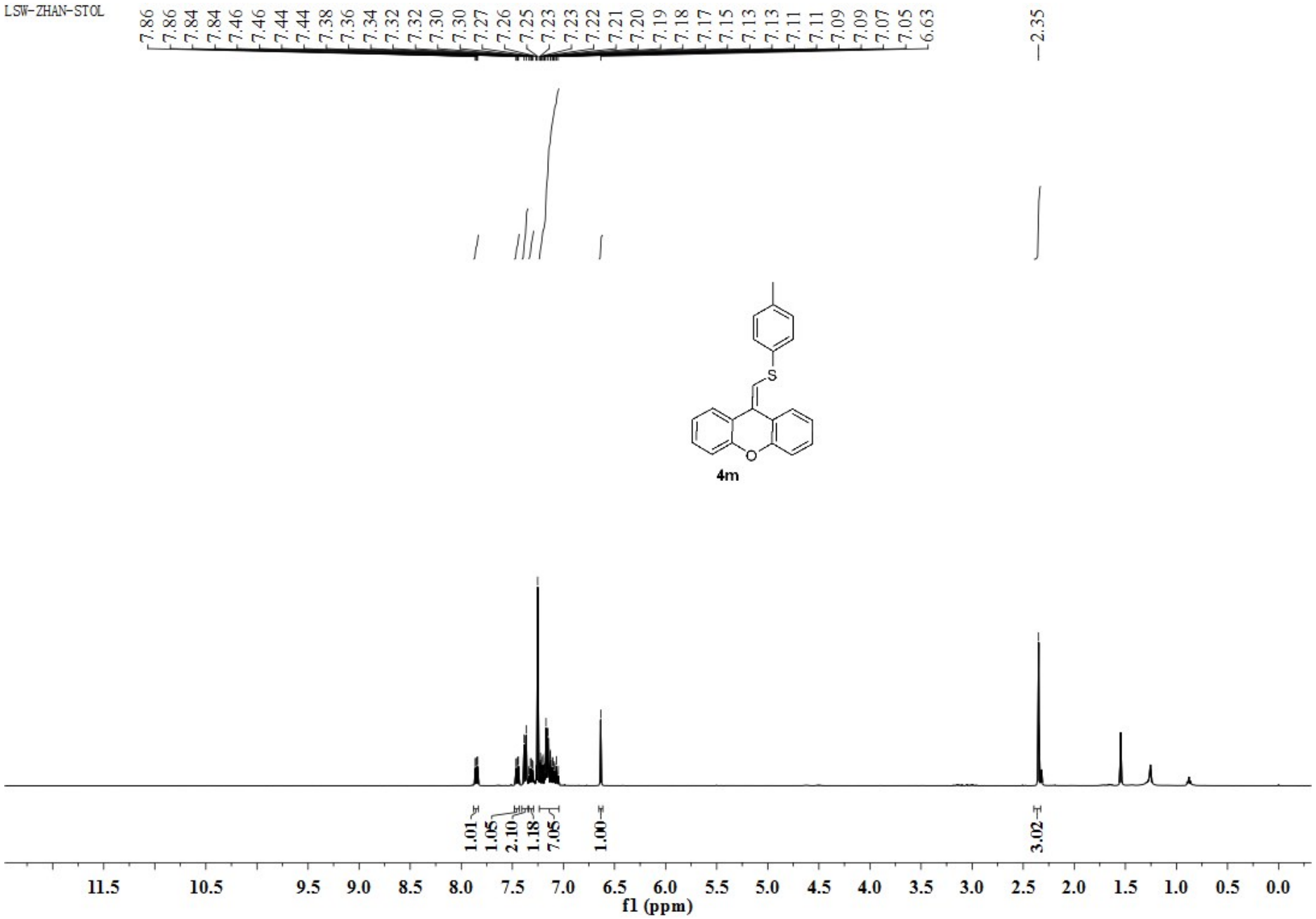
LSW-11-C

159.07
159.01
140.20
136.71
134.72
133.30
131.78
131.07
129.86
129.77
128.51
122.07
113.69
113.66
55.33
55.26
21.08



4l



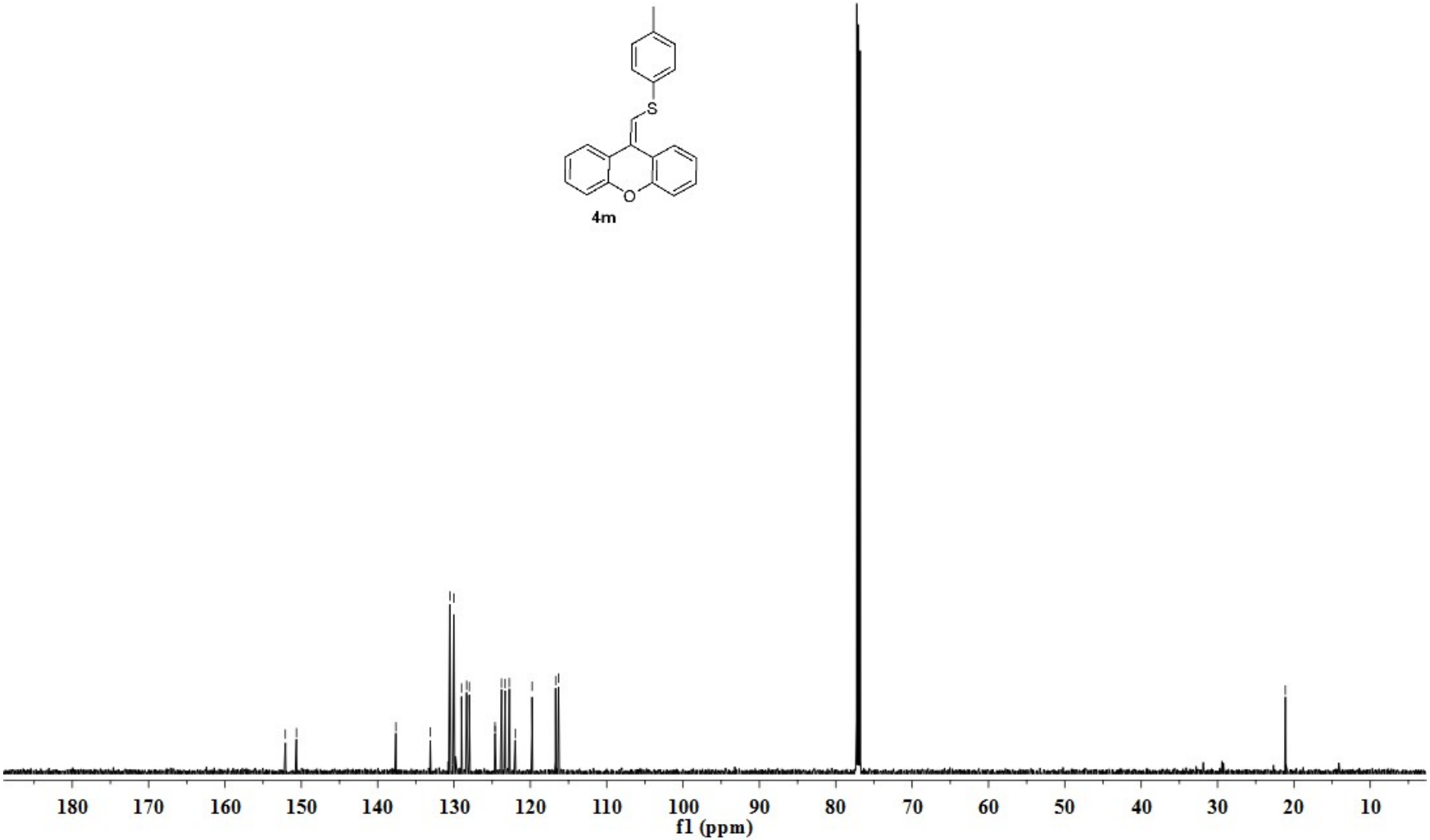

LSW-ZHAN-STOL
7.86
7.86
7.84
7.84
7.46
7.46
7.44
7.44
7.38
7.36
7.34
7.32
7.32
7.30
7.30
7.27
7.26
7.25
7.23
7.23
7.22
7.21
7.20
7.19
7.18
7.17
7.15
7.13
7.13
7.11
7.11
7.09
7.09
7.07
7.05
6.63
2.35
S
O
4m
1.01
1.05
2.10
1.18
7.05
1.00
3.02
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

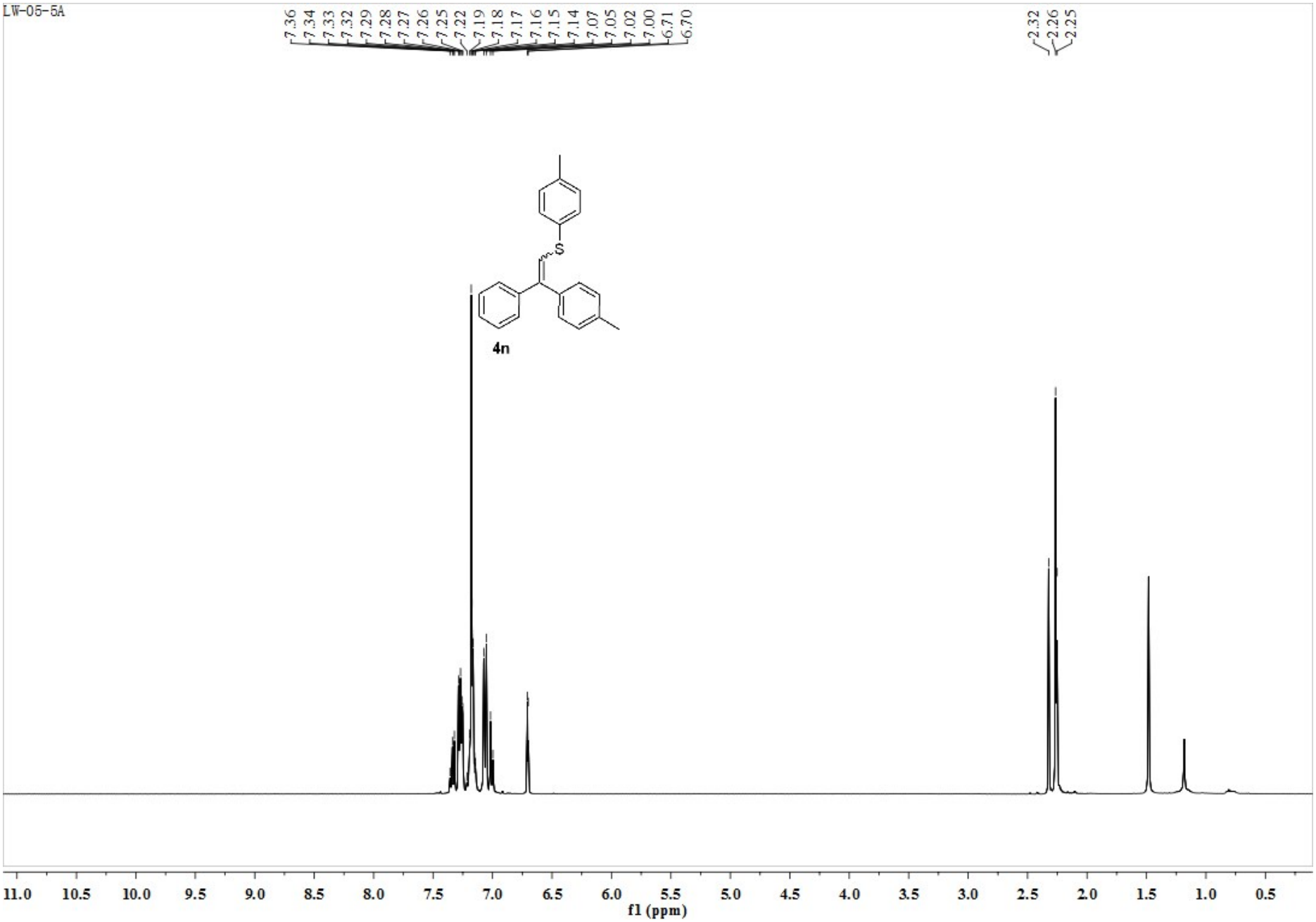
LSW-ZHAN-STOL

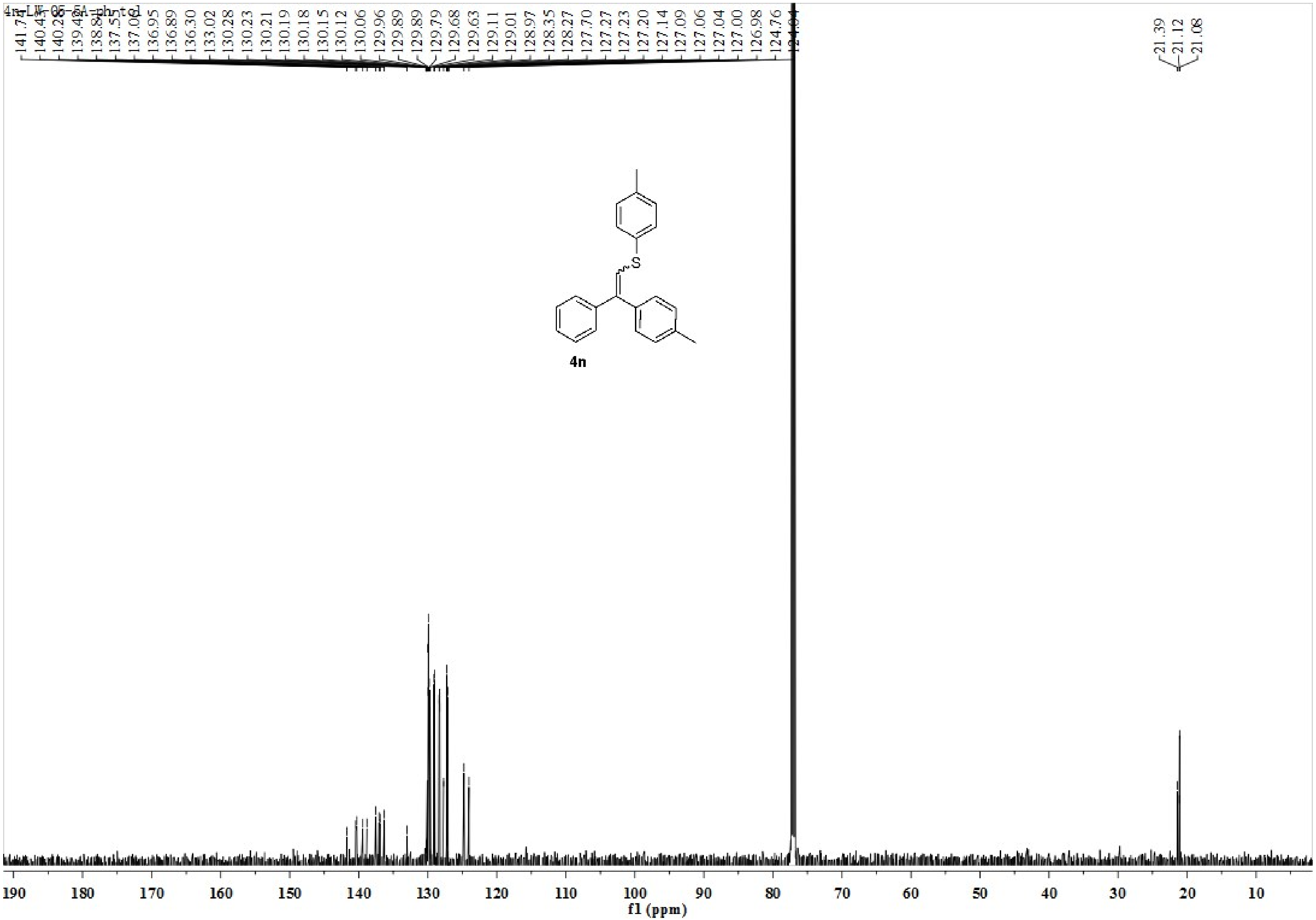
152.09
150.64
137.61
133.10
130.54
130.01
129.02
128.35
128.00
124.63
124.61
123.77
123.30
122.75
121.98
119.78
116.68
116.31

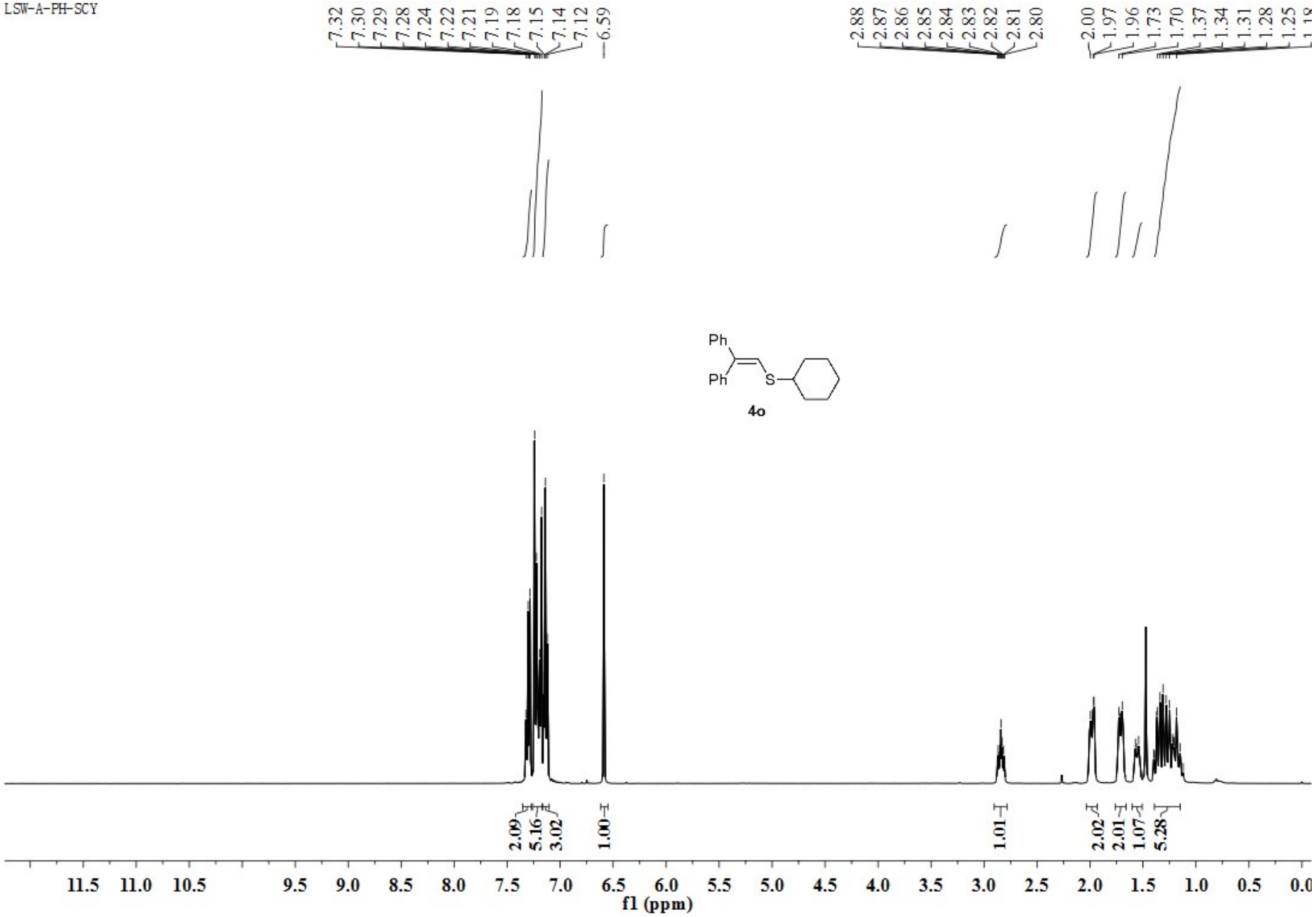
21.12

4m




LW-05-5A
7.36
7.34
7.33
7.32
7.29
7.28
7.27
7.26
7.25
7.22
7.19
7.18
7.17
7.16
7.15
7.14
7.07
7.05
7.02
7.00
6.71
6.70
2.32
2.26
2.25
S
4n
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

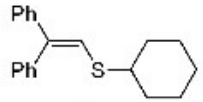

141.7
140.4
140.2
139.4
138.8
137.5
137.0
136.95
136.89
136.30
133.02
130.28
130.23
130.21
130.19
130.18
130.15
130.12
130.06
129.96
129.89
129.89
129.79
129.68
129.63
129.11
129.01
128.97
128.35
128.27
127.70
127.27
127.23
127.20
127.14
127.09
127.06
127.04
127.00
126.98
124.76
21.39
21.12
21.08
S
4n
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


LSW-A-PH-SCY
7.32
7.30
7.29
7.28
7.24
7.22
7.21
7.19
7.18
7.15
7.14
7.12
6.59
2.88
2.87
2.86
2.85
2.84
2.83
2.82
2.81
2.80
2.00
1.97
1.96
1.73
1.70
1.37
1.34
1.31
1.28
1.25
Ph
Ph
S
4o
2.09
5.16
3.02
1.00
1.01
2.02
2.01
1.07
5.28
11.5
11.0
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

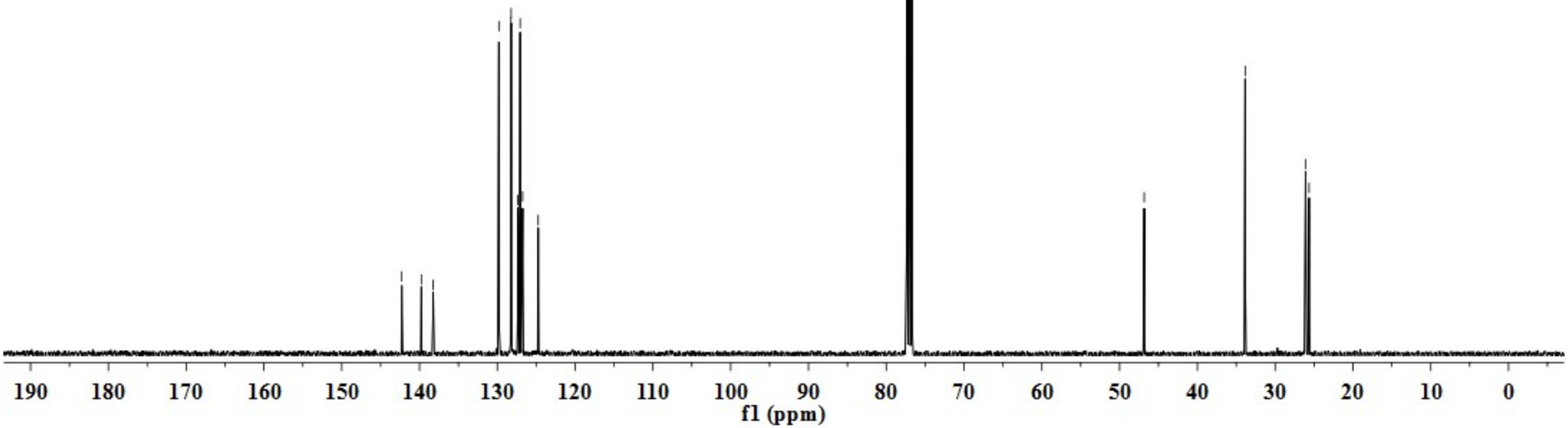
LSW-2PH-SCY-C

142.28
139.76
138.26
129.80
128.25
128.22
127.37
127.06
126.74
124.74

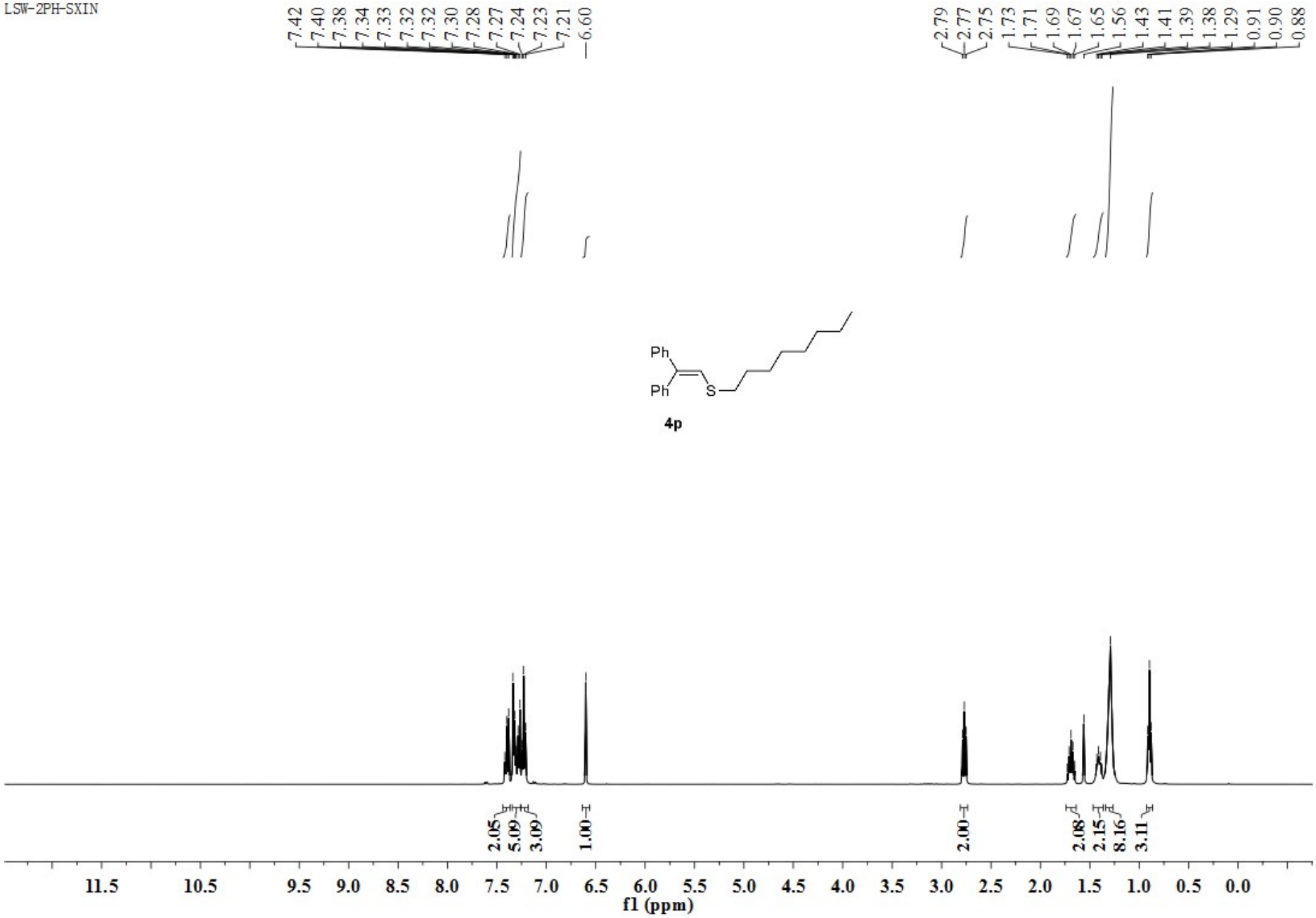
46.84
33.86
26.09
25.64



4o



LSW-2PH-SXIN

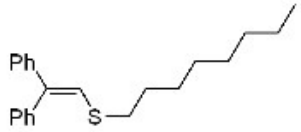


4p

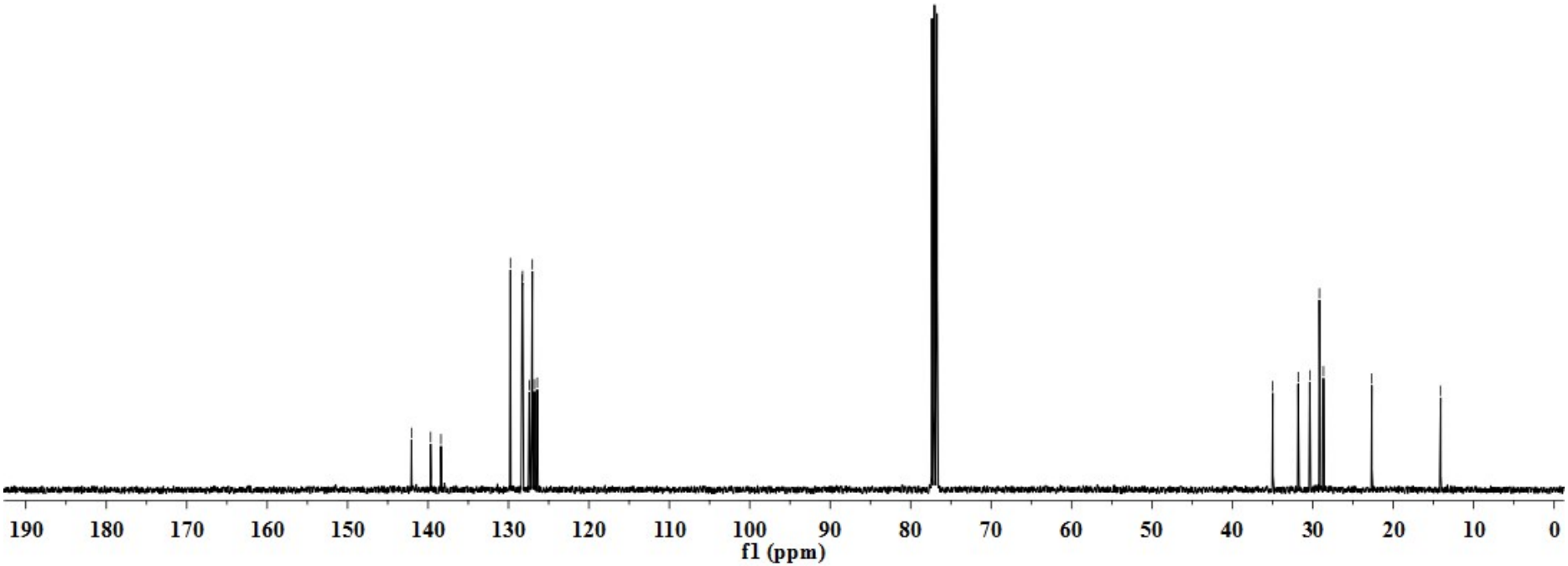
LSW-2PH-SXIN

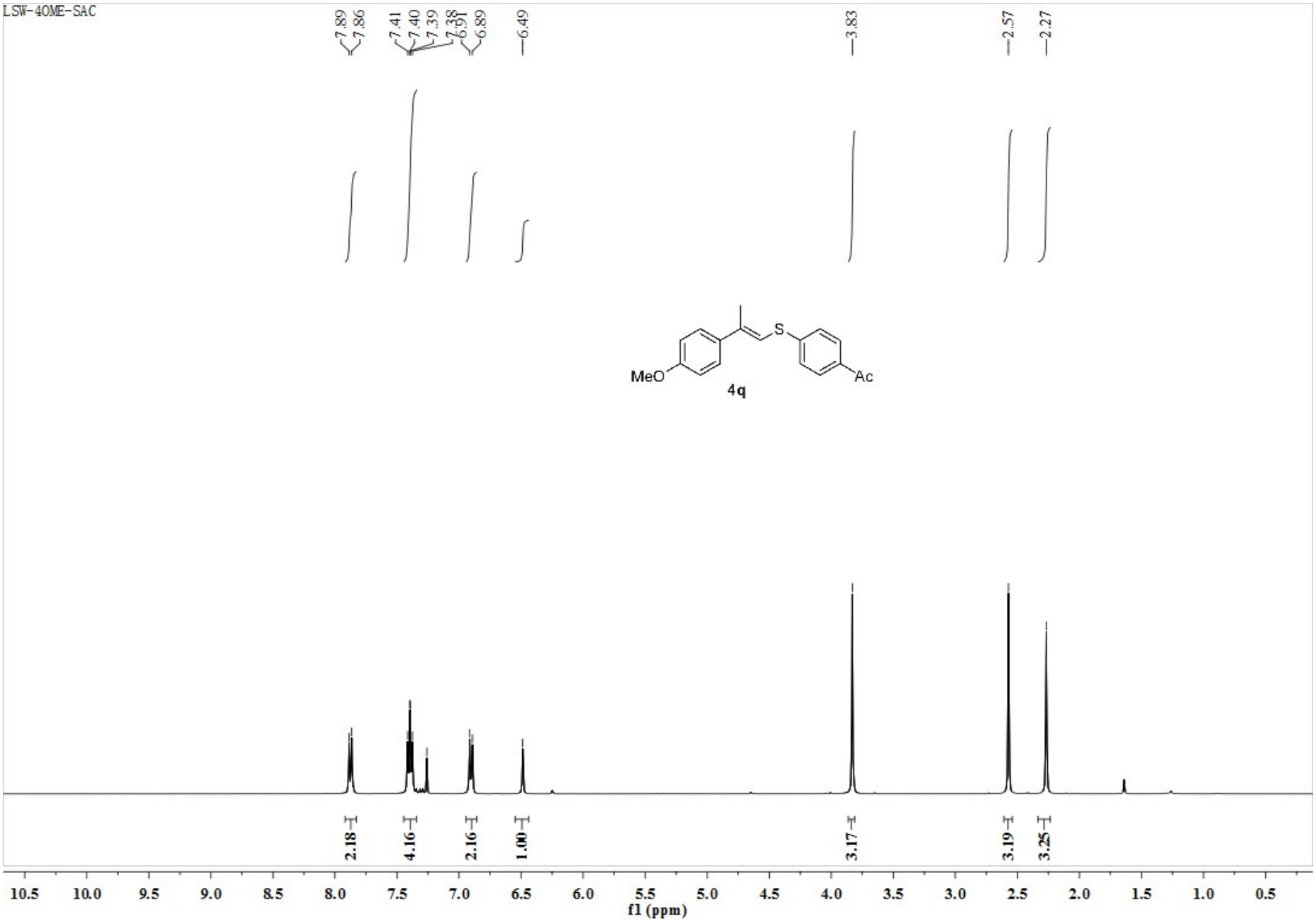
142.06
139.68
138.39
129.76
128.29
128.24
127.43
127.03
126.79
126.43

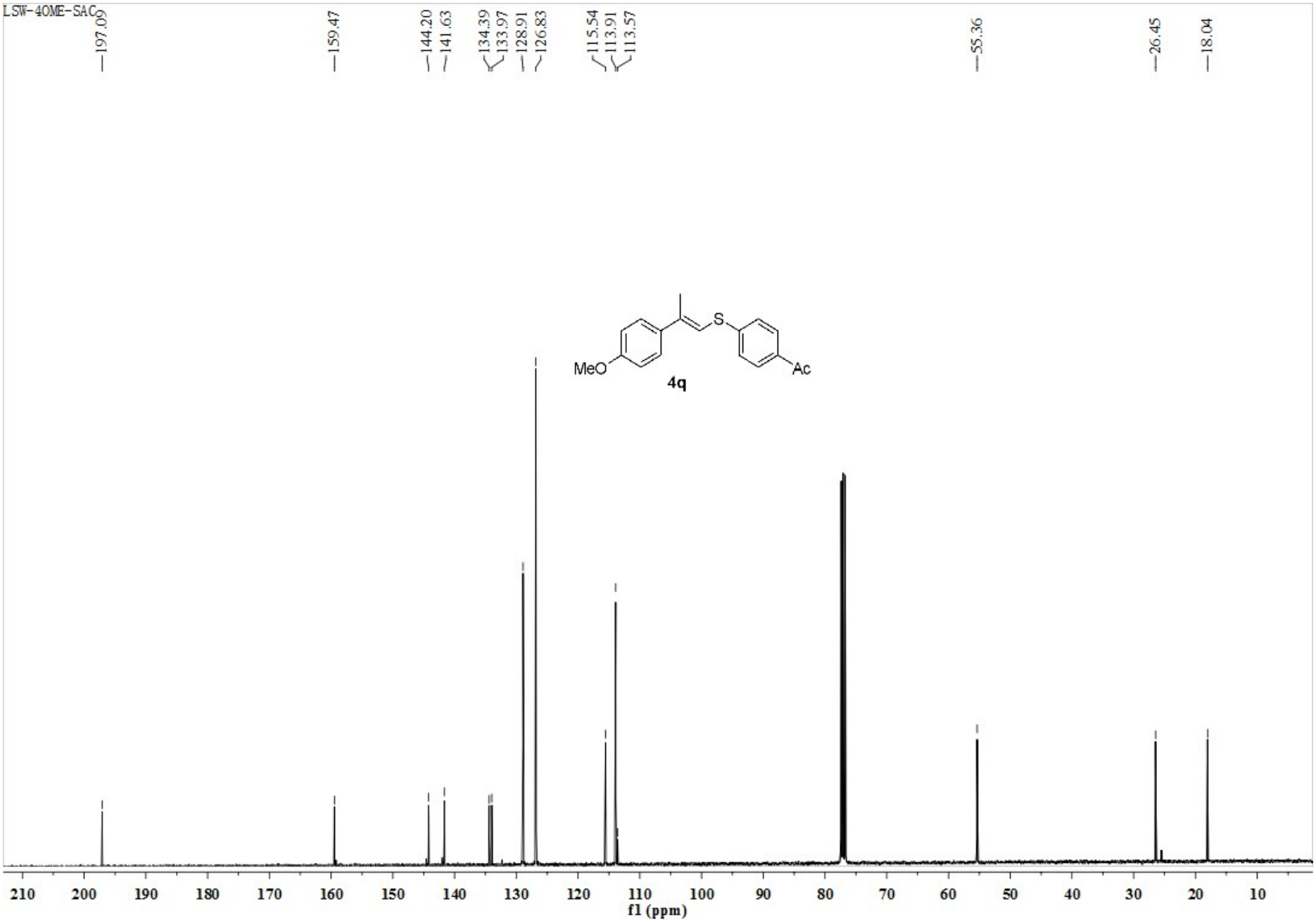
34.98
31.82
30.38
29.18
28.67
22.66
14.10

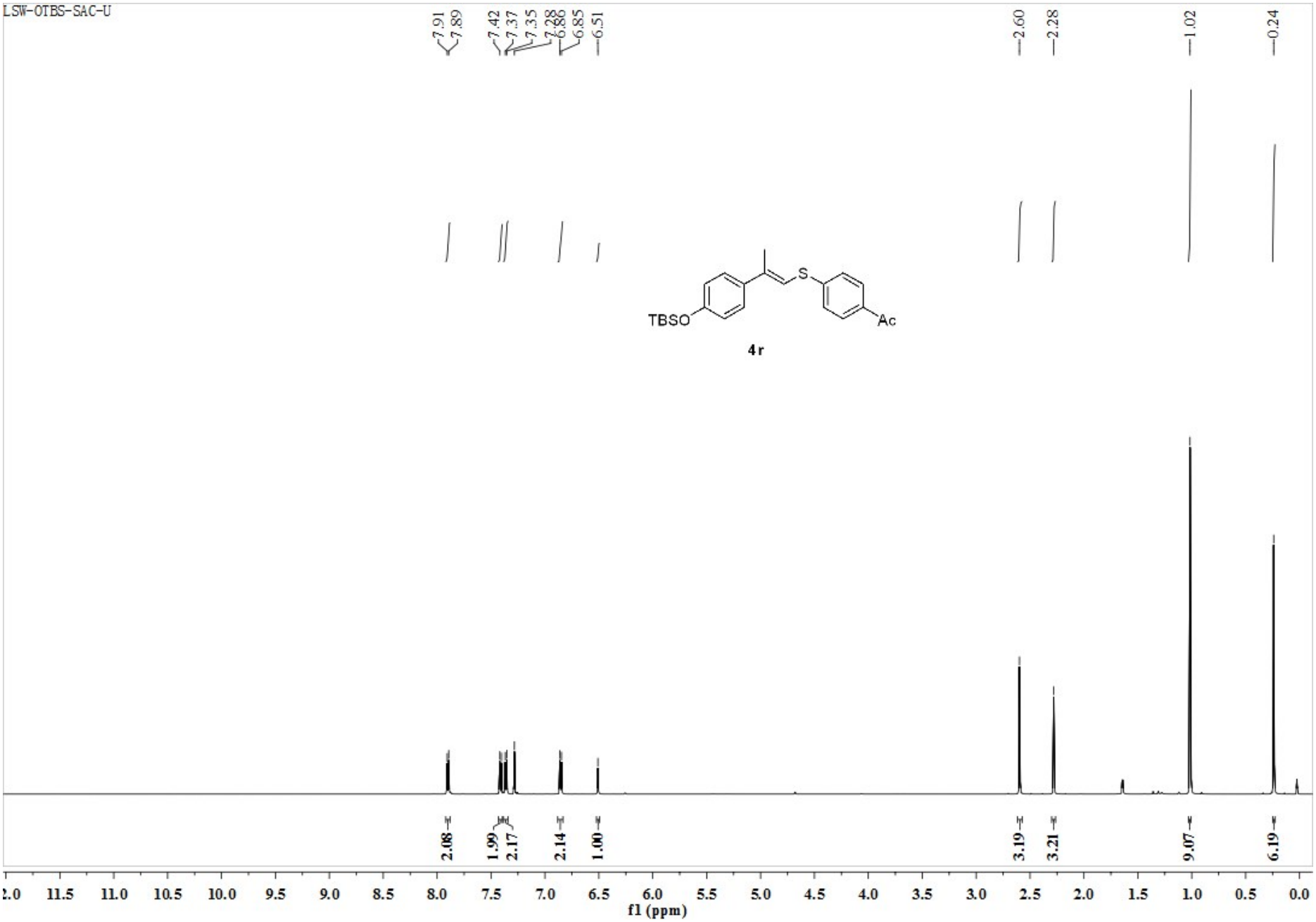


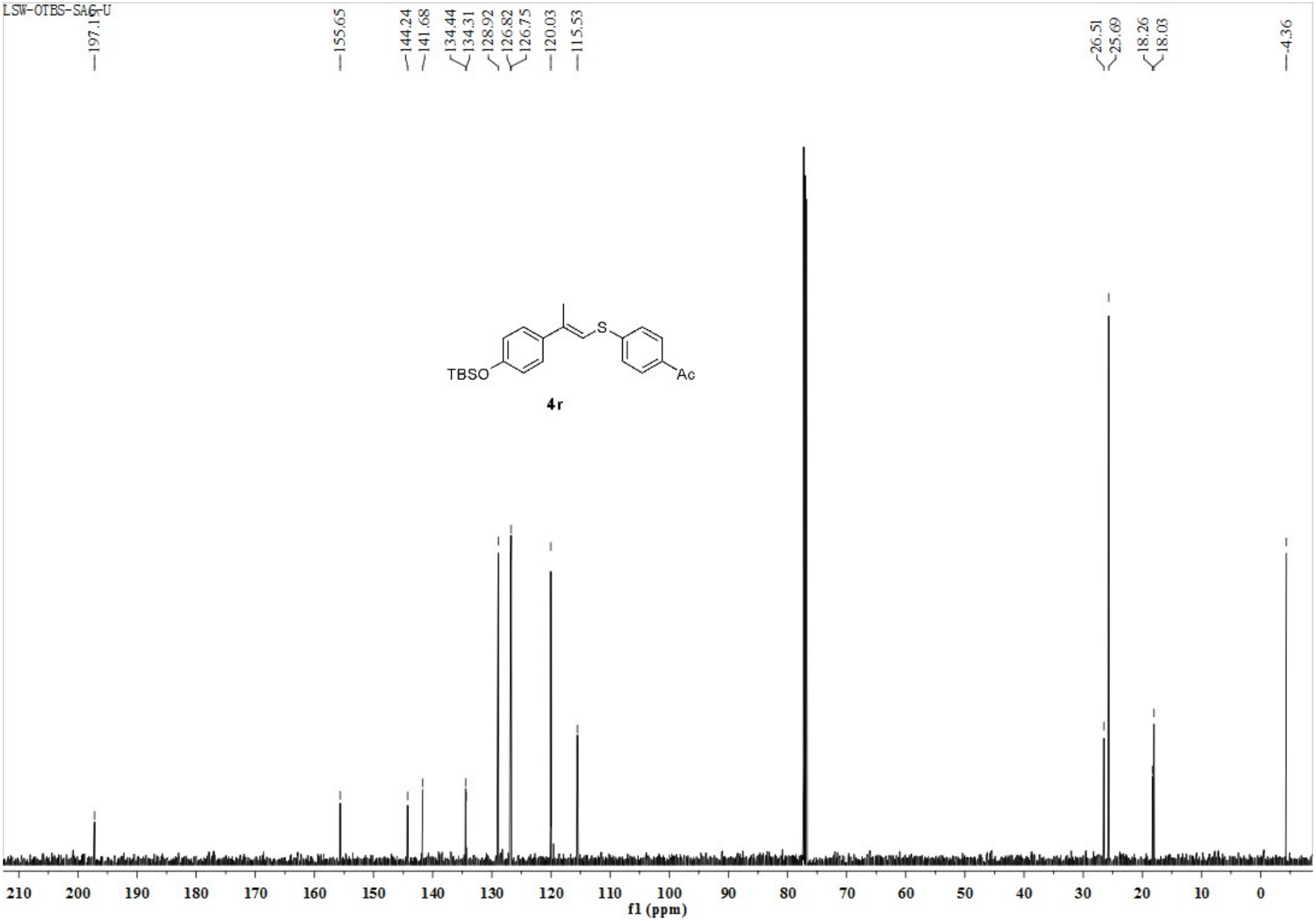
4p

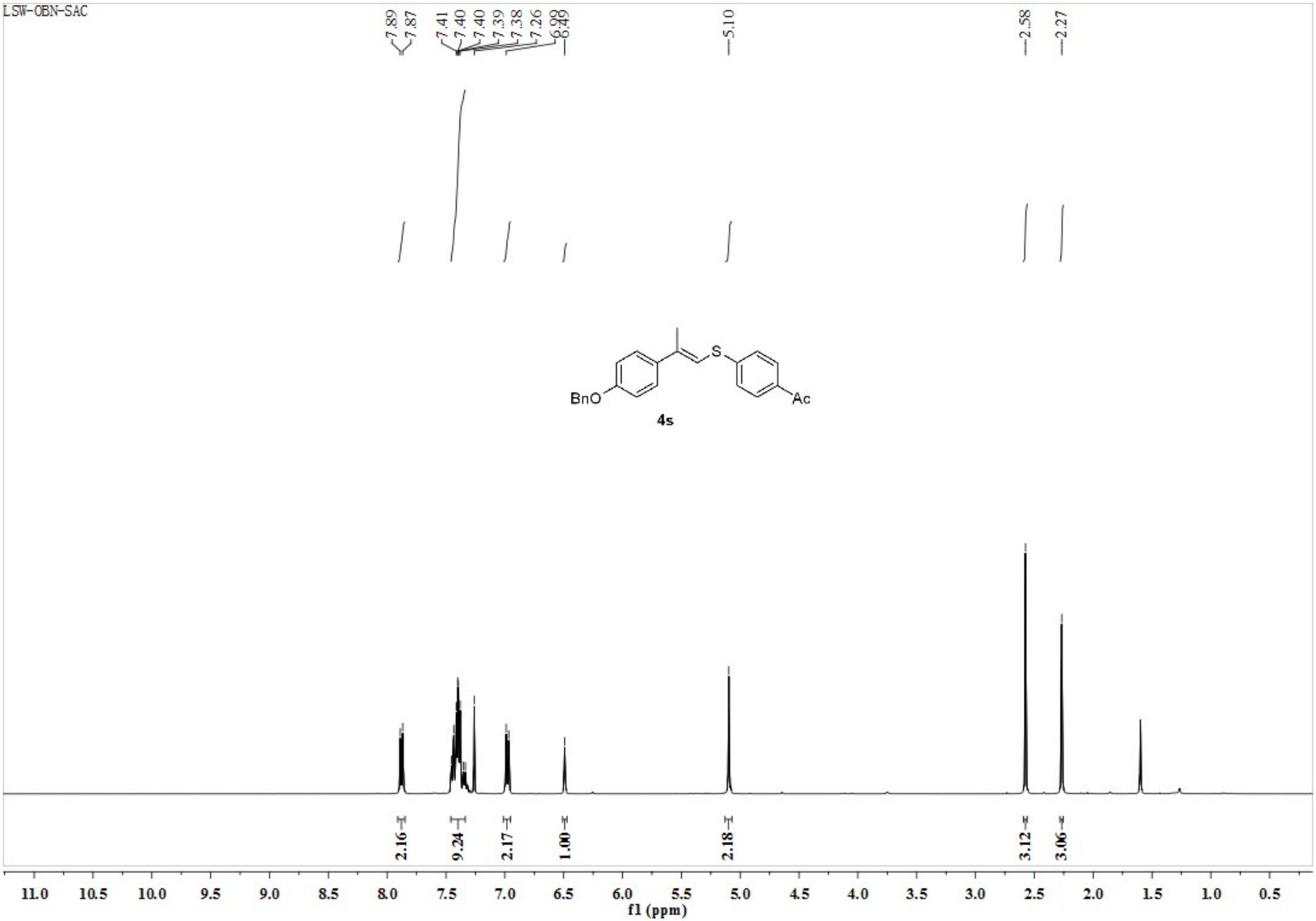


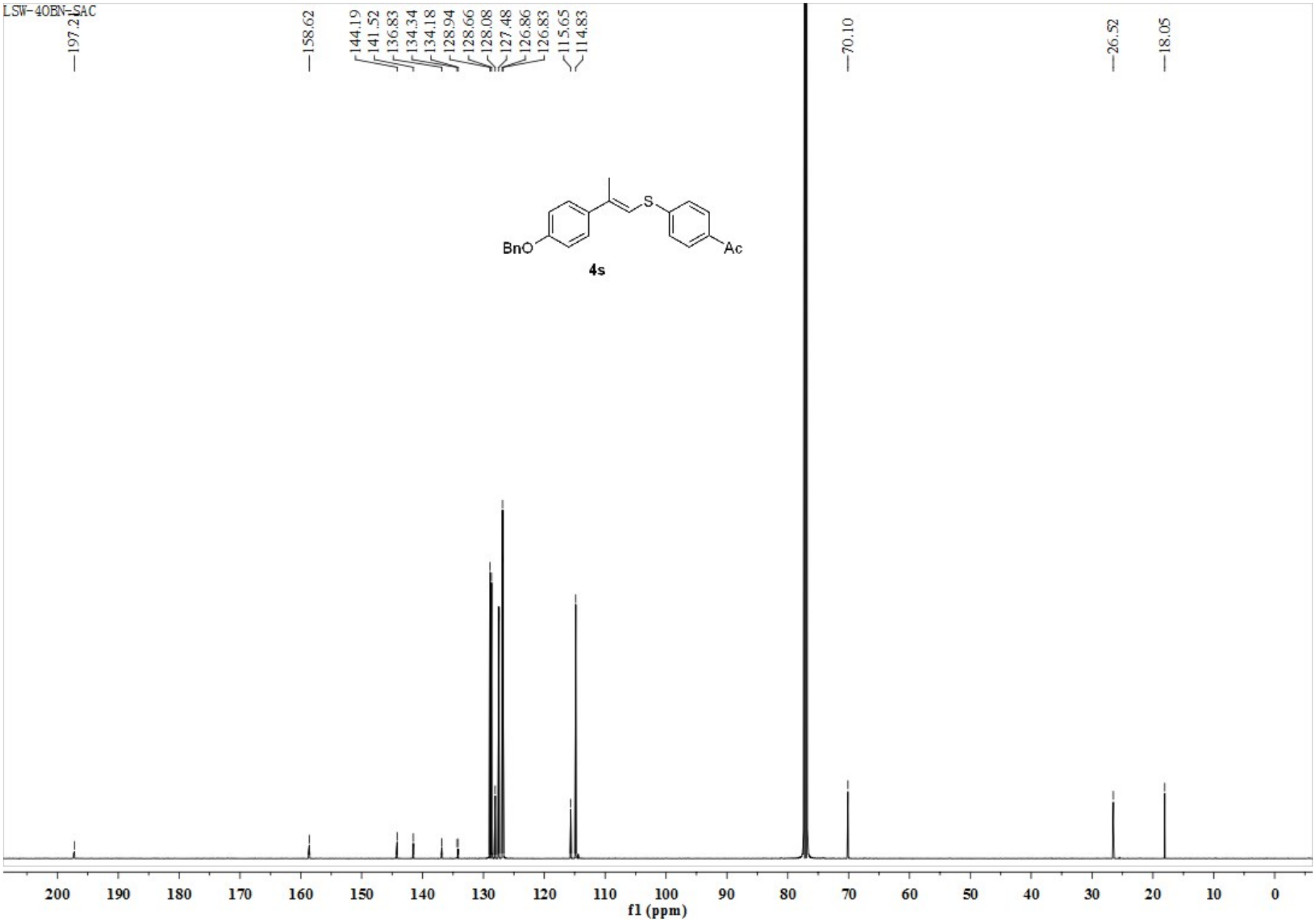

LSW-4OME-SAC
7.89
7.86
7.41
7.40
7.39
7.38
6.91
6.89
6.49
3.83
2.57
2.27
MeO
S
Ac
4q
2.18
4.16
2.16
1.00
3.17
3.19
3.25
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

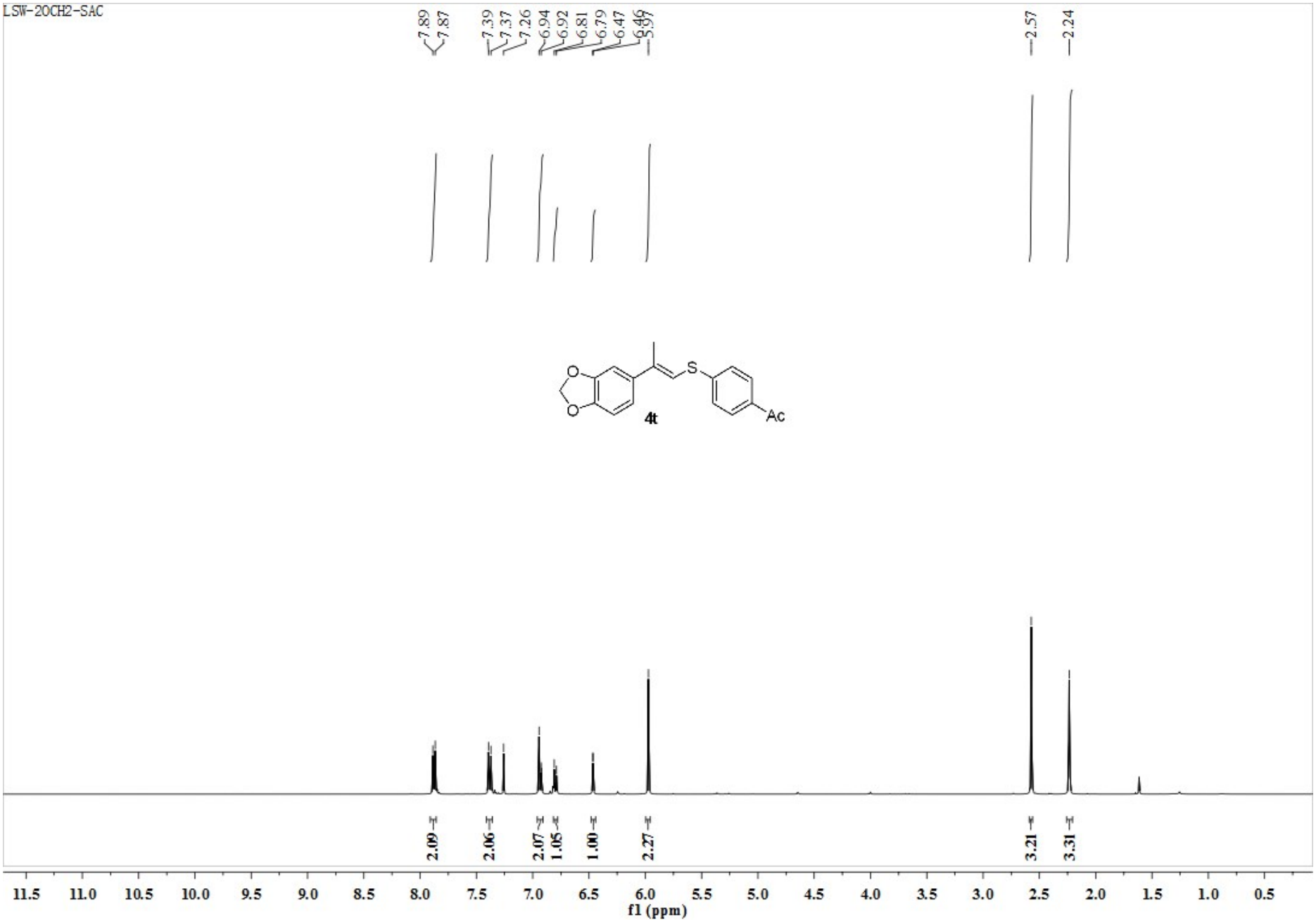

LSW-40ME-SAC
197.09
159.47
144.20
141.63
134.39
133.97
128.91
126.83
115.54
113.91
113.57
55.36
26.45
18.04
MeO
S
Ac
4q
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

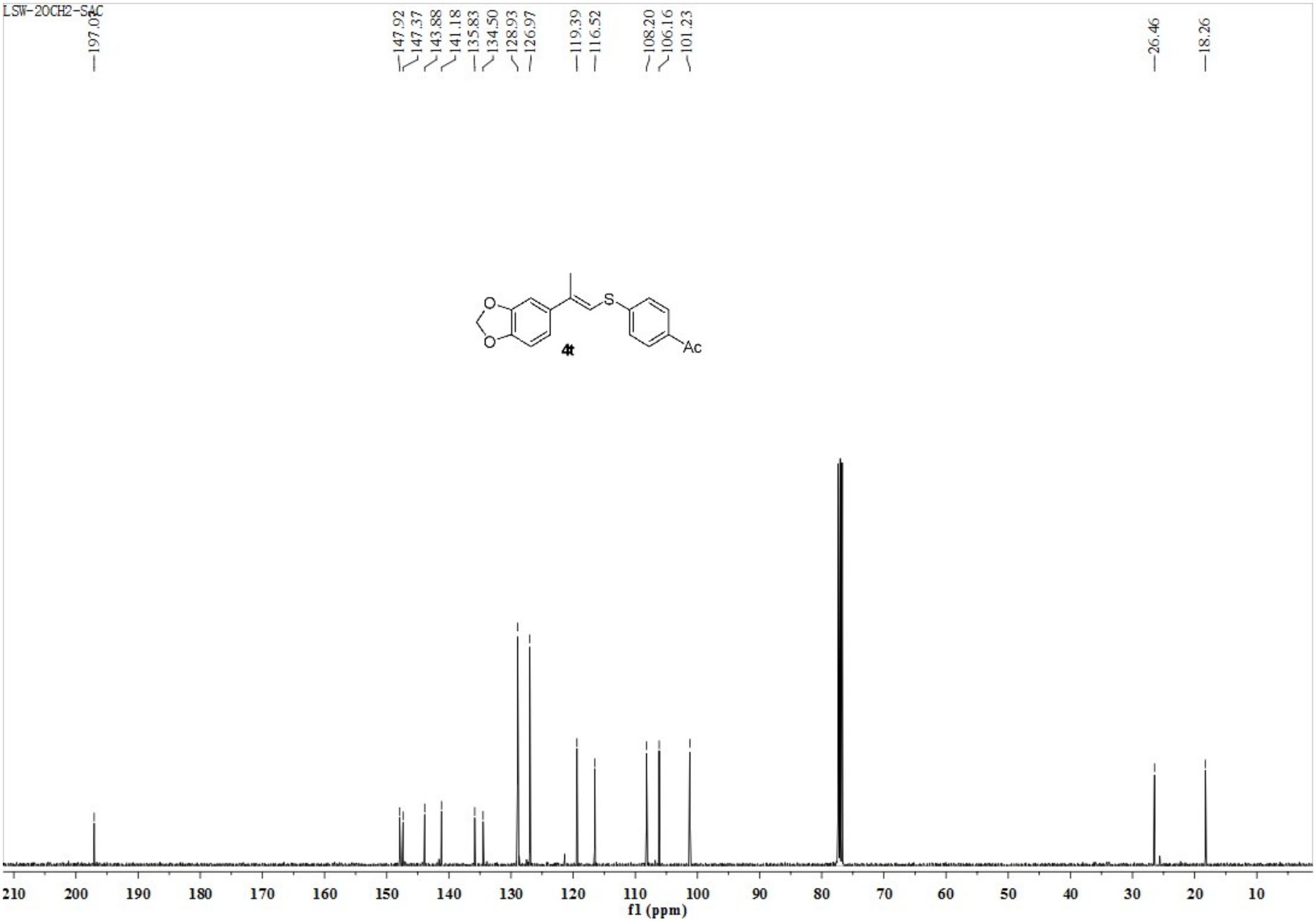

LSW-OTBS-SAC-U
7.91
7.89
7.42
7.37
7.35
7.28
6.86
6.85
6.51
2.60
2.28
1.02
0.24
TBSO
S
Ac
4r
2.08
1.99
2.17
2.14
1.00
3.19
3.21
9.07
6.19
f1 (ppm)

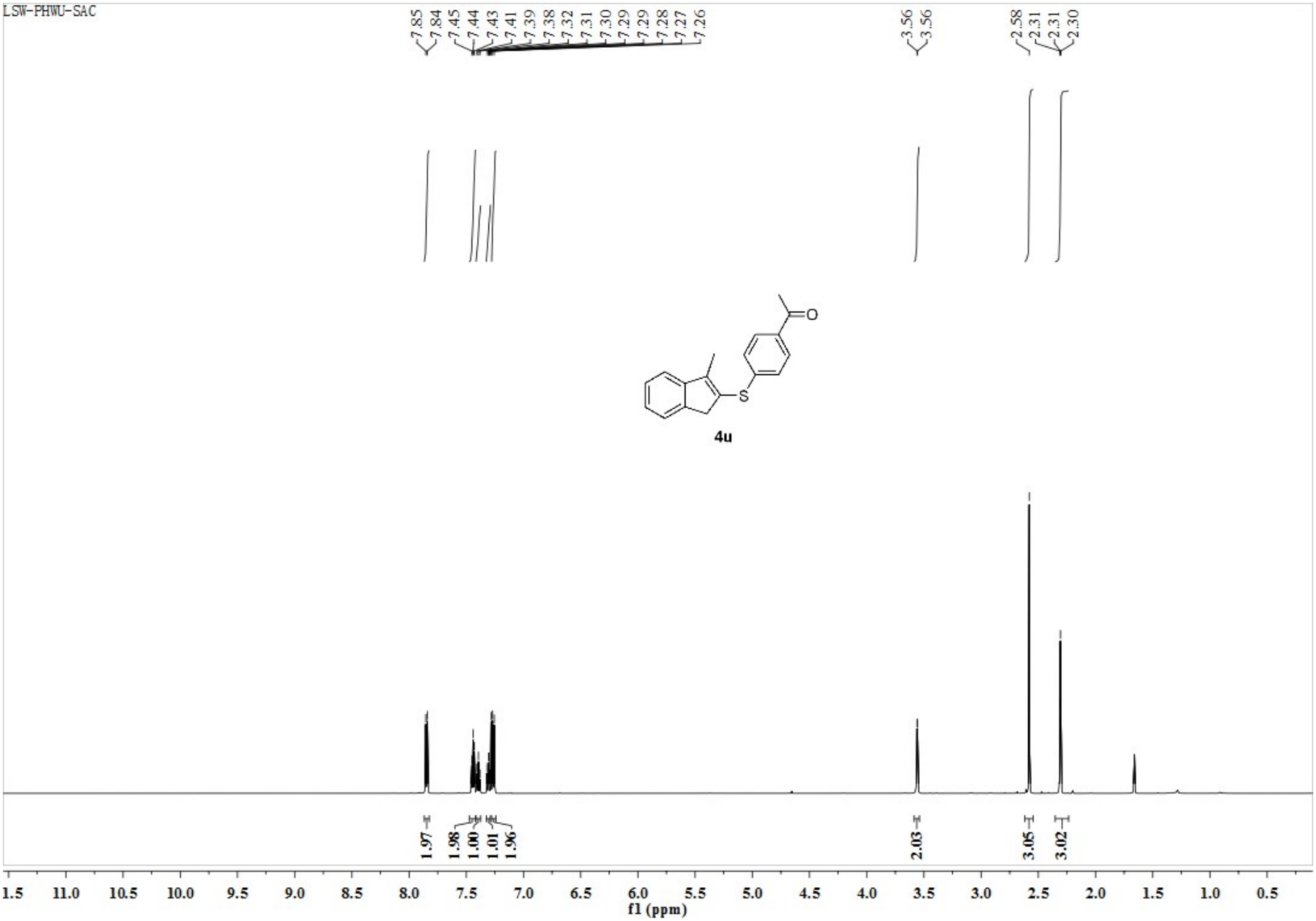

LSW-OTBS-SAC-U
197.15
155.65
144.24
141.68
134.44
134.31
128.92
126.82
126.75
120.03
115.53
26.51
25.69
18.26
18.03
-4.36
TBSO
S
Ac
4r
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

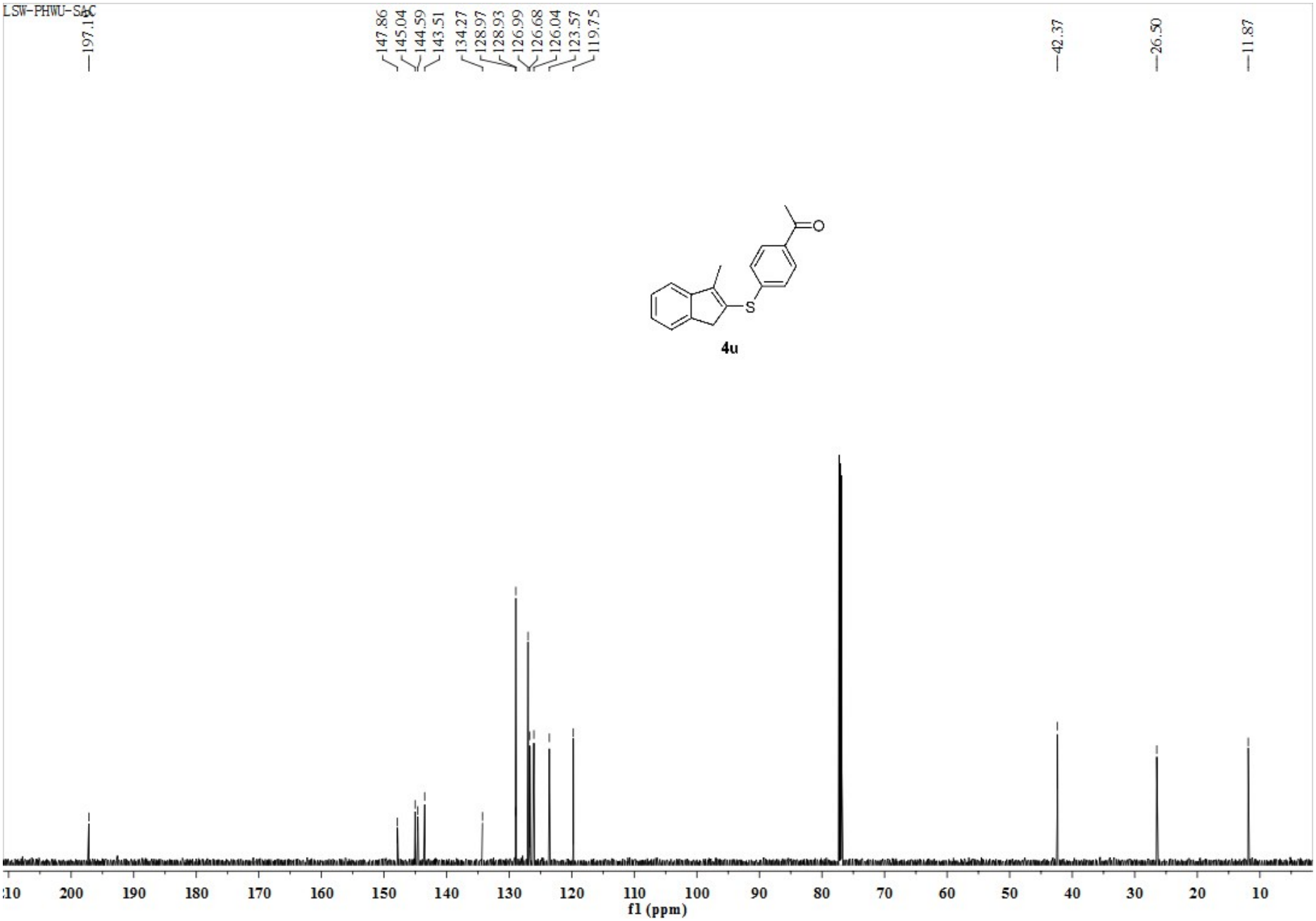

LSW-OBN-SAC
7.89
7.87
7.41
7.40
7.40
7.39
7.38
7.26
6.99
6.49
5.10
2.58
2.27
BnO
S
Ac
4s
2.16
9.24
2.17
1.00
2.18
3.12
3.06
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


LSW-4OBN-SAC
197.21
158.62
144.19
141.52
136.83
134.34
134.18
128.94
128.66
128.08
127.48
126.86
126.83
115.65
114.83
70.10
26.52
18.05
BnO
S
Ac
4s
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


LSW-2OCH2-SAC
7.89
7.87
7.39
7.37
7.26
6.94
6.92
6.81
6.79
6.47
6.46
5.97
2.57
2.24
O
O
S
Ac
4t
2.09
2.06
2.07
1.05
1.00
2.27
3.21
3.31
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


LSW-2OCH2-SAC
197.05
147.92
147.37
143.88
141.18
135.83
134.50
128.93
126.97
119.39
116.52
108.20
106.16
101.23
26.46
18.26
O
O
S
Ac
4t
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


LSW-PHWU-SAC
7.85
7.84
7.45
7.44
7.43
7.41
7.39
7.38
7.32
7.31
7.30
7.29
7.29
7.28
7.27
7.26
3.56
3.56
2.58
2.31
2.31
2.30
O
S
4u
1.97
1.98
1.00
1.01
1.96
2.03
3.05
3.02
1.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


LSW-PHWU-SAC
197.14
147.86
145.04
144.59
143.51
134.27
128.97
128.93
126.99
126.68
126.04
123.57
119.75
42.37
26.50
11.87
O
S
4u
f1 (ppm)

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