Electronic Supplementary Material (ESI) for ChemComm.

Photoredox-catalyzed synthesis of sulfones through deaminative insertion of sulfur dioxide

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Supporting Information

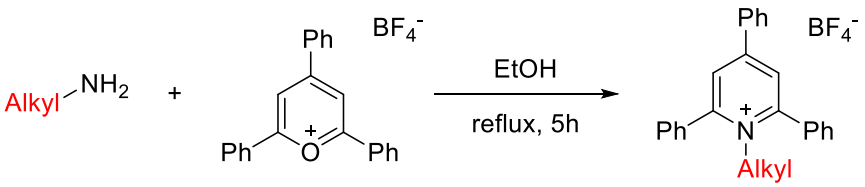
1. General experimental methods:

Unless otherwise stated, all commercial reagents were used as received. Dimethyl sulfoxide (DMSO, 99.7%, Extra Dry, with molecular sieves, Water≤50 ppm) was purchased from *Energy Chemicals* and used as received. Most alkyl amines and 2,4,6-triphenylpyrylium tetrafluoroborate were purchased from *Bidepharm* and used as received. Flash column chromatography was performed using silica gel (300-400 mesh, standard grade). Analytical thin–layer chromatography was performed using glass plates pre-coated with 0.25 mm 230–400 mesh silica gel impregnated with a fluorescent indicator (254 nm). Thin layer chromatography plates were visualized by exposure to 254 nm ultraviolet light or iodine stain. Organic solutions were concentrated on rotary evaporators at ~20 Torr at 30–40°C. Nuclear magnetic resonance (NMR) spectra are recorded in parts per million(ppm) from solvent residual peak on the δ scale. ^{1}H, ^{13}C and ^{19}F NMR spectra were recorded in Chloroform-*d* on a Bruker DRX-400 spectrometer operating at 400 MHz, 101 MHz and 376 MHz, respectively. All chemical shift values are quoted in ppm and coupling constants quoted in Hz. High resolution mass spectrometry (HRMS) spectra were obtained on Agilent GCQTOF or microTOF Instrument.

2. General experimental procedure:

2.1 Procedure of synthesis of Katritzky salts

General experimental procedure for the synthesis of 1-alkyl-2,4,6-triphenyl-pyridin-1-ium tetrafluoroborate ***1*** *as reported in Org. Lett.* ***2019****, 218, 2941-2946.*

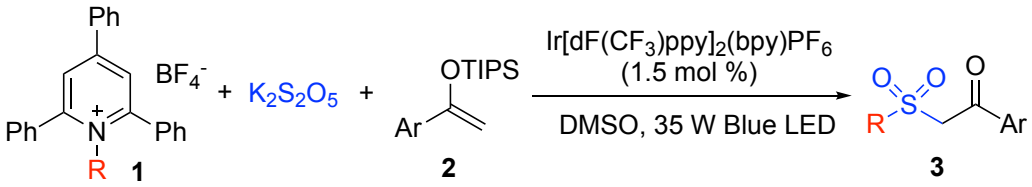


The corresponding alkyl amine (2.4 mmol, 1.2 equiv) was diluted in anhydrous EtOH (2.0 mL) and added to 2,4,6-triphenylpyrylium tetrafluoroborate (2.0 mmol, 792 mg) under N_2. The mixture was refluxed at 90 ^{o}C for 5 hours. After the scheduled time, the mixture was cooled down to 0 ^{o}C and diethyl ether (10 mL) was added under vigorous stirring. The precipitates were filtered and washed with diethyl ether to give the Katritzky salts as white to off-white solids. If necessary, the salts could be washed in refluxing EtOAc or recrystallized with EtOH to achieve better purities. When amine

hydrochloride was used, Et_3N (1.2 equiv.) was added in the reaction and the Katritzky salts were washed with deionized water (5 mL) before purification to remove triethylamine hydrochloride.

2.2 Procedure of visible-light induced reaction

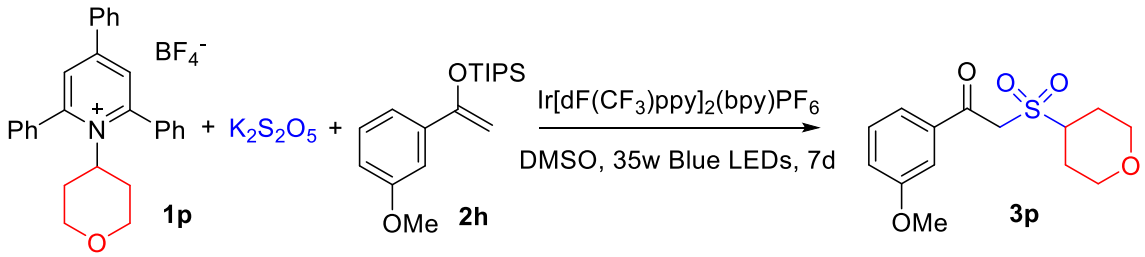
*General experimental procedure for the reaction of 1-alkyl-2,4,6-triphenyl-pyridin-1-ium tetrafluoroborate **1**, $K_2S_2O_5$ and triisopropyl((1-arylvinyl)oxy)silane **2**.*



Dimethyl sulfoxide (2.5 mL) was added to a tube containing 1-alkyl-2,4,6-triphenyl-pyridin-1-ium tetrafluoroborate **1** (0.2 mmol), $K_2S_2O_5$ (0.4 mmol, 2.0 equiv) and $Ir[dF(CF_3)ppy]_2(bpy)PF_6$ (0.003 mmol, 1.5 mol %) under Ar atmosphere via a syringe. Silyl enol ether **2** (0.6mmol, 3.0 equiv) was then added by another microsyringe. The mixture was then exposed to a 35 W blue LED lamp at room temperature (~ 25°C) for 48 hours (as shown next page in Picture 1 and 2). After the scheduled time, the reaction mixture was diluted with water (60 mL) then extracted with EtOAc (20 mL × 3). The organic phases were combined and washed with brine before dried with anhydrous Na_2SO_4. The solvent was then evaporated under reduced pressure and the residue was purified directly by flash column chromatography (EtOAc/*n*-hexane 1:3) to afford the corresponding product **3**.

2.3 Procedure of the gram-scale synthesis

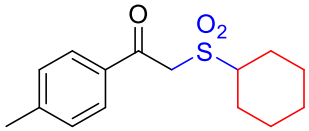
*Experimental procedure for the gram-scale reaction of 2,4,6-triphenyl-1-(tetrahydro-2H-pyran-4-yl)pyridin-1-ium tetrafluoroborate **1p**, $K_2S_2O_5$ and triisopropyl((1-(3-methoxyphenyl)vinyl)oxy)silane **2h**.*



Dimethyl sulfoxide (25.0 mL) was added to a flask (50 mL) containing 2,4,6-triphenyl-1-(tetrahydro-2*H*-pyran-4-yl)pyridin-1-ium tetrafluoroborate **1p** (2.0 mmol), $K_2S_2O_5$ (4.0 mmol, 2.0 equiv) and $Ir[dF(CF_3)ppy]_2(bpy)PF_6$ (0.03 mmol, 1.5 mol %) under Ar atmosphere via a syringe. Triisopropyl((1-(*p*-tolyl)vinyl)oxy)silane **2h** (6.0 mmol, 3.0 equiv.) was then added by another syringe. The mixture was then exposed to a 35 W blue LED lamp at room temperature (20 – 25°C) for 7d. After the scheduled time, the reaction mixture was diluted with water (200 mL) then extracted with EtOAc (100 mL × 4). The organic phases were combined and washed with brine for two times before dried with anhydrous Na_2SO_4. The solvent was then evaporated under reduced pressure and the residue was purified directly by flash column chromatography (Eluent: 25% EtOAc/Hexanes) to afford the corresponding product **3p** (362 mg, 61% yield).

Picture 1 and 2 Photoreactors

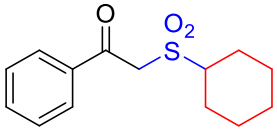
3. Characterization data:



2-(Cyclohexylsulfonyl)-1-(*p*-tolyl)ethan-1-one (**3a**)

51.3 mg (92% yield). White Solid. Melting point: 91.2 – 91.8 °C.

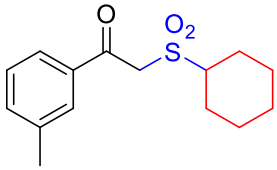
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.90 (d, *J* = 7.8 Hz, 2H), 7.29 (d, *J* = 7.8 Hz, 2H), 4.52 (s, 2H), 3.28 (t, *J* = 12.1 Hz, 1H), 2.42 (s, 3H), 2.21 (d, *J* = 12.0 Hz, 2H), 1.92 (d, *J* = 12.9 Hz, 2H), 1.72 (d, *J* = 12.2 Hz, 1H), 1.59 (q, *J* = 10.8 Hz, 2H), 1.39 – 1.20 (m, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 188.97, 145.88, 133.58, 129.72, 129.62, 61.34, 56.88, 25.15, 25.03, 24.85, 21.89. HRMS (EI) Calc. for $C_{15}H_{21}O_3S^+$: 281.1206. Found: 281.1224.



2-(Cyclohexylsulfonyl)-1-phenylethan-1-one (**3b**)

47.2 mg (89% yield). White Solid. Melting point: 87.4 – 88.5 °C.

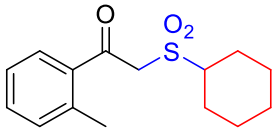
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.02 (d, *J* = 7.8 Hz, 2H), 7.65 (t, *J* = 7.4 Hz, 1H), 7.52 (t, *J* = 7.5 Hz, 2H), 4.56 (s, 2H), 3.30 (t, *J* = 12.1 Hz, 1H), 2.23 (d, *J* = 12.2 Hz, 2H), 1.94 (d, *J* = 13.2 Hz, 2H), 1.74 (d, *J* = 12.5 Hz, 1H), 1.66 – 1.56 (m, 2H), 1.40 – 1.21 (m, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.52, 136.04, 134.68, 129.52, 129.09, 61.46, 56.99, 25.19, 25.10, 24.93. HRMS (EI) Calc. for $C_{14}H_{18}O_3S$: 266.0977. Found: 266.0974.



2-(Cyclohexylsulfonyl)-1-(*m*-tolyl)ethan-1-one (**3c**)

50.2 mg (90% yield). White Solid. Melting point: 87.8 – 90.2 °C.

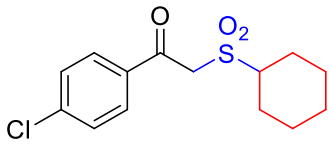
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.80 (d, *J* = 7.0 Hz, 2H), 7.44 (d, *J* = 7.4 Hz, 1H), 7.38 (t, *J* = 7.5 Hz, 1H), 4.54 (s, 2H), 3.29 (d, *J* = 12.4 Hz, 1H), 2.41 (s, 3H), 2.20 (d, *J* = 12.1 Hz, 2H), 1.92 (d, *J* = 13.0 Hz, 2H), 1.73 (d, *J* = 12.4 Hz, 1H), 1.64 – 1.54 (m, 2H), 1.38 – 1.21 (m, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.63, 138.92, 136.02, 135.42, 129.81, 128.88, 126.75, 61.33, 56.88, 25.13, 25.02, 24.83, 21.41. HRMS (EI) Calc. for $C_{15}H_{21}O_3S^+$: 281.1206. Found: 281.1213.



2-(Cyclohexylsulfonyl)-1-(*o*-tolyl)ethan-1-one (**3d**)

17.7 mg (32% yield). Colorless oil.

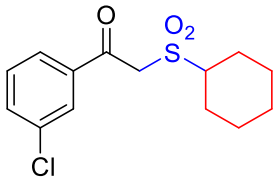
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.83 (d, *J* = 7.8 Hz, 1H), 7.46 (t, *J* = 7.5 Hz, 1H), 7.34 (t, *J* = 7.5 Hz, 1H), 7.29 (d, *J* = 7.7 Hz, 1H), 4.51 (s, 2H), 3.34 (t, *J* = 12.1 Hz, 1H), 2.55 (s, 3H), 2.23 (d, *J* = 11.8 Hz, 2H), 1.95 (d, *J* = 13.1 Hz, 2H), 1.75 (d, *J* = 12.7 Hz, 1H), 1.67 – 1.60 (m, 2H), 1.43 – 1.27 (m, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.12, 167.20, 133.13, 132.54, 130.60, 126.24, 61.48, 59.02, 25.23, 25.14, 24.91, 21.83. HRMS (EI) Calc. for $C_{15}H_{21}O_3S^+$: 281.1206. Found: 281.1220.



2-(Cyclohexylsulfonyl)-1-(4-chlorophenyl)ethan-1-one (**3e**)

52.8 mg (89% yield). Off-white Solid. Melting point: 106.9 – 109.2 °C.

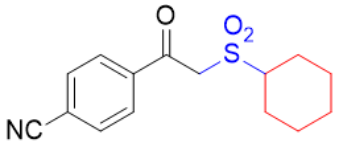
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.96 (d, *J* = 8.2 Hz, 2H), 7.48 (d, *J* = 8.3 Hz, 2H), 4.52 (s, 2H), 3.23 (tt, *J* = 12.2, 3.7 Hz, 1H), 2.20 (d, *J* = 12.0 Hz, 2H), 1.93 (d, *J* = 13.0 Hz, 2H), 1.73 (d, *J* = 12.4 Hz, 1H), 1.59 (q, *J* = 12.3, 11.6 Hz, 2H), 1.32 (dt, *J* = 19.0, 9.2 Hz, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*)) δ 188.33, 141.38, 134.33, 130.94, 129.37, 61.57, 57.05, 25.11, 25.03, 24.89. HRMS (EI) Calc. for $C_{14}H_{18}ClO_3S^+$: 301.0660. Found: 301.0663.



2-(Cyclohexylsulfonyl)-1-(3-chlorophenyl)ethan-1-one (**3f**)

54.7 mg (90% yield). Off-white Solid. Melting point: 96.1 – 97.8 °C.

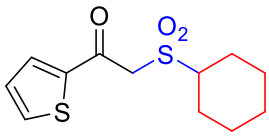
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.98 (s, 1H), 7.89 (d, *J* = 7.7 Hz, 1H), 7.59 (d, *J* = 7.9 Hz, 1H), 7.45 (t, *J* = 7.9 Hz, 1H), 4.53 (s, 2H), 3.24 (t, *J* = 12.1 Hz, 1H), 2.20 (d, *J* = 11.9 Hz, 2H), 1.93 (d, *J* = 13.0 Hz, 2H), 1.73 (d, *J* = 12.5 Hz, 1H), 1.64 – 1.53 (m, 2H), 1.39 – 1.20 (m, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 188.40, 137.45, 135.42, 134.49, 130.34, 129.28, 127.76, 61.59, 57.01, 25.10, 25.02, 24.87. HRMS (EI) Calc. for $C_{14}H_{18}ClO_3S^+$: 301.0660. Found: 301.0665.



4-(2-(Cyclohexylsulfonyl)acetyl)benzonitrile (**3g**)

Get 39.6 mg (68% yield). White solid. Melting point: 114.4 – 114.8 °C.

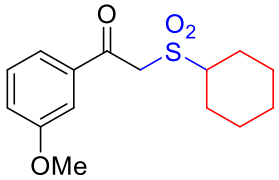
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.13 (d, *J* = 7.9 Hz, 2H), 7.82 (d, *J* = 8.0 Hz, 2H), 4.57 (s, 2H), 3.20 (t, *J* = 12.0 Hz, 1H), 2.21 (d, *J* = 12.1 Hz, 2H), 1.95 (d, *J* = 13.0 Hz, 2H), 1.75 (d, *J* = 12.4 Hz, 1H), 1.64 – 1.55 (m, 2H), 1.38 – 1.24 (m, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 188.46, 138.79, 132.79, 129.95, 117.71, 117.69, 61.87, 57.28, 25.08, 25.03, 24.94. HRMS(ESI) Calc. for $C_{15}H_{21}O_4S^+$: 292.1002. Found: 292.0998.



2-(Cyclohexylsulfonyl)-1-(thiophen-2-yl)ethan-1-one (**3h**)

49.6 mg (91% yield). Off-white Solid. Melting point: 95.0 – 96.1 °C.

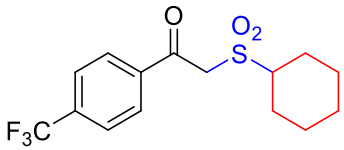
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.87 (d, *J* = 3.0 Hz, 1H), 7.79 (d, *J* = 4.7 Hz, 1H), 7.20 (t, *J* = 3.6 Hz, 1H), 4.46 (s, 2H), 3.28 (t, *J* = 12.1 Hz, 1H), 2.22 (d, *J* = 12.2 Hz, 2H), 1.93 (d, *J* = 12.9 Hz, 2H), 1.73 (d, *J* = 12.2 Hz, 1H), 1.60 (q, *J* = 12.2 Hz, 2H), 1.39 – 1.21 (m, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 181.59, 143.46, 136.90, 135.66, 128.99, 61.37, 58.07, 25.16, 25.05, 24.91. HRMS (ESI) Calc. for $C_{12}H_{16}NaO_3S_2$: 295.0433. Found: 295.0445.



2-(Cyclohexylsulfonyl)-1-(3-methoxyphenyl)ethan-1-one (**3i**)

55.1 mg (93% yield). Colorless oil.

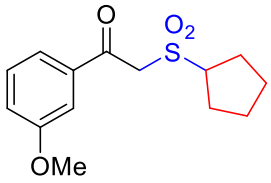
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.58 (d, *J* = 7.6 Hz, 1H), 7.51 (s, 1H), 7.41 (t, *J* = 7.9 Hz, 1H), 7.17 (d, *J* = 8.2 Hz, 1H), 4.54 (s, 2H), 3.85 (s, 3H), 3.29 (t, *J* = 12.1 Hz, 1H), 2.21 (d, *J* = 12.2 Hz, 2H), 1.93 (d, *J* = 13.1 Hz, 2H), 1.73 (d, *J* = 12.4 Hz, 1H), 1.59 (q, *J* = 12.5 Hz, 2H), 1.38 – 1.22 (m, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.31, 160.06, 137.28, 130.03, 122.33, 121.43, 113.08, 61.45, 57.03, 55.61, 25.14, 25.04, 24.86. HRMS (EI) Calc. for $C_{15}H_{20}O_4S$: 296.1082. Found: 296.1082.



2-(Cyclohexylsulfonyl)-1-(4-(trifluoromethyl)phenyl)ethan-1-one (**3j**)

55.4 mg (83% yield). Off-white Solid. Melting point: 110.2 – 113.9 °C.

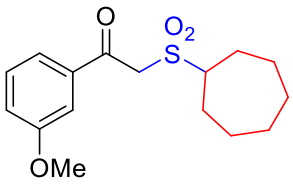
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.14 (d, *J* = 7.9 Hz, 2H), 7.77 (d, *J* = 8.0 Hz, 2H), 4.58 (s, 2H), 3.23 (t, *J* = 12.0 Hz, 1H), 2.22 (d, *J* = 12.0 Hz, 2H), 1.95 (d, *J* = 12.9 Hz, 2H), 1.75 (d, *J* = 12.4 Hz, 1H), 1.60 (q, *J* = 12.1 Hz, 2H), 1.40 – 1.22 (m, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 188.78, 138.57, 135.66 (d, J_F = 33.1 Hz), 129.92, 126.08 (q, J_F = 3.6 Hz), 123.46 (q, J_F = 274.0 Hz), 61.78, 57.28, 25.11, 25.05, 24.94. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -63.34. HRMS (ESI) Calc. for $C_{15}H_{17}F_3NaO_4S$: 357.0743. Found: 357.0755.



2-(Cyclopentylsulfonyl)-1-(3-methoxyphenyl)ethan-1-one (**3k**)

55.2 mg (96% yield). Colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.59 (d, *J* = 7.6 Hz, 1H), 7.52 (s, 1H), 7.41 (t, *J* = 7.9 Hz, 1H), 7.17 (d, *J* = 8.0 Hz, 1H), 4.54 (s, 2H), 3.85 (s, 3H), 3.77 (p, *J* = 8.0 Hz, 1H), 2.09 (dh, *J* = 13.4, 6.7 Hz, 4H), 1.87 – 1.78 (m, 2H), 1.72 – 1.62 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.12, 160.08, 137.24, 130.04, 122.39, 121.42, 113.17, 61.97, 59.24, 55.62, 26.95, 26.17. HRMS (EI) Calc. for $C_{14}H_{18}O_4S$: 282.0926. Found: 282.0926.

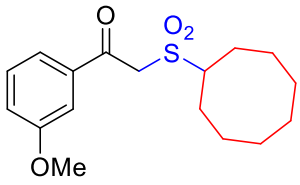


2-(Cycloheptylsulfonyl)-1-(3-methoxyphenyl)ethan-1-one (**3l**)

57.9 mg (94% yield). Colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.59 (d, *J* = 7.6 Hz, 1H), 7.51 (s, 1H), 7.41 (t, *J* = 7.9 Hz, 1H), 7.17 (d, *J* = 7.9 Hz, 1H), 4.56 (s, 2H), 3.84 (s, 3H), 3.38 (hept, *J* = 4.4 Hz, 1H), 2.30 – 2.21 (m, 2H), 1.91 – 1.78 (m, 4H), 1.63 – 1.49 (m, 6H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.27, 160.05, 137.27, 130.02, 122.35, 121.43, 113.06, 63.24,

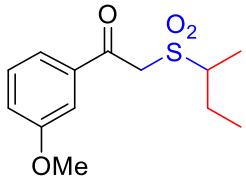
57.37, 55.60, 28.21, 26.55, 25.87. HRMS (EI) Calc. for $C_{16}H_{22}O_4S$: 310.1239. Found: 310.1238.



2-(Cyclooctylsulfonyl)-1-(3-methoxyphenyl)ethan-1-one (**3m**)

51.2 mg (80% yield). Off-white Solid. Melting point: 61.9 – 63.4 °C.

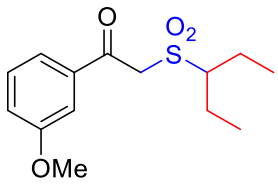
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.60 (d, *J* = 7.6 Hz, 1H), 7.52 (s, 1H), 7.42 (t, *J* = 7.9 Hz, 1H), 7.18 (d, *J* = 8.2 Hz, 1H), 4.55 (s, 2H), 3.85 (s, 3H), 3.49 (t, *J* = 9.3 Hz, 1H), 2.24 – 2.19 (m, 2H), 1.86 – 1.79 (m, 4H), 1.64 – 1.51 (m, 8H). ^{13}C NMR (101 MHz, Chloroform-*d*)) δ 189.30, 160.10, 137.37, 130.06, 122.41, 121.50, 113.07, 62.29, 57.20, 55.65, 26.40, 26.13, 25.60, 25.16. HRMS (EI) Calc. for $C_{17}H_{24}O_4S$: 324.1395. Found: 324.1396.



2-(*sec*-Butylsulfonyl)-1-(3-methoxyphenyl)ethan-1-one **(3n)**

38.0 mg (71% yield). Colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.59 (d, *J* = 7.6 Hz, 1H), 7.51 (s, 1H), 7.41 (t, *J* = 7.9 Hz, 1H), 7.17 (d, *J* = 8.1 Hz, 1H), 4.56 (dd, *J* = 24.0, 14.4 Hz, 2H), 3.85 (s, 3H), 3.30 (broad, 1H), 2.14 – 2.07 (m, 1H), 1.62 (dp, *J* = 15.5, 7.7 Hz, 1H), 1.43 (d, *J* = 6.8 Hz, 3H), 1.06 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.23, 160.04, 137.23, 130.03, 122.32, 121.40, 113.09, 59.62, 57.43, 55.59, 21.91, 12.21, 11.06. HRMS (EI) Calc. for $C_{13}H_{18}O_4S$: 270.0926. Found: 270.0921.

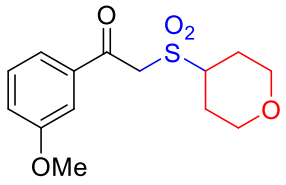


1-(3-Methoxyphenyl)-2-(pentan-3-ylsulfonyl)ethan-1-one (**3o**)

35.7 mg (63% yield). Colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.60 (d, *J* = 7.6 Hz, 1H), 7.52 (s, 1H), 7.42 (t, *J* = 7.9 Hz, 1H), 7.18 (d, *J* = 8.1 Hz, 1H), 4.56 (s, 2H), 3.86 (s, 3H), 3.24 – 3.18 (m, 1H),

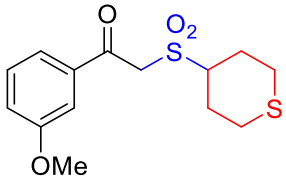
2.01 (dp, J = 13.2, 7.3 Hz, 2H), 1.86 (dp, J = 14.7, 7.3 Hz, 2H), 1.10 (t, J = 7.5 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.32, 160.11, 137.36, 130.07, 122.39, 121.49, 113.11, 64.87, 58.50, 55.65, 20.02, 11.07. HRMS (EI) Calc. for $C_{13}H_{18}O_4S$: 284.1082. Found: 284.1077.



1-(3-Methoxyphenyl)-2-((tetrahydro-2*H*-pyran-4-yl)sulfonyl)ethan-1-one (**3p**)

58.2 mg (97% yield). White Solid. Melting point: 123.4 – 124.2 °C.

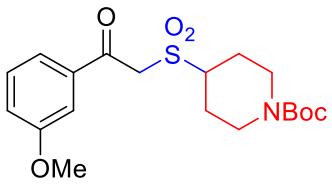
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.59 (d, J = 7.6 Hz, 1H), 7.51 (s, 1H), 7.44 (t, J = 7.9 Hz, 1H), 7.20 (d, J = 8.2 Hz, 1H), 4.55 (s, 2H), 4.13 (d, J = 10.5 Hz, 2H), 3.86 (s, 3H), 3.59 (tt, J = 10.4, 4.1 Hz, 1H), 3.45 (t, J = 11.4 Hz, 2H), 2.11 – 1.95 (m, 4H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.29, 160.18, 137.13, 130.17, 122.38, 121.65, 113.18, 66.45, 58.39, 56.98, 55.67, 24.89. HRMS (EI) Calc. for $C_{14}H_{18}O_5S$: 298.0875. Found: 298.0871.



1-(3-Methoxyphenyl)-2-((tetrahydro-2H-thiopyran-4-yl)sulfonyl)ethan-1-one (**3q**)

28.7 mg (46% yield). Light yellow oil.

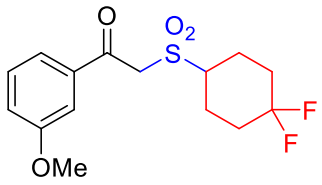
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.58 (d, J = 7.6 Hz, 1H), 7.50 (s, 1H), 7.43 (t, J = 7.9 Hz, 1H), 7.19 (d, J = 8.1 Hz, 1H), 4.56 (s, 2H), 3.86 (s, 3H), 3.35 (t, J = 11.8 Hz, 1H), 2.81 – 2.70 (m, 4H), 2.53 (d, J = 12.8 Hz, 2H), 2.00 (qd, J = 12.4, 4.0 Hz, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.21, 160.15, 137.12, 130.14, 122.33, 121.60, 113.15, 61.01, 56.86, 55.66, 27.51, 26.28. HRMS (EI) Calc. for $C_{14}H_{18}O_4S_2$: 314.0647. Found: 314.0644.



tert-Butyl 4-((2-(3-methoxyphenyl)-2-oxoethyl)sulfonyl)piperidine-1-carboxylate (**3r**)

60.8 mg (78% yield). Off-white crystalline solid. Melting point: 118.8 – 119.9 °C.

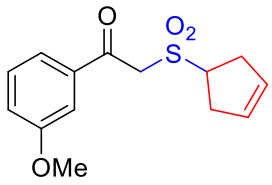
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.58 (d, *J* = 7.6 Hz, 1H), 7.50 (s, 1H), 7.42 (t, *J* = 7.9 Hz, 1H), 7.19 (d, *J* = 8.2 Hz, 1H), 4.56 (s, 2H), 4.29 (broad, 2H), 3.85 (s, 3H), 3.49 (t, *J* = 12.0 Hz, 1H), 2.78 (broad, 2H), 2.12 (d, *J* = 12.3 Hz, 2H), 1.80 (qd, *J* = 12.4, 4.2 Hz, 2H), 1.45 (s, 9H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.26, 160.15, 154.40, 137.09, 130.15, 122.33, 121.63, 113.14, 80.31, 59.46, 57.17, 55.65, 28.49, 24.34. HRMS (ESI) Calc. for $C_{19}H_{27}NNaO_6S$: 420.1451. Found: 420.1458.



2-((4,4-Difluorocyclohexyl)sulfonyl)-1-(3-methoxyphenyl)ethan-1-one (**3s**)

53.5 mg (81% yield). White powder. Melting point: 130.5 – 134.9 °C.

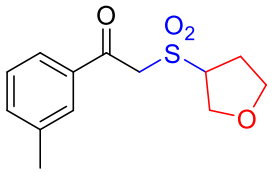
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.59 (d, *J* = 7.7 Hz, 1H), 7.51 (s, 1H), 7.44 (t, *J* = 8.0 Hz, 1H), 7.21 (d, *J* = 8.2 Hz, 1H), 4.59 (s, 2H), 3.87 (s, 3H), 3.42 (t, *J* = 11.5 Hz, 1H), 2.39 – 2.24 (m, 4H), 2.05 (q, *J* = 12.8, 11.8 Hz, 2H), 1.93 – 1.77 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.27, 160.20, 137.05, 130.21, 122.34, 121.68, 113.21, 58.40, 57.65, 55.68, 32.19 (t, J_F = 25.2 Hz), 21.81, 21.71. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -94.34 (d, *J* = 239.4 Hz), -101.80 (dt, *J* = 240.3, 31.6 Hz). HRMS (EI) Calc. for $C_{15}H_{18}F_2O_4S$: 332.0894. Found: 332.0889.



2-(Cyclopent-3-en-1-ylsulfonyl)-1-(3-methoxyphenyl)ethan-1-one (**3t**)

32.9 mg (59% yield). Light yellow oil.

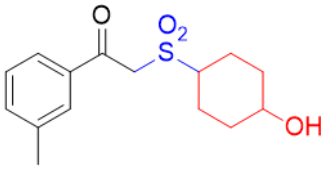
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.50 (d, *J* = 7.6 Hz, 1H), 7.42 (s, 1H), 7.32 (t, *J* = 7.9 Hz, 1H), 7.08 (d, *J* = 8.2 Hz, 1H), 5.61 (s, 2H), 4.45 (s, 2H), 4.01 (p, *J* = 8.0 Hz, 1H), 3.76 (s, 3H), 2.85 (dd, *J* = 15.8, 6.4 Hz, 2H), 2.72 (dd, *J* = 15.6, 9.7 Hz, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 188.93, 160.12, 137.22, 130.08, 128.39, 122.42, 121.51, 113.20, 59.97, 58.87, 55.64, 33.66. HRMS (EI) Calc. for $C_{14}H_{16}O_4S$: 280.0769. Found: 280.0769.



1-(*m*-Tolyl)-2-((tetrahydrofuran-3-yl)sulfonyl)ethan-1-one (**3u**)

36.3 mg (68% yield). White powder. Melting point: 132.3 – 132.5 °C.

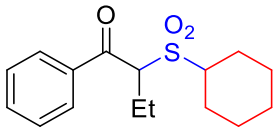
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.82 (d, *J* = 6.6 Hz, 2H), 7.48 (d, *J* = 7.4 Hz, 1H), 7.42 (t, *J* = 7.7 Hz, 1H), 4.58 (s, 2H), 4.26 – 4.21 (m, 1H), 4.15 – 4.07 (m, 2H), 4.00 (q, *J* = 7.3 Hz, 1H), 3.86 (q, *J* = 7.3 Hz, 1H), , 2.48 – 2.41 (m, 1H), 2.44 (s, 3H), 2.38 – 2.32 (m, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 189.11, 139.18, 135.80, 129.93, 129.07, 126.89, 68.57, 67.31, 61.72, 59.68, 27.53, 21.49. HRMS (EI) Calc. for $C_{13}H_{17}O_4S^+$: 269.0842. Found: 269.0844.



2-((4-Hydroxycyclohexyl)sulfonyl)-1-(*m*-tolyl)ethan-1-one (**3v**)

Get 44.3 mg (75% yield). Colorless oil. 1:1 mixture of two isomers.

^{1}H NMR (400 MHz, Acetone-d_6) δ 7.92 – 7.89 (m, 2H), 7.52 (d, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.5 Hz, 1H), 4.84 (s, 1H), 4.82 (s, 1H), 4.02 (s, 0.5H), 3.86 (d, *J* = 3.2 Hz, 0.5H), 3.67 (s, 0.5H), 3.59 – 3.54 (m, 0.5H), 3.37 – 3.26 (m, 1H), 2.42 (s, 3H), 2.24 (d, *J* = 12.7 Hz, 1H), 2.12 – 2.04 (m, 2H), 1.98 – 1.91 (m, 2H), 1.61 (t, *J* = 12.9 Hz, 2H), 1.36 – 1.28 (m, 1H). ^{13}C NMR (101 MHz, Acetone-d_6) δ 190.57, 190.50, 139.46, 139.44, 137.53, 137.48, 135.63, 135.59, 130.51, 129.51, 127.45, 69.30, 64.29, 61.82, 61.32, 57.93, 57.60, 34.63, 32.14, 24.10, 21.26, 19.59. HRMS(ESI) Calc. for $C_{15}H_{21}O_4S^+$: 297.1155. Found: 297.1149.



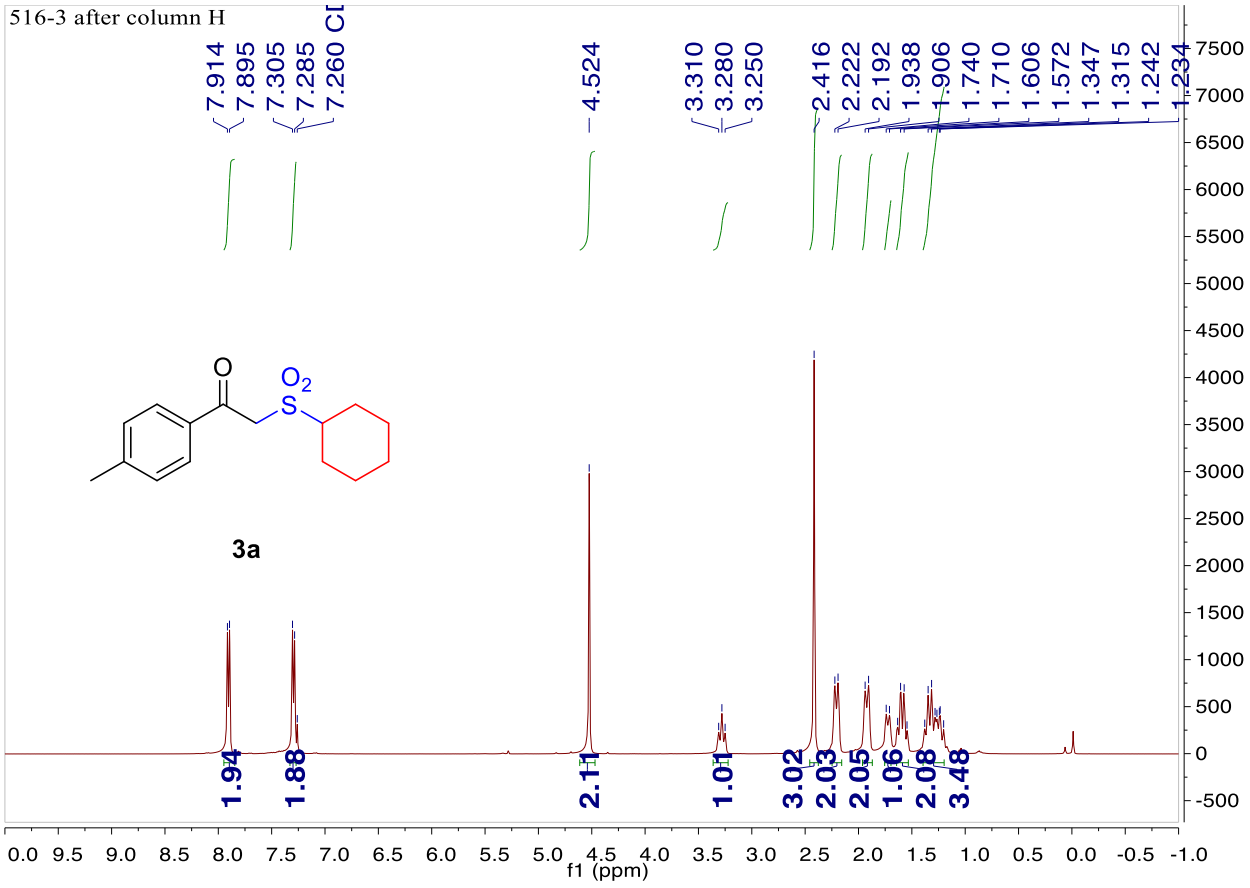
2-(Cyclohexylsulfonyl)-1-phenylbutan-1-one (**3w**)

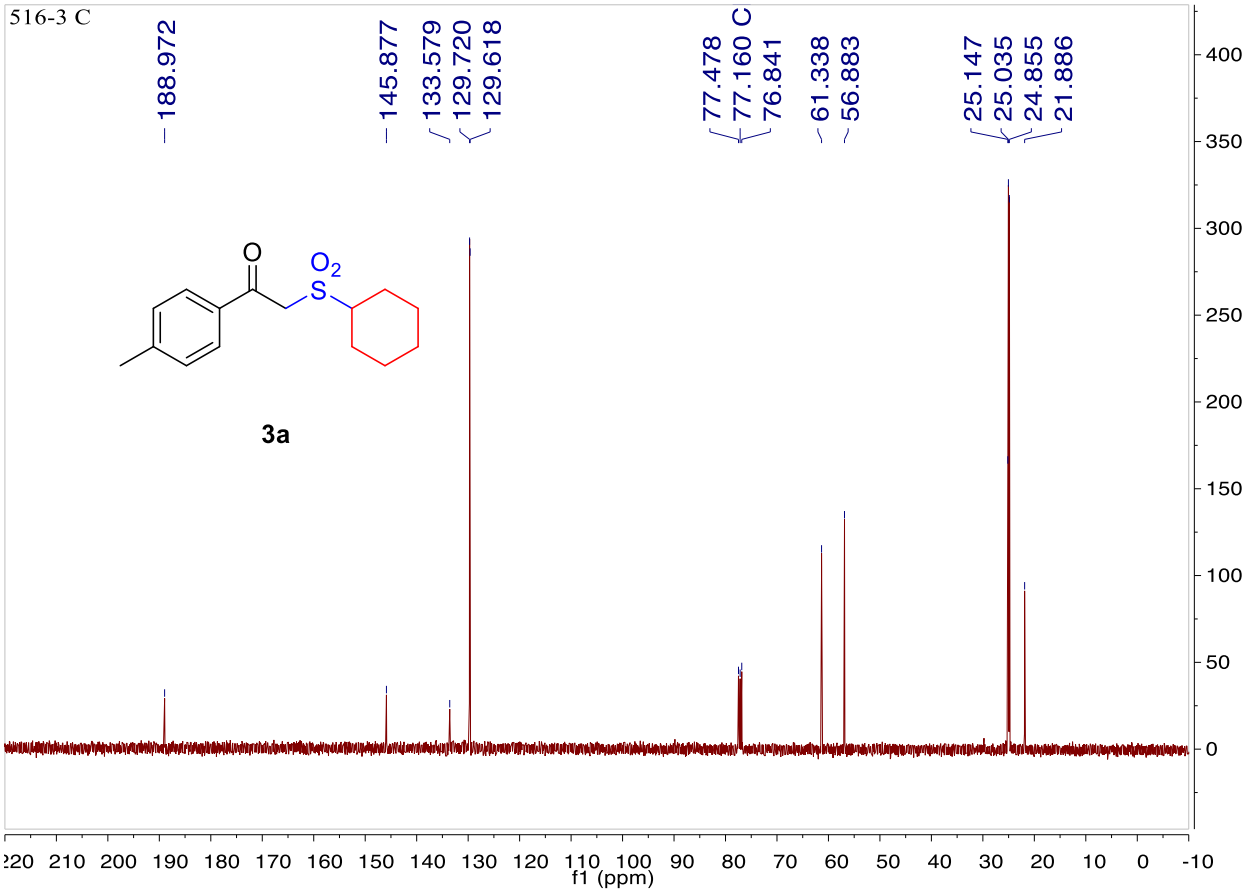
21.7 mg (37% yield). Colorless oil.

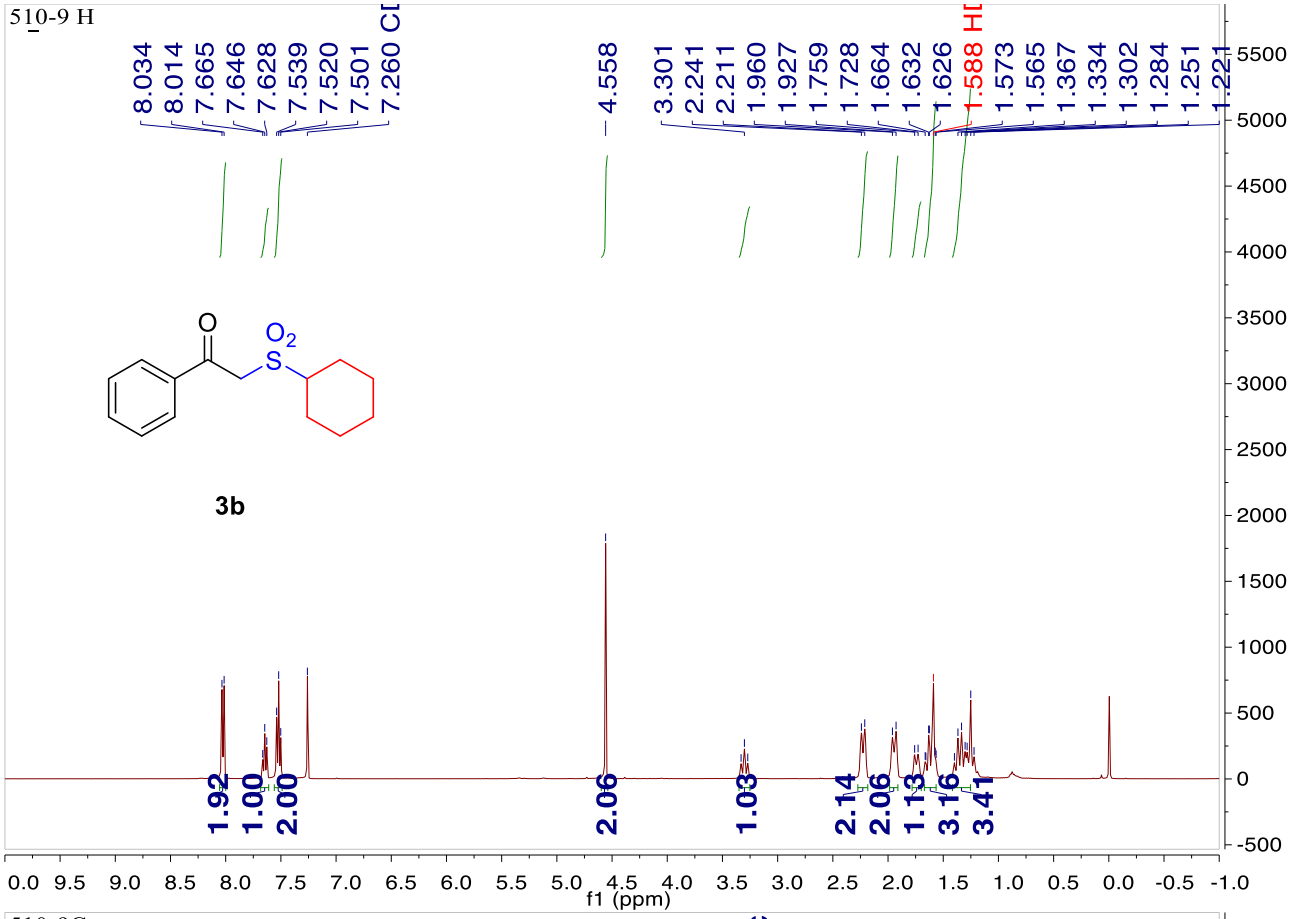
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.99 (d, *J* = 7.7 Hz, 2H), 7.61 (t, *J* = 7.3 Hz, 1H), 7.49 (t, *J* = 7.5 Hz, 2H), 3.98 – 3.88 (m, 1H), 3.72 (dd, *J* = 17.7, 2.7 Hz, 1H), 3.21 (dd, *J* = 18.0, 9.3 Hz, 1H), 3.02 (t, *J* = 12.1 Hz, 1H), 2.22 (d, *J* = 13.8 Hz, 1H), 2.12 (d, *J* = 12.4 Hz, 1H), 1.95 (t, *J* = 11.6 Hz, 2H), 1.74 (d, *J* = 9.3 Hz, 1H), 1.68 – 1.59 (m, 2H),

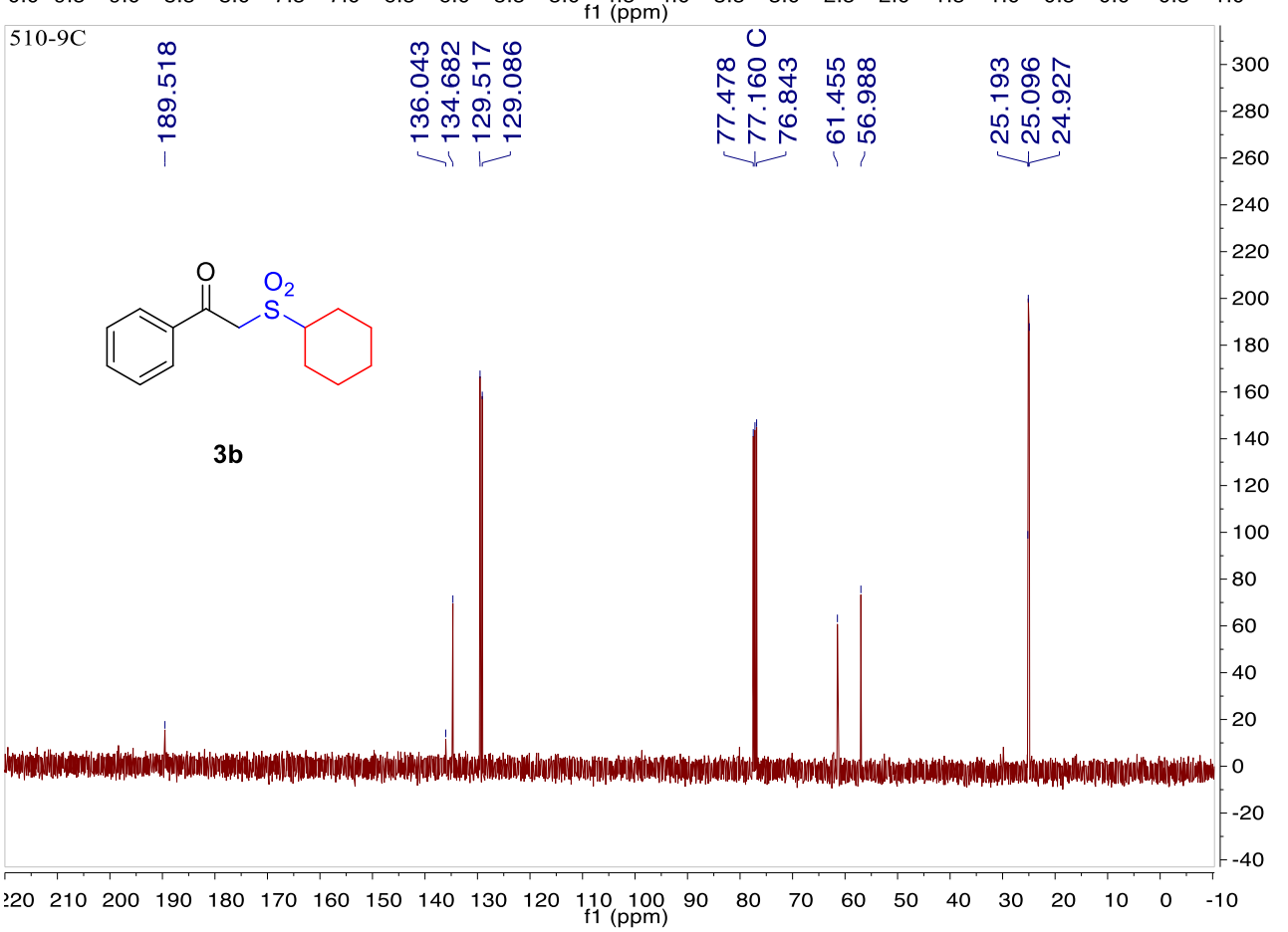
1.43 (d, J = 6.7 Hz, 3H), 1.35 – 1.27 (m, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 196.27, 133.90, 128.95, 128.32, 58.35, 49.68, 37.40, 25.78, 25.28, 25.24, 25.23, 24.03, 14.67. HRMS (ESI) Calc. for $C_{16}H_{22}NaO_3S$: 317.1182. Found: 317.1189.

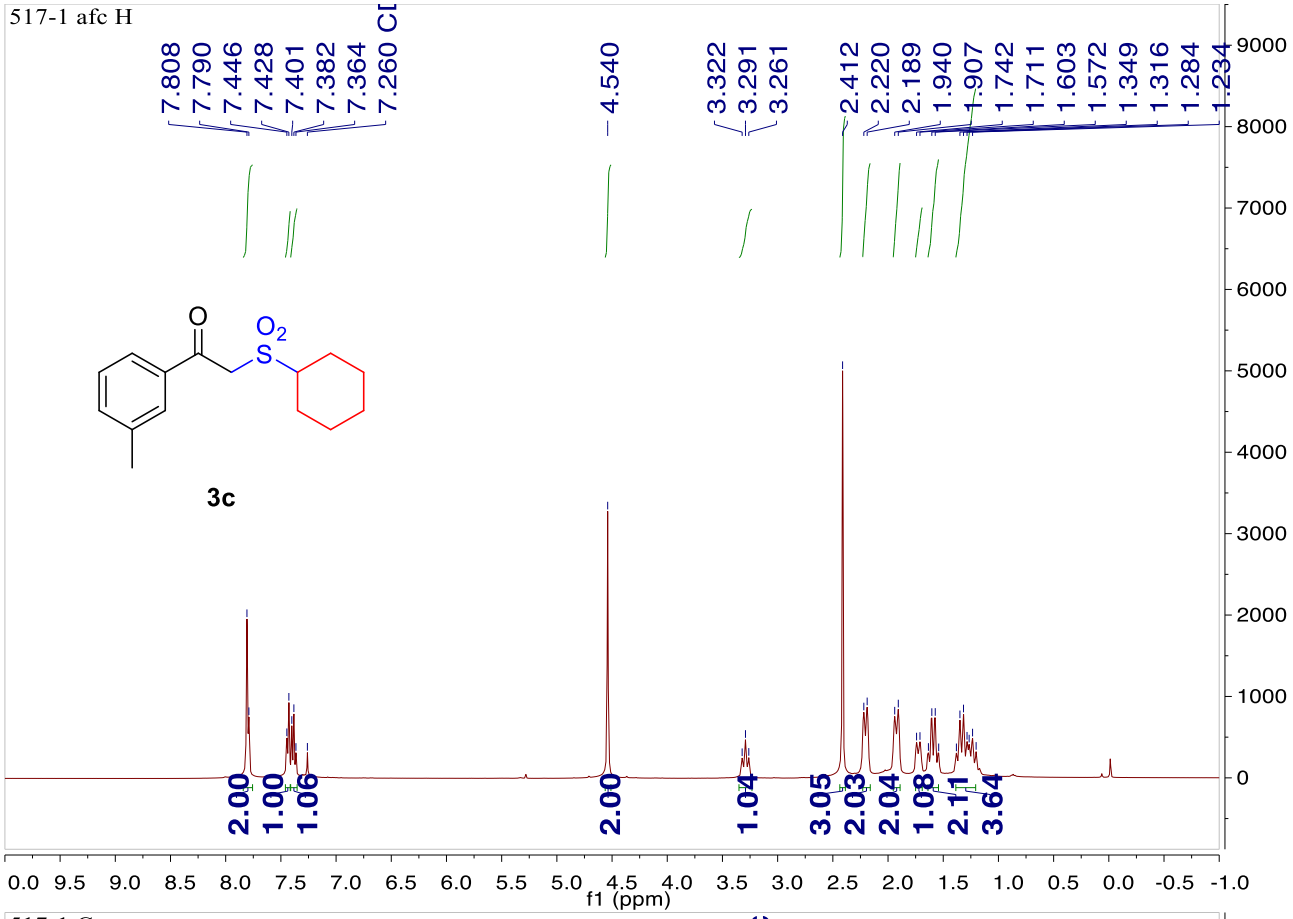
4. ^{1}H, ^{13}C and ^{19}F NMR spectra of compounds 3.

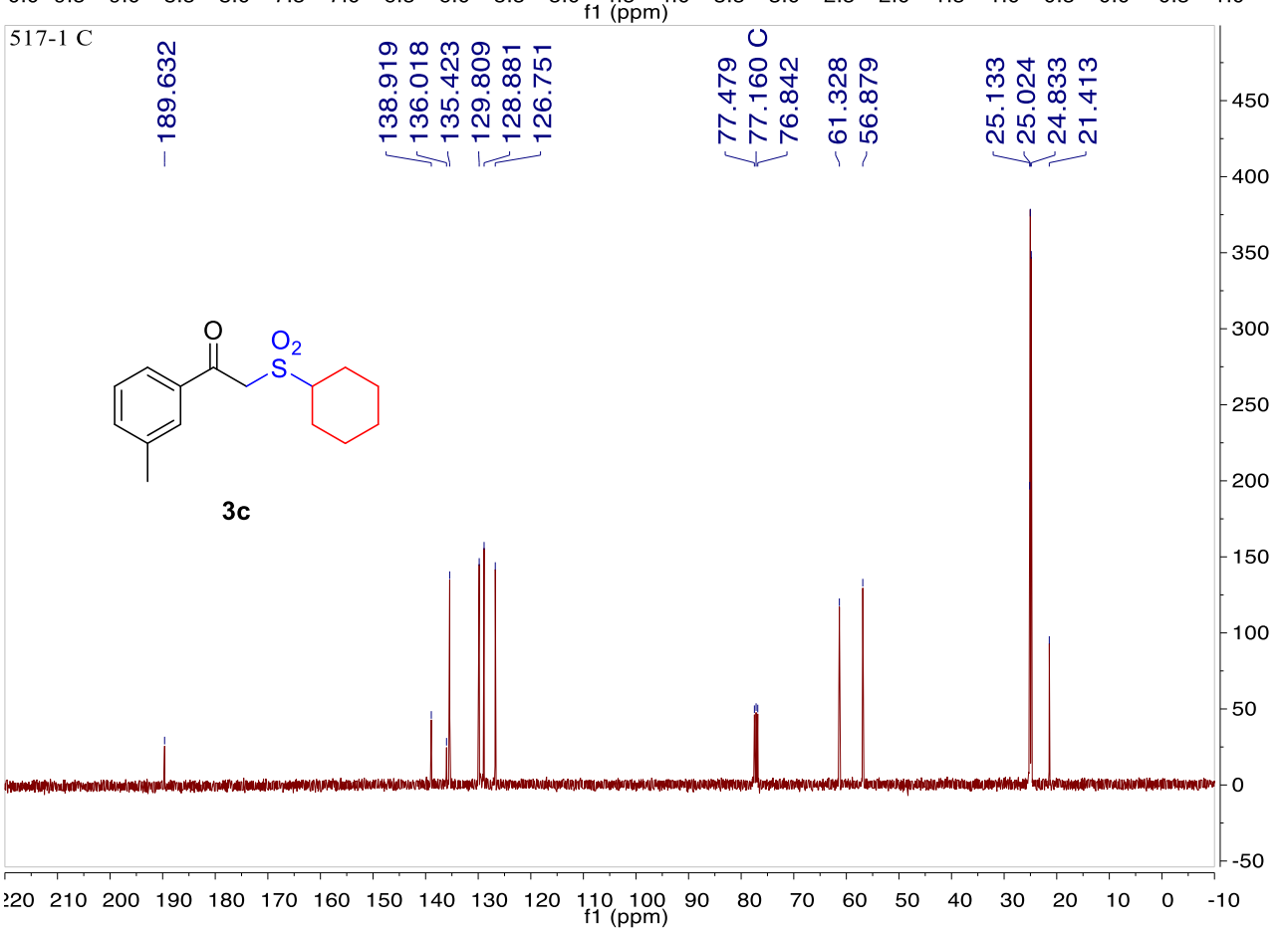





510-9 H
8.034
8.014
7.665
7.646
7.628
7.539
7.520
7.501
7.260
4.558
3.301
2.241
2.211
1.960
1.927
1.759
1.728
1.664
1.632
1.626
1.588
1.573
1.565
1.367
1.334
1.302
1.284
1.251
1.221
O
O2
S
3b
1.92
1.00
2.00
2.06
1.03
2.14
2.06
1.13
3.16
3.41
f1 (ppm)


510-9C
189.518
136.043
134.682
129.517
129.086
77.478
77.160
76.843
61.455
56.988
25.193
25.096
24.927
O
O2
S
3b
f1 (ppm)


517-1 afc H
7.808
7.790
7.446
7.428
7.401
7.382
7.364
7.260
4.540
3.322
3.291
3.261
2.412
2.220
2.189
1.940
1.907
1.742
1.711
1.603
1.572
1.349
1.316
1.284
1.234
O
O2
S
3c
2.00
1.00
1.06
2.00
1.04
3.05
2.03
2.04
1.08
2.11
3.64
f1 (ppm)


517-1 C
189.632
138.919
136.018
135.423
129.809
128.881
126.751
77.479
77.160
76.842
61.328
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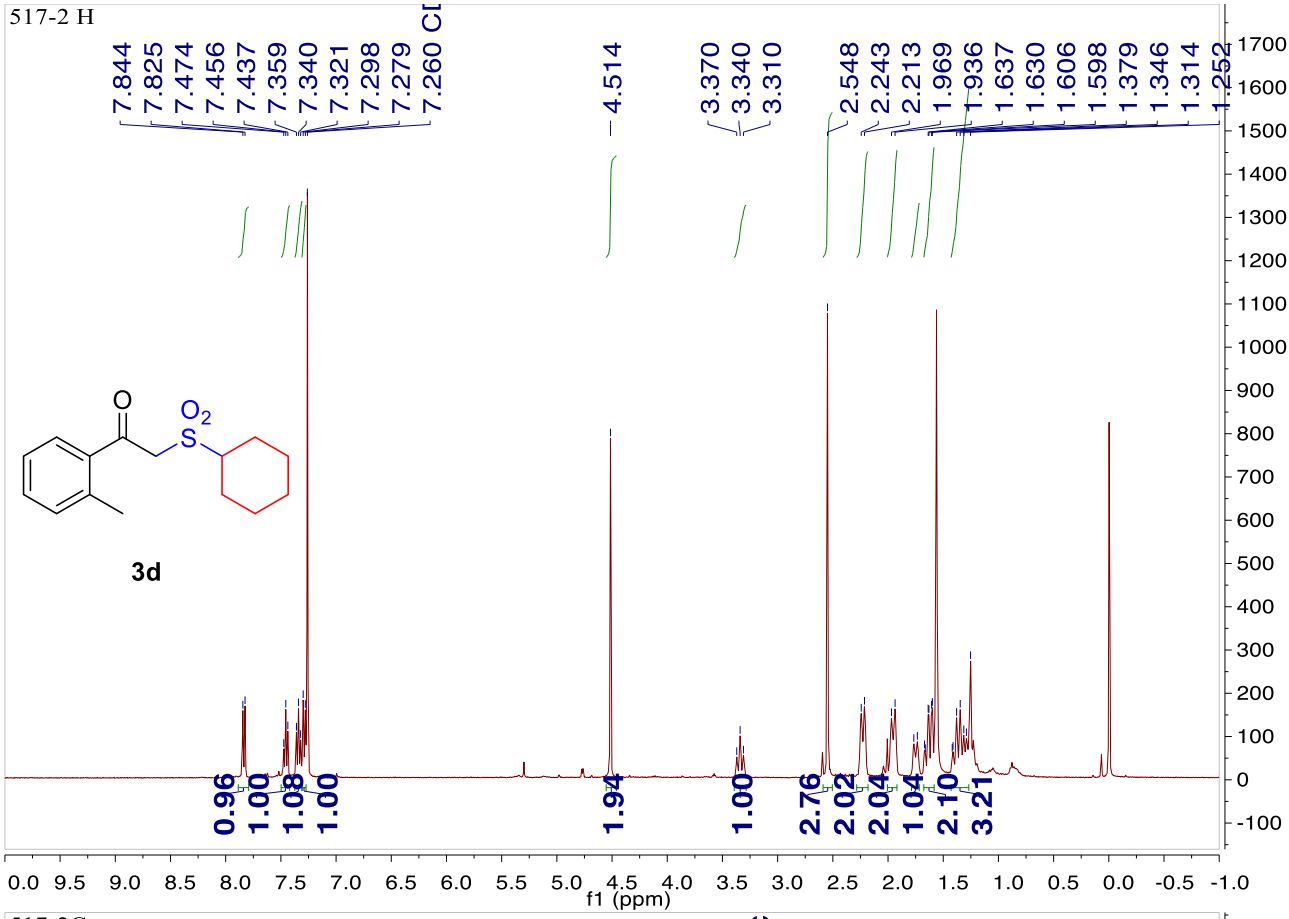
25.133
25.024
24.833
21.413
O
O2
S
3c
f1 (ppm)


517-2 H
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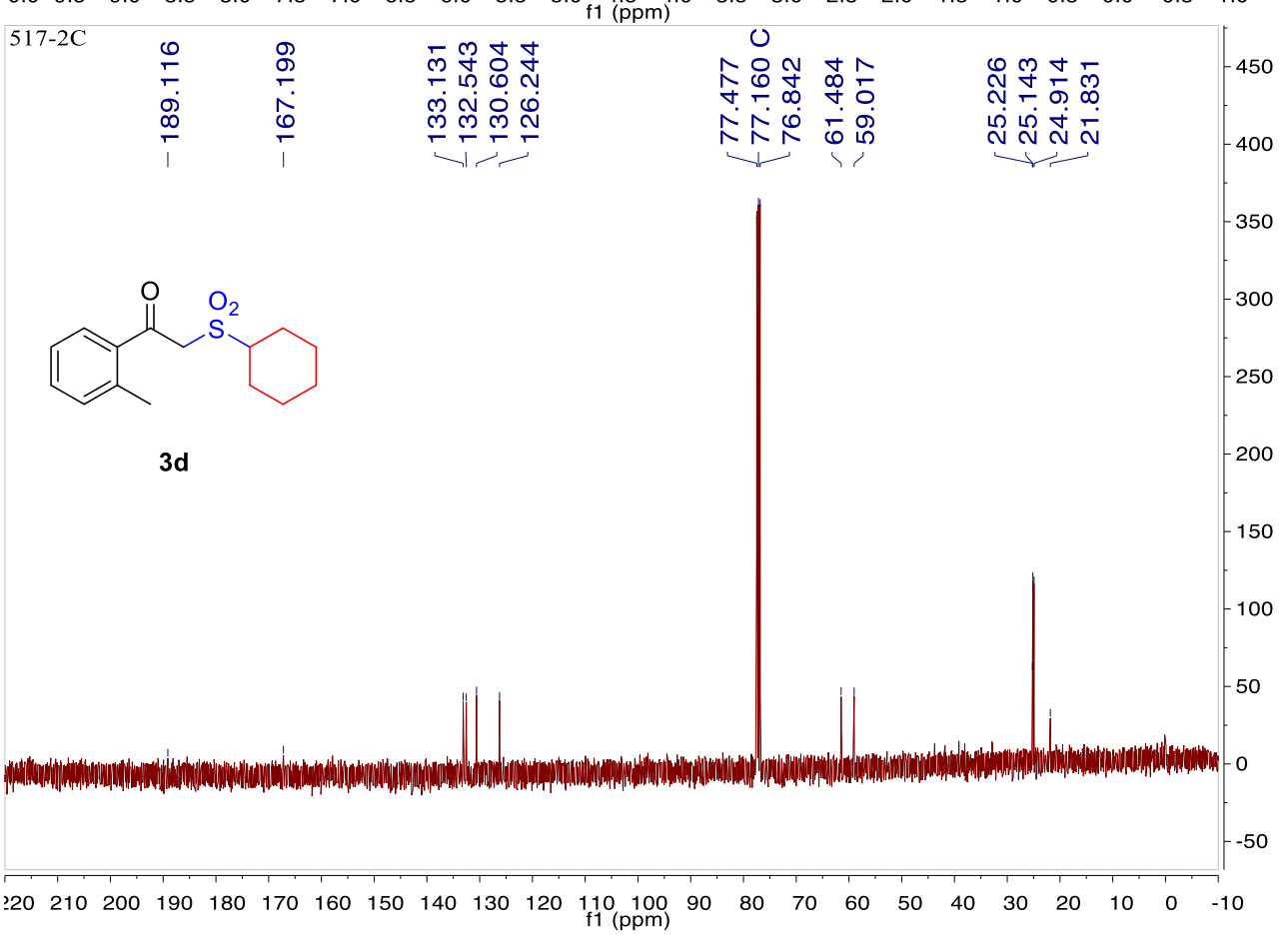
7.825
7.474
7.456
7.437
7.359
7.340
7.321
7.298
7.279
7.260
4.514
3.370
3.340
3.310
2.548
2.243
2.213
1.969
1.936
1.637
1.630
1.606
1.598
1.379
1.346
1.314
1.252
0.96
1.00
1.08
1.00
1.94
1.00
2.76
2.02
2.04
1.04
2.10
3.21
O
O2
S
3d
f1 (ppm)


517-2C
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167.199
133.131
132.543
130.604
126.244
77.477
77.160
76.842
61.484
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25.143
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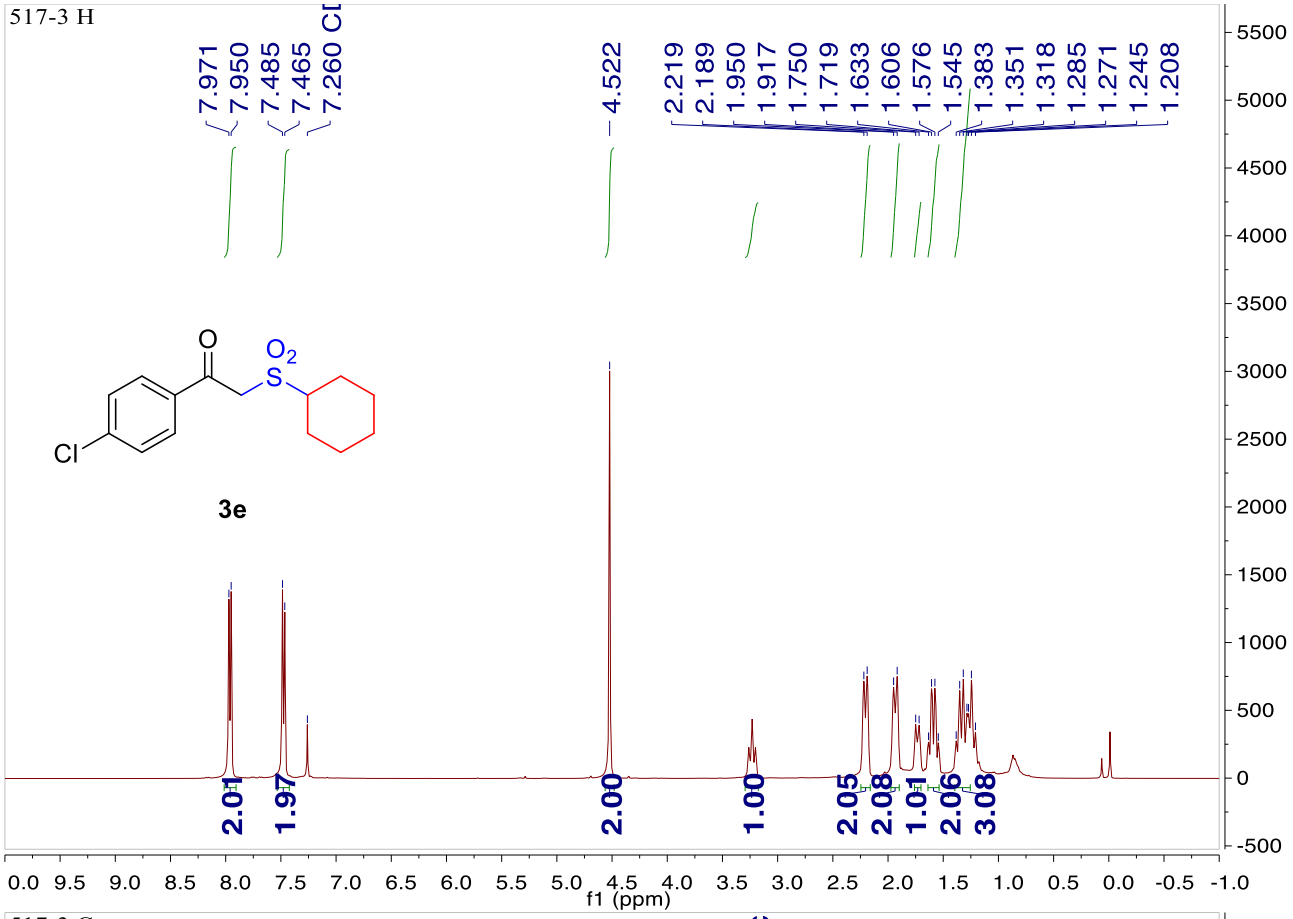
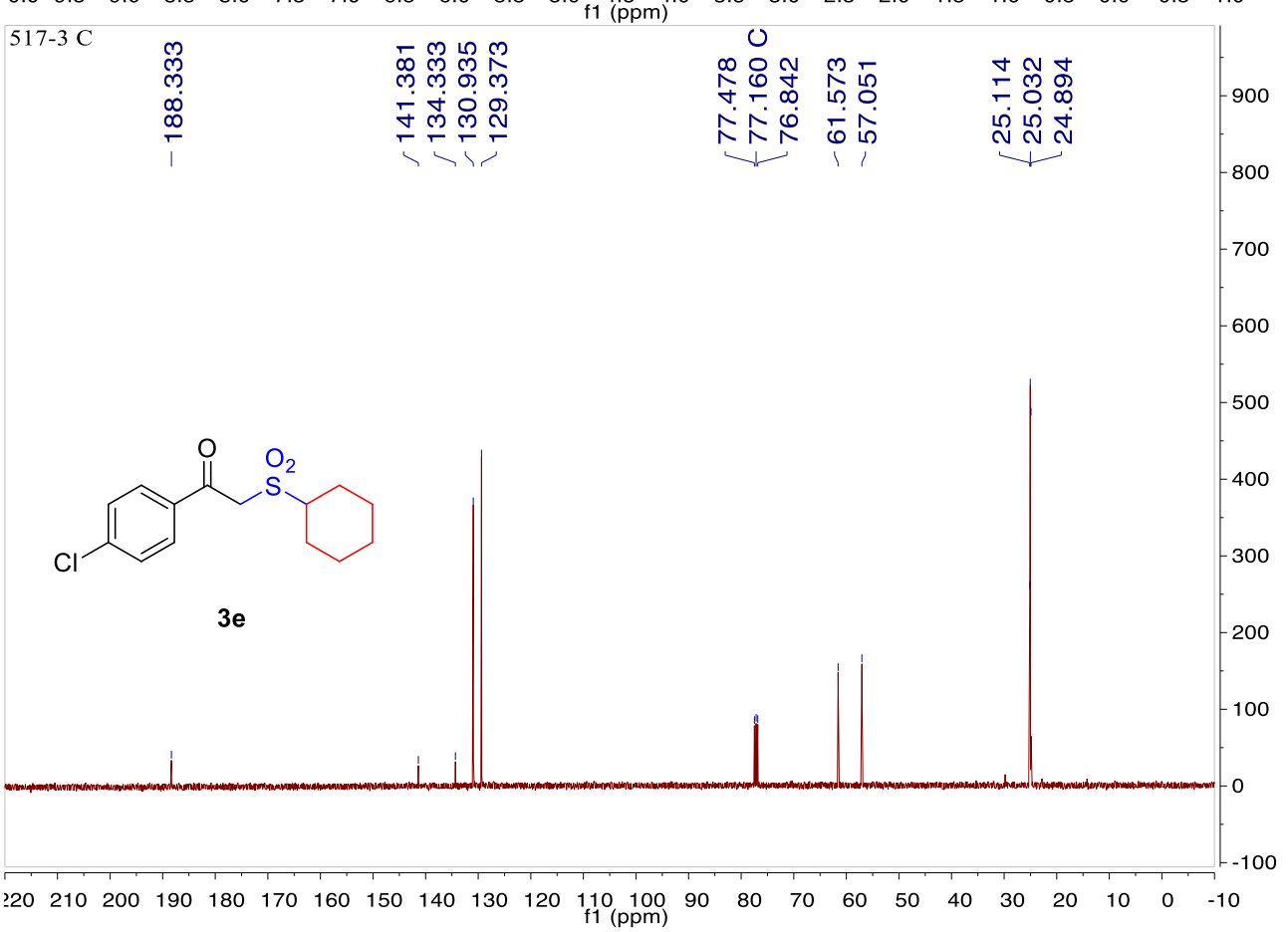
21.831
O
O2
S
3d
f1 (ppm)


517-3 H
7.971
7.950
7.485
7.465
7.260
4.522
2.219
2.189
1.950
1.917
1.750
1.719
1.633
1.606
1.576
1.545
1.383
1.351
1.318
1.285
1.271
1.245
1.208
O
O2
S
Cl
3e
2.01
1.97
2.00
1.00
2.05
2.08
1.01
2.06
3.08
f1 (ppm)


517-3 C
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141.381
134.333
130.935
129.373
77.478
77.160
76.842
61.573
57.051
25.114
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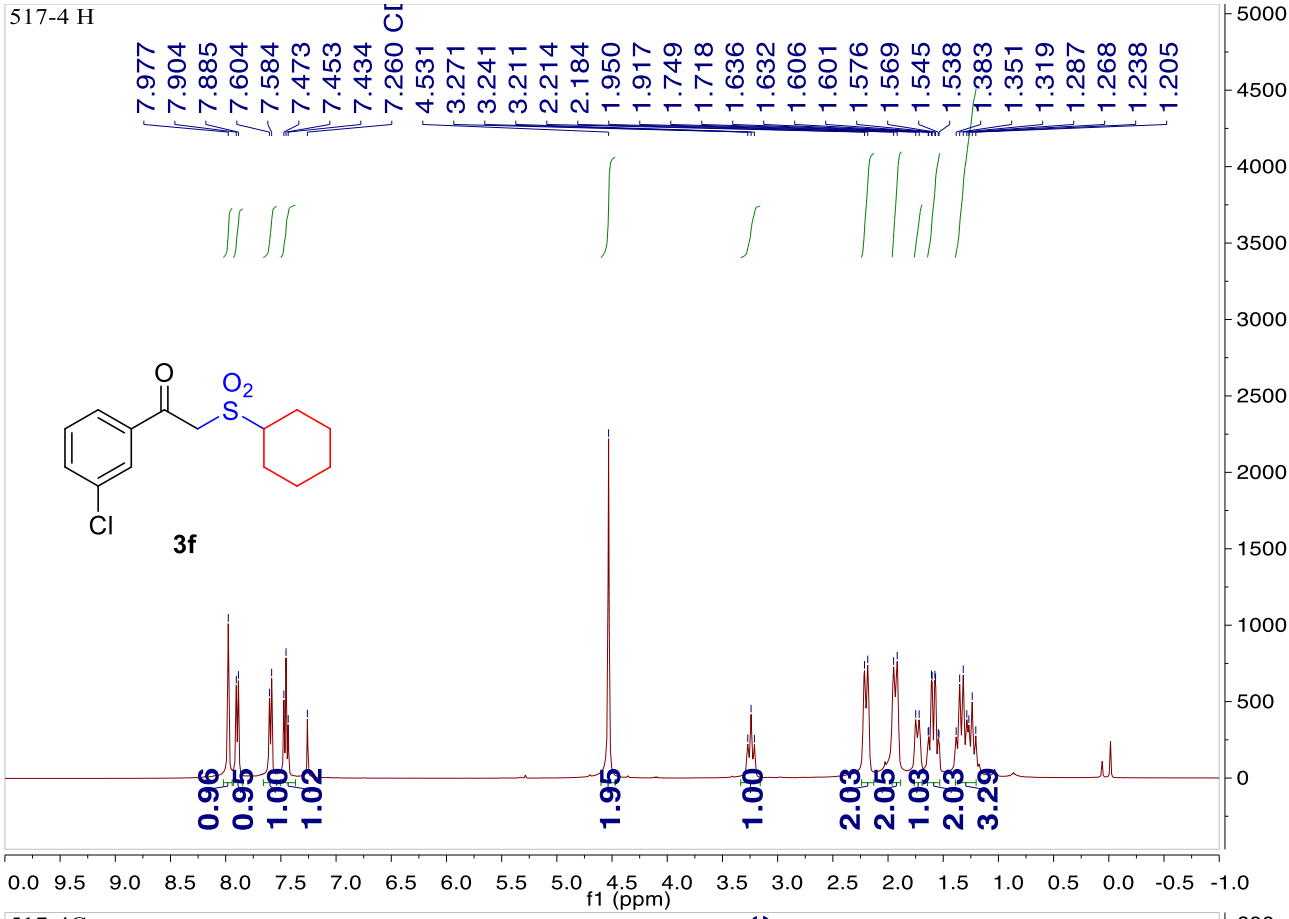
24.894
O
O2
S
Cl
3e
f1 (ppm)


517-4 H
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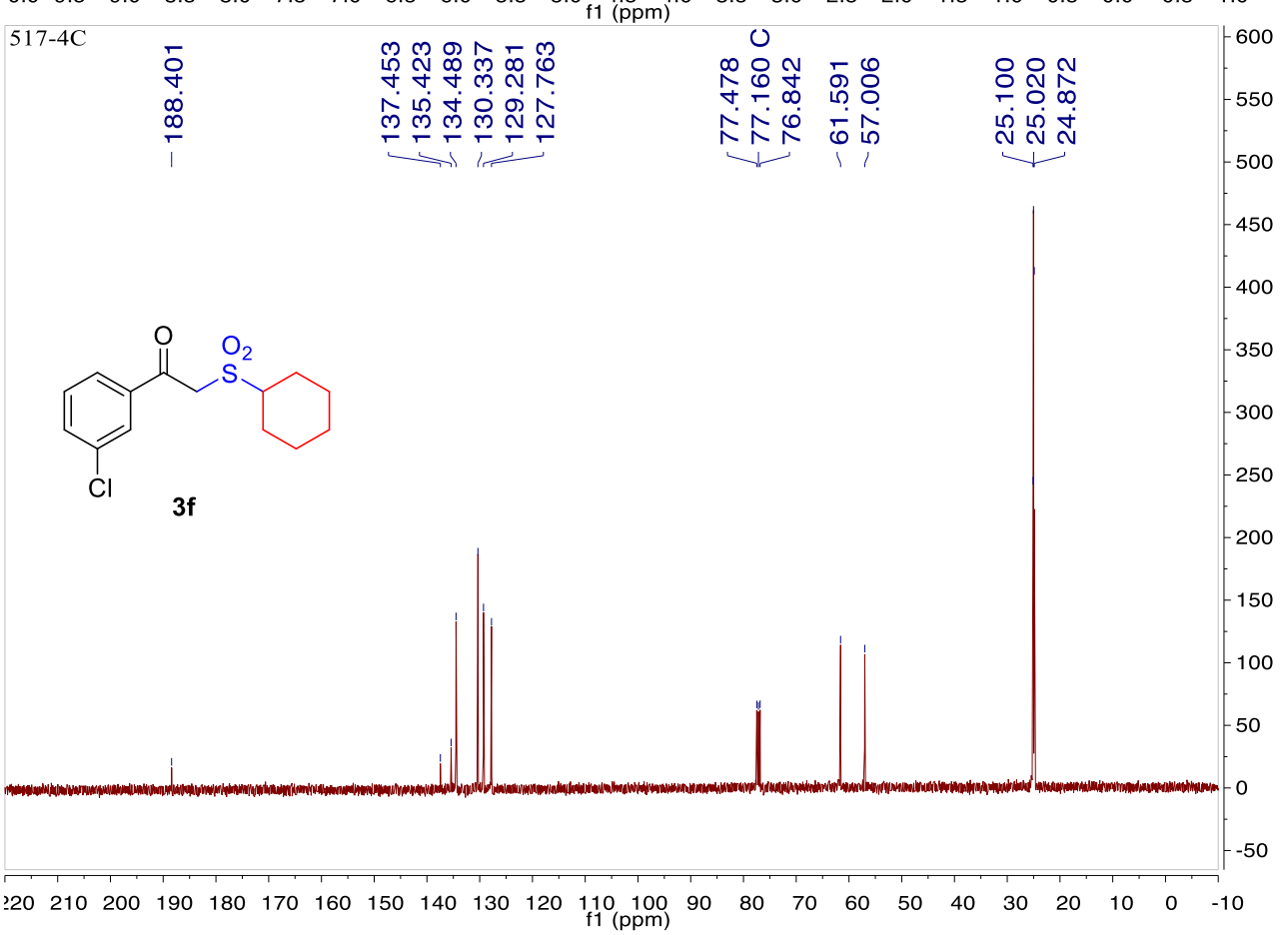
7.904
7.885
7.604
7.584
7.473
7.453
7.434
7.260
4.531
3.271
3.241
3.211
2.214
2.184
1.950
1.917
1.749
1.718
1.636
1.632
1.606
1.601
1.576
1.569
1.545
1.538
1.383
1.351
1.319
1.287
1.268
1.238
1.205
O
O2
S
Cl
3f
0.96
0.95
1.00
1.02
1.95
1.00
2.03
2.05
1.03
2.03
3.29
f1 (ppm)


517-4C
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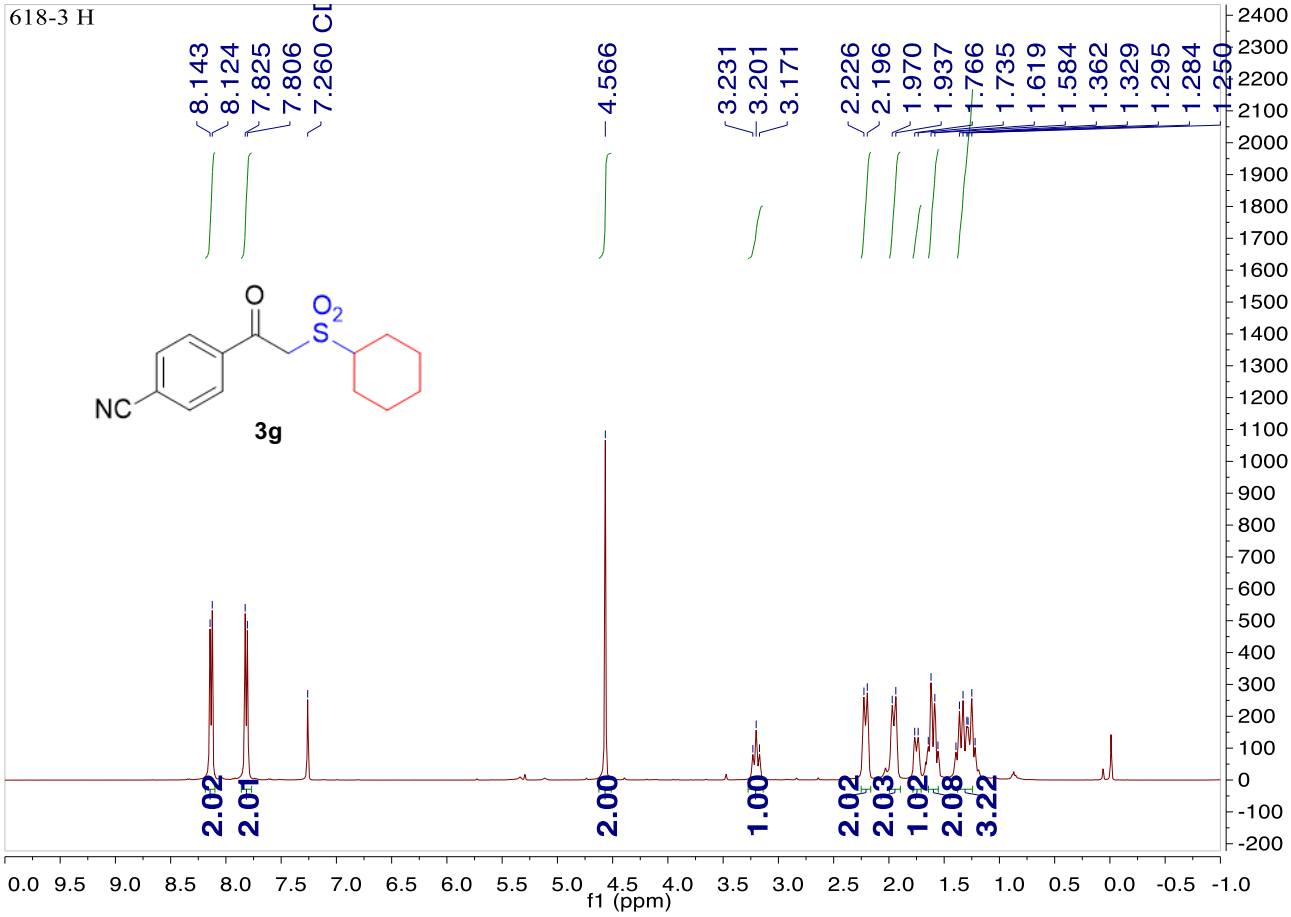
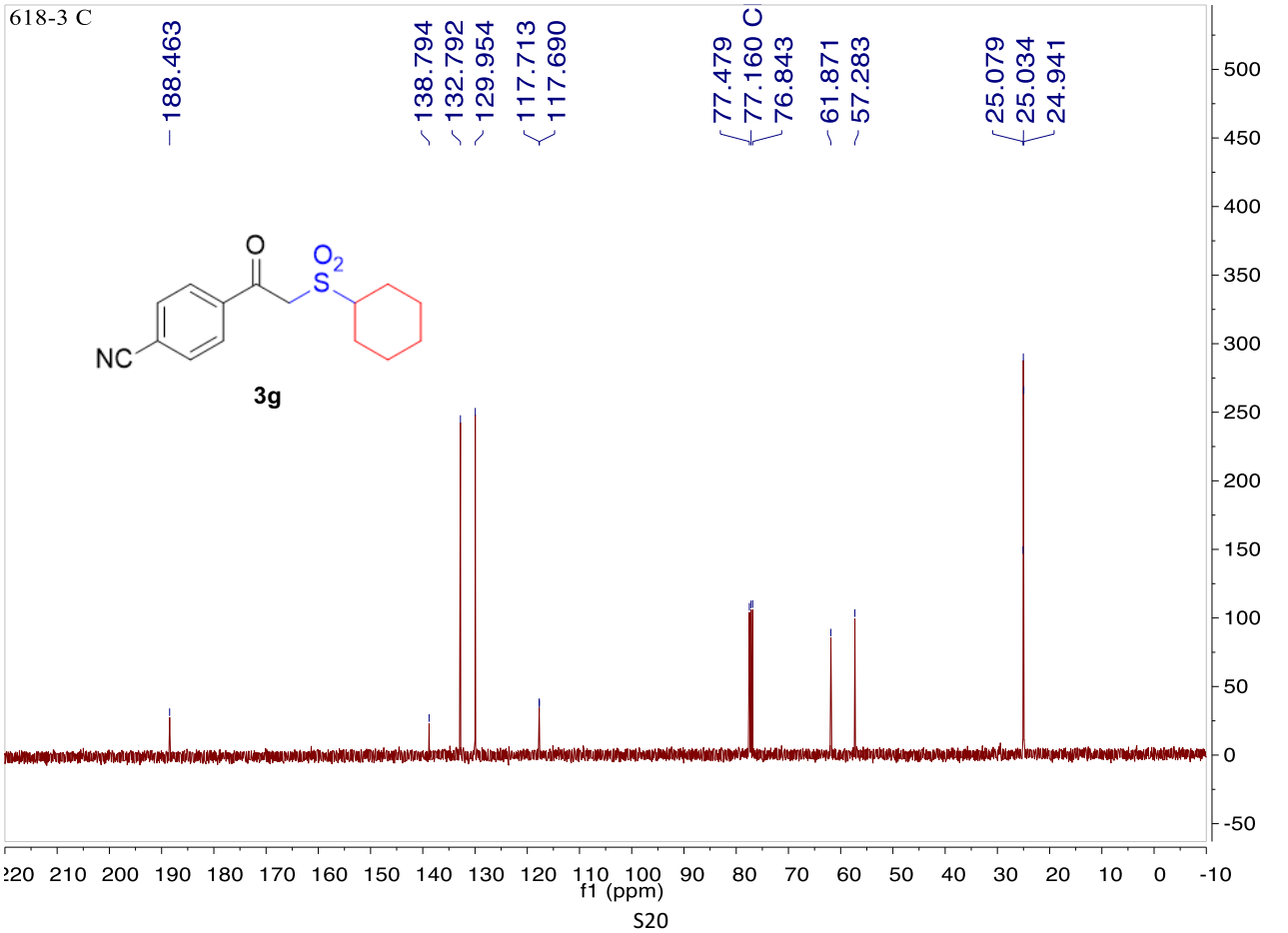
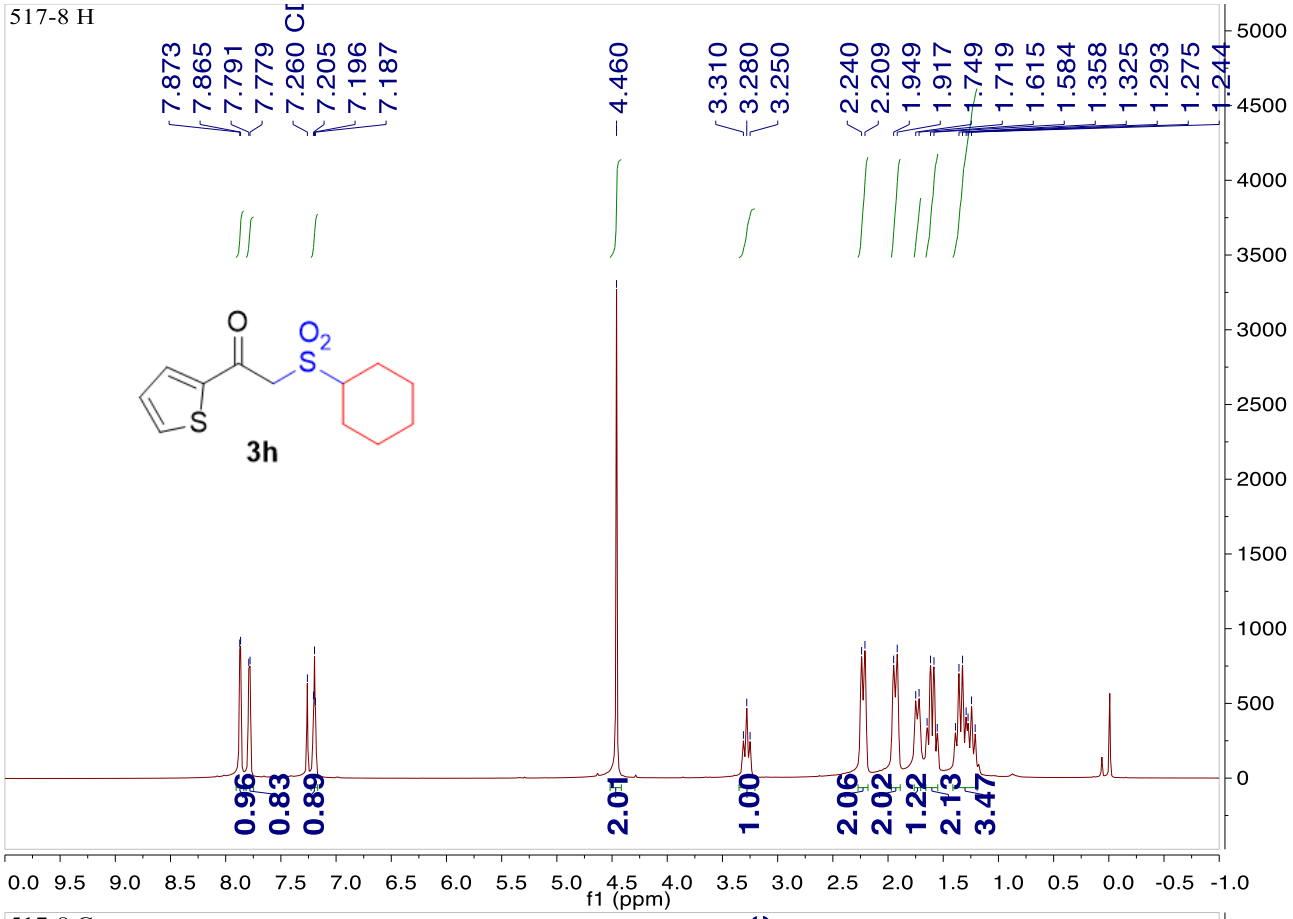
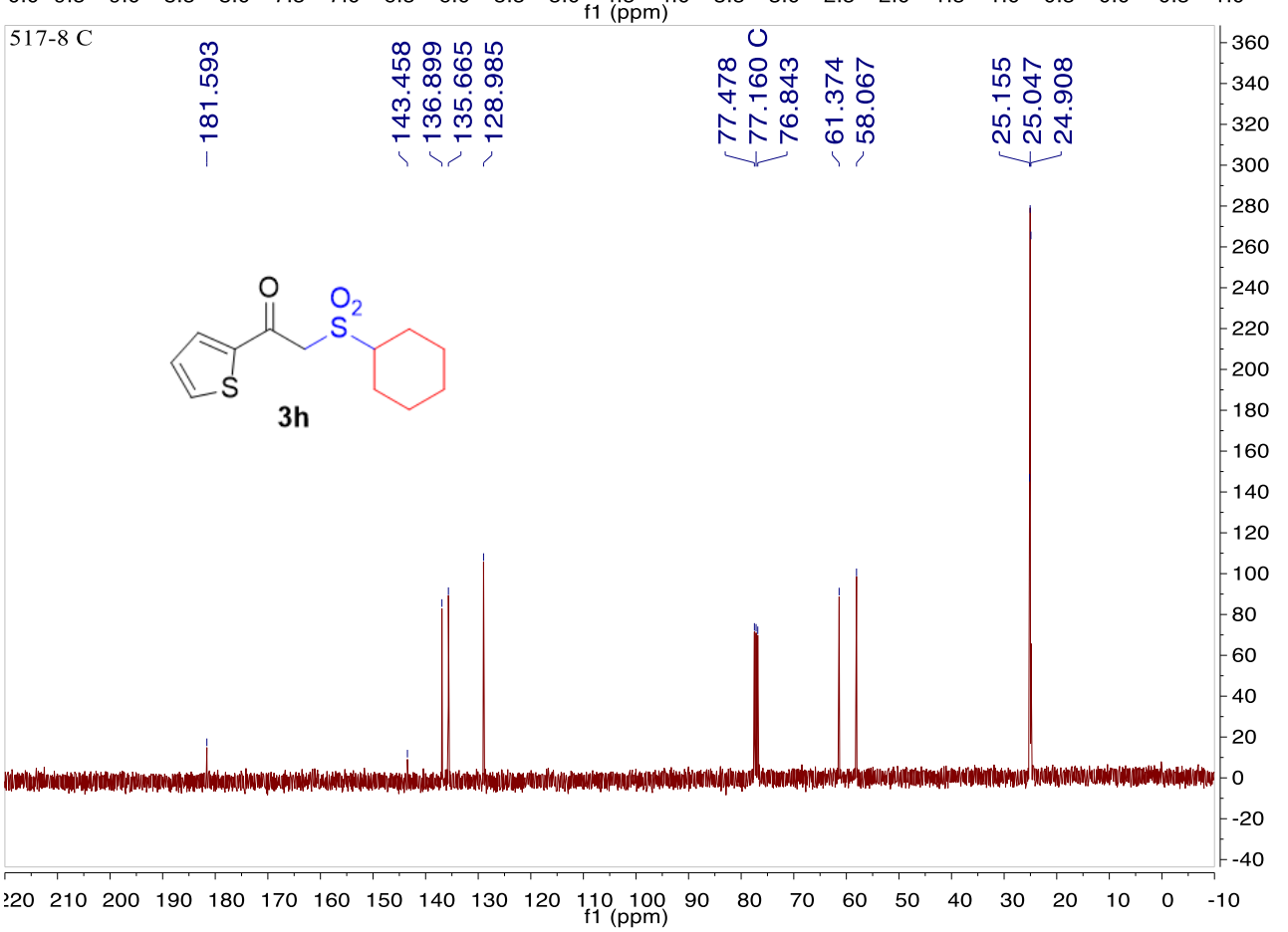
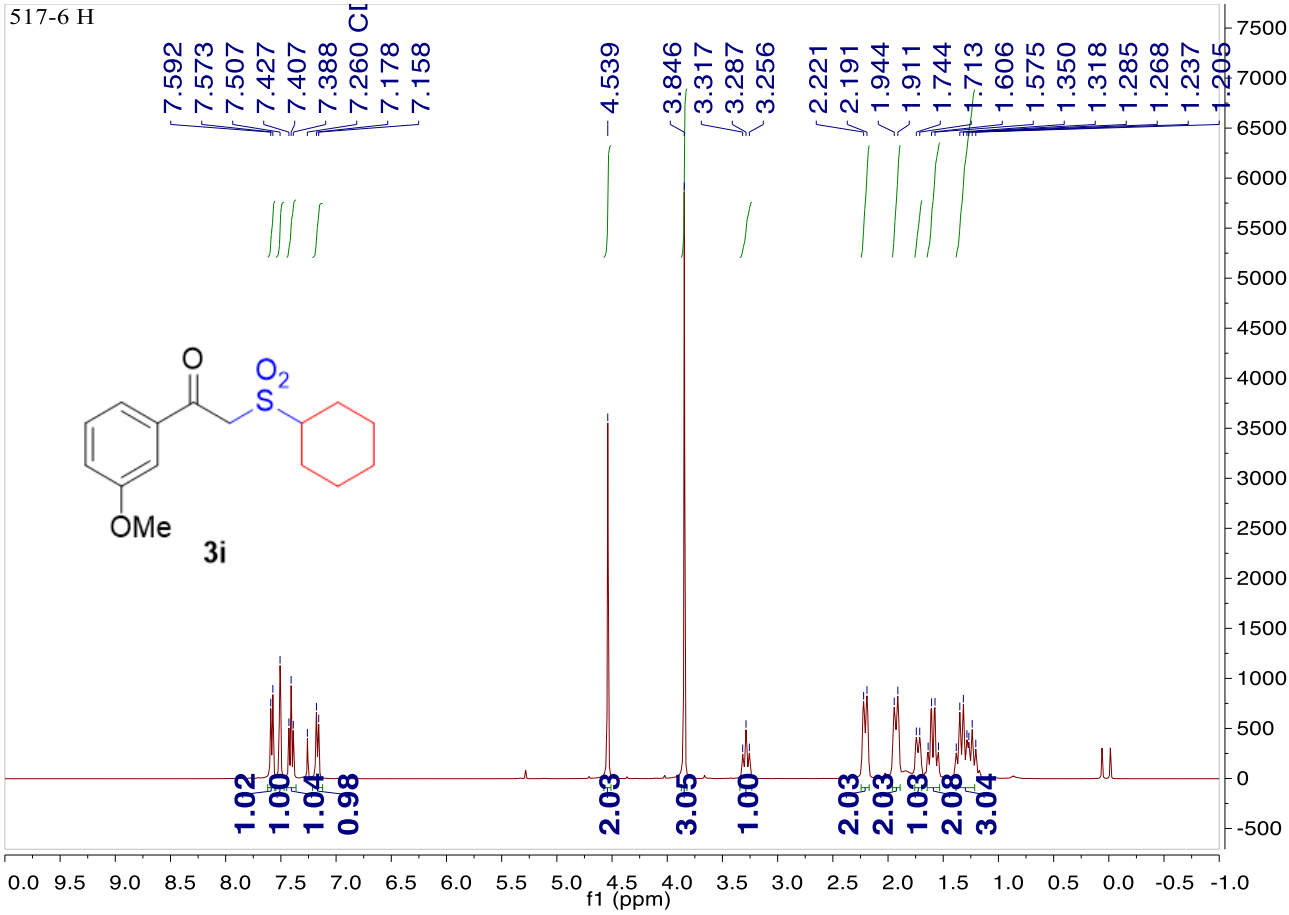
137.453
135.423
134.489
130.337
129.281
127.763
77.478
77.160
76.842
61.591
57.006
25.100
25.020
24.872
O
O2
S
Cl
3f
f1 (ppm)

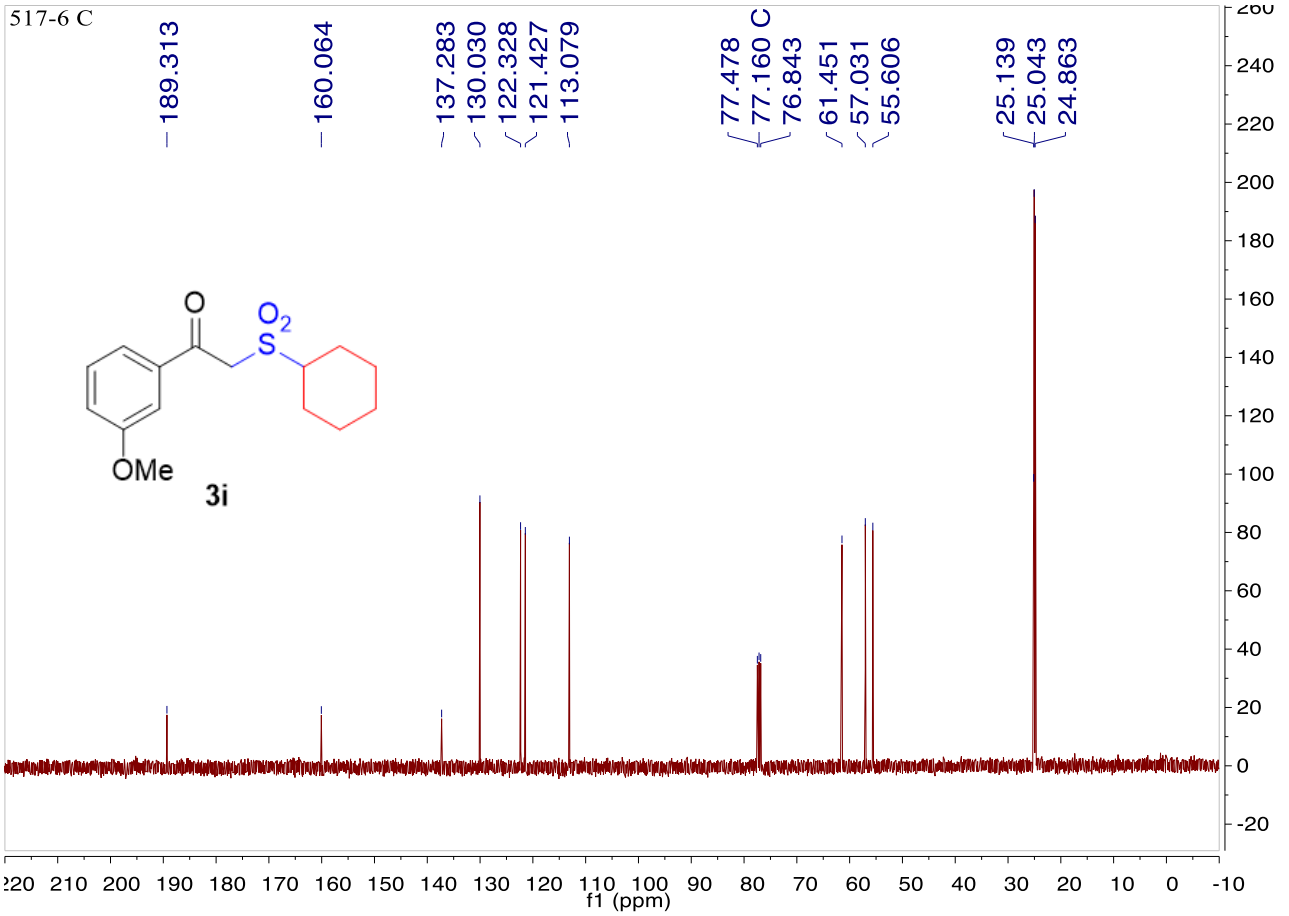

618-3 H
8.143
8.124
7.825
7.806
7.260
4.566
3.231
3.201
3.171
2.226
2.196
1.970
1.937
1.766
1.735
1.619
1.584
1.362
1.329
1.295
1.284
1.250
O
O2
S
NC
3g
2.02
2.01
2.00
1.00
2.02
2.03
1.02
2.08
3.22
f1 (ppm)

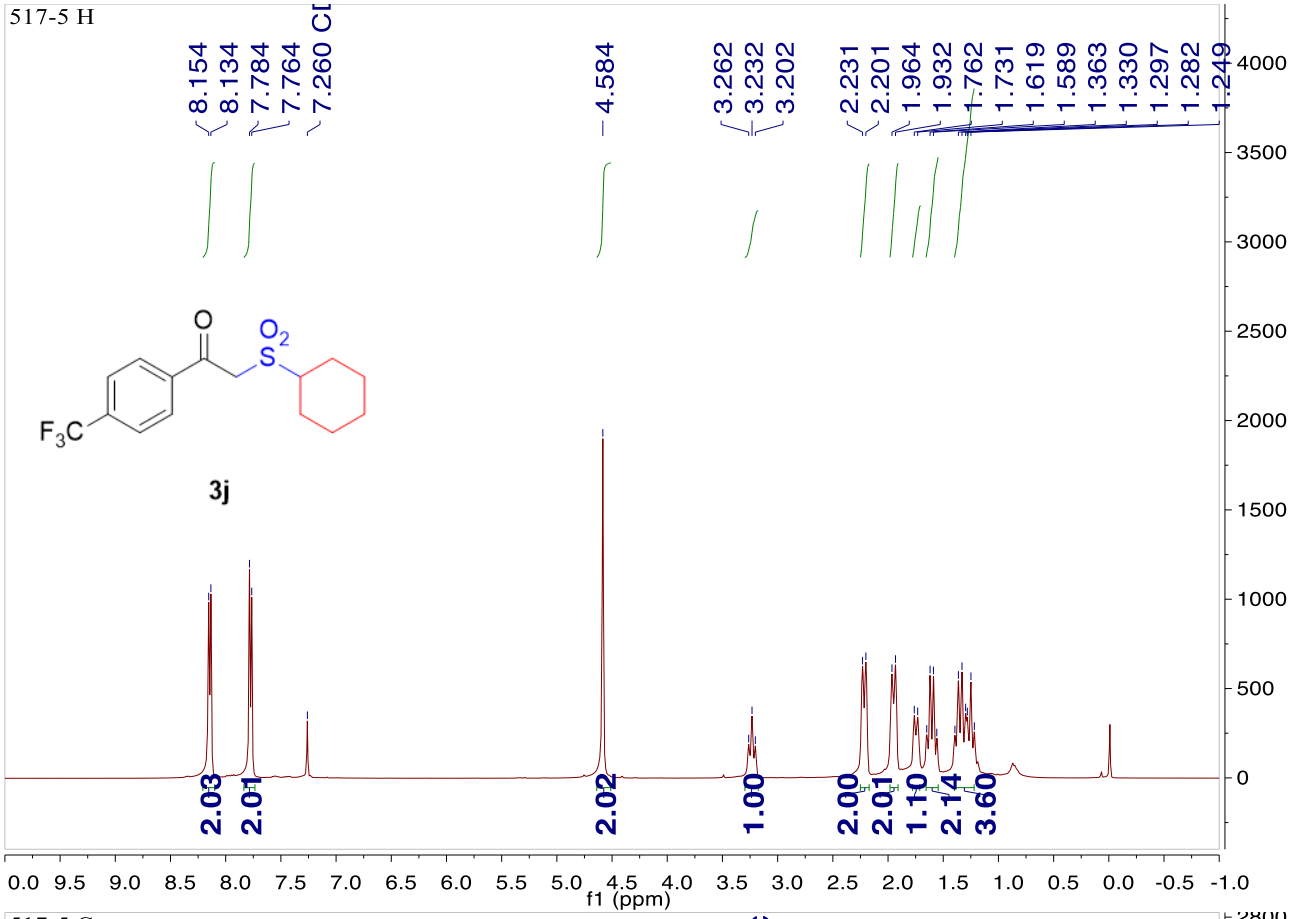

618-3 C
188.463
138.794
132.792
129.954
117.713
117.690
77.479
77.160
76.843
61.871
57.283
25.079
25.034
24.941
O
O2
S
NC
3g
f1 (ppm)

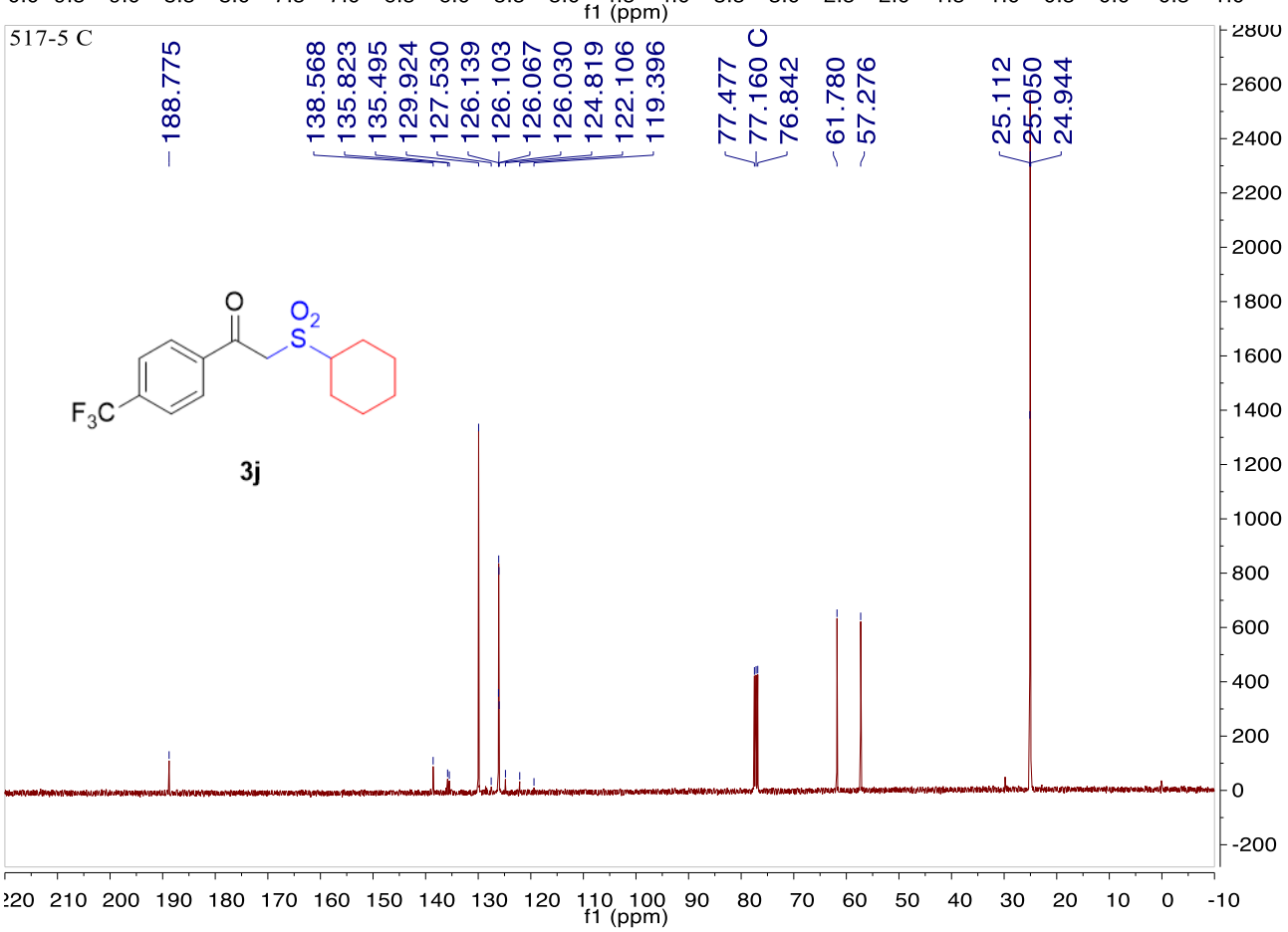

517-8 H
7.873
7.865
7.791
7.779
7.260
7.205
7.196
7.187
4.460
3.310
3.280
3.250
2.240
2.209
1.949
1.917
1.749
1.719
1.615
1.584
1.358
1.325
1.293
1.275
1.244
0.96
0.83
0.89
2.01
1.00
2.06
2.02
1.22
2.13
3.47
f1 (ppm)

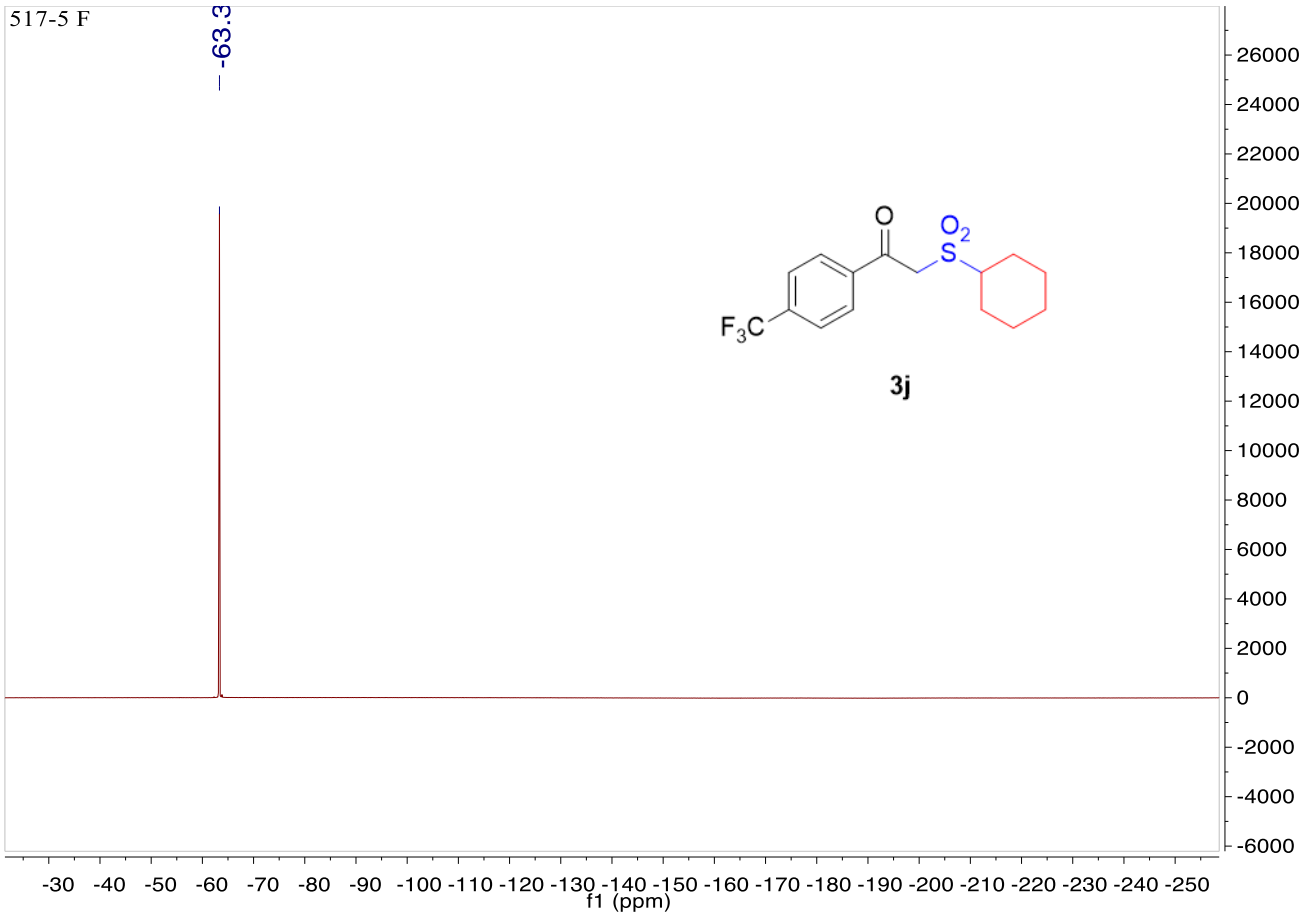

517-8 C
181.593
143.458
136.899
135.665
128.985
77.478
77.160
76.843
61.374
58.067
25.155
25.047
24.908
f1 (ppm)

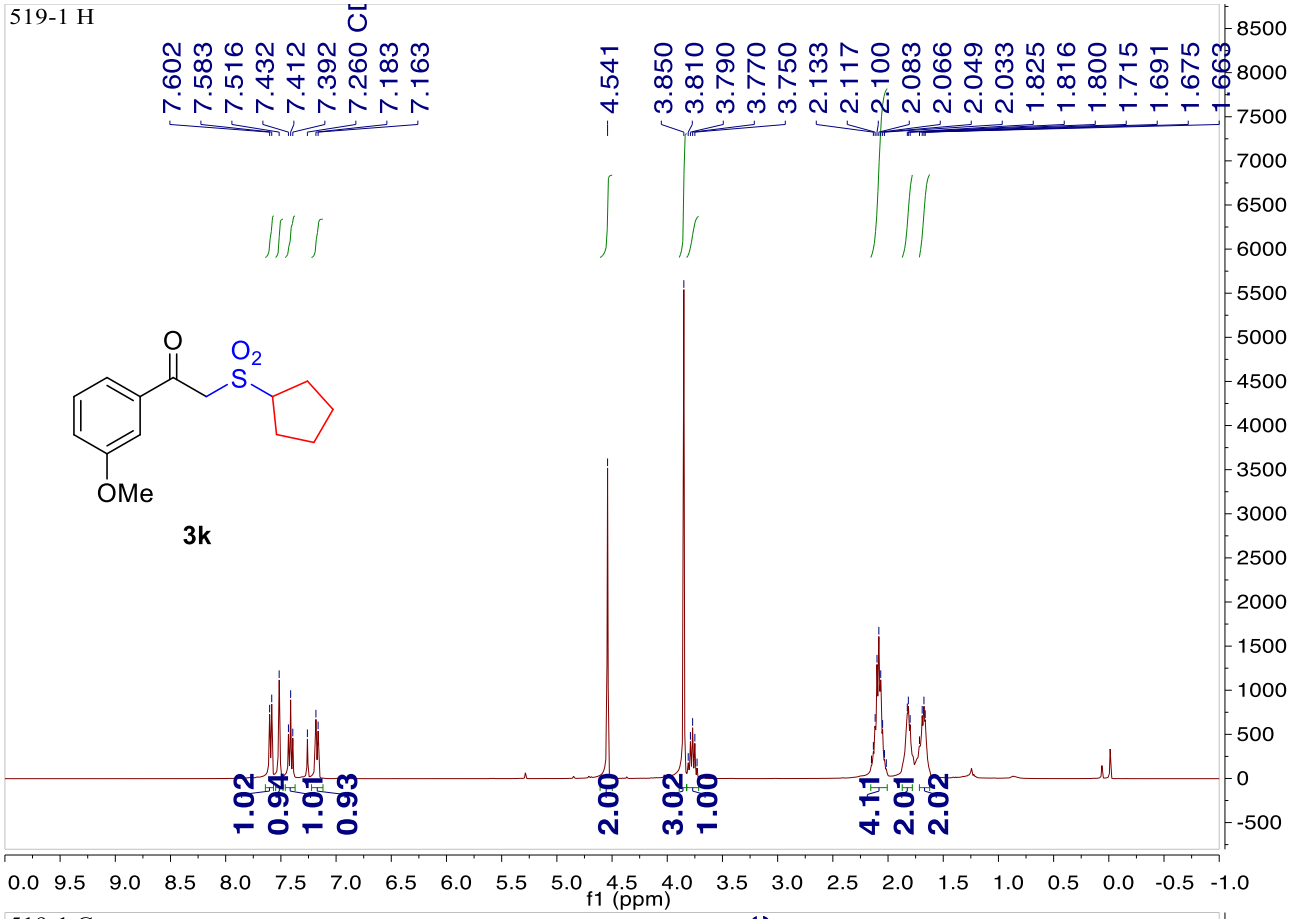

517-6 H
7.592
7.573
7.507
7.427
7.407
7.388
7.260 CD
7.178
7.158
4.539
3.846
3.317
3.287
3.256
2.221
2.191
1.944
1.911
1.744
1.713
1.606
1.575
1.350
1.318
1.285
1.268
1.237
1.205
1.02
1.00
1.04
0.98
2.03
3.05
1.00
2.03
2.03
1.03
2.08
3.04
OMe
3i
f1 (ppm)

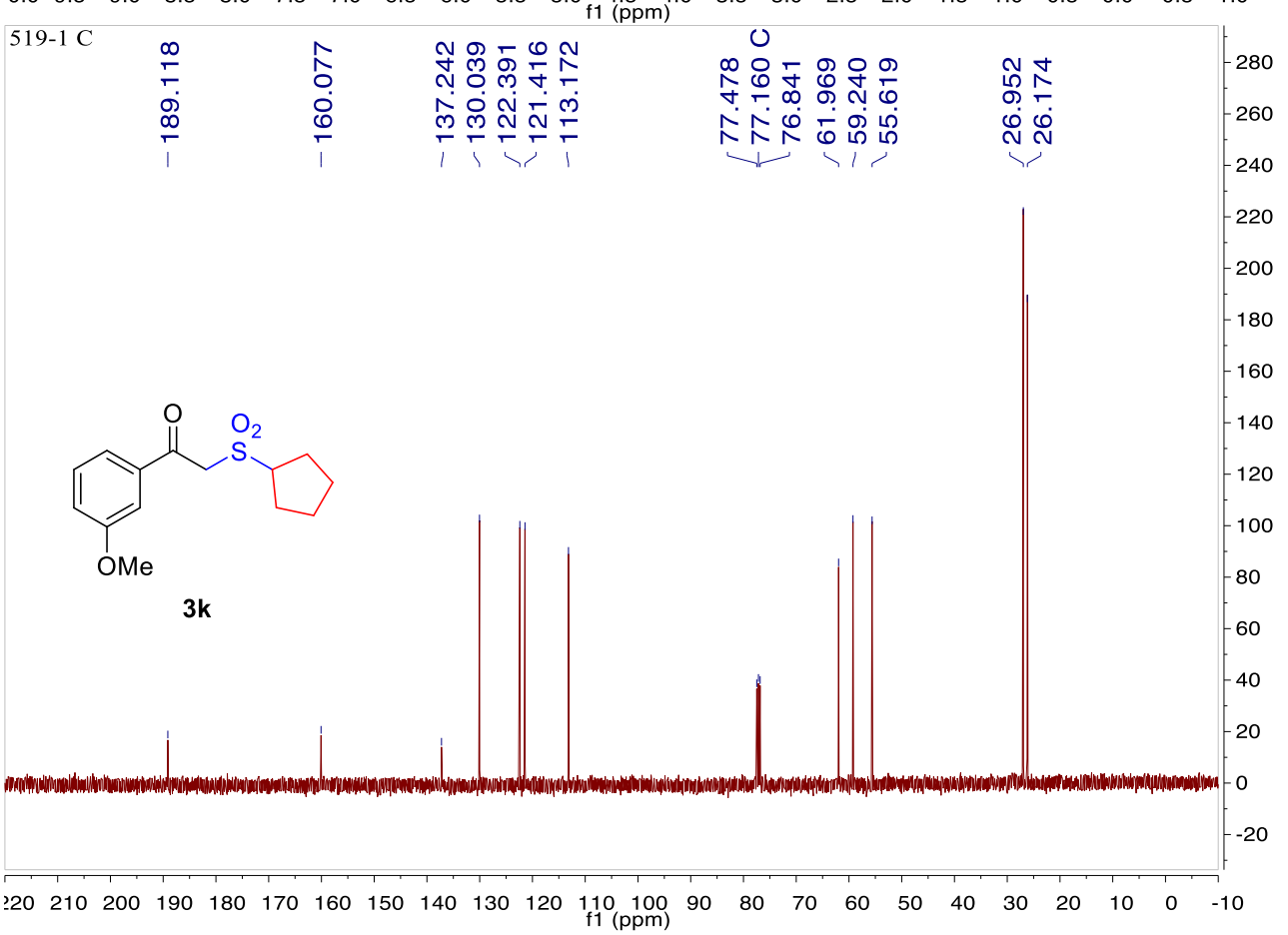

517-6 C
189.313
160.064
137.283
130.030
122.328
121.427
113.079
77.478
77.160 CD
76.843
61.451
57.031
55.606
25.139
25.043
24.863
OMe
3i
f1 (ppm)

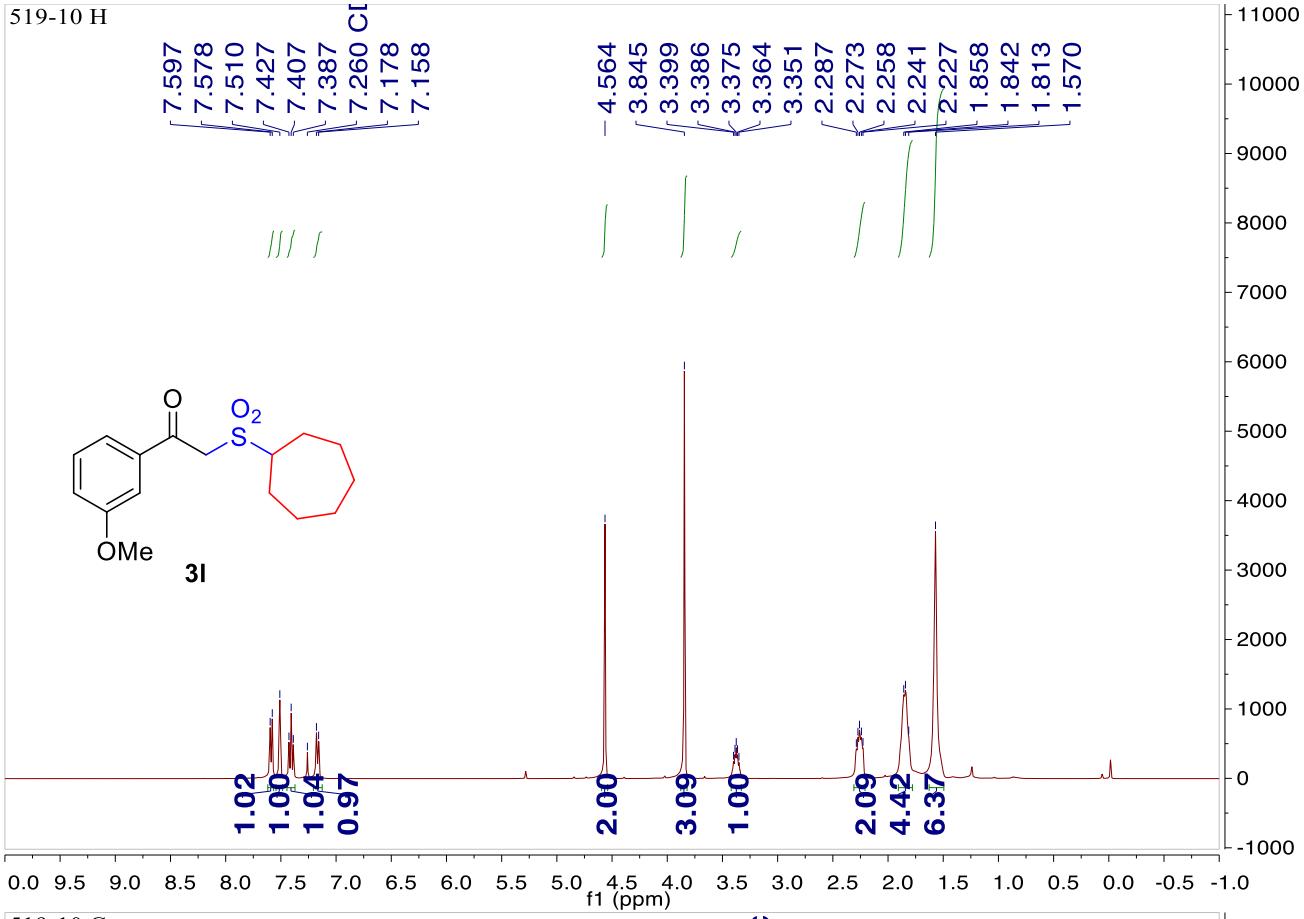

517-5 H
8.154
8.134
7.784
7.764
7.260
4.584
3.262
3.232
3.202
2.231
2.201
1.964
1.932
1.762
1.731
1.619
1.589
1.363
1.330
1.297
1.282
1.249
O
O2
S
F3C
3j
2.03
2.01
2.02
1.00
2.00
2.01
1.10
2.14
3.60
f1 (ppm)


517-5 C
188.775
138.568
135.823
135.495
129.924
127.530
126.139
126.103
126.067
126.030
124.819
122.106
119.396
77.477
77.160
76.842
61.780
57.276
25.112
25.050
24.944
O
O2
S
F3C
3j
f1 (ppm)


517-5 F
-63.3
O
O2
S
F3C
3j
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
-30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210 -220 -230 -240 -250
f1 (ppm)

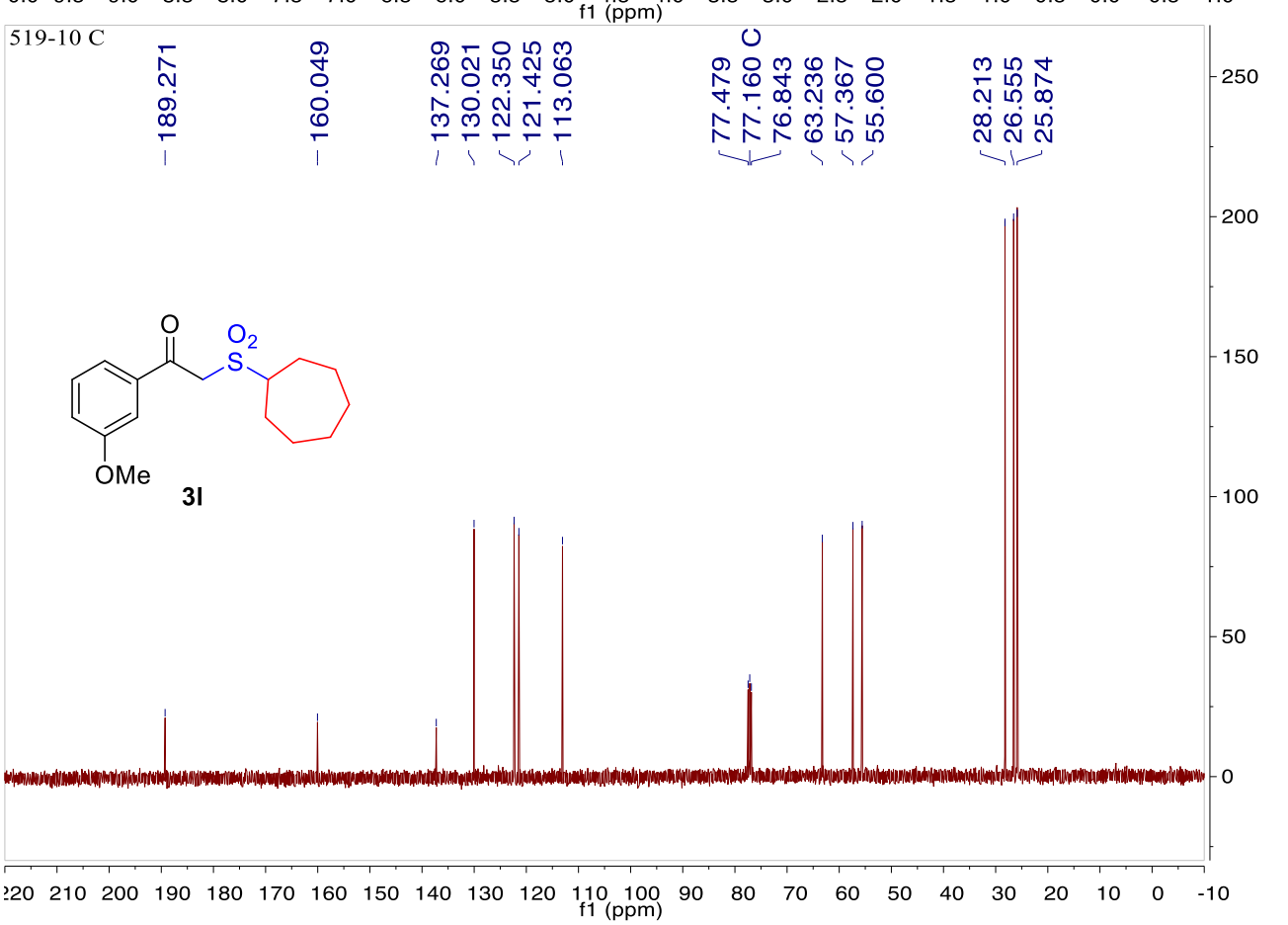

519-1 H
7.602
7.583
7.516
7.432
7.412
7.392
7.260
7.183
7.163
4.541
3.850
3.810
3.790
3.770
3.750
2.133
2.117
2.100
2.083
2.066
2.049
2.033
1.825
1.816
1.800
1.715
1.691
1.675
1.663
O
O2
S
OMe
3k
1.02
0.94
1.01
0.93
2.00
3.02
1.00
4.11
2.01
2.02
f1 (ppm)


519-1 C
189.118
160.077
137.242
130.039
122.391
121.416
113.172
77.478
77.160
76.841
61.969
59.240
55.619
26.952
26.174
O
O2
S
OMe
3k
f1 (ppm)


519-10 H
7.597
7.578
7.510
7.427
7.407
7.387
7.260
7.178
7.158
4.564
3.845
3.399
3.386
3.375
3.364
3.351
2.287
2.273
2.258
2.241
2.227
1.858
1.842
1.813
1.570
1.02
1.00
1.04
0.97
2.00
3.09
1.00
2.09
4.42
6.37
f1 (ppm)

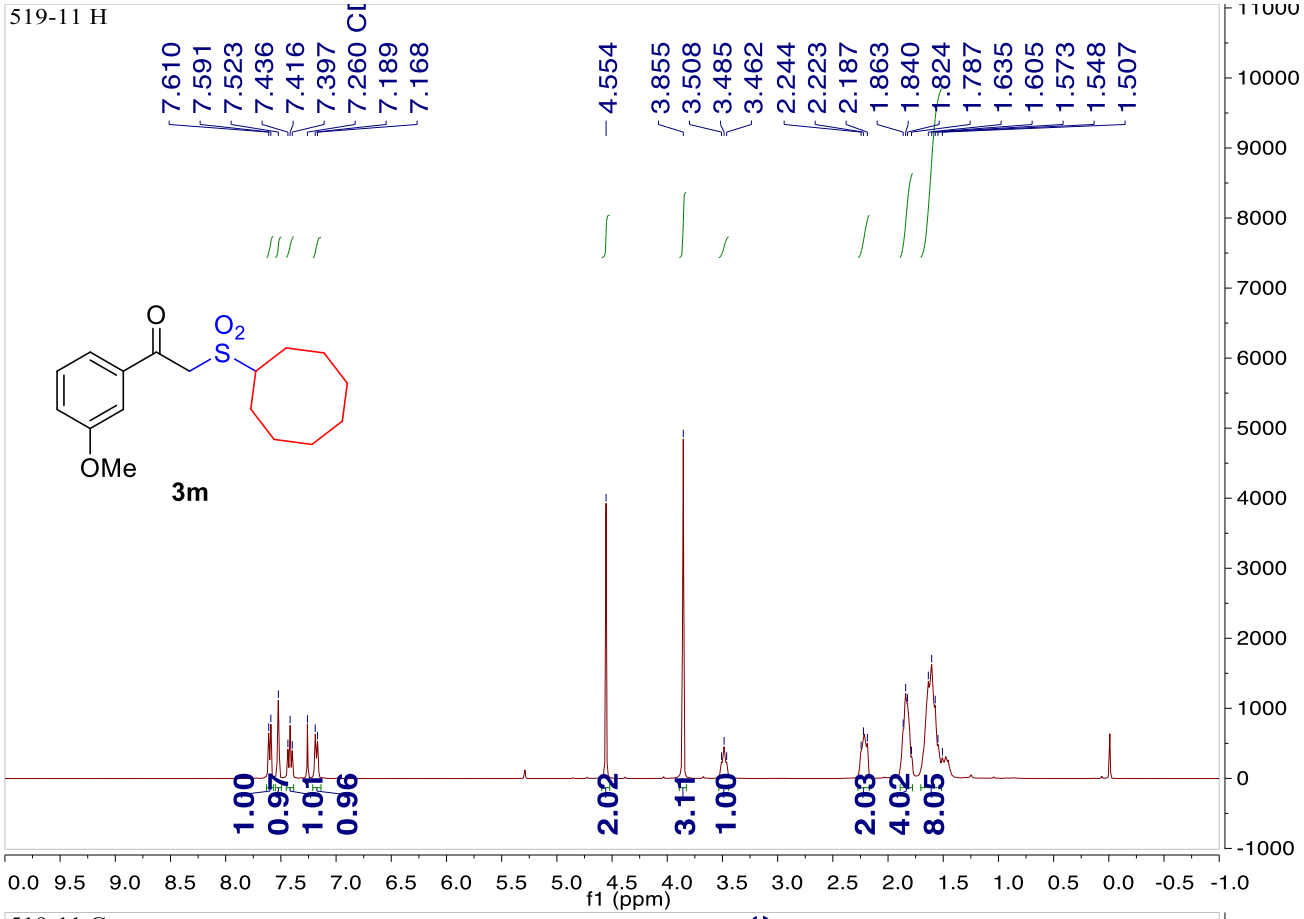
O
O2
S
OMe

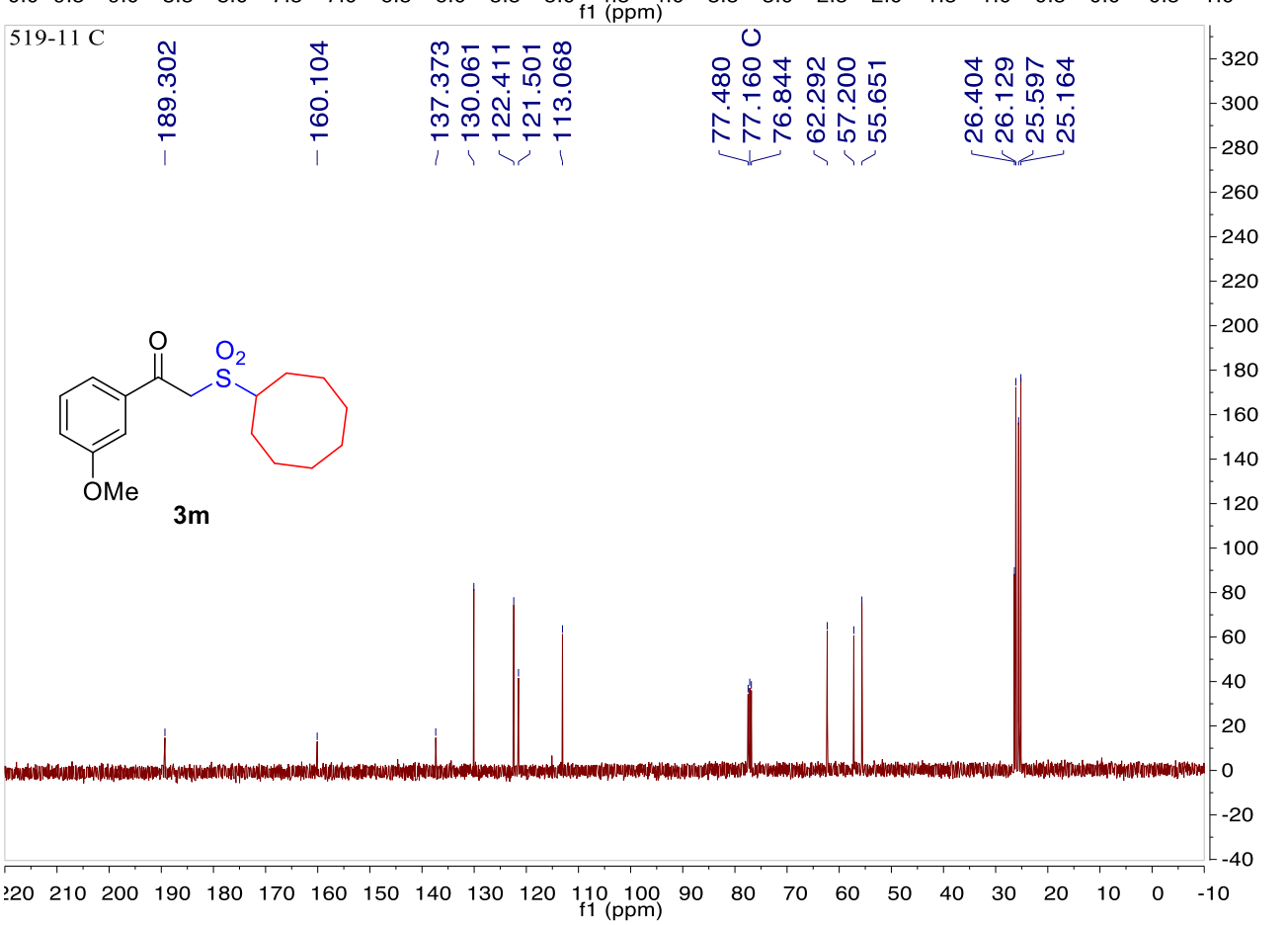
3l

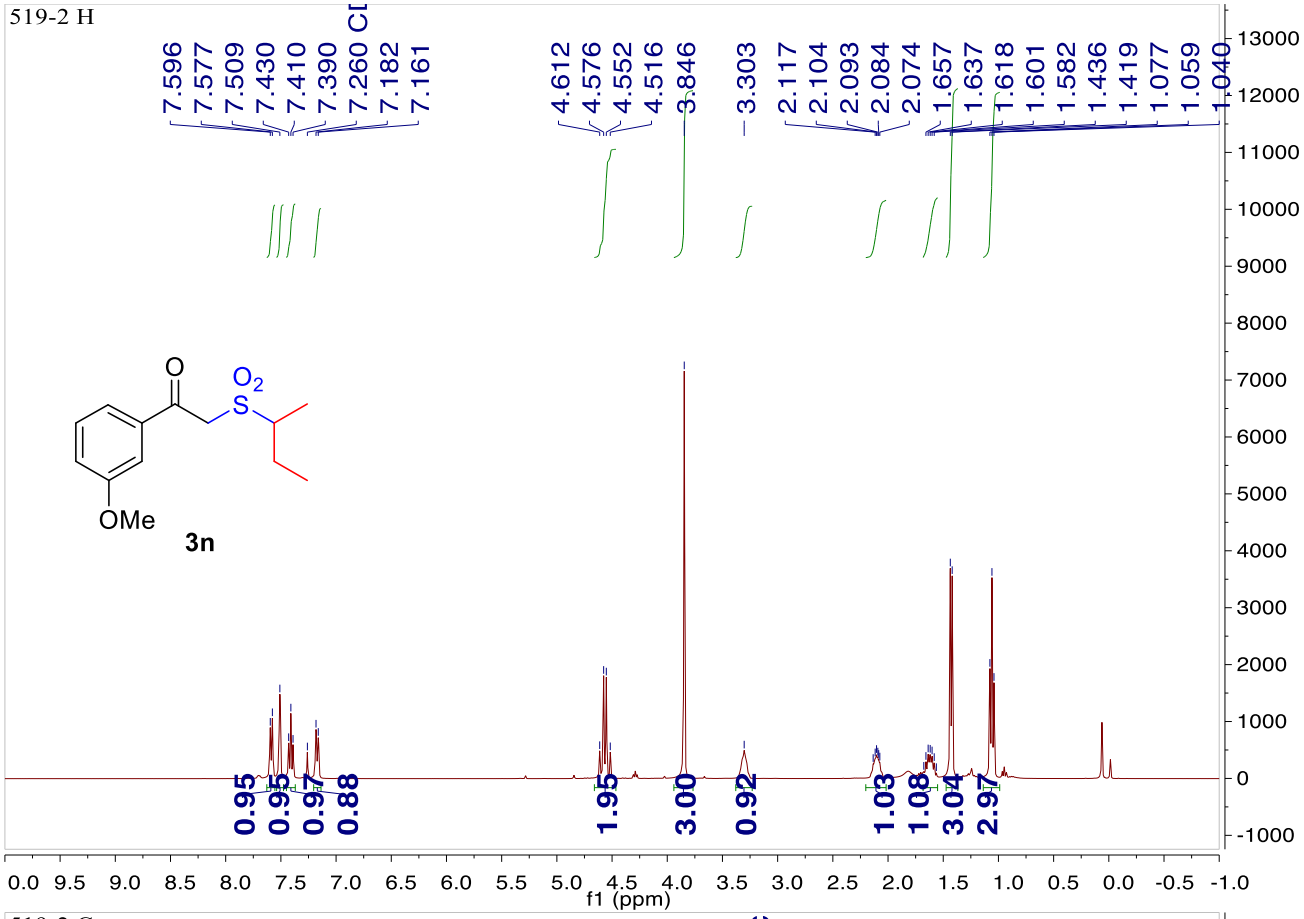

519-10 C
189.271
160.049
137.269
130.021
122.350
121.425
113.063
77.479
77.160
76.843
63.236
57.367
55.600
28.213
26.555
25.874
f1 (ppm)

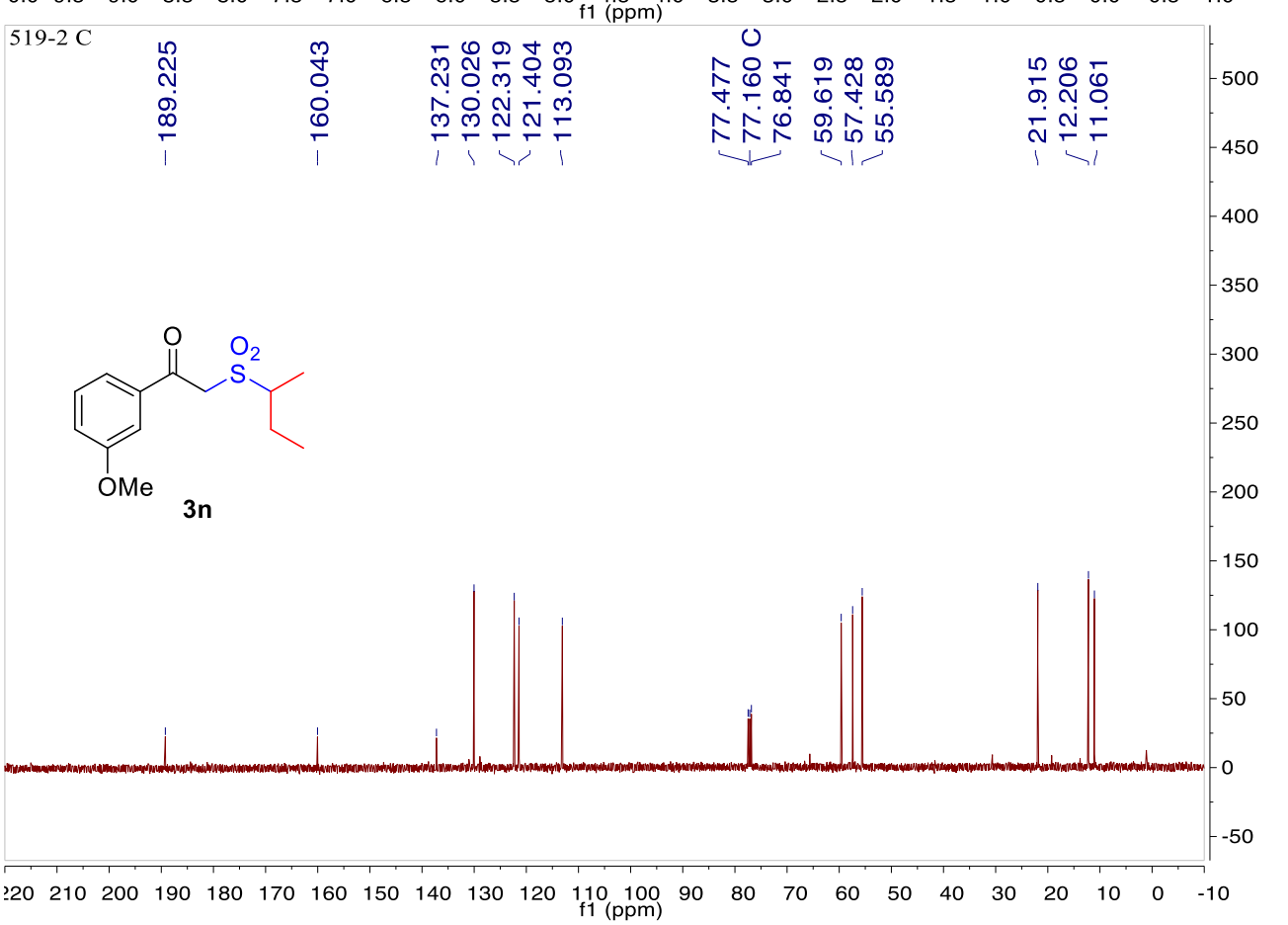
O
O2
S
OMe

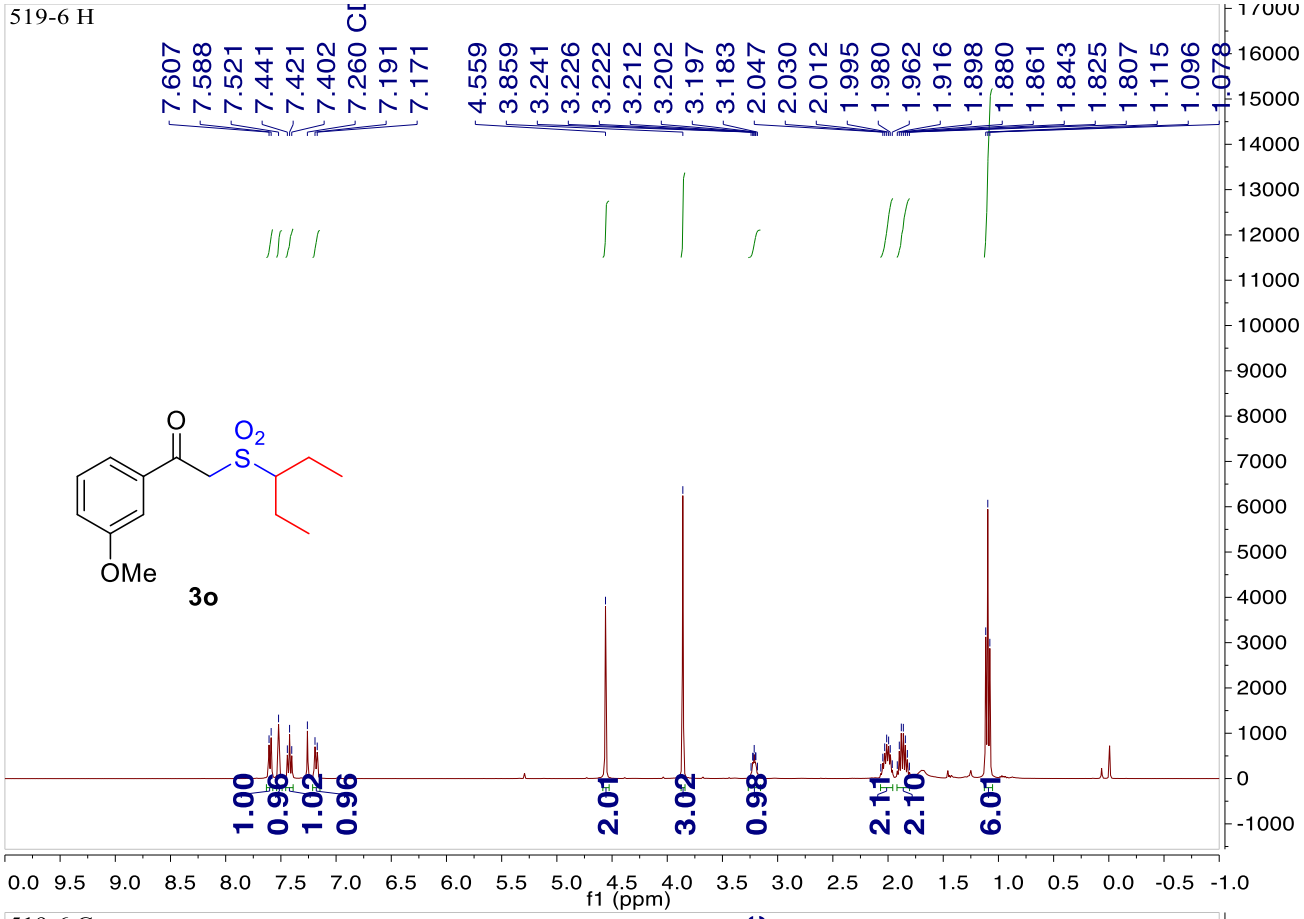
3l

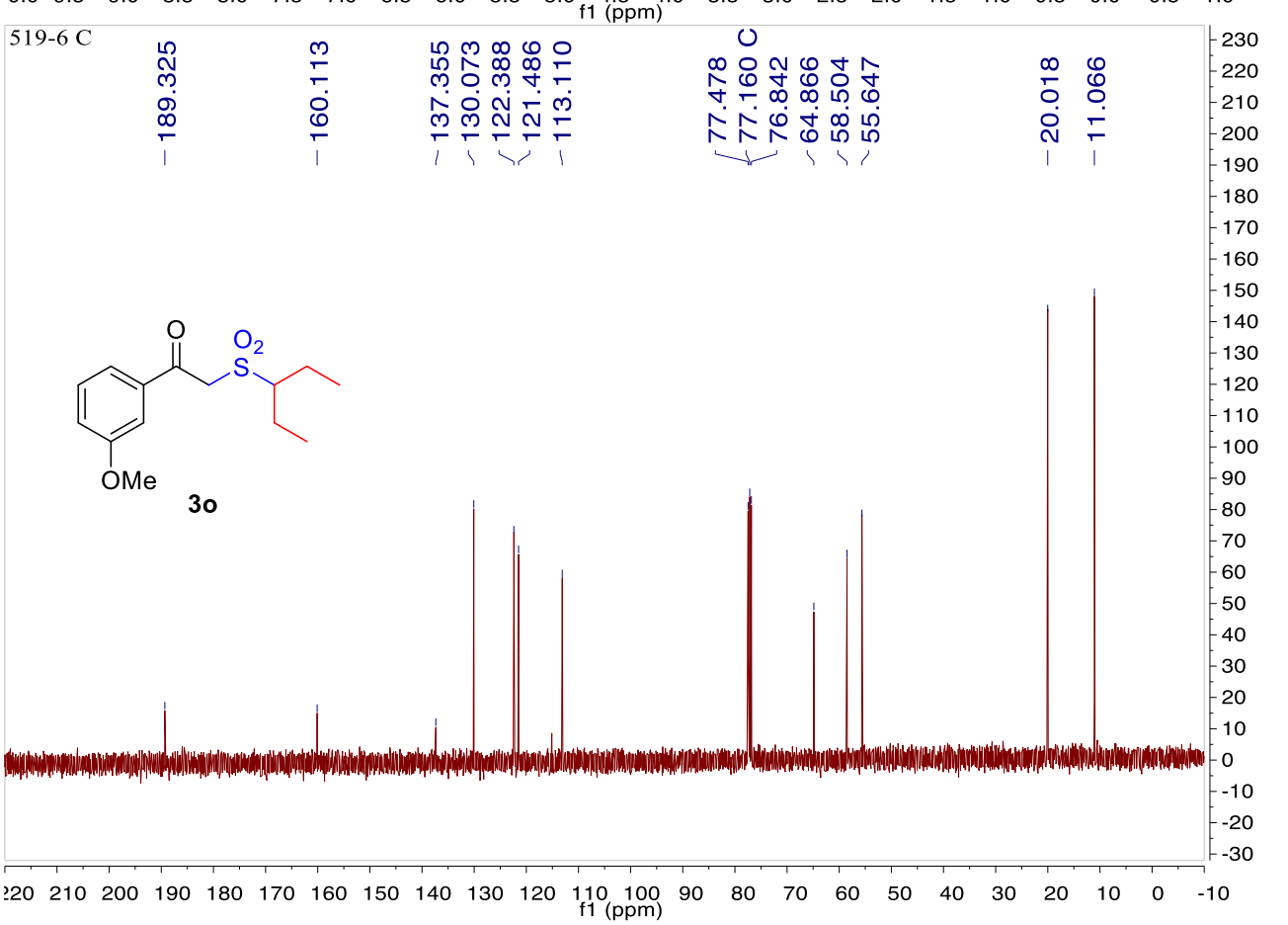

519-11 H
7.610
7.591
7.523
7.436
7.416
7.397
7.260 CD
7.189
7.168
4.554
3.855
3.508
3.485
3.462
2.244
2.223
2.187
1.863
1.840
1.824
1.787
1.635
1.605
1.573
1.548
1.507
O
O2
S
OMe
3m
1.00
0.99
1.01
0.96
2.02
3.11
1.00
2.03
4.02
8.05
f1 (ppm)

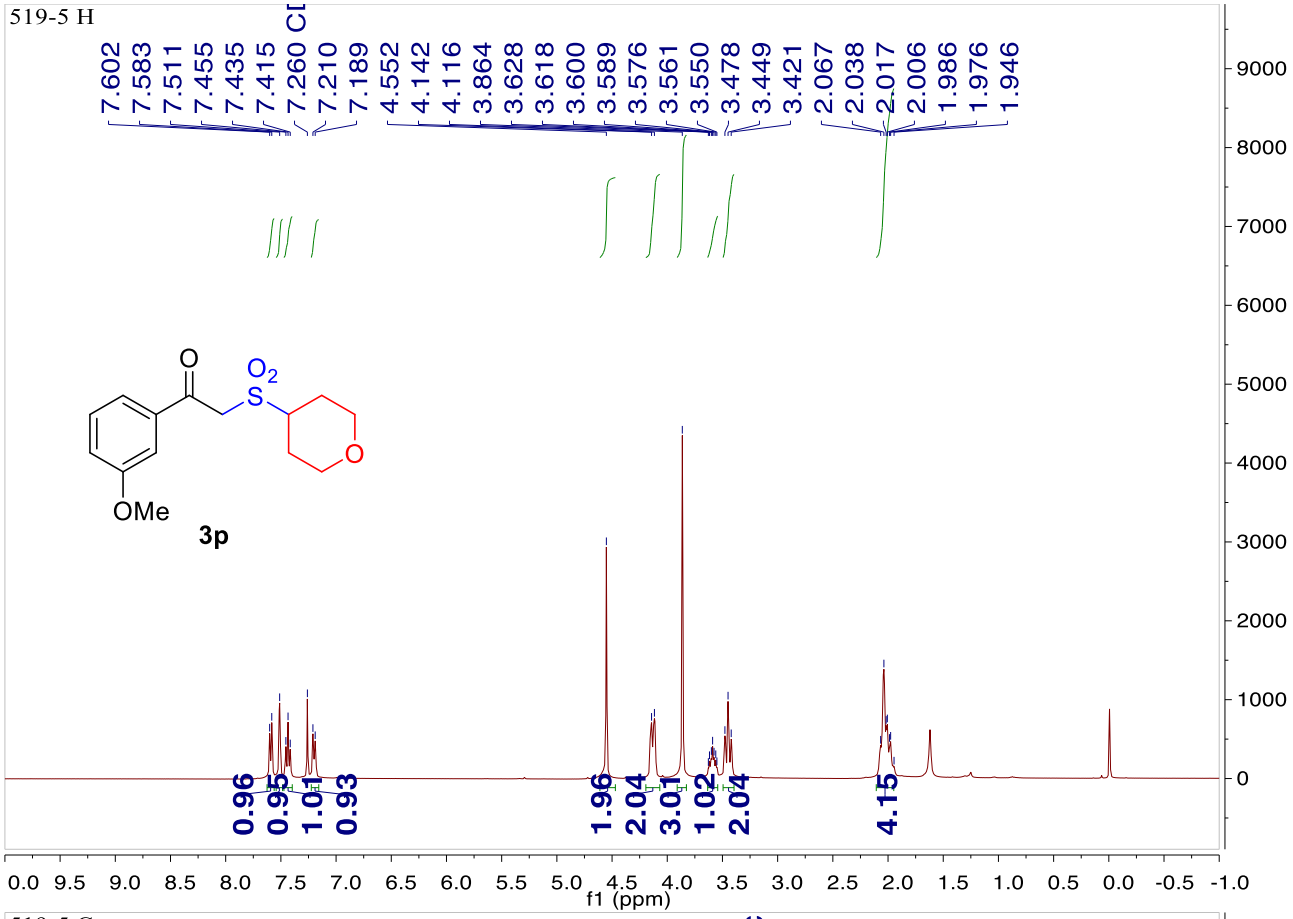

519-11 C
189.302
160.104
137.373
130.061
122.411
121.501
113.068
77.480
77.160 C
76.844
62.292
57.200
55.651
26.404
26.129
25.597
25.164
O
O2
S
OMe
3m
f1 (ppm)

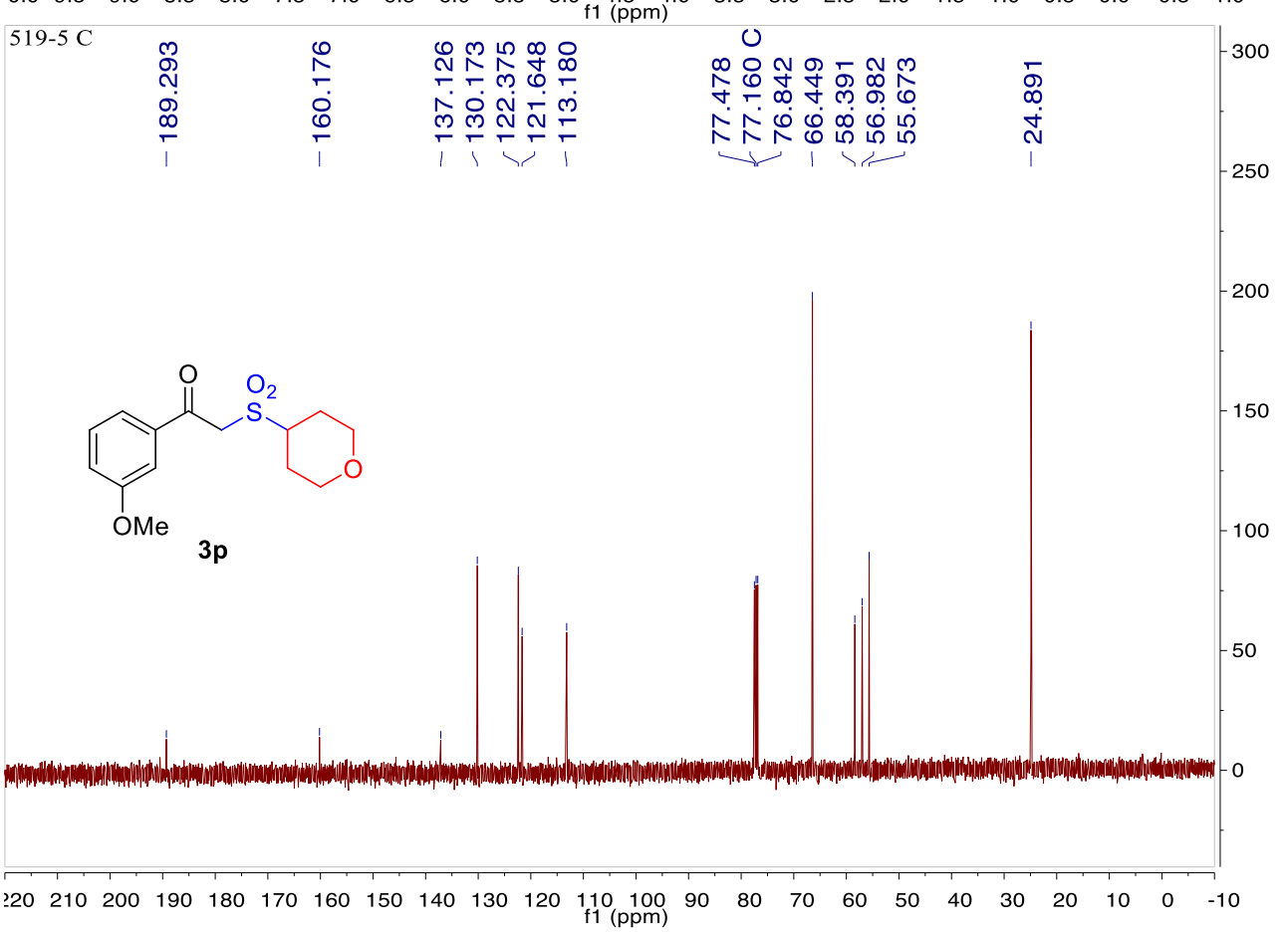

519-2 H
7.596
7.577
7.509
7.430
7.410
7.390
7.260 CDCl3
7.182
7.161
4.612
4.576
4.552
4.516
3.846
3.303
2.117
2.104
2.093
2.084
2.074
1.657
1.637
1.618
1.601
1.582
1.436
1.419
1.077
1.059
1.040
O
O2
S
OMe
3n
0.95
0.95
0.97
0.88
1.95
3.00
0.92
1.03
1.08
3.04
2.97
f1 (ppm)

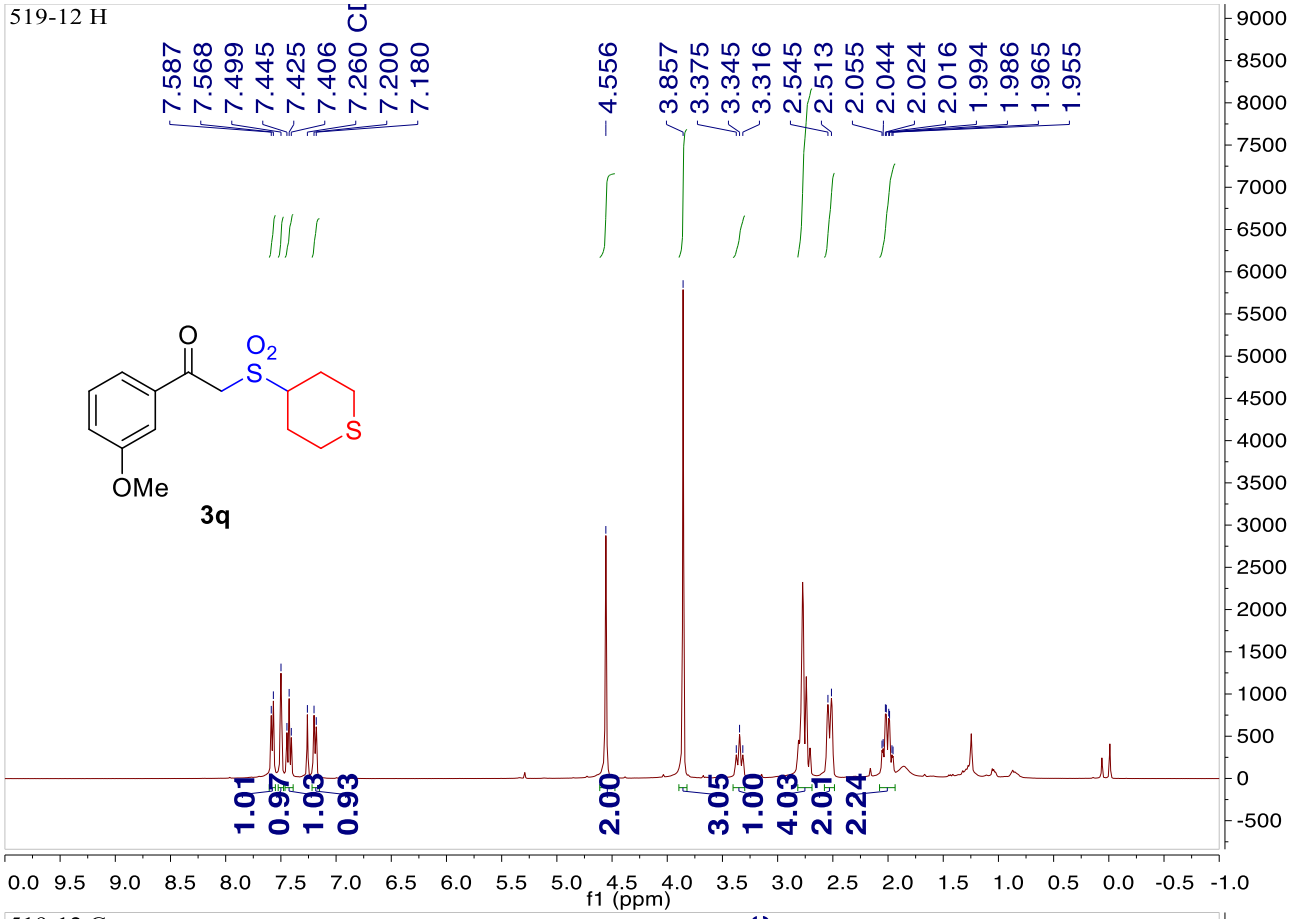

519-2 C
189.225
160.043
137.231
130.026
122.319
121.404
113.093
77.477
77.160 CDCl3
76.841
59.619
57.428
55.589
21.915
12.206
11.061
O
O2
S
OMe
3n
f1 (ppm)

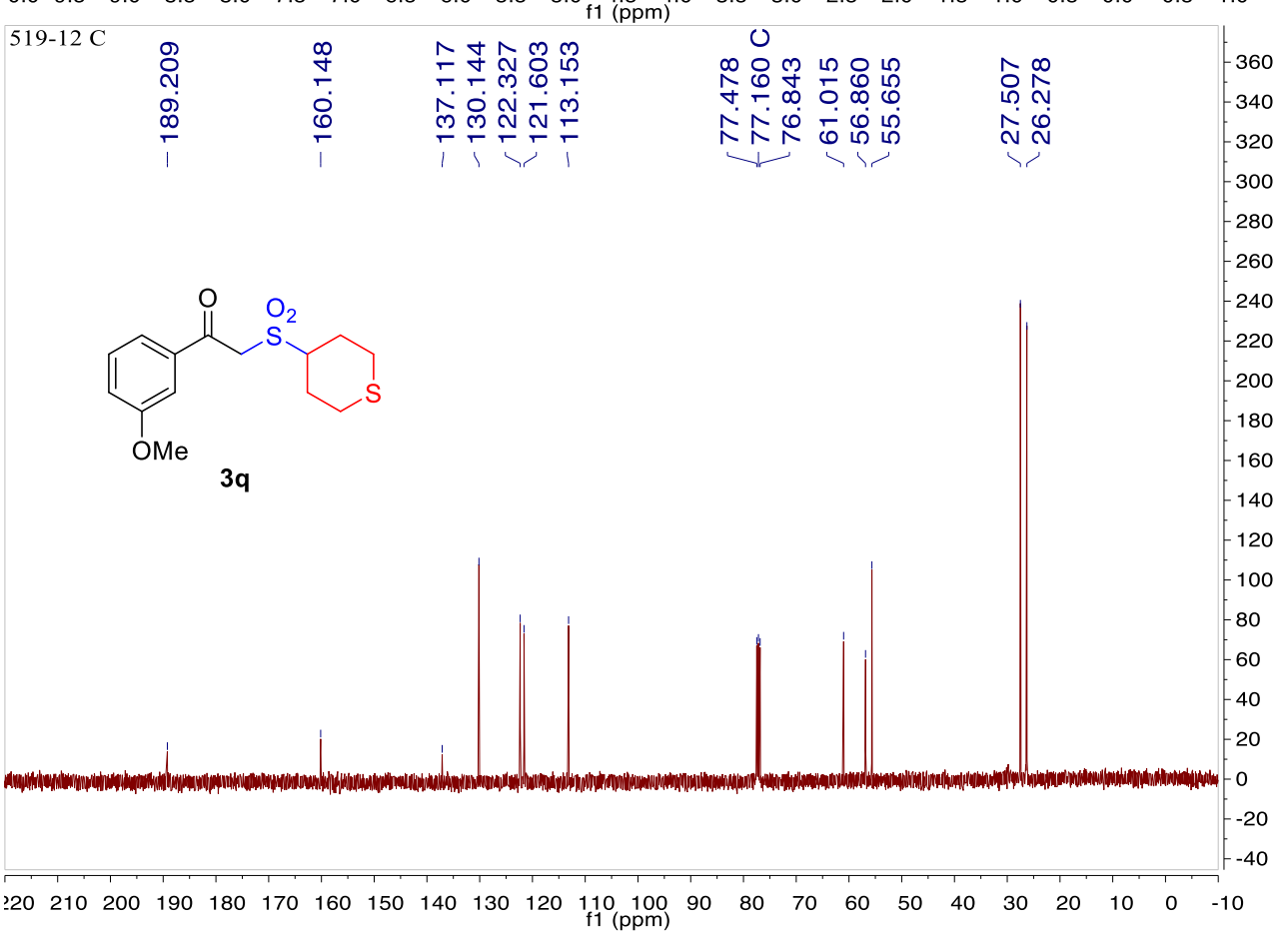

519-6 H
7.607
7.588
7.521
7.441
7.421
7.402
7.260
7.191
7.171
4.559
3.859
3.241
3.226
3.222
3.212
3.202
3.197
3.183
2.047
2.030
2.012
1.995
1.980
1.962
1.916
1.898
1.880
1.861
1.843
1.825
1.807
1.115
1.096
1.078
O
O2
S
OMe
3o
1.00
0.96
1.02
0.96
2.01
3.02
0.98
2.11
2.10
6.01
f1 (ppm)

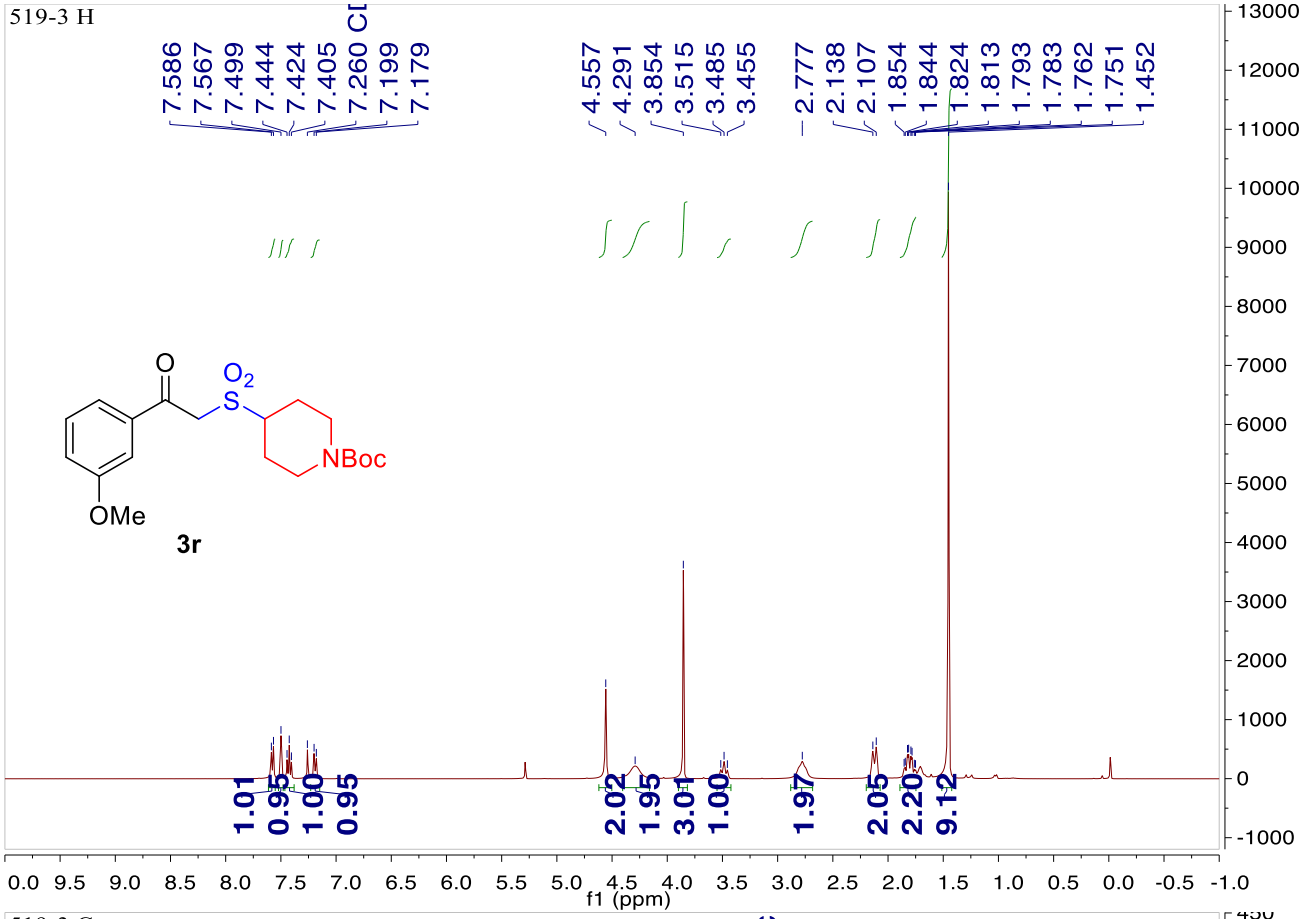

519-6 C
189.325
160.113
137.355
130.073
122.388
121.486
113.110
77.478
77.160
76.842
64.866
58.504
55.647
20.018
11.066
O
O2
S
OMe
3o
f1 (ppm)

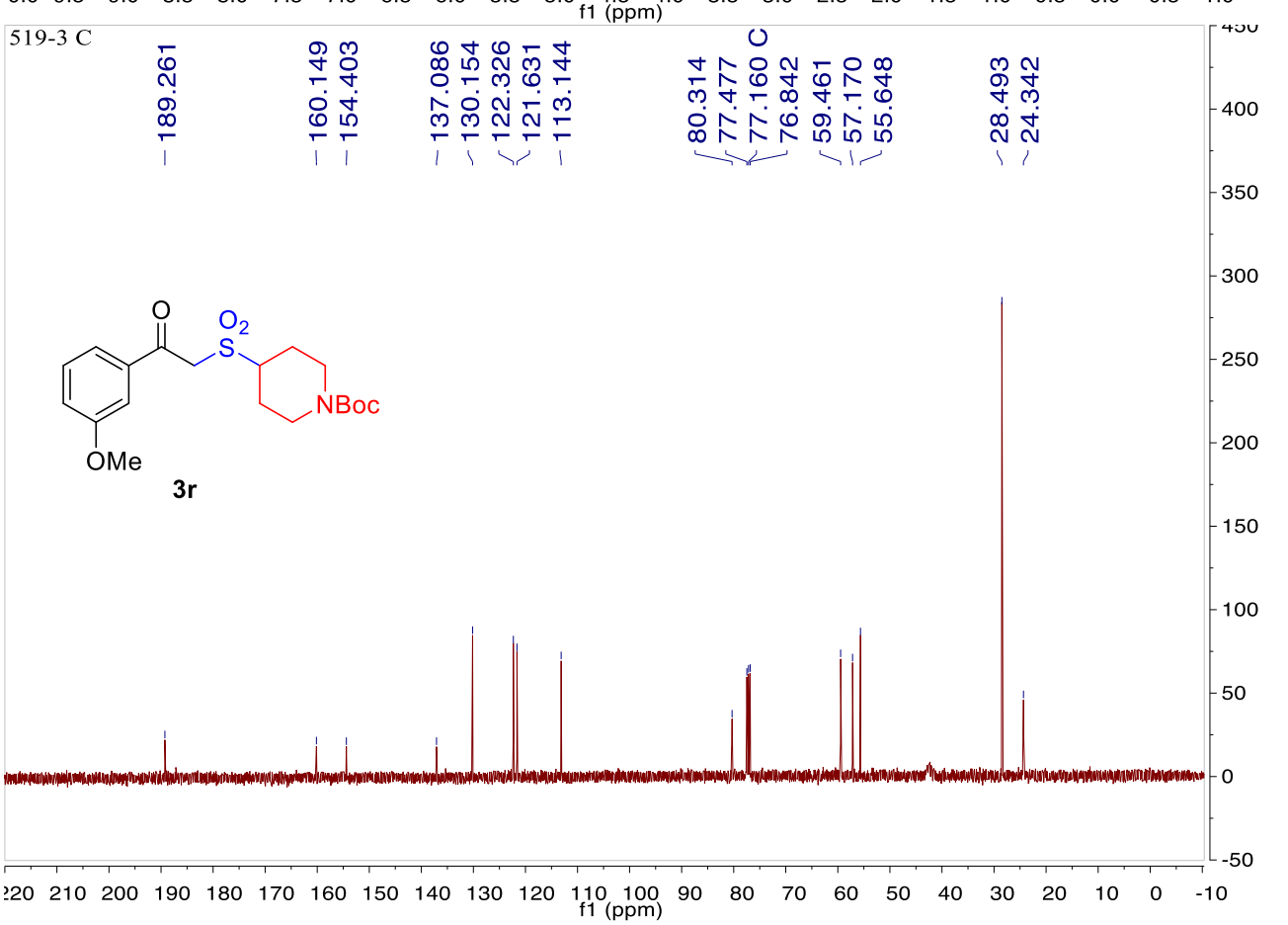

519-5 H
7.602
7.583
7.511
7.455
7.435
7.415
7.260 CD
7.210
7.189
4.552
4.142
4.116
3.864
3.628
3.618
3.600
3.589
3.576
3.561
3.550
3.478
3.449
3.421
2.067
2.038
2.017
2.006
1.986
1.976
1.946
O
O2
S
O
OMe
3p
0.96
0.95
1.01
0.93
1.96
2.04
3.01
1.02
2.04
4.15
f1 (ppm)

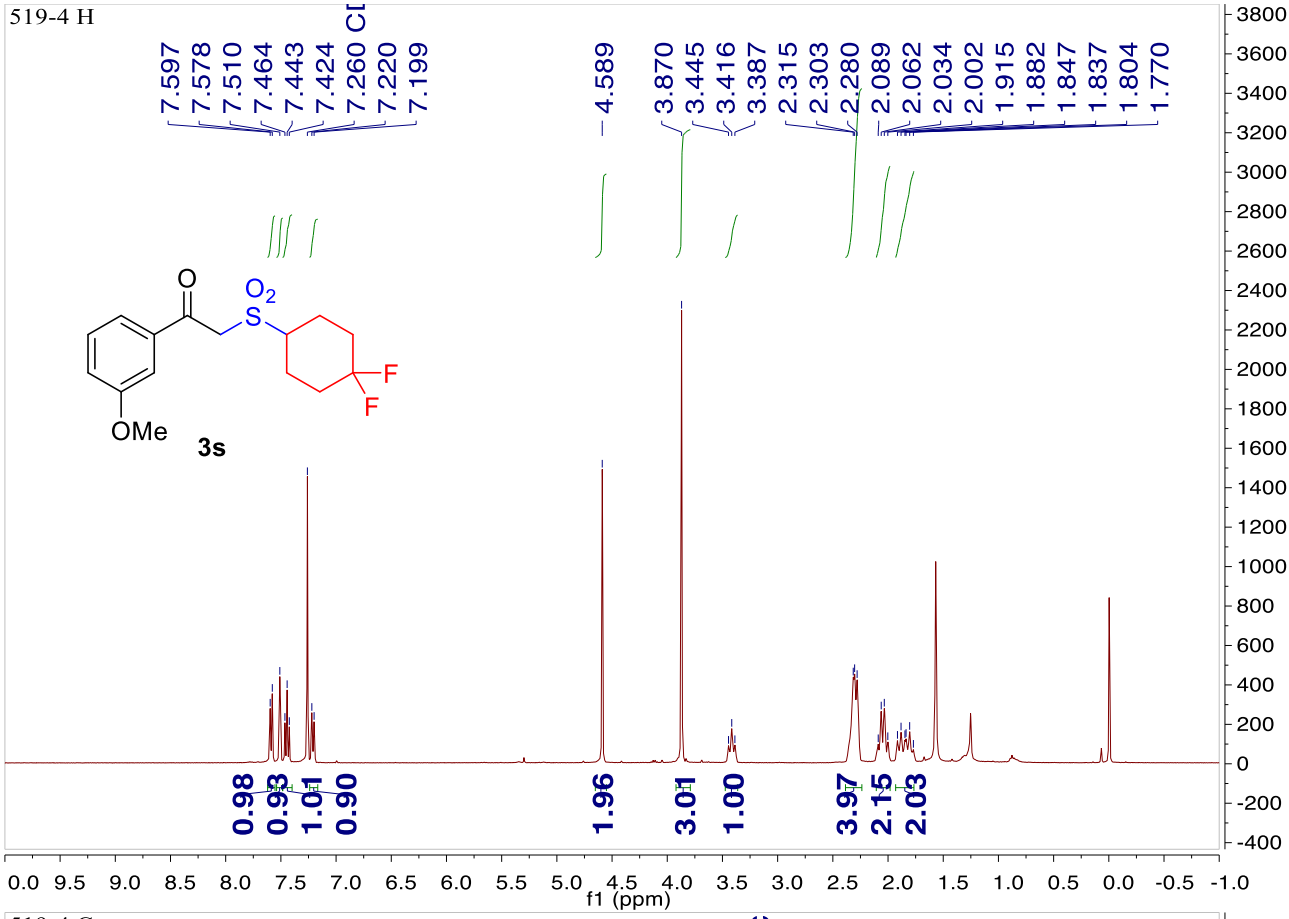

519-5 C
189.293
160.176
137.126
130.173
122.375
121.648
113.180
77.478
77.160 C
76.842
66.449
58.391
56.982
55.673
24.891
O
O2
S
O
OMe
3p
f1 (ppm)

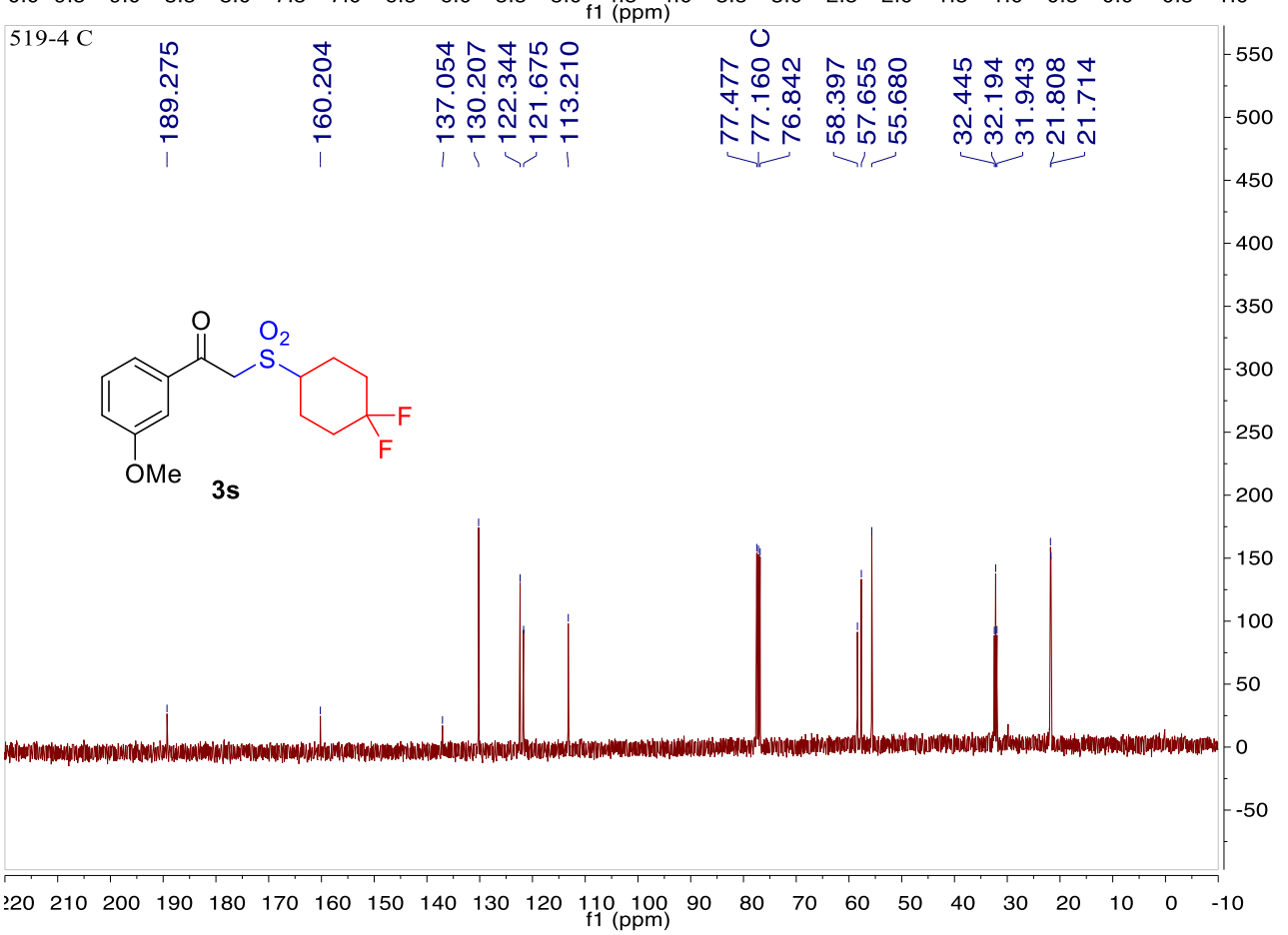

519-12 H
7.587
7.568
7.499
7.445
7.425
7.406
7.260 CDCl3
7.200
7.180
4.556
3.857
3.375
3.345
3.316
2.545
2.513
2.055
2.044
2.024
2.016
1.994
1.986
1.965
1.955
O
O2
S
S
OMe
3q
1.01
0.91
1.03
0.93
2.00
3.05
1.00
4.03
2.01
2.24
f1 (ppm)

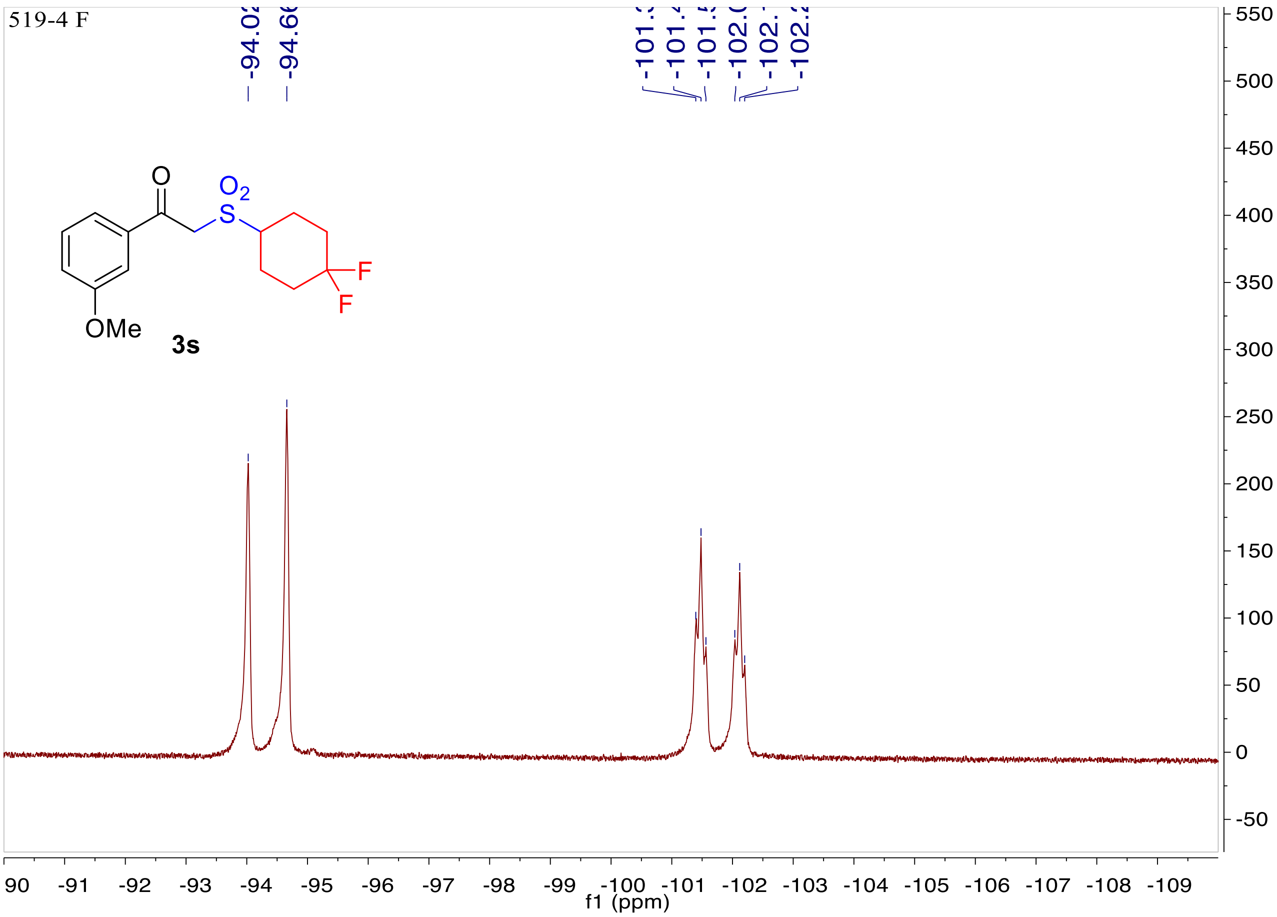

519-12 C
189.209
160.148
137.117
130.144
122.327
121.603
113.153
77.478
77.160 CDCl3
76.843
61.015
56.860
55.655
27.507
26.278
O
O2
S
S
OMe
3q
f1 (ppm)


519-3 H
7.586
7.567
7.499
7.444
7.424
7.405
7.260 CDCl3
7.199
7.179
4.557
4.291
3.854
3.515
3.485
3.455
2.777
2.138
2.107
1.854
1.844
1.824
1.813
1.793
1.783
1.762
1.751
1.452
1.01
0.95
1.00
0.95
2.02
1.95
3.01
1.00
1.97
2.05
2.20
9.12
O
O2
S
NBoc
OMe
3r
f1 (ppm)

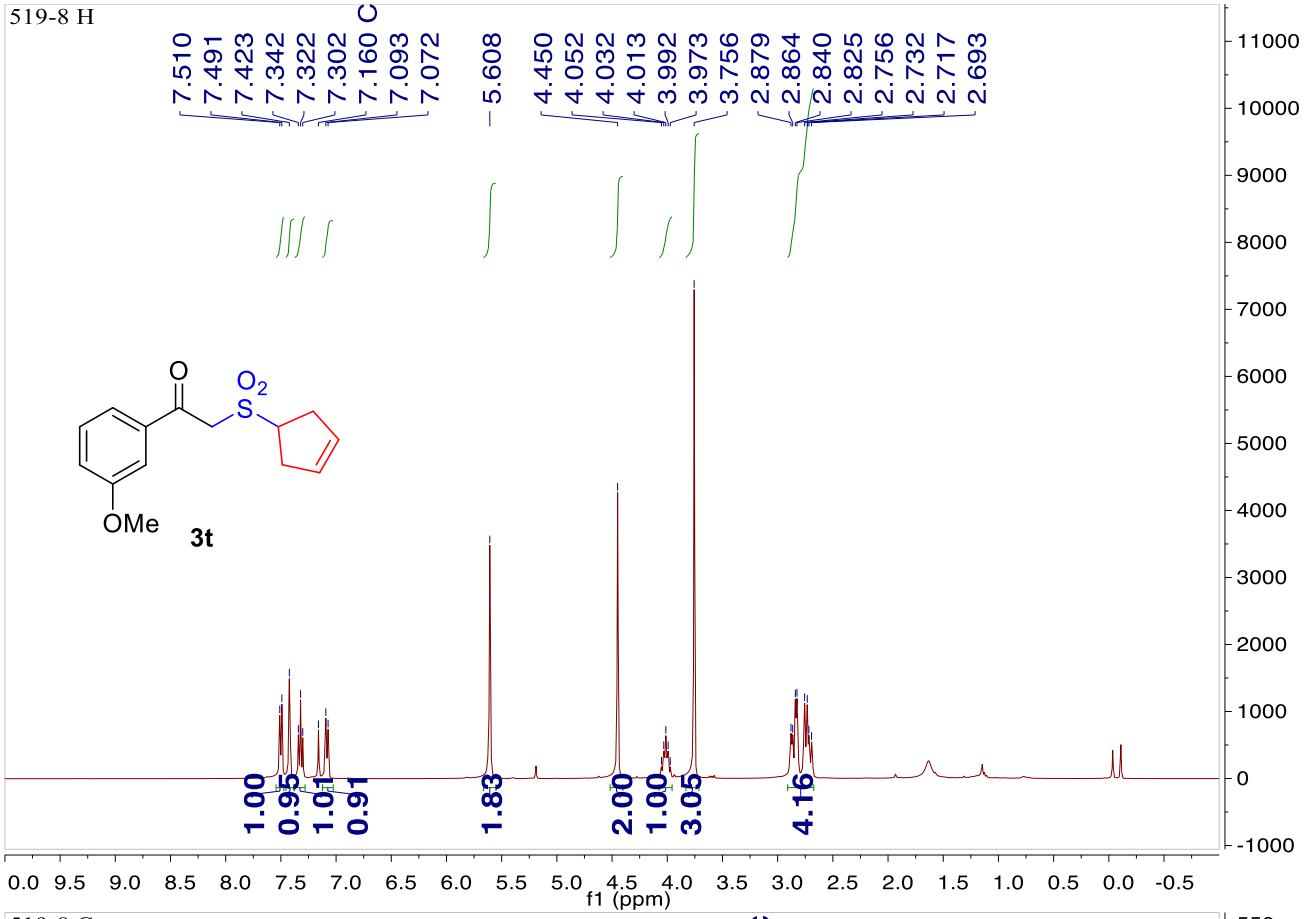

519-3 C
189.261
160.149
154.403
137.086
130.154
122.326
121.631
113.144
80.314
77.477
77.160 CDCl3
76.842
59.461
57.170
55.648
28.493
24.342
O
O2
S
NBoc
OMe
3r
f1 (ppm)

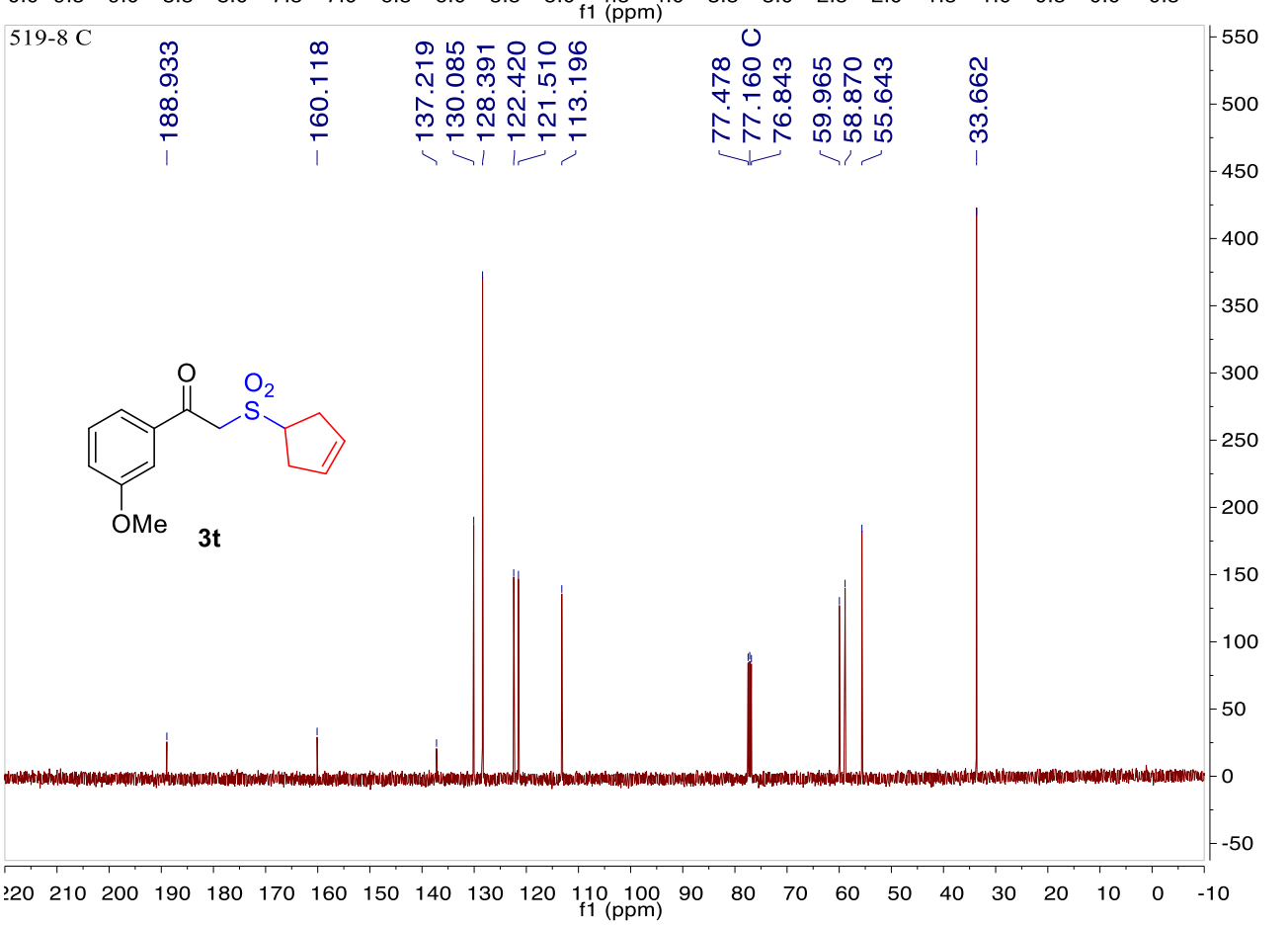

519-4 H
7.597
7.578
7.510
7.464
7.443
7.424
7.260
7.220
7.199
4.589
3.870
3.445
3.416
3.387
2.315
2.303
2.280
2.089
2.062
2.034
2.002
1.915
1.882
1.847
1.837
1.804
1.770
O
O2
S
F
F
OMe
3s
0.98
0.93
1.01
0.90
1.96
3.01
1.00
3.97
2.15
2.03
f1 (ppm)

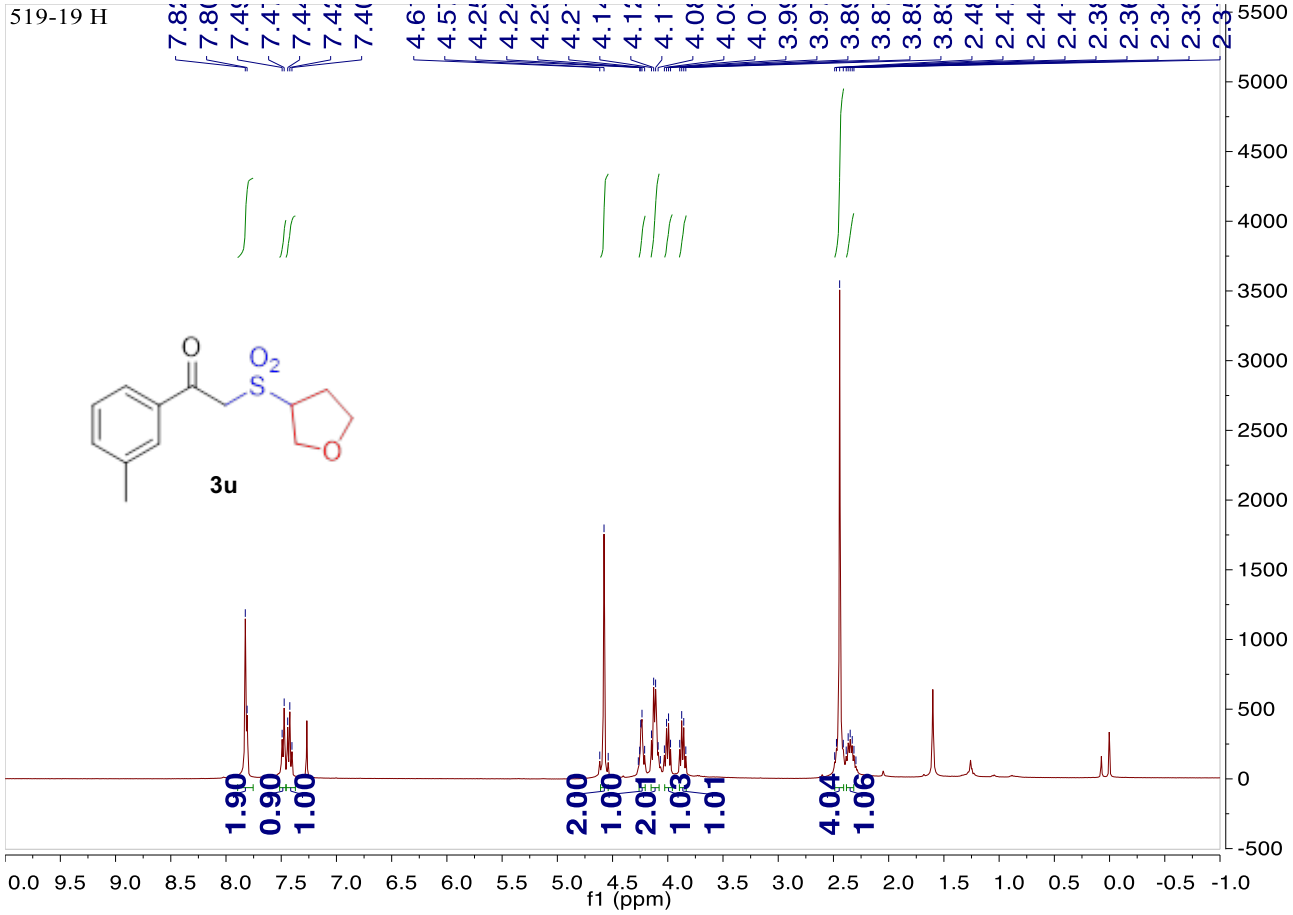

519-4 C
189.275
160.204
137.054
130.207
122.344
121.675
113.210
77.477
77.160
76.842
58.397
57.655
55.680
32.445
32.194
31.943
21.808
21.714
O
O2
S
F
F
OMe
3s
f1 (ppm)

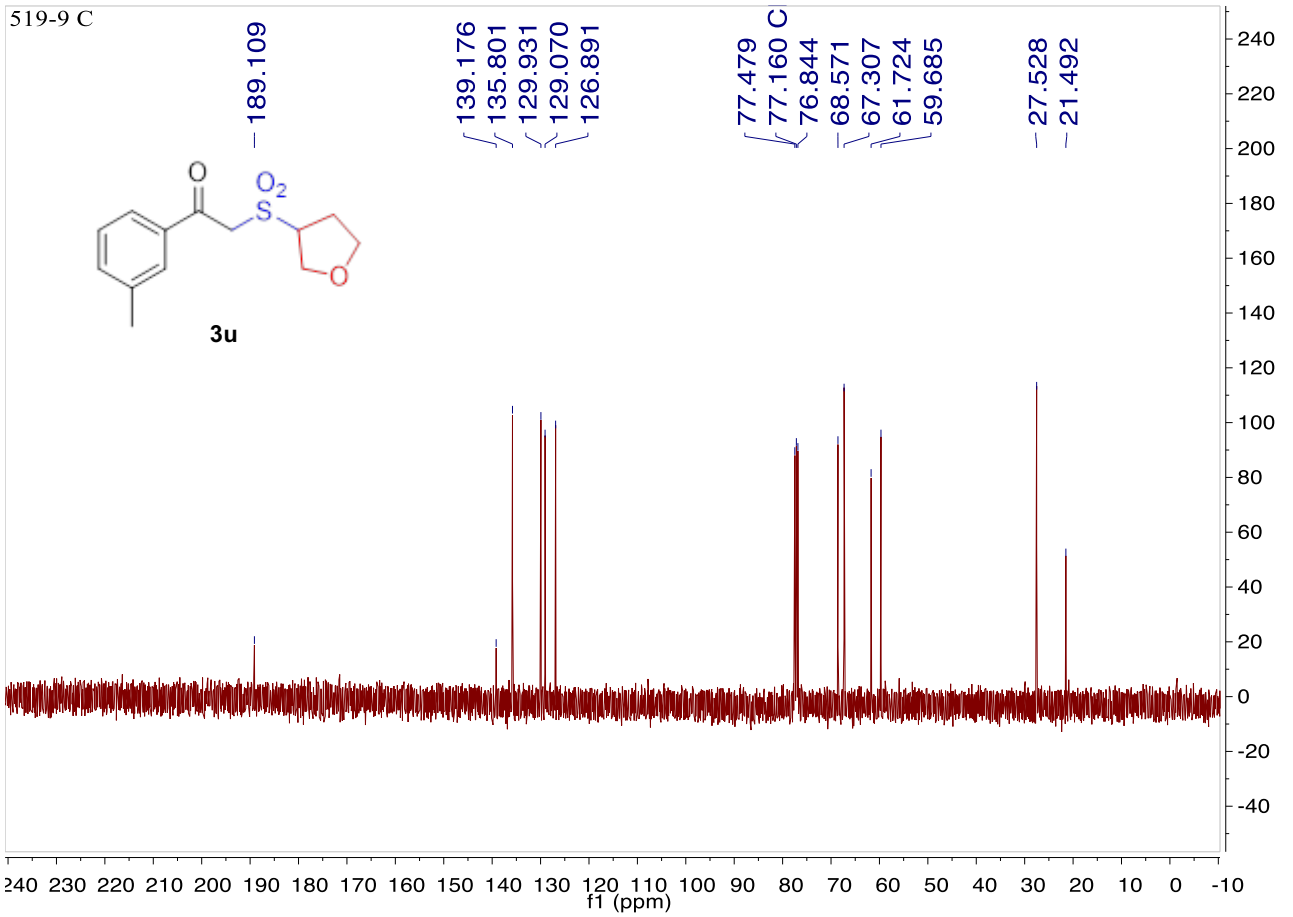


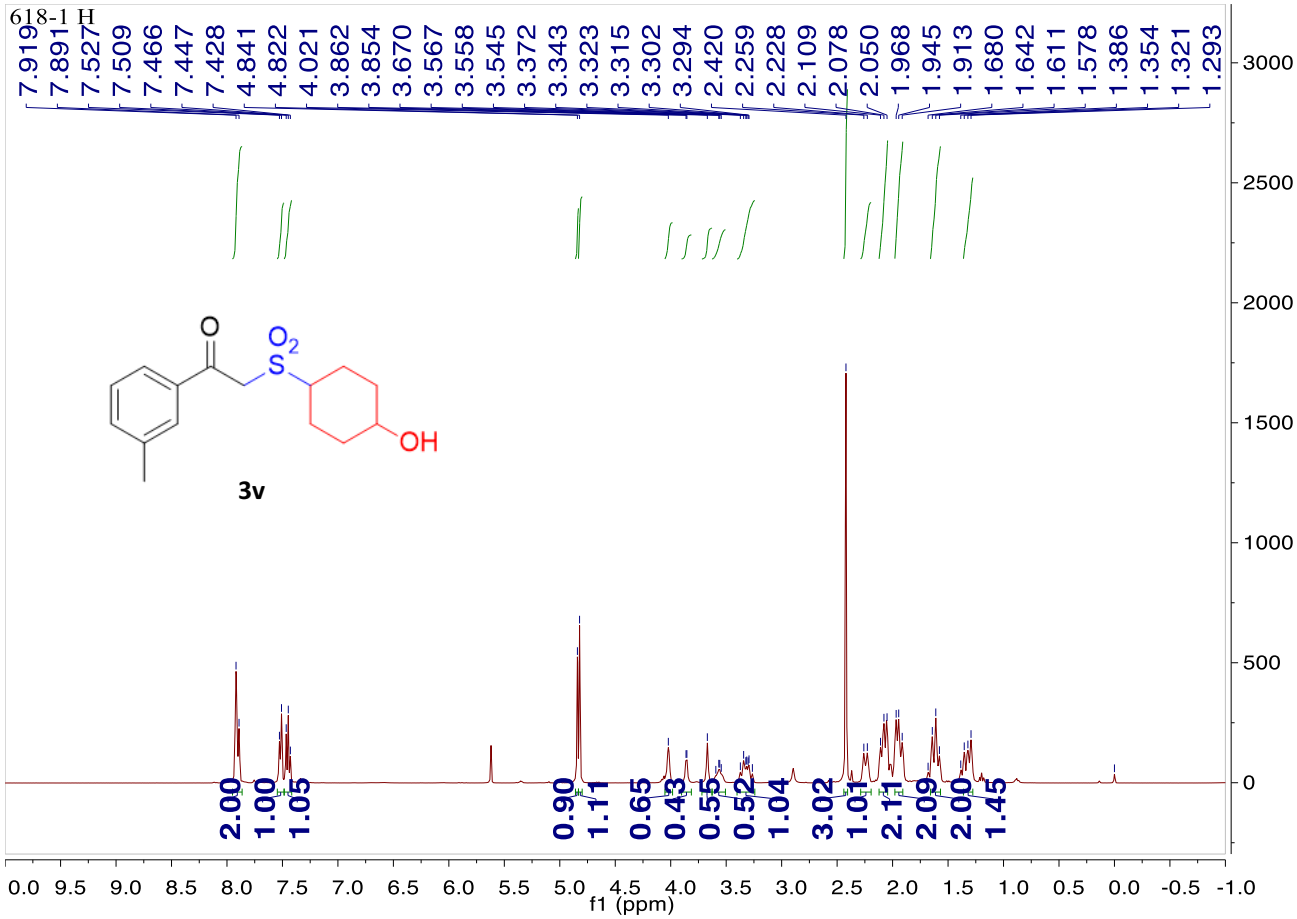
519-4 F
-94.02
-94.60
f1 (ppm)
3s

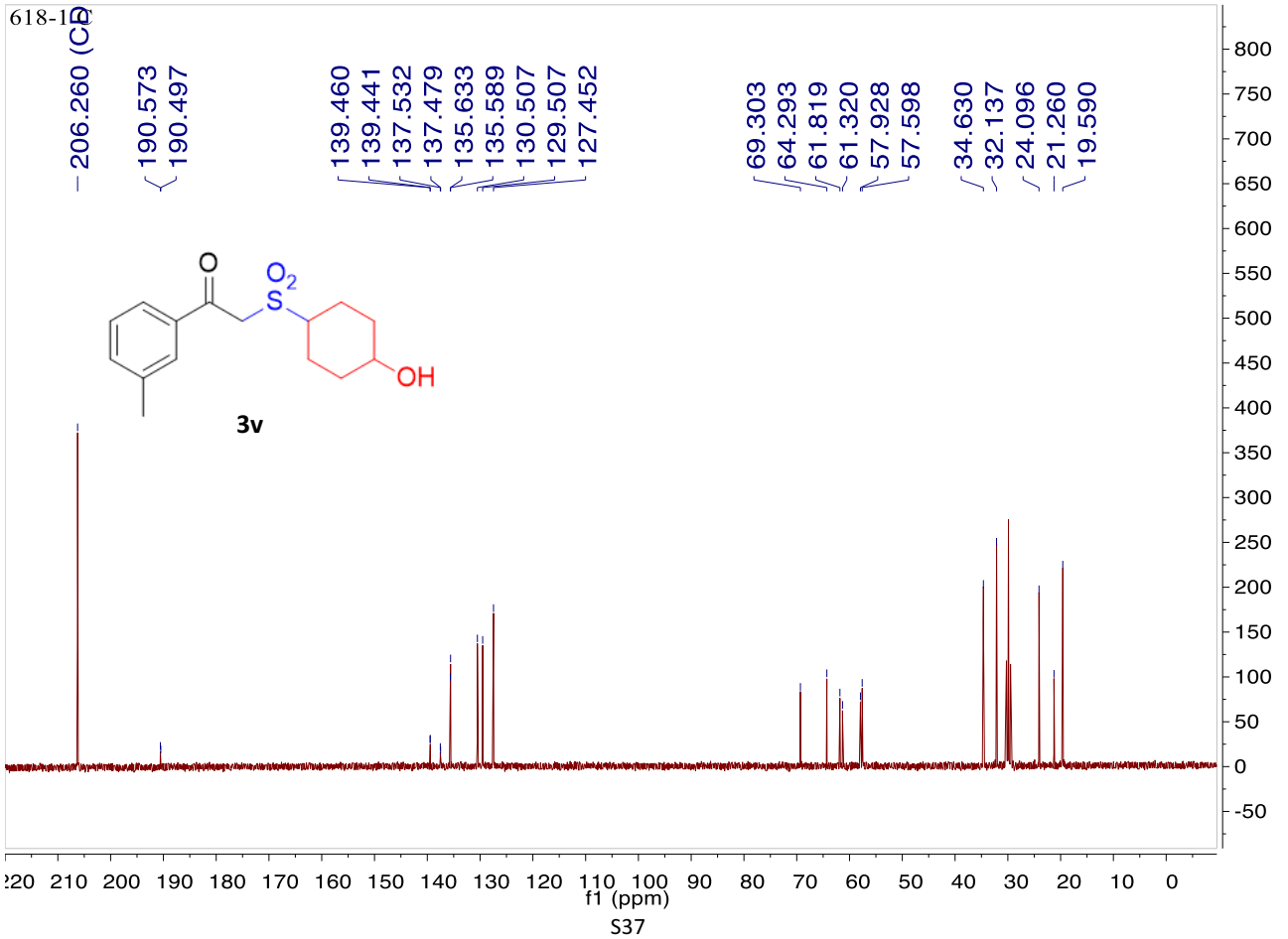

519-8 H
7.510
7.491
7.423
7.342
7.322
7.302
7.160 C
7.093
7.072
5.608
4.450
4.052
4.032
4.013
3.992
3.973
3.756
2.879
2.864
2.840
2.825
2.756
2.732
2.717
2.693
O
O2
S
OMe
3t
1.00
0.95
1.01
0.91
1.83
2.00
1.00
3.05
4.16
f1 (ppm)

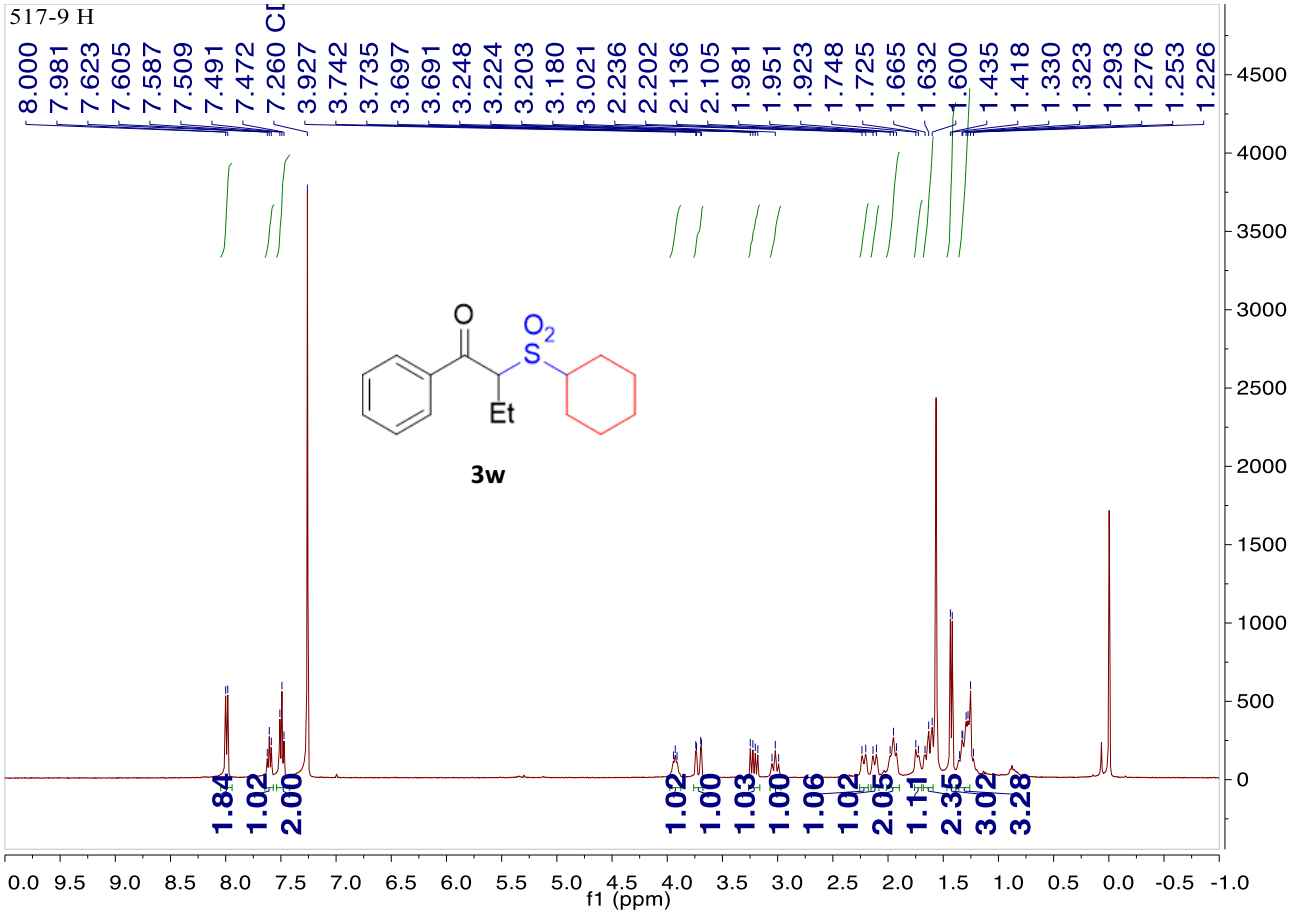

519-8 C
188.933
160.118
137.219
130.085
128.391
122.420
121.510
113.196
77.478
77.160 C
76.843
59.965
58.870
55.643
33.662
O
O2
S
OMe
3t
f1 (ppm)

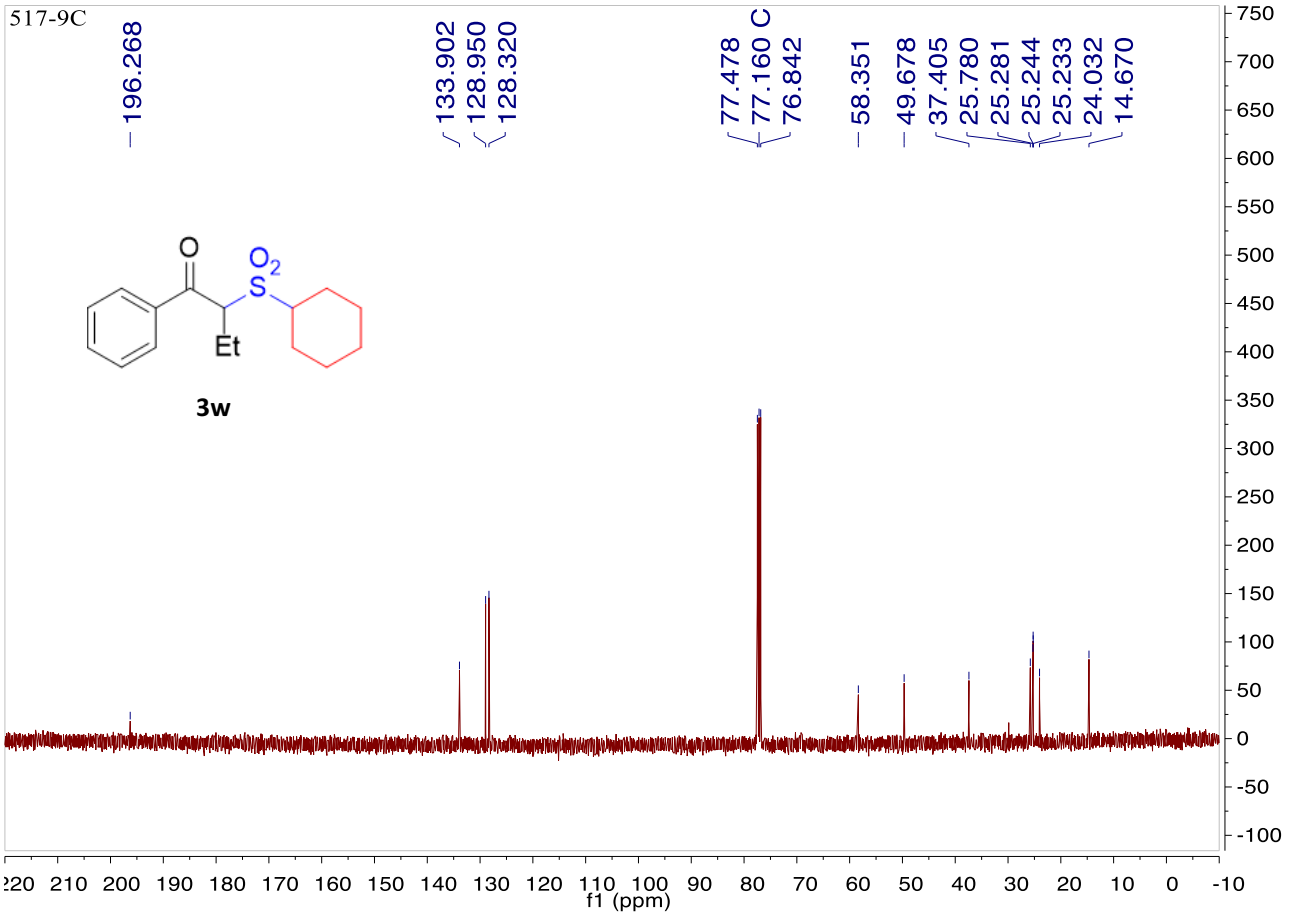

519-19 H
3u
1.90
0.90
1.00
2.00
1.00
2.01
1.03
1.01
4.04
1.06
f1 (ppm)


519-9 C
189.109
139.176
135.801
129.931
129.070
126.891
77.479
77.160 C
76.844
68.571
67.307
61.724
59.685
27.528
21.492
3u
f1 (ppm)


618-1 H
7.919
7.891
7.527
7.509
7.466
7.447
7.428
4.841
4.822
4.021
3.862
3.854
3.670
3.567
3.558
3.545
3.372
3.343
3.323
3.315
3.302
3.294
2.420
2.259
2.228
2.109
2.078
2.050
1.968
1.945
1.913
1.680
1.642
1.611
1.578
1.386
1.354
1.321
1.293
O
O2
S
OH
3v
2.00
1.00
1.05
0.90
1.11
0.65
0.43
0.55
0.52
1.04
3.02
1.01
2.11
2.09
2.00
1.45
f1 (ppm)


618-1C
206.260 (CD
190.573
190.497
139.460
139.441
137.532
137.479
135.633
135.589
130.507
129.507
127.452
69.303
64.293
61.819
61.320
57.928
57.598
34.630
32.137
24.096
21.260
19.590
O
O2
S
OH
3v
f1 (ppm)


517-9 H
8.000
7.981
7.623
7.605
7.587
7.509
7.491
7.472
7.260 CD
3.927
3.742
3.735
3.697
3.691
3.248
3.224
3.203
3.180
3.021
2.236
2.202
2.136
2.105
1.981
1.951
1.923
1.748
1.725
1.665
1.632
1.600
1.435
1.418
1.330
1.323
1.293
1.276
1.253
1.226
O
O2
S
Et
3w
1.84
1.02
2.00
1.02
1.00
1.03
1.00
1.06
1.02
2.05
1.11
2.35
3.02
3.28
f1 (ppm)


517-9C
196.268
133.902
128.950
128.320
77.478
77.160 C
76.842
58.351
49.678
37.405
25.780
25.281
25.244
25.233
24.032
14.670
O
O2
S
Et
3w
f1 (ppm)