Modular Synthesis of Divergent Thiofunctionalized Sulfoxonium Ylides

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Supporting Information

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1. General information

Unless otherwise noted, all reactions were carried out at room temperature under an atmosphere of nitrogen with flame-dried glassware. If reaction was not conducted at room temperature, reaction temperatures are reported as the temperature of the bath surrounding the vessel unless otherwise stated. The dry solvents used were purified by distillation over the drying agents indicated in parentheses and were transferred under nitrogen: THF (Na-benzophenone), 1,2-dichloroethane (CaH_2), dichloromethane (CaH_2). Anhydrous CF_3CH_2OH, CH_3CN, DMF and MeOH were purchased from Acros Organics and stored under nitrogen atmosphere. Commercially available chemicals such as CS_2, aliphatic amines **2** and thiophenols were obtained from commercial suppliers (Tansoole, Bidepharm, Alfa Aesar and Sigma-Aldrich) and used without further purification unless otherwise stated.

Proton NMR (^1H) were recorded at 400 MHz, and Carbon NMR (^{13}C) at 101 MHz NMR spectrometer unless otherwise stated. The following abbreviations are used for the multiplicities: s: singlet, d: doublet, t: triplet, q: quartet, m: multiplet, br s: broad singlet for proton spectra. Coupling constants (J) are reported in Hertz (Hz).

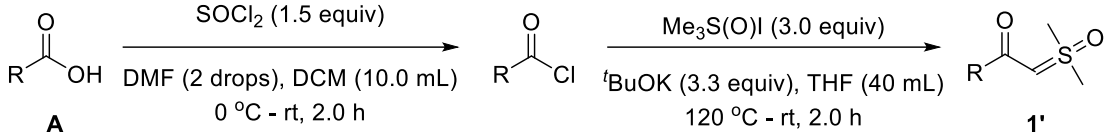
High-resolution mass spectra HRMS-ESI (TOF) was recorded on a BRUKER VPEXII spectrometer with EI and ESI mode unless otherwise stated.

Analytical thin layer chromatography was performed on Polygram SIL G/UV254 plates. Visualization was accomplished with short wave UV light, or $KMnO_4$ staining solutions followed by heating. Flash column chromatography was performed using silica gel (200-300 mesh) with solvents distilled prior to use.

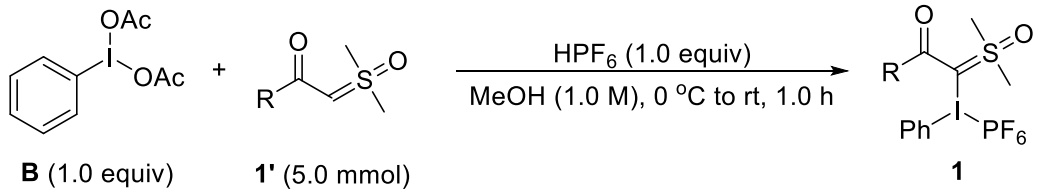
No attempts were made to optimize yields for substrate synthesis.

2 Synthesis of substrates

2.1 General Procedure for the synthesis of sulfoxonium-iodonium hybrid ylides **1** and **6**.[1-2]

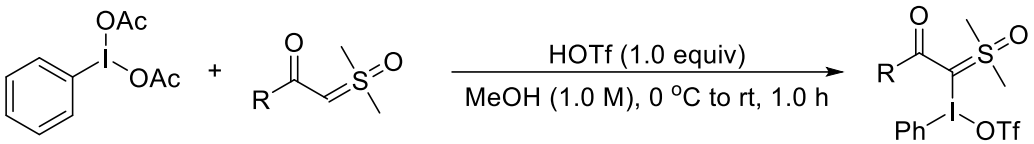


According to the literature, the slightly modified method is as follows. Under N_2, acid (5.0 mmol) in CH_2Cl_2 (10.0 mL) at 0 °C before adding $SOCl_2$ (7.5 mmol, 1.5 equiv) and two drop of DMF. After 60 minutes stirring at 50 °C, and the volatiles were carefully evaporated under high-vacuum. During that time, trimethylsulfoxonium iodide (3.3 g, 16.5 mmol, 3.0 equiv) was suspended under N_2 in dry THF (40.0 mL) in a flame-dried 100 mL round bottom flask that was protected from light with aluminium foil. Potassium tertbutoxide (1.8 g, 16.5 mmol, 3.3 equiv) was added, and the mixture was stirred at reflux for 3.0 hours. After cooling to 0 °C, a solution of acid chloride obtained above in THF (10.0 mL) was added dropwise to the mixture. The mixture was stirred at room temperature for another hour and then solvents were removed under vacuum. Then 80.0 ml water were added, extraction with CH_2Cl_2 (50.0 × 3 mL). Purification by flash chromatography (dichloromethane/MeOH = 30/1) provided the sulfoxonium ylides **1'** with high yields.



A solution of aryliodoso diacetate (5.0 mmol, 1.0 equiv.) in MeOH (5.0 mL, 1.0 M) was treated with corresponding acid HPF_6 (5.0 mmol, 1.0 equiv.) at room temperature. This clear solution was added dropwise to the ice bath-cooled solution of sulfoxonium ylides (5.0 mmol, 1.0 equiv.) in MeOH (5.0 mL, 1.0 M) over 10 min with stirring. The resulting reaction mixture was stirred at 0 °C for an additional 1.0 hour. During this period, a lot of white precipitate was formed. The product **1** was collected by filtration, washed successively with MeOH (5 mL × 3) and Et_2O (5 mL × 3), dried

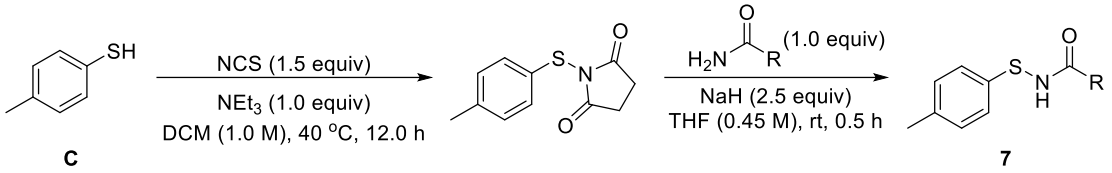
under high vacuum and stored at -30 °C. If the hypervalent iodine reagent failed to precipitate, it was subjected to flash column chromatography, eluting with DCM/Acetone mixtures.



B (1.0 equiv) **1'** (5.0 mmol) **6**

A solution of aryliodoso diacetate (5.0 mmol, 1.0 equiv.) in MeOH (5.0 mL, 1.0 M) was treated with corresponding acid HOTf (5.0 mmol, 1.0 equiv.) at room temperature. This clear solution was added dropwise to the ice bath-cooled solution of sulfoxonium ylides (5.0 mmol, 1.0 equiv.) in MeOH (5.0 mL, 1.0 M) over 10 min with stirring. The resulting reaction mixture was stirred at 0 °C for an additional 1.0 hour. During this period, a lot of white precipitate was formed. The product **6** was collected by filtration, washed successively with MeOH (5 mL × 3) and Et_2O (5 mL × 3), dried under high vacuum and stored at -30 °C. If the hypervalent iodine reagent failed to precipitate, it was subjected to flash column chromatography, eluting with DCM/Acetone mixtures.

2.2 General Procedure for the synthesis of sulfenamides **7**.[3]



c **7**

General Procedure for the synthesis of *N*-thiosuccinimides:

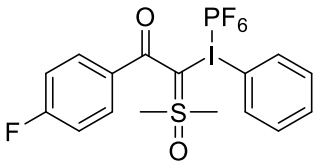
To a stirred solution of the indicated thiol (5.0 mmol, 1.0 equiv) in DCM (0.3 M) under nitrogen was added *N*-chlorosuccinimide (7.5 mmol, 1.5 equiv) at room temperature. After stirring at room temperature for one hour, a solution of triethylamine (5.0 mmol, 1.0 equiv) in DCM (0.7 M) was added dropwise over 30 minutes. The reaction mixture was heated to 40 °C overnight. After cooling to room temperature, the reaction mixture was diluted with H_2O, and extracted 3x with ethyl acetate. The combined organic layers were washed with brine, dried over Na_2SO_4, and concentrated. The crude residue was purified through column chromatography.

General Procedure for the synthesis of sulfenamides:

To a flame dried round bottom flask under nitrogen and equipped with an addition funnel and stir bar was added pivalamide (1.0 mmol, 1.0 equiv). THF (0.15 M) was added and the solution was cooled to 0 °C. NaH (2.5 mmol, 2.5 equiv) was added, then the solution was warmed to room temperature and stirred for 30 minutes. The addition funnel was charged with a solution of the indicated thiosuccinimide (1.0 mmol, 1.0 equiv) in THF (0.3 M), which was added dropwise over one hour. Upon completion of the addition, the reaction mixture was stirred at room temperature for 30 minutes, then quenched with saturated aqueous ammonium chloride and extracted 3x with ethyl acetate. The combined organic layers were washed with brine, dried over Na_2SO_4, and concentrated. The crude residue was purified through column chromatography and given the product **7** in moderate to high yields, all the characteristic data are consistent with the data reported before.[3]

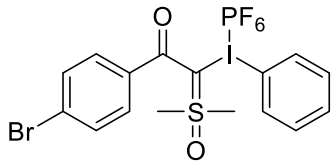
2.3 Characterization of substrates **1** and **6**

2-(dimethyl(oxo)-λ^6-sulfaneylidene)-1-(4-fluorophenyl)-2-((hexafluoro-λ^7-phosphaneyl)(phenyl)-λ^3-iodaneyl)ethan-1-one (1b)



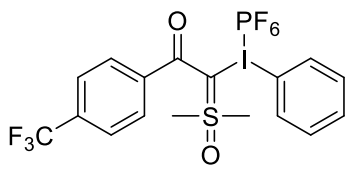
Following the general procedure 2.1. After filtration, **1b** was collected as a yellow solid (4.1 g, 7.29 mmol, 73% yield). ^{1}H NMR (400 MHz, DMSO-d$_6$) δ 7.82 (d, *J* = 7.7 Hz, 2H), 7.67 (t, *J* = 7.3 Hz, 1H), 7.60 – 7.48 (m, 4H), 7.38 – 7.25 (m, 2H), 3.82 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d$_6$) δ 186.76, 163.50 (d, J = 248.7 Hz), 135.53 (d, J = 3.1 Hz), 132.45, 131.78, 131.63, 129.99 (d, J = 8.9 Hz), 119.91, 115.42 (d, J = 21.9 Hz), 64.75, 42.01. ^{19}F NMR (376 MHz, DMSO-d$_6$) δ -69.11, -71.00, -108.64. ^{31}P NMR (162 MHz, DMSO-d$_6$) δ -130.97, -135.36, -139.75, -144.14, -148.53, -152.93, -157.32. EI-MS: calculated $C_{16}H_{15}F_7IO_2PS$ $[M]^+$ 561.9463, Found 561.9463.

1-(4-bromophenyl)-2-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-((hexafluoro-λ^7-phosphaneyl)(phenyl)-λ^3-iodaneyl)ethan-1-one (1c)



Following the general procedure 2.1. After filtration, **1c** was collected as a white solid (4.9 g, 7.86 mmol, 79% yield). ^{1}H NMR (400 MHz, DMSO-d$_6$) δ 7.82 (d, *J* = 7.3 Hz, 2H), 7.72 – 7.62 (m, 3H), 7.56 (t, *J* = 7.6 Hz, 2H), 7.37 (d, *J* = 8.5 Hz, 2H), 3.81 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d$_6$) δ 186.77, 138.21, 132.47, 131.80, 131.64, 131.41, 129.38, 124.58, 119.93, 65.00, 41.94. ^{19}F NMR (376 MHz, DMSO-d$_6$) δ -69.12, -71.01. ^{31}P NMR (162 MHz, DMSO-d$_6$) δ -130.99, -135.38, -139.77, -144.16, -148.56, -152.95, -157.34. EI-MS: calculated $C_{16}H_{15}BrF_6IO_2PS$ $[M]^+$ 621.8663, Found 621.8656.

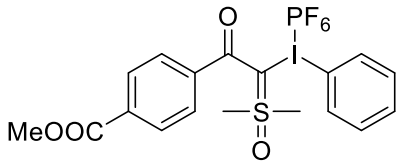
2-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-((hexafluoro-λ^7-phosphaneyl)(phenyl)-λ^3-iodaneyl)-1-(4-(trifluoromethyl)phenyl)ethan-1-one (1d)



Following the general procedure 2.1. After filtration, **1d** was collected as a white solid (4.1 g, 6.70 mmol, 67% yield).^{1}H NMR (400 MHz, DMSO-d$_6$) δ 7.87 (d, *J* = 8.2 Hz, 2H), 7.81 (d, *J* = 7.4 Hz, 2H), 7.67 (t, *J* = 7.4 Hz, 1H), 7.62 (d, *J* = 8.0 Hz, 2H), 7.56 (t,

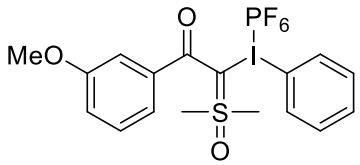
J = 7.7 Hz, 2H), 3.84 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 186.47, 143.12, 132.49, 131.81, 131.66, 130.82 (q, *J* = 32.0 Hz), 128.02, 125.47 (d, *J* = 4.0 Hz), 123.83 (q, *J* = 272.6 Hz), 119.86, 65.50, 41.91. ^{19}F NMR (376 MHz, DMSO-d_6) δ -61.29, -69.15, -71.04. ^{31}P NMR (162 MHz, DMSO-d_6) δ -130.97, -135.36, -139.75, -144.14, -148.53, -152.92, -157.31. EI-MS: calculated $C_{17}H_{15}F_9IO_2PS$ $[M]^+$ 611.9431, Found 611.9436.

Methyl 4-(2-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-((hexafluoro-λ^7-phosphaneyl)(phenyl)-λ^3-iodaneyl)acetyl)benzoate (1e)



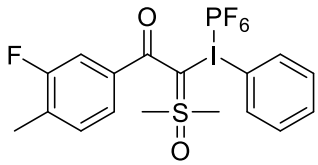
Following the general procedure 2.1. Purification by flash chromatography (dichloromethane/methanol = 20/1) provided **1e** as a yellow solid (2.1 g, 3.49 mmol, 35% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.04 (d, *J* = 8.2 Hz, 2H), 7.79 (d, *J* = 7.7 Hz, 2H), 7.66 (t, *J* = 7.3 Hz, 1H), 7.60 – 7.46 (m, 4H), 3.88 (s, 3H), 3.83 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 186.90, 165.57, 143.44, 132.56, 131.76, 131.62, 131.47, 129.21, 127.54, 120.02, 65.57, 52.41, 41.89. ^{19}F NMR (376 MHz, DMSO-d_6) δ -69.18, -71.07. ^{31}P NMR (162 MHz, DMSO-d_6) δ -131.00, -135.39, -139.78, -144.17, -148.56, -152.95, -157.34. EI-MS: calculated $C_{18}H_{18}F_6IO_4PS$ $[M]^+$ 601.9612, Found 601.9609.

2-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-((hexafluoro-λ^7-phosphaneyl)(phenyl)-λ^3-iodaneyl)-1-(3-methoxyphenyl)ethan-1-one (1f)



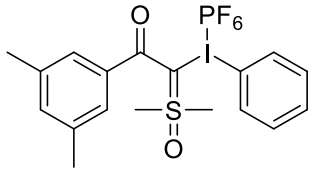
Following the general procedure 2.1. After filtration, **1f** was collected as a white solid (5.1 g, 8.88 mmol, 89% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.79 (d, *J* = 7.3 Hz, 2H), 7.65 (t, *J* = 7.4 Hz, 1H), 7.55 (t, *J* = 7.6 Hz, 2H), 7.38 (t, 1H), 7.08 (d, *J* = 8.3 Hz, 1H), 6.97 (d, *J* = 7.6 Hz, 1H), 6.90 (s, 1H), 3.82 (s, 6H), 3.66 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 187.72, 158.83, 140.42, 132.07, 131.71, 131.48, 129.62, 119.64, 119.42, 116.92, 112.35, 64.46, 55.16, 41.99. ^{19}F NMR (376 MHz, DMSO-d_6) δ -69.17, -71.05. ^{31}P NMR (162 MHz, DMSO-d_6) δ -131.00, -135.39, -139.78, -144.17, -148.56, -152.95, -157.35. EI-MS: calculated $C_{17}H_{18}F_6IO_3PS$ $[M]^+$ 573.9663, Found 573.9669.

2-(dimethyl(oxo)-λ^6-sulfaneylidene)-1-(3-fluoro-4-methylphenyl)-2-((hexafluoro-λ^7-phosphaneyl)(phenyl)-λ^3-iodaneyl)ethan-1-one (1g)



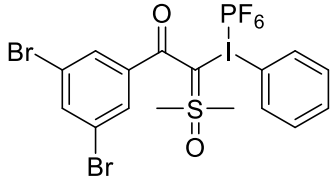
Following the general procedure 2.1. After filtration, **1g** was collected as a white solid (4.4 g, 7.64 mmol, 76% yield). ^{1}H NMR (400 MHz, DMSO-d$_6$) δ 7.81 (dd, *J* = 8.3, 1.0 Hz, 2H), 7.66 (t, *J* = 7.4 Hz, 1H), 7.56 (t, *J* = 7.6 Hz, 2H), 7.39 (t, *J* = 7.7 Hz, 1H), 7.25 – 7.00 (m, 2H), 3.80 (s, 6H), 2.30 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d$_6$) δ 186.31 (d, *J* = 2.1 Hz), 159.91 (d, *J* = 245.1 Hz), 138.59 (d, *J* = 6.6 Hz), 132.36, 131.75, 131.67, 131.60, 127.78 (d, *J* = 17.0 Hz), 123.26 (d, *J* = 3.3 Hz), 119.92, 113.98 (d, *J* = 23.6 Hz), 64.70, 41.95, 14.19 (d, *J* = 3.1 Hz). ^{9}F NMR (376 MHz, DMSO-d$_6$) δ -69.15, -71.04, -116.45. ^{31}P NMR (162 MHz, DMSO-d$_6$) δ -130.99, -135.38, -139.77, -144.16, -148.55, -152.95, -157.34. EI-MS: calculated $C_{17}H_{17}F_7IO_2PS$ $[M]^+$ 575.9620, Found 575.9620.

2-(dimethyl(oxo)-λ^6-sulfaneylidene)-1-(3,5-dimethylphenyl)-2-((hexafluoro-λ^7-phosphaneyl)(phenyl)-λ^3-iodaneyl)ethan-1-one (1h)



Following the general procedure 2.1. After filtration, **1h** was collected as a white solid (5.4 g, 9.44 mmol, 94% yield). ^{1}H NMR (400 MHz, DMSO-d$_6$) δ 7.84 – 7.77 (m, 2H), 7.68 (t, *J* = 7.4 Hz, 1H), 7.59 (t, *J* = 7.6 Hz, 2H), 7.16 (s, 1H), 6.89 (s, 2H), 3.83 (s, 6H), 2.22 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d$_6$) δ 188.58, 139.15, 137.47, 132.41, 132.39, 131.61, 131.48, 124.87, 120.42, 64.71, 41.92, 20.69. ^{19}F NMR (376 MHz, DMSO-d$_6$) δ -69.18, -71.07. ^{31}P NMR (162 MHz, DMSO-d$_6$) δ -131.00, -135.39, -139.78, -144.18, -148.57, -152.96, -157.35. EI-MS: calculated: $C_{18}H_{20}F_6IO_2PS$ $[M]^+$ 571.9870, Found 571.9869.

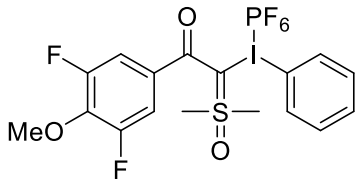
1-(3,5-dibromophenyl)-2-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-((hexafluoro-λ^7-phosphaneyl)(phenyl)-λ^3-iodaneyl)ethan-1-one (1i)



Following the general procedure 2.1. After filtration, **1i** was collected as a white solid (5.7 g, 8.12 mmol, 81% yield). ^{1}H NMR (400 MHz, DMSO-d$_6$) δ 8.03 (t, *J* = 1.8 Hz, 1H), 7.80 (d, *J* = 7.3

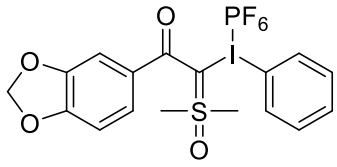
Hz, 2H), 7.68 (t, *J* = 7.4 Hz, 1H), 7.58 (t, *J* = 7.6 Hz, 2H), 7.50 (d, *J* = 1.8 Hz, 2H), 3.82 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 184.48, 142.85, 135.64, 132.61, 131.79, 131.66, 128.95, 122.51, 119.98, 65.64, 41.78. ^{19}F NMR (376 MHz, DMSO-d_6) δ -69.13, -71.02. ^{31}P NMR (162 MHz, DMSO-d_6) δ -131.00, -135.39, -139.78, -144.17, -148.56, -152.95, -157.35. EI-MS: calculated $C_{16}H_{14}Br_2F_6IO_2PS$ $[M]^+$ 699.7768, Found 699.7767.

1-(3,5-difluoro-4-methoxyphenyl)-2-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-((hexafluoro-λ^7-phosphaneyl)(phenyl)-λ^3-iodaneyl)ethan-1-one (1j)



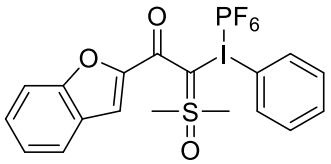
Following the general procedure 2.1. After filtration, **1j** was collected as a white solid (4.3 g, 7.04 mmol, 70% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.83 (dd, *J* = 8.3, 1.0 Hz, 2H), 7.67 (t, *J* = 7.4 Hz, 1H), 7.56 (t, *J* = 7.7 Hz, 2H), 7.17 (d, *J* = 8.7 6Hz, 2H), 4.02 (s, 3H), 3.78 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 184.60, 154.10 (dd, *J* = 248.9, 6.0 Hz), 138.00 (t, *J* = 13.7 Hz), 133.44 (t, *J* = 7.5 Hz), 132.63, 131.77, 131.70, 120.04, 112.17 (q, J = 9.2, 7.8, 7.3 Hz), 64.78, 61.82, 41.91. ^{19}F NMR (376 MHz, DMSO-d_6) δ -69.16, -71.05, -127.21. ^{31}P NMR (162 MHz, DMSO-d_6) δ -131.00, -135.39, -139.78, -144.17, -148.56, -152.96, -157.35. EI-MS: calculated $C_{17}H_{16}F_8IO_3PS$ $[M]^+$ 609.9475 Found 609.9470.

1-(benzo[d][1,3]dioxol-5-yl)-2-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-((hexafluoro-λ^7-phosphaneyl)(phenyl)-λ^3-iodaneyl)ethan-1-one (1k)



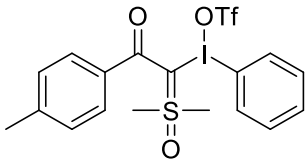
Following the general procedure 2.1. Purification by flash chromatography (dichloromethane/methanol = 20/1) provided **1k** as a yellow solid (2.9 g, 4.93 mmol, 49% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.84 (d, *J* = 7.4 Hz, 2H), 7.66 (t, *J* = 7.4 Hz, 1H), 7.56 (t, *J* = 7.6 Hz, 2H), 7.11 – 6.80 (m, 3H), 6.11 (s, 2H), 3.79 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 186.94, 149.78, 147.20, 132.69, 132.43, 131.77, 131.62, 122.64, 120.02, 107.90, 107.85, 101.88, 64.05, 42.11. ^{19}F NMR (376 MHz, DMSO-d_6) δ -69.08, -70.97. ^{31}P NMR (162 MHz, DMSO-d_6) δ -130.95, -135.34, -139.74, -144.13, -148.52, -152.91, -157.31. EI-MS: calculated: $C_{17}H_{16}F_6IO_4PS$ $[M]^+$ 587.9456, Found 587.9461.

1-(benzofuran-2-yl)-2-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-((hexafluoro-λ^7-phosphaneyl)(phenyl)-λ^3-iodaneyl)ethan-1-one (1l)



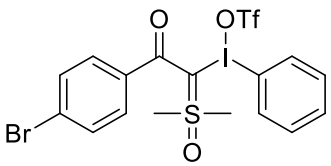
Following the general procedure 2.1. After filtration, **1l** was collected as a white solid (3.3 g, 5.65 mmol, 57% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.12 (d, *J* = 7.4 Hz, 2H), 7.81 (d, *J* = 7.8 Hz, 1H), 7.75 – 7.57 (m, 5H), 7.53 (t, *J* = 7.8 Hz, 1H), 7.38 (t, *J* = 7.5 Hz, 1H), 3.86 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 173.52, 154.24, 151.90, 132.90, 131.59, 131.48, 127.73, 126.76, 124.19, 123.13, 120.51, 111.92, 111.75, 63.22, 42.20. ^{19}F NMR (376 MHz, DMSO-d_6) δ -69.11, -71.00. ^{31}P NMR (162 MHz, DMSO-d_6) δ -130.96, -135.35, -139.74, -144.13, -148.53, -152.92, -157.31. EI-MS: calculated: $C_{18}H_{16}F_6IO_3PS$ $[M]^+$ 583.9507, Found 583.9500.

(1-(dimethyl(oxo)-λ^6-sulfanylidene)-2-oxo-2-(p-tolyl)ethyl)(phenyl)-λ^3-iodanyl trifluoromethanesulfonate (6b)



Following the general procedure 2.1. After filtration, **6b** was collected as a white solid (5.0 g, 8.89 mmol, 89% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.81 (d, J = 8.0 Hz, 2H), 7.65 (d, J = 7.3 Hz, 1H), 7.56 (t, J = 7.6 Hz, 2H), 7.33 (d, J = 8.0 Hz, 2H), 7.26 (d, J = 7.8 Hz, 2H), 3.81 (s, 6H), 2.37 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 187.90, 141.20, 136.12, 132.25, 131.72, 131.53, 128.77, 127.48, 120.69 (q, J = 322.0 Hz), 119.93, 64.29, 42.04, 21.01. ^{19}F NMR (376 MHz, DMSO-d_6) δ -77.73. EI-MS: calculated $C_{18}H_{18}F_3IO_5S$ $[M]^+$ 561.9592; Found 561.9594.

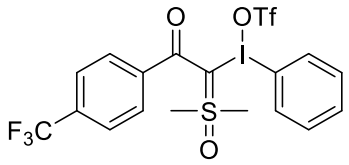
(2-(4-bromophenyl)-1-(dimethyl(oxo)-λ^6-sulfanylidene)-2-oxoethyl)(phenyl)-λ^3-iodanyl trifluoromethanesulfonate (6c)



Following the general procedure 2.1. After filtration, **6c** was collected as a white solid (5.2 g, 8.29 mmol, 83% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.81 (d, J = 7.5 Hz, 2H), 7.70 (d, J = 8.5 Hz, 2H), 7.65 (d, J = 7.4 Hz, 1H), 7.56 (t, J = 7.6 Hz, 2H), 7.36 (d, J = 8.4 Hz, 2H), 3.80 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 186.70, 138.18, 132.43, 131.77, 131.60, 131.38, 129.34, 120.67 (q, J = 322.3 Hz), 124.53, 119.89, 64.95, 41.19. ^{19}F NMR (376 MHz, DMSO-d_6) δ -77.72. EI-MS:

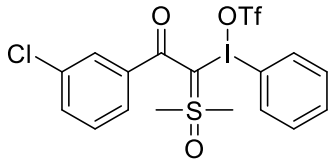
calculated $C_{17}H_{15}BrF_3IO_5S$ $[M]^+$ 625.8541; Found 625.8545.

(1-(dimethyl(oxo)-λ⁶-sulfanylidene)-2-oxo-2-(4-(trifluoromethyl)phenyl)ethyl)(phenyl)-λ³-iodanyl trifluoromethanesulfonate (6d)



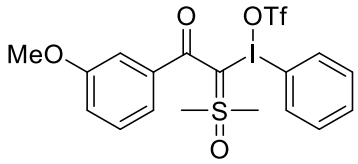
Following the general procedure 2.1. After filtration, **6d** was collected as a white solid (4.4 g, 7.14 mmol, 71% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.87 (d, J = 8.1 Hz, 2H), 7.81 (d, J = 7.6 Hz, 2H), 7.68 – 7.60 (m, 3H), 7.56 (t, J = 7.7 Hz, 2H), 3.84 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 186.46, 143.11, 132.48, 131.81, 131.65, 130.80 (q, J = 32.2 Hz), 128.02, 125.46 (d, J = 3.7 Hz), 123.82 (d, J = 272.5 Hz), 120.73(q, J = 275.9 Hz),119.10, ,65.47, 41.90. ^{19}F NMR (376 MHz, DMSO-d_6) δ -61.31, -77.75. EI-MS: calculated $C_{18}H_{15}F_6IO_5SO_3$ $[M]^+$615.9310; Found 615.9313.

(2-(3-chlorophenyl)-1-(dimethyl(oxo)-λ⁶-sulfanylidene)-2-oxoethyl)(phenyl)-λ³-iodanyl trifluoromethanesulfonate (6e)



Following the general procedure 2.1. After filtration, **6e** was collected as a white solid (3.6 g, 6.21 mmol, 62% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.79 (d, J = 7.3 Hz, 2H), 7.67 (t, J = 7.4 Hz, 1H), 7.60 (d, J = 12.3 Hz, 2H), 7.56 (s, 1H), 7.52 (t, J = 7.8 Hz, 1H), 7.38 – 7.34 (m, 2H), 3.82 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 186.73, 141.62, 133.38, 132.94, 132.23, 132.09, 131.31, 131.04, 127.56, 126.24, 121.16 (q, J = 322.3 Hz), 120.42, 65.69, 42.36. ^{19}F NMR (376 MHz, DMSO-d_6) δ -77.70. EI-MS: calculated $C_{17}H_{15}ClF_3IO_6S$ $[M]^+$ 581.9046; Found 581.9044.

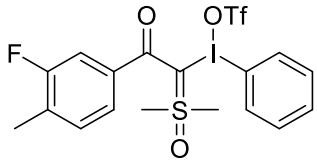
(1-(dimethyl(oxo)-λ⁶-sulfanylidene)-2-(3-methoxyphenyl)-2-oxoethyl)(phenyl)-λ³-iodanyl trifluoromethanesulfonate (6f)



Following the general procedure 2.1. After filtration, **6f** was collected as a white solid (4.9 g, 8.47 mmol, 85% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.79 (d, J = 7.5 Hz, 2H), 7.63 (d, J = 7.3 Hz, 1H), 7.55 (t, J = 7.6 Hz, 2H), 7.38 (t, J = 7.9 Hz, 1H), 7.08 (d, J = 8.2 Hz, 1H), 6.97 (d, J = 7.6 Hz, 1H), 6.91 (d, J = 0.6 Hz, 1H), 3.82 (s, 6H), 3.66 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ

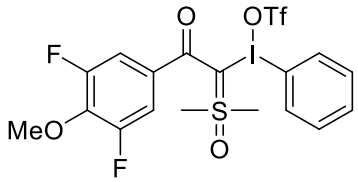
187.76, 158.84, 140.45, 132.09, 131.72, 131.48, 129.63, 120.70 (q, J = 322.3 Hz), 119.65, 119.42, 116.94, 112.34, 64.46, 55.17, 41.99. ^{19}F NMR (376 MHz, DMSO-d_6) δ -77.70. EI-MS: calculated $C_{18}H_{18}F_3IO_6S_2$ $[M]^+$ 577.9542; Found 577.9538.

(1-(dimethyl(oxo)-λ^6-sulfanylidene)-2-(3-fluoro-4-methylphenyl)-2-oxoethyl)(phenyl)-λ^3-iodanyl trifluoromethanesulfonate (6g)



Following the general procedure 2.1. After filtration, **6g** was collected as a white solid (4.9 g, 8.44 mmol, 84% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.80 (d, J = 7.3 Hz, 2H), 7.69 – 7.65 (m, 1H), 7.56 (t, J = 7.6 Hz, 2H), 7.39 (t, J = 7.7 Hz, 1H), 7.17 – 7.12 (m, 2H), 3.80 (s, 6H), 2.30 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 186.76, 160.38 (d, *J* = 245.0 Hz), 139.07 (d, *J* = 6.7 Hz), 132.82, 132.23, 132.15, 132.08, 128.25 (d, *J* = 17.0 Hz), 123.74 (d, *J* = 3.3 Hz), 121.12 (q *J* = 322.3 Hz), 120.39, 114.45 (d, *J* = 23.6 Hz), 65.17, 42.42, 14.68 (d, *J* = 3.0 Hz). ^{19}F NMR (376 MHz, DMSO-d_6) δ -77.73, -116.48. EI-MS: calculated $C_{18}H_{17}F_4IO_5S_2$ $[M]^+$ 579.9498; Found 579.9508.

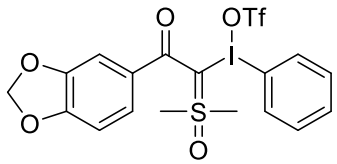
(2-(3,5-difluoro-4-methoxyphenyl)-1-(dimethyl(oxo)-λ^6-sulfanylidene)-2-oxoethyl)(phenyl)-λ^3-iodanyl trifluoromethanesulfonate (6h)



Following the general procedure 2.1. After filtration, **6h** was collected as a yellow solid (3.7 g, 6.02 mmol, 60% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.93 (d, *J* = 7.6 Hz, 2H), 7.76 (t, *J* = 7.3 Hz, 1H), 7.65 (t, *J* = 7.7 Hz, 2H), 7.27 (d, *J* = 8.2 Hz, 2H), 4.11 (s, 3H), 3.89 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 184.67, 154.15 (dd, *J* = 248.9, 5.9 Hz), 138.03 (t, *J* = 13.7 Hz), 133.50 (t, *J* = 7.5 Hz), 132.65, 131.80, 131.71, 120.72 (q, *J* = 322.2 Hz), 120.06, 112.19 (dd, *J* = 17.0, 7.3 Hz), 64.77, 61.82, 41.92. ^{19}F NMR (376 MHz, DMSO-d_6) δ -77.75, -127.24, -127.26. EI-MS: calculated $C_{18}H_{16}F_5IO_6S_2$ $[M]^+$ 613.9353; Found 613.9346.

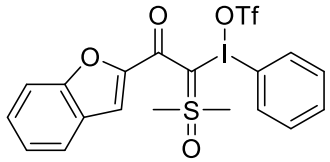
(2-(benzo[d][1,3]dioxol-5-yl)-1-(dimethyl(oxo)-λ^6-sulfanylidene)-2-oxoethyl)(phenyl)-λ^3-iodanyl trifluoromethanesulfonate (6i)

Following the general procedure 2.1. Purification by flash chromatography



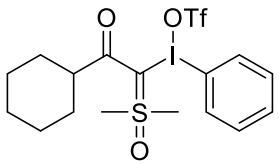
(dichloromethane/methanol = 20/1) provided **6i** as a white solid (2.5 g, 4.22mmol, 42% yield).^{1}H NMR (400 MHz, DMSO-d_6) δ 7.82 (d, J = 7.7 Hz, 2H), 7.66 (t, J = 7.3 Hz, 1H), 7.56 (t, J = 7.7 Hz, 2H), 6.97 (d, J = 12.9 Hz, 3H), 6.11 (s, 2H), 3.78 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 186.82, 149.70, 147.12, 137.10, 132.63, 132.34, 131.71, 131.55, 122.28, 120.95 (q *J* = 322.3 Hz),119.93, 107.84, 101.83, 63.96, 42.06. ^{19}F NMR (376 MHz, DMSO-d_6) δ -77.73. EI-MS: calculated $C_{18}H_{16}F_3IO_7S_2$ $[M]^+$ 591.9334; Found 591.9340.

(2-(benzofuran-2-yl)-1-(dimethyl(oxo)-λ^6-sulfanylidene)-2-oxoethyl)(phenyl)-λ^3-iodanyl trifluoromethanesulfonate (6j)



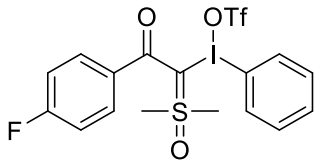
Following the general procedure 2.1. After filtration, **6j** was collected as a white solid (4.9 g, 8.33 mmol, 83% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.11 (d, J = 7.4 Hz, 2H), 7.80 (d, J = 7.6 Hz, 1H), 7.70 – 7.65 (m, 2H), 7.64 – 7.61 (m, 2H), 7.60 (s, 1H), 7.53 (t, J = 7.8 Hz, 1H), 7.39 – 7.35 (m, 1H), 3.86 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 173.94, 154.67, 152.33, 133.33, 132.03, 131.91, 128.16, 127.19, 121.14 (q, J = 322.3 Hz), 124.62, 123.57, 120.95, 112.36, 112.17, 63.64, 42.62. ^{19}F NMR (376 MHz, DMSO-d_6) δ -77.70. EI-MS: calculated $C_{19}H_{16}F_3IO_6S_2$ $[M]^+$ 587.9385; Found 587.9394.

(2-cyclohexyl-1-(dimethyl(oxo)-λ^6-sulfanylidene)-2-oxoethyl)(phenyl)-λ^3-iodanyl trifluoromethanesulfonate (6k)



Following the general procedure 2.1. After filtration, **6k** was collected as a white solid (4.4 g, 7.93 mmol, 79% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.51 (d, J = 7.6 Hz, 2H), 7.16 (t, J = 7.3 Hz, 1H), 7.07 (t, J = 7.6 Hz, 2H), 3.20 (s, 6H), 2.89 (s, 1H), 1.13 (d, J = 13.4 Hz, 4H), 0.84 – 0.60 (m, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 194.17, 132.53, 131.62, 131.46, 120.71 (q, J = 322.3 Hz), 119.96, 62.10, 45.77, 42.20, 29.27, 25.37, 24.89. ^{19}F NMR (376 MHz, DMSO-d_6) δ -77.74. EI-MS: calculated $C_{17}H_{22}F_3IO_5S_2$ $[M]^+$ 553.9905; Found 553.9902.

(1-(dimethyl(oxo)-λ^6-sulfanylidene)-2-(4-fluorophenyl)-2-oxoethyl)(phenyl)-λ^3-iodanyl trifluoromethanesulfonate (6l)



Following the general procedure 2.1. After filtration, **6l** was collected as a white solid (4.7 g, 8.29 mmol, 83% yield). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.81 (d, J = 7.4 Hz, 2H), 7.66 (t, J = 7.4 Hz, 1H), 7.56 (t, J = 7.6 Hz, 2H), 7.49 (dd, J = 8.7, 5.5 Hz, 2H), 7.31 (t, J = 8.9 Hz, 2H), 3.81 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 186.70, 163.45 (d, *J* = 248.7 Hz), 135.50 (d, *J* = 3.1 Hz), 132.40, 131.76, 131.59, 129.96 (d, *J* = 8.9 Hz), 120.68 (q, *J* = 322.3 Hz), 119.86, 115.39 (d, *J* = 21.9 Hz), 64.69, 41.97. ^{19}F NMR (376 MHz, DMSO-d_6) δ -77.72, -108.69. EI-MS: calculated $C_{17}H_{15}ClF_3IO_5S_2$ $[M]^+$ 581.9046; Found 581.9044.

3 General procedure and characterization of products

General procedure A

In an oven-dried Schlenk tube, a mixture of the aliphatic amine **2** (0.24 mmol, 1.2 equiv), CS_2 (0.50 mmol, 2.5 equiv), CsOPiv (1.5 equiv), acyclic I,S-ylide **1** (0.2 mmol, 1.0 equiv), and DCM (1.0 mL, 0.2 M) was stirred at 25 °C in the reaction agitator for 0.5 h. The pure product was purified by flash column chromatography on silica with an appropriate solvent to afford the pure product **3.**

General procedure B

In an oven-dried Schlenk tube, a mixture of the acyclic I,S-ylide **1** (0.2 mmol, 1.0 equiv), thiophenols (0.4 mmol, 2.0 equiv), DMAP (0.4 mmol, 2.0 equiv) and PhCl (2.0 ml, 0.1 M) was stirred at 25 °C in the reaction agitator for 0.5 h. The pure product was purified by flash column chromatography on silica with an appropriate solvent to afford the pure product **4.**

General procedure C

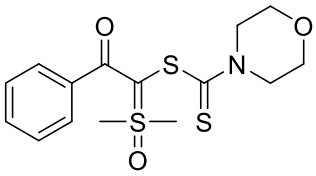
In an oven-dried Schlenk tube, a mixture of the acyclic I,S-ylide **1** (0.2 mmol, 1.0 equiv), thiophenols (0.4 mmol, 2.0 equiv), NaOAc (0.5 mmol, 2.5 equiv) and HFIP (2.0 ml, 0.1 M) was stirred at 0 °C in the ice bath for 2.0 h. The pure product was purified by flash column chromatography on silica with an appropriate solvent to afford the pure product **5.**

General procedure D

In an oven-dried Schlenk tube, a mixture of the acyclic I,S-ylide **6** (0.3 mmol, 1.5 equiv), **7** (0.2 mmol, 1.0 equiv), NaOAc (1.0 equiv) and HFIP (1.0 mL, 0.2 M) was stirred at 60 °C in the oil bath for 6.0 h. The pure product was purified by flash column chromatography on silica with an appropriate solvent to afford the pure product **8.**

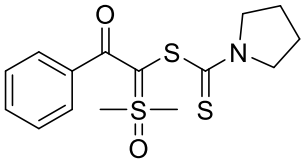
Characterization of products

1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-oxo-2-phenylethyl morpholine-4-carbodithioate (3a)



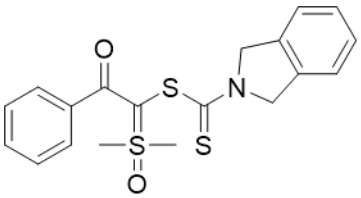
Following the general procedure A, the product **3a** was obtained in 95% yield (67.9 mg, 0.190 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). R_f (Petroleum ether/EtOAc 1:2): 0.19. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.57 (d, J = 7.5 Hz, 2H), 7.34 (t, J = 7.3 Hz, 1H), 7.29 (t, J = 7.5 Hz, 2H), 4.42 (s, 1H), 4.08 (s, 1H), 3.97 (s, 1H), 3.86 (s, 1H), 3.81 (s, 3H), 3.78 (s, 1H), 3.70 (s, 1H), 3.68 (s, 3H), 3.66 (s, 1H), 3.50 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.86, 189.88, 140.14, 129.78, 127.60, 127.52, 76.73, 66.64, 66.22, 53.33, 50.72, 43.62, 42.85. ESI-MS: calculated $C_{15}H_{19}NO_3NaS_3$ $[M+Na]^+$ 380.0425; Found 380.0416.

1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-oxo-2-phenylethyl pyrrolidine-1-carbodithioate (3b)



Following the general procedure A, the product **3b** was obtained in 62% yield (42.2 mg, 0.124 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc 1:1): 0.17. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.60 (d, *J* = 7.9 Hz, 2H), 7.32 (t, *J* = 7.3 Hz, 1H), 7.27 (t, *J* = 7.5 Hz, 2H), 3.83 (t, *J* = 7.0 Hz, 2H), 3.80 (s, 3H), 3.74 – 3.69 (m, 1H), 3.68 (s, 3H), 3.57 – 3.50 (m, 1H), 2.05 – 1.95 (m, 2H), 1.94 – 1.86 (m, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 197.39, 189.86, 140.18, 129.69, 127.75, 127.50, 77.67, 56.11, 50.41, 43.59, 43.01, 26.41, 24.03. ESI-MS: calculated $C_{15}H_{19}NO_2NaS_3$ $[M+Na]^+$ 364.0476; Found 364.0467.

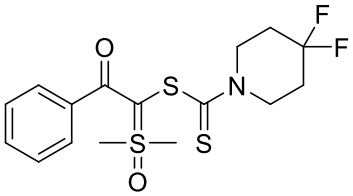
1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-oxo-2-phenylethyl soindoline-2-carbodithioate (3c)



Following the general procedure A, the product **3c** was obtained in 50% yield (39.1 mg, 0.100 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). R_f (Petroleum ether/EtOAc 1:3): 0.22. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.64 (d, J = 7.1 Hz, 2H), 7.36 – 7.27 (m, 6H), 7.22 (d, J = 6.6 Hz, 1H), 5.15 (d, J = 3.6 Hz, 2H), 5.08 (d, J = 15.1 Hz, 1H), 4.91 (d, J = 15.1 Hz, 1H), 3.87 (s, 3H), 3.74 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 198.68, 190.08, 140.13, 135.42, 135.15, 129.93, 128.20, 128.04, 127.79,

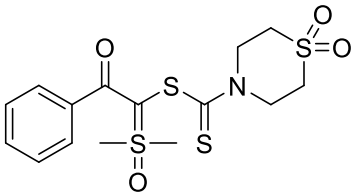
127.66, 122.80, 122.75, 77.23, 61.62, 55.72, 43.83, 43.38. ESI-MS: calculated $C_{19}H_{19}NO_2NaS_3$ $[M+Na]^+$ 412.0476; Found 412.0467.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl 4,4-difluoropiperidine-1-carbodithioate (3d)



Following the general procedure A, the product **3d** was obtained in 88% yield (69.5 mg, 0.176 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). R_f (Petroleum ether/EtOAc 2:1): 0.25. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.54 (d, J = 7.2 Hz, 2H), 7.34 (t, J = 7.4 Hz, 1H), 7.28 (t, J = 7.5 Hz, 2H), 4.61 (s, 1H), 4.22 – 3.96 (m, 2H), 3.85 (s, 1H), 3.82 (s, 3H), 3.69 (s, 3H), 2.19 – 1.90 (m, 3H), 1.76 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.74, 190.07, 140.25, 129.84, 127.54, 127.49, 120.97 (t, J = 242.7 Hz), 77.29, 50.08, 46.49, 43.67, 43.01, 34.26, 33.68. ^{19}F NMR (377 MHz, Chloroform-d) δ -96.26 (d, J = 239.0 Hz), -99.38 (d, J = 238.6 Hz). ESI-MS: calculated $C_{16}H_{19}NO_2NaS_3F_2$ $[M+Na]^+$ 414.0444; Found 414.0438.

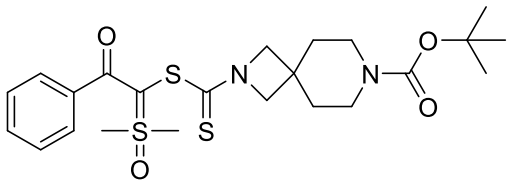
1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl thiomorpholine-4-carbodithioate 1, 1-dioxide (3e)



Following the general procedure A, the product **3e** was obtained in 41% yield (33.6 mg, 0.082 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc 1:1): 0.20. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.44 (d, J = 7.4 Hz, 2H), 7.34 (t, J = 7.1 Hz, 1H), 7.27 (t, J = 7.3 Hz, 2H), 4.81 (s, 1H), 4.39 (s, 2H), 4.19 (s, 1H), 3.80 (s, 3H), 3.64 (s, 3H), 3.32 (s, 1H), 3.02 (s, 2H), 2.69 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 205.42, 190.47, 140.00, 130.07, 127.63, 127.06, 77.49, 54.09, 53.14, 51.42, 51.30, 43.30, 43.05. ESI-MS: calculated $C_{15}H_{19}NO_4NaS_4$ $[M+Na]^+$ 428.0095; Found 428.0086.

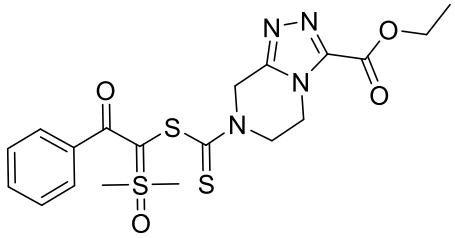
tert-butyl 2-(((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl)thio)carbonothioyl)-

2,7-diazaspiro[3.5]nonane-7-carboxylate (3f)



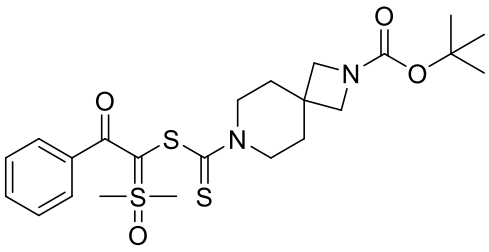
Following the general procedure A, the product **3f** was obtained in 87% yield (87.0 mg, 0.174 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc 1:1): 0.22. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.59 (d, J = 8.0 Hz, 2H), 7.36 (t, J = 7.3 Hz, 1H), 7.31 (t, J = 7.6 Hz, 2H), 4.01 – 3.91 (m, 3H), 3.84 (s, 3H), 3.80 (d, J = 10.2 Hz, 1H), 3.70 (s, 3H), 3.41 – 3.25 (m, 4H), 1.79 – 1.62 (m, 4H), 1.44 (s, 9H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 199.67, 190.16, 154.74, 140.17, 129.87, 127.79, 127.64, 80.02, 75.48, 64.92, 63.10, 43.72, 43.59, 41.05, 40.67, 34.97, 34.91, 34.69, 28.49. ESI-MS: calculated $C_{23}H_{32}N_2O_4NaS_3$ $[M+Na]^+$ 519.1422; Found 519.1427.

ethyl 7-(((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl)thio)carbonothioyl)-5,6,7,8-tetrahydro-[1,2,4]triazolo[4,3-a]pyrazine-3-carboxylate (3g)



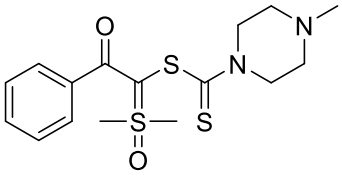
Following the general procedure A, the product **3g** was obtained in 73% yield (72.5 mg, 0.146 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). R_f (Petroleum ether/EtOAc 1:3): 0.23. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.55 (d, J = 7.7 Hz, 2H), 7.33 (t, 1H), 7.28 (t, J = 4.3 Hz, 2H), 5.49 (s, 2H), 4.67 – 4.20 (m, 6H), 3.88 (s, 3H), 3.67 (s, 3H), 1.46 (t, J = 7.1 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 205.18, 190.34, 157.45, 149.87, 144.48, 139.74, 129.95, 127.58, 127.37, 76.50, 62.73, 53.48, 43.99, 43.44, 43.40, 40.47, 14.06. ESI-MS: calculated $C_{19}H_{22}N_4O_4NaS_3$ $[M+Na]^+$ 489.0701; Found 489.0706.

tert-butyl 7-(((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl)thio)carbonothioyl)-2,7-diazaspiro[3.5]nonane-2-carboxylate (3h)



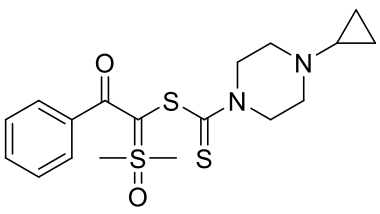
Following the general procedure A, the product **3h** was obtained in 78% yield (78.0 mg, 0.156 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). R_f (Petroleum ether/EtOAc 2:1): 0.22. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.53 (d, J = 8.1 Hz, 2H), 7.32 (t, J = 7.3 Hz, 1H), 7.26 (t, J = 7.4 Hz, 2H), 4.39 (s, 1H), 4.01 – 3.87 (m, 2H), 3.79 (s, 3H), 3.70 (s, 3H), 3.68 – 3.57 (m, 5H), 1.84 (s, 1H), 1.76 (s, 2H), 1.55 (s, 1H), 1.42 (s, 9H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.01, 190.21, 156.47, 140.20, 129.70, 127.51, 127.48, 79.97, 78.18, 59.13, 58.04, 50.98, 47.55, 43.47, 42.56, 35.50, 34.83, 33.54, 28.36. ESI-MS: calculated $C_{23}H_{32}N_2O_4NaS_3$ $[M+Na]^+$ 519.1422; Found 519.1423.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl 4-methylpiperazine-1-carbodithioate (3i)



Following the general procedure A, the product **3i** was obtained in 99% yield (73.3 mg, 0.198 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). R_f (Petroleum ether/EtOAc 2:1): 0.19. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.58 (d, *J* = 7.7 Hz, 2H), 7.34 (t, *J* = 7.1 Hz, 1H), 7.29 (t, *J* = 7.4 Hz, 2H), 4.48 (s, 1H), 4.05 (d, *J* = 46.2 Hz, 2H), 3.85 (s, 1H), 3.82 (s, 3H), 3.72 (s, 3H), 2.56 (s, 1H), 2.48 (s, 1H), 2.40 (s, 1H), 2.29 (s, 3H), 2.23 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.44, 189.97, 140.25, 129.79, 127.74, 127.58, 77.37, 54.74, 54.61, 53.23, 50.06, 45.71, 43.74, 42.77. ESI-MS: calculated $C_{16}H_{22}N_2O_2NaS_3$ $[M+Na]^+$ 393.0741; Found 393.0735.

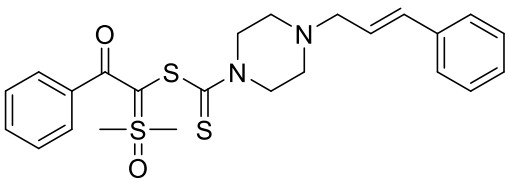
1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl 4-cyclopropylpiperazine-1-carbodithioate (3j)



Following the general procedure A, the product **3j** was obtained in 85% yield (67.8 mg, 0.170 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc = 1:1): 0.21. ^{1}H NMR (600

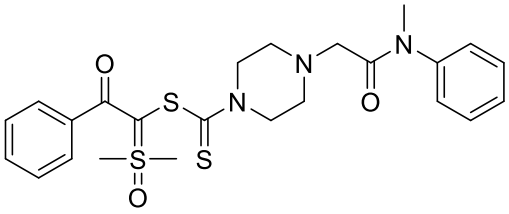
MHz, Chloroform-d) δ 7.53 (d, *J* = 11.2 Hz, 2H), 7.32 (t, 1H), 7.28 (t, 2H), 4.39 (s, 1H), 4.09 – 3.80 (m, 3H), 3.77 (s, 3H), 3.71 (s, 3H), 2.80 – 2.52 (m, 4H), 2.41 (s, 1H), 0.49 – 0.43 (m, 2H), 0.44 – 0.35 (m, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 201.82, 190.26, 140.02, 129.74, 127.49, 127.46, 78.37, 53.11, 52.83, 52.64, 49.97, 43.35, 42.30, 37.92, 5.81. ESI-MS: calculated $C_{18}H_{24}N_2O_2NaS_3$ $[M+Na]^+$ 419.0898; Found 419.0890.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl 4-cinnamylpiperazine-1-carbodithioate (3k)



Following the general procedure A, the product **3k** was obtained in 72% yield (68.3 mg, 0.144 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). R_f (Petroleum ether/EtOAc = 2:1): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.45 (d, *J* = 7.1 Hz, 4H), 7.33 (t, *J* = 7.5 Hz, 2H), 7.30 – 7.27 (m, 3H), 7.25 (t, *J* = 7.3 Hz, 1H), 6.56 (d, *J* = 15.9 Hz, 1H), 6.34 – 6.25 (m, 1H), 4.43 (s, 1H), 4.00 (s, 2H), 3.82 (s, 1H), 3.77 (s, 3H), 3.70 (s, 3H), 3.34 (s, 4H), 3.16 (s, 2H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 201.35, 188.07, 140.69, 136.48, 132.82, 129.22, 128.59, 127.56, 127.30, 127.13, 126.28, 125.95, 77.24, 59.32, 52.95, 52.17, 52.01, 49.76, 42.30, 41.18. ESI-MS: calculated $C_{24}H_{28}N_2O_2NaS_3$ $[M+Na]^+$ 495.1211; Found 495.1205.

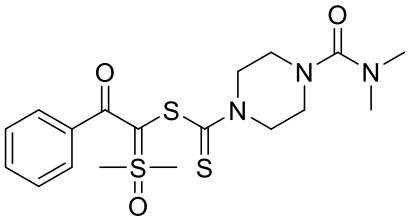
1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl 4-(2-(methyl(phenyl)amino)-2-oxoethyl)piperazine-1-carbodithioate (3l)



Following the general procedure A, the product **3l** was obtained in 94% yield (95.0 mg, 0.188 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). R_f (Petroleum ether/EtOAc = 1:3): 0.25. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.54 (d, *J* = 7.5 Hz, 2H), 7.42 (t, *J* = 7.5 Hz, 2H), 7.36 (t, *J* = 7.3 Hz, 1H), 7.30 – 7.21 (m, 3H), 7.17 (d, *J* = 7.6 Hz, 2H), 4.40 (s, 1H), 4.07 (s, 1H), 3.94 (s, 1H), 3.82 (s, 1H), 3.77 (s, 3H), 3.71 (s, 3H), 3.25 (s, 3H), 2.92 (s, 2H), 2.54 (d, *J* = 30.2 Hz, 2H), 2.41 (s, 1H), 2.27 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.23, 189.98,

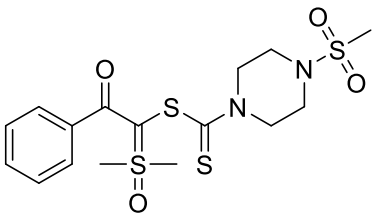
168.93, 143.34, 140.22, 130.00, 129.73, 128.26, 127.72, 127.56, 127.32, 77.37, 59.00, 53.23, 52.85, 52.76, 50.08, 43.73, 42.73, 37.59. ESI-MS: calculated $C_{24}H_{29}NO_3NaS_3$ $[M+Na]^+$ 526.1269; Found 526.1277.

1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-oxo-2-phenylethyl 4-(dimethylcarbamoyl)piperazine-1-carbodithioate (3m)



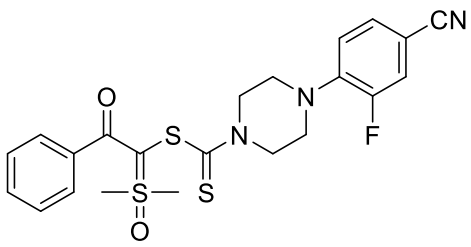
Following the general procedure A, the product **3m** was obtained in 93% yield (80.1 mg, 0.186 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). R_f (Petroleum ether/EtOAc = 1:3): 0.23. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.56 (d, *J* = 7.7 Hz, 2H), 7.33 (t, *J* = 7.1 Hz, 1H), 7.27 (t, *J* = 7.6 Hz, 2H), 4.43 (s, 1H), 4.04 (d, *J* = 35.8 Hz, 2H), 3.86 (s, 1H), 3.81 (s, 3H), 3.69 (s, 3H), 3.42 – 3.20 (m, 3H), 3.08 (s, 1H), 2.81 (s, 6H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.91, 189.91, 164.13, 140.16, 129.80, 127.62, 127.54, 76.90, 52.85, 49.89, 46.47, 46.21, 43.67, 42.88, 38.42. ESI-MS: calculated $C_{18}H_{25}N_3O_3NaS_3$ $[M+Na]^+$ 450.0956; Found 450.0952.

1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-oxo-2-phenylethyl 4-(methylsulfonyl)piperazine-1-carbodithioate (3n)



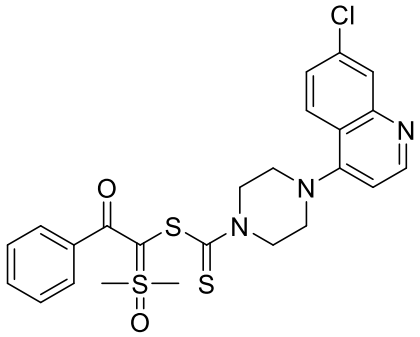
Following the general procedure A, the product **3n** was obtained in 77% yield (66.9 mg, 0.154 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc = 1:1): 0.20. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.51 (d, *J* = 6.9 Hz, 2H), 7.31 (t, 1H), 7.27 (t, 2H), 4.44 (s, 1H), 4.32 – 3.86 (m, 3H), 3.81 (s, 3H), 3.65 (s, 3H), 3.42 – 3.08 (m, 4H), 2.75 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.62, 190.27, 140.08, 129.76, 127.52, 127.50, 77.27, 52.45, 49.73, 45.29, 45.18, 43.44, 43.01, 34.95. ESI-MS: calculated $C_{16}H_{22}N_2O_4NaS_4$ $[M+Na]^+$ 457.0360; Found 457.0367.

1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-oxo-2-phenylethyl 4-(4-cyano-2-fluorophenyl)piperazine-1-carbodithioate (3o)



Following the general procedure A, the product **3o** was obtained in 65% yield (62.3 mg, 0.130 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). R_f (Petroleum ether/EtOAc = 2:1): 0.22. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.59 (d, *J* = 7.7 Hz, 2H), 7.38 (d, *J* = 8.4 Hz, 1H), 7.36 – 7.27 (m, 4H), 6.87 (t, *J* = 8.4 Hz, 1H), 4.58 (s, 1H), 4.22 (d, *J* = 69.9 Hz, 2H), 4.06 (s, 1H), 3.86 (s, 3H), 3.70 (s, 3H), 3.43 – 3.18 (m, 3H), 3.07 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.37, 189.99, 154.07 (d, *J* = 248.9 Hz), 143.14 (d, *J* = 7.9 Hz), 140.24, 129.87, 129.62 (d, *J* = 3.3 Hz), 127.73, 127.62, 120.06 (d, *J* = 24.4 Hz), 118.94 (d, *J* = 3.6 Hz), 118.17 (d, *J* = 2.5 Hz), 104.92 (d, *J* = 9.3 Hz), 76.72, 52.69, 49.79, 49.36, 49.21, 43.78, 43.20. ^{19}F NMR (377 MHz, $CDCl_3$) δ -119.53. ESI-MS: calculated $C_{22}H_{22}N_3O_2NaS_3F$ $[M+Na]^+$ 498.0756; Found 498.0754.

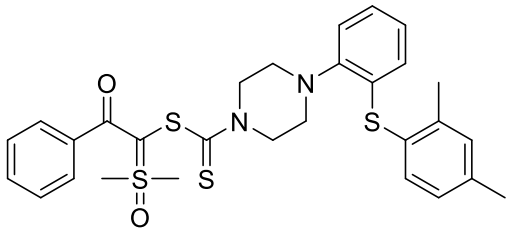
1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl 4-(7-chloroquinolin-4-yl)piperazine-1-carbodithioate (3p)



Following the general procedure A, the product **3p** was obtained in 91% yield (95.3 mg, 0.182 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). R_f (Petroleum ether/EtOAc = 1:2): 0.21. ^{1}H NMR (600 MHz, Chloroform-d) δ 8.75 (d, J = 4.9 Hz, 1H), 8.07 (d, J = 2.0 Hz, 1H), 7.91 (d, J = 9.0 Hz, 1H), 7.61 (d, J = 7.1 Hz, 2H), 7.45 (dd, J = 9.0, 2.1 Hz, 1H), 7.35 (t, J = 7.3 Hz, 1H), 7.31 (t, J = 7.4 Hz, 2H), 6.81 (d, J = 5.0 Hz, 1H), 4.69 (s, 1H), 4.47 – 4.10 (m, 3H), 3.88 (s, 3H), 3.71 (s, 3H), 3.30 (d, J = 51.2 Hz, 3H), 3.07 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.57, 189.91, 155.83, 151.92, 150.10, 140.20, 135.32, 129.82, 129.06, 127.66, 127.57, 126.79, 124.70, 121.69, 109.37, 76.75, 52.85, 51.73, 49.91, 43.68, 43.08. ESI-MS: calculated $C_{24}H_{24}N_3O_2NaS_3Cl$ $[M+Na]^+$ 540.0617; Found 540.0623.

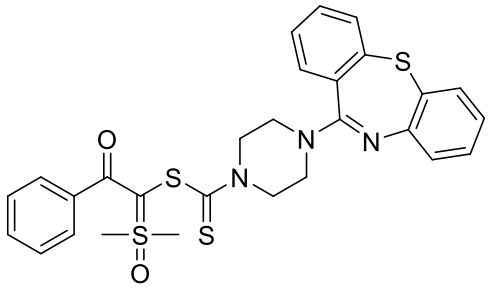
1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl 4-(2-((2,4-dimethylphenyl)thio)phe

nyl)piperazine-1-carbodithioate (3q)



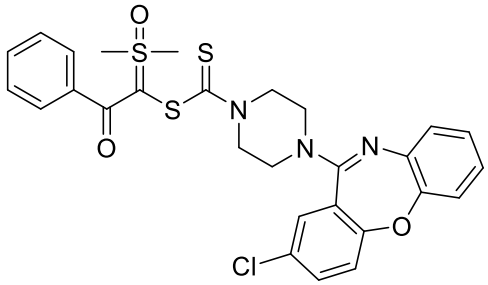
Following the general procedure A, the product **3q** was obtained in 72% yield (81.9 mg, 0.144 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). R_f (Petroleum ether/EtOAc = 2:1): 0.20. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.63 (d, *J* = 7.7 Hz, 2H), 7.41 – 7.29 (m, 4H), 7.15 (s, 1H), 7.09 (t, *J* = 7.6 Hz, 1H), 7.03 (d, *J* = 7.7 Hz, 1H), 6.98 (d, *J* = 7.8 Hz, 1H), 6.91 (t, *J* = 7.6 Hz, 1H), 6.55 (d, *J* = 7.9 Hz, 1H), 4.65 (s, 1H), 4.23 (d, *J* = 61.6 Hz, 2H), 4.04 (s, 1H), 3.86 (s, 3H), 3.75 (s, 3H), 3.19 (s, 1H), 3.10 (d, *J* = 29.3 Hz, 2H), 2.91 (s, 1H), 2.36 (s, 3H), 2.30 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.62, 190.04, 147.94, 142.30, 140.29, 139.47, 136.06, 134.70, 131.87, 129.81, 127.98, 127.77, 127.60, 127.59, 126.66, 125.79, 125.20, 120.10, 77.46, 53.93, 51.51, 51.27, 50.87, 43.75, 42.80, 21.29, 20.68. ESI-MS: calculated $C_{29}H_{32}N_2O_2NaS_4$ $[M+Na]^+$ 591.1244; Found 591.1241.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl 4-(dibenzo[b,f][1,4]thiazepin-11-yl) piperazine-1-carbodithioate (3r)



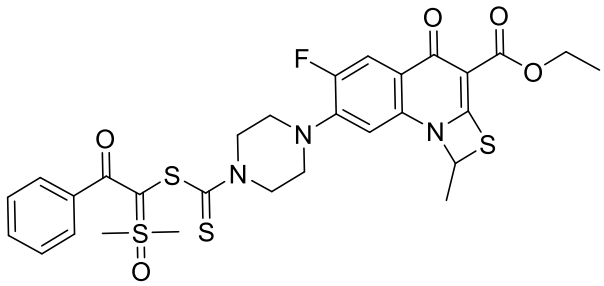
Following the general procedure A, the product **3r** was obtained in 88% yield (100.0 mg, 0.176 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc = 1:1): 0.23. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.52 (s, 2H), 7.49 – 7.44 (m, 1H), 7.36 (t, J = 7.7 Hz, 1H), 7.33 – 7.22 (m, 6H), 7.14 (t, J = 7.5 Hz, 1H), 7.06 – 6.98 (m, 1H), 6.96 – 6.81 (m, 1H), 4.64 – 4.14 (m, 2H), 4.14 – 3.82 (m, 3H), 3.76 (s, 3H), 3.67 (s, 3H), 3.58 – 3.19 (m, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.90, 190.09, 160.45, 140.24, 140.21, 133.76, 132.47, 132.42, 131.37, 129.94, 129.91, 129.37, 128.90, 128.67, 128.07, 127.72, 127.65, 125.40, 123.59, 77.03, 52.89, 49.77, 43.79, 43.77, 43.04, 42.94. ESI-MS: calculated $C_{28}H_{27}N_3O_2NaS_4$ $[M+Na]^+$ 588.0884; Found 588.0886.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl 4-(2-chlorodibenzo[b,f][1,4]oxazepin-11-yl)piperazine-1-carbodithioate (3s)



Following the general procedure A, the product **3s** was obtained in 82% yield (96.7 mg, 0.164 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc = 1:1): 0.24. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.60 (d, J = 7.2 Hz, 2H), 7.44 – 7.39 (m, 1H), 7.36 (t, J = 7.3 Hz, 1H), 7.31 (t, J = 7.4 Hz, 2H), 7.29 (d, J = 2.5 Hz, 1H), 7.20 (d, J = 8.7 Hz, 1H), 7.15 – 7.08 (m, 3H), 7.05 – 6.99 (m, 1H), 4.53 (s, 1H), 4.29 – 3.90 (m, 3H), 3.84 (s, 3H), 3.72 (s, 3H), 3.69 – 3.24 (m, 4H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.14, 190.07, 159.45, 158.34, 151.79, 140.20, 139.74, 133.08, 130.63, 129.92, 128.87, 127.69, 127.65, 127.25, 126.02, 125.25, 124.66, 123.02, 120.32, 76.98, 52.78, 49.70, 47.19, 47.07, 43.77, 43.01. ESI-MS: calculated $C_{28}H_{26}N_3O_3NaS_3Cl$ $[M+Na]^+$ 606.0723; Found 606.0726.

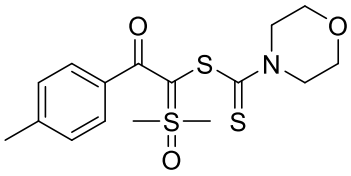
ethyl 7-(4-(((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl)thio)carbonothioyl)piperazin-1-yl)-6-fluoro-1-methyl-4-oxo-1H,4*H*-[1,3]thiazeto[3,2-a]quinoline-3-carboxylate (3t)



Following the general procedure A, the product **3t** was obtained in 81% yield (105.6 mg, 0.162 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). R_f (Petroleum ether/EtOAc = 2:1): 0.19. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.90 (d, *J* = 13.2 Hz, 1H), 7.60 (d, *J* = 6.9 Hz, 2H), 7.32 – 7.27 (m, 2H), 6.33 – 6.24 (m, 1H), 5.90 (d, *J* = 6.0 Hz, 1H), 4.56 (s, 1H), 4.36 (s, 1H), 4.33 (q, *J* = 7.1 Hz, 2H), 4.14 (s, 2H), 3.87 (s, 3H), 3.70 (s, 3H), 3.37 – 3.20 (m, 4H), 3.10 (s, 1H), 2.10 (d, *J* = 6.1 Hz, 3H), 1.37 (t, *J* = 6.9 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.30 (d, *J* = 5.6 Hz), 189.94, 172.11, 164.52 (d, *J* = 207.3 Hz), 153.17, 151.53, 143.51 (d, *J* = 13.4 Hz), 140.21, 135.22, 129.86 (d, *J* = 2.8 Hz), 127.77 (d, *J* = 3.2 Hz), 127.62, 122.93 (d, *J* = 6.4 Hz), 114.80 (d, *J* = 23.5 Hz), 104.43, 100.63, 76.75, 67.10, 60.79, 52.69, 49.79, 49.68, 49.33,

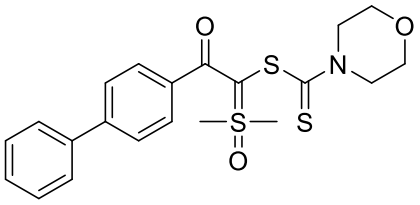
43.77, 43.26, 21.36, 14.57. ^{19}F NMR (377 MHz, $CDCl_3$) δ -124.06. ESI-MS: calculated $C_{29}H_{30}N_3O_5NaS_4F$ $[M+Na]^+$ 670.0950; Found 670.0954.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-(p-tolyl)ethyl morpholine-4-carbodithioate (3u)



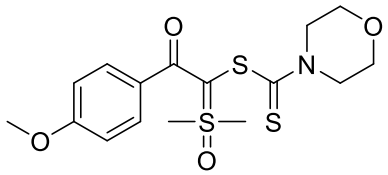
Following the general procedure A, the product **3u** was obtained in 99% yield (74.3 mg, 0.198 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc = 1:1): 0.20. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.50 (d, *J* = 7.9 Hz, 2H), 7.10 (d, *J* = 7.8 Hz, 2H), 4.42 (s, 1H), 4.13 (s, 1H), 4.00 (s, 1H), 3.91 (s, 1H), 3.81 (s, 3H), 3.75 – 3.69 (m, 3H), 3.68 (s, 3H), 3.56 (s, 1H), 2.34 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.10, 189.71, 140.04, 137.20, 128.24, 127.82, 76.48, 66.71, 66.32, 53.34, 50.72, 43.79, 43.01, 21.54. ESI-MS: calculated $C_{16}H_{21}NO_3NaS_3$ $[M+Na]^+$ 394.0581; Found 394.0572.

2-([1,1'-biphenyl]-4-yl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl morpholine-4-carbodithioate (3v)



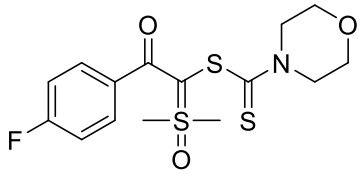
Following the general procedure A, the product **3v** was obtained in 88% yield (76.5 mg, 0.176 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc = 1:1): 0.19. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.70 (d, *J* = 8.1 Hz, 2H), 7.60 (d, *J* = 7.8 Hz, 2H), 7.55 (d, *J* = 8.1 Hz, 2H), 7.44 (t, *J* = 7.6 Hz, 2H), 7.35 (t, *J* = 7.4 Hz, 1H), 4.44 (s, 1H), 4.16 (s, 1H), 4.02 (s, 1H), 3.94 (s, 1H), 3.87 (s, 3H), 3.81 (s, 1H), 3.77 – 3.67 (m, 2H), 3.72 (s, 3H), 3.58 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.02, 189.54, 142.67, 140.71, 138.97, 128.95, 128.39, 127.74, 127.26, 126.36, 76.77, 66.79, 66.39, 53.45, 50.83, 43.85, 43.12. ESI-MS: calculated $C_{21}H_{23}NO_3NaS_3$ $[M+Na]^+$ 456.0738; Found 456.0728.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-(4-methoxyphenyl)-2-oxoethyl morpholine-4-carbodithioate (3w)



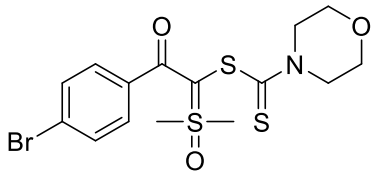
Following the general procedure A, the product **3w** was obtained in 99% yield (77.1 mg, 0.198 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc = 1:1): 0.20. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.62 (d, *J* = 8.3 Hz, 2H), 6.82 (d, *J* = 8.4 Hz, 2H), 4.40 (s, 1H), 4.17 (s, 1H), 3.98 (d, *J* = 37.1 Hz, 2H), 3.81 (s, 3H), 3.80 (s, 3H), 3.76 – 3.71 (m, 3H), 3.68 (s, 3H), 3.61 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.13, 189.00, 161.10, 132.39, 129.85, 112.86, 76.19, 66.74, 66.38, 55.37, 53.37, 50.70, 43.97, 43.15. ESI-MS: calculated $C_{16}H_{21}NO_4NaS_3$ $[M+Na]^+$ 410.0530; Found 410.0521.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-(4-fluorophenyl)-2-oxoethyl morpholine-4-carbodithioate (3x)



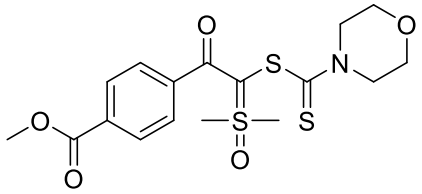
Following the general procedure A, the product **3x** was obtained in 82% yield (61.5 mg, 0.164 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). Rf (Petroleum ether/EtOAc = 2:1): 0.19. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.54 (dd, *J* = 8.1, 5.9 Hz, 2H), 6.94 (t, *J* = 8.4 Hz, 2H), 4.32 (s, 1H), 4.12 (s, 1H), 3.90 (s, 2H), 3.76 (s, 3H), 3.75 – 3.66 (m, 3H), 3.65 (s, 3H), 3.53 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.32, 188.94, 163.64 (d, *J* = 249.3 Hz), 136.00 (d, *J* = 3.2 Hz), 129.86 (d, *J* = 8.3 Hz), 114.49 (d, *J* = 21.5 Hz), 77.47, 66.59, 66.20, 53.32, 50.65, 43.45, 42.65. ^{19}F NMR (377 MHz, $CDCl_3$) δ -110.55. ESI-MS: calculated $C_{15}H_{18}NO_3NaS_3F$ $[M+Na]^+$ 398.0331; Found 398.0324.

2-(4-bromophenyl)-1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-oxoethyl morpholine-4-carbodithioate (3y)



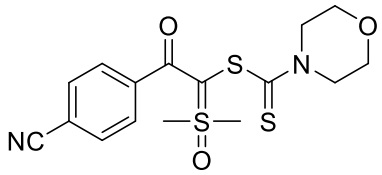
Following the general procedure A, the product **3y** was obtained in 60% yield (52.8 mg, 0.120 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc = 1:1): 0.24. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.39 (d, *J* = 2.6 Hz, 4H), 4.29 (s, 1H), 4.12 (s, 1H), 3.88 (s, 2H), 3.74 (s, 3H), 3.71 – 3.65 (m, 3H), 3.64 (s, 3H), 3.53 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.09, 189.03, 138.79, 130.72, 129.25, 124.15, 77.82, 66.57, 66.17, 53.31, 50.64, 43.30, 42.49. ESI-MS: calculated $C_{15}H_{18}NO_3NaS_3Br$ $[M+Na]^+$ 457.9530; Found 457.9528.

methyl 4-(2-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-((morpholine-4-carbonothioyl)thio)acetyl)benzoate (3z)



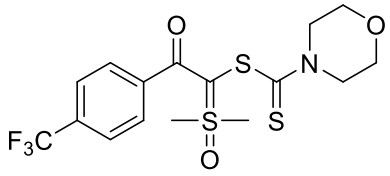
Following the general procedure A, the product **3z** was obtained in 83% yield (69.4 mg, 0.166 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc = 1:2): 0.22. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.97 (d, *J* = 8.2 Hz, 2H), 7.62 (d, *J* = 8.1 Hz, 2H), 4.37 (s, 1H), 4.14 (s, 1H), 3.94 (d, *J* = 16.6 Hz, 2H), 3.90 (s, 3H), 3.84 (s, 3H), 3.78 (s, 1H), 3.72 (s, 1H), 3.70 (s, 3H), 3.69 (s, 1H), 3.54 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.40, 189.17, 166.88, 144.55, 130.99, 128.97, 127.62, 77.31, 66.69, 66.29, 53.44, 52.32, 50.74, 43.59, 42.90. ESI-MS: calculated $C_{17}H_{21}NO_5NaS_3$ $[M+Na]^+$ 438.0480; Found 438.0472.

2-(4-cyanophenyl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl morpholine-4-carbodithioate (3aa)



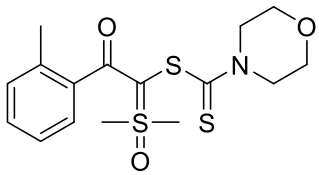
Following the general procedure A, the product **3aa** was obtained in 43% yield (32.8 mg, 0.086 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc = 1:1): 0.20. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.67 (d, *J* = 8.1 Hz, 2H), 7.60 (d, *J* = 8.2 Hz, 2H), 4.26 (d, *J* = 60.2 Hz, 2H), 3.92 (s, 2H), 3.83 (s, 3H), 3.79 (s, 1H), 3.76 – 3.71 (m, 2H), 3.70 (s, 3H), 3.58 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 201.94, 188.13, 144.55, 131.60, 128.30, 118.76, 113.18, 77.55, 66.70, 66.28, 53.53, 50.75, 43.52, 42.83. ESI-MS: calculated $C_{16}H_{18}N_2O_3NaS_3$ $[M+Na]^+$ 405.0377; Found 405.0367.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-(4-(trifluoromethyl)phenyl)ethyl morpholine-4-carbodithioate (3ab)



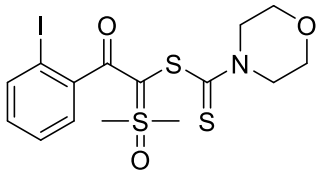
Following the general procedure A, the product **3ab** was obtained in 74% yield (62.6 mg, 0.148 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). Rf (Petroleum ether/EtOAc = 2:1): 0.20. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.61 (d, *J* = 7.7 Hz, 2H), 7.52 (d, *J* = 7.7 Hz, 2H), 4.28 (s, 1H), 4.12 (s, 1H), 3.86 (s, 2H), 3.77 (s, 3H), 3.73 (s, 1H), 3.66 (s, 3H), 3.64 (s, 2H), 3.48 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 201.92, 188.85, 143.53, 131.33 (q, *J* = 32.3 Hz), 127.78, 124.56 (q, *J* = 3.5 Hz), 123.97 (q, *J* = 272.2 Hz), 78.12, 66.57, 66.13, 53.35, 50.66, 43.24, 42.50. ^{19}F NMR (377 MHz, $CDCl_3$) δ -62.66. ESI-MS: calculated $C_{16}H_{18}NO_3NaS_3F_3$ $[M+Na]^+$ 448.0299; Found 448.0293.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-(o-tolyl)ethyl morpholine-4-carbodithioate (3ac)



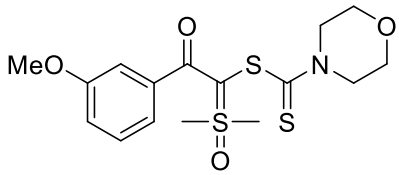
Following the general procedure A, the product **3ac** was obtained in 77% yield (57.4 mg, 0.154 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc = 1:1): 0.23. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.27 (d, *J* = 6.7 Hz, 1H), 7.18 (t, *J* = 7.5 Hz, 1H), 7.13 (d, *J* = 7.5 Hz, 1H), 7.07 (t, *J* = 7.4 Hz, 1H), 4.45 (s, 1H), 3.98 (s, 1H), 3.89 (s, 1H), 3.86 (s, 3H), 3.75 (s, 3H), 3.74 – 3.56 (m, 4H), 3.31 (s, 1H), 2.33 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.85, 191.97, 140.66, 134.55, 130.12, 128.38, 126.22, 124.67, 77.41, 66.62, 66.02, 53.32, 50.92, 43.45, 42.92, 19.35. ESI-MS: calculated $C_{16}H_{21}NO_3NaS_3$ $[M+Na]^+$ 394.0581; Found 394.0572.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-(2-iodophenyl)-2-oxoethyl morpholine-4-carbodithioa te (3ad)



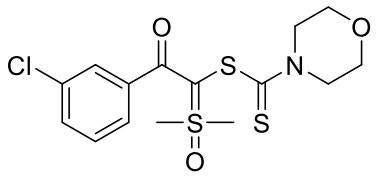
Following the general procedure A, the product **3ad** was obtained in 62% yield (60.2 mg, 0.124 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). Rf (Petroleum ether/EtOAc = 2:1): 0.18. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.75 (d, *J* = 7.9 Hz, 1H), 7.35 (d, *J* = 7.5 Hz, 1H), 7.24 (t, *J* = 7.5 Hz, 1H), 6.98 (t, *J* = 7.6 Hz, 1H), 4.41 (s, 1H), 4.02 (s, 1H), 3.93 (s, 3H), 3.83 (s, 1H), 3.76 (s, 2H), 3.71 (s, 3H), 3.66 – 3.57 (m, 2H), 3.32 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.46, 190.27, 146.10, 138.68, 129.70, 127.43, 126.78, 93.46, 76.36, 66.65, 66.08, 53.39, 50.87, 43.29, 42.39. ESI-MS: calculated $C_{15}H_{18}NO_3NaS_3I$ $[M+Na]^+$ 505.9391; Found 505.9392.

1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-(3-methoxyphenyl)-2-oxoethyl morpholine-4-carbodithioate (3ae)



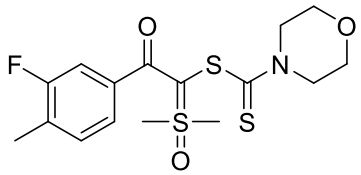
Following the general procedure A, the product **3ae** was obtained in 86% yield (67.2 mg, 0.172 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc = 1:1): 0.20. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.21 (t, *J* = 8.0 Hz, 1H), 7.16 (d, *J* = 7.5 Hz, 2H), 6.90 (d, *J* = 7.3 Hz, 1H), 4.45 (s, 1H), 4.05 (d, *J* = 52.4 Hz, 2H), 3.87 (s, 1H), 3.81 (s, 3H), 3.80 (s, 1H), 3.76 (s, 3H), 3.72 – 3.71 (m, 1H), 3.70 (s, 3H), 3.70 – 3.68 (m, 1H), 3.55 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.00, 189.54, 158.88, 141.42, 128.69, 119.99, 116.29, 112.47, 76.91, 66.67, 66.25, 55.38, 53.35, 50.76, 43.66, 42.73. ESI-MS: calculated $C_{16}H_{21}NO_4NaS_3$ $[M+Na]^+$ 410.0530; Found 410.0523.

2-(3-chlorophenyl)-1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-oxoethyl morpholine-4-carbodithioate (3af)



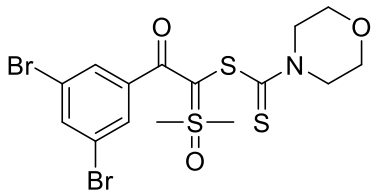
Following the general procedure A, the product **3af** was obtained in 79% yield (62.2 mg, 0.158 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc = 21:1): 0.19. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.60 (s, 1H), 7.49 (d, *J* = 7.6 Hz, 1H), 7.35 (d, *J* = 7.9 Hz, 1H), 7.27 (t, *J* = 7.6 Hz, 1H), 4.58 (s, 1H), 4.06 (s, 2H), 3.92 (s, 1H), 3.84 (s, 3H), 3.80 – 3.74 (m, 3H), 3.73 (s, 3H), 3.59 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.36, 188.09, 141.84, 133.34, 129.82, 129.13, 127.85, 125.85, 77.34, 66.74, 66.33, 53.56, 50.93, 43.57, 42.69. ESI-MS: calculated $C_{15}H_{18}NO_3NaS_3Cl$ $[M+H]^+$ 414.0035; Found 414.0033.

1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-(3-fluoro-4-methylphenyl)-2-oxoethyl morpholine-4-carbodithioate (3ag)



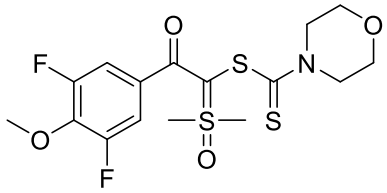
Following the general procedure A, the product **3ag** was obtained in 78% yield (61.0 mg, 0.156 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). Rf (Petroleum ether/EtOAc = 2:1): 0.19. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.42 – 7.24 (m, 2H), 7.13 (t, *J* = 7.7 Hz, 1H), 4.50 (s, 1H), 4.12 – 4.01 (m, 2H), 3.92 (s, 2H), 3.83 (s, 3H), 3.80 – 3.73 (m, 2H), 3.71 (s, 3H), 3.60 (s, 1H), 2.28 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.67, 188.13 (d, *J* = 2.1 Hz), 160.41 (d, *J* = 244.6 Hz), 139.44 (d, *J* = 6.7 Hz), 130.67 (d, *J* = 4.9 Hz), 126.83 (d, *J* = 17.4 Hz), 123.31 (d, *J* = 3.3 Hz), 114.56 (d, *J* = 23.7 Hz), 76.92, 66.73, 66.33, 53.46, 50.81, 43.68, 42.84, 14.69 (d, *J* = 3.4 Hz). ^{19}F NMR (377 MHz, $CDCl_3$) δ -117.98. ESI-MS: calculated $C_{16}H_{20}NO_3NaS_3F$ $[M+Na]^+$ 412.0487; Found 412.0479.

2-(3,5-dibromophenyl)-1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-oxoethyl morpholine-4-carbodithioate (3ah)



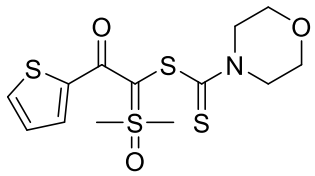
Following the general procedure A, the product **3ah** was obtained in 81% yield (84.0 mg, 0.162 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). Rf (Petroleum ether/EtOAc = 2:1): 0.21. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.65 (s, 2H), 7.63 (s, 1H), 4.66 (s, 1H), 4.10 (s, 1H), 3.95 (s, 1H), 3.80 (s, 3H), 3.78 – 3.73 (m, 4H), 3.69 (s, 3H), 3.60 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 201.71, 185.96, 143.24, 134.95, 129.41, 122.11, 77.81, 66.69, 66.32, 53.66, 50.99, 43.36, 42.37. ESI-MS: calculated $C_{15}H_{17}NO_3NaS_3Br_2$ $[M+Na]^+$ 535.8635; Found 535.8633.

2-(3,5-difluoro-4-methoxyphenyl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl morpholine-4-carbodithioate (3ai)



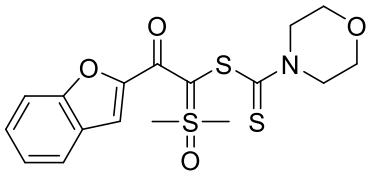
Following the general procedure A, the product **3ai** was obtained in 89% yield (76.0 mg, 0.178 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). Rf (Petroleum ether/EtOAc = 2:1): 0.21. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.21 (d, *J* = 8.6 Hz, 2H), 4.48 (s, 1H), 4.06 (d, 2H), 3.98 (s, 3H), 3.89 (s, 1H), 3.80 (s, 1H), 3.78 (s, 3H), 3.73 (s, 2H), 3.66 (s, 3H), 3.59 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.05, 186.12, 154.53 (dd, *J* = 248.0, 5.8 Hz), 137.81 (t, *J* = 13.9 Hz), 134.31 (t, *J* = 7.5 Hz), 112.16 (dd, *J* = 18.9, 5.4 Hz), 77.22, 66.69, 66.31, 61.77, 53.52, 50.83, 43.52, 42.63. ^{19}F NMR (377 MHz, DMSO-d) δ -61.08. ESI-MS: calculated $C_{16}H_{19}NO_4NaS_3F_2$ $[M+Na]^+$ 446.0342; Found 446.0340.

1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-(thiophen-2-yl)ethyl morpholine-4-carbodithioate (3aj)



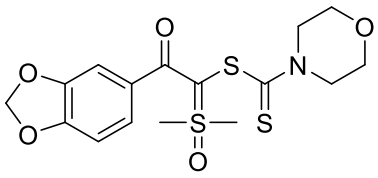
Following the general procedure A, the product **3aj** was obtained in 71% yield (51.4 mg, 0.142 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 2:1 v/v). Rf (Petroleum ether/EtOAc = 2:1): 0.20. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.77 (d, *J* = 3.7 Hz, 1H), 7.39 (d, *J* = 5.0 Hz, 1H), 6.98 (t, *J* = 4.3 Hz, 1H), 4.38 (s, 1H), 4.15 (s, 2H), 4.05 (s, 1H), 3.78 (s, 3H), 3.76 (s, 4H), 3.62 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 201.81, 179.53, 141.50, 131.42, 130.74, 126.69, 76.39, 66.62, 66.45, 53.36, 50.67, 44.09, 43.10. ESI-MS: calculated $C_{13}H_{17}NO_3NaS_4$ $[M+Na]^+$ 385.9989; Found 385.9983.

2-(benzofuran-2-yl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl morpholine-4-carbodithioate (3ak)



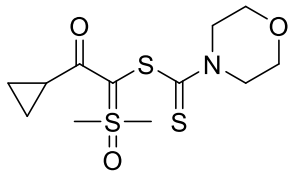
Following the general procedure A, the product **3ak** was obtained in 73% yield (57.7 mg, 0.146 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc = 1:1): 0.21. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.56 (d, *J* = 7.8 Hz, 1H), 7.45 (d, *J* = 8.3 Hz, 1H), 7.39 (s, 1H), 7.30 (t, *J* = 7.7 Hz, 1H), 7.18 (t, *J* = 7.5 Hz, 1H), 4.34 – 4.01 (m, 4H), 3.81 (s, 3H), 3.75 (s, 4H), 3.62 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 201.66, 176.98, 154.51, 151.69, 127.47, 126.58, 123.27, 122.53, 111.83, 111.24, 77.58, 66.59, 66.32, 53.31, 50.67, 43.73, 42.98. ESI-MS: calculated $C_{17}H_{19}NO_4NaS_3$ $[M+Na]^+$ 420.0374; Found 420.0366.

2-(benzo[d][1,3]dioxol-5-yl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl morpholine-4-carbodithioate (3al)



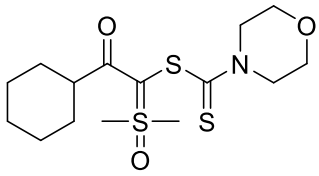
Following the general procedure A, the product **3al** was obtained in 92% yield (74.0 mg, 0.184 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc = 1:1): 0.21. ^{1}H NMR (600 MHz, Chloroform-d) δ 7.19 (d, *J* = 8.0 Hz, 1H), 7.12 (s, 1H), 6.72 (d, *J* = 8.0 Hz, 1H), 5.93 (s, 2H), 4.44 (s, 1H), 4.07 (d, *J* = 27.1 Hz, 2H), 3.91 (s, 1H), 3.78 (s, 3H), 3.76 – 3.69 (m, 3H), 3.67 (s, 3H), 3.60 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 202.85, 188.41, 149.00, 146.80, 133.91, 122.70, 108.66, 107.44, 101.24, 76.43, 66.71, 66.32, 53.38, 50.75, 43.79, 42.92. ESI-MS: calculated $C_{16}H_{19}NO_5NaS_3$ $[M+Na]^+$ 424.0323; Found 424.0318.

2-cyclopropyl-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl morpholine-4-carbodithioate (3am)



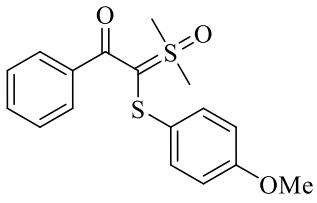
Following the general procedure A, the product **3am** was obtained in 90% yield (57.8 mg, 0.180 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc = 1:1): 0.19. ^{1}H NMR (600 MHz, Chloroform-d) δ 4.32 (s, 2H), 4.11 (s, 2H), 3.80 (s, 4H), 3.67 (s, 3H), 3.56 (s, 3H), 2.36 – 2.14 (m, 1H), 1.03 – 0.83 (m, 2H), 0.78 – 0.57 (m, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.28, 194.19, 74.21, 66.67, 66.30, 53.33, 50.43, 44.35, 43.00, 15.93, 8.83, 8.70. ESI-MS: calculated $C_{12}H_{19}NO_3NaS_3$ $[M+Na]^+$ 344.0425; Found 344.0415.

2-cyclohexyl-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl morpholine-4-carbodithioate (3an)



Following the general procedure A, the product **3an** was obtained in 79% yield (57.6 mg, 0.158 mmol) as a white solid after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc = 1:1): 0.27. ^{1}H NMR (600 MHz, Chloroform-d) δ 4.30 (d, J = 46.3 Hz, 2H), 4.10 (s, 2H), 3.79 (s, 4H), 3.68 (s, 3H), 3.53 (s, 3H), 2.82 – 2.67 (m, 1H), 1.80 – 1.52 (m, 5H), 1.43 – 1.03 (m, 5H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.54, 198.86, 73.63, 66.70, 66.35, 53.38, 50.57, 44.85, 44.14, 43.13, 30.23, 28.70, 26.27, 26.11, 25.89. ESI-MS: calculated $C_{15}H_{25}NO_3NaS_3$ $[M+Na]^+$ 386.0894; Found 386.0888.

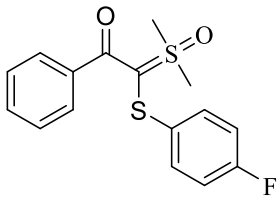
2-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-((4-methoxyphenyl)thio)-1-phenylethan-1-one (4a)



Following the above procedure B, the product **4a** was obtained in 35% yield (23.4 mg, 0.070 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.50 (d, *J* = 7.1 Hz, 2H), 7.34 (t, *J* = 7.3 Hz, 1H), 7.28 (t, *J* = 7.5 Hz, 2H), 7.14 (d, *J* = 8.8 Hz, 2H), 6.89 (d, *J* = 8.8 Hz, 2H), 3.71 (s, 6H), 3.65 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 188.52,

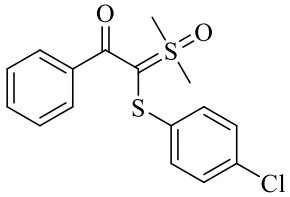
157.42, 140.39, 131.72, 129.52, 127.38, 127.34, 125.57, 114.79, 77.61, 55.13, 41.42, 41.13. ESI-MS: calculated $C_{17}H_{18}O_3NaS_2$ $[M+Na]^+$ 357.0595; Found 357.0589.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-((4-fluorophenyl)thio)-1-phenylethan-1-one (4b)



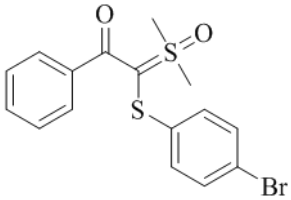
Following the above procedure B, the product **4b** was obtained in 30% yield (19.3 mg, 0.060 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.48 (d, *J* = 7.2 Hz, 2H), 7.35 (t, *J* = 7.4 Hz, 1H), 7.29 (d, *J* = 7.7 Hz, 2H), 7.25 (dd, *J* = 9.1, 5.9 Hz, 2H), 7.15 (t, *J* = 8.8 Hz, 2H), 3.76 (s, 3H), 3.67 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 189.12, 160.82 (d, *J* = 241.5 Hz), 140.77, 137.27, 130.08, 127.92, 127.67, 126.19 (d, *J* = 8.0 Hz), 116.48 (d, *J* = 22.0 Hz), 77.30, 41.97, 41.56. ^{19}F NMR (377 MHz, DMSO-d_6) δ -118.32. ESI-MS: calculated $C_{16}H_{16}O_2S_2F$ $[M+H]^+$ 323.0576; Found 323.0570.

2-((4-chlorophenyl)thio)-2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-phenylethan-1-one (4c)



Following the above procedure B, the product **4c** was obtained in 32% yield (21.6 mg, 0.064 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). Rf (Petroleum ether/EtOAc 1:3): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.46 (d, *J* = 7.2 Hz, 2H), 7.34 (t, *J* = 8.6 Hz, 3H), 7.28 (d, *J* = 7.7 Hz, 2H), 7.25 (d, *J* = 8.6 Hz, 2H), 3.75 (s, 3H), 3.66 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 188.61, 140.55, 140.24, 129.62, 129.56, 128.90, 127.46, 127.10, 125.47, 75.94, 41.49, 41.06. ESI-MS: calculated $C_{16}H_{16}O_2S_2Cl$ $[M+H]^+$ 339.0280; Found 339.0275.

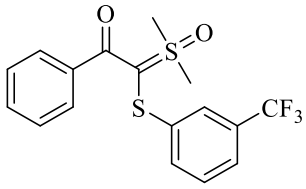
2-((4-chlorophenyl)thio)-2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-phenylethan-1-one (4d)



Following the above procedure B, the product **4d** was obtained in 36% yield (27.6 mg, 0.072 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.19. ^{1}H NMR (600 MHz, DMSO-d_6) δ

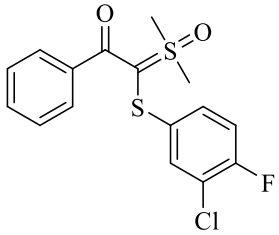
7.46 (t, *J* = 8.3 Hz, 4H), 7.34 (t, *J* = 7.4 Hz, 1H), 7.27 (t, *J* = 7.5 Hz, 2H), 7.19 (d, *J* = 8.6 Hz, 2H), 3.75 (s, 3H), 3.66 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 188.59, 141.12, 140.23, 131.74, 129.62, 127.47, 127.09, 125.80, 117.75, 75.80, 41.49, 41.06. ESI-MS: calculated $C_{16}H_{16}O_2S_2Br$ $[M+H]^+$ 382.9775; Found 382.9768.

2-(dimethyl(oxo)- λ^6-sulfaneylidene)-1-phenyl-2-((3-(trifluoromethyl)phenyl)thio)ethan-1-one (4e)



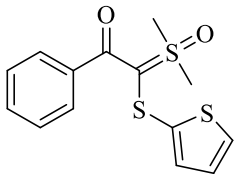
Following the above procedure B, the product **4e** was obtained in 37% yield (27.6 mg, 0.074 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.54 (t, *J* = 6.8 Hz, 1H), 7.51 (d, *J* = 12.4 Hz, 2H), 7.45 (t, 3H), 7.33 (t, *J* = 7.3 Hz, 1H), 7.27 (t, *J* = 7.4 Hz, 2H), 3.80 (s, 3H), 3.66 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 188.81, 143.58, 140.19, 130.02, 129.74 (t), 129.67, 127.69, 127.51, 127.05, 124.86 (q), 121.74 (d, *J* = 3.7 Hz), 120.04 (d, *J* = 3.9 Hz), 75.42, 41.66, 40.96. ^{19}F NMR (377 MHz, DMSO-d_6) δ -61.34. ESI-MS: calculated $C_{17}H_{16}O_2S_2F_3$ $[M+H]^+$ 373.0544; Found 373.0537.

2-((3-chloro-4-fluorophenyl)thio)-2-(dimethyl(oxo)- λ^6-sulfaneylidene)-1-phenylethan-1-one (4f)



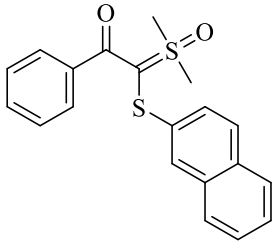
Following the above procedure B, the product **4f** was obtained in 40% yield (28.5 mg, 0.080mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.45 (d, *J* = 7.4 Hz, 2H), 7.36 (d, *J* = 2.1 Hz, 1H), 7.35 (t, 1H), 7.33 (d, *J* = 3.6 Hz, 1H), 7.29 (t, *J* = 7.4 Hz, 2H), 7.22 (ddd, *J* = 8.6, 4.3, 2.4 Hz, 1H), 3.79 (s, 3H), 3.65 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 188.71, 155.22 (d, *J* = 244.3 Hz), 140.13, 138.91 (d, *J* = 3.2 Hz), 129.68, 127.52, 127.12, 125.31, 124.31 (d, *J* = 7.1 Hz), 120.32 (d, *J* = 18.5 Hz), 117.50 (d, *J* = 21.7 Hz), 76.39, 41.58, 40.94. ^{19}F NMR (377 MHz, DMSO-d_6) δ -121.26. ESI-MS: calculated $C_{16}H_{15}O_2S_2ClF$ $[M+H]^+$ 357.0186; Found 357.0182.

2-((1,3,4-thiadiazol-2-yl)thio)-2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-phenylethan-1-one (4g)



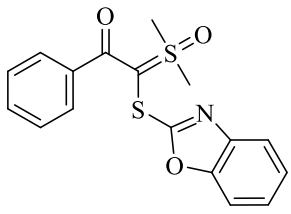
Following the above procedure B, the product **4g** was obtained in 33% yield (20.5 mg, 0.066mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.19. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.57 (d, *J* = 7.1 Hz, 2H), 7.40 (dd, *J* = 8.4, 6.2 Hz, 2H), 7.36 (t, *J* = 7.4 Hz, 2H), 6.92 (t, 1H), 6.84 (d, *J* = 3.5 Hz, 1H), 3.67 (s, 6H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.96, 142.58, 140.36, 129.59, 127.83, 127.69, 127.46, 126.74, 126.28, 80.44, 41.39, 41.29. ESI-MS: calculated $C_{14}H_{14}O_2NaS_3$ $[M+Na]^+$ 333.0054; Found 333.0047.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-(naphthalen-2-ylthio)-1-phenylethan-1-one (4h)



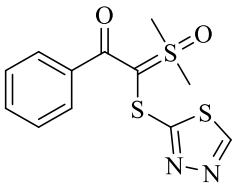
Following the above procedure B, the product **4h** was obtained in 32% yield (22.4 mg, 0.064mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.85 (d, *J* = 8.6 Hz, 3H), 7.73 (s, 1H), 7.52 (s, 2H), 7.48 (t, *J* = 7.5 Hz, 1H), 7.43 (t, *J* = 7.5 Hz, 1H), 7.38 (d, *J* = 8.5 Hz, 1H), 7.30 (t, *J* = 7.3 Hz, 1H), 7.24 (t, *J* = 7.6 Hz, 2H), 3.78 (s, 3H), 3.72 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 189.15, 140.83, 139.51, 133.93, 131.59, 130.09, 129.08, 128.15, 127.92, 127.63, 127.39, 127.18, 125.74, 123.11, 121.58, 76.70, 41.98, 41.68. ESI-MS: calculated $C_{20}H_{19}O_2S_2$ $[M+H]^+$ 355.0826; Found 355.0824.

2-(benzo[d]oxazol-2-ylthio)-2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-phenylethan-1-one (4i)



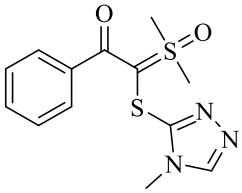
Following the above procedure B, the product **4i** was obtained in 99% yield (68.4 mg, 0.198 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.63 (d, *J* = 7.3 Hz, 2H), 7.51 (t, *J* = 8.3 Hz, 2H), 7.36 (t, 1H), 7.31 (t, *J* = 7.3 Hz, 4H), 3.81 (s, 6H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.98, 166.56, 151.58, 141.42, 140.25, 129.67, 127.71, 127.17, 124.61, 124.24, 118.53, 110.43, 70.18, 41.52, 41.23. ESI-MS: calculated $C_{17}H_{15}NO_3NaS_2$ $[M+Na]^+$ 368.0391; Found 368.0385.

2-((1,3,4-thiadiazol-2-yl)thio)-2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-phenylethan-1-one (4j)



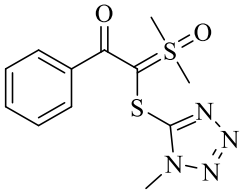
Following the above procedure B, the product **4j** was obtained in 99% yield (65.0 mg, 0.198 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). Rf (Petroleum ether/EtOAc 1:3): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 9.40 (s, 1H), 7.52 (d, *J* = 7.1 Hz, 2H), 7.39 (t, *J* = 7.3 Hz, 1H), 7.34 (t, *J* = 7.3 Hz, 2H), 3.81 (s, 3H), 3.74 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.85, 176.28, 153.88, 139.88, 129.95, 127.73, 127.22, 76.85, 41.72, 41.12. ESI-MS: calculated $C_{13}H_{16}N_2O_2S_3Na$ $[M+Na]^+$ 351.0374; Found 351.0371.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-((4-methyl-4H-1,2,4-triazol-3-yl)thio)-1-phenylethan-1-one (4k)



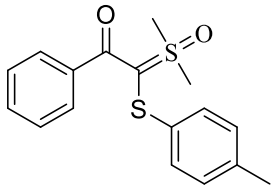
Following the above procedure B, the product **4k** was obtained in 99% yield (61.3 mg, 0.198 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). Rf (Petroleum ether/EtOAc 1:3): 0.19. ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.40 (s, 1H), 7.47 (d, *J* = 7.2 Hz, 2H), 7.39 (t, *J* = 7.2 Hz, 1H), 7.34 (t, *J* = 7.3 Hz, 2H), 3.76 (s, 6H), 3.25 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 188.28, 152.71, 145.91, 140.57, 129.64, 127.67, 127.44, 73.12, 41.17, 30.44. ESI-MS: calculated $C_{13}H_{15}N_3O_2NaS_2$ $[M+Na]^+$ 332.0503; Found 332.0497.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-((1-methyl-1H-tetrazol-5-yl)thio)-1-phenylethan-1-one (4l)



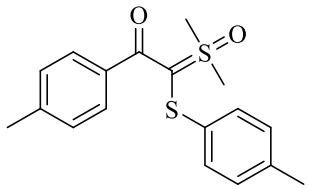
Following the above procedure B, the product **4l** was obtained in 99% yield (61.5 mg, 0.198 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). Rf (Petroleum ether/EtOAc 1:3): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.45 (d, *J* = 7.1 Hz, 3H), 7.39 (t, *J* = 7.3 Hz, 2H), 7.34 (t, *J* = 7.3 Hz, 3H), 3.72 (s, 6H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 188.18, 156.65, 140.24, 129.69, 127.73, 127.17, 70.48, 41.43, 41.08, 33.42. ESI-MS: calculated $C_{12}H_{14}N_4O_2NaS_2$ $[M+Na]^+$ 333.0456; Found 333.0446.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-phenyl-2-(p-tolylthio)ethan-1-one (4m)



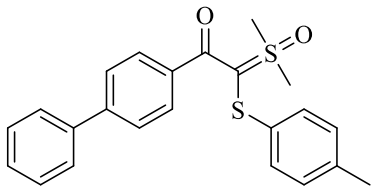
Following the above procedure B, the product **4m** was obtained in 80% yield (51.0 mg, 0.160 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). Rf (Petroleum ether/EtOAc 1:3): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.49 (d, *J* = 7.0 Hz, 2H), 7.33 (t, *J* = 7.3 Hz, 1H), 7.26 (t, *J* = 7.6 Hz, 2H), 7.12 (s, 4H), 3.71 (s, 3H), 3.65 (s, 3H), 2.24 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 188.59, 140.36, 137.75, 134.28, 129.71, 129.54, 127.39, 127.24, 123.79, 76.59, 41.43, 41.12, 20.41. ESI-MS: calculated $C_{17}H_{19}O_2S_2$ $[M+H]^+$ 319.0826; Found 319.0821.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-(p-tolyl)-2-(p-tolylthio)ethan-1-one (4n)



Following the above procedure B, the product **4n** was obtained in 54% yield (35.9 mg, 0.108 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.41 (d, *J* = 8.0 Hz, 2H), 7.11 (s, 4H), 7.06 (d, *J* = 8.0 Hz, 2H), 3.69 (s, 3H), 3.64 (s, 3H), 2.26 (s, 3H), 2.24 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 188.92, 139.72, 138.33, 137.90, 134.69, 130.15, 128.38, 127.88, 124.21, 76.77, 41.94, 41.66, 21.37, 20.88. ESI-MS: calculated $C_{18}H_{20}O_2NaS_2$ $[M+Na]^+$ 355.0802; Found 355.0806.

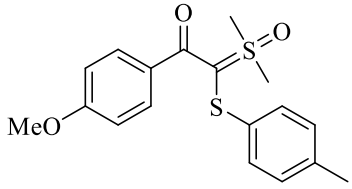
1-([1,1'-biphenyl]-4-yl)-2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-(p-tolylthio)ethan-1-one (4o)



Following the above procedure B, the product **4o** was obtained in 49% yield (38.7 mg, 0.098 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.65 (d, *J* = 7.5 Hz, 2H), 7.62 (d, *J* = 8.4 Hz, 2H), 7.58 (d, *J* = 8.3 Hz, 2H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.35 (t, *J* = 7.3 Hz, 1H), 7.14 (q, *J* = 8.3 Hz, 4H), 3.73 (s, 3H), 3.67 (s, 3H), 2.24 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 188.50, 141.65, 139.86, 139.69, 138.24, 134.80, 130.24, 129.40, 128.54, 128.20, 127.17, 126.11, 124.27, 77.13, 41.94, 41.62, 20.89. ESI-MS: calculated

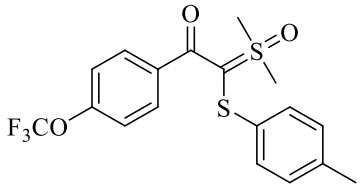
$C_{23}H_{23}O_2S_2$ $[M+H]^+$ 395.1139; Found 395.1133.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-(4-methoxyphenyl)-2-(p-tolylthio)ethan-1-one (4p)



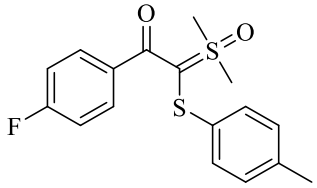
Following the above procedure B, the product **4p** was obtained in 67% yield (46.7 mg, 0.134 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.56 (d, *J* = 8.8 Hz, 2H), 7.11 (q, 4H), 6.81 (d, *J* = 8.8 Hz, 2H), 3.72 (s, 3H), 3.67 (s, 3H), 3.63 (s, 3H), 2.23 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.50, 160.51, 137.90, 134.26, 132.21, 129.74, 129.46, 123.75, 112.63, 75.97, 55.13, 41.56, 41.35, 20.42. ESI-MS: calculated $C_{18}H_{20}O_3NaS_2$ $[M+Na]^+$ 371.0752; Found 371.0748.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-(p-tolylthio)-1-(4-(trifluoromethoxy)phenyl)ethan-1-one (4q)



Following the above procedure B, the product **4q** was obtained in 48% yield (38.8 mg, 0.096 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.60 (d, *J* = 8.6 Hz, 2H), 7.27 (d, *J* = 8.3 Hz, 2H), 7.11 (s, 4H), 3.72 (s, 3H), 3.66 (s, 3H), 2.24 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.36, 149.39, 139.94, 137.85, 134.93, 130.26, 129.84, 124.31, 120.32 (q), 117.89, 77.50, 41.84, 41.48, 20.87. ^{19}F NMR (377 MHz, DMSO-d_6) δ -56.68. ESI-MS: calculated $C_{18}H_{18}O_3F_3S_2$ $[M+H]^+$ 403.0649; Found 403.0648.

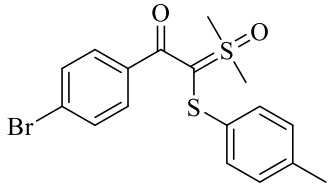
2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-(4-fluorophenyl)-2-(p-tolylthio)ethan-1-one (4r)



Following the above procedure B, the product **4r** was obtained in 70% yield (47.1 mg, 0.140 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.19. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.57 (dd, *J* = 8.5, 5.8 Hz, 2H), 7.11 (s, 4H), 7.09 (d, *J* = 8.8 Hz, 2H), 3.71 (s, 3H), 3.65 (s, 3H),

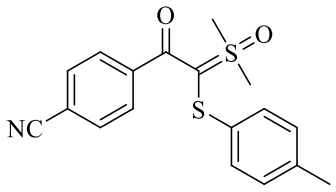
2.24 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.13, 162.76 (d, *J* = 246.5 Hz), 137.55, 136.64 (d, *J* = 3.1 Hz), 134.41, 129.80 (t), 123.81, 114.38, 114.24, 76.70, 41.44, 41.14, 20.42. ^{19}F NMR (377 MHz, DMSO-d_6) δ -111.09. ESI-MS: calculated $C_7H_{17}O_2NaS_2F$ $[M+Na]^+$ 359.0552; Found 359.0548.

1-(4-bromophenyl)-2-(dimethyl(oxo)- λ^6-sulfaneylidene)-2-(p-tolylthio)ethan-1-one (4s)



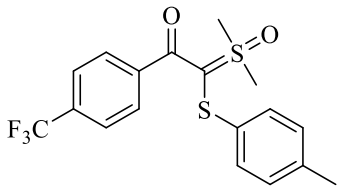
Following the above procedure B, the product **4s** was obtained in 50% yield (40.0 mg, 0.100 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.47 (d, *J* = 8.5 Hz, 2H), 7.42 (d, *J* = 8.4 Hz, 2H), 7.10 (s, 4H), 3.71 (s, 3H), 3.64 (s, 3H), 2.23 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.74, 139.98, 137.90, 134.88, 130.91, 130.24, 129.82, 124.27, 123.40, 77.38, 41.83, 41.48, 20.88. ESI-MS: calculated $C_{17}H_{18}O_2S_2Br$ $[M+H]^+$ 396.9932; Found 396.9930.

4-(2-(dimethyl(oxo)- λ^6-sulfaneylidene)-2-(p-tolylthio)acetyl)benzonitrile (4t)



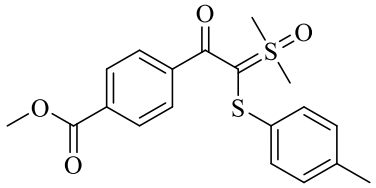
Following the above procedure B, the product **4t** was obtained in 50% yield (34.3 mg, 0.100 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.21. ^{1}H NMR (600 MHz, DMSO--d_6) δ 7.71 (d, *J* = 8.3 Hz, 2H), 7.53 (d, *J* = 8.3 Hz, 2H), 7.07 (s, 4H), 3.70 (s, 3H), 3.63 (s, 3H), 2.20 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 186.81, 145.04, 137.10, 134.52, 131.64, 129.80, 127.74, 123.83, 118.51, 111.73, 77.46, 41.24, 40.83, 20.40. ESI-MS: calculated $C_{18}H_{17}NO_2NaS_2$ $[M+Na]^+$ 366.0590; Found 366.0598.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-(p-tolylthio)-1-(4-(trifluoromethyl)phenyl)ethan-1-one (4u)



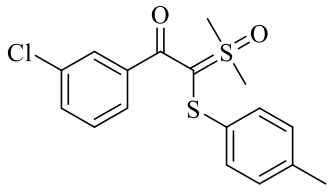
Following the above procedure B, the product **4u** was obtained in 47% yield (36.0 mg, 0.094 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.22. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.63 (q, *J* = 8.4 Hz, 4H), 7.11 (s, 4H), 3.74 (s, 3H), 3.67 (s, 3H), 2.24 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.70, 145.07, 137.73, 134.95, 130.25, 129.84 (q, *J* = 31.6 Hz), 128.21, 124.50 (q, *J* = 272.3 Hz), 124.97, 124.30, 77.80, 41.77, 41.36, 20.87. ^{19}F NMR (377 MHz, DMSO-d_6) δ -61.14. ESI-MS: calculated $C_{18}H_{17}O_2NaS_2F_3$ $[M+Na]^+$ 409.0520; Found 409.0511.

methyl 4-(2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-(p-tolylthio)acetyl)benzoate (4v)



Following the above procedure B, the product **4v** was obtained in 46% yield (34.6 mg, 0.092 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.84 (d, *J* = 8.2 Hz, 2H), 7.54 (d, *J* = 8.2 Hz, 2H), 7.09 (s, 4H), 3.81 (s, 3H), 3.74 (s, 3H), 3.66 (s, 3H), 2.23 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.75, 165.82, 145.12, 137.35, 134.45, 130.06, 129.73, 128.39, 127.33, 123.90, 77.36, 52.18, 41.31, 40.92, 20.41. ESI-MS: calculated $C_{19}H_{20}O_4NaS_2$ $[M+Na]^+$ 399.0701; Found 399.0693.

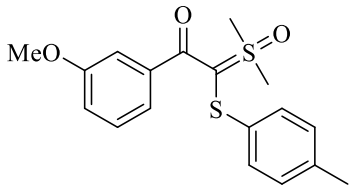
1-(3-chlorophenyl)-2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-(p-tolylthio)ethan-1-one (4w)



Following the above procedure B, the product **4w** was obtained in 50% yield (35.0 mg, 0.100 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.24. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.45 (s, 1H), 7.40 (dd, *J* = 13.0, 7.9 Hz, 2H), 7.30 (t, *J* = 7.8 Hz, 1H), 7.12 (s, 4H), 3.73 (s, 3H), 3.66 (s, 3H), 2.24 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 186.70, 142.45, 137.35, 134.46, 132.12, 129.75, 129.47, 129.27, 127.05, 125.74, 123.88, 77.13, 41.29, 40.94, 20.41. ESI-MS: calculated

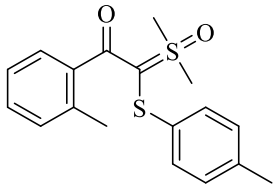
$C_{17}H_{17}O_2NaS_2Cl$ $[M+Na]^+$ 375.0256; Found 375.0254.

2-(dimethyl(oxo)-λ⁶-sulfaneylidene)-1-(3-methoxyphenyl)-2-(p-tolylthio)ethan-1-one (4x)



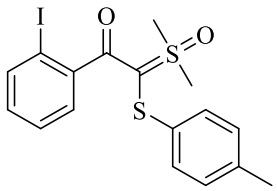
Following the above procedure B, the product **4x** was obtained in 59% yield (41.4 mg, 0.118 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.18 (t, *J* = 7.9 Hz, 1H), 7.15 (q, 4H), 7.06 (d, *J* = 7.6 Hz, 1H), 6.99 (s, 1H), 6.88 (dd, *J* = 8.2, 2.5 Hz, 1H), 3.70 (s, 3H), 3.66 (s, 3H), 3.49 (s, 3H), 2.25 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 188.28, 158.18, 141.73, 137.81, 134.25, 129.71, 128.58, 123.74, 119.49, 115.58, 112.16, 76.48, 54.61, 41.34, 41.11, 20.40. ESI-MS: calculated $C_{18}H_{21}O_3S_2$ $[M+H]^+$ 349.0932; Found 349.0928.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-(o-tolyl)-2-(p-tolylthio)ethan-1-one (4y)



Following the above procedure B, the product **4y** was obtained in 54% yield (35.9 mg, 0.108 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.11 (d, *J* = 10.6 Hz, 2H), 7.06 (d, *J* = 4.0 Hz, 4H), 6.98 (t, *J* = 7.3 Hz, 2H), 3.76 (s, 3H), 3.64 (s, 3H), 2.22 (s, 3H), 2.20 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 190.89, 141.73, 137.50, 134.16, 133.63, 129.71, 129.47, 127.68, 125.46, 124.61, 123.97, 77.33, 41.41, 40.93, 20.39, 18.74. ESI-MS: calculated $C_{18}H_{21}O_2S_2$ $[M+H]^+$ 333.0983; Found 333.0978.

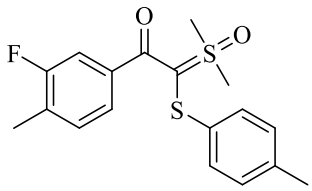
2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-(2-iodophenyl)-2-(p-tolylthio)ethan-1-one (4z)



Following the above procedure B, the product **4z** was obtained in 48% yield (42.7 mg, 0.096 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.22. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.74 (d, *J* = 7.9 Hz, 1H), 7.20 (t, *J* = 7.4 Hz, 1H), 7.07 (dd, 4H), 7.05 (d, *J* = 7.3 Hz, 1H), 6.98 (t, *J* = 7.6 Hz, 1H), 3.75 (s, 3H), 3.65 (s, 3H), 2.23 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 190.28,

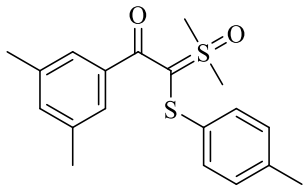
147.19, 138.79, 137.47, 134.72, 129.99, 129.85, 127.86, 126.67, 124.59, 94.50, 76.73, 41.71, 41.00, 20.88. ESI-MS: calculated $C_{17}H_{18}O_2S_2I$ $[M+H]^+$ 444.9793; Found 444.9783.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-(3-fluoro-4-methylphenyl)-2-(p-tolylthio)ethan-1-one (4aa)



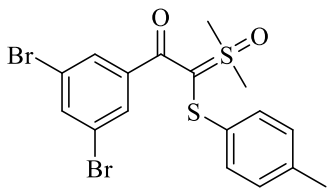
Following the above procedure B, the product **4aa** was obtained in 45% yield (31.5 mg, 0.090 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.24 (d, *J* = 9.1 Hz, 1H), 7.17 (s, 2H), 7.11 (s, 4H), 3.70 (s, 3H), 3.64 (s, 3H), 2.24 (s, 3H), 2.18 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 186.67, 159.59 (d, *J* = 242.8 Hz), 139.95, 137.52, 134.37, 130.63, 129.76, 125.85 (d, *J* = 17.1 Hz), 123.77, 123.18, 113.73 (d, *J* = 23.0 Hz), 76.75, 41.35, 41.05, 20.40, 14.05. ^{19}F NMR (377 MHz, DMSO-d_6) δ -118.26. ESI-MS: calculated $C_{18}H_{19}O_2FNaS_2$ $[M+Na]^+$ 373.0706; Found 373.0708.

2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-1-(3,5-dimethylphenyl)-2-(p-tolylthio)ethan-1-one (4ab)



Following the above procedure B, the product **4ab** was obtained in 42% yield (29.1 mg, 0.084 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.23. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.11 (s, 4H), 7.04 (s, 2H), 6.95 (s, 1H), 3.70 (s, 3H), 3.63 (s, 3H), 2.24 (s, 3H), 2.14 (s, 6H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 189.19, 140.41, 138.04, 136.17, 134.22, 130.77, 129.58, 125.09, 123.99, 76.56, 41.40, 41.11, 20.79, 20.41. ESI-MS: calculated $C_{19}H_{22}O_2NaS_2$ $[M+Na]^+$ 369.0959; Found 369.0956.

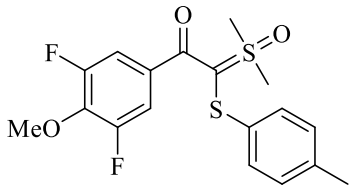
1-(3,5-dibromophenyl)-2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-(p-tolylthio)ethan-1-one (4ac)



Following the above procedure B, the product **4ac** was obtained in 45% yield (42.9 mg, 0.090 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf

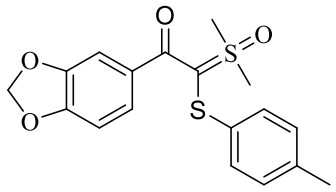
(Petroleum ether/EtOAc 1:1): 0.19. ^{1}H NMR (500 MHz, DMSO-d_6) δ 7.80 (t, *J* = 1.7 Hz, 1H), 7.55 (d, *J* = 1.7 Hz, 2H), 7.12 (dd, 4H), 3.72 (s, 3H), 3.65 (s, 3H), 2.25 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 185.04, 144.30, 137.15, 134.82, 134.16, 129.91, 129.15, 124.20, 121.72, 77.86, 41.27, 40.90, 20.48. ESI-MS: calculated $C_{17}H_{17}O_2S_2Br_2$ $[M+H]^+$ 474.9037; Found 474.9037.

1-(3,5-difluoro-4-methoxyphenyl)-2-(dimethyl(oxo)- λ^6-sulfaneylidene)-2-(p-tolylthio)ethan-1-one (4ad)



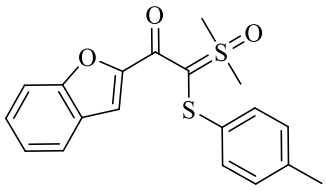
Following the above procedure B, the product **4ad** was obtained in 48% yield (36.7 mg, 0.096 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.23 (d, *J* = 9.2 Hz, 2H), 7.14 (s, 4H), 3.92 (s, 3H), 3.70 (s, 3H), 3.65 (s, 3H), 2.25 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 184.44, 153.74 (dd, *J* = 246.7, 5.8 Hz), 137.16, 136.84 (t, *J* = 14.0 Hz), 134.95 (t, *J* = 7.1 Hz), 134.60, 129.87, 123.88, 111.77 (dd, *J* = 18.6, 5.0 Hz), 77.10, 61.66, 41.26, 40.97, 20.41. ^{19}F NMR (377 MHz, DMSO-d_6) δ -129.10. ESI-MS: calculated $C_{18}H_{19}O_3S_2F_2$ $[M+H]^+$ 385.0744; Found 385.0744.

1-(benzo[d][1,3]dioxol-5-yl)-2-(dimethyl(oxo)- λ^6-sulfaneylidene)-2-(p-tolylthio)ethan-1-one (4ae)



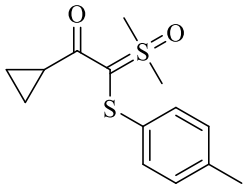
Following the above procedure B, the product **4ae** was obtained in 44% yield (31.9 mg, 0.088 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.19. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.10 (dd, *J* = 8.1, 1.6 Hz, 1H), 7.08 (s, 4H), 7.00 (d, *J* = 1.6 Hz, 1H), 6.77 (d, *J* = 8.1 Hz, 1H), 5.95 (s, 2H), 3.63 (s, 3H), 3.59 (s, 3H), 2.20 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.04, 148.45, 146.23, 137.74, 134.30, 133.94, 129.75, 123.75, 122.25, 107.92, 107.25, 101.19, 76.12, 41.46, 41.25, 20.41. ESI-MS: calculated $C_{18}H_{18}O_4NaS_2$ $[M+Na]^+$ 385.0544; Found 385.0535.

1-(benzofuran-2-yl)-2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-(p-tolylthio)ethan-1-one (4af)



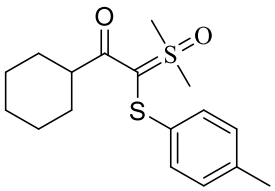
Following the above procedure B, the product **4af** was obtained in 43% yield (30.8 mg, 0.086 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.22. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.66 (d, *J* = 7.8 Hz, 1H), 7.55 (d, *J* = 8.3 Hz, 1H), 7.50 (s, 1H), 7.37 (t, *J* = 7.8 Hz, 1H), 7.24 (d, *J* = 7.5 Hz, 1H), 7.21 (d, *J* = 8.2 Hz, 2H), 7.13 (d, *J* = 8.1 Hz, 2H), 3.73 (s, 3H), 3.68 (s, 3H), 2.23 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 175.67, 153.58, 152.04, 136.78, 134.67, 129.88, 127.18, 126.41, 124.20, 123.31, 122.69, 111.51, 109.95, 77.81, 41.48, 41.14, 20.42. ESI-MS: calculated $C_{19}H_{19}O_3S_2$ $[M+H]^+$ 359.0776; Found 359.0767.

1-cyclopropyl-2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-(p-tolylthio)ethan-1-one (4ag)



Following the above procedure B, the product **4ag** was obtained in 85% yield (48.0 mg, 0.170 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.24. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.13 (q, *J* = 8.3 Hz, 4H), 3.57 (s, 3H), 3.54 (s, 3H), 2.45 (tt, *J* = 8.0, 4.7 Hz, 1H), 2.24 (s, 3H), 0.72 (t, *J* = 3.9 Hz, 2H), 0.60 (t, 1H), 0.53 (t, *J* = 11.8 Hz, 1H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 192.06, 137.53, 134.40, 129.68, 124.06, 74.98, 41.63, 41.43, 20.43, 15.02, 8.00, 7.69. ESI-MS: calculated $C_{14}H_{18}O_2NaS_2$ $[M+Na]^+$ 305.0646; Found 305.0640.

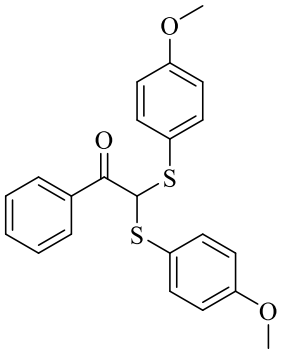
1-cyclohexyl-2-(dimethyl(oxo)- λ⁶-sulfaneylidene)-2-(p-tolylthio)ethan-1-one (4ah)



Following the above procedure B, the product **4ah** was obtained in 49% yield (31.8 mg, 0.098 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.10 (t, *J* = 8.9 Hz, 4H), 3.57 (s, 3H), 3.51 (s, 3H), 2.90 (t, *J* = 11.2 Hz, 1H), 2.24 (s, 3H), 1.67 (d, *J* = 12.4 Hz, 1H), 1.63 (d, *J* = 12.8 Hz, 1H), 1.57 (t, 2H), 1.37 (d, *J* = 12.2 Hz, 1H), 1.28 (dq, *J* = 24.9, 12.2 Hz, 2H), 1.17 (q, *J* = 12.4 Hz, 1H), 1.05 (dq, *J* = 37.9, 11.9 Hz, 2H). ^{13}C NMR (151 MHz,

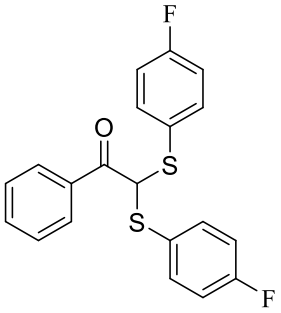
DMSO-d_6) δ 196.57, 137.77, 134.29, 129.70, 123.75, 73.98, 41.66, 41.33, 29.60, 28.67, 25.63, 25.35, 20.42. ESI-MS: calculated $C_{17}H_{24}O_2S_2Na$ $[M+Na]^+$ 347.1115; Found 347.1110.

2,2-bis((4-methoxyphenyl)thio)-1-phenylethan-1-one (5a)



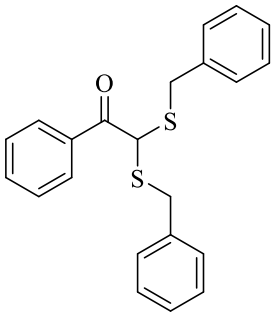
Following the above procedure C, the product **5a** was obtained in 49% yield (39.2 mg, 0.098 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 32:1 v/v). Rf (Petroleum ether/EtOAc 32:1): 0.24. ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.01 (d, *J* = 8.0 Hz, 2H), 7.66 (t, *J* = 7.4 Hz, 1H), 7.52 (t, *J* = 7.3 Hz, 2H), 7.35 (d, *J* = 8.6 Hz, 4H), 6.93 (d, *J* = 8.1 Hz, 4H), 6.31 (s, 1H), 3.76 (s, 6H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 191.47, 159.96, 136.13, 134.48, 133.61, 128.93, 128.73, 121.60, 114.65, 62.19, 55.27. ESI-MS: calculated $C_{22}H_{20}O_3NaS_2$ $[M+Na]^+$ 419.0752; Found 419.0743.

2,2-bis((4-fluorophenyl)thio)-1-phenylethan-1-one (5b)



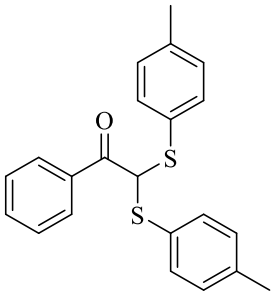
Following the above procedure C, the product **5b** was obtained in 40% yield (29.8 mg, 0.080 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.05 (d, *J* = 9.3 Hz, 2H), 7.68 (t, *J* = 7.4 Hz, 1H), 7.54 (t, *J* = 7.8 Hz, 2H), 7.47 (dd, *J* = 8.8, 5.4 Hz, 4H), 7.22 (t, *J* = 8.8 Hz, 4H), 6.61 (s, 1H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 191.33, 162.51 (d, *J* = 246.7 Hz), 136.24 (d, *J* = 8.5 Hz), 134.19, 133.87, 129.04, 128.80, 126.69 (d, *J* = 2.8 Hz), 116.16 (d, *J* = 21.9 Hz), 61.13. ^{19}F NMR (377 MHz, DMSO-d_6) δ -112.59. ESI-MS: calculated $C_{20}H_{14}ONaS_2F_2$ $[M+Na]^+$ 395.0352; Found 395.0347.

2,2-bis(benzylthio)-1-phenylethan-1-one (5c)



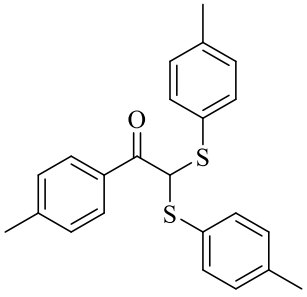
Following the above procedure C, the product **5c** was obtained in 61% yield (44.8 mg, 0.122 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 32:1 v/v). Rf (Petroleum ether/EtOAc 32:1): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.82 (d, *J* = 7.4 Hz, 2H), 7.64 (t, *J* = 7.4 Hz, 1H), 7.48 (t, *J* = 7.8 Hz, 2H), 7.28 (q, 5H), 7.24 (t, *J* = 7.1 Hz, 5H), 5.74 (s, 1H), 3.92 (s, 2H), 3.80 (s, 2H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 191.79, 137.06, 134.03, 133.72, 129.10, 128.76, 128.59, 128.54, 127.14, 54.00, 34.12. ESI-MS: calculated $C_{22}H_{20}ONaS_2$ $[M+Na]^+$ 387.0853; Found 387.0858.

1-phenyl-2,2-bis(p-tolylthio)ethan-1-one (5d)



Following the above procedure C, the product **5d** was obtained in 90% yield (65.6 mg, 0.180 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.25. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 7.5 Hz, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.46 (t, *J* = 7.7 Hz, 2H), 7.40 (d, *J* = 8.0 Hz, 4H), 7.15 (d, *J* = 8.0 Hz, 4H), 5.70 (s, 1H), 2.36 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.47, 139.11, 134.64, 134.40, 133.46, 129.91, 129.08, 128.73, 128.63, 63.41, 21.30. ESI-MS: calculated $C_{22}H_{20}ONaS_2$ $[M+Na]^+$ 387.0853; Found 387.0845.

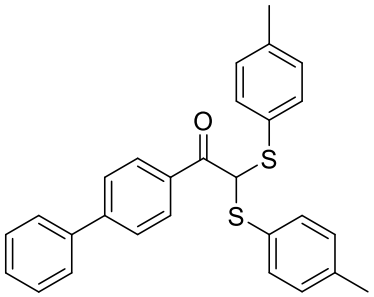
1-(p-tolyl)-2,2-bis(p-tolylthio)ethan-1-one (5e)



Following the above procedure C, the product **5e** was obtained in 66% yield (50.1 mg, 0.132 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.20. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.2 Hz, 2H), 7.37 (d, *J* = 8.1 Hz, 4H), 7.26 (d, *J* = 8.1 Hz, 2H), 7.14 (d, *J* = 8.3 Hz, 4H), 5.65 (s, 1H), 2.43 (s, 3H), 2.36 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.04, 144.29, 138.92, 134.25, 131.86, 129.73, 129.20, 129.10,

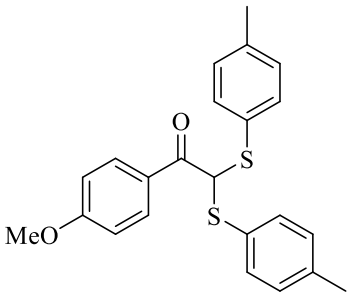
128.65, 63.28, 21.63, 21.17. ESI-MS: calculated $C_{23}H_{22}ONaS_2$ $[M+Na]^+$ 401.1010; Found 401.1002.

1-([1,1'-biphenyl]-4-yl)-2,2-bis(p-tolylthio)ethan-1-one (5f)



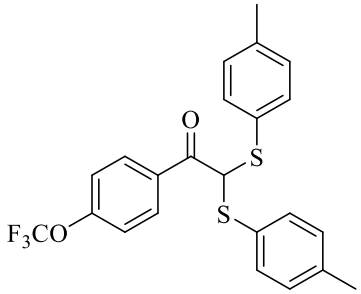
Following the above procedure C, the product **5f** was obtained in 59% yield (52.0 mg, 0.118 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.21. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 (d, *J* = 8.4 Hz, 2H), 7.67 (dd, *J* = 11.5, 7.8 Hz, 4H), 7.50 (t, *J* = 7.9 Hz, 2H), 7.42 (t, *J* = 8.1 Hz, 5H), 7.16 (d, *J* = 8.0 Hz, 4H), 5.72 (s, 1H), 2.37 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.10, 146.12, 139.76, 139.16, 134.44, 133.33, 129.97, 129.77, 129.05, 128.83, 128.42, 127.33, 127.26, 63.55, 21.35. ESI-MS: calculated $C_{28}H_{24}ONaS_2$ $[M+Na]^+$ 463.1166; Found 463.1159.

1-(4-methoxyphenyl)-2,2-bis(p-tolylthio)ethan-1-one (5g)



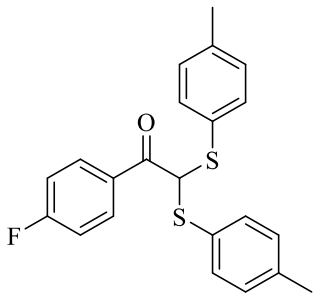
Following the above procedure C, the product **5g** was obtained in 80% yield (63.1 mg, 0.160 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 32:1 v/v). Rf (Petroleum ether/EtOAc 32:1): 0.20. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.9 Hz, 2H), 7.36 (d, *J* = 8.1 Hz, 4H), 7.12 (d, *J* = 8.3 Hz, 4H), 6.92 (d, *J* = 8.9 Hz, 2H), 5.60 (s, 1H), 3.87 (s, 3H), 2.35 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.39, 163.86, 139.07, 134.39, 131.60, 129.93, 129.03, 127.38, 113.87, 63.49, 55.62, 21.37. ESI-MS: calculated $C_{23}H_{22}O_2NaS_2$ $[M+Na]^+$ 417.0959; Found 417.0953.

2,2-bis(p-tolylthio)-1-(4-(trifluoromethoxy)phenyl)ethan-1-one (5h)



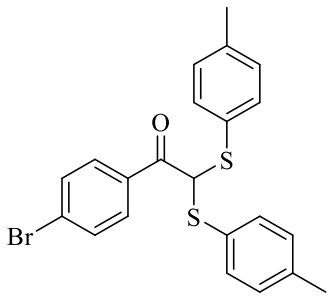
Following the above procedure C, the product **5h** was obtained in 54% yield (48.6 mg, 0.108 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.20. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 8.9 Hz, 2H), 7.27 (d, *J* = 8.1 Hz, 4H), 7.18 (d, *J* = 7.3 Hz, 2H), 7.06 (d, *J* = 7.9 Hz, 4H), 5.48 (s, 1H), 2.27 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.19, 152.89, 139.47, 134.53, 132.89, 131.32, 130.09, 128.58, 120.40 (d, *J* = 259.0 Hz), 120.37, 63.65, 21.40. ^{19}F NMR (376 MHz, $CDCl_3$) δ -57.53. ESI-MS: calculated $C_{23}H_{19}O_2NaS_2F_3$ $[M+Na]^+$ 471.0676; Found 471.0678.

1-(4-fluorophenyl)-2,2-bis(p-tolylthio)ethan-1-one (5i)



Following the above procedure C, the product **5i** was obtained in 99% yield (75.7 mg, 0.198 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.23. ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.13 (q, *J* = 8.9, 5.5 Hz, 2H), 7.36 (t, 2H), 7.28 (d, *J* = 8.1 Hz, 4H), 7.16 (d, *J* = 8.3 Hz, 4H), 6.53 (s, 1H), 2.29 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 190.43, 165.71 (d, *J* = 252.8 Hz), 138.77, 134.12, 132.58 (d, *J* = 9.5 Hz), 131.46 (d, *J* = 2.9 Hz), 130.16, 128.16, 116.28 (d, *J* = 22.0 Hz), 61.07, 21.20. ^{19}F NMR (376 MHz, DMSO-d_6) δ -104.92. ESI-MS: calculated $C_{22}H_{19}OFNaS_2$ $[M+Na]^+$ 405.0759; Found 405.0758.

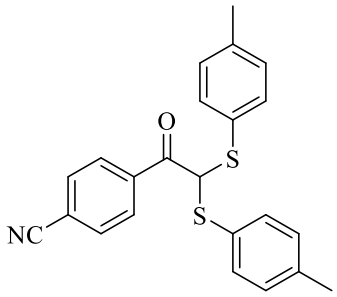
1-(4-bromophenyl)-2,2-bis(p-tolylthio)ethan-1-one (5j)



Following the above procedure C, the product **5j** was obtained in 66% yield (58.5 mg, 0.132 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.20. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.6 Hz, 2H), 7.58 (d, *J* = 8.6 Hz, 2H), 7.34 (d, *J* = 8.1 Hz, 4H), 7.13 (d, *J* = 7.9 Hz, 4H), 5.55 (s, 1H), 2.35 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.55, 139.33, 134.41, 133.33, 131.92, 130.64, 129.97, 128.68, 128.46,

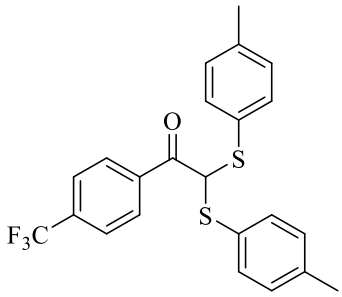
63.49, 21.31. ESI-MS: calculated $C_{22}H_{19}ONaS_2Br$ $[M+Na]^+$ 464.9958; Found 464.9950.

4-(2,2-bis(p-tolylthio)acetyl)benzonitrile (5k)



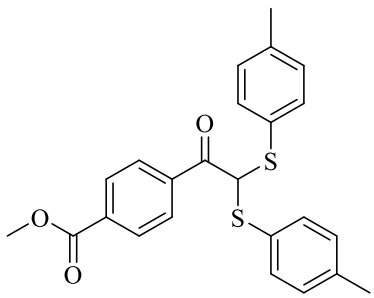
Following the above procedure C, the product **5k** was obtained in 63% yield (49.1 mg, 0.126 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 32:1 v/v). Rf (Petroleum ether/EtOAc 32:1): 0.23. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, J = 8.5 Hz, 2H), 7.73 (d, J = 8.5 Hz, 2H), 7.33 (d, J = 8.1 Hz, 4H), 7.13 (d, J = 7.9 Hz, 4H), 5.56 (s, 1H), 2.35 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.08, 139.63, 137.93, 134.49, 132.44, 130.12, 129.56, 128.12, 117.96, 116.54, 63.66, 21.37. ESI-MS: calculated $C_{23}H_{19}NONaS_2$ $[M+Na]^+$ 412.0806; Found 412.0799.

2,2-bis(p-tolylthio)-1-(4-(trifluoromethyl)phenyl)ethan-1-one (5l)



Following the above procedure C, the product **5l** was obtained in 93% yield (80.4 mg, 0.186 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 32:1 v/v). Rf (Petroleum ether/EtOAc 32:1): 0.20. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04 (d, J = 8.2 Hz, 2H), 7.70 (d, J = 8.3 Hz, 2H), 7.35 (d, J = 8.1 Hz, 4H), 7.14 (d, J = 7.9 Hz, 4H), 5.59 (s, 1H), 2.35 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.54, 139.57, 136.21 (d, J = 282.0 Hz), 134.56, 130.13, 129.53, 128.36, 125.73 (q, J = 3.7 Hz), 125.00, 122.29, 63.73, 21.40. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.13. ESI-MS: calculated $C_{23}H_{19}ONaS_2F_3$ $[M+Na]^+$ 455.0727; Found 455.0732.

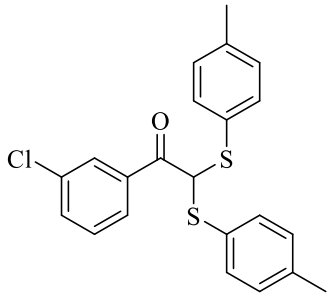
methyl 4-(2,2-bis(p-tolylthio)acetyl)benzoate (5m)



Following the above procedure C, the product **5m** was obtained in 48% yield (40.6 mg, 0.096 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 32:1 v/v). Rf (Petroleum ether/EtOAc 32:1): 0.21. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09 (d, J = 8.6 Hz, 2H), 7.98 (d, J = 8.6 Hz, 2H), 7.34

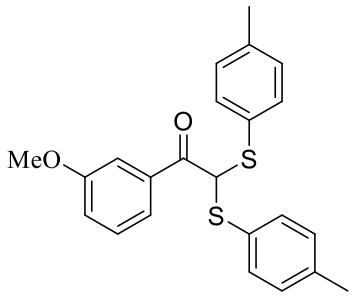
(d, J = 8.1 Hz, 4H), 7.13 (d, J = 7.9 Hz, 4H), 5.62 (s, 1H), 3.96 (s, 3H), 2.35 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.97, 166.25, 139.46, 138.17, 134.55, 134.15, 130.08, 129.85, 129.09, 128.44, 63.75, 52.64, 21.40. ESI-MS: calculated $C_{24}H_{22}O_3NaS_2$ $[M+Na]^+$ 445.0908; Found 445.0905.

1-(3-chlorophenyl)-2,2-bis(p-tolylthio)ethan-1-one (5n)



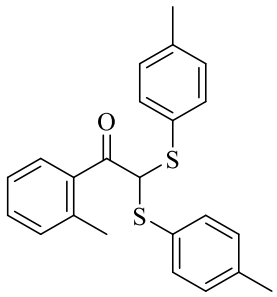
Following the above procedure C, the product **5n** was obtained in 78% yield (62.2 mg, 0.156 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.07 (s, 1H), 7.96 (d, J = 7.9 Hz, 1H), 7.72 (d, J = 8.7 Hz, 1H), 7.56 (t, J = 7.9 Hz, 1H), 7.29 (d, J = 8.0 Hz, 4H), 7.17 (d, J = 8.0 Hz, 4H), 6.57 (s, 1H), 2.30 (s, 6H). ^{13}C NMR (151 MHz, DMSO-d_6)) δ 190.20, 138.36, 136.28, 133.69, 133.33, 130.68, 129.68, 128.67, 127.54, 60.72, 20.72. ESI-MS: calculated $C_{22}H_{19}ONaS_2Cl$ $[M+Na]^+$ 421.0464; Found 421.0454.

1-(3-methoxyphenyl)-2,2-bis(p-tolylthio)ethan-1-one (5o)



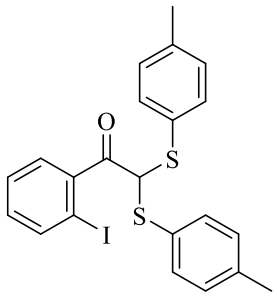
Following the above procedure C, the product **5o** was obtained in 86% yield (67.9 mg, 0.172 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.23. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, J = 7.7 Hz, 1H), 7.48 (s, 1H), 7.38 (d, J = 8.1 Hz, 4H), 7.34 (t, J = 8.0 Hz, 1H), 7.14 (d, J = 7.9 Hz, 4H), 7.12 (d, J = 3.5 Hz, 1H), 5.64 (s, 1H), 3.82 (s, 3H), 2.36 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.38, 159.82, 139.14, 136.05, 134.42, 129.93, 129.60, 128.83, 121.56, 120.02, 113.44, 63.54, 55.48, 21.32. ESI-MS: calculated $C_{23}H_{22}O_2NaS_2$ $[M+Na]^+$ 417.0959; Found 417.0957.

1-(o-tolyl)-2,2-bis(p-tolylthio)ethan-1-one (5p)



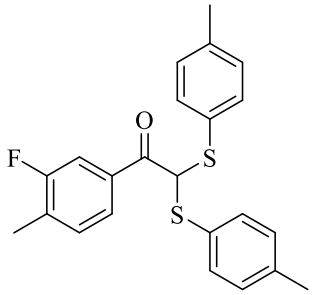
Following the above procedure C, the product **5p** was obtained in 89% yield (67.4 mg, 0.178 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 32:1 v/v). Rf (Petroleum ether/EtOAc 32:1): 0.19. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (d, *J* = 7.1 Hz, 1H), 7.38 (d, *J* = 7.5 Hz, 1H), 7.34 (d, *J* = 8.1 Hz, 4H), 7.25 (d, *J* = 8.7 Hz, 1H), 7.17 (t, *J* = 7.6 Hz, 1H), 7.11 (d, *J* = 7.9 Hz, 4H), 5.55 (s, 1H), 2.40 (s, 3H), 2.34 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 194.78, 139.47, 139.00, 135.89, 134.25, 131.97, 131.69, 129.85, 129.04, 128.48, 125.44, 65.43, 21.29, 21.06. ESI-MS: calculated $C_{23}H_{22}ONaS_2$ $[M+Na]^+$ 401.1010; Found 401.1011.

1-(2-iodophenyl)-2,2-bis(p-tolylthio)ethan-1-one (5q)



Following the above procedure C, the product **5q** was obtained in 42% yield (41.2 mg, 0.084 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.23. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.9 Hz, 1H), 7.46 (d, *J* = 6.3 Hz, 1H), 7.35 (d, *J* = 8.0 Hz, 5H), 7.11 (d, *J* = 7.8 Hz, 5H), 5.64 (s, 1H), 2.34 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 194.71, 142.35, 140.50, 139.12, 134.29, 132.05, 130.09, 129.93, 128.79, 127.84, 92.36, 65.56, 21.35. ESI-MS: calculated $C_{22}H_{19}ONaS_2I$ $[M+Na]^+$ 512.9820; Found 512.9816.

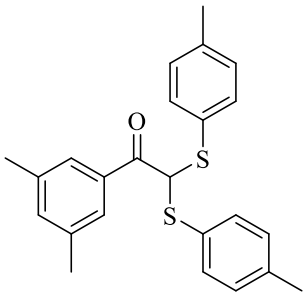
1-(3-fluoro-4-methylphenyl)-2,2-bis(p-tolylthio)ethan-1-one (5r)



Following the above procedure C, the product **5r** was obtained in 70% yield (55.5 mg, 0.140 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.20. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (dd, *J* = 7.9, 1.7 Hz, 1H), 7.50 (dd, *J* = 10.3, 1.6 Hz, 1H), 7.27 (d, *J* = 8.1 Hz, 4H), 7.20 – 7.13 (t, 1H), 7.05 (d, *J* = 7.9 Hz, 4H), 5.47 (s, 1H), 2.26 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.23, 161.21 (d, *J* = 246.7 Hz), 139.33, 134.51, 134.32 (d, *J* = 6.5 Hz), 131.66 (d, *J* = 4.9 Hz), 131.47 (d, *J* = 17.5 Hz), 130.02, 128.63,

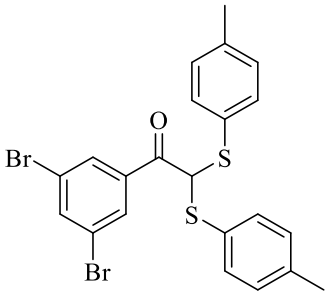
124.75 (d, J = 3.3 Hz), 115.61 (d, J = 23.8 Hz), 63.53, 21.38, 15.05 (d, J = 3.4 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -115.81. ESI-MS: calculated $C_{23}H_{21}ONaS_2F$ $[M+Na]^+$ 419.0916; Found 419.0914.

1-(3,5-dimethylphenyl)-2,2-bis(p-tolylthio)ethan-1-one (5s)



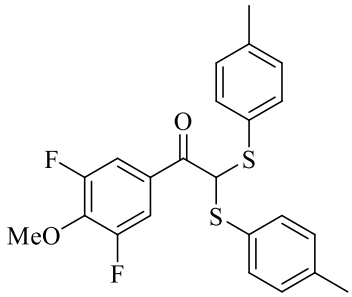
Following the above procedure C, the product **5s** was obtained in 76% yield (59.7 mg, 0.152 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.23. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 (s, 2H), 7.37 (d, J = 8.1 Hz, 4H), 7.20 (s, 1H), 7.14 (d, J = 8.0 Hz, 4H), 5.62 (s, 1H), 2.36 (s, 6H) , 2.33 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.92, 139.09, 138.25, 135.20, 134.72, 134.53, 129.87, 128.95, 126.84, 63.65, 21.31, 21.26. ^{19}F NMR (376 MHz, $CDCl_3$) δ -115.81. ESI-MS: calculated $C_{24}H_{24}ONaS_2$ $[M+Na]^+$ 415.1166; Found 415.1162.

1-(3,5-dibromophenyl)-2,2-bis(p-tolylthio)ethan-1-one (5t)



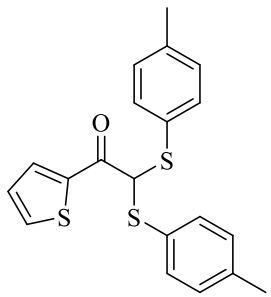
Following the above procedure C, the product **5t** was obtained in 84% yield (87.7 mg, 0.168 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 100:1 v/v). Rf (Petroleum ether/EtOAc 100:1): 0.20. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (s, 2H), 7.82 (s, 1H), 7.36 (d, J = 8.1 Hz, 4H), 7.15 (d, J = 8.0 Hz, 4H), 5.48 (s, 1H), 2.37 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 188.91, 139.61, 138.44, 137.67, 134.59, 130.72, 130.12, 128.24, 123.34, 63.63, 21.38. ESI-MS: calculated $C_{22}H_{18}ONaS_2Br_2$ $[M+Na]^+$ 542.9064; Found 542.9066.

1-(3,5-difluoro-4-methoxyphenyl)-2,2-bis(p-tolylthio)ethan-1-one (5u)



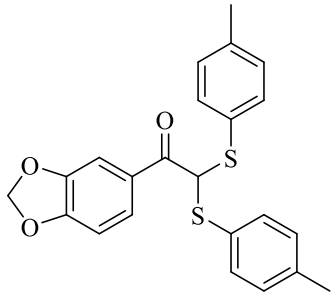
Following the above procedure C, the product **5u** was obtained in 72% yield (62.0 mg, 0.144 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.23. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, *J* = 7.8 Hz, 2H), 7.35 (d, *J* = 6.3 Hz, 4H), 7.14 (d, *J* = 6.9 Hz, 4H), 5.46 (s, 1H), 4.12 (s, 3H), 2.36 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 188.55, 154.57 (dd, *J* = 249.7, 5.8 Hz), 140.96 (t, *J* = 13.3 Hz), 139.44, 134.77, 134.43, 130.01, 128.32 (q, *J* = 10.3 Hz), 113.51 (q), 63.30, 61.65 (t, *J* = 4.2 Hz), 21.29. ^{19}F NMR (376 MHz, $CDCl_3$) δ -127.04. ESI-MS: calculated $C_{23}H_{20}O_2NaS_2F_2$ $[M+Na]^+$ 453.0770; Found 453.0777.

1-(thiophen-2-yl)-2,2-bis(p-tolylthio)ethan-1-one (5v)



Following the above procedure C, the product **5v** was obtained in 85% yield (63.0 mg, 0.170 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.20. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (d, J = 3.8 Hz, 1H), 7.66 (d, J = 4.9 Hz, 1H), 7.37 (d, J = 7.6 Hz, 4H), 7.12 (d, J = 7.9 Hz, 4H), 7.09 (d, J = 3.9 Hz, 1H), 5.39 (s, 1H), 2.34 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 185.23, 141.07, 139.16, 134.53, 134.22, 133.32, 129.94, 128.91, 128.11, 64.12, 21.29. ESI-MS: calculated $C_{20}H_{18}ONaS_3$ $[M+Na]^+$ 393.0417; Found 393.0410.

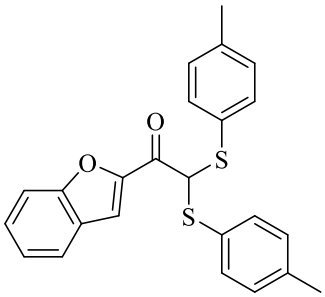
1-(benzo[d][1,3]dioxol-5-yl)-2,2-bis(p-tolylthio)ethan-1-one (5w)



Following the above procedure C, the product **5w** was obtained in 60% yield (49.0 mg, 0.120 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.23. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.44 (d, *J* = 1.7 Hz, 1H), 7.36 (d, *J* = 8.1 Hz, 4H), 7.13 (d, *J* = 8.0 Hz, 4H), 6.82 (d, *J* = 8.2 Hz, 1H), 6.05 (s, 2H), 5.55 (s, 1H), 2.35 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.98, 152.21, 148.23,

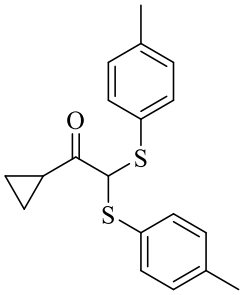
139.16, 134.43, 129.95, 129.17, 128.92, 125.59, 109.00, 108.00, 102.09, 63.51, 21.37. ESI-MS: calculated $C_{23}H_{20}O_3NaS_2$ $[M+Na]^+$ 431.0752; Found 431.0758.

1-(benzofuran-2-yl)-2,2-bis(p-tolylthio)ethan-1-one (5x)



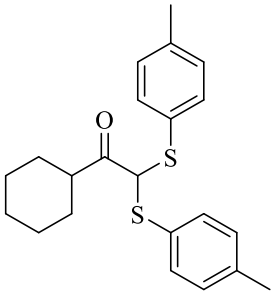
Following the above procedure C, the product **5x** was obtained in 99% yield (80.1 mg, 0.198 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.19. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 7.8 Hz, 1H), 7.61 (d, *J* = 0.8 Hz, 1H), 7.53 (d, *J* = 8.0 Hz, 1H), 7.49 (ddd, *J* = 8.4, 6.8, 1.2 Hz, 1H), 7.41 (d, *J* = 8.0 Hz, 4H), 7.32 (ddd, *J* = 8.0, 6.8, 1.3 Hz, 1H), 7.13 (d, *J* = 7.9 Hz, 4H), 5.62 (s, 1H), 2.34 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 182.59, 155.72, 150.53, 139.31, 134.50, 130.01, 129.61, 128.62, 127.17, 124.14, 123.45, 114.69, 112.58, 62.78, 21.36. ESI-MS: calculated $C_{24}H_{20}O_2NaS_2$ $[M+Na]^+$ 427.0802; Found 427.0800.

1-cyclopropyl-2,2-bis(p-tolylthio)ethan-1-one (5y)



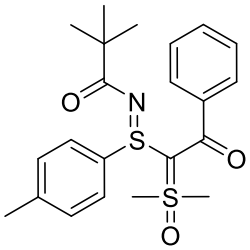
Following the above procedure C, the product **5y** was obtained in 77% yield (50.6 mg, 0.154 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.36 (d, J = 8.1 Hz, 4H), 7.18 (d, J = 8.0 Hz, 4H), 5.69 (s, 1H), 2.41 (tt, J = 8.1, 4.5 Hz, 1H), 2.30 (s, 6H), 1.00 (dq, J = 7.0, 3.4 Hz, 2H), 0.80 (p, J = 3.5 Hz, 2H). ^{13}C NMR (151 MHz, DMSO d_6)) δ 201.69, 139.24, 138.11, 134.66, 133.17, 129.73, 129.57, 128.09, 127.26, 64.25, 20.71, 18.70, 11.79. ESI-MS: calculated $C_{19}H_{20}ONaS_2$ $[M+Na]^+$ 351.0853; Found 351.0858.

1-cyclohexyl-2,2-bis(p-tolylthio)ethan-1-one (5z)



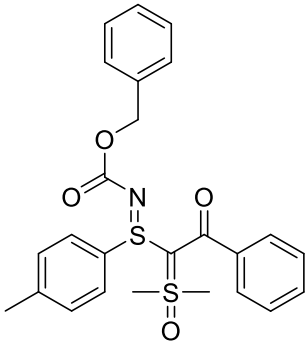
Following the above procedure C, the product **5z** was obtained in 47% yield (34.8 mg, 0.094 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 64:1 v/v). Rf (Petroleum ether/EtOAc 64:1): 0.24. ^{1}H NMR (600 MHz, DMSO d_6)) δ 7.32 (d, J = 8.2 Hz, 4H), 7.16 (d, J = 7.9 Hz, 4H), 5.64 (s, 1H), 2.29 (s, 6H), 1.77 (d, J = 11.7 Hz, 2H), 1.68 (d, J = 12.5 Hz, 2H), 1.59 (d, J = 12.8 Hz, 1H), 1.26 – 1.17 (m, 4H), 1.17 – 1.07 (m, 2H), . ^{13}C NMR (151 MHz, DMSO d_6)) δ 203.48, 138.04, 133.14, 129.67, 128.14, 62.14, 47.08, 28.57, 25.27, 25.04, 20.69. ESI-MS: calculated $C_{22}H_{26}ONaS_2$ $[M+Na]^+$ 393.1323; Found 393.1317.

(*E*)-*N*-((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8a)



Following the general procedure D, the product **8a** was obtained in 80% yield (66.8 mg, 0.160 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). R_f (Petroleum ether/EtOAc 1:2): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.63 – 7.36 (m, 5H), 7.30 (d, J = 28.7 Hz, 4H), 3.77 (s, 6H), 2.32 (s, 3H), 1.16 (s, 9H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.65, 186.84, 139.77, 139.55, 133.53, 130.29, 129.70, 127.69, 127.59, 126.31, 84.30, 42.52, 42.08, 39.59, 28.62, 20.66. ESI-MS: calculated $C_{22}H_{28}NO_3S_2$ $[M+H]^+$ 418.1511; Found 418.1505.

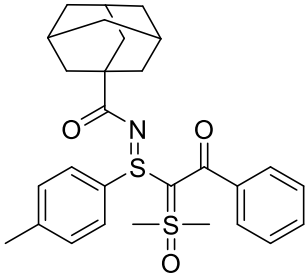
Benzyl (*E*)-((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl)(p-tolyl)-λ^4-sulfaneylidene)carbamate (8b)



Following the general procedure D, the product **8b** was obtained in 43% yield (40.4 mg, 0.086 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.66 – 7.52 (m, 6H), 7.49 – 7.22 (m, 9H), 6.76 (d, J = 15.7 Hz, 1H), 3.77 (s, 6H), 2.34 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.90,

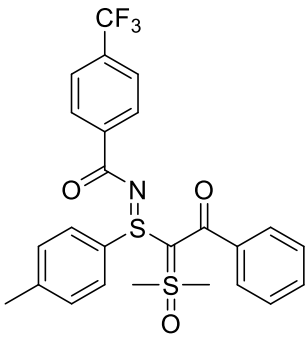
174.62, 140.44, 139.96, 138.26, 135.96, 130.94, 130.24, 129.46, 129.26, 128.33, 128.27, 128.05, 126.85, 126.53, 79.23, 43.23, 42.95, 21.18. ESI-MS: calculated $C_{25}H_{26}NO_4S_2$ $[M+H]^+$ 468.1225; Found 468.1223.

(*E*)-*N*-((1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-oxo-2-phenylethyl)(p-tolyl)-λ⁴-sulfaneylidene)adamantane-1-carboxamide (8c)



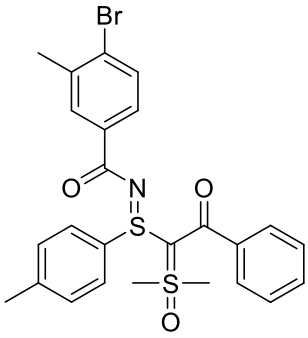
Following the general procedure D, the product **8c** was obtained in 60% yield (59.2 mg, 0.120 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.22. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.55 – 7.38 (m, 5H), 7.30 (d, J = 29.5 Hz, 4H), 3.75 (s, 6H), 2.32 (s, 3H), 1.95 (s, 3H), 1.84 (s, 6H), 1.66 (s, 6H).^{13}C NMR (151 MHz, DMSO-d_6) δ 187.65, 186.15, 139.82, 139.58, 133.62, 130.39, 129.77, 127.77, 127.69, 126.37, 83.61, 42.60, 42.20, 41.51, 40.13, 36.54, 28.06, 20.72. ESI-MS: calculated $C_{28}H_{34}NO_3S_2$ $[M+H]^+$ 496.1980; Found 496.1984.

(*E*)-*N*-((1-(dimethyl(oxo)-λ⁶-sulfaneylidene)-2-oxo-2-phenylethyl)(p-tolyl)-λ⁴-sulfaneylidene)-4-(trifluoromethyl)benzamide (8d)



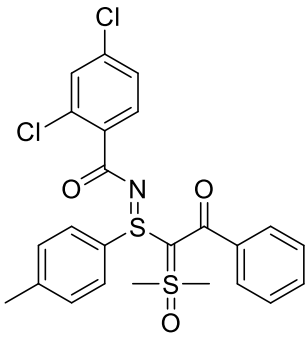
Following the general procedure D, the product **8d** was obtained in 54% yield (54.4 mg, 0.108 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.22. ^{1}H NMR (600 MHz, DMSO-d_6) δ 8.21 (s, 2H), 7.78 (s, 2H), 7.74 – 7.12 (m, 9H), 3.81 (s, 6H), 2.34 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.68, 172.36, 140.88, 140.22, 139.46, 132.58, 130.62, 130.49, 130.41, 129.90, 129.03, 127.74, 126.38, 124.95, 124.25 (q, J = 273.0, 272.5 Hz)76.17, 42.76, 42.32, 20.72. ^{19}F NMR (471 MHz, DMSO-d_6) δ -61.07. ESI-MS: calculated $C_{25}H_{22}NO_3NaS_2F_3$ $[M+Na]^+$ 528.0891; Found 528.0883.

(*E*)-4-bromo-*N*-((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl)(p-tolyl)-λ^4-sulfan eylidene)-3-methylbenzamide (8e)



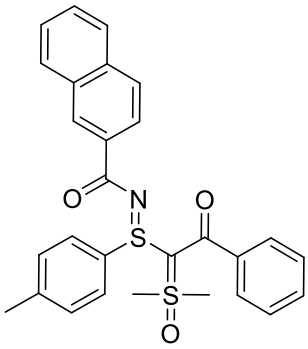
Following the general procedure D, the product **8e** was obtained in 81% yield (86.2 mg, 0.162 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.95 (s, 1H), 7.76 (s, 1H), 7.64 – 7.42 (m, 6H), 7.33 (d, J = 25.5 Hz, 4H), 3.81 (s, 3H), 3.79 (s, 3H), 2.39 (s, 3H), 2.34 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.67, 172.97, 140.08, 139.50, 136.72, 136.55, 132.82, 131.67, 130.81, 130.42, 129.83, 128.49, 127.78, 127.75, 126.75, 126.37, 82.04, 42.67, 42.30, 22.50, 20.71. ESI-MS: calculated $C_{25}H_{25}NO_3S_2Br$ $[M+H]^+$ 530.0459; Found 530.0458.

(*E*)-2,4-dichloro-*N*-((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl)(p-tolyl)-λ^4-sulf aneylidene)benzamide (8f)



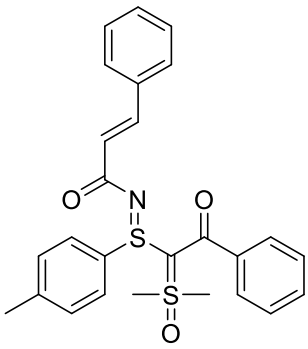
Following the general procedure D, the product **8f** was obtained in 76% yield (77.1 mg, 0.152 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.69 – 7.62 (m, 3H), 7.57 (d, *J* = 18.9 Hz, 3H), 7.46 – 7.41 (m, 2H), 7.35 (d, *J* = 27.8 Hz, 4H), 3.77 (s, 6H), 2.34 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.52, 173.74, 140.28, 139.40, 137.47, 133.64, 132.31, 131.49, 131.28, 130.56, 129.94, 129.22, 127.92, 127.72, 127.05, 126.40, 81.04, 42.76, 42.45, 20.71. ESI-MS: calculated $C_{24}H_{22}NO_3S_2Cl_2$ $[M+H]^+$ 506.0418; Found 506.0412.

(*E*)-*N*-((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl)(p-tolyl)-λ^4-sulfaneylidene)-2-naphthamide (8g)



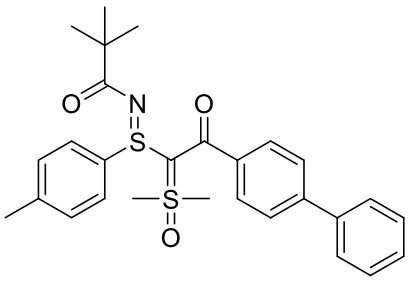
Following the general procedure D, the product **8g** was obtained in 66% yield (64.8 mg, 0.132 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.19. ^{1}H NMR (600 MHz, DMSO-d$_6$) δ 8.58 (s, 1H), 8.15 (d, *J* = 8.4 Hz, 1H), 8.04 (d, *J* = 7.5 Hz, 1H), 7.97 – 7.85 (m, 2H), 7.73 – 7.42 (m, 7H), 7.35 (d, *J* = 22.6 Hz, 4H), 3.83 (s, 6H), 2.35 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d$_6$) δ 187.66, 173.76, 140.05, 139.54, 134.52, 134.05, 133.23, 133.01, 132.34, 130.43, 129.84, 128.95, 128.25, 127.79, 127.50, 127.23, 127.07, 126.42, 126.23, 125.73, 80.79, 42.70, 42.34, 20.72. ESI-MS: calculated $C_{28}H_{26}NO_3S_2$ $[M+H]^+$ 488.1354; Found 488.1349.

***N*-((*E*)-(1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-phenylethyl)(p-tolyl)-λ^4-sulfaneylidene)cinnamamide (8h)**



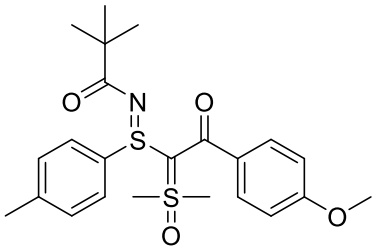
Following the general procedure D, the product **8h** was obtained in 40% yield (37.1 mg, 0.080 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). Rf (Petroleum ether/EtOAc 1:3): 0.23. ^{1}H NMR (600 MHz, DMSO-d$_6$) δ 7.58 (d, J = 36.6 Hz, 6H), 7.47 – 7.23 (m, 9H), 6.77 (d, J = 15.7 Hz, 1H), 3.78 (s, 6H), 2.34 (s, 3H). ^{13}C NMR (151 MHz, DMSO-d$_6$) δ 187.39, 174.10, 139.93, 139.46, 137.75, 135.46, 133.07, 130.43, 129.73, 128.94, 128.74, 127.81, 127.77, 127.54, 126.35, 126.03, 78.94, 42.72, 42.44, 20.67. ESI-MS: calculated $C_{26}H_{26}NO_3S_2$ $[M+H]^+$ 464.1354; Found 464.1345.

(*E*)-*N*-((2-([1,1'-biphenyl]-4-yl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8k)



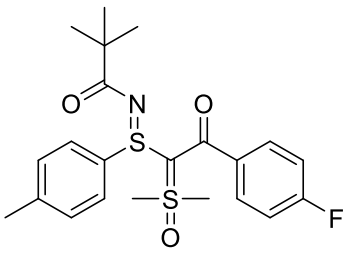
Following the general procedure D, the product **8k** was obtained in 44% yield (43.4 mg, 0.088 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.74 – 7.54 (m, 8H), 7.48 (d, J = 7.3 Hz, 2H), 7.42 – 7.25 (m, 3H), 3.78 (s, 6H), 2.35 (s, 3H), 1.17 (s, 9H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.13, 186.85, 141.99, 139.82, 139.34, 138.40, 133.59, 129.74, 128.98, 128.45, 127.88, 126.79, 126.35, 125.91, 84.19, 42.62, 42.13, 40.03, 28.63, 20.67. ESI-MS: calculated $C_{28}H_{32}NO_3S_2$ $[M+H]^+$ 494.1824; Found 494.1831.

(*E*)-*N*-((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-(4-methoxyphenyl)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8l)



Following the general procedure D, the product **8l** was obtained in 63% yield (56.6 mg, 0.126 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). Rf (Petroleum ether/EtOAc 1:2): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.54 (s, 4H), 7.31 (s, 2H), 6.90 (s, 2H), 3.78 (s, 3H), 3.74 (s, 6H), 2.34 (s, 3H), 1.15 (s, 9H).^{13}C NMR (151 MHz, DMSO-d_6) δ 186.75, 186.63, 161.19, 139.74, 131.59, 129.94, 129.73, 129.62, 126.28, 112.98, 81.81, 55.26, 42.81, 42.30, 40.03, 28.63, 20.65. ESI-MS: calculated $C_{23}H_{30}NO_4S_2$ $[M+H]^+$ 448.1616; Found 448.1617.

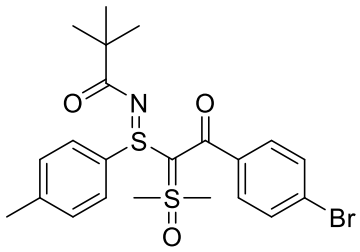
(*E*)-*N*-((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-(4-fluorophenyl)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8m)



Following the general procedure D, the product **8m** was obtained in 65% yield (57.0 mg, 0.130 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). Rf (Petroleum ether/EtOAc 1:1): 0.24. ^{1}H NMR (600 MHz, DMSO-

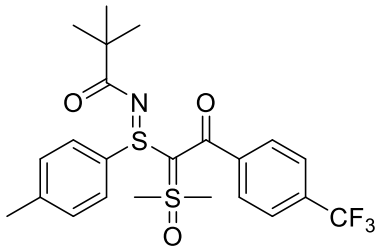
d_6) δ 7.53 (s, 4H), 7.29 (s, 2H), 7.15 (s, 2H), 3.80 (s, 6H), 2.34 (s, 3H), 1.17 (s, 9H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 186.97, 186.51, 163.18 (d, J = 247.5 Hz), 139.86, 136.03, 133.24, 130.25 (d, J = 8.6 Hz), 129.70, 126.30, 114.48 (d, J = 21.5 Hz), 76.35, 42.43, 42.00, 40.03, 28.62, 20.65. ^{19}F NMR (377 MHz, DMSO-d_6) δ -77.74. ESI-MS: calculated $C_{22}H_{27}NO_3FS_2$ $[M+H]^+$ 436.1416; Found 436.1415.

(*E*)-*N*-((2-(4-bromophenyl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8n)



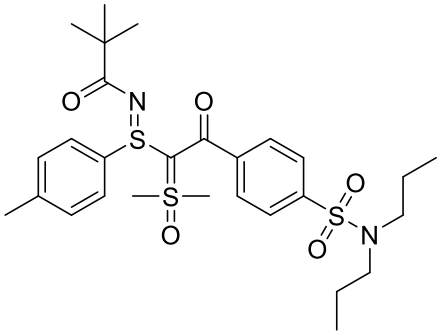
Following the general procedure D, the product **8n** was obtained in 62% yield (61.2 mg, 0.124 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). R_f (Petroleum ether/EtOAc 1:2): 0.21.^{1}H NMR (600 MHz, DMSO-d_6) δ 7.52 (s, 4H), 7.40 (s, 2H), 7.28 (s, 2H), 3.78 (s, 6H), 2.33 (s, 3H), 1.16 (s, 9H).^{13}C NMR (151 MHz, DMSO-d_6) δ 187.01, 186.56, 139.94, 138.72, 133.12, 130.58, 129.75, 129.71, 126.36, 123.78, 79.19, 42.42, 41.97, 40.05, 28.62, 20.69. ESI-MS: calculated $C_{22}H_{27}NO_3S_2Br$ $[M+H]^+$ 496.0616; Found 496.0615.

(*E*)-*N*-((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxo-2-(4-(trifluoromethyl)phenyl)ethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8o)



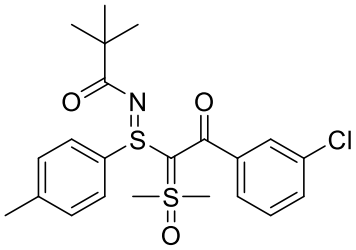
Following the general procedure D, the product **8o** was obtained in 67% yield (65.2 mg, 0.134 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). R_f (Petroleum ether/EtOAc 1:2): 0.22. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.78 – 7.35 (m, 6H), 7.25 (s, 2H), 3.83 (s, 6H), 2.33 (s, 3H), 1.17 (s, 9H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.13, 186.54, 143.57, 139.98, 132.71, 129.72, 128.14, 126.40, 125.09, 124.49, 123.97 (q, J = 273.0, 272.5 Hz), 73.63, 42.24, 41.77, 39.67, 28.60, 20.64. ^{19}F NMR (471 MHz, $CDCl_3$) δ -62.92. ESI-MS: calculated $C_{23}H_{26}NO_3NaS_2F_3$ $[M+Na]^+$ 508.1204; Found 508.1212.

(*E*)-*N*-((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-(4-(*N*,*N*-dipropylsulfamoyl)phenyl)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8p)



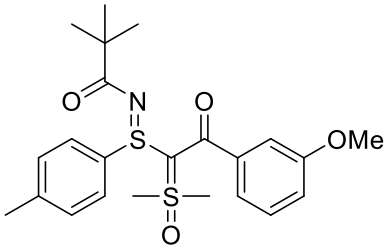
Following the general procedure D, the product **8p** was obtained in 47% yield (47.2 mg, 0.094 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc2:1 v/v). R_f (Petroleum ether/EtOAc 2:1): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.80 – 7.07 (m, 8H), 3.87 (s, 6H), 3.01 (d, J = 7.3 Hz, 4H), 2.42 – 2.16 (m, 3H), 1.49 (t, J = 7.5 Hz, 4H), 1.17 (s, 9H), 0.82 (d, J = 7.2 Hz, 6H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.11, 186.67, 143.26, 140.18, 139.87, 132.73, 129.66, 128.28, 126.36, 125.81, 69.70, 49.81, 42.00, 41.58, 39.70, 28.59, 21.73, 20.63, 10.98. ESI-MS: calculated $C_{28}H_{41}N_2O_5S_3$ $[M+H]^+$ 581.2178; Found 581.2184.

(*E*)-*N*-((2-(2-chlorophenyl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8q)



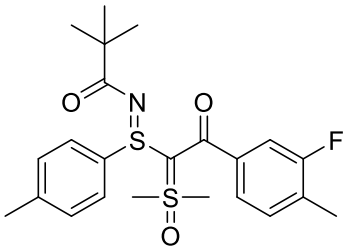
Following the general procedure D, the product **8q** was obtained in 65% yield (59.1 mg, 0.130 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc 1:1): 0.24. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.43 (d, J = 22.4 Hz, 4H), 7.25 (d, J = 24.0 Hz, 4H), 3.84 (s, 6H), 2.31 (s, 3H), 1.18 (s, 9H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.14, 186.14, 141.58, 139.86, 132.61, 132.21, 129.73, 129.61, 129.37, 127.11, 126.30, 126.01, 73.00, 42.06, 41.67, 40.43, 28.60, 20.66. ESI-MS: calculated $C_{22}H_{26}NO_3NaS_2Cl$ $[M+Na]^+$ 474.0940; Found 474.0932.

(*E*)-*N*-((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-(3-methoxyphenyl)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8r)



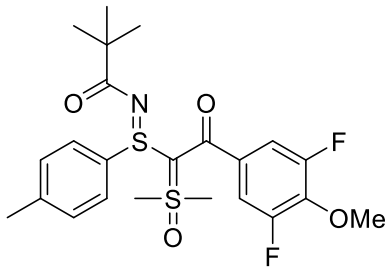
Following the general procedure D, the product **8r** was obtained in 48% yield (42.6 mg, 0.096 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). R_f (Petroleum ether/EtOAc 1:3): 0.19. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.51 (s, 2H), 7.28 (d, J = 20.5 Hz, 3H), 7.17 – 6.82 (m, 3H), 3.77 (s, 6H), 3.70 (s, 3H), 2.34 (s, 3H), 1.16 (s, 9H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.27, 186.92, 158.54, 140.87, 139.85, 133.55, 129.78, 128.82, 126.32, 120.04, 116.09, 112.67, 76.24, 55.03, 42.55, 42.08, 40.03, 28.64, 20.68. ESI-MS: calculated $C_{23}H_{29}NO_4NaS_2$ $[M+Na]^+$ 470.1436; Found 470.1437.

(*E*)-*N*-((1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-(3-fluoro-4-methylphenyl)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8s)



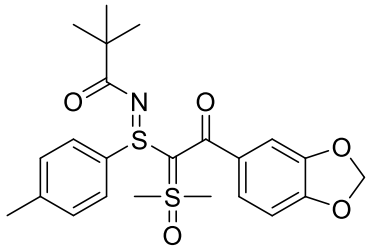
Following the general procedure, D the product **8s** was obtained in 55% yield (49.2 mg, 0.110 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc 1:1): 0.23. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.50 (s, 2H), 7.36 – 6.94 (m, 5H), 3.79 (s, 6H), 2.32 (s, 3H), 2.23 (s, 3H), 1.17 (s, 9H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 186.98, 186.09, 159.66 (d, J = 244.1 Hz), 139.93, 139.14 (d, J = 6.4 Hz), 130.80, 129.70, 126.32, 123.50, 121.74, 119.61, 114.22 (d, J = 23.8 Hz), 75.87, 42.39, 41.99, 40.40, 28.58, 20.66, 14.12 (d, J = 2.4 Hz). ^{19}F NMR (377 MHz, DMSO-d_6) δ -77.74. ESI-MS: calculated $C_{23}H_{28}NO_3NaS_2F$ $[M+Na]^+$ 472.1392; Found 472.1385.

(*E*)-*N*-((2-(3,5-difluoro-4-methoxyphenyl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8t)



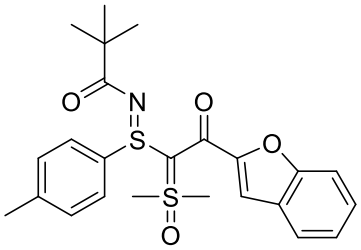
Following the general procedure D, the product **8t** was obtained in 58% yield (56.7 mg, 0.116 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc 1:1): 0.19. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.42 (s, 2H), 7.23 (d, J = 8.0 Hz, 2H), 7.09 (s, 2H), 3.92 (s, 3H), 3.87 (s, 6H), 2.30 (s, 3H), 1.19 (s, 9H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.35, 184.72, 153.74 (dd, J = 247.1, 5.2 Hz), 139.98, 137.19 (t, J = 13.7 Hz), 134.34 (t, J = 7.6 Hz), 132.31, 129.61, 126.32, 112.02 (d, J = 23.3 Hz), 82.17, 61.76, 41.89, 41.66, 40.03, 28.58, 20.62. ^{19}F NMR (471 MHz, $CDCl_3$) δ -78.19, -128.73. ESI-MS: calculated $C_{23}H_{27}NO_4NaS_2F_2$ $[M+Na]^+$ 506.1247; Found 506.1246.

(*E*)-*N*-((2-(benzo[d][1,3]dioxol-5-yl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8u)



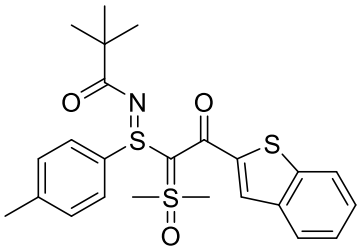
Following the general procedure D, the product **8u** was obtained in 56% yield (51.4 mg, 0.112 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:2 v/v). R_f (Petroleum ether/EtOAc 1:2): 0.20. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.51 (s, 2H), 7.29 (s, 2H), 7.05 (d, J = 14.2 Hz, 2H), 6.85 (s, 1H), 6.04 (s, 2H), 3.77 (s, 6H), 2.33 (s, 3H), 1.16 (s, 9H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 186.87, 186.45, 149.14, 146.61, 139.79, 133.58, 133.39, 129.68, 126.30, 122.86, 108.17, 107.29, 101.42, 76.03, 42.56, 42.16, 40.04, 28.63, 20.66. ESI-MS: calculated $C_{23}H_{27}NO_5NaS_2$ $[M+Na]^+$ 484.1228; Found 484.1223.

(*E*)-*N*-((2-(benzofuran-2-yl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8v)



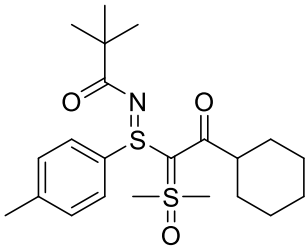
Following the general procedure D, the product **8v** was obtained in 54% yield (49.6 mg, 0.108 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc 1:1): 0.21. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.79 – 7.62 (m, 4H), 7.53 (s, 1H), 7.46 – 7.24 (m, 4H), 3.79 (s, 3H), 3.74 (s, 3H), 2.36 (s, 3H), 1.14 (s, 9H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.08, 174.60, 154.08, 151.72, 140.01, 133.62, 129.89, 126.97, 126.83, 126.38, 123.66, 122.84, 111.69, 111.30, 84.60, 42.97, 41.98, 40.03, 28.58, 20.71. ESI-MS: calculated $C_{24}H_{28}NO_4S_2$ $[M+H]^+$ 458.1460; Found 458.1452.

(*E*)-*N*-((2-(benzo[b]thiophen-2-yl)-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8w)



Following the general procedure D, the product **8w** was obtained in 49% yield (46.4 mg, 0.098 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:1 v/v). R_f (Petroleum ether/EtOAc 1:1): 0.28. ^{1}H NMR (600 MHz, DMSO-d6) δ 8.32 (s, 1H), 7.91 (d, J = 55.3 Hz, 2H), 7.64 (s, 2H), 7.36 (d, J = 59.2 Hz, 4H), 3.82 (s, 6H), 2.31 (s, 3H), 1.20 (s, 9H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 187.19, 178.68, 142.45, 140.12, 139.94, 138.73, 132.95, 129.87, 127.98, 126.45, 126.31, 125.36, 124.87, 122.54, 84.09, 42.92, 42.19, 40.04, 28.61, 20.65. ESI-MS: calculated $C_{24}H_{28}NO_3S_3$ $[M+H]^+$ 474.1231; Found 474.1234.

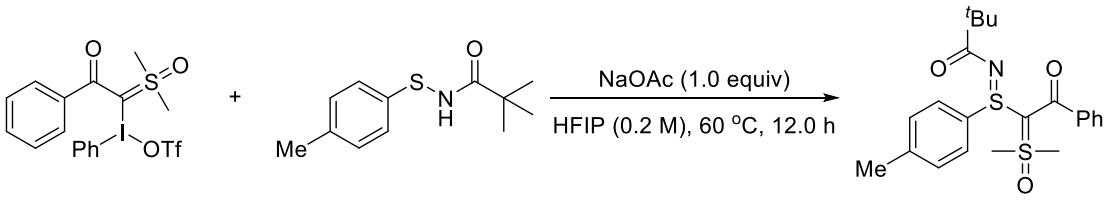
(*E*)-*N*-((2-cyclohexyl-1-(dimethyl(oxo)-λ^6-sulfaneylidene)-2-oxoethyl)(p-tolyl)-λ^4-sulfaneylidene)pivalamide (8x)



Following the general procedure D, the product **8x** was obtained in 40% yield (34.2 mg, 0.080 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 1:3 v/v). R_f (Petroleum ether/EtOAc 1:3): 0.18. ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.77 (s, 2H), 7.41 (d, J = 14.1 Hz, 2H), 3.86 (s, 3H), 3.77 (s, 3H), 2.54 (s, 1H), 2.37 (s, 3H), 1.60 (s, 1H), 1.45 (s, 1H), 1.32 – 1.20 (m, 2H), 1.17 (s, 9H), 1.14 – 1.03 (m, 2H), 1.00 – 0.79 (m, 2H), 0.44 (d, J = 60.1 Hz, 2H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 195.65, 187.24, 139.99, 133.95, 129.75, 126.89, 85.29, 45.27, 41.48, 40.41, 40.04, 28.61, 27.86, 25.25, 25.18, 20.69. ESI-MS: calculated $C_{22}H_{34}NO_3S_2$ $[M+H]^+$ 424.1980; Found 424.1985.

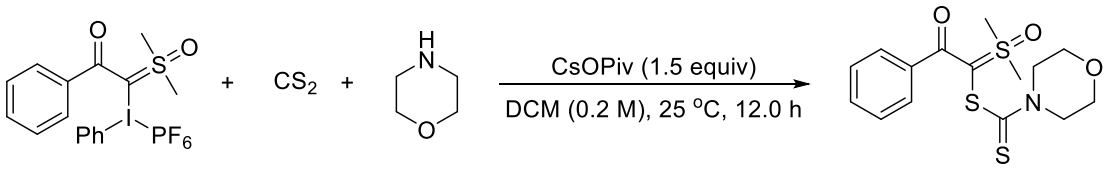
4. Gram-scale experiment and synthetic application of the product

4.1 Gram-scale experiment



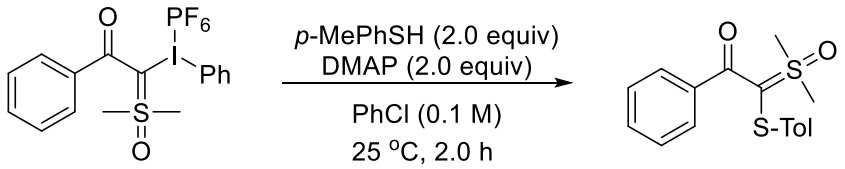
6a (1.5 equiv) **7a** (5.0 mmol) **8a**, 1.8 g, 86%

In an 100 mL oven-dried round-bottom flask, a mixture of the acyclic I,S-ylide **6a** (7.5 mmol, 1.5 equiv), **7a** (5.0 mmol, 1.0 equiv), NaOAc (5.0 mmol, 1.0 equiv) and HFIP (25.0 mL, 0.2 M) was stirred at 60 °C in the oil bath for 12.0 h. The pure product **8a** (1.8 g, 86%) was purified by flash column chromatography on silica with an appropriate solvent.



1a (3.0 mmol) 2.5 equiv 1.2 equiv **3a**, 0.90 g, 84%

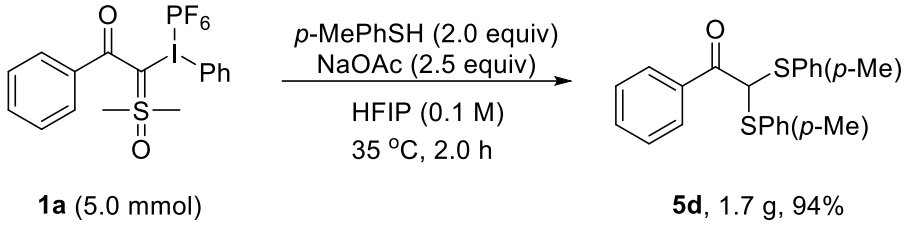
In an 50 mL oven-dried round-bottom flask, a mixture of the aliphatic amine (3.6 mmol, 1.2 equiv), CS_2 (7.5 mmol, 2.5 equiv), CsOPiv (4.5 mmol, 1.5 equiv), acyclic I,S-ylide **1a** (3.0 mmol, 1.0 equiv), and DCM (15.0 mL, 0.2 M) was stirred at 25 °C in the reaction agitator for 12.0 h. The pure product **3a** (0.90 g, 84%) was purified by flash column chromatography on silica with an appropriate solvent.



1a (5.0 mmol) **4m**, 1.0 g, 64%

In an 150 mL oven-dried round-bottom flask, a mixture of the acyclic I,S-ylide **1a** (5.0 mmol,

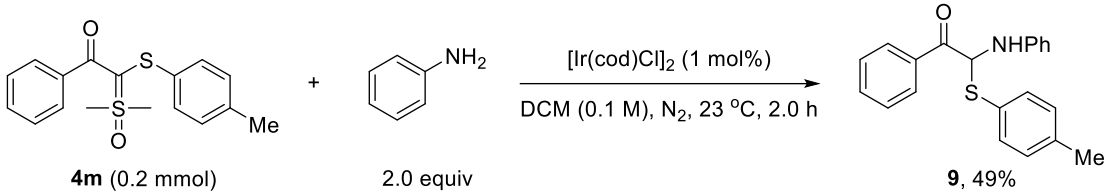
1.0 equiv), thiophenols (10.0 mmol, 2.0 equiv), DMAP (10.0 mmol, 2.0 equiv) and PhCl (50.0 ml, 0.1 M) was stirred at 25 °C in the reaction agitator for 2.0 h. The pure product **4m** (1.0 g, 64%) was purified by flash column chromatography on silica with an appropriate solvent.



1a (5.0 mmol) **5d**, 1.7 g, 94%

In an 150 mL oven-dried round-bottom flask, a mixture of the acyclic I,S-ylide **1a** (5.0 mmol, 1.0 equiv), thiophenols (10.0 mmol, 2.0 equiv), NaOAc (12.5 mmol, 2.5 equiv) and HFIP (50.0 ml, 0.1 M) was stirred at 35 °C in the oil bath for 2.0 h. The pure product **5d** (1.7 g, 94%) was purified by flash column chromatography on silica with an appropriate solvent.

4.2 Synthetic application



4m (0.2 mmol) 2.0 equiv **9**, 49%

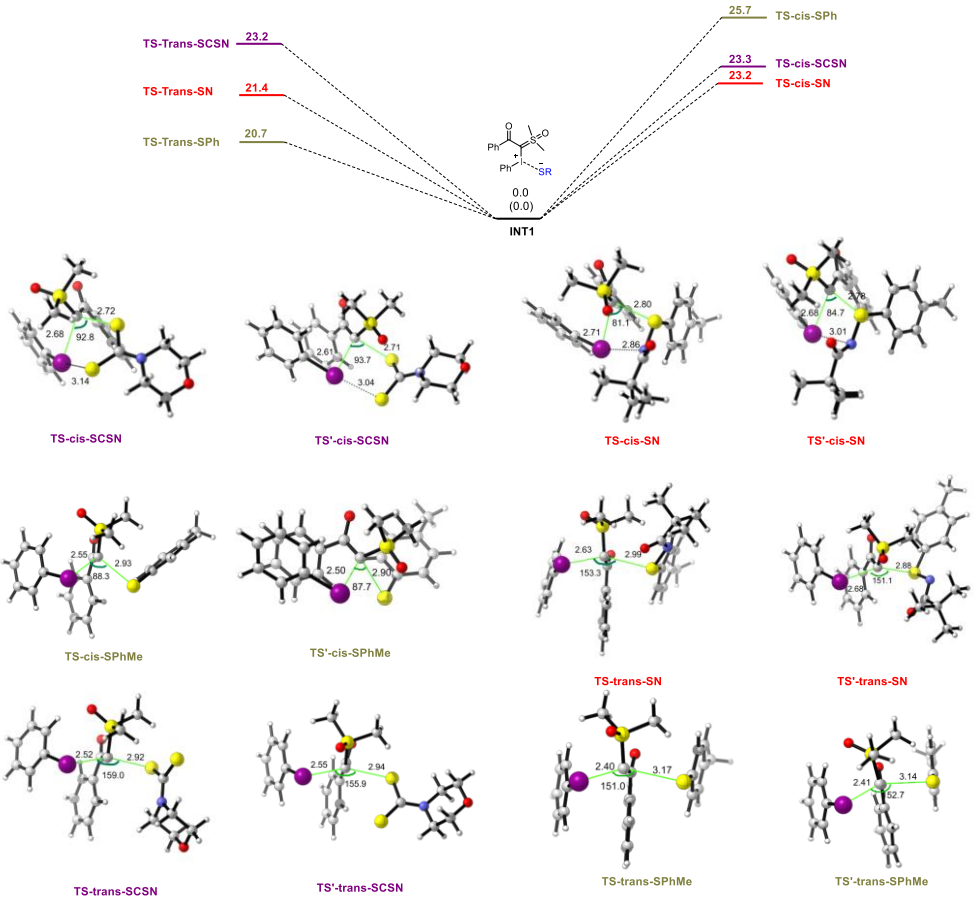
In an oven-dried Schlenk tube, a mixture of the **4m** (0.20 mmol, 1.0 equiv.), aniline (0.40 mmol, 2.0 equiv.), $[Ir(cod)Cl]_2$ (1.0 mol%) and DCM (0.1 M) was stirred at 23 °C under N_2 for 2.0 h. the product **9** was obtained in 49% yield (32.7 mg, 0.098 mmol) as a yellow oil after column chromatography (eluent = Petroleum ether/EtOAc 32:1 v/v). R_f (Petroleum ether/EtOAc 32:1): 0.26. ^{1}H NMR (600 MHz, Chloroform-d) δ 8.04 (d, J = 7.5 Hz, 2H), 7.63 (t, J = 7.4 Hz, 1H), 7.53 (t, J = 7.7 Hz, 2H), 7.32 (t, J = 7.8 Hz, 2H), 7.04 (d, J = 7.8 Hz, 2H), 6.90 (dq, J = 12.6, 7.4, 6.4 Hz, 5H), 6.27 (d, J = 9.5 Hz, 1H), 2.33 (s, 3H). ^{13}C NMR (151 MHz, Chloroform-d) δ 188.31, 143.08, 139.95, 137.44, 134.54, 133.63, 129.76, 129.53, 128.93, 128.73, 124.96, 119.28, 115.05, 62.99, 21.49. ESI-MS: calculated $C_{21}H_{19}NONaS$ $[M+Na]^+$ 356.1085; Found 356.1079.

5. Computational Studies.

5.1 Computational Methods

All the calculations in this study were performed with Gaussian09 D.01.[4] DFT studies were carried out with the B3LYP functional[5] including the D3 version of Grimme's empirical dispersion correction[6-7]. The def2-SVP basis sets of Weigend and Ahlrichs[8] were employed for all atoms. Optimizations were conducted in the corresponding solvents (SMD[9] model). Frequency analyses (at 298.15 K and 1 atm) were carried out to confirm that each structure is a local minimum (no imaginary frequency) or a transition state (only one imaginary frequency). All transition states were confirmed by intrinsic reaction coordinate (IRC) calculations were performed to confirm the connection between two correct minima for a transition state. In order to get more accurate electronic energies, the single point energy was calculated with B3LYP-D3(BJ) functional and def2-TZVP basis sets in corresponding solvents (SMD model).

5.2 Summary of calculation results



5.3 Calculated energy data and imaginary frequencies for all structure

Table S1 Relative gibbs free energy for transition states

SR	INT1(defined)	TS-trans-SR	TS'-trans-SR	TS-cis-SR	TS'-cis-SR
SCSN	0.0	23.2	24.2	23.3	24.7
SN	0.0	21.4	22.7	22.9	23.2
SPhMe	0.0	20.7	21.0	25.7	25.8

Table S2 The calculated energy data and imaginary frequencies for all structure

	Energy (au)	Thermal correction to Enthalpy（au）	Thermal correction to Gibbs Free Energy (au)	Imaginary frequency (cm^{-1})
	B3LYP-D3(BJ) /def2tzvp/SMD	B3LYP-D3 /def2SVP/SMD	B3LYP-D3 /def2SVP/SMD	B3LYP-D3 /def2SVP/SMD
Substrate-OTf (DCM)	-2427.883562	0.337348	0.245614	None
morpholine	-287.940657	0.140977	0.106418	None
CS_2	-834.573832	0.010961	-0.016025	None
PivO-Anion	-346.715765	0.140387	0.101966	None
PivOH	-347.206308	0.154959	0.113881	None
Anion-OTf (DCM)	-961.942165	0.035235	-0.005711	None
INT1-SCSN	-2588.008297	0.443637	0.347889	None
TS-trans-SCSN	-2587.969027	0.441349	0.345563	-235.61
TS'-trans-SCSN	-2587.965226	0.441047	0.343414	-180.30
TS-cis-SCSN	-2587.969349	0.441765	0.346067	-208.11
TS'-cis-SCSN	-2587.969349	0.441669	0.348364	-274.32
INT2-SCSN	-2588.078168	0.444553	0.347837	None
Product-SCSN	-2058.501586	0.345383	0.269154	None
PhI (DCM)	-529.566828	0.096815	0.058281	None
Substrate-OTf (HFIP)	-2427.889037	0.337274	0.244374	None
HSN	-996.039798	0.284391	0.222569	None
Anion-AcO	-228.735307	0.053628	0.021538	None
AcOH	-229.207512	0.065914	0.03523	None
Anion-OTf (HFIP)	-961.953871	0.035195	-0.005622	None
INT1-SN	-2461.495874	0.572399	0.458796	None
TS-trans-SN	-2461.462453	0.570461	0.459522	-193.29
TS'-trans-SN	-2461.46255	0.570735	0.461607	-174.19
TS-cis-SN	-2461.463397	0.571270	0.46323	-196.26
TS'-cis-SN	-2461.463022	0.462370	0.570971	-189.83
INT2-SN	-2461.495874	0.572399	0.458796	None

Product-SN	-1931.958286	0.474400	0.383024	None
PhI （HFIP）	-529.564819	0.096836	0.058311	None
INT1-SPhMe	-2135.401018	0.427521	0.335072	None
TS-trans-SPhMe	-2135.367229	0.425204	0.334207	-190.83
TS'-trans-SPhMe	-2135.365359	0.425075	0.332867	-186.06
TS-cis-SPhMe	-2135.359886	0.425836	0.334887	-225.77
TS'-cis-SPhMe	-2135.359018	0.425572	0.334262	-241.63

5.4 Cartesian Coordinates for All the Optimized Structures

Substrate-OTf (DCM)

C	0.41484900	3.84635100	-0.53097200
C	0.46186600	2.51651900	-0.10269800
C	-0.28658000	2.11187900	1.01544400
C	-1.06896000	3.05672800	1.70146200
C	-1.13008000	4.37867100	1.25764500
C	-0.38530100	4.77683700	0.14066500
H	1.01351500	4.15557900	-1.39166000
H	1.09386600	1.80291400	-0.63222100
H	-1.62845200	2.74118100	2.58491300
H	-1.75327700	5.10308000	1.78858700
H	-0.42372700	5.81453700	-0.20134800
C	-0.21763100	0.72728300	1.59327100
O	-0.13787600	0.58903000	2.81995300
C	-0.23390800	-0.45515100	0.75660000
S	-0.10537300	-1.94238000	1.65121900
O	-1.20959900	-2.28302500	2.58286900
C	1.47316300	-1.93733800	2.50976800
H	1.49342600	-2.87489600	3.08306500
H	2.25827400	-1.89644500	1.74336900
H	1.47404300	-1.06620200	3.17254400
C	0.10127000	-3.26931600	0.46509700
H	0.94183000	-3.03165700	-0.20212600
H	0.31025200	-4.15524800	1.08142800
H	-0.85304600	-3.39635200	-0.06163500
I	-0.90139800	-0.49619700	-1.20049700
C	-3.03616500	-0.43872800	-0.82388300
C	-3.52995700	-0.77028000	0.43656600
C	-3.86311400	-0.04304700	-1.87690400
C	-4.91361100	-0.70033100	0.64264400
H	-2.86725700	-1.08109900	1.24709100
C	-5.24334300	0.01631300	-1.65019700
H	-3.45312200	0.22368800	-2.85448300
C	-5.76705100	-0.30945400	-0.39440400

H	-5.31941800	-0.95665500	1.62460200
H	-5.90661300	0.32725300	-2.46142600
H	-6.84490800	-0.25656700	-0.22272800
O	1.79418100	-0.15940600	-1.75582700
S	3.04836200	-0.77283100	-1.22615900
O	2.82991300	-1.98071100	-0.39103500
O	4.14795100	-0.85098300	-2.19791600
C	3.66277800	0.49035700	0.02145500
F	2.82911900	0.58639000	1.06850500
F	4.86505900	0.13490000	0.48189300
F	3.76415000	1.69934400	-0.53998700

Morpholine

C	-1.20216200	0.71940400	-0.19426000
C	1.20342000	0.71735300	-0.19423100
C	-1.17632400	-0.75586400	0.19311700
H	-1.28209900	0.78526800	-1.30291600
H	-2.09806700	1.19766900	0.23495100
C	1.17494500	-0.75791700	0.19309200
H	1.28362700	0.78316700	-1.30288500
H	2.10020200	1.19391600	0.23507700
H	-2.03499400	-1.29041400	-0.24276300
H	-1.23468500	-0.84466100	1.29816700
H	2.03270400	-1.29388400	-0.24284200
H	1.23324600	-0.84685100	1.29814700
N	0.00121500	1.36563000	0.32270100
O	-0.00121900	-1.39213000	-0.28761300
H	0.00203800	2.35556500	0.08076400

CS_2

C	0.00000000	0.00000000	0.00000000
S	0.00000000	0.00000000	1.56243300
S	0.00000000	0.00000000	-1.56243300

PivO-Anion

C	0.99362000	-0.74741700	1.25365600
C	0.52693900	0.01051900	-0.00001000
H	0.68452400	-0.22200100	2.17464700
H	0.54247100	-1.75111100	1.27614800
H	2.09382200	-0.85478500	1.28376300
C	0.99374000	-0.74863000	-1.25288500
C	1.10528600	1.42877600	-0.00066900
H	0.68471200	-0.22411500	-2.17441300
H	2.09394600	-0.85601100	-1.28279600

H	0.54258000	-1.75233700	-1.27442800
H	2.21110100	1.41411900	-0.00054200
H	0.76715700	1.99163800	-0.88469600
H	0.76693100	1.99255900	0.88267800
C	-1.05677900	0.03051200	-0.00004500
O	-1.61661100	1.15174700	-0.00002700
O	-1.60389900	-1.09931200	-0.00005300

PivOH

C	0.96494400	-0.80588500	1.26334400
C	0.57182900	-0.01272000	-0.00000400
H	0.66900800	-0.26817800	2.17889400
H	0.48936000	-1.79767600	1.27804700
H	2.05753300	-0.94610200	1.28899000
C	0.96498600	-0.80610700	-1.26319600
C	1.25627300	1.35923500	-0.00010700
H	0.66896100	-0.26862800	-2.17885100
H	2.05759000	-0.94621000	-1.28884900
H	0.48951200	-1.79795400	-1.27767500
H	2.35025800	1.23193400	-0.00006000
H	0.97698200	1.94538400	-0.88902700
H	0.97692400	1.94554400	0.88868700
C	-0.94507400	0.18542200	-0.00002600
O	-1.51603600	1.25248900	-0.00001900
O	-1.61454400	-0.98240100	-0.00000800
H	-2.56924600	-0.77848800	0.00000200

Anion-OTf (DCM)

S	0.92616400	0.00012100	-0.00003000
O	1.24477900	-0.56990800	-1.32803600
O	1.24343400	-0.86515400	1.15781600
O	1.24365500	1.43545600	0.17044000
C	-0.95193000	-0.00004700	-0.00020800
F	-1.44388800	0.73930500	-1.00889500
F	-1.44266400	0.50389900	1.14487700
F	-1.44255800	-1.24373900	-0.13598600

INT1-SCSN

C	0.29961300	3.37181400	1.01061200
C	0.21756900	1.97810100	1.07009200
C	-0.93312800	1.36116700	1.58430400
C	-1.99505400	2.15302700	2.05000700
C	-1.91959800	3.54522400	1.97115200
C	-0.77227200	4.15688600	1.45109300

H	1.20348700	3.84603300	0.61939600
H	1.04777700	1.36061600	0.72593200
H	-2.88296100	1.66594500	2.45907400
H	-2.75721300	4.15622000	2.31754600
H	-0.71162500	5.24701000	1.39426100
C	-1.05912200	-0.13061200	1.70528200
O	-1.52337100	-0.61557200	2.74367300
C	-0.63865800	-0.99000800	0.61391300
S	-0.91211400	-2.68502400	0.90132800
O	-2.30986400	-3.17791200	1.02069600
C	0.02944200	-3.11397500	2.37005100
H	-0.01038200	-4.21034200	2.43529100
H	1.05584600	-2.74432200	2.22863500
H	-0.48021200	-2.63810800	3.21326400
C	-0.07078500	-3.59965400	-0.38482100
H	0.97409400	-3.25853300	-0.45487800
H	-0.15269100	-4.65069100	-0.07394300
H	-0.62162000	-3.43998400	-1.32087700
I	-0.77433700	-0.31153100	-1.37609300
C	-2.85065100	0.37056700	-1.11641900
C	-3.77300400	-0.43049800	-0.44135800
C	-3.18094400	1.63403400	-1.60752800
C	-5.07135100	0.06006600	-0.25708000
H	-3.48754800	-1.40557500	-0.03921000
C	-4.48586300	2.10754100	-1.41910400
H	-2.43626000	2.25550400	-2.11180000
C	-5.42761700	1.32307200	-0.74514900
H	-5.80494400	-0.55167700	0.27477200
H	-4.75885200	3.09885800	-1.79047800
H	-6.44249200	1.69936700	-0.59346600
S	3.20991800	-2.13925300	0.72238200
C	2.86073900	-0.88538800	-0.38751800
S	2.10000700	-1.25370200	-1.92195700
C	3.18398700	1.49775800	-1.09592400
C	3.86854900	0.82886200	1.11977600
C	4.62055900	1.94612400	-1.36287100
H	2.60833000	2.34451600	-0.68508200
H	2.70410100	1.15048500	-2.01732100
C	5.28461000	1.29611800	0.79306800
H	3.29907200	1.66598900	1.55984300
H	3.88433900	-0.00901400	1.82605700
H	4.62496400	2.81537000	-2.03909700
H	5.17149200	1.11864000	-1.85586400
H	5.77300300	1.69157200	1.69723900

H	5.87526100	0.43208700	0.42546400
N	3.19018100	0.41091700	-0.11106700
O	5.27655500	2.33861700	-0.16959900

TS-trans-SCSN

C	-0.11822900	3.50794400	-0.31587900
C	-0.00394200	2.13492200	-0.09666500
C	-0.75679900	1.51533300	0.91525500
C	-1.62349700	2.29068500	1.70236300
C	-1.74054800	3.66425100	1.48016400
C	-0.98819400	4.27536400	0.47063600
H	0.47625600	3.98489100	-1.09950400
H	0.67592700	1.53290100	-0.69936500
H	-2.21034500	1.79690200	2.47916500
H	-2.42280000	4.25912300	2.09289400
H	-1.07783200	5.35087400	0.29530700
C	-0.70009900	0.04080300	1.17585000
O	-1.19050900	-0.43597800	2.19692300
C	-0.04828800	-0.81621100	0.11443500
S	-0.36060700	-2.57388400	0.51541000
O	-1.75346500	-3.09474400	0.62101900
C	0.56708100	-3.05859900	1.97311300
H	0.32511300	-4.12602900	2.08926500
H	1.63863300	-2.88037900	1.79415200
H	0.17387400	-2.45974100	2.80128200
C	0.49721500	-3.42453200	-0.80579200
H	1.55173100	-3.10902000	-0.78177500
H	0.38416700	-4.49991100	-0.60865500
H	0.00985200	-3.14820100	-1.75005900
I	-1.75175000	-0.58260800	-1.72495500
C	-3.49422500	0.07273700	-0.67555800
C	-4.02357800	-0.73288900	0.33607400
C	-4.01543400	1.33216700	-0.98593400
C	-5.12744200	-0.25205900	1.04973300
H	-3.56882800	-1.69404300	0.58051800
C	-5.12428600	1.78650200	-0.26464700
H	-3.56519900	1.95452000	-1.76129000
C	-5.67828100	0.99866700	0.75053900
H	-5.55202800	-0.86444200	1.84928600
H	-5.54611800	2.76826000	-0.49422900
H	-6.53877400	1.36474200	1.31601000
S	2.19908300	-0.13567700	1.85716700
C	3.29412500	-0.60422900	0.58159100
S	3.79763800	-2.23894600	0.42030200

C	4.71090200	0.08641900	-1.35201100
C	3.53892200	1.79215500	-0.11295900
C	6.01930700	0.82145000	-1.06865000
H	4.27923500	0.45889800	-2.29781000
H	4.87769900	-0.99392600	-1.43014500
C	4.87925400	2.48214900	0.13606400
H	3.09272300	2.18705000	-1.04203300
H	2.84778600	1.96639300	0.71852200
H	6.71583300	0.69700800	-1.91240400
H	6.48807400	0.38556400	-0.16235100
H	4.73971700	3.57384800	0.17302400
H	5.28058900	2.14860500	1.11530300
N	3.75481300	0.35152800	-0.27430700
O	5.80924200	2.21341900	-0.89978300

TS'-trans-SCSN

C	-1.06709300	3.38061900	-0.65543300
C	-0.61883700	2.08889500	-0.37363700
C	-1.02628400	1.44979500	0.80955000
C	-1.87648300	2.11946900	1.70455900
C	-2.33110000	3.40713200	1.41431200
C	-1.92870900	4.03945200	0.23193600
H	-0.73445700	3.88090900	-1.56887200
H	0.08708100	1.58588300	-1.03938700
H	-2.18440900	1.61007300	2.61980800
H	-3.00396200	3.91735700	2.10844900
H	-2.28261500	5.04841200	0.00302200
C	-0.60070500	0.05761500	1.15166100
O	-0.66150200	-0.34850200	2.31759600
C	-0.12363700	-0.80714100	0.02683900
S	0.00007300	-2.53549400	0.49868400
O	0.12923100	-3.38523600	-0.70984500
C	-1.33004600	-3.21722000	1.52314400
H	-1.01697000	-4.23061200	1.81287700
H	-1.47917200	-2.56194200	2.38912800
H	-2.21636300	-3.26083800	0.87755700
C	1.43278200	-2.71964400	1.55687300
H	1.27825800	-2.11771200	2.46080100
H	1.49960700	-3.79677900	1.77004800
H	2.29722600	-2.36135000	0.98658100
I	-2.16340000	-1.03006100	-1.48638700
C	-3.79918700	-0.14099600	-0.45275300
C	-4.36968800	-0.80192900	0.63984000
C	-4.22977100	1.12572100	-0.86048000

C	-5.40593000	-0.17048200	1.33594800
H	-4.01288500	-1.78452600	0.95203700
C	-5.27253800	1.73596400	-0.15665300
H	-3.75424700	1.63705800	-1.69891000
C	-5.85811700	1.09310300	0.93934600
H	-5.85952100	-0.67332800	2.19388200
H	-5.61596300	2.72693800	-0.46371100
H	-6.66655800	1.58068100	1.48964100
S	2.29113300	0.48541900	1.10904900
C	3.32448900	0.80060200	-0.26102800
S	2.66973700	0.95288400	-1.82800900
C	5.64368900	1.20053700	-1.08896600
C	5.31187000	0.76753500	1.26715600
C	6.70323800	0.10216800	-1.10421700
H	6.12551000	2.17400700	-0.88370800
H	5.12438100	1.25561400	-2.05341500
C	6.38471500	-0.31608600	1.18146400
H	5.77826100	1.72714400	1.55565800
H	4.56119700	0.50428000	2.02217900
H	7.49350100	0.34811700	-1.83047300
H	6.23039100	-0.85305200	-1.41351000
H	6.93931100	-0.37535900	2.13107000
H	5.89380300	-1.29584400	1.00334900
N	4.66541600	0.92870800	-0.03538500
O	7.32850100	-0.04231900	0.16096600

TS-cis-SCSN

C	-0.66264500	3.48085000	0.87736800
C	-0.53999400	2.09222200	0.97808100
C	-1.56175500	1.33144800	1.57100100
C	-2.69888000	1.98965800	2.07288400
C	-2.82515600	3.37493100	1.96219200
C	-1.80705500	4.12517500	1.36074200
H	0.14116900	4.06279300	0.41835100
H	0.35868500	1.59619100	0.61307500
H	-3.48599800	1.39139300	2.53562500
H	-3.72162300	3.87194000	2.34245900
H	-1.90394600	5.21082200	1.27292300
C	-1.52356000	-0.15802100	1.69835700
O	-2.23132000	-0.73416600	2.56479800
C	-0.76895400	-0.98891100	0.84281300
S	-0.91449900	-2.67041100	1.06706800
O	-2.25491000	-3.29633100	0.89978700
C	-0.26962900	-3.14153800	2.68830900

H	-0.41919500	-4.22589500	2.78667300
H	0.79091000	-2.86093700	2.73603900
H	-0.87486500	-2.58331200	3.41256300
C	0.21443100	-3.44969300	-0.07983900
H	1.20153900	-2.97434000	-0.03943600
H	0.24130000	-4.50776700	0.21525600
H	-0.23623600	-3.34117700	-1.07442800
I	-0.66794300	-0.26627000	-1.73758600
C	-2.72427300	0.25794900	-1.40509400
C	-3.14119400	1.54941500	-1.74466000
C	-3.60250700	-0.66270900	-0.82478100
C	-4.46866400	1.92101100	-1.50400500
H	-2.43927700	2.26664600	-2.17578200
C	-4.92611400	-0.27448600	-0.58649000
H	-3.26041300	-1.65441100	-0.52512300
C	-5.36066700	1.01186800	-0.92486100
H	-4.79910800	2.93116100	-1.76014700
H	-5.61657700	-0.98523300	-0.12455400
H	-6.39457400	1.30867200	-0.73025300
S	1.89484600	-0.56753300	1.20488500
C	2.98704000	-0.50745900	-0.13498100
S	2.38791800	-0.98843600	-1.67636400
C	4.82561900	0.33205400	1.31393200
C	5.23098300	0.02782300	-1.06219500
C	5.36891000	1.75367300	1.18101500
H	5.64430100	-0.35714900	1.58484100
H	4.05649700	0.28836400	2.09511100
C	5.76197100	1.45931200	-1.11048500
H	6.06278800	-0.67256000	-0.87241200
H	4.75193000	-0.24042800	-2.01158300
H	5.87713600	2.04767500	2.11207400
H	4.52210000	2.44985000	1.01035300
H	6.56065200	1.53491100	-1.86413200
H	4.93894500	2.14288200	-1.40413400
N	4.26158700	-0.09941200	0.03077200
O	6.31548800	1.85333900	0.13267100

TS'-cis-SCSN

C	2.91030300	-0.05451800	3.27125000
C	1.97676300	0.30118400	2.29364200
C	2.30861300	1.24795900	1.30918100
C	3.58234500	1.84288100	1.33425500
C	4.51631100	1.47983800	2.30513300
C	4.18372100	0.52615100	3.27568300

H	2.63986900	-0.78913300	4.03454500
H	0.98123900	-0.14419200	2.30219400
H	3.82830600	2.58043800	0.56799900
H	5.50931300	1.93742100	2.30436900
H	4.91441300	0.24006700	4.03719400
C	1.37134100	1.66870500	0.22345000
O	1.54666700	2.77557100	-0.36277000
C	0.30316600	0.85861800	-0.20115200
S	-0.80631600	1.48063300	-1.34709900
O	-1.91309200	0.55124100	-1.66888100
C	0.04112200	1.89497700	-2.88190300
H	-0.66962400	2.46947800	-3.49343000
H	0.94307200	2.46864000	-2.63891800
H	0.26624800	0.93252200	-3.35886900
C	-1.45420100	3.07630900	-0.80326200
H	-0.59724400	3.74421200	-0.65336600
H	-2.13123400	3.42580100	-1.59545500
H	-1.98521500	2.88188500	0.13604900
I	0.73576200	-1.70606700	-0.45269800
C	2.71393400	-1.08116700	-1.02037300
C	3.77555200	-1.45519600	-0.18856500
C	2.93537600	-0.31858100	-2.17079400
C	5.07532900	-1.05544000	-0.51608100
H	3.59296900	-2.03386300	0.71921500
C	4.23910300	0.08186400	-2.48533200
H	2.10572300	-0.03215300	-2.81652300
C	5.30823400	-0.28422300	-1.66003100
H	5.90527000	-1.33739700	0.13700600
H	4.41682100	0.68119600	-3.38231300
H	6.32409600	0.03409000	-1.90775400
S	-1.59740600	0.53137300	1.70510700
C	-2.63223700	-0.62565500	0.94652500
S	-2.02591800	-2.21682300	0.71263200
C	-4.37253500	1.09915800	0.57622600
C	-4.65351500	-1.11867500	-0.38931600
C	-5.87296600	1.10982400	0.84761600
H	-4.15538300	1.59222200	-0.38844800
H	-3.84862500	1.64709300	1.36793400
C	-6.14115000	-1.00841100	-0.07958500
H	-4.45290100	-0.78830600	-1.42542700
H	-4.32107700	-2.15926400	-0.29510500
H	-6.24923500	2.14220400	0.78185400
H	-6.06288000	0.73712400	1.87548200
H	-6.71635700	-1.55647400	-0.84140000

H	-6.34747500	-1.46927800	0.90852100
N	-3.86705400	-0.27405800	0.51365900
O	-6.58726500	0.33557000	-0.09680600

INT2-SCSN

C	-1.09777700	3.10811900	2.33094300
C	-0.79929000	2.33448100	1.20615300
C	-0.58196500	2.94927300	-0.03721700
C	-0.64784100	4.34837100	-0.13302000
C	-0.96600400	5.11980100	0.98759100
C	-1.19331400	4.50040800	2.22263900
H	-1.24854300	2.62072600	3.29795000
H	-0.69167200	1.25288200	1.29982300
H	-0.44391900	4.82426400	-1.09513800
H	-1.02923800	6.20790300	0.90034200
H	-1.43374300	5.10377600	3.10228700
C	-0.16151400	2.16976400	-1.25425300
O	0.77574400	2.60586200	-1.94696200
C	-0.84272500	0.94998400	-1.59771100
S	-0.04299000	0.08763600	-2.88690600
O	1.37367800	-0.30328600	-2.68610500
C	-0.15931500	1.02905400	-4.41835600
H	0.30849700	0.42462900	-5.20803400
H	-1.21811900	1.23314000	-4.62837000
H	0.40110500	1.95302100	-4.23404000
C	-1.01740300	-1.37645000	-3.22956600
H	-2.03191400	-1.10973100	-3.54912300
H	-0.46487400	-1.89358000	-4.02635700
H	-1.01825300	-1.97031400	-2.30575900
I	3.33451300	-2.31191300	0.24293500
C	3.23449200	-0.30997700	0.98570300
C	2.74059200	0.70425700	0.15905600
C	3.67606200	-0.04193800	2.28625700
C	2.70697100	2.01568300	0.64929500
H	2.37288800	0.48652500	-0.84495600
C	3.62373800	1.27394900	2.76251100
H	4.05629700	-0.84282800	2.92364900
C	3.14457600	2.30376800	1.94571900
H	2.31868600	2.80161500	-0.00125800
H	3.96311100	1.48887800	3.77961300
H	3.10568000	3.32957300	2.32115800
S	-2.41085600	0.46196900	-1.04800500
C	-2.11996000	-0.81369800	0.25217900
S	-0.60518200	-1.48807300	0.45826900

C	-3.24974000	-2.18968000	1.96712700
C	-4.54695800	-0.50183200	0.80461400
C	-4.33242600	-3.20480700	1.60900600
H	-3.47488600	-1.72894900	2.94411500
H	-2.26447400	-2.66633800	2.01652200
C	-5.58525200	-1.57557900	0.48294300
H	-4.80250000	-0.01267500	1.75996500
H	-4.54504200	0.26638300	0.02387300
H	-4.41730000	-3.95455600	2.41025800
H	-4.04734700	-3.72730000	0.67290400
H	-6.58892900	-1.12497600	0.45674500
H	-5.36757200	-2.00279900	-0.51755600
N	-3.22249100	-1.12400100	0.95479500
O	-5.60128500	-2.59033700	1.46792200

Product-SCSN

C	1.54442800	3.54713900	0.73607400
C	1.46269700	2.15220400	0.69023700
C	2.43190100	1.40957400	-0.00318600
C	3.49177400	2.08379800	-0.63201300
C	3.56193500	3.47833600	-0.60272900
C	2.58618800	4.21390800	0.08115100
H	0.79285600	4.11569600	1.29059500
H	0.66408900	1.63361900	1.22331200
H	4.26012100	1.49897000	-1.14316000
H	4.38319600	3.99369200	-1.10815000
H	2.64332600	5.30547400	0.11121300
C	2.44467800	-0.09678600	-0.02289500
O	3.52643900	-0.68270200	0.14593400
C	1.22669000	-0.82746100	-0.26818800
S	1.43467200	-2.54018600	-0.00708700
O	1.88763500	-2.97763600	1.33215200
C	2.55328800	-3.22364800	-1.24576100
H	2.60581800	-4.30704100	-1.06826500
H	2.16354500	-2.98954800	-2.24573600
H	3.51981500	-2.73972600	-1.06468000
C	-0.12566700	-3.33211200	-0.40383100
H	-0.41411200	-3.14398300	-1.44489300
H	0.05629600	-4.40056500	-0.22126800
H	-0.86478200	-2.93892500	0.30636400
S	-0.24061000	-0.21176900	-0.94737200
C	-1.40392800	0.00795700	0.46822800
S	-1.02153400	-0.57929800	1.98548500
C	-3.65718100	0.82772700	1.07373000

C	-2.88903000	1.14498800	-1.20200300
C	-4.90254100	0.14344200	0.51472900
H	-3.84079600	1.91014000	1.18123200
H	-3.38333200	0.41112700	2.04934000
C	-4.15950100	0.44822700	-1.68965800
H	-3.06848100	2.23045300	-1.12331800
H	-2.07391100	0.98950000	-1.91697300
H	-5.76508500	0.34943800	1.16652100
H	-4.73644200	-0.95306100	0.49240000
H	-4.47310800	0.87963400	-2.65247800
H	-3.94541700	-0.62964100	-1.84248900
N	-2.53951200	0.64505500	0.13648700
O	-5.22680300	0.62354500	-0.77867400

PhI （DCM）

I	-1.56336800	0.00001600	0.00005900
C	0.57038200	0.00017700	-0.00043600
C	1.25824600	1.21868600	0.00007600
C	1.25818200	-1.21877900	-0.00052300
C	2.65836600	1.20987700	-0.00020400
H	0.71543000	2.16596100	-0.00055000
C	2.65787700	-1.21003400	0.00011200
H	0.71492300	-2.16577900	-0.00003500
C	3.35991200	-0.00003400	0.00035100
H	3.19898000	2.16034900	0.00008500
H	3.19853600	-2.16033600	0.00053100
H	4.45287000	-0.00037400	0.00058700

Substrate-OTf (HFIP)

C	0.40060100	3.84287900	-0.53510800
C	0.44731700	2.51304000	-0.10798000
C	-0.30414400	2.10601000	1.00749800
C	-1.08997700	3.04942900	1.69168900
C	-1.15010500	4.37190300	1.24924200
C	-0.40225200	4.77202600	0.13526100
H	0.99977300	4.15333400	-1.39517000
H	1.07766700	1.79893100	-0.63823100
H	-1.65701800	2.73406400	2.57060500
H	-1.77680500	5.09484000	1.77821800
H	-0.44143400	5.80990700	-0.20645000
C	-0.23530600	0.72037700	1.58036600
O	-0.16453400	0.58107900	2.81161100
C	-0.23667200	-0.45677800	0.74194100
S	-0.08833900	-1.94323800	1.63511300

O	-1.18194800	-2.27951300	2.58638200
C	1.49222700	-1.93547400	2.48613500
H	1.50978800	-2.86791000	3.06813600
H	2.27764100	-1.90782000	1.72024800
H	1.50288400	-1.05902000	3.14190800
C	0.10120500	-3.27087000	0.45202000
H	0.93019500	-3.03231600	-0.22841600
H	0.32122900	-4.15618600	1.06569200
H	-0.85933100	-3.39705800	-0.06411900
I	-0.91922600	-0.49797200	-1.21166800
C	-3.04845800	-0.44156400	-0.81795100
C	-3.52804700	-0.77749600	0.44641900
C	-3.88564700	-0.04818000	-1.86323900
C	-4.90985600	-0.71410200	0.66554900
H	-2.85756200	-1.08657500	1.25053800
C	-5.26388800	0.00395900	-1.62293800
H	-3.48490000	0.21981100	-2.84418000
C	-5.77470800	-0.32641900	-0.36310400
H	-5.30527000	-0.97407600	1.65093800
H	-5.93608400	0.31187300	-2.42810900
H	-6.85140900	-0.27963100	-0.18167100
O	1.83885900	-0.15377000	-1.77917500
S	3.08650400	-0.75162800	-1.22703300
O	2.88014000	-1.98572400	-0.42883400
O	4.21410700	-0.79144900	-2.17605500
C	3.66356000	0.49495900	0.05451900
F	2.80619200	0.57882600	1.08073500
F	4.85434600	0.13061100	0.53627300
F	3.77844800	1.70845500	-0.49302600

HSN

S	0.04212700	-2.02854000	-0.28255900
C	1.41592900	-0.87963800	-0.17620300
C	1.32629400	0.46466600	-0.55306500
C	2.63788400	-1.38492100	0.29908200
C	2.44944000	1.29239900	-0.44914000
H	0.38442000	0.87340900	-0.92408000
C	3.75046200	-0.54792700	0.38601300
H	2.72299800	-2.43117300	0.60868100
C	3.68031300	0.80765000	0.01712100
H	2.36033200	2.34255300	-0.74258400
H	4.69514700	-0.95553300	0.75887900
N	-1.28993800	-0.99945100	-0.56904800
C	-1.91043000	-0.27256800	0.42098700

O	-1.54483900	-0.32290400	1.58584300
C	-3.08158100	0.63664200	-0.00916000
C	-4.29605100	0.23867900	0.85222200
C	-2.65162300	2.08099900	0.31987400
C	-3.44810500	0.53293600	-1.49711900
H	-4.61712100	-0.79286400	0.63269500
H	-4.05648600	0.30170500	1.92398100
H	-5.14330800	0.91175800	0.64484400
H	-1.76918200	2.37970600	-0.26972100
H	-3.47069800	2.77990800	0.08601100
H	-2.40068000	2.18380400	1.38633200
H	-4.29208600	1.20635900	-1.71427600
H	-2.61599300	0.83747100	-2.15315000
H	-3.76235900	-0.48624600	-1.77537700
C	4.89337400	1.69607900	0.12601000
H	4.66637200	2.73193000	-0.16845300
H	5.28398800	1.71440400	1.15766300
H	5.71308000	1.33287700	-0.51751900
H	-1.57961400	-0.88401400	-1.53611600

Anion-AcO

C	0.19537600	-0.00052400	-0.00007000
O	0.81804000	-1.09220500	-0.00014100
O	0.70091100	1.15207300	0.00023700
C	-1.35075600	-0.05653300	-0.00007500
H	-1.74205400	0.47430200	0.88544100
H	-1.74227400	0.47770900	-0.88342800
H	-1.73500500	-1.08860600	-0.00190800

AcOH

C	-0.09221200	0.11926400	-0.00013800
O	-0.63178000	1.20549900	0.00012000
O	-0.78386200	-1.03181300	-0.00006300
H	-1.73672200	-0.82049000	0.00014300
C	1.39080100	-0.11802800	-0.00002800
H	1.67254000	-0.70615600	0.88790500
H	1.67231900	-0.70980900	-0.88557100
H	1.92546200	0.83955700	-0.00194100

Anion-OTf (HFIP)

S	0.91676100	0.00001600	-0.00002600
O	1.24368600	-1.42827600	0.21813000
O	1.24527800	0.90278100	1.12751400
O	1.24565200	0.52506200	-1.34547500

C	-0.95741900	0.00030200	-0.00011200
F	-1.43682800	-0.77656800	-0.98146900
F	-1.43779800	1.23828000	-0.18183500
F	-1.43655100	-0.46155700	1.16327500

INT1-SN

C	-3.17329400	1.39679000	-2.03869800
C	-2.42695600	1.09348200	-0.89646800
C	-2.92225500	0.18362300	0.05025200
C	-4.17857100	-0.41168100	-0.15892300
C	-4.91216200	-0.12428200	-1.31154900
C	-4.41168300	0.78281800	-2.25365700
H	-2.78267300	2.12059900	-2.75871400
H	-1.46908100	1.58368500	-0.73398800
H	-4.57144300	-1.10626400	0.58730100
H	-5.88056300	-0.60542700	-1.47304000
H	-4.99016500	1.01417800	-3.15219600
C	-2.21705700	-0.14569800	1.33697100
O	-2.86759500	-0.14182800	2.39511600
C	-0.82794700	-0.53025700	1.36874600
S	-0.29464500	-1.08035700	2.92888600
O	-1.06295000	-2.20540200	3.52238300
C	-0.29464600	0.32414100	4.04542900
H	-0.00302100	-0.06530600	5.03115400
H	0.42787900	1.05942000	3.66713700
H	-1.31860400	0.71442800	4.05554600
C	1.43011000	-1.54614800	2.83093000
H	2.06149000	-0.75778200	2.39190200
H	1.70376400	-1.75574500	3.87522700
H	1.47538800	-2.46952900	2.23709800
I	0.39764000	-0.80022600	-0.27928700
C	-0.58846100	-2.57325400	-1.04315700
C	-0.48176500	-2.84016800	-2.40707500
C	-1.31341600	-3.37847200	-0.16702100
C	-1.13295800	-3.97418900	-2.90888900
H	0.08441600	-2.18480900	-3.07347400
C	-1.95969300	-4.50426400	-0.69077600
H	-1.38542900	-3.13935600	0.89662000
C	-1.87003800	-4.80150500	-2.05528000
H	-1.06676800	-4.20150700	-3.97607500
H	-2.53578700	-5.14856200	-0.02155900
H	-2.38005900	-5.68121200	-2.45580500
S	1.91131900	1.79926200	1.06016900
C	0.68374500	2.85443600	0.33001600

C	0.69400500	3.25952000	-1.01214200
C	-0.37250800	3.27326200	1.16362900
C	-0.34198800	4.06034600	-1.50749600
H	1.50877400	2.93595300	-1.66033400
C	-1.39379400	4.07240500	0.65368900
H	-0.40673600	2.95586500	2.21029500
C	-1.40514400	4.47883400	-0.69376100
H	-0.32190700	4.35995800	-2.55993400
H	-2.21311300	4.37383500	1.31348300
N	2.90342000	1.41693100	-0.30609900
C	3.71417300	0.40213500	-0.03618000
O	3.81285400	-0.20853300	1.06735900
C	4.58306100	-0.09885100	-1.22110800
C	6.05366300	-0.10032100	-0.76522500
C	4.13515200	-1.54304800	-1.52498800
C	4.43589100	0.75631000	-2.48599300
H	6.40392100	0.92479200	-0.55618100
H	6.17599900	-0.69188200	0.15453400
H	6.70725200	-0.52907700	-1.54363600
H	3.08598900	-1.56797200	-1.86758900
H	4.75850800	-1.99062400	-2.31752200
H	4.21115200	-2.17476400	-0.62689500
H	5.09037300	0.36830700	-3.28563600
H	3.40140000	0.74713900	-2.86205100
H	4.71199300	1.80547000	-2.29886700
C	-2.54563400	5.30031300	-1.23810800
H	-2.35170100	5.63144300	-2.26968900
H	-3.48440200	4.71873100	-1.24452500
H	-2.72996200	6.19542800	-0.62043900

TS-trans-SN

C	1.94356300	1.18879300	3.33998100
C	1.26695700	0.54089600	2.30483700
C	1.38435700	1.00856100	0.98422100
C	2.18455700	2.13329000	0.71837700
C	2.86696000	2.77392000	1.75175600
C	2.74695800	2.30271200	3.06533600
H	1.84415100	0.82495800	4.36589600
H	0.63608200	-0.32397000	2.51484400
H	2.26753100	2.48849100	-0.31012000
H	3.49588300	3.64123000	1.53498100
H	3.27973600	2.80488900	3.87745900
C	0.68286000	0.35840600	-0.16228300
O	0.59952400	0.94261400	-1.25019500

C	0.09645100	-0.99232600	0.08855200
S	-0.48356000	-1.67718500	-1.48278600
O	0.45774900	-1.91601300	-2.61796700
C	-1.86307800	-0.69989100	-2.07783000
H	-2.28388600	-1.28084600	-2.91089100
H	-2.60162600	-0.52913800	-1.28321300
H	-1.41711000	0.23846700	-2.42603200
C	-1.21636800	-3.22804300	-0.97981300
H	-1.90739500	-3.02212900	-0.14996600
H	-1.72018300	-3.64919600	-1.86052900
H	-0.38828300	-3.87595900	-0.66017500
I	2.27935700	-2.43231000	0.34108700
C	3.67176000	-1.02033500	-0.43383100
C	3.54318500	-0.59604200	-1.76028300
C	4.64108400	-0.49690500	0.42733600
C	4.42710500	0.37994300	-2.23298800
H	2.75258100	-0.99516500	-2.39777400
C	5.51828600	0.47265300	-0.06915500
H	4.70632200	-0.82256500	1.46701400
C	5.41231900	0.91145800	-1.39364700
H	4.33572200	0.72748600	-3.26535700
H	6.28019600	0.89350200	0.59205800
H	6.09637900	1.67563400	-1.77133600
S	-2.06113300	0.79072800	1.13708800
C	-1.93606400	2.34125400	0.29297200
C	-1.03723400	3.28887400	0.81373200
C	-2.63404900	2.63334400	-0.89244700
C	-0.83217100	4.49846300	0.14801400
H	-0.49984100	3.08513800	1.74258200
C	-2.42358700	3.85014700	-1.53873700
H	-3.33909600	1.90522400	-1.29479100
C	-1.51565000	4.80346700	-1.04022500
H	-0.12647400	5.22142400	0.56723000
H	-2.97502200	4.06526200	-2.45933700
N	-3.55757900	0.23666600	0.56753800
C	-3.81846900	-1.04148300	0.87531500
O	-3.03626900	-1.83637700	1.44982200
C	-5.21135700	-1.56089400	0.43124700
C	-5.89315300	-2.18004800	1.66606000
C	-6.10891900	-0.46296400	-0.15469500
C	-4.97579700	-2.65393500	-0.63093600
H	-5.25741700	-2.95879400	2.11340700
H	-6.08670800	-1.41620600	2.43827800
H	-6.85929100	-2.63462400	1.39055000

H	-5.67434800	-0.02311300	-1.06504200
H	-7.09401900	-0.88355300	-0.42007300
H	-6.27068500	0.35431100	0.56491300
H	-5.93593200	-3.07907100	-0.96842300
H	-4.45888100	-2.24494800	-1.51478300
H	-4.36383000	-3.47433900	-0.22630300
C	-1.27844500	6.09631800	-1.77636400
H	-0.68913900	5.92388700	-2.69456600
H	-2.22714400	6.56164500	-2.09055200
H	-0.72642400	6.82156700	-1.15943100

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C	1.95347900	0.37967200	3.40154800
C	1.25783400	0.13750400	2.21603200
C	1.22469900	1.11708600	1.20667000
C	1.88442300	2.34096100	1.41012400
C	2.58170200	2.57865900	2.59515400
C	2.62029000	1.59667400	3.59220100
H	1.97129100	-0.38318500	4.18439000
H	0.71283500	-0.79805200	2.07802500
H	1.85738000	3.09296400	0.61931800
H	3.10409900	3.52795000	2.73951200
H	3.16862100	1.78038100	4.52023400
C	0.52505500	0.90133600	-0.09834000
O	0.30309600	1.86158300	-0.85367600
C	0.12843800	-0.49402500	-0.41284800
S	-0.46181100	-0.71342800	-2.07799300
O	-0.45235200	-2.15880300	-2.43631300
C	0.38400900	0.18270200	-3.39901600
H	-0.17172500	-0.03108600	-4.32350900
H	0.38949700	1.24984500	-3.14959000
H	1.39975800	-0.22990100	-3.45118000
C	-2.12128700	-0.06551600	-2.12883100
H	-2.07498400	1.02318600	-2.00084600
H	-2.52147700	-0.34974000	-3.11257300
H	-2.67553400	-0.55732300	-1.31355900
I	2.48812700	-1.71510800	-0.78483400
C	3.79422600	-0.06231600	-0.51252800
C	3.82560700	0.94815500	-1.47912200
C	4.55363900	0.01085500	0.65981100
C	4.64297700	2.06151400	-1.25706900
H	3.21998200	0.87873100	-2.38414100
C	5.36920800	1.12908200	0.85949800
H	4.50178800	-0.77667800	1.41347600

C	5.41251300	2.15373300	-0.09248200
H	4.67137300	2.86069300	-2.00242600
H	5.96249800	1.20175800	1.77450600
H	6.04395200	3.02955600	0.07663300
S	-2.03256200	0.34542800	1.28992000
C	-2.94826000	1.67247100	0.57125300
C	-2.32531600	2.93404400	0.55423400
C	-4.23544600	1.52687400	0.02279100
C	-2.98433300	4.02727800	-0.01191300
H	-1.32507600	3.06177600	0.97441900
C	-4.87577400	2.62959300	-0.53660500
H	-4.71647500	0.54852200	0.03768900
C	-4.26648200	3.89934700	-0.56969700
H	-2.48655700	5.00102200	-0.02162400
H	-5.87770700	2.50607800	-0.95938800
N	-2.96023800	-0.98724100	0.85924300
C	-2.47998200	-2.13606500	1.37097300
O	-1.50482900	-2.24417900	2.14634000
C	-3.19329900	-3.42514200	0.89265700
C	-3.57329200	-4.25461000	2.13230000
C	-4.44669900	-3.15136900	0.05184400
C	-2.15991600	-4.19516900	0.04332800
H	-2.69318100	-4.43546200	2.76710800
H	-4.33024000	-3.73312400	2.74245100
H	-3.99253600	-5.23007100	1.83417500
H	-4.20807500	-2.59389900	-0.86646600
H	-4.91785000	-4.10418700	-0.24405200
H	-5.19137300	-2.56643400	0.61418600
H	-2.59044900	-5.13785300	-0.33470000
H	-1.82846900	-3.59473300	-0.81918800
H	-1.26728000	-4.43916700	0.64016000
C	-4.98158200	5.07227200	-1.18687800
H	-5.19486400	4.88945900	-2.25421900
H	-5.95421200	5.24881000	-0.69665900
H	-4.39001600	5.99714600	-1.11283600

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C	-3.40670300	1.63207100	-0.83280100
C	-2.37159900	1.07507900	-0.07819900
C	-2.62664300	0.03966500	0.83286500
C	-3.94699600	-0.42476700	0.97525500
C	-4.98084600	0.12172000	0.21301300
C	-4.71441700	1.15497800	-0.69393500
H	-3.18664400	2.44215200	-1.53297700

H	-1.35958200	1.44841400	-0.19958500
H	-4.14721700	-1.22950800	1.68537100
H	-5.99918600	-0.26065400	0.32451800
H	-5.52394200	1.58672400	-1.28887500
C	-1.57220700	-0.61151700	1.67462300
O	-1.93402700	-1.22704700	2.72480500
C	-0.20245700	-0.61311300	1.34882600
S	0.84435500	-1.50893100	2.35792800
O	2.23995200	-1.53742400	1.84790600
C	0.32186900	-3.21971400	2.58524100
H	0.91574000	-3.62098600	3.41875300
H	-0.75396300	-3.24980900	2.78844300
H	0.59157800	-3.72523400	1.64879200
C	0.83746900	-0.82763500	4.02606200
H	-0.19209100	-0.86895400	4.40185200
H	1.53111800	-1.43373500	4.62633600
H	1.19642100	0.20600500	3.93486500
I	0.46486200	-0.88701100	-1.26186700
C	-1.36689800	-1.97188900	-1.41829900
C	-2.36541300	-1.46724200	-2.25948100
C	-1.56682300	-3.14574900	-0.68568900
C	-3.58391600	-2.14666100	-2.35630000
H	-2.20816500	-0.54409400	-2.82016000
C	-2.79287400	-3.81307400	-0.78650500
H	-0.78386900	-3.54035900	-0.03921800
C	-3.80213300	-3.31443000	-1.61669200
H	-4.37014500	-1.74957800	-3.00372800
H	-2.95501600	-4.72803700	-0.21033300
H	-4.76015800	-3.83596300	-1.68749100
S	1.73384300	1.39954500	1.18159200
C	0.62026500	2.65025500	0.63687100
C	0.53404300	3.08051600	-0.69433800
C	-0.23366800	3.19969400	1.61257200
C	-0.42002600	4.03890100	-1.04467300
H	1.20042300	2.65244200	-1.44347000
C	-1.17692600	4.15230000	1.24293400
H	-0.17469300	2.86484200	2.65221600
C	-1.29702500	4.58342900	-0.09298900
H	-0.49000600	4.36236700	-2.08706300
H	-1.84807900	4.56352700	2.00242100
N	2.44635400	0.90208100	-0.22688800
C	3.73812600	0.45611700	-0.07643200
O	4.37525800	0.49209100	0.98028100
C	4.41419300	-0.10954800	-1.35054700

C	5.89441000	0.31568900	-1.32699200
C	4.33093100	-1.64852700	-1.26518100
C	3.77460700	0.39167600	-2.65381500
H	5.99522800	1.41330800	-1.36243700
H	6.39637900	-0.03891800	-0.41554200
H	6.42307600	-0.10193100	-2.19922200
H	3.29023100	-2.00376100	-1.30019500
H	4.87483500	-2.10714900	-2.10791300
H	4.78121800	-2.01234900	-0.32786200
H	4.34579800	0.01359900	-3.51817200
H	2.73689400	0.05238300	-2.77565500
H	3.77569800	1.49228800	-2.70258500
C	-2.34951100	5.58967500	-0.47439700
H	-2.19488800	6.54635600	0.05376400
H	-2.34779400	5.79315800	-1.55560700
H	-3.35500600	5.23230800	-0.19434100

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C	-2.67132600	1.68158100	-1.86654600
C	-1.88212100	1.20695000	-0.81645100
C	-2.45624700	0.49034900	0.24419100
C	-3.84535000	0.26527200	0.23173200
C	-4.63331100	0.72465200	-0.82486200
C	-4.04876700	1.43674000	-1.87912000
H	-2.20447600	2.24689200	-2.67751100
H	-0.81514400	1.40815800	-0.82087100
H	-4.29698700	-0.28860100	1.05675600
H	-5.70840900	0.52540600	-0.82713200
H	-4.66524700	1.80142300	-2.70535900
C	-1.68952300	-0.06911700	1.40443200
O	-2.30440300	-0.28112800	2.48704600
C	-0.33030600	-0.46458500	1.34675600
S	0.19282600	-1.36777500	2.70044800
O	-0.57816800	-2.59161600	3.07337300
C	0.31437400	-0.31864300	4.16585200
H	0.67869600	-0.95454200	4.98501400
H	1.00683200	0.50749200	3.95848400
H	-0.70446500	0.03917200	4.35382500
C	1.88309800	-1.87629400	2.41298400
H	2.55830800	-1.02766100	2.24706300
H	2.15723100	-2.43210200	3.32062100
H	1.87130700	-2.54821300	1.54501400
I	0.54188100	-1.34970500	-1.03110100
C	-1.37571900	-2.28981400	-1.10260200

C	-2.16996500	-2.04682500	-2.22782900
C	-1.83107200	-3.07298700	-0.03903600
C	-3.45229700	-2.60330100	-2.28413600
H	-1.80839600	-1.41589600	-3.04223900
C	-3.11718800	-3.62041100	-0.11087000
H	-1.22020400	-3.22729700	0.85067000
C	-3.92785700	-3.38652400	-1.22693900
H	-4.08431300	-2.40750500	-3.15434000
H	-3.48609900	-4.22749800	0.72026200
H	-4.93459100	-3.81013000	-1.26996100
S	1.78484200	1.32379600	1.16929500
C	0.74925400	2.66367200	0.67998800
C	0.89011800	3.32764300	-0.54768700
C	-0.25848200	3.04924500	1.58018000
C	0.00154900	4.35033300	-0.87752100
H	1.67714800	3.02534000	-1.23935700
C	-1.13542700	4.07493700	1.23153400
H	-0.37712500	2.53146000	2.53552000
C	-1.03406700	4.73399500	-0.00641800
H	0.10962900	4.85929500	-1.83971000
H	-1.92992700	4.35584100	1.92834400
N	2.46114800	0.83522500	-0.26765200
C	3.62939900	0.13931000	-0.12758500
O	4.13933700	-0.19342200	0.95454500
C	4.36032700	-0.22499700	-1.44171400
C	5.77775300	0.37576400	-1.33814900
C	4.46125300	-1.76187600	-1.50973900
C	3.67028100	0.31494400	-2.70124600
H	5.73963000	1.47606100	-1.27172900
H	6.30145000	-0.00124800	-0.44708000
H	6.37115500	0.11022800	-2.22832400
H	3.46786800	-2.22825900	-1.60776700
H	5.06475900	-2.06869600	-2.37969400
H	4.93658600	-2.16156800	-0.60075700
H	4.25124300	0.02840100	-3.59393800
H	2.65303100	-0.08586500	-2.82281400
H	3.59679500	1.41305600	-2.68387000
C	-2.03351600	5.78555300	-0.40878200
H	-2.44531700	6.31317100	0.46545900
H	-1.59057600	6.52897900	-1.08981400
H	-2.88409400	5.32210600	-0.94092400

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C	2.21287100	2.45923900	1.61386900

C	1.60960700	1.53029900	0.76278500
C	1.10775000	1.93412900	-0.48380200
C	1.22274400	3.27879800	-0.87121000
C	1.80500600	4.21080000	-0.01130300
C	2.30351500	3.80198700	1.23279000
H	2.61390100	2.13133600	2.57630000
H	1.54191500	0.48391400	1.06339900
H	0.83480800	3.58512500	-1.84506400
H	1.87157900	5.26044900	-0.30964200
H	2.76483900	4.53185700	1.90356700
C	0.47999000	0.96303900	-1.44425400
O	0.66304000	1.10890000	-2.66081000
C	-0.30392500	-0.12247300	-0.88907000
S	-0.61215600	-1.44701200	-1.94957500
O	0.50632500	-1.72324900	-2.88785800
C	-2.09753500	-1.20630000	-2.93016000
H	-2.23289300	-2.09976000	-3.55611600
H	-2.93345400	-1.03167200	-2.24120400
H	-1.88342400	-0.31860000	-3.54191800
C	-0.86510400	-2.92817300	-0.97274100
H	-1.39777300	-2.75904200	-0.02930400
H	-1.39664300	-3.64020600	-1.61877800
H	0.15894400	-3.27157400	-0.77175000
I	2.50898700	-2.55791300	1.20750600
C	3.61880700	-1.08396600	0.13525400
C	3.27302100	-0.80311800	-1.18916500
C	4.62723300	-0.37122700	0.79191700
C	3.94369400	0.22546600	-1.86072800
H	2.46949300	-1.34448900	-1.68839600
C	5.29077300	0.65130500	0.10383800
H	4.88531100	-0.59292300	1.82933800
C	4.94856300	0.95506600	-1.21835600
H	3.65200600	0.46696000	-2.88588700
H	6.07399800	1.21868300	0.61404400
H	5.46124800	1.76429200	-1.74470200
S	-1.32664600	0.06525300	0.59278400
C	-1.73224200	1.81930200	0.52387900
C	-1.43500300	2.59670900	1.64218500
C	-2.33061900	2.37353400	-0.61326800
C	-1.72578800	3.96423900	1.61171500
H	-0.96255100	2.15252900	2.52090400
C	-2.61293300	3.73599700	-0.62496900
H	-2.55592100	1.74847500	-1.47917500
C	-2.30929500	4.55547800	0.48136200

H	-1.48322000	4.58052400	2.48140700
H	-3.07337000	4.18021400	-1.51202100
N	-2.83048400	-0.55479400	0.12225200
C	-3.25521700	-1.60206300	0.86480100
O	-2.58884400	-2.23600500	1.70301700
C	-4.69360600	-2.06941200	0.52372300
C	-5.40006100	-2.44500700	1.83771600
C	-5.51332700	-1.00482100	-0.21879400
C	-4.54230900	-3.32181000	-0.36524200
H	-4.83260500	-3.20819300	2.38982800
H	-5.51269400	-1.56562800	2.49355600
H	-6.40607700	-2.84414400	1.62941300
H	-5.08060100	-0.76660500	-1.20127600
H	-6.54119200	-1.37000500	-0.38239200
H	-5.57133800	-0.06732400	0.35678900
H	-5.53320800	-3.74101200	-0.60670700
H	-4.03869600	-3.07734000	-1.31453400
H	-3.95486700	-4.10166200	0.14426300
C	-2.58607500	6.03376400	0.42561400
H	-1.89474900	6.52946900	-0.27806000
H	-3.60785500	6.23519300	0.06451800
H	-2.46439900	6.51042100	1.40955600

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C	3.52906600	-1.21478000	2.39044400
C	2.39101100	-1.56869600	1.65983700
C	2.40316400	-1.50031500	0.25748400
C	3.57226800	-1.09319500	-0.40541100
C	4.70096500	-0.72191700	0.32556700
C	4.68046400	-0.78023700	1.72552900
H	3.51579000	-1.27656800	3.48179100
H	1.49180000	-1.90859300	2.17957100
H	3.57469200	-1.04810400	-1.49664800
H	5.59996400	-0.38149400	-0.19505500
H	5.56568600	-0.48956000	2.29771000
C	1.19985200	-1.86610200	-0.56646000
O	1.35497200	-2.47552700	-1.63170600
C	-0.09536900	-1.47297600	-0.04534200
S	-1.45951400	-2.31263800	-0.67928500
O	-1.15058600	-3.71640700	-1.04251000
C	-2.16494900	-1.50592400	-2.11949500
H	-3.03718100	-2.09294000	-2.44114500
H	-2.41693300	-0.47467800	-1.84406100
H	-1.36173900	-1.53767700	-2.86976500

C	-2.73210000	-2.35510500	0.58225700
H	-2.85644900	-1.41174400	1.12591400
H	-3.66012500	-2.65991400	0.07917800
H	-2.38005000	-3.14421200	1.26199600
S	-0.34745600	0.07928400	0.85035100
C	0.91232300	1.12931000	0.10586000
C	1.82018600	1.75571200	0.95851900
C	0.96872500	1.30937200	-1.28098100
C	2.81739600	2.56602300	0.40644800
H	1.77058200	1.60198500	2.03864200
C	1.96776800	2.11959500	-1.81169700
H	0.24900900	0.80963500	-1.93194000
C	2.91267800	2.75489700	-0.98018500
H	3.53924500	3.04973100	1.06961000
H	2.02403400	2.26121400	-2.89470000
N	-1.71258700	0.74097200	0.09636200
C	-2.75438600	0.94632500	0.93331500
O	-2.84188700	0.57085200	2.11631000
C	-3.96968300	1.64228100	0.26812600
C	-4.52667100	2.67920400	1.25848000
C	-3.62698600	2.32844100	-1.06140700
C	-5.01610200	0.53373600	0.02532400
H	-4.77374000	2.21213500	2.22284700
H	-3.79413800	3.48166400	1.44816300
H	-5.44030700	3.14357300	0.85287800
H	-3.30477500	1.60596100	-1.82524500
H	-4.51534000	2.85390500	-1.45033900
H	-2.81996600	3.06779300	-0.93975600
H	-5.93310200	0.96104700	-0.41325200
H	-4.63192500	-0.22909400	-0.67149900
H	-5.28688000	0.03130900	0.96709100
C	4.00799700	3.59276900	-1.58333900
H	4.72541500	2.95625500	-2.13004400
H	3.60331100	4.31478100	-2.31132200
H	4.56706600	4.14860700	-0.81618300

PhI（HFIP）

I	-1.56335700	0.00000000	-0.00001500
C	0.57023900	-0.00001200	0.00004600
C	1.25815000	-1.21871400	0.00010900
C	1.25820400	1.21875100	0.00013600
C	2.65806800	-1.20991000	0.00003600
H	0.71572500	-2.16639300	-0.00006000
C	2.65803500	1.20992300	-0.00003200

H	0.71564300	2.16635700	0.00004900
C	3.35995600	-0.00003300	-0.00013000
H	3.19873600	-2.16037700	-0.00002900
H	3.19884700	2.16031100	0.00000000
H	4.45307800	0.00005800	-0.00013900

INT1-SPhMe

C	-1.34052400	3.69743900	-1.17227900
C	-0.68093000	2.57015500	-0.67462200
C	-0.94535100	2.11302600	0.62801400
C	-1.87357700	2.80918500	1.42201700
C	-2.54612300	3.92271600	0.91560500
C	-2.28006400	4.37031900	-0.38379800
H	-1.11781700	4.05014400	-2.18276800
H	0.04883900	2.05822600	-1.30398400
H	-2.06682500	2.46193000	2.43940000
H	-3.27821600	4.44502000	1.53724600
H	-2.80203800	5.24550900	-0.78023300
C	-0.24647900	0.94384500	1.26642700
O	0.08133300	1.02599800	2.46445000
C	0.03105500	-0.26772800	0.54096300
S	0.76865300	-1.50561900	1.50386600
O	-0.01057300	-2.04403300	2.65384900
C	2.36513400	-0.92789200	2.08973900
H	2.69092200	-1.68913600	2.81256700
H	3.04667400	-0.86525300	1.23497300
H	2.20649800	0.04008400	2.57437100
C	1.20406800	-2.85365100	0.40856300
H	1.68293700	-2.46574400	-0.50252900
H	1.88055400	-3.49130600	0.99473400
H	0.27424100	-3.39304700	0.18274000
I	-0.91988800	-0.81771100	-1.23979500
C	-2.90896700	-0.98283600	-0.27127100
C	-3.04545200	-1.26919500	1.08733000
C	-4.01943300	-0.78314600	-1.09401700
C	-4.33320000	-1.35377400	1.63269800
H	-2.17052500	-1.42685000	1.72146500
C	-5.30174700	-0.87356700	-0.53697900
H	-3.89910400	-0.55071100	-2.15656200
C	-5.45857500	-1.15655000	0.82434200
H	-4.45231700	-1.57651000	2.69679200
H	-6.17864600	-0.71376800	-1.17057000
H	-6.46039100	-1.22184000	1.25693800
S	1.72715300	-0.54724800	-2.57615300

C	2.97460700	-0.06065200	-1.41969900
C	4.09219000	-0.89174400	-1.17265600
C	2.94201400	1.17636300	-0.73508800
C	5.11257000	-0.50509700	-0.29856700
H	4.15870100	-1.85553100	-1.68476800
C	3.95944600	1.55178100	0.14359700
H	2.10442800	1.85557600	-0.89789500
C	5.06858700	0.72211500	0.38494200
H	5.96047100	-1.17877800	-0.13801400
H	3.88845400	2.51622100	0.65708900
C	6.14173500	1.11818800	1.36739300
H	5.84609500	0.87001000	2.40307800
H	7.09056500	0.59588600	1.16714400
H	6.33570300	2.20288500	1.34222300

TS-trans-SPhMe

C	-0.01715700	2.42959300	-2.60823300
C	-0.09920000	1.16301800	-2.03121900
C	0.34274400	0.95393100	-0.71338900
C	0.88032200	2.03205600	0.00663000
C	0.96214500	3.30205600	-0.57060600
C	0.51086200	3.50481900	-1.87812600
H	-0.36007900	2.58220100	-3.63510400
H	-0.48851800	0.32244200	-2.60631300
H	1.22266200	1.86177900	1.02856600
H	1.37654200	4.13507400	0.00333500
H	0.57184400	4.49732700	-2.33296700
C	0.24225000	-0.36633800	-0.01686500
O	0.82383300	-0.54042300	1.06674600
C	-0.66452900	-1.39444900	-0.59986400
S	-0.83851800	-2.83281600	0.42625100
O	-1.87421200	-3.73640600	-0.14160200
C	-1.22777900	-2.58030500	2.17385600
H	-1.13643300	-3.56035300	2.66479600
H	-0.52395600	-1.84591400	2.58301700
H	-2.26615200	-2.22556800	2.20852400
C	0.75931100	-3.63436000	0.49086300
H	1.42064800	-3.01228200	1.10586300
H	0.56841600	-4.61879000	0.94373800
H	1.13616200	-3.70188600	-0.53716300
I	-2.90264700	-0.52761400	-0.53974800
C	-2.65819300	1.21894400	0.65984300
C	-2.34029400	1.08597600	2.01414400
C	-2.73317400	2.46347200	0.02721800

C	-2.09174700	2.24735700	2.75367700
H	-2.27556000	0.10582000	2.48627400
C	-2.49030600	3.61125200	0.78787800
H	-2.95504800	2.54094200	-1.03826100
C	-2.16590300	3.50473100	2.14482800
H	-1.83630000	2.16192500	3.81301800
H	-2.54086700	4.59143400	0.30725600
H	-1.96428200	4.40588400	2.72933800
S	2.21347800	-1.55342500	-1.92009500
C	3.35844200	-0.77807200	-0.85074100
C	3.74147700	0.57585500	-1.03460500
C	3.91999900	-1.44618400	0.26727600
C	4.62604300	1.20993200	-0.16248600
H	3.32234300	1.12940100	-1.87843300
C	4.80153600	-0.80263100	1.13711900
H	3.65252600	-2.49109500	0.44520600
C	5.17688100	0.53893100	0.94450500
H	4.89017500	2.25785400	-0.34011700
H	5.20987200	-1.35541600	1.98994300
C	6.15667100	1.22151200	1.86545400
H	6.11902500	0.80274900	2.88390500
H	7.19569500	1.10376300	1.50601400
H	5.96282500	2.30419200	1.93362800

TS'-trans-SPhMe

C	0.27169300	2.21764800	-2.88769300
C	0.08292900	1.01128400	-2.21334900
C	0.42776600	0.89718200	-0.85579700
C	0.97724700	2.00591100	-0.19313700
C	1.16272600	3.21575400	-0.86665500
C	0.80808700	3.32519300	-2.21485100
H	0.00518200	2.29660800	-3.94511300
H	-0.31573600	0.14378900	-2.74007800
H	1.24487100	1.90845400	0.86023700
H	1.58444500	4.07446100	-0.33754600
H	0.95206300	4.27029400	-2.74581600
C	0.20863000	-0.34959400	-0.05754100
O	0.71787200	-0.46325600	1.06683000
C	-0.73951500	-1.37031100	-0.60271800
S	-1.01718100	-2.64381700	0.64120900
O	-1.67558900	-2.34854300	1.95021300
C	0.53985500	-3.49046200	0.92521200
H	0.27744100	-4.46952900	1.35110500
H	1.09403700	-3.54725900	-0.02378900

H	1.07138500	-2.86087900	1.64726000
C	-2.00068100	-3.86646400	-0.22364300
H	-1.45529300	-4.19576600	-1.11784700
H	-2.16114800	-4.69110000	0.48507700
H	-2.95874300	-3.40067700	-0.49114100
I	-2.89113700	-0.27603200	-0.62240900
C	-2.52005300	1.32328400	0.74142100
C	-2.14294400	1.02145200	2.05241100
C	-2.57405300	2.63203500	0.25436400
C	-1.82192900	2.08264500	2.90591400
H	-2.07350700	-0.01422400	2.38904600
C	-2.25617300	3.67631500	1.12864900
H	-2.84092100	2.83917100	-0.78357700
C	-1.88007600	3.40373000	2.44863000
H	-1.51923000	1.86739500	3.93392800
H	-2.29152600	4.70686400	0.76629900
H	-1.62349300	4.22539700	3.12203100
S	2.13922800	-1.88176400	-1.73995700
C	3.28310000	-1.02292300	-0.73040700
C	3.75126800	0.26735100	-1.08252500
C	3.76010900	-1.55517000	0.49516300
C	4.63277600	0.97508900	-0.26296500
H	3.40425200	0.71567200	-2.01680600
C	4.63781900	-0.84020900	1.30923800
H	3.43045400	-2.55020800	0.80453700
C	5.09345800	0.44302400	0.95317700
H	4.96391800	1.97166500	-0.57321500
H	4.97926900	-1.28714700	2.24931100
C	6.02424600	1.21151200	1.85702500
H	5.52437100	1.49632800	2.80016600
H	6.90687200	0.61123100	2.13720300
H	6.38253700	2.13720500	1.38049600

TS-cis-SPhMe

C	-1.43328000	3.01450400	-1.80698100
C	-0.71587600	1.97118800	-1.21492000
C	-0.78027800	1.77121300	0.17501600
C	-1.56003500	2.63998300	0.95893600
C	-2.28620200	3.67207400	0.36330600
C	-2.22697700	3.86023300	-1.02331200
H	-1.37275300	3.16798300	-2.88803500
H	-0.08316300	1.31877800	-1.82181400
H	-1.60395800	2.47997600	2.03798500
H	-2.90522200	4.32910800	0.98024200

H	-2.79643900	4.66758100	-1.49209700
C	-0.06608400	0.66068300	0.87616500
O	0.21830400	0.77691600	2.09888000
C	0.29443900	-0.53384900	0.20212900
S	0.89944500	-1.80020700	1.18550100
O	0.04860000	-2.35638000	2.28088600
C	2.47424900	-1.28215800	1.89114100
H	2.79683400	-2.11350100	2.53428100
H	3.17946100	-1.09292400	1.07317000
H	2.26385800	-0.37868100	2.47276800
C	1.36650400	-3.12832900	0.07995000
H	1.90717200	-2.70198500	-0.77753700
H	1.98118200	-3.81526200	0.67791900
H	0.43812200	-3.62411200	-0.23435400
I	-1.60817100	-1.47818300	-1.20798700
C	-3.04270200	-0.60528700	0.09439300
C	-3.99657500	0.26571700	-0.43871000
C	-2.94435600	-0.86355200	1.46435300
C	-4.88955500	0.88919500	0.43890700
H	-4.03685700	0.47187900	-1.50966400
C	-3.84290500	-0.22155600	2.32369900
H	-2.16730200	-1.52117400	1.85818900
C	-4.81285800	0.64908700	1.81528700
H	-5.63862600	1.57783100	0.03974800
H	-3.77502400	-0.40424300	3.39929200
H	-5.50765100	1.14852400	2.49523500
S	1.93058100	-0.44052600	-2.22709000
C	3.19478900	0.23434700	-1.22590000
C	4.43926500	-0.42659800	-1.05676300
C	3.00393500	1.43588200	-0.50255500
C	5.42220600	0.08460100	-0.21198000
H	4.61983000	-1.36007600	-1.59699200
C	3.98877400	1.92833300	0.35714400
H	2.06381000	1.97884500	-0.61026400
C	5.21724400	1.26903100	0.52301300
H	6.37067100	-0.45258700	-0.10669700
H	3.79550000	2.85142500	0.91287100
C	6.28775700	1.79830200	1.44262800
H	6.60652100	1.03278800	2.17080800
H	7.19073600	2.09429200	0.87989800
H	5.94184700	2.67839700	2.00600000

TS'-cis-SPhMe

C	-1.34777800	3.03518300	-1.60410900

C	-0.67123800	1.94037300	-1.05885900
C	-0.69456500	1.71534500	0.32894300
C	-1.39656600	2.60907100	1.15668300
C	-2.08537400	3.69163400	0.60754500
C	-2.06326700	3.90774000	-0.77615300
H	-1.31738600	3.20749500	-2.68361600
H	-0.09824100	1.26608500	-1.70033400
H	-1.40614200	2.43261900	2.23423200
H	-2.64470300	4.36847700	1.25919600
H	-2.60115800	4.75655500	-1.20741500
C	0.00351200	0.56331000	0.97838700
O	0.37866200	0.65865600	2.18741600
C	0.23913300	-0.63235900	0.27846100
S	0.95175200	-1.95872700	1.09609800
O	1.04917100	-3.17248700	0.24790700
C	0.03861700	-2.38717600	2.58679000
H	0.63899800	-3.12485000	3.13817900
H	-0.12905000	-1.46965500	3.16378500
H	-0.89993300	-2.83622800	2.23583300
C	2.57443200	-1.48468500	1.69746200
H	2.46786900	-0.54755300	2.25647000
H	2.93102900	-2.31260800	2.32709300
H	3.19469100	-1.36350000	0.80185100
I	-1.61089900	-1.55455000	-1.13629200
C	-3.11008200	-0.48805900	-0.07948100
C	-3.82778400	0.50510100	-0.75308400
C	-3.29915800	-0.74918600	1.28047300
C	-4.76395900	1.25444400	-0.03433900
H	-3.65164900	0.70648000	-1.81065600
C	-4.23358100	0.01895600	1.98363500
H	-2.72637000	-1.52424700	1.78960100
C	-4.96346600	1.01739400	1.33042500
H	-5.32749100	2.03867600	-0.54597700
H	-4.38659000	-0.16902400	3.04949000
H	-5.68859500	1.61605600	1.88739600
S	1.87801600	-0.56442000	-2.11686100
C	3.18204300	0.19348000	-1.23620200
C	4.45261900	-0.42931100	-1.12053300
C	3.00605100	1.41783200	-0.54604800
C	5.47176900	0.13496200	-0.35666000
H	4.61972100	-1.38155400	-1.63153600
C	4.02799200	1.96373400	0.23363400
H	2.04749900	1.93404300	-0.61210500
C	5.28125200	1.33947100	0.34827200

H	6.43729000	-0.37734100	-0.29001600
H	3.84543900	2.90178000	0.76786600
C	6.39320900	1.93857700	1.17008100
H	7.14033800	2.44033600	0.52851600
H	6.01526600	2.68861100	1.88221600
H	6.93500400	1.16649500	1.74108800

Referee comments: In the reaction involving NaOAc and HFIP, why does one more thiol add to the ylide? Can the authors provide insight into the kinetics of the two thiol addition steps using DFT?

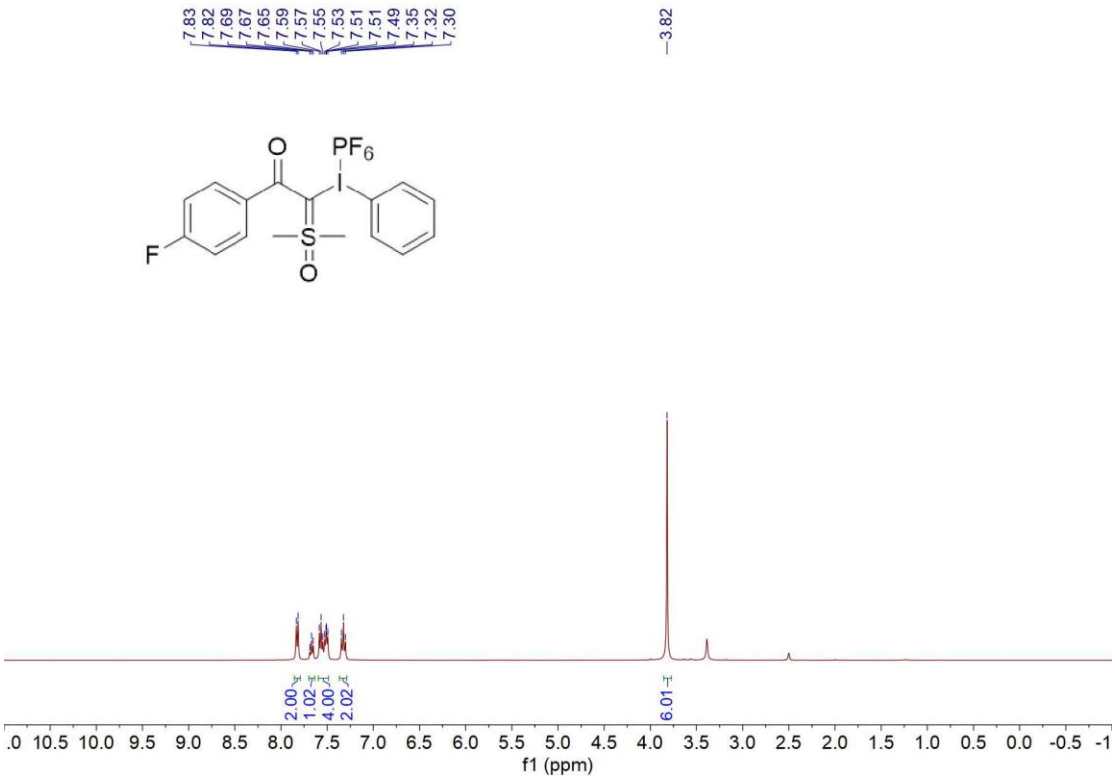
Thanks reviewer No. 2 very valuable comments, as for the two thiol addition steps, we have conducted part of DFT calculations, The nucleophilic addition reaction mechanism of single molecule thiophenol with $I^{(III)}/S^{(VI)}$-mixed ylides was similar to the formation mechanism of product **3a** and **8a**. However, for the second addition reaction of another thiophenol molecule, we have not yet determined the key intermediate transition state. We currently speculated that the reaction solvent HFIP promotes the formation of the α,α-S,S-substituted ketones product **5**. We have added the corresponding results in the revised supporting information, thanks!

Referee comments: Does the counterion of the mixed ylide play any role in this reaction. The DFT study suggests there is an anion exchange process.

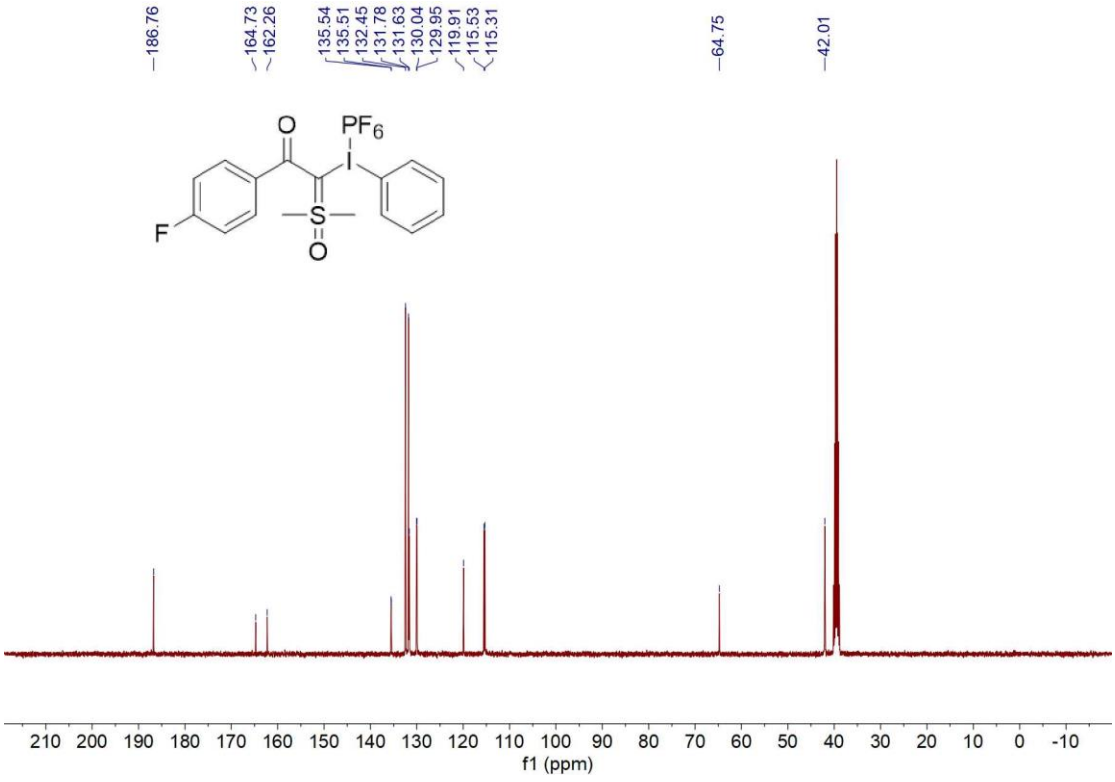
Thanks reviewer No. 2 very valuable comments, we consider that the counterion of the mixed ylide are only used as ligands to stabilize the ylide substrate. The calculation results have shown that the dissociation of anions and the coordination of nucleophiles is a thermodynamically induced process, we have added the corresponding results in the revised supporting information, thanks!

6. NMR Spectra for New Compounds

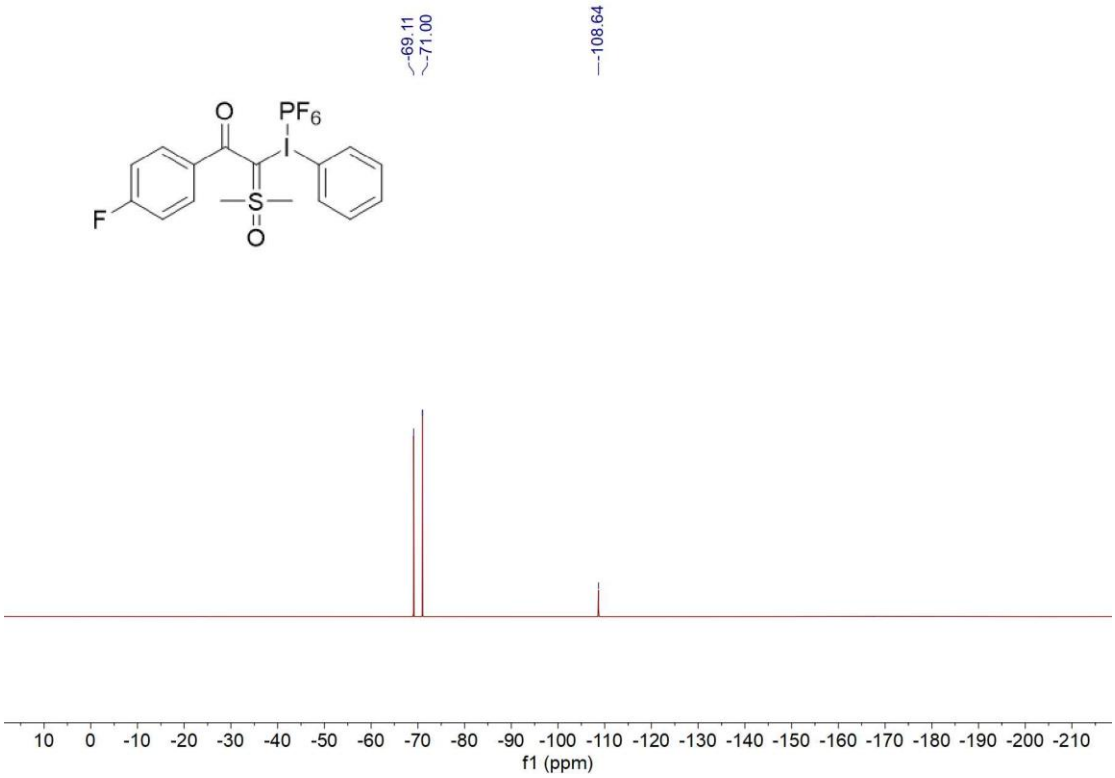
^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **1b**



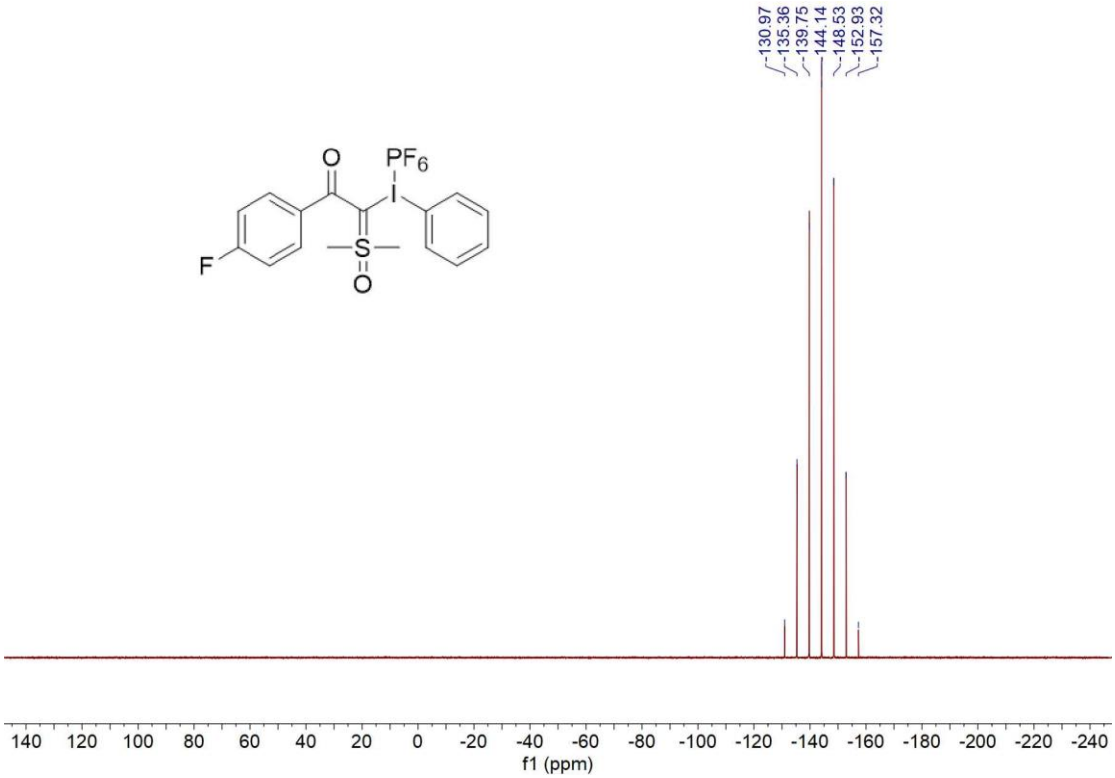
^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **1b**



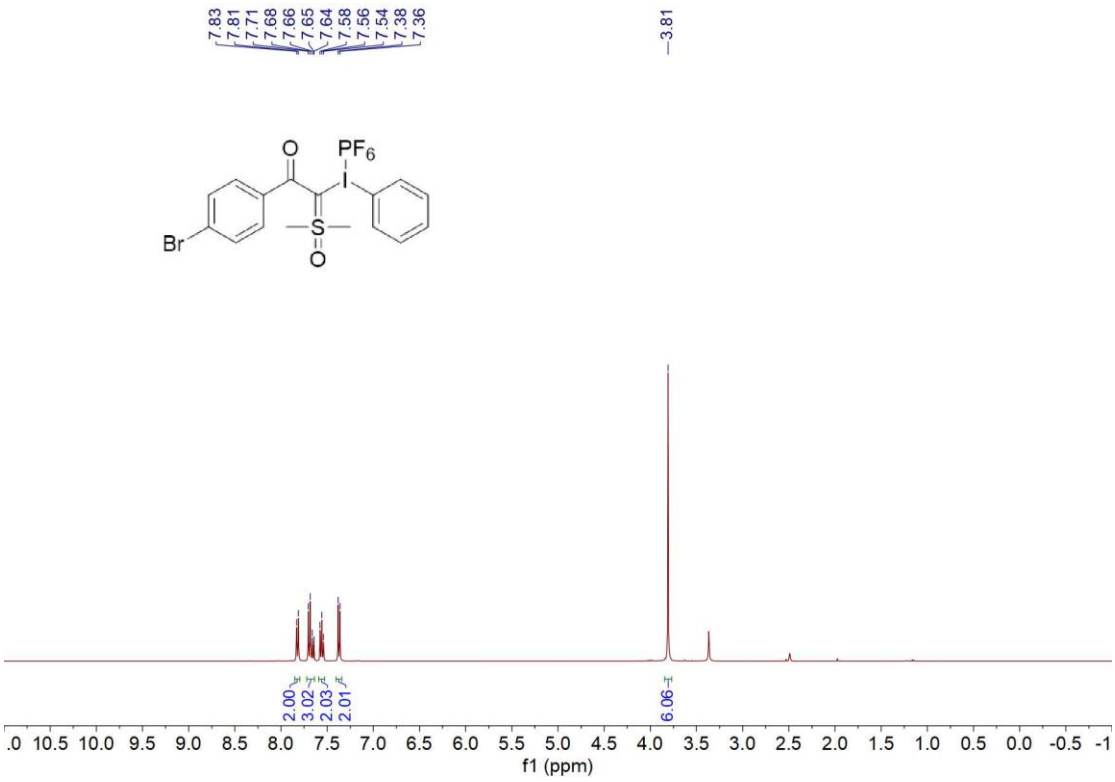
^{19}F NMR (376 MHz, DMSO-d_6) Spectra of **1b**



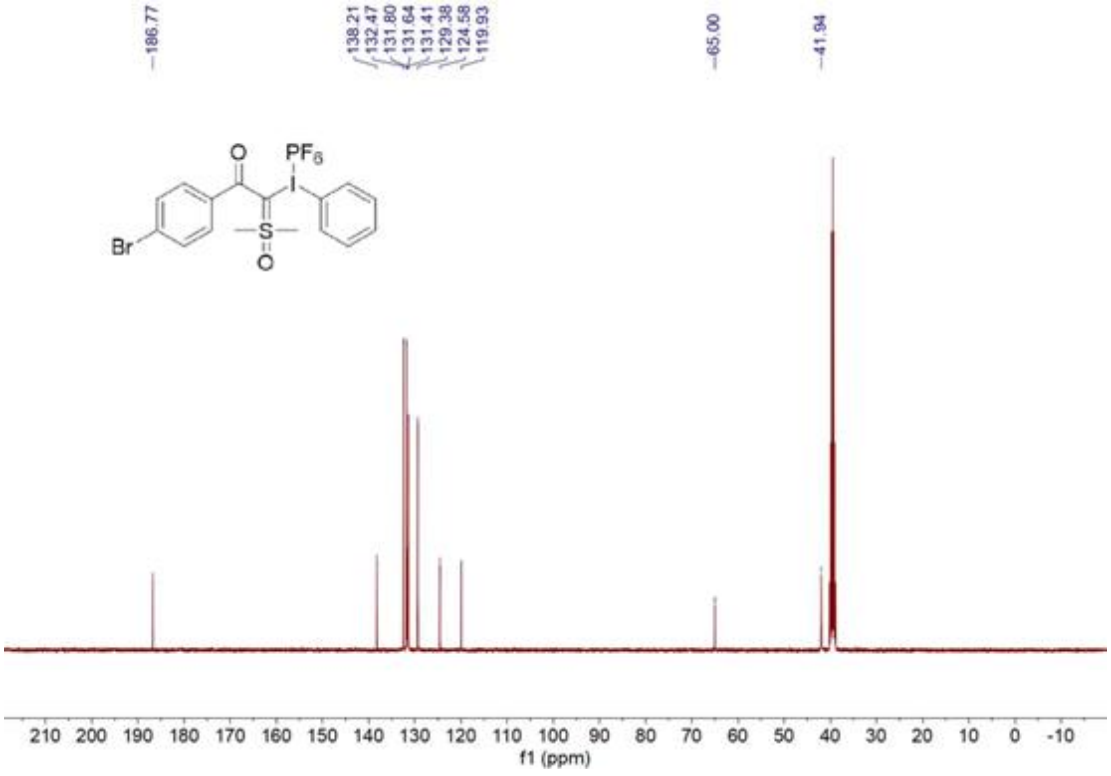
^{31}P NMR (162 MHz, DMSO-d_6) Spectra of **1b**



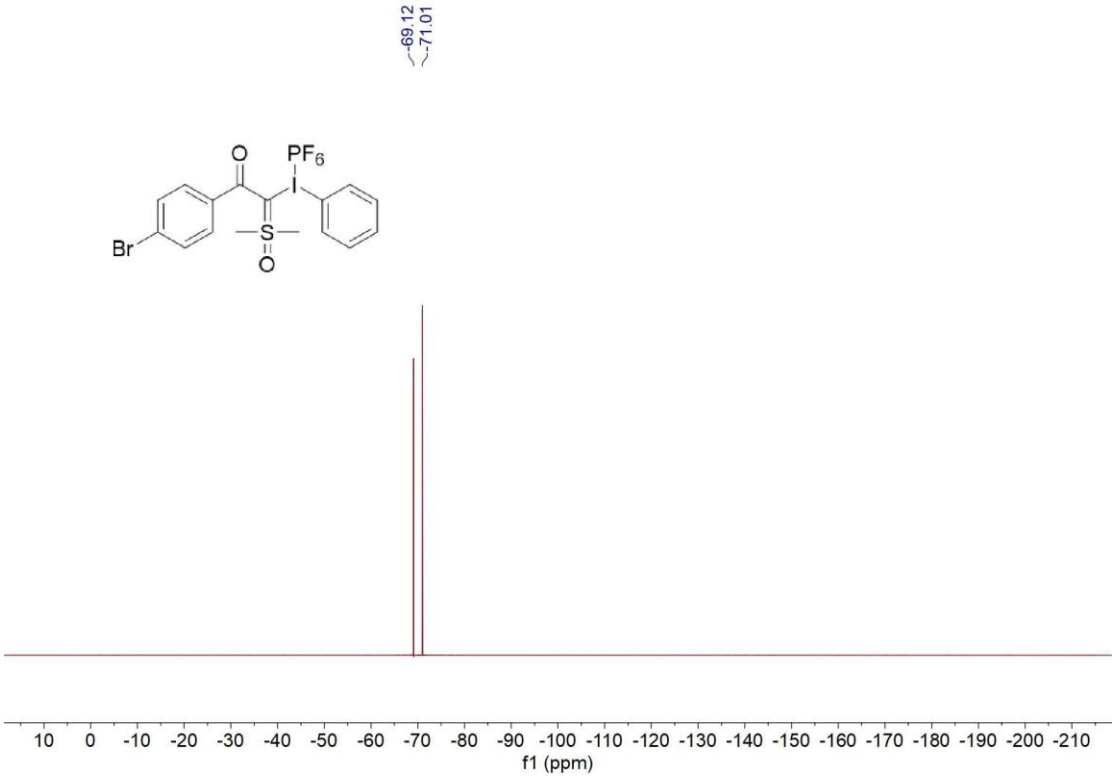
^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **1c**



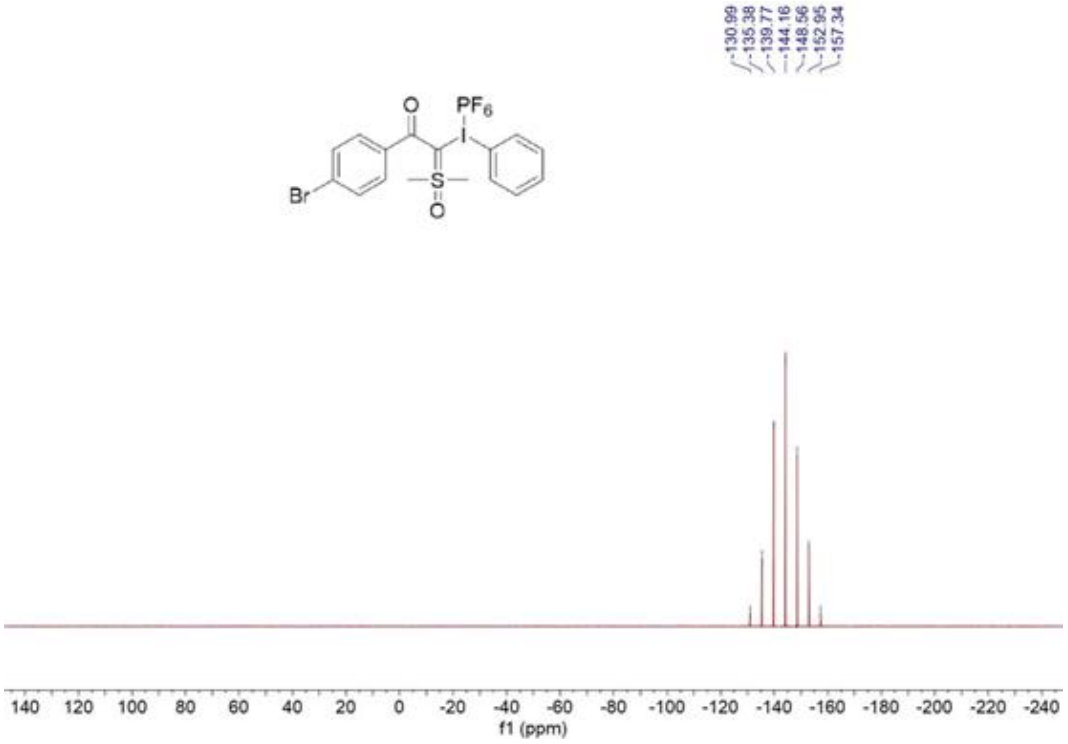
^{13}C NMR (101 MHz, DMSO) Spectra of **1c**



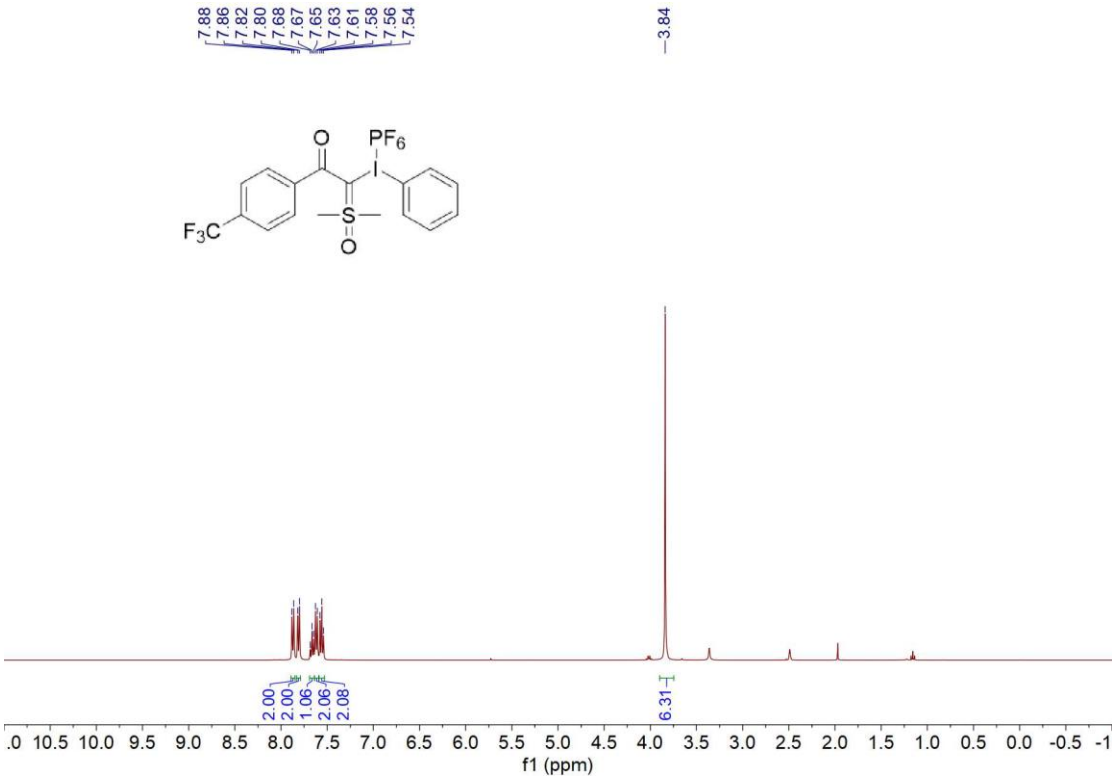
^{19}F NMR (376 MHz, DMSO) Spectra of **1c**



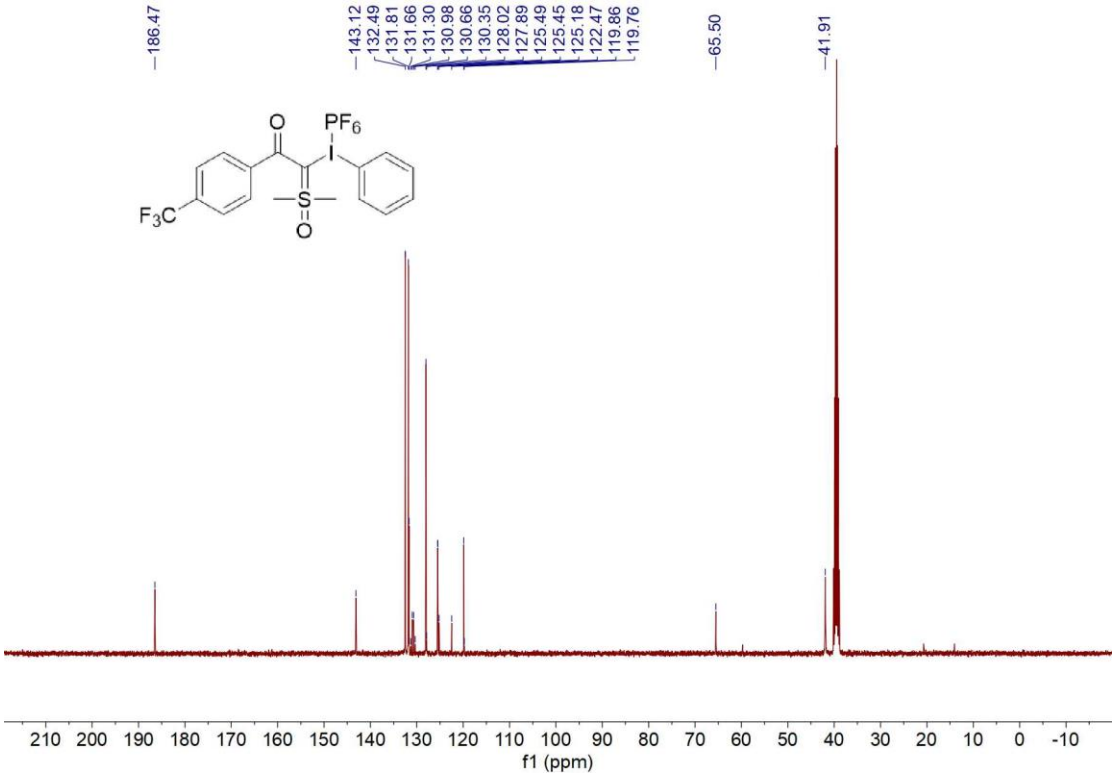
^{31}P NMR (162 MHz, DMSO) Spectra of **1c**



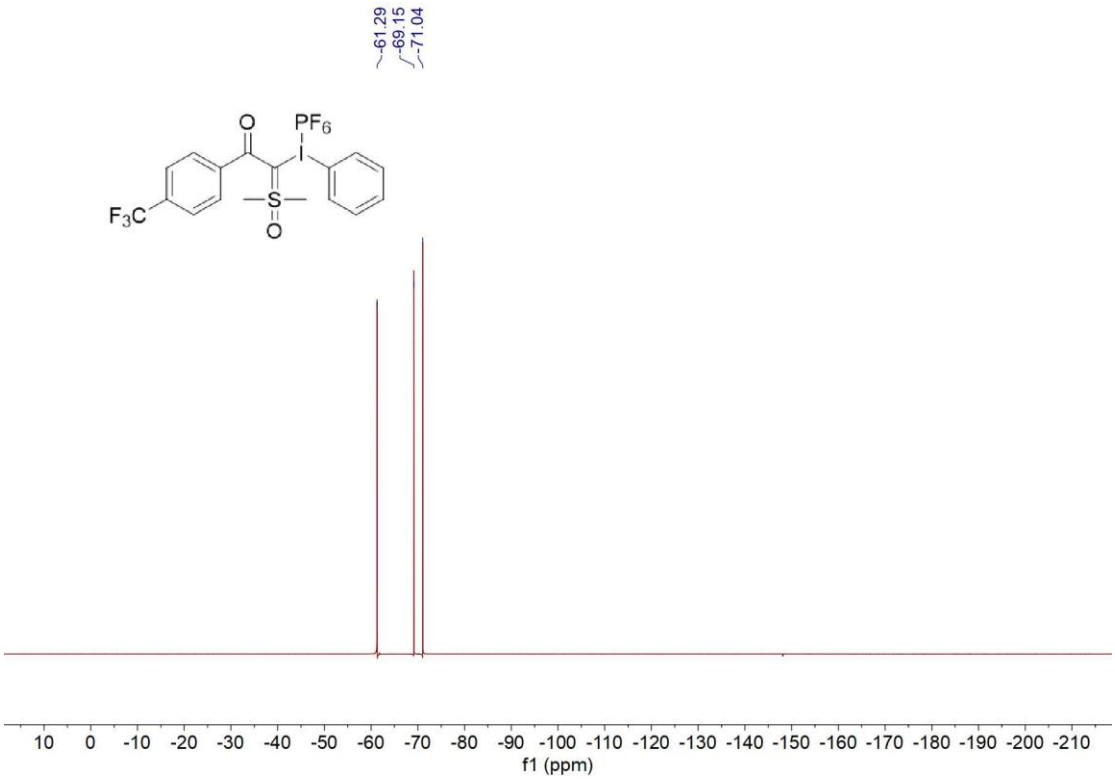
^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **1d**



^{13}C NMR (101 MHz, DMSO) Spectra of **1d**



^{19}F NMR (376 MHz, DMSO) Spectra of **1d**



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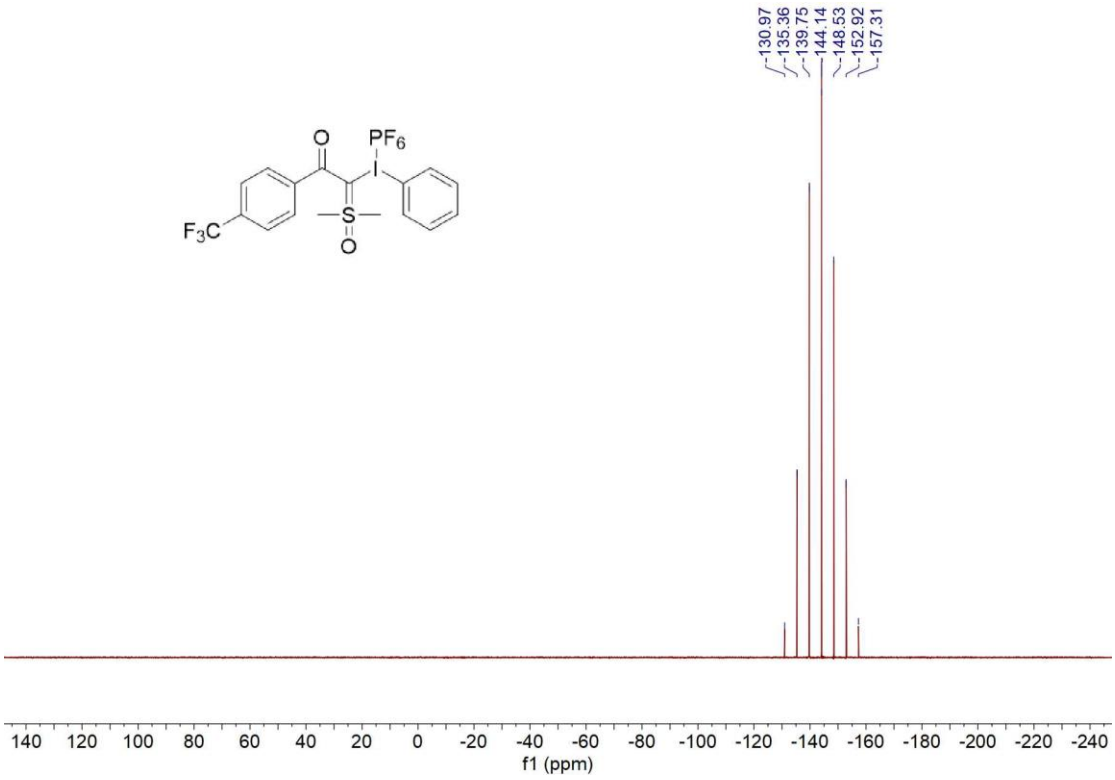

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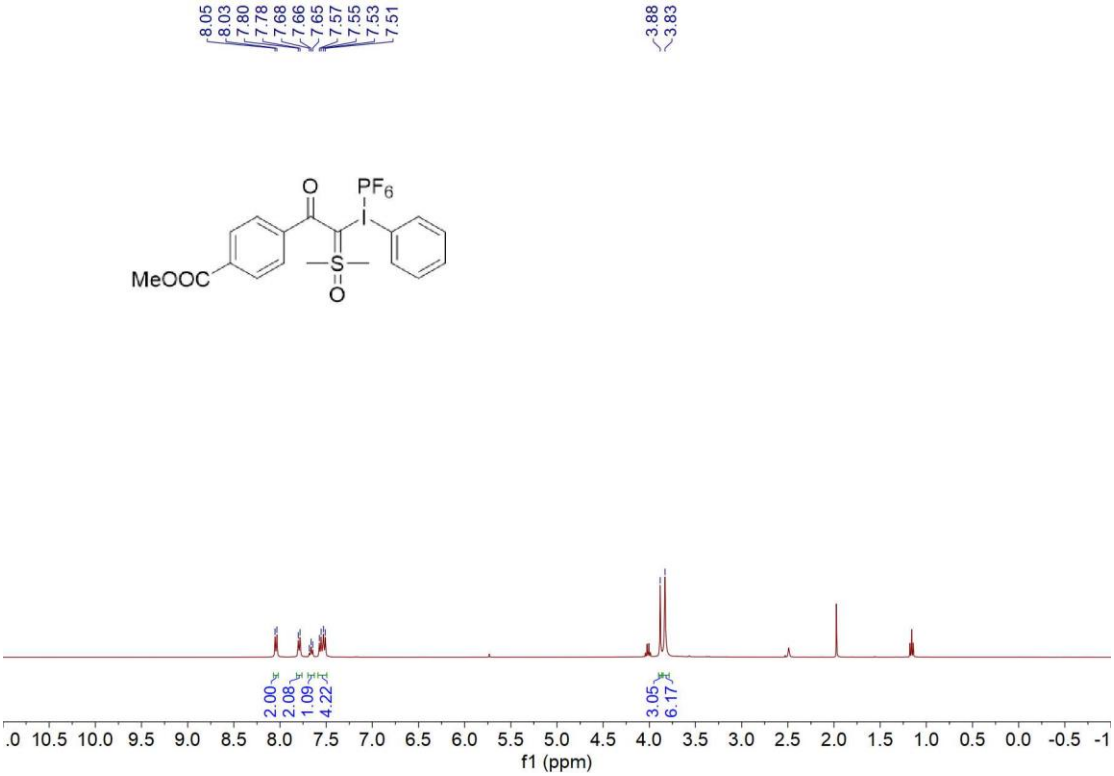

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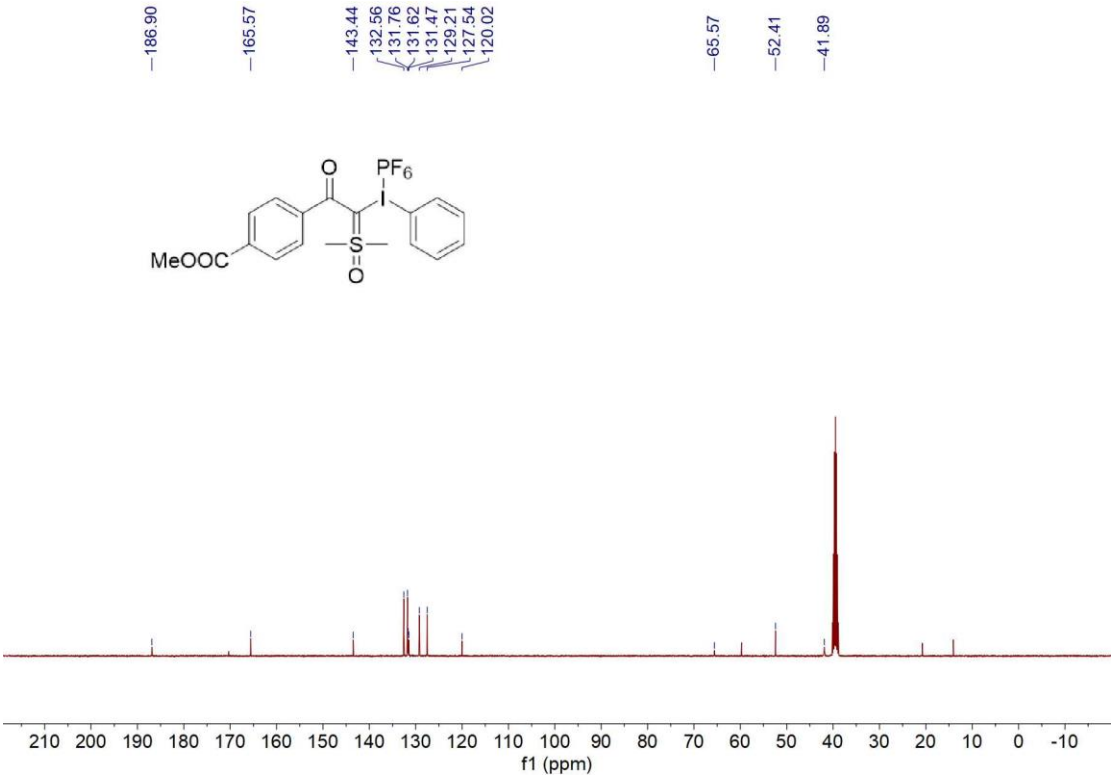

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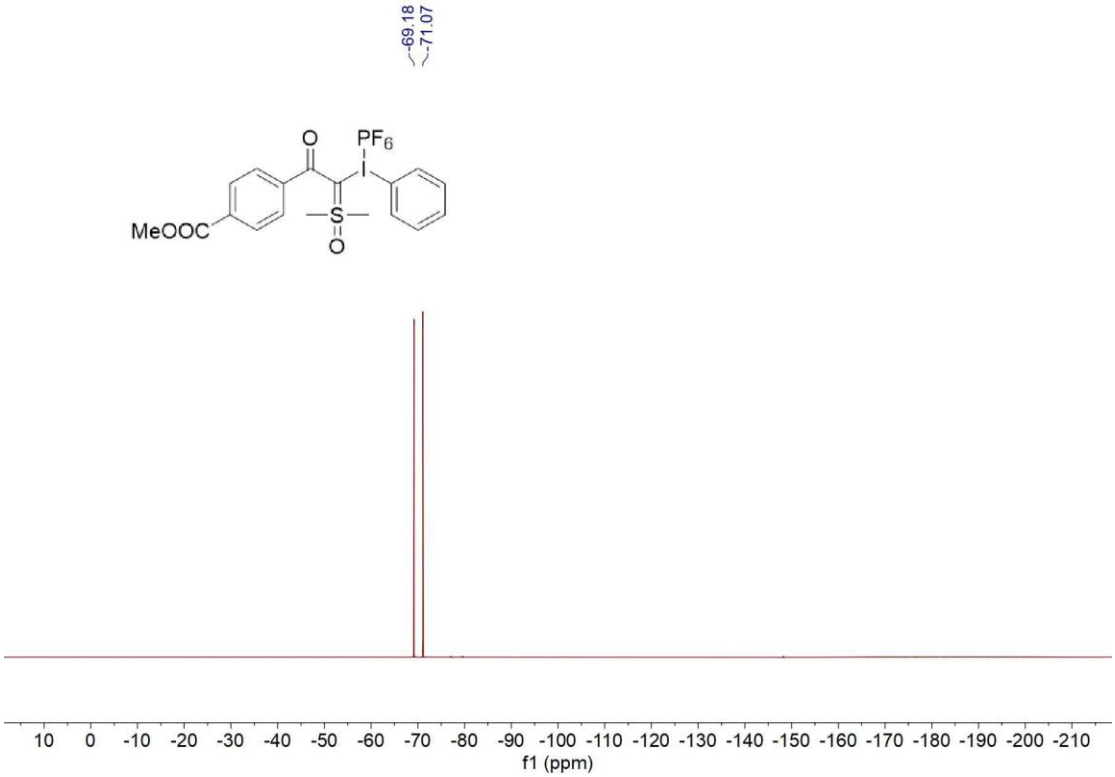

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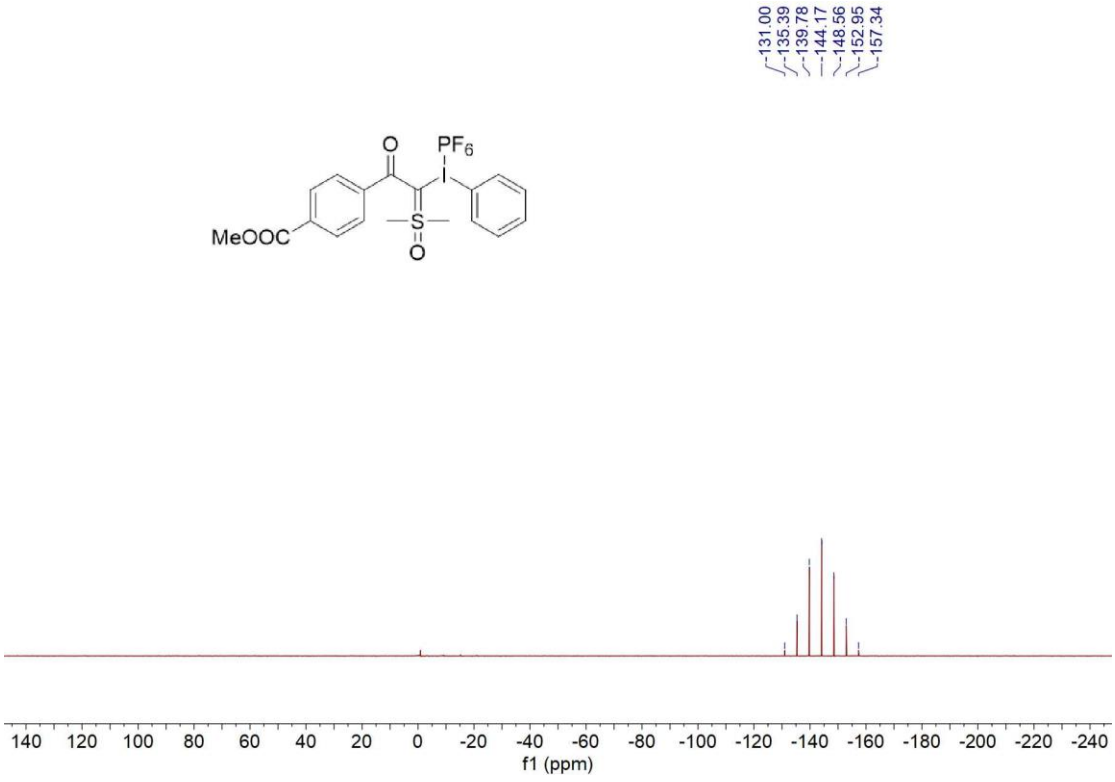

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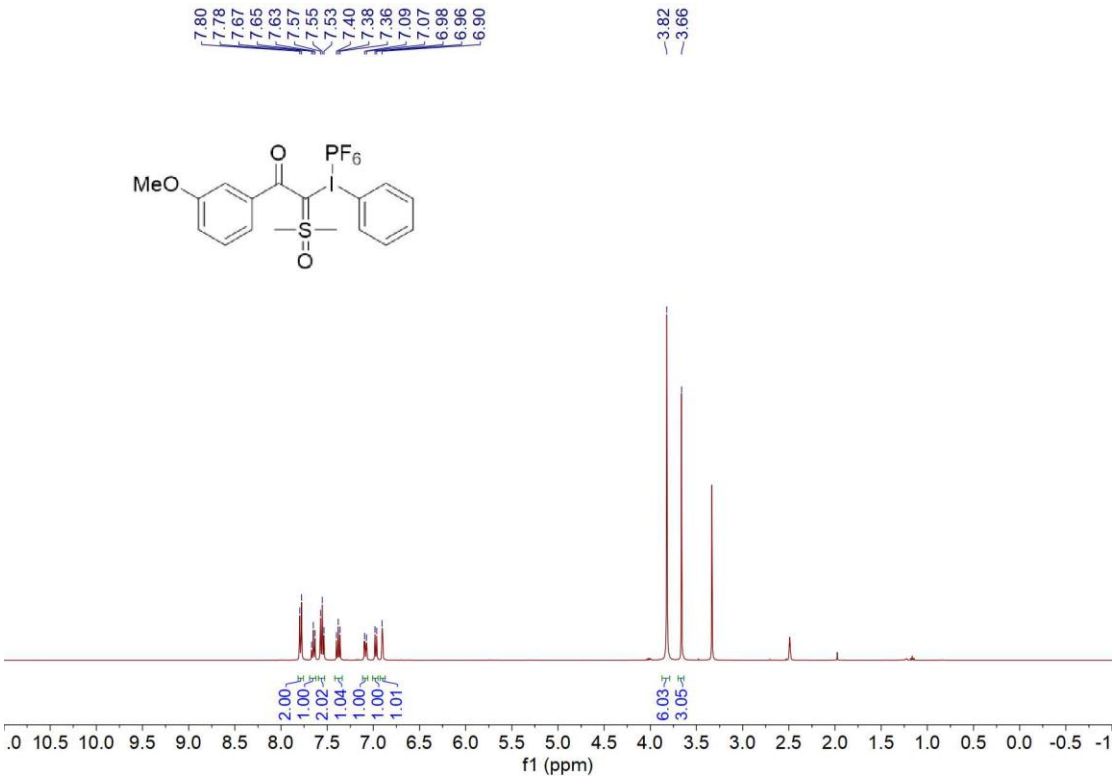
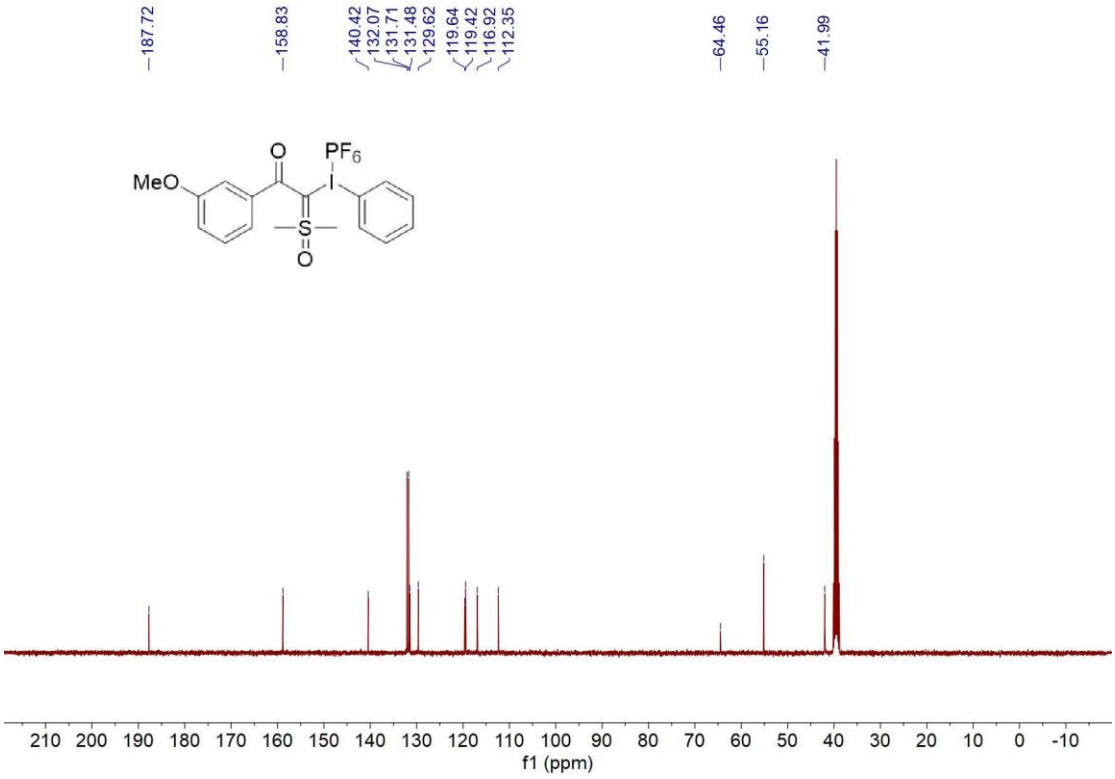
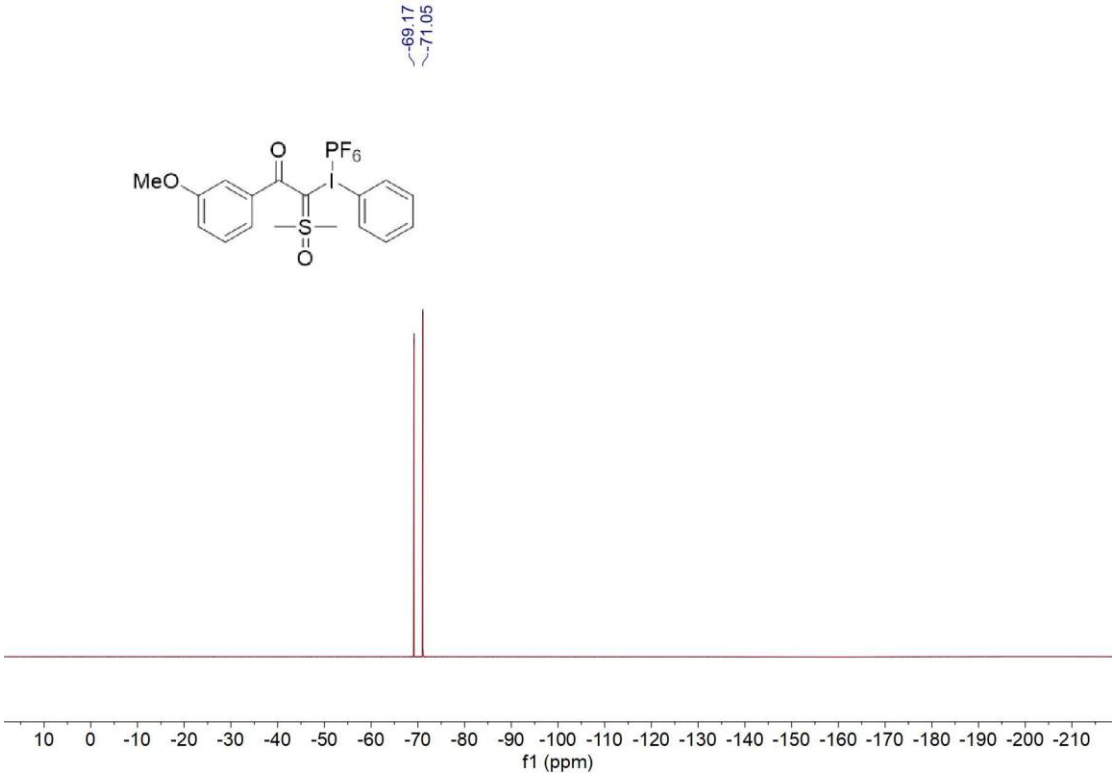


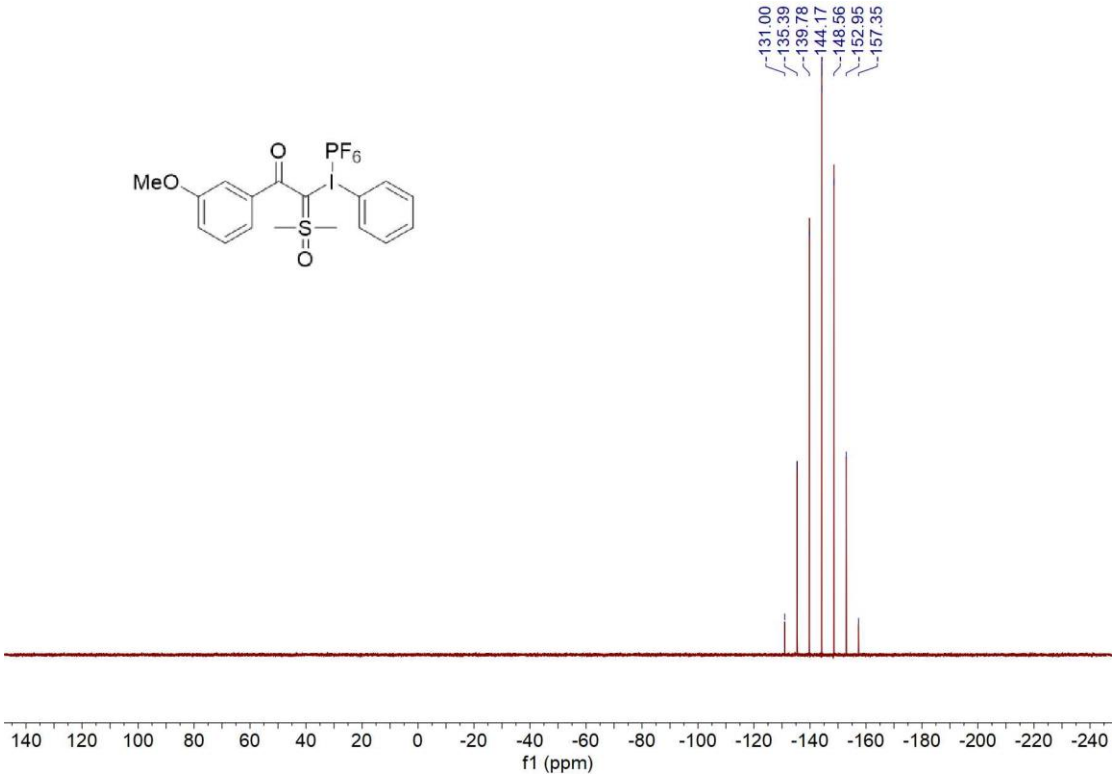
^{13}C NMR (101 MHz, DMSO) Spectra of **1f**



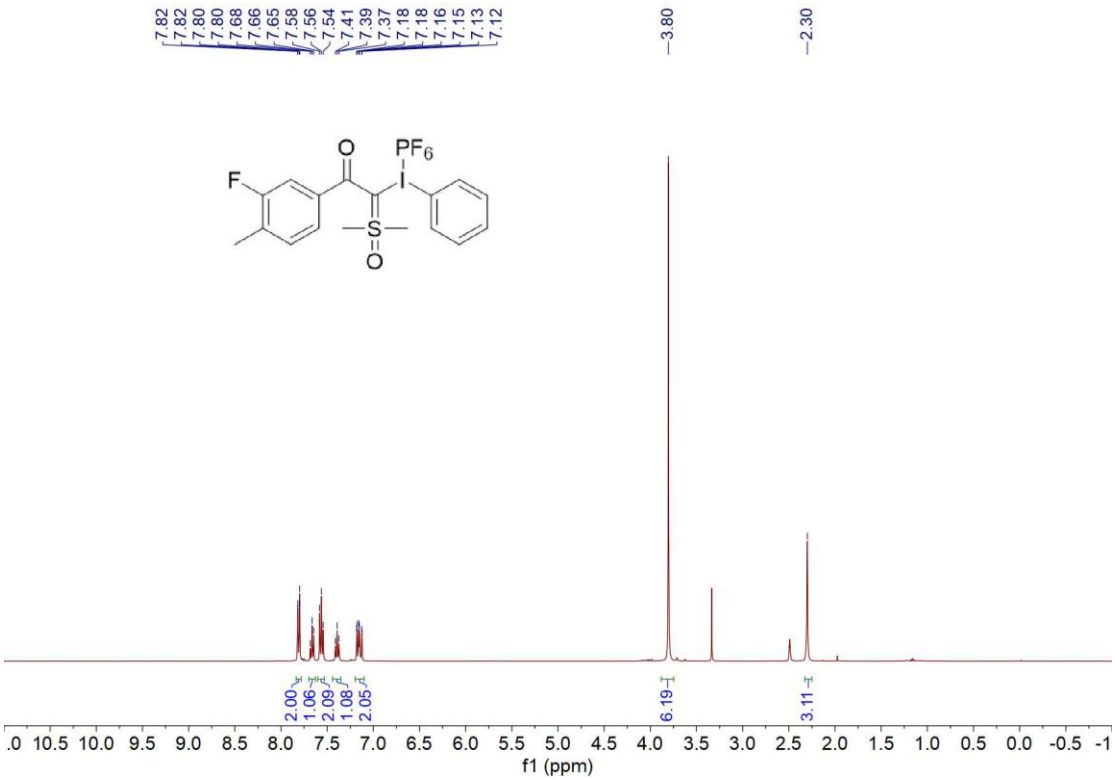
^{19}F NMR (376 MHz, DMSO) Spectra of **1f**



^{31}P NMR (162 MHz, DMSO) Spectra of **1f**



^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **1g**



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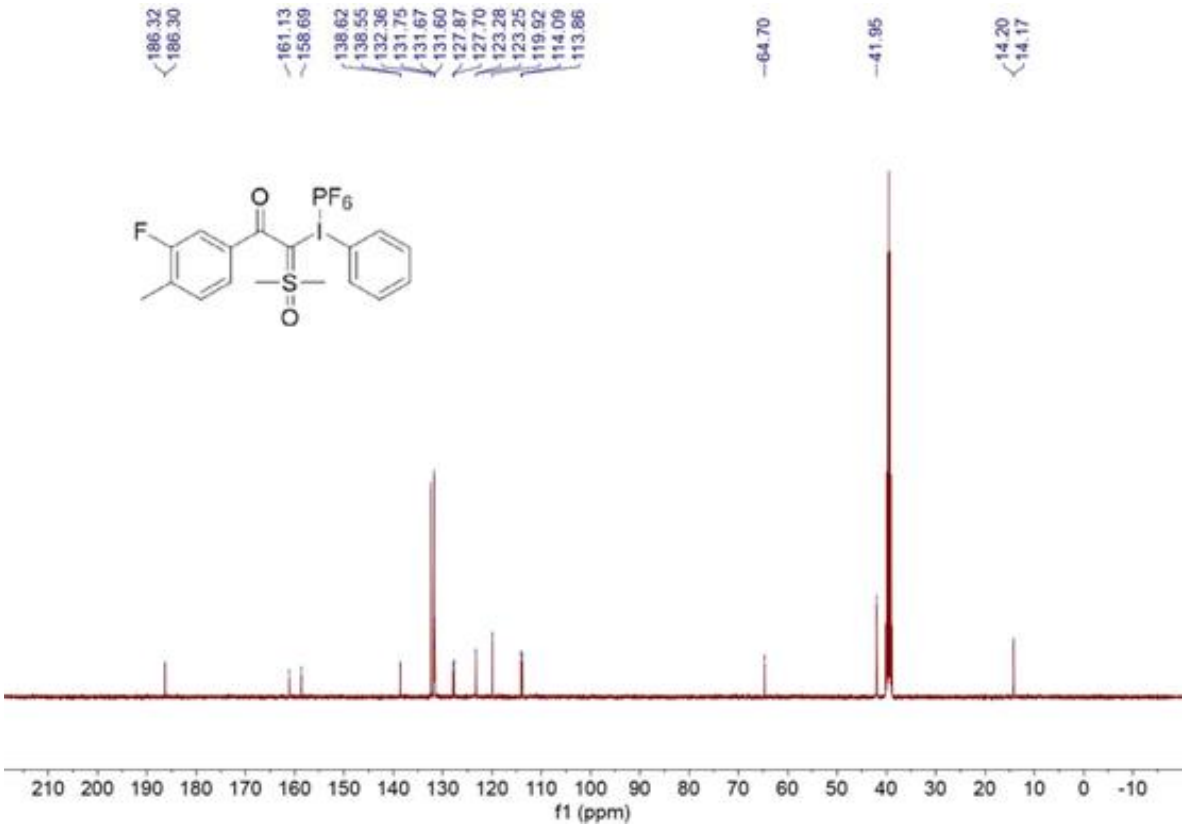
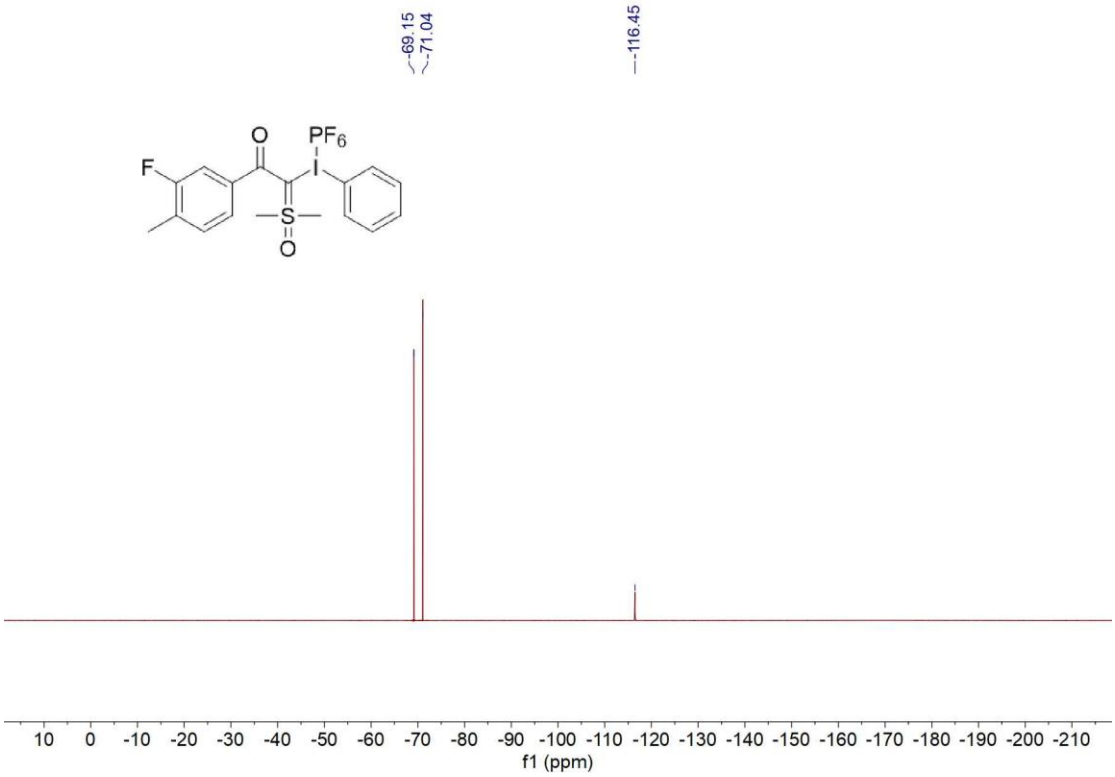
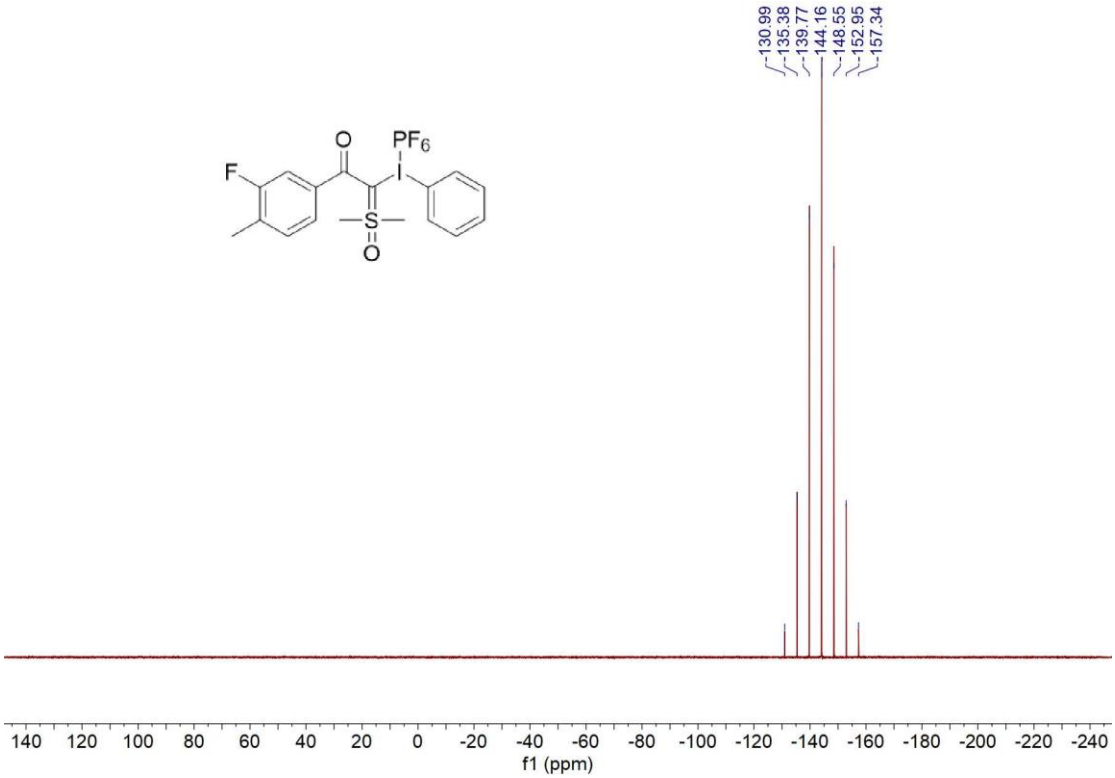


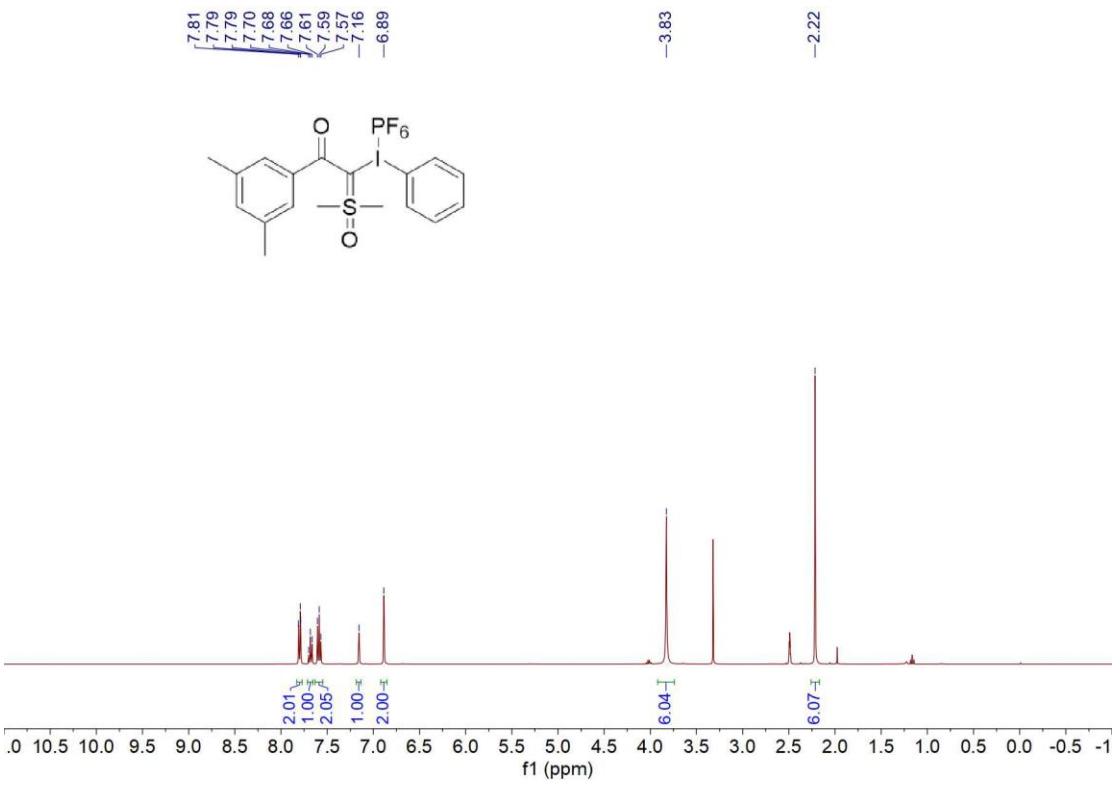
^{19}F NMR (376 MHz, DMSO-d_6) Spectra of **1g**



^{31}P NMR (162 MHz, DMSO-d_6) Spectra of **1g**



^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **1h**



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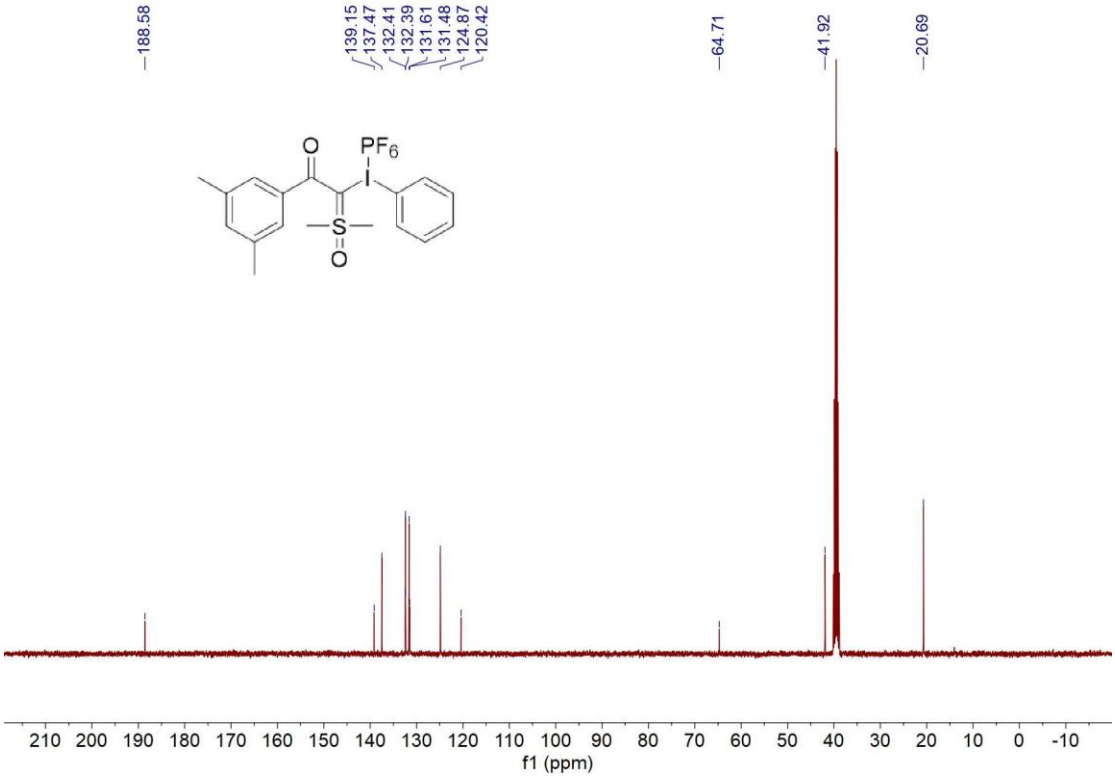
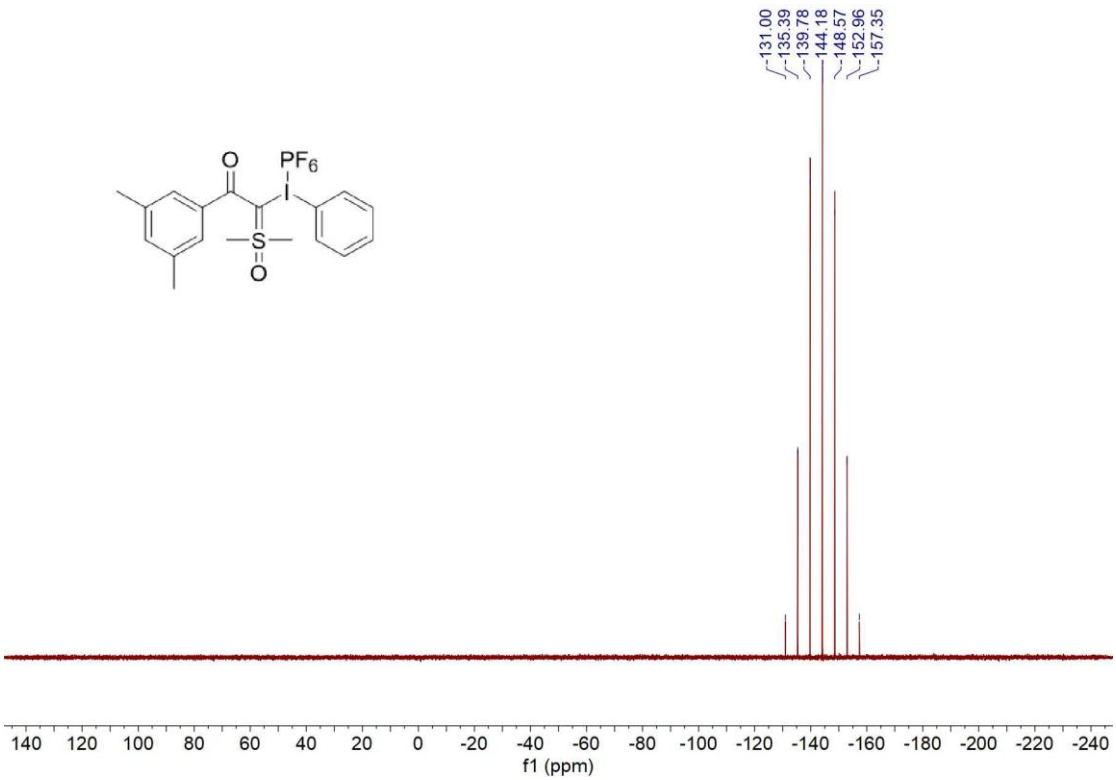


^{19}F NMR (376 MHz, DMSO) Spectra of **1h**

^{31}P NMR (162 MHz, DMSO) Spectra of **1h**



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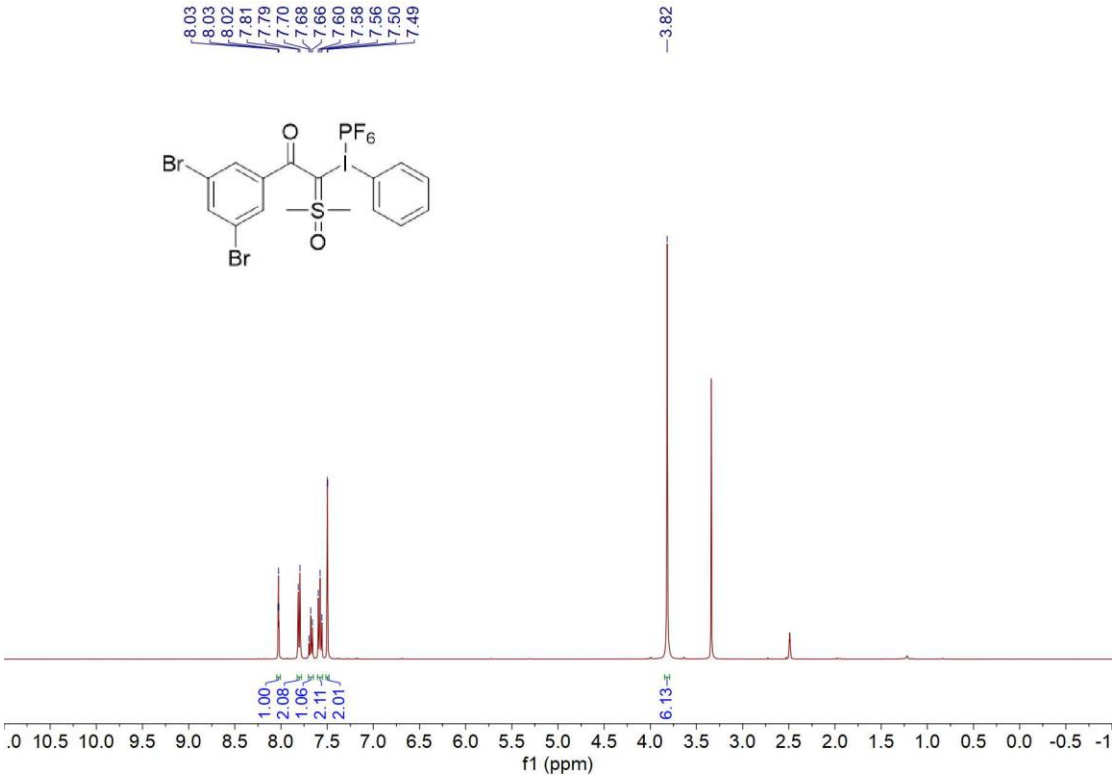
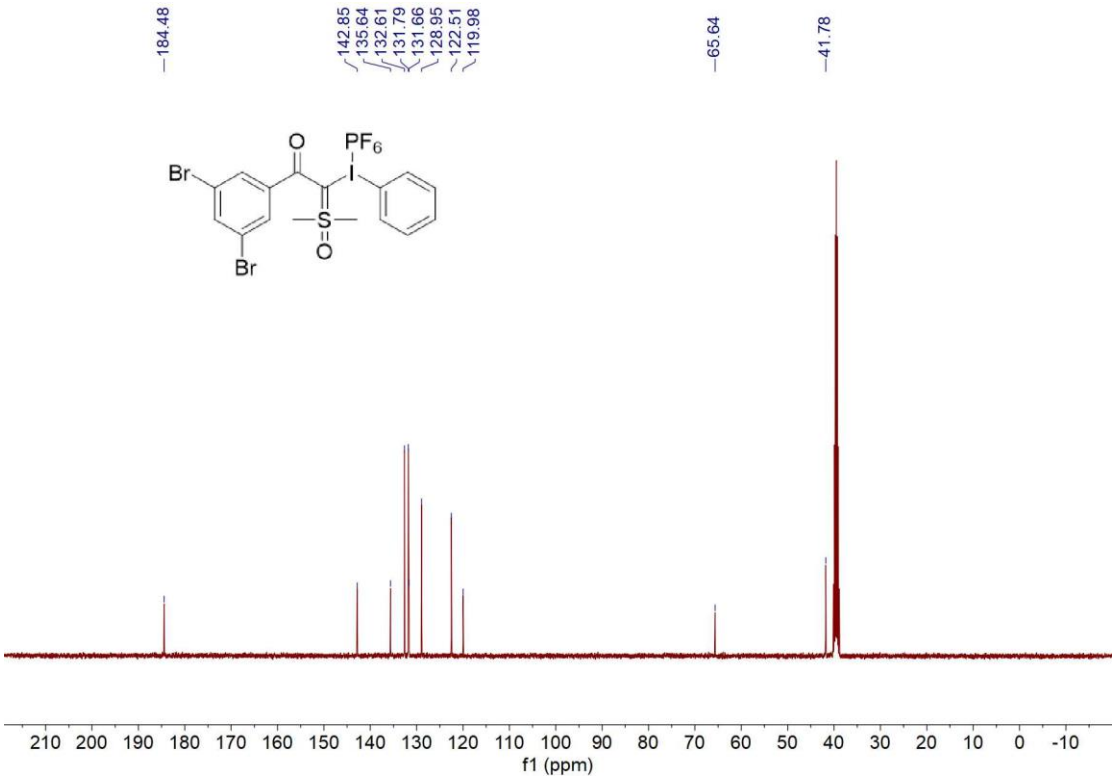


^{13}C NMR (101 MHz, DMSO) Spectra of **1i**



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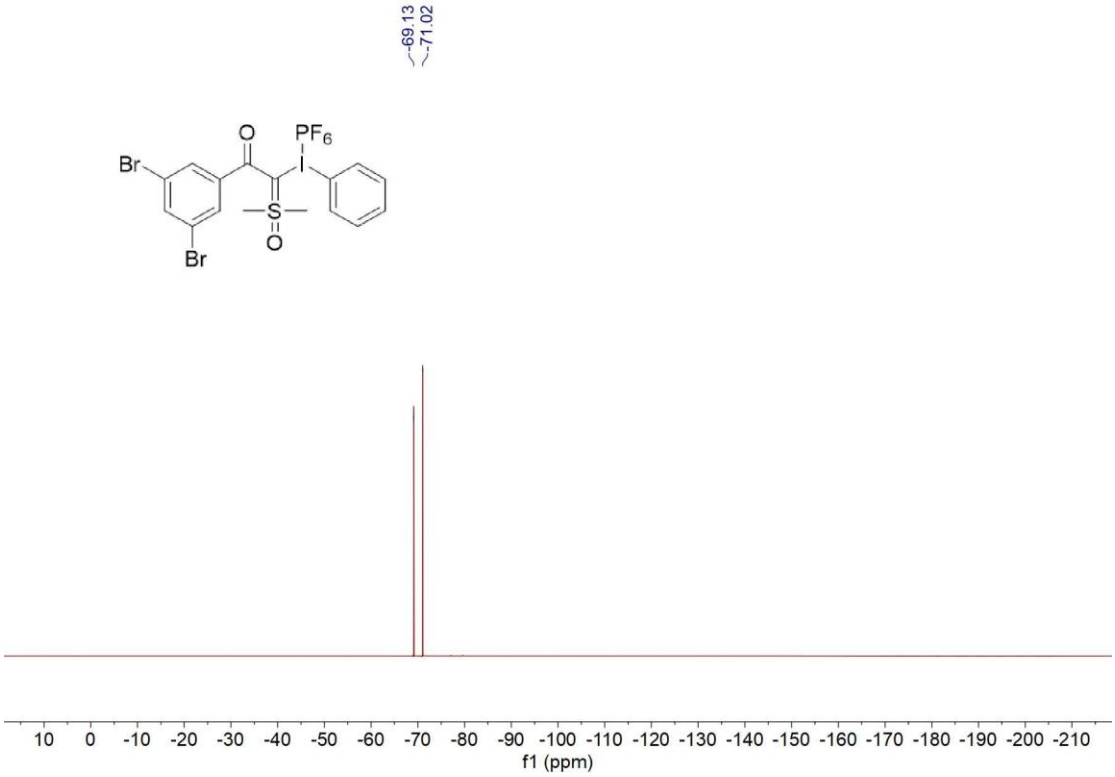
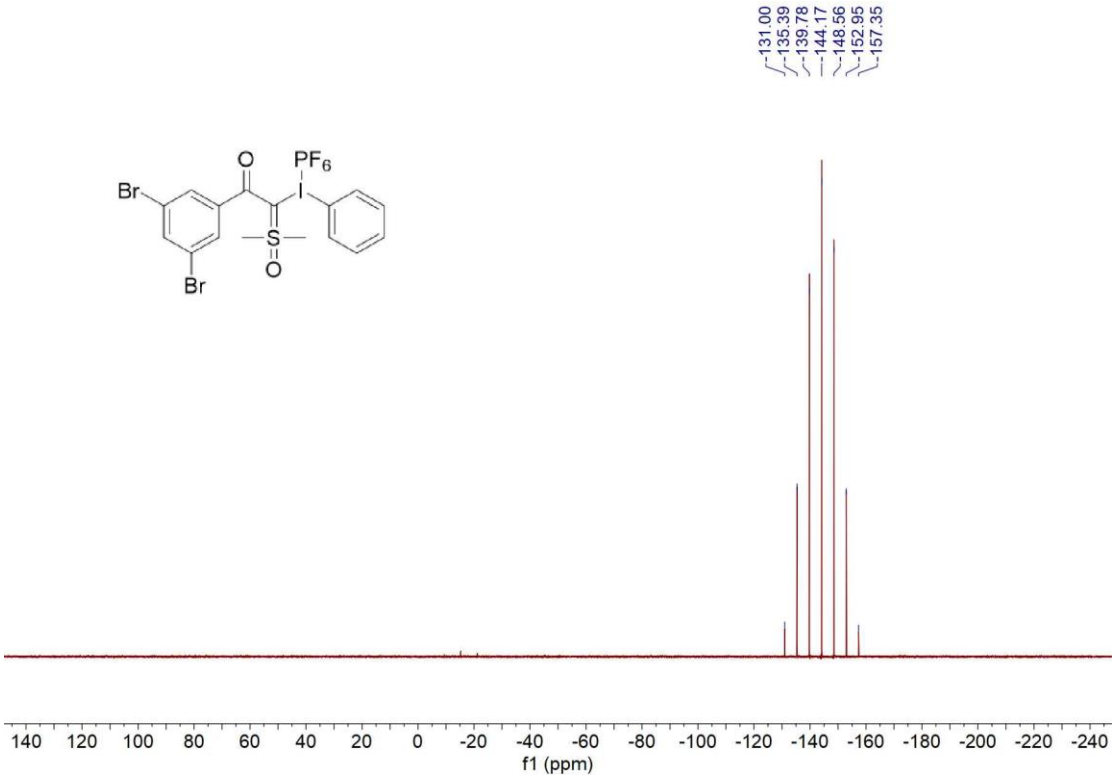


^{31}P NMR (162 MHz, DMSO) Spectra of **1i**



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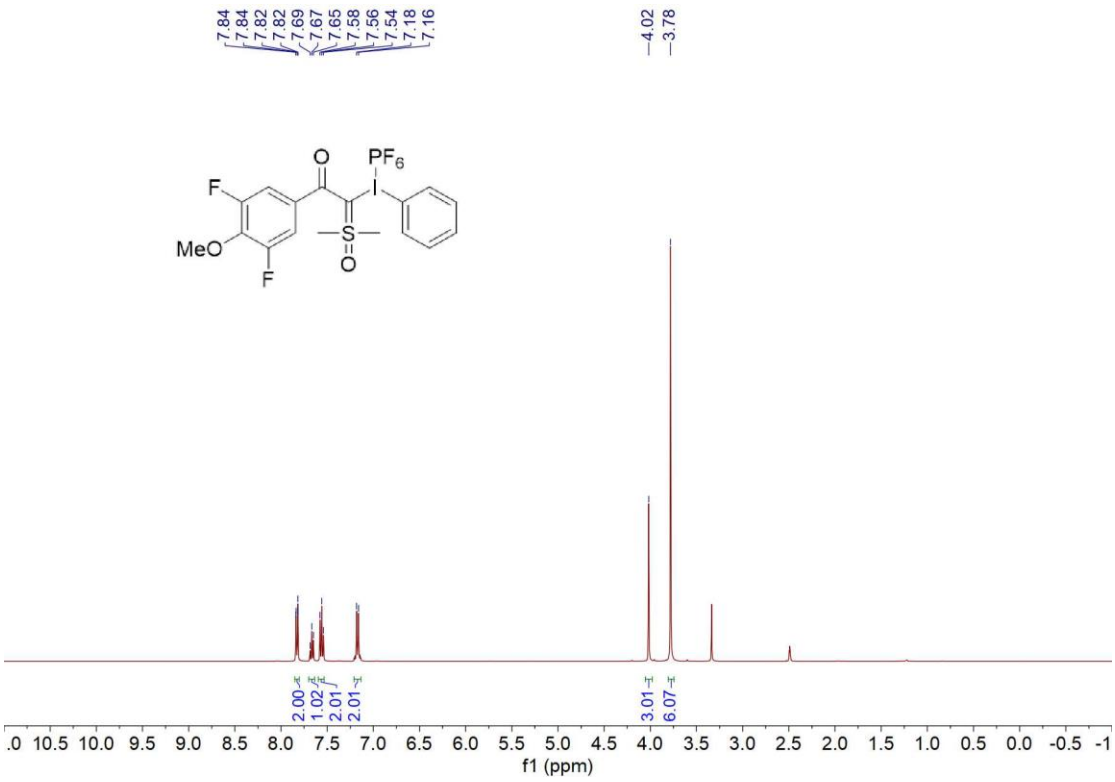

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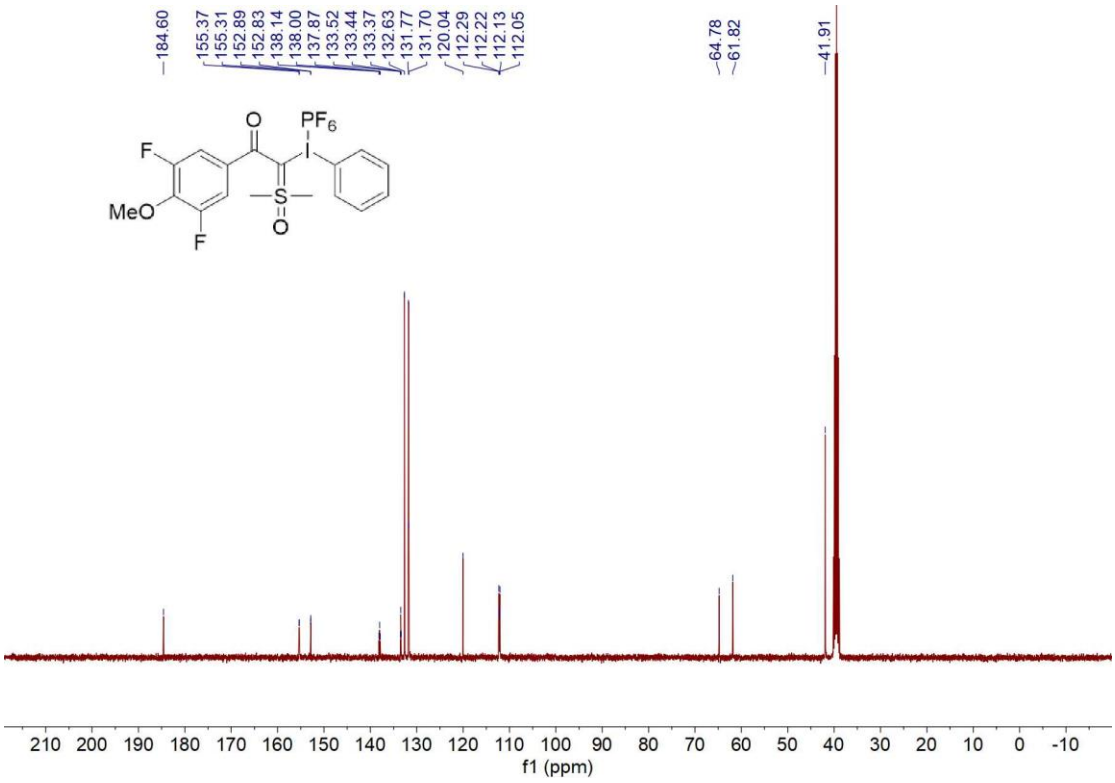

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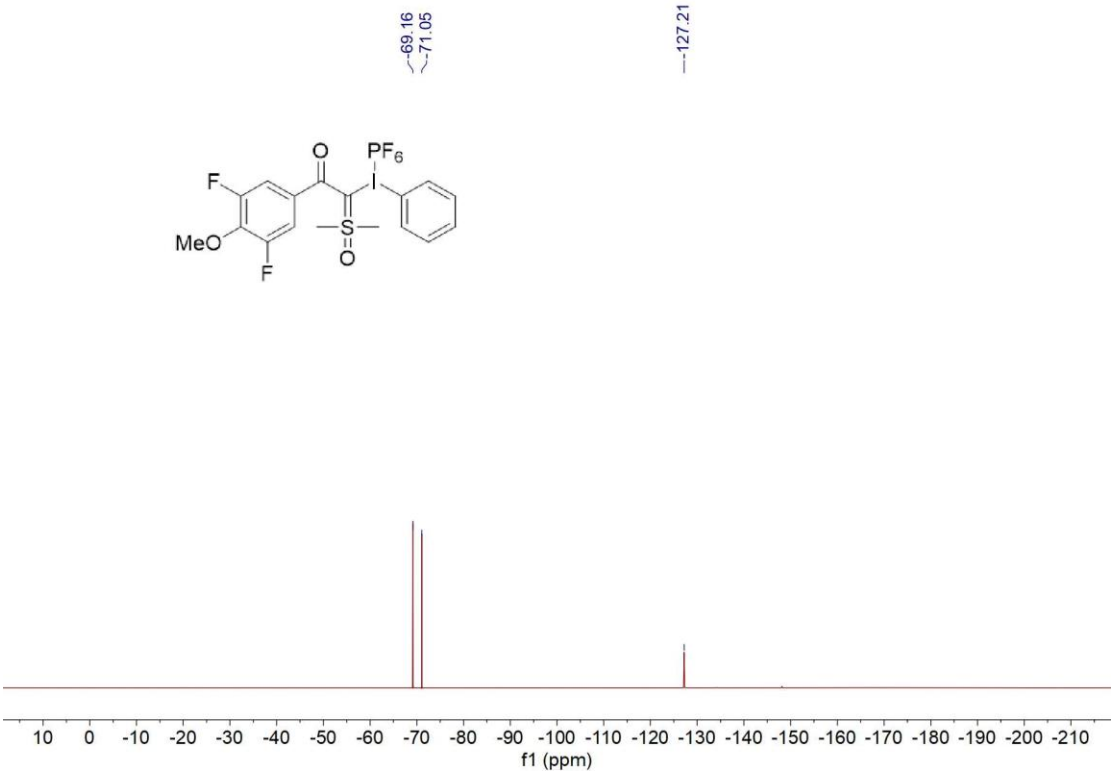

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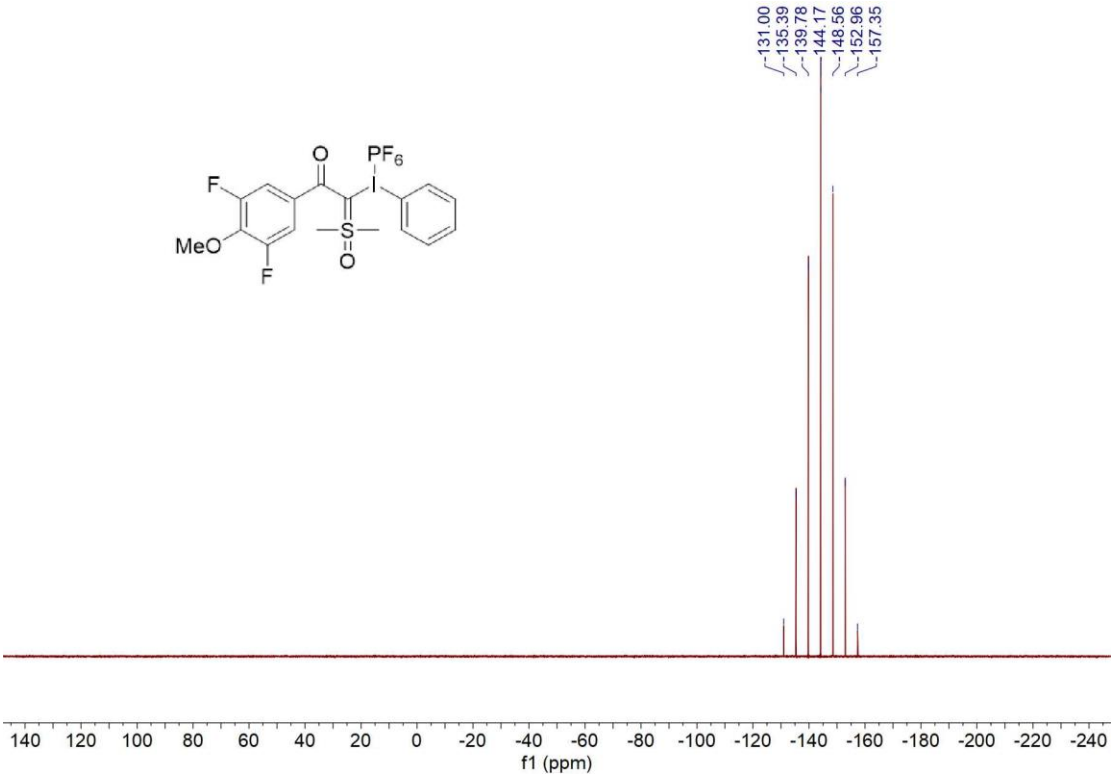

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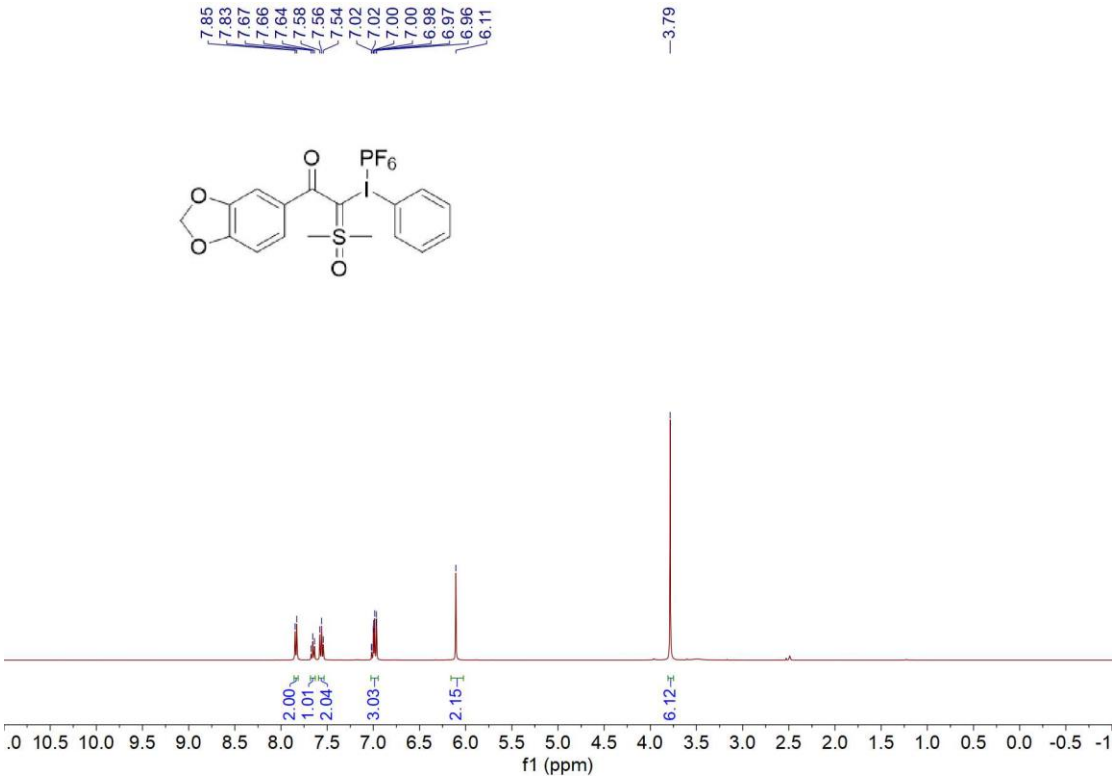

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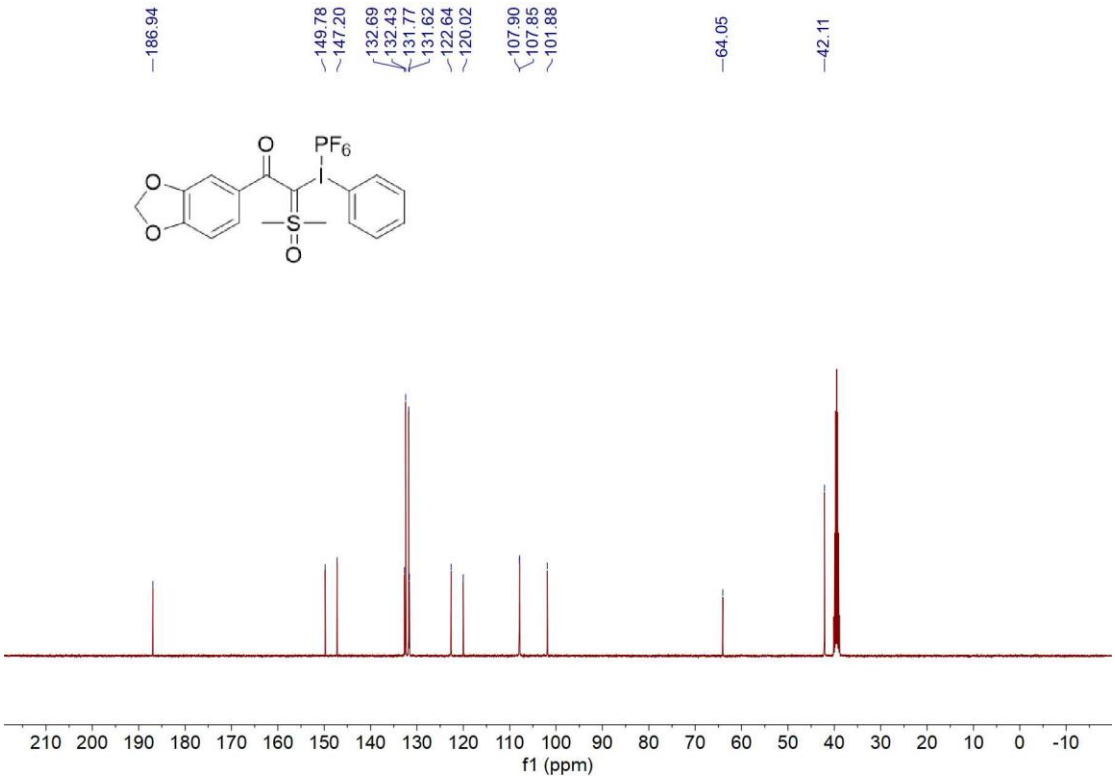

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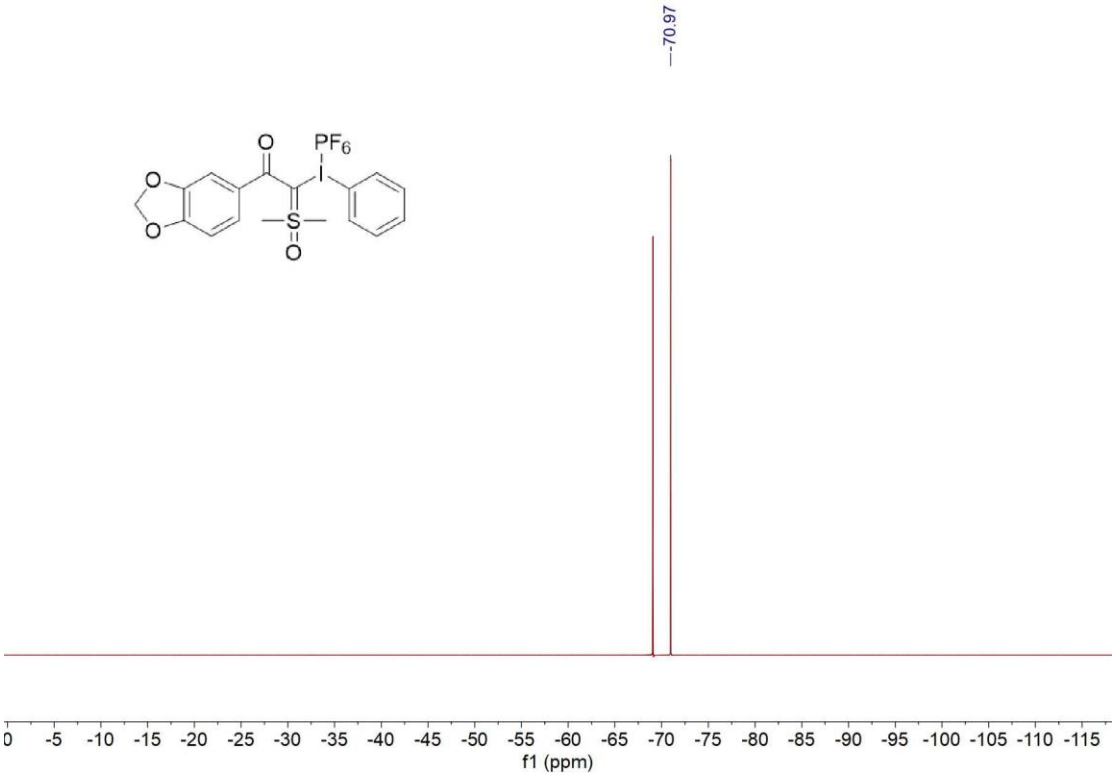

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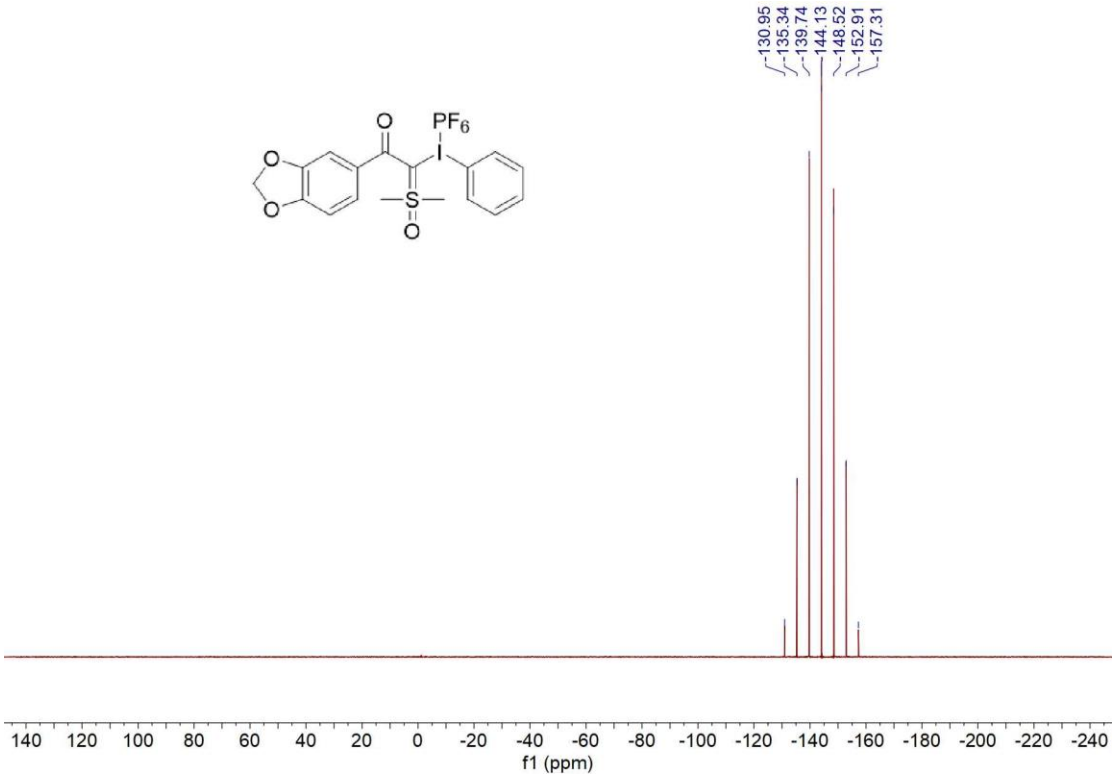

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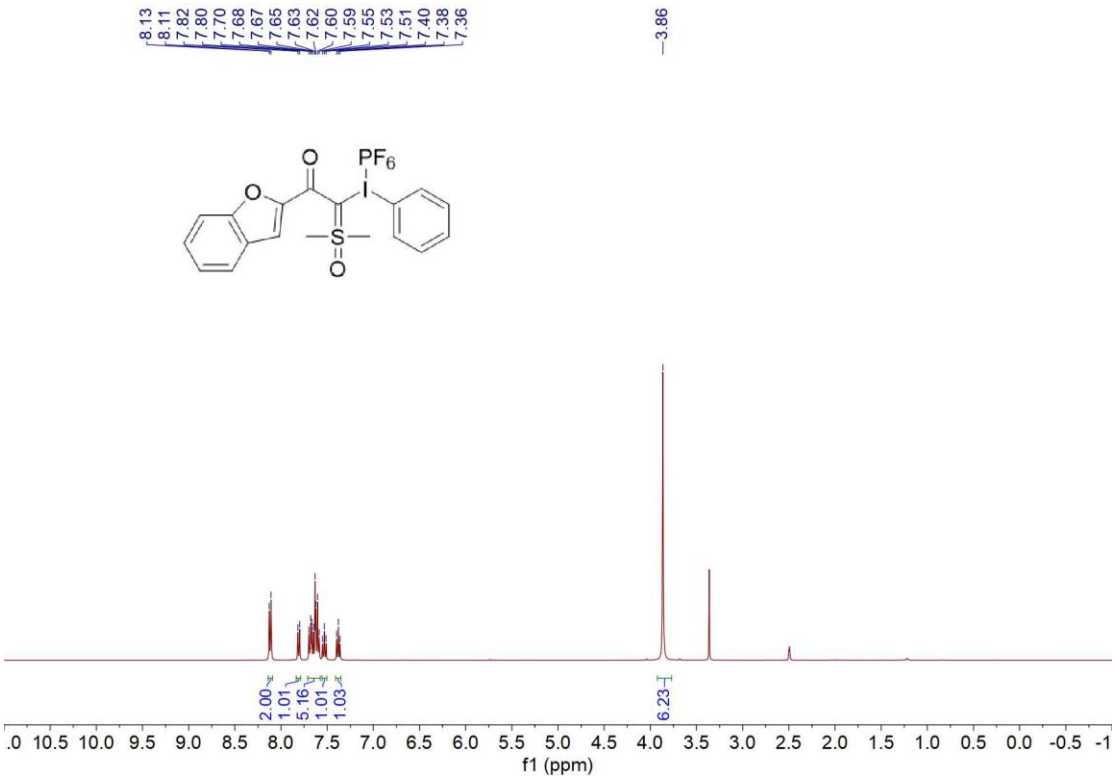

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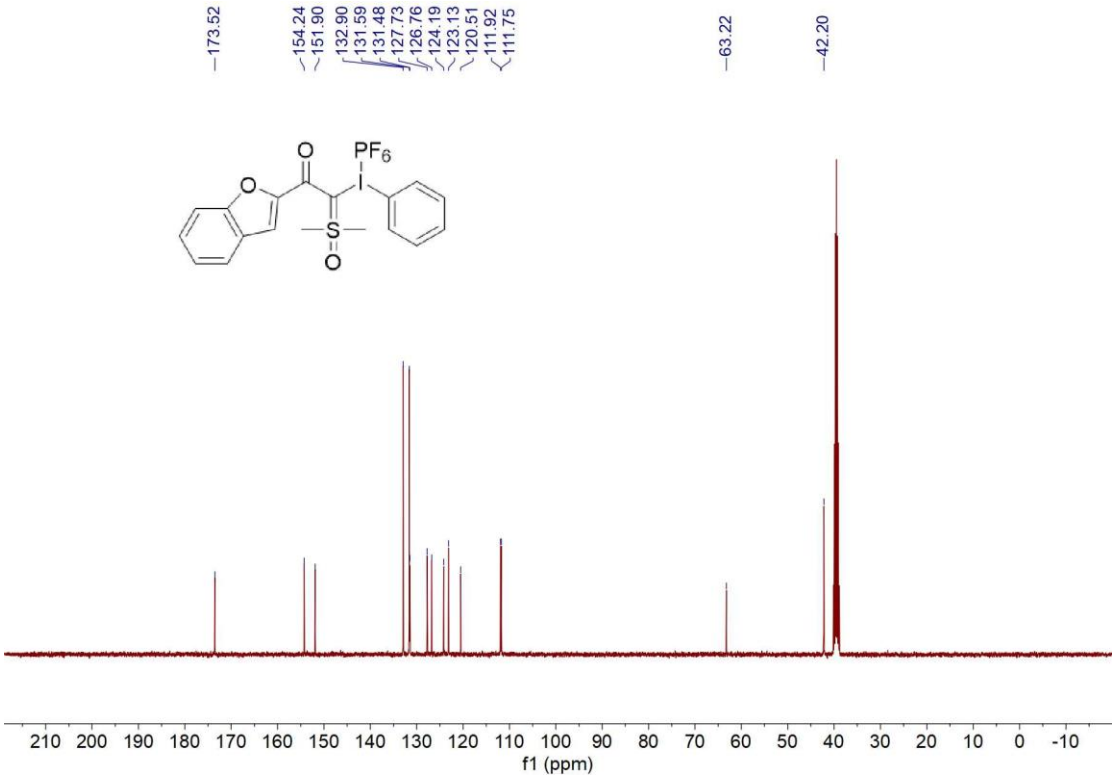
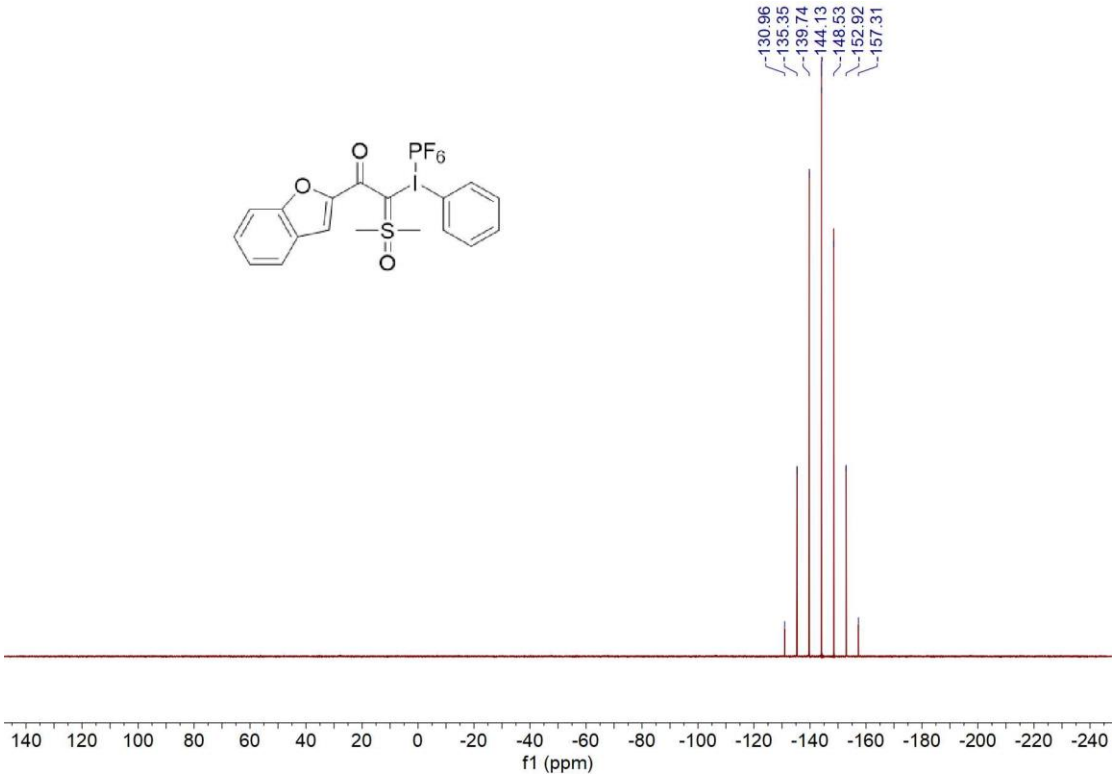
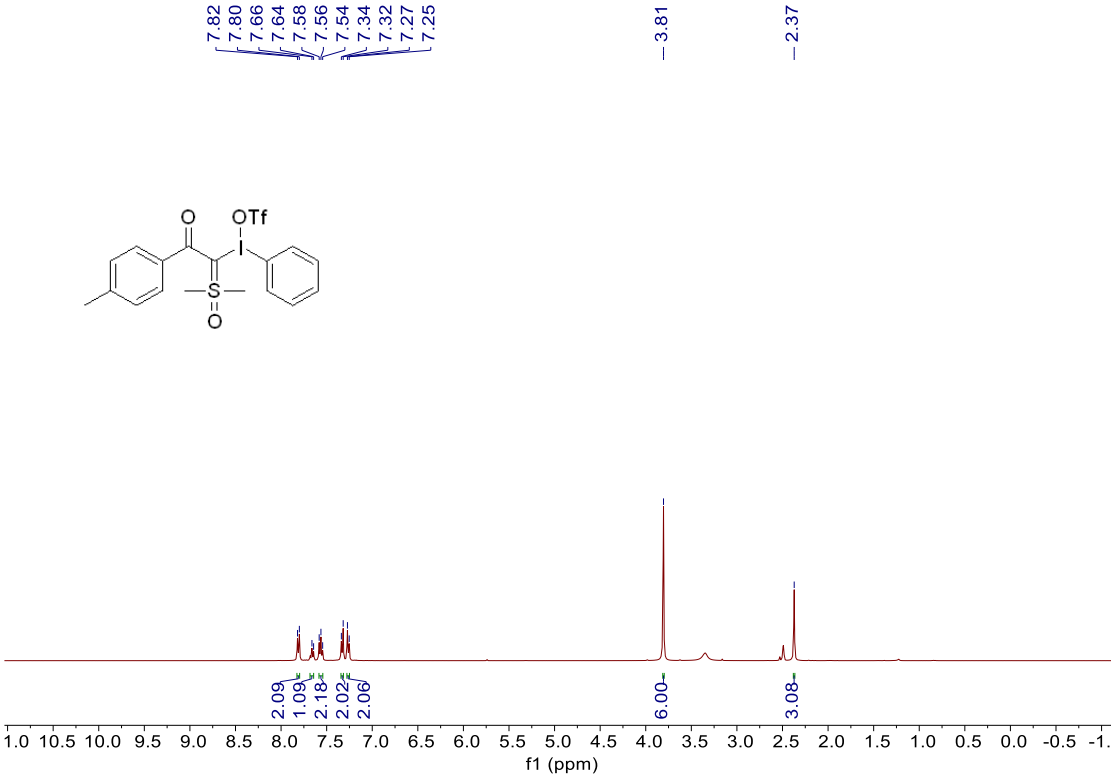


^{19}F NMR (376 MHz, DMSO) Spectra of **1l**

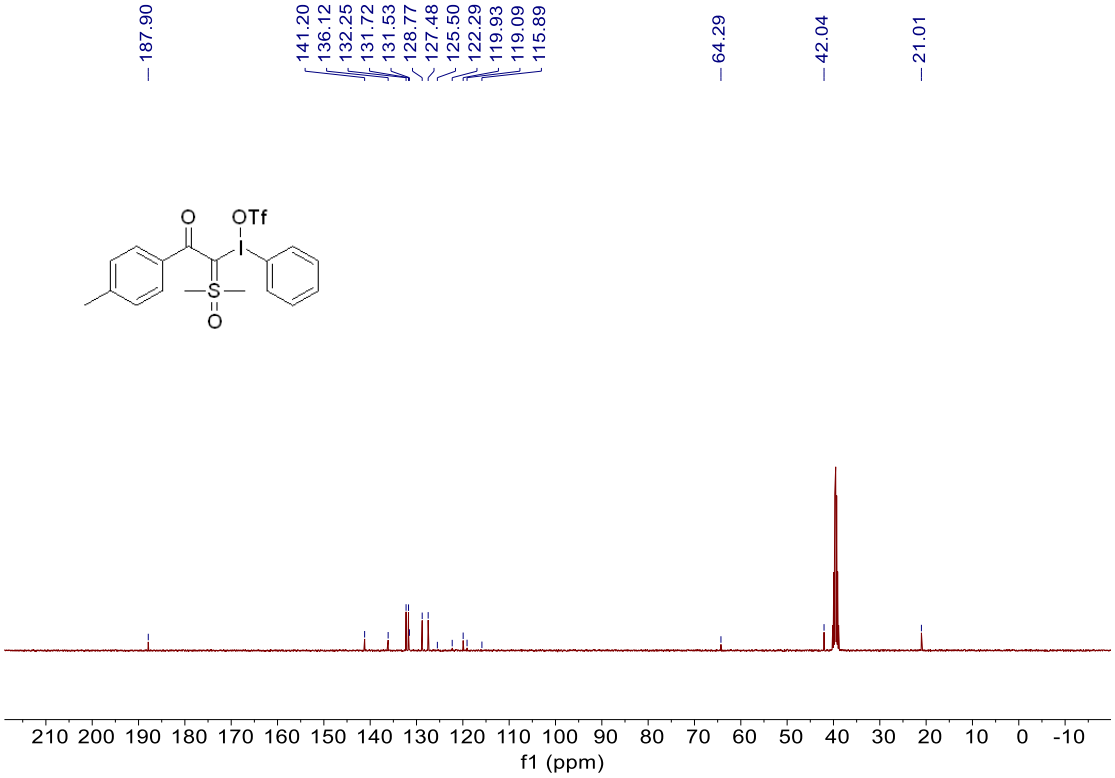
^{31}P NMR (162 MHz, DMSO) Spectra of **1l**



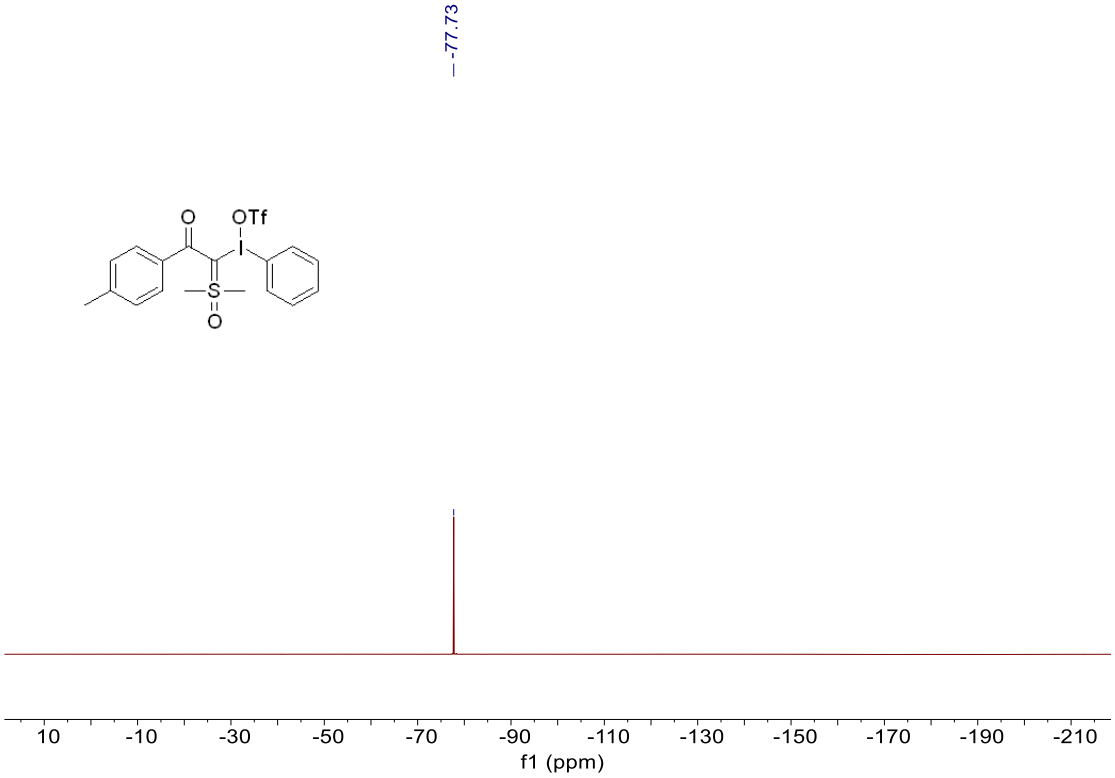
^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **6b**



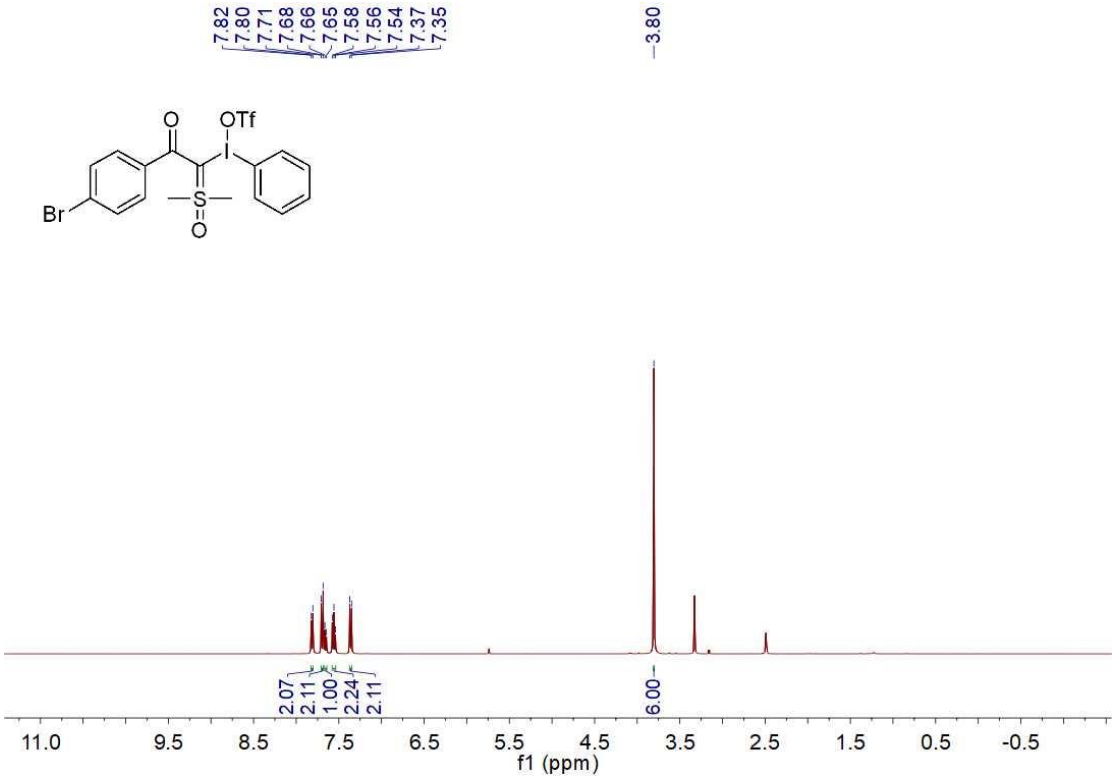
^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **6b**



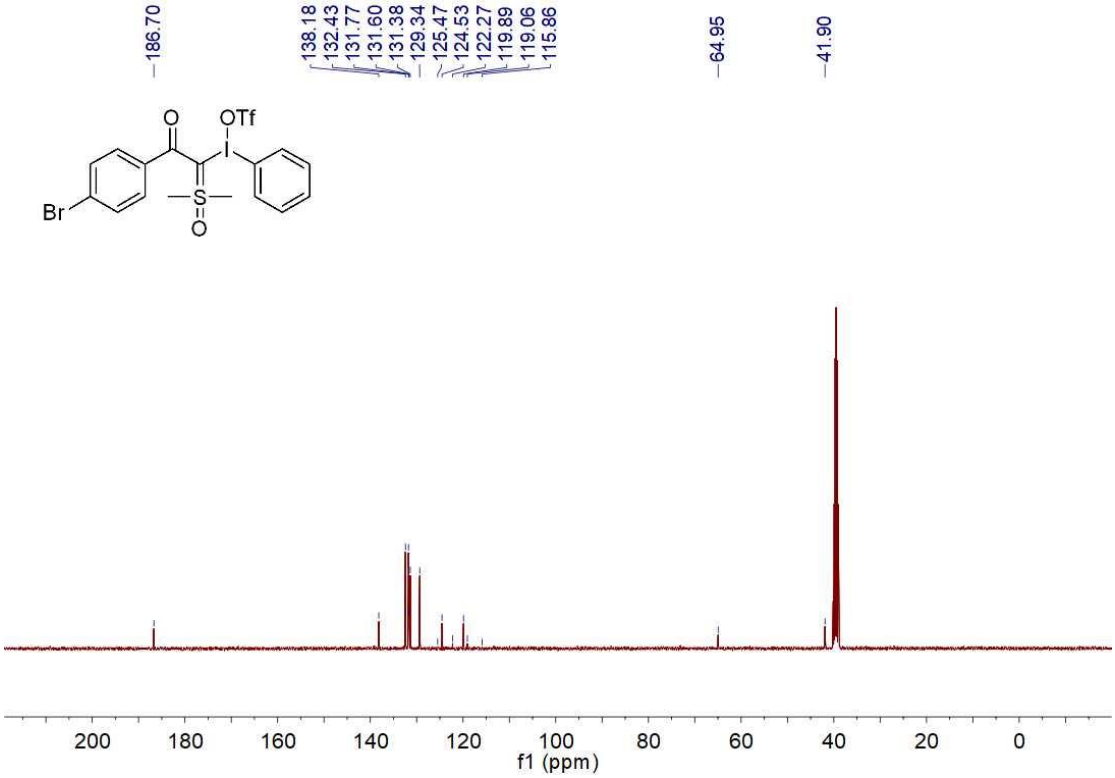
^{19}F NMR (376 MHz, DMSO-d_6) Spectra of **6b**



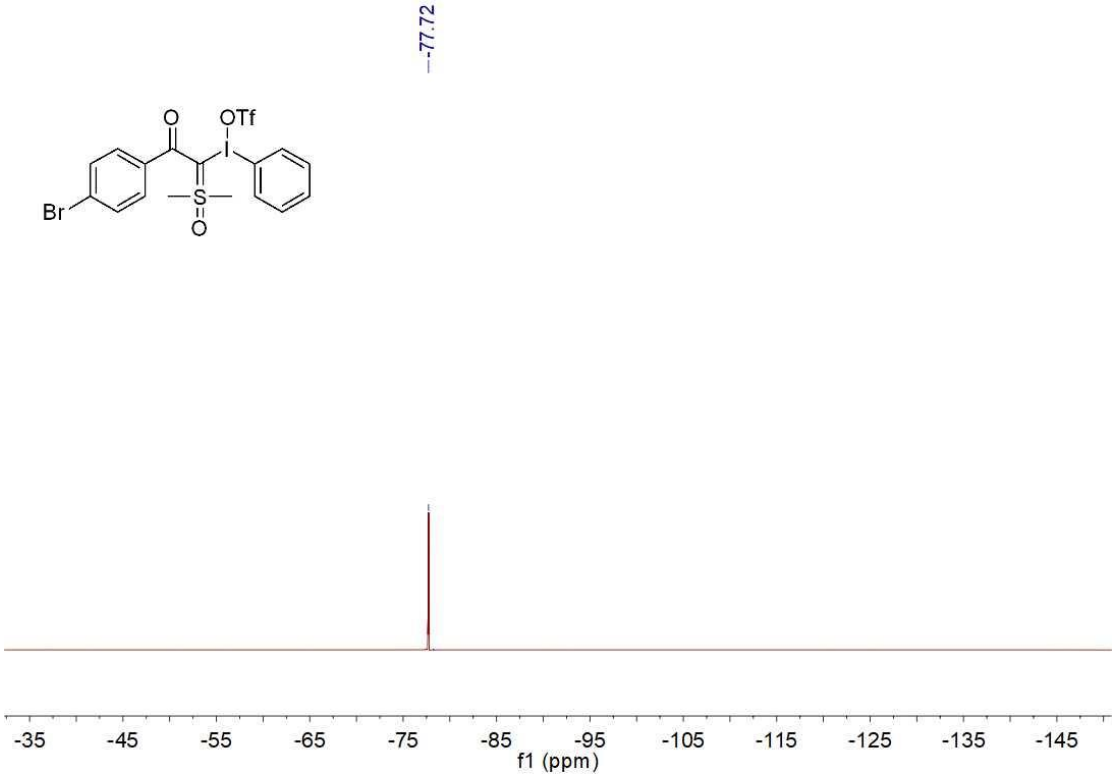
^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **6c**



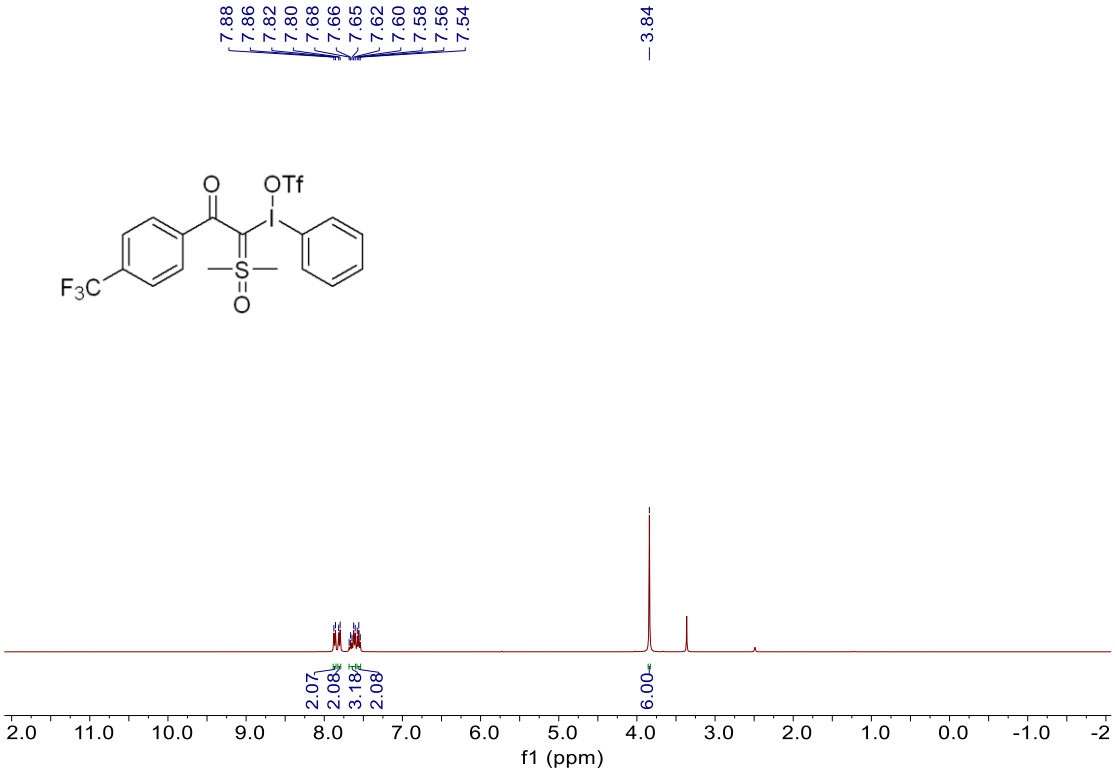
^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **6c**



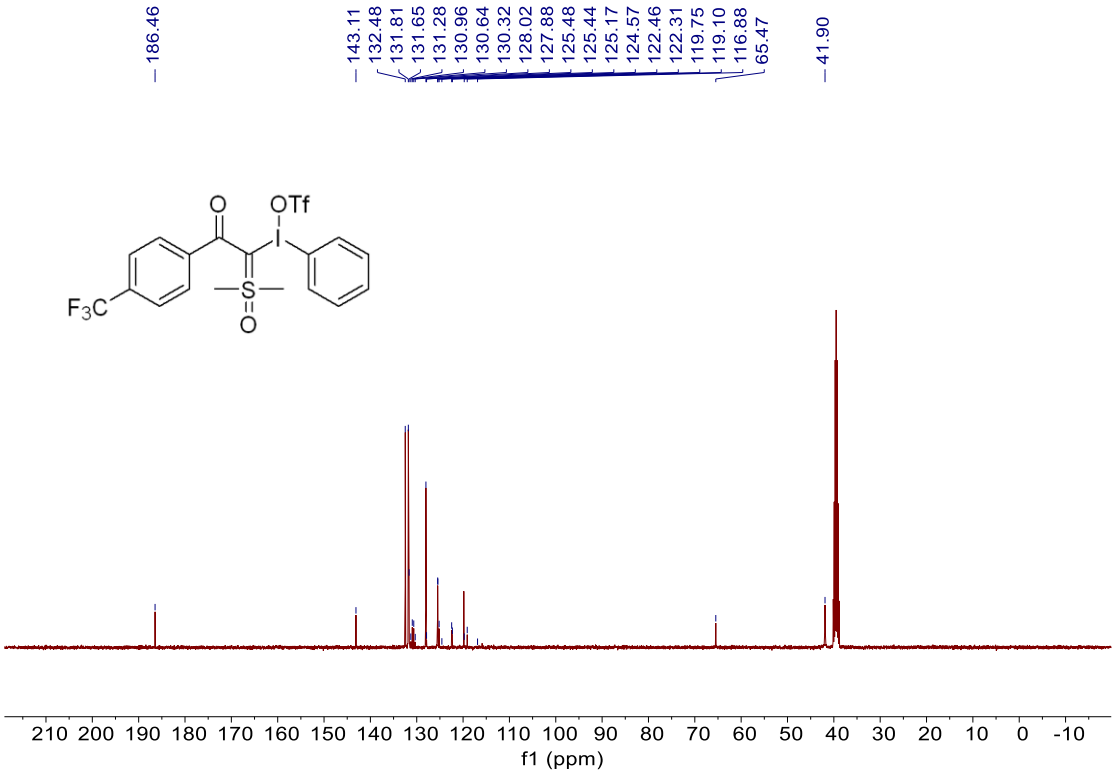
^{19}F NMR (376 MHz, DMSO-d_6) Spectra of **6c**



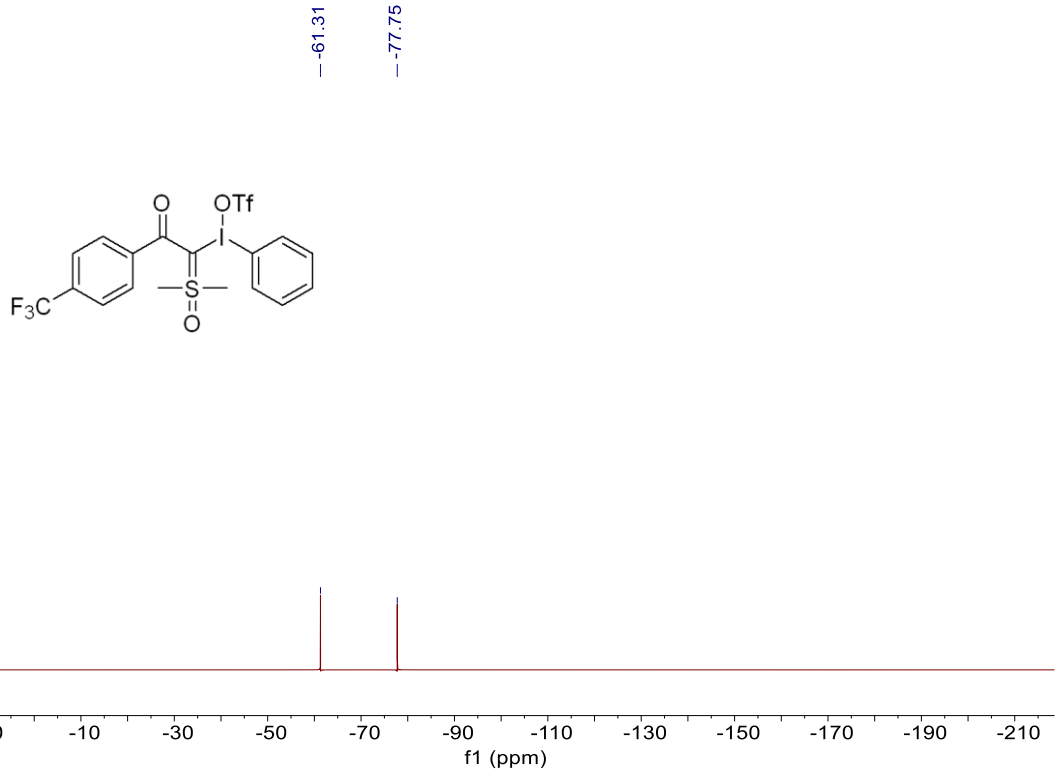
^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **6d**



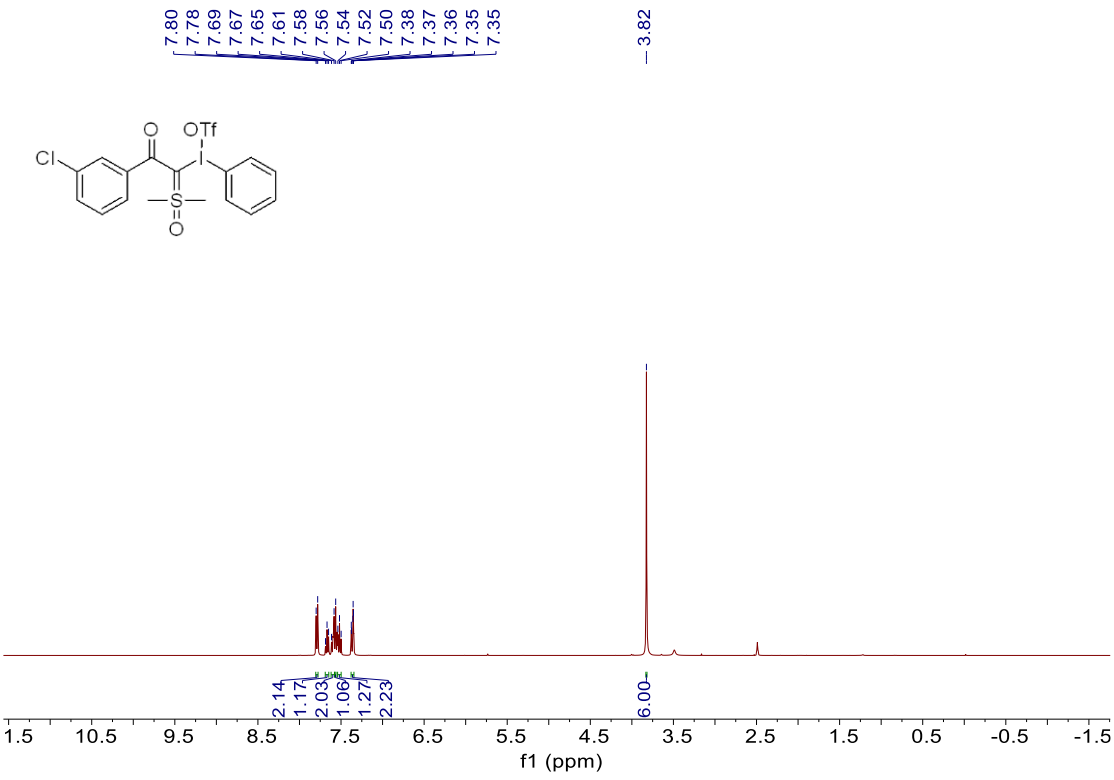
^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **6d**



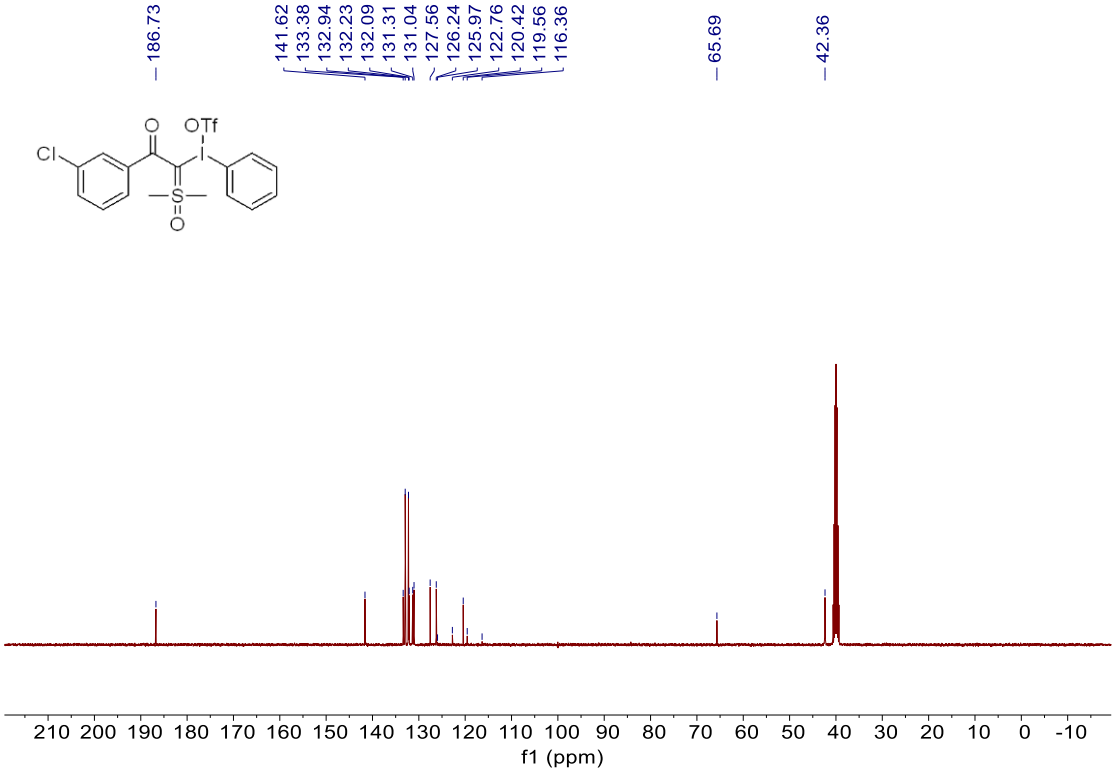
^{19}F NMR (376 MHz, DMSO-d_6) Spectra of **6d**



^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **6e**



^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **6e**



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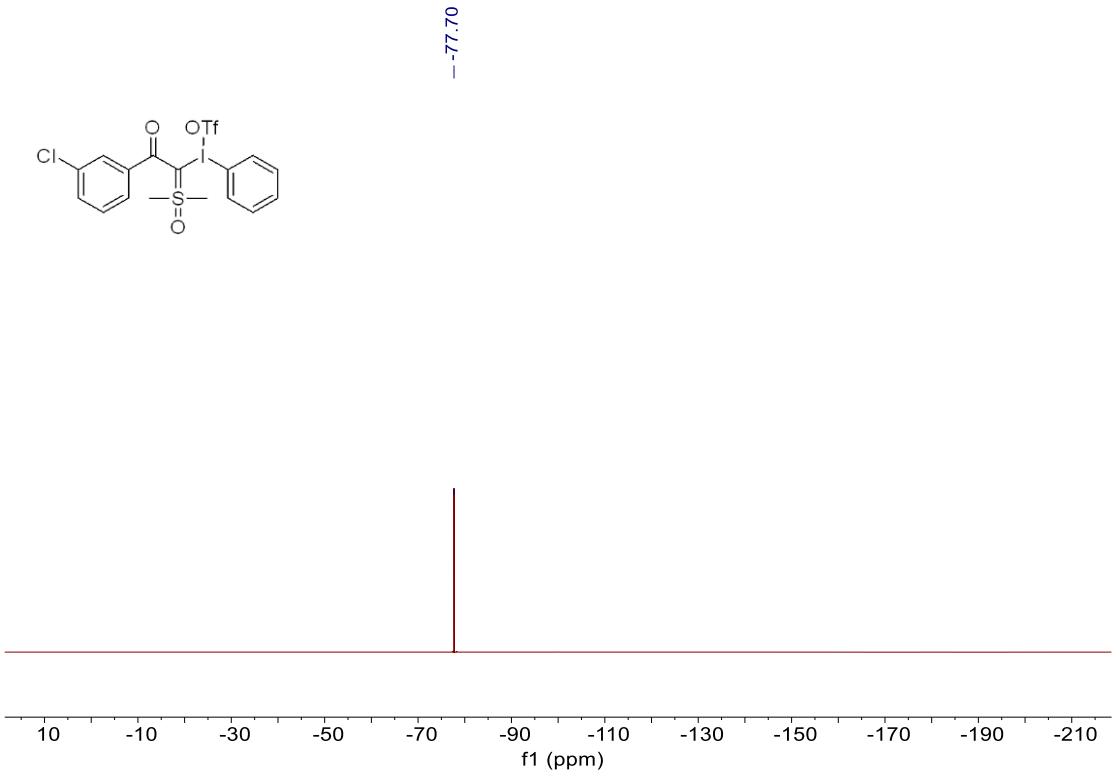

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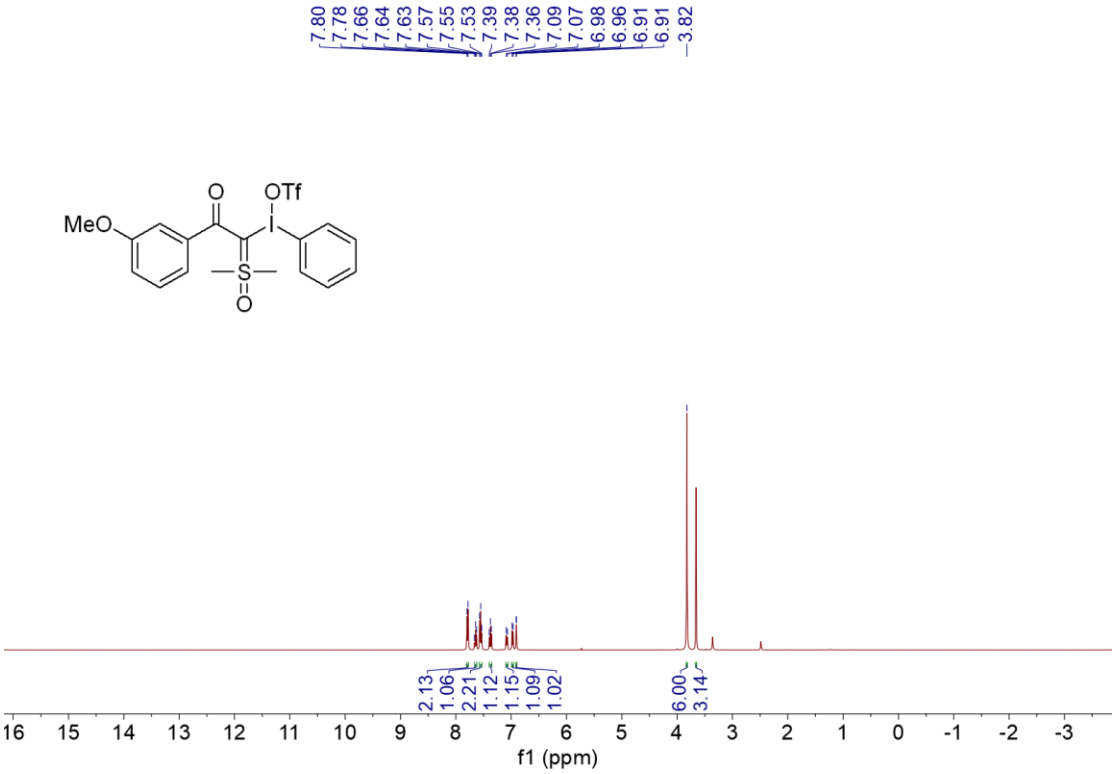
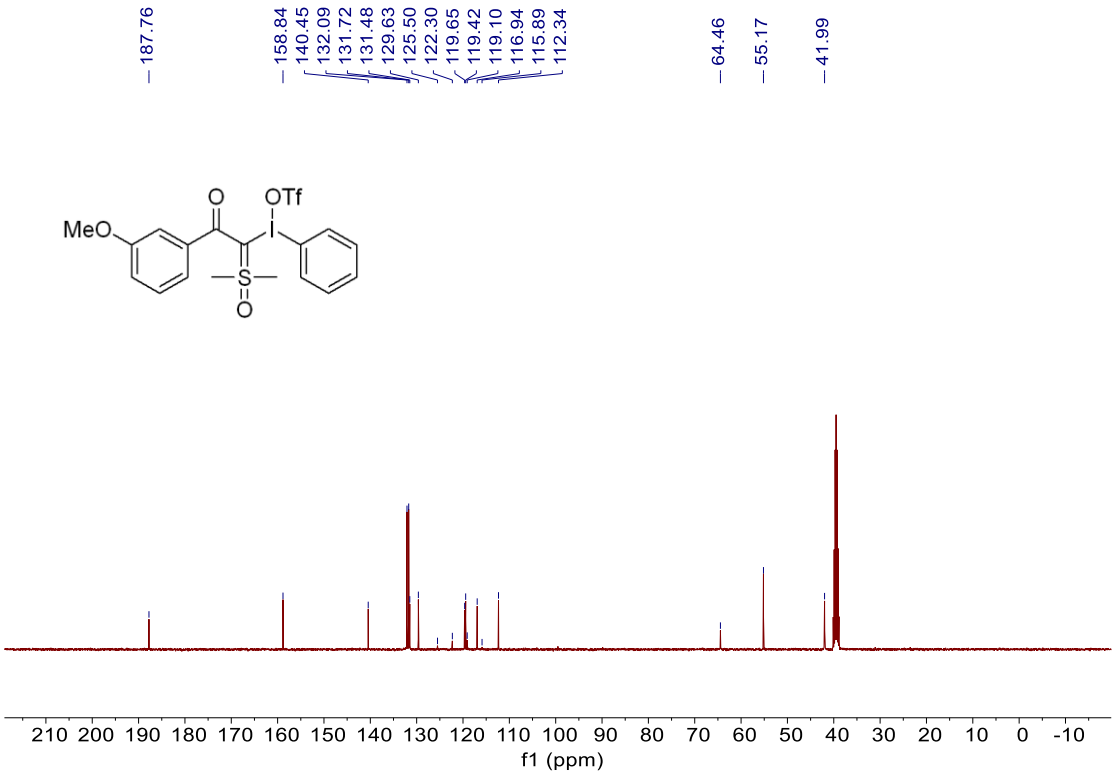
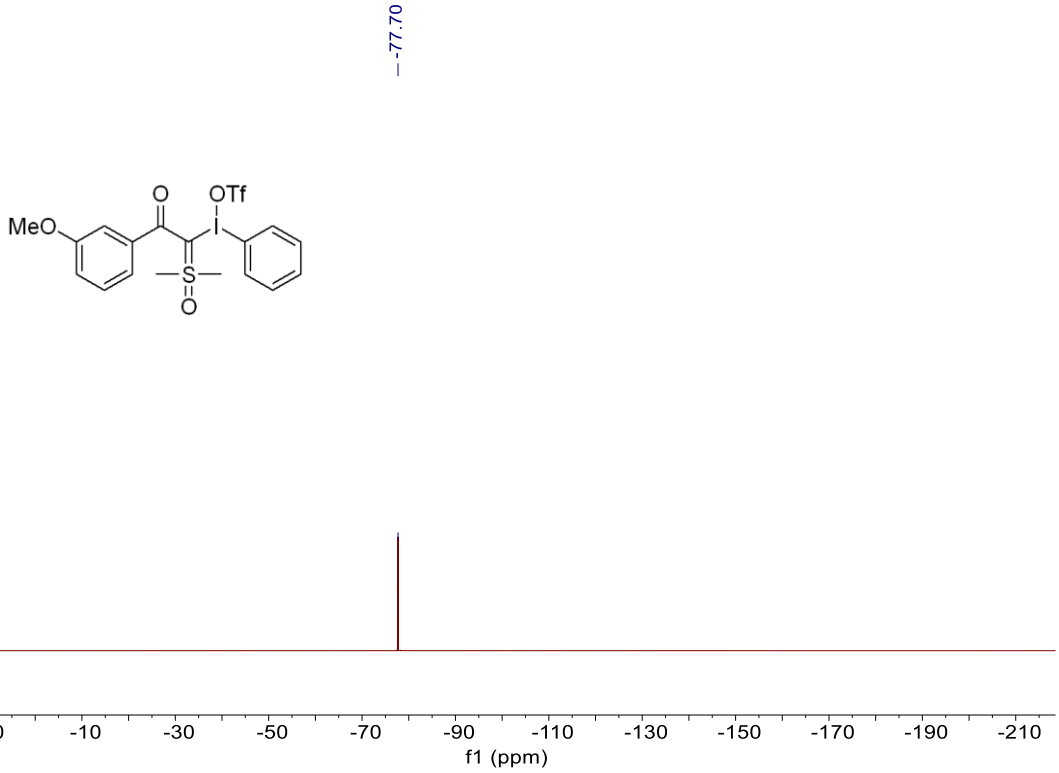


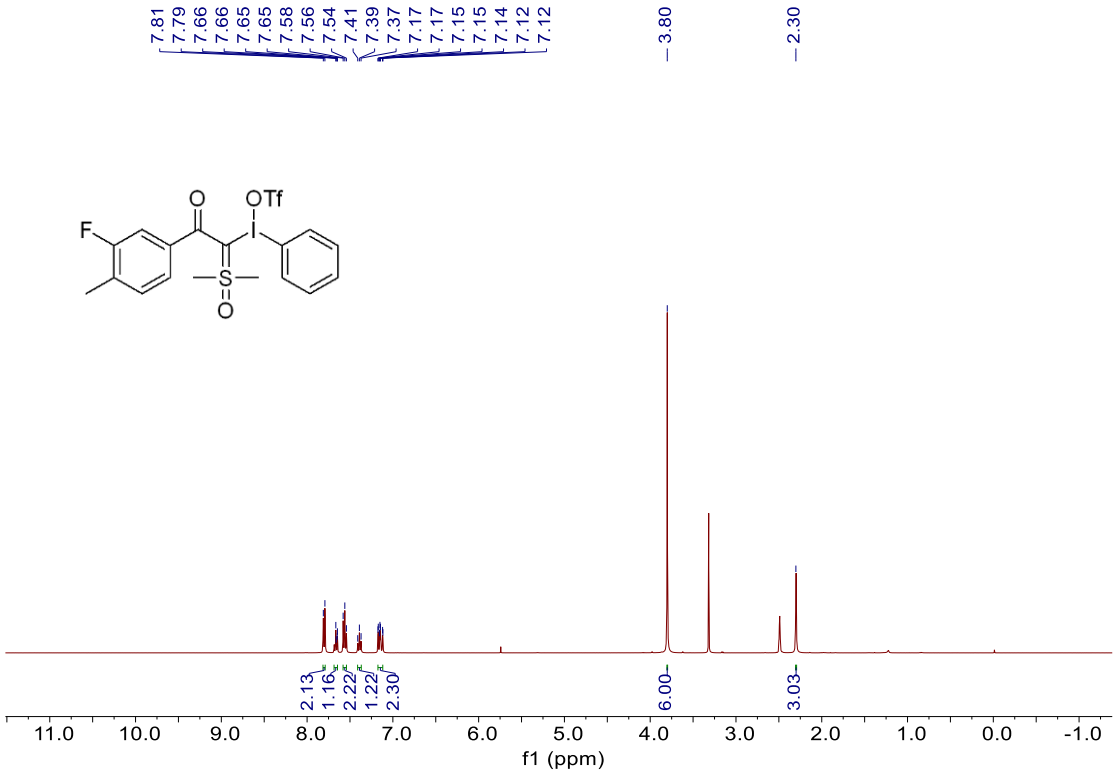
^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **6f**



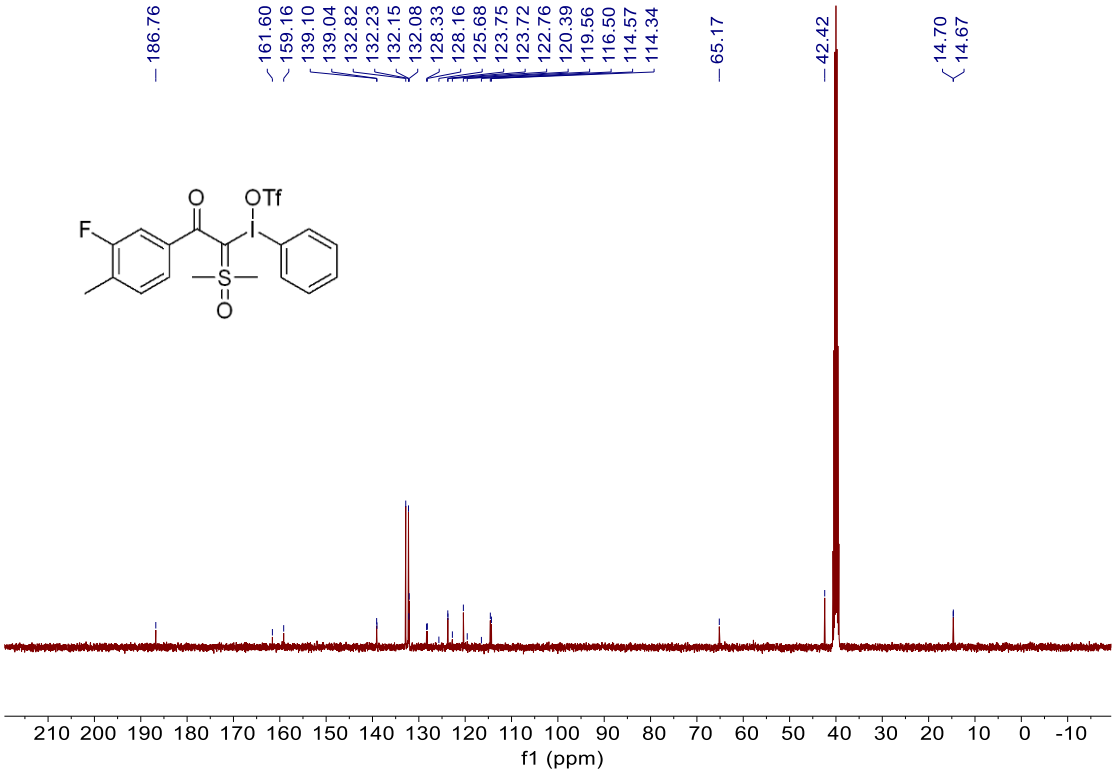
^{19}F NMR (376 MHz, DMSO-d$_6$) Spectra of **6f**



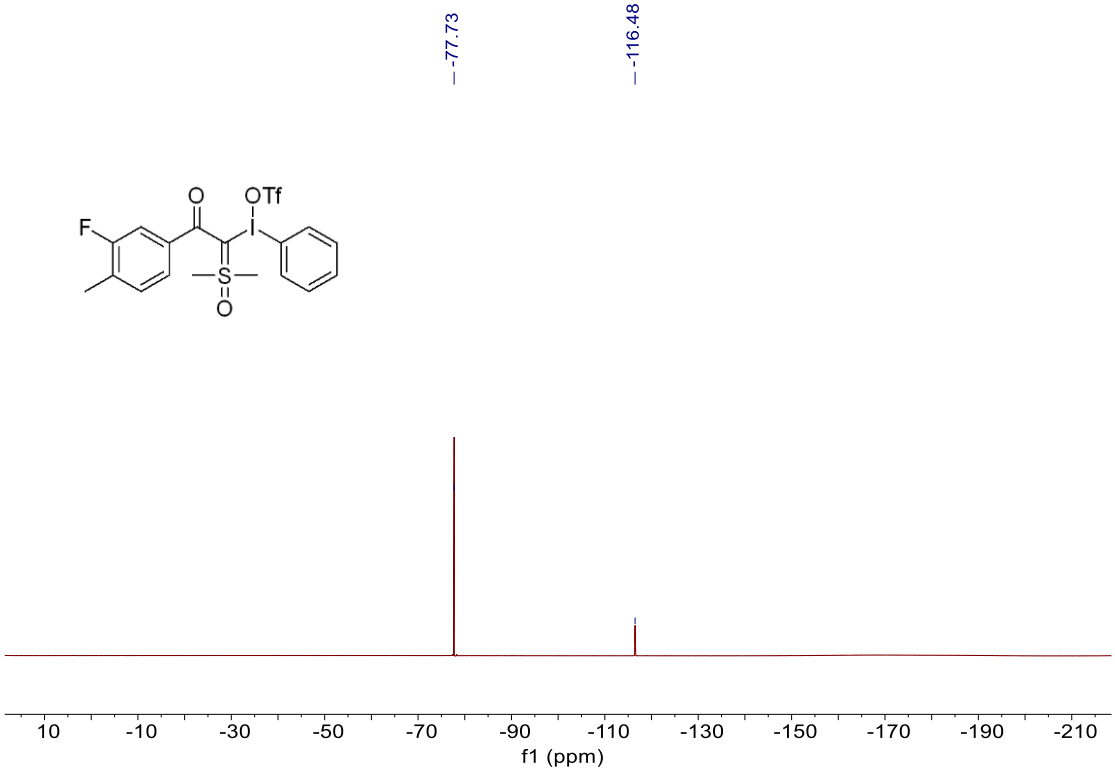
^{1}H NMR (400 MHz, DMSO-d$_6$) Spectra of **6g**



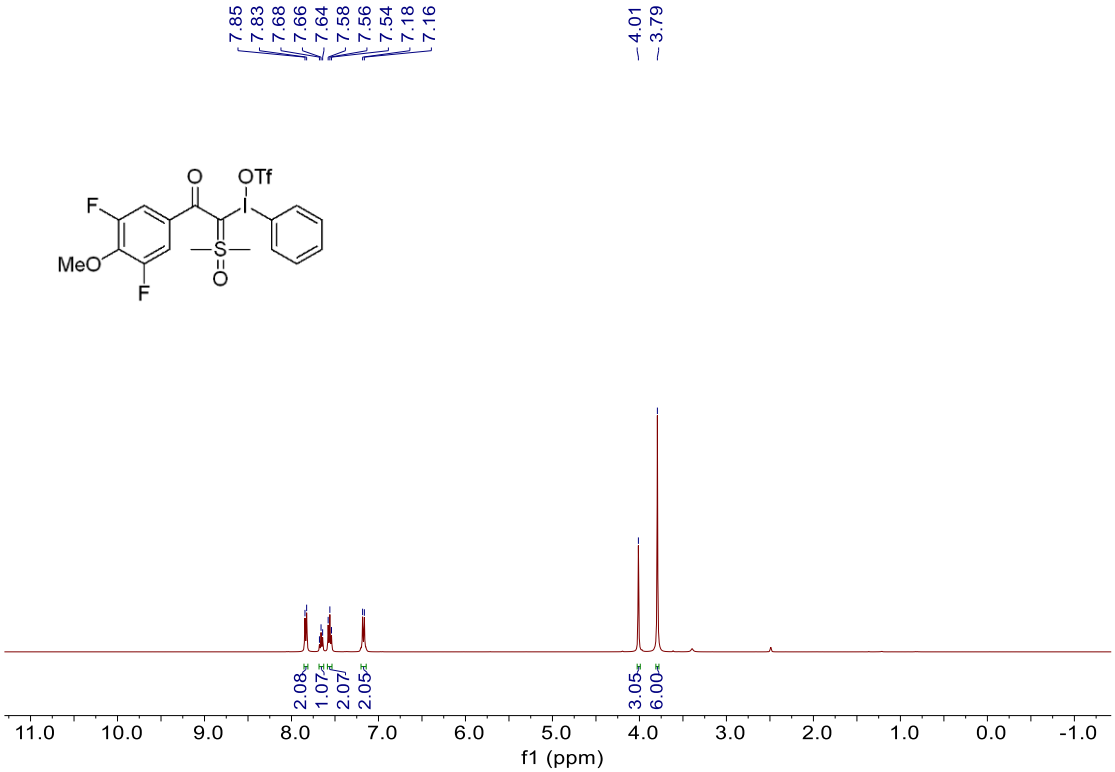
^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **6g**



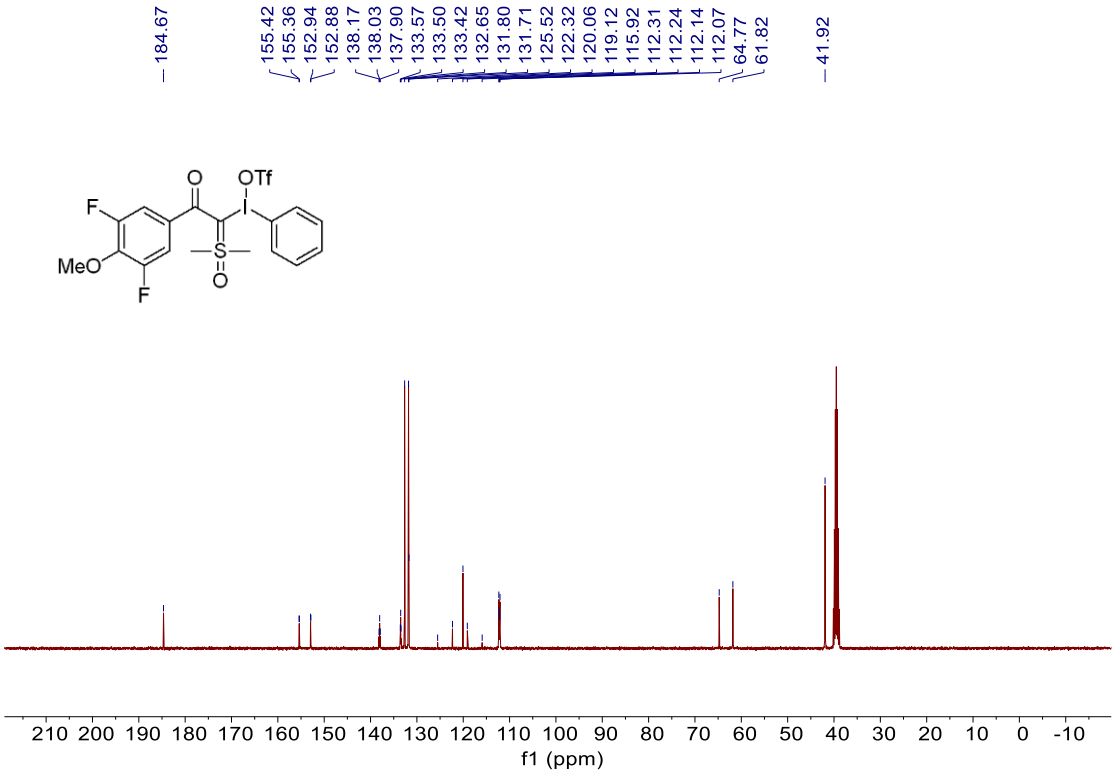
^{19}F NMR (376 MHz, DMSO-d_6) Spectra of **6g**



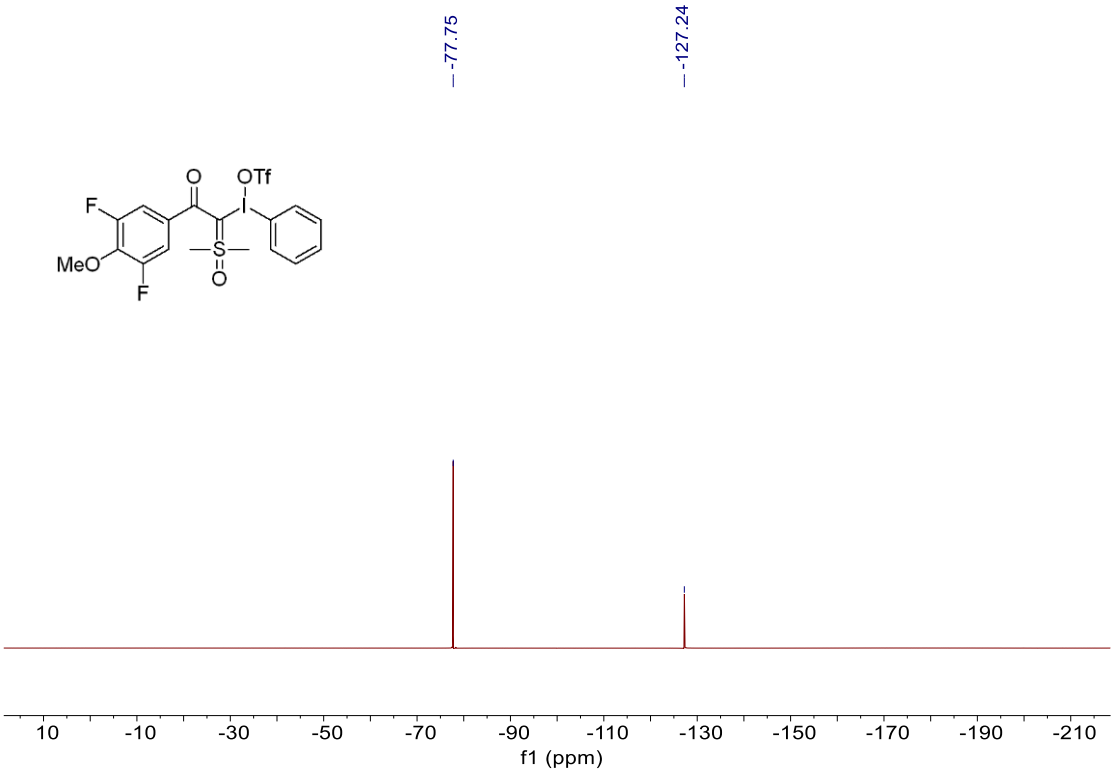
^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **6h**



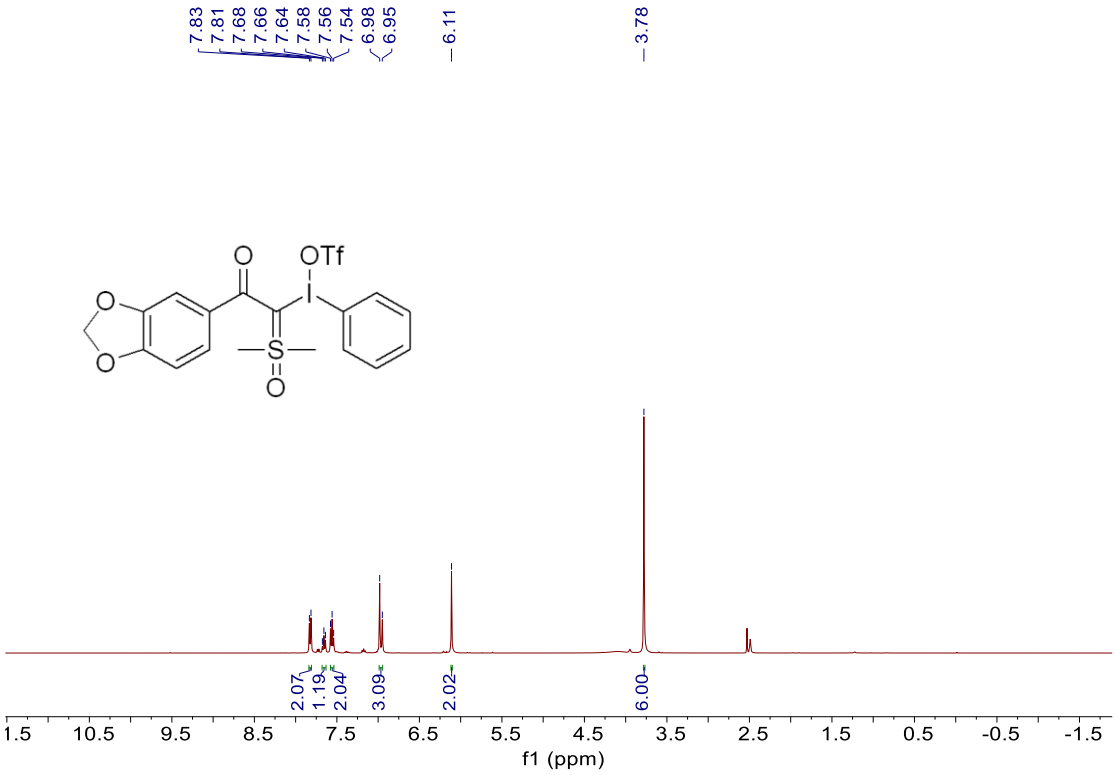
^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **6h**



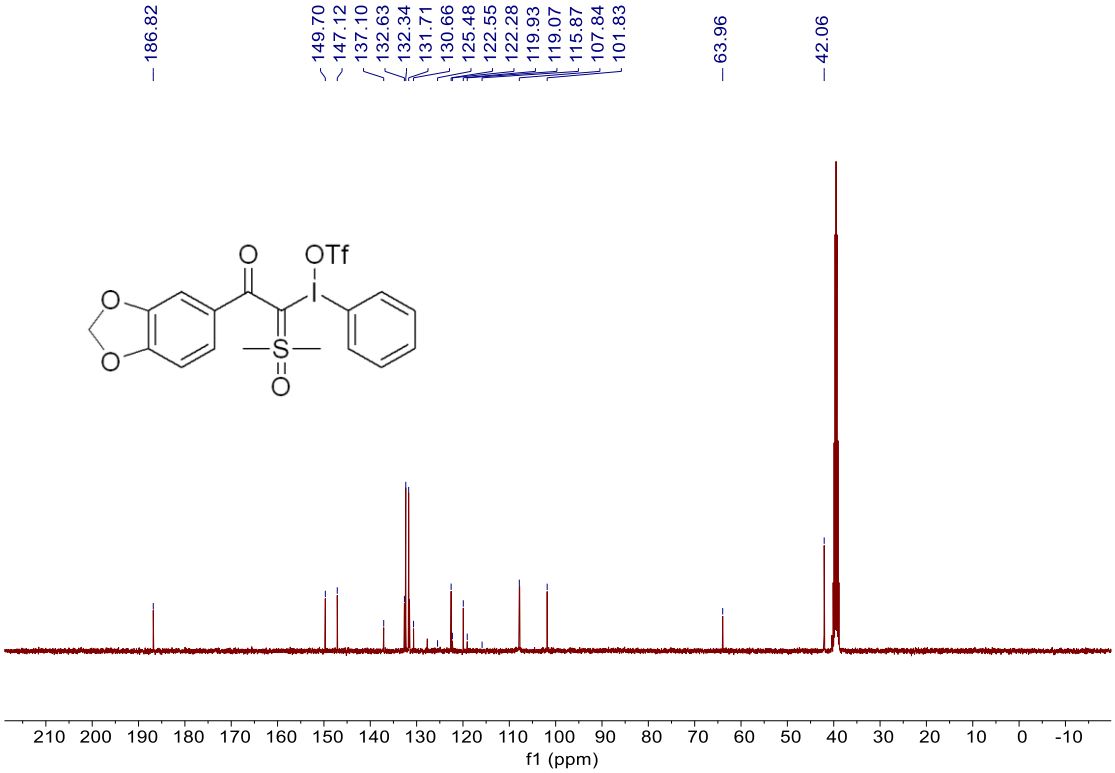
^{19}F NMR (376 MHz, DMSO-d_6) Spectra of **6h**



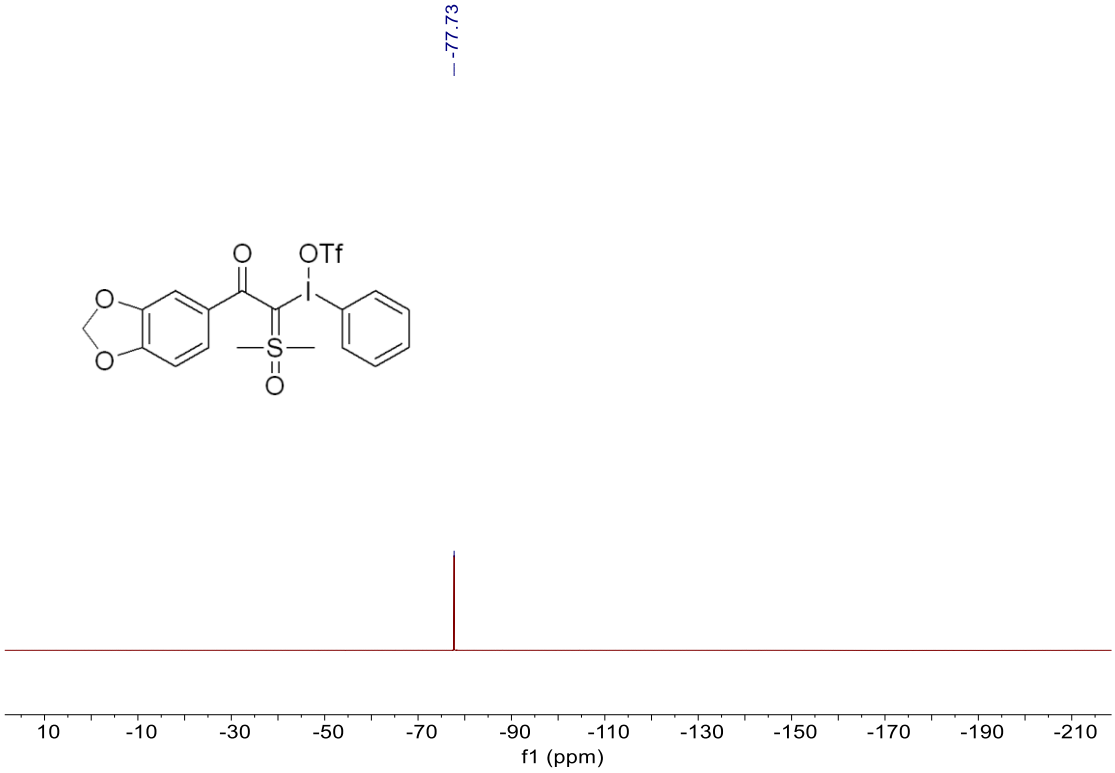
^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **6i**



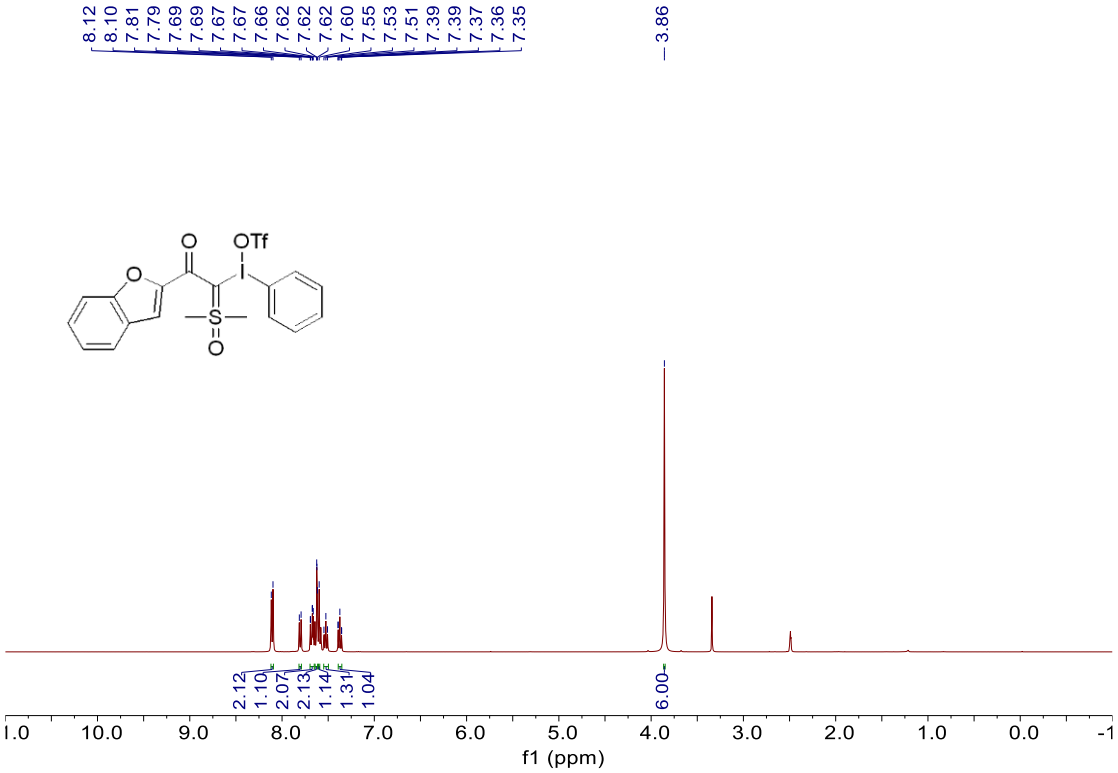
^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **6i**



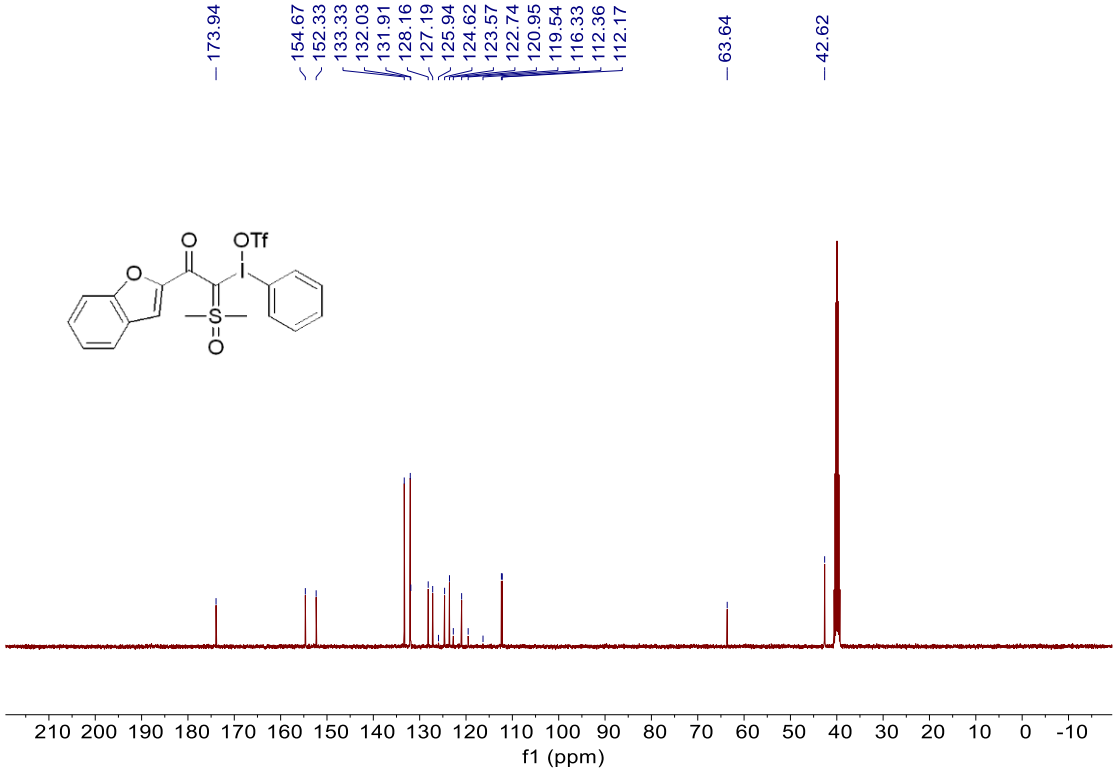
^{19}F NMR (376 MHz, DMSO-d_6) Spectra of **6i**



^{1}H NMR (400 MHz, DMSO-d$_6$) Spectra of **6j**



^{13}C NMR (101 MHz, DMSO-d$_6$) Spectra of **6j**



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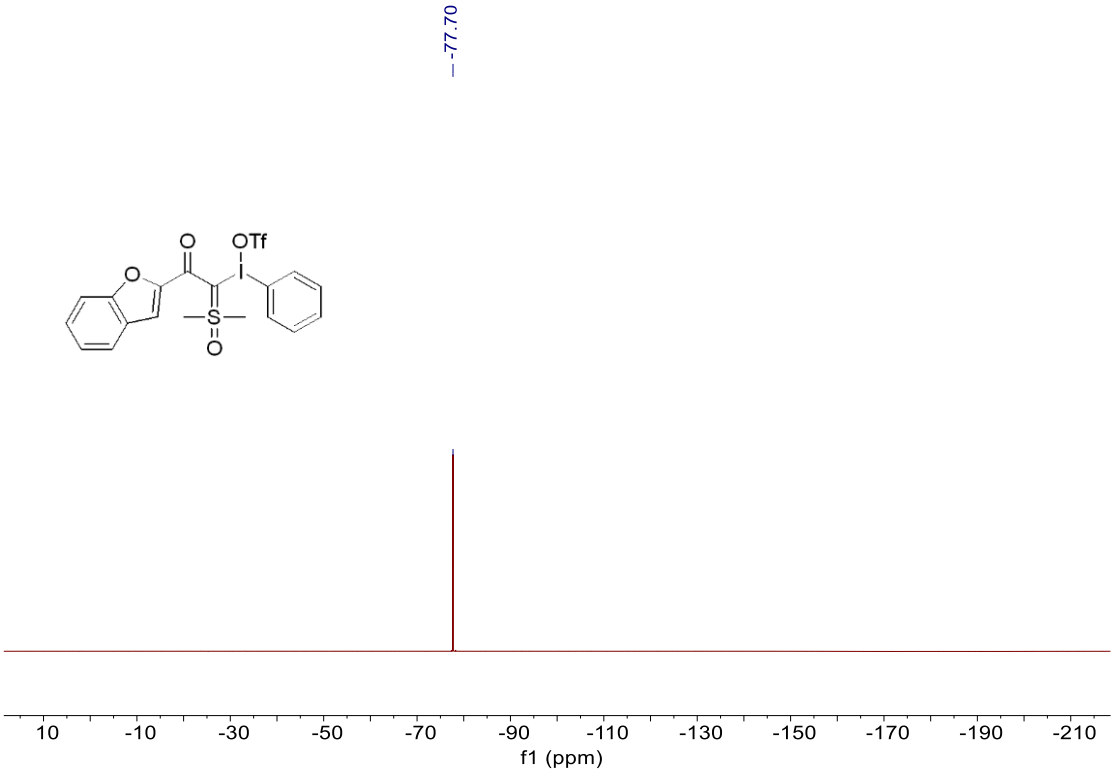
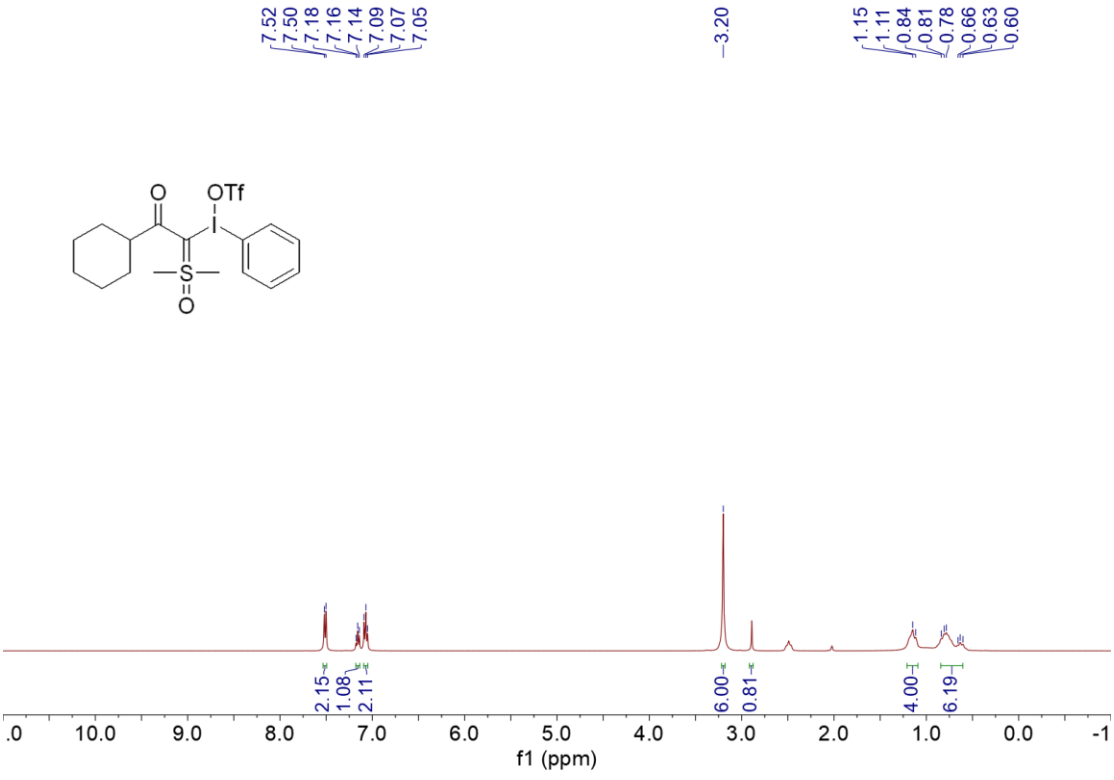
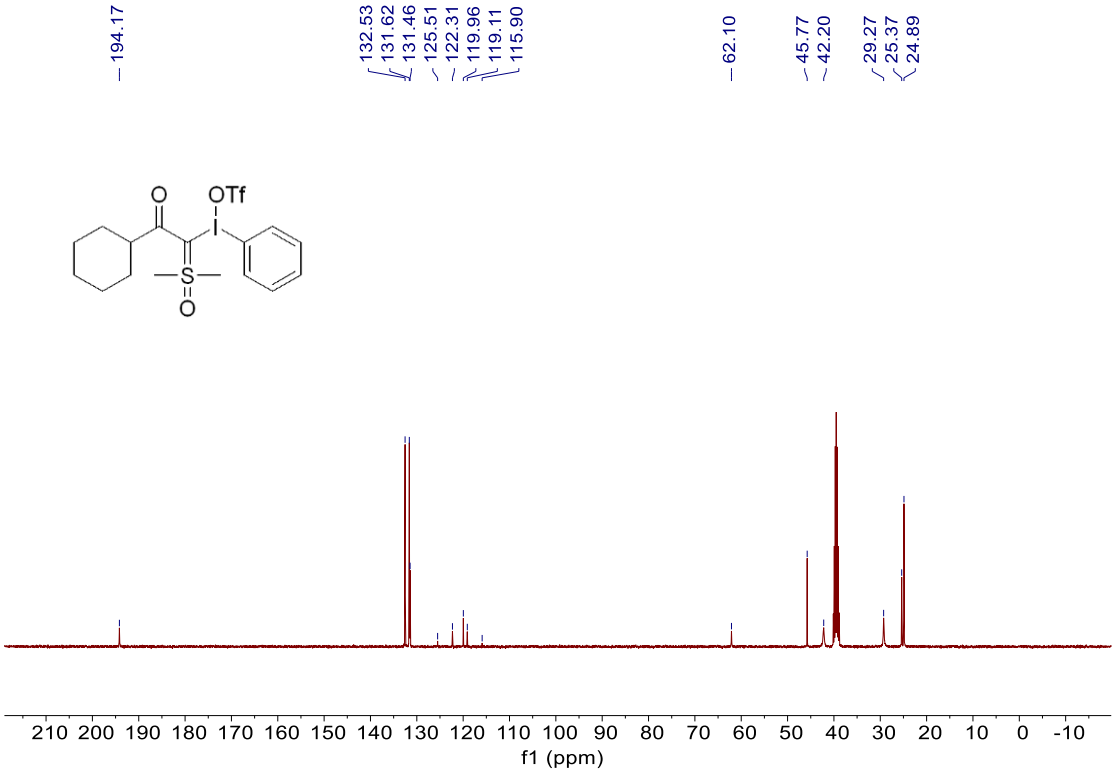


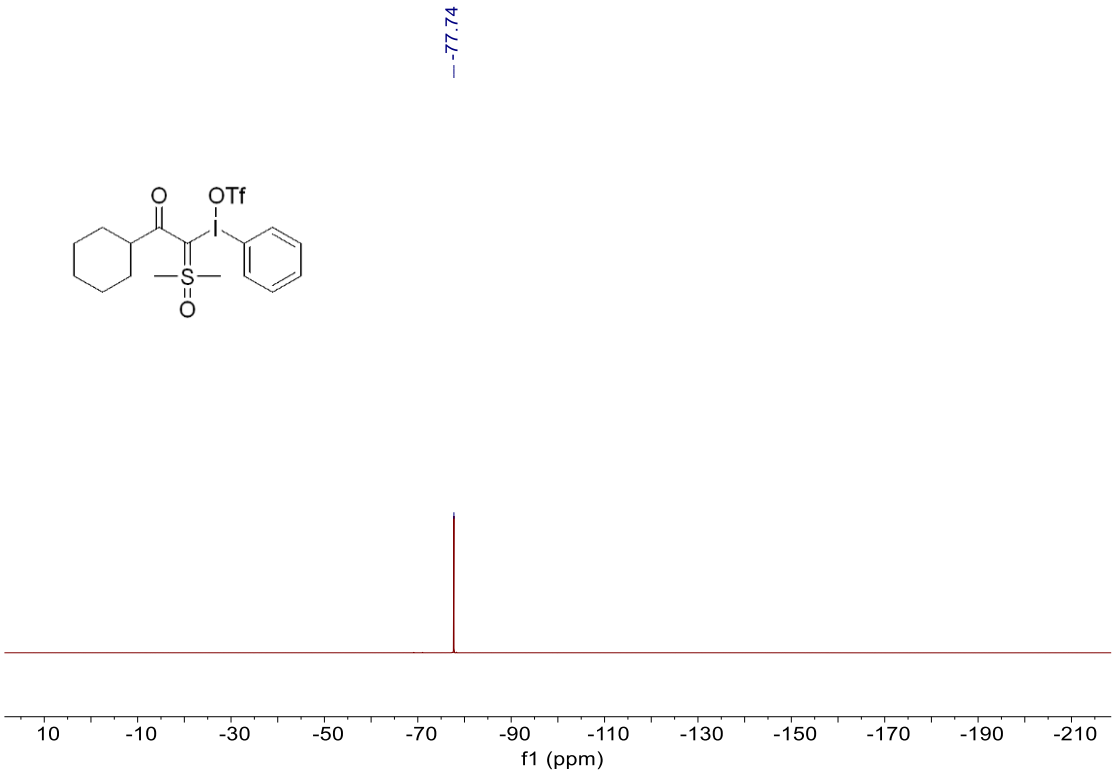
^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **6k**



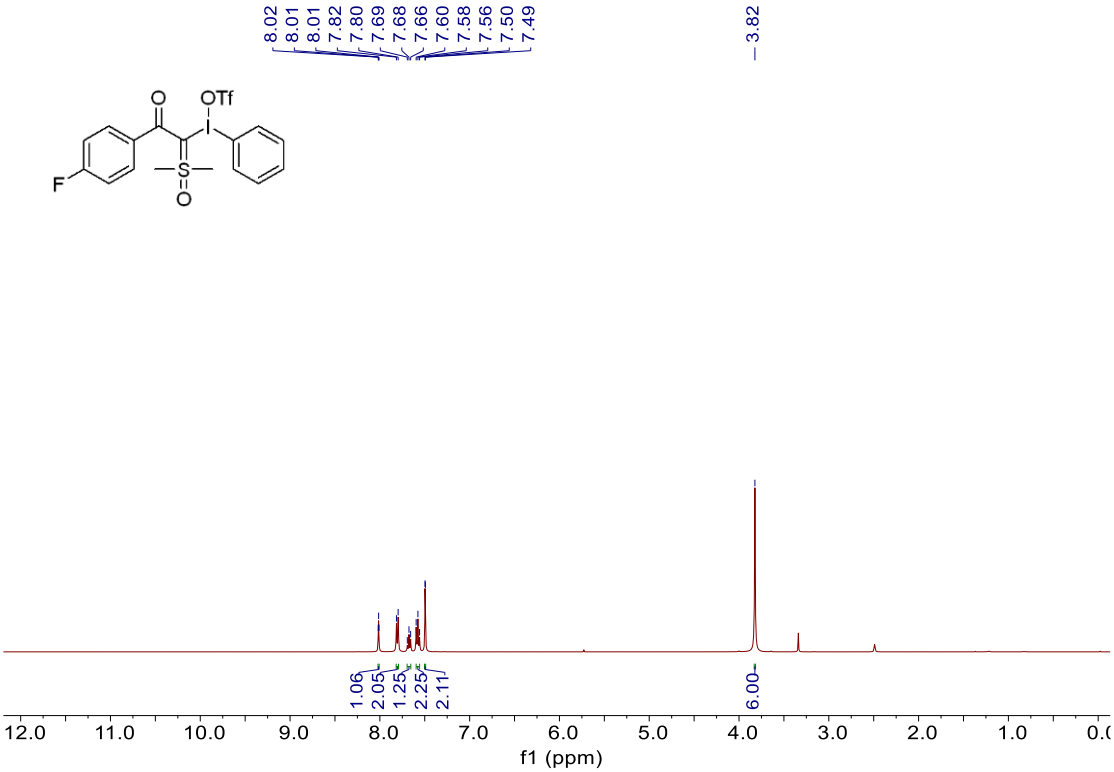
^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **6k**



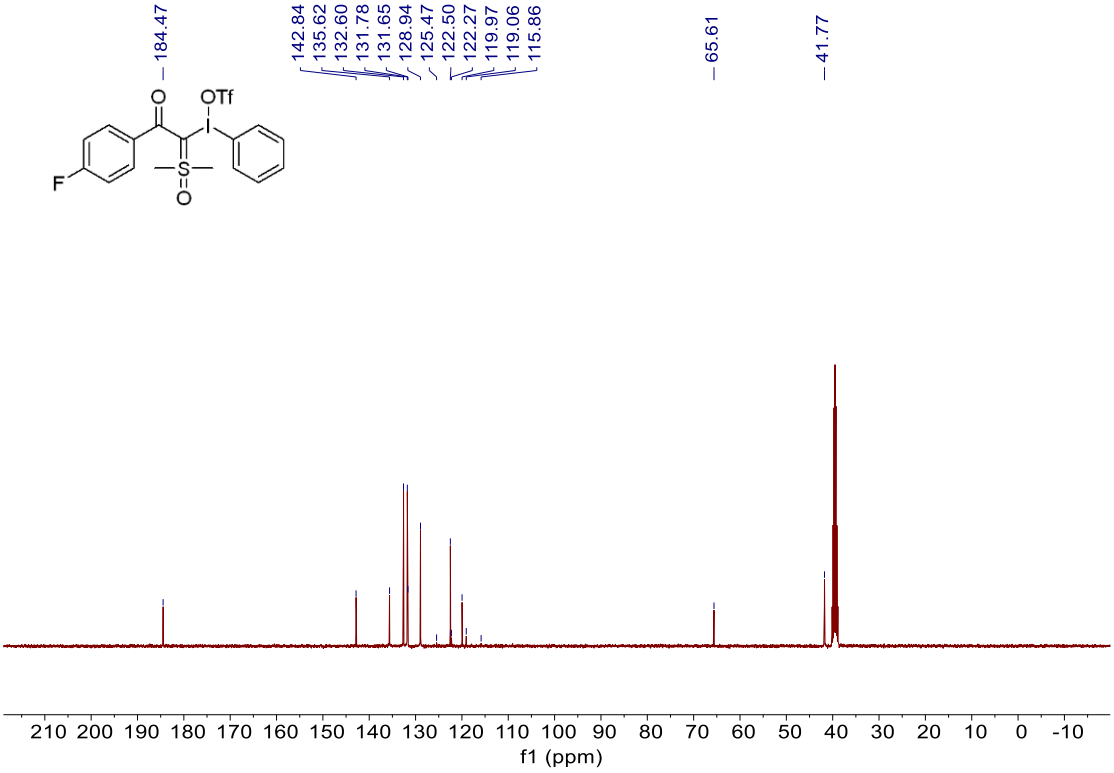
^{19}F NMR (376 MHz, DMSO-d_6) Spectra of **6k**



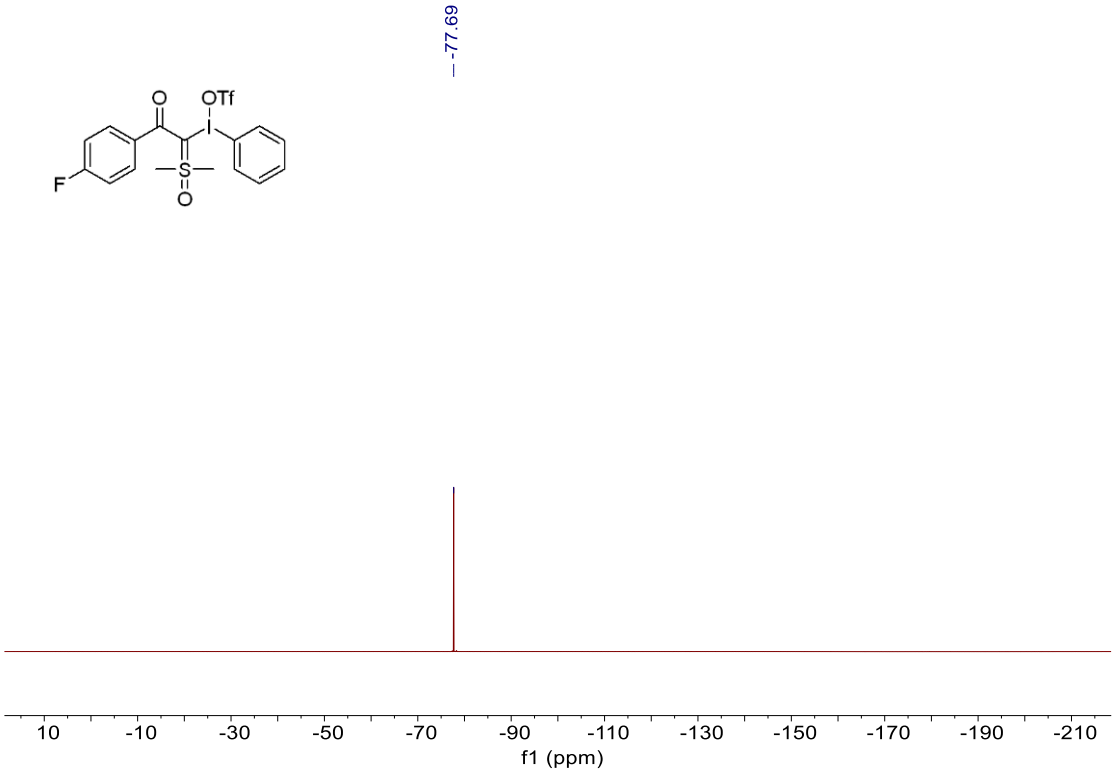
^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **6l**



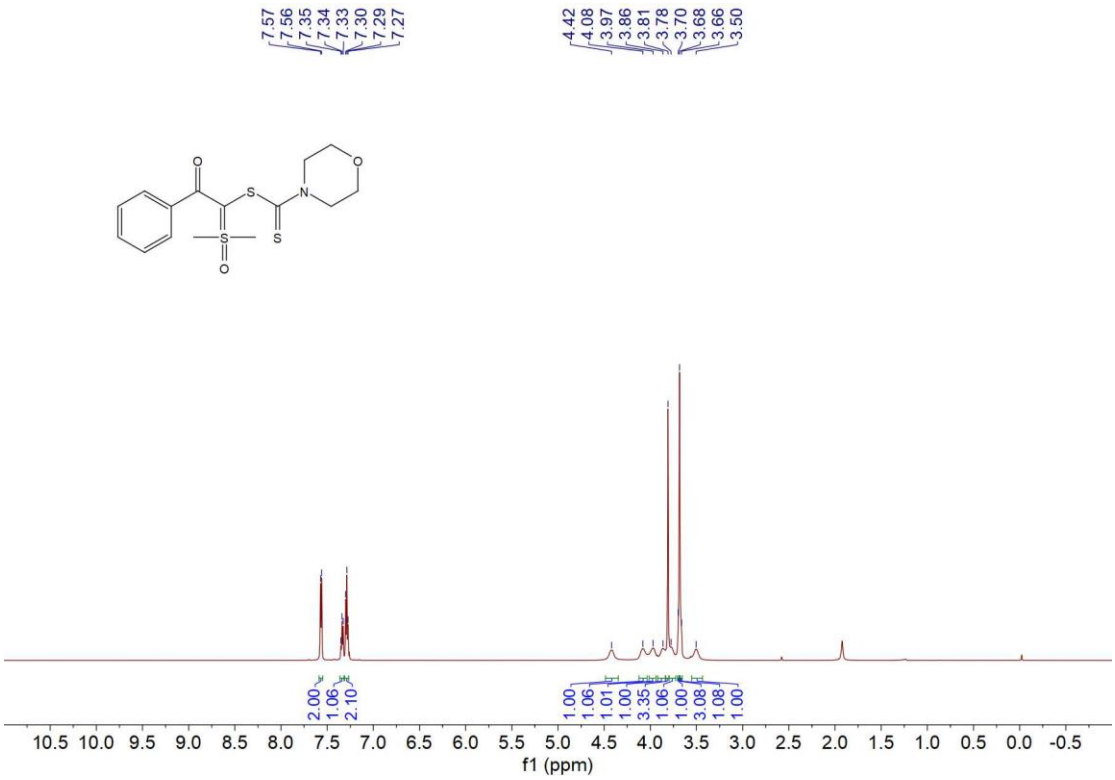
^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **6l**



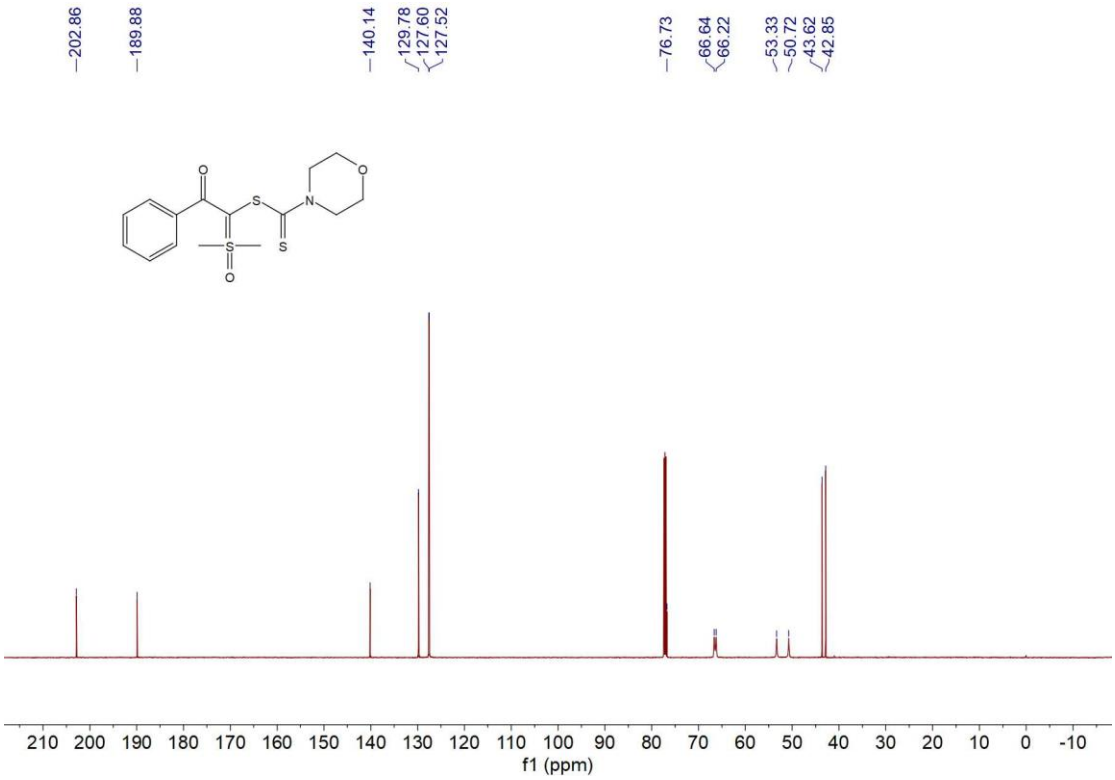
^{19}F NMR (376 MHz, DMSO-d_6) Spectra of **6l**



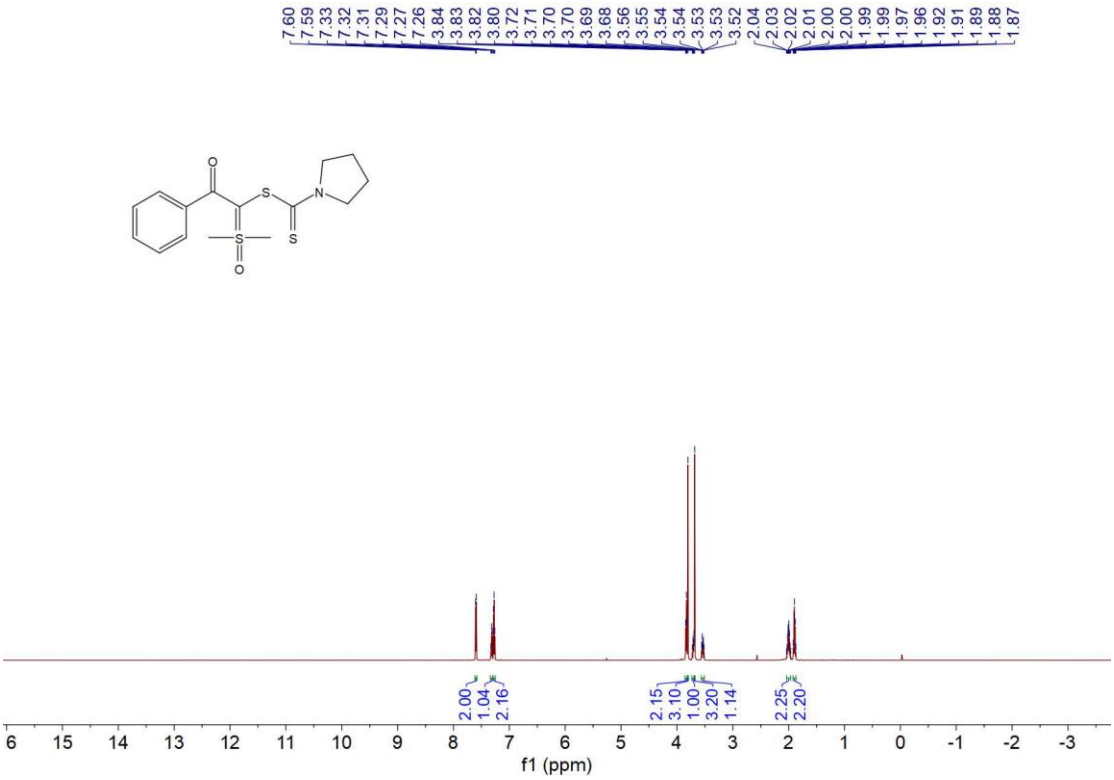
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3a**



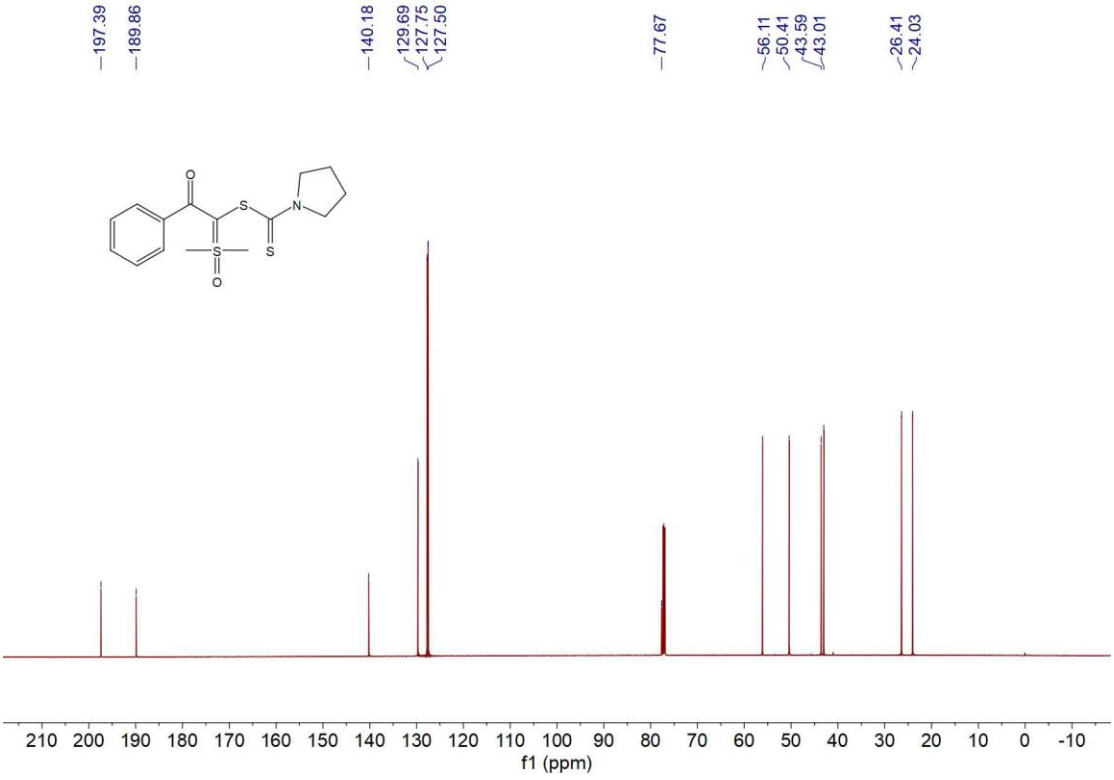
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3a**



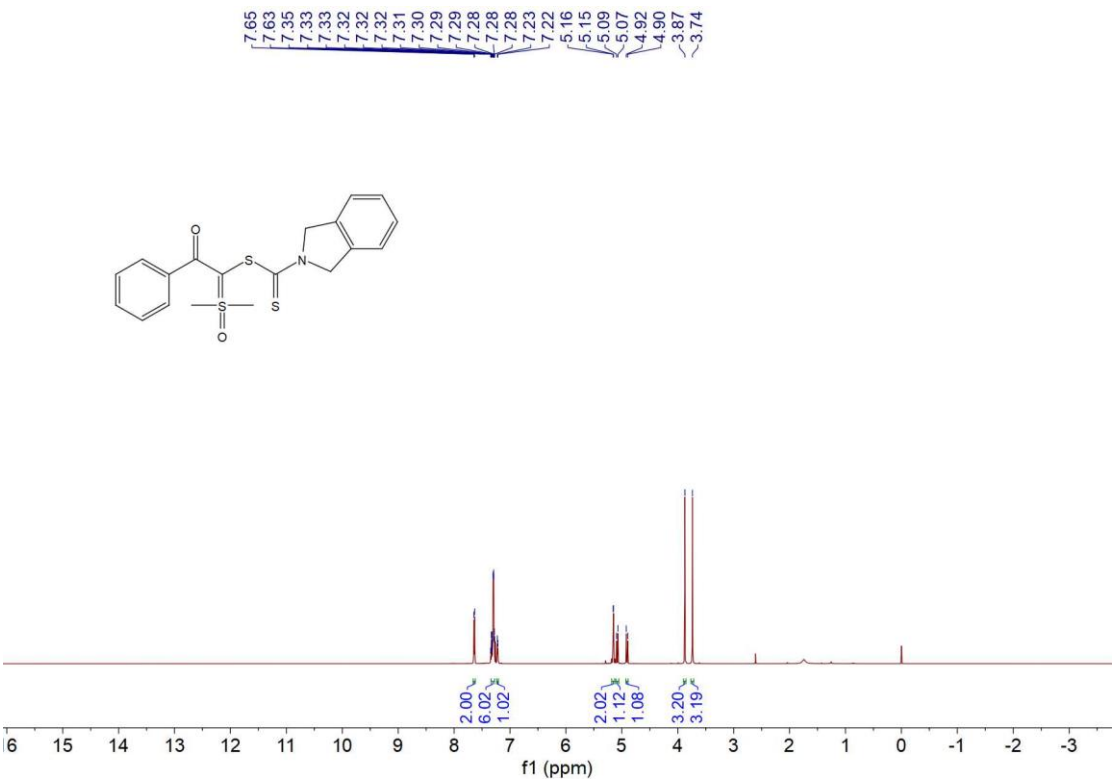
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3b**



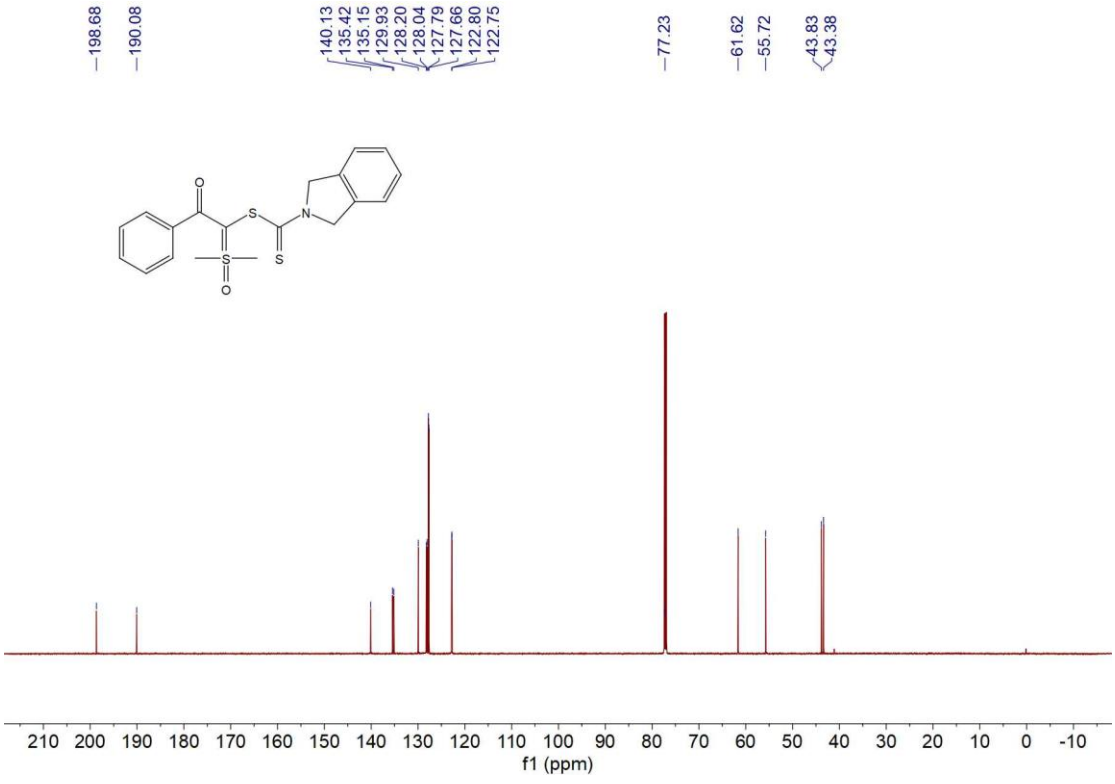
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3b**



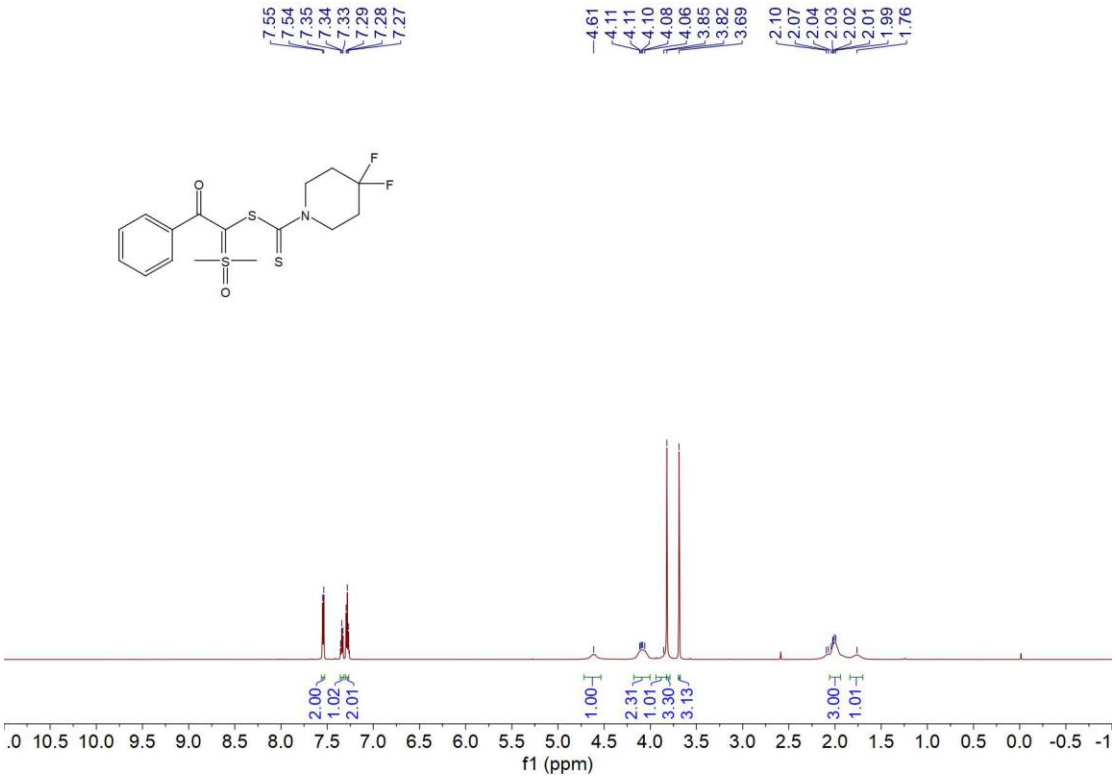
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3c**



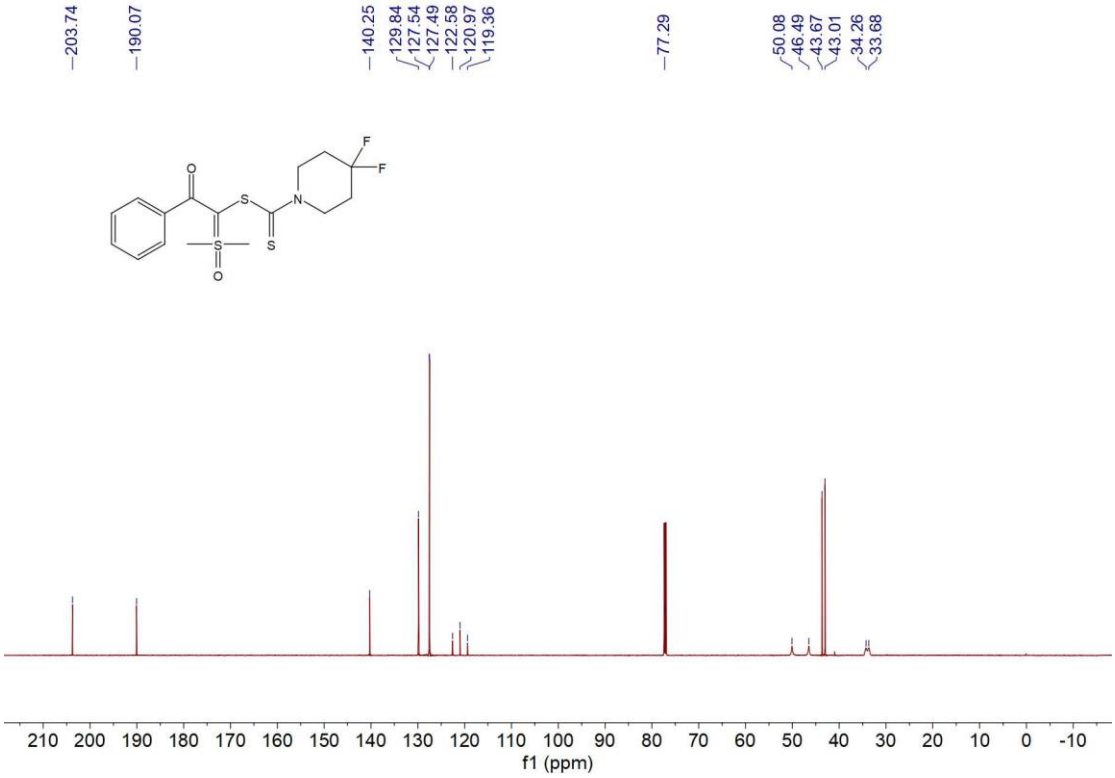
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3c**



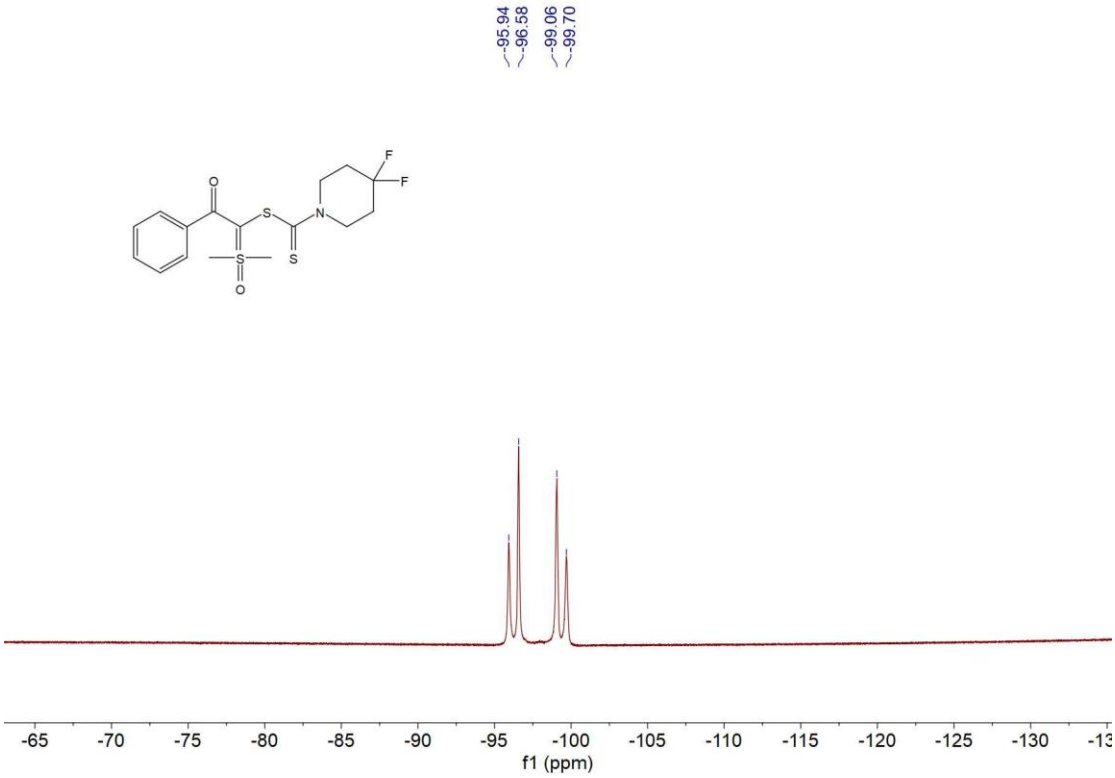
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3d**



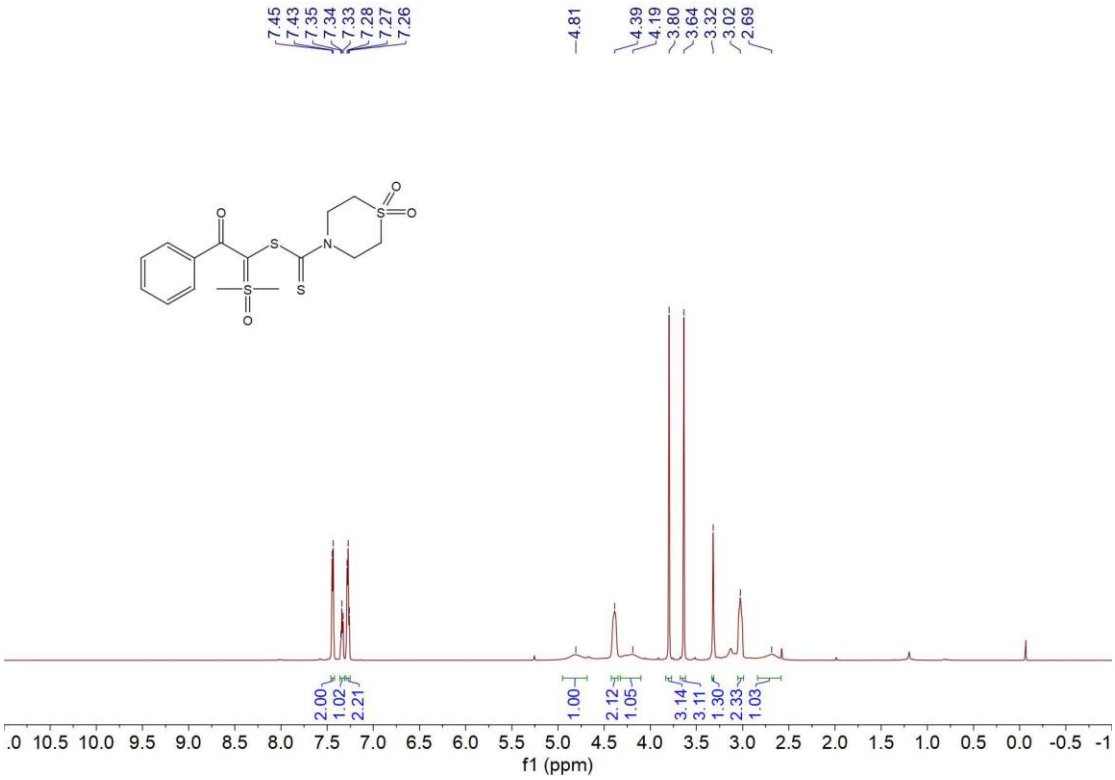
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3d**



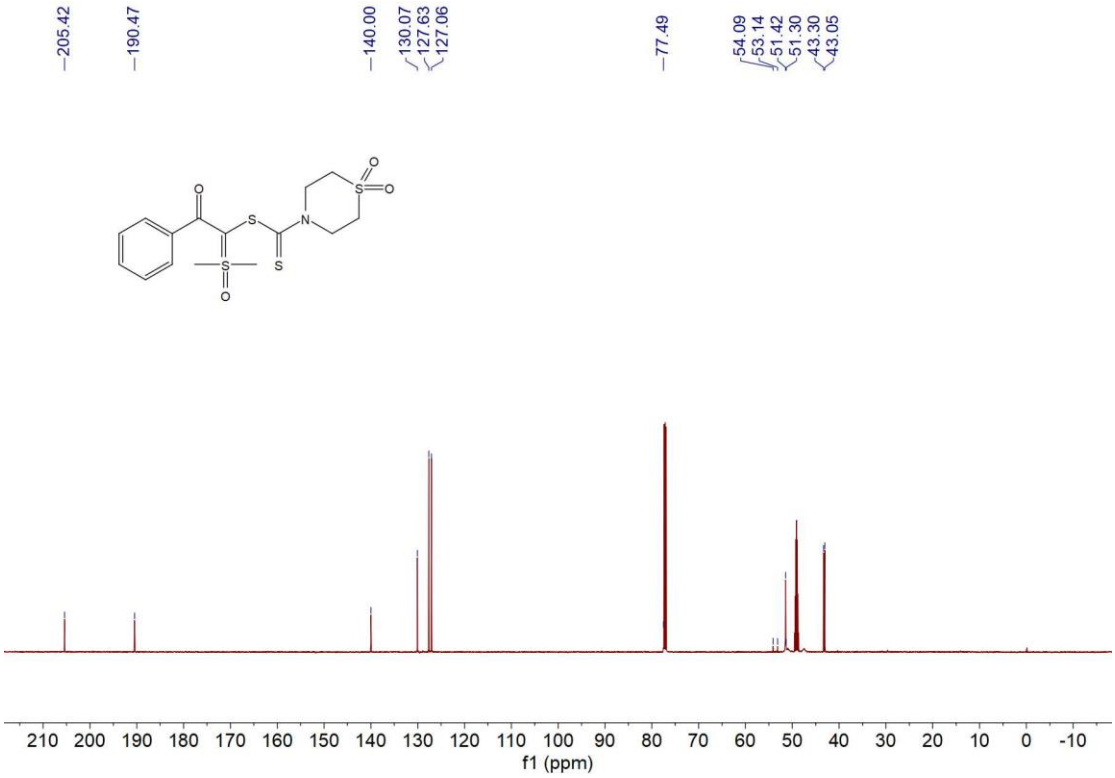
^{19}F NMR (377 MHz, $CDCl_3$) Spectra of **3d**



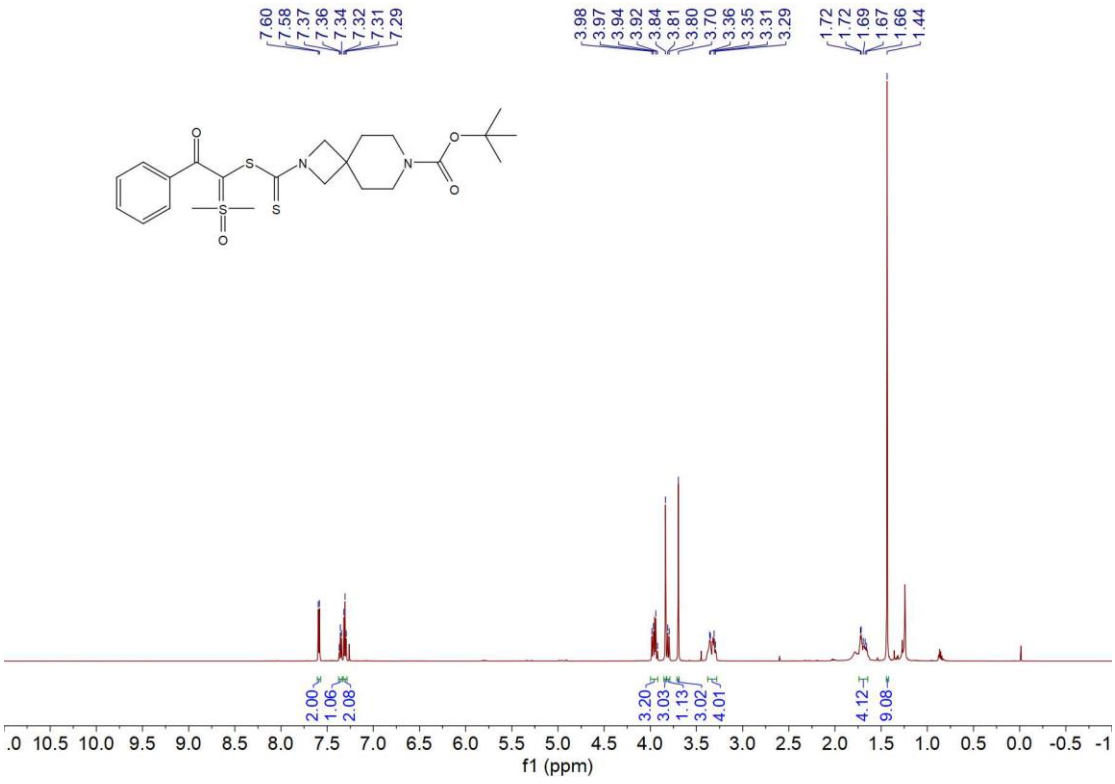
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3e**



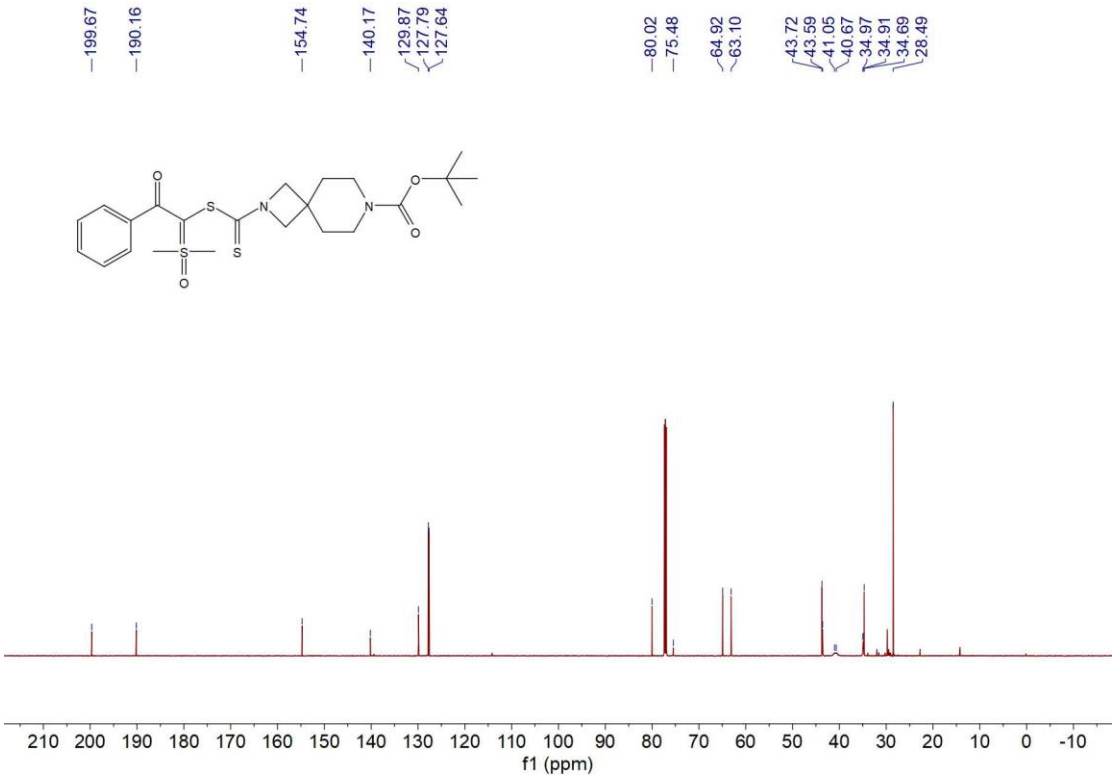
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3e**



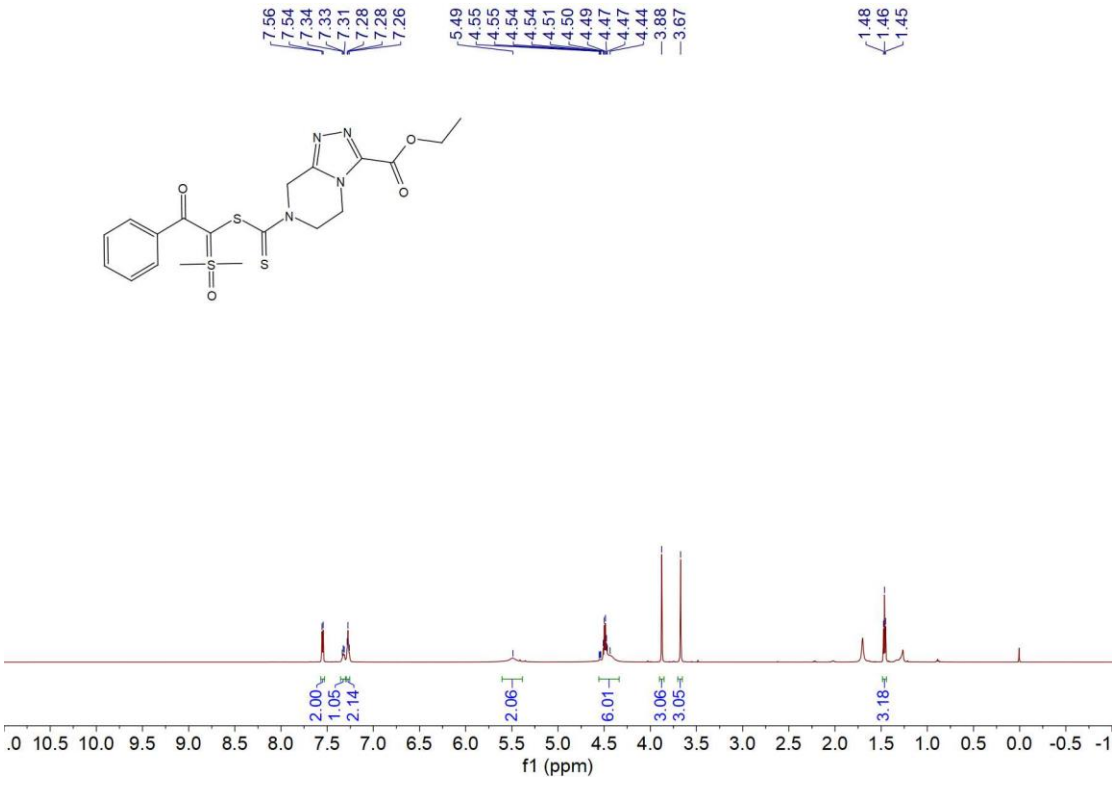
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3f**



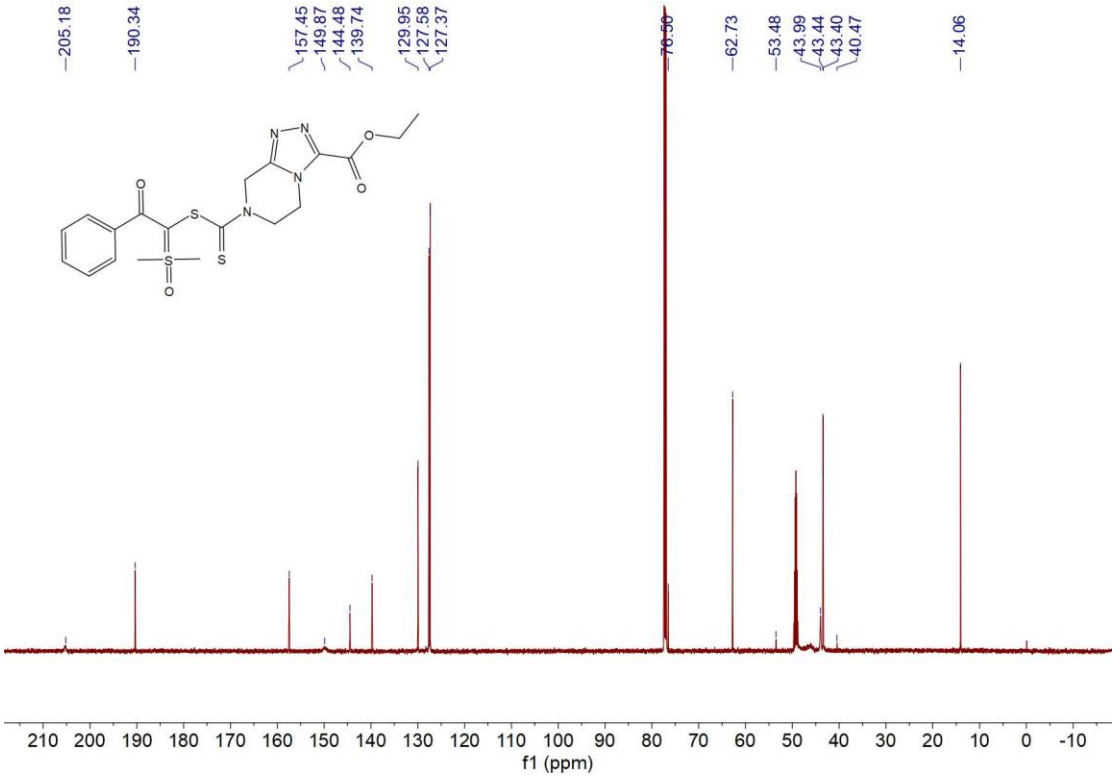
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3f**



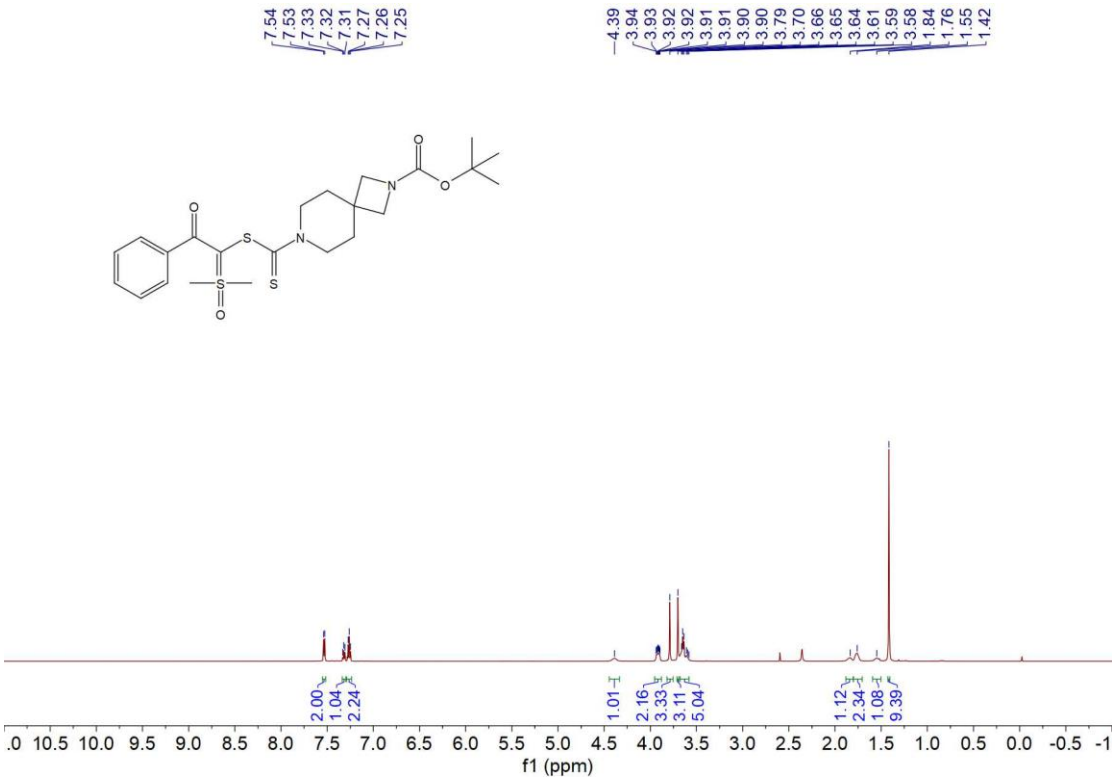
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3g**



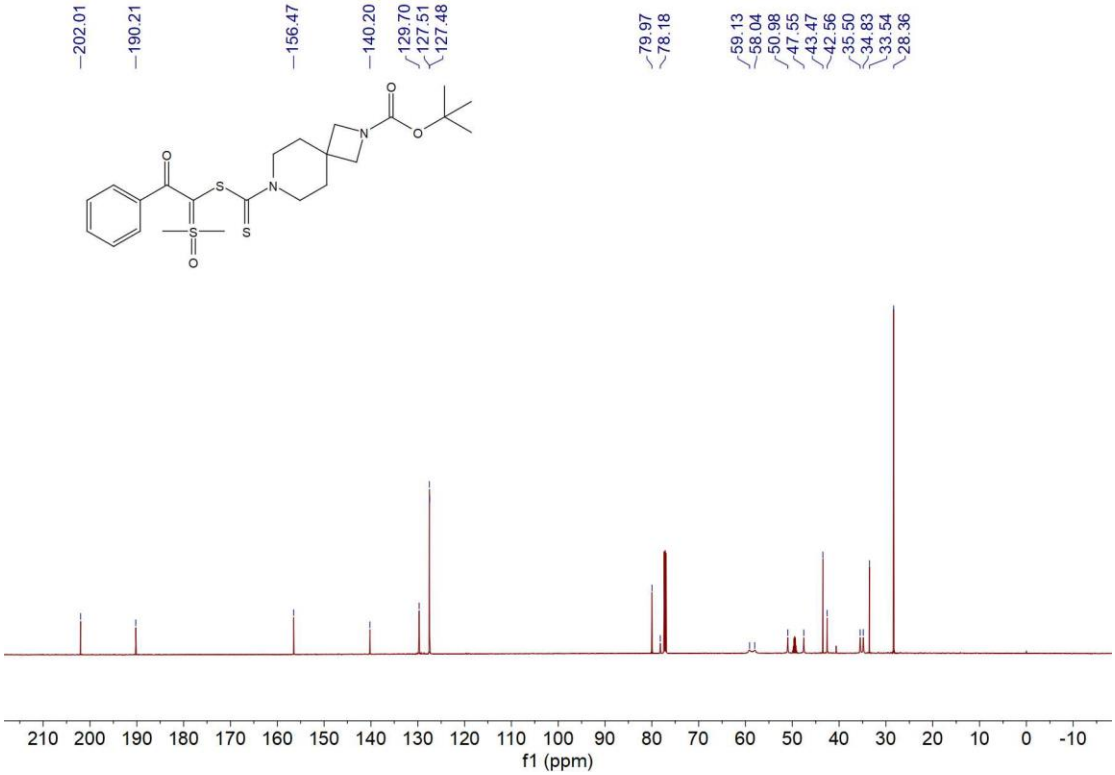
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3g**



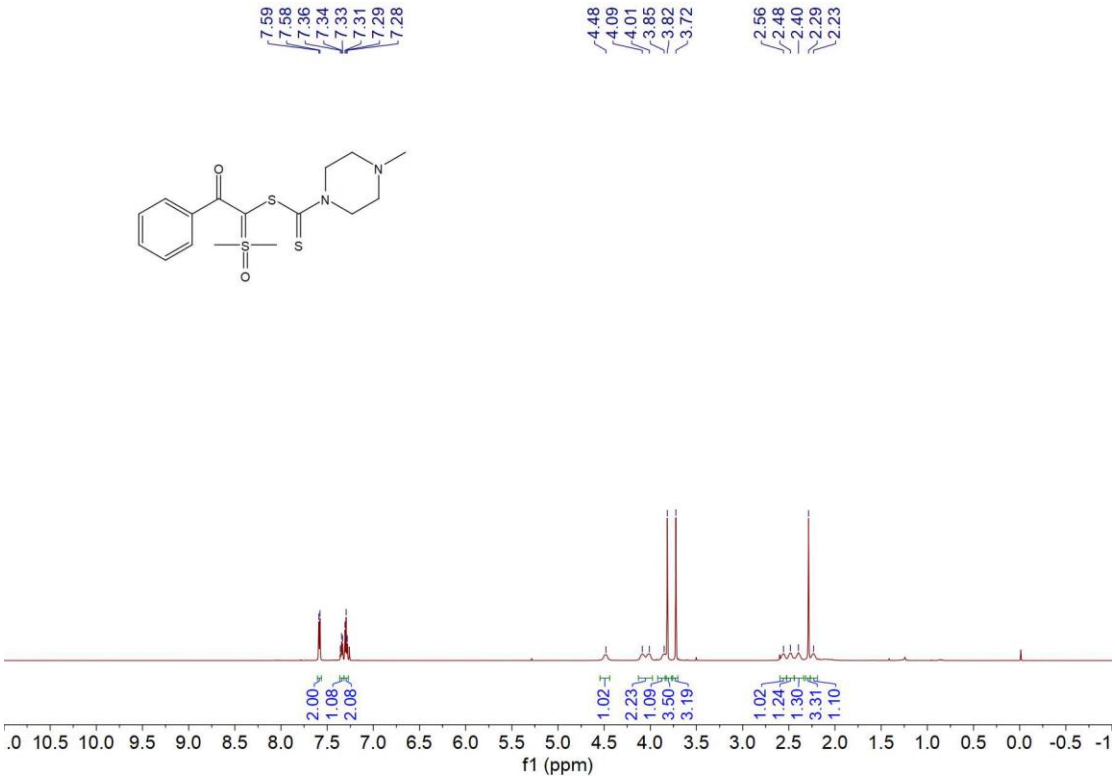
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3h**



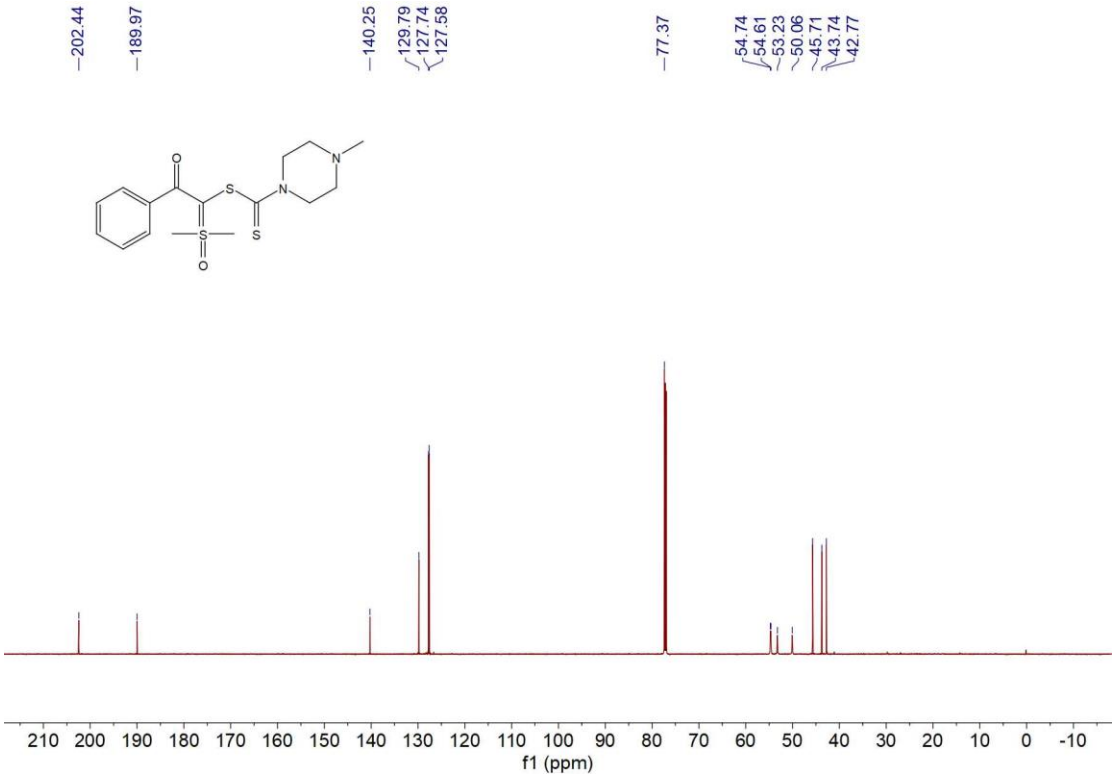
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3h**



^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3i**



^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3i**



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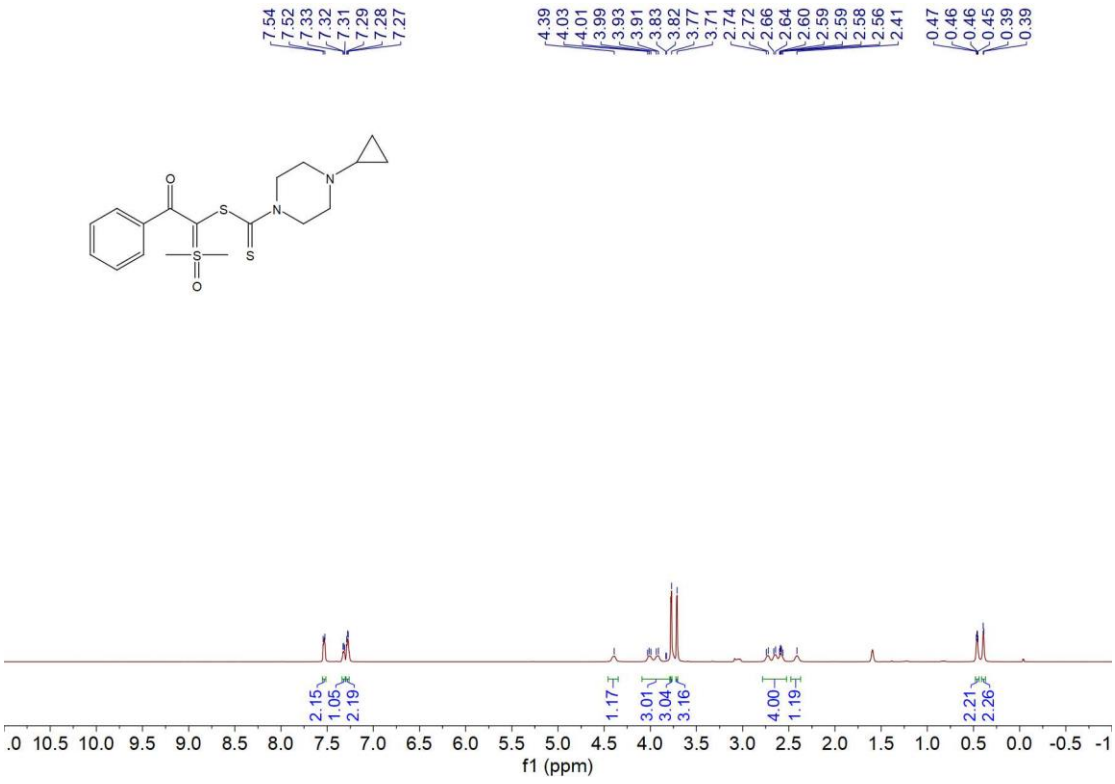
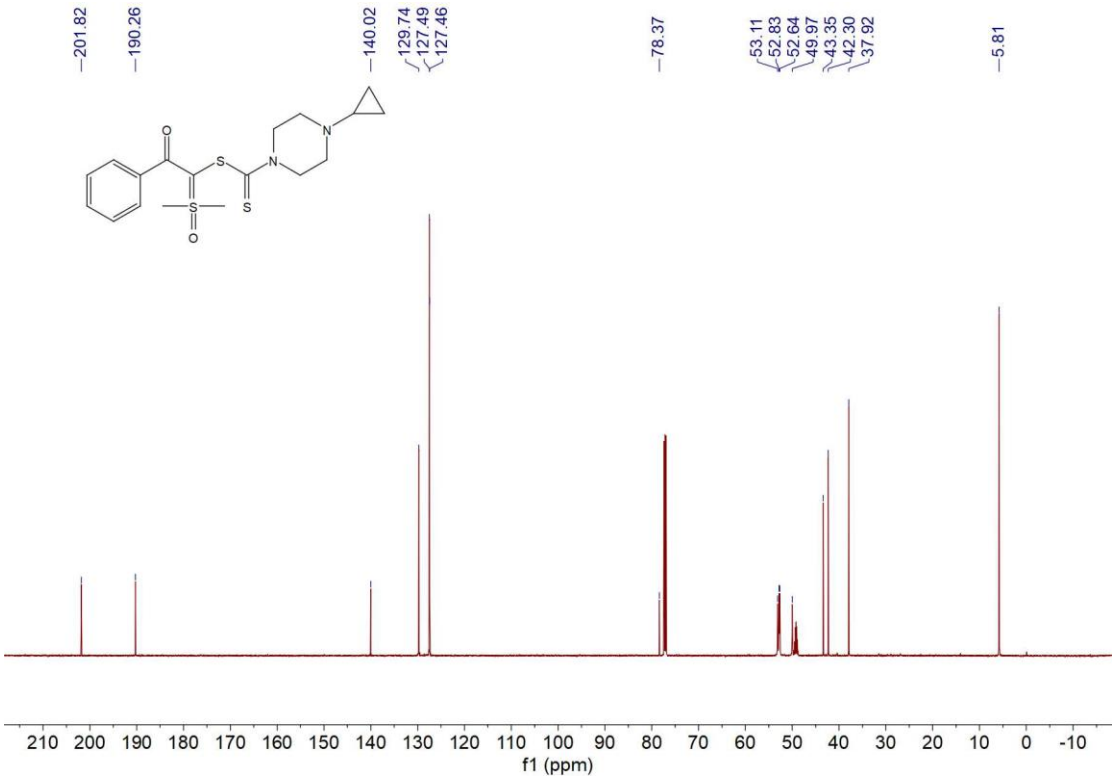
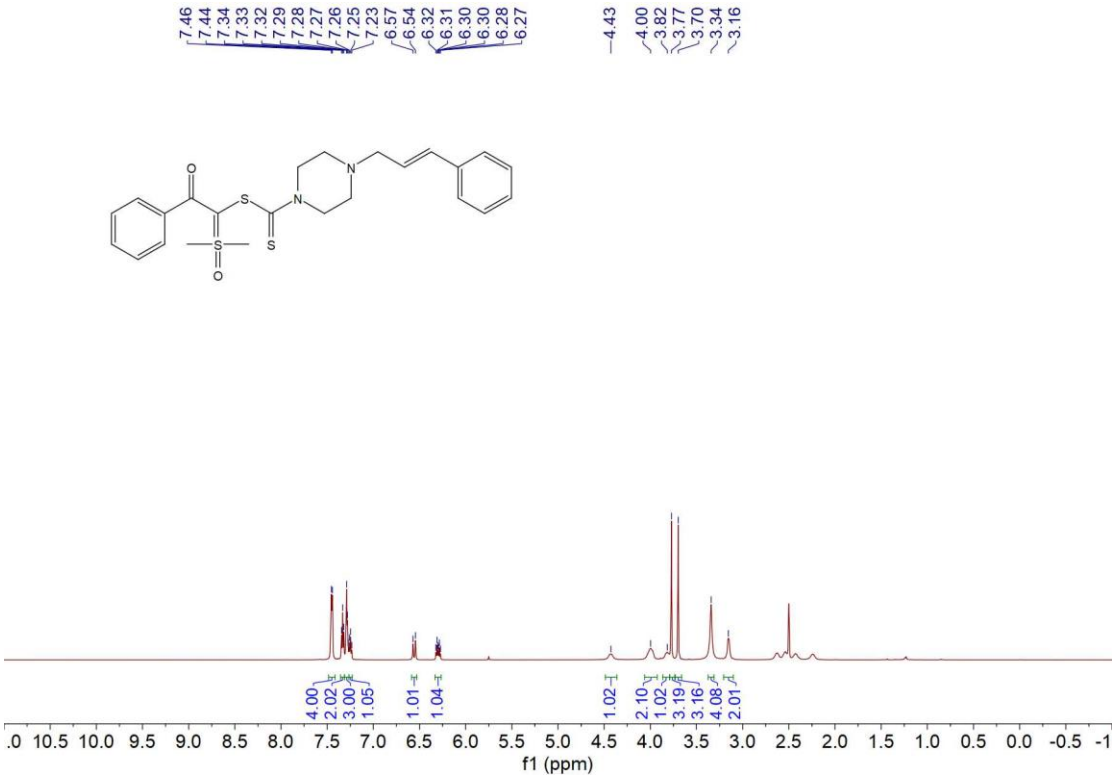


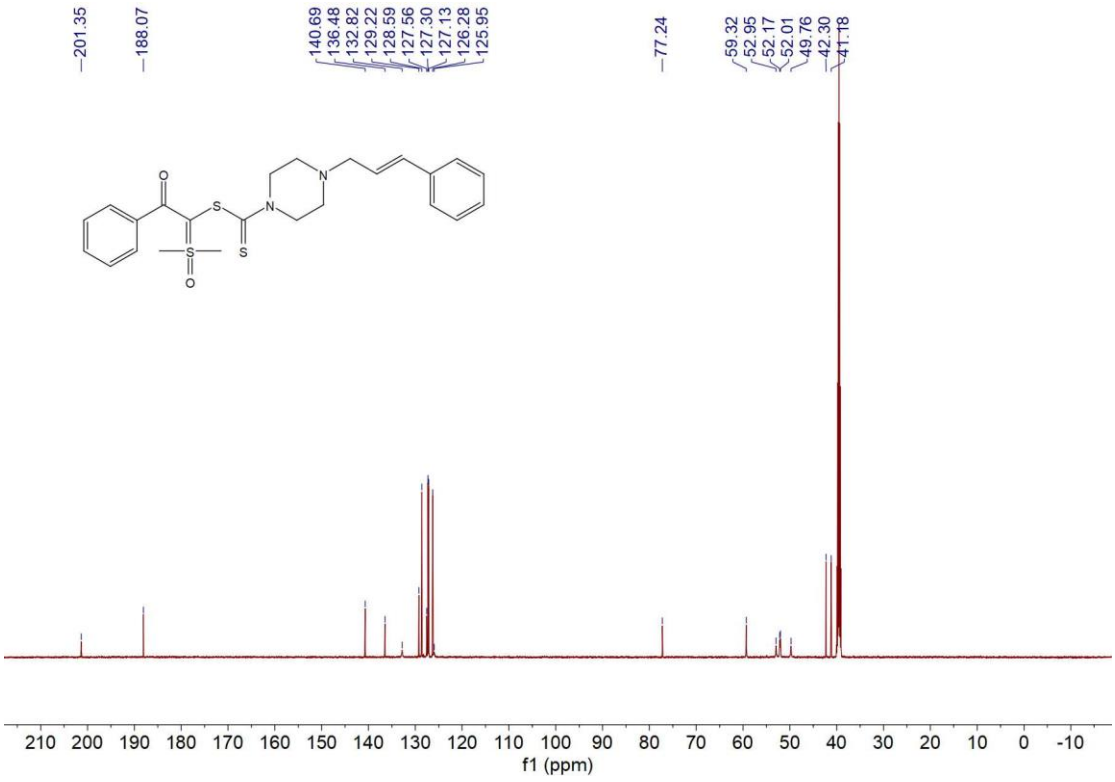
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3j**



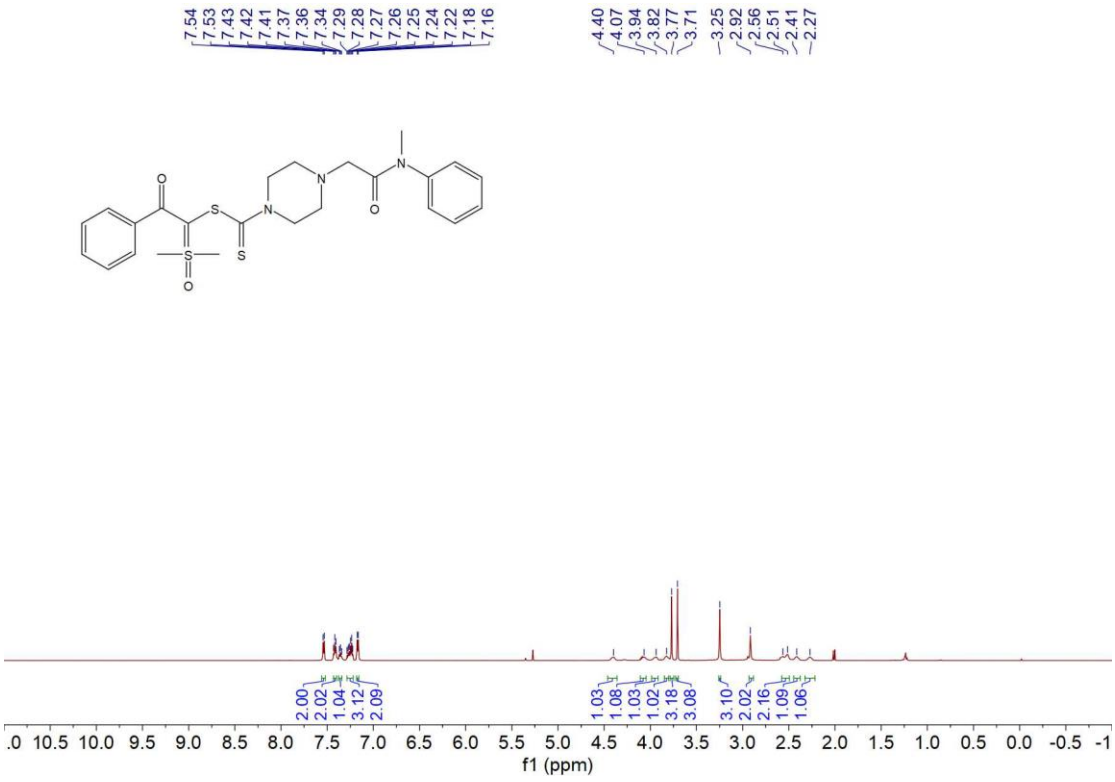
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3k**



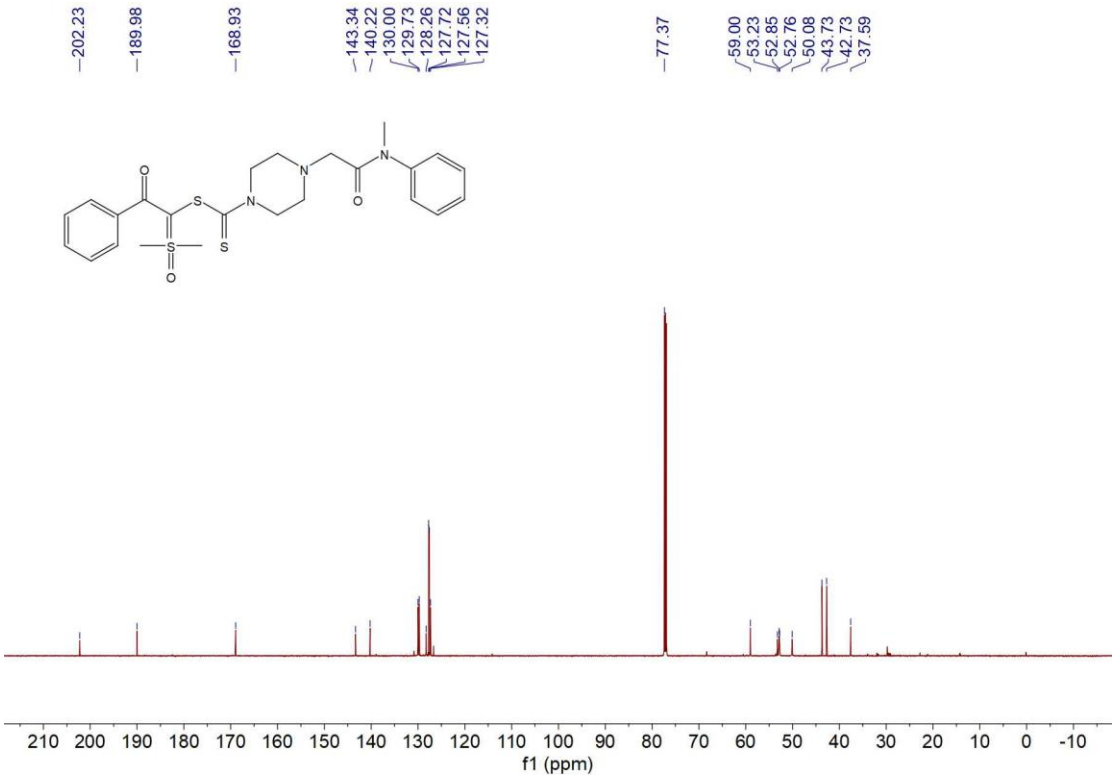
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3k**



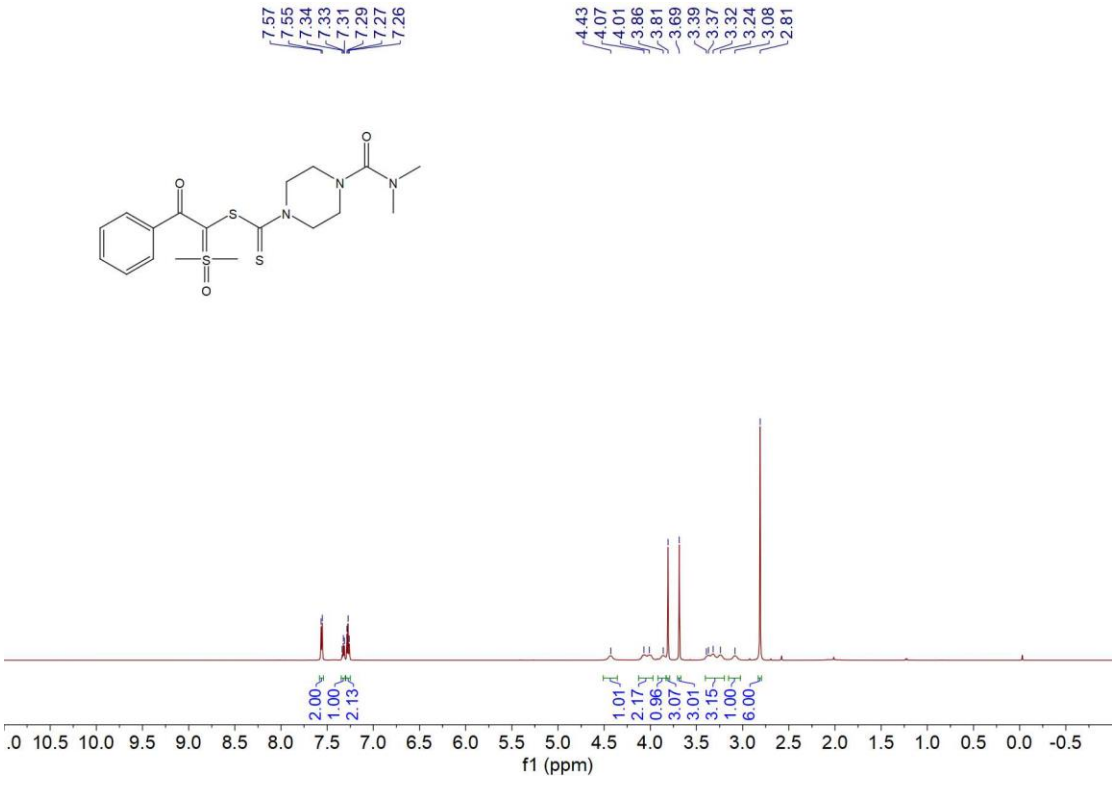
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3l**



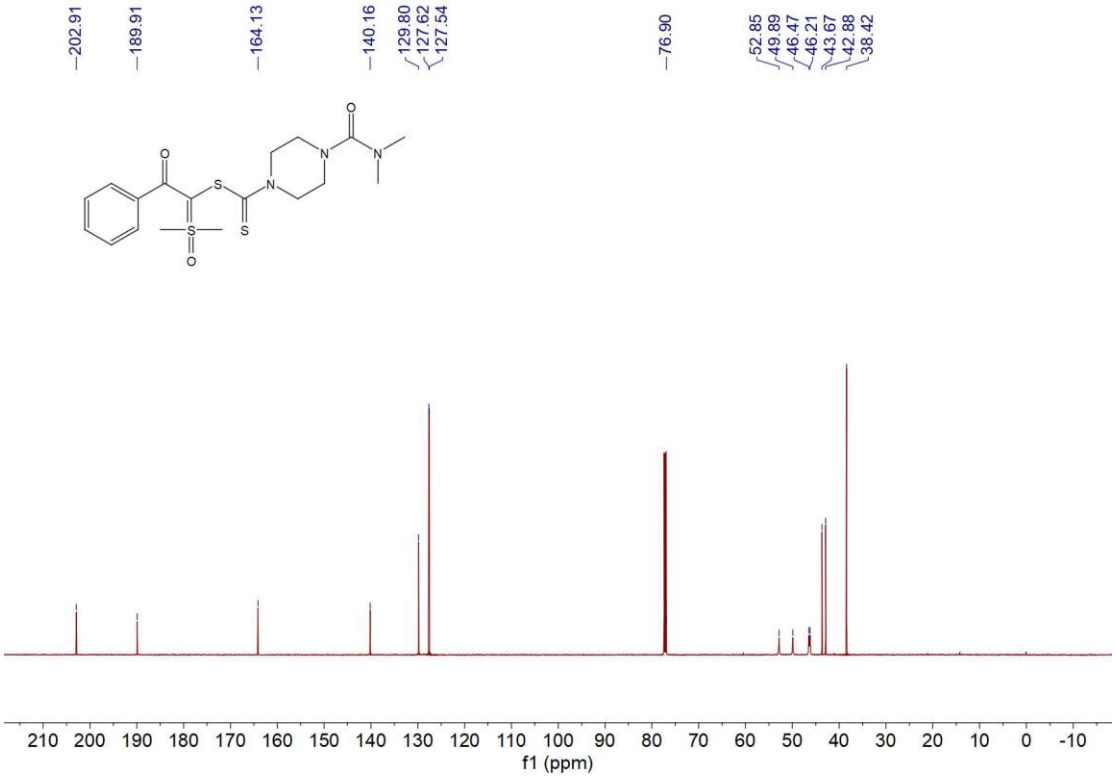
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3l**



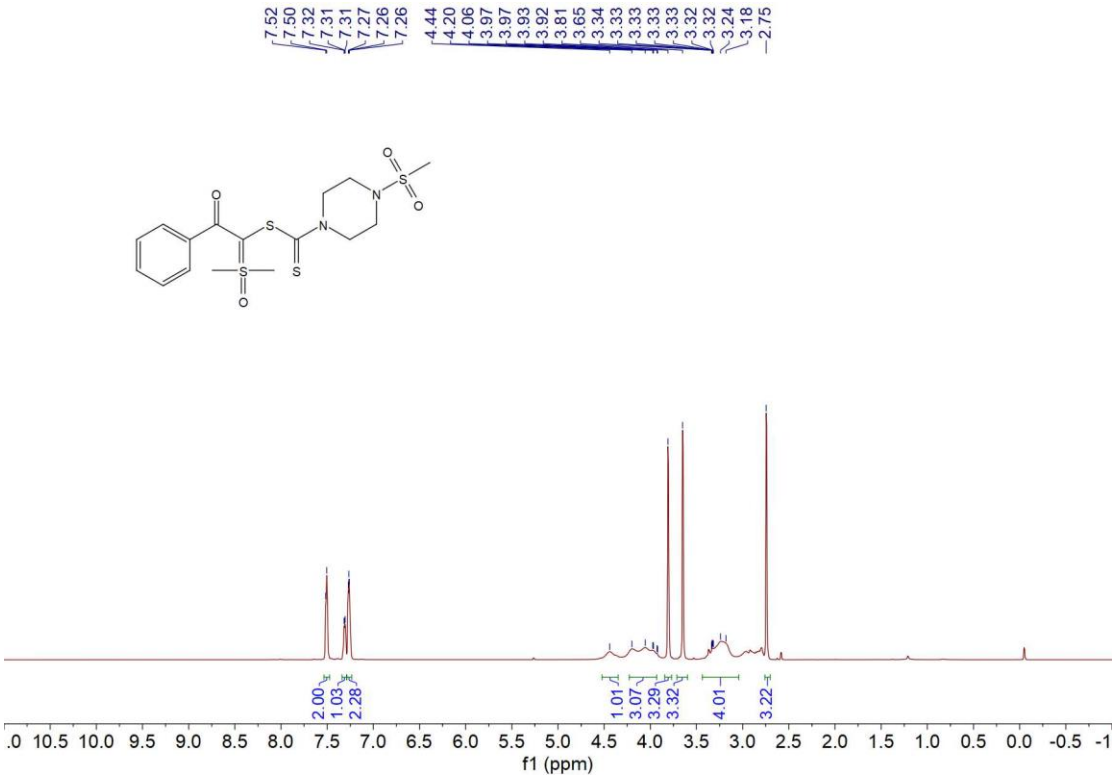
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3m**



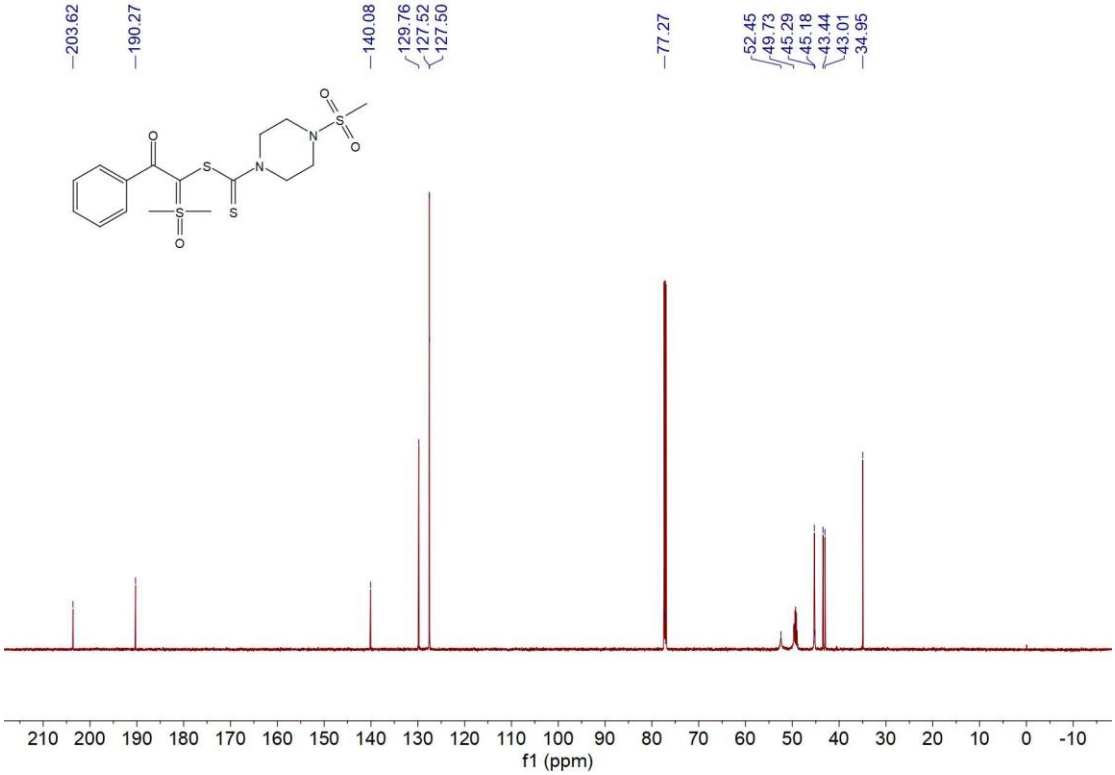
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3m**



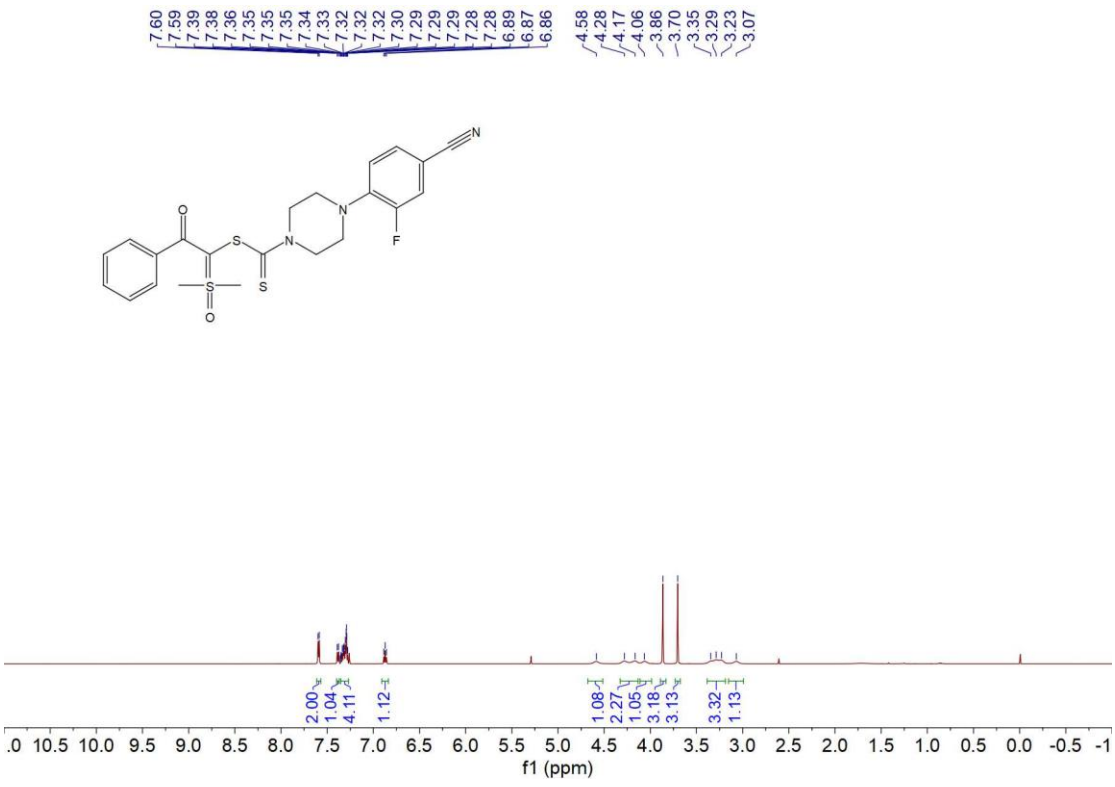
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3n**



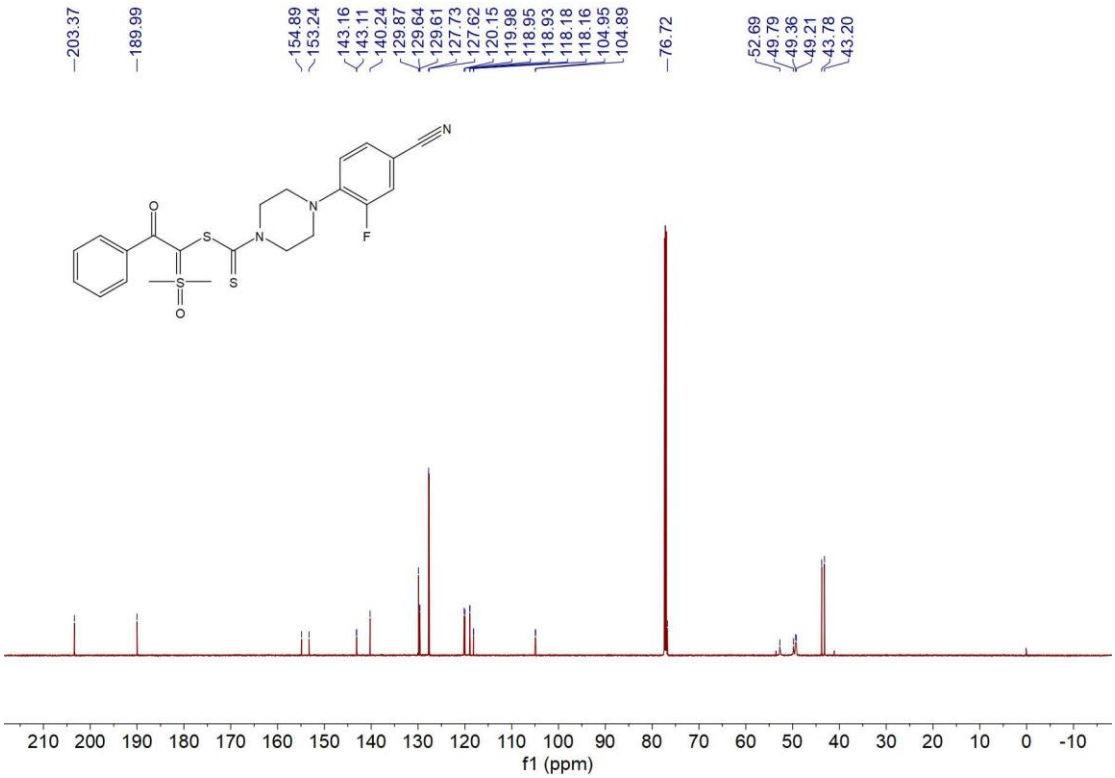
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3n**



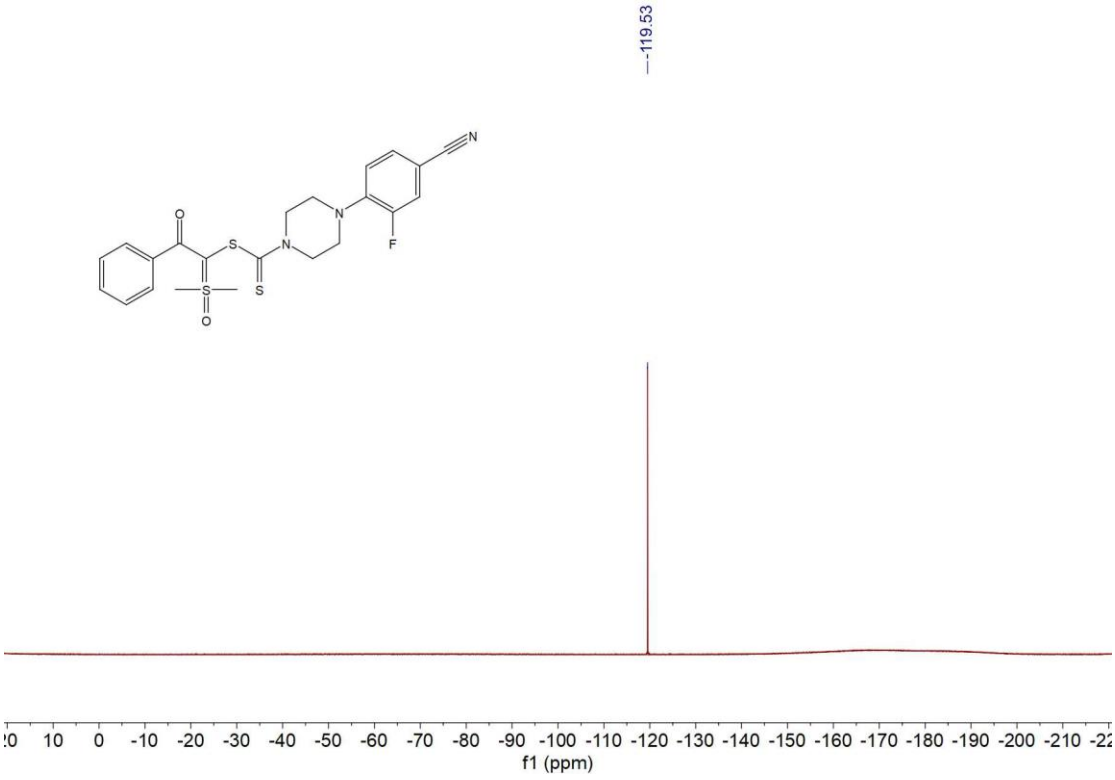
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3o**



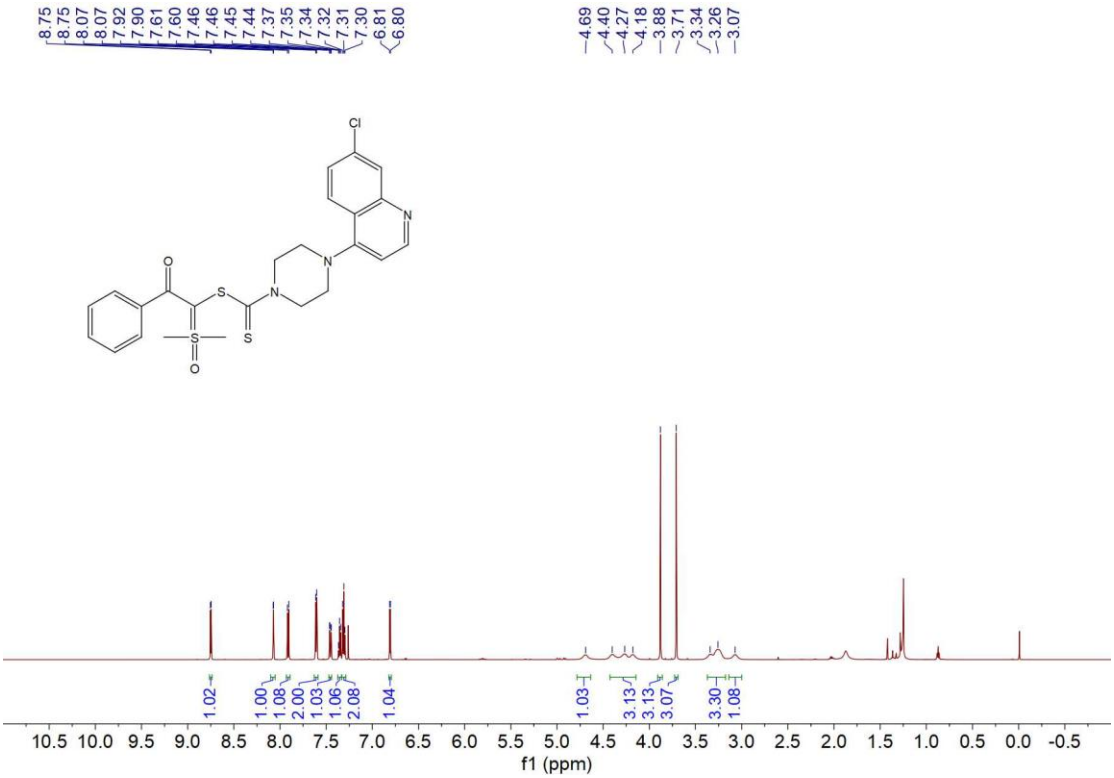
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3o**



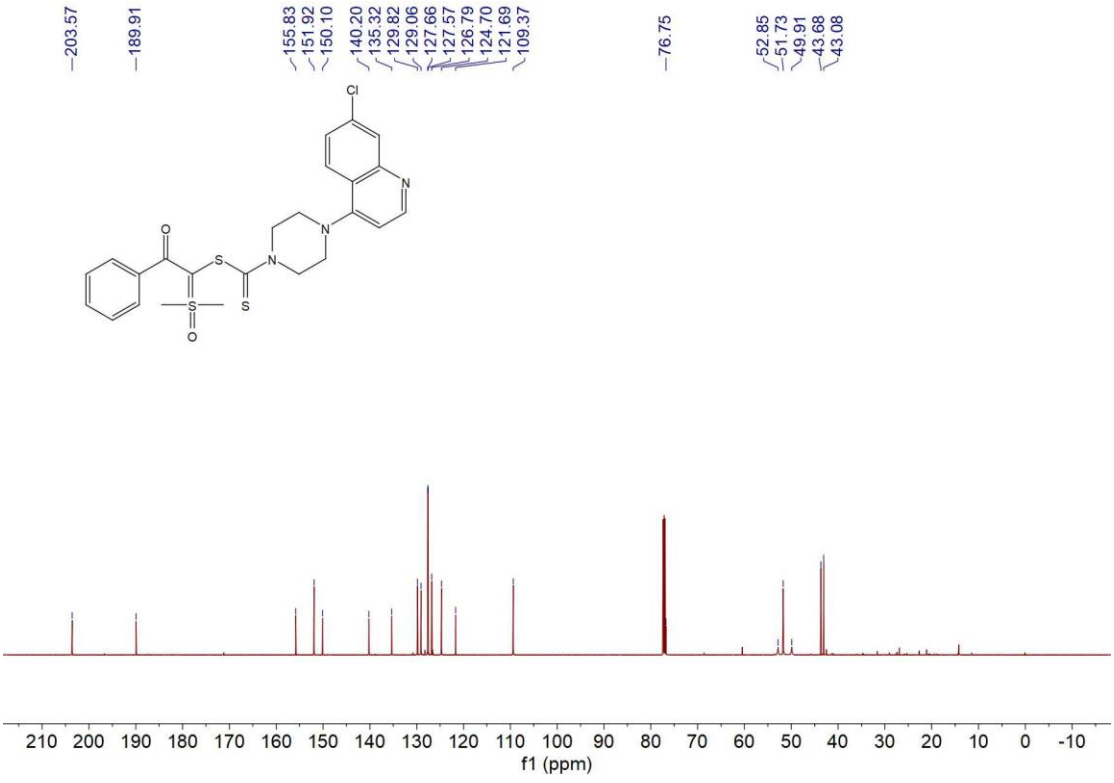
^{19}F NMR (377 MHz, $CDCl_3$) Spectra of **3o**



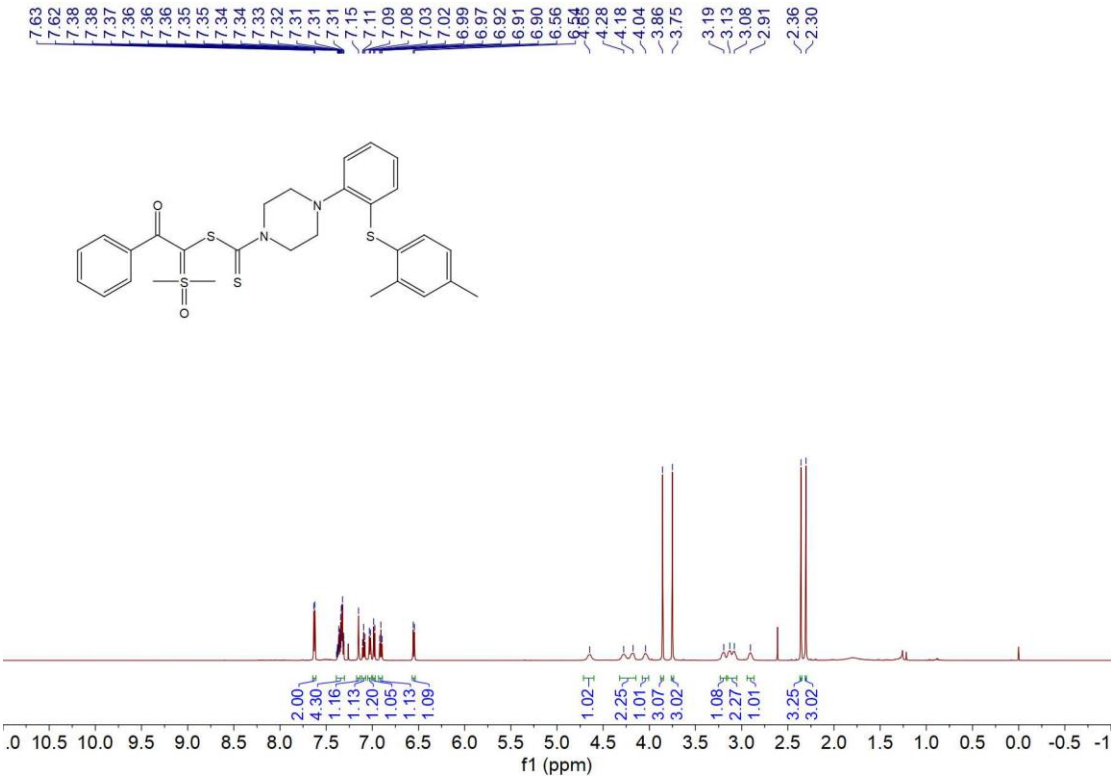
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3p**



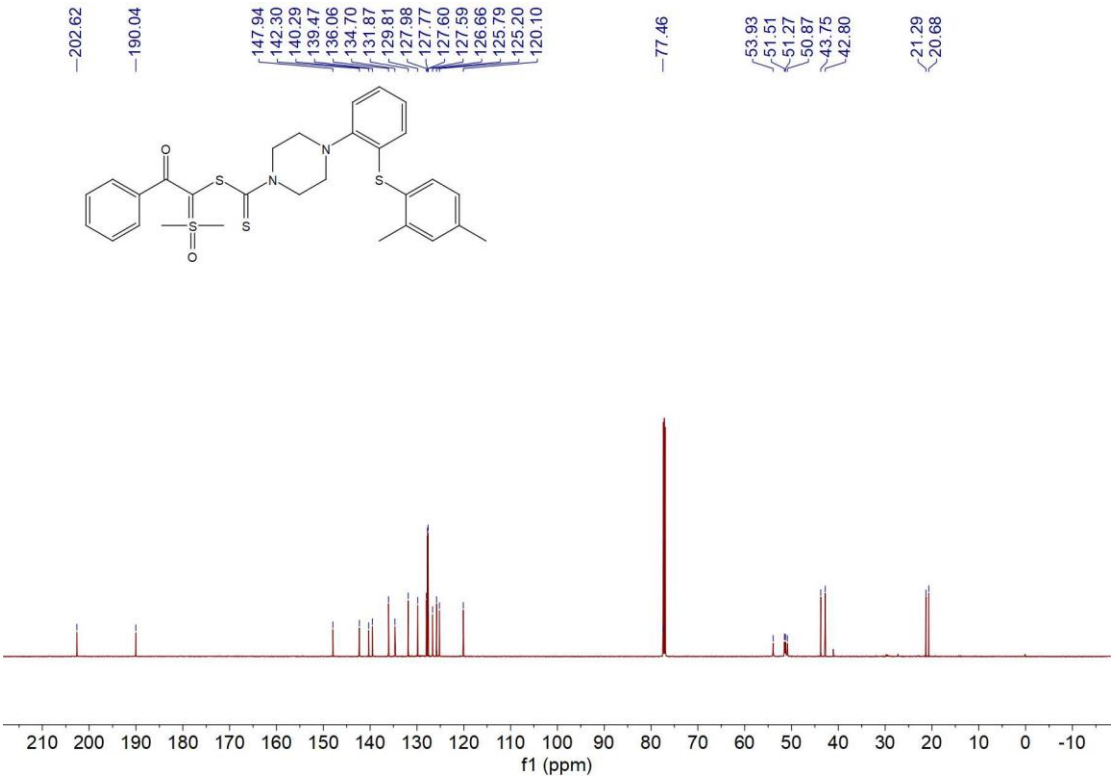
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3p**



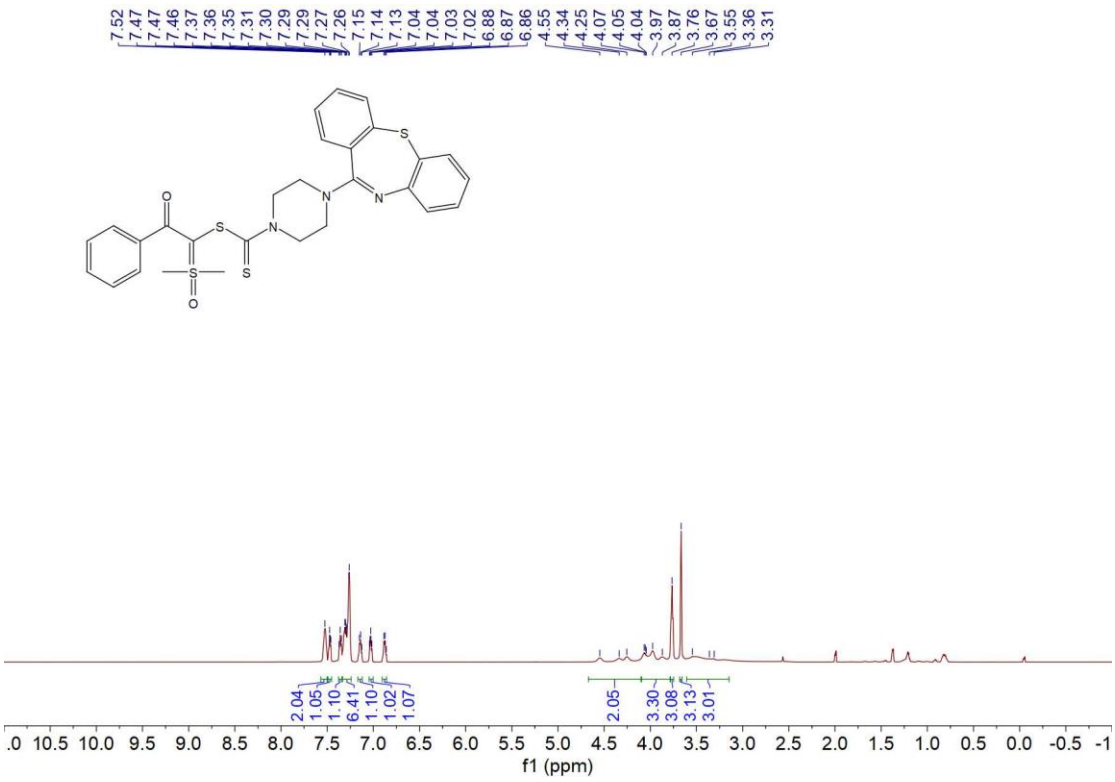
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3q**



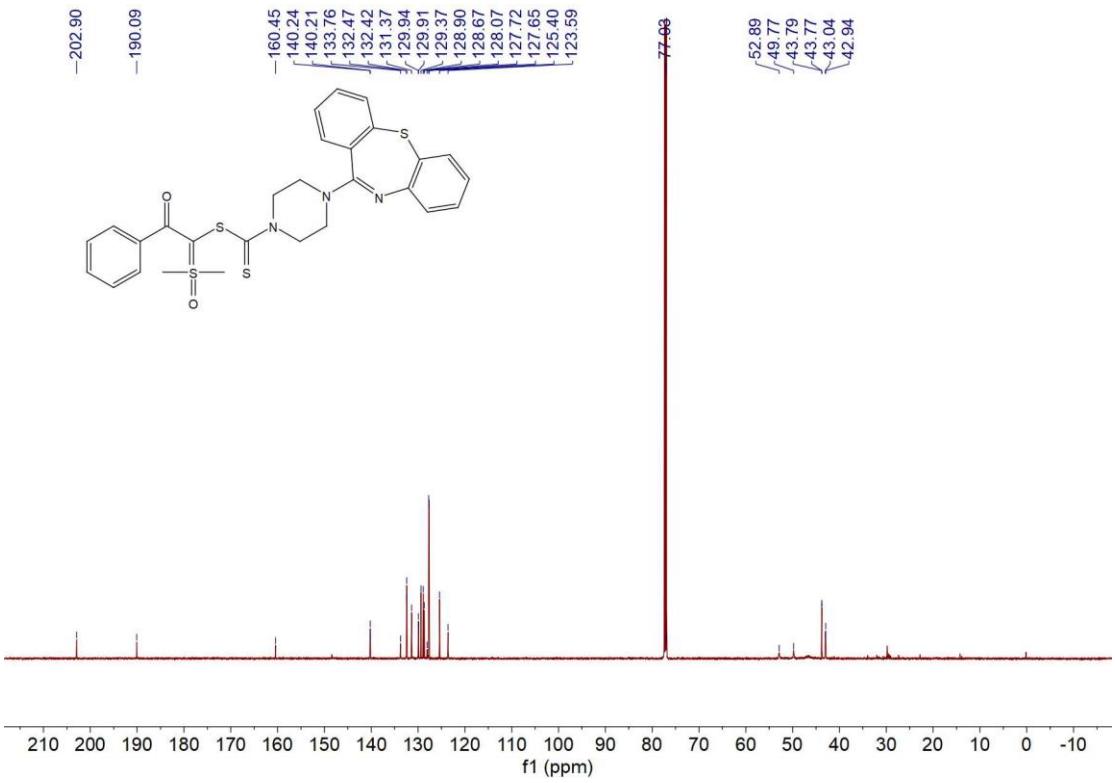
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3q**



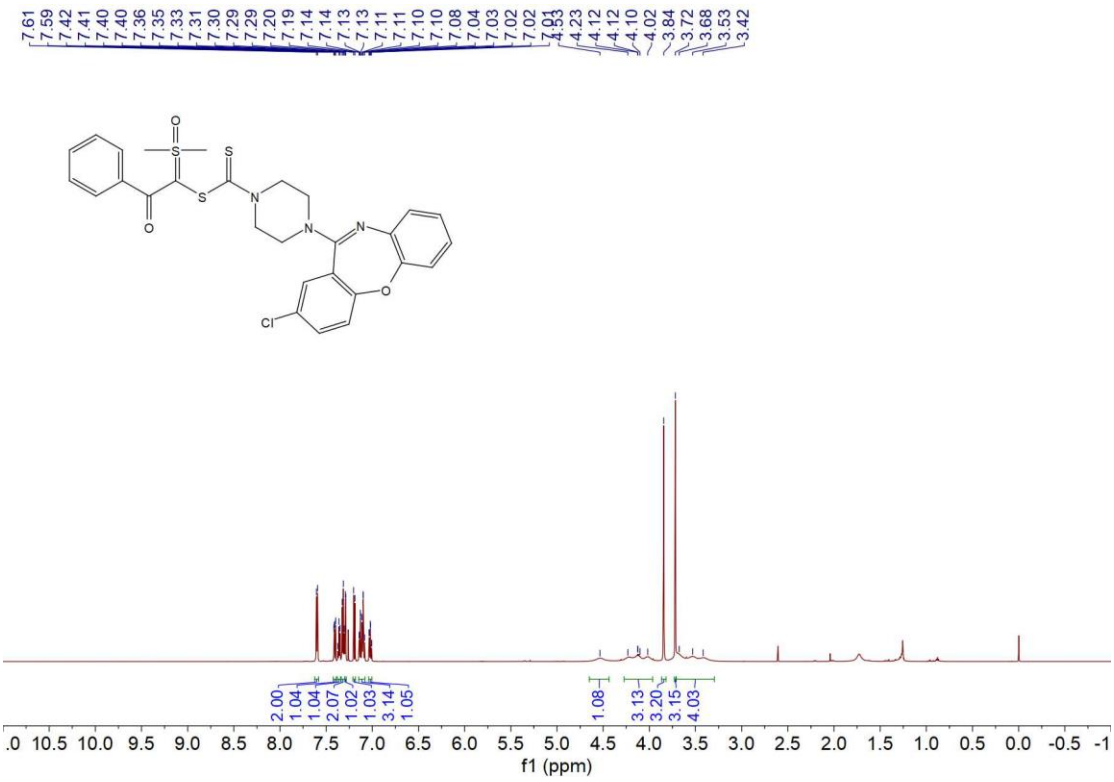
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3r**



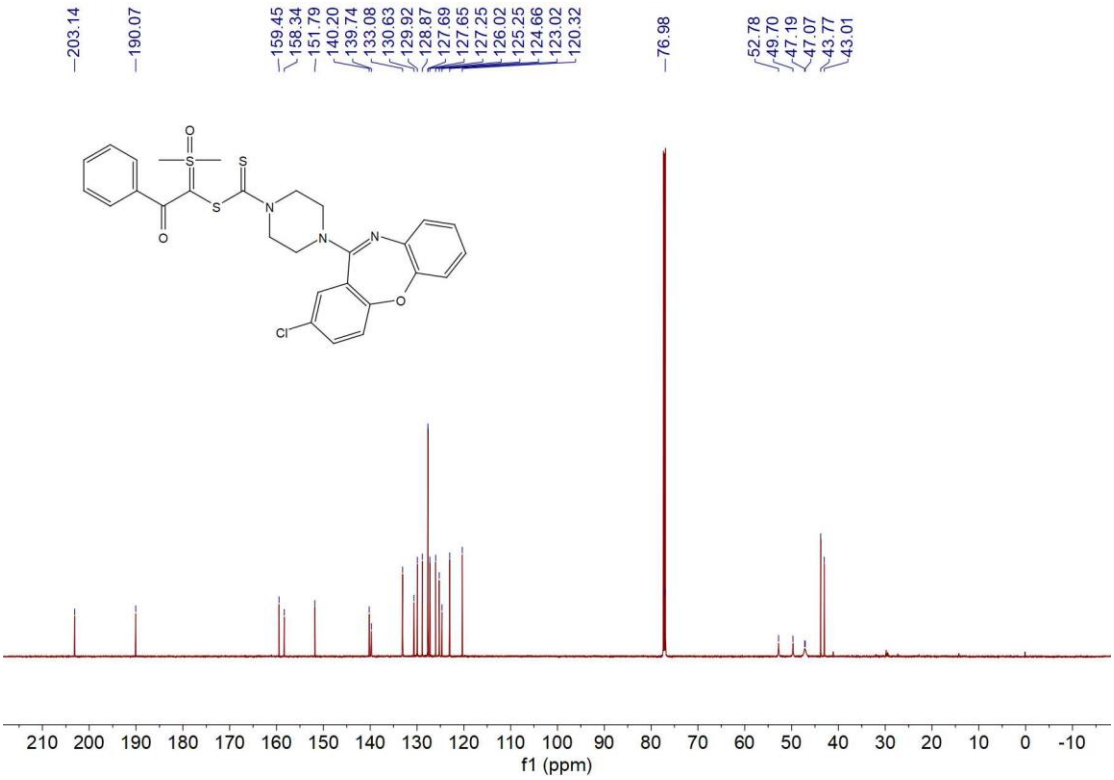
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3r**



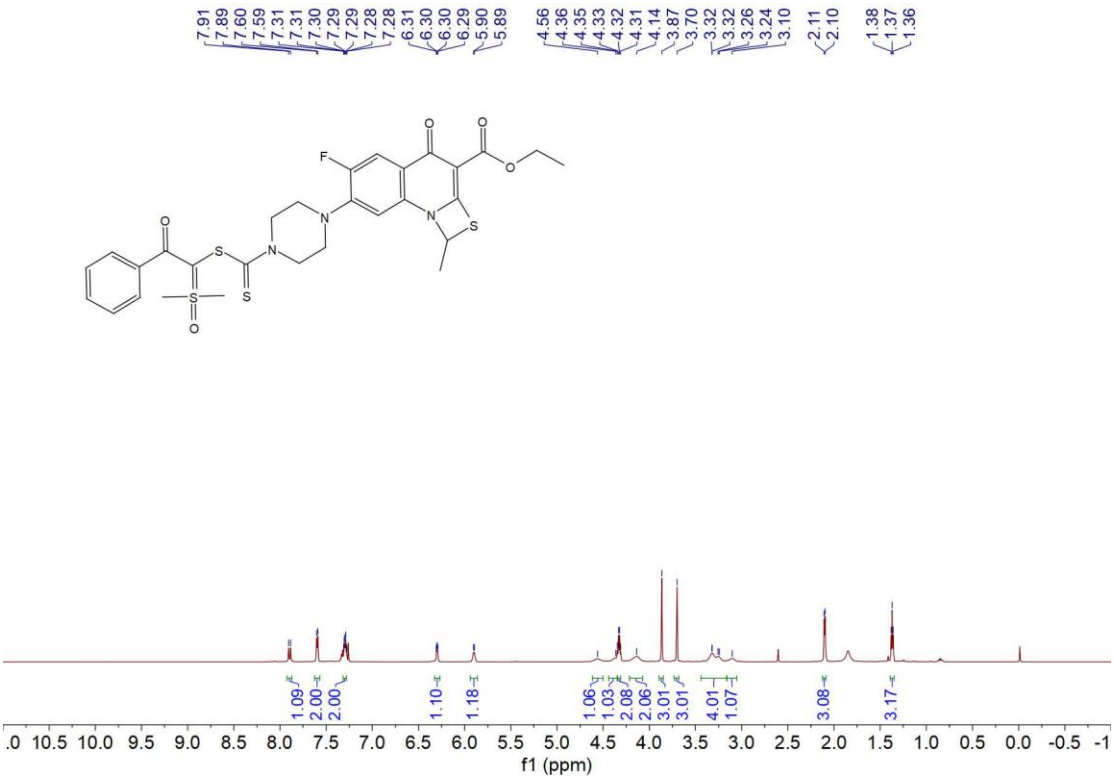
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3s**



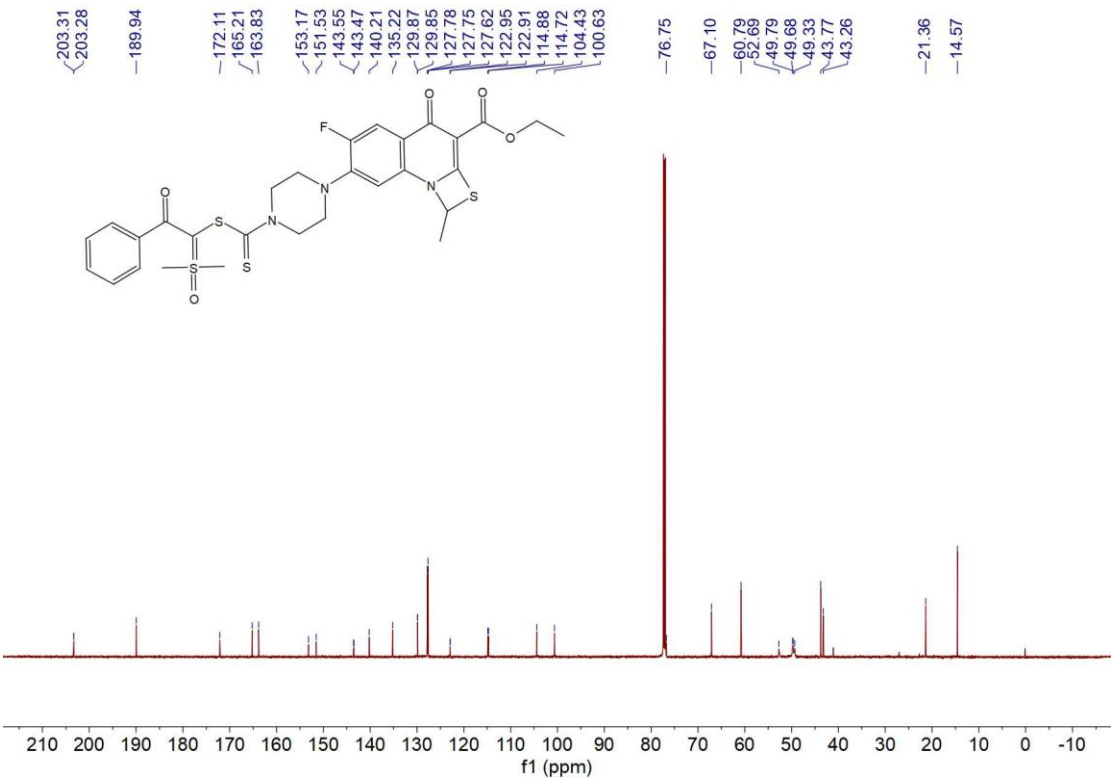
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3s**



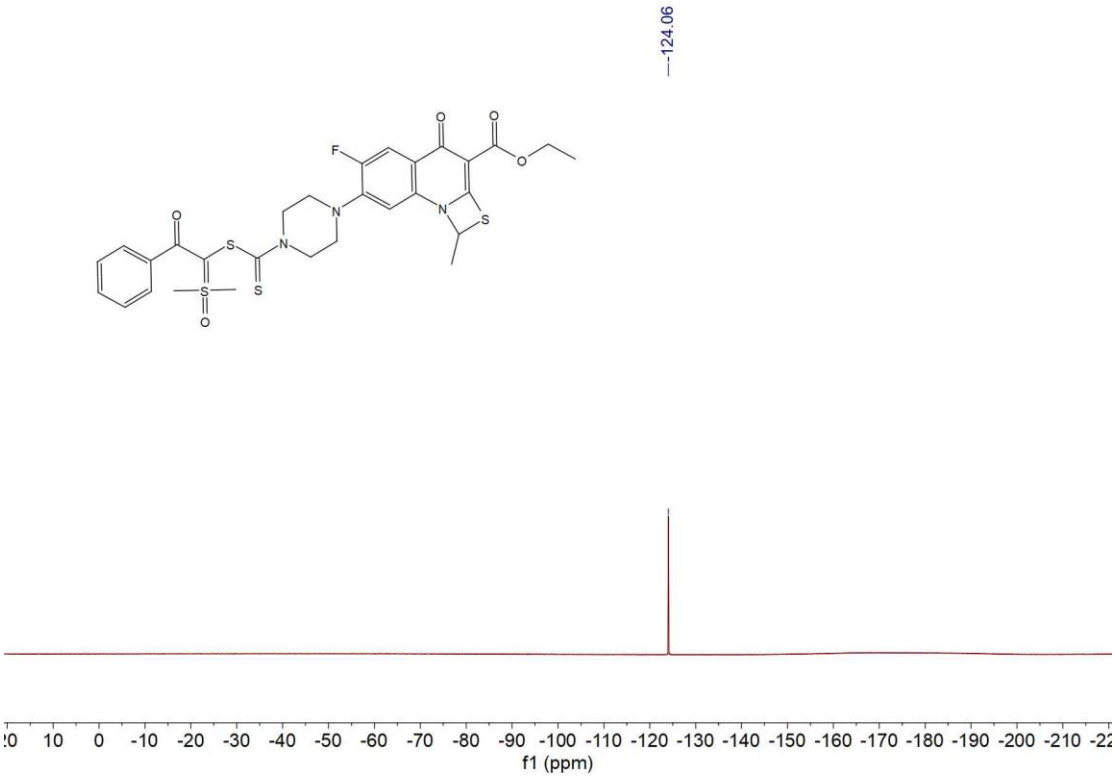
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3t**



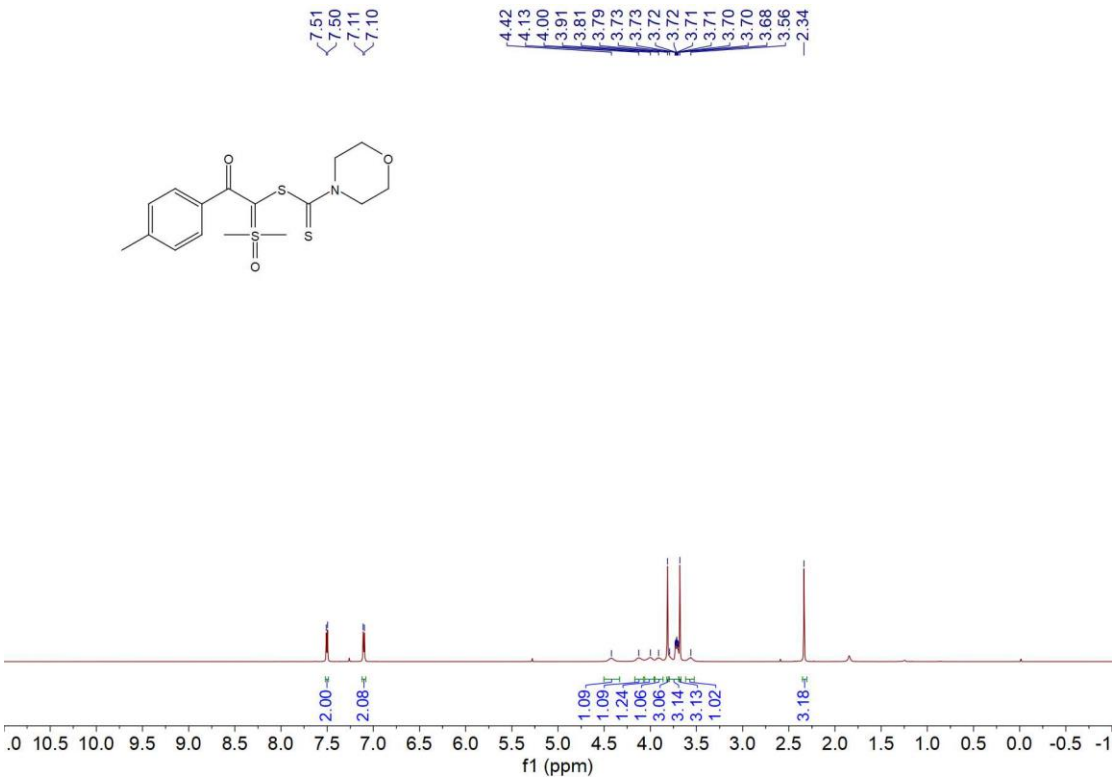
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3t**



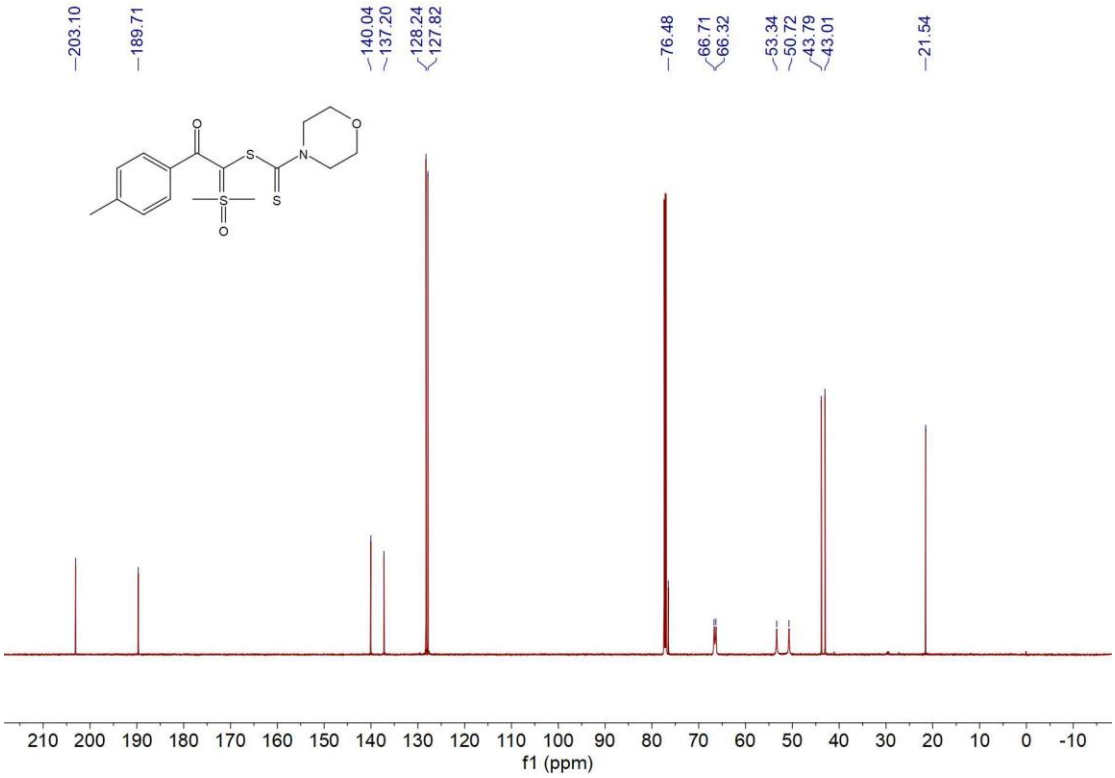
^{19}F NMR (377 MHz, $CDCl_3$) Spectra of **3t**



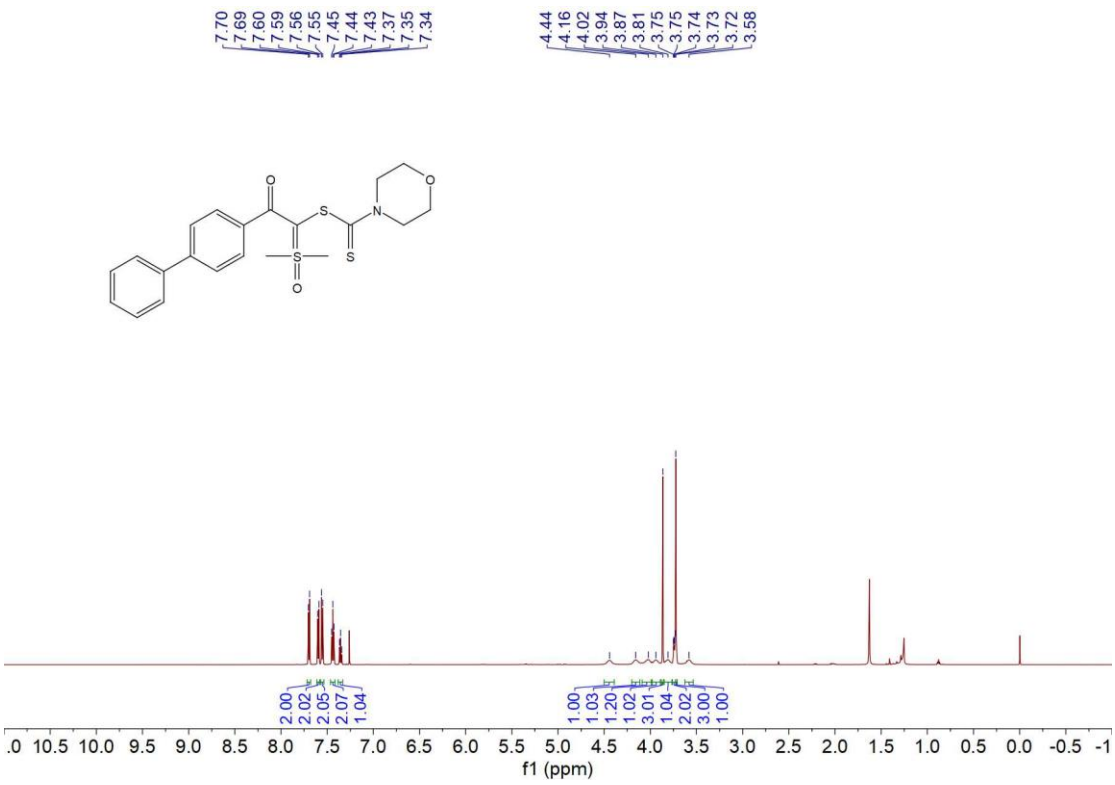
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3u**



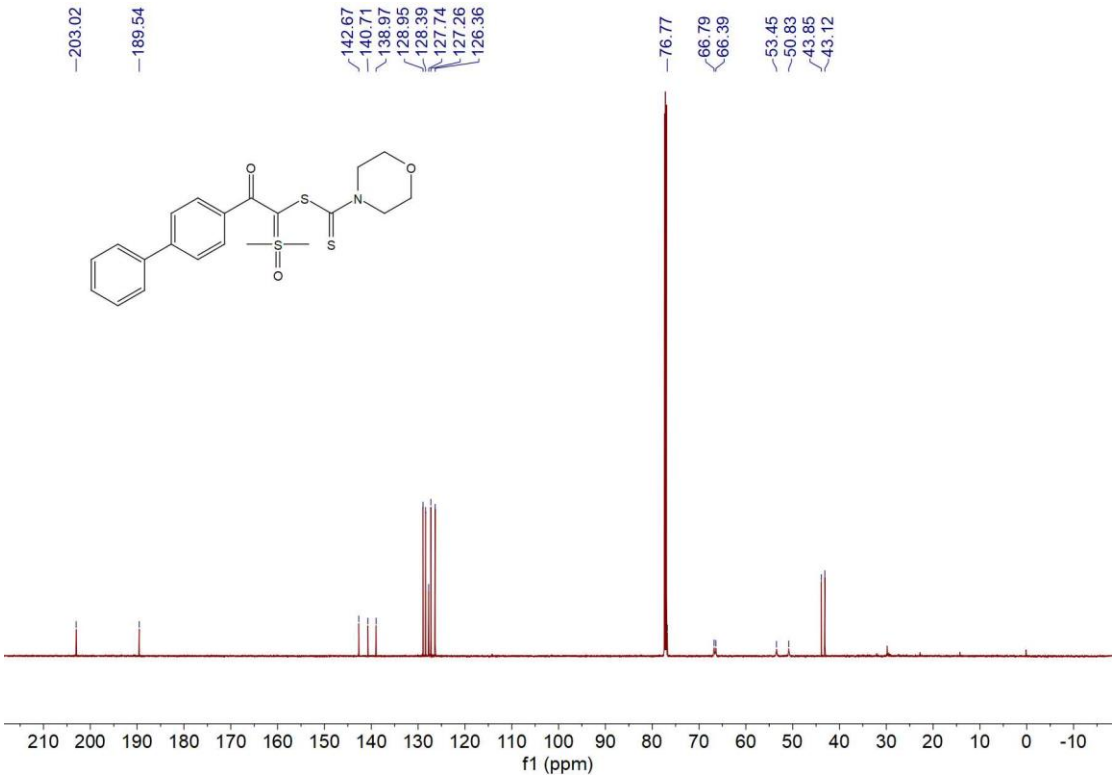
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3u**



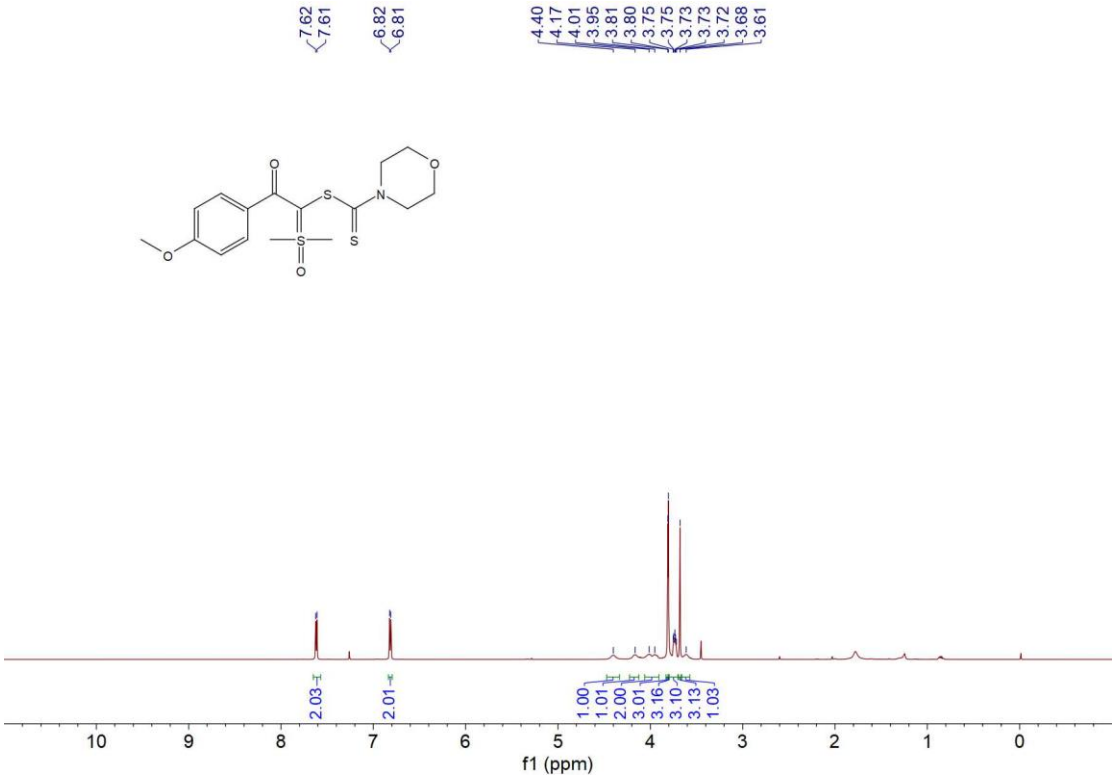
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3v**



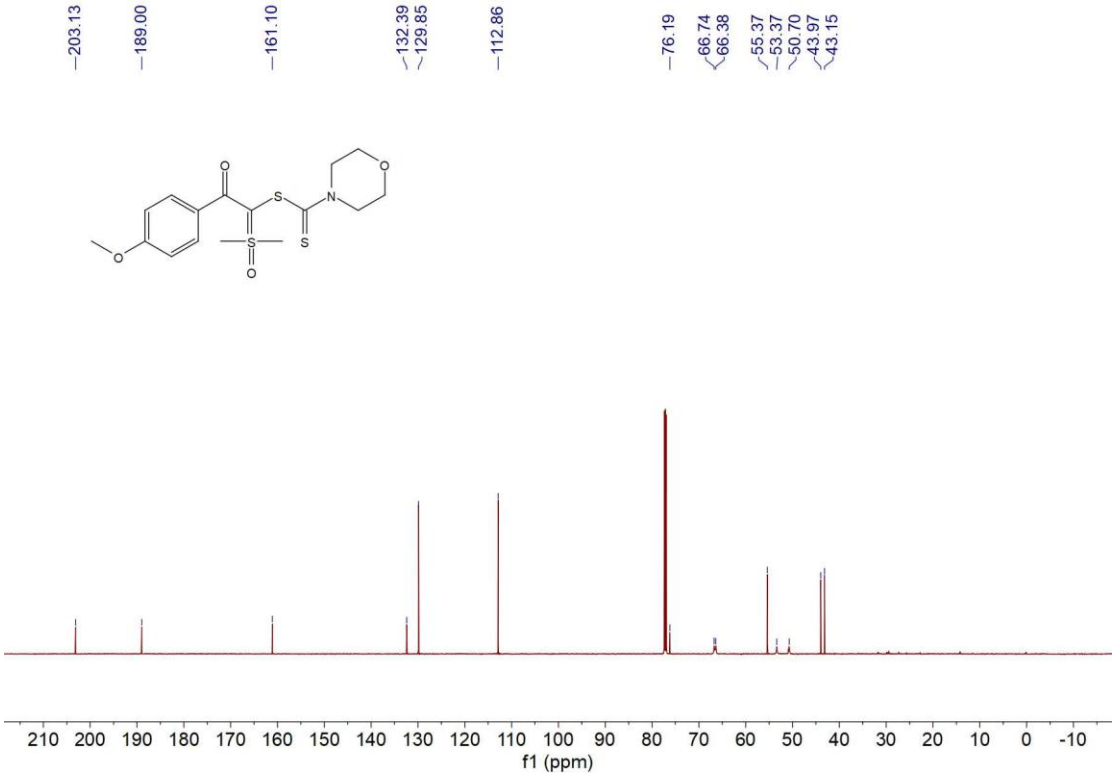
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3v**



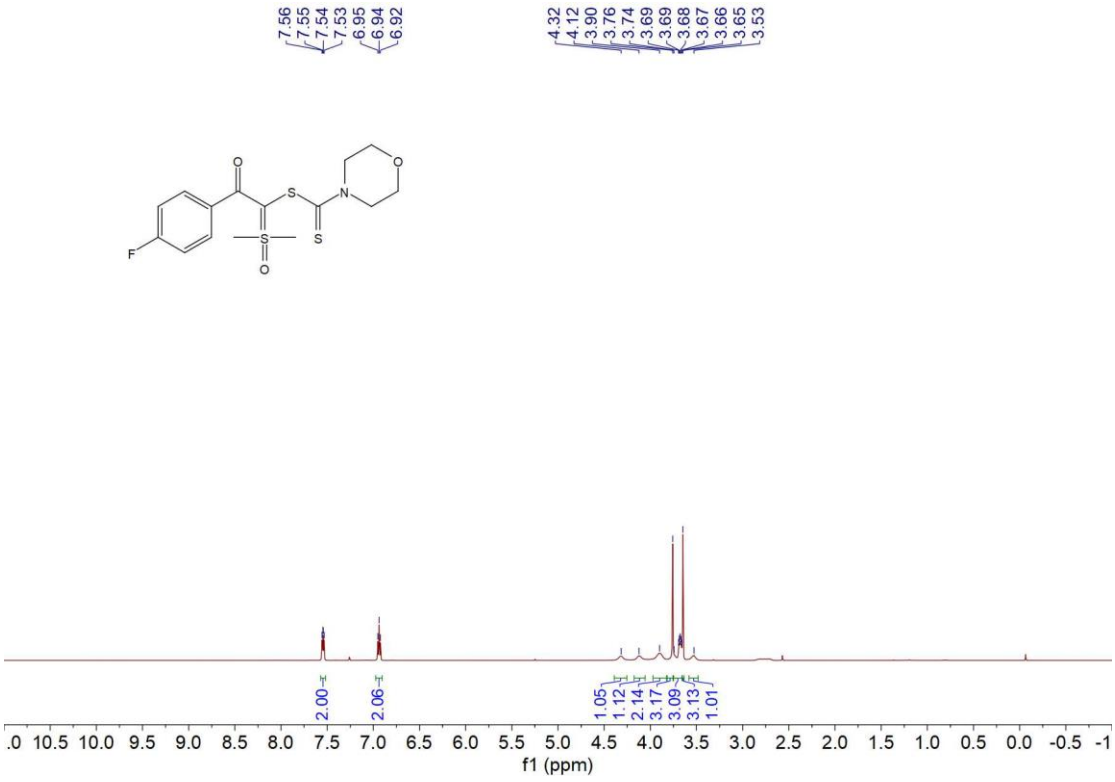
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3w**



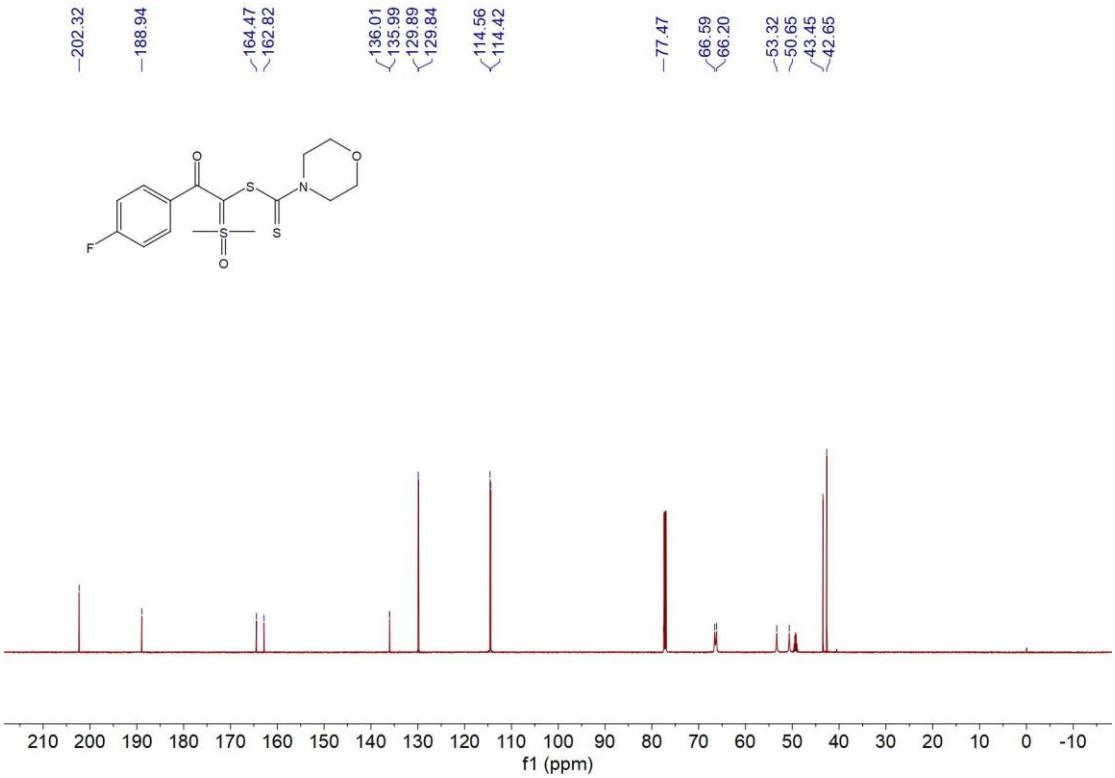
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3w**



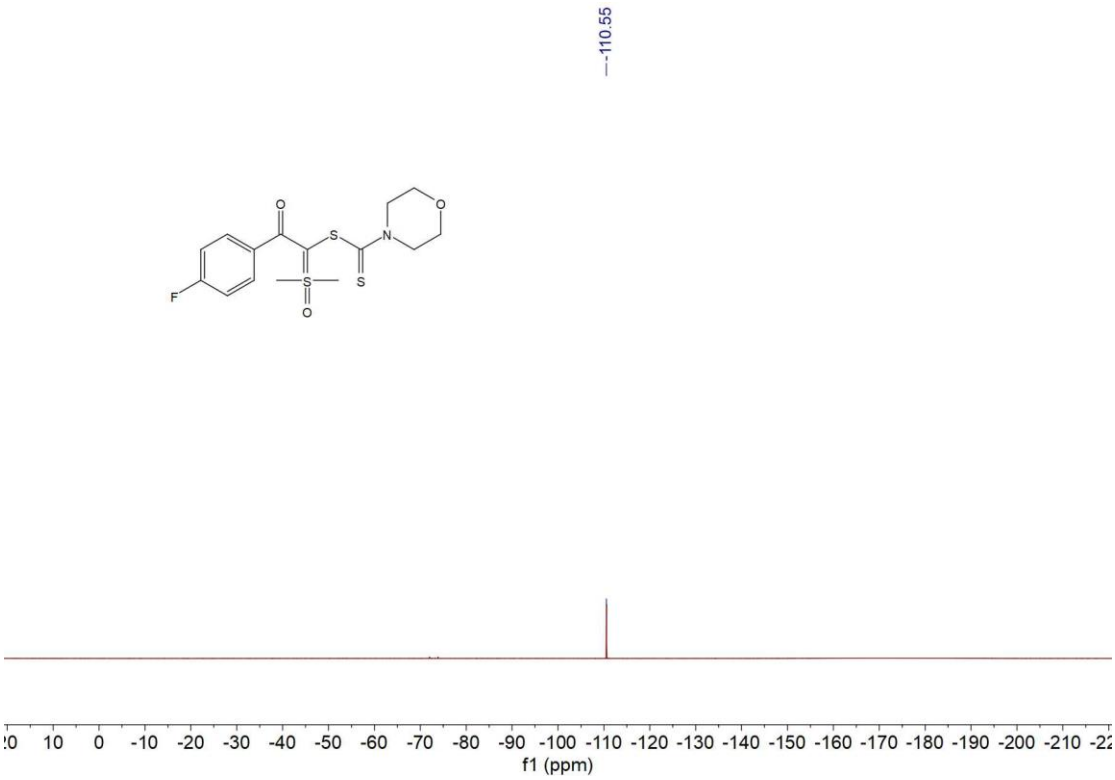
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3x**



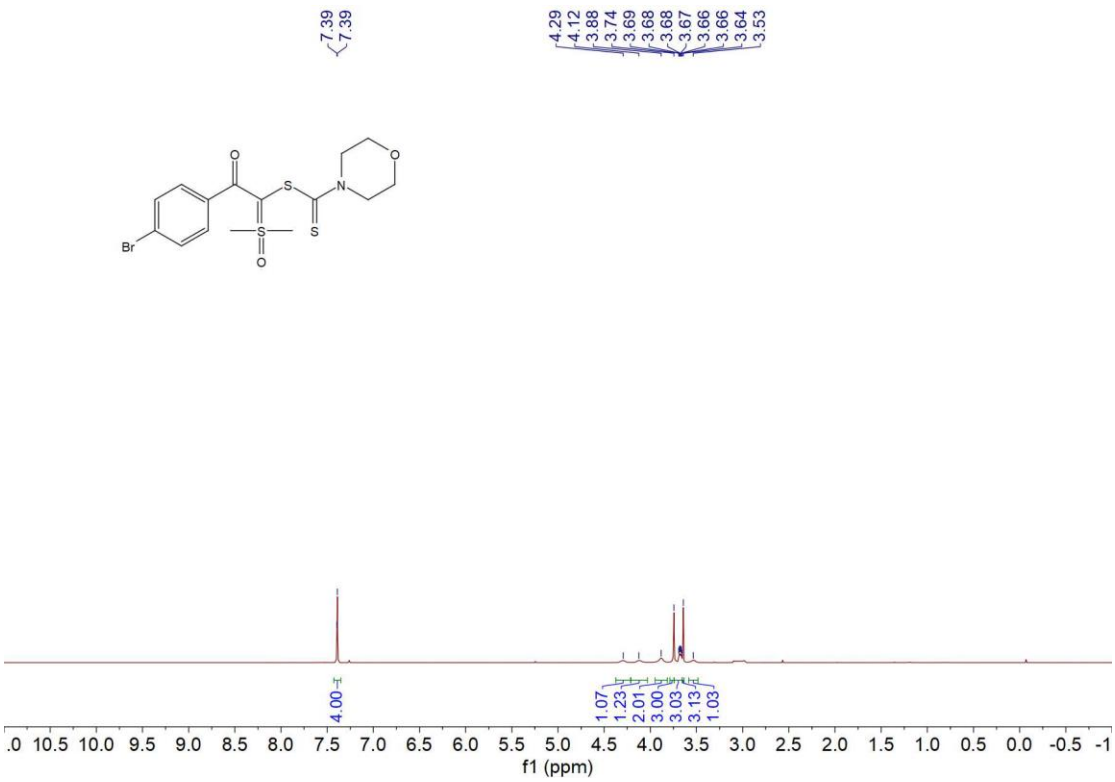
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3x**



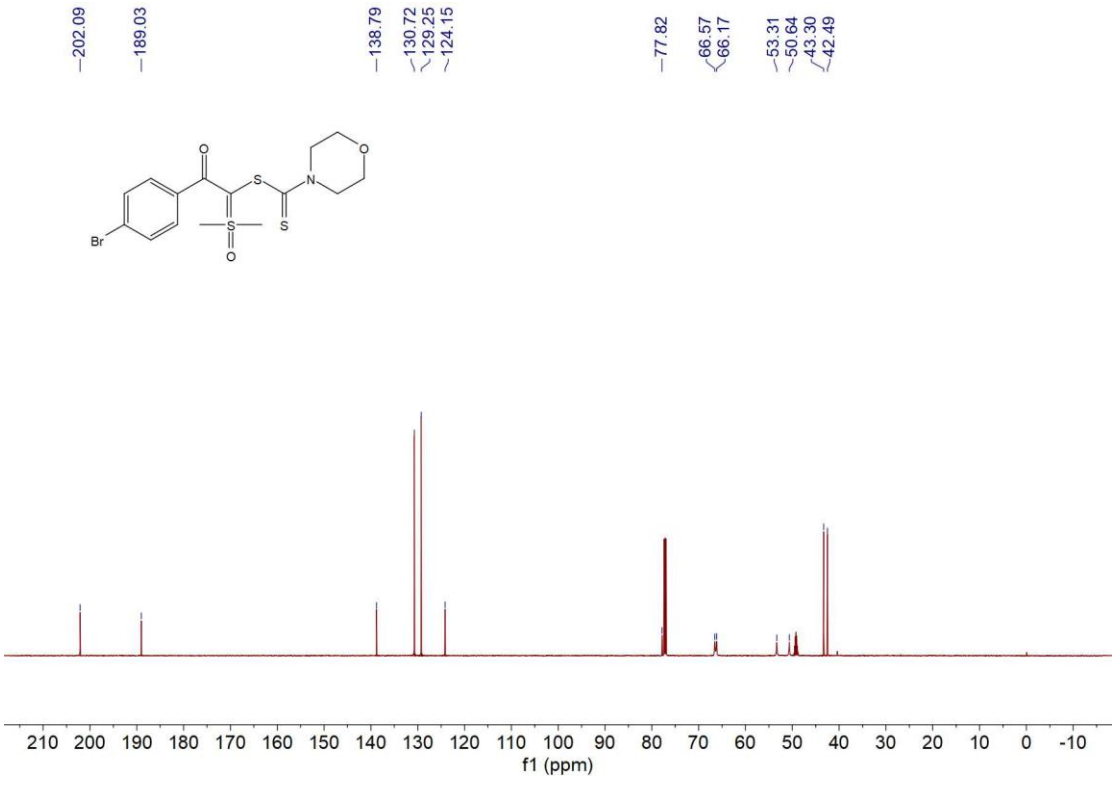
^{19}F NMR (377 MHz, $CDCl_3$) Spectra of **3x**



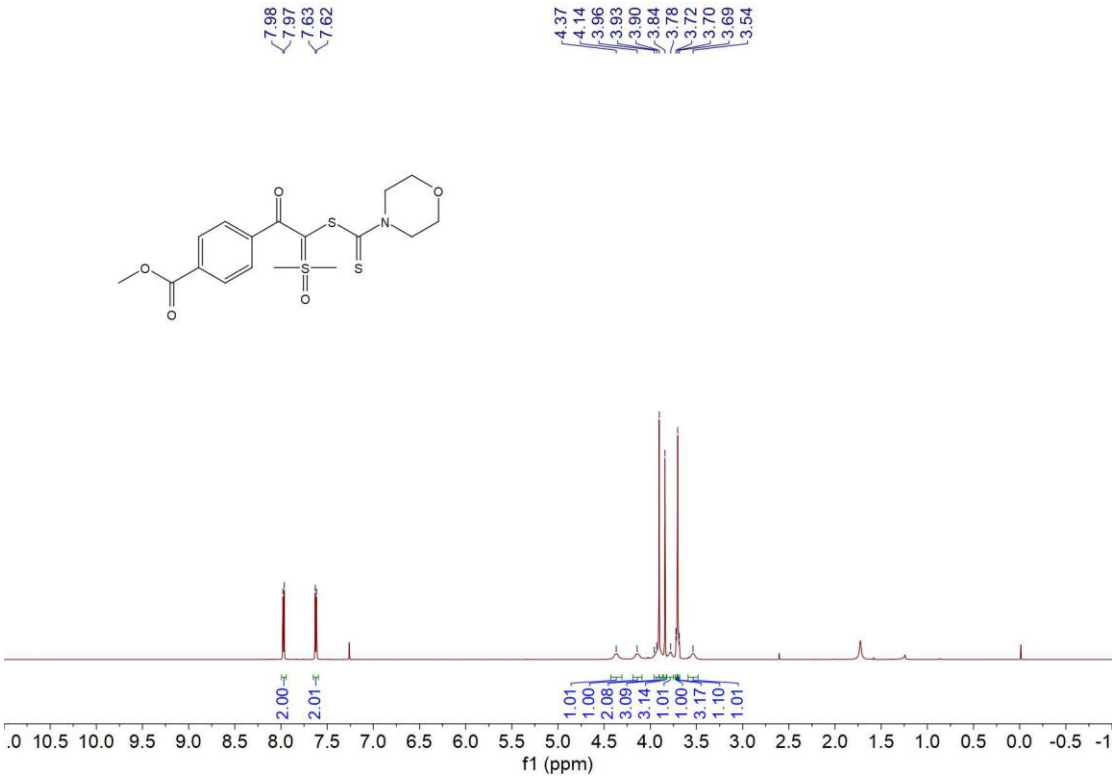
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3y**



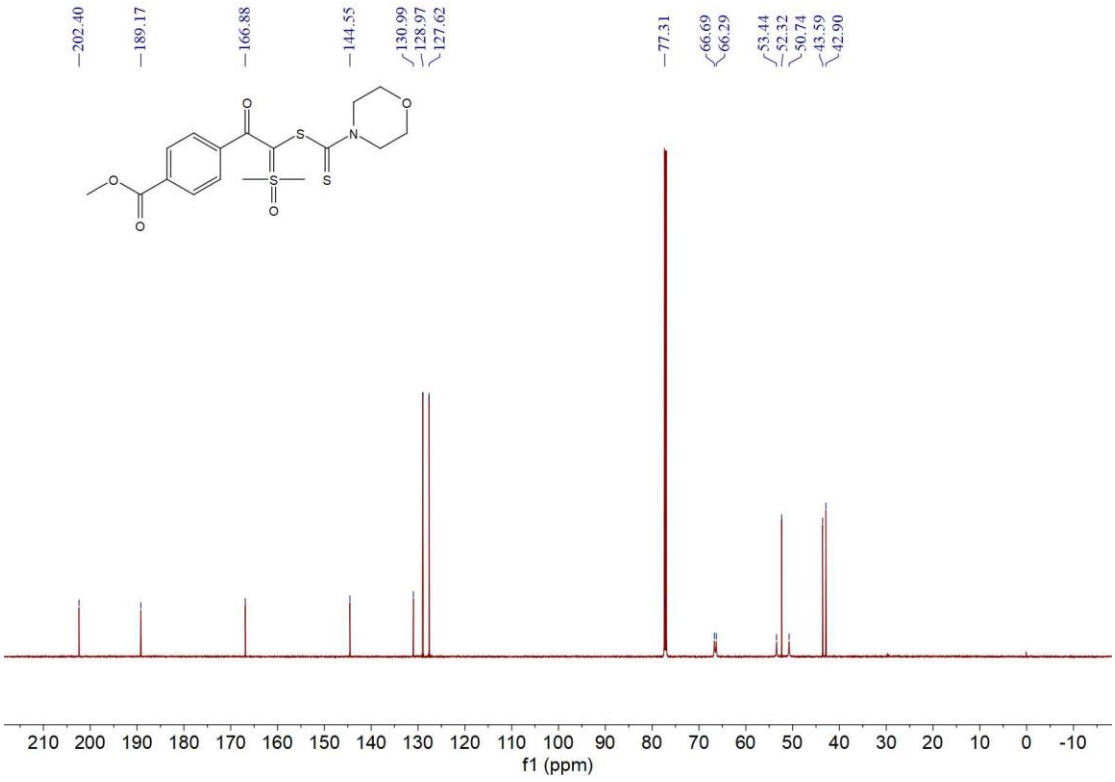
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3y**



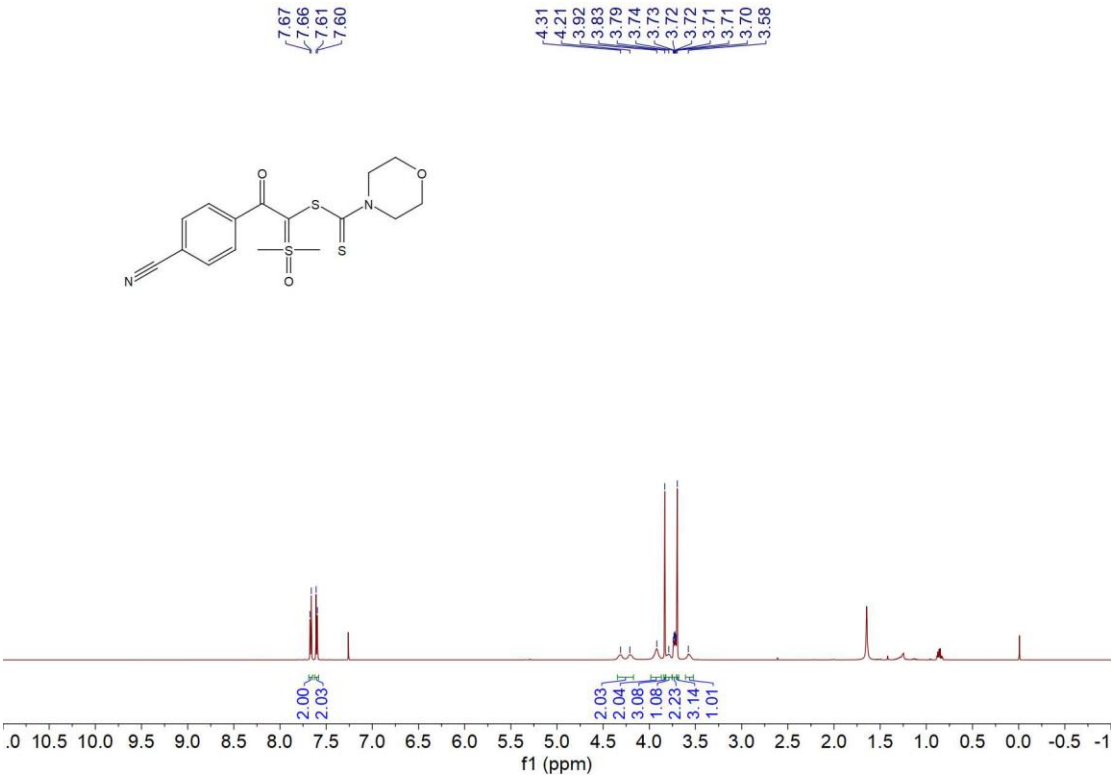
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3z**



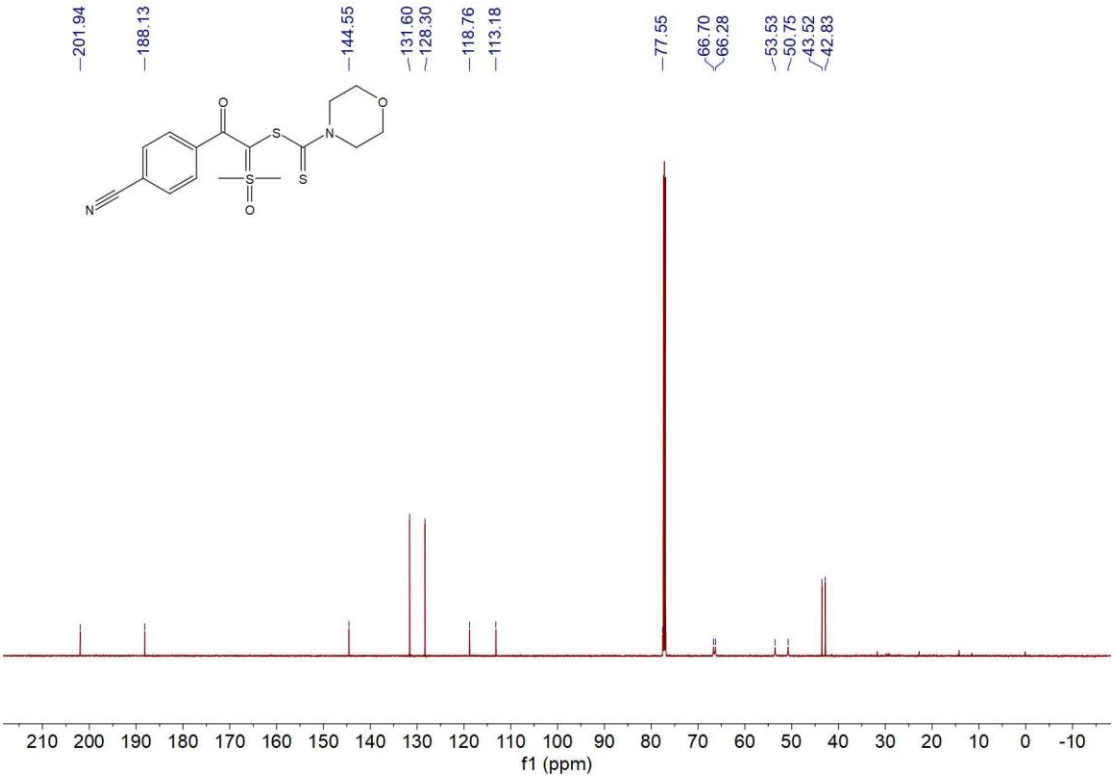
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3z**



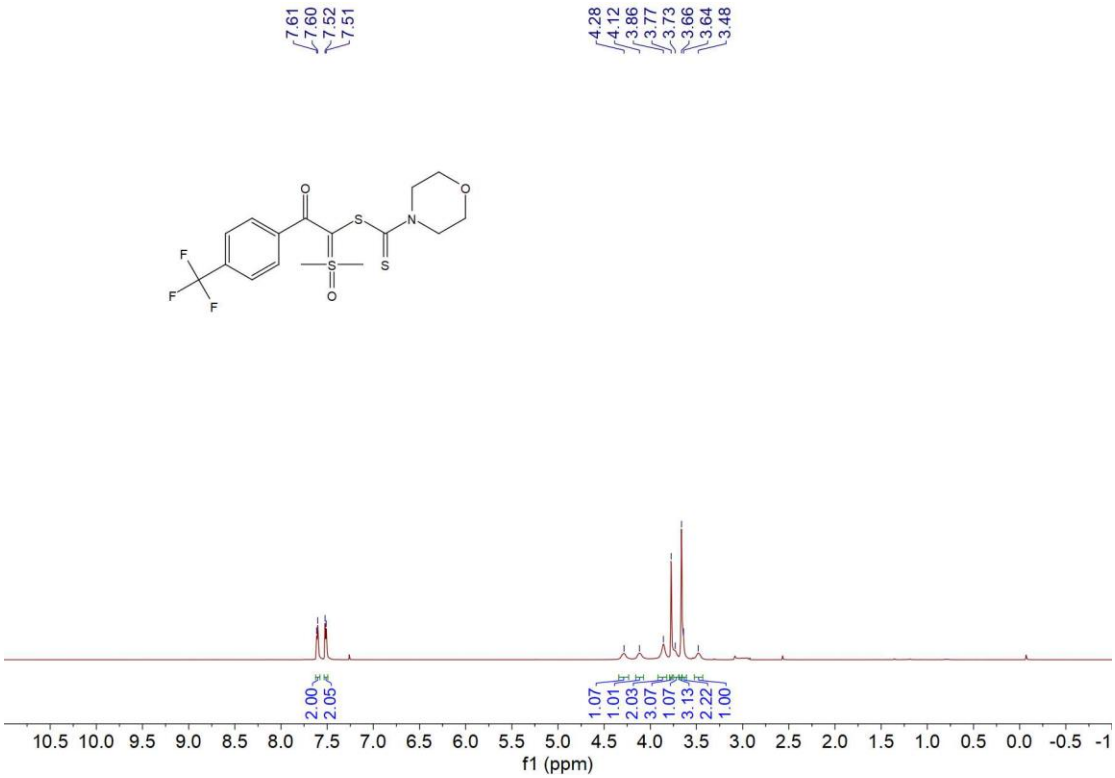
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3aa**



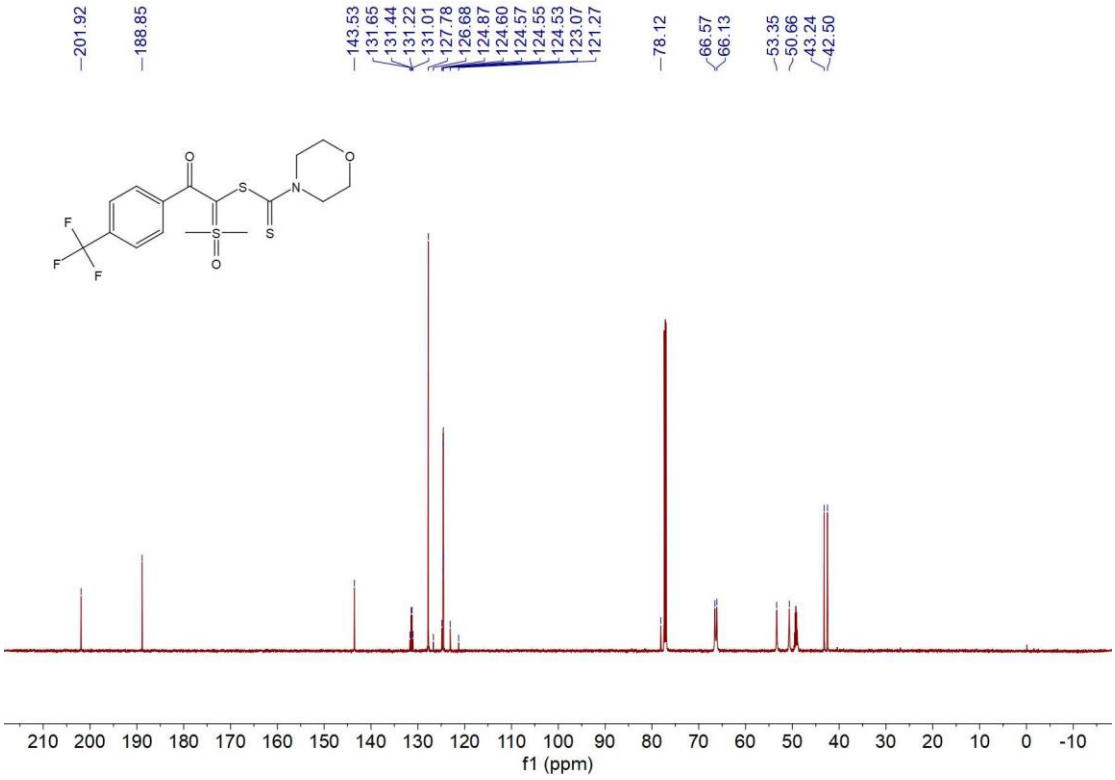
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3aa**



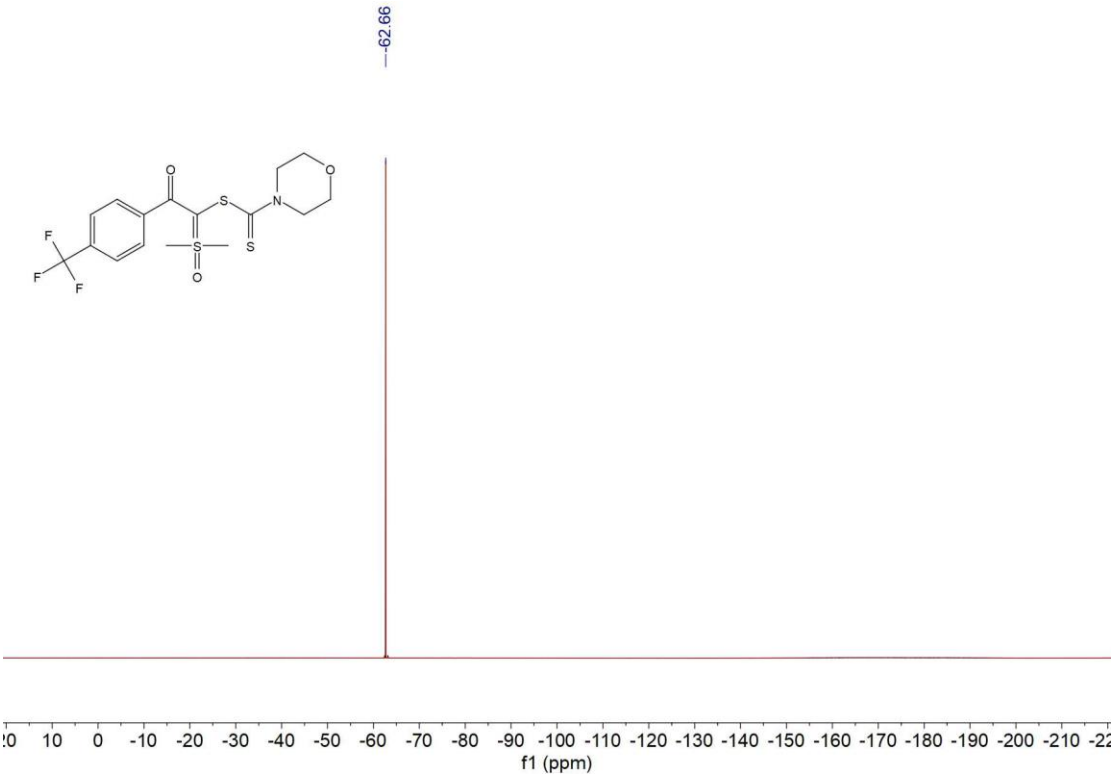
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3ab**



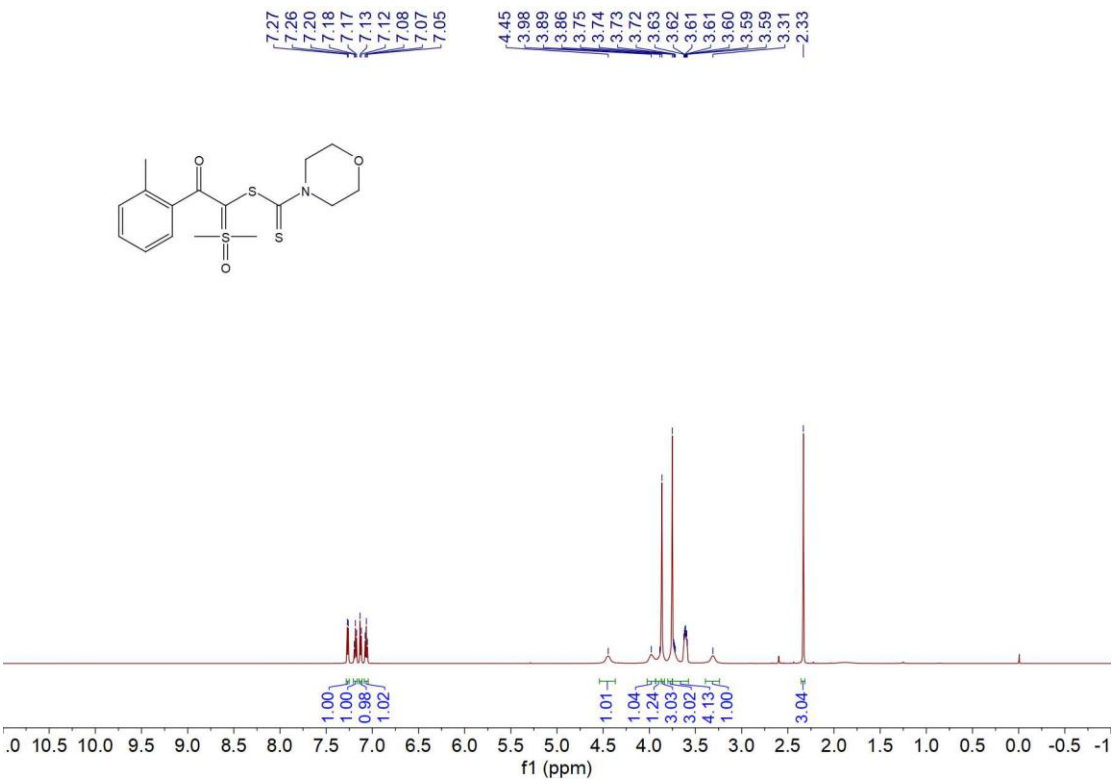
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3ab**



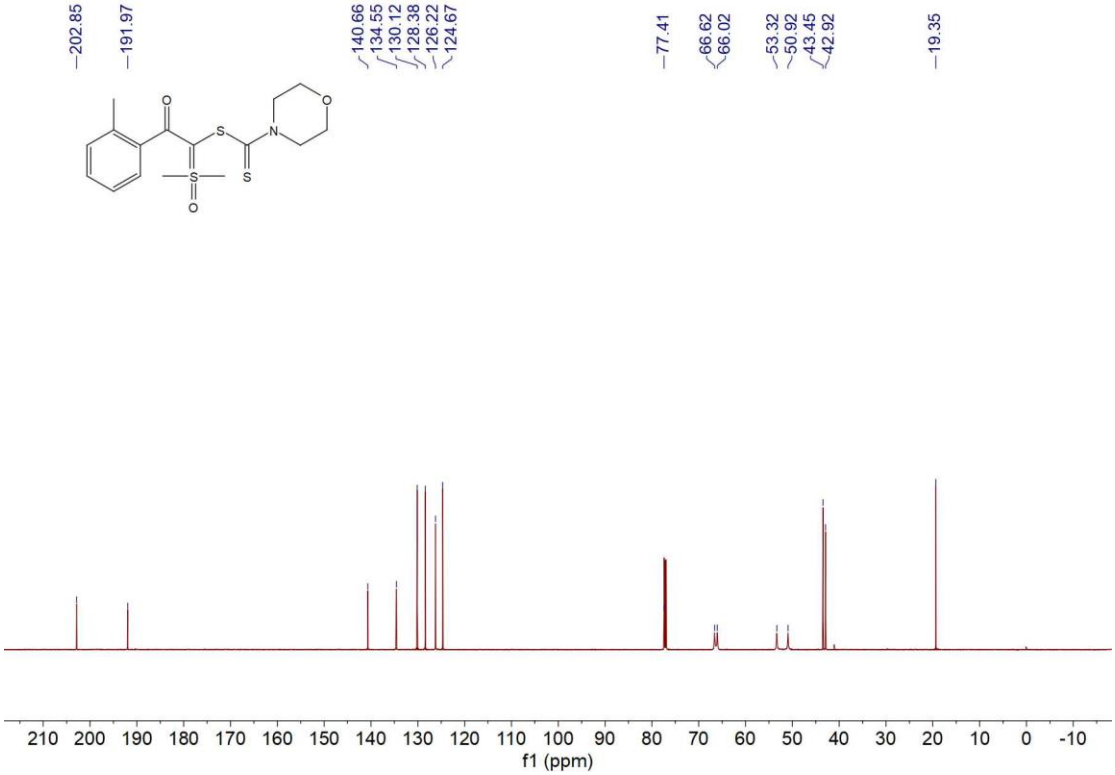
^{19}F NMR (377 MHz, $CDCl_3$) Spectra of **3ab**



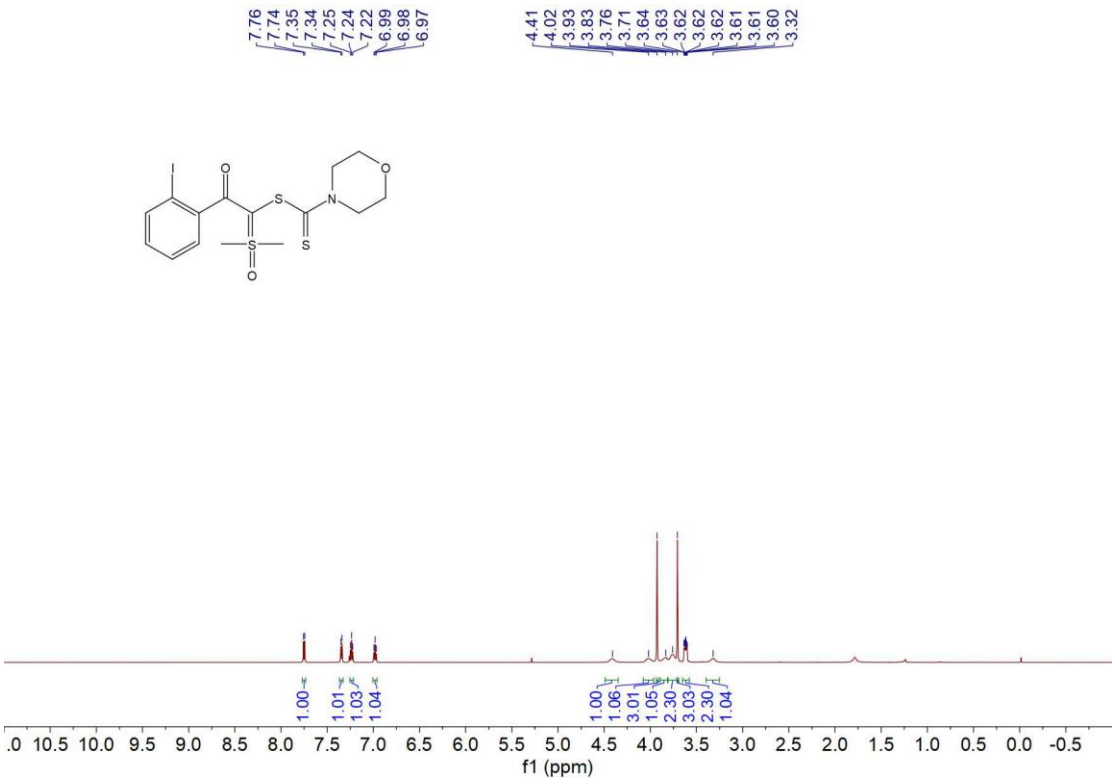
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3ac**



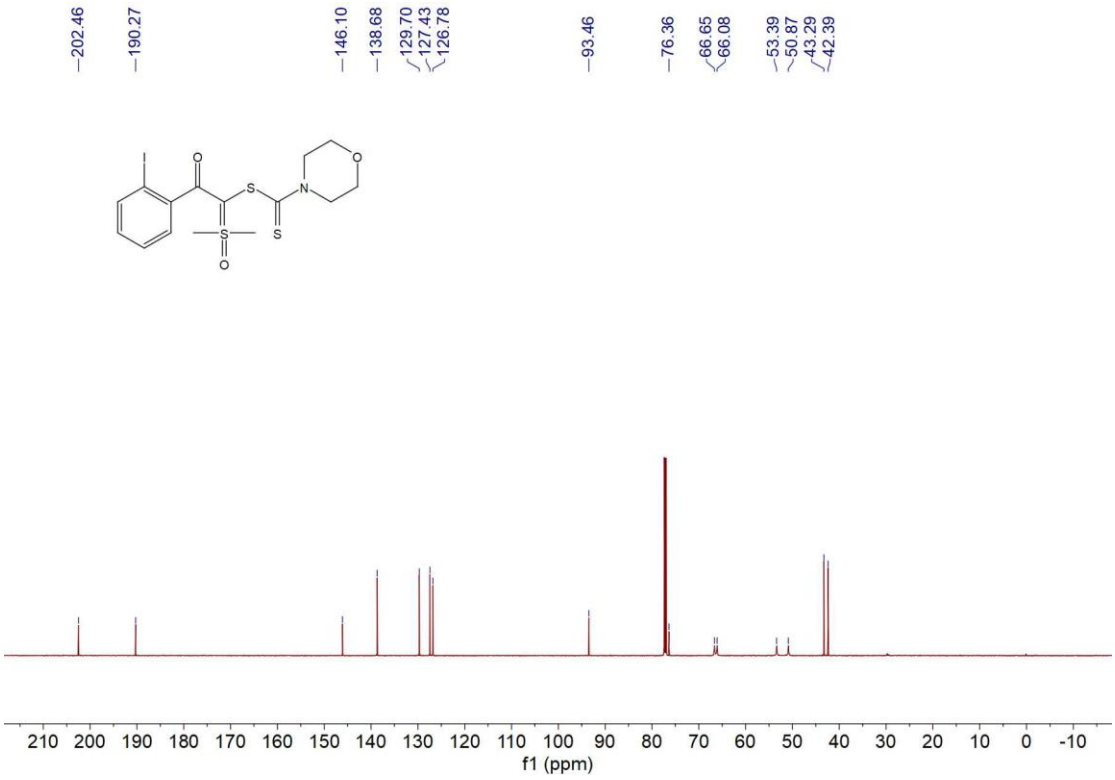
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3ac**



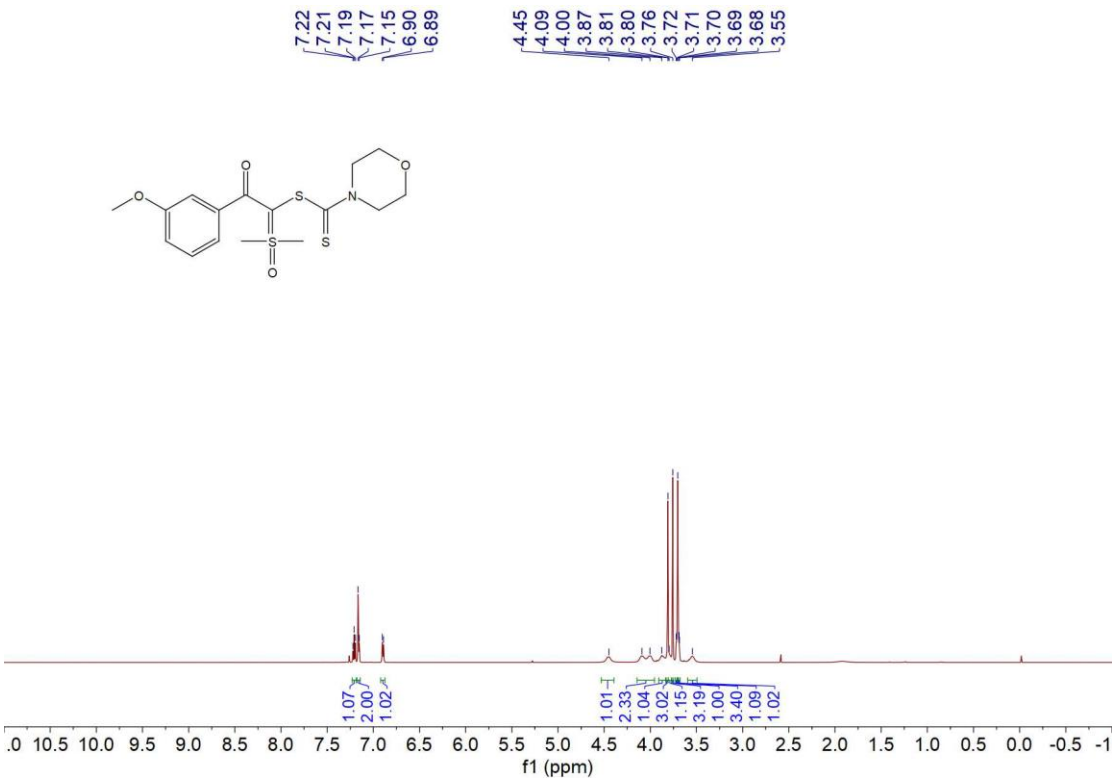
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3ad**



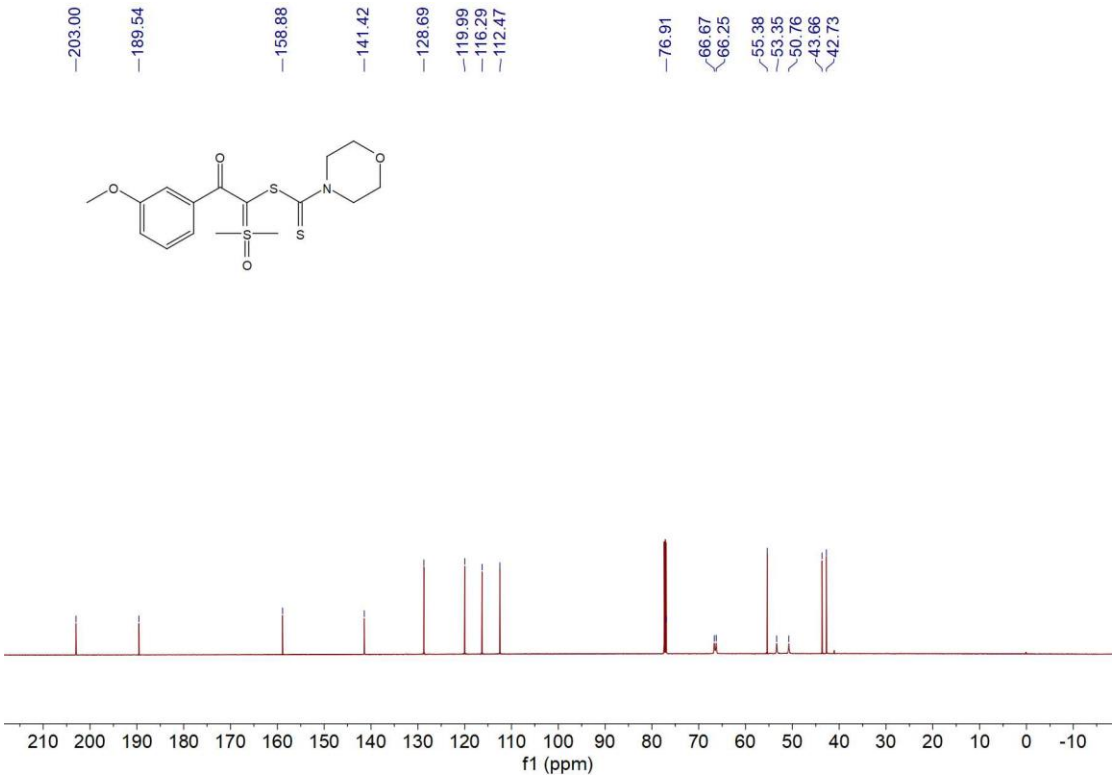
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3ad**



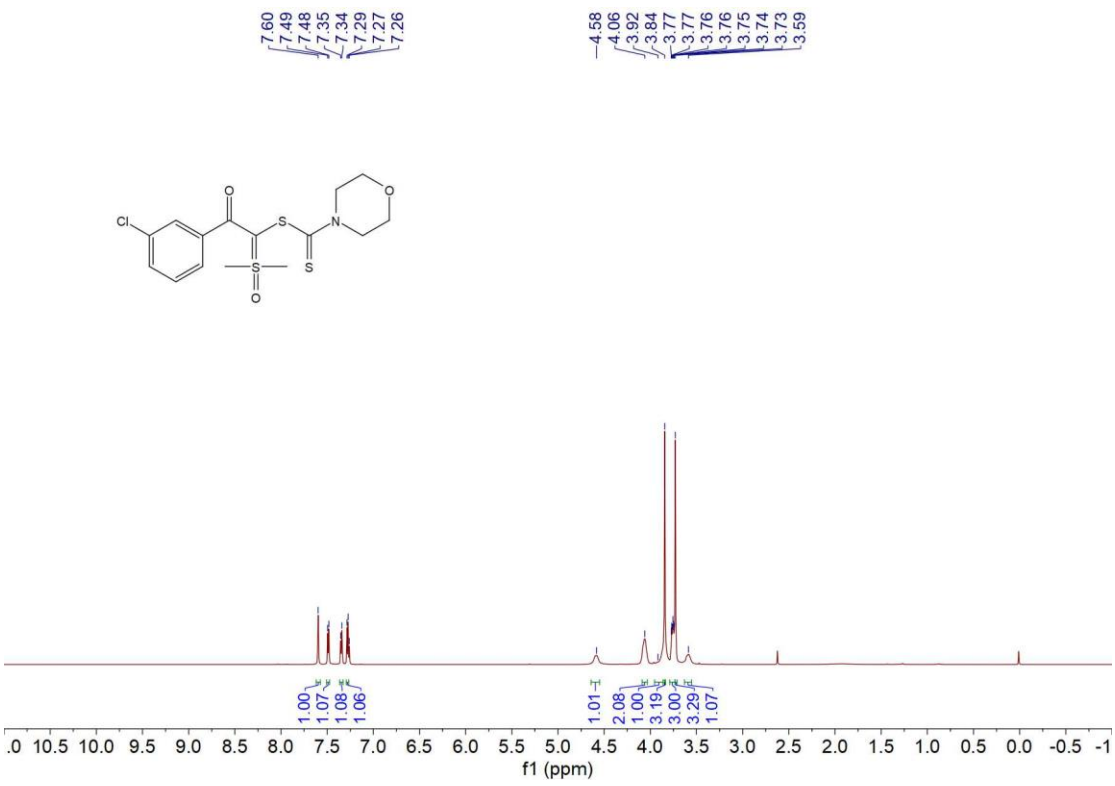
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3ae**



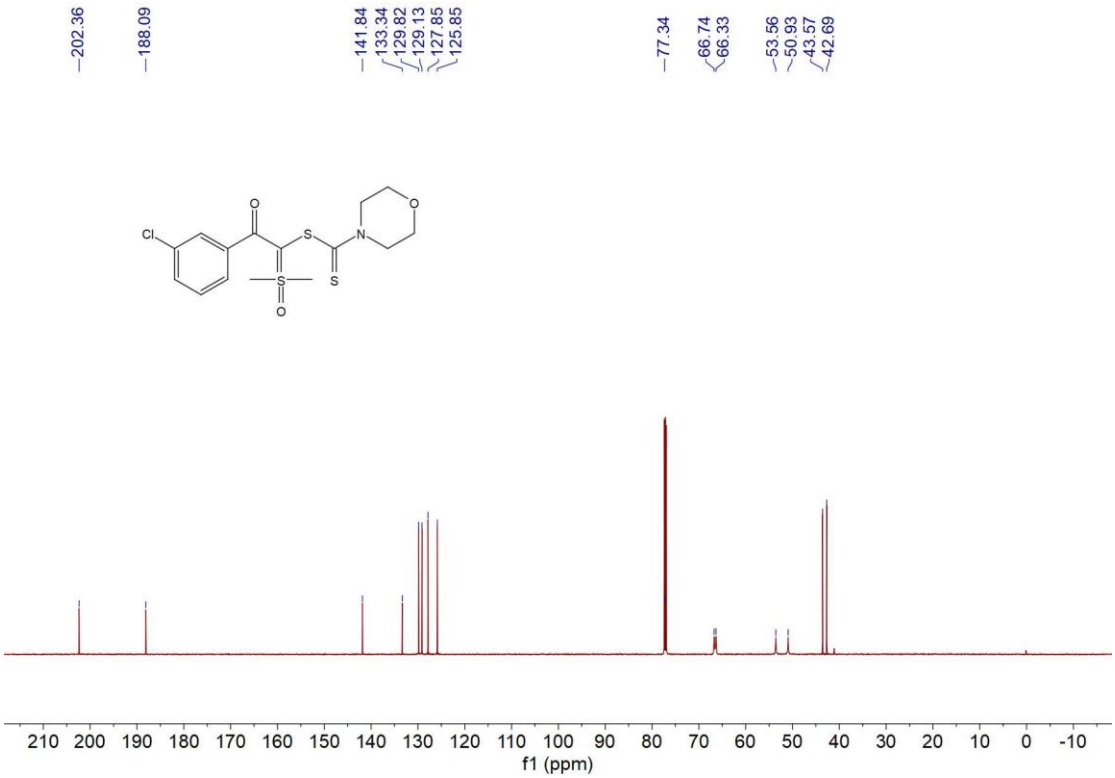
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3ae**



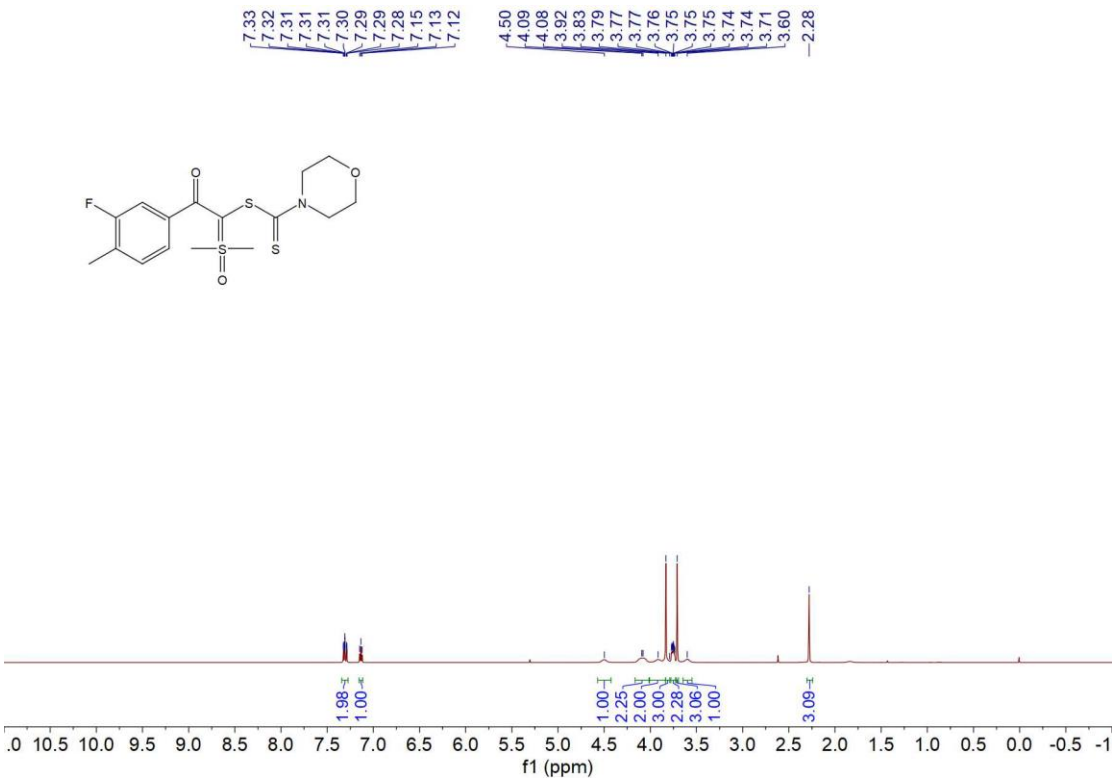
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3af**



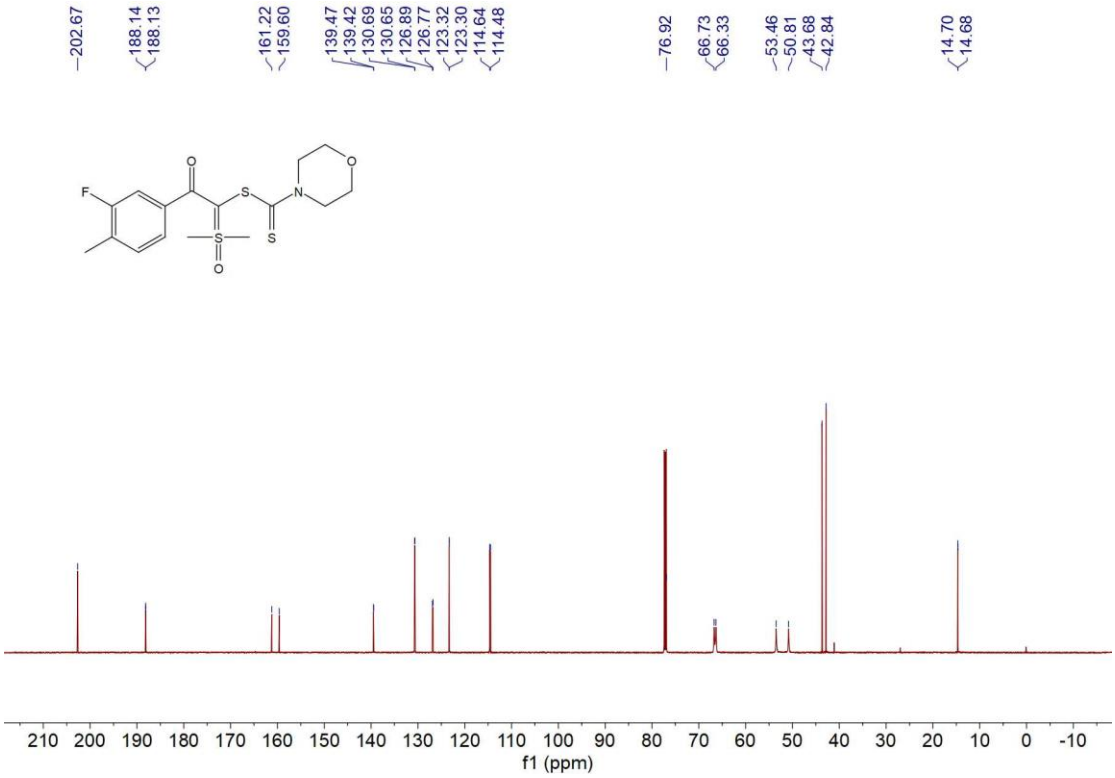
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3af**



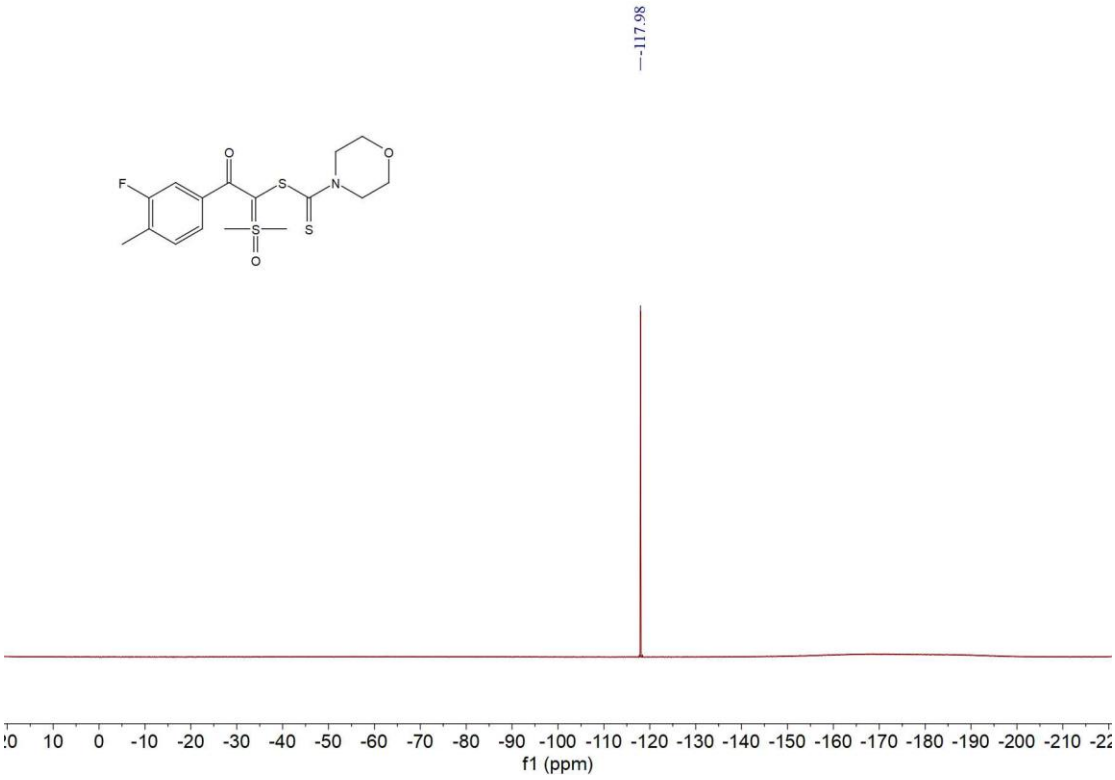
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3ag**



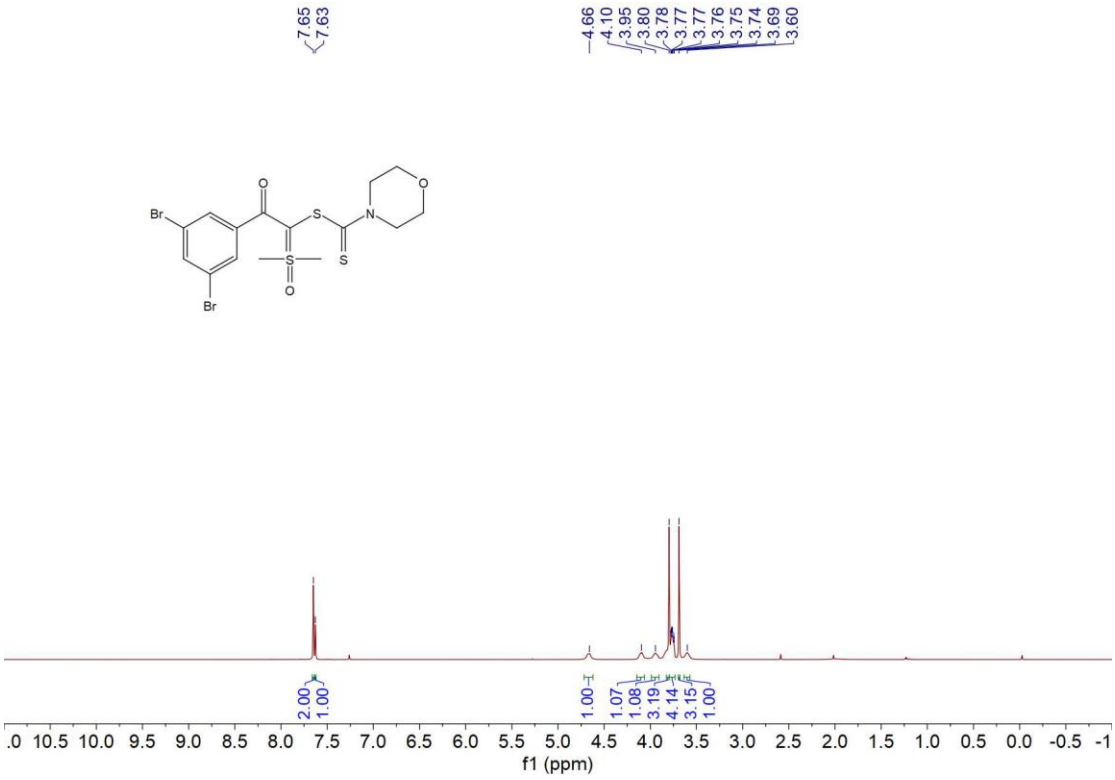
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3ag**



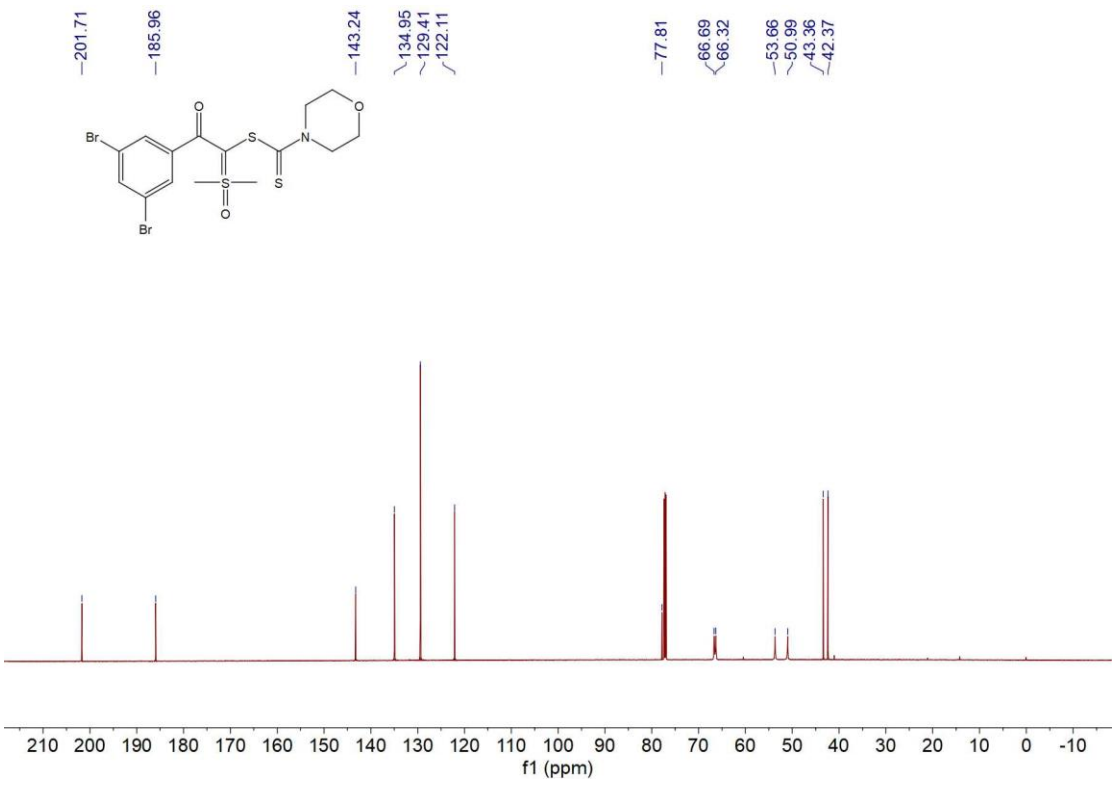
^{19}F NMR (377 MHz, $CDCl_3$) Spectra of **3ag**



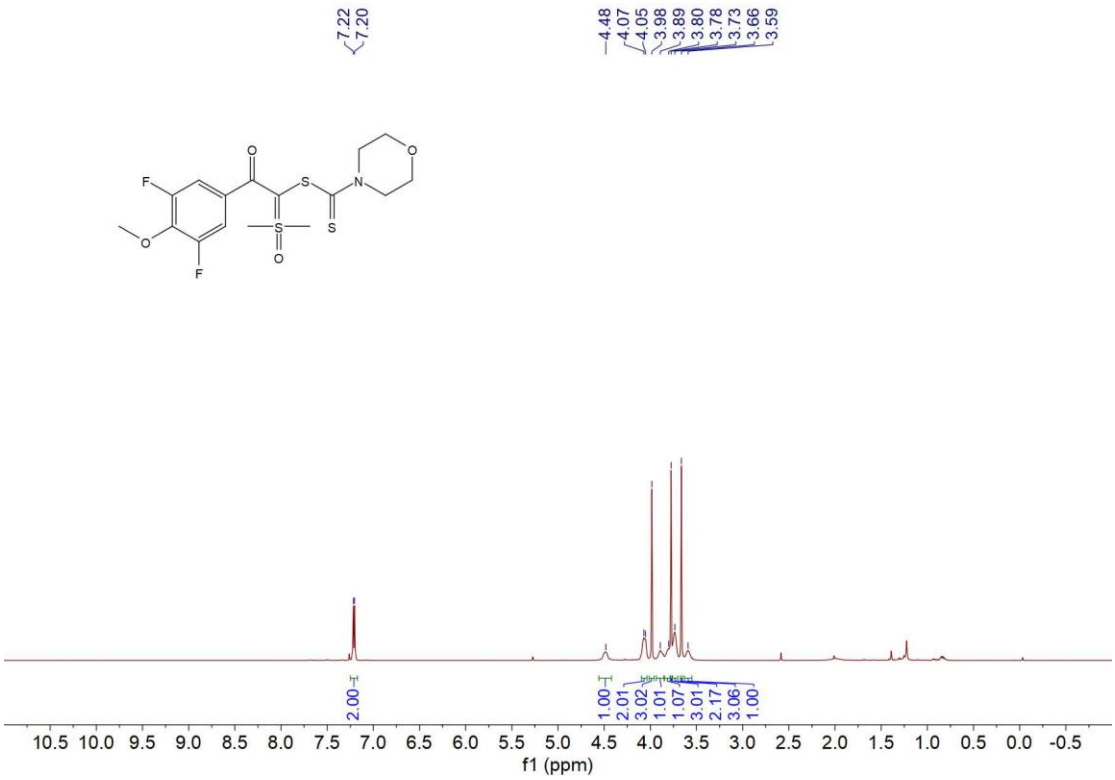
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3ah**



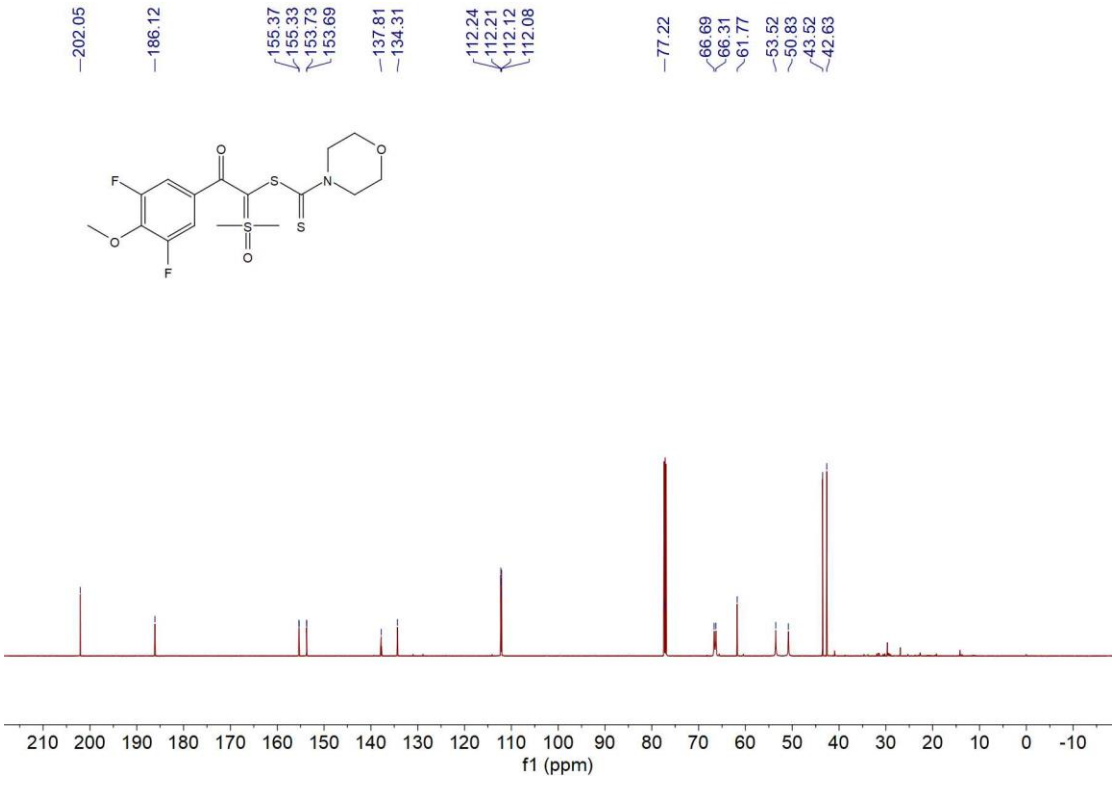
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3ah**



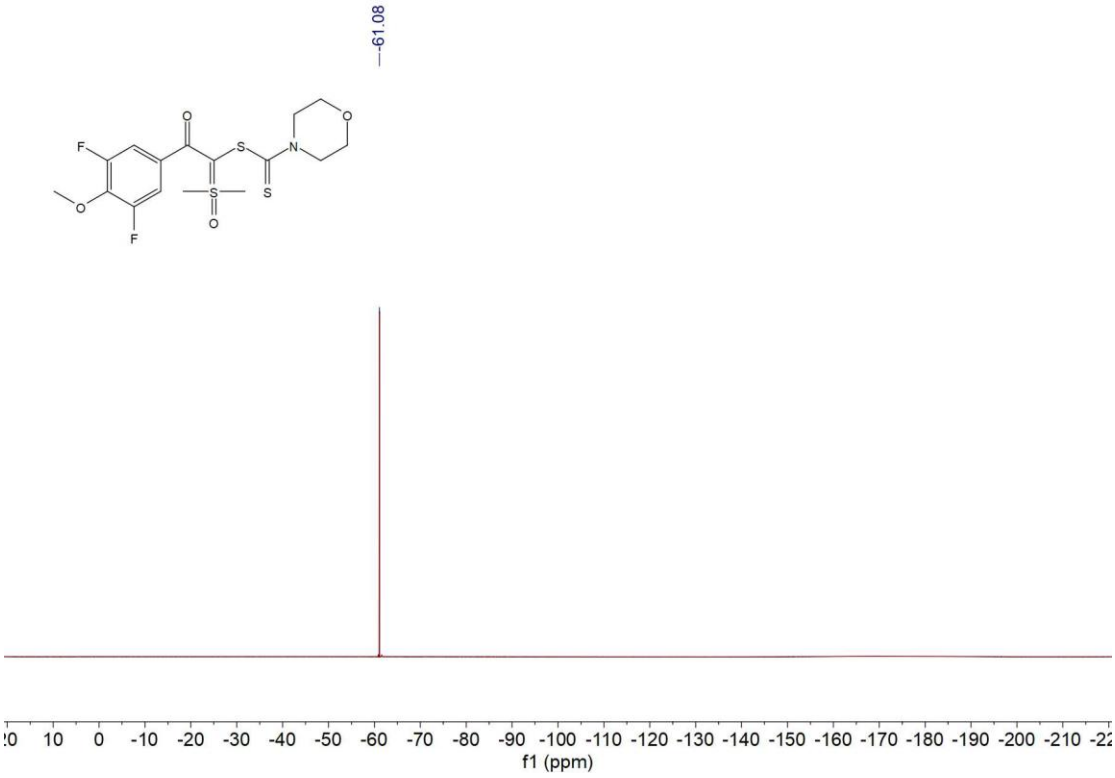
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3ai**



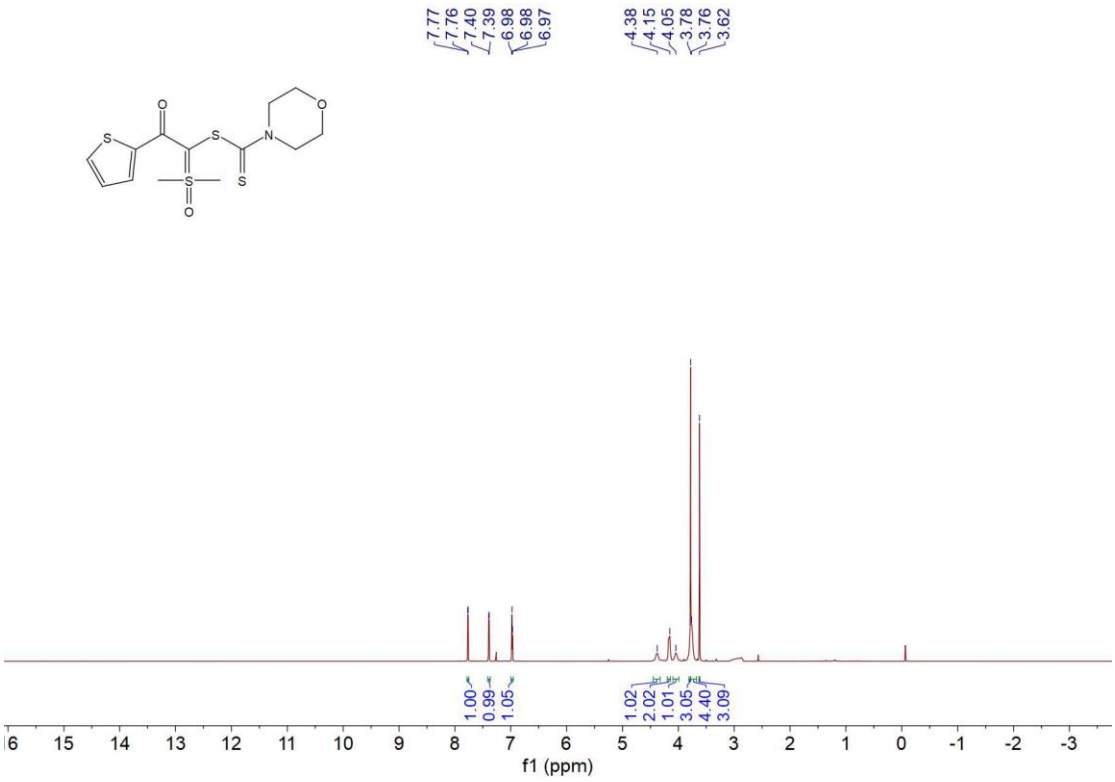
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3ai**



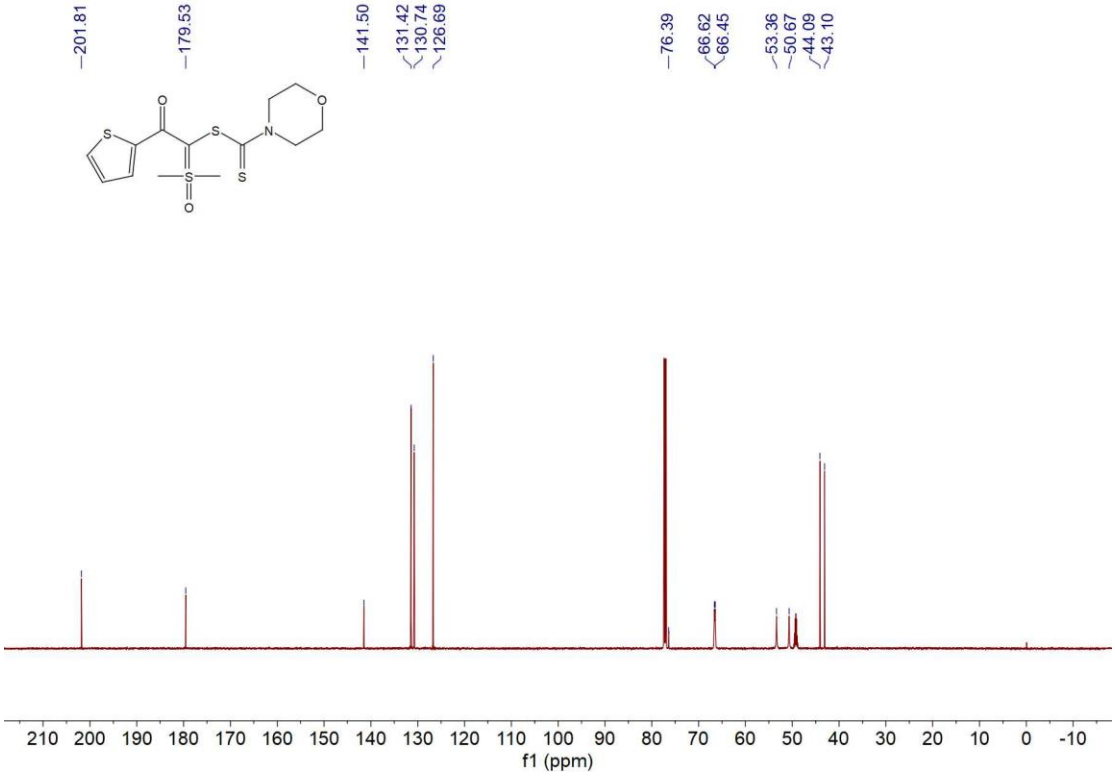
^{19}F NMR (377 MHz, DMSO) Spectra of **3ai**



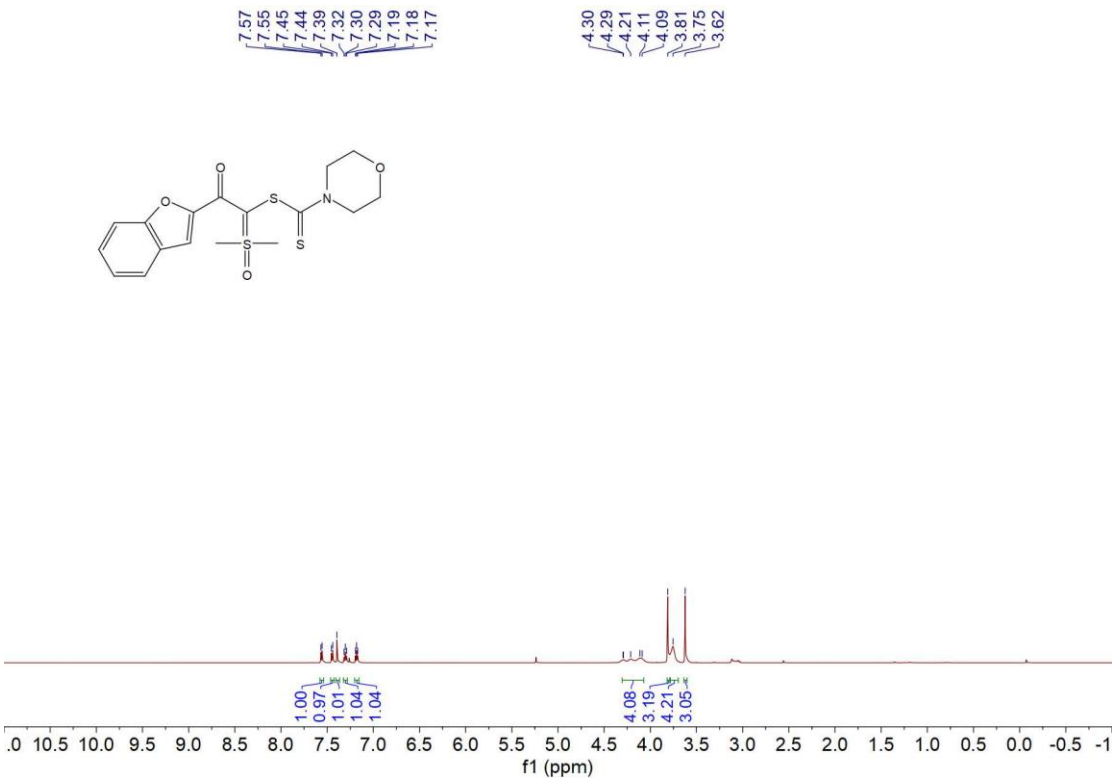
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3aj**



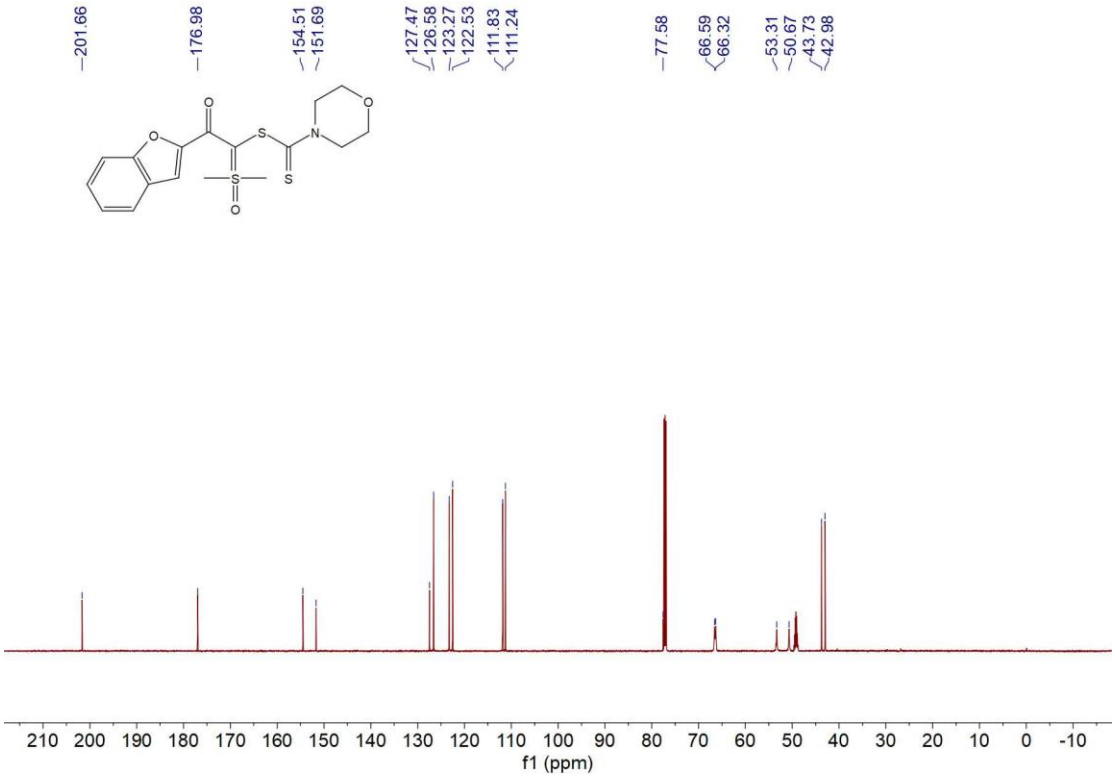
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3aj**



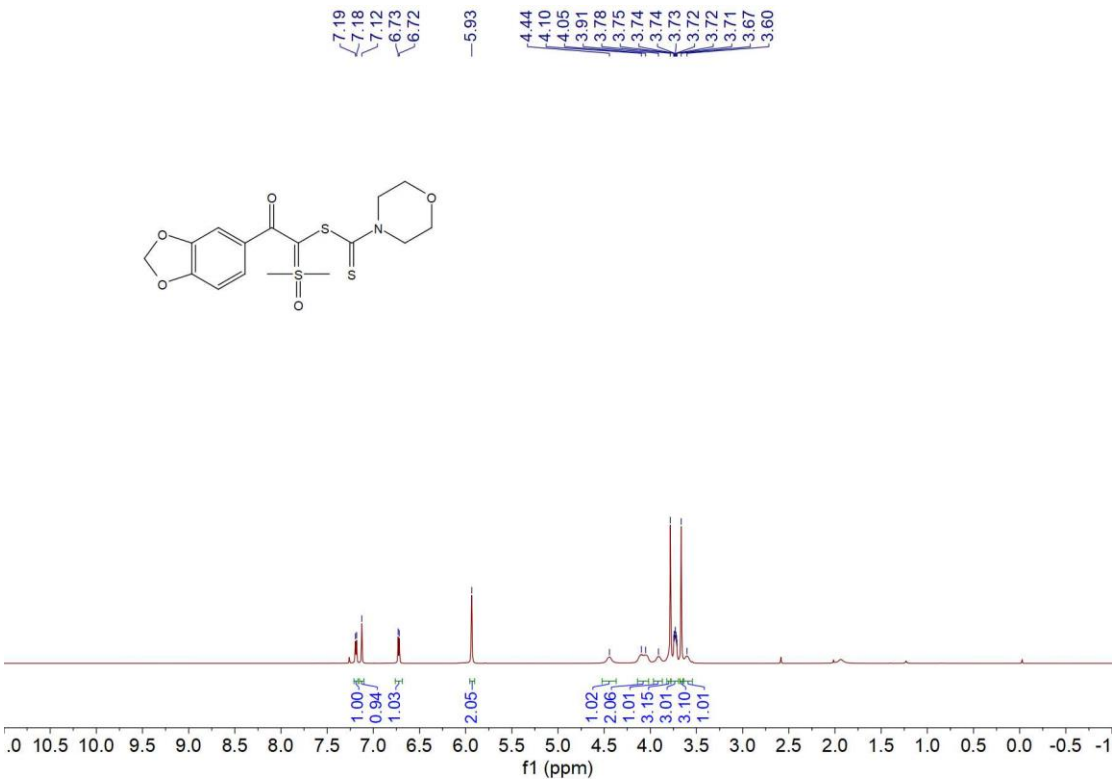
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3ak**



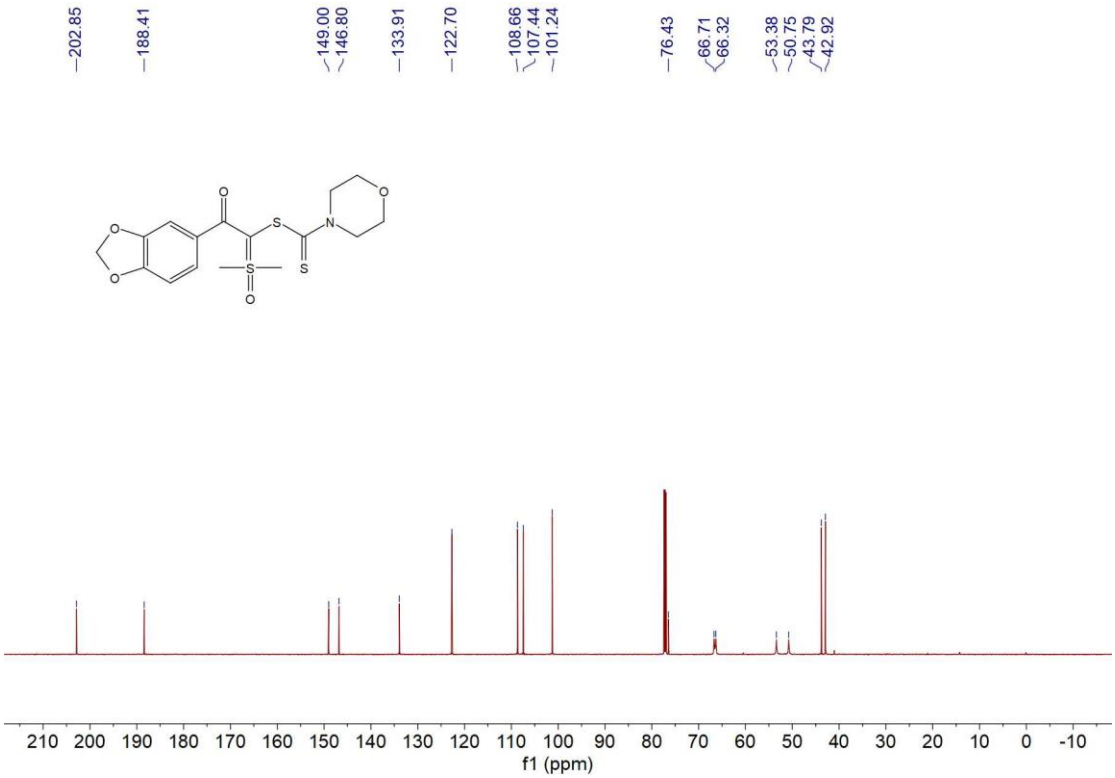
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3ak**



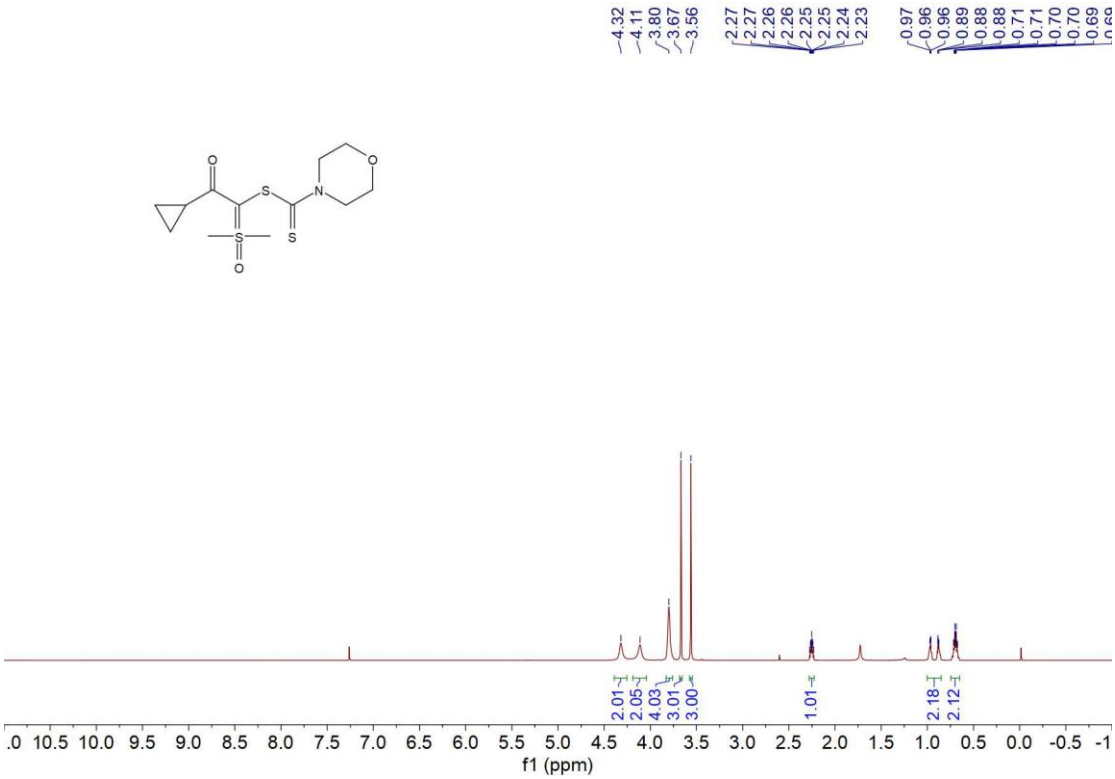
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3al**



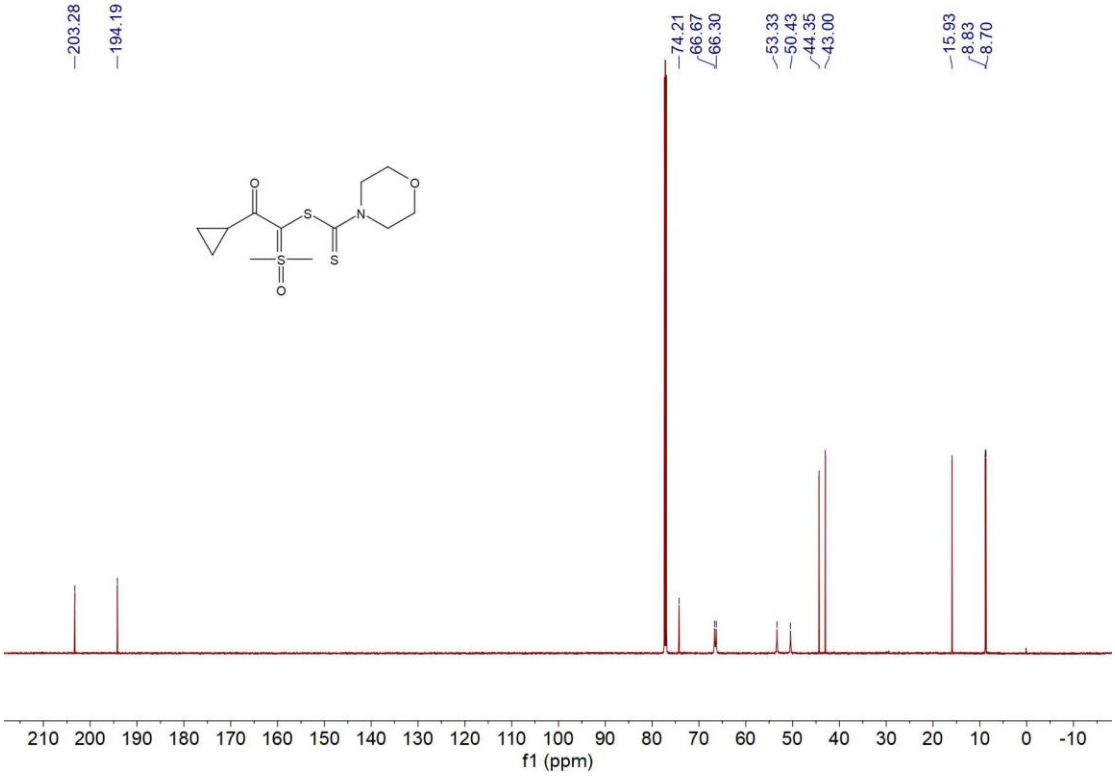
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3al**



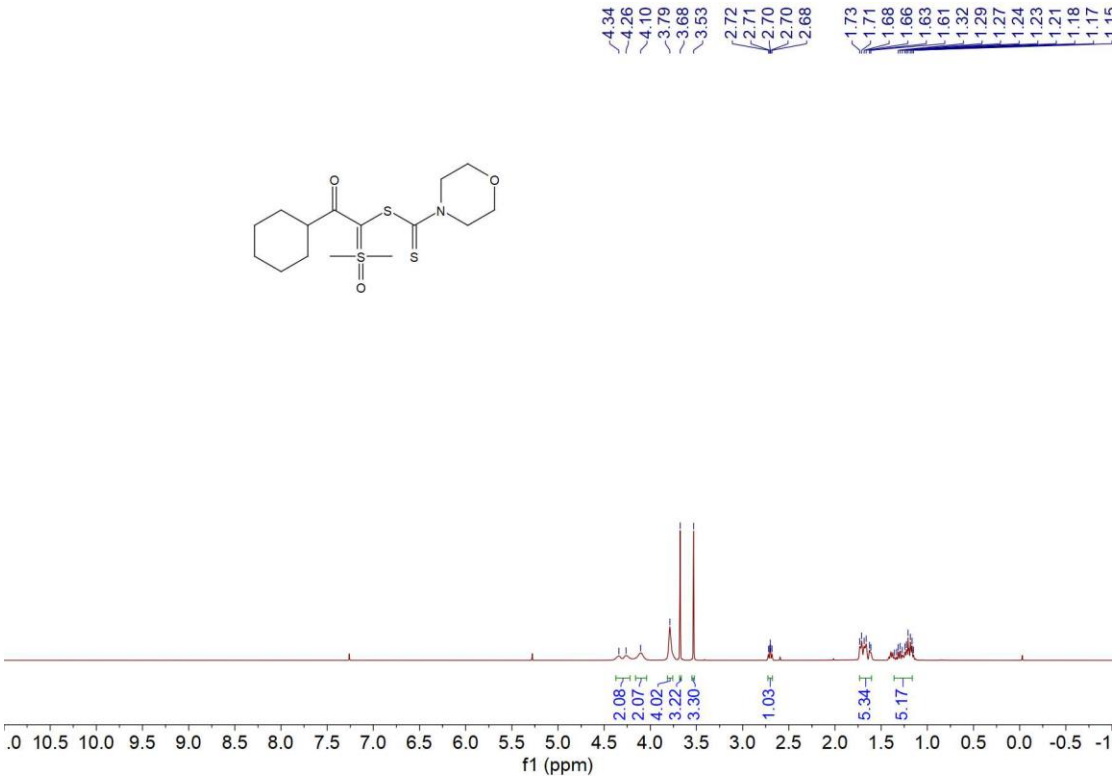
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3am**



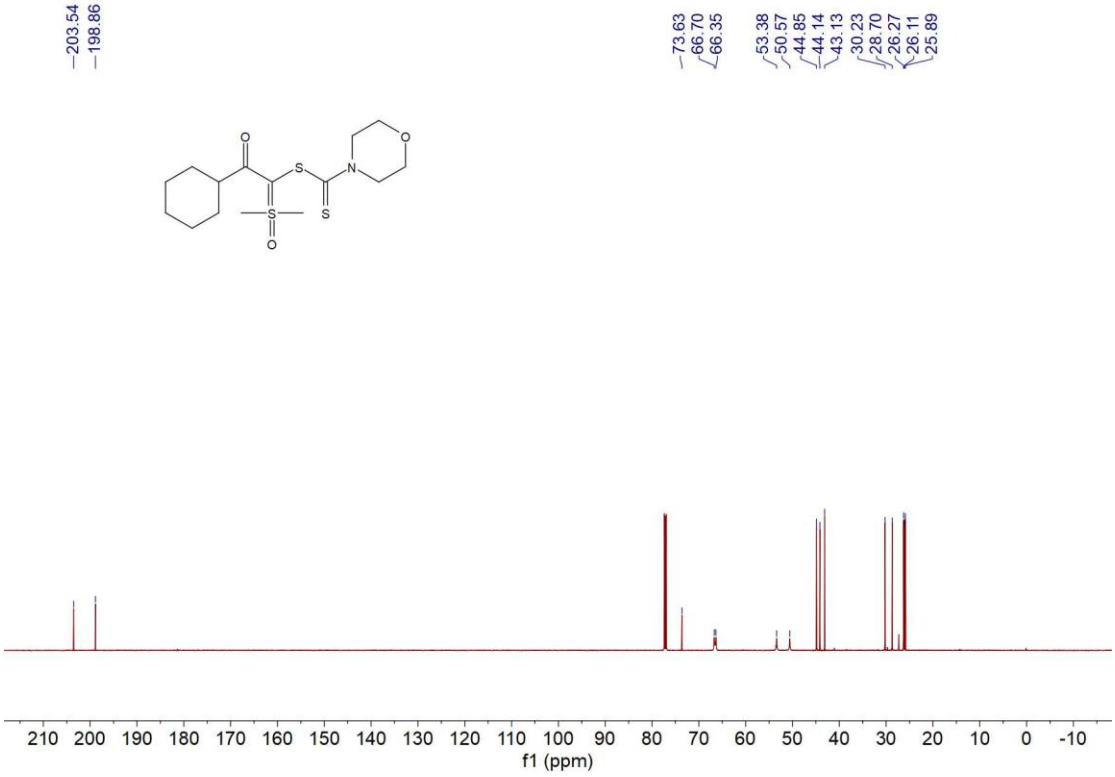
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3am**



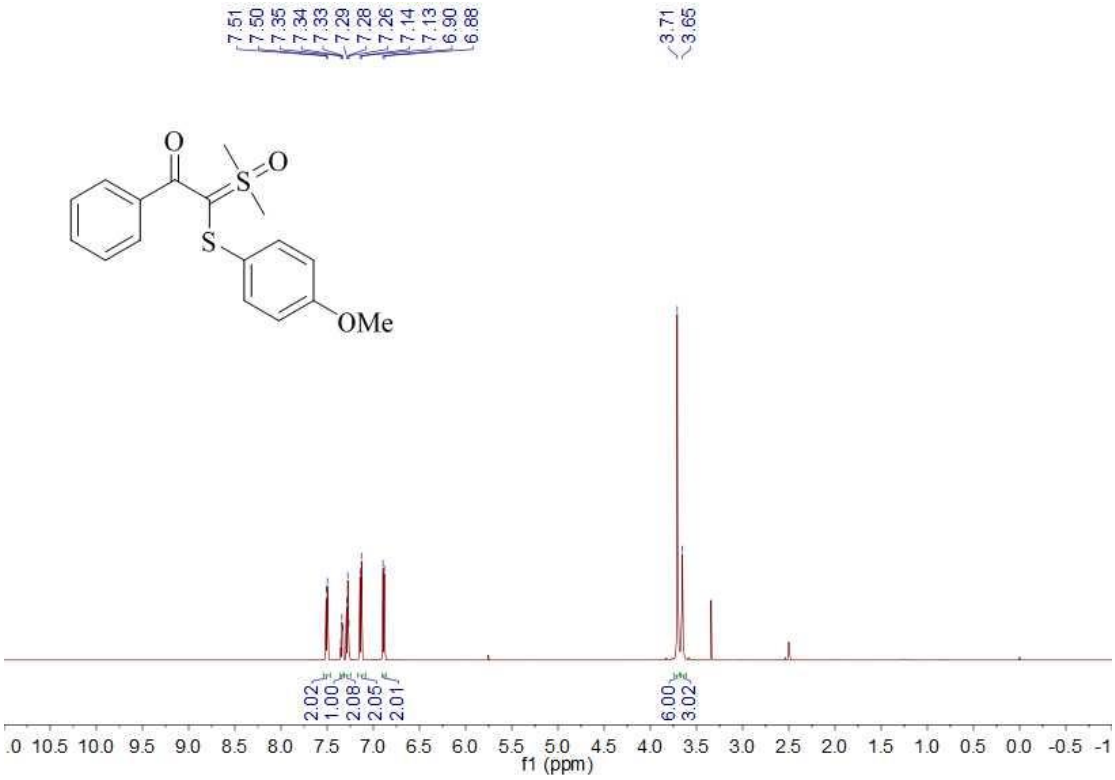
^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **3an**



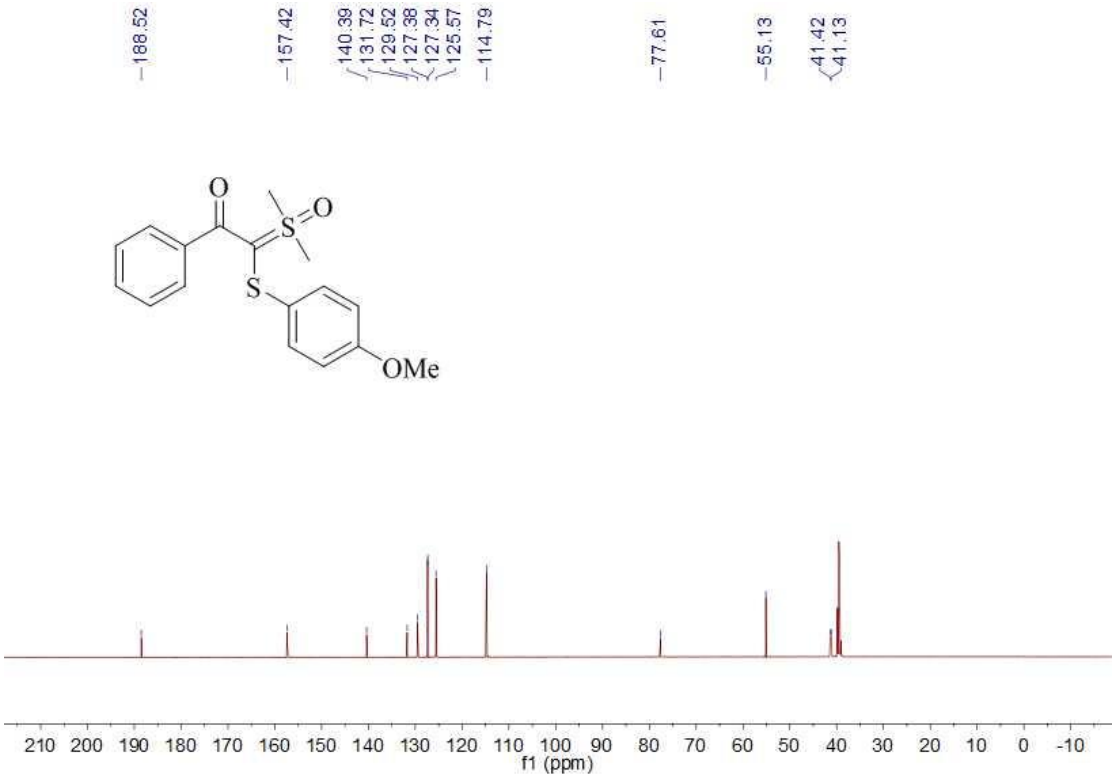
^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **3an**



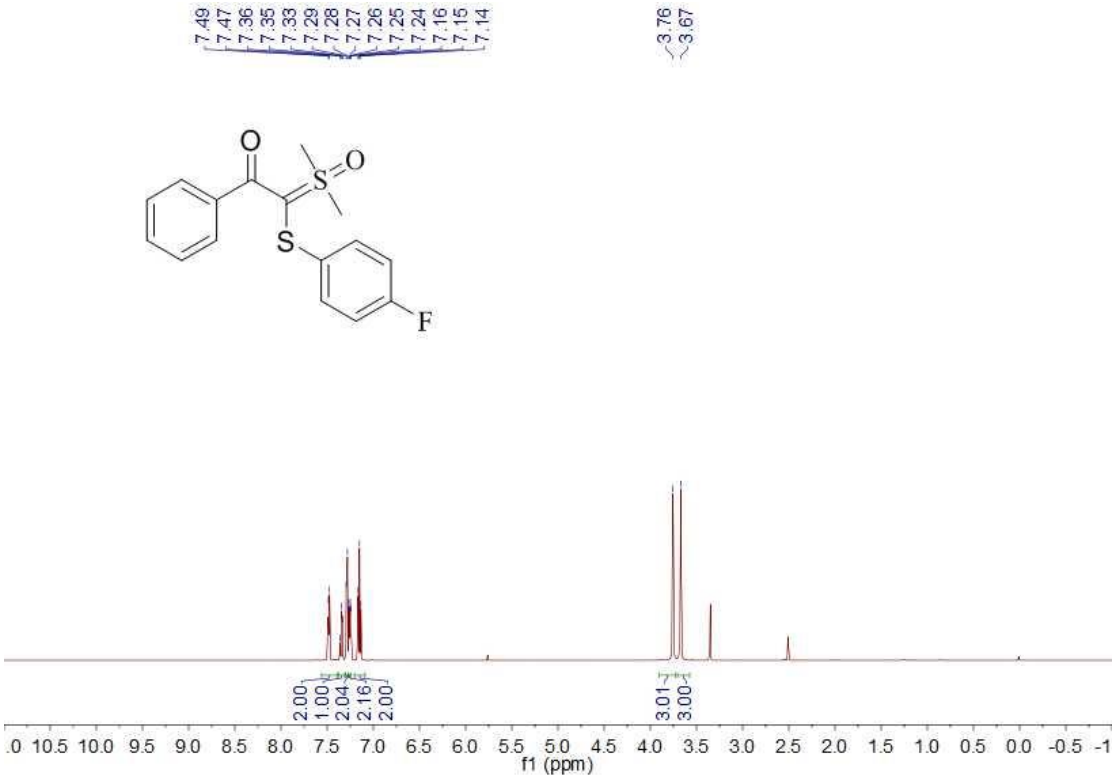
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4a**



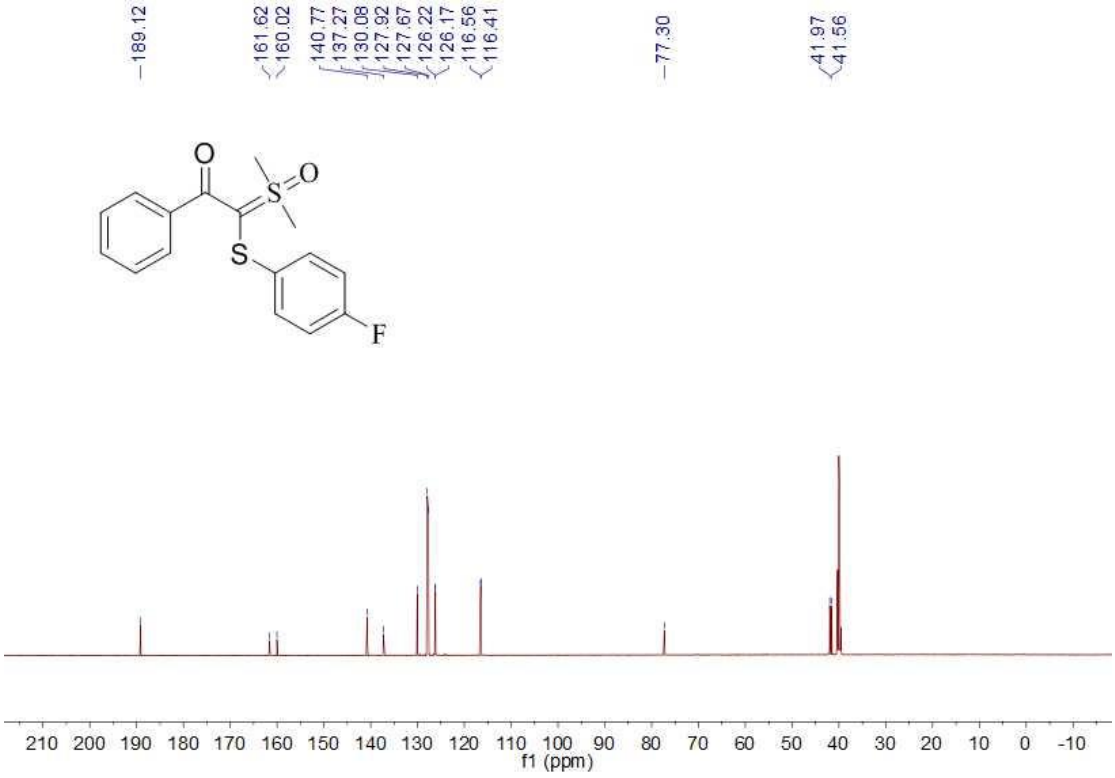
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4a**



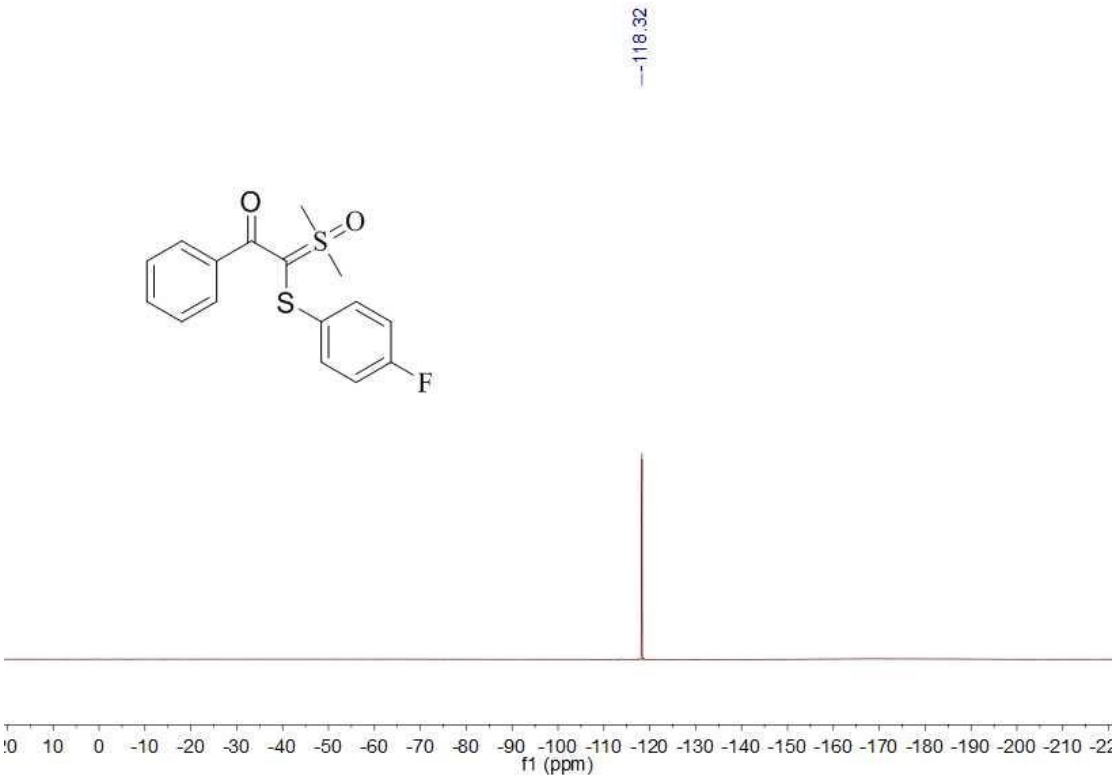
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4b**



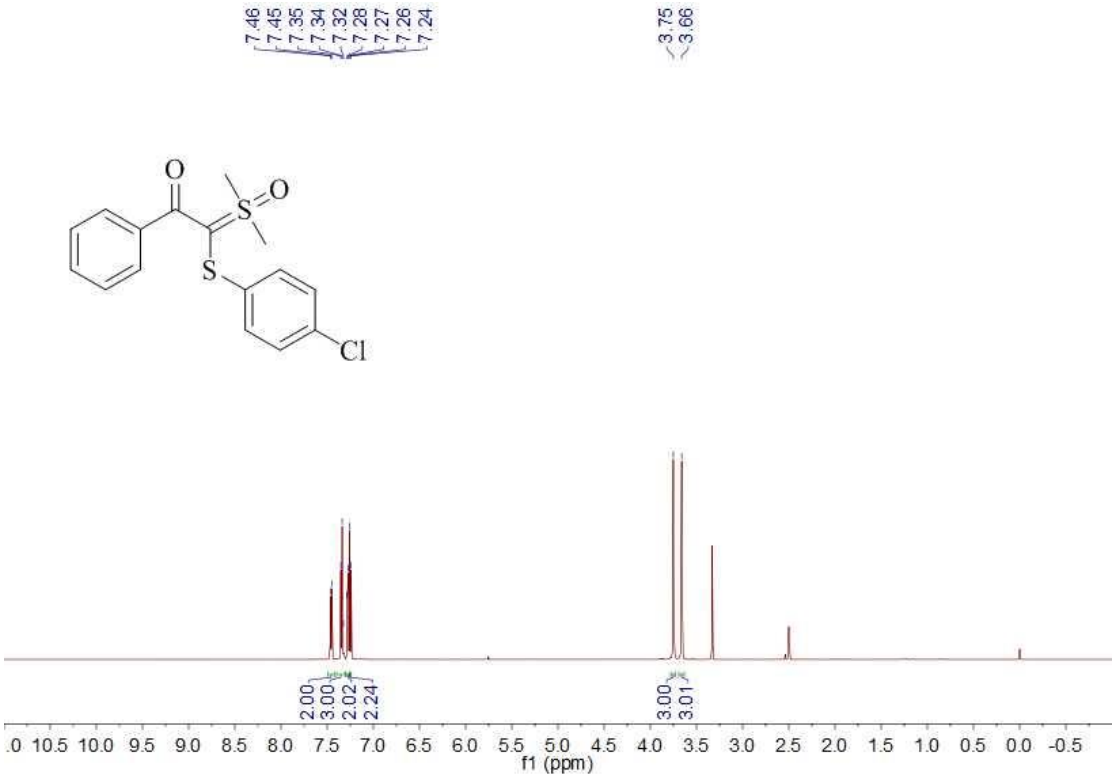
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4b**



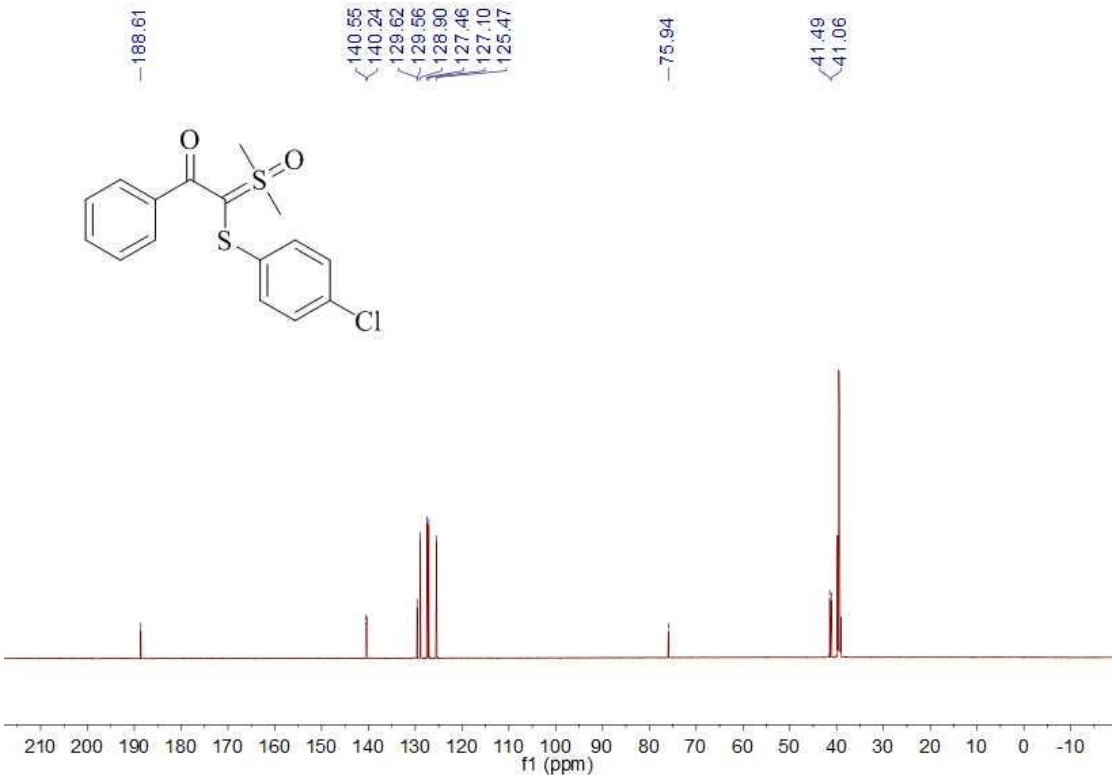
^{19}F NMR (377 MHz, DMSO-d_6) Spectra of **4b**



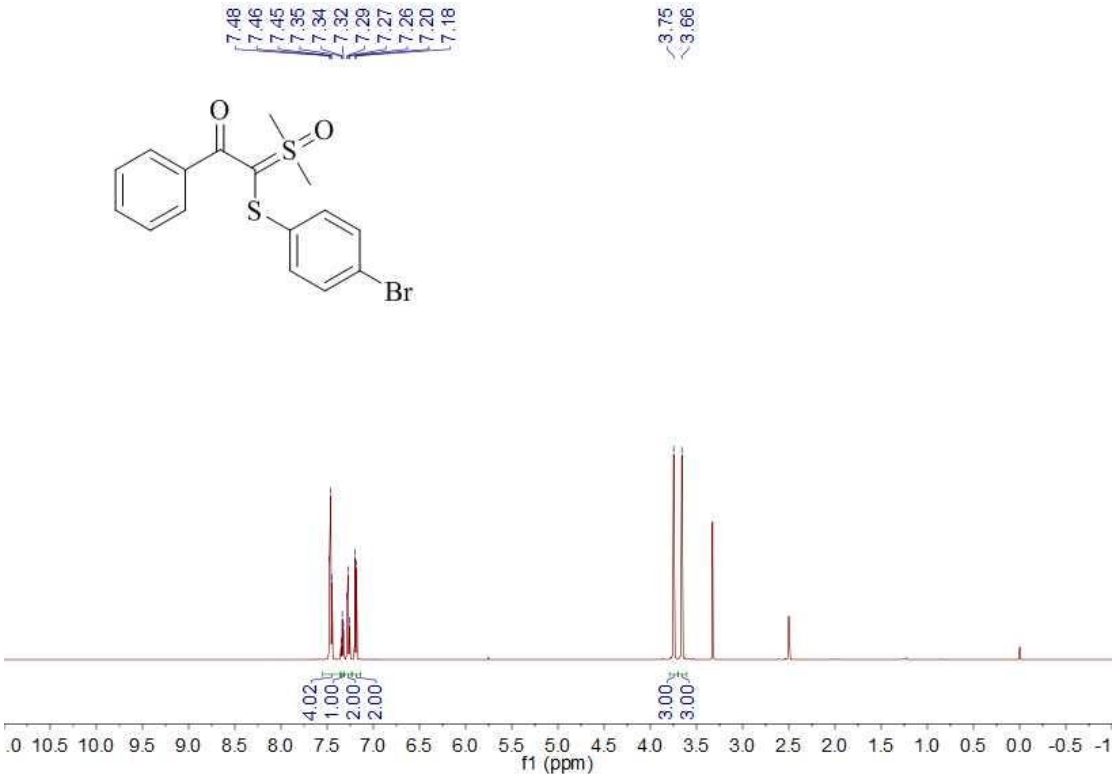
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4c**



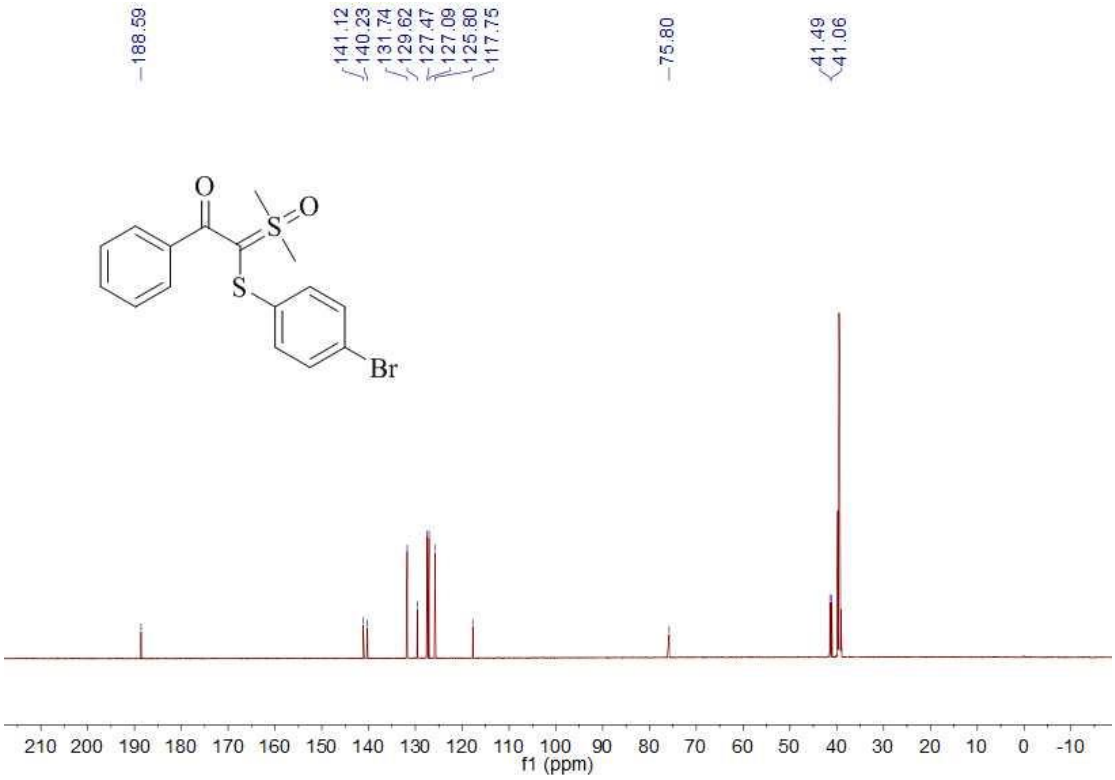
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4c**



^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4d**



^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4d**



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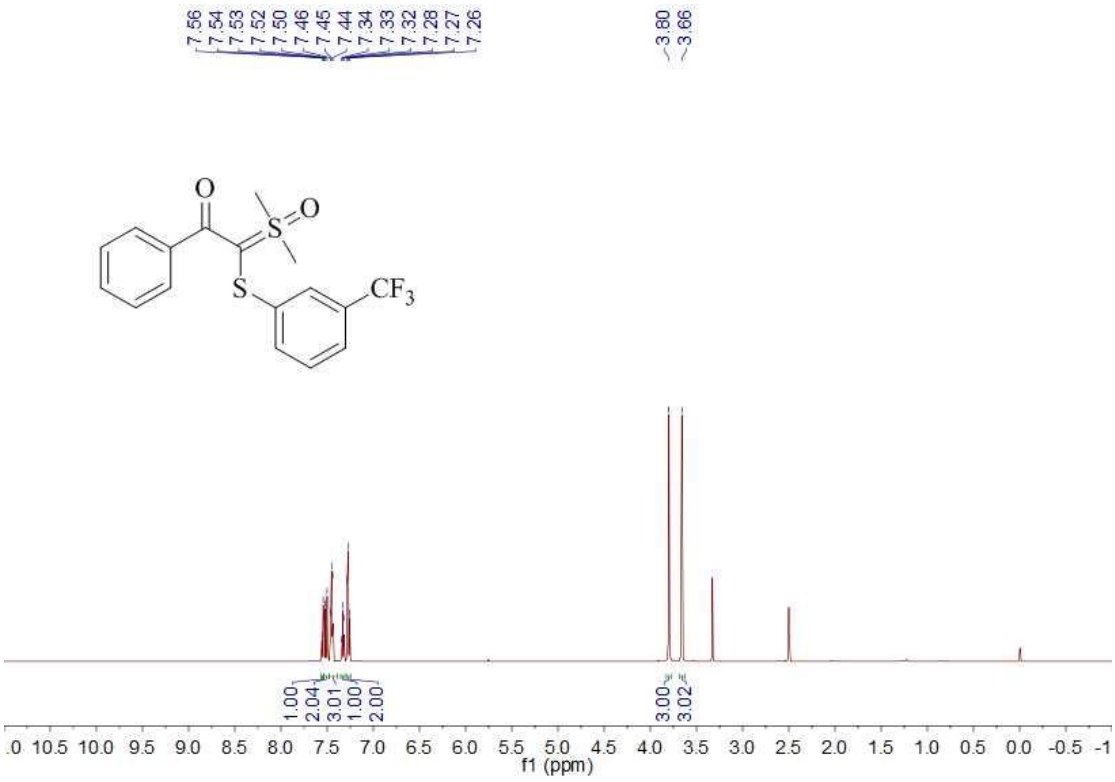
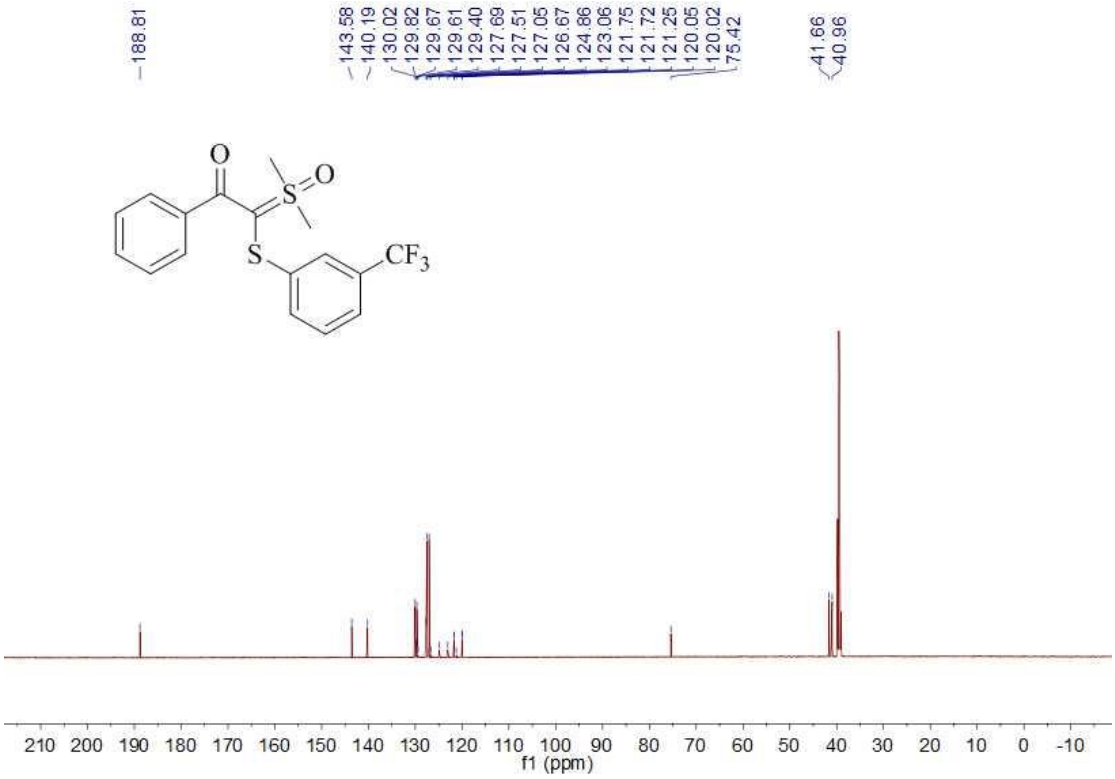
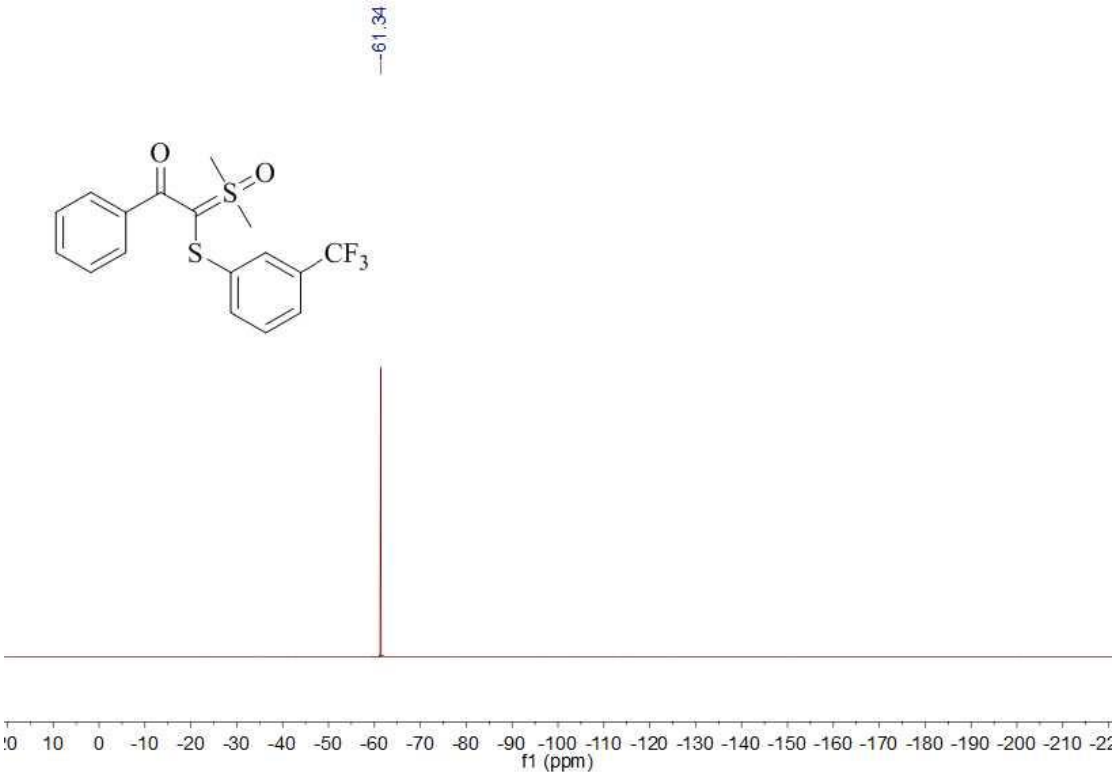


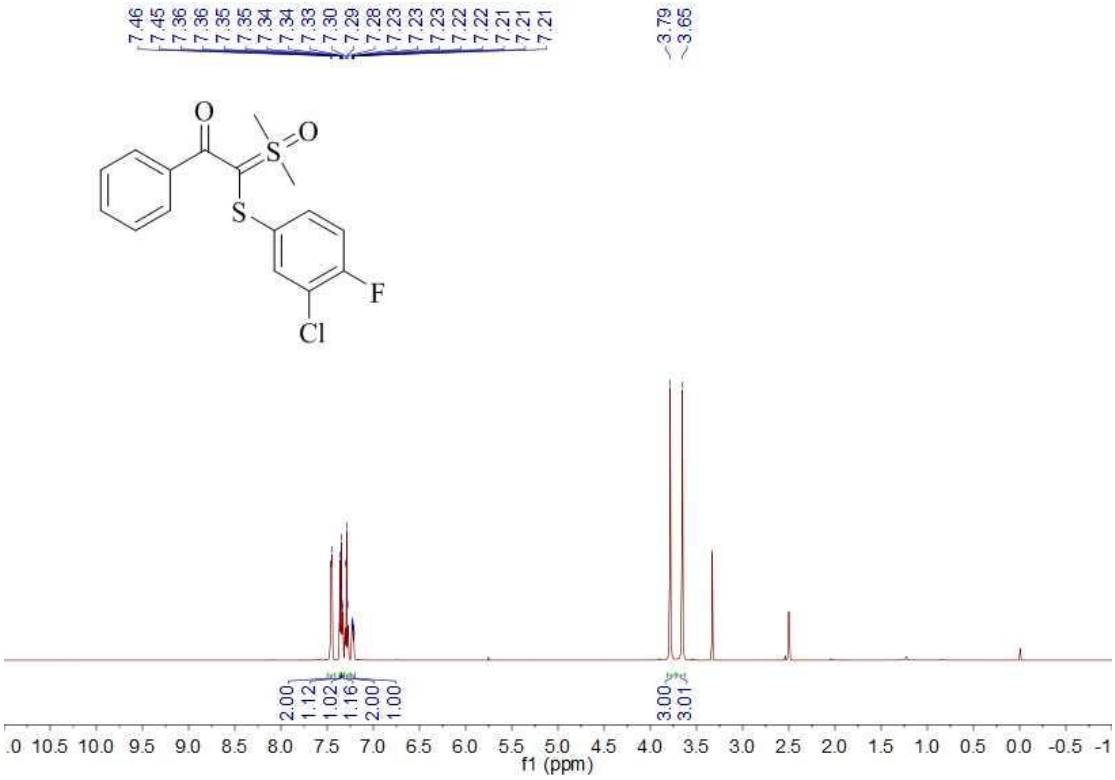
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4e**



^{19}F NMR (377 MHz, DMSO-d_6) Spectra of **4e**



^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4f**



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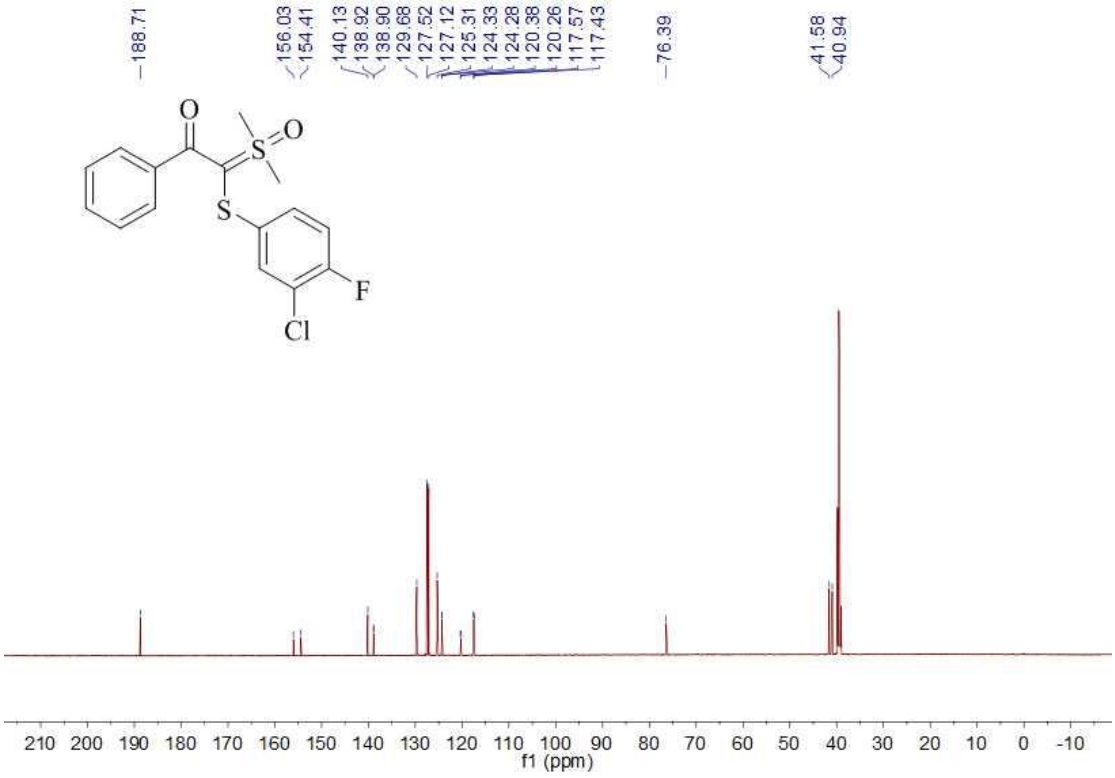
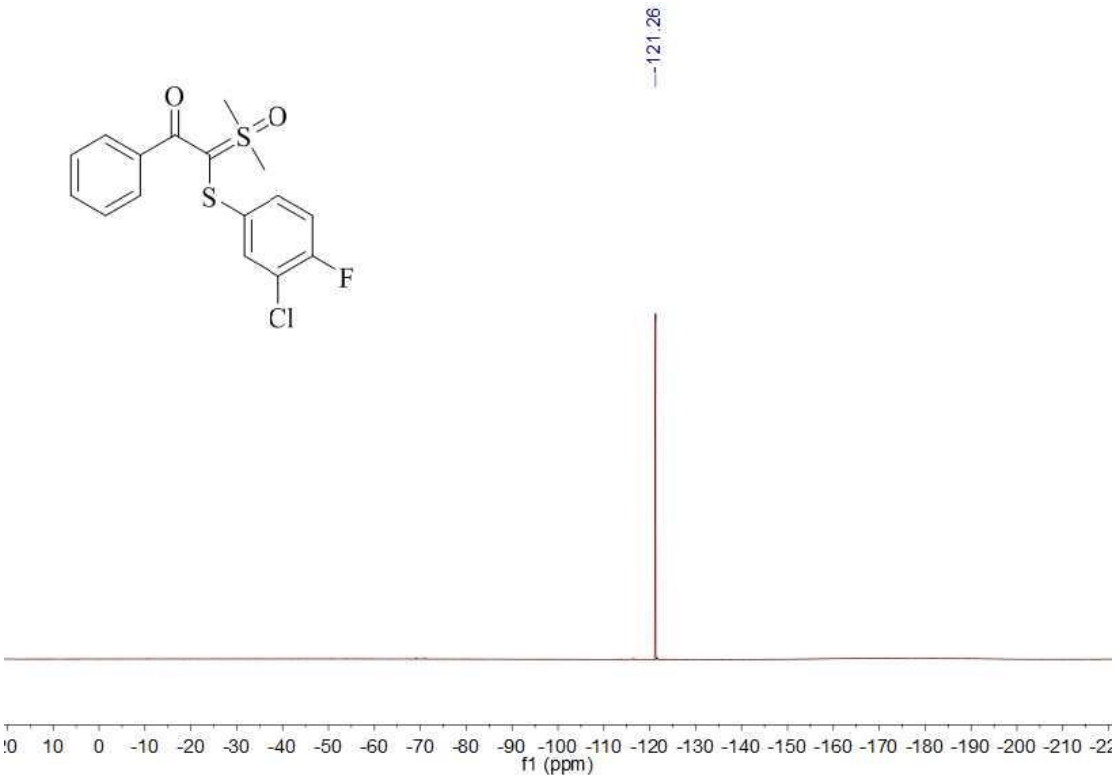
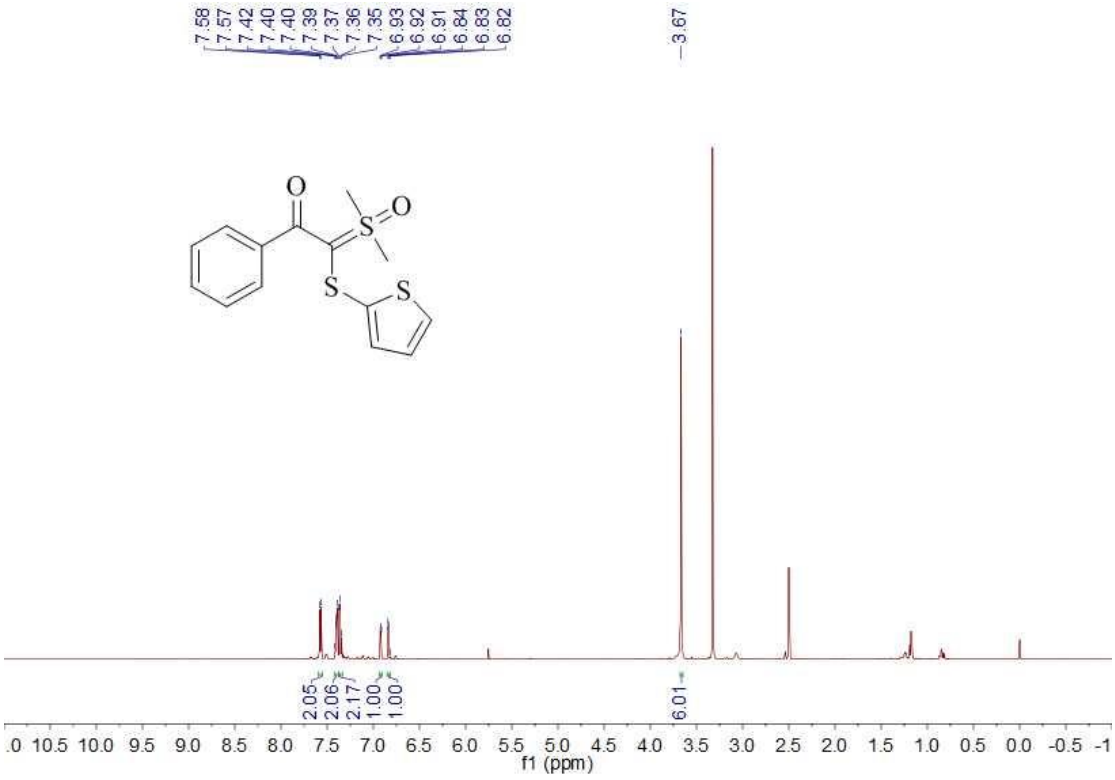


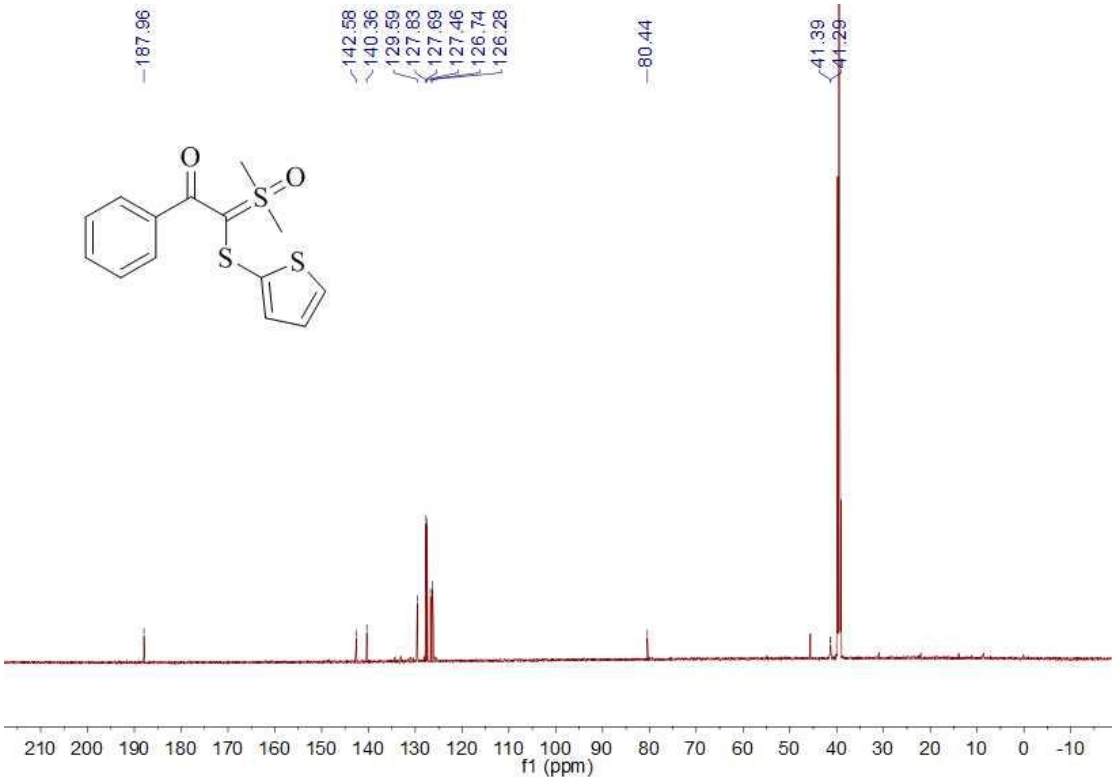
^{19}F NMR (377 MHz, DMSO-d_6) Spectra of **4f**



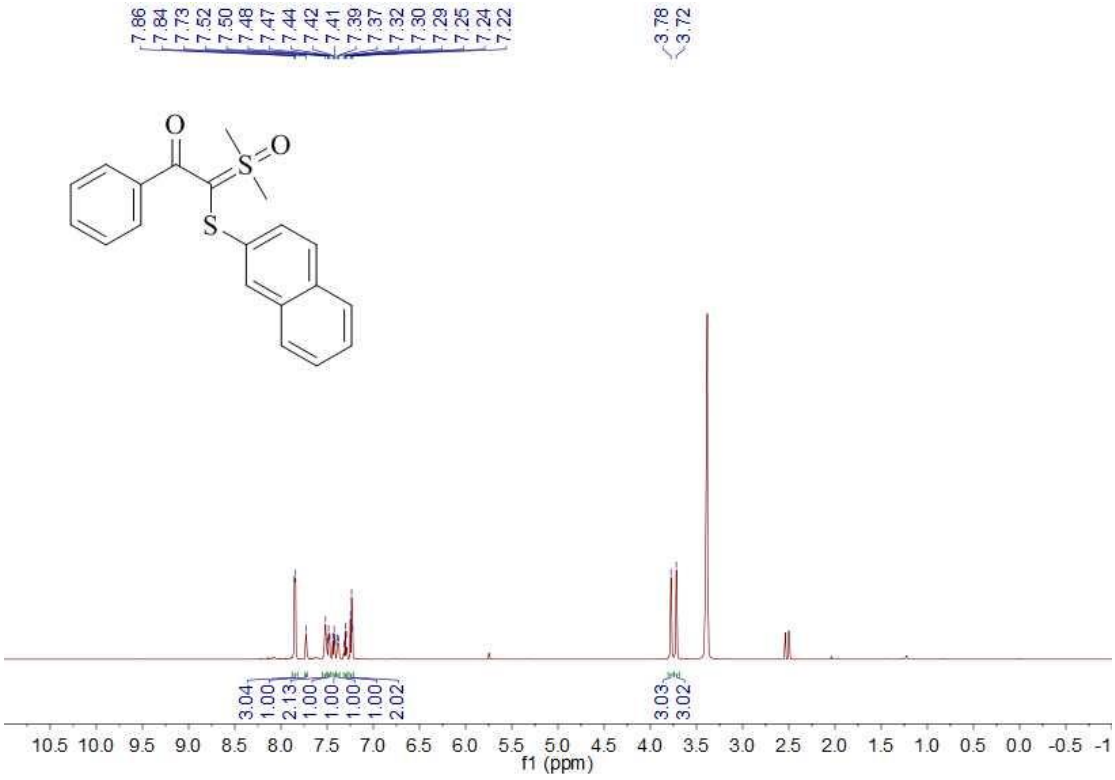
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4g**



^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4g**



^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4h**



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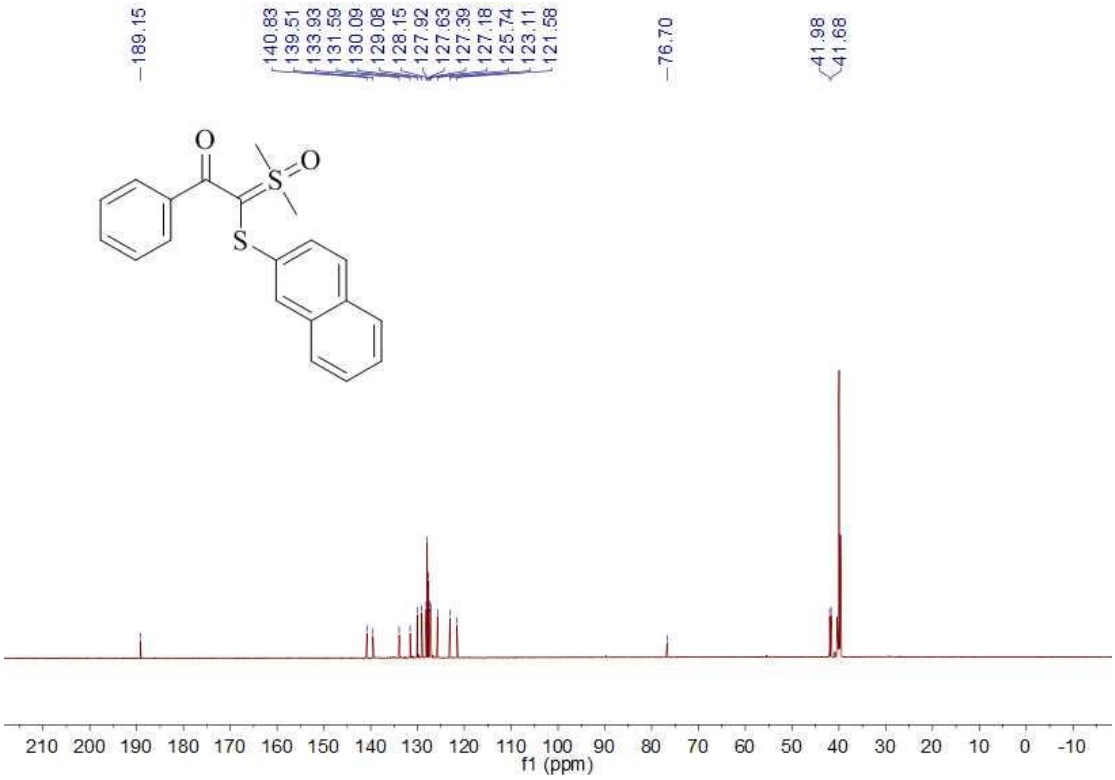

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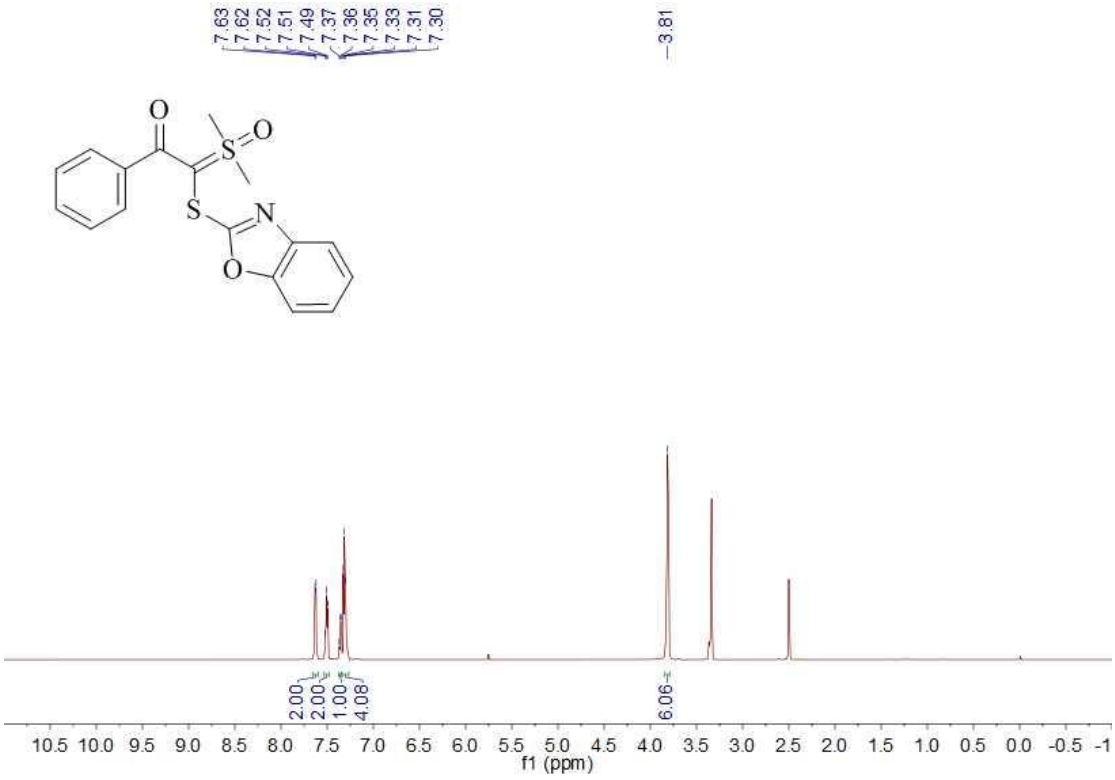
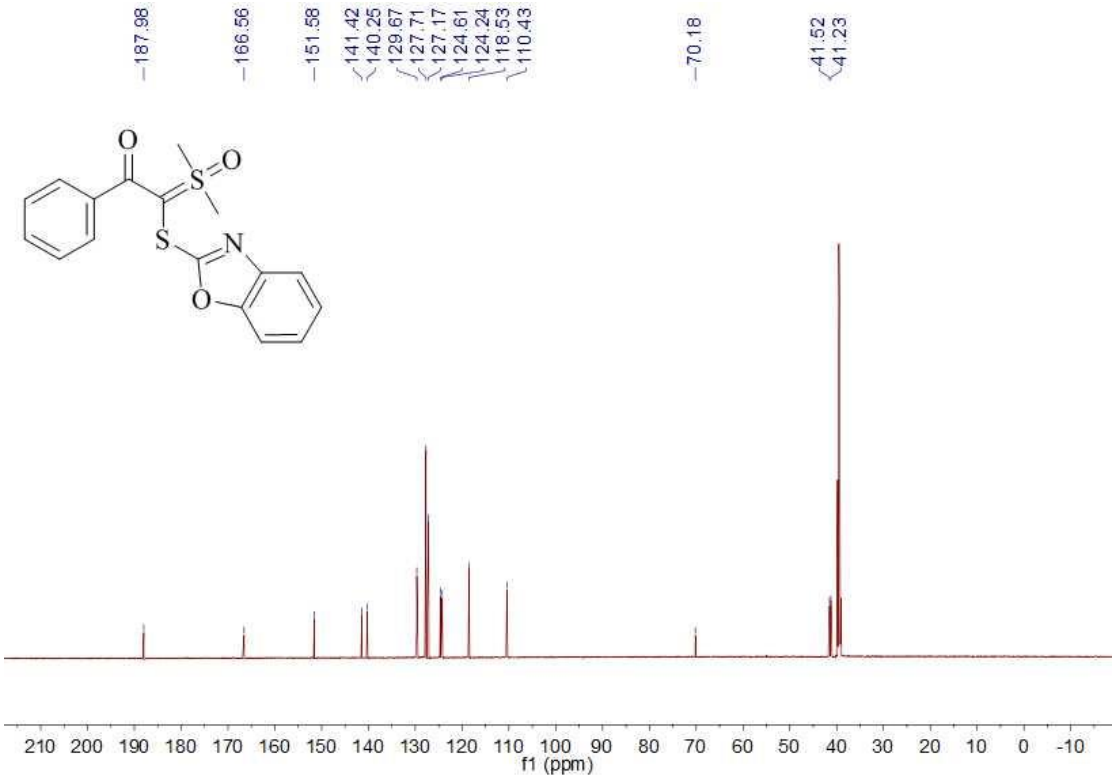


^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4i**



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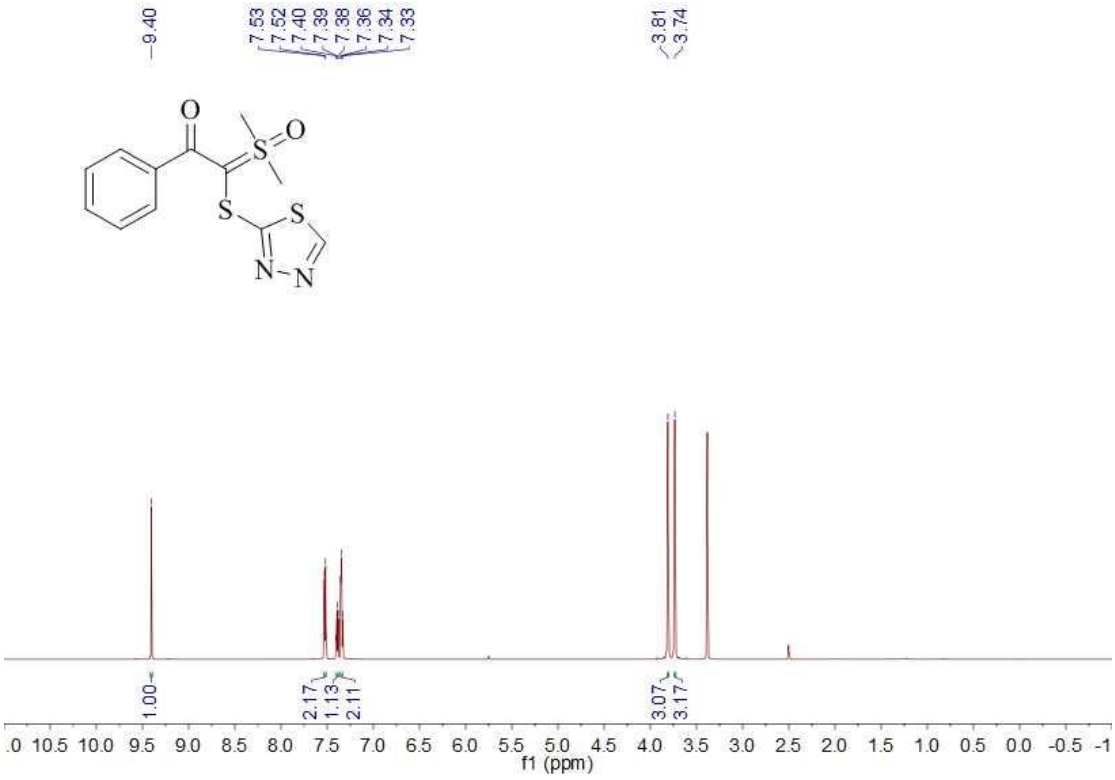

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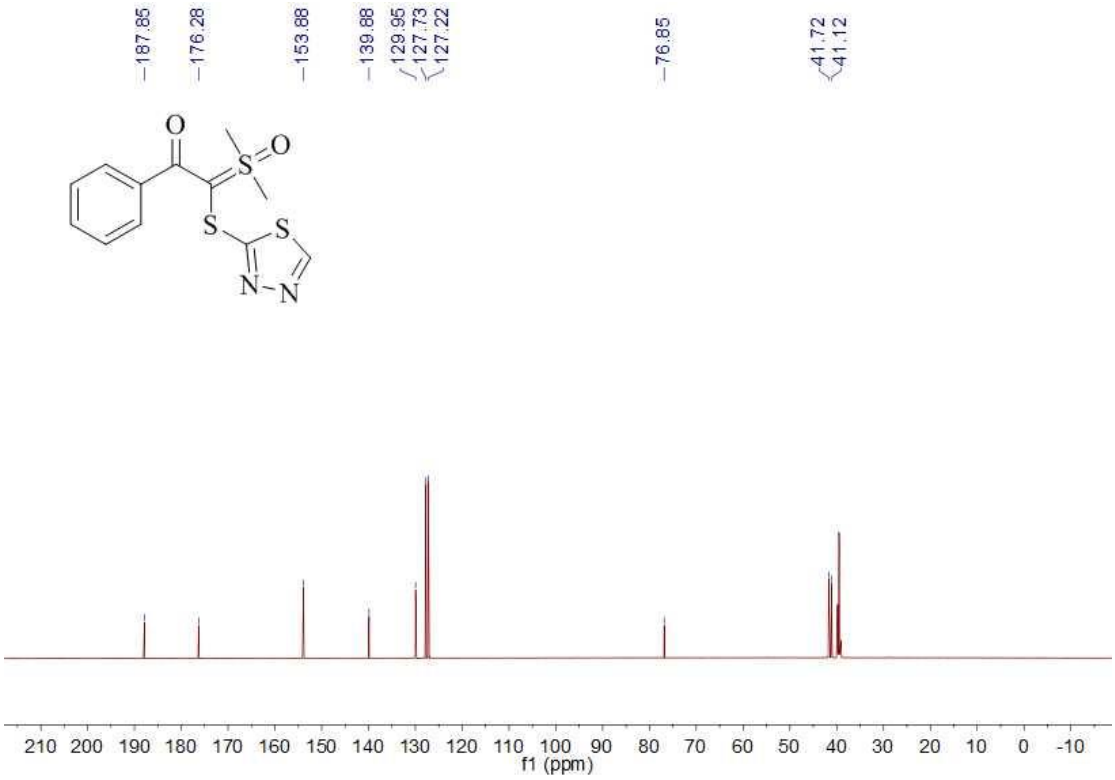

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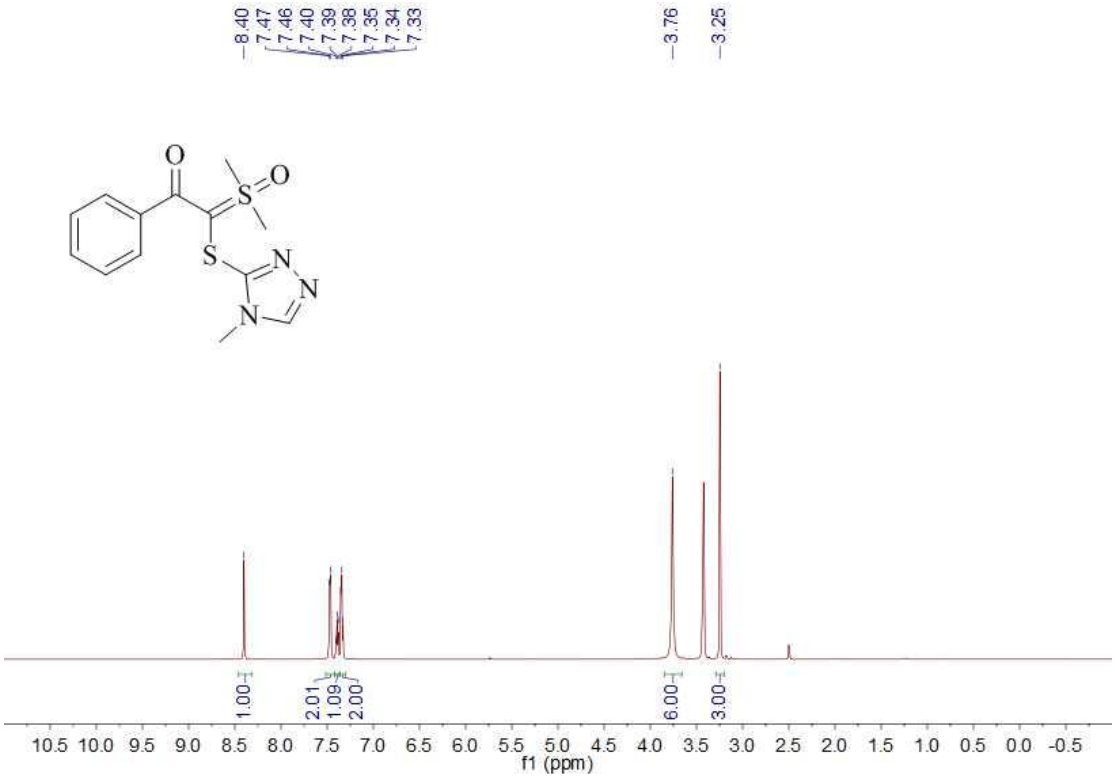

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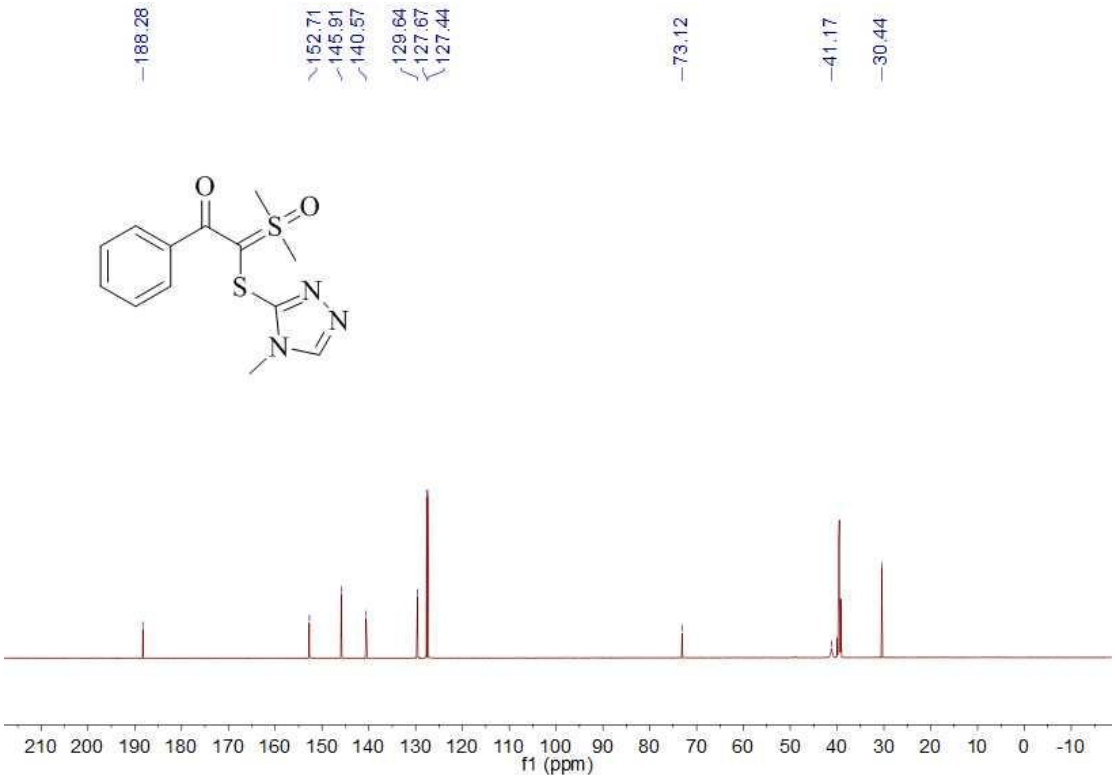
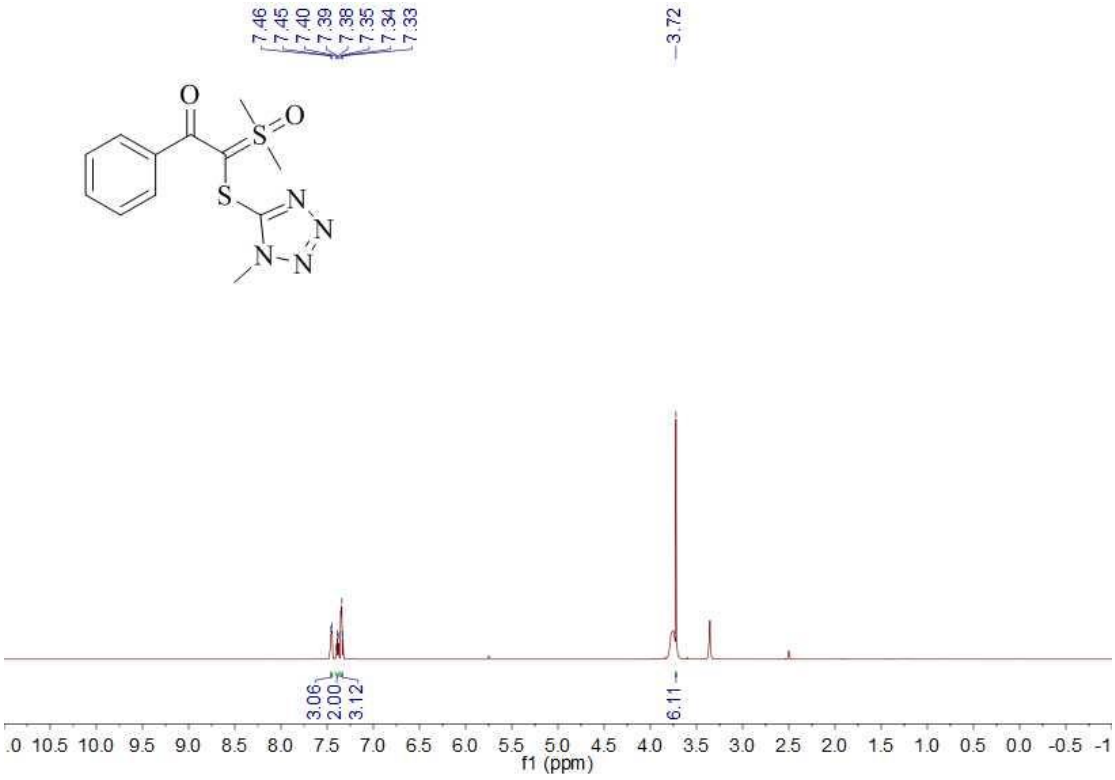
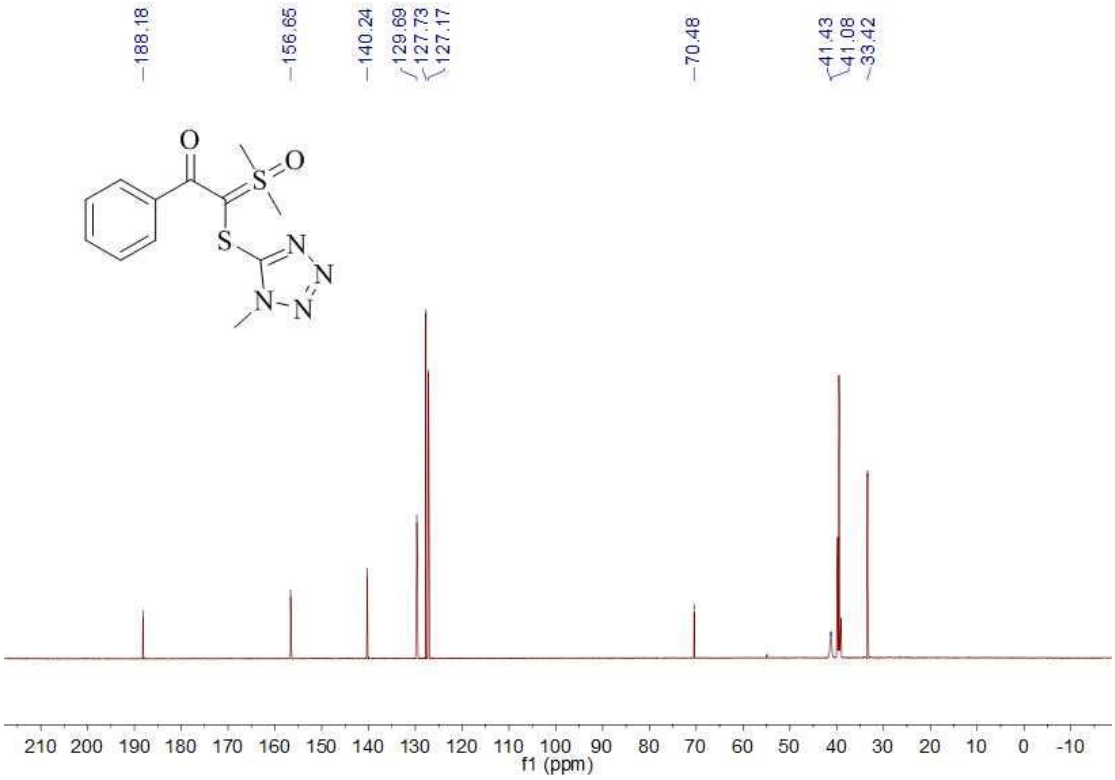


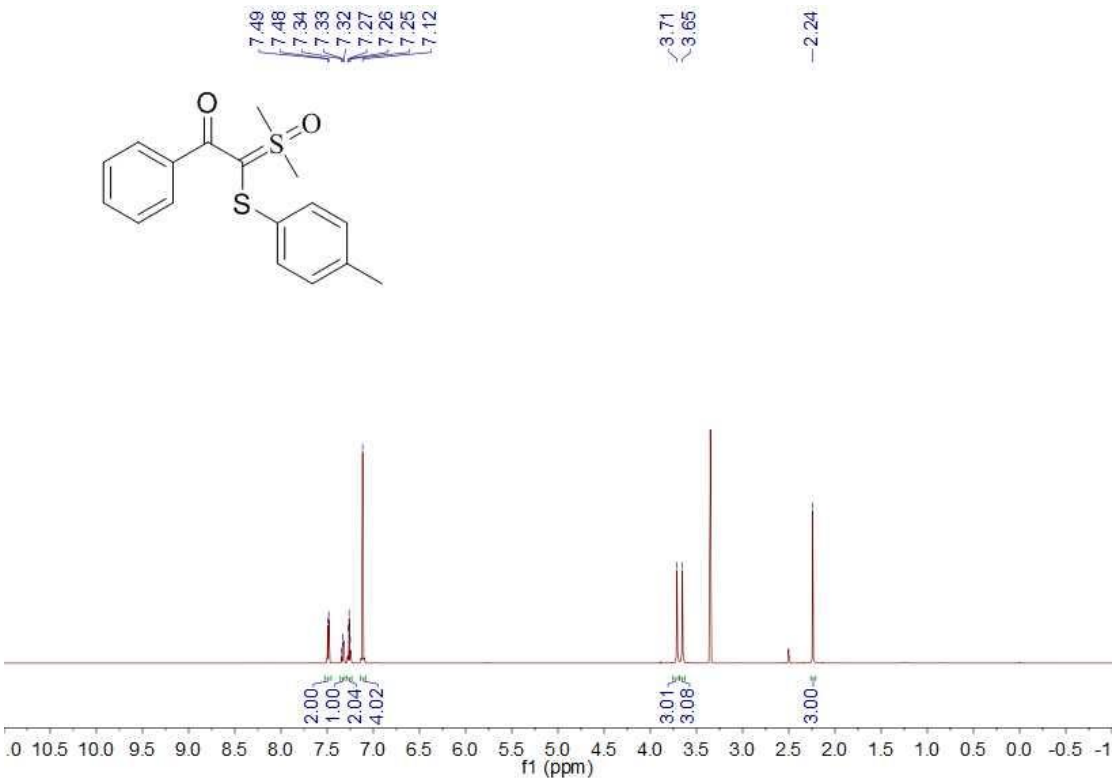
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4l**



^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4l**



^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4m**



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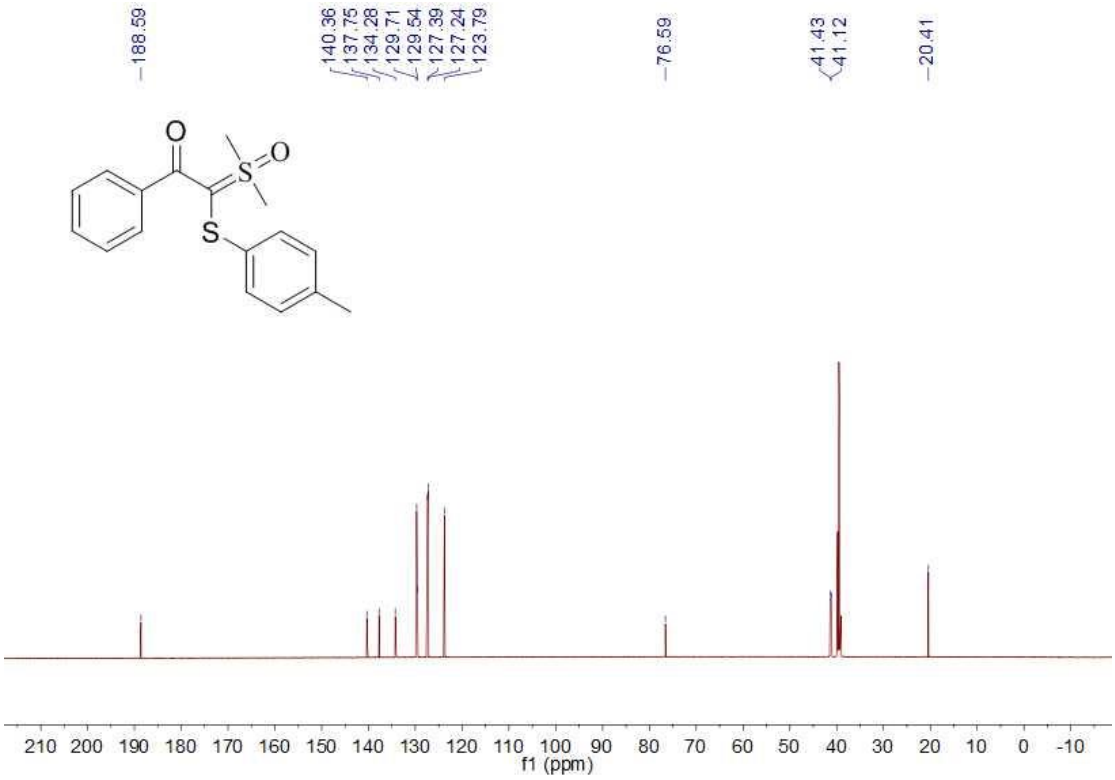
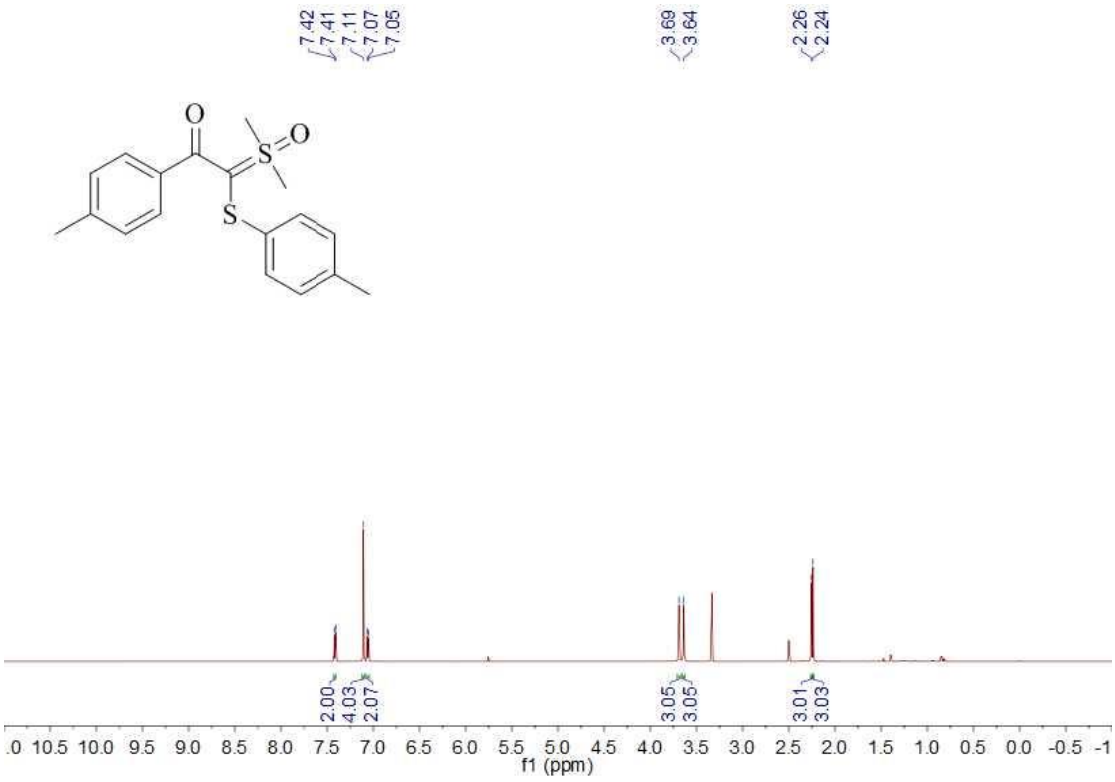
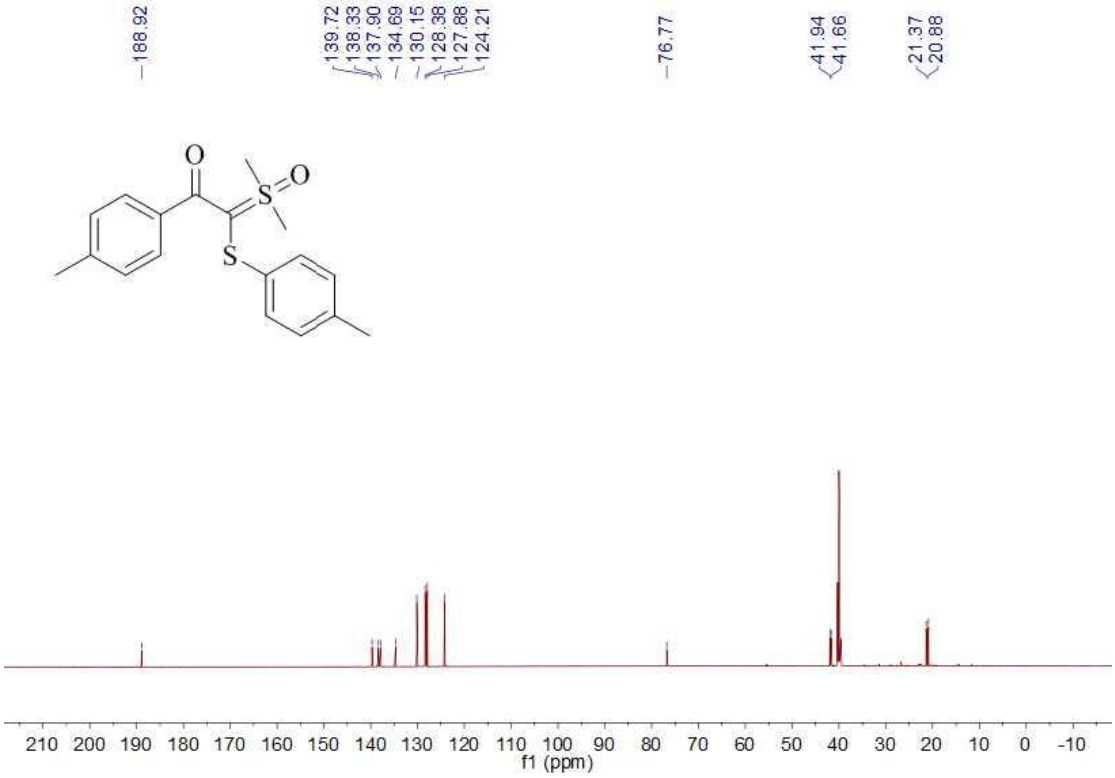


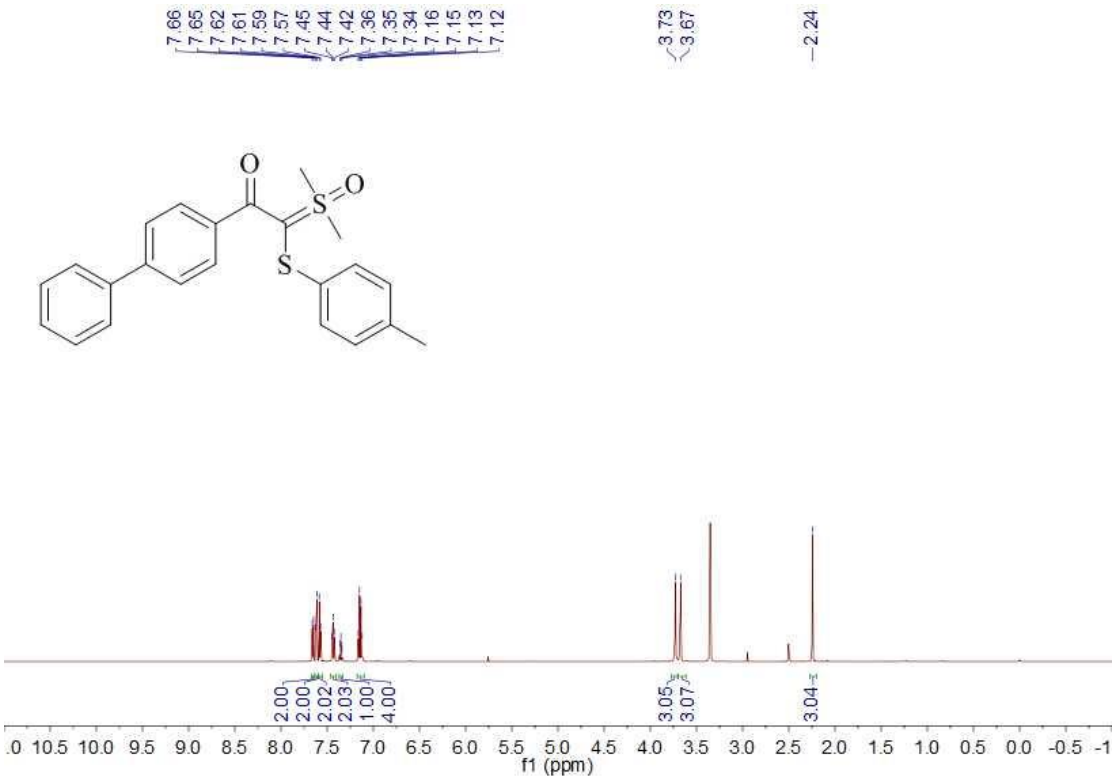
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4n**



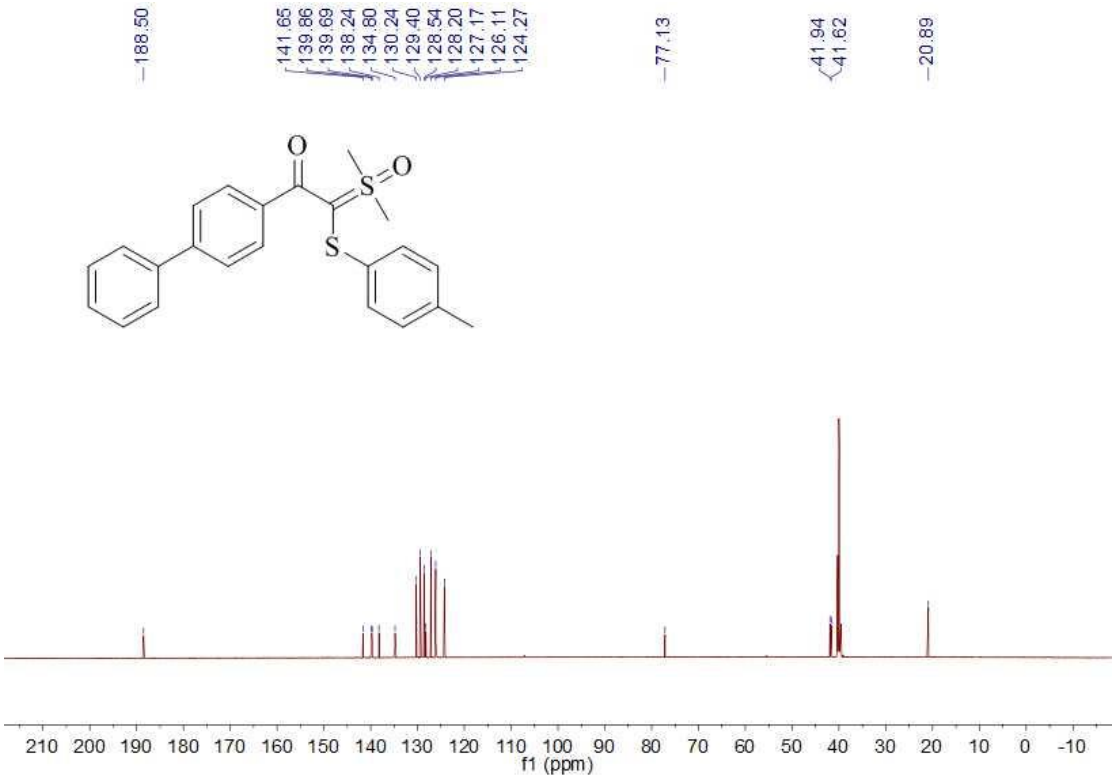
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4n**



^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4o**



^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4o**



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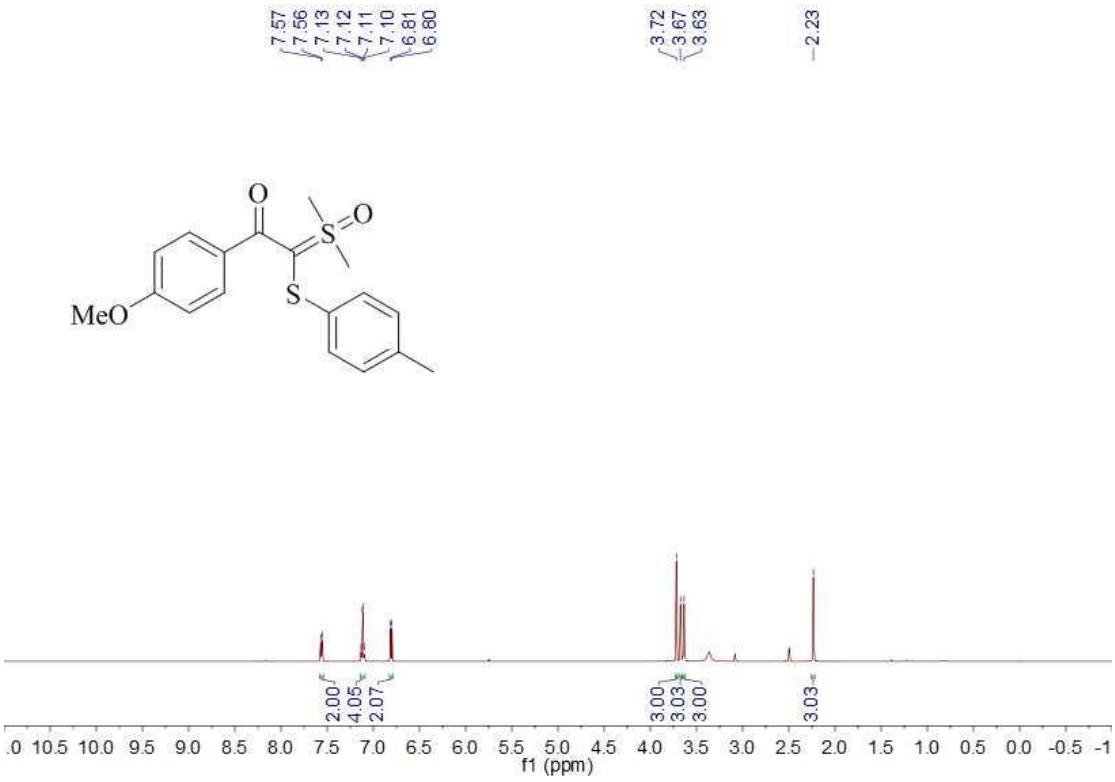
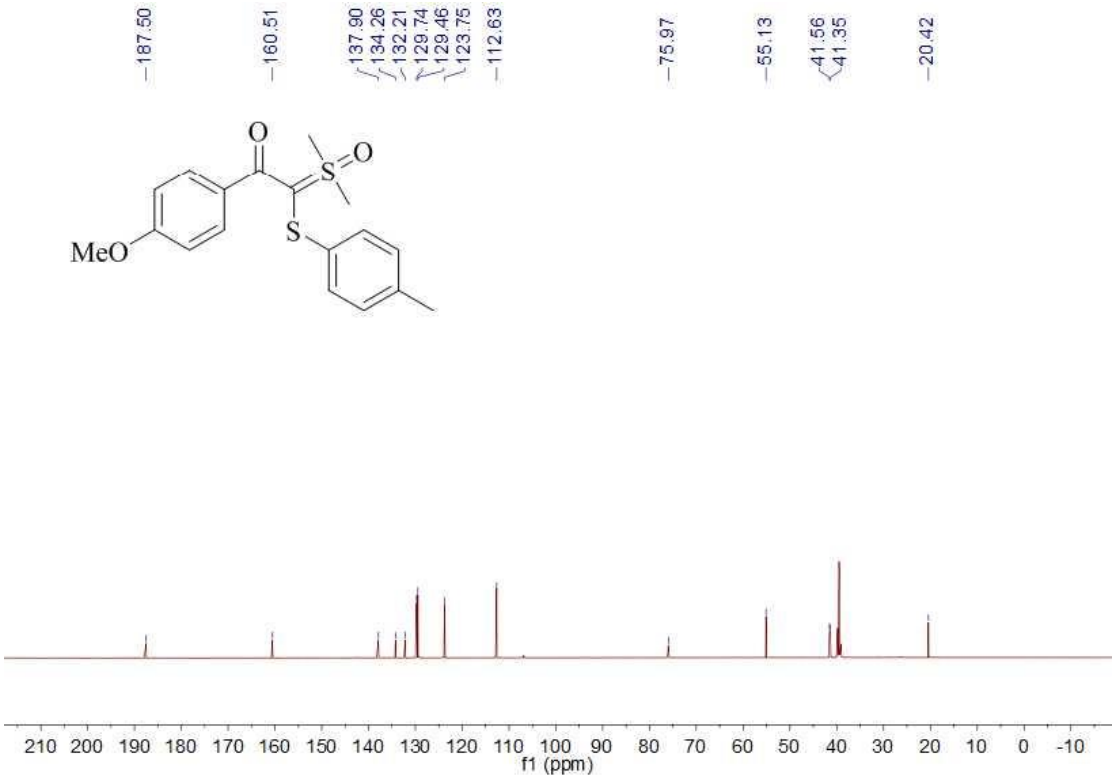
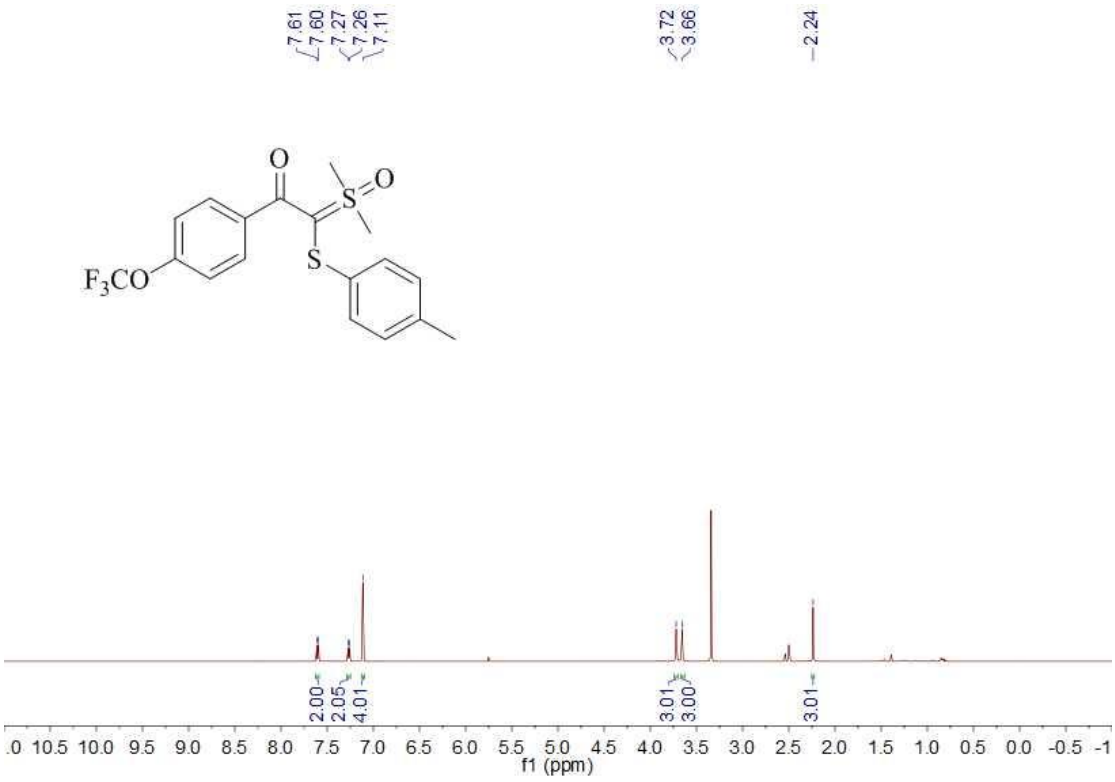


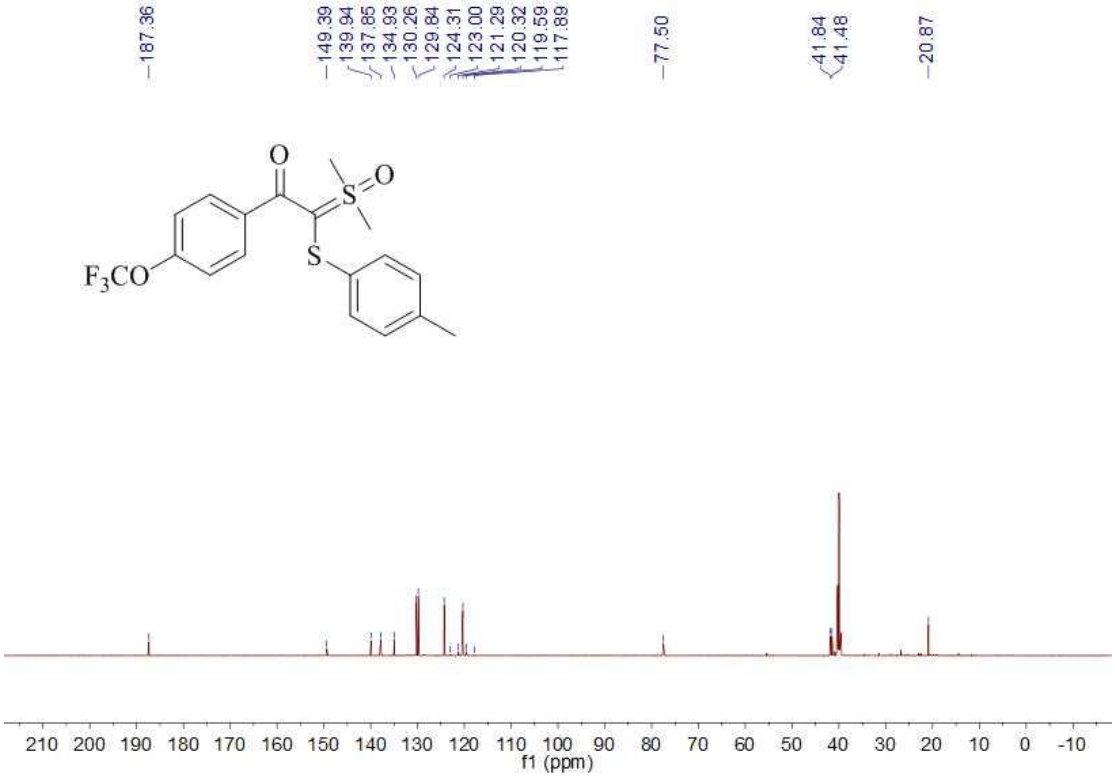
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4p**



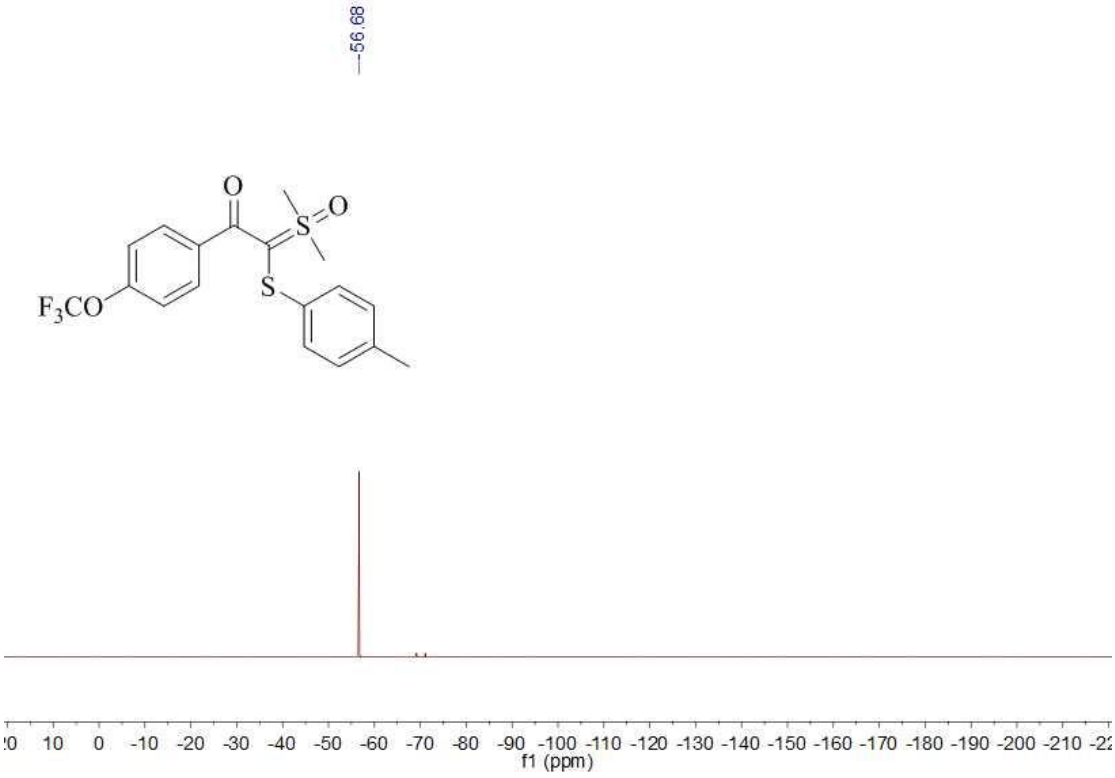
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4q**



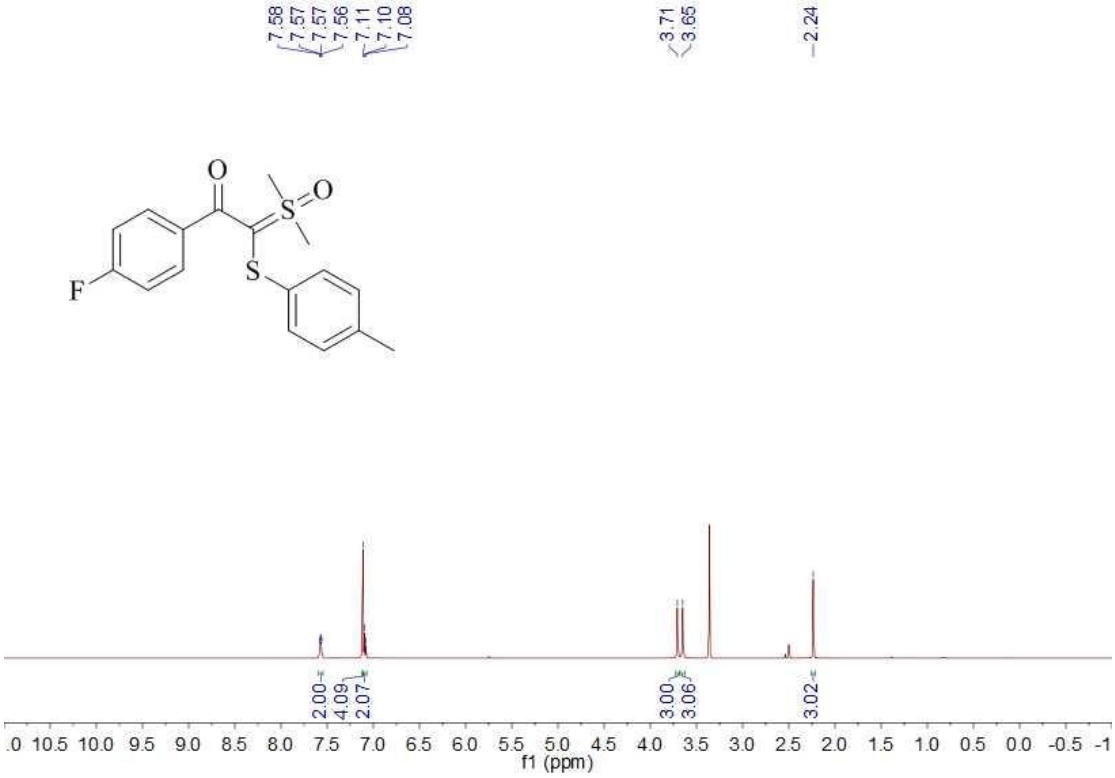
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4q**



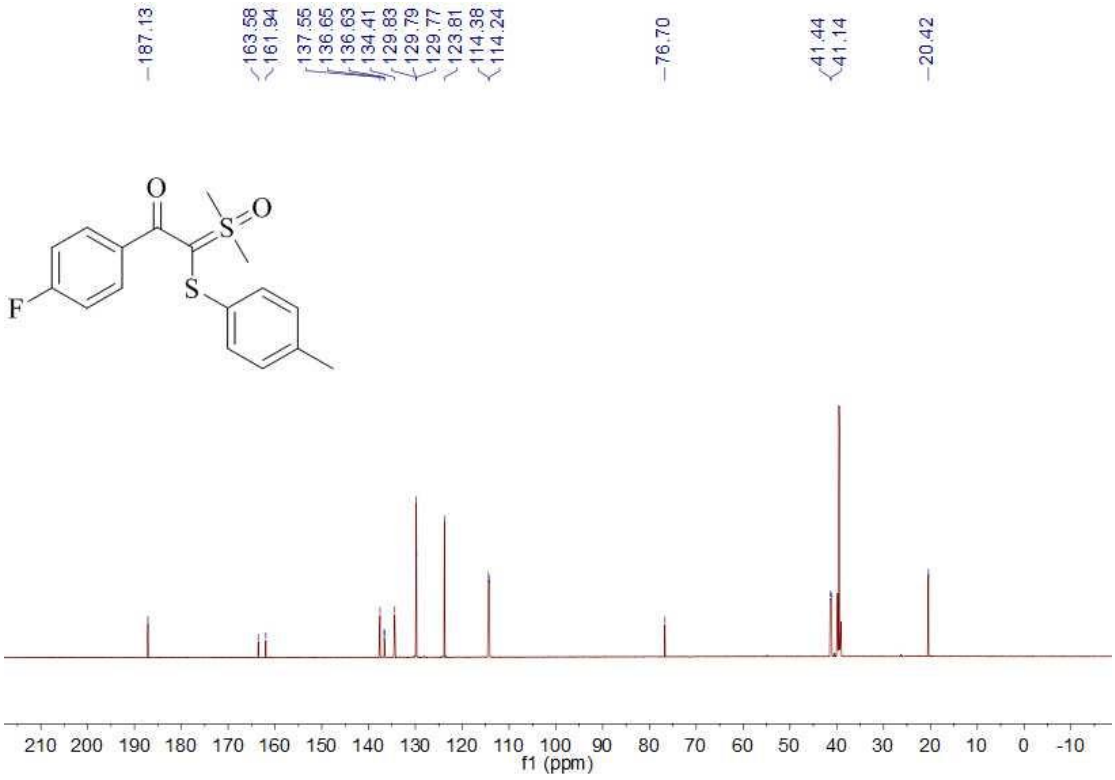
^{19}F NMR (377 MHz, DMSO-d_6) Spectra of **4q**



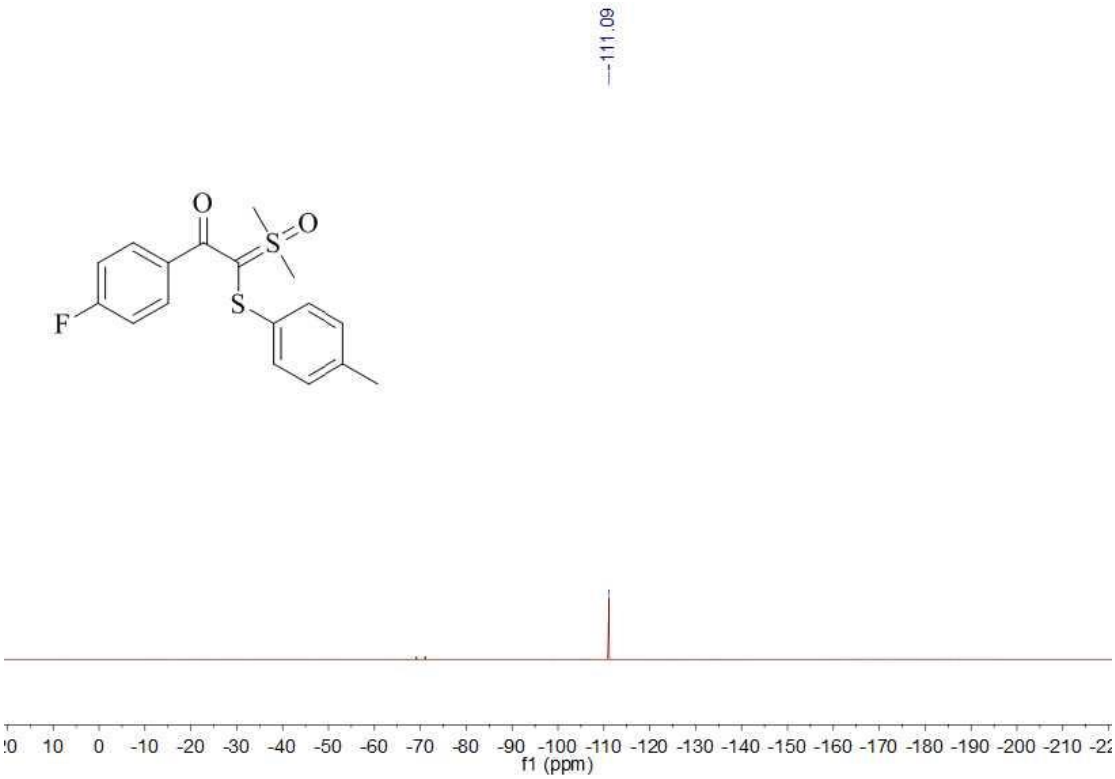
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4r**



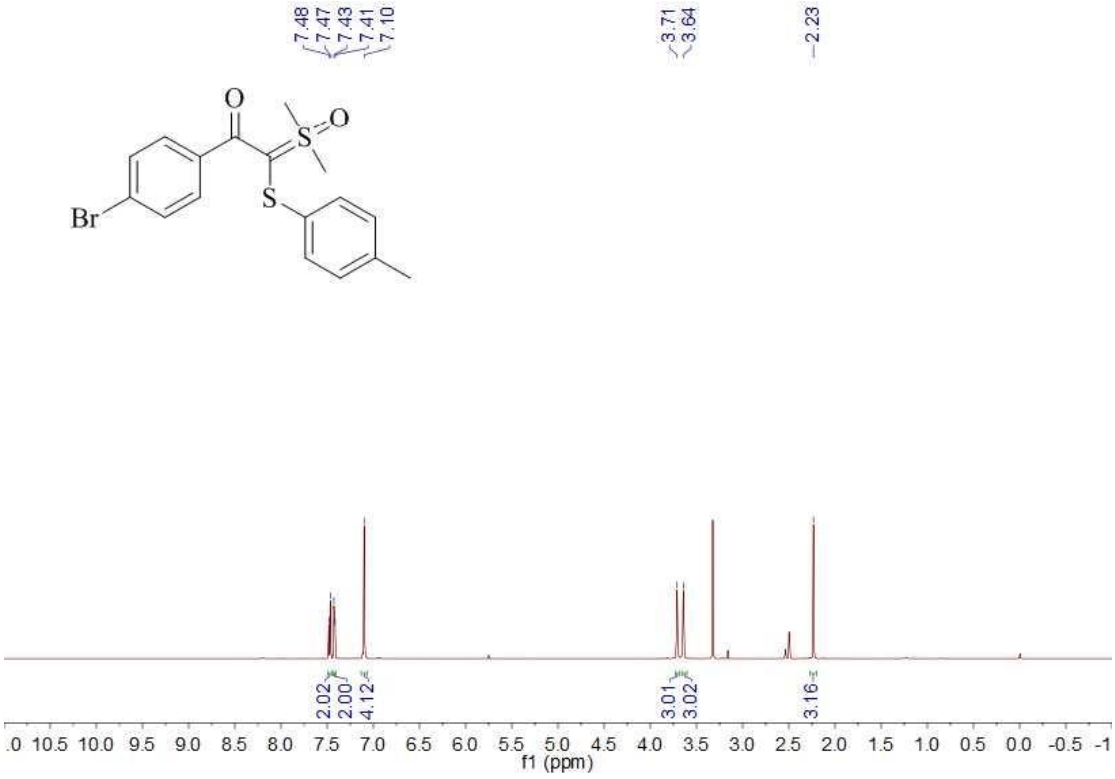
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4r**



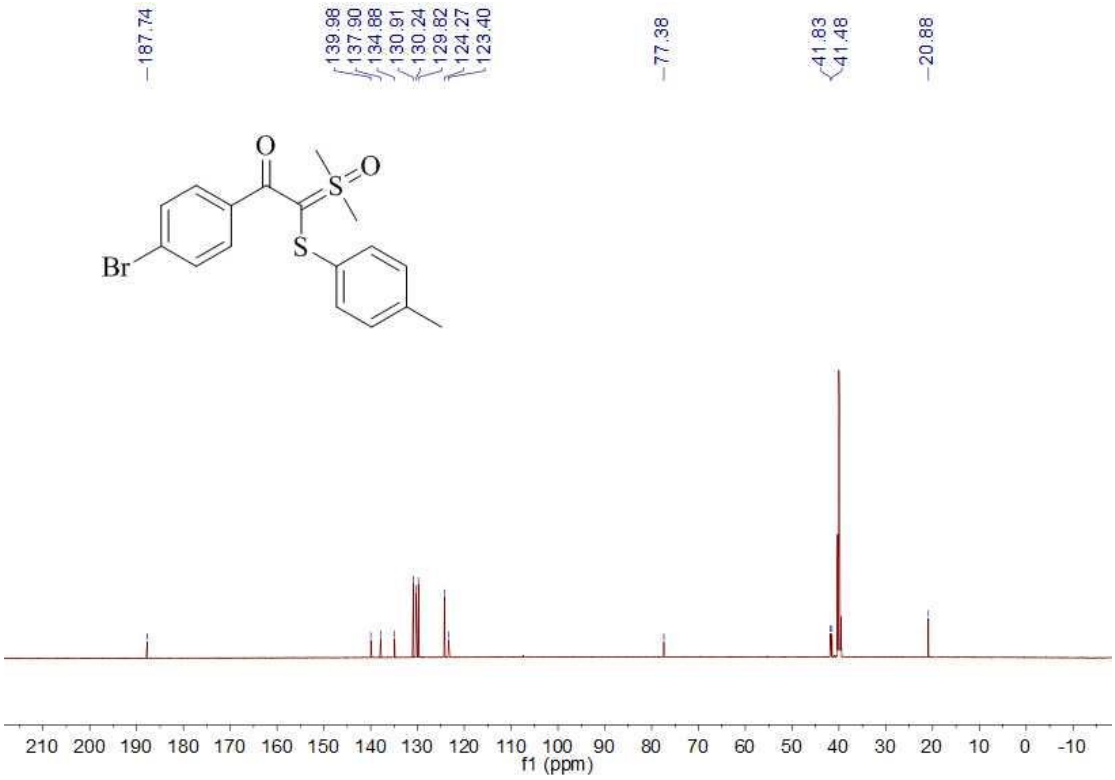
^{19}F NMR (377 MHz, DMSO-d_6) Spectra of **4r**



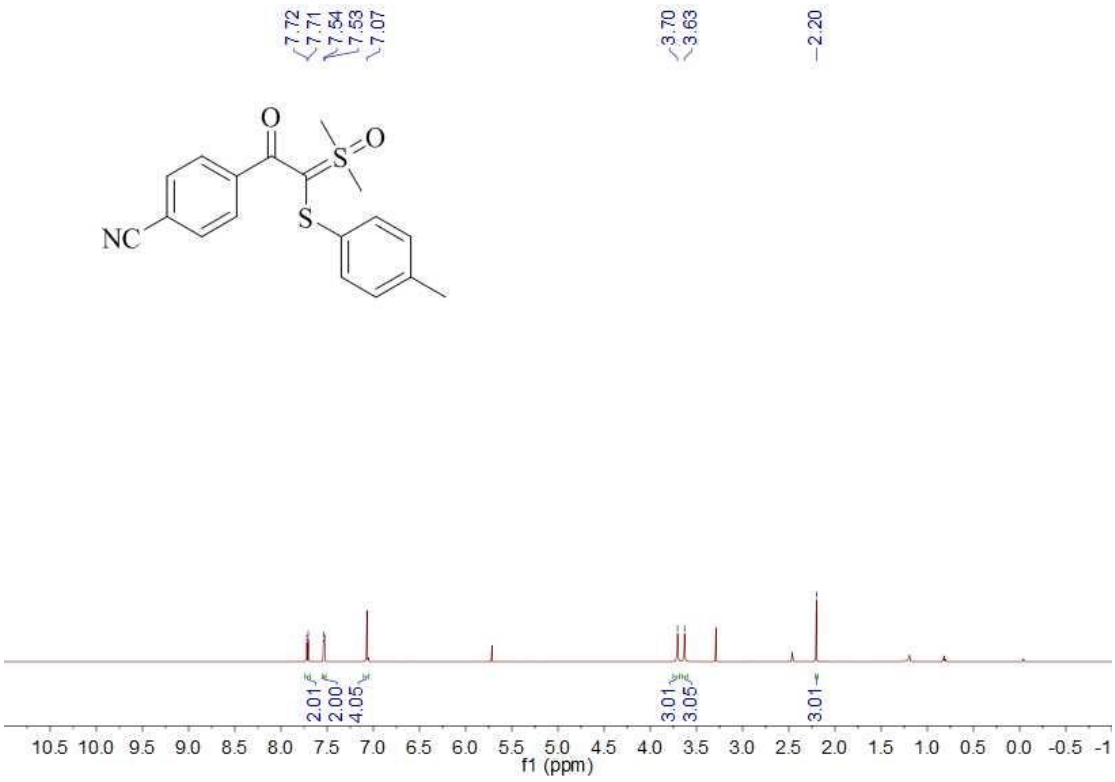
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4s**



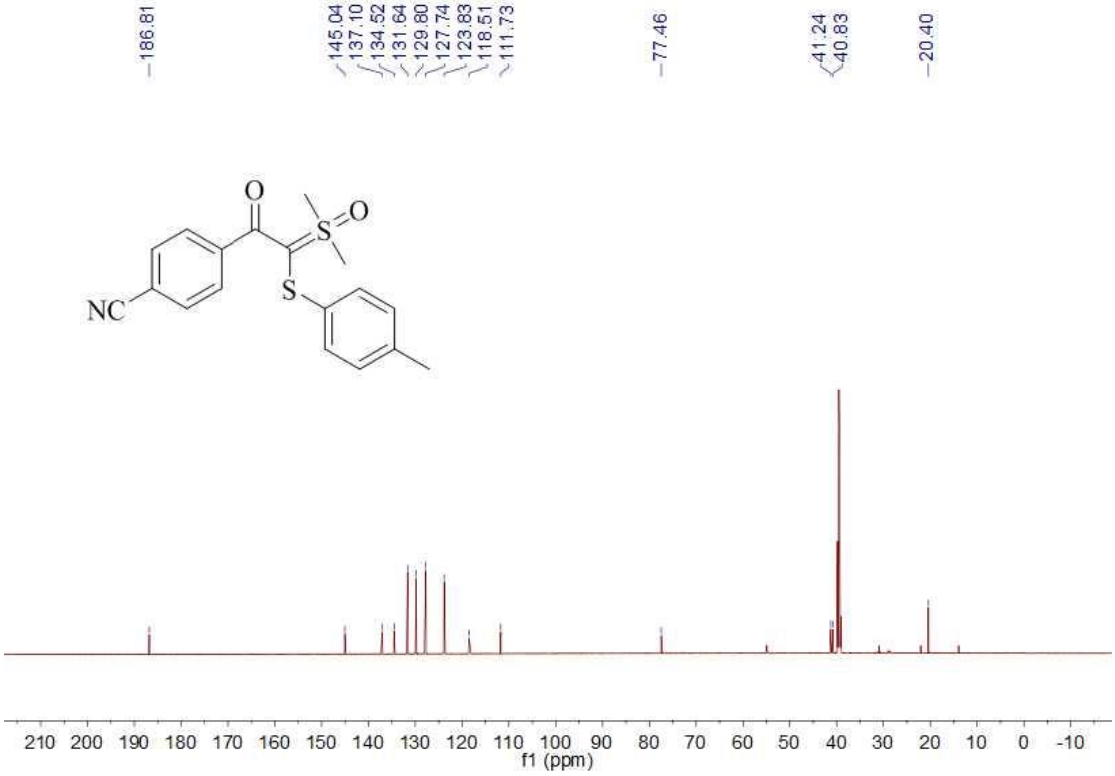
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4s**



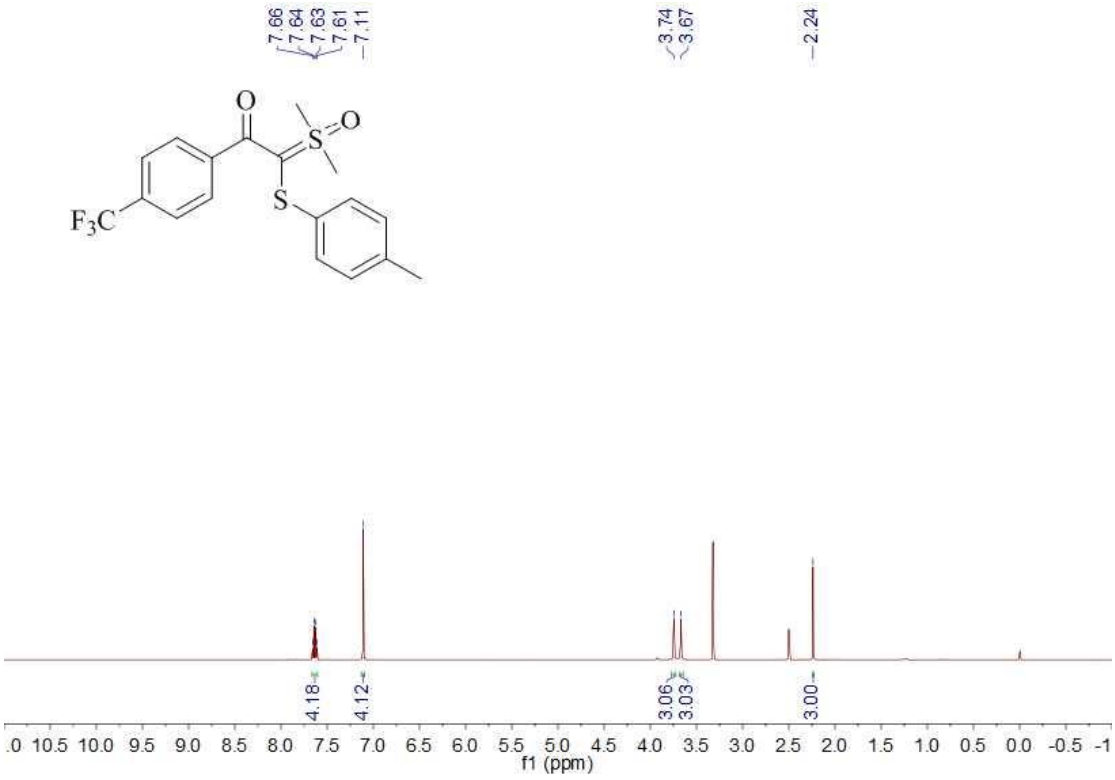
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4t**



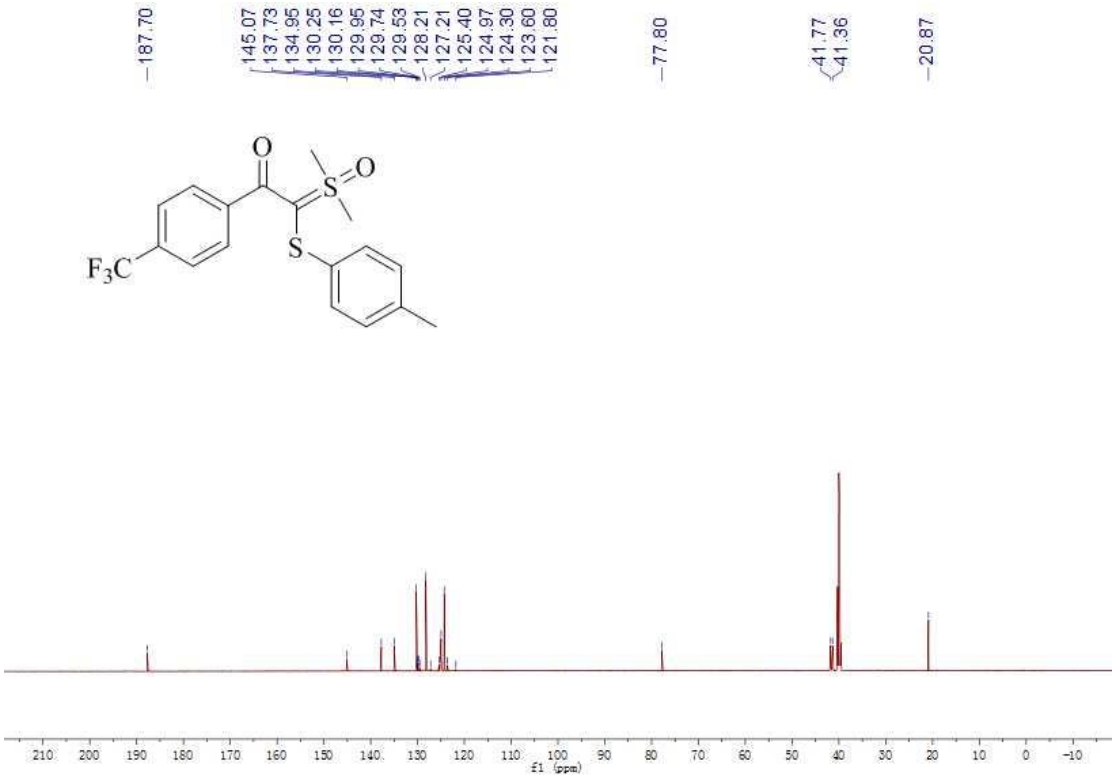
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4t**



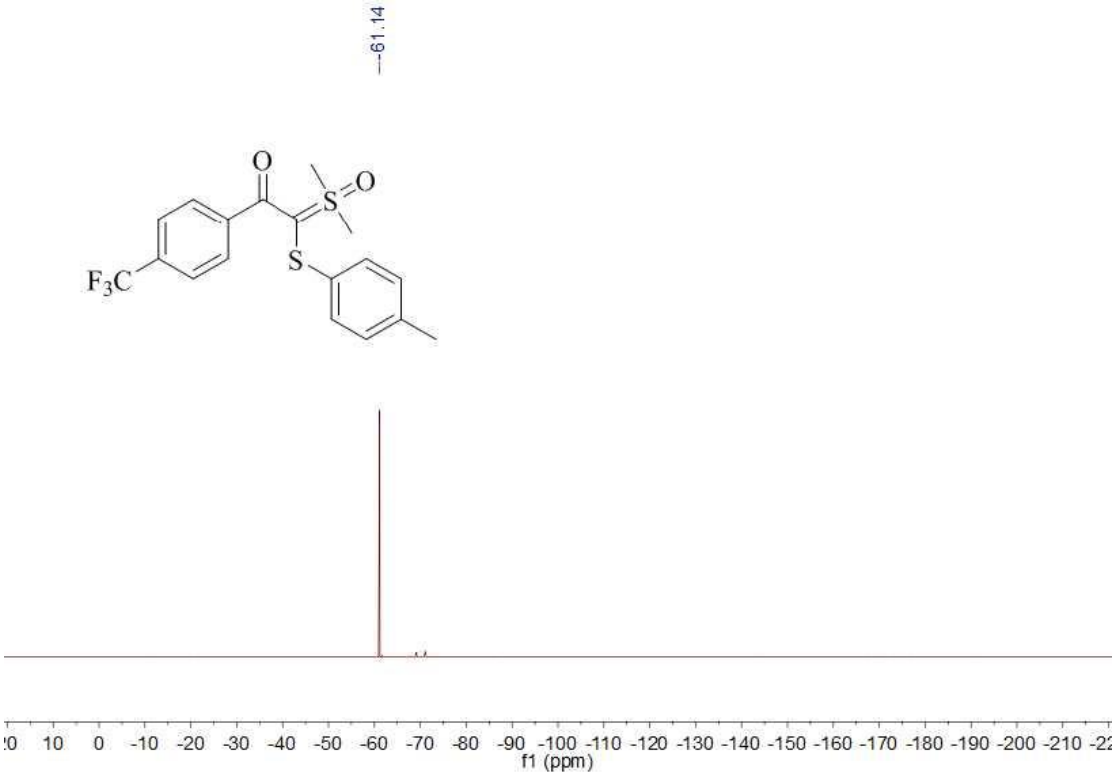
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4u**



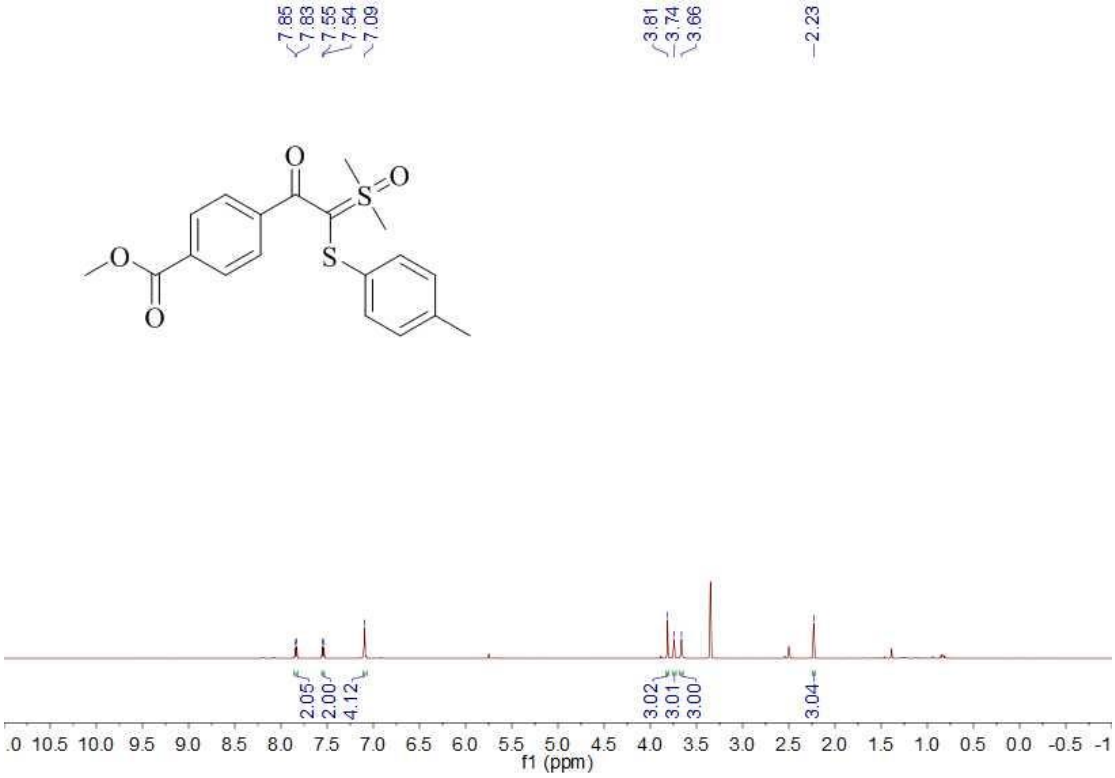
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4u**



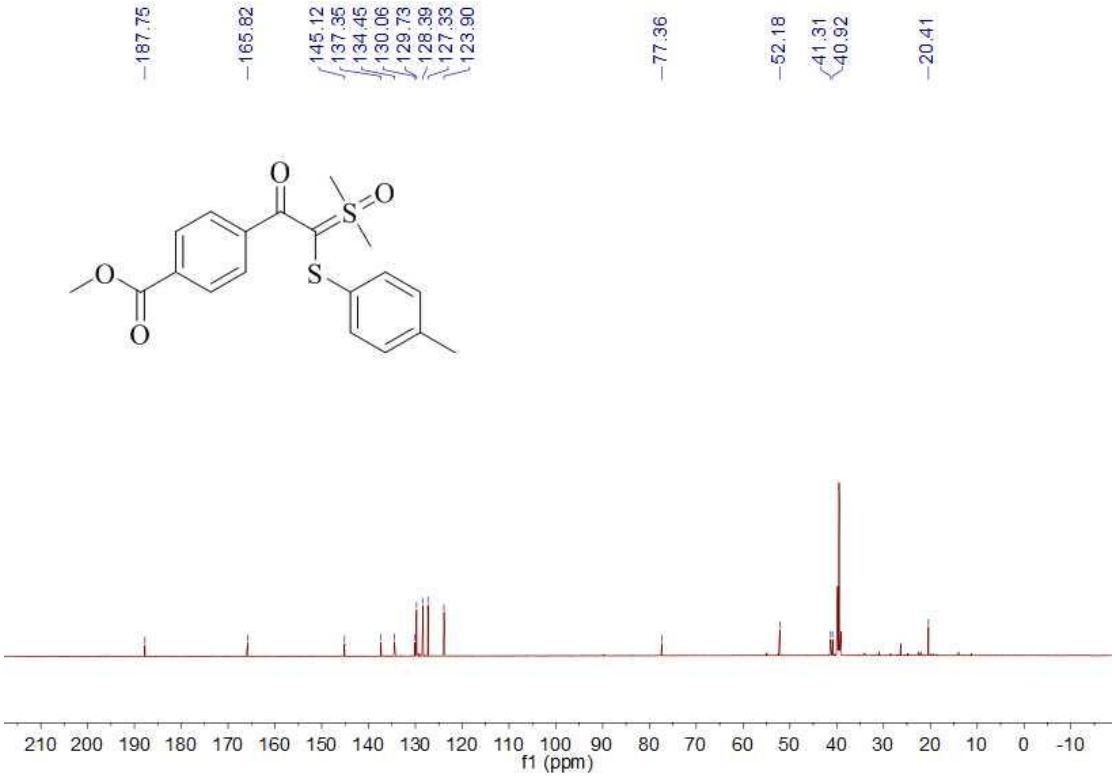
^{19}F NMR (377 MHz, DMSO-d_6) Spectra of **4u**



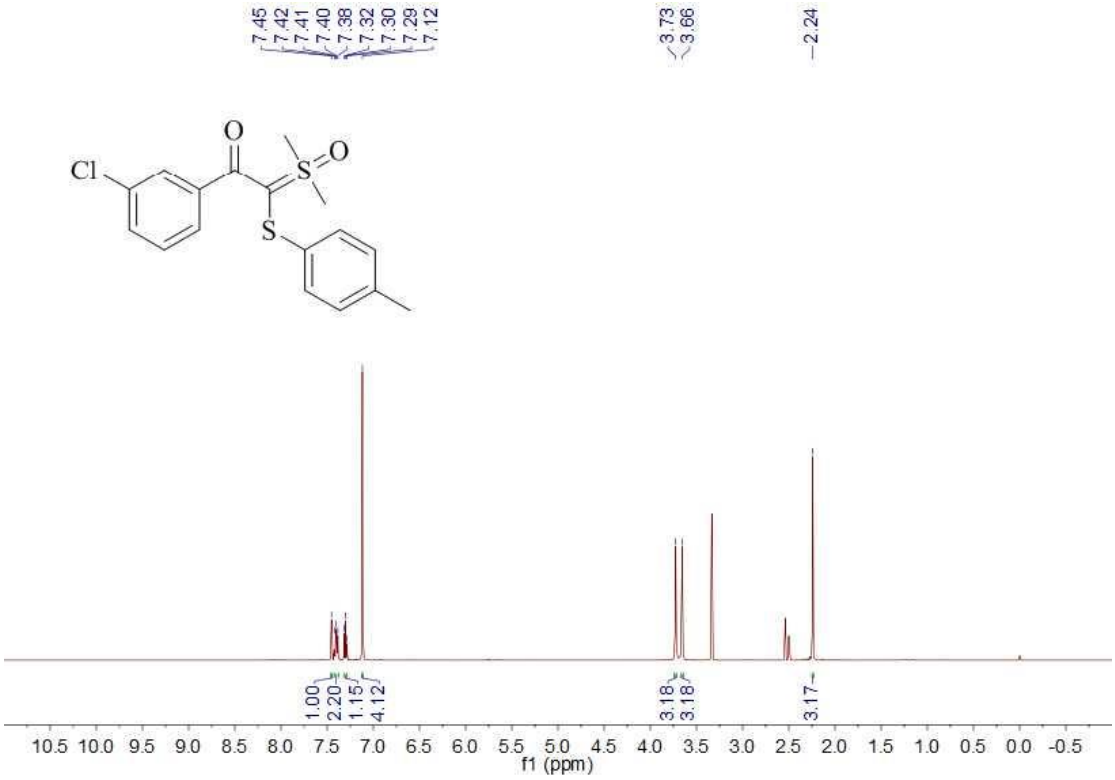
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4v**



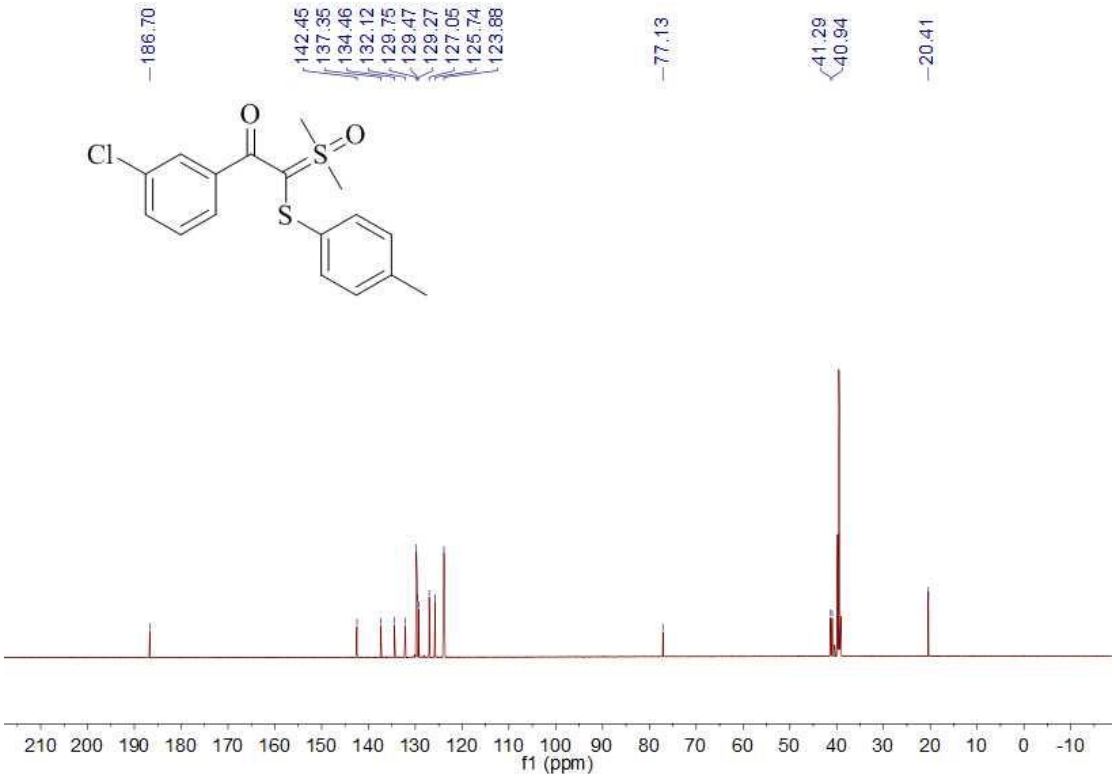
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4v**



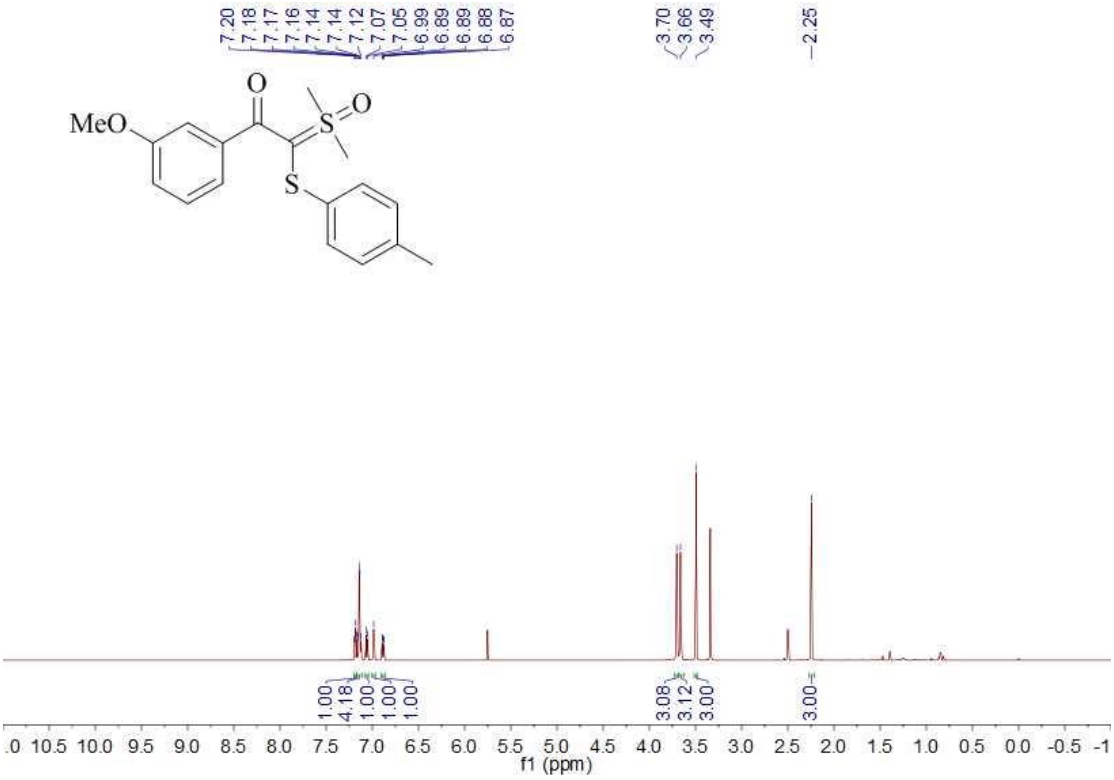
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4w**



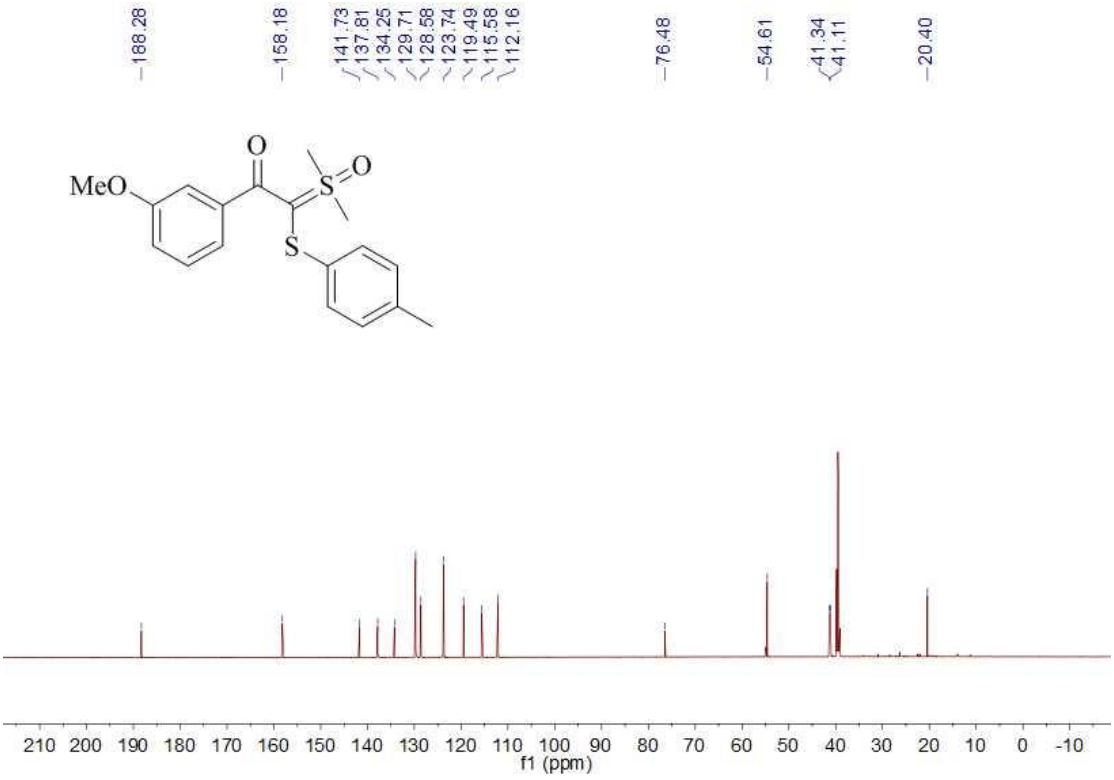
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4w**



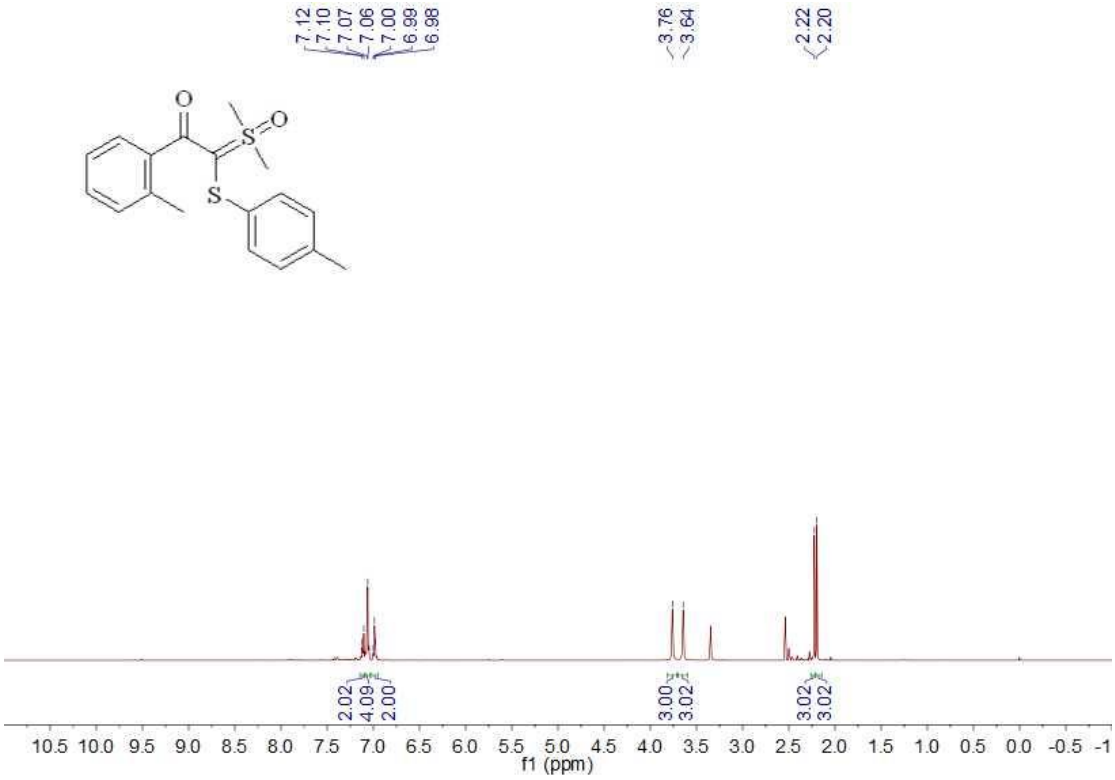
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4x**



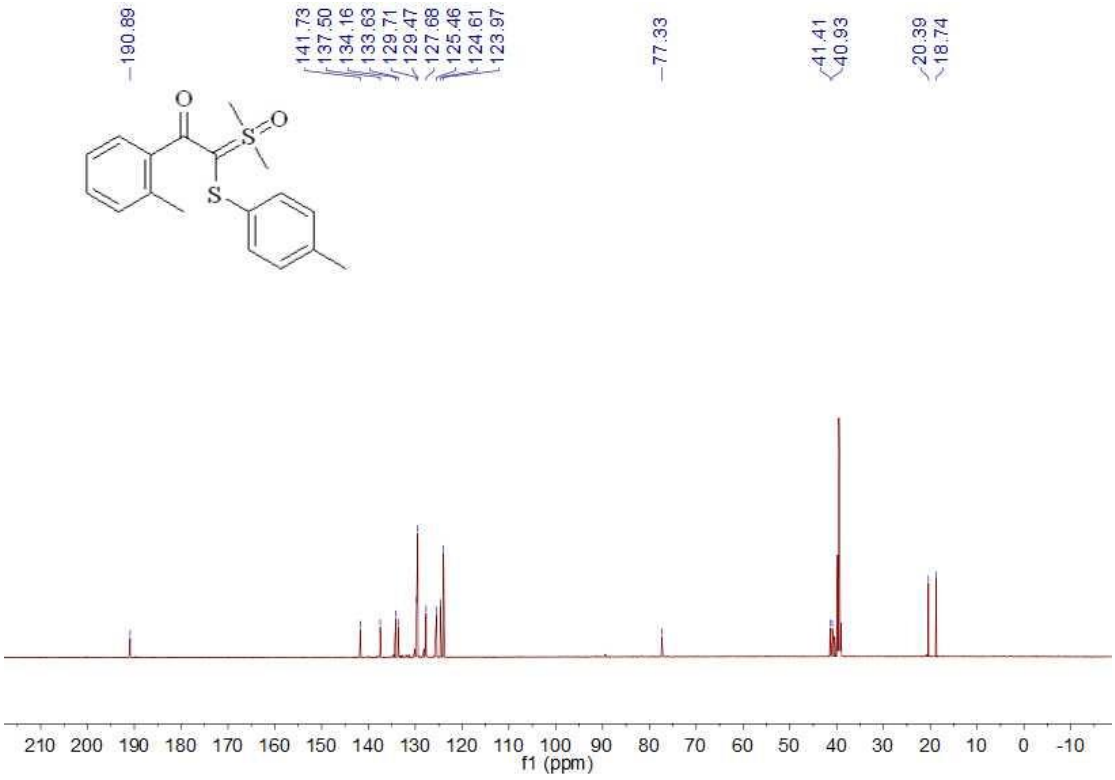
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4x**



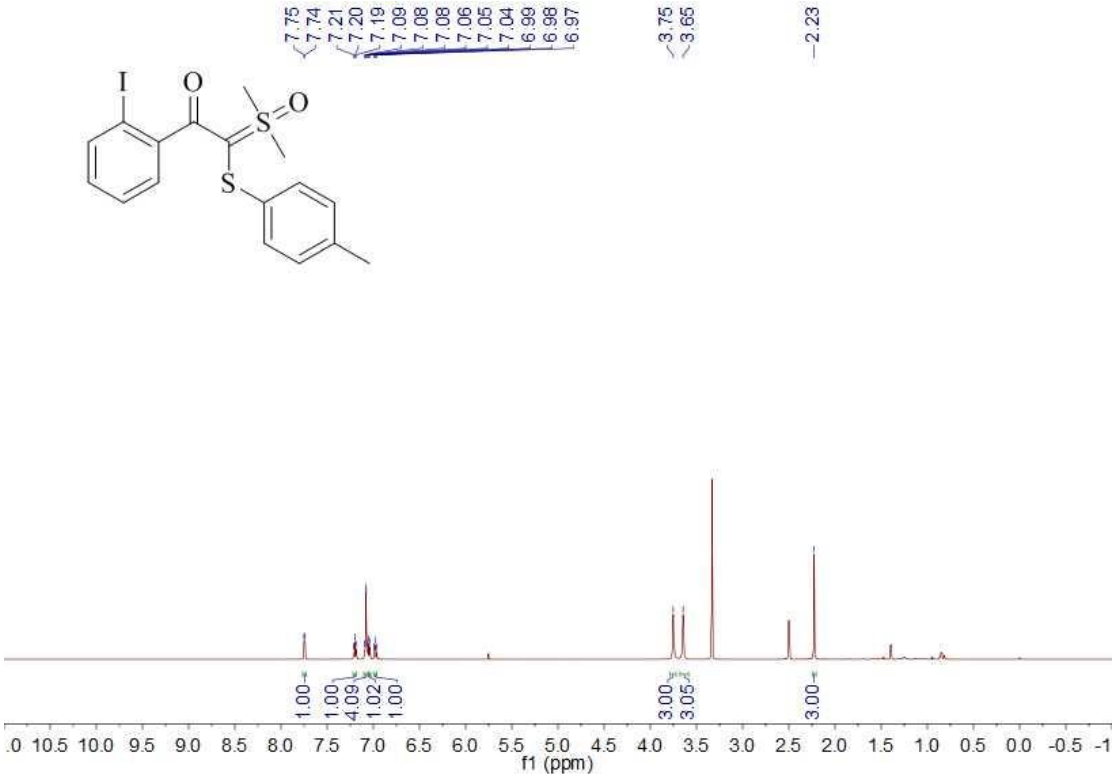
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4y**



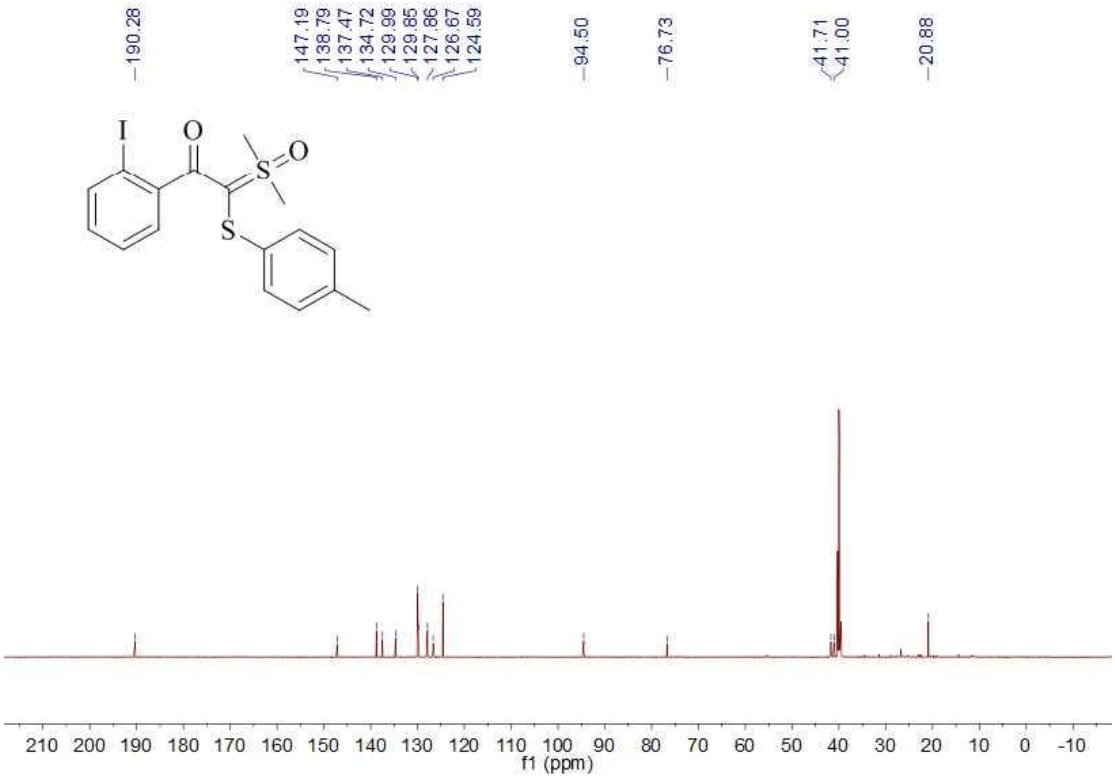
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4y**



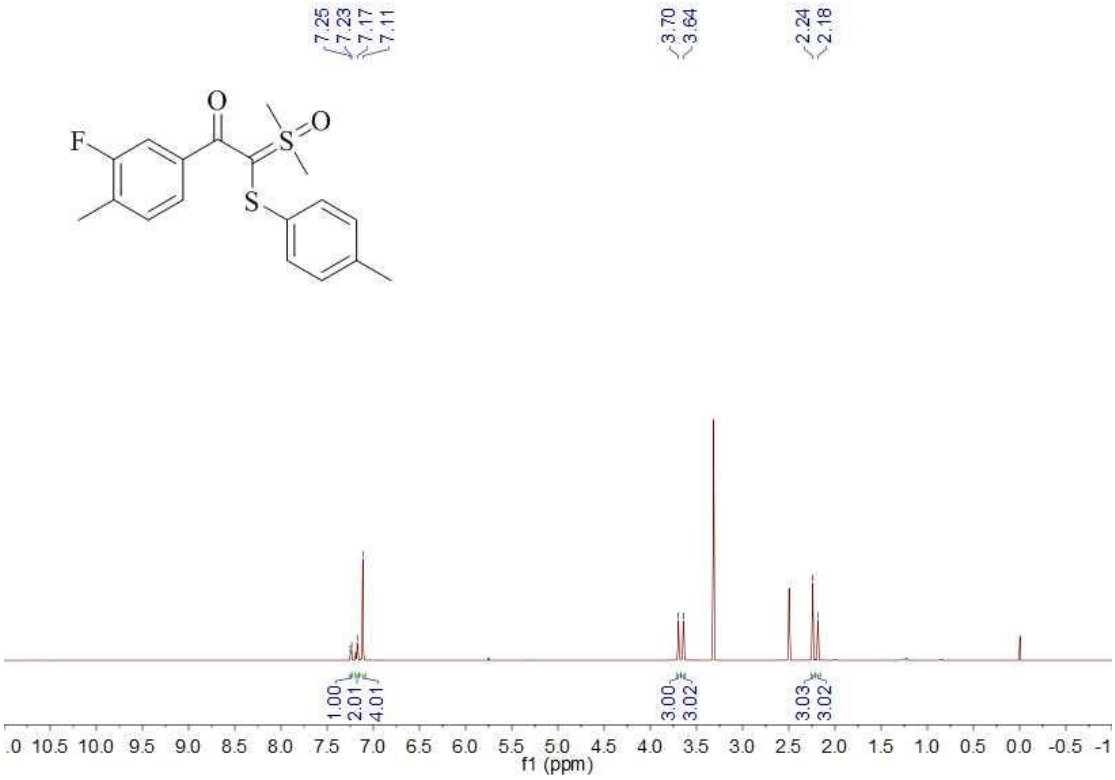
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4z**



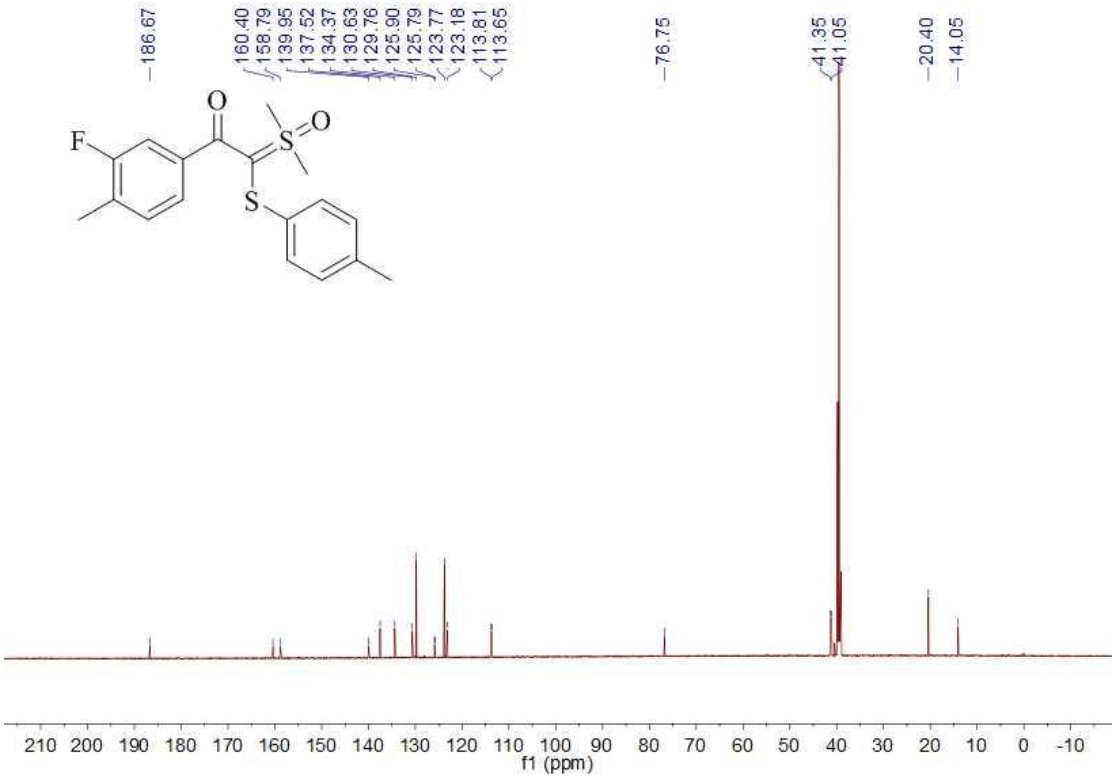
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4z**



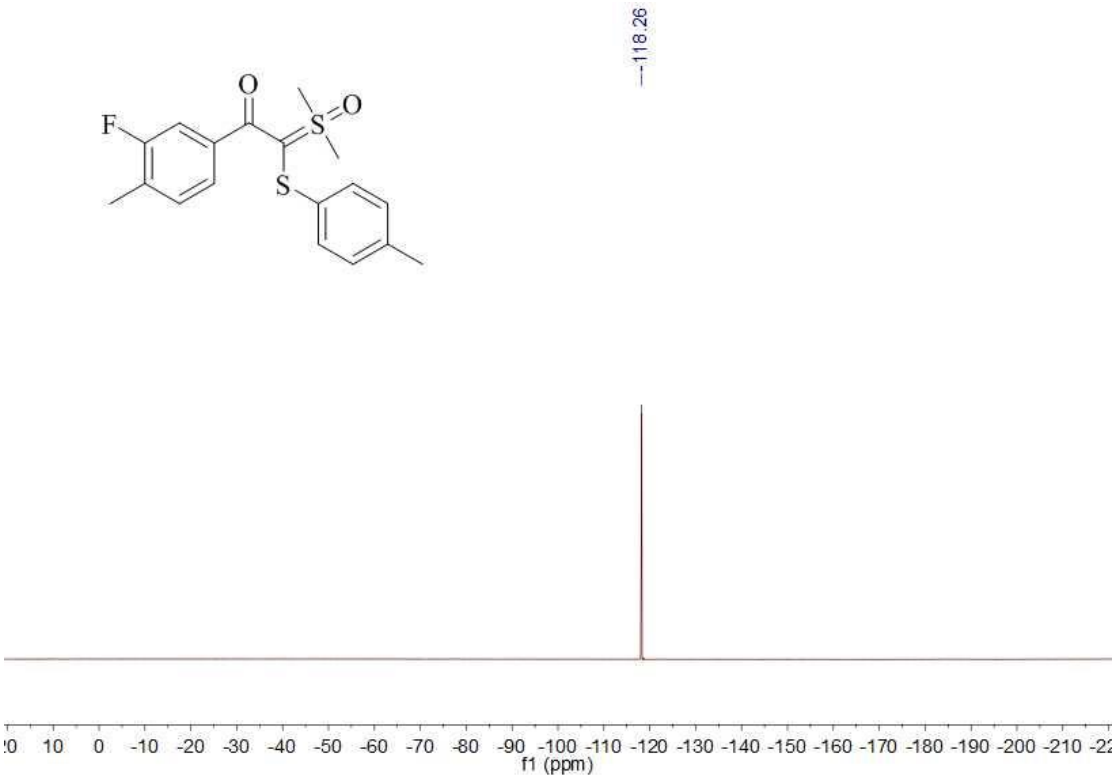
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4aa**



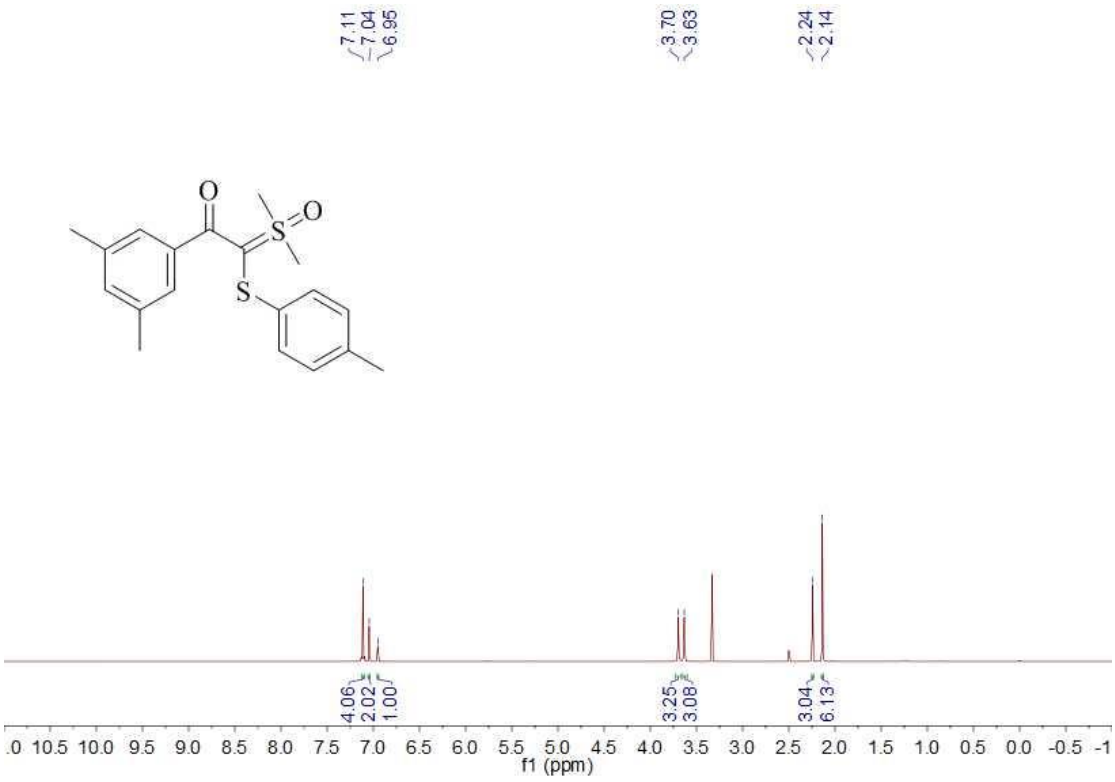
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4aa**



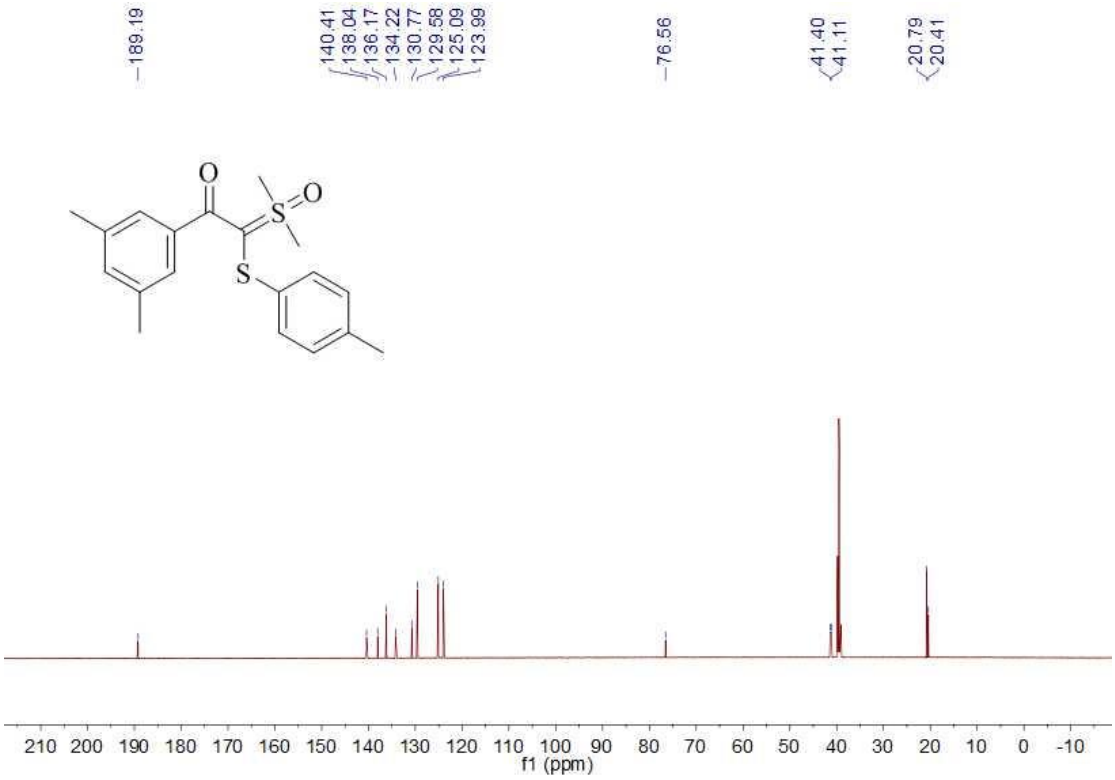
^{19}F NMR (377 MHz, DMSO-d_6) Spectra of **4aa**



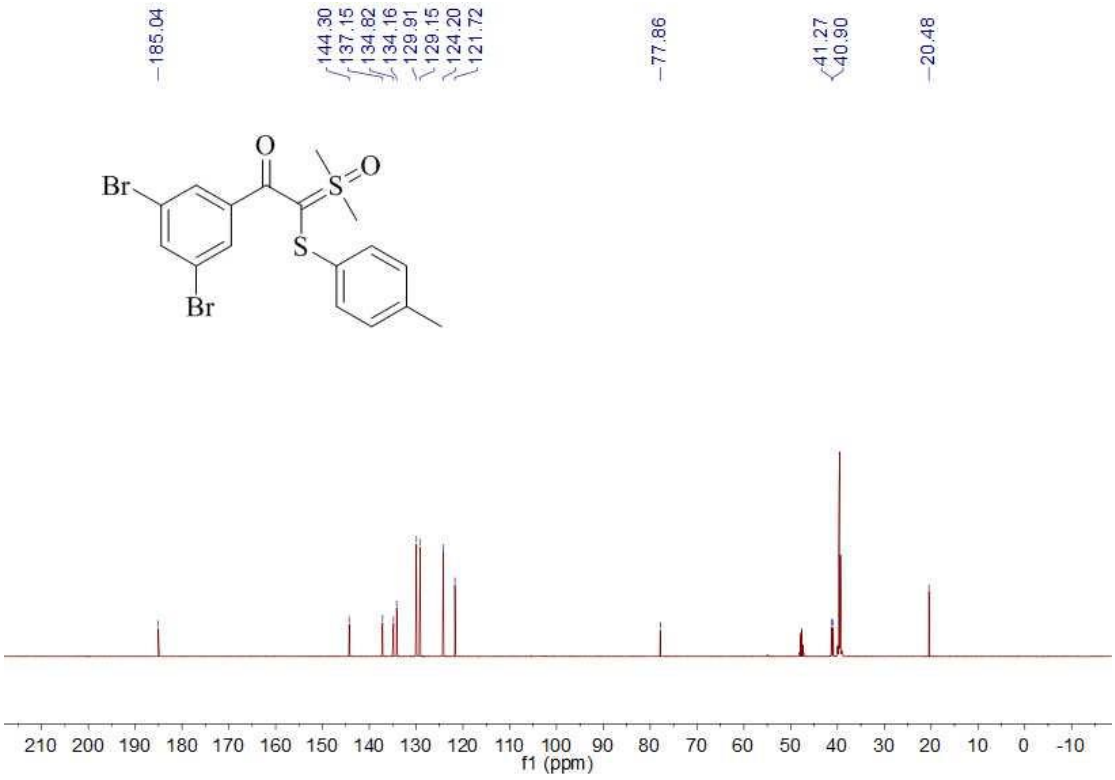
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4ab**



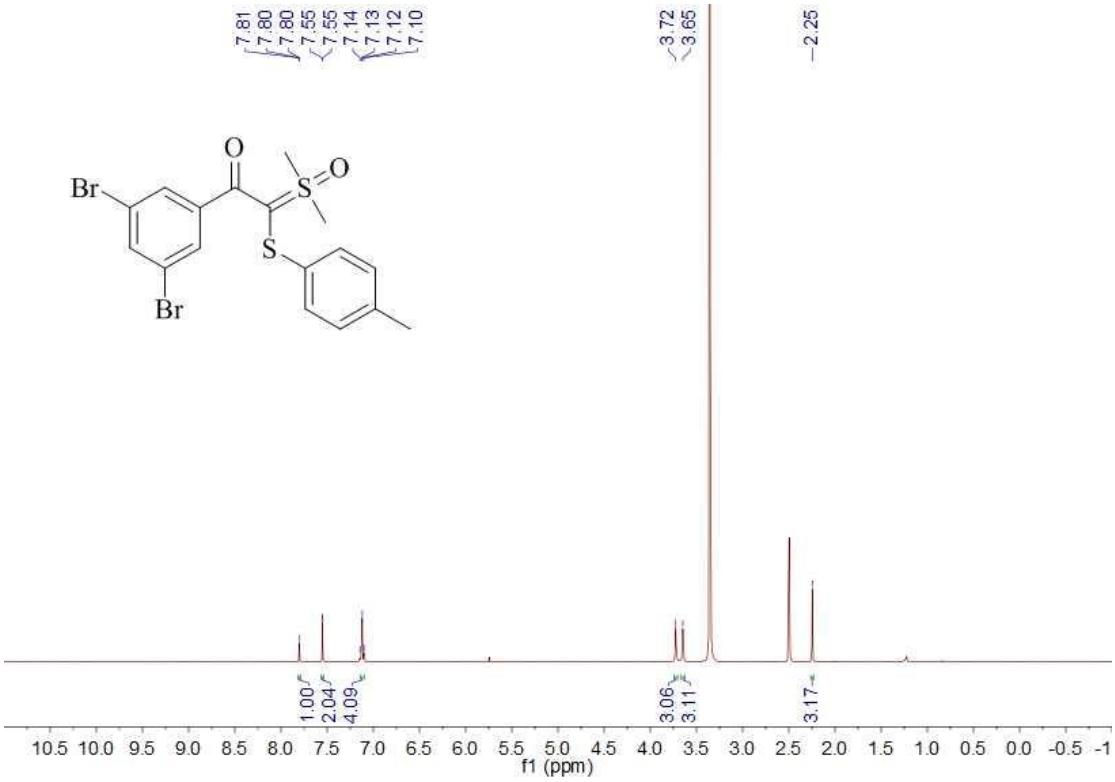
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4ab**



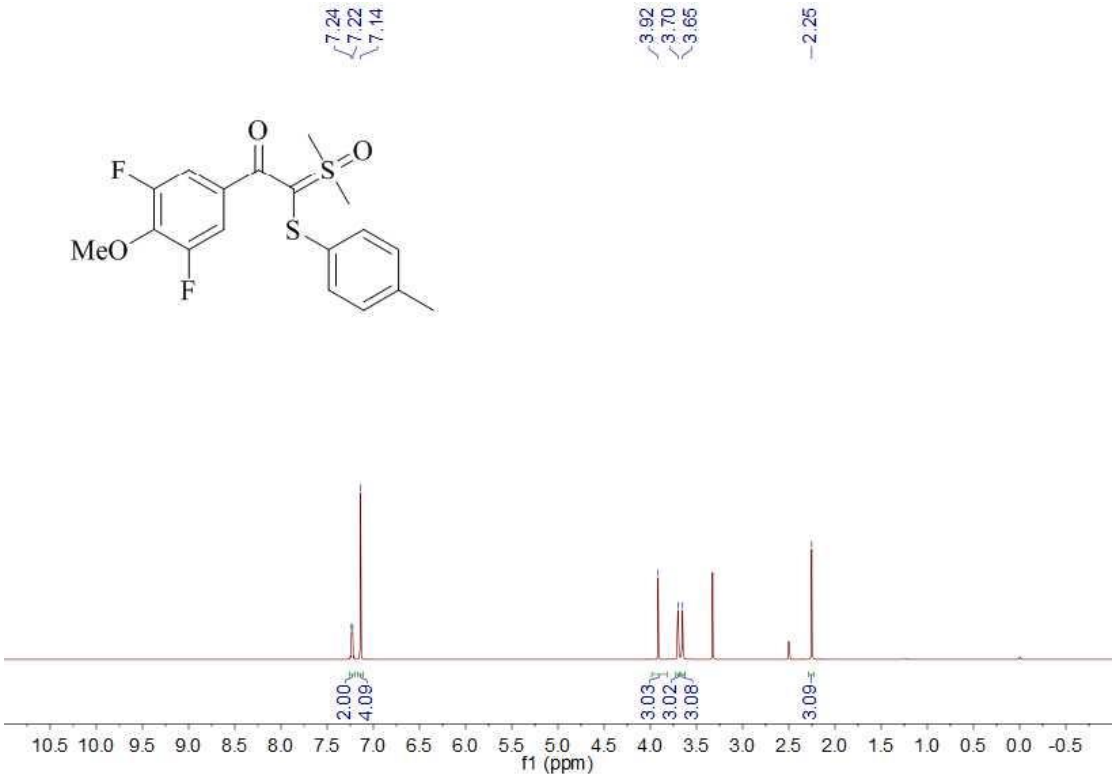
^{1}H NMR (500 MHz, DMSO-d_6) Spectra of **4ac**



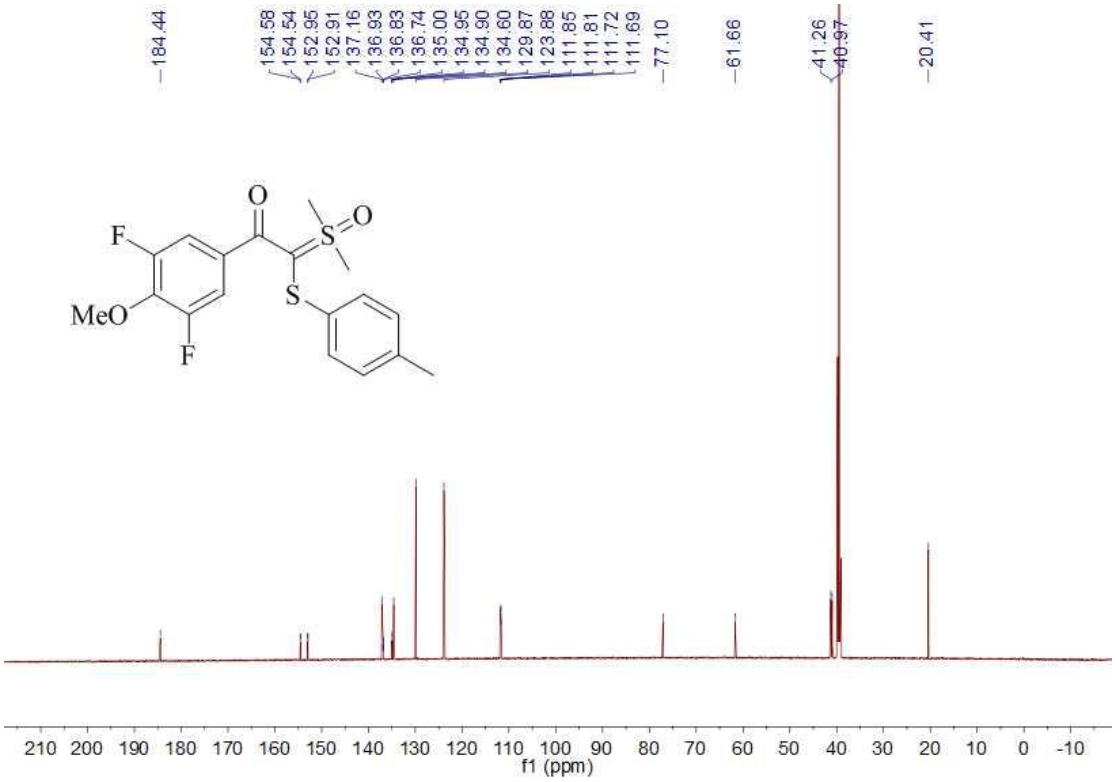
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4ac**



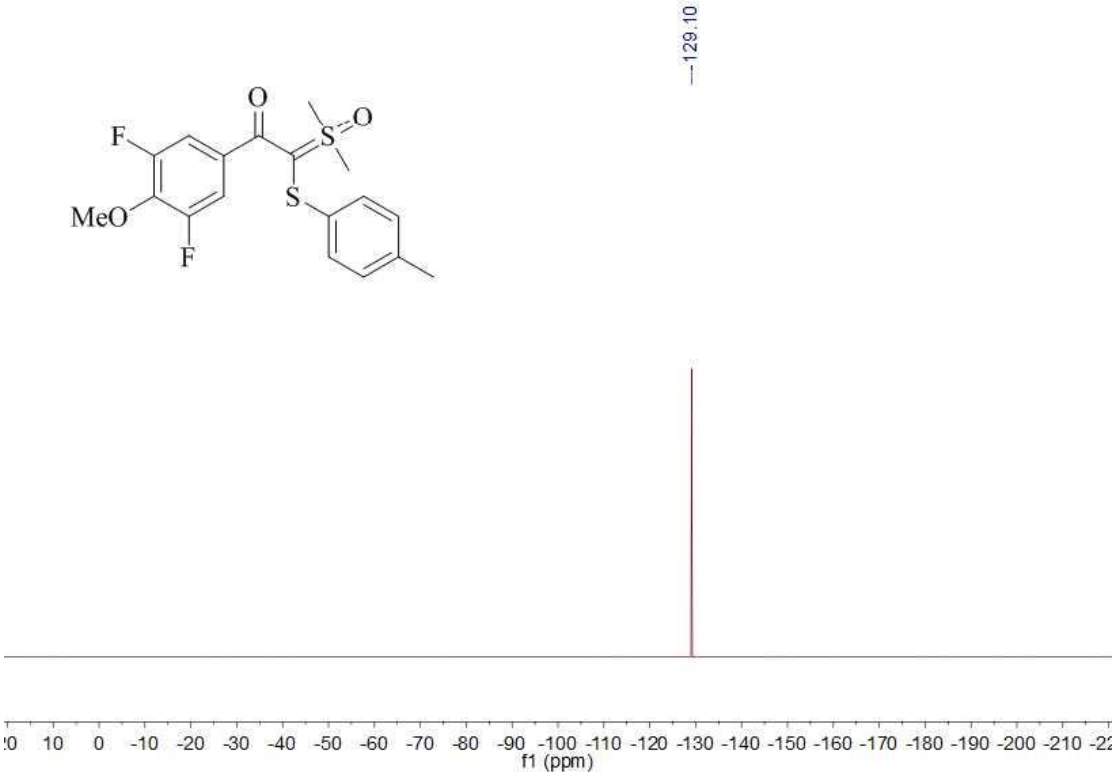
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4ad**



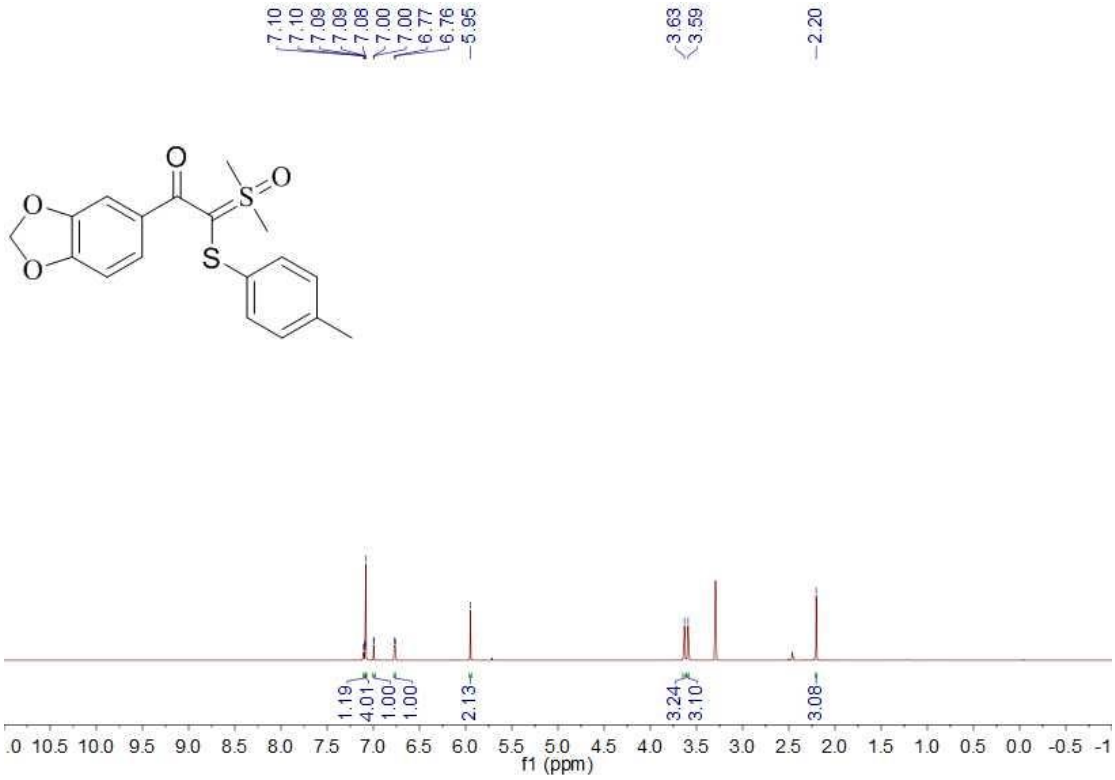
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4ad**



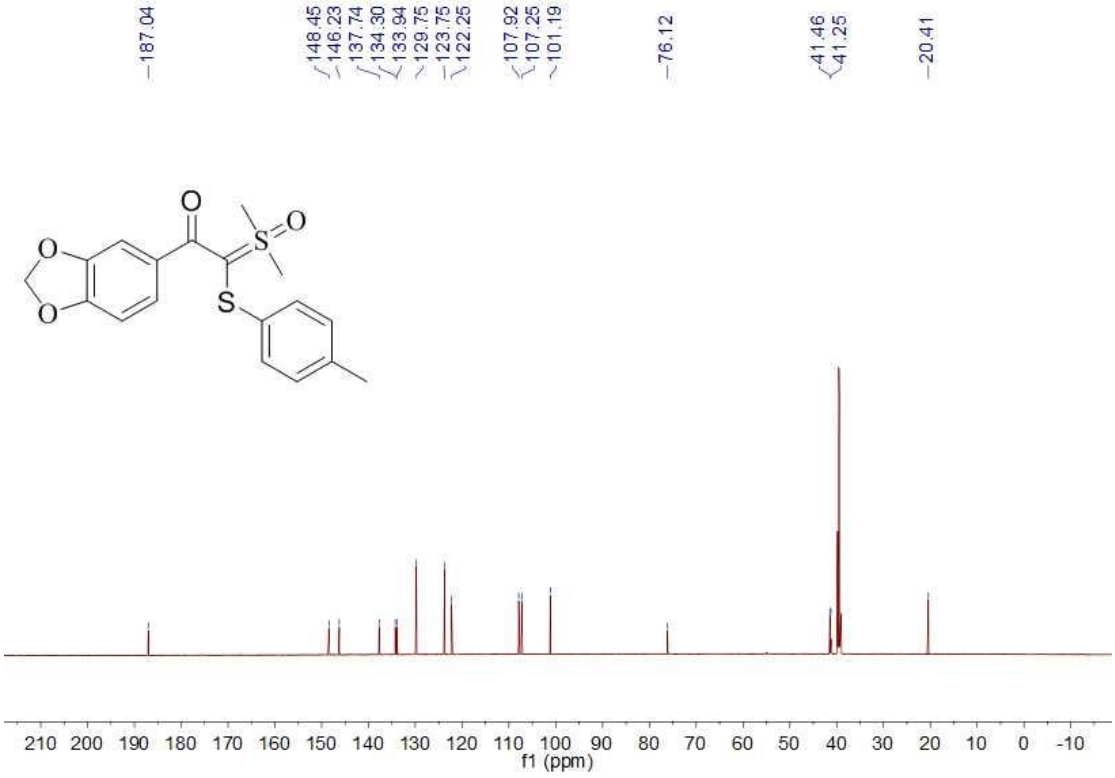
^{19}F NMR (377 MHz, DMSO-d_6) Spectra of **4ad**



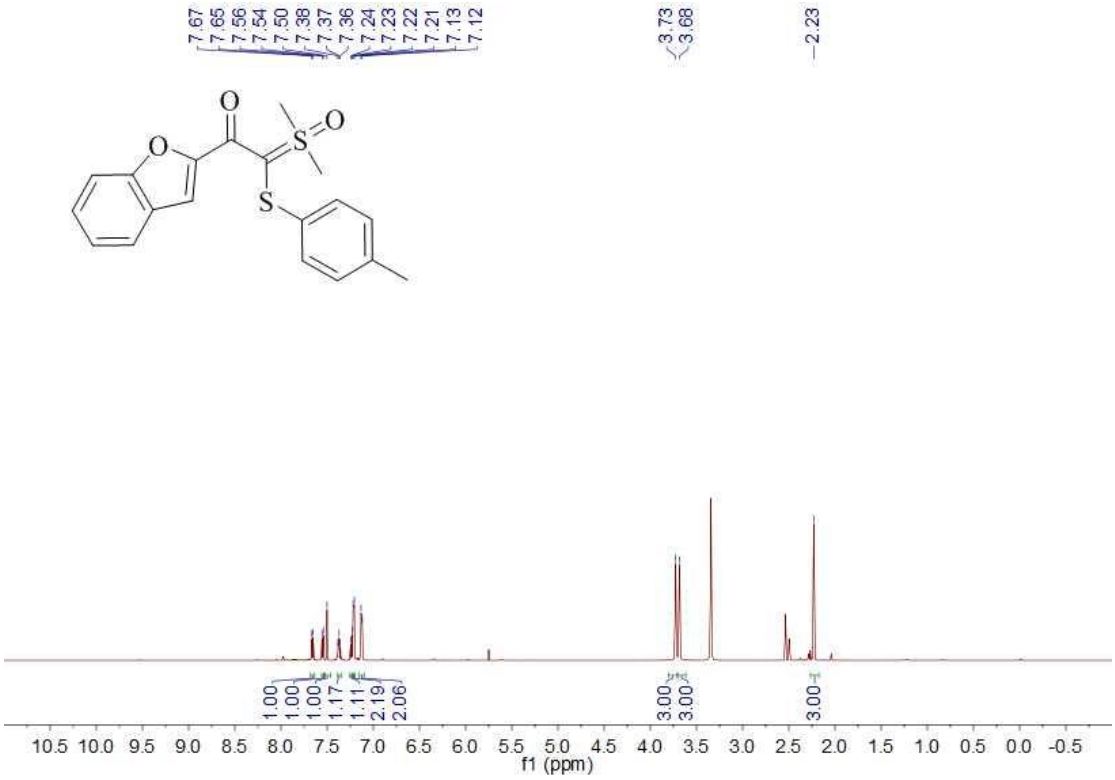
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4ae**



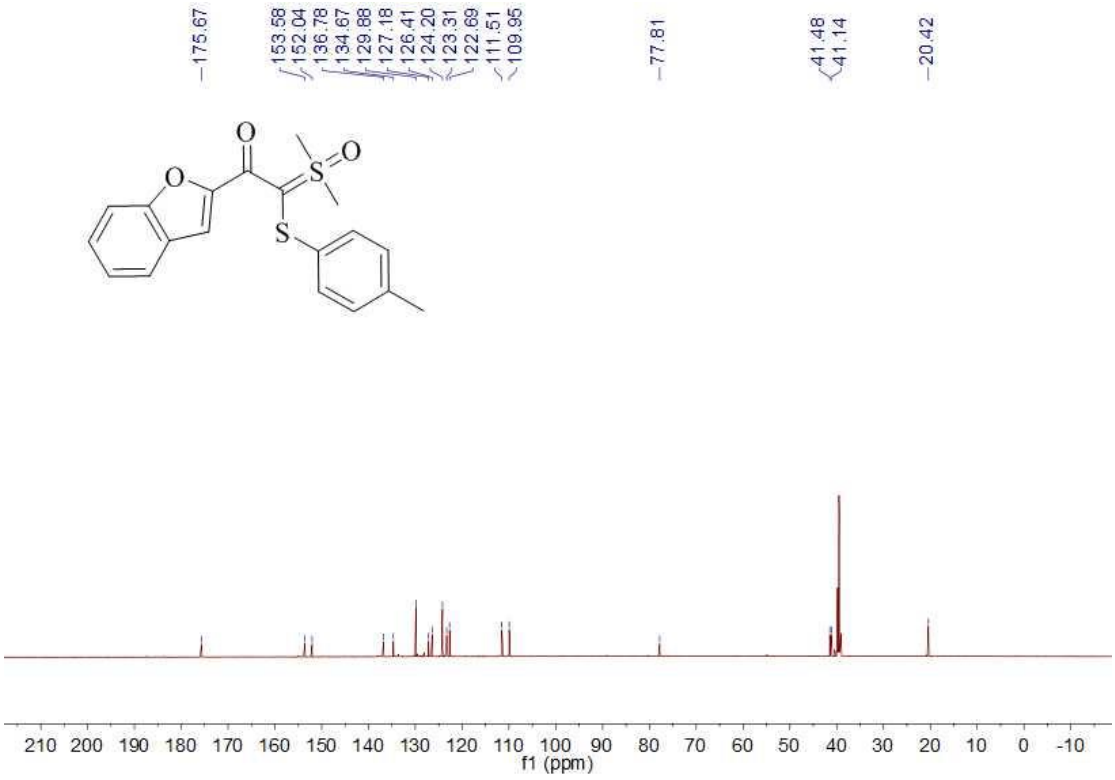
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4ae**



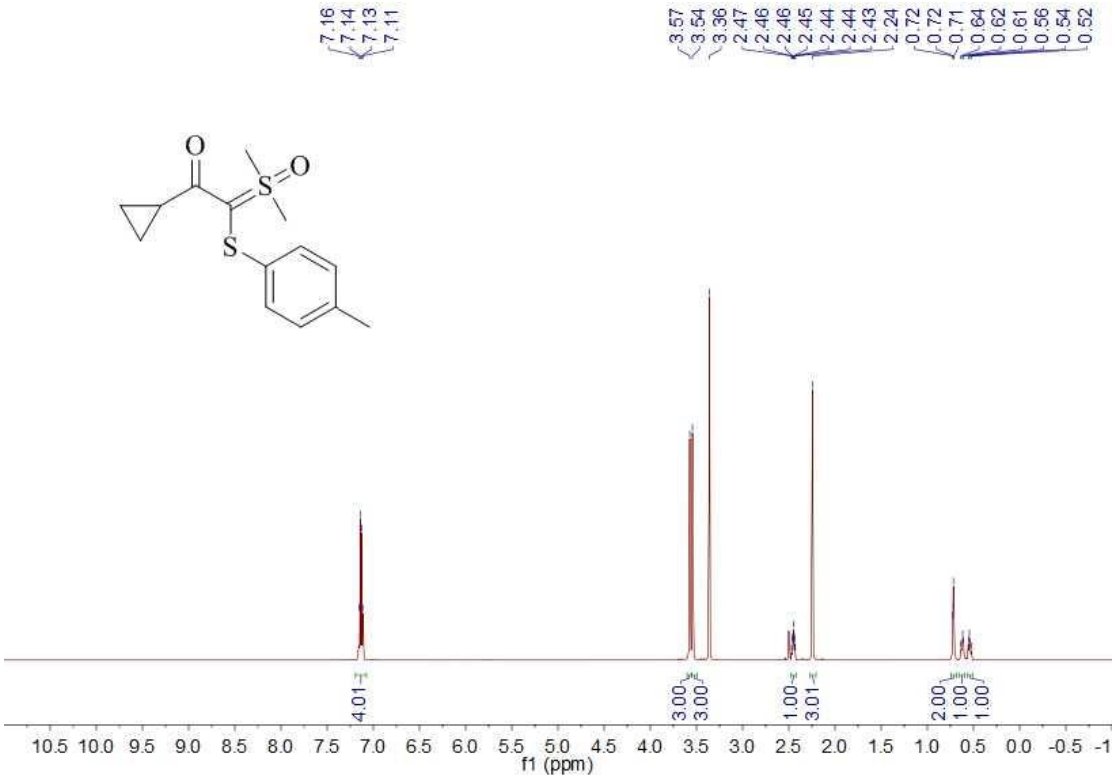
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4af**



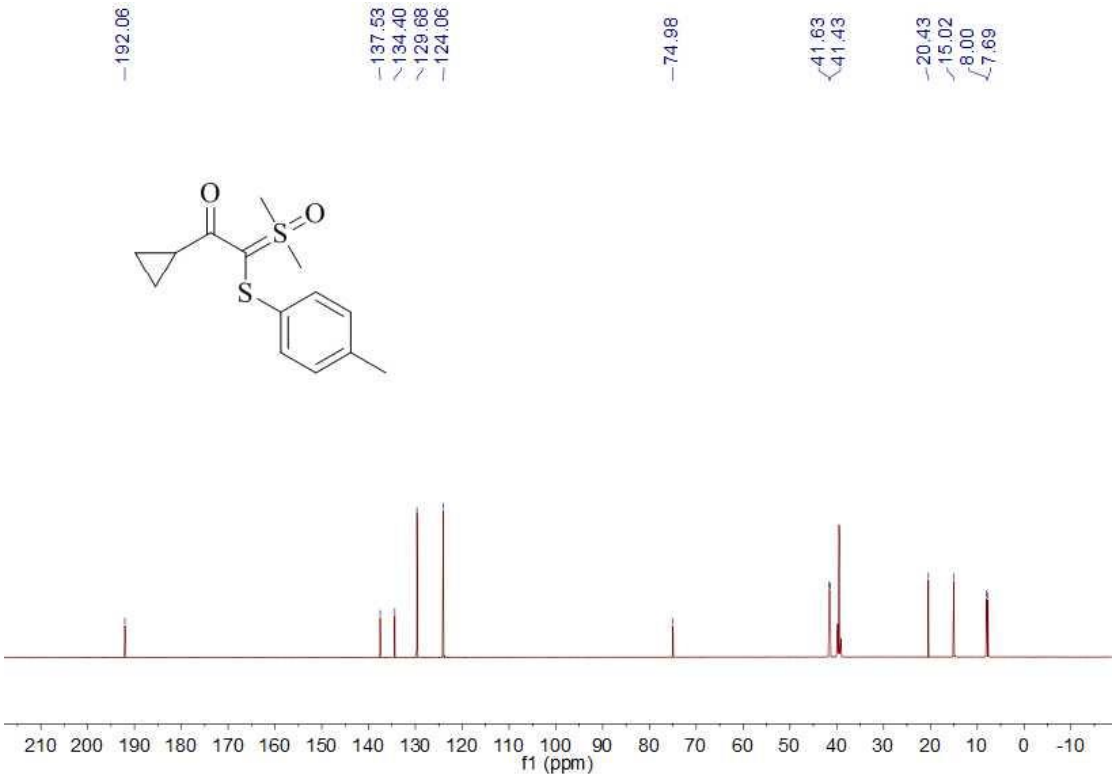
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4af**



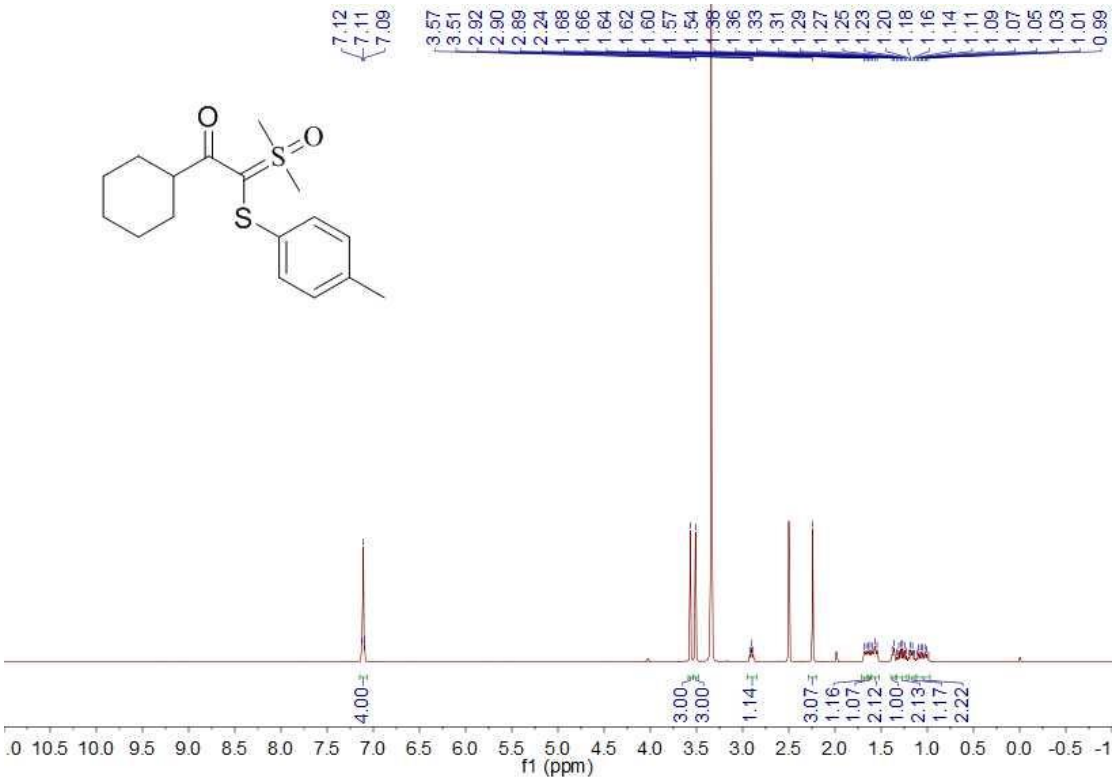
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4ag**



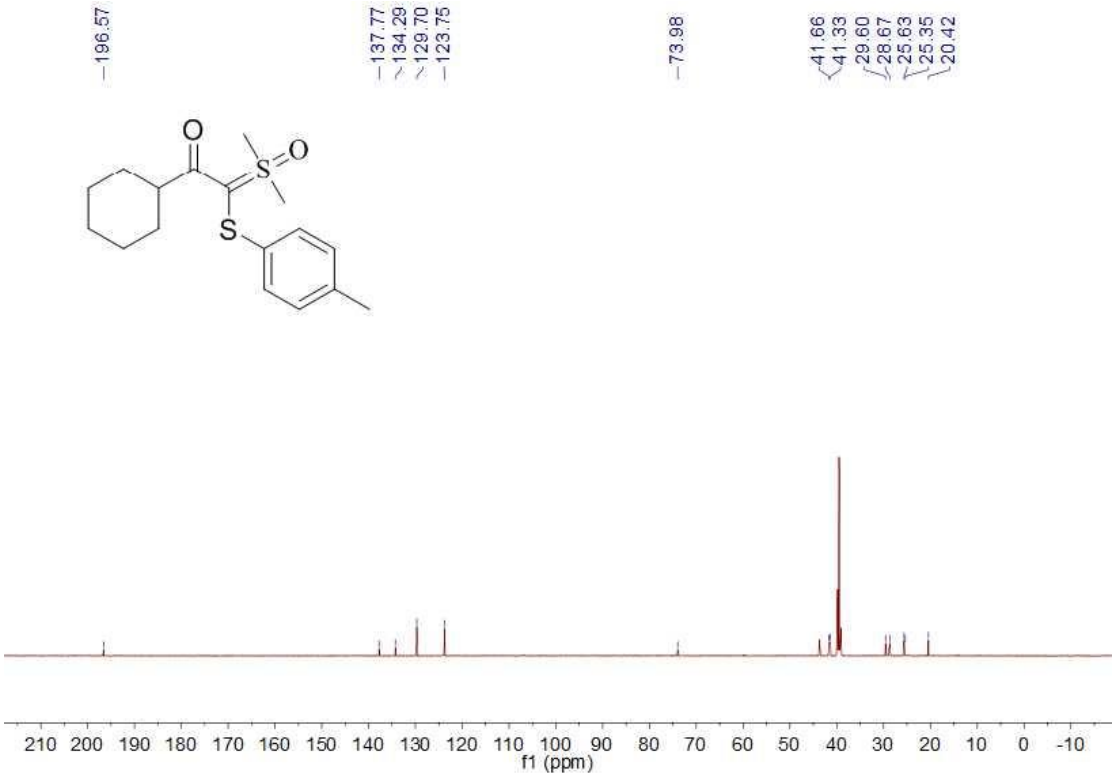
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4ag**



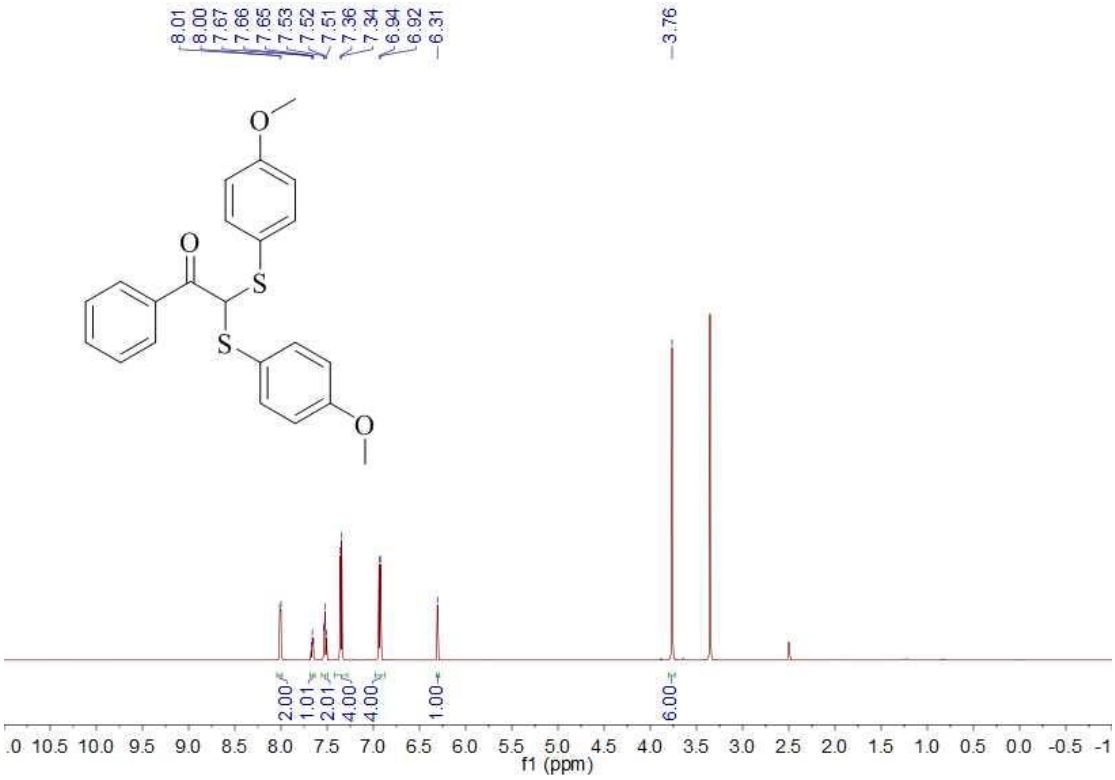
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **4ah**



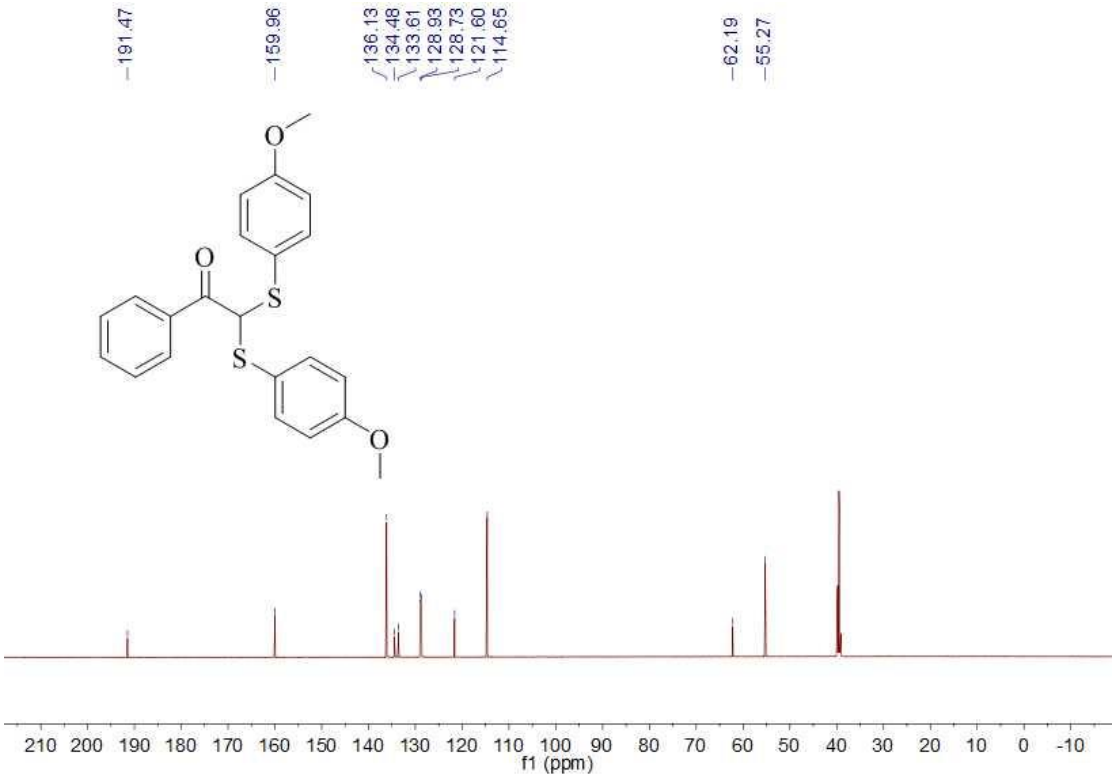
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **4ah**



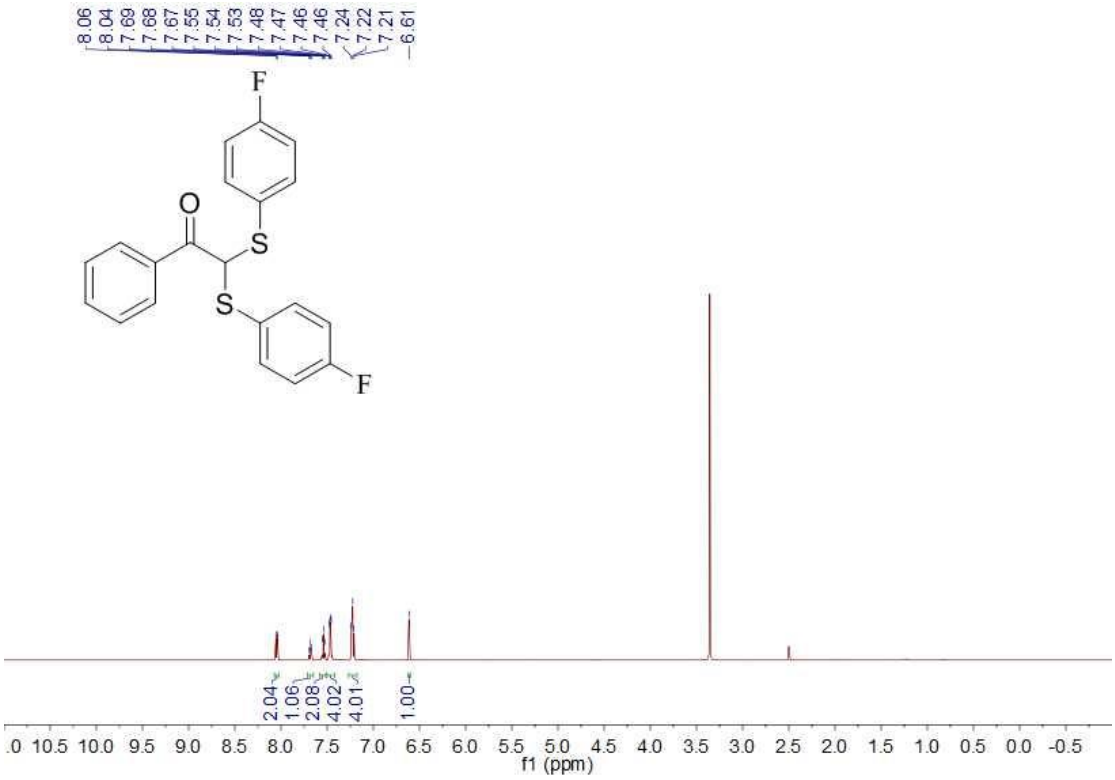
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **5a**



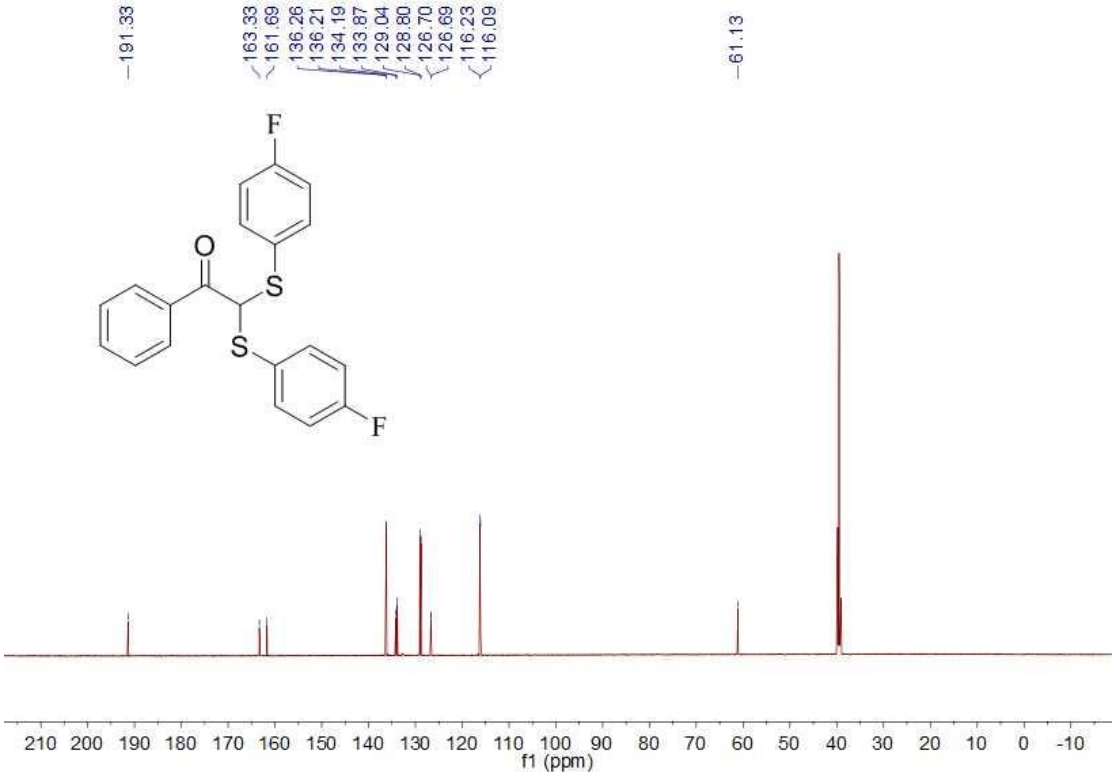
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **5a**



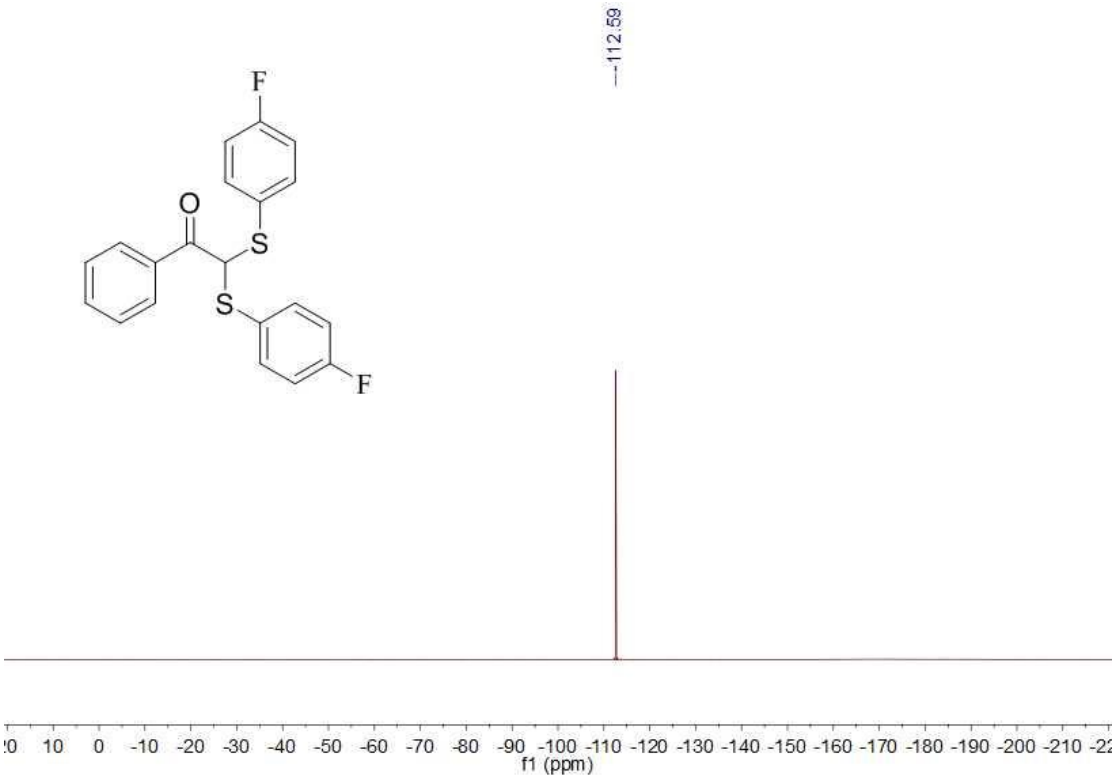
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **5b**



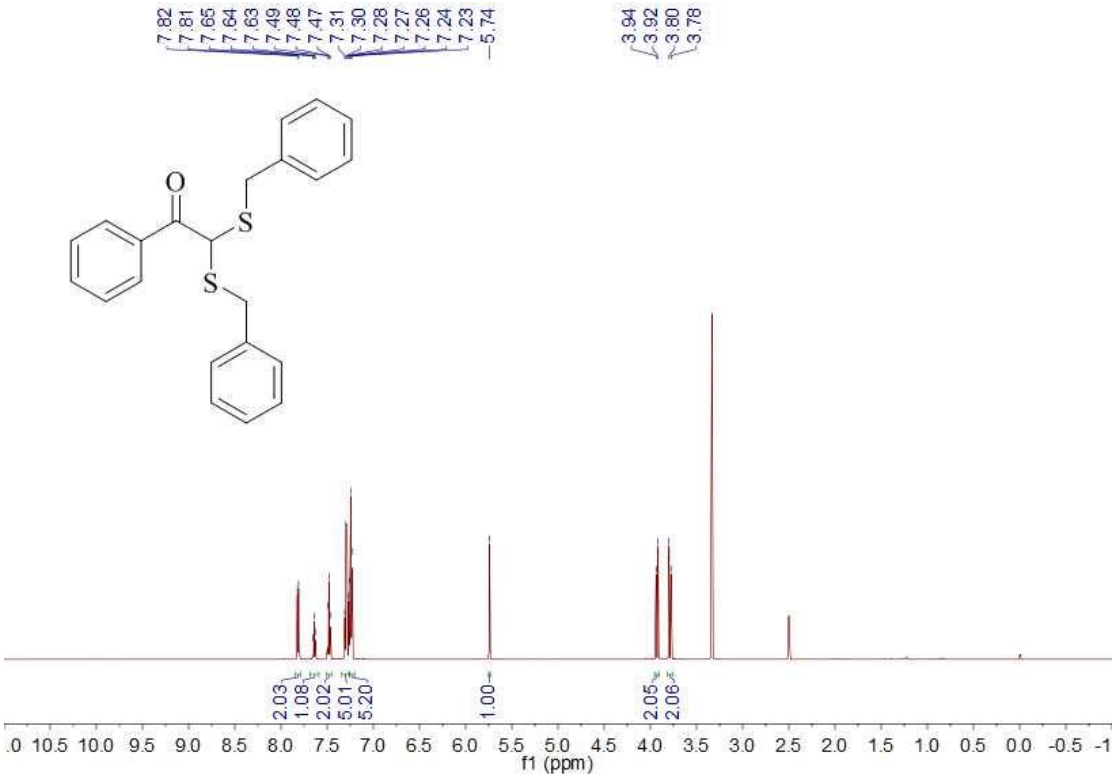
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **5b**



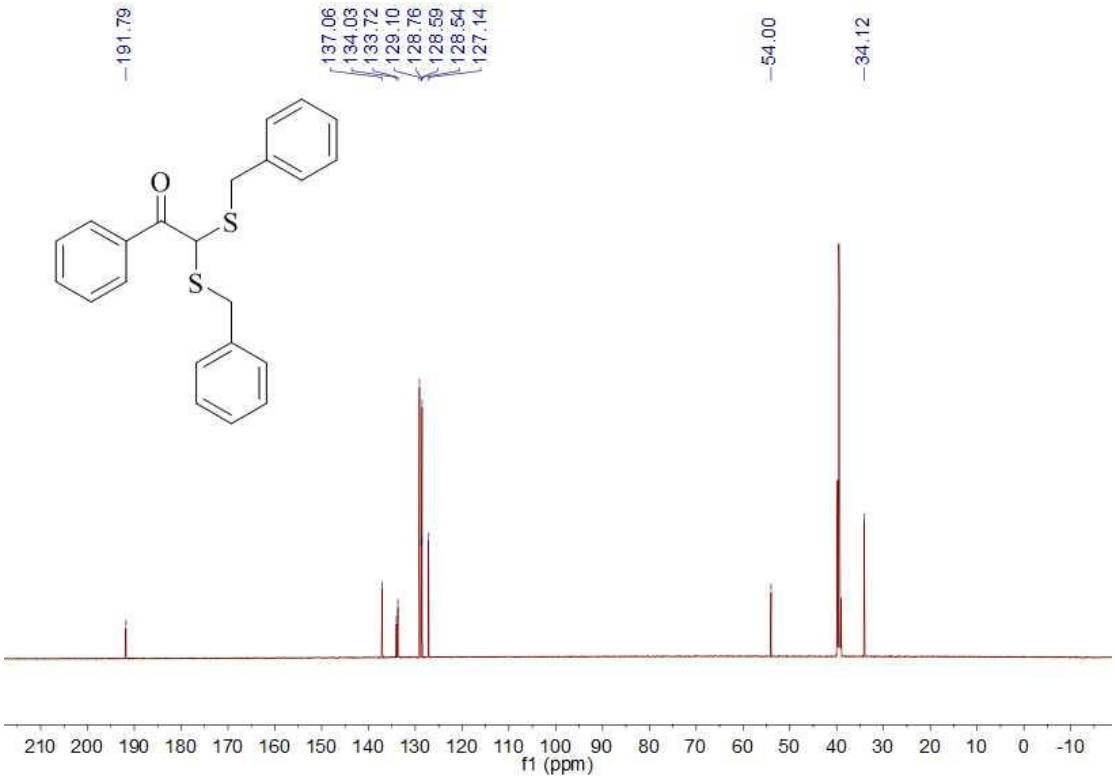
^{19}F NMR (377 MHz, DMSO-d_6) Spectra of **5b**



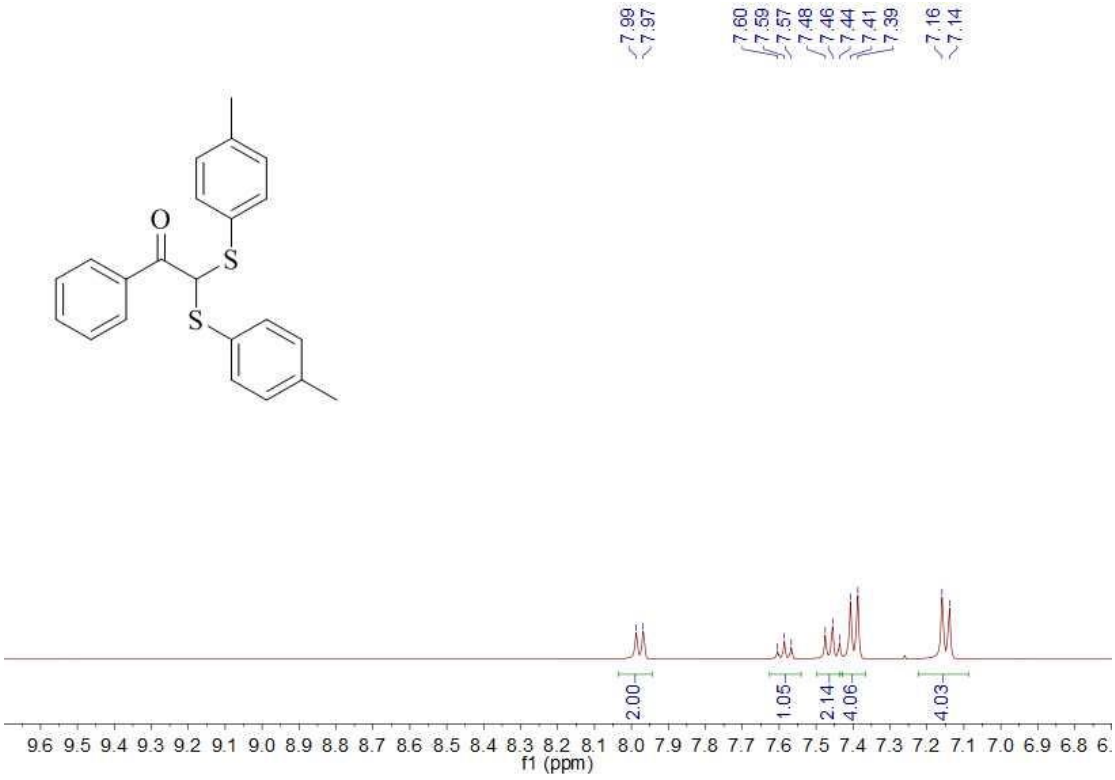
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **5c**



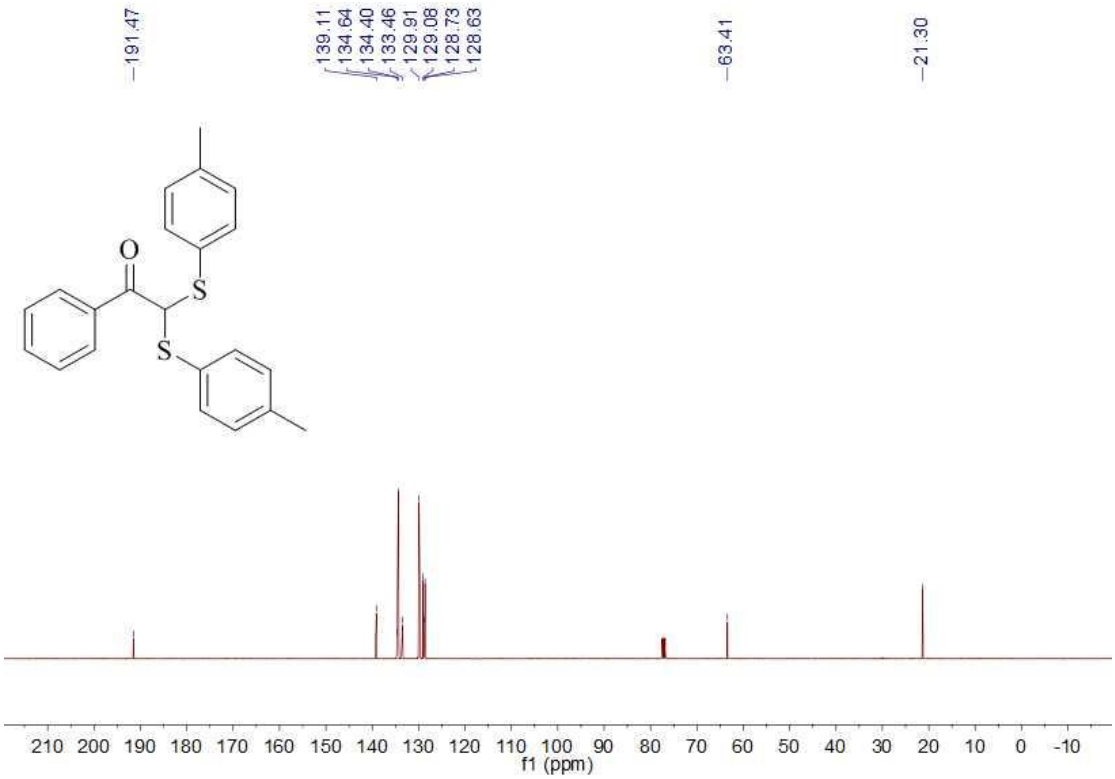
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **5c**



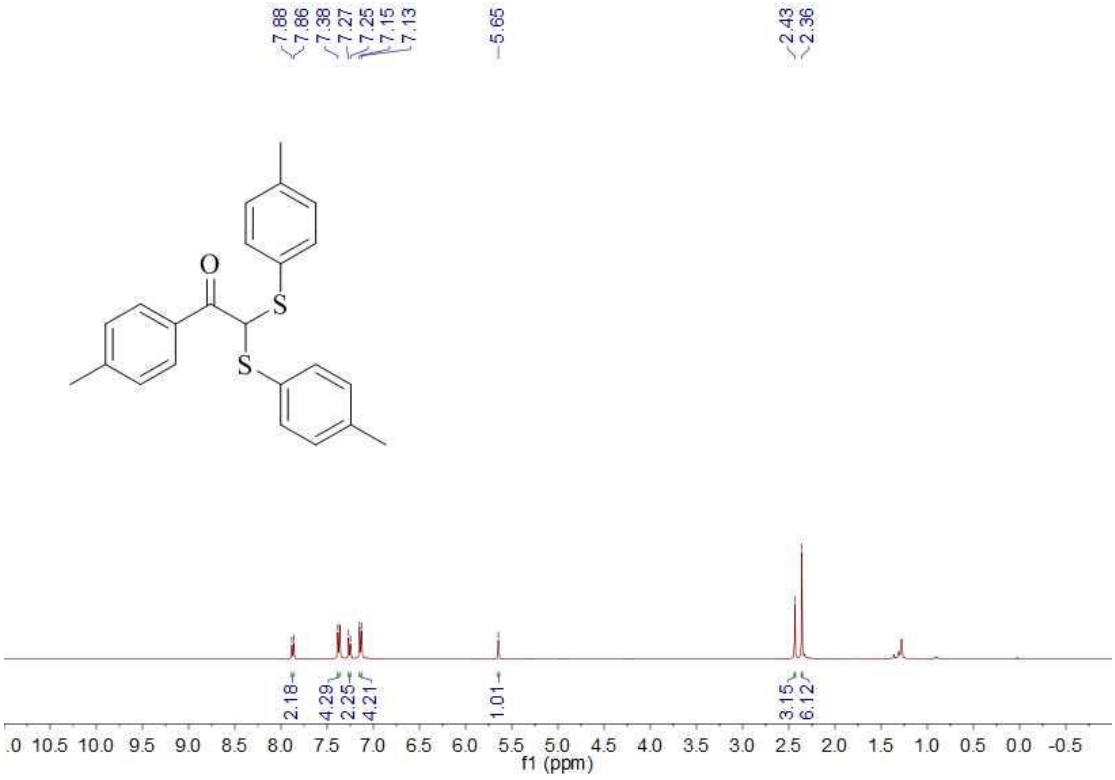
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5d**



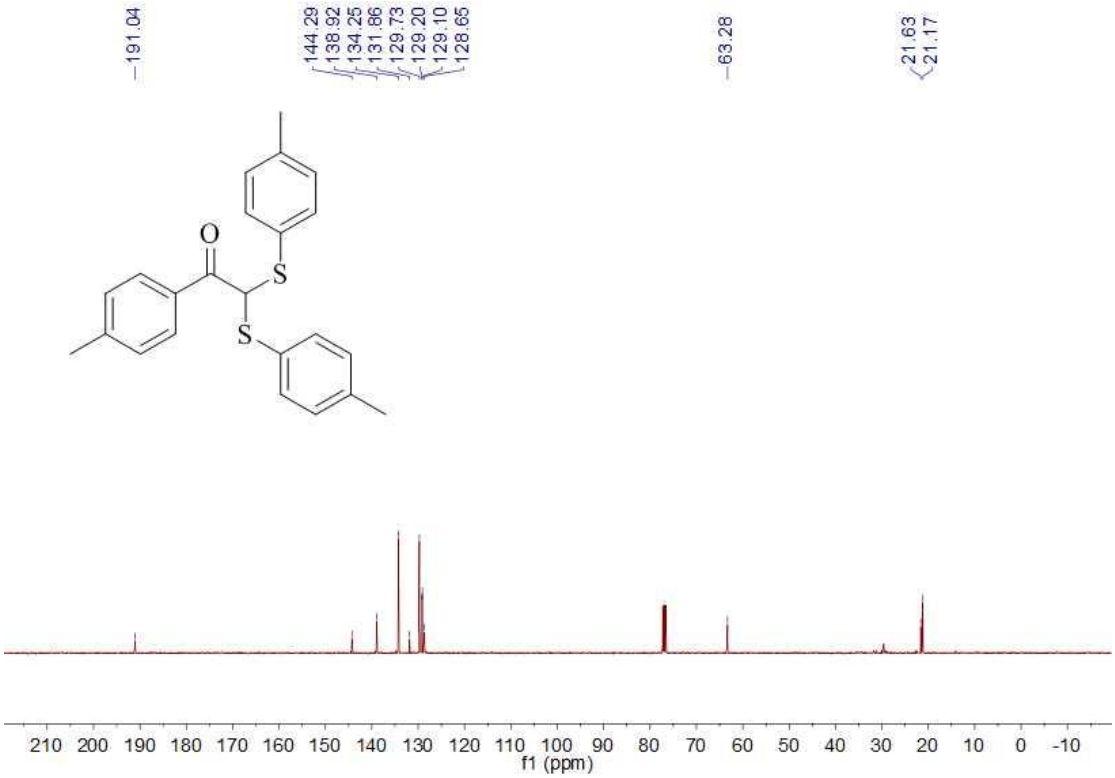
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5d**



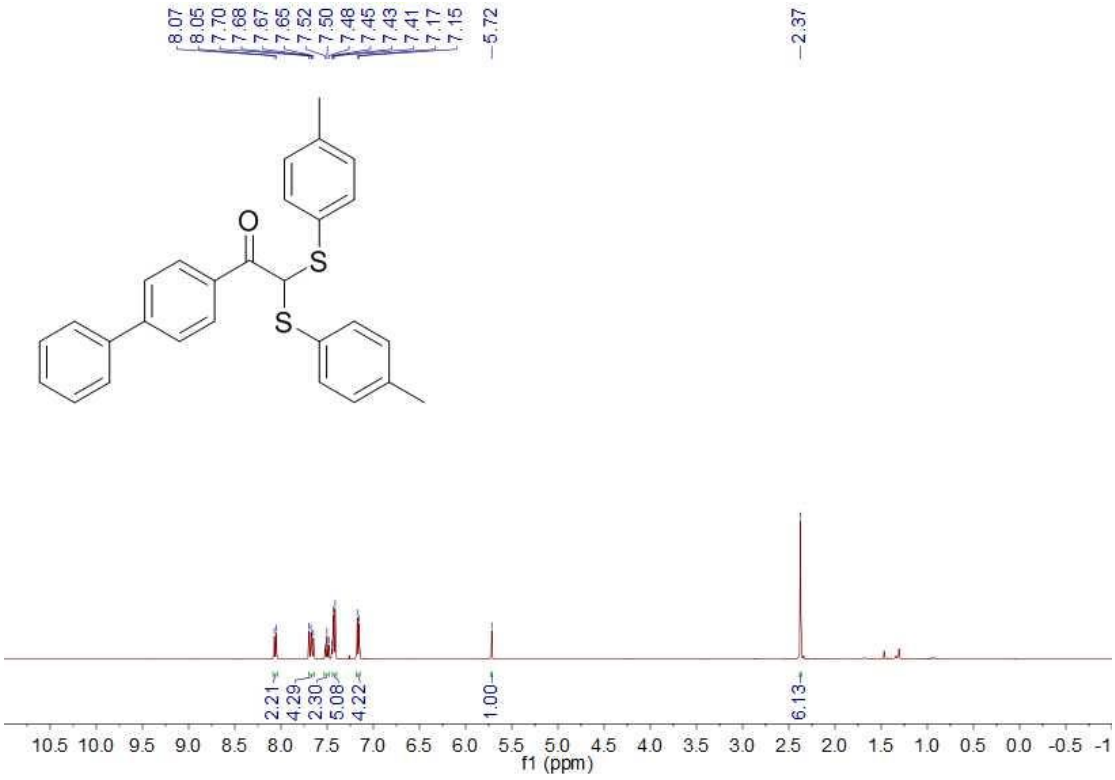
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5e**



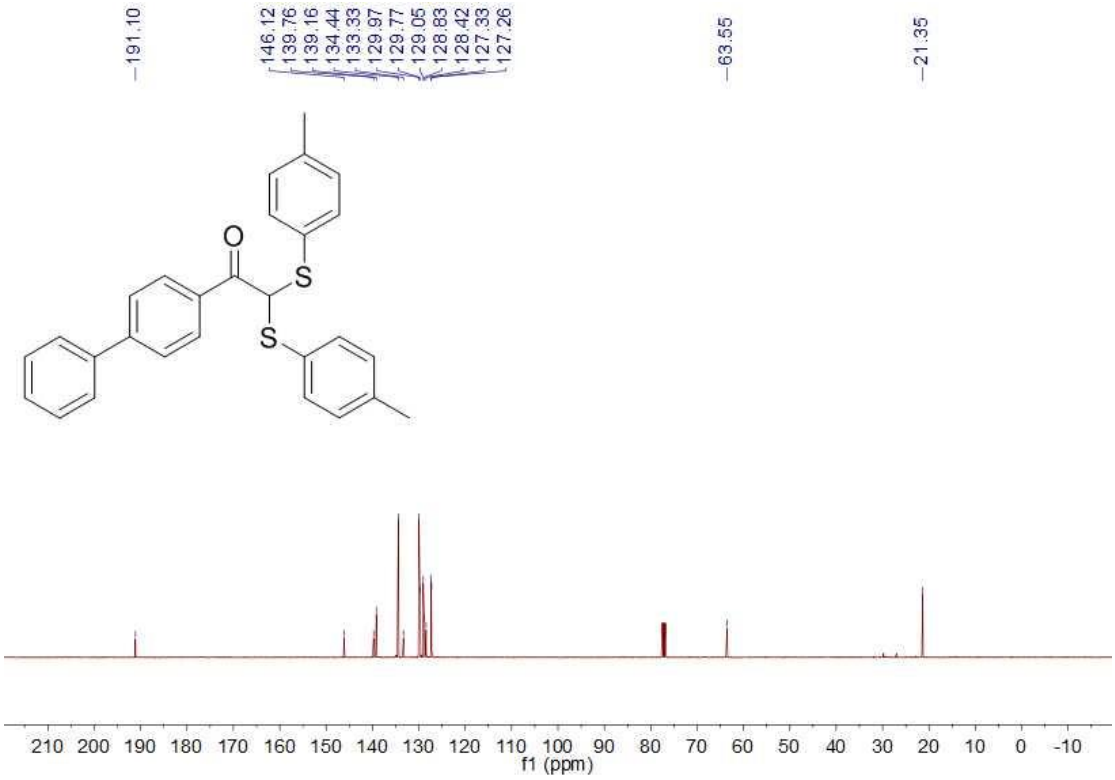
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5e**



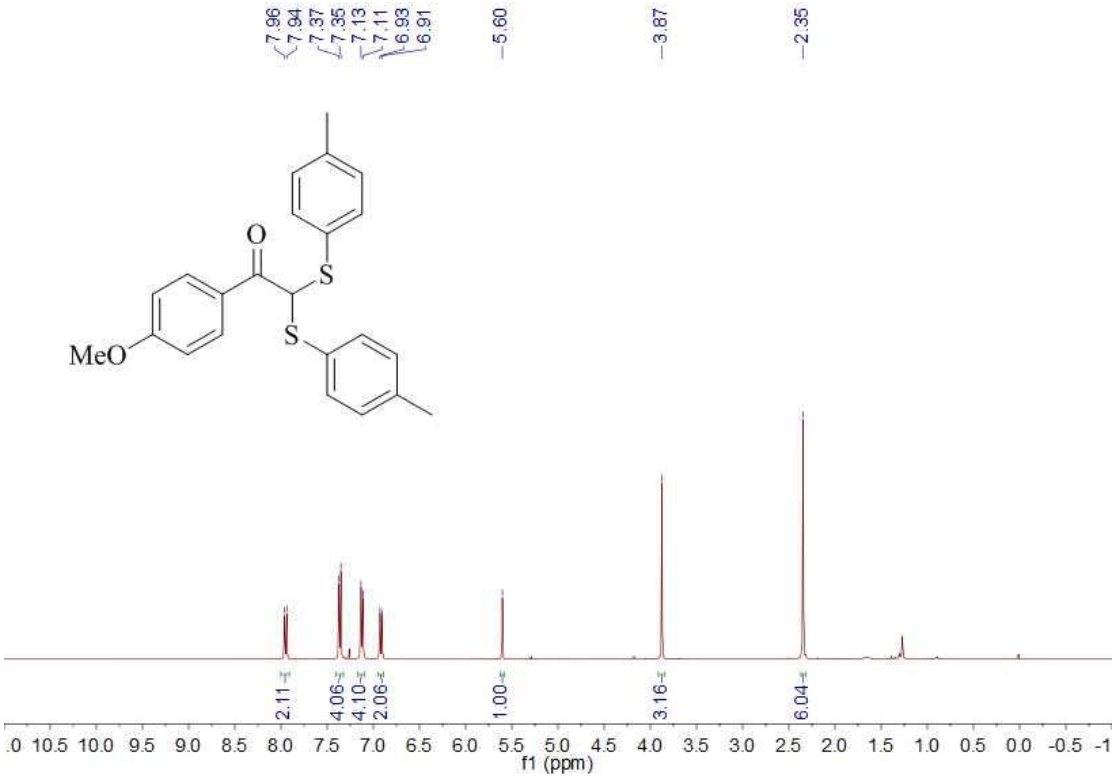
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5f**



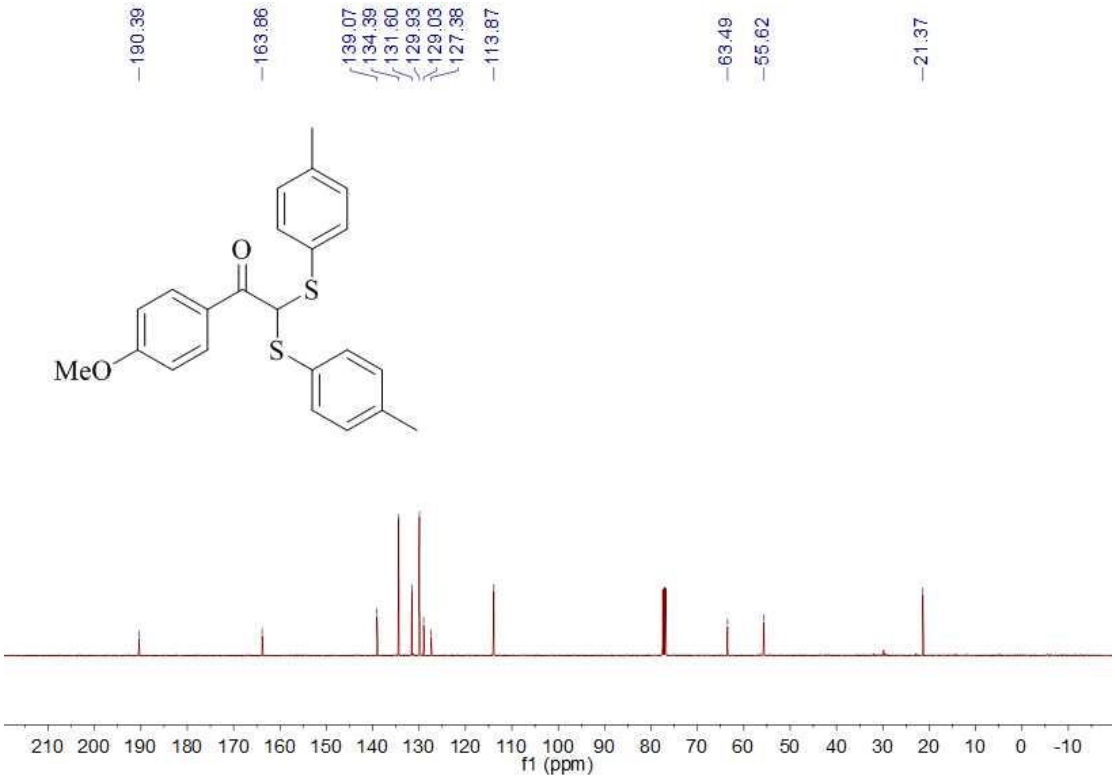
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5f**



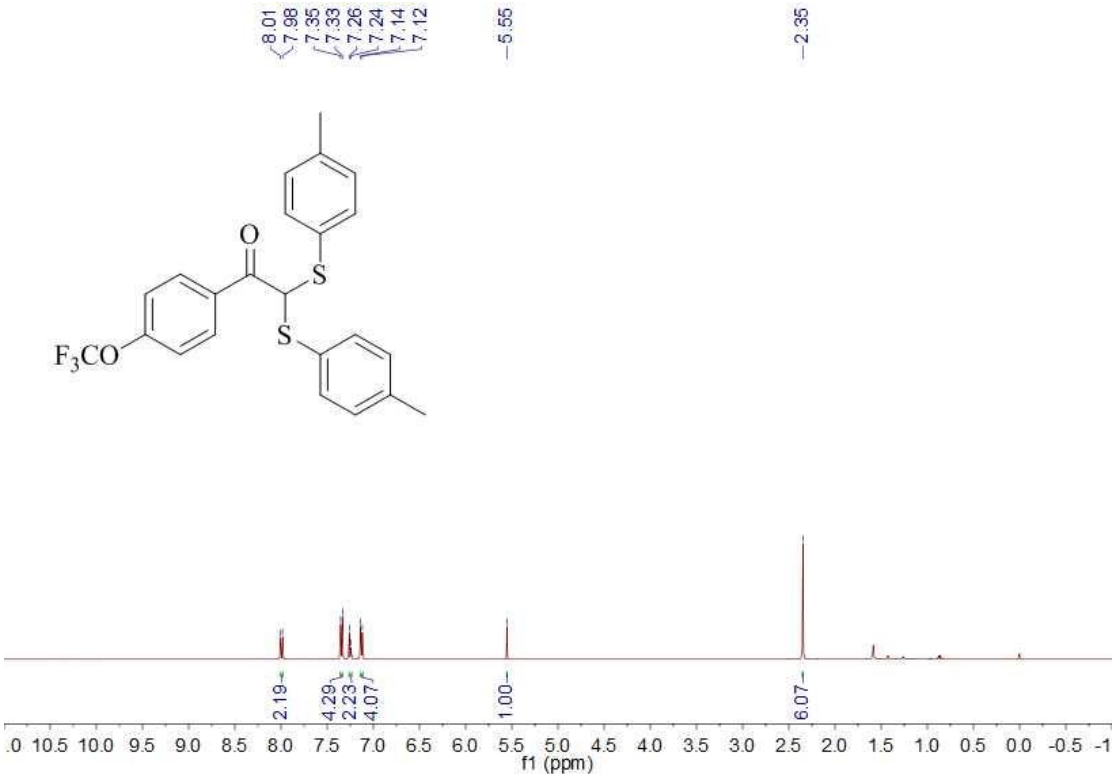
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5g**



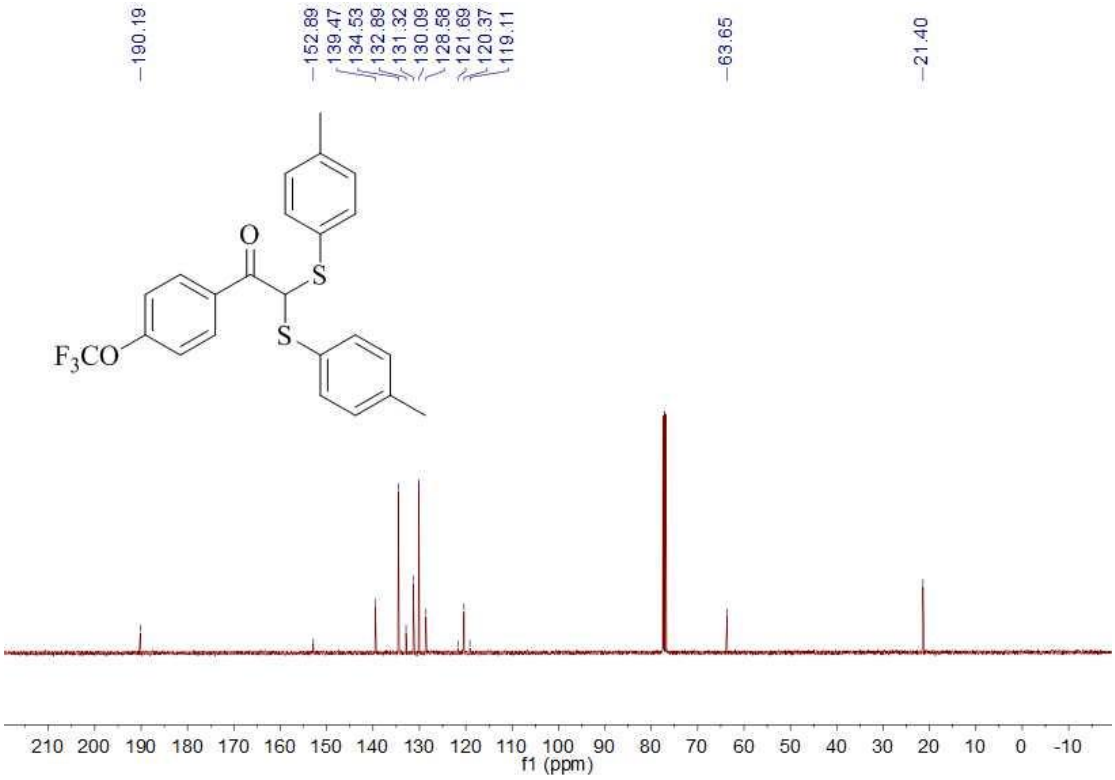
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5g**



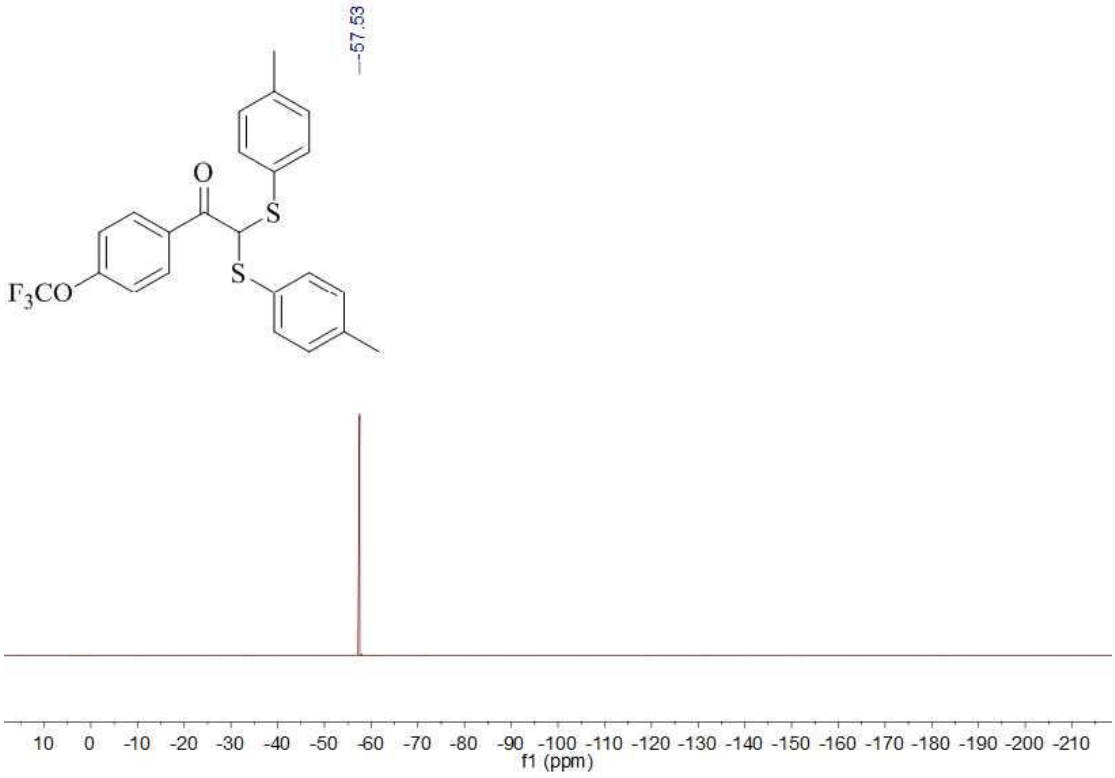
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5h**



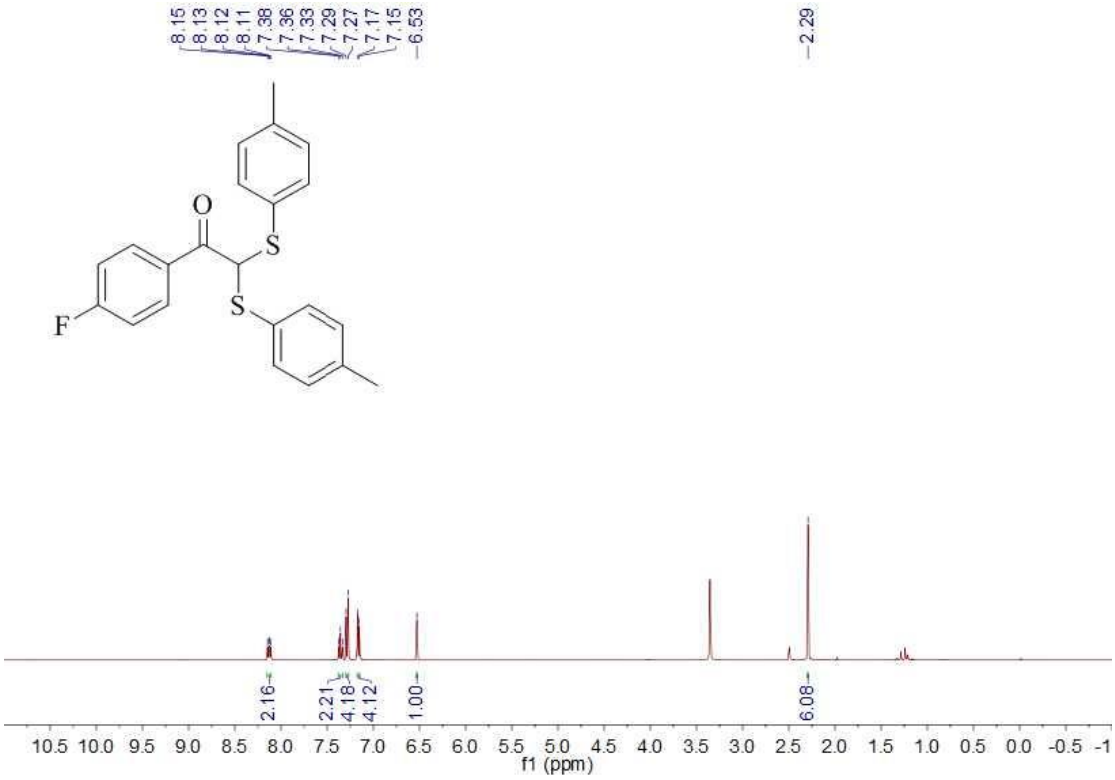
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5h**



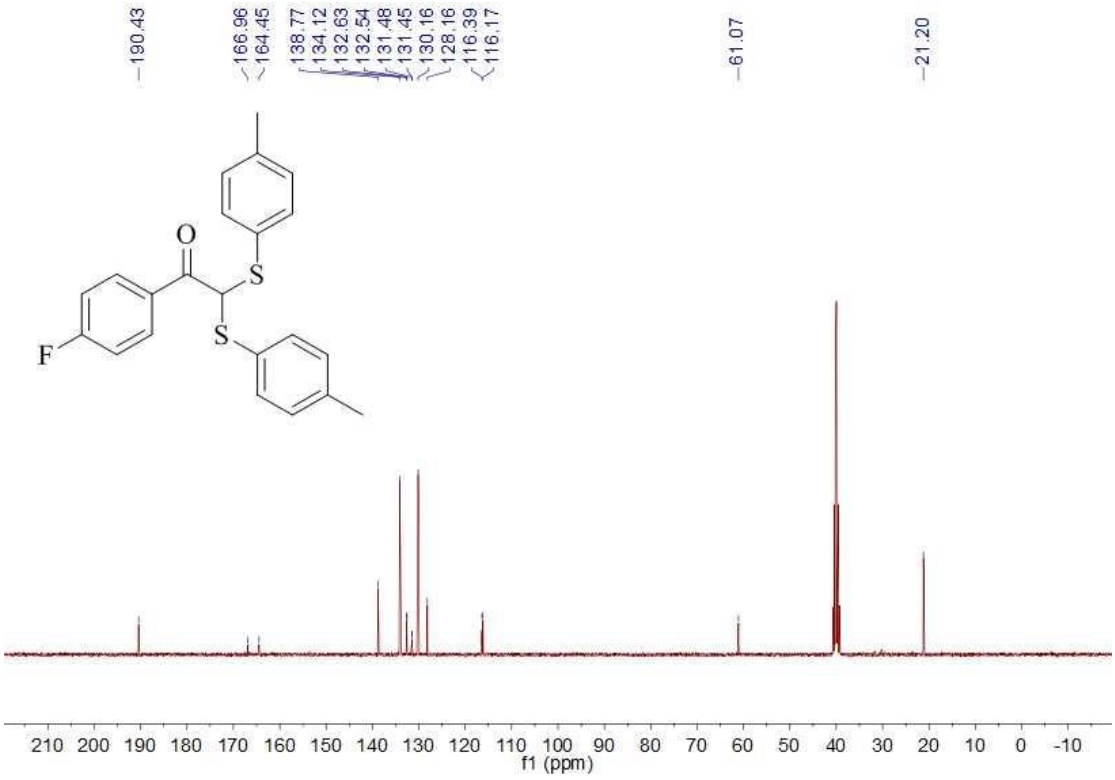
^{19}F NMR (376 MHz, $CDCl_3$) Spectra of **5h**



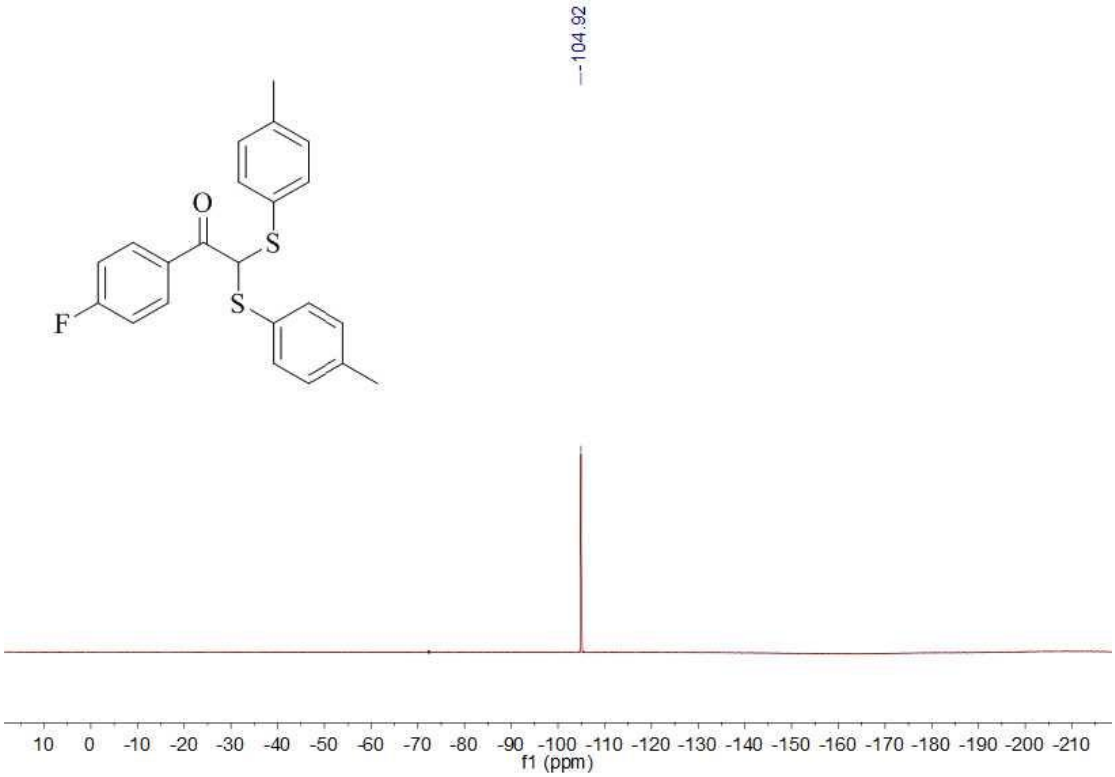
^{1}H NMR (400 MHz, DMSO-d_6) Spectra of **5i**



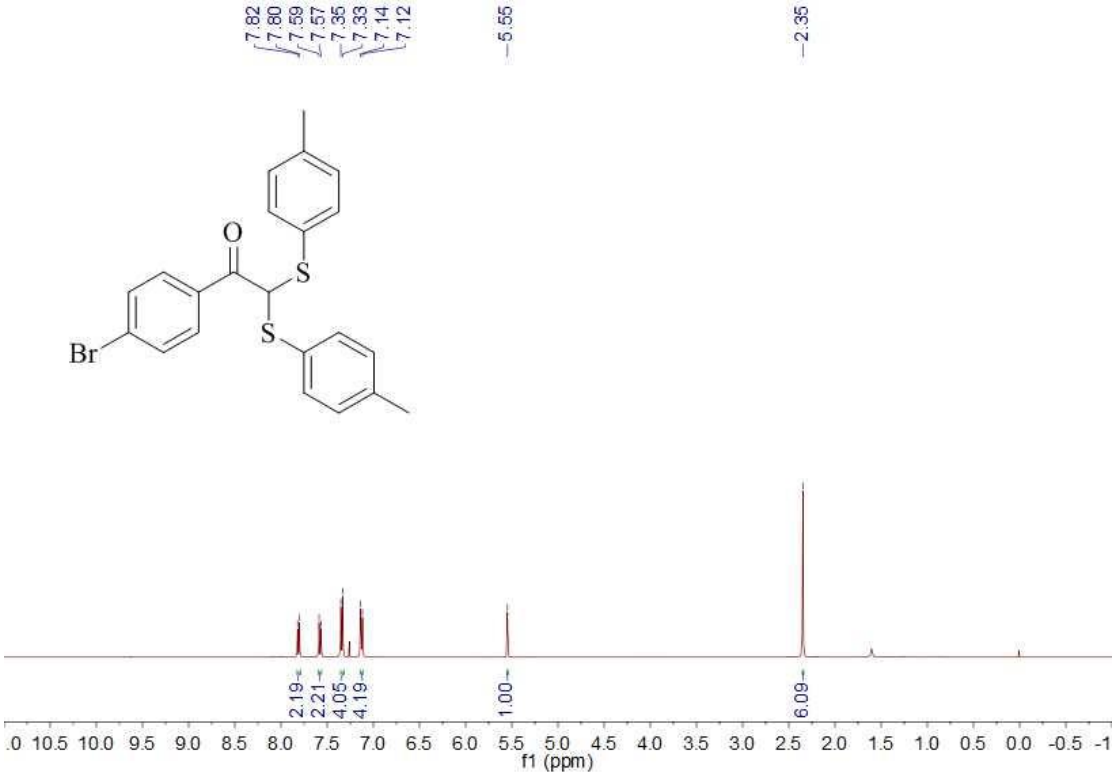
^{13}C NMR (101 MHz, DMSO-d_6) Spectra of **5i**



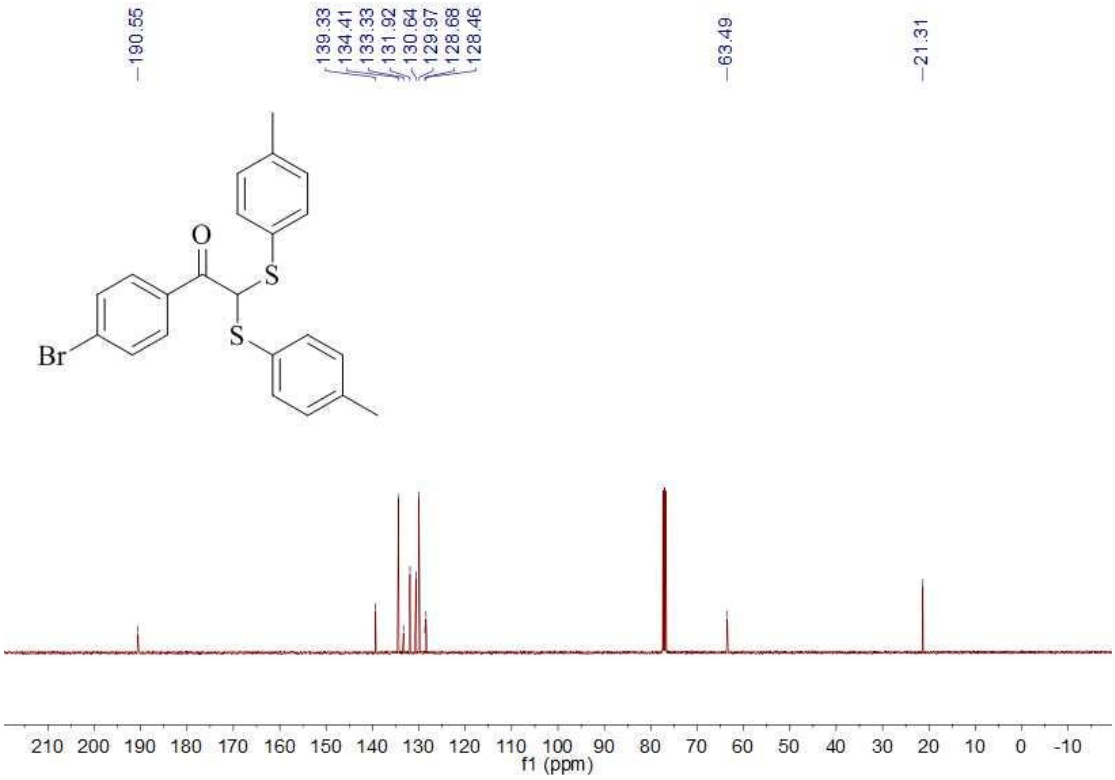
^{19}F NMR (376 MHz, DMSO-d_6) Spectra of **5i**



^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5j**



^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5j**



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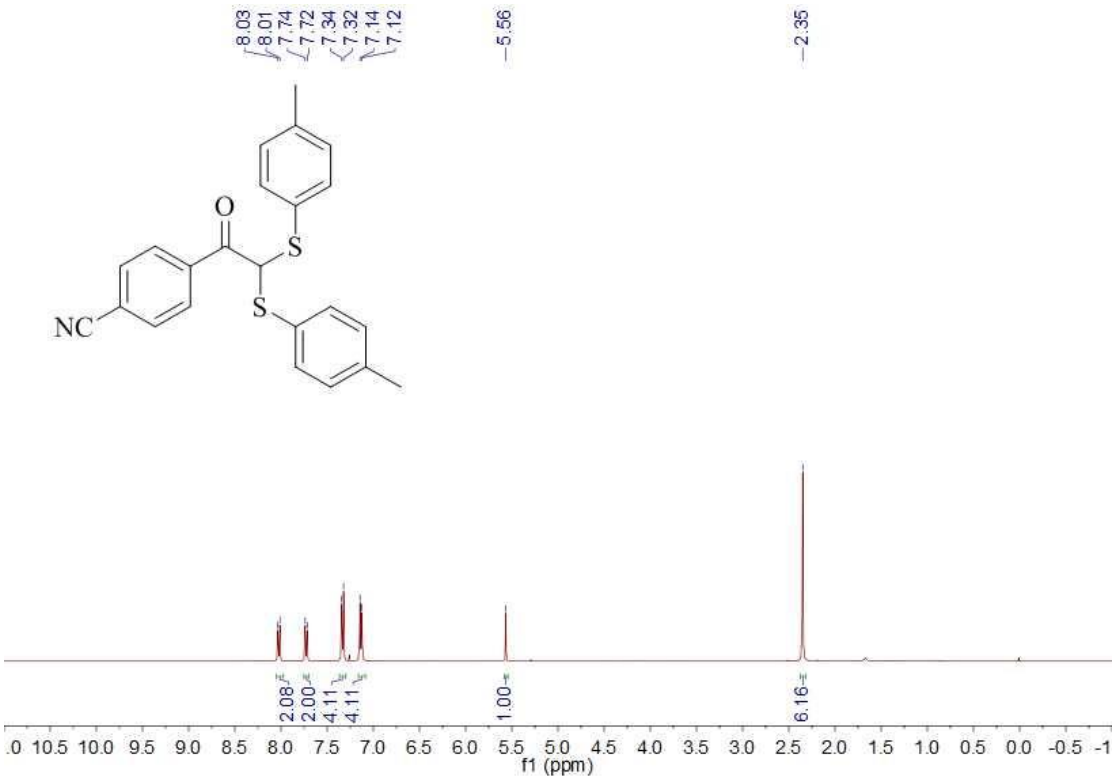
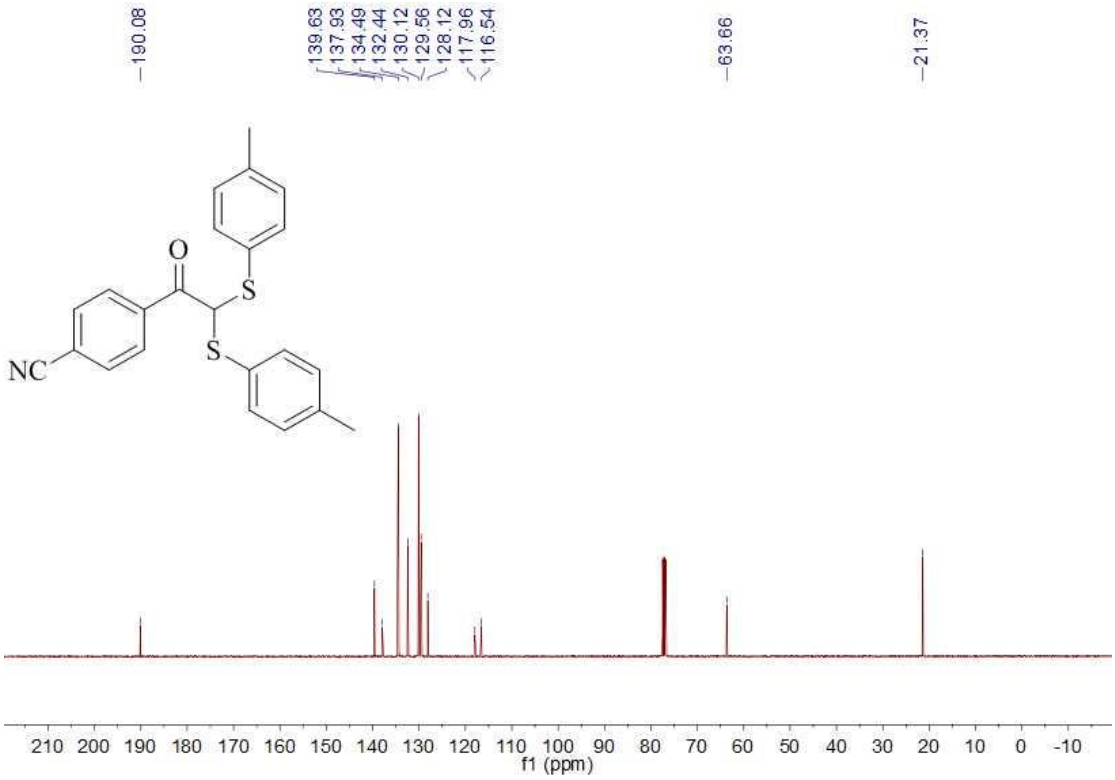
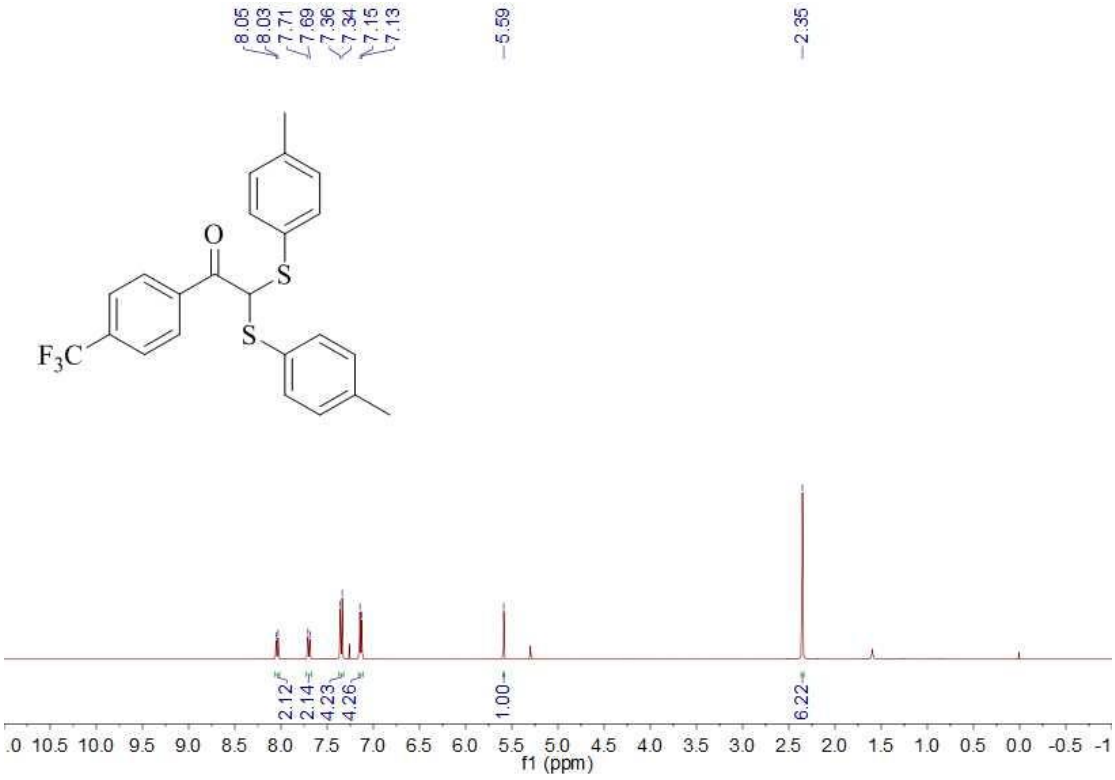


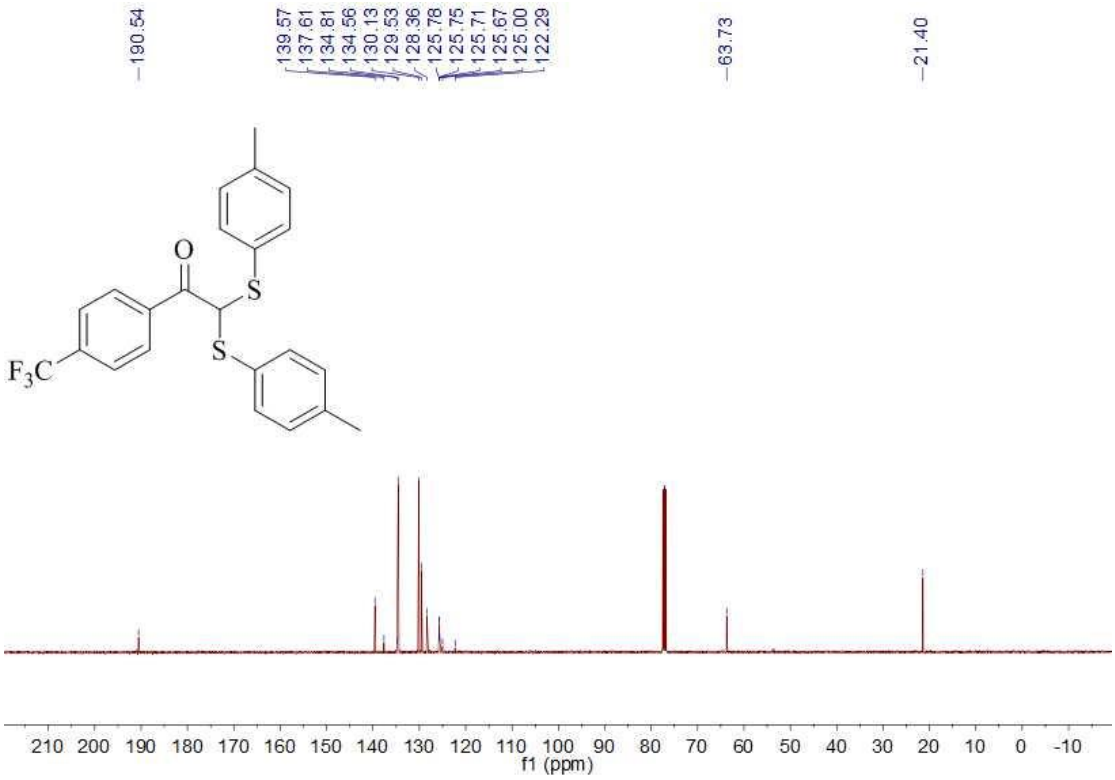
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5k**



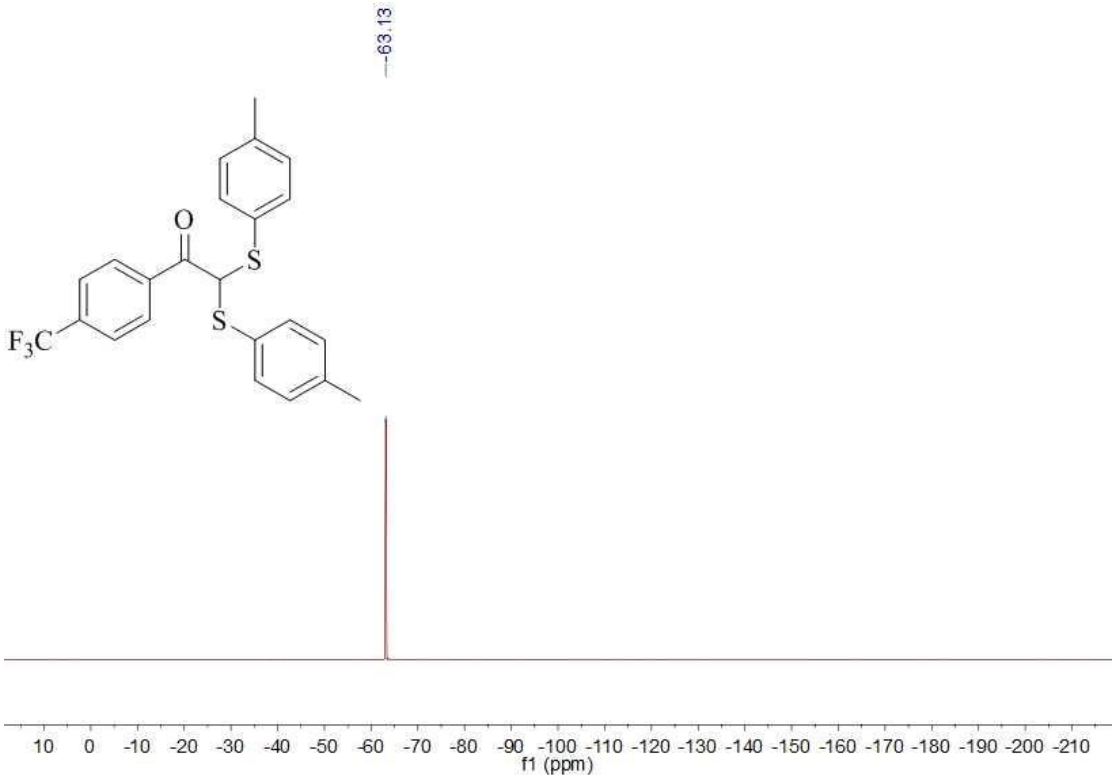
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5l**



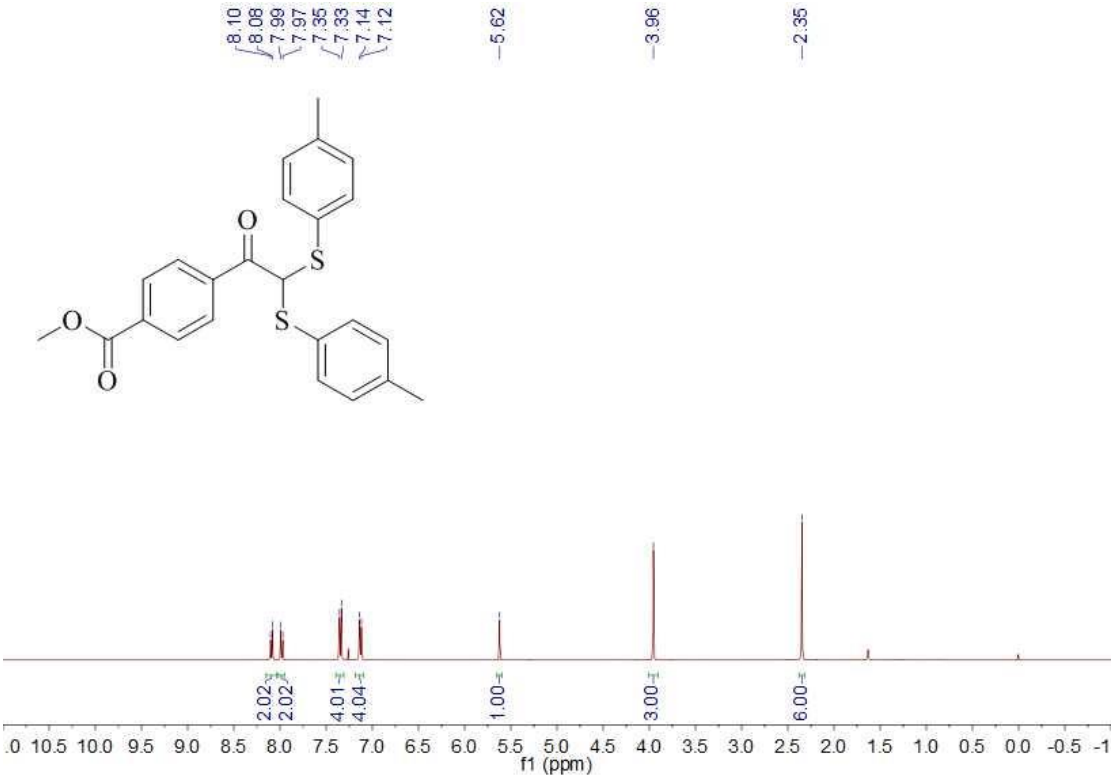
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5l**



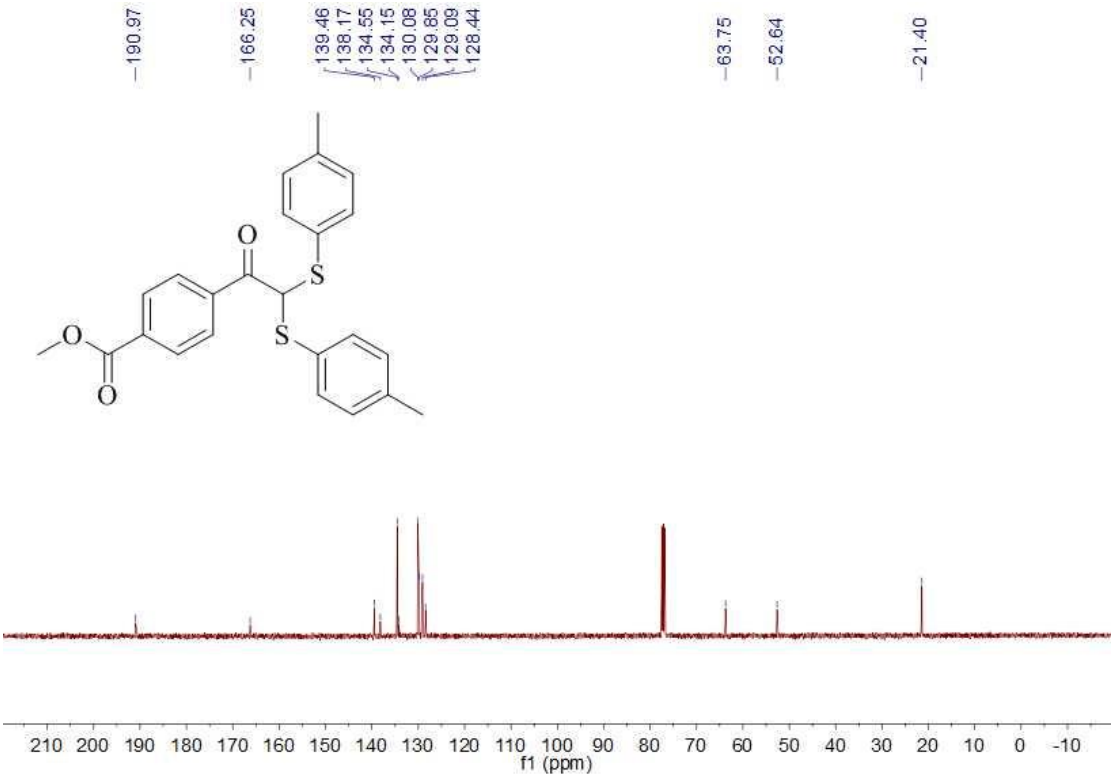
^{19}F NMR (376 MHz, $CDCl_3$) Spectra of **5l**



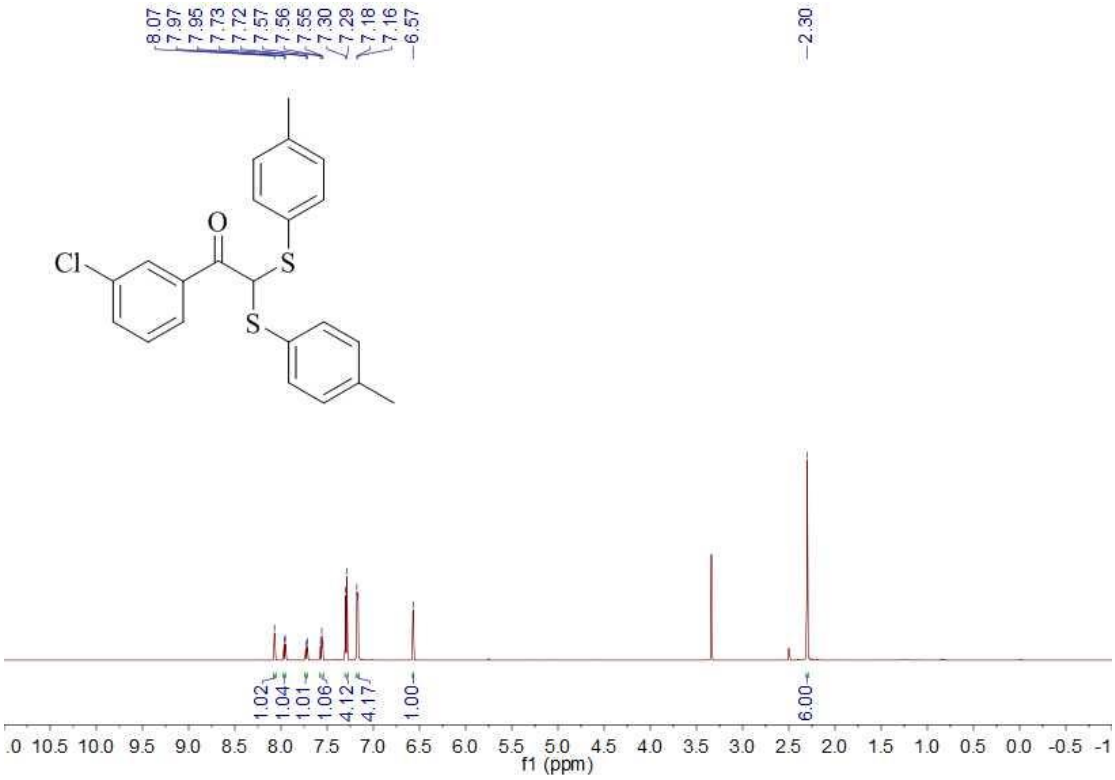
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5m**



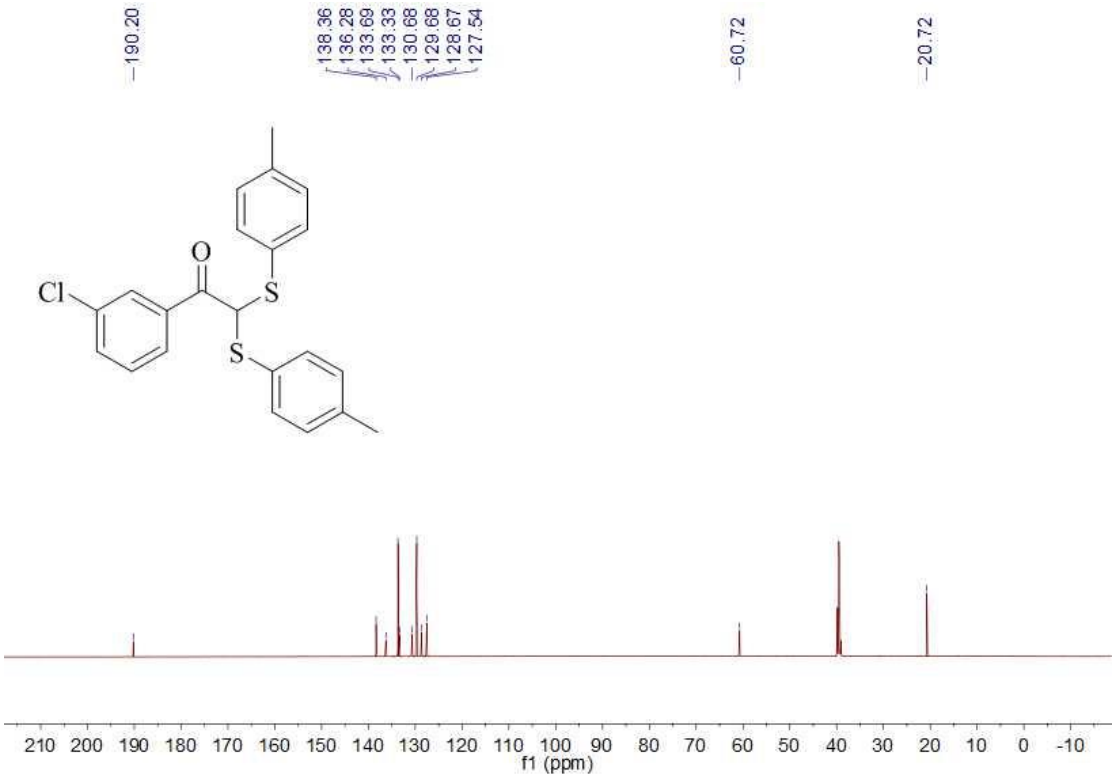
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5m**



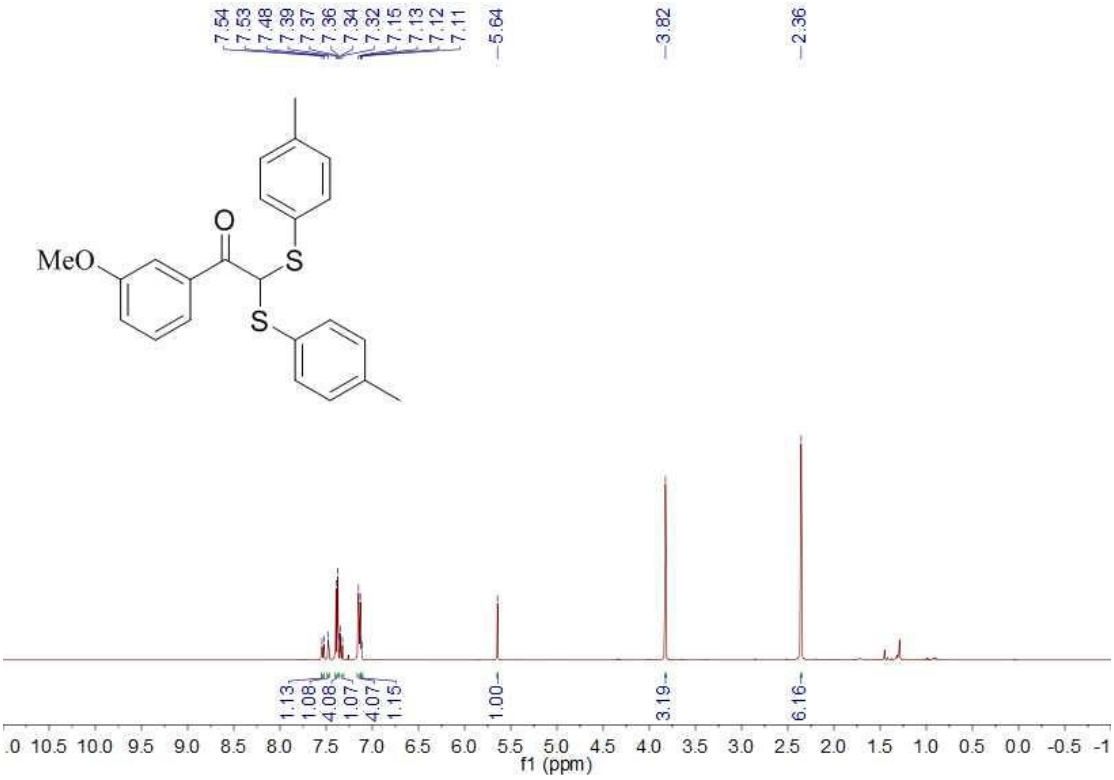
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **5n**



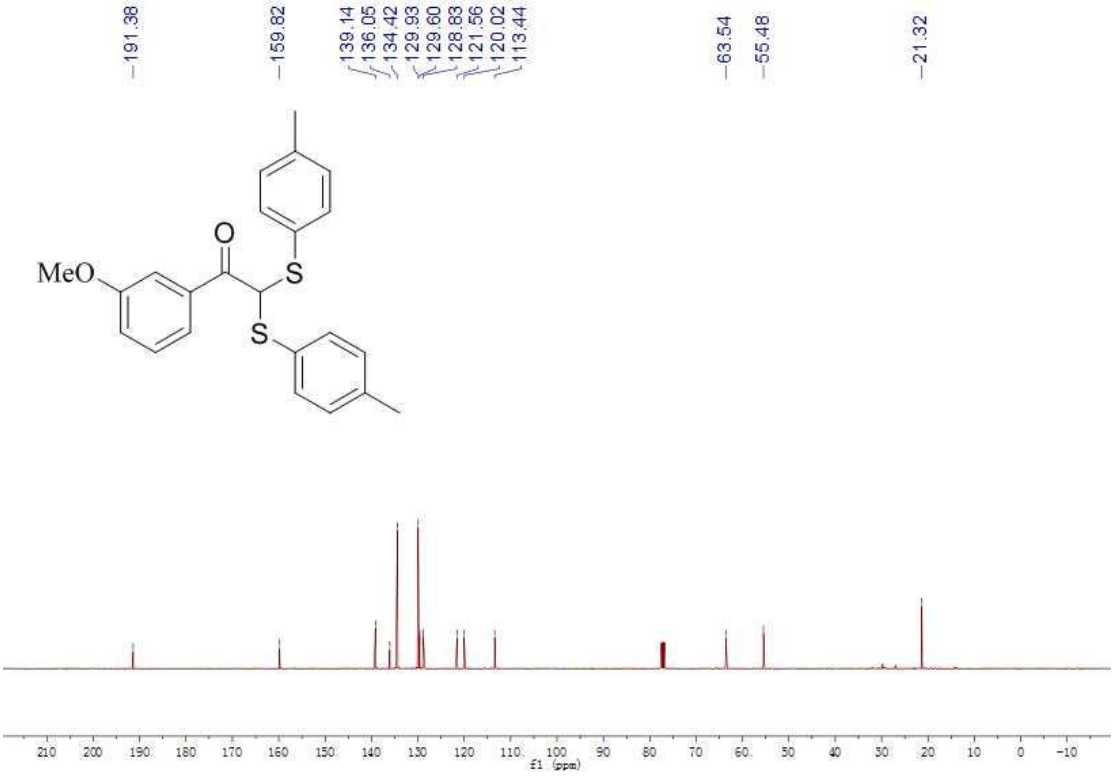
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **5n**



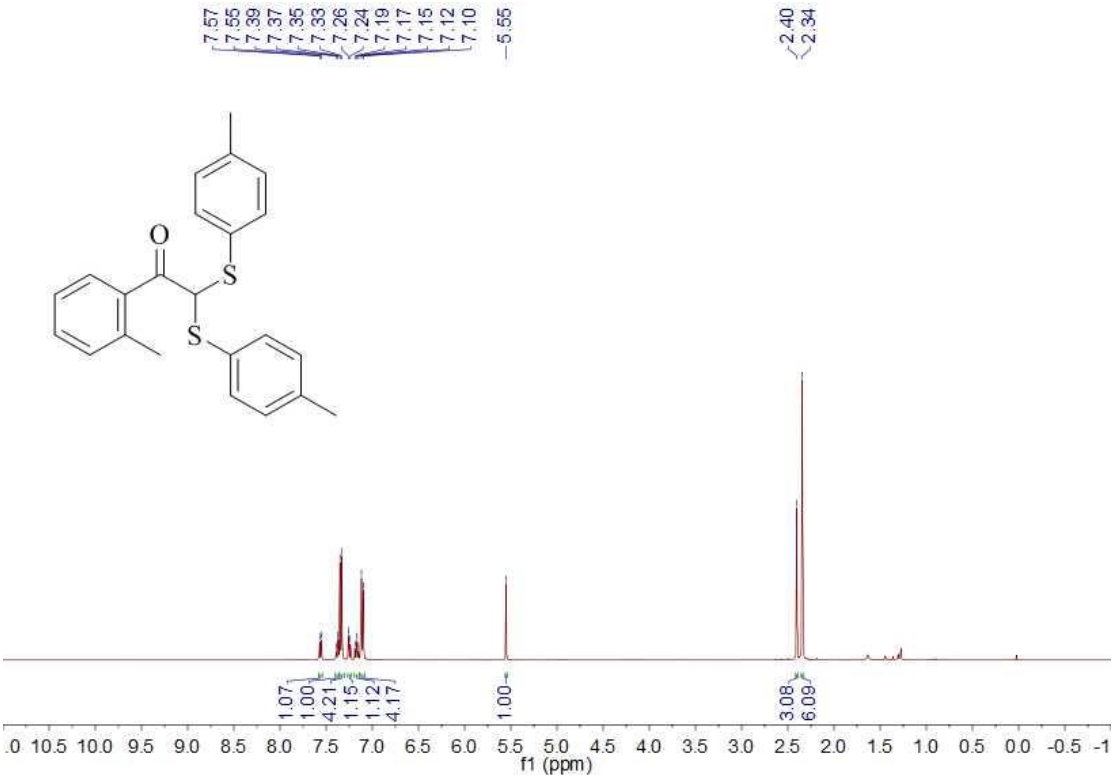
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5o**



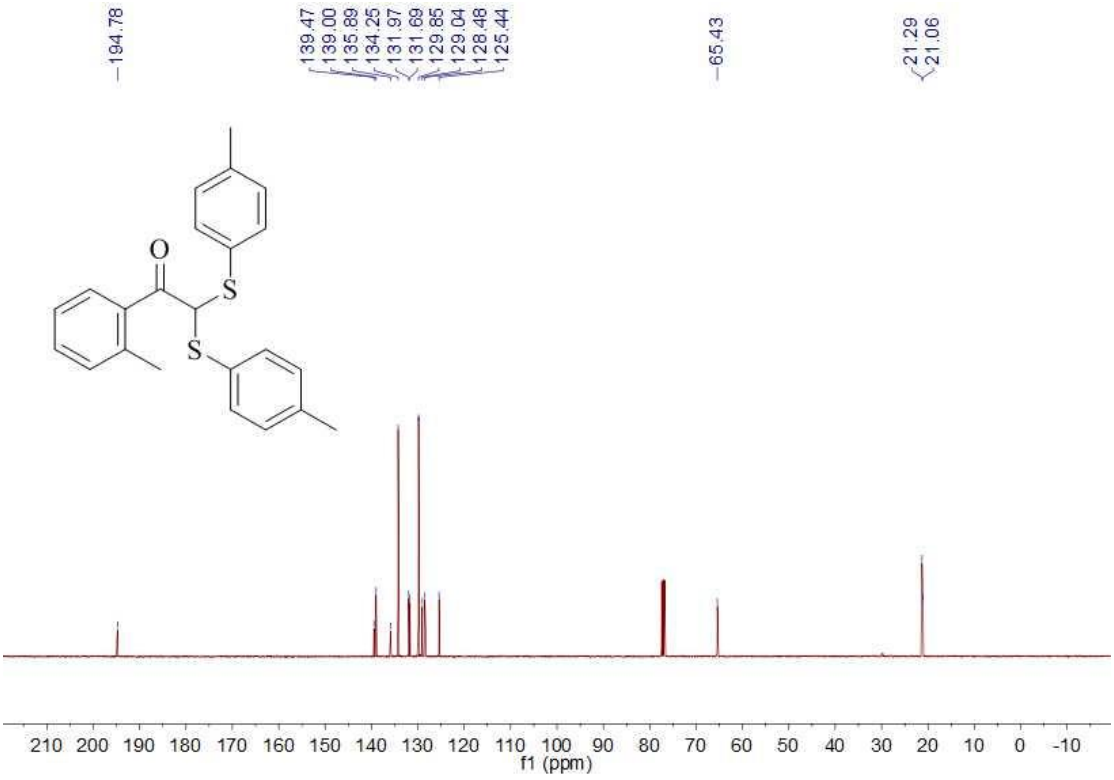
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5o**



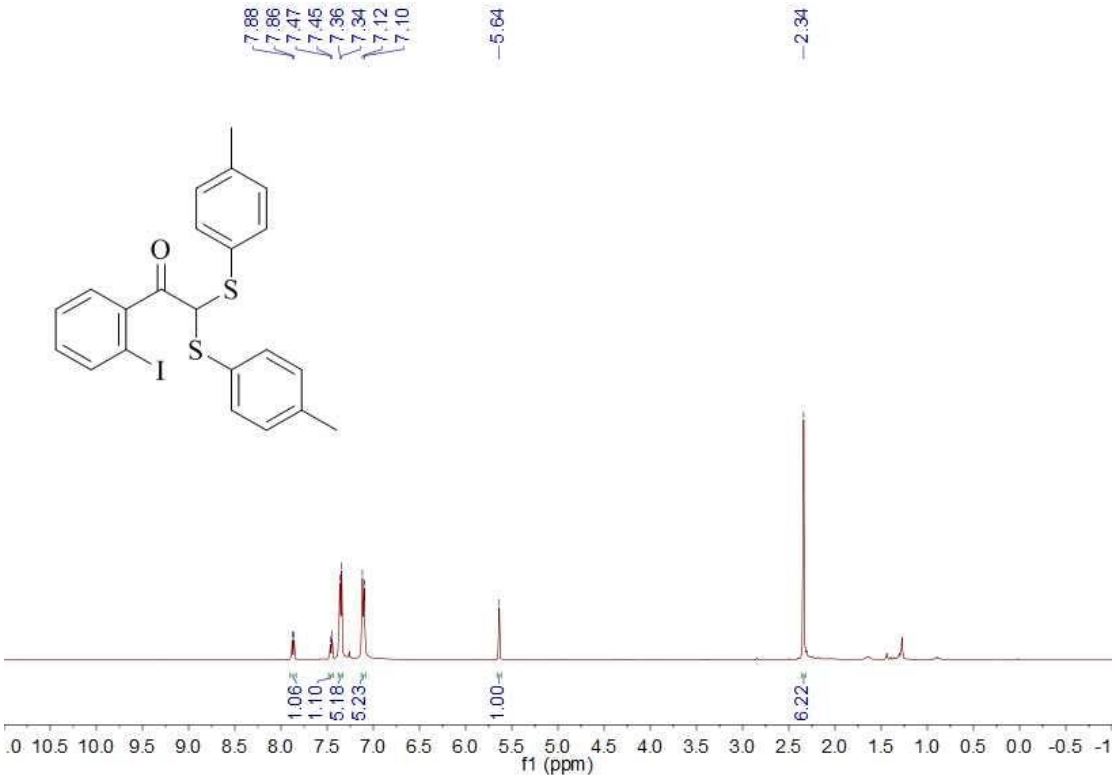
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5p**



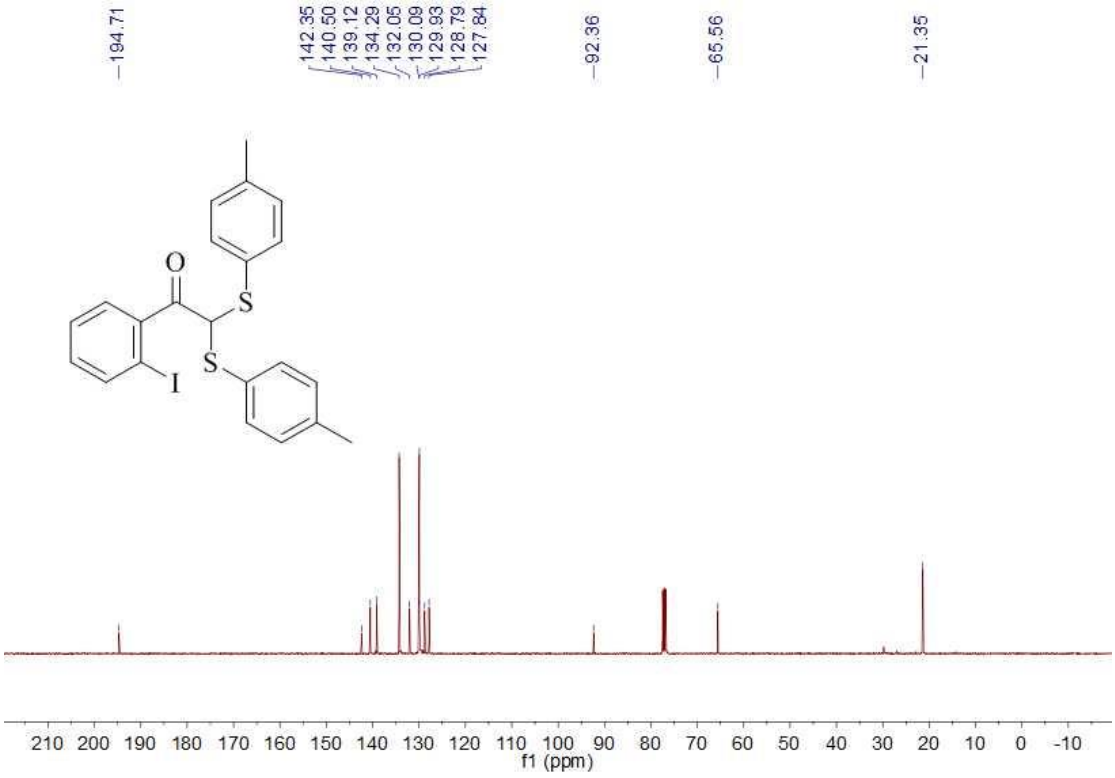
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5p**



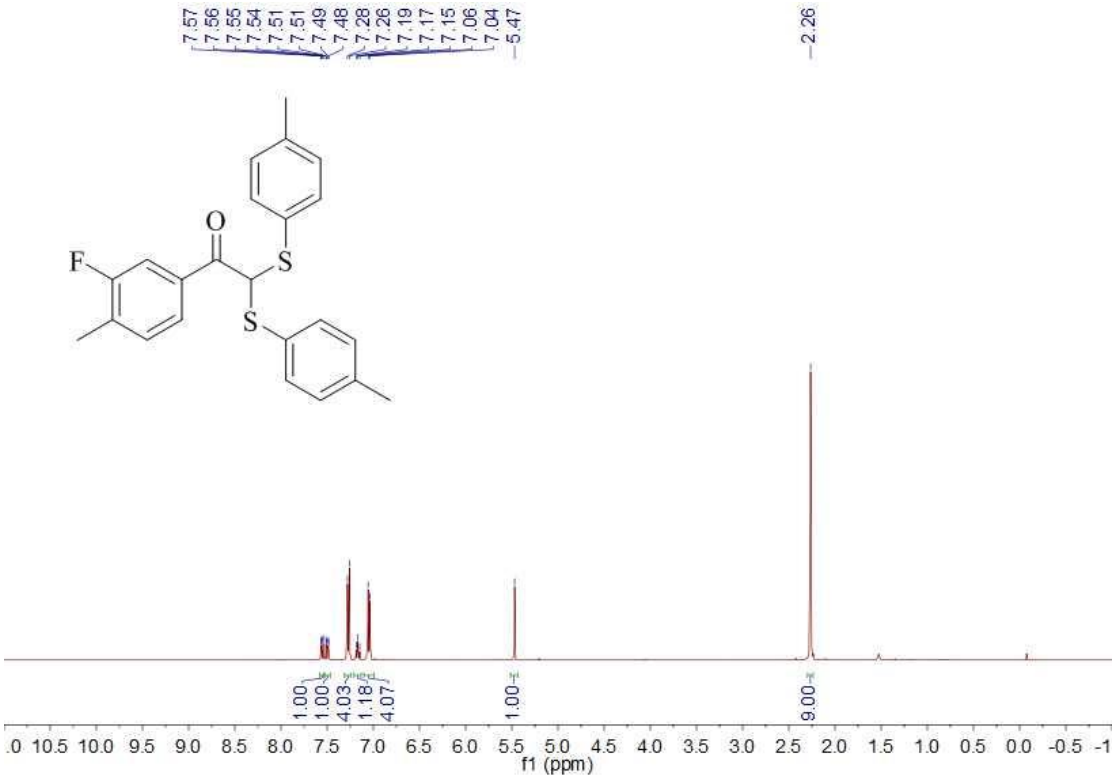
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5q**



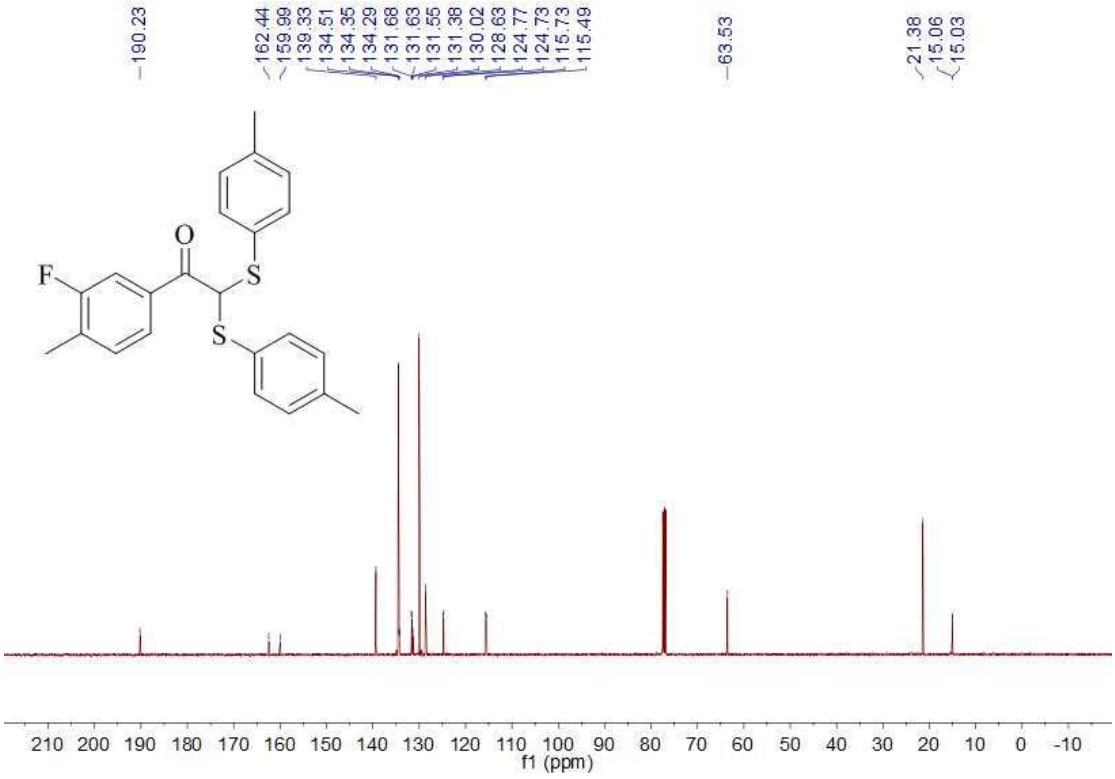
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5q**



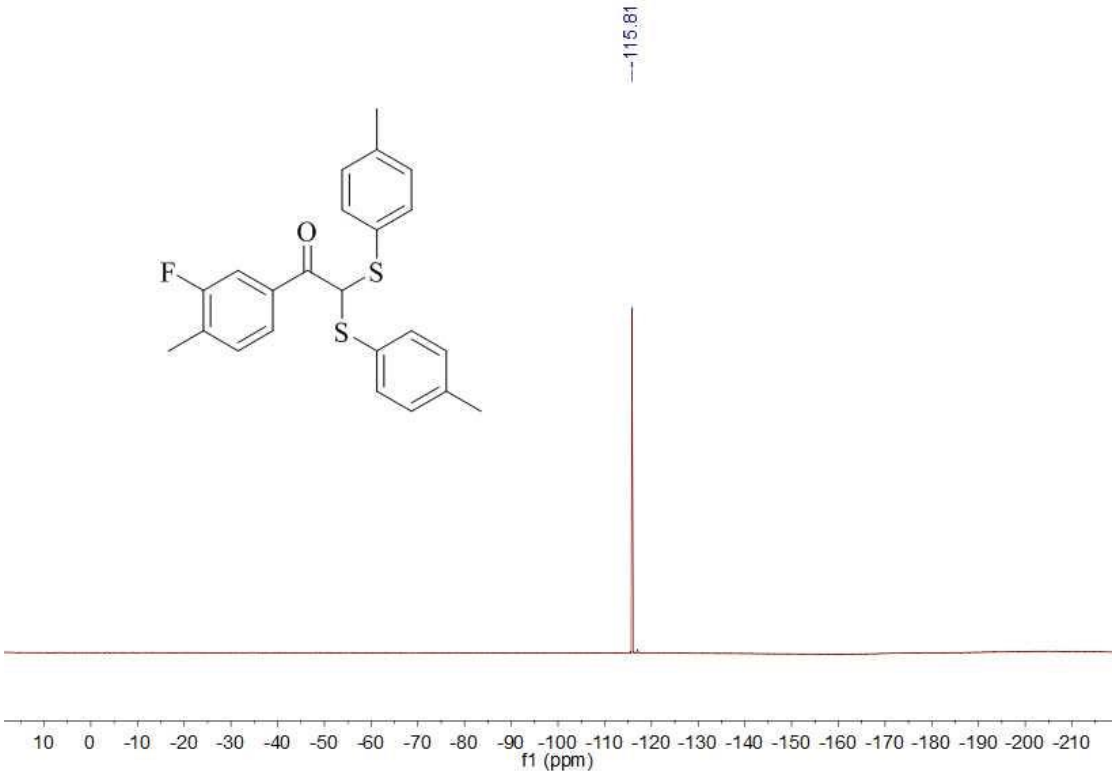
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5r**



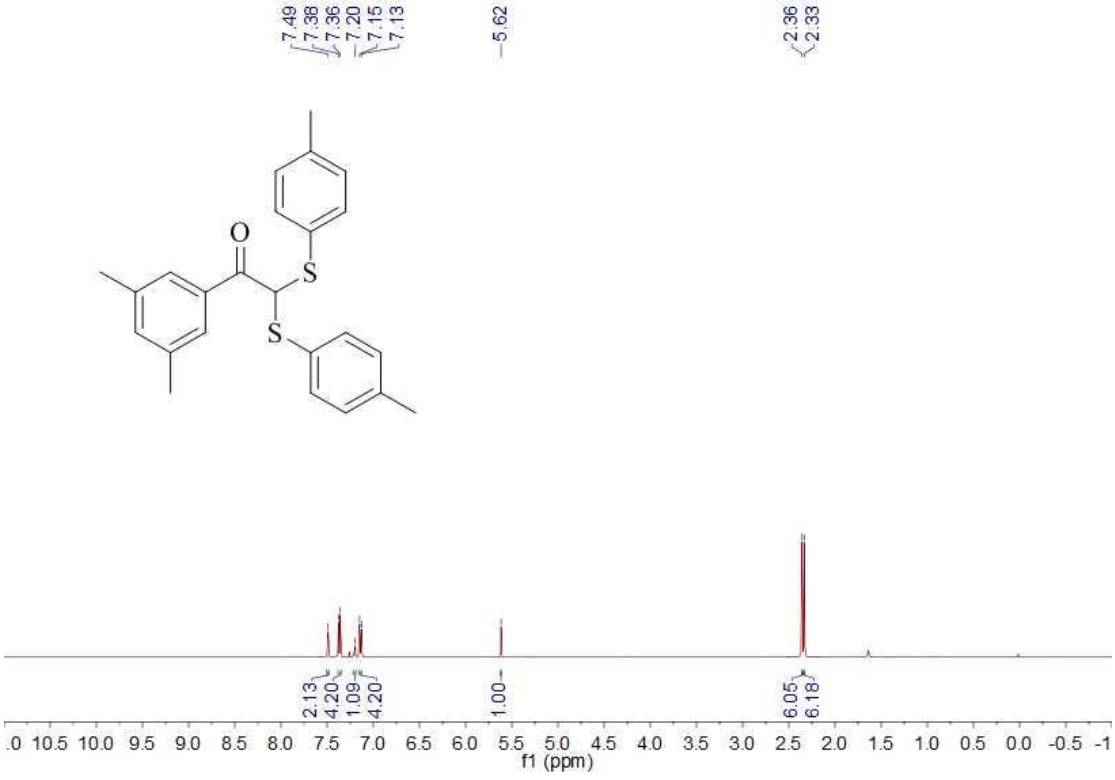
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5r**



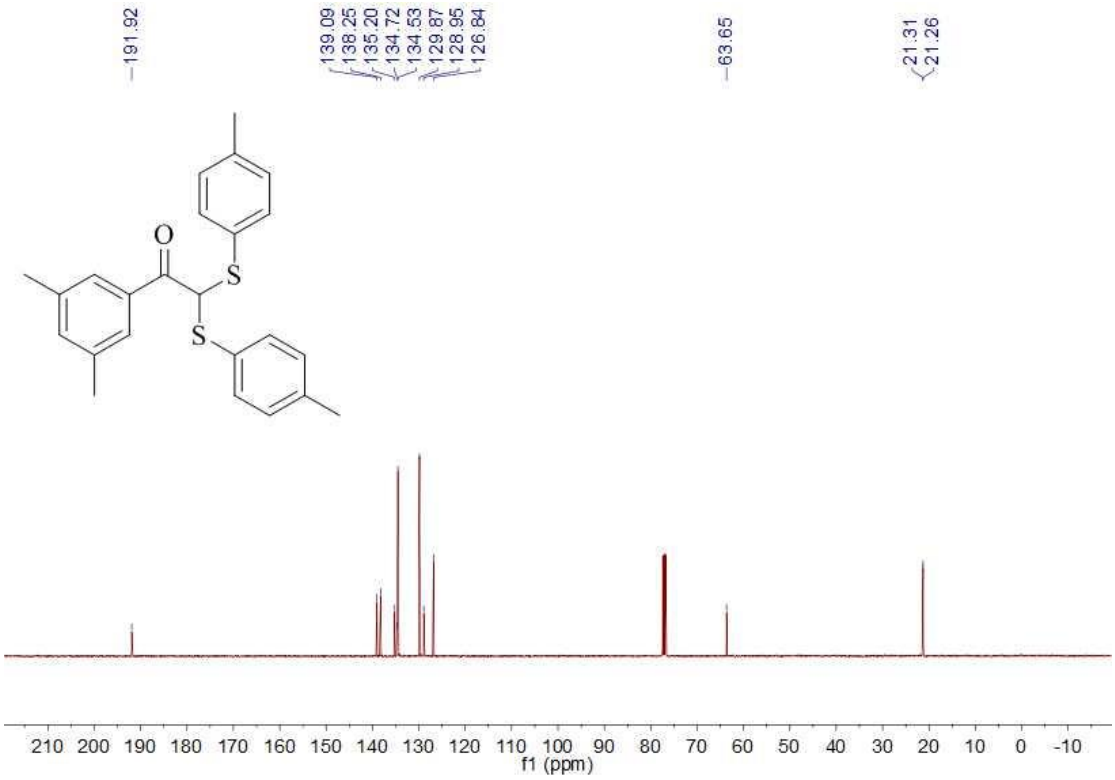
^{19}F NMR (376 MHz, $CDCl_3$) Spectra of **5r**



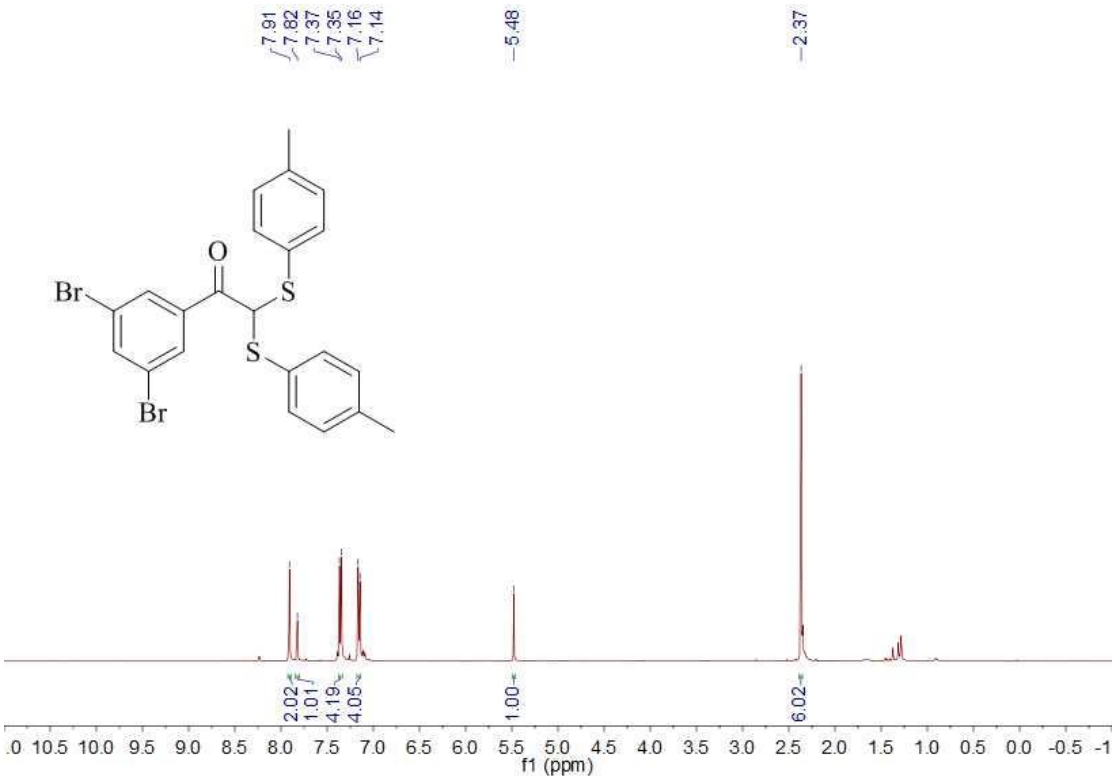
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5s**



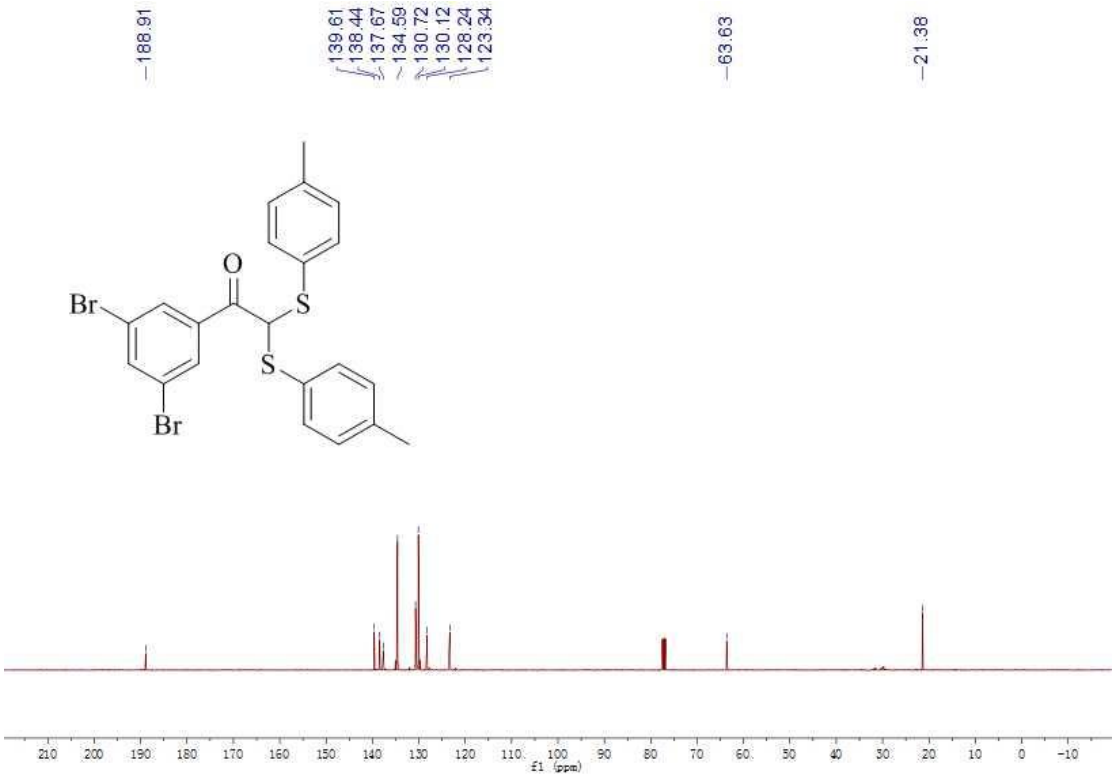
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5s**



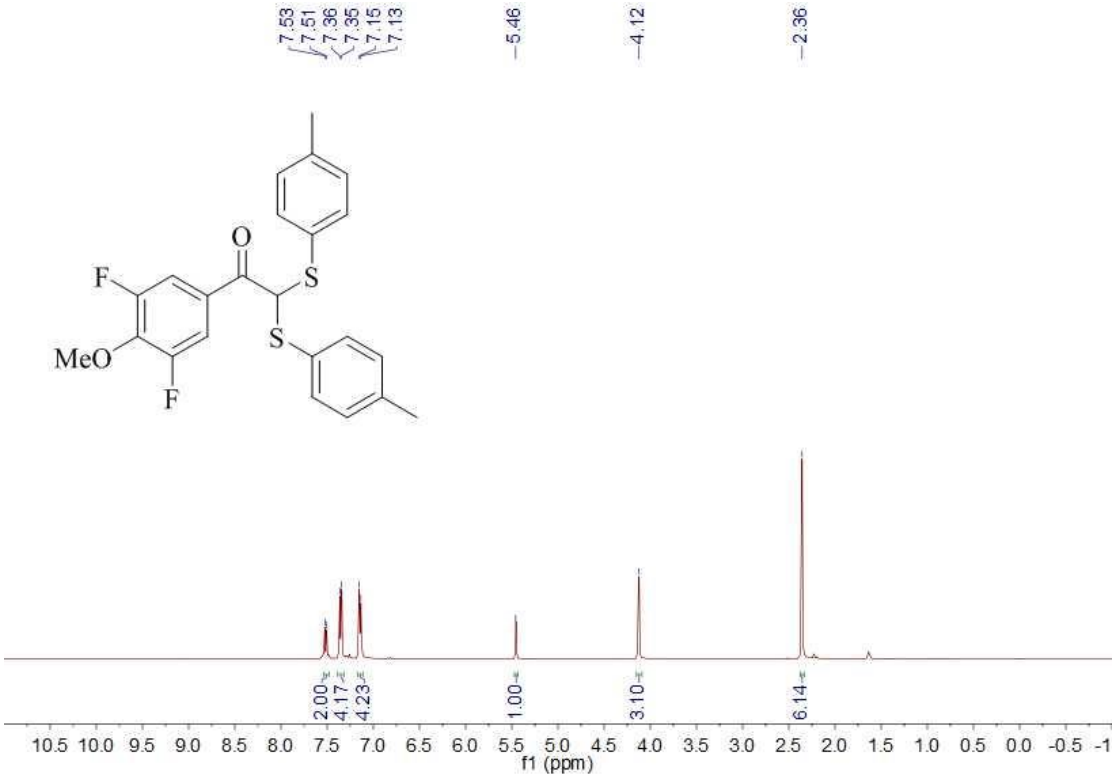
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5t**



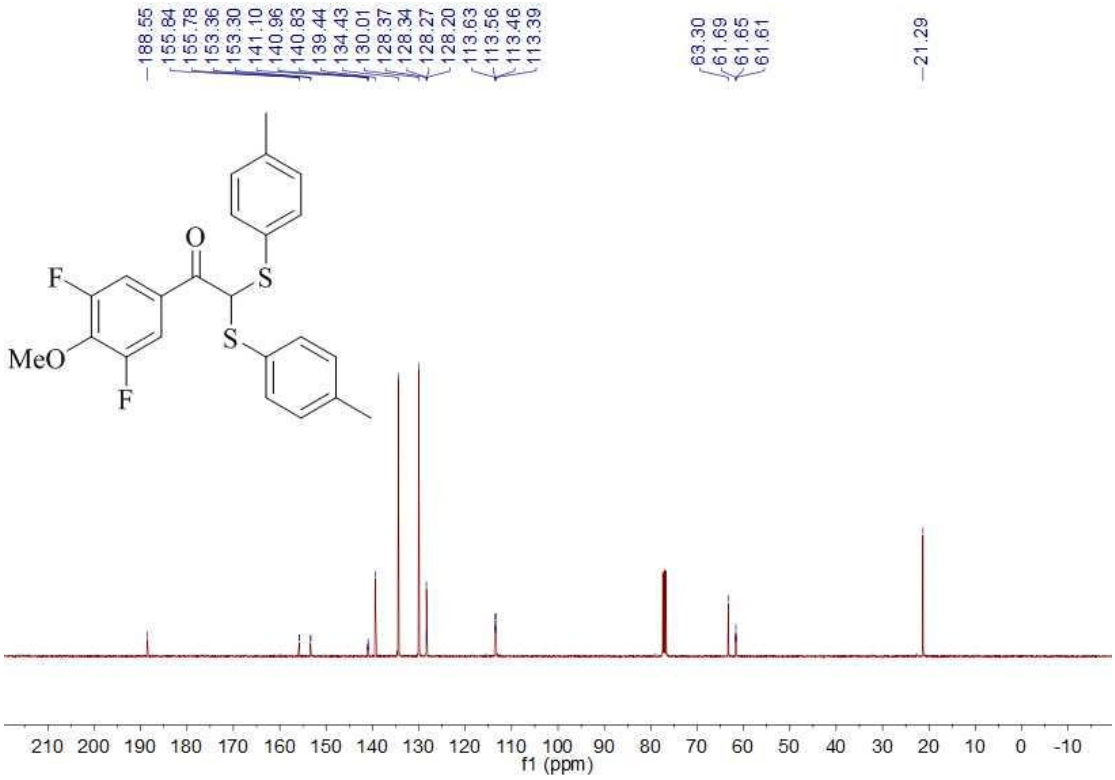
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5t**



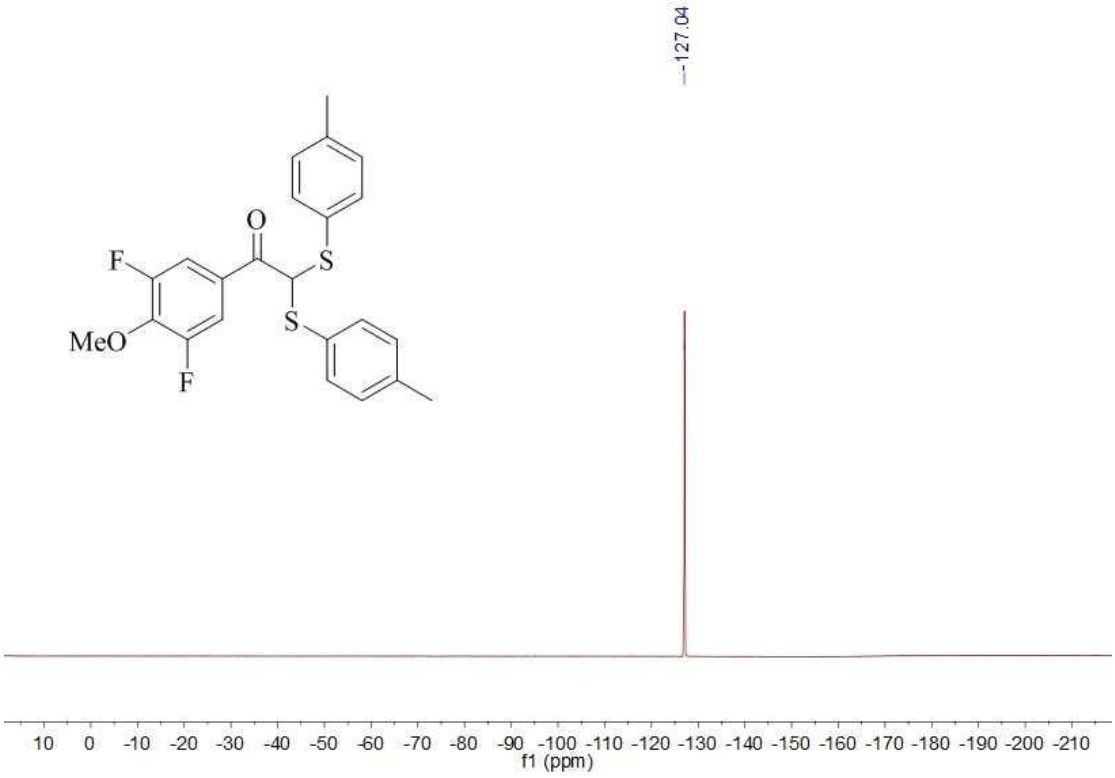
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5u**



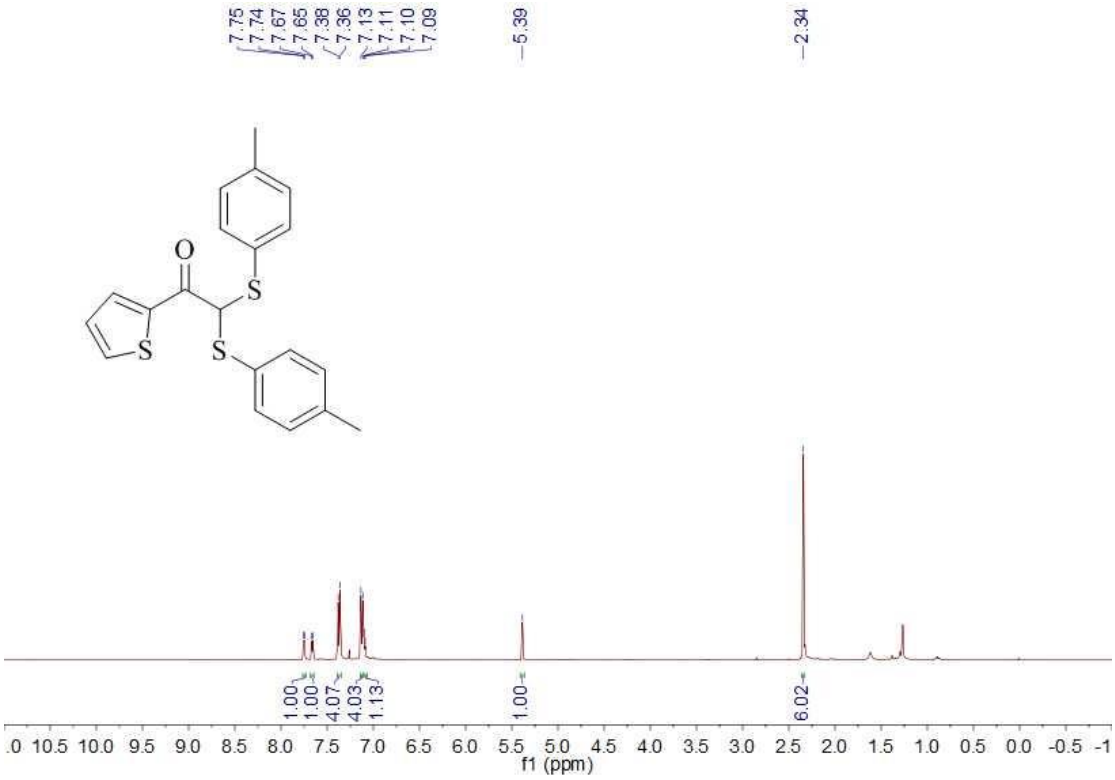
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5u**



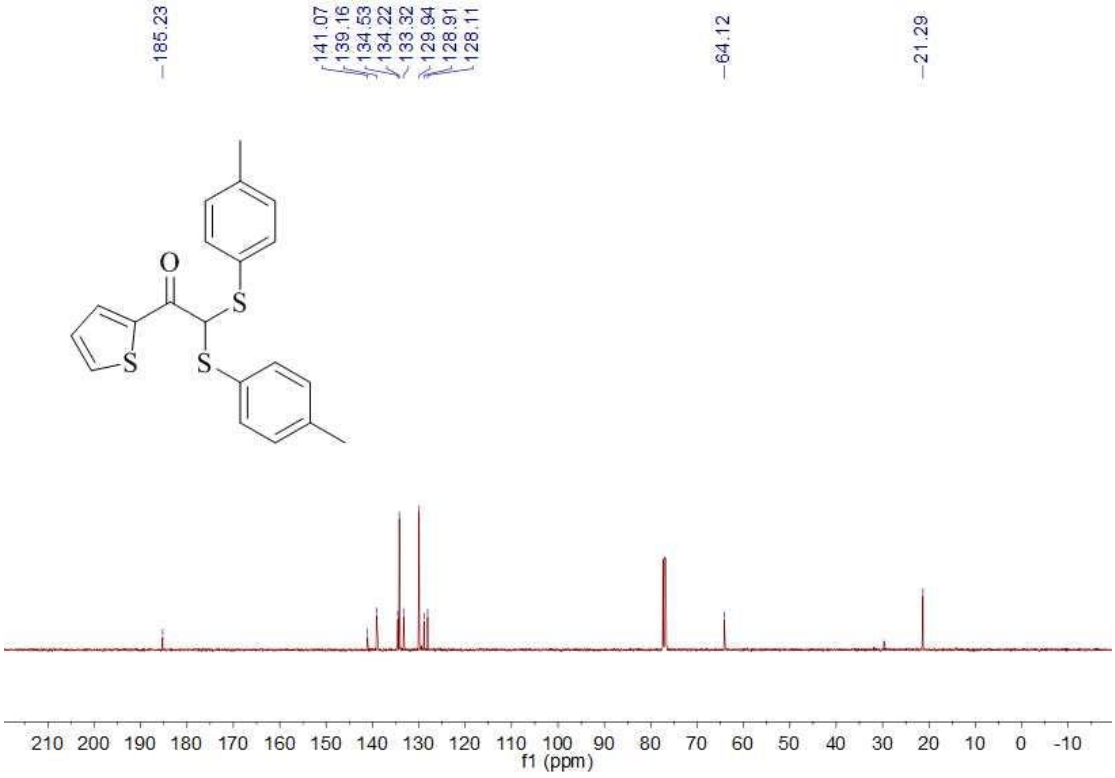
^{19}F NMR (376 MHz, $CDCl_3$) Spectra of **5u**



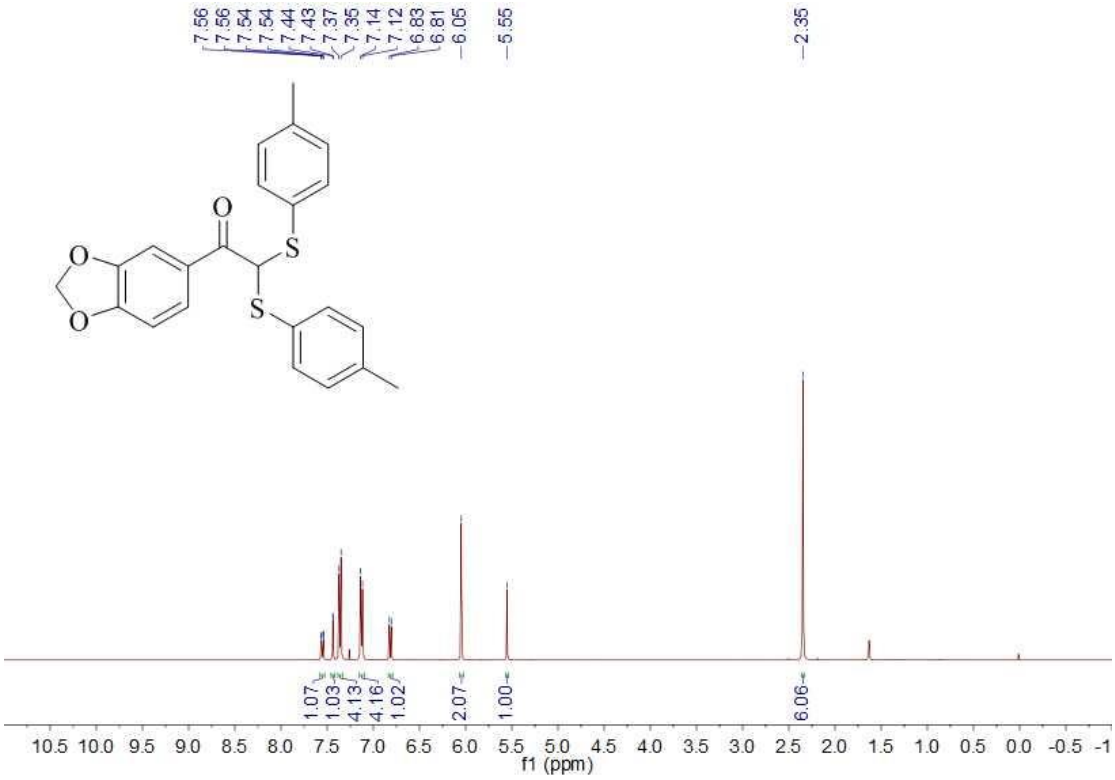
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5v**



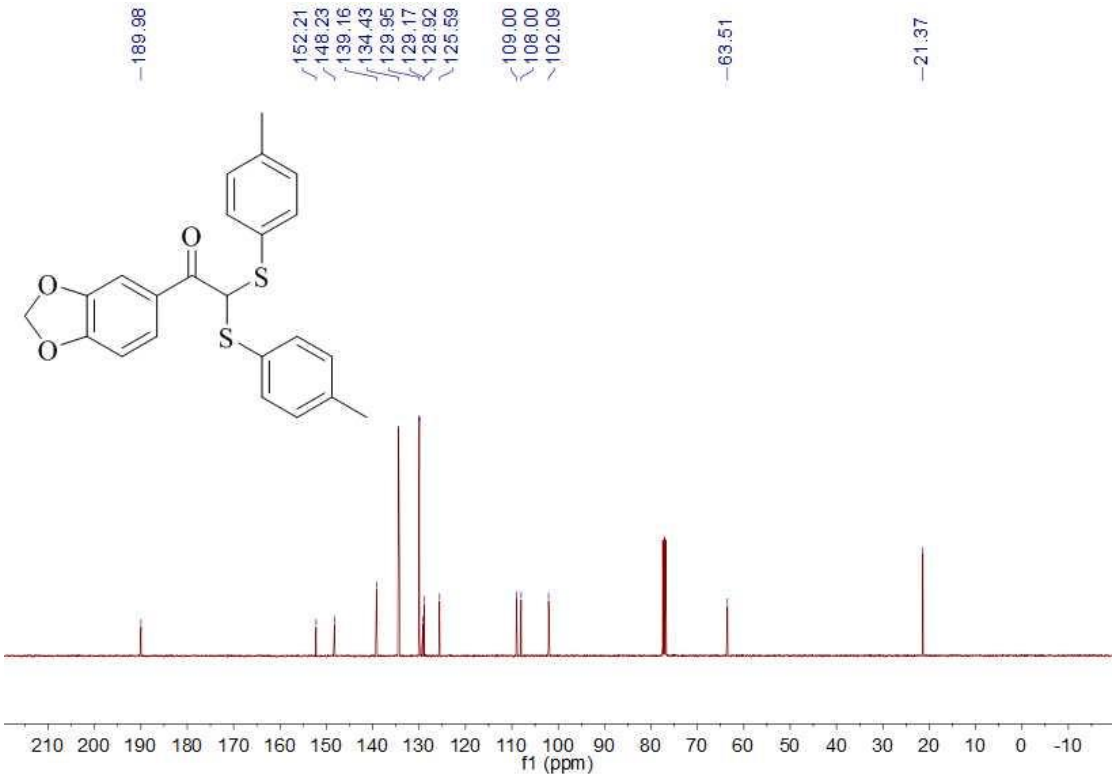
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5v**



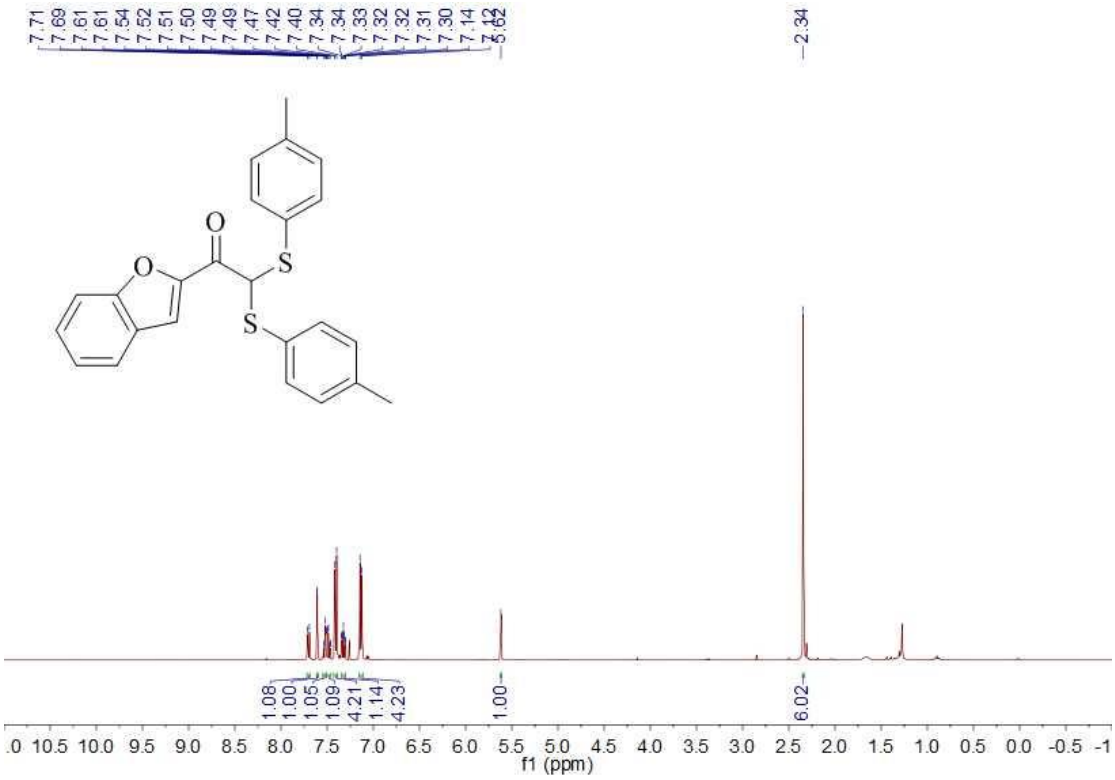
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5w**



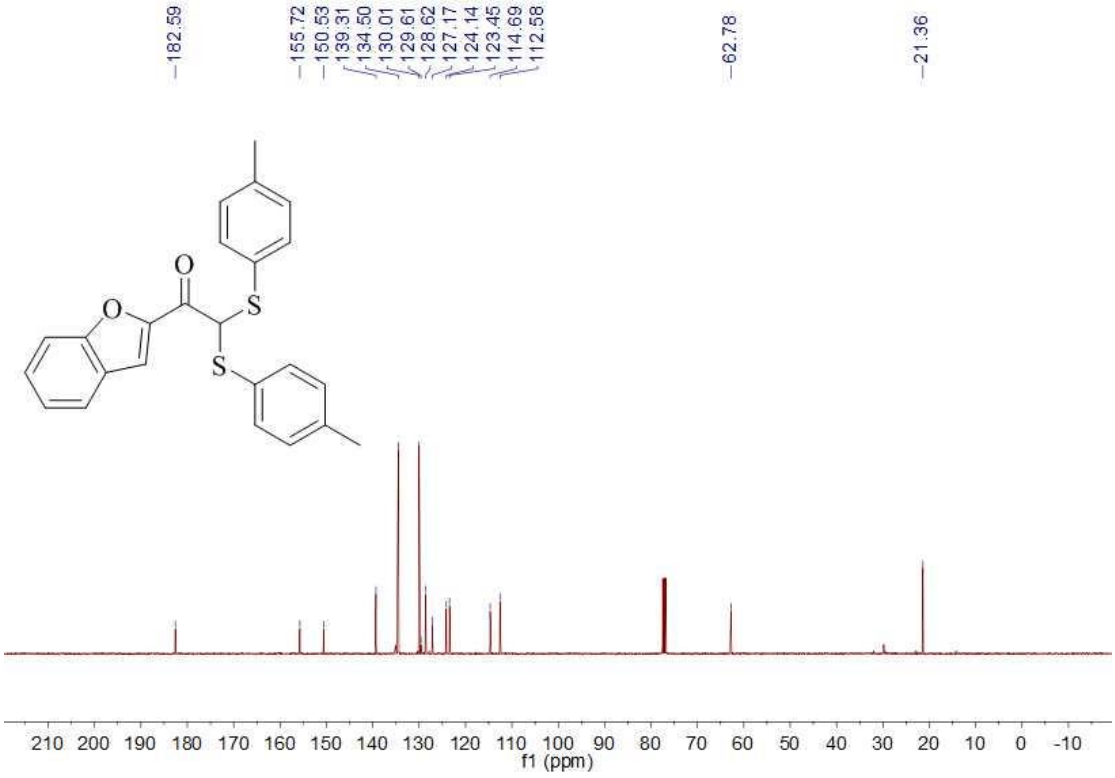
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5w**



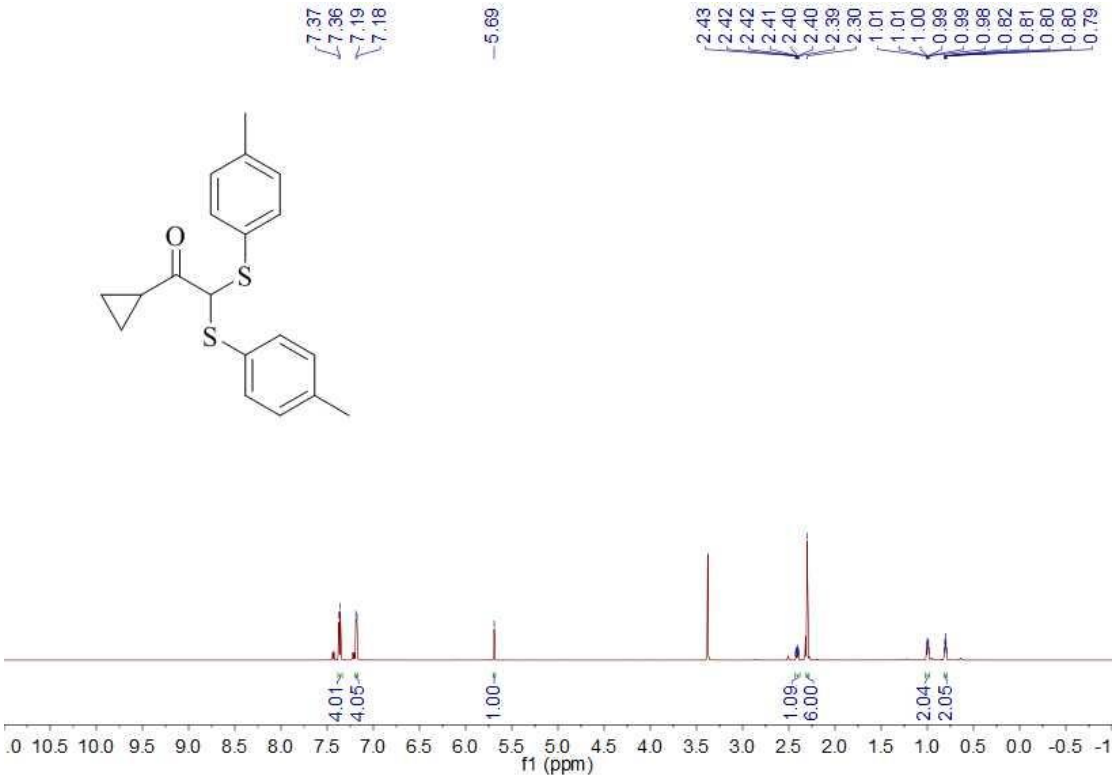
^{1}H NMR (400 MHz, $CDCl_3$) Spectra of **5x**



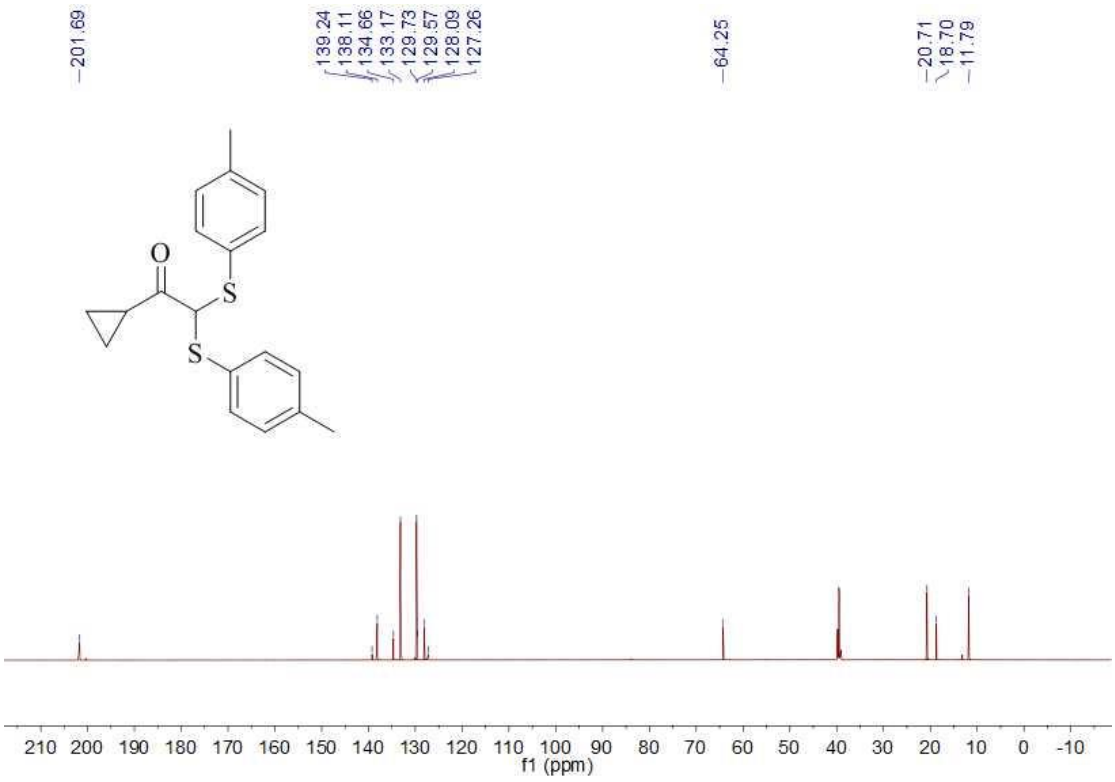
^{13}C NMR (101 MHz, $CDCl_3$) Spectra of **5x**



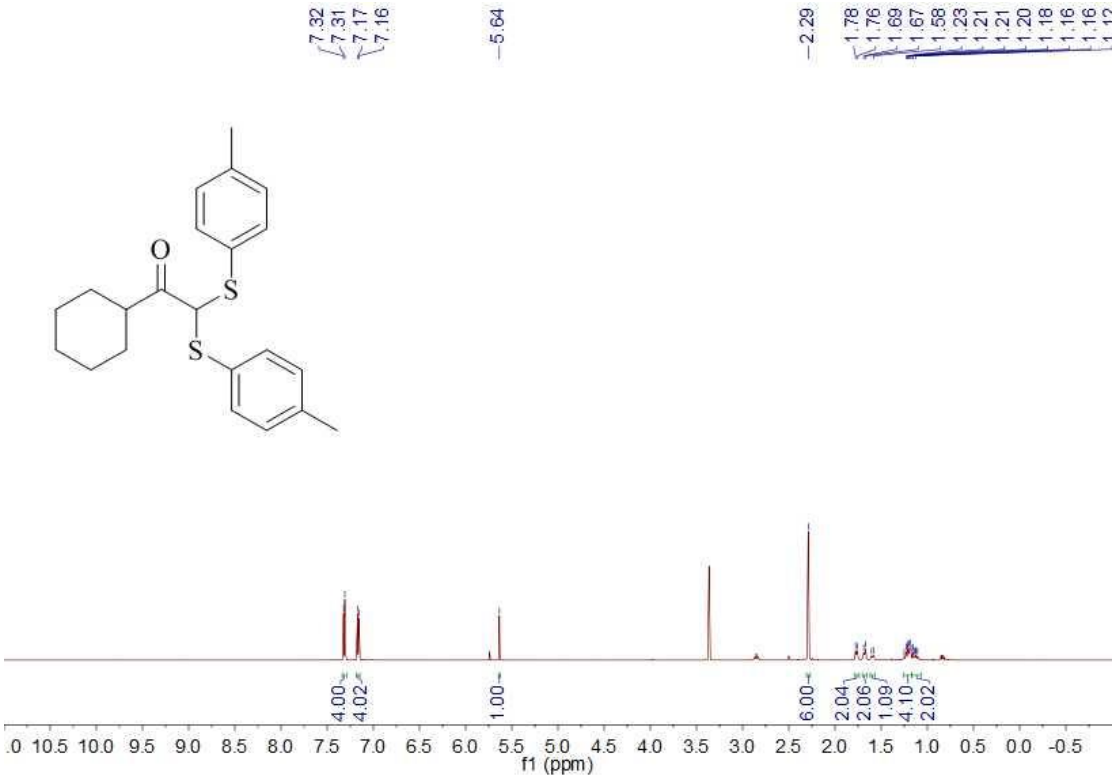
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **5y**



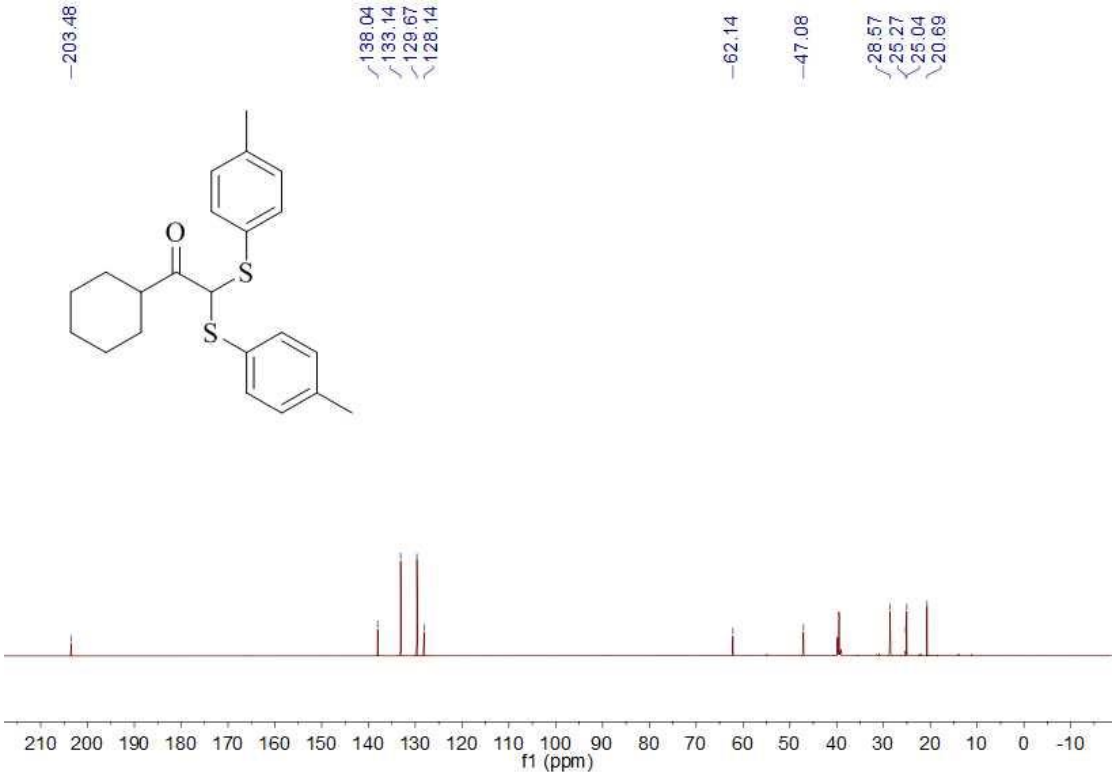
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **5y**



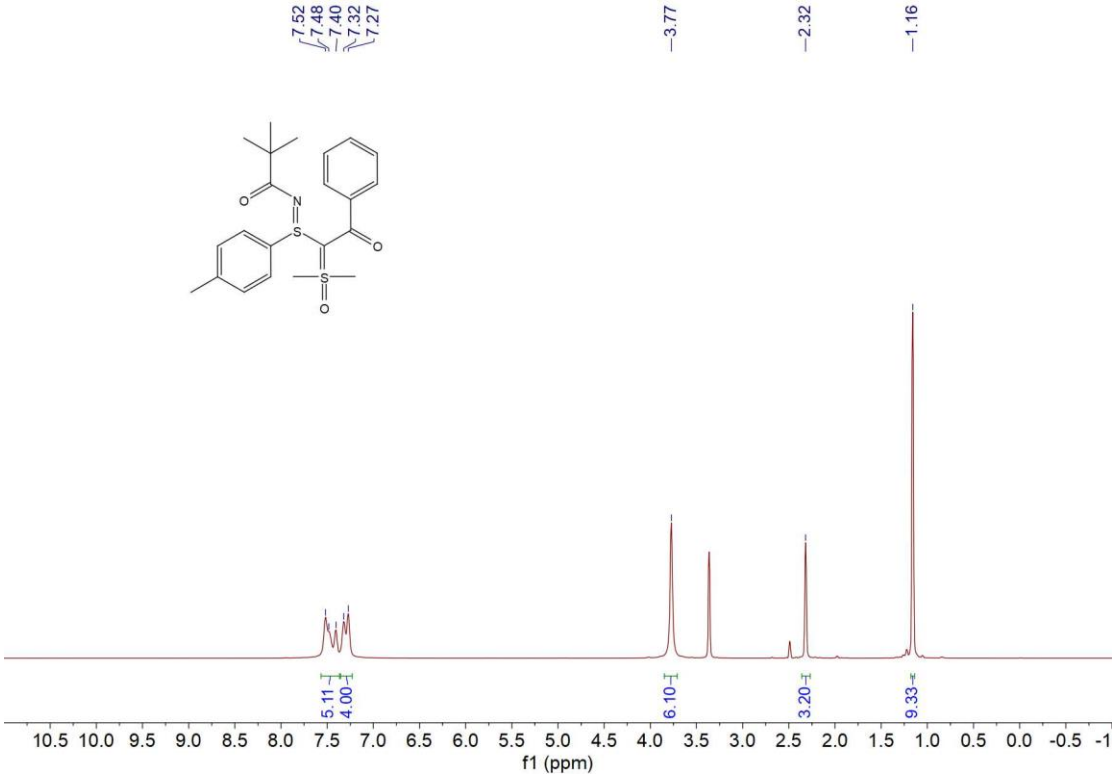
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **5z**



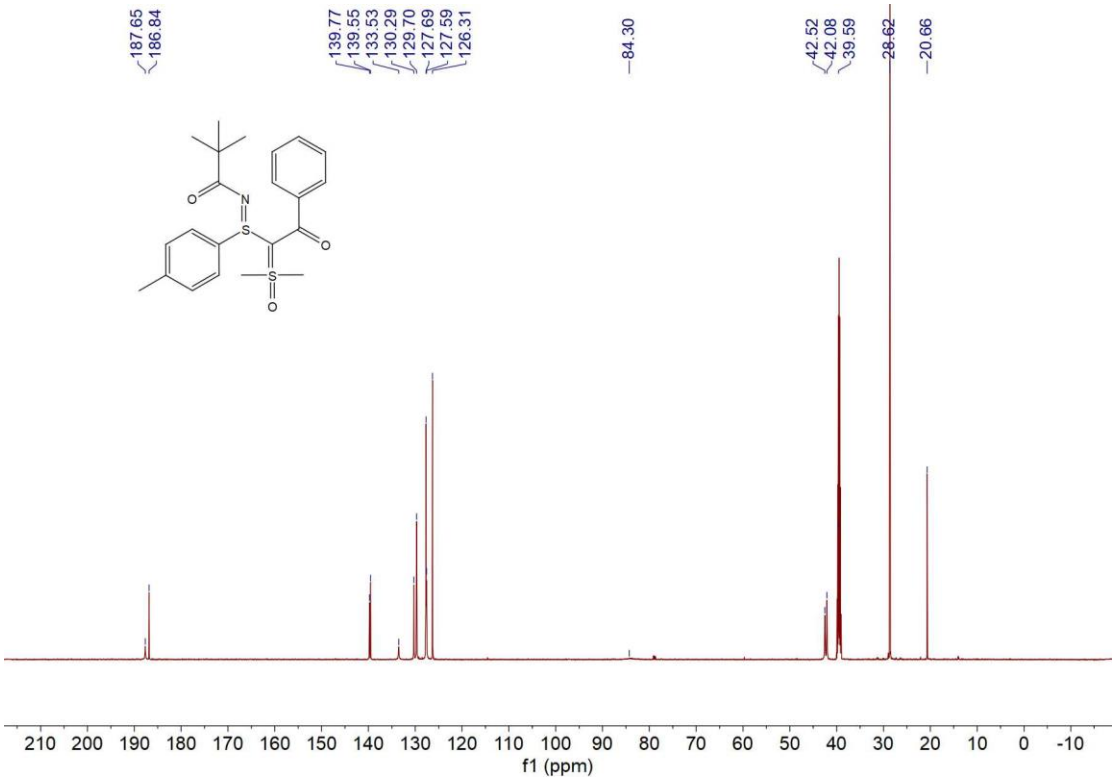
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **5z**



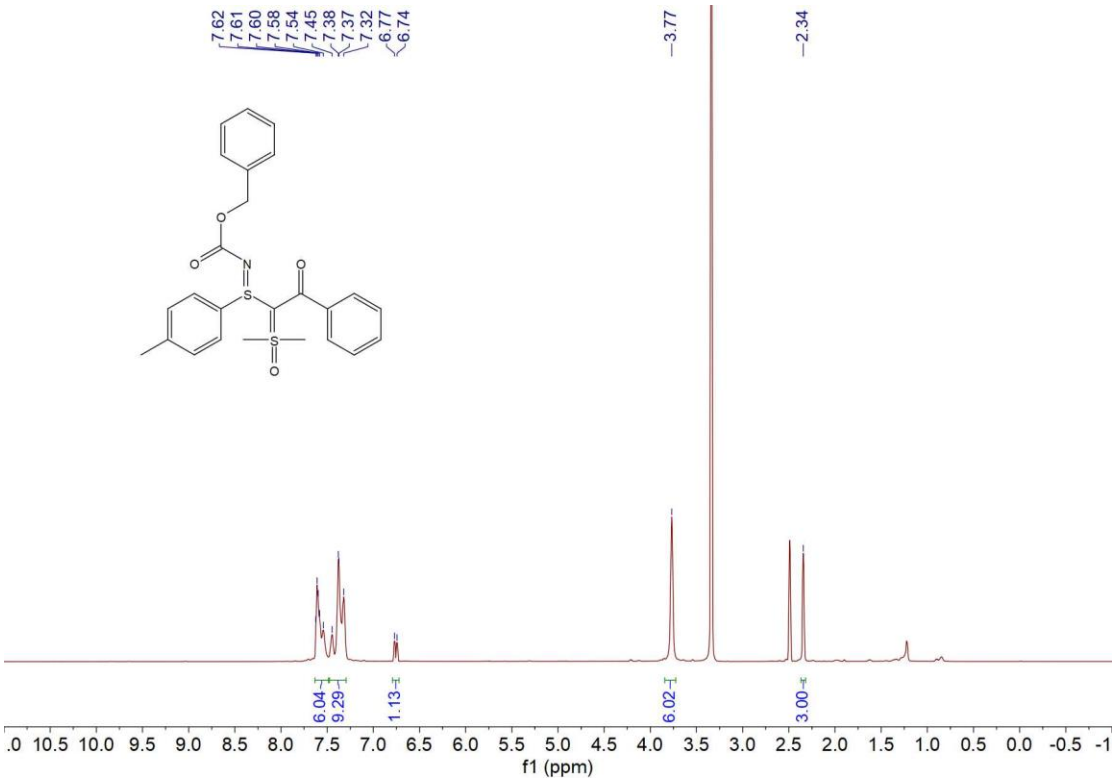
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8a**



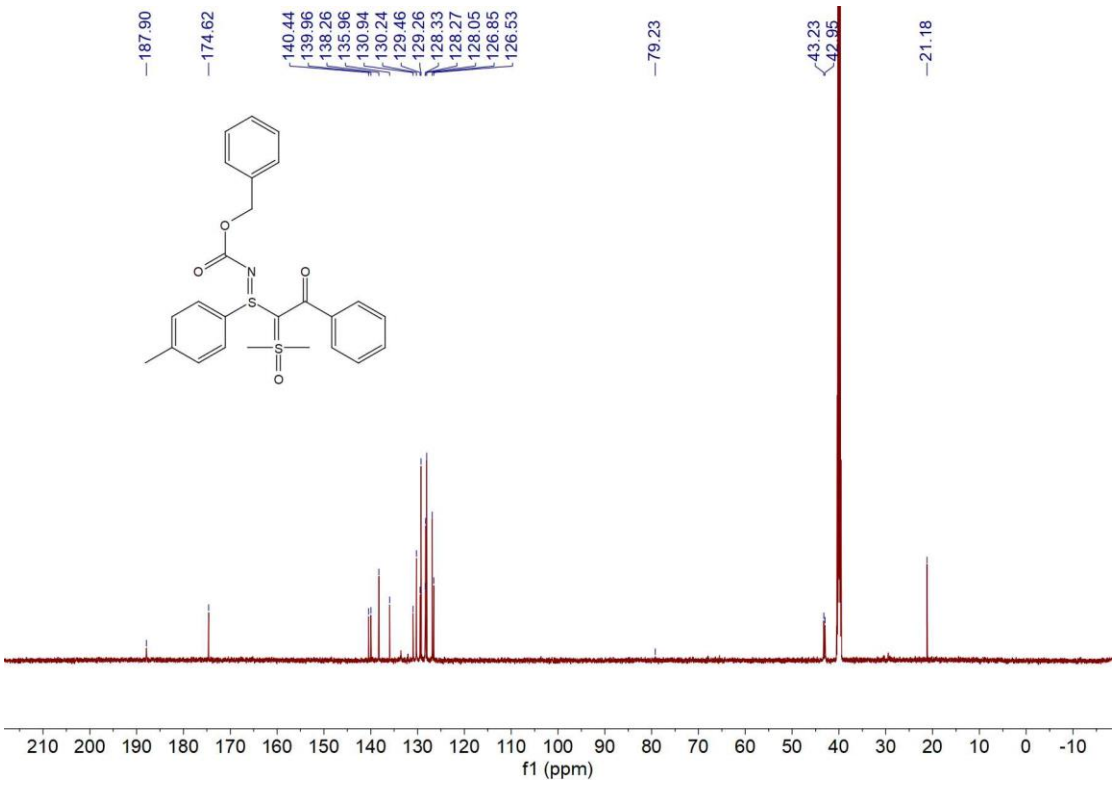
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8a**



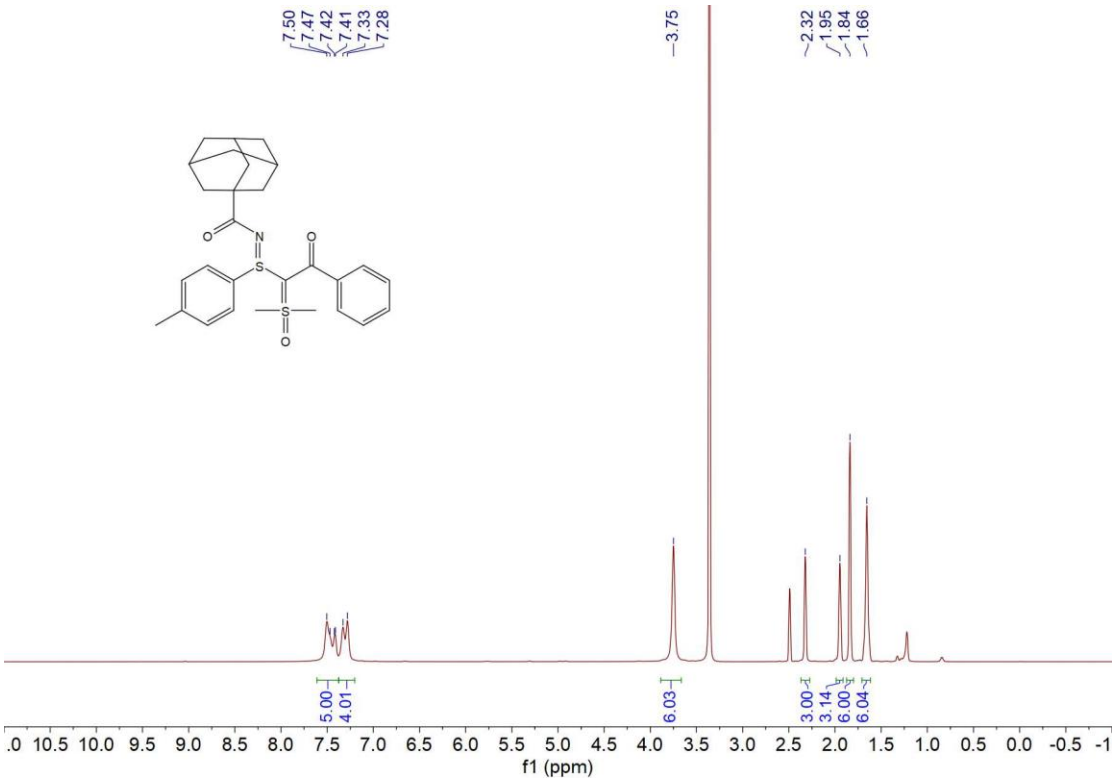
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8b**



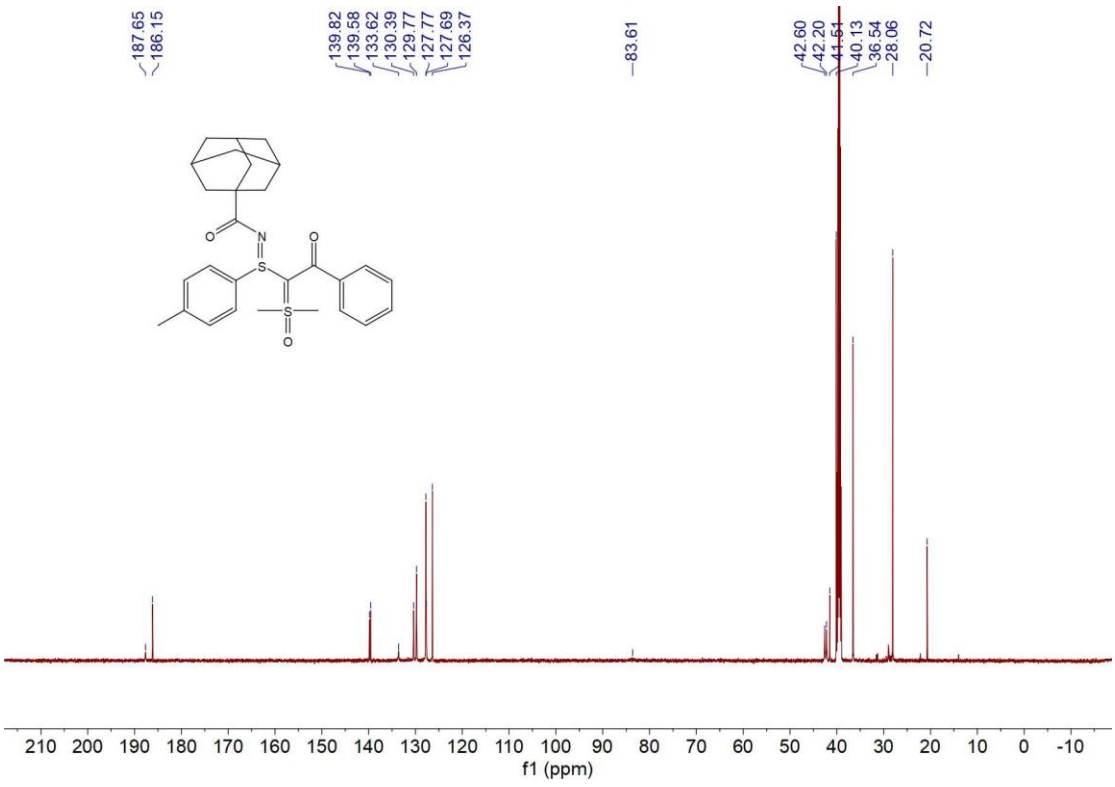
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8b**



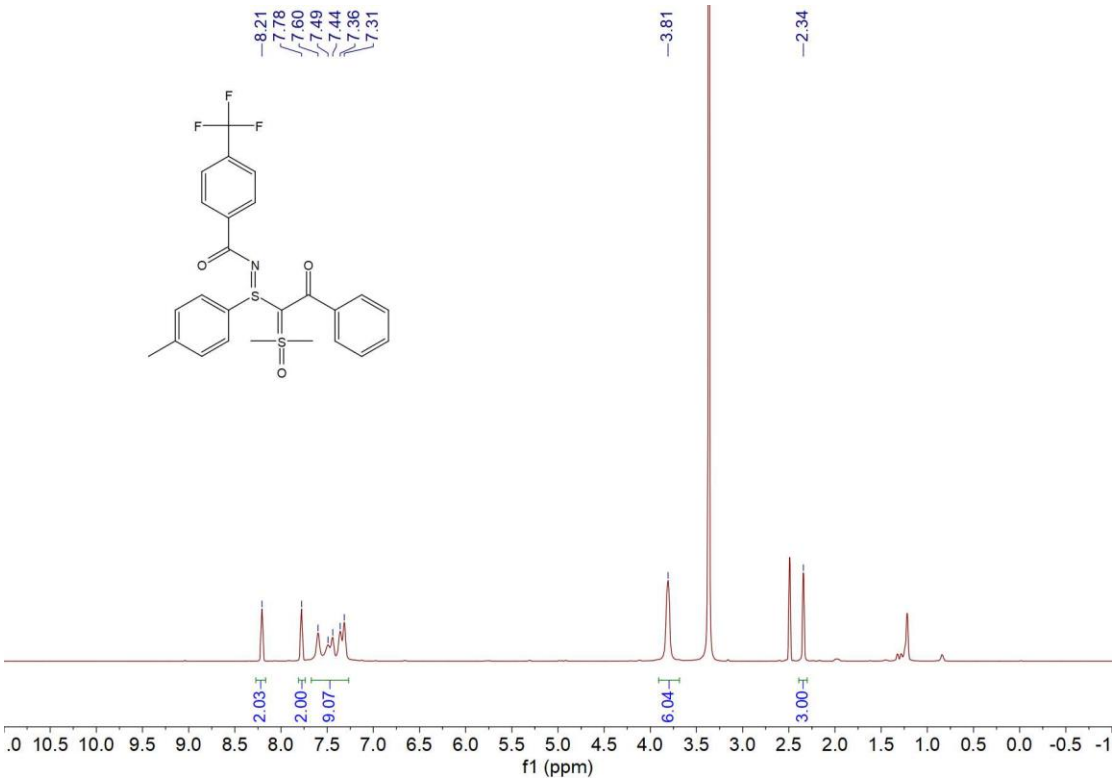
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8c**



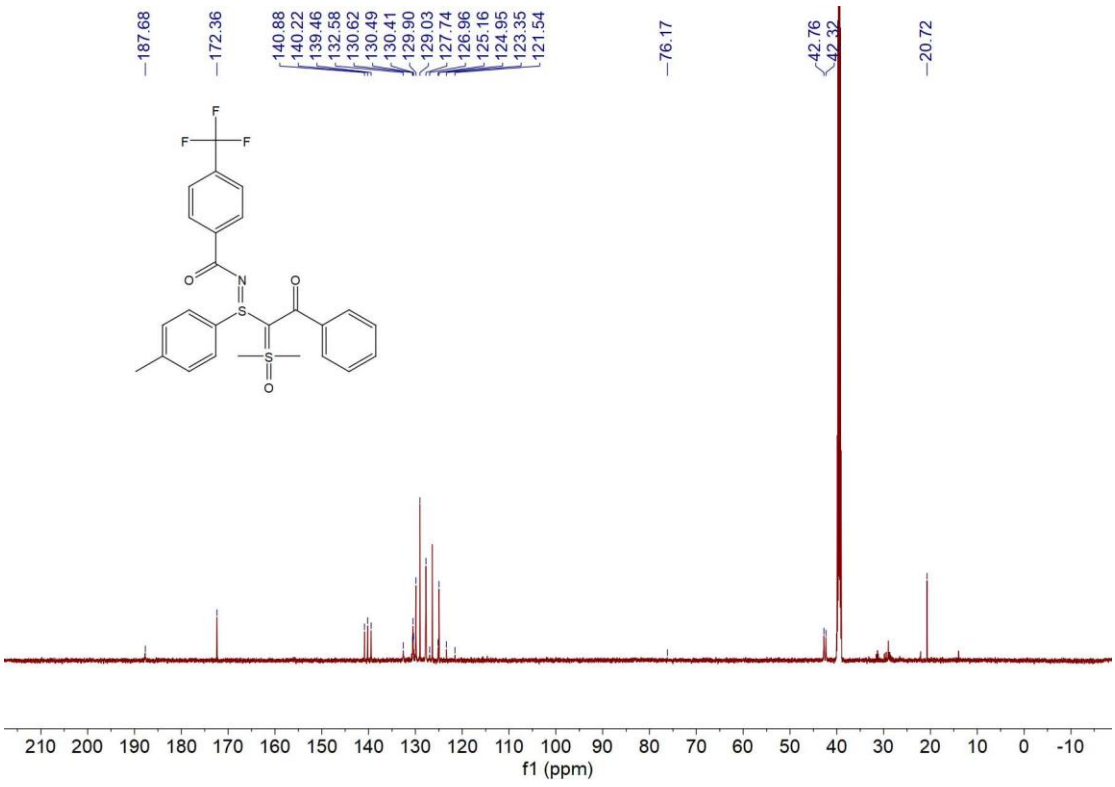
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8c**



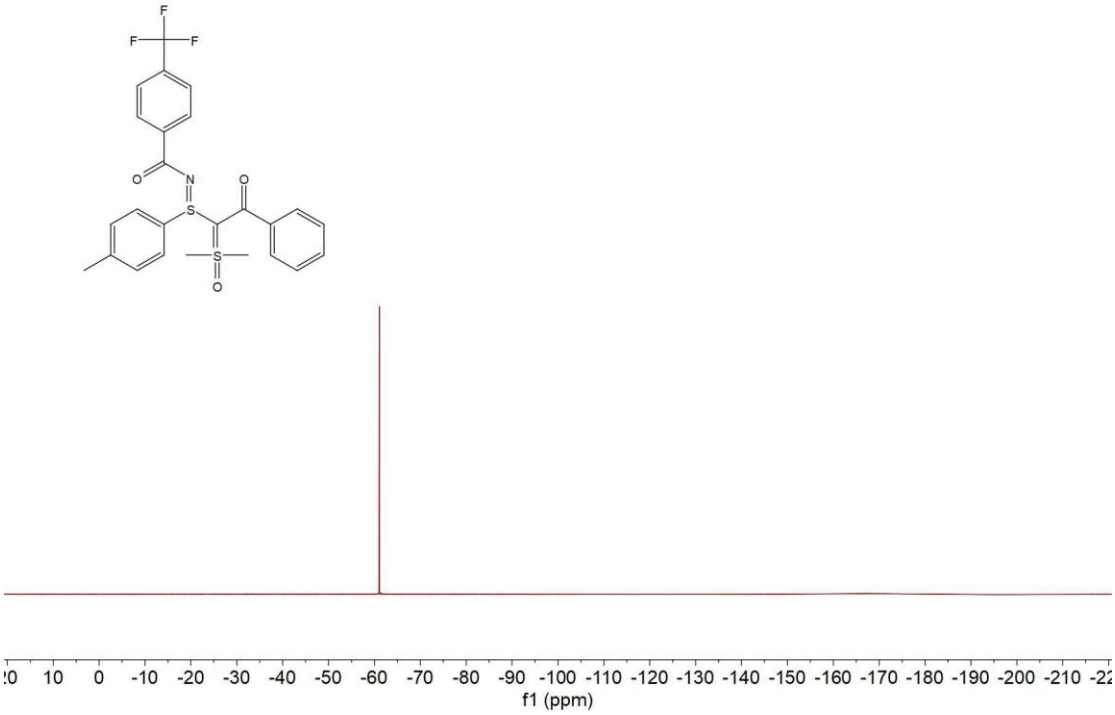
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8d**



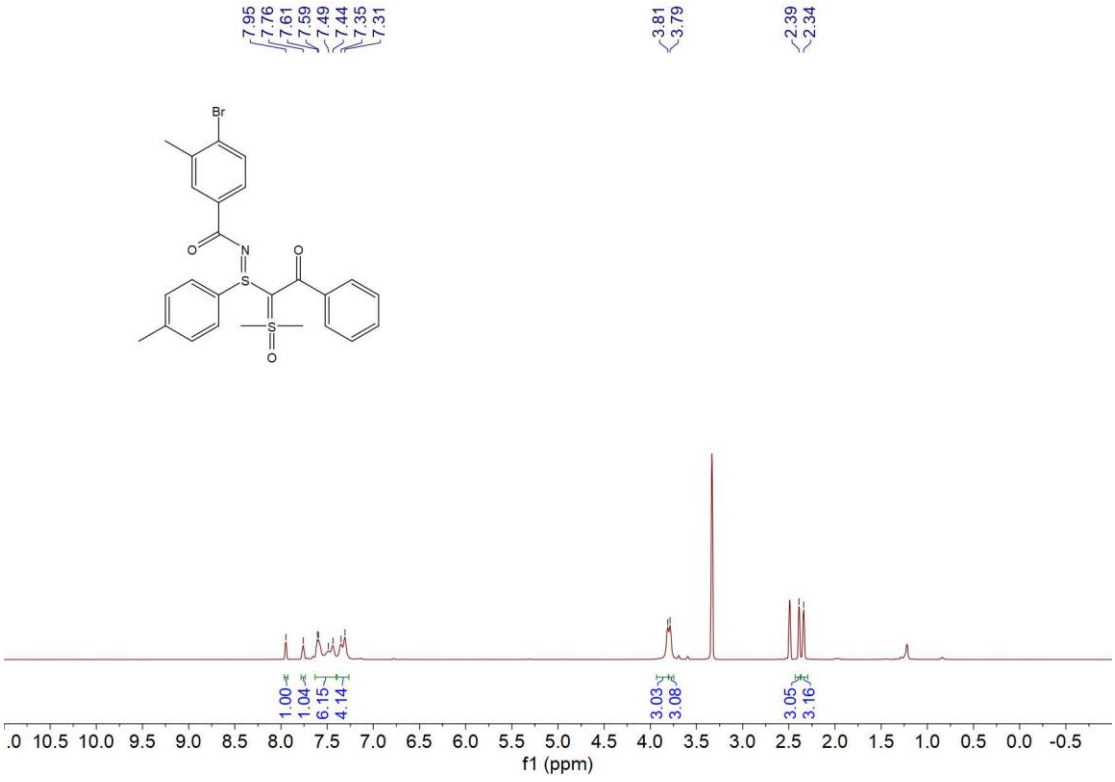
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8d**



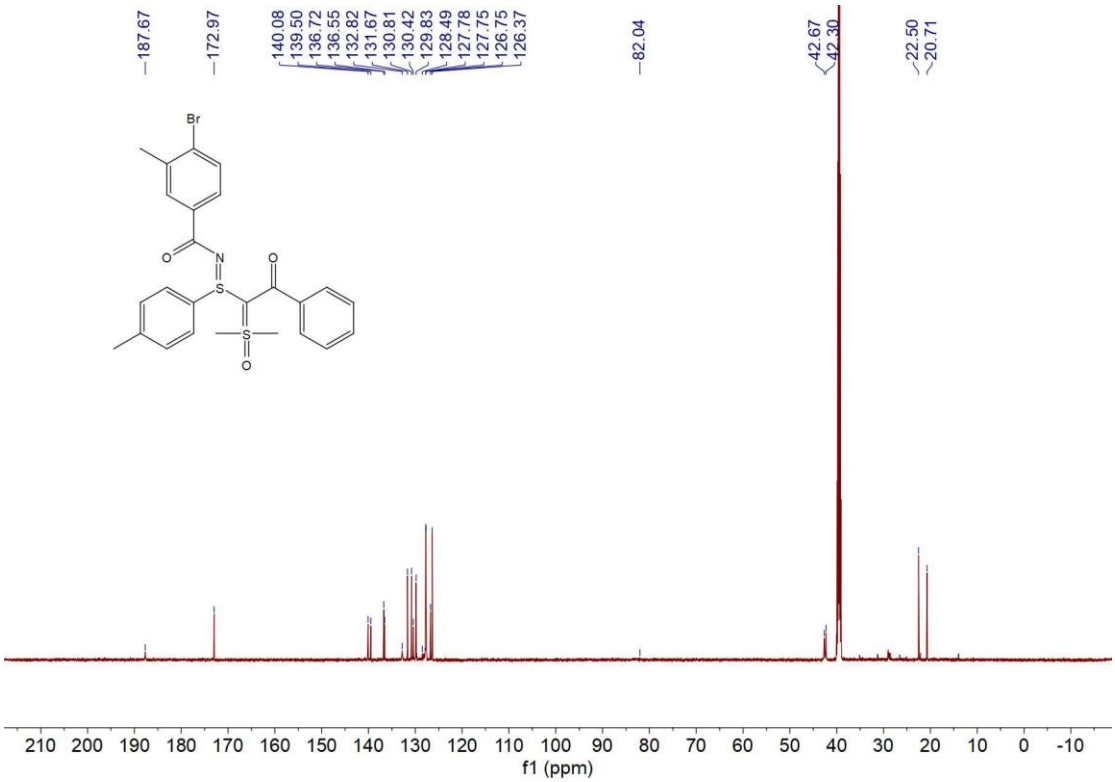
^{19}F NMR (471 MHz, DMSO-d_6) Spectra of **8d**



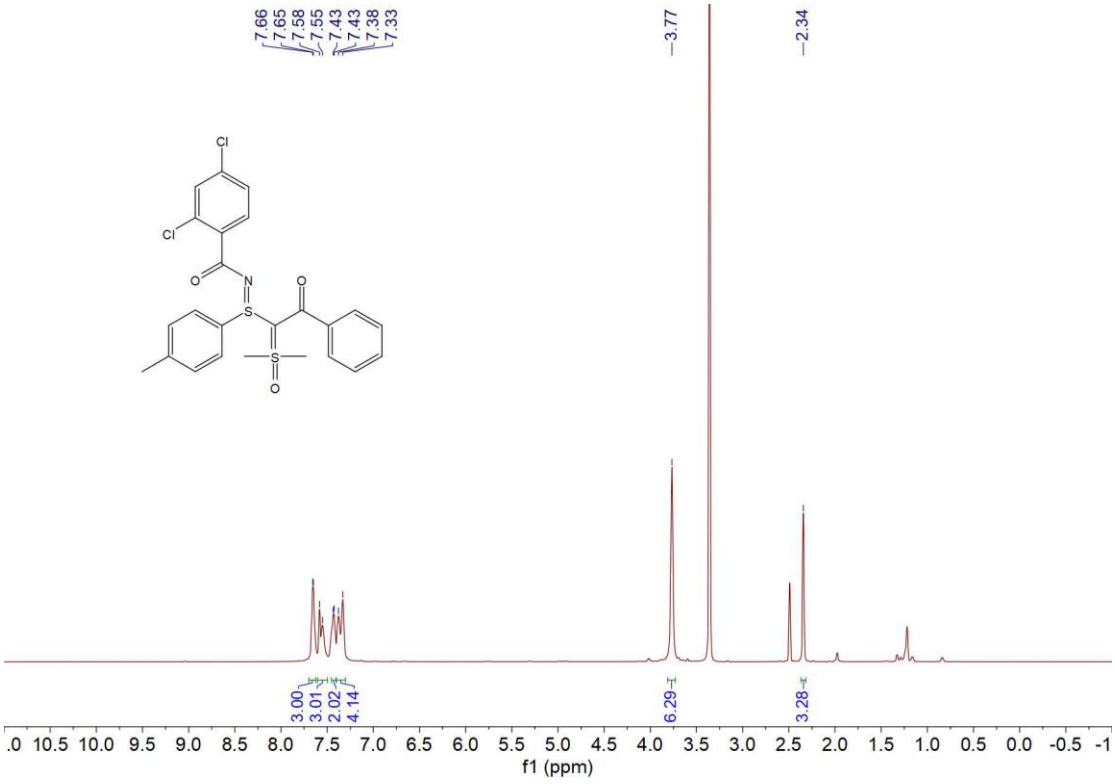
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8e**



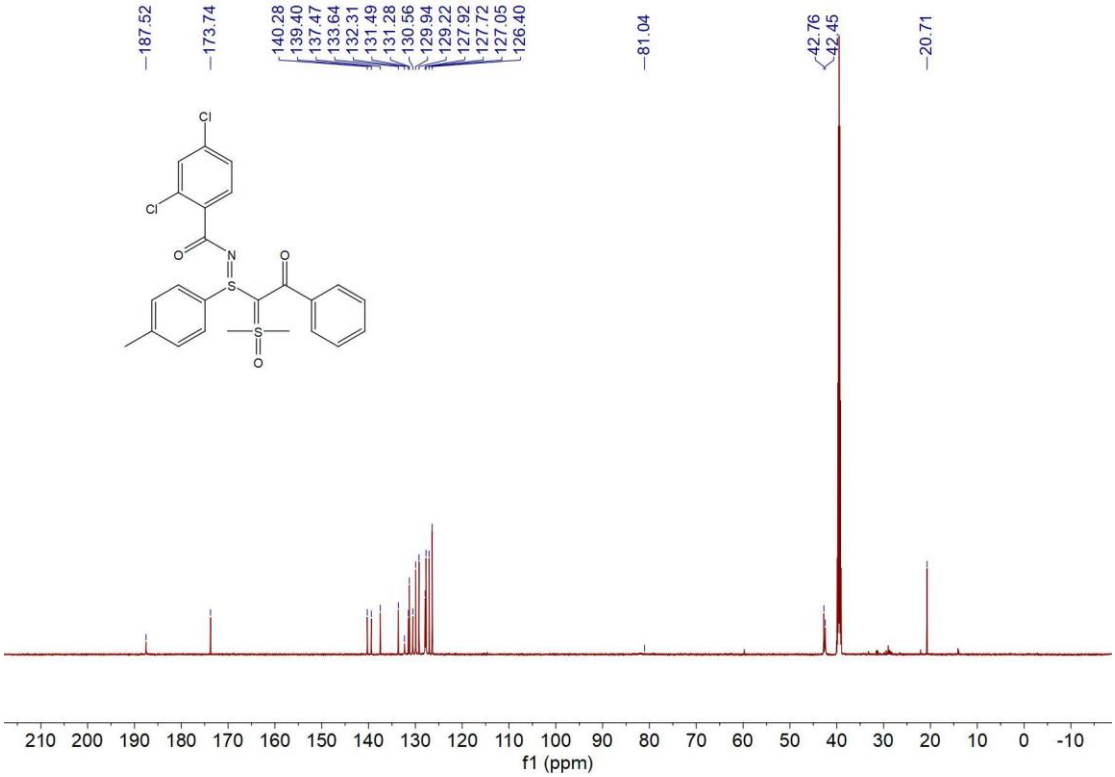
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8e**



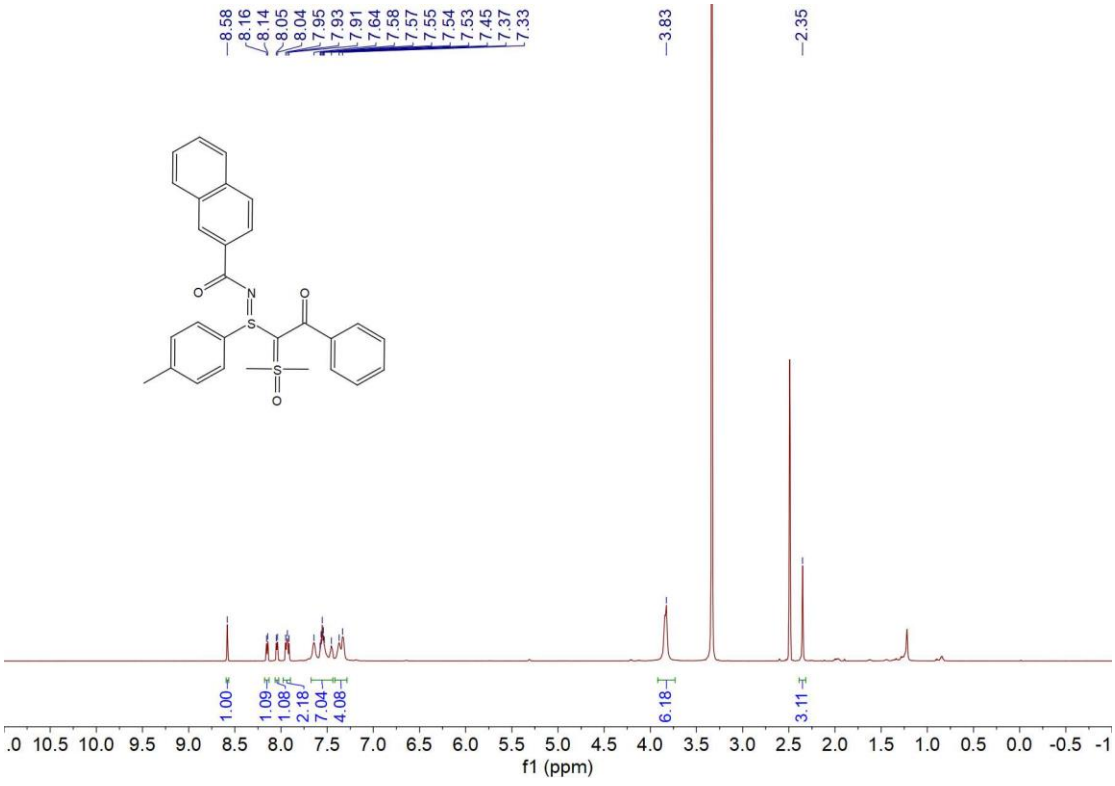
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8f**



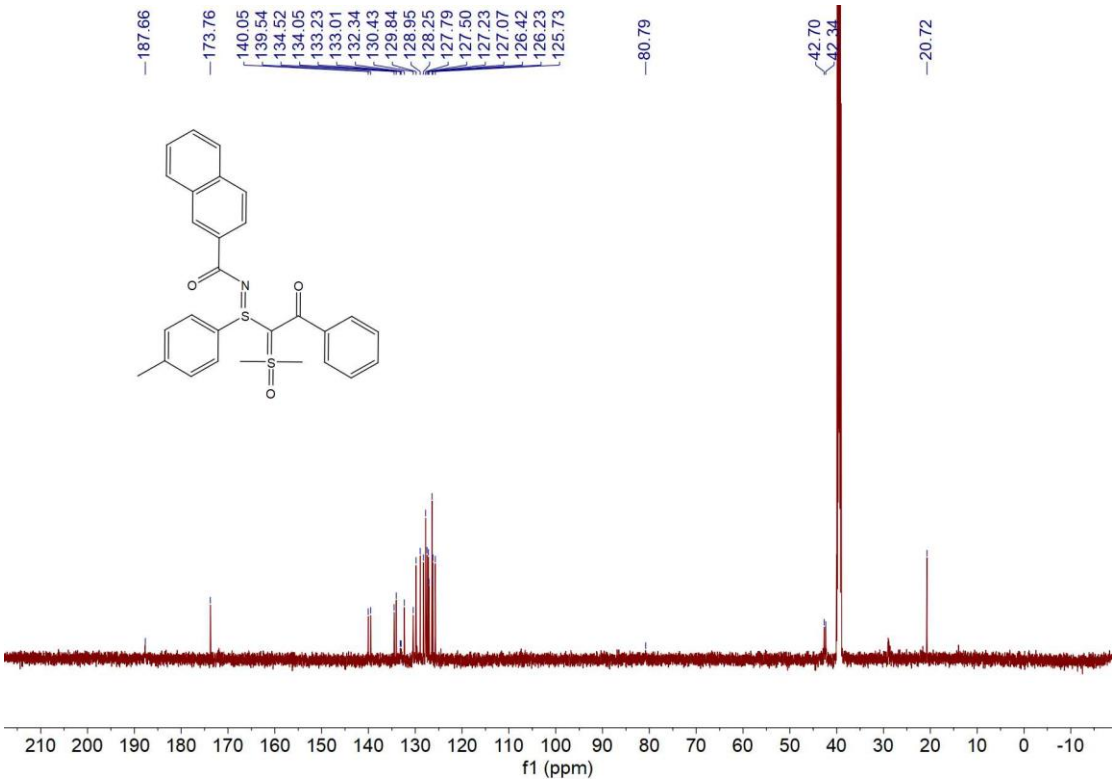
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8f**



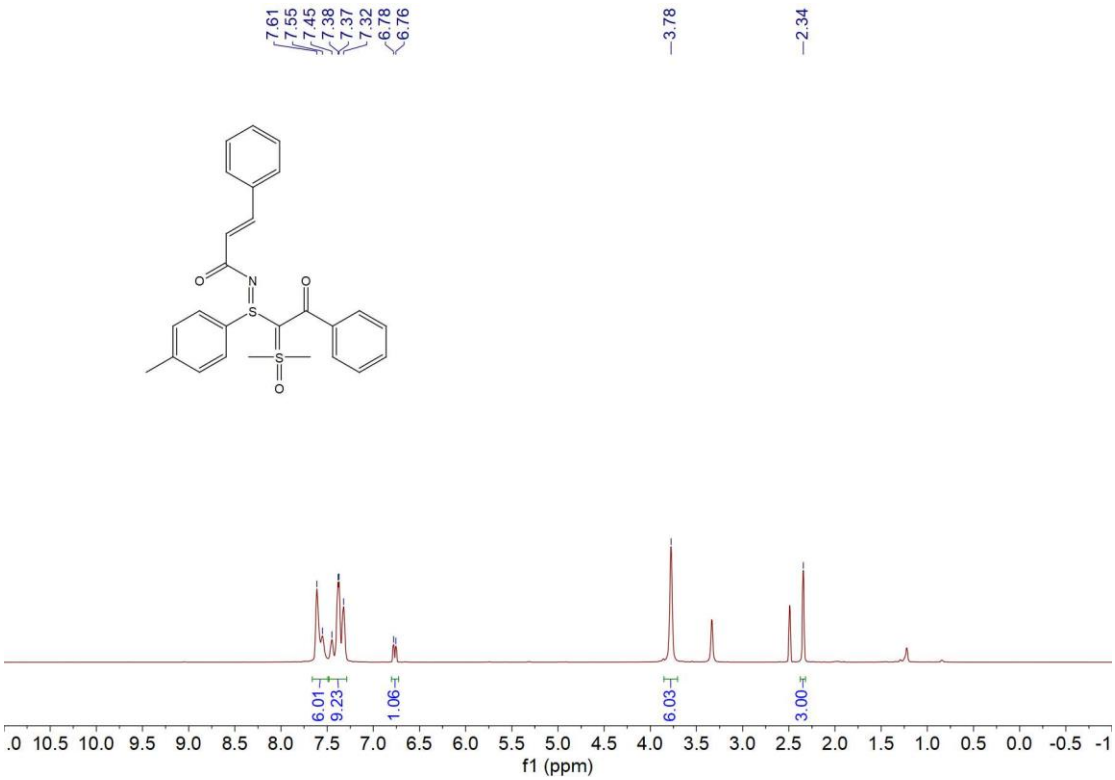
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8g**



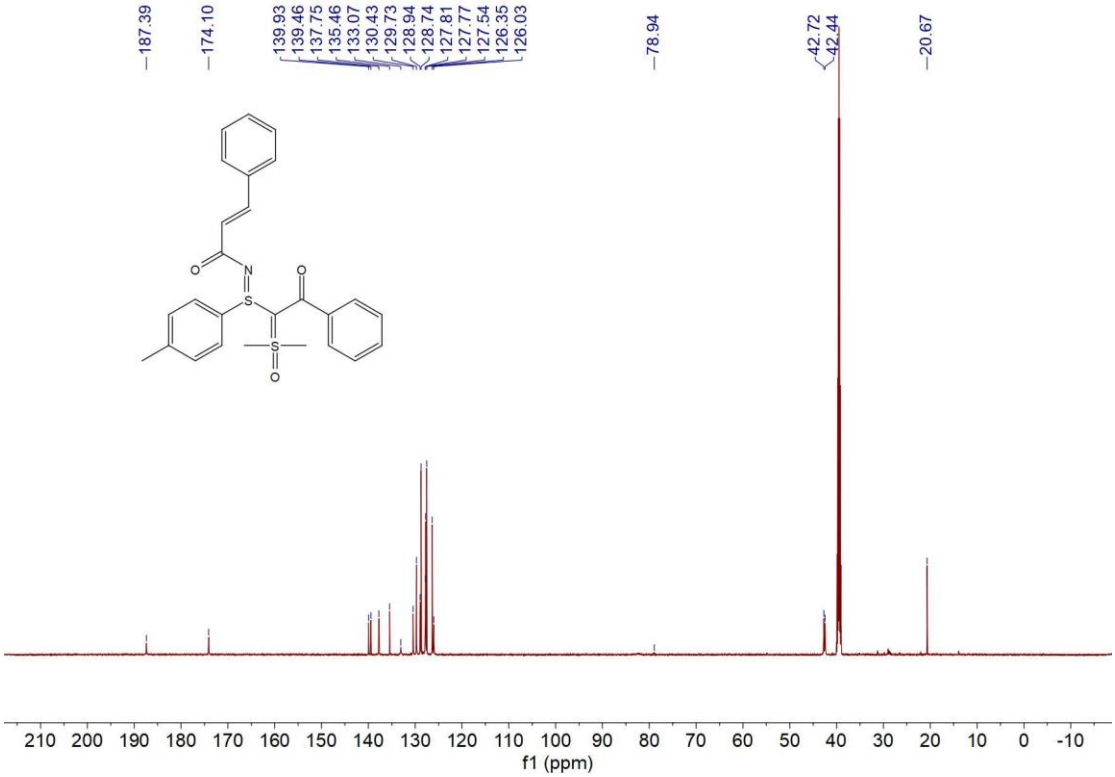
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8g**



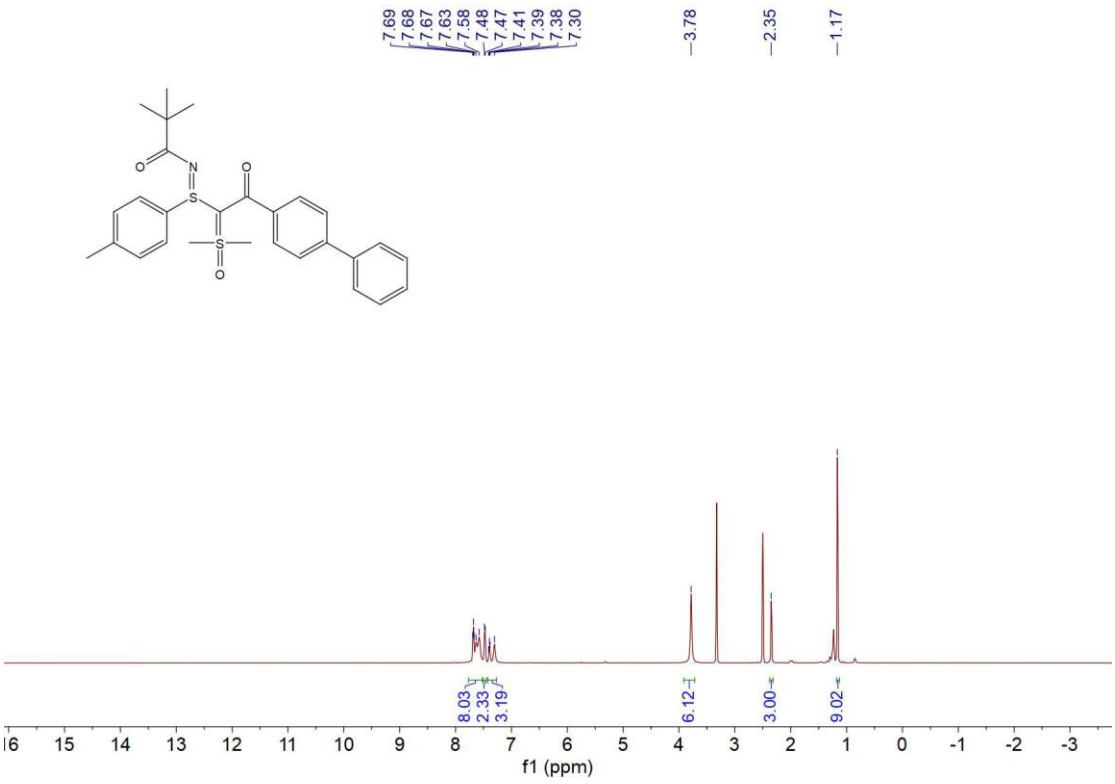
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8h**



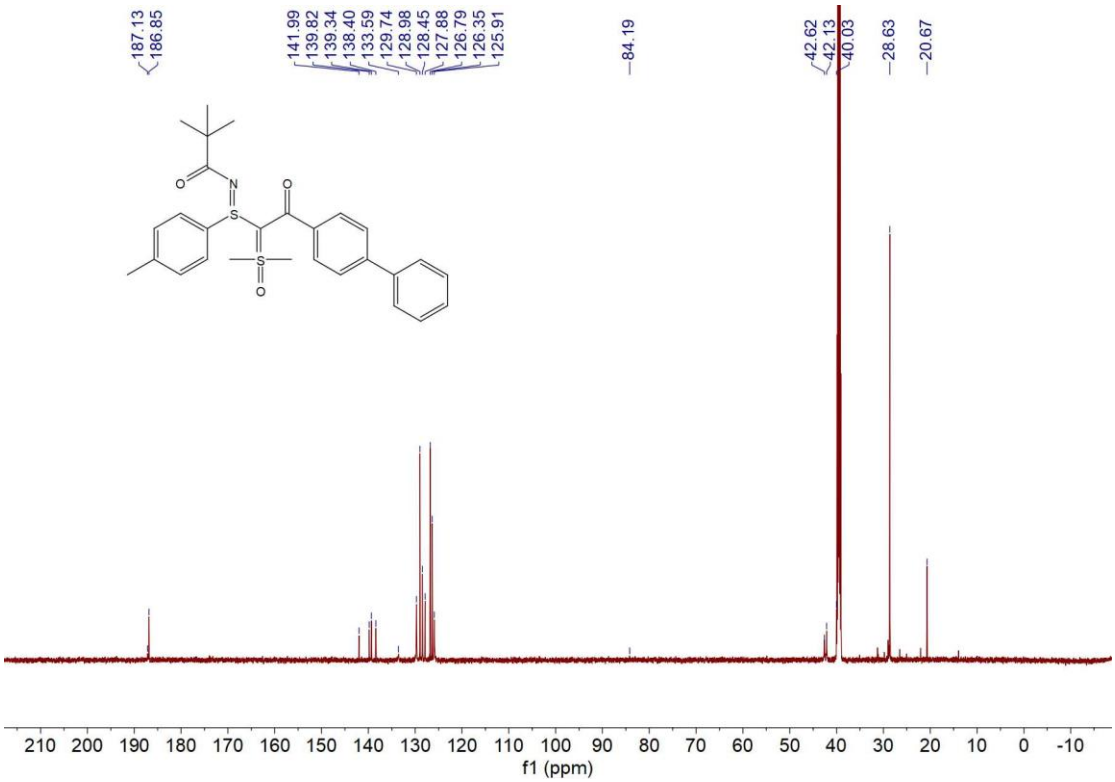
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8h**



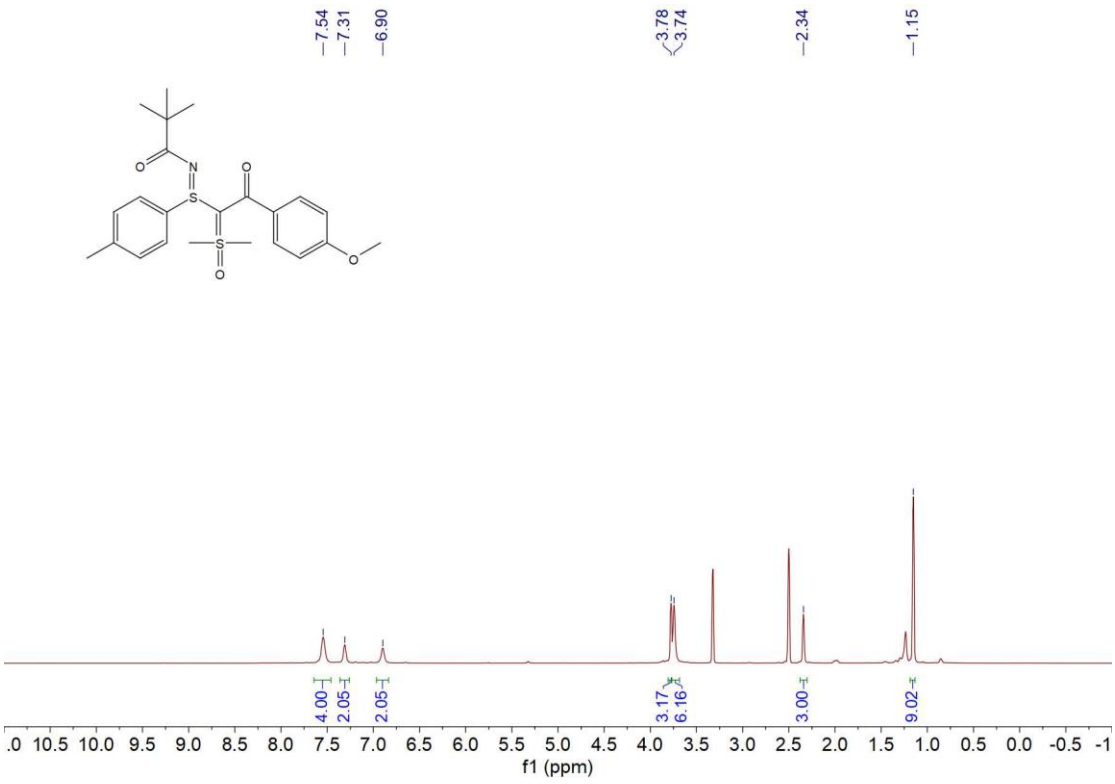
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8k**



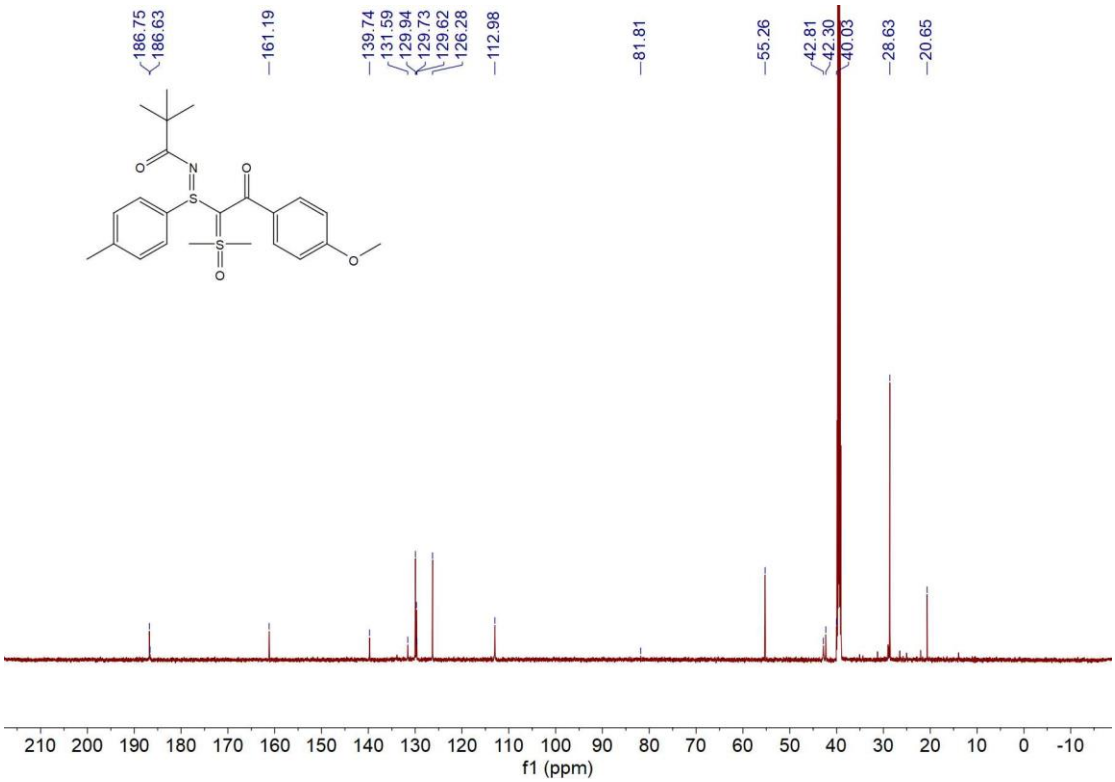
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8k**



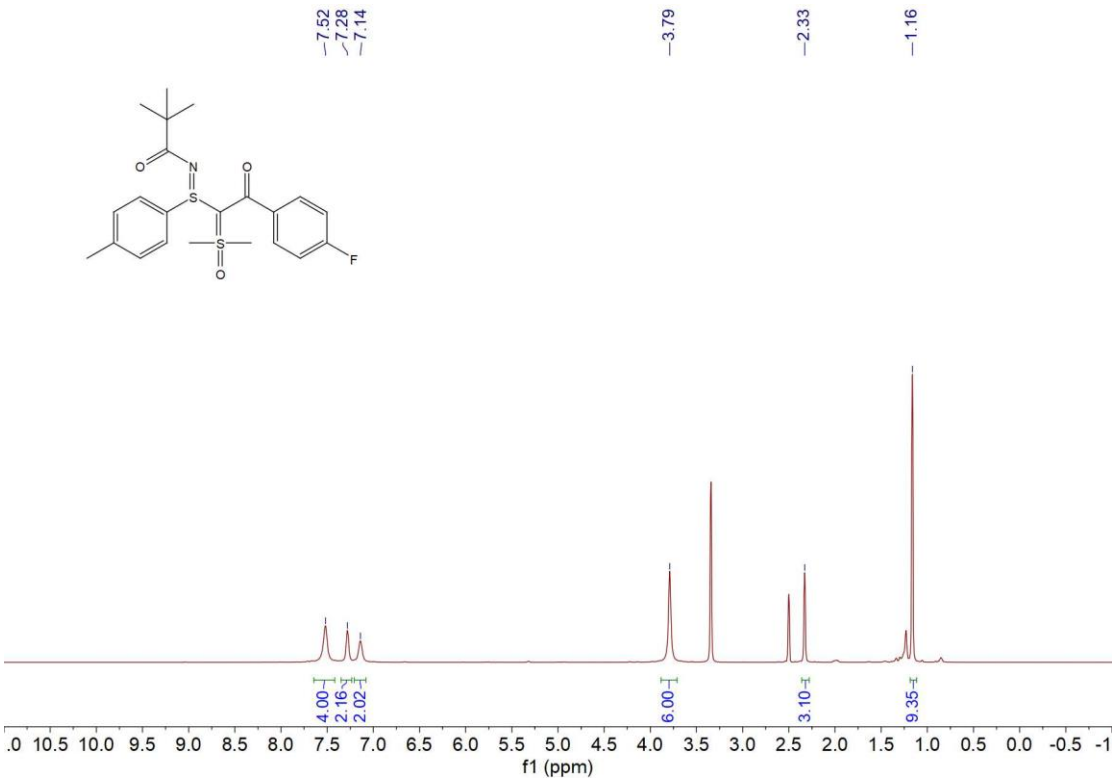
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8l**



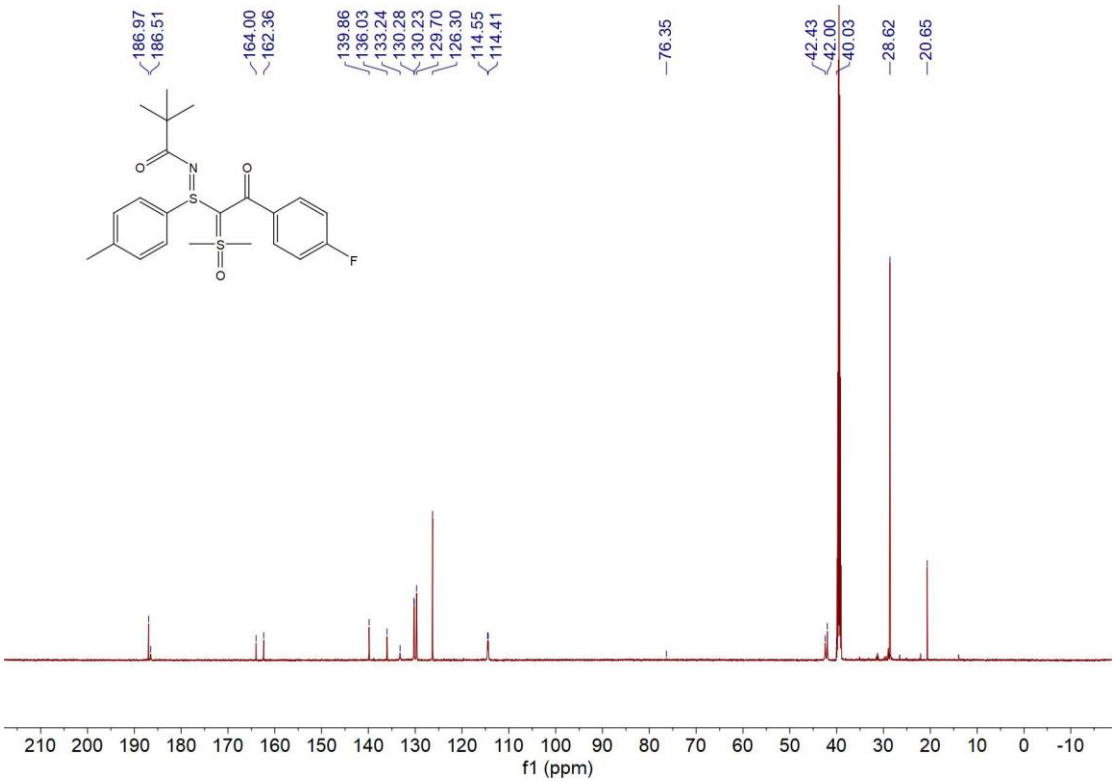
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8l**



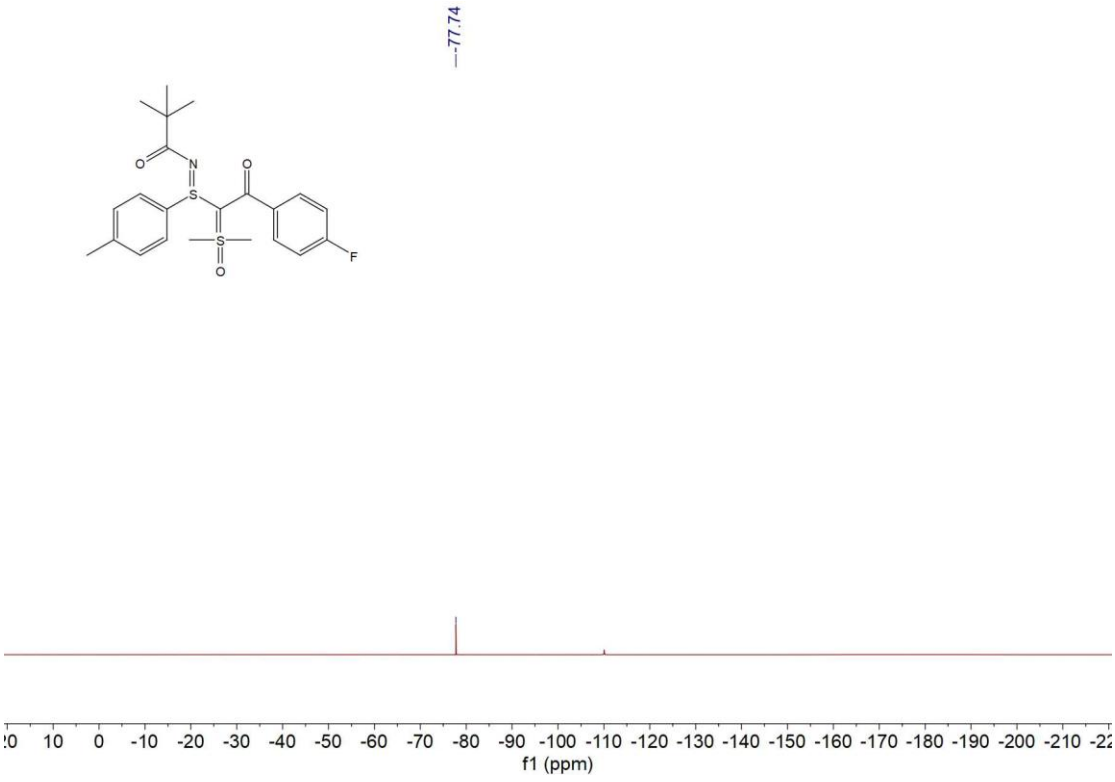
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8m**



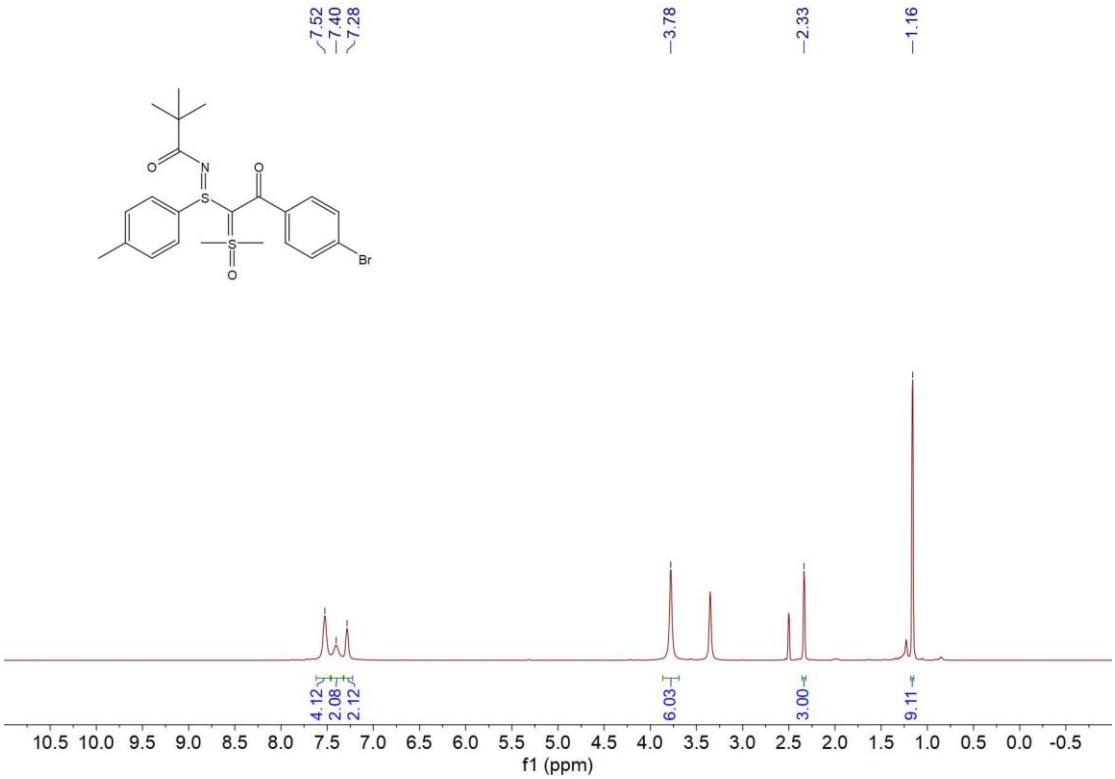
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8m**



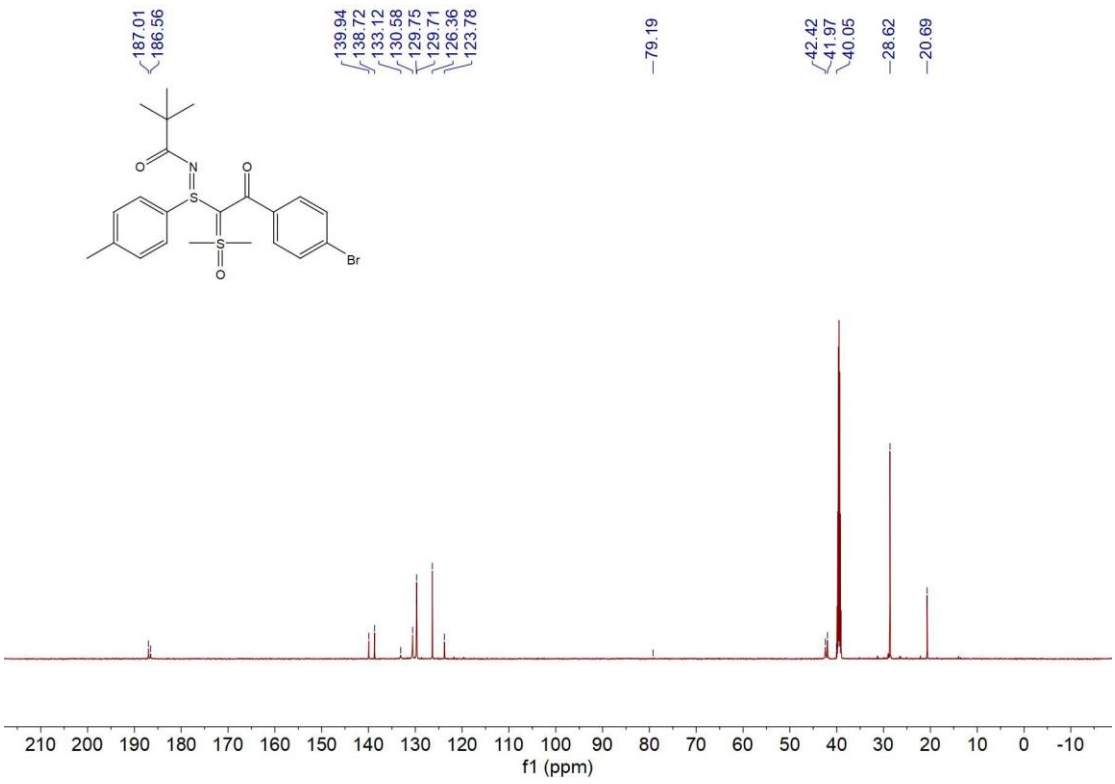
^{19}F NMR (377 MHz, DMSO-d_6) Spectra of **8m**



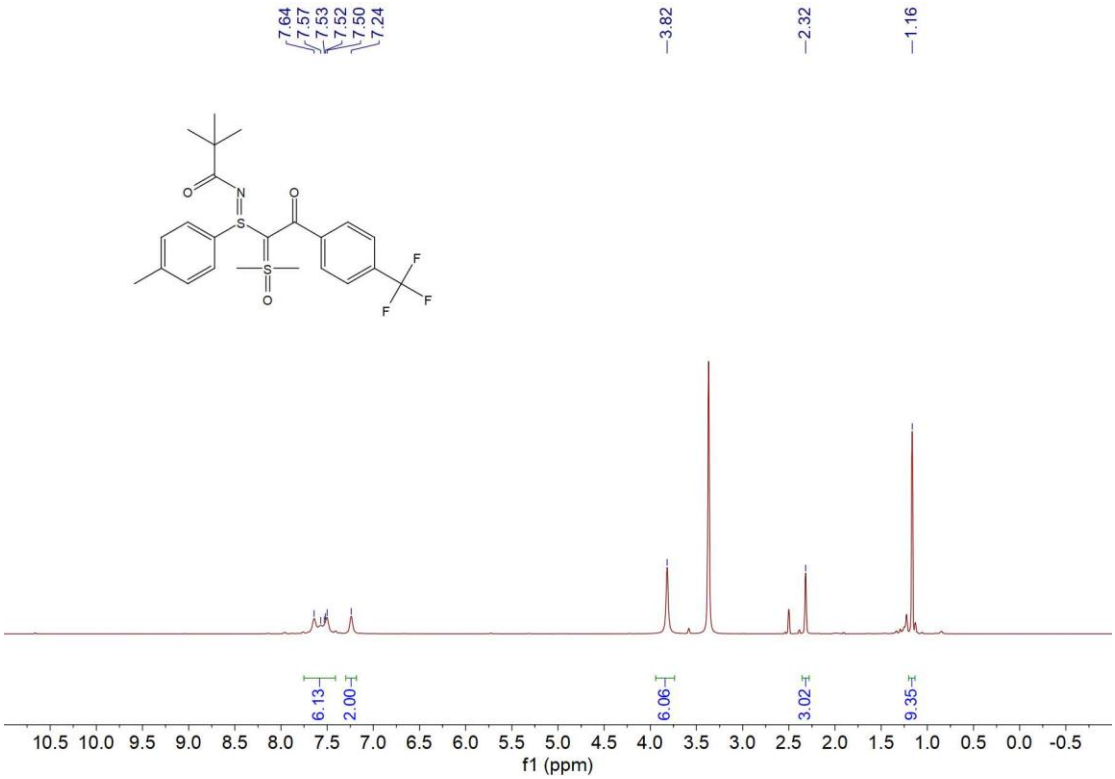
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8n**



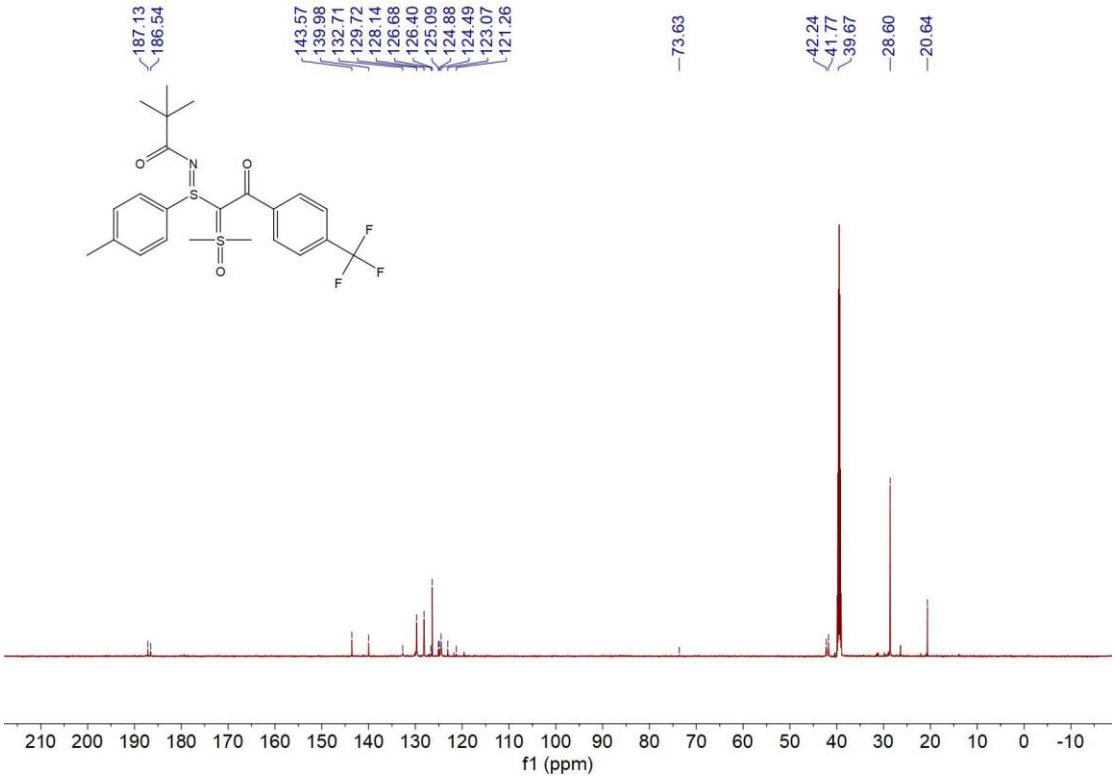
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8n**



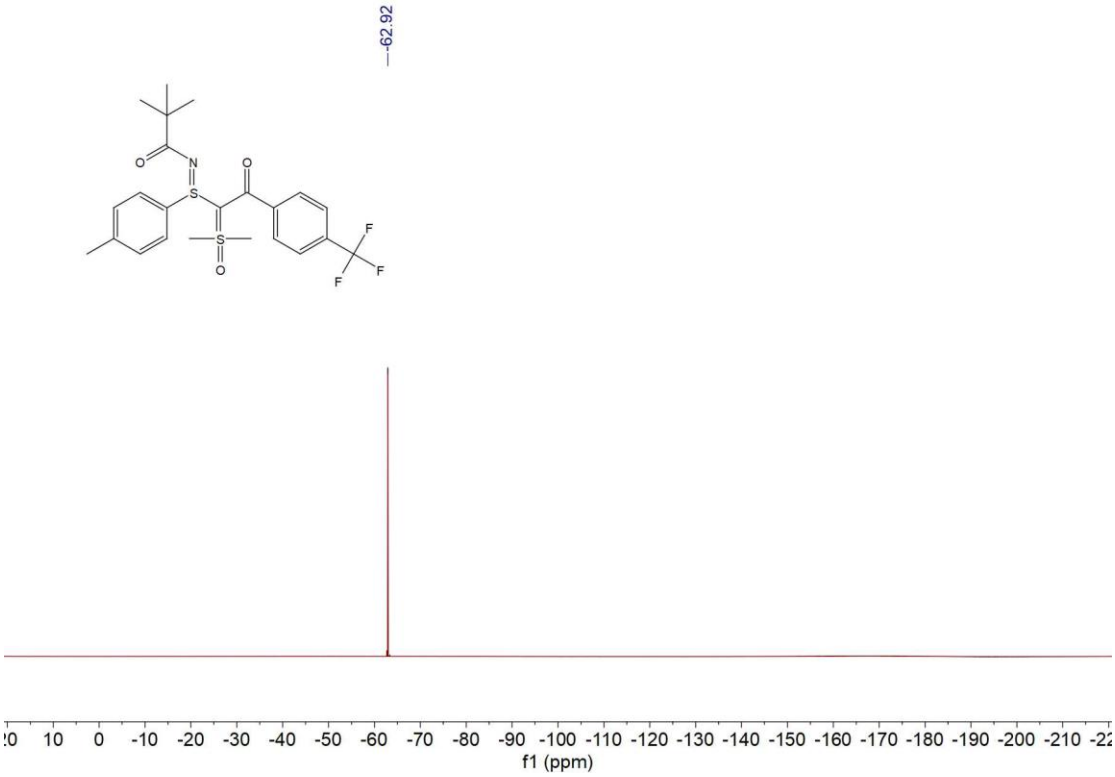
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8o**



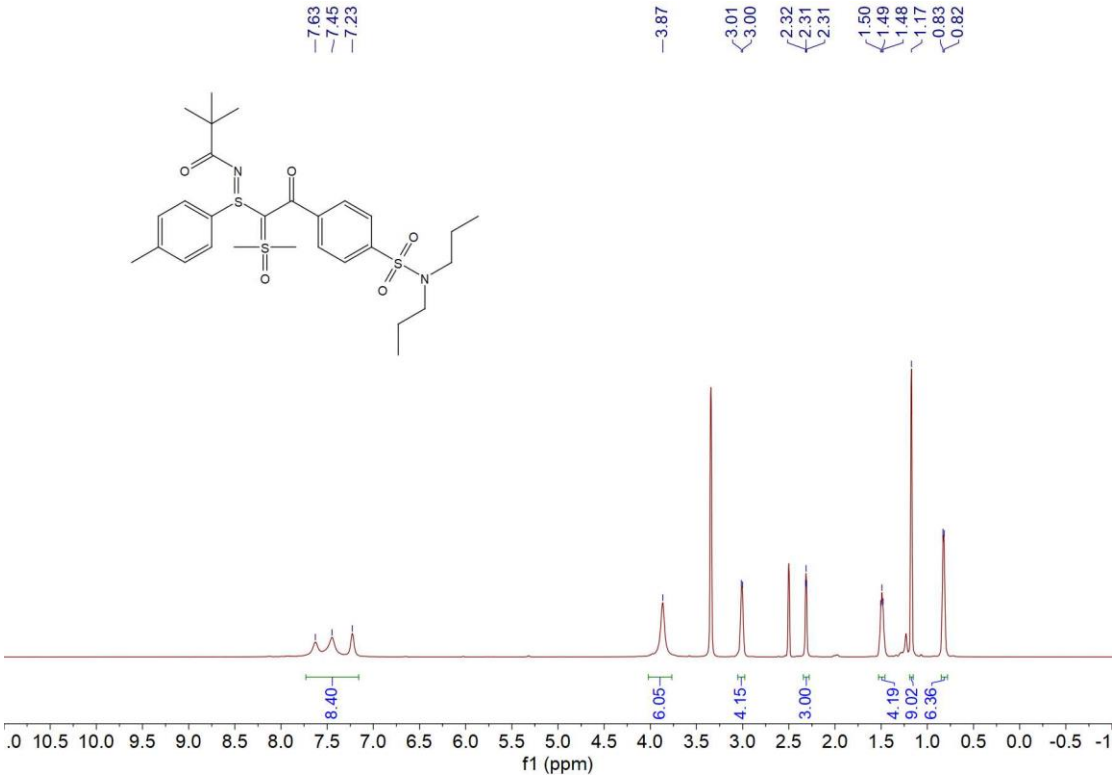
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8o**



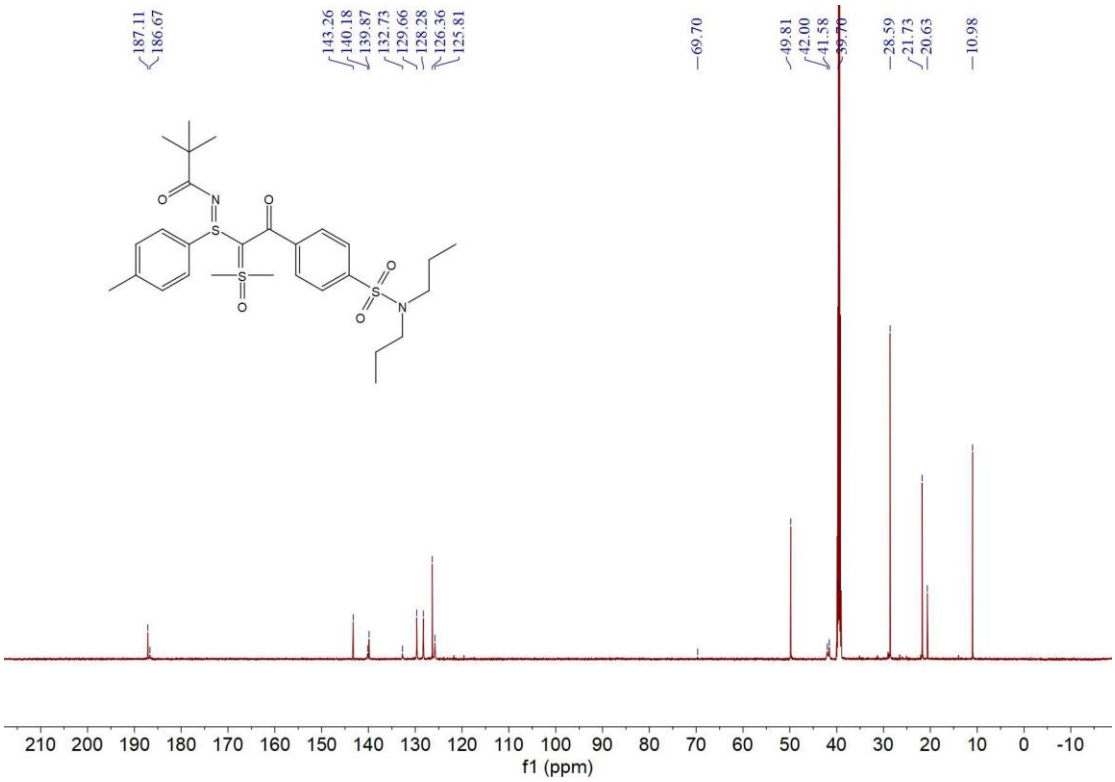
^{19}F NMR (471 MHz, $CDCl_3$-d_6) Spectra of **8o**



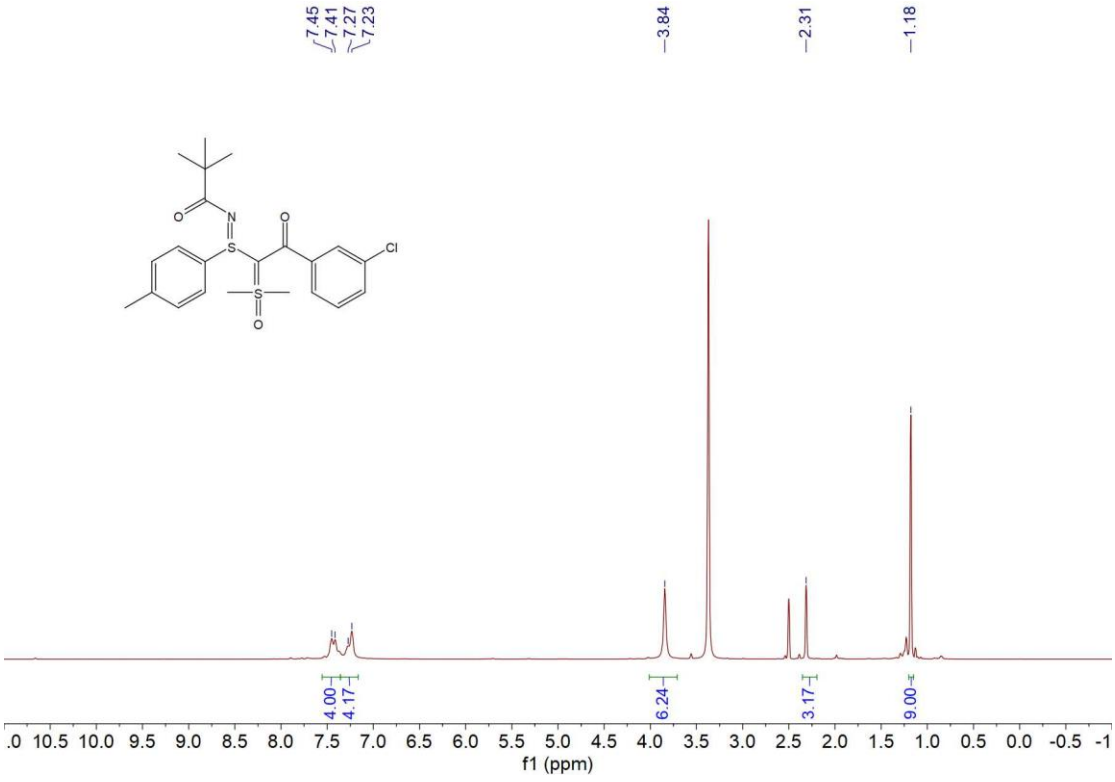
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8p**



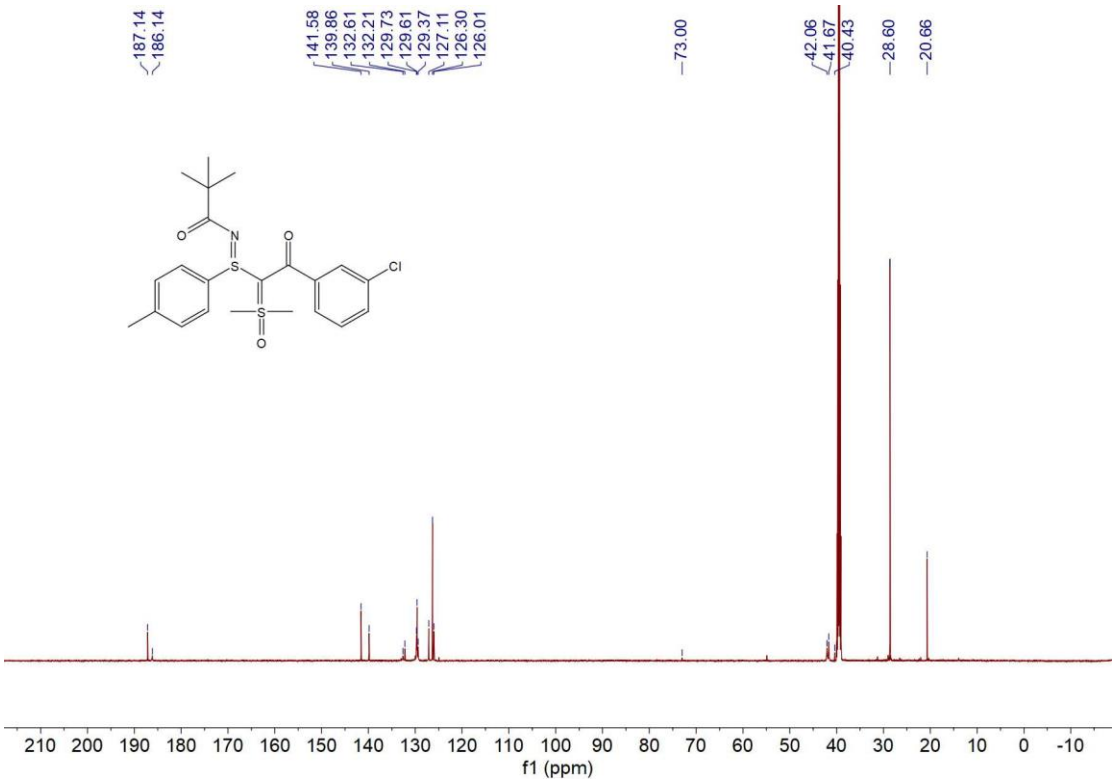
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8p**



^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8q**



^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8q**



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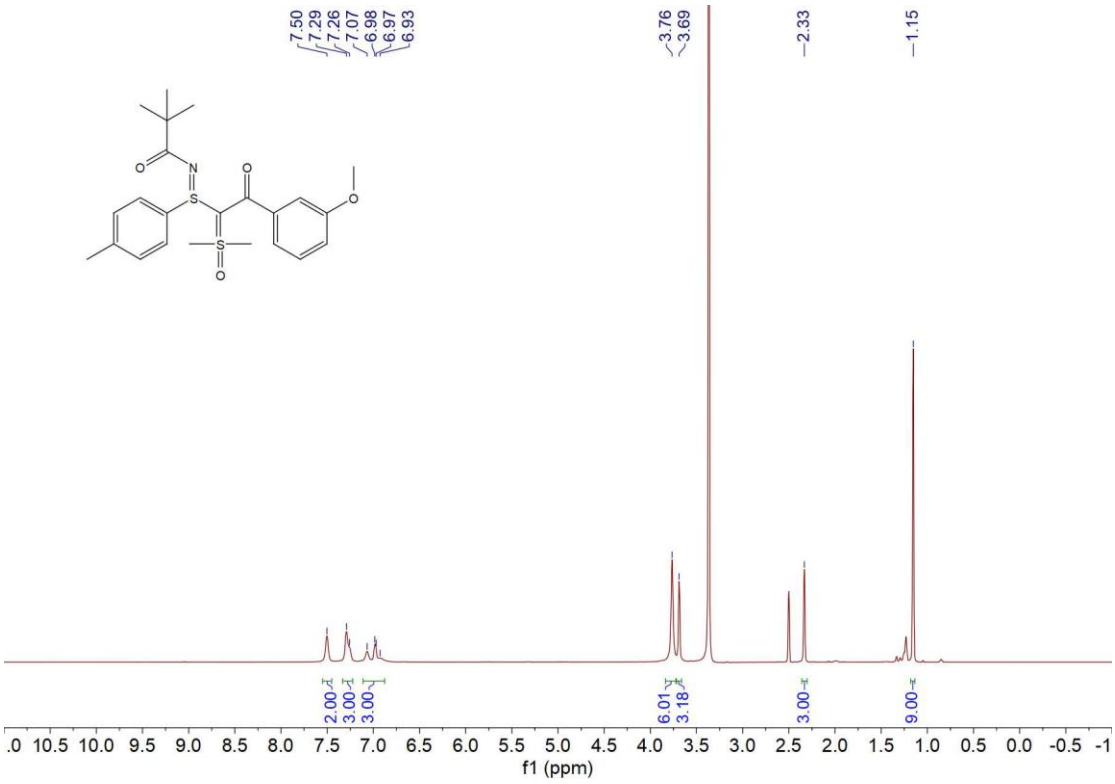
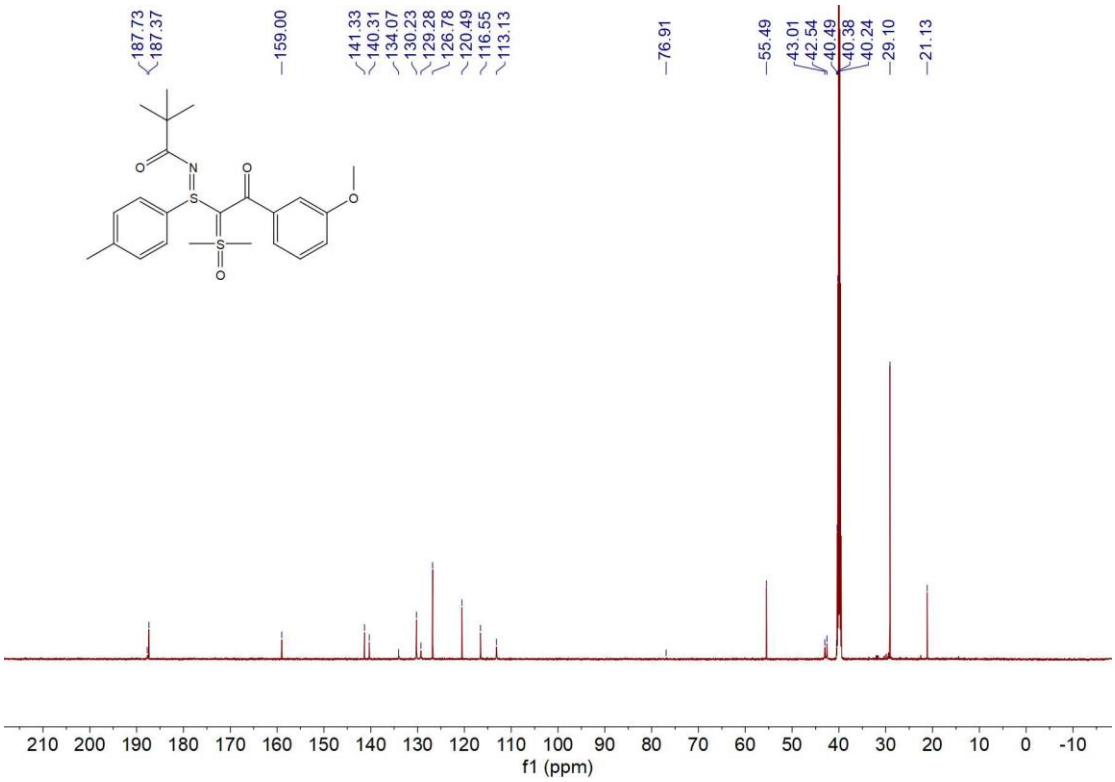


^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8r**



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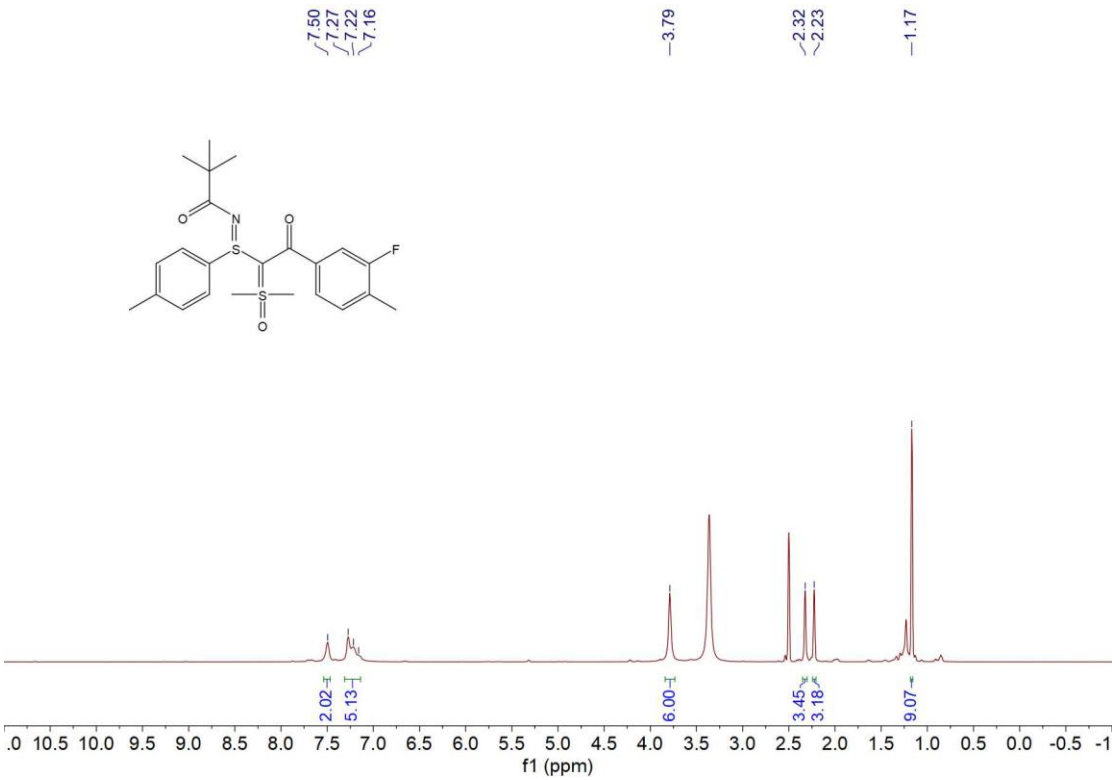
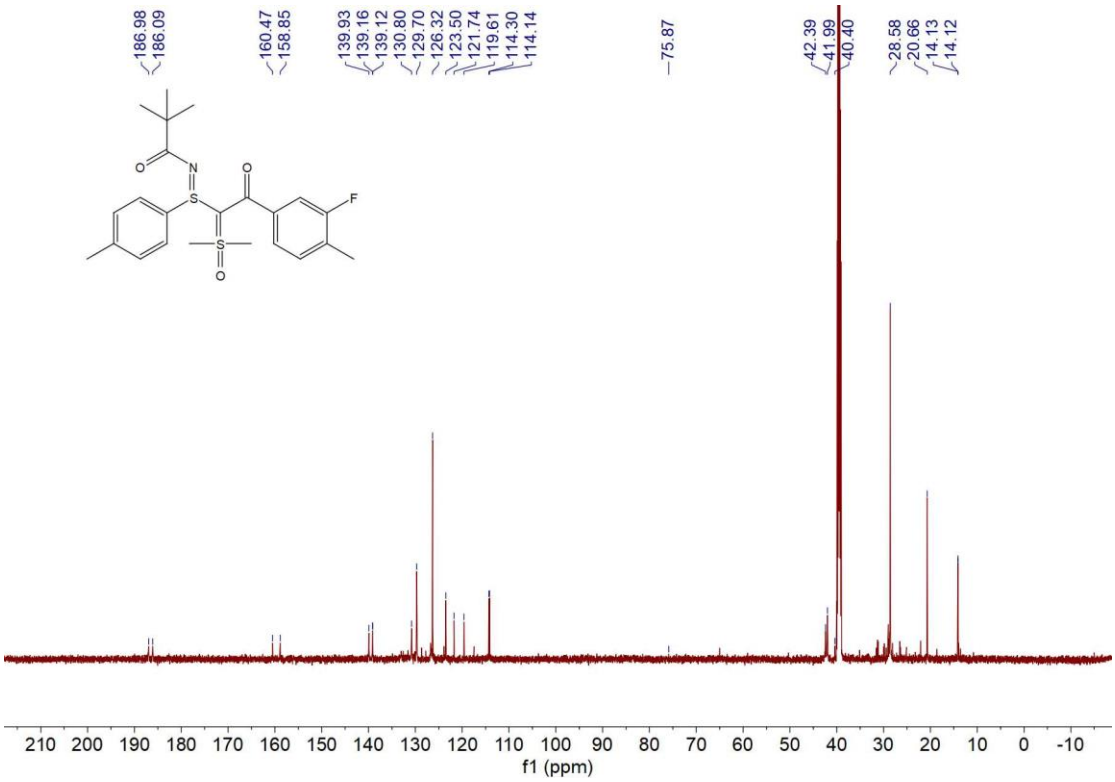
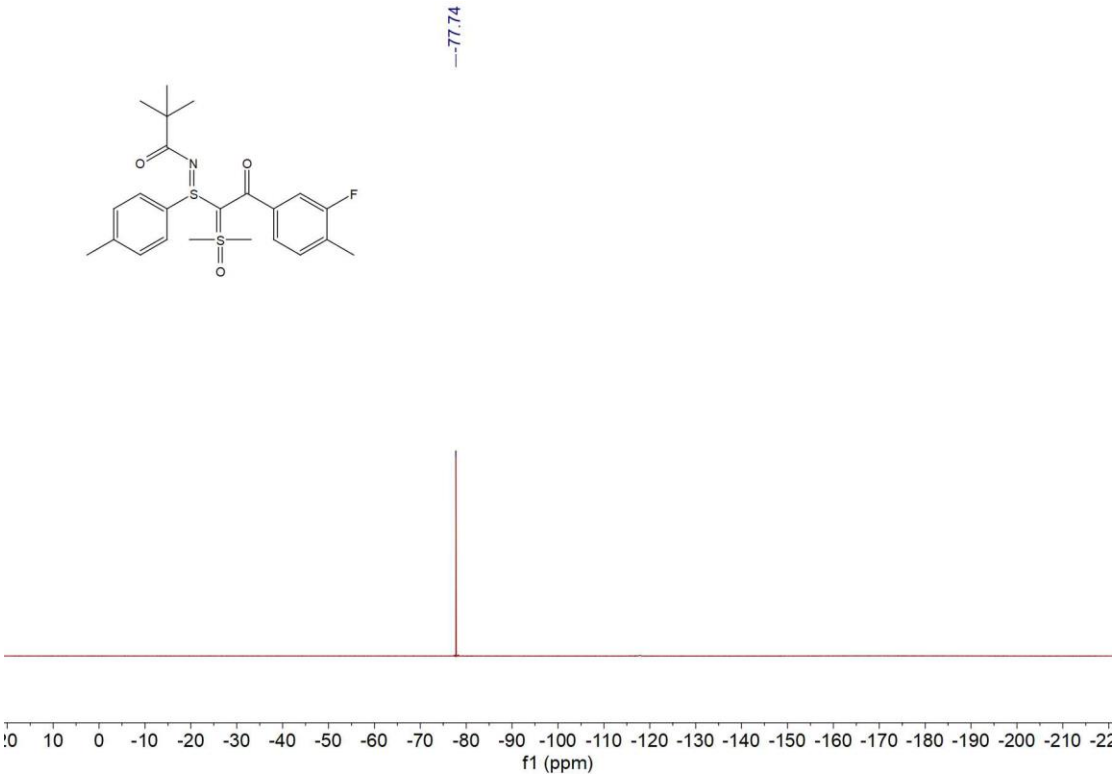


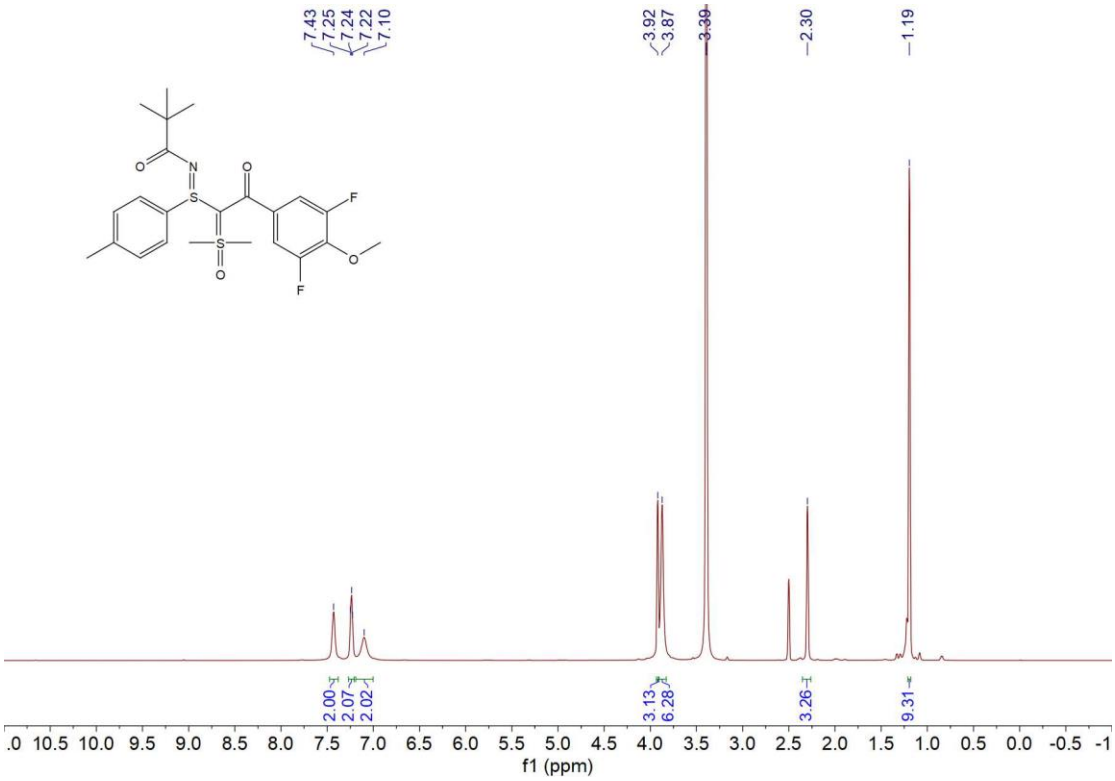
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8s**



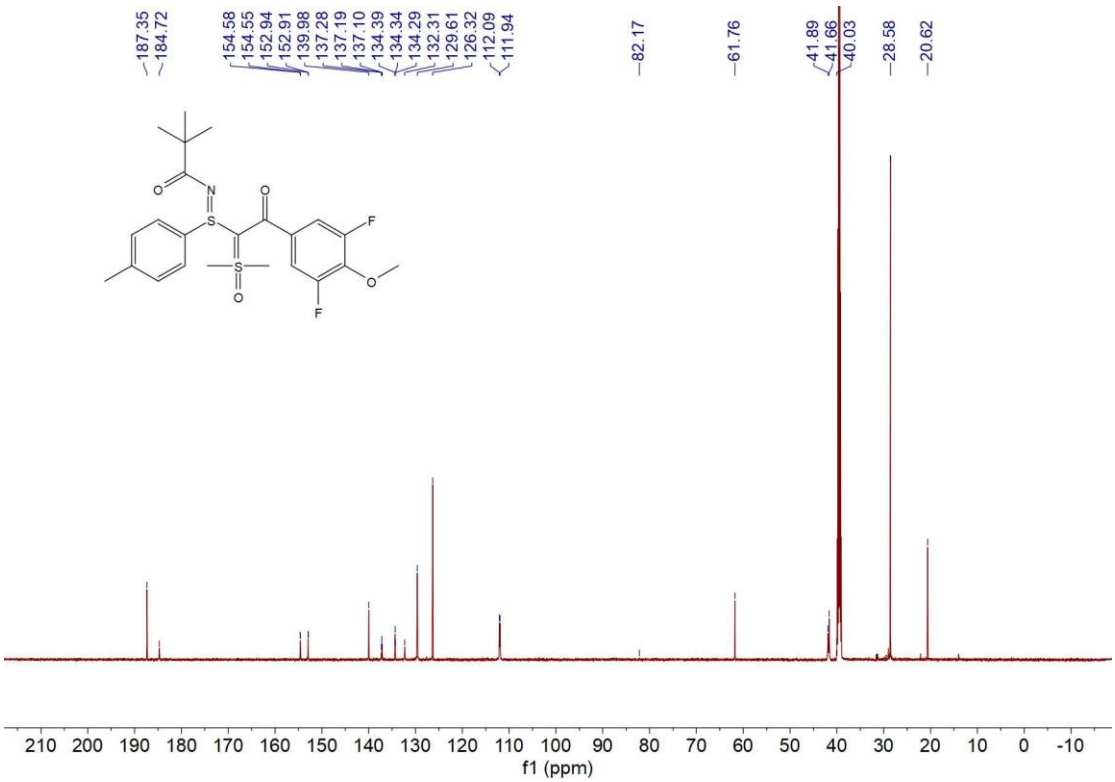
^{19}F NMR (377 MHz, DMSO-d_6) Spectra of **8s**



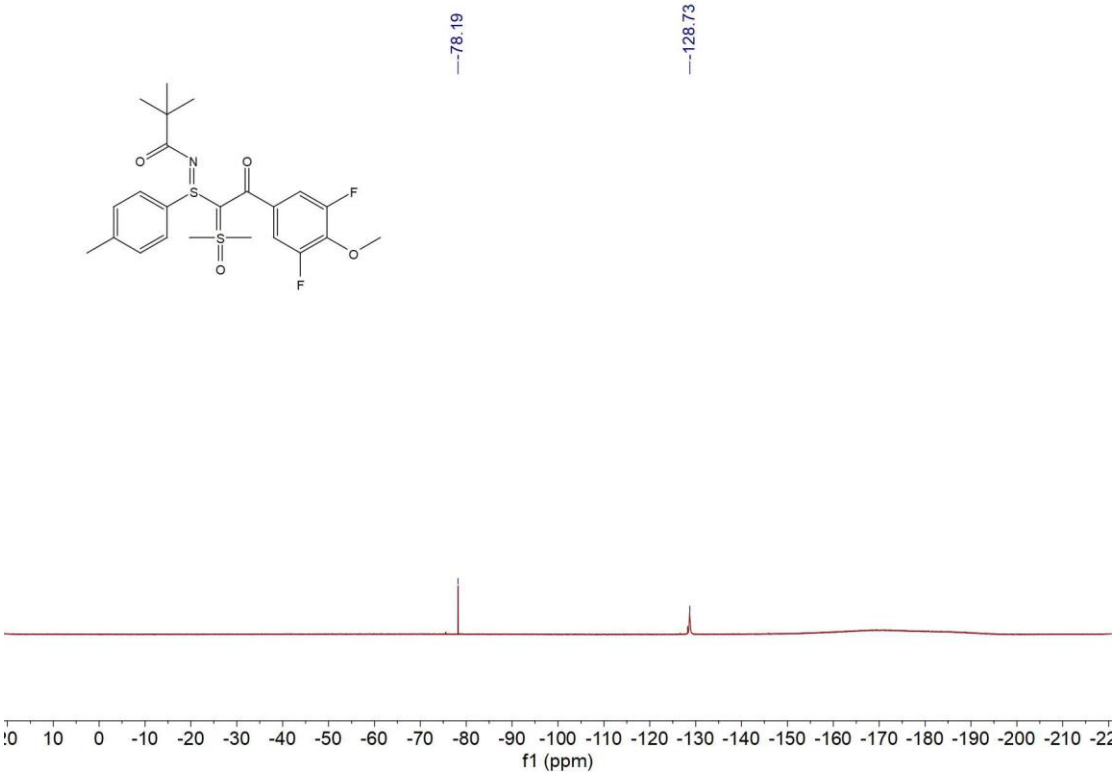
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8t**



^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8t**



^{19}F NMR (471 MHz, $CDCl_3$) Spectra of **8t**



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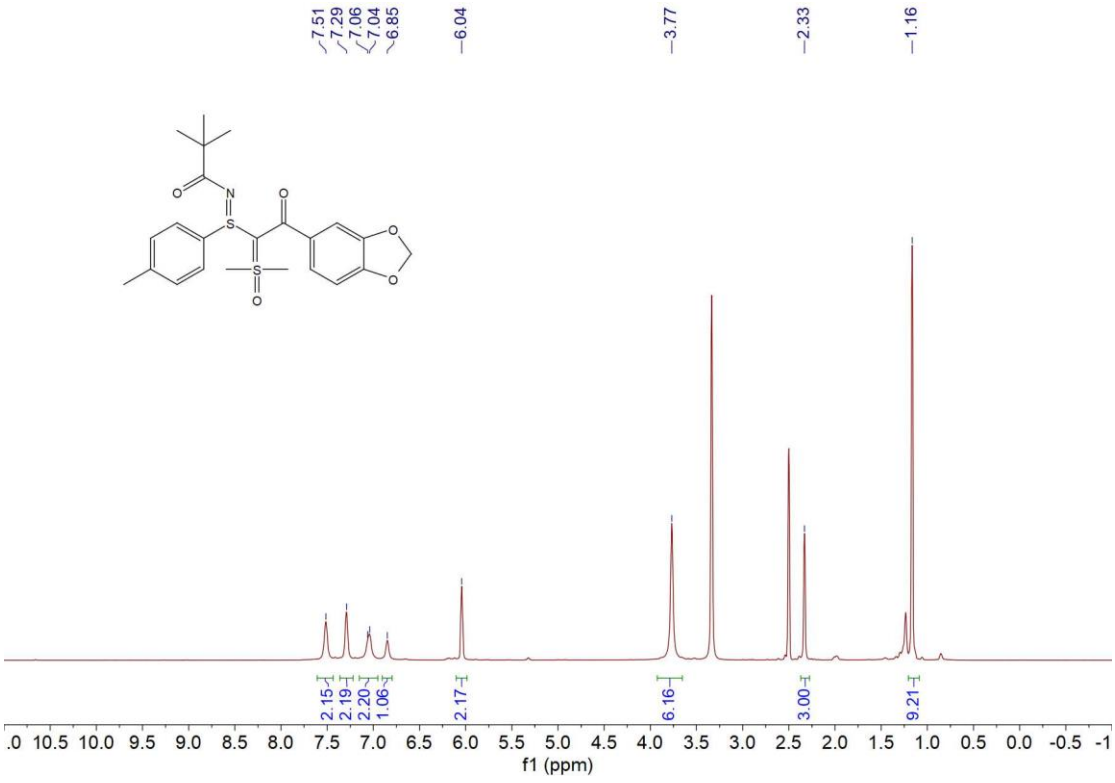
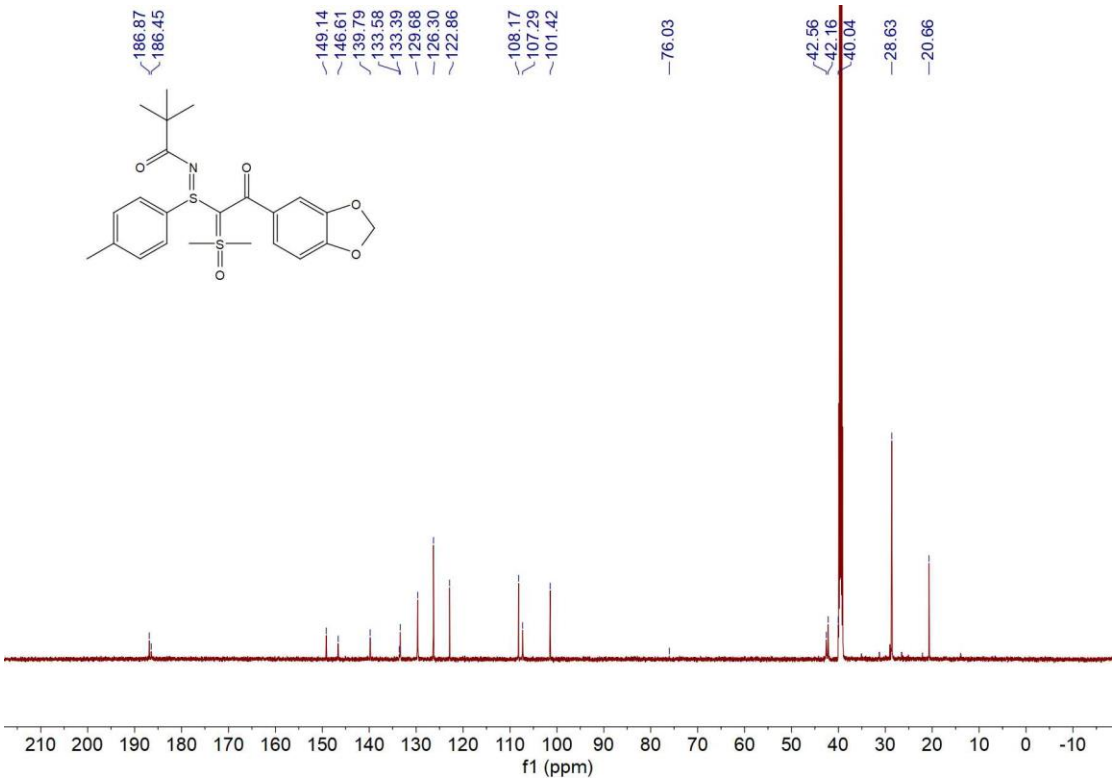


^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8u**



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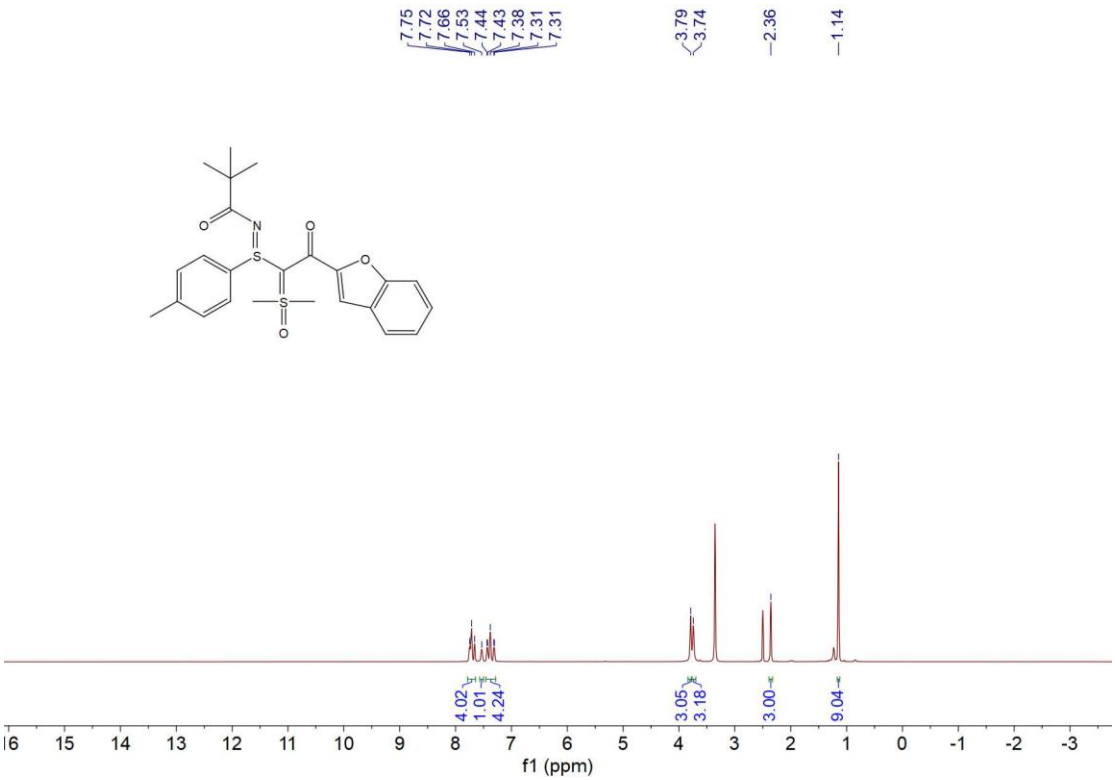
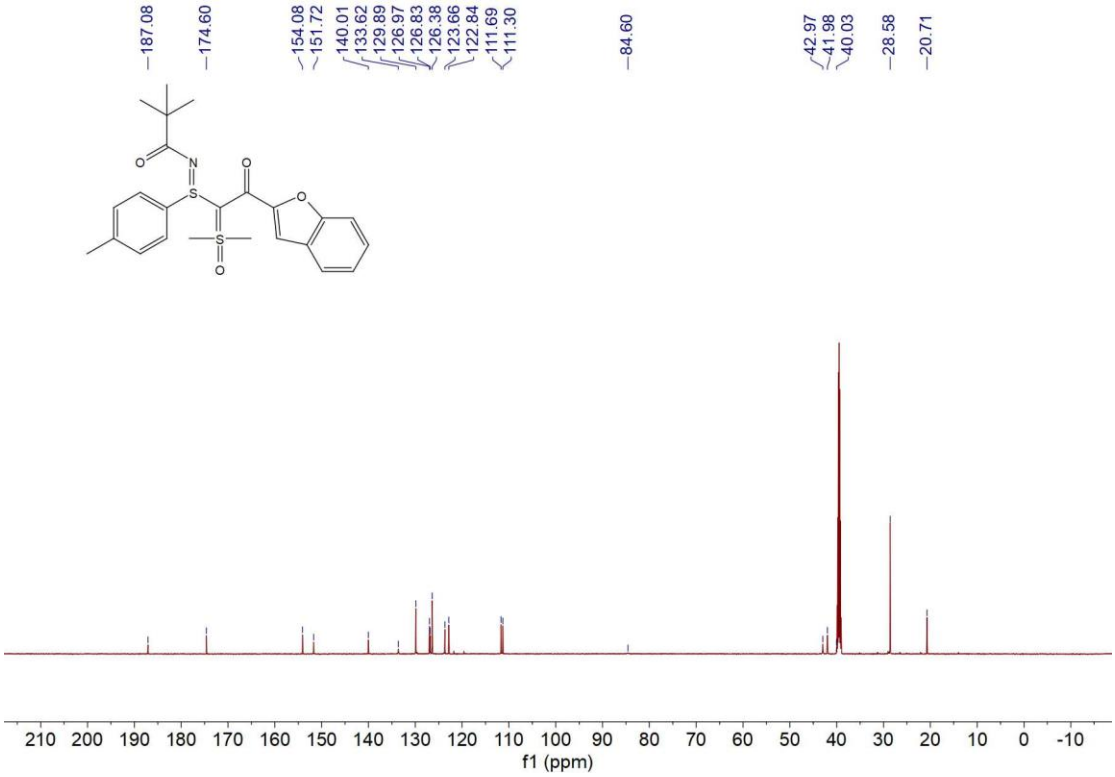
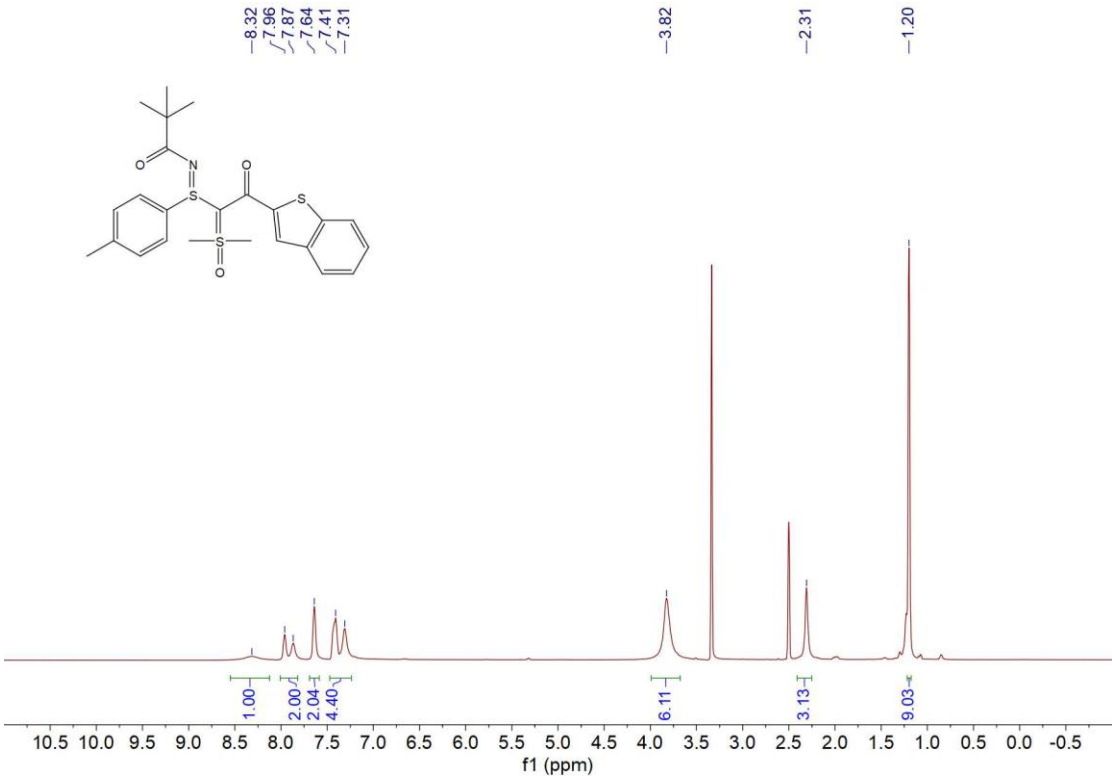


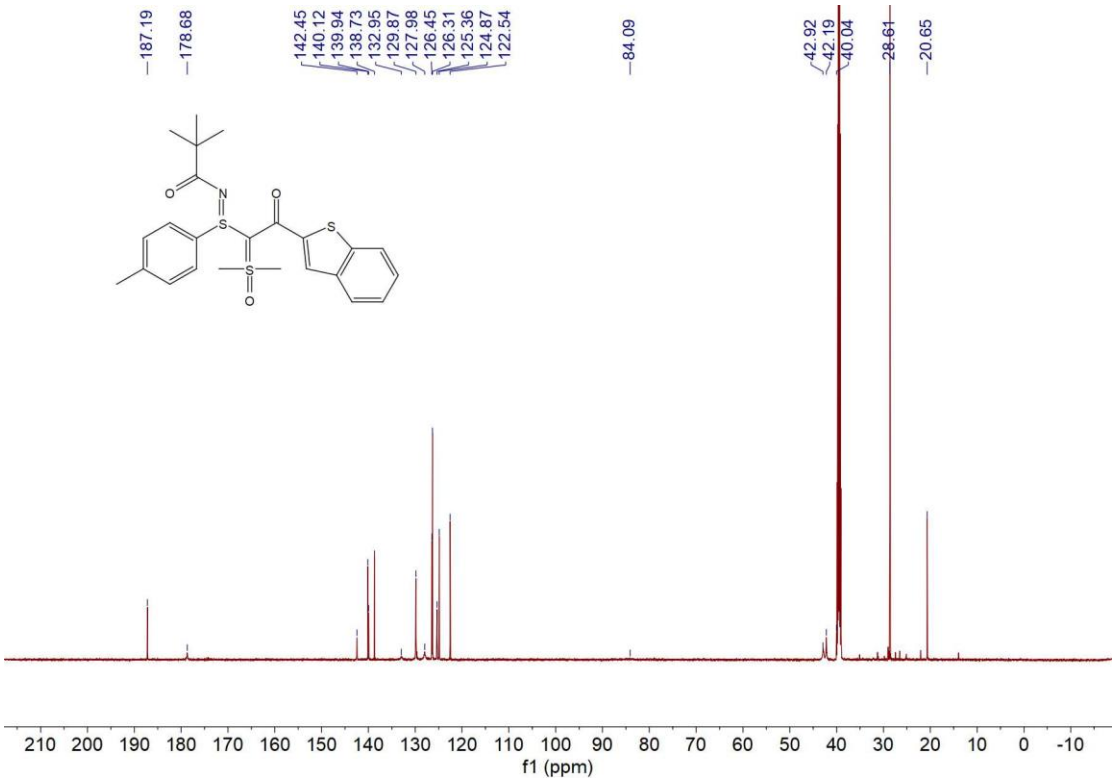
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8v**



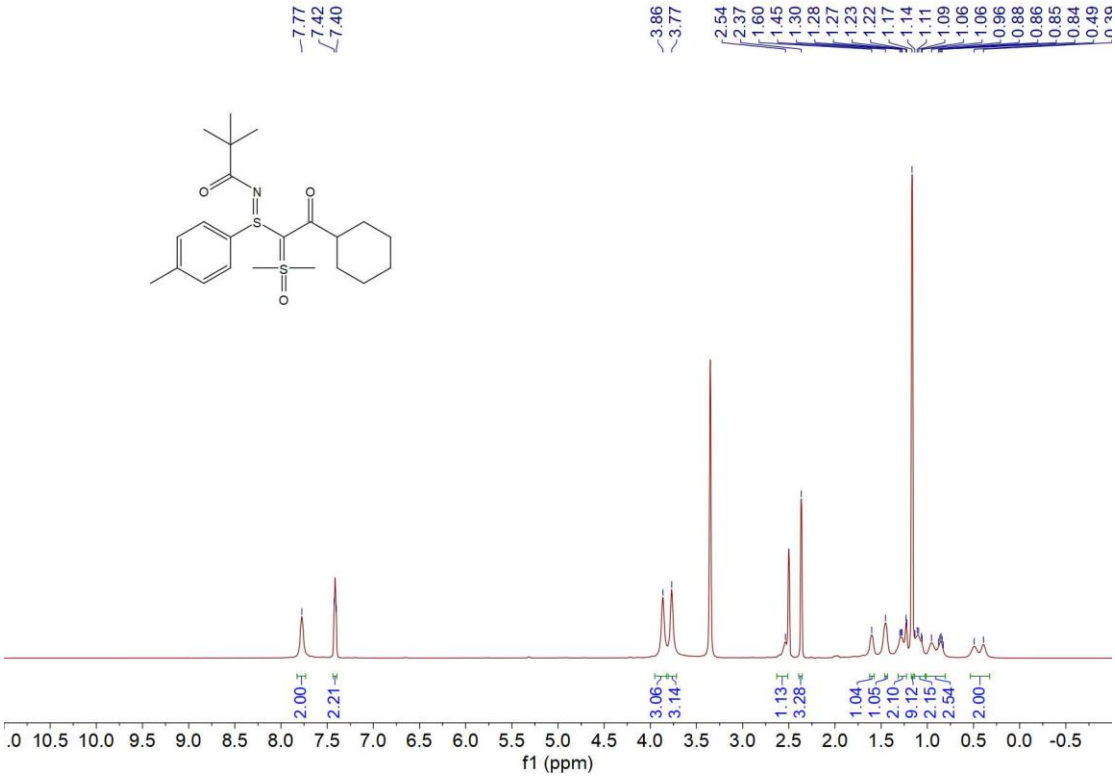
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8w**



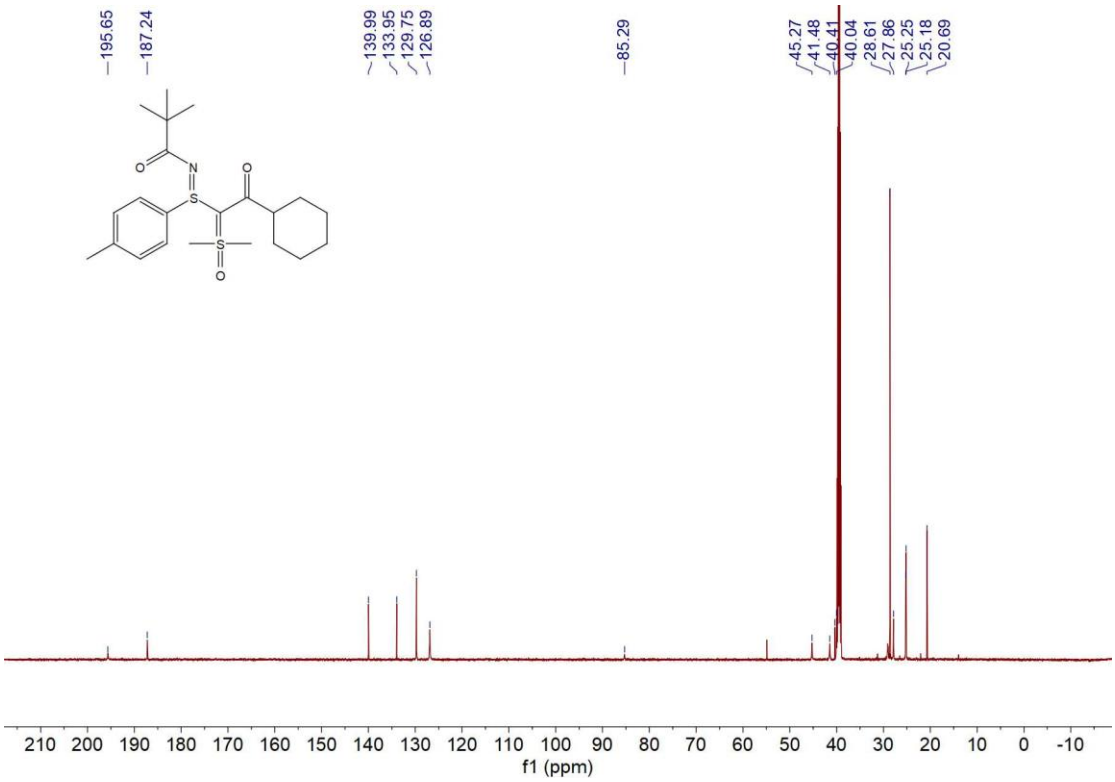
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8w**



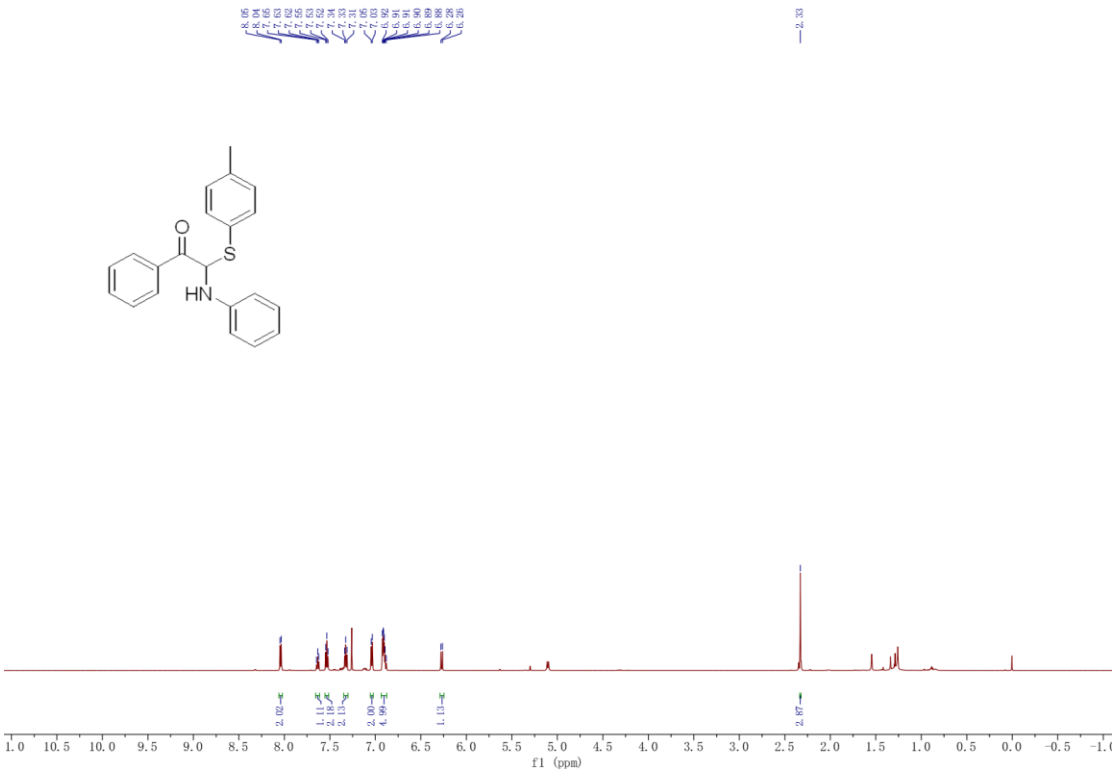
^{1}H NMR (600 MHz, DMSO-d_6) Spectra of **8x**



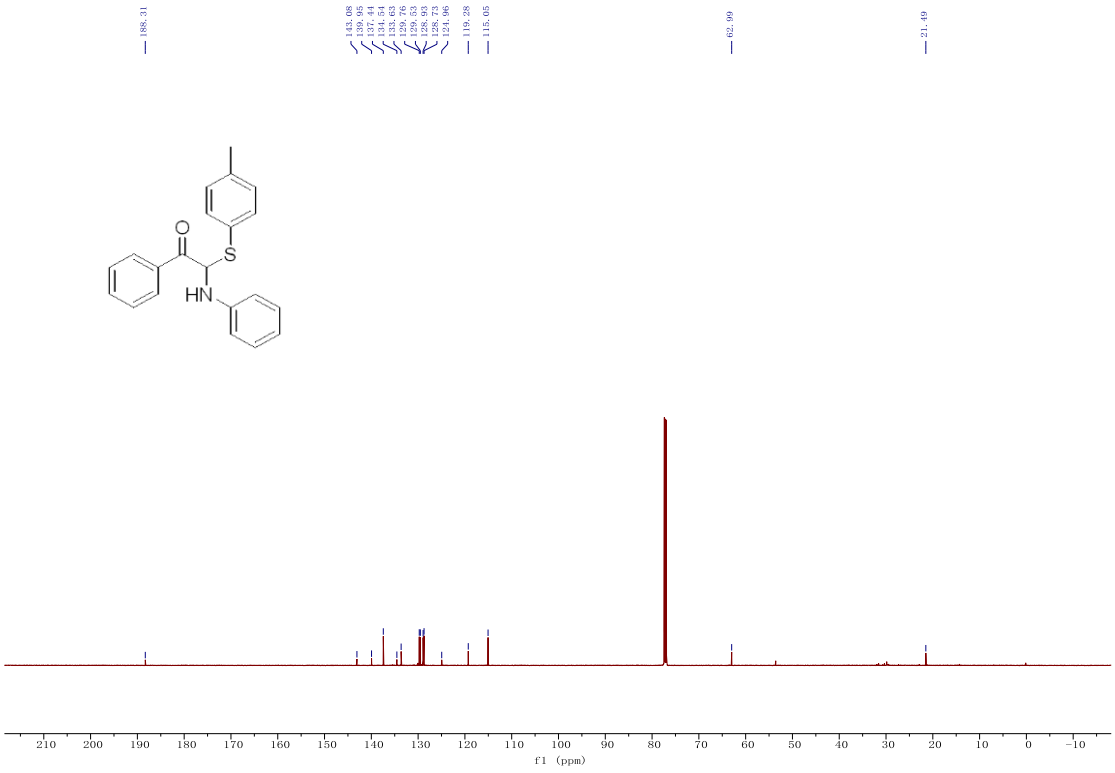
^{13}C NMR (151 MHz, DMSO-d_6) Spectra of **8x**



^{1}H NMR (600 MHz, $CDCl_3$) Spectra of **9**



^{13}C NMR (151 MHz, $CDCl_3$) Spectra of **9**



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