Supporting Information

Single-Atom-Nickel Photocatalytic Site-Selective Sulfonation of Enamides Access to Amidosulfones

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1. General information

The glassware was oven dried at 100 °C for 3 hours and cooled down under vacuum. Sulfinic acids were prepared according to reported procedures.[1] All of the reaction solvents of CH_3CN (99.9%, Extra Dry with molecular sieves, Water≤50 ppm) and others were purchased from Innochem. Unless otherwise noted, materials were obtained from commercial suppliers and used without further purification. X-ray diffraction (XRD) patterns were recorded on a Rigaku smartlab system at 45 kV and 200 mA with Cu-Kα radiation. Fourier transform infrared (FT-IR) were measured using Bruker VERTEX 70 spectrophotometers. The spherical aberration corrected Transmission Electron Microscope (ACTEM) was carried out on a FEI Themis G2 microscope at 100 kV. The scanning electron microscope (SEM) was carried out on a ZEISS Merlin. The elemental composition was characterized with an energy dispersive X-ray spectroscope (EDX, EMAX-5770, HORIBA). UV–vis absorbance spectra were obtained on a Scan UV–vis spectrophotometer (PerkinElmer, Lambda 750S) at the range of 200 – 800 nm. Inductively coupled plasma mass spectrometry (ICP-MS) result was obtained on a GSE200plus. X-ray photoelectron spectroscopy (XPS) data were collected using the AXIS Nova spectrometer (Kratos Analytical) equipped with a monochromatic Al Kα X-ray source. The Al anode was powered at 10 mA and 15 kV. Gas chromatography (Shimazu: Nexis GC-2030). Thin layer chromatography (TLC) employed glass 0.25 mm silica gel plates. Flash chromatography columns were packed with 200-300 mesh silica gel in petroleum (bp. 60 - 90 °C). ^{1}H, ^{13}C and ^{19}F NMR data were recorded with Bruker Advance III (500 MHz) spectrometers with tetramethylsilane as an internal standard. All chemical shifts (δ) are reported in ppm and coupling constants (*J*) in Hz. All chemical shifts are reported relative to tetramethylsilane and d-solvent peaks (77.00 ppm, chloroform), respectively.

2. Preparation of photocatalysts

Synthesis of Ni/TiO_2: Typically, $NiCl_2$•$6H_2O$ (35.7 mg) and TiO_2 (P25: 500 mg) were added into formamide (15.0 mL) under sonication for 10 min. Then the mixture was transferred into a 20 mL Teflon-lined autoclave and heated at 180 °C for 12 h. The resulted black product was washed with deionized water and ethanol 3 times and dried at 60 °C overnight.

3. Characterization of the photocatalysts

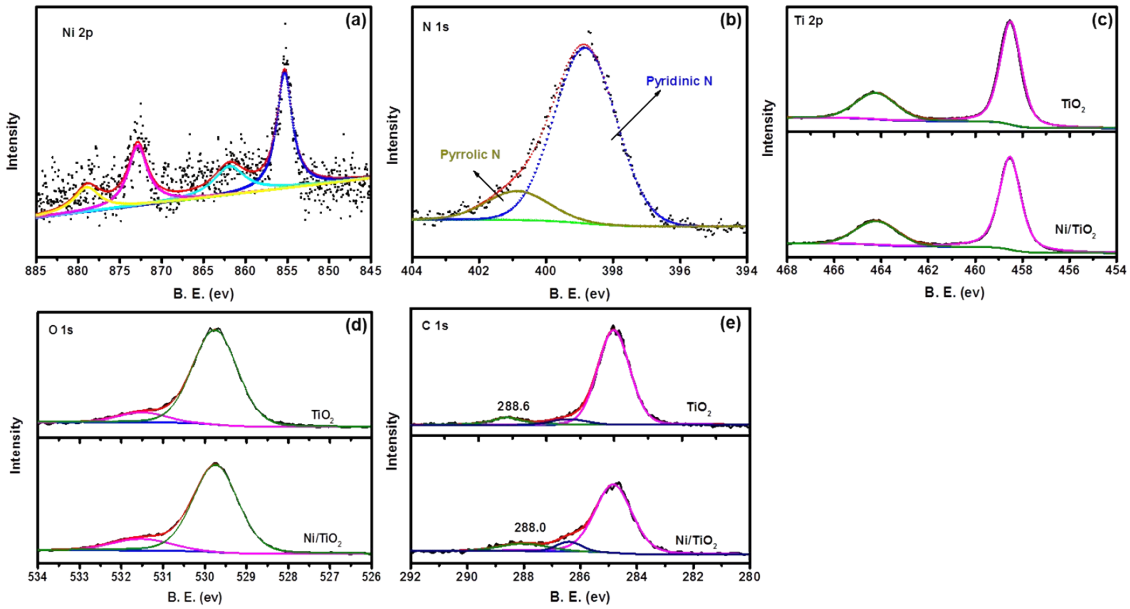


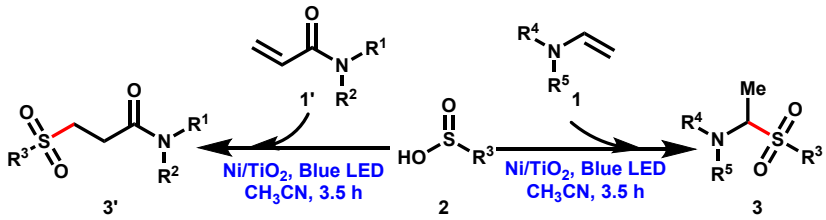
Figure S1. XPS results of Ni/TiO_2. (a) Ni2p; (b) N 1s; (c) Ti2p; (d) O1s; (e) C1s.

Table S1. ICP-MS results of Ni/TiO_2.

Sample	Sampling Quality/g	Constant Volume/mL	Constant Volume	Element	Swot mg/mL	Content mg/kg
Ni/TiO_2	0.0464	25	1	Ni	0.4017	10821.8
Recycle-1	0. 7814	10	1	Ni	0. 1471	0. 0115
Recycle-2	0. 7798	10	1	Ni	0. 1521	0. 0118
Recycle-3	0. 7835	10	1	Ni	0. 7325	0. 0574
Recycle-4	0. 7784	10	1	Ni	0. 4016	0. 0313
Recycle-5	0. 7801	10	1	Ni	0. 3067	0. 0239

Recycle 1-5: This is the content of Ni in the reaction solution.

4. General procedure for single-atom-nickel photocatalytic site-selective sulfonation of enamides access to amidosulfones.



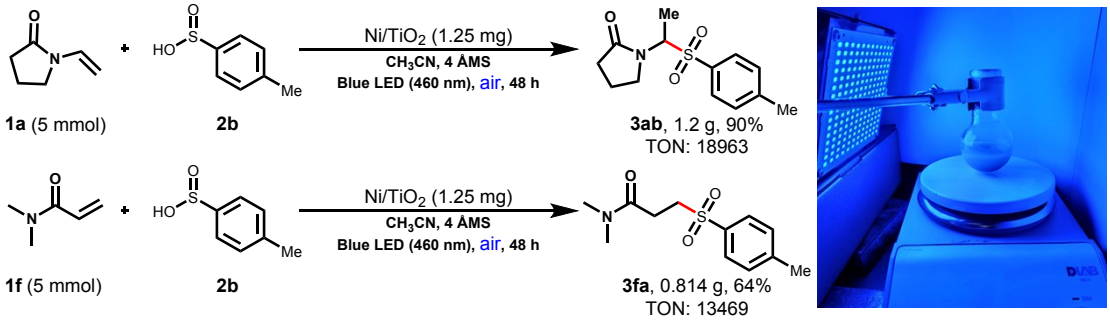
A schlenk tube equipped with a stir bar was loaded with 1.25 mg (0.625 mg/mL) of Ni/TiO_2, enamides **1** or **1'** (0.5 mmol), Sulfonic acid **2** (1.0 mmol) and 4 ÅMS (40.0 mg) in 2.0 mL CH_3CN under air atmosphere. The solution was then stirred at room temperature under the irradiation of blue LED lamp (460 nm) for 3.5 h. After the completion of reaction, the reaction mixture was washed with saturated potassium carbonate solution and extracted with CH_2Cl_2 (10 mL × 3). The organic layers were combined, dried over Na_2SO_4, and concentrated. Then, the pure product was obtained by flash column chromatography on silica gel (petroleum: ethyl ether = 5:1 - 1:1) to afford corresponding products **3** or **3'**.

5. Table S2. Optimization of the reaction conditions [a]

Entry	Solvent (mL)	Yield of **3ab** (%) [b]
1	CH_3OH	33
2	EtOH	37
3	Toluene	62
4	DCE	57
5	DMF	48
6	DMSO	82
7	THF	49
8	1,4-dioxane	39
9	**CH_3CN**	**97**
10	CH_3CN	61[c]
11	CH_3CN	85[d]
12	CH_3CN	82[f]

[a] Standard Conditions: **1a** (0.5 mmol), **2b** (1.0 mmol), Ni/TiO_2 (2.5 mg), 4 ÅMS (40.0 mg), anhydrous solvent (2.0 mL), air, blue LED (460 nm), r. t., 3.5 h. [b] GC yield, 2-phenylphenol as internal standard. [c] 1 h. [d] 2 h. [f] **1a** : **2**b = 1 : 1.

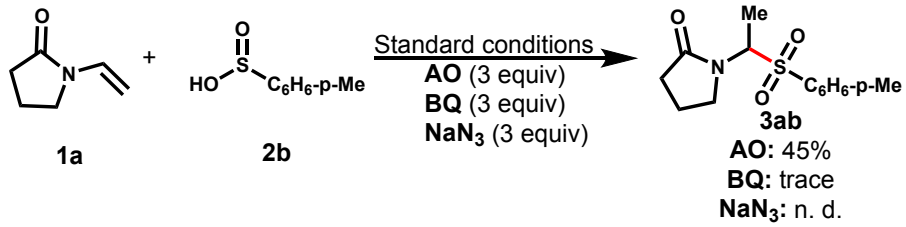
6. Gram-scale experiments



A round-bottom flask (50.0 mL) equipped with a stir bar was loaded with 1.25 mg of Ni/TiO_2, **1a**, **1f** (5.0 mmol), *p*-methylbenzenesulfinic acid **2b** (20.0 mmol) and 4 ÅMS (400.0 mg) in 20.0 mL CH_3CN under air atmosphere. The solution was then stirred at room temperature under the irradiation of blue LED lamp (460 nm) for 48 h. After the completion of reaction, the reaction mixture was washed with saturated potassium carbonate solution and extracted with CH_2Cl_2 (10 mL × 3). The organic layers were combined, dried over Na_2SO_4, and concentrated. The pure product was obtained in 90% (**3ab**, 1.2 g, TON: 18963) and 64% (**3fa**, 0.814 g, TON: 13469) yields by flash column chromatography on silica gel.

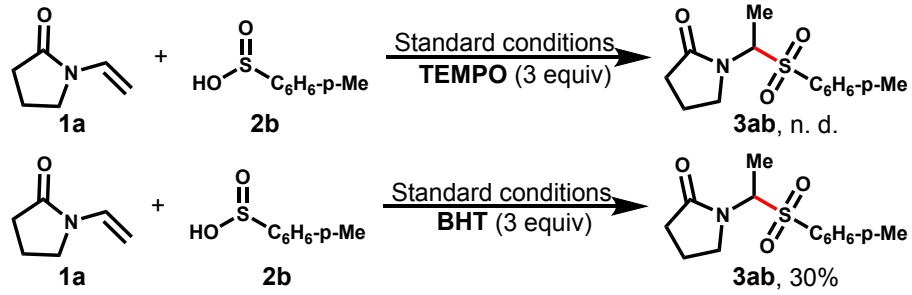
7. Preliminary mechanistic studies

(1) Active species trapping experiments



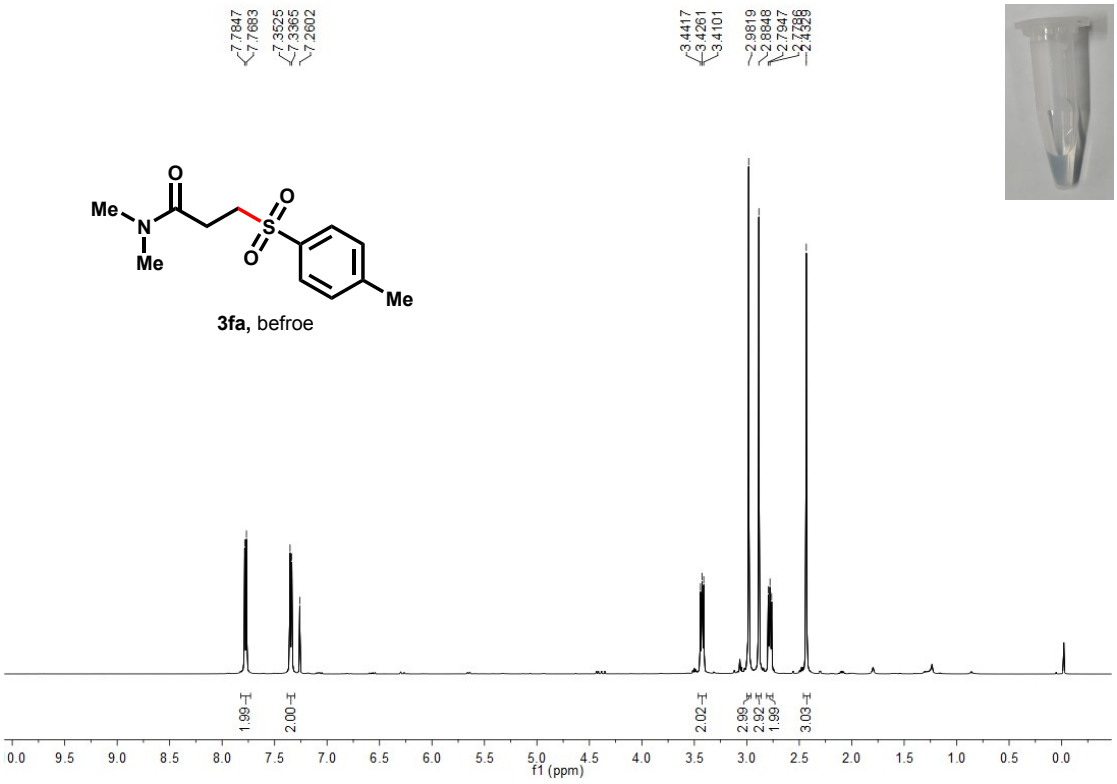
A schlenk tube equipped with a stir bar was loaded with 1.25 mg of Ni/TiO_2, **1a** (0.50 mmol), 4-methylbenzenesulfinic acid **2b** (1.0 mmol), 4 ÅMS (40.0 mg) and three equivalent of ammonium oxalate (AO: hole scavenger), or benzoquinone (BQ: superoxide scavenger) or sodium azide (NaN_3: singlet oxygen scavenger) in 2.0 mL CH_3CN under air atmosphere. The mixture was then stirred at room temperature under the irradiation of blue LED lamp (460 nm) for 3.5 h. After the completion of reaction, it was washed with saturated potassium carbonate solution and then extracted with CH_2Cl_2 (10 mL × 3). The organic layers were combined, dried over Na_2SO_4, and concentrated. Subsequently, the pure product was obtained by flash column chromatography on silica gel (petroleum: ethyl ether = 1 : 1) to afford products **3ab** in yield of 45%, trace and n.d., respectively.

(2) The reaction of 1a and 2b with TEMPO or BHT under the standard conditions.



In an oven-dried schlenk tube equipped with a stir bar, Ni/TiO_2 (1.25 mg), **1a** (0.5 mmol), 4-methylbenzenesulfinic acid **2b** (1.0 mmol), 4 ÅMS (40.0 mg), TEMPO or BHT (1.5 mmol) and CH_3CN (2.0 mL) were separately added. The mixture was then stirred at room temperature under the irradiation of blue LED lamp (460 nm) for 3.5 h. When the reaction was completed, the product **3ab** can be obtained with a yield of 30% when BHT was added in the reaction system.

(3) The ^{1}H NMR results of 3fa before and after irradiation



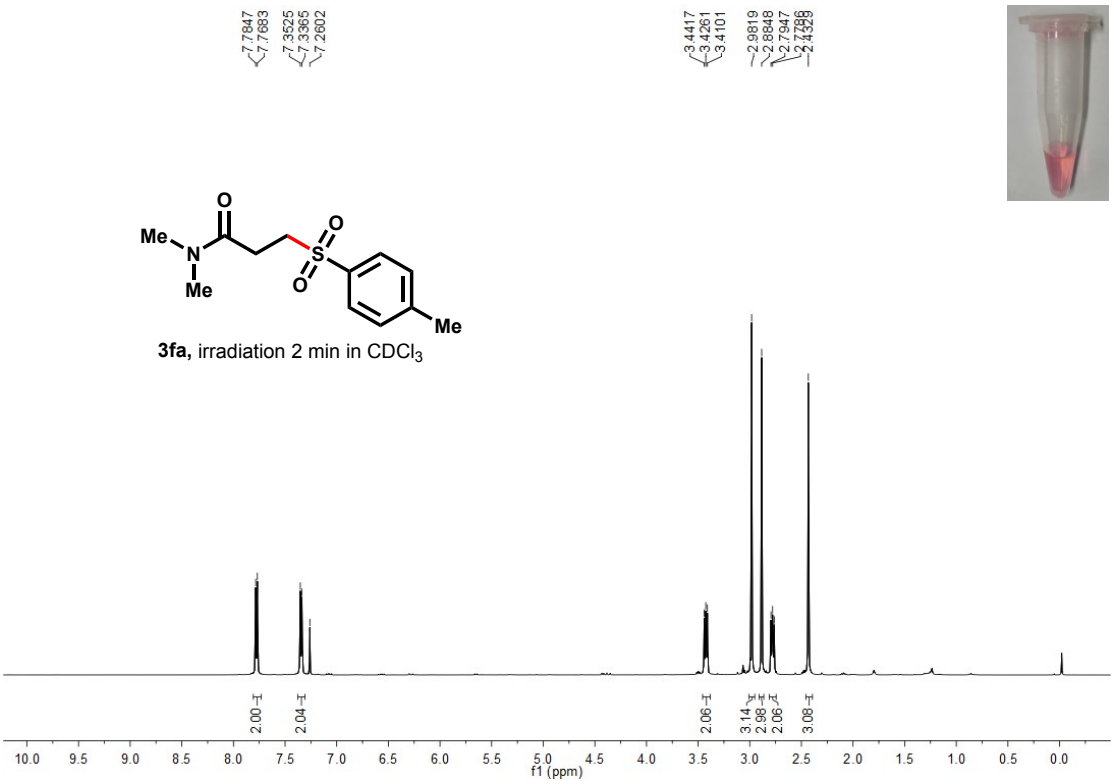
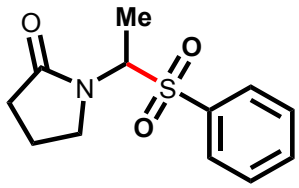


Figure S2. ^{1}H NMR results of **3ea**. (a) before; (b) irradiation 2 min in $CDCl_3$.

8. References

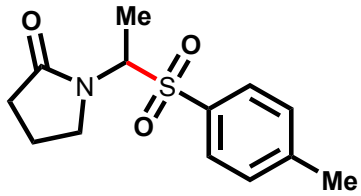
1. S. Oae and H. Togo, *Bull. Chem. Soc. Jpn.*, 1983, **56**, 3802-3812.
2. a) Q. Lu, J. Zhang, G. Zhao, Y. Qi, H. Wang and A. Lei, *J. Am. Chem. Soc.*, 2013, **135**, 11481-11484; b) W. Wei, C. Liu, D. Yang, J. Wen, J. You, Y. Suo and H. Wang, *Chem. Commun.*, 2013, **49**, 10239-10241; c) A. K. Singh, R. Chawla, T. Keshari, V. K. Yadav and L. D. S. Yadav, *Org. Biomol. Chem.*, 2014, **12**, 8550-8554; d) X. Tang, L. Huang, Y. Xu, J. Yang, W. Wu and H. Jiang, *Angew. Chem. Int. Ed.*, 2014, **53**, 4205-4208; e) W. Wei, J. Wen, D. Yang, M. Wu, J. You and H. Wang, *Org. Biomol. Chem.*, 2014, **12**, 7678-7681; f) V. K. Yadav, V. P. Srivastava and L. D. S. Yadav, *Synlett*, 2016, **27**, 427-431.

9. Detail descriptions for products.

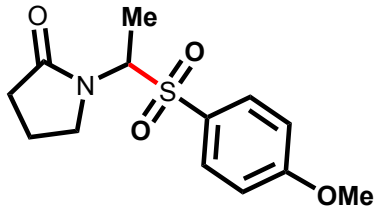


1-(1-(phenylsulfonyl)ethyl)pyrrolidin-2-one (3aa):[2] white solid was obtained with 99% isolated yield (125.3 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (d, J = 7.6 Hz, 2H), 7.62 (t, J = 7.4 Hz, 1H), 7.51 (t, J = 7.7 Hz, 2H), 5.36 (q, J = 7.1 Hz, 1H), 3.75 (dd, J = 14.7, 8.3 Hz, 1H), 3.41 (dd, J = 16.2, 7.8 Hz, 1H), 2.17 (dt, J = 16.4, 8.4 Hz, 1H), 2.08 – 1.85 (m, 3H), 1.61 (d, J = 7.1 Hz, 3H^{13}C NMR (126 MHz, $CDCl_3$) δ 174.7, 136.6, 134.3, 129.1, 128.8, 66.9, 42.8, 30.2, 18.3, 10.1. HRMS (EI) calcd for $C_{12}H_{15}NO_3SNa$

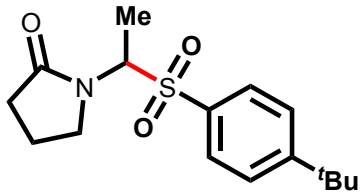
[M+Na]$^+$: 276.0665; found: 276.0664.



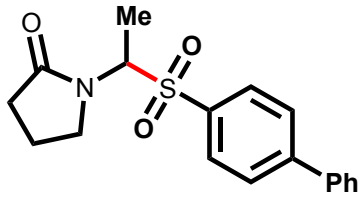
1-(1-tosylethyl)pyrrolidin-2-one (3ab): white solid was obtained with 97% isolated yield (129.5 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.3 Hz, 2H), 7.29 (d, *J* = 8.1 Hz, 2H), 5.33 (q, *J* = 7.1 Hz, 1H), 3.76 – 3.71 (m, 1H), 3.43 – 3.34 (m, 1H), 2.38 (s, 3H), 2.22 – 2.12 (m, 1H), 2.07 – 1.98 (m, 1H), 1.96 – 1.87 (m, 2H), 1.58 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 173.8, 144.3, 132.5, 128.7, 127.8, 65.9, 41.8, 29.2, 20.7, 17.3, 9.1. HRMS (EI) calcd for $C_{13}H_{17}NO_3SNa$ [M+Na]$^+$: 290.0821; found: 290.0816.



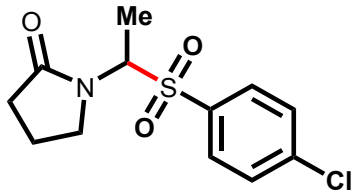
1-(1-((4-methoxyphenyl)sulfonyl)ethyl)pyrrolidin-2-one (3ac): white oil was obtained with 99% isolated yield (140.1 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79 (d, *J* = 8.9 Hz, 2H), 7.00 (d, *J* = 8.9 Hz, 2H), 5.36 (q, *J* = 7.1 Hz, 1H), 3.87 (s, 3H), 3.82 – 3.77 (m, 1H), 3.49 – 3.41 (m, 1H), 2.23 (dt, *J* = 16.8, 8.1 Hz, 1H), 2.15 – 2.06 (m, 1H), 2.03 – 1.94 (m, 2H), 1.64 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 174.8, 164.2, 130.9, 127.7, 114.4, 67.0, 55.6, 42.8, 30.3, 18.3, 10.2. HRMS (EI) calcd for $C_{13}H_{17}NO_4SNa$ [M+Na]$^+$: 306.0770; found: 306.0766.



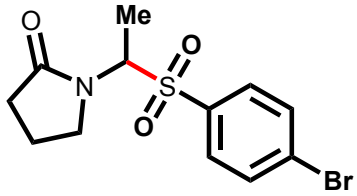
1-(1-((4-(tert-butyl)phenyl)sulfonyl)ethyl)pyrrolidin-2-one (3ad): white oil was obtained with 92% isolated yield (142.1 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78 (d, *J* = 7.8 Hz, 2H), 7.53 (d, *J* = 8.2 Hz, 2H), 5.39 (q, *J* = 6.9 Hz, 1H), 3.76 (dd, *J* = 14.9, 7.5 Hz, 1H), 3.43 (dd, *J* = 15.9, 7.9 Hz, 1H), 2.21 (dt, *J* = 16.2, 8.0 Hz, 1H), 2.00 (m, 3H), 1.60 (d, *J* = 7.1 Hz, 3H), 1.32 (s, 9H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 174.7, 158.2, 133.5, 128.6, 126.0, 67.0, 42.8, 35.2, 31.0, 30.2, 18.2, 10.3. HRMS (EI) calcd for $C_{16}H_{23}NO_3SNa$ [M+Na]$^+$: 332.1291; found: 332.1286.



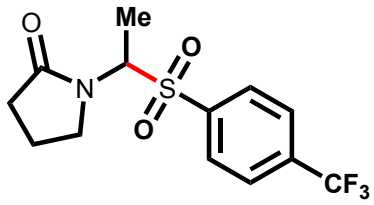
1-(1-([1,1'-biphenyl]-4-ylsulfonyl)ethyl)pyrrolidin-2-one (3ae): white solid was obtained with 79% isolated yield (130.0 mg). ^{1}H NMR (500 MHz, DMSO) δ 7.95 (d, *J* = 8.5 Hz, 2H), 7.89 (d, *J* = 8.5 Hz, 2H), 7.77 (d, *J* = 7.2 Hz, 2H), 7.54 (t, *J* = 7.5 Hz, 2H), 7.47 (t, *J* = 7.3 Hz, 1H), 5.30 (q, *J* = 7.1 Hz, 1H), 3.59 (dt, *J* = 9.1, 6.6 Hz, 1H), 3.48 – 3.42 (m, 1H), 2.14 (dt, *J* = 15.3, 7.5 Hz, 1H), 2.02 – 1.88 (m, 3H), 1.56 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, DMSO) δ 174.6, 146.0, 138.6, 135.5, 129.8, 129.7, 129.3, 127.8, 127.6, 67.4, 42.8, 30.2, 18.3, 10.3. HRMS (EI) calcd for $C_{18}H_{19}NO_3SNa$ $[M+Na]^+$:352.0978; found: 352.0974.



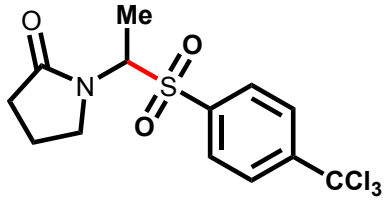
1-(1-((4-chlorophenyl)sulfonyl)ethyl)pyrrolidin-2-one (3af): white oil was obtained with 92% isolated yield (132.0 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.5 Hz, 2H), 7.48 (d, *J* = 8.5 Hz, 2H), 5.37 (q, *J* = 7.1 Hz, 1H), 3.74 (td, *J* = 8.8, 5.3 Hz, 1H), 3.41 (dd, *J* = 16.4, 7.8 Hz, 1H), 2.26 – 2.15 (m, 1H), 2.09 – 1.87 (m, 3H), 1.62 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 174.8, 141.0, 135.2, 130.3, 129.4, 67.1, 42.8, 30.2, 18.3, 10.0. HRMS (EI) calcd for $C_{12}H_{14}NO_3ClSNa$ $[M+Na]^+$: 310.0275; found:310.0271.



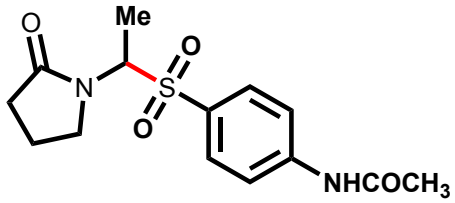
1-(1-((4-bromophenyl)sulfonyl)ethyl)pyrrolidin-2-one (3ag): white oil was obtained with 82% isolated yield (135.7 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.72 (d, *J* = 8.5 Hz, 2H), 7.67 (d, *J* = 8.6 Hz, 2H), 5.40 (q, *J* = 7.1 Hz, 1H), 3.81 – 3.69 (m, 1H), 3.48 – 3.38 (m, 1H), 2.28 – 2.16 (m, 1H), 2.14 – 1.88 (m, 3H), 1.64 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 174.8, 135.8, 132.4, 130.3, 129.7, 67.1, 42.8, 30.2, 18.4, 10.0. HRMS (EI) calcd for $C_{12}H_{14}NO_3BrSNa$ $[M+Na]^+$: 353.9770; found: 353.9765.



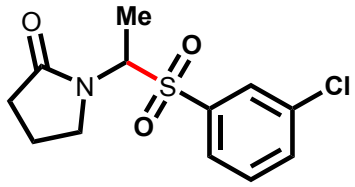
1-(1-((4-(trifluoromethyl)phenyl)sulfonyl)ethyl)pyrrolidin-2-one (3ah): white oil was obtained with 83% isolated yield (133.2 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.01 (d, *J* = 8.2 Hz, 2H), 7.80 (d, *J* = 8.3 Hz, 2H), 5.44 (q, *J* = 7.1 Hz, 1H), 3.86 – 3.70 (m, 1H), 3.45 (dd, *J* = 16.5, 7.6 Hz, 1H), 2.27 – 2.15 (m, 1H), 2.08 – 1.90 (m, 3H), 1.66 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 174.8, 140.6, 135.8 (q, *J* = 33.2 Hz), 129.5, 126.2 (q, *J* = 3.6 Hz), 124.6 (q, *J* = 273.7 Hz), 67.1, 42.8, 30.1, 18.3, 9.9. HRMS (EI) calcd for $C_{13}H_{14}NO_3F_3SNa$ $[M+Na]^+$: 344.0539; found: 344.0535.



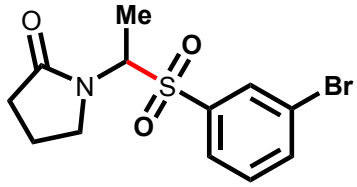
1-(1-((4-(trichloromethyl)phenyl)sulfonyl)ethyl)pyrrolidin-2-one (3ai): white oil was obtained with 86% isolated yield (158.7 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00 (d, *J* = 8.1 Hz, 2H), 7.79 (d, *J* = 8.2 Hz, 2H), 5.43 (q, *J* = 7.1 Hz, 1H), 3.76 (td, *J* = 8.9, 5.1 Hz, 1H), 3.44 (dd, *J* = 16.5, 7.5 Hz, 1H), 2.26 – 2.14 (m, 1H), 2.08 – 1.89 (m, 3H), 1.65 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, CDCl3) δ 174.8, 146.9, 135.2, 130.2, 129.4, 97.5, 67.0, 42.8, 30.2, 18.3, 10.0. HRMS (EI) calcd for $C_{13}H_{15}NO_3Cl_3$ $[M+H]^+$: 369.9833; found: 369.9830.



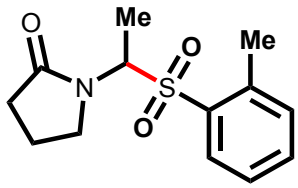
N-(4-((1-(2-oxopyrrolidin-1-yl)ethyl)sulfonyl)phenyl)acetamide (3aj): white oil was obtained with 90% isolated yield (139.5 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.31 (s, 1H), 7.78 (d, *J* = 8.8 Hz, 2H), 7.72 (d, *J* = 8.8 Hz, 2H), 5.36 (q, *J* = 7.1 Hz, 1H), 3.84 (dt, *J* = 9.7, 6.8 Hz, 1H), 3.48 (dt, *J* = 9.7, 7.3 Hz, 1H), 2.29 – 2.22 (m, 1H), 2.17 (s, 3H), 2.15 – 2.09 (m, 1H), 2.06 – 1.99 (m, 2H), 1.67 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, DMSO) δ 170.4, 164.3, 139.1, 125.7, 125.3, 114.3, 62.4, 38.3, 25.7, 19.9, 13.5, 5.4. HRMS (EI) calcd for $C_{14}H_{18}N_2O_4SNa$ $[M+Na]^+$: 333.0879; found: 333.0878.



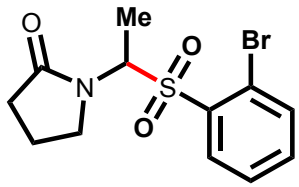
1-(1-((3-chlorophenyl)sulfonyl)ethyl)pyrrolidin-2-one (3ak): white oil was obtained with 71% isolated yield (101.9 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (s, 1H), 7.79 (d, *J* = 7.8 Hz, 1H), 7.63 (dd, *J* = 8.0, 0.9 Hz, 1H), 7.51 (t, *J* = 7.9 Hz, 1H), 5.39 (q, *J* = 7.1 Hz, 1H), 3.88 – 3.76 (m, 1H), 3.54 – 3.40 (m, 1H), 2.29 – 2.20 (m, 1H), 2.17 – 2.07 (m, 1H), 2.06 – 1.99 (m, 2H), 1.67 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 174.8, 138.4, 135.2, 134.4, 130.5, 128.9, 127.1, 67.3, 4, 30.2, 18.1, 9.9. HRMS (EI) calcd for $C_{12}H_{14}NO_3ClSNa$ $[M+Na]^+$: 310.0275; found:310.0271.



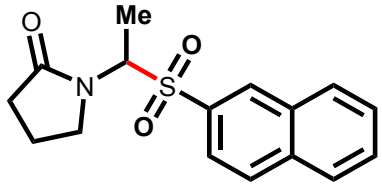
1-(1-((3-bromophenyl)sulfonyl)ethyl)pyrrolidin-2-one (3al): white oil was obtained with 64% isolated yield (105.9 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.79 (d, *J* = 7.8 Hz, 1H), 7.74 (d, *J* = 8.0 Hz, 1H), 7.41 (t, *J* = 7.9 Hz, 1H), 5.33 (q, *J* = 7.1 Hz, 1H), 3.76 (dd, *J* = 14.4, 8.4 Hz, 1H), 3.42 (dd, *J* = 16.8, 7.5 Hz, 1H), 2.21 (dt, *J* = 16.8, 8.4 Hz, 1H), 2.12 – 1.88 (m, 3H), 1.62 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 174.7, 138.4, 137.3, 131.7, 130.8, 127.5, 122.9, 67.3, 42.8, 30.2, 18.3, 9.9. HRMS (EI) calcd for $C_{12}H_{14}NO_3BrSNa$ $[M+Na]^+$: 353.9770; found: 353.9765.



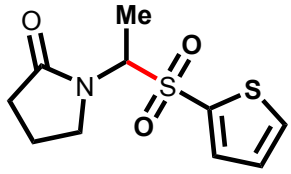
1-(1-(o-tolylsulfonyl)ethyl)pyrrolidin-2-one (3am): white oil was obtained with 76% isolated yield (101.5 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.91 (d, *J* = 7.8 Hz, 1H), 7.51 (t, *J* = 7.2 Hz, 1H), 7.39 – 7.28 (m, 2H), 5.52 (q, *J* = 7.1 Hz, 1H), 3.83 – 3.70 (m, 1H), 3.43 (dd, *J* = 15.7, 7.8 Hz, 1H), 2.78 (s, 3H), 2.23 – 2.14 (m, 1H), 2.02 – 1.86 (m, 3H), 1.65 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 175.0, 140.1, 134.5, 134.2, 133.1, 130.5, 125.8, 65.9, 42.9, 30.2, 20.4, 18.3, 9.9. HRMS (EI) calcd for $C_{13}H_{17}NO_3SNa$ $[M+Na]^+$: 290.0821; found: 290.0816.



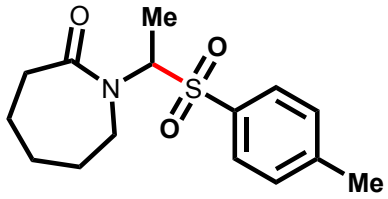
1-(1-((2-bromophenyl)sulfonyl)ethyl)pyrrolidin-2-one (3an): white oil was obtained with 77% isolated yield (127.4 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.06 – 7.96 (m, 1H), 7.80 – 7.71 (m, 1H), 7.49 – 7.41 (m, 2H), 5.92 (q, *J* = 7.2 Hz, 1H), 3.86 – 3.77 (m, 1H), 3.41 (dt, *J* = 9.3, 7.7 Hz, 1H), 2.23 – 2.14 (m, 1H), 2.04 – 1.86 (m, 3H), 1.67 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 175.4, 136.2, 135.9, 135.2, 132.4, 127.4, 122.6, 65.4, 43.1, 30.3, 18.4, 9.7. HRMS (EI) calcd for $C_{12}H_{14}NO_3BrSNa$ $[M+Na]^+$: 353.9770; found: 353.9765.



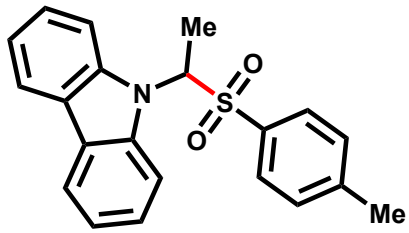
1-(1-(naphthalen-2-ylsulfonyl)ethyl)pyrrolidin-2-one (3ao): white solid was obtained with 88% isolated yield (133.3 mg) ^{1}H NMR (500 MHz, DMSO) δ 7.94 (d, *J* = 8.6 Hz, 2H), 7.89 (d, *J* = 8.6 Hz, 2H), 7.80 – 7.75 (m, 2H), 7.53 (t, *J* = 7.5 Hz, 2H), 7.49 – 7.44 (m, 1H), 5.30 (q, *J* = 7.1 Hz, 1H), 3.59 (dt, *J* = 9.1, 6.6 Hz, 1H), 3.45 (dt, *J* = 9.2, 7.2 Hz, 1H), 2.16 – 2.07 (m, 1H), 2.03 – 1.85 (m, 3H), 1.56 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, DMSO) δ 174.6, 146.0, 138.6, 135.5, 129.8, 129.7, 129.3, 127.8, 127.6, 67.4, 42.8, 30.2, 18.3, 10.3. HRMS (EI) calcd for $C_{16}H_{17}NO_3SNa$ $[M + Na]^+$: 326.0821; found: 326.0820



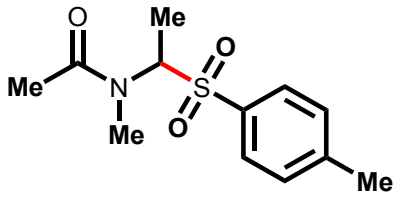
1-(1-(thiophen-2-ylsulfonyl)ethyl)pyrrolidin-2-one (3ap): white oil was obtained with 60% isolated yield (77.7 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.75 (dd, *J* = 5.0, 1.3 Hz, 1H), 7.71 (dd, *J* = 3.8, 1.3 Hz, 1H), 7.18 (dd, *J* = 4.9, 3.8 Hz, 1H), 5.47 (q, *J* = 7.1 Hz, 1H), 3.91 – 3.83 (m, 1H), 3.50 – 3.42 (m, 1H), 2.34 – 2.17 (m, 2H), 2.13 – 1.95 (m, 3H), 1.69 (d, *J* = 7.1 Hz, 3H ^{13}C NMR (126 MHz, $CDCl_3$) δ 174.9, 137.0, 135.5, 135.2, 128.3, 68.3, 42.8, 30.3, 18.4, 10.2. HRMS (EI) calcd for $C_{10}H_{13}NO_3SNa$ $[M + Na]^+$: 282.0229; found: 282.0226.



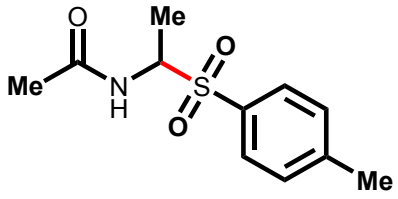
1-(1-tosylethyl)azepan-2-one (3ba): white solid was obtained with 99% isolated yield (146.0 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.3 Hz, 2H), 7.24 (d, *J* = 8.1 Hz, 2H), 5.94 (q, *J* = 7.1 Hz, 1H), 3.61 (dd, *J* = 15.5, 7.2 Hz, 1H), 3.32 (dd, *J* = 15.6, 9.7 Hz, 1H), 2.35 (s, 3H), 2.23 (dd, *J* = 7.3, 4.1 Hz, 2H), 1.89 – 1.77 (m, 1H), 1.73 – 1.65 (m, 1H), 1.56 – 1.47 (m, 5H), 1.43 – 1.33 (m, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 175.8, 144.9, 134.1, 129.5, 128.8, 67.6, 43.8, 36.6, 29.6, 29.1, 23.1, 21.6, 10.7. HRMS (EI) calcd for $C_{15}H_{21}NO_3SNa$ $[M+Na]^+$: 318.1134; found: 318.1131.



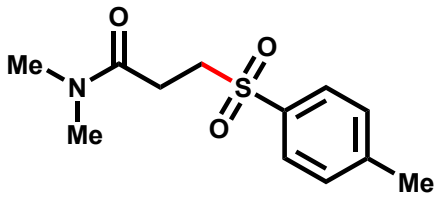
9-(1-tosylethyl)-9H-carbazole (3ca): white solid was obtained with 67% isolated yield (116.9 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.17 (s, 1H), 7.95 (d, *J* = 7.7 Hz, 1H), 7.82 (s, 1H), 7.46 – 7.42 (m, 2H), 7.41 (d, *J* = 3.6 Hz, 2H), 7.25 – 7.19 (m, 2H), 7.16 (d, *J* = 8.4 Hz, 1H), 7.13 (d, *J* = 8.0 Hz, 2H), 4.40 (q, *J* = 7.1 Hz, 1H), 2.35 (s, 3H), 1.85 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 144.3, 139.8, 139.6, 134.1, 129.3, 129.3, 127.2, 126.1, 124.5, 123.3, 123.0, 121.3, 120.4, 119.6, 110.7, 110.4, 66.4, 21.6, 14.7. HRMS (EI) calcd for $C_{21}H_{19}NO_2SNa$ $[M+Na]^+$: 372.1029; found: 372.1028.



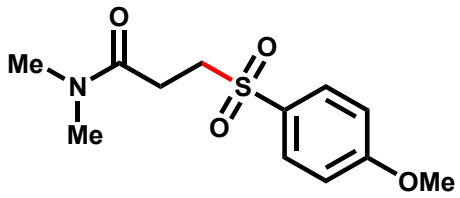
N-methyl-N-(1-tosylethyl)acetamide (3da): white oil was obtained with 95% isolated yield (121.1 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.1 Hz, 2H), 7.31 (d, *J* = 8.0 Hz, 2H), 6.00 (q, *J* = 7.1 Hz, 1H), 3.07 (s, 3H), 2.42 (s, 3H), 1.87 (s, 3H), 1.59 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, DMSO) δ 166.3, 140.3, 129.3, 124.9, 124.1, 62.5, 26.1, 16.9, 16.8, 5.4. HRMS (EI) calcd for $C_{12}H_7NO_3SNa$ $[M+Na]^+$: 278.0821; found: 278.2820.



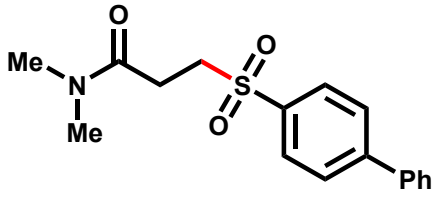
N-(1-tosylethyl)acetamide (3ea): white oil was obtained with 92% isolated yield (110.8 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.2 Hz, 2H), 7.35 (d, *J* = 8.1 Hz, 2H), 6.72 (d, *J* = 10.2 Hz, 1H), 5.42 – 5.33 (m, 1H), 2.44 (s, 3H), 1.85 (s, 3H), 1.60 (d, *J* = 7.0 Hz, 3H). ^{13}C NMR (126 MHz, DMSO) δ 164.4, 140.6, 128.6, 125.1, 124.3, 60.3, 17.9, 16.9, 8.4. HRMS (EI) calcd for $C_{11}H_{15}O_3SNa$ $[M+Na]^+$: 264.0665; found: 264.0663.



N,N-dimethyl-3-tosylpropanamide (3fa): white oil was obtained with 76% isolated yield (96.9 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.2 Hz, 2H), 7.34 (d, *J* = 8.0 Hz, 2H), 3.43 (t, *J* = 7.8 Hz, 2H), 2.98 (s, 3H), 2.88 (s, 3H), 2.78 (t, *J* = 8.1 Hz, 2H), 2.43 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 168.7, 144.8, 136.2, 129.9, 127.9, 52.2, 37.1, 35.6, 26.3, 21.6. HRMS (EI) calcd for $C_{12}H_{18}NO_3S$ $[M+H]^+$: 256.1002 ; found: 256.1000.

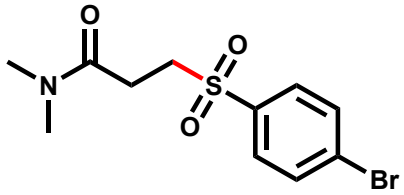


3-((4-methoxyphenyl)sulfonyl)-N,N-dimethylpropanamide (3fb): white oil was obtained with 64% isolated yield (86.7 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.9 Hz, 2H), 7.02 (d, *J* = 8.9 Hz, 2H), 3.89 (s, 3H), 3.44 (t, *J* = 7.9 Hz, 2H), 3.01 (s, 3H), 2.91 (s, 3H), 2.81 (t, *J* = 8.1 Hz, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 168.8, 163.8, 130.7, 130.2, 114.5, 55.7, 52.4, 37.1, 35.6, 26.3. HRMS (EI) calcd for $C_{12}H_{18}NO_4S$ $[M+H]^+$: 272.0951 ; found: 272.0952.

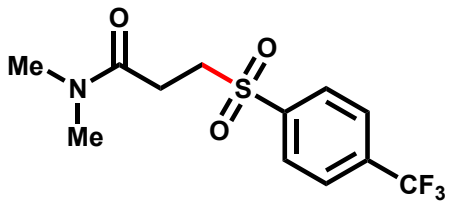


3-([1,1'-biphenyl]-4-ylsulfonyl)-N,N-dimethylpropanamide (**3fd**): white oil was obtained with 58%

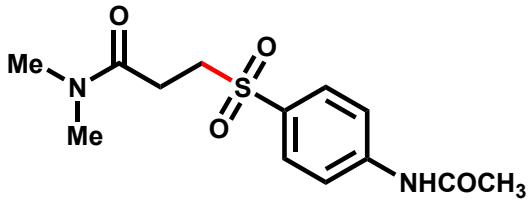
isolated yield (91.9 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.98 (d, J = 8.4 Hz, 2H), 7.78 (d, J = 8.4 Hz, 2H), 7.62 (d, J = 7.2 Hz, 2H), 7.50 (d, J = 7.1 Hz, 2H), 7.44 (t, J = 7.3 Hz, 1H), 3.52 (t, J = 7.8 Hz, 2H), 3.02 (s, 3H), 2.92 (s, 3H), 2.85 (t, J = 8.0 Hz, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 168.7, 146.8, 139.1, 137.6, 132.1, 129.1, 128.5, 127.9, 127.4, 52.2, 37.1, 35.6, 26.2, 21.1. HRMS (EI) calcd for $C_{17}H_{20}NO_3S$ $[M+H]^+$: 318.1158 ; found: 318.1158.



3-((4-bromophenyl)sulfonyl)-N,N-dimethylpropanamide (3ff): white oil was obtained with 76% isolated yield (121.2 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.77 (d, J = 8.5 Hz, 2H), 7.71 (d, J = 8.6 Hz, 2H), 3.46 (t, J = 7.7 Hz, 2H), 3.00 (s, 3H), 2.90 (s, 3H), 2.80 (t, J = 7.9 Hz, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 168.5, 138.2, 132.7, 129.5, 129.3, 52.1, 37.1, 35.7, 26.1. HRMS (EI) calcd for $C_{11}H_{15}BrNO_3S$ $[M+H]^+$: 319.9951 ; found: 319.9949.

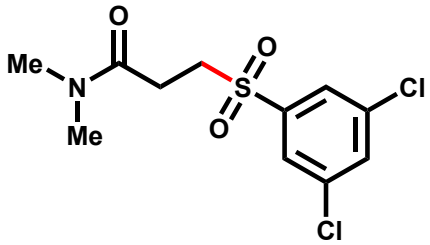


N,N-dimethyl-3-((4-(trifluoromethyl)phenyl)sulfonyl)propanamide (3fh): white oil was obtained with 79% isolated yield (122.0 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.06 (d, J = 8.1 Hz, 2H), 7.84 (d, J = 8.1 Hz, 2H), 3.51 (t, J = 7.6 Hz, 2H), 3.01 (s, 3H), 2.89 (s, 3H), 2.83 (t, J = 7.8 Hz, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 168.3, 142.7, 135.6 (q, J = 33.2 Hz), 128.6 (d, J = 15.8 Hz), 126.5 (q, J = 3.6 Hz), 125.9 (q, J = 273.4 Hz), 52.0, 37.1, 35.6, 25.9. HRMS (EI) calcd for $C_{12}H_{15}NO_3F_3S$ $[M+H]^+$: 310.0719 ; found: 310.0716.

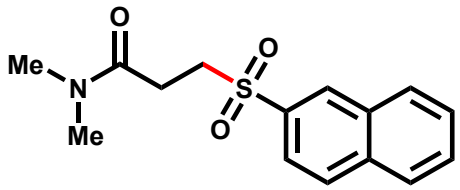


3-((4-acetamidophenyl)sulfonyl)-N,N-dimethylpropanamide (3fi): white oil was obtained with 71% isolated yield (105.8 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.98 (s, 1H), 7.81 (d, J = 8.5 Hz, 2H), 7.71 (d, J = 8.3 Hz, 2H), 3.44 (t, J = 7.7 Hz, 2H), 3.01 (s, 3H), 2.91 (s, 3H), 2.80 (t, J = 8.0 Hz, 2H), 2.21 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 169.1, 168.8, 143.4, 133.2, 129.2, 119.4, 52.2, 37.2, 35.7, 26.3. HRMS

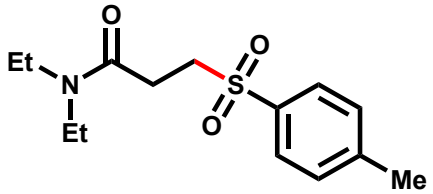
(EI) calcd for $C_{13}H_{19}N_2O_4S$ $[M+H]^+$: 299.1060; found: 299.1058.



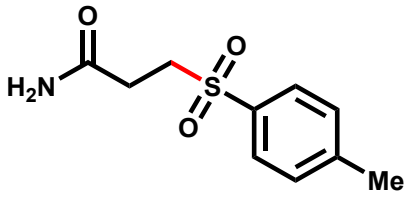
3-((3,5-dichlorophenyl)sulfonyl)-N,N-dimethylpropanamide (3fj): white oil was obtained with 68% isolated yield (105.1 mg). ^{1}H NMR (500 MHz, DMSO) δ 8.06 (t, *J* = 1.8 Hz, 1H), 7.94 (s, 1H), 7.93 (s, 1H), 3.66 (t, *J* = 7.3 Hz, 2H), 2.93 (s, 3H), 2.75 (s, 3H), 2.69 (t, *J* = 7.3 Hz, 2H). ^{13}C NMR (126 MHz, DMSO) δ 168.6, 142.4, 135.6, 133.9, 127.0, 51.3, 37.0, 35.5, 26.3. HRMS (EI) calcd for $C_{11}H_{13}Cl_2NNaO_3S$ $[M+Na]^+$: 331.9985 ; found: 331.9882.



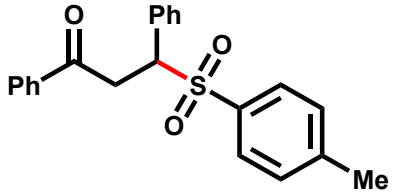
N,N-dimethyl-3-(naphthalen-2-ylsulfonyl)propanamide (3fn): white oil was obtained with 66% isolated yield (96.0 mg). ^{1}H NMR (500 MHz, DMSO) δ 8.60 (s, 1H), 8.22 (d, *J* = 8.1 Hz, 1H), 8.18 (d, *J* = 8.7 Hz, 1H), 8.08 (d, *J* = 8.1 Hz, 1H), 7.92 (dd, *J* = 8.6, 1.6 Hz, 1H), 7.75 (t, *J* = 7.3 Hz, 1H), 7.70 (t, *J* = 7.4 Hz, 1H), 3.60 (t, *J* = 7.4 Hz, 2H), 2.89 (s, 3H), 2.69 (t, *J* = 7.8 Hz, 2H), 2.66 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 168.7, 136.3, 135.3, 132.2, 130.0, 129.9, 129.8, 129.8, 128.4, 128.2, 123.2, 51.6, 36.9, 35.4, 26.4. HRMS (EI) calcd for $C_{15}H_{18}NO_3S$ $[M+H]^+$:292.1002; found: 292.1000.



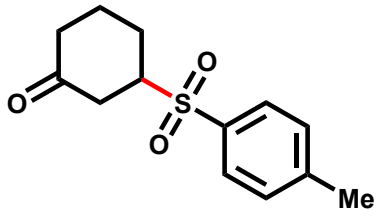
N,N-diethyl-3-tosylpropanamide (3ga): white oil was obtained with 80% isolated yield (113.2 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.80 (d, *J* = 8.3 Hz, 2H), 7.36 (d, *J* = 8.4 Hz, 2H), 3.47 (t, *J* = 7.7 Hz, 2H), 3.31 (dq, *J* = 11.8, 7.1 Hz, 4H), 2.81 (t, *J* = 7.9 Hz, 2H), 2.45 (s, 3H), 1.18 (t, *J* = 7.2 Hz, 3H), 1.06 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 167.8, 144.8, 136.2, 129.9, 127.9, 52.2, 41.9, 40.5, 25.9, 21.6, 14.2, 12.9. HRMS (EI) calcd for $C_{12}H_{24}NO_3S$ $[M+H]^+$: 284.1315 ; found: 284.1311.



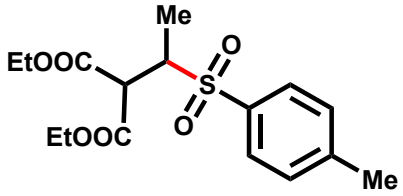
3-tosylpropanamide (3ha): white oil was obtained with 71% isolated yield (80.5 mg). ^{1}H NMR (500 MHz, DMSO) δ 7.77 (d, *J* = 8.2 Hz, 2H), 7.47 (d, *J* = 8.0 Hz, 2H), 3.44 (t, *J* = 7.6 Hz, 2H), 2.42 (s, 3H), 2.37 (t, *J* = 7.8 Hz, 2H). ^{13}C NMR (126 MHz, DMSO) δ 170.7, 144.9, 136.3, 130.4, 128.2, 51.4, 28.6, 21.5. HRMS (EI) calcd for $C_{10}H_{13}NO_3SNa$ $[M+Na]^+$: 250.0508 ; found: 250.0506.



1,3-diphenyl-3-tosylpropan-1-one (3ia): white solid was obtained with 71% isolated yield (80.5 mg). ^{1}H NMR (500 MHz, DMSO) δ 7.96 (d, *J* = 7.6 Hz, 2H), 7.65 (t, *J* = 7.4 Hz, 1H), 7.52 (m, 4H), 7.33 (d, *J* = 8.1 Hz, 2H), 7.26 (m, 5H), 5.04 (dd, *J* = 9.1, 4.3 Hz, 1H), 4.03 (dd, *J* = 18.0, 9.2 Hz, 1H), 3.89 (dd, *J* = 18.0, 4.3 Hz, 1H), 2.36 (s, 3H). ^{13}C NMR (126 MHz, DMSO) δ 195.7, 145.0, 136.3, 134.3, 134.1, 132.9, 130.4, 130.0, 129.2, 129.0, 128.5, 65.9, 37.2, 21.5. HRMS (EI) calcd for $C_{22}H_{20}NO_3SNa$ $[M+Na]^+$: 387.1025 ; found: 387.1024.

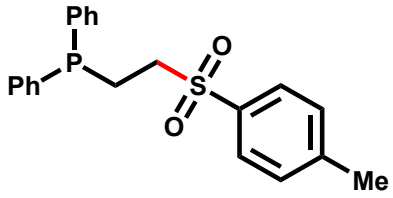


3-tosylcyclohexan-1-one (3ja): white solid was obtained with 86% isolated yield (108.3 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.66 (d, *J* = 8.2 Hz, 2H), 7.30 (d, *J* = 8.1 Hz, 2H), 3.21 (m, 1H), 2.49 (td, *J* = 14.0, 8.4 Hz, 2H), 2.37 (s, 3H), 2.31 (dd, *J* = 13.5, 1.4 Hz, 1H), 2.17 (m, 3H), 1.80 (m, 1H), 1.56 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 206.5, 145.3, 133.5, 130.0, 128.9, 62.2, 40.4, 40.3, 23.7, 23.3, 21.6. HRMS (EI) calcd for $C_{13}H_{16}O_3SNa$ $[M+Na]^+$: 275.0712 ; found: 275.0708.



diethyl 2-(1-tosylethyl)malonate (3ka): white solid was obtained with 98% isolated yield (167.5 mg).

^{1}H NMR (500 MHz, DMSO) δ 7.76 (d, *J* = 8.3 Hz, 2H), 7.50 (d, *J* = 8.1 Hz, 2H), 4.14 (t, *J* = 7.1 Hz, 2H), 4.08 (t, *J* = 7.1 Hz, 2H), 3.90 (dd, *J* = 14.1, 7.0 Hz, 1H), 3.74 (d, *J* = 6.9 Hz, 1H), 2.43 (s, 3H), 1.27 (d, *J* = 7.1 Hz, 3H), 1.17 (t, *J* = 7.5 Hz, 6H). ^{13}C NMR (126 MHz, DMSO) δ 166.5, 166.2, 145.7, 133.8, 130.5, 129.3, 62.3, 62.1, 58.5, 51.0, 21.5, 14.2, 14.1, 11.4. HRMS (EI) calcd for $C_{16}H_{22}NO_6SNa$ $[M+Na]^+$: 365.1029 ; found: 365.1027.

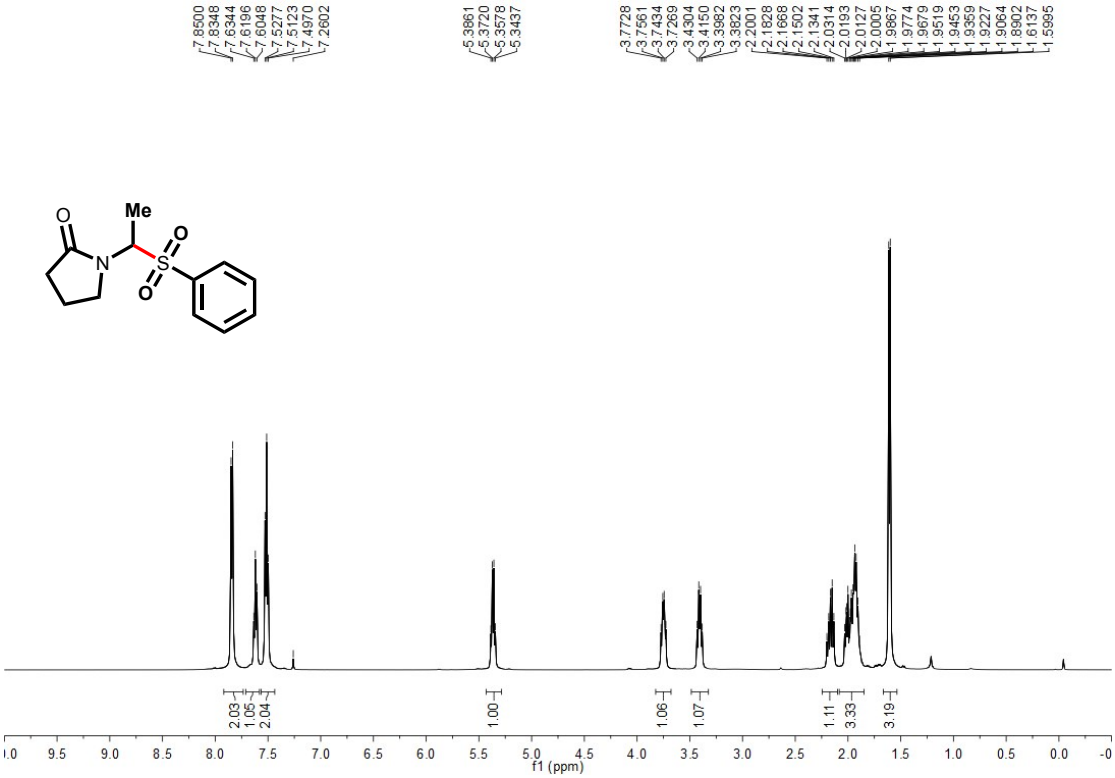


diphenyl(2-tosylethyl)phosphane (3la):): white solid was obtained with 51% isolated yield (93.8 mg). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.74 (d, *J* = 8.1 Hz, 2H), 7.34 (m, 12H), 3.08 (m, 2H), 2.45 (s, 3H), 2.40 (m, 2H). ^{13}C NMR (126 MHz, DMSO) δ 140.1, 131.6, 130.9, 127.9, 125.2, 124.5, 124.0, 123.4, 48.4, 16.9, 15.8. HRMS (EI) calcd for $C_{21}H_{22}PO_2S$ $[M+H]^+$: 369.1073 ; found: 369.1071.

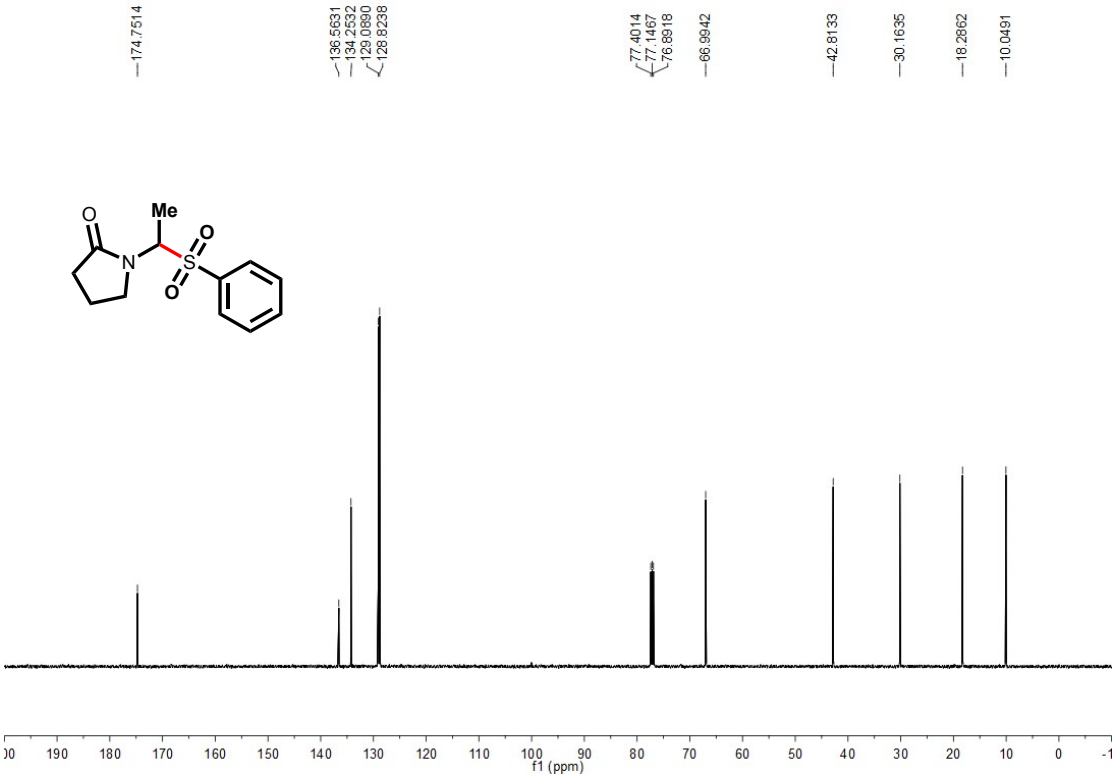
10. Copy NMR Spectra of products

3aa

^{1}H NMR

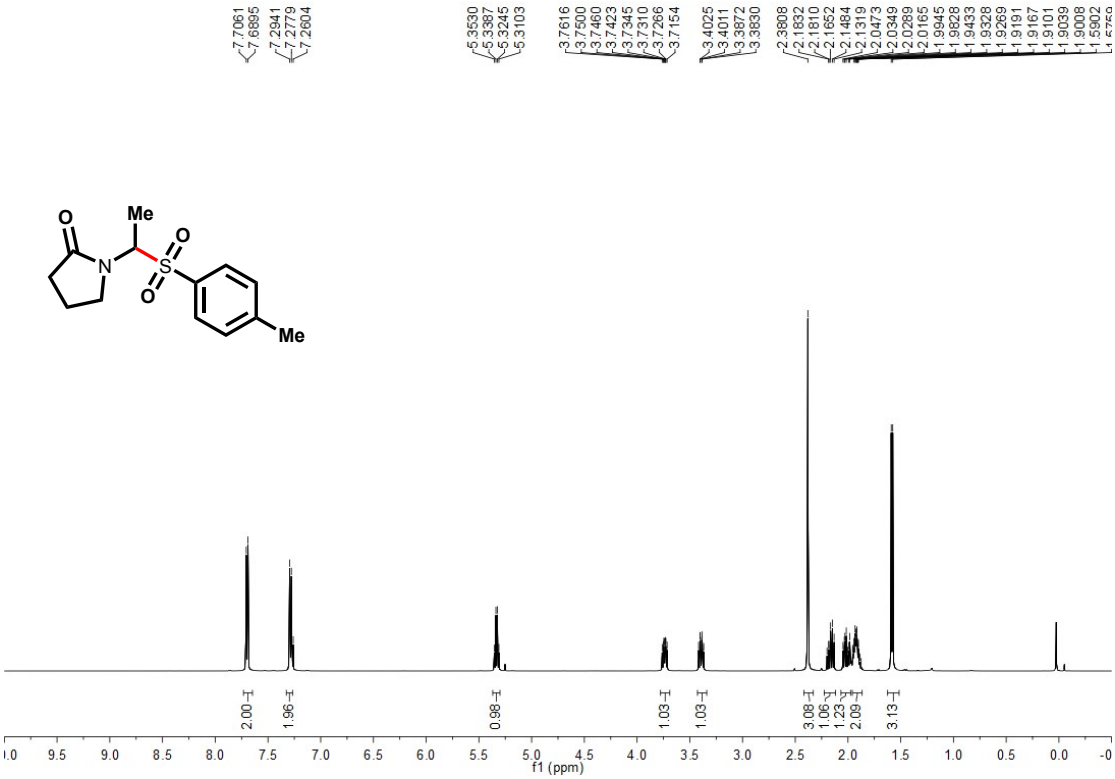


^{13}C NMR

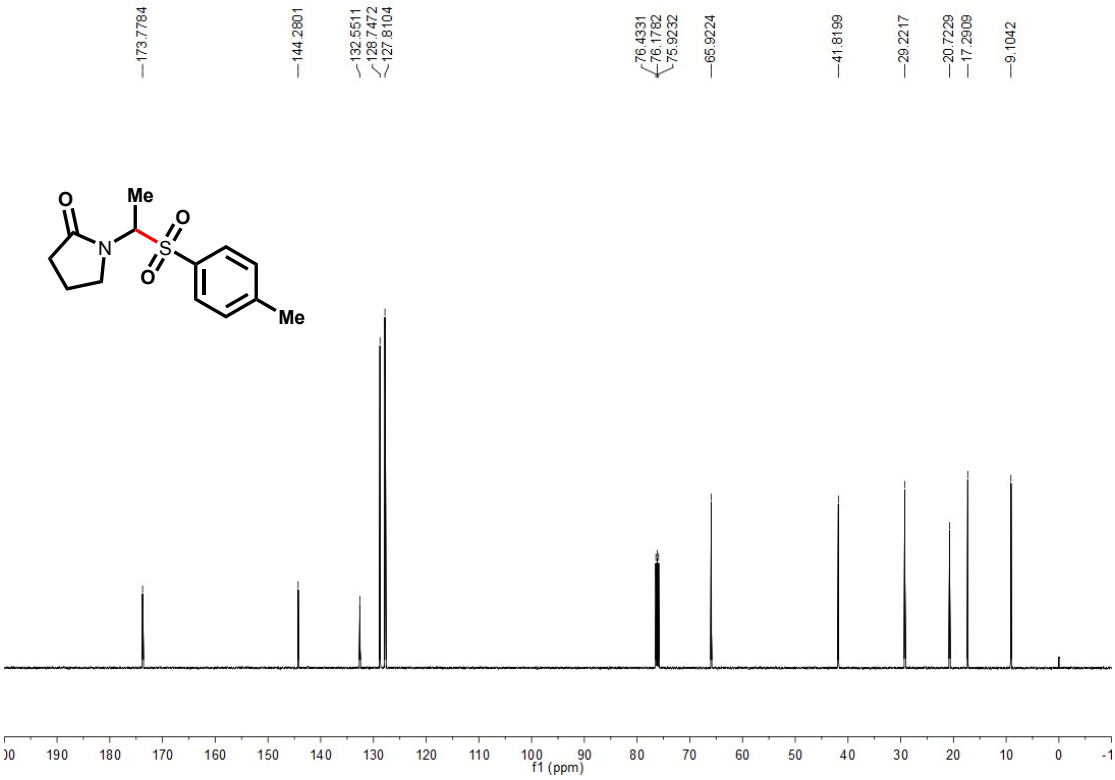


3ab

^{1}H NMR

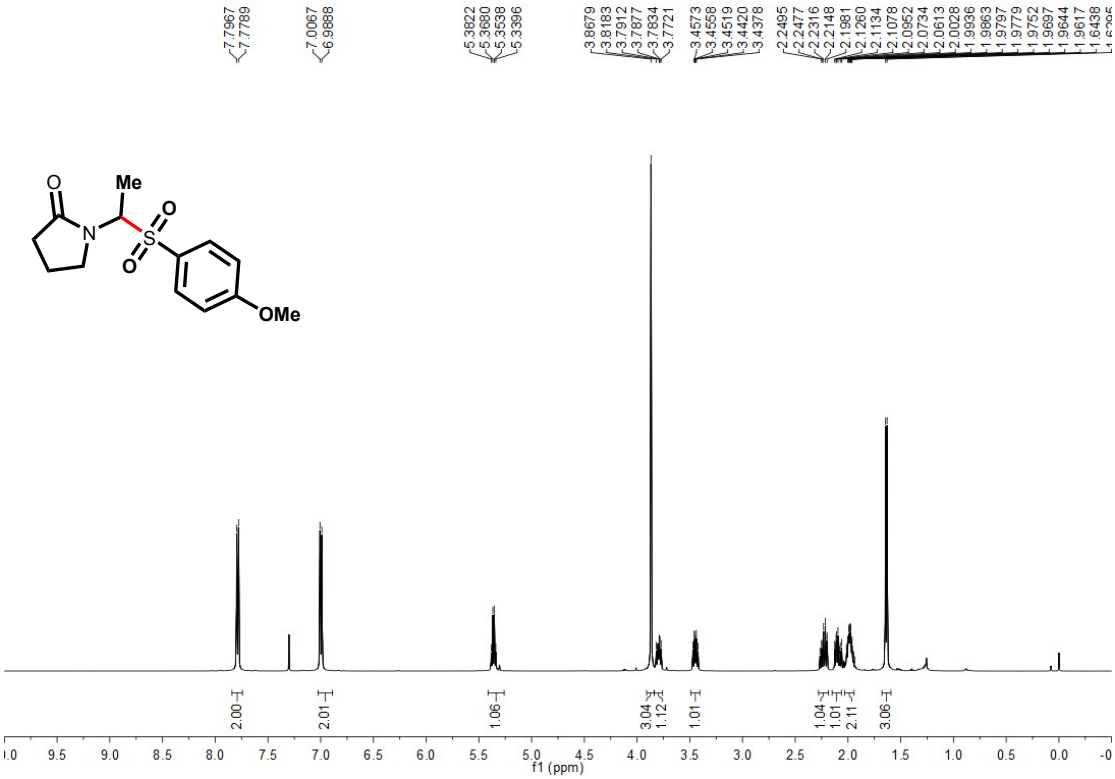


^{13}C NMR

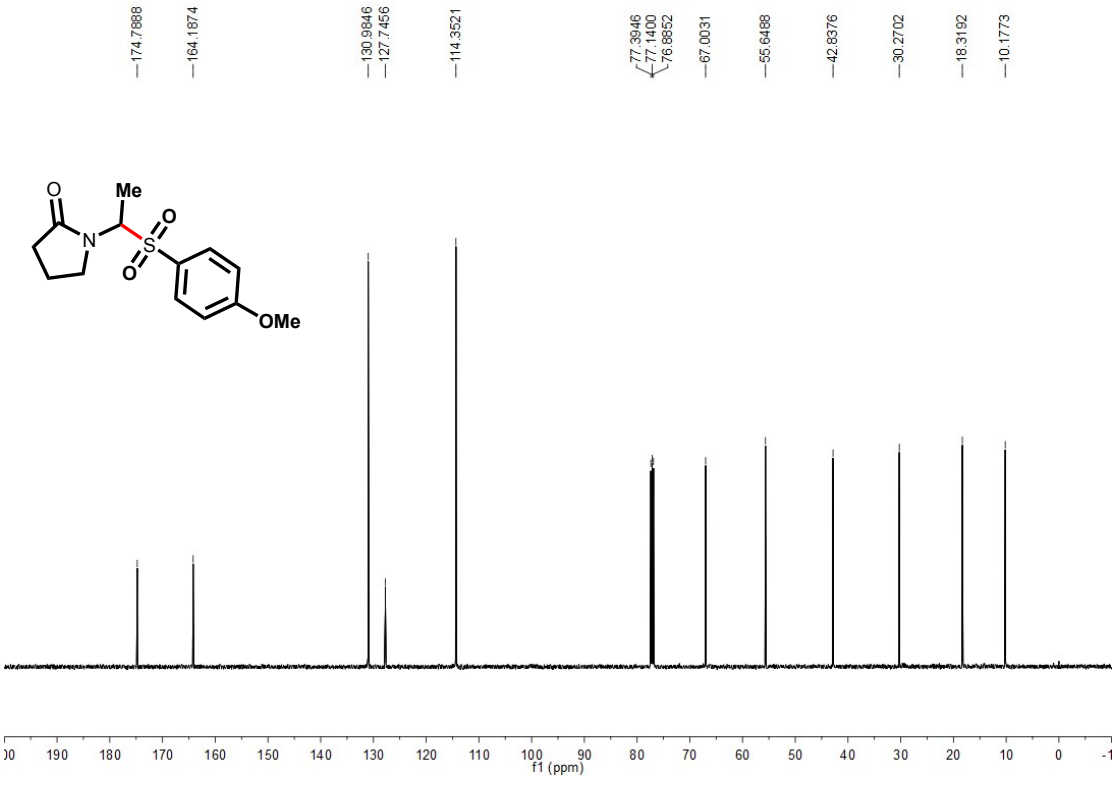


3ac

^{1}H NMR

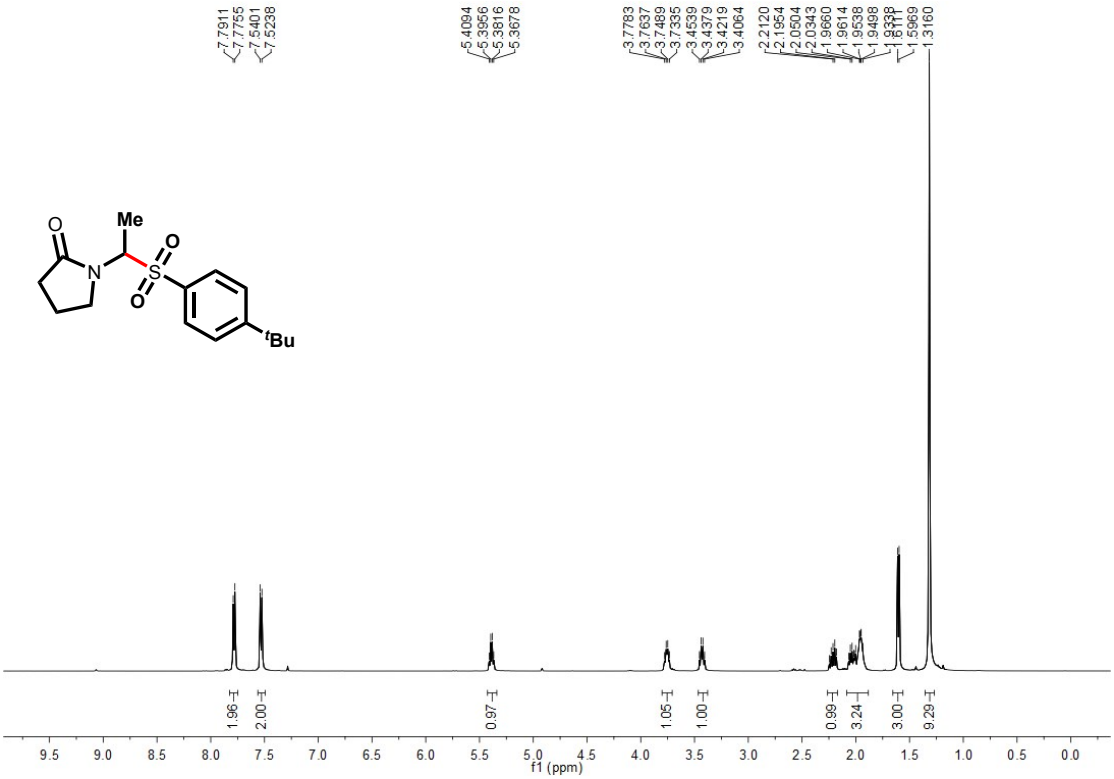


^{13}C NMR

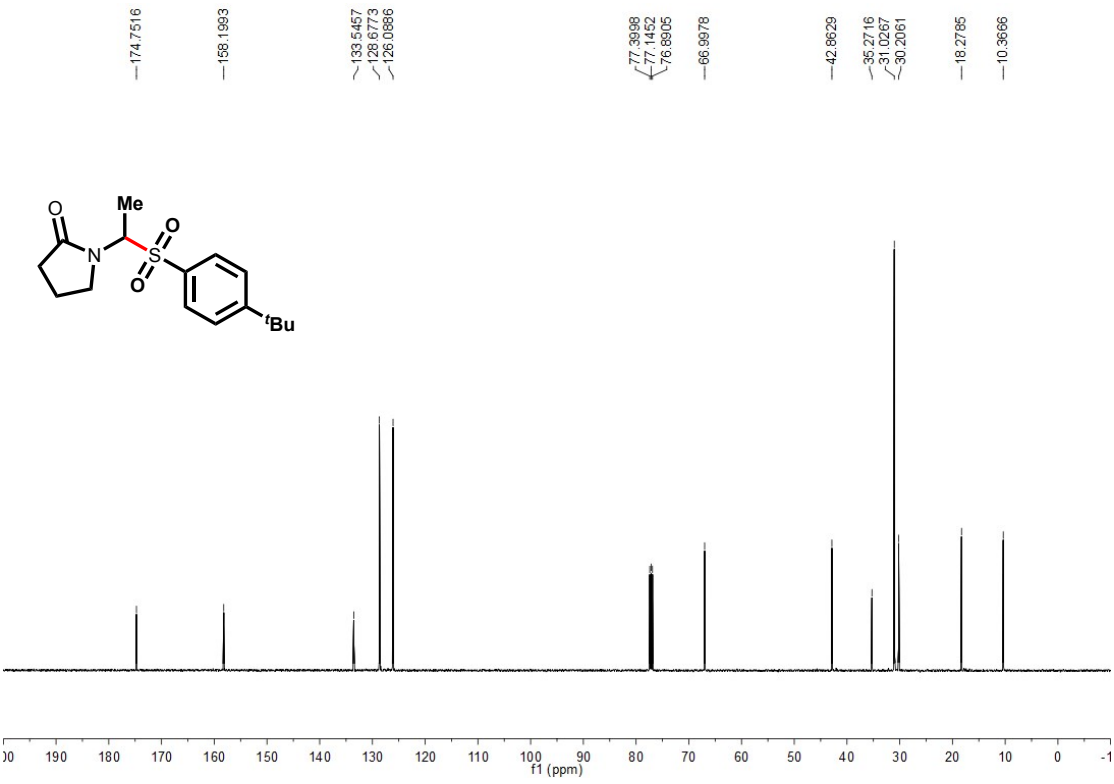


3ad

^{1}H NMR

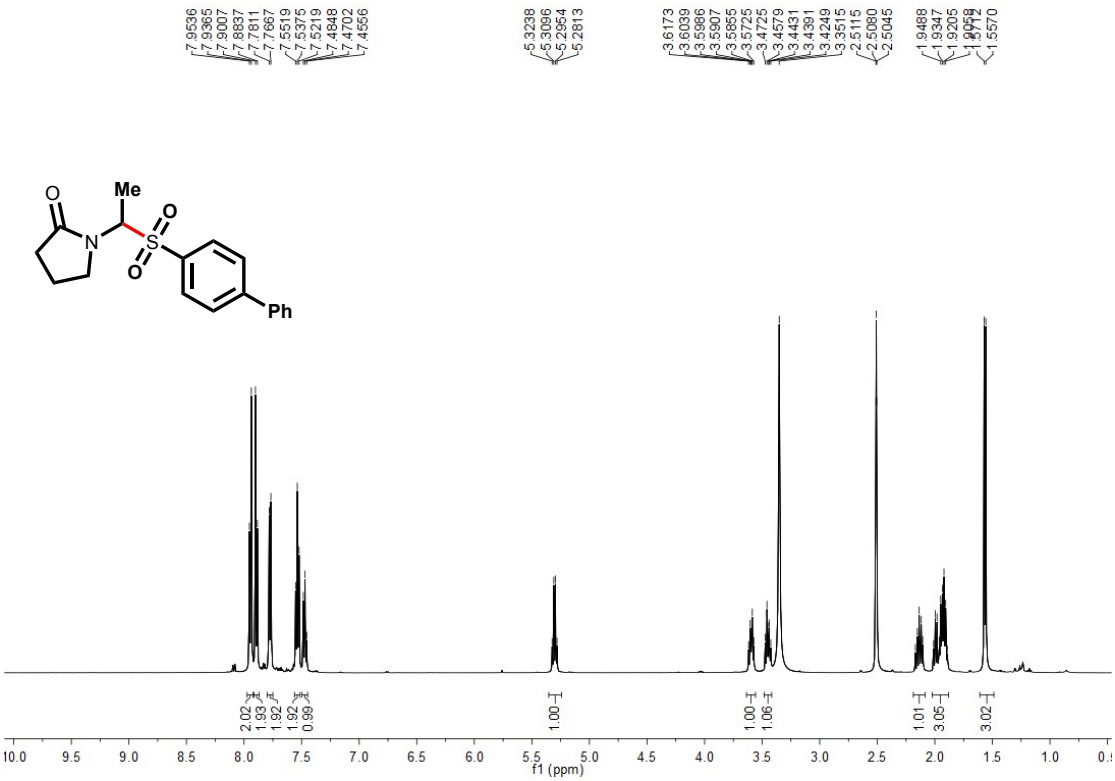


^{13}C NMR

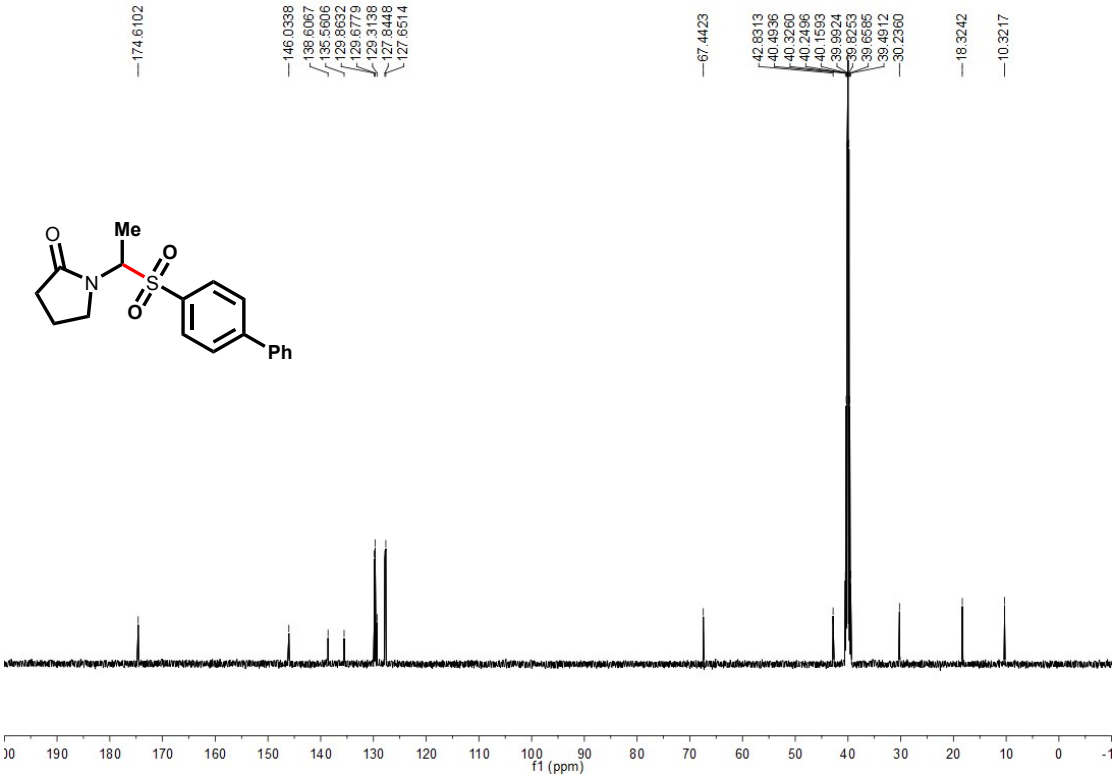


3ae

^{1}H NMR



^{13}C NMR



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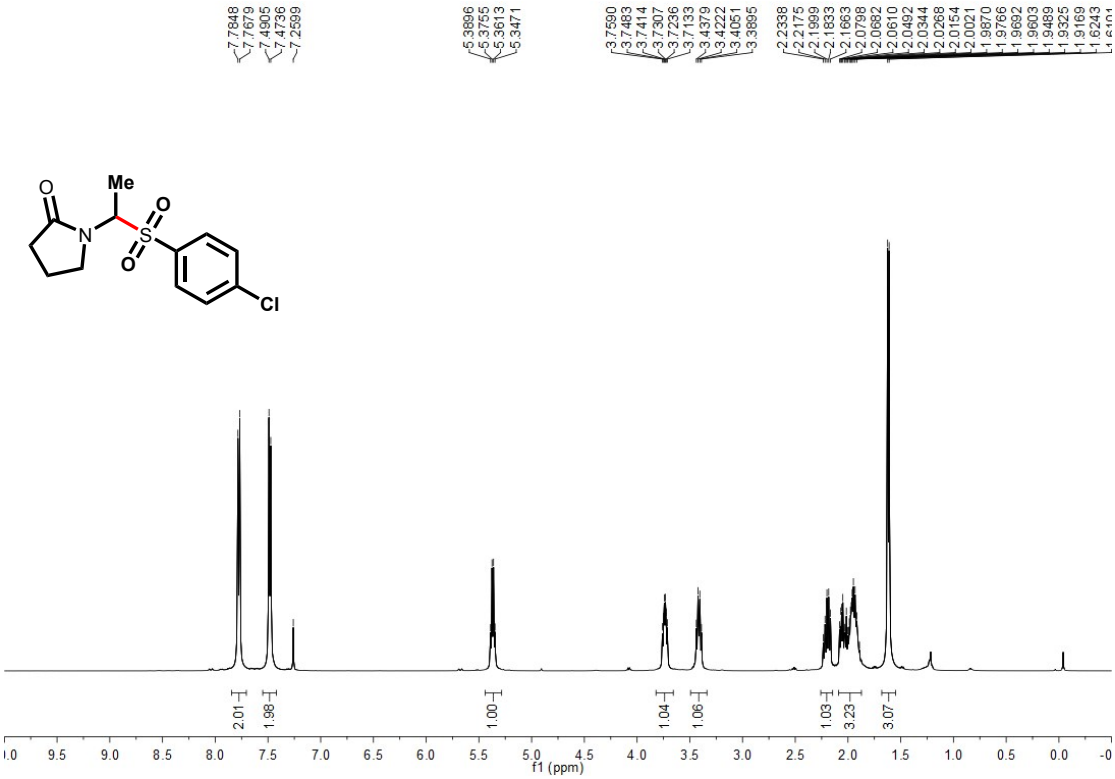
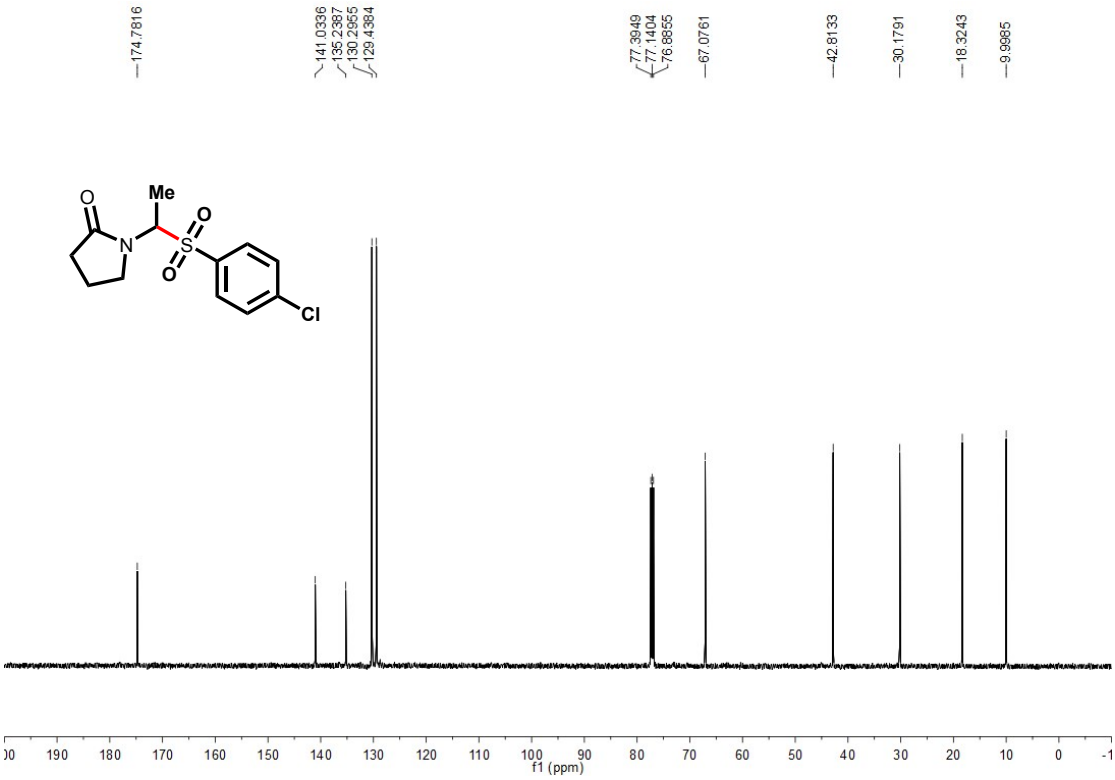
^{1}H NMR



^{13}C NMR



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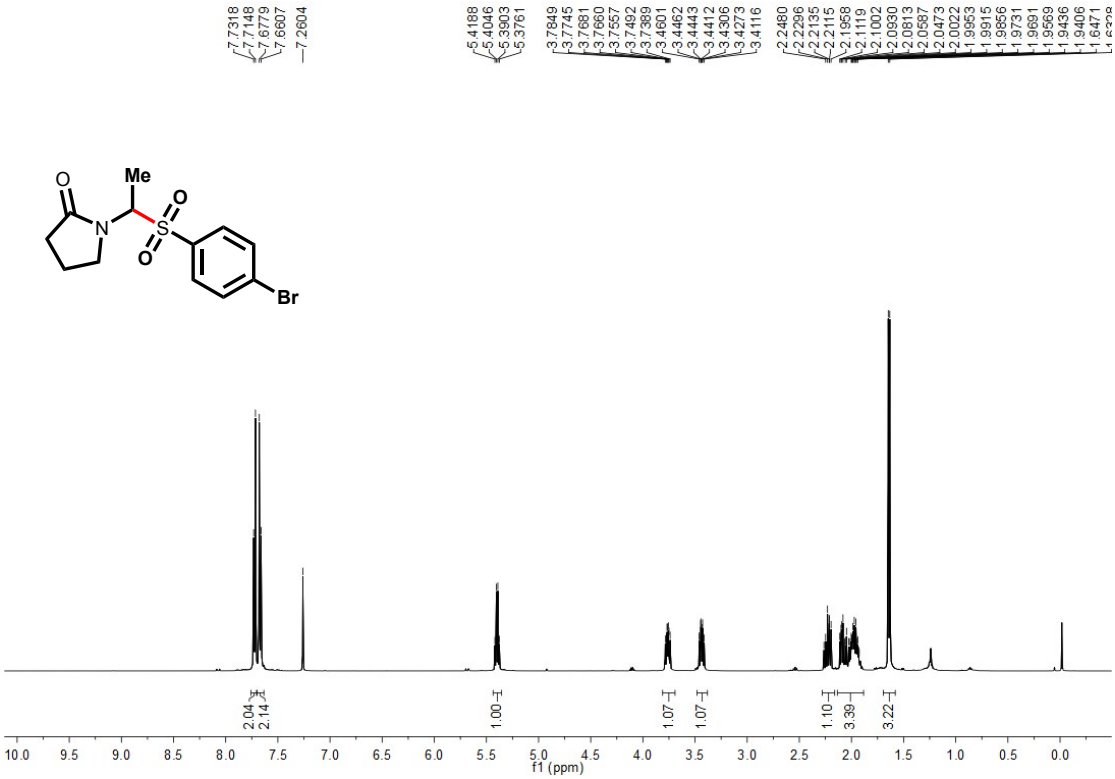
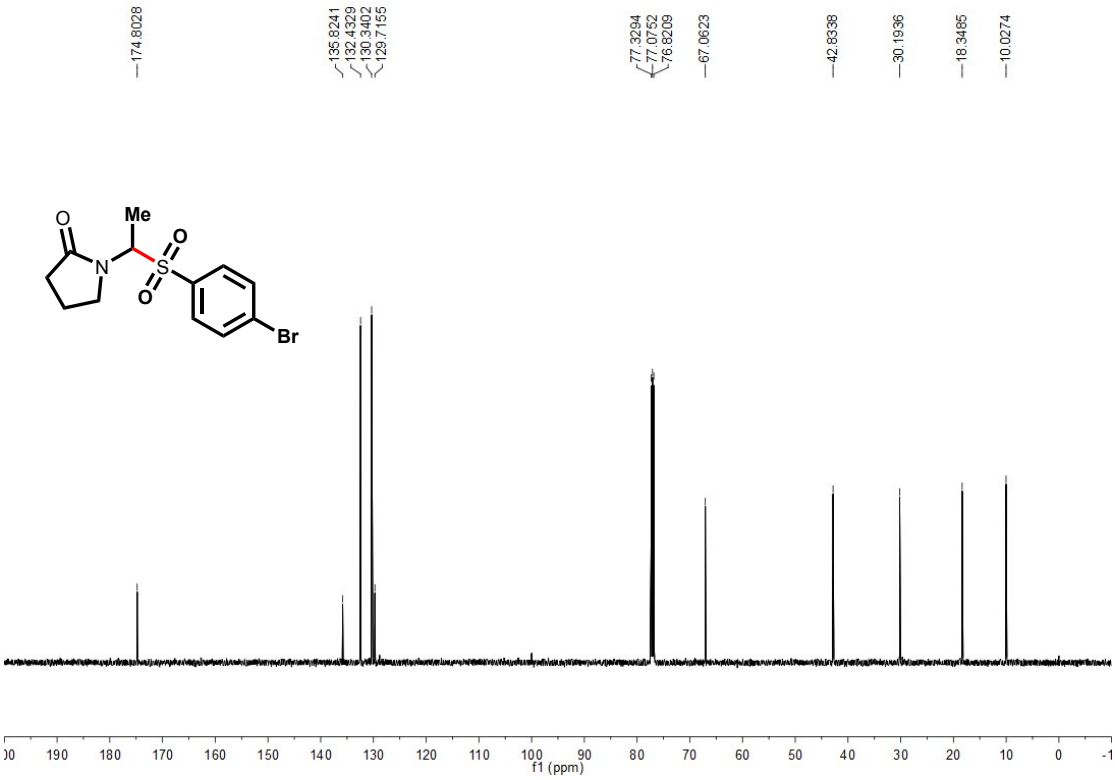
^{1}H NMR



^{13}C NMR



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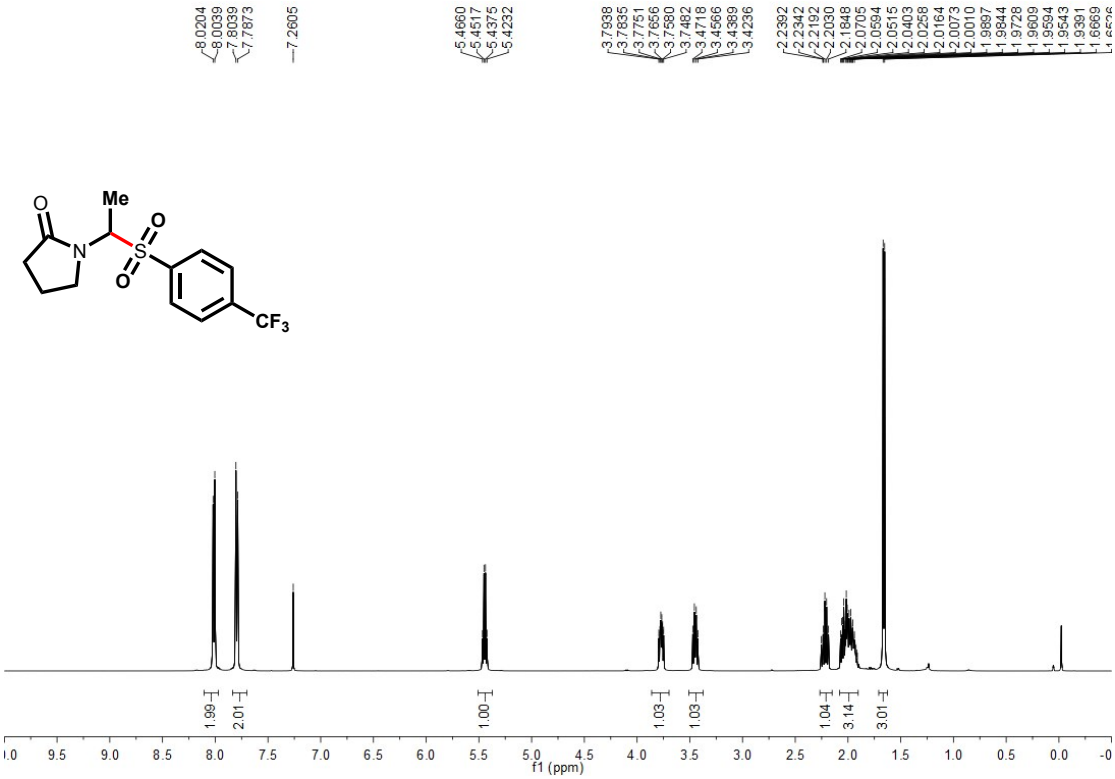
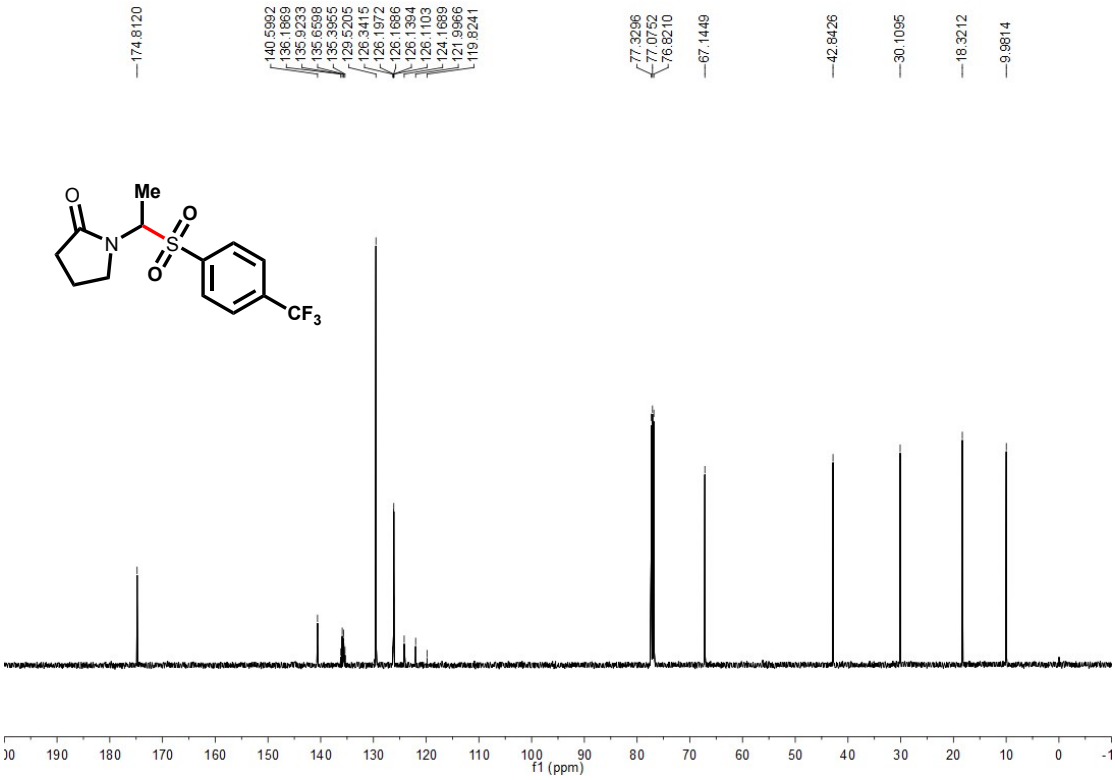


^{13}C NMR



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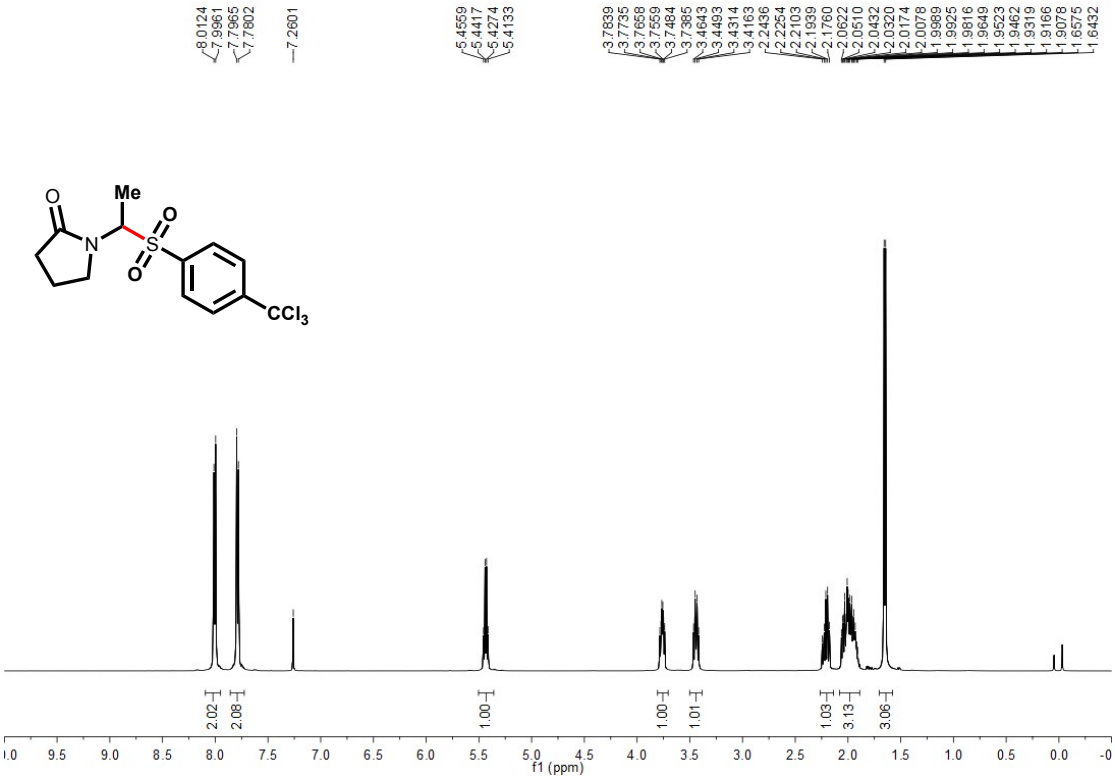
[1]H NMR



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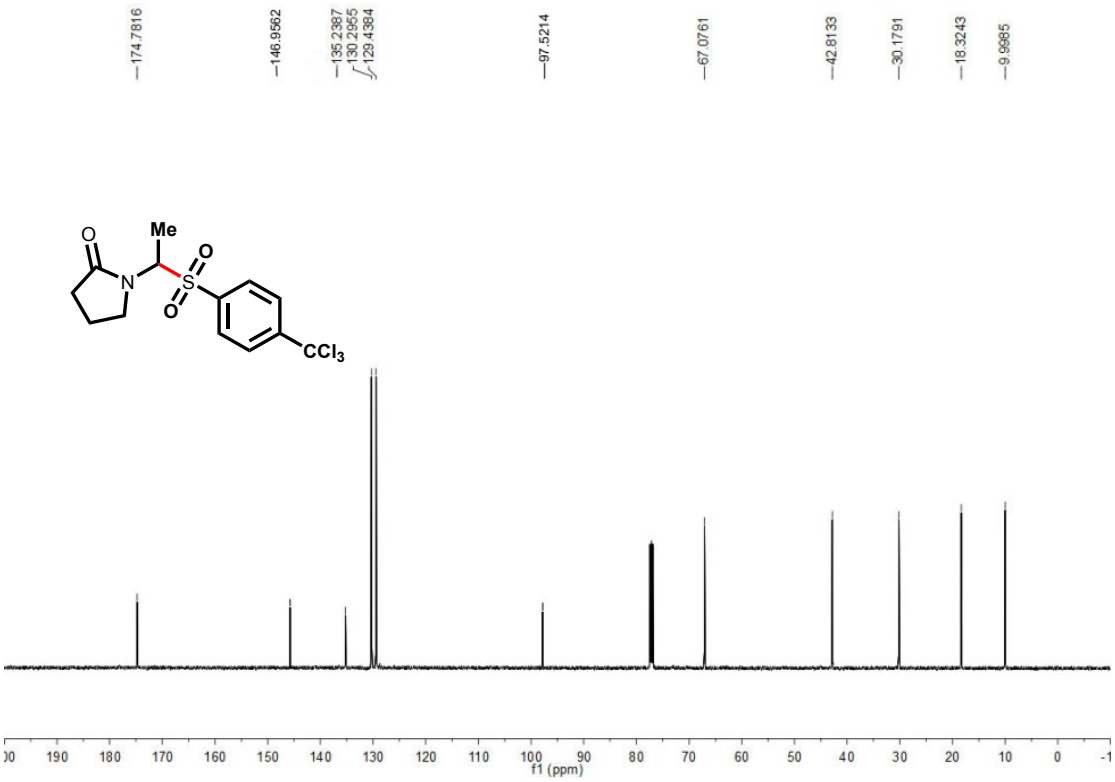
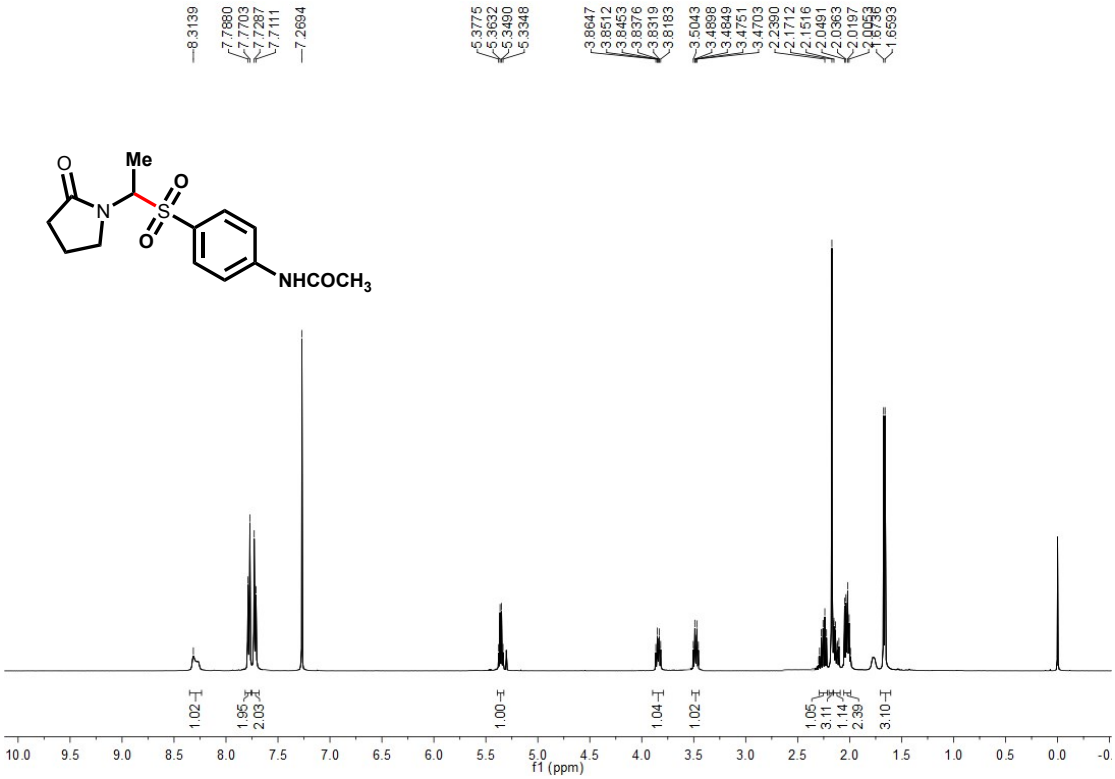


3aj

^{1}H NMR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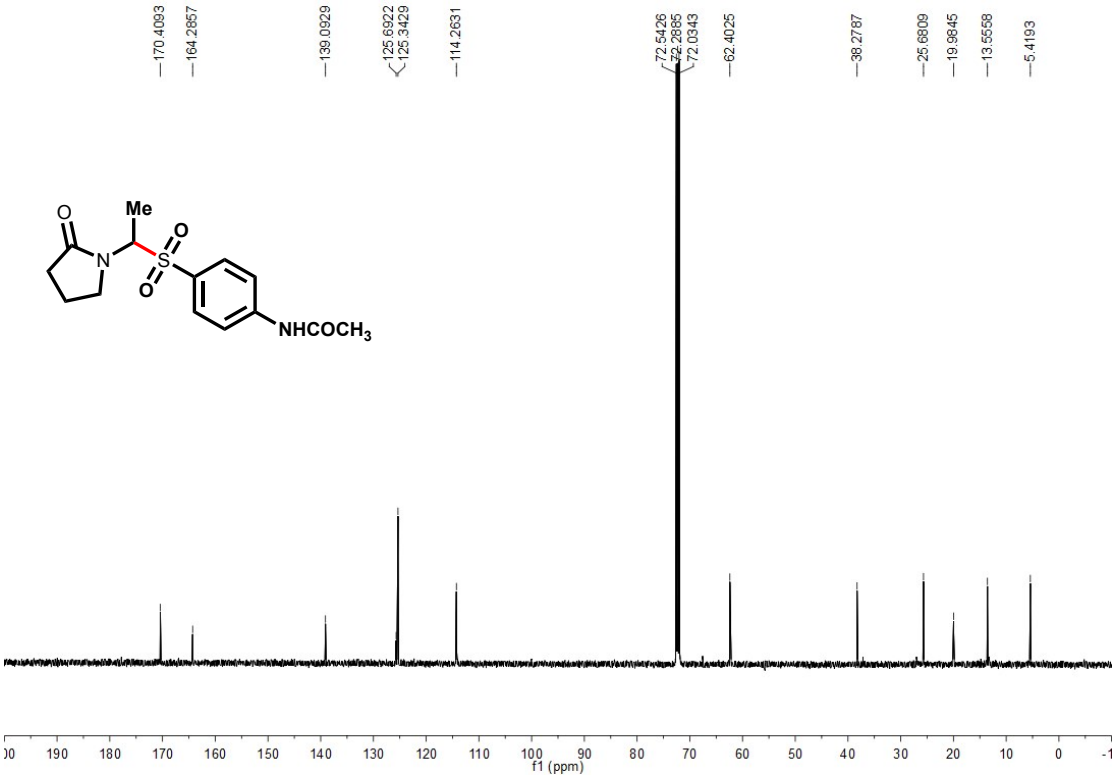
3.8512
3.8453
3.8376
3.8319
3.8183
3.5043
3.4898
3.4849
3.4751
3.4703
2.2390
2.1712
2.1516
2.0491
2.0363
2.0197
2.0053
1.8738
1.6593
Me
O
N
S
O
O
NHCOCH3
1.02
1.95
2.03
1.00
1.04
1.02
1.05
3.11
1.14
2.39
3.10
f1 (ppm)

(b)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125.3429
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72.0343
62.4025
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25.6809
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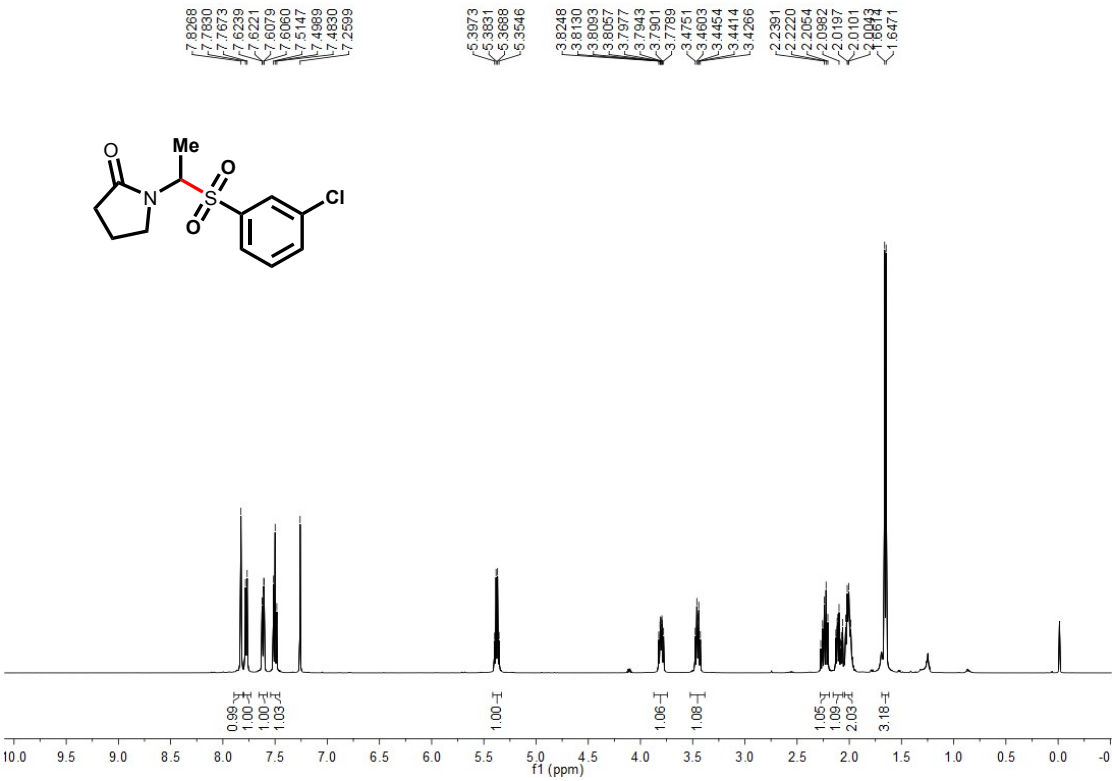
5.4193
Me
O
N
S
O
O
NHCOCH3
f1 (ppm)

3ak

^{1}H NMR



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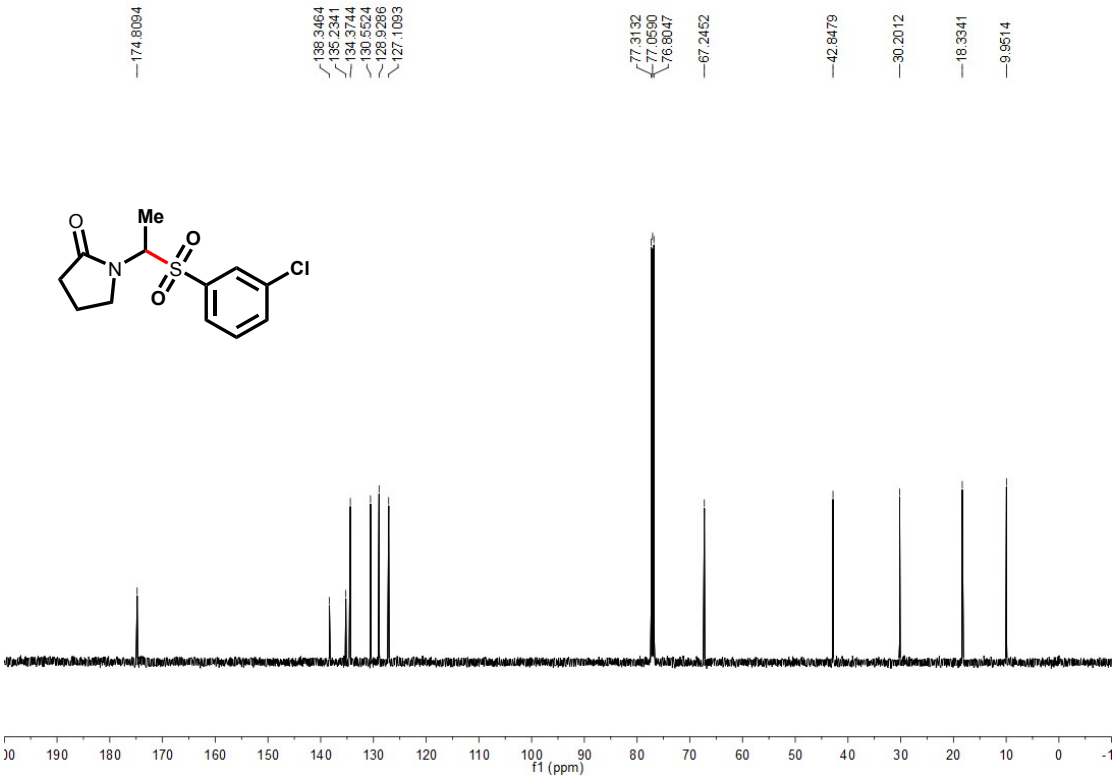
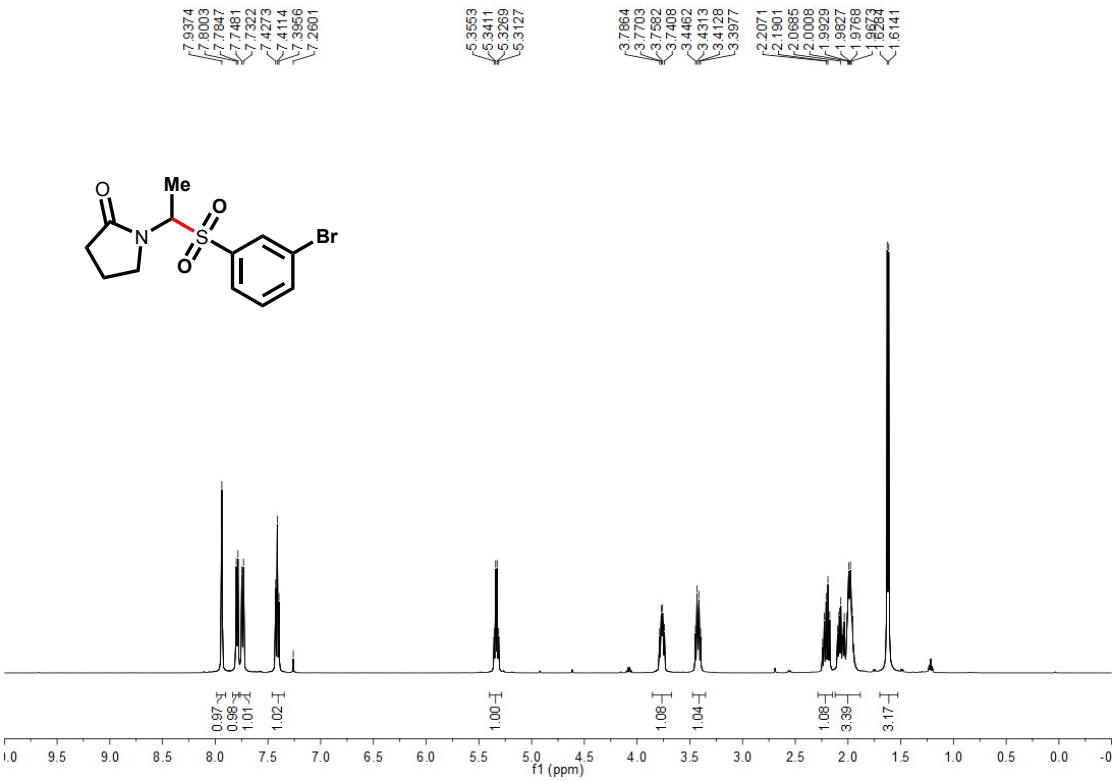


3al

^{1}H NMR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3.4128
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2.1901
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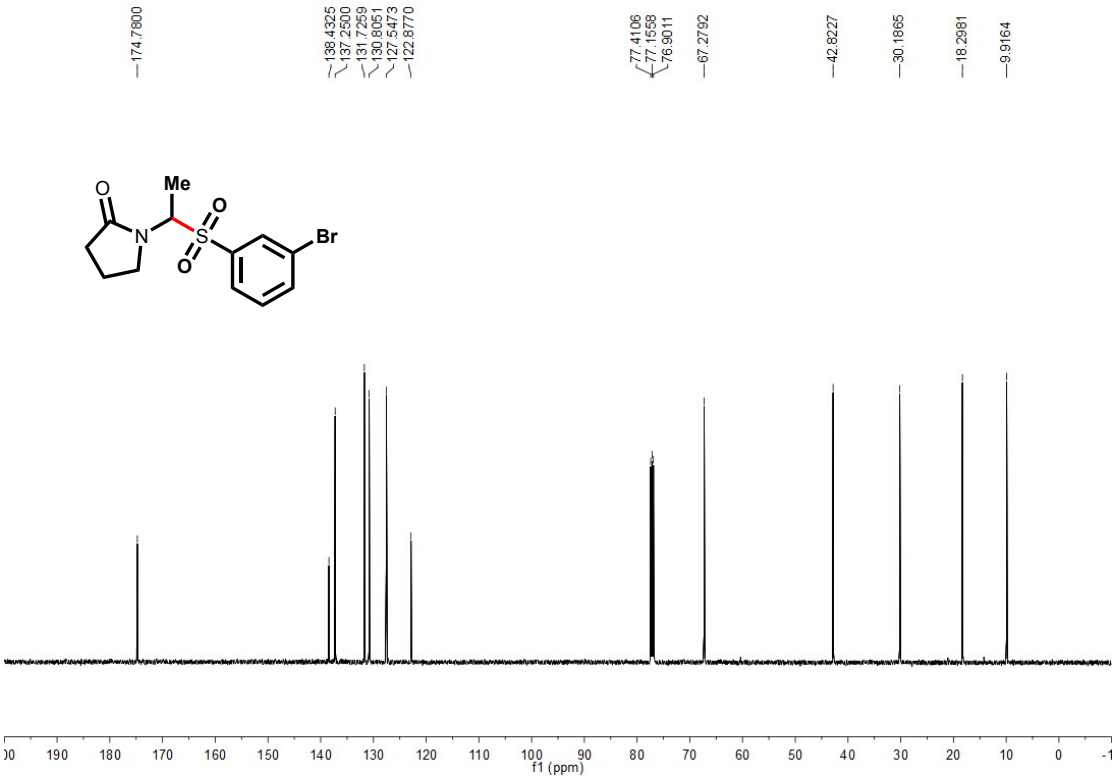
f1 (ppm)

(b)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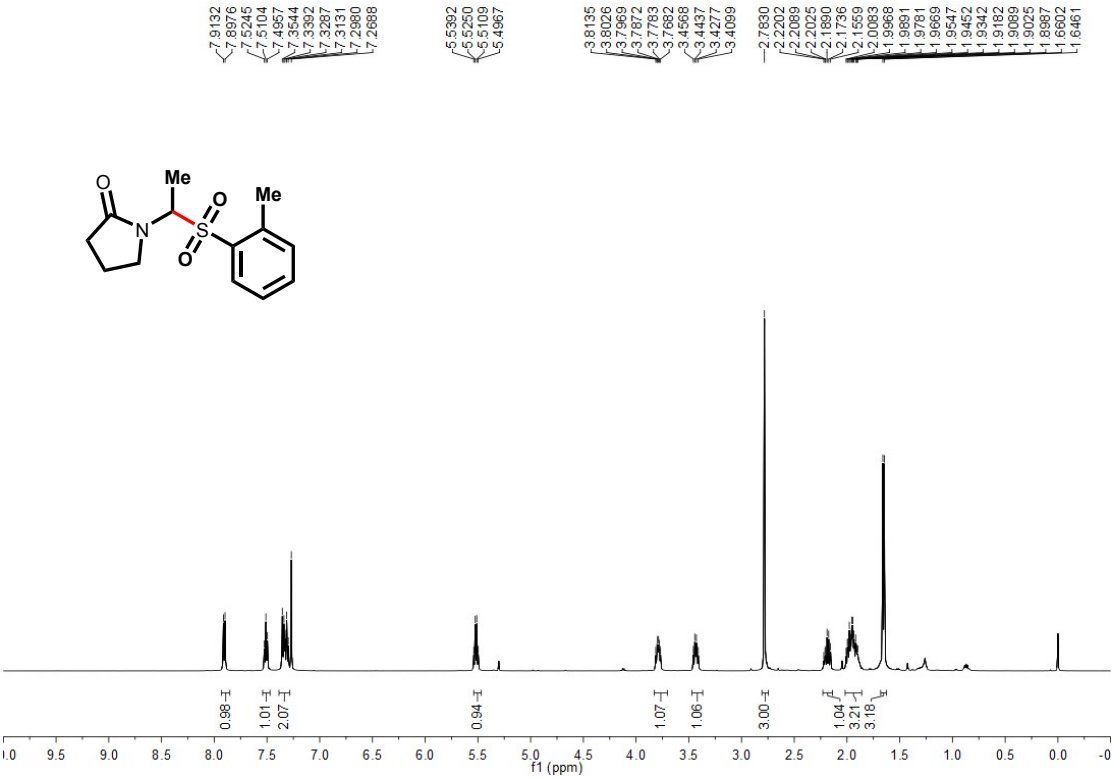
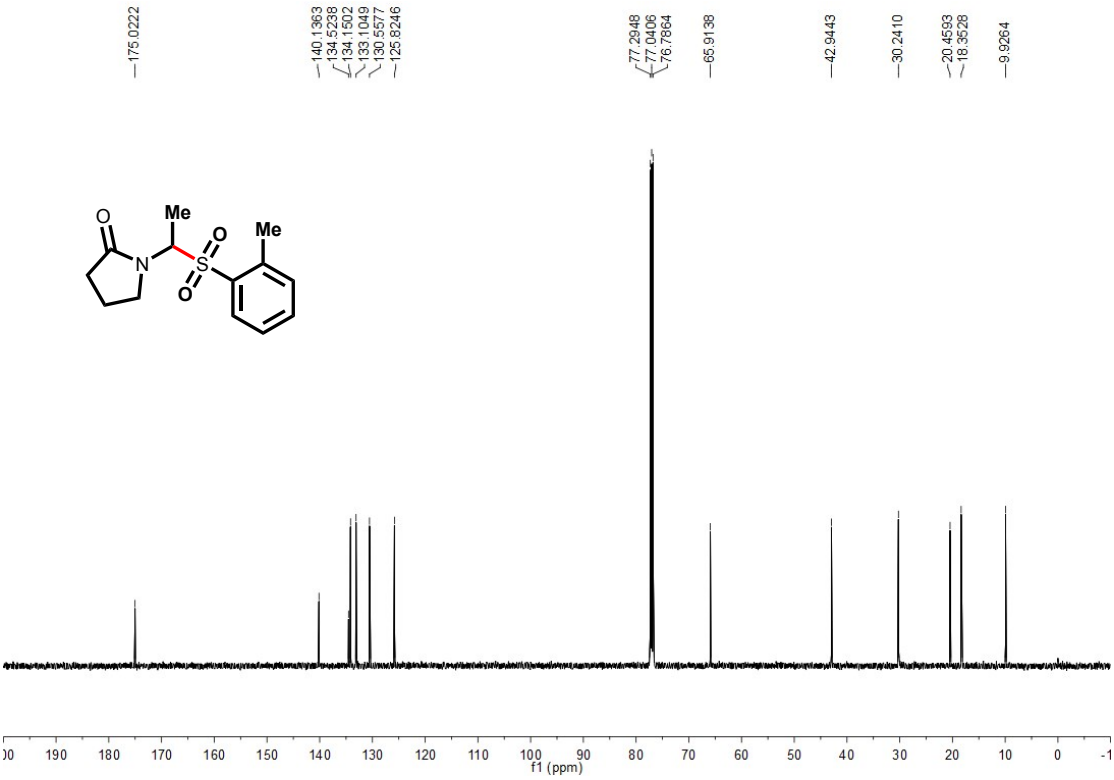
Me
O
N
S
O
O
Br
f1 (ppm)

3am

^{1}H NMR

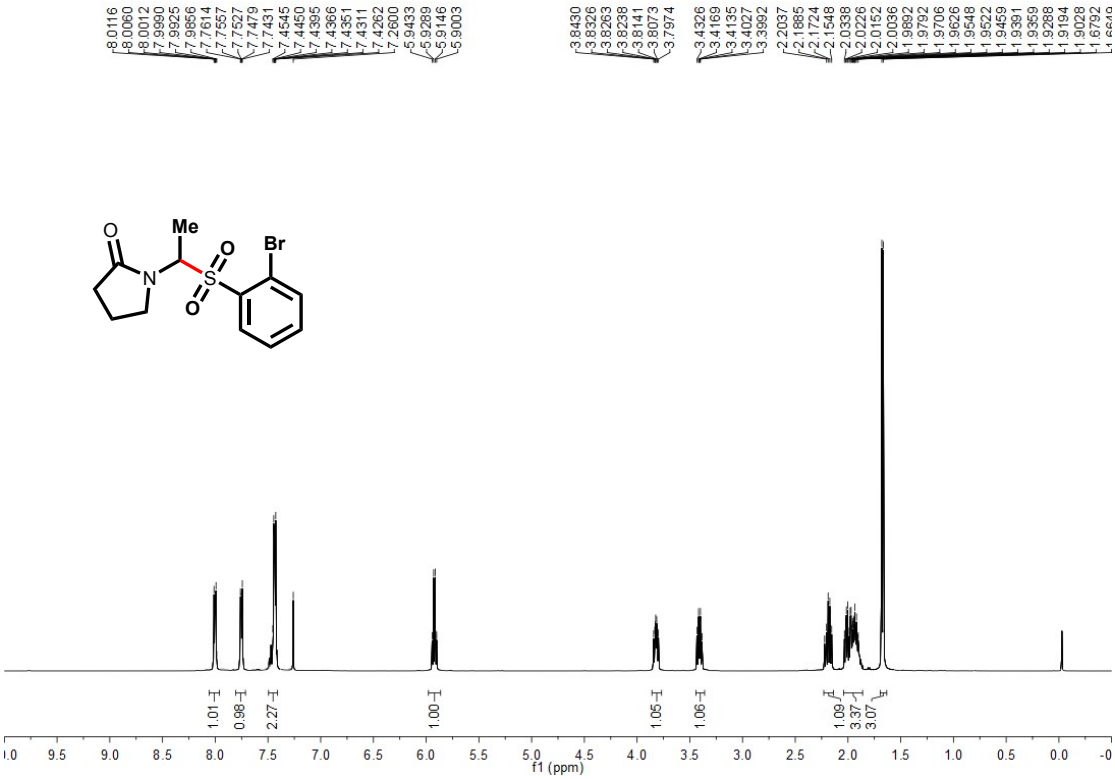


^{13}C NMR

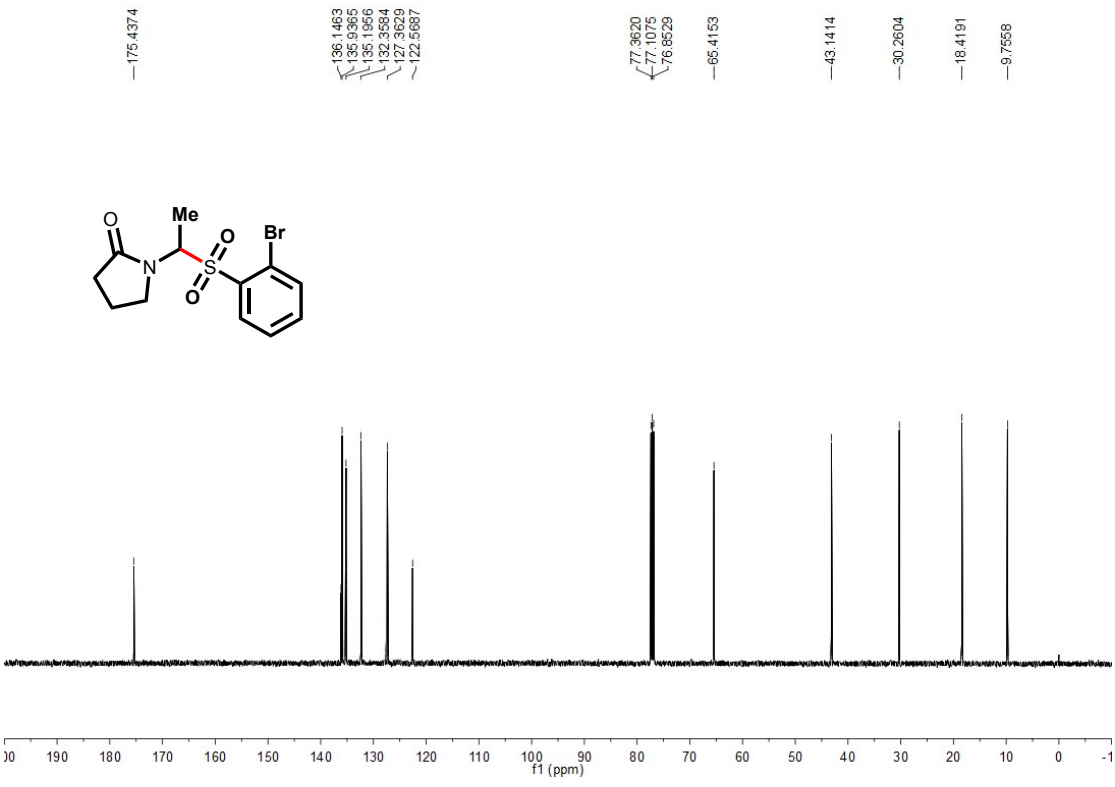


3an

^{1}H NMR



^{13}C NMR



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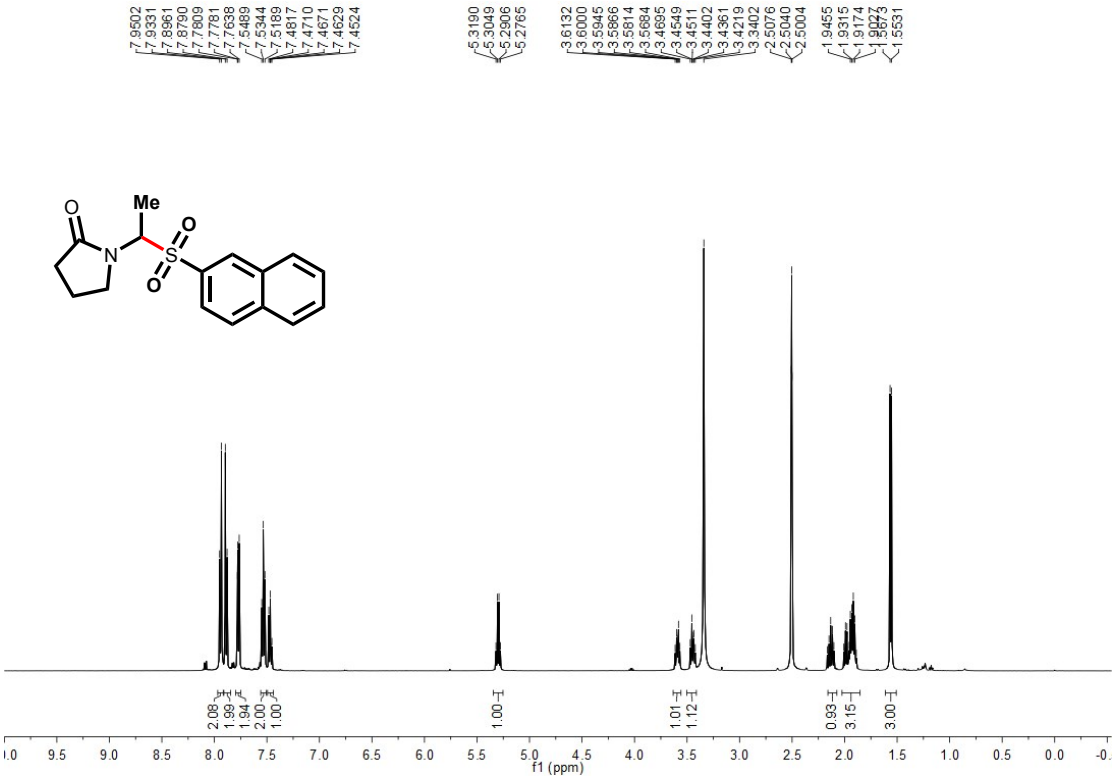
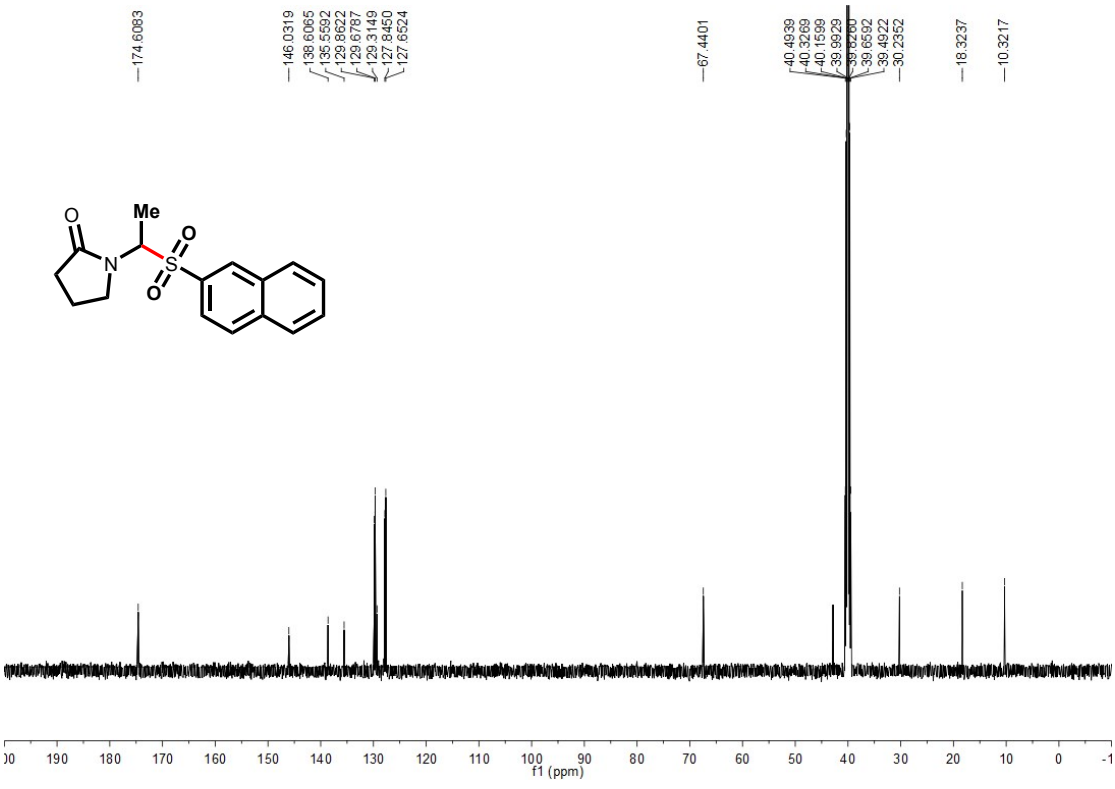
^{1}H NMR

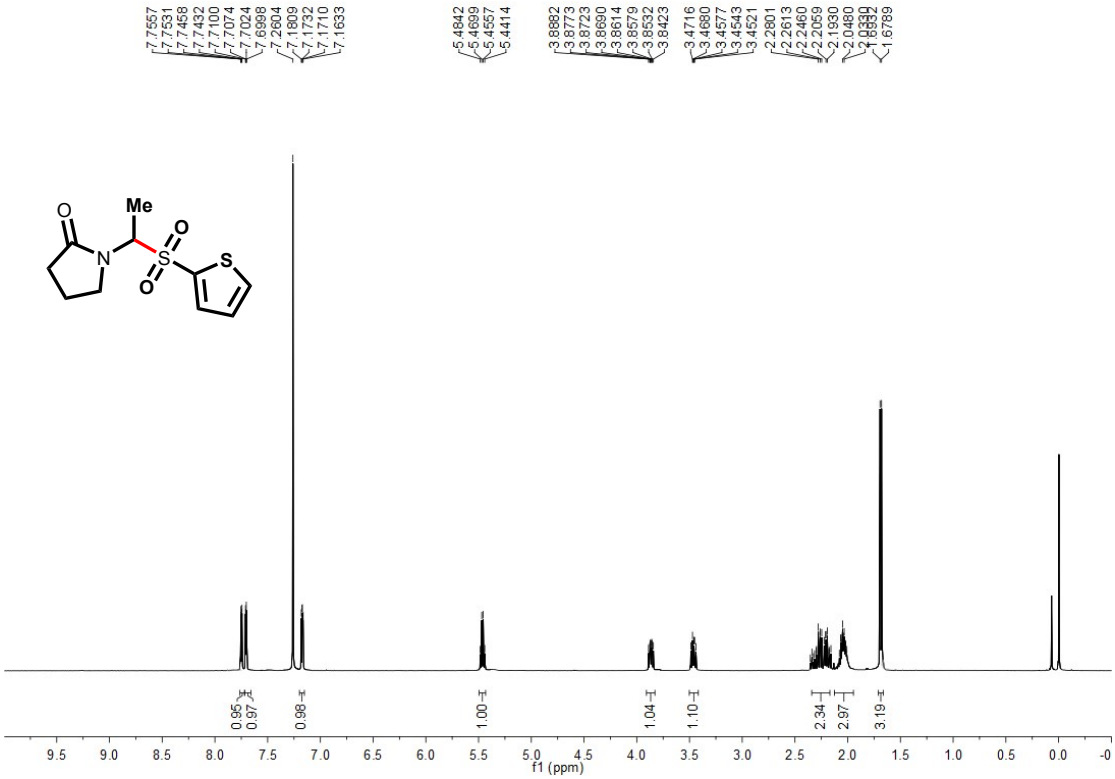


^{13}C NMR

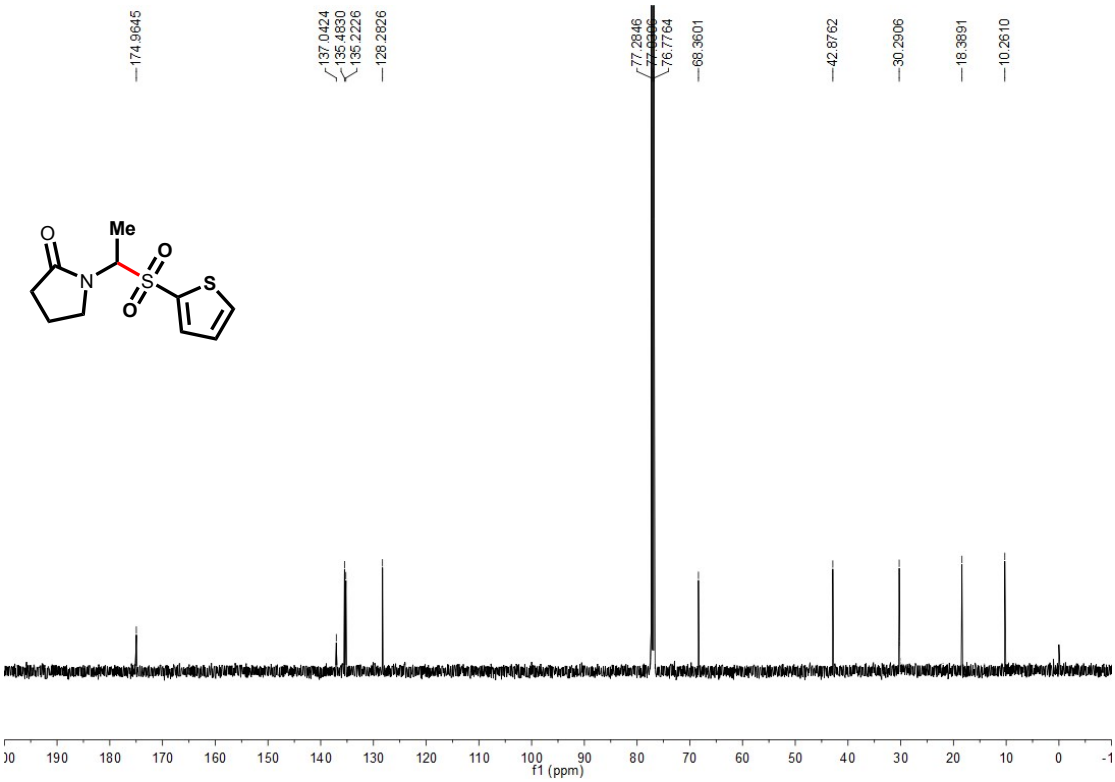


3ap

^{1}H NMR

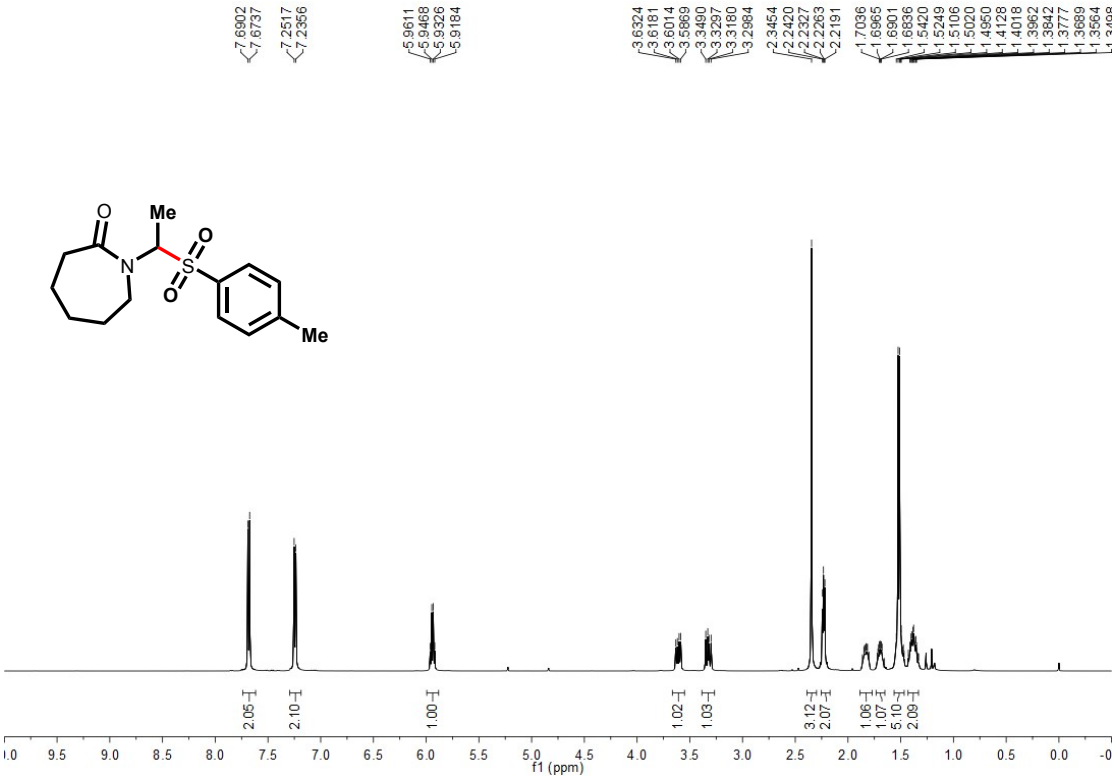


^{13}C NMR

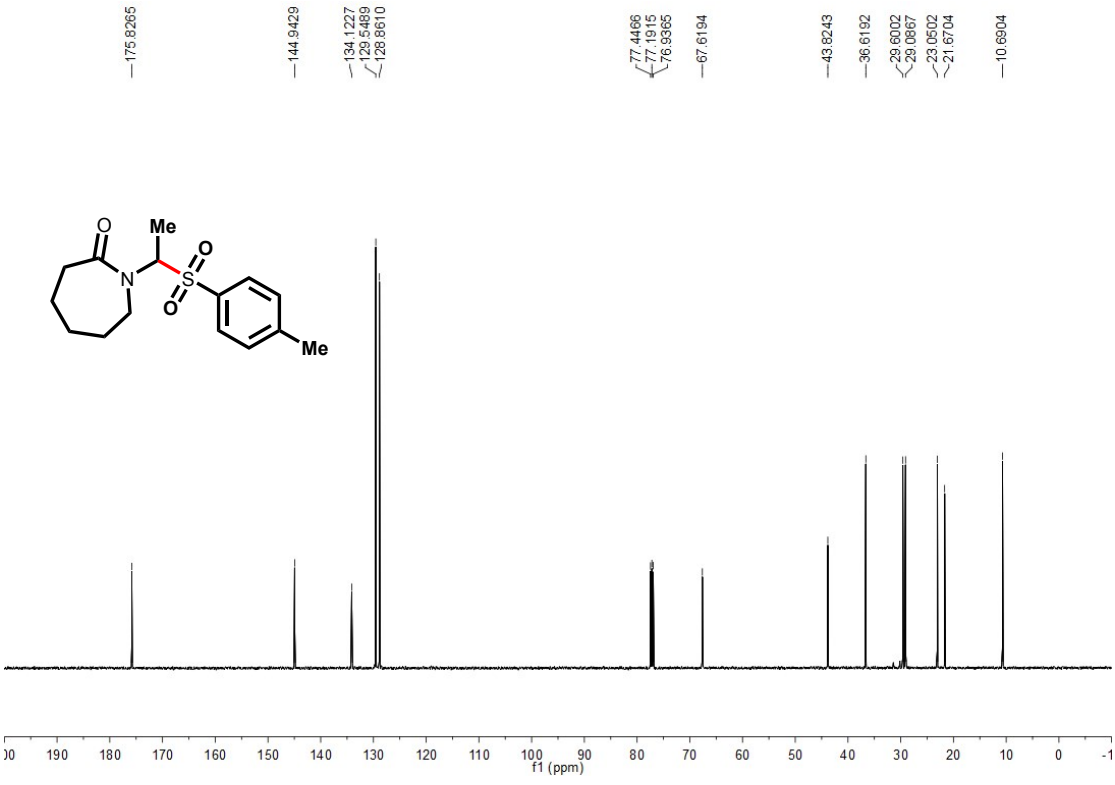


3ba

^{1}H NMR

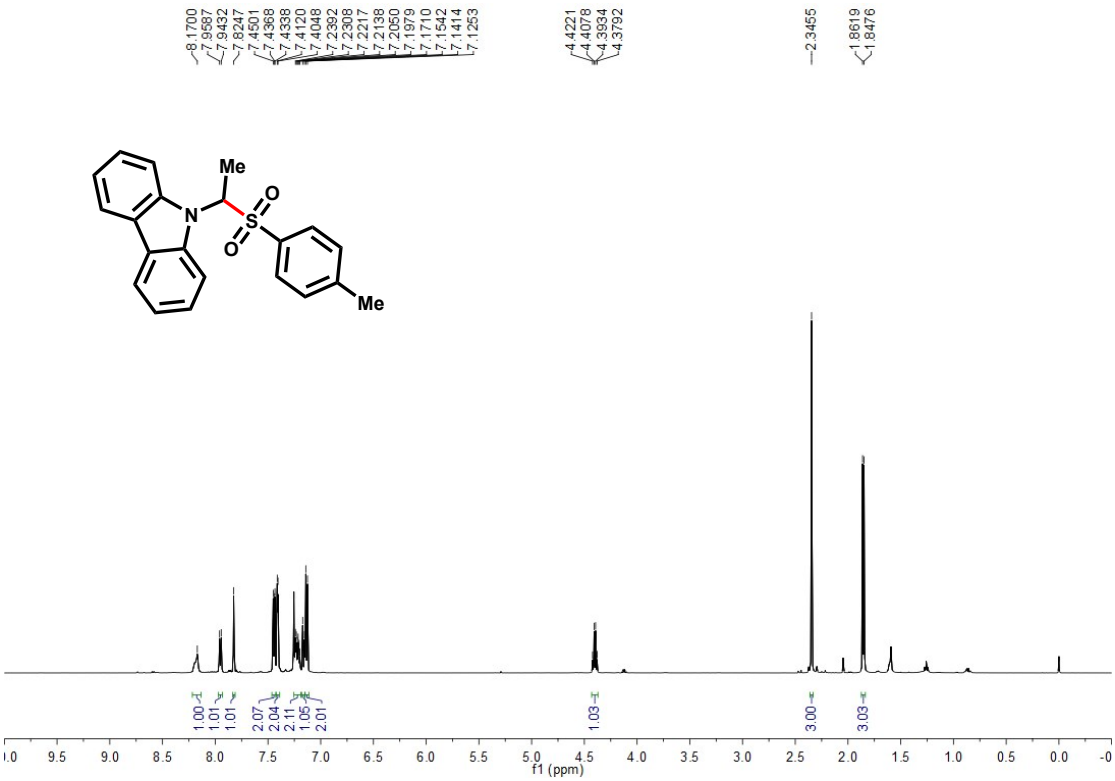


^{13}C NMR

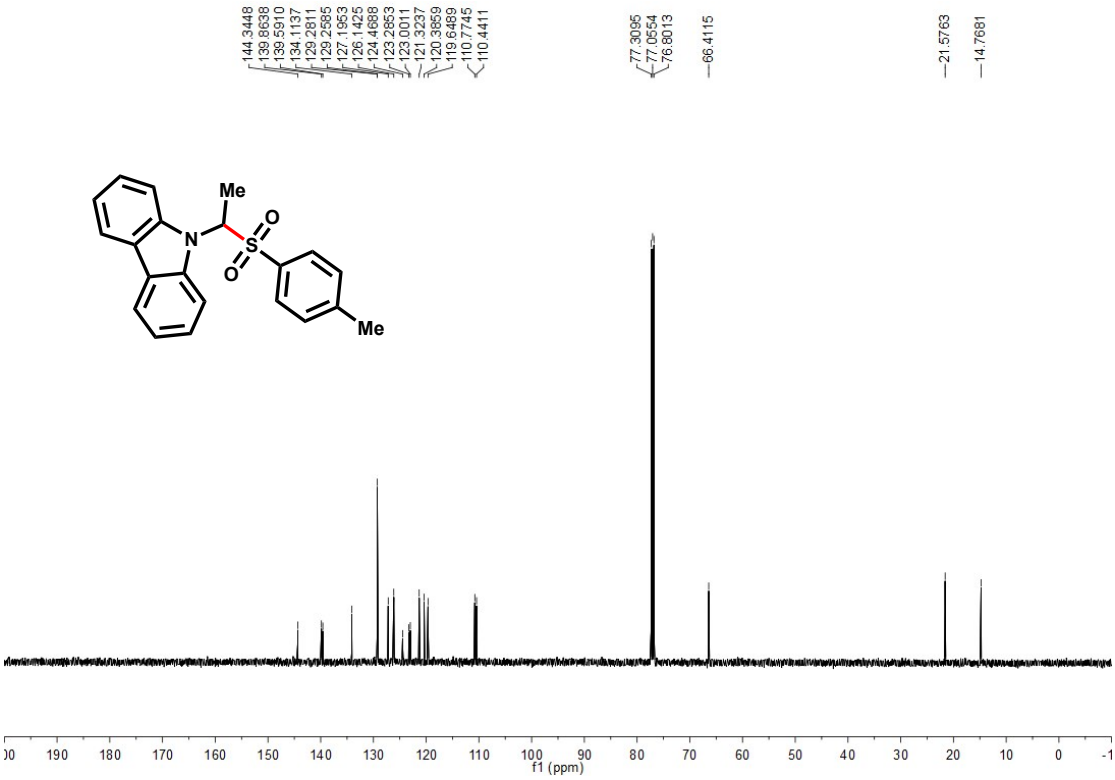


3ca

^{1}H NMR

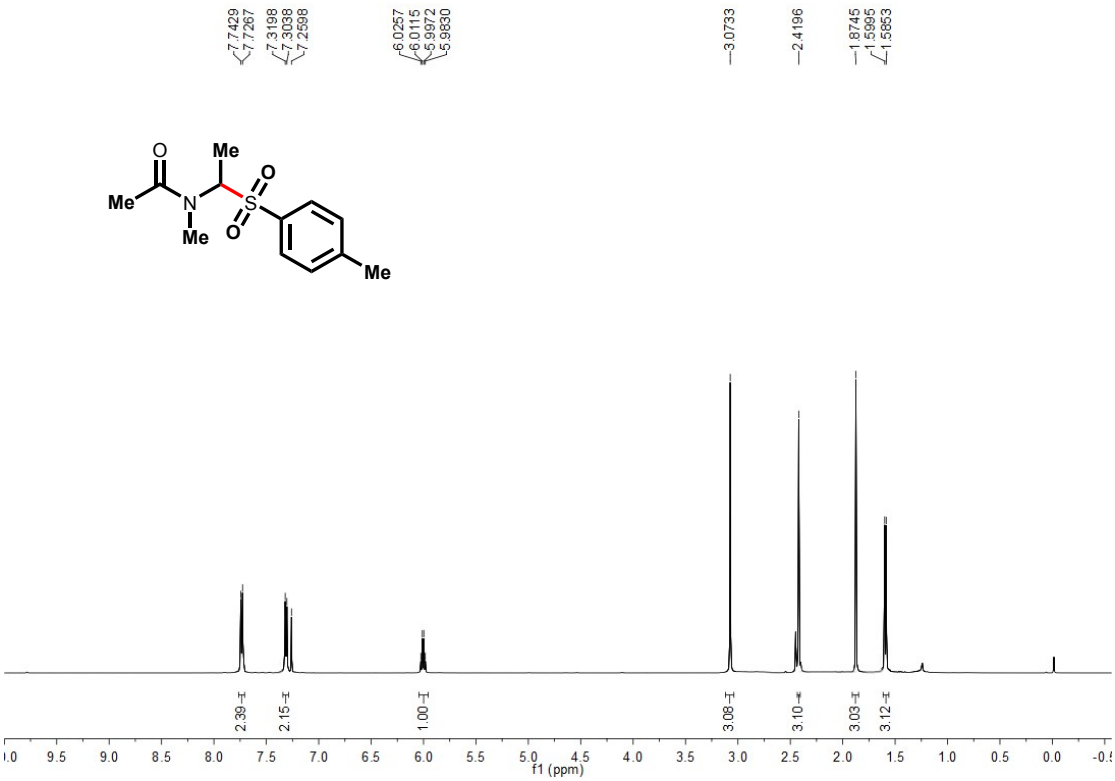


^{13}C NMR

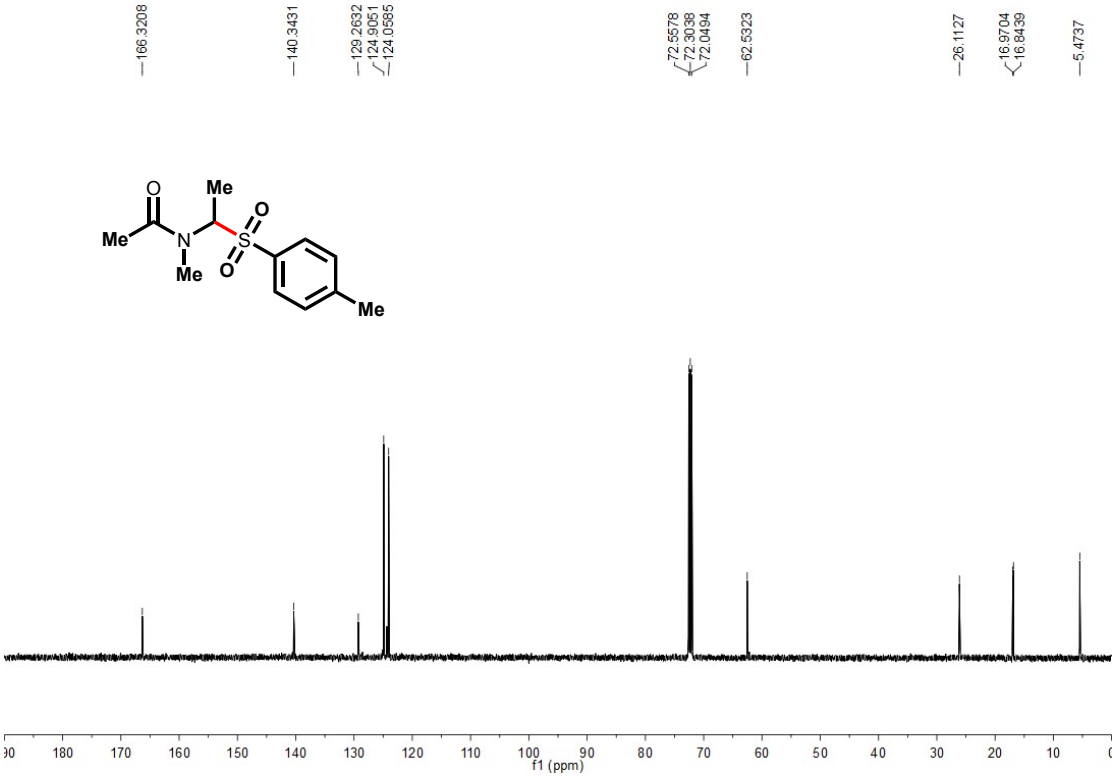


3da

^{1}H NMR

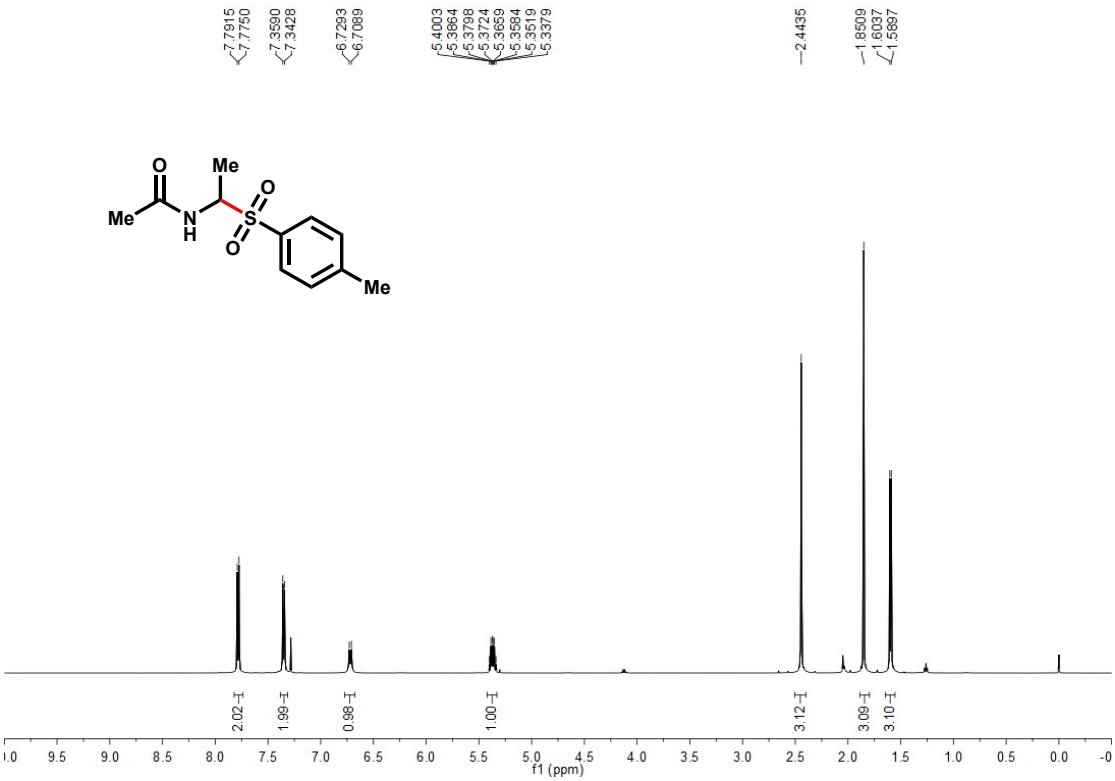


^{13}C NMR

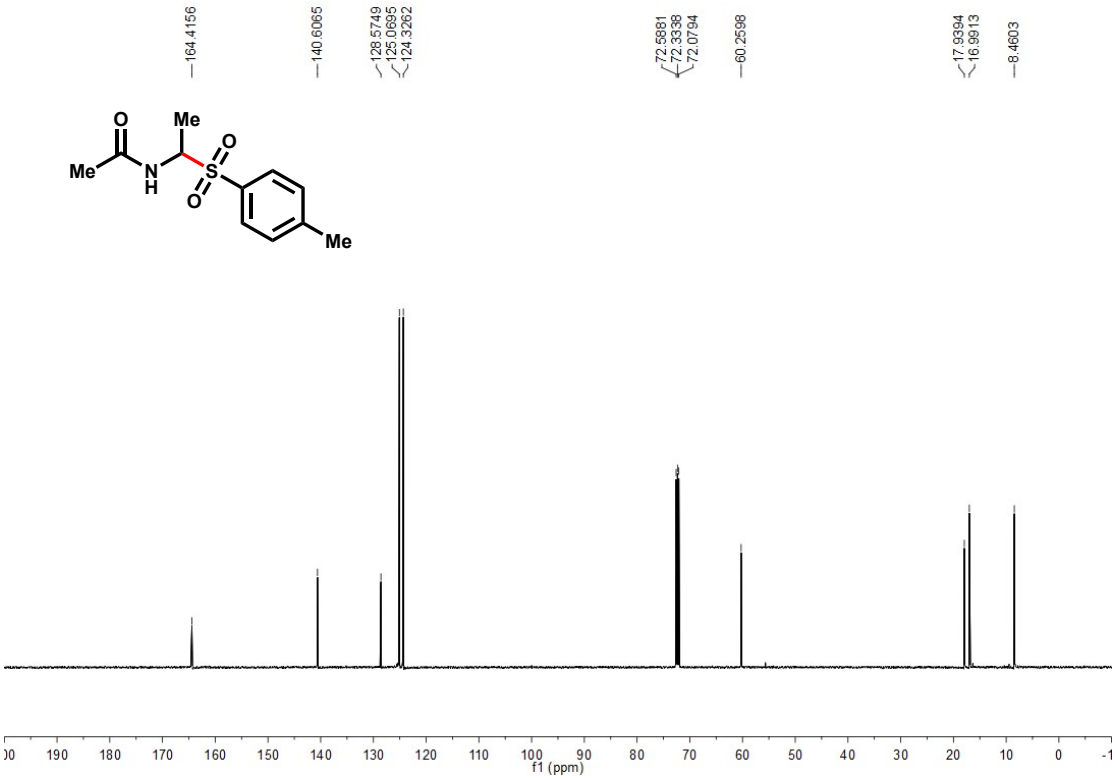


3ea

^{1}H NMR

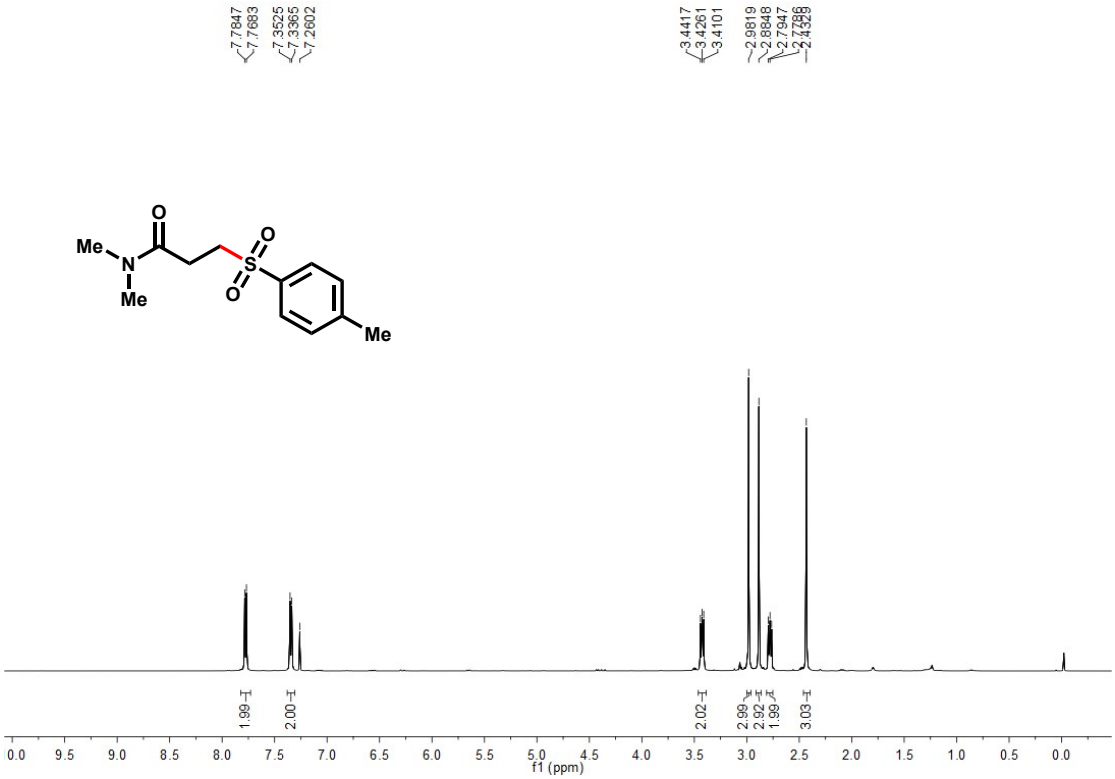


^{13}C NMR

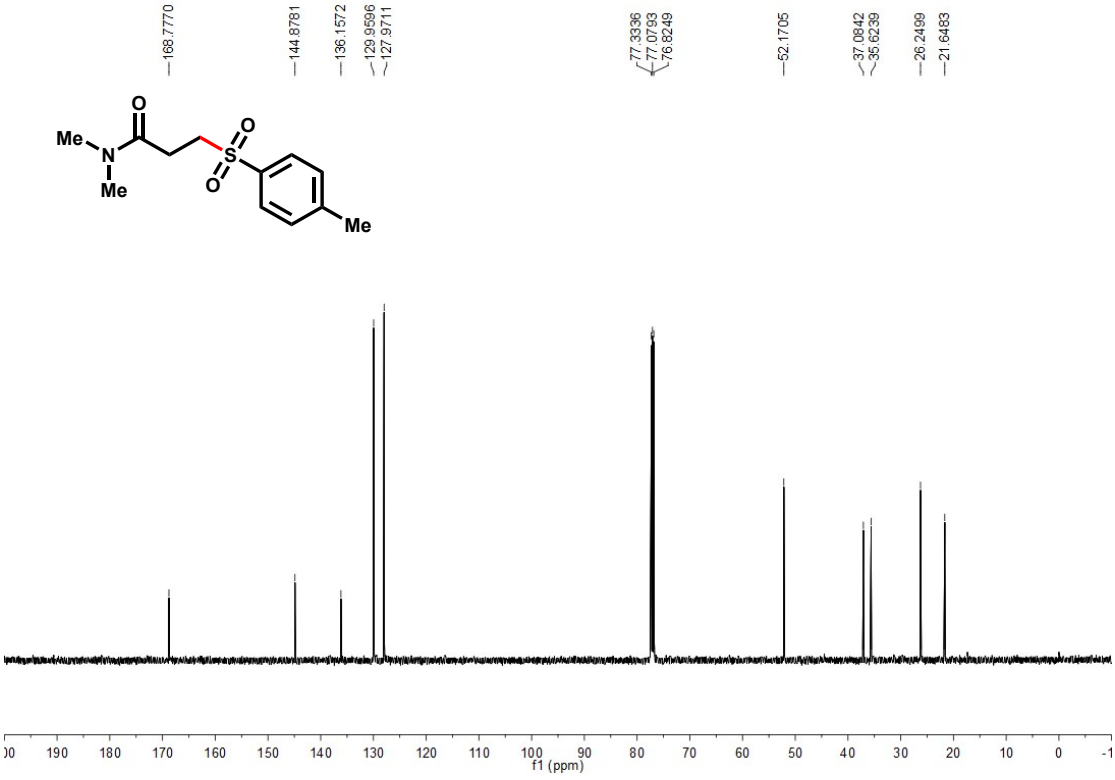


3fa

^{1}H NMR



^{13}C NMR



3fb

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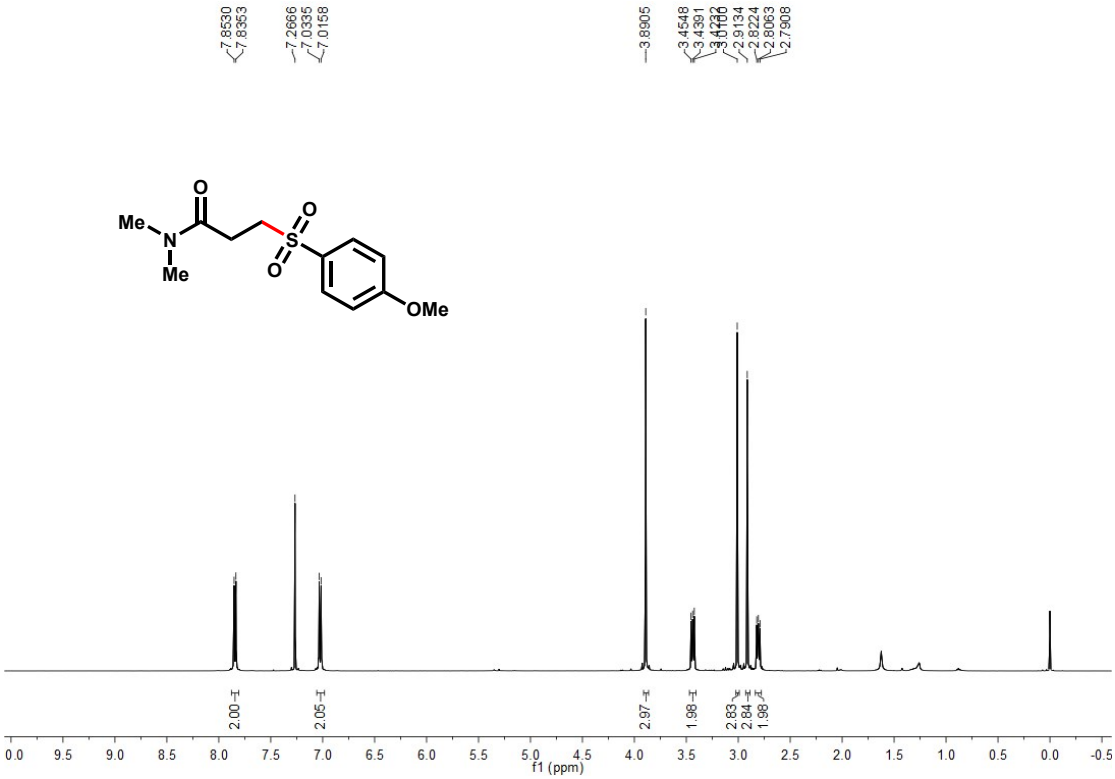
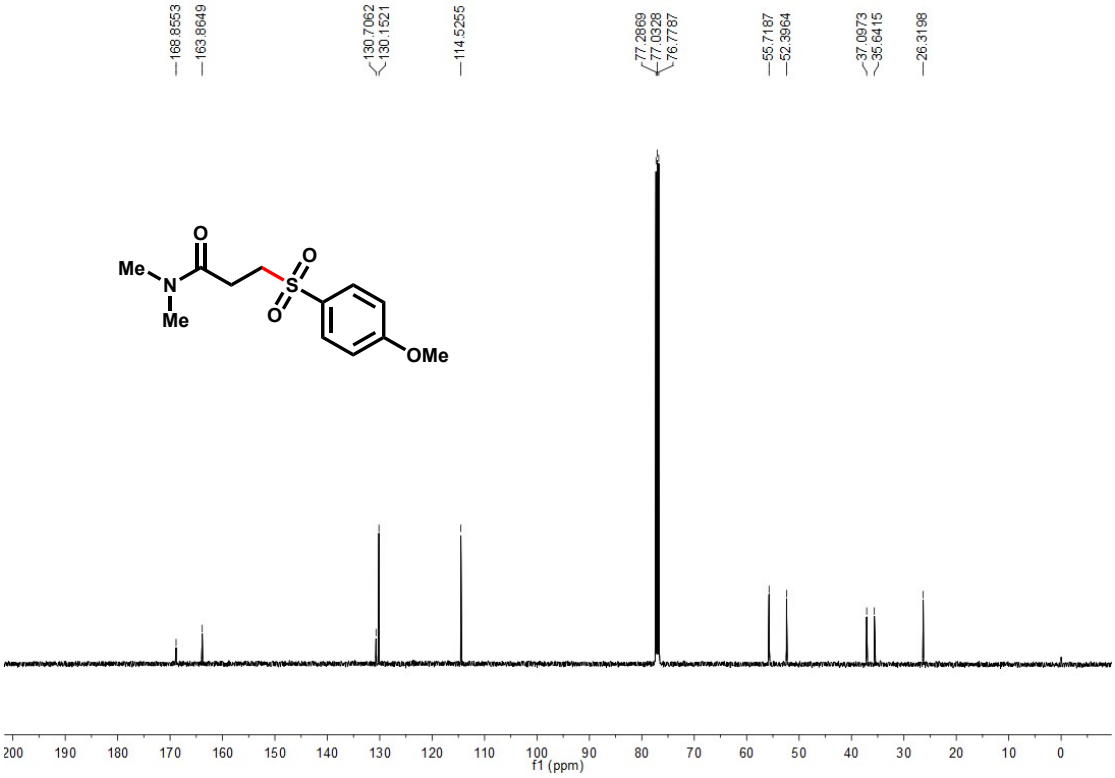
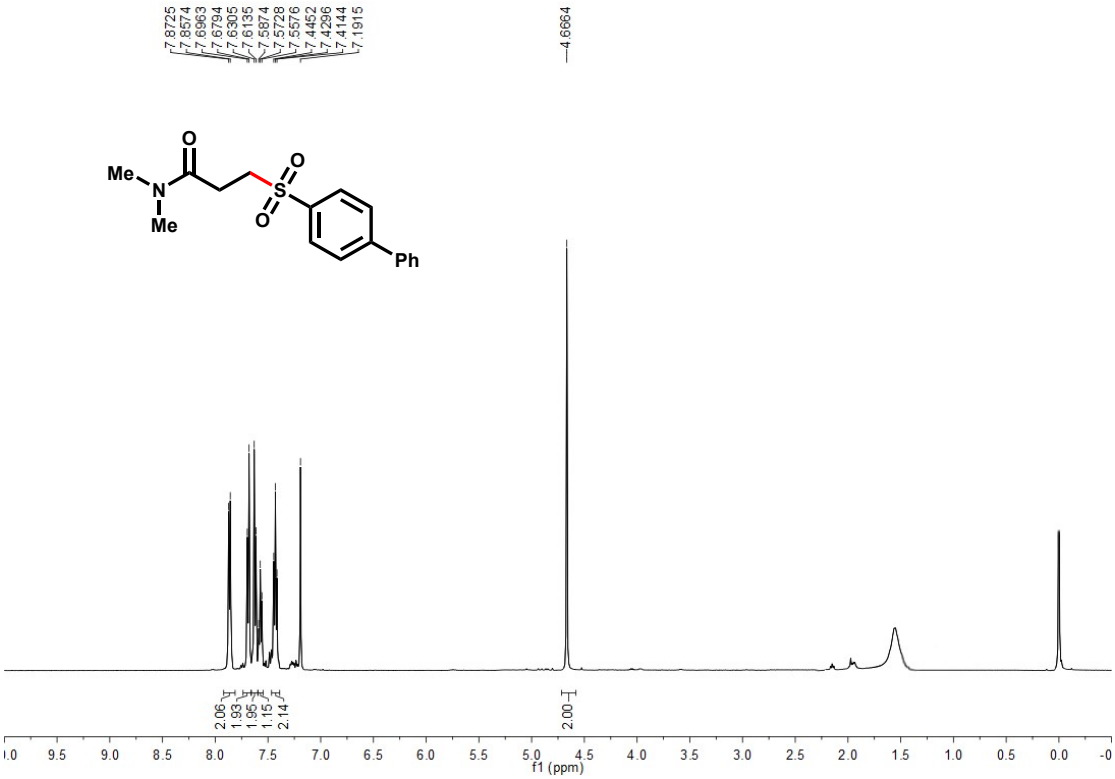


^{13}C NMR

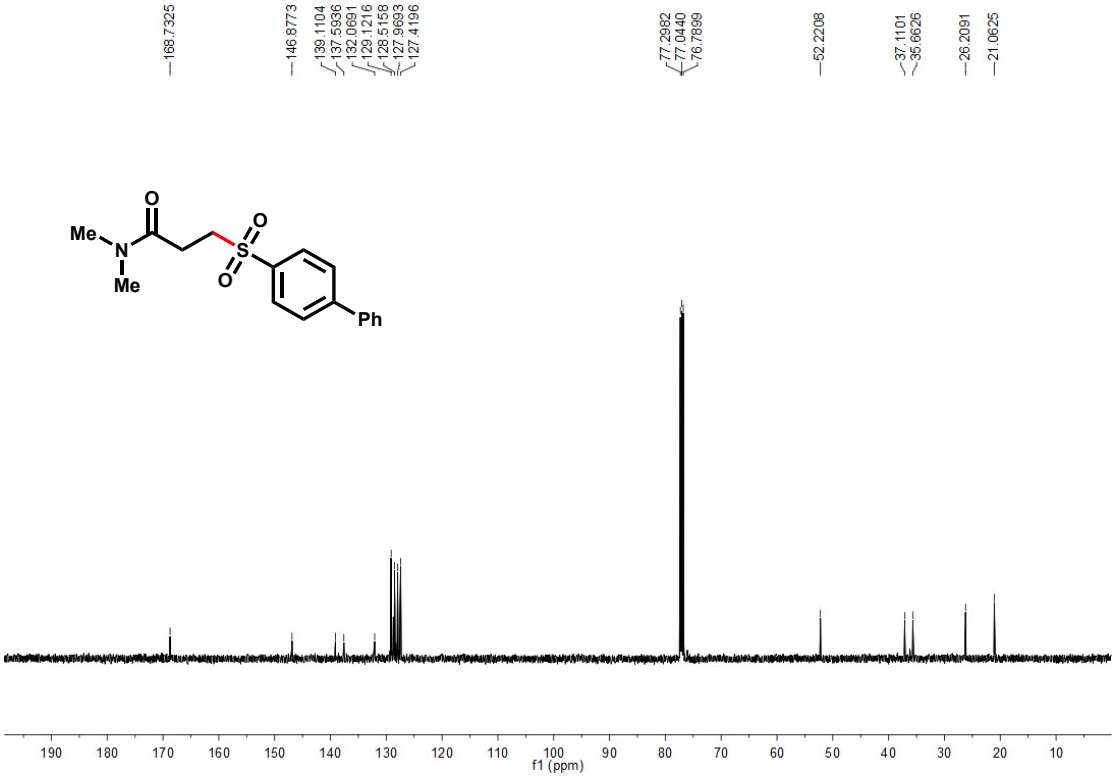


3fd

^{1}H NMR

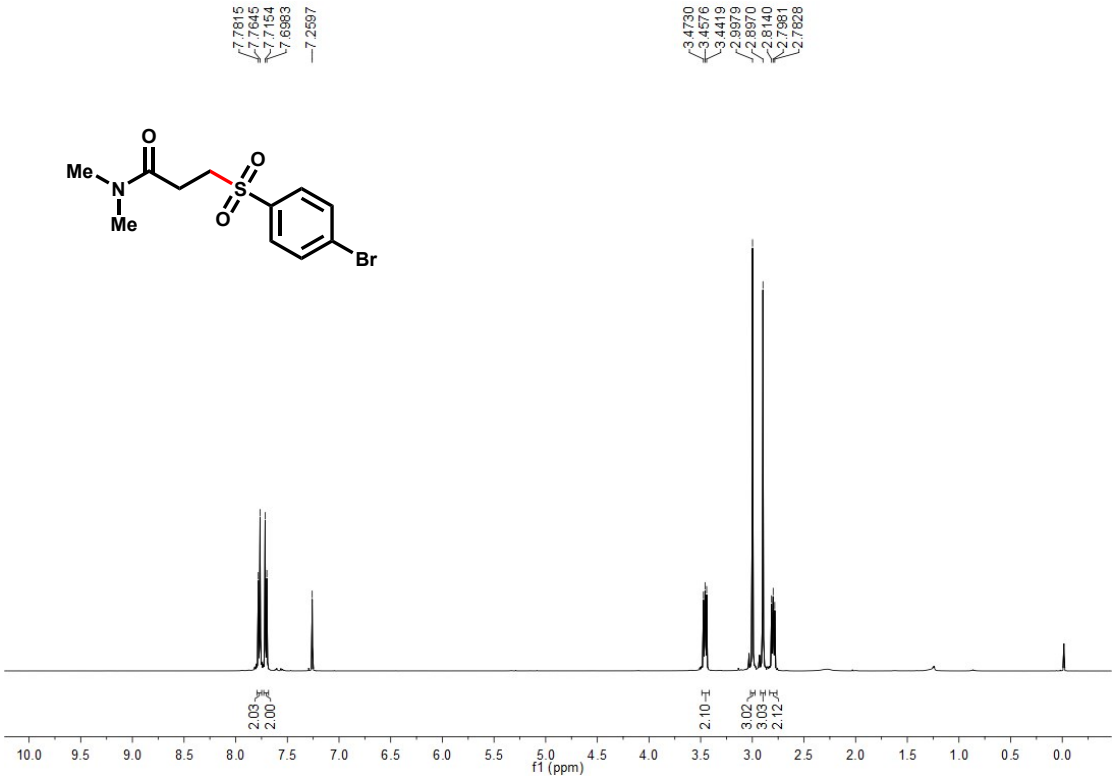


^{13}C NMR

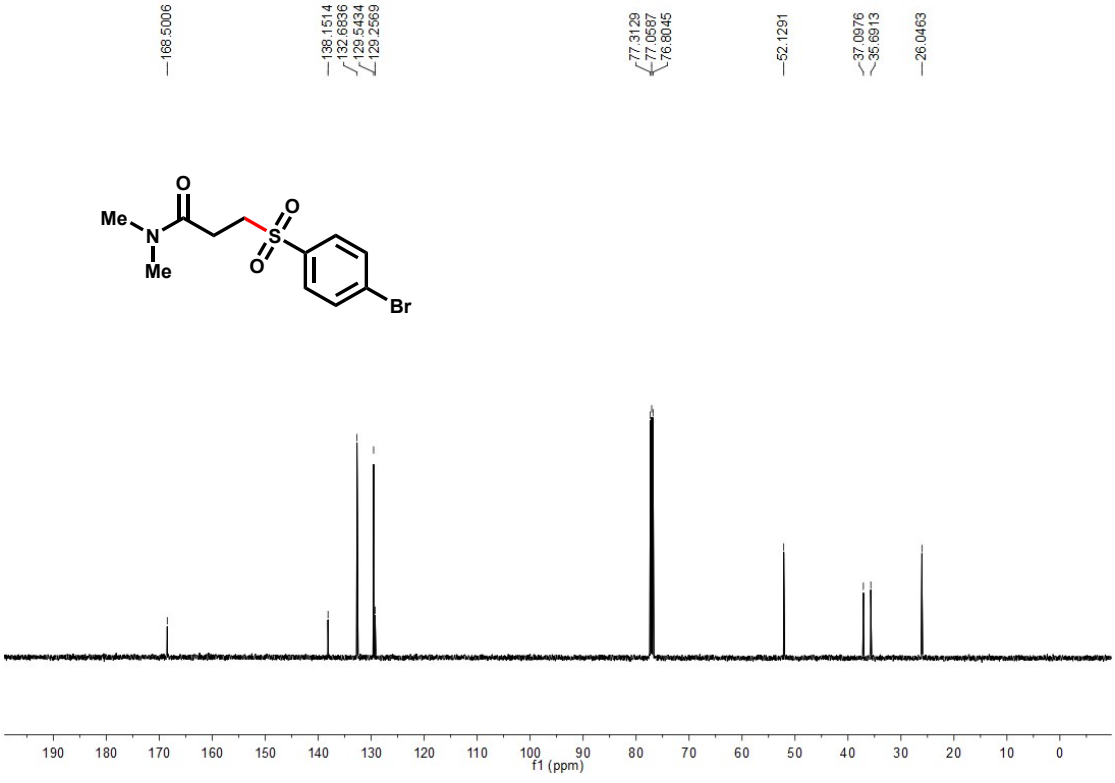


3ff

^{1}H NMR

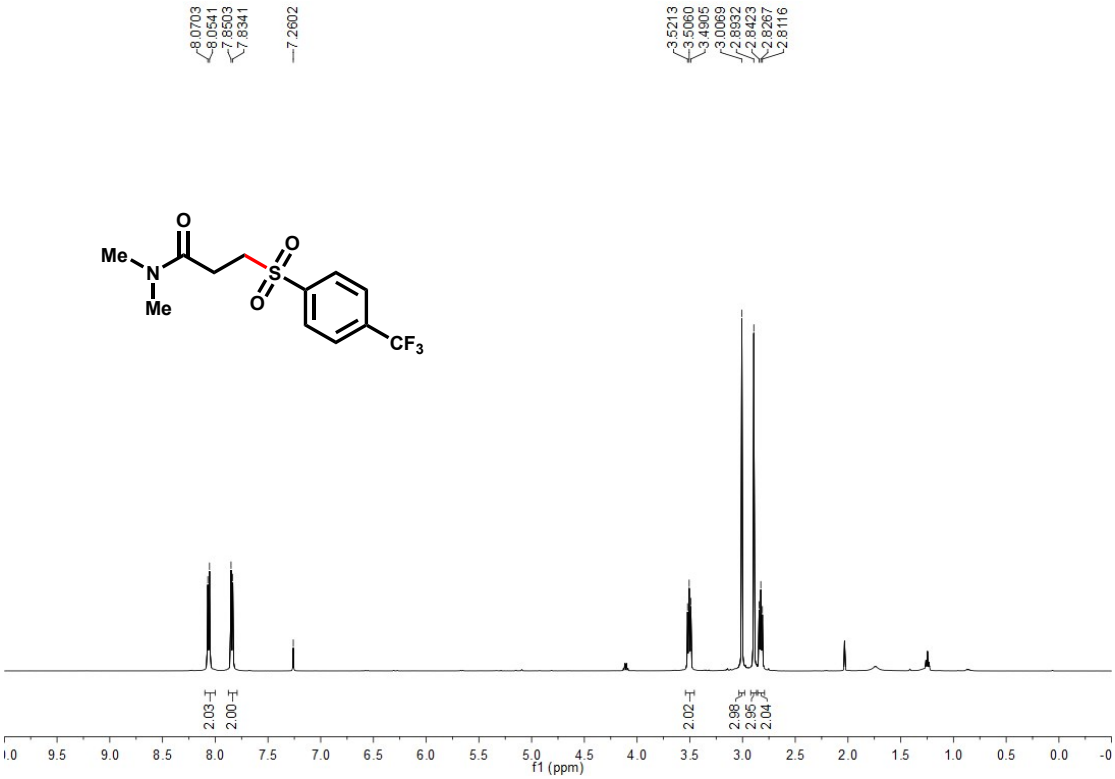


^{13}C NMR

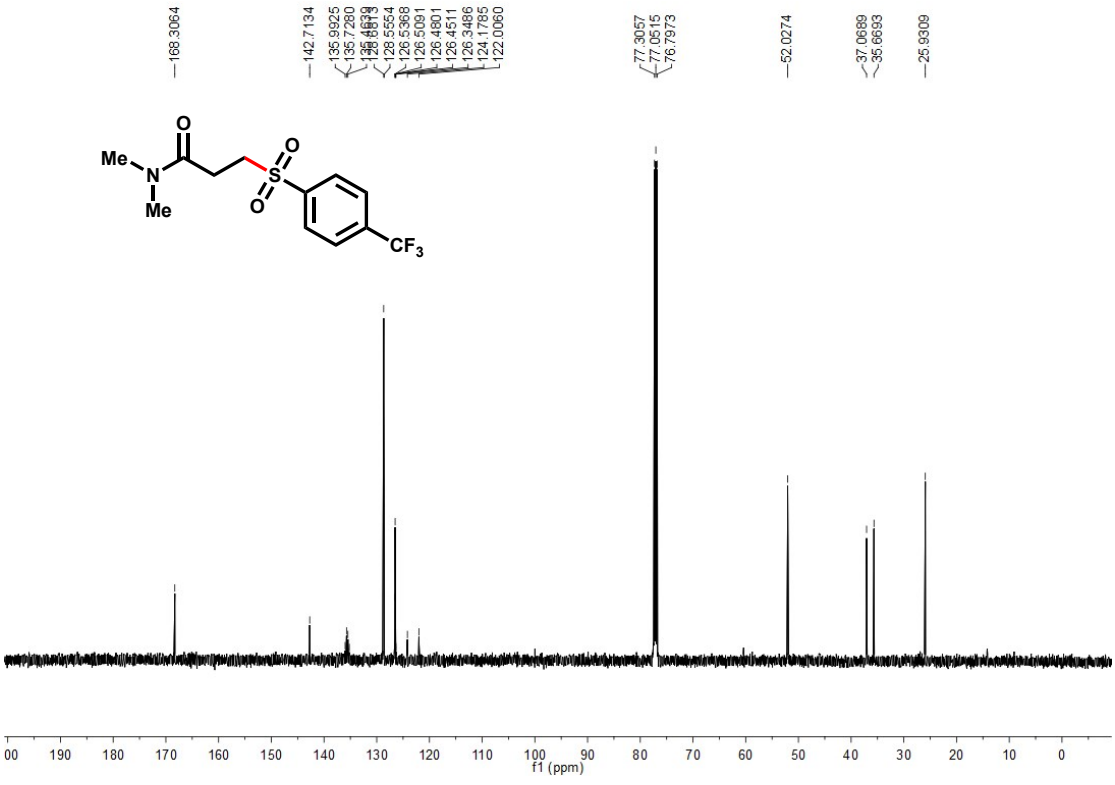


3fh

^{1}H NMR

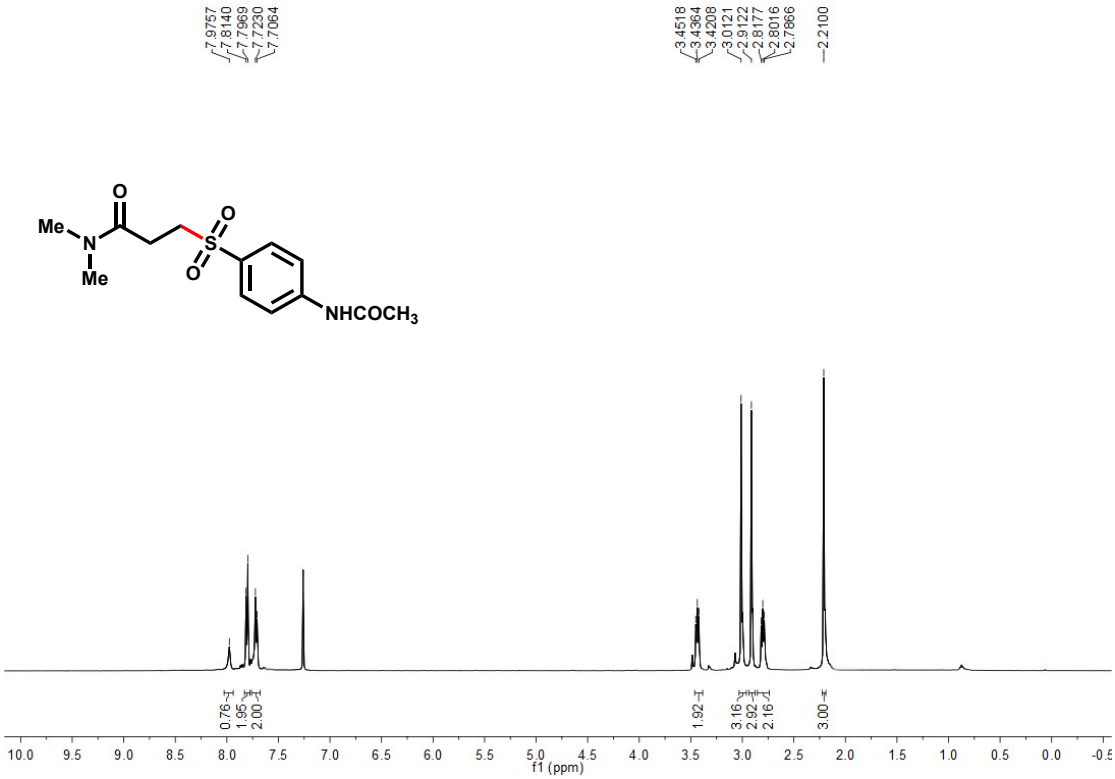


^{13}C NMR



3fi

^{1}H NMR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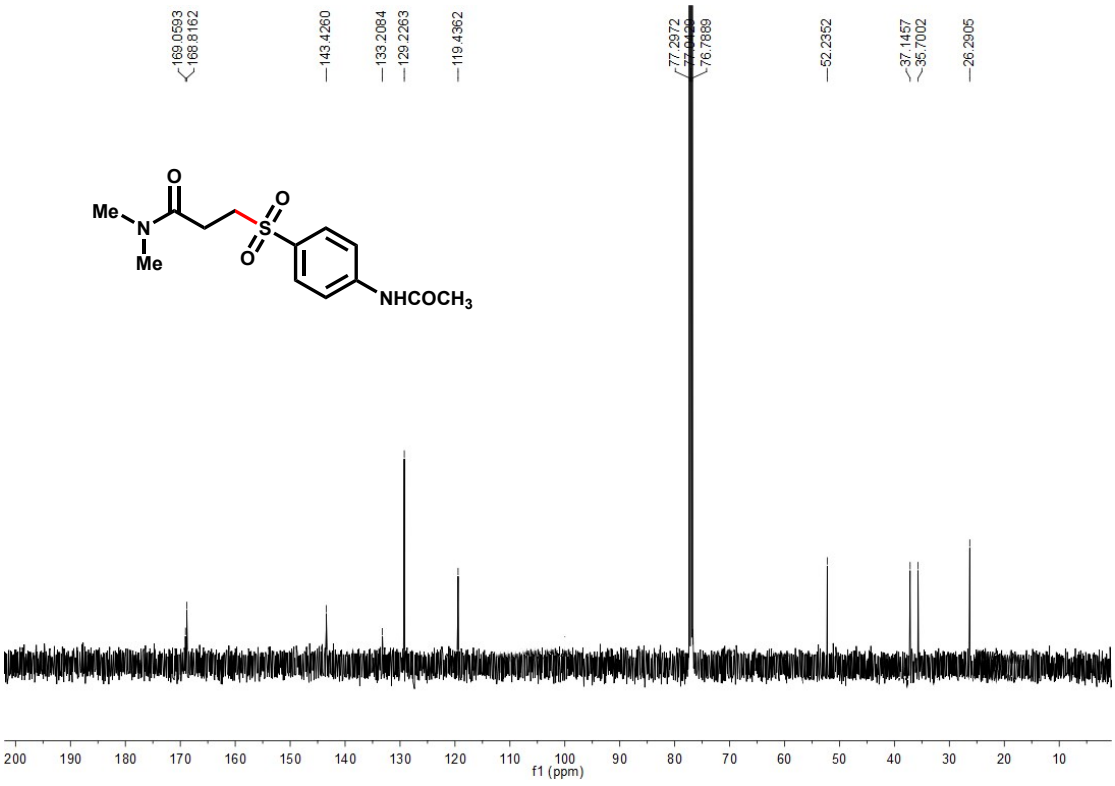
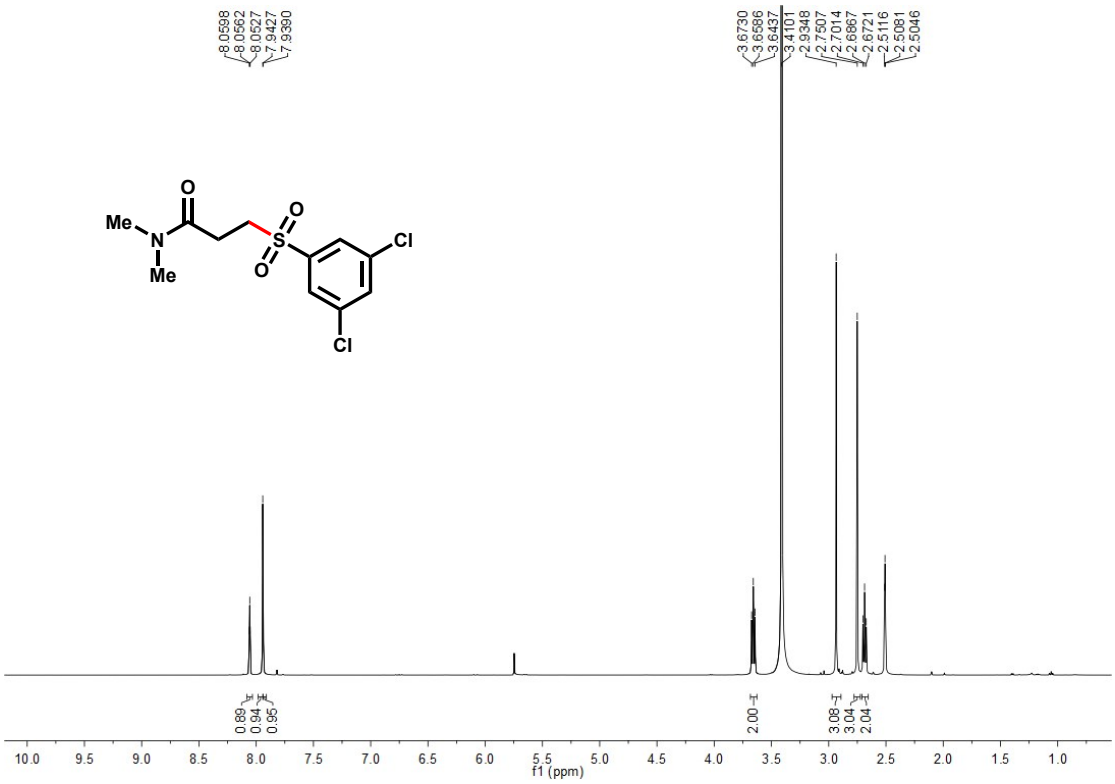
7.8140
7.7969
7.7230
7.7064
3.4518
3.4364
3.4208
3.0121
2.9122
2.8177
2.8016
2.7866
2.2100
Me
N
Me
O
O
S
O
NHCOCH3
0.76
1.95
2.00
1.92
3.16
2.92
2.16
3.00
f1 (ppm)

(b)

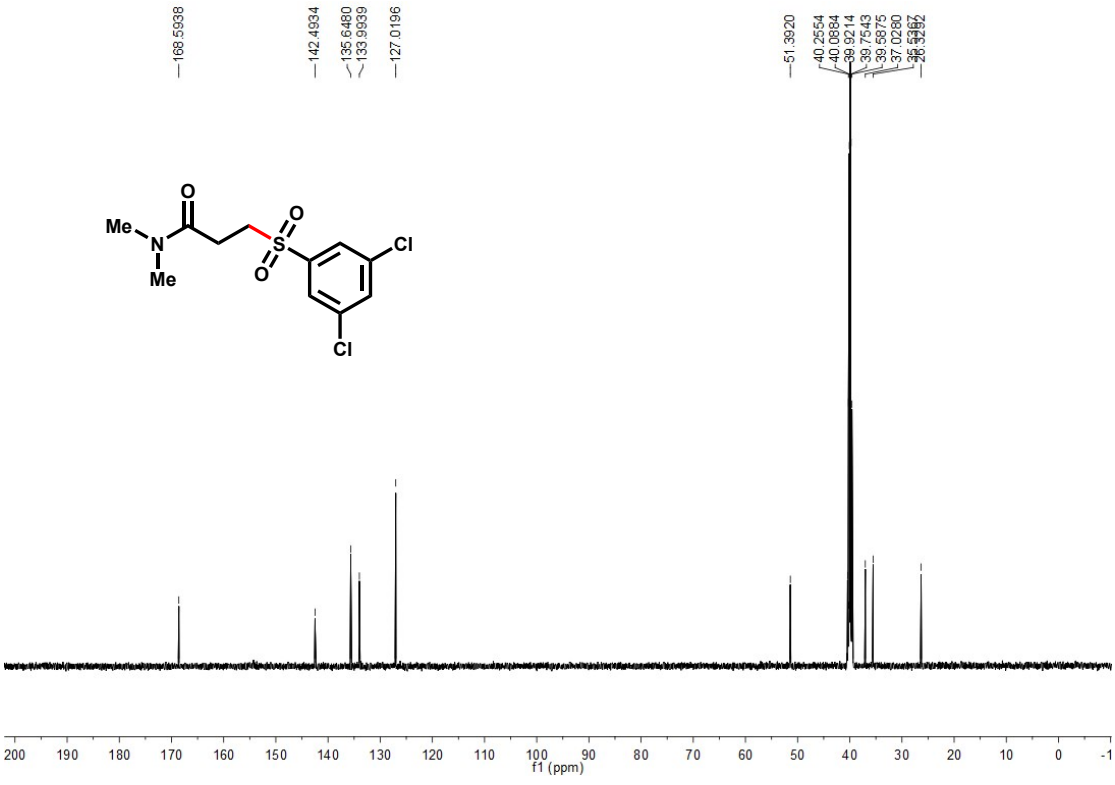

169.0593
168.8162
143.4260
133.2084
129.2263
119.4362
77.2972
77.0438
76.7889
52.2352
37.1457
36.7002
26.2905
Me
N
Me
O
O
S
O
NHCOCH3
f1 (ppm)

3fj

^{1}H NMR

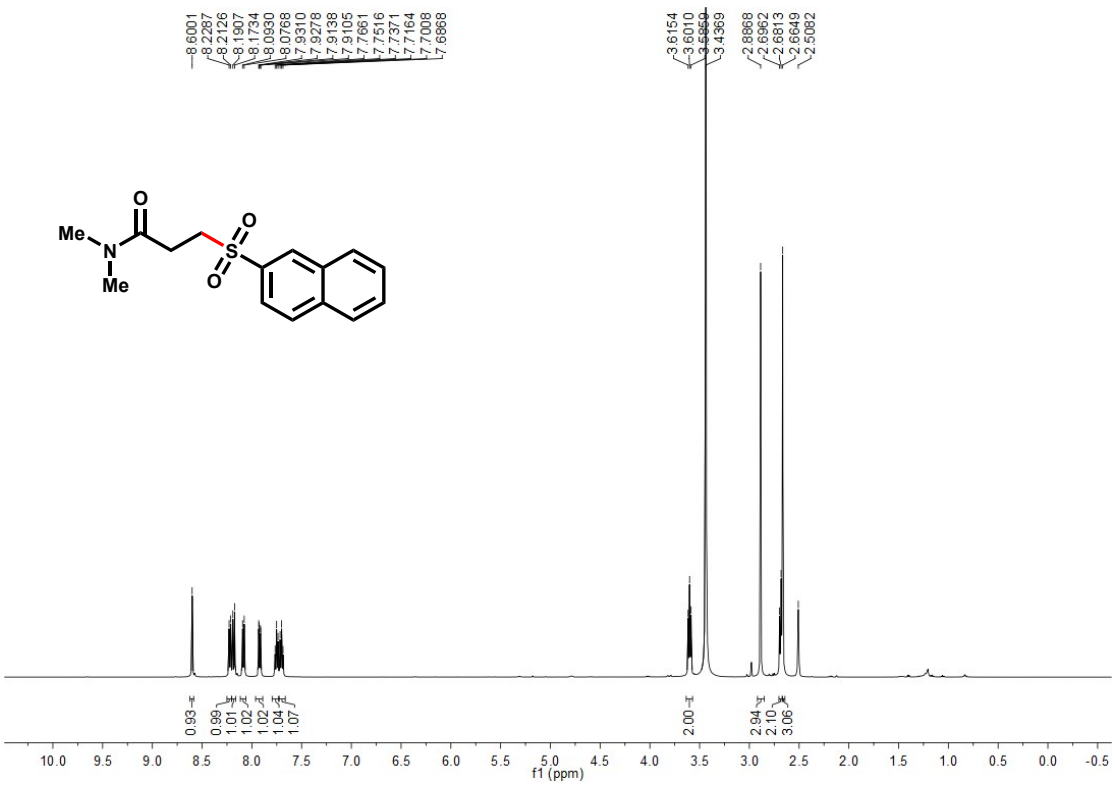


^{13}C NMR

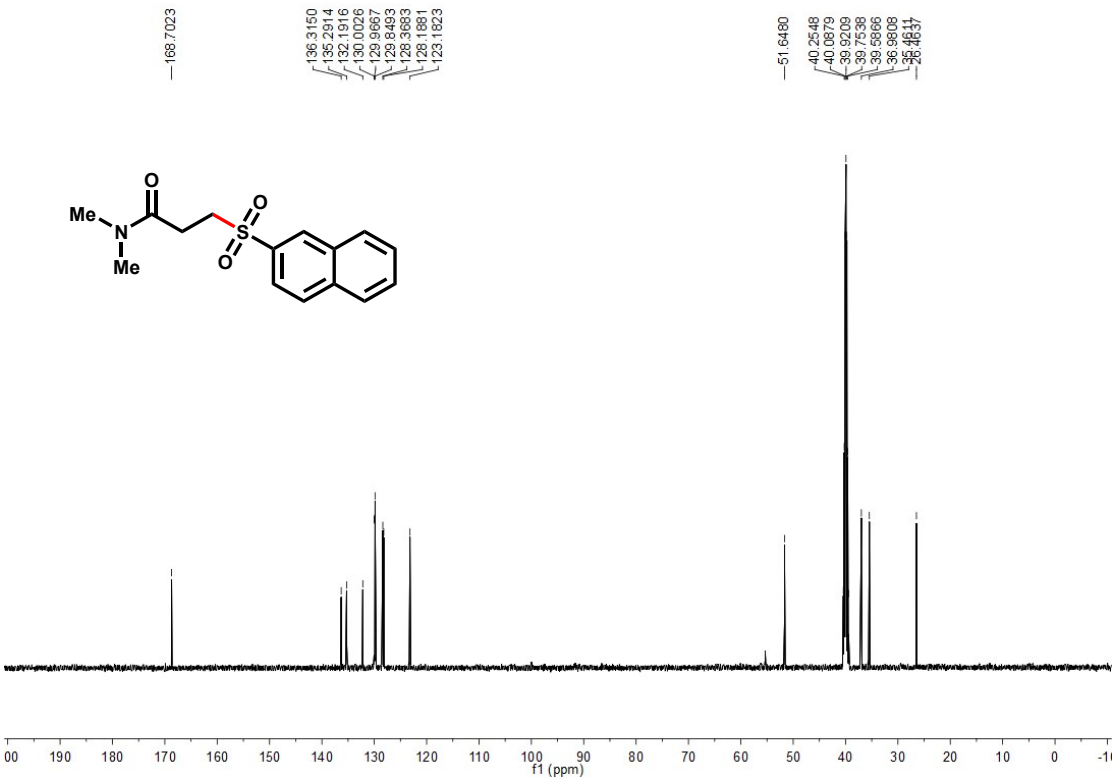


3fn

^{1}H NMR

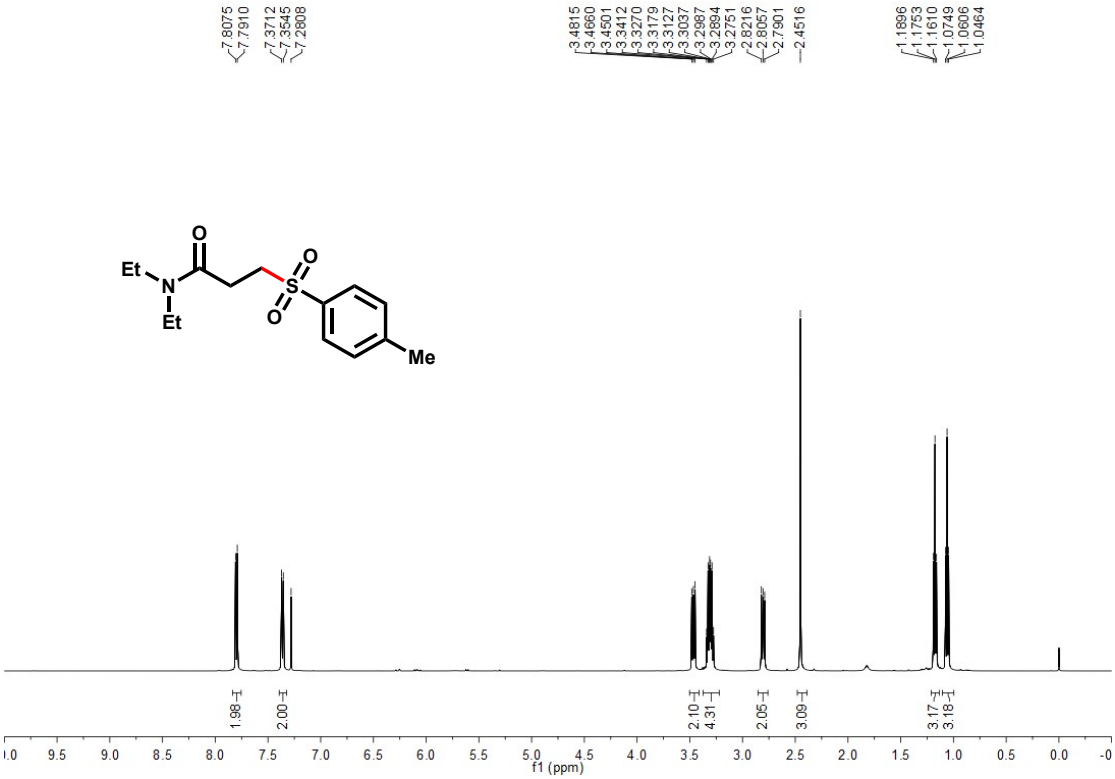


^{13}C NMR

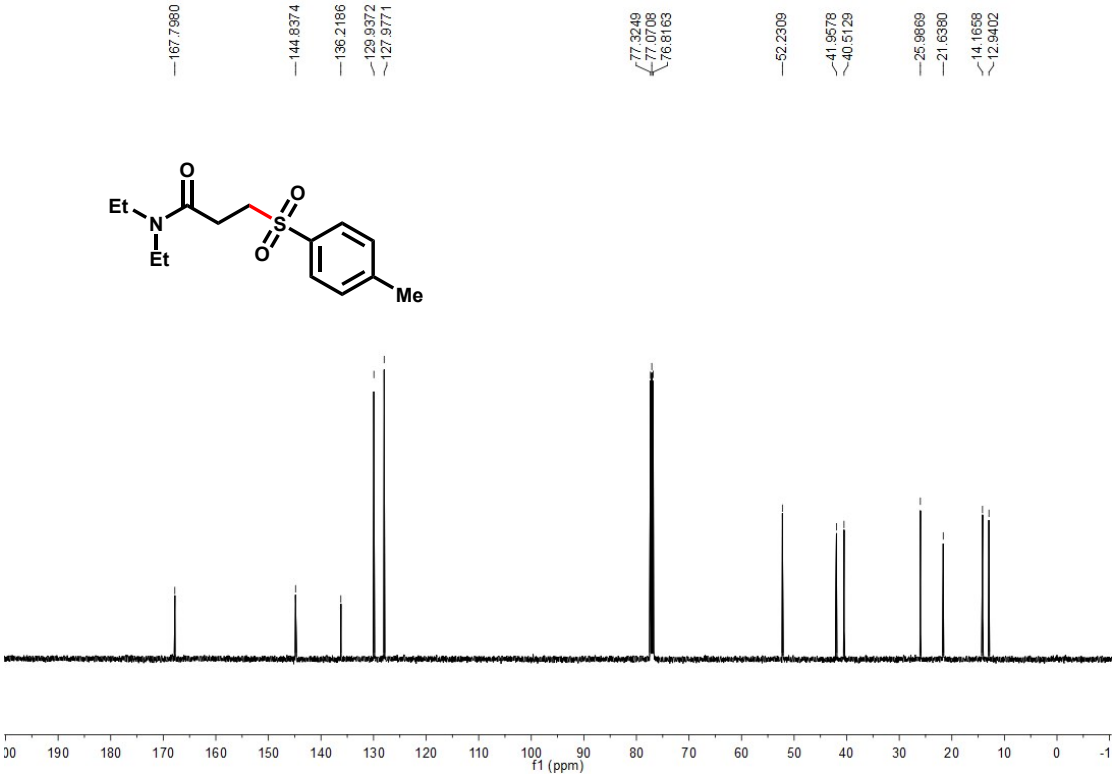


3ga

^{1}H NMR

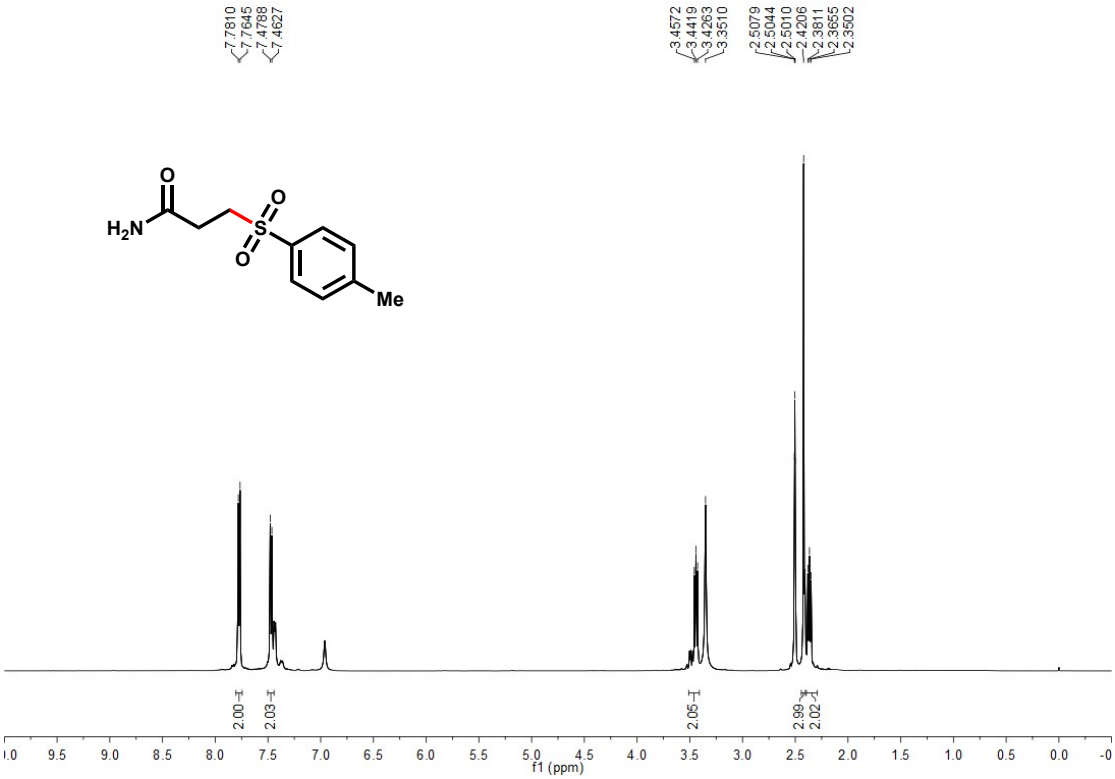


^{13}C NMR

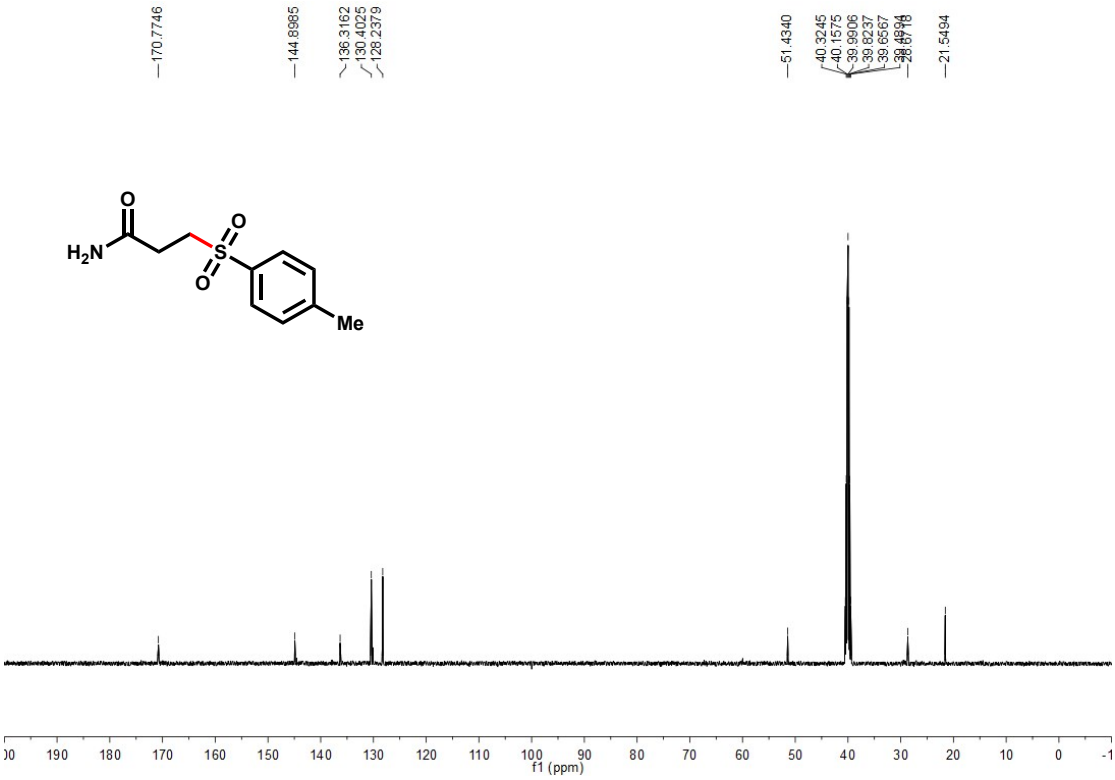


3ha

^{1}H NMR

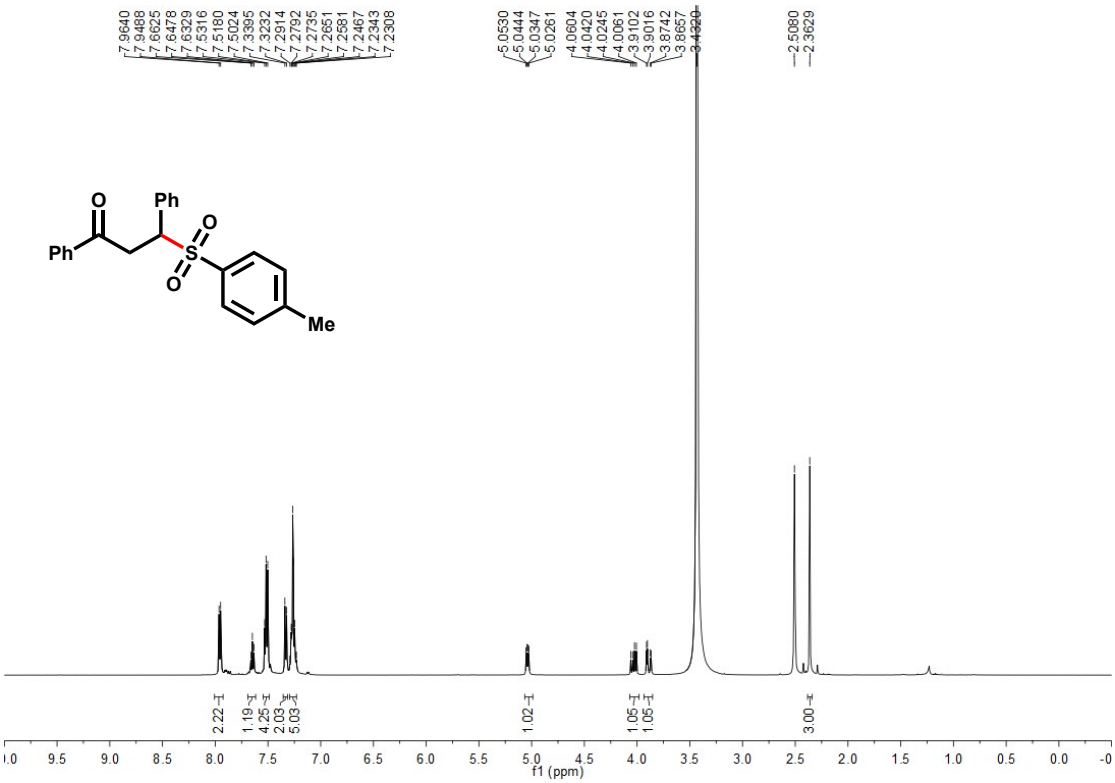


^{13}C NMR

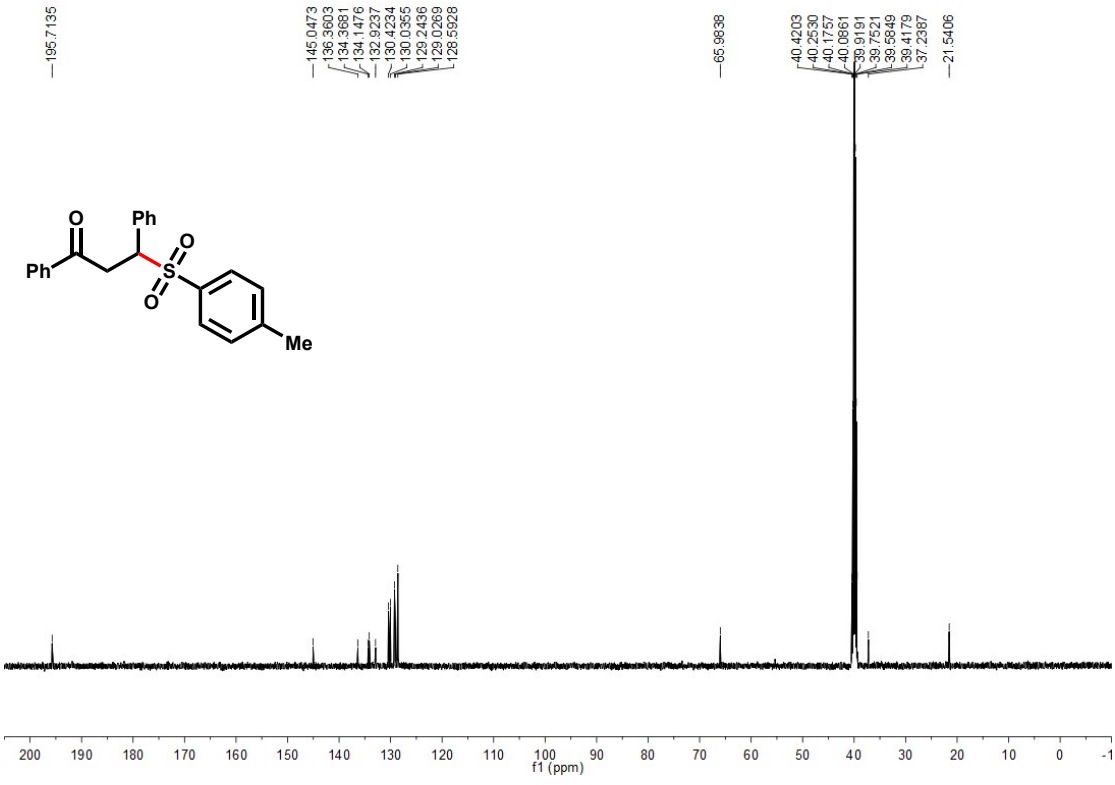


3ia

^{1}H NMR

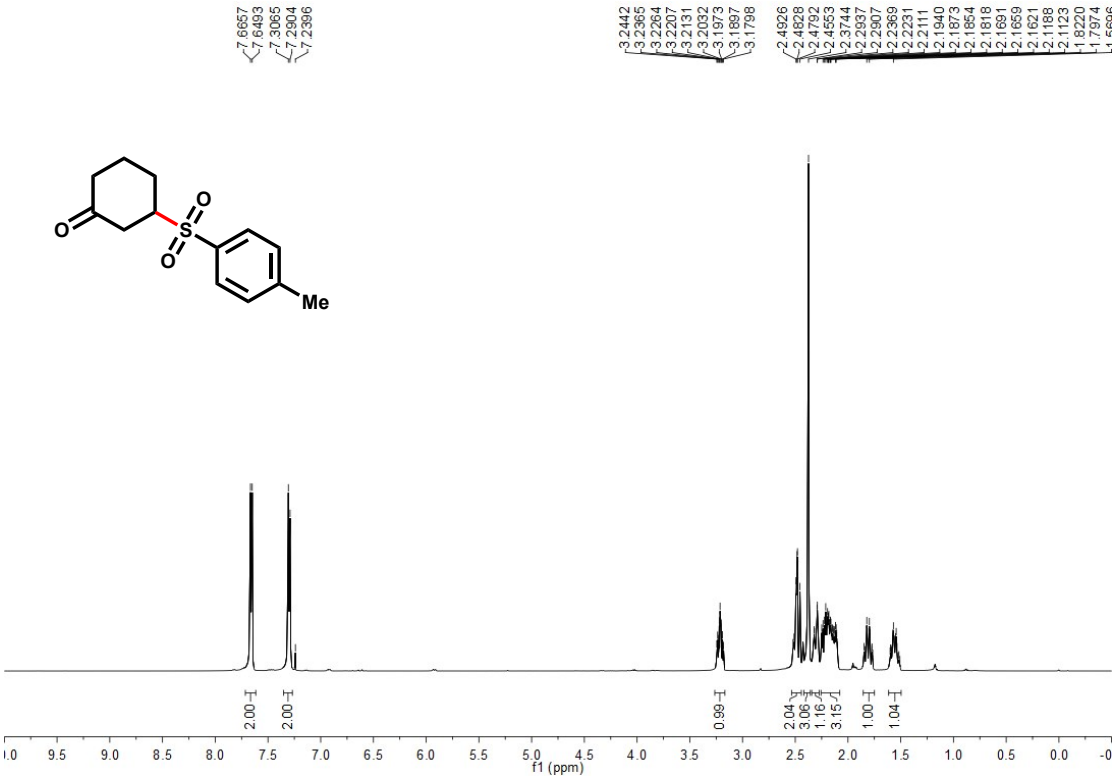


^{13}C NMR

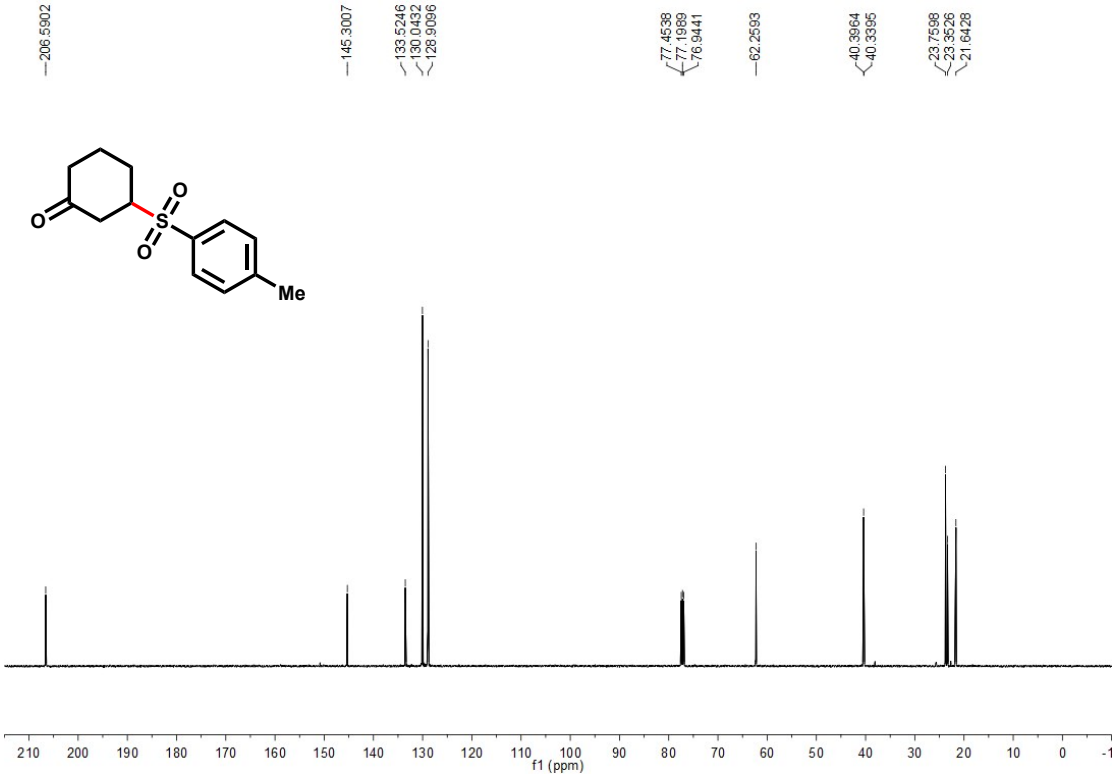


3ja

^{1}H NMR

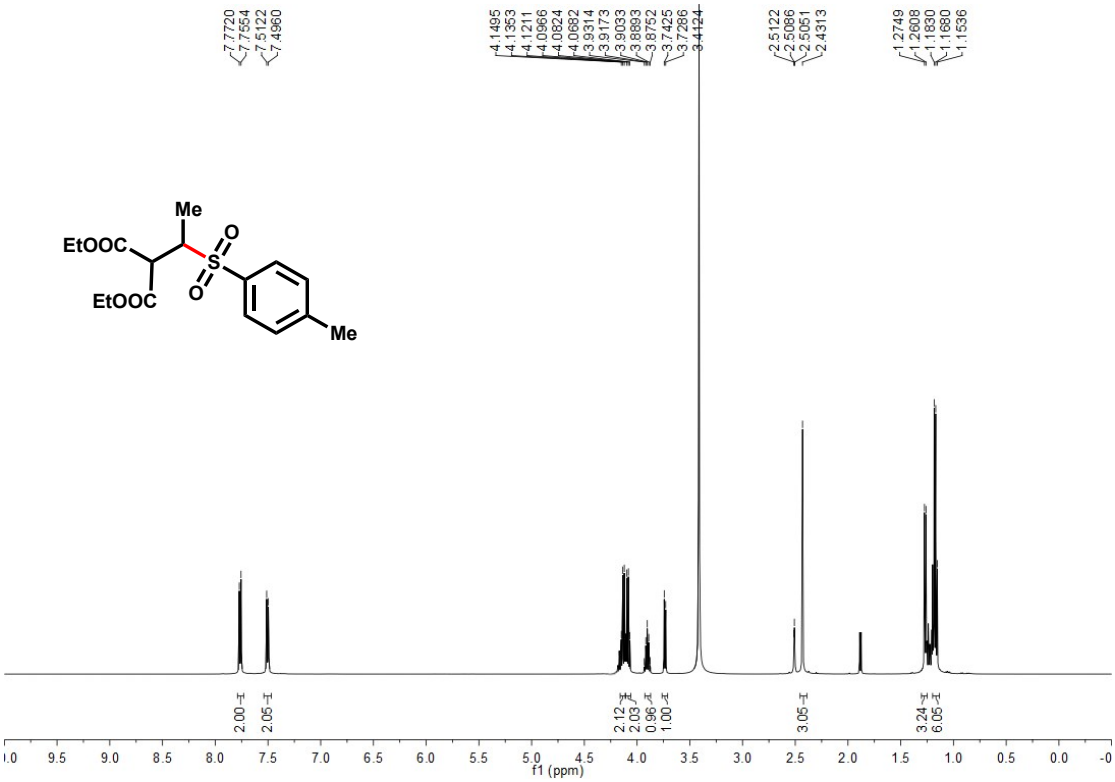


^{13}C NMR

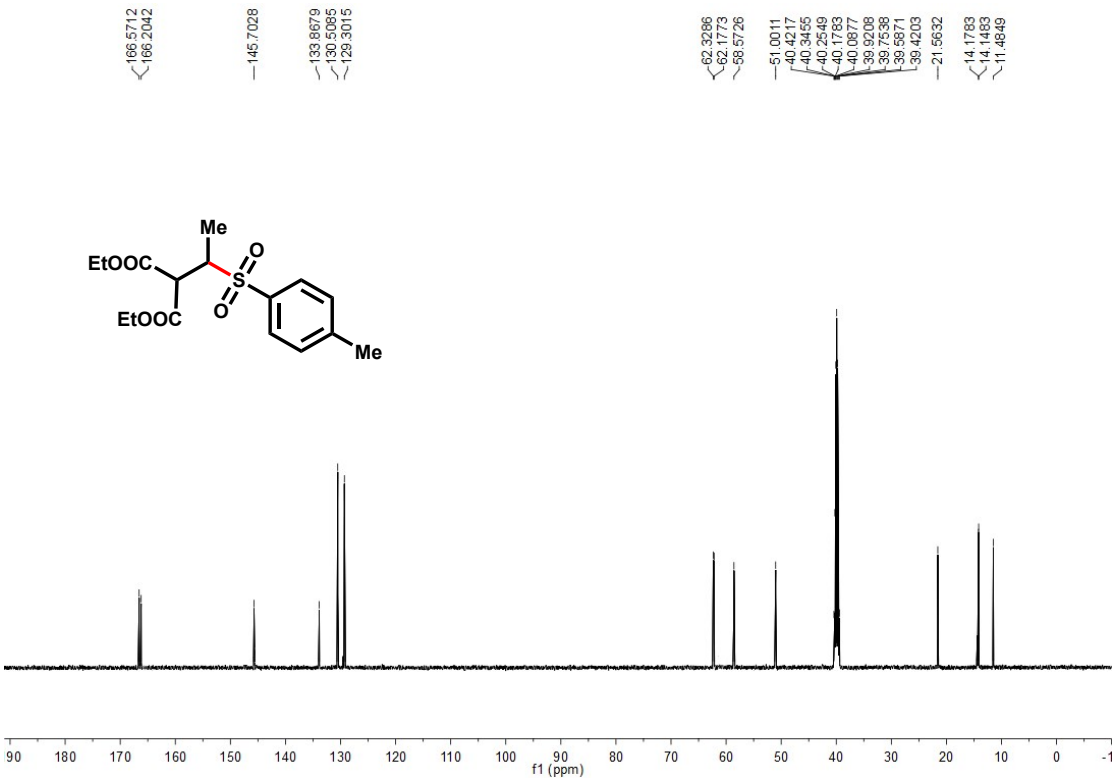


3ka

^{1}H NMR

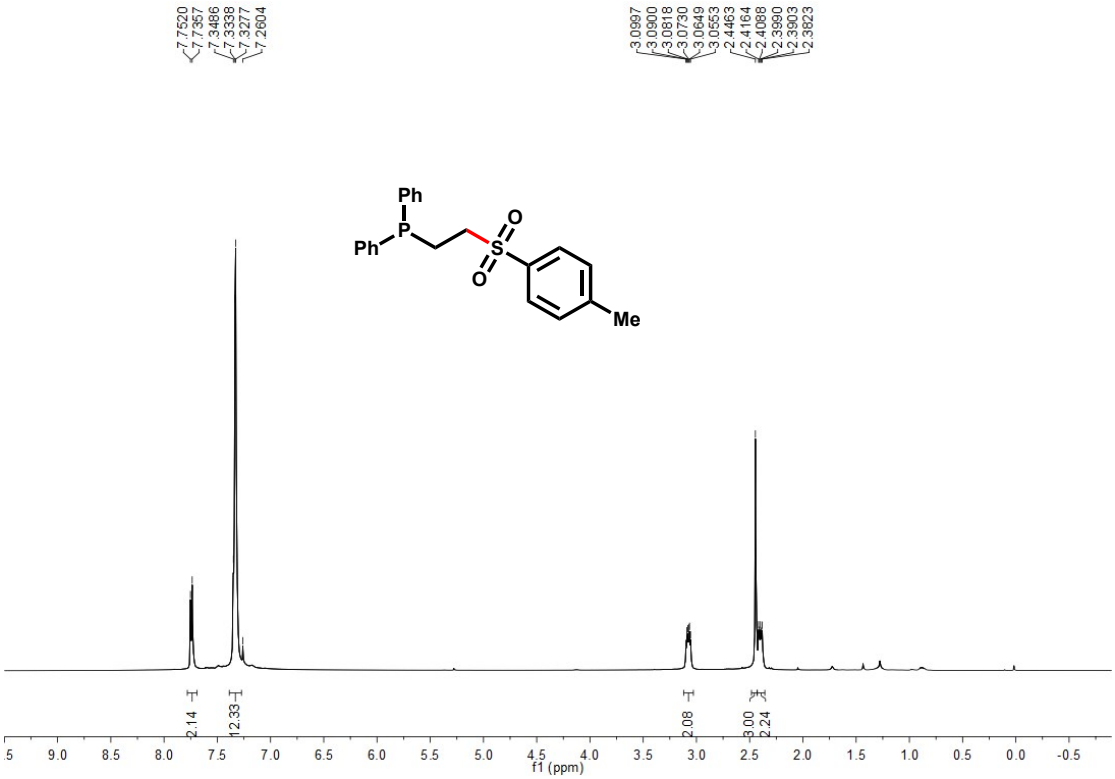


^{13}C NMR



3la

^{1}H NMR



^{13}C NMR