Supporting Information

Palladium-catalyzed regioselective hydrosulfonylation of allenamides with arylsulfinic acids

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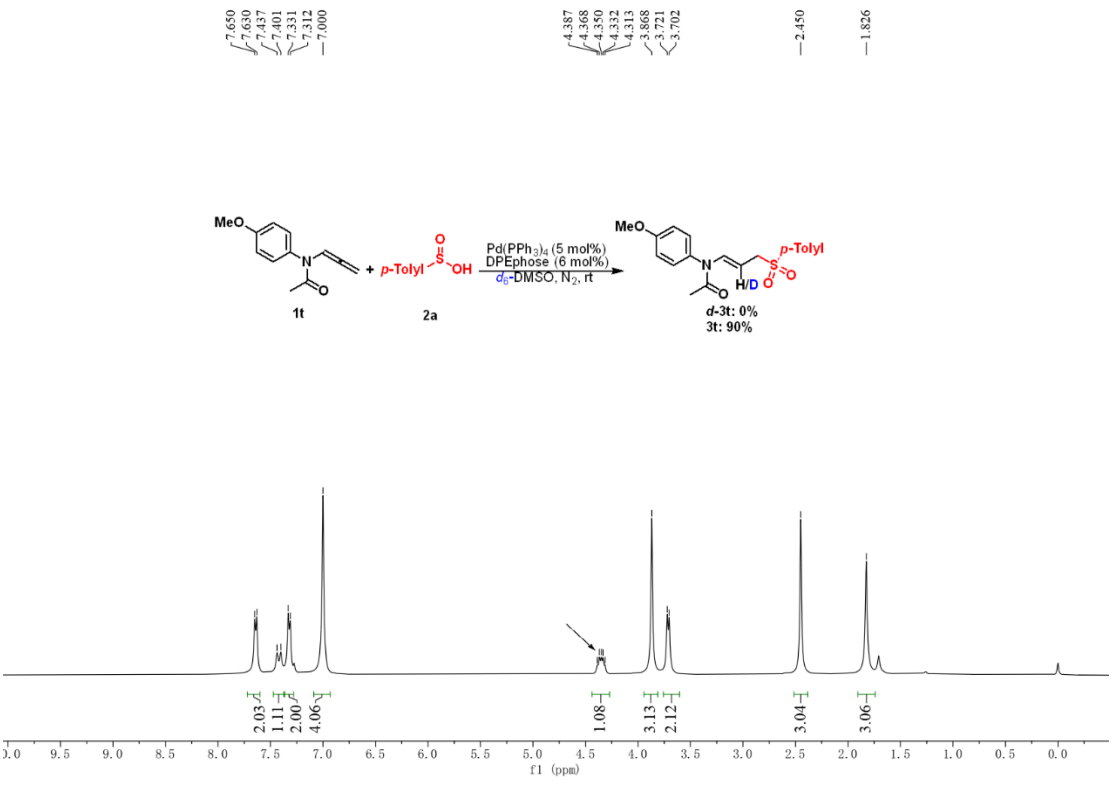
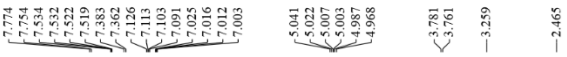
Context

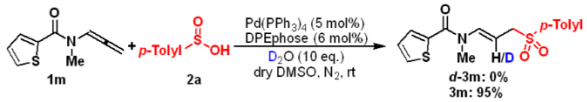
General Information

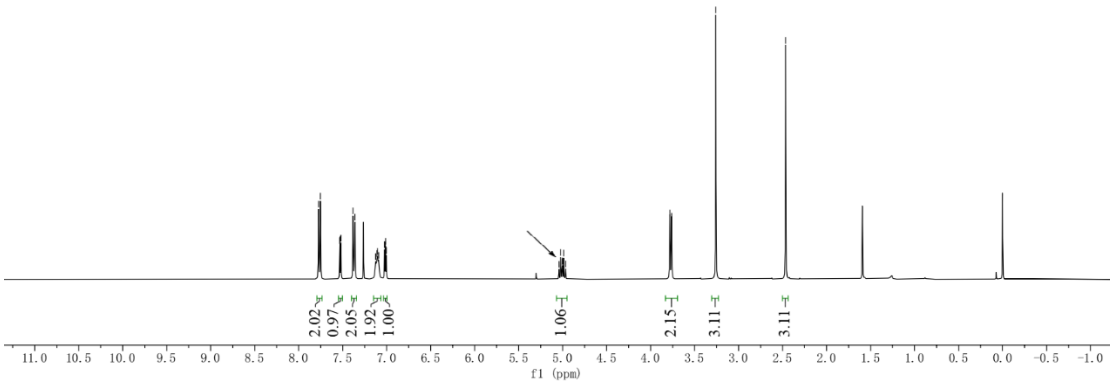
^{1}H NMR (^{13}C NMR) spectra were measured on a Bruker DPX 400 MHz spectrometer in $CDCl_3$ with chemical shift (δ) given in ppm relative to TMS as internal standard [(s = singlet, d = doublet, t = triplet, brs = broad singlet, m = multiplet), coupling constant (Hz)]. High-resolution mass spectra (HRMS) were obtained on an Agilent mass spectrometer using ESI-TOF (electrospray ionization-time of flight). X-Ray crystallographic analysis was performed with a Siemens SMART CCD and a Siemens P4 diffractometer. Column chromatography was generally performed on silica gel (200-300 mesh) and reactions were monitored with thinlayer chromatography (TLC) using 254 nm UV light. The melting points were measured with digital melting point detector.

Deuterium-Labeling Experiment Result



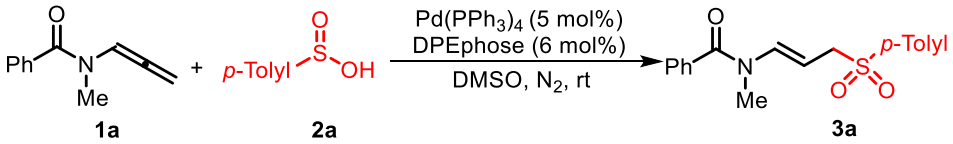






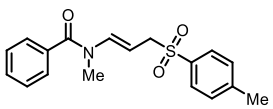
General Procedure for the Synthesis of Compound 3 and 4

Example for the synthesis of 3a



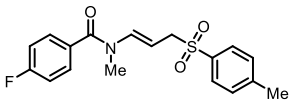
In a flame-dried Schlenk tube along with a stir bar under nitrogen conditions, allenamide (**1a**, 0.2 mmol, 34.6 mg), *p*-methylbenzenesulfinic acid (**2a**, 0.24 mmol, 37.5 mg) and $Pd(PPh_3)_4$ (11.55 mg, 0.01 mmol), DPEphos (6.45 mg, 0.012 mmol) was added into the tube and then dry DMSO (2 mL) was injected into the reaction system. Subsequently, the tube was stirred at room temperature. The reaction was stirred for 6h and monitored by TLC. Upon completion, the reaction mixture was concentrated by vacuum distillation and purified by flash column chromatography to afford the desired pure product **3a** (eluent: ethyl acetate/petroleum ether = 1:6).

Characterization Data of Compounds 3a-3z and 3aa-3ab



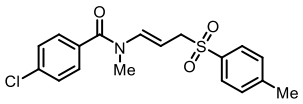
(E)-N-methyl-N-(3-tosylprop-1-en-1-yl)benzamide (3a)

Light yellow solid; 63.2mg, 96 % yield; mp: 123-125°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.73 (d, *J* = 7.6 Hz, 2H), 7.49-7.41 (m, 1H), 7.41-7.32 (m, 4H), 7.30-7.19 (m, 2H), 6.61 (s, 1H), 5.04-4.85 (m, 1H), 3.69 (d, J = 7.6 Hz, 2H), 3.20 (s, 3H), 2.48 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 170.3, 144.8, 135.4, 134.3, 130.7, 129.8, 128.5, 128.5, 128.0, 58.5, 21.7. HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{19}NO_3S$ $[M+Na]^+$ 352.0983; found, 352.0974.



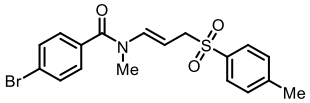
(E)-4-fluoro-N-methyl-N-(3-tosylprop-1-en-1-yl)benzamide (3b)

White solid; 64.5mg, 93% yield; mp: 128-130°C;^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.74 (d, J = 8.4 Hz, 2H), 7.38 (d, J = 8.0 Hz, 2H), 7.35-7.25 (m, 2H), 7.06 (t, J = 8.4 Hz, 2H), 5.09-4.85 (m, 2H), 3.70 (d, J = 6.8 Hz, 2H), 3.20 (s, 1H), 2.48 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 169.3, 163.9 (d, *J* = 250.4 Hz), 162.7, 144.8, 135.4, 130.6, 130.5, 130.4 129.8, 128.5, 115.7 (d, *J* = 21.7 Hz), 58.4, 21.7.; ^{19}F NMR (376 MHz, Chloroform-*d*) δ -108.16. HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{18}FNO_3S$ $[M+Na]^+$ 370.0889; found, 370.0880.



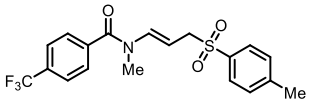
(*E)-4-chloro-N-methyl-N-(3-tosylprop-1-en-1-yl)benzamide (3c)*

White solid; 67.5mg, 93 % yield; mp: 159-161°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.74 (d, *J* = 8.0 Hz, 2H), 7.36 (t, *J* = 8.4 Hz, 4H), 7.30-7.21 (m, 2H), 6.60 (s, 1H), 5.07-4.88 (m, 1H), 3.69 (d, *J* = 7.6 Hz, 2H), 3.20 (s, 3H), 2.48 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 169.2, 144.8, 137.0, 135.5, 135.1, 132.7, 129.8, 129.6, 128.8, 128.5, 108.2, 58.4, 21.7; HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{18}ClNO_3S$ $[M+Na]^-$ 386.0594; found, 386.0598.



(E)-4-bromo-N-methyl-N-(3-tosylprop-1-en-1-yl)benzamide (3d)

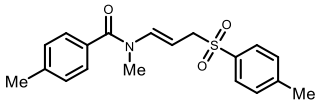
White solid;76.5mg, 94 % yield; mp: 165-167°C;^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.74 (d, *J* = 8.0 Hz, 2H), 7.51 (d, *J* = 8.0 Hz, 2H), 7.38 (d, *J* = 8.0 Hz, 2H), 7.17 (d, *J* = 7.6 Hz, 2H), 6.57 (s, 1H), 5.10-4.89 (m, 1H), 3.70 (s, 2H), 3.20 (s, 3H), 2.49 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 169.3, 144.9, 135.4, 133.1, 131.8, 130.1, 129.8, 129.7, 128.5, 128.5, 125.3, 58.3, 21.7; HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{18}FNO_3S$ $[M+Na]^+$ 430.0086; found, 430.0080.



(E)-N-methyl-N-(3-tosylprop-1-en-1-yl)-4-(trifluoromethyl)benzamide (3e)

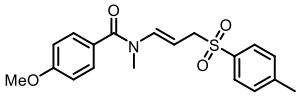
White solid;65.1mg, 82 % yield; mp: 149-151°C;^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.74 (d, *J* = 8.0 Hz, 2H), 7.64 (d, *J* = 8.0 Hz, 2H), 7.51-7.33 (m, 4H), 6.48 (s, 1H), 5.02 (s, 1H), 3.68 (s, 2H), 3.24 (s, 3H), 2.48 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 168.8, 144.9, 137.9, 135.5, 132.5 (*J* =

32.6 Hz), 129.9, 128.5, 125.6 (J = 3.9 Hz), 123.5 (J = 272.5 Hz), 58.2, 30.4, 21.7. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -63.04. HR-MS (ESI-TOF, m/z) calcd for $C_{19}H_{18}F_3NO_3S$ $[M+Na]^+$ 420.0857; found, 420.0854.



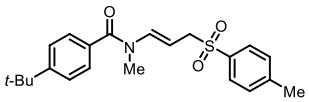
(E)-N,4-dimethyl-N-(3-tosylprop-1-en-1-yl)benzamide (3f)

White solid, 62.4mg, 91% yield; mp: 110-112°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ7.73 (d, J = 8.4 Hz, 2H), 7.37 (d, J = 8.0 Hz, 2H), 7.24-7.10 (m, 4H), 6.69 (s, 1H), 5.00-4.83 (m, 1H), 3.69 (d, J = 7.6 Hz, 2H), 3.19 (s, 3H), 2.48 (s, 3H), 2.39 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ170.5, 144.8, 141.2, 135.4, 131.4, 129.8, 129.1, 128.6, 128.2, 58.5, 21.7, 21.5.; HR-MS (ESI-TOF, m/z) calcd for $C_{19}H_{21}NO_3S$ $[M+Na]^+$ 366.1140; found, 366.1132.



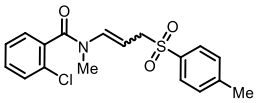
(E)-4-methoxy-N-methyl-N-(3-tosylprop-1-en-1-yl)benzamide (3g)

White solid; 66.7mg, 93 % yield; mp: 162-164°C;^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.74 (d, J = 8.4 Hz, 2H), 7.37 (d, J = 8.4 Hz, 2H), 7.32-7.19 (m, 2H), 6.94-6.82 (m, 3H), 4.99-4.83 (m, 1H), 3.85 (s, 3H), 3.71 (d, J = 7.6 Hz, 2H), 3.20 (s, 3H), 2.48 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 170.2, 161.6, 144.8, 135.4, 130.4, 130.1, 129.8, 128.6, 126.3, 113.7, 94.9, 58.6, 55.4, 21.7. HR-MS (ESI-TOF, m/z) calcd for $C_{19}H_{21}NO_4S$ $[M+Na]^+$ 382.1089; found, 382.1082.



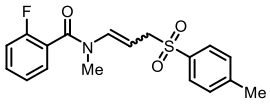
(E)-4-(tert-butyl)-N-methyl-N-(3-tosylprop-1-en-1-yl)benzamide (3h)

White solid; 71.6mg, 93 % yield; mp: 95-97°C;^{1} H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.74 (d, J = 8.0 Hz, 2H), 7.37 (dd, J = 8.4, 3.6 Hz, 4H), 7.21 (d, J = 7.6 Hz, 2H), 6.76 (s, 1H), 5.09-4.78 (m, 1H), 3.72 (d, J = 5.2 Hz, 2H), 3.20 (s, 3H), 2.49 (s, 3H), 1.33 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$; δ, ppm) δ170.5, 154.2, 144.8, 135.4, 131.2, 129. 8, 128.6, 128.1, 125.4, 58.5, 34.9, 31.2, 21.7.; HR-MS (ESI-TOF, m/z) calcd for $C_{22}H_{27}NO_3S$ $[M+Na]^+$ 408.1609; found, 408.1614.



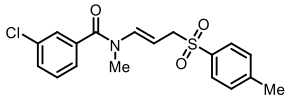
2-chloro-N-methyl-N-(3-tosylprop-1-en-1-yl)benzamide (3i)

Light yellow solid, 68.2mg, 94 % yield; mp:118-119°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.66 (d, J = 8.0 Hz, 2H), 7.45-7.09 (m, 6H), 6.16 (s, 1H), 5.17-4.91 (m, 1H), 3.86 (d, J = 7.6 Hz, 2H), 3.25 (s, 3H), 2.46 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 167.4, 144.8, 136.2, 133.8, 131.0, 130.6, 129.8, 129.8, 128.4, 128.3, 127.2, 96.6, 58.2, 33.6, 21.7. HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{18}ClNO_3S$ $[M+Na]^+$ 386.0594; found, 386.0586.



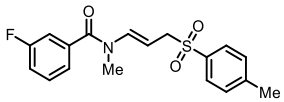
2-fluoro-N-methyl-N-(3-tosylprop-1-en-1-yl)benzamide (3j)

Light yellow solid, 63.1mg, 91% yield; mp: 139-140°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.68 (d, *J* = 8.0 Hz, 2H), 7.50-7.30 (m, 4H), 7.23-6.98 (m, 3H), 6.34 (d, *J* = 14.0, 1H), 4.99-4.92 (m, 1H), 3.65 (d, *J* = 7.6 Hz, 2H), 3.24 (s, 3H), 2.47 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.9, 158.27 (*J* = 248.6 Hz), 144.8, 136.7, 135.2, 132.3 (*J* = 8.0 Hz), 129.8, 129.4, 128.4, 124.75 (*J* = 20.1 Hz), 116.1 (*J* = 20.5 Hz), 96.4, 58.2, 33.92, 29.8, 21.7.; ^{19}F NMR (376 MHz, Chloroform-*d*) δ -113.61, 114.09. HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{18}FNO_3S$ $[M+Na]^+$ 370.0889; found, 370.0887.



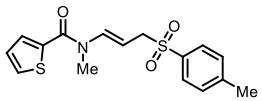
(E)-3-chloro-N-methyl-N-(3-tosylprop-1-en-1-yl)benzamide (3k)

Light yellow solid; 93 % yield; 67.5mg, mp: 128-129°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.73 (d, *J* = 8.0 Hz, 2H), 7.43 (d, *J* = 8.0 Hz, 1H), 7.37 (d, *J* = 8.0 Hz, 2H), 7.34-7.26 (m, 2H), 7.13 (s, 1H), 6.53 (s, 1H), 5.19-4.82 (m, 1H), 3.70 (s, 2H), 3.20 (s, 3H), 2.47 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 168.8, 144.9, 136.1, 135.3, 134.8, 130.8, 129.8, 128.8, 128.5, 128.0, 125.9, 58.3, 21.7.; HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{18}ClNO_3S$ $[M+Na]^+$ 386.0594; found, 386.0588.



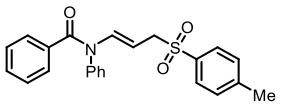
(E)-3-fluoro-N-methyl-N-(3-tosylprop-1-en-1-yl)benzamide (3l)

White solid; 64.5mg, 93 % yield;mp: 136-138°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.72 (d, *J* = 8.0 Hz, 2H), 7.42-7.30 (m, 3H), 7.20-7.11 (m, 1H), 7.05 (s, 1H), 6.97 (s, 1H), 6.52 (s, 1H), 5.10-4.88 (m, 1H), 3.70 (s, 2H), 3.20 (s, 3H), 2.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 168.8, 162.4 (*J* = 247.3 Hz), 144.9, 136.4 (d, *J* = 7.0 Hz), 135.3, 130.4 (*J* = 8.0 Hz), 129.8, 128.5, 123.6, 117.8 (d, *J* = 20.9 Hz), 115.1 (*J* = 22.9 Hz), 96.3, 58.4, 41.0, 21.7; ^{19}F NMR (376 MHz, Chloroform-*d*) δ -111.09. HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{18}FNO_3S$ $[M+Na]^+$ 370.0889; found, 370.0890.



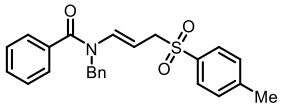
(E)-N-methyl-N-(3-tosylprop-1-en-1-yl)thiophene-2-carboxamide (3m)

White solid; 63mg, 94 % yield; mp: 136-137°C;[1] H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.76 (d, *J* = 8.4 Hz, 2H), 7.53 (dd, *J* = 4.8, 1.2 Hz, 1H), 7.37 (d, *J* = 8.0 Hz, 2H), 7.18-7.06 (m, 2H), 7.01 (dd, *J* = 5.2, 4.0 Hz, 1H), 5.09-4.91 (m, 1H), 3.77 (d, *J* = 7.6 Hz, 2H), 3.26 (s, 3H), 2.47 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 163.4, 144.9, 136.5, 135.4, 131.2, 130.9, 129.9, 128.6, 127.1, 96.3, 58.4, 41.0, 21.7; HR-MS (ESI-TOF, m/z) calcd for $C_{16}H_{17}NO_3S_2$ $[M+Na]^+$ 358.0548; found, 358.0546.



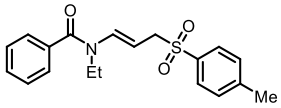
(E)-N-phenyl-N-(3-tosylprop-1-en-1-yl)benzamide (3n)

White solid; 63.3mg, 81 % yield; mp: 141-142°C;[1] H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.69 (d, *J* = 8.0 Hz, 2H), 7.40 (d, *J* = 14.4 Hz, 1H), 7.37-7.30 (m, 4H), 7.31-7.23 (m, 4H), 7.21-7.13 (m, 2H), 7.05 (d, *J* = 7.6 Hz, 2H), 4.70-4.49 (m, 1H), 3.75 (d, *J* = 8.0 Hz, 2H), 2.45 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 168.9, 144.8, 139.1, 136.8, 135.5, 134.6, 130.4, 129.7(4), 129.7(0), 128.9, 128.6, 128.5, 128.4, 127.9, 100.3, 58.6, 21.7. HR-MS (ESI-TOF, m/z) calcd for $C_{23}H_{21}NO_3S$ $[M+Na]^+$ 414.114; found, 414.1120.



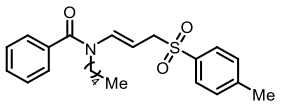
(E)-N-benzyl-N-(3-tosylprop-1-en-1-yl)benzamide (3o)

White solid; 74.5mg, 92 % yield; mp: 108-109°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ) δ 7.48-7.39 (m, 5H), 7.37 (d, *J* = 5.6 Hz, 1H), 7.33 (d, *J* = 7.6 Hz, 2H), 7.31-7.28 (m, 2H), 7.25-7.20 (m, 4H), 6.51 (s, 1H)4.97 (s, 2H), 4.90-4.82 (m, 1H), 3.56 (d, *J* = 8.0 Hz, 2H), 2.45 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 170.6, 144.5, 136.1, 134.9, 134.2, 130.9, 129.6, 128.9, 128.6(1), 128.5(6), 128.0, 127.5, 126.8, 58.6, 21.7; HR-MS (ESI-TOF, m/z) calcd for $C_{24}H_{23}NO_3S$ $[M+Na]^+$ 428.1296; found, 428.1289.



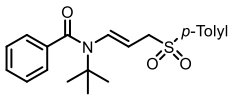
(E)-N-ethyl-N-(3-tosylprop-1-en-1-yl)benzamide (3p)

Light yellow solid; 61.7mg, 90 % yield; mp: 74-75 °C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.72 (d, *J* = 7.6 Hz, 2H), 7.52-7.28 (m, 5H), 7.21 (s, 2H), 6.48 (s, 1H), 5.10-4.82 (m, 1H), 3.77 (s, 2H), 3.68 (d, *J* = 8.0 Hz, 2H), 2.48 (s, 3H), 1.21 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 170.0, 144.8, 135.3, 134.6, 130.6, 129.8, 128.6, 128.5, 127.9, 95.1, 58.7, 38.5, 21.7, 12.0; HR-MS (ESI-TOF, m/z) calcd for $C_{19}H_{21}NO_3S$ $[M+Na]^+$ 366.1140; found, 366.1136.



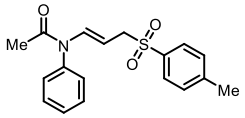
(E)-N-pentyl-N-(3-(p-tolylsulfinyl)prop-1-en-1-yl)benzamide (3q)

Light yellow oli, 68.5mg, 89 % yield; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.72 (d, *J* = 8.0 Hz, 2H), 7.43 (t, *J* = 7.6 Hz, 1H), 7.39-7.20 (m, 4H), 7.20 (d, *J* = 7.6 Hz, 2H), 6.47 (s, 1H), 5.00-4.82 (m, 1H), 3.79-3.59 (m, 2H), 2.49 (s, 3H), 1.66-1.54 (m, 2H), 1.37-1.23 (m, 4H), 0.92 (t, *J* = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ170.2, 144.8, 135.3, 134.6, 130.6, 129.8, 128.6, 128.4, 127.9, 58.7, 29.7, 29.1, 26.4, 22.4, 21.7, 14.0. HR-MS (ESI-TOF, m/z) calcd for $C_{22}H_{27}NO_3S$ $[M+Na]^+$ 408.1609; found, 408.1616.



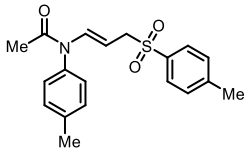
(E)-N-(tert-butyl)-N-(3-tosylprop-1-en-1-yl)benzamide (3r)

White solid; 59.4mg, 80 % yield; mp: 101-102°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.51-7.43 (m, 4H), 7.39-7.31 (m, 3H), 7.30-7.25 (m, 2H), 6.27 (d, *J* = 13.6 Hz, 1H), 4.82-4.65 (m, 1H), 3.52 (d, *J* = 8.0 Hz, 2H), 2.43 (s, 3H), 1.38 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 171.8, 144.8, 137.6, 137.6, 135.4, 130.3, 129.9, 128.9, 128.2, 128.1, 117.5, 58.7, 57.6, 27.6, 21.6. R-MS (ESI-TOF, m/z) calcd for $C_{21}H_{25}NO_3S$ $[M+Na]^+$ 394.1453; found, 394.1461.



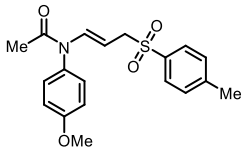
(E)-N-phenyl-N-(3-tosylprop-1-en-1-yl)acetamide (3s)

White solid; 59.8mg, 91 % yield; mp: 173-175°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.64 (d, *J* = 8.0 Hz, 2H), 7.55-7.40 (m, 4H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.11 (d, *J* = 6.8 Hz, 2H), 4.39-4.22 (m, 1H), 3.71 (d, *J* = 7.6 Hz, 2H). 2.45 (s, 3H), 1.82 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 168.8, 144.8, 138.9, 135.2(3), 135.2(8), 130.3, 129.7, 129.2, 128.6, 128.5, 99.2, 58.6, 23.1, 21.7; HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{19}NO_3S$ $[M+Na]^+$ 352.0983; found, 352.0979.



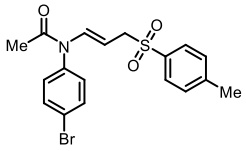
(E)-N-(p-tolyl)-N-(3-tosylprop-1-en-1-yl)acetamide (3t)

White solid; 63.8mg, 93 % yield; mp: 132-135°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) 7.63 (d, *J* = 8.4 Hz, 2H), 7.41 (d, *J* = 14.4 Hz, 1H), 7.34-7.26 (m, 4H), 6.97 (d, *J* = 8.0 Hz, 2H), 4.38-4.27 (m, 1H), 3.71 (dd, *J* = 7.6, 1.2 Hz, 2H), 2.45 (s, 3H), 2.42 (s, 3H), 1.82 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 169.0, 144.7, 139.3, 136.2, 135.2, 130.9, 129.6, 128.5, 128.2, 99.1, 58.6, 23.1, 21.7, 21.2; HR-MS (ESI-TOF, m/z) calcd for $C_{19}H_{21}NO_3S$ $[M+Na]^+$ 366.1140; found, 366.1136.



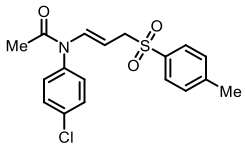
(E)-N-(4-methoxyphenyl)-N-(3-tosylprop-1-en-1-yl)acetamide (3u)

White solid; 65.3mg, 91 % yield; mp: 121-123°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.64 (d, *J* = 8.4 Hz, 2H), 7.43 (d, *J* = 14.0 Hz, 1H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.05-6.95 (m, 4H), 4.38-4.28 (m, 1H), 3.86 (s, 3H), 3.72 (dd, *J* = 7.6, 1.0 Hz, 2H), 2.44 (s, 3H), 1.82 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 169.2, 159.8, 144.7, 135.4, 135.2, 131.4, 129.6, 129.5, 128.5, 115.4, 99.0, 58.6, 55.5, 23.1, 21.6; HR-MS (ESI-TOF, m/z) calcd for $C_{19}H_{21}NO_4S$ $[M+Na]^+$ 382.1089; found, 382.1092.



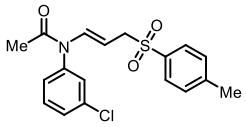
(E)-N-(4-bromophenyl)-N-(3-tosylprop-1-en-1-yl)acetamide (3v)

White solid; 70.8mg, 87% yield; mp: 147-148°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.64 (dd, *J* = 8.4, 2.0 Hz, 4H), 7.44 (d, *J* = 14.0 Hz, 1H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.04-6.98 (m, 2H), 4.34-4.21 (m, 1H), 3.71 (dd, *J* = 7.6, 1.2 Hz, 2H), 2.45 (s, 3H), 1.84 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 168.3, 144.9, 137.9, 135.3, 135.0, 133.7, 130.3, 129.7, 128.4, 123.3, 99.4, 58.4, 23.1, 21.7; HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{18}BrNO_3S$ $[M+Na]^+$ 430.0088; found, 430.0080.



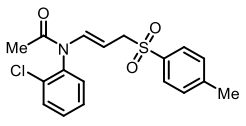
(E)-N-(4-chlorophenyl)-N-(3-tosylprop-1-en-1-yl)acetamide (3w)

White solid; 60.2mg, 83 % yield; mp: 129-131°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.67-7.61 (m, 2H), 7.54-7.38 (m, 3H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.10-7.03 (m, 2H), 4.34-4.25 (m, 1H), 3.71 (dd, *J* = 8.0, 1.2 Hz, 2H), 2.45 (s, 3H), 1.84 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 168.4, 144.9, 137.4, 135.3, 135.1, 130.7, 130.0, 129.7, 128.4, 99.4, 58.4, 23.1, 21.7; HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{18}ClNO_3S$ $[M+Na]^+$ 386.0594; found, 386.0585.



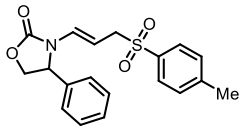
(E)-N-(3-chlorophenyl)-N-(3-tosylprop-1-en-1-yl)acetamide (3x)

White solid; 59.5mg, 82 % yield; mp: 159-160°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.64 (d, *J* = 8.0 Hz, 2H), 7.49-7.38 (m, 3H), 7.34 (d, *J* = 8.0 Hz, 2H), 7.11 (s, 1H), 7.07-6.99 (m, 1H), 4.38-4.22 (m, 1H), 3.82-3.61 (m, 2H), 2.46 (s, 3H), 1.86 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 168.3, 144.9, 140.0, 135.8, 135.2, 135.0, 131.3, 129.7, 129.6, 129.0, 128.5, 127.0, 99.7, 58.5, 23.1, 21.7; HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{18}ClNO_3S$ $[M+Na]^+$ 386.0594; found, 386.0589.



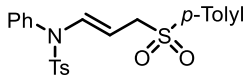
(E)-N-(2-chlorophenyl)-N-(3-tosylprop-1-en-1-yl)acetamide (3y)

White solid; 62.4mg, 86 % yield; mp: 151-152°C; ^{1}H NMR (400 MHz, CDCl3; δ, ppm) δ 7.65 (d, *J* = 8.4 Hz, 2H), 7.61-7.55 (m, 1H), 7.49-7.40 (m, 2H), 7.35 (d, *J* = 14.4 Hz, 1H), 7.31 (d, *J* = 8.0 Hz, 2H), 7.25-7.16 (m, 1H), 4.30-4.21 (m, 1H), 3.73 (dd, *J* = 8.0, 1.2 Hz, 2H), 2.44 (s, 3H), 1.81 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 168.4, 144.8, 136.2, 134.9, 133.5, 133.3, 131.2, 130.8, 130.6, 129.6, 128.8, 128.6, 98.7, 58.5, 22.5, 21.7; HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{18}ClNO_3S$ $[M+Na]^+$ 386.0594; found, 386.0589.



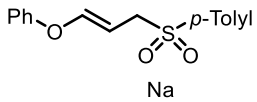
(E)-4-phenyl-3-(3-tosylprop-1-en-1-yl)oxazolidin-2-one (3z)

Clear oil; 43.6mg, 61% yield; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.51-7.40 (m, 3H), 7.37 (d, *J* = 8.0 Hz, 2H), 7.26-7.19 (m, 4H), 6.58 (d, *J* = 14.4 Hz, 1H), 5.00 (dd, *J* = 9.2, 5.2 Hz, 1H), 4.72 (t, *J* = 8.8 Hz, 1H), 4.65-4.50 (m, 1H), 4.14 (dd, *J* = 9.2, 5.2 Hz, 1H), 3.74-3.53 (m, 2H), 2.43 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ155.3, 144.7, 137.5, 134.9, 130.0, 129.7, 129.6, 129.2, 128.3, 126.1, 98.4, 70.8, 58.4, 58.2, 21.7. HR-MS (ESI-TOF, m/z) calcd for $C_{19}H_{19}NO_4S$ $[M+Na]^+$ 380.0932; found, 380.0937.



(E)-4-methyl-N-phenyl-N-(3-tosylprop-1-en-1-yl)benzenesulfonamide (3aa)

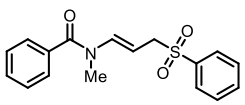
Clear oil; 70.6mg, 80% yield; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.61 (d, *J* = 8.4 Hz, 2H), 7.45 (d, *J* = 8.4 Hz, 2H), 7.41-7.33 (m, 3H), 7.30 (d, *J* = 8.0 Hz, 2H), 7.25 (d, *J* = 7.6 Hz, 2H), 7.03 (d, *J* = 14.0 Hz, 1H), 6.89-6.84 (m, 2H), 4.26-4.14 (m, 1H), 3.67 (d, *J* = 7.6 Hz, 2H), 2.46 (s, 3H), 2.44 (s, 3H).^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 144.7, 144.4, 136.5, 135.5, 135.26, 135.2, 130.0, 129.7, 129.7, 129.5, 128.5, 127.5, 96.3, 77.3, 58.2, 21.7, 21.7. HR-MS (ESI-TOF, m/z) calcd for $C_{23}H_{23}NO_4S_2$ $[M+Na]^+$ 464.0966; found, 464.0972.



(E)-1-methyl-4-((3-phenoxyallyl)sulfonyl)benzene (3ab)

White solid; 41.5mg, 72% yield; mp: 96-97°C ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.78 (d, *J* = 8.4 Hz, 2H), 7.38 (d, *J* = 8.0 Hz, 2H), 7.33-7.25 (m, 2H), 7.09 (t, *J* = 7.6 Hz, 1H), 6.83 (d, *J* = 7.6 Hz, 2H), 6.45 (d, *J* = 12.4 Hz, 1H), 5.27-5.14 (m, 1H), 3.74 (d, *J* = 9.2 Hz, 2H), 2.47 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 156.4, 149.7, 144.8, 135.2, 129.8, 129.7, 128.7, 123.7, 117.1, 98.4, 56.1, 21.7. HR-MS (ESI-TOF, m/z) calcd for $C_{16}H_{16}O_3S$ $[M+Na]^+$ 311.0718.0966; found, 311.0725.

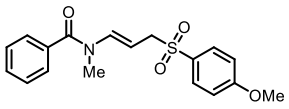
Characterization Data of Compounds 4a-4j



(E)-N-methyl-N-(3-(phenylsulfonyl)prop-1-en-1-yl)benzamide (4a)

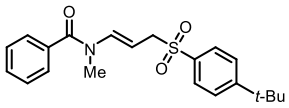
White solid; 59.2mg, 94 % yield; mp: 135-137 °C; ^{1} H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.86 (d, *J* = 7.6 Hz, 2H), 7.69 (t, *J* = 7.6 Hz, 1H), 7.58 (t, *J* = 8.0 Hz, 2H), 7.45 (t, *J* = 7.6 Hz, 1H), 7.36 (t, *J* = 7.6 Hz, 2H), 7.31-7.18 (m, 2H), 6.62 (s, 1H), 5.10-4.79 (m, 1H), 3.72 (s, 2H), 3.20 (s, 3H). ^{13}C NMR

(100 MHz, $CDCl_3$; δ, ppm) δ 170.4, 138.3, 134.3, 133.8, 130.7, 129.2, 128.5, 128.5, 128.0, 58.4. HR-MS (ESI-TOF, m/z) calcd for $C_{17}H_{17}NO_3S$ $[M+H]^+$ 316.1007; found, 316.1006.



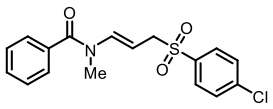
(E)-N-(3-((4-methoxyphenyl)sulfonyl)prop-1-en-1-yl)-N-methylbenzamide (4b)

White solid; 64.2mg, 93% yield; mp 154-156°C; ^1H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.77 (d, *J* = 8.8 Hz, 2H), 7.49-7.41 (m, 1H), 7.37 (t, *J* = 7.6 Hz, 2H), 7.31-7.23 (m, 2H), 7.08-6.98 (m, 2H), 6.58 (s, 1H), 5.05-4.85 (m, 1H), 3.91 (s, 3H), 3.78-3.57 (m, 2H), 3.21 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ170.4, 163.8, 134.3, 130.7(1), 130.6(8), 129.7, 128.5, 128.5, 128.0, 114.3, 58.6, 55.8. HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{19}NO_4S$ $[M+Na]^+$ 368.0932; found, 368.0931.



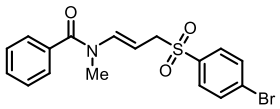
(E)-N-(3-((4-(tert-butyl)phenyl)sulfonyl)prop-1-en-1-yl)-N-methylbenzamide (4c)

White solid; 40.1mg, 54 % yield; mp: 133-135°C; ^1H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.78 (d, *J* = 8.4 Hz, 2H), 7.61-7.54 (m, 2H), 7.49-7.42 (m, 1H), 7.38 (t, *J* = 7.6 Hz, 2H), 7.34-7.25 (m, 2H), 6.71 (s, 1H), 5.06-4.89 (m, 1H), 3.71 (d, *J* = 7.6 Hz, 2H), 3.21 (s, 3H), 1.36 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 170.3, 157.8, 135.5, 134.4, 130.7, 128.5, 128.3, 128.0, 126.2, 58.5, 35.3, 31.1; HR-MS (ESI-TOF, m/z) calcd for $C_{21}H_{25}NO_3S$ $[M+Na]^+$ 394.1453; found, 394.1447.



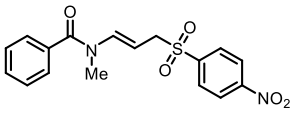
(E)-N-(3-((4-chlorophenyl)sulfonyl)prop-1-en-1-yl)-N-methylbenzamide (4d)

White solid; 41.2mg, 59 % yield; mp: 137-140°C; ^1H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 8.16 (d, *J* = 8.4 Hz, 2H), 8.01-7.91 (m, 2H), 7.88-7.81 (m, 1H), 7.80-7.73 (m, 2H), 7.69-7.60 (m, 2H), 6.98 (s, 1H), 549-5.13 (m, 1H), 4.19-3.99 (m, 2H), 3.58 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 170.4, 140.6, 136.7, 134.2, 130.8, 130.0, 129.5, 128.6, 127.9, 58.4. HR-MS (ESI-TOF, m/z) calcd for $C_{17}H_{16}ClNO_3S$ $[M+Na]^+$ 372.0437; found, 372.0437.



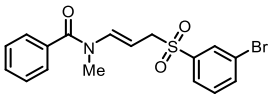
(E)-N-(3-((4-bromophenyl)sulfonyl)prop-1-en-1-yl)-N-methylbenzamide (4e)

White solid; 62.9mg, 80 % yield; mp: 127-128°C; ^1H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.76-7.67 (m, 4H), 7.50-7.44 (m, 1H), 7.40 (t, *J* = 7.6 Hz, 2H), 7.33-7.19 (m, 2H), 6.61 (s, 1H), 5.01-4.85 (m, 1H), 3.71 (s, 2H), 3.21 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 170.4, 137.2, 134.2, 132.5, 130.8, 130.4, 130.1, 129.4, 129.2, 128.6, 127.9, 58.4, 41.0. HR-MS (ESI-TOF, m/z) calcd for $C_{17}H_{16}BrNO_3S$ $[M+Na]^+$ 415.9932; found, 415.9930.



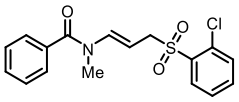
(E)-N-methyl-N-(3-((4-nitrophenyl)sulfonyl)prop-1-en-1-yl)benzamide (4f)

Light yellow solid; 62.6mg, 87 % yield; mp: 169-171°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 8.41 (t, *J* = 8.0 Hz, 2H), 8.06 (d, *J* = 8.0 Hz, 2H), 7.46 (t, *J* = 8.0 Hz, 1H), 7.38 (t, *J* = 8.0 Hz, 2H), 7.31 (d, *J* = 8.0 Hz, 2H), 6.82 (s, 1H), 5.00-4.85 (m, 1H), 3.80 (s, 2H), 3.20 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 170.4, 151.9, 150.9, 144.1, 134.1, 130.9, 130.0, 128.6, 127.9, 124.3, 95.1, 58.4, 26.1; HR-MS (ESI-TOF, m/z) calcd for $C_{17}H_{16}N2O_5S$ $[M+Na]^+$ 383.0678; found, 383.0668.



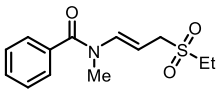
(E)-N-(3-((3-bromophenyl)sulfonyl)prop-1-en-1-yl)-N-methylbenzamide (4g)

White solid; 50.3mg, 64 % yield; mp: 174-175 °C;^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 8.13-7.91 (m, 1H), 7.80 (t, *J* = 8.0 Hz, 2H), 7.65-7.17 (m, 7H), 6.67 (s, 1H), 5.02-4.82 (m, 1H), 3.74 (s, 2H), 3.21 (s, 3H), ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 170.4, 140.1, 136.9, 134.3, 131.5, 130.8, 130.7, 128.6, 127.9, 127.1, 123.2, 94.7, 58.5, 40.9; HR-MS (ESI-TOF, m/z) calcd for $C_{17}H_{16}BrNO_3S$ $[M+Na]^+$ 415.9932; found, 415.9929.



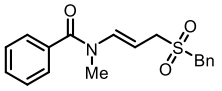
(E)-N-(3-((2-chlorophenyl)sulfonyl)prop-1-en-1-yl)-N-methylbenzamide (4h)

White solid; 62.1mg, 89% yield; mp: 137-140°C; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 8.07-8.02 (m, 1H), 7.61-7.50 (m, 2H), 7.49-7.42 (m, 2H), 7.39 (t, *J* = 8.0 Hz, 2H), 7.26 (d, *J* = 4.0 Hz, 2H), 6.74 (s, 1H), 5.00-4.81 (m, 1H), 4.04 (s, 2H), 3.11 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 170.3, 136.0, 134.9, 134.3, 132.6, 132.2, 131.8, 130.8, 128.6, 127.9, 127.4, 94.6, 56.4, 41.0; HR-MS (ESI-TOF, m/z) calcd for $C_{17}H_{16}ClNO_3S$ $[M+Na]^+$ 372.0437; found, 372.0430.



(E)-N-(3-(ethylsulfonyl)prop-1-en-1-yl)-N-methylbenzamide (4i)

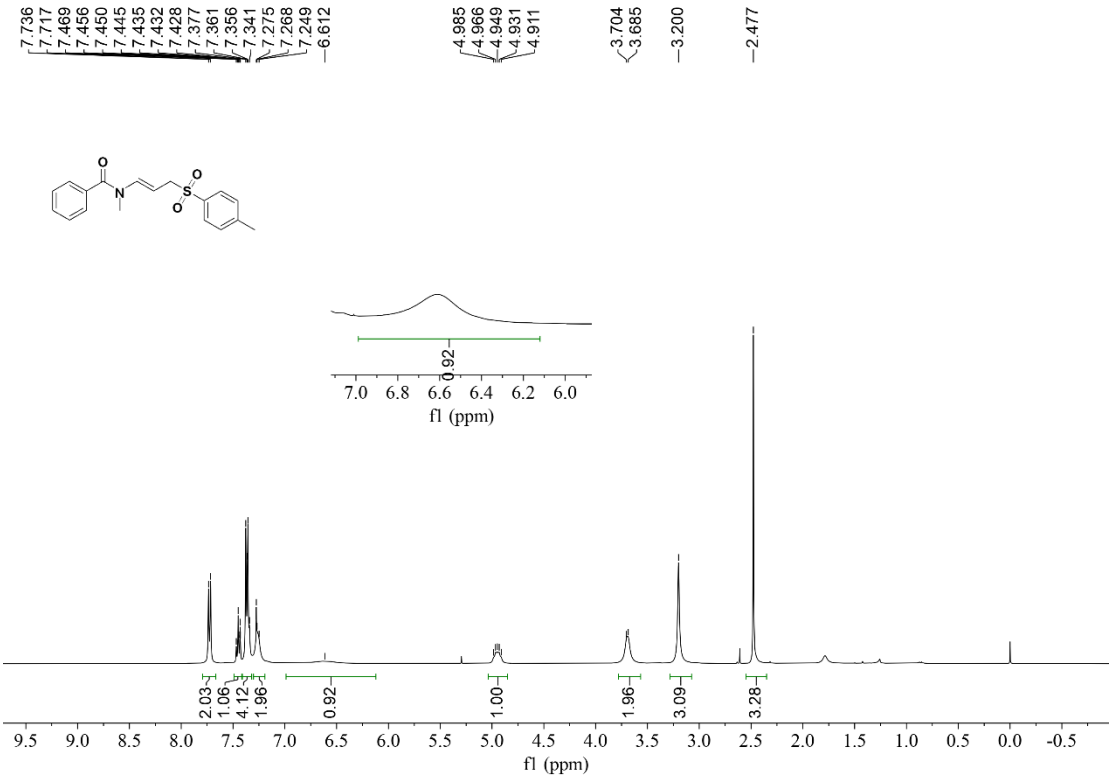
Light yellow oil; 50.2mg, 94 % yield; ^{1} H NMR (400 MHz, $CDCl_3$; δ, ppm) δ7.63-7.03 (m, 6H), 5.08-4.88 (m, 1H), 3.62 (s, 2H), 3.22 (s, 3H), 3.02-2.87 (m, 2H), 1.34 (t, *J* = 8.0 Hz, 3H).^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ170.5, 134.5, 133.0, 130.8, 128.6, 128.0, 113.2, 54.2, 45.6, 29.7, 14.1; HR-MS (ESI-TOF, m/z) calcd for $C_{13}H_{17}NO_3S$ $[M+Na]^+$ 290.0827; found, 290.0824.



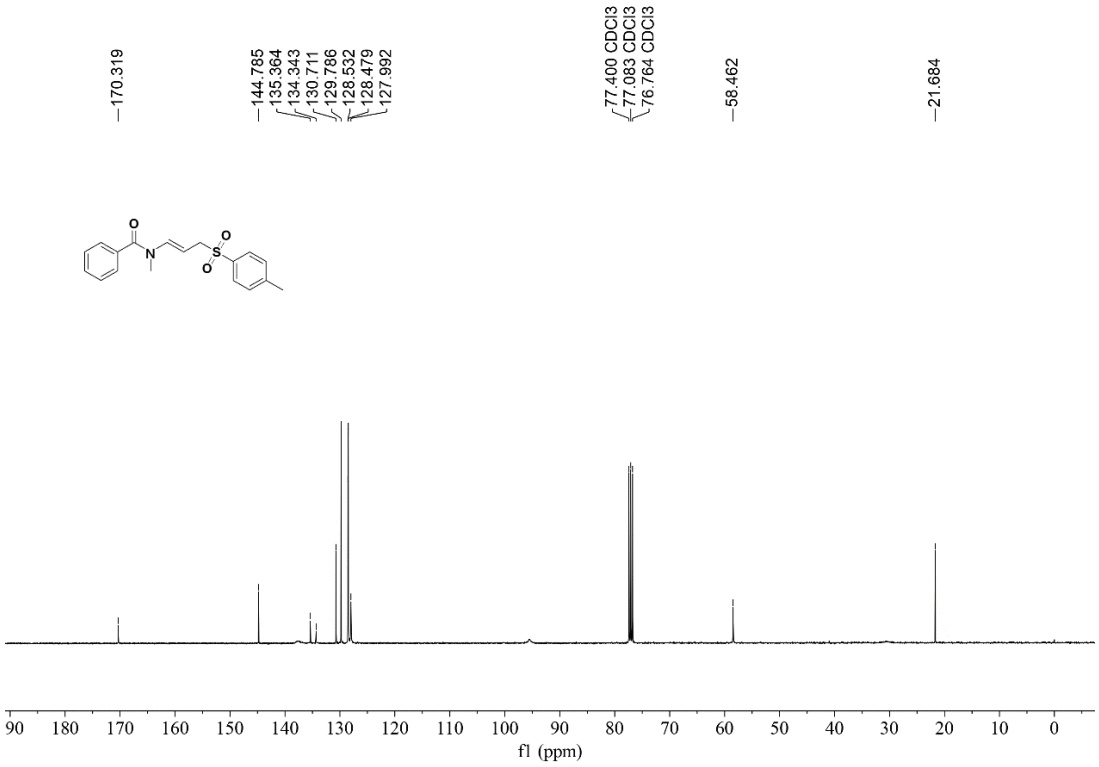
(E)-N-(3-(benzylsulfonyl)prop-1-en-1-yl)-N-methylbenzamide (4j)

Light yellow oil; 59.2mg, 90 % yield; ^{1}H NMR (400 MHz, $CDCl_3$; δ, ppm) δ 7.52-7.44 (m, 6H), 7.35 (s, 5H)., 5.04-4.78 (m, 1H), 4.21 (s, 2H), 3.51 (s, 2H), 3.22 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$; δ, ppm) δ 170.4, 134.5, 130.8, 130.7, 129.1, 129.1, 128.7, 127.9, 127.9, 126.9, 58.2, 53.5, 29.7; HR-MS (ESI-TOF, m/z) calcd for $C_{18}H_{19}NO_3S$ $[M+Na]^+$ 352.0983 ; found, 352.0976.

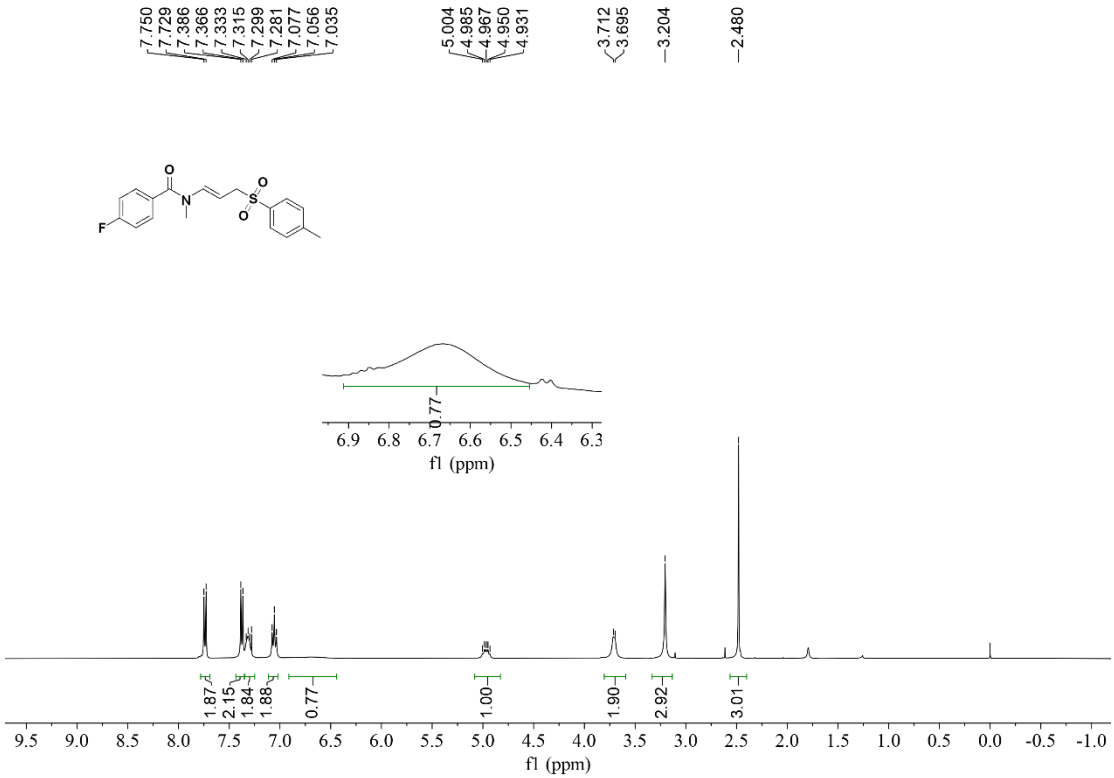
Copies of ^{1}H, ^{13}C NMR and ^{19}F NMR Spectra of Products 3a-3z and 3aa-3ab



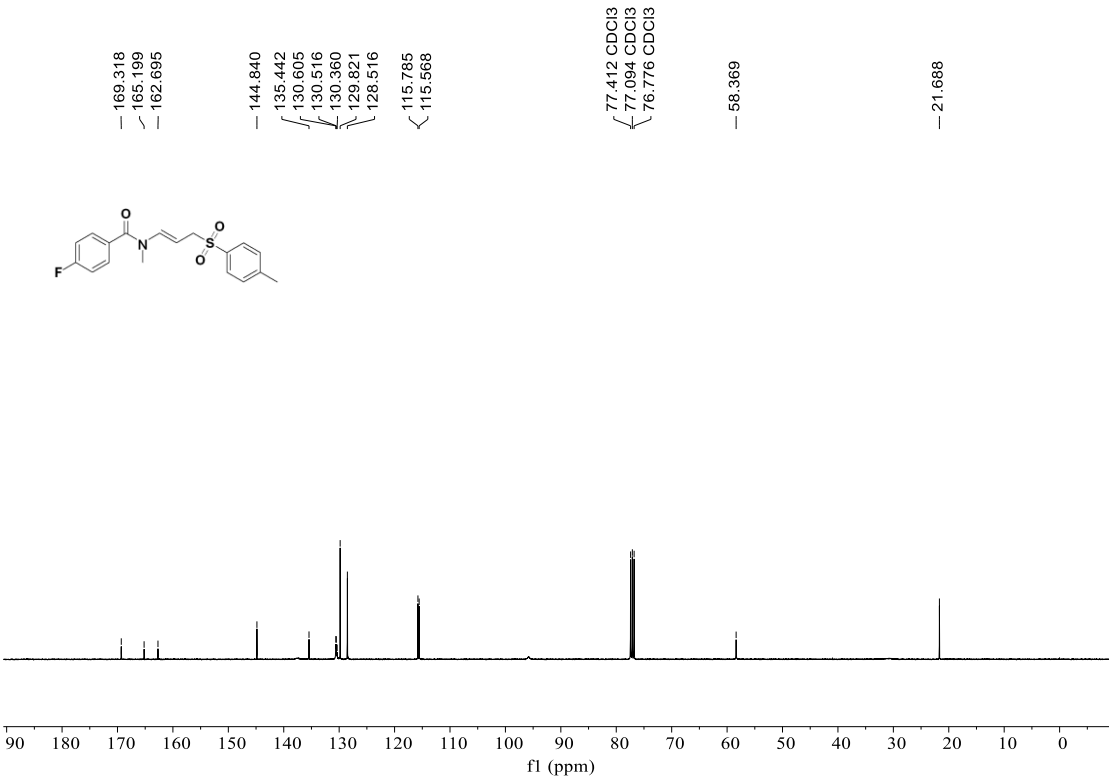
^{1} H NMR Spectrum of Compound **3a**



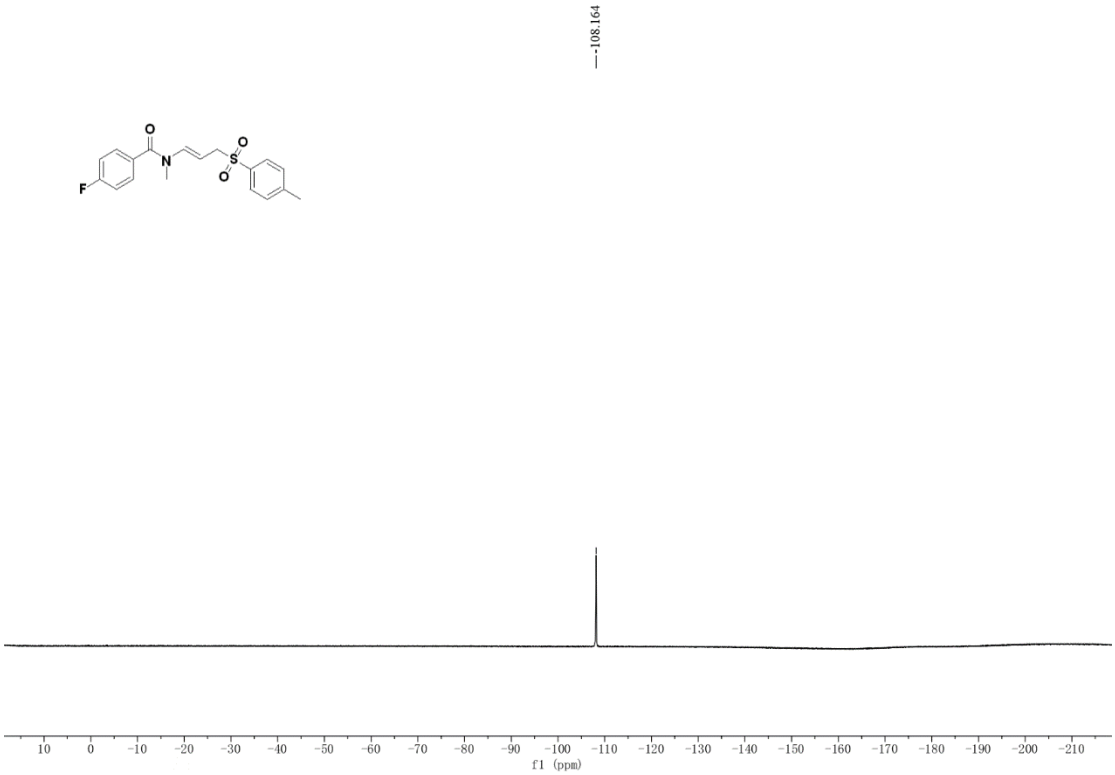
^{13}C NMR Spectrum of Compound **3a**



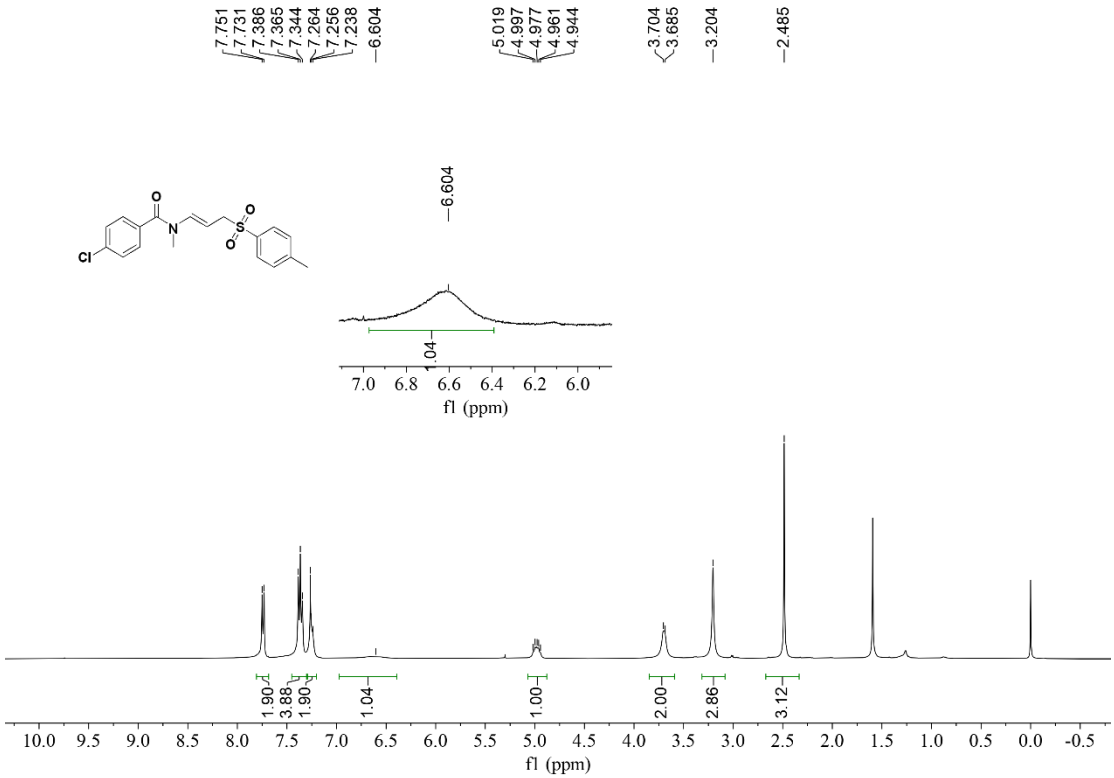
^{1}H NMR Spectrum of Compound **3b**



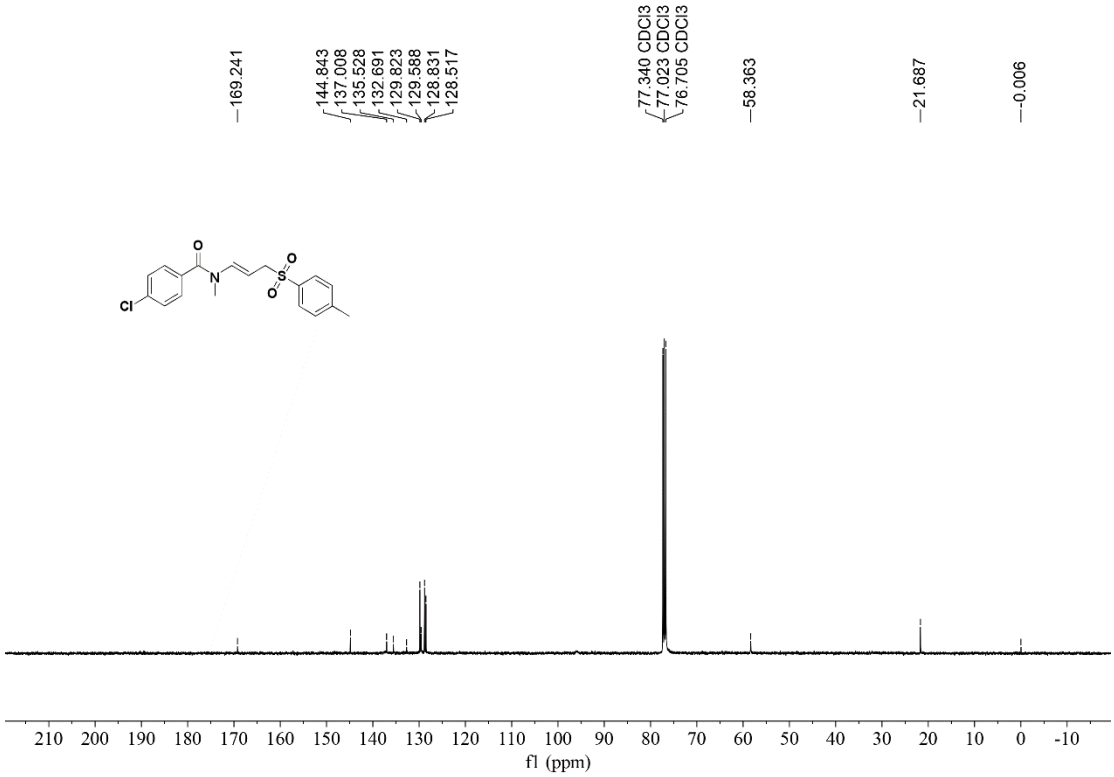
^{13}C NMR Spectrum of Compound **3b**



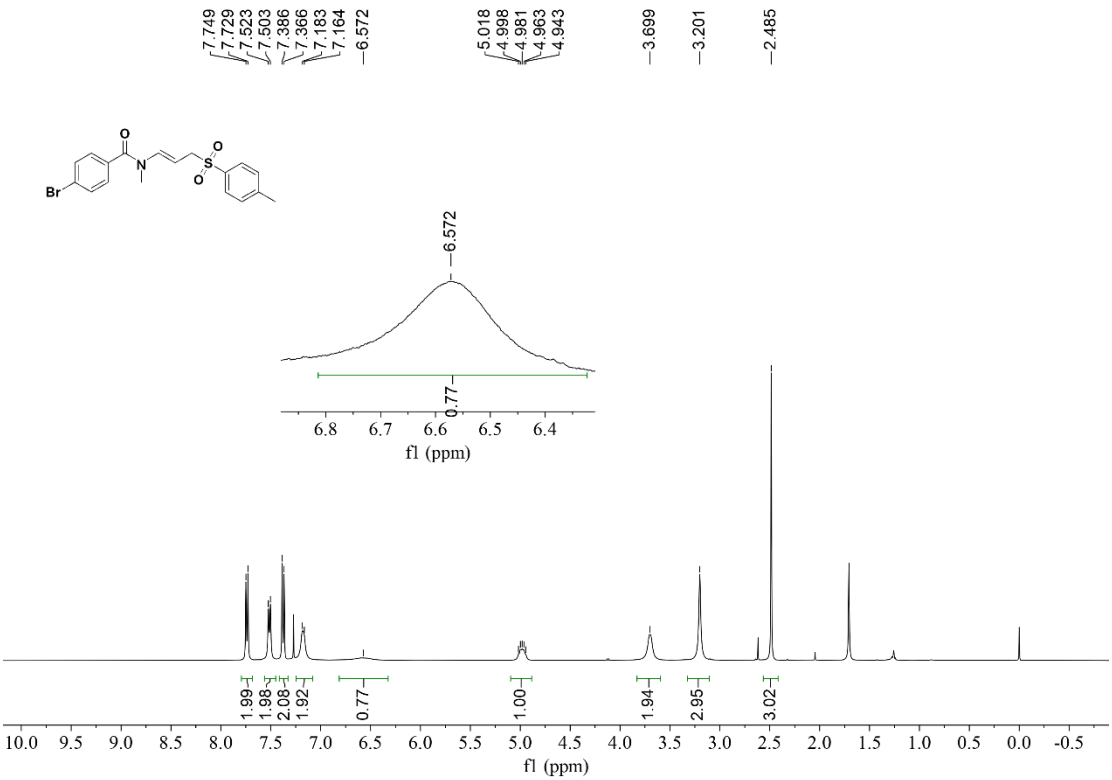
^{19}F NMR Spectrum of Compound **3b**



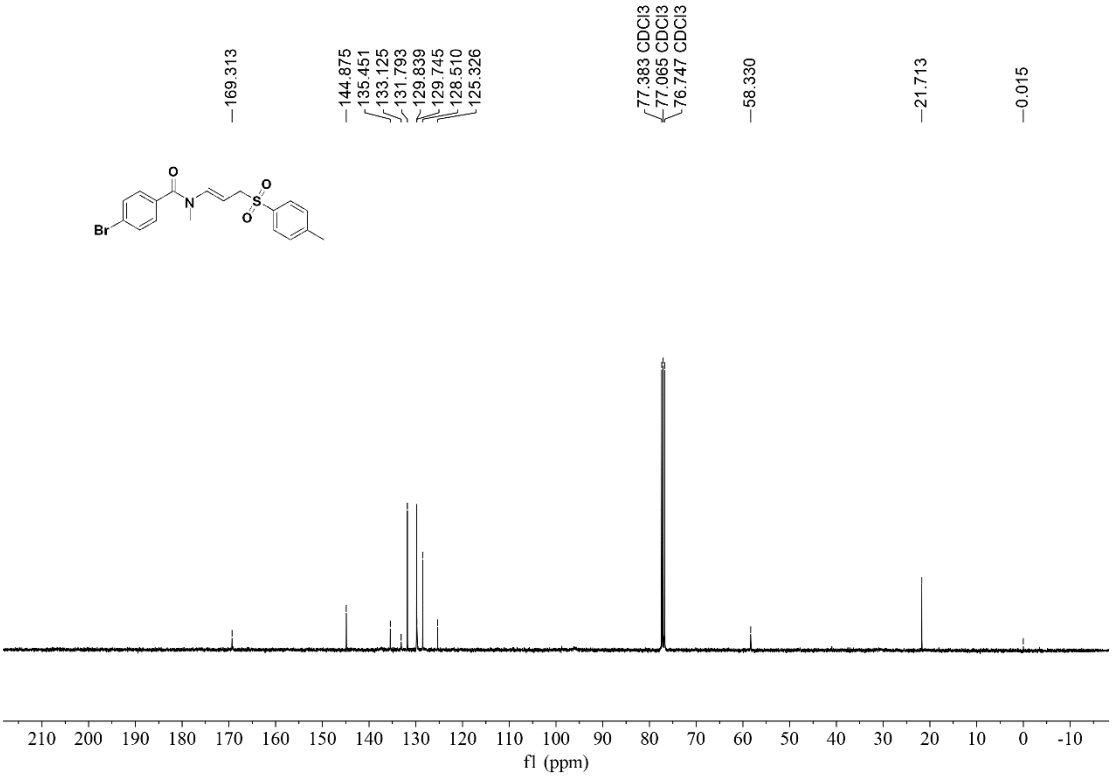
^{1}H NMR Spectrum of Compound **3c**



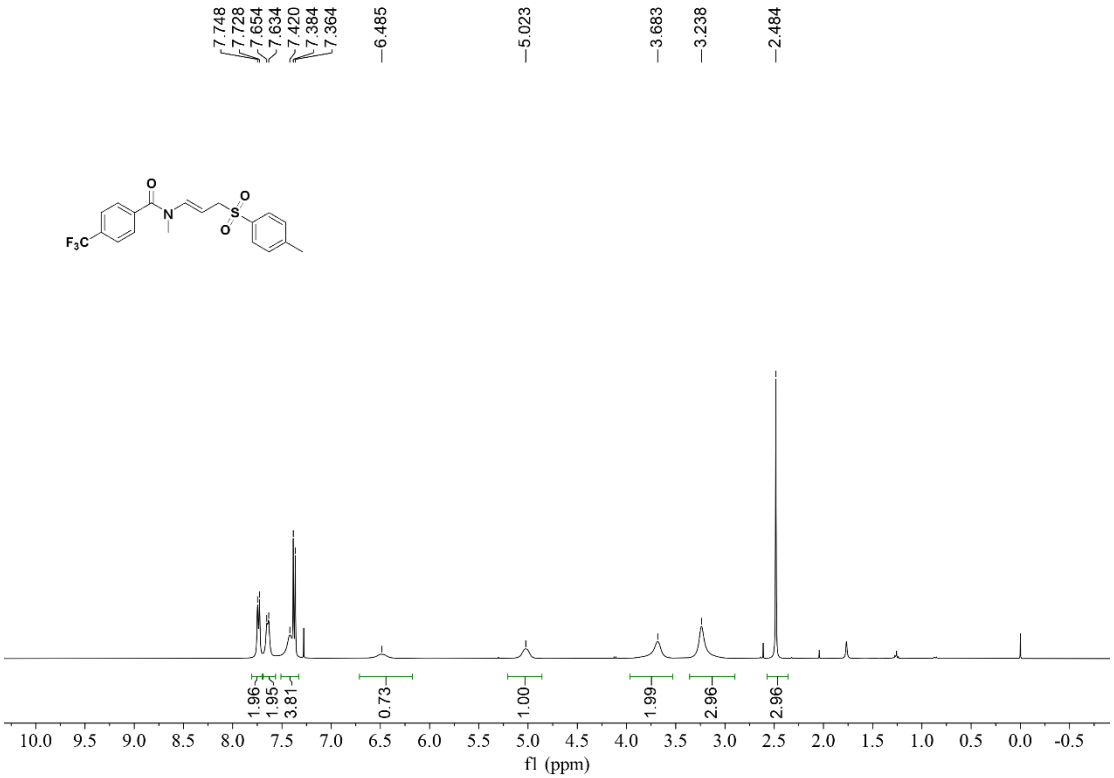
^{13}C NMR Spectrum of Compound **3c**



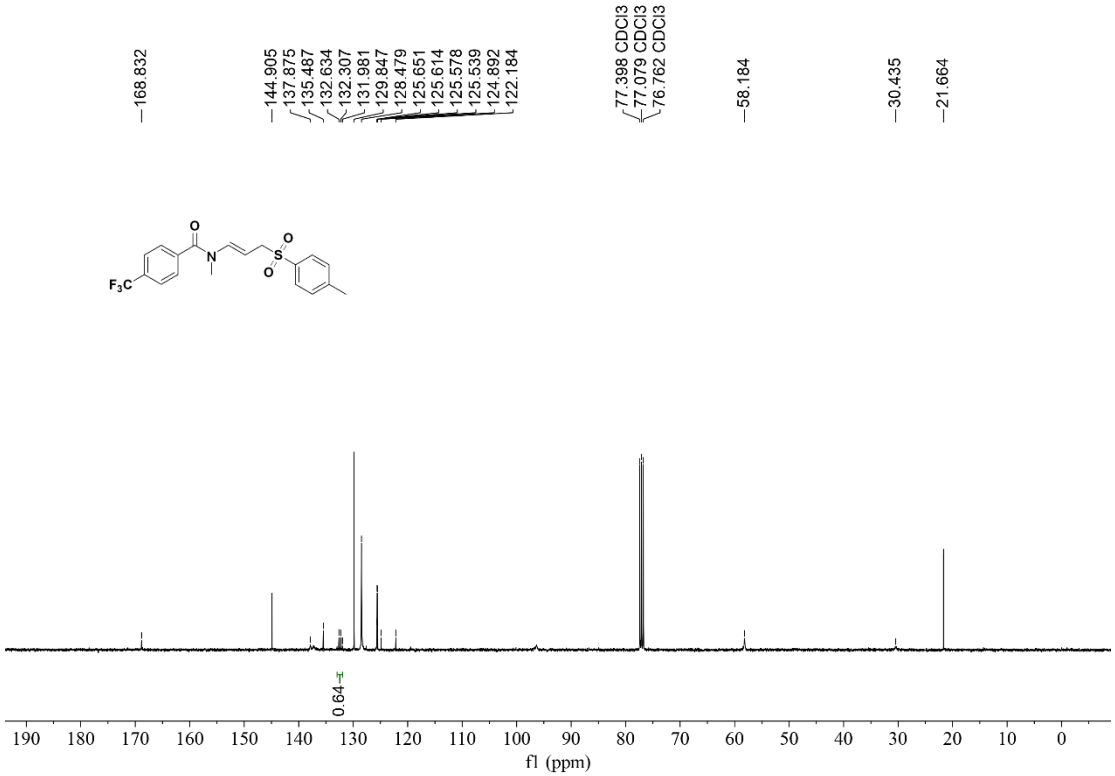
^{1}H NMR Spectrum of Compound **3d**



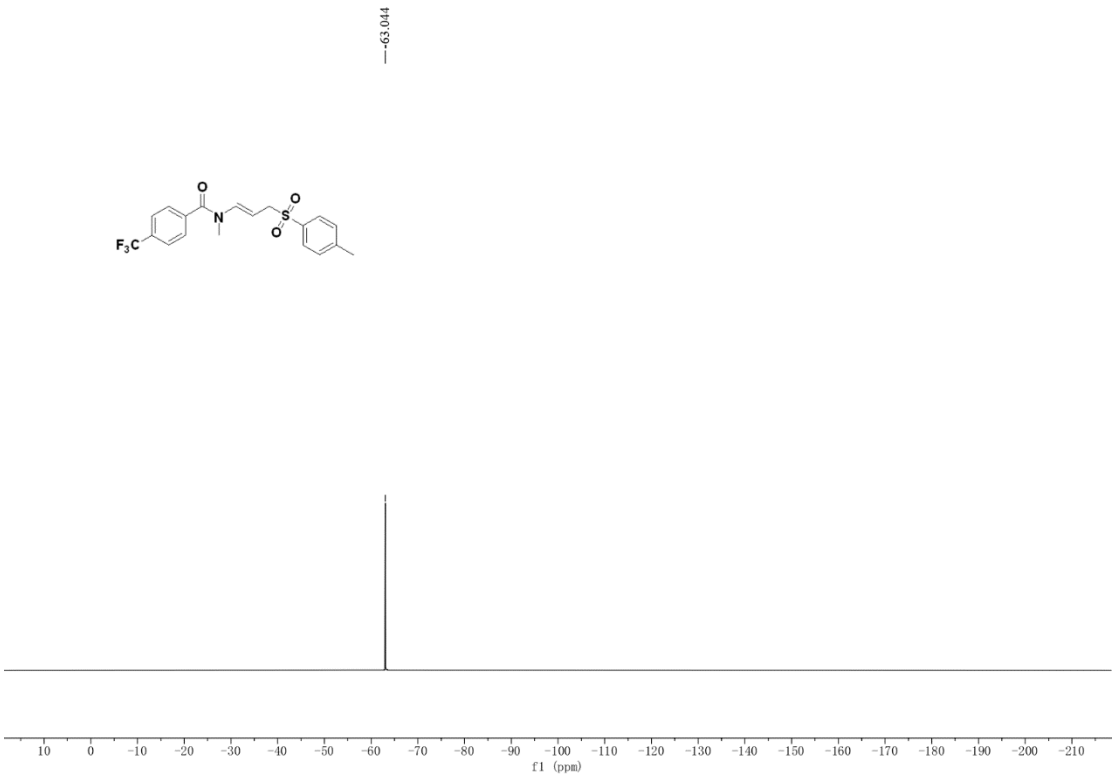
^{13}C NMR Spectrum of Compound **3d**



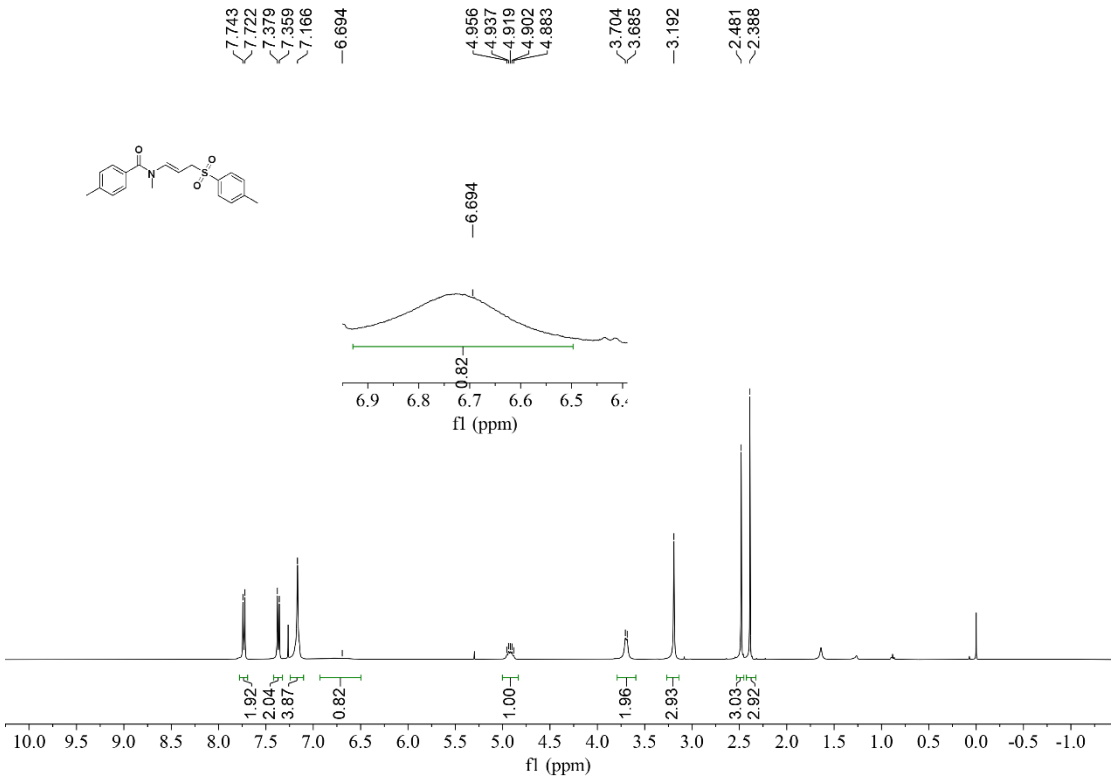
^{1}H NMR Spectrum of Compound **3e**



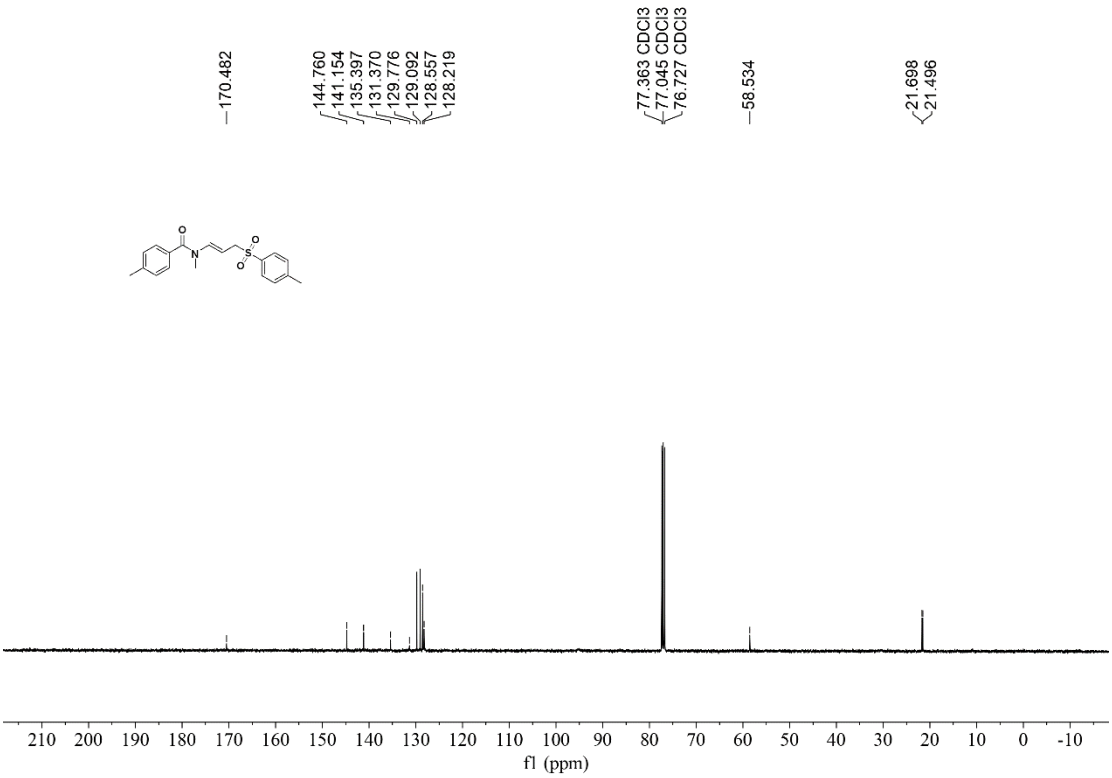
^{13}C NMR Spectrum of Compound **3e**



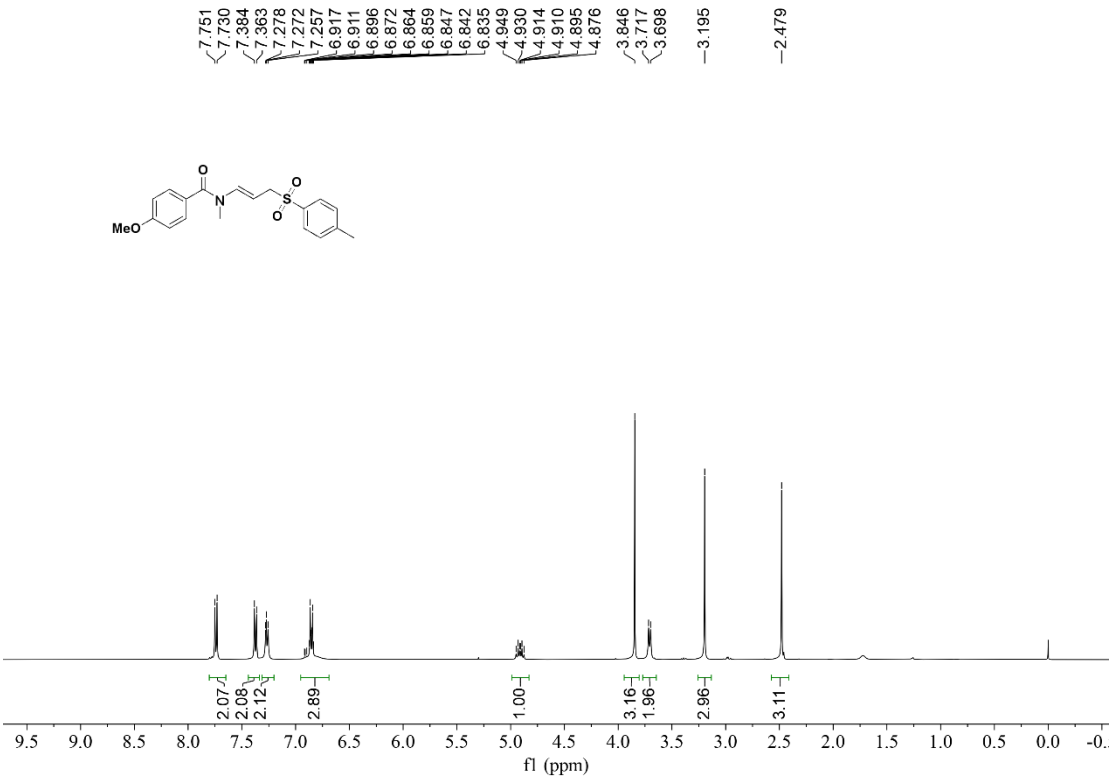
^{19}F NMR Spectrum of Compound **3e**



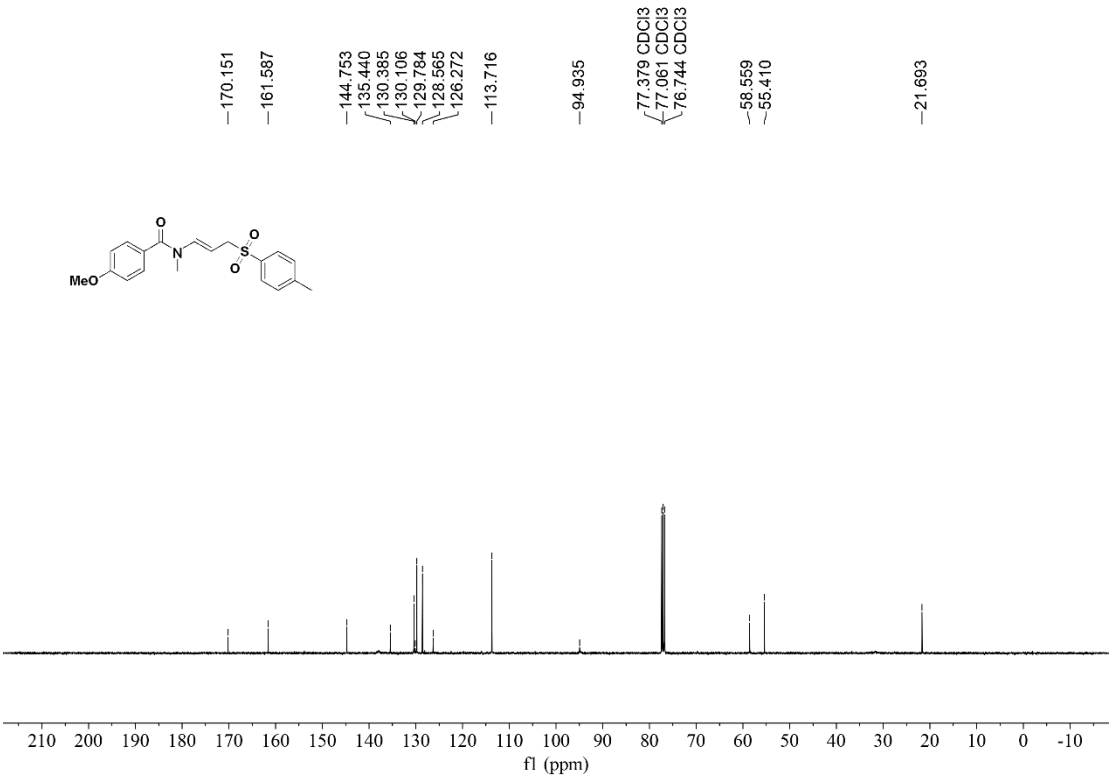
^{1}H NMR Spectrum of Compound **3f**



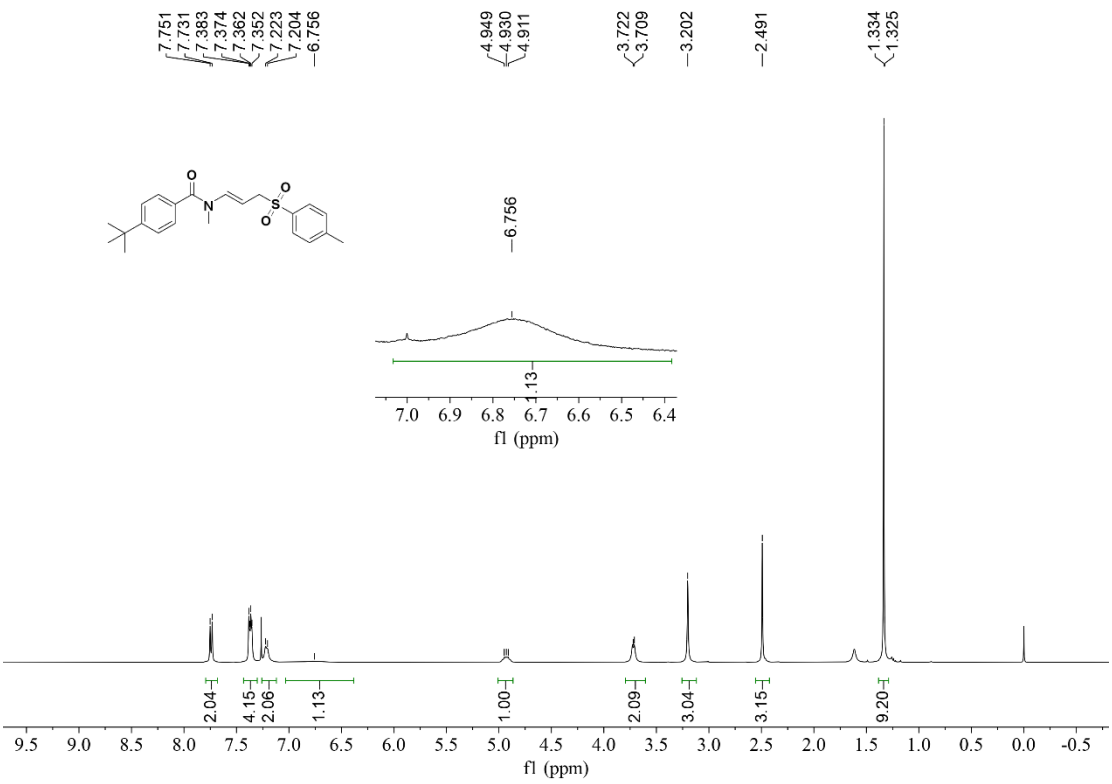
^{13}C NMR Spectrum of Compound **3f**



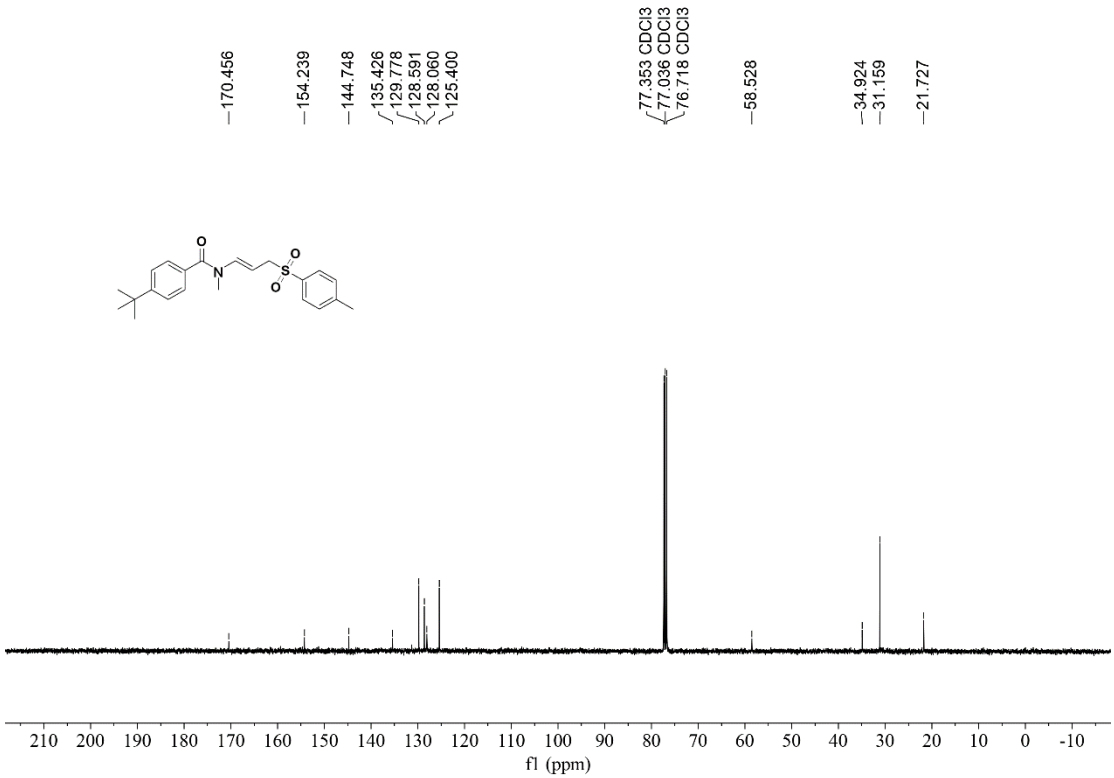
^{1}H NMR Spectrum of Compound **3g**



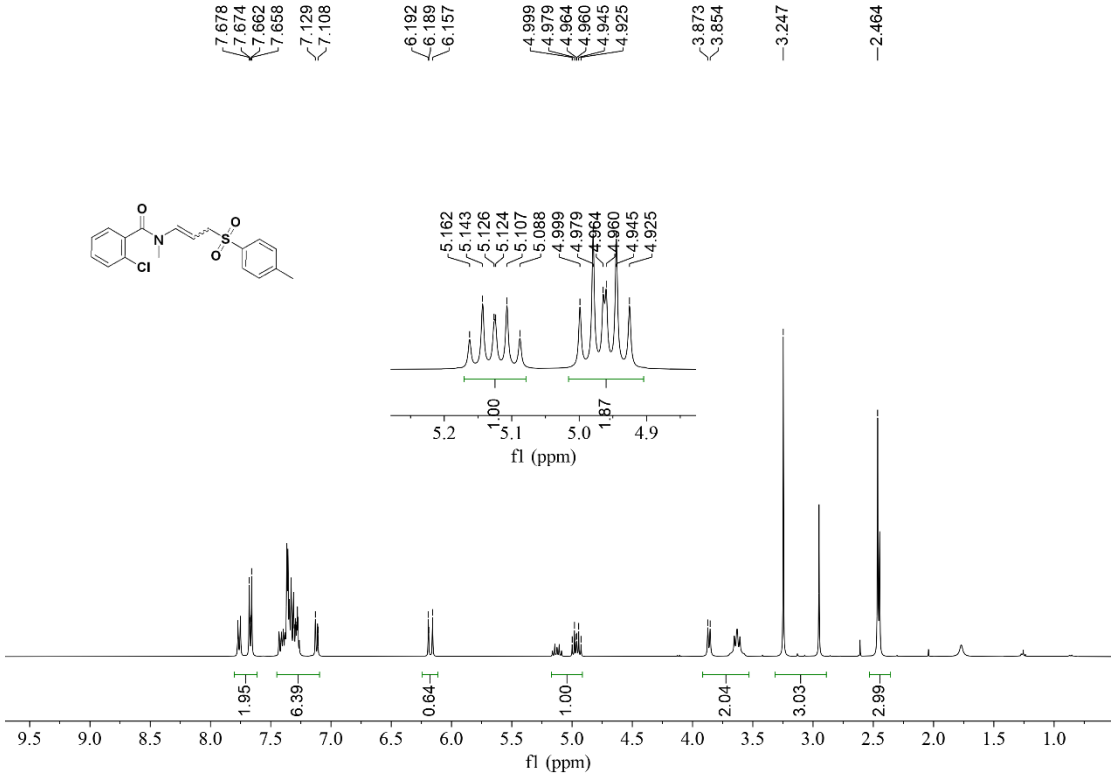
^{13}C NMR Spectrum of Compound **3g**



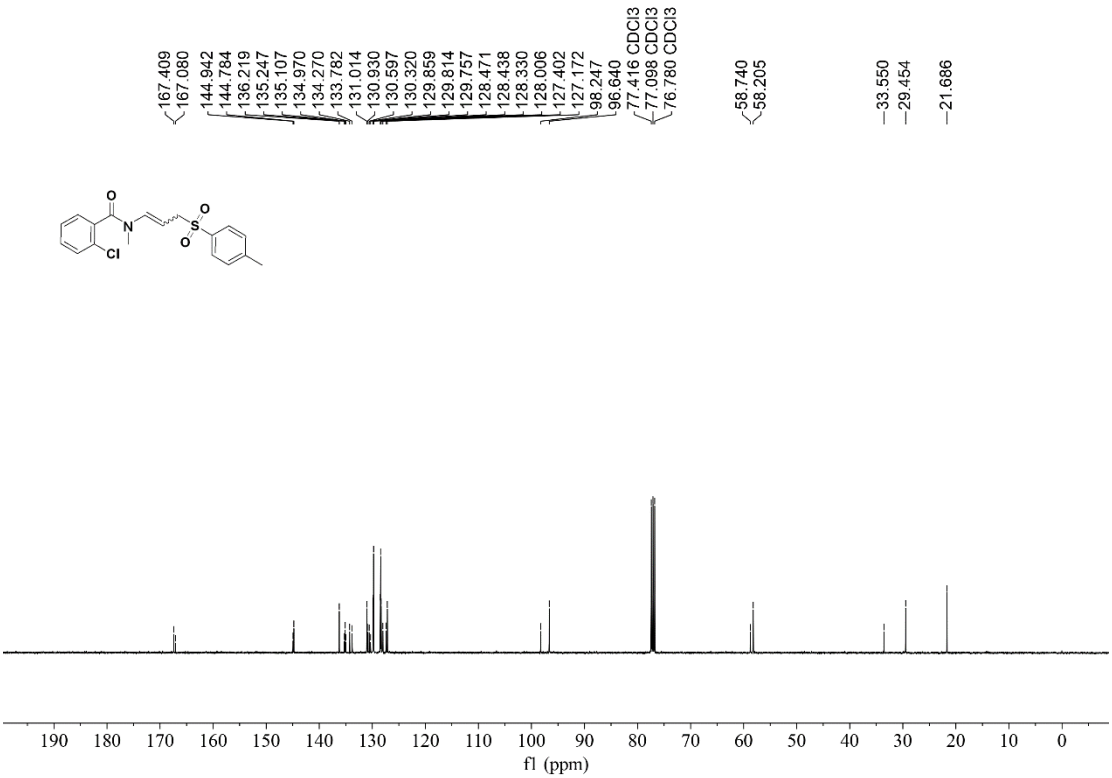
^{1}H NMR Spectrum of Compound **3h**



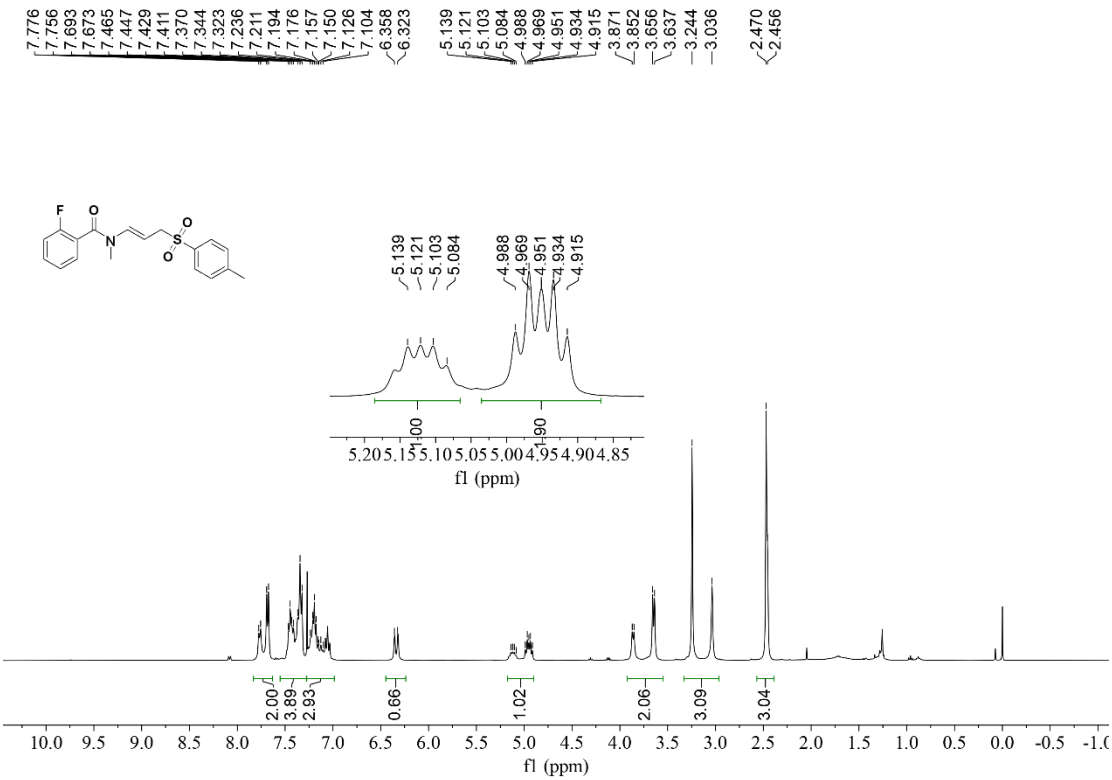
^{13}C NMR Spectrum of Compound **3h**



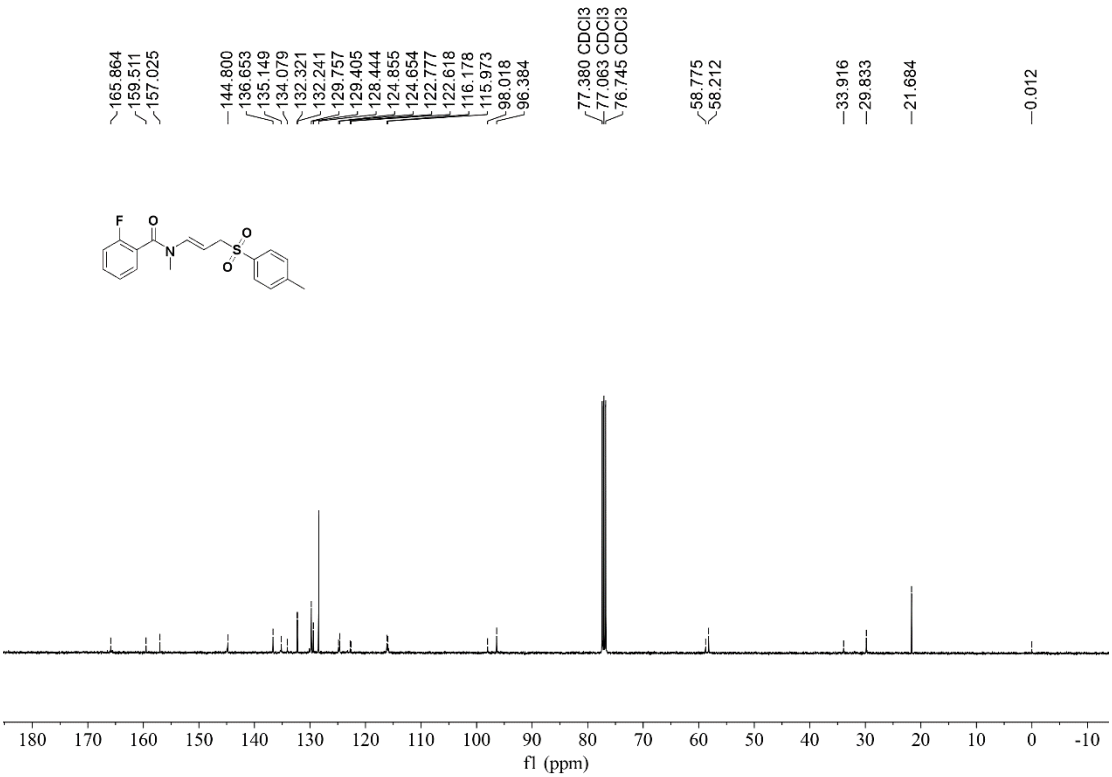
^{1}H NMR Spectrum of Compound **3i**



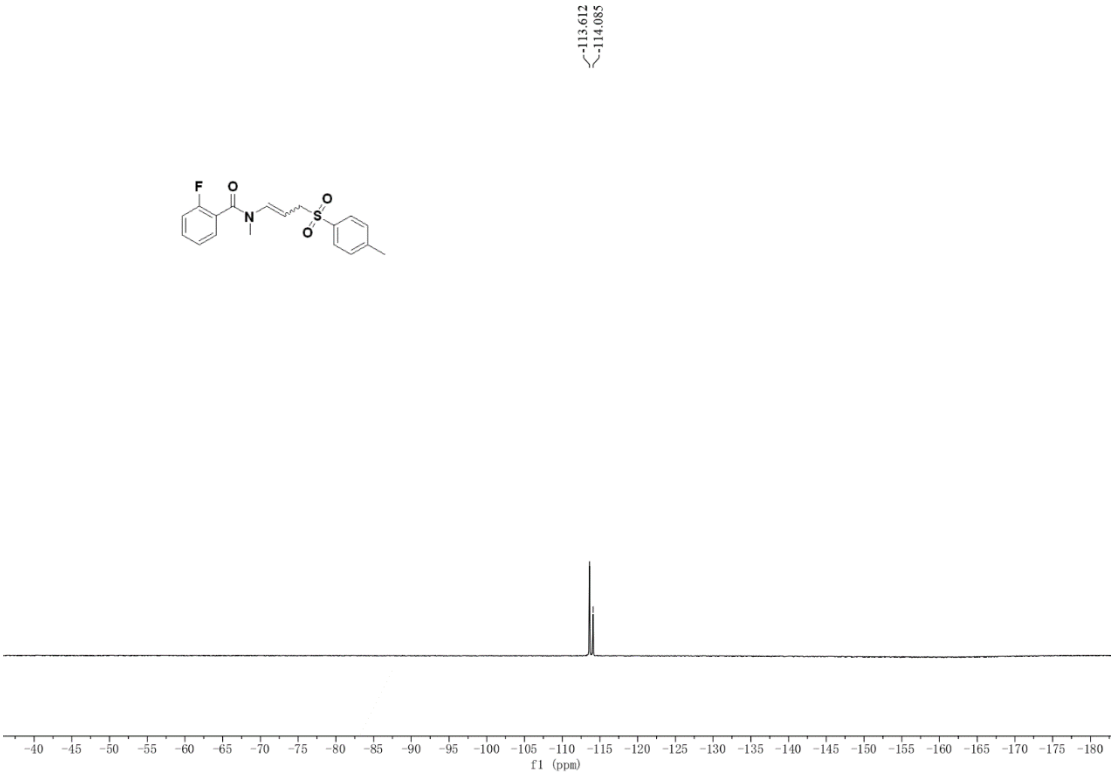
^{13}C NMR Spectrum of Compound **3i**



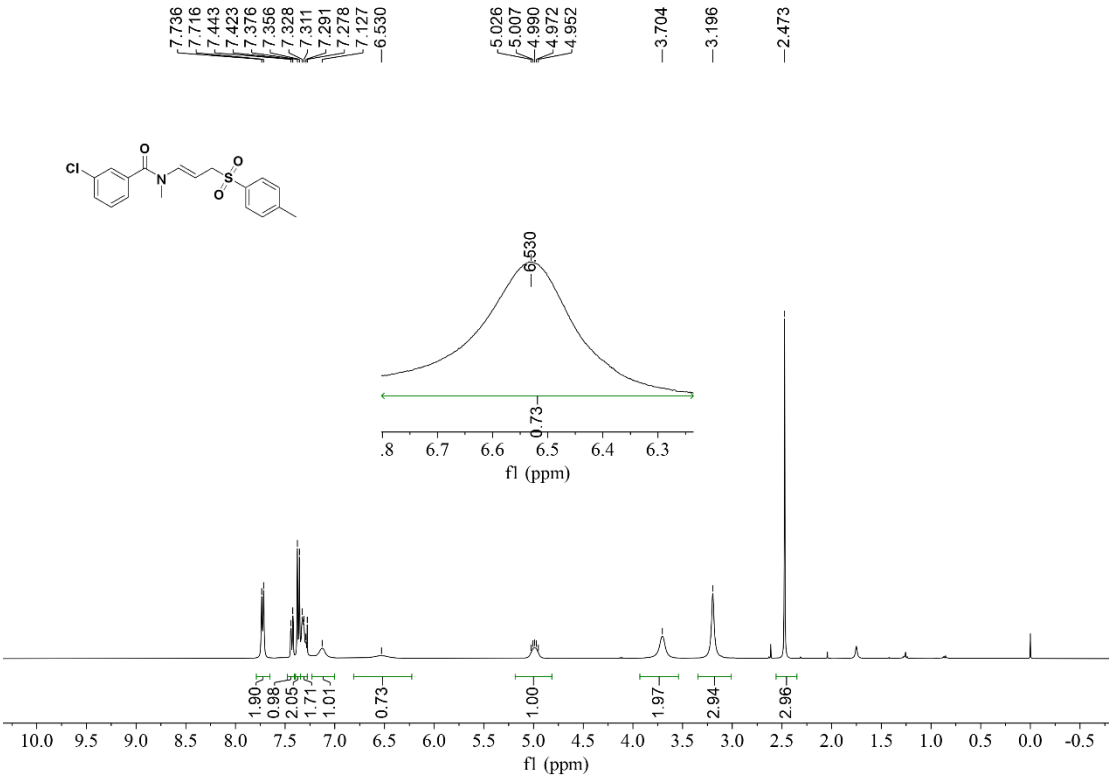
^{1}H NMR Spectrum of Compound **3j**



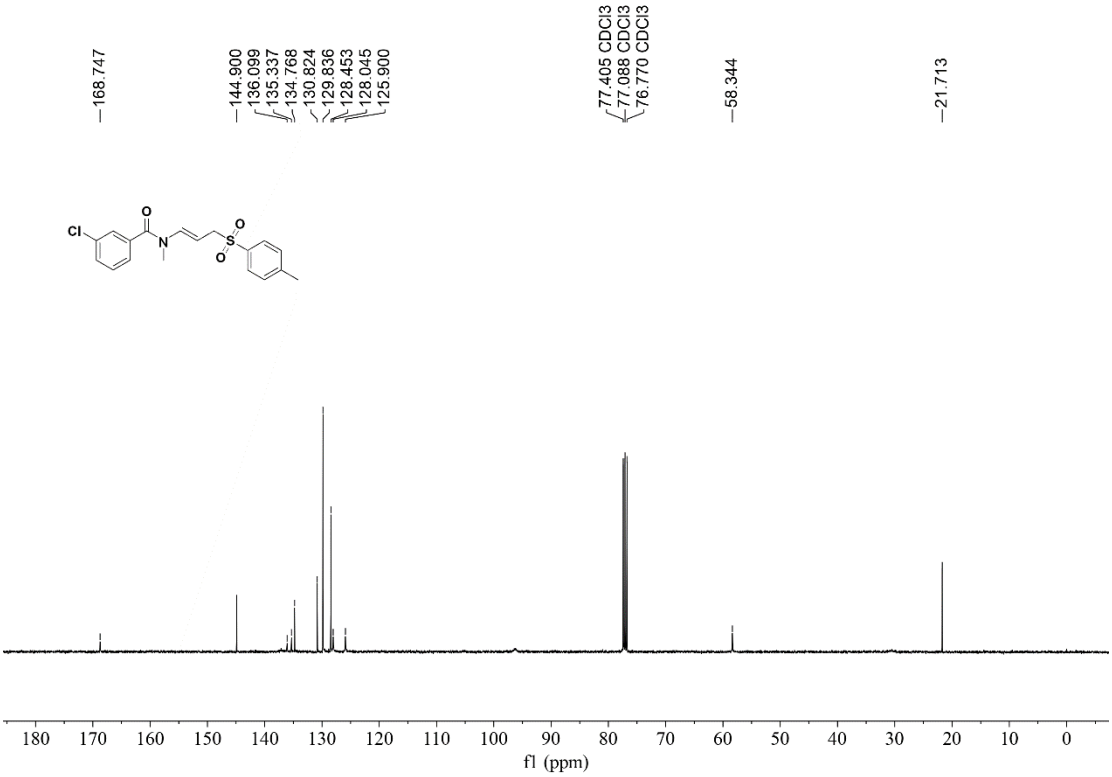
^{13}C NMR Spectrum of Compound **3j**



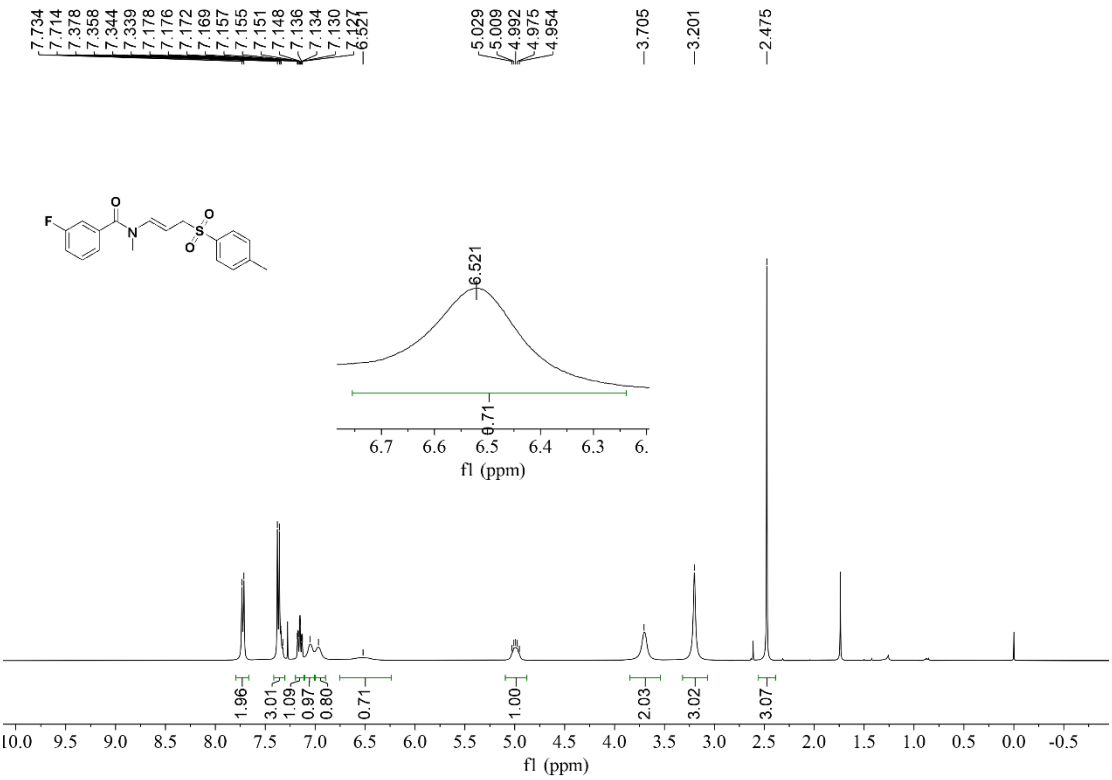
^{19}F NMR Spectrum of Compound **3j**



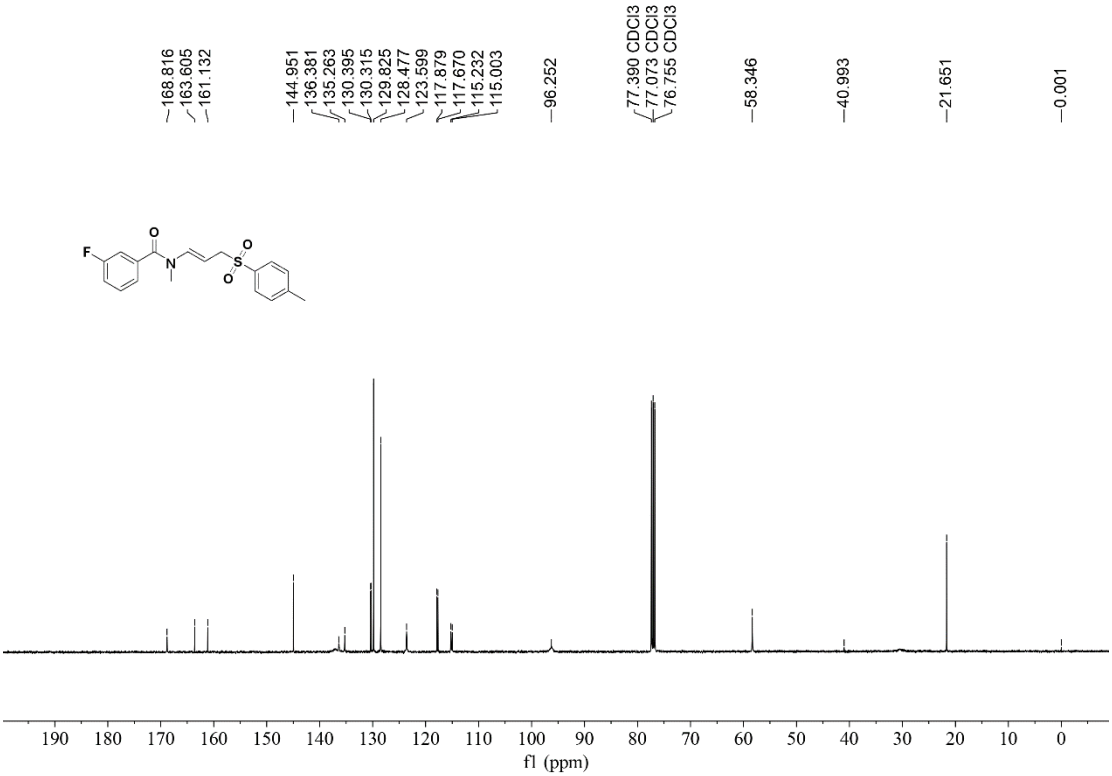
^{1}H NMR Spectrum of Compound **3k**



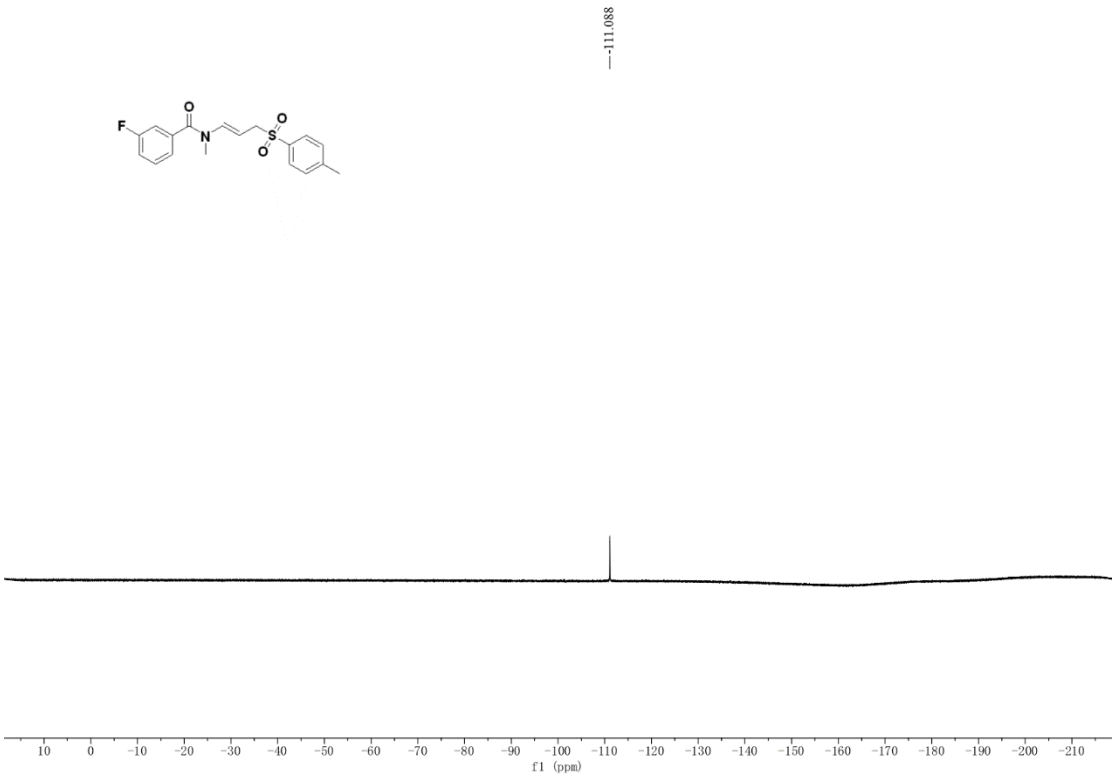
^{13}C NMR Spectrum of Compound **3k**



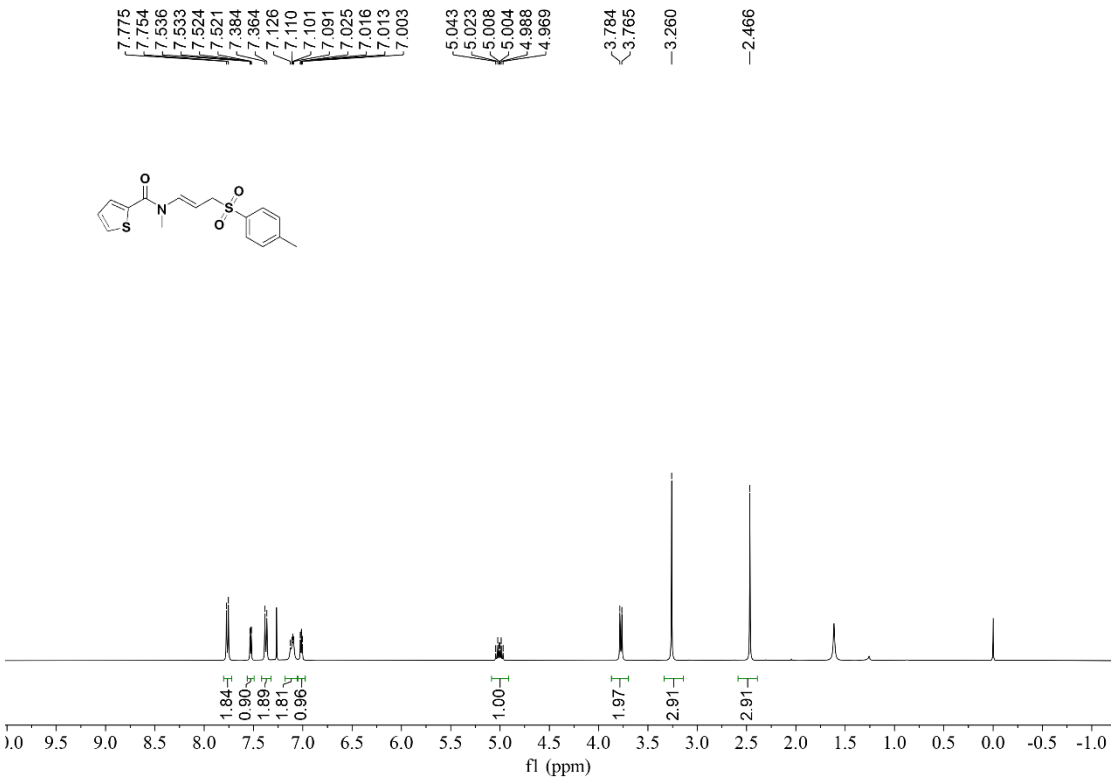
^{1}H NMR Spectrum of Compound **3l**



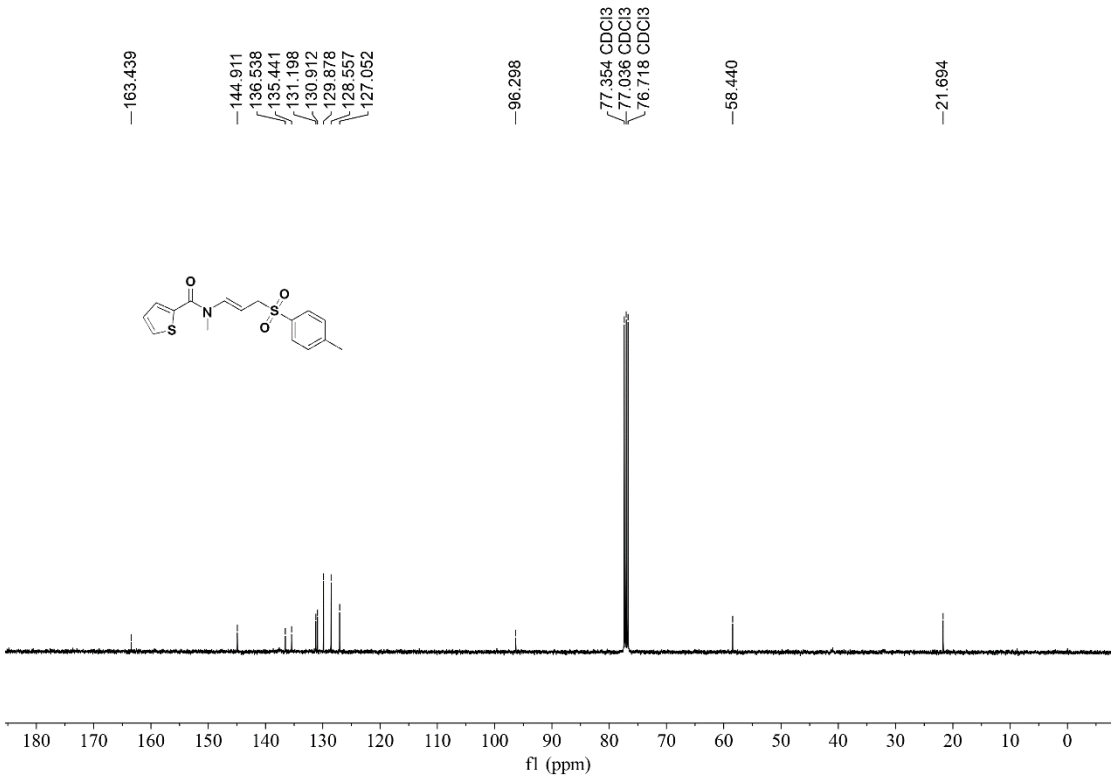
^{13}C NMR Spectrum of Compound **3l**



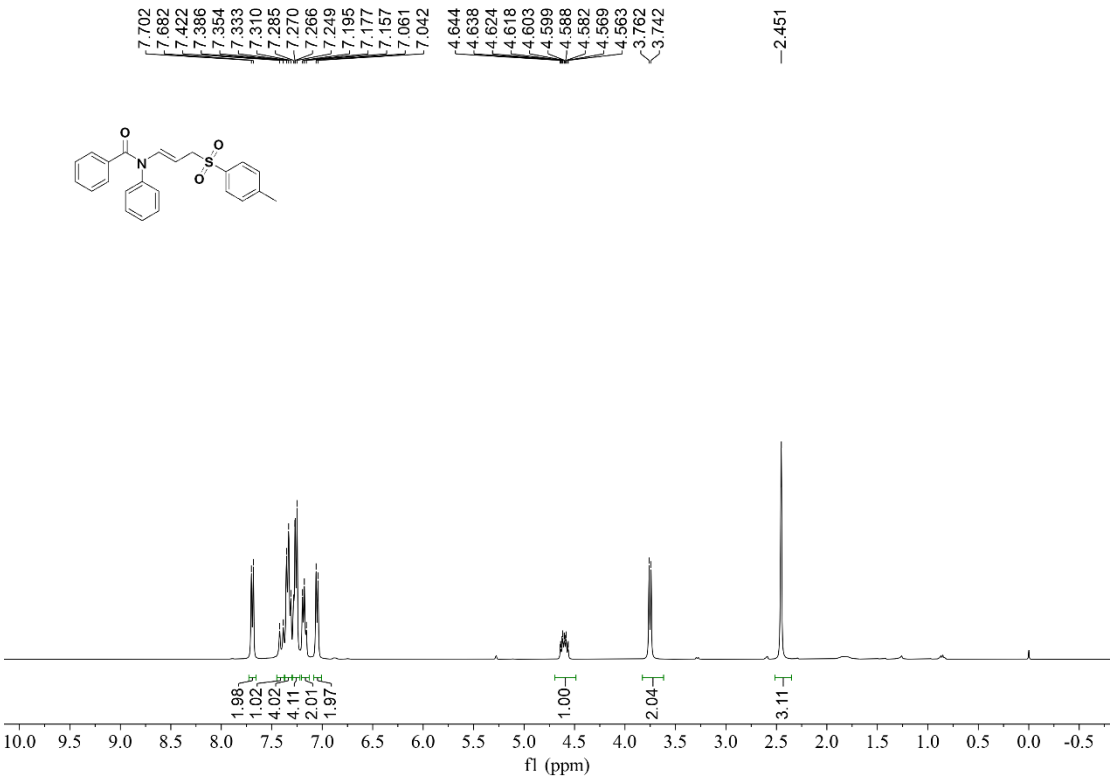
^{19}F NMR Spectrum of Compound **3l**



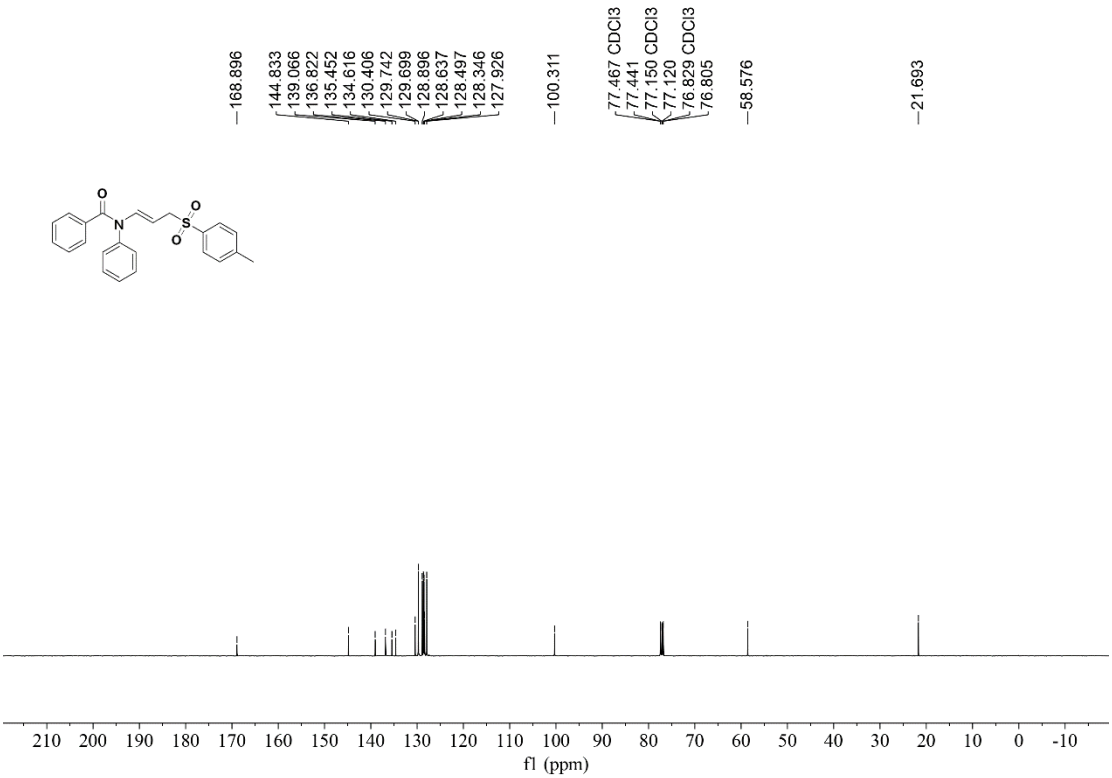
^{1}H NMR Spectrum of Compound **3m**



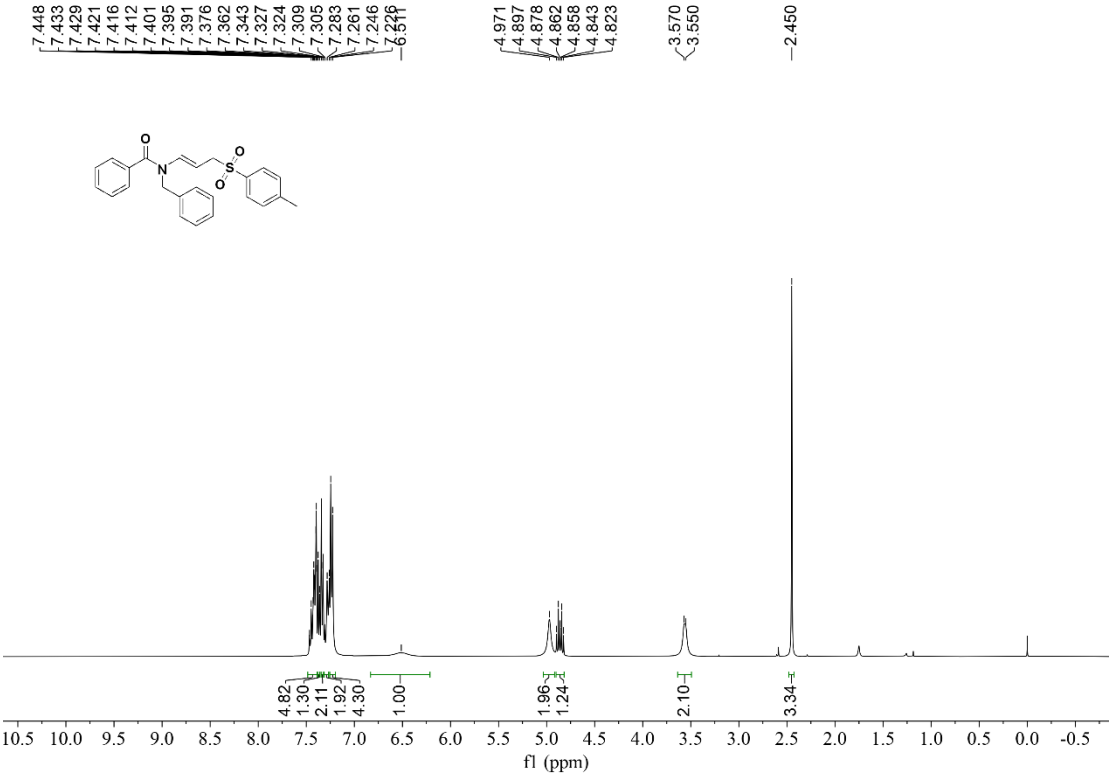
^{13}C NMR Spectrum of Compound **3m**



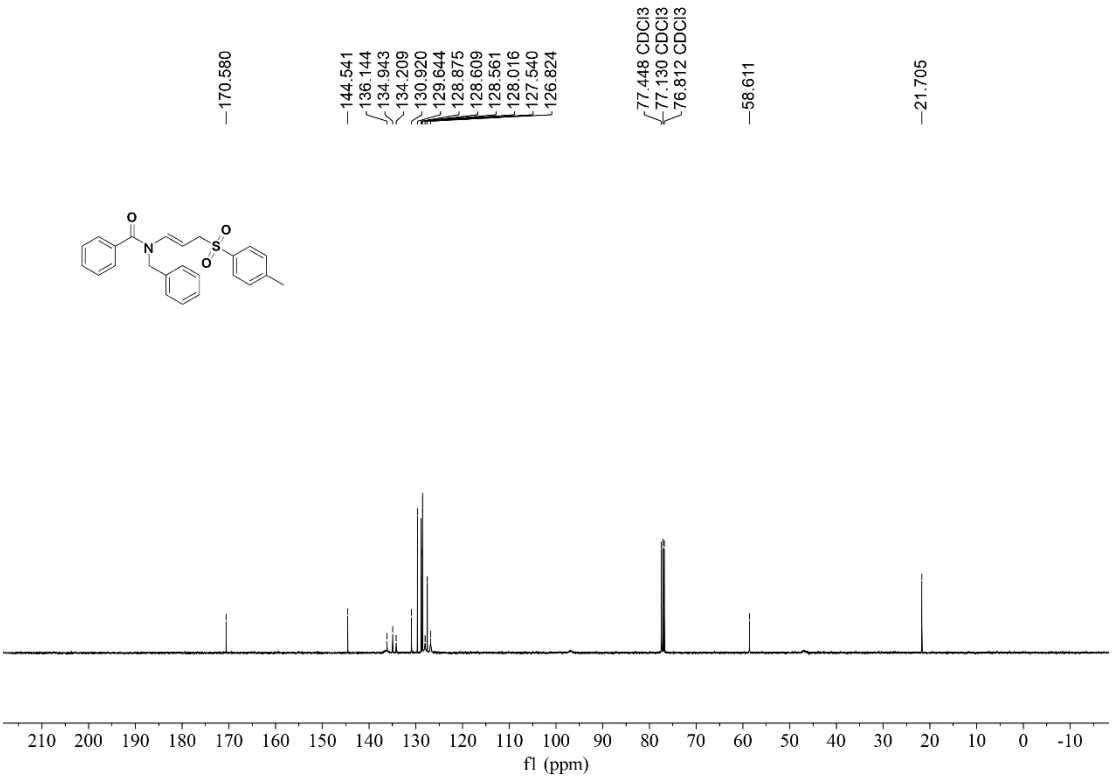
^{1}H NMR Spectrum of Compound **3n**



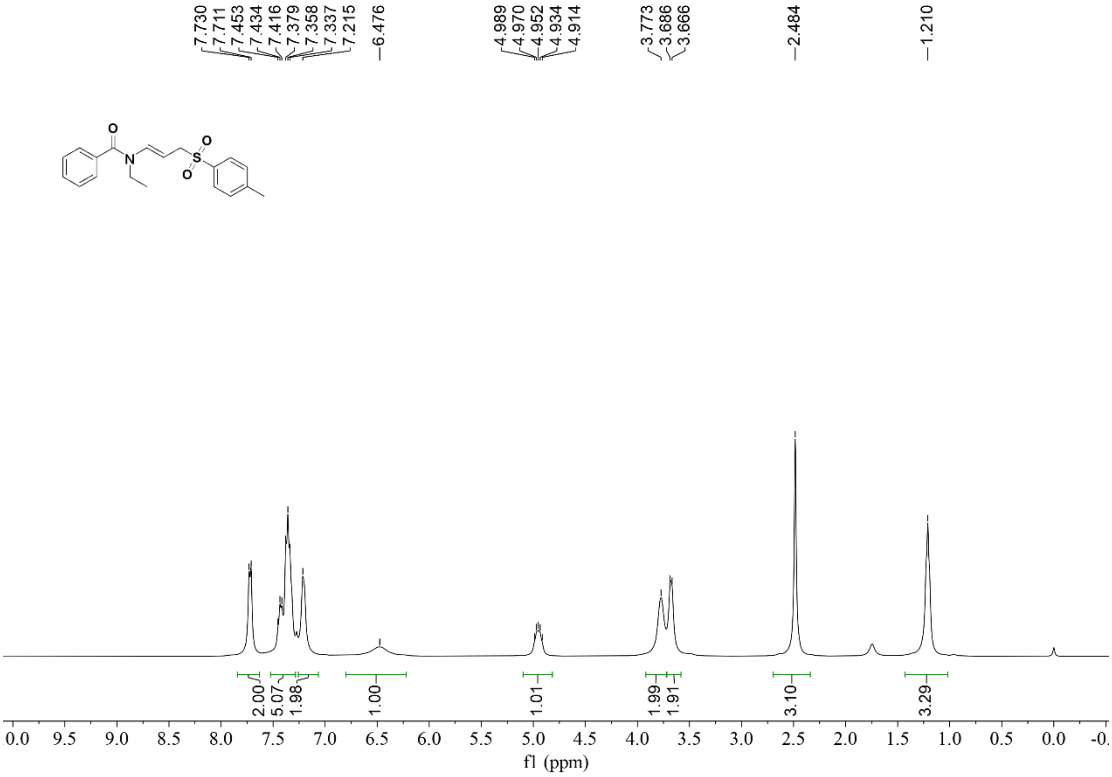
^{13}C NMR Spectrum of Compound **3n**



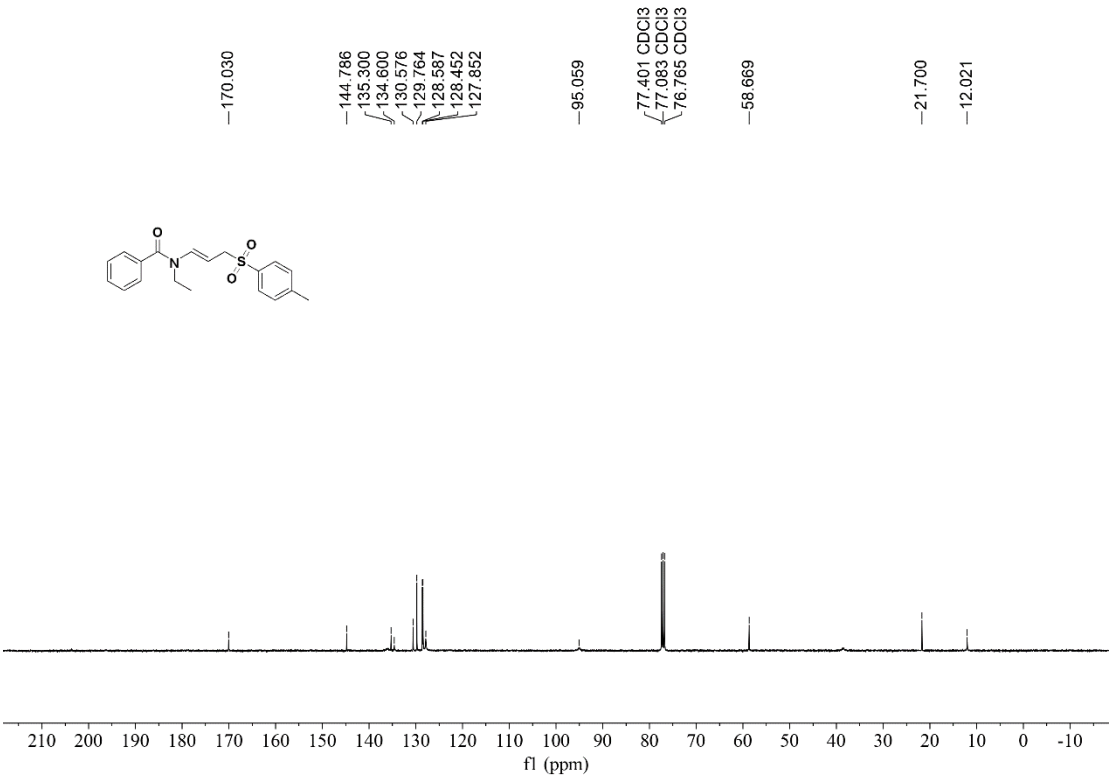
^{1}H NMR Spectrum of Compound **3o**



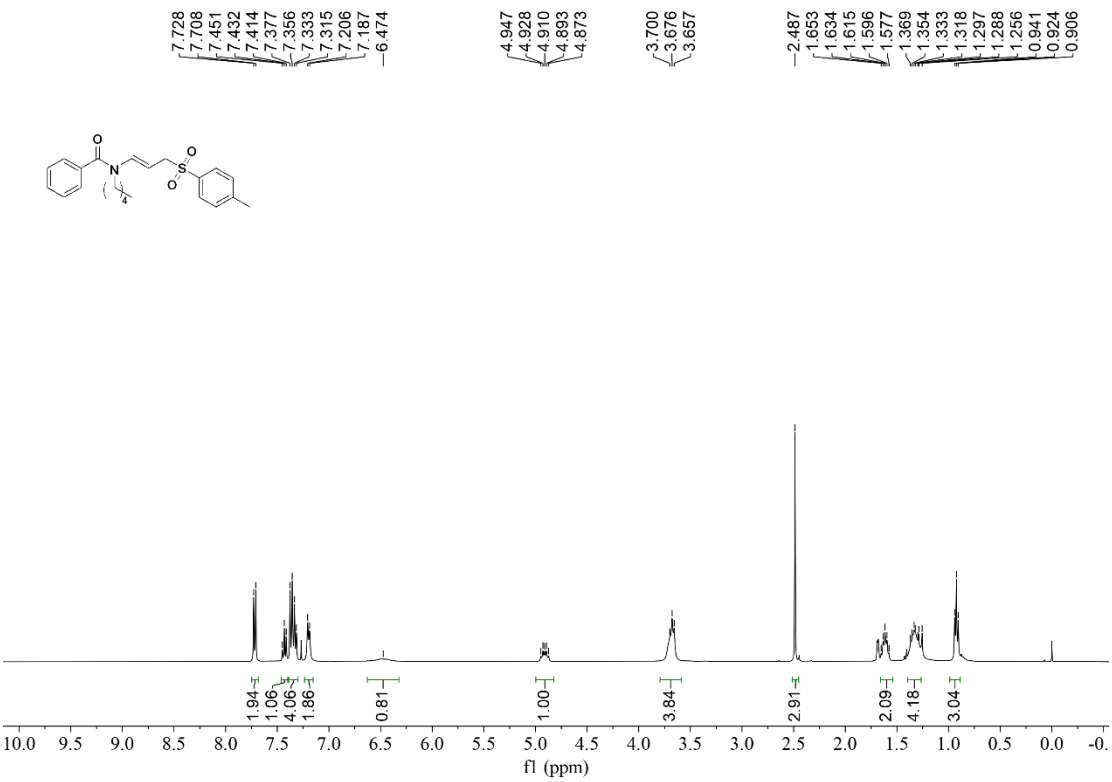
^{13}C NMR Spectrum of Compound **3o**



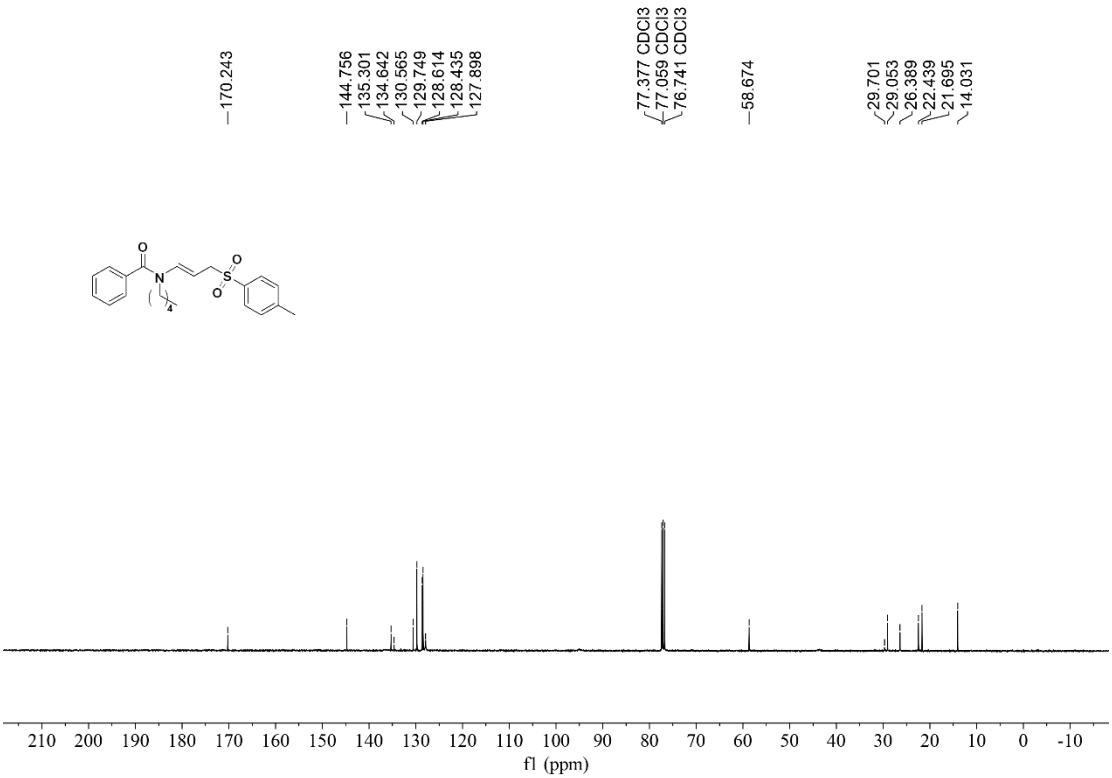
^{1}H NMR Spectrum of Compound **3p**



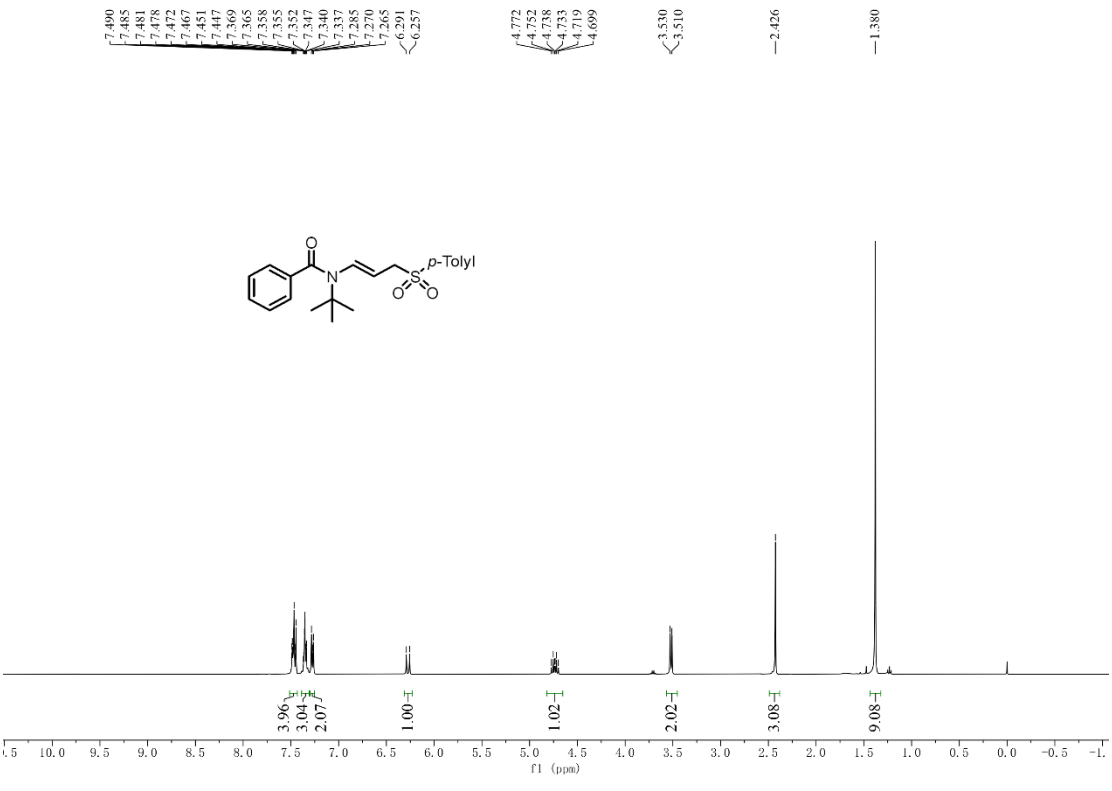
^{13}C NMR Spectrum of Compound **3p**



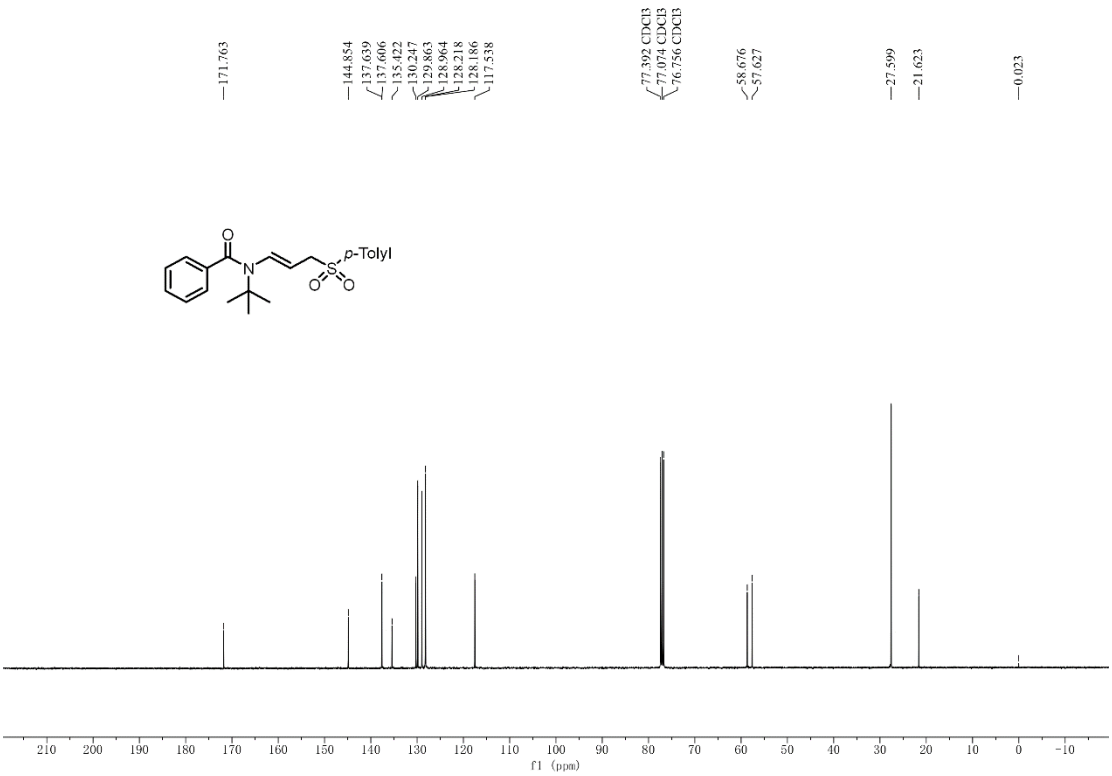
^{1}H NMR Spectrum of Compound **3q**



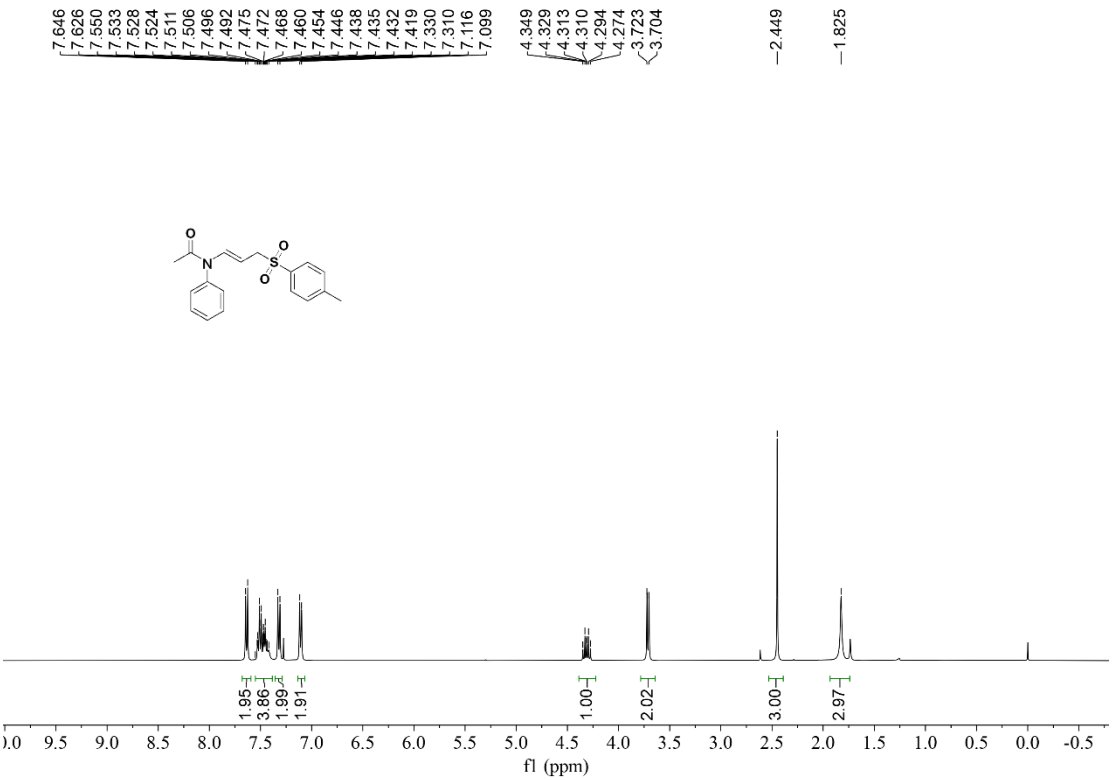
^{13}C NMR Spectrum of Compound **3q**



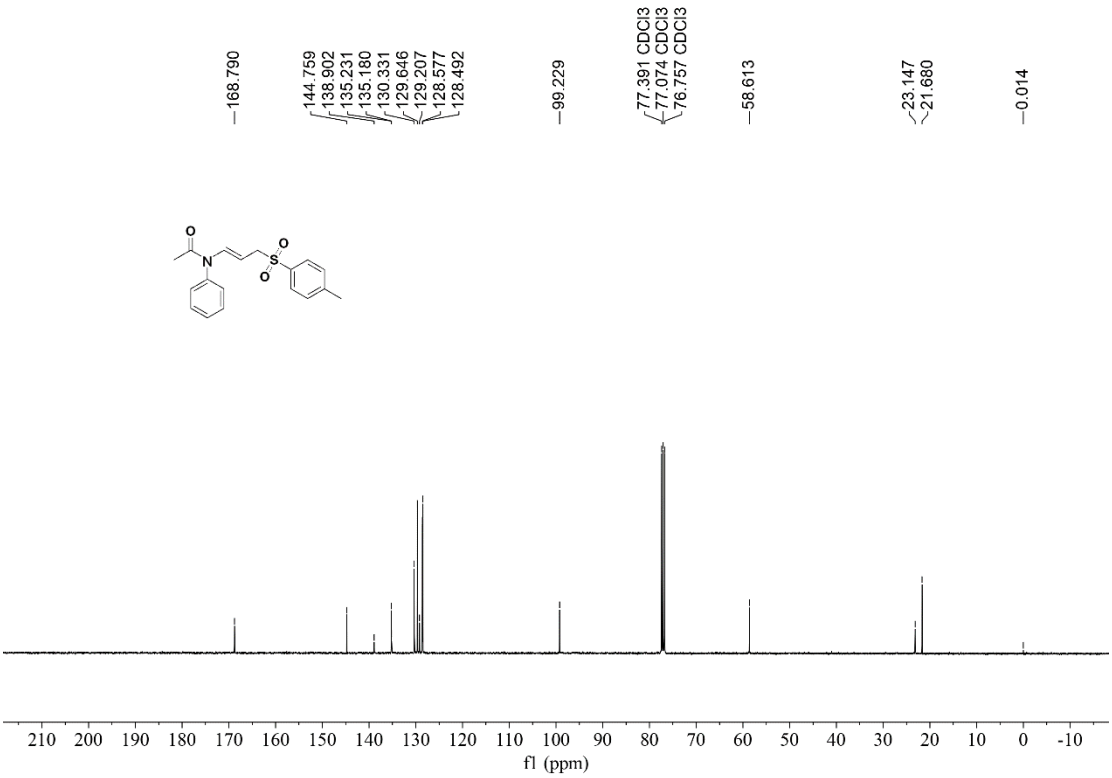
^{1}H NMR Spectrum of Compound **3r**



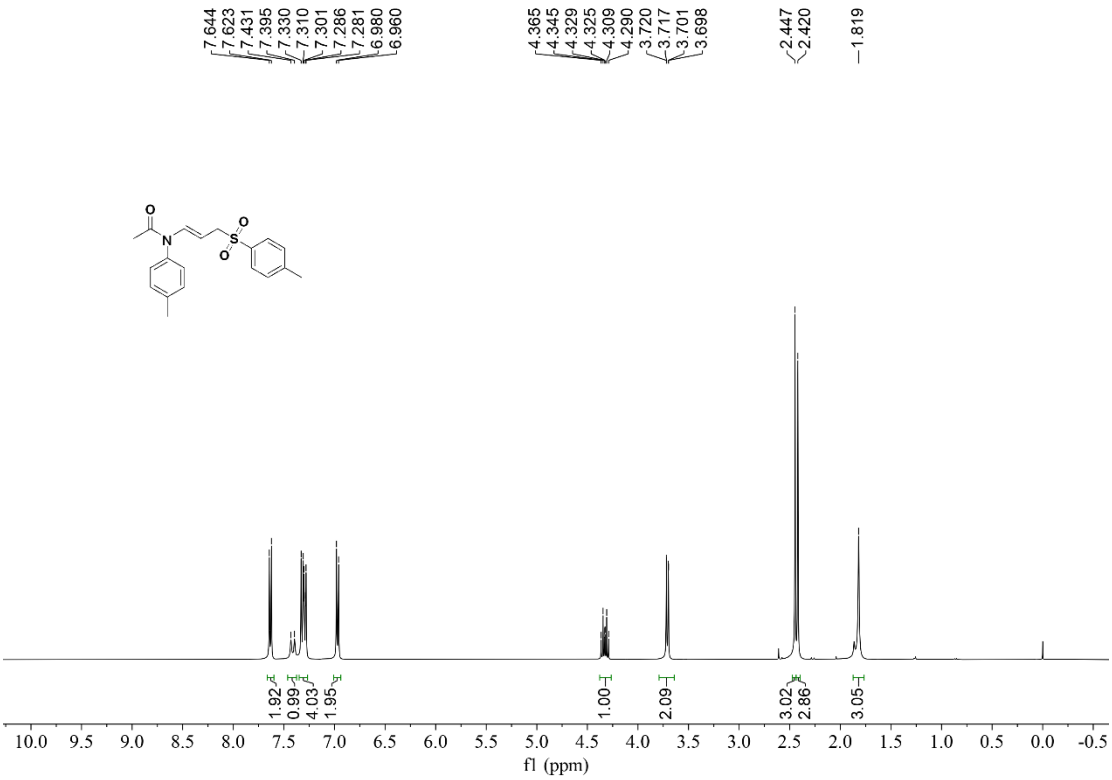
^{13}C NMR Spectrum of Compound **3r**



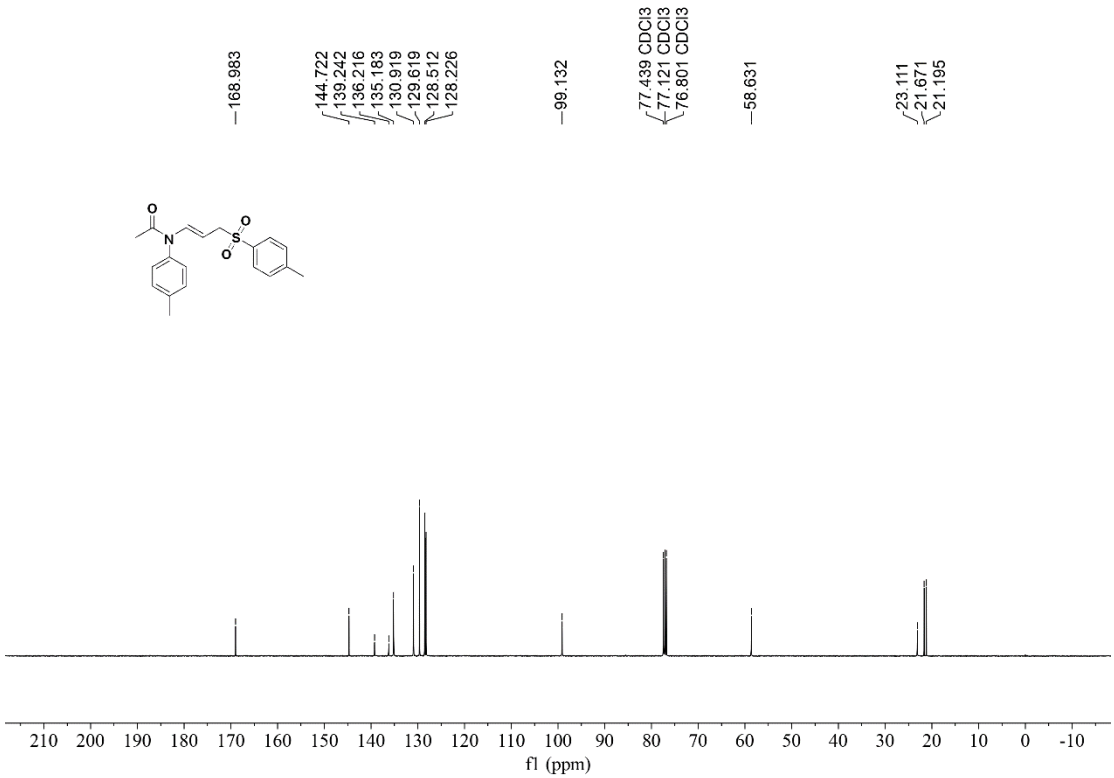
^{1}H NMR Spectrum of Compound **3s**



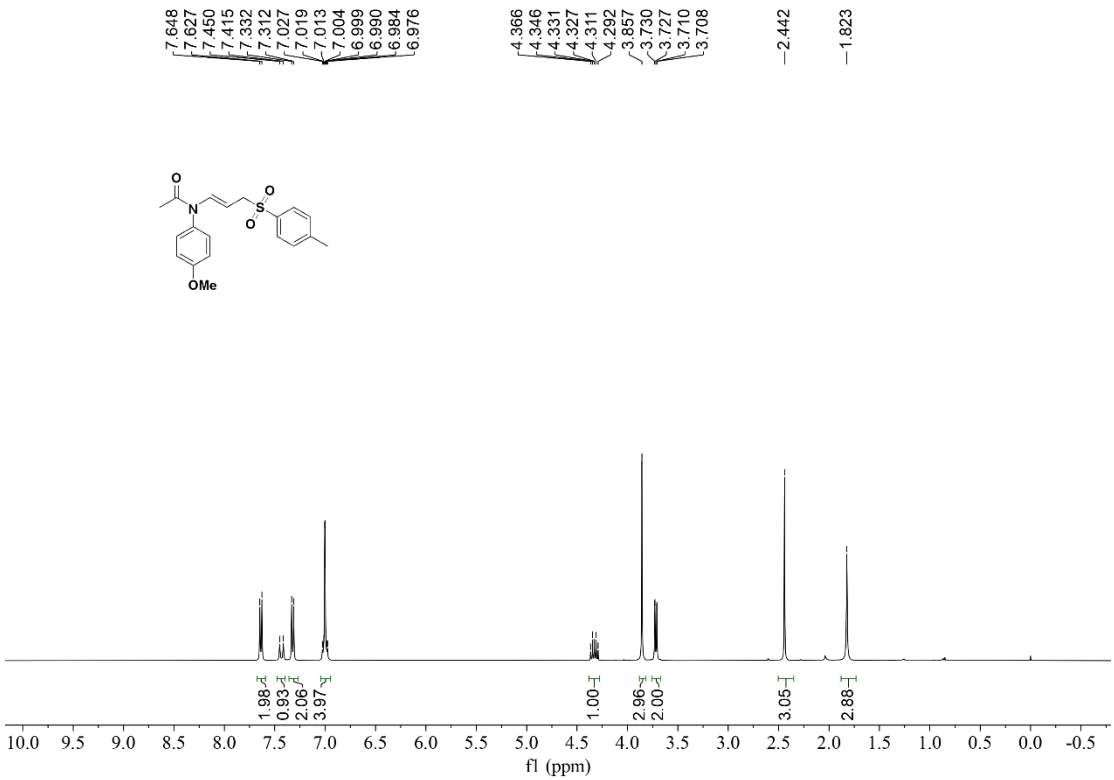
^{13}C NMR Spectrum of Compound **3s**



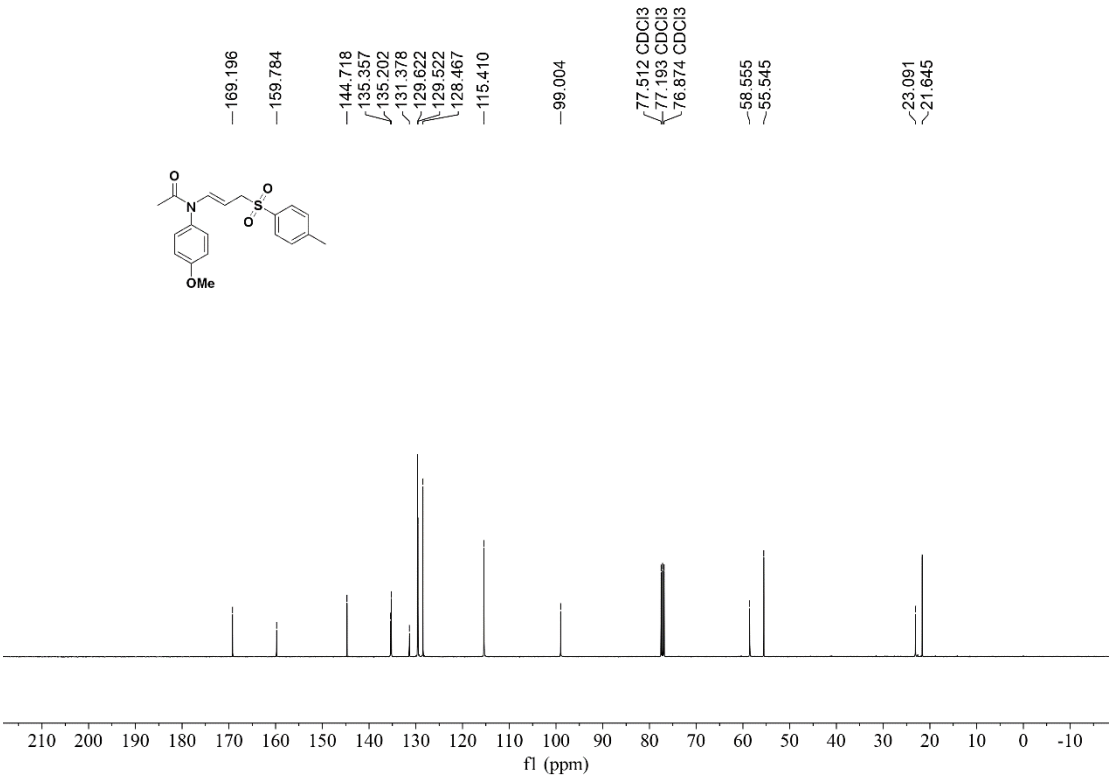
^{1}H NMR Spectrum of Compound **3t**



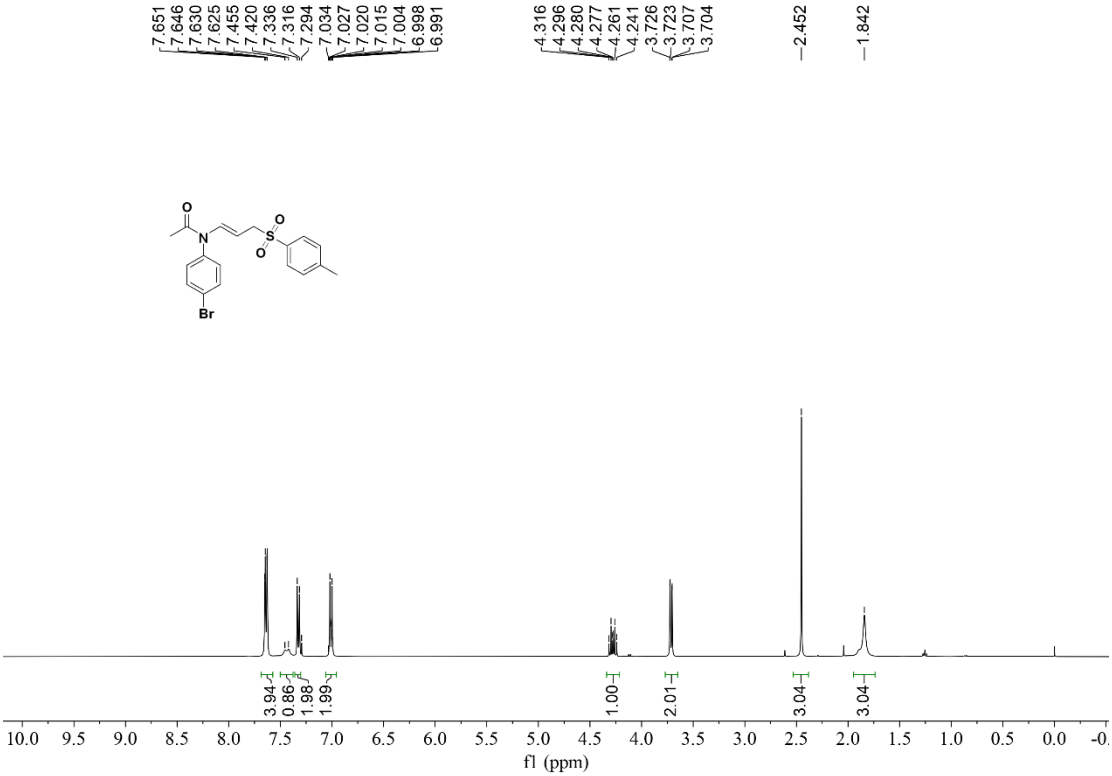
^{13}C NMR Spectrum of Compound **3t**



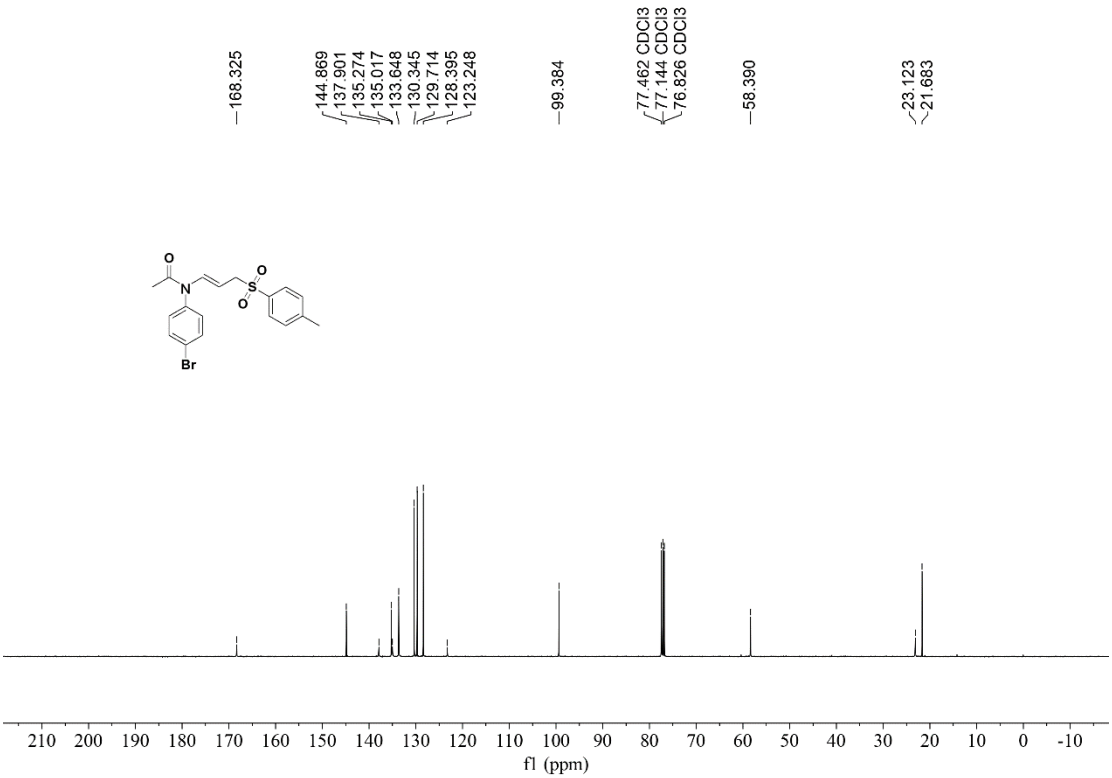
^{1}H NMR Spectrum of Compound **3u**



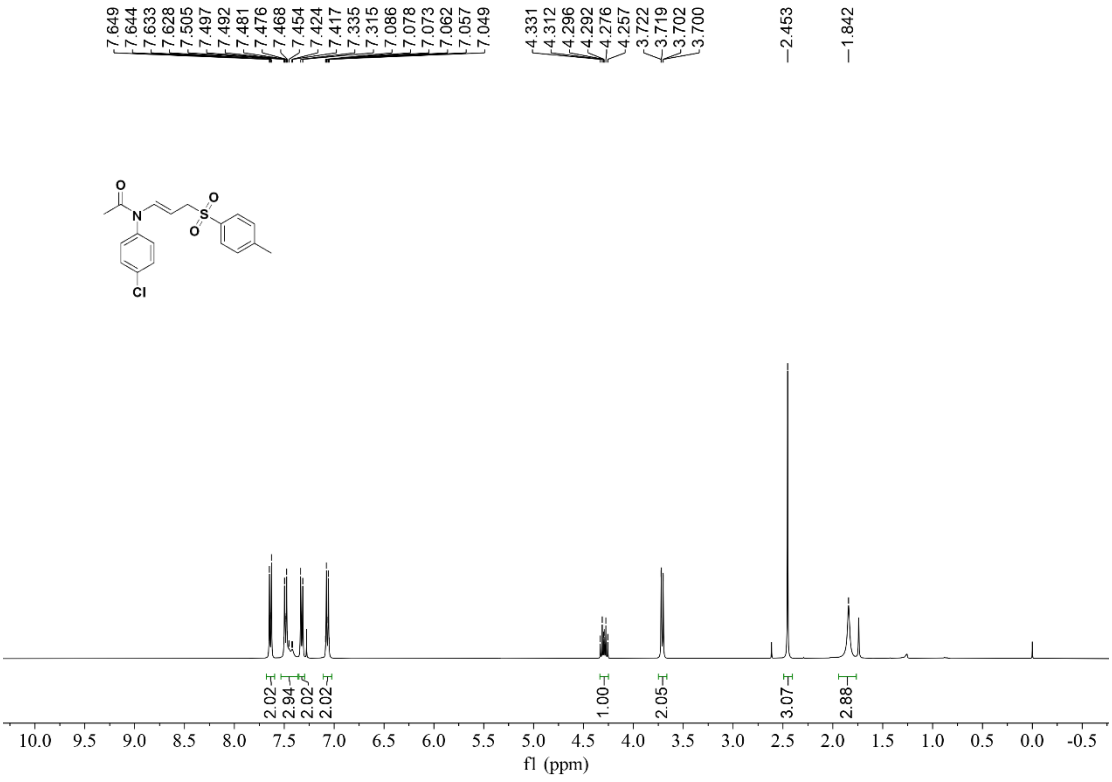
^{13}C NMR Spectrum of Compound **3u**



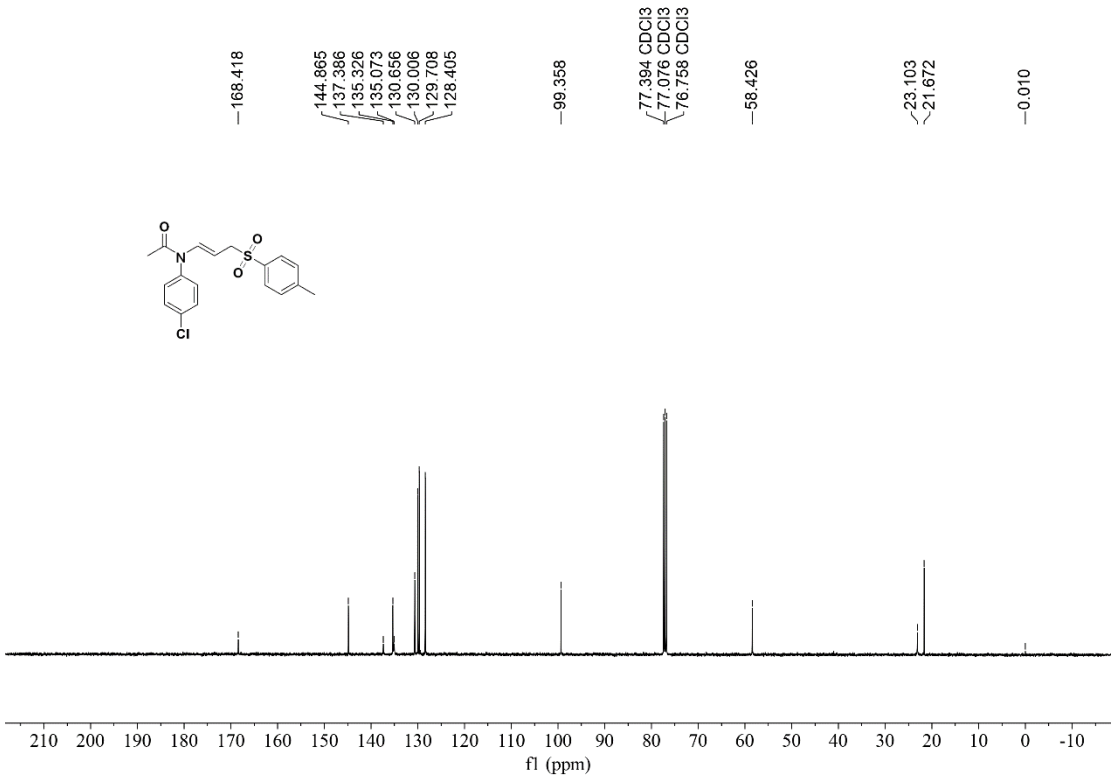
^{1}H NMR Spectrum of Compound **3v**



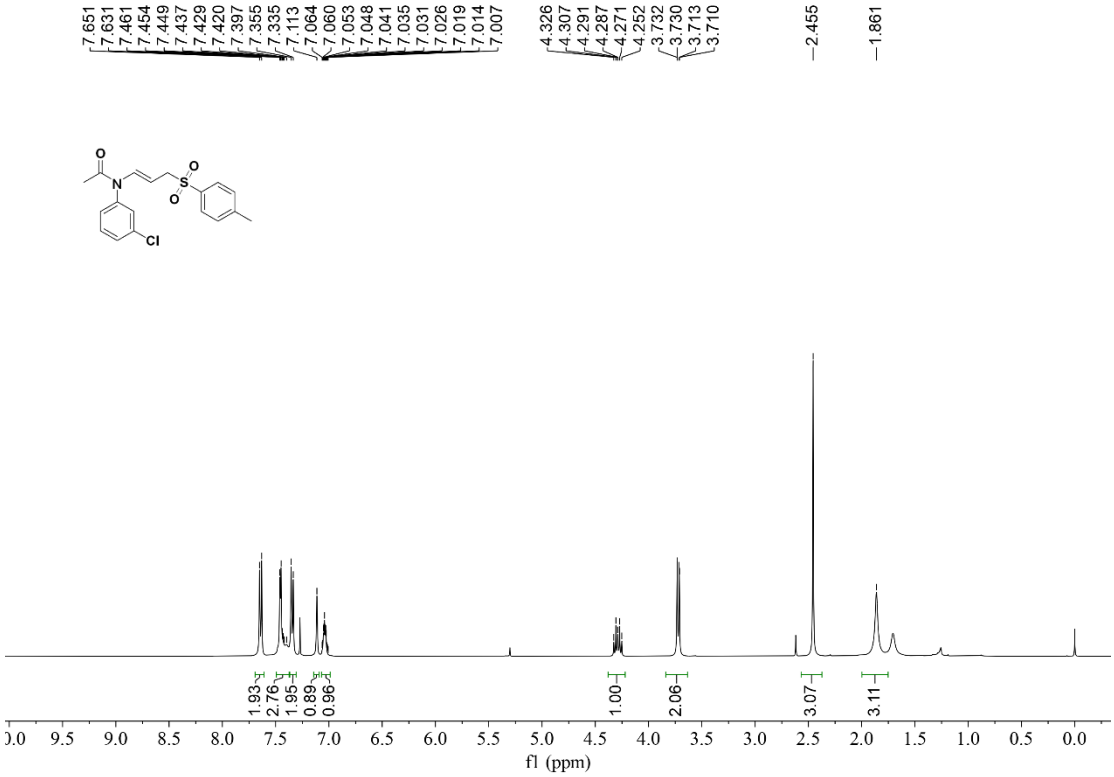
^{13}C NMR Spectrum of Compound **3v**



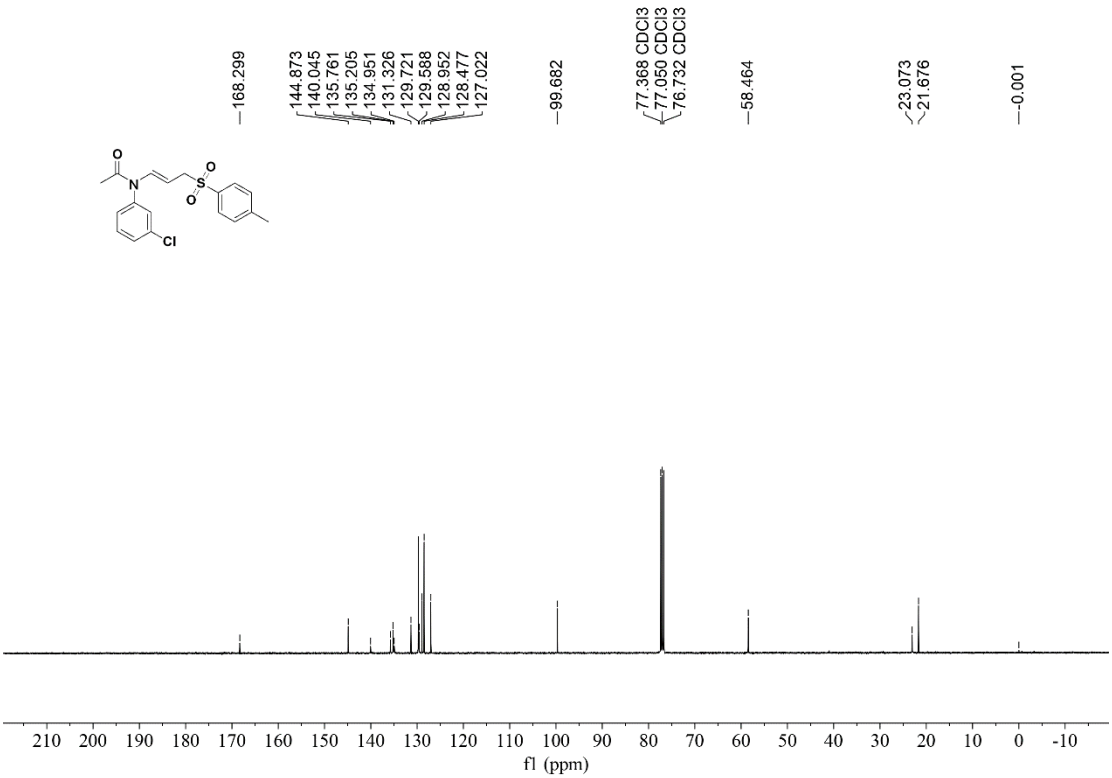
^{1}H NMR Spectrum of Compound **3w**



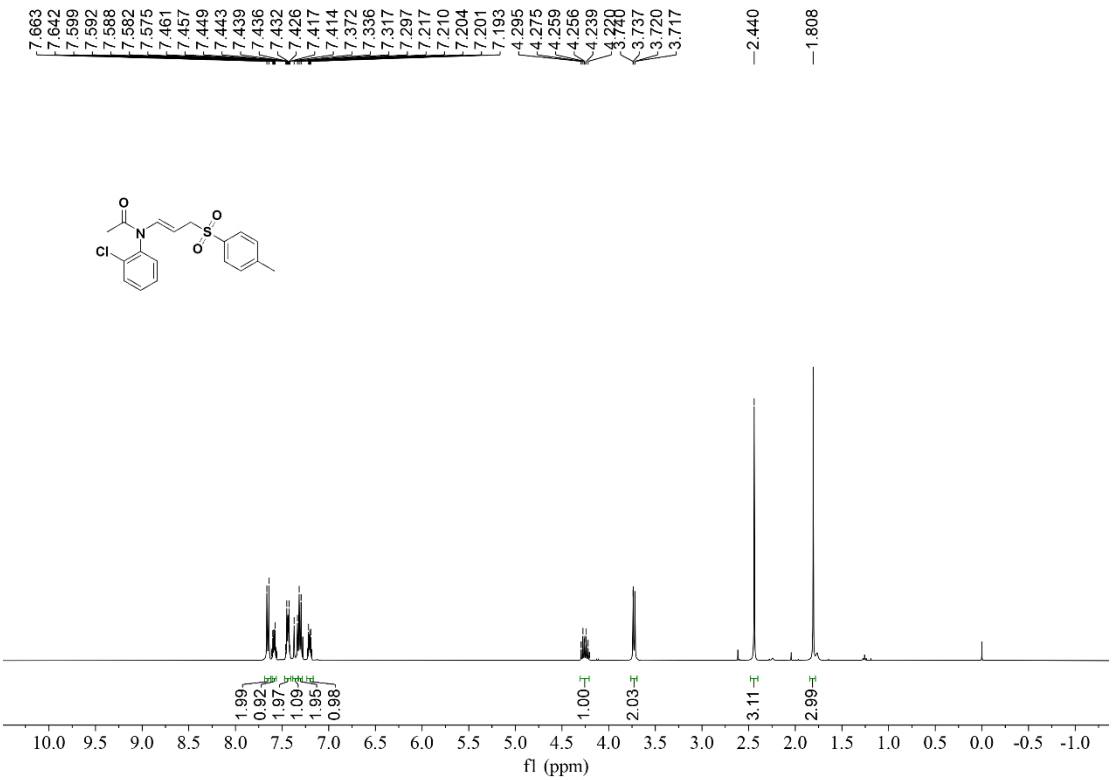
^{13}C NMR Spectrum of Compound **3w**



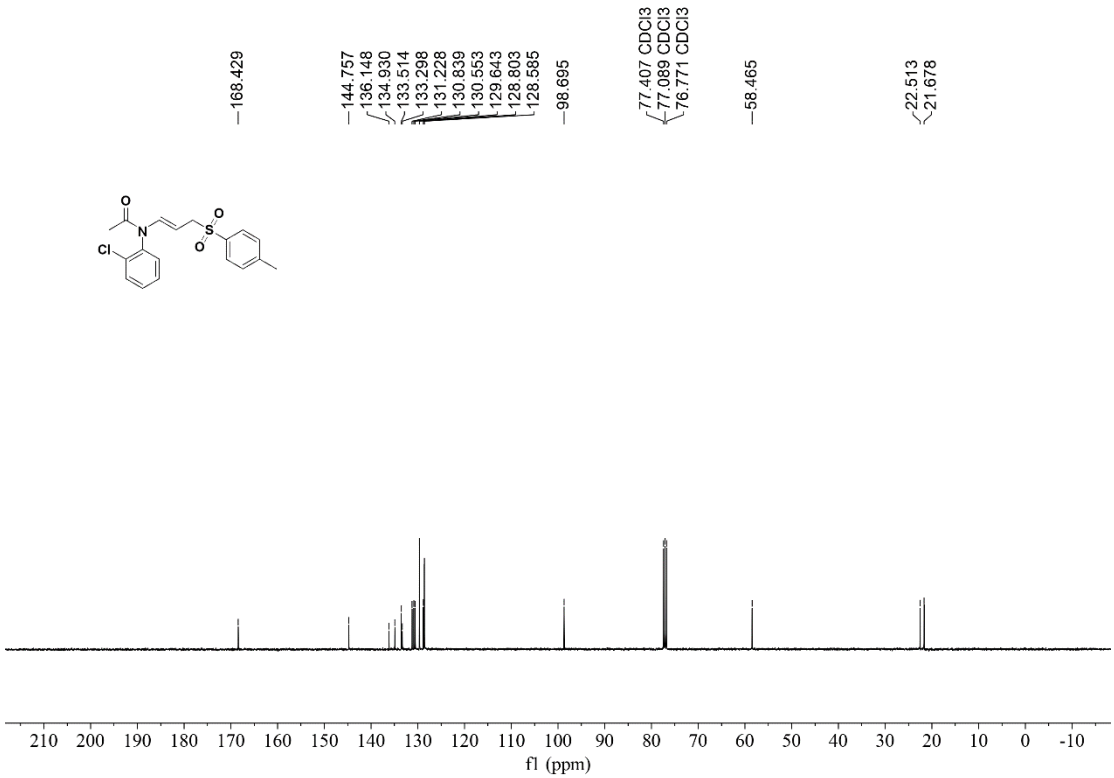
^{1}H NMR Spectrum of Compound **3x**



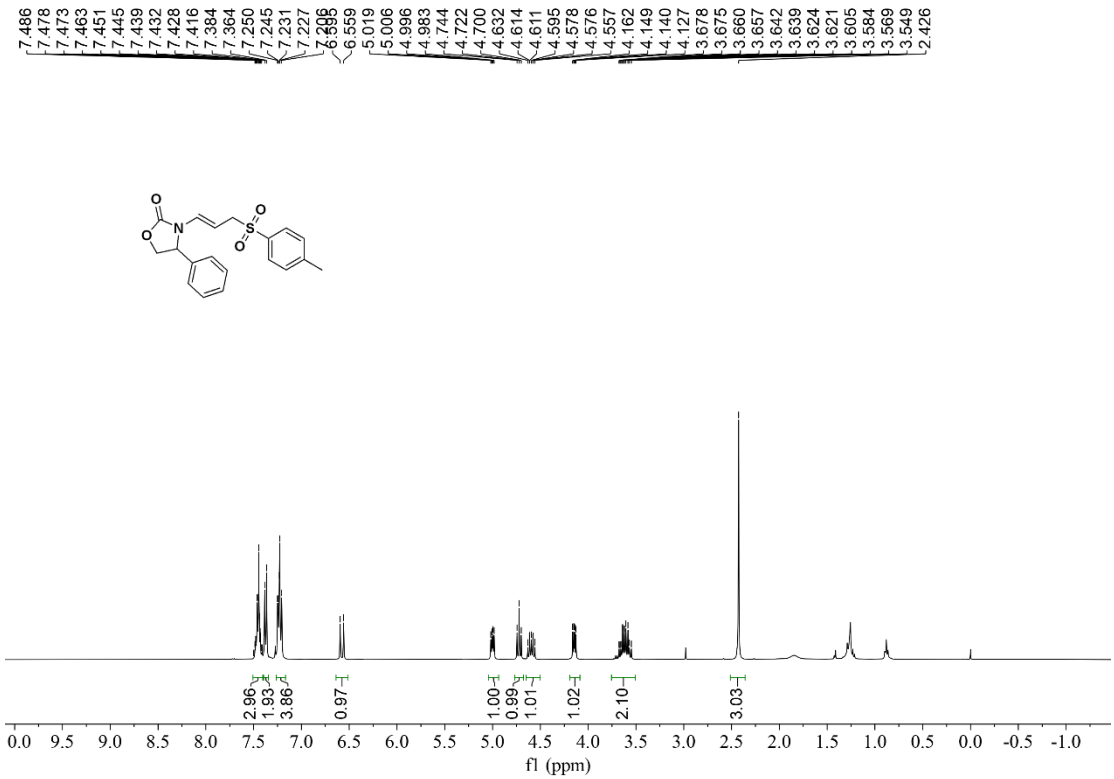
^{13}C NMR Spectrum of Compound **3x**



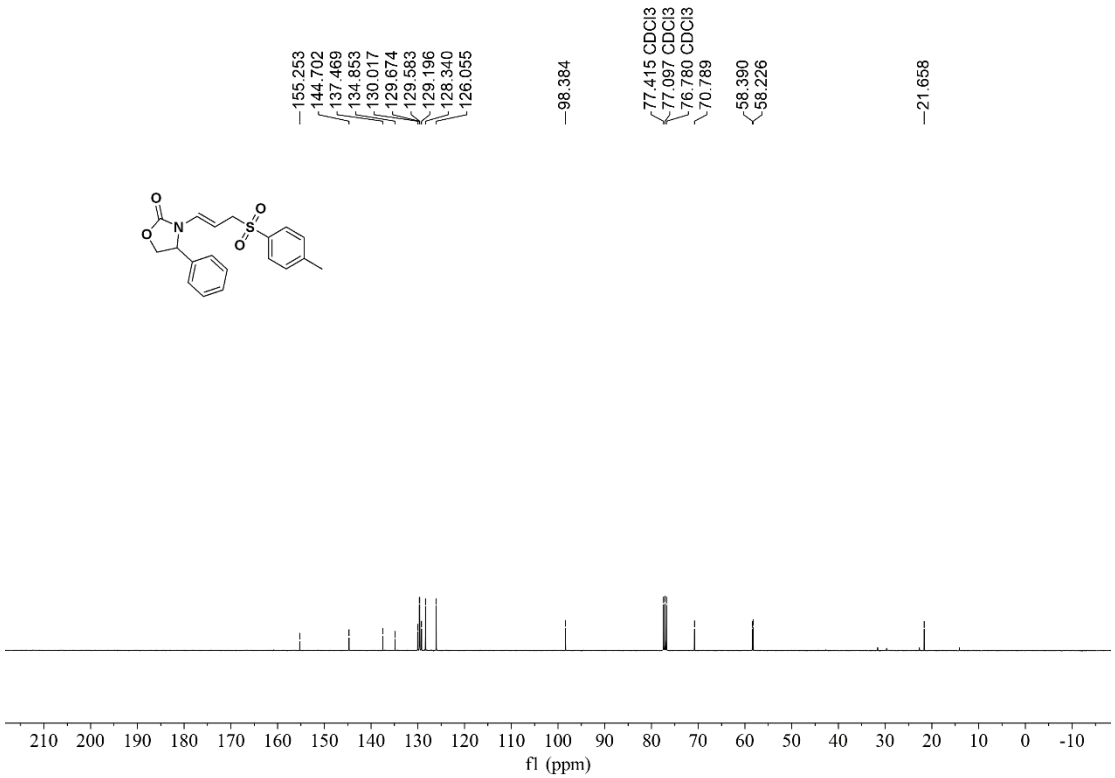
^{1}H NMR Spectrum of Compound **3y**



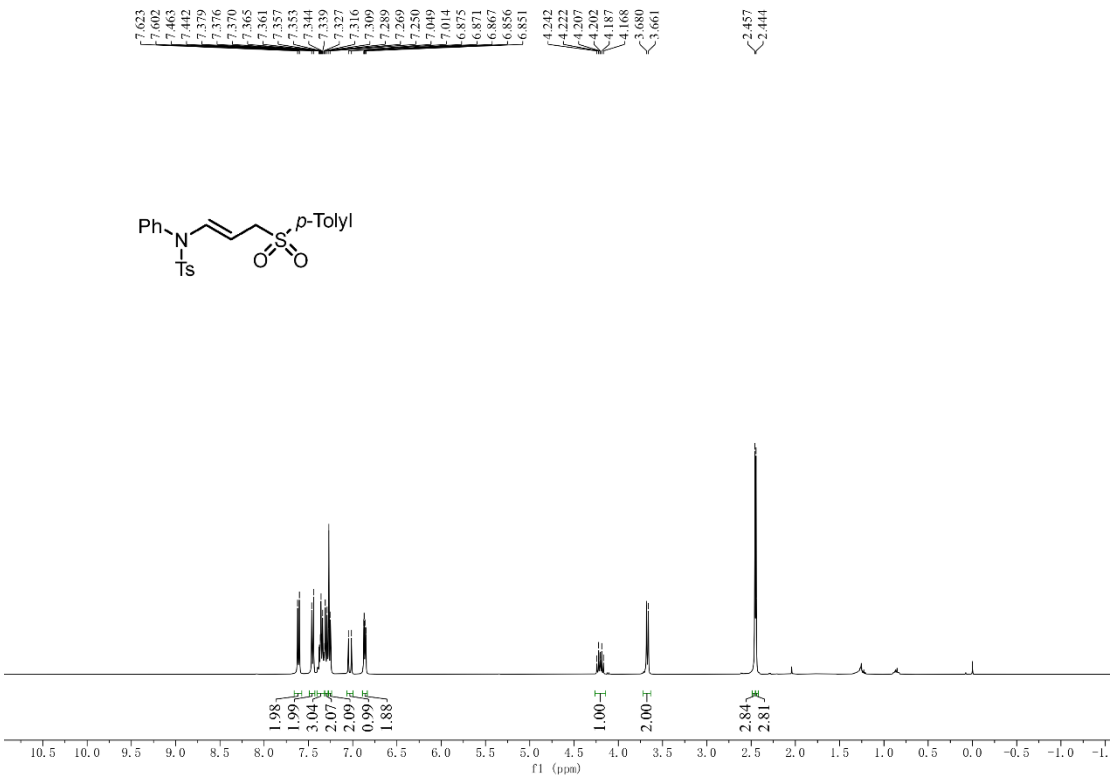
^{13}C NMR Spectrum of Compound **3y**



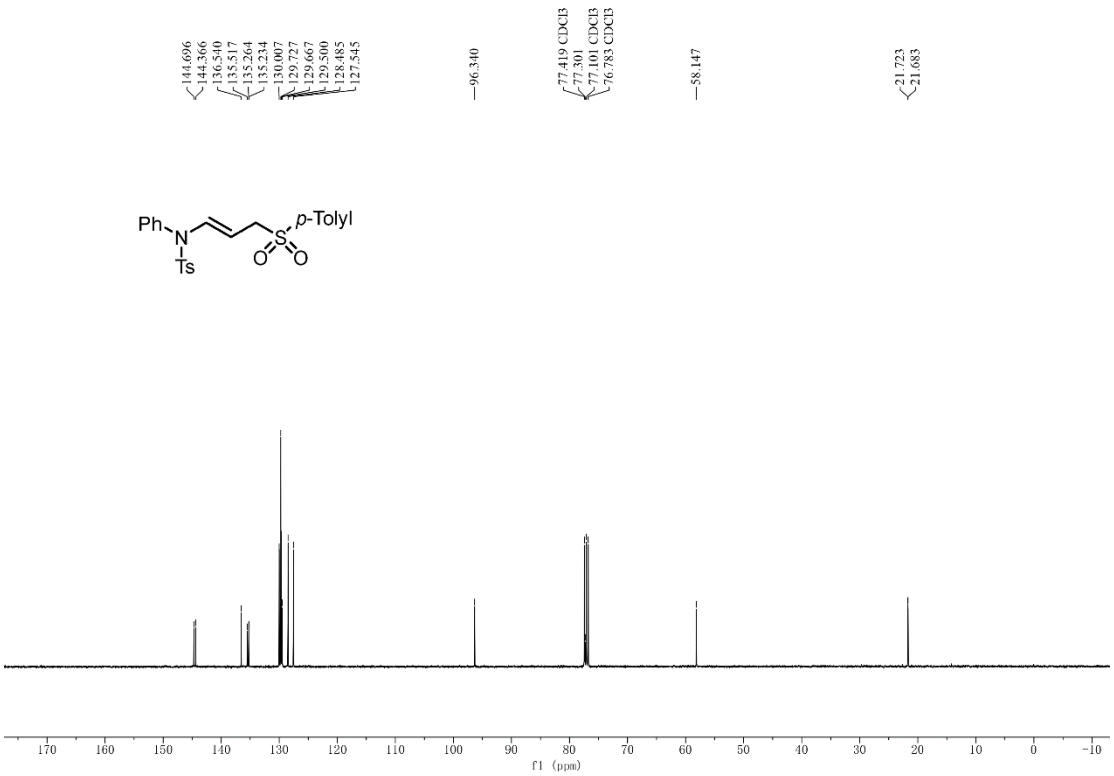
^{1}H NMR Spectrum of Compound **3z**



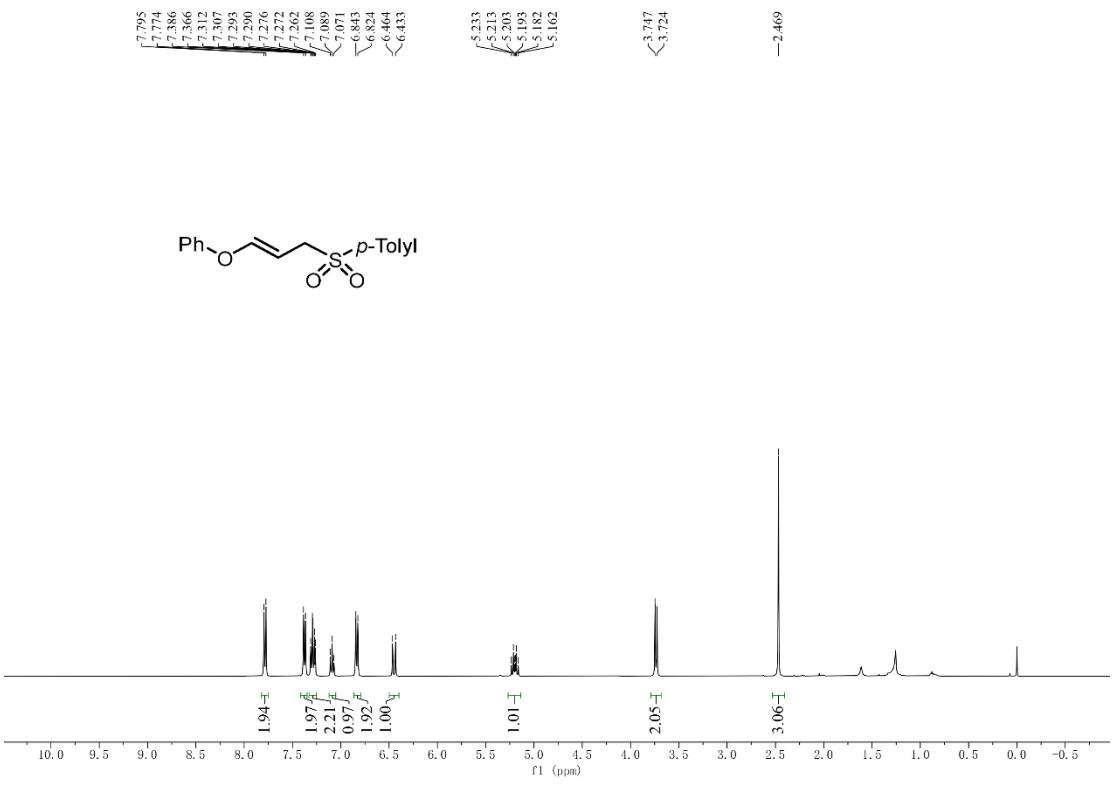
^{13}C NMR Spectrum of Compound **3z**



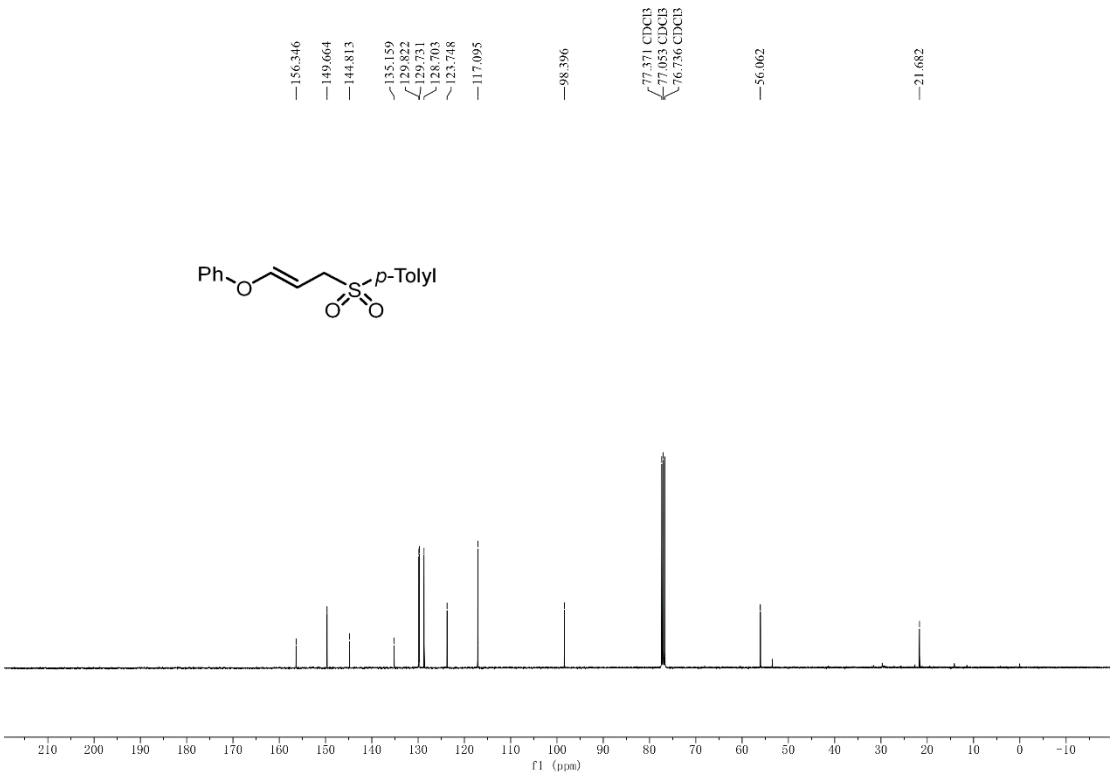
^{1}H NMR Spectrum of Compound **3aa**



^{13}C NMR Spectrum of Compound **3aa**

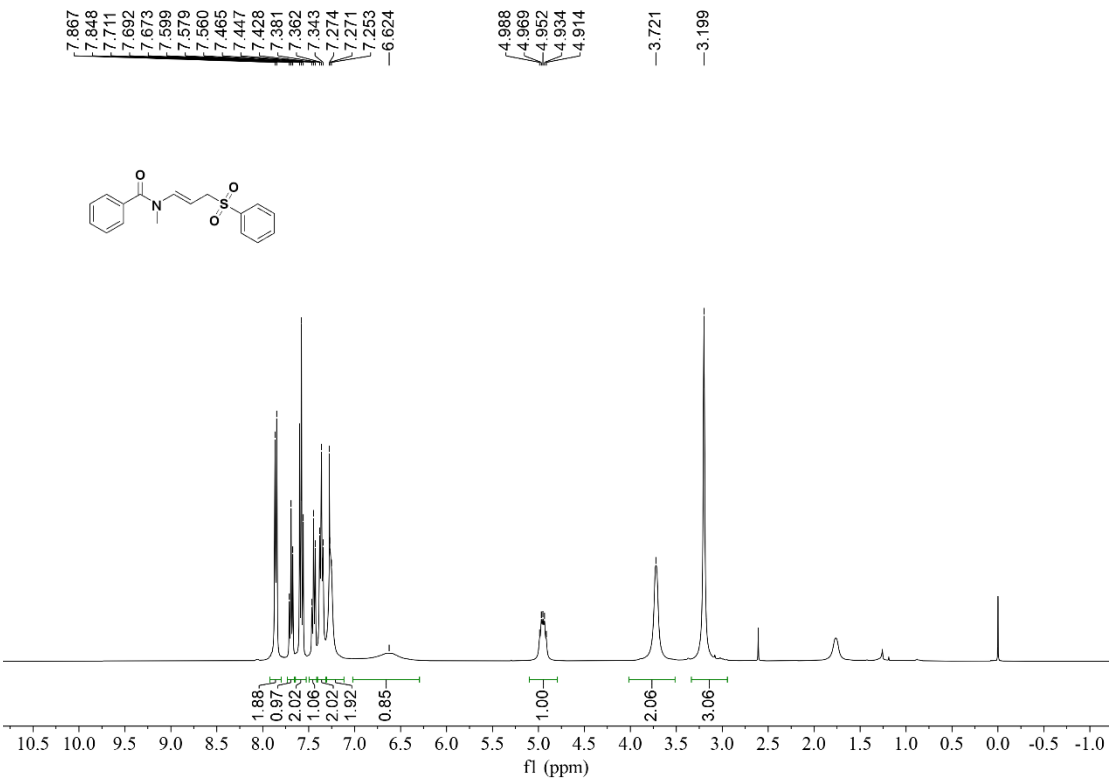


^{1}H NMR Spectrum of Compound **3ab**

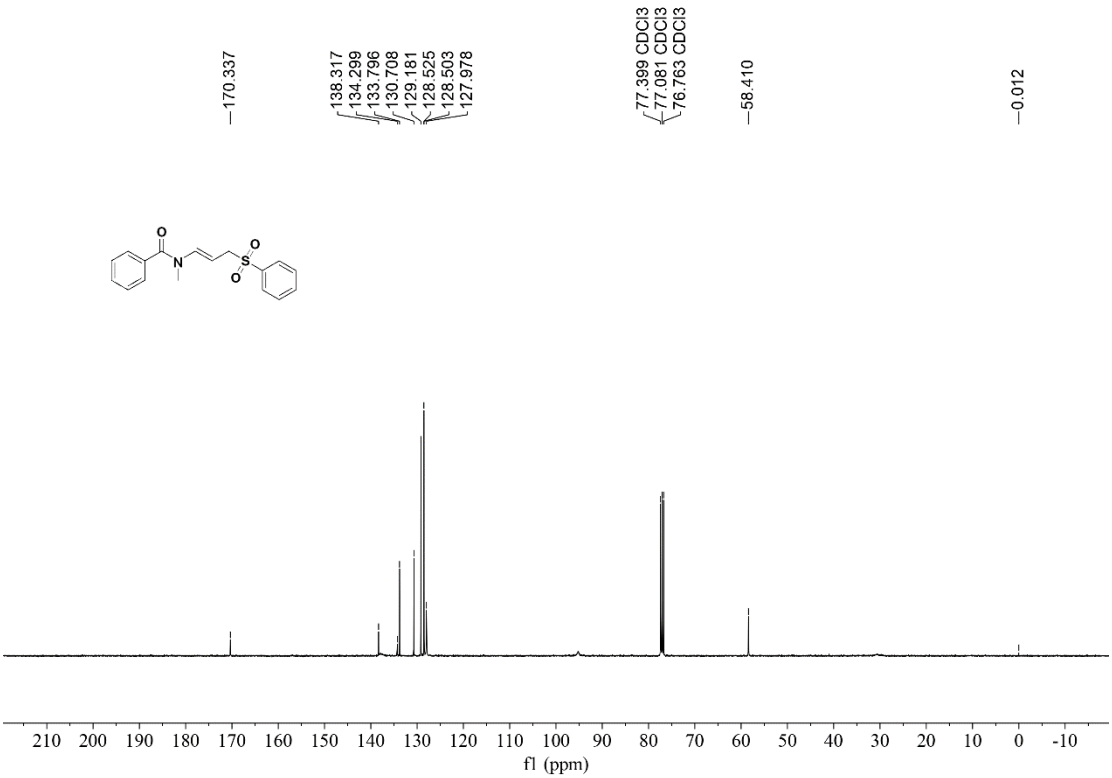


^{13}C NMR Spectrum of Compound **3ab**

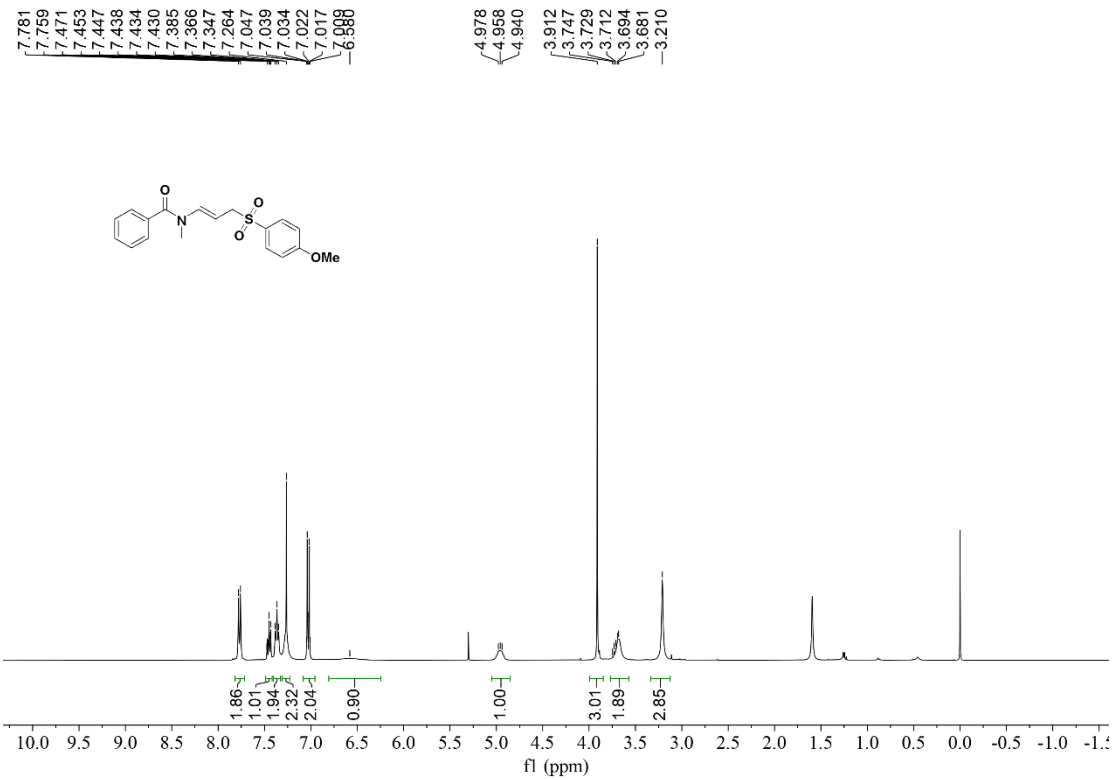
Copies of ^{1}H, ^{13}C NMR and ^{19}F NMR Spectra of Products 4a-4j



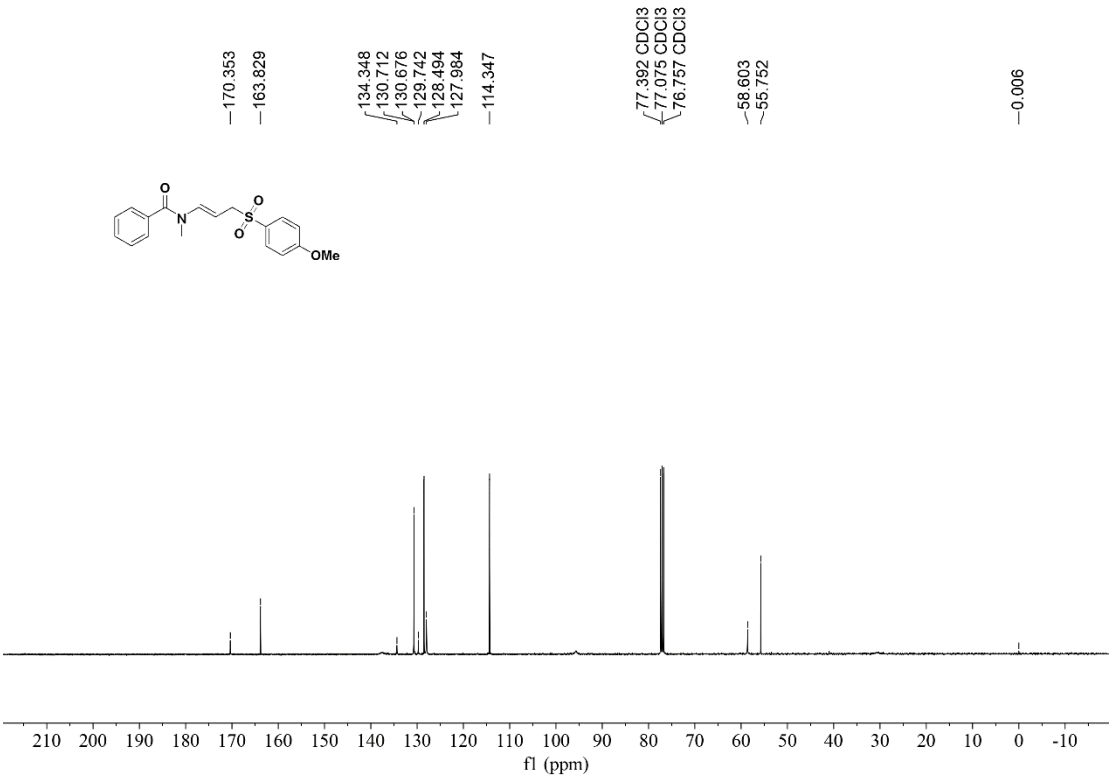
^{1}H NMR Spectrum of Compound **4a**



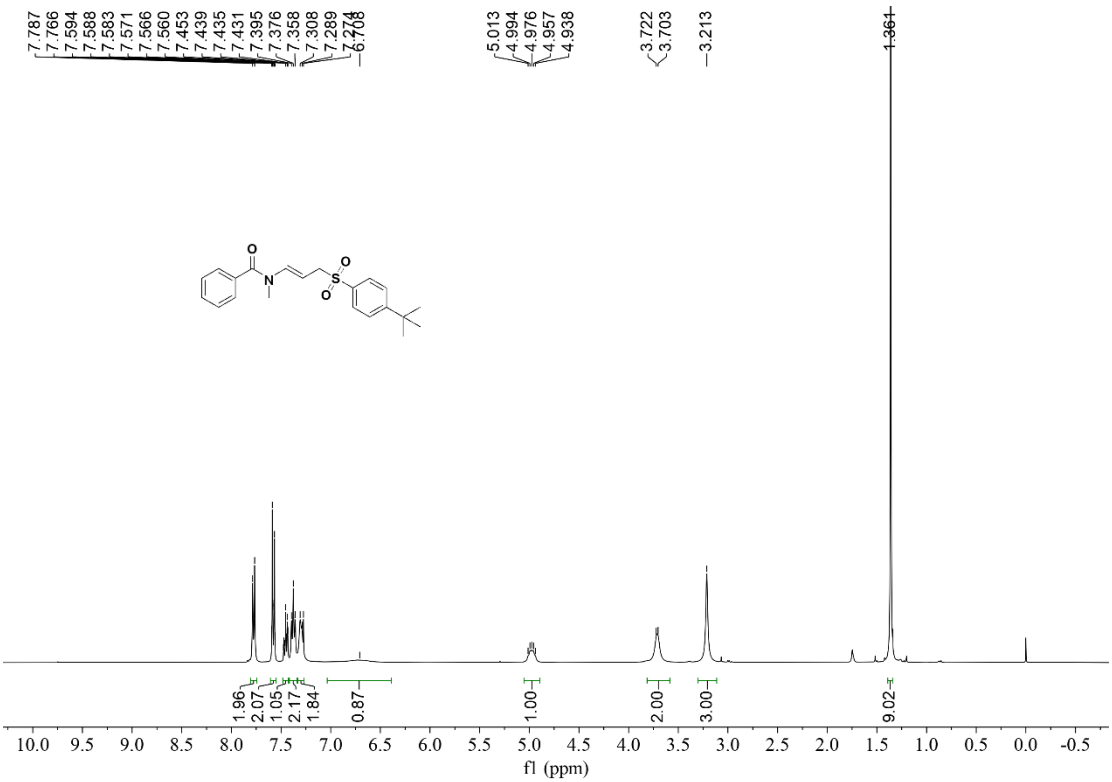
^{13}C NMR Spectrum of Compound **4a**



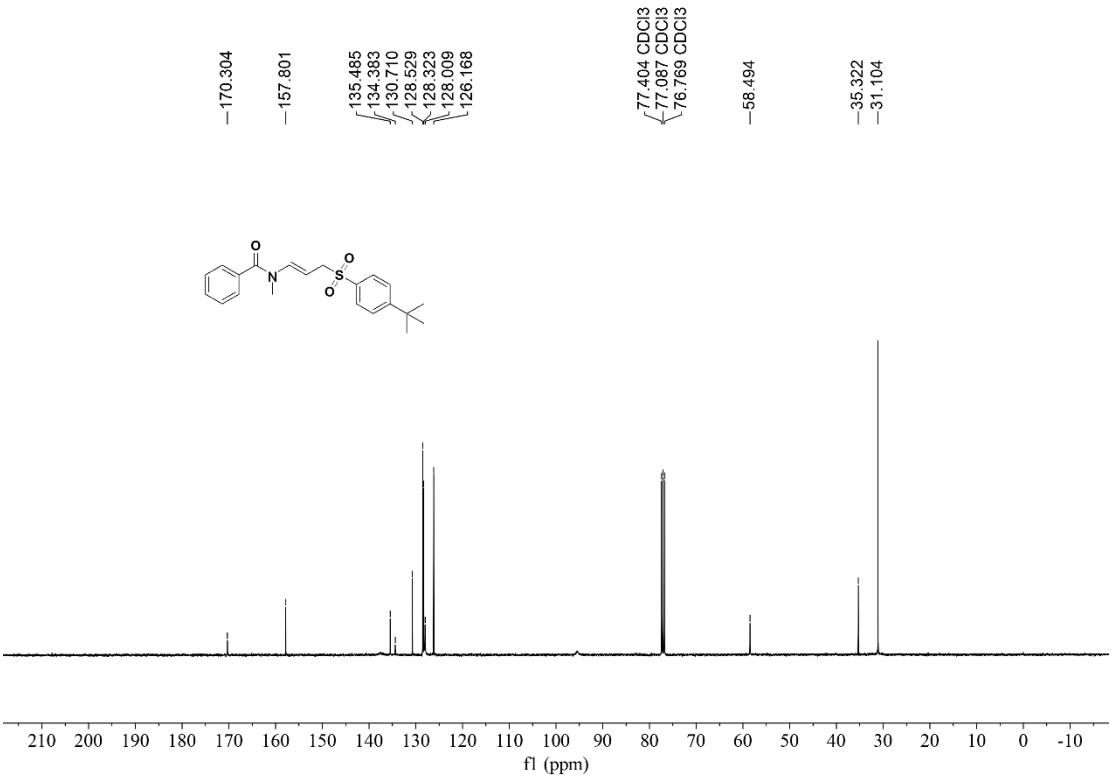
^{1}H NMR Spectrum of Compound **4b**



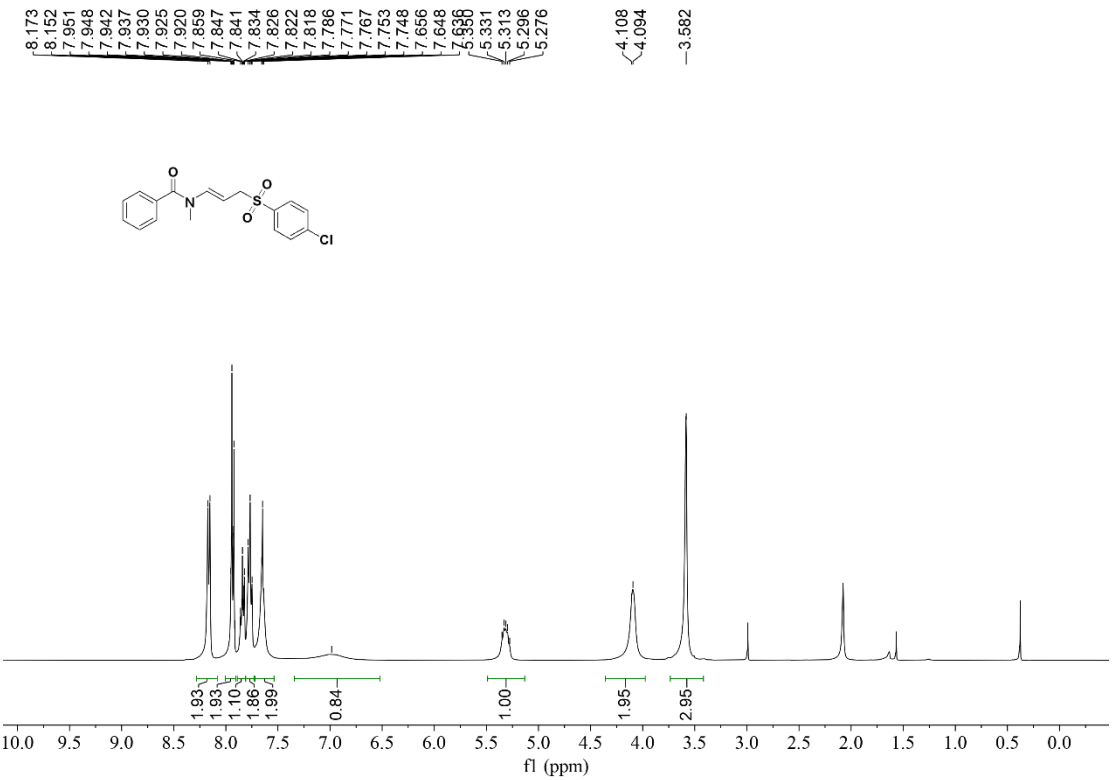
^{13}C NMR Spectrum of Compound **4b**



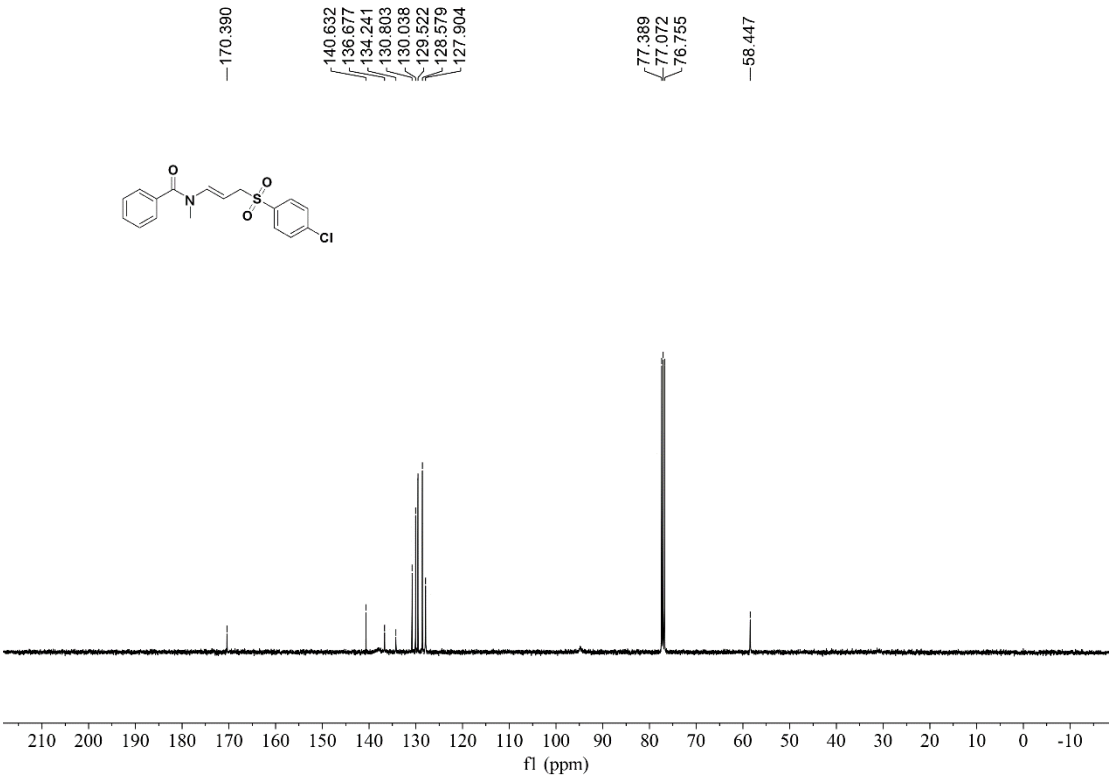
^{1}H NMR Spectrum of Compound **4c**



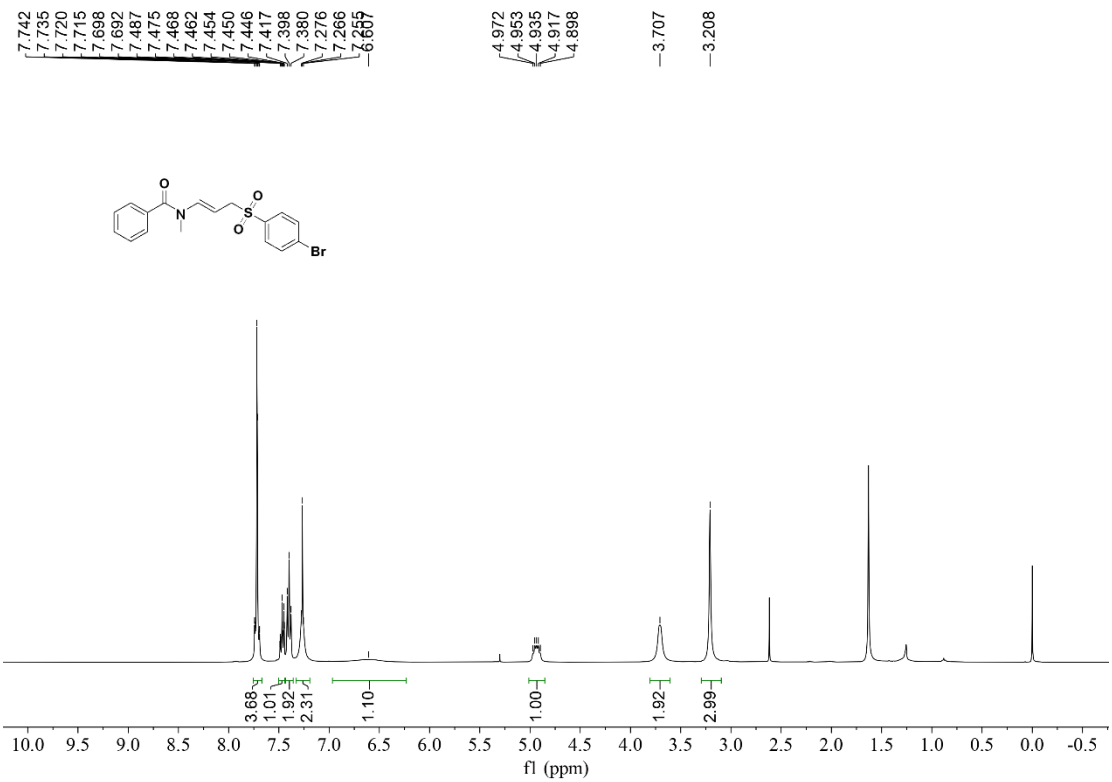
^{13}C NMR Spectrum of Compound **4c**



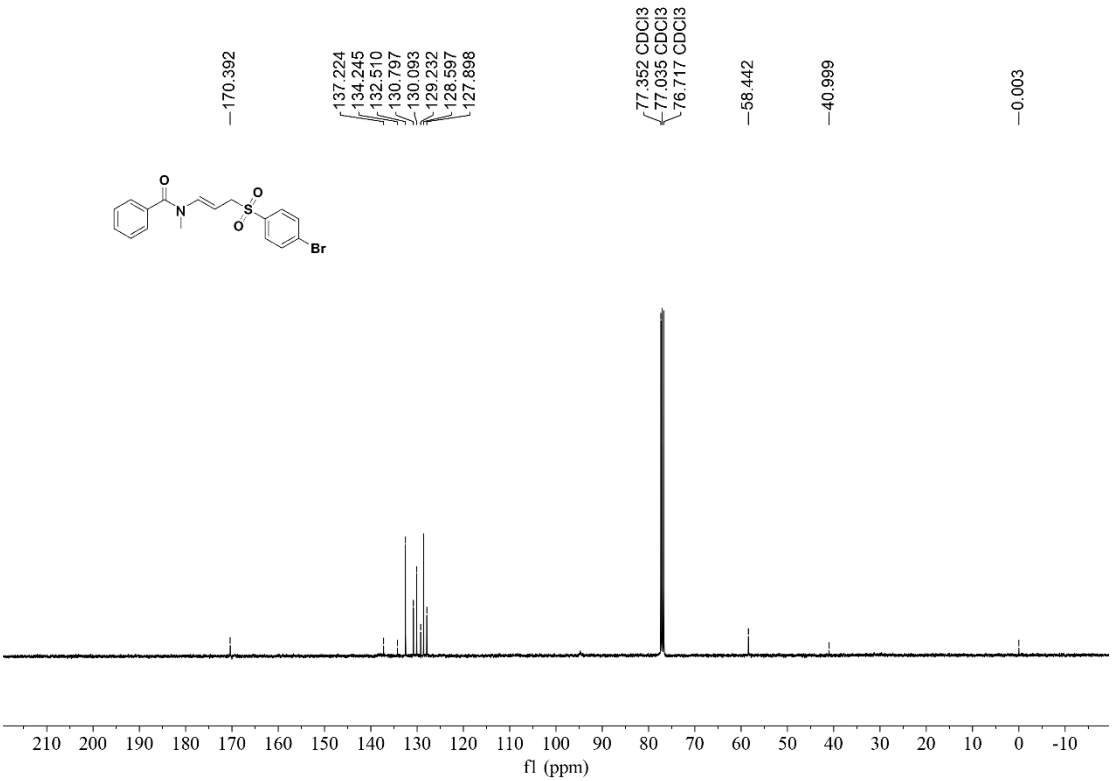
^{1}H NMR Spectrum of Compound **4d**



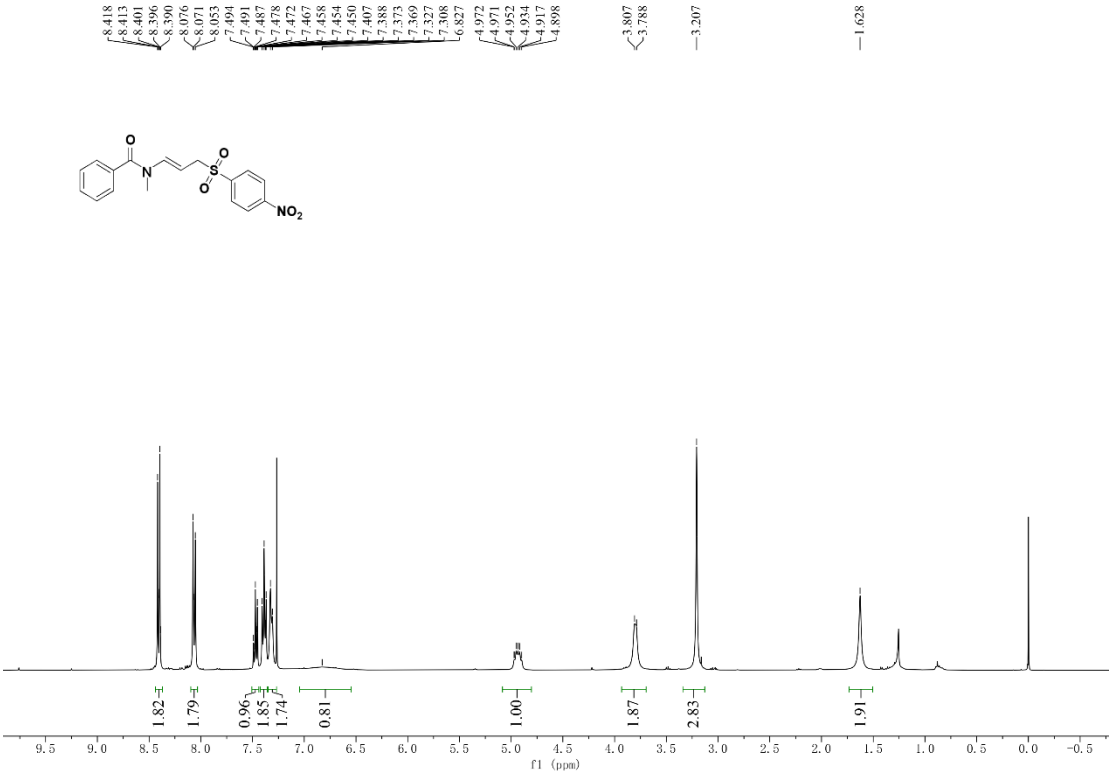
^{13}C NMR Spectrum of Compound **4d**



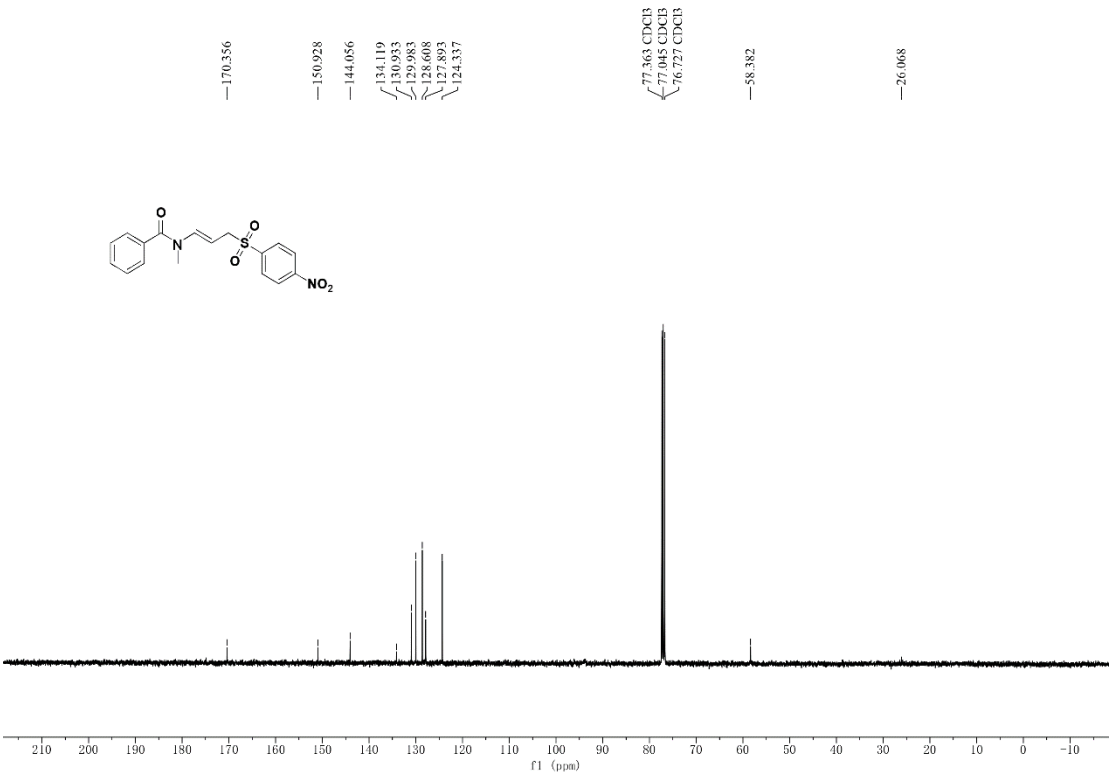
^{1}H NMR Spectrum of Compound **4e**



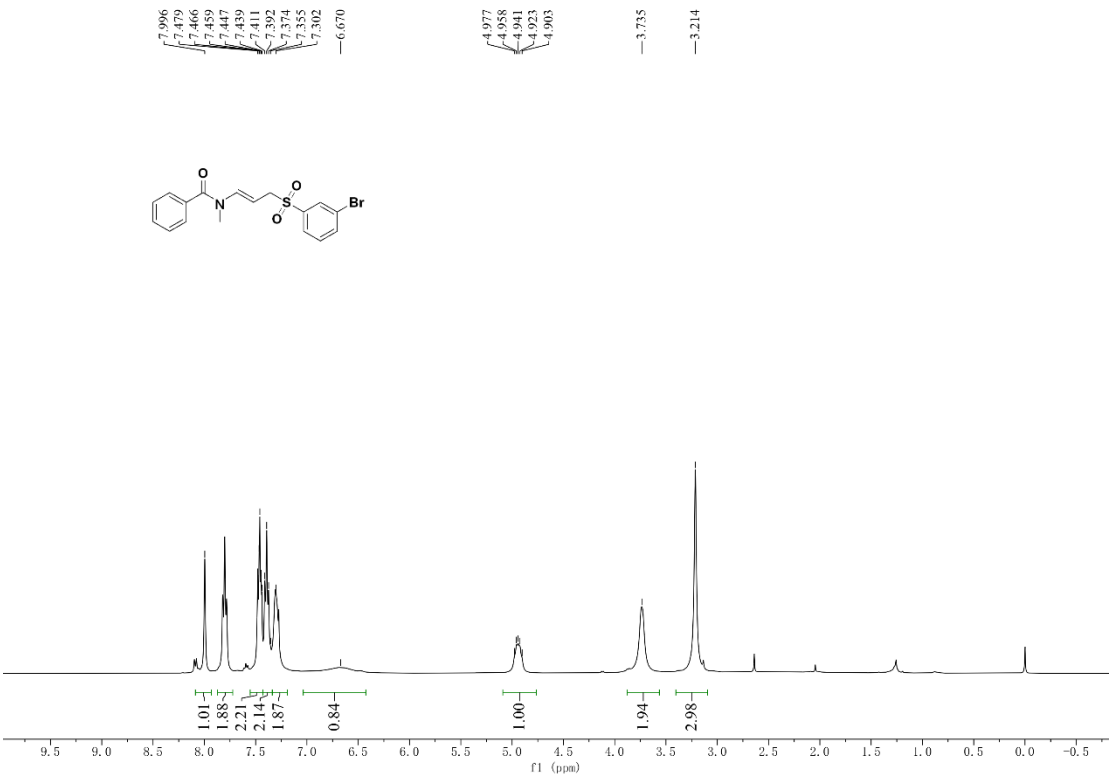
^{13}C NMR Spectrum of Compound **4e**



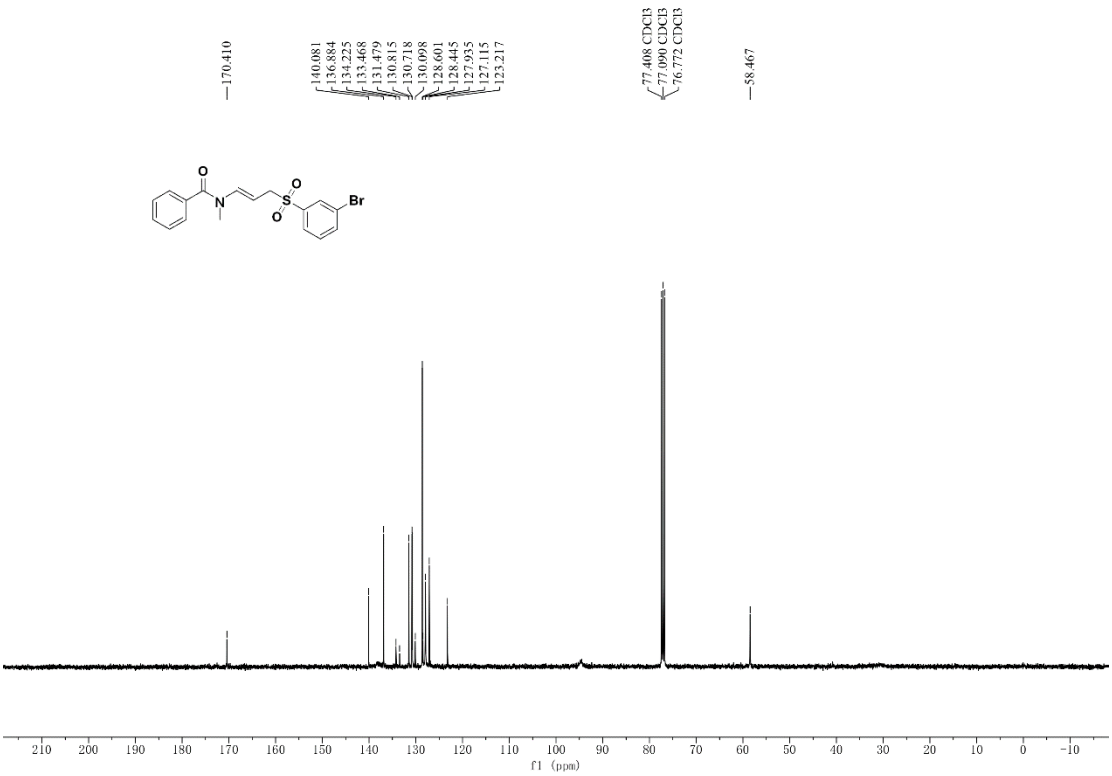
^{1}H NMR Spectrum of Compound **4f**



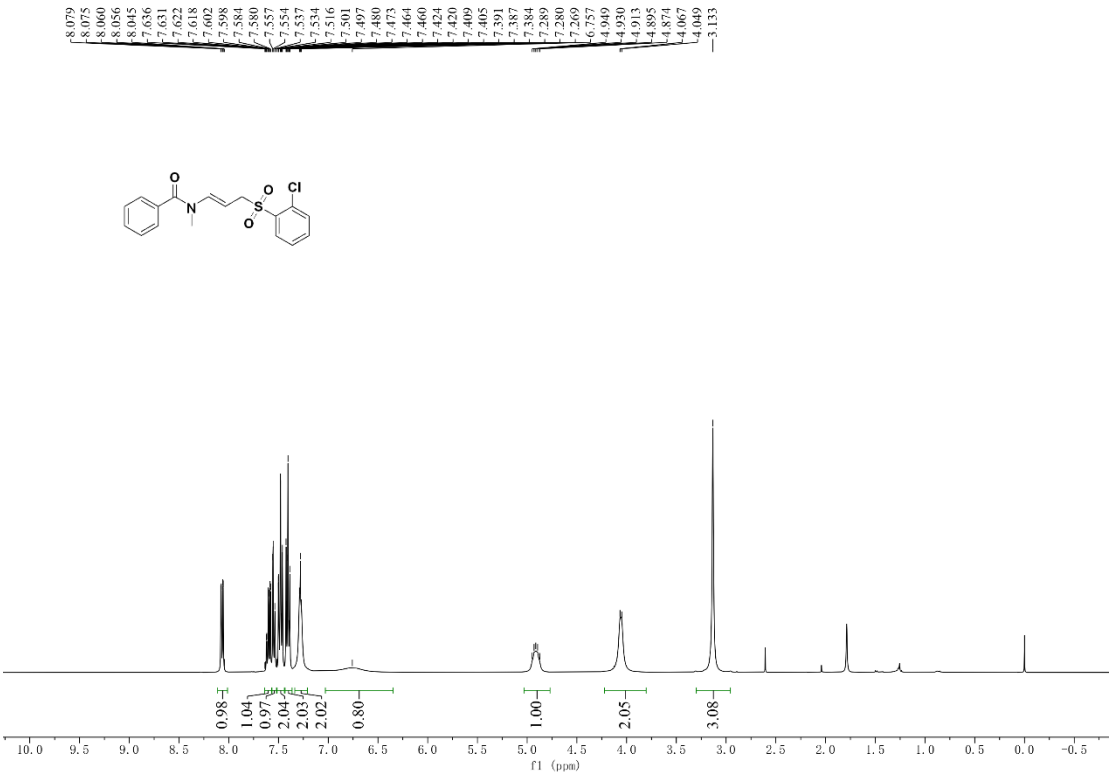
^{13}C NMR Spectrum of Compound **4f**



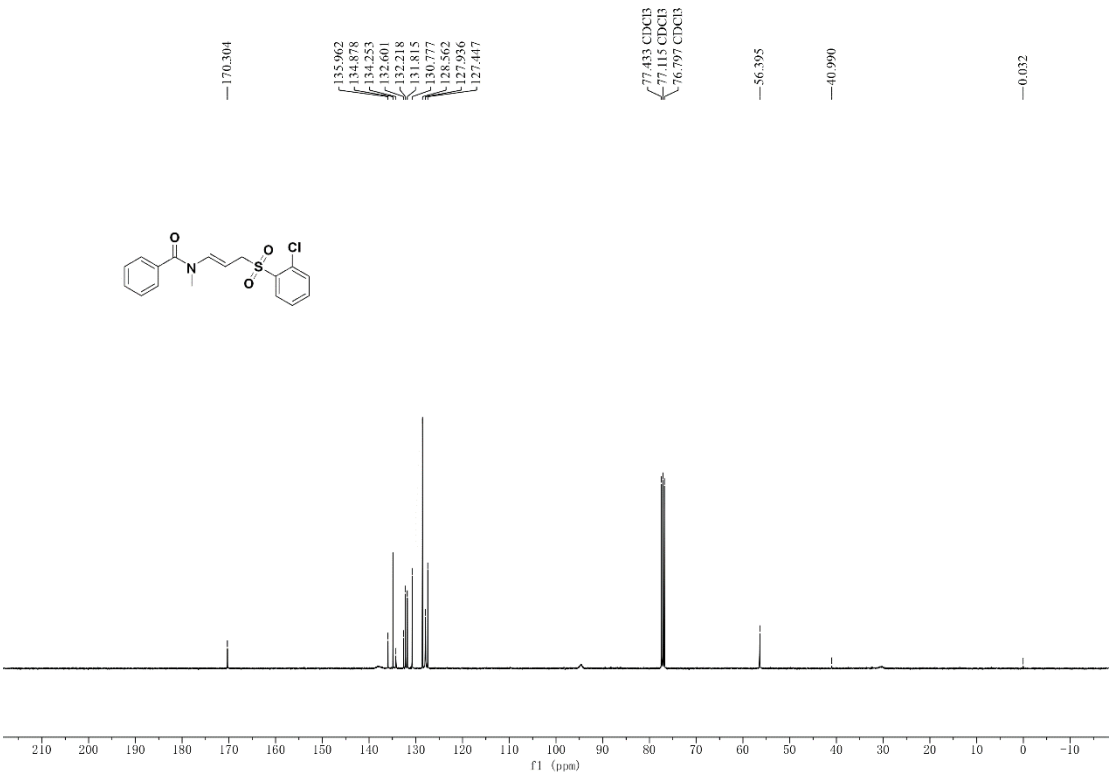
^{1}H NMR Spectrum of Compound **4g**



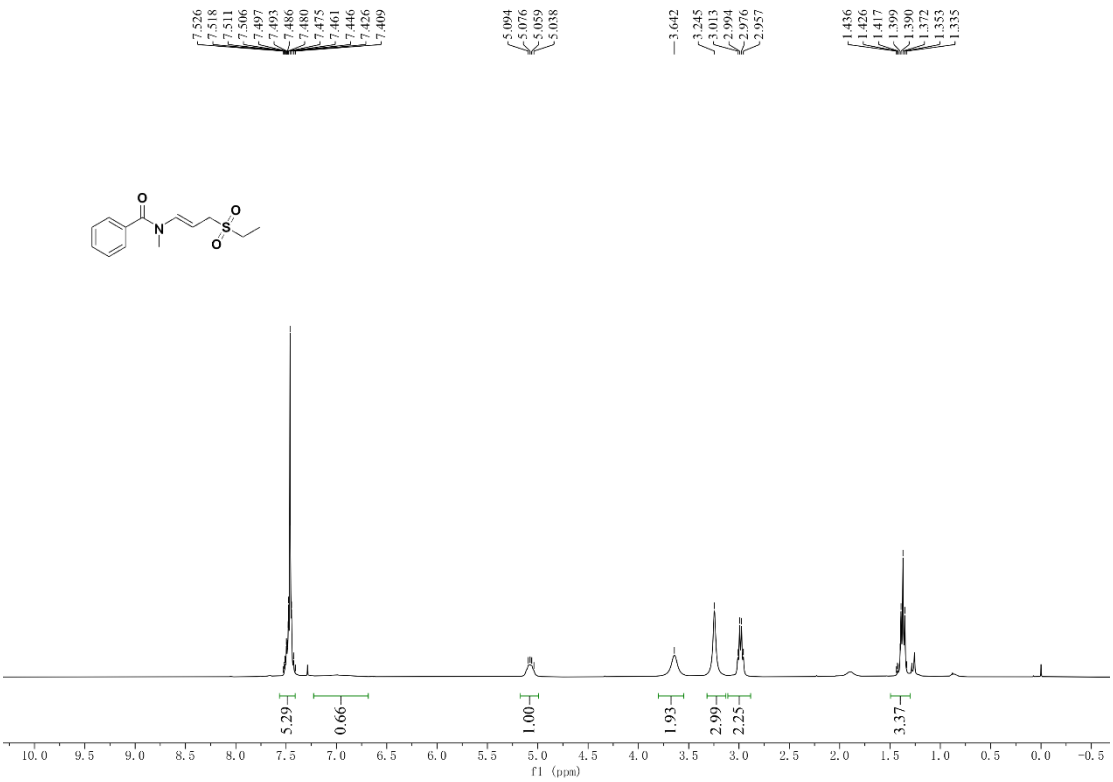
^{13}C NMR Spectrum of Compound **4g**



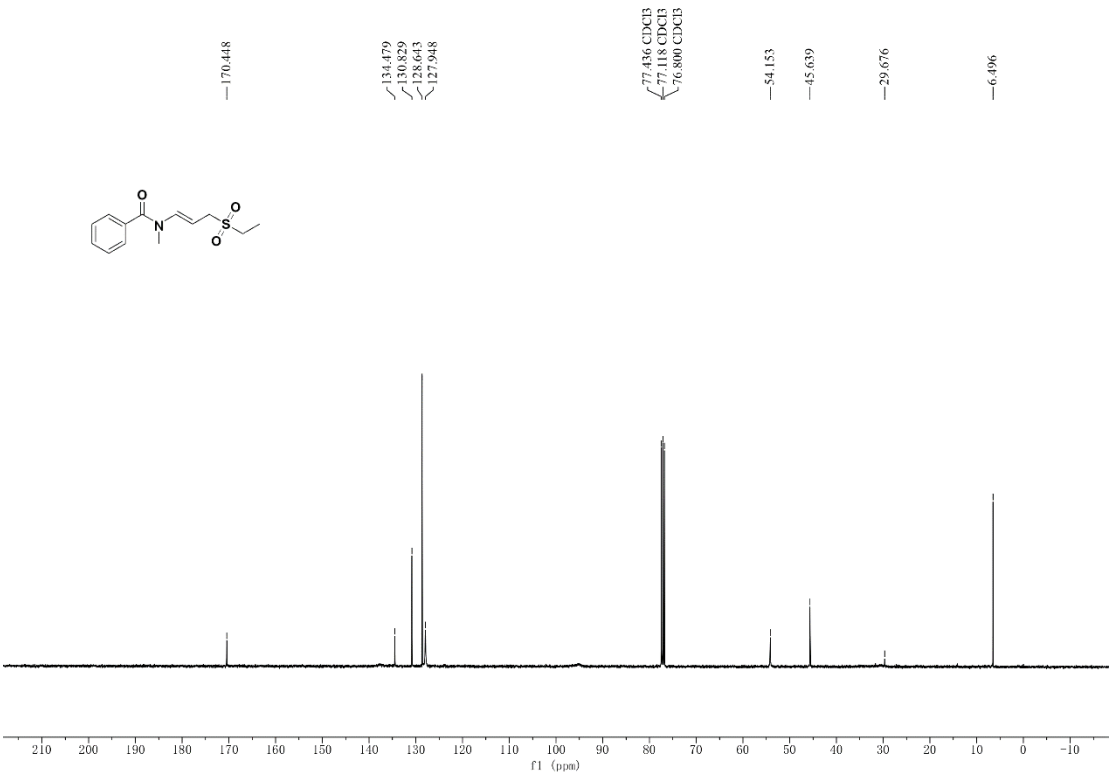
^{1}H NMR Spectrum of Compound **4h**



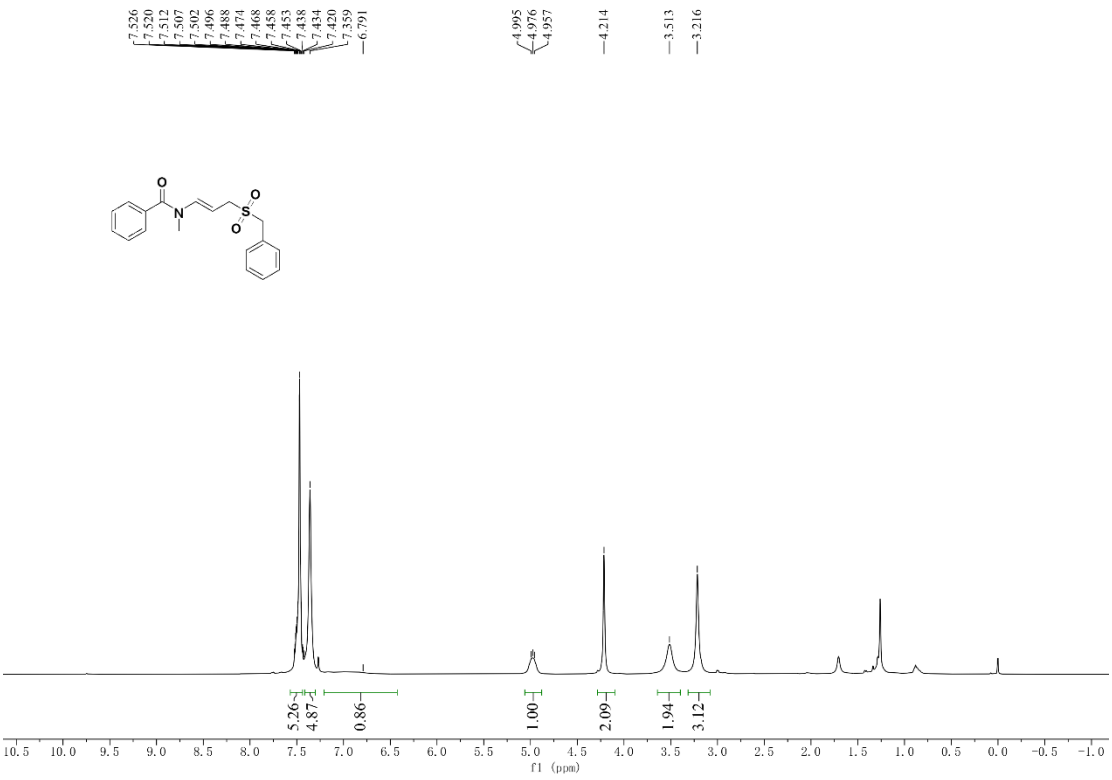
^{13}C NMR Spectrum of Compound **4h**



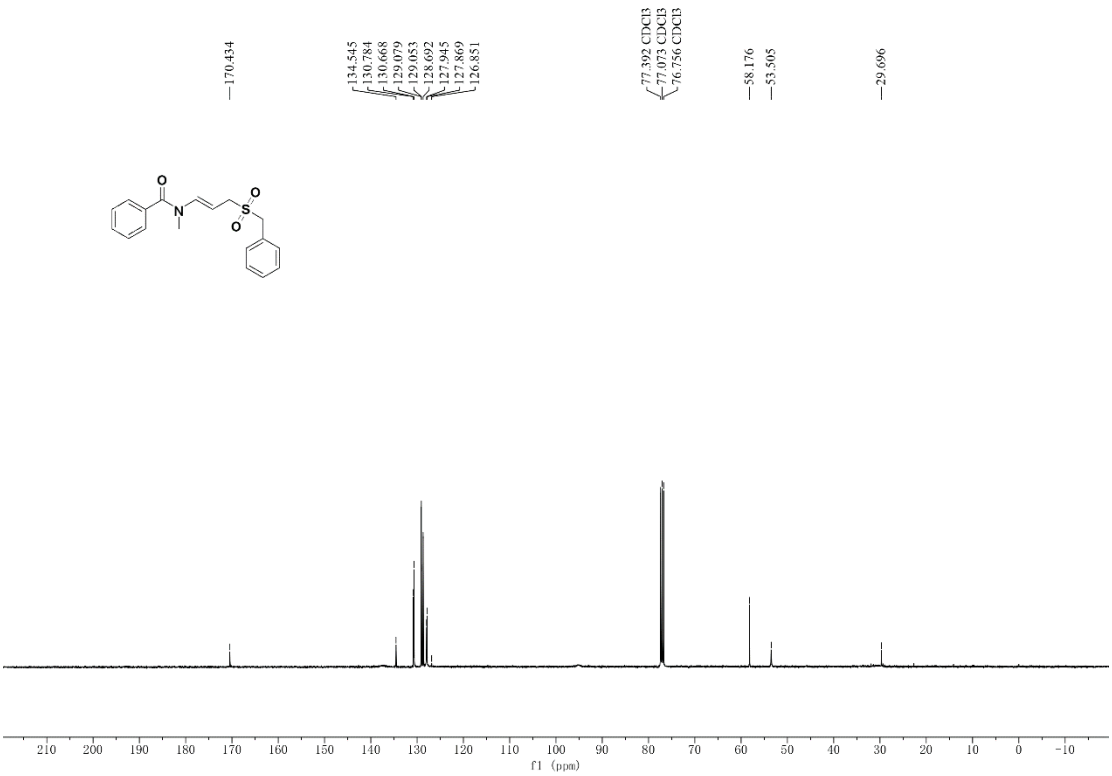
^{1}H NMR Spectrum of Compound **4i**



^{13}C NMR Spectrum of Compound **4i**



^{1}H NMR Spectrum of Compound **4j**



^{13}C NMR Spectrum of Compound **4j**