Electronic Supplementary Information for Iodine(III)-Mediated Intramolecular Sulfeno- and Selenofunctionalization of β, γ-unsaturated Tosyl Hydrazones and Oximes

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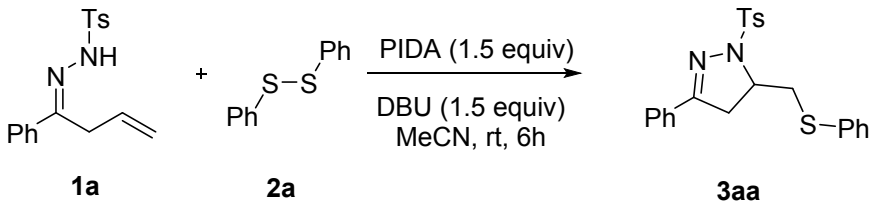
1. General Information

All chemical reagents are obtained from commercial suppliers and used without further purification. All unknown compounds are characterized by ^{1}H NMR, ^{13}C NMR, MS. Analytical thin-layer chromatography are performed on glass plates precoated with silica gel impregnated with a fluorescent indicator (254 nm), and the plates are visualized by exposure to ultraviolet light.^{1}H NMR and ^{13}C NMR spectra are recorded on an AVANCE 500 Bruker spectrometer operating at 500 MHz and 125 MHz in $CDCl_3$, respectively, and chemical shifts are reported in ppm. Multiplicities are indicated by s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), and br (broad). Mass spectra are taken on a Waters UPLC H-class LC-MS instrument in the electrospray ionization (ESI) mode. Only molecular ions (M + 1) are given for the ESI-MS analysis.

2. General Procedure

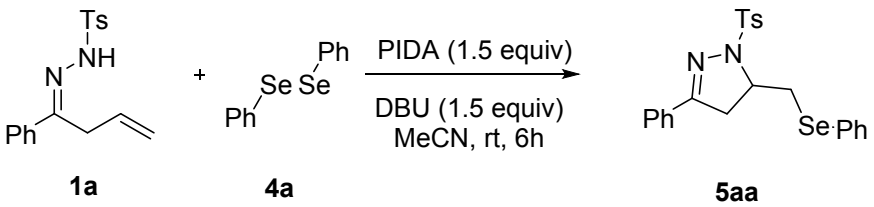
2.1 General procedure for Iodine(III)-Mediated Intramolecular Sulfenofunctionalization of β, γ-unsaturated Hydrazones



1a **2a** **3aa**

A 10 mL reaction vessel with a magnetic stirring bar was equipped with β,γ-unsaturated hydrazone (**1a**) (0.2 mmol), disulfide (**2a**) (0.15 mmol), PIDA (0.3 mmol), DBU (0.3 mmol) and MeCN (2 mL). The mixture was stirred under Ar atmosphere at r.t. for 6 h. The reaction solution was diluted with ethyl acetate, washed with water, dried over anhydrous Na_2SO_4. After the solvent had been removed under reduced pressure, the residue was purified by flash chromatography using PE-AcOEt (10:1-5:1, v/v) as the eluent to sulfer- containing pyrazoline (**3aa**).

2.2 General procedure for Iodine(III)-Mediated Intramolecular Selenofunctionalization of β, γ-unsaturated Hydrazones

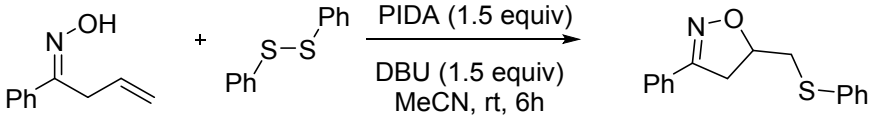


1a **4a** **5aa**

A 10 mL reaction vessel with a magnetic stirring bar was equipped with β,γ-unsaturated hydrazone (**1a**) (0.2 mmol), diselenide (**4a**) (0.15 mmol), PIDA (0.3 mmol), DBU (0.3 mmol) and MeCN (2 mL). The mixture was stirred under Ar atmosphere at r.t. for 6 h. The reaction solution was diluted with ethyl acetate, washed with water,

dried over anhydrous Na_2SO_4. After the solvent had been removed under reduced pressure, the residue was purified by flash chromatography using PE-AcOEt (10:1-5:1, v/v) as the eluent to selenium - containing pyrazoline (**5aa**).

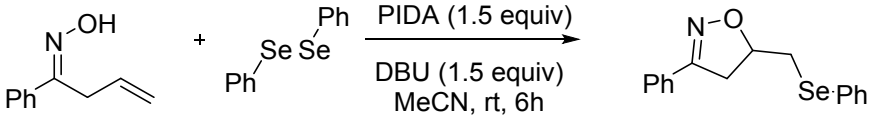
2.3 General procedure for Iodine(III)-Mediated Intramolecular Sulfenofunctionalization of β, γ-unsaturated Oximes



6a **2a** **7aa**

A 10 mL reaction vessel with a magnetic stirring bar was equipped with β,γ-unsaturated oxime (**6a**) (0.2 mmol), disulfide (**2a**) (0.15 mmol), PIDA (0.3 mmol), DBU (0.3 mmol) and MeCN (2 mL). The mixture was stirred under Ar atmosphere at r.t. for 6 h. The reaction solution was diluted with ethyl acetate, washed with water, dried over anhydrous Na_2SO_4. After the solvent had been removed under reduced pressure, the residue was purified by flash chromatography using PE-AcOEt (10:1-5:1, v/v) as the eluent to sulfer- containing isoxazoline (**7aa**).

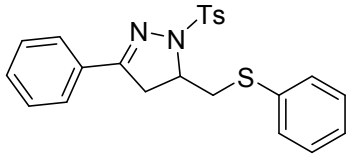
2.2 General procedure for Iodine(III)-Mediated Intramolecular Selenofunctionalization of β, γ-unsaturated Oximes



6a **4a** **8aa**

A 10 mL reaction vessel with a magnetic stirring bar was equipped with β,γ-unsaturated oxime (**6a**) (0.2 mmol), diselenide (**4a**) (0.15 mmol), PIDA (0.3 mmol), DBU (0.3 mmol) and MeCN (2 mL). The mixture was stirred under Ar atmosphere at r.t. for 6 h. The reaction solution was diluted with ethyl acetate, washed with water, dried over anhydrous Na_2SO_4. After the solvent had been removed under reduced pressure, the residue was purified by flash chromatography using PE-AcOEt (10:1-5:1, v/v) as the eluent to selenium- containing isoxazoline (**8aa**).

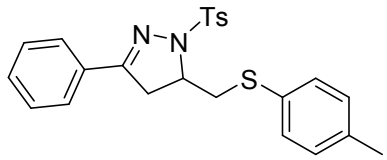
3. Characterization Data



3aa

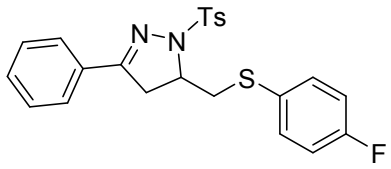
3-phenyl-5-((phenylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3aa**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.74 – 7.63 (m, 4H), 7.57 – 7.50 (m, 2H), 7.49 – 7.38 (m, 5H), 7.35 – 7.31 (m, 1H), 7.24 (d, *J* = 8.0 Hz, 2H), 4.07 (dd, *J* = 13.7, 3.2 Hz, 1H), 3.97 (tdd, *J* = 10.6, 9.2, 3.2 Hz, 1H), 3.27 (dd, *J* = 17.4, 10.8 Hz, 1H), 3.12 – 3.06 (m, 2H), 2.40 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ

156.68, 143.35, 133.37, 130.64, 129.71, 128.79, 128.55, 128.25, 127.66, 125.96, 125.72, 60.06, 38.83, 37.62, 20.61. ESI-MS *m/z*: 423 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{23}H_{22}N_2O_2S_2]$ requires $[M+H]^+$ 423.1195, found 423.1194.



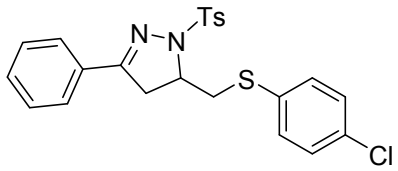
3ab

3-phenyl-5-((*p*-tolylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ab**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 – 7.67 (m, 2H), 7.64 (d, *J* = 8.1 Hz, 2H), 7.48 – 7.39 (m, 5H), 7.23 (dd, *J* = 8.2, 3.0 Hz, 4H), 4.01 (dd, *J* = 13.6, 3.2 Hz, 1H), 3.93 (qd, *J* = 10.4, 3.2 Hz, 1H), 3.27 (dd, *J* = 17.4, 10.7 Hz, 1H), 3.11 – 3.02 (m, 2H), 2.43 (s, 3H), 2.40 (s, 3H). ^{13}C NMR (125 Hz, $CDCl_3$) δ 156.70, 143.30, 135.92, 130.63, 129.69, 129.51, 128.99, 128.50, 127.65, 125.95, 60.16, 38.76, 38.19, 20.62, 20.13. ESI-MS *m/z*: 437 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{24}H_{24}N_2O_2S_2]$ requires $[M+H]^+$ 437.1352, found 437.1349.



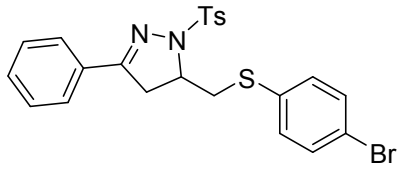
3ac

5-(((4-fluorophenyl)thio)methyl)-3-phenyl-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ac**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.72 – 7.67 (m, 2H), 7.63 (d, *J* = 8.3 Hz, 2H), 7.57 – 7.47 (m, 2H), 7.47 – 7.40 (m, 3H), 7.25 (d, *J* = 8.1 Hz, 2H), 7.14 (d, *J* = 8.7 Hz, 1H), 3.98 – 3.87 (m, 2H), 3.28 (dd, *J* = 17.3, 10.7 Hz, 1H), 3.12 – 3.06 (m, 2H), 2.41 (s, 3H). ^{19}F NMR (470 MHz, $CDCl_3$) δ -114.59. ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.61, 143.43, 131.74, 131.68, 130.59, 129.74, 128.54, 128.28, 127.67, 127.59, 125.94, 115.44, 115.27, 60.01, 38.73, 20.60. ESI-MS *m/z*: 441 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{23}H_{21}FN_2O_2S_2]$ requires $[M+H]^+$ 441.1101, found 441.1099.



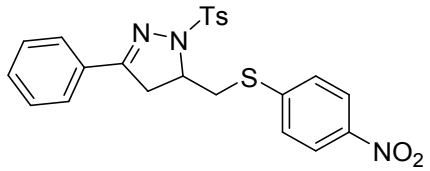
3ad

5-(((4-chlorophenyl)thio)methyl)-3-phenyl-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ad**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.72 – 7.63 (m, 4H), 7.51 – 7.34 (m, 7H), 7.26 (d, *J* = 8.1 Hz, 2H), 3.99 (dd, *J* = 13.7, 3.1 Hz, 1H), 3.92 (qd, *J* = 10.3, 3.1 Hz, 1H), 3.27 (dd, *J* = 17.4, 10.8 Hz, 1H), 3.12 – 3.05 (m, 2H), 2.41 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.62, 143.49, 131.95, 130.60, 130.19, 129.77, 129.61, 128.60, 128.36, 127.68, 127.60, 125.96, 59.84, 38.76, 37.90, 20.63. ESI-MS *m/z*: 457 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{23}H_{21}ClN_2O_2S_2]$ requires $[M+H]^+$ 457.0806, found 457.0808.



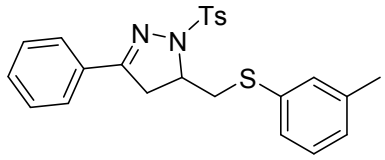
3ae

5-(((4-bromophenyl)thio)methyl)-3-phenyl-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ae**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 – 7.68 (m, 2H), 7.66 (d, *J* = 8.2 Hz, 2H), 7.54 (d, *J* = 8.5 Hz, 2H), 7.49 – 7.37 (m, 5H), 7.27 (d, *J* = 8.0 Hz, 2H), 4.00 (dd, *J* = 13.7, 3.1 Hz, 1H), 3.92 (tdd, *J* = 10.5, 9.3, 3.1 Hz, 1H), 3.28 (dd, *J* = 17.4, 10.8 Hz, 1H), 3.12 – 3.05 (m, 2H), 2.41 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.60, 143.50, 132.62, 131.28, 130.55, 130.34, 129.78, 129.59, 128.62, 127.68, 127.60, 125.95, 119.66, 59.79, 38.76, 37.71, 20.63. ESI-MS *m/z*: 501 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{23}H_{21}BrN_2O_2S_2]$ requires $[M+H]^+$ 501.0301, found 501.0299.



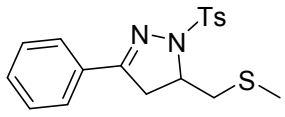
3af

5-(((4-nitrophenyl)thio)methyl)-3-phenyl-1-tosyl-4,5-dihydro-1*H*-pyrazole **3af**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.19 – 8.15 (m, 2H), 7.70 (d, *J* = 8.2 Hz, 2H), 7.64 – 7.56 (m, 3H), 7.51 (d, *J* = 8.9 Hz, 2H), 7.42 – 7.32 (m, 3H), 7.21 (s, 1H), 4.09 – 3.96 (m, 2H), 3.27 – 3.15 (m, 2H), 3.04 (dd, *J* = 17.4, 8.6 Hz, 1H), 2.33 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.55, 144.11, 143.75, 130.77, 129.92, 129.39, 128.74, 127.74, 127.55, 125.95, 125.44, 123.48, 123.22, 59.13, 38.78, 36.12, 20.62. ESI-MS *m/z*: 468 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{23}H_{21}N_3O_4S_2]$ requires $[M+H]^+$ 468.1046, found 468.1043.



3ag

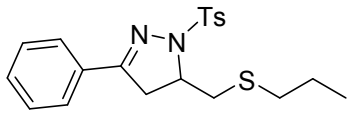
3-phenyl-5-((*m*-tolylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ag**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.76 – 7.59 (m, 4H), 7.48 – 7.39 (m, 3H), 7.35 – 7.29 (m, 3H), 7.24 (d, *J* = 8.0 Hz, 2H), 7.13 (d, *J* = 6.7 Hz, 1H), 4.07 (dd, *J* = 13.7, 3.2 Hz, 1H), 3.98 (tdd, *J* = 10.7, 9.2, 3.2 Hz, 1H), 3.27 (dd, *J* = 17.4, 10.8 Hz, 1H), 3.12 – 3.03 (m, 2H), 2.44 (s, 3H), 2.40 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.65, 143.28, 138.09, 130.74, 129.69, 129.08, 128.51, 128.06, 127.63, 126.47, 125.95, 125.57, 60.03, 38.83, 37.44, 20.59. ESI-MS *m/z*: 437 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{24}H_{24}N_2O_2S_2]$ requires $[M+H]^+$ 437.1352, found 437.1349.



3ah

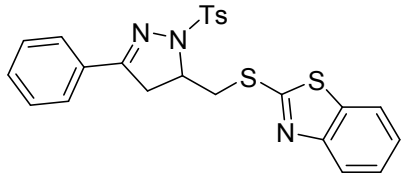
5-((methylthio)methyl)-3-phenyl-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ah**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.3 Hz, 2H), 7.74 – 7.69 (m, 2H), 7.49 – 7.40 (m, 3H), 7.33 (d, *J* = 8.1

Hz, 2H), 4.12 (dtd, *J* = 10.6, 9.0, 3.2 Hz, 1H), 3.30 (dd, *J* = 13.6, 3.2 Hz, 1H), 3.26 – 3.16 (m, 2H), 3.01 (dd, *J* = 13.5, 8.9 Hz, 1H), 2.44 (s, 3H), 2.31 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.85, 143.40, 131.10, 129.67, 128.63, 127.64, 125.98, 60.44, 38.46, 38.32, 20.63, 15.24. ESI-MS *m/z*: 361 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{18}H_{20}N_2O_2S_2]$ requires $[M+H]^+$ 361.1039, found 361.1041.



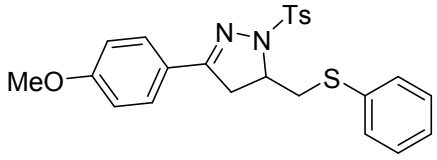
3ai

3-phenyl-5-((propylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ai**, colorless oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.4 Hz, 2H), 7.74 – 7.69 (m, 2H), 7.47 – 7.40 (m, 3H), 7.33 (d, *J* = 8.0 Hz, 2H), 4.08 (dtd, *J* = 10.7, 9.2, 3.3 Hz, 1H), 3.34 (dd, *J* = 13.4, 3.3 Hz, 1H), 3.25 (dd, *J* = 17.3, 10.7 Hz, 1H), 3.16 (dd, *J* = 17.3, 9.1 Hz, 1H), 2.98 (dd, *J* = 13.4, 9.3 Hz, 1H), 2.69 (t, *J* = 7.3 Hz, 2H), 2.44 (s, 3H), 1.74 (dt, *J* = 14.6, 7.3 Hz, 2H), 1.07 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.81, 143.37, 131.11, 129.80, 129.65, 128.61, 127.64, 125.98, 60.73, 38.44, 36.30, 33.75, 22.12, 20.63, 12.43. ESI-MS *m/z*: 389 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{20}H_{24}N_2O_2S_2]$ requires $[M+H]^+$ 389.1352, found 389.1353.



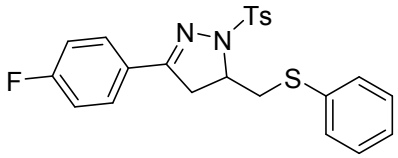
3aj

2-(((3-phenyl-1-tosyl-4,5-dihydro-1*H*-pyrazol-5-yl)methyl)thio)benzo[*d*]thiazole **3aj**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00 – 7.94 (m, 1H), 7.94 – 7.89 (m, 2H), 7.87 – 7.79 (m, 1H), 7.71 – 7.66 (m, 2H), 7.51 (ddd, *J* = 8.4, 7.3, 1.2 Hz, 1H), 7.47 – 7.36 (m, 4H), 7.30 (d, *J* = 8.0 Hz, 2H), 4.50 – 4.39 (m, 2H), 3.72 – 3.65 (m, 1H), 3.28 (dd, *J* = 9.9, 2.9 Hz, 2H), 2.42 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 164.47, 156.81, 152.06, 143.48, 134.65, 130.79, 129.72, 129.61, 128.61, 127.84, 127.64, 125.99, 125.23, 123.57, 120.60, 120.17, 60.30, 38.23, 36.65, 20.63. ESI-MS *m/z*: 480 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{24}H_{21}N_3O_2S_3]$ requires $[M+H]^+$ 480.0869, found 480.0867.



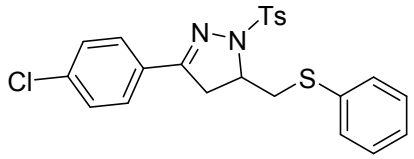
3ba

3-(4-methoxyphenyl)-5-((phenylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ba**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 – 7.60 (m, 4H), 7.56 – 7.50 (m, 2H), 7.42 (dd, *J* = 8.4, 7.0 Hz, 2H), 7.35 – 7.30 (m, 1H), 7.23 (d, *J* = 8.1 Hz, 2H), 6.95 – 6.90 (m, 2H), 4.06 (dd, *J* = 13.7, 3.2 Hz, 1H), 3.93 (tdd, *J* = 10.6, 9.1, 3.2 Hz, 1H), 3.87 (d, *J* = 0.6 Hz, 3H), 3.23 (dd, *J* = 17.3, 10.7 Hz, 1H), 3.10 – 3.02 (m, 2H), 2.39 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 160.63, 156.45, 143.22, 133.41, 130.57, 128.70, 128.48, 128.22, 127.67, 127.60, 125.65, 122.31, 113.05, 59.87, 54.42, 38.90, 37.59, 20.59. ESI-MS *m/z*: 453 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{24}H_{24}N_2O_3S_2]$ requires $[M+H]^+$ 453.1301, found 453.1299.



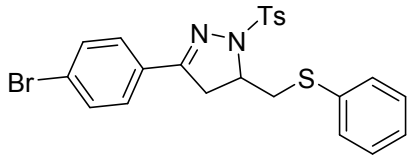
3ca

3-(4-fluorophenyl)-5-((phenylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ca**, light yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 – 7.62 (m, 4H), 7.56 – 7.50 (m, 2H), 7.42 (dd, *J* = 8.5, 6.9 Hz, 2H), 7.35 – 7.31 (m, 1H), 7.24 (d, *J* = 8.1 Hz, 2H), 7.15 – 7.06 (m, 2H), 4.06 (dd, *J* = 13.7, 3.2 Hz, 1H), 3.97 (tdd, *J* = 10.6, 9.3, 3.2 Hz, 1H), 3.25 (dd, *J* = 17.4, 10.8 Hz, 1H), 3.11 – 3.04 (m, 2H), 2.40 (s, 3H). ^{19}F NMR (470 MHz, $CDCl_3$) δ -108.76. ^{13}C NMR (125 MHz, $CDCl_3$) δ 164.19, 162.19, 155.62, 143.40, 133.28, 130.60, 128.79, 128.54, 128.24, 128.00, 127.93, 127.63, 125.96, 125.75, 114.92, 114.75, 60.12, 38.85, 37.56, 20.61. ESI-MS *m/z*: 441 [M+1] $^{+}$. HRMS (ESI) Calcd for [$C_{23}H_{21}FN_2O_2S_2$] requires [M+H]$^{+}$ 441.1101, found 441.1099.



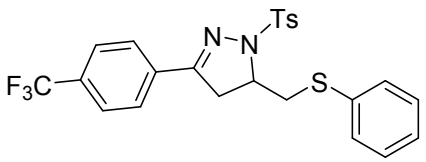
3da

3-(4-chlorophenyl)-5-((phenylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3da**, yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.58 (dd, *J* = 16.2, 8.0 Hz, 4H), 7.47 (d, *J* = 7.7 Hz, 2H), 7.39 – 7.31 (m, 4H), 7.28 (d, *J* = 7.4 Hz, 1H), 7.19 (d, *J* = 7.9 Hz, 2H), 4.00 (dd, *J* = 13.7, 3.1 Hz, 1H), 3.92 (qd, *J* = 10.4, 3.2 Hz, 1H), 3.19 (dd, *J* = 17.4, 10.8 Hz, 1H), 3.07 – 2.96 (m, 2H), 2.35 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.58, 143.47, 135.80, 133.24, 130.55, 128.80, 128.58, 128.26, 127.96, 127.61, 127.16, 125.77, 60.20, 38.70, 37.54, 20.62. ESI-MS *m/z*: 457 [M+1] $^{+}$. HRMS (ESI) Calcd for [$C_{23}H_{21}ClN_2O_2S_2$] requires [M+H]$^{+}$ 457.0806, found 457.0808.



3ea

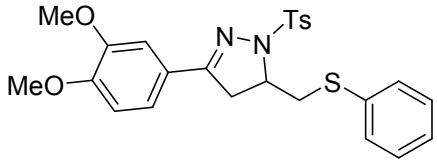
3-(4-bromophenyl)-5-((phenylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ea**, yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.59 (d, *J* = 8.2 Hz, 2H), 7.52 – 7.44 (m, 6H), 7.37 (t, *J* = 7.7 Hz, 2H), 7.29 (d, *J* = 7.4 Hz, 1H), 7.19 (d, *J* = 8.1 Hz, 2H), 4.01 (dd, *J* = 13.8, 3.2 Hz, 1H), 3.92 (tdd, *J* = 10.7, 9.3, 3.2 Hz, 1H), 3.20 (dd, *J* = 17.4, 10.8 Hz, 1H), 3.08 – 2.96 (m, 2H), 2.35 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.65, 143.48, 133.23, 130.92, 130.55, 128.80, 128.58, 128.26, 127.60, 127.35, 125.77, 124.20, 60.22, 38.65, 37.54, 20.62. ESI-MS *m/z*: 501 [M+1] $^{+}$. HRMS (ESI) Calcd for [$C_{23}H_{21}BrN_2O_2S_2$] requires [M+H]$^{+}$ 501.0301, found 501.0299.



3fa

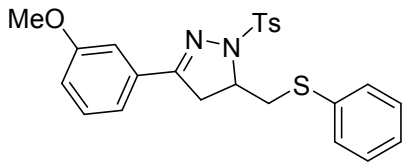
5-((phenylthio)methyl)-1-tosyl-3-(4-(trifluoromethyl)phenyl)-4,5-dihydro-1*H*-pyrazole **3fa**, colorless oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79 (d, *J* = 8.3 Hz, 2H), 7.66 (dd, *J* = 8.1, 5.7 Hz, 4H), 7.58 – 7.49 (m, 2H), 7.42 (t, *J* = 7.5 Hz, 2H), 7.37 – 7.32 (m, 1H), 7.25 (d, *J* = 8.0 Hz, 2H), 4.10 – 3.97 (m, 2H), 3.30

(dd, *J* = 17.5, 10.7 Hz, 1H), 3.15 – 3.06 (m, 2H), 2.40 (s, 3H). ^{19}F NMR (470 MHz, $CDCl_3$) δ -62.92. ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.14, 143.59, 133.18, 130.62, 128.88, 128.64, 128.29, 127.58, 126.16, 125.85, 124.65, 60.40, 38.63, 37.57, 20.62. ESI-MS *m/z*: 491 [M+1] $^+$. HRMS (ESI) Calcd for [$C_{24}H_{21}F_3N_2O_2S_2$] requires [M+H]$^+$ 491.1069, found 491.1068.



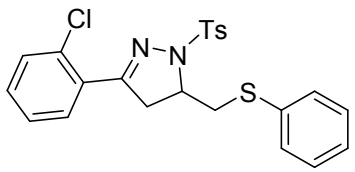
3ga

3-(3,4-dimethoxyphenyl)-5-((phenylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ga**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.70 – 7.62 (m, 2H), 7.57 – 7.50 (m, 2H), 7.45 – 7.36 (m, 3H), 7.35 – 7.30 (m, 1H), 7.23 (d, *J* = 8.0 Hz, 2H), 7.07 (dd, *J* = 8.3, 2.0 Hz, 1H), 6.85 (d, *J* = 8.3 Hz, 1H), 4.05 (dd, *J* = 13.7, 3.2 Hz, 1H), 3.98 (s, 3H), 3.94 (s, 4H), 3.24 (dd, *J* = 17.3, 10.7 Hz, 1H), 3.10 – 3.01 (m, 2H), 2.39 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.61, 150.48, 148.17, 143.28, 133.36, 130.53, 128.71, 128.49, 128.23, 127.65, 125.67, 122.58, 119.86, 109.46, 108.02, 59.91, 55.20, 55.00, 38.86, 37.61, 20.59. ESI-MS *m/z*: 483 [M+1] $^+$. HRMS (ESI) Calcd for [$C_{25}H_{26}N_2O_4S_2$] requires [M+H]$^+$ 483.1407, found 483.1406.



3ha

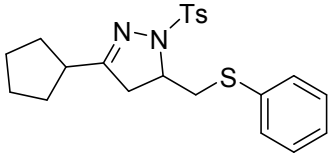
3-(3-methoxyphenyl)-5-((phenylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ha**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.62 (d, *J* = 8.3 Hz, 2H), 7.52 – 7.45 (m, 2H), 7.38 (dd, *J* = 8.5, 6.9 Hz, 2H), 7.31 – 7.26 (m, 2H), 7.19 (d, *J* = 8.1 Hz, 2H), 7.16 (dt, *J* = 7.6, 1.2 Hz, 1H), 6.96 (ddd, *J* = 8.2, 2.6, 1.0 Hz, 1H), 4.01 (dd, *J* = 13.7, 3.2 Hz, 1H), 3.95 – 3.88 (m, 1H), 3.83 (s, 3H), 3.21 (dd, *J* = 17.4, 10.8 Hz, 1H), 3.06 – 3.00 (m, 2H), 2.35 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 158.72, 156.69, 143.38, 133.33, 130.97, 130.53, 128.78, 128.66, 128.55, 128.24, 127.61, 125.71, 118.64, 115.88, 110.70, 60.06, 54.50, 38.89, 37.60, 20.61. ESI-MS *m/z*: 453 [M+1] $^+$. HRMS (ESI) Calcd for [$C_{24}H_{24}N_2O_3S_2$] requires [M+H]$^+$ 453.1301, found 453.1299.



3ia

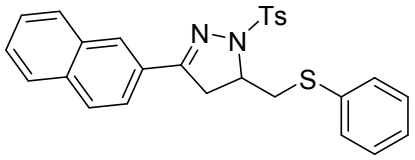
3-(2-chlorophenyl)-5-((phenylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ia**, light yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 – 7.60 (m, 2H), 7.56 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.52 – 7.44 (m, 2H), 7.40 – 7.32 (m, 3H), 7.32 – 7.21 (m, 5H), 4.07 – 3.87 (m, 2H), 3.35 (dd, *J* = 17.9, 10.4 Hz, 1H), 3.24 (dd, *J* = 17.9, 9.7 Hz, 1H), 3.10 (dd, *J* = 13.7, 10.3 Hz, 1H), 2.40 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.83, 143.50, 133.45, 131.88, 130.64, 130.15, 129.61, 129.53, 129.18, 128.95, 128.56, 128.23,

127.75, 125.89, 125.75, 60.72, 41.81, 37.58, 20.64. ESI-MS *m/z*: 457 [M+1]$^+$. HRMS (ESI) Calcd for [$C_{23}H_{21}ClN_2O_2S_2$] requires [M+H]$^+$ 457.0806, found 457.0808.



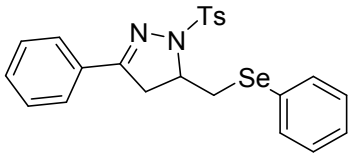
3ja

3-cyclopentyl-5-((phenylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ja**, colorless oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.66 – 7.56 (m, 2H), 7.48 (d, *J* = 7.6 Hz, 2H), 7.40 (t, *J* = 7.7 Hz, 2H), 7.33 – 7.29 (m, 1H), 7.26 (d, *J* = 8.0 Hz, 2H), 3.95 (dd, *J* = 13.7, 3.2 Hz, 1H), 3.77 (tdd, *J* = 10.7, 9.0, 3.2 Hz, 1H), 2.98 (dd, *J* = 13.7, 10.6 Hz, 1H), 2.75 (td, *J* = 17.1, 16.4, 9.3 Hz, 2H), 2.64 (dd, *J* = 17.8, 9.1 Hz, 1H), 2.44 (s, 3H), 1.80 (ddd, *J* = 12.3, 8.1, 5.1 Hz, 2H), 1.71 – 1.60 (m, 4H), 1.50 (dtd, *J* = 24.7, 7.5, 4.2 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 165.34, 143.14, 133.54, 130.35, 128.42, 128.27, 128.17, 127.77, 125.51, 59.28, 39.71, 39.40, 37.50, 29.33, 24.35, 20.62. ESI-MS *m/z*: 415 [M+1]$^+$. HRMS (ESI) Calcd for [$C_{22}H_{26}N_2O_2S_2$] requires [M+H]$^+$ 415.1508, found 415.1507.



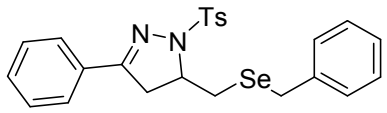
3ka

3-(naphthalen-2-yl)-5-((phenylthio)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **3ka**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.02 (dd, *J* = 8.6, 1.7 Hz, 1H), 7.91 (d, *J* = 1.6 Hz, 1H), 7.87 (ddd, *J* = 8.1, 4.0, 2.0 Hz, 3H), 7.69 (d, *J* = 8.3 Hz, 2H), 7.60 – 7.53 (m, 4H), 7.44 (t, *J* = 7.8 Hz, 2H), 7.36 – 7.32 (m, 1H), 7.23 (d, *J* = 8.1 Hz, 2H), 4.10 (dd, *J* = 13.7, 3.2 Hz, 1H), 4.01 (tdd, *J* = 10.6, 9.2, 3.2 Hz, 1H), 3.41 (dd, *J* = 17.3, 10.8 Hz, 1H), 3.21 (dd, *J* = 17.3, 9.2 Hz, 1H), 3.12 (dd, *J* = 13.7, 10.6 Hz, 1H), 2.38 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.71, 143.34, 133.36, 131.84, 130.70, 128.80, 128.53, 128.25, 127.66, 127.49, 127.27, 126.86, 126.52, 125.81, 125.72, 122.53, 60.14, 38.78, 37.66, 20.57. ESI-MS *m/z*: 473 [M+1]$^+$. HRMS (ESI) Calcd for [$C_{27}H_{24}N_2O_2S_2$] requires [M+H]$^+$ 473.1352, found 473.1353.



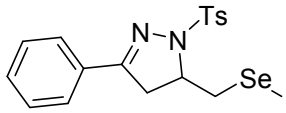
5aa

3-phenyl-5-((phenylselanyl)methyl)-1-tosyl-4,5-dihydro-1*H*-pyrazole **5aa**, yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.62 (td, *J* = 7.2, 6.6, 1.8 Hz, 4H), 7.59 – 7.54 (m, 2H), 7.42 – 7.33 (m, 6H), 7.18 (d, *J* = 8.1 Hz, 2H), 3.95 – 3.85 (m, 2H), 3.25 (dd, *J* = 17.4, 10.7 Hz, 1H), 3.07 (dd, *J* = 13.0, 11.0 Hz, 1H), 2.98 (dd, *J* = 17.3, 9.6 Hz, 1H), 2.35 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.33, 143.25, 132.11, 130.60, 129.66, 128.49, 128.41, 127.64, 126.49, 125.93, 61.09, 39.43, 31.26, 20.61. ESI-MS *m/z*: 471 [M+1]$^+$. HRMS (ESI) Calcd for [$C_{23}H_{22}N_2O_2SSe$] requires [M+H]$^+$ 471.0640, found 471.0642.



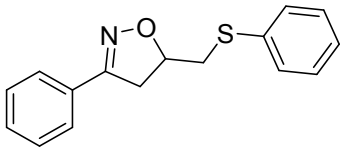
5ab

5-((benzylselanyl)methyl)-3-phenyl-1-tosyl-4,5-dihydro-1*H*-pyrazole **5ab**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79 (d, *J* = 8.3 Hz, 2H), 7.68 – 7.65 (m, 2H), 7.43 (dddd, *J* = 14.2, 8.4, 5.9, 2.3 Hz, 5H), 7.37 (dd, *J* = 8.5, 6.8 Hz, 2H), 7.33 – 7.28 (m, 3H), 4.11 – 4.05 (m, 1H), 3.97 (s, 2H), 3.31 (dd, *J* = 12.7, 3.3 Hz, 1H), 3.16 – 3.05 (m, 2H), 2.92 (dd, *J* = 17.3, 8.8 Hz, 1H), 2.43 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.67, 143.36, 138.46, 131.17, 129.66, 128.61, 128.02, 127.70, 127.62, 125.98, 60.99, 39.18, 28.62, 27.30, 20.65. ESI-MS *m/z*: 485 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{24}H_{24}N_2O_2SSe]$ requires $[M+H]^+$ 485.0796, found 485.0797.



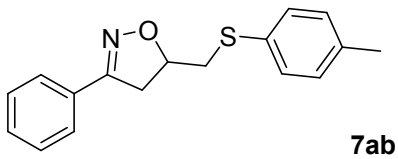
5ac

5-((methylselanyl)methyl)-3-phenyl-1-tosyl-4,5-dihydro-1*H*-pyrazole **5ac**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.3 Hz, 2H), 7.74 – 7.70 (m, 2H), 7.47 – 7.41 (m, 3H), 7.33 (d, *J* = 8.1 Hz, 2H), 4.15 (dtd, *J* = 10.7, 9.1, 3.1 Hz, 1H), 3.33 – 3.25 (m, 2H), 3.14 – 3.04 (m, 2H), 2.44 (s, 3H), 2.20 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.55, 143.38, 131.11, 129.79, 129.65, 128.62, 127.63, 125.95, 61.06, 39.19, 29.69, 20.63, 4.18. ESI-MS *m/z*: 409 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{18}H_{20}N_2O_2SSe]$ requires $[M+H]^+$ 409.0483, found 409.0481.



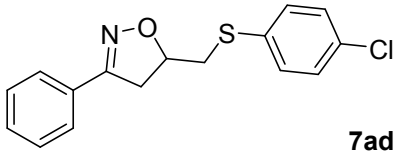
7aa

3-phenyl-5-((phenylthio)methyl)-4,5-dihydroisoxazole **7aa**, light yellow solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.68 – 7.64 (m, 2H), 7.47 – 7.38 (m, 5H), 7.32 (dd, *J* = 8.4, 6.8 Hz, 2H), 7.27 – 7.21 (m, 1H), 4.88 (dddd, *J* = 10.8, 9.1, 6.6, 4.5 Hz, 1H), 3.48 – 3.42 (m, 1H), 3.38 (dd, *J* = 13.6, 4.5 Hz, 1H), 3.28 (dd, *J* = 16.8, 6.6 Hz, 1H), 2.99 (dd, *J* = 13.6, 8.9 Hz, 1H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.30, 133.75, 129.21, 128.40, 128.21, 127.77, 125.90, 125.77, 78.58, 38.59, 36.82. ESI-MS *m/z*: 270 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{16}H_{15}NOS]$ requires $[M+H]^+$ 270.0947, found 270.0945.



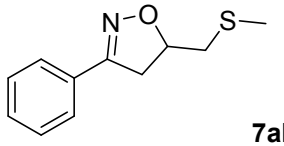
7ab

3-phenyl-5-((*p*-tolylthio)methyl)-4,5-dihydroisoxazole 7ab, yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.70 – 7.65 (m, 2H), 7.41 (dd, *J* = 5.2, 2.1 Hz, 3H), 7.34 (d, *J* = 8.2 Hz, 2H), 7.13 (d, *J* = 7.9 Hz, 2H), 4.85 (dddd, *J* = 10.8, 9.0, 6.6, 4.6 Hz, 1H), 3.47 – 3.41 (m, 1H), 3.38 – 3.23 (m, 2H), 2.94 (dd, *J* = 13.5, 8.9 Hz, 1H), 2.34 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.29, 136.20, 129.99, 129.21, 129.00, 128.46, 127.76, 125.78, 78.69, 38.55, 37.45, 20.10. ESI-MS *m/z*: 284 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{17}H_{17}NOS]$ requires $[M+H]^+$ 284.1104, found 284.1103.



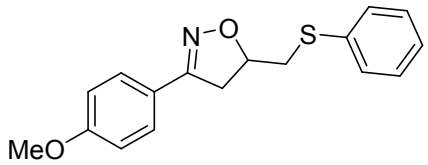
7ad

5-(((4-chlorophenyl)thio)methyl)-3-phenyl-4,5-dihydroisoxazole **7ad**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 – 7.63 (m, 2H), 7.47 – 7.39 (m, 3H), 7.39 – 7.32 (m, 2H), 7.31 – 7.27 (m, 2H), 4.88 (dddd, *J* = 10.2, 8.4, 6.6, 4.7 Hz, 1H), 3.46 (dd, *J* = 16.8, 10.3 Hz, 1H), 3.33 (dd, *J* = 13.7, 4.7 Hz, 1H), 3.27 (dd, *J* = 16.8, 6.6 Hz, 1H), 3.01 (dd, *J* = 13.7, 8.4 Hz, 1H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.29, 132.40, 132.00, 130.52, 129.32, 128.35, 127.81, 125.79, 78.41, 38.62, 37.17. ESI-MS *m/z*: 304 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{16}H_{14}ClNOS]$ requires $[M+H]^+$ 304.0557, found 304.0558.



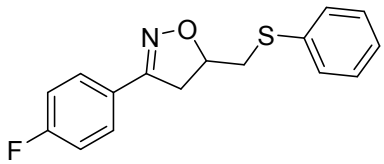
7ah

5-((methylthio)methyl)-3-phenyl-4,5-dihydroisoxazole 7ah, colorless liquid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 – 7.64 (m, 2H), 7.45 – 7.37 (m, 3H), 5.00 – 4.92 (m, 1H), 3.47 (dd, *J* = 16.7, 10.3 Hz, 1H), 3.29 (dd, *J* = 16.7, 7.0 Hz, 1H), 2.86 (dd, *J* = 13.8, 4.9 Hz, 1H), 2.72 (dd, *J* = 13.7, 7.6 Hz, 1H), 2.22 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.44, 131.23, 129.19, 127.76, 125.76, 79.43, 38.63, 37.09, 15.28. ESI-MS *m/z*: 208 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{11}H_{13}NOS]$ requires $[M+H]^+$ 208.0791, found 208.0789.



7ba

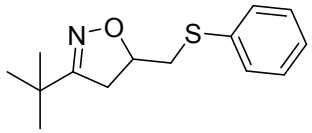
3-(4-methoxyphenyl)-5-((phenylthio)methyl)-4,5-dihydroisoxazole **7ba**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.64 – 7.54 (m, 2H), 7.45 – 7.36 (m, 2H), 7.30 (dd, *J* = 8.4, 6.8 Hz, 2H), 7.25 – 7.19 (m, 1H), 6.97 – 6.87 (m, 2H), 4.83 (dddd, *J* = 10.1, 8.9, 6.5, 4.5 Hz, 1H), 3.83 (s, 3H), 3.47 – 3.32 (m, 2H), 3.23 (dd, *J* = 16.7, 6.5 Hz, 1H), 2.97 (dd, *J* = 13.5, 8.9 Hz, 1H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 160.18, 154.86, 133.86, 129.12, 128.20, 127.31, 125.84, 120.97, 113.18, 78.29, 54.41, 38.84, 36.79. ESI-MS *m/z*: 300 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{17}H_{17}NO_2S]$ requires $[M+H]^+$ 300.1053, found 300.1052.



7ca

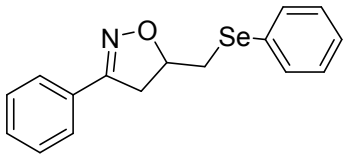
3-(4-fluorophenyl)-5-((phenylthio)methyl)-4,5-dihydroisoxazole **7ca**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.68 – 7.56 (m, 2H), 7.48 – 7.36 (m, 2H), 7.31 (dd, *J* = 8.4, 6.8 Hz, 2H), 7.25 – 7.18 (m, 1H), 7.13 – 7.01 (m, 2H), 4.87 (dddd, *J* = 10.8, 9.0, 6.6, 4.5 Hz, 1H), 3.46 – 3.33 (m, 2H), 3.24 (dd, *J* = 16.8, 6.7 Hz, 1H), 2.98 (dd, *J* = 13.6, 8.9 Hz, 1H). ^{19}F NMR (470 MHz, $CDCl_3$) δ -109.72. ^{13}C NMR (125 MHz, $CDCl_3$) δ 163.84, 161.84, 154.32, 133.71, 129.20, 128.22, 127.74, 127.67, 125.93, 124.70, 115.00, 114.83, 78.72, 38.63, 36.80. ESI-MS *m/z*: 288 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{16}H_{14}FNOS]$ requires

$[M+H]^+$ 288.0853, found 288.0851.



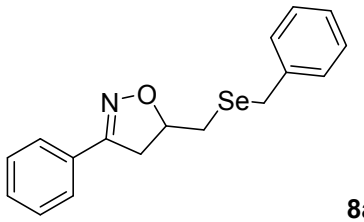
7da

3-(*tert*-butyl)-5-((phenylthio)methyl)-4,5-dihydroisoxazole **7da**, colorless oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.43 (dt, *J* = 8.1, 1.4 Hz, 2H), 7.34 (td, *J* = 7.7, 1.6 Hz, 2H), 7.26 (td, *J* = 7.2, 1.4 Hz, 1H), 4.78 – 4.65 (m, 1H), 3.31 (ddd, *J* = 13.5, 4.5, 1.5 Hz, 1H), 3.10 (ddd, *J* = 17.0, 10.1, 1.5 Hz, 1H), 2.96 – 2.87 (m, 2H), 1.23 (d, *J* = 1.6 Hz, 9H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 164.72, 134.03, 128.99, 128.14, 125.72, 77.60, 37.93, 36.64, 32.05, 27.11. ESI-MS *m/z*: 250 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{14}H_{19}NOS]$ requires $[M+H]^+$ 250.1260, found 250.1258.



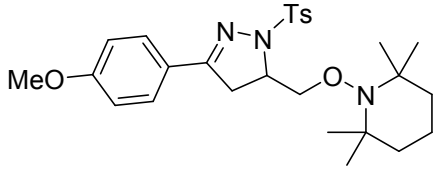
8aa

3-phenyl-5-((phenylselanyl)methyl)-4,5-dihydroisoxazole **8aa**, white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.67 – 7.62 (m, 2H), 7.57 (dd, *J* = 6.5, 3.1 Hz, 2H), 7.41 (dd, *J* = 5.3, 2.0 Hz, 3H), 7.33 – 7.27 (m, 3H), 4.91 (dddd, *J* = 11.0, 9.3, 6.8, 4.5 Hz, 1H), 3.45 (dd, *J* = 16.8, 10.2 Hz, 1H), 3.32 (dd, *J* = 12.6, 4.6 Hz, 1H), 3.21 (dd, *J* = 16.8, 6.8 Hz, 1H), 3.01 (dd, *J* = 12.6, 9.0 Hz, 1H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.23, 132.30, 129.20, 128.38, 127.76, 126.62, 125.75, 79.43, 39.12, 30.47. ESI-MS *m/z*: 318 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{16}H_{15}NOSe]$ requires $[M+H]^+$ 318.0392, found 318.0391.



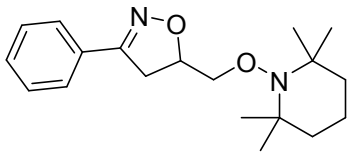
8ab

5-((benzylselanyl)methyl)-3-phenyl-4,5-dihydroisoxazole **8ab**, colorless liquid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.65 (dd, *J* = 6.7, 3.0 Hz, 2H), 7.41 (dd, *J* = 5.1, 2.0 Hz, 3H), 7.36 – 7.25 (m, 4H), 7.25 – 7.18 (m, 1H), 4.88 (dtd, *J* = 10.3, 7.4, 4.8 Hz, 1H), 3.92 – 3.88 (m, 2H), 3.39 (dd, *J* = 16.7, 10.3 Hz, 1H), 3.11 (dd, *J* = 16.7, 7.2 Hz, 1H), 2.84 (dd, *J* = 12.9, 4.9 Hz, 1H), 2.73 (dd, *J* = 12.9, 7.6 Hz, 1H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.38, 138.03, 129.12, 128.54, 128.03, 127.72, 127.63, 125.98, 125.74, 79.90, 39.38, 26.90, 26.49. ESI-MS *m/z*: 332 $[M+1]^+$. HRMS (ESI) Calcd for $[C_{17}H_{17}NOSe]$ requires $[M+H]^+$ 332.0548, found 332.0547.



9a

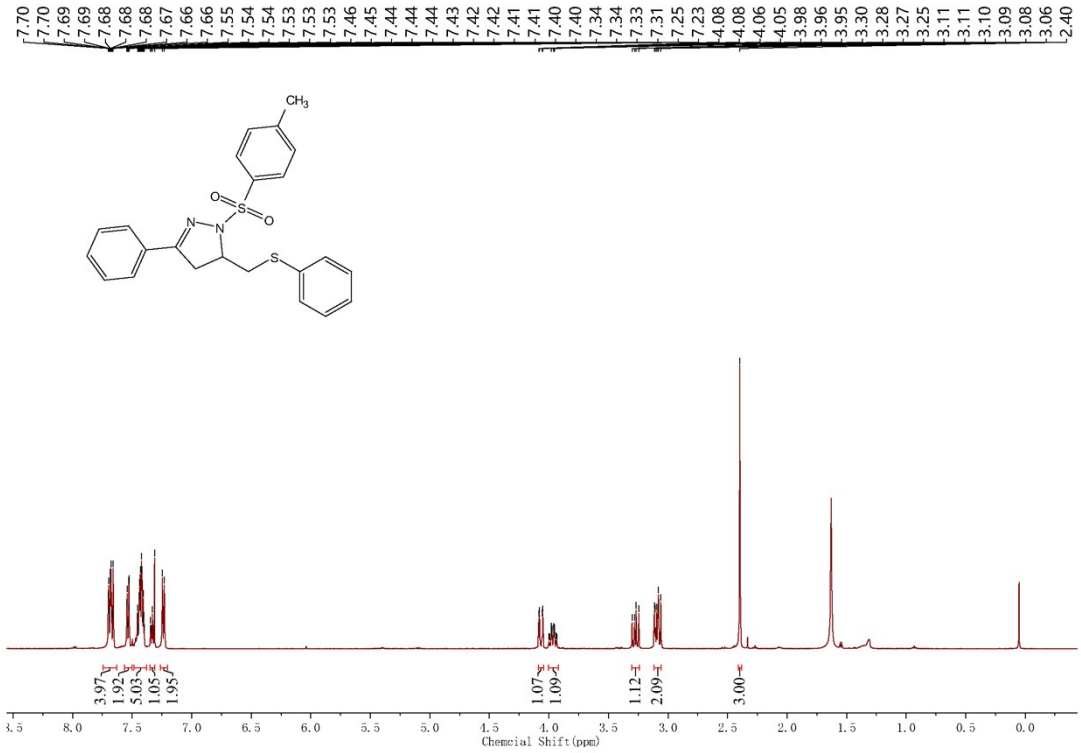
1-((3-(4-methoxyphenyl)-1-tosyl-4,5-dihydro-1*H*-pyrazol-5-yl)methoxy)-2,2,6,6-tetramethylpiperidine **9a**, light yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.2 Hz, 2H), 7.64 (d, *J* = 8.8 Hz, 2H), 7.27 (d, *J* = 8.1 Hz, 2H), 6.90 (d, *J* = 8.8 Hz, 2H), 4.30 (dd, *J* = 9.2, 3.8 Hz, 1H), 4.10 (dd, *J* = 9.2, 7.4 Hz, 1H), 3.96 – 3.90 (m, 1H), 3.83 (s, 3H), 3.16 – 3.01 (m, 2H), 2.38 (s, 3H), 1.47 (d, *J* = 16.0 Hz, 6H), 1.23 (s, 6H), 1.07 (d, *J* = 11.1 Hz, 6H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 160.53, 157.26, 143.08, 131.20, 128.50, 127.68, 113.02, 77.20, 59.07, 58.79, 54.43, 38.68, 36.59, 32.27, 32.09, 20.64, 19.23, 16.13.



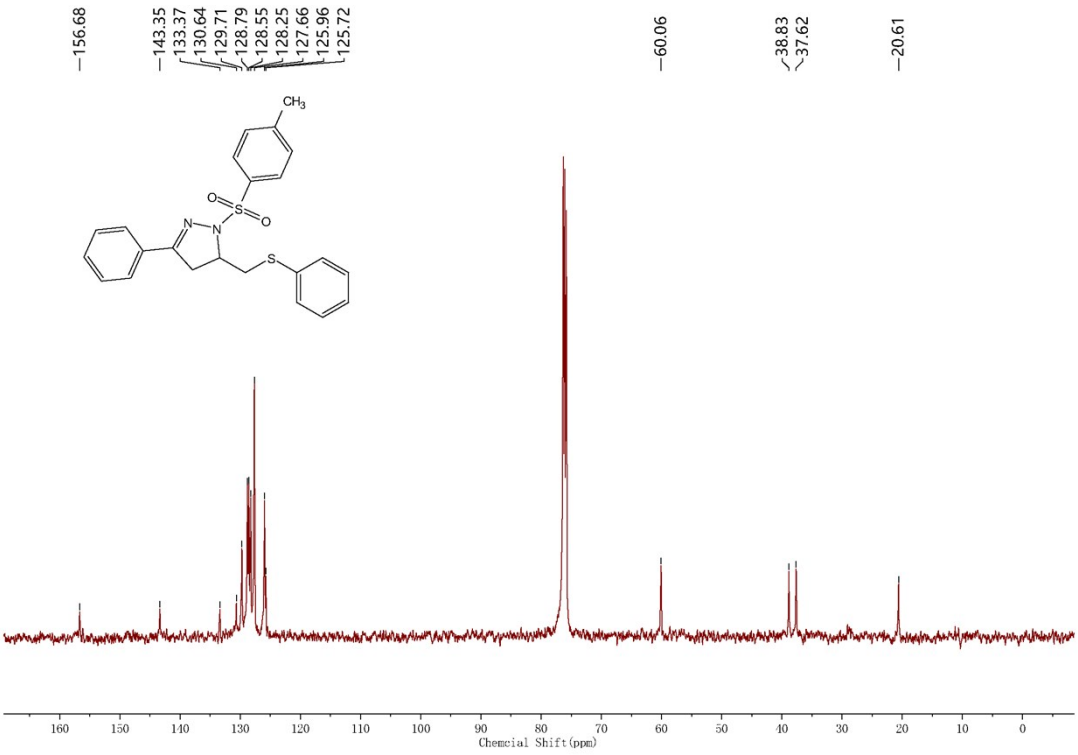
10a

3-phenyl-5-(((2,2,6,6-tetramethylpiperidin-1-yl)oxy)methyl)-4,5-dihydroisoxazole **10a**, yellow solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.75 (dd, *J* = 6.5, 3.0 Hz, 2H), 7.51 – 7.44 (m, 3H), 4.94 (ddt, *J* = 12.0, 7.5, 4.8 Hz, 1H), 4.12 – 3.97 (m, 2H), 3.44 (dd, *J* = 16.4, 10.9 Hz, 1H), 3.32 (dd, *J* = 16.4, 7.5 Hz, 1H), 1.65 – 1.45 (m, 5H), 1.38 (t, *J* = 7.8 Hz, 1H), 1.30 – 1.20 (m, 6H), 1.14 (d, *J* = 4.9 Hz, 6H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.19, 128.97, 128.81, 127.73, 125.71, 78.24, 59.17, 38.70, 36.16, 32.05, 19.17, 16.10.

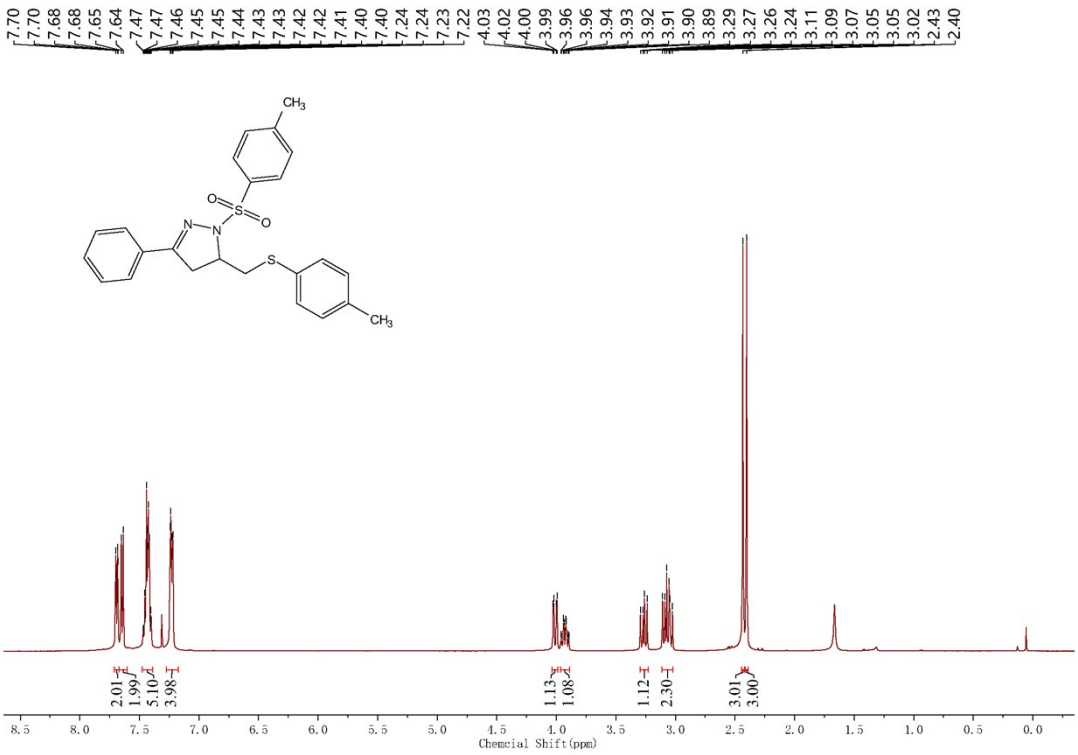
4. NMR Spectra of All Products



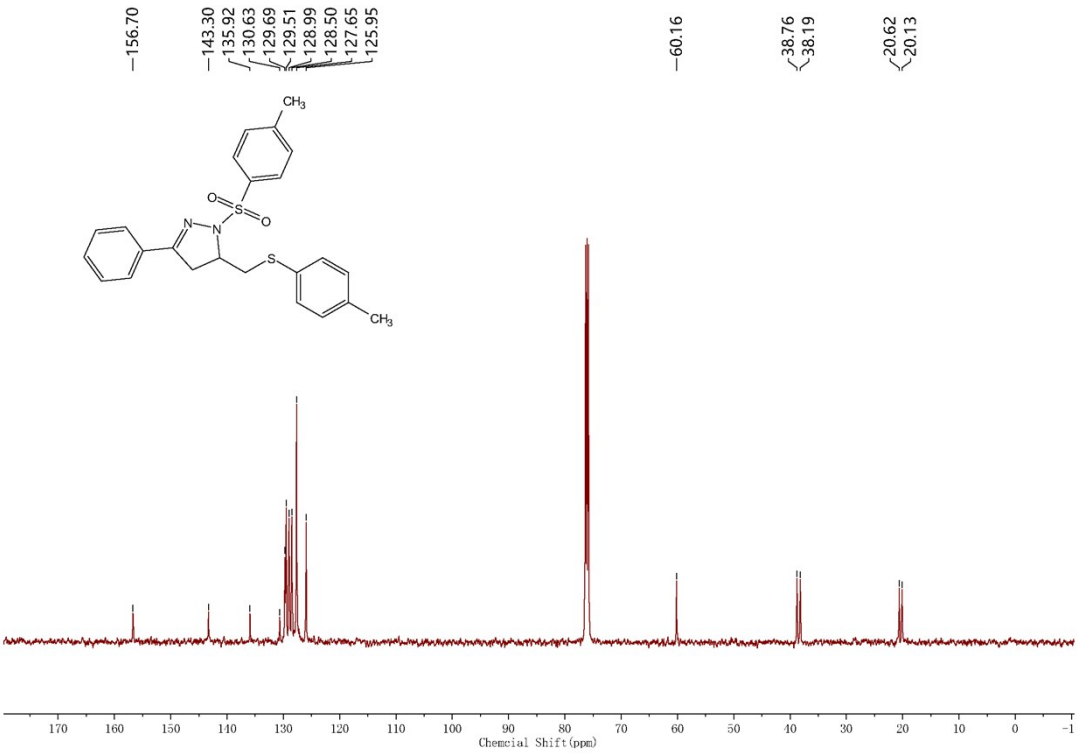
^{1}H NMR Spectrum of Compound **3aa** (500MHz, $CDCl_3$)



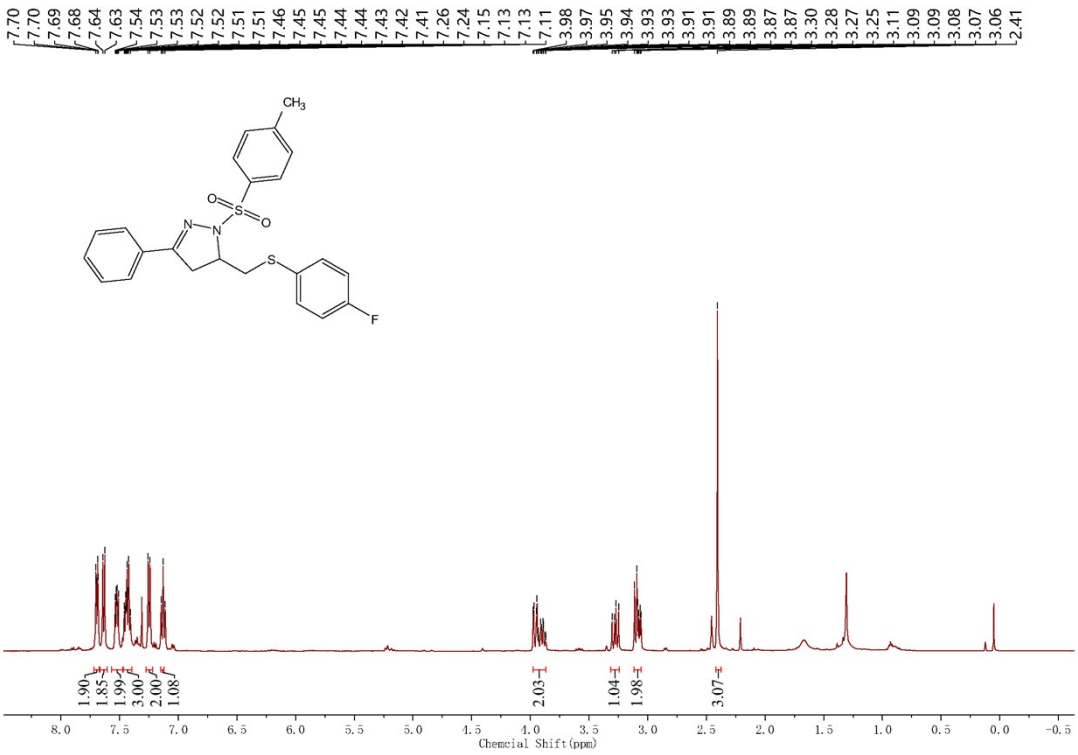
^{13}C NMR Spectrum of Compound **3aa** (125MHz, $CDCl_3$)



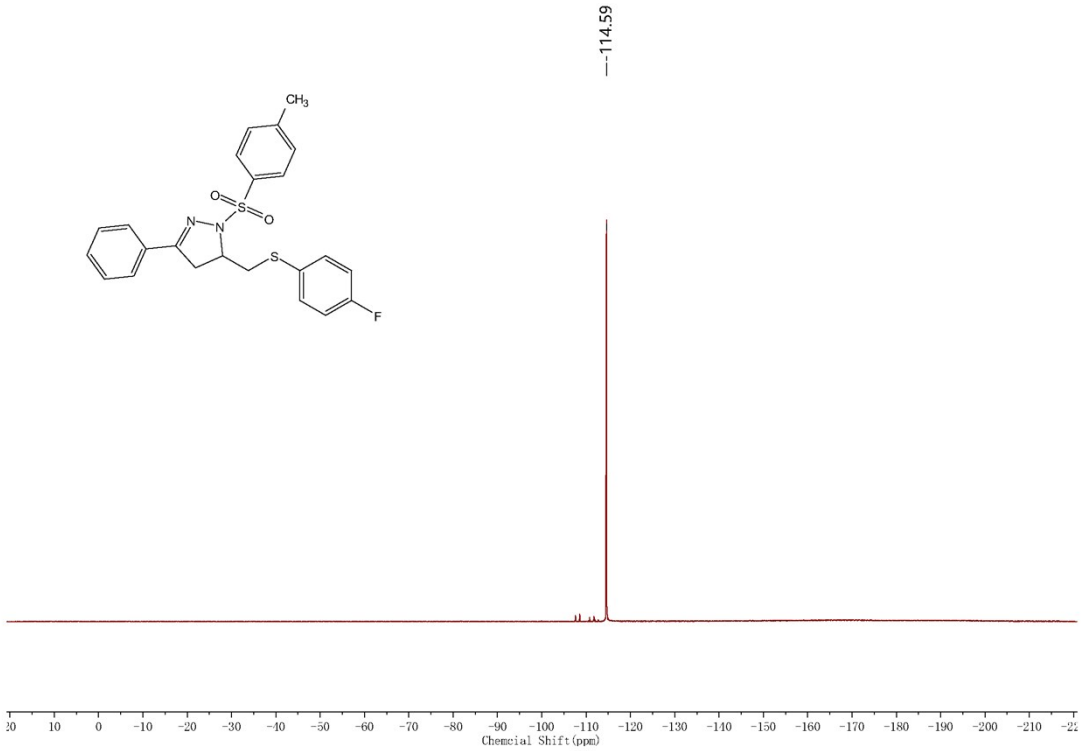
^{1}H NMR Spectrum of Compound **3ab** (500MHz, $CDCl_3$)



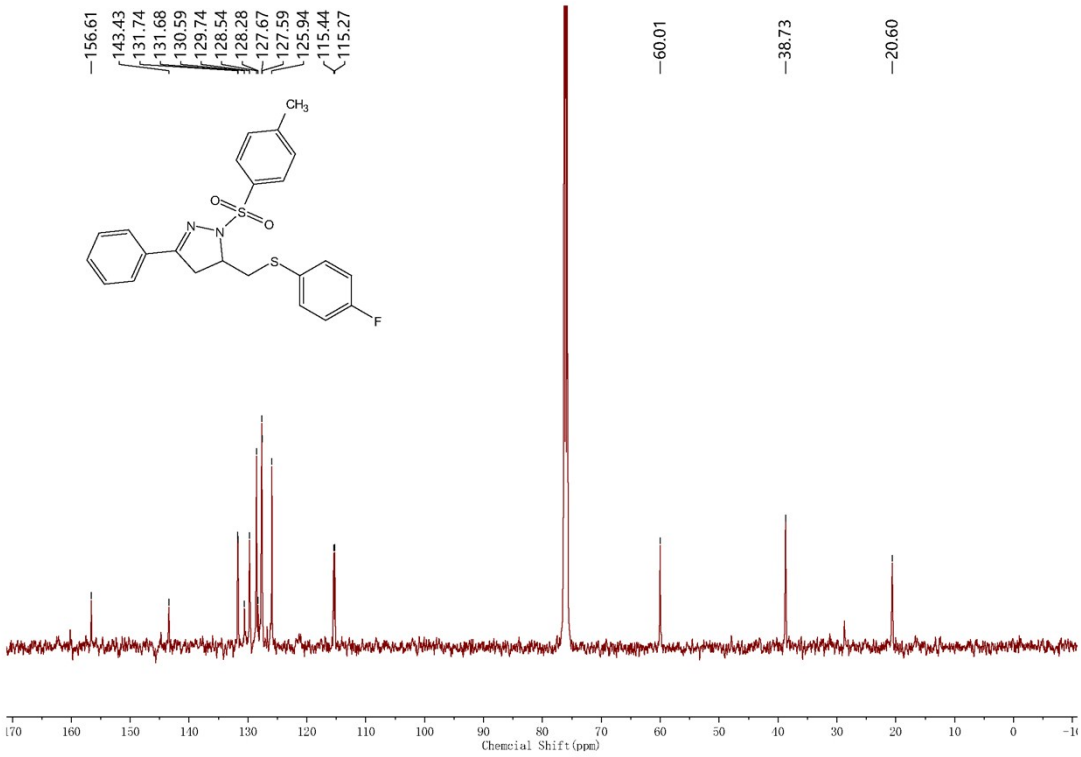
^{13}C NMR Spectrum of Compound **3ab** (125MHz, $CDCl_3$)



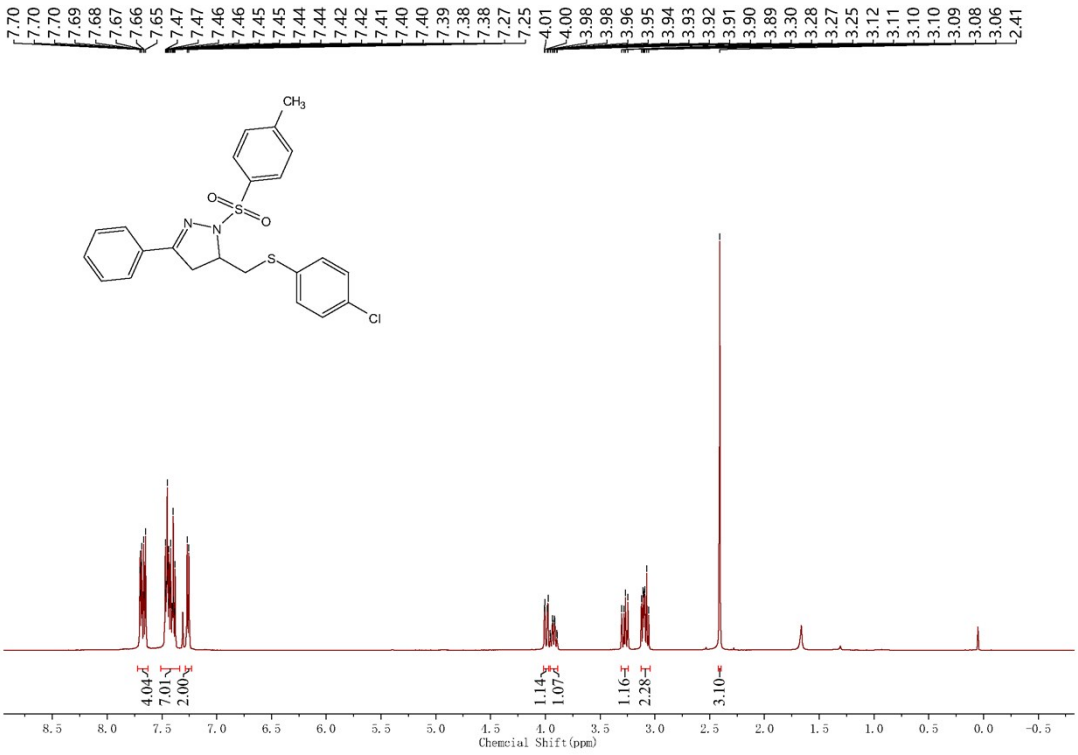
^{1}H NMR Spectrum of Compound **3ac** (500MHz, $CDCl_3$)



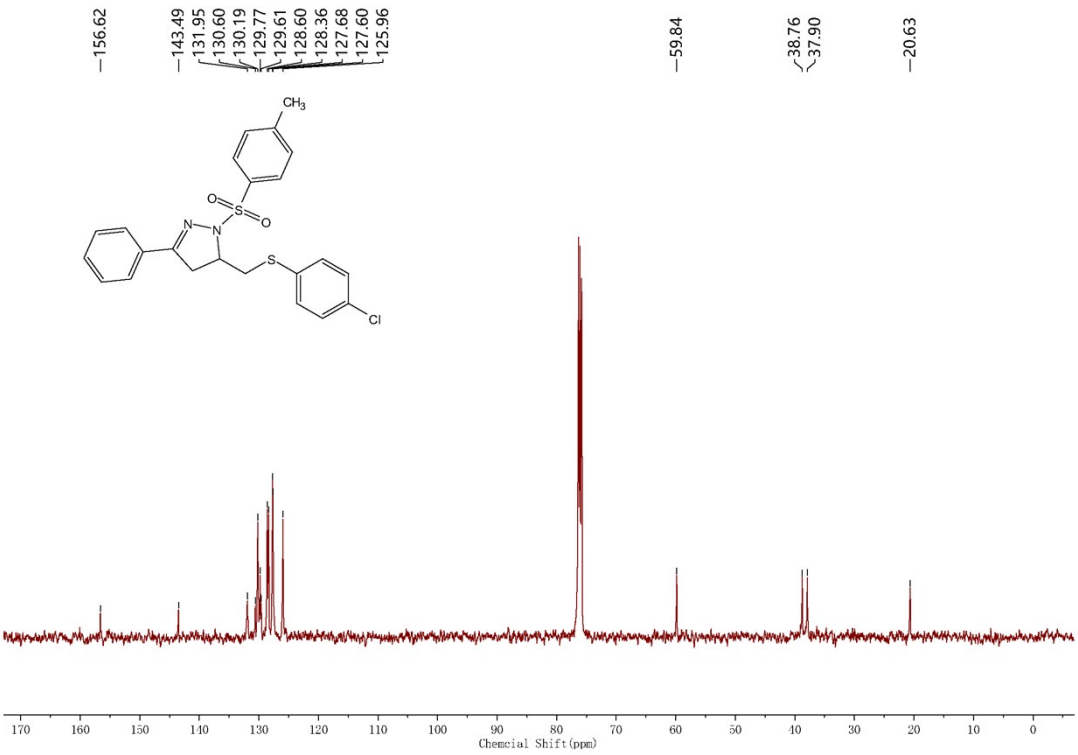
^{19}F NMR Spectrum of Compound **3ac** (470MHz, $CDCl_3$)



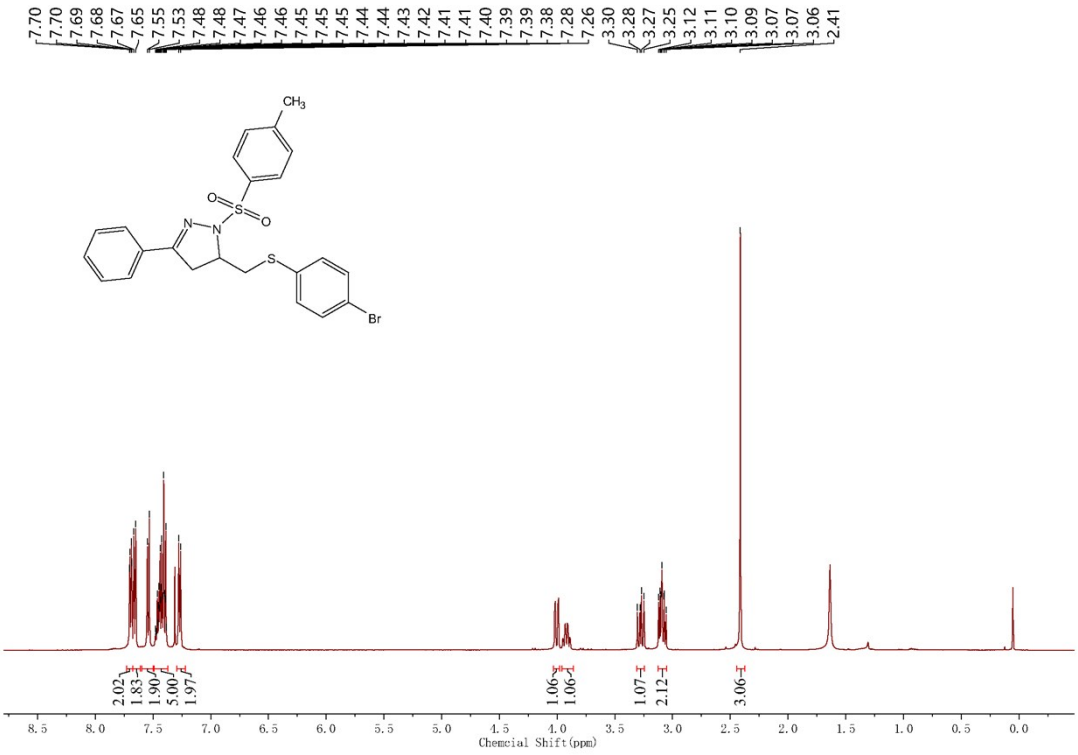
^{13}C NMR Spectrum of Compound **3ac** (125MHz, $CDCl_3$)



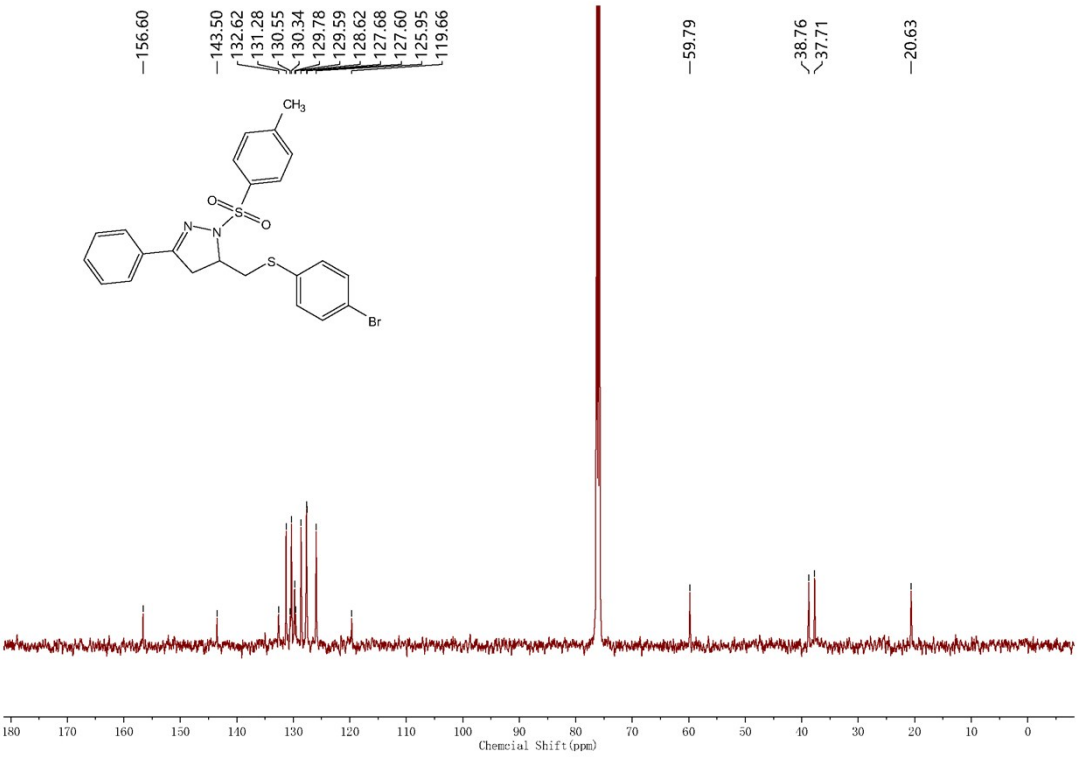
^{1}H NMR Spectrum of Compound **3ad** (500MHz, $CDCl_3$)



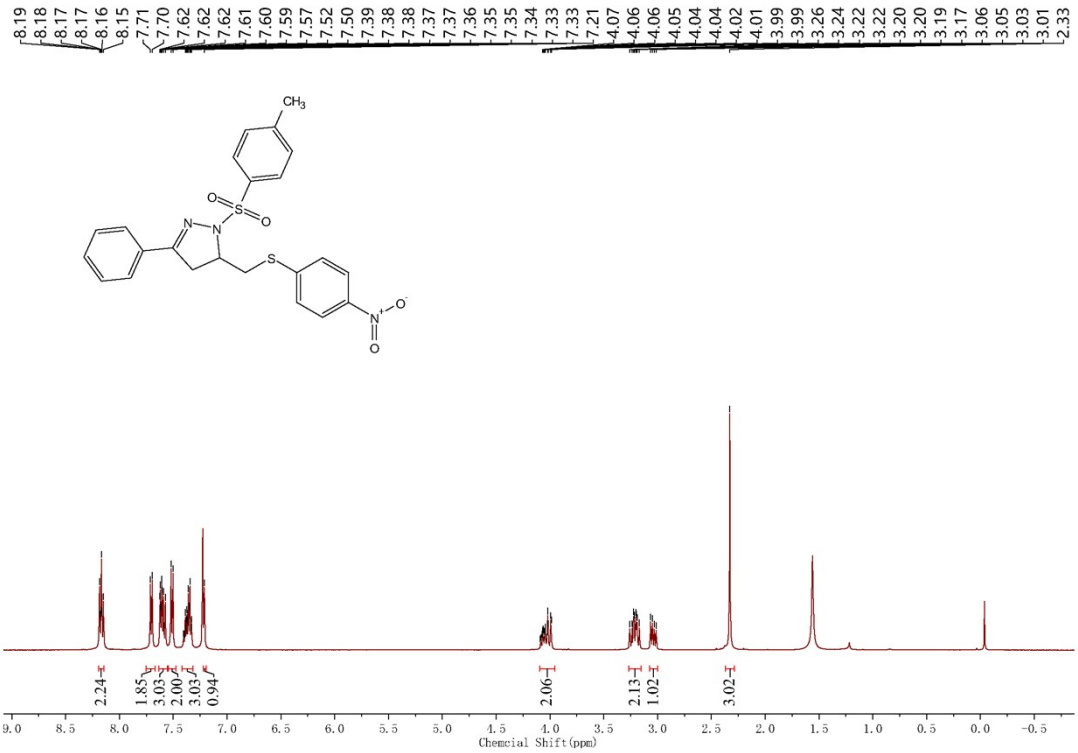
^{13}C NMR Spectrum of Compound **3ad** (125MHz, $CDCl_3$)



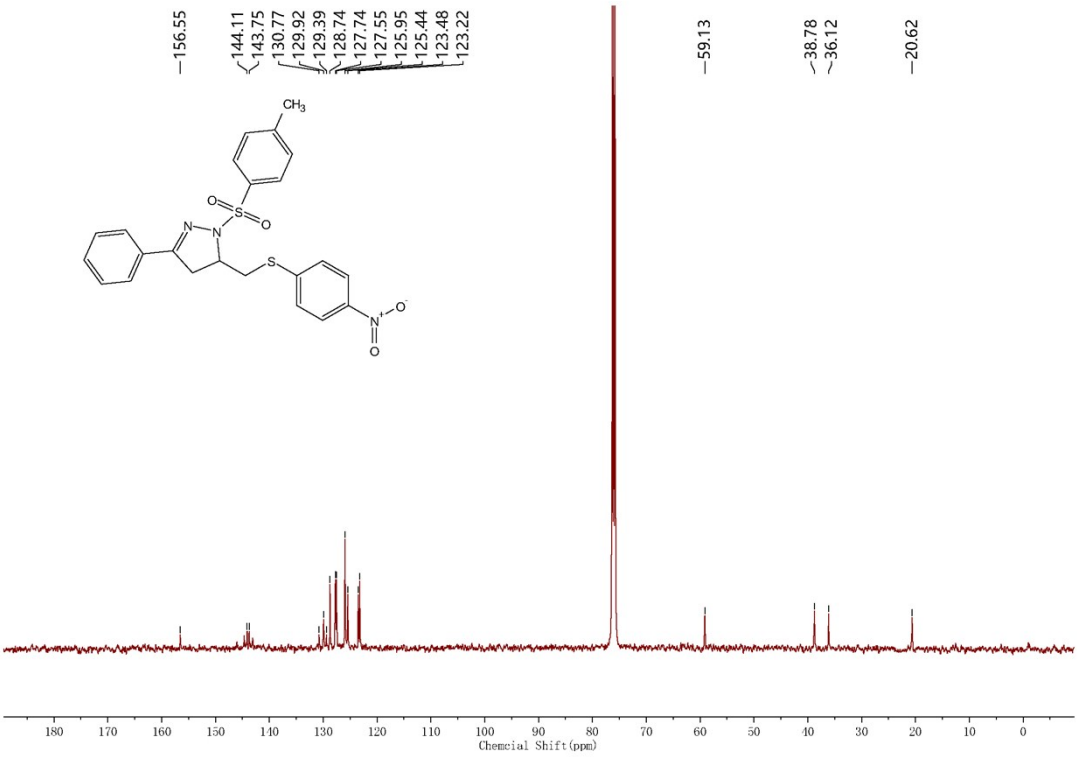
^{1}H NMR Spectrum of Compound **3ae** (500MHz, $CDCl_3$)



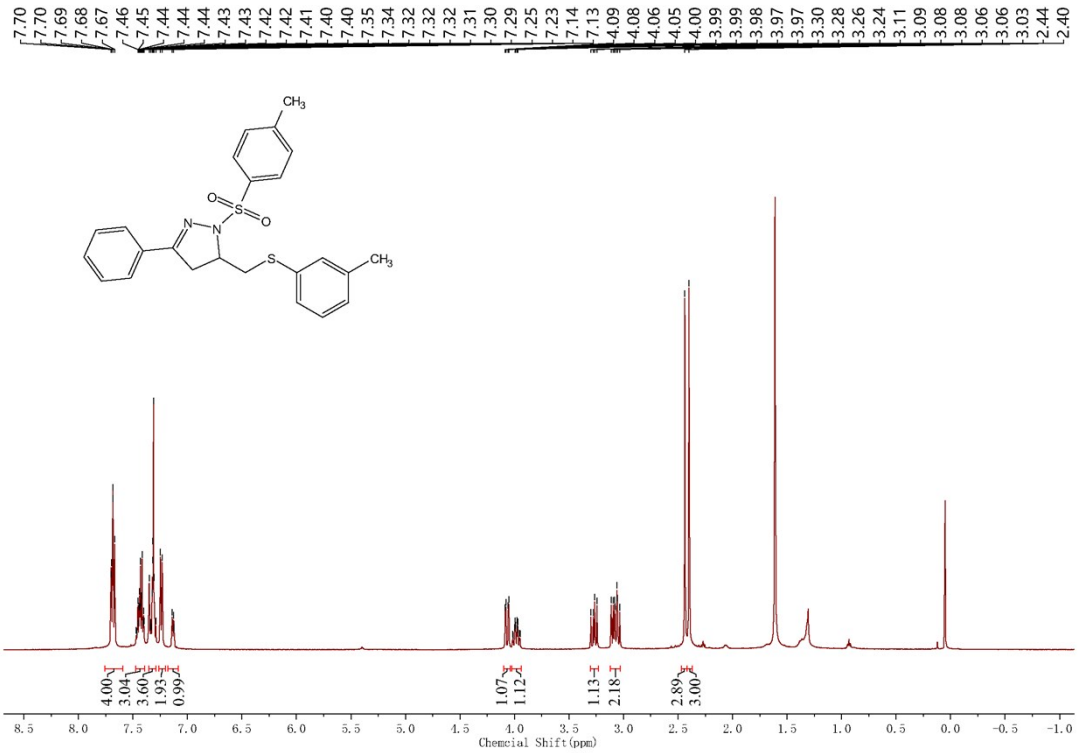
^{13}C NMR Spectrum of Compound **3ae** (125MHz, $CDCl_3$)



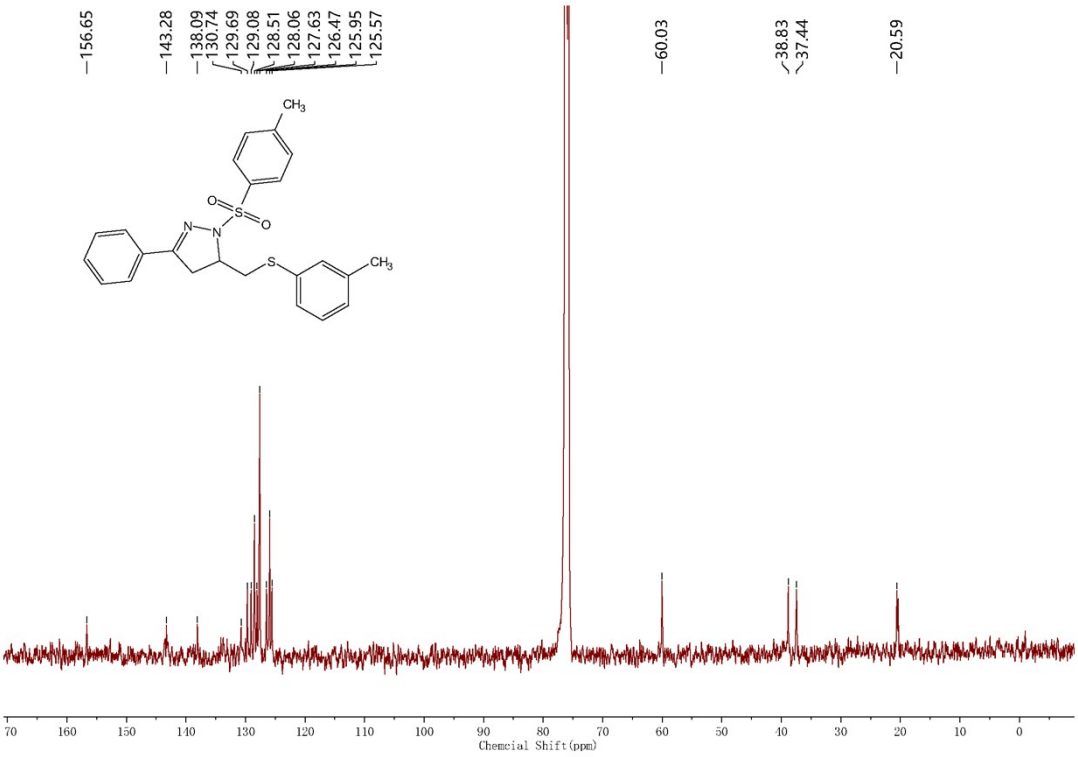
^{1}H NMR Spectrum of Compound **3af** (500MHz, $CDCl_3$)



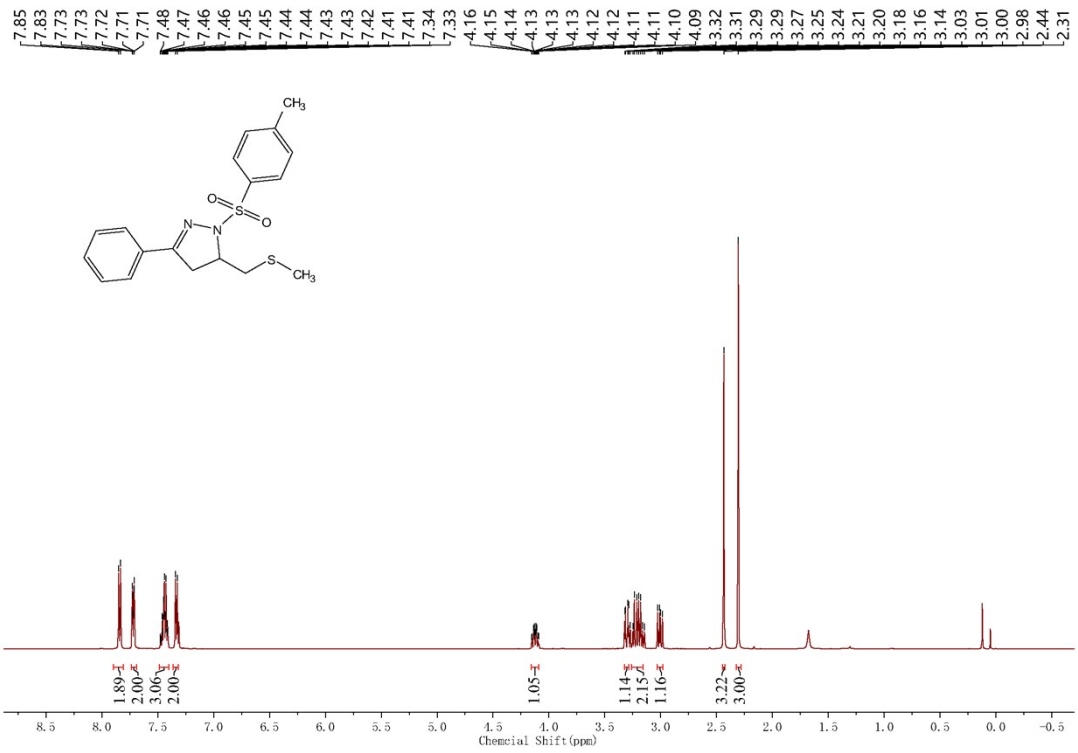
^{13}C NMR Spectrum of Compound **3af** (125MHz, $CDCl_3$)



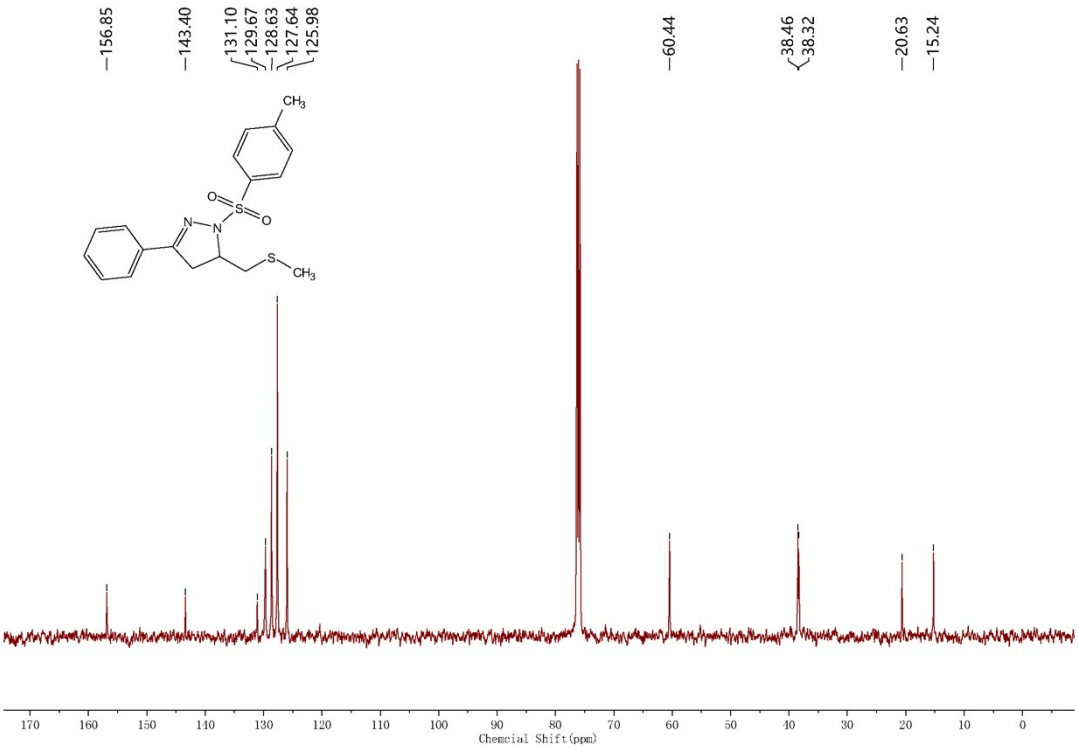
^{1}H NMR Spectrum of Compound **3ag** (500MHz, $CDCl_3$)



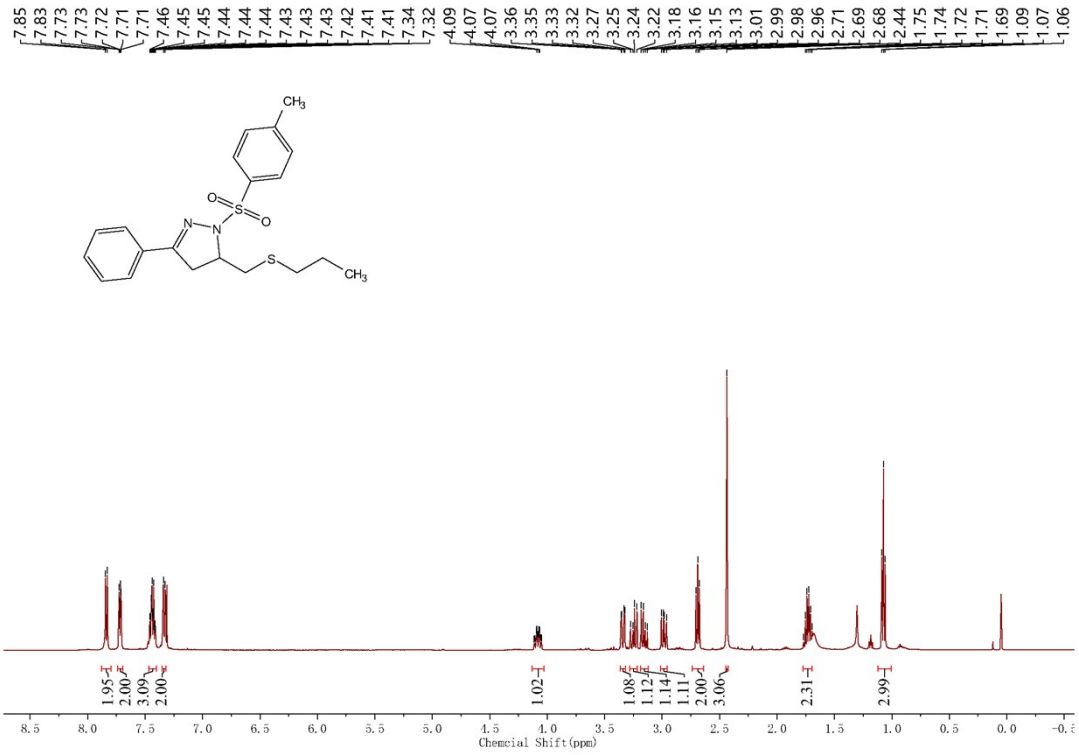
^{13}C NMR Spectrum of Compound **3ag** (125MHz, $CDCl_3$)



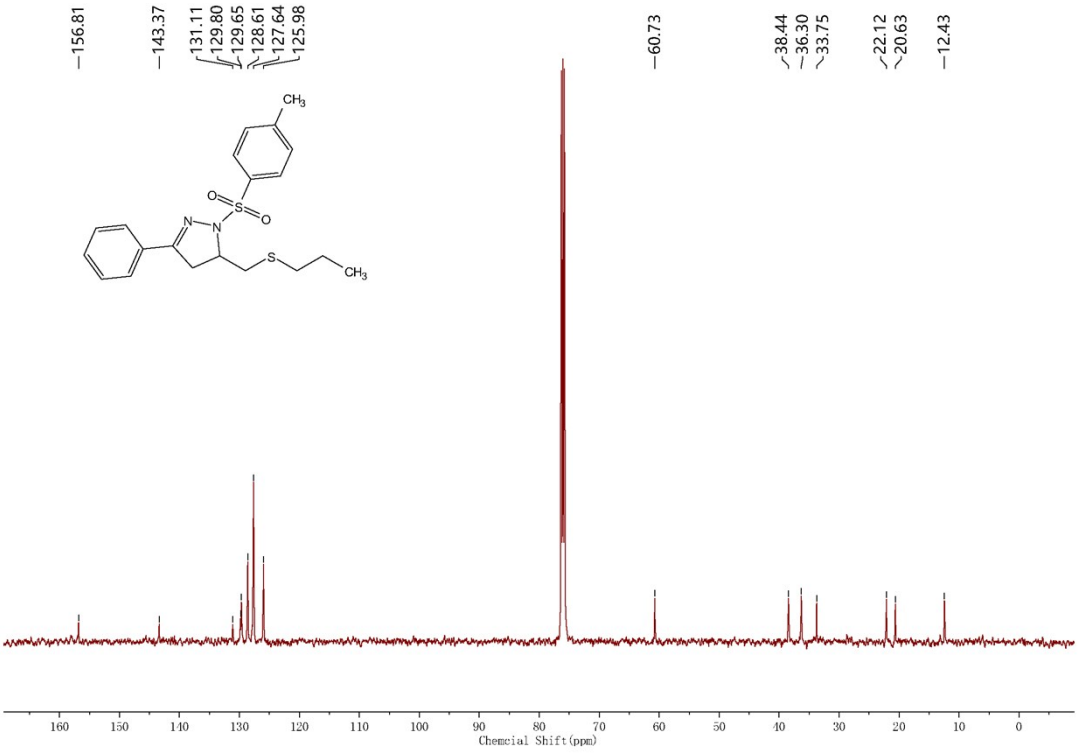
^{1}H NMR Spectrum of Compound **3ah** (500MHz, $CDCl_3$)



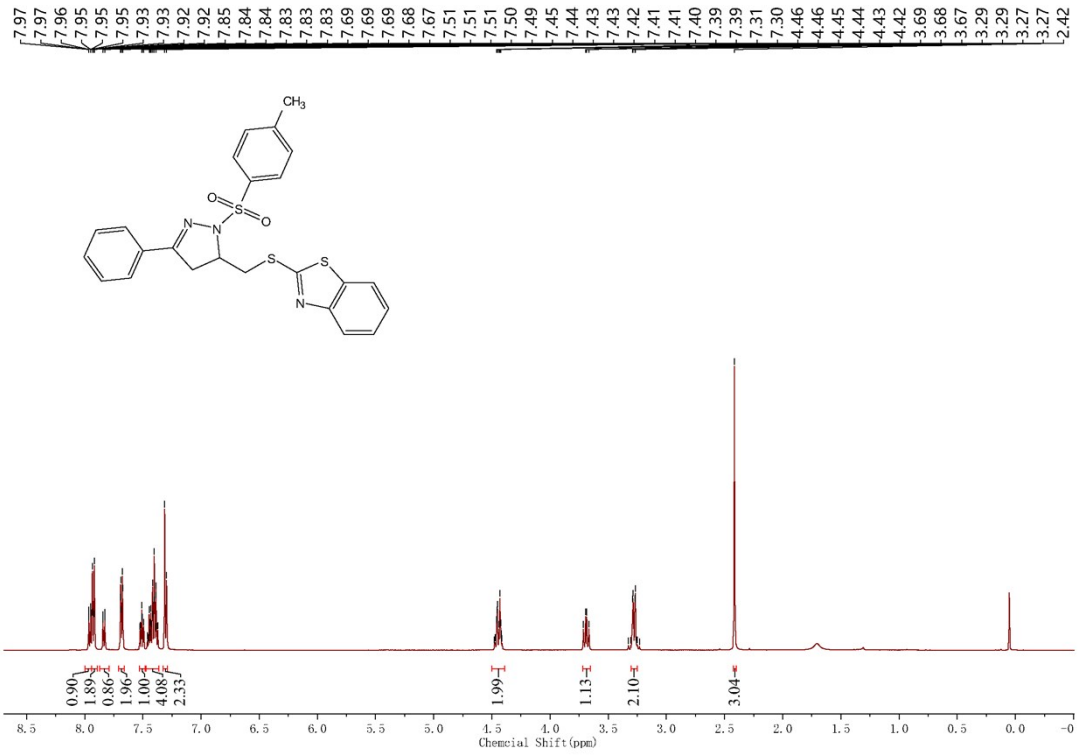
^{13}C NMR Spectrum of Compound **3ah** (125MHz, $CDCl_3$)



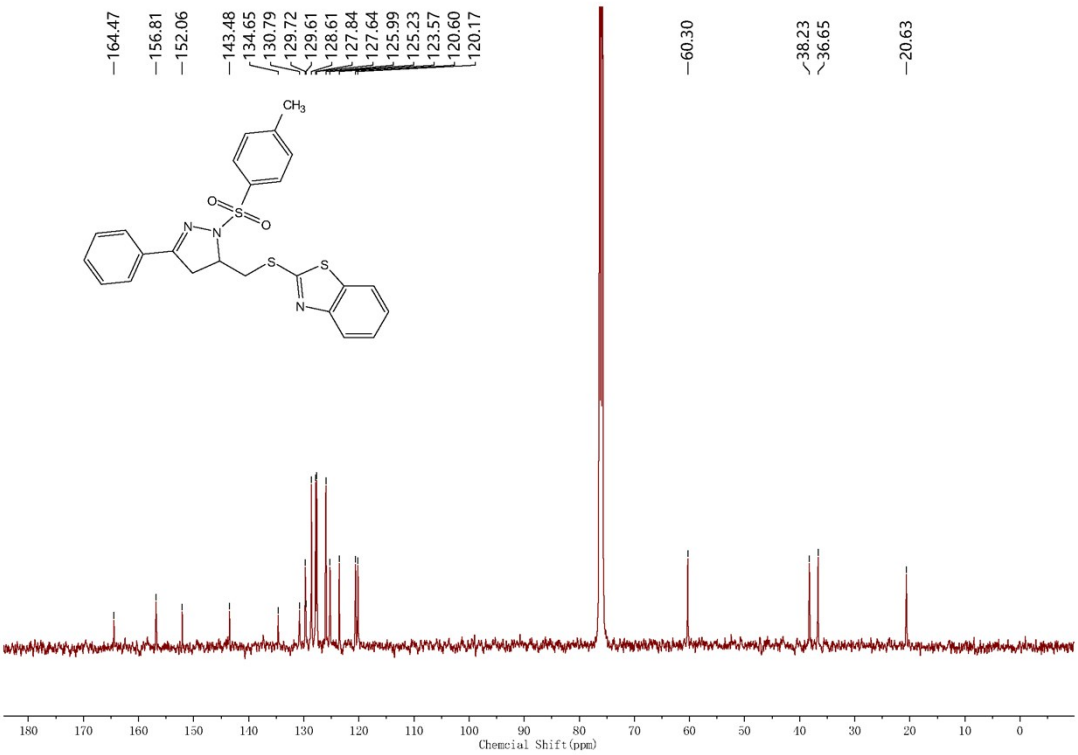
^{1}H NMR Spectrum of Compound **3ai** (500MHz, $CDCl_3$)



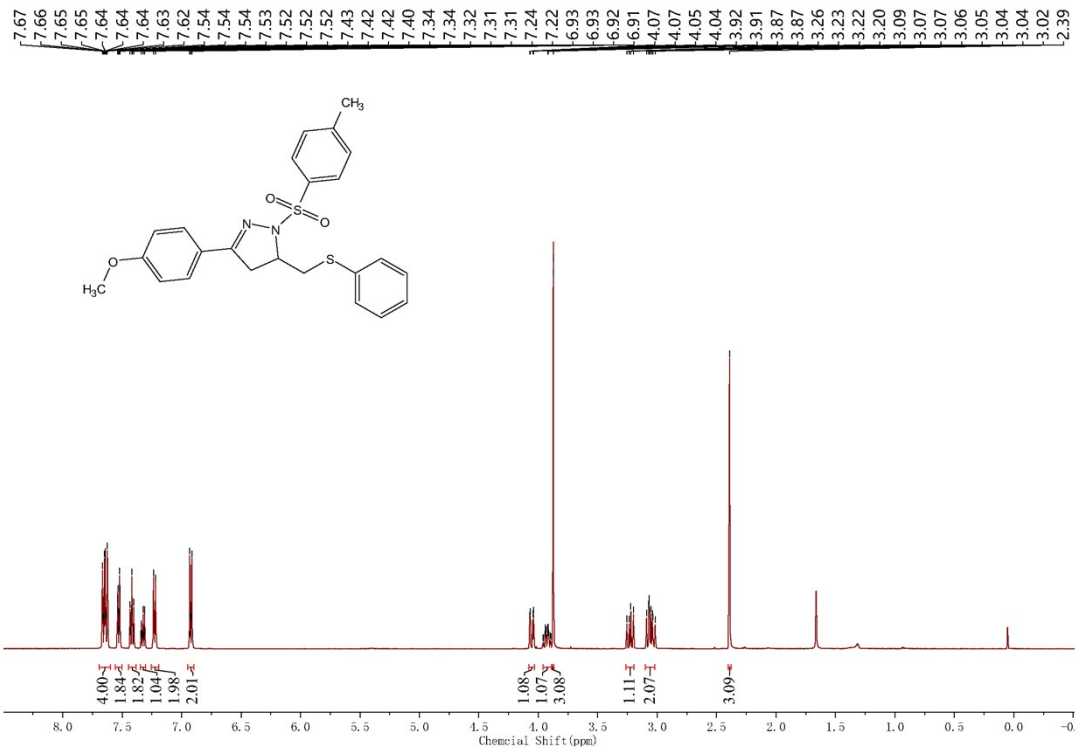
^{13}C NMR Spectrum of Compound **3ai** (125MHz, $CDCl_3$)



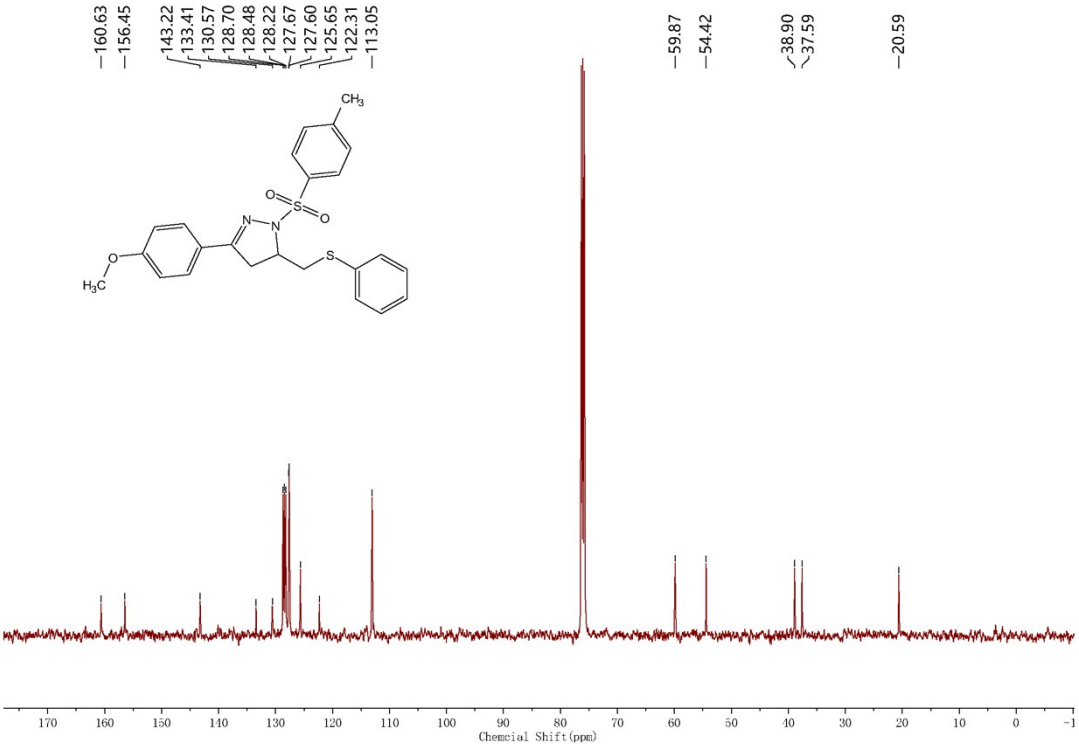
^{1}H NMR Spectrum of Compound **3aj** (500MHz, $CDCl_3$)



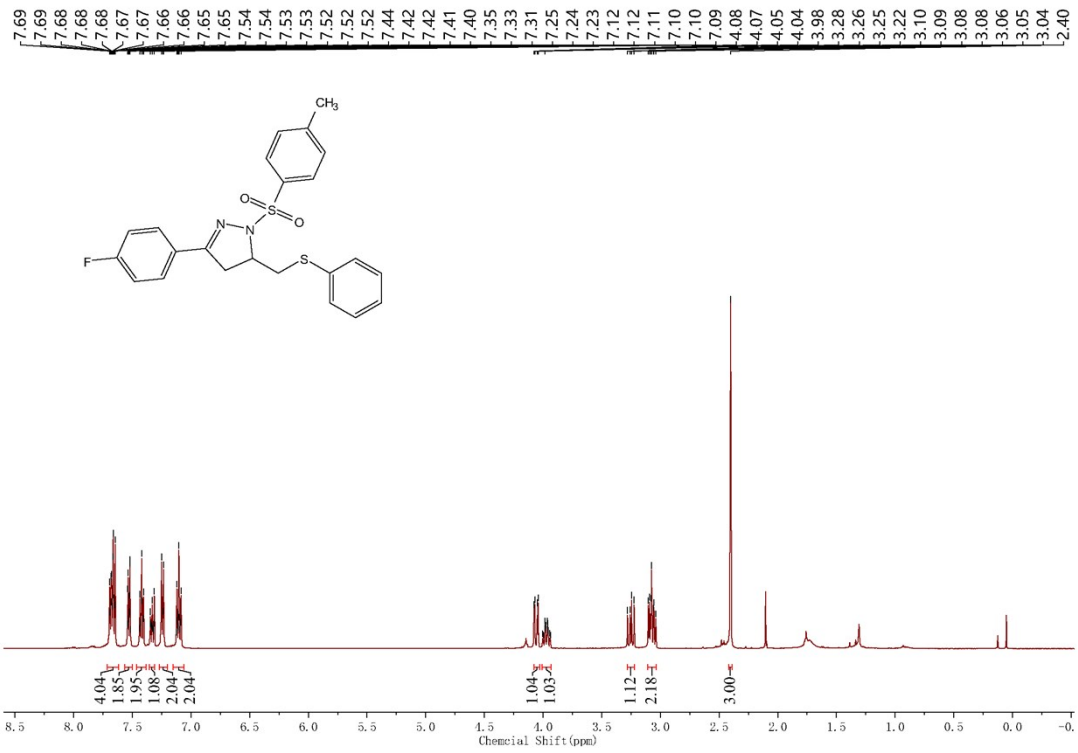
^{13}C NMR Spectrum of Compound **3aj** (125MHz, $CDCl_3$)



^{1}H NMR Spectrum of Compound **3ba** (500MHz, $CDCl_3$)

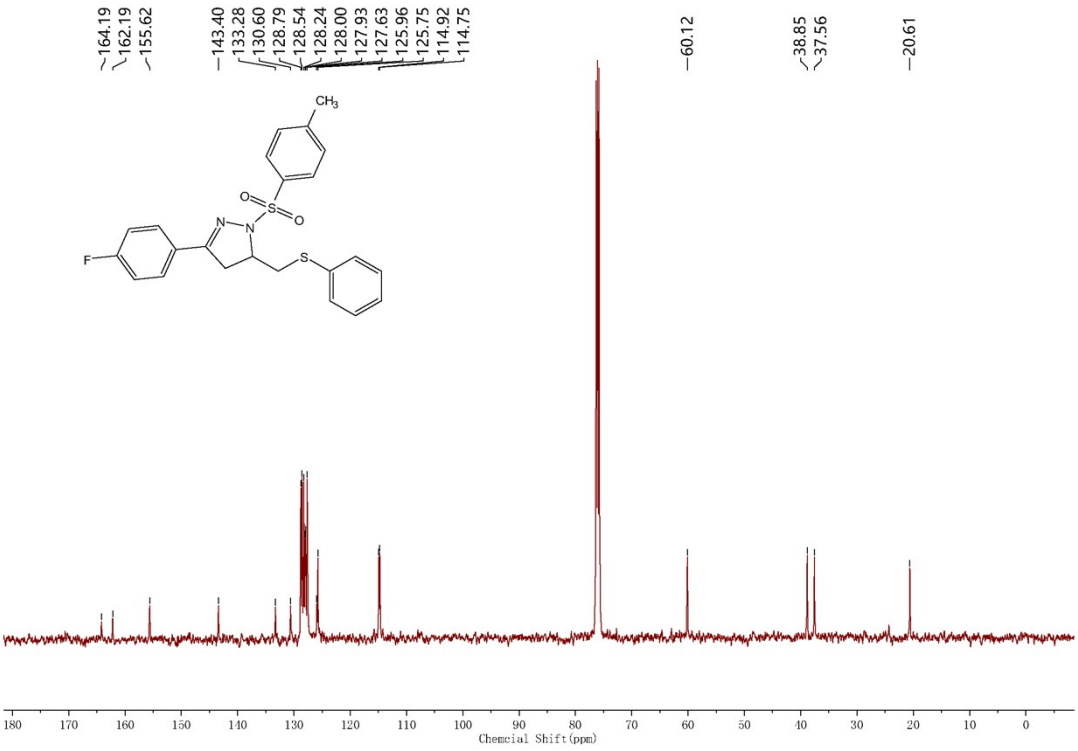


^{13}C NMR Spectrum of Compound **3ba** (125MHz, $CDCl_3$)

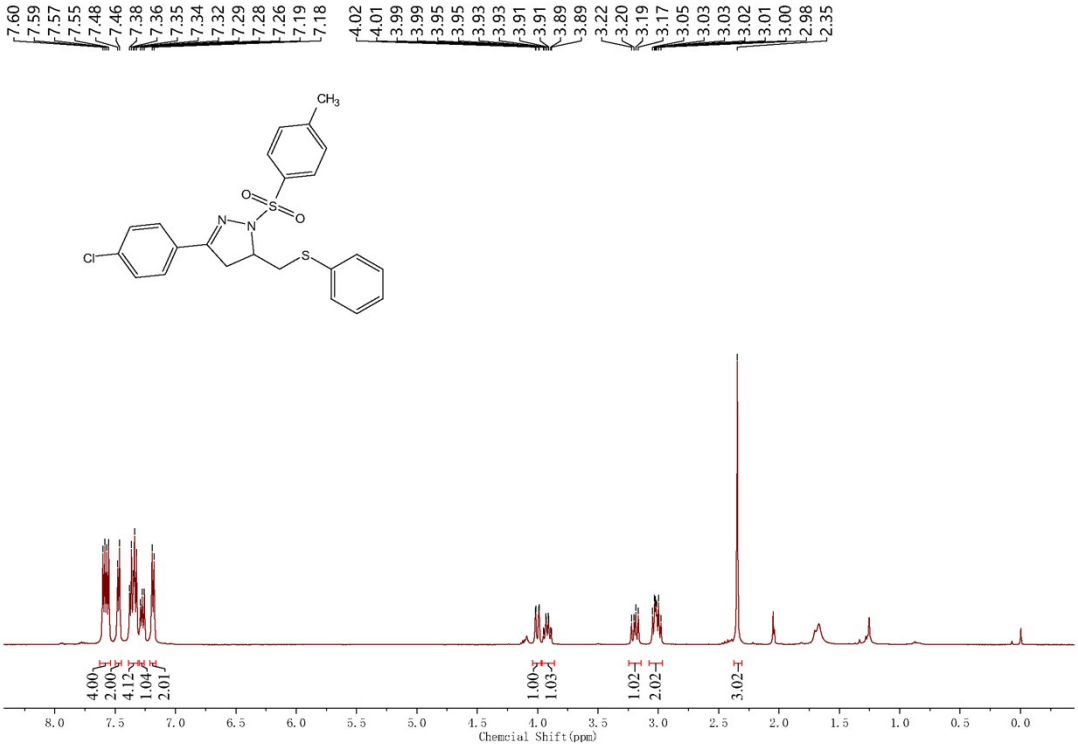


^{1}H NMR Spectrum of Compound **3ca** (500MHz, $CDCl_3$)

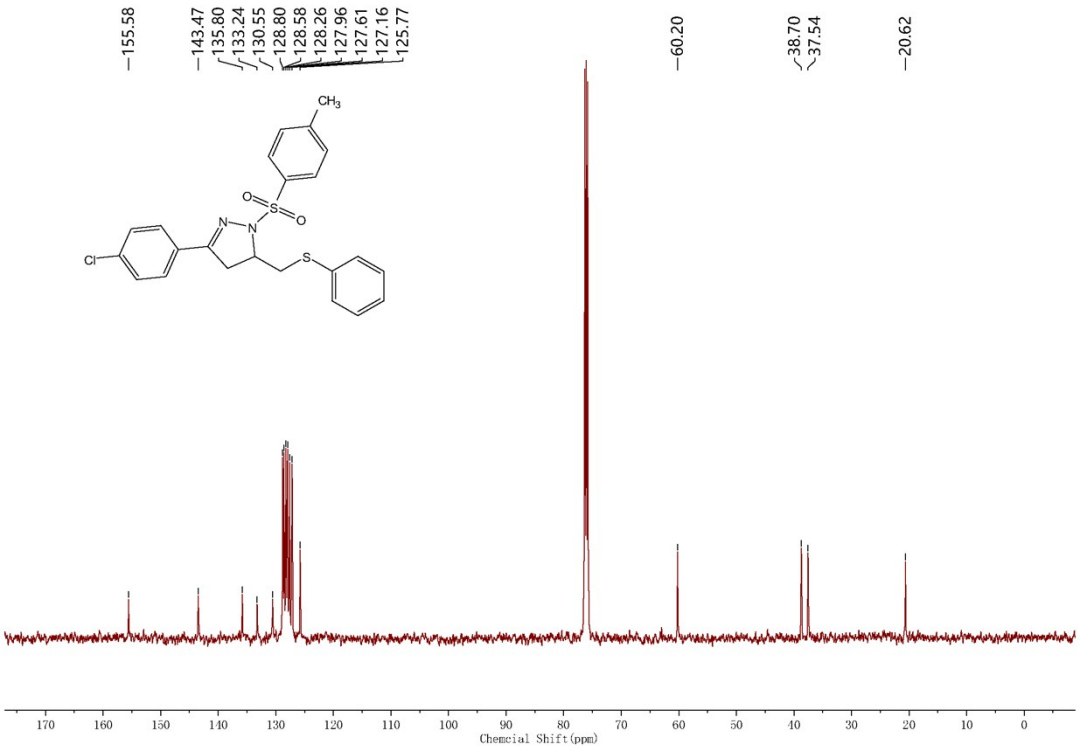
^{19}F NMR Spectrum of Compound **3ca** (470MHz, $CDCl_3$)



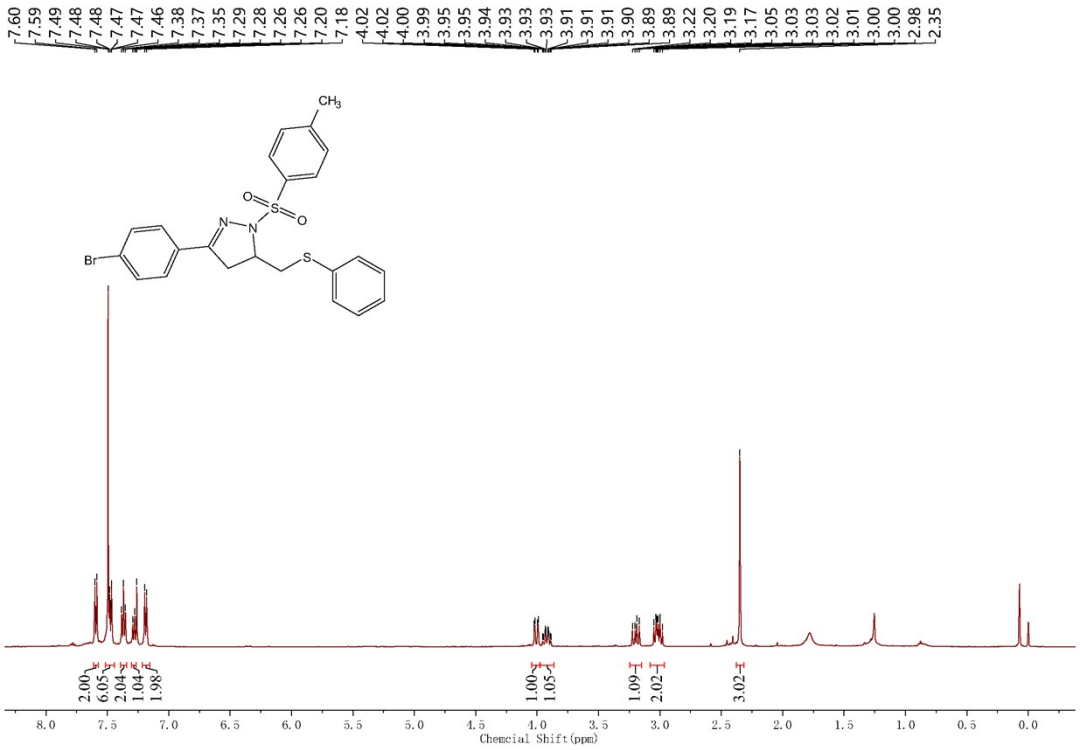
^{13}C NMR Spectrum of Compound **3ca** (125MHz, $CDCl_3$)



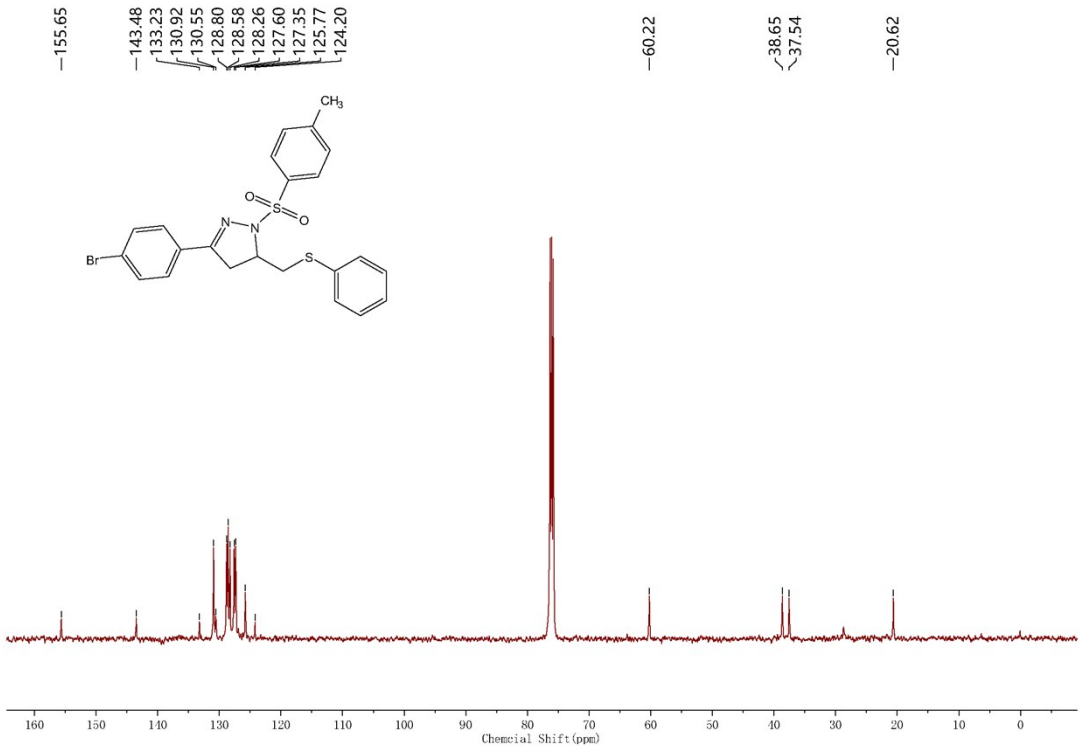
^{1}H NMR Spectrum of Compound **3da** (500MHz, $CDCl_3$)



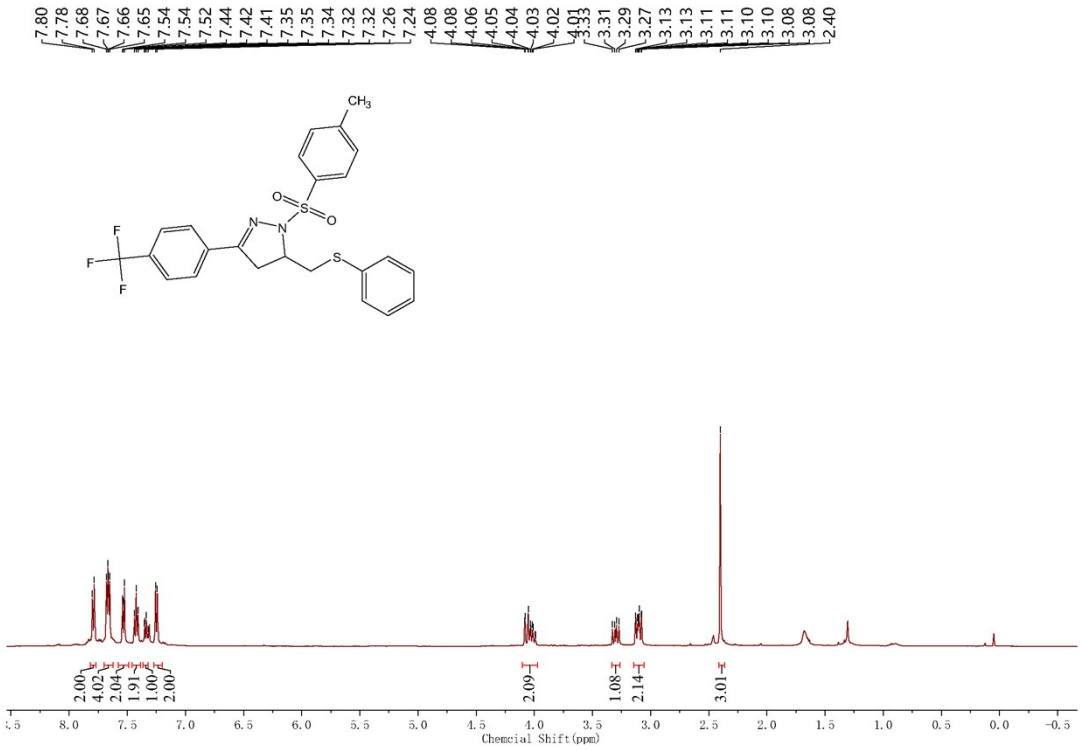
^{13}C NMR Spectrum of Compound **3da** (125MHz, $CDCl_3$)



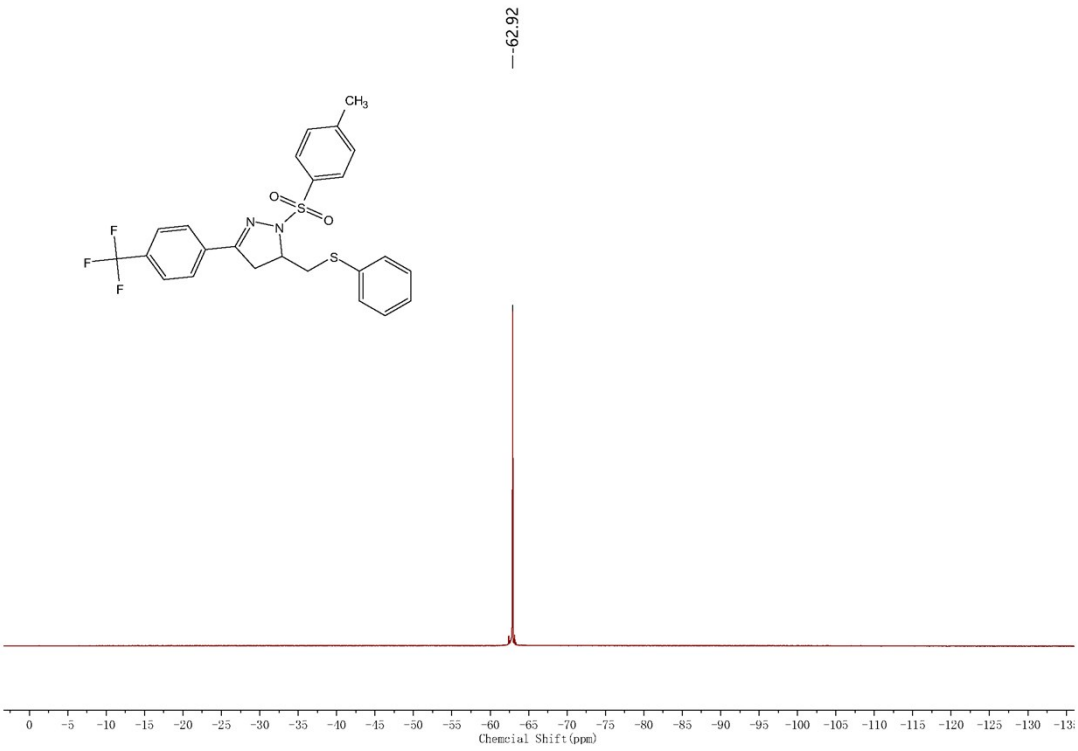
^{1}H NMR Spectrum of Compound **3ea** (500MHz, $CDCl_3$)



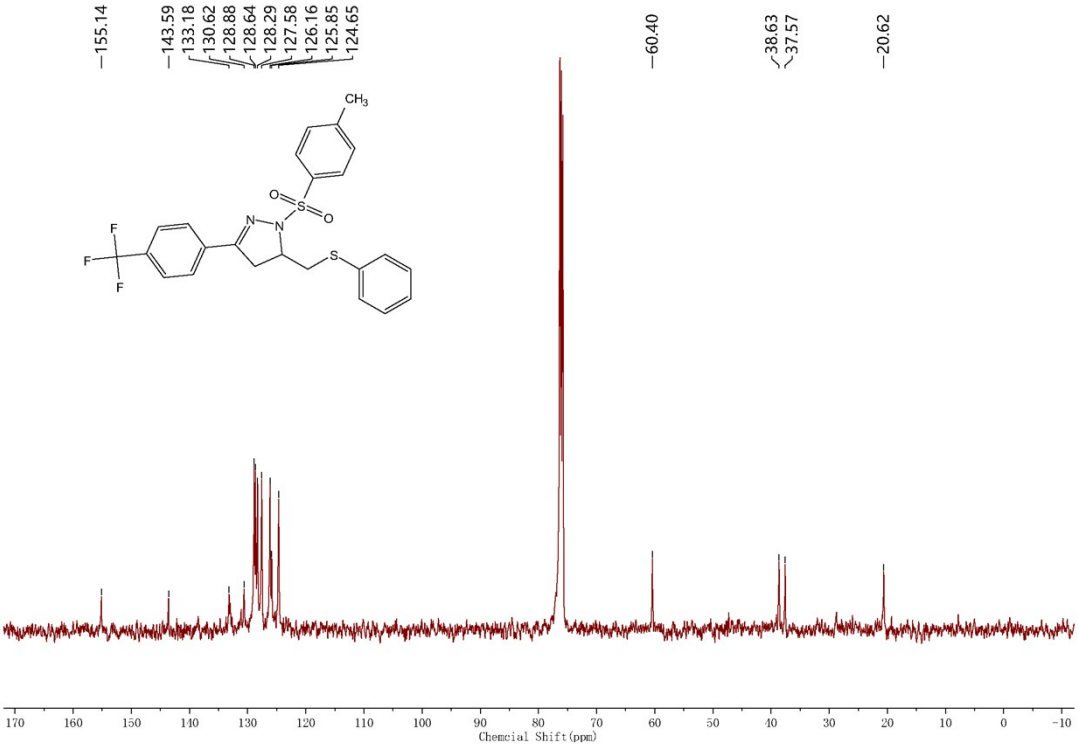
^{13}C NMR Spectrum of Compound **3ea** (125MHz, $CDCl_3$)



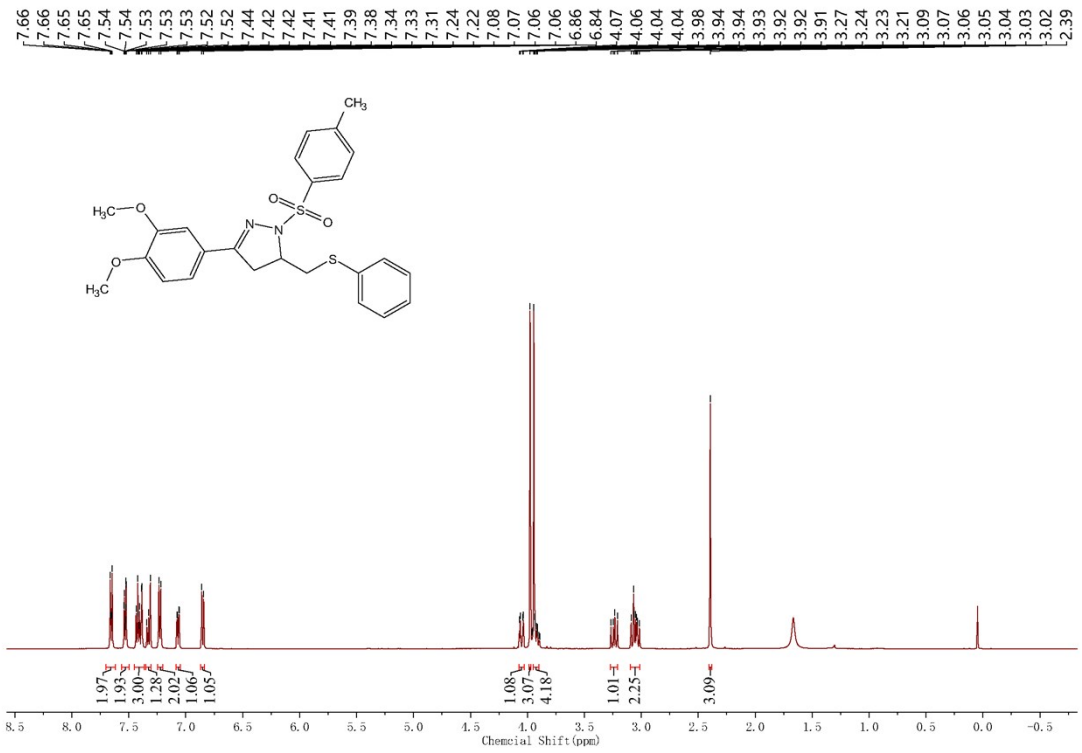
^{1}H NMR Spectrum of Compound **3fa** (500MHz, $CDCl_3$)



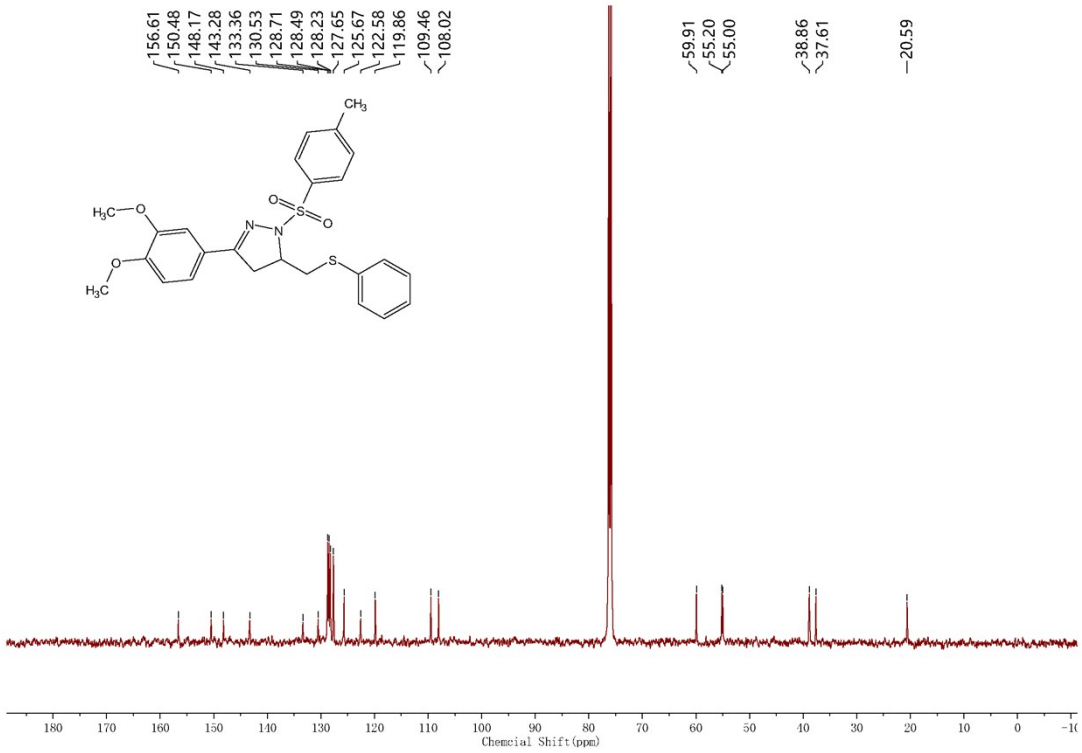
^{19}F NMR Spectrum of Compound **3fa** (470MHz, $CDCl_3$)



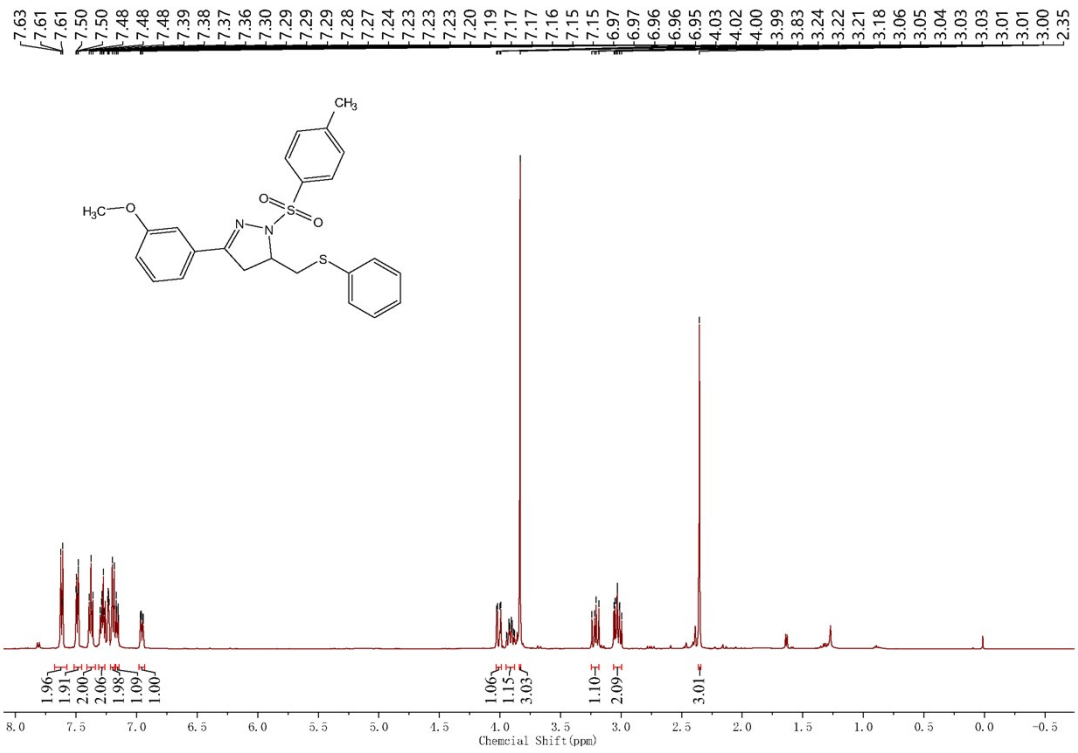
^{13}C NMR Spectrum of Compound **3fa** (125MHz, $CDCl_3$)



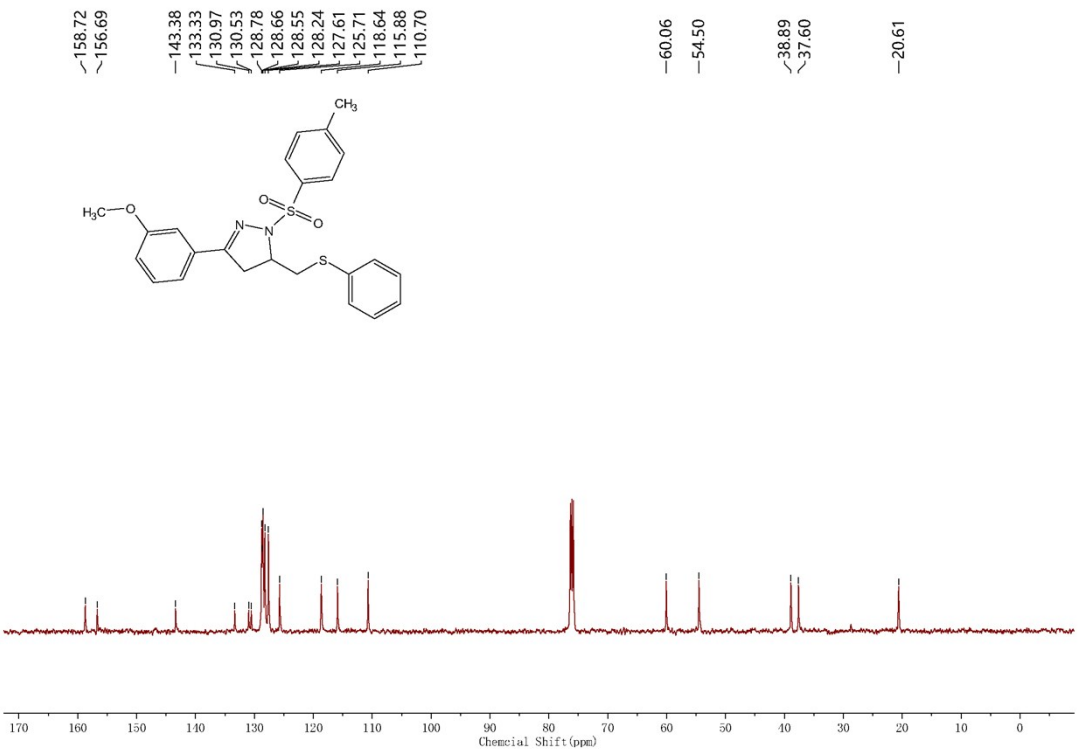
^{1}H NMR Spectrum of Compound **3ga** (500MHz, $CDCl_3$)



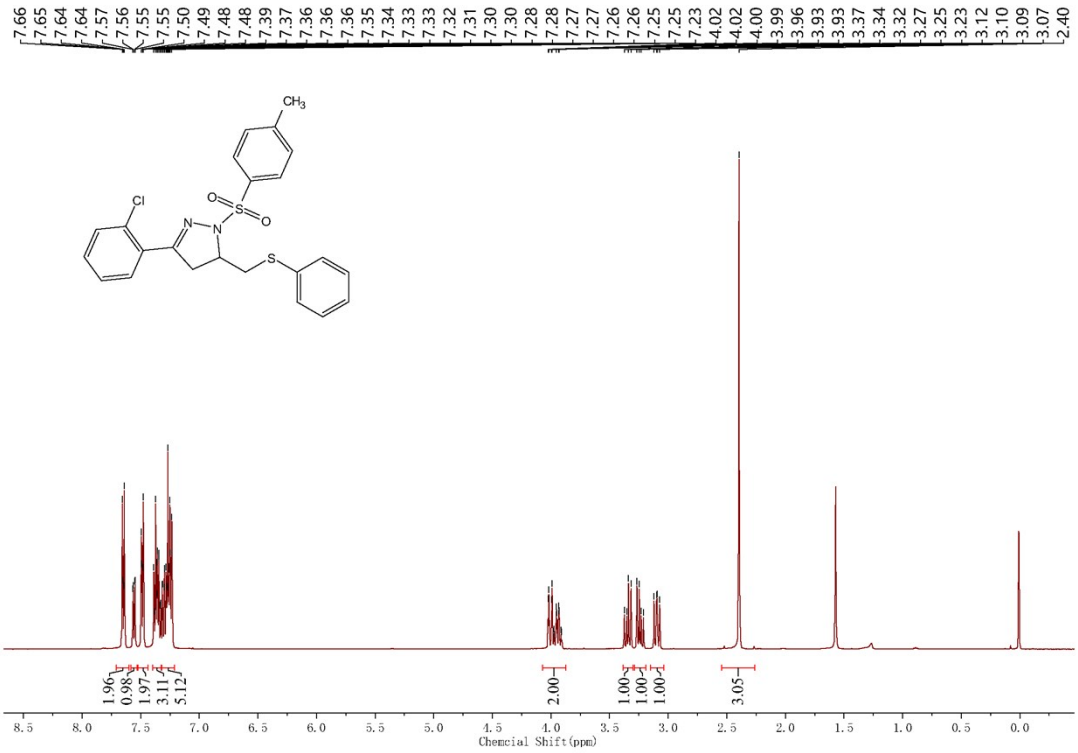
^{13}C NMR Spectrum of Compound **3ga** (125MHz, $CDCl_3$)



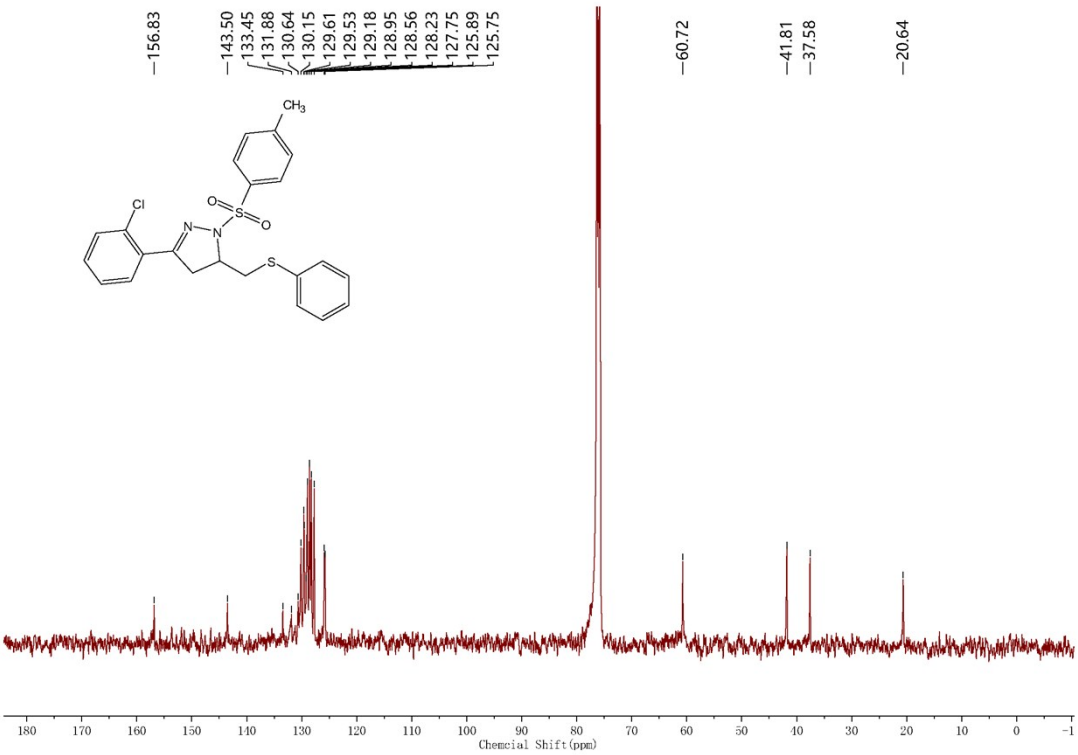
^{1}H NMR Spectrum of Compound **3ha** (500MHz, $CDCl_3$)



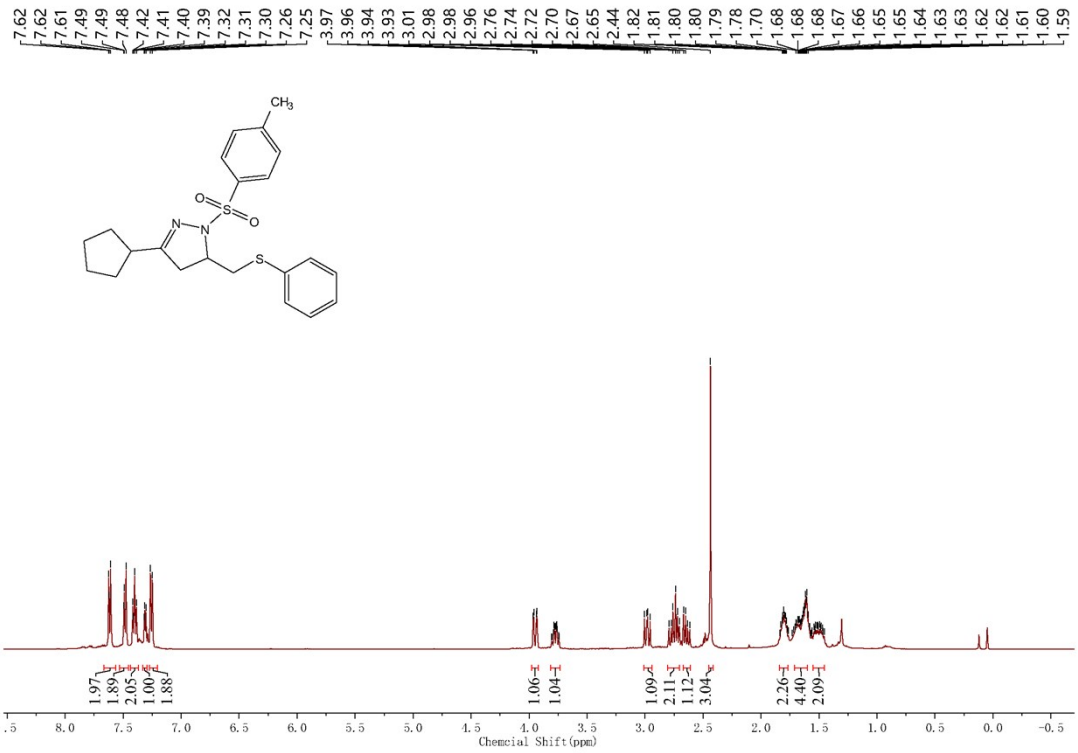
^{13}C NMR Spectrum of Compound **3ha** (125MHz, $CDCl_3$)



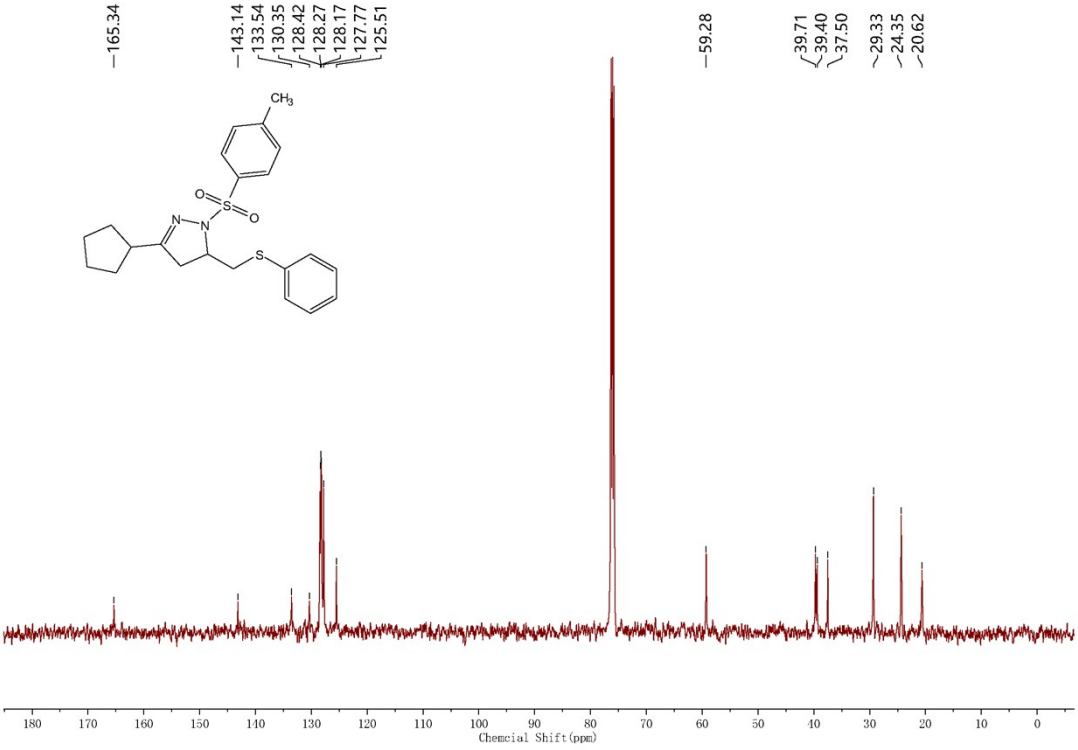
^{1}H NMR Spectrum of Compound **3ia** (500MHz, $CDCl_3$)



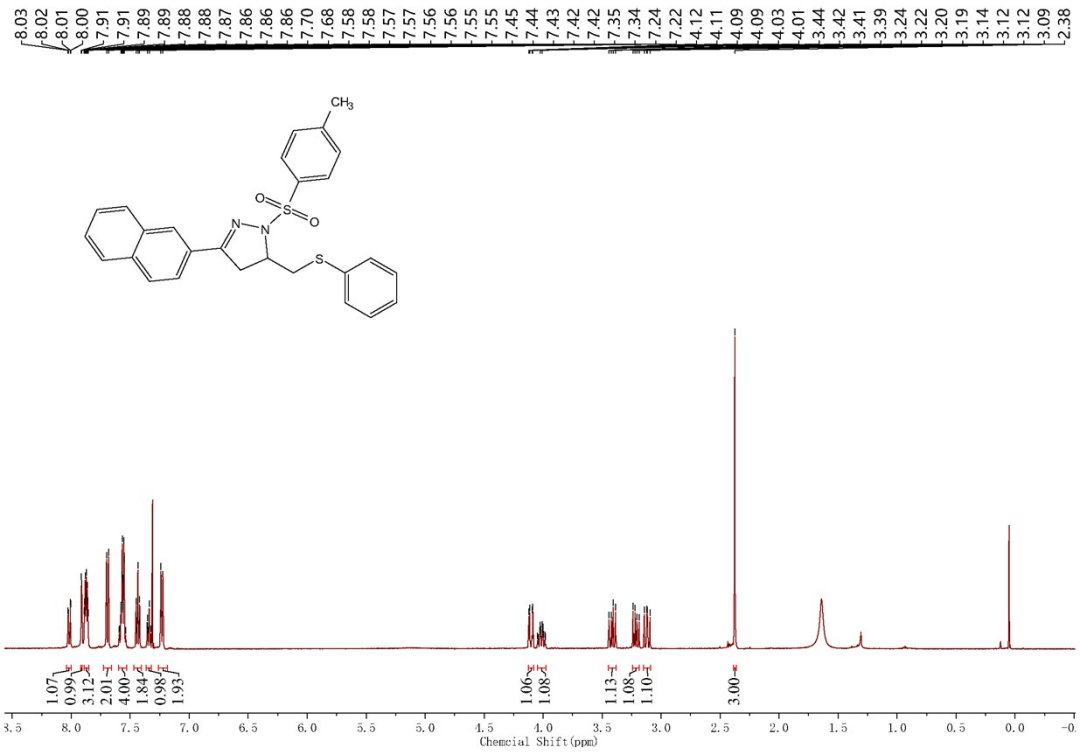
^{13}C NMR Spectrum of Compound **3ia** (125MHz, $CDCl_3$)



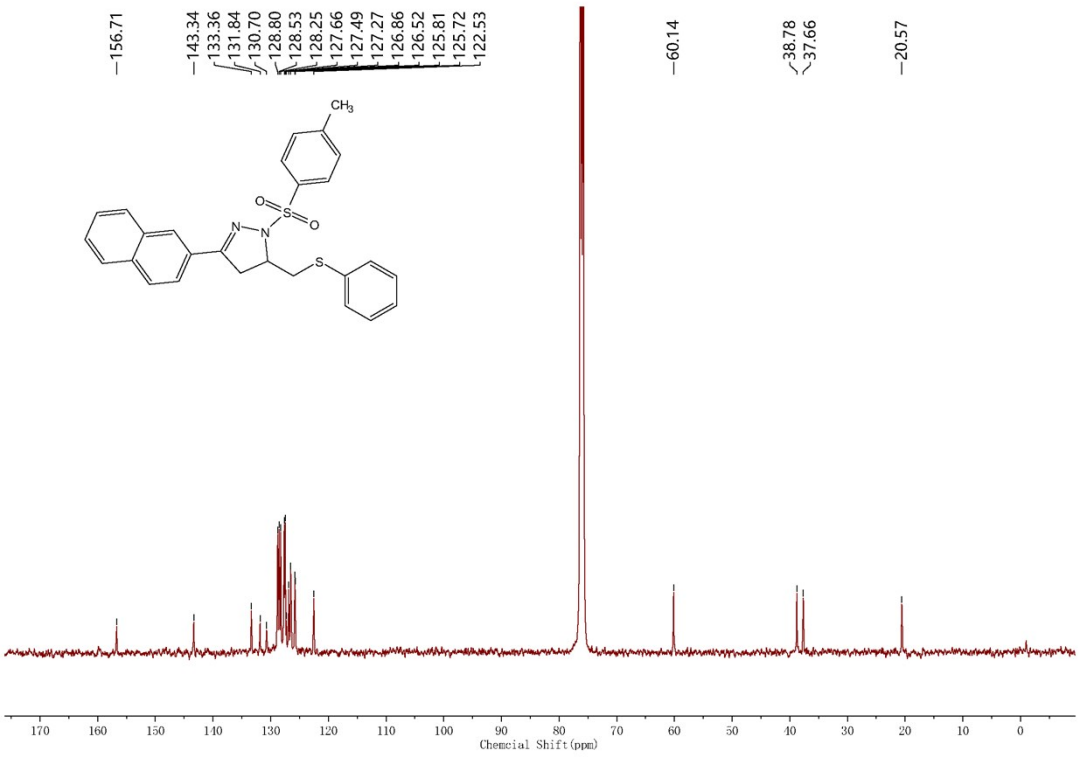
^{1}H NMR Spectrum of Compound **3ja** (500MHz, $CDCl_3$)



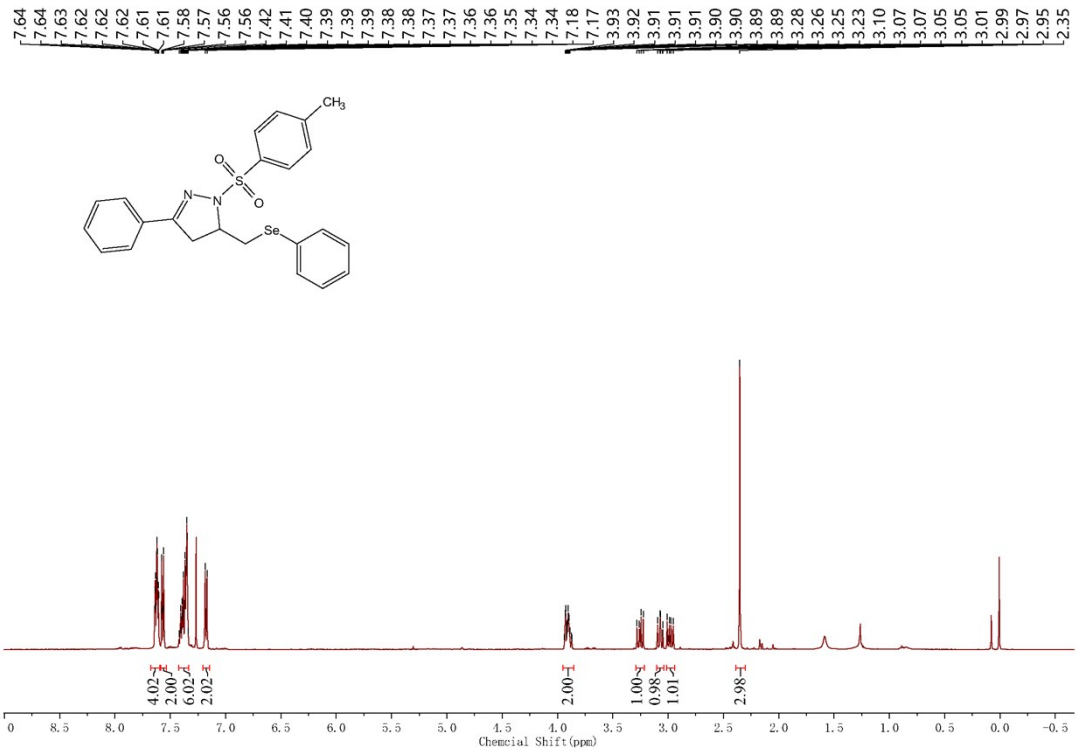
^{13}C NMR Spectrum of Compound **3ja** (125MHz, $CDCl_3$)



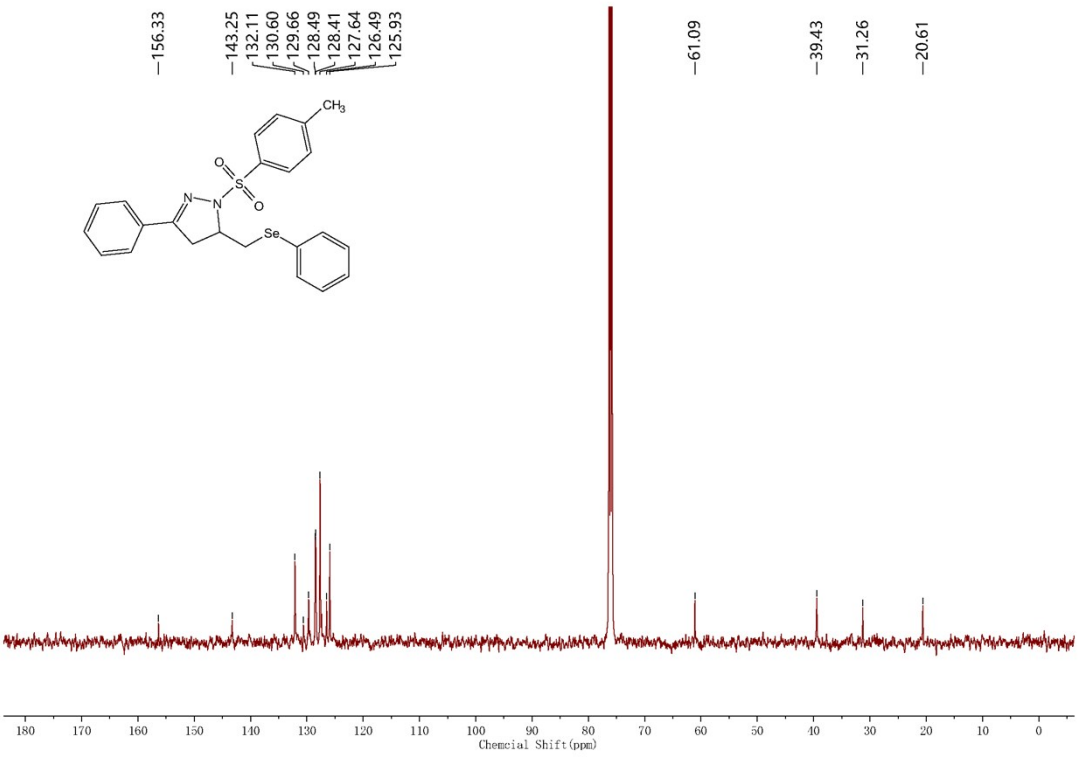
^{1}H NMR Spectrum of Compound **3ka** (500MHz, $CDCl_3$)



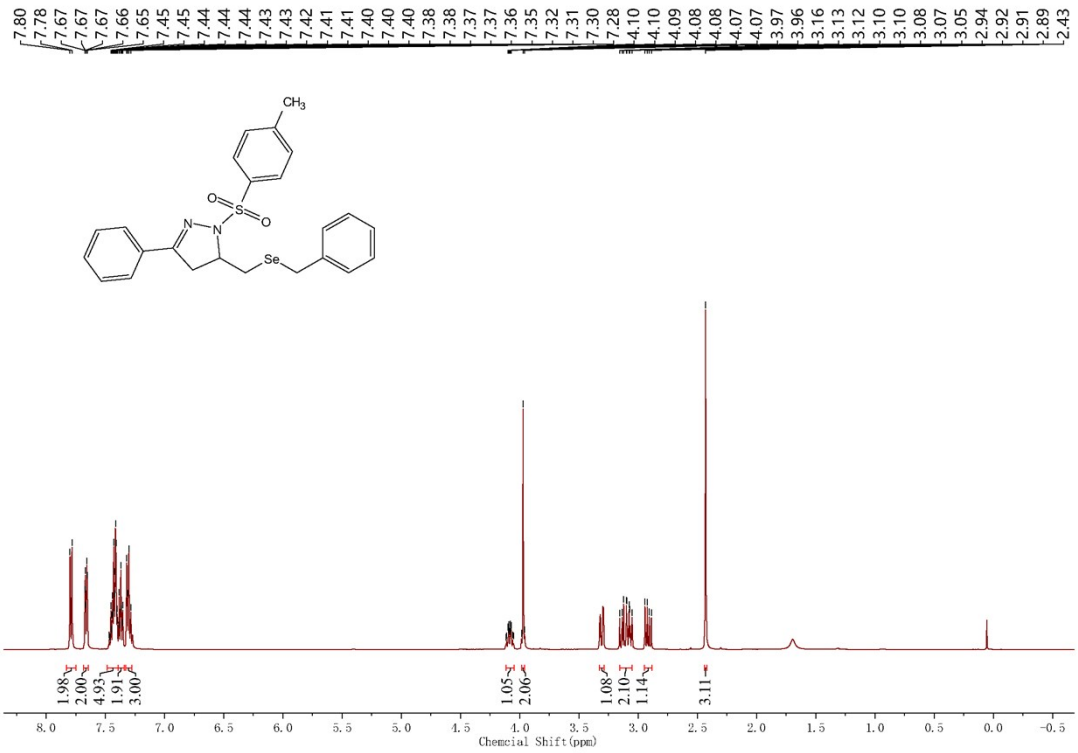
^{13}C NMR Spectrum of Compound **3ka** (125MHz, $CDCl_3$)



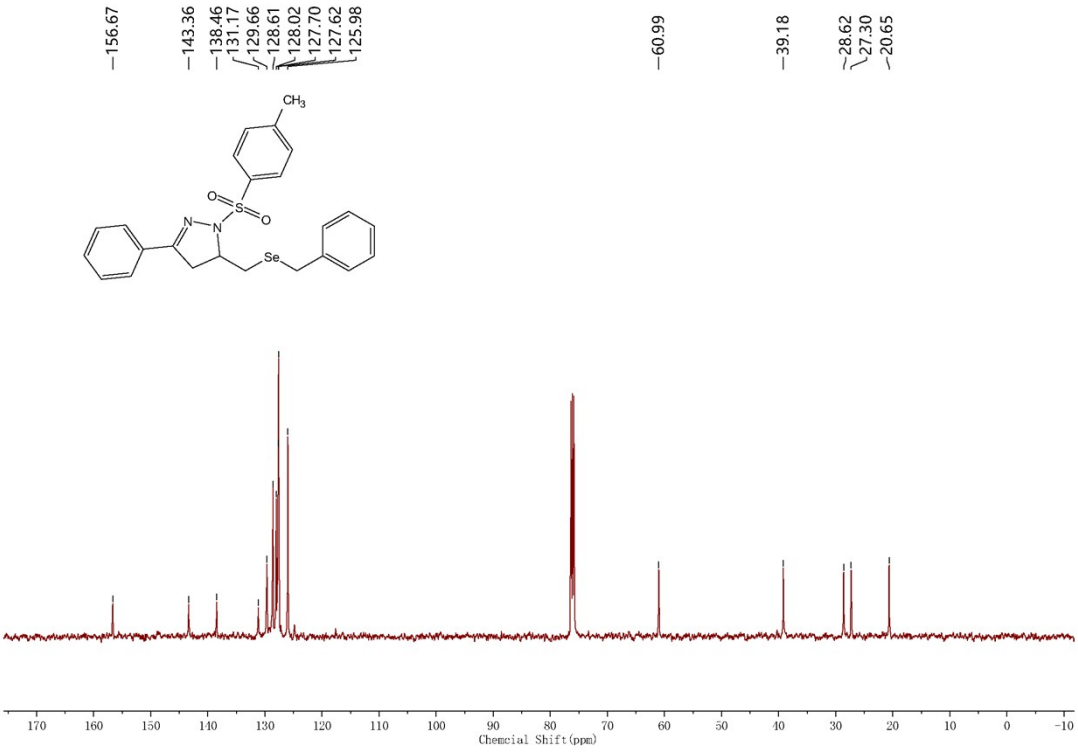
^{1}H NMR Spectrum of Compound **5aa** (500MHz, $CDCl_3$)



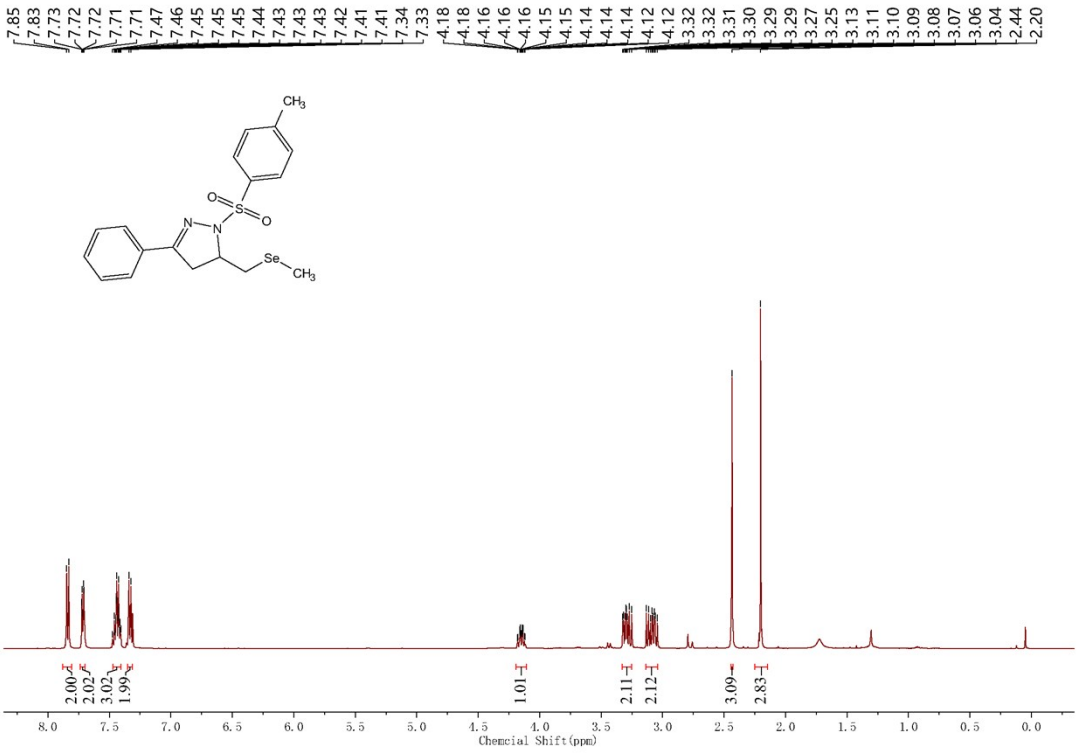
^{13}C NMR Spectrum of Compound **5aa** (125MHz, $CDCl_3$)



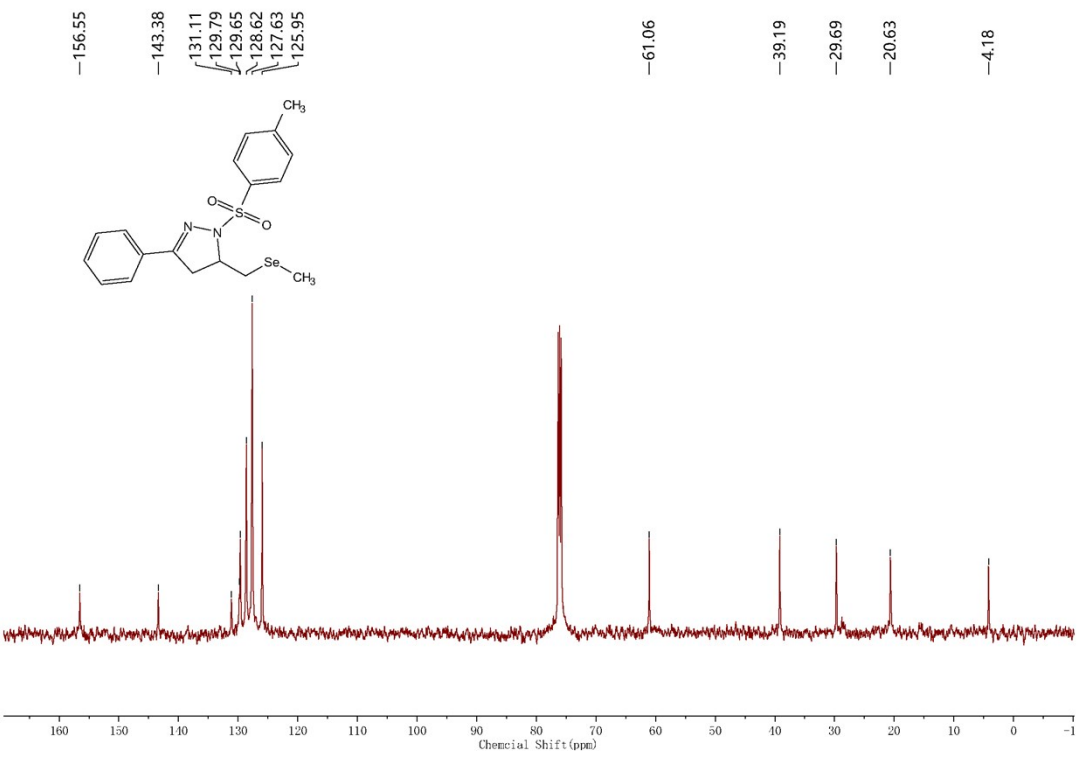
^{1}H NMR Spectrum of Compound **5ab** (500MHz, $CDCl_3$)



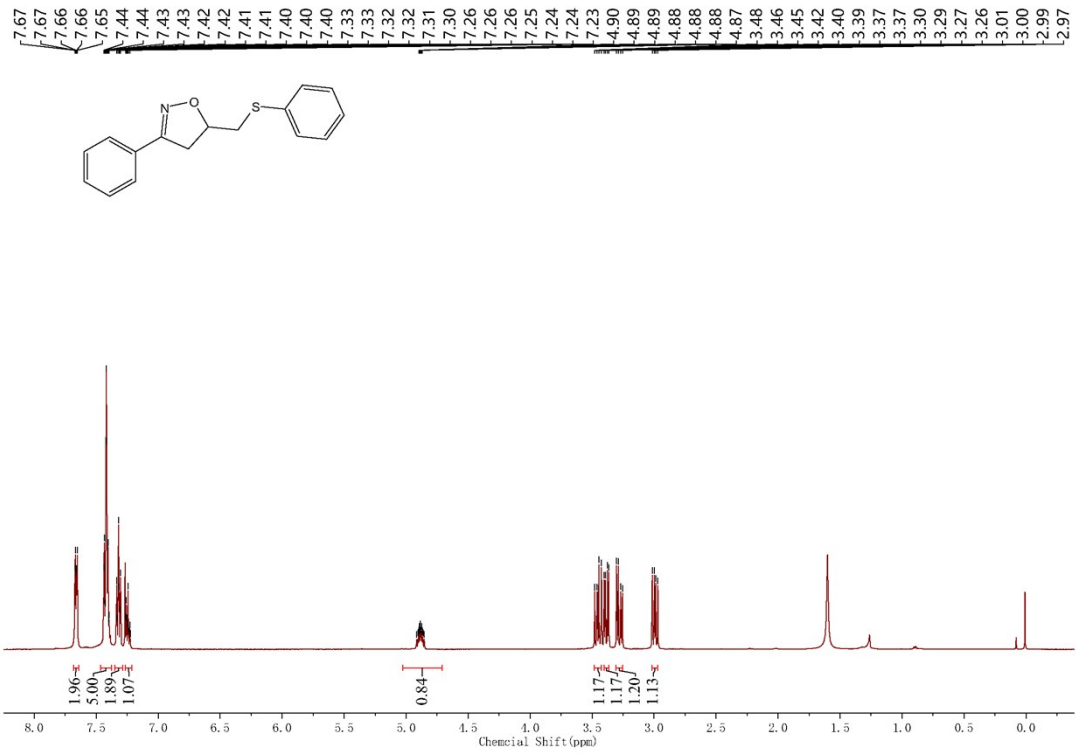
^{13}C NMR Spectrum of Compound **5ab** (125MHz, $CDCl_3$)



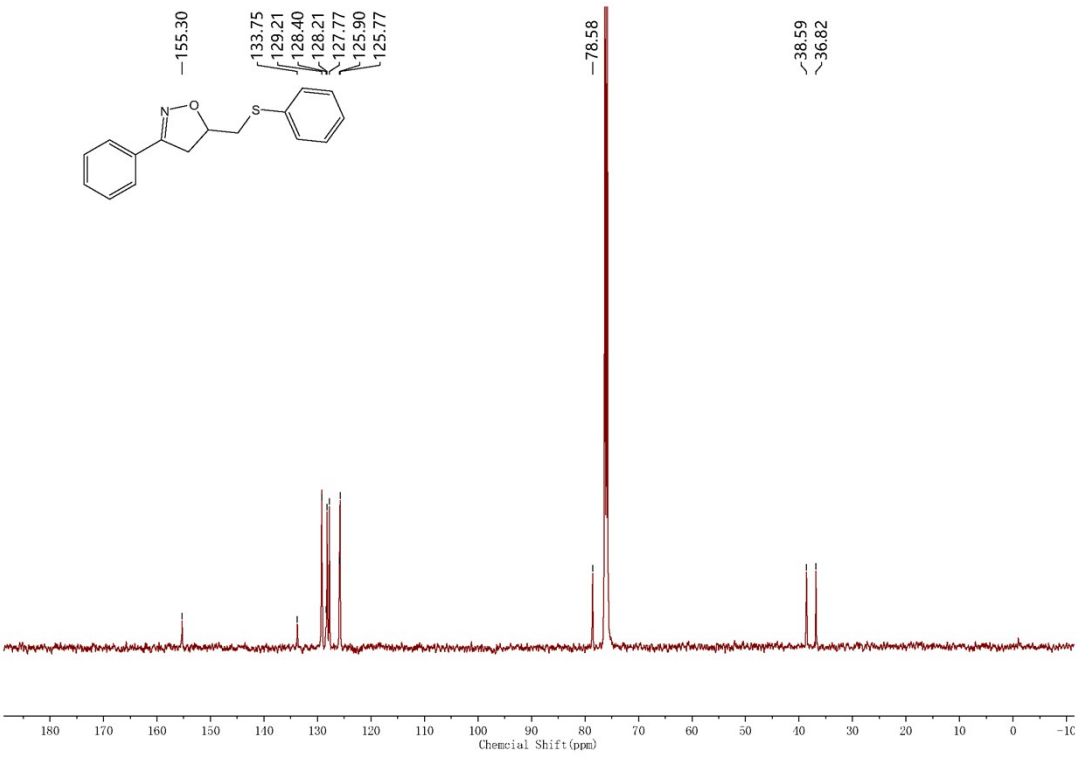
^{1}H NMR Spectrum of Compound **5ac** (500MHz, $CDCl_3$)



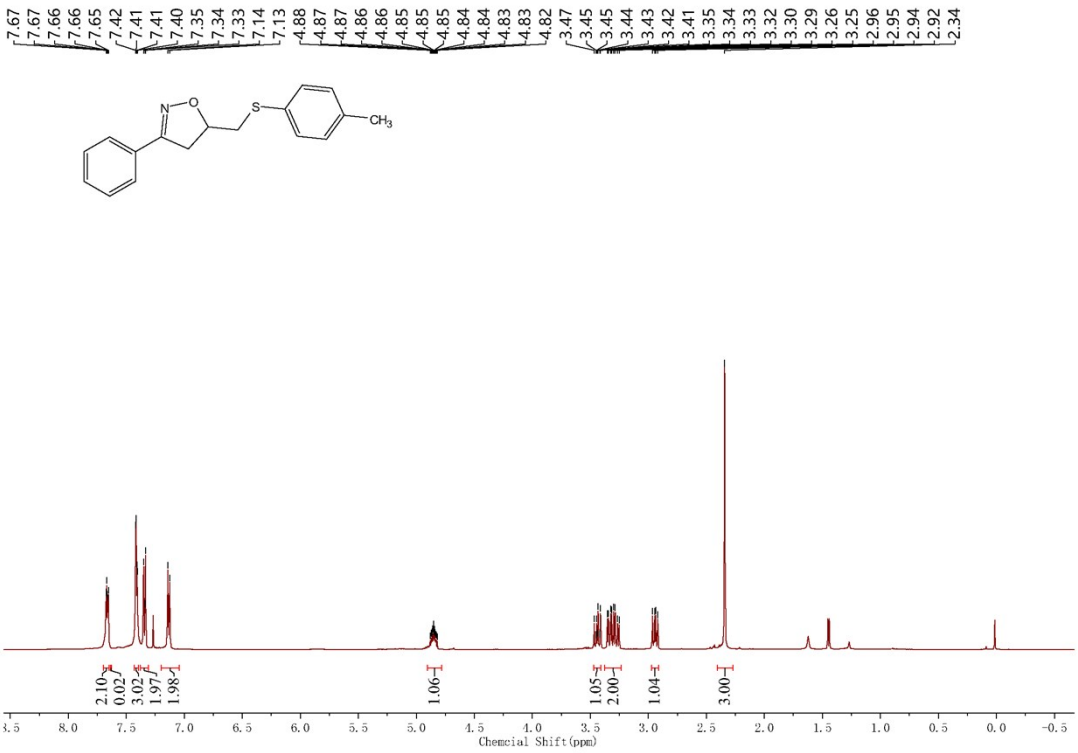
^{13}C NMR Spectrum of Compound **5ac** (125MHz, $CDCl_3$)



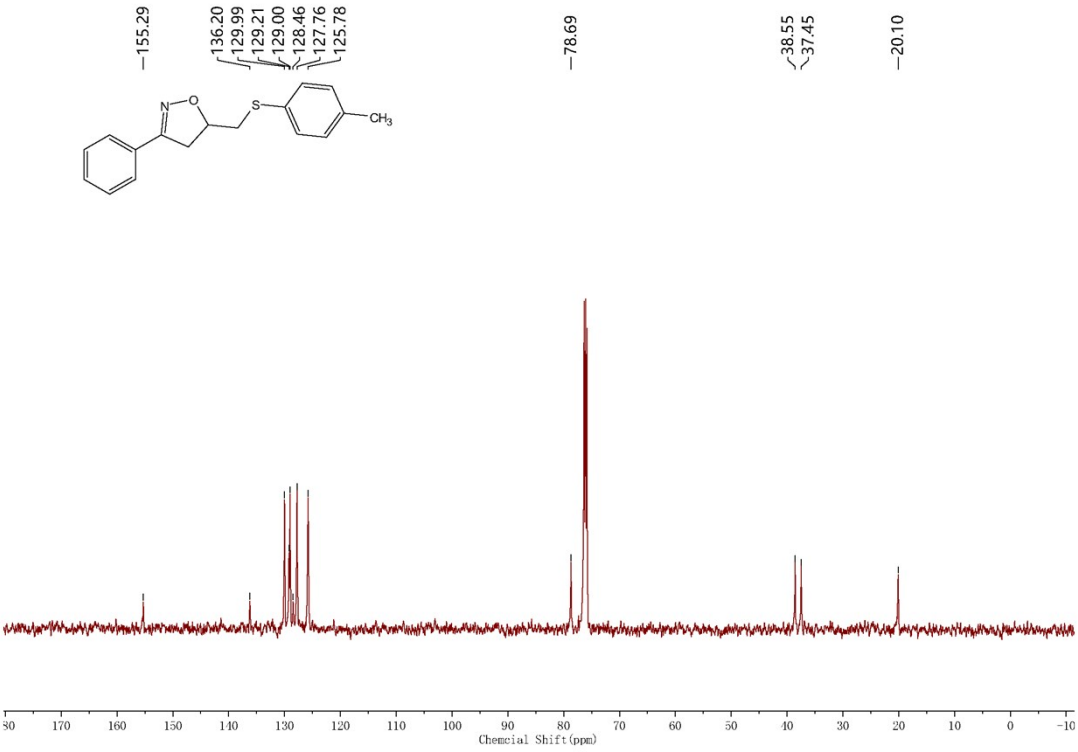
^{1}H NMR Spectrum of Compound **7aa** (500MHz, $CDCl_3$)



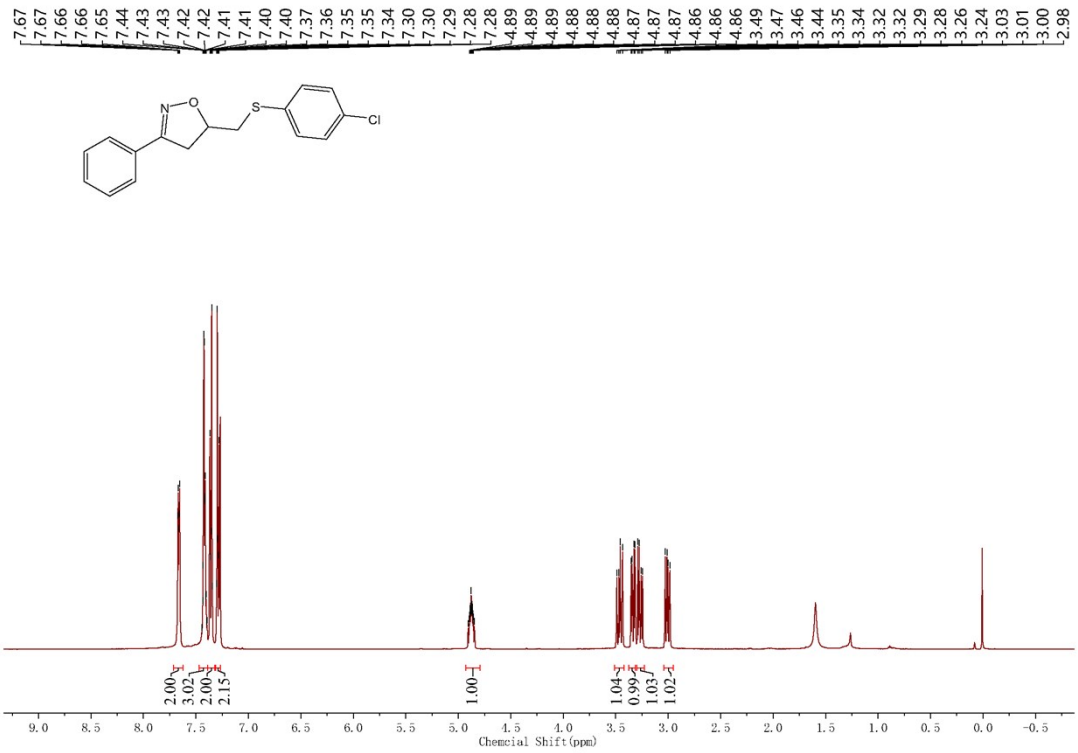
^{13}C NMR Spectrum of Compound **7aa** (125MHz, $CDCl_3$)



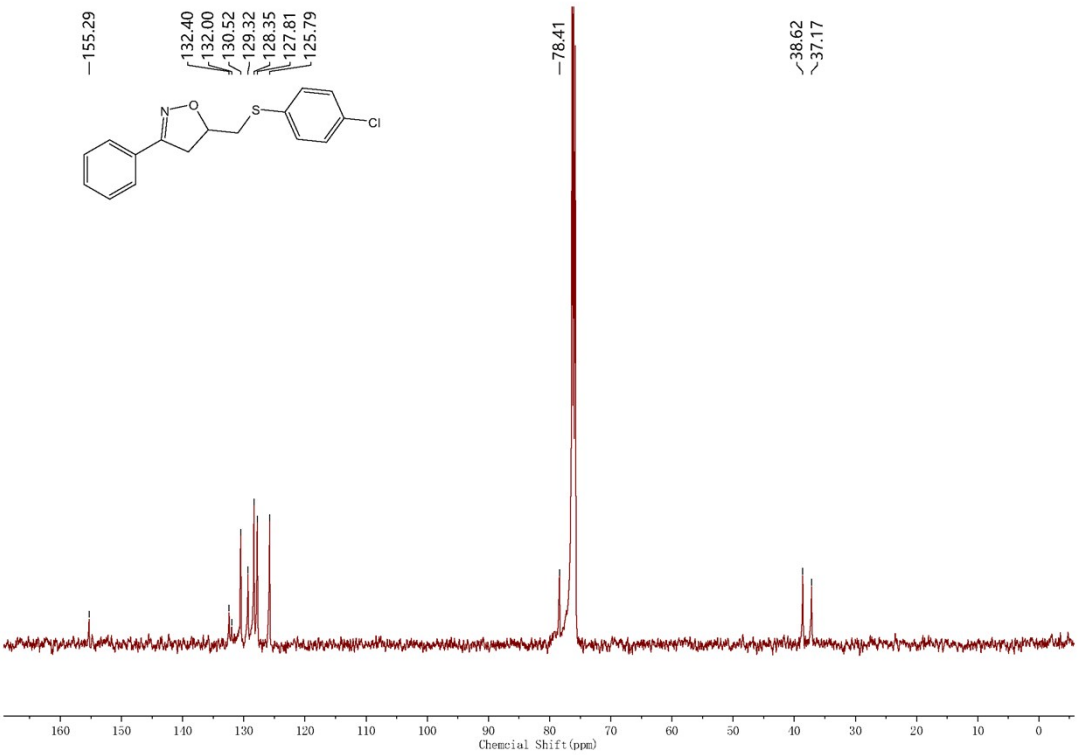
^{1}H NMR Spectrum of Compound **7ab** (500MHz, $CDCl_3$)



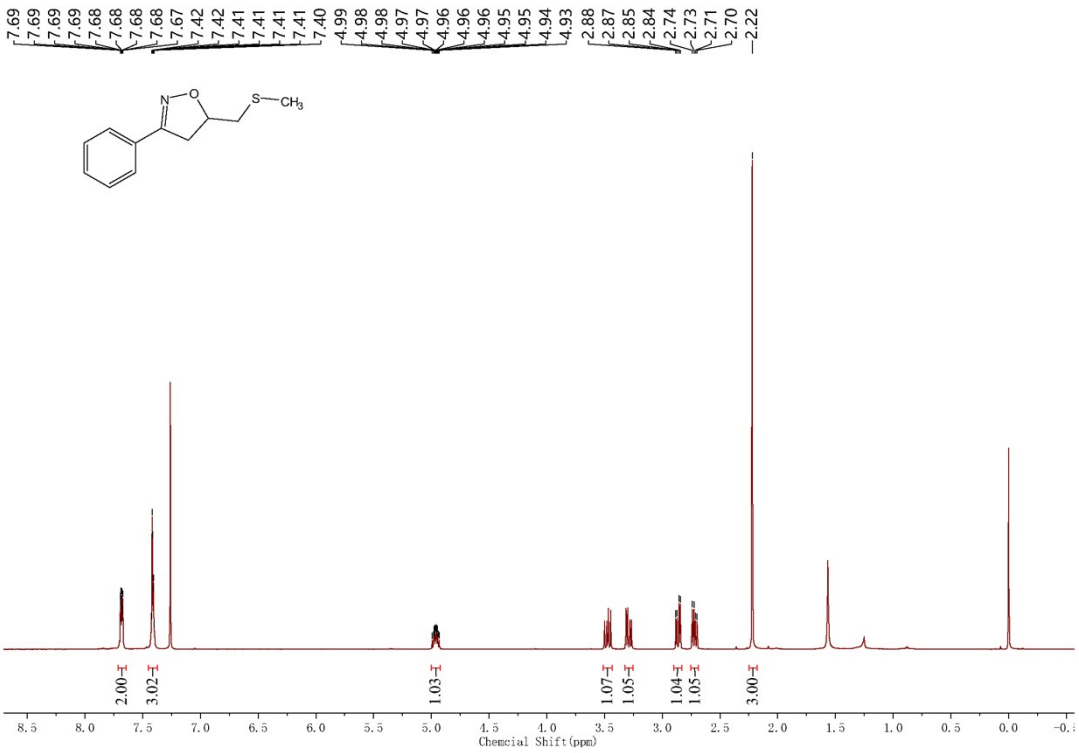
^{13}C NMR Spectrum of Compound **7ab** (125MHz, $CDCl_3$)



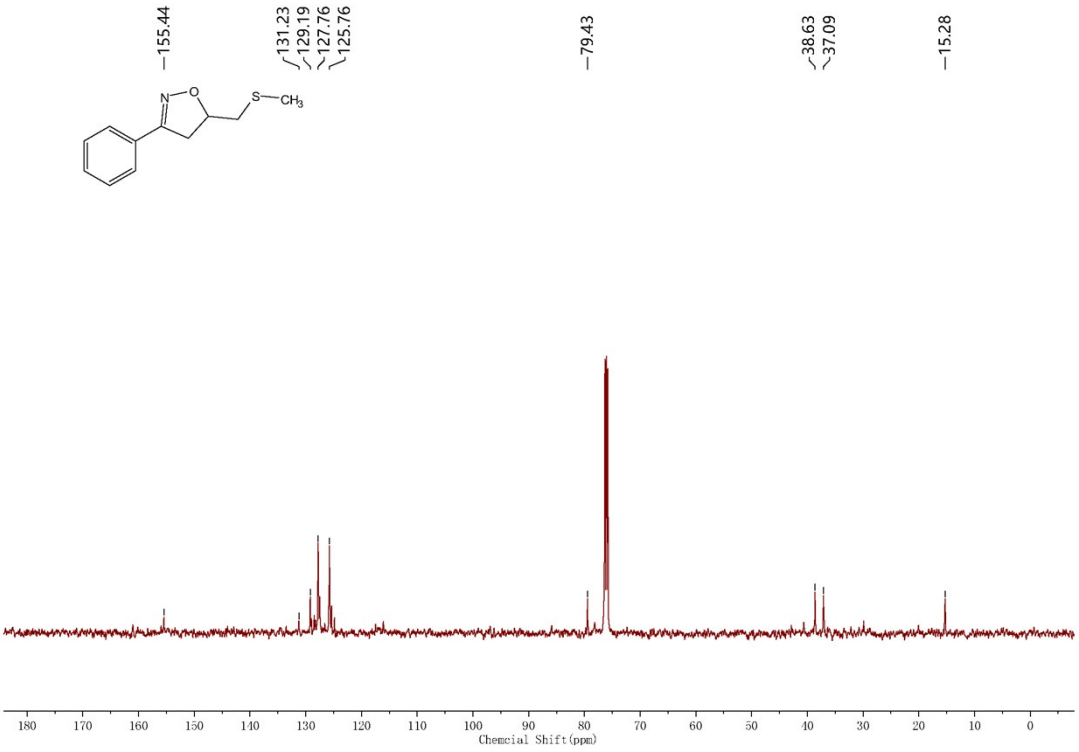
^{1}H NMR Spectrum of Compound **7ad** (500MHz, $CDCl_3$)



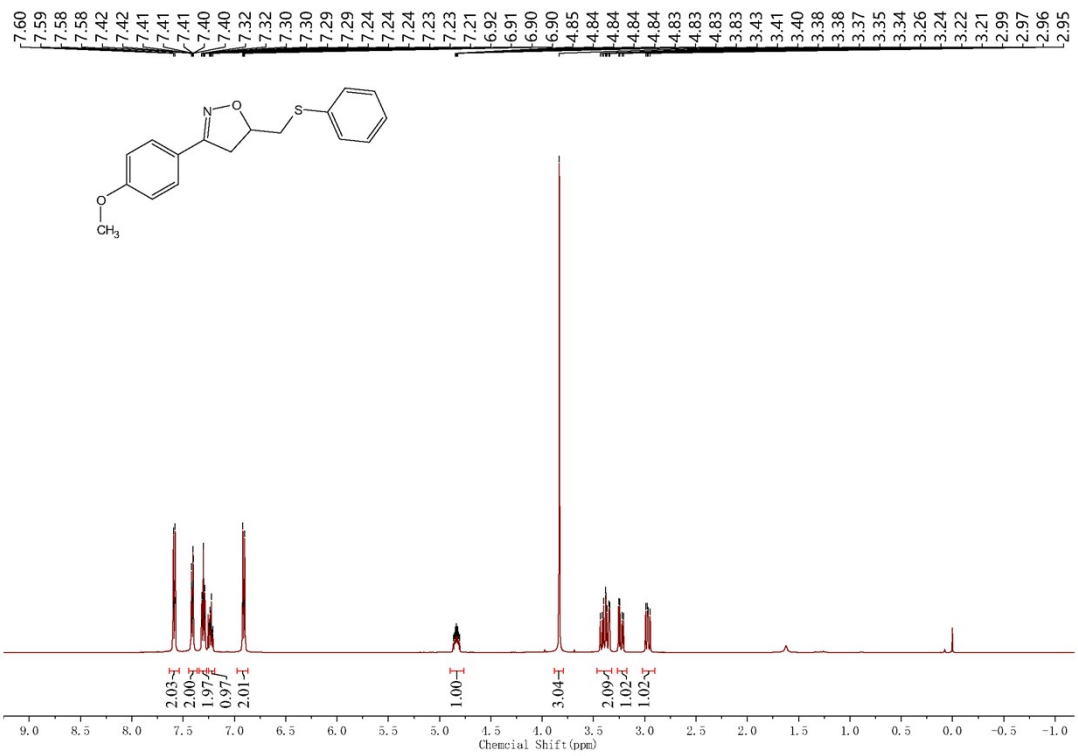
^{13}C NMR Spectrum of Compound **7ad** (125MHz, $CDCl_3$)



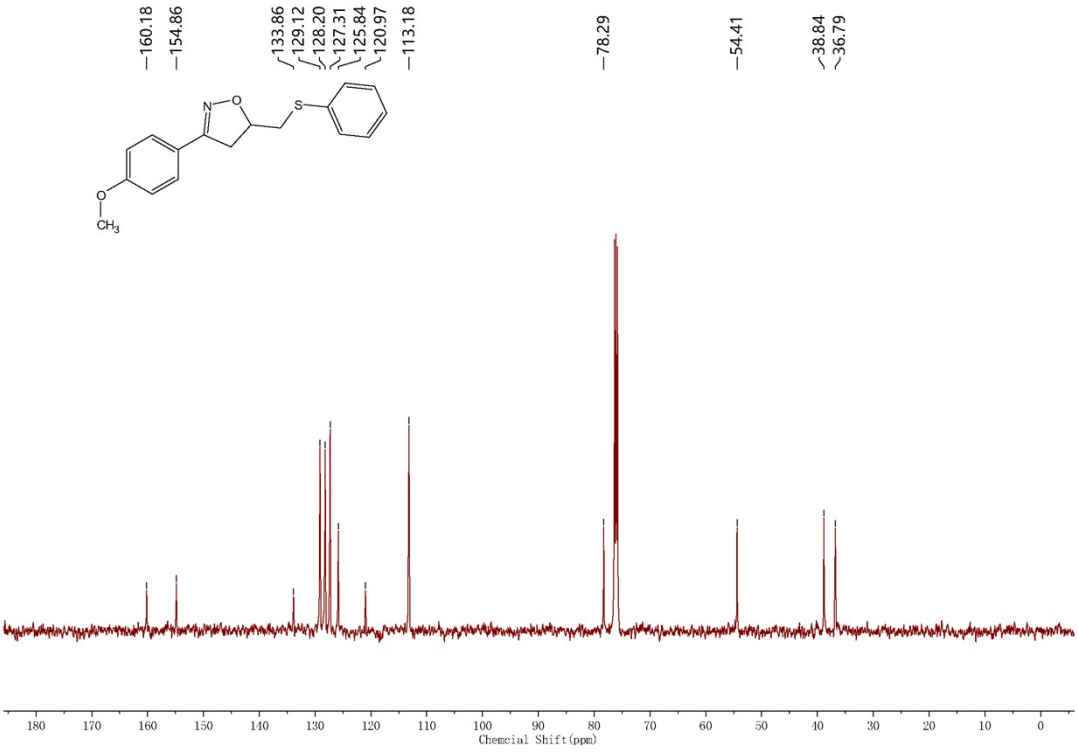
^{1}H NMR Spectrum of Compound **7ah** (500MHz, $CDCl_3$)



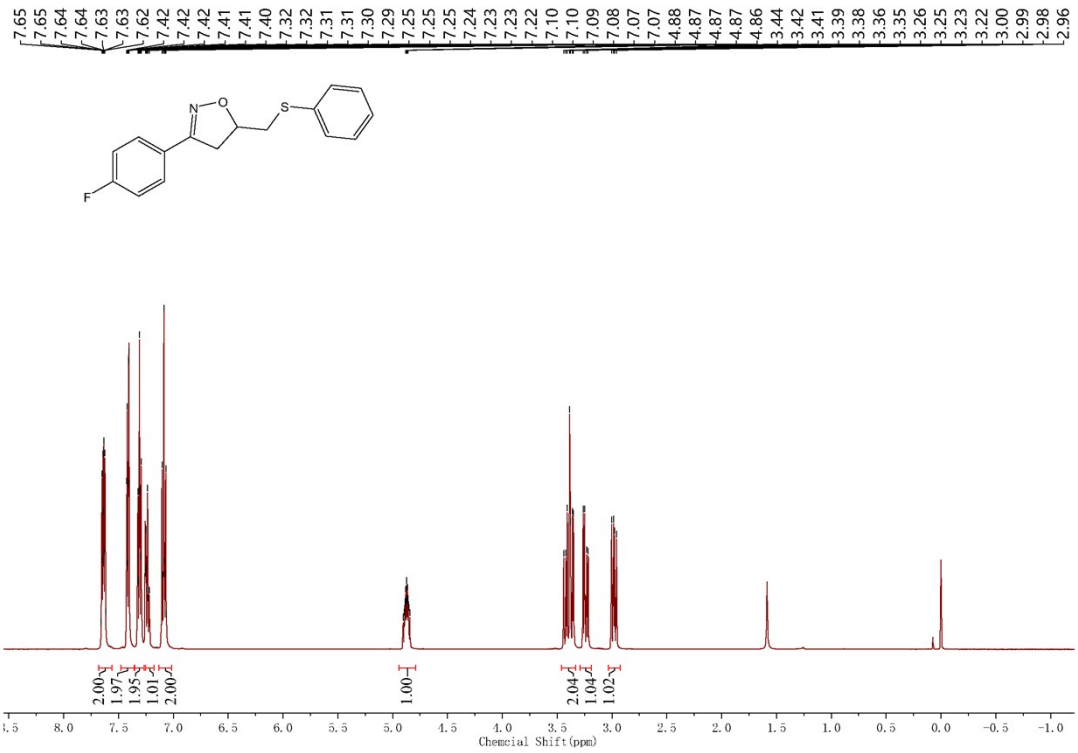
^{13}C NMR Spectrum of Compound **7ah** (125MHz, $CDCl_3$)



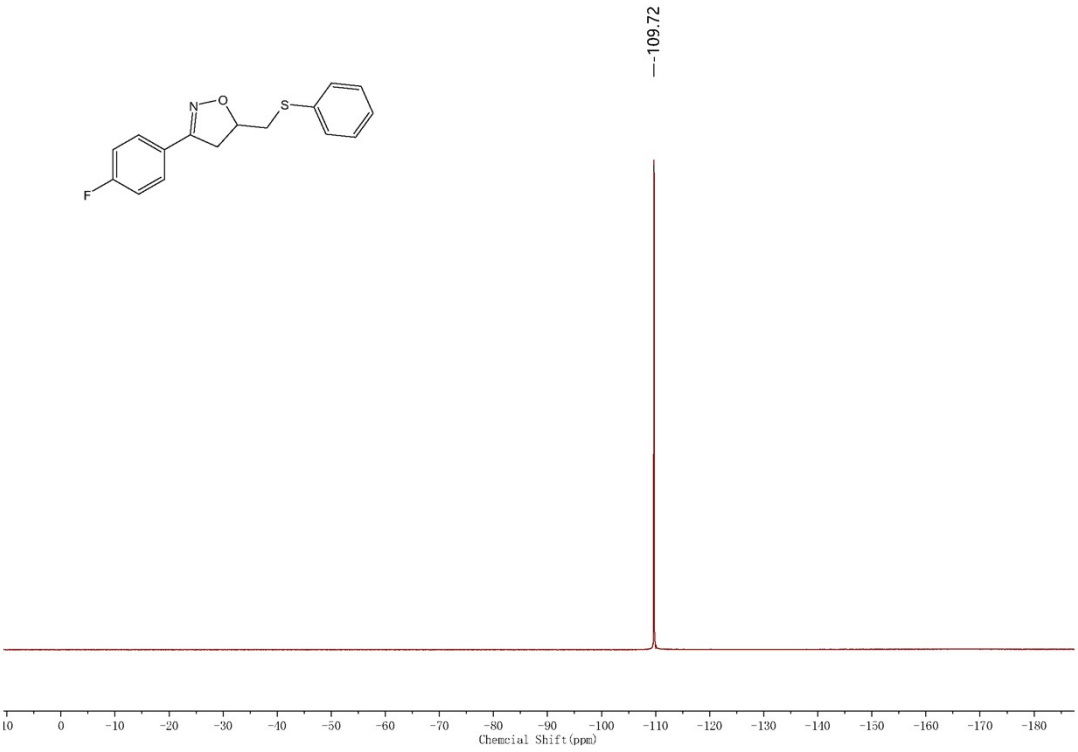
^{1}H NMR Spectrum of Compound **7ba** (500MHz, $CDCl_3$)



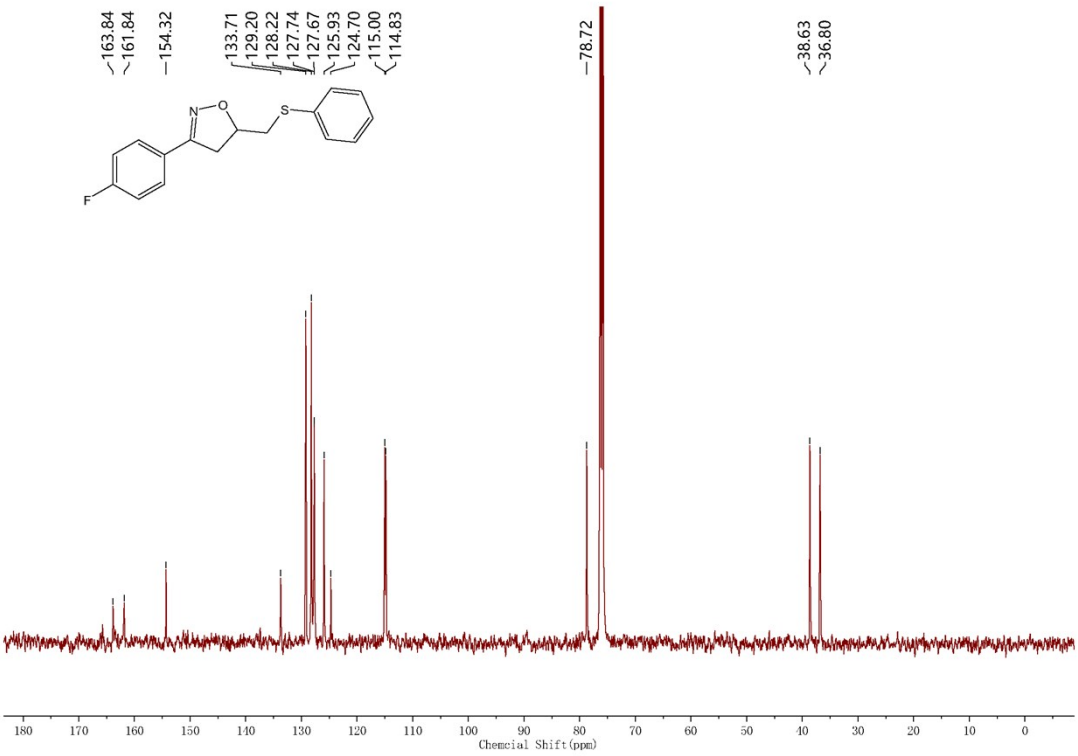
^{13}C NMR Spectrum of Compound **7ba** (125MHz, $CDCl_3$)



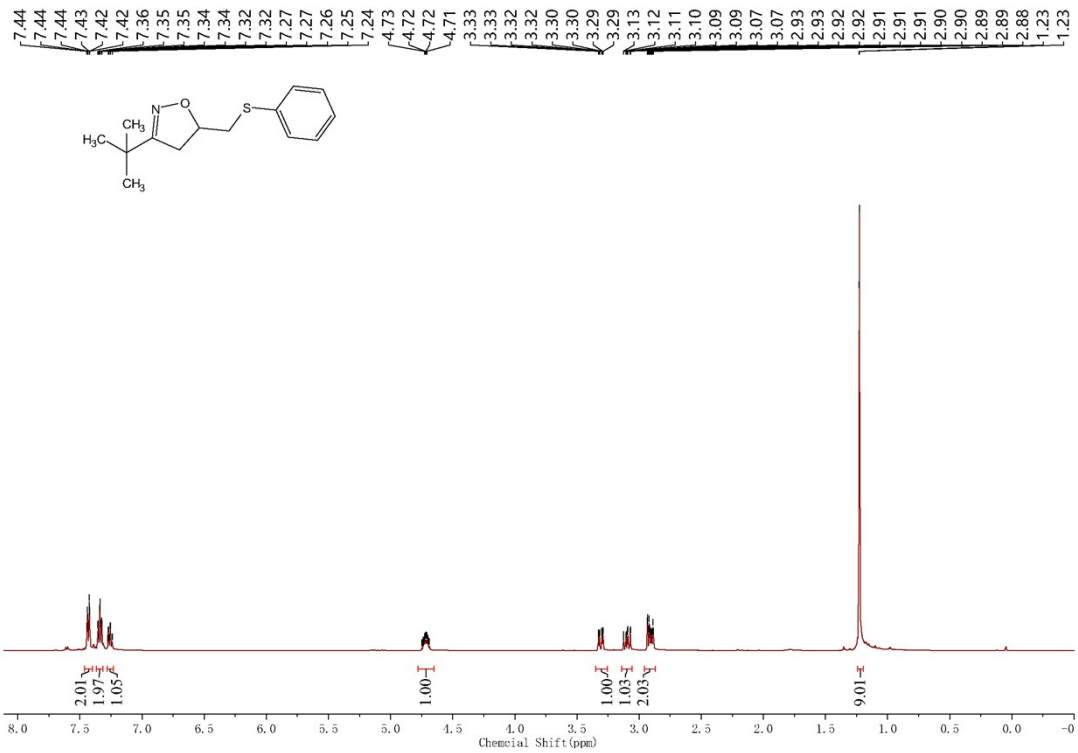
^{1}H NMR Spectrum of Compound **7ca** (500MHz, $CDCl_3$)



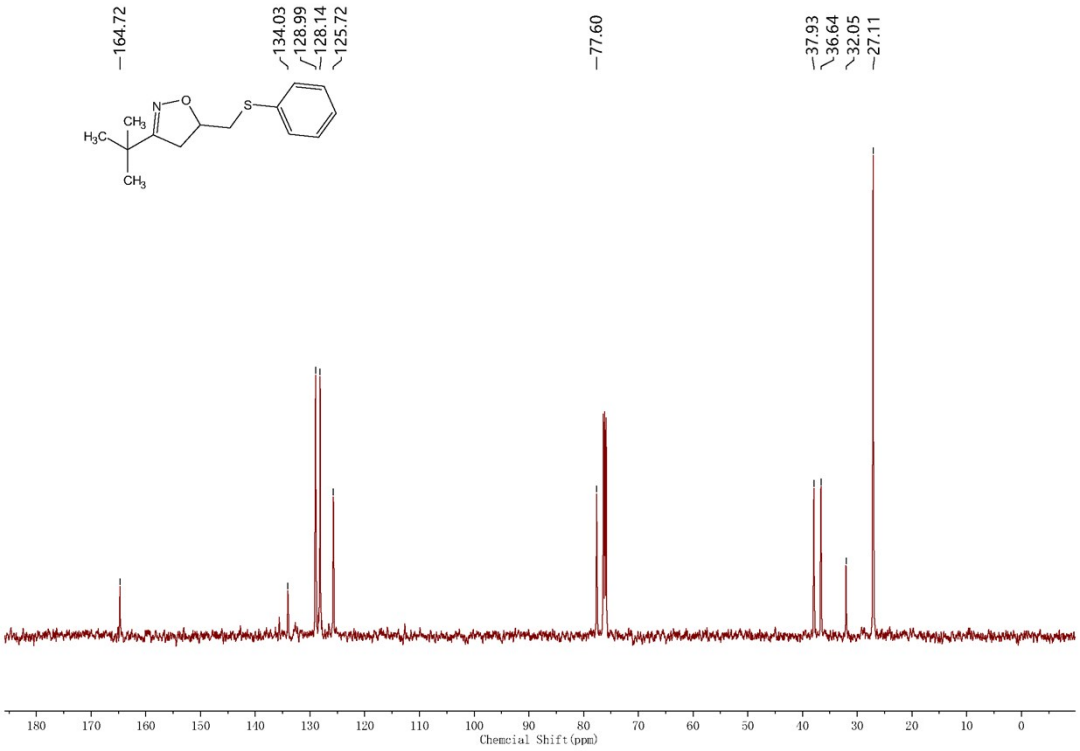
^{19}F NMR Spectrum of Compound **7ca** (470MHz, $CDCl_3$)



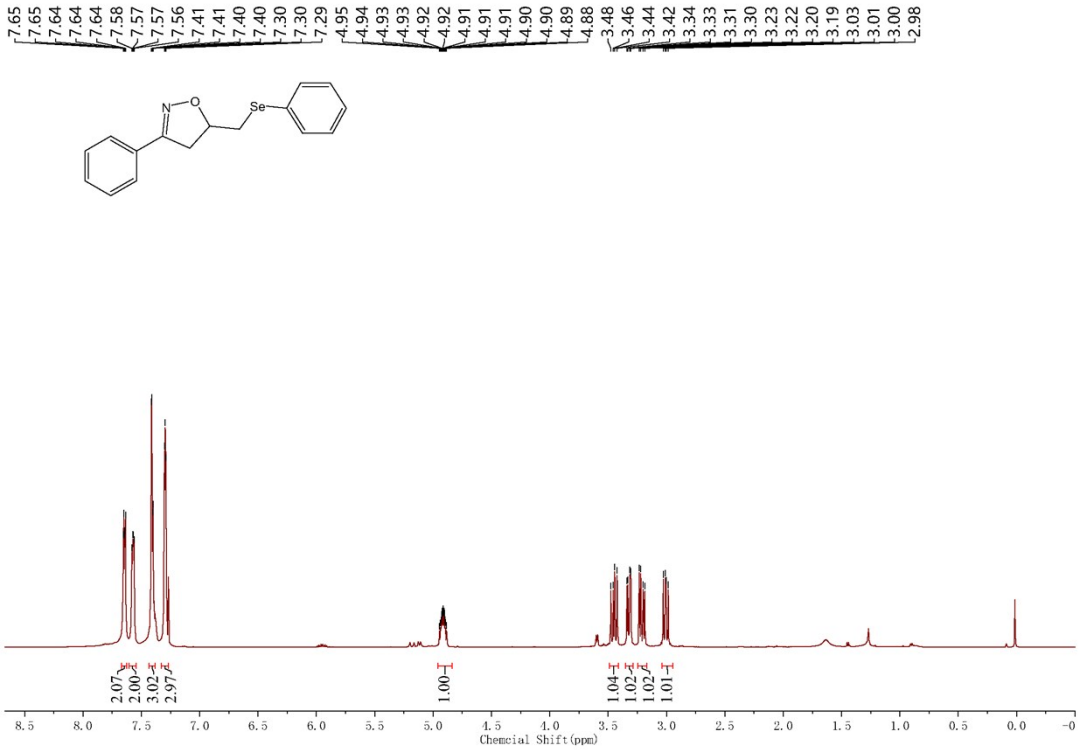
^{13}C NMR Spectrum of Compound **7ca** (125MHz, $CDCl_3$)



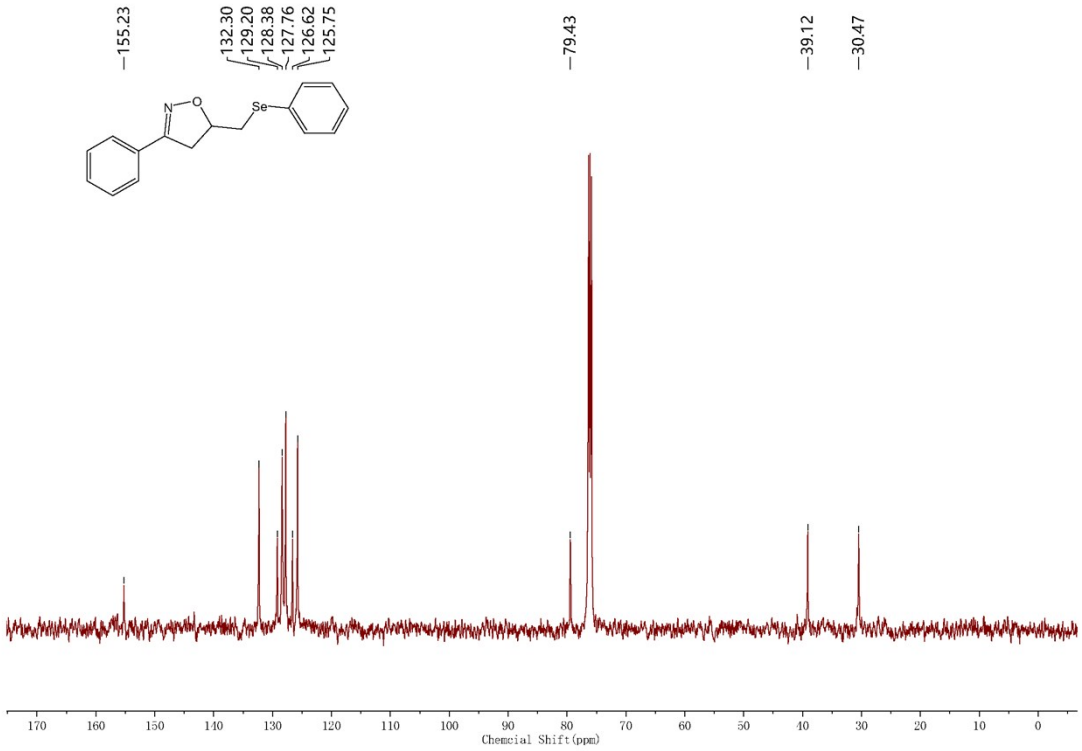
^{1}H NMR Spectrum of Compound **7da** (500MHz, $CDCl_3$)



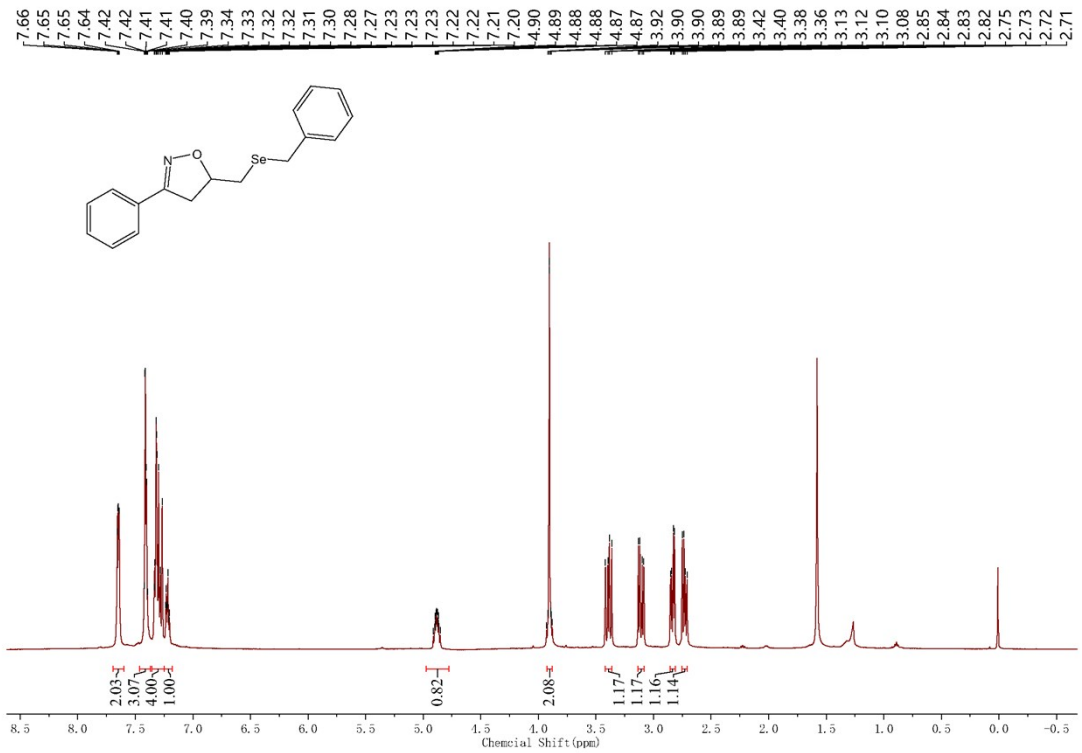
^{13}C NMR Spectrum of Compound **7da** (125MHz, $CDCl_3$)



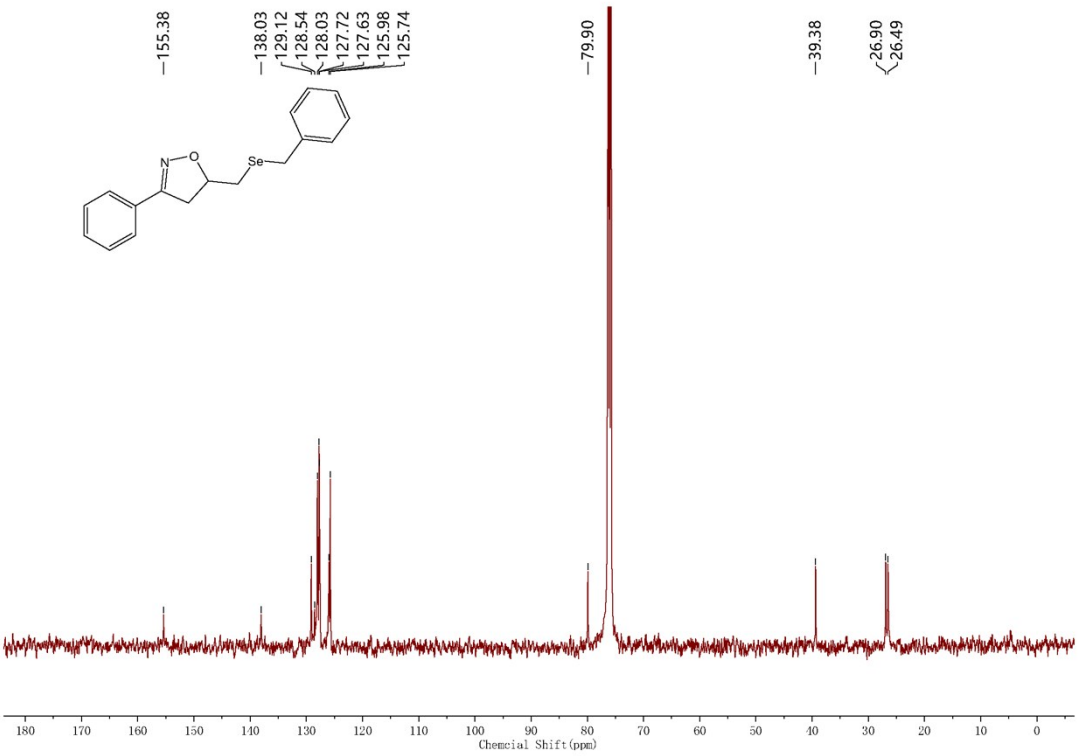
^{1}H NMR Spectrum of Compound **8aa** (500MHz, $CDCl_3$)



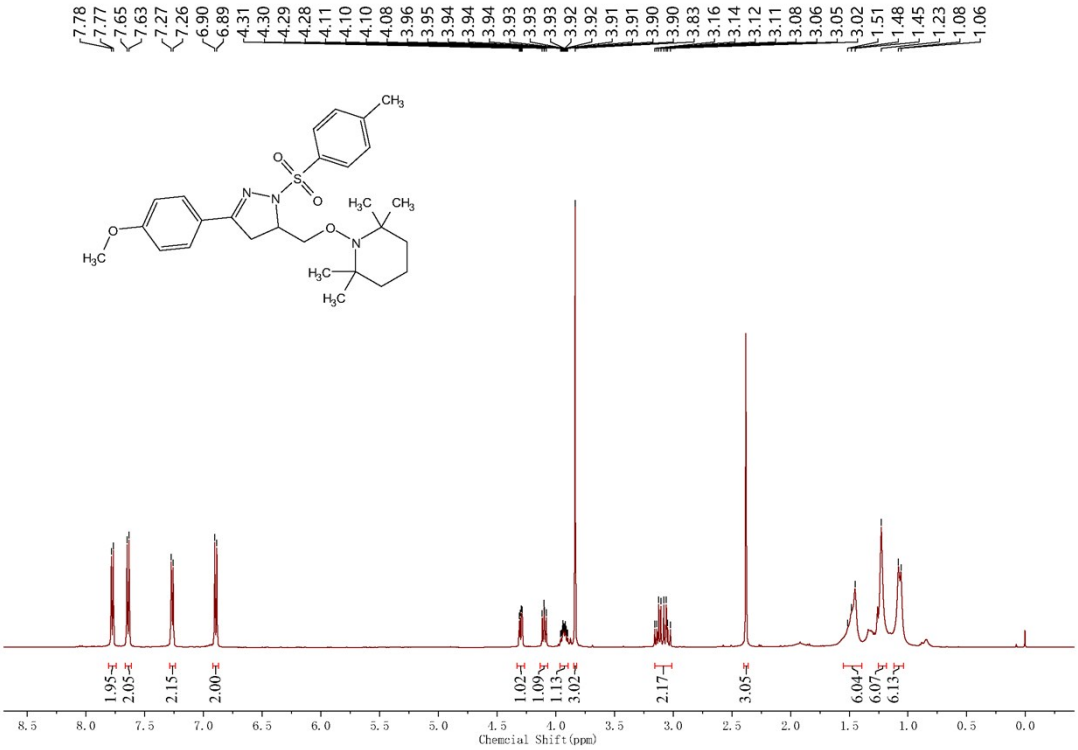
^{13}C NMR Spectrum of Compound **8aa** (125MHz, $CDCl_3$)



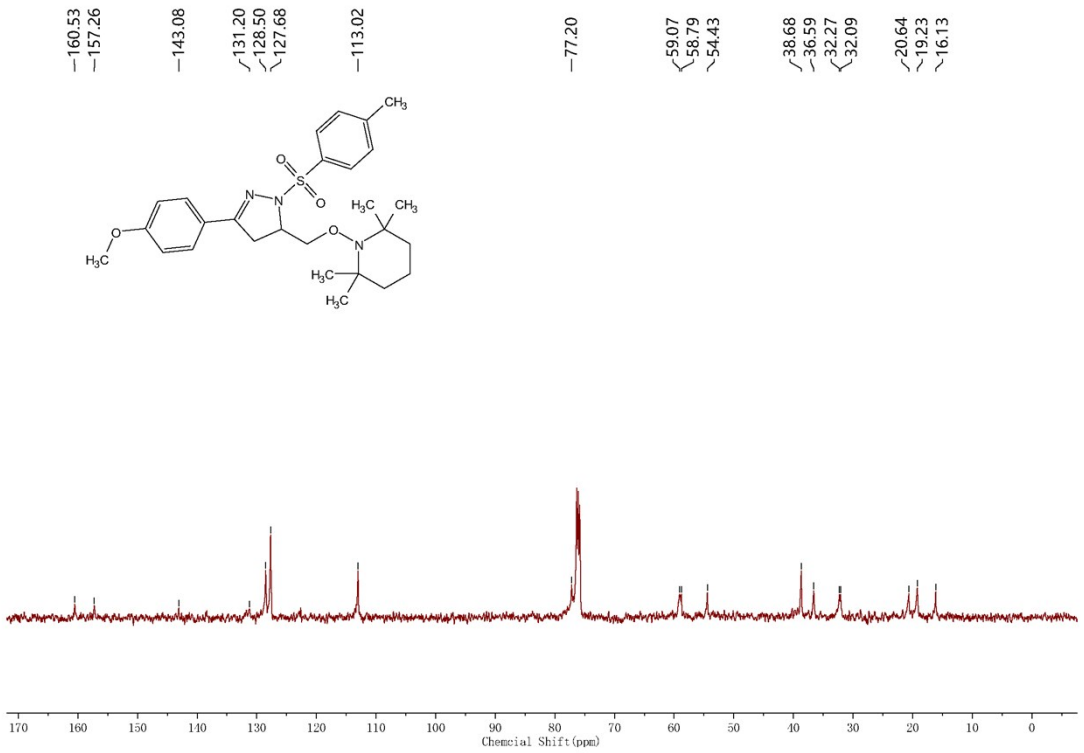
^{1}H NMR Spectrum of Compound **8ab** (500MHz, $CDCl_3$)



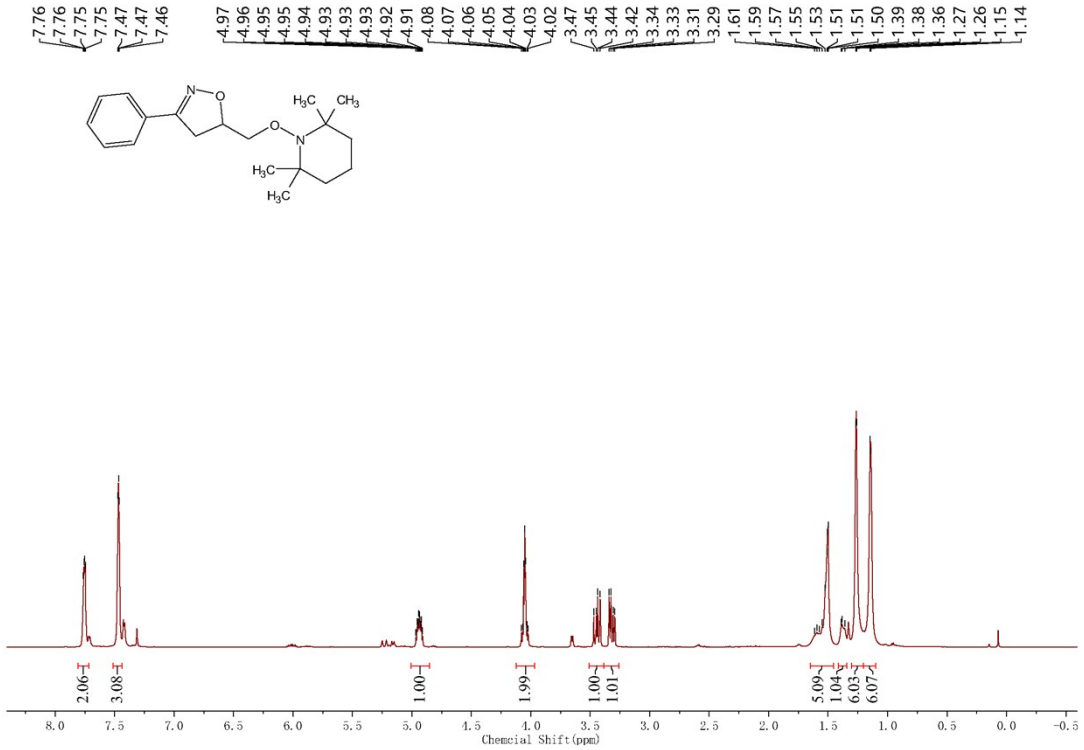
^{13}C NMR Spectrum of Compound **8ab** (125MHz, $CDCl_3$)



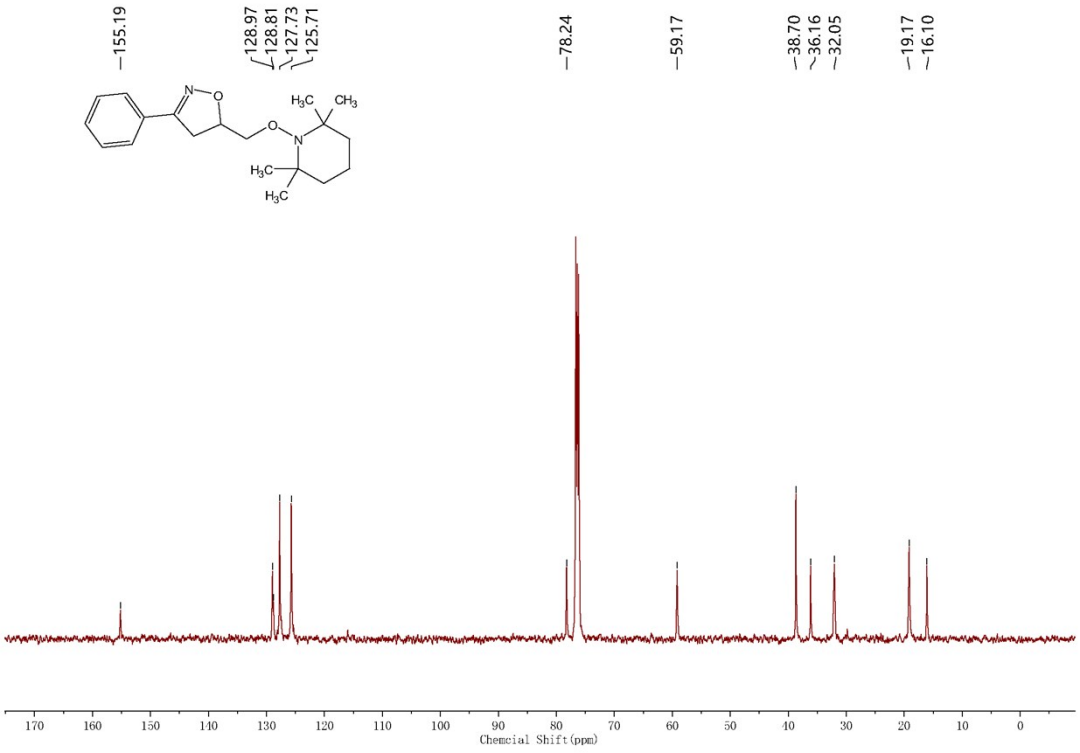
^{1}H NMR Spectrum of Compound **9a** (500MHz, $CDCl_3$)



^{13}C NMR Spectrum of Compound **9a** (125MHz, $CDCl_3$)



^{1}H NMR Spectrum of Compound **10a** (500MHz, $CDCl_3$)



^{13}C NMR Spectrum of Compound **10a** (125MHz, $CDCl_3$)