

Supporting Information

Gold(I)-Catalyzed Domino Ring-opening Ring-closing Hydroamination of Methylenecyclopropanes (MCPs) with Sulfonamides: Facile Preparation of Pyrrolidine Derivatives

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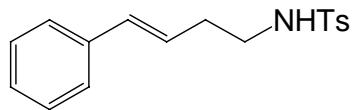
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Experimental Procedures.

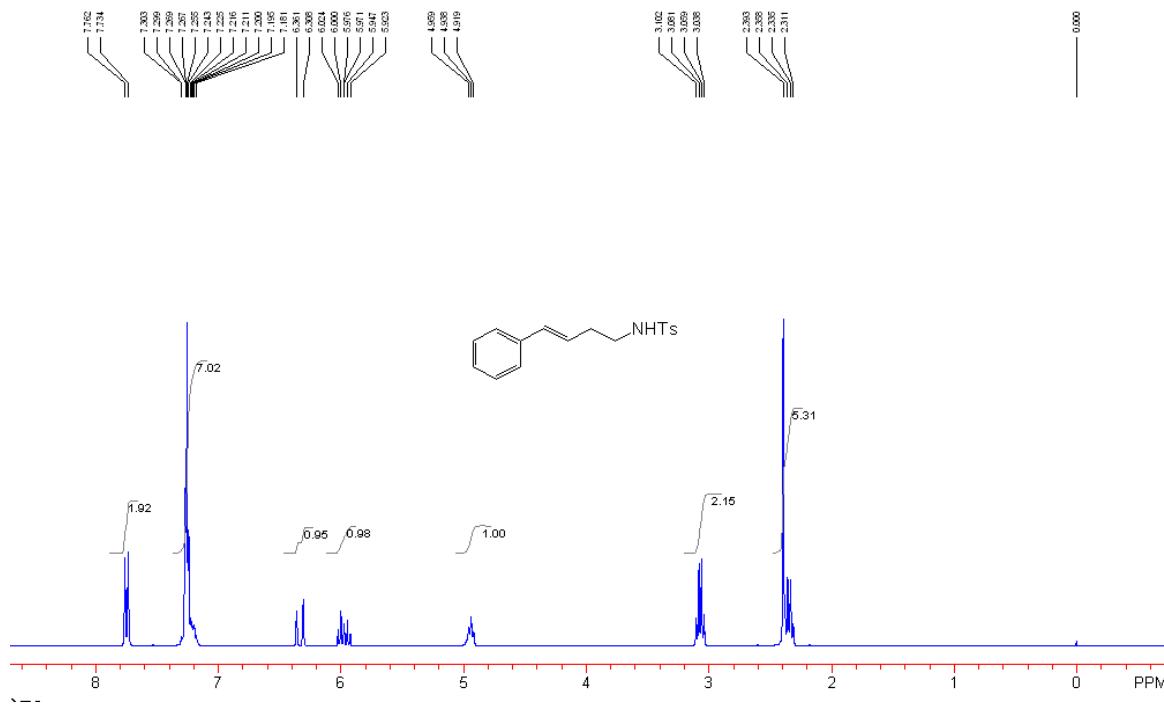
General Methods. Melting points are uncorrected. ^1H and ^{13}C NMR spectra were recorded at 300 and 75 MHz respectively using tetramethylsilane as the internal standard. Mass spectra were recorded by EI, MALDI and ESI methods, and HRMS was measured on a Finnigan MA⁺ mass spectrometer. Organic solvents used were dried by standard methods when necessary. Commercially obtained reagents were used without further purification. All reactions were monitored by TLC with Huanghai GF254 silica gel coated plates. Flash column chromatography was carried out using 300-400 mesh silica gel or 200-300 mesh Al₂O₃ at increased pressure.

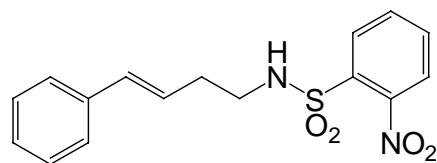
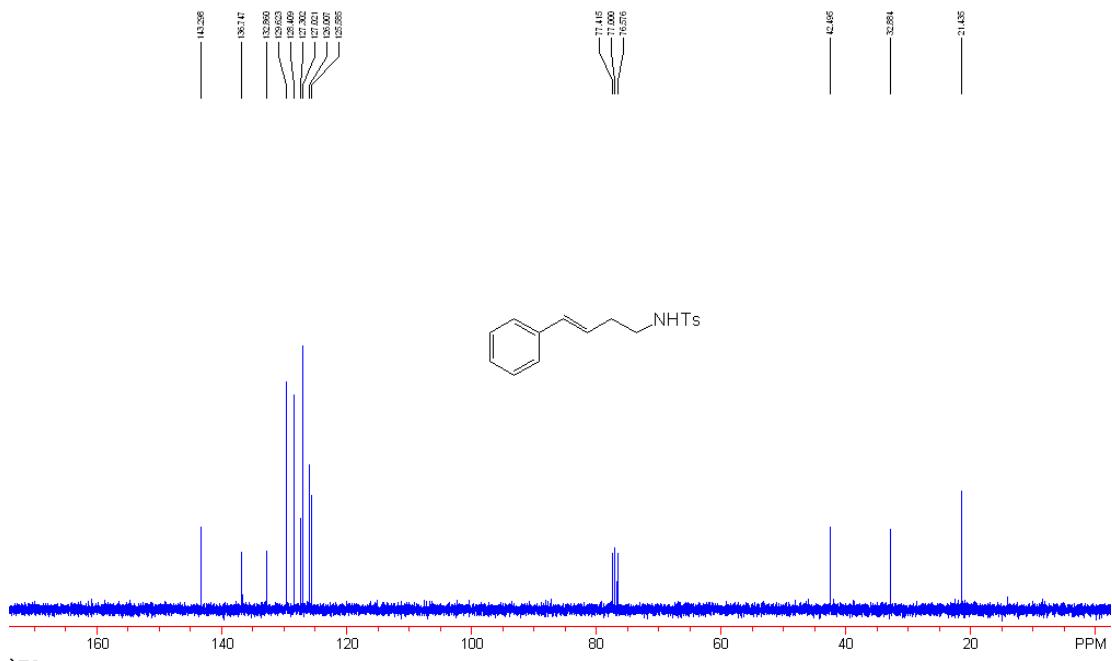
Typical reaction procedure for gold(I)-catalyzed domino ring-opening ring-closing hydroamination of methylenecyclopropanes with *p*-toluenesulfonamide: To a solution of MCP **1a** (65 mg, 0.5 mmol) and *p*-toluenesulfonamide (85 mg, 0.5 mmol) in toluene (2.0 mL) **were** added Au(PPh₃)Cl (12 mg, 5 mol%) and AgOTf (6 mg, 5 mol%), the mixture was stirred for 12 hours at 85 °C (monitored by TLC), then the solvent was removed under reduced pressure and the residue was subjected to a flash column chromatography (**SiO₂**) to give the desired product **3a** (105 mg, 70%) (**eluent: petroleum ether/ethyl acetate = 8/1**) as a white solid.



2a, (E)-4-methyl-N-(4-phenylbut-3-enyl)benzenesulfonamide

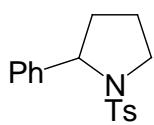
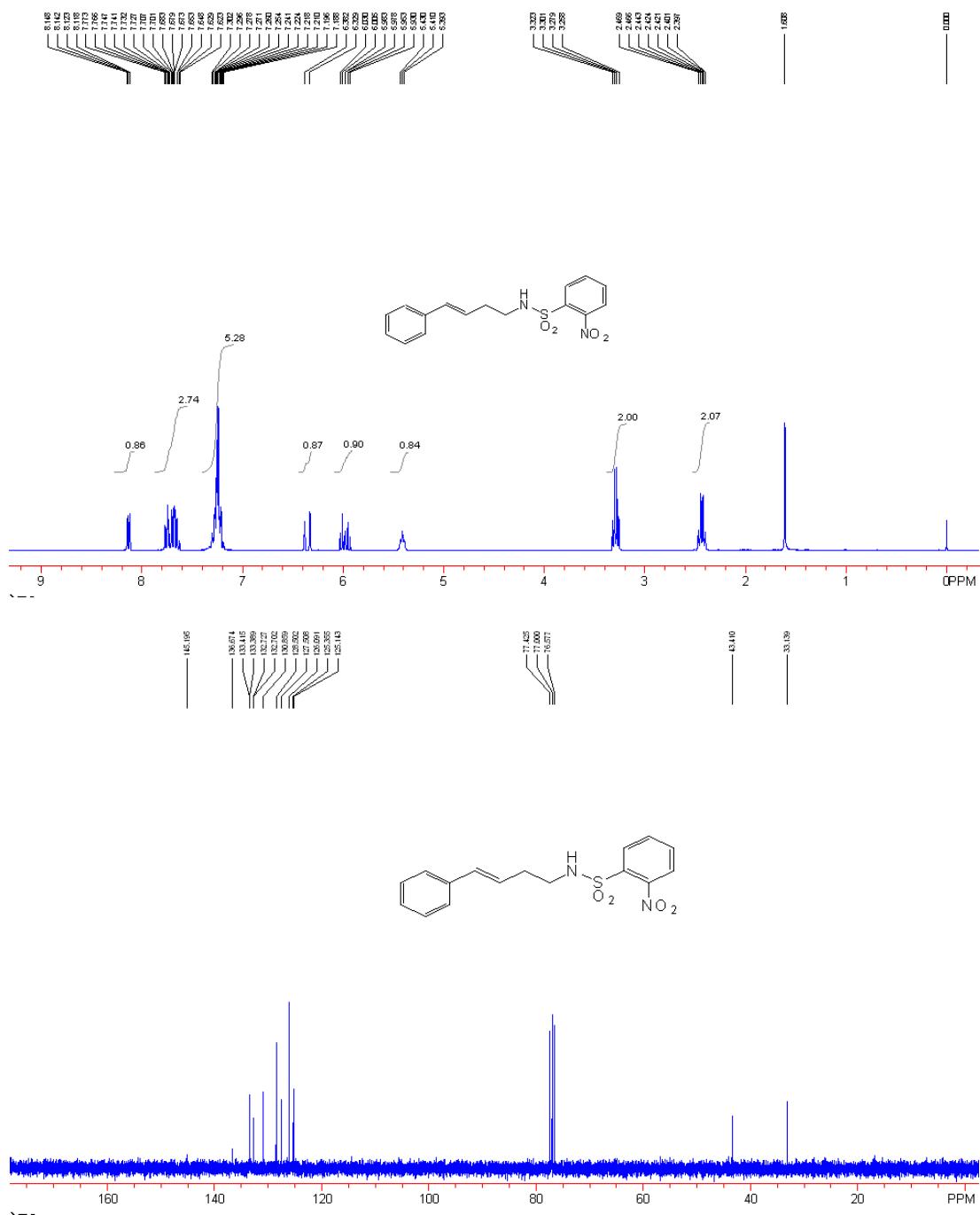
Compound **2a**, (E)-4-methyl-N-(4-phenylbut-3-enyl)benzenesulfonamide¹: a colorless oil; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 2.34 (2H, q, *J* = 6.9 Hz, CH₂), 2.39 (3H, s, CH₃), 3.07 (2H, q, *J* = 6.9 Hz, CH₂), 4.94 (1H, t, *J* = 6.3 Hz, NH), 5.97 (1H, dt, *J* = 15.9, 6.9 Hz, =CH), 6.33 (1H, d, *J* = 15.9 Hz, =CH), 7.20-7.27 (7H, m, Ar), 7.75 (2H, d, *J* = 8.4 Hz, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 21.4, 32.9, 42.5, 125.6, 126.0 (2C), 127.0, 127.3, 128.4, 129.6, 132.9, 136.7, 143.3.





2s, (E)-2-nitro-N-(4-phenylbut-3-enyl)benzenesulfonamide

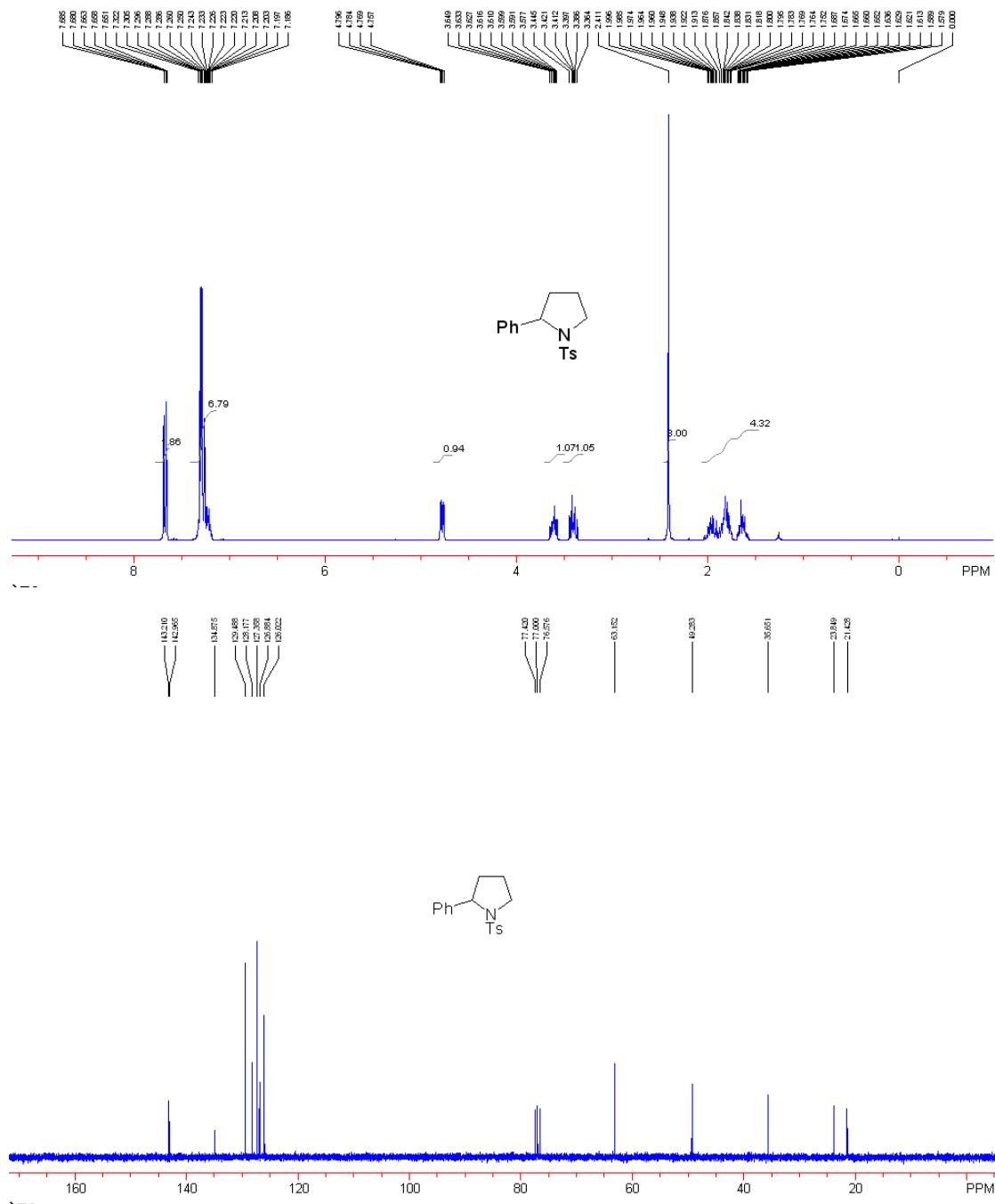
Compound **2s**, (E)-2-nitro-N-(4-phenylbut-3-enyl)benzenesulfonamide: a yellow oil; IR (KBr) ν 2923, 1541, 1413, 1360, 1166, 1074, 696, cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz, TMS) δ 2.43 (2H, dq, J = 1.2, 6.9 Hz, CH_2), 3.29 (2H, q, J = 6.9 Hz, CH_2), 5.41 (1H, t, J = 5.7 Hz, NH), 5.98 (1H, dt, J = 15.9, 6.9 Hz, =CH), 6.35 (1H, d, J = 15.9 Hz, =CH), 7.20-7.30 (5H, m, Ar), 7.62-7.77 (3H, m, Ar), 8.12-8.15 (2H, m, Ar); ^{13}C NMR (CDCl_3 , 75 MHz, TMS) δ 33.1, 43.4, 125.1, 125.4, 126.1, 127.5, 128.3, 130.9, 132.70, 132.73, 133.39, 133.42, 136.7, 145.2; MS (EI) m/z 332 (M^+ , 1), 215 (22), 186 (100), 144 (18), 117 (42); HRMS (EI) Calcd. for $\text{C}_{16}\text{H}_{16}\text{N}_2\text{O}_4\text{S}$ requires 332.0831, Found: 332.0831.

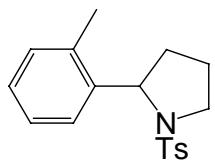


3a, 2-phenyl-1-tosylpyrrolidine

Compound **3a**, 2-phenyl-1-tosylpyrrolidine^{1,2}: a white solid, m.p. 110–112 °C; ¹H NMR (CDCl₃, 300

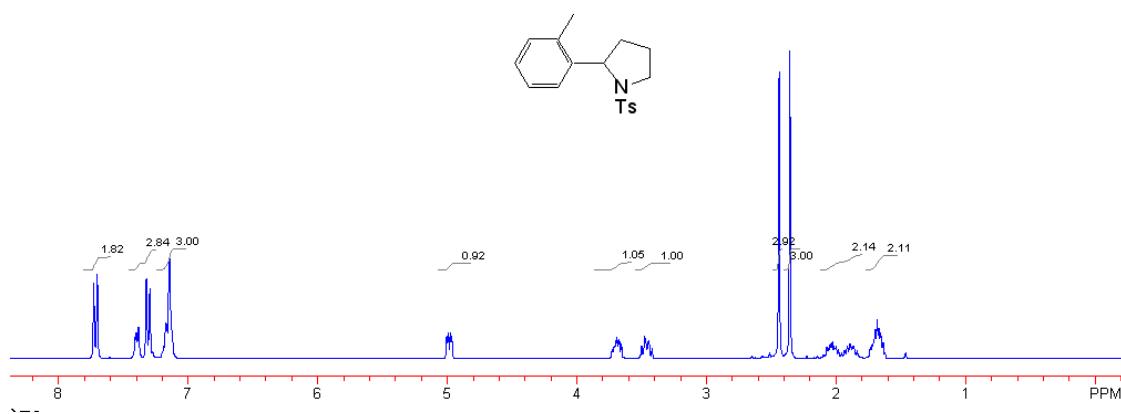
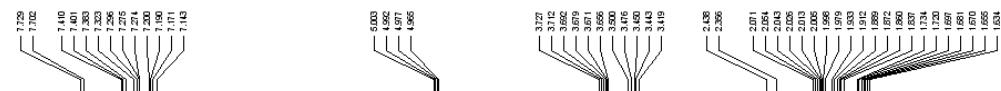
MHz, TMS) δ 1.58-2.00 (4H, m, CH₂), 2.41 (3H, s, CH₃), 3.36-3.45 (1H, m, NCH₂), 3.58-3.65 (1H, m, NCH₂), 4.78 (1H, dd, *J* = 3.6, 8.1 Hz, NCH), 7.19-7.32 (7H, m, Ar), 7.65-7.69 (2H, m, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 21.4, 23.8, 35.7, 49.3, 63.2, 126.0, 126.9, 127.4, 128.2, 129.5, 134.9, 143.0, 143.2.

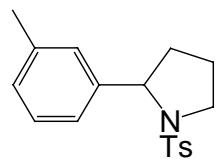
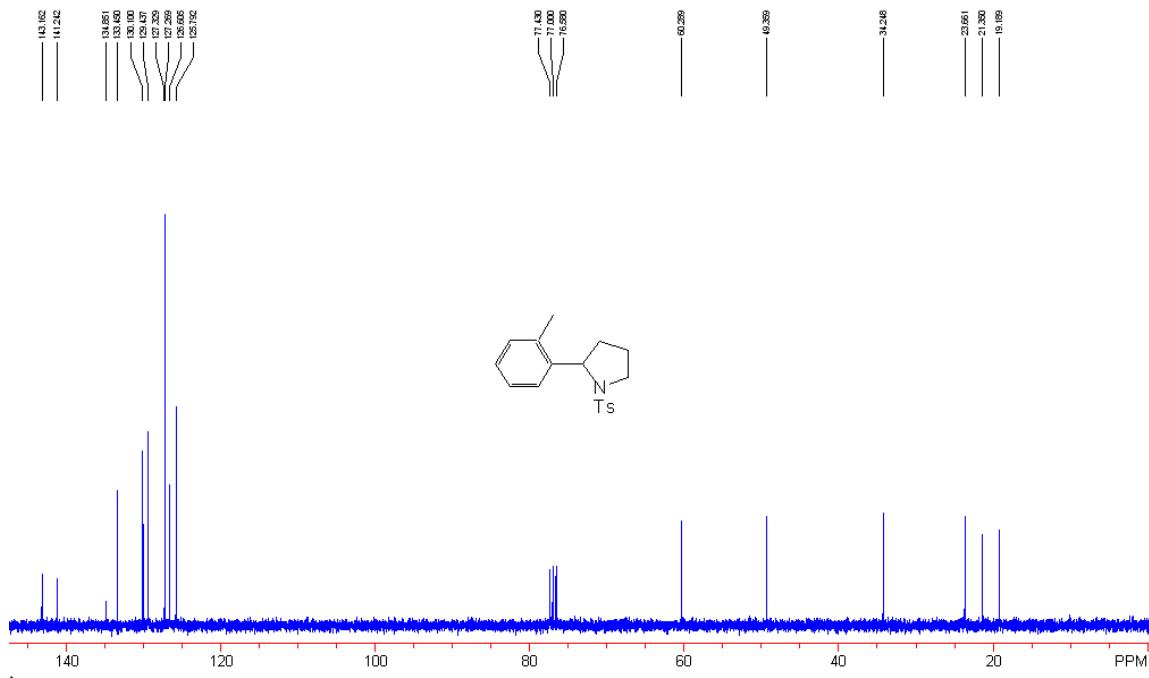




3b, 2-o-tolyl-1-tosylpyrrolidine

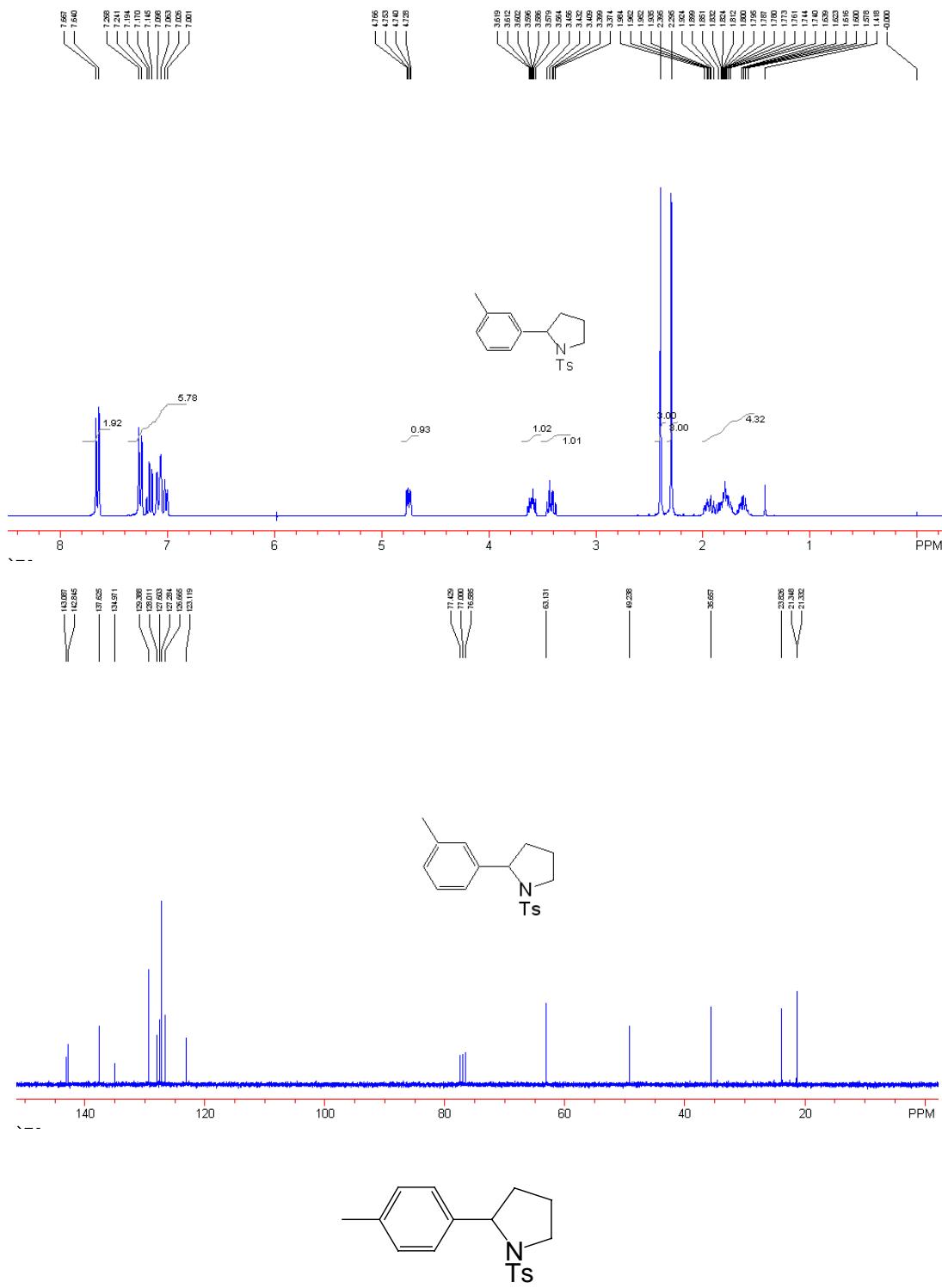
Compound **3b**, 2-o-tolyl-1-tosylpyrrolidine²: a white solid, m.p. 160-162 °C; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 1.63-1.73 (2H, m, CH₂), 1.84-2.07 (2H, m, CH₂), 2.36 (3H, s, CH₃), 2.44 (3H, s, CH₃), 3.42-3.50 (1H, m, NCH₂), 3.66-3.73 (1H, m, NCH₂), 4.98 (1H, dd, *J* = 3.3, 8.1 Hz, NCH), 7.14-7.20 (3H, m, Ar), 7.27-7.41 (3H, m, Ar), 7.72 (2H, d, *J* = 8.1 Hz, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 19.2, 21.3, 23.7, 34.2, 49.4, 60.3, 125.8, 126.6, 127.27, 127.33, 129.4, 130.1, 133.5, 134.8, 141.2, 143.2.





3c, 2-m-tolyl-1-tosylpyrrolidine

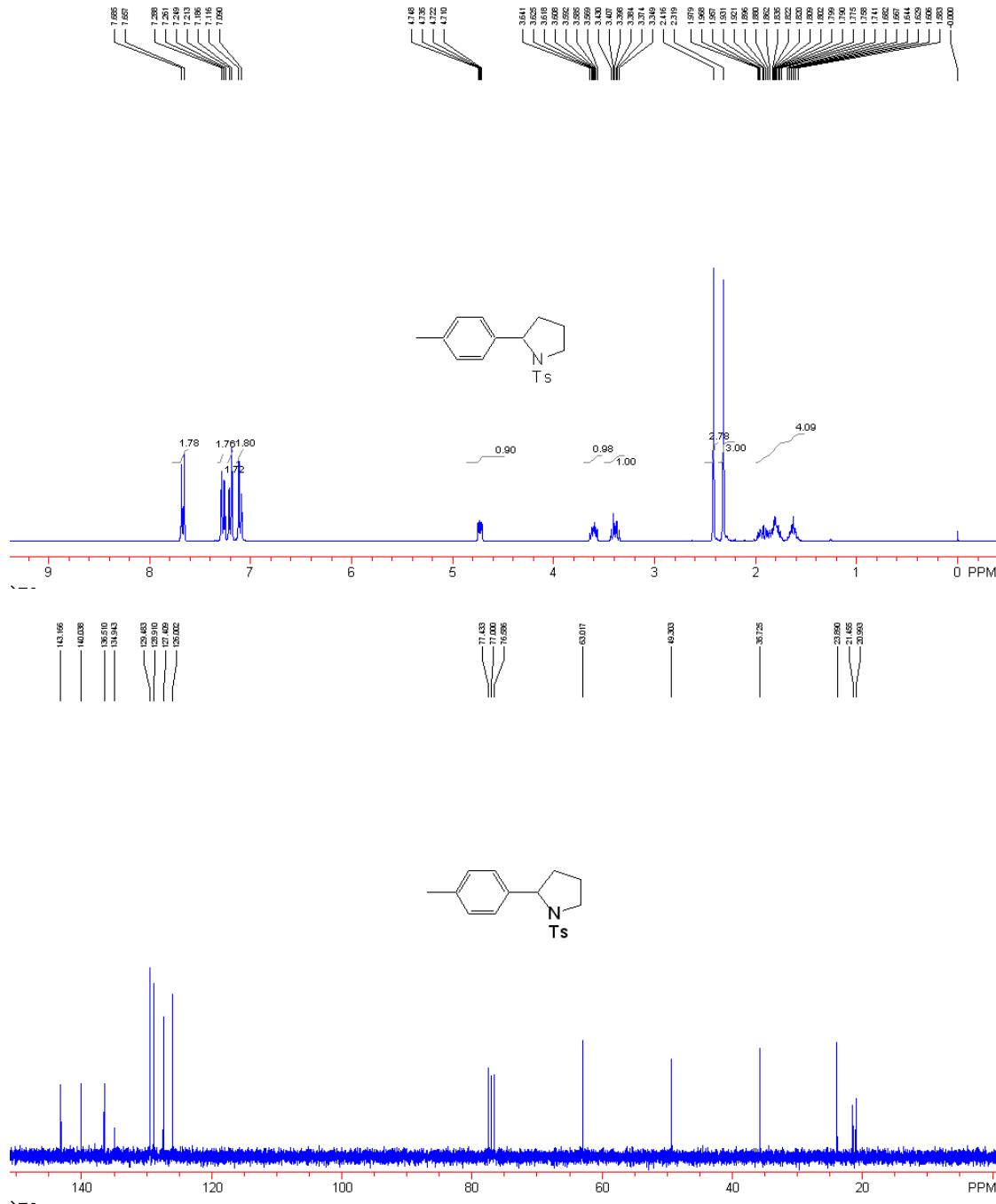
Compound **3c**, 2-m-tolyl-1-tosylpyrrolidine²: a white solid, m.p. 80-82 °C; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 1.58-1.98 (4H, m, CH₂), 2.30 (3H, s, CH₃), 2.40 (3H, s, CH₃), 3.37-3.46 (1H, m, NCH₂), 3.56-3.62 (1H, m, NCH₂), 4.75 (1H, dd, *J* = 3.6, 7.8 Hz, NCH), 7.00-7.27 (6H, m, Ar), 7.65 (2H, d, *J* = 8.4 Hz, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 21.33, 21.35, 23.8, 35.6, 49.2, 63.1, 123.1, 126.7, 127.3, 127.6, 128.0, 129.4, 135.0, 137.6, 142.8, 143.1.

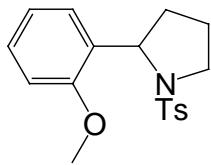


3d, 2-*p*-tolyl-1-tosylpyrrolidine

Compound **3d**, 2-*p*-tolyl-1-tosylpyrrolidine²: a white solid, m.p. 118-120 °C; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 1.58-1.98 (4H, m, CH₂), 2.32 (3H, s, CH₃), 2.42 (3H, s, CH₃), 3.35-3.43 (1H, m, NCH₂), 3.57-3.64 (1H, m, NCH₂), 4.73 (1H, dd, *J* = 3.6, 7.8 Hz, NCH), 7.10 (2H, d, *J* = 7.8 Hz, Ar),

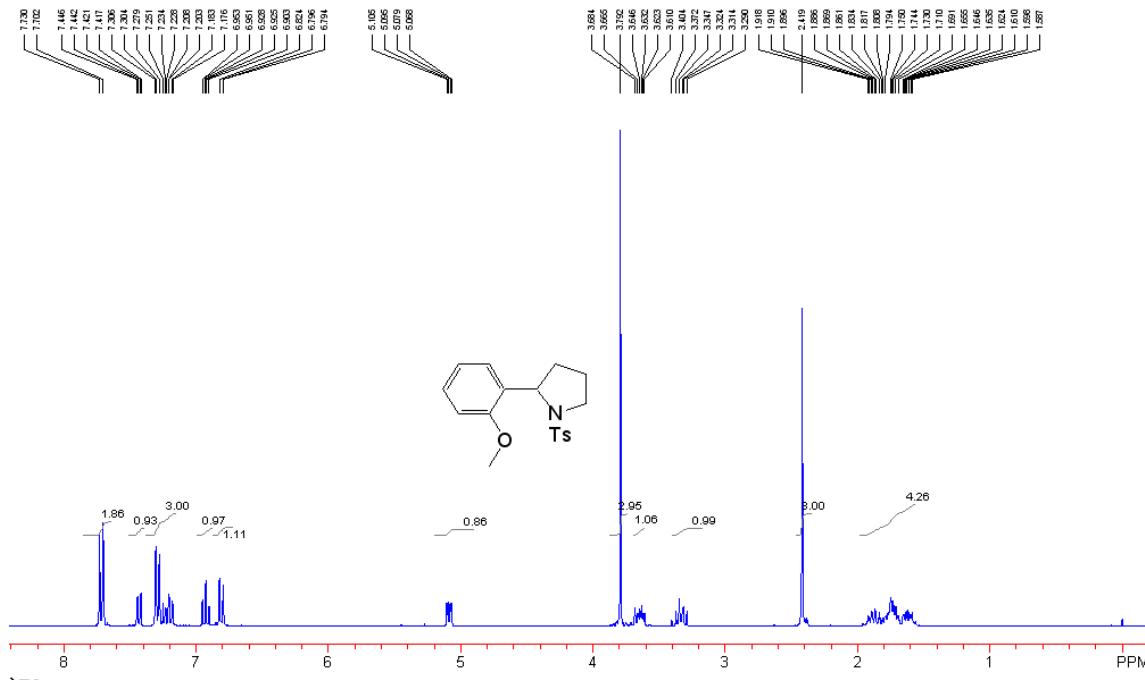
7.20 (2H, d, J = 7.8 Hz, Ar), 7.27 (2H, d, J = 8.1 Hz, Ar), 7.67 (2H, d, J = 8.1 Hz, Ar); ^{13}C NMR (CDCl₃, 75 MHz, TMS) δ 21.0, 21.5, 23.9, 35.7, 49.3, 63.0, 126.0, 127.4, 128.9, 129.5, 134.9, 136.5, 140.0, 143.2.

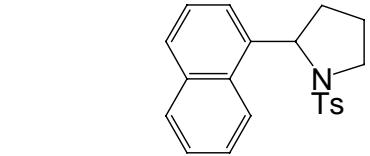
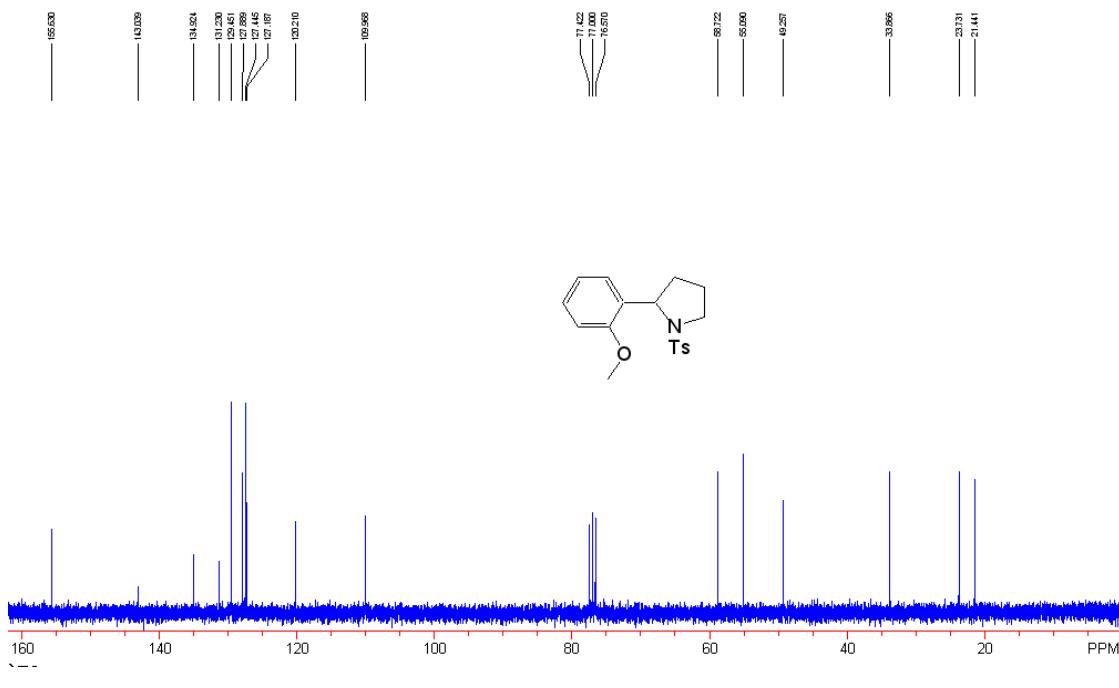




3e, 2-(2-methoxyphenyl)-1-tosylpyrrolidine

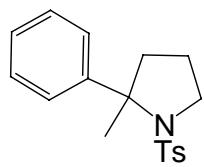
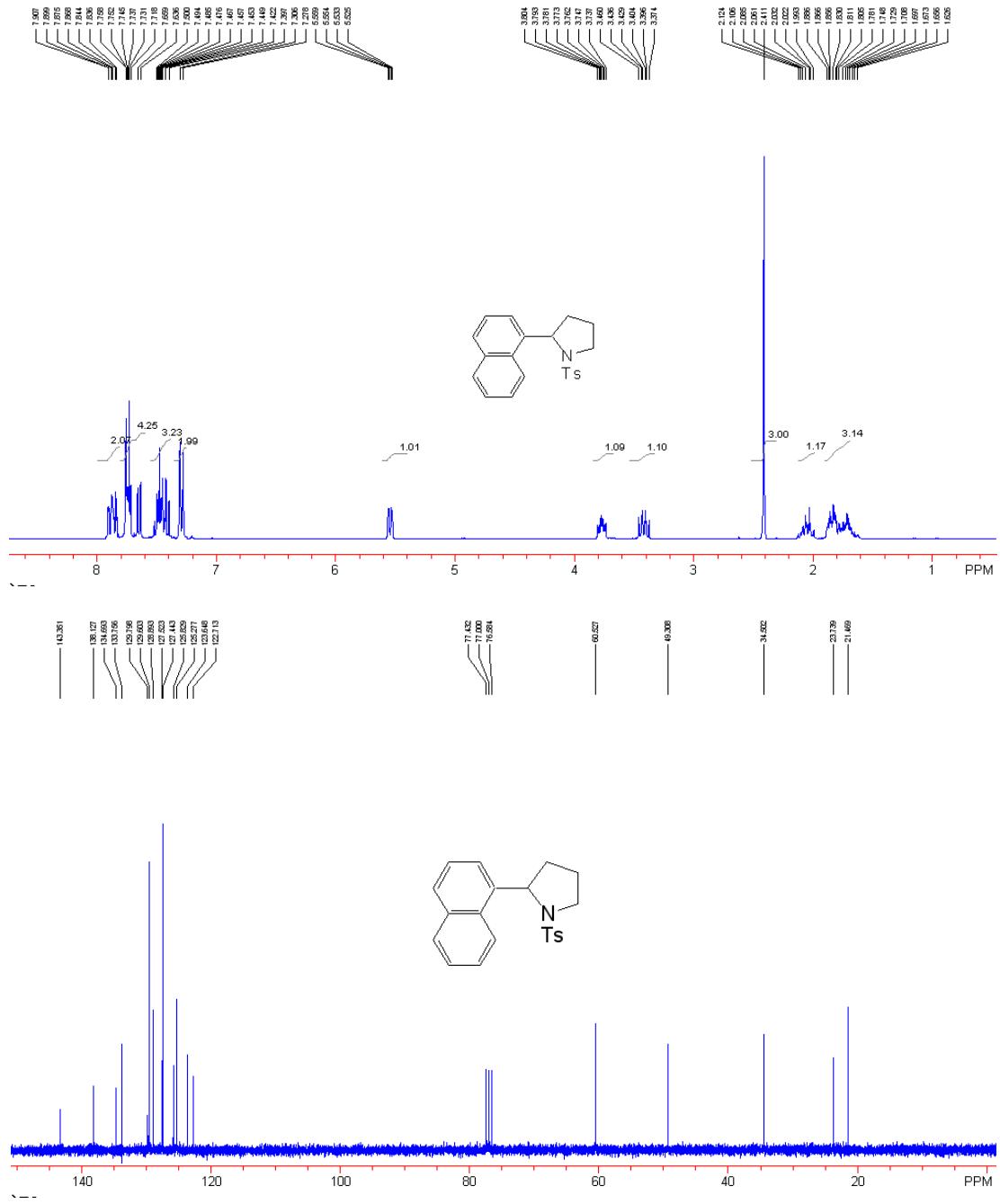
Compound **3e**, 2-(2-methoxyphenyl)-1-tosylpyrrolidine: a white solid, m.p. 170-172 °C; IR (KBr) ν 2948, 1596, 1490, 1340, 1156, 1094, 819, 757, 667 cm⁻¹; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 1.59-1.92 (4H, m, CH₂), 2.42 (3H, s, CH₃), 3.29-3.37 (1H, m, NCH₂), 3.61-3.68 (1H, m, NCH₂), 3.79 (3H, s, OCH₃), 5.09 (1H, dd, *J* = 3.0, 7.8 Hz, NCH), 6.79-6.82 (1H, m, Ar), 6.90-6.95 (1H, m, Ar), 7.18-7.31 (3H, m, Ar), 7.42-7.45 (1H, m, Ar), 7.72 (2H, d, *J* = 8.4 Hz, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 21.4, 23.7, 33.9, 49.3, 55.1, 58.7, 110.0, 120.2, 127.2, 127.4, 127.9, 129.5, 131.2, 134.9, 143.0, 155.6; MS (EI) *m/z* 331 (M⁺, 5), 300 (3), 224 (12), 176 (100), 91 (48); Anal. Calcd. for C₁₈H₂₁NO₃S requires C, 65.23; H, 6.39, N, 4.23%. Found: C, 65.18; H, 6.35, N, 4.03%.





3f, 2-(naphthalen-1-yl)-1-tosylpyrrolidine

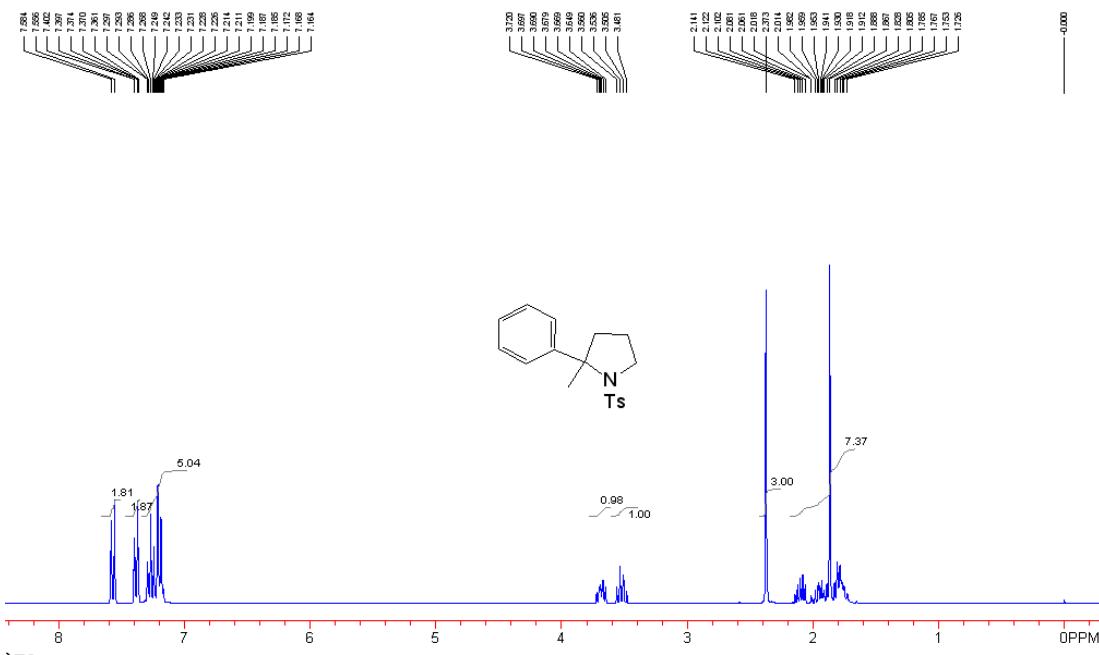
Compound **3f**, 2-(naphthalen-1-yl)-1-tosylpyrrolidine: a white solid, m.p. 148-150 °C; IR (KBr) ν 3045, 2942, 1597, 1345, 1160, 1094, 800, 737, 670 cm⁻¹; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 1.63-1.89 (3H, m, CH₂), 1.99-2.12 (H, m, CH₂), 2.41 (3H, s, CH₃), 3.37-3.46 (1H, m, NCH₂), 3.74-3.80 (1H, m, NCH₂), 5.54 (1H, dd, *J* = 2.7, 9.0 Hz, NCH), 7.29 (2H, d, *J* = 8.7 Hz, Ar), 7.40-7.52 (3H, m, Ar), 7.64-7.77 (4H, m, Ar), 7.84-7.91 (2H, m, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 21.5, 23.7, 34.5, 49.3, 60.5, 122.7, 123.7, 125.3, 125.8, 127.4, 127.5, 128.9, 129.6, 129.8, 133.8, 134.7, 138.1, 143.4; MS (EI) *m/z* 351 (M⁺, 8), 246 (11), 224 (10), 195 (100), 155 (18), 127 (6), 91 (31); Anal. Calcd. for C₂₁H₂₁NO₂S requires C, 71.76; H, 6.02, N, 3.99%. Found: C, 72.10, H, 5.98, N, 3.74%.

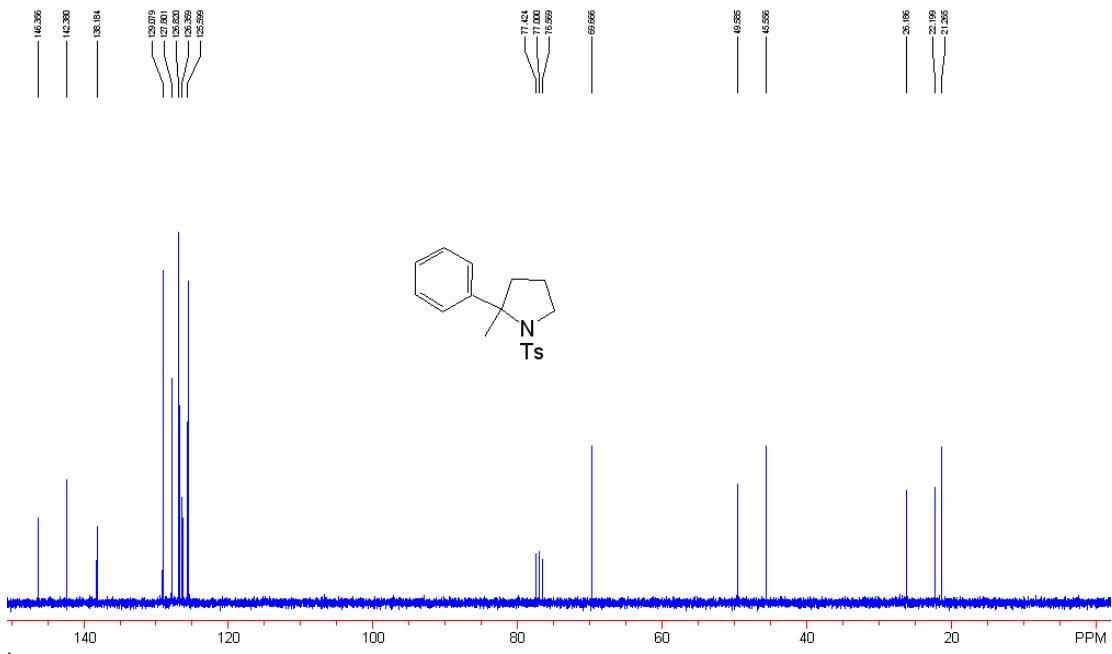


3g, 2-methyl-2-phenyl-1-tosylpyrrolidine

Compound **3g**, 2-methyl-2-phenyl-1-tosylpyrrolidine: a colorless oil; IR (KBr) ν 3058, 2976, 1599,

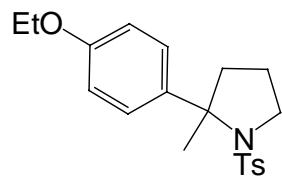
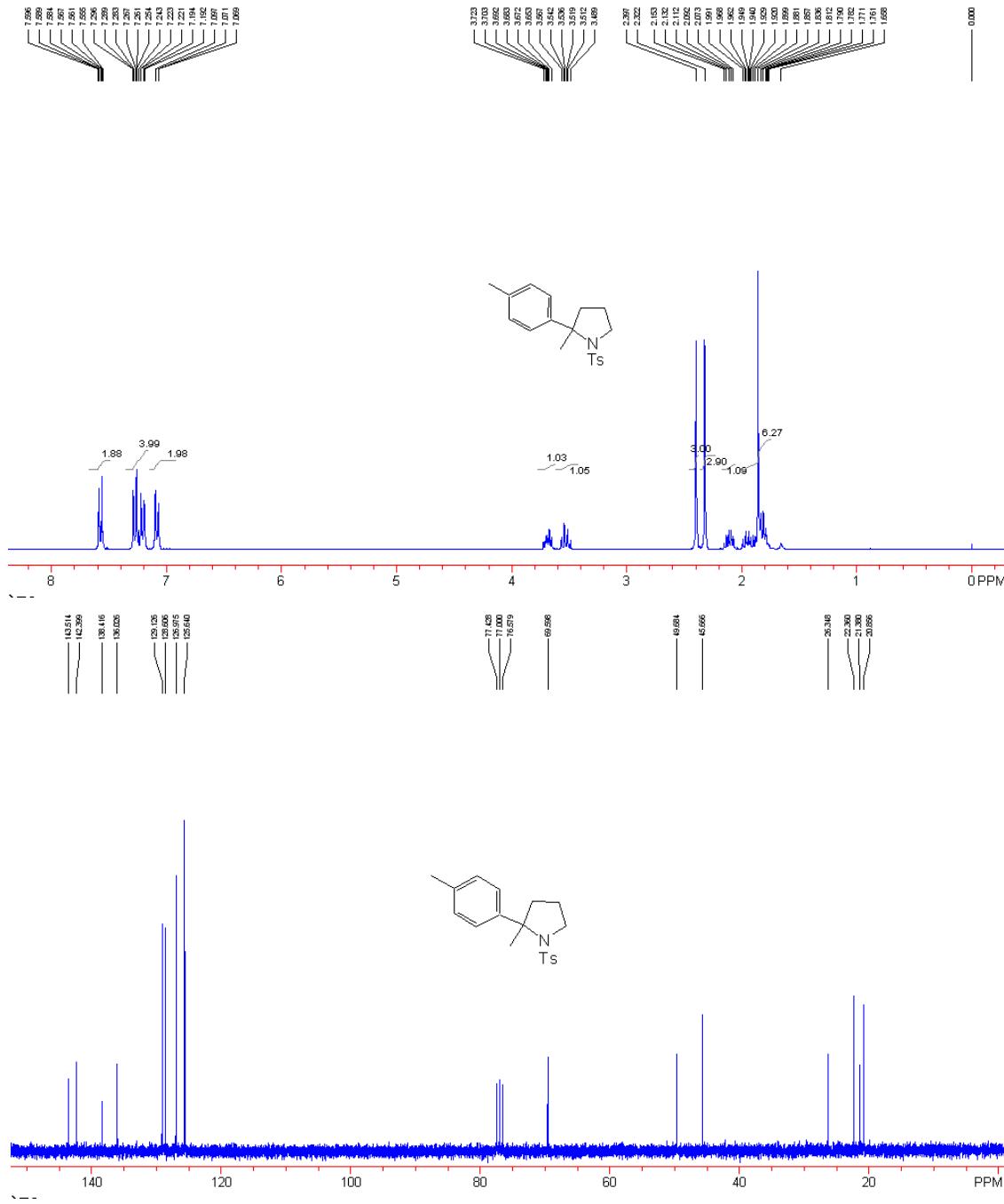
1446, 1337, 1155, 1005, 815, 682 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz, TMS) δ 1.73-2.14 (4H, m, CH_2), 1.87 (3H, s, CH_3), 2.37 (3H, s, CH_3), 3.48-3.56 (1H, m, NCH_2), 3.65-3.70 (1H, m, NCH_2), 7.16-7.30 (5H, m, Ar), 7.36-7.40 (2H, m, Ar), 7.57 (2H, d, $J = 8.4$ Hz, Ar); ^{13}C NMR (CDCl_3 , 75 MHz, TMS) δ 21.3, 22.2, 26.2, 45.6, 49.6, 69.7, 125.6, 126.4, 126.8, 127.8, 129.1, 138.2, 142.4, 146.4; MS (EI) m/z 315 (M^+ , 8), 300 (100), 238 (46), 155 (40), 91 (82); HRMS (EI) Calcd. for $\text{C}_{18}\text{H}_{21}\text{NO}_2\text{S}$ requires 315.1293, Found: 315.1294.





3h, 2-methyl-2-p-tolyl-1-tosylpyrrolidine

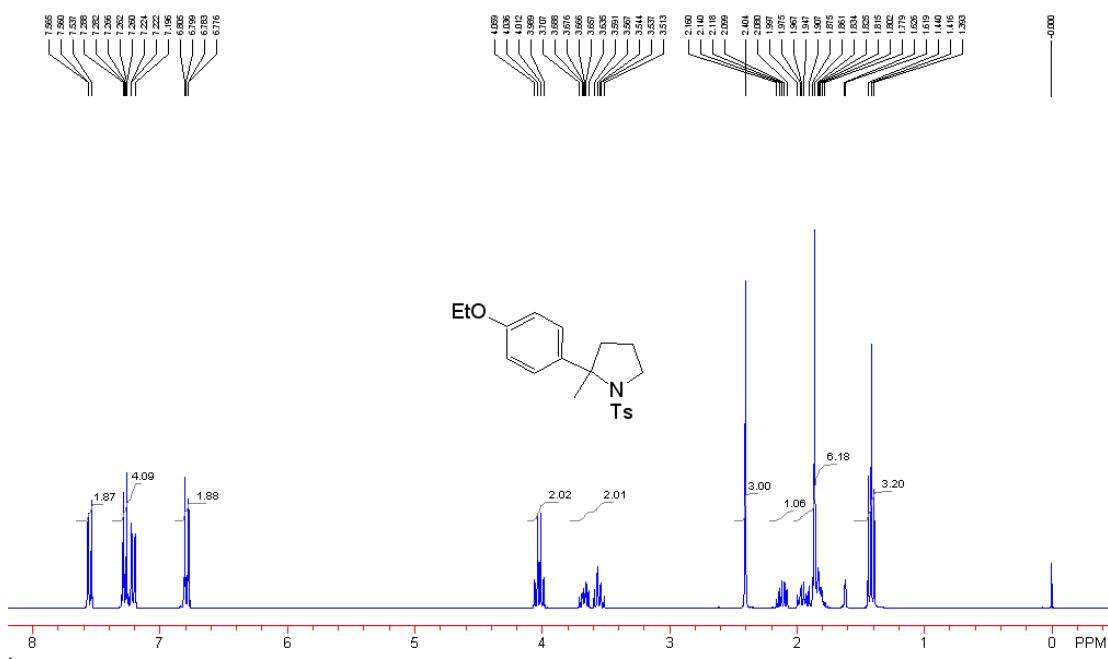
Compound **3h**, 2-methyl-2-p-tolyl-1-tosylpyrrolidine: a white solid, m.p. 126-128 °C; IR (KBr) ν 3025, 2974, 1598, 1452, 1337, 1155, 1094, 815, 670 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz, TMS) δ 1.76-1.99 (3H, m, CH_2), 1.86 (3H, s, CH_3), 2.07-2.15 (1H, m, CH_2), 2.32 (3H, s, CH_3), 2.40 (3H, s, CH_3), 3.49-3.57 (1H, m, NCH_2), 3.65-3.72 (1H, m, NCH_2), 7.07-7.10 (2H, m, Ar), 7.19-7.29 (4H, m, Ar), 7.56-7.60 (2H, m, Ar); ^{13}C NMR (CDCl_3 , 75 MHz, TMS) δ 20.9, 21.4, 22.4, 26.3, 45.7, 49.7, 69.6, 125.6, 127.0, 128.6, 129.1, 136.0, 138.4, 142.4, 143.5; MS (EI) m/z 329 (M^+ , 12), 314 (63), 238 (25), 155 (42), 91 (100); HRMS (EI) Calcd. for $\text{C}_{19}\text{H}_{23}\text{NO}_2\text{S}$ requires 329.1450, Found: 329.1427.

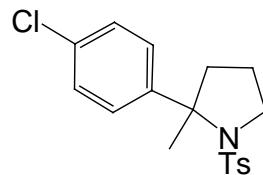
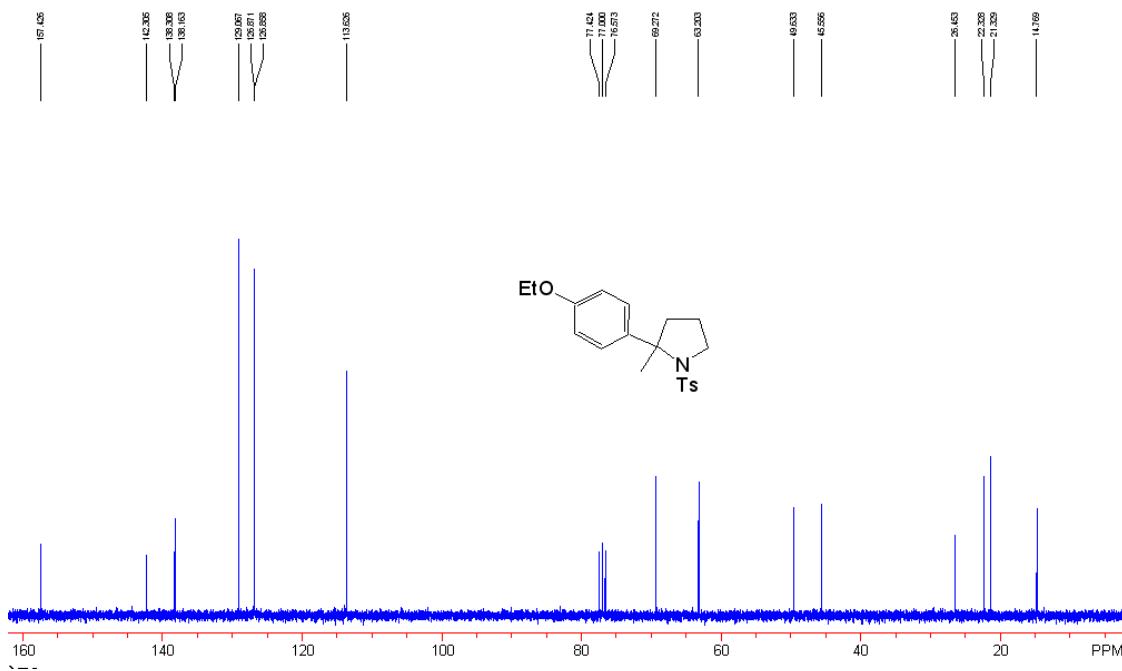


3i, 2-(4-ethoxyphenyl)-2-methyl-1-tosylpyrrolidine

Compound **3i**, 2-(4-ethoxyphenyl)-2-methyl-1-tosylpyrrolidine: a white solid, m.p. 118-120 °C; IR

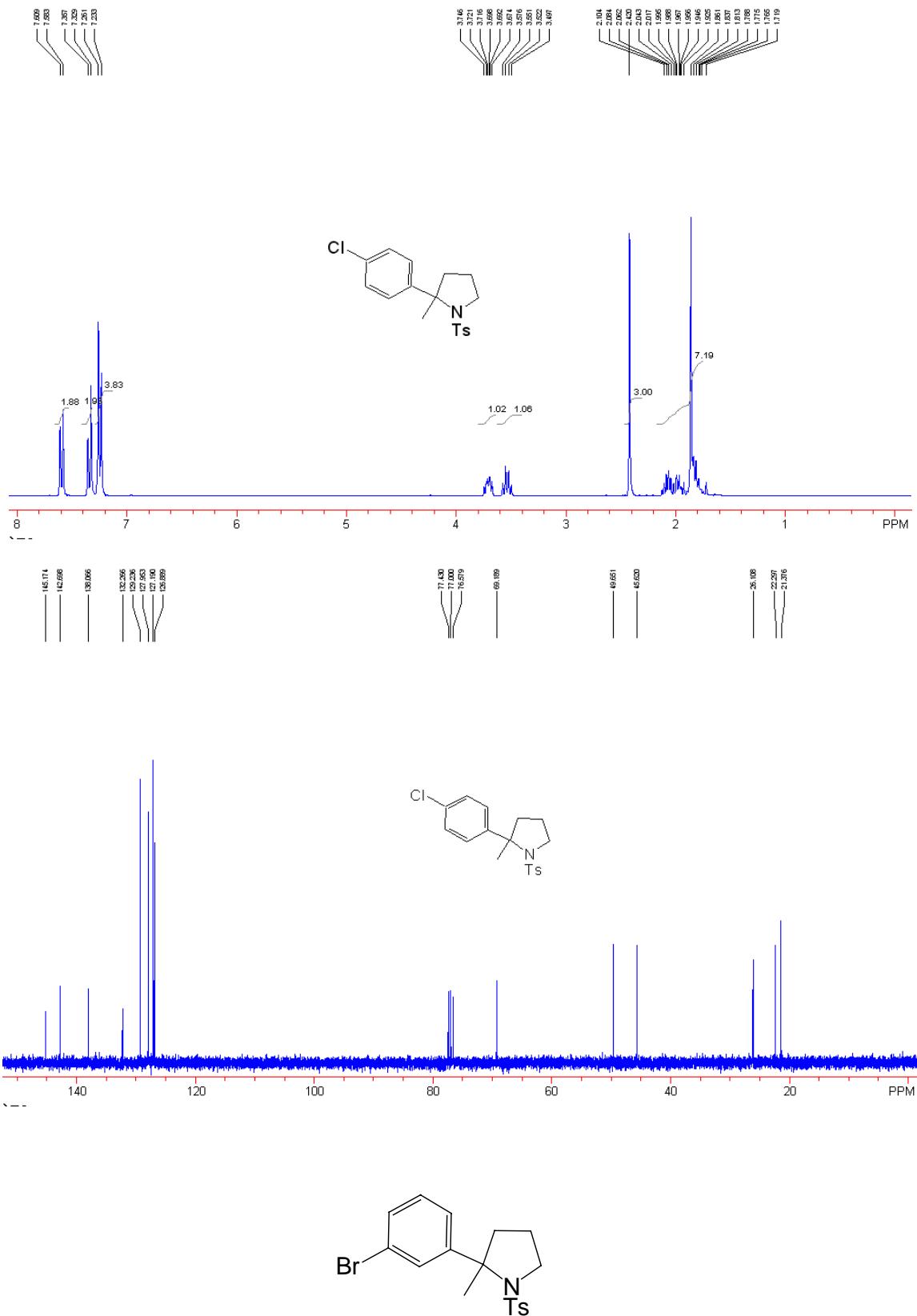
(KBr) ν 2976, 1610, 1511, 1337, 1249, 1155, 816, 672 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz, TMS) δ 1.42 (3H, t, $J = 7.2$ Hz, CH_3), 1.78-2.00 (3H, m, CH_2), 1.86 (3H, s, CH_3), 2.06-2.16 (1H, m, CH_2), 2.40 (3H, s, CH_3), 3.51-3.71 (2H, m, NCH_2), 4.02 (2H, q, $J = 7.2$ Hz, OCH_2), 6.79 (2H, d, $J = 8.4$ Hz, Ar), 7.20-7.29 (4H, m, Ar), 7.55 (2H, d, $J = 8.4$ Hz, Ar); ^{13}C NMR (CDCl_3 , 75 MHz, TMS) δ 14.8, 21.3, 22.3, 26.4, 45.6, 49.6, 63.2, 69.3, 113.6, 126.86, 126.87, 129.1, 138.2, 138.3, 142.3, 157.4; MS (EI) m/z 359 (M^+ , 3), 344 (8), 238 (5), 155 (20), 91 (100); Anal. Calcd. for $\text{C}_{20}\text{H}_{25}\text{NO}_3\text{S}$ requires C, 66.82; H, 7.01, N, 3.90%. Found: C, 67.12, H, 6.96, N, 3.68%.





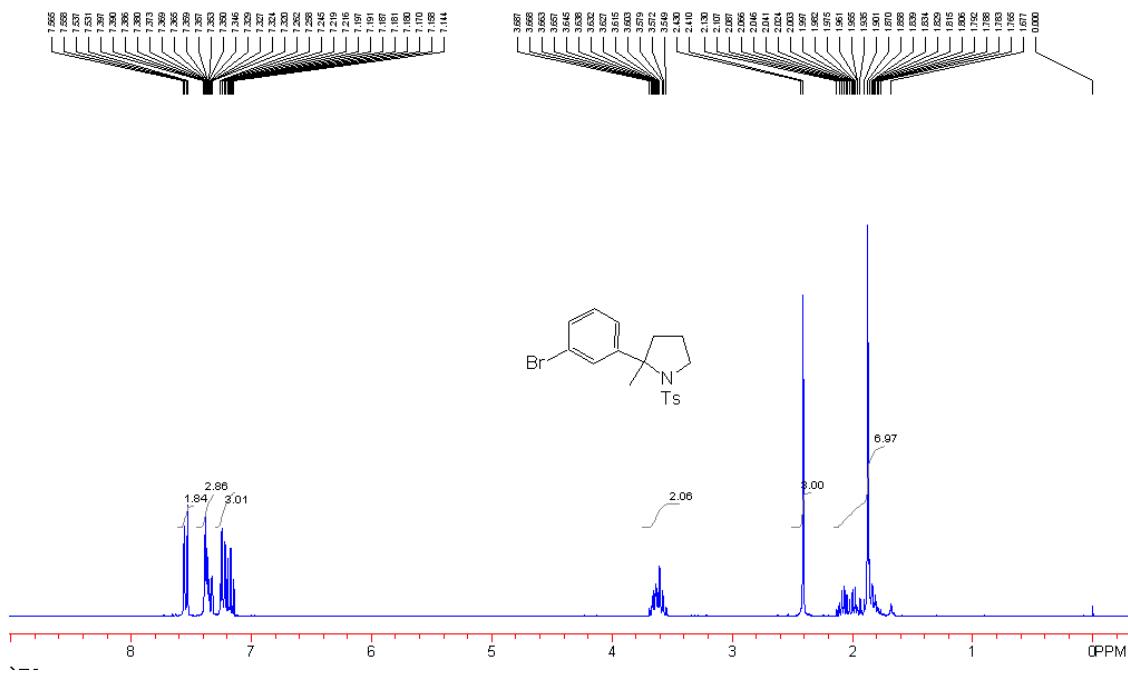
3j, 2-(4-chlorophenyl)-2-methyl-1-tosylpyrrolidine

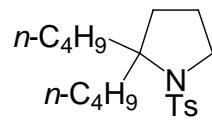
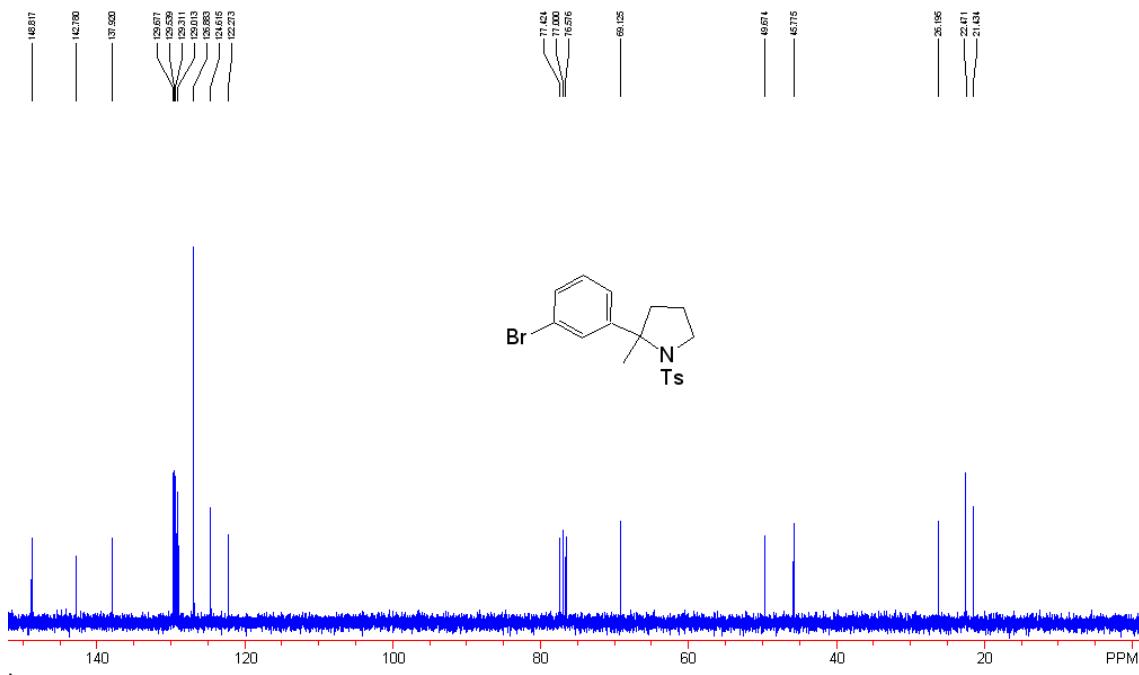
Compound **3j**, 2-(4-chlorophenyl)-2-methyl-1-tosylpyrrolidine: a white solid, m.p. 116-118 °C; IR (KBr) ν 2976, 1589, 1492, 1337, 1156, 1094, 816, 716 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz, TMS) δ 1.77-2.10 (4H, m, CH_2), 1.86 (3H, s, CH_3), 2.42 (3H, s, CH_3), 3.50-3.58 (1H, m, NCH_2), 3.67-3.75 (1H, m, NCH_2), 7.25 (4H, d, $J = 8.4$ Hz, Ar), 7.34 (2H, d, $J = 8.4$ Hz, Ar), 7.60 (2H, d, $J = 8.4$ Hz, Ar); ^{13}C NMR (CDCl_3 , 75 MHz, TMS) δ 21.4, 22.3, 26.1, 45.6, 49.6, 69.2, 126.9, 127.2, 128.0, 129.2, 132.3, 138.1, 142.7, 145.2; MS (EI) m/z 349 (M^+ , 6), 334 (76), 238 (22), 155 (81), 91 (100); HRMS (EI) Calcd. for $\text{C}_{18}\text{H}_{20}\text{ClNO}_2\text{S}$ requires 349.0903, Found: 349.0917.



3k, 2-(3-bromophenyl)-2-methyl-1-tosylpyrrolidine

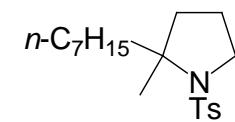
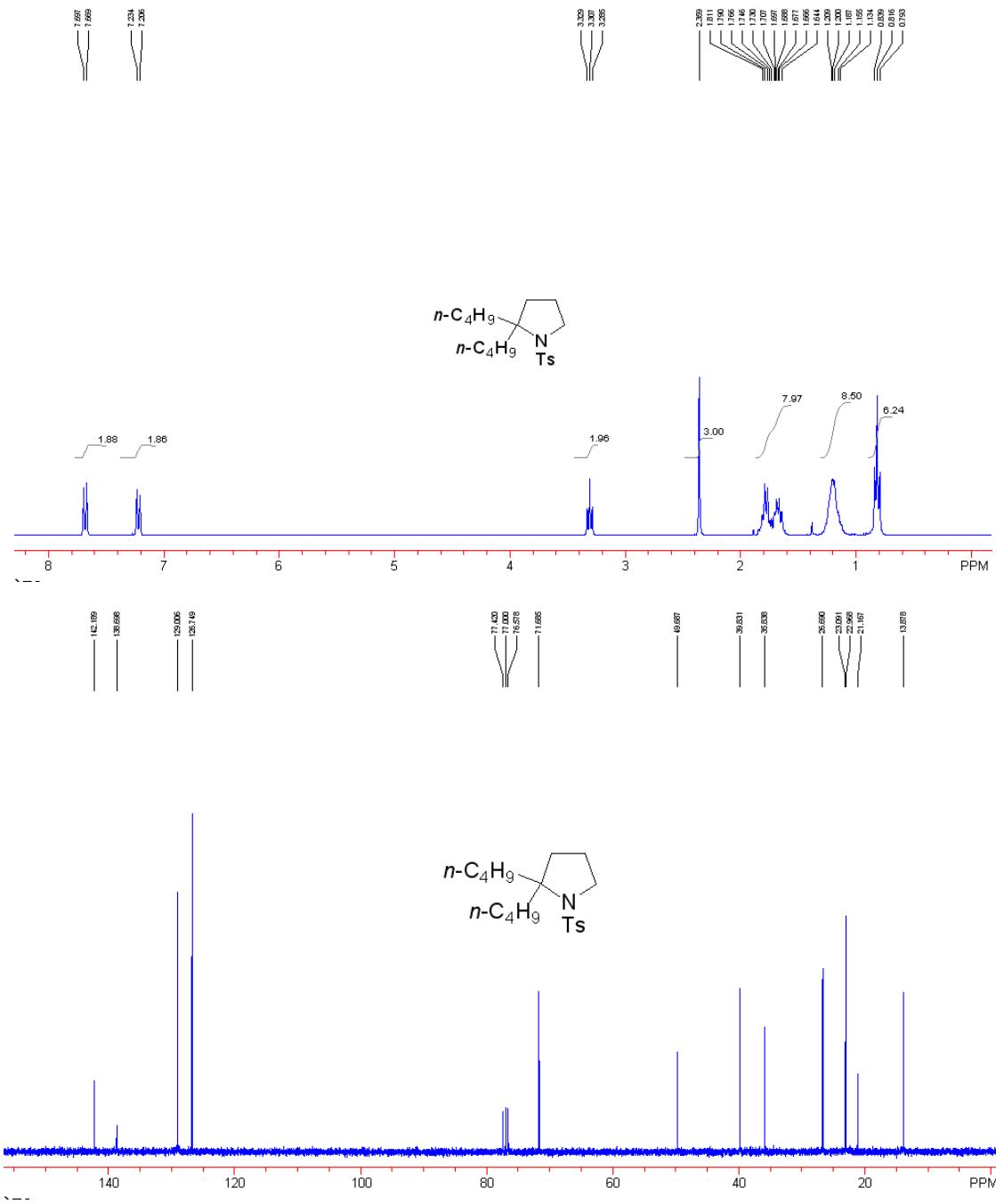
Compound **3k**, 2-(3-bromophenyl)-2-methyl-1-tosylpyrrolidine: a white solid, m.p. 96-98 °C; IR (KBr) ν 2976, 1595, 1474, 1337, 1155, 1093, 814, 665 cm⁻¹; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 1.77-2.13 (4H, m, CH₂), 1.87 (3H, s, CH₃), 2.41 (3H, s, CH₃), 3.55-3.69 (2H, m, NCH₂), 7.14-7.26 (3H, m, Ar), 7.32-7.40 (3H, m, Ar), 7.53-7.57 (2H, m, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 21.4, 22.5, 26.2, 45.8, 49.7, 69.1, 122.3, 124.6, 126.9, 129.0, 129.3, 129.5, 129.7, 137.9, 142.8, 148.8; MS (EI) *m/z* 395 (M⁺, 8), 393 (10), 380 (25), 238 (46), 155 (57), 91 (100); HRMS (EI) Calcd. for C₁₈H₂₀BrNO₂S requires 395.0378, Found: 395.0371.





3I, 2,2-di-*n*-butyl-1-tosylpyrrolidine

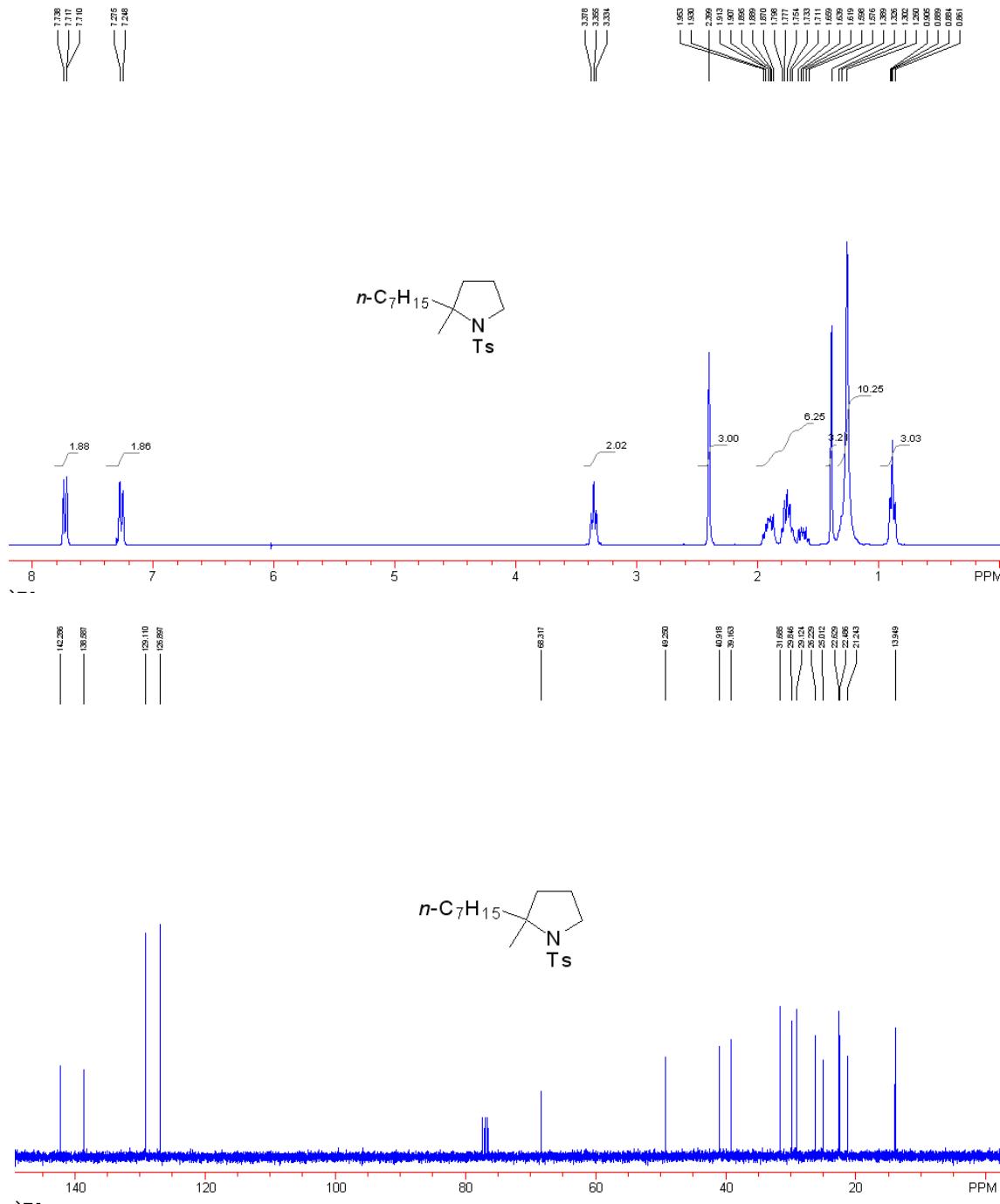
Compound **3I**, 2,2-di-*n*-butyl-1-tosylpyrrolidine³: a colorless oil; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 0.82 (6H, t, *J* = 6.9 Hz, CH₃), 1.13-1.21 (8H, m, CH₂), 1.64-1.81 (8H, m, CH₂), 2.36 (3H, s, CH₃), 3.31 (2H, t, *J* = 6.6 Hz, NCH₂), 7.22 (2H, t, *J* = 8.4 Hz, Ar), 7.68 (2H, t, *J* = 8.4 Hz, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 13.9, 21.2, 23.0, 23.1, 26.7, 35.8, 39.8, 49.7, 71.7, 126.7, 129.0, 138.7, 142.2.

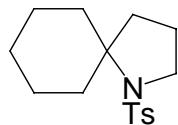


3m, 2-methyl-2-*n*-heptyl-1-tosylpyrrolidine

Compound **3m**, 2-methyl-2-*n*-heptyl-1-tosylpyrrolidine³: a colorless oil; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 0.88 (3H, t, *J* = 6.9 Hz, CH₃), 1.15-1.32 (10H, m, CH₂), 1.39 (3H, s, CH₃), 1.58-1.96 (6H, m,

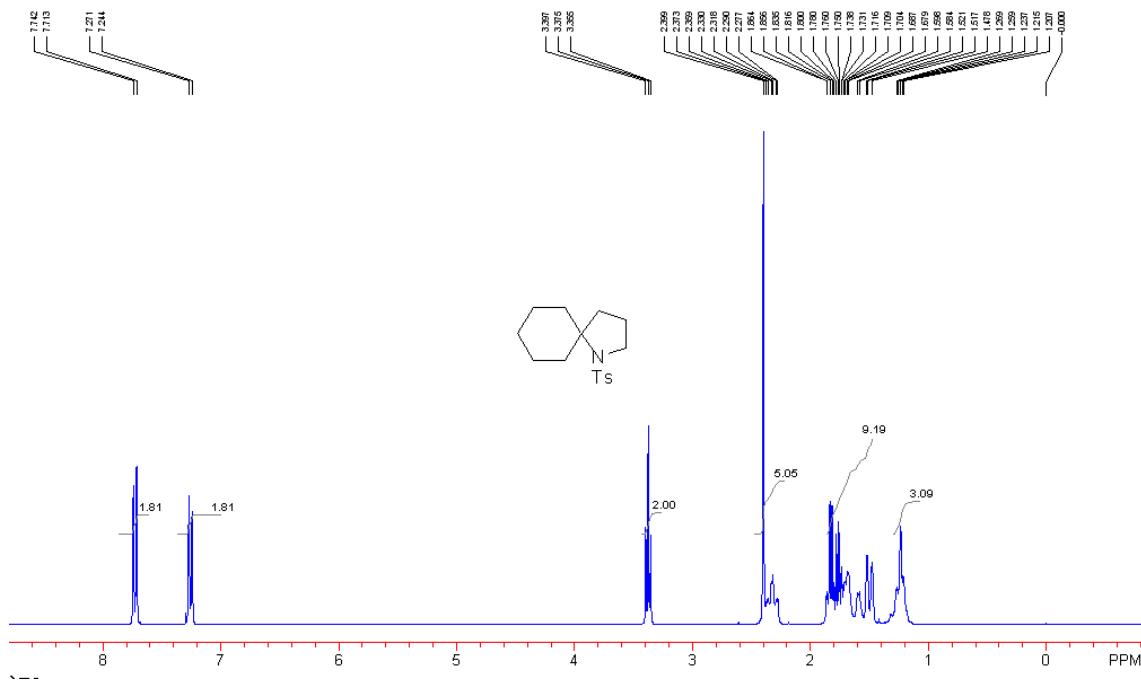
CH_2), 2.40 (3H, s, CH_3), 3.36 (2H, t, $J = 6.6$ Hz, NCH_2), 7.26 (2H, d, $J = 8.1$ Hz, Ar), 7.72 (2H, d, $J = 8.1$ Hz, Ar); ^{13}C NMR (CDCl_3 , 75 MHz, TMS) δ 14.0, 21.3, 22.5, 22.6, 25.0, 26.2, 29.1, 29.9, 31.7, 39.2, 40.9, 68.3, 126.9, 129.1, 138.6, 142.3.

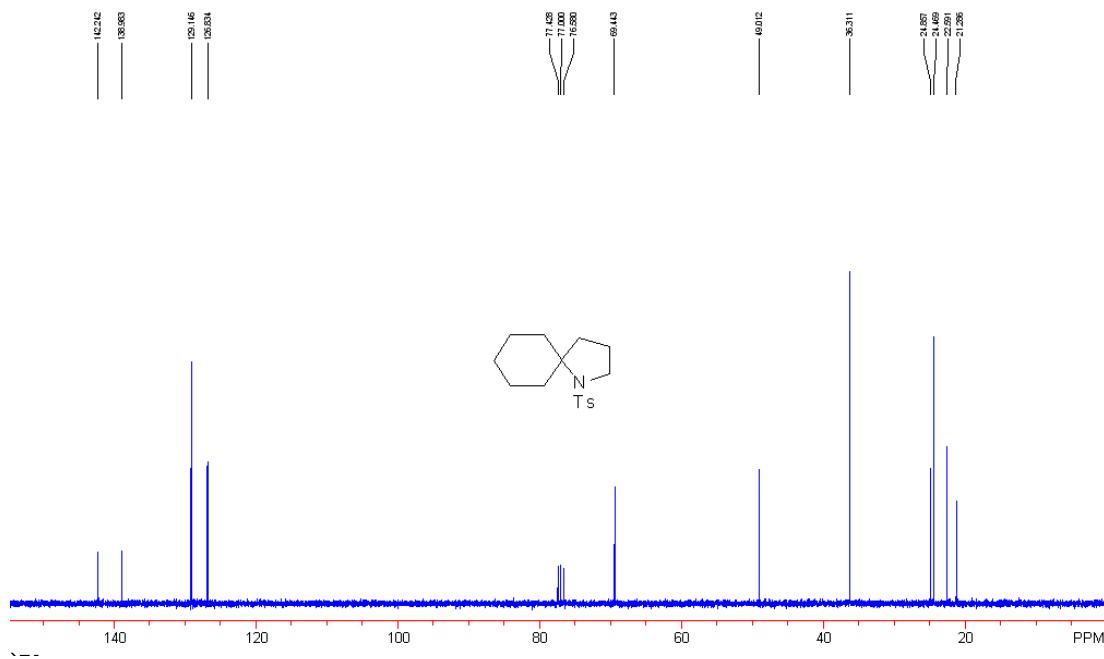




3n, 1-tosyl-1-aza-spiro[4,5]decane

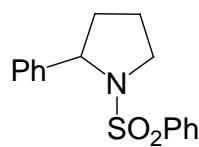
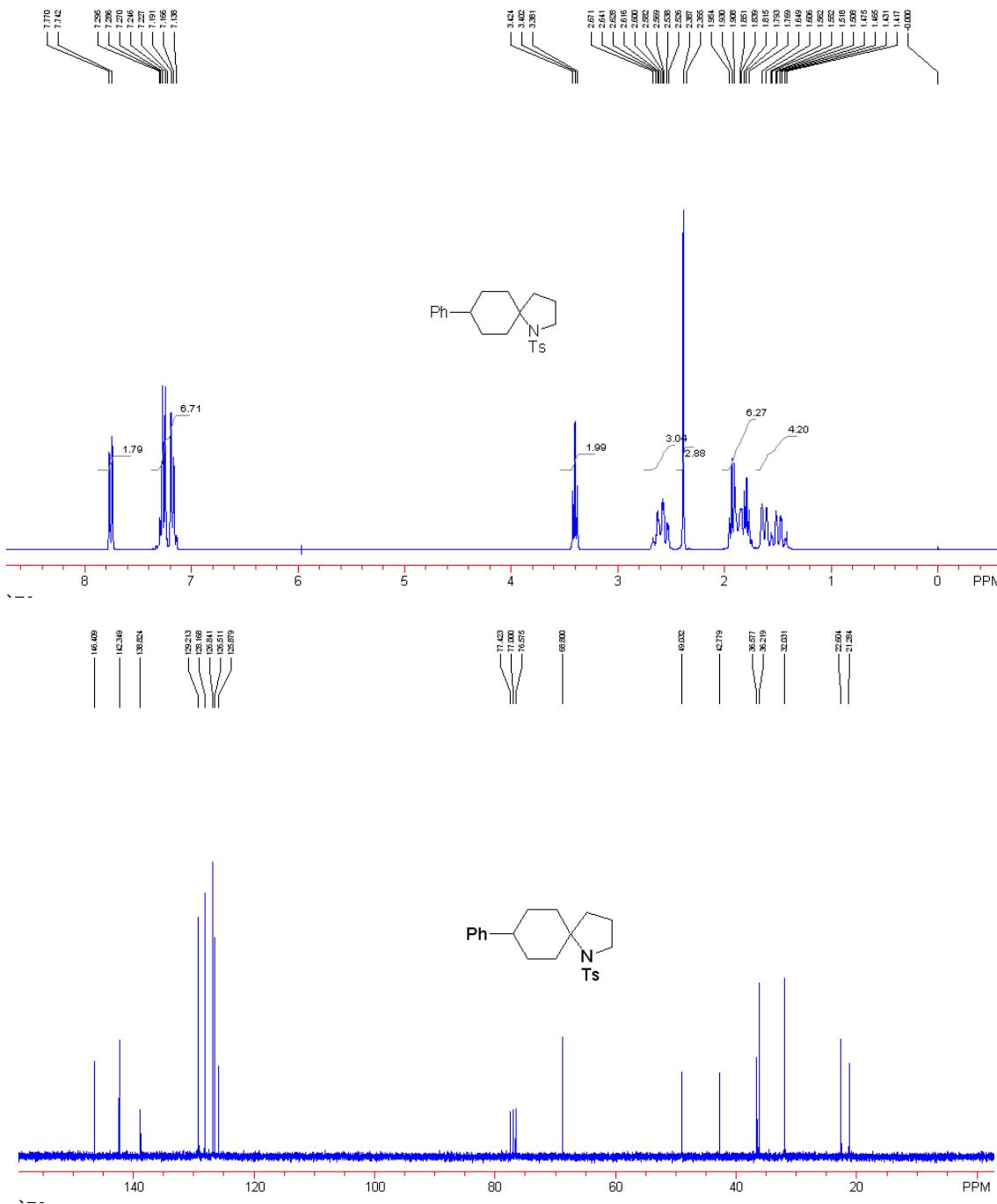
Compound **3n**, 1-tosyl-1-aza-spiro[4,5]decane³: a white solid, m.p. 106-108 °C; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 1.21-1.27 (3H, m, CH₂), 1.48-1.86 (9H, m, CH₂), 2.33 (2H, dt, *J* = 3.6, 12.0 Hz, CH₂), 2.40 (3H, s, CH₃), 3.38 (2H, t, *J* = 6.3 Hz, NCH₂), 7.26 (2H, d, *J* = 8.4 Hz, Ar), 7.73 (2H, d, *J* = 8.4 Hz, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 21.3, 22.6, 24.5, 24.8, 36.3 (2C), 49.0, 69.4, 126.8, 129.1, 139.0, 142.2.





3o, 1-tosyl-7-phenyl-1-aza-spiro[4,5]decane

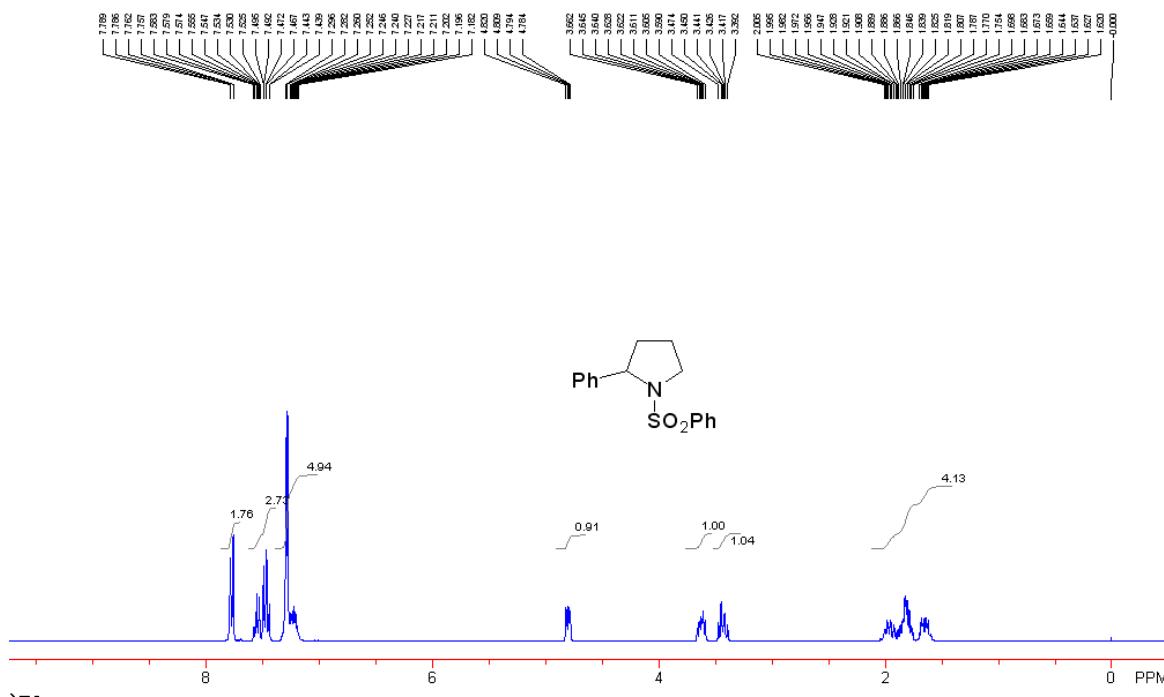
Compound **3o**, 1-tosyl-7-phenyl-1-aza-spiro[4,5]decane³: a white solid, m.p. 152-154 °C; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 1.42-1.65 (4H, m, CH₂), 1.77-1.95 (6H, m, CH₂), 2.39 (3H, s, CH₃), 2.53-2.67 (3H, m, CH₂), 3.40 (2H, t, *J* = 6.6 Hz, NCH₂), 7.14-7.30 (7H, m, Ar), 7.76 (2H, d, *J* = 8.4 Hz, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 21.3, 22.6, 32.0, 36.2, 36.6, 42.8, 49.0, 68.8, 125.9, 126.5, 126.8, 128.2, 129.2, 138.8, 142.4, 146.4.

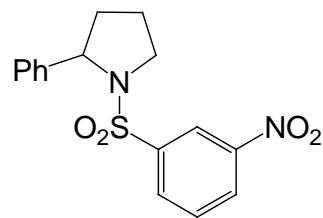
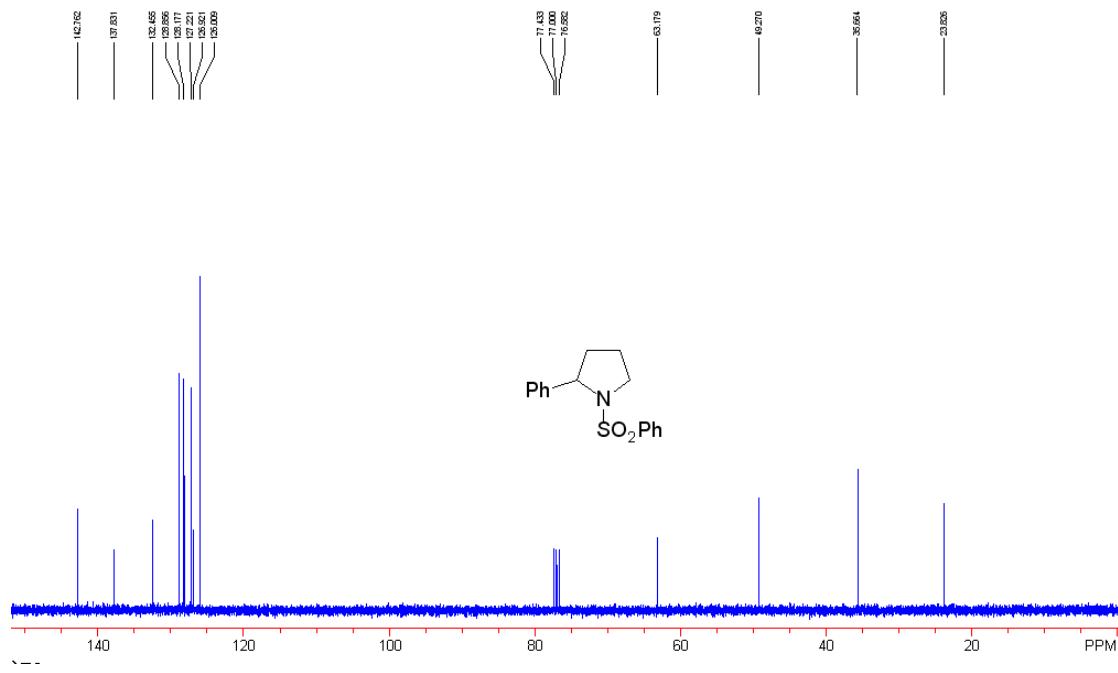


3p, 2-phenyl-1-(phenylsulfonyl)pyrrolidine

Compound **3p**, 2-phenyl-1-(phenylsulfonyl)pyrrolidine: a white solid; m.p. 112–114 °C; IR (KBr) v

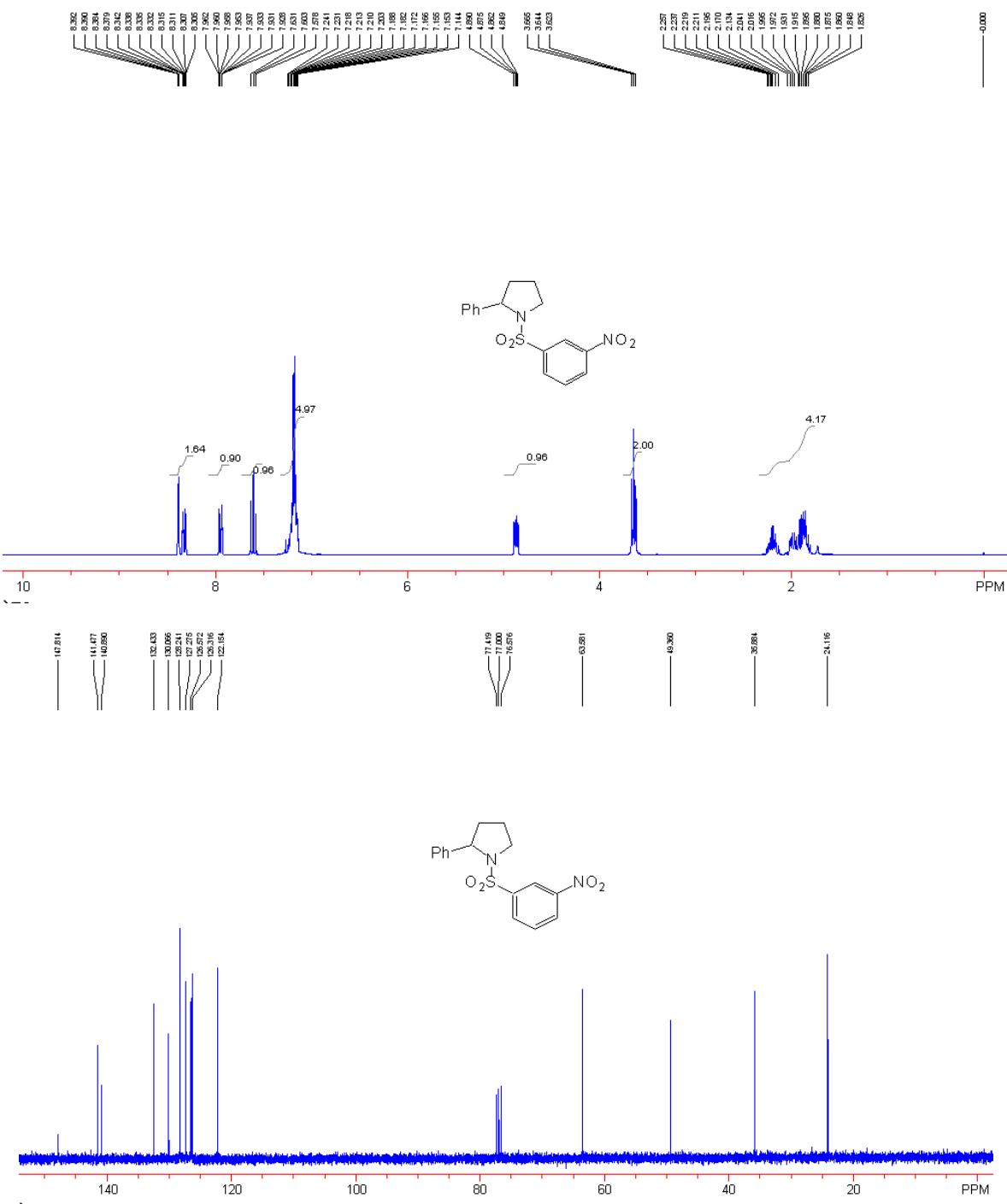
3056, 1607, 1440, 1337, 1153, 1006, 842, 760 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz, TMS) δ 1.62-2.01 (4H, m, CH_2), 3.39-3.47 (1H, m, NCH_2), 3.59-3.66 (1H, m, NCH_2), 4.80 (1H, dd, J = 3.3, 7.5 Hz, NCH), 7.18-7.30 (5H, m, Ar), 7.44-7.58 (3H, m, Ar), 7.76-7.79 (2H, m, Ar); ^{13}C NMR (CDCl_3 , 75 MHz, TMS) δ 23.8, 35.7, 49.3, 63.2, 126.0, 126.9, 127.2, 128.2, 128.9, 132.5, 137.8, 142.8. MS (EI) m/z 287 (M^+ , 4), 210 (35), 146 (80), 77 (100); Anal. Calcd. for $\text{C}_{16}\text{H}_{17}\text{NO}_2\text{S}$ requires C, 66.87; H, 5.96, N, 4.87%. Found: C, 67.05; H, 6.18, N, 4.97%.

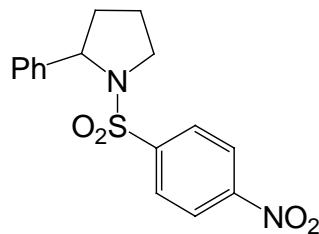




3q, 1-(3-nitrophenylsulfonyl)-2-phenylpyrrolidine

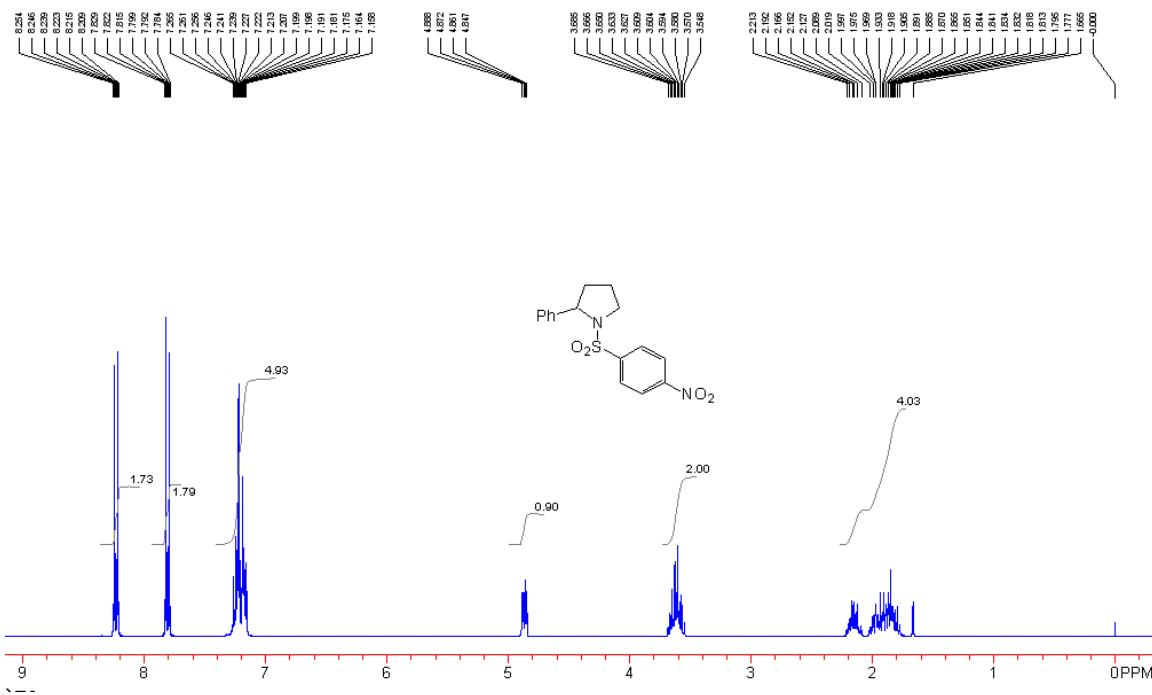
Compound **3q**, 1-(3-nitrophenylsulfonyl)-2-phenylpyrrolidine: a yellow oil; IR (KBr) ν 3088, 2977, 1605, 1532, 1353, 1167, 1074, 878, 601 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz, TMS) δ 1.83-2.26 (4H, m, CH_2), 3.64 (2H, t, J = 6.9 Hz, NCH_2), 4.87 (1H, dd, J = 4.5, 8.1 Hz, NCH), 7.14-7.23 (5H, m, Ar), 7.60 (1H, t, J = 8.1 Hz, Ar), 7.93-7.96 (1H, m, Ar), 8.31-8.39 (2H, m, Ar); ^{13}C NMR (CDCl_3 , 75 MHz, TMS) δ 24.1, 35.9, 49.4, 122.2, 126.3, 126.6, 127.3, 128.3, 130.1, 132.4, 140.9, 141.5, 147.8; MS (EI) m/z 332 (M^+ , 10), 255 (42), 185 (16), 146 (100), 117 (53); HRMS (EI) Calcd. for $\text{C}_{16}\text{H}_{16}\text{N}_2\text{O}_4\text{S}$ requires 332.0831, Found: 332.0829.

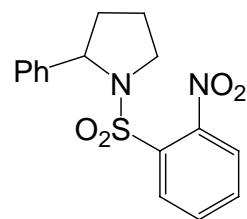
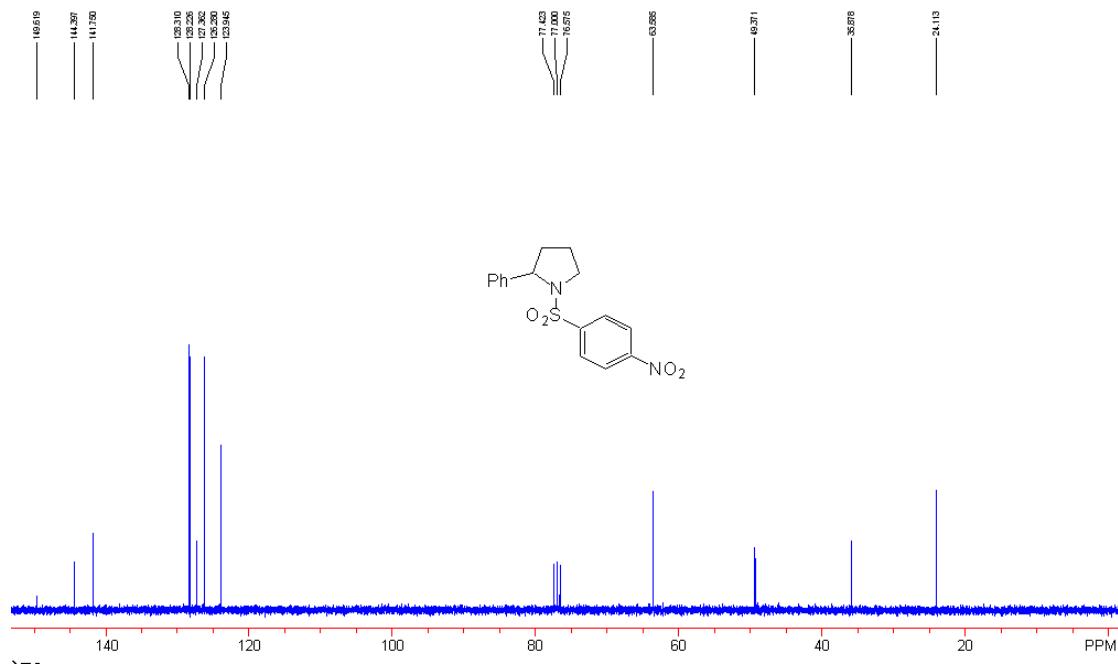




3r, 1-(4-nitrophenylsulfonyl)-2-phenylpyrrolidine

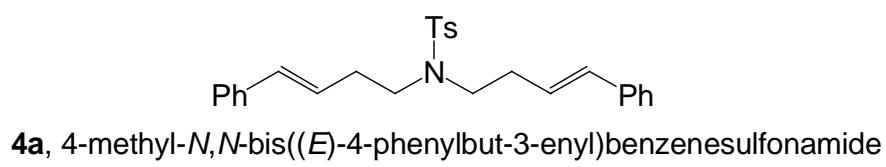
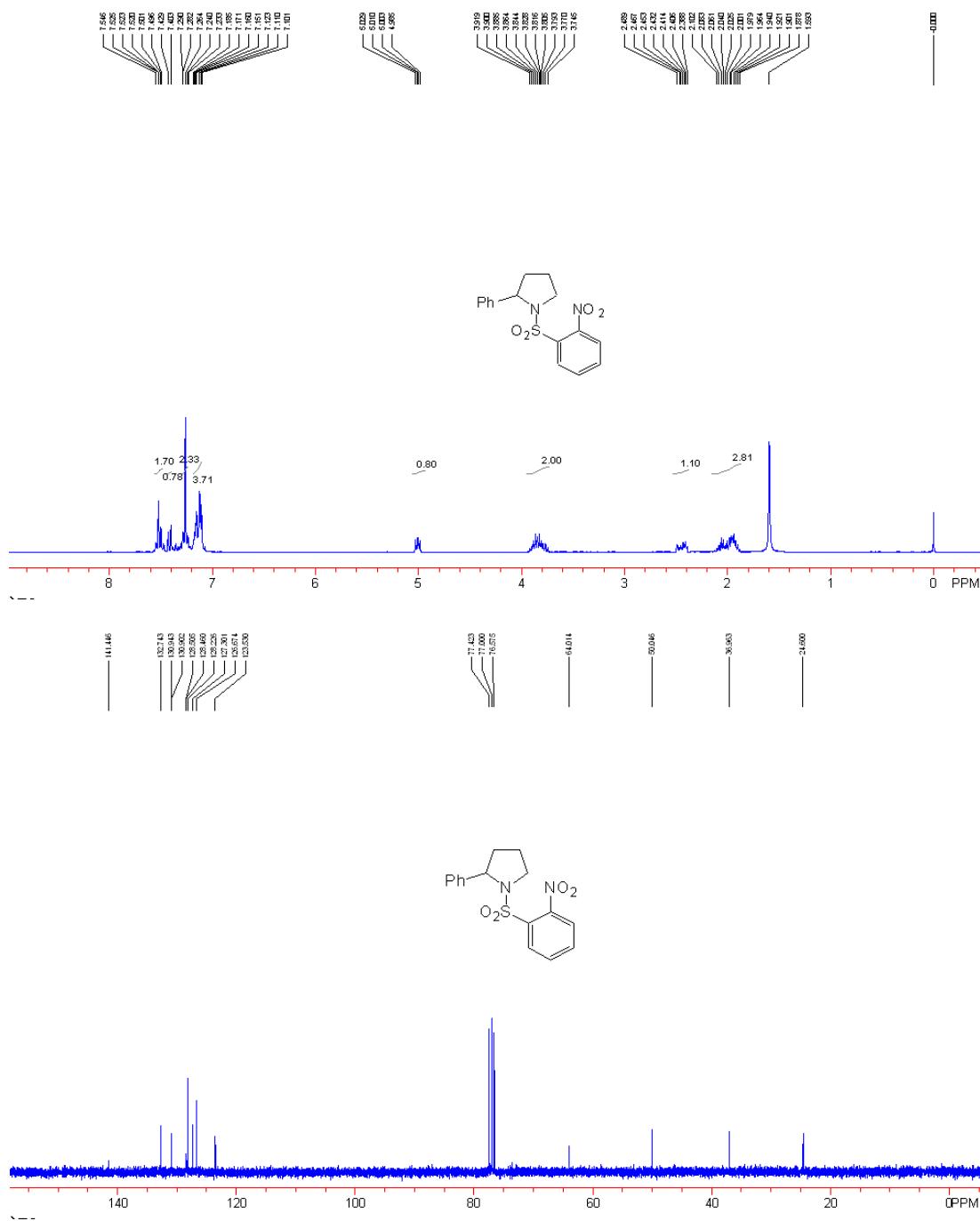
Compound **3r**, 1-(4-nitrophenylsulfonyl)-2-phenylpyrrolidine²: a white solid, m.p. 130-132 °C; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 1.78-2.21 (4H, m, CH₂), 3.55-3.69 (2H, m, NCH₂), 4.87 (1H, dd, J = 4.5, 8.4 Hz, NCH), 7.16-7.27 (5H, m, Ar), 7.78-7.83 (2H, m, Ar), 8.21-8.25 (2H, m, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 24.1, 35.9, 49.4, 63.6, 123.9, 126.3, 127.4, 128.2, 128.3, 141.8, 144.4, 149.6.





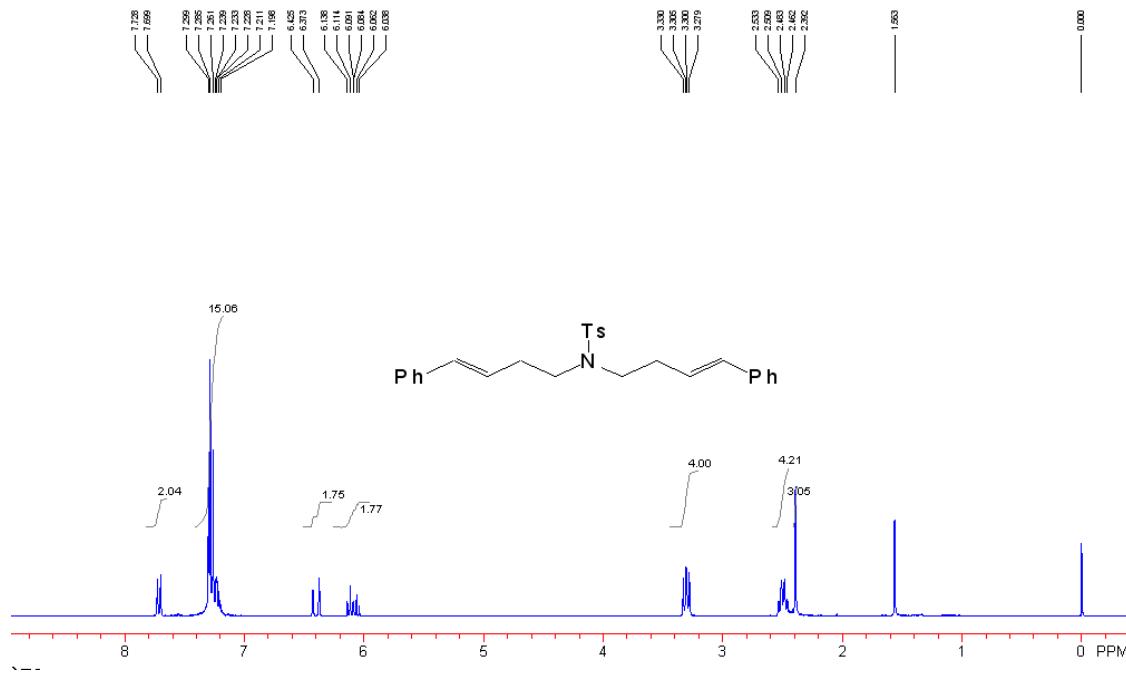
3s, 1-(2-nitrophenylsulfonyl)-2-phenylpyrrolidine

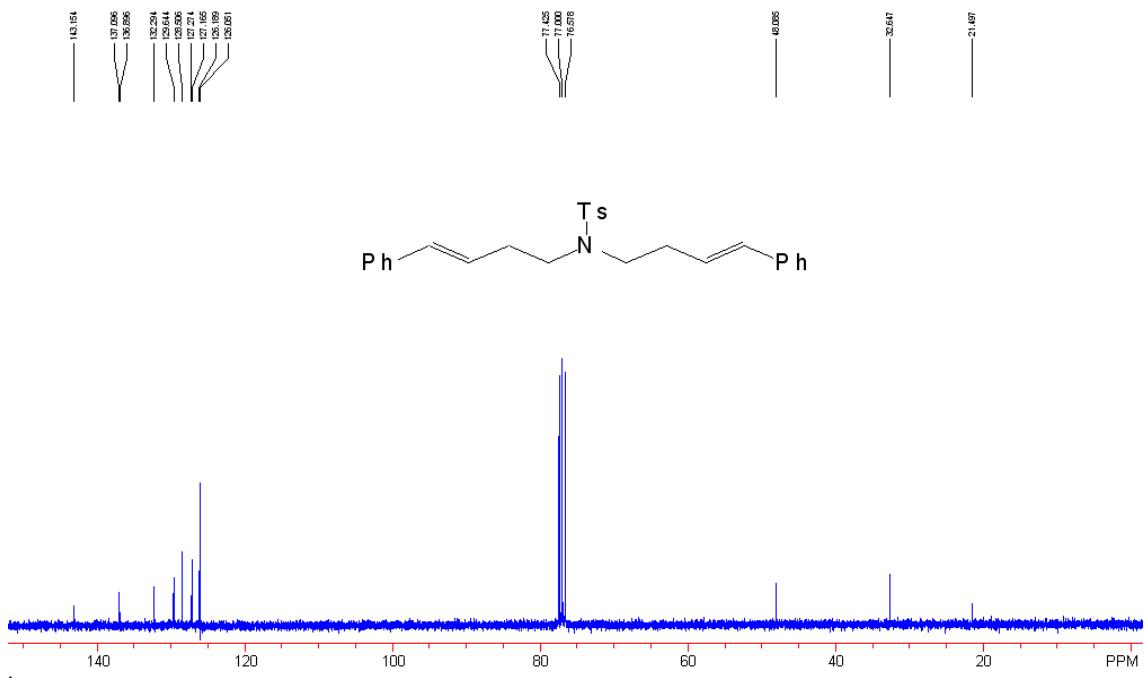
Compound **3s**, 1-(2-nitrophenylsulfonyl)-2-phenylpyrrolidine: a yellow oil; IR (KBr) ν 2924, 1542, 1371, 1161, 1127, 1078, 700 cm⁻¹; ¹H NMR (CDCl₃, 300 MHz, TMS) δ 1.88-2.10 (3H, m, CH₂), 2.39-2.49 (1H, m, CH₂), 3.75-3.92 (2H, m, NCH₂), 5.01 (1H, dd, *J* = 5.7, 7.5 Hz, NCH), 7.10-7.19 (4H, m, Ar), 7.23-7.29 (2H, m, Ar), 7.40-7.43 (1H, m, Ar), 7.50-7.55 (2H, m, Ar); ¹³C NMR (CDCl₃, 75 MHz, TMS) δ 24.6, 37.0, 50.0, 64.0, 123.5, 126.7, 127.3, 128.2, 128.46, 128.51, 130.90, 130.94, 132.7, 141.4; MS (EI) *m/z* 332 (M⁺, 4), 315 (20), 186 (38), 146 (55), 117 (100), 91 (92); HRMS (EI) Calcd. for C₁₆H₁₆N₂O₄S requires 332.0831, Found: 332.0830.



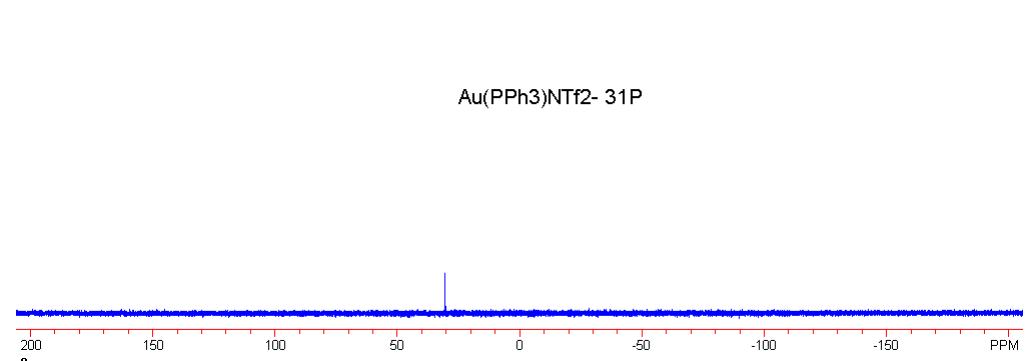
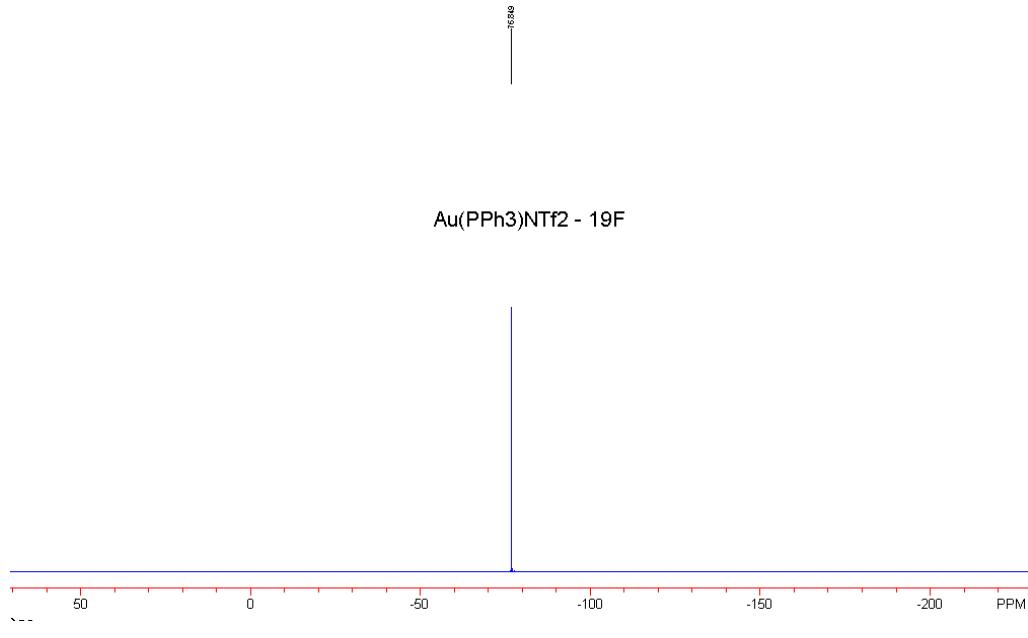
Compound **4a**, 4-methyl-N,N-bis((E)-4-phenylbut-3-enyl)benzenesulfonamide: a colorless oil; IR

(KBr) ν 3025, 2925, 1598, 1494, 1340, 1156, 1090, 966, 815, 694 cm^{-1} ; ^1H NMR (CDCl_3 , 300 MHz, TMS) δ 2.39 (3H, s, CH_3), 2.50 (4H, q, $J = 7.2$ Hz, 2 CH_2), 3.30 (4H, t, $J = 7.2$ Hz, 2 CH_2), 6.09 (2H, dt, $J = 15.9, 6.9$ Hz, 2=CH), 6.40 (2H, d, $J = 15.9$ Hz, 2=CH), 7.20-7.30 (12H, m, Ar), 7.71 (2H, d, $J = 8.4$ Hz, Ar); ^{13}C NMR (CDCl_3 , 75 MHz, TMS) δ 21.5, 32.6, 48.1, 126.1, 126.2, 127.2, 127.3, 128.5, 129.7, 132.3, 136.9, 137.1, 143.2; MS (EI) m/z 431 (M^+ , 5), 388 (8), 314 (34), 260 (12), 184 (12), 155 (30), 91 (100); HRMS (EI) Calcd. for $\text{C}_{27}\text{H}_{29}\text{NO}_2\text{S}$ requires 431.1919, Found: 431.1919.





Au(PPh₃)NTf₂, a white solid. ¹⁹F NMR (CDCl₃, 282 MHz, CFCl₃) δ -76.8; ³¹P NMR (CH₂Cl₂, 121 MHz, 85% H₃PO₄) δ 30.5.



References:

1. Tamaru, Y.; Hojo, M.; Kawamura, S.; Yoshida, Z. *J. Org. Chem.* **1986**, *51*, 4089-4090.
2. Schlummer, B.; Hartwig, J. F. *Org. Lett.* **2002**, *4*, 1471-1474.
3. Chen, Y.; Shi, M. *J. Org. Chem.* **2004**, *69*, 426-431.